TUGAS AKHIR – MN 184802

REKONSTRUKSI DESAIN LAYAR UNTUK PERAHU KUNO PUNJULHARJO

Zulfikar Bisma Wicaksana
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Dosen Pembimbing
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DEPARTEMEN TEKNIK PERKAPALAN
FAKULTAS TEKNOLOGI KELAUTAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
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2020

FINAL PROJECT – MN 184802

RECONSTRUCTION OF SAIL DESIGN FOR PUNJULHARJO BOAT

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DEPARTMENT OF NAVAL ARCHITECTURE
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SURABAYA
2020

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Memperoleh Gelar Sarjana Teknik
pada
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REKONSTRUKSI DESAIN LAYAR UNTUK PERAHU KUNO PUNJULHARJO

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Tanggal 23 Juli 2020

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SURABAYA, 9 AGUSTUS 2020

Dipersembahkan kepada seluruh keluarga.

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Puji syukur kepada Tuhan Yang Maha Esa, karena atas karunianya, Tugas Akhir ini dapat diselesaikan. Pada kesempatan ini Penulis ingin mengucapkan terima kasih kepada pihak-pihak yang membantu penyelesaian Tugas Akhir ini, yaitu:

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Surabaya, Agustus 2020

Penulis

REKONSTRUKSI DESAIN LAYAR UNTUK PERAHU KUNO PUNJULHARJO

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ABSTRAK

Perahu Kuno Punjulharjo merupakan salah satu kapal dengan teknologi *lashed-lug* yang ditemukan di Kepulauan Asia Tenggara. Perahu Kuno Punjulharjo, yang diperkirakan berasal dari abad ke-7 hingga ke-8 Masehi, diperkirakan menggunakan teknologi layar khas masyarakat Austronesia. Terdapat dua layar khas masyarakat Austronesia, yaitu layar madura dan layar tanja. Akan tetapi, pada situs temuan Perahu Kuno Punjulharjo, tidak ditemukan sisa-sisa dari layar. Maka dari itu, perlu dilakukan rekonstruksi desain layar untuk mengetahui layar yang digunakan oleh Perahu Kuno Punjulharjo serta kemampuan berlayarnya. Penentuan jenis layar dilakukan dengan metode ikonografi dan kajian pada catatan tekstual dari berbagai sumber sejarah. Ukuran layar didapatkan dengan menggunakan layar sejenis dari kapal lain sebagai data pembanding. Layar hasil rekonstruksi kemudian dianalisis untuk mendapatkan gaya yang akan menggerakkan kapal jika diaplikasikan pada Perahu Kuno Punjulharjo. Berdasarkan hasil rekonstruksi, jenis layar yang digunakan adalah layar tanja. *Sail plan* hasil rekonstruksi yang paling cocok digunakan oleh Perahu Kuno Punjulharjo adalah model Peledang dua layar, dengan ukuran *main sail* 8 × 4 m dan *mizzen sail* 5,016 × 2,508 m. Dengan *sail plan* tersebut, pada kecepatan angin rata-rata 16 knot, Perahu Kuno Punjulharjo memiliki kecepatan antara 2,5 knot hingga 6,5 knot, bergantung pada arah berlayarnya.

Kata kunci: Perahu Kuno Punjulharjo, Kapal Layar, Rekonstruksi, *Experimental Archaeology*

RECONSTRUCTION OF SAIL DESIGN FOR PUNJULHARJO BOAT

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ABSTRACT

Punjulharjo Boat is one of the boats that soared within Insular Southeast Asia that used lashed-lug technology. Dated around 7th to 8th CE, Punjulharjo Boat is predicted to had used Austronesian sail technology. There are two known types of Austronesian sails: madurese rig and tanja sail. But, there was no remains of its sail on the site where Punjulharjo Boat was found. Therefore, the reconstuction of its sail design is necessary to know the shape and its sailing performacne. Sail type is determined by examining of various historical records and iconography method. The dimension of the sail is obtained by comparing sails that have similar form from other ship. Then, the reconstructed sail is analysed to calculate its force, which will be used to propel the boat. Based on the reconstruction result, the sail type is tanja sail. The most suitable reconstructed sail plan for Punjulharjo Boat is two-masted Peledang, with the dimension of 8 × 4 m for its main sail and 5,016 × 2,508 m for its mizzen sail. With an average true wind speed of 16 knots, the sail plan gives Punjulharjo Boat a service speed that ranges between 2,5 knots and 6,5 knots, depending on its point of sail.

Keyword: Punjulharjo Boat, Sailing Ship, Reconstruction, Experimental Archaeology

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DAFTAR SIMBOL

L_{OA} = Panjang kapal secara keseluruhan (m)
L_{WL} = Panjang kapal pada garis air (m)
B = Lebar kapal tanpa kulit (m)
H = Tinggi kapal tanpa kulit (m)
T = Sarat kapal (m)
Δ = Berat *displacement* (ton)
g = Percepatan gravitasi (m/s^2)
V_T = Kecepatan *true wind* (kn)
V_A = Kecepatan *apparent wind* (kn)
V_S = Kecepatan kapal (kn)
γ = *Point of sail* (°)
β = *Apparent wind angle* (°)
A = Luas permukaan layar (m^2)
ρ_a = Massa jenis udara (kg/m^3)
ρ_w = Massa jenis air (kg/m^3)
F_D = *Drag* (N)
F_L = *Lift* (N)
C_D = Koefisien *drag*
C_L = Koefisien *lift*
α = *Angle of attack* (°)
F_{wind} = Gaya pada layar akibat angin (N)
F_{water} = Gaya pada kapal akibat air (N)
R = Hambatan kapal (N)
F_R = *Driving force* (N)
F_{LAT} = *Lateral force* (N)
CE = *Center of effort*
CLR = *Center of lateral resistance*
F_H = *Heeling force* (N)
τ_1 = Torsi akibat gaya arah melintang pada layar (Nm)
τ_2 = Torsi akibat gaya arah melintang pada lambung kapal (Nm)
τ_3 = Torsi akibat *displacement* (Nm)
h_1 = Jarak CE terhadap titik berat kapal (m)
h_2 = Jarak CLR terhadap titik berat kapal (m)
h = *Heeling arm* (m)
GZ = *Righting arm* (m)
θ = *Heeling angle* (°)
φ = Sudut antara arah gaya pada layar dengan *mast* (°)
M_H = *Heeling moment* (Nm)
M_R = *Righting moment* (Nm)

BAB 1
PENDAHULUAN

1.1. Latar Belakang Masalah

Pelayaran merupakan aktivitas yang telah dilakukan sejak lama oleh masyarakat di wilayah Asia Tenggara dan Pasifik, termasuk Indonesia. Hal ini ditunjukkan dari persebaran bahasa Malayo-Polynesia/Austronesia di wilayah tersebut. Wilayah Asia Tenggara dan Pasifik yang terdiri dari pulau-pulau menunjukkan bahwa persebaran tersebut tentu tidak dapat dilakukan tanpa aktivitas pelayaran. Selain itu, terdapat kemiripan dalam teknologi pelayaran tradisional yang dimiliki oleh masyarakat setempat. Hal ini ditunjukkan oleh bentuk kapal dan layar yang digunakan. Sebagai contoh, kapal bercadik yang terdapat di Asia Tenggara dan Pasifik menunjukkan bahwa kapal-kapal tersebut berkembang dari satu teknologi yang sama (Liebner, 2016).

Selain petunjuk di atas, di wilayah Asia Tenggara juga ditemukan sisa-sisa lambung kapal dengan bentuk yang identik. Salah satunya adalah Perahu Kuno Punjulharjo yang diperkirakan berasal dari abad ke-7 hingga ke-8 Masehi. Perahu Kuno Punjulharjo menunjukkan teknologi pembangunan lambung kapal yang digunakan masyarakat Kepulauan Asia Tenggara dari masa tersebut, yaitu dengan cara mengikat dan menggunakan pasak. Lajur kayu disusun membentuk lambung dengan cara mengikatkannya satu sama lain dan dikuatkan dengan pemasangan pasak di sisi-sisi lajur yang menempel. Gading kemudian diikatkan di dalam lambung yang telah terbentuk. Pembuatan lambung dengan cara ini dilakukan karena masyarakat Austronesia di masa tersebut belum mengenal paku, akan tetapi cara ini tetap digunakan dalam waktu yang lama (Lacsina, 2016).

Masyarakat Austronesia menggunakan layar untuk menggerakkan kapalnya. Terdapat dua jenis layar yang khas dari wilayah Austronesia, yaitu layar madura dan layar tanja. Layar madura berbentuk segitiga, sedangkan layar tanja berbentuk persegi panjang. Kedua layar ini dapat dipasang memanjang pada tiang utama, memungkinkan kapal bergerak ke arah datangnya angin (*windward*). Layar madura dan layar tanja telah digunakan sejak lama. Hal ini ditunjukkan oleh banyaknya catatan penjelajah yang menyebutkan soal layar tersebut (Liebner, 2002).

Dengan mempertimbangkan berbagai hal tersebut, diperkirakan Perahu Kuno Punjulharjo juga menggunakan teknologi layar yang serupa. Akan tetapi, tidak ditemukan sisa-sisa layar pada situs Perahu Kuno Punjulharjo. Untuk mengetahui jenis layar yang digunakan serta kemampuan berlayar dari Perahu Kuno Punjulharjo, maka perlu dilakukan rekonstruksi desain layar.

1.2. Perumusan Masalah

Berdasarkan latar belakang yang telah dijelaskan, masalah yang akan dikaji dalam Tugas Akhir ini adalah:

1. Bagaimana merekonstruksi jenis dan ukuran layar yang digunakan oleh Perahu Kuno Punjulharjo?
2. Bagaimana melakukan perhitungan teknis dari layar dan aplikasinya pada Perahu Kuno Punjulharjo?
3. Bagaimana membuat model tiga dimensi Perahu Kuno Punjulharjo beserta layar hasil rekonstruksi?

1.3. Tujuan

Berdasarkan perumusan masalah yang telah disebutkan, tujuan dari pengerjaan Tugas Akhir ini adalah:

1. Merekonstruksi jenis dan ukuran layar yang digunakan oleh Perahu Kuno Punjulharjo.
2. Melakukan perhitungan teknis dari layar dan aplikasinya pada Perahu Kuno Punjulharjo.
3. Membuat model tiga dimensi Perahu Kuno Punjulharjo beserta layar hasil rekonstruksi.

1.4. Batasan Masalah

Batasan masalah dalam pengerjaan Tugas Akhir ini adalah:

1. Tidak melakukan rekonstruksi desain lambung Perahu Kuno Punjulharjo.

1.5. Manfaat

Dari pengerjaan Tugas Akhir ini, diharapkan hasil sebagai berikut:

1. Bagi akademisi, Tugas Akhir ini diharapkan dapat membantu menunjang proses belajar mengajar dan dapat menjadi referensi bagi penelitian berikutnya.
2. Bagi praktisi, Tugas Akhir ini diharapkan dapat menjadi acuan dalam pembangunan ulang layar Perahu Kuno Punjulharjo.

1.6. Hipotesis

Rekonstruksi desain akan menghasilkan desain layar yang dapat digunakan sebagai sistem penggerak bagi Perahu Kuno Punjulharjo dan dapat dibuktikan melalui perhitungan teknis.

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BAB 2
STUDI LITERATUR

2.1. Dasar Teori

Layar merupakan salah satu sistem penggerak untuk kapal dan banyak digunakan sebelum mesin uap pertama kali ditemukan. Pada prinsipnya, kapal yang menggunakan layar sebagai penggerak memanfaatkan kecepatan angin untuk mendapatkan gaya dorong bagi kapal. Pemanfaatan angin untuk berlayar dapat dibagi berdasarkan arah angin terhadap kapal, yaitu *downwind*, di mana arah gerak kapal (*point of sail*) searah dengan arah angin, dan *upwind*, di mana kapal bergerak melawan arah angin.

2.1.1. *True Wind* dan *Apparent Wind*

Ketika berlayar, kecepatan angin yang dirasakan di atas kapal akan berbeda dalam keadaan *downwind* dan *upwind*. Hal ini terjadi karena kecepatan angin akan berbeda berdasarkan titik acuan relatifnya. Terdapat dua jenis kecepatan angin, yaitu kecepatan *true wind*, V_T, dan kecepatan *apparent wind*, V_A. Kecepatan *true wind* merupakan kecepatan angin yang relatif terhadap permukaan air laut. Kecepatan *apparent wind* merupakan kecepatan yang relatif terhadap kapal yang bergerak. Karena relatif terhadap kapal, kecepatan *apparent wind* dipengaruhi kecepatan kapal, V_S, yang relatif terhadap permukaan air laut. Interaksi antara ketiga kecepatan ini dapat dituliskan sebagai persamaan vektor

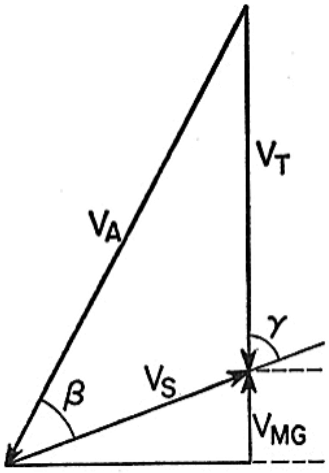
$$\overrightarrow{V_T} = \overrightarrow{V_A} + \overrightarrow{V_S} \quad (2.1)$$

Persamaan ini dapat digambarkan sebagai sebuah segitiga, dengan masing-masing sisi sepanjang V_T, V_A, dan V_S, seperti Gambar 2.1. Sudut yang terbentuk dari garis arah datangnya *true wind* dan arah gerak kapal disebut *true wind angle* atau *point of sail*, γ. Sudut ini menggambarkan arah gerak kapal terhadap arah datangnya angin. Kapal yang berlayar tepat menuju arah datangnya angin memiliki nilai $\gamma = 0°$, dan kapal yang berlayar mengikuti angin (*downwind*) memiliki nilai $\gamma = 180°$. Sudut yang terbentuk dari garis arah datangnya *apparent wind* dan arah gerak kapal disebut *apparent wind angle*, β. Dalam keadaan *downwind* dengan $\gamma = 180°$, kecepatan *apparent wind* dapat dihitung dengan

$$V_A = V_T - V_S \quad (2.2)$$

Hal ini membuat pelayaran dalam keadaan *downwind* mudah dijelaskan, namun kurang diminati untuk dilakukan (Kimball, 2010).

Pada kapal layar, angin yang mempengaruhi kondisi kapal merupakan *apparent wind*. Angin akan bekerja pada layar dengan kecepatan yang relatif terhadap layar tersebut, sedangkan layar bergerak bersama kapal dengan kecepatan kapal. Hal ini membuat gaya yang dihasilkan dari layar sangat bergantung pada nilai kecepatan *apparent wind* dan *apparent wind angle* (Kimball, 2010).



Gambar 2.1 Segitiga Kecepatan Kapal Layar
Sumber: Doran, 1972

2.1.2. *Downwind Sailing*

Dalam keadaan *downwind*, gaya yang bekerja pada kapal merupakan *drag* yang dihasilkan dari interaksi angin dengan layar. *Drag* merupakan gaya dengan arah yang sama dengan arah gerak angin. Karena kapal bergerak searah dengan arah angin, maka *drag* lah yang menggerakkan kapal. Pada awal perkembangannya, digunakan teori tumbukan untuk menjelaskan *drag* yang dihasilkan pada layar. Digambarkan bahwa angin tersusun dari sejumlah partikel udara dengan massa partikel m, yang bergerak dengan kecepatan V. Partikel tersebut akan kehilangan kecepatannya ketika ditangkap oleh layar. Pada proses ini partikel dan layar mengalami tumbukan, maka dalam suatu periode waktu t, partikel mengalami gaya dari layar yang membuat kecepatan relatifnya terhadap layar hilang. Partikel kemudian akan memberikan gaya reaksi dengan nilai yang sama besar ke arah yang berlawanan. Untuk satu partikel udara yang dihentikan, tumbukan yang terjadi dapat ditulis

$$t \cdot f = t \cdot ma \quad (2.3)$$

dengan a merupakan percepatan. Jika percepatan dikali dengan waktu, maka didapatkan

$$f = \frac{mV}{t} \quad (2.4)$$

Nilai f merupakan gaya yang dibutuhkan untuk satu partikel udara. Jika pada tumbukan terdapat partikel sejumlah N, maka seluruh gaya yang dibutuhkan, F_D, dapat ditulis sebagai

$F_D = N \cdot f$ ..... (2.5)

Jumlah partikel udara yang menumbuk layar didapatkan dari perkalian jumlah partikel udara per satuan volume dengan volume udara yang ditangkap oleh layar. Selama periode tumbukan, t, angin bergerak dengan kecepatan V menuju layar, menempuh suatu jarak bernilai Vt. Jika luas permukaan layar sebesar A, maka didapatkan volume udara yang ditangkap oleh layar sebesar

$Volume = A \cdot Vt$ ..... (2.6)

Nilai volume yang telah didapatkan dapat digunakan untuk menentukan nilai N. Jika volume dikalikan dengan jumlah partikel per satuan volume, nilai N dapat dituliskan sebagai

$N = A \cdot Vt \cdot jumlah/volume$ ..... (2.7)

Setiap partikel udara memiliki massa sebesar m. Maka, jika massa partikel dikalikan dengan jumlah partikel yang terdapat dalam suatu satuan volume, akan didapatkan massa jenis udara, ρ_a. Substitusi persamaan-persamaan yang telah didapat akan menghasilkan nilai F_D sebesar

$F_D = \rho_a \cdot A \cdot V^2$ ..... (2.8)

Gaya ini lah yang akan mendorong layar. Semakin luas permukaan layar sehingga banyak partikel yang tertangkap dan memberikan gaya reaksi, atau semakin besar kecepatan awal yang dimiliki partikel, maka gaya yang diterima oleh layar semakin besar (Kimball, 2010).

Seiring dengan berkembangnya ilmu tentang mekanika fluida, diketahui bahwa gerakan fluida merupakan sesuatu yang kompleks. Konsep tumbukan yang digunakan kejadian angin yang bekerja pada layar menjadi kurang sesuai dan dikembangkan menjadi bentuk yang baru. Persamaan gaya yang dihasilkan dituliskan sebagai

$F_D = \frac{C_D}{2} \rho_a \cdot A \cdot V^2$ ..... (2.9)

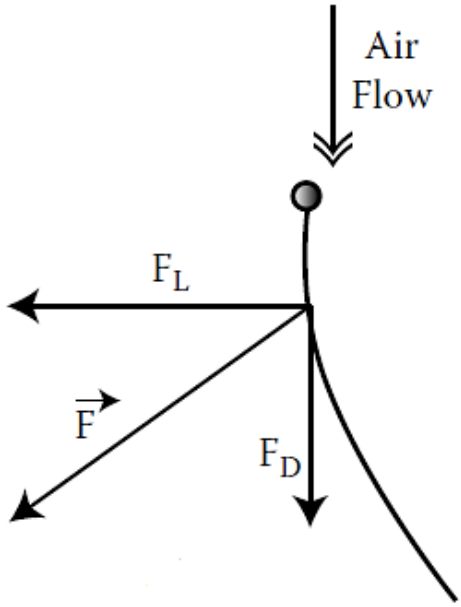
dengan koefisien *drag*, C_D, sebagai koreksi untuk teori tumbukan yang sebelumnya digunakan. Nilai C_D akan menggambarkan pengaruh bentuk benda pada aliran fluida terhadap gaya yang dihasilkan. Sebagai contoh, benda dengan bentuk yang *streamline* akan menghasikan koefisien yang lebih kecil dibanding benda yang berbentuk cembung. Dalam penggunaannya pada pelayaran, peningkatan nilai C_D dari layar cenderung berdampak positif karena akan meningkatkan kecepatan berlayar dalam keadaan *downwind* (Kimball, 2010).

Terdapat keterbatasan dalam pelayaran *downwind*. Kapal yang berlayar dalam keadaan *downwind* tidak dapat berlayar dalam kecepatan yang melebihi kecepatan angin. Hal ini terjadi karena ketika kapal mencapai kecepatan angin, tidak akan ada angin yang dirasakan pada kapal. Layar akan bergerak beriringan dengan partikel udara pada angin, sehingga tidak ada gaya yang dihasilkan pada layar. Sebesar apa pun layar yang digunakan, seringan apa pun kapal yang

berlayar, berlayar lebih cepat dari kecepatan angin dalam keadaan *downwind* tidak mungkin dilakukan (Kimball, 2010).

2.1.3. *Upwind Sailing*

Dalam keadaan *upwind*, kapal mengalami dua gaya, yaitu *drag* dan *lift*. *Lift* merupakan gaya dengan arah yang tegak lurus terhadap arah *drag*, seperti yang terlihat pada Gambar 2.2. *Lift* dapat terjadi karena dalam keadaan ini layar berperan seperti *foil*. Terdapat sudut yang dibentuk antara arah angin yang bergerak di sekitar layar dengan *chord line* (garis lurus antara dua tepi) pada layar, yang disebut *angle of attack*, α. Sudut ini membelokkan aliran angin, membuat angin yang melewati sisi layar yang menghadap arah angin (*windward*) memiliki kecepatan yang lebih rendah dibandingkan dengan angin yang melewati sisi layar sebaliknya (*leeward*). Perbedaan kecepatan membuat kedua sisi memiliki tekanan yang berbeda, di mana tekanan pada sisi *windward* lebih besar. Perbedaan tekanan tersebut membuat layar mengalami gaya *lift* (Anderson, 2008).



Gambar 2.2 Gaya pada Layar dalam Keadaan *Upwind*
Sumber: Kimball, 2010

Seperti *drag*, koreksi untuk teori tumbukan pada fenomena terjadinya *lift* digambarkan dengan koefisien *lift*, C_L. Total gaya *lift* yang dihasilkan pada layar, F_L, dapat dituliskan sebagai

$$F_L = \frac{C_L}{2}\rho_a \cdot A \cdot V^2 \quad (2.10)$$

dengan A merupakan luas layar dan V merupakan kecepatan angin. Koefisien pada layar, baik C_L maupun C_D, merupakan penyederhanaan dari rumitnya interaksi antara benda dengan fluida,

dalam hal ini layar dengan aliran udara. Posisi layar terhadap arah angin akan menghasilkan *lift* dan *drag* yang berbeda, sehingga nilai C_L dan C_D akan dipengaruhi oleh *angle of attack*. Dalam keadaan *downwind* di mana layar diposisikan tegak lurus dengan arah angin ($\alpha = 90°$), tidak ada *lift* yang dihasilkan, sehingga nilai $C_L = 0$ (Kimball, 2010).

Pada keadaan *downwind*, arah gerak kapal sama dengan arah gerak angin, sehingga *drag* akan langsung menjadi gaya dorong bagi kapal. Namun pada keadaan *upwind*, arah gerak kapal dan arah angin berbeda, sehingga *lift* dan *drag* yang dihasilkan dapat berbeda pula dengan arah gerak kapal. Untuk mendapatkan gaya dorong, *lift* dan *drag* pada layar akan diproyeksikan untuk mendapatkan komponen gaya yang arahnya paralel dengan *centerline* kapal. Akan tetapi, *lift* dan *drag* juga akan menghasilkan gaya yang arahnya tegak lurus terhadap *centerline* kapal. Karena kapal mengalami gaya ke arah melintang, maka gerakan kapal tidak benar-benar searah *centerline* (Kimball, 2010).

2.1.4. Gaya pada Kapal Layar

Interaksi layar dengan angin akan menghasilkan gaya berupa *drag* dan *lift*, yang merupakan komponen dari gaya yang dihasilkan oleh angin secara keseluruhan, F_{wind}. F_{wind} merupakan gaya yang berfungsi untuk menggerakkan kapal. Sementara itu, lambung kapal yang bergerak di air juga menghasilkan gaya, F_{water}. F_{water} dihasilkan dari seluruh bagian kapal yang berada di bawah permukaan air. Ketika kapal bergerak dalam keadaan konstan, maka keseluruhan gaya yang bekerja pada kapal dapat dituliskan

$$\overrightarrow{F_{wind}} + \overrightarrow{F_{water}} = 0 \quad (2.11)$$

F_{water} berfungsi sebagai gaya yang melawan F_{wind}, sehingga kedua gaya akan saling meniadakan (Kimball, 2010).

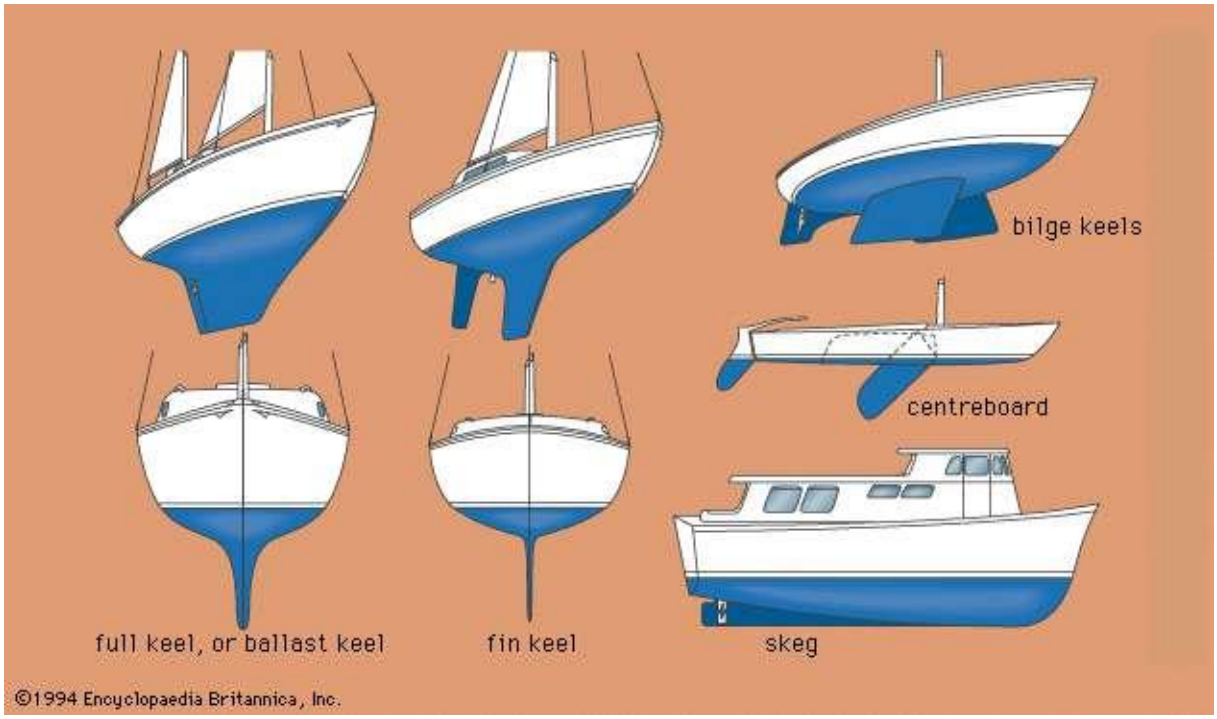
Gaya yang menentukan kecepatan kapal ketika berlayar merupakan *driving force*, F_R. F_R merupakan komponen gaya dari F_{wind} yang searah dengan arah gerak yang dituju oleh kapal. Gaya ini akan berlawanan dengan hambatan kapal (*hull resistance*), R, yang arahnya melawan arah gerak kapal. Ketika kapal mencapai kecepatan konstan, didapatkan persamaan

$$F_R = R \quad (2.12)$$

Berdasarkan hal ini, secara umum dapat dikatakan bahwa kapal layar akan berlayar lebih cepat jika memiliki layar yang lebih besar dan lambung yang ramping dengan permukaan basah yang lebih sedikit (Anderson, 2008).

Selain F_R, terdapat komponen gaya lain dari F_{wind}, yaitu *lateral force*. *Lateral force*, F_{LAT}, merupakan komponen gaya yang arahnya tegak lurus terhadap F_R. Karena arahnya yang

melintang terhadap *centerline*, maka kapal tidak benar-benar bergerak lurus menuju arah yang dituju. Kapal akan memiliki kecepatan dengan arah melintang menuju *leeward* yang disebut *leeway*. Sudut deviasi antara arah tujuan kapal dengan arah gerak kapal sesungguhnya disebut *leeway angle*. Arah gerak secara melintang yang terjadi pada kapal menghasilkan interaksi seperti *foil* antara lambung kapal dengan aliran air relatif terhadap kapal. Hal ini akan menghasilkan gaya melintang *lateral resistance* yang arahnya melawan F_{LAT}. *Lateral resistance* berfungsi untuk mengurangi *leeway*, mencegah kapal terbawa angin yang dapat menyebabkan kapal kehilangan kecepatan. Akan tetapi, bentuk lambung kapal secara keseluruhan tidak dirancang untuk bekerja sebagai sebuah *foil* yang efisien. Maka dari itu, *lateral resistance* harus dihasilkan dari bagian-bagian tambahan pada lambung kapal, seperti *fin keel*, *center-board*, atau *leeboard*, seperti pada Gambar 2.3. Bagian-bagian tadi dirancang untuk menghasilkan *lift* di air yang analog dengan *lift* pada layar, sehingga didapatkan *lateral resistance* yang dapat mengimbangi F_{LAT}. Hal ini akan menentukan bagaimana kemampuan sebuah kapal dalam berlayar (Satterthwaite, 1960).



Gambar 2.3 Bagian Tambahan pada Lambung Kapal
Sumber: www.britannica.com

2.1.5. *Heeling Force*

F_{wind} merupakan gaya yang dihasilkan dari sistem tekanan yang kompoleks pada layar akibat aliran udara yang melewatinya. Perbedaan tekanan yang terjadi pada seluruh permukaan layar digambarkan oleh resultan F_{wind} yang bekerja pada suatu titik pusat gaya, *center of effort*

(CE). Hal yang sama juga terjadi pada lambung kapal. Sistem tekanan kompleks yang terjadi pada lambung kapal akibat aliran air yang relatif terhadap kapal menghasilkan F_{water} yang bekerja pada suatu titik pusat gaya, *center of lateral resistance* (CLR). Letak CE berada pada titik pusat luasan dari penampang layar jika tekanan yang terjadi pada seluruh permukaan layar seragam, namun posisi CE yang sebenarnya dapat berbeda ketika dalam keadaan berlayar. Pada CLR, letak CLR secara konvensional digambarkan sebagai titik pusat luasan dari penampang tampak samping kapal yang berada di bawah permukaan air (*underwater profile*) (Satterthwaite, 1960).

Posisi CE pada layar akan selalu berada di atas posisi CLR pada lambung kapal. Hal ini membuat gaya ke arah melintang yang terjadi pada layar dan lambung kapal menghasilkan momen kopel yang menyebabkan *heeling*. Dalam keadaan setimbang, gaya dan momen yang dihasilkan dari aliran udara pada layar akan sama besar dengan gaya dan momen yang dihasilkan dari aliran air pada lambung kapal (Satterthwaite, 1960). Untuk meninjau kondisi momen pada kapal layar, kapal jenis katamaran akan digunakan sebagai contoh. Kapal layar katamaran memiliki lambung ganda dengan posisi tiang layar berada di tengah struktur penghubung kedua lambung, seperti pada Gambar 2.4. Stabilitas katamaran ditentukan oleh tiga momen gaya. Momen gaya pertama, τ_1, disebabkan oleh *heeling force*, gaya pada layar yang menyebabkan *heeling*, F_H. Jika letak CE berada pada jarak vertikal h_1 di atas titik berat kapal, maka momen yang terjadi adalah

$$\tau_1 = F_H \times h_1 \quad (2.13)$$

Momen gaya kedua, τ_2, disebabkan oleh gaya pada lambung kapal yang sama besar dan berlawanan arah dengan F_H. Jika letak CLR berada pada jarak vertikal h_2 di bawah titik berat kapal, maka momen yang terjadi adalah

$$\tau_2 = F_H \times h_2 \quad (2.14)$$

Momen gaya yang ketiga, τ_3, disebabkan oleh gaya angkat pada kapal, yang besarnya sama dengan gaya berat kapal. Jika diasumsikan kapal katamaran dalam keadaan salah satu lambungnya tepat akan terangkat dari permukaan air, maka gaya angkat hanya terjadi pada lambung di seberangnya. Jarak titik pusat gaya angkat terhadap titik berat kapal adalah setengah lebar kapal, sehingga besar momen yang terjadi adalah

$$\tau_3 = \Delta g \times \frac{B}{2} \quad (2.15)$$

dengan Δ merupakan berat *displacement* kapal, g merupakan percepatan gravitasi, dan B merupakan lebar kapal. Momen yang dihasilkan oleh gaya angkat kapal akan berperan sebagai

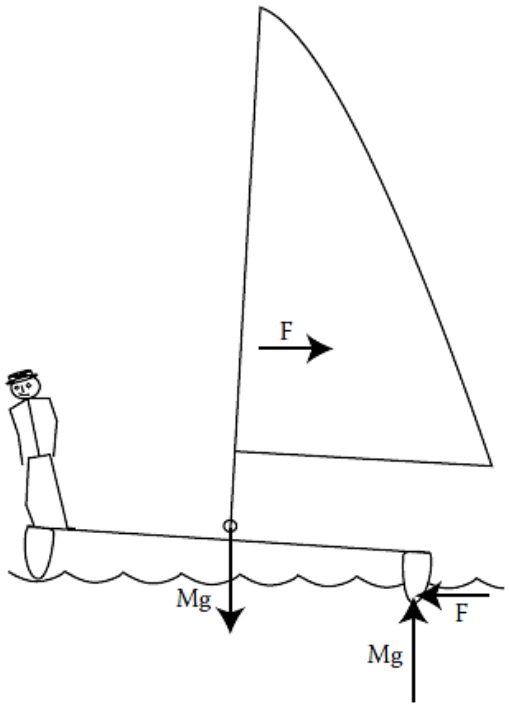
momen yang melawan *heeling*, atau disebut momen pembalik (*righting moment*, M_R). Kapal akan stabil jika total momen gaya yang bekerja sama dengan nol, sehingga dapat dituliskan

$\tau_1 + \tau_2 = \tau_3$ ..... (2.16)

Hal ini memungkinkan nilai F_H maksimum untuk katamaran dapat dihitung. Nilai F_H maksimum adalah

$F_{Hmax} = \frac{\Delta g \times B/2}{h_1 + h_2}$ ..... (2.17)

Jika angin pada layar menghasilkan F_H yang lebih besar dari nilai maksimum, maka kapal katamaran dapat mengalami *capsize* (Kimball, 2010).



Gambar 2.4 Kapal Layar Katamaran serta Momen yang Bekerja
Sumber: Kimball, 2010

Dibandingkan dengan kapal katamaran, potensi *capsize* merupakan masalah yang lebih serius pada kapal layar *monohull*. Pada kapal *monohull*, momen gaya yang dihasilkan oleh gaya angkat adalah

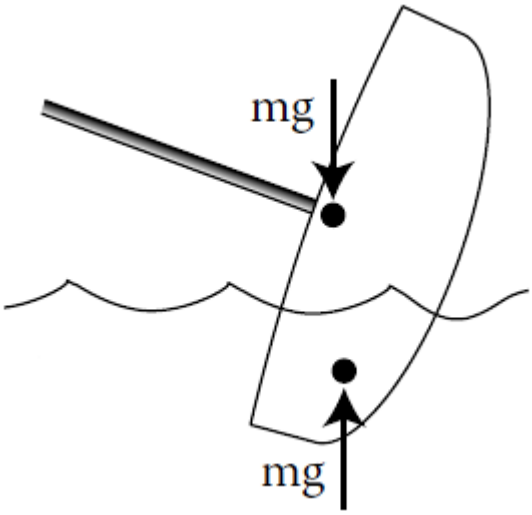
$\tau_3 = \Delta g \times GZ$ ..... (2.18)

dengan GZ merupakan jarak horizontal antara titik gaya angkat dan titik berat kapal. Lambung kapal yang lebih sempit membuat momen yang dihasilkan oleh gaya angkat kapal lebih kecil. Pada awal terjadinya *heeling*, nilai momen pembalik akan proporsional dengan sudut *heeling* (*heeling angle*), θ. Akan tetapi, pada suatu sudut tertentu, jarak antara titik berat dan titik gaya angkat kapal akan berkurang, seperti pada Gambar 2.5, sehingga nilai momen pembalik yang

dihasilkan akan semakin kecil. Hal ini dapat diukur pada kapal layar berukuran kecil dari percobaan secara langsung. Kapal layar yang sedang berlabuh dapat dibuat *capsize* dengan cara menarik tali yang diikatkan pada puncak tiangnya. Tali yang ditarik secara tegak lurus terhadap tiang kapal akan menghasilkan momen gaya dengan nilai yang mendekati hasil perkalian gaya tarik dengan tinggi tiang. Jika posisi tali terhadap tiang tidak tegak lurus dan membentuk sudut φ, maka gaya yang bekerja pada tiang untuk menghasilkan momen gaya adalah

$F_H = F \times \sin \varphi$ ..... (2.19)

Ketika kapal mulai mengalami *heeling*, momen pembalik akan meningkat, namun kemudian akan berkurang seiring dengan tiang kapal yang semakin mendekati posisi horizontal (Kimball, 2010).



Gambar 2.5 Letak Titik Berat dan Titik Gaya Angkat yang Semakin Dekat
Sumber: Kimball, 2010

2.1.6. *Experimental Archaeology*

Experimental archaeology merupakan praktik rekonstruksi yang dilakukan pada bangunan, teknologi, benda, dan hal lain berdasarkan bukti-bukti arkeologis. Rekonstruksi juga dapat dilakukan pada fungsi dan penggunaan dari benda-benda tersebut. Hal ini dilakukan untuk memahami karateristik dan peran dari berbagai benda tersebut dalam kehidupan manusia. Akan tetapi, tujuan yang ingin dicapai dari *experimental archaeology* dapat berbeda-beda tergantung dari para pelakunya. Praktik dalam *experimental archaeology* bervariasi, mulai dari percobaan tertutup di laboratorium, percobaan praktis di lapangan, hingga investigasi pada bangunan dan benda-benda. Semua itu merupakan cara yang valid untuk lebih memahami kehidupan manusia di masa lalu.

Experimental archaeology biasanya dilakukan dengan pendekatan ilmiah, berupa pengujian pada hipotesis dan pengumpulan data pada suatu topik tertentu. Pencarian solusi pada suatu permasalahan dari topik eksperimen diharapkan dapat membuat pelaku eksperimen lebih memahami bagaimana hal tersebut dilakukan di masa lalu. Seiring dengan berkembangnya ilmu arkeologi secara umum, *experimental archaeology* mulai melibatkan pendekatan interdisiplin meliputi pendekatan kognitif dan fenomenologi untuk mendapatkan pemahaman yang lebih sensitif mengenai perilaku manusia di masa lalu (O'Sullivan & Souyoudzoglou-Haywood, 2017).

Gambar 2.6 Kapal Borobudur
Sumber: Burningham, 2005

Salah satu contoh *experimental archaeology* yang pernah dilakukan di Indonesia adalah Kapal Borobudur. Kapal Borobudur, yang terdapat pada Gambar 2.6, merupakan kapal hasil rekonstruksi dari gambar kapal pada Candi Borobudur (Burningham, 2005). Kapal Borobudur, selain direkonstruksi, juga digunakan untuk berlayar menyusuri rute pelayaran historis dari Asia Tenggara menuju Afrika. Hal ini dilakukan untuk membuktikan kemampuan berlayar masyarakat Asia Tenggara di masanya, serta memahami kondisi interaksi antar masyarakat di Samudra Hindia (Beale, 2006).

2.2. Tinjauan Pustaka

2.2.1. Jenis Layar

Terdapat berbagai jenis layar yang digunakan pada kapal layar. Jenis-jenis layar dapat dibagi berdasarkan bentuk layar dan tali-temalinya. Secara garis besar, jenis layar dapat dibagi dua, yaitu *square rig* dan *fore-and-aft*. Pembagian ini didasarkan pada pemasangan layar terhadap tiang utama (*mast*) yang juga berpengaruh terhadap talinya. *Square rig* merupakan jenis layar di mana layar berbentuk persegi dipasang pada tiang yang melintang terhadap garis lunas kapal (Chatterton, 1912). Contoh *square rig* sederhana terdapat pada Gambar 2.7. Tiang ini disebut *yard*. Pemasangan layar dengan jenis *square rig* membuat layar bekerja dengan efisien jika kapal berlayar dalam keadaan *downwind*.

Gambar 2.7 *Square Rig* Sederhana
Sumber: smallboatsmonthly.com

Fore-and-aft merupakan jenis layar di mana layar terpasang pada tiang (*spar*) yang memanjang sejajar dengan garis lunas kapal (Chatterton, 1912). Layar dapat berbentuk segitiga (*triangular*) atau segi empat (*quadrilateral*/*rectangular*). Cara pemasangan layar (*rigging*) yang berbeda pada *spar* menghasilkan layar dengan jenis yang berbeda. Sebagai contoh, jika *spar* terpasang pada sudut layar yang berada di seberang *mast* (*peak*), maka layar ini disebut *spritsail*. Akan tetapi, jika *spar* terpasang sepanjang tepi atas layar (*head*), maka layar ini disebut *gaff rig*. Contoh perbandingan tersebut dapat dilihat pada Gambar 2.8. Layar dengan jenis *fore-and-aft* memungkinkan kapal berlayar dalam keadaan *upwind* dengan baik.

Gambar 2.8 *Spritsail* (Putih) dan *Gaff Rig* (Merah)
Sumber: forum.woodenboat.com

Gambar 2.9 Kapal *Full-rigged* Amerigo Vespucci
Sumber: www.iitaly.org

Berdasarkan penggunaan bentuk, jenis, dan *rigging* layar pada kapal, baik satu jenis maupun kombinasi berbagai jenis, *sail plan* kapal dapat ditentukan. Kombinasi penggunaan jenis layar akan semakin kompleks pada kapal-kapal dengan ukuran besar. Kapal berukuran

besar membutuhkan gaya dorong yang lebih besar sehingga kapal akan menggunakan layar dalam jumlah banyak. Contoh *sail plan* yang banyak ditemui pada kapal besar adalah layar jenis *square rig* dipasang bertingkat pada satu *mast* yang tinggi, dan satu kapal dapat memiliki beberapa *mast* sekaligus. Susunan layar seperti ini menghasilkan *sail plan* jenis *full-rigged* seperti pada Gambar 2.9. Jika layar jenis *fore-and-aft* dipasang pada *mast* yang terletak paling belakang, susunan ini akan menghasilkan *sail plan* jenis *barque*. Jika keseluruhan *mast* menggunakan layar jenis *fore-and-aft*, jenis *sail plan* yang dihasilkan adalah *schooner*.

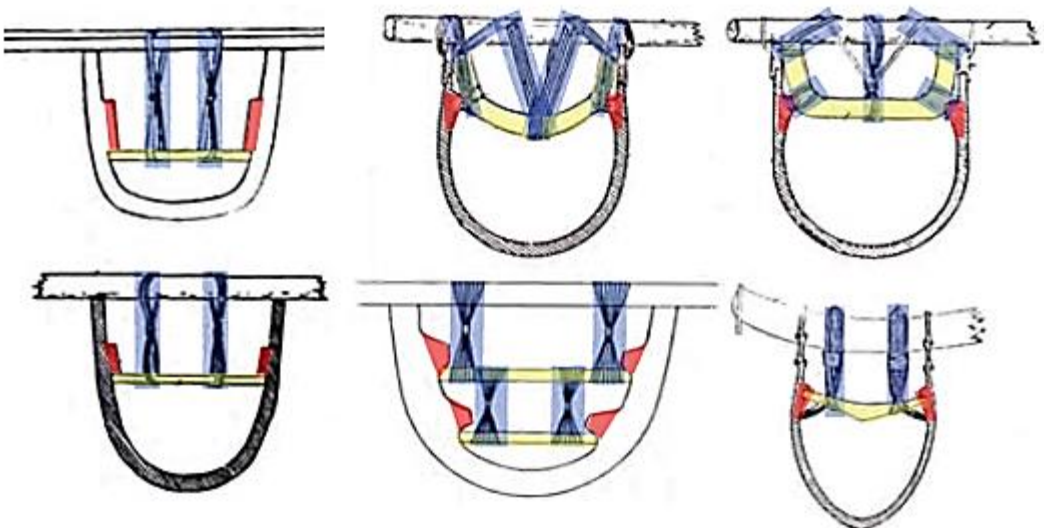
Gambar 2.10 Persebaran Bahasa Austronesia
Sumber: www.britannica.com

2.2.2. Kapal Layar Austronesia

Pelayaran merupakan aktivitas yang telah dilakukan sejak lama oleh masyarakat di wilayah Kepulauan Asia Tenggara dan Pasifik, termasuk Indonesia. Hal ini tidak lepas dari asal mula persebaran penduduk Kepulauan Asia Tenggara dan Pasifik itu sendiri. Masyarakat Kepulauan Asia Tenggara dan Pasifik diperkirakan berasal dari satu leluhur yang sama, yaitu masyarakat penutur bahasa Austronesia. Bahasa Austronesia merupakan bahasa kuno yang pertama kali dituturkan di wilayah Taiwan sekitar tahun 3000 SM. Bahasa ini dibagi menjadi empat kelompok, yaitu bahasa Atayalic, Tsouic, Paiwanic, dan Malayo-Polynesian (Tryon, 1995). Bahasa Malayo-Polynesian merupakan satu-satunya bahasa Austronesia yang dikenal di luar Taiwan. Hal ini terjadi karena penutur bahasa Malayo-Polynesian adalah satu-satunya kelompok yang melakukan penjelajahan ke luar Taiwan, dengan tujuan awal menuju Filipina. Dari Filipina, penutur bahasa ini terus menjelajah ke selatan dan menduduki wilayah Kalimantan, Sulawesi, dan Maluku. Penjelajahan kemudian dilakukan ke barat menuju Jawa, Sumatra, dan Malaya, dan ke timur menuju Oseania (Bellwood, 1995). Puncak dari

penjelajahan dan pendudukan yang dilakukan menghasilkan bahasa yang persebarannya digambarkan pada Gambar 2.10, yaitu membentang dari Pulau Paskah di timur, Selandia Baru di selatan, Taiwan dan Filipina di utara, kepulauan di wilayah Indonesia dan Malaysia, dan Madagaskar di barat (Tryon, 1995).

Selain persebaran bahasa, penjelajahan masyarakat Austronesia juga ditunjukkan oleh bukti arkeologi. Di berbagai pulau di wilayah Pasifik, terdapat situs-situs yang menandakan sebuah peradaban kuno yang disebut Lapita. Peradaban ini ditandai dengan kerajinan tembikar yang khas (*Lapita pottery*). Persebarannya dimulai dari Kepulauan Bismarck, kemudian menuju ke timur meliputi Kepulauan Solomon, Vanuatu, dan Kaledonia Baru, hingga tersebar ke Fiji dan wilayah barat dari Polinesia. Pola persebaran ini ditunjukkan dari usia situs yang ditemukan, di mana wilayah paling barat berusia paling tua (1600-1200 SM) dan semakin ke timur semakin muda (1000 SM). Corak pada tembikar juga mengalami penyederhanaan seiring dengan wilayah persebaran yang semakin jauh ke timur. Selain keberadaan tembikar yang khas, situs-situs peradaban Lapita juga menyisakan berbagai ciri lain seperti perkakas, pola pemukiman, dan sisa kegiatan agrikultur. Ketiadaan situs peradaban Lapita di wilayah lain menandakan kebudayaan ini berkembang di wilayah Melanesia yang merupakan hasil interaksi dari masyarakat Austronesia pendatang dengan masyarakat indigenos non-Austronesia setempat. Penduduk Melanesia ini lah yang kemudian menjelajah dan pertama kali menghuni Polinesia, karena tidak ditemukan sisa peradaban yang lebih tua dari peradaban Lapita di sana (Spriggs, 1995). Hal ini juga diperkuat dengan keberadaan tanaman domestik di Polinesia yang berasal dari wilayah Papua Nugini dan Asia Tenggara, serta keberadaan hewan seperti anjing, babi, ayam, dan tikus yang secara genetik berasal dari Asia (Thomas, 2011).



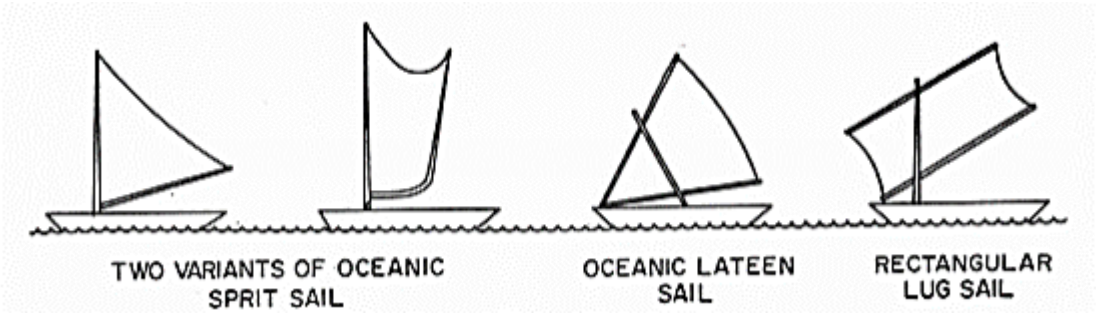
Gambar 2.11 Detail Pemasangan Cadik pada Kapal dari Berbagai Daerah
Sumber: Liebner, 2016

Bukti-bukti lain dari penjelajahan masyarakat Austronesia juga ditemukan di berbagai wilayah pesisir yang berbatasan dengan Samudra Hindia. Samudra Hindia diperkirakan telah menjadi jalur perdagangan yang menghubungkan wilayah Timur Tengah, Asia Selatan, dan Asia Tenggara sejak tahun 500 SM. Jalur ini merupakan bagian dari jalur perdagangan lintas Asia yang membentang dari Laut Merah hingga Cina. Jaringan perdagangan Samudra Hindia bahkan terhubung dengan wilayah pesisir Afrika Timur, dengan pengiriman komoditas dari Afrika ke India dilakukan baik secara langsung maupun melalui pelabuhan di Semenanjung Arabia (Campbell G., 2016). Aktivitas perdagangan dapat terlihat dari pengenalan berbagai komoditas yang asing ke suatu wilayah tertentu. Beberapa di antaranya adalah pisang, ubi, dan talas yang dibawa ke Afrika dan menjadi sumber makanan penting di sana. Ketiga tanaman ini diketahui berasal dari Asia Tenggara dan Pasifik (Blench, 2010). Pengenalan barang atau konsep baru di suatu wilayah juga dapat diketahui berdasarkan nama barang tersebut dalam bahasa setempat. Terdapat berbagai nama benda di berbagai bahasa yang tersebar di Asia Selatan yang menggunakan kata serapan dari bahasa Melayu, menunjukkan pengenalan barang-barang eksotis dari Asia Tenggara ke wilayah tersebut (Hoogervorst, 2014).

Gambar 2.12 *Ngalawa*, Kapal Bercadik dari Tanzania
Sumber: tradewindssailing.com

Kondisi geografis wilayah persebaran masyarakat Austronesia yang dipisahkan oleh lautan menunjukkan bahwa persebaran tersebut tentu tidak dapat dilakukan tanpa aktivitas pelayaran. Hal ini harus dilakukan dengan menggunakan sebuah alat terapung yang dioperasikan dengan kemampuan navigasi (Liebner, 2016). Petunjuk bahwa aktivitas pelayaran

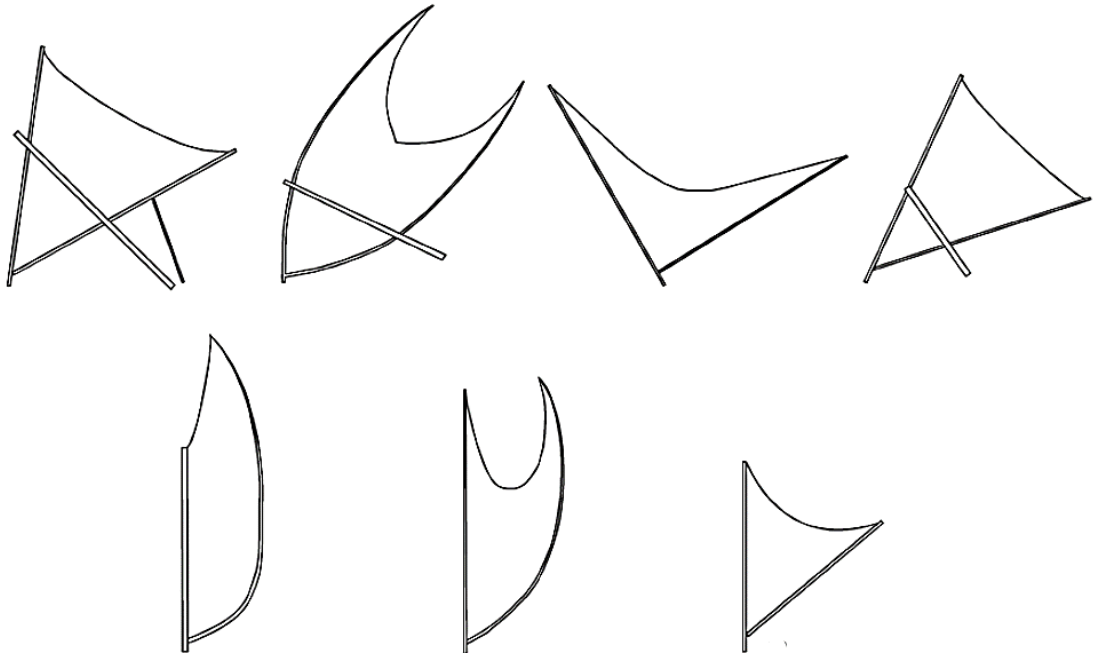
telah lama dilakukan dapat dilihat pada adanya kemiripan dalam teknologi pelayaran tradisional yang dimiliki oleh masyarakat Austronesia. Hal ini ditunjukkan oleh bentuk kapal dan layar yang digunakan, baik kapal-kapal di masa lalu maupun kapal-kapal tradisional yang masih digunakan hingga saat ini. Kesamaan karakteristik yang terdapat pada kapal tradisional di wilayah tersebut adalah penggunaan cadik pada beberapa jenis kapal. Kapal bercadik merupakan kapal yang dikembangkan oleh masyarakat Austronesia. Teknologi ini dimulai dari penggunaan rakit bambu untuk berlayar. Rakit bambu adalah kendaraan terapung yang paling sederhana yang dapat dibuat dengan menggunakan perkakas dari batu. Ketika teknologi untuk membuat kano dengan cara melubangi batang kayu utuh mulai ditemukan, rakit mulai dibuat dari kano. Rakit ini kemudian berkembang menjadi kapal bercadik (Horridge, 1986). Kapal bercadik tersebar di seluruh wilayah penutur bahasa Austronesia, baik bercadik tunggal yang tersebar di Melanesia, Mikronesia, dan Polinesia, maupun bercadik ganda yang tersebar di Asia Tenggara. Meski setiap wilayah memiliki detail yang berbeda dalam pemasangan cadik pada lambung kapal, tapi pola pemasangan cadik, seperti yang terlihat pada Gambar 2.11, menunjukkan bahwa cadik pada kapal-kapal tersebut berkembang dari satu teknologi yang sama (Liebner, 2016). Kapal bercadik juga dapat ditemukan di wilayah lain yang pernah berhubungan dengan jalur pelayaran masyarakat Austronesia, yaitu di pesisir yang berhubungan dengan Samudra Hindia hingga Madagaskar (Campbell I. C., 1995). Salah satu contohnya terdapat pada Gambar 2.12.



Gambar 2.13 Jenis Layar Masyarakat Austronesia
Sumber: Doran, 1974

Penggunaan layar pada kapal tradisional di wilayah tersebut juga memiliki kemiripan. Secara garis besar, jenis layar yang berkembang di masyarakat Austronesia dapat dibagi dua, yaitu layar madura (*oceanic lateen/oceanic spritsail*) yang berbentuk segitiga dan layar tanja (*tilted rectangular sail*) yang berbentuk segi empat, dengan ilustrasi pada Gambar 2.13. Layar madura merupakan layar yang berkembang secara independen di wilayah Asia Tenggara dan Pasifik karena pelayaran masyarakat Austronesia telah dilakukan jauh sebelum pengaruh

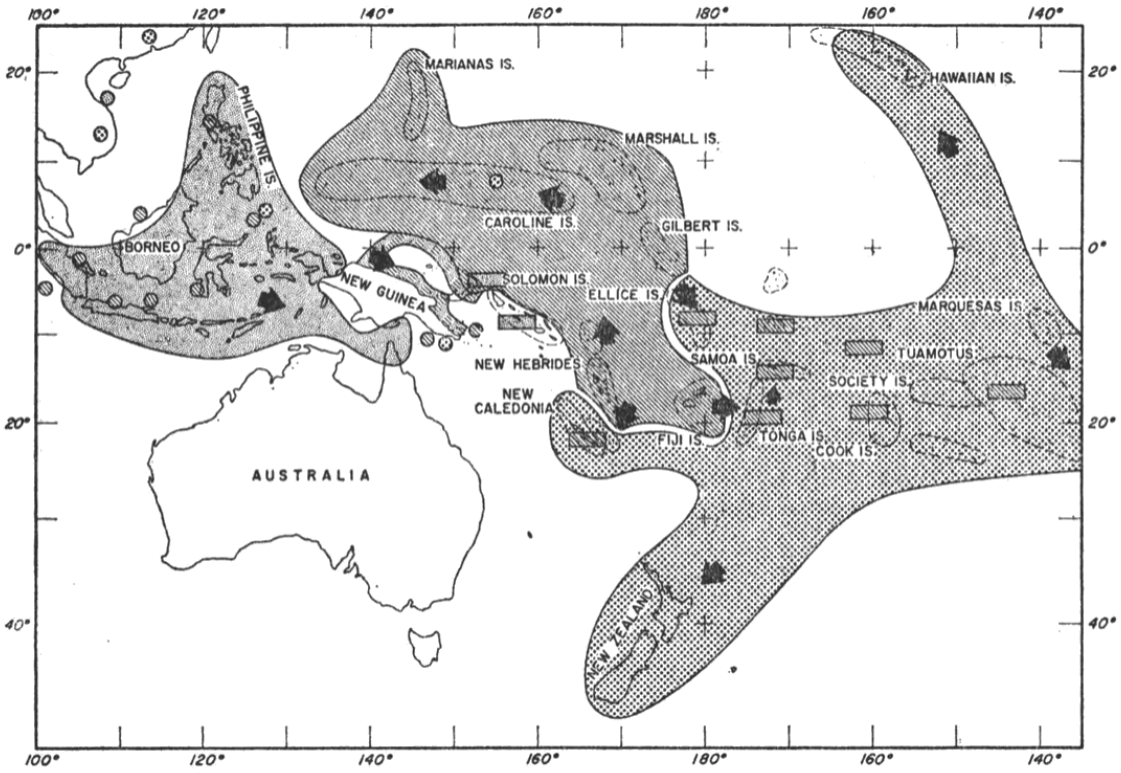
teknologi pelayaran dari wilayah lain mulai memasuki perairan di wilayah tersebut (Horridge, 1986). Layar madura digunakan dan dikembangkan sejak masyarakat Austronesia mulai menempati Kepulauan Asia Tenggara, kemudian dibawa dalam penjelajahannya ke timur menuju Pasifik. Selama proses ini, layar madura mengalami perkembangan sehingga memiliki detail yang berbeda-beda di berbagai daerah, seperti yang ditunjukkan pada Gambar 2.14. Layar tanja kemudian berkembang di Kepulauan Asia Tenggara dari pengaruh yang datang dari aktivitas pelayaran Samudra Hindia, menggantikan layar madura yang sebelumnya digunakan di wilayah tersebut (Mahdi, 2016). Penggunaan kedua jenis layar ini dicatat pada berbagai catatan perjalanan penjelajah di masa lalu yang melalui Asia Tenggara dan Pasifik, menunjukkan bahwa layar madura dan layar tanja merupakan teknologi yang sejak lama digunakan oleh masyarakat setempat (Liebner, 2002).



Gambar 2.14 Variasi Layar Madura di Wilayah Pasifik
Sumber: Di Piazza et al., 2014

Persebaran teknologi cadik dan layar yang digunakan membentuk pola secara geografis yang ditunjukkan pada Gambar 2.15. Berdasarkan jumlah cadik, bentuk layar, dan cara berlayarnya dalam keadaan *upwind*, kapal bercadik dapat dibagi menjadi tiga jenis, yaitu Polinesia, Mikronesia, dan Indonesia. Jenis Polinesia merupakan kapal bercadik tunggal atau lambung ganda, memiliki layar *oceanic spritsail*, dan berlayar dengan cara *tacking*. Jenis Mikronesia merupakan kapal bercadik tunggal, memiliki layar *oceanic lateen*, dan berlayar dengan cara *shunting*. Jenis Indonesia merupakan kapal bercadik ganda, memiliki layar *rectangular sail*, dan berlayar dengan cara *tacking*. Di wilayah Melanesia, kapal yang

ditemukan biasanya bercadik tunggal dan berlayar dengan cara *shunting*, akan tetapi memiliki layar *rectangular*. Hal ini merupakan kombinasi dari jenis Mikronesia dan Indonesia (Doran, 1974).



Gambar 2.15 Persebaran Kapal Bercadik
Sumber: Doran, 1974

Gambar 2.16 Kapal Nelayan dengan Layar Madura di Surabaya, Jawa Timur

2.2.3. Layar Madura

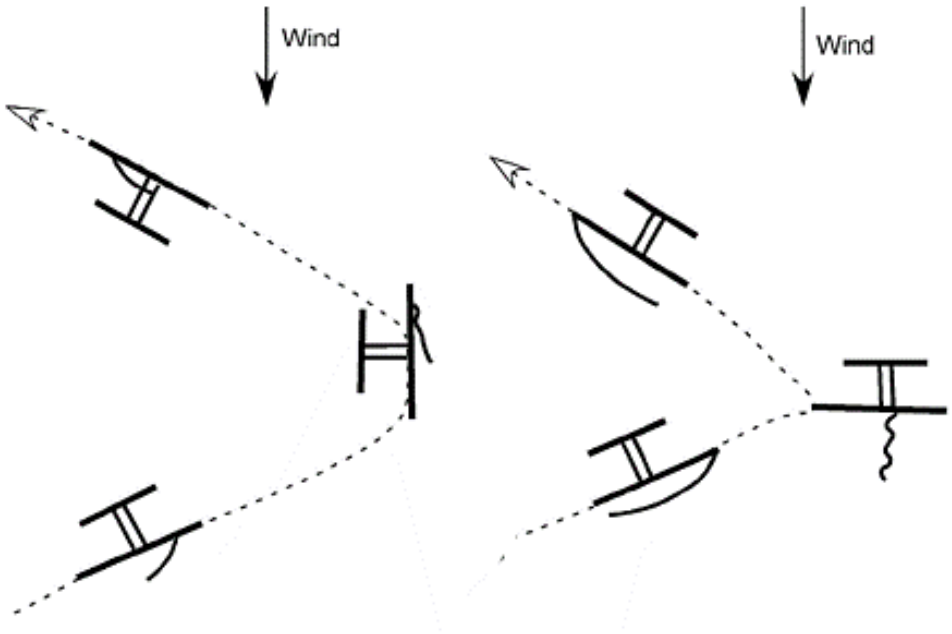
Layar madura merupakan layar khas masyarakat Austronesia yang banyak digunakan di kepulauan Pasifik. Sebelum mengalami berbagai variasi dan modifikasi di tiap-tiap daerah layar ini digunakan, layar jenis ini, dalam bentuknya yang paling sederhana, diperkirakan merupakan layar yang pertama kali digunakan masyarakat Austronesia dalam penjelajahannya. Di wilayah Indonesia, layar madura hanya ditemukan di wilayah perairan sekitar Madura, Jawa Timur. Contoh penggunaan layar jenis ini dapat ditemukan pada kapal nelayan di wilayah Kenjeran, Surabaya, Jawa Timur, yang ditunjukkan pada Gambar 2.16.

Gambar 2.17 *Oceanic Spritsail* Hawaii pada Hōkūle'a, Kapal asal Hawaii, AS
Sumber: wikipedia.org

Secara prinsip, layar madura merupakan layar *fore-and-aft* berbentuk segitiga yang dipasang pada dua buah tiang (*spar*) sebagai penyangganya. Akan tetapi, detail pemasangan memiliki banyak variasi dengan penyebutan yang berbeda-beda di berbagai daerah. Secara garis besar, terdapat dua jenis layar madura, yaitu *oceanic spritsail* dan *oceanic lateen*. Jenis *spritsail* merupakan jenis yang hanya menggunakan dua buah tiang. Tiang pertama dipasang pada tepi atas layar (*luff*) dan berfungsi untuk menopang layar saat dikembangkan. Tiang ini ditegakkan di haluan kapal dan ujung bawahnya dipasangkan pada lubang di lambung atau konstruksi melintang kapal. Tiang kedua dipasang pada tepi bawah layar (*foot*). Ujung tiang kedua yang berada di bawah diikatkan pada tiang pertama, sedangkan ujung lainnya dibiarkan

bebas. Tiang kedua ini berfungsi untuk mengatur posisi layar sebagai *boom*, atau dapat juga disebut *sprit* karena menopang sudut layar. Untuk mengendalikan layar, digunakan tali (*sheet*) pada *sprit*. Tiang pertama dapat dipasang pada lubang yang longgar sehingga ikut berotasi atau dipasang pada lubang yang tetap sehingga pergerakan layar hanya bergantung dari *sprit*. Terdapat berbagai variasi bentuk *oceanic spritsail* dengan detail bentuk tiang, layar, dan cara pengoperasian yang berbeda-beda (Di Piazza, 2015). Salah satu contohnya adalah varian Hawaii yang ditunjukkan pada Gambar 2.17.

Oceanic lateen merupakan jenis yang menggunakan tiga buah tiang. Seperti jenis *oceanic spritsail*, layar dipasang pada dua buah tiang, yaitu tiang pertama di bagian *luff* dan tiang kedua di bagian *foot*. Kedua tiang diikatkan satu sama lain di ujung layar tempat kedua tiang bertemu, dan pertemuan kedua tiang ini ditempatkan di haluan kapal. Yang membedakan jenis *lateen* dengan *spritsail* adalah penggunaan tiang ketiga untuk menopang tiang pertama. Tiang ketiga ditegakkan dengan cara dipasangkan pada lubang di lambung atau konstruksi melintang kapal. Kemudian, tiang pertama dipasang pada ujung atas tiang ketiga, sehingga berfungsi seperti *yard* yang terpasang pada *mast* (Di Piazza, 2015).



Gambar 2.18 Manuver *Tacking* (Kiri) dan *Shunting* (Kanan)
Sumber: Di Piazza, 2015

Penggunaan *oceanic spritsail* atau *oceanic lateen* pada sebuah kapal biasanya ditentukan berdasarkan cara kapal tersebut bermanuver. Ketika bergerak dalam keadaan *upwind*, kapal harus bergerak secara zig-zag (*beating to windward*) karena kapal tidak dapat bergerak lurus menuju arah angin. Pada kapal-kapal di wilayah Pasifik, terdapat dua manuver yang biasa

dilakukan ketika kapal berlayar dalam keadaan *upwind*. Manuver pertama adalah *tacking*, yaitu mengubah arah berlayar kapal dengan cara membelokkan haluan melewati arah datangnya angin. Manuver ini membuat angin akan bertiup dari sisi kapal yang berbeda, sehingga posisi layar harus disesuaikan. *Boom* pada layar akan dipindahkan dari satu sisi kapal ke sisi lainnya dan sisi *windward* dan *leeward* layar akan bertukar. Manuver kedua adalah *shunting*, yaitu menukar posisi haluan dan buritan pada kapal dengan cara memindahkan layar dan kemudi. Angin akan tetap bertiup dari sisi kapal yang sama, dan biasanya ini merupakan sisi tempat cadik terpasang. Perbandingan manuver *tacking* dan *shunting* ditunjukkan pada Gambar 2.18. Hampir di semua wilayah di Pasifik, layar jenis *oceanic spritsail* digunakan pada kapal yang bermanuver dengan cara *tacking*, sedangkan layar jenis *oceanic lateen* digunakan pada kapal yang bermanuver dengan cara *shunting*. Akan tetapi, terdapat pengecualian di beberapa wilayah untuk pola tersebut. Hal ini dapat disebabkan oleh pengadaptasian jenis layar yang berbeda untuk kapal tradisional setempat (Di Piazza, 2015).

Jenis *oceanic spritsail* diperkirakan merupakan layar yang paling awal dikembangkan oleh masyarakat Austronesia. Ketika rakit masih digunakan, diperlukan cara untuk menegakkan layar yang besar pada rakit. Hal yang paling mudah dilakukan dengan ketiadaan teknologi katrol adalah mengikatkan layar pada sebuah tiang kemudian menegakkannya. Tiang ini kemudian dipasang pada sebuah lubang (takik) yang dibuat pada rakit. Hal ini lebih mungkin dilakukan karena penggunaan tiang utama (*mast*) yang dipasang pada konstruksi melintang tidak cocok diterapkan pada rakit jika ukuran layar terlalu besar. Selain itu, layar masyarakat Austronesia juga berjenis *fore-and-aft* yang memungkinkan mereka berlayar secara *windward*. Cara berlayar seperti ini membuat konsep *mast* tidak dikenal. Layar untuk rakit ini kemudian tetap digunakan pada kapal bercadik (Horridge, 1986). Jenis *oceanic lateen* kemudian berkembang dari usaha untuk menambah luas layar guna menghasilkan daya dorong yang lebih besar. Ukuran layar yang semakin besar membuat *center of effort* berada pada posisi yang lebih tinggi, sehingga kapal tidak stabil. Untuk membuat layar tidak terlalu tinggi, posisi layar harus dimiringkan, membuat ujung depan tiang pertama tidak terpasang langsung pada lambung kapal, sehingga digunakan tiang ketiga untuk menyangga tiang pertama (Campbell I. C., 1995).

2.2.4. Layar Tanja

Layar tanja merupakan layar khas dari wilayah Kepulauan Asia Tenggara. Sebelum masuknya pengaruh teknologi pelayaran dari Eropa, jenis layar ini merupakan layar yang banyak digunakan oleh kapal-kapal di wilayah tersebut. Layar jenis ini masih digunakan pada

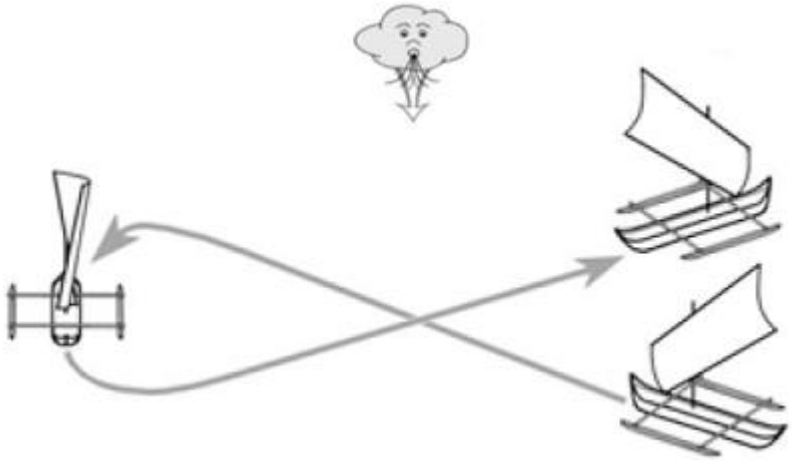
kapal tradisional di beberapa wilayah di Indonesia, contohnya pada kapal jenis *peledang* yang ditunjukkan pada Gambar 2.19. *Peledang* merupakan kapal pemburu paus yang berasal dari Lamalera A, Lembata, Nusa Tenggara Timur.

Gambar 2.19 *Peledang* dari Lamalera A, Lembata, Nusa Tenggara Timur
Sumber: Agung, 2018

Nama dan detail tali-temali layar ini dapat berbeda-beda di berbagai daerah, tapi memiliki prinsip yang sama, yaitu layar *fore-and-aft* berbentuk segi empat yang dipasang miring secara diagonal terhadap tiang (*mast*). Tepi layar bagian ataas (*head*) dan bawah (*foot*) terpasang pada dua buah tiang, yaitu *yard* pada *head* dan *boom* pada *foot*. Pemasangan layar pada *yard* dan *boom* dilakukan dengan cara menjahit layar secara spiral. Pada keempat sudut layar terdapat tali yang berfungsi untuk mengatur posisi layar, disebut *brace* untuk mengatur *yard* dan *sheet* untuk mengatur *boom*. Pada bagian tengah *yard*, diikatkan tali (*halyard*) yang digantungkan atau diikatkan di bagian atas *mast* (*masthead*). Ketika layar dikembangkan, *halyard* ditarik hingga *yard* berada pada *masthead*. Layar akan diposisikan secara diagonal terhadap *mast*. Tepi layar yang akan dihadapkan dengan arah datangnya angin (dijadikan *luff*/*leading edge*) akan dimiringkan ke bawah, sehingga tepi layar seberangnya (*leech*/*trailing edge*) akan naik ke atas. Hal ini dilakukan dengan cara menarik *brace* dan *sheet* yang terletak pada ujung-ujung *luff*. Kemiringan akan disesuaikan dan dipertahankan dengan cara mengatur *brace* dan *sheet*, baik pada *luff* maupun pada *leech* (Dwyer & Akerman, 1996).

Meskipun tergolong *fore-and-aft*, *yard* pada layar tanja dapat dipasang secara melintang terhadap *mast*. Hal ini membuat layar tanja tetap dapat bergerak dengan efisien dalam keadaan

downwind, karena posisi *yard* yang melintang membuat layar berfungsi seperti *square rig* (Liebner, 2002). Susunan tali-temali yang memungkinkan layar dapat berfungsi dengan baik pada kedua kondisi tersebut di sisi lain memberikan keterbatasan dalam manuver kapal. Ketika kapal melakukan *beating to windward*, kapal harus melakukan *gybe*/*jibing*, yaitu membelokkan buritan melalui arah datangnya angin, atau dengan kata lain kapal harus bergerak *downwind* terlebih dahulu, seperti yang ditunjukkan pada Gambar 2.20. Ketika arah kapal berubah, angin akan datang dari sisi kapal sebaliknya dan layar akan diputar mengelilingi bagian depan *mast*, sehingga tepi layar yang sebelumnya menjadi *leech* kini menjadi *luff* (Dwyer & Akerman, 1996). Jika kapal dengan layar tanja harus melakukan *tacking*, layar harus dipindahkan ke sisi *mast* yang berbeda tanpa memutar layar mengelilingi *mast*. Hal ini dapat dilakukan dengan cara menarik layar ke belakang *mast*, kemudian mendorongnya ke sisi *mast* yang berbeda. *Leech* dan *luff* pada layar tidak akan berubah. Proses pemindahan ini merupakan sesuatu yang sulit dilakukan (Liebner, 2002).



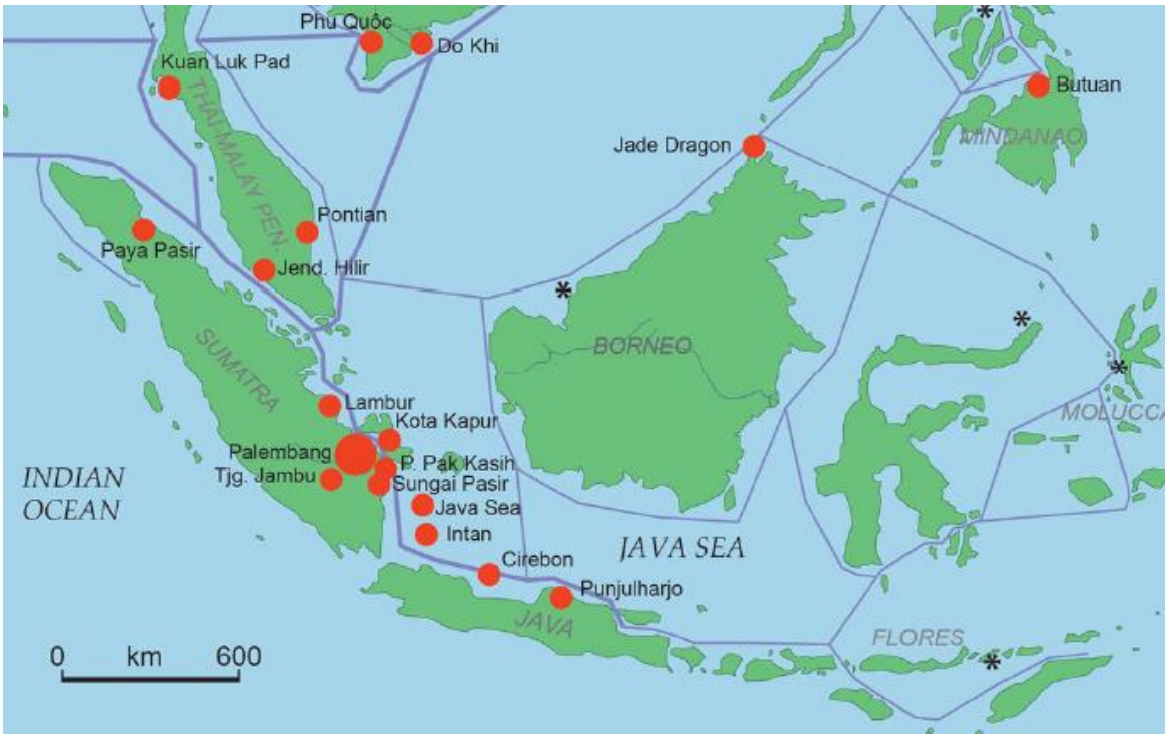
Gambar 2.20 Manuver *Gybe*/*Jibing*
Sumber: Mahdi, 2016

Layar tanja telah digunakan dalam waktu yang lama pada kapal-kapal di wilayah Asia Tenggara. Hal ini ditunjukkan oleh penggambaran yang ada di dalam berbagai catatan perjalanan penjelajah dari Cina, Arab, dan Eropa (Liebner, 2016). Selain itu, layar sejenis juga digambarkan pada berbagai ukiran yang terdapat di dinding Candi Borobudur (Liebner, 2002). Layar tanja diperkirakan merupakan hasil adaptasi masyarakat Kepulauan Asia Tenggara terhadap pengaruh teknologi pelayaran yang datang dari wilayah Timur Tengah, yaitu layar *lateen* (Mahdi, 2016). Layar tanja menggantikan jenis layar Austronesia lain di wilayah Kepulauan Asia Tenggara, menjadi layar yang umum digunakan oleh kapal-kapal setempat. Kapal yang menggunakan layar tanja mulai berkurang ketika aktivitas pelayaran orang Eropa

semakin intensif di wilayah tersebut. Kapal-kapal lokal Asia Tenggara mulai mengadopsi teknologi pelayaran dari wilayah Eropa dan pada pertengahan abad ke-19, layar jenis *schooner* mulai marak dijumpai (Salam, 2016).

2.2.5. Perahu Kuno Punjulharjo

Selain persebaran bahasa dan keberadaan teknologi pelayaran tradisional yang menunjukkan bahwa aktivitas pelayaran di Asia Tenggara dan Pasifik telah berlangsung lama, terdapat juga beberapa temuan sisa-sisa lambung kapal yang cukup tua dengan bentuk yang identik di berbagai titik di Asia Tenggara. Persebaran penemuan lambung kapal digambarkan pada Gambar 2.21. Salah satu di antara situs temuan yang berada di Indonesia terdapat di Desa Punjulharjo, Kabupaten Rembang, Jawa Tengah. Temuan yang dikenal dengan nama Perahu Kuno Punjulharjo, yang ditunjukkan pada Gambar 2.22, diperkirakan berasal dari abad ke-7 hingga ke-8 Masehi. Perahu Kuno Punjulharjo merupakan temuan kapal yang kondisinya paling baik (Lacsina, 2016).



Gambar 2.21 Lokasi Temuan Lambung Kapal yang Identik di Asia Tenggara
Sumber: Manguin, 2019

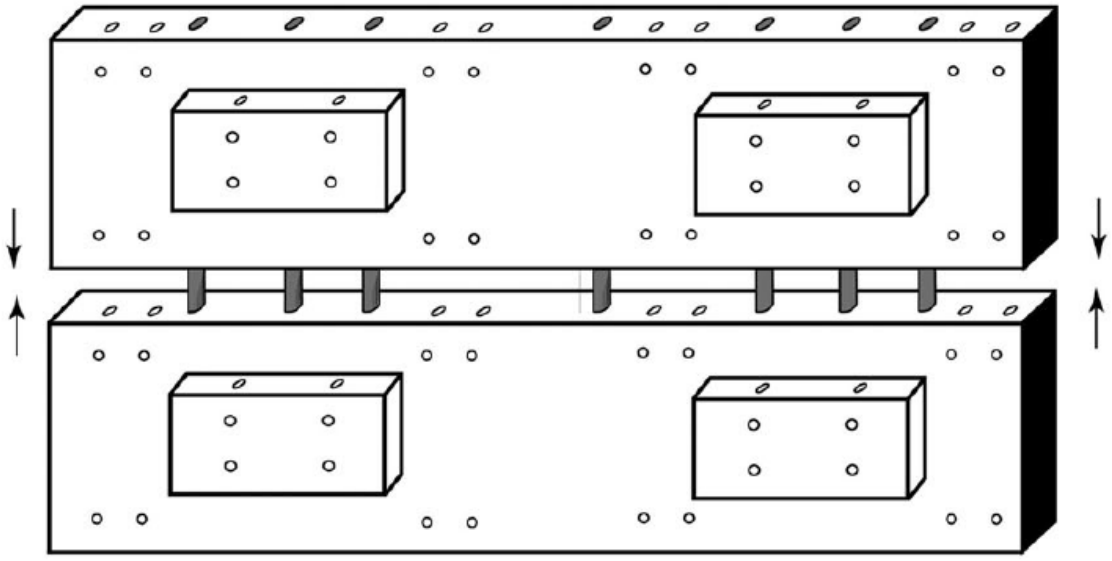
Perahu Kuno Punjulharjo menunjukkan teknologi pembangunan lambung kapal yang digunakan masyarakat wilayah Kepulauan Asia Tenggara di masanya, teknologi yang disebut *lashed-lug*. Lambung kapal terdiri dari lunas yang terbuat dari sebatang kayu yang dibentuk papan, dengan lajur-lajur kayu lain di masing-masing sisi lunas. Tiap lajur kayu terdiri dari

beberapa papan yang dihubungkan dengan cara diikat. Pembuatan lambung dilakukan dengan pemasangan pasak sebagai penghubung pada lubang di sisi lajur yang saling menempel, kemudian lajur diikat satu sama lain. Ikatan untuk menyambung lajur-lajur kayu dipasang pada tual (*lug*), bagian menonjol pada permukaan dalam lajur kayu, yang diberi lubang untuk memasukkan ikatan. Hal ini ditunjukkan pada Gambar 2.23. Konstruksi melintang berupa gading pada lambung kapal akan dipasang setelah kulit lambung selesai dibuat. Pemasangan dilakukan dengan cara mengikat gading pada tual yang sama dengan tempat pemasangan ikatan antar lajur kayu lambung. Ikatan tidak langsung terpasang pada gading, melainkan diikatkan pada pasak yang ditempelkan sejajar dengan gading tersebut. Gading kemudian akan diperkuat dengan pasak lain yang dipasang melintang di atasnya dan diikat pada tual yang sama. Ketebalan tual membuat rangka tidak menempel langsung pada kulit lambung. Pembuatan lambung dengan cara mengikat dan menggunakan pasak diperkirakan dilakukan karena di masa tersebut masyarakat Austronesia belum mengenal teknologi paku. Akan tetapi, cara ini masih banyak digunakan pada kapal-kapal Asia Tenggara di masa ketika paku dan peralatan logam lain telah dikenal (Lacsina, 2016). Selain itu, pembuatan kapal dimulai dari pemasangan kulit lambung. Cara ini berbeda dari cara pembuatan kapal yang umum dilakukan di Eropa, di mana kulit lambung akan dipasang pada rangka yang telah membentuk badan kapal (Liebner, 2002).

Gambar 2.22 Perahu Kuno Punjulharjo
Sumber: kholilmedia.id

Selain penemuan bagian lambung kapal, di sekitar situs penggalian juga ditemukan dudukan beserta tongkat kemudi. Lokasi penemuan berada di dekat bagian lambung yang

diduga merupakan buritan kapal, karena pada lajur kayu di bagian tersebut terdapat bentuk tual yang mirip dengan konstruksi di bagian buritan kapal tradisional Indonesia saat ini. Berdasarkan temuan ini, diperkirakan Perahu Kuno Punjulharjo memiliki kemudi samping (*quarter rudder*), sesuatu yang masih banyak digunakan pada kapal tradisional di Indonesia hingga saat ini (Lacsina, 2016). Pada dudukan kemudi, terdapat dua takik berbentuk cekung. Hal ini menandakan bahwa Perahu Kuno Punjulharjo memiliki dua buah kemudi. Selain itu, dudukan kemudi juga terbuat dari kayu yang penampang melintangnya berbentuk lingkaran. Bentuk kedua ujung dudukan menunjukkan kemungkinan pemasangan pada lambung dilakukan dengan cara menguncinya di bawah lajur sisi atas di buritan kapal. Karakteristik dudukan kemudi seperti ini berbeda dengan dudukan kemudi samping pada kapal tradisional Indonesia di masa kini, di mana dudukan dibuat dari bahan komposit dan dipasang di atas lajur sisi atas. Dudukan pada Perahu Kuno Punjulharjo lebih mirip dengan posisi kemudi kapal yang digambarkan pada ukiran di Candi Borobudur (Mochtar, 2018).



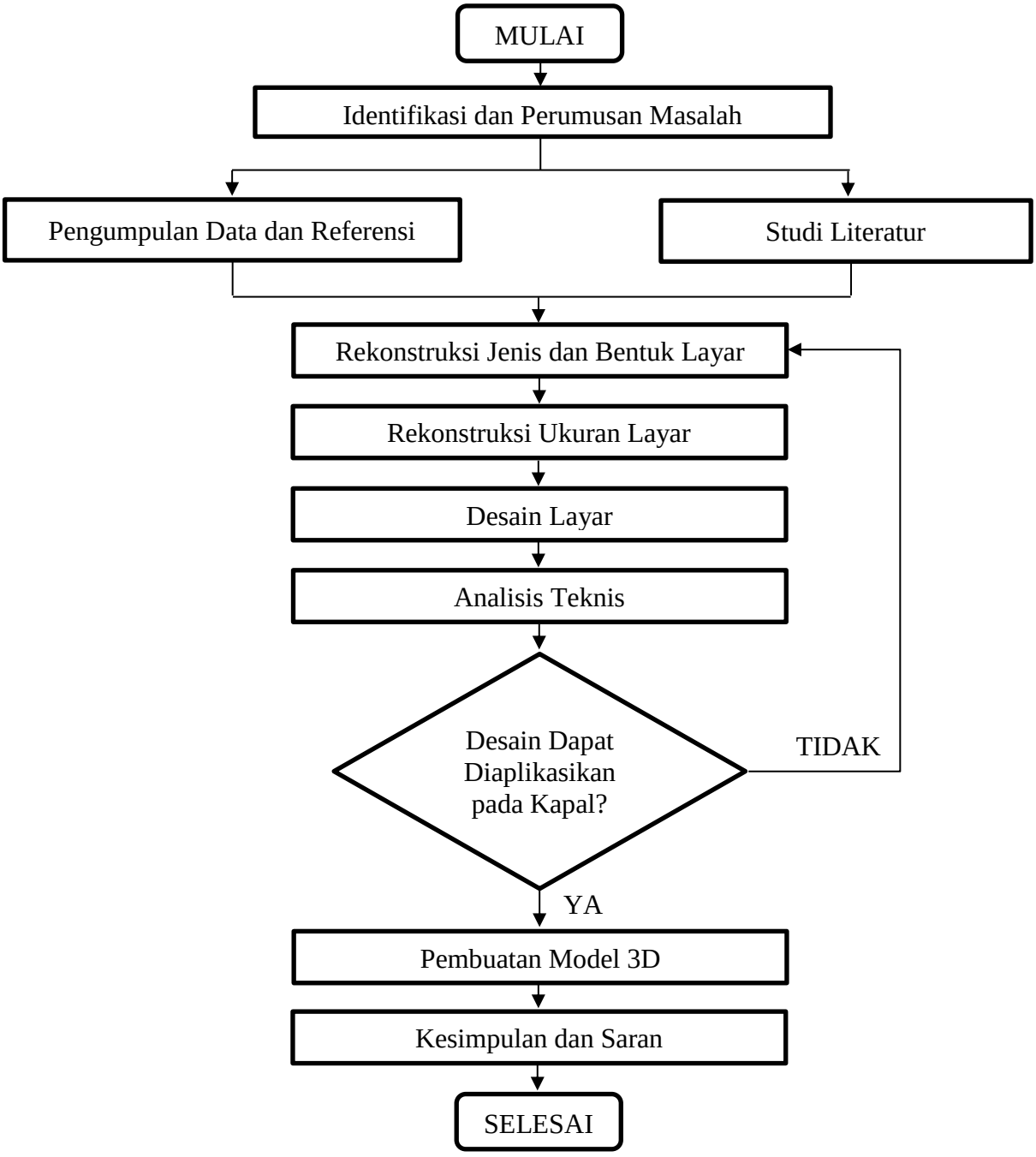
Gambar 2.23 Ilustrasi Pemasangan Lajur Kayu pada Lambung Perahu Kuno Punjulharjo
Sumber: Manguin, 2019

Bukti lain yang menunjukkan bahwa Perahu Kuno Punjulharjo merupakan kapal yang berasal dari wilayah Asia Tenggara adalah jenis material yang digunakan. Lajur kayu pada lambung Perahu Kuno Punjulharjo dibuat dari kayu getah perca (*Palaquium gutta*). Kayu kulim (*Scorodocarpus borneensis*) digunakan untuk penegar. Pasak yang menyambungan sisi-sisi lajur kayu dibuat dari kayu putih (*Melaleuca leucadendron*). Ketiga jenis kayu ini merupakan kayu khas yang berasal dari wilayah Asia Tenggara (Mochtar, 2018).

BAB 3
METODOLOGI

3.1. Diagram Alir

Tahap pengerjaan Tugas Akhir ditunjukkan oleh diagram alir yang terdapat pada Gambar 3.1.



Gambar 3.1 Diagram Alir Pengerjaan Tugas Akhir

3.2. Identifikasi Masalah

Langkah awal yang dilakukan adalah menentukan permasalahan yang menjadi latar belakang pengerjaan Tugas Akhir. Permasalahan yang ada pada Perahu Kuno Punjulharjo adalah kondisinya ketika ditemukan hanya berupa bagian lambung tanpa adanya layar dan performanya ketika berlayar yang belum diketahui.

3.3. Studi Literatur

Sebelum permasalahan pada Tugas Akhir dibahas, studi literatur dilakukan untuk mengkaji teori-teori yang berkaitan dengan permasalahan tersebut. Materi-materi yang akan dikaji dalam studi literatur meliputi:

a. *True wind* dan *apparent wind*
b. *Downwind sailing* dan *upwind sailing*
c. Gaya pada kapal layar

3.4. Pengumpulan Data dan Referensi

Untuk menambah pemahaman mengenai permasalahan yang akan dibahas, data dan referensi mengenai hal-hal yang berkaitan dengan permasalahan dikumpulkan. Pengumpulan data dilakukan dengan metode pengumpulan data secara tidak langsung (sekunder). Data dan referensi yang diperlukan meliputi:

a. Kapal layar masyarakat Austronesia di masa lalu
b. Perahu Kuno Punjulharjo

3.5. Rekonstruksi Jenis dan Bentuk Layar

Data dan referensi yang telah didapatkan akan digunakan untuk melakukan rekonstruksi jenis dan bentuk layar. Rekonstruksi dilakukan dengan metode ikonografi pada gambar-gambar dan kajian pada catatan tekstual dari berbagai sumber sejarah. Rekonstruksi tahap ini dilakukan untuk mendapatkan jenis dan bentuk layar yang digunakan oleh Perahu Kuno Punjulharjo.

3.6. Rekonstruksi Ukuran Layar

Setelah jenis dan bentuk layar didapatkan, dilakukan rekonstruksi ukuran layar. Rekonstruksi dilakukan dengan metode ikonografi pada gambar-gambar dan kajian pada catatan tekstual dari berbagai sumber sejarah. Selain itu, dilakukan juga perbandingan dengan

data etnografis berupa layar sejenis yang saat ini masih digunakan. Rekonstruksi tahap ini dilakukan untuk mendapatkan ukuran dari layar yang digunakan oleh Perahu Kuno Punjulharjo.

3.7. Desain Layar

Desain layar yang akan digunakan oleh Perahu Kuno Punjulharjo dibuat berdasarkan jenis, bentuk, dan ukuran layar yang telah didapatkan dari tahap rekonstruksi. Pembuatan desain layar dilakukan dengan bantuan perangkat lunak (*software*). Desain layar dibuat dalam bentuk dua dimensi dan tiga dimensi.

3.8. Analisis Teknis

Analisis dilakukan pada desain layar hasil rekonstruksi. Analisis dilakukan dengan menggunakan *computational fluid dynamics* (CFD) dan metode numerik berdasarkan teori-teori yang telah dikaji pada studi literatur. Tujuan dari analisis ini adalah untuk mengetahui performa yang dihasilkan jika desain layar hasil rekonstruksi diaplikasikan pada Perahu Kuno Punjulharjo. Hasil yang akan dicari dari tahap analisis adalah:

a. *Lift* dan *drag*
b. *Center of effort*
c. *Driving force* dan *lateral force*
d. *Heeling force*
e. Kecepatan kapal

3.9. Pembuatan Model Tiga Dimensi

Pengaplikasian desain layar hasil rekonstruksi pada Perahu Kuno Punjulharjo digambarkan dengan model tiga dimensi. Pembuatan model tiga dimensi bertujuan untuk memberikan gambaran bentuk Perahu Kuno Punjulharjo secara lengkap beserta layarnya. Model tiga dimensi dibuat dengan bantuan perangkat lunak .

3.10. Kesimpulan dan Saran

Kesimpulan didapatkan setelah semua tahap pengerjaan Tugas Akhir selesai dilakukan. Kesimpulan yang didapatkan berupa jenis, bentuk, dan ukuran layar hasil rekonstruksi, serta aplikasinya pada Perahu Kuno Punjulharjo. Setelah itu, saran diberikan untuk penelitian berikutnya sebagai penyempurnaan dari keterbatasan yang terdapat dalam pengerjaan Tugas Akhir ini.

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BAB 4
REKONSTRUKSI DESAIN LAYAR

4.1. Jenis dan Bentuk Layar

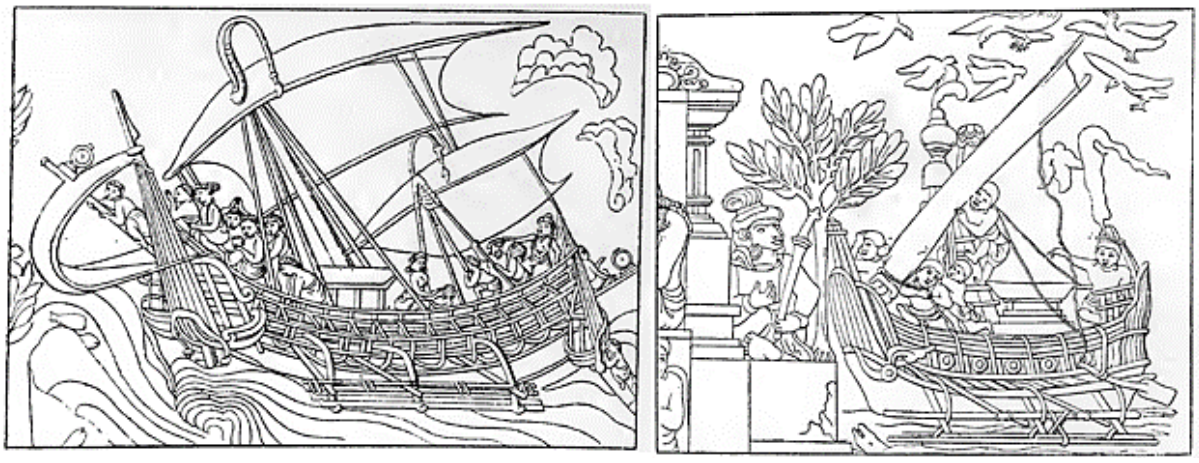
Proses penentuan jenis layar yang digunakan oleh Perahu Kuno Punjulharjo harus dilakukan dengan pendekatan secara tidak langsung. Hal ini dilakukan karena pada situs Perahu Kuno Punjulharjo, bagian yang ditemukan hanya berupa lambung kapal dan tidak ditemukan sisa-sisa dari layar kapal (Mochtar, 2018). Jenis layar bisa didapatkan dari perkiraan layar yang umum digunakan di wilayah dan masa ketika Perahu Kuno Punjulharjo dioperasikan.

Gambar 4.1 Lokasi Situs Perahu Kuno Punjulharjo
Sumber: www.google.com/maps

Perlu digarisbawahi beberapa informasi penting yang dimiliki oleh Perahu Kuno Punjulharjo untuk mengetahui wilayah dan masa operasionalnya. Perahu Kuno Punjulharjo ditemukan di Rembang, pesisir utara Jawa Tengah, seperti yang ditunjukkan pada Gambar 4.1. Bentuk dan konstruksi lambung Perahu Kuno Punjulharjo menunjukkan teknologi pembangunan kapal khas wilayah Kepulauan Asia Tenggara (*lashed-lug*). Hal ini juga diperkuat oleh material yang digunakan pada berbagai bagian lambung kapal, yaitu berupa jenis-jenis kayu yang berasal dari Asia Tenggara. Karakteristik ini menunjukkan bahwa Perahu Kuno Punjulharjo bukan kapal yang berasal dari luar kawasan Kepulauan Asia Tenggara. Berdasarkan hasil uji radiokarbon, Perahu Kuno Punjulharjo diperkirakan berasal dari abad ke-7 hingga ke-8 Masehi (Mochtar, 2018). Maka dari itu, dapat diasumsikan bahwa Perahu Kuno Punjulharjo memiliki layar yang umum digunakan di wilayah Kepulauan Asia Tenggara di sekitar abad ke-7 hingga ke-8 Masehi.

Cara yang dapat dilakukan untuk mencari tahu jenis layar yang digunakan di masa lalu adalah melakukan tinjauan pada berbagai bukti sejarah. Aktivitas pelayaran di wilayah Kepulauan Asia Tenggara, termasuk bagian yang saat ini merupakan perairan Indonesia, banyak didokumentasikan dalam berbagai bentuk, baik berupa gambar maupun catatan. Hal ini dapat memberikan petunjuk tentang kapal-kapal yang digunakan di masa gambar atau catatan tersebut dibuat. Sumber yang datang dari berbagai masa yang berbeda memberikan gambaran tentang kapal yang dioperasikan dari masa ke masa.

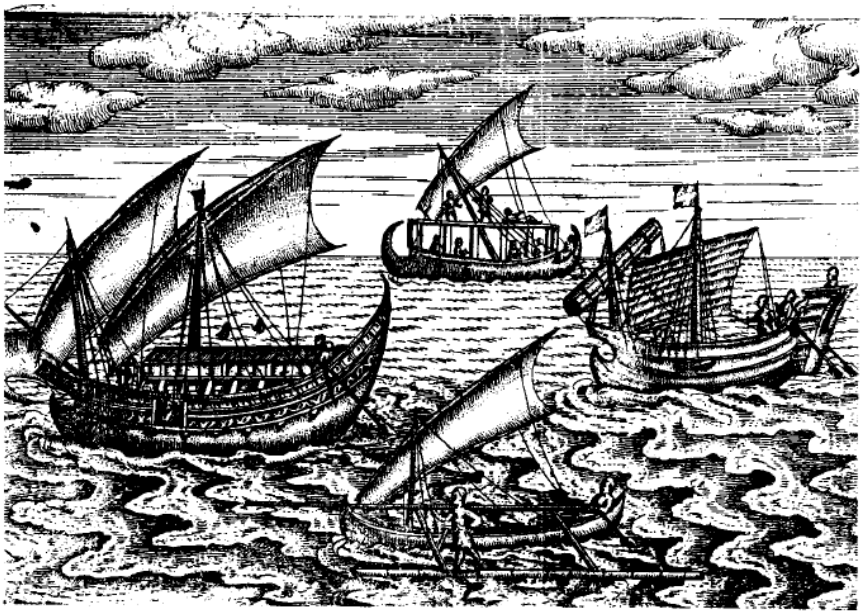
Salah satu petunjuk tentang kapal khas perairan Asia Tenggara di masa lalu yang paling terkenal adalah pahatan di Candi Borobudur. Candi Borobudur merupakan candi yang pembangunannya berlangsung sejak abad ke-6 hingga ke-8 Masehi. Terdapat beberapa gambar kapal yang berbeda pada pahatan di Candi Borobudur. Tujuh di antaranya digambarkan secara detail dalam atlas *Bôrô-Boedoer* yang diterbitkan pada tahun 1873 oleh Conrad Leemans. Dua dari tujuh gambar adalah kapal tanpa cadik, sedangkan lima sisanya memiliki cadik dengan berbagai variasi bentuk pemasangan. Tiang layar (*mast*) yang digambarkan pada kapal-kapal tersebut bervariasi, terdiri dari tiang tunggal, berkaki dua, atau berkaki tiga. Baik kapal dengan satu layar maupun dua layar digambarkan pada pahatan di Candi Borobudur. Secara keseluruhan, kapal-kapal yang digambarkan di pahatan ini cukup lengkap, menggambarkan berbagai bagian kapal dan bahkan awak kapal di atasnya dengan detail yang cukup baik (Haddon, 1920). Dari keseluruhan kapal layar yang digambarkan pada Candi Borobudur, kapal selalu digambarkan memiliki layar berbentuk persegi yang dimiringkan. Beberapa contohnya terdapat pada Gambar 4.2.



Gambar 4.2 Ilustrasi Gambar Kapal di Candi Borobudur, oleh Conrad Leemans, 1873
Sumber: Haddon, 1920

Perlu diingat bahwa pahatan kapal di Candi Borobudur merupakan produk seni, di mana terdapat kemungkinan bahwa pembuat pahatan merupakan seorang seniman yang tidak memiliki pengetahuan yang rinci mengenai bangunan kapal. Selain itu, media pahatan yang cukup kecil juga memberikan kesulitan tersendiri untuk menggambarkan keseluruhan bentuk kapal yang kompleks. Maka dari itu, tidak dapat dipungkiri bahwa terdapat unsur yang kurang akurat dalam penggambaran kapal tersebut, terutama dalam perbandingan ukuran-ukuran pada berbagai unsur dalam gambar yang dibuat (Haddon, 1920). Akan tetapi, secara umum, gambar-gambar tersebut memberikan deskripsi mengenai bentuk kapal yang biasa dijumpai di masa tersebut.

Selain pahatan pada Candi Borobudur, terdapat juga berbagai catatan yang menggambarkan kapal yang dioperasikan di wilayah Kepulauan Asia Tenggara. Catatan ini berasal dari penjelajah yang datang dari luar wilayah tersebut. Catatan yang berasal dari Kepulauan Asia Tenggara sendiri tidak ditemukan karena membuat catatan tertulis bukan merupakan budaya penjelajah setempat di masa lalu. Hal ini menyebabkan keterbatasan dalam penggambaran detail dari bagian-bagian yang terdapat pada kapal setempat karena deskripsi yang tertuang dalam catatan umumnya hanya berdasarkan pengamatan visual.



Gambar 4.3 *Jong* (Kiri) dan Beberapa Kapal Lain, oleh Willem Lodewijcksz, 1598
Sumber: Manguin, 1980

Penggambaran mengenai kapal-kapal yang digunakan di perairan Kepulauan Asia Tenggara disajikan dengan cukup jelas oleh beberapa penjelajah dari Eropa. Tomé Pires, penjelajah asal Portugal, menulis catatan pada tahun 1512 bahwa di sepanjang pantai utara

Pulau Jawa banyak ditemukan *pangajava*. *Pangajava*, yang sejatinya merupakan kata dalam bahasa Bugis untuk menyebut kapal yang berasal dari Pulau Jawa, digunakan Pires untuk menyebut seluruh kapal yang memiliki ciri-ciri lambung yang diikat, kemudi samping, dan layar persegi (Salam, 2016). Sebuah buku yang diterbitkan pada tahun 1598, *D'Eerste Boeck* karya Willem Lodewijcksz, memuat gambar kapal-kapal yang umum dijumpai di wilayah "Hindia", seperti yang ditunjukkan pada Gambar 4.3. *Jong*, kapal berukuran besar yang biasa digunakan di wilayah perairan Asia Tenggara dan Laut Cina Selatan, serta beberapa kapal kecil lainnya, digambarkan memiliki layar persegi yang dimiringkan (Manguin, 1980). Selain itu, Joan Blaeu, pembuat peta asal Belanda, juga menggambarkan kapal di *Atlas Maior* yang diterbitkannya pada tahun 1662, seperti yang ditunjukkan pada Gambar 4.4. Kapal yang digambarkan merupakan kapal jenis *kora-kora*, kapal asal Maluku, yang dioperasikan sebagai kapal berbendera Belanda (van der Peter C.J., 2005). Berdasarkan pendataan persebaran jenis kapal di wilayah Asia Tenggara dan Pasifik sekitar tahun 1750, diketahu bahwa kapal di wilayah Kepulauan Asia Tenggara memiliki layar tanja (Doran, 1974). Layar persegi yang dimiringkan juga disebutkan dalam berbagai catatan lain oleh beberapa pelaut asal Inggris dan Australia di sepanjang abad ke-19 Masehi, salah satunya pada Gambar 4.5. Kapal-kapal ini merupakan kapal pemburu teripang yang beroperasi hingga ke perairan di bagian utara Australia (Salam, 2016). Dari keseluruhan penggambaran mengenai kapal ini, setidaknya dapat diketahui bahwa pada masa awal kedatangan penjelajah Eropa hingga sekitar abad ke-19 Masehi, layar yang umum digunakan di wilayah Kepulauan Asia Tenggara merupakan layar persegi yang dimiringkan, atau dengan kata lain layar tanja. Akan tetapi, terdapat jarak yang cukup jauh antara kedatangan penjelajah Eropa dengan masa ketika Perahu Kuno Punjulharjo digunakan.

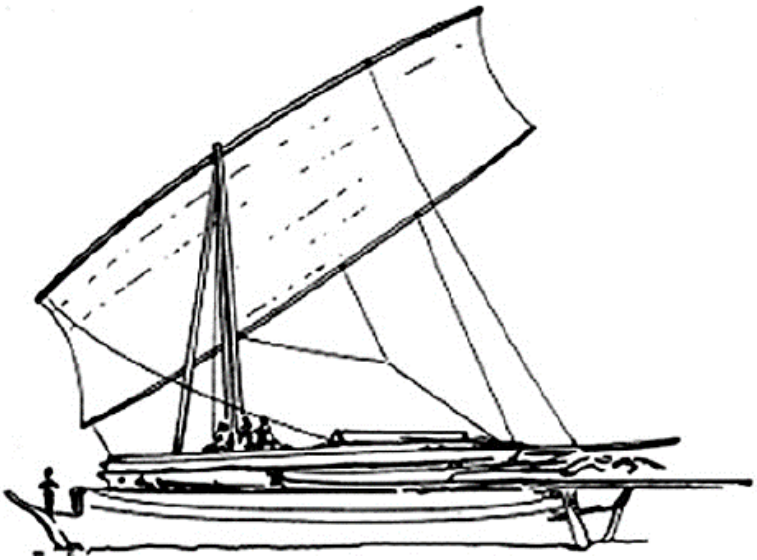
Perlu diketahui bahwa tradisi pelayaran, termasuk juga teknologi di dalamnya, merupakan sesuatu yang sangat konservatif. Bukan tidak mungkin bahwa suatu teknologi dapat bertahan dan terus digunakan tanpa mengalami variasi yang signifikan selama ratusan tahun. Salah satu bukti pendukungnya adalah beberapa catatan penjelajah dari Cina. Dalam catatan yang berasal dari abad ke-3 Masehi, *bo*, sebutan untuk kapal dari Asia Tenggara, digambarkan memiliki ukuran besar dan digerakkan dengan beberapa layar. Layar tidak menghadap ke depan, tetapi dipasang dengan posisi miring. Selain itu, catatan lain dari abad ke-8 juga menggambarkan bahwa *bo* berukuran besar, tanpa paku besi, memiliki lambung berlapis, dan digerakkan dengan beberapa layar (Manguin, 1993). Catatan ini menunjukkan bahwa setidaknya ketika penjelajah dari Cina tersebut datang ke wilayah Asia Tenggara, layar persegi

yang dimiringkan, yang merupakan ciri layar tanja, merupakan layar yang telah umum digunakan oleh kapal-kapal di sana. Hal ini bukan merupakan sesuatu yang tidak mungkin, mengingat bahwa layar tanja berkembang dari pengaruh teknologi pelayaran yang digunakan di Samudra Hindia (Horridge, 1995). Pelayaran di Asia Tenggara sendiri diperkirakan telah terhubung dengan Samudra Hindia sejak sekitar tahun 200-100 SM (Campbell G., 2016). Dapat diperkirakan bahwa selama periode tersebut, layar tanja mulai dikembangkan dan telah mencapai bentuk tetapnya ketika catatan-catatan asal Cina dituliskan. Layar ini terus digunakan hingga memasuki masa awal kedatangan penjelajah dari Eropa dan bahkan beberapa abad setelahnya. Layar tanja mulai digantikan dengan layar gaya Eropa pada abad ke-19 Masehi. Kapal-kapal *schooner* asal Eropa mulai banyak beroperasi di wilayah Kepulauan Asia Tenggara dan menginspirasi pelaut setempat untuk mengadopsi layarnya (Liebner, 2002).

Gambar 4.4 *Kora-kora* Berbendera Belanda, oleh Joan Blaeu, 1662
Sumber: van der Peter C.J., 2005

Berdasarkan penggambaran kapal di wilayah Kepulauan Asia Tenggara yang berasal dari berbagai masa, setidaknya diketahui bahwa layar tanja telah umum digunakan pada kapal yang dibuat dan dioperasikan di perairan tersebut sejak abad ke-3 Masehi dan penggunaannya bertahan hingga abad ke-19 Masehi. Hal ini kemudian akan dibandingkan dengan Perahu Kuno Punjulharjo untuk mengetahui layar yang digunakannya. Dari segi lokasi, lokasi ditemukannya Perahu Kuno Punjulharjo berada di pesisir utara pulau Jawa. Hal ini dapat menunjukkan bahwa daerah operasional Perahu Kuno Punjulharjo setidaknya berada di perairan Asia Tenggara. Selain itu, teknologi pembangunan serta penggunaan kayu khas Asia Tenggara yang ditemukan pada lambung Perahu Kuno Punjulharjo juga menunjukkan bahwa Perahu Kuno Punjulharjo

bukan merupakan kapal dengan teknologi impor yang datang dari luar wilayah tersebut. Dari segi waktu, Perahu Kuno Punjulharjo diperkirakan berasal dari abad ke-7 hingga ke-8 Masehi. Berdasarkan hal-hal tersebut, dapat disimpulkan bahwa Perahu Kuno Punjulharjo memiliki layar yang umum digunakan di wilayah dan masa tersebut, yaitu layar tanja.



Gambar 4.5 Kapal Pelaut Bugis di Arnhem Land, Australia, oleh William Westall, 1803
Sumber: Salam, 2016

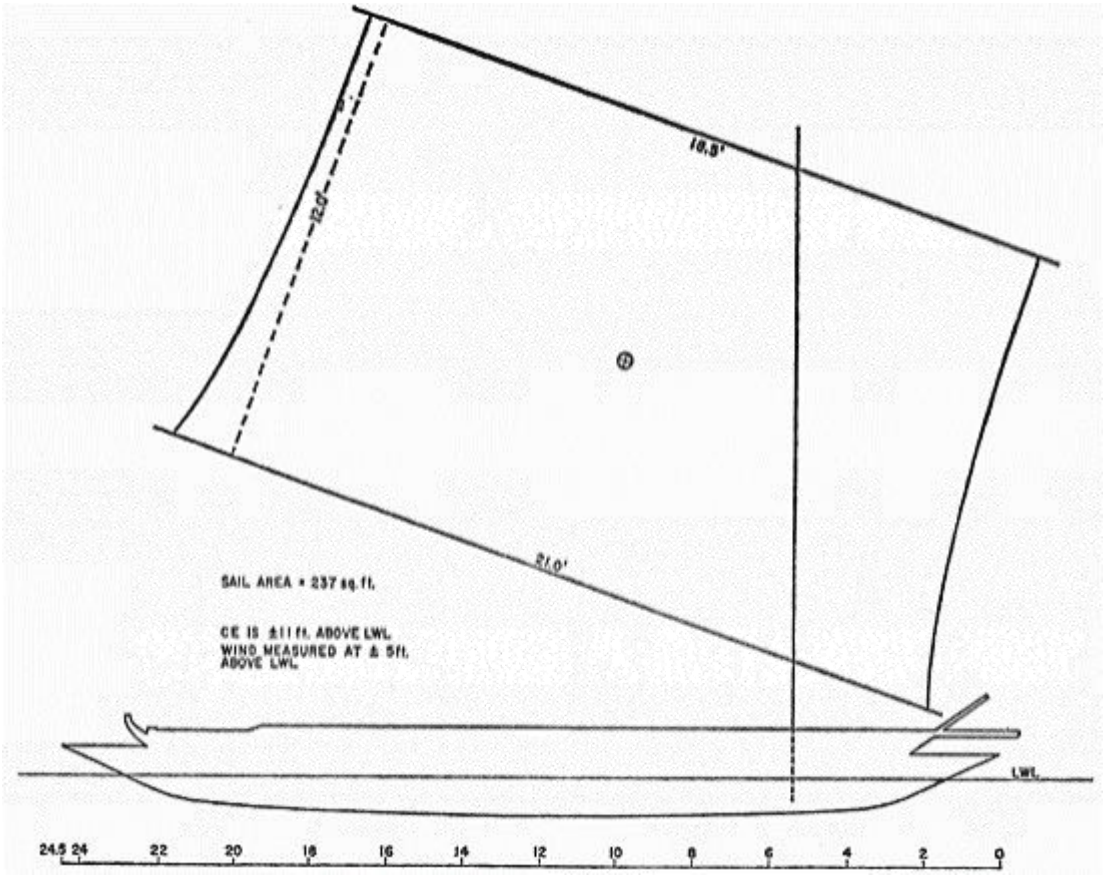
Jumlah layar pada kapal yang menggunakan layar tanja dapat bervariasi. Penggambaran kapal yang berasal dari catatan pelaut dan penjelajah Eropa menunjukkan bahwa baik kapal yang menggunakan satu layar maupun dua layar dapat ditemukan di perairan Kepulauan Asia Tenggara. Begitu pula pahatan yang berada di Candi Borobudur, menunjukkan variasi kapal yang memiliki satu layar dan dua layar. Bahkan, catatan penjelajah Cina menyebutkan bahwa kapal yang sangat besar dapat memiliki hingga empat layar. Berdasarkan ukuran Perahu Kuno Punjulharjo, serta kedekatan masanya dengan masa pembangunan Candi Borobudur, maka rekonstruksi desain layar akan dilakukan dengan variasi jumlah layar berupa satu layar dan dua layar.

4.2. Ukuran Layar

Setelah jenis layar ditentukan, perlu diketahui perkiraan ukuran layar yang digunakan pada Perahu Kuno Punjulharjo. Seperti yang telah diketahui sebelumnya, bahwa tidak terdapat sisa-sisa dari layar pada situs ditemukannya Perahu Kuno Punjulharjo. Maka dari itu, untuk menentukan ukuran layar, digunakan layar sejenis dari kapal lain sebagai data pembanding. Kapal yang akan dijadikan pembanding merupakan kapal tradisional dari berbagai daerah yang menggunakan layar tanja. Kapal-kapal tersebut adalah *vinta*, *peledang*, dan *padewakang*.

4.2.1. Model *Vinta*

Vinta merupakan kapal tradisional yang berasal dari Filipina. *Vinta* digunakan oleh masyarakat di sekitar Kepulauan Sulu untuk berbagai keperluan, mulai transportasi, menangkap ikan, hingga tempat tinggal. Lambung *vinta* tidak memiliki geladak, terdiri dari lunas yang dibuat dari batang pohon yang digali dan beberapa lajur kayu, serta memiliki cadik ganda. Layar yang digunakan pada *vinta* adalah layar tanja, meski penggunaannya mulai berkurang.

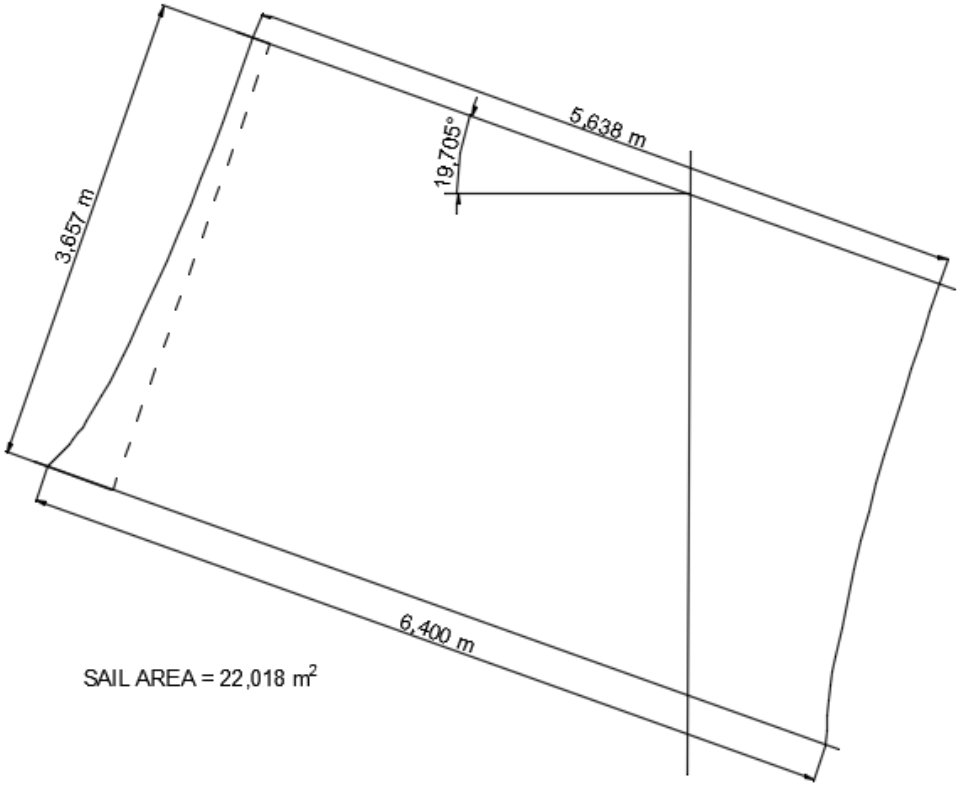


Gambar 4.6 *Sail Plan Vinta* Nardi
Sumber: Doran, 1972

Model layar tanja pada *vinta* yang akan digunakan sebagai pembanding diambil dari Nardi, sebuah *vinta* yang berfungsi sebagai kapal nelayan yang berasal dari Pulau Tawi Tawi, Kepulauan Sulu, Filipina (Doran, 1972). *Sail plan* kapal tersebut ditunjukkan pada Gambar 4.6. Layar tanja pada kapal ini memiliki lebar (*chord*) sepanjang 3,658 m. Panjang (*span*) pada *head* dan *foot* layar ini berbeda, dengan *head* sepanjang 5,639 m dan *foot* sepanjang 6,4 m. Hal ini membuat layar pada *vinta* tersebut berbentuk trapesium, dengan luas permukaan layar sebesar 22,018 m^2.

Pengukuran pada bagian-bagian lain dilakukan pada gambar. Hal ini dilakukan untuk mengetahui posisi pemasangan layar terhadap kapal. Sebelum dilakukan pengukuran, gambar

yang dijadikan acuan digambar ulang untuk memperjelas garis-garis yang dibutuhkan sehingga pengukuran dapat dilakukan dengan mudah. Berdasarkan gambar, *yard* terpasang pada *mast* setinggi 4,485 m dari tinggi kapal (H). Posisi *mast* terletak pada jarak 0,22 kali panjang kapal keseluruhan (L_{OA}) dari ujung depan kapal. Layar memiliki kemiringan sebesar 19,705° terhadap sumbu horizontal. Model layar ini selanjutnya akan disebut Vinta-Ma. Model dapat dilihat pada Gambar 4.7.



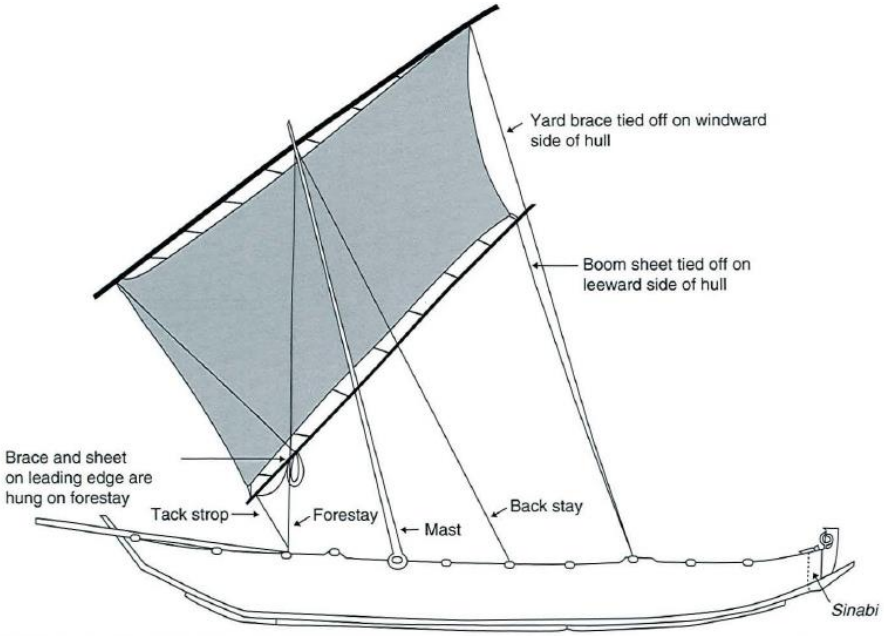
Gambar 4.7 Model Vinta-Ma

4.2.2. Model *Peledang*

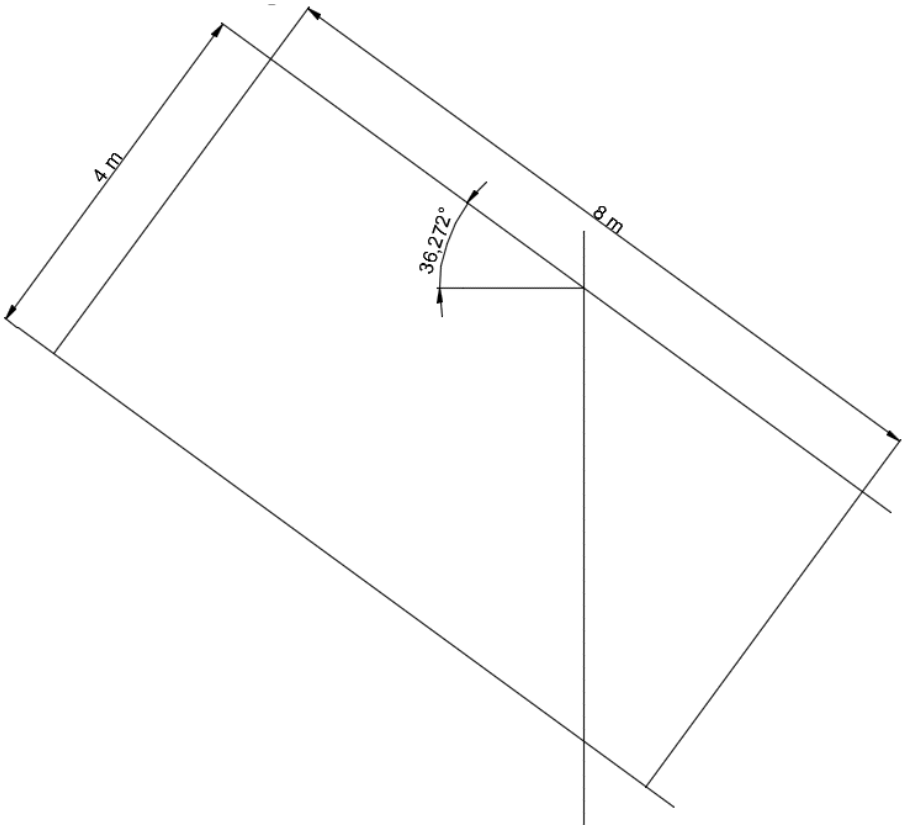
Peledang merupakan kapal tradisional yang berasal dari Desa Lamalera A, Kabupaten Lembata, Nusa Tenggara Timur. *Peledang* digunakan oleh masyarakat setempat untuk berburu hewan laut, seperti ikan pari, ikan mola-mola, penyu belimbing, dan yang paling terkenal, paus. Lambung *peledang* tidak memiliki geladak dan masih dibuat dengan cara *lashed-lug*, teknologi khas Kepulauan Asia Tenggara yang telah digunakan sejak lama. Layar yang digunakan pada *peledang* adalah layar tanja yang dibuat dari daun lontar.

Model layar tanja pada *peledang* yang akan digunakan sebagai pembanding diambil dari Sili Téna (Dwyer & Akerman, 1996). Sketsa kapal tersebut ditunjukkan pada Gambar 4.8. Layar tanja pada kapal ini memiliki *chord* sepanjang 4 m. *Span* pada *head* dan *foot* memiliki

panjang yang sama, yaitu 8 m. Bentuk keseluruhan dari layar merupakan persegi, dengan luas permukaan layar sebesar 32 m^2.



Gambar 4.8 Sketsa Peledang Sili Téna
Sumber: Dwyer & Akerman, 1996



Gambar 4.9 Model Peledang-Ma

Pengukuran pada bagian-bagian lain dilakukan pada gambar. Hal ini dilakukan untuk mengetahui posisi pemasangan layar terhadap kapal. Sebelum dilakukan pengukuran, gambar yang dijadikan acuan digambar ulang untuk memperjelas garis-garis yang dibutuhkan sehingga pengukuran dapat dilakukan dengan mudah. Berdasarkan gambar, *yard* terpasang pada *mast* setinggi 6,325 m dari H. Posisi *mast* terletak pada jarak $0{,}26L_{OA}$ dari ujung depan kapal. Layar memiliki kemiringan sebesar 36,272° terhadap sumbu horizontal. Model layar ini selanjutnya akan disebut Peledang-Ma. Model dapat dilihat pada Gambar 4.9.

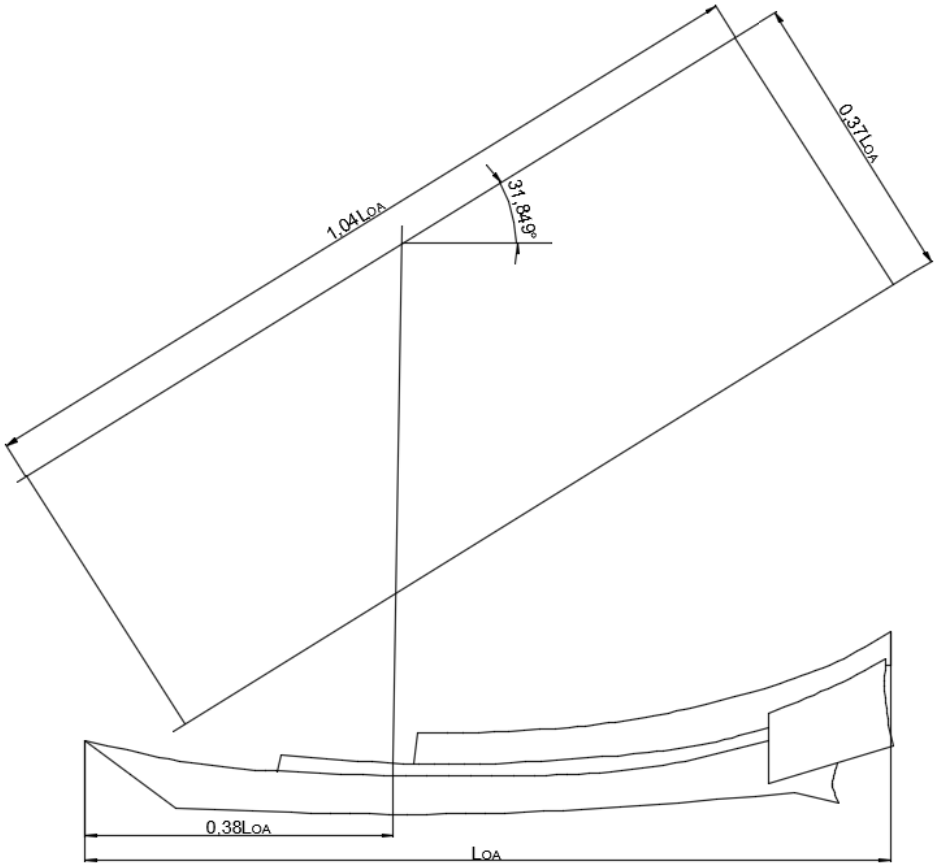
4.2.3. Model *Padewakang*

Padewakang merupakan kapal kuno yang berasal dari Sulawesi Selatan. Pada masanya, *padewakang* merupakan kapal yang digunakan oleh suku Mandar, Makassar, dan Bugis untuk berdagang. Lambung *padewakang* berukuran besar dengan geladak tertutup. Layar yang digunakan pada *padewakang* adalah layar tanja.

Gambar 4.10 Foto *Padewakang* dari Nationaal Museum van Wereldculturen
Sumber: seasiapasts.com

Model layar tanja pada *padewakang* yang akan digunakan sebagai pembanding diambil dari sebuah foto *padewakang* yang sedang berlayar (Seasiapasts, 2017). Foto ditunjukkan pada Gambar 4.10. Tidak terdapat ukuran yang diketahui pada foto, sehingga ukuran layar harus didapatkan dengan cara mengukur bentuk layar yang terlihat pada foto. Sebelum dilakukan pengukuran, foto yang dijadikan acuan digambar ulang untuk memperjelas garis-garis yang dibutuhkan sehingga pengukuran dapat dilakukan dengan mudah. Ukuran layar akan dinyatakan dalam perbandingan terhadap panjang kapal yang terlihat. Hasil pengukuran

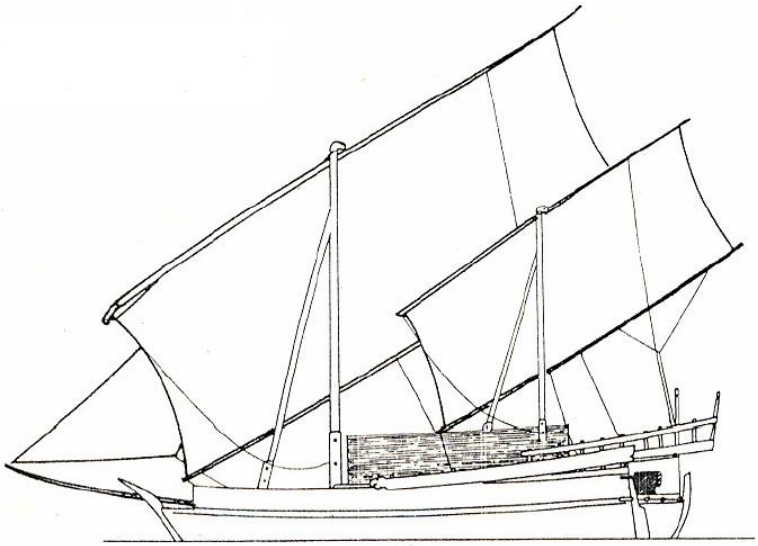
ditunjukkan pada Gambar 4.11. Layar tanja pada kapal ini memiliki diasumsikan berbentuk persegi panjang. Layar ini memiliki *chord* sepanjang $0{,}37L_{OA}$ dan *span* sepanjang $1{,}04L_{OA}$. *Yard* terpasang pada *mast* setinggi $0{,}66L_{OA}$ dari H. Posisi *mast* terletak pada jarak $0{,}38L_{OA}$ dari ujung depan kapal. Layar memiliki kemiringan sebesar 31,849° terhadap sumbu horizontal. Model layar ini selanjutnya akan disebut Padewakang-Ma.



Gambar 4.11 Hasil Pengukuran Foto Padewakang

4.2.4. Variasi Jumlah Layar

Terdapat dua susunan layar yang akan dibuat berdasarkan jumlahnya, yaitu satu layar dan dua layar. Pada susunan satu layar, masing-masing model akan digunakan langsung sebagai layar pada kapal. Namun, pada susunan dua layar, dibutuhkan dua model layar untuk digunakan pada kapal. Berdasarkan catatan yang menggambarkan kapal dengan dua layar tanja, tiang yang terletak di belakang mempunya ukuran yang lebih kecil dibandingkan dengan tiang yang lain, sehingga pada kapal terdapat *main mast* (di depan) dan *mizzen mast* (di belakang). Layar pada *mizzen mast* (*mizzen sail*) lebih kecil dibandingkan dengan layar pada *main mast* (*main sail*).



Gambar 4.12 Contoh Gambar Kapal dengan Dua Layar Tanja
Sumber: Liebner, 2002

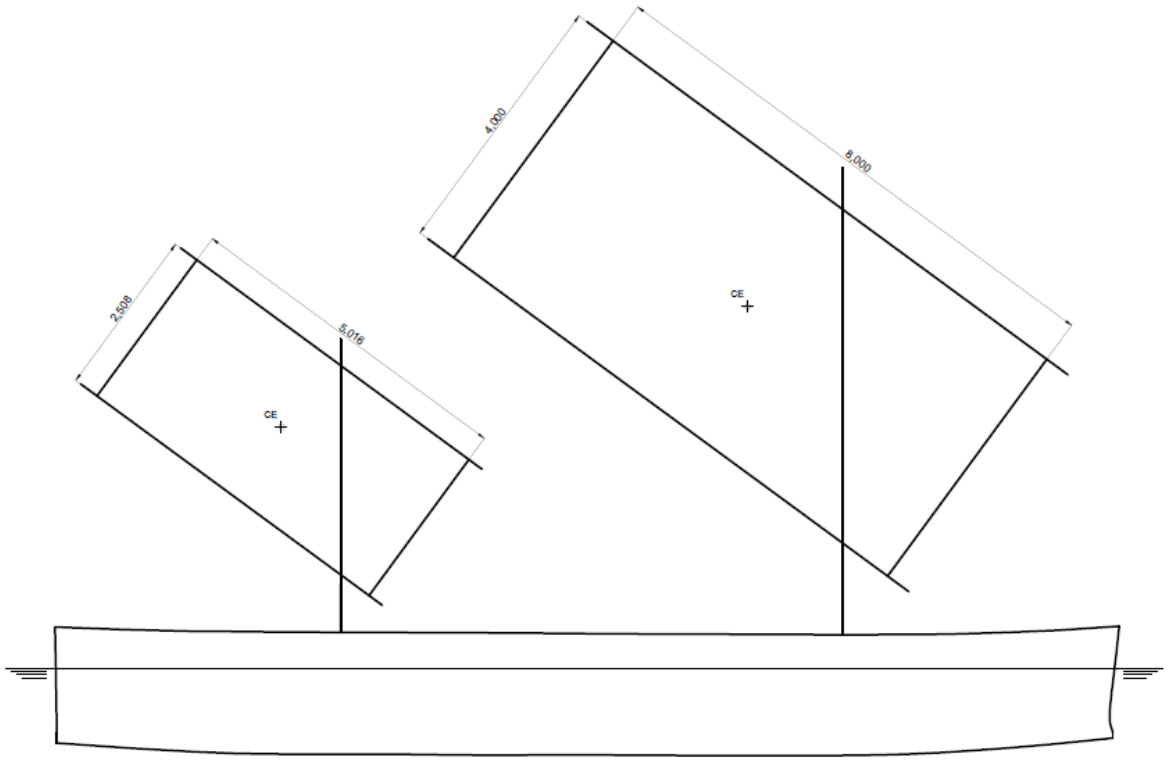
Untuk mendapatkan ukuran *mizzen sail*, perbandingan ukuran akan dilakukan terhadap *main sail* yang digunakan. Perbandingan ukuran didasarkan pada gambar, di mana *span mizzen sail* akan dinyatakan dalam perbandingan terhadap *span main sail*. Ukuran ini kemudian diterapkan pada model yang dijadikan *main sail* untuk mendapatkan *mizzen sail* yang akan dipasangkan dengan masing-masing model. Gambar yang akan digunakan untuk perbandingan terdapat pada Gambar 4.12. Hasil pengukuran pada gambar menunjukkan bahwa panjang *span mizzen sail* memiliki ukuran 0,627 kali *span main sail*. Pada susunan layar yang menggunakan Vinta-Ma sebagai *main sail*, perbandingan yang dilakukan menghasilkan model Vinta-Mi sebagai *mizzen sail*. Pada susunan layar yang menggunakan Peledang-Ma sebagai *main sail*, perbandingan yang dilakukan menghasilkan model Peledang-Mi sebagai *mizzen sail*. Pada susunan layar yang menggunakan Padewakang-Ma sebagai *main sail*, perbandingan yang dilakukan menghasilkan model Padewakang-Mi sebagai *mizzen sail*.

4.3. Desain Layar

Setelah ukuran untuk berbagai model layar didapatkan, desain untuk tiap-tiap model dibuat. Susunan layar yang akan diaplikasikan pada Perahu Kuno Punjulharjo akan dibuat dalam bentuk dua dimensi dan menghasilkan *sail plan*. Model tiga dimensi untuk masing-masing layar akan digunakan untuk melakukan perhitungan gaya yang dihasilkan pada layar.

4.3.1. *Sail Plan*

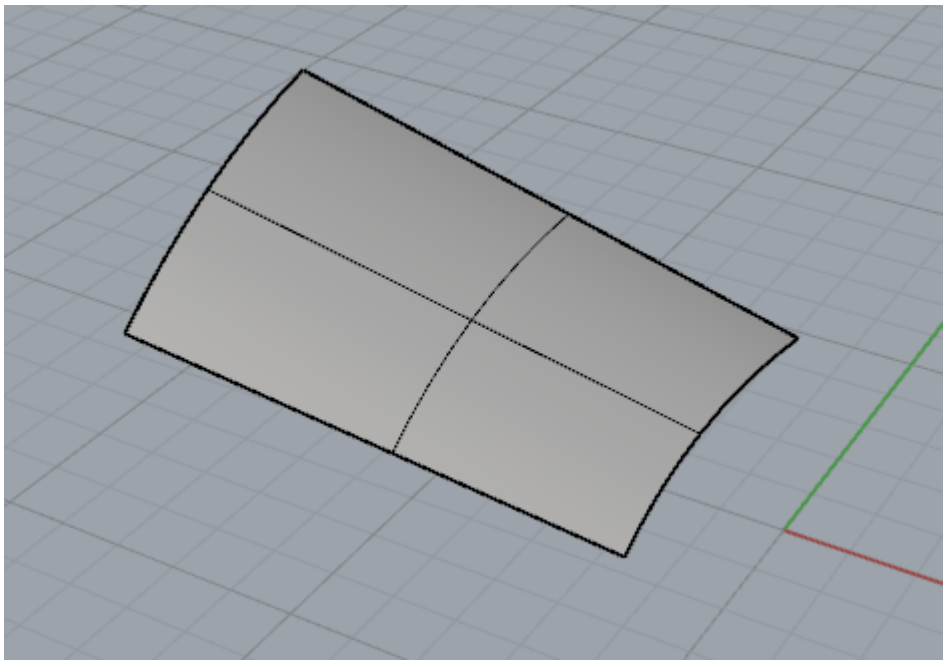
Sail plan akan dibagi menjadi dua berdasarkan jumlah layar yang digunakan, yaitu satu layar dan dua layar. Pada masing-masing jumlah, terdapat tiga model yang akan diterapkan, yaitu model Vinta, Peledang, dan Padewakang. Secara keseluruhan, dibuat enam *sail plan*. Pada *sail plan* satu layar yang menggunakan model Vinta, model layar yang akan digunakan adalah Vinta-Ma dan *sail plan* yang dihasilkan akan disebut Vinta-1, sedangkan susunan dua layar akan menggunakan model Vinta-Ma dan Vinta-Mi, dan *sail plan* yang dihasilkan akan disebut Vinta-2. Pada *sail plan* satu layar yang menggunakan model Peledang, model layar yang akan digunakan adalah Peledang-Ma dan *sail plan* yang dihasilkan akan disebut Peledang-1, sedangkan susunan dua layar akan menggunakan model Peledang-Ma dan Peledang-Mi, dan *sail plan* yang dihasilkan akan disebut Vinta-2. Pada *sail plan* satu layar yang menggunakan model Padewakang, model layar yang akan digunakan adalah Padewakang-Ma dan *sail plan* yang dihasilkan akan disebut Padewakang-1, sedangkan susunan dua layar akan menggunakan model Padewakang-Ma dan Padewakang-Mi, dan *sail plan* yang dihasilkan akan disebut Vinta-2. Contoh *sail plan* untuk satu layar ditunjukkan pada Gambar 4.13. Seluruh gambar *sail plan* dicantumkan pada Lampiran B.



Gambar 4.13 *Sail Plan* Peledang-2

4.3.2. Model Tiga Dimensi

Model tiga dimensi dibuat untuk setiap model layar. Model ini digunakan untuk melakukan perhitungan *lift* dan *drag* yang dihasilkan pada layar. Perhitungan tersebut akan dilakukan dengan bantuan perangkat *computational fluid dynamics* (CFD). Perhitungan dilakukan dalam keadaan layar kaku dan tanpa puntiran (*rigid*, *untwisted*), dengan ketebalan layar diasumsikan 3 mm (Nasirudin, 2002). Layar memiliki *camber* di tengah *chord* dengan nilai sebesar 1/10. *Camber* ini dipilih karena menghasilkan gaya dorong paling besar (Di Piazza, Pearthree, & Paillé, 2014). Setiap model layar dibuat dalam berbagai variasi *angle of attack* menyesuaikan dengan analisis teknis yang akan dilakukan. Contoh model tiga dimensi layar ditunjukkan pada Gambar 4.14. Seluruh model tiga dimensi dari layar dicantumkan pada Lampiran C.



Gambar 4.14 Model Tiga Dimensi Peledang-Ma

BAB 5
ANALISIS TEKNIS MODEL LAYAR DAN PEMBUATAN MODEL KAPAL

5.1. Analisis Teknis

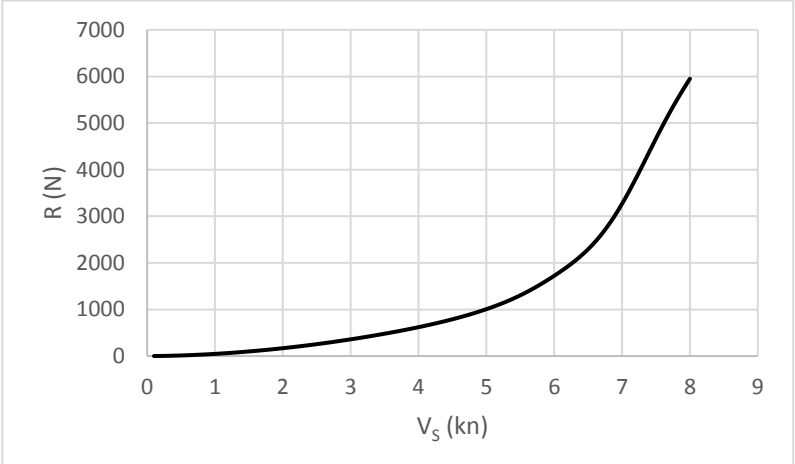
Analisis teknis dilakukan pada tiap-tiap model layar. Tujuan dari analisis teknis adalah untuk mendapatkan gaya yang dihasilkan pada layar. Gaya ini kemudian akan diaplikasikan pada lambung Perahu Kuno Punjulharjo sebagai tenaga penggeraknya berdasarkan *sail plan* yang telah dibuat. Hasil akhir yang didapatkan adalah kecepatan berlayar Perahu Kuno Punjulharjo dalam berbagai variasi *sail plan* dan *point of sail*. Sebelum analisis pada layar dilakukan, perlu diketahui berbagai data teknis dari Perahu Kuno Punjulharjo.

5.1.1. Data Teknis Perahu Kuno Punjulharjo

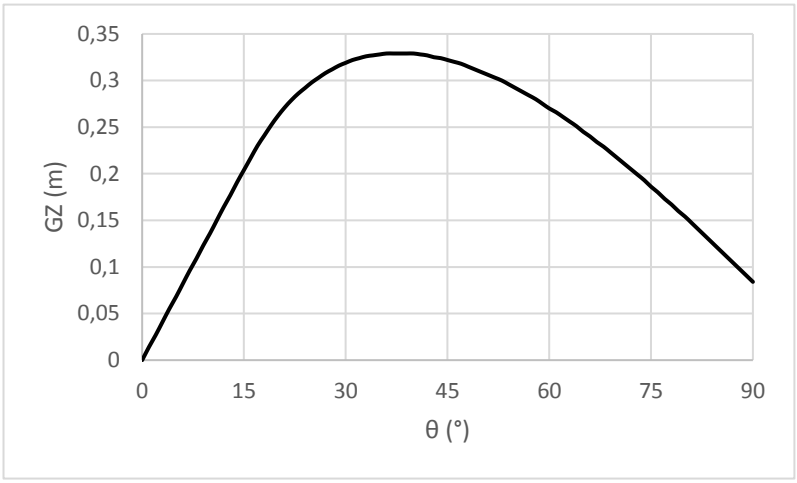
Data teknis dari lambung Perahu Kuno Punjulharjo didapatkan berdasarkan rekonstruksi yang telah dilakukan pada lambung kapal tersebut (Wibowo, 2020). Hasil rekonstruksi yang digunakan berupa *lines plan* dan model tiga dimensi. Ukuran utama Perahu Kuno Punjulharjo ditampilkan pada Tabel 5.1. Data teknis Perahu Kuno Punjulharjo terdapat pada Lampiran A.

Tabel 5.1 Ukuran Utama Perahu Kuno Punjulharjo

Ukuran	Nilai
L_{OA}	15,821 m
L_{WL}	15,741 m
$B_{MIDSHIP}$	3,740 m
B_{MAX}	4,052 m
H	18,047 m
T	1,300 m

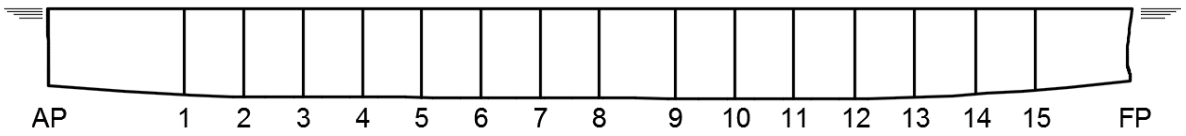


Gambar 5.1 Grafik Nilai Hambatan terhadap Kecepatan Kapal



Gambar 5.2 Grafik Nilai GZ terhadap Sudut *Heeling*

Nilai hambatan serta stabilitas dari Perahu Kuno Punjulharjo didapatkan dengan bantuan *software*. Nilai hambatan Perahu Kuno Punjulharjo digambarkan dalam grafik pada Gambar 5.1. Nilai GZ pada berbagai sudut *heeling* digambarkan dalam grafik pada Gambar 5.2.



Gambar 5.3 *Underwater Profile*

Center of lateral resistance (CLR) dicari pada luasan penampang tampak samping kapal yang berada di bawah permukaan air (*underwater profile*). Luas *underwater profile* didapatkan dengan melakukan integral metode simpson pada kedalaman air di tiap-tiap *station* berdasarkan *sheer plan* kapal. Integral metode simpson digunakan karena persamaan dari lambung kapal tidak diketahui, sehingga luasan ditentukan berdasarkan garis-garis yang menyusun bidang tersebut, seperti yang digambarkan pada Gambar 5.3. Kemudian, titik berat luasan dari *underwater profile* dicari untuk mendapatkan posisi CLR. Penentuan lokasi titik berat luasan dilakukan dengan cara mencari titik berat gabungan dari tiap-tiap garis *station* penyusun *underwater profile*. Lokasi titik berat gabungan digambarkan dalam jarak horizontal dari AP (CLR_x) dan jarak vertikal dari sarat (CLR_z). Lokasi titik berat garis *station* berada di tengah garis. Jika x merupakan jarak horizontal garis *station* terhadap AP dan z merupakan panjang *station* yang tercelup di bawah air, maka titik berat gabungan dapat dinyatakan dalam persamaan

$$CLR_x = \frac{\sum xz}{\sum z} \quad \text{.....(5.1)}$$

$$CLR_z = \frac{\sum 0{,}5z^2}{\sum z} \quad \text{..... (5.2)}$$

Perhitungan CLR dituliskan pada Tabel 5.2. Berdasarkan perhitungan, letak CLR diketahui berada pada jarak 7,652 m dari AP dengan kedalaman 0,633 m dari permukaan air.

Tabel 5.2 Perhitungan CLR

ST	x (m)	z (m)	xz (m^2)	$0{,}5z^2$ (m^2)
AP	0,000	1,115	0,000	0,622
1	1,970	1,240	2,443	0,769
2	2,840	1,272	3,612	0,809
3	3,700	1,280	4,735	0,819
4	4,560	1,280	5,837	0,819
5	5,420	1,284	6,961	0,825
6	6,280	1,294	8,124	0,837
7	7,140	1,292	9,225	0,835
8	8,000	1,292	10,335	0,835
9	9,100	1,298	11,813	0,843
10	9,960	1,300	12,943	0,844
11	10,820	1,299	14,060	0,844
12	11,710	1,298	15,194	0,842
13	12,570	1,281	16,103	0,821
14	13,460	1,236	16,642	0,764
15	14,320	1,173	16,797	0,688
FP	15,725	0,000	0,000	0,000
Σ		**20,234**	**154,824**	**12,814**
CLR_x	**=**	**7,652 m**		
CLR_z	**=**	**0,633 m**		

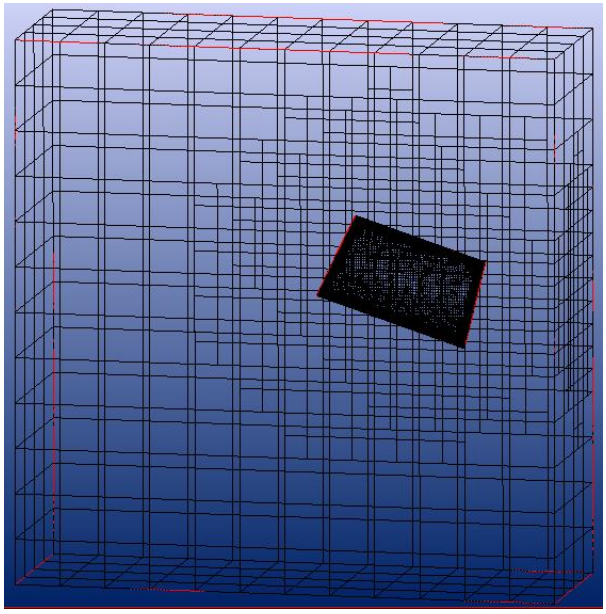
5.1.2. *Lift* dan *Drag*

Gaya yang dihasilkan ketika layar berinteraksi dengan angin didapatkan dengan bantuan perangkat *computational fluid dynamics* (CFD). Simulasi CFD dilakukan pada model tiga dimensi layar yang telah dibuat. Data mengenai ukuran layar ditunjukkan pada Tabel 5.3. Masing-masing model layar disimulasikan dalam berbagai nilai *angle of attack* dengan rentang antara 5° hingga 45° untuk *upwind* dan 90° untuk *downwind*.

Tabel 5.3 Data Ukuran Layar

Model	Main			Mizzen		
	Span (m)		Chord (m)	Span (m)		Chord (m)
	Head	Boom		Head	Boom	
Vinta	5,639	6,400	3,658	3,536	4,013	2,294
Peledang	8,000	8,000	4,000	5,016	5,016	2,508
Padewakang	16,454	16,454	5,854	10,317	10,317	3,670

Untuk melakukan simulasi, layar ditempatkan pada sebuah *domain* tiga dimensi. *Domain* dibuat dengan ukuran tinggi sebesar 4 kali panjang *chord*, lebar 2-4 kali panjang *chord* menyesuaikan *angle of attack* yang akan disimulasikan, dan panjang 5 kali panjang *chord*, 1 *chord* di depan model dan 4 *chord* di belakang model. *Domain* merupakan batasan untuk aliran fluida. Fluida yang dialirkan pada layar adalah udara pada suhu 25°C, dengan massa jenis sebesar 1,2 kg/m^3 dan *dynamic viscosity* sebesar 1,85×10^{-5} Pa.s. Kecepatan udara yang digunakan dalam simulasi sebesar 5 knot (2,5722 m/s).



Gambar 5.4 Model Layar untuk Simulasi CFD

Model layar yang telah ditempatkan dalam *domain* akan dibagi menjadi elemen-elemen untuk digunakan dalam simulasi CFD. Pembagian elemen dibagi menjadi beberapa tahap. Tahap yang pertama dilakukan adalah *initial mesh*. *Initial mesh* dilakukan untuk membagi seluruh *domain* menjadi beberapa elemen sama besar. Jumlah elemen yang digunakan pada *initial mesh* berkisar antara 400 hingga 1000 elemen, menyesuaikan dengan model layar serta rekomendasi yang diberikan oleh *software*. Tahap berikutnya adalah *adapt to geometry*. *Adapt to geometry* berfungsi untuk membuat elemen-elemen dalam *domain* menjadi semakin rapat dan mendekati bentuk model yang akan disimulasikan. Hal ini dilakukan dengan *refinement*, yaitu pembagian elemen menjadi ukuran-ukuran yang lebih kecil. *Refinement* dilakukan di kurva penyusun dan permukaan model layar, dengan jumlah *refinement* yang digunakan adalah 6. Tahap *adapt to geometry* akan menghasilkan jumlah elemen keseluruhan sebanyak 100.000 hingga 200.000, bergantung pada model layar. Elemen ini kemudian memasuki tahap *snap to geometry*, di mana elemen yang sudah dibagi disesuaikan dengan bentuk model yang

sesungguhnya. Pengaturan pada *snap to geometry* dibiarkan sesuai pengaturan *software* (*default*) untuk menghindari munculnya kesalahan ukuran elemen. Tahap berikutnya adalah *optimize*. *Optimize* dilakukan untuk menghindari kecacatan pada elemen yang telah dibuat. Tahap terakhir adalah *viscous layer*. Tahap ini dilakukan untuk membuat *first layer thickness* yang berfungsi untuk menggambarkan aliran di sekitar model seakurat mungkin mendekati aliran sesungguhnya. Pengaturan pada *first layer thickness* telah dibuat secara otomatis oleh *software*. Setelah seluruh tahap dilakukan, model akan memiliki jumlah elemen antara 300.000 hingga 500.000, bergantung pada model layar yang dibuat. Model layar yang telah dibagi menjadi elemen-elemen ditunjukkan pada Gambar 5.4.

Tabel 5.4 Hasil Simulasi CFD pada Model Layar

Model	**α**	**Main**		**Mizzen**	
		F_X	**F_Y**	**F_X**	**F_Y**
	(°)	**(N)**	**(N)**	**(N)**	**(N)**
Vinta	5	2,662	21,103	1,045	7,809
	15	16,162	62,053	6,805	24,276
	25	47,647	106,019	17,135	38,174
	35	85,750	124,331	33,620	48,744
	45	127,217	128,509	49,876	50,373
	90	210,548	-1,314	82,416	-0,511
Peledang	5	7,401	57,854	2,213	18,224
	15	26,296	112,487	9,133	41,569
	25	72,843	173,634	28,518	67,894
	35	132,250	199,617	54,530	78,916
	45	152,611	158,405	73,532	76,237
	90	356,651	-0,088	139,899	-0,027
Padewakang	5	15,430	154,842	6,056	56,408
	15	82,887	365,052	29,403	128,269
	25	256,763	604,876	86,576	205,780
	35	412,220	620,738	161,535	243,243
	45	591,105	610,276	232,079	239,499
	90	1235,777	0,240	485,776	0,084

Setelah pengaturan elemen pada model selesai, pengaturan *solver* dilakukan. Fluida yang digunakan adalah udara dengan spesifikasi sesuai dengan yang telah ditentukan pada saat pembuatan *domain*, yaitu massa jenis sebesar 1,2 kg/m^3 dan *dynamic viscosity* sebesar 1,85×10^{-5} Pa.s. Kecepatan udara yang digunakan adalah 5 knot, atau setara 2,5722 m/s. *Body motion* diatur pada 1 derajat kebebasan, yaitu sumbu x. Hal ini digunakan untuk menggambarkan arah gerak fluida yang hanya terdapat pada satu arah, dari sumbu x positif menuju sumbu x negatif. Sumbu x dipilih karena *angle of attack* pada model layar telah diposisikan terhadap sumbu x.

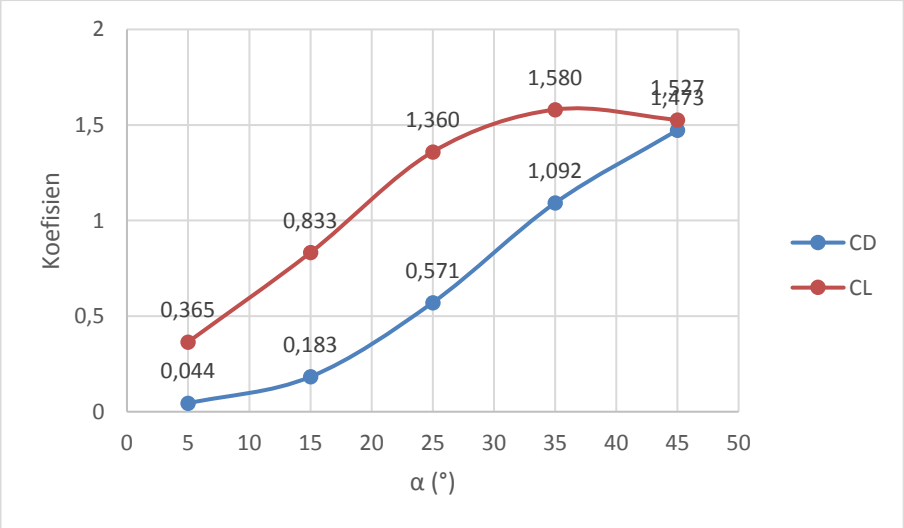
Pengaturan lain pada *solver* dibiarkan sesuai pengaturan *software* (*default*). Setelah pengaturan *solver* selesai, simulasi dapat dilakukan. Hasil simulasi yang didapat berupa gaya pada sumbu x dan y, ditunjukkan pada Tabel 5.4.

Drag merupakan gaya yang searah dengan arah angin, sedangkan *lift* merupakan gaya yang tegak lurus terhadap *drag*. Untuk mendapatkan nilai *lift* dan *drag*, kedua koefisien gaya tersebut (C_L dan C_D) perlu diketahui. Nilai C_D dan C_L bisa didapatkan dengan menggunakan persamaan (2.9) dan (2.10), sehingga didapatkan

$$C_D = \frac{2F_D}{\rho_a A V^2} \quad (5.3)$$

$$C_L = \frac{2F_L}{\rho_a A V^2} \quad (5.4)$$

Pada hasil simulasi, F_X merupakan gaya yang searah dengan arah angin dan F_Y merupakan gaya yang tegak lurus dengan arah angin. Maka dari itu, F_X dan F_Y berperan sebagai F_D dan F_L untuk nilai V = 5 knot. Dengan memasukkan massa jenis udara yang digunakan pada simulasi (1,2 kg/m^3) serta luas permukaan masing-masing layar, nilai C_D dan C_L untuk tiap layar pada berbagai nilai *angle of attack* didapatkan. Contoh nilai C_D dan C_L terhadap berbagai variasi α digambarkan pada Gambar 5.5. Nilai C_D dan C_L untuk setiap model layar ditunjukkan pada Tabel 5.5. Nilai C_L dan C_D tidak akan terpengaruh oleh perbedaan kecepatan (Di Piazza, Pearthree, & Paillé, 2014). Oleh sebab itu, meski simulasi yang dilakukan menggunakan kecepatan udara sebesar 5 knot, hasil koefisien yang didapatkan bisa digunakan untuk menentukan nilai *lift* dan *drag* pada berbagai variasi kecepatan lain.



Gambar 5.5 Grafik Nilai Koefisien Layar Model Peledang-Mi

Tabel 5.5 Nilai C_D dan C_L dari Tiap Model Layar

Model	α (°)	Main		Mizzen	
		C_D	C_L	C_D	C_L
Vinta	5	0,030	0,241	0,030	0,227
	15	0,185	0,710	0,198	0,707
	25	0,545	1,213	0,499	1,111
	35	0,981	1,423	0,978	1,419
	45	1,456	1,470	1,452	1,466
	90	2,409	-0,015	2,399	-0,015
Peledang	5	0,058	0,456	0,044	0,365
	15	0,207	0,886	0,183	0,833
	25	0,574	1,367	0,571	1,360
	35	1,041	1,572	1,092	1,580
	45	1,202	1,247	1,473	1,527
	90	2,808	-0,001	2,802	-0,001
Padewakang	5	0,040	0,405	0,040	0,375
	15	0,217	0,955	0,196	0,853
	25	0,672	1,582	0,576	1,369
	35	1,078	1,624	1,075	1,618
	45	1,546	1,596	1,544	1,593
	90	3,232	0,001	3,232	0,001

Sebelum mendapatkan kecepatan yang bekerja pada layar, *apparent wind speed*, hubungan antara berbagai kecepatan yang bekerja pada kapal layar perlu ditinjau kembali. Tiga kecepatan yang bekerja pada kapal layar, yaitu *true wind speed*, *apparent wind speed*, dan kecepatan kapal, saling berhubungan satu sama lain. Ketiga kecepatan ini membentuk segitiga kecepatan kapal layar yang digambarkan pada Gambar 2.1. Berdasarkan hal tersebut, persamaan (2.1) dapat dijabarkan menjadi

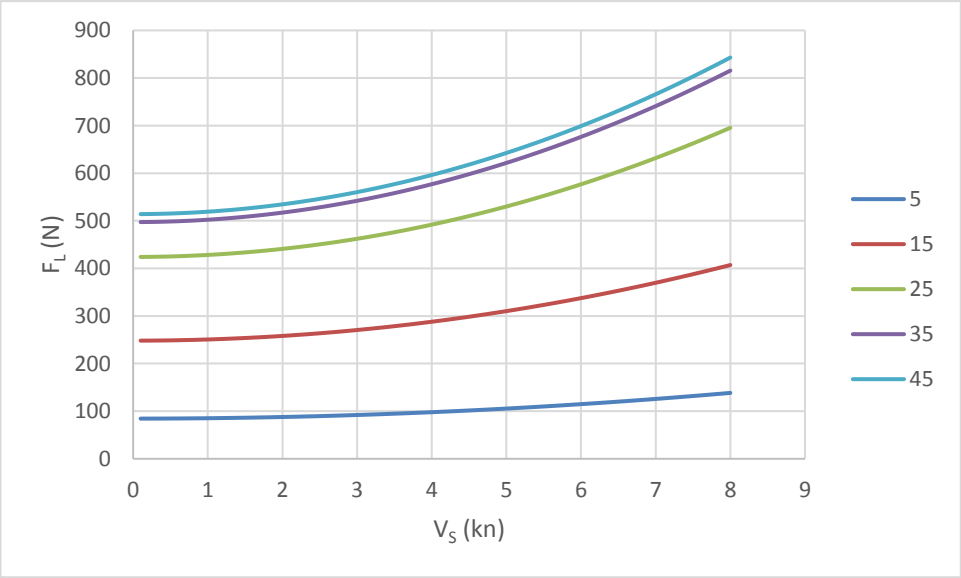
$$V_T = \sqrt{{V_S}^2 + {V_A}^2 - 2V_S V_A \cos(\beta)} \quad \text{..... (5.5)}$$

Persamaan (5.5) menggambarkan hubungan antar ketiga kecepatan dengan lebih jelas. Akan tetapi, meski pada persamaan (2.1) *true wind speed* merupakan vektor resultan, pada kenyataannya, *true wind speed* tidak dipengaruhi oleh kecepatan kapal. Hal ini terjadi karena *true wind speed* merupakan kecepatan angin yang relatif terhadap permukaan laut, bukan terhadap kapal yang bergerak. Di sisi lain, *apparent wind speed* merupakan kecepatan angin yang relatif terhadap layar, dan layar bergerak bersama kapal yang memiliki kecepatan. Maka dari itu, nilai *apparent wind speed* dapat berubah seiring dengan berubahnya kecepatan kapal.

Untuk menentukan nilai *apparent wind speed*, persamaan serupa dapat digunakan dan menghasilkan persamaan

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)} \quad (5.6)$$

Persamaan (5.6) menunjukkan bahwa nilai *apparent wind speed* dipengaruhi oleh *true wind speed*, kecepatan kapal, dan arah berlayar kapal (*point of sail*).



Gambar 5.6 *Lift* pada Vinta-1, V_T = 10 kn, γ = 90°

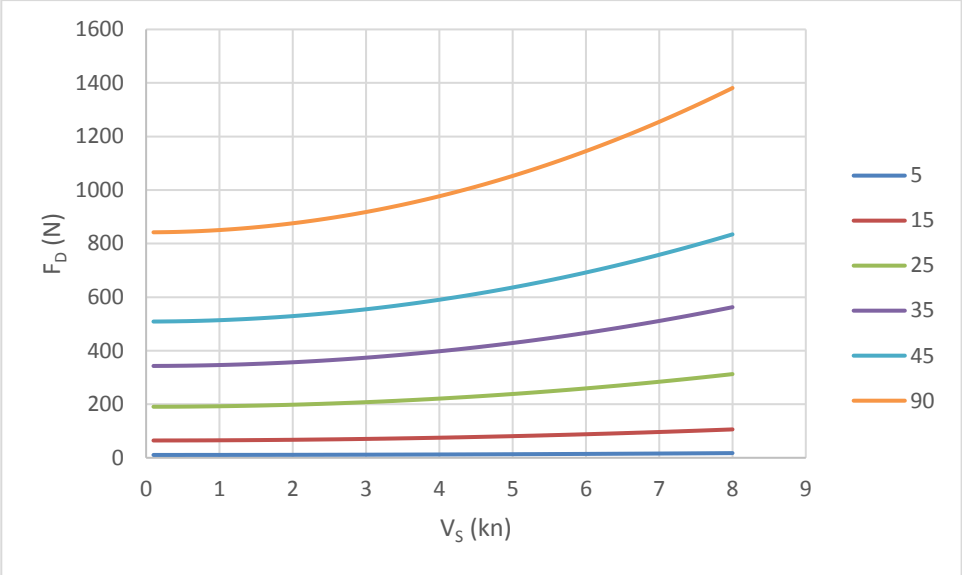
Berbagai variasi *apparent wind speed* menghasilkan berbagai nilai *lift* dan *drag* yang berbeda-beda. Untuk mendapatkan nilai *drag* dan *lift*, nilai V_A dapat digunakan sebagai nilai V pada persamaan (2.9) dan (2.10) sehingga menghasilkan

$$F_D = \frac{C_D}{2} \rho_a \cdot A \cdot {V_A}^2 \quad (5.7)$$

$$F_L = \frac{C_L}{2} \rho_a \cdot A \cdot {V_A}^2 \quad (5.8)$$

Dengan menggunakan persamaan (5.6), (5.7), dan (5.8), serta nilai koefisien yang telah didapatkan pada Tabel 5.5, nilai *lift* dan *drag* yang dihasilkan oleh setiap model layar dapat diketahui. *Lift* dan *drag* akan dihitung berdasarkan penggunaan layar yang ditentukan pada *sail plan*. Perhitungan dilakukan untuk tiap variasi *angle of attack*, dalam berbagai nilai *true wind speed* dengan rentang 5 knot hingga 15 knot dan variasi *point of sail* dari 30° hingga 180°. Pada *sail plan* yang menggunakan dua layar, *lift* dan *drag* dari *main sail* dan *mizzen sail* dijumlahkan untuk mendapatkan *lift* dan *drag* total. Nilai *lift* dan *drag* dinyatakan dalam bentuk grafik

terhadap kecepatan kapal, dengan contoh seperti yang terdapat pada Gambar 5.6 dan Gambar 5.7. Seluruh nilai *lift* dan *drag* dilampirkan pada Lampiran C.



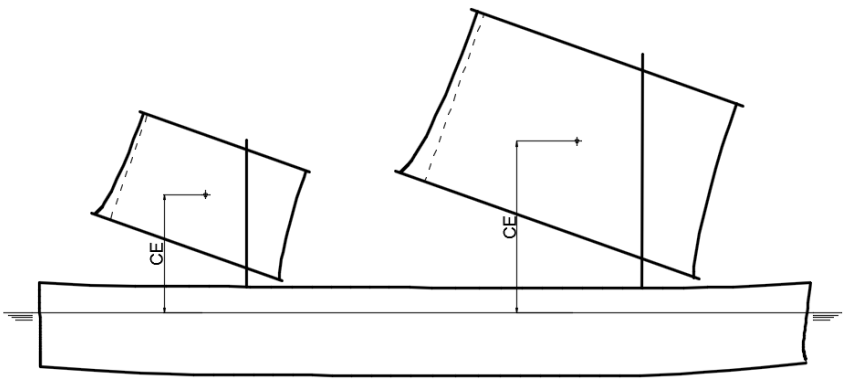
Gambar 5.7 *Drag* pada Vinta-1, V_T = 10 kn, γ = 90°

5.1.3. *Center of Effort*

Center of effort (CE) merupakan letak titik pusat gaya yang bekerja pada layar. Letak CE diasumsikan berada di titik pusat luasan penampang layar (Satterthwaite, 1960). Posisi CE dideskripsikan dalam ketinggian dari garis air, menyesuaikan dengan *sail plan* yang telah dibuat, dengan ilustrasi ditunjukkan pada Gambar 5.8. CE pada tiap model layar tuliskan pada Tabel 5.6.

Tabel 5.6 Nilai CE Tiap Model Layar

Model	CE (m)	
	Main	Mizzen
Vinta	3,523	2,430
Peledang	5,374	3,590
Padewakang	8,050	5,300



Gambar 5.8 Ilustrasi Letak CE

5.1.4. *Driving Force* dan *Lateral Force*

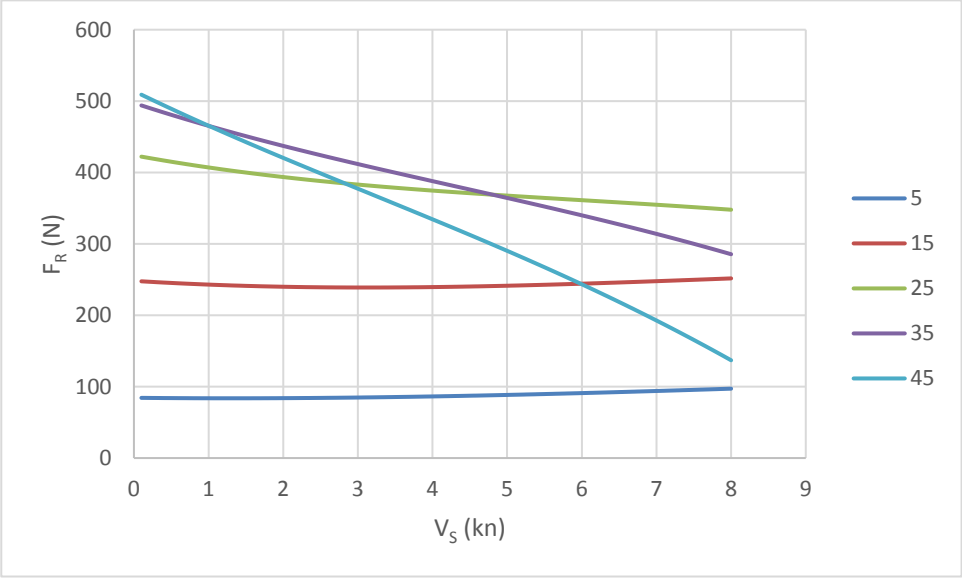
Lift dan *drag* yang dihasilkan oleh layar berfungsi sebagai gaya penggerak bagi kapal. Maka dari itu, *lift* dan *drag* diproyeksikan terhadap dua sumbu, yaitu searah dengan arah gerak kapal dan melintang terhadap arah gerak kapal. Gaya yang searah dengan arah gerak kapal merupakan *driving force* (F_R) dan berperan dalam menentukan kecepatan kapal. Gaya yang tegak lurus dengan arah gerak kapal merupakan *lateral force* (F_{LAT}) dan akan menyebabkan *heeling* pada kapal. *Drag* dan *lift* yang bekerja pada layar memiliki arah sejajar dan tegak lurus terhadap *apparent wind speed*, sehingga untuk memproyeksikannya terhadap arah gerak kapal, digunakan persamaan

$$F_R = F_L \sin\beta - F_D \cos\beta \quad \text{.....(5.13)}$$

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta \quad \text{.....(5.14)}$$

Kedua persamaan di atas menunjukkan bahwa baik F_R maupun F_{LAT} dipengaruhi oleh *lift* dan *drag*. Seperti yang telah diketahui sebelumnya, proporsi antara *lift* atau *drag* yang akan dominan berdampak pada F_R dan F_{LAT} dipengaruhi oleh arah berlayar kapal. Hal ini dapat terlihat pada persamaan (5.13) dan (5.14), di mana *apparent wind angle* (β) akan menentukan porsi dari *lift* dan *drag* yang akan bekerja pada F_R dan F_{LAT}. Dengan menurunkan persamaan (5.5), didapatkan persamaan untuk menentukan nilai β sebagai berikut

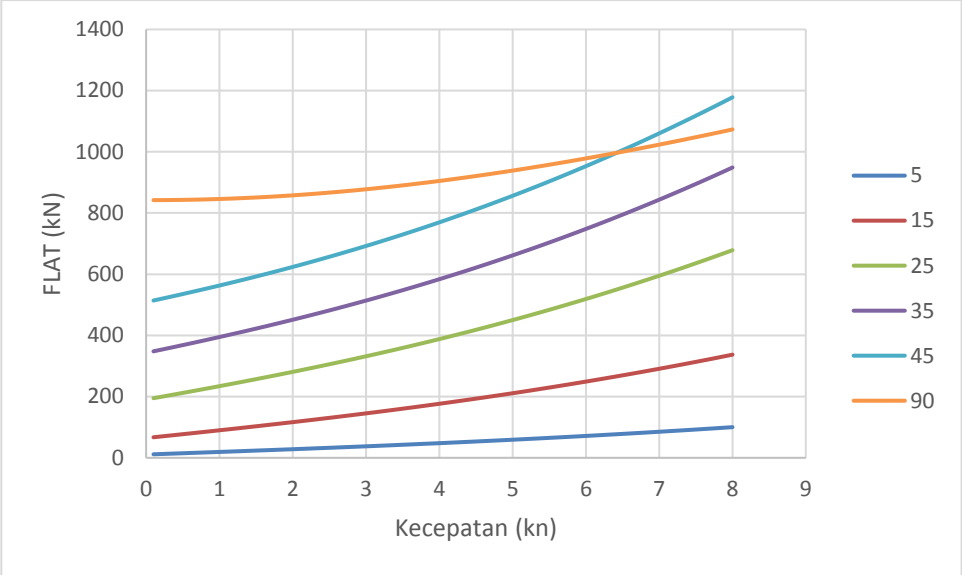
$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right) \quad \text{.....(5.13)}$$



Gambar 5.9 *Driving Force* pada Vinta-1, V_T = 10 kn, γ = 90°

Driving force dan *lateral force* akan dihitung berdasarkan *lift* dan *drag* yang telah didapatkan, yaitu pada tiap variasi *angle of attack*, dalam berbagai nilai *true wind speed* dengan

rentang 5 knot hingga 15 knot, dan variasi *point of sail* dari 30° hingga 180°. Nilai F_R dan F_{LAT} dinyatakan dalam bentuk grafik terhadap kecepatan kapal, dengan contoh seperti yang terdapat pada Gambar 5.9 dan Gambar 5.10. Seluruh nilai F_R dan F_{LAT} dilampirkan pada Lampiran C.



Gambar 5.10 *Lateral Force* pada Vinta-1, V_T = 10 kn, γ = 90°

5.1.5. *Heeling Force*

Gaya dengan arah melintang kapal yang bekerja pada layar akan menghasilkan *heeling force* (F_H). Gaya yang memenuhi kondisi tersebut adalah *lateral force*, di mana F_{LAT} memiliki arah yang paralel dengan permukaan air. Akan tetapi, dalam keadaan *heeling*, tiang kapal tidak tegak lurus terhadap permukaan air, sehingga F_{LAT} tidak langsung bekerja sebagai F_H. Arah F_{LAT} akan membentuk sudut terhadap tiang dengan nilai

$$\varphi = 90 + \theta \quad (5.14)$$

dengan θ merupakan sudut *heeling*. Dengan memasukkan *lateral force* sebagai gaya yang bekerja pada layar dalam sudut φ terhadap tiang ke dalam persamaan (2.19), maka nilai F_H dapat dituliskan sebagai

$$F_H = F_{LAT} \cos\theta \quad (5.15)$$

Seperti yang telah dijelaskan sebelumnya, bahwa selain momen akibat F_H yang bekerja pada layar, *heeling* juga disebabkan oleh momen yang terjadi akibat gaya yang sama besar pada lambung kapal. Kedua momen momen ini, seperti yang dituliskan pada persamaan (2.13) dan (2.14), akan membentuk momen kopel sebesar

$$M_H = F_H(h_1 + h_2) \quad (5.16)$$

dengan M_H merupakan momen *heeling*. Jarak CE terhadap titik berat kapal (h_1) dan jarak CLR terhadap titik berat kapal (h_2) dapat dituliskan sebagai *heeling arm* (h), yaitu jarak antara CE dan CLR, dengan persamaan

$$h = h_1 + h_2 \quad (5.17)$$

Berdasarkan persamaan (5.15), nilai F_H akan semakin besar seiring dengan bertambahnya nilai F_{LAT}, sehingga F_{LAT} yang besar akan menghasilkan momen *heeling* yang besar pula. Dalam keadaan stabil, nilai momen *heeling* akan sama besar dengan momen pembalik, dan persamaan (2.16) dapat dituliskan

$$M_H = M_R \quad (5.18)$$

dengan M_R merupakan momen pembalik. Hal ini menunjukkan bahwa untuk menghadapi momen *heeling* yang besar, kapal harus memiliki momen pembalik yang besar pula untuk mencegah terjadinya *capsize*. Maka dari itu, gaya yang dihasilkan oleh layar dibatasi oleh kemampuan lambung kapal dalam menghasilkan momen pembalik. Layar diharapkan dapat menghasilkan *driving force* paling besar namun dengan batasan *lateral force* tidak menyebabkan *capsize*.

Nilai momen *heeling* maksimum yang dapat bekerja pada lambung kapal dapat ditentukan dengan menggabungkan persamaan (2.18) dan (5.18) sehingga didapatkan persamaan

$$M_H = \Delta g \times GZ \quad (5.19)$$

Substitusi persamaan (5.15), (5.16), dan (5.17) ke dalam persamaan (5.19) akan menghasilkan persamaan untuk menentukan nilai F_{LAT} maksimum, yang dapat dituliskan sebagai berikut

$$F_{LAT} = \frac{\Delta g \times GZ}{\cos\theta \times h} \quad (5.20)$$

Untuk menentukan nilai F_{LAT} maksimum, perlu diketahui sudut *heeling* maksimum yang dapat dialami oleh kapal. Berdasarkan pengujian stabilitas model lambung Perahu Kuno Punjulharjo dengan bantuan *software*, diketahui bahwa nilai GZ maksimum terjadi pada θ = 36°. Hal ini menunjukkan bahwa momen pembalik terbesar yang dimiliki oleh lambung kapal terjadi pada sudut *heeling* tersebut. Akan tetapi, pada θ = 11°, kapal telah mengalami kondisi *deck edge immersion*, sehingga *heeling* yang lebih besar dari sudut tersebut akan menyebabkan air masuk ke dalam kapal. Kondisi ini membuat kapal memiliki sudut *heeling* maksimum sebesar 11°.

Nilai GZ pada θ = 11° adalah 0,150 m. Berat *displacement* kapal diketahui sebesar 45,96 ton. Karena nilai F_{LAT} maksimum dipengaruhi oleh *heeling arm*, maka tiap model layar akan memiliki nilai F_{LAT} maksimum yang berbeda-beda. Nilai *heeling arm* beserta F_{LAT} maksimum tiap model layar dituliskan pada Tabel 5.7.

Tabel 5.7 Nilai F_{LAT} Maksimum

Model	h (m)	F_{LATmax} (N)
Vinta	4,156	1689,735
Peledang	6,007	1169,084
Padewakang	8,683	808,798

5.1.6. Kecepatan Kapal

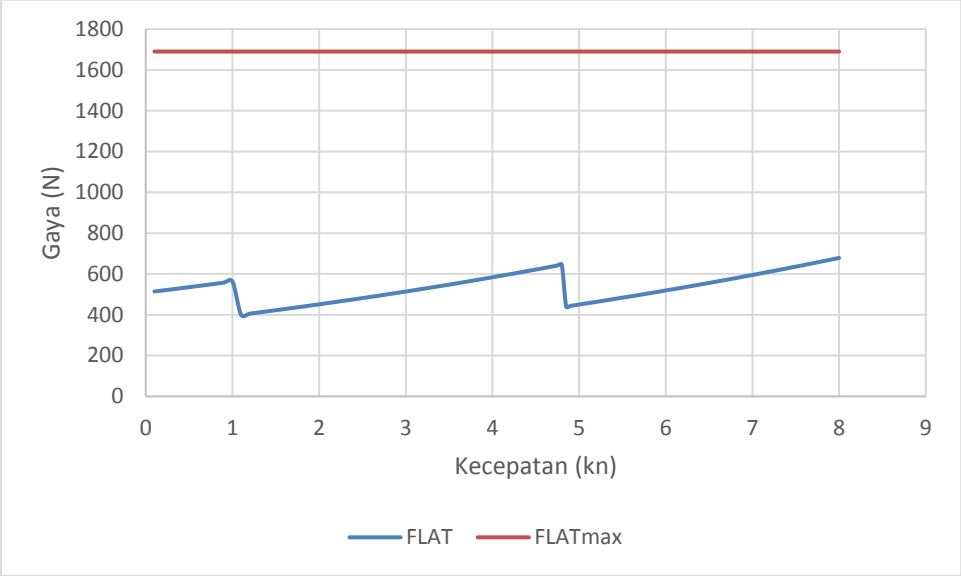
Dalam kecepatan konstan, *driving force* yang bekerja pada kapal akan sama besar dengan hambatan kapal di kecepatan tersebut. Hal ini telah dijelaskan pada persamaan (2.12). Berdasarkan hal tersebut, untuk mengetahui kecepatan kapal ketika berlayar dalam suatu kondisi pelayaran, pencarian selisih antara *driving force* dan hambatan kapal dilakukan. Berbagai nilai *driving force* telah didapatkan pada suatu kondisi pelayaran dengan *true wind speed* dan *point of sail* tertentu, di mana besar *driving force* akan berbeda-beda bergantung pada *angle of attack* layar yang digunakan. Untuk mendapatkan kecepatan maksimal yang dapat ditempuh oleh kapal, maka pada tiap kecepatan kapal, diambil *angle of attack* layar yang menghasilkan *driving force* paling besar. Akan tetapi, *angle of attack* yang digunakan harus menghasilkan *lateral force* di bawah batasan *heeling force* yang telah didapatkan sebelumnya. Contoh pemilihan *angle of attack* layar serta hasilnya ditunjukkan pada Tabel 5.8. Contoh yang ditampilkan merupakan hasil dari contoh perhitungan yang digunakan sebelumnya, yaitu perhitungan untuk *sail plan* Vinta-1 pada *true wind speed* 10 kn dan γ sebesar 90°.

Tabel 5.8 Contoh Pemilihan *Angle of Attack* Optimum Layar

V_S (kn)	Sudut Layar Optimal		
	α	F_R	F_{LAT}
0,800	45	474,838	551,747
0,900	45	470,130	557,374
1,000	45	465,459	563,065
1,100	35	462,368	400,106
1,200	35	459,439	405,569
4,800	35	369,026	645,261
4,850	25	368,590	440,411
4,900	25	368,256	443,641
4,950	25	367,923	446,887
5,000	25	367,592	450,149

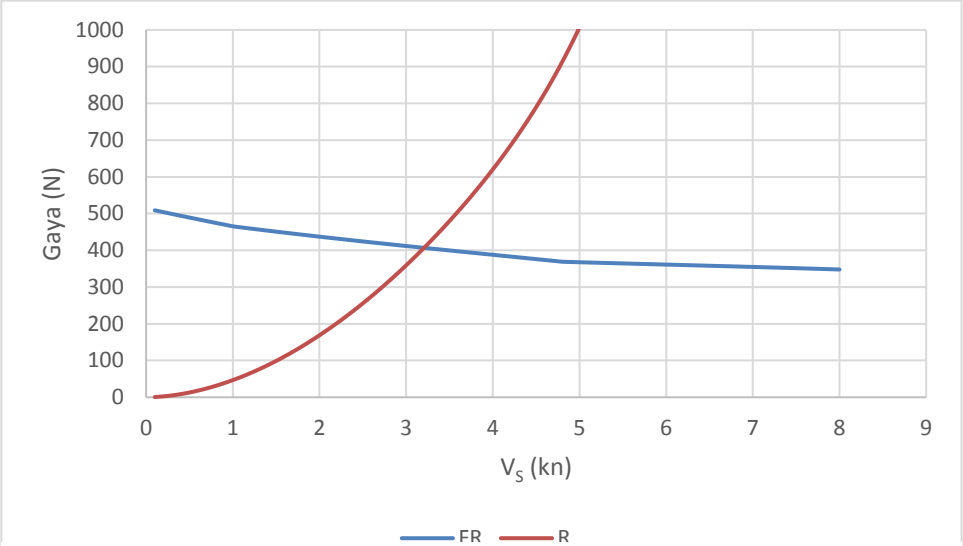
Berdasarkan Gambar 5.9, *angle of attack* yang menghasilkan *driving force* paling besar adalah sebesar 45° pada kecepatan 0-1 knot, 35° pada kecepatan 1-5 knot, dan 25° pada kecepatan 5-8 knot. Pemilihan ini akan menghasilkan berbagai *lateral force* yang bergantung

pada kondisi masing-masing *angle of attack*. Hasil *lateral force* berdasarkan pemilihan *driving force* maksimal ditunjukkan pada Gambar 5.11. Dapat dilihat bahwa seluruh *lateral force* yang dihasilkan dari *angle of attack* yang dipilih memiliki nilai yang lebih kecil dari *lateral force* maksimal, sehingga pemilihan *angle of attack* tersebut tidak akan menyebabkan kapal *heeling* melebihi sudut *heeling* maksimal yang dapat diterima kapal. Pada kecepatan sekitar 1 knot dan 5 knot, terdapat perubahan pada nilai *lateral force* di mana pada kecepatan tersebut *lateral force* mengalami penurunan sebelum akhirnya nilainya kembali membesar seiring dengan bertambahnya kecepatan. Hal ini disebabkan karena perubahan *angle of attack* pada kecepatan tadi untuk menghasilkan *driving force* maksimal pada seluruh rentang kecepatan.



Gambar 5.11 Grafik Nilai F_{LAT} Berdasarkan F_R Maksimal

Pemilihan *angle of attack* yang menghasilkan *driving force* paling optimal dari seluruh kecepatan akan menghasilkan potensi *driving force* paling baik yang mampu didapatkan oleh kapal pada kondisi pelayaran tersebut. Hasil *driving force* ini dibandingkan dengan nilai hambatan kapal untuk mencari kecepatan kapal di mana besar *driving force* dan hambatan kapal sama, sehingga total gaya yang bekerja sama dengan nol. Kecepatan tersebut merupakan kecepatan yang ditempuh kapal pada kondisi pelayaran yang ditentukan. Perbandingan antara *driving force* dan hambatan kapal ditunjukkan pada Gambar 5.12.

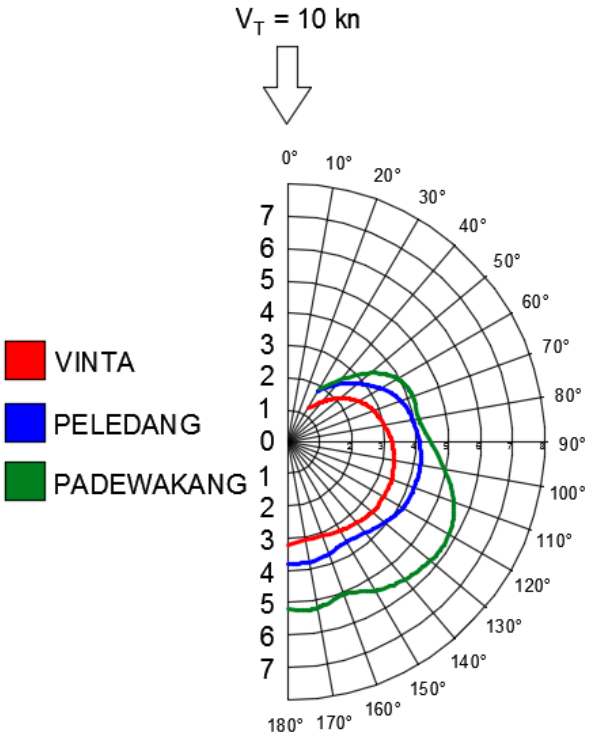


Gambar 5.12 Penentuan Kecepatan pada Vinta-1, V_T = 10 kn, γ = 90°

Kecepatan kapal dihitung untuk tiap *sail plan* pada berbagai nilai *true wind speed*, yaitu 5 knot, 10 knot, dan 15 knot. Kecepatan kapal dihitung untuk nilai *point of sail* antara 30° hingga 180°. Hasil perhitungan terdapat pada Lampiran C. Contoh hasil perhitungan kecepatan kapal untuk *sail plan* satu layar pada *true wind speed* 10 knot ditunjukkan pada Tabel 5.9.

Tabel 5.9 Hasil Perhitungan V_S untuk *Sail Plan* 1 Layar, V_T = 10 kn

γ	Vs (kn)		
	Vinta	**Peledang**	**Padewakang**
30	1,200	1,800	1,900
40	1,600	2,300	2,500
50	2,100	2,800	3,300
60	2,500	3,300	3,900
70	2,800	3,700	4,100
80	3,000	3,900	4,100
90	3,200	4,050	4,050
100	3,300	4,150	4,900
110	3,400	4,150	5,450
120	3,400	4,100	5,750
130	3,400	3,900	5,750
140	3,300	3,700	5,600
150	3,200	3,600	5,350
160	3,100	3,700	5,050
170	3,100	3,800	5,250
180	3,200	3,800	5,200

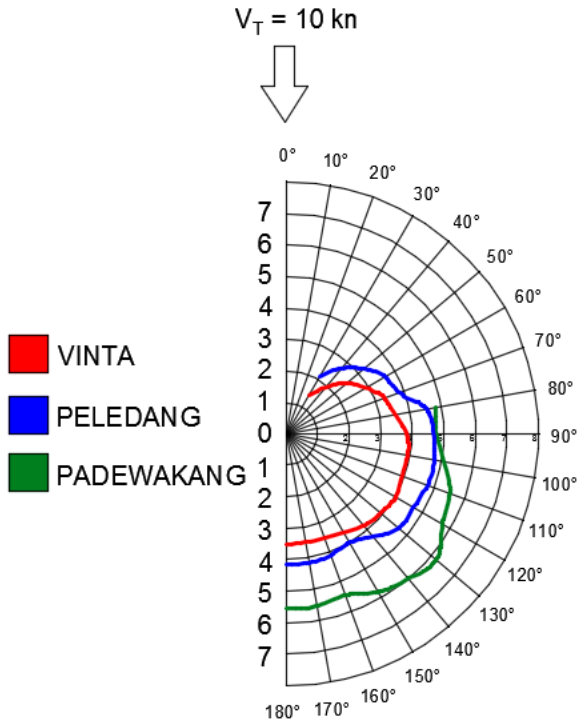


Gambar 5.13 Diagram Polar V_S, Satu Layar, V_T = 10 kn

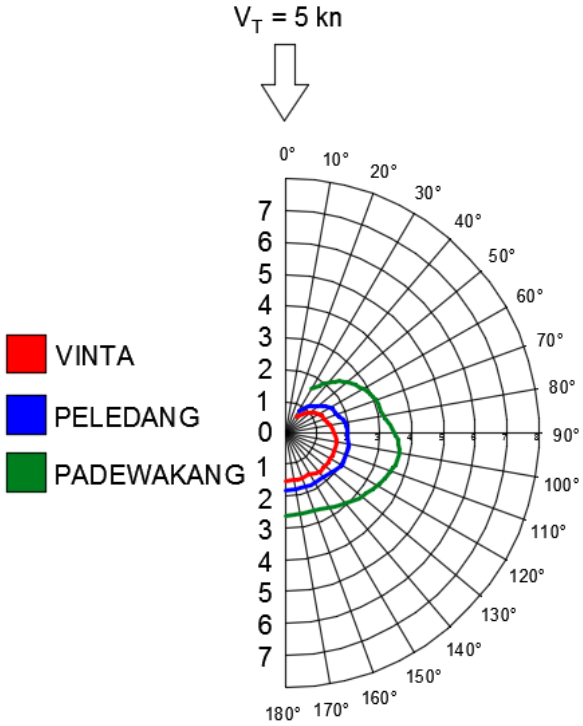
Hasil perhitungan kecepatan kapal disajikan dalam bentuk diagram polar, dengan contoh seperti pada Gambar 5.13. Diagram polar tersebut menunjukkan performa kapal dengan menggunakan *sail plan* satu layar pada nilai *true wind speed* sebesar 10 knot. Berdasarkan kecepatan yang dihasilkan, *sail plan* Padewakang-1 menghasilkan kecepatan paling tinggi, kemudian Peledang-1 dan terakhir Vinta-1. Hal ini sebanding dengan ukuran masing-masing model layar, di mana model Padewakang memiliki ukuran paling besar. Akan tetapi, ukuran layar yang besar juga menghasilkan *lateral force* yang besar. Hal ini akan menjadi masalah ketika kecepatan angin di laut cukup tinggi.

Pada *sail plan* dengan dua layar, pola urutan kecepatan antar model layar juga terlihat serupa. Seperti yang ditunjukkan pada Gambar 5.14, model Padewakang menghasilkan kecepatan paling tinggi, disusul oleh model Peledang dan Vinta. *Sail plan* dengan dua layar menghasilkan gaya yang lebih besar dibandingkan dengan *sail plan* satu layar, sehingga kecepatan yang dihasilkan lebih besar pada kondisi *true wind speed* dan *point of sail* yang sama. Akan tetapi, di sisi lain, hal ini juga akan semakin membatasi kemampuan berlayar kapal pada kondisi angin kencang. Dapat dilihat bahwa pada kondisi *true wind speed* yang sama yaitu 10 knot, *sail plan* Padewakang-2 mengalami kesulitan dalam pelayaran *upwind* sehingga hanya mampu mencapai *point of sail* 80°. *Point of sail* yang lebih rendah dari itu akan menyebabkan

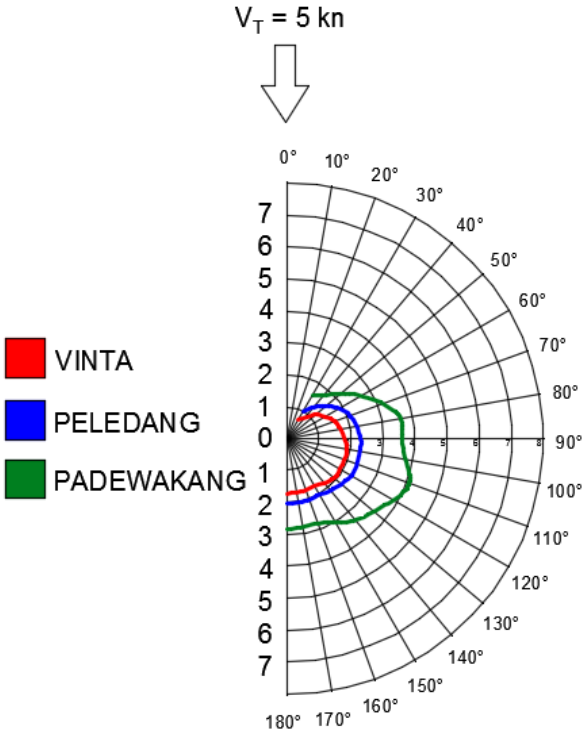
lateral force yang besar terlepas dari *angle of attack* berapapun yang digunakan pada layar. Hal ini membuat kapal dapat mengalami heeling melebihi 11° pada pelayaran *upwind* dengan *point of sail* yang rendah.



Gambar 5.14 Diagram Polar V_S, Dua Layar, V_T = 10 kn



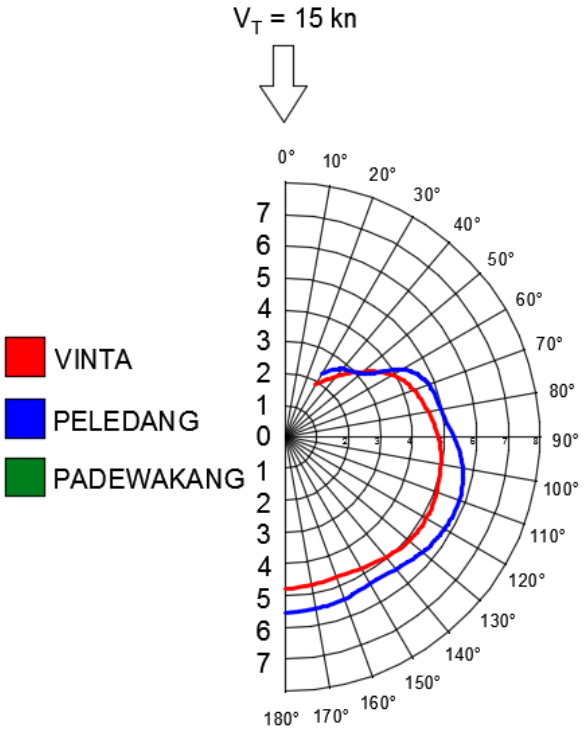
Gambar 5.15 Diagram Polar V_S, Satu Layar, V_T = 5 kn



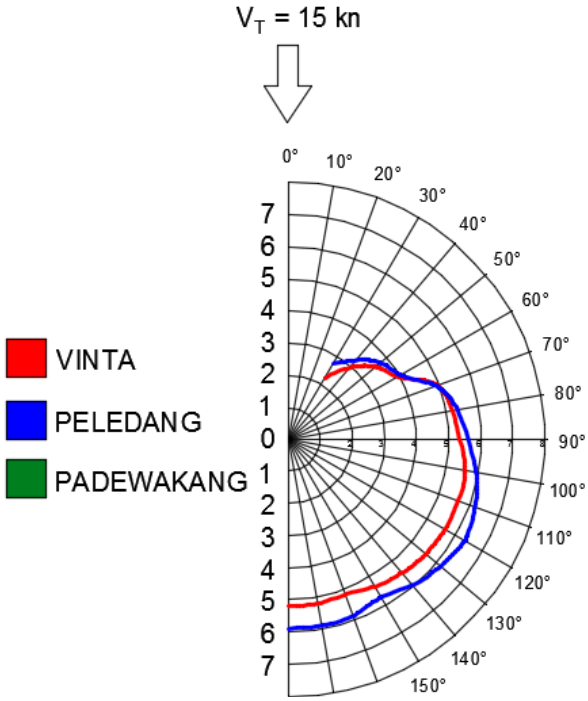
Gambar 5.16 Diagram Polar V_S, Dua Layar, V_T = 5 kn

Kecepatan kapal pada *true wind speed* 5 knot ditunjukkan pada Gambar 5.15 dan 5.16. Dapat dilihat bahwa kecepatan yang dihasilkan oleh seluruh model layar jauh lebih kecil dibandingkan dengan kondisi *true wind speed* 10 knot. Kecepatan maksimal tetap dihasilkan oleh model Padewakang, dengan besar kecepatan yang dihasilkan pada *true wind speed* 5 knot hanya berkisar pada nilai 3,5-4 knot, sedangkan pada *true wind speed* 10 knot dapat mencapai nilai 5,5-6 knot. Hal ini menunjukkan bahwa kondisi kecepatan angin di laut sangat berpengaruh pada kecepatan kapal. Akan tetapi, dapat dilihat bahwa pada kondisi ini, *sail plan* Padewakang-2 dapat berfungsi pada seluruh *point of sail*. Kecepatan angin yang lebih rendah di sisi lain juga menghasilkan *lateral force* yang lebih rendah pada *sail plan* tersebut.

Kecepatan kapal pada *true wind speed* 15 knot ditunjukkan pada Gambar 5.17 dan Gambar 5.18. Kecepatan maksimal yang dapat ditempuh oleh kapal berkisar pada nilai 5,5-6 knot, sama seperti pada *true wind speed* 10 knot. Akan tetapi, kecepatan ini didapatkan pada model Peledang. Baik pada *sail plan* satu layar maupun dua layar, model Padewakang tidak dapat digunakan pada *true wind speed* 15 knot. Hal ini terjadi karena *lateral force* yang dihasilkan terlalu besar pada semua *angle of attack*, sehingga penggunaan model Padewakang pada kondisi pelayaran tersebut akan menyebabkan kapal *heeling* melebihi *heeling* maksimal yang disyaratkan.



Gambar 5.17 Diagram Polar V_S, Satu Layar, V_T = 15 kn

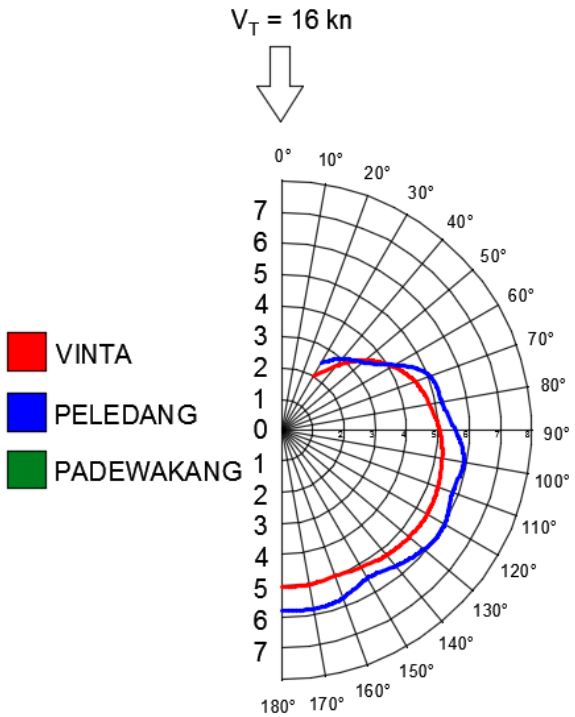


Gambar 5.18 Diagram Polar V_S, Dua Layar, V_T = 15 kn

Pada kenyataannya, kondisi di mana layar menyebabkan *heeling* yang terlalu besar dapat ditanggulangi dengan cara menggulung layar untuk menghurangi luas permukaannya sehingga sesuai dengan kondisi angin di laut. Pengurangan luas permukaan akan mengurangi gaya yang dihasilkan oleh layar. Namun, hal tersebut di luar cakupan analisis yang dilakukan. Hasil

analisis hanya cukup untuk menunjukkan bahwa layar berukuran besar lebih sulit digunakan dalam keadaan angin yang lebih kencang meski menghasilkan gaya dorong paling besar di angin dengan kecepatan rendah. Di sisi lain, hasil analisis juga menunjukkan bahwa layar berukuran kecil menghasilkan kecepatan yang lebih rendah, namun mudah digunakan dalam keadaan angin kencang.

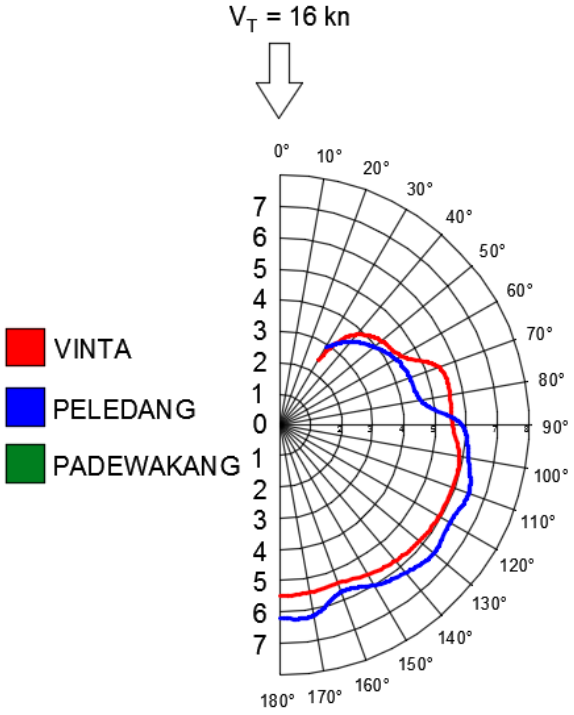
Kecepatan maksimum yang dihasilkan oleh tiap *sail plan* dapat dicapai pada saat kapal berlayar dalam kondisi *point of sail* berkisar antara 90° hingga 130°. Pada *point of sail* lebih rendah dari 90°, kecepatan kapal cenderung berkurang. Hal ini terjadi karena kapal semakin dekat dengan arah datangnya angin, sehingga arah gerak kapal semakin melawan arah angin. *Lift* dan *drag* yang diproyeksikan menjadi gaya dorong bagi kapal semakin sedikit jika nilai *apparent wind angle* semakin kecil. Dalam keadaan *downwind*, kapal tidak dapat mencapai kecepatan yang tinggi karena semakin cepat kapal bergerak, angin yang dirasakan oleh kapal akan semakin berkurang. Hal ini menyebabkan layar tidak terisi angin dan gaya yang dihasilkan juga berkurang. Hasil tersebut menunjukkan bahwa pemanfaatan *lift* dan *drag* dari layar pada pelayaran 90°-130° menghasilkan kecepatan yang lebih tinggi dibandingkan dengan pelayaran *downwind* yang hanya memanfaatkan *drag*.



Gambar 5.19 Diagram Polar V_S, Satu Layar, V_T = 16 kn

Untuk mengetahui kemampuan berlayar Perahu Kuno Punjulharjo di wilayah operasionalnya, perhitungan kecepatan juga dilakukan dalam kondisi *true wind speed* yang

sesuai dengan perairannya. Kondisi perairan Laut Jawa dipilih untuk perhitungan. Hal ini didasarkan pada lokasi penemuan Perahu Kuno Punjulharjo yang berada di pesisir utara Pulau Jawa. Kondisi yang digunakan merupakan kondisi Laut Jawa di masa kini. Kecepatan angin rata-rata di Laut Jawa diketahui berkisar pada nilai ≥8 m/s berdasarkan data dari tahun 1999 hingga 2014 (Dida, Suparman, & Widhiyanuriyawan, 2016). Berdasarkan hal tersebut, perhitungan akan dilakukan dalam kondisi *true wind speed* sebesar 16 knot.

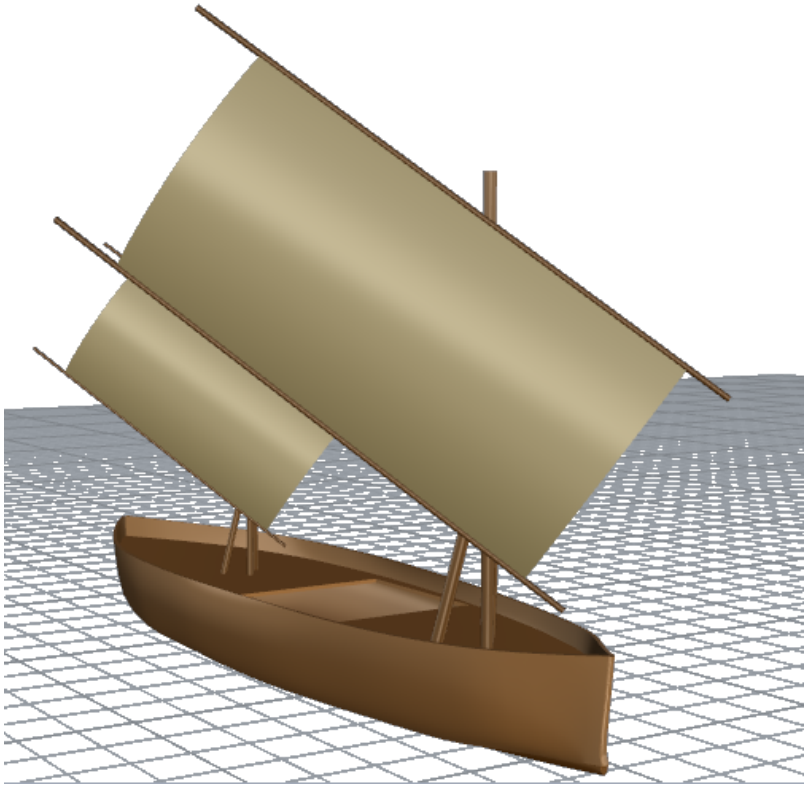


Gambar 5.20 Diagram Polar V_S, Dua Layar, V_T = 16 kn

Hasil perhitungan kecepatan kapal pada *true wind speed* 16 knot ditunjukkan pada Gambar 5.19 dan Gambar 5.20. Pada *sail plan* satu layar, model Peledang menghasilkan kecepatan yang lebih tinggi dibandingkan model Vinta, sedangkan model Padewakang tidak dapat digunakan. Seperti pada *true wind speed* 15 knot, penggunaan model Padewakang akan menghasilkan *heeling* yang terlalu besar. Pada *sail plan* dua layar, model Padewakang juga tidak dapat digunakan. Baik model Vinta maupun model Peledang dua layar menghasilkan kecepatan yang relatif lebih tinggi dibandingkan dengan *sail plan* satu layarnya. Akan tetapi, terdapat pengecualian pada arah pelayaran yang lebih kecil dari 90°, di mana model Peledang mengalami penurunan kecepatan, bahkan menjadi lebih rendah dibandingkan dengan model Vinta. *Sail plan* Peledang-2 harus menggunakan *angle of attack* yang menghasilkan *lateral force* cukup kecil untuk mencegah kapal mengalami *heeling* di atas 11° pada kondisi pelayaran tersebut, sehingga tidak dapat menghasilkan *driving force* yang lebih maksimal. Dari hasil

perhitungan, seluruh *sail plan* menghasilkan kecepatan maksimal pada rentang *point of sail* 90°-130°. Pada susunan satu layar, Vinta-1 menghasilkan kecepatan maksimal sekitar 5,5 knot dan Peledang-1 menghasilkan kecepatan maksimal sekitar 6 knot. Pada susunan dua layar, Vinta-2 menghasilkan kecepatan maksimal sekitar 6 knot dan Peledang-2 menghasilkan kecepatan maksimal sekitar 6,5 knot.

Berdasarkan perhitungan yang dilakukan pada kondisi kecepatan angin rata-rata yang menggambarkan perairan Laut Jawa, layar hasil rekonstruksi yang paling cocok digunakan untuk Perahu Kuno Punjulharjo adalah Peledang-2. *Sail plan* Peledang-2 menggunakan *main sail* dengan ukuran 8 × 4 m dan *mizzen sail* dengan ukuran 5,016 × 2,508 m. Dengan *sail plan* Peledang-2, Perahu Kuno Punjulharjo akan memiliki kecepatan maksimum sekitar 6,5 knot pada arah pelayaran 90°-130°. Dalam pelayaran *downwind* (180°), Perahu Kuno Punjulharjo akan memiliki kecepatan sekitar 6 knot. Kendala pada pelayaran *upwind* dengan sudut lebih kecil dari 90° yang dimiliki *sail plan* Peledang-2 dapat ditanggulangi dengan cara menggulung *mizzen sail*, sehingga hanya *main sail* yang digunakan, menjadikan kapal seolah-olah menggunakan *sail plan* Peledang-1 pada arah pelayaran tersebut. Hal ini akan menghasilkan kecepatan yang lebih baik pada pelayaran 30°-90°, dengan rentang kecepatan antara 2,5 knot hingga 5,5 knot bergantung pada arah pelayarannya.



Gambar 5.21 Model Tiga Dimensi *Sail Plan* Peledang-2

5.2. Pembuatan Model Kapal Tiga Dimensi

Model tiga dimensi dibuat untuk tiap *sail plan*. Pembuatan model tiga dimensi dilakukan untuk memberikan ilustrasi dari penggunaan layar hasil rekonstruksi pada Perahu Kuno Punjulharjo. Model tiga dimensi dibuat dengan bantuan *software*, dengan contoh seperti pada Gambar 5.21. Seluruh model tiga dimensi dicantumkan pada Lampiran D.

Gambar 5.21 menunjukkan model tiga dimensi dari *sail plan* Peledang-2. Layar digambarkan dalam kondisi dikembangkan secara penuh. Kedua layar diposisikan dalam sudut 45° terhadap *centerline* kapal. Tiang (*mast*) yang dipilih dalam model adalah tiang berkaki tiga. Hal ini didasarkan pada berbagai ilustrasi kapal dengan layar tanja, baik yang tertua yang berada di Candi Borobudur maupun foto kapal dengan layar tanja di masa modern, yang menggunakan tiang berkaki tiga. Warna cokelat gelap yang digunakan pada lambung kapal, *mast*, dan *spar*, menunjukkan bahwa bagian-bagian tersebut dibuat dari kayu. Warna pada layar didasarkan pada bahan yang umum digunakan untuk membuat layar tanja setidaknya hingga abad ke-19, yaitu anyaman daun lontar (Liebner, 2002).

Halaman ini sengaja dikosongkan

BAB 6
KESIMPULAN DAN SARAN

6.1. Kesimpulan

Setelah melalui seluruh tahapan pengerjaan dari Tugas Akhir ini didapat beberapa kesimpulan sebagai berikut:

1. Berdasarkan tahapan rekonstruksi yang telah dilakukan, didapatkan hasil:
    a. Perahu Kuno Punjulharjo menggunakan layar dengan jenis layar tanja.
    b. Terdapat tiga model layar rekonstruksi yang dibuat:
        i. Vinta : ±6,40 × 3,657 m
        ii. Peledang : 8 × 4 m
        iii. Padewakang : 16,454 × 5,854 m
    c. *Sail plan* hasil rekonstruksi yang paling cocok digunakan oleh Perahu Kuno Punjulharjo adalah Peledang dua layar, dengan ukuran:
        i. *Main sail* : 8 × 4 m
        ii. *Mizzen sail* : 5,016 × 2,508 m
2. Berdasarkan pengaplikasian layar hasil rekonstruksi pada Perahu Kuno Punjulharjo dalam kondisi wilayah operasionalnya, didapatkan hasil:
    a. Kecepatan kapal maksimum sekitar 6,5 knot dan dapat dicapai pada rentang *point of sail* antara 90° hingga 130°.
    b. Dalam pelayaran *downwind*, kapal akan memilki kecepatan sekitar 6 knot.
    c. Dalam pelayaran *upwind* (30°-90°), kapal akan memiliki kecepatan 2,5-5,5 knot bergantung pada arah pelayaran.
3. Model tiga dimensi Perahu Kuno Punjulharjo beserta layar hasil rekonstruksi dapat dilihat pada lampiran.

6.2. Saran

Adapun saran dari Tugas Akhir ini, yaitu:

1. Variasi *angle of attack* pada model layar dapat ditambahkan untuk meningkatkan keakuratan hasil perhitungan kecepatan.

2. Penentuan *center of effort* dan *center of lateral resistance* dengan metode yang lebih rinci akan menghasilkan perhitungan *heeling* yang lebih mendekati kondisi pelayaran sesungguhnya dibandingkan dengan metode konvensional.
3. Kondisi perairan Laut Jawa di masa operasional Perahu Kuno Punjulharjo perlu diketahui supaya kemampuan berlayar Perahu Kuno Punjulharjo dapat dihitung dalam kondisi yang lebih mendekati kondisi asli di masa tersebut.

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LAMPIRAN

Lampiran A Data Perahu Kuno Punjulharjo
Lampiran B *Sail Plan*
Lampiran C Analisis Teknis
Lampiran D Model Tiga Dimensi *Sail Plan*

LAMPIRAN A
DATA PERAHU KUNO PUNJULHARJO

UKURAN UTAMA

L_{OA}	15,821	m
L_{WL}	15,741	m
$B_{MIDSHIP}$	3,740	m
B_{MAX}	4,052	m
H	1,805	m
T	1,300	m

TITIK BERAT

LCG (m)	KG (m)
7,893	0,923

Disp.	45,960	t

HAMBATAN KAPAL

V_S (kn)	V_S (m/s)	R (N)
0,100	0,051	0,700
0,200	0,103	2,450
0,300	0,154	5,130
0,400	0,206	8,670
0,500	0,257	13,040
0,600	0,309	18,230
0,700	0,360	24,200
0,800	0,412	30,950
0,900	0,463	38,460
1,000	0,514	46,720
1,100	0,566	55,720
1,200	0,617	65,440
1,300	0,669	75,890
1,400	0,720	87,060
1,500	0,772	98,930
1,600	0,823	111,510
1,700	0,874	124,790
1,800	0,926	138,760
1,900	0,977	153,420
2,000	1,029	168,760
2,100	1,080	184,780
2,200	1,132	201,480
2,300	1,183	218,860
2,400	1,235	236,900
2,500	1,286	255,610
2,600	1,337	274,980
2,700	1,389	295,020
2,800	1,440	315,720
2,900	1,492	337,090
3,000	1,543	359,120
3,100	1,595	381,830
3,200	1,646	405,230
3,300	1,698	429,330
3,400	1,749	454,140
3,500	1,800	479,710
3,600	1,852	506,050
3,700	1,903	533,220
3,800	1,955	561,270
3,900	2,006	590,270
4,000	2,058	620,300
4,050	2,083	635,730
4,100	2,109	651,450
4,150	2,135	667,480
4,200	2,160	683,830
4,250	2,186	700,530
4,300	2,212	717,580
4,350	2,238	735,010
4,400	2,263	752,830
4,450	2,289	771,080
4,500	2,315	789,760
4,550	2,341	808,910
4,600	2,366	828,560
4,650	2,392	848,720
4,700	2,418	869,440
4,750	2,443	890,730
4,800	2,469	912,620
4,850	2,495	935,150

HEELING

θ (°)	GZ (m)	M_R (kNm)
0	0,000	0,000
1	0,014	0,643
2	0,027	1,241
3	0,041	1,884
4	0,055	2,528
5	0,068	3,125
6	0,082	3,769
7	0,096	4,412
8	0,109	5,010
9	0,123	5,653
10	0,136	6,251
11	0,150	6,894
12	0,164	7,537
13	0,177	8,135
14	0,191	8,778
15	0,204	9,376
16	0,217	9,973
17	0,230	10,571
18	0,241	11,076
19	0,252	11,582
20	0,262	12,042
21	0,271	12,455
22	0,279	12,823
23	0,286	13,145
24	0,292	13,420
25	0,298	13,696
26	0,303	13,926
27	0,308	14,156
28	0,312	14,340
29	0,316	14,523
30	0,319	14,661
31	0,322	14,799
32	0,324	14,891
33	0,326	14,983
34	0,327	15,029
35	0,328	15,075
36	0,329	15,121
37	0,329	15,121
38	0,329	15,121
39	0,329	15,121
40	0,329	15,121
41	0,328	15,075
42	0,327	15,029
43	0,325	14,937
44	0,324	14,891
45	0,322	14,799
46	0,320	14,707
47	0,318	14,615
48	0,315	14,477
49	0,312	14,340
50	0,309	14,202
51	0,306	14,064
52	0,303	13,926
53	0,300	13,788
54	0,296	13,604
55	0,292	13,420
56	0,288	13,236

CENTER OF LATERAL RESISTANCE

ST	x (m)	z (m)	xz (m^2)	$0,5z^2$ (m^2)
AP	0,000	1,115	0,000	0,622
1	1,970	1,240	2,443	0,769
2	2,840	1,272	3,612	0,809
3	3,700	1,280	4,735	0,819
4	4,560	1,280	5,837	0,819
5	5,420	1,284	6,961	0,825
6	6,280	1,294	8,124	0,837
7	7,140	1,292	9,225	0,835
8	8,000	1,292	10,335	0,835
9	9,100	1,298	11,813	0,843
10	9,960	1,300	12,943	0,844
11	10,820	1,299	14,060	0,844
12	11,710	1,298	15,194	0,842
13	12,570	1,281	16,103	0,821
14	13,460	1,236	16,642	0,764
15	14,320	1,173	16,797	0,688
FP	15,725	0,000	0,000	0,000
Σ		**20,234**	**154,824**	**12,814**

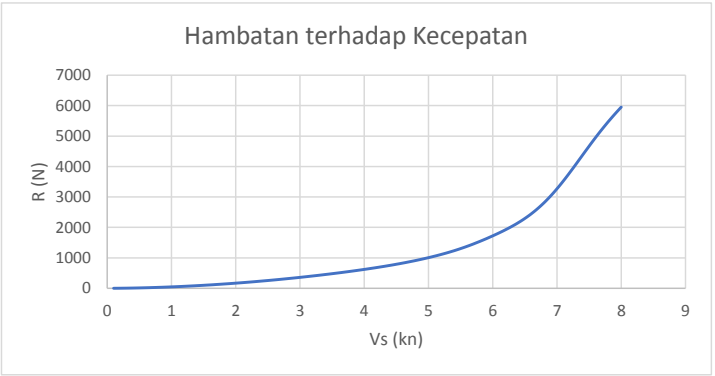
CLR **7,652 m dari AP**

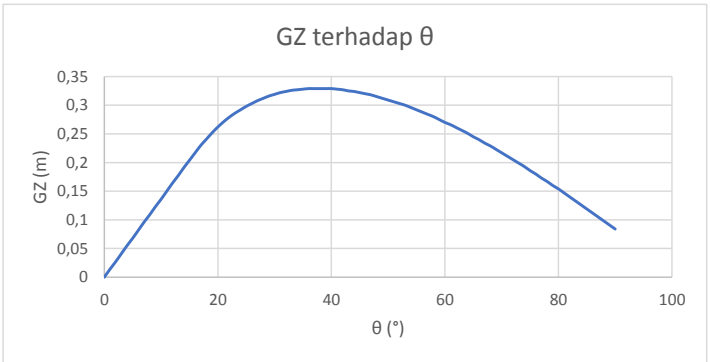
0,633 m dari DWL

4,900	2,521	958,340
4,950	2,546	982,220
5,000	2,572	1006,830
5,050	2,598	1032,180
5,100	2,623	1058,340
5,150	2,649	1085,360
5,200	2,675	1113,280
5,250	2,701	1142,190
5,300	2,726	1172,160
5,350	2,752	1203,270
5,400	2,778	1235,580
5,450	2,803	1269,170
5,500	2,829	1304,070
5,550	2,855	1340,320
5,600	2,881	1377,920
5,650	2,906	1416,850
5,700	2,932	1457,080
5,750	2,958	1498,550
5,800	2,984	1541,200
5,850	3,009	1584,980
5,900	3,035	1629,860
5,950	3,061	1675,810
6,000	3,086	1722,870
6,050	3,112	1771,110
6,100	3,138	1820,650
6,150	3,164	1871,660
6,200	3,189	1924,390
6,250	3,215	1979,090
6,300	3,241	2036,090
6,350	3,266	2095,740
6,400	3,292	2158,400
6,450	3,318	2224,470
6,500	3,344	2294,350
6,550	3,369	2368,430
6,600	3,395	2447,070
6,650	3,421	2530,620
6,700	3,446	2619,380
6,750	3,472	2713,590
6,800	3,498	2813,420
6,850	3,524	2918,970
6,900	3,549	3030,230
6,950	3,575	3147,090
7,000	3,601	3269,330
7,050	3,627	3396,620
7,100	3,652	3528,520
7,150	3,678	3664,470
7,200	3,704	3803,850
7,250	3,729	3945,920
7,300	3,755	4089,920
7,350	3,781	4235,050
7,400	3,807	4380,510
7,450	3,832	4525,510
7,500	3,858	4669,310
7,550	3,884	4811,270
7,600	3,909	4950,820
7,650	3,935	5087,500
7,700	3,961	5220,970
7,750	3,987	5351,030
7,800	4,012	5477,620
7,850	4,038	5600,770
7,900	4,064	5720,650
7,950	4,089	5837,550
8,000	4,115	5951,860

57	0,284	13,053
58	0,280	12,869
59	0,275	12,639
60	0,270	12,409
61	0,266	12,225
62	0,261	11,996
63	0,256	11,766
64	0,251	11,536
65	0,245	11,260
66	0,240	11,030
67	0,234	10,755
68	0,229	10,525
69	0,223	10,249
70	0,217	9,973
71	0,211	9,698
72	0,205	9,422
73	0,199	9,146
74	0,193	8,870
75	0,186	8,549
76	0,180	8,273
77	0,173	7,951
78	0,167	7,675
79	0,160	7,354
80	0,154	7,078
81	0,147	6,756
82	0,140	6,434
83	0,133	6,113
84	0,126	5,791
85	0,119	5,469
86	0,112	5,148
87	0,105	4,826
88	0,098	4,504
89	0,091	4,182
90	0,084	3,861

θ_{maxGZ}	36 °
$\theta_{deckline}$	11 °
θ_{max}	**11 °**
M_{Rmax}	**6,894 kNm**





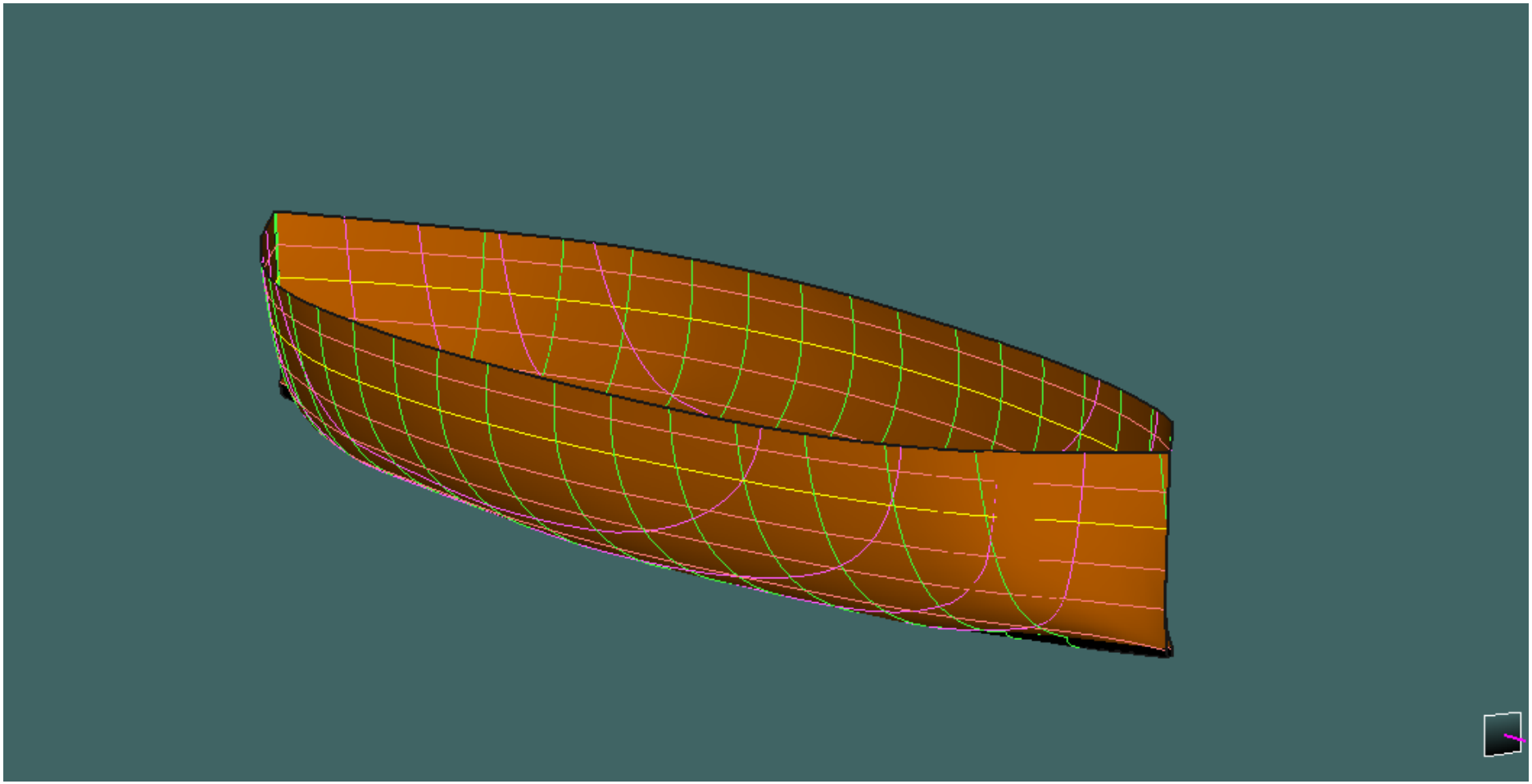


TABLE ORDINATE OF HEIGHT ABOVE BASELINE

BL / ST	CL	BL 1	BL 2	BL 3	BL 4
AP					
ST 1	0,0599	0,1221	0,4194		
ST 2	0,0282	0,0998	0,2045	0,6063	
ST 3	0,0202	0,0534	0,1291	0,3228	1,1142
ST 4	0,0199	0,0455	0,1108	0,2546	0,6319
ST 5	0,0157	0,0262	0,0866	0,2263	0,5305
ST 6	0,0064	0,0188	0,0790	0,2042	0,4640
ST 7	0,0080	0,0225	0,0671	0,1751	0,4240
ST 8	0,0081	0,0158	0,0465	0,1611	0,4336
ST 9	0,0019	0,0135	0,0549	0,1896	0,4986
ST 10	0,0000	0,0157	0,0747	0,2366	0,6185
ST 11	0,0001	0,0229	0,1066	0,3182	0,8550
ST 12	0,0025	0,0338	0,1548	0,4494	1,3184
ST 13	0,0188	0,0669	0,2418	0,6784	
ST 14	0,0636	0,1777	0,4272	1,3694	
ST 15	0,1270	0,3502	1,1094		
FP					

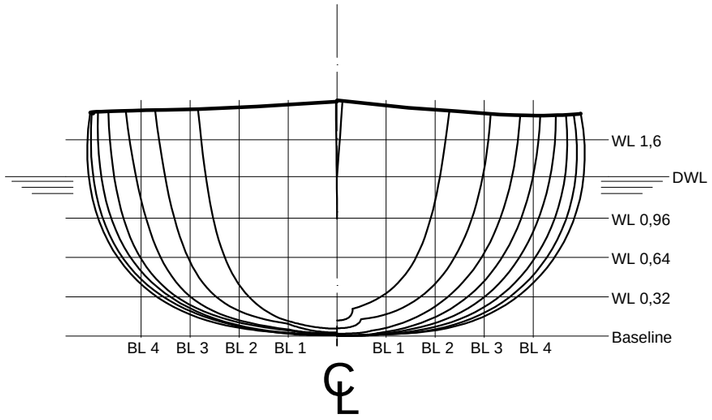
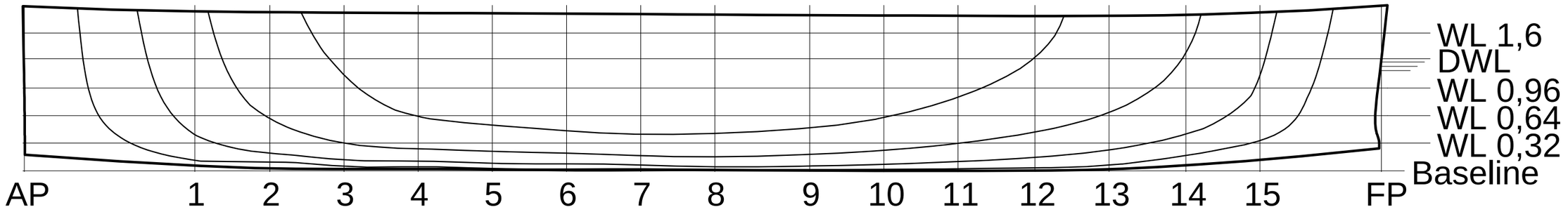
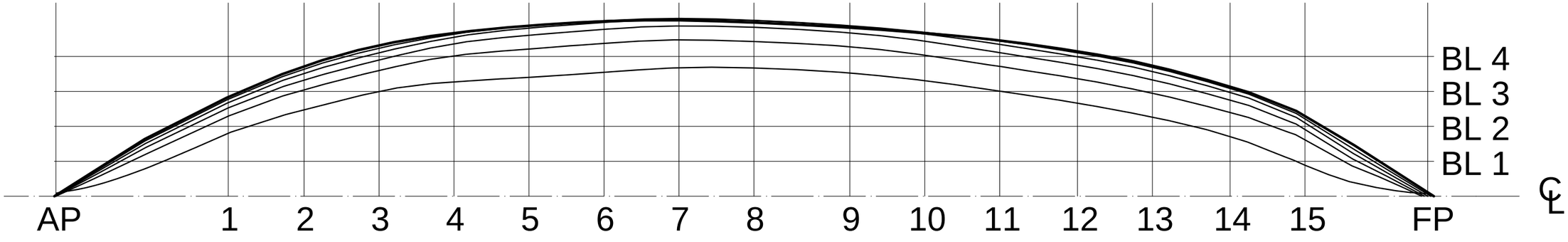


TABLE ORDINATE OF HALF BREADTH

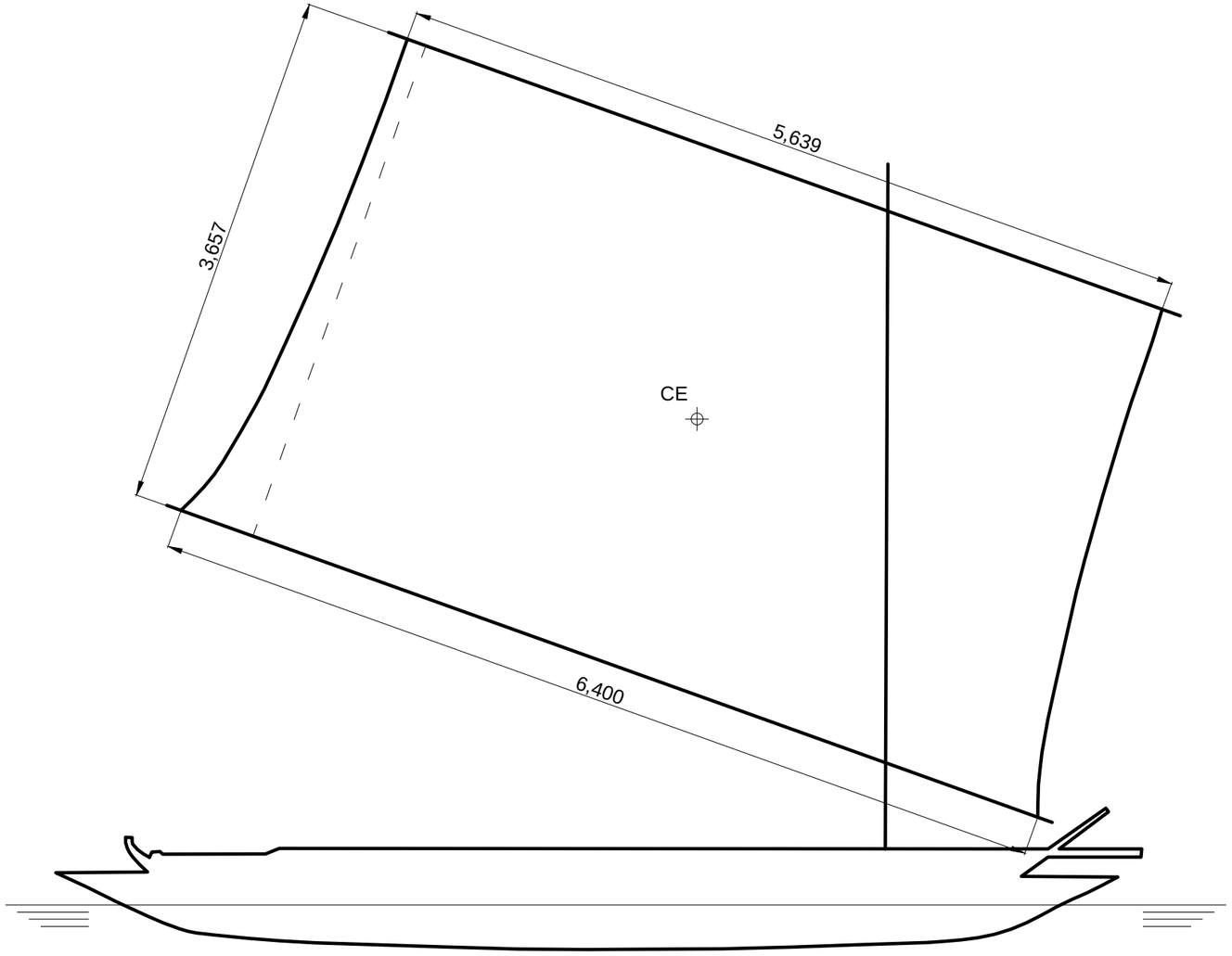
WL / ST	Baseline	WL 0.32	WL 0.64	WL 0.96	WL 1.3	WL 1.6	Main Deck
AP				0,0003	0,0033	0,0066	0,0105
ST 1		0,7195	0,9161	1,0113	1,0713	1,1090	1,1349
ST 2		0,9870	1,2159	1,3277	1,4036	1,4526	1,4843
ST 3		1,1964	1,4382	1,5587	1,6406	1,6925	1,7246
ST 4		1,3076	1,6047	1,7424	1,8185	1,8535	1,8670
ST 5		1,3614	1,6841	1,8424	1,9235	1,9505	1,9517
ST 6		1,4174	1,7501	1,9106	1,9887	2,0086	2,0019
ST 7		1,4701	1,7884	1,9494	2,0258	2,0350	2,0148
ST 8		1,4686	1,7717	1,9334	2,0101	2,0141	1,9876
ST 9		1,4089	1,7096	1,8693	1,9453	1,9519	1,9298
ST 10		1,3208	1,6142	1,7741	1,8575	1,8766	1,8660
ST 11		1,2022	1,4852	1,6429	1,7377	1,7762	1,7830
ST 12		1,0640	1,3443	1,5006	1,5964	1,6419	1,6572
ST 13		0,9037	1,1772	1,3308	1,4262	1,4742	1,4930
ST 14		0,6810	0,9571	1,0990	1,1873	1,2332	1,2527
ST 15		0,3552	0,6427	0,7630	0,8382	0,8854	0,9157
FP					0,0001	0,0214	0,0443





SCALE 1:50

LAMPIRAN B
SAIL PLAN



SAIL DIMENSIONS

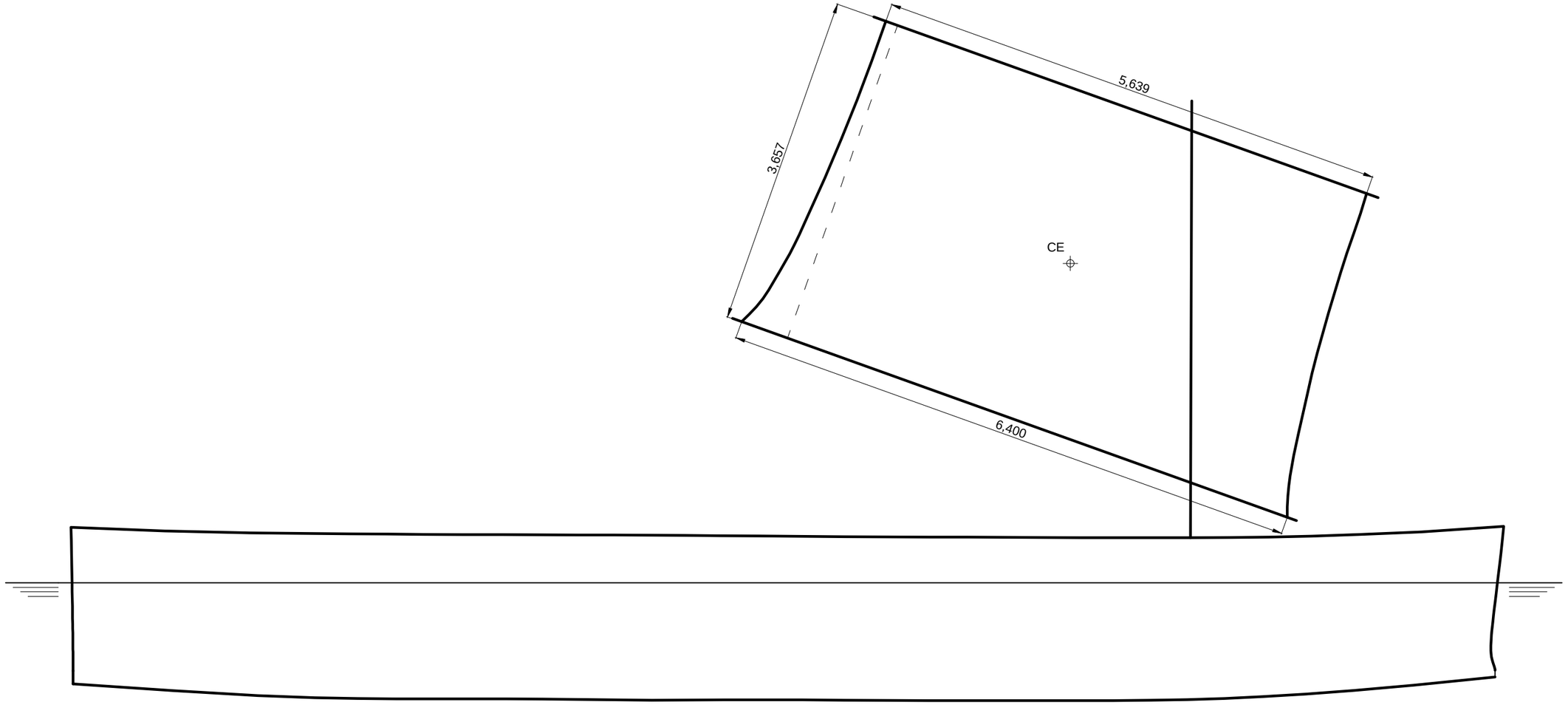
Head Span	5.639 m
Foot Span	6.400 m
Chrod	3.657 m
Sail Area	22.019 m^2
CE above WL	3.353 m

DEPARTMENT OF NAVAL ARCHITECTURE
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

VINTA - HORNELL 1972

REDRAW SAIL PLAN

SCALE	1 : 40	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



SAIL DIMENSIONS

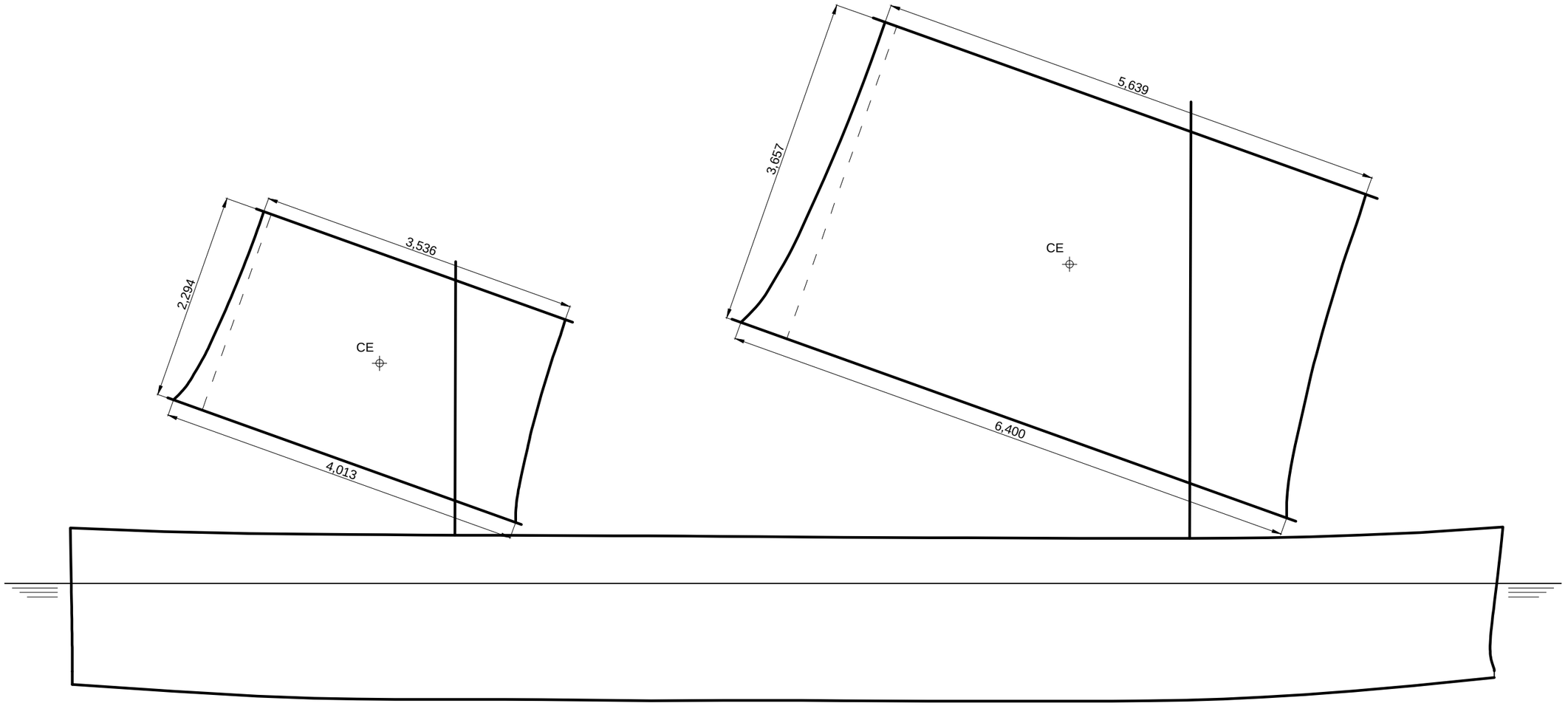
Head Span	5.639 m
Foot Span	6.400 m
Chrod	3.657 m
Sail Area	22.019 m^2
CE above WL	3.523 m

DEPARTMENT OF NAVAL ARCHITECTURE
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

VINTA-1

SAIL PLAN

SCALE	1 : 50	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



MAIN SAIL DIMENSIONS

Head Span	5.639 m
Foot Span	6.400 m
Chrod	3.657 m
Sail Area	22.019 m^2
CE above WL	3.523 m

MIZZEN SAIL DIMENSIONS

Head Span	3.536 m
Foot Span	4.013 m
Chrod	2.294 m
Sail Area	8.656 m^2
CE above WL	2.430 m

DEPARTMENT OF NAVAL ARCHITECTURE
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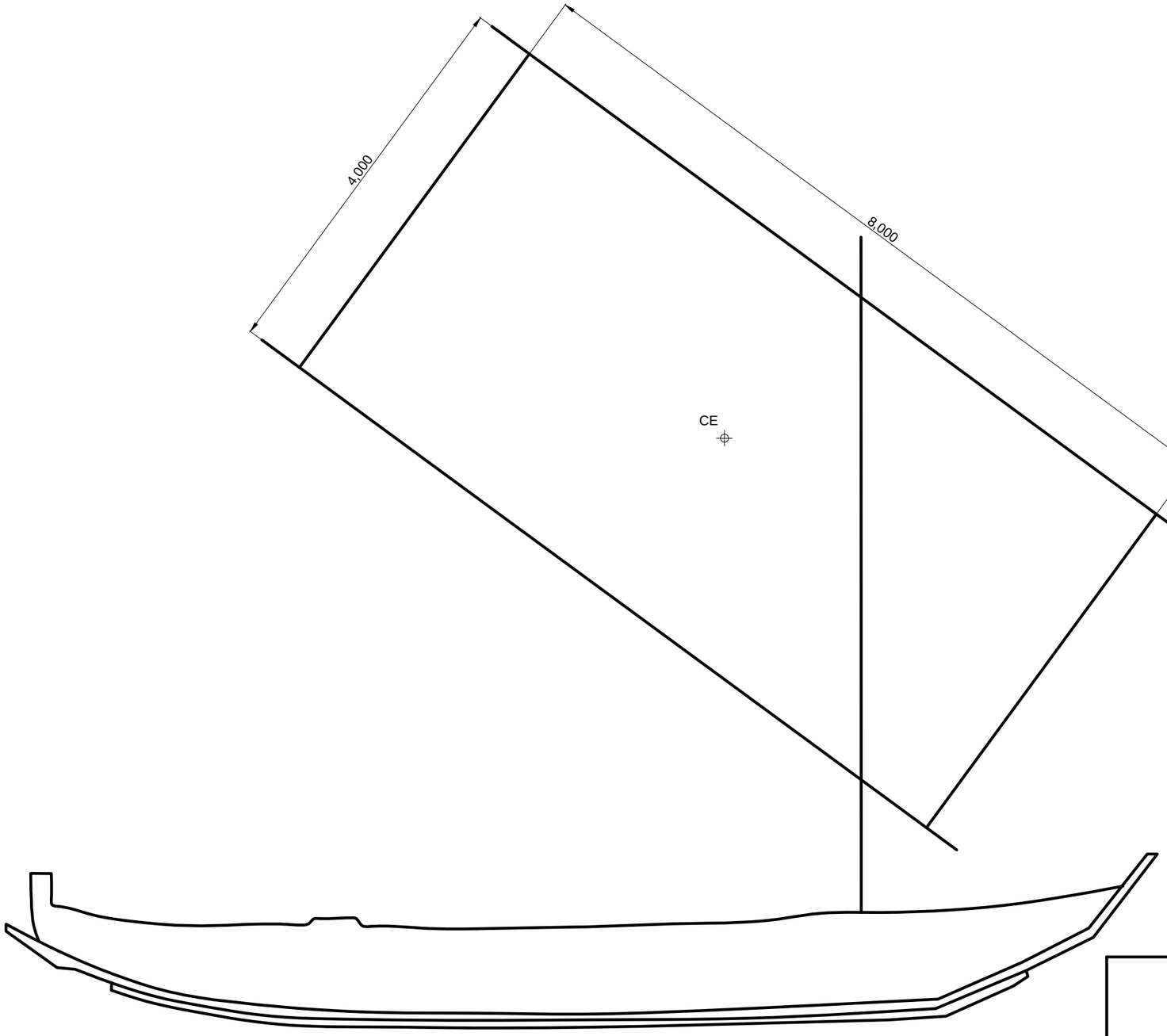
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

VINTA-2

SAIL PLAN

SCALE	1 : 50	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



SAIL DIMENSIONS

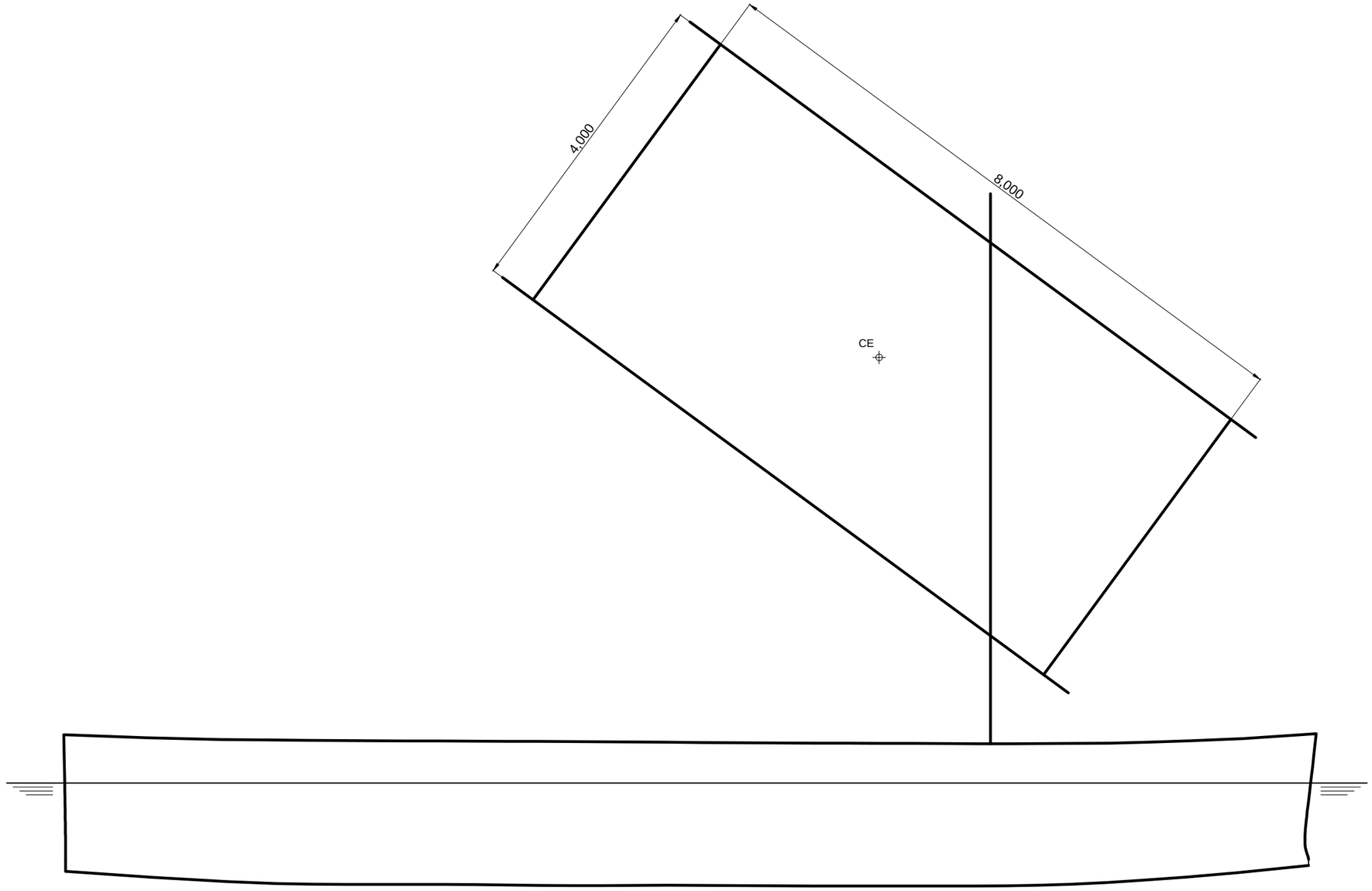
Span	8.000 m
Chrod	4.000 m
Sail Area	32.000 m^2
CE above WL	-

DEPARTMENT OF NAVAL ARCHITECTURE
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

PELEDANG - DWYER & AKERMAN 1996

REDRAW SAIL PLAN

SCALE	1 : 50	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



SAIL DIMENSIONS

Span	8.000 m
Chrod	4.000 m
Sail Area	32.000 m^2
CE above WL	5,374 m

DEPARTMENT OF NAVAL ARCHITECTURE

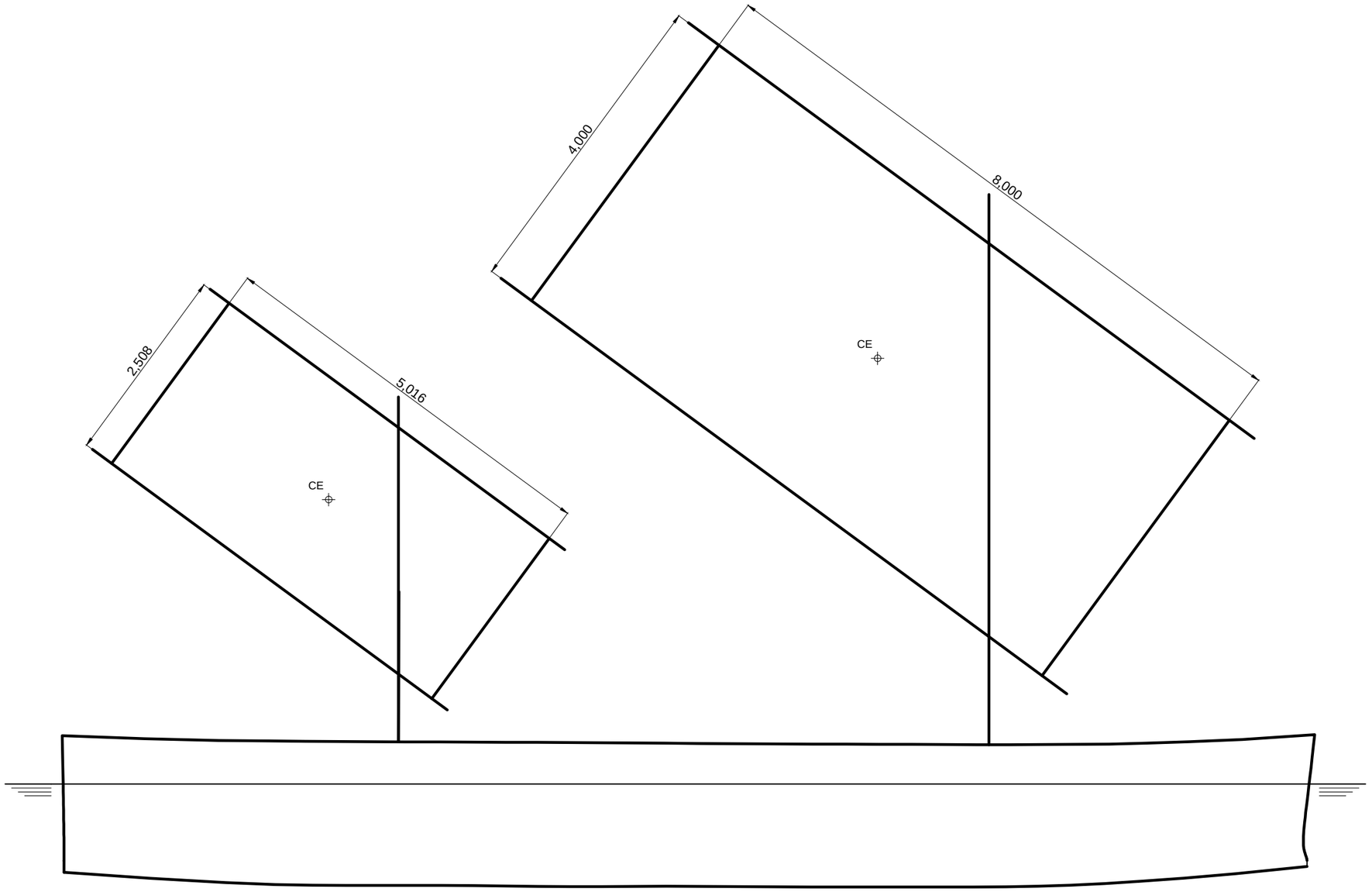
FACULTY OF MARINE TECHNOLOGY

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

PELEDANG-1

SAIL PLAN

SCALE	1 : 60	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



MAIN SAIL DIMENSIONS

Span	8.000 m
Chrod	4.000 m
Sail Area	32.000 m^2
CE above WL	5.374 m

MIZZEN SAIL DIMENSIONS

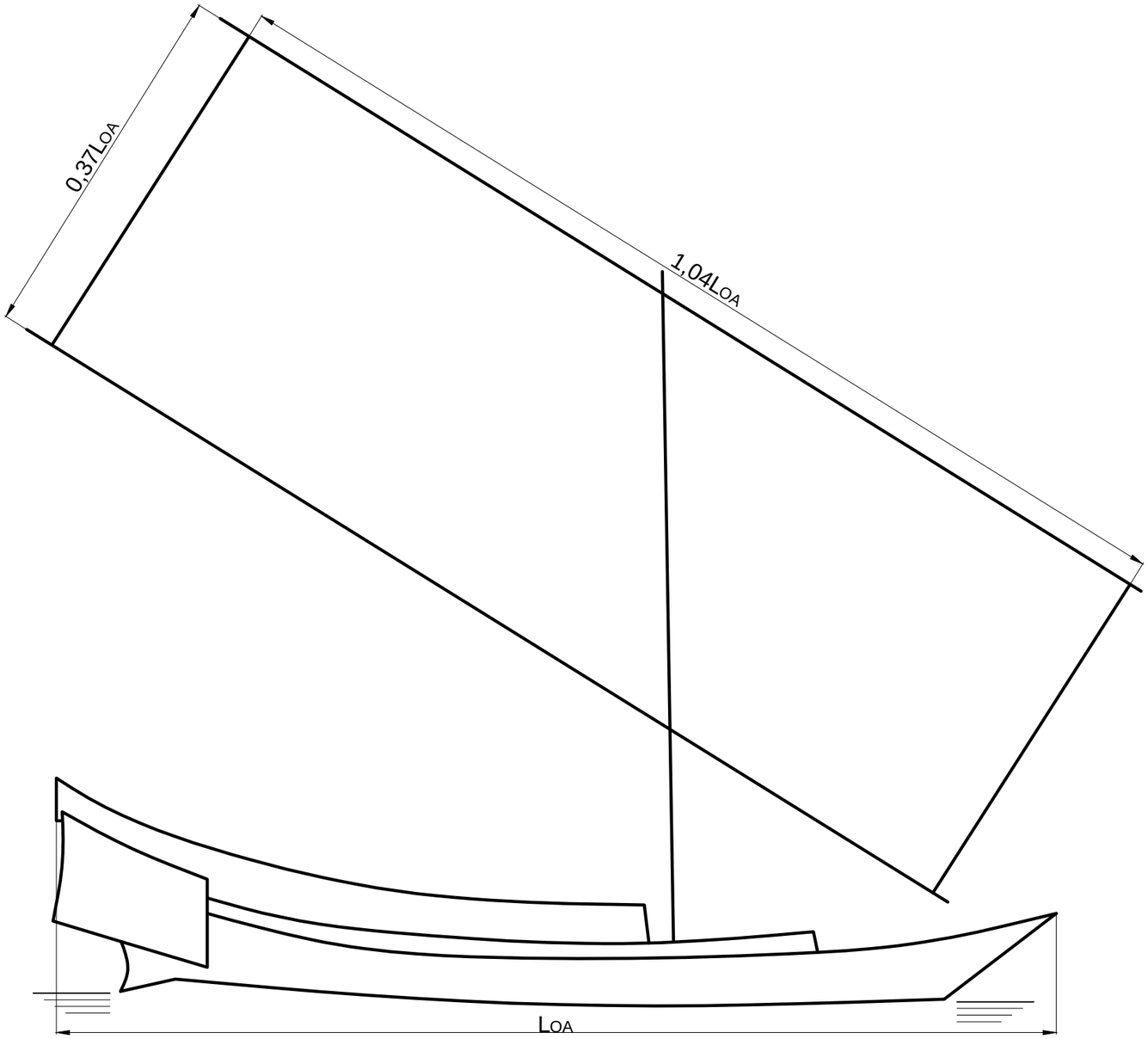
Span	5.016 m
Chrod	2.508 m
Sail Area	12.580 m^2
CE above WL	3.590 m

DEPARTMENT OF NAVAL ARCHITECTURE
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

PELEDANG-2

SAIL PLAN

SCALE	1 : 60	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



SAIL DIMENSIONS

Span	1.040 L_{OA}
Chrod	0.370 L_{OA}
Sail Area	-
CE above WL	-

DEPARTMENT OF NAVAL ARCHITECTURE

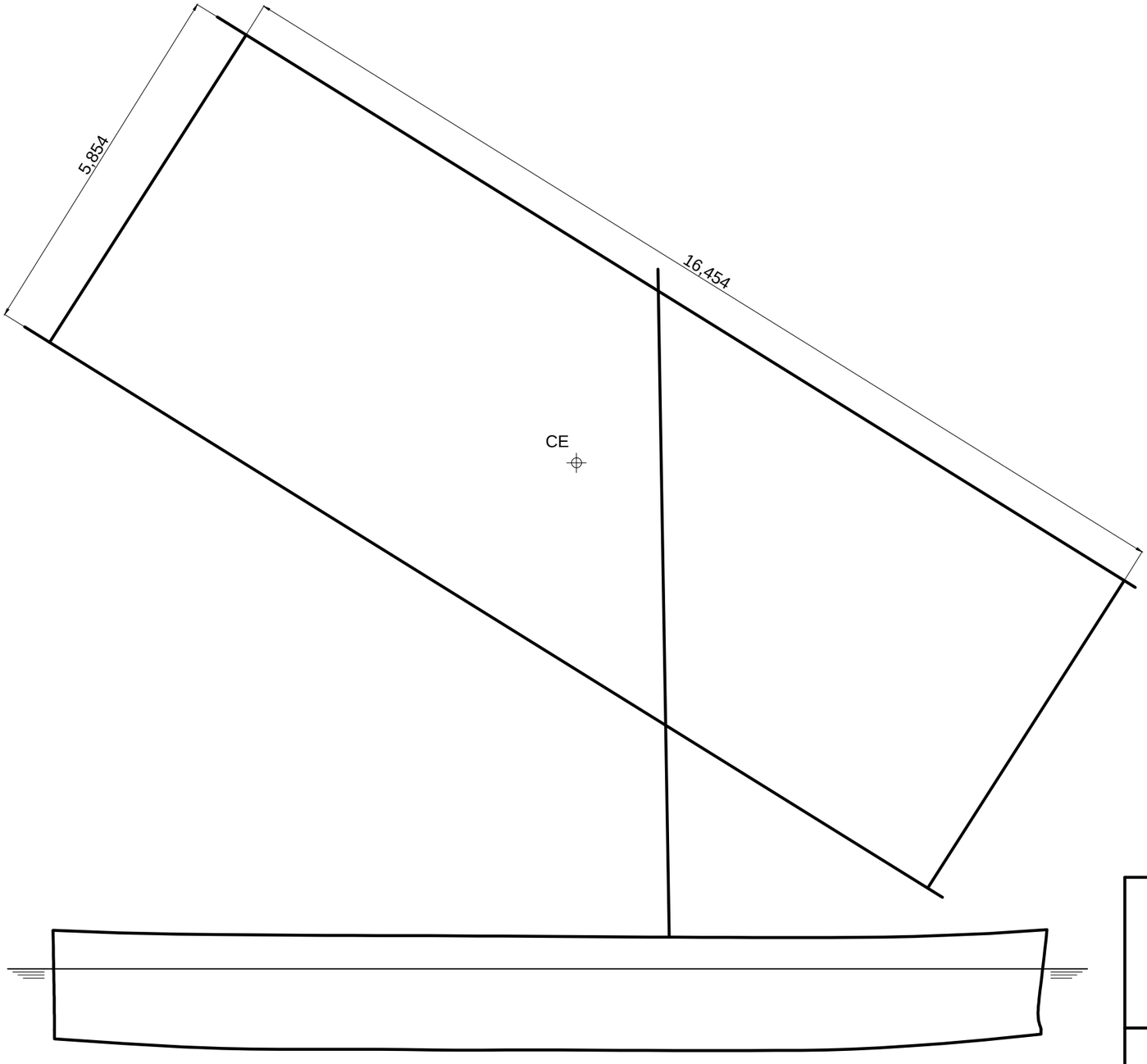
FACULTY OF MARINE TECHNOLOGY

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

PADEWAKANG - NMVW

REDRAW SAIL PLAN

SCALE	-	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



SAIL DIMENSIONS

Span	16.454 m
Chrod	5.854 m
Sail Area	96.322 m^2
CE above WL	8.050 m

DEPARTMENT OF NAVAL ARCHITECTURE

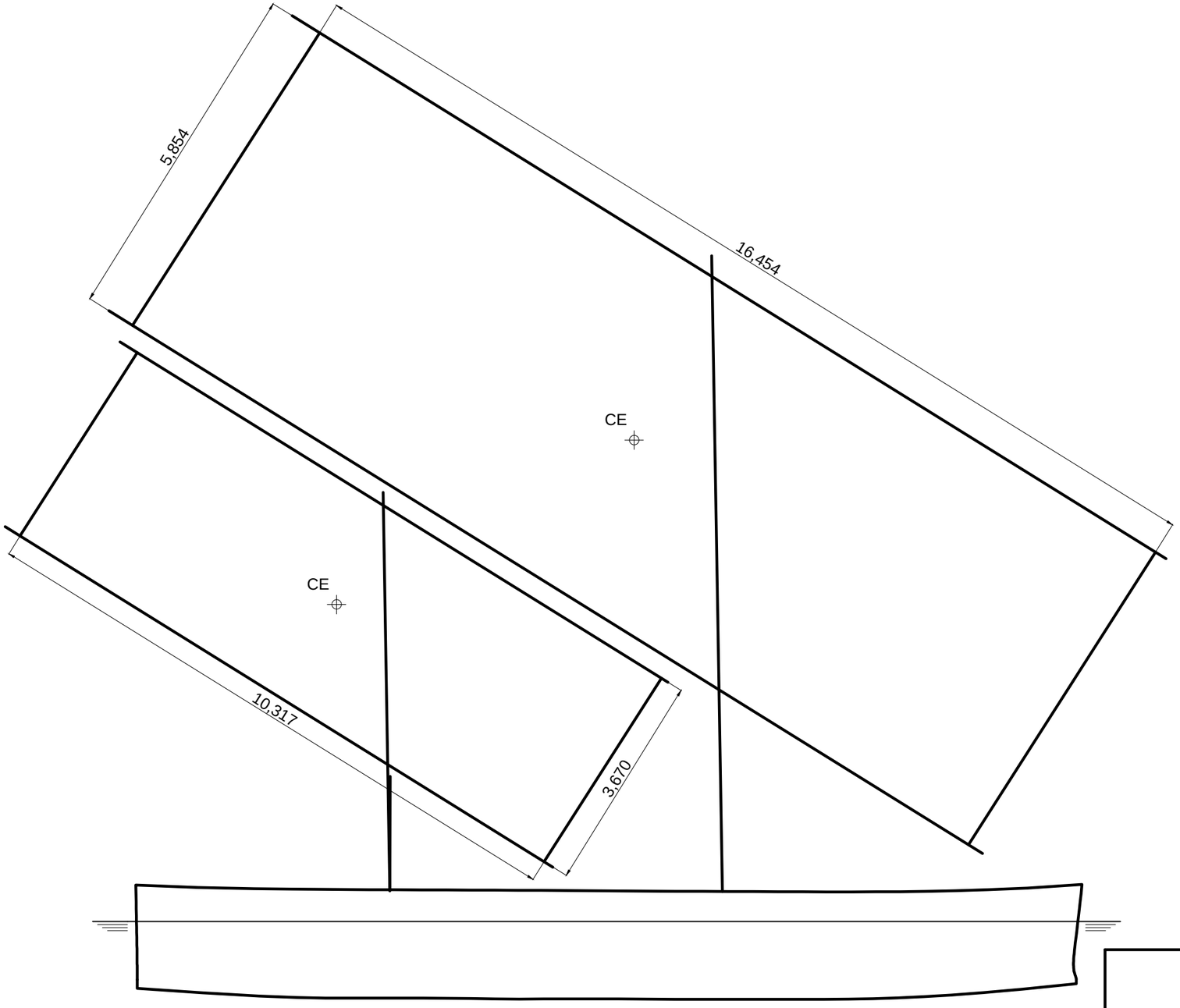
FACULTY OF MARINE TECHNOLOGY

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

PADEWAKANG-1

SAIL PLAN

SCALE	1 : 80	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3



MAIN SAIL DIMENSIONS

Span	16.454 m
Chrod	5.854 m
Sail Area	96.322 m^2
CE above WL	8.050 m

MIZZEN SAIL DIMENSIONS

Span	10.317 m
Chrod	3.670 m
Sail Area	37.867 m^2
CE above WL	5.300 m

DEPARTMENT OF NAVAL ARCHITECTURE
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

PADEWAKANG-2

SAIL PLAN

SCALE	1 : 80	SIGNATURE	DATE	REMARK
DRAWN	Zulfikar Bisma Wicaksana			04111640000012
APPROVED	Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.			A3

LAMPIRAN C
ANALISIS TEKNIS

DATA LAYAR

Model		Vinta-Ma	
Span	Yard	5,639	m
	Boom	6,400	m
Chord		3,658	m
Area		22,019	m^2
CE above WL		3,523	m

Model		Vinta-Mi	
Span	Yard	3,536	m
	Boom	4,013	m
Chord		2,294	m
Area		8,659	m^2
CE above WL		2,430	m

Model		Peledang-Ma	
Span	Yard	8,000	m
	Boom	8,000	m
Chord		4,000	m
Area		32,000	m^2
CE above WL		5,374	m

Model		Peledang-Mi	
Span	Yard	5,016	m
	Boom	5,016	m
Chord		2,508	m
Area		12,580	m^2
CE above WL		3,590	m

Model		Padewakang-Ma	
Span	Yard	16,454	m
	Boom	16,454	m
Chord		5,854	m
Area		96,322	m^2
CE above WL		8,050	m

Model		Padewakang-Mi	
Span	Yard	10,317	m
	Boom	10,317	m
Chord		3,670	m
Area		37,863	m^2
CE above WL		5,300	m

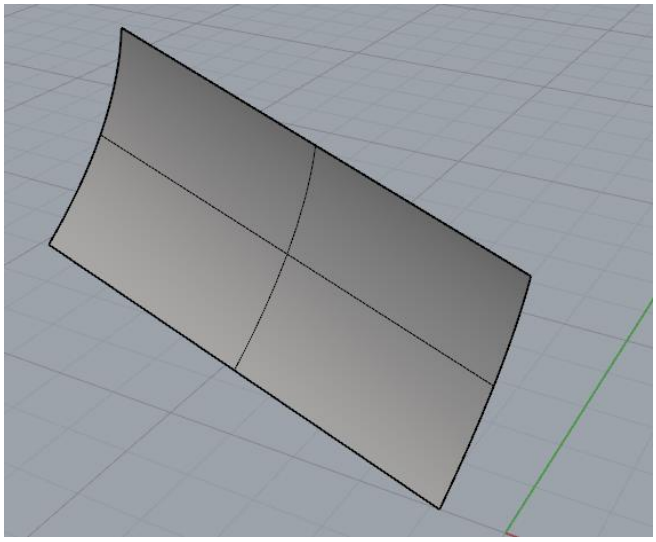
Model	Main			Mizzen		
	Span (m)		Chord (m)	Span (m)		Chord (m)
	Head	Boom		Head	Boom	
Vinta	5,639	6,400	3,658	3,536	4,013	2,294
Peledang	8,000	8,000	4,000	5,016	5,016	2,508
Padewakar	16,454	16,454	5,854	10,317	10,317	3,670

Model	CE (m)	
	Main	Mizzen
Vinta	3,523	2,430
Peledang	5,374	3,590
Padewakar	8,050	5,300

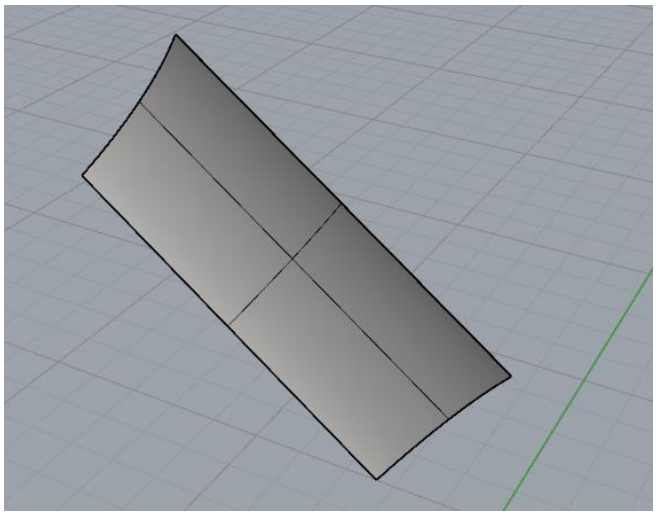
HASIL SIMULASI

Model	α (°)	Main		Mizzen	
		F_X (N)	F_Y (N)	F_X (N)	F_Y (N)
Vinta	5	2,662	21,103	1,045	7,809
	15	16,162	62,053	6,805	24,276
	25	47,647	106,019	17,135	38,174
	35	85,750	124,331	33,620	48,744
	45	127,217	128,509	49,876	50,373
	90	210,548	-1,314	82,416	-0,511
Peledang	5	7,401	57,854	2,213	18,224
	15	26,296	112,487	9,133	41,569
	25	72,843	173,634	28,518	67,894
	35	132,250	199,617	54,530	78,916
	45	152,611	158,405	73,532	76,237
	90	356,651	-0,088	139,899	-0,027
Padewakang	5	15,430	154,842	6,056	56,408
	15	82,887	365,052	29,403	128,269
	25	256,763	604,876	86,576	205,780
	35	412,220	620,738	161,535	243,243
	45	591,105	610,276	232,079	239,499
	90	1235,777	0,240	485,776	0,084

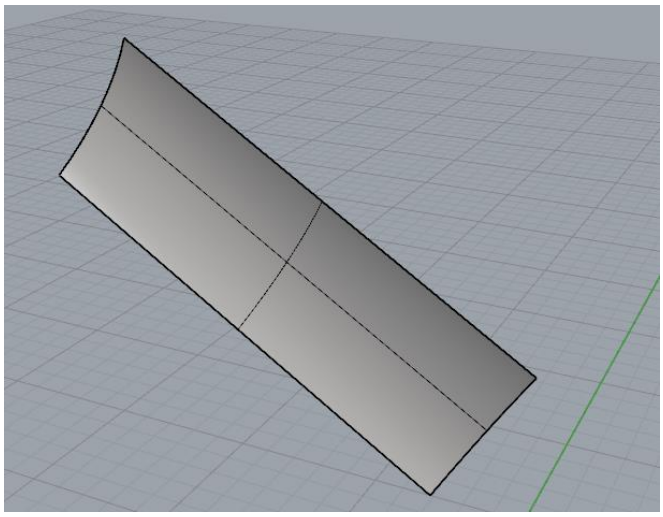
MODEL 3D VINTA



MODEL 3D PELEDANG



MODEL 3D PADEWAKANG



SPESIFIKASI LAYAR

Model		Vinta-Ma	
Span	Yard	5,639	m
	Boom	6,400	m
Chord		3,658	m
Area		22,019	m^2

APPARENT WIND

ρ	1,2	kg/m^3

NILAI KOEFISIEN

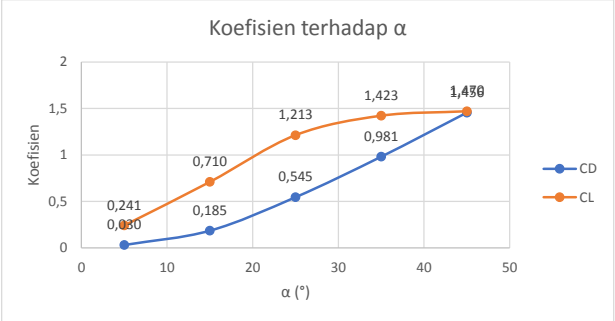
V_A	5	kn		
α (°)	F_D (N)	F_L (N)	C_D	C_L
5	2,662	21,103	0,030	0,241
15	16,162	62,053	0,185	0,710
25	47,647	106,019	0,545	1,213
35	85,750	124,331	0,981	1,423
45	127,217	128,509	1,456	1,470
90	210,548	-1,314	2,409	-0,015

LIFT COEFFICIENT

$$C_L = \frac{2F_L}{\rho A V_A{}^2}$$

DRAG COEFFICIENT

$$C_D = \frac{2F_D}{\rho A V_A{}^2}$$



SPESIFIKASI LAYAR

Model		Peledang-Ma	
Span	Yard	8,000	m
	Boom	8,000	m
Chord		4,000	m
Area		32,000	m^2

APPARENT WIND

ρ	1,2	kg/m^3

NILAI KOEFISIEN

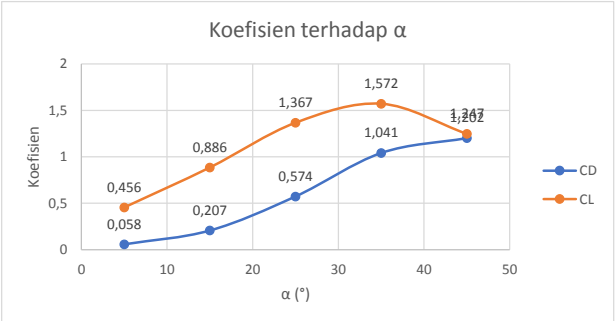
V_A	5	kn		
α (°)	F_D (N)	F_L (N)	C_D	C_L
5	7,401	57,854	0,058	0,456
15	26,296	112,487	0,207	0,886
25	72,843	173,634	0,574	1,367
35	132,250	199,617	1,041	1,572
45	152,611	158,405	1,202	1,247
90	356,651	-0,088	2,808	-0,001

LIFT COEFFICIENT

$$C_L = \frac{2F_L}{\rho A V_A{}^2}$$

DRAG COEFFICIENT

$$C_D = \frac{2F_D}{\rho A V_A{}^2}$$



SPESIFIKASI LAYAR

Model		Padewakang-Ma	
Span	Yard	16,454	m
	Boom	16,454	m
Chord		5,854	m
Area		96,322	m^2

APPARENT WIND

ρ	1,2	kg/m^3

NILAI KOEFISIEN

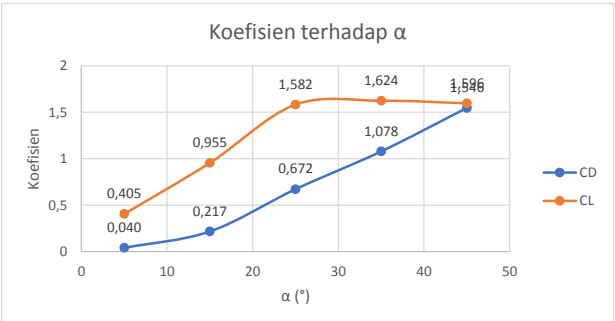
V_A	5	kn		
α (°)	F_D (N)	F_L (N)	C_D	C_L
5	15,430	154,842	0,040	0,405
15	82,887	365,052	0,217	0,955
25	256,763	604,876	0,672	1,582
35	412,220	620,738	1,078	1,624
45	591,105	610,276	1,546	1,596
90	1235,777	0,240	3,232	0,001

LIFT COEFFICIENT

$$C_L = \frac{2F_L}{\rho A V_A{}^2}$$

DRAG COEFFICIENT

$$C_D = \frac{2F_D}{\rho A V_A{}^2}$$



SPESIFIKASI LAYAR

Model		Vinta-Mi
Span	Yard	3,536 m
	Boom	4,013 m
Chord		2,294 m
Area		8,656 m^2

APPARENT WIND

ρ	1,2 kg/m^3

NILAI KOEFISIEN

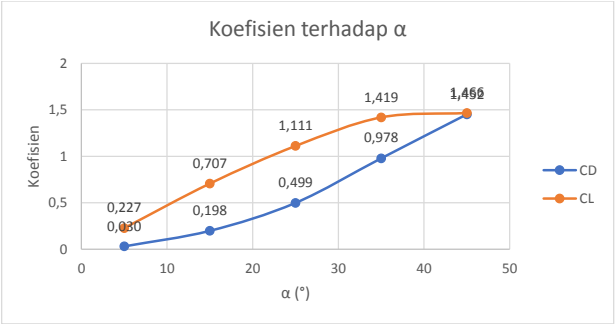
V_A	5 kn			
α (°)	F_D (N)	F_L (N)	C_D	C_L
5	1,045	7,809	0,030	0,227
15	6,805	24,276	0,198	0,707
25	17,135	38,174	0,499	1,111
35	33,620	48,744	0,978	1,419
45	49,876	50,373	1,452	1,466
90	82,416	-0,511	2,399	-0,015

LIFT COEFFICIENT

$$C_L = \frac{2F_L}{\rho A V_A^{\,2}}$$

DRAG COEFFICIENT

$$C_D = \frac{2F_D}{\rho A V_A^{\,2}}$$



SPESIFIKASI LAYAR

Model		Peledang-Mi
Span	Yard	5,016 m
	Boom	5,016 m
Chord		2,508 m
Area		12,580 m^2

APPARENT WIND

ρ	1,2 kg/m^3

NILAI KOEFISIEN

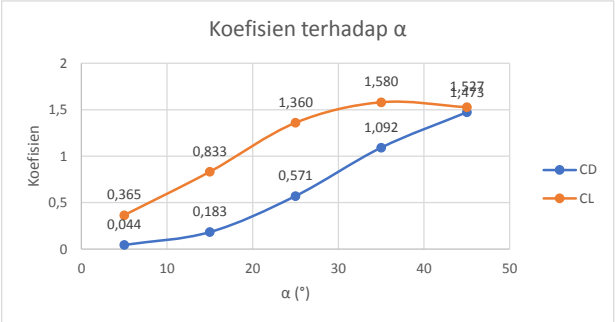
V_A	5 kn			
α (°)	F_D (N)	F_L (N)	C_D	C_L
5	2,213236	18,22416	0,044	0,365
15	9,133316	41,56925	0,183	0,833
25	28,51777	67,8935	0,571	1,360
35	54,52982	78,91582	1,092	1,580
45	73,53174	76,23693	1,473	1,527
90	139,8994	-0,02668	2,802	-0,001

LIFT COEFFICIENT

$$C_L = \frac{2F_L}{\rho A V_A^{\,2}}$$

DRAG COEFFICIENT

$$C_D = \frac{2F_D}{\rho A V_A^{\,2}}$$



SPESIFIKASI LAYAR

Model		Padewakang-Mi
Span	Yard	10,317 m
	Boom	10,317 m
Chord		3,670 m
Area		37,867 m^2

APPARENT WIND

ρ	1,2 kg/m^3

NILAI KOEFISIEN

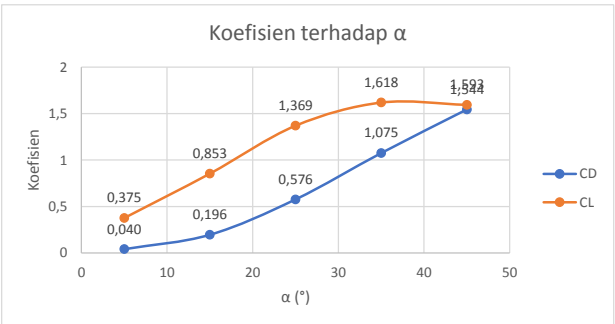
V_A	5 kn			
α (°)	F_D (N)	F_L (N)	C_D	C_L
5	6,056	56,408	0,040	0,375
15	29,403	128,269	0,196	0,853
25	86,576	205,780	0,576	1,369
35	161,535	243,243	1,075	1,618
45	232,079	239,499	1,544	1,593
90	485,776	0,084	3,232	0,001

LIFT COEFFICIENT

$$C_L = \frac{2F_L}{\rho A V_A^{\,2}}$$

DRAG COEFFICIENT

$$C_D = \frac{2F_D}{\rho A V_A^{\,2}}$$



SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

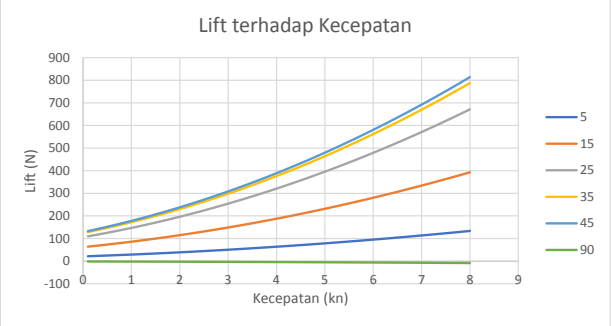
HEELING MOMENT

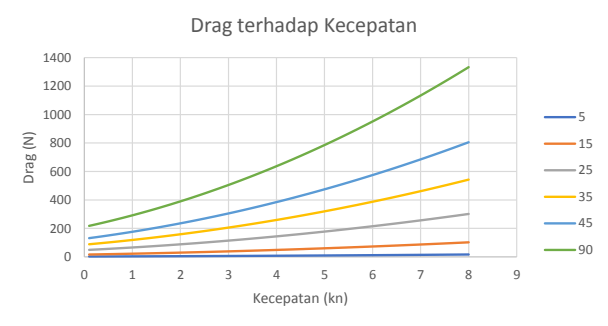
$$M_H = F_H \times h$$

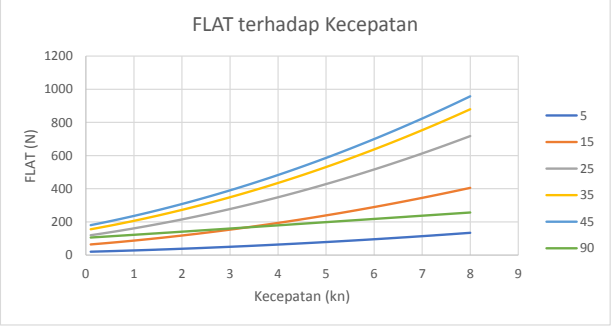
KOEFISIEN LAYAR

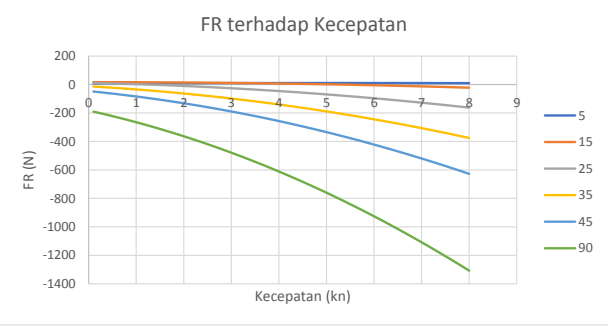
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

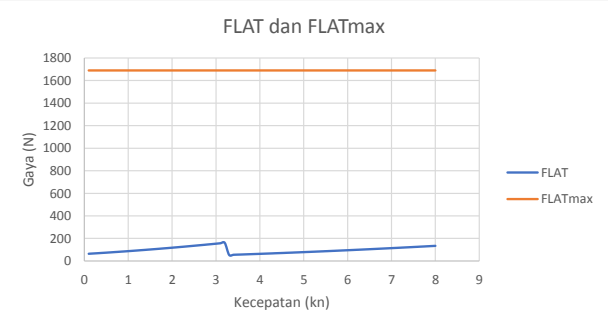
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	30 °
V_A	2,843 m/s
β	26,889 °
V_S	**0,309 m/s**
	0,600 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

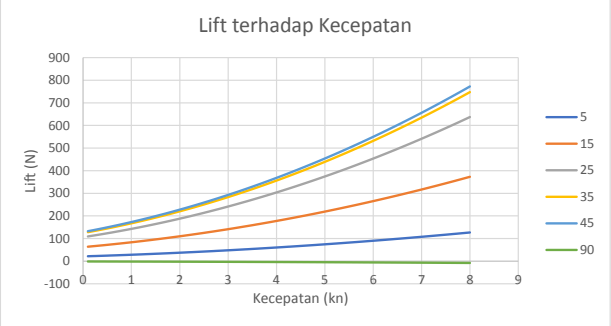
HEELING MOMENT

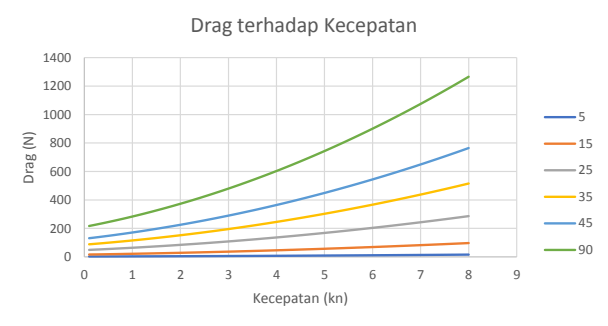
$$M_H = F_H \times h$$

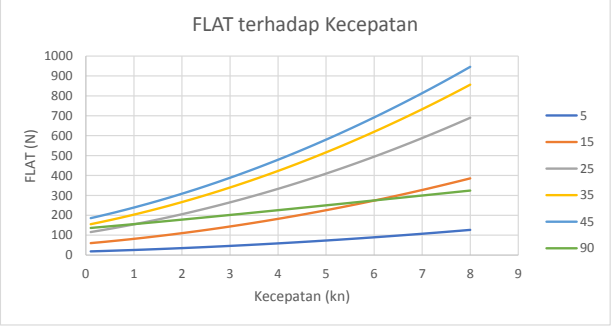
KOEFISIEN LAYAR

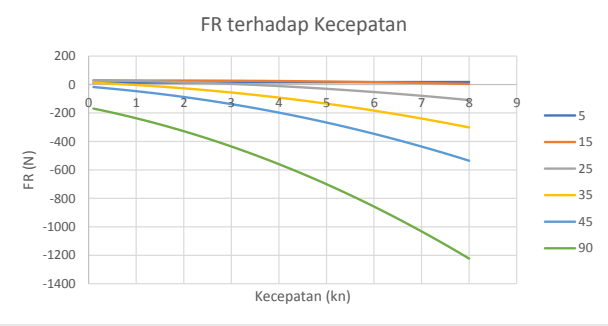
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

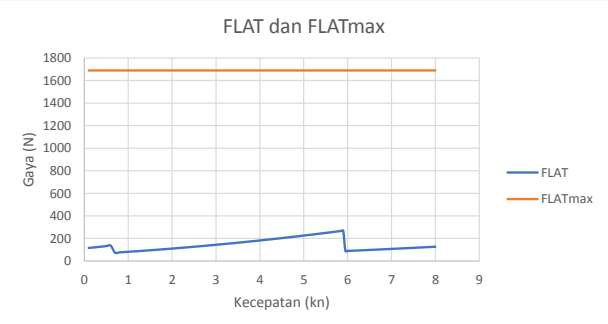
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	40 °
V_A	2,899 m/s
β	34,765 °
V_S	**0,412 m/s**
	0,800 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

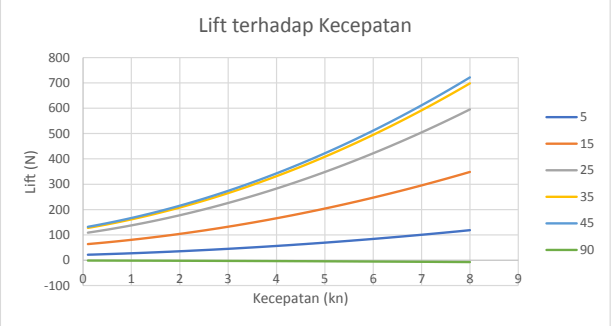
HEELING MOMENT

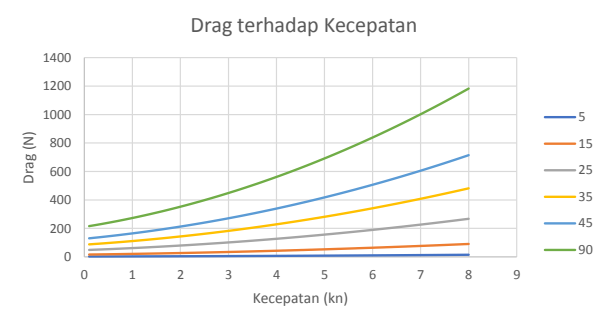
$$M_H = F_H \times h$$

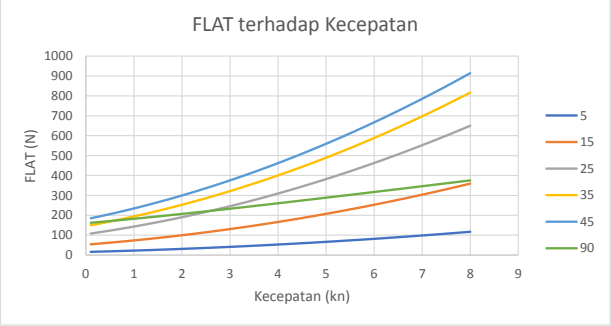
KOEFISIEN LAYAR

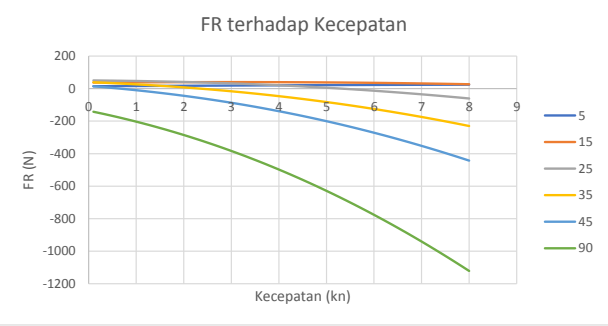
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

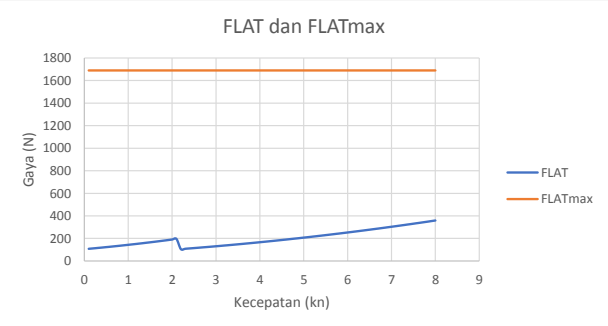
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	50 °
V_A	2,929 m/s
β	42,269 °
V_S	**0,514 m/s**
	1,000 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

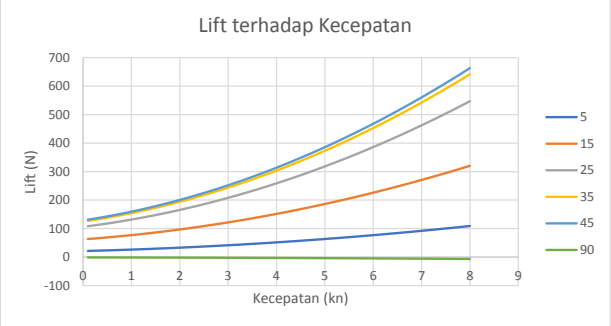
HEELING MOMENT

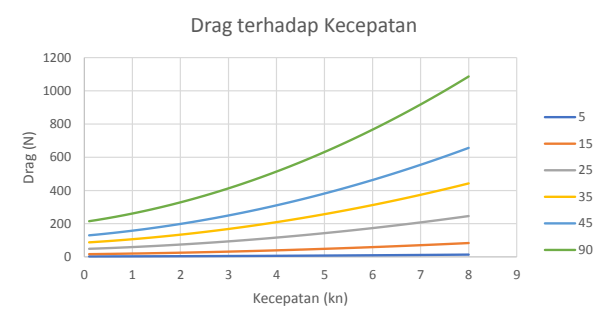
$$M_H = F_H \times h$$

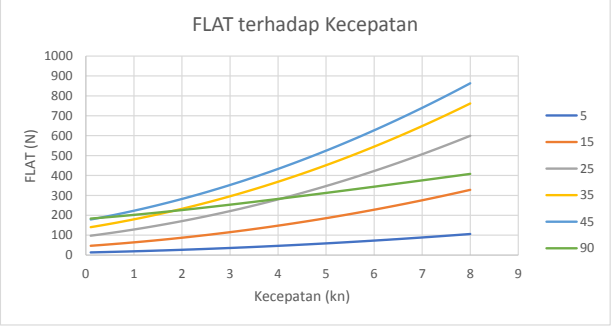
KOEFISIEN LAYAR

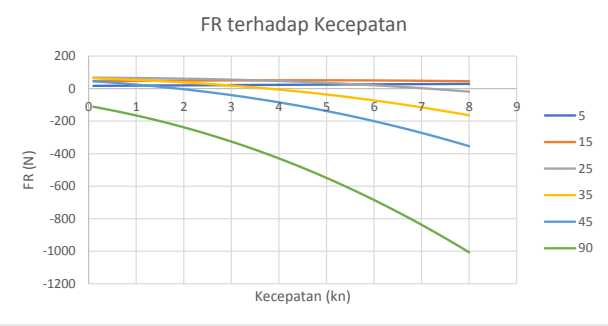
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

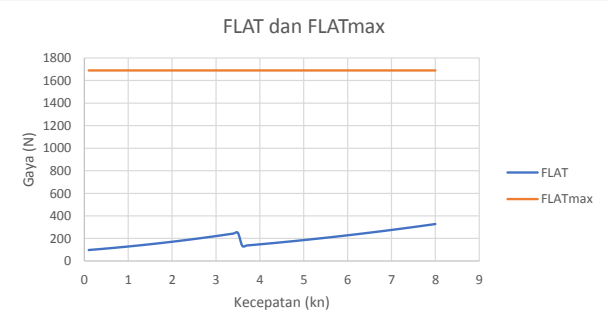
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	60 °
V_A	2,930 m/s
β	49,487 °
V_S	**0,617 m/s**
	1,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

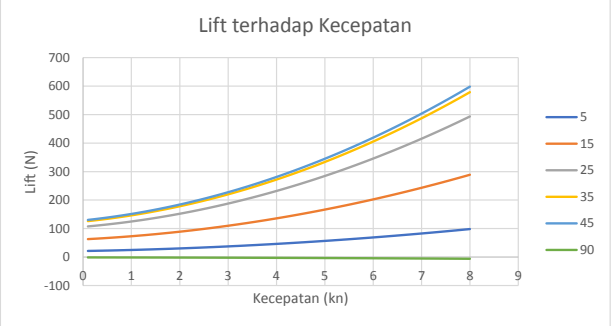
HEELING MOMENT

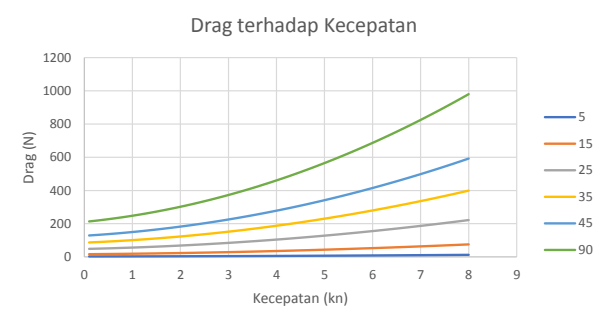
$$M_H = F_H \times h$$

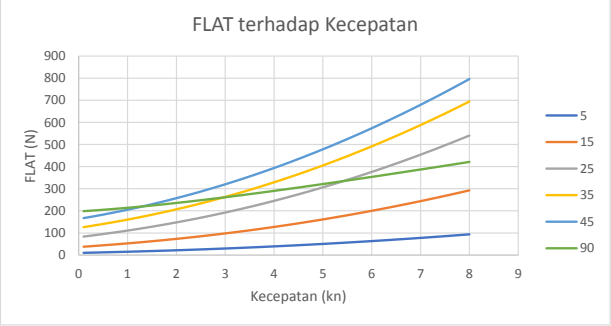
KOEFISIEN LAYAR

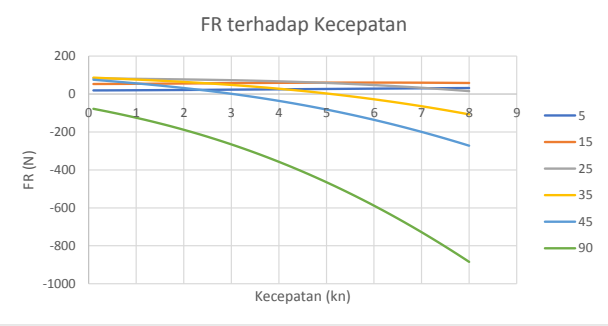
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

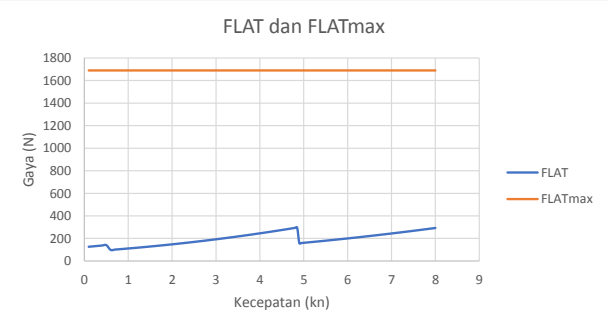
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	70 °
V_A	2,870 m/s
β	57,354 °
V_S	**0,669 m/s**
	1,300 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

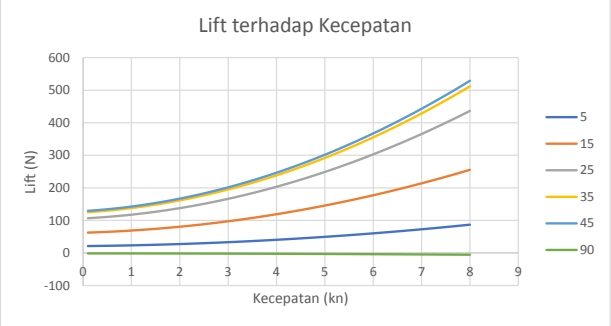
HEELING MOMENT

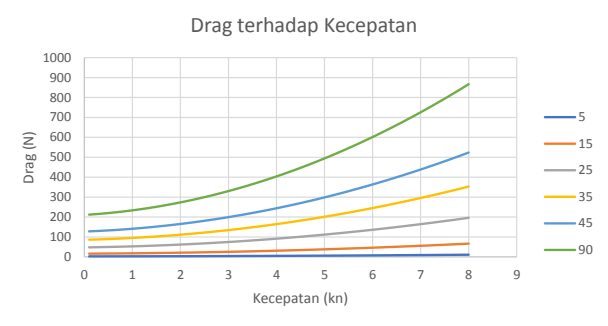
$$M_H = F_H \times h$$

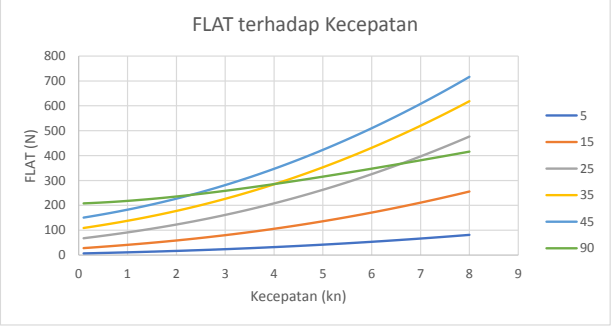
KOEFISIEN LAYAR

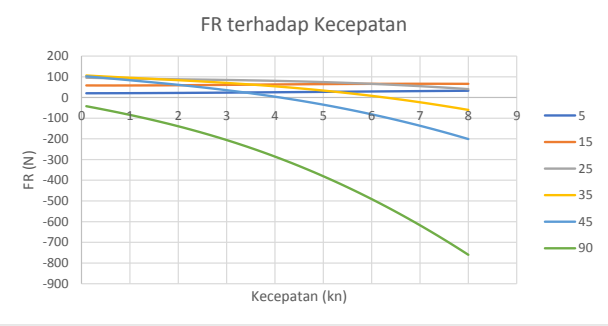
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

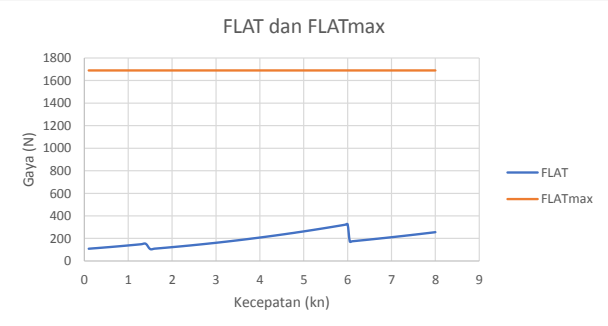
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	80 °
V_A	2,789 m/s
β	65,267 °
V_S	**0,720 m/s**
	1,400 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

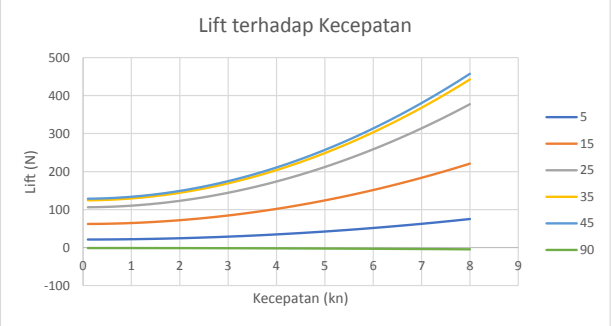
HEELING MOMENT

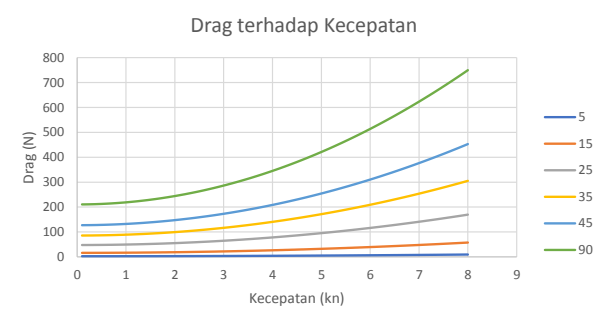
$$M_H = F_H \times h$$

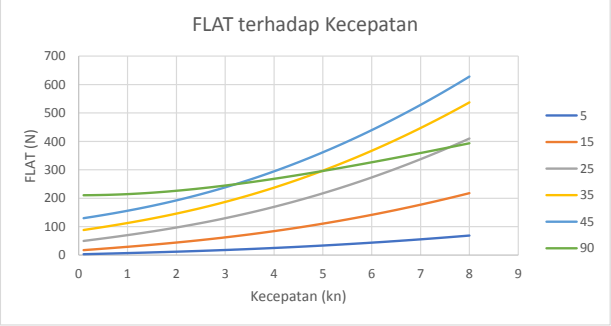
KOEFISIEN LAYAR

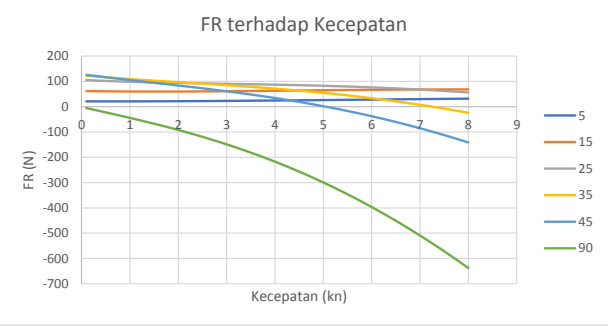
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

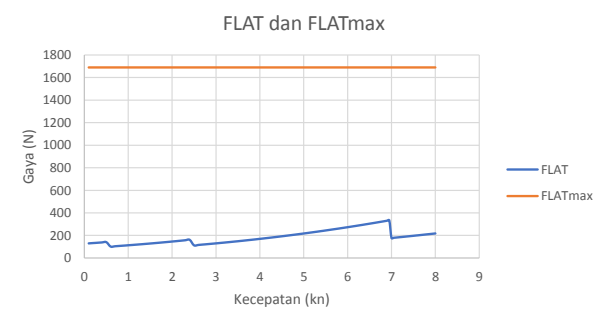
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	90 °
V_A	2,685 m/s
β	73,301 °
V_S	**0,772 m/s**
	1,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

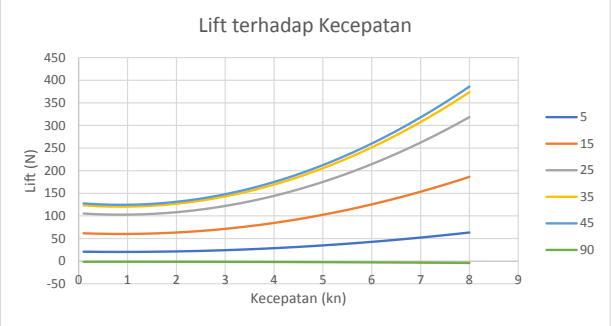
HEELING MOMENT

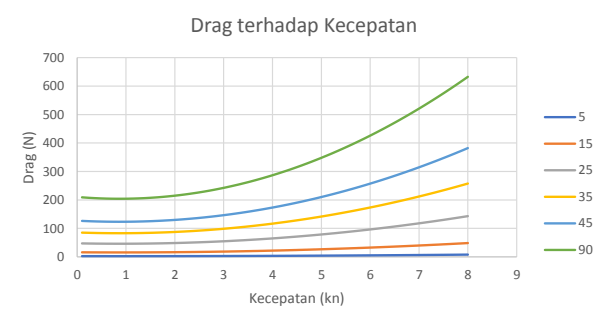
$$M_H = F_H \times h$$

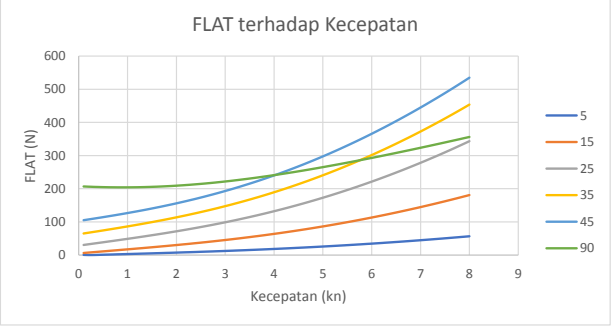
KOEFISIEN LAYAR

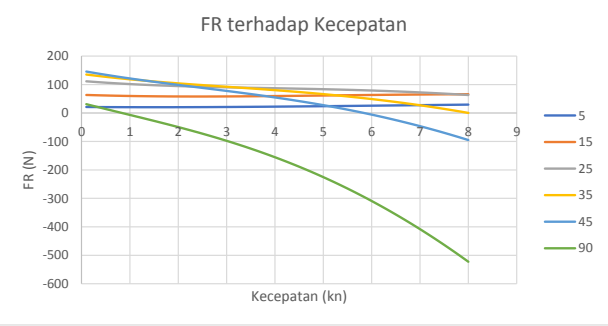
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

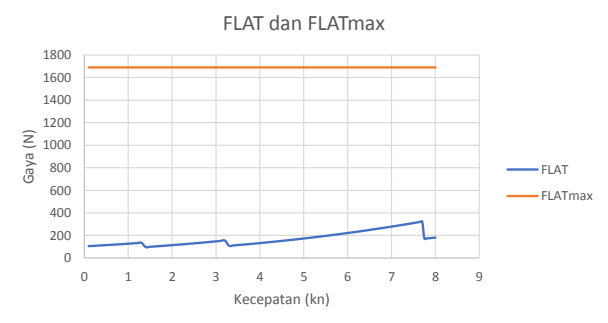
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	100 °
V_A	2,561 m/s
β	81,547 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

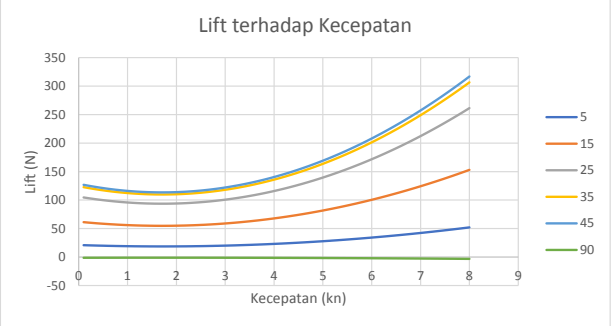
HEELING MOMENT

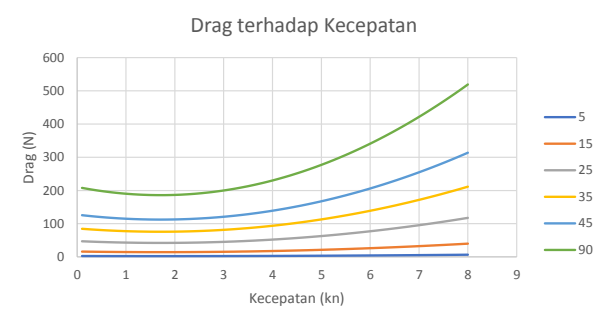
$$M_H = F_H \times h$$

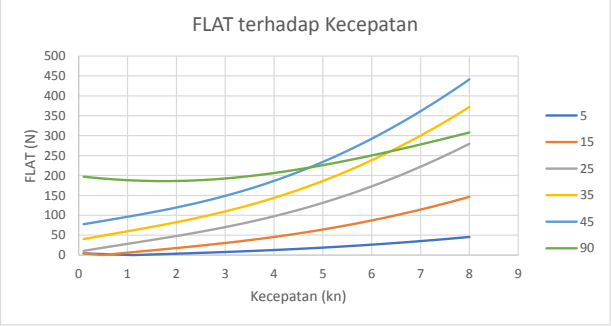
KOEFISIEN LAYAR

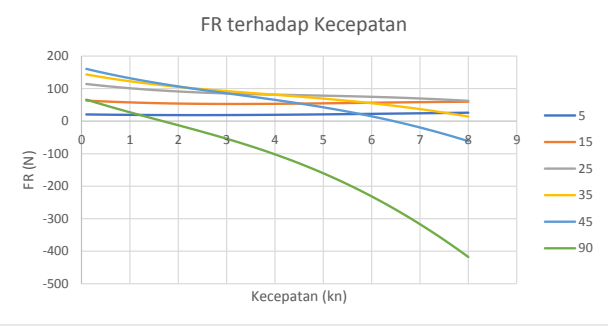
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

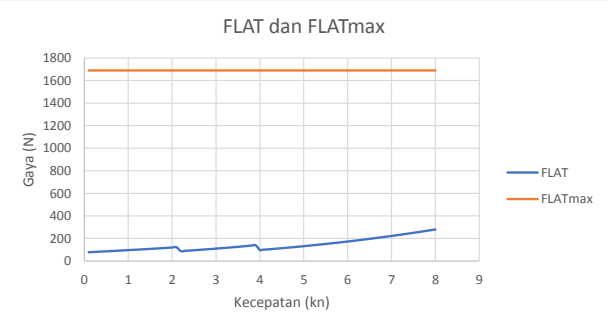
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	110 °
V_A	2,418 m/s
β	91,342 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

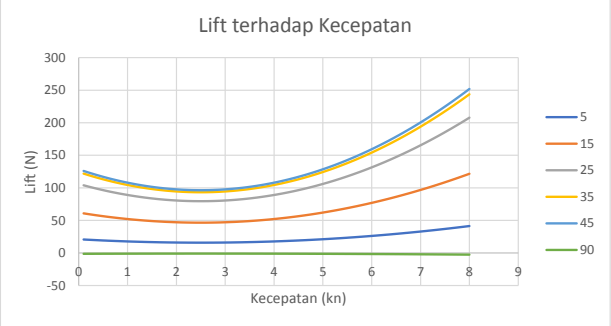
HEELING MOMENT

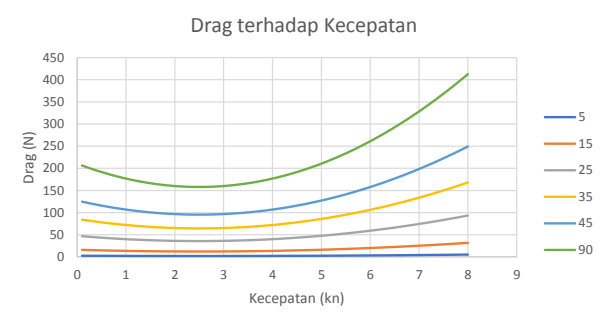
$$M_H = F_H \times h$$

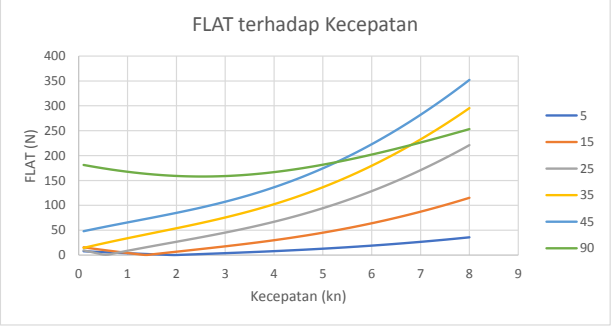
KOEFISIEN LAYAR

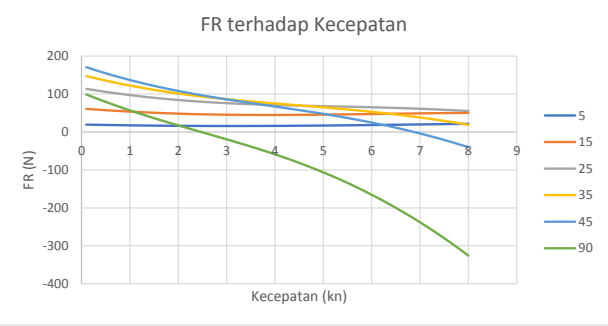
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

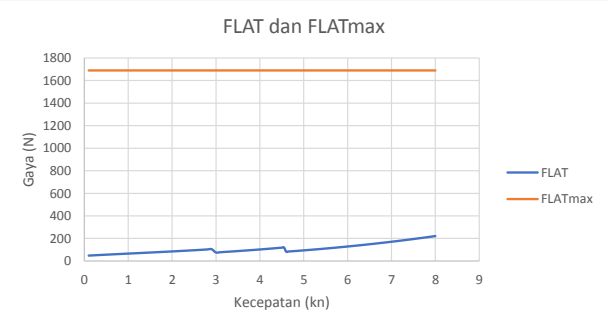
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	120 °
V_A	2,275 m/s
β	101,742 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

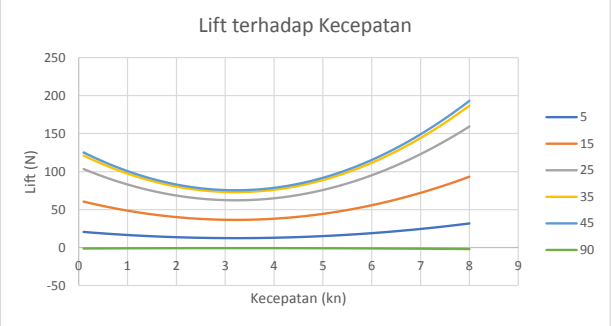
HEELING MOMENT

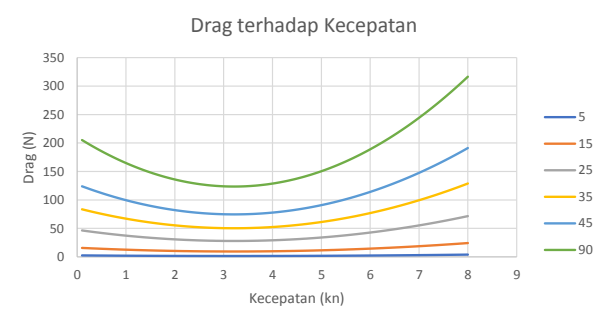
$$M_H = F_H \times h$$

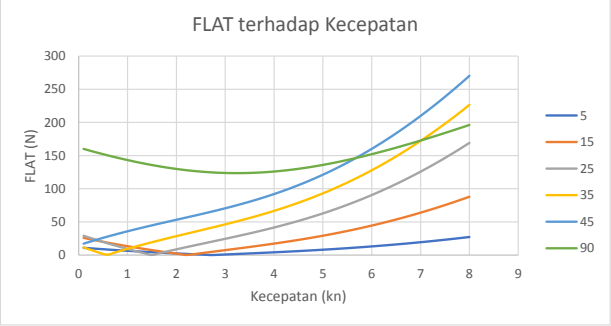
KOEFISIEN LAYAR

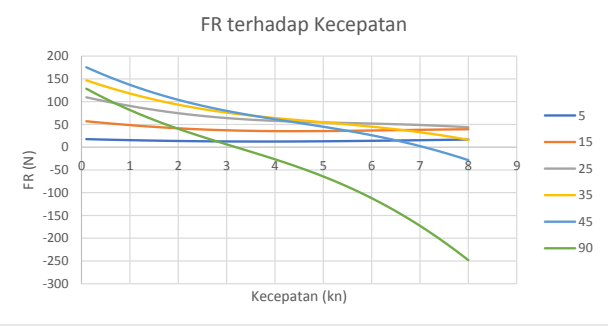
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

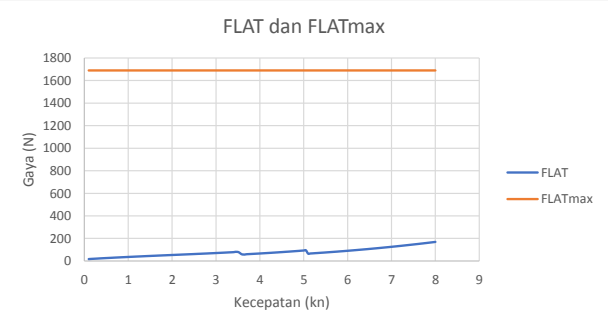
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	130 °
V_A	2,138 m/s
β	112,849 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

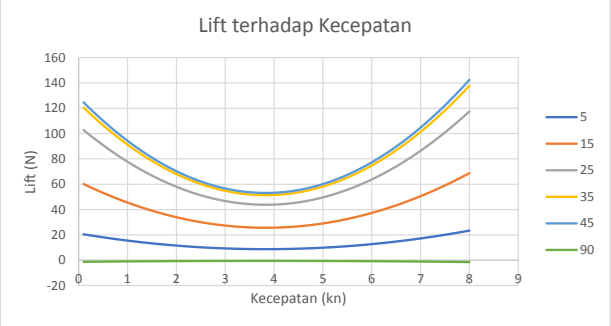
HEELING MOMENT

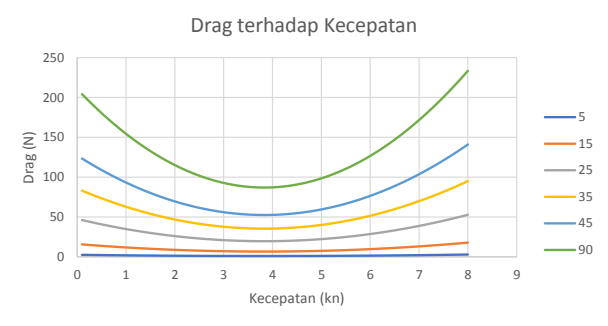
$$M_H = F_H \times h$$

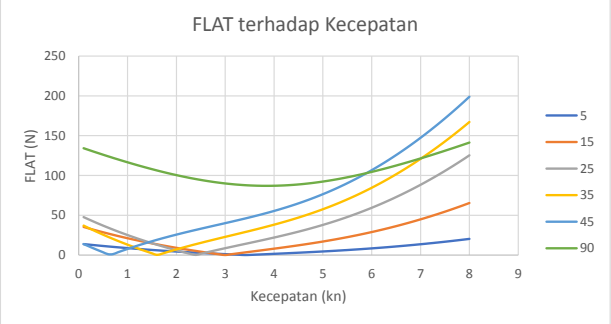
KOEFISIEN LAYAR

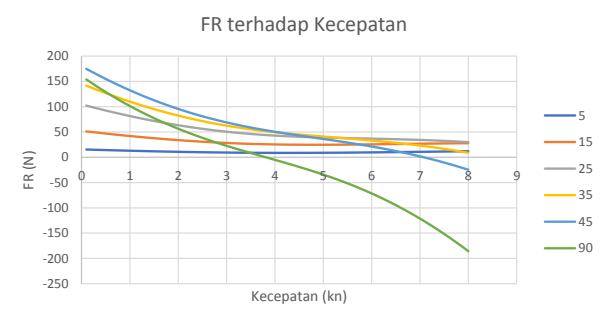
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

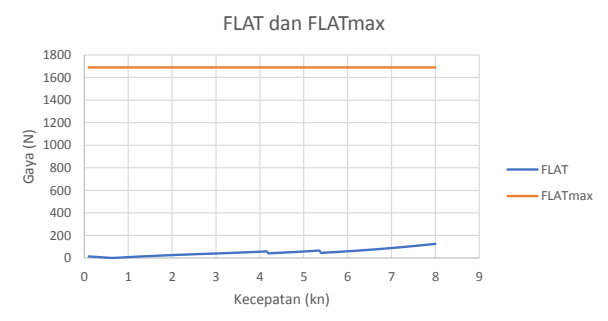
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	140 °
V_A	2,012 m/s
β	124,758 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

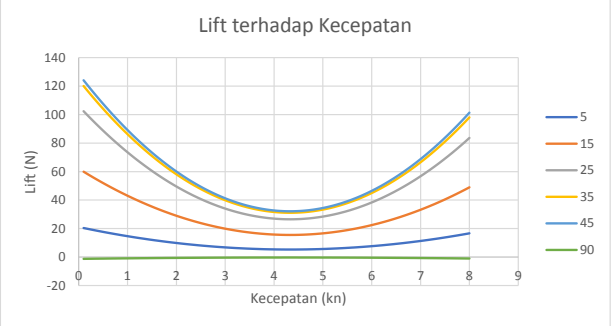
HEELING MOMENT

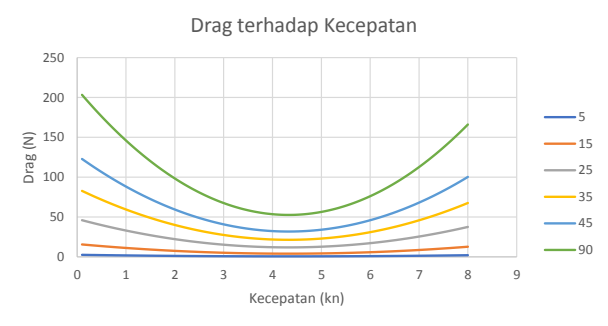
$$M_H = F_H \times h$$

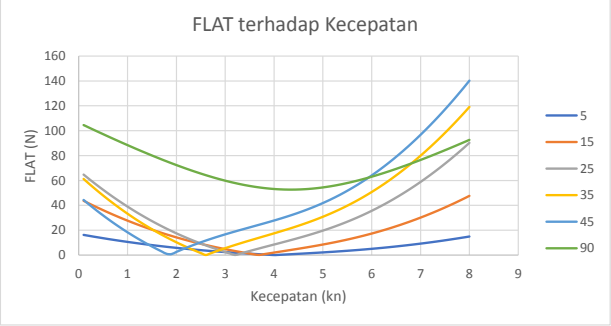
KOEFISIEN LAYAR

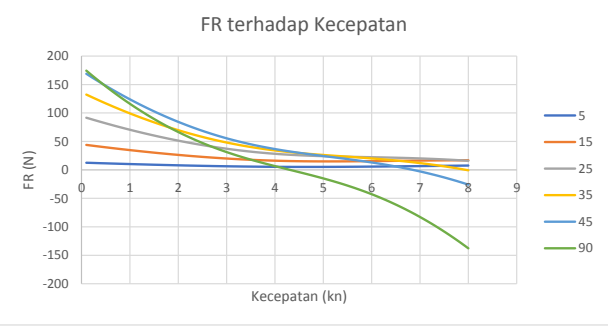
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

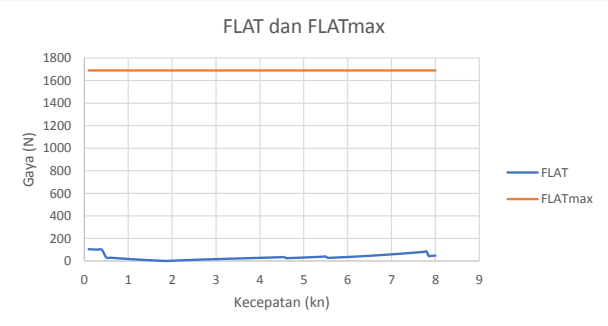
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	5,000 kn
	2,572 m/s
γ	150 °
V_A	1,942 m/s
β	138,544 °
V_S	**0,772 m/s**
	1,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

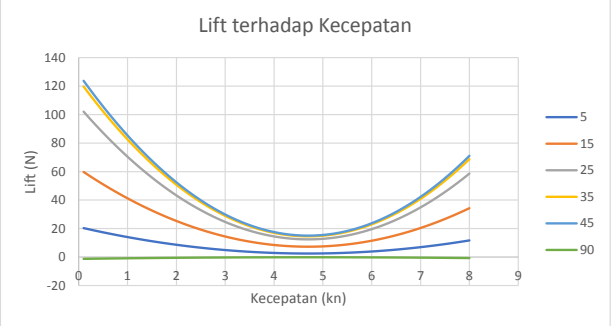
HEELING MOMENT

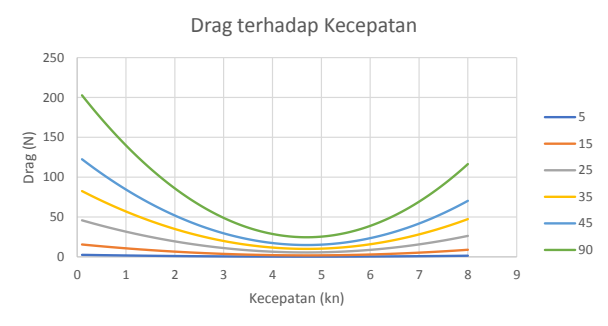
$$M_H = F_H \times h$$

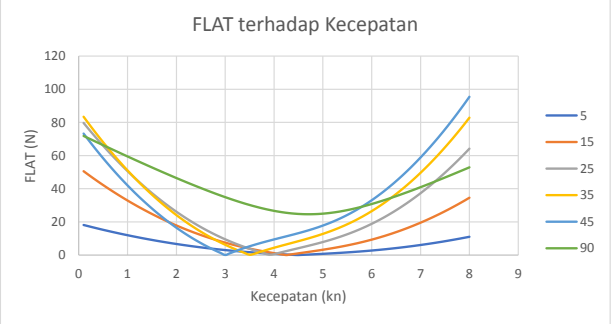
KOEFISIEN LAYAR

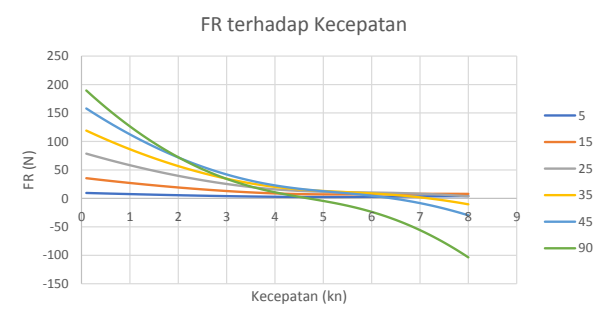
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

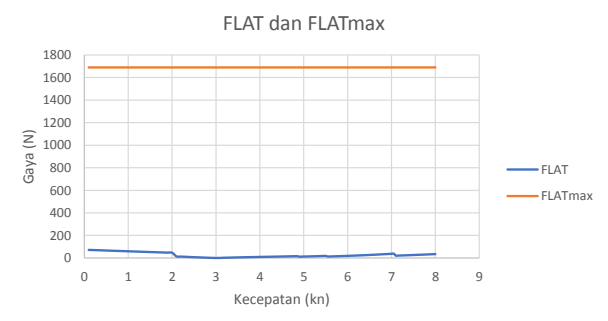
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	160 °
V_A	1,866 m/s
β	151,868 °
V_S	**0,772 m/s**
	1,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

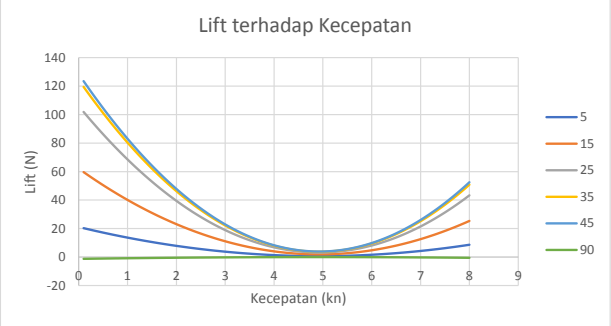
HEELING MOMENT

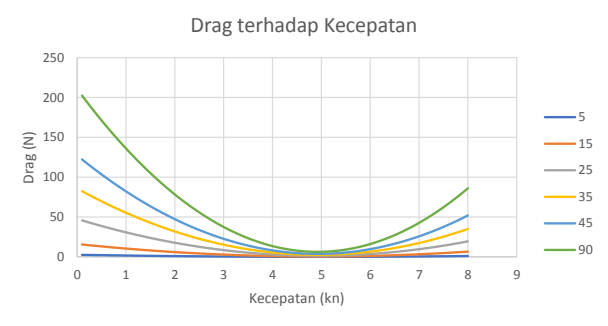
$$M_H = F_H \times h$$

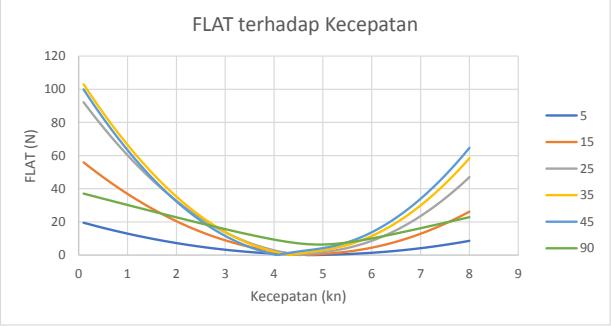
KOEFISIEN LAYAR

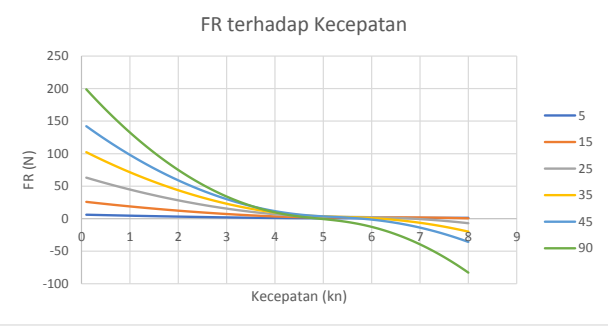
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

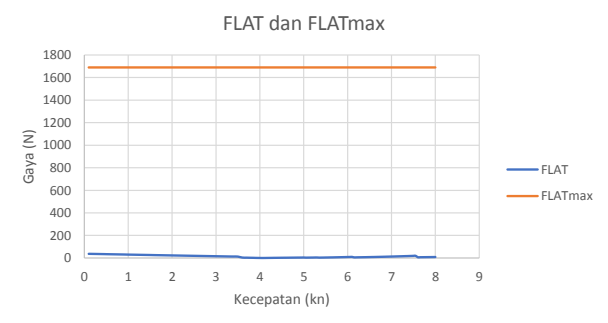
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	170 °
V_A	1,817 m/s
β	165,771 °
V_S	**0,772 m/s**
	1,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

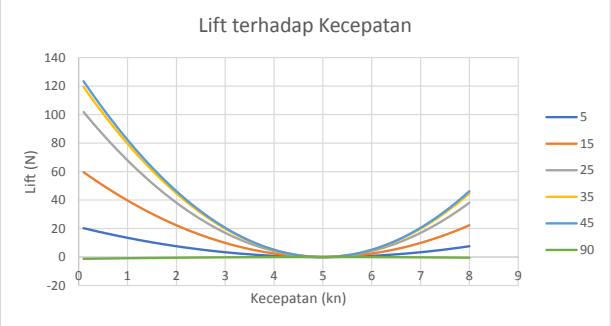
HEELING MOMENT

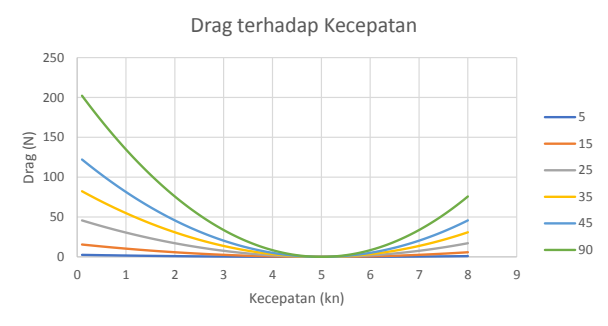
$$M_H = F_H \times h$$

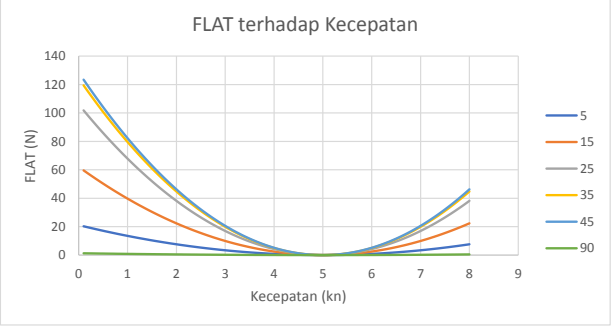
KOEFISIEN LAYAR

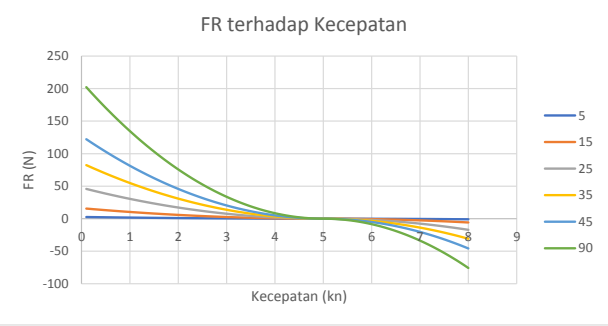
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

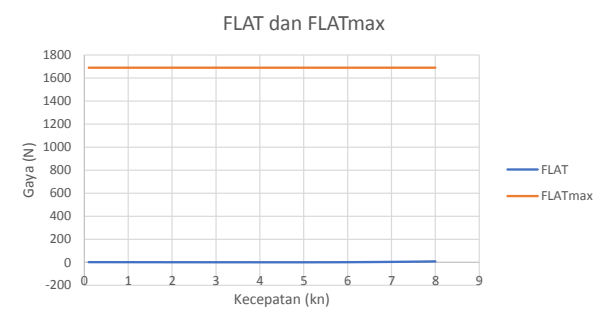
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	180 °
V_A	1,800 m/s
β	180,000 °
V_S	**0,772 m/s**
	1,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

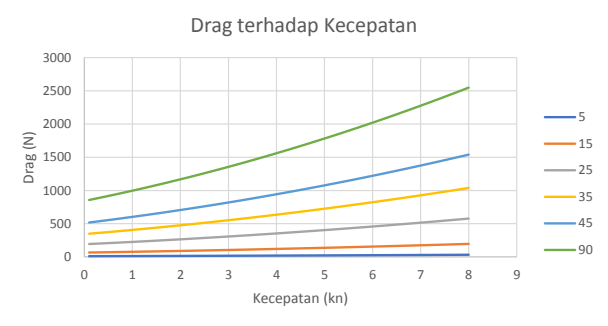
HEELING MOMENT

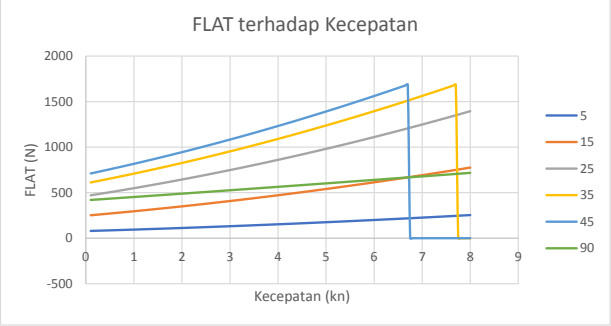
$$M_H = F_H \times h$$

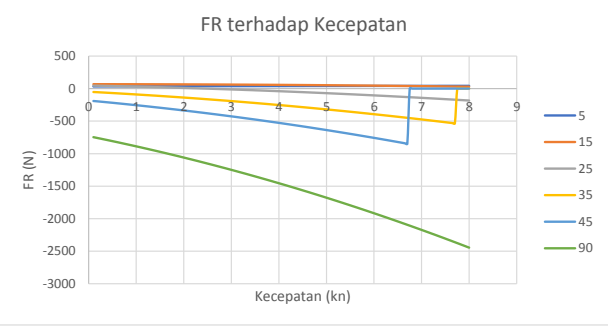
KOEFISIEN LAYAR

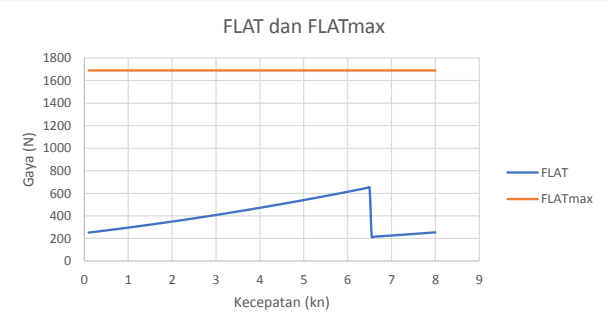
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	10,000 kn
	5,144 m/s
γ	30 °
V_A	5,687 m/s
β	26,889 °
V_S	**0,617 m/s**
	1,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

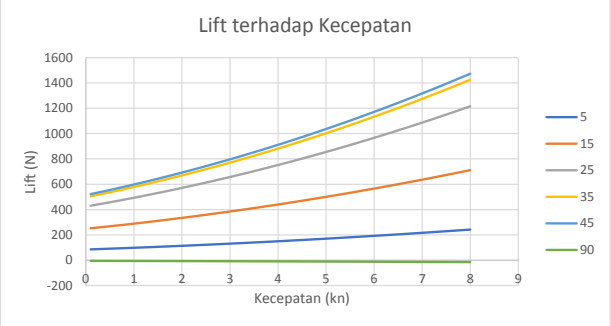
HEELING MOMENT

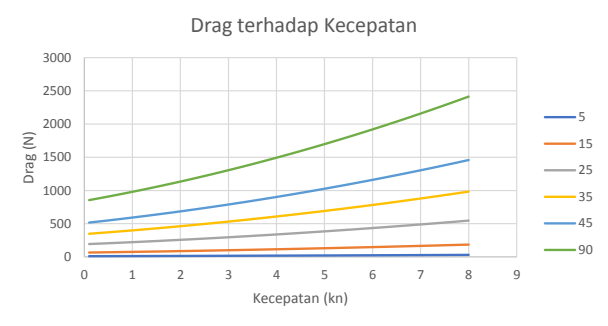
$$M_H = F_H \times h$$

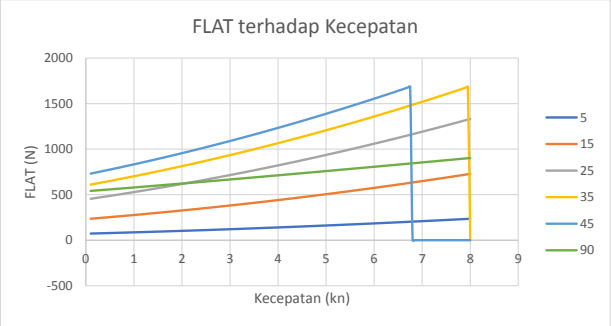
KOEFISIEN LAYAR

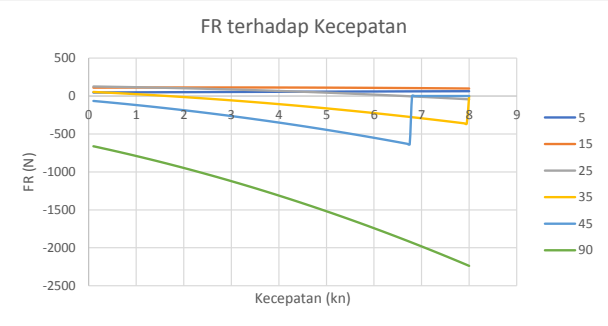
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

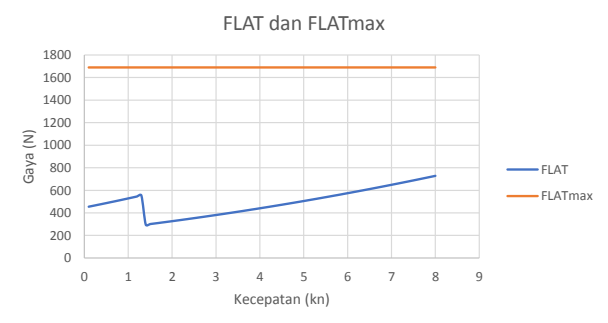
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	10,000 kn
	5,144 m/s
γ	40 °
V_A	5,799 m/s
β	34,765 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

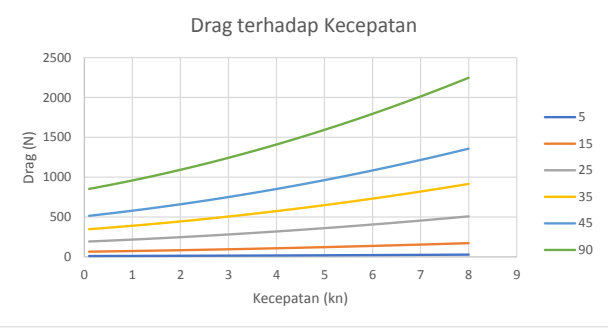
HEELING MOMENT

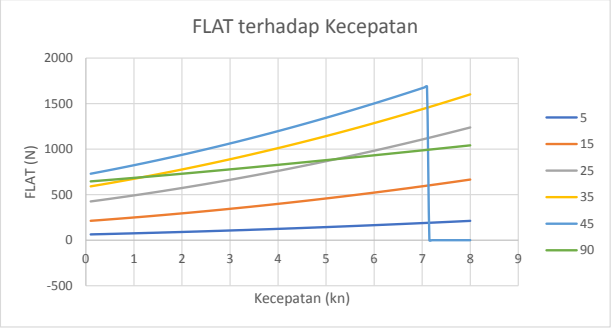
$$M_H = F_H \times h$$

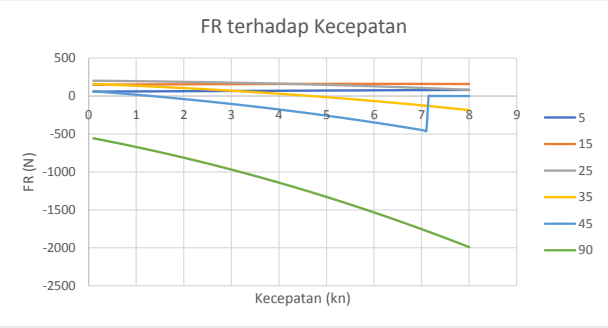
KOEFISIEN LAYAR

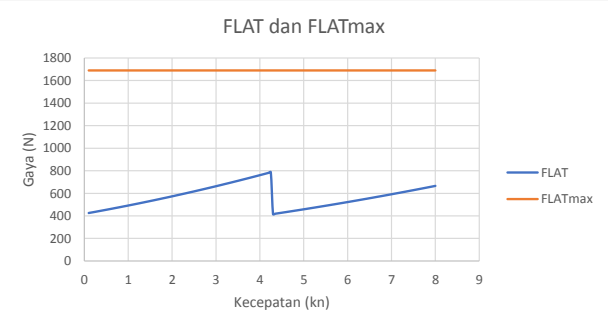
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	10,000 kn
	5,144 m/s
γ	50 °
V_A	5,897 m/s
β	41,933 °
V_S	**1,080 m/s**
	2,100 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

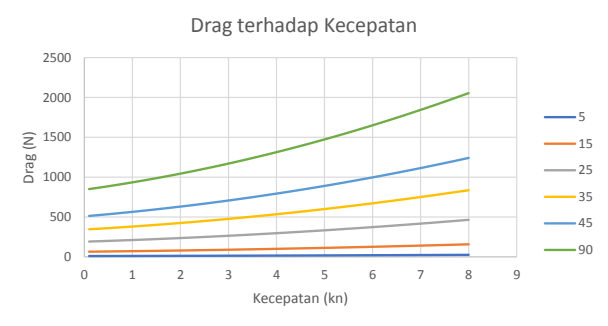
HEELING MOMENT

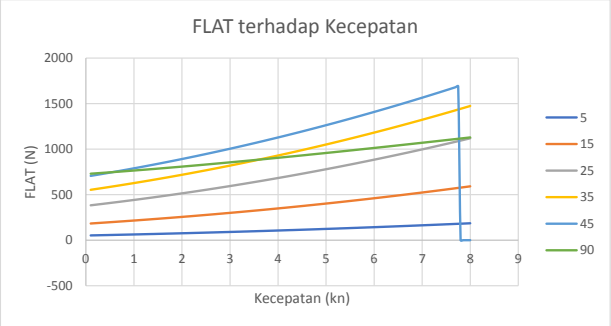
$$M_H = F_H \times h$$

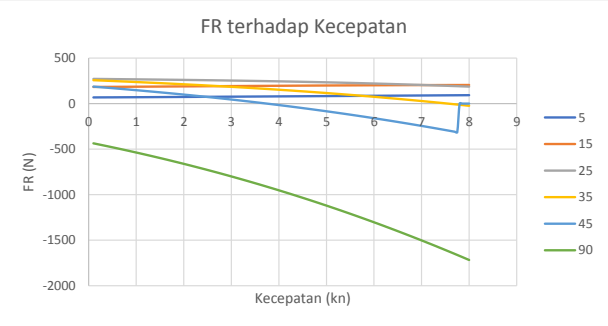
KOEFISIEN LAYAR

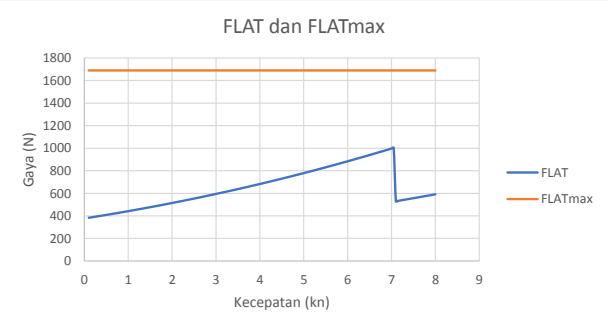
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N









V_T	10,000 kn
	5,144 m/s
γ	60 °
V_A	5,893 m/s
β	49,107 °
V_S	**1,286 m/s**
	2,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

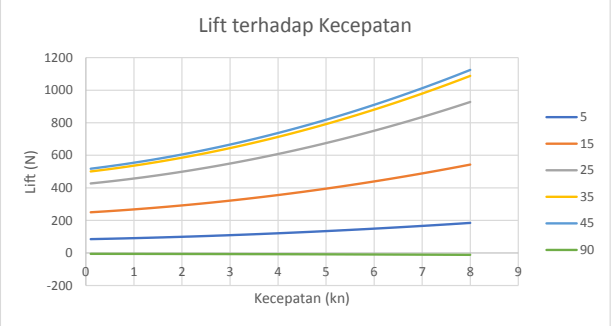
HEELING MOMENT

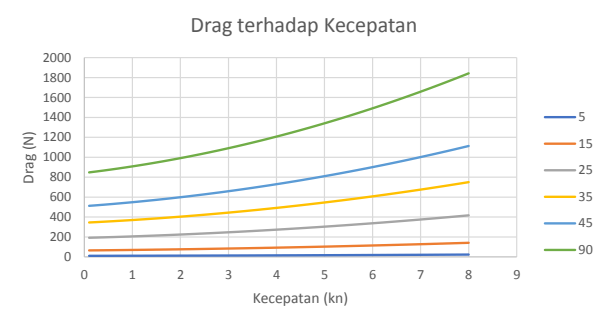
$$M_H = F_H \times h$$

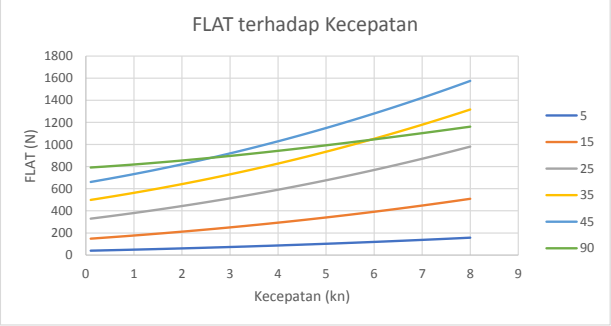
KOEFISIEN LAYAR

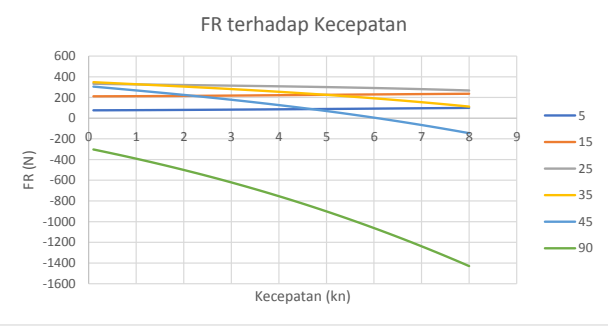
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

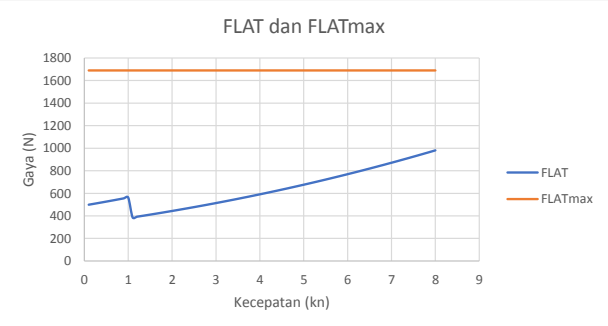
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	70 °
V_A	5,797 m/s
β	56,498 °
V_S	**1,440 m/s**
	2,800 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

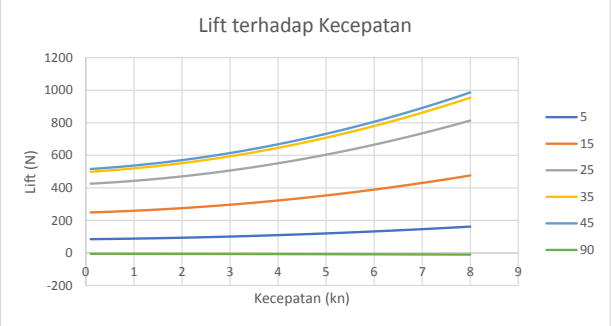
HEELING MOMENT

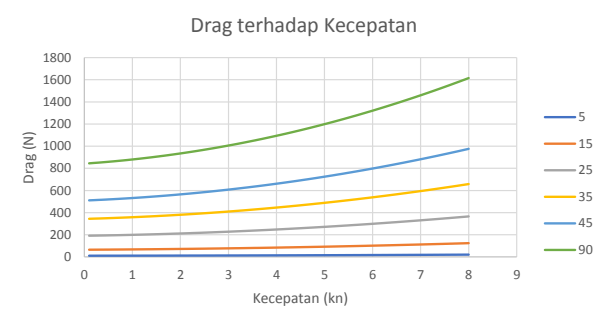
$$M_H = F_H \times h$$

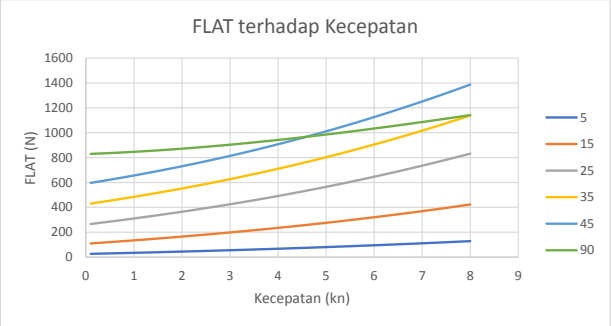
KOEFISIEN LAYAR

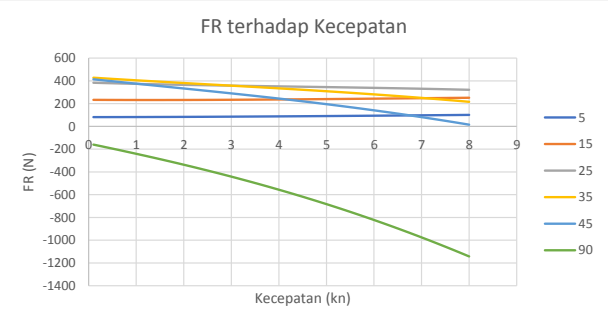
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

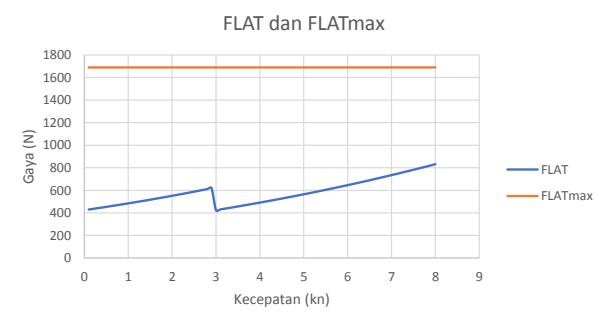
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	10,000 kn
	5,144 m/s
γ	80 °
V_A	5,621 m/s
β	64,315 °
V_S	**1,543 m/s**
	3,000 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

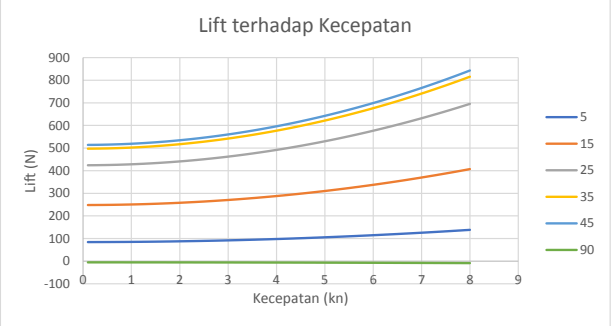
HEELING MOMENT

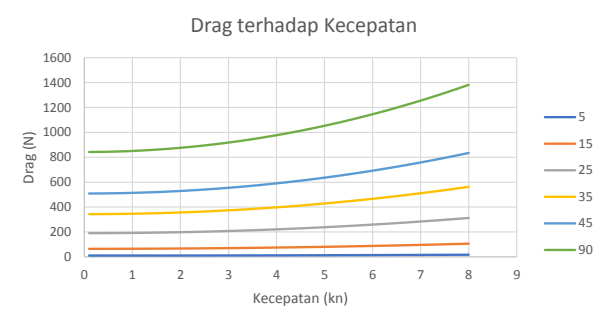
$$M_H = F_H \times h$$

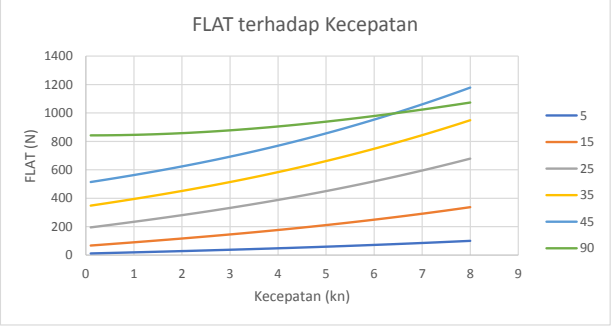
KOEFISIEN LAYAR

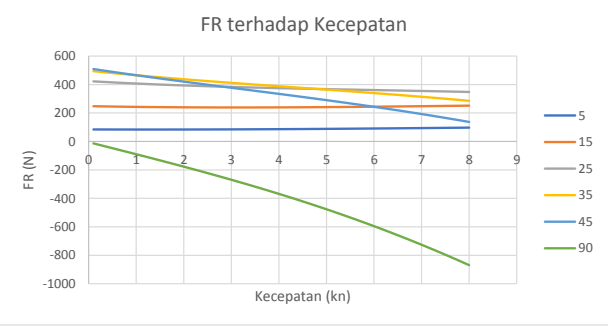
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

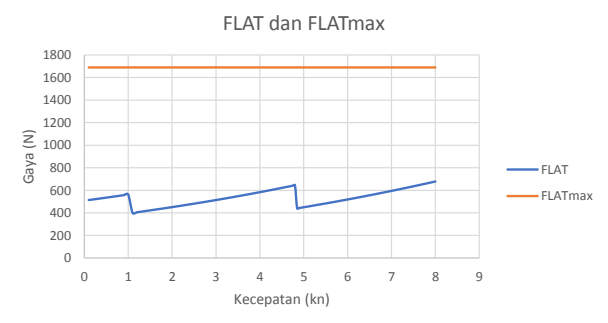
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	90 °
V_A	5,401 m/s
β	72,255 °
V_S	**1,646 m/s**
	3,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

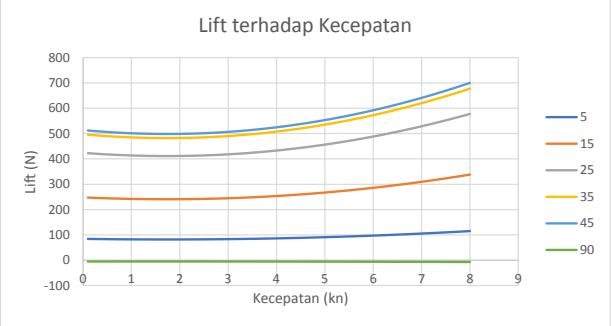
HEELING MOMENT

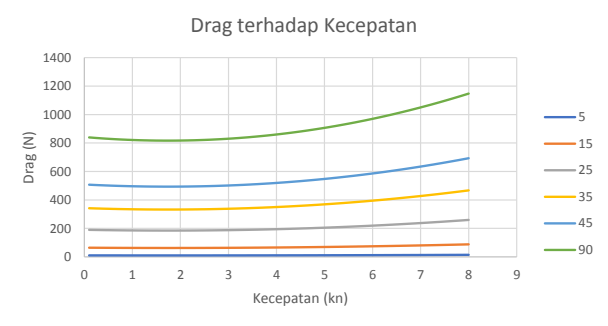
$$M_H = F_H \times h$$

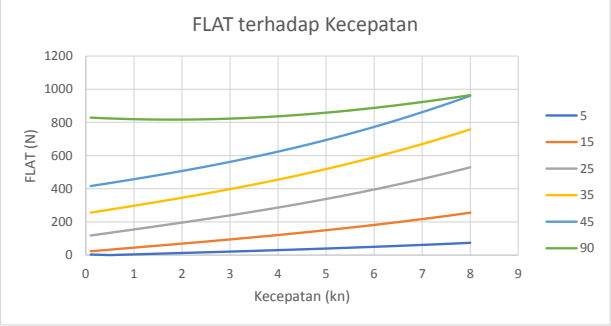
KOEFISIEN LAYAR

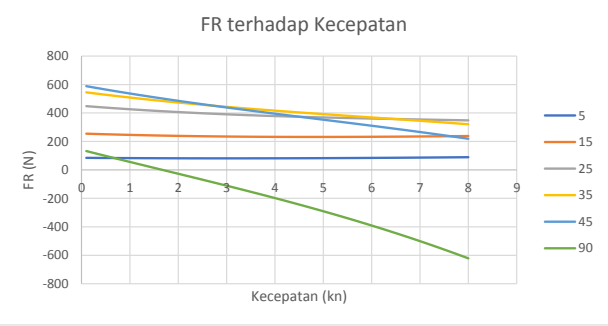
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

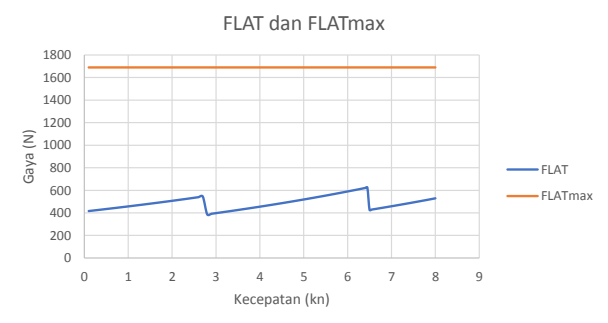
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	100 °
V_A	5,129 m/s
β	80,979 °
V_S	**1,698 m/s**
	3,300 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

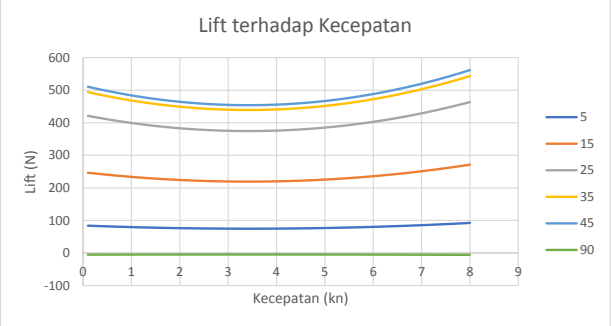
HEELING MOMENT

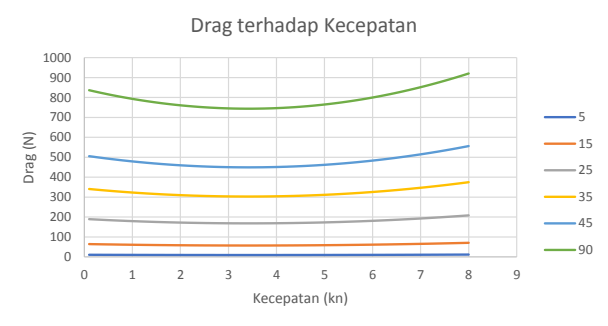
$$M_H = F_H \times h$$

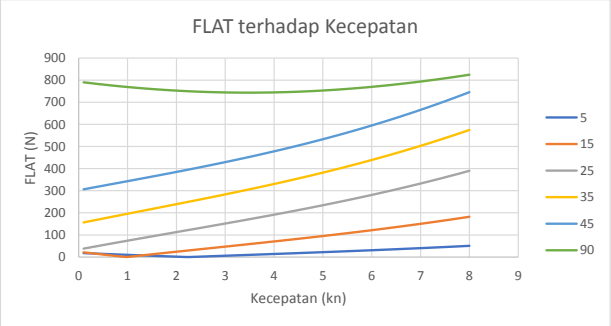
KOEFISIEN LAYAR

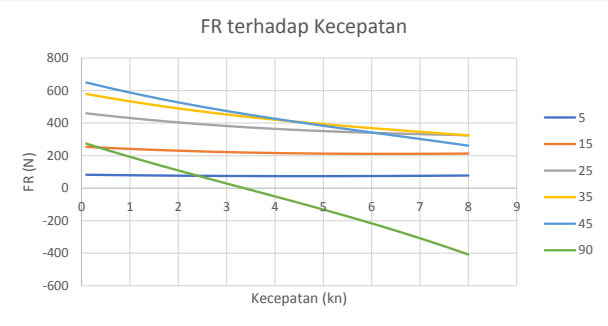
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

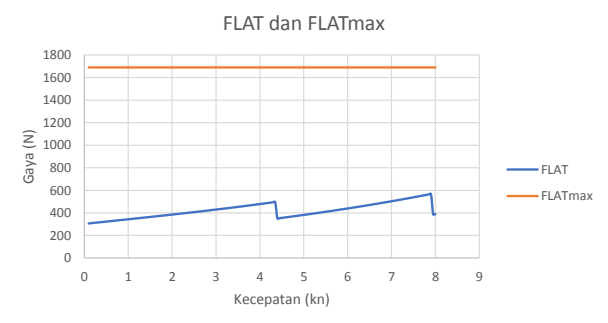
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	10,000 kn
	5,144 m/s
γ	110 °
V_A	4,834 m/s
β	90,123 °
V_S	**1,749 m/s**
	3,400 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

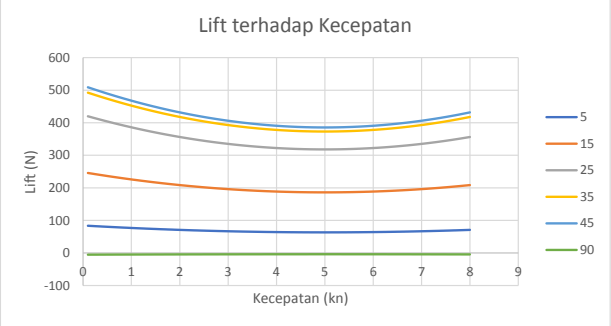
HEELING MOMENT

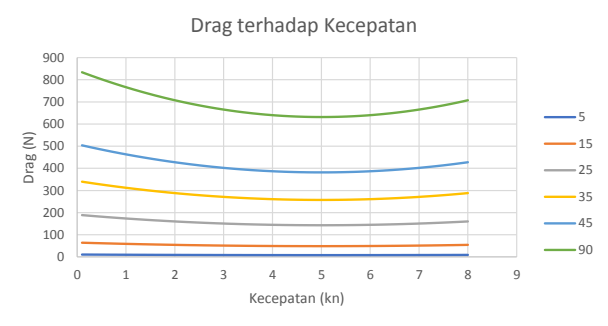
$$M_H = F_H \times h$$

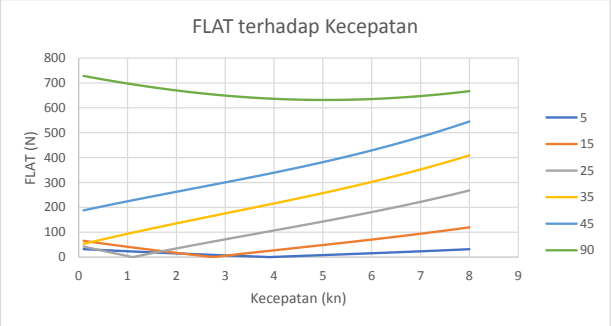
KOEFISIEN LAYAR

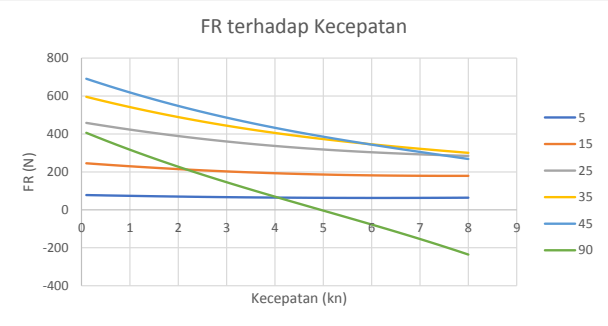
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

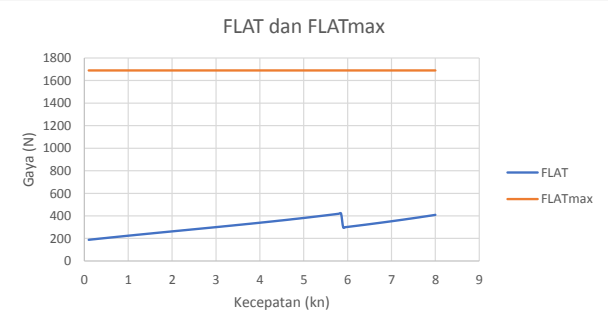
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	120 °
V_A	4,530 m/s
β	100,467 °
V_S	**1,749 m/s**
	3,400 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN LAYAR

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
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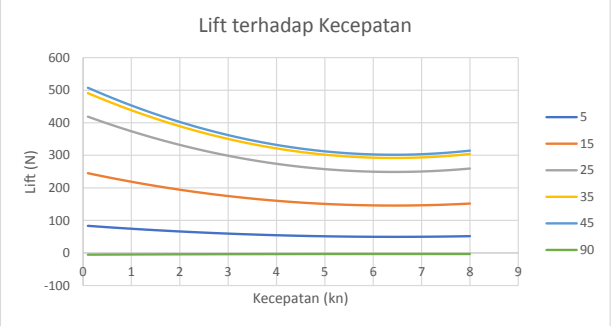
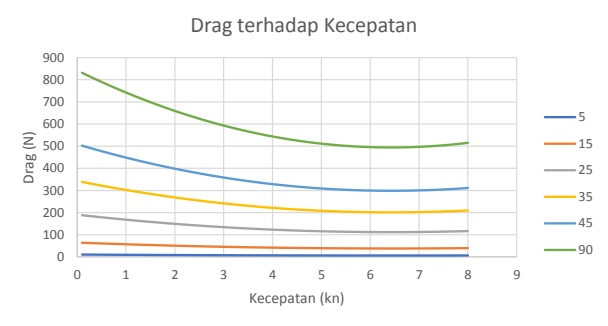
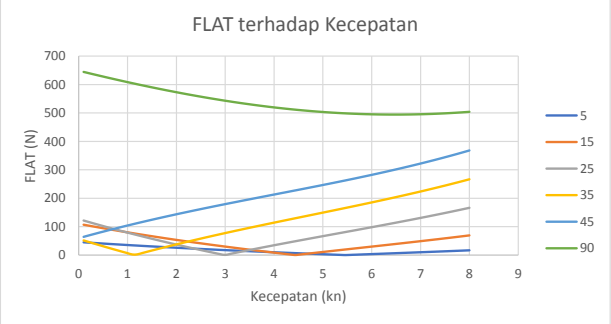
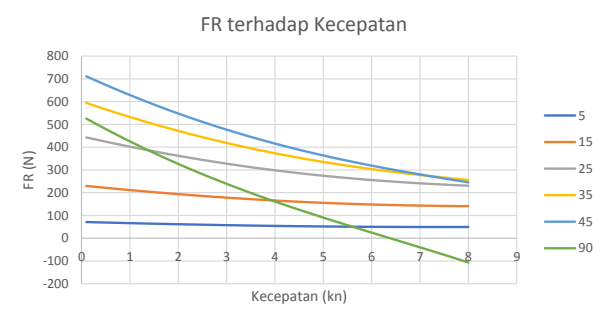
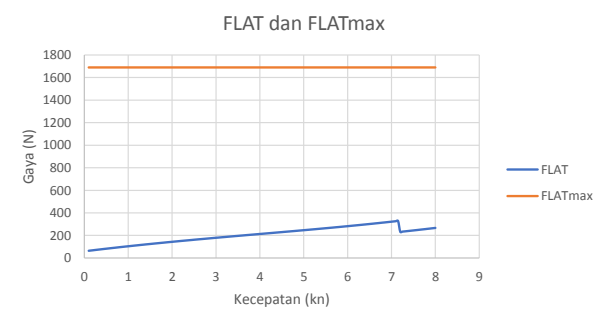
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	10,000 kn
	5,144 m/s
γ	130 °
V_A	4,237 m/s
β	111,567 °
V_S	**1,749 m/s**
	3,400 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN LAYAR

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C_L	0,241	0,710	1,213	1,423	1,470	-0,015
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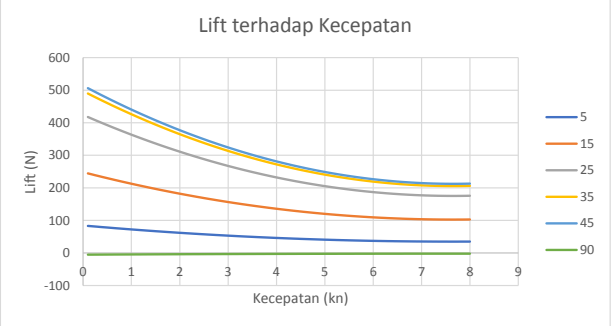
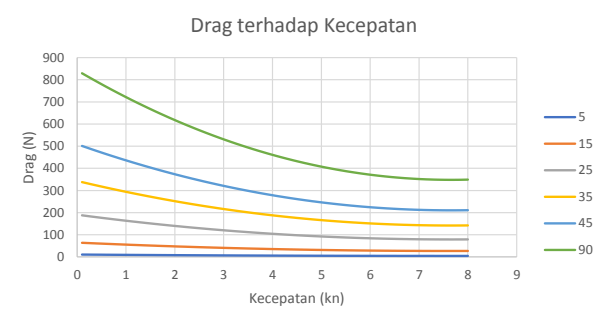
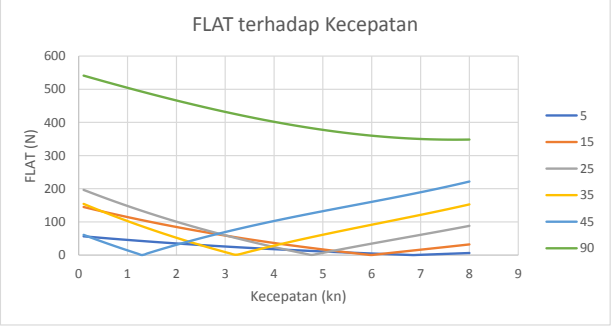
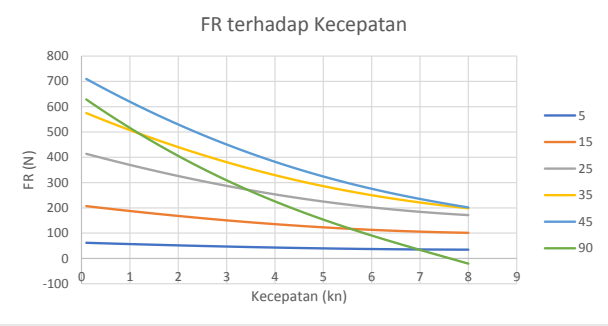
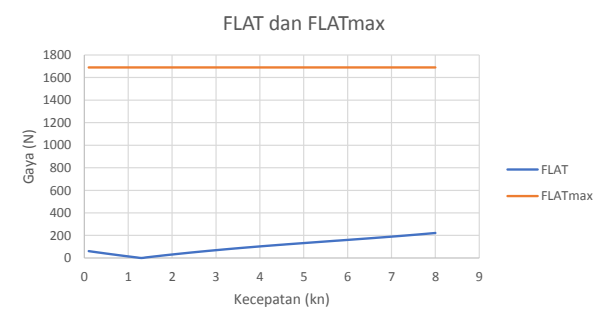
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	140 °
V_A	3,996 m/s
β	124,152 °
V_S	**1,698 m/s**
	3,300 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

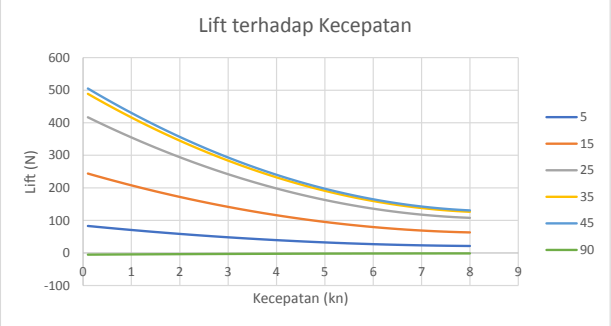
HEELING MOMENT

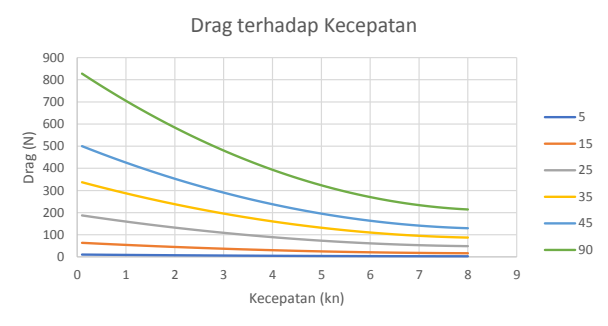
$$M_H = F_H \times h$$

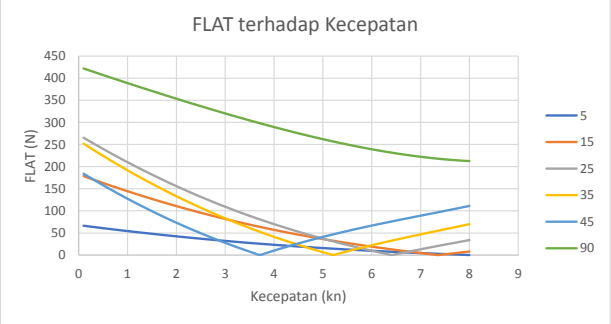
KOEFISIEN LAYAR

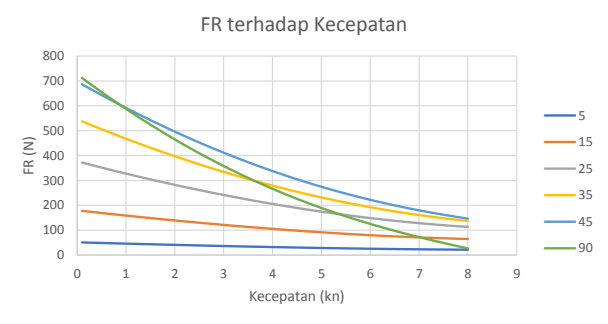
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

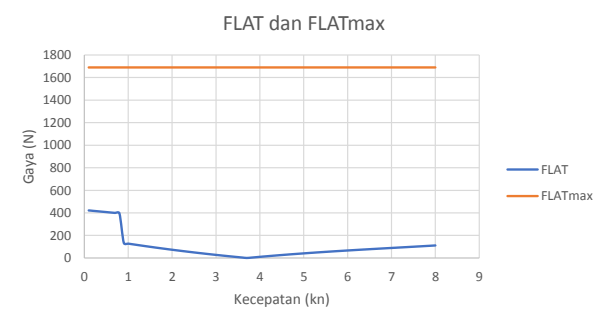
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	10,000 kn
	5,144 m/s
γ	150 °
V_A	3,808 m/s
β	137,519 °
V_S	**1,646 m/s**
	3,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

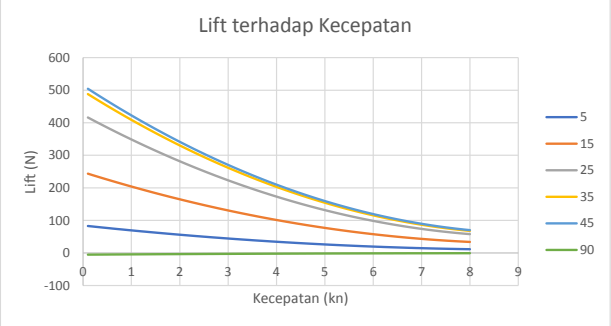
HEELING MOMENT

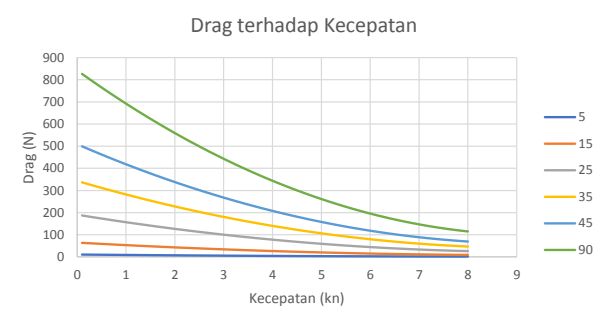
$$M_H = F_H \times h$$

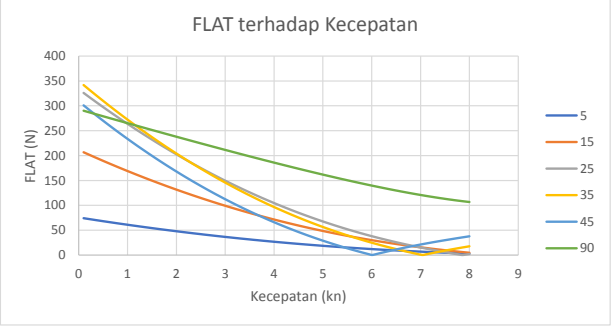
KOEFISIEN LAYAR

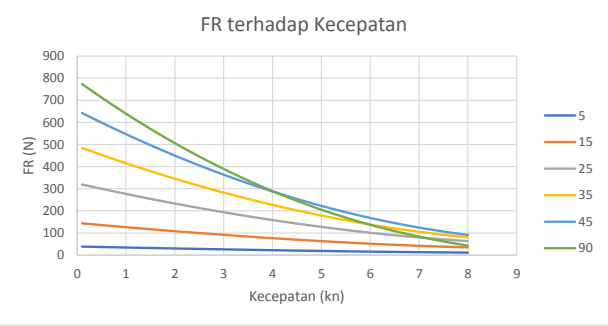
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

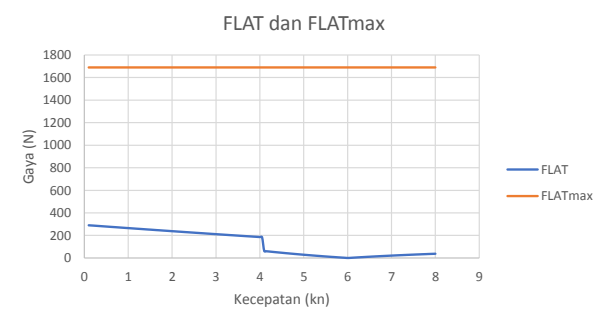
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	10,000 kn
	5,144 m/s
γ	160 °
V_A	3,686 m/s
β	151,491 °
V_S	**1,595 m/s**
	3,100 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

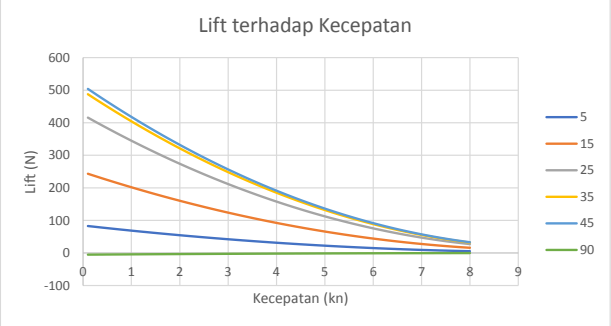
HEELING MOMENT

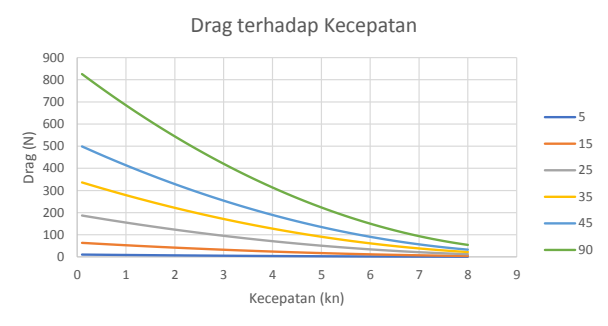
$$M_H = F_H \times h$$

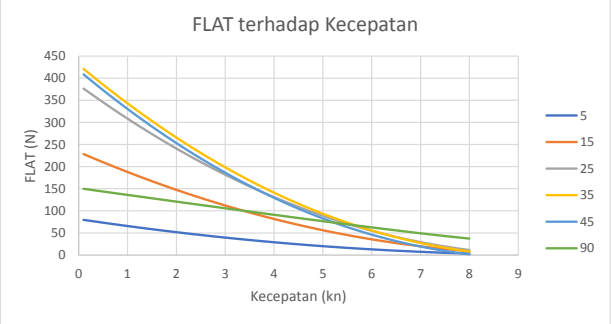
KOEFISIEN LAYAR

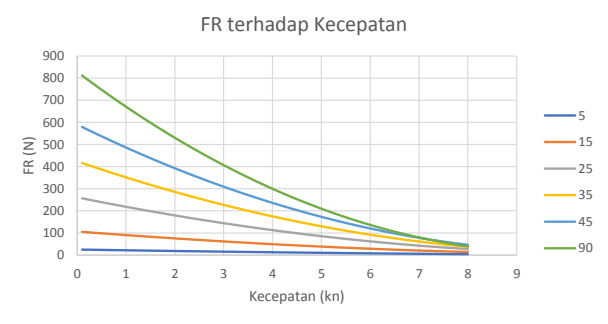
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

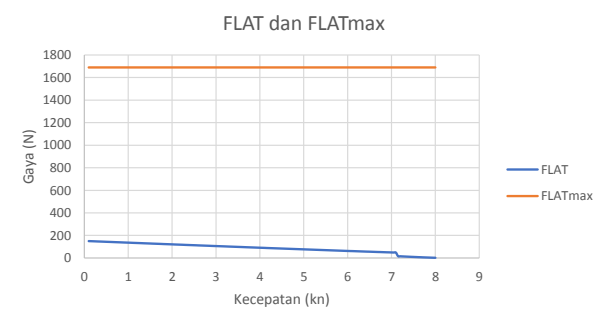
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	170 °
V_A	3,584 m/s
β	165,569 °
V_S	**1,595 m/s**
	3,100 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

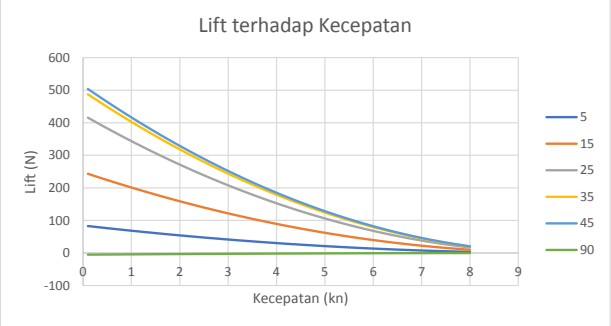
HEELING MOMENT

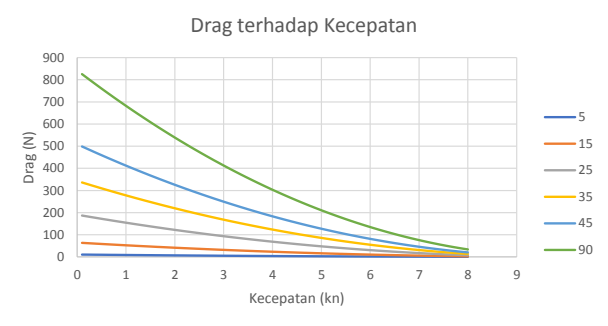
$$M_H = F_H \times h$$

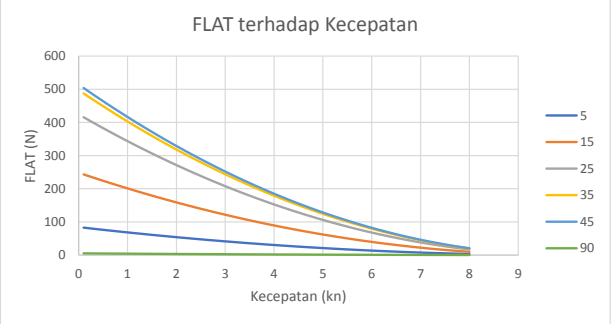
KOEFISIEN LAYAR

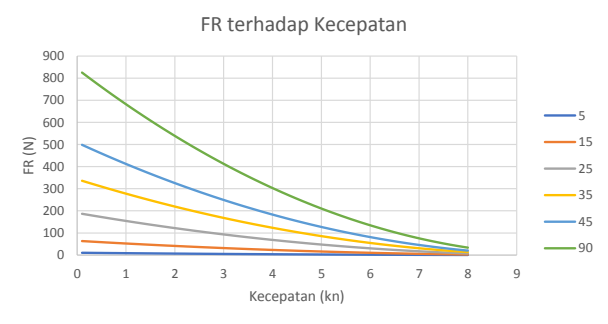
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

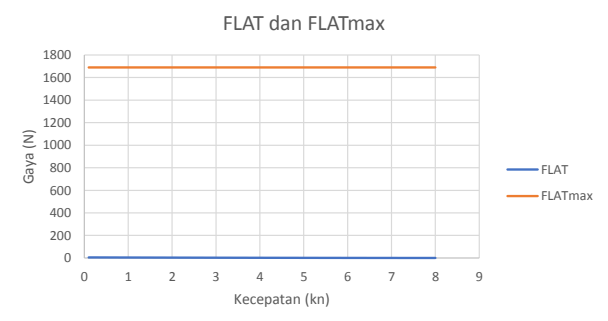
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	180 °
V_A	3,498 m/s
β	180,000 °
V_S	**1,646 m/s**
	3,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

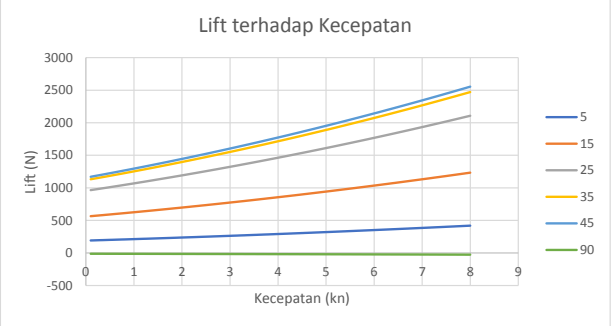
HEELING MOMENT

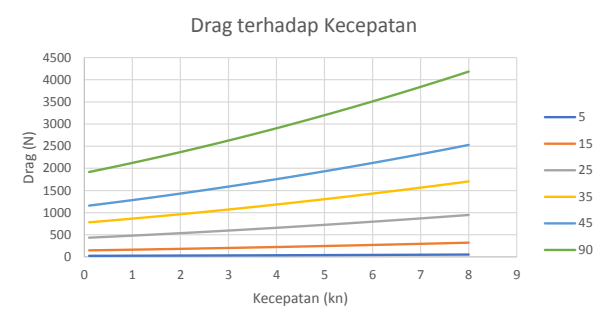
$$M_H = F_H \times h$$

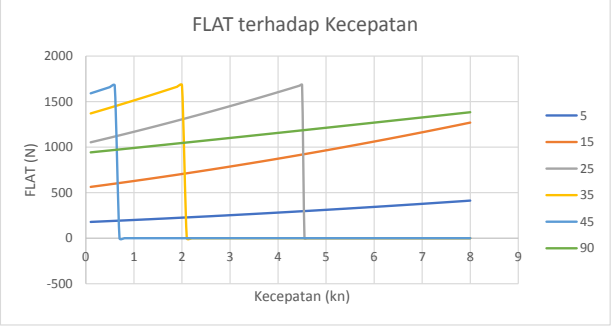
KOEFISIEN LAYAR

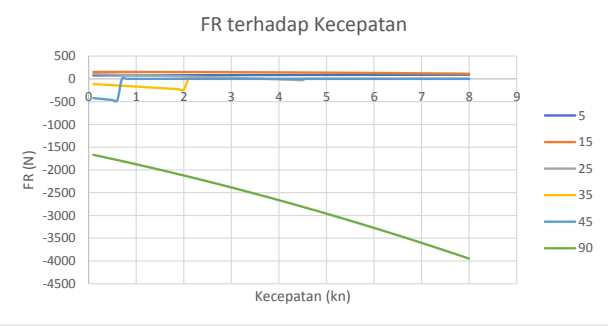
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

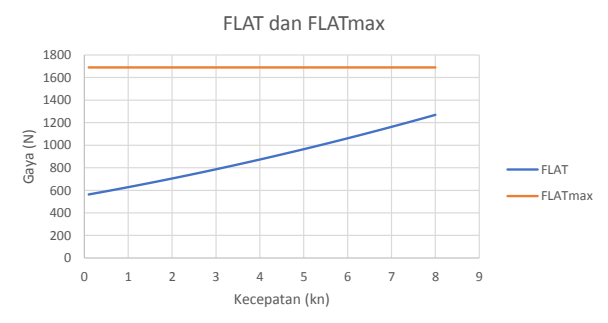
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	30 °
V_A	8,576 m/s
β	26,734 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

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HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN LAYAR

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
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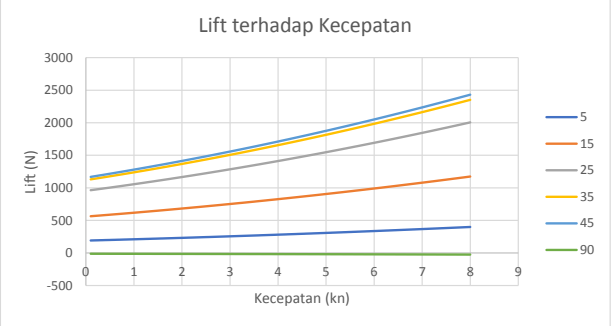
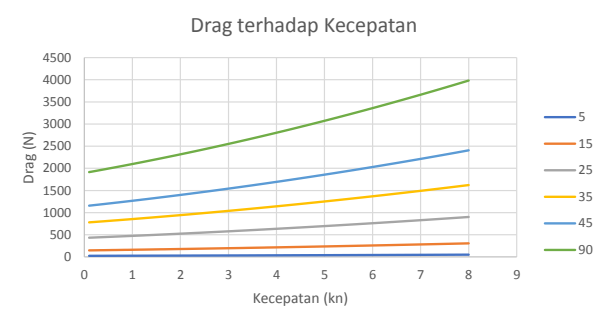
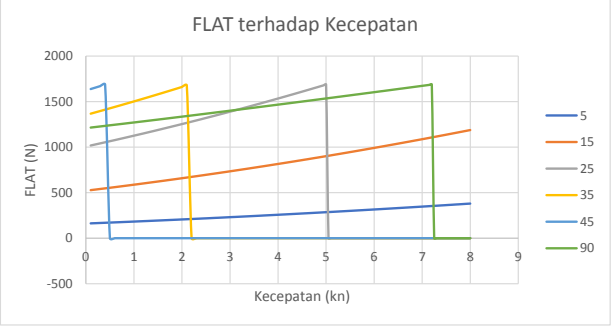
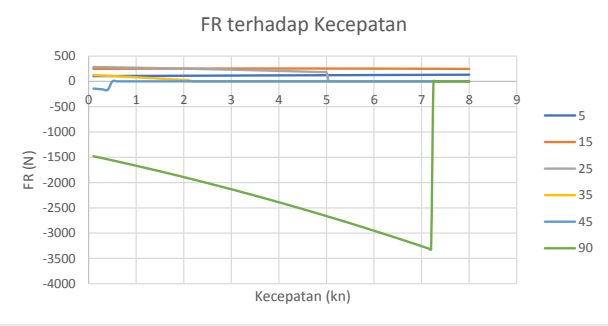
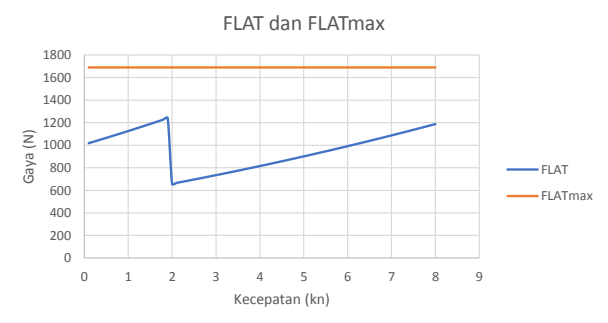










V_T	15,000 kn
	7,716 m/s
γ	40 °
V_A	8,740 m/s
β	34,573 °
V_S	**1,286 m/s**
	2,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

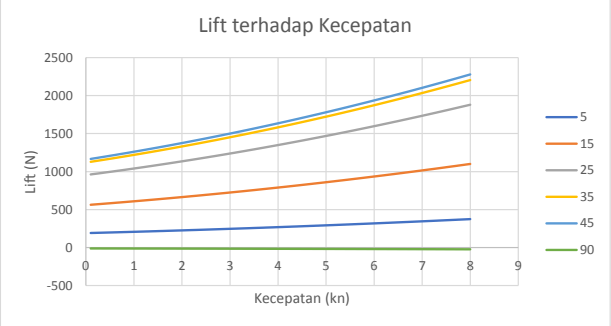
HEELING MOMENT

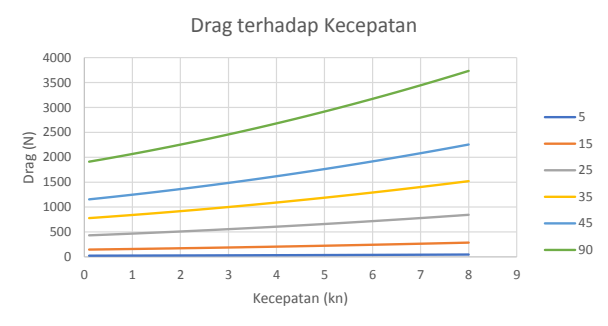
$$M_H = F_H \times h$$

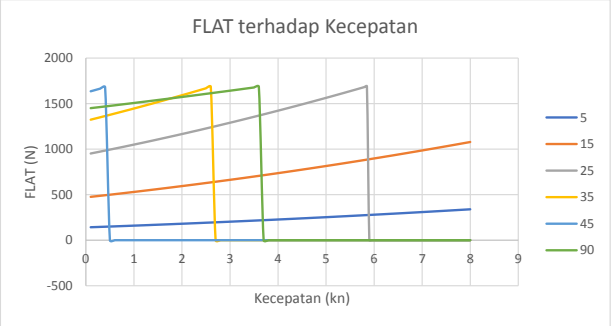
KOEFISIEN LAYAR

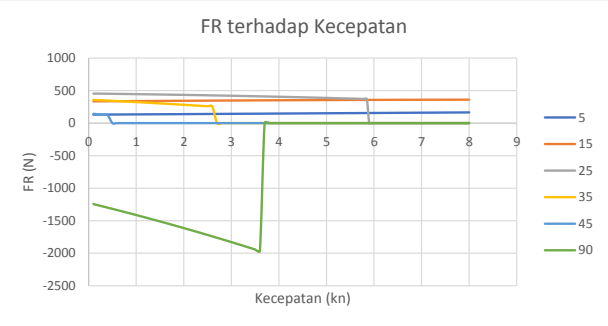
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

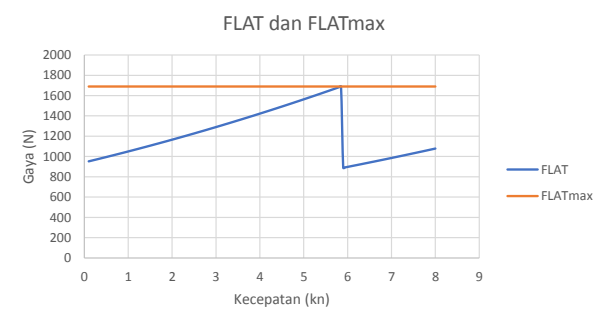
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	50 °
V_A	8,864 m/s
β	41,822 °
V_S	**1,646 m/s**
	3,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

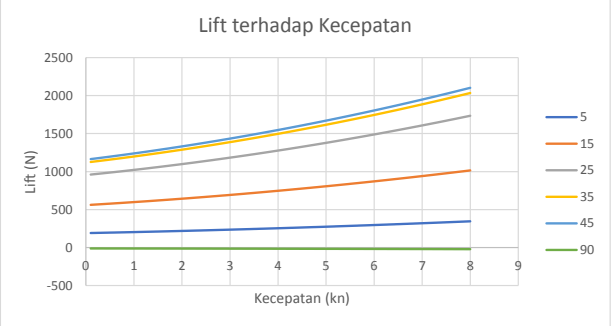
HEELING MOMENT

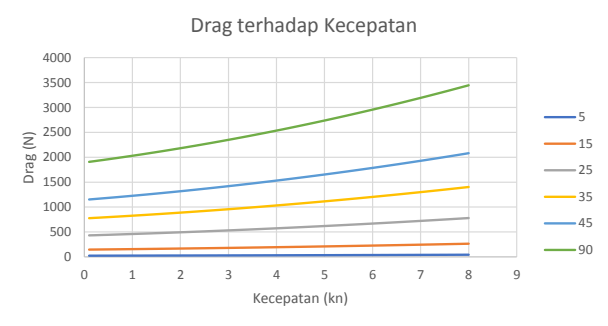
$$M_H = F_H \times h$$

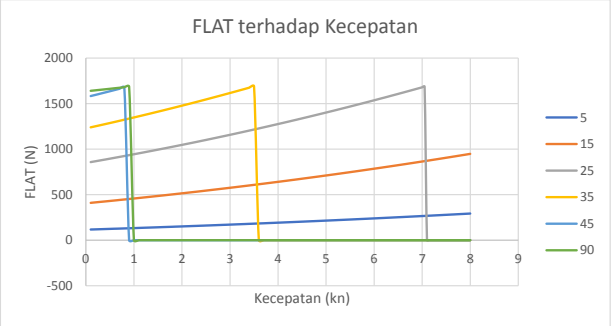
KOEFISIEN LAYAR

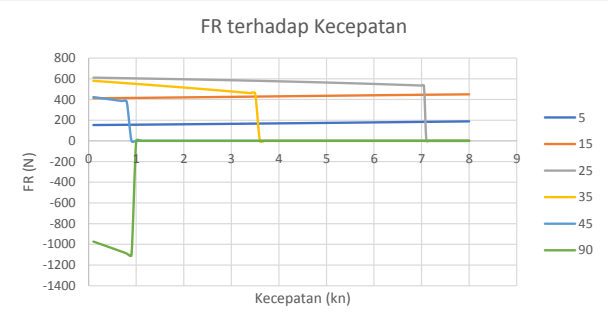
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

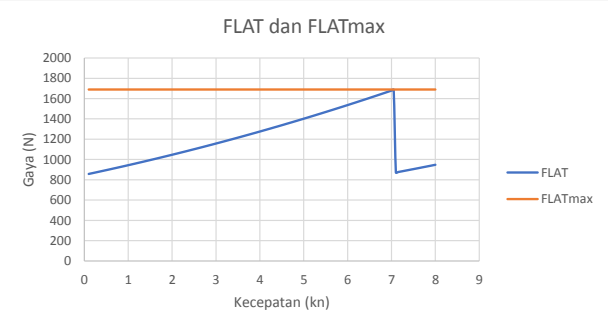
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	15,000 kn
	7,716 m/s
γ	60 °
V_A	8,890 m/s
β	48,731 °
V_S	**2,006 m/s**
	3,900 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

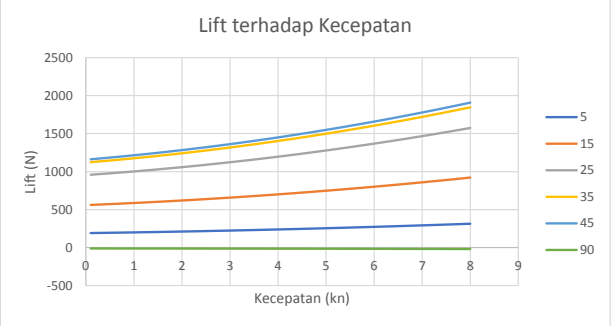
HEELING MOMENT

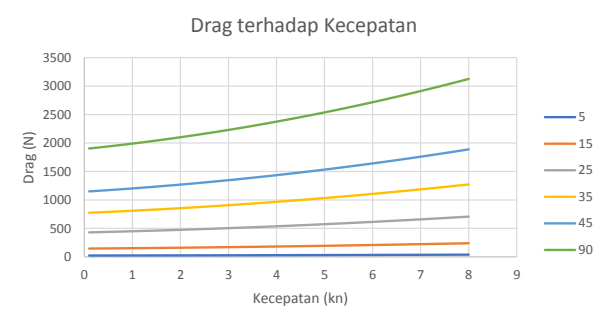
$$M_H = F_H \times h$$

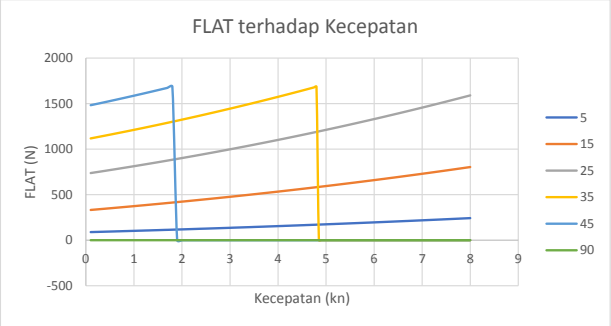
KOEFISIEN LAYAR

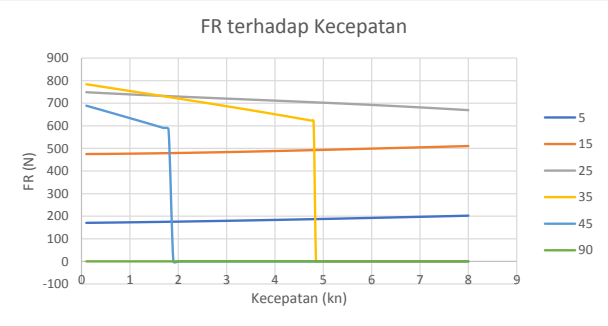
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

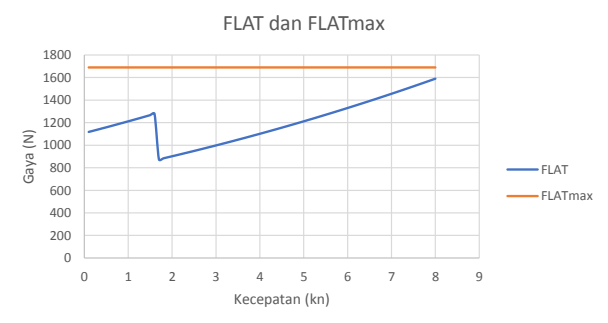
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	15,000 kn
	7,716 m/s
γ	70 °
V_A	8,639 m/s
β	57,067 °
V_S	**2,212 m/s**
	4,300 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

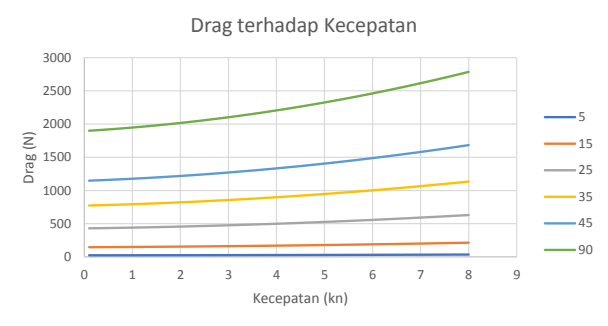
HEELING MOMENT

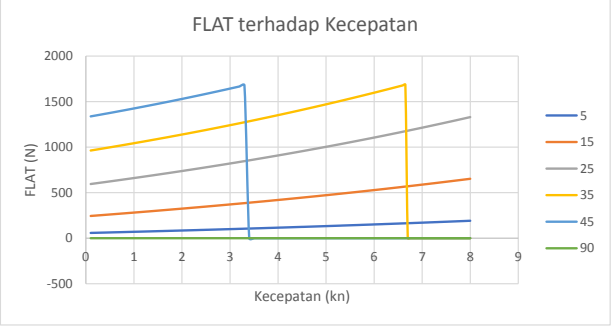
$$M_H = F_H \times h$$

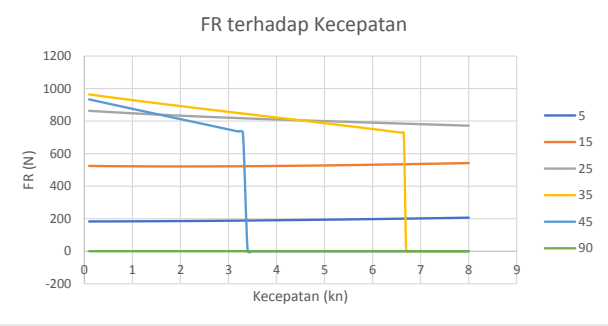
KOEFISIEN LAYAR

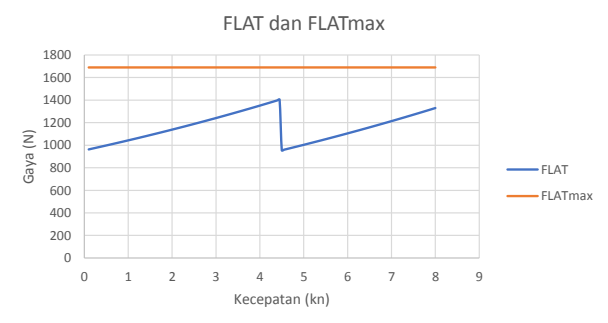
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	15,000 kn
	7,716 m/s
γ	80 °
V_A	8,324 m/s
β	65,910 °
V_S	**2,341 m/s**
	4,550 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

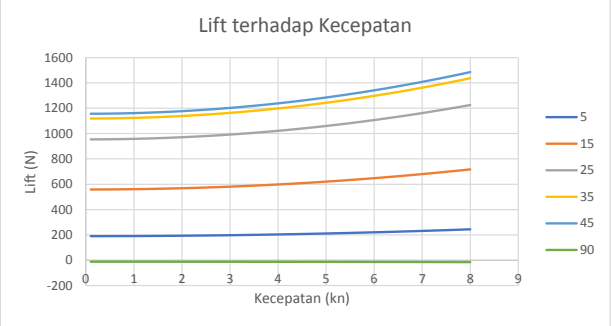
HEELING MOMENT

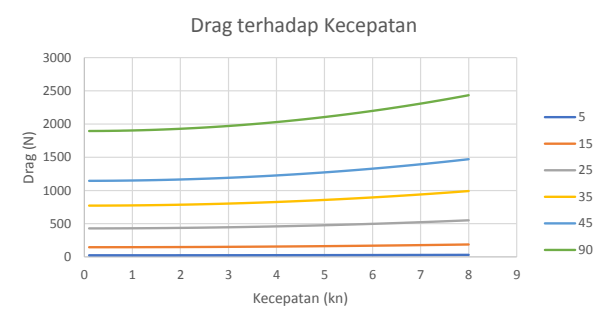
$$M_H = F_H \times h$$

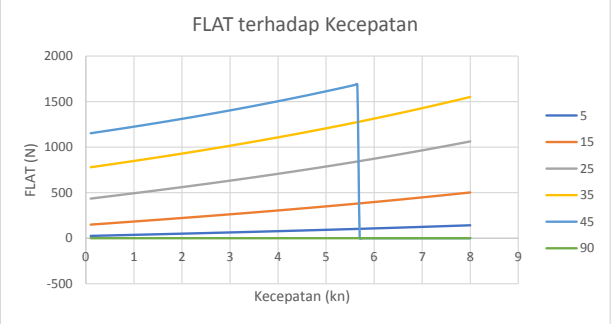
KOEFISIEN LAYAR

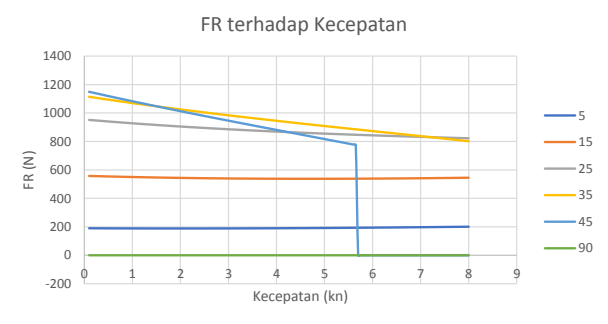
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

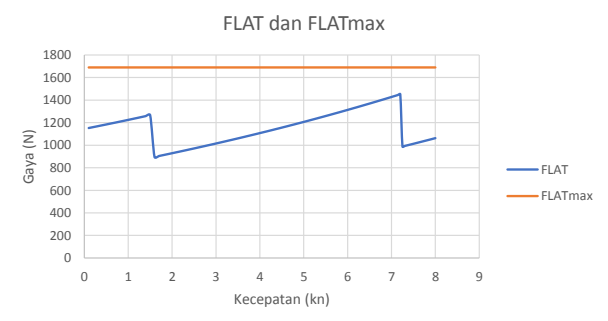
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	90 °
V_A	7,986 m/s
β	75,069 °
V_S	**2,469 m/s**
	4,800 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

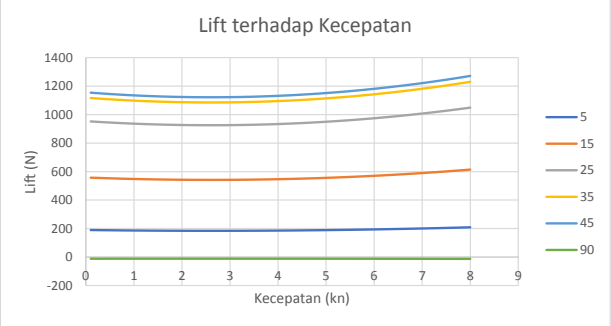
HEELING MOMENT

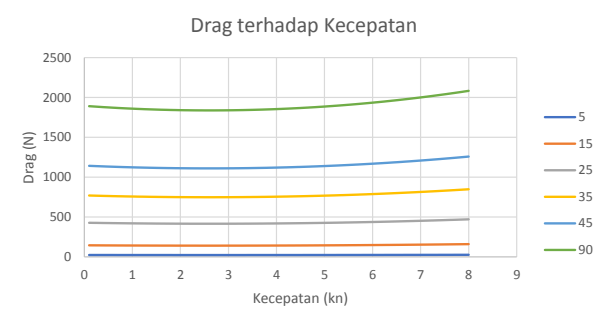
$$M_H = F_H \times h$$

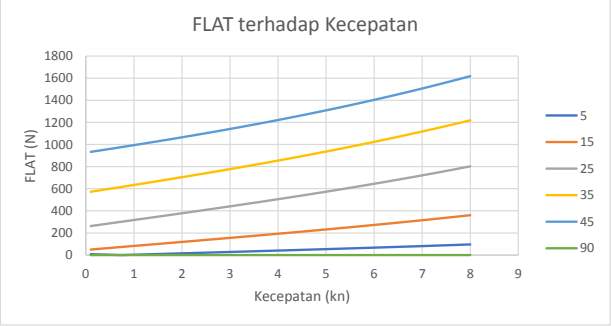
KOEFISIEN LAYAR

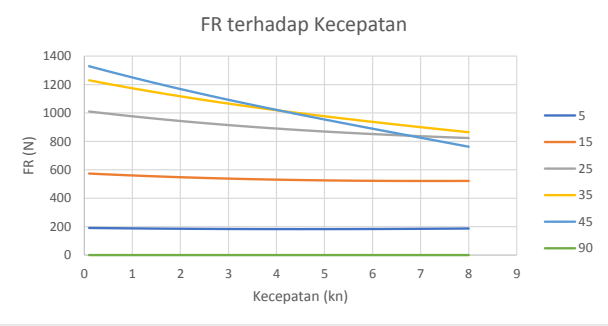
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

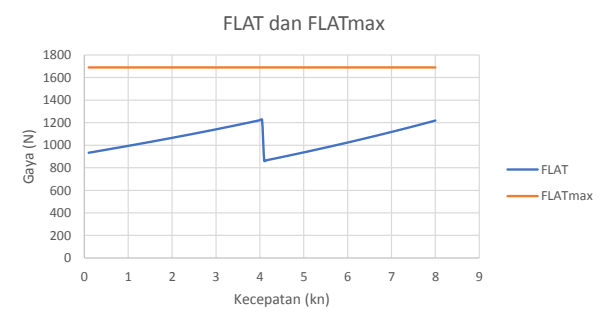
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	100 °
V_A	7,633 m/s
β	84,604 °
V_S	**2,546 m/s**
	4,950 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

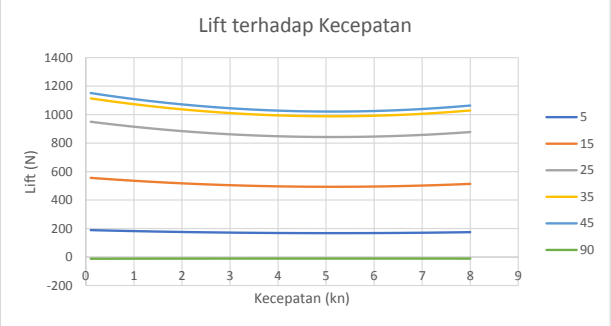
HEELING MOMENT

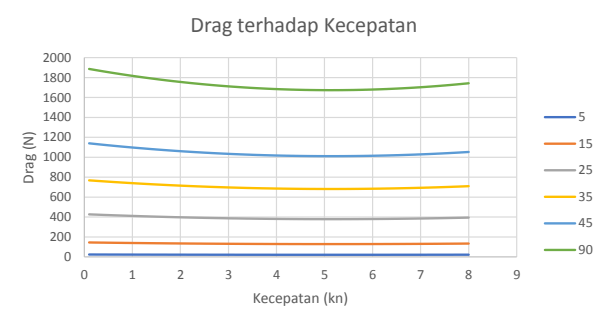
$$M_H = F_H \times h$$

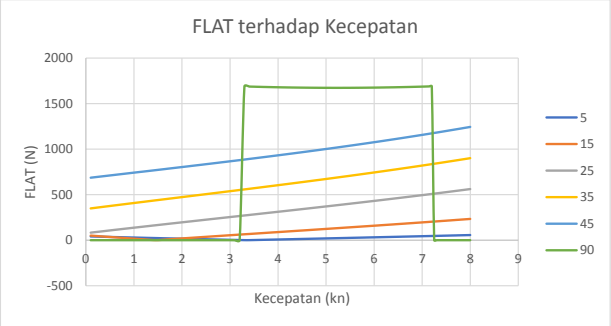
KOEFISIEN LAYAR

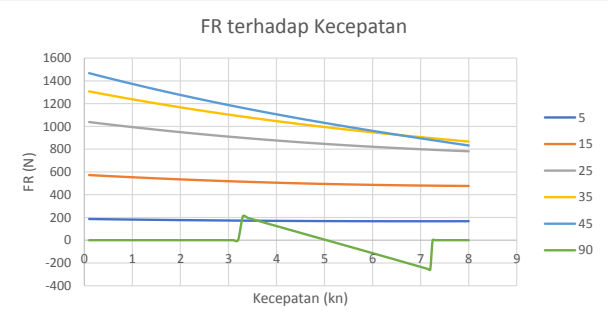
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

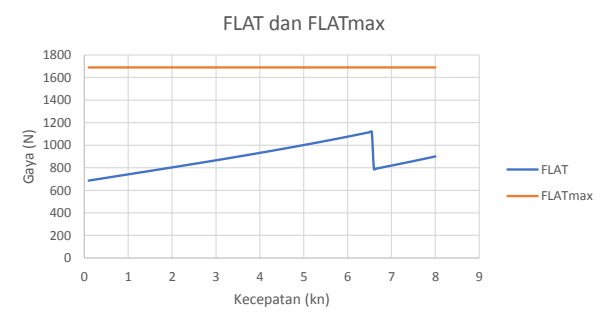
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	15,000 kn
	7,716 m/s
γ	110 °
V_A	7,274 m/s
β	94,585 °
V_S	**2,598 m/s**
	5,050 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

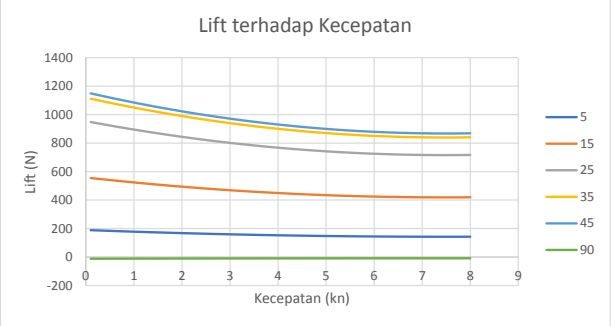
HEELING MOMENT

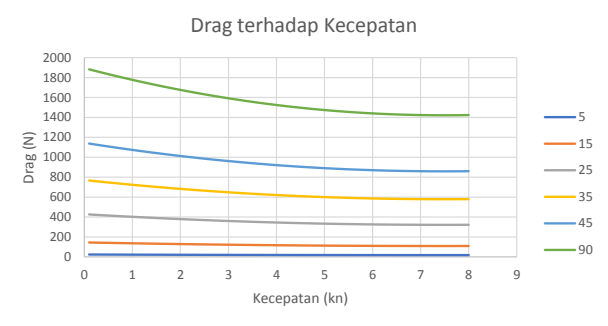
$$M_H = F_H \times h$$

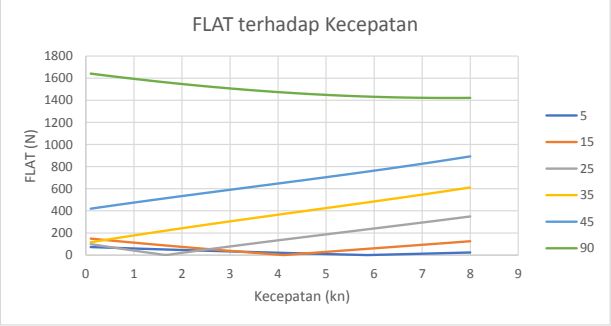
KOEFISIEN LAYAR

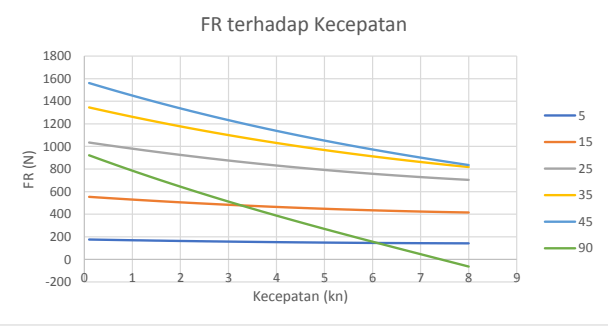
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

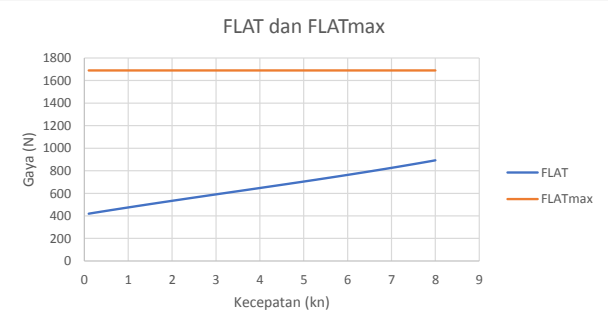
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	15,000 kn
	7,716 m/s
γ	120 °
V_A	6,921 m/s
β	105,079 °
V_S	**2,623 m/s**
	5,100 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

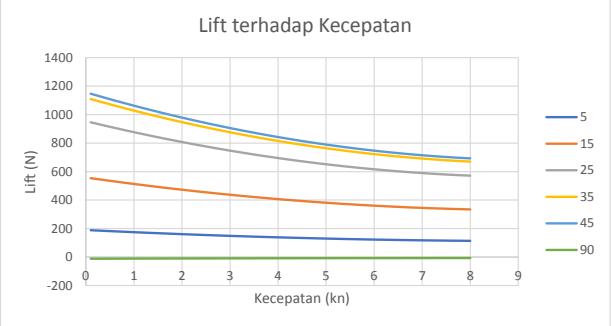
HEELING MOMENT

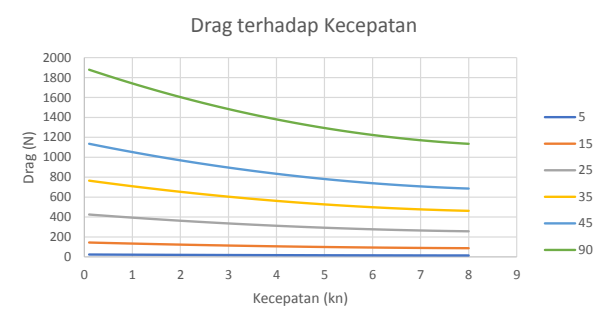
$$M_H = F_H \times h$$

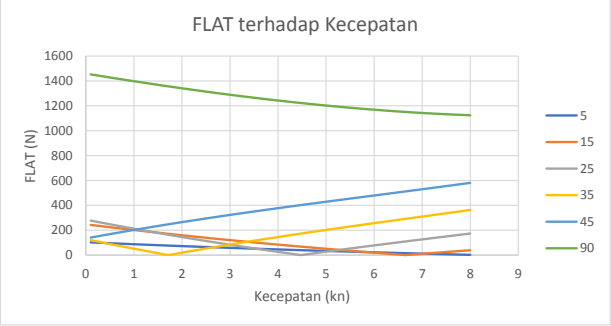
KOEFISIEN LAYAR

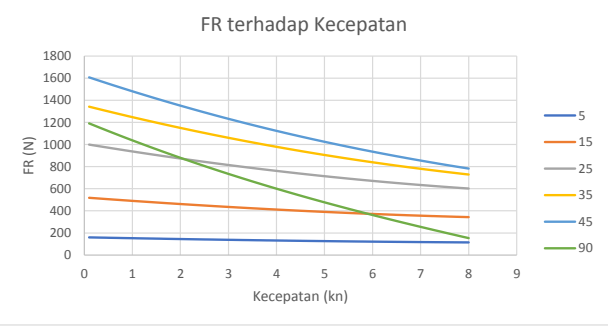
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

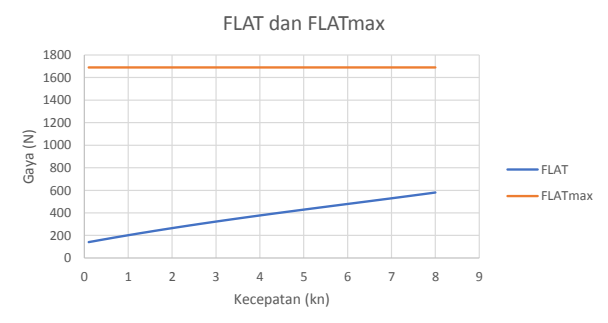
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	130 °
V_A	6,585 m/s
β	116,151 °
V_S	**2,598 m/s**
	5,050 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

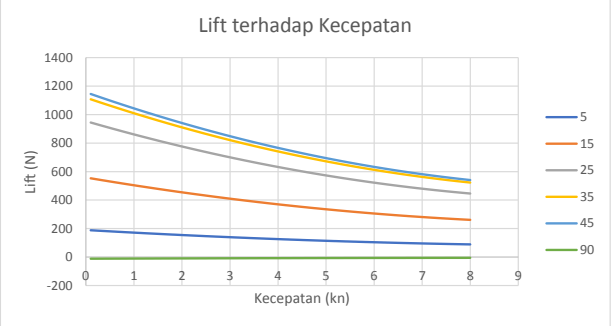
HEELING MOMENT

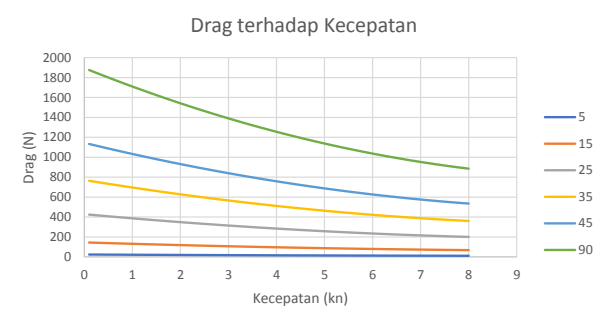
$$M_H = F_H \times h$$

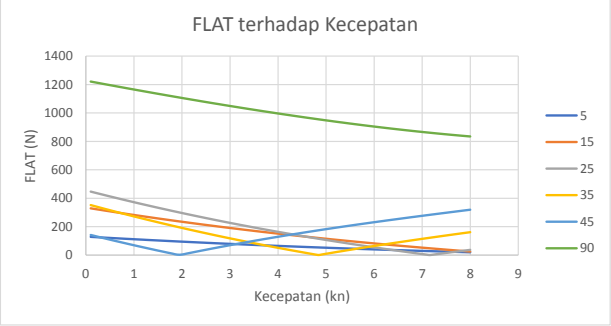
KOEFISIEN LAYAR

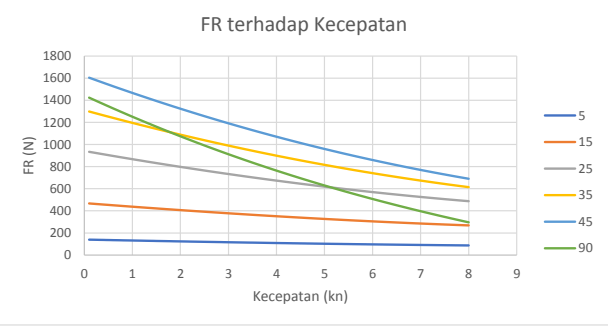
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

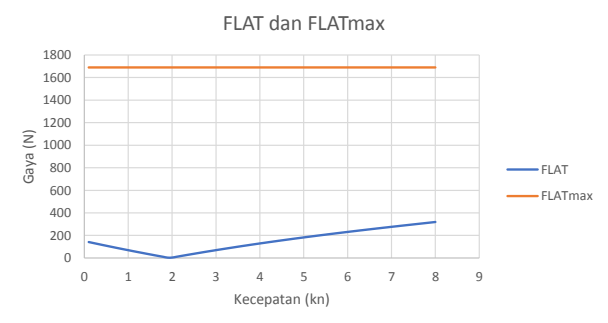
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	140 °
V_A	6,281 m/s
β	127,843 °
V_S	**2,521 m/s**
	4,900 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

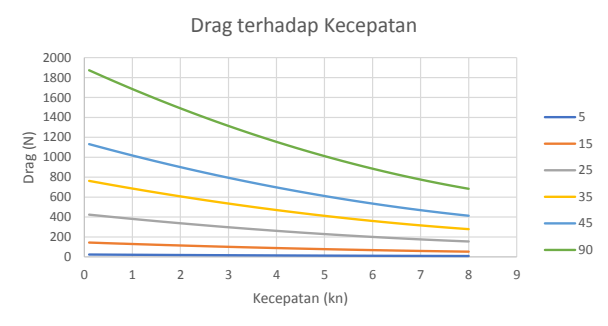
HEELING MOMENT

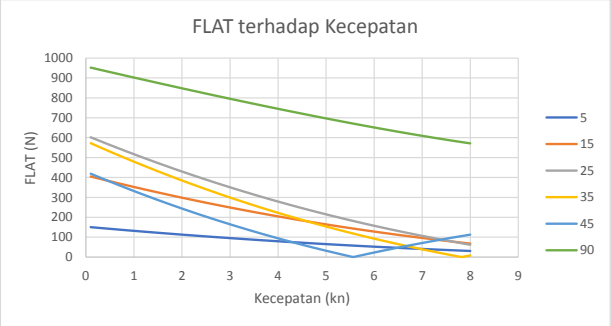
$$M_H = F_H \times h$$

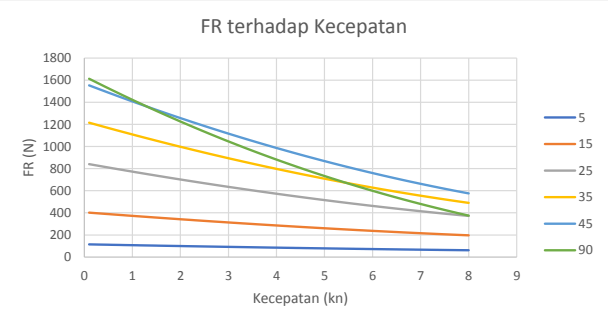
KOEFISIEN LAYAR

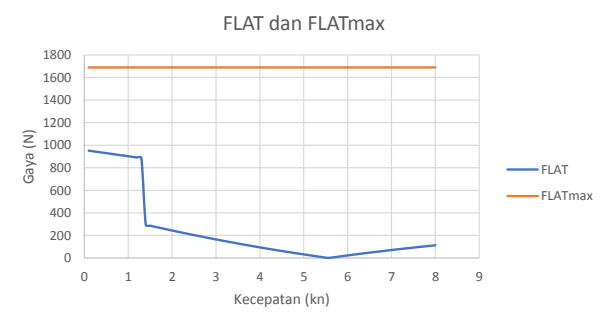
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	15,000 kn
	7,716 m/s
γ	150 °
V_A	6,023 m/s
β	140,164 °
V_S	**2,443 m/s**
	4,750 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

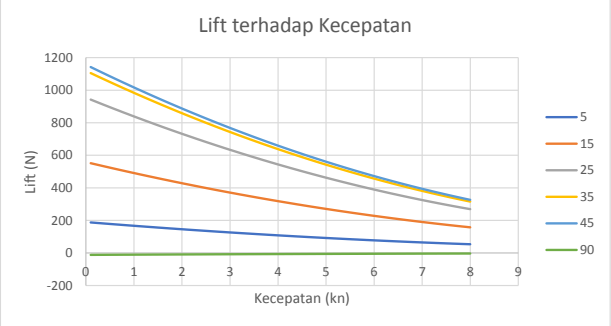
HEELING MOMENT

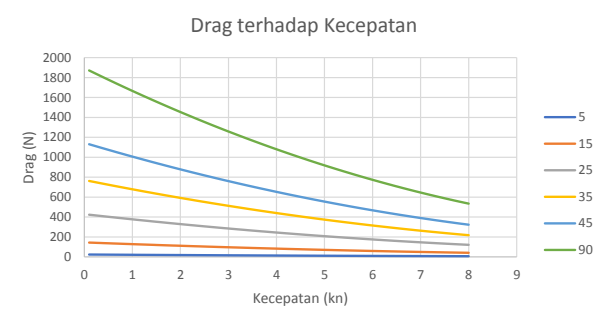
$$M_H = F_H \times h$$

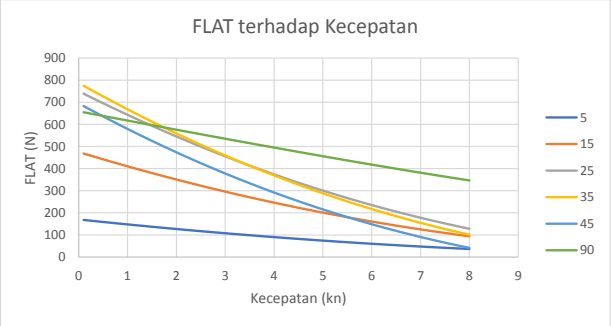
KOEFISIEN LAYAR

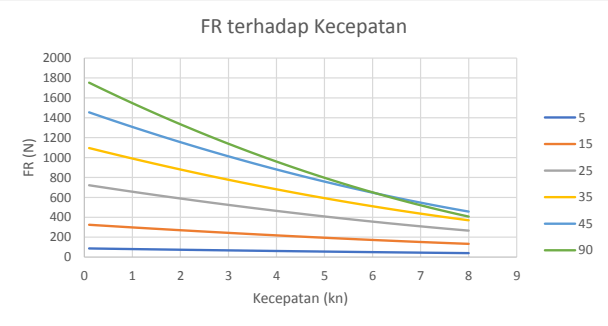
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

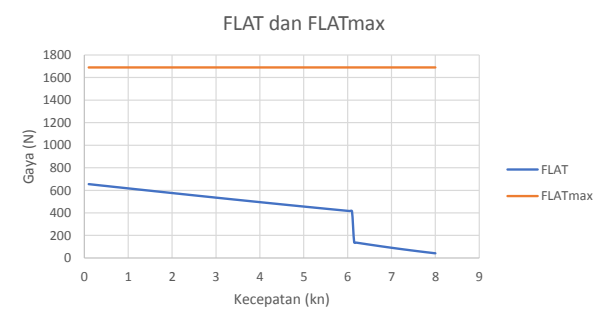
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	160 °
V_A	5,825 m/s
β	153,061 °
V_S	**2,392 m/s**
	4,650 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

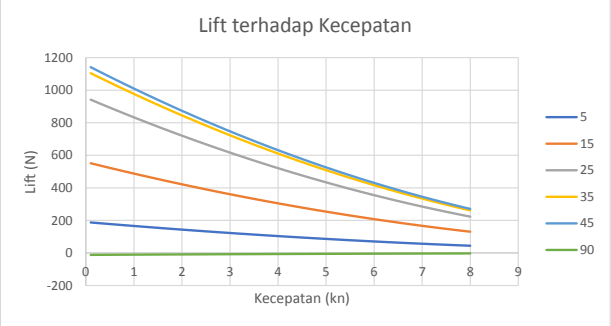
HEELING MOMENT

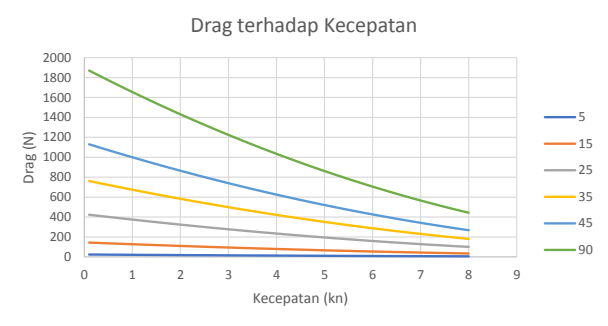
$$M_H = F_H \times h$$

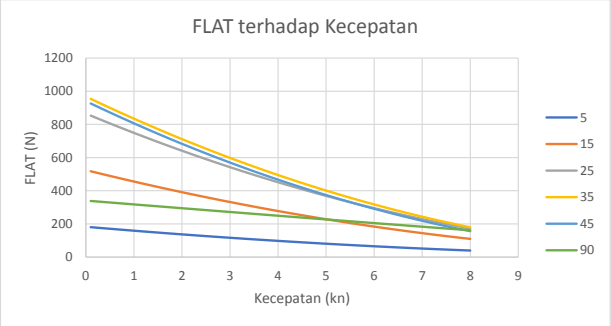
KOEFISIEN LAYAR

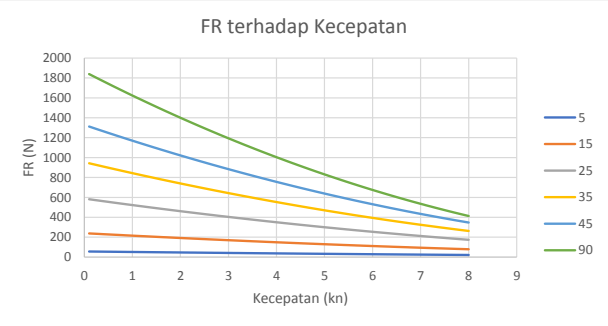
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

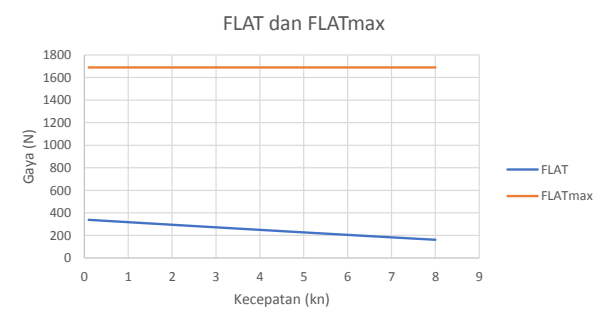
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	15,000 kn
	7,716 m/s
γ	170 °
V_A	5,701 m/s
β	166,407 °
V_S	**2,418 m/s**
	4,700 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

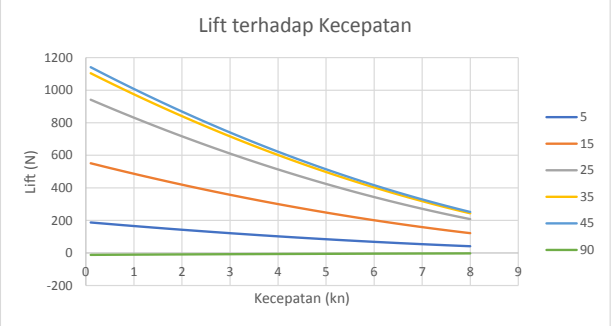
HEELING MOMENT

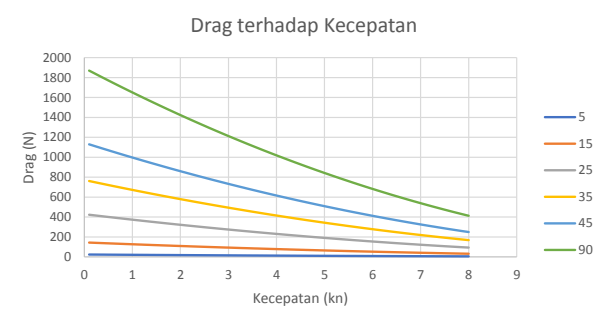
$$M_H = F_H \times h$$

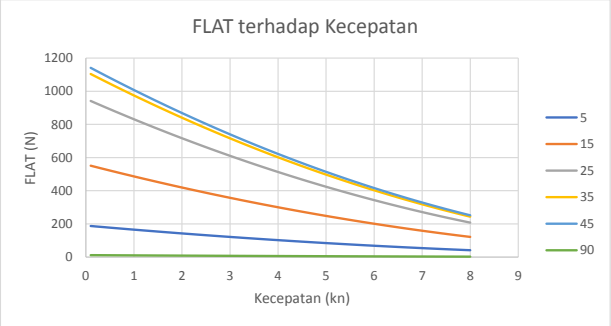
KOEFISIEN LAYAR

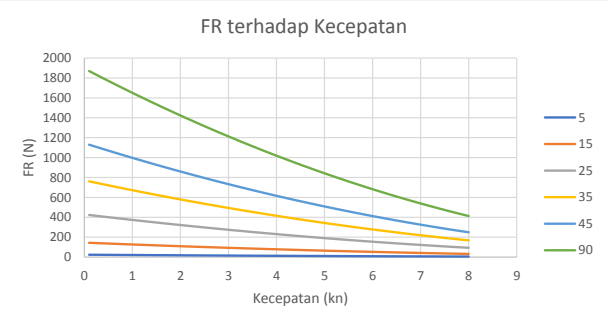
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

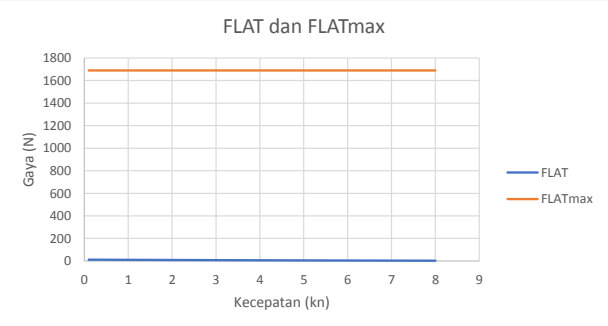
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000	kn
	7,716	m/s
γ	180	°
V_A	5,658	m/s
β	180,000	°
V_S	**2,443**	**m/s**
	4,750	**kn**

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

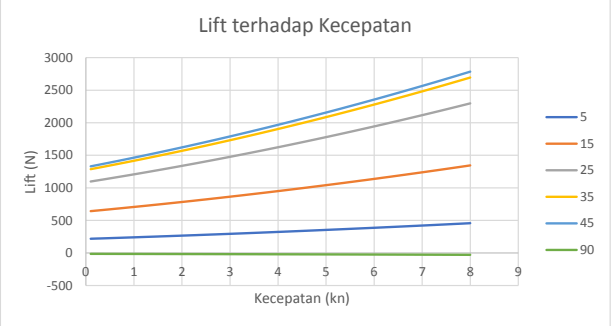
HEELING MOMENT

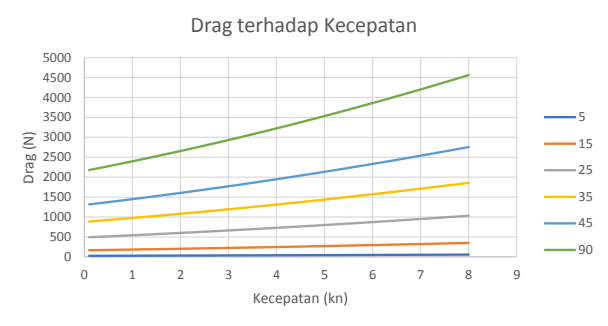
$$M_H = F_H \times h$$

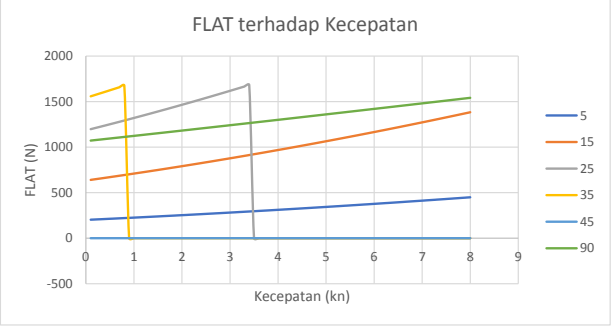
KOEFISIEN LAYAR

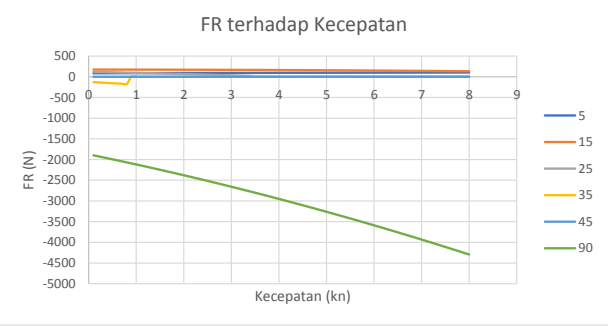
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

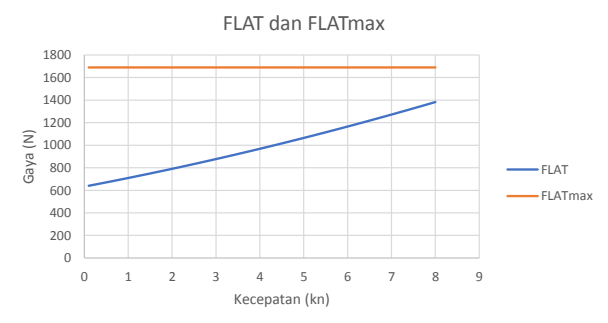
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	30 °
V_A	9,136 m/s
β	26,772 °
V_S	**1,029 m/s**
	2,000 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

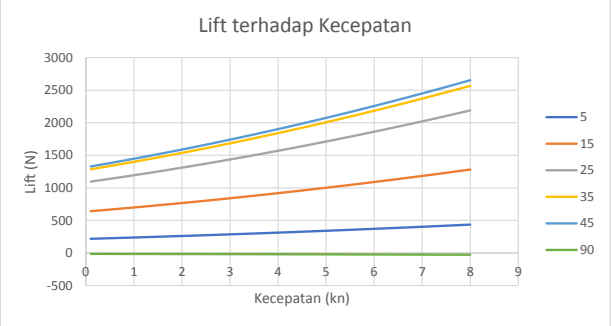
HEELING MOMENT

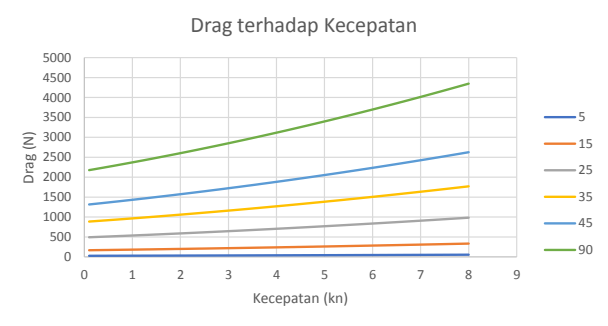
$$M_H = F_H \times h$$

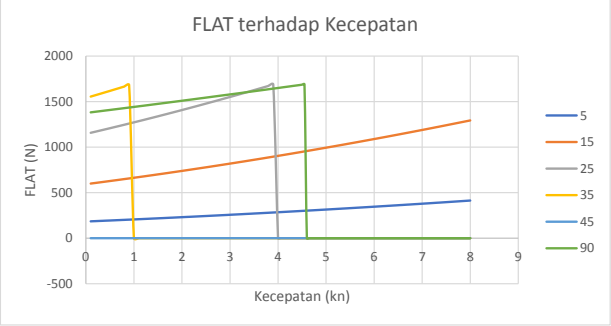
KOEFISIEN LAYAR

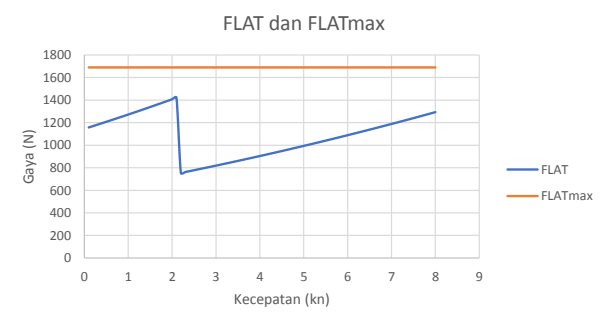
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	16,000 kn
	8,230 m/s
γ	40 °
V_A	9,337 m/s
β	34,513 °
V_S	**1,389 m/s**
	2,700 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

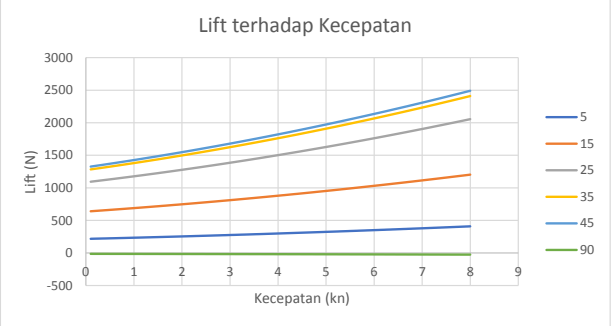
HEELING MOMENT

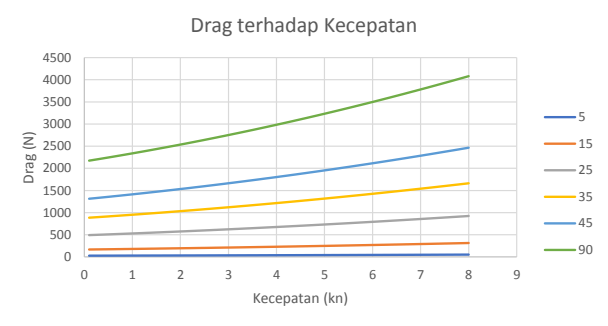
$$M_H = F_H \times h$$

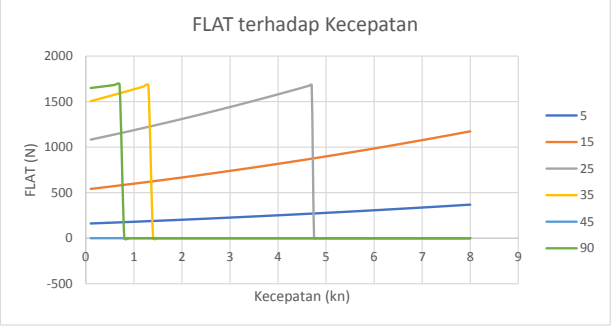
KOEFISIEN LAYAR

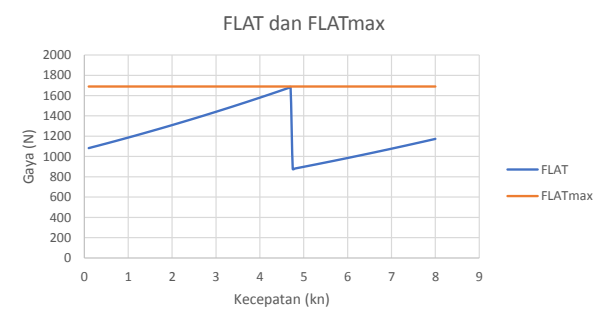
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	16,000 kn
	8,230 m/s
γ	50 °
V_A	9,488 m/s
β	41,642 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

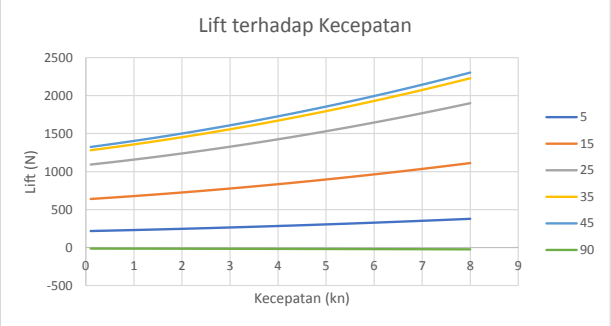
HEELING MOMENT

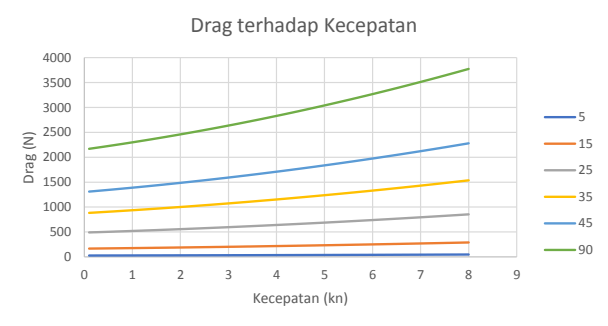
$$M_H = F_H \times h$$

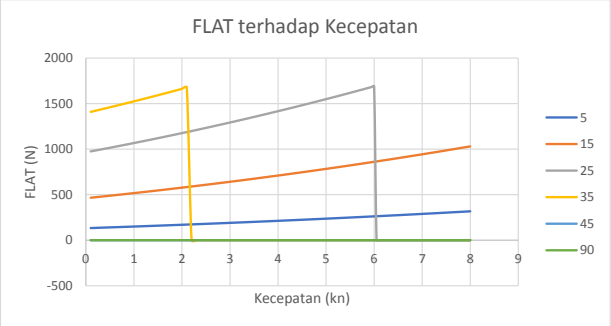
KOEFISIEN LAYAR

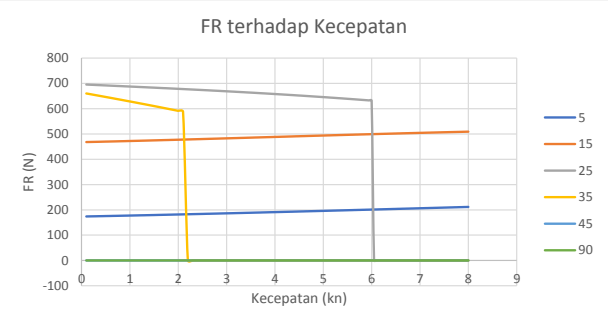
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

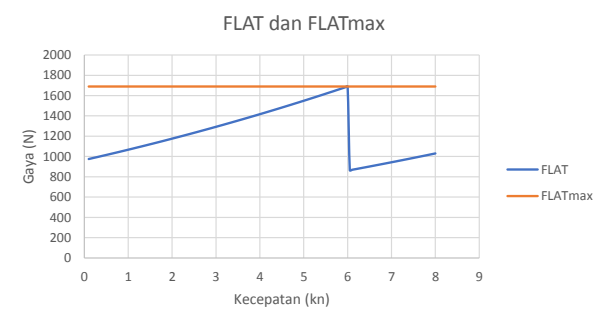
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	60 °
V_A	9,429 m/s
β	49,107 °
V_S	**2,109 m/s**
	4,100 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

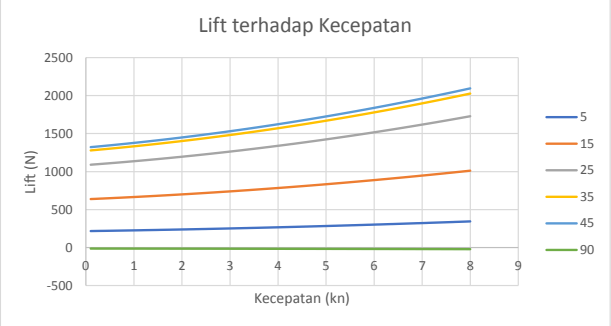
HEELING MOMENT

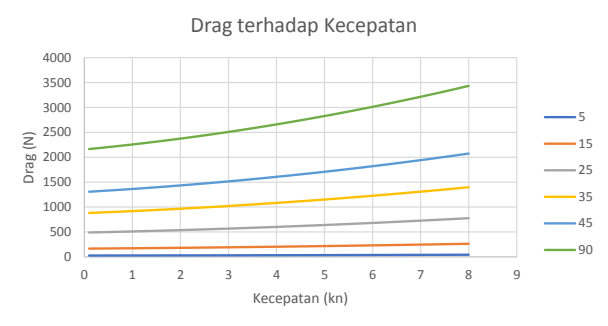
$$M_H = F_H \times h$$

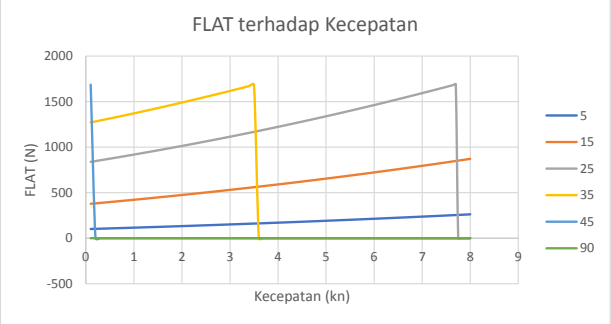
KOEFISIEN LAYAR

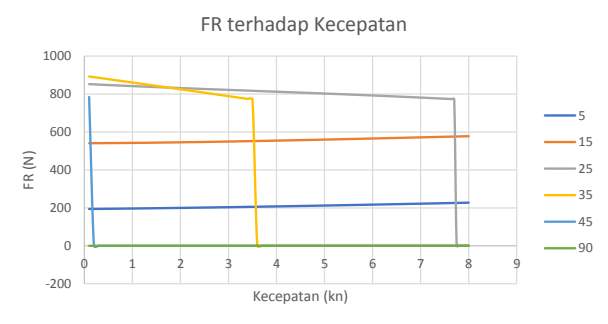
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

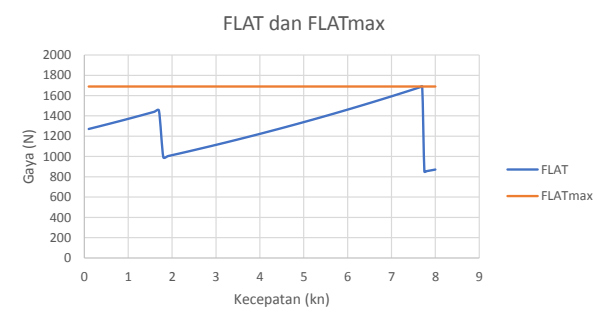
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	70 °
V_A	9,141 m/s
β	57,788 °
V_S	**2,341 m/s**
	4,550 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

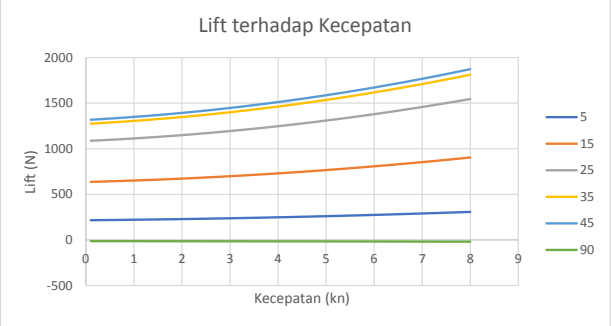
HEELING MOMENT

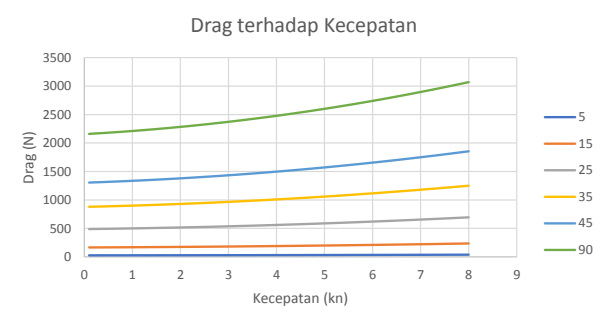
$$M_H = F_H \times h$$

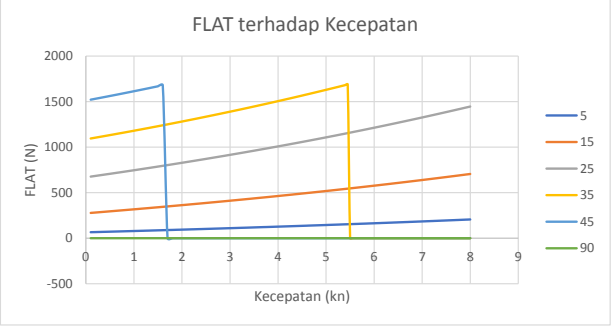
KOEFISIEN LAYAR

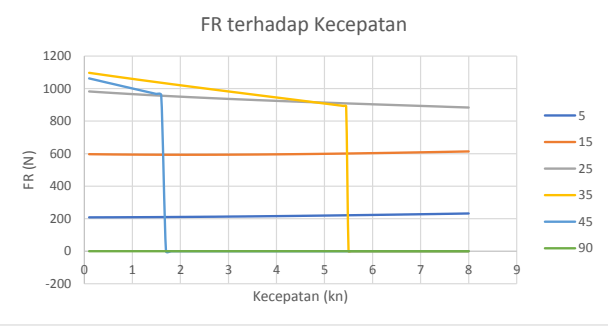
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

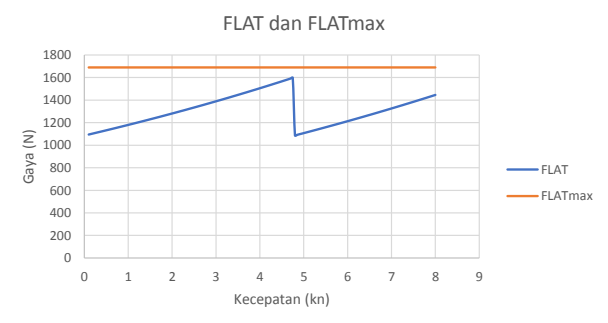
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	80 °
V_A	8,824 m/s
β	66,723 °
V_S	**2,469 m/s**
	4,800 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

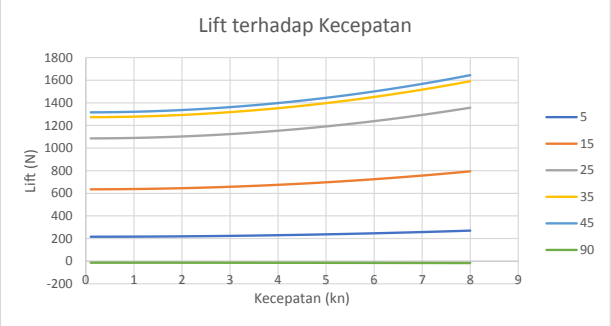
HEELING MOMENT

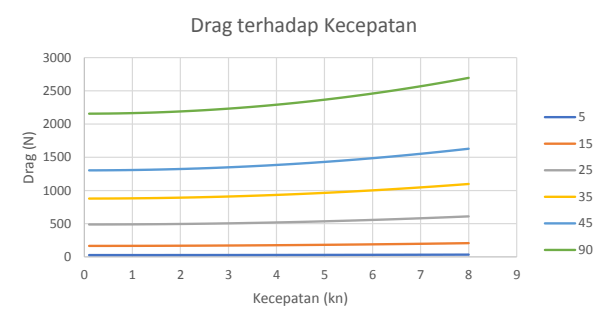
$$M_H = F_H \times h$$

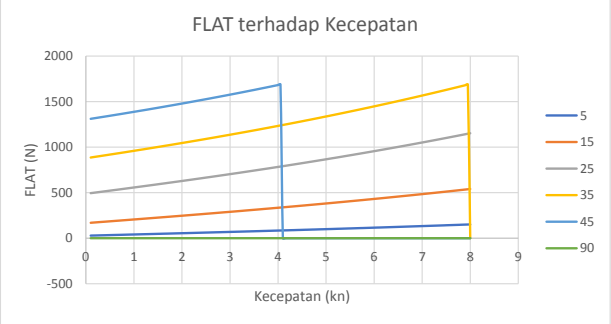
KOEFISIEN LAYAR

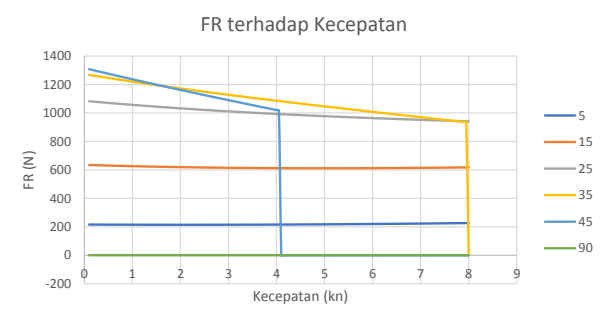
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

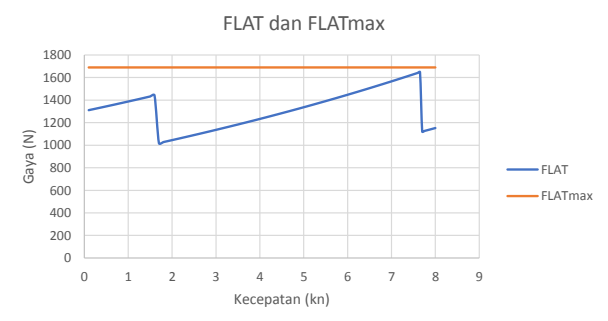
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	90 °
V_A	8,484 m/s
β	75,964 °
V_S	**2,598 m/s**
	5,050 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

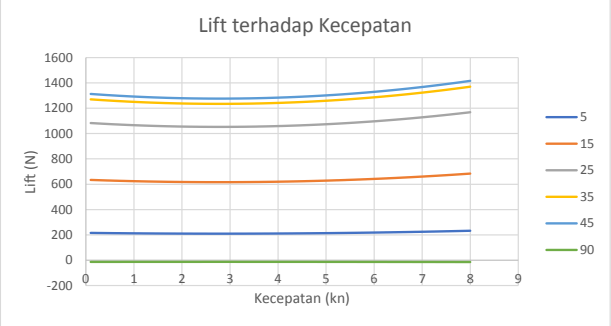
HEELING MOMENT

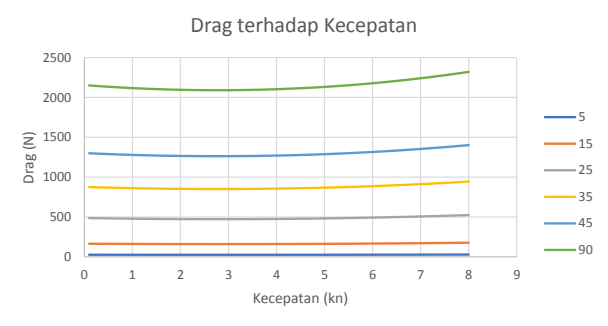
$$M_H = F_H \times h$$

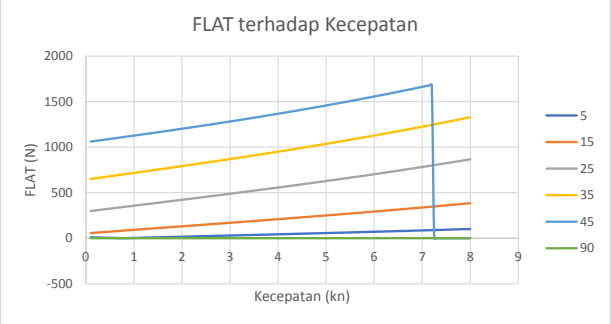
KOEFISIEN LAYAR

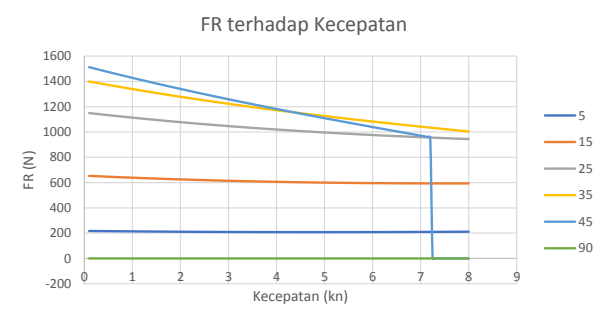
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

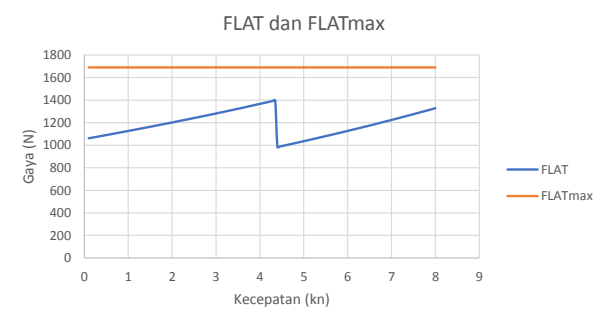
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	100 °
V_A	8,130 m/s
β	85,567 °
V_S	**2,675 m/s**
	5,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

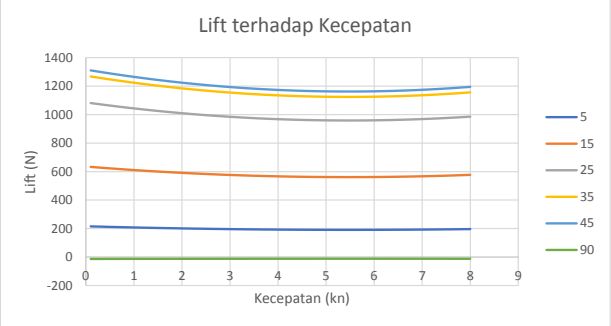
HEELING MOMENT

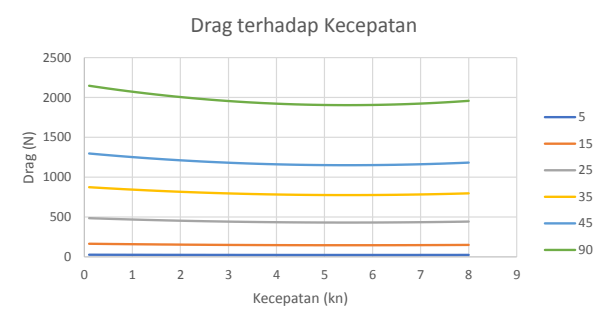
$$M_H = F_H \times h$$

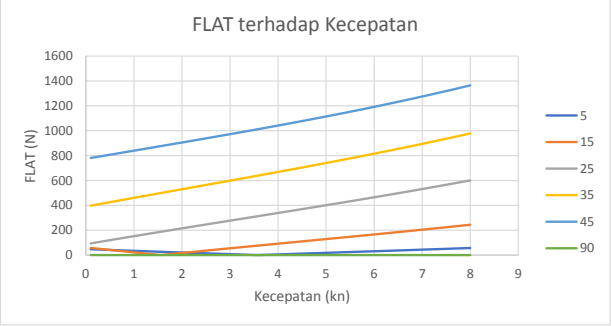
KOEFISIEN LAYAR

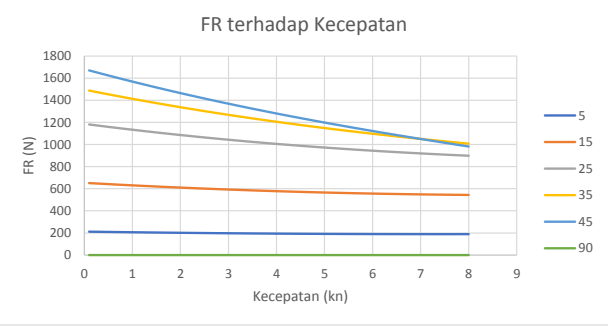
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

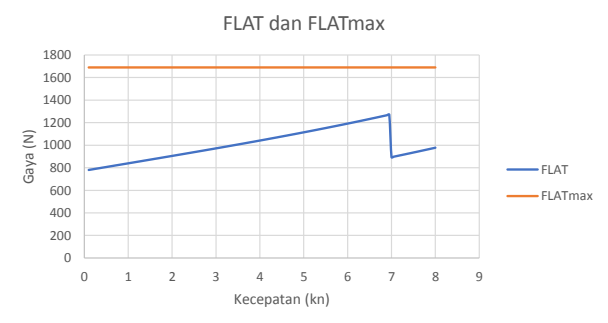
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	110 °
V_A	7,771 m/s
β	95,593 °
V_S	**2,726 m/s**
	5,300 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

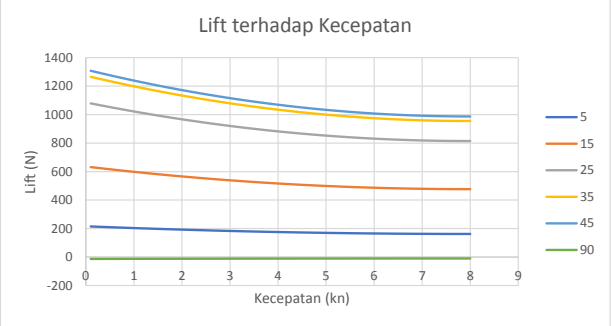
HEELING MOMENT

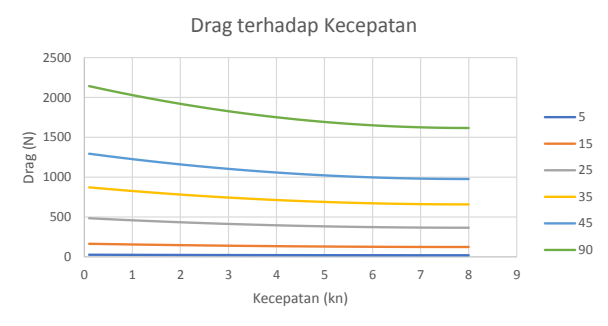
$$M_H = F_H \times h$$

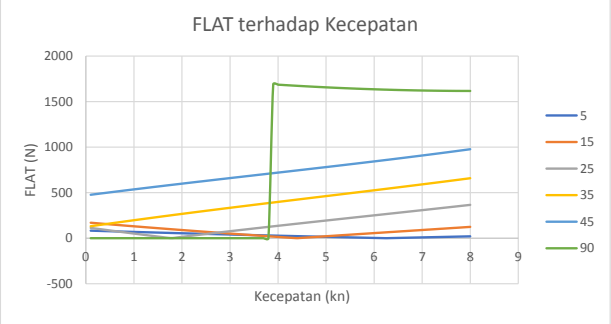
KOEFISIEN LAYAR

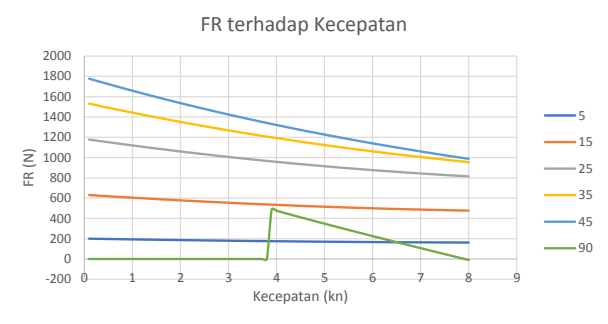
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

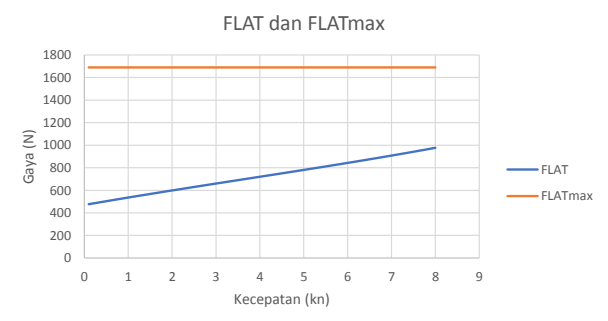
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	16,000 kn
	8,230 m/s
γ	120 °
V_A	7,419 m/s
β	106,102 °
V_S	**2,752 m/s**
	5,350 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

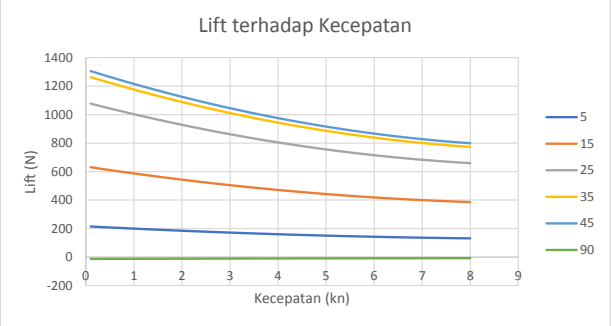
HEELING MOMENT

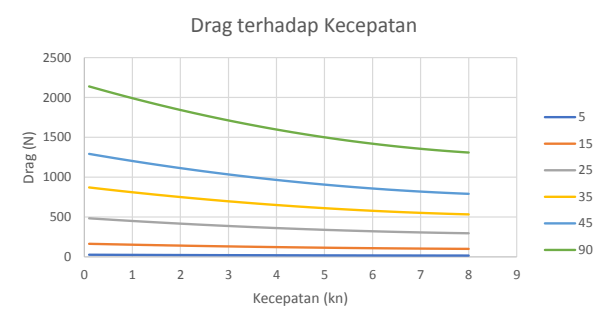
$$M_H = F_H \times h$$

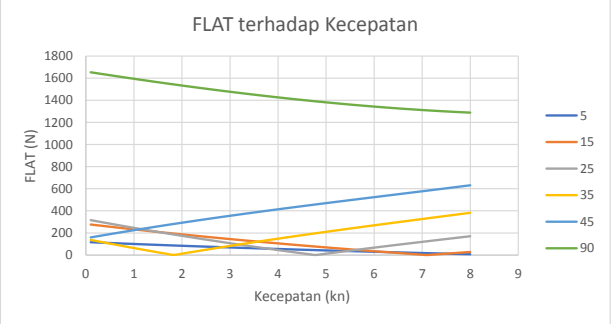
KOEFISIEN LAYAR

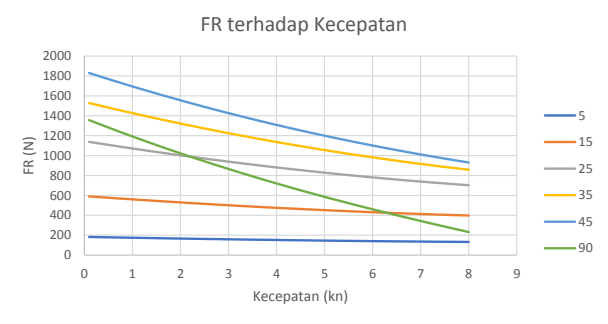
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

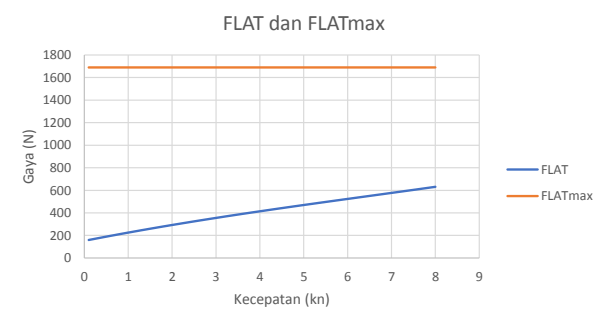
MUATAN	θ_{max}	11 °	h	4,156	m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735	N











V_T	16,000 kn
	8,230 m/s
γ	130 °
V_A	7,085 m/s
β	117,146 °
V_S	**2,726 m/s**
	5,300 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

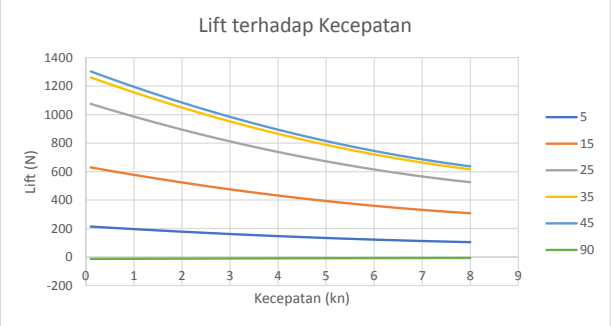
HEELING MOMENT

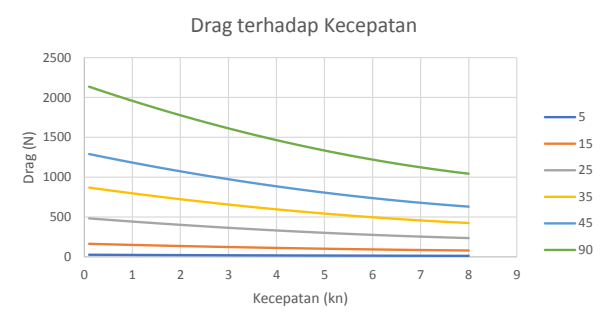
$$M_H = F_H \times h$$

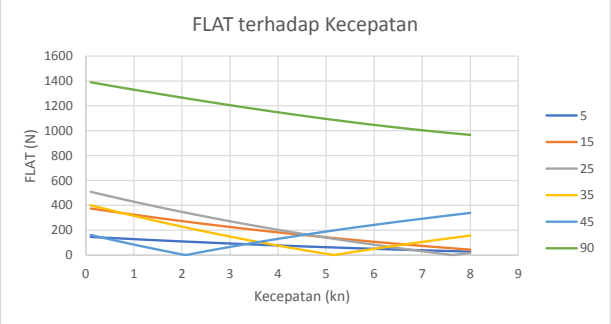
KOEFISIEN LAYAR

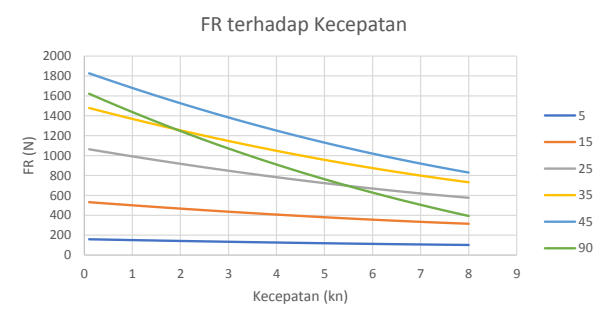
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

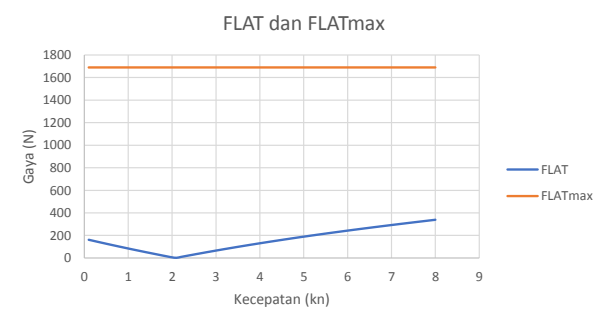
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	140 °
V_A	6,784 m/s
β	128,758 °
V_S	**2,675 m/s**
	5,200 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

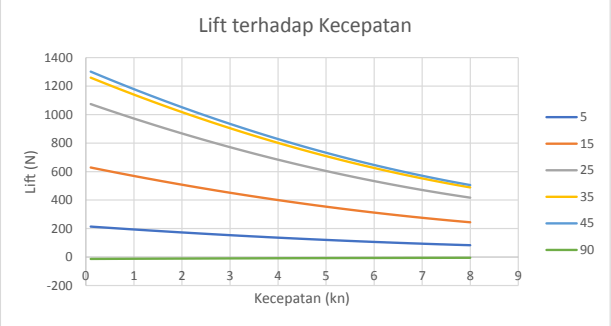
HEELING MOMENT

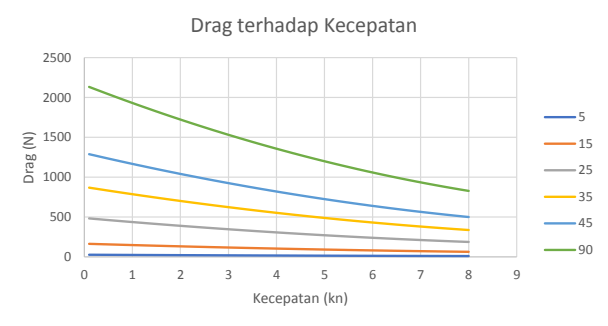
$$M_H = F_H \times h$$

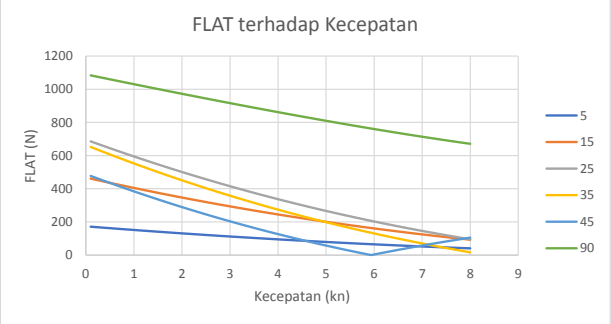
KOEFISIEN LAYAR

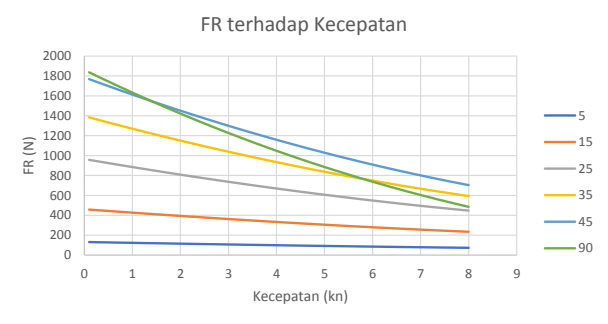
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

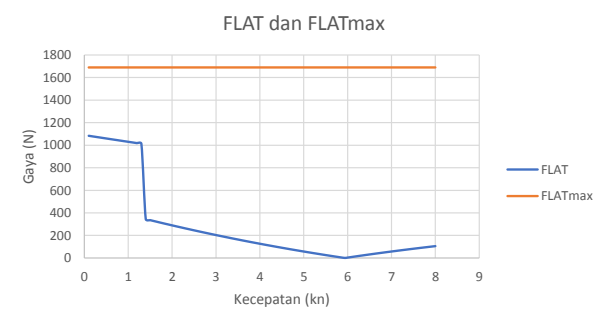
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	150 °
V_A	6,530 m/s
β	140,935 °
V_S	**2,598 m/s**
	5,050 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

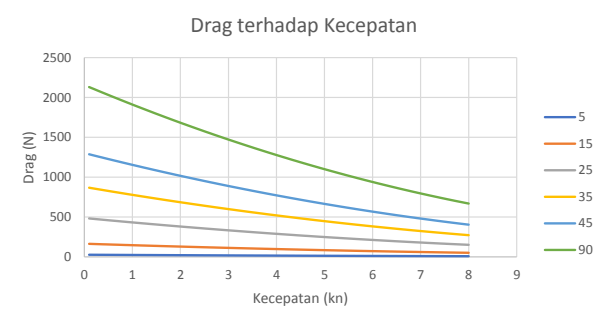
HEELING MOMENT

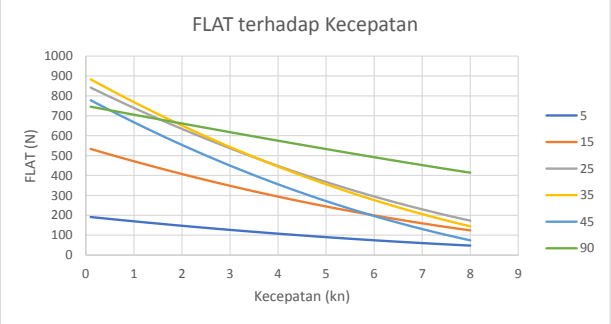
$$M_H = F_H \times h$$

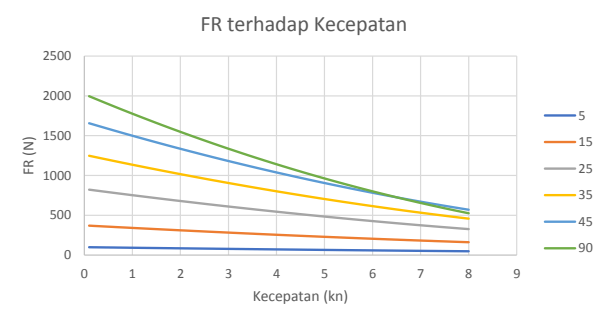
KOEFISIEN LAYAR

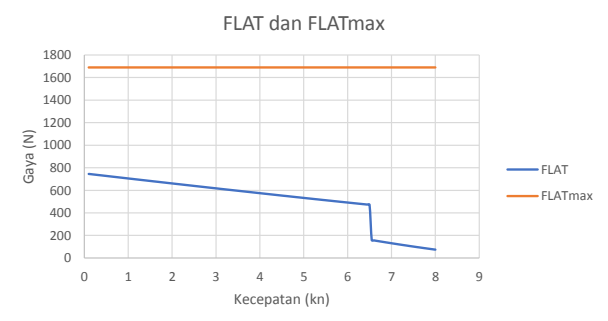
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	16,000 kn
	8,230 m/s
γ	160 °
V_A	6,336 m/s
β	153,623 °
V_S	**2,546 m/s**
	4,950 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

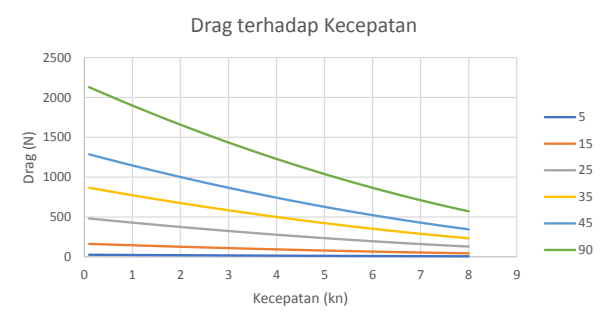
HEELING MOMENT

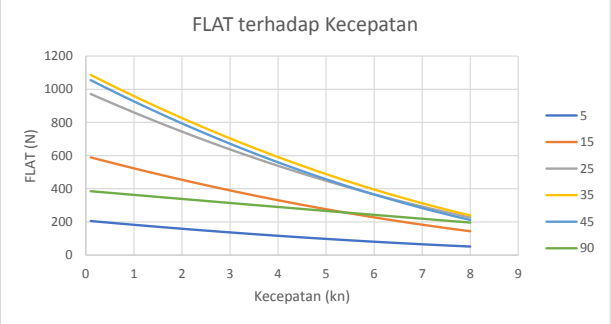
$$M_H = F_H \times h$$

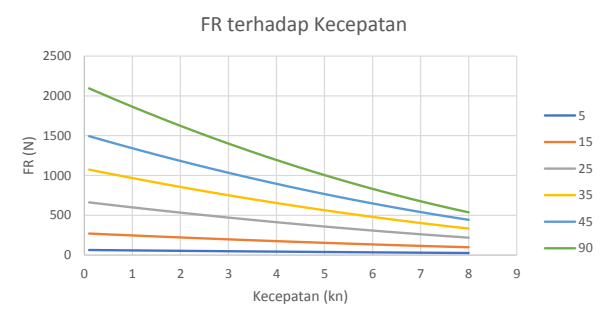
KOEFISIEN LAYAR

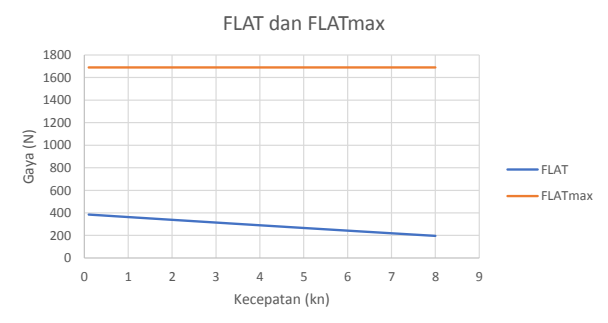
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	16,000 kn
	8,230 m/s
γ	170 °
V_A	6,214 m/s
β	166,704 °
V_S	**2,572 m/s**
	5,000 kn

SPESIFIKASI LAYAR

Model		Vinta-Ma
Span	Yard	5,639 m
	Boom	6,400 m
Chord		3,658 m
Area		22,019 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

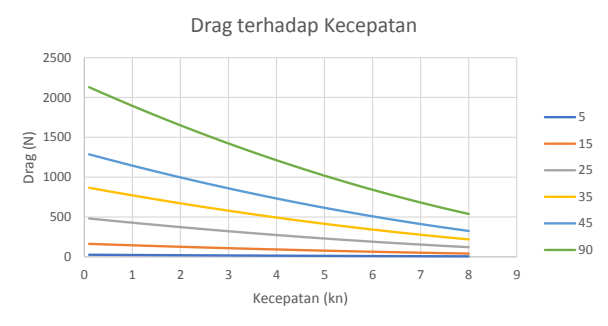
HEELING MOMENT

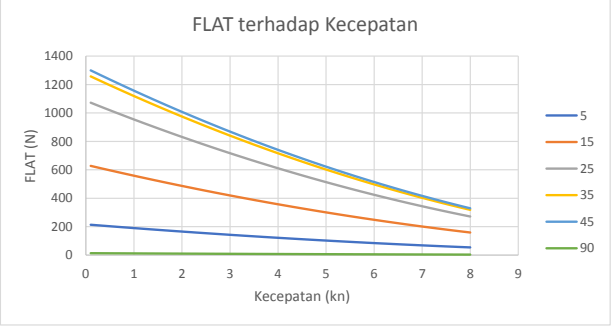
$$M_H = F_H \times h$$

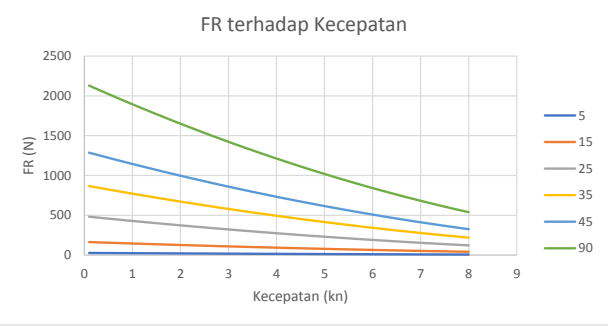
KOEFISIEN LAYAR

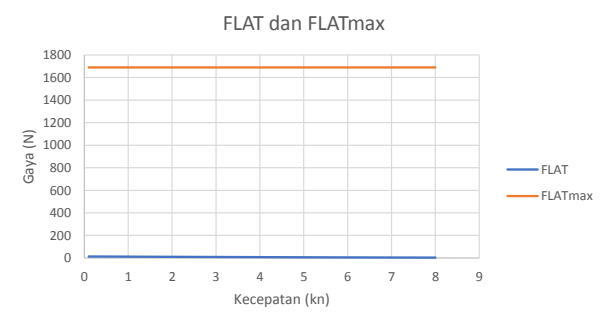
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	16,000 kn
	8,230 m/s
γ	180 °
V_A	6,173 m/s
β	180,000 °
V_S	**2,572 m/s**
	5,000 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

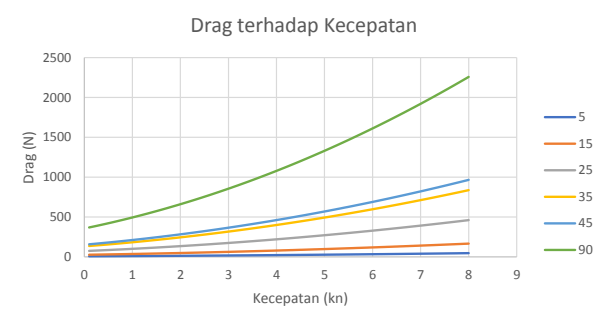
HEELING MOMENT

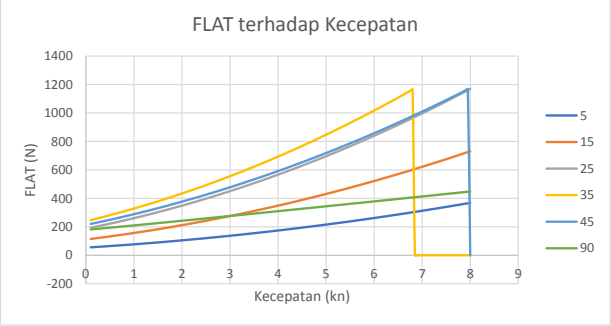
$$M_H = F_H \times h$$

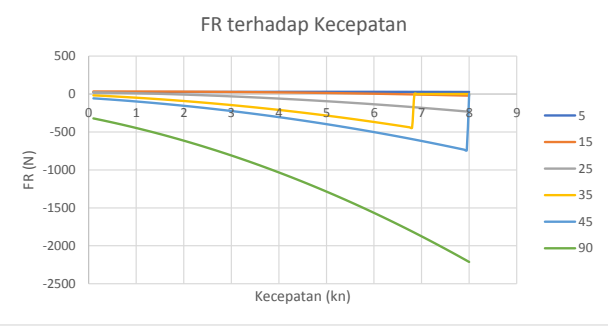
KOEFISIEN LAYAR

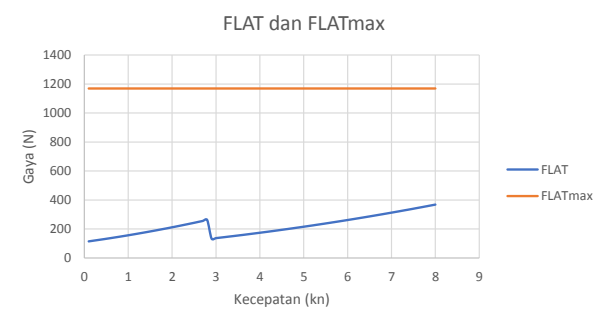
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	5,000 kn
	2,572 m/s
γ	30 °
V_A	2,936 m/s
β	25,981 °
V_S	**0,412 m/s**
	0,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

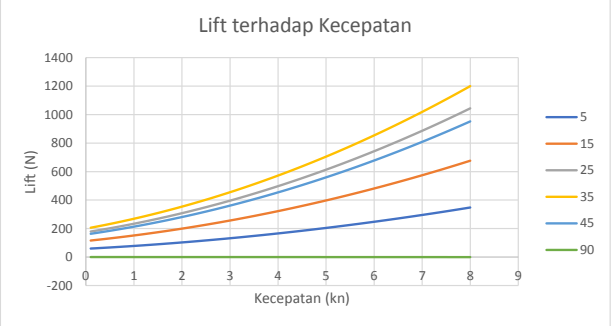
HEELING MOMENT

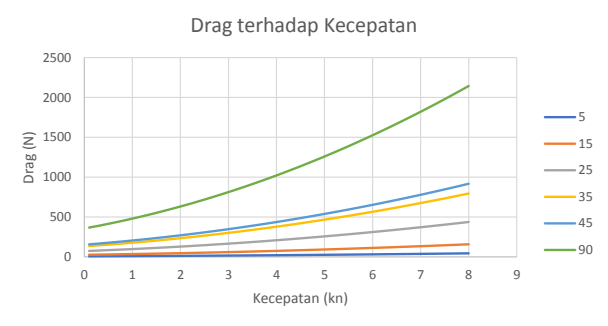
$$M_H = F_H \times h$$

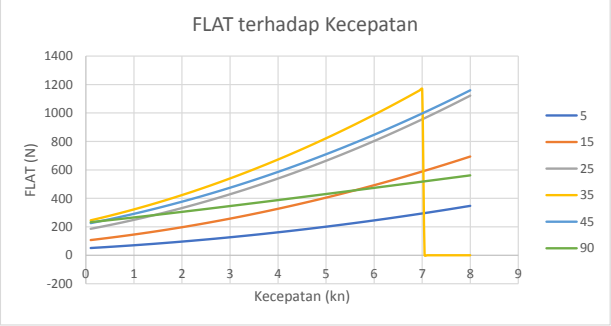
KOEFISIEN LAYAR

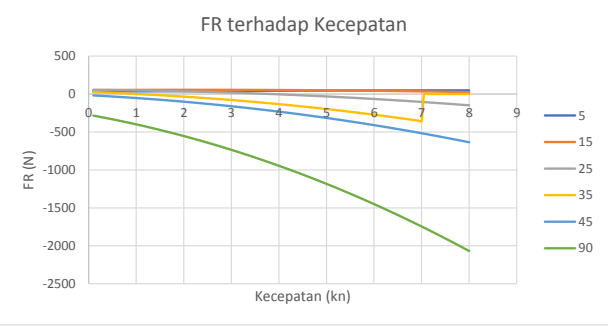
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

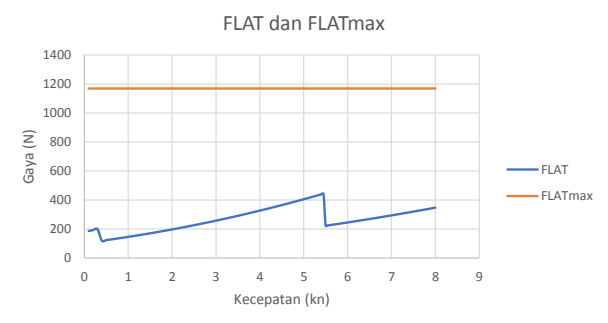
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	40 °
V_A	3,027 m/s
β	33,100 °
V_S	**0,566 m/s**
	1,100 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

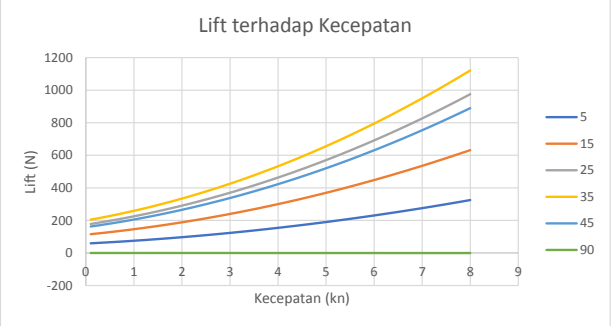
HEELING MOMENT

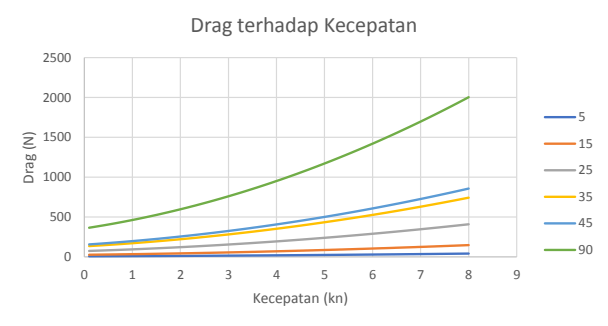
$$M_H = F_H \times h$$

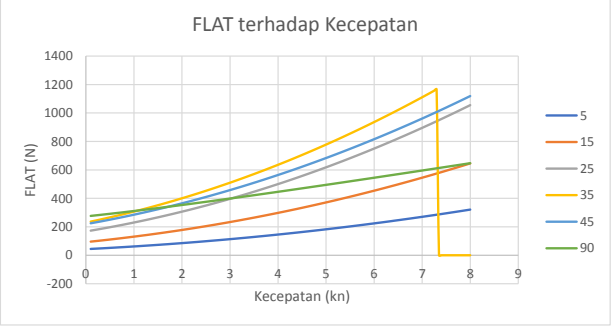
KOEFISIEN LAYAR

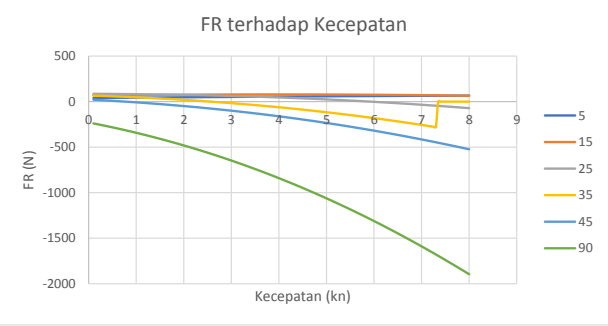
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

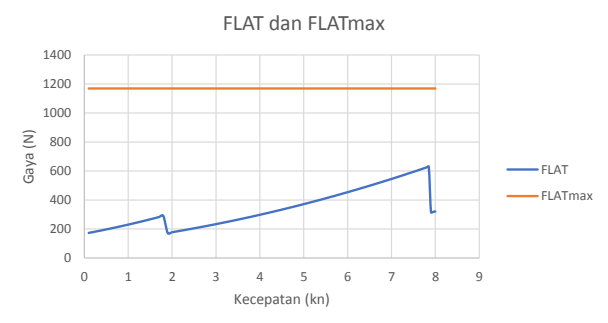
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	50 °
V_A	3,045 m/s
β	40,316 °
V_S	**0,669 m/s**
	1,300 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

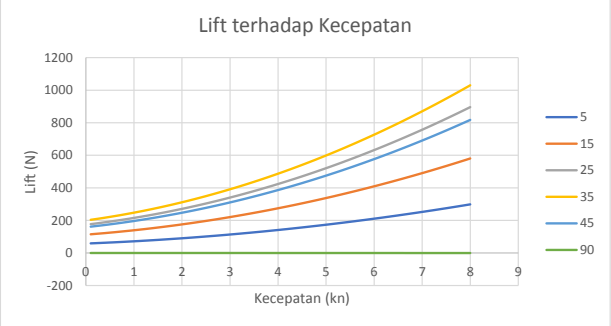
HEELING MOMENT

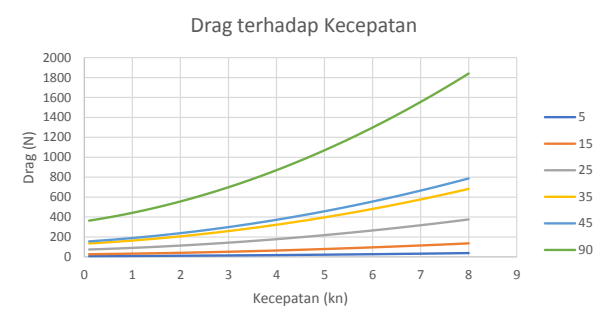
$$M_H = F_H \times h$$

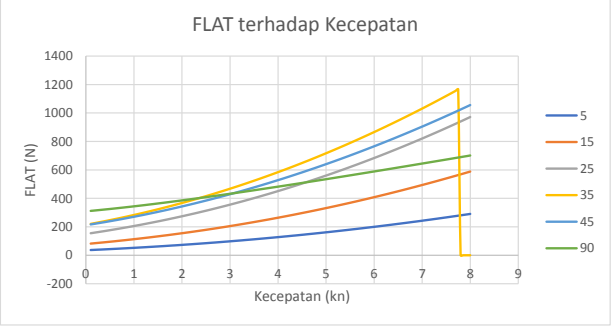
KOEFISIEN LAYAR

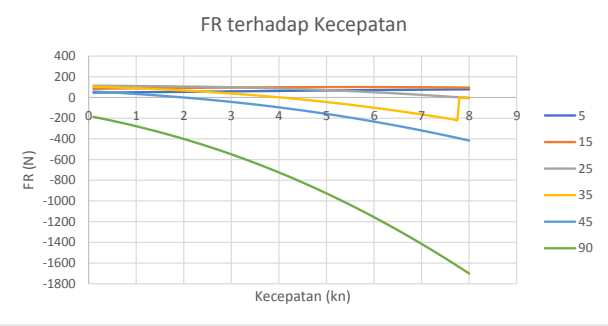
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

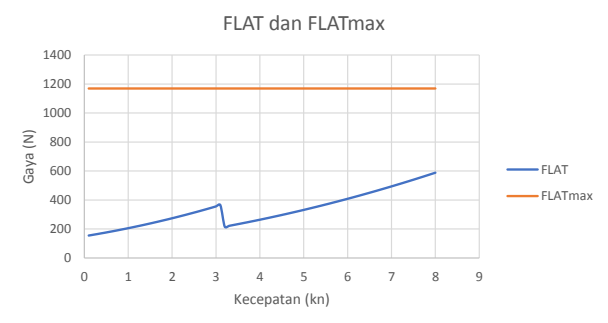
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	60 °
V_A	3,067 m/s
β	46,564 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

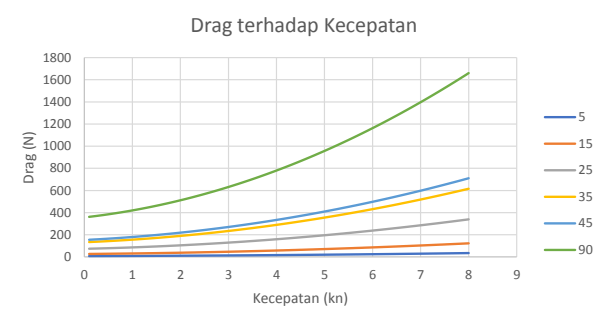
HEELING MOMENT

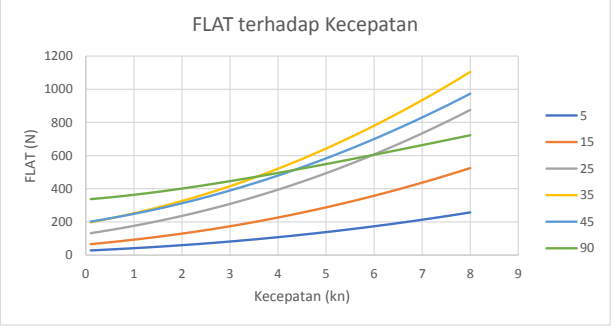
$$M_H = F_H \times h$$

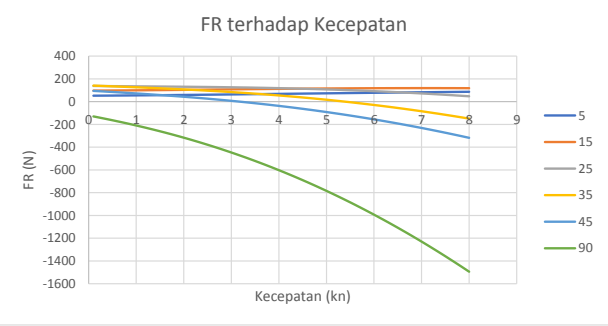
KOEFISIEN LAYAR

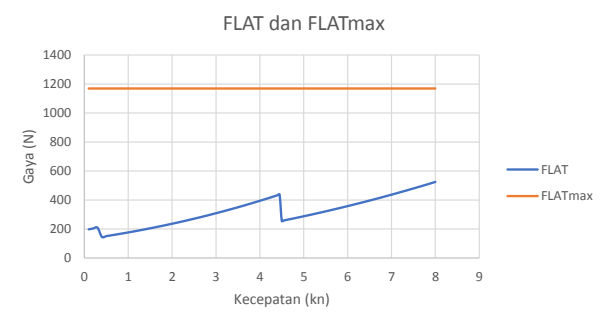
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	5,000 kn
	2,572 m/s
γ	70 °
V_A	2,986 m/s
β	54,028 °
V_S	**0,874 m/s**
	1,700 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

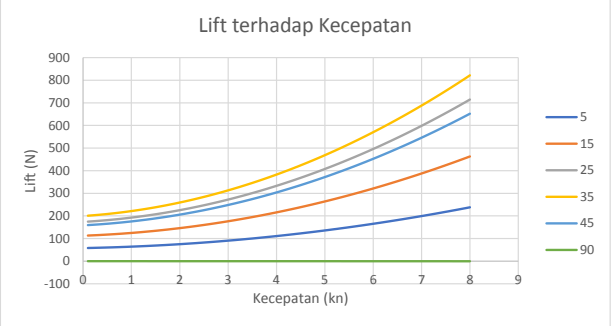
HEELING MOMENT

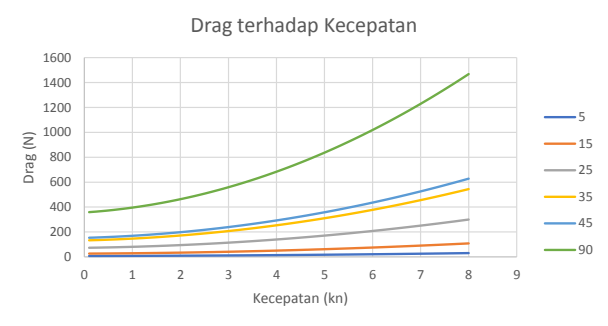
$$M_H = F_H \times h$$

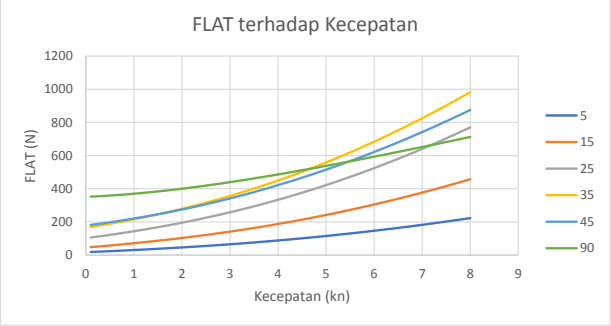
KOEFISIEN LAYAR

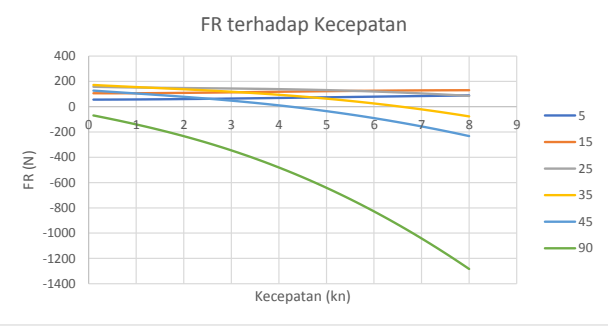
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

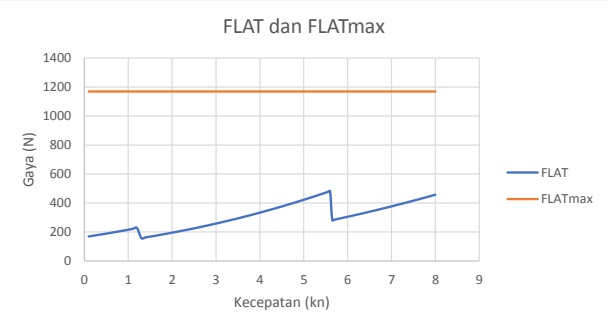
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	80 °
V_A	2,906 m/s
β	60,656 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

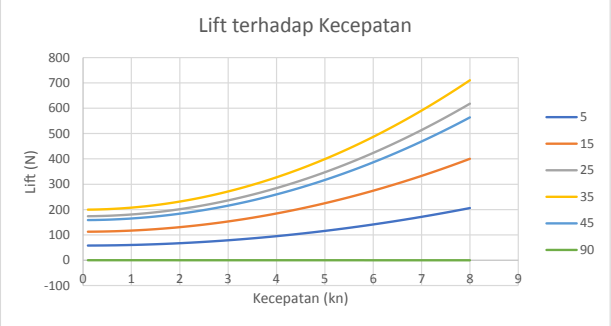
HEELING MOMENT

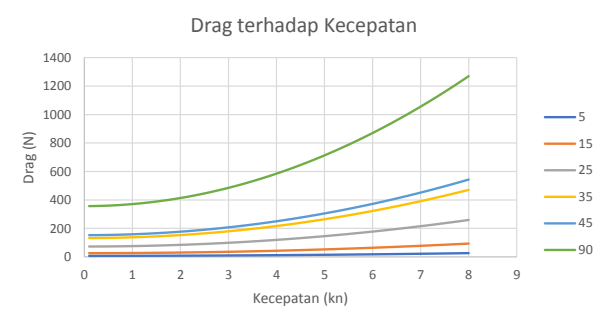
$$M_H = F_H \times h$$

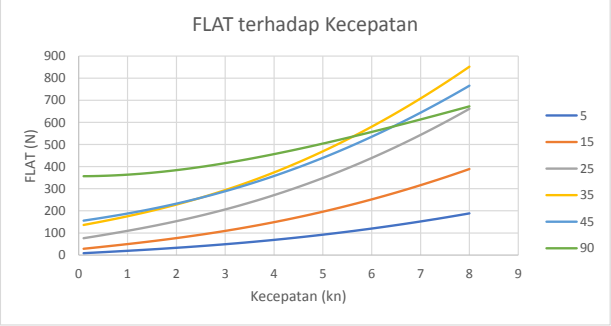
KOEFISIEN LAYAR

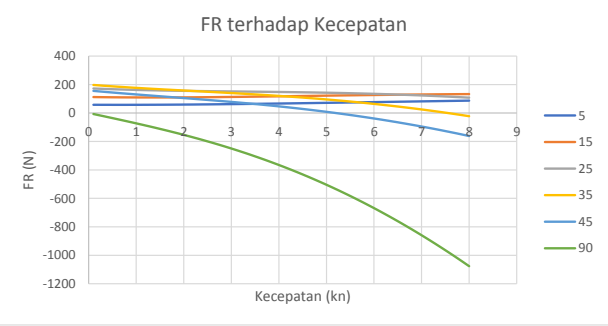
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

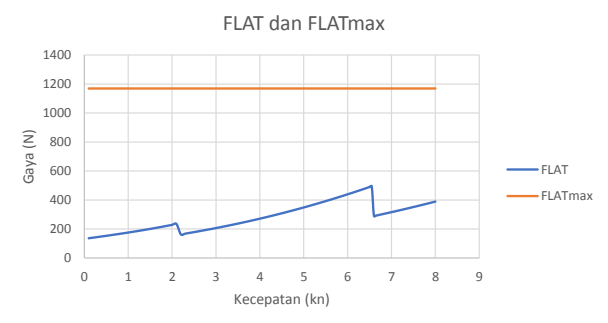
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	90 °
V_A	2,751 m/s
β	69,193 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

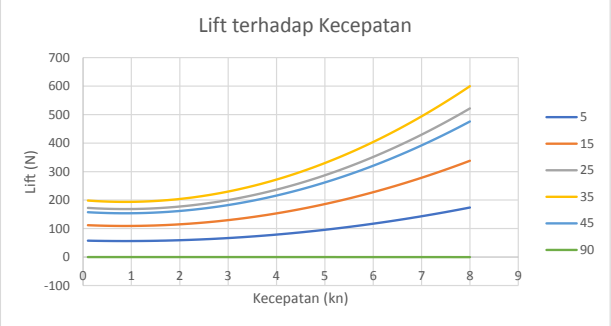
HEELING MOMENT

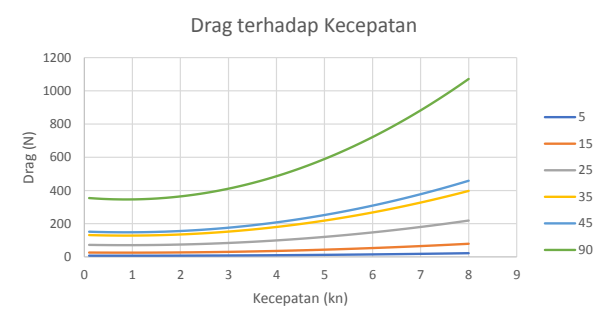
$$M_H = F_H \times h$$

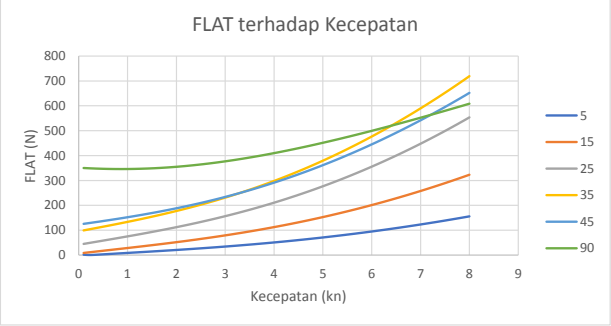
KOEFISIEN LAYAR

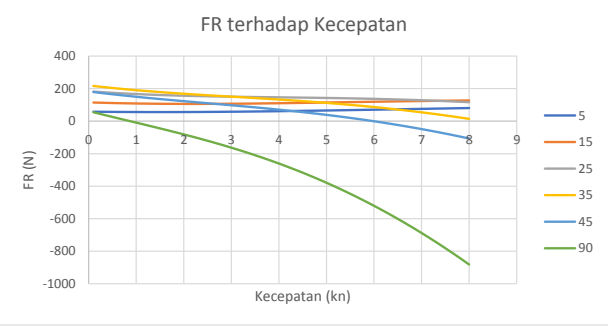
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

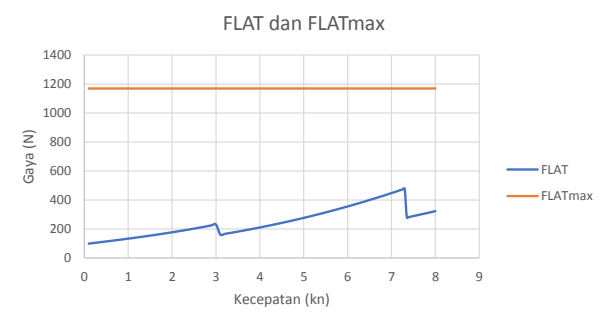
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	100 °
V_A	2,599 m/s
β	77,056 °
V_S	**1,029 m/s**
	2,000 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

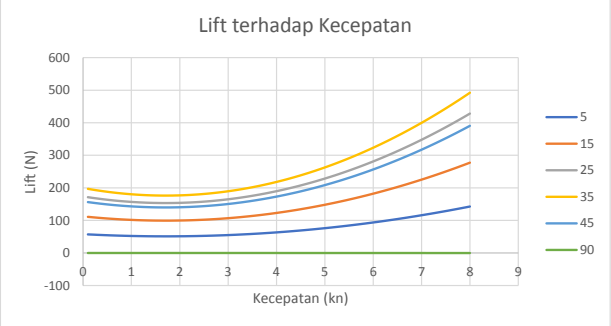
HEELING MOMENT

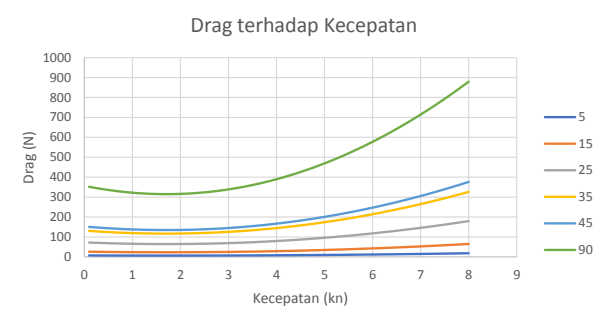
$$M_H = F_H \times h$$

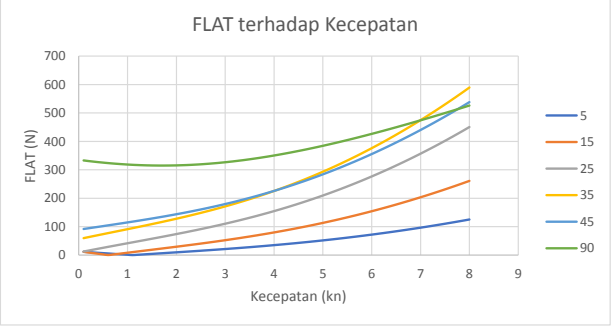
KOEFISIEN LAYAR

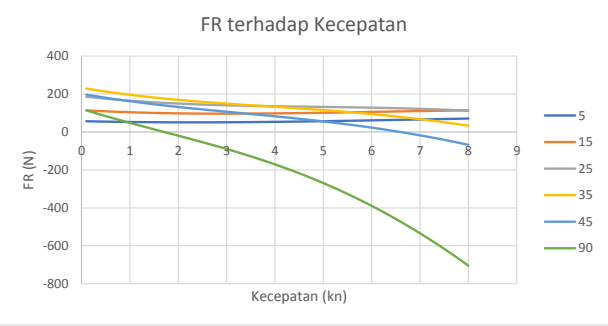
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

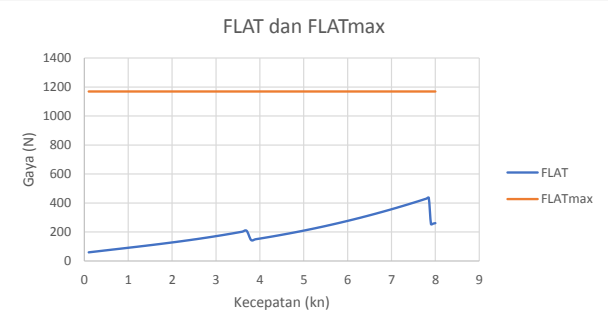
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	110 °
V_A	2,421 m/s
β	86,469 °
V_S	**1,029 m/s**
	2,000 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

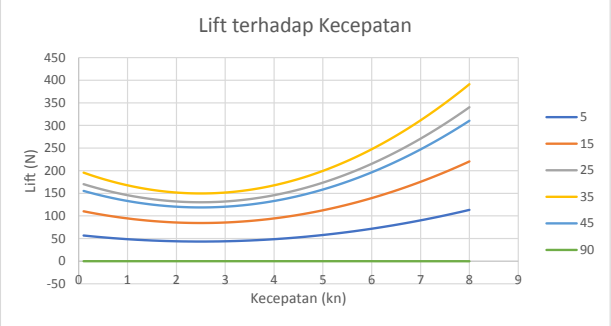
HEELING MOMENT

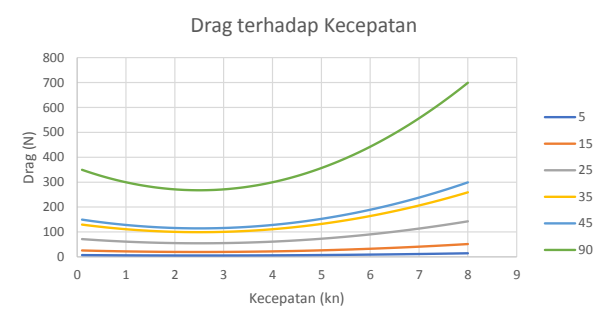
$$M_H = F_H \times h$$

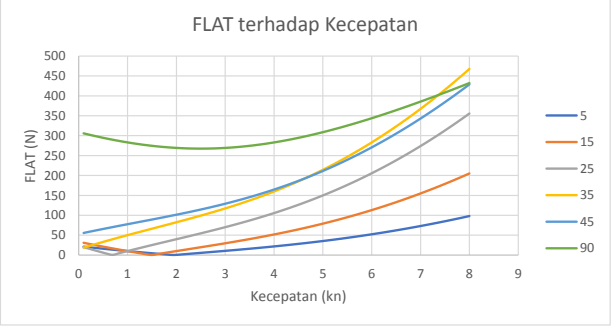
KOEFISIEN LAYAR

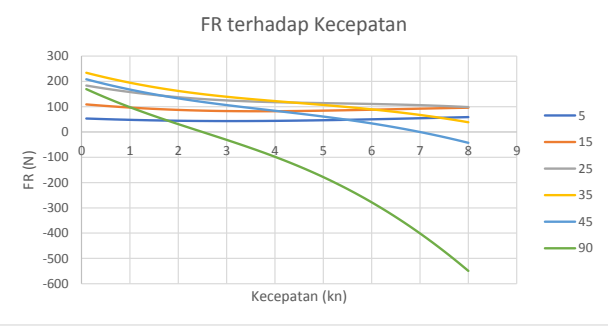
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

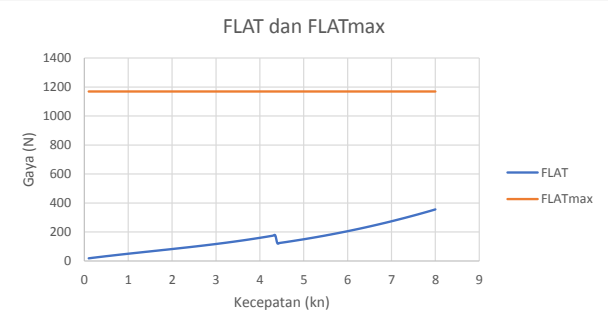
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	120 °
V_A	2,242 m/s
β	96,587 °
V_S	**1,029 m/s**
	2,000 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

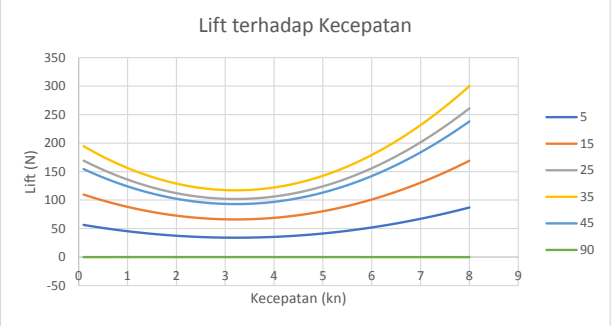
HEELING MOMENT

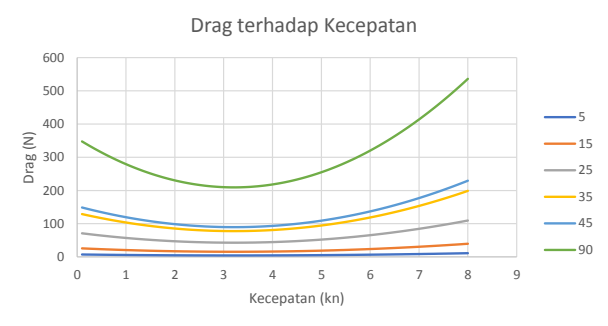
$$M_H = F_H \times h$$

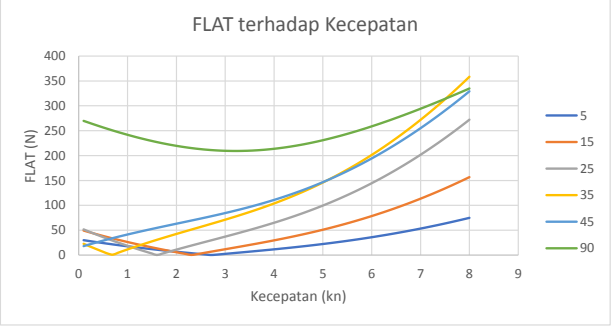
KOEFISIEN LAYAR

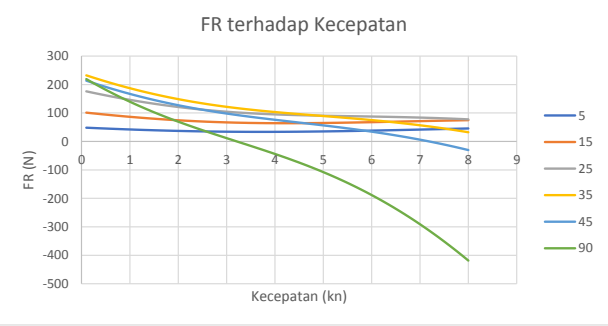
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

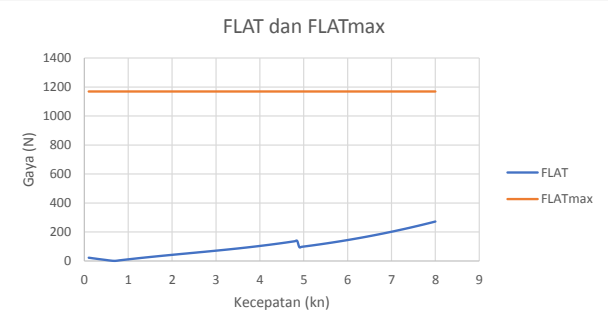
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	130 °
V_A	2,083 m/s
β	108,934 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

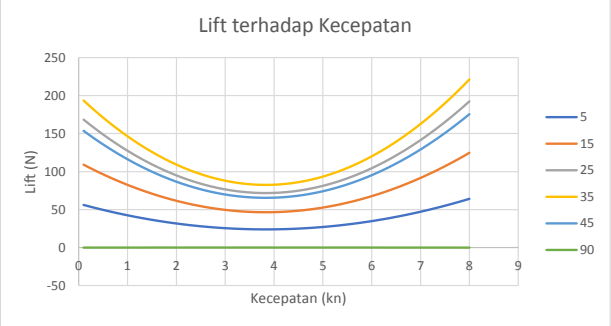
HEELING MOMENT

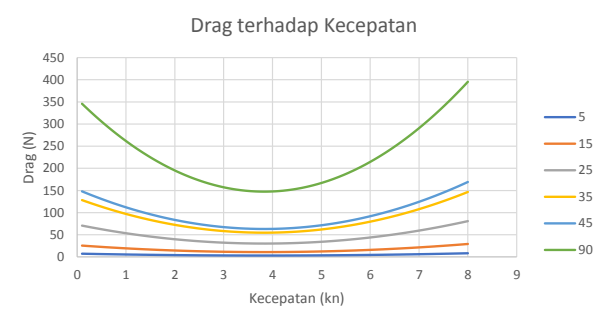
$$M_H = F_H \times h$$

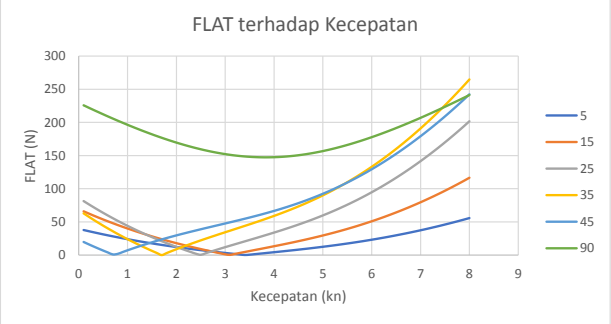
KOEFISIEN LAYAR

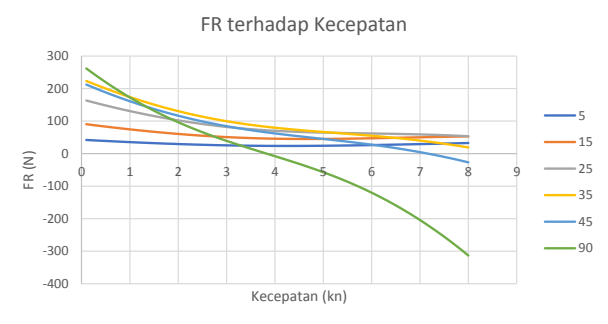
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

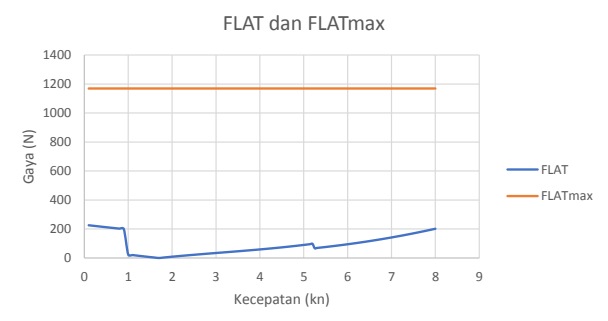
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	140 °
V_A	1,955 m/s
β	122,280 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

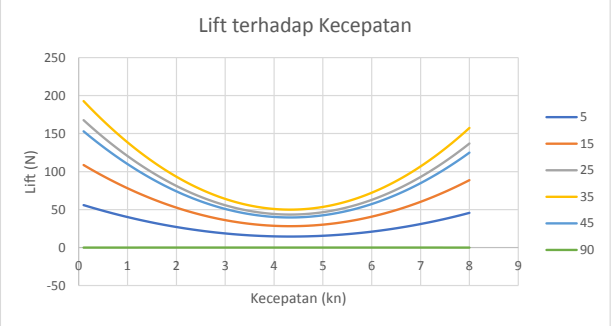
HEELING MOMENT

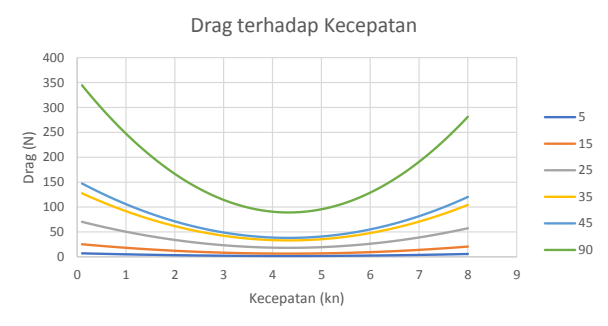
$$M_H = F_H \times h$$

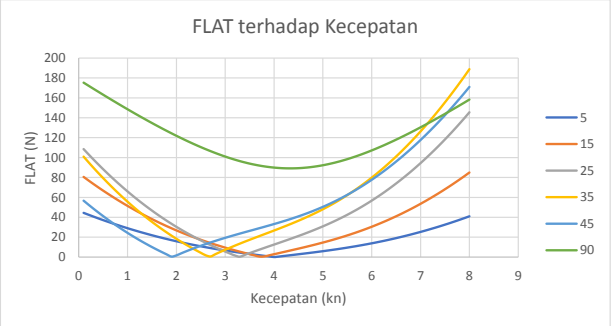
KOEFISIEN LAYAR

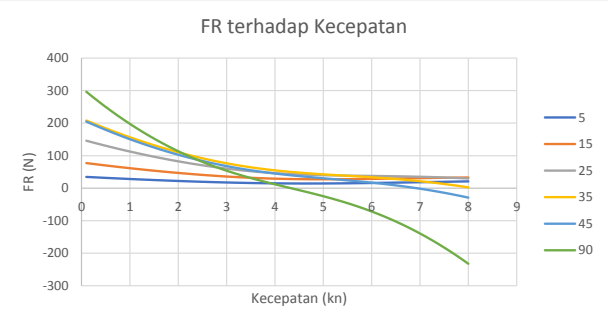
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

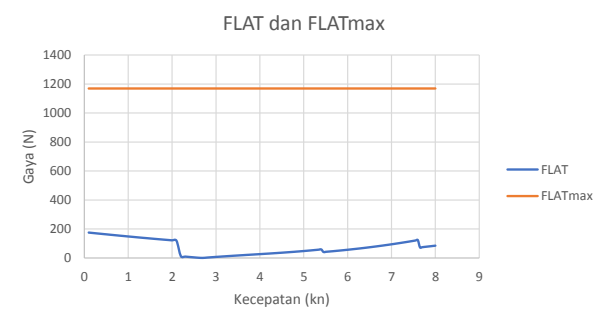
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	150 °
V_A	1,830 m/s
β	135,343 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

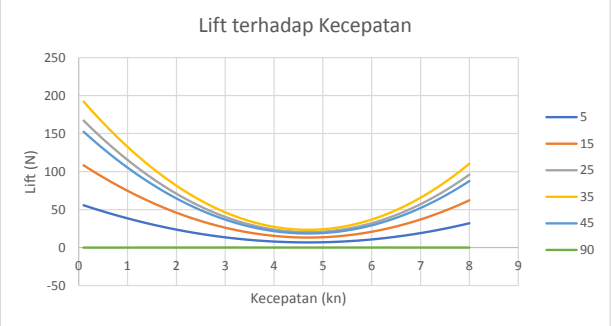
HEELING MOMENT

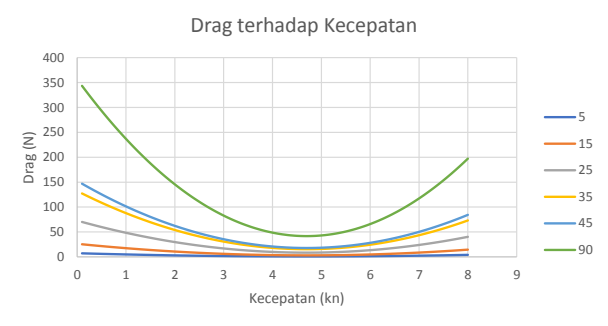
$$M_H = F_H \times h$$

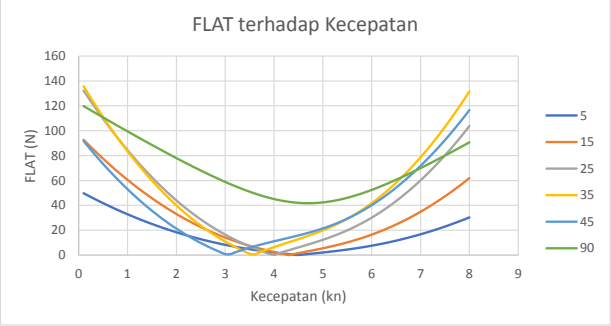
KOEFISIEN LAYAR

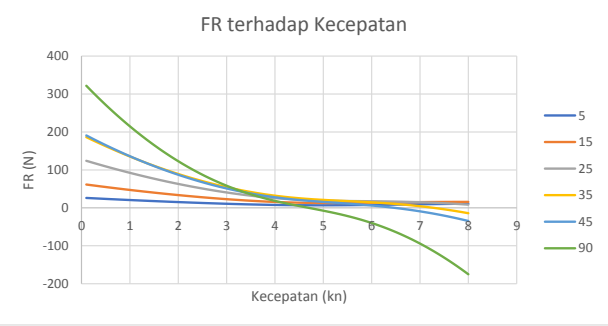
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

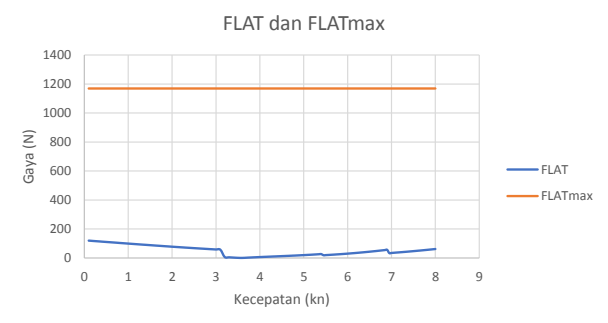
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	160 °
V_A	1,731 m/s
β	149,459 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

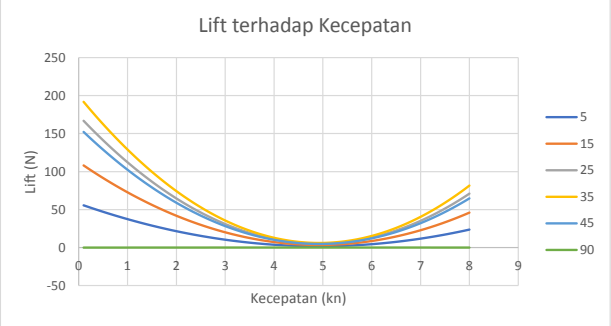
HEELING MOMENT

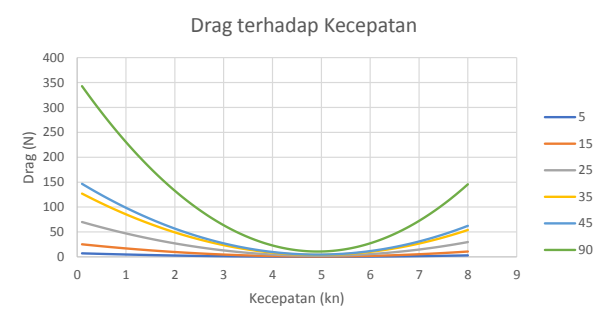
$$M_H = F_H \times h$$

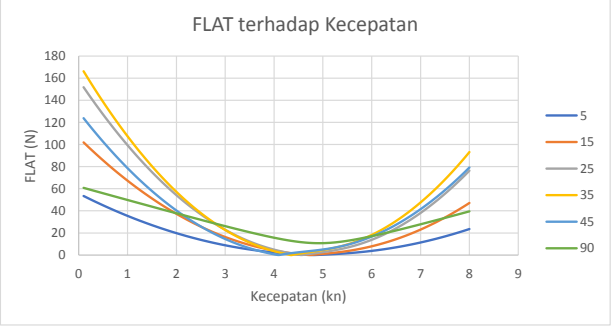
KOEFISIEN LAYAR

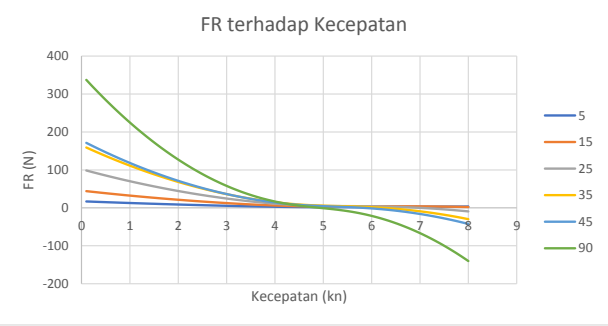
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

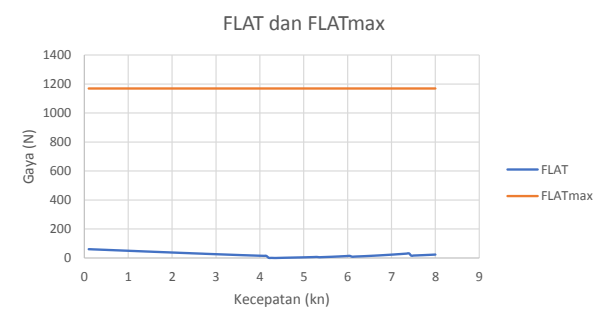
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	170 °
V_A	1,668 m/s
β	164,468 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

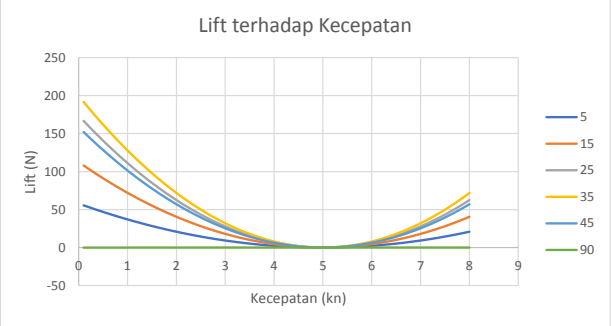
HEELING MOMENT

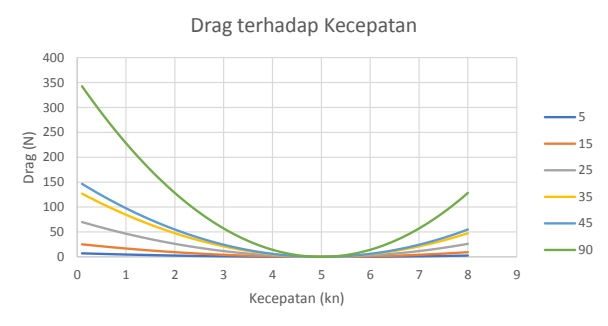
$$M_H = F_H \times h$$

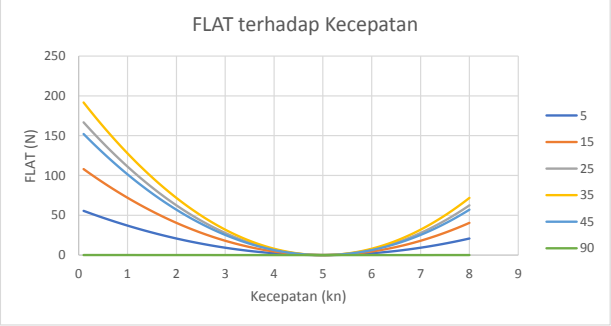
KOEFISIEN LAYAR

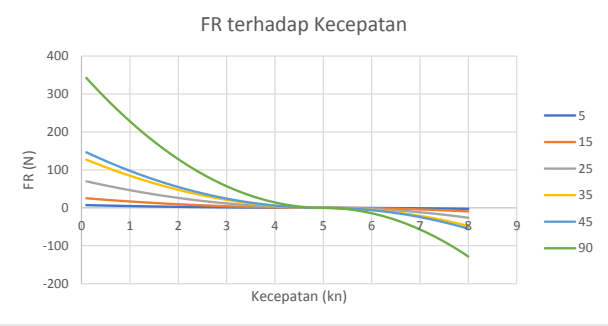
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

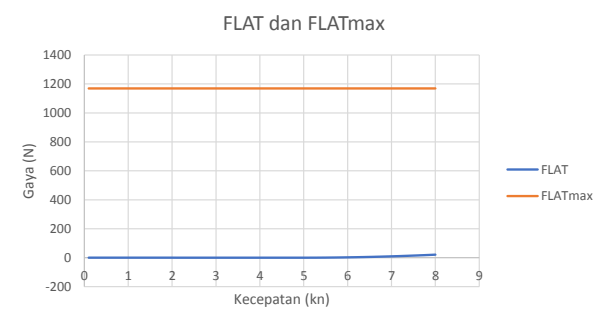
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	180 °
V_A	1,646 m/s
β	180,000 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

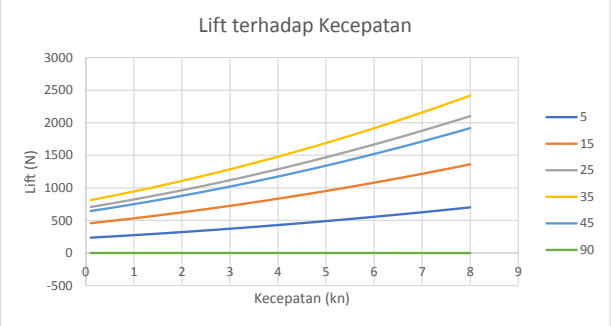
HEELING MOMENT

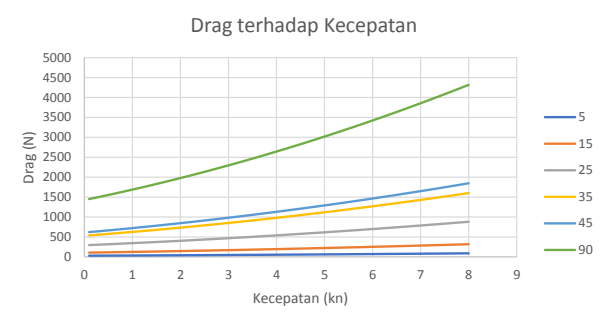
$$M_H = F_H \times h$$

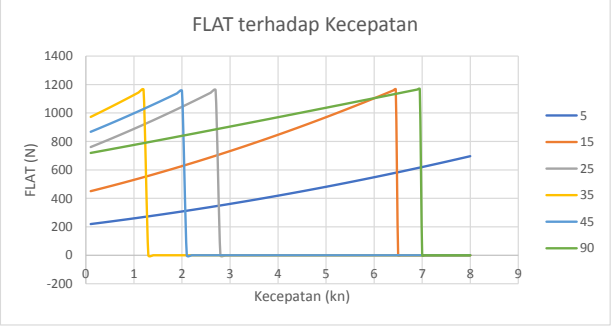
KOEFISIEN LAYAR

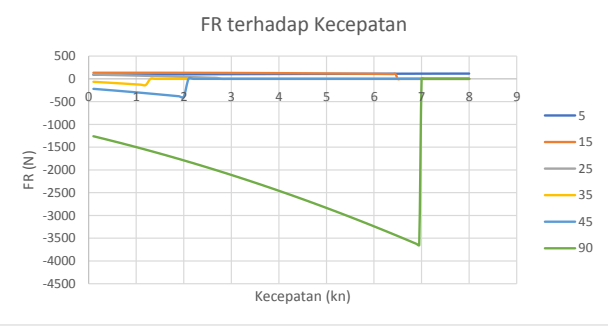
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

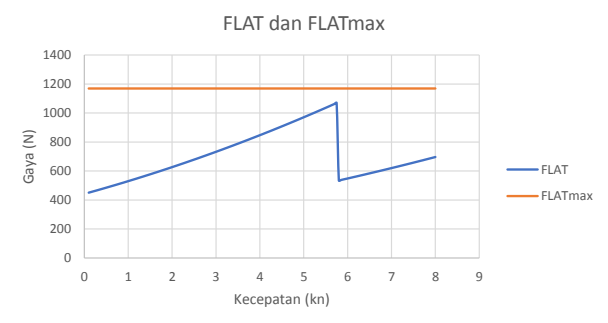
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	30 °
V_A	5,964 m/s
β	25,548 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

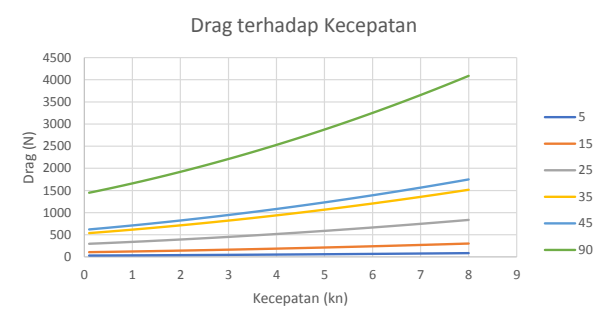
HEELING MOMENT

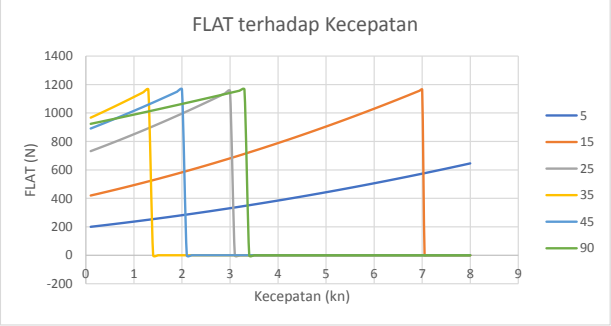
$$M_H = F_H \times h$$

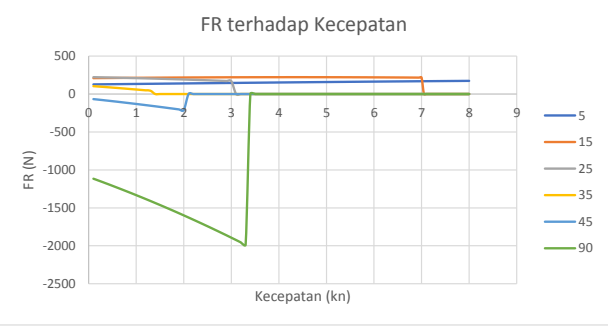
KOEFISIEN LAYAR

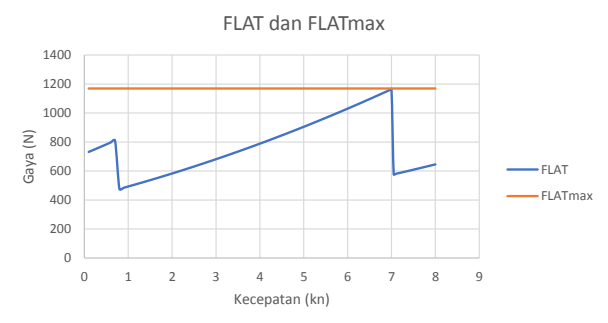
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	10,000 kn
	5,144 m/s
γ	40 °
V_A	6,098 m/s
β	32,836 °
V_S	**1,183 m/s**
	2,300 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

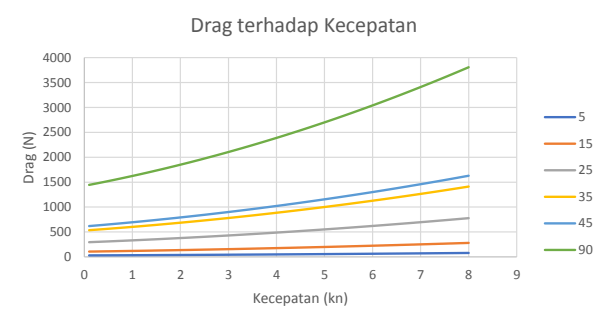
HEELING MOMENT

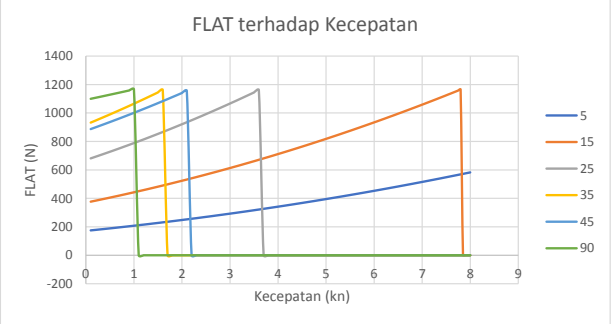
$$M_H = F_H \times h$$

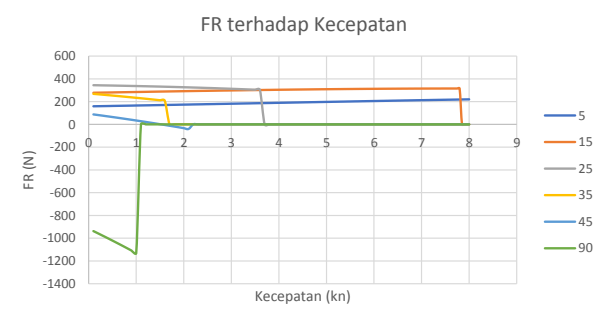
KOEFISIEN LAYAR

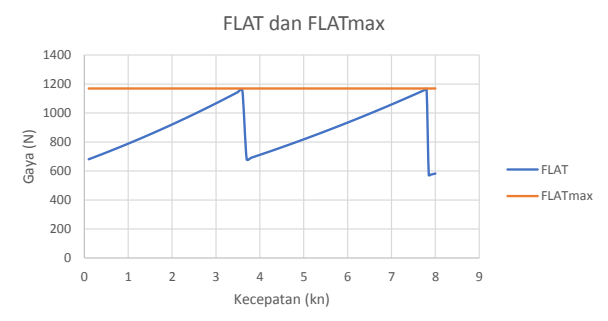
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	10,000 kn
	5,144 m/s
γ	50 °
V_A	6,169 m/s
β	39,697 °
V_S	**1,440 m/s**
	2,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

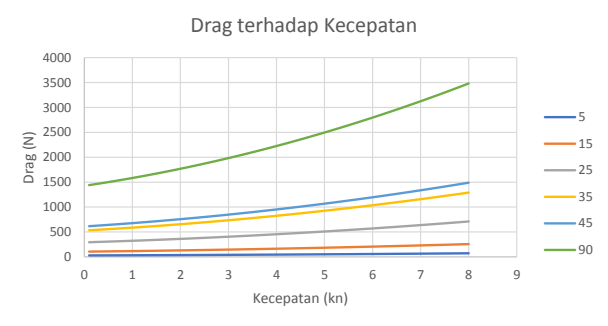
HEELING MOMENT

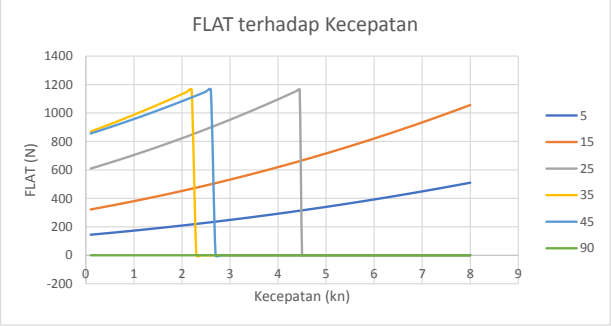
$$M_H = F_H \times h$$

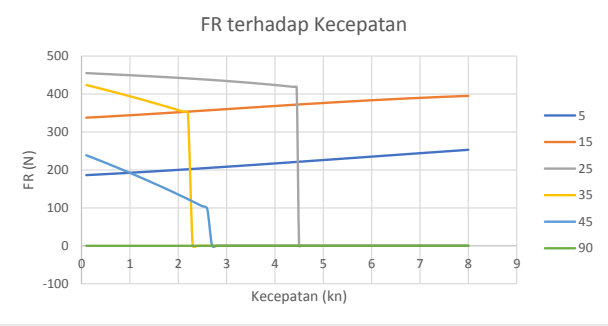
KOEFISIEN LAYAR

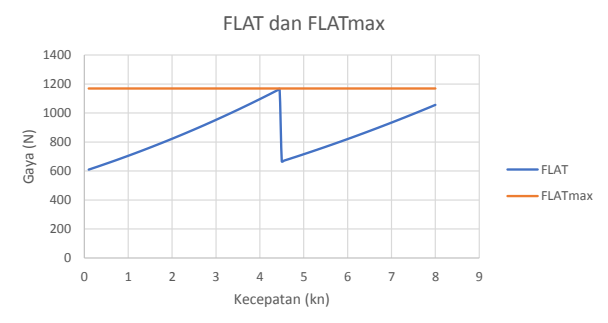
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	10,000 kn
	5,144 m/s
γ	60 °
V_A	6,170 m/s
β	46,217 °
V_S	**1,698 m/s**
	3,300 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN LAYAR

α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
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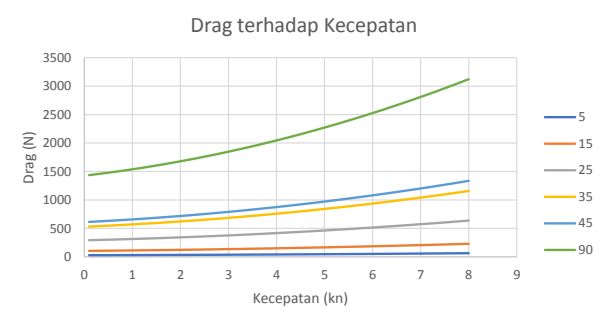
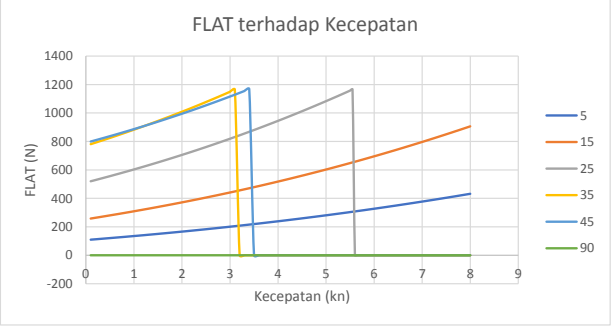
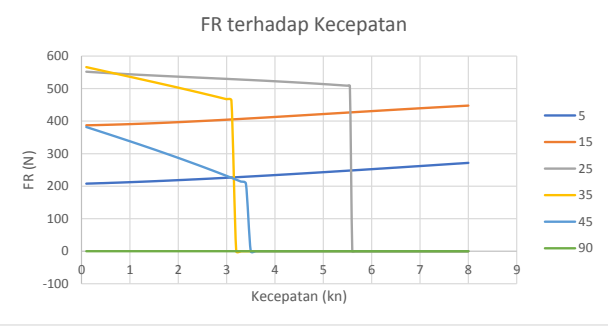
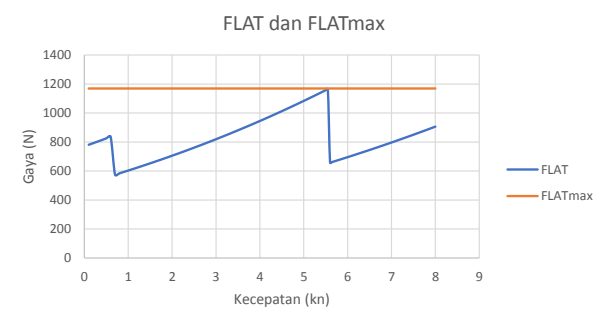
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	10,000 kn
	5,144 m/s
γ	70 °
V_A	6,065 m/s
β	52,848 °
V_S	**1,903 m/s**
	3,700 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

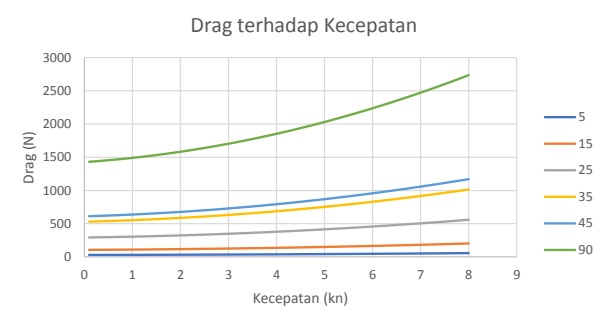
HEELING MOMENT

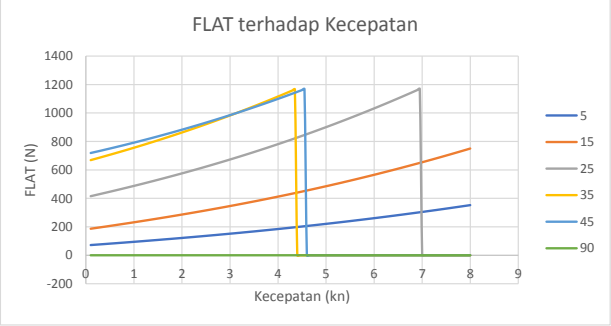
$$M_H = F_H \times h$$

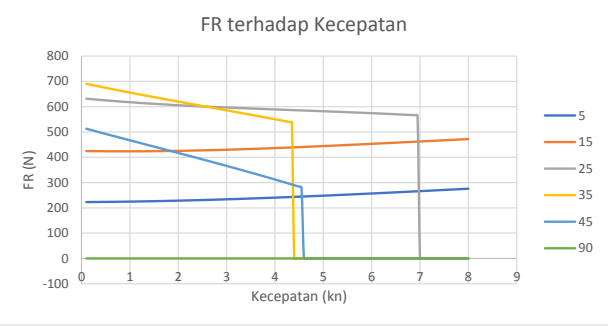
KOEFISIEN LAYAR

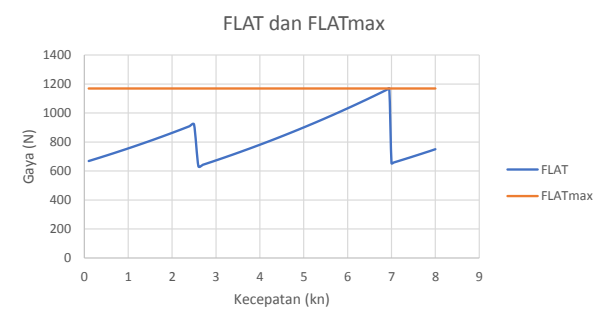
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN				
	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	10,000 kn
	5,144 m/s
γ	80 °
V_A	5,837 m/s
β	60,216 °
V_S	**2,006 m/s**
	3,900 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

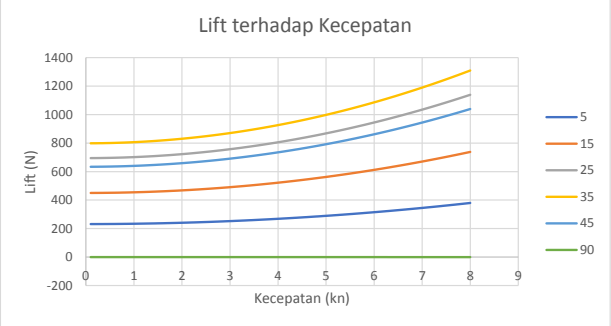
HEELING MOMENT

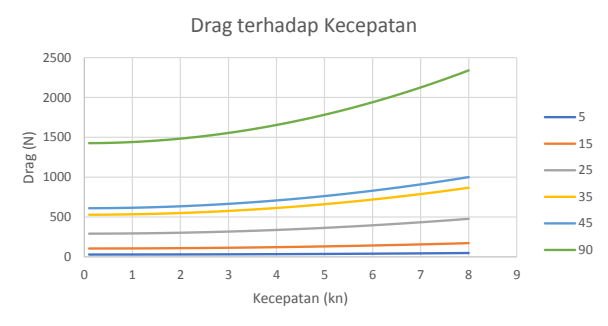
$$M_H = F_H \times h$$

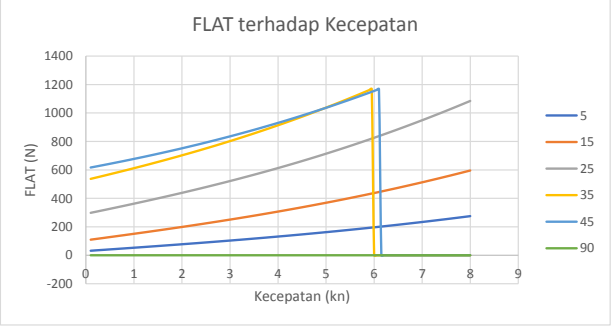
KOEFISIEN LAYAR

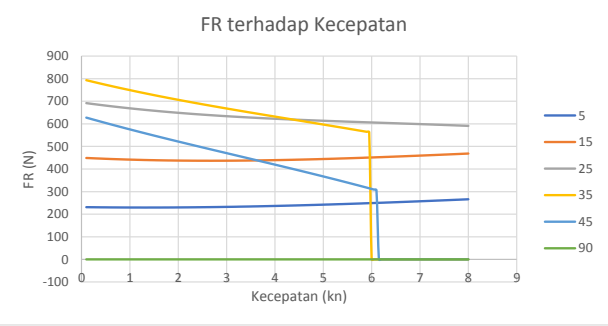
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

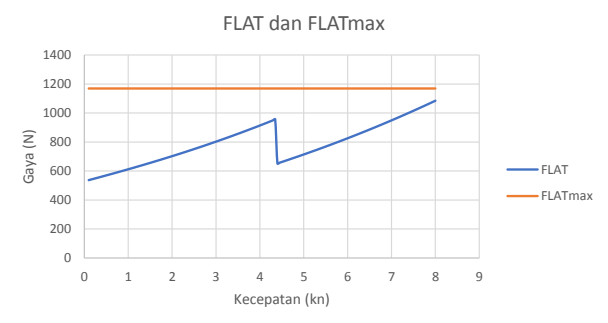
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	90 °
V_A	5,540 m/s
β	68,199 °
V_S	**2,083 m/s**
	4,050 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

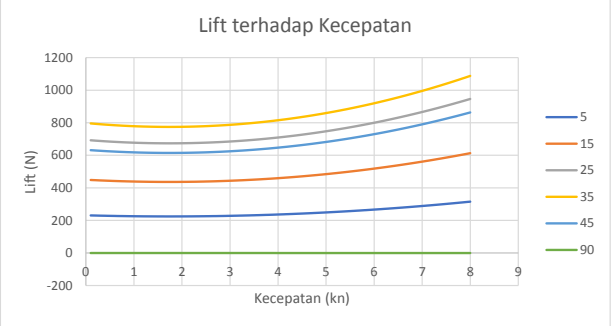
HEELING MOMENT

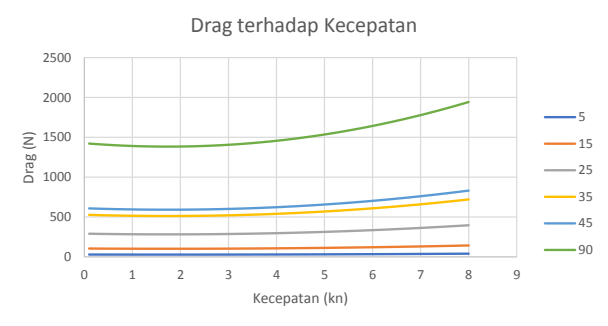
$$M_H = F_H \times h$$

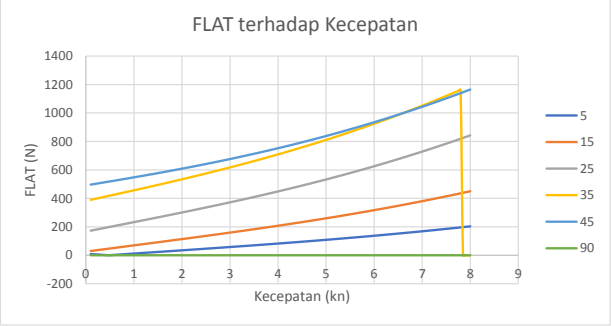
KOEFISIEN LAYAR

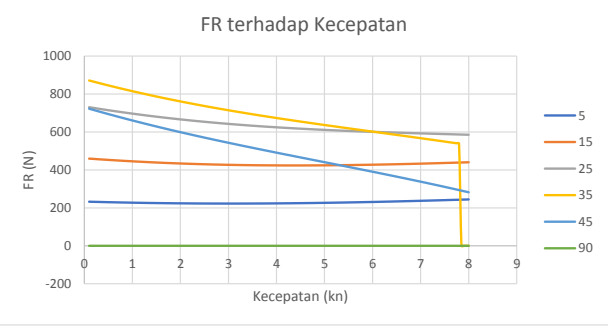
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

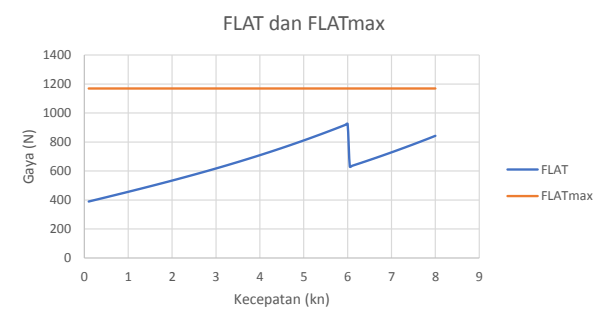
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	100 °
V_A	5,198 m/s
β	77,056 °
V_S	**2,135 m/s**
	4,150 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

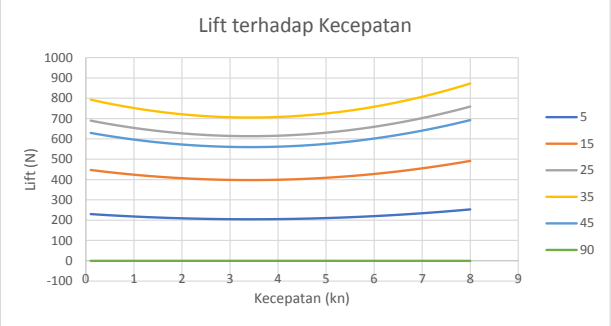
HEELING MOMENT

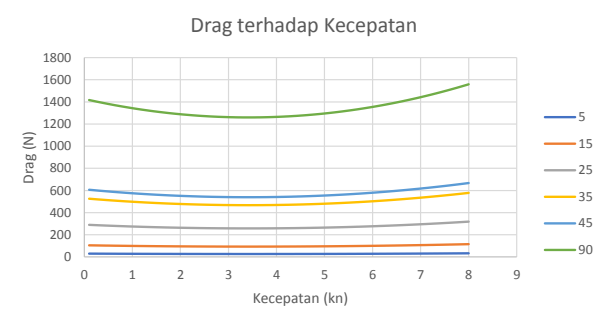
$$M_H = F_H \times h$$

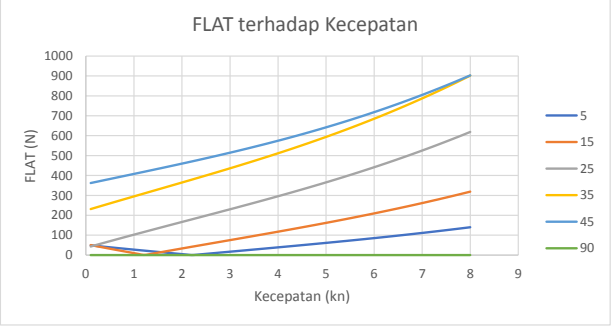
KOEFISIEN LAYAR

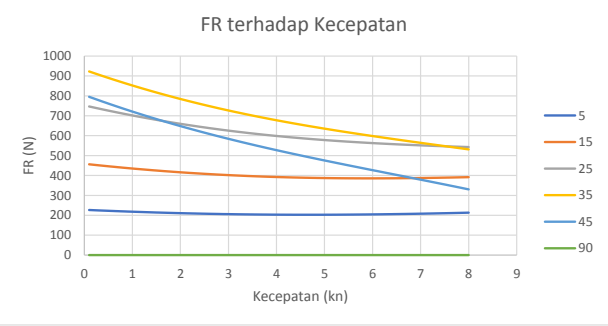
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

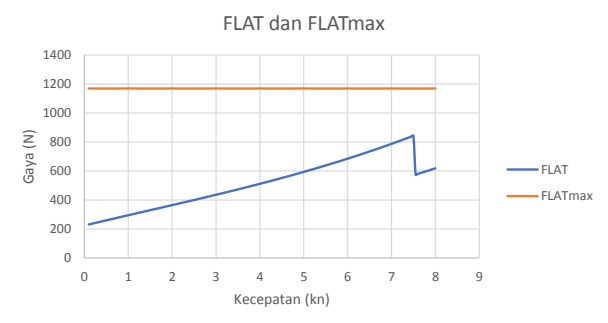
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	110 °
V_A	4,843 m/s
β	86,469 °
V_S	**2,135 m/s**
	4,150 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

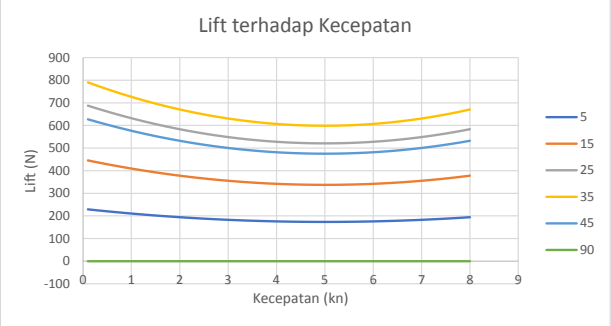
HEELING MOMENT

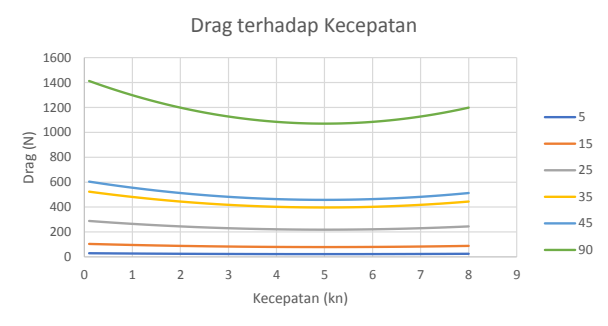
$$M_H = F_H \times h$$

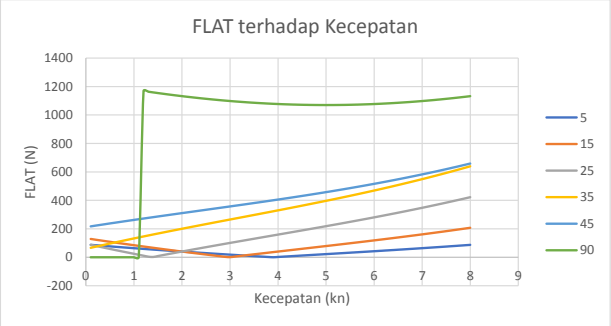
KOEFISIEN LAYAR

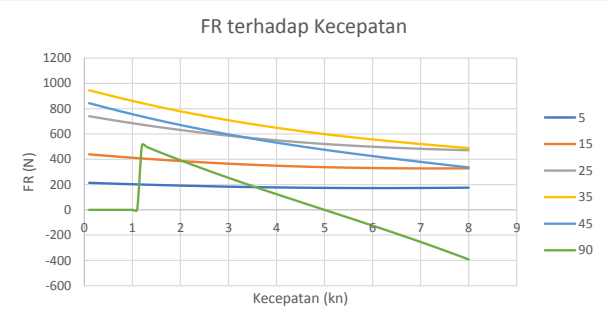
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

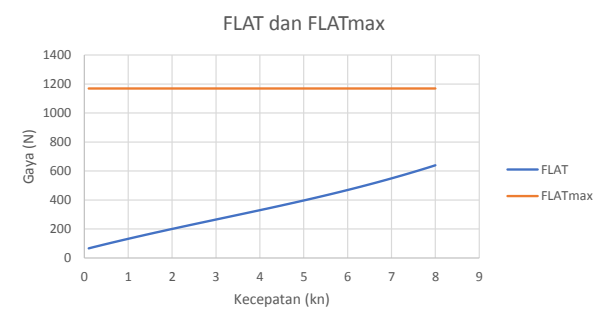
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	120 °
V_A	4,484 m/s
β	96,587 °
V_S	**2,109 m/s**
	4,100 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

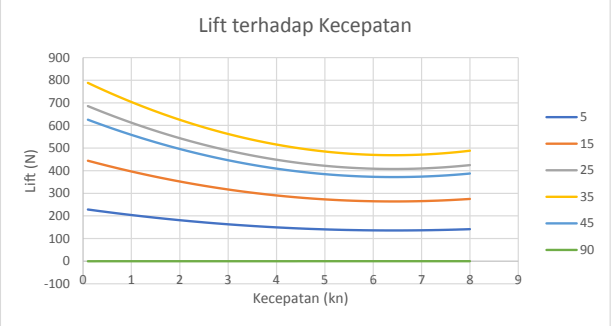
HEELING MOMENT

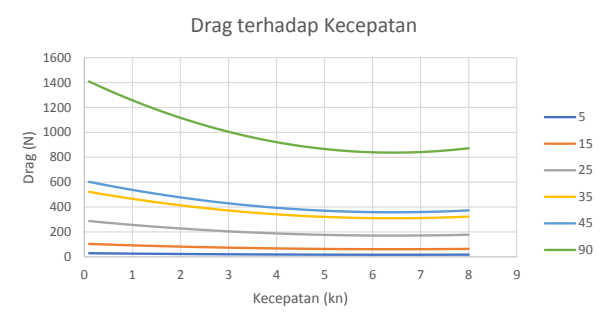
$$M_H = F_H \times h$$

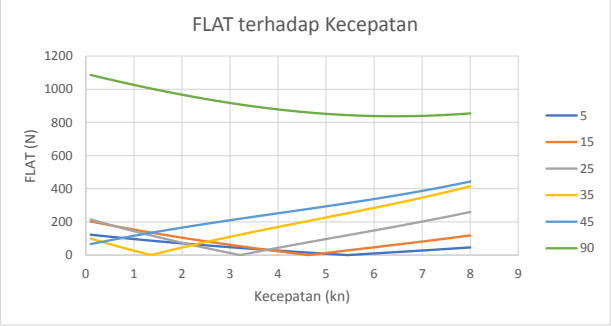
KOEFISIEN LAYAR

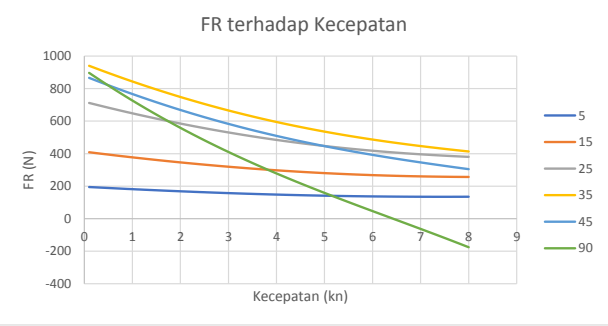
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

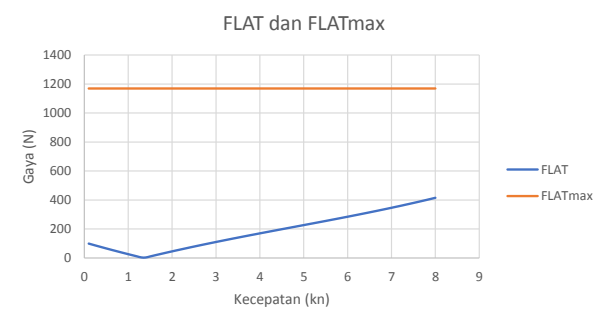
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	130 °
V_A	4,150 m/s
β	108,262 °
V_S	**2,006 m/s**
	3,900 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

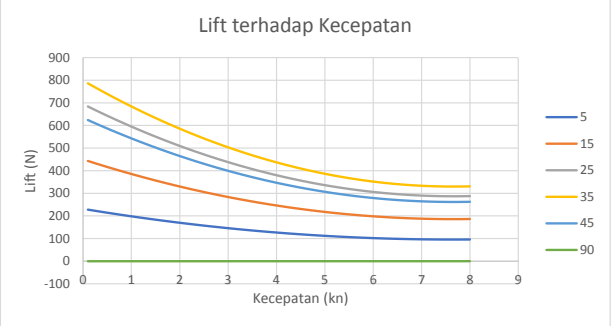
HEELING MOMENT

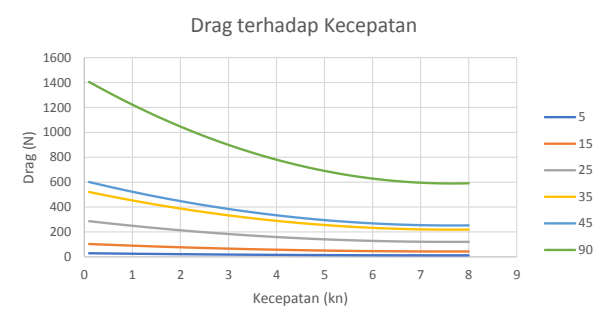
$$M_H = F_H \times h$$

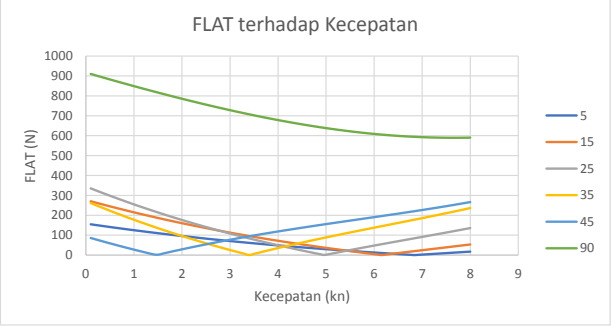
KOEFISIEN LAYAR

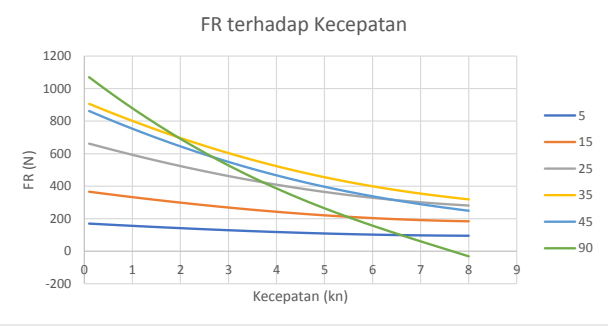
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

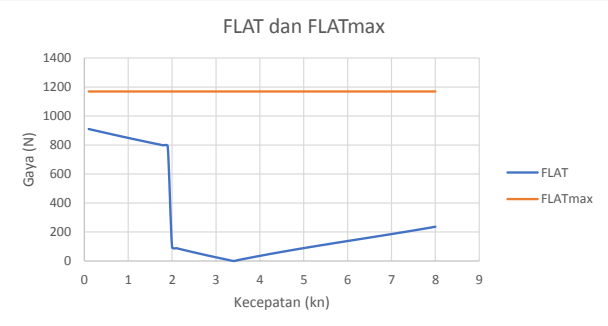
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	140 °
V_A	3,884 m/s
β	121,639 °
V_S	**1,903 m/s**
	3,700 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

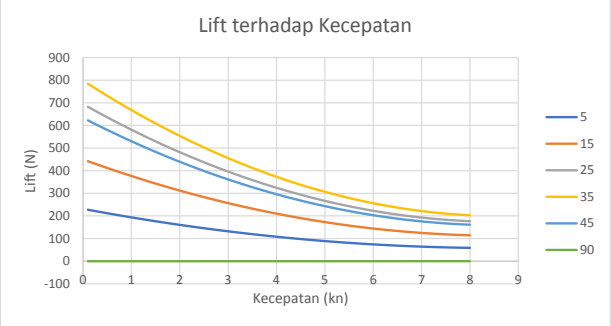
HEELING MOMENT

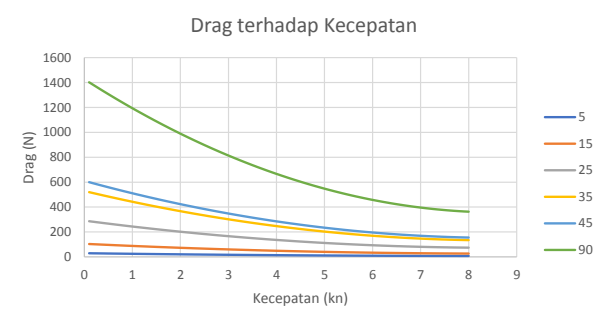
$$M_H = F_H \times h$$

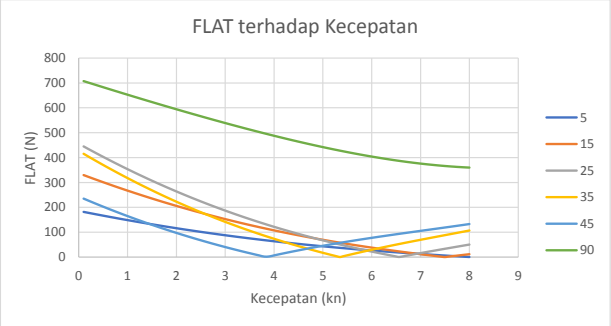
KOEFISIEN LAYAR

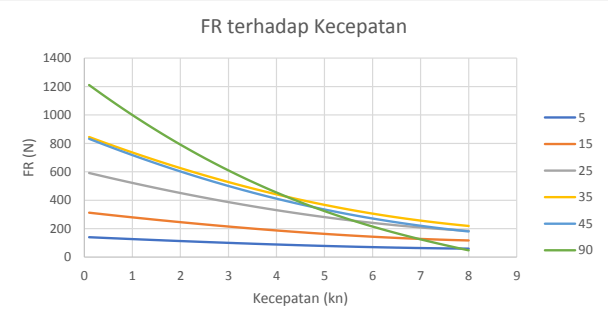
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

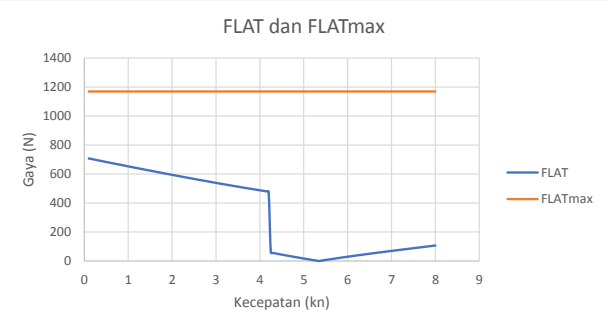
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	150 °
V_A	3,659 m/s
β	135,343 °
V_S	**1,852 m/s**
	3,600 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

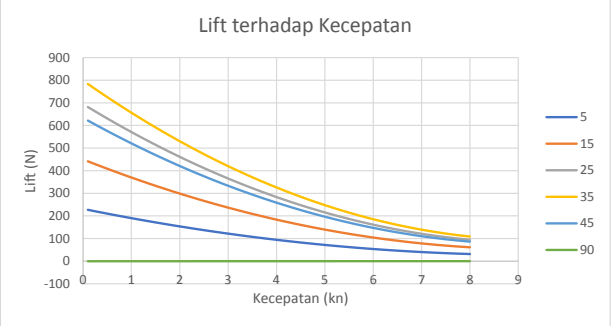
HEELING MOMENT

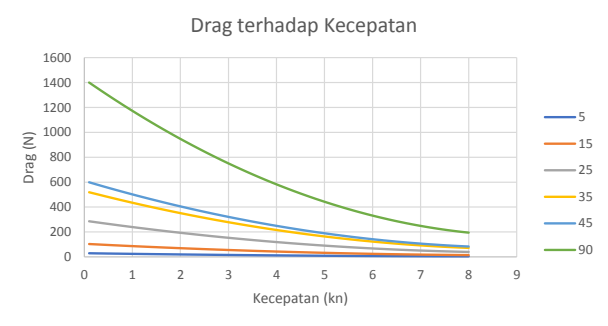
$$M_H = F_H \times h$$

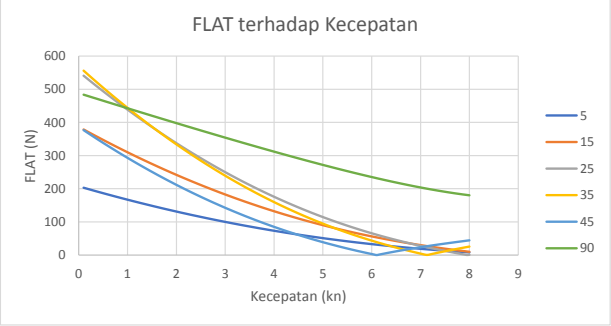
KOEFISIEN LAYAR

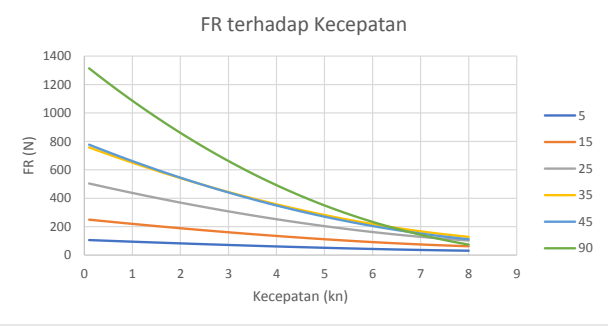
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

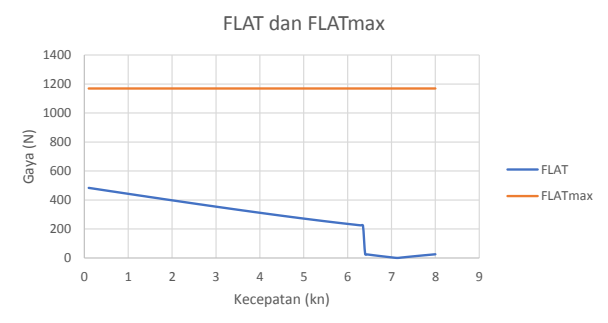
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	160 °
V_A	3,418 m/s
β	149,021 °
V_S	**1,903 m/s**
	3,700 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

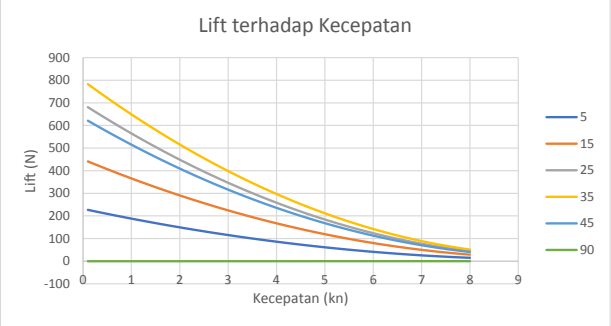
HEELING MOMENT

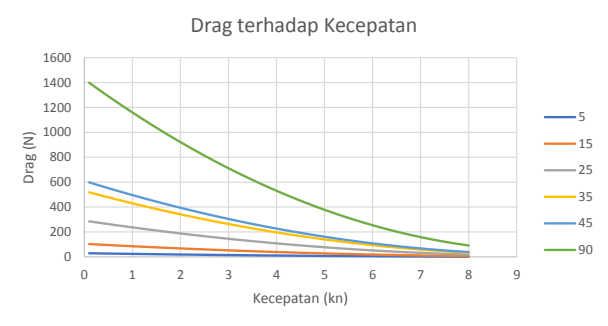
$$M_H = F_H \times h$$

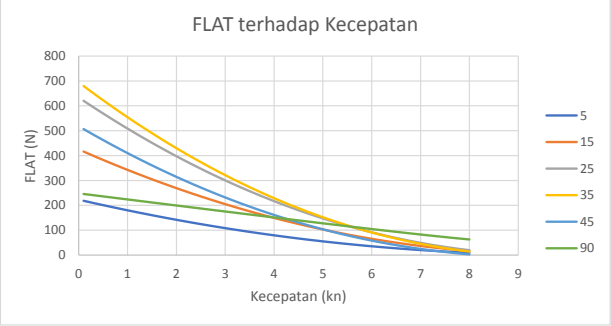
KOEFISIEN LAYAR

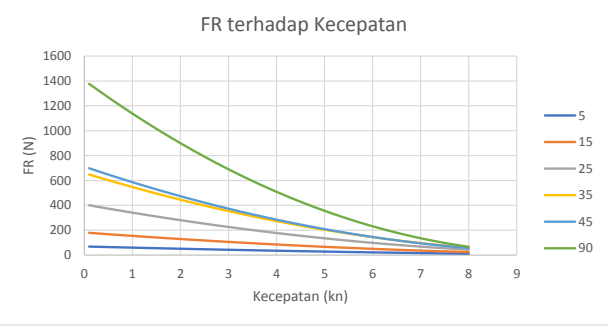
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

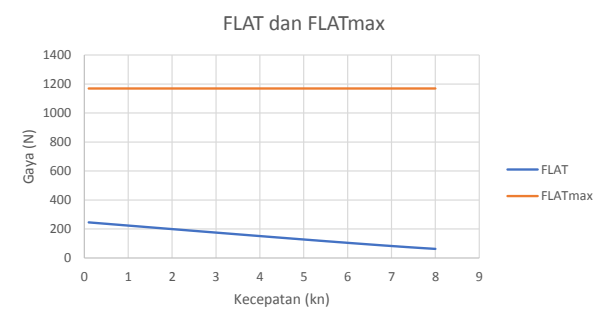
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	170 °
V_A	3,237 m/s
β	163,981 °
V_S	**1,955 m/s**
	3,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

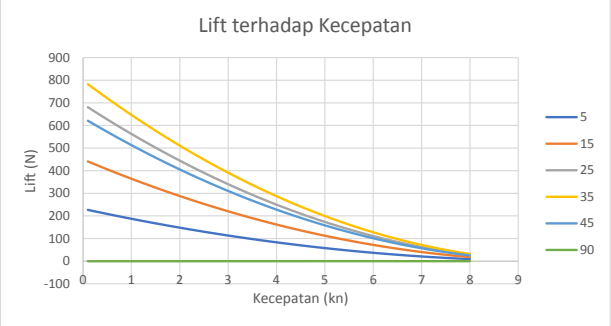
HEELING MOMENT

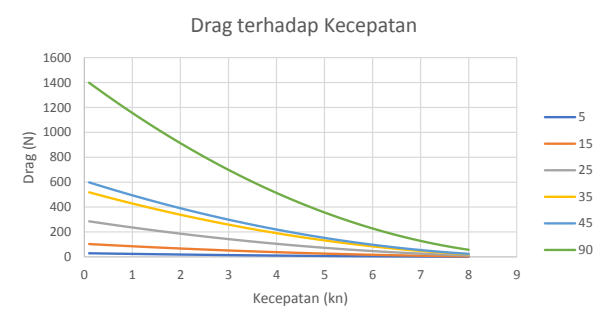
$$M_H = F_H \times h$$

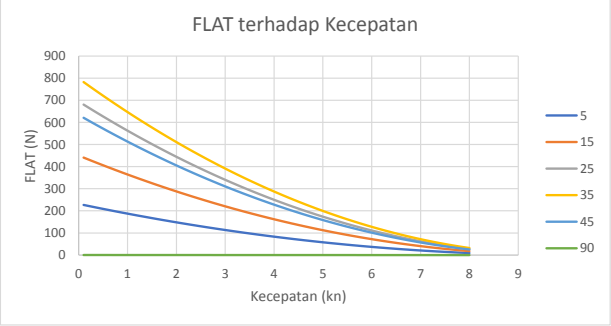
KOEFISIEN LAYAR

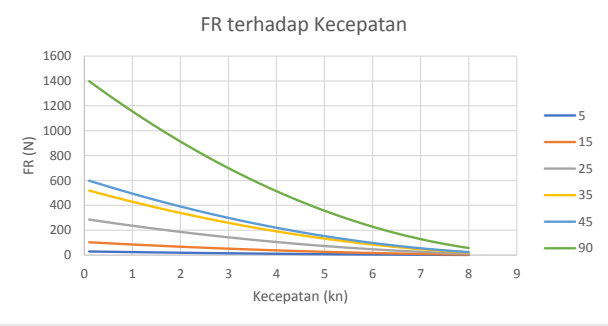
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

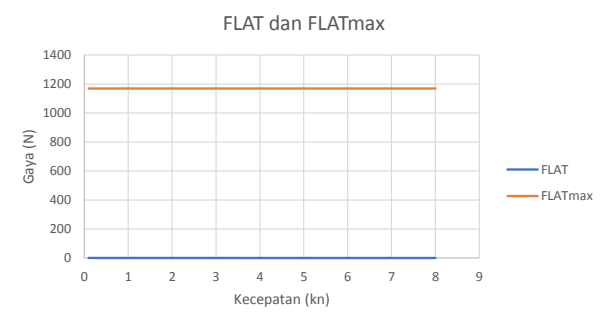
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	180 °
V_A	3,189 m/s
β	180,000 °
V_S	**1,955 m/s**
	3,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

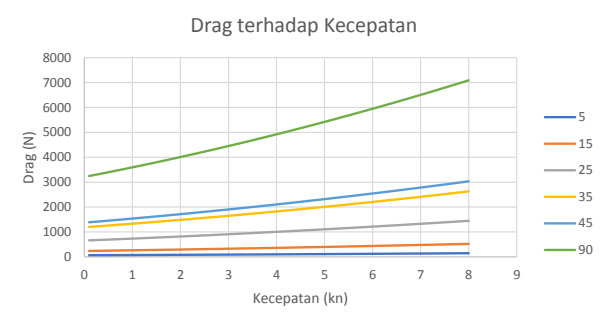
HEELING MOMENT

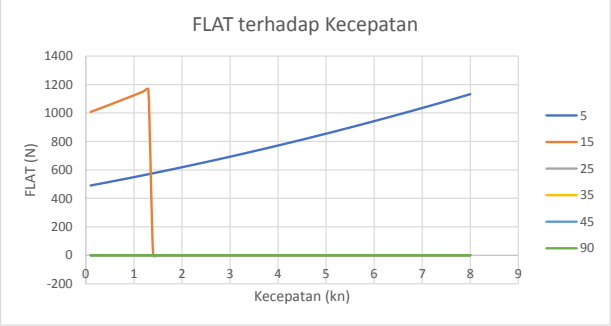
$$M_H = F_H \times h$$

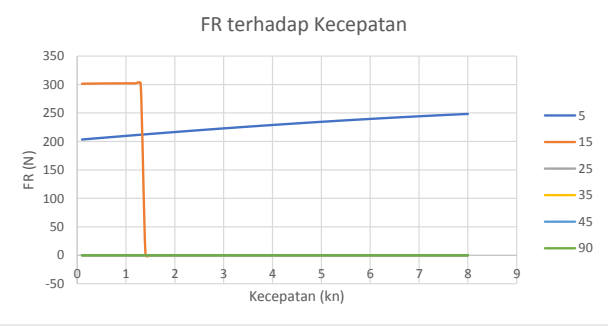
KOEFISIEN LAYAR

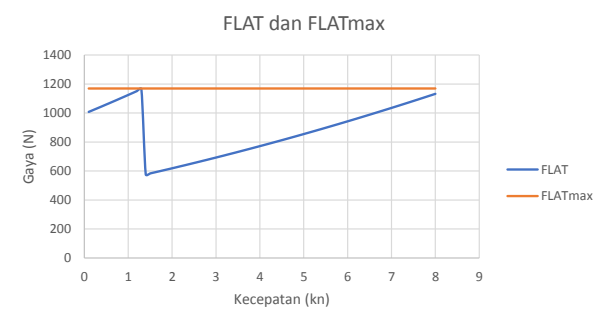
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	15,000 kn
	7,716 m/s
γ	30 °
V_A	8,761 m/s
β	26,128 °
V_S	**1,183 m/s**
	2,300 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

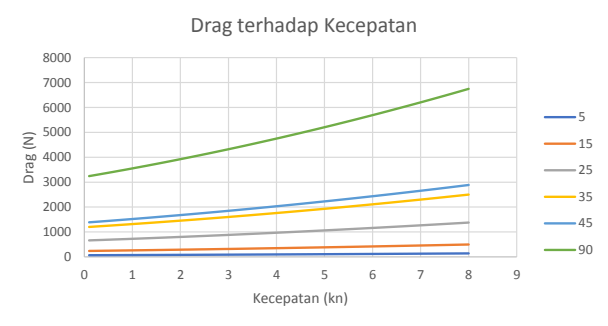
HEELING MOMENT

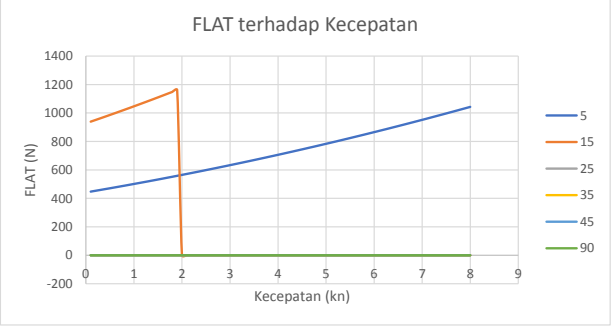
$$M_H = F_H \times h$$

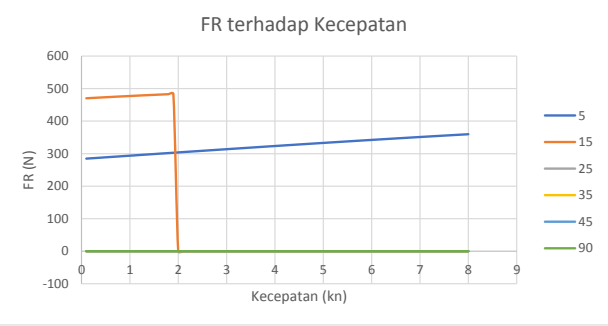
KOEFISIEN LAYAR

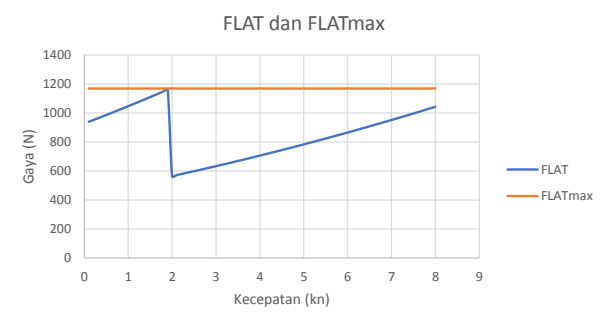
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	15,000 kn
	7,716 m/s
γ	40 °
V_A	8,868 m/s
β	34,007 °
V_S	**1,440 m/s**
	2,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

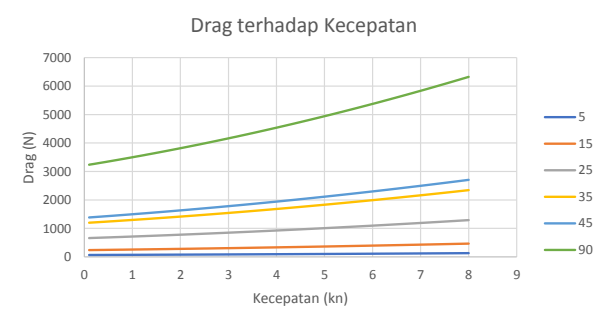
HEELING MOMENT

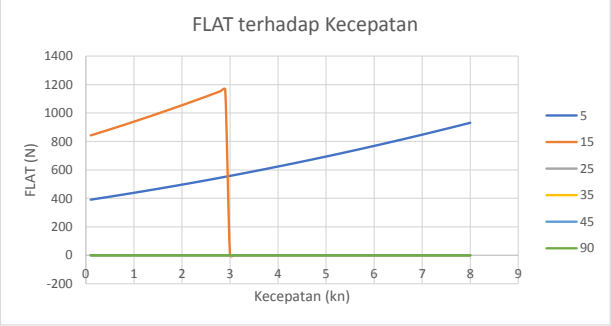
$$M_H = F_H \times h$$

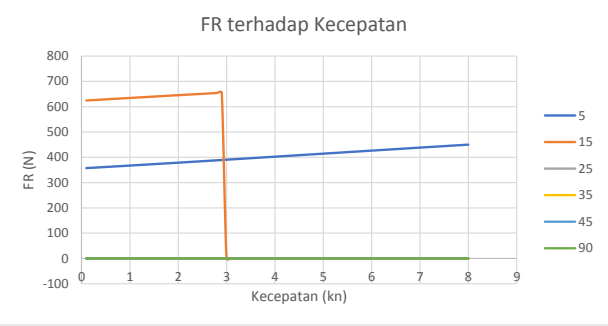
KOEFISIEN LAYAR

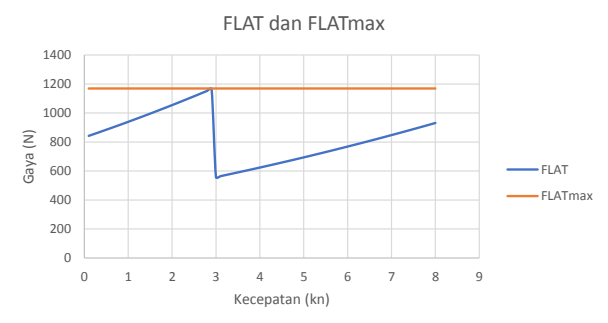
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	15,000 kn
	7,716 m/s
γ	50 °
V_A	8,826 m/s
β	42,044 °
V_S	**1,595 m/s**
	3,100 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

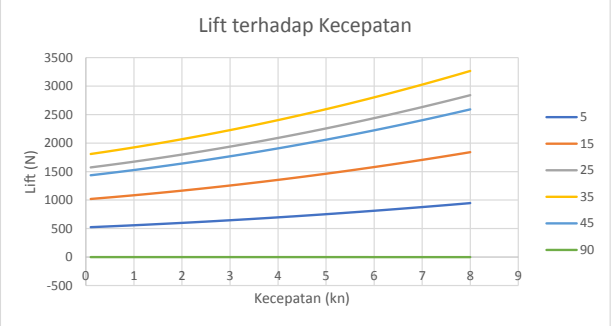
HEELING MOMENT

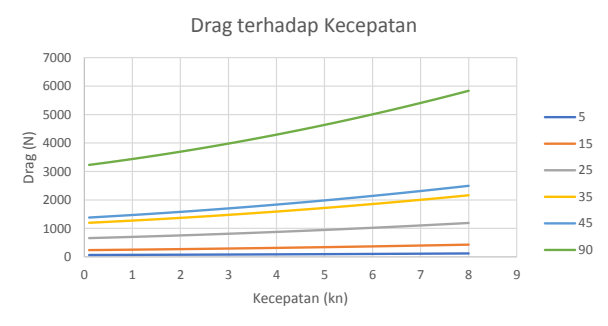
$$M_H = F_H \times h$$

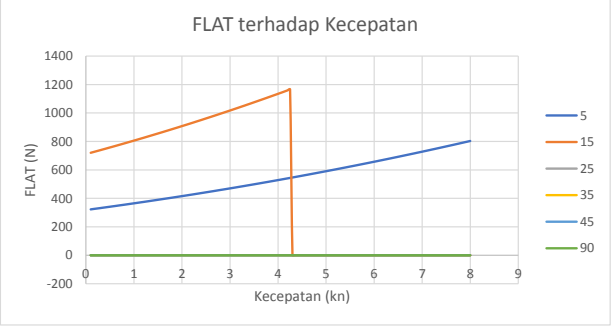
KOEFISIEN LAYAR

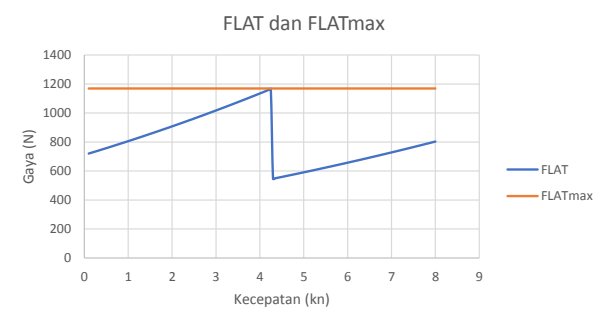
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	15,000 kn
	7,716 m/s
γ	60 °
V_A	8,925 m/s
β	48,482 °
V_S	**2,186 m/s**
	4,250 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

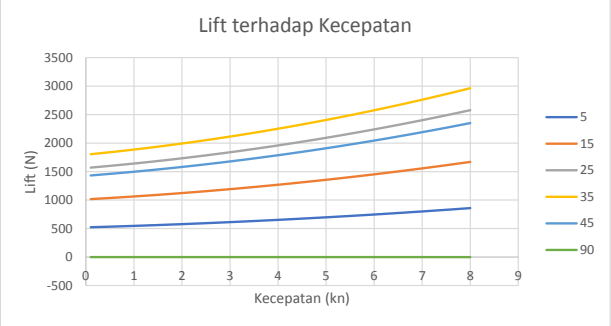
HEELING MOMENT

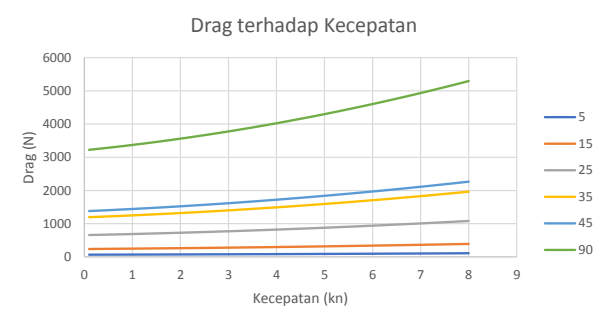
$$M_H = F_H \times h$$

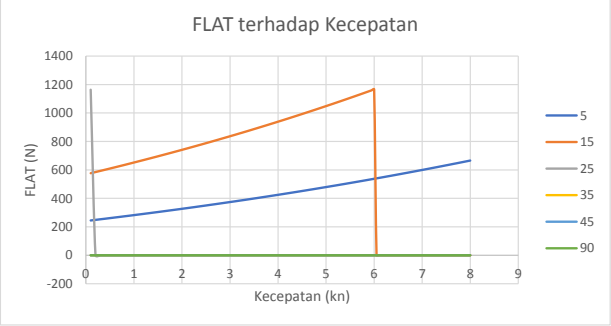
KOEFISIEN LAYAR

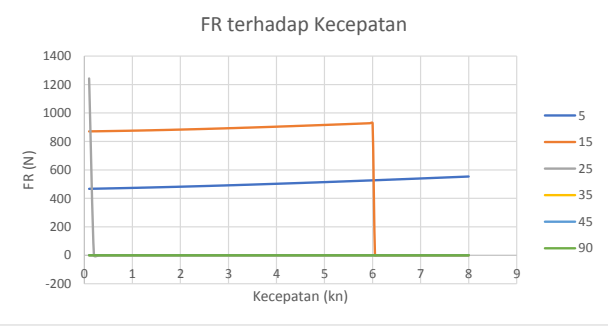
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

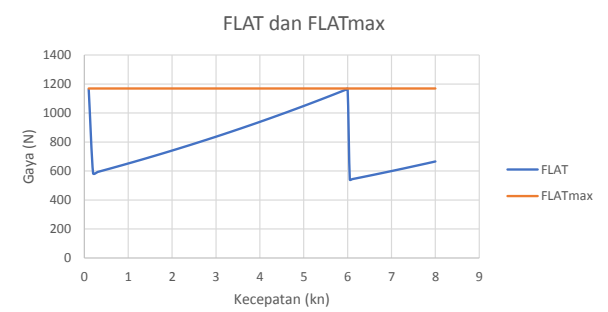
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	70 °
V_A	8,639 m/s
β	57,067 °
V_S	**2,469 m/s**
	4,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

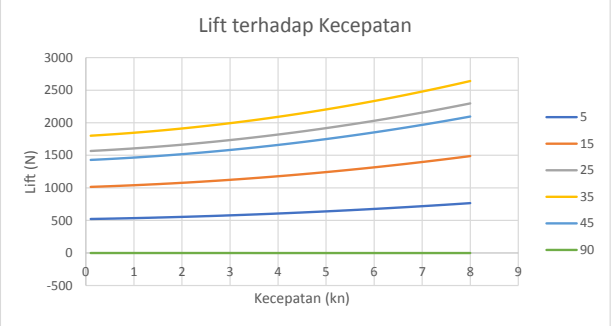
HEELING MOMENT

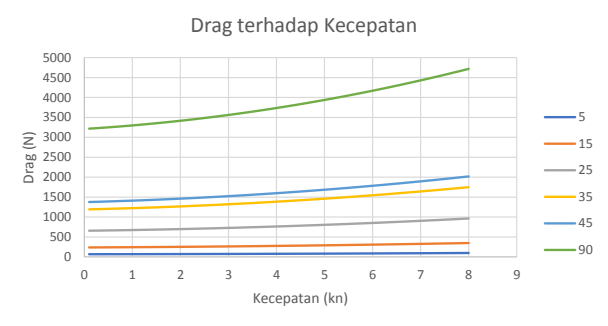
$$M_H = F_H \times h$$

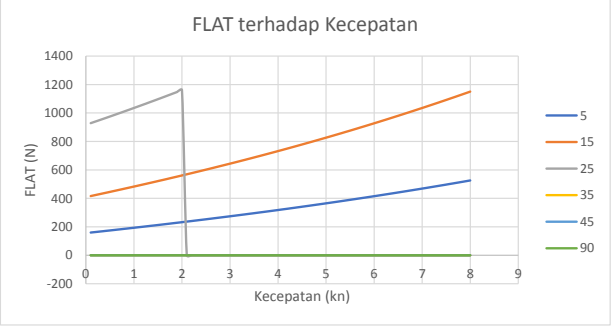
KOEFISIEN LAYAR

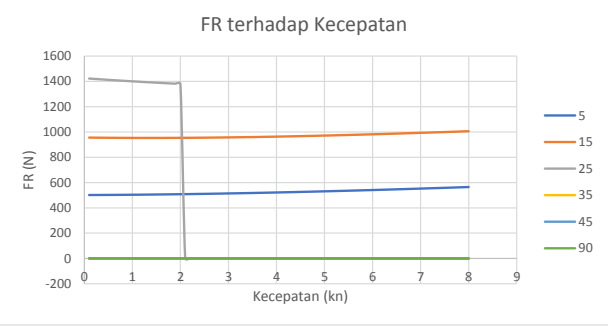
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

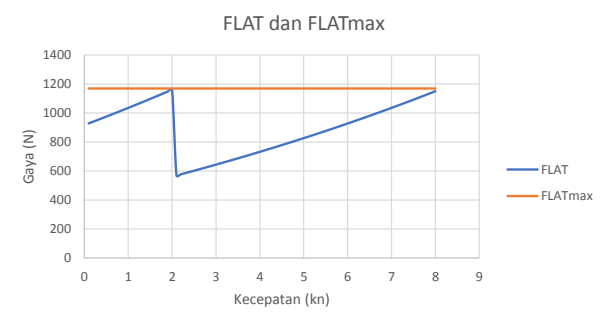
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	80 °
V_A	8,324 m/s
β	65,910 °
V_S	**2,546 m/s**
	4,950 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

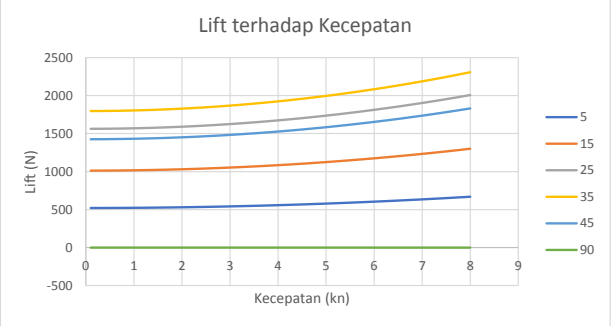
HEELING MOMENT

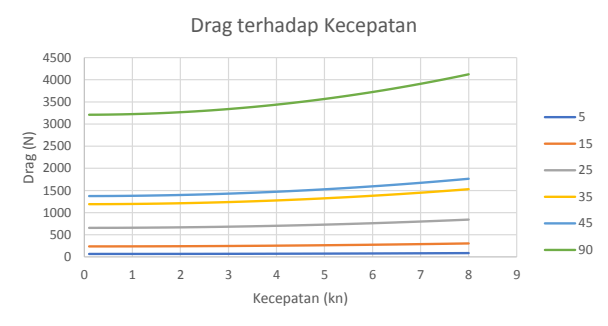
$$M_H = F_H \times h$$

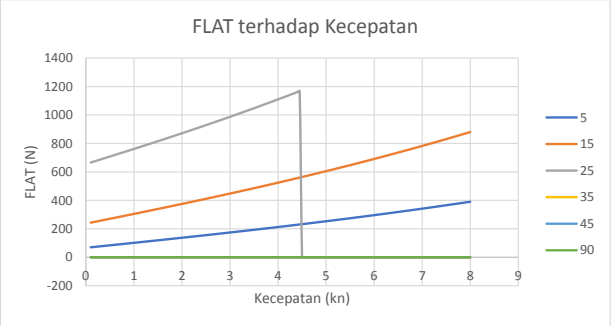
KOEFISIEN LAYAR

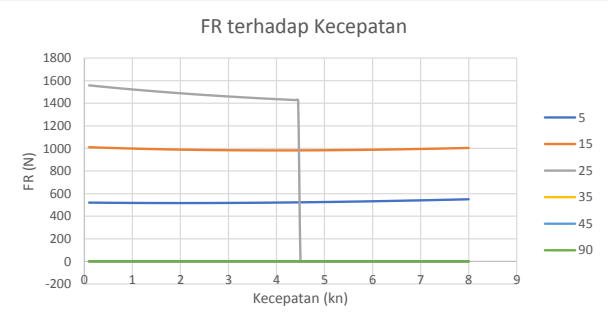
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

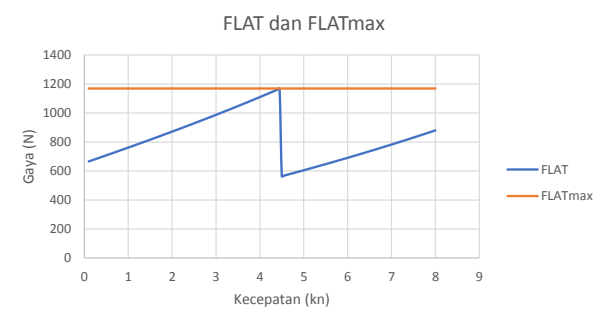
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	90 °
V_A	7,986 m/s
β	75,069 °
V_S	**2,546 m/s**
	4,950 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

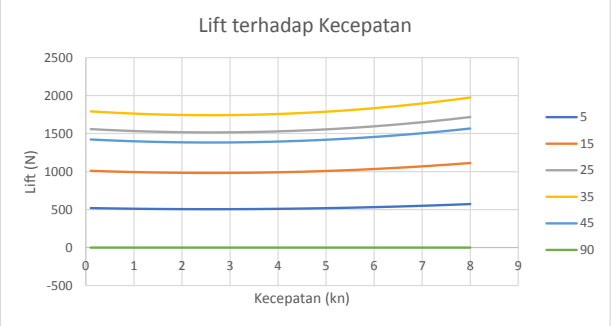
HEELING MOMENT

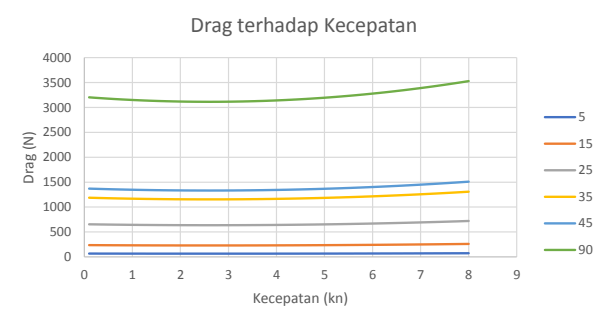
$$M_H = F_H \times h$$

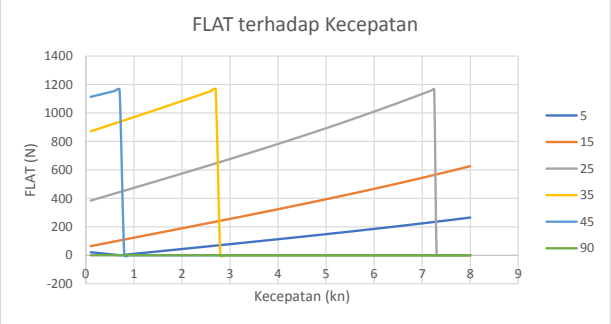
KOEFISIEN LAYAR

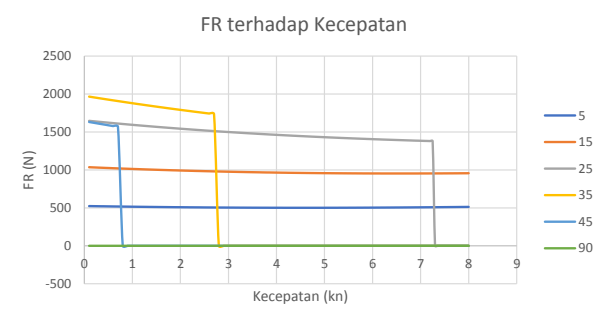
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

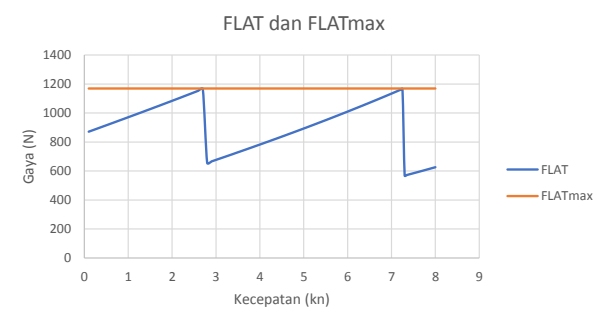
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	100 °
V_A	7,633 m/s
β	84,604 °
V_S	**2,906 m/s**
	5,650 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

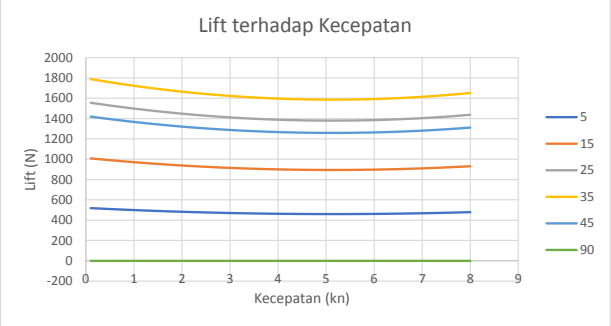
HEELING MOMENT

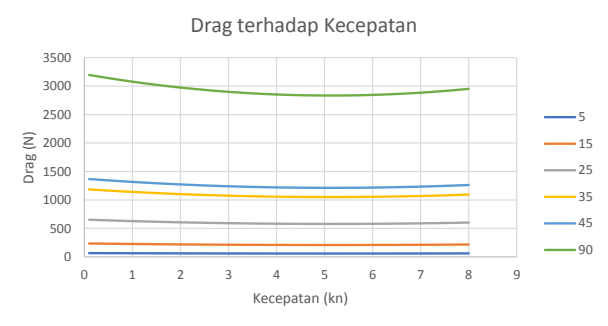
$$M_H = F_H \times h$$

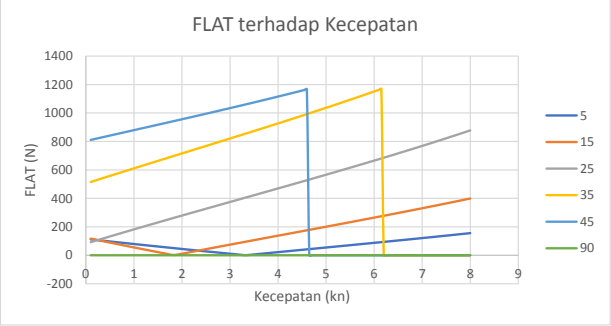
KOEFISIEN LAYAR

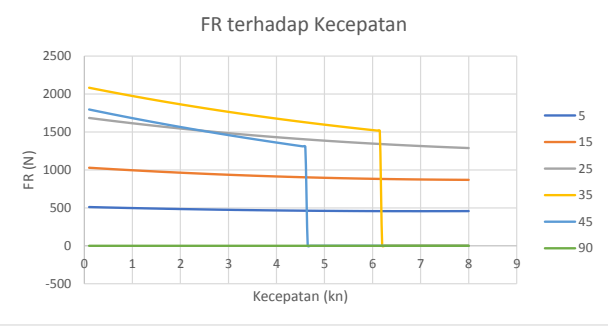
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

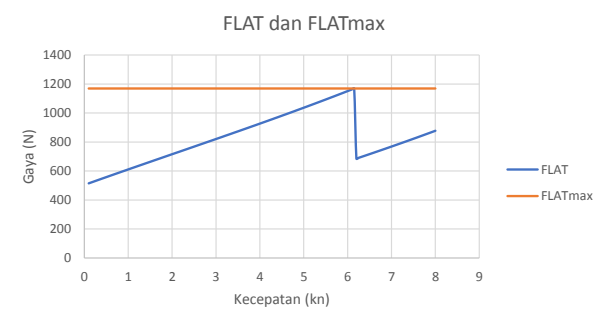
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	110 °
V_A	7,274 m/s
β	94,585 °
V_S	**2,984 m/s**
	5,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

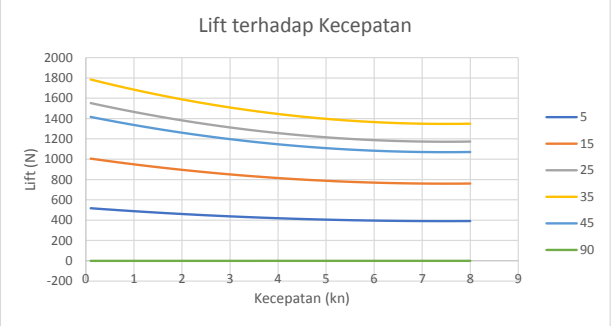
HEELING MOMENT

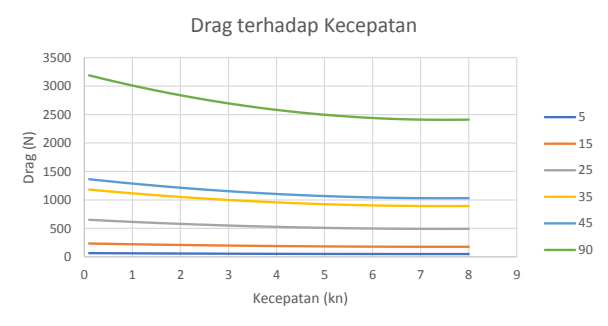
$$M_H = F_H \times h$$

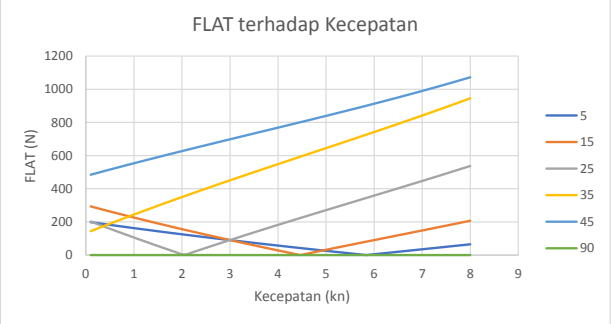
KOEFISIEN LAYAR

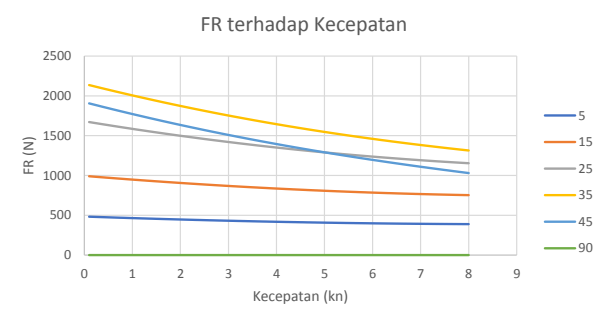
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

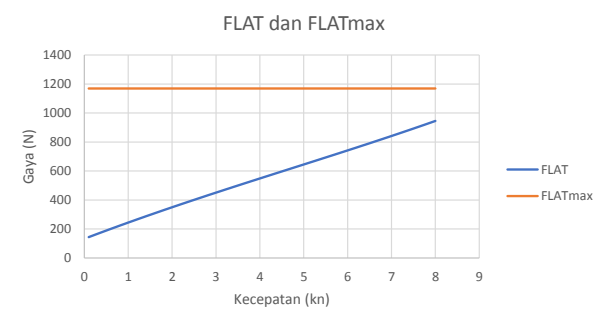
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	120 °
V_A	6,921 m/s
β	105,079 °
V_S	**2,958 m/s**
	5,750 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

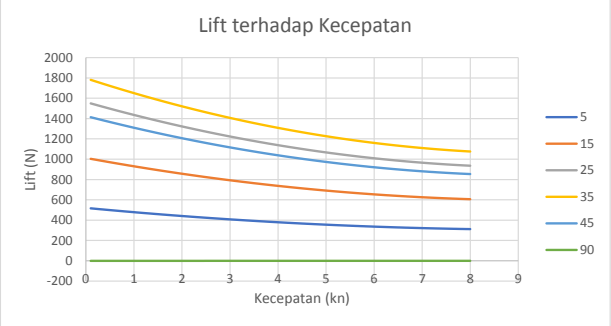
HEELING MOMENT

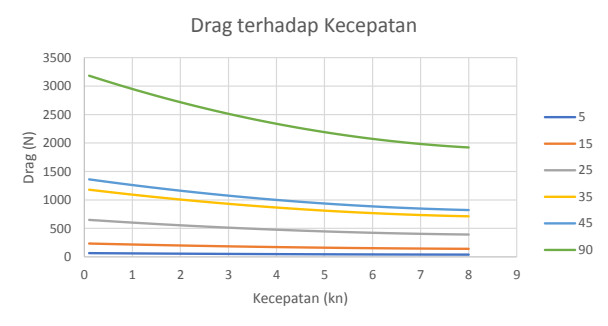
$$M_H = F_H \times h$$

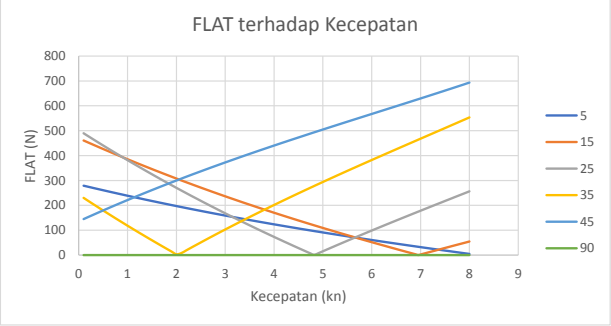
KOEFISIEN LAYAR

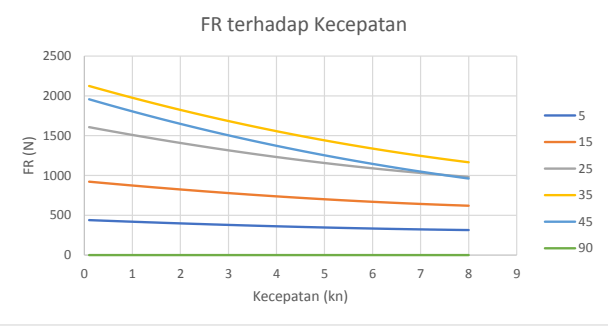
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

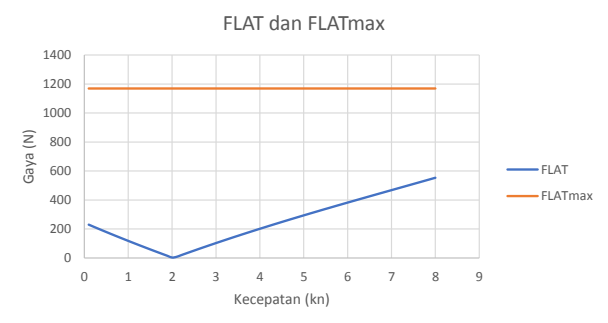
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	130 °
V_A	6,585 m/s
β	116,151 °
V_S	**2,881 m/s**
	5,600 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

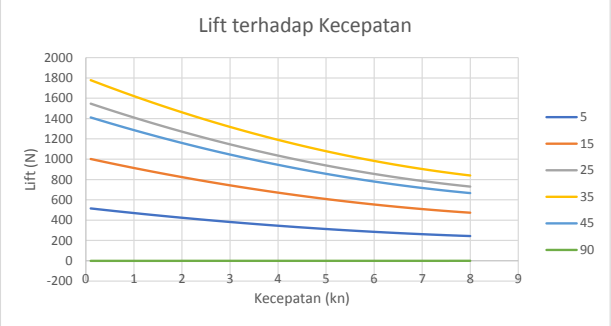
HEELING MOMENT

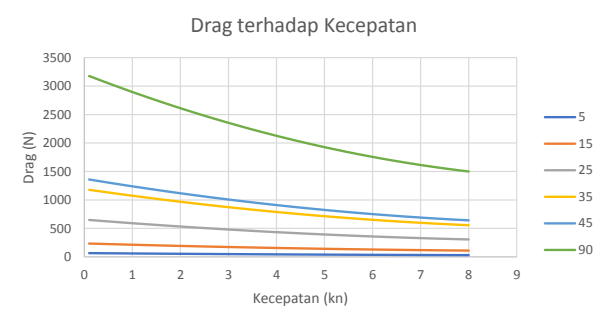
$$M_H = F_H \times h$$

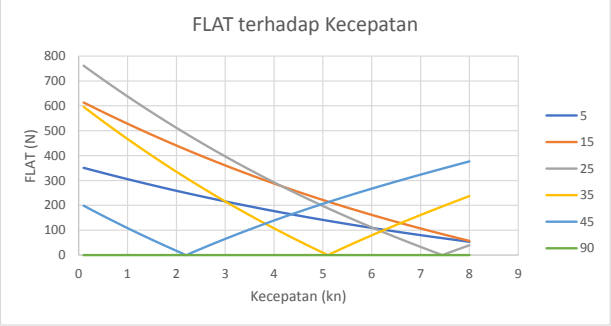
KOEFISIEN LAYAR

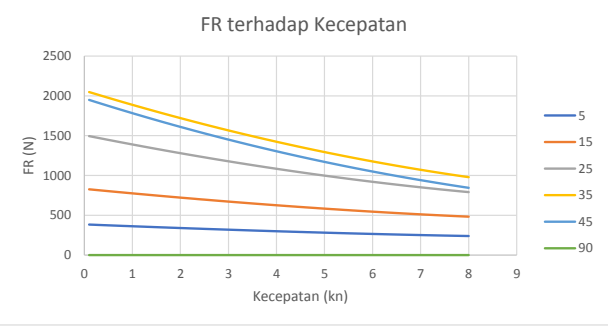
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

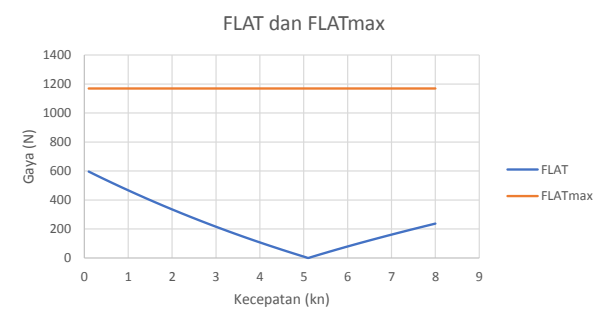
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	140 °
V_A	6,281 m/s
β	127,843 °
V_S	**2,778 m/s**
	5,400 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

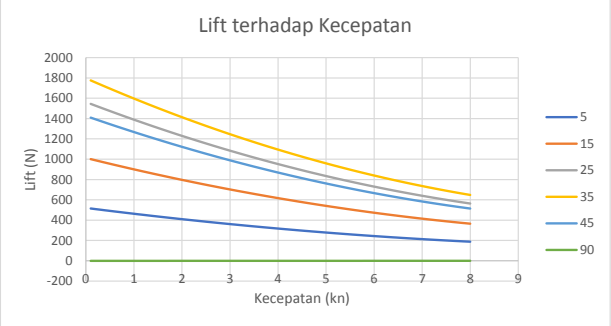
HEELING MOMENT

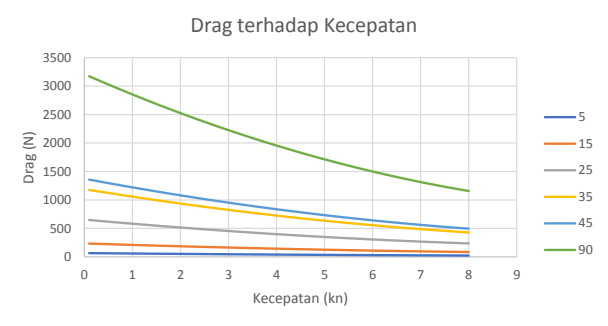
$$M_H = F_H \times h$$

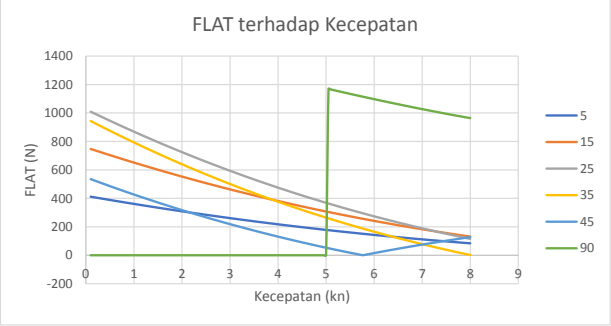
KOEFISIEN LAYAR

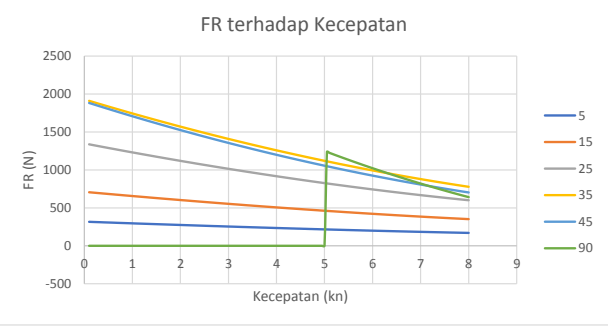
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

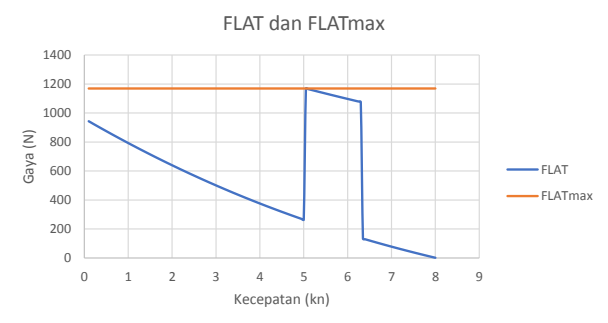
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	150 °
V_A	6,023 m/s
β	140,164 °
V_S	**2,726 m/s**
	5,300 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

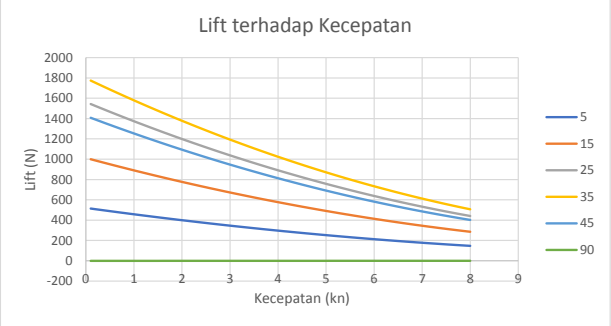
HEELING MOMENT

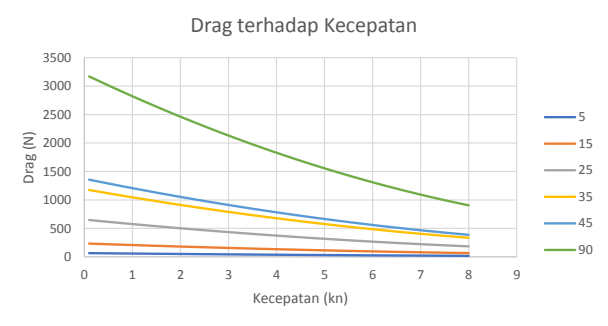
$$M_H = F_H \times h$$

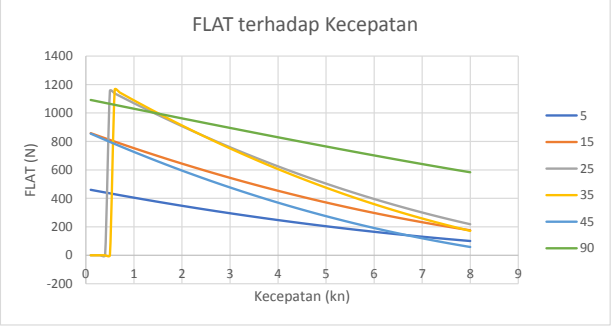
KOEFISIEN LAYAR

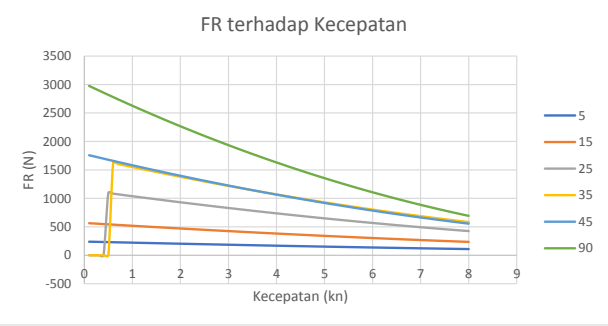
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

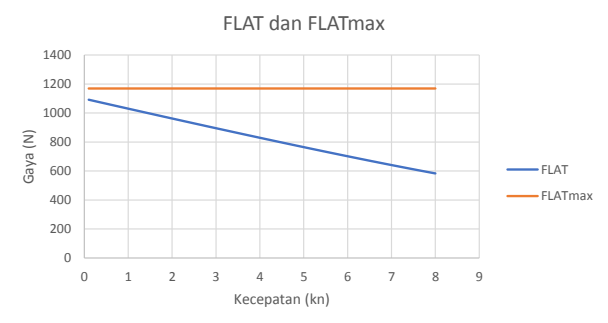
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	160 °
V_A	5,825 m/s
β	153,061 °
V_S	**2,778 m/s**
	5,400 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

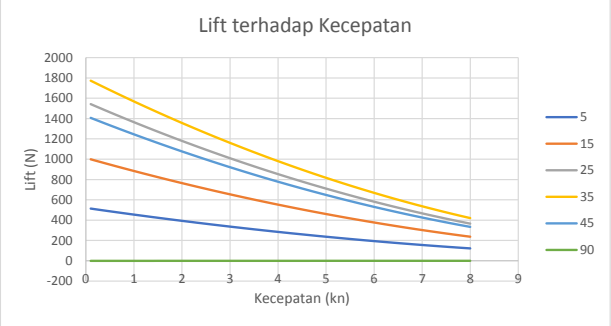
HEELING MOMENT

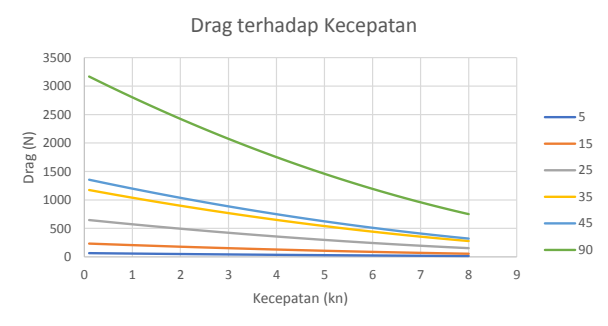
$$M_H = F_H \times h$$

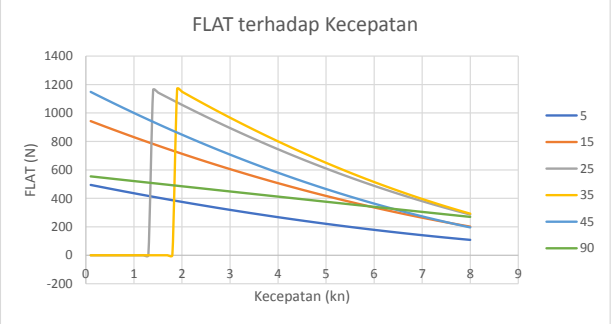
KOEFISIEN LAYAR

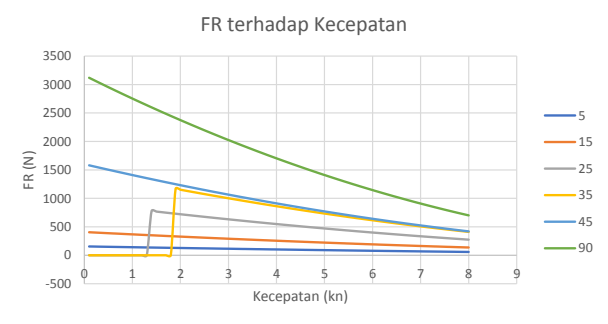
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

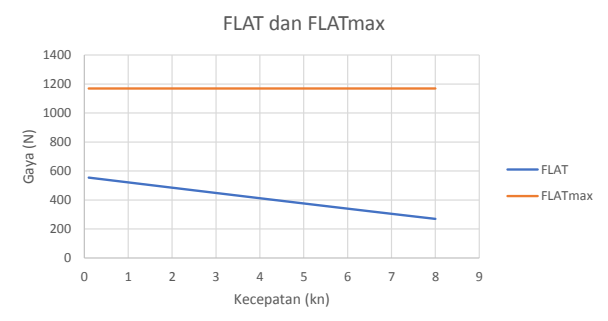
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	170 °
V_A	5,701 m/s
β	166,407 °
V_S	**2,803 m/s**
	5,450 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	15,000 kn
	7,716 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

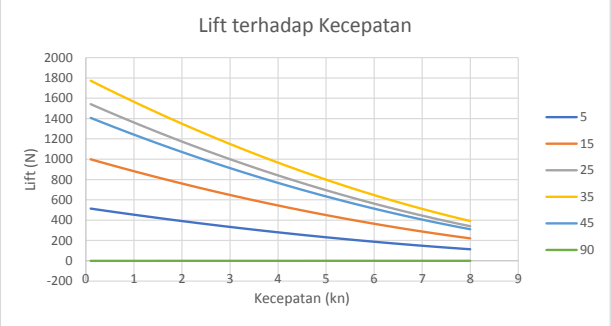
HEELING MOMENT

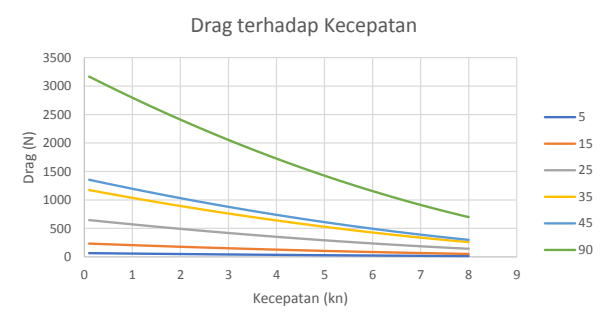
$$M_H = F_H \times h$$

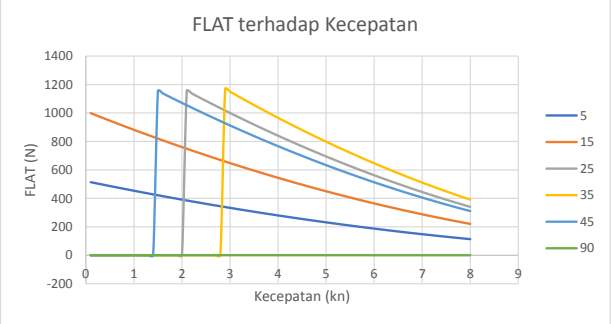
KOEFISIEN LAYAR

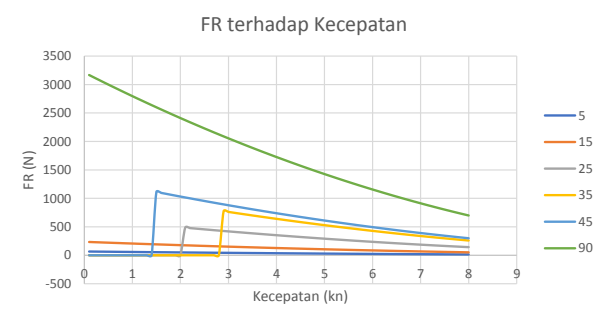
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

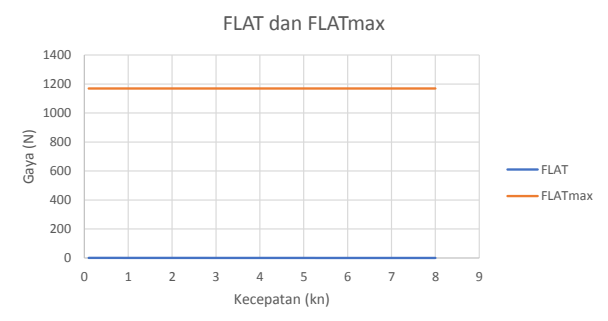
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	180 °
V_A	5,658 m/s
β	180,000 °
V_S	**2,829 m/s**
	5,500 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

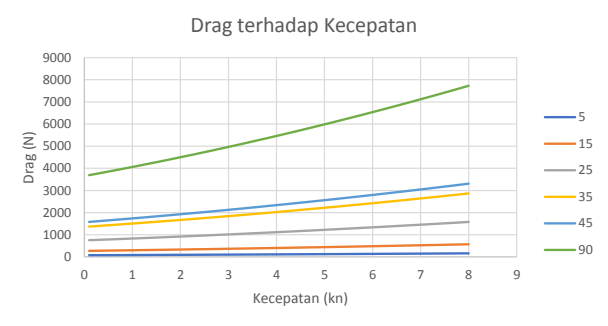
HEELING MOMENT

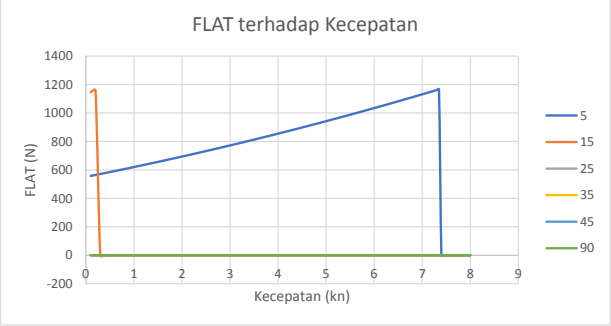
$$M_H = F_H \times h$$

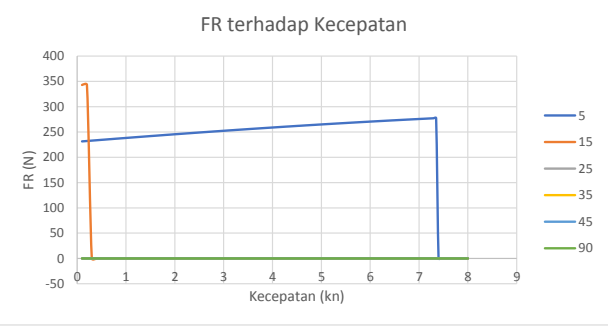
KOEFISIEN LAYAR

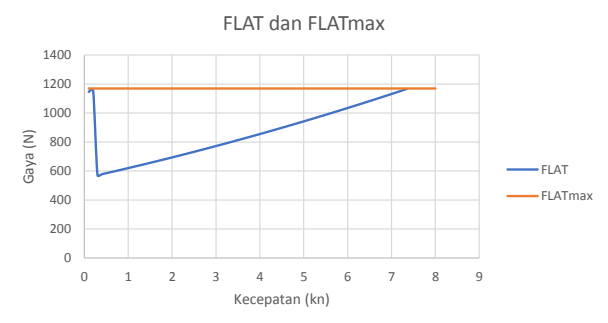
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	30 °
V_A	9,366 m/s
β	26,063 °
V_S	**1,286 m/s**
	2,500 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

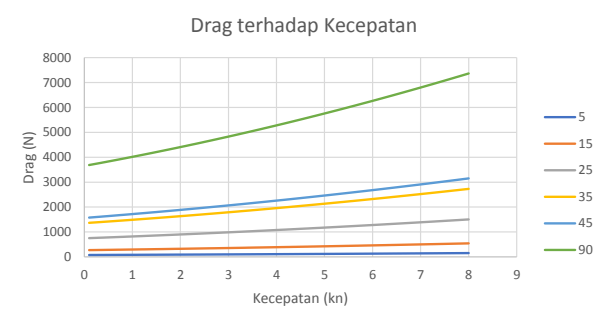
HEELING MOMENT

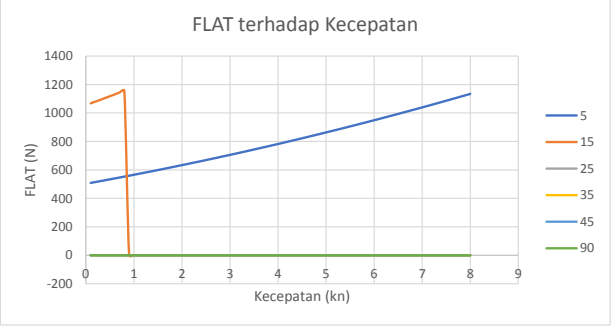
$$M_H = F_H \times h$$

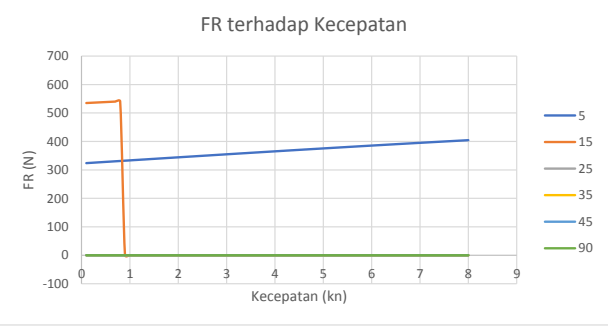
KOEFISIEN LAYAR

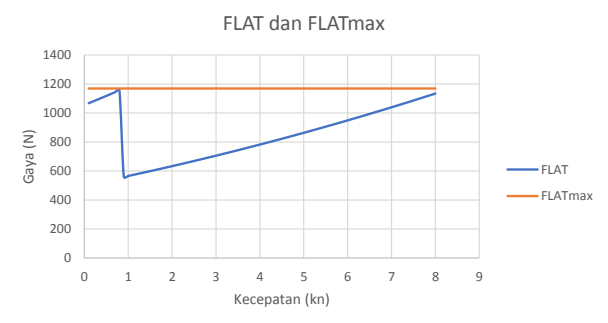
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	40 °
V_A	9,465 m/s
β	33,984 °
V_S	**1,543 m/s**
	3,000 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

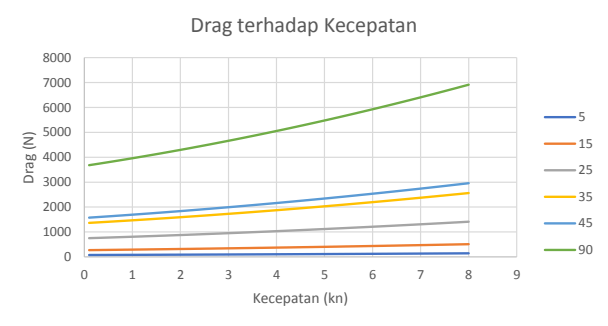
HEELING MOMENT

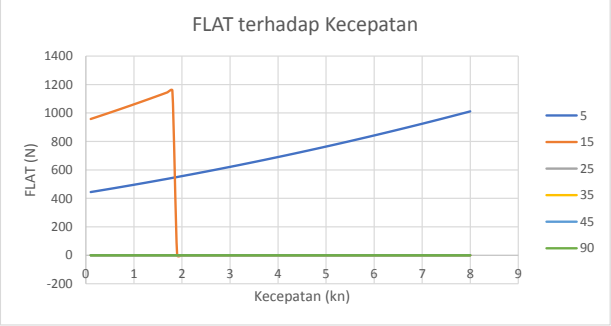
$$M_H = F_H \times h$$

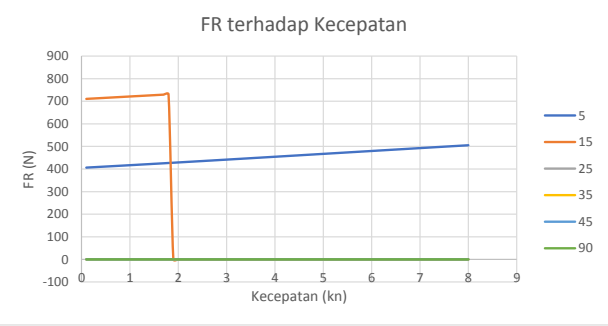
KOEFISIEN LAYAR

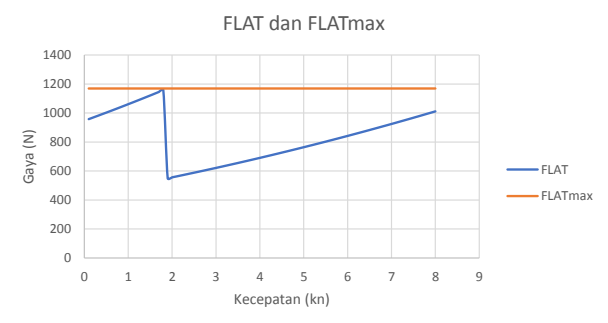
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	50 °
V_A	9,450 m/s
β	41,849 °
V_S	**1,749 m/s**
	3,400 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

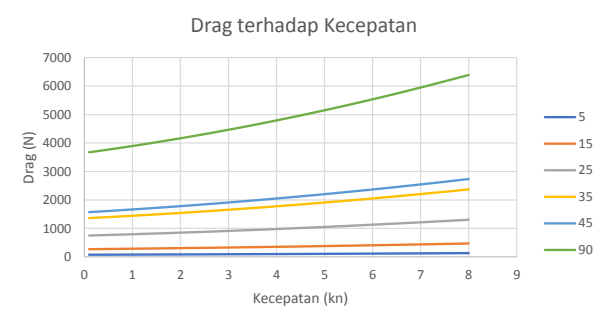
HEELING MOMENT

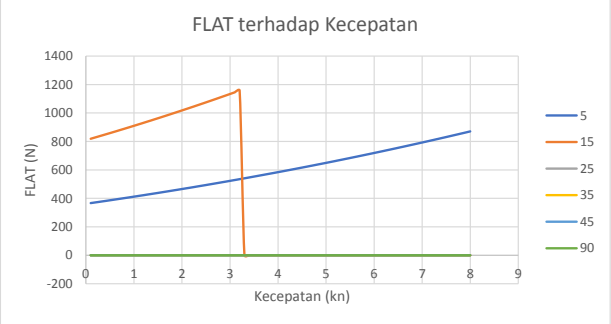
$$M_H = F_H \times h$$

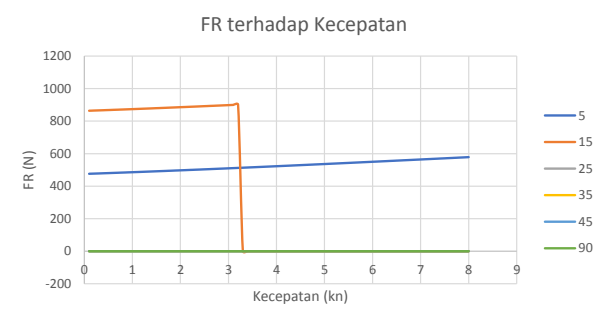
KOEFISIEN LAYAR

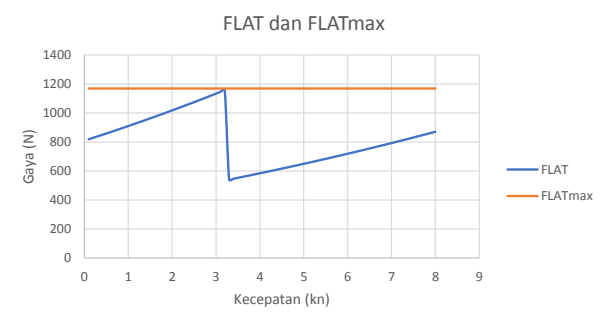
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	60 °
V_A	9,296 m/s
β	50,065 °
V_S	**1,852 m/s**
	3,600 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

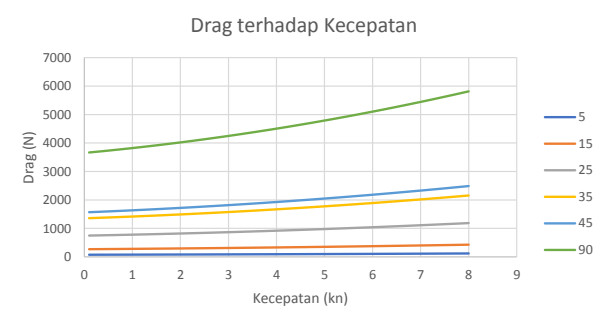
HEELING MOMENT

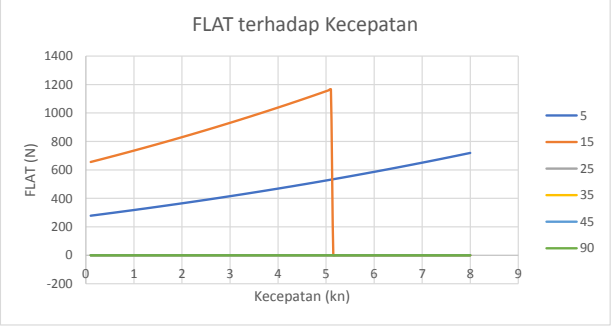
$$M_H = F_H \times h$$

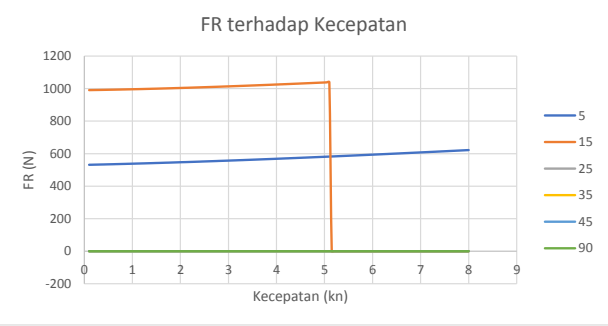
KOEFISIEN LAYAR

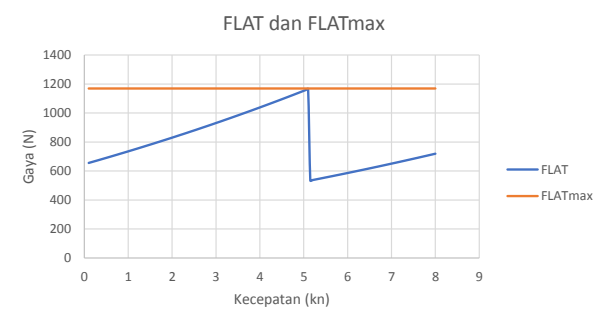
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	70 °
V_A	9,141 m/s
β	57,788 °
V_S	**2,598 m/s**
	5,050 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

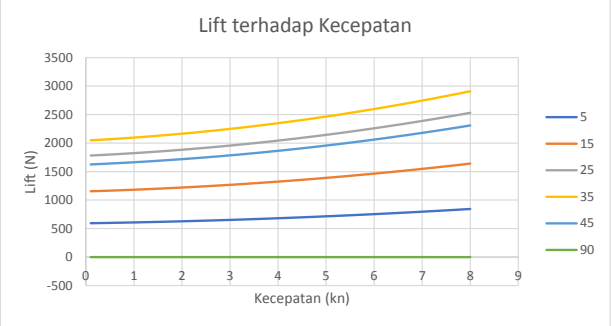
HEELING MOMENT

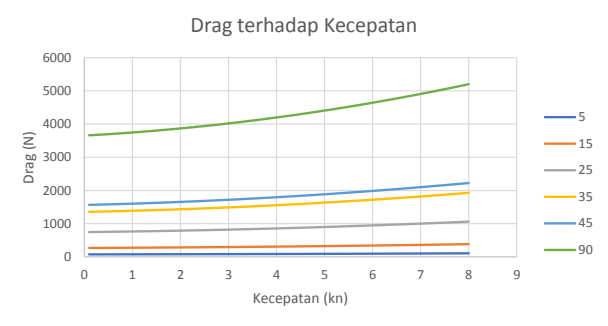
$$M_H = F_H \times h$$

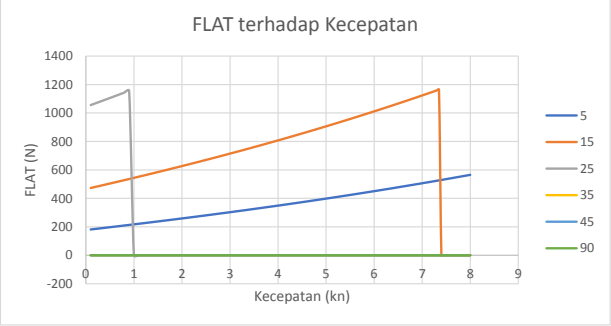
KOEFISIEN LAYAR

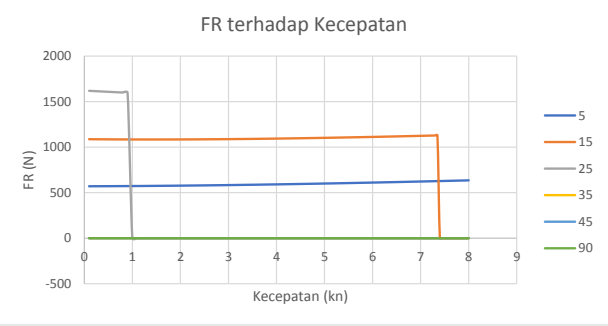
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

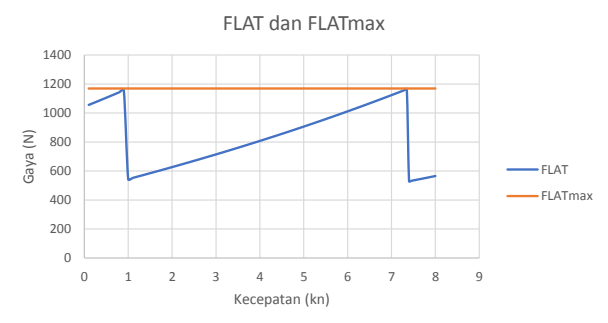
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	80 °
V_A	8,824 m/s
β	66,723 °
V_S	**2,675 m/s**
	5,200 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

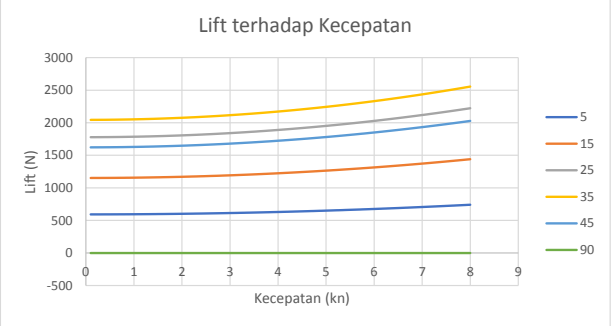
HEELING MOMENT

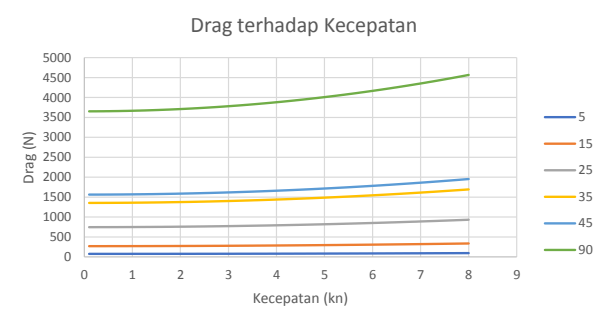
$$M_H = F_H \times h$$

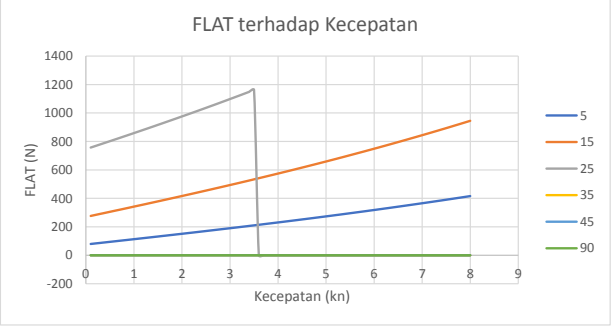
KOEFISIEN LAYAR

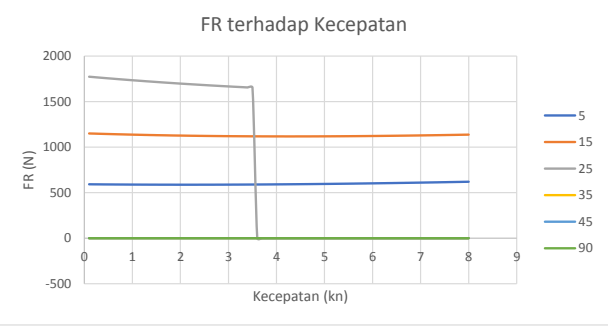
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

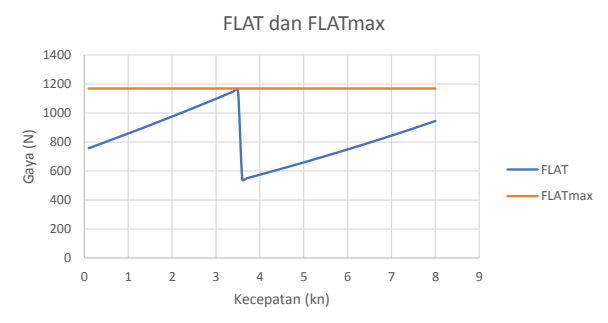
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	90 °
V_A	8,484 m/s
β	75,964 °
V_S	**2,675 m/s**
	5,200 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

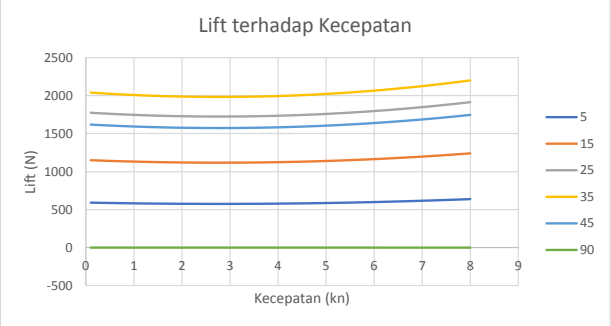
HEELING MOMENT

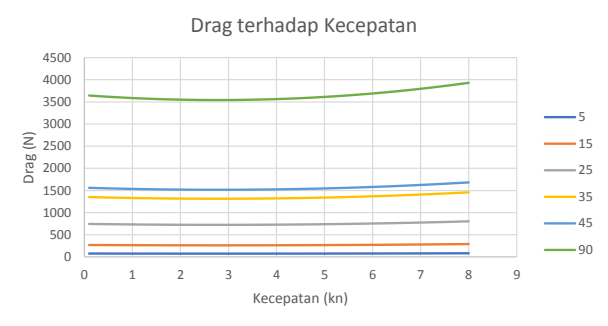
$$M_H = F_H \times h$$

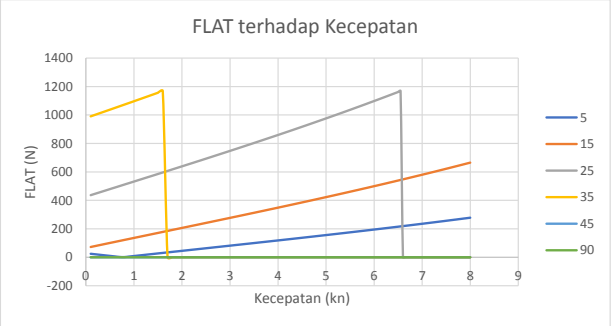
KOEFISIEN LAYAR

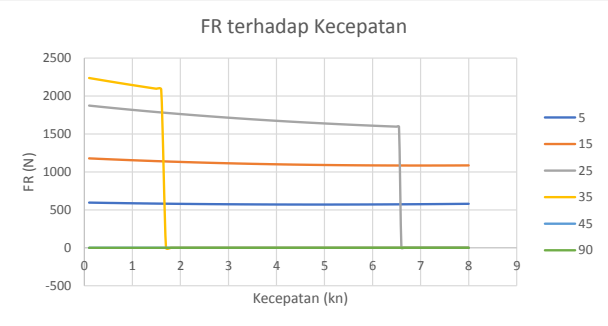
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

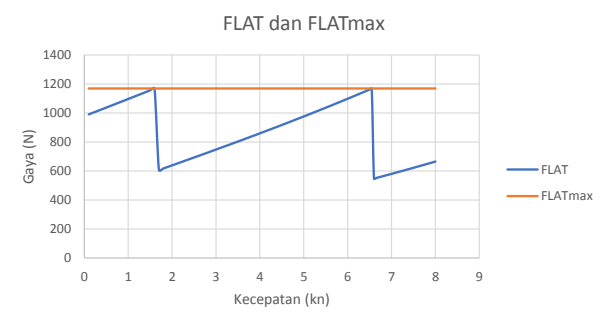
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	100 °
V_A	8,130 m/s
β	85,567 °
V_S	**3,035 m/s**
	5,900 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

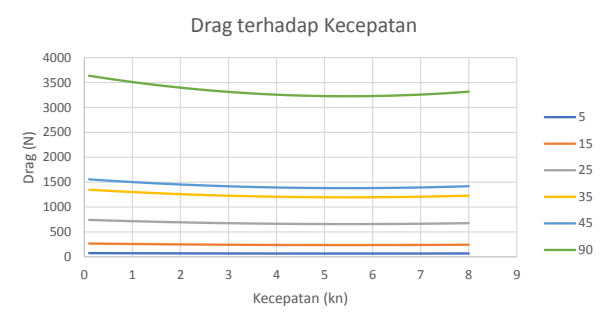
HEELING MOMENT

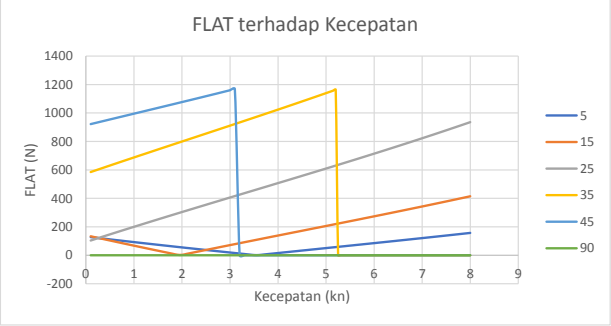
$$M_H = F_H \times h$$

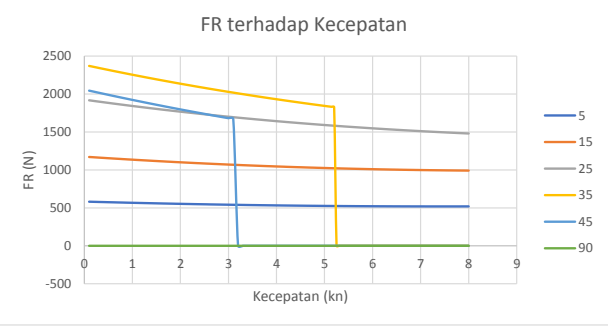
KOEFISIEN LAYAR

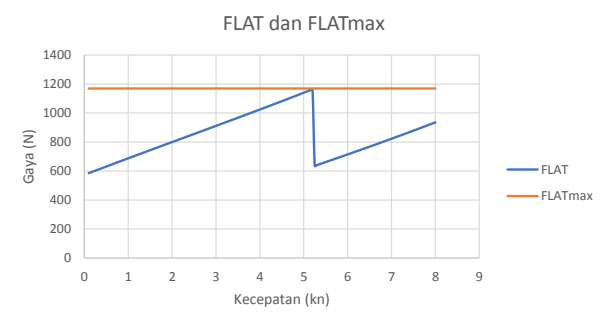
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	110 °
V_A	7,771 m/s
β	95,593 °
V_S	**2,984 m/s**
	5,800 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

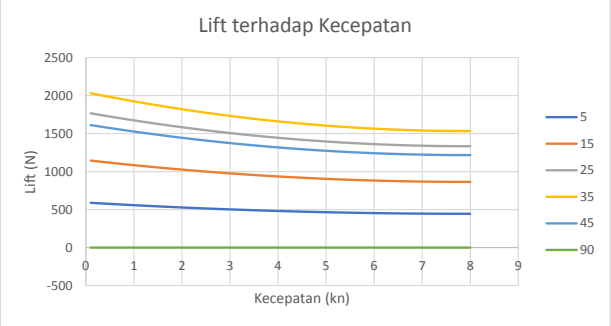
HEELING MOMENT

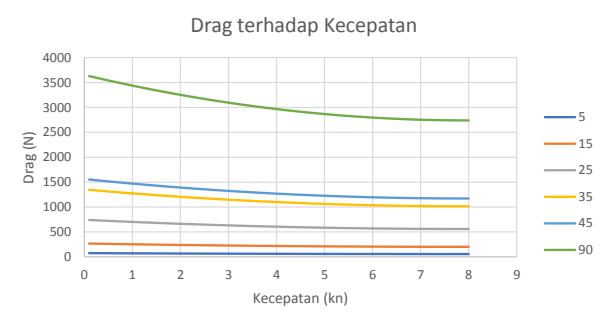
$$M_H = F_H \times h$$

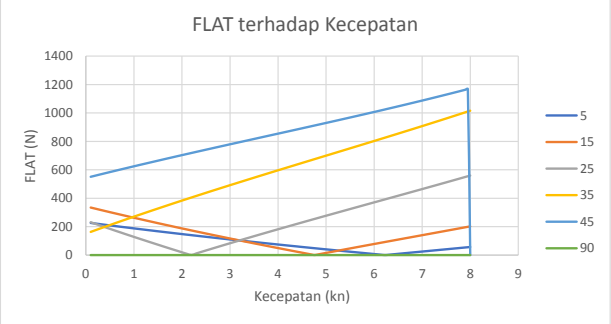
KOEFISIEN LAYAR

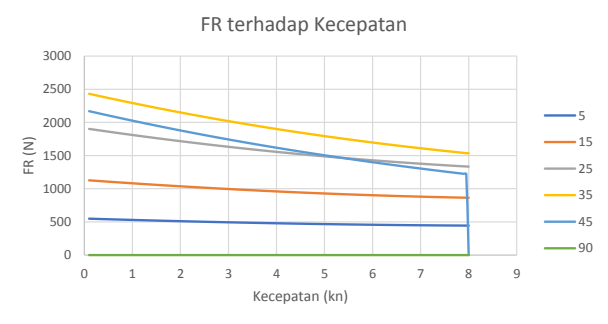
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

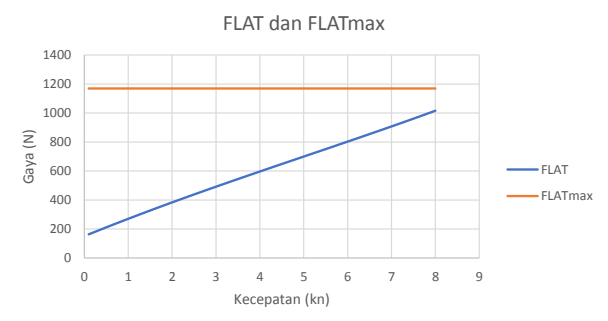
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	120 °
V_A	7,419 m/s
β	106,102 °
V_S	**3,086 m/s**
	6,000 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

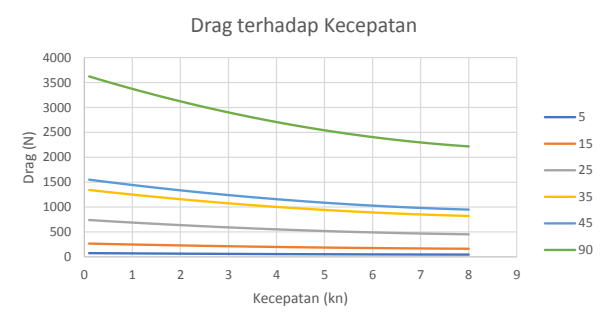
HEELING MOMENT

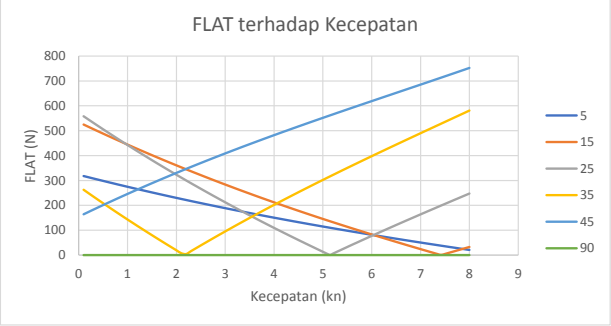
$$M_H = F_H \times h$$

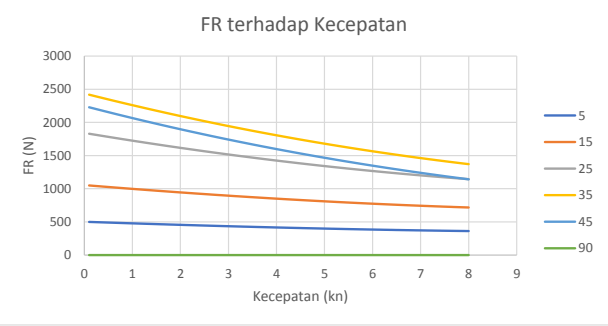
KOEFISIEN LAYAR

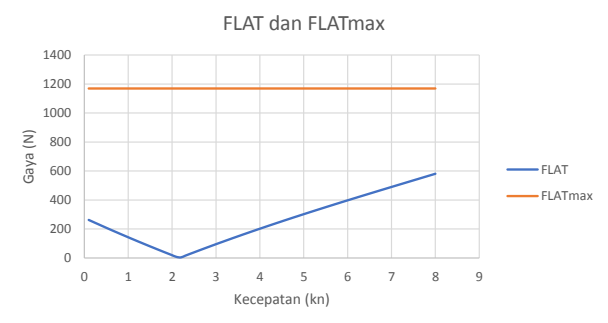
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	130 °
V_A	7,085 m/s
β	117,146 °
V_S	**3,009 m/s**
	5,850 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

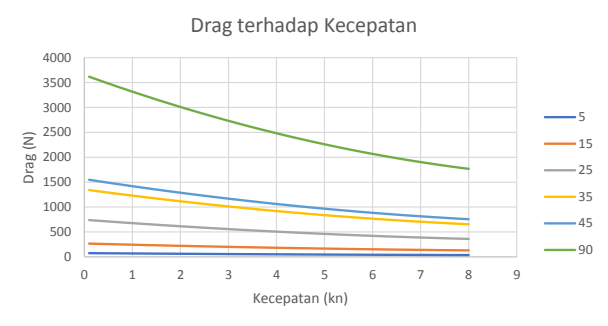
HEELING MOMENT

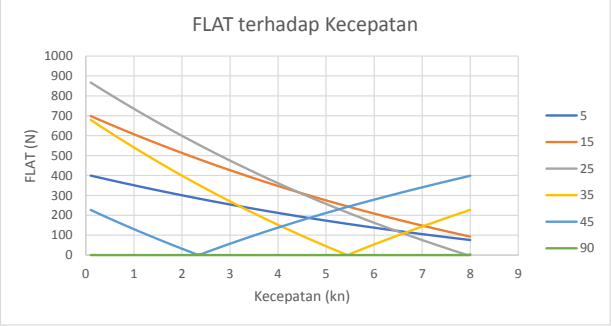
$$M_H = F_H \times h$$

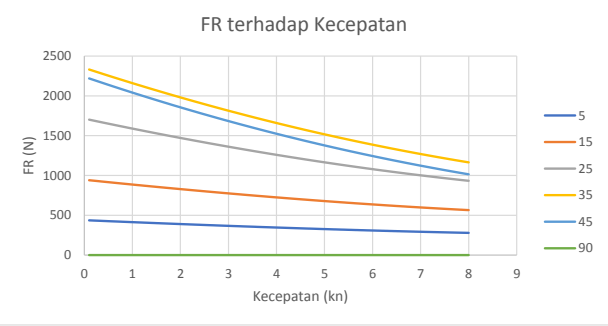
KOEFISIEN LAYAR

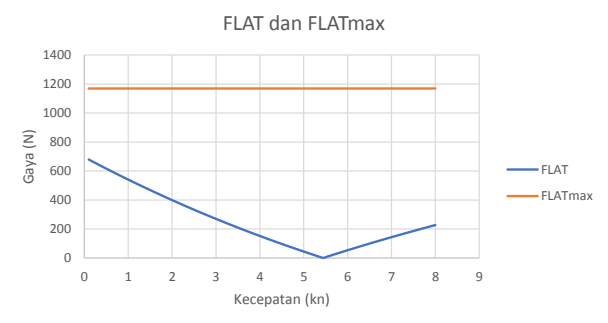
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	140 °
V_A	6,784 m/s
β	128,758 °
V_S	**2,906 m/s**
	5,650 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

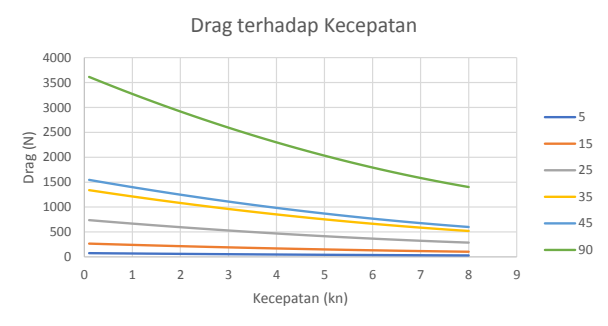
HEELING MOMENT

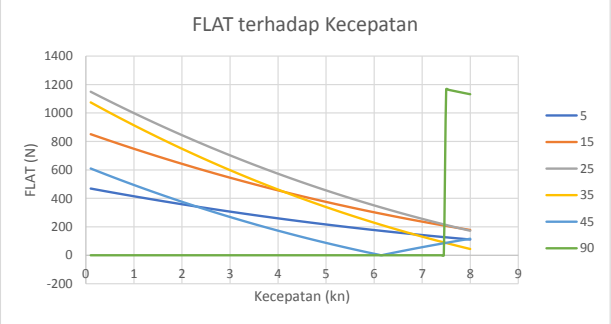
$$M_H = F_H \times h$$

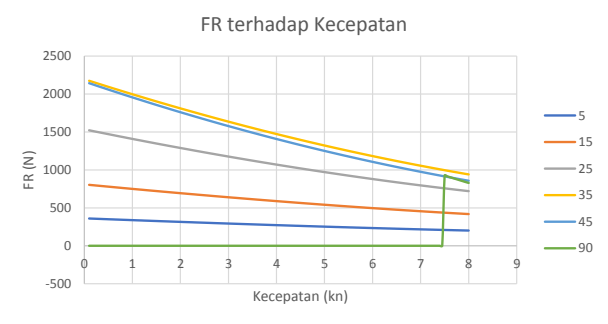
KOEFISIEN LAYAR

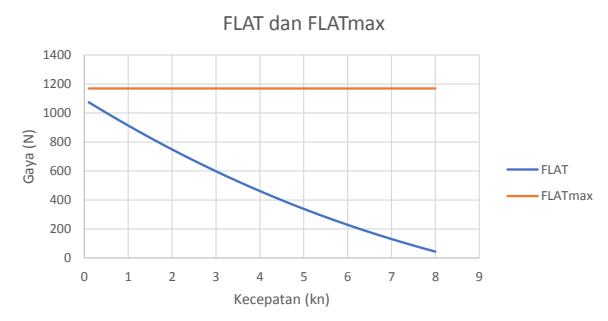
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	150 °
V_A	6,530 m/s
β	140,935 °
V_S	**2,803 m/s**
	5,450 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

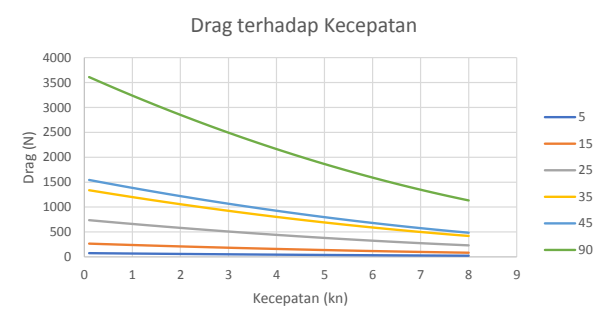
HEELING MOMENT

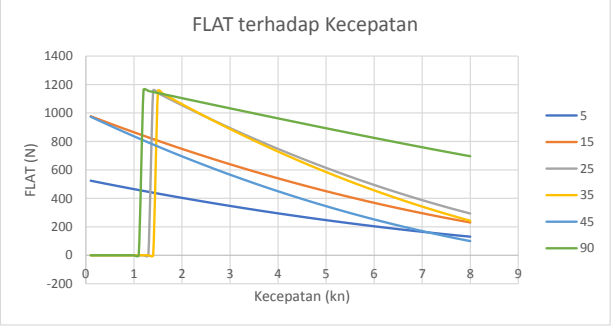
$$M_H = F_H \times h$$

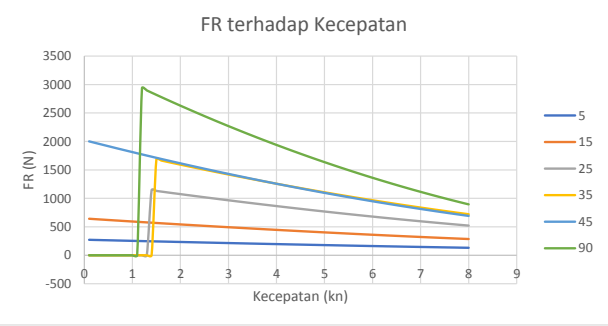
KOEFISIEN LAYAR

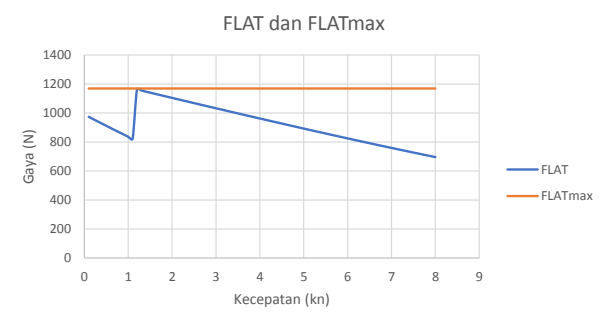
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	160 °
V_A	6,336 m/s
β	153,623 °
V_S	**2,932 m/s**
	5,700 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

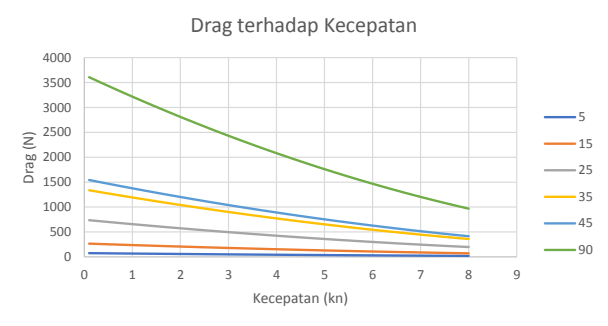
HEELING MOMENT

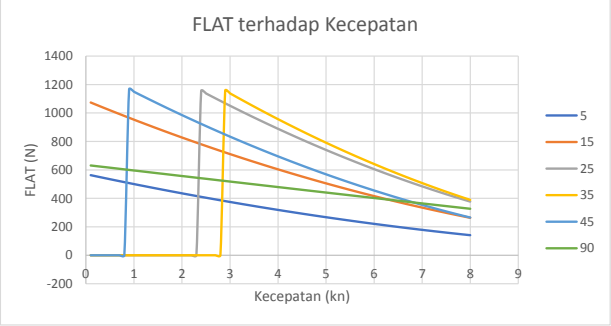
$$M_H = F_H \times h$$

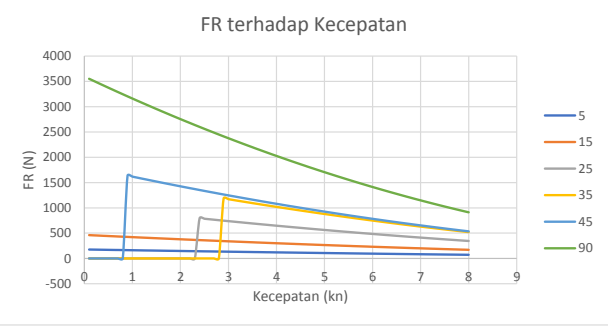
KOEFISIEN LAYAR

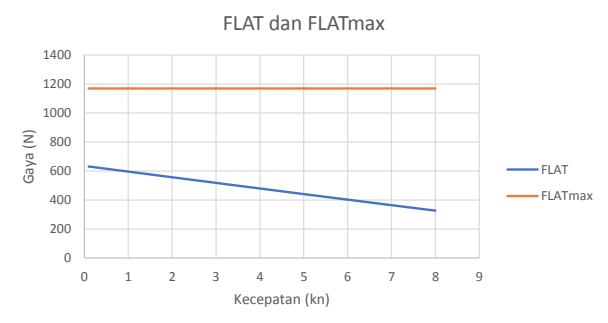
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	170 °
V_A	6,214 m/s
β	166,704 °
V_S	**2,958 m/s**
	5,750 kn

SPESIFIKASI LAYAR

Model		Peledang-Ma
Span	Yard	8,000 m
	Boom	8,000 m
Chord		4,000 m
Area		32,000 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	16,000 kn
	8,230 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

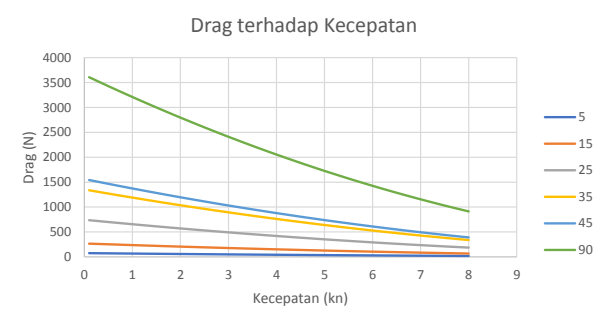
HEELING MOMENT

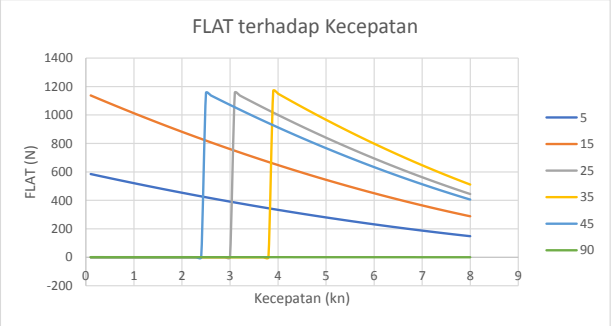
$$M_H = F_H \times h$$

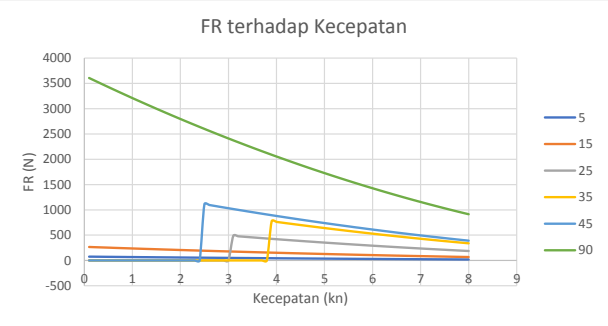
KOEFISIEN LAYAR

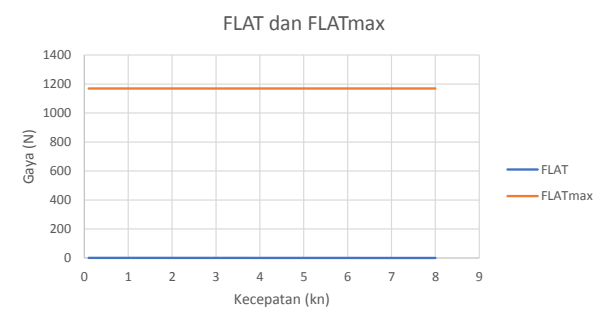
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	16,000 kn
	8,230 m/s
γ	180 °
V_A	6,173 m/s
β	180,000 °
V_S	**2,958 m/s**
	5,750 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

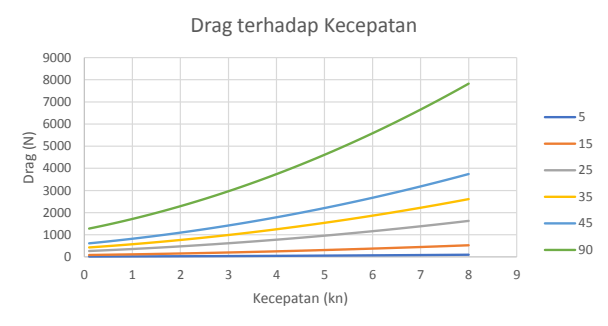
HEELING MOMENT

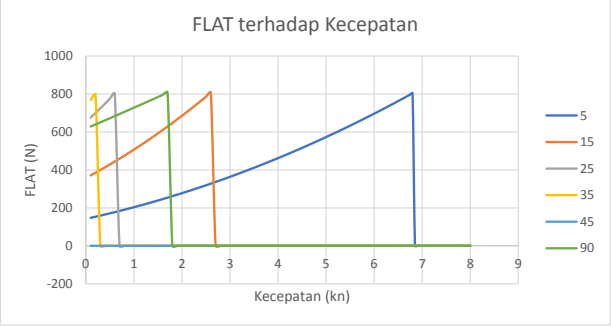
$$M_H = F_H \times h$$

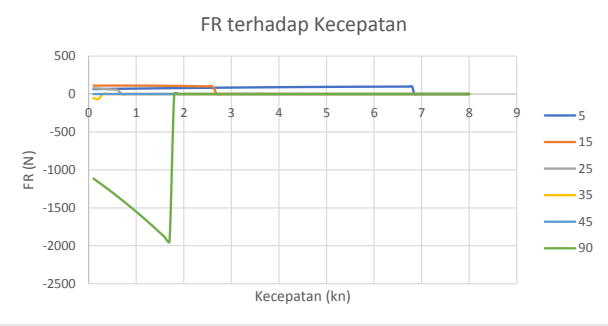
KOEFISIEN LAYAR

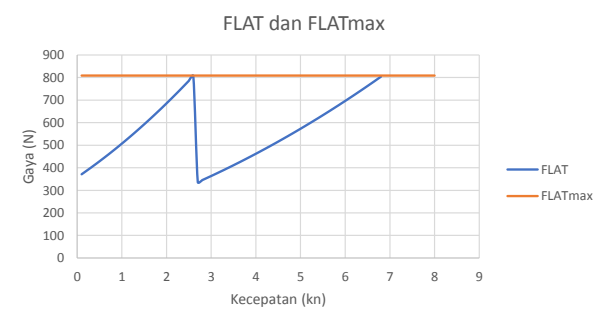
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	5,000 kn
	2,572 m/s
γ	30 °
V_A	3,310 m/s
β	22,859 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

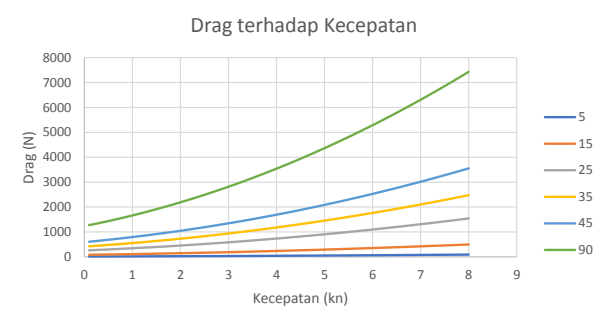
HEELING MOMENT

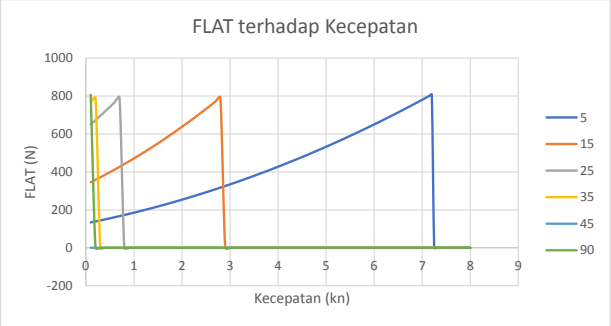
$$M_H = F_H \times h$$

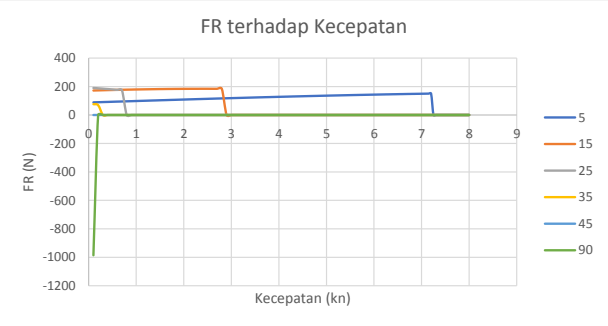
KOEFISIEN LAYAR

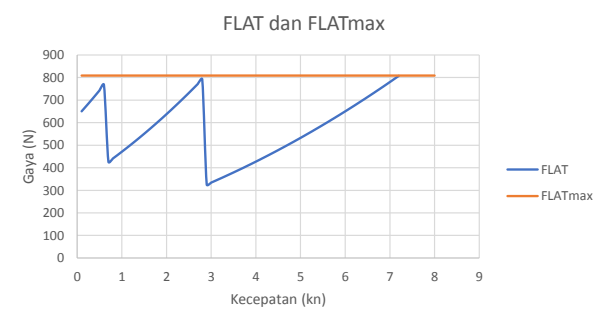
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	5,000 kn
	2,572 m/s
γ	40 °
V_A	3,470 m/s
β	28,456 °
V_S	**1,080 m/s**
	2,100 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

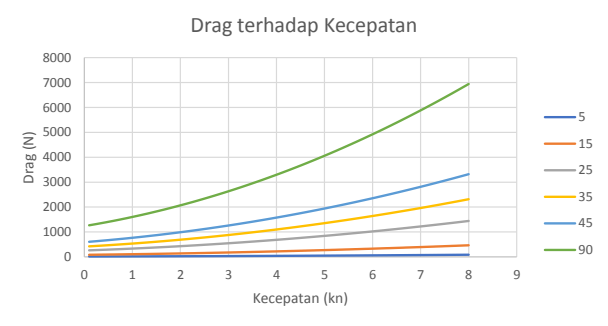
HEELING MOMENT

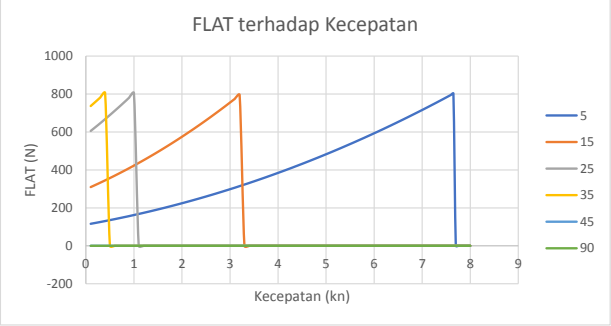
$$M_H = F_H \times h$$

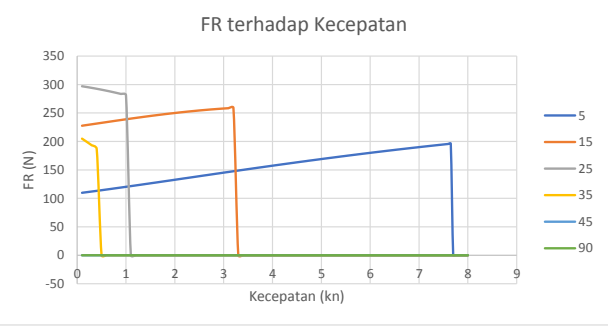
KOEFISIEN LAYAR

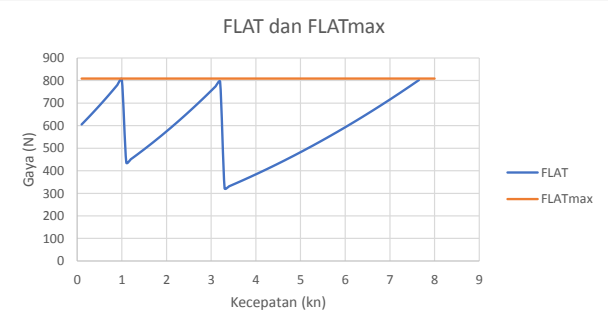
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	5,000 kn
	2,572 m/s
γ	50 °
V_A	3,539 m/s
β	33,835 °
V_S	**1,286 m/s**
	2,500 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

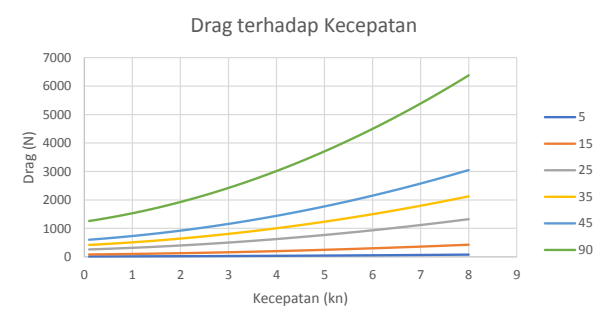
HEELING MOMENT

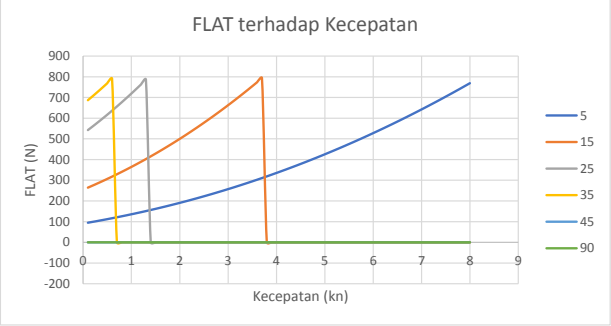
$$M_H = F_H \times h$$

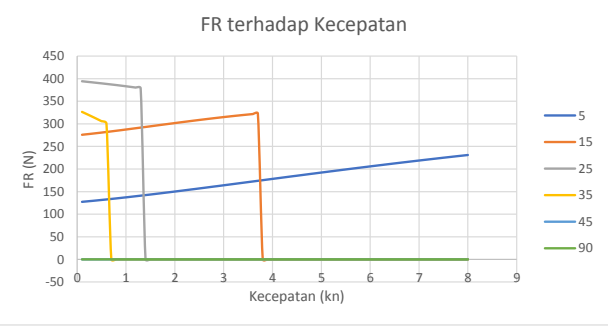
KOEFISIEN LAYAR

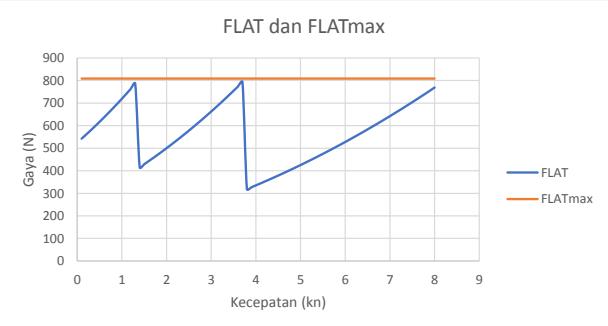
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	5,000 kn
	2,572 m/s
γ	60 °
V_A	3,521 m/s
β	39,249 °
V_S	**1,440 m/s**
	2,800 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

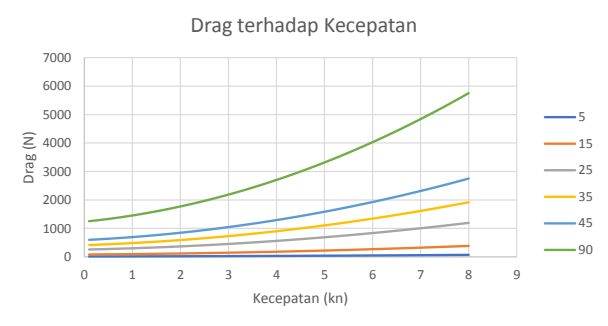
HEELING MOMENT

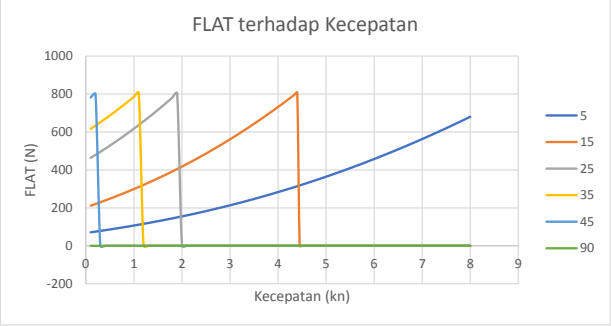
$$M_H = F_H \times h$$

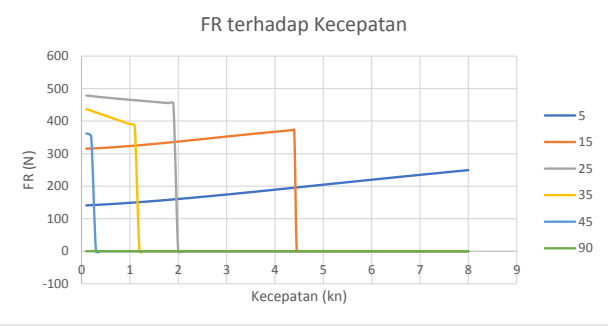
KOEFISIEN LAYAR

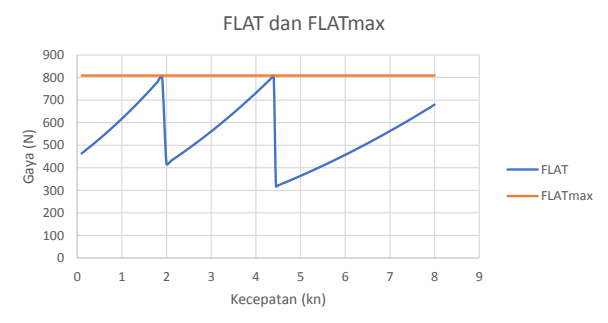
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN				
PENUH	θ_{max}	11 °	h	8,683 m
	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	5,000 kn
	2,572 m/s
γ	70 °
V_A	3,422 m/s
β	44,929 °
V_S	**1,543 m/s**
	3,000 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

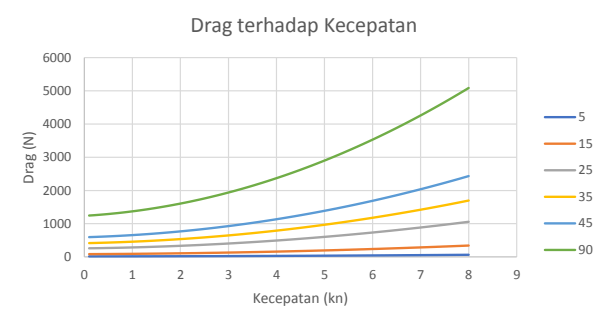
HEELING MOMENT

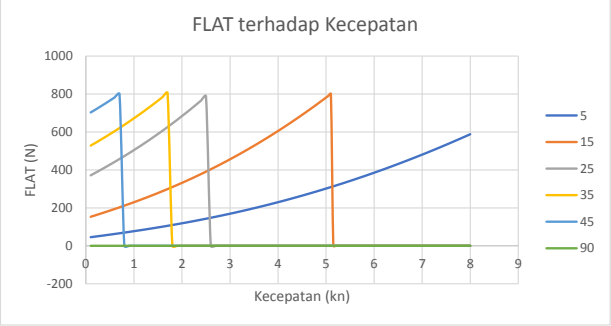
$$M_H = F_H \times h$$

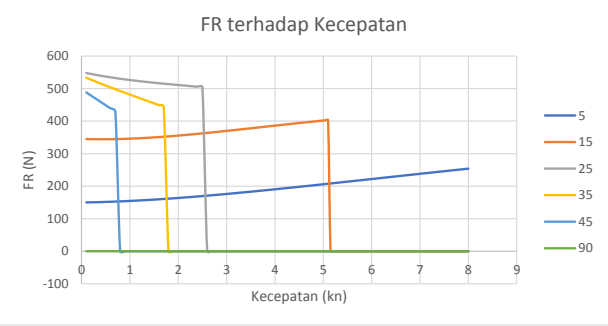
KOEFISIEN LAYAR

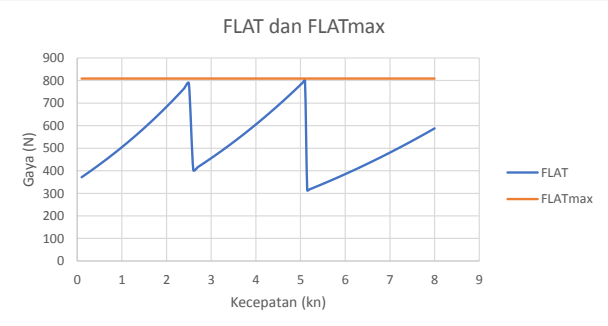
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	5,000 kn
	2,572 m/s
γ	80 °
V_A	3,253 m/s
β	51,135 °
V_S	**1,595 m/s**
	3,100 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

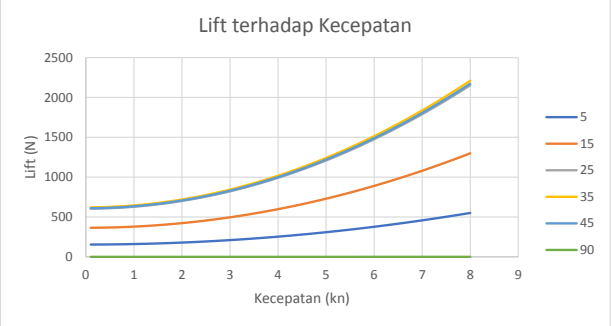
HEELING MOMENT

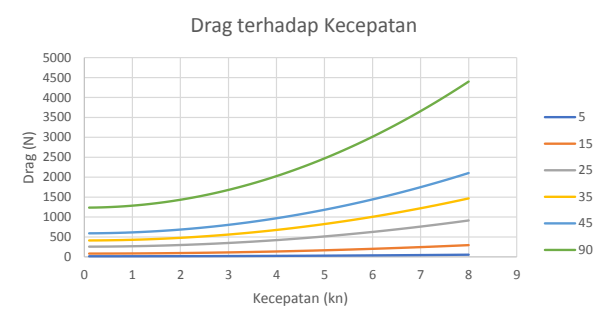
$$M_H = F_H \times h$$

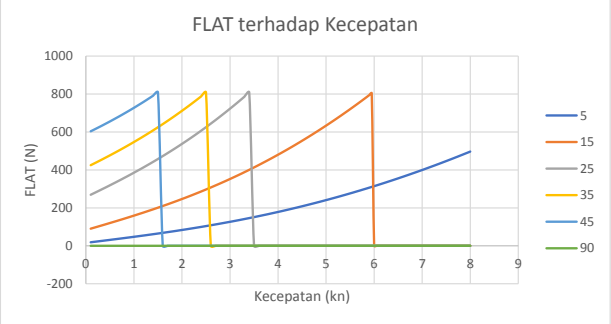
KOEFISIEN LAYAR

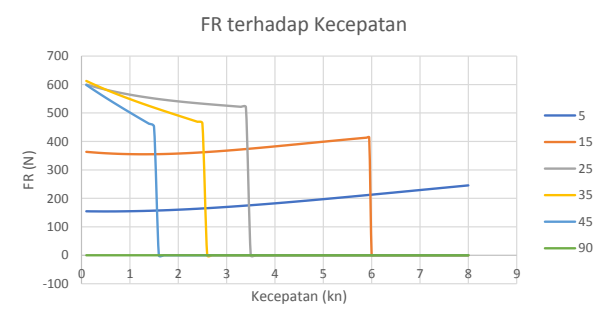
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

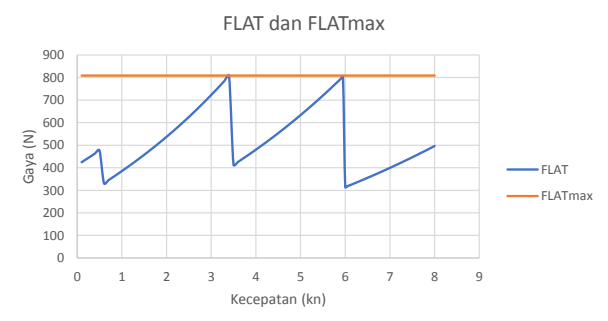
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	90 °
V_A	3,110 m/s
β	55,784 °
V_S	**1,749 m/s**
	3,400 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

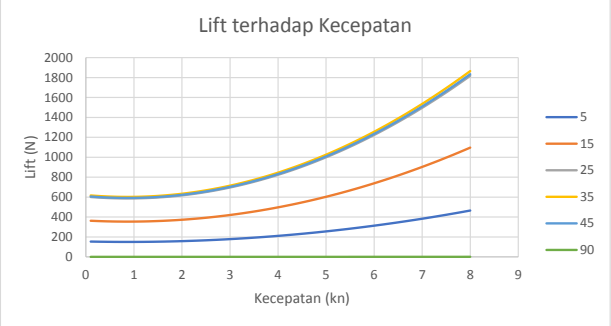
HEELING MOMENT

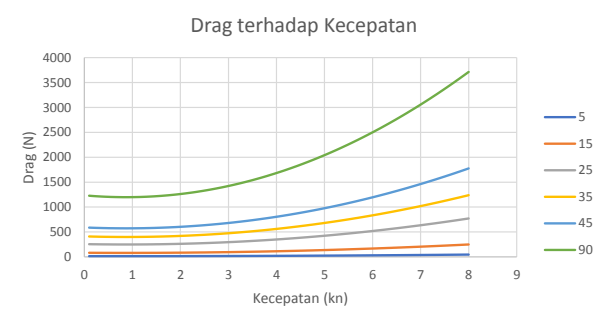
$$M_H = F_H \times h$$

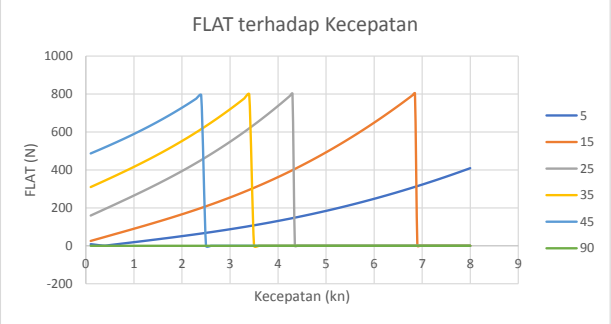
KOEFISIEN LAYAR

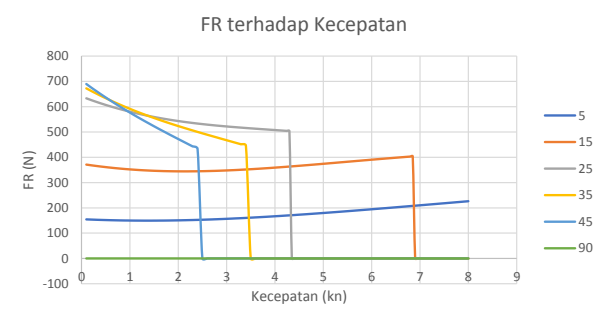
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

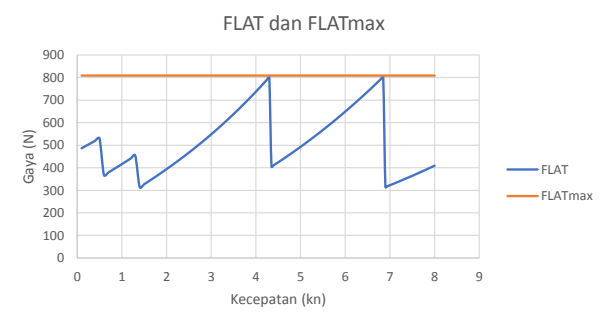
MUATAN				
PENUH	θ_{max}	11 °	h	8,683 m
	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	100 °
V_A	2,897 m/s
β	60,979 °
V_S	**1,852 m/s**
	3,600 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

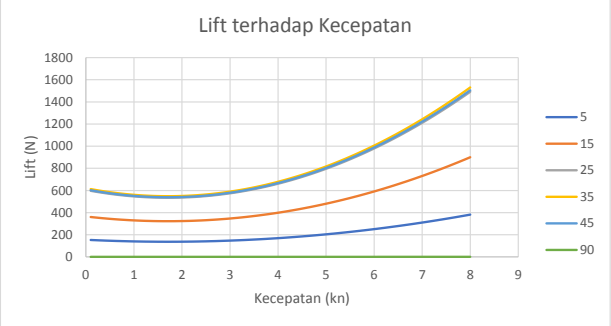
HEELING MOMENT

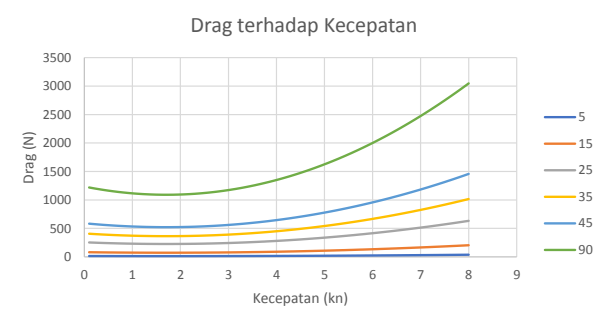
$$M_H = F_H \times h$$

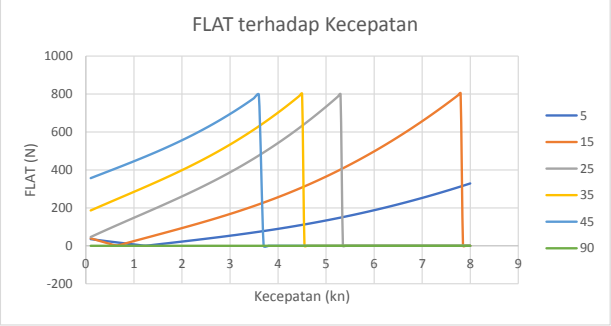
KOEFISIEN LAYAR

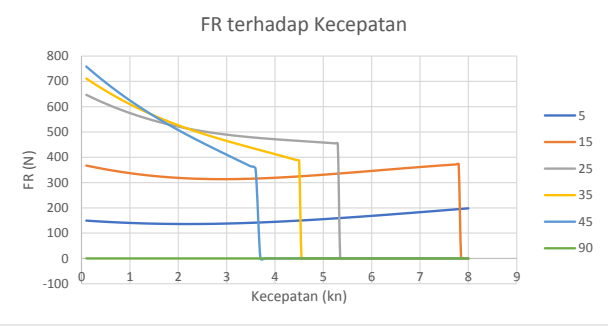
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

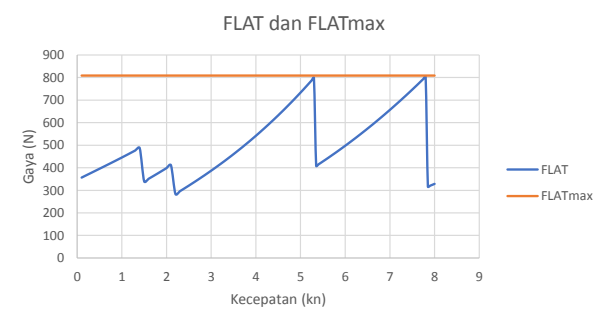
MUATAN				
PENUH	θ_{max}	11 °	h	8,683 m
	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	110 °
V_A	2,586 m/s
β	69,145 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

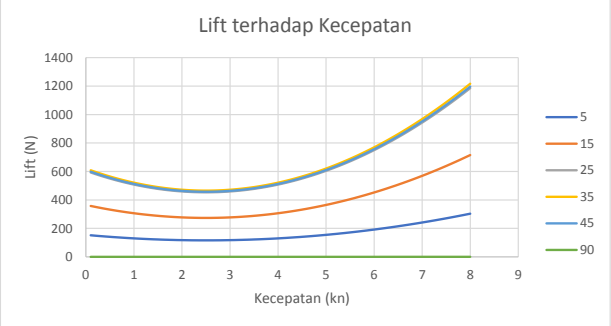
HEELING MOMENT

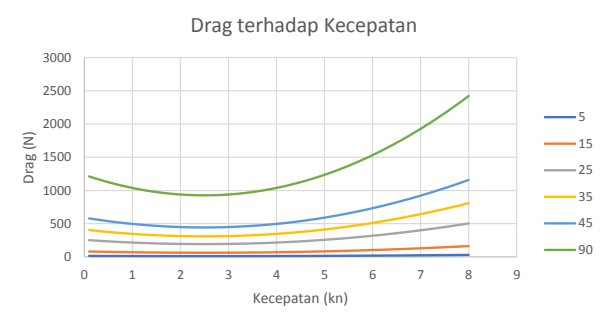
$$M_H = F_H \times h$$

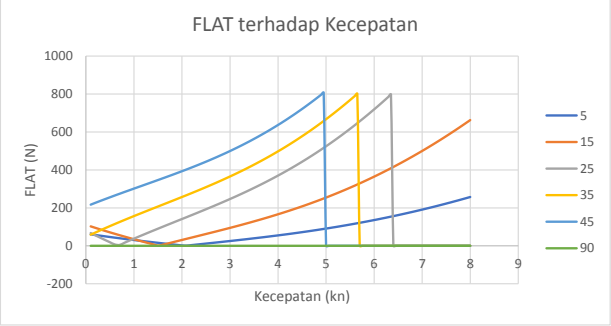
KOEFISIEN LAYAR

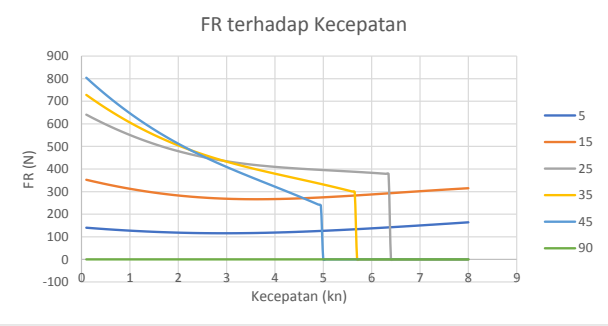
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

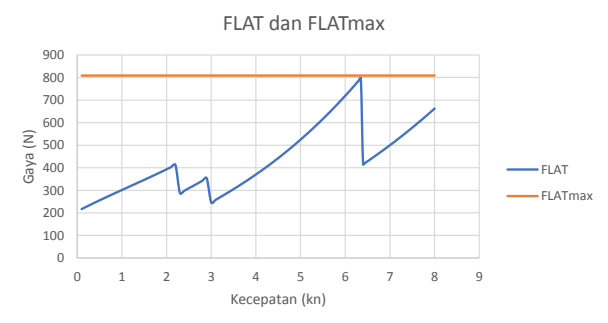
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	120 °
V_A	2,265 m/s
β	79,533 °
V_S	**1,698 m/s**
	3,300 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

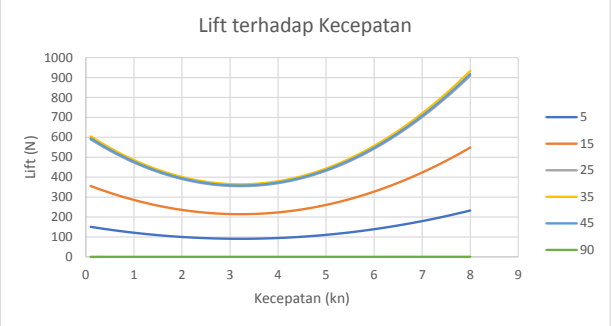
HEELING MOMENT

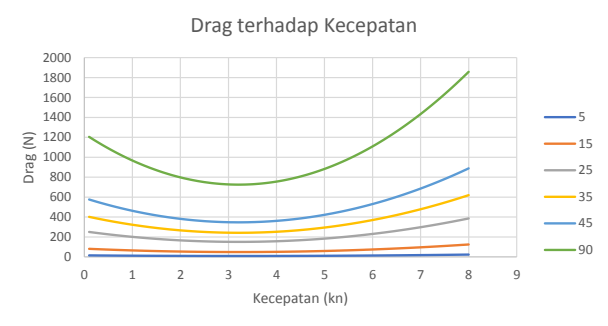
$$M_H = F_H \times h$$

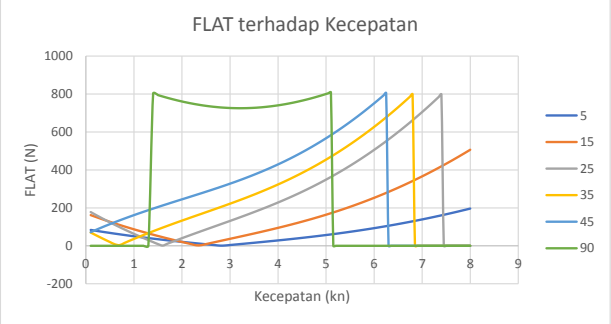
KOEFISIEN LAYAR

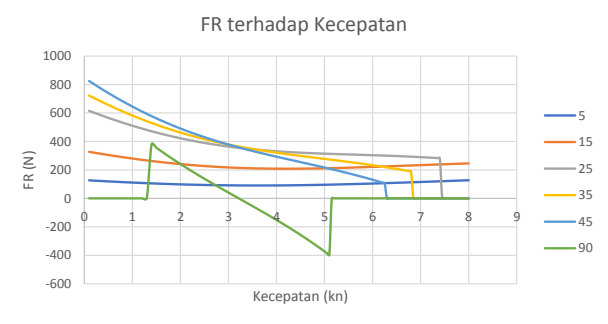
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

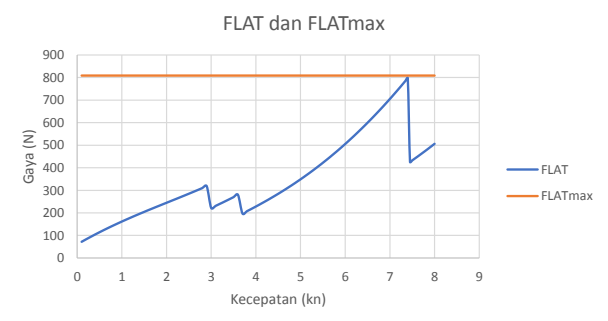
MUATAN				
PENUH	θ_{max}	11 °	h	8,683 m
	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	130 °
V_A	1,971 m/s
β	91,704 °
V_S	**1,595 m/s**
	3,100 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

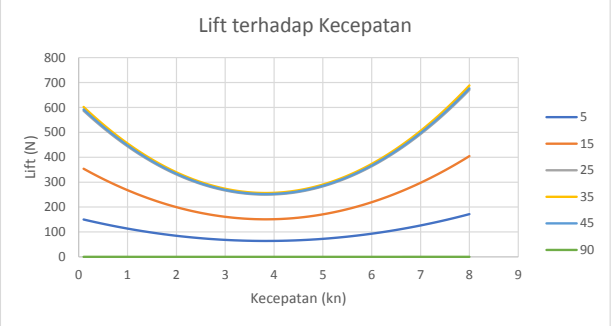
HEELING MOMENT

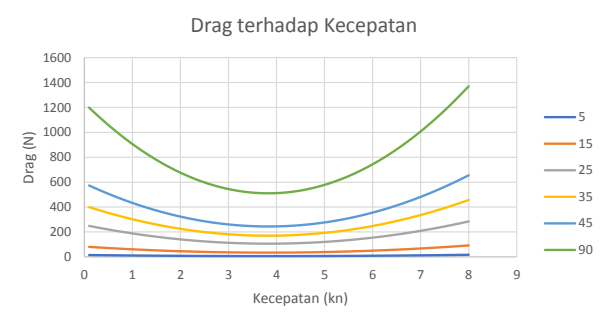
$$M_H = F_H \times h$$

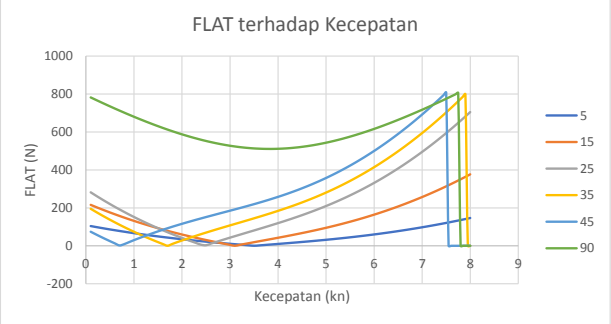
KOEFISIEN LAYAR

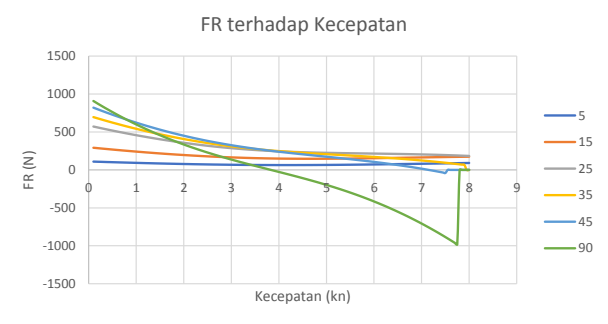
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

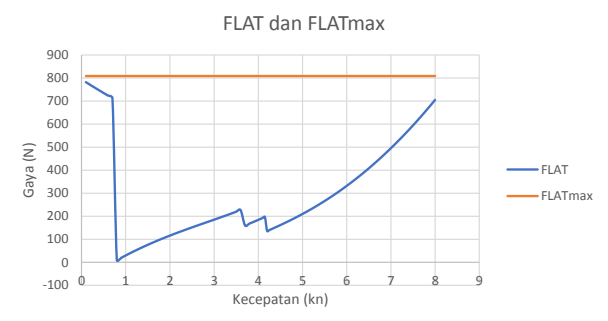
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	140 °
V_A	1,721 m/s
β	106,142 °
V_S	**1,492 m/s**
	2,900 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

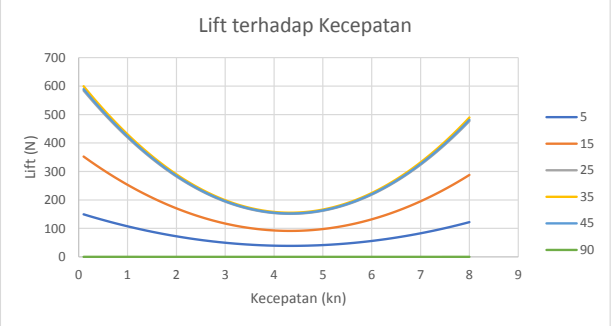
HEELING MOMENT

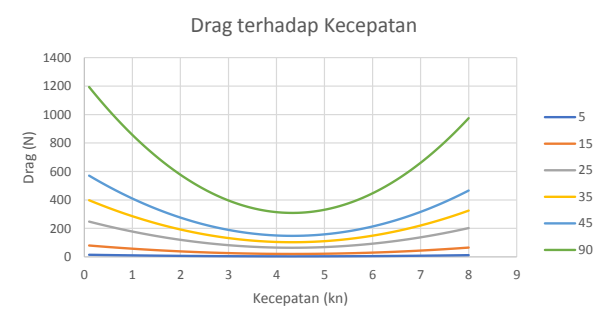
$$M_H = F_H \times h$$

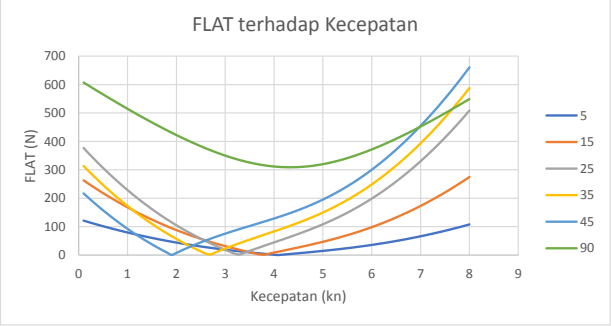
KOEFISIEN LAYAR

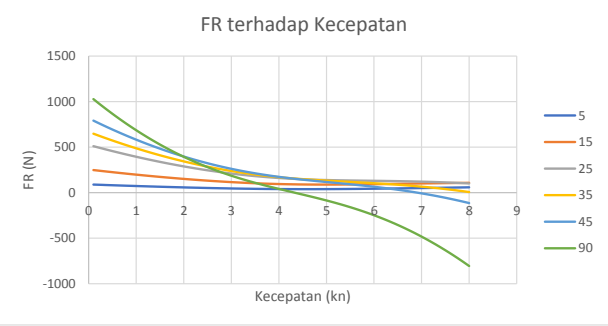
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

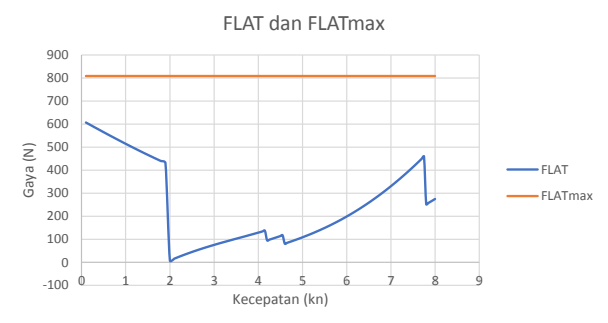
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	150 °
V_A	1,535 m/s
β	123,106 °
V_S	**1,389 m/s**
	2,700 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

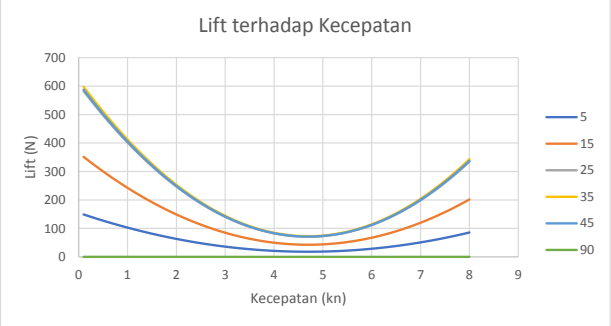
HEELING MOMENT

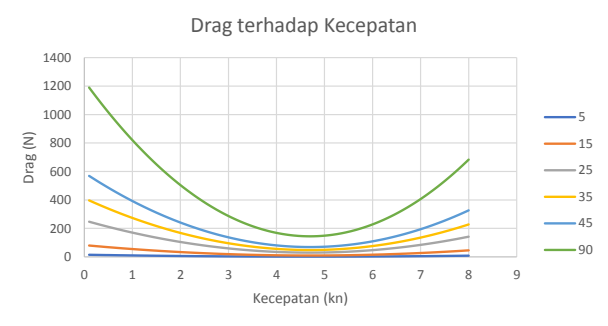
$$M_H = F_H \times h$$

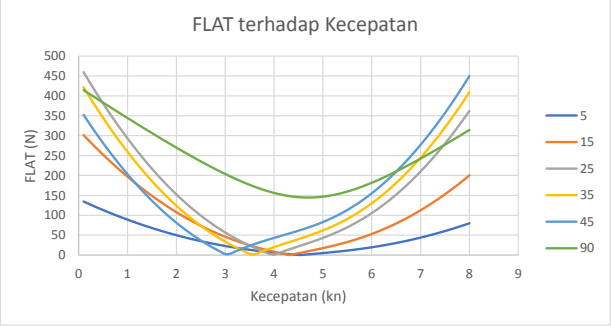
KOEFISIEN LAYAR

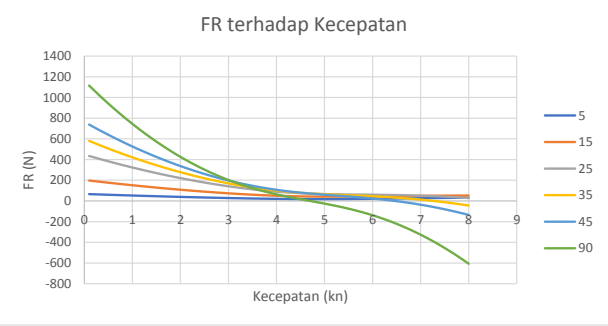
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

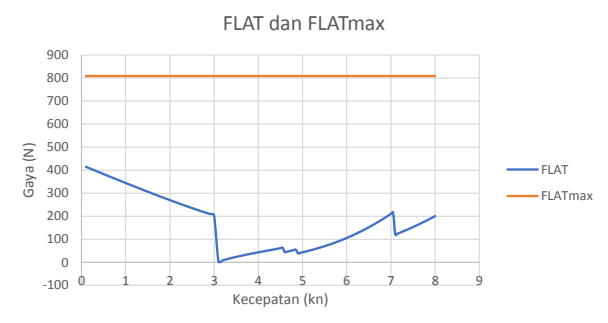
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	160 °
V_A	1,392 m/s
β	140,822 °
V_S	**1,337 m/s**
	2,600 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

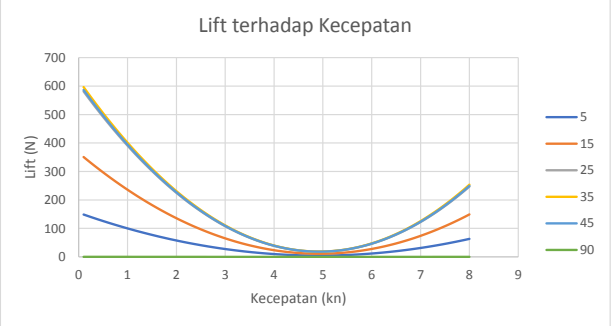
HEELING MOMENT

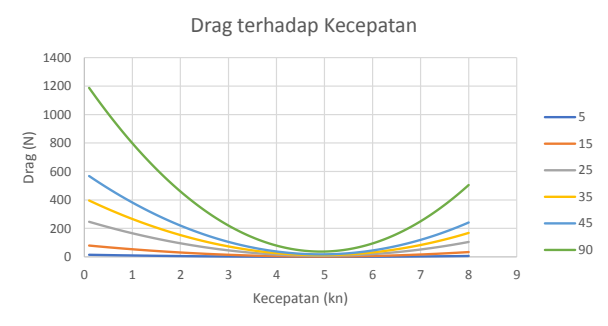
$$M_H = F_H \times h$$

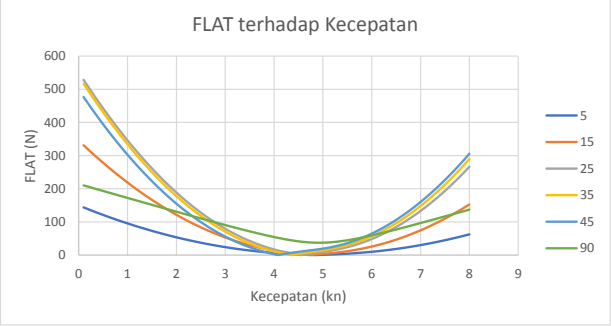
KOEFISIEN LAYAR

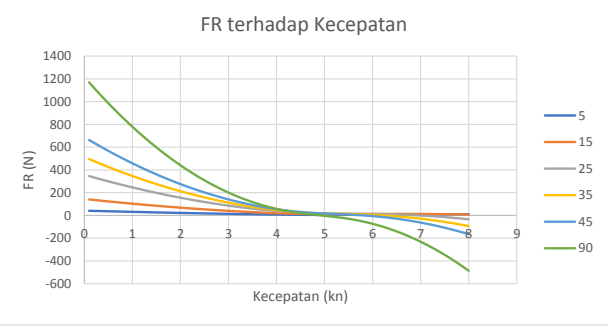
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

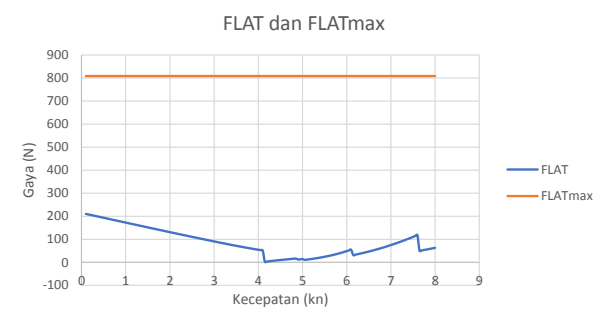
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	170 °
V_A	1,276 m/s
β	159,515 °
V_S	**1,337 m/s**
	2,600 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	5,000 kn
	2,572 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

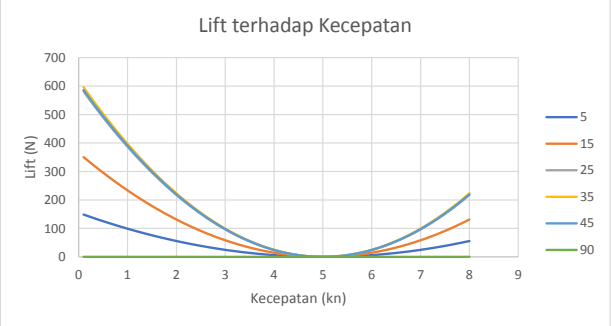
HEELING MOMENT

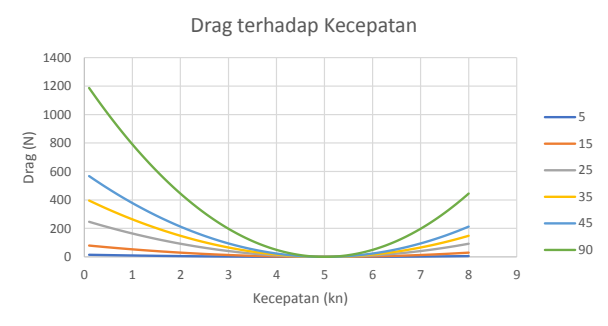
$$M_H = F_H \times h$$

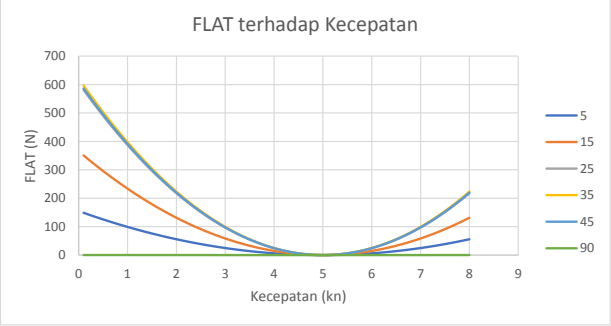
KOEFISIEN LAYAR

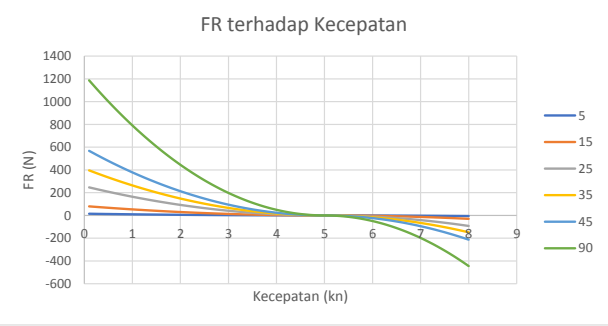
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

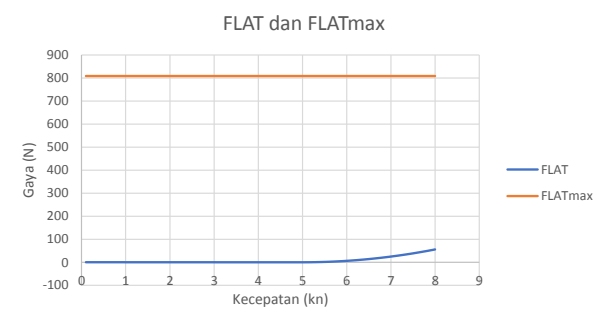
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	180 °
V_A	1,235 m/s
β	180,000 °
V_S	**1,337 m/s**
	2,600 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	30 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

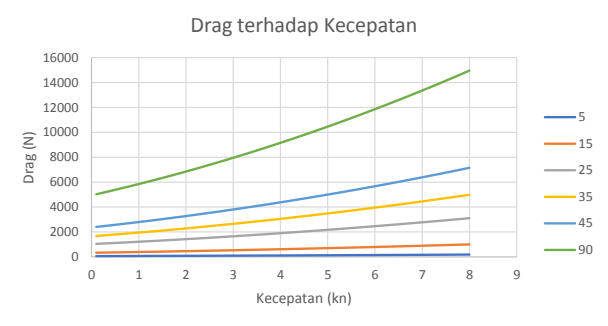
HEELING MOMENT

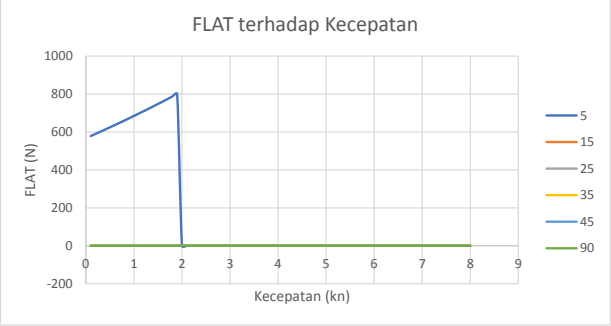
$$M_H = F_H \times h$$

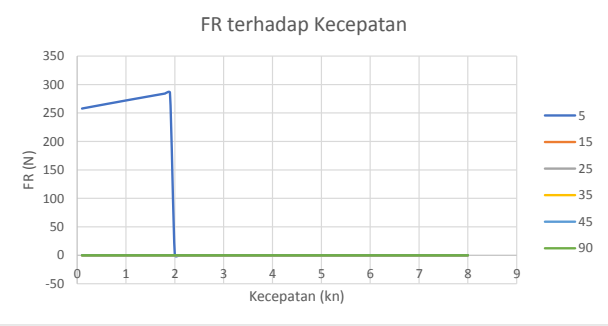
KOEFISIEN LAYAR

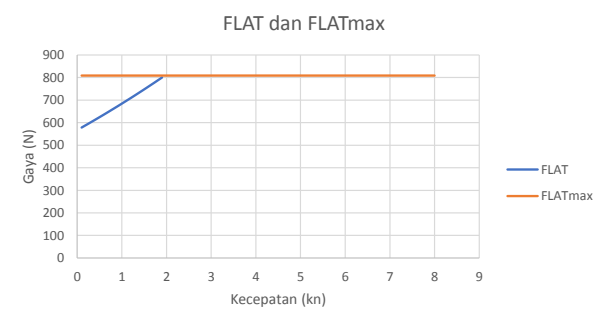
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	30 °
V_A	6,010 m/s
β	25,336 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	40 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

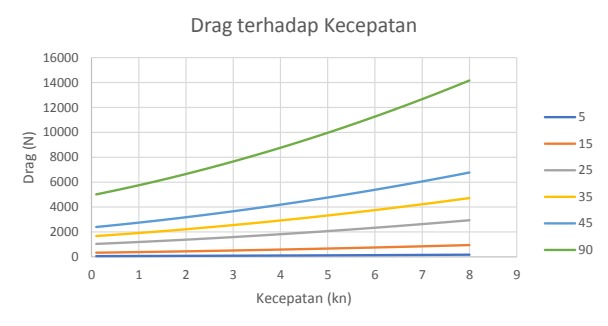
HEELING MOMENT

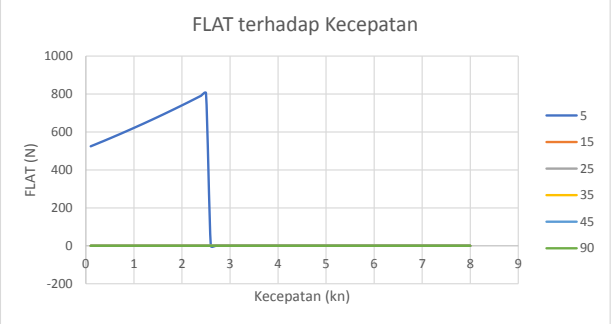
$$M_H = F_H \times h$$

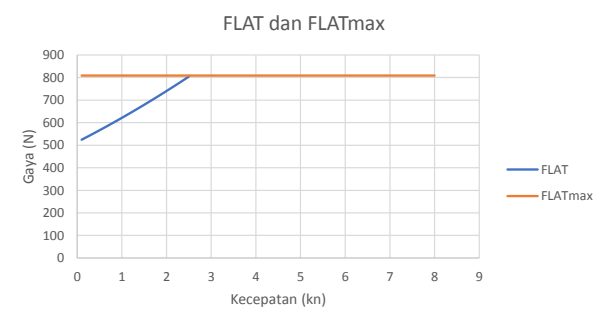
KOEFISIEN LAYAR

α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N







V_T	10,000 kn
	5,144 m/s
γ	40 °
V_A	6,185 m/s
β	32,319 °
V_S	**1,286 m/s**
	2,500 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	50 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

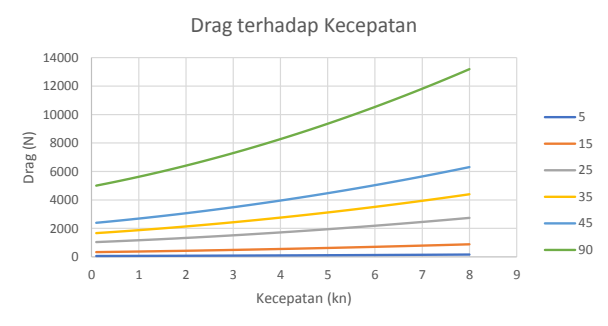
HEELING MOMENT

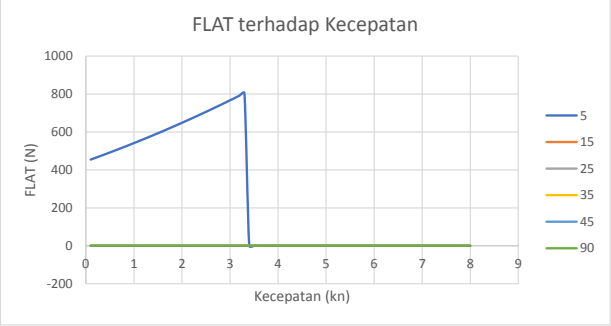
$$M_H = F_H \times h$$

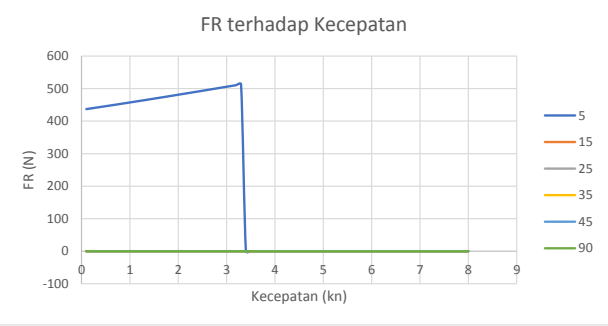
KOEFISIEN LAYAR

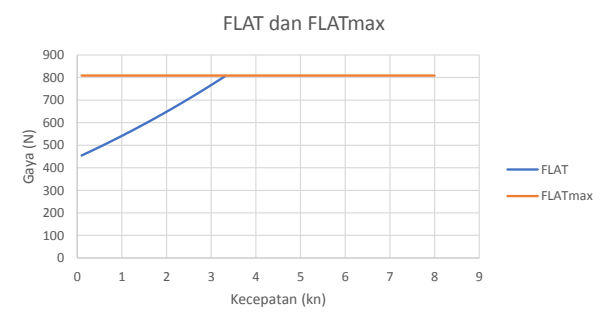
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	50 °
V_A	6,369 m/s
β	38,219 °
V_S	**1,698 m/s**
	3,300 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	60 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

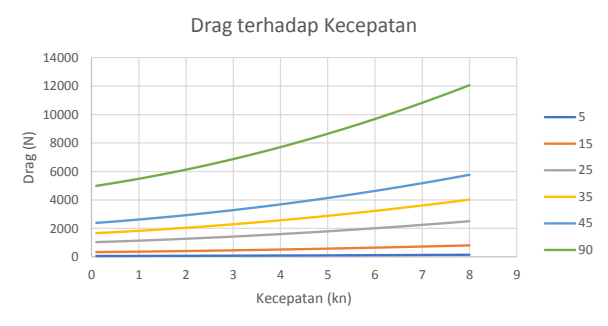
HEELING MOMENT

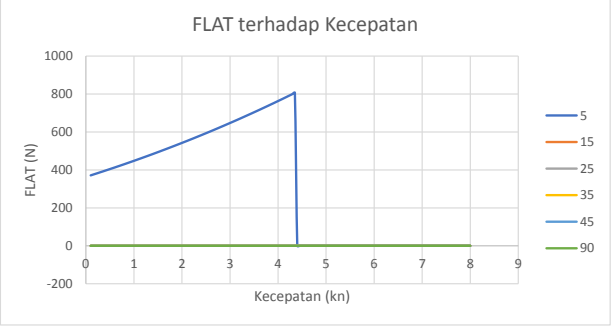
$$M_H = F_H \times h$$

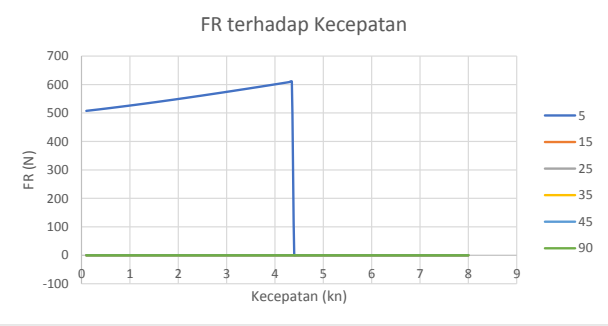
KOEFISIEN LAYAR

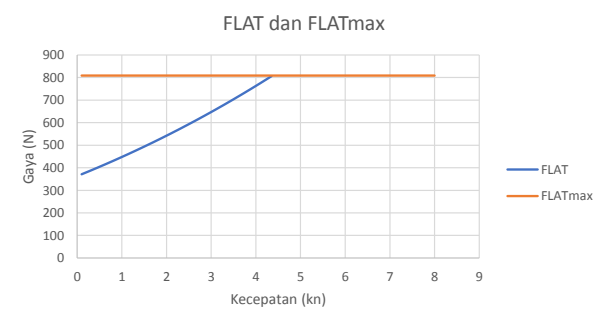
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	60 °
V_A	6,388 m/s
β	44,218 °
V_S	**2,006 m/s**
	3,900 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	70 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

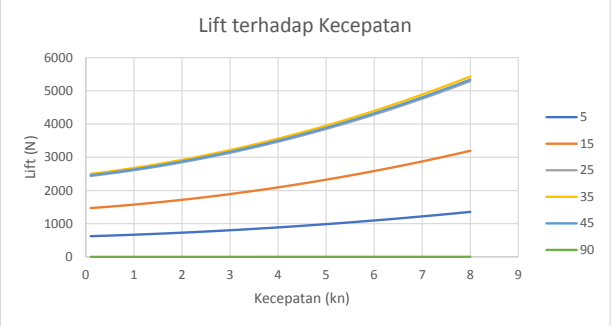
HEELING MOMENT

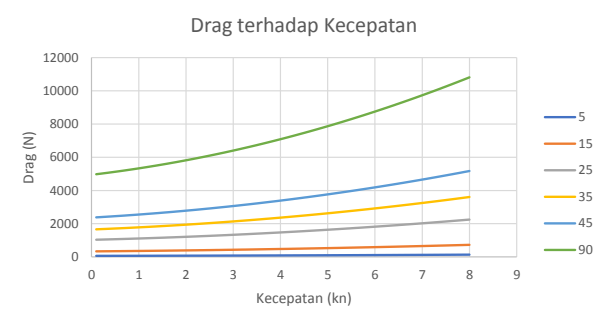
$$M_H = F_H \times h$$

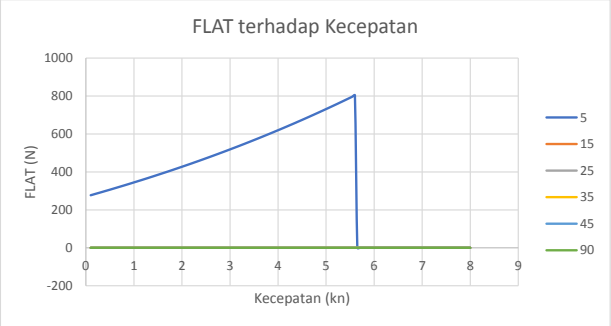
KOEFISIEN LAYAR

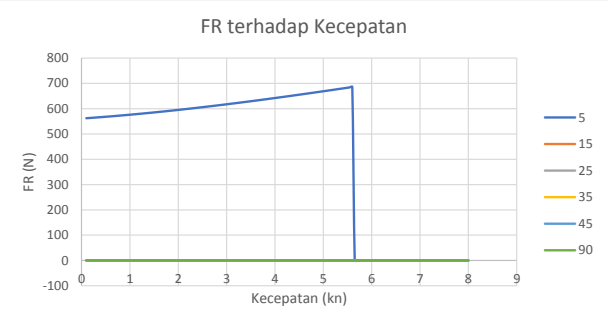
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

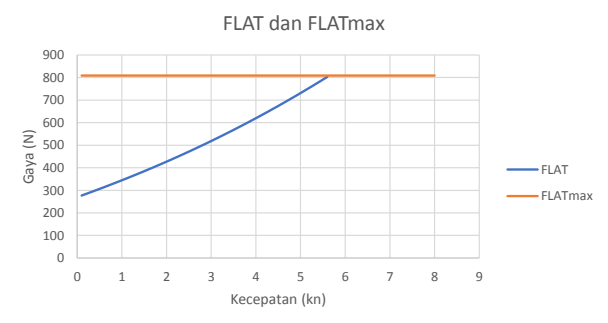
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	70 °
V_A	6,159 m/s
β	51,704 °
V_S	**2,109 m/s**
	4,100 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	80 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

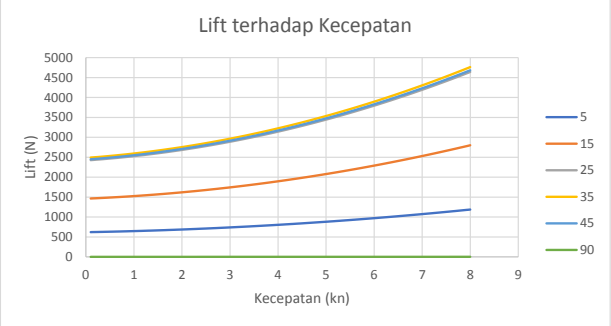
HEELING MOMENT

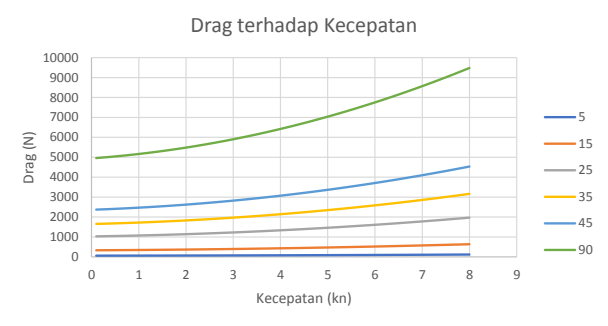
$$M_H = F_H \times h$$

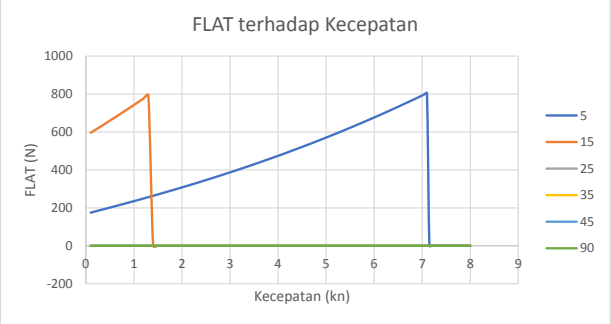
KOEFISIEN LAYAR

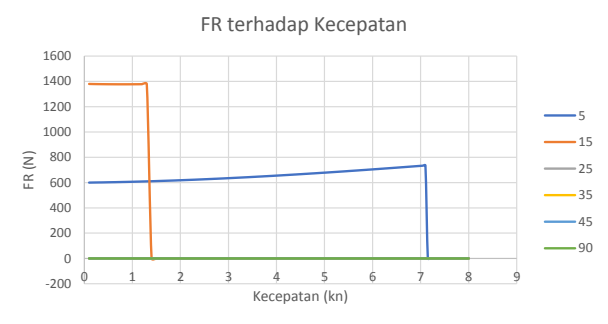
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

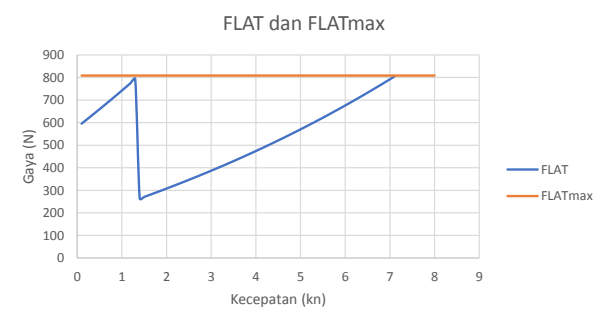
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	80 °
V_A	5,863 m/s
β	59,779 °
V_S	**2,109 m/s**
	4,100 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	90 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

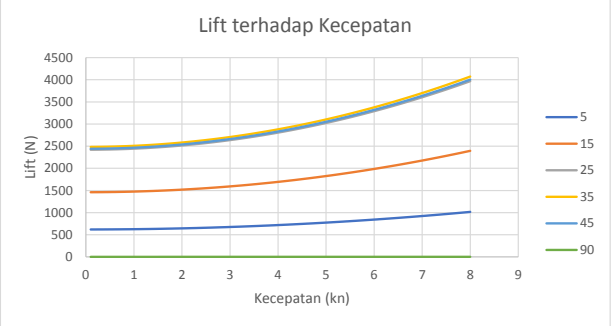
HEELING MOMENT

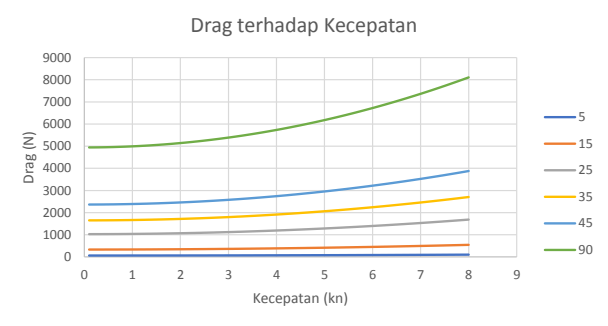
$$M_H = F_H \times h$$

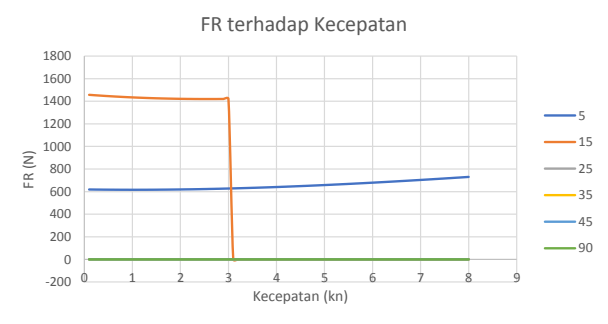
KOEFISIEN LAYAR

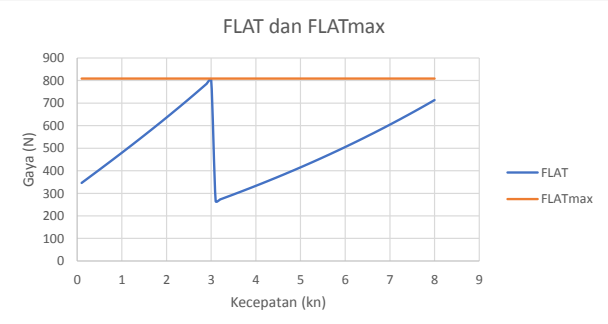
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	90 °
V_A	5,540 m/s
β	68,199 °
V_S	**2,083 m/s**
	4,050 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	100 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

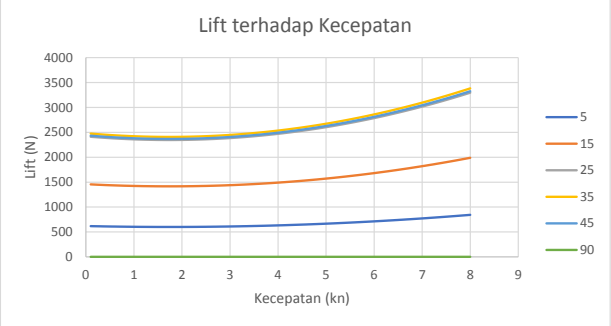
HEELING MOMENT

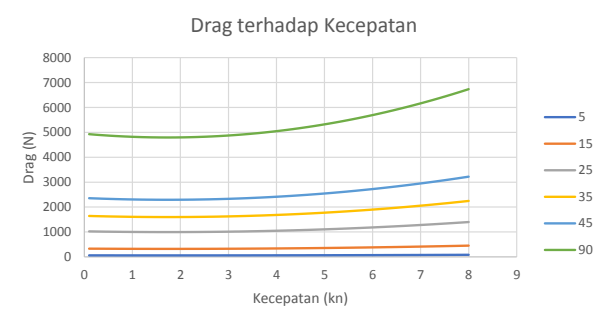
$$M_H = F_H \times h$$

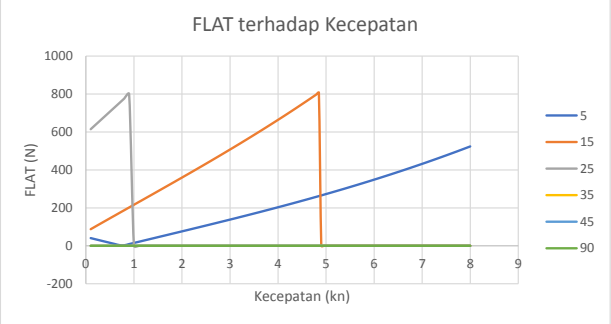
KOEFISIEN LAYAR

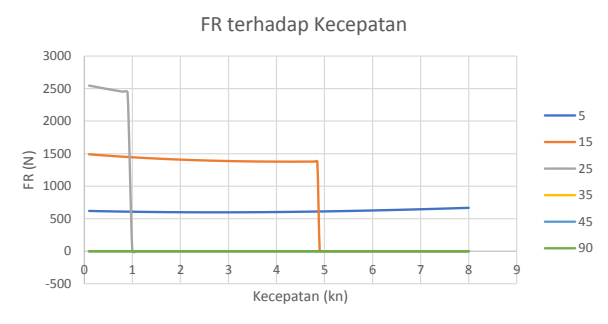
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

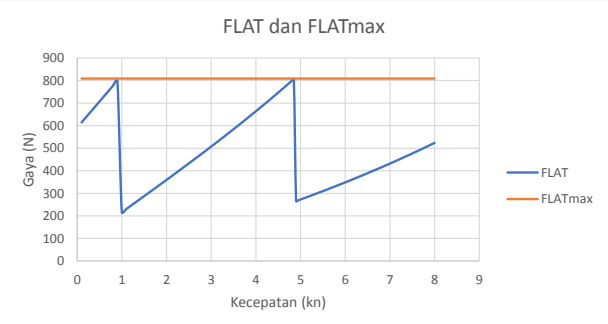
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	100 °
V_A	5,198 m/s
β	77,056 °
V_S	**2,521 m/s**
	4,900 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	110 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

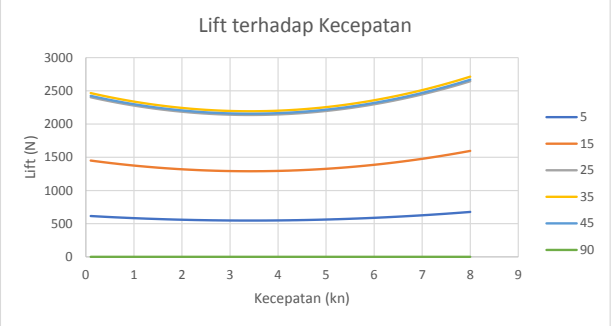
HEELING MOMENT

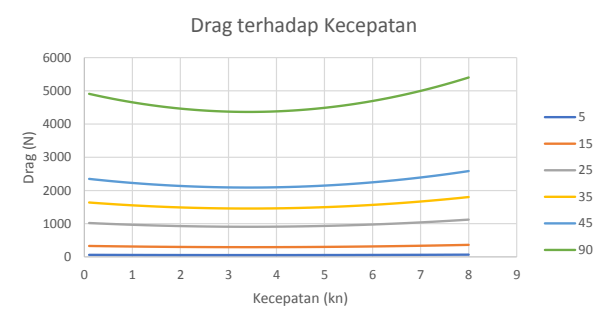
$$M_H = F_H \times h$$

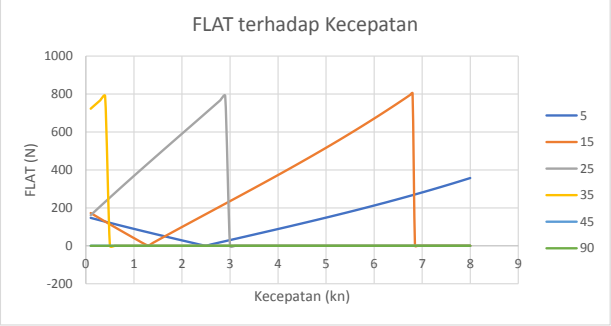
KOEFISIEN LAYAR

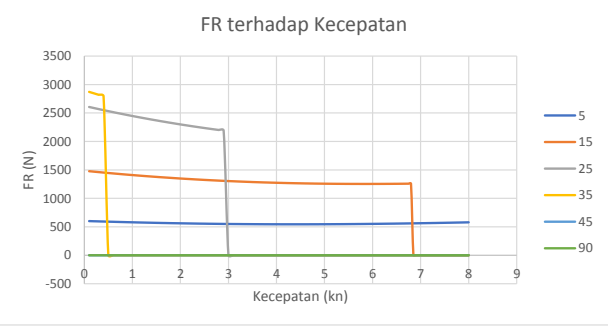
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

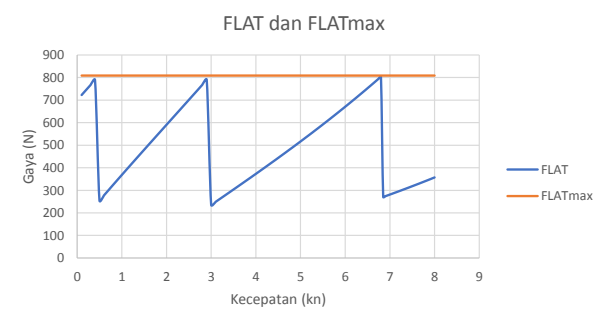
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	110 °
V_A	4,843 m/s
β	86,469 °
V_S	**2,803 m/s**
	5,450 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	120 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

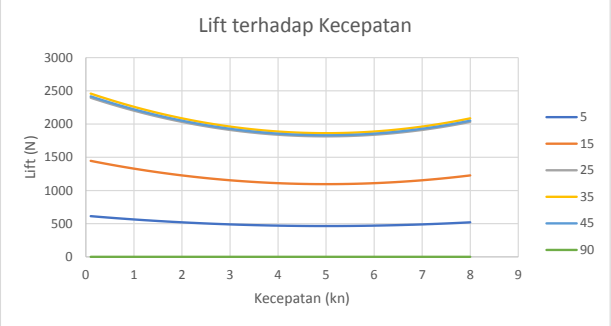
HEELING MOMENT

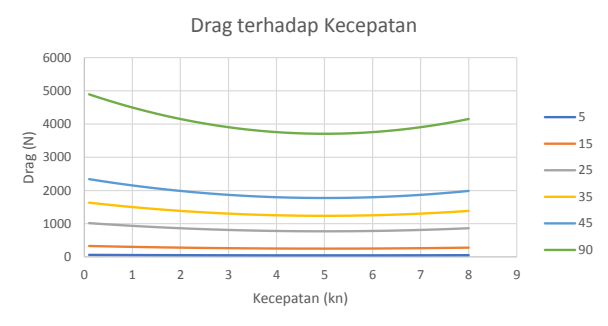
$$M_H = F_H \times h$$

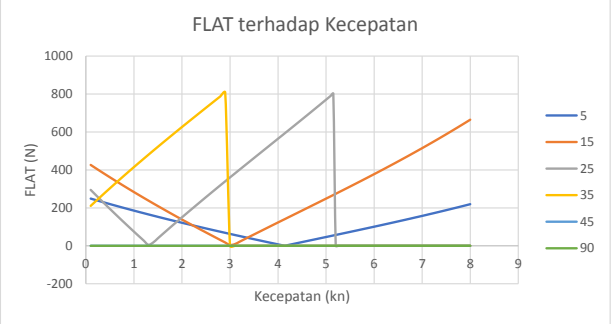
KOEFISIEN LAYAR

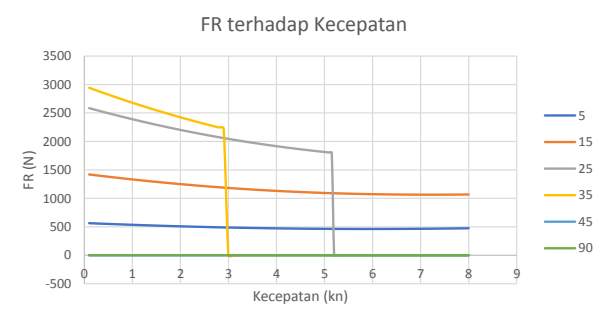
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

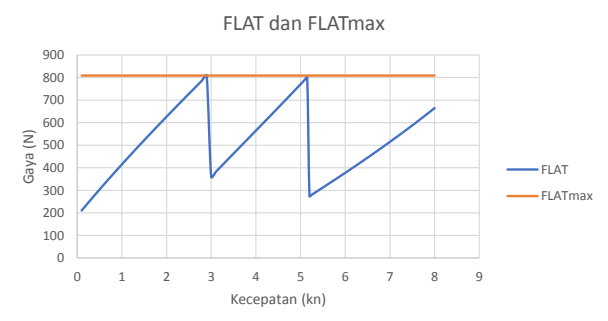
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	120 °
V_A	4,484 m/s
β	96,587 °
V_S	**2,675 m/s**
	5,200 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	130 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

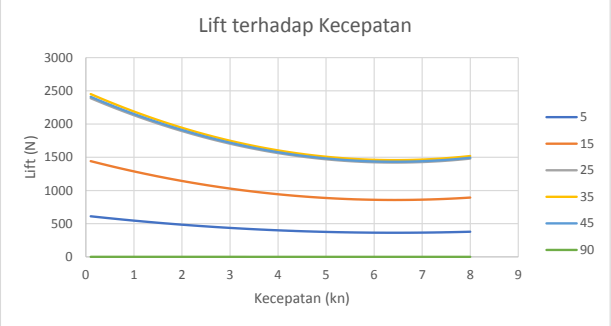
HEELING MOMENT

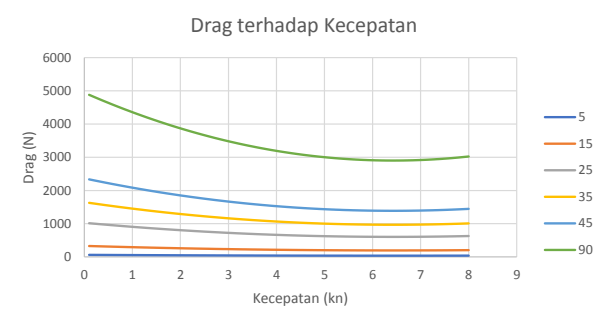
$$M_H = F_H \times h$$

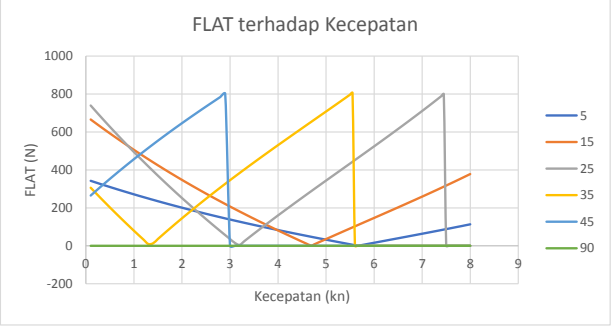
KOEFISIEN LAYAR

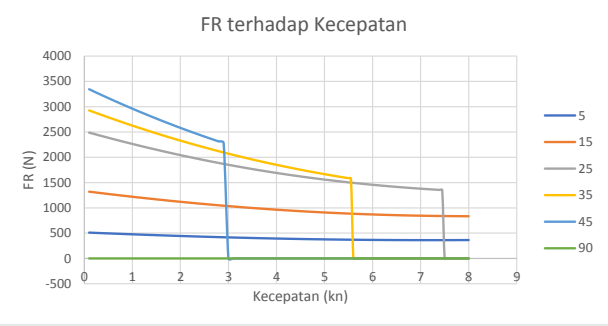
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

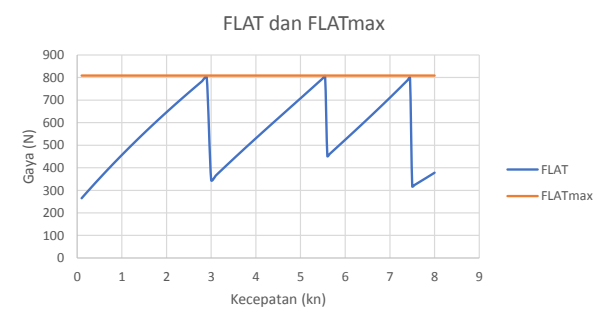
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	130 °
V_A	4,134 m/s
β	107,585 °
V_S	**2,958 m/s**
	5,750 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	140 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

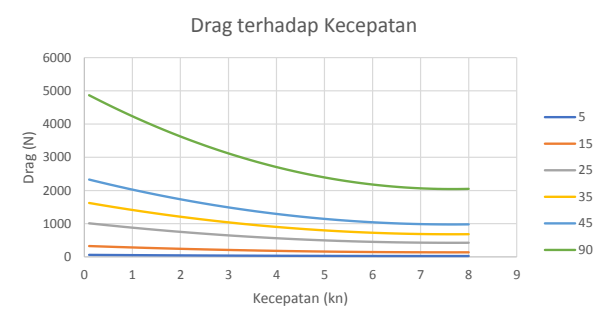
HEELING MOMENT

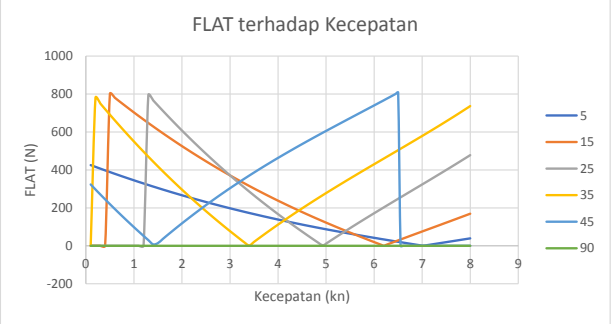
$$M_H = F_H \times h$$

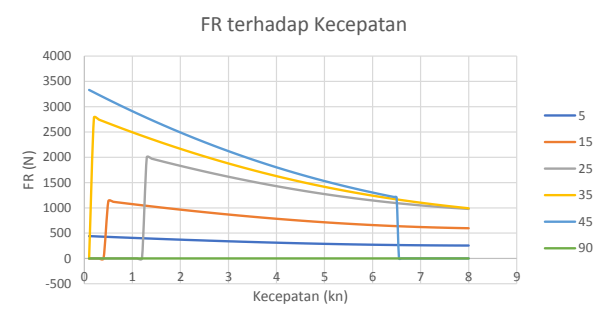
KOEFISIEN LAYAR

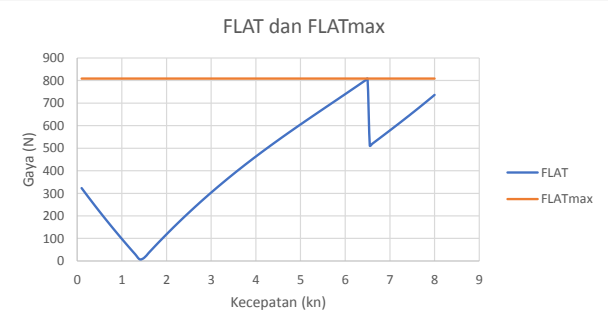
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	140 °
V_A	3,805 m/s
β	119,660 °
V_S	**2,881 m/s**
	5,600 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	150 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

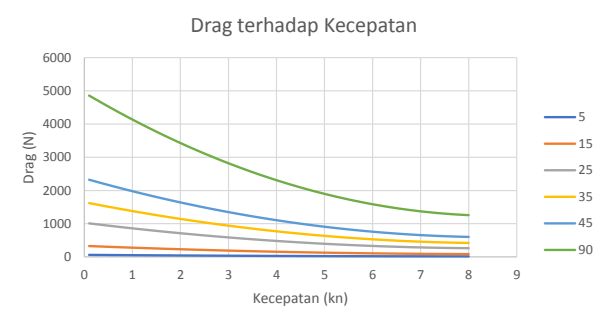
HEELING MOMENT

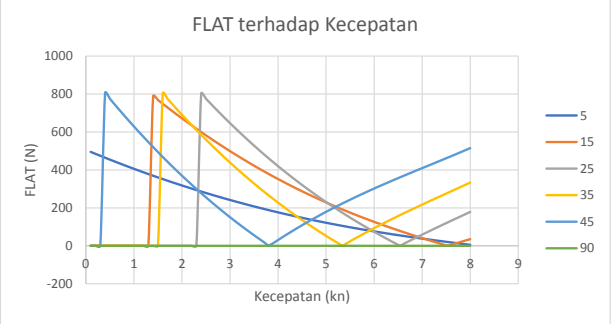
$$M_H = F_H \times h$$

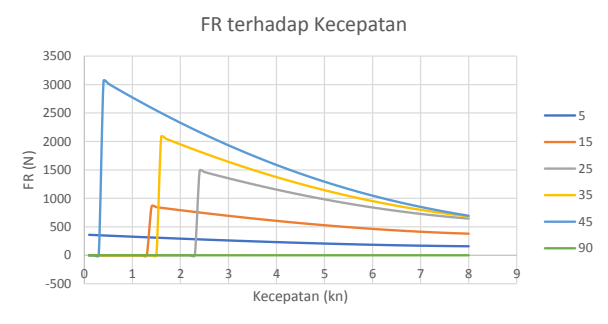
KOEFISIEN LAYAR

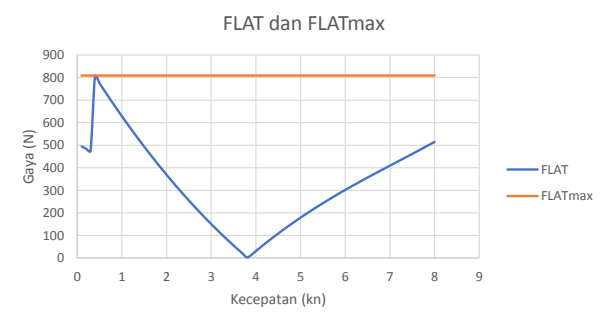
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	150 °
V_A	5,011 m/s
β	149,118 °
V_S	**2,752 m/s**
	5,350 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	160 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

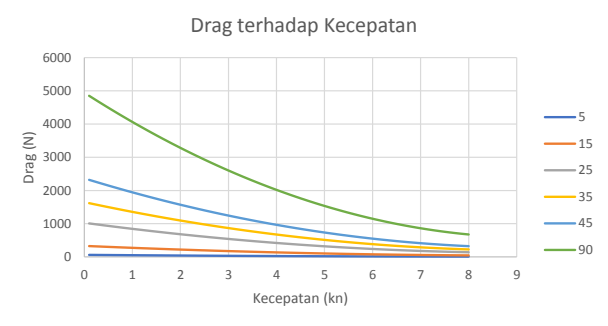
HEELING MOMENT

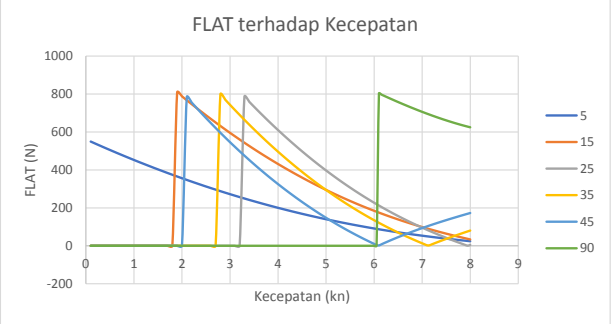
$$M_H = F_H \times h$$

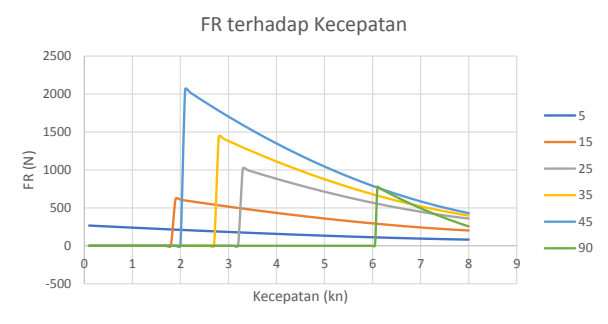
KOEFISIEN LAYAR

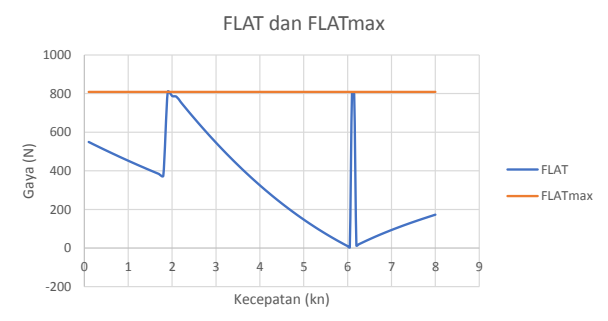
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN				
PENUH	θ_{max}	11 °	h	8,683 m
	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	160 °
V_A	4,286 m/s
β	155,762 °
V_S	**2,598 m/s**
	5,050 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	170 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

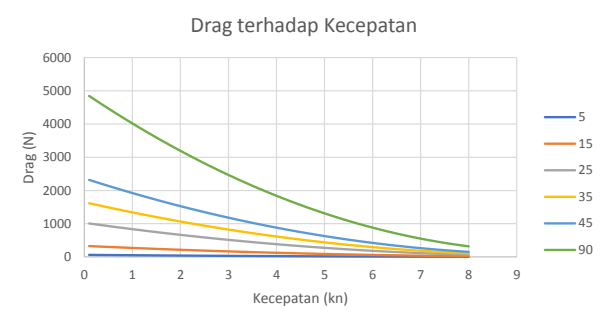
HEELING MOMENT

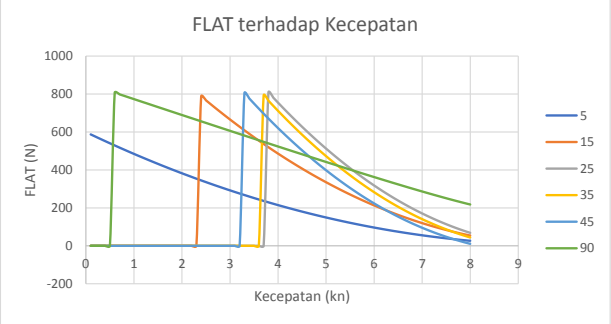
$$M_H = F_H \times h$$

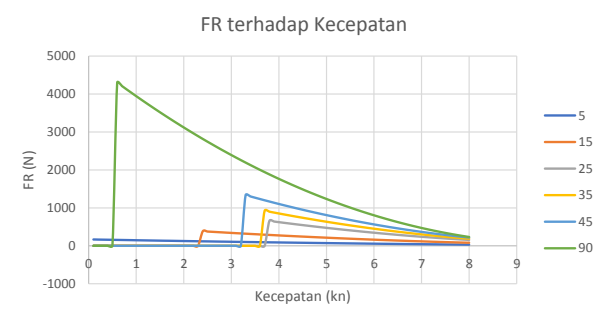
KOEFISIEN LAYAR

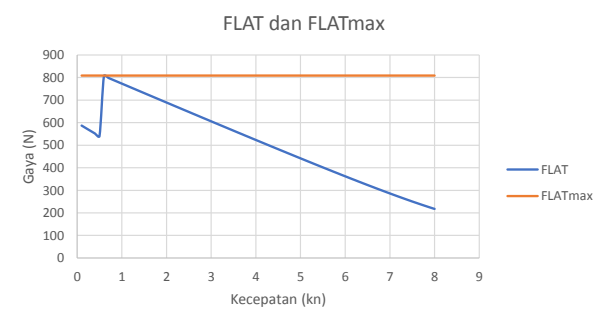
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	170 °
V_A	4,891 m/s
β	169,477 °
V_S	**2,701 m/s**
	5,250 kn

SPESIFIKASI LAYAR

Model		Padewakang-Ma
Span	Yard	16,454 m
	Boom	16,454 m
Chord		5,854 m
Area		96,322 m^2

TRUE WIND

ρ	1,2 kg/m^3
V_T	10,000 kn
	5,144 m/s
γ	180 °

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

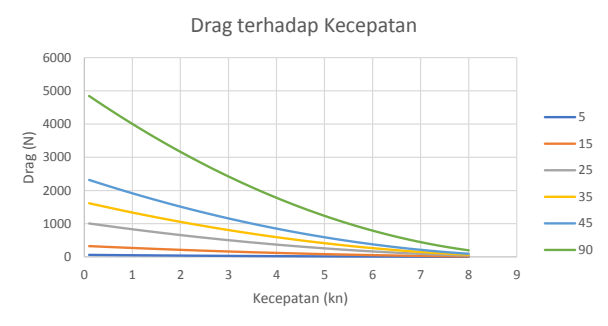
HEELING MOMENT

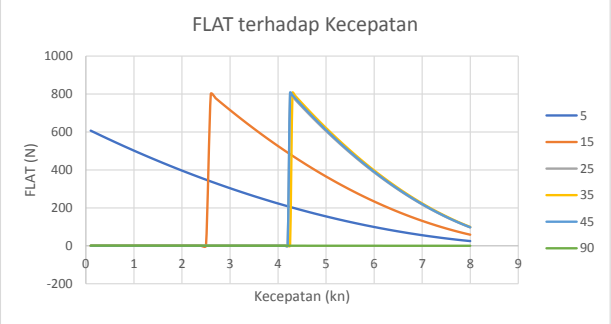
$$M_H = F_H \times h$$

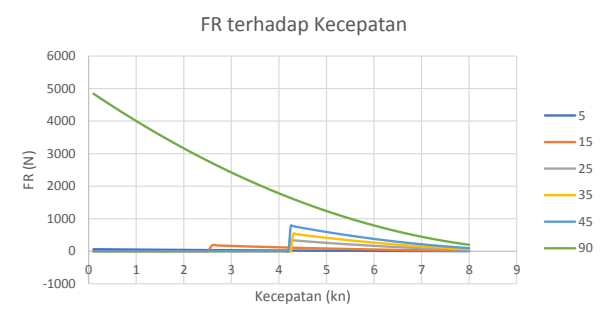
KOEFISIEN LAYAR

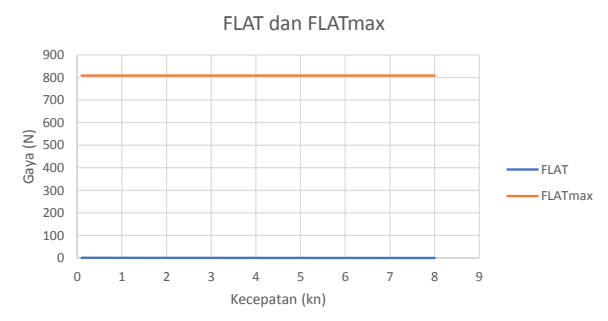
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N









V_T	10,000 kn
	5,144 m/s
γ	180 °
V_A	3,086 m/s
β	180,000 °
V_S	**2,675 m/s**
	5,200 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

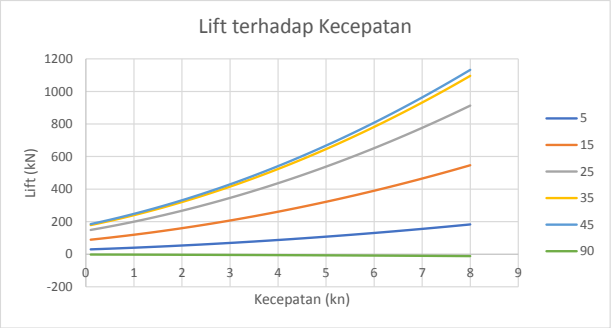
KOEFISIEN MAIN SAIL

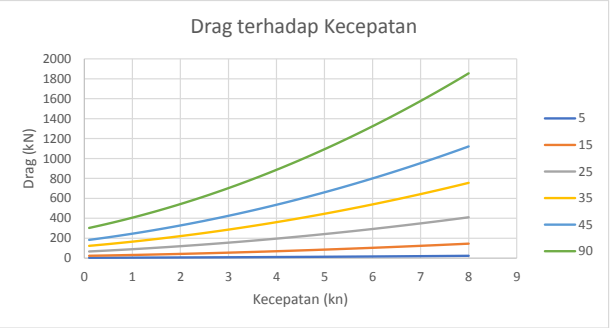
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

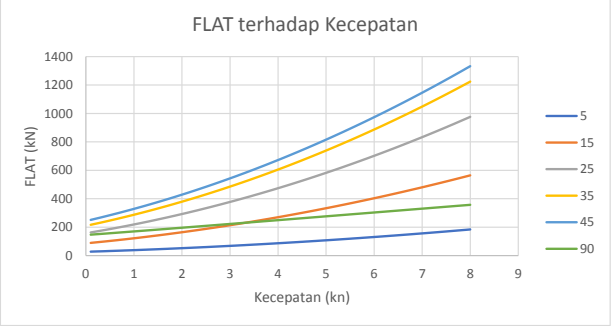
KOEFISIEN MIZZEN SAIL

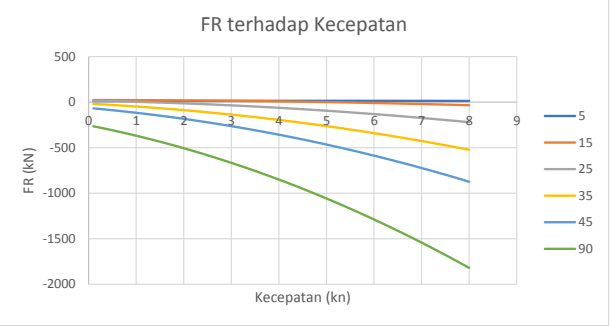
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

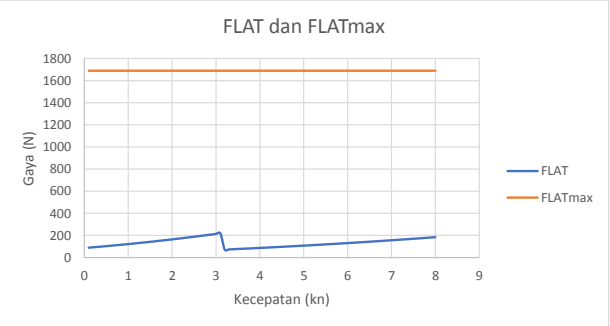
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	30 °
V_A	2,889 m/s
β	26,428 °
V_S	**0,360 m/s**
	0,700 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

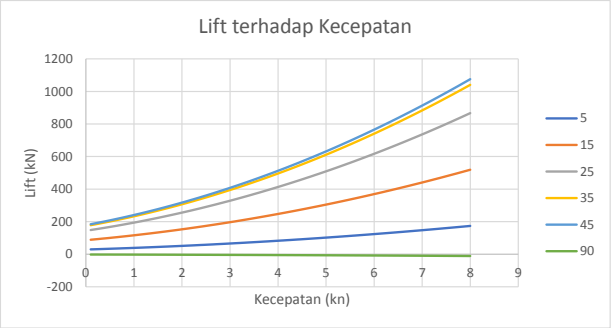
KOEFISIEN MAIN SAIL

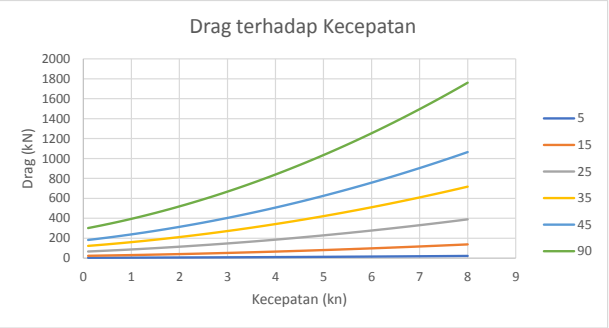
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

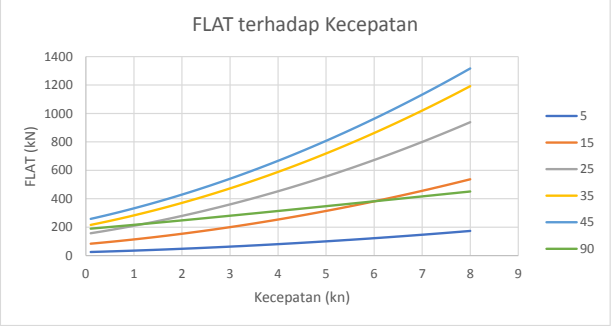
KOEFISIEN MIZZEN SAIL

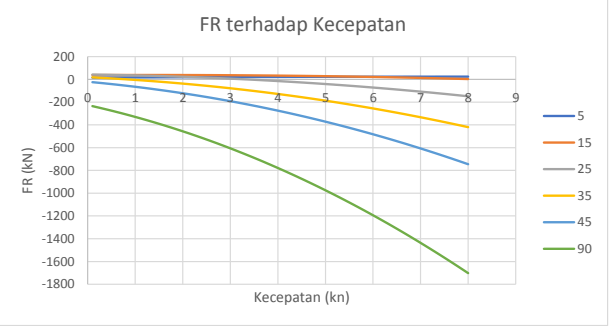
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

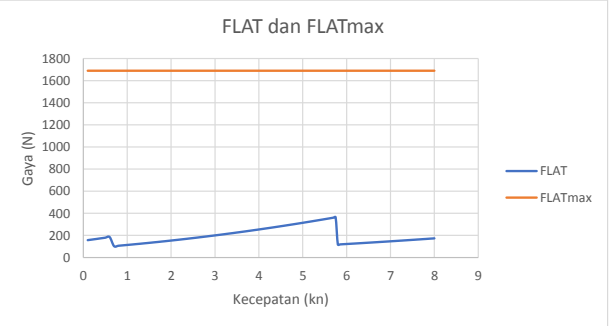
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	40 °
V_A	2,942 m/s
β	34,194 °
V_S	**0,463 m/s**
	0,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

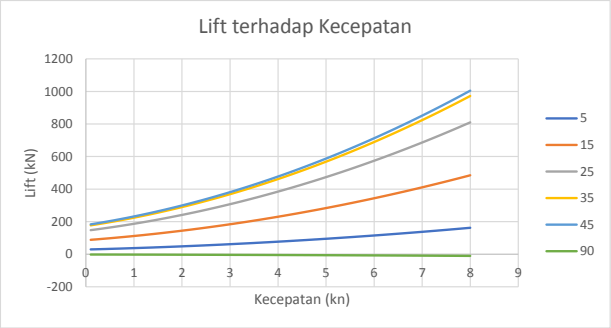
KOEFISIEN MAIN SAIL

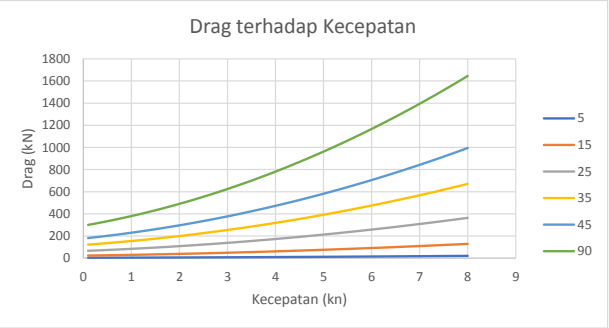
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

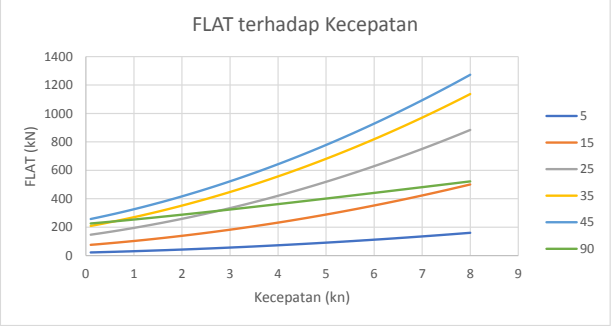
KOEFISIEN MIZZEN SAIL

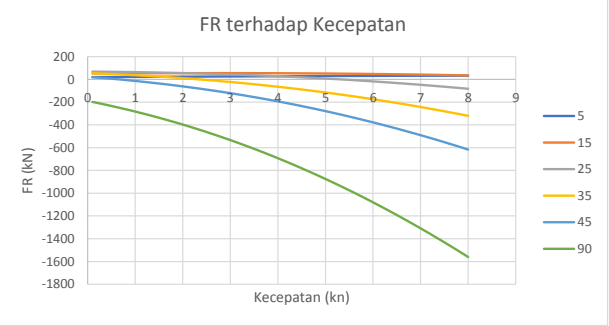
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

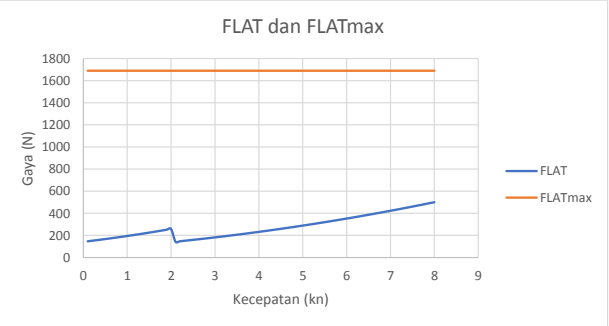
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	50 °
V_A	3,006 m/s
β	40,950 °
V_S	**0,617 m/s**
	1,200 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

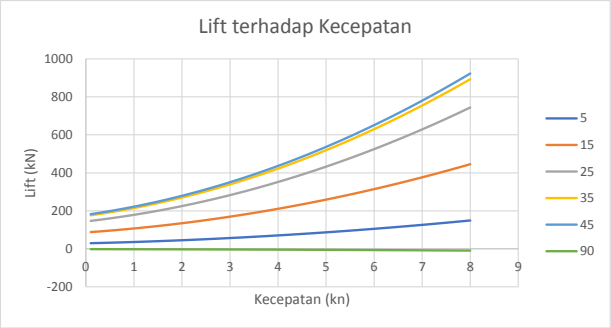
KOEFISIEN MAIN SAIL

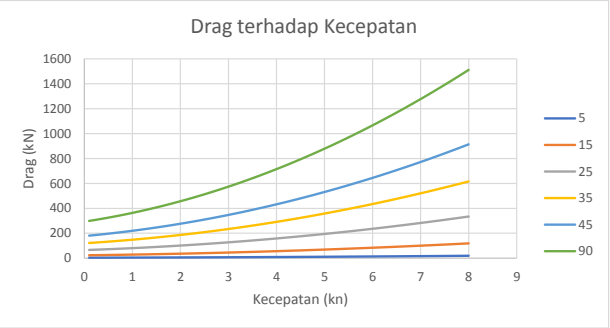
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

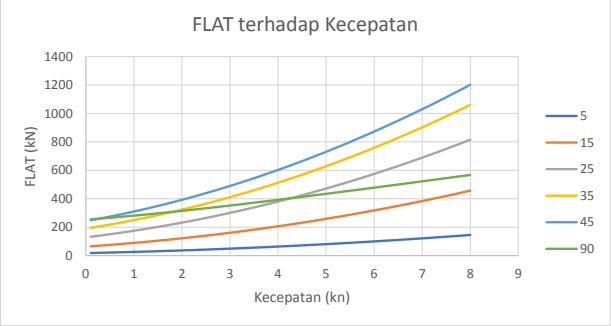
KOEFISIEN MIZZEN SAIL

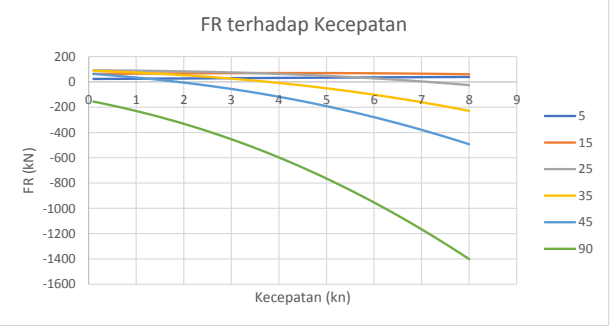
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

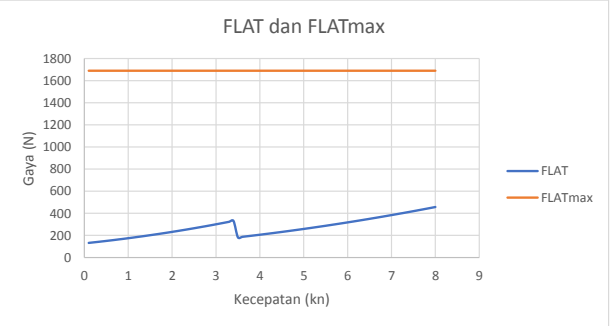
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	60 °
V_A	2,998 m/s
β	47,992 °
V_S	**0,720 m/s**
	1,400 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

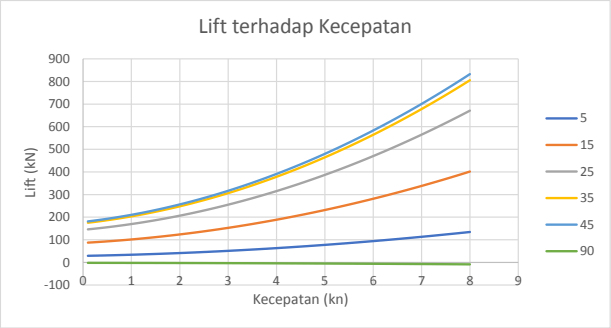
KOEFISIEN MAIN SAIL

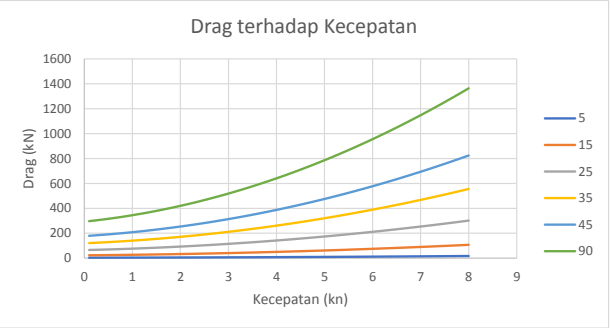
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

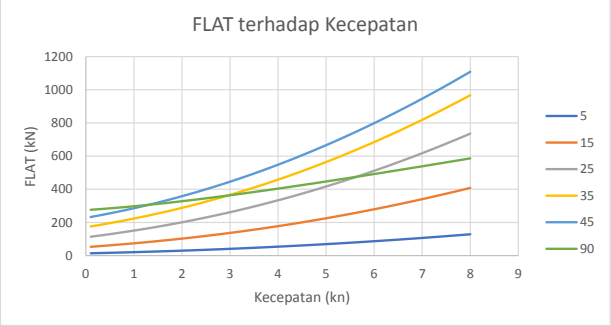
KOEFISIEN MIZZEN SAIL

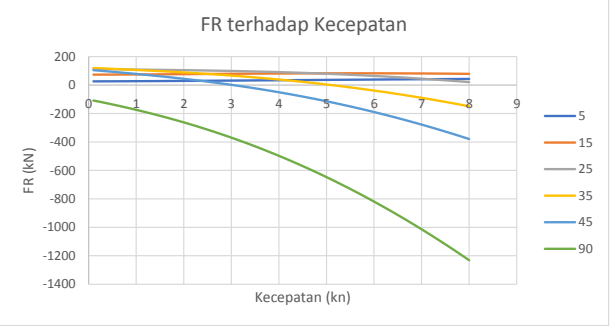
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

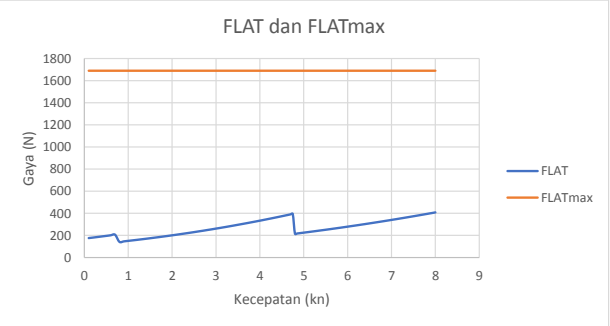
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	70 °
V_A	2,956 m/s
β	54,835 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

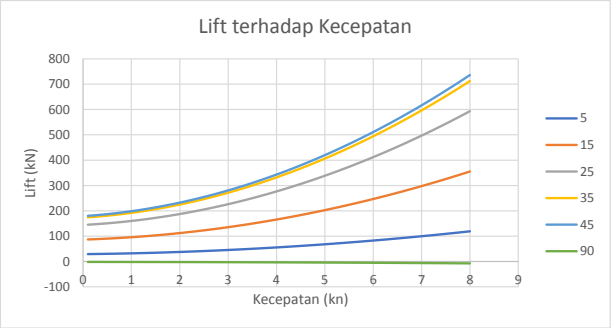
KOEFISIEN MAIN SAIL

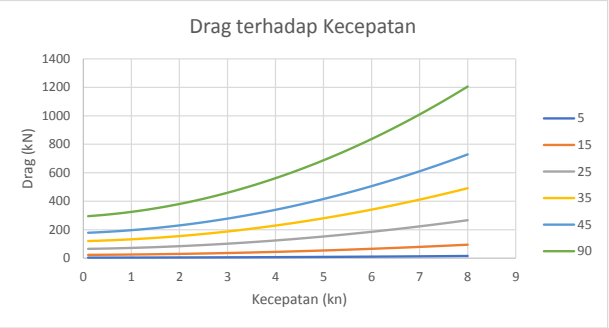
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

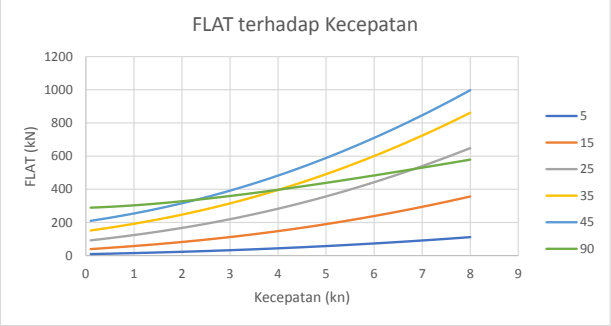
KOEFISIEN MIZZEN SAIL

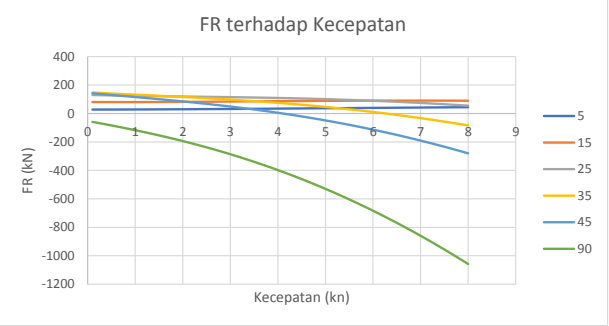
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

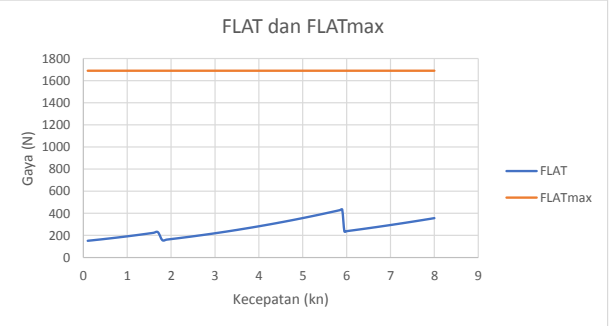
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	80 °
V_A	2,857 m/s
β	62,455 °
V_S	**0,874 m/s**
	1,700 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

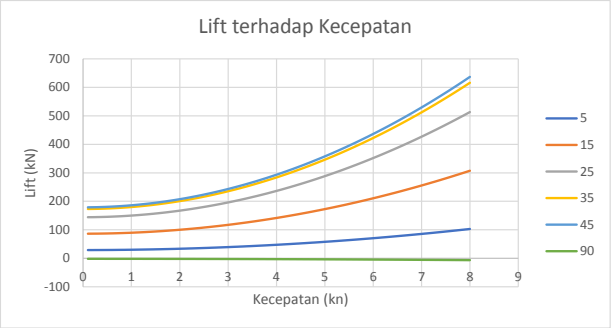
KOEFISIEN MAIN SAIL

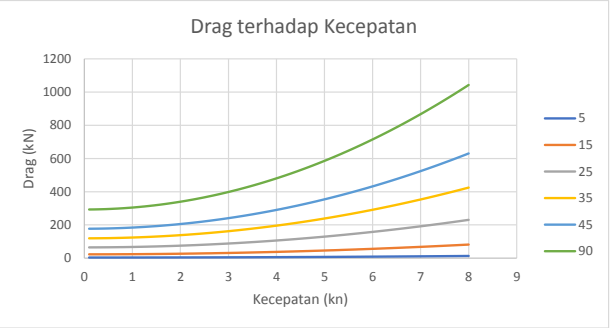
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

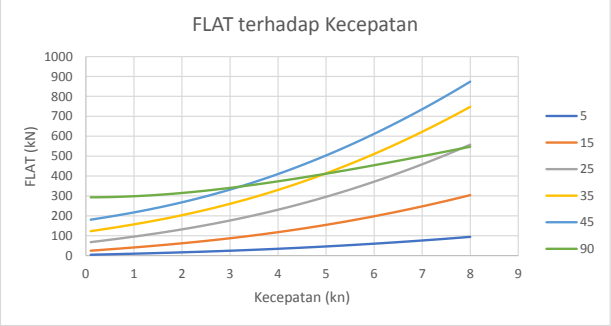
KOEFISIEN MIZZEN SAIL

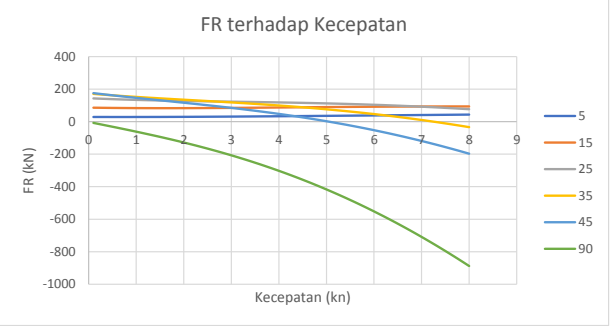
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

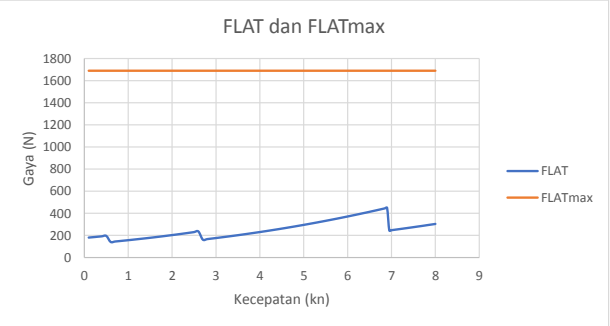
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	90 °
V_A	2,734 m/s
β	70,201 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

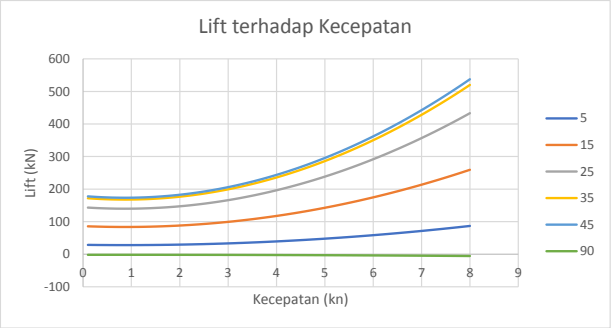
KOEFISIEN MAIN SAIL

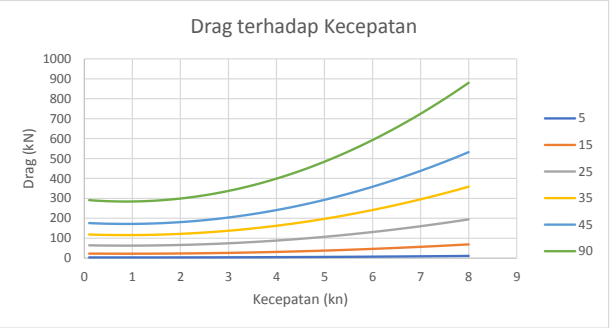
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

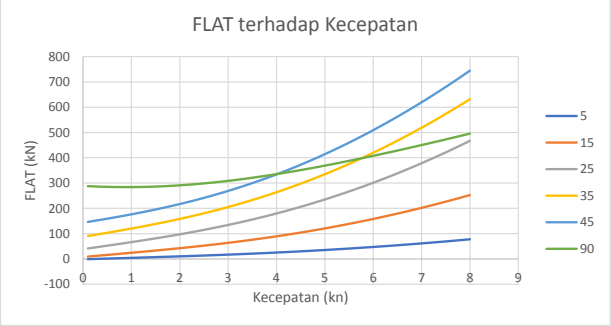
KOEFISIEN MIZZEN SAIL

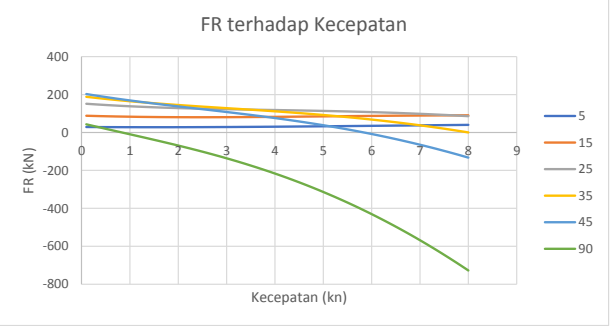
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

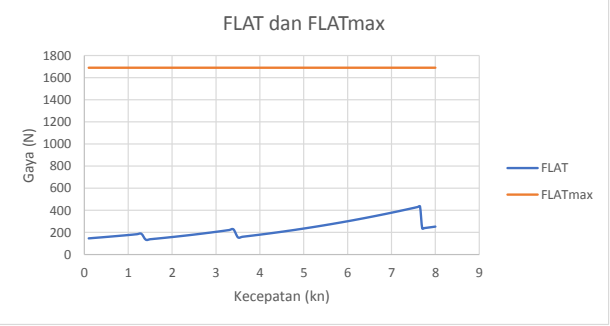
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	100 °
V_A	2,588 m/s
β	78,166 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

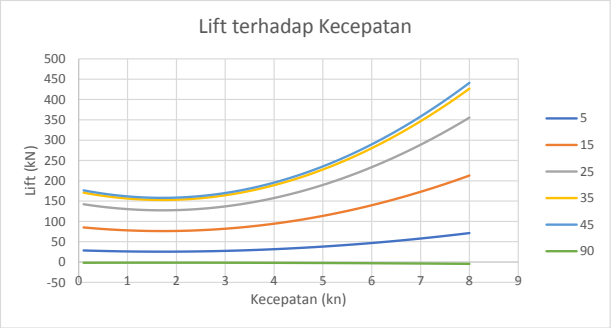
KOEFISIEN MAIN SAIL

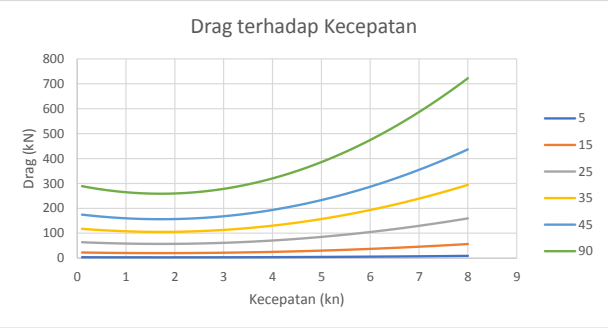
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

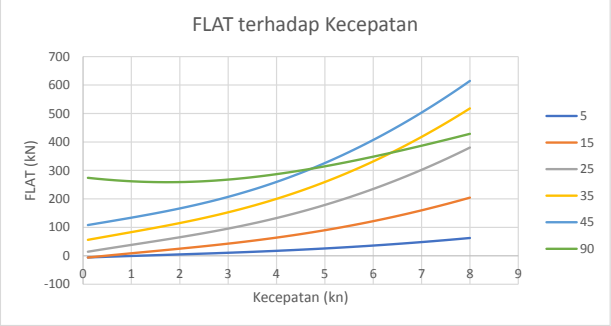
KOEFISIEN MIZZEN SAIL

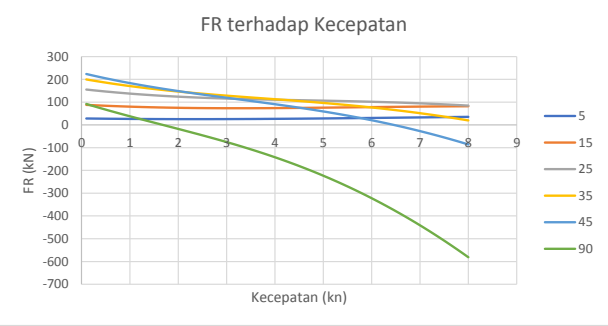
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

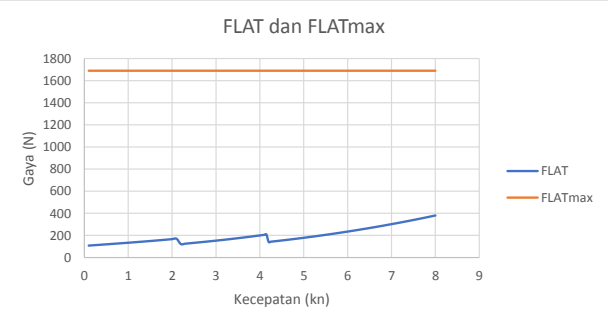
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	110 °
V_A	2,419 m/s
β	87,686 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
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KOEFISIEN MIZZEN SAIL

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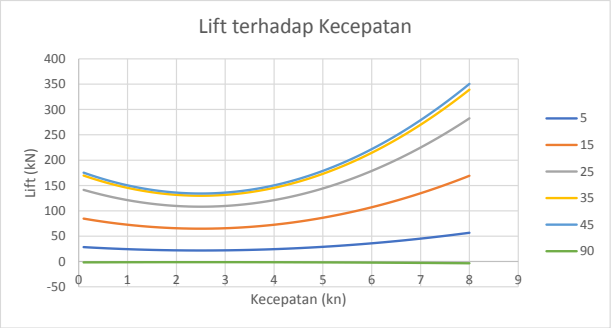
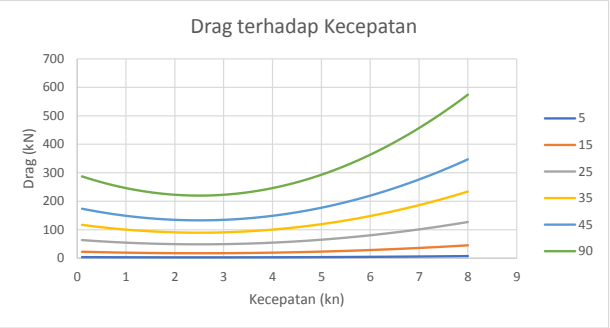
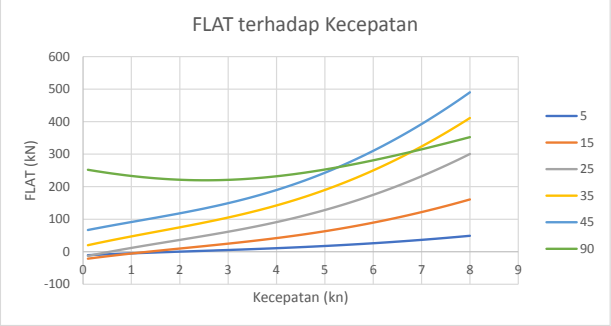
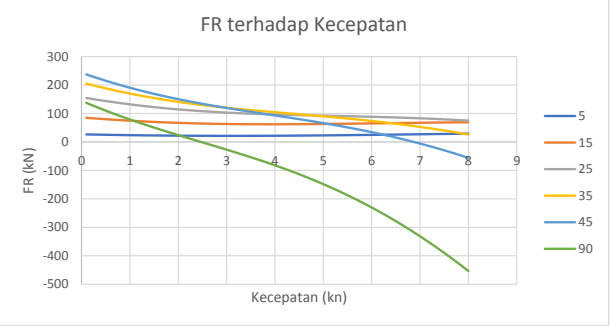
C_D	0,030	0,198	0,499	0,978	1,452	2,399

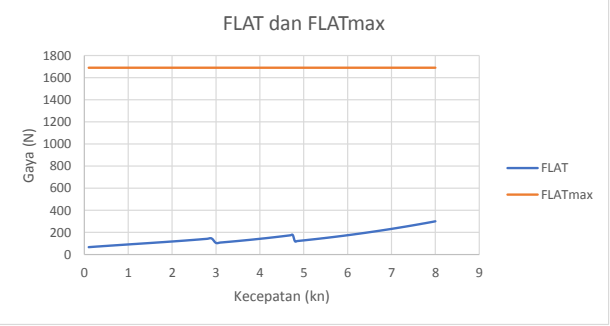
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	120 °
V_A	2,249 m/s
β	97,889 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

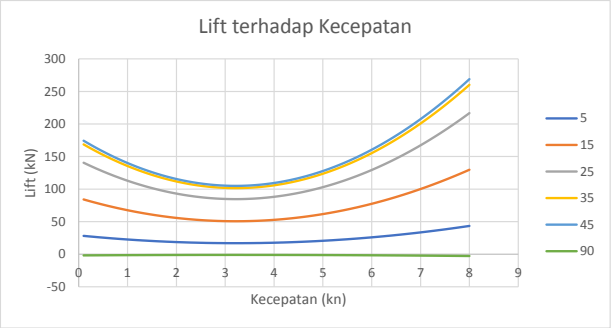
KOEFISIEN MAIN SAIL

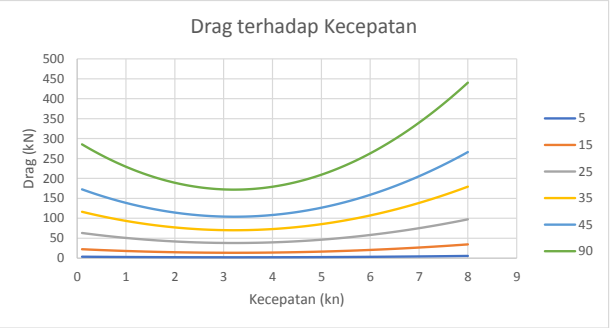
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

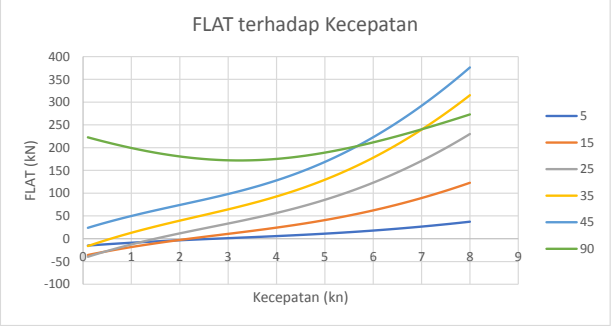
KOEFISIEN MIZZEN SAIL

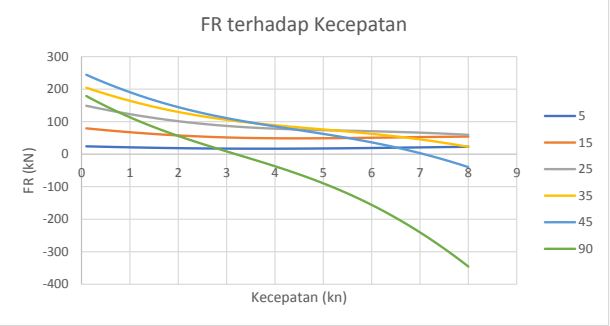
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

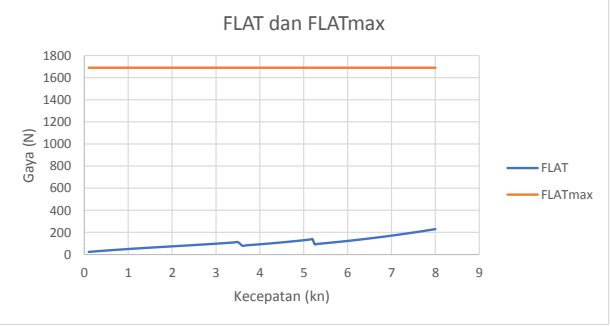
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	130 °
V_A	2,083 m/s
β	108,934 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

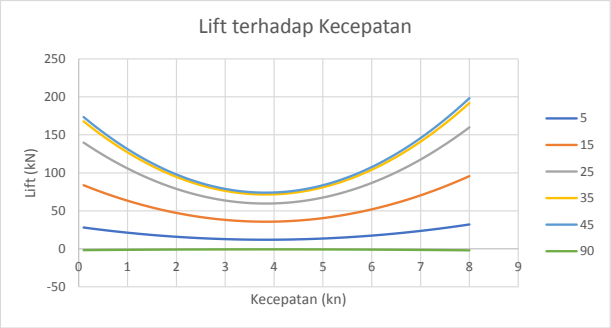
KOEFISIEN MAIN SAIL

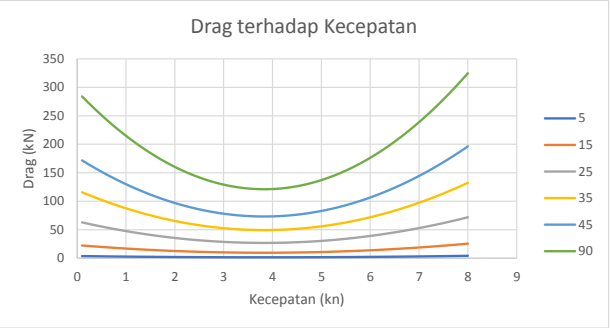
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

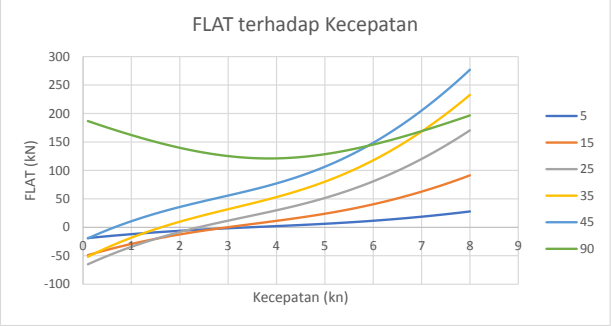
KOEFISIEN MIZZEN SAIL

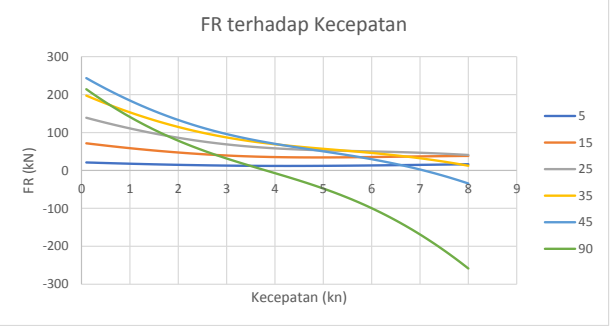
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

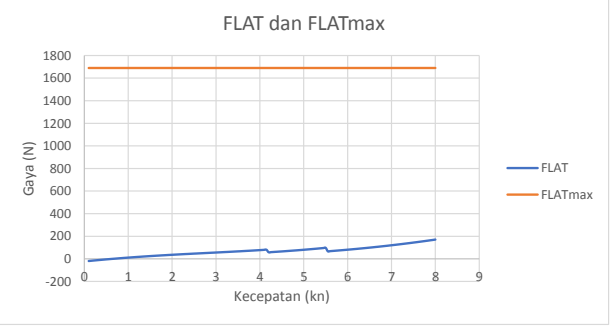
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	140 °
V_A	1,955 m/s
β	122,280 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

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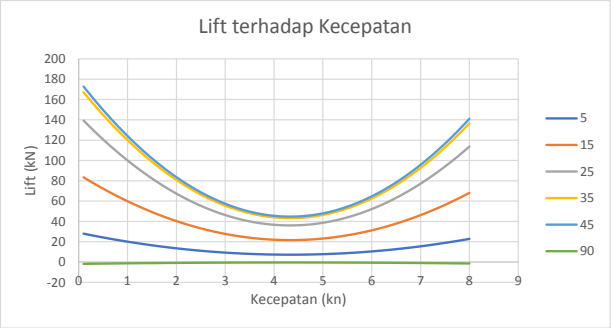
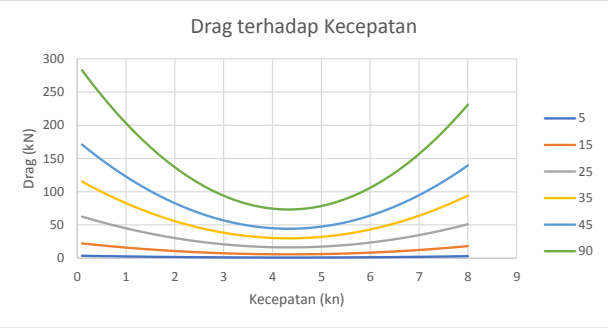
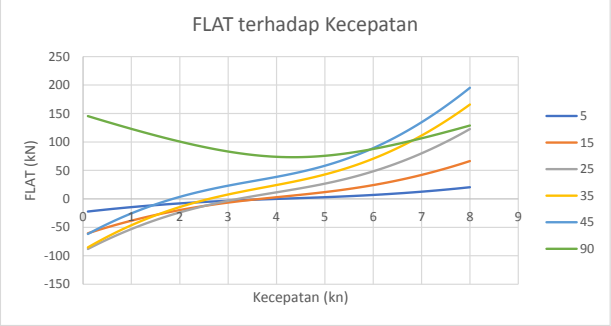
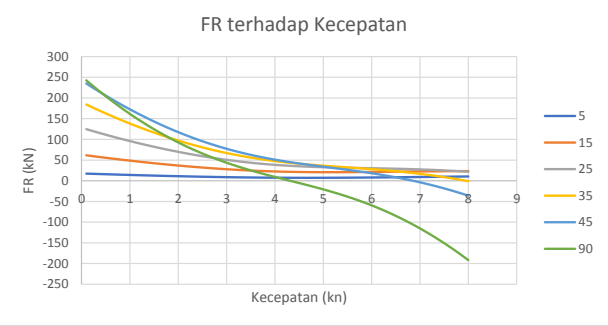
C_D	0,030	0,198	0,499	0,978	1,452	2,399

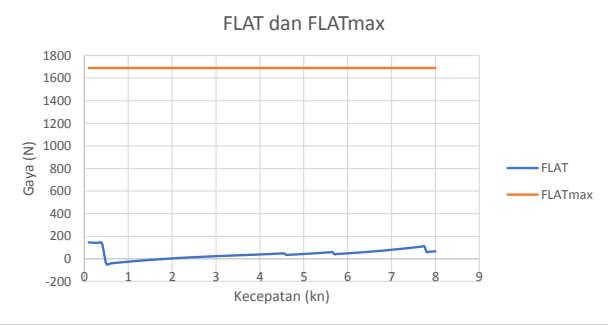
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	150 °
V_A	1,867 m/s
β	136,453 °
V_S	**0,874 m/s**
	1,700 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
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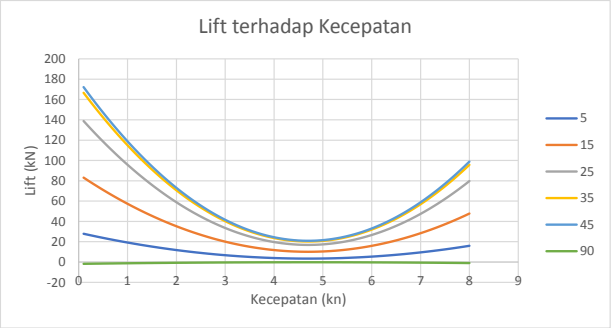
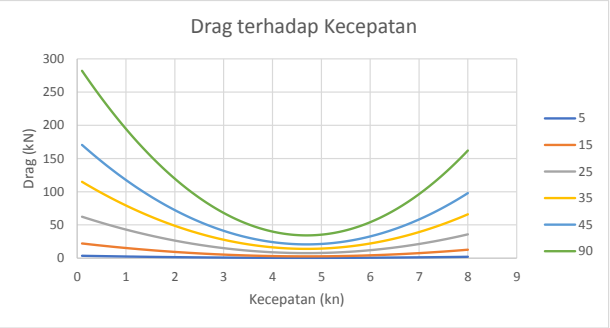
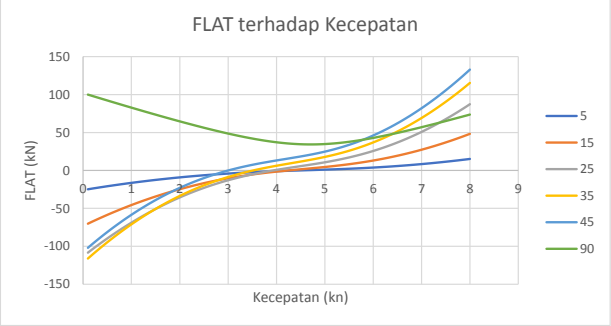
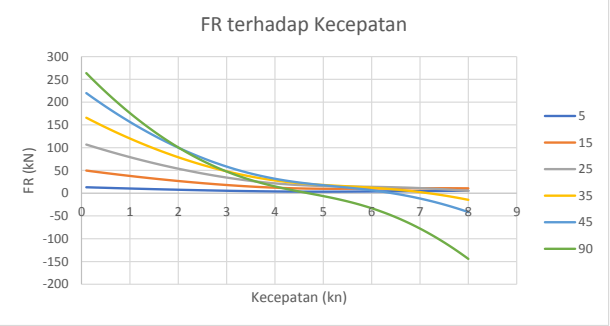
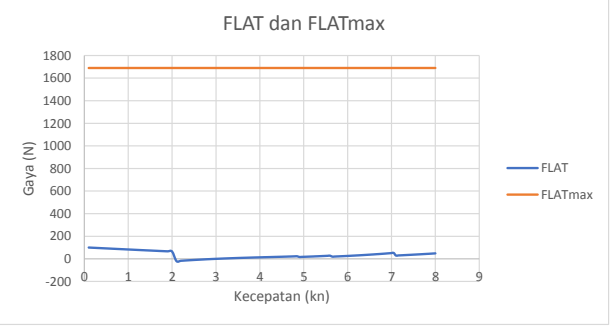
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	5,000 kn
	2,572 m/s
γ	160 °
V_A	1,776 m/s
β	150,303 °
V_S	**0,874 m/s**
	1,700 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

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MUATAN	θ_{max}	11 °	h	4,156 m
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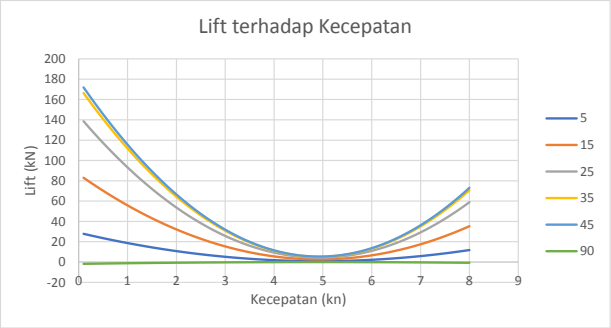

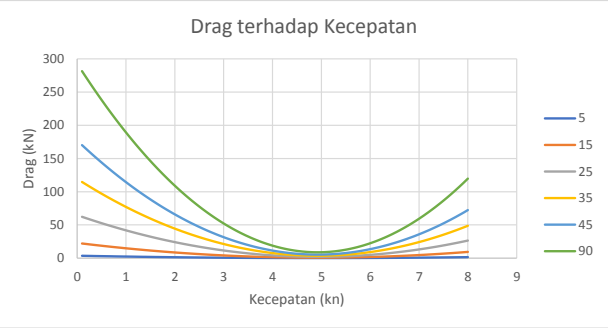

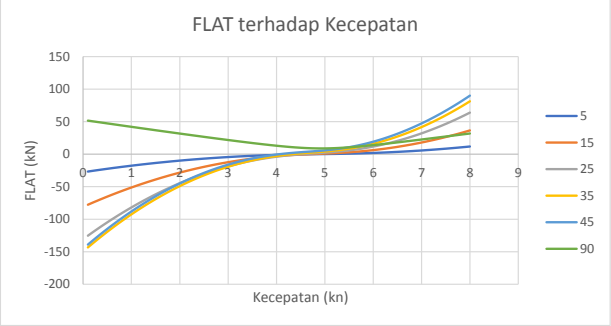

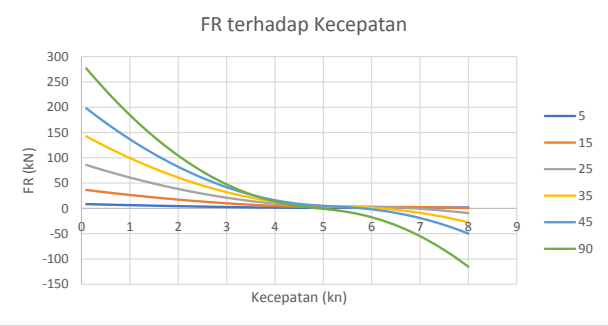

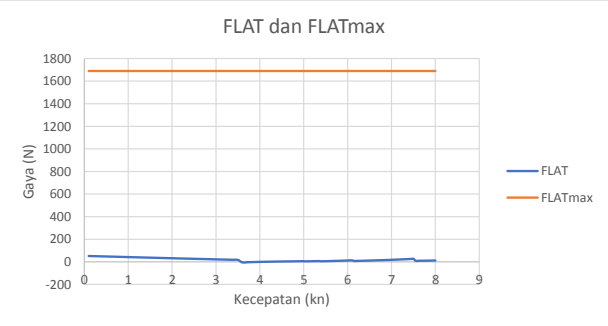

V_T	5,000 kn
	2,572 m/s
γ	170 °
V_A	1,718 m/s
β	164,928 °
V_S	**0,874 m/s**
	1,700 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
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Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

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HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

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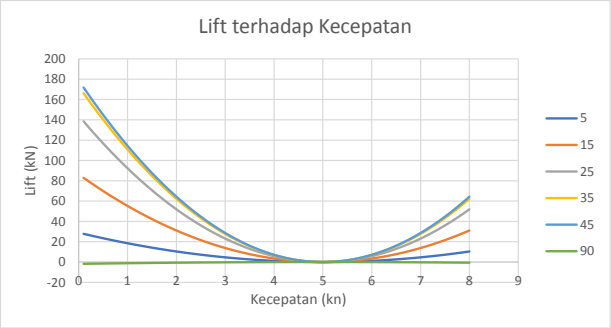
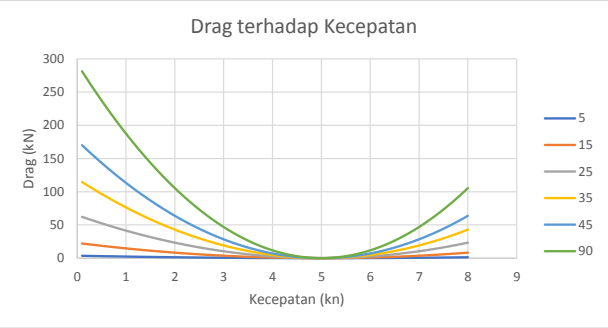
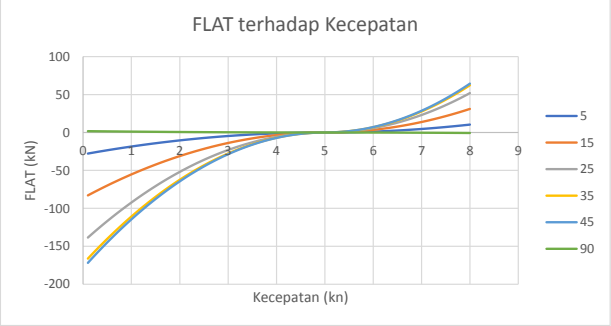
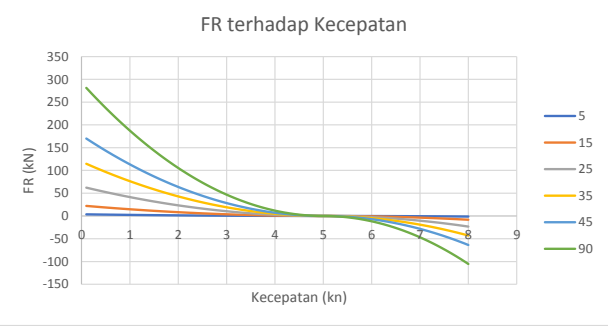
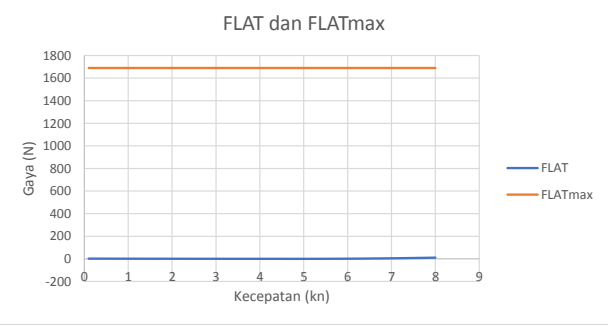










V_T	5,000	kn
	2,572	m/s
γ	180	°
V_A	1,698	m/s
β	180,000	°
V_S	**0,874**	**m/s**
	1,700	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

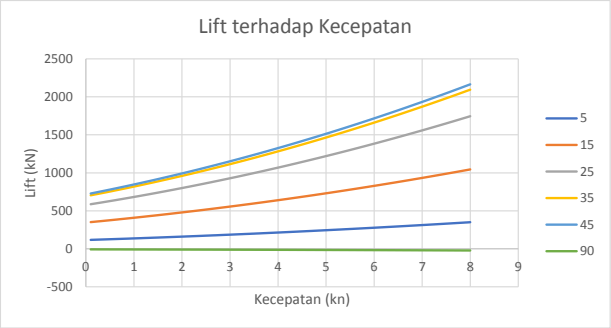
KOEFISIEN MAIN SAIL

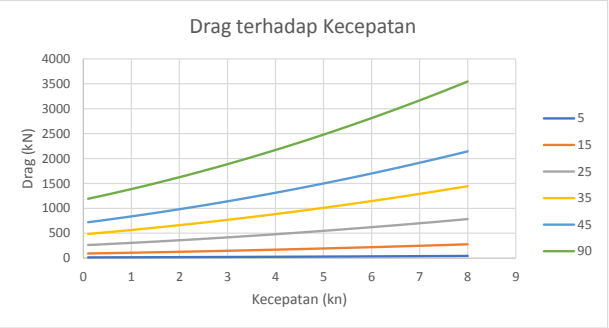
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

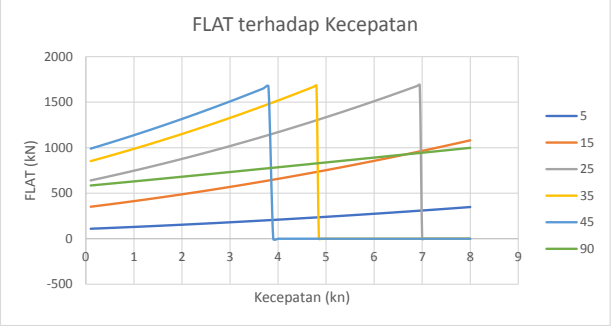
KOEFISIEN MIZZEN SAIL

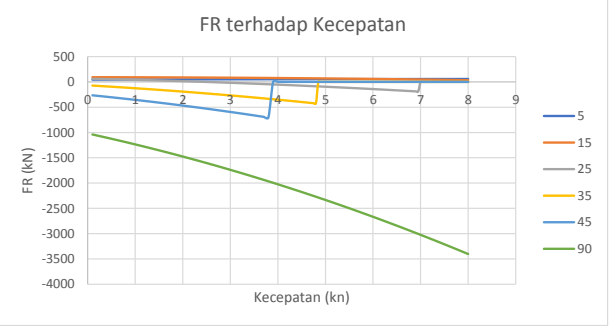
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

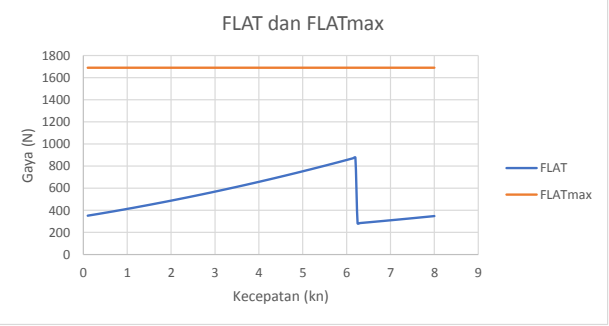
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	30 °
V_A	5,779 m/s
β	26,428 °
V_S	**0,720 m/s**
	1,400 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

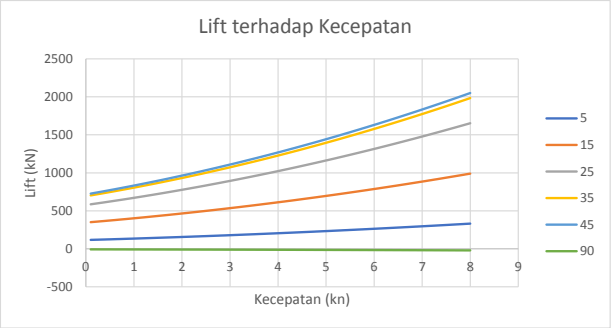
KOEFISIEN MAIN SAIL

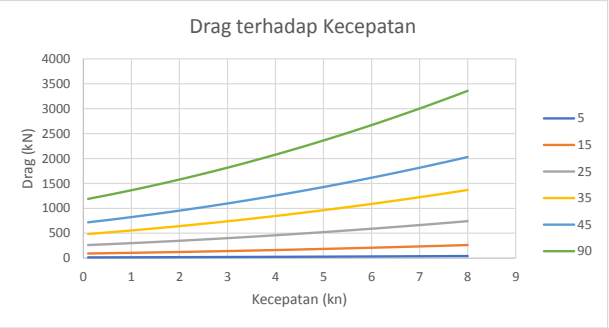
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

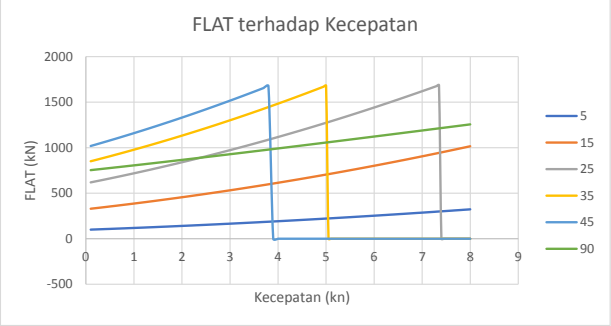
KOEFISIEN MIZZEN SAIL

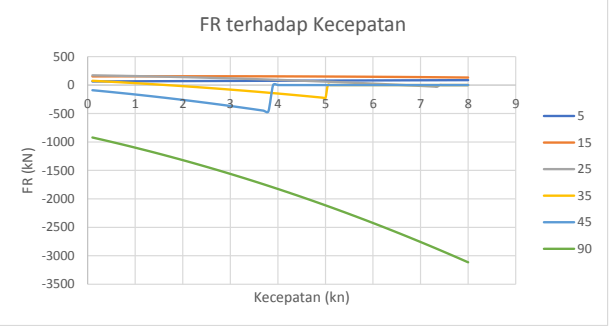
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

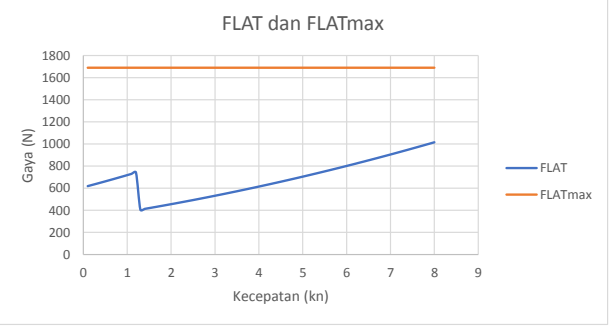
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	40 °
V_A	5,926 m/s
β	33,915 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

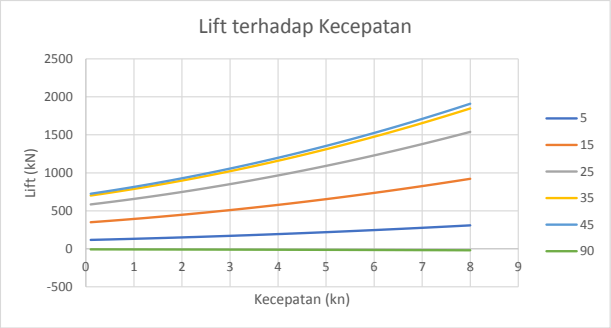
KOEFISIEN MAIN SAIL

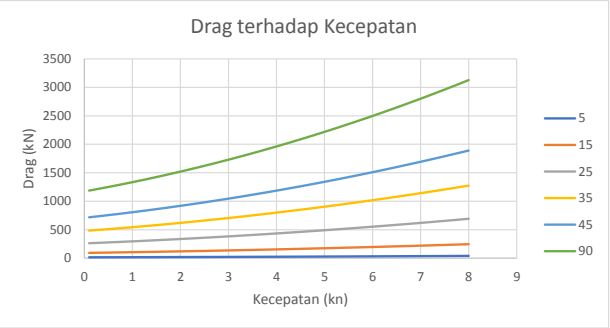
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

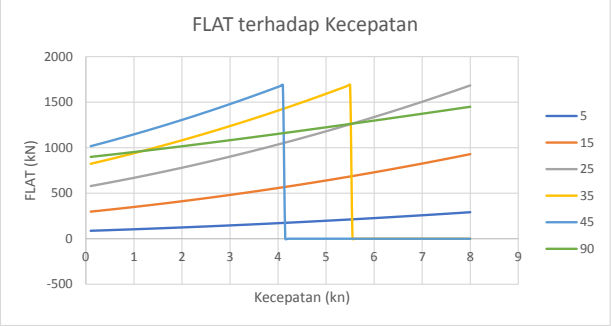
KOEFISIEN MIZZEN SAIL

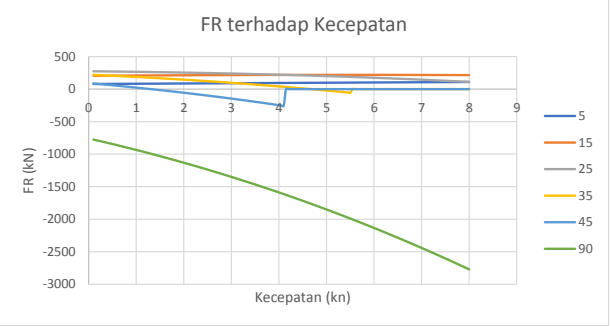
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

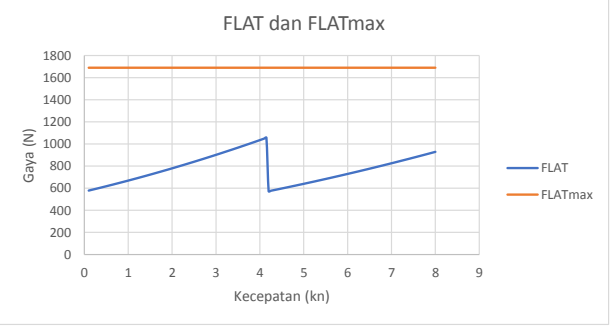
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	50 °
V_A	6,051 m/s
β	40,631 °
V_S	**1,286 m/s**
	2,500 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

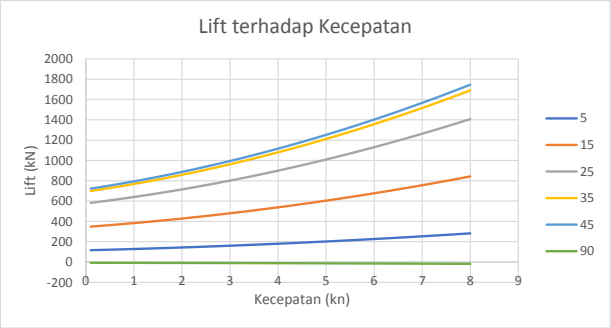
KOEFISIEN MAIN SAIL

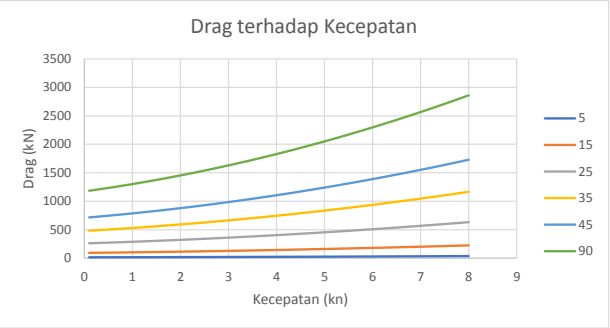
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

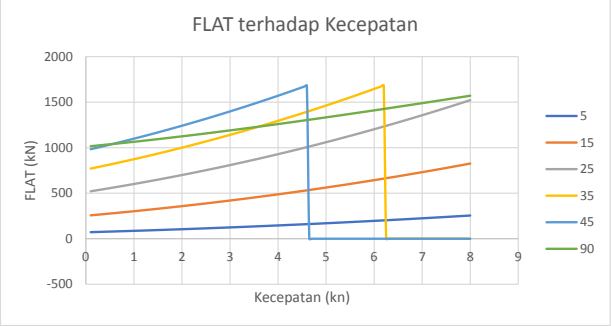
KOEFISIEN MIZZEN SAIL

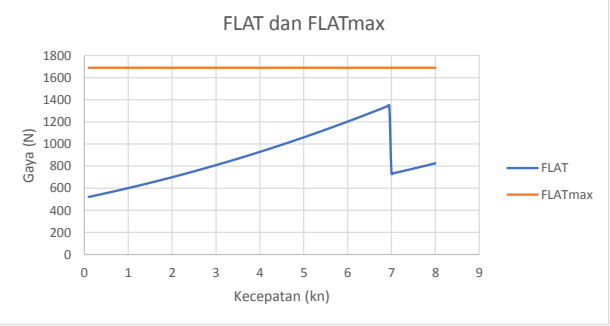
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N









V_T	10,000 kn
	5,144 m/s
γ	60 °
V_A	6,030 m/s
β	47,629 °
V_S	**1,492 m/s**
	2,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

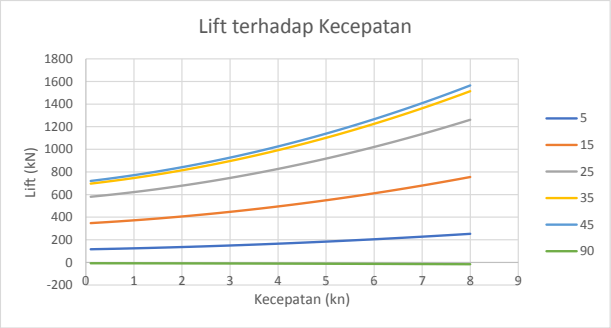
KOEFISIEN MAIN SAIL

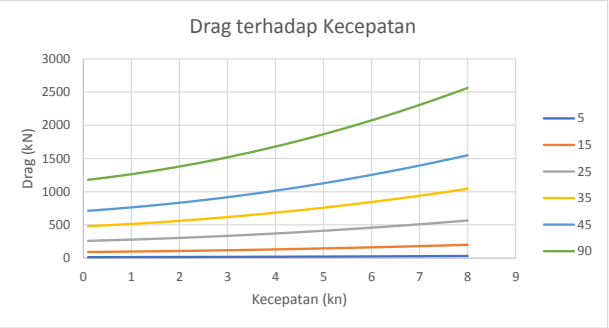
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

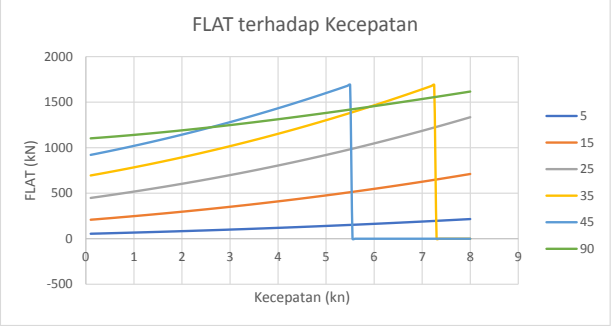
KOEFISIEN MIZZEN SAIL

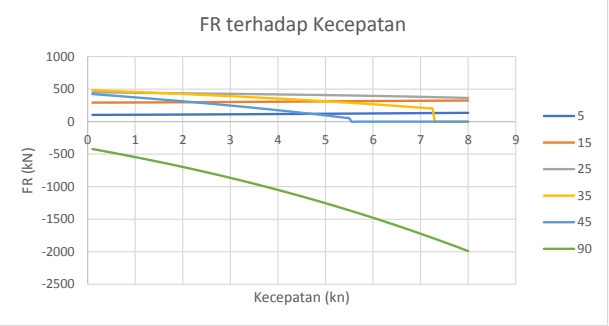
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

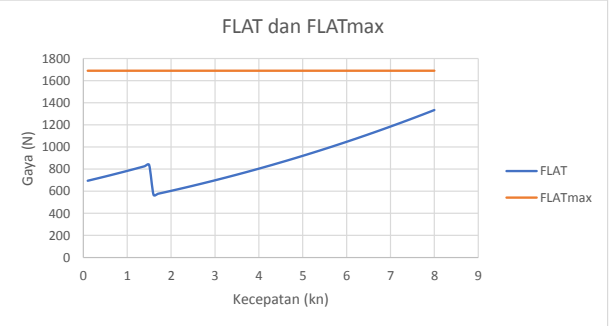
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	70 °
V_A	5,943 m/s
β	54,430 °
V_S	**1,698 m/s**
	3,300 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

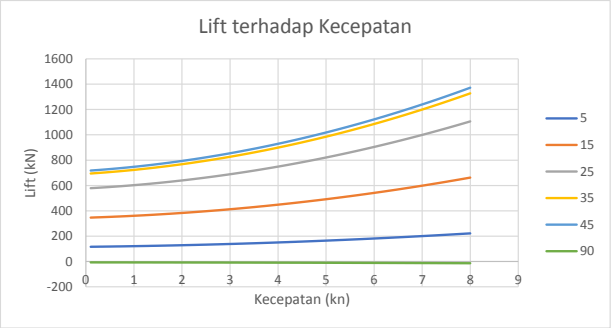
KOEFISIEN MAIN SAIL

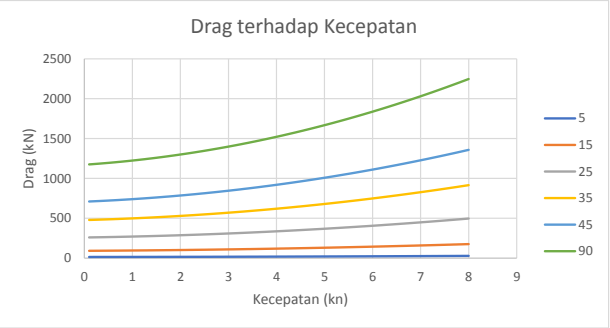
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

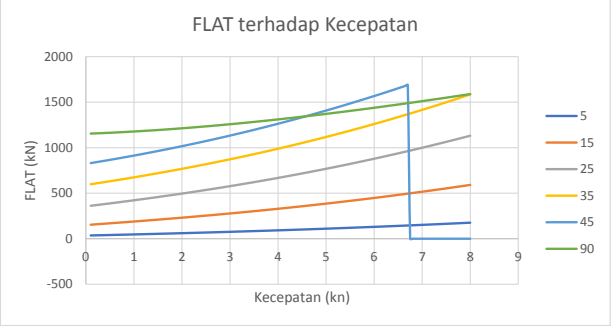
KOEFISIEN MIZZEN SAIL

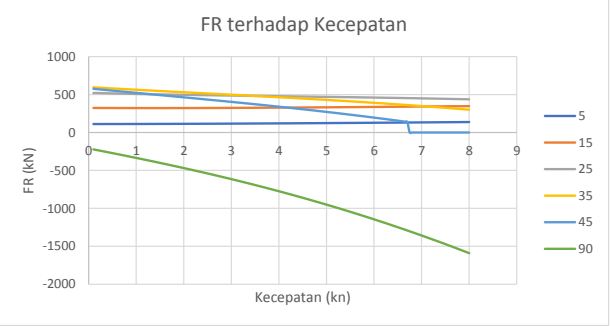
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

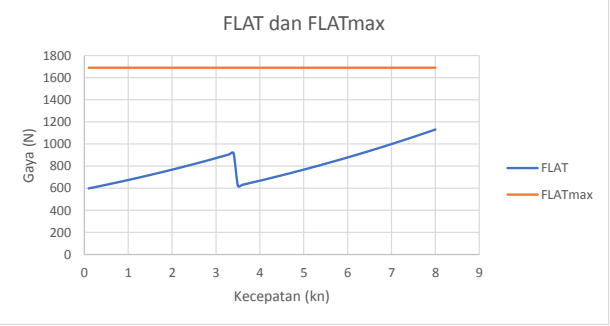
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	80 °
V_A	5,737 m/s
β	61,999 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

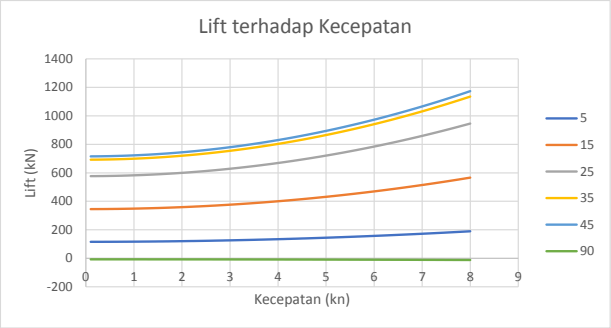
KOEFISIEN MAIN SAIL

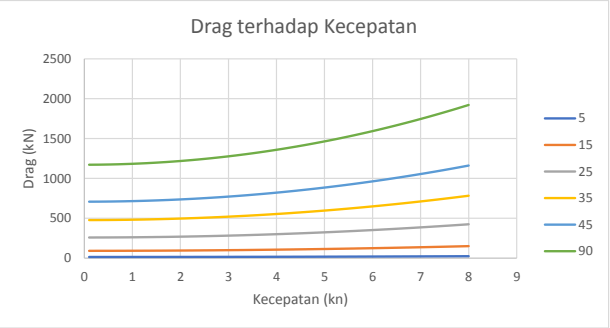
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

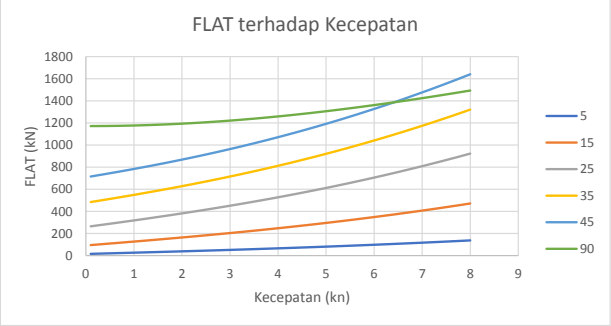
KOEFISIEN MIZZEN SAIL

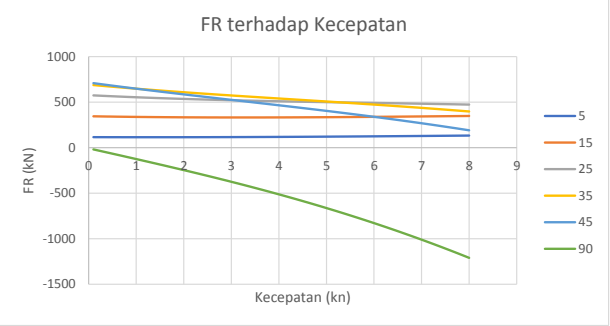
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

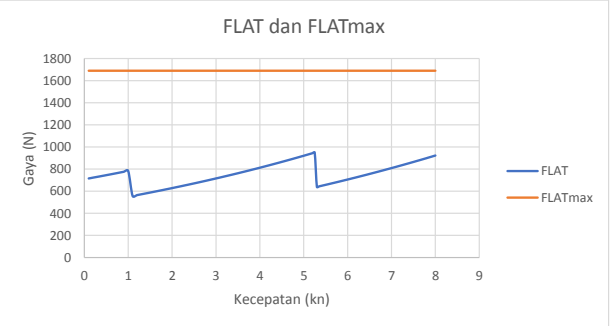
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	90 °
V_A	5,503 m/s
β	69,193 °
V_S	**1,955 m/s**
	3,800 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

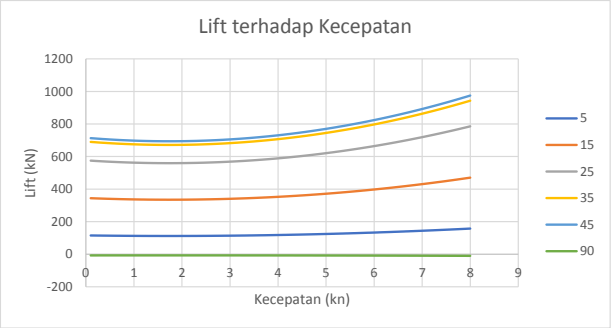
KOEFISIEN MAIN SAIL

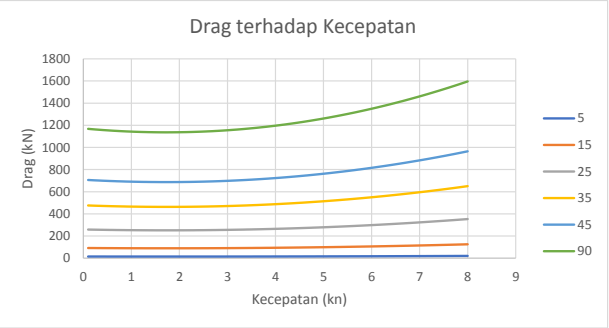
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

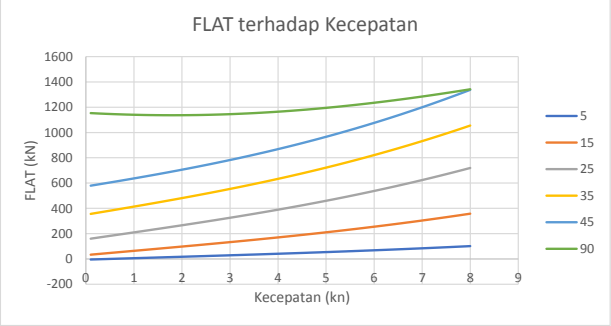
KOEFISIEN MIZZEN SAIL

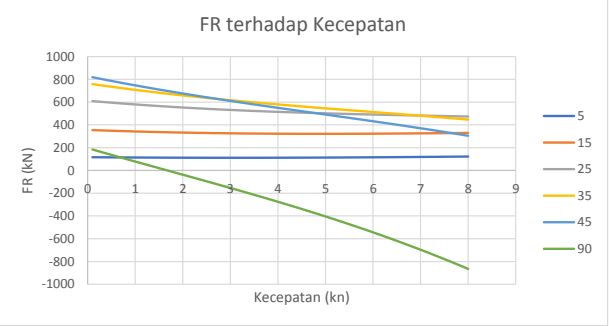
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

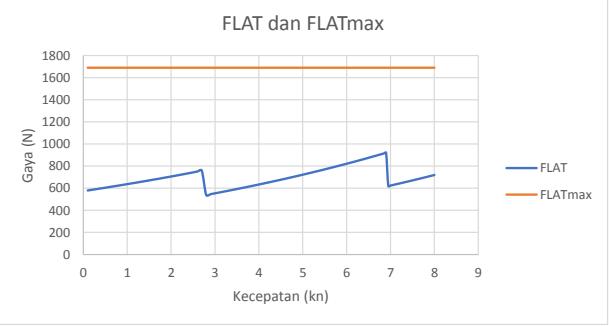
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000	kn
	5,144	m/s
γ	100	°
V_A	5,187	m/s
β	77,610	°
V_S	**2,006**	**m/s**
	3,900	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

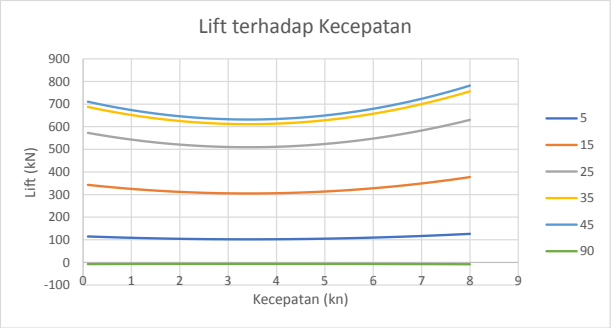
KOEFISIEN MAIN SAIL

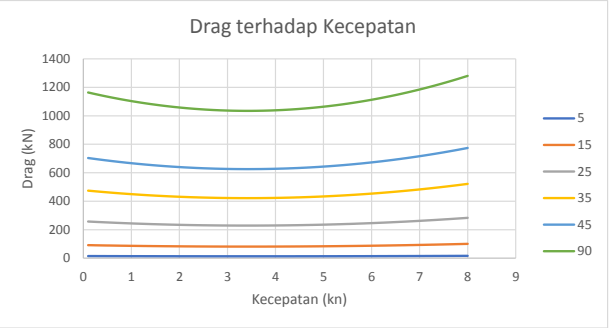
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

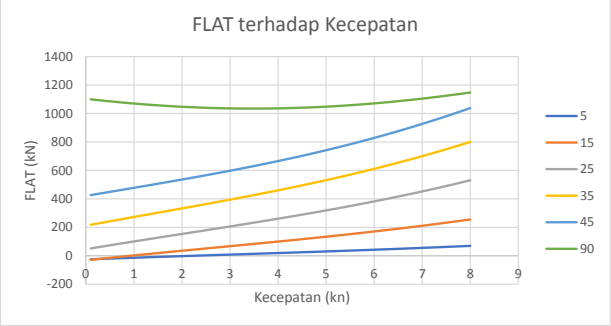
KOEFISIEN MIZZEN SAIL

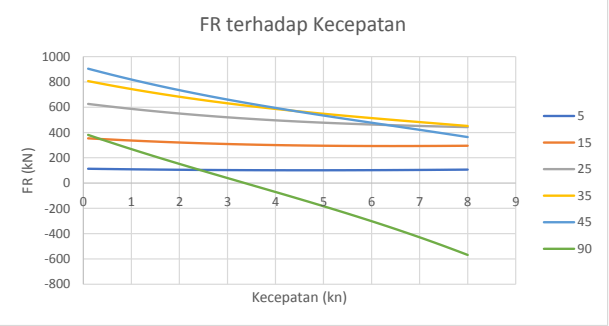
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

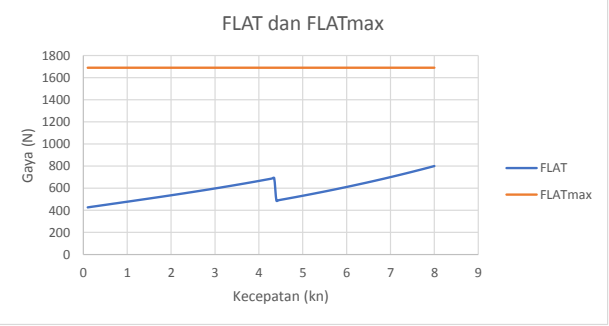
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	110 °
V_A	4,840 m/s
β	87,077 °
V_S	**2,006 m/s**
	3,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

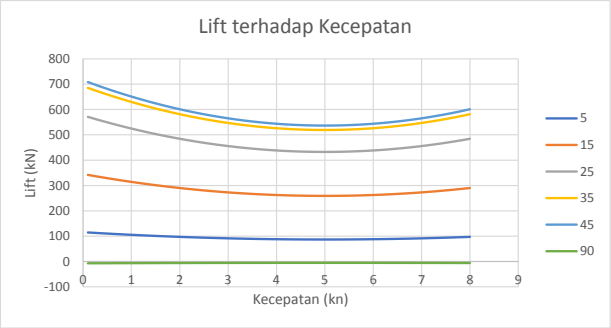
KOEFISIEN MAIN SAIL

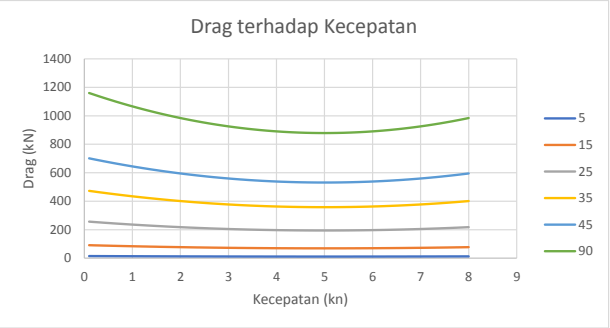
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

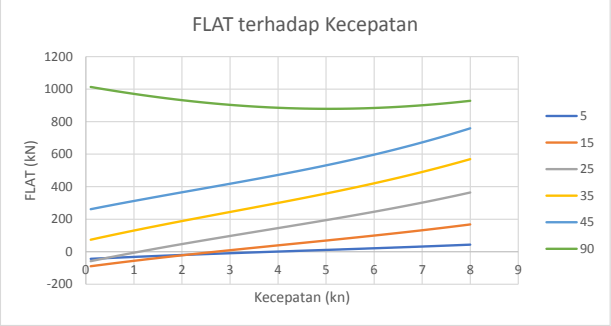
KOEFISIEN MIZZEN SAIL

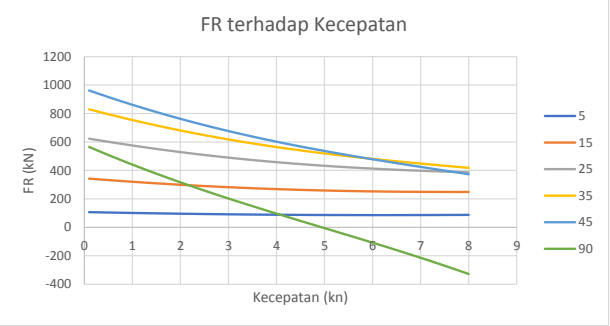
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

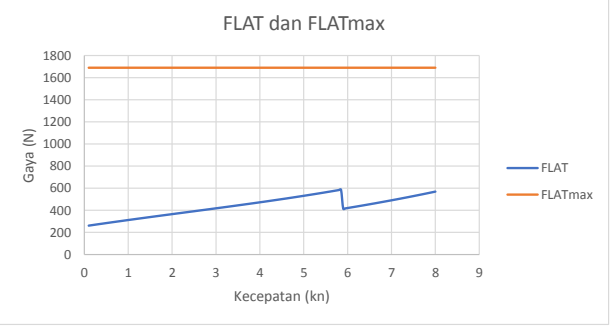
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	120 °
V_A	4,484 m/s
β	96,587 °
V_S	**2,058 m/s**
	4,000 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

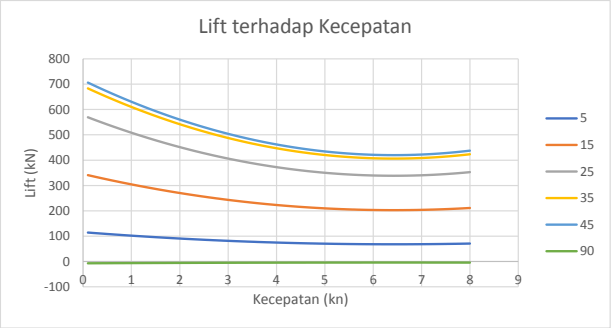
KOEFISIEN MAIN SAIL

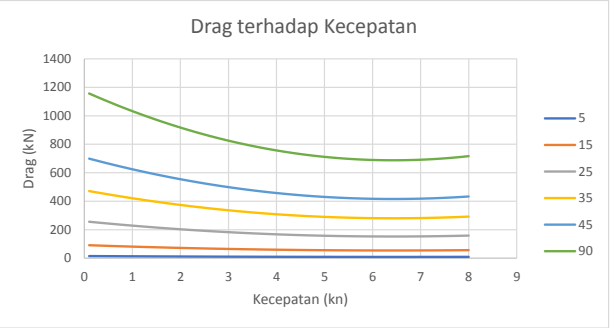
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

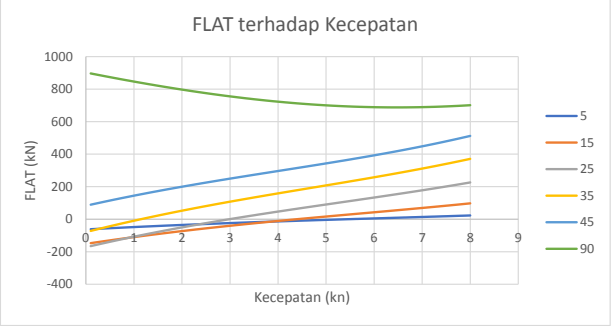
KOEFISIEN MIZZEN SAIL

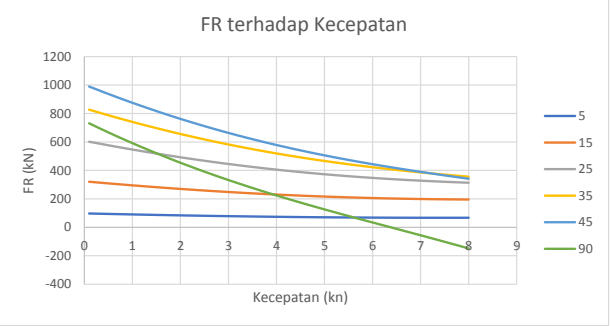
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

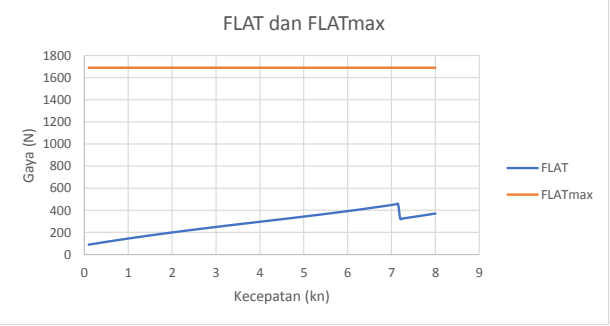
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	130 °
V_A	4,150 m/s
β	108,262 °
V_S	**2,006 m/s**
	3,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
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	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

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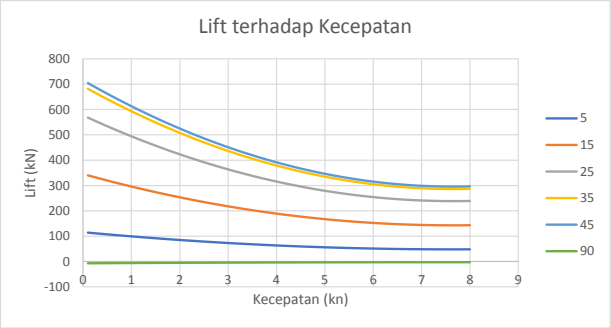
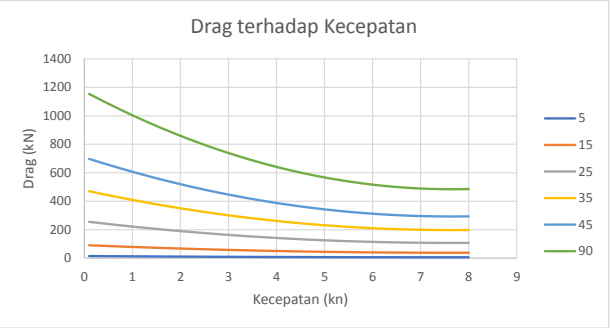
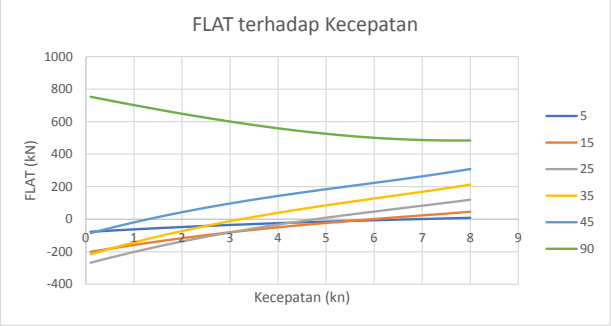
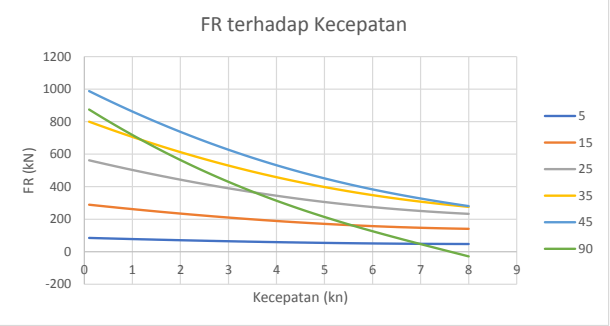
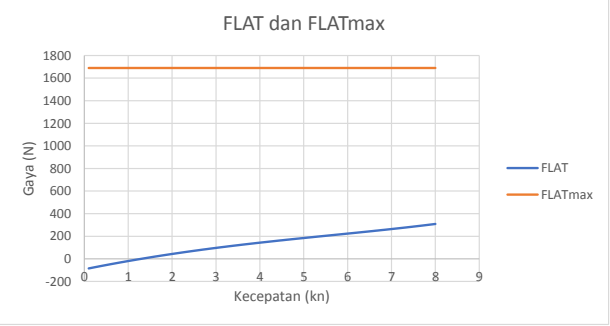
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	140 °
V_A	3,857 m/s
β	120,988 °
V_S	**1,955 m/s**
	3,800 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

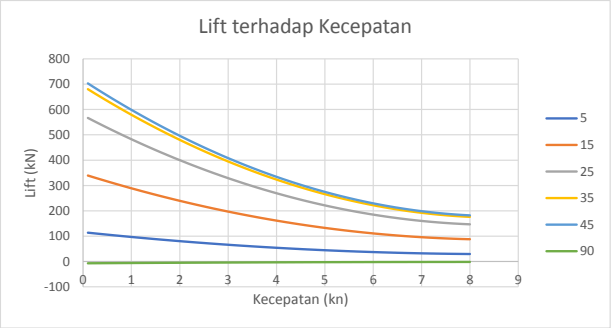
KOEFISIEN MAIN SAIL

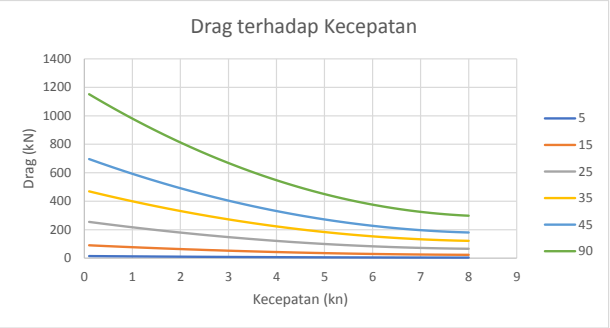
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

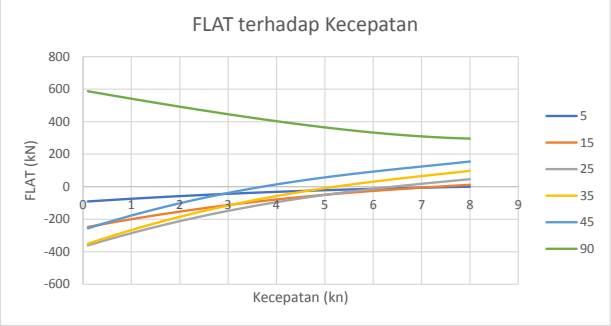
KOEFISIEN MIZZEN SAIL

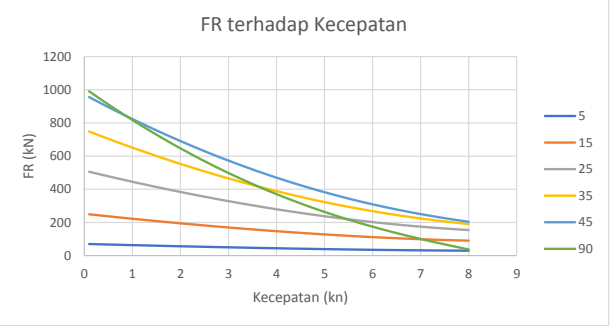
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

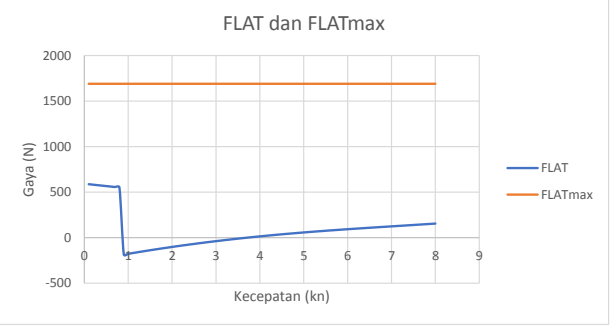
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	150 °
V_A	3,659 m/s
β	135,343 °
V_S	**1,852 m/s**
	3,600 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

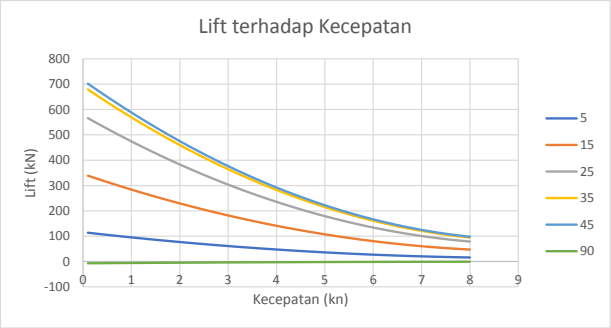
KOEFISIEN MAIN SAIL

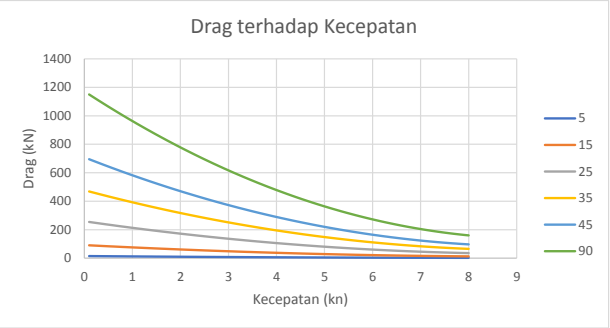
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

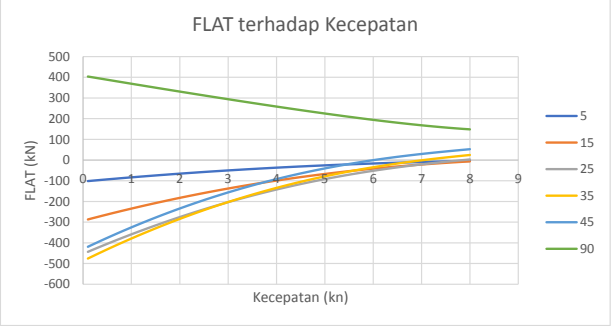
KOEFISIEN MIZZEN SAIL

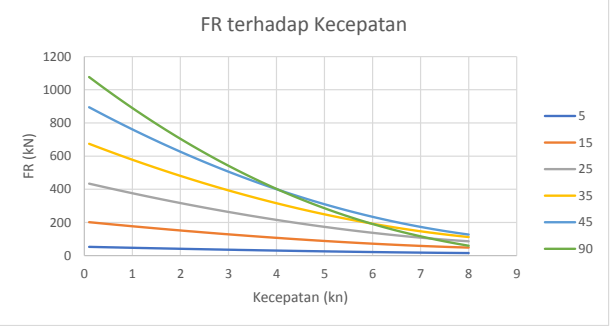
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

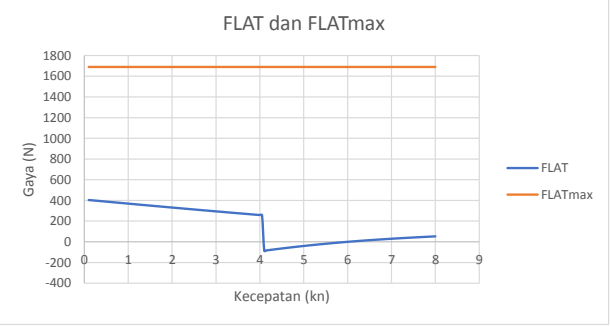
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	160 °
V_A	3,507 m/s
β	149,886 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

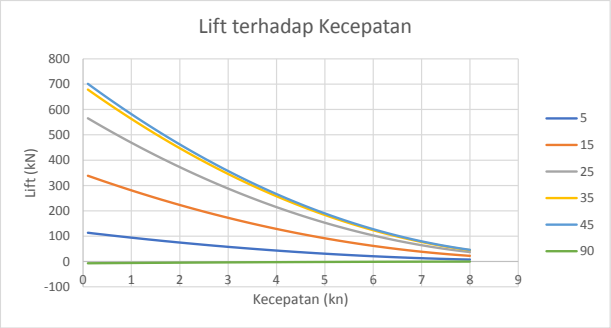
KOEFISIEN MAIN SAIL

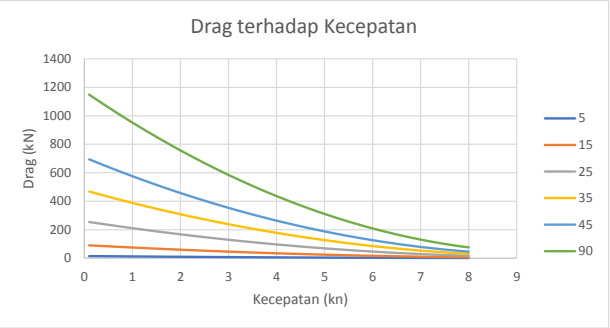
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

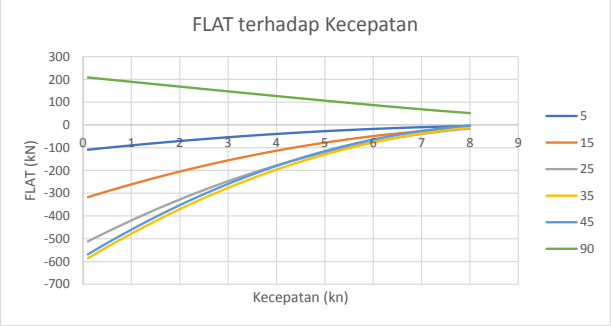
KOEFISIEN MIZZEN SAIL

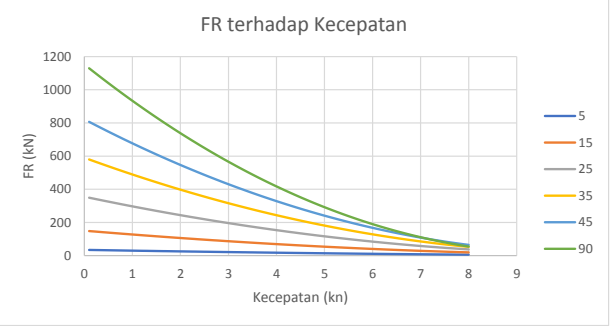
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

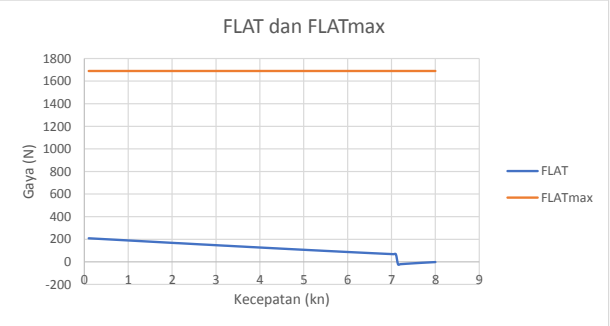
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	170 °
V_A	3,385 m/s
β	164,701 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

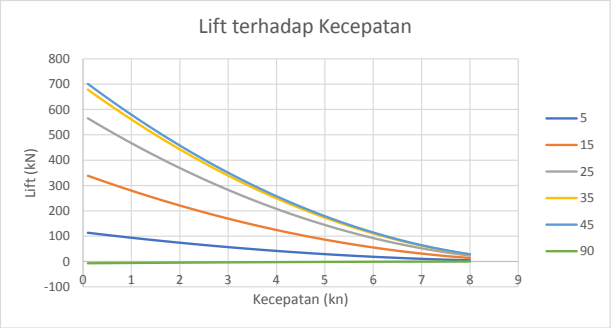
KOEFISIEN MAIN SAIL

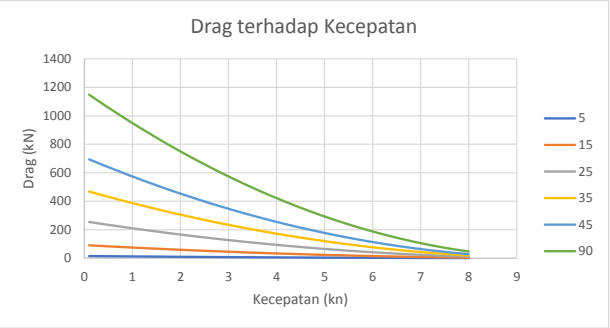
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

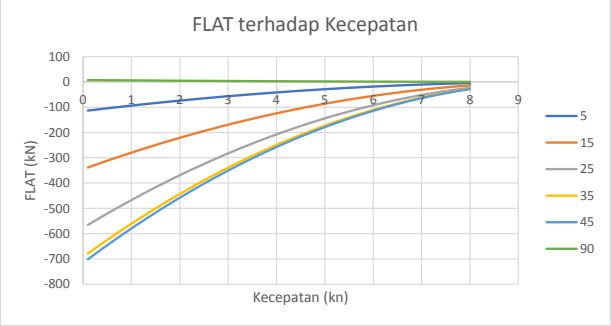
KOEFISIEN MIZZEN SAIL

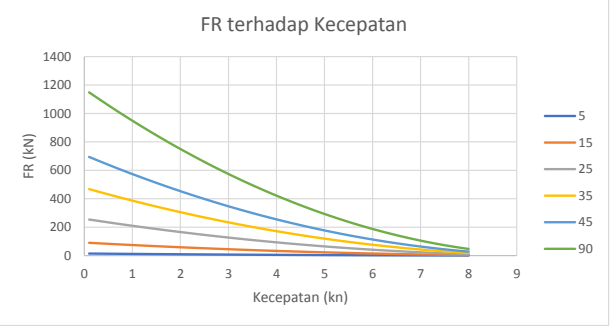
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

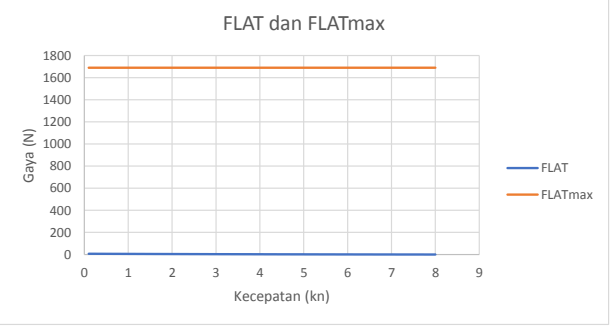
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	10,000 kn
	5,144 m/s
γ	180 °
V_A	3,344 m/s
β	180,000 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

KOEFISIEN MIZZEN SAIL

α (°)	5	15	25	35	45	90
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MUATAN	θ_{max}	11 °	h	4,156 m
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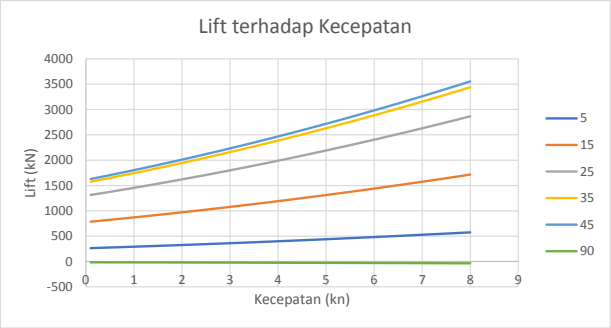

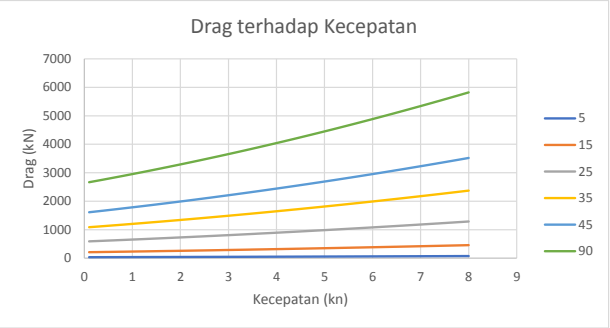

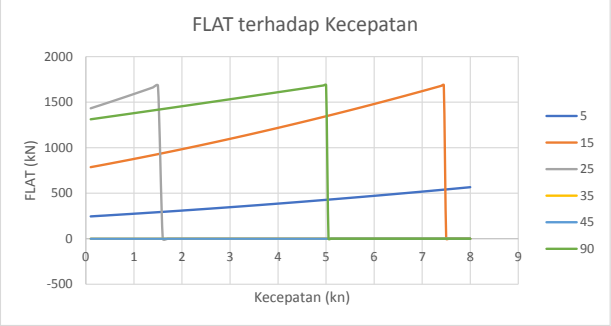

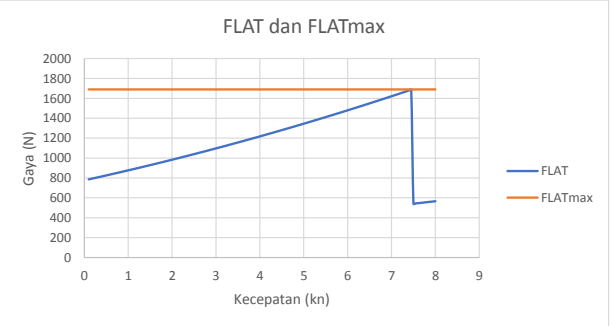

V_T	15,000 kn
	7,716 m/s
γ	30 °
V_A	8,714 m/s
β	26,277 °
V_S	**1,132 m/s**
	2,200 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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α (°)	5	15	25	35	45	90
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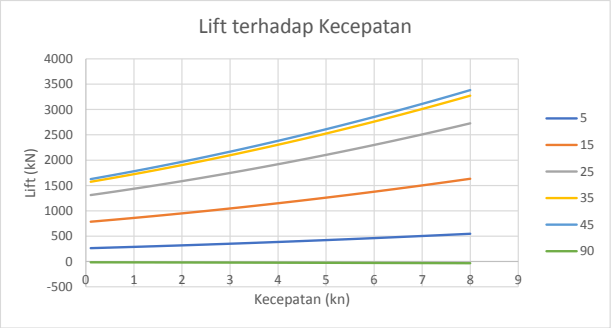
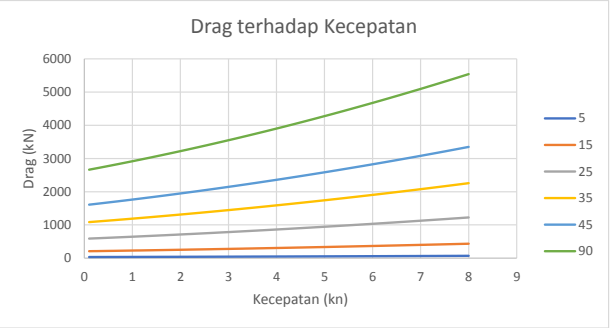
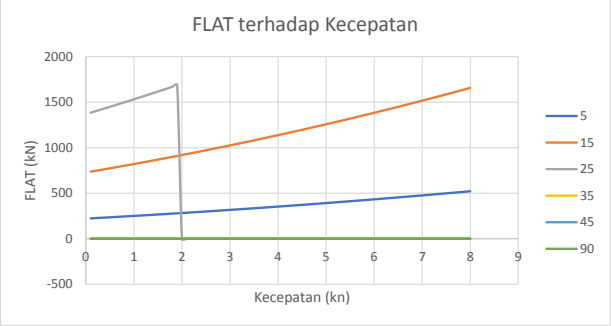
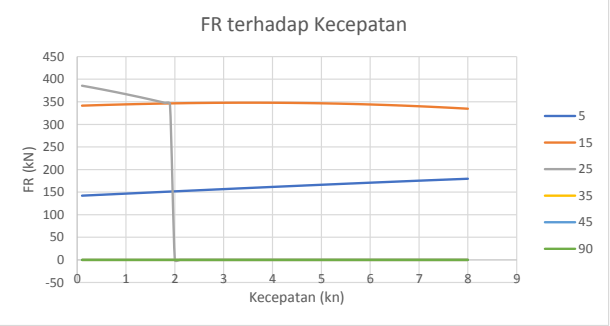
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

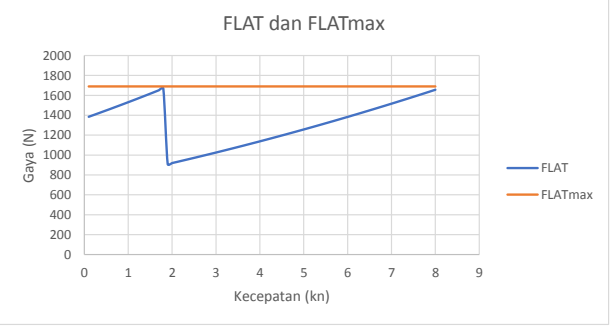
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	40 °
V_A	8,910 m/s
β	33,822 °
V_S	**1,492 m/s**
	2,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

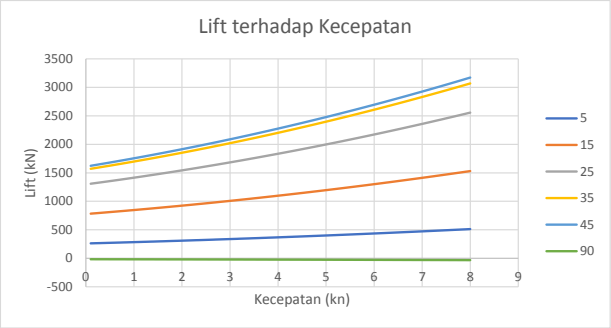
KOEFISIEN MAIN SAIL

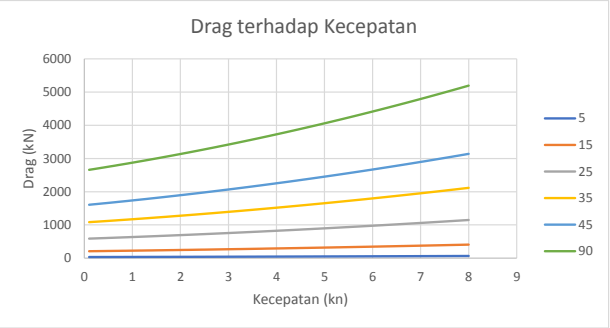
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

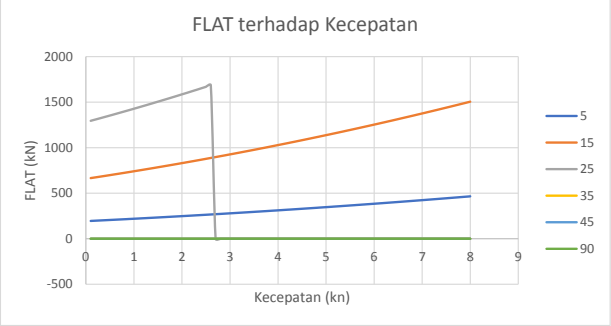
KOEFISIEN MIZZEN SAIL

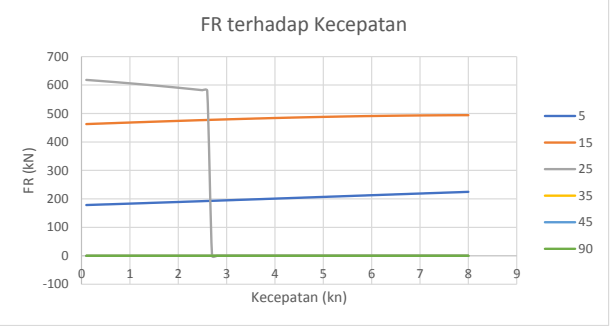
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

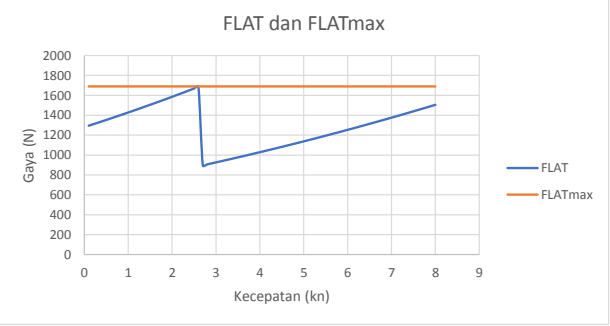
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000	kn
	7,716	m/s
γ	50	°
V_A	8,980	m/s
β	41,165	°
V_S	**1,800**	**m/s**
	3,500	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

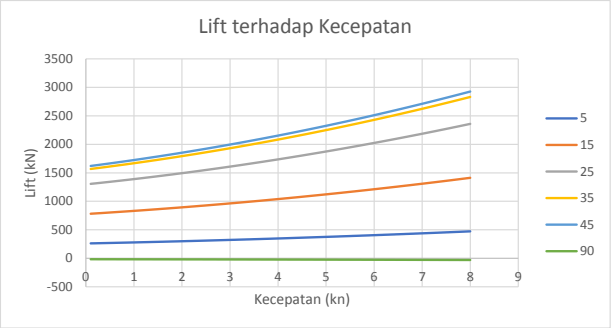
KOEFISIEN MAIN SAIL

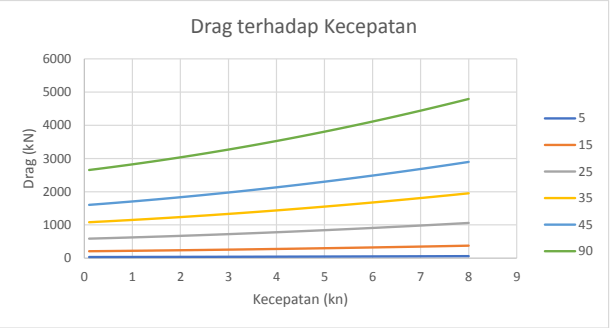
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

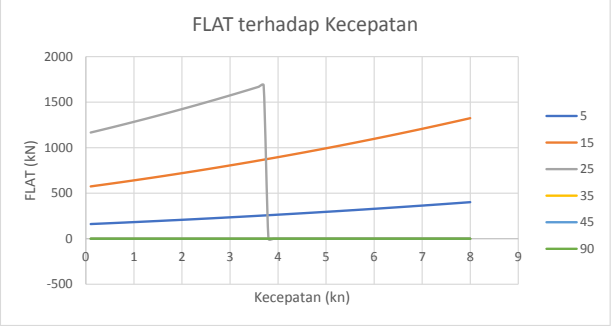
KOEFISIEN MIZZEN SAIL

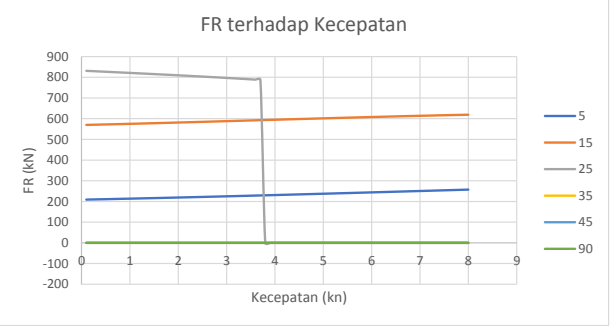
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

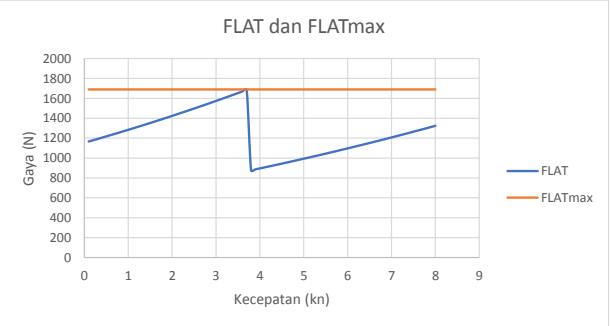
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	60 °
V_A	8,890 m/s
β	48,731 °
V_S	**2,006 m/s**
	3,900 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

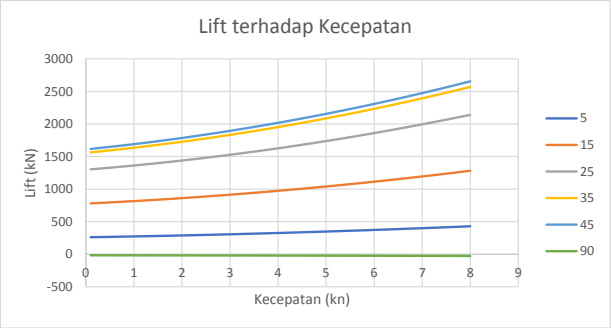
KOEFISIEN MAIN SAIL

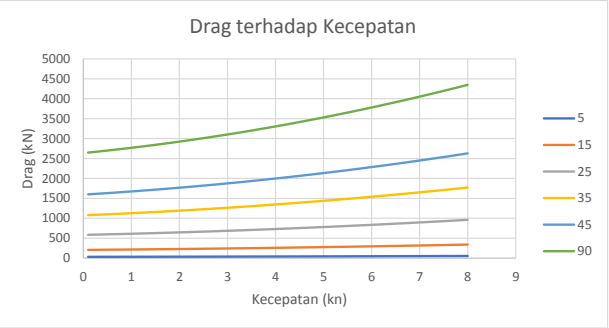
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

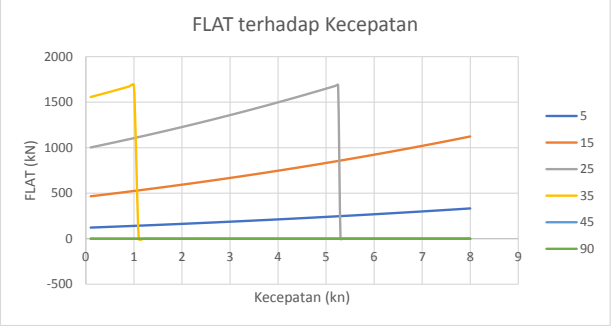
KOEFISIEN MIZZEN SAIL

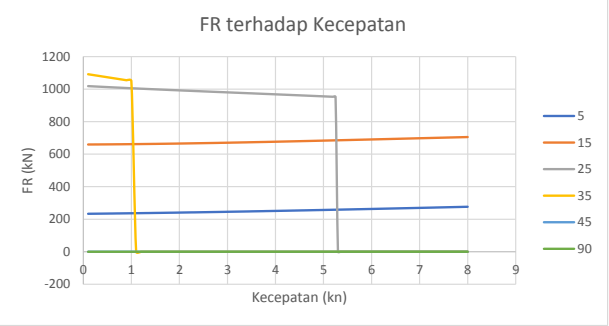
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

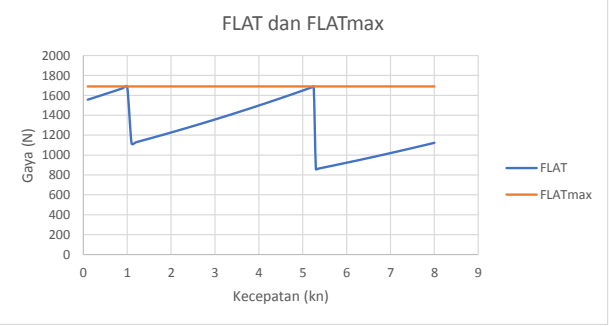
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000	kn
	7,716	m/s
γ	70	°
V_A	8,639	m/s
β	57,067	°
V_S	**2,521**	**m/s**
	4,900	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

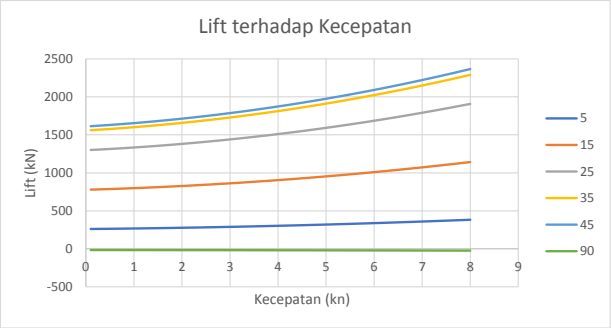
KOEFISIEN MAIN SAIL

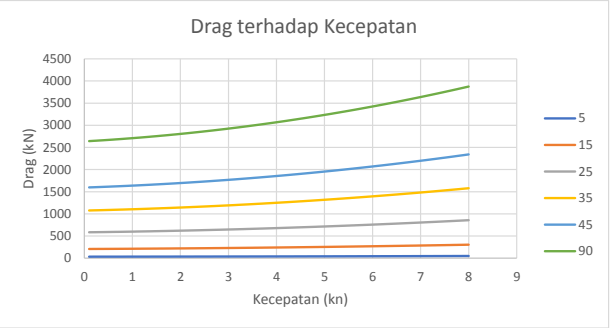
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

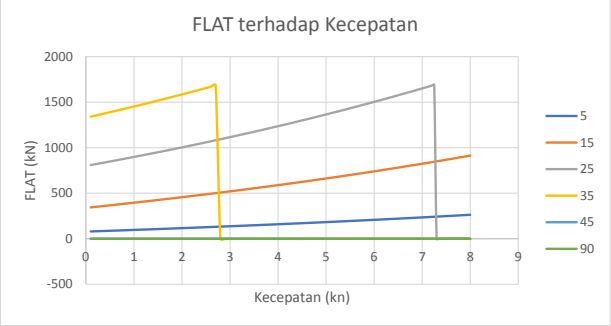
KOEFISIEN MIZZEN SAIL

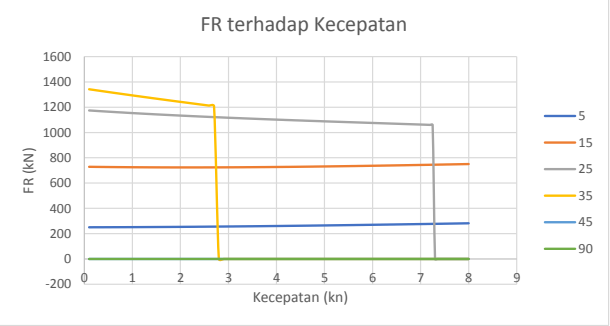
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

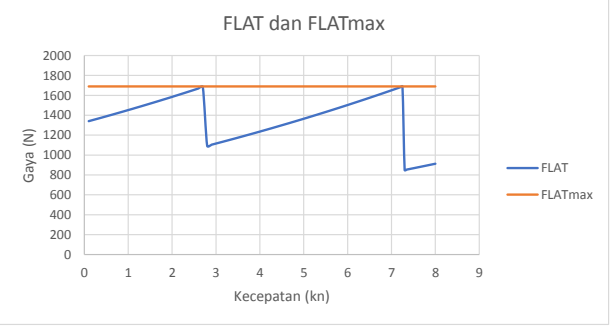
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	80 °
V_A	8,324 m/s
β	65,910 °
V_S	**2,649 m/s**
	5,150 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

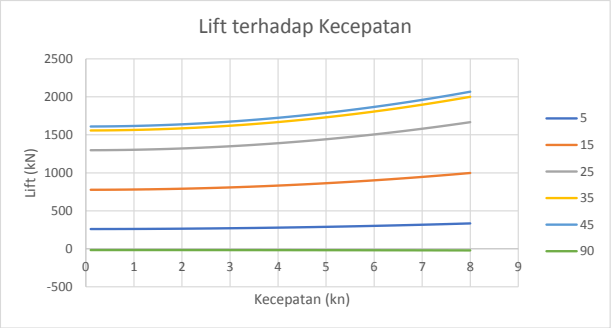
KOEFISIEN MAIN SAIL

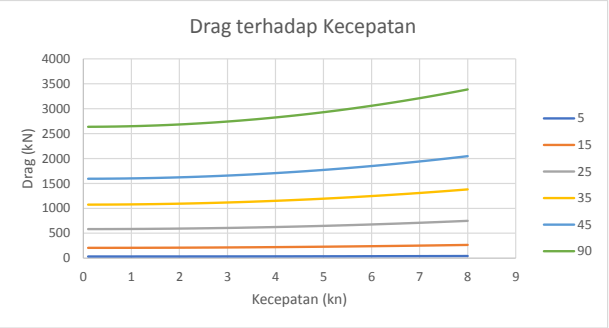
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

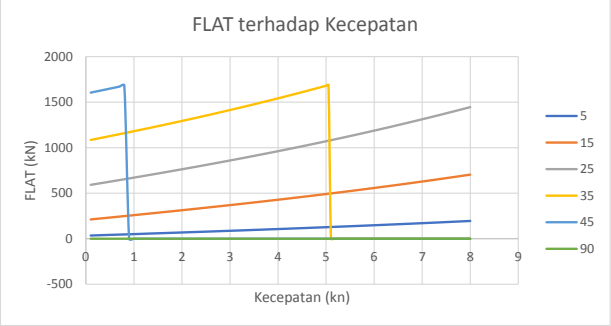
KOEFISIEN MIZZEN SAIL

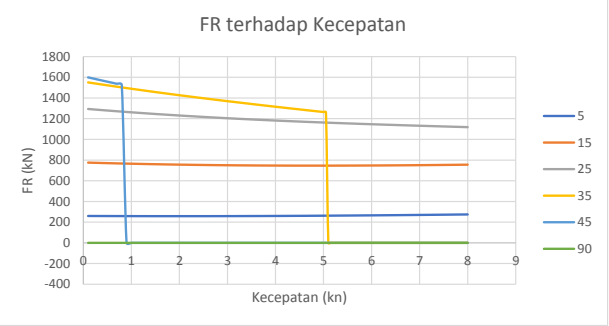
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

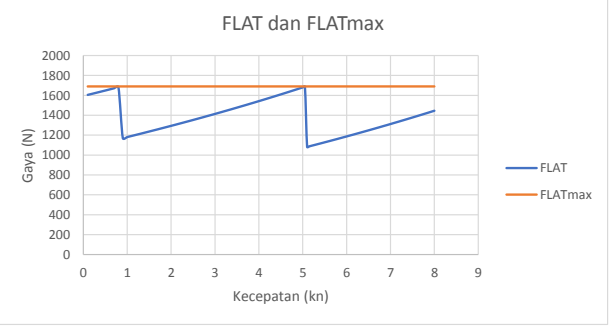
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	90 °
V_A	7,986 m/s
β	75,069 °
V_S	**2,726 m/s**
	5,300 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

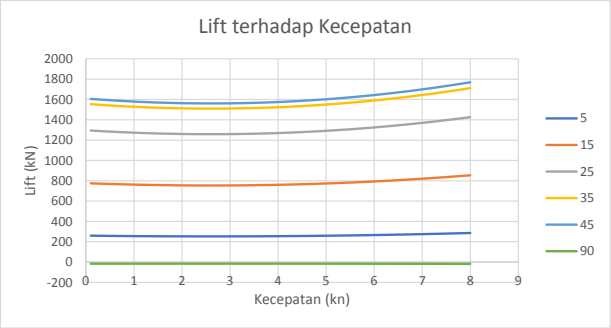
KOEFISIEN MAIN SAIL

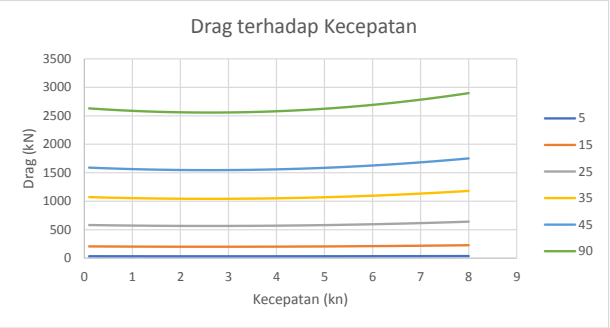
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

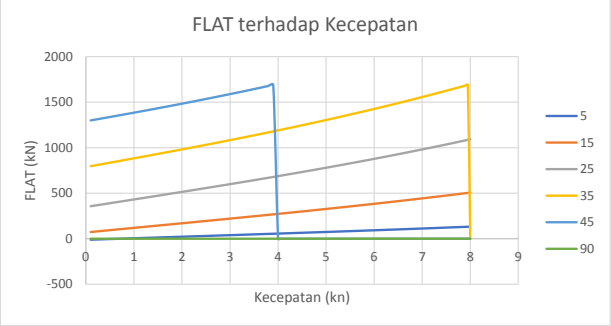
KOEFISIEN MIZZEN SAIL

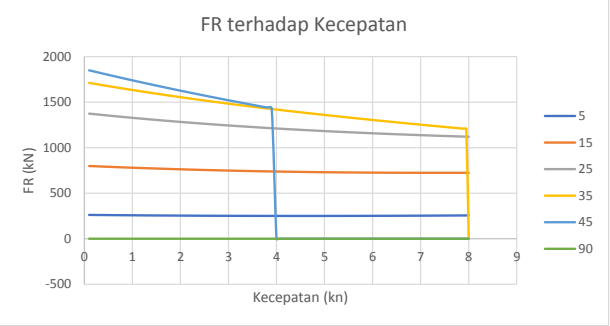
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

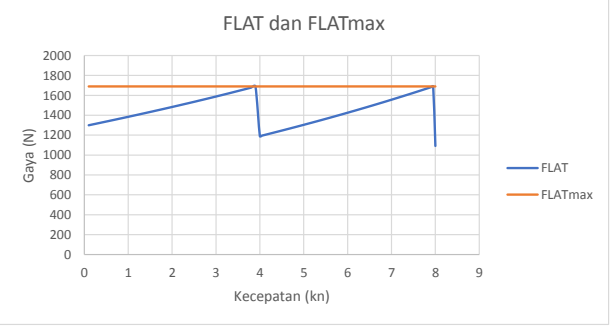
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000	kn
	7,716	m/s
γ	100	°
V_A	7,633	m/s
β	84,604	°
V_S	**2,855**	**m/s**
	5,550	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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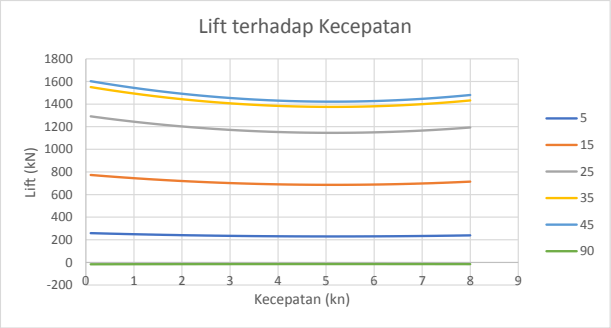
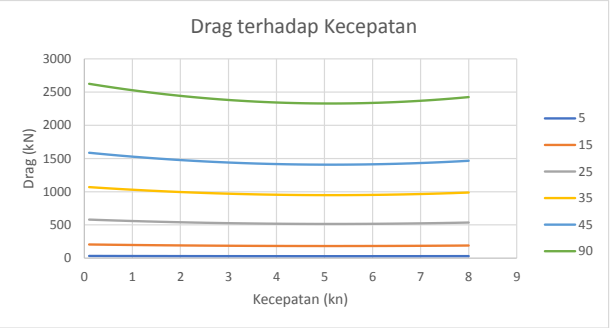
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

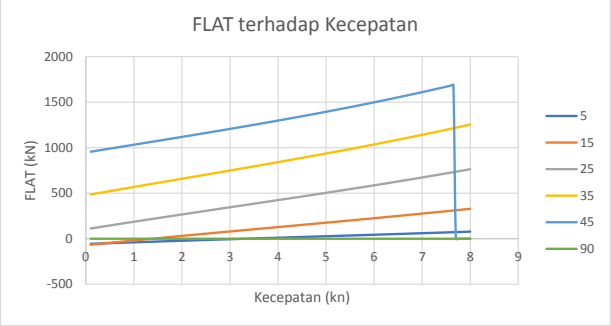
KOEFISIEN MIZZEN SAIL

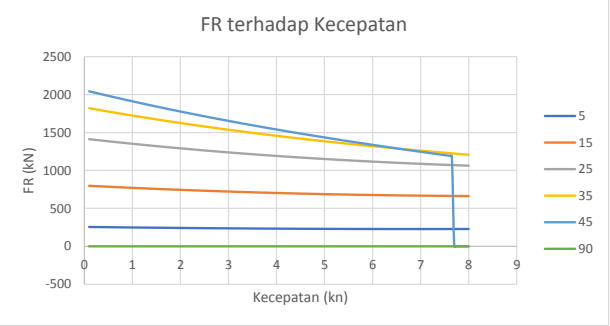
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

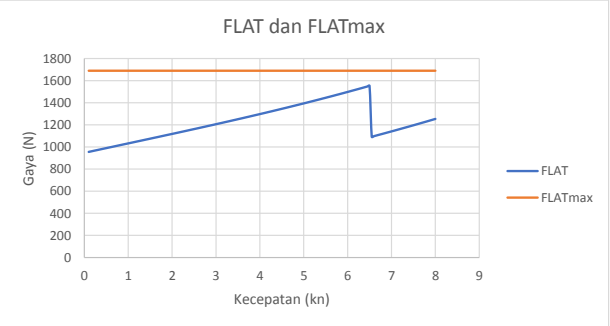
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	110 °
V_A	7,274 m/s
β	94,585 °
V_S	**2,881 m/s**
	5,600 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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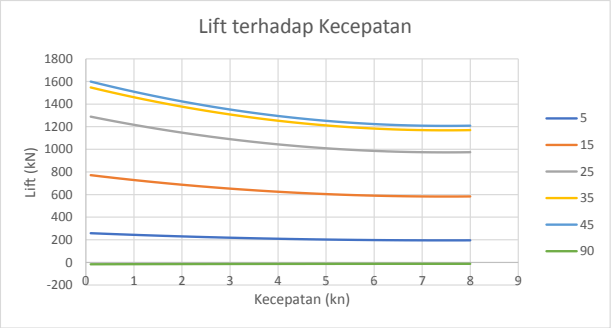
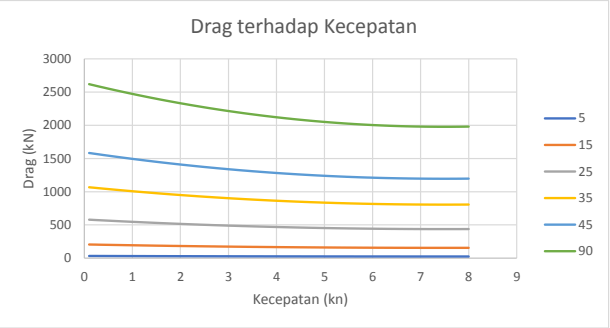
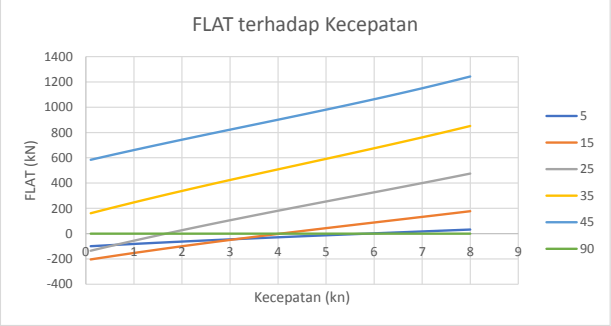
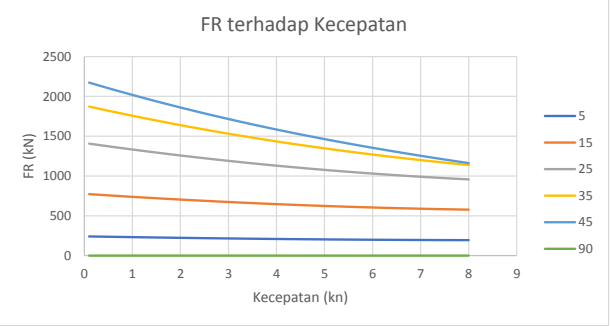
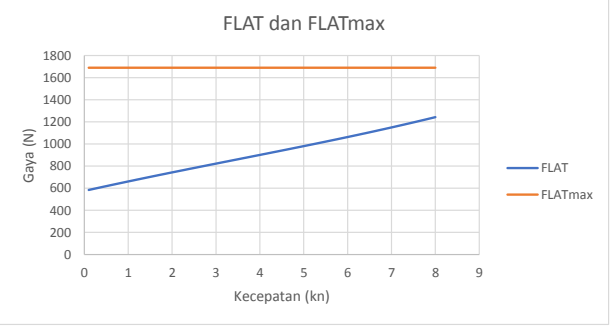
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	120 °
V_A	6,921 m/s
β	105,079 °
V_S	**2,881 m/s**
	5,600 kn

SPESIFIKASI LAYAR

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	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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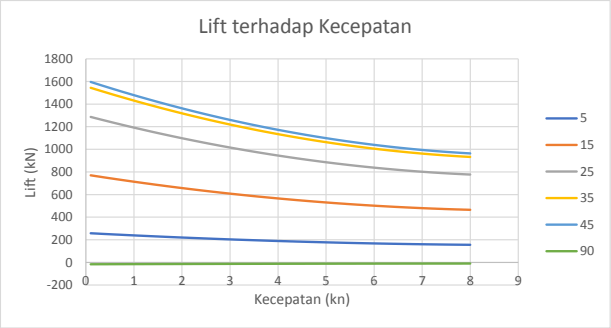

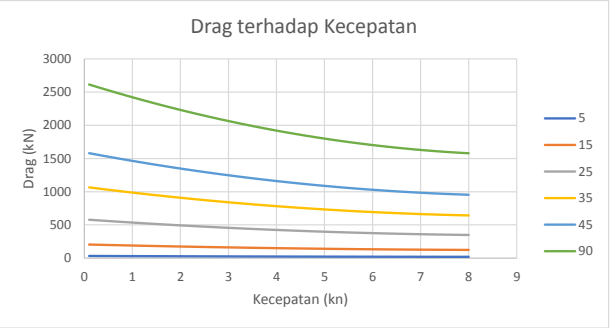

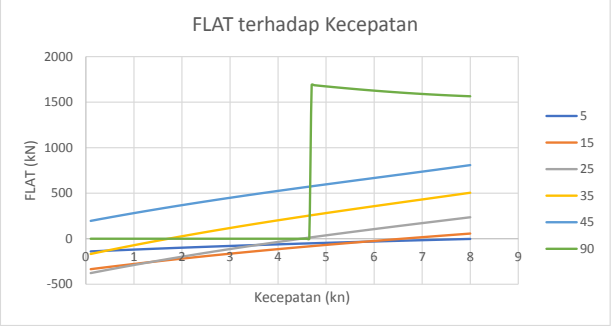

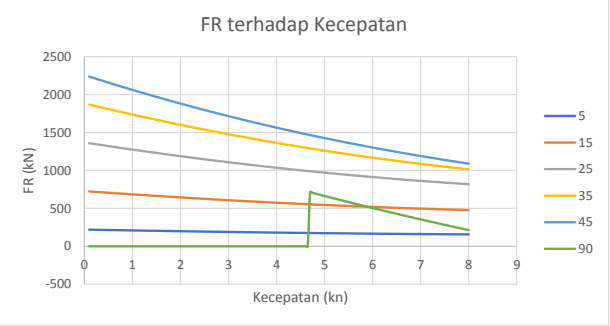

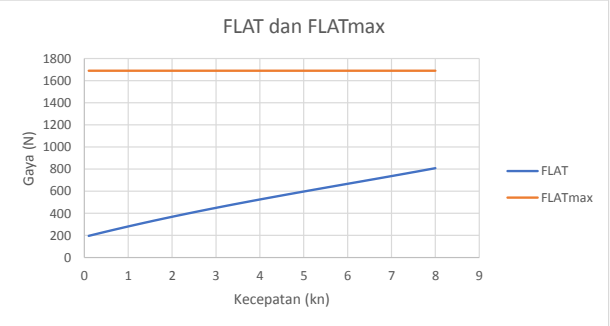

V_T	15,000	kn
	7,716	m/s
γ	130	°
V_A	6,585	m/s
β	116,151	°
V_S	**2,855**	**m/s**
	5,550	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

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HEELING MOMENT

$$M_H = F_H \times h$$

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MUATAN	θ_{max}	11 °	h	4,156 m
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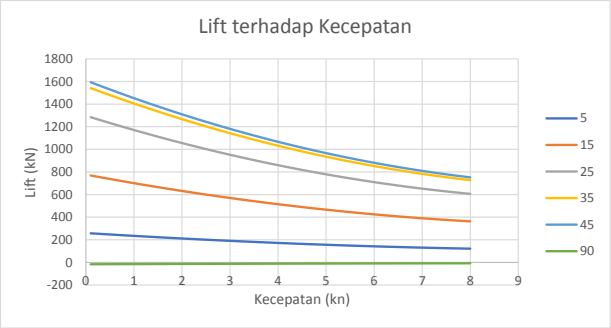

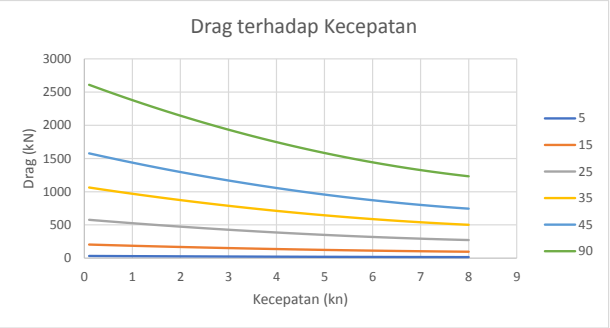

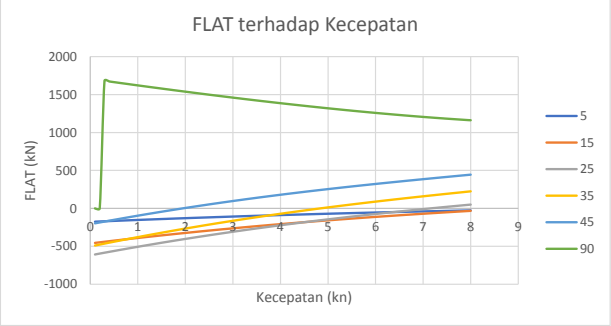

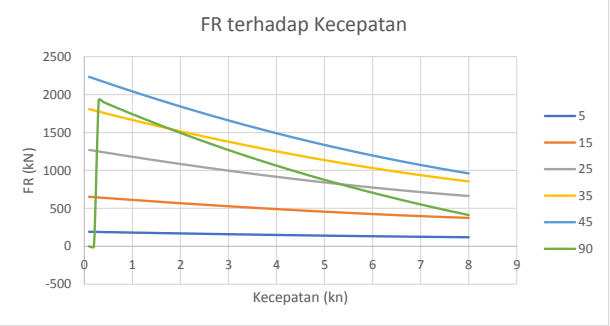

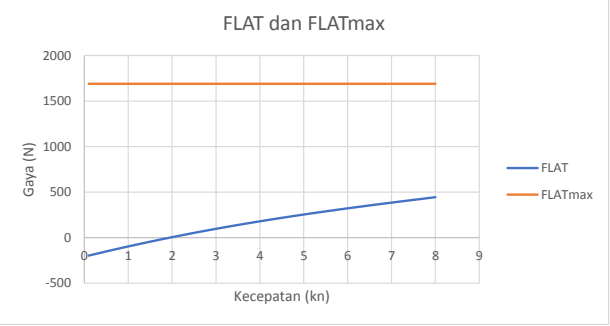

V_T	15,000	kn
	7,716	m/s
γ	140	°
V_A	6,281	m/s
β	127,843	°
V_S	**2,803**	**m/s**
	5,450	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
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	Boom	6,400	4,013
Chord (m)		3,658	2,294
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TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

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HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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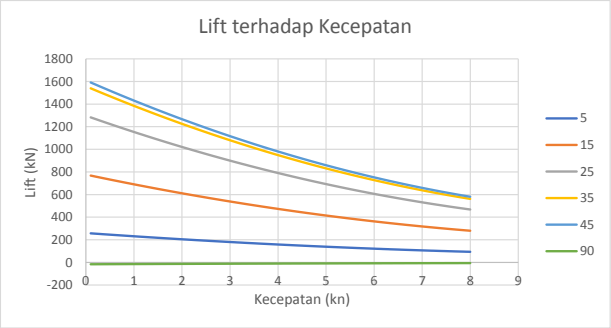
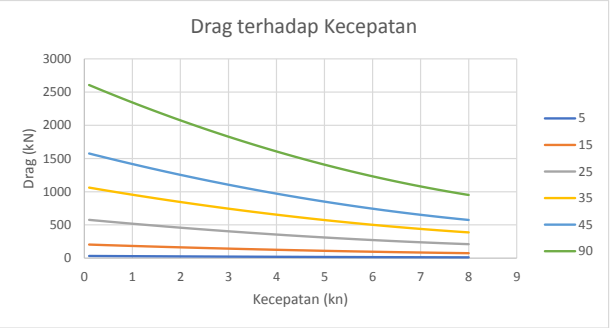
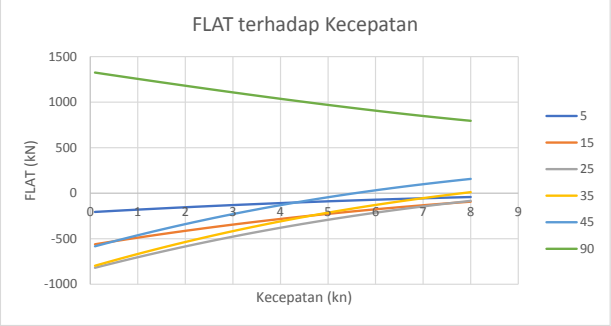
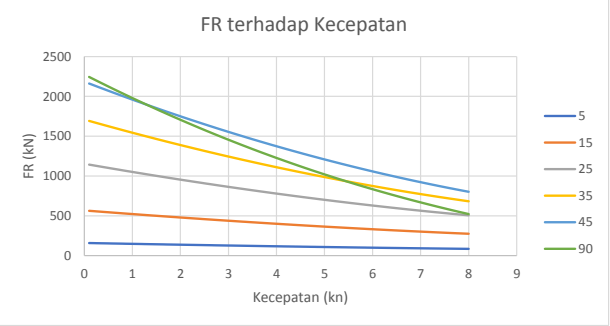
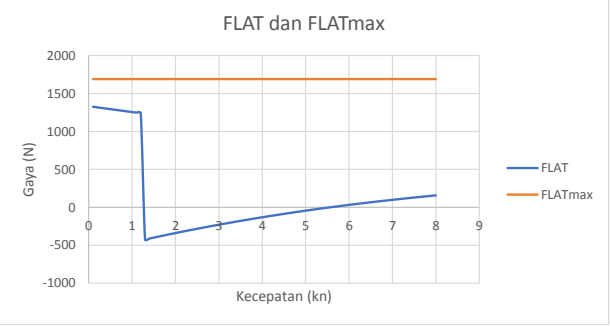










V_T	15,000	kn
	7,716	m/s
γ	150	°
V_A	6,023	m/s
β	140,164	°
V_S	**2,726**	**m/s**
	5,300	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

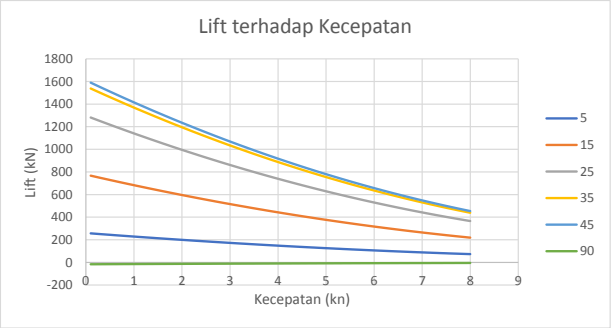
KOEFISIEN MAIN SAIL

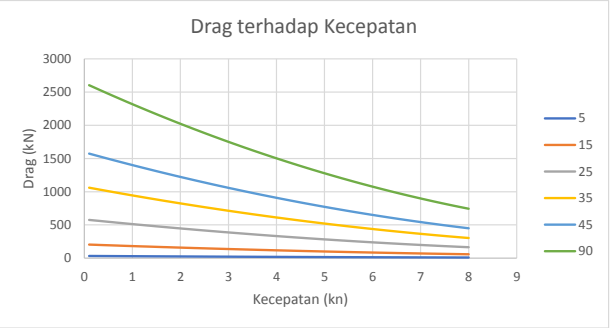
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

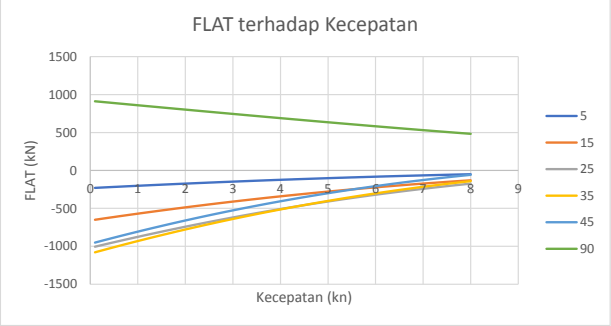
KOEFISIEN MIZZEN SAIL

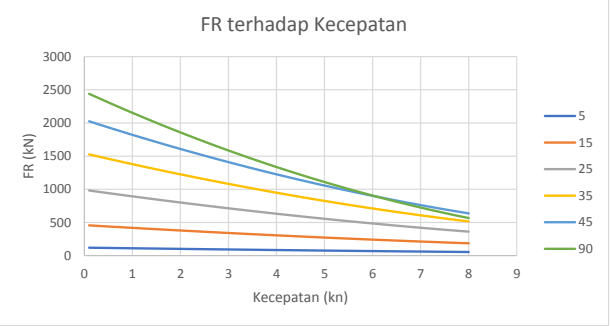
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

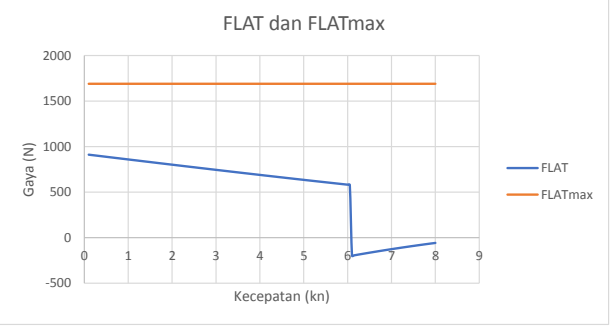
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000	kn
	7,716	m/s
γ	160	°
V_A	5,825	m/s
β	153,061	°
V_S	**2,649**	**m/s**
	5,150	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

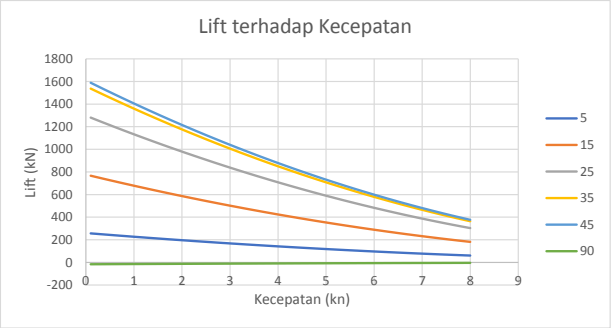
KOEFISIEN MAIN SAIL

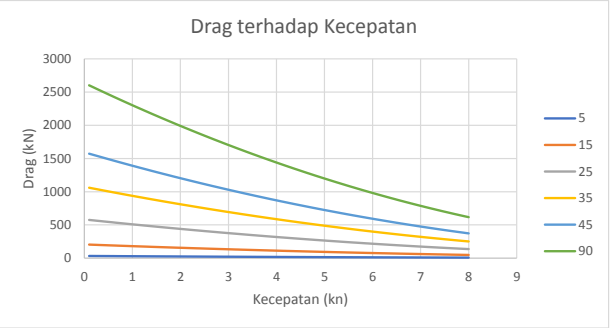
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

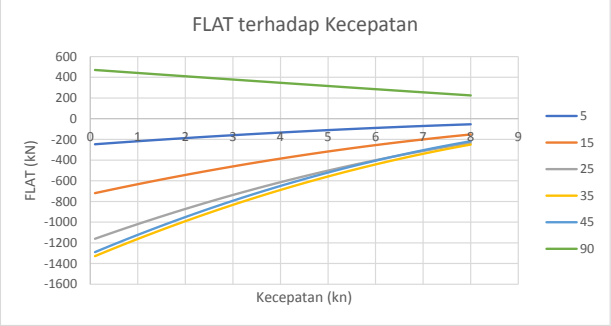
KOEFISIEN MIZZEN SAIL

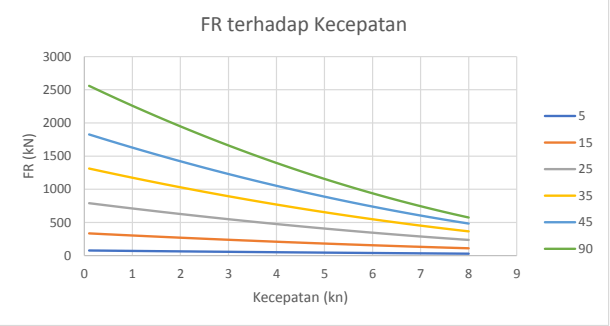
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

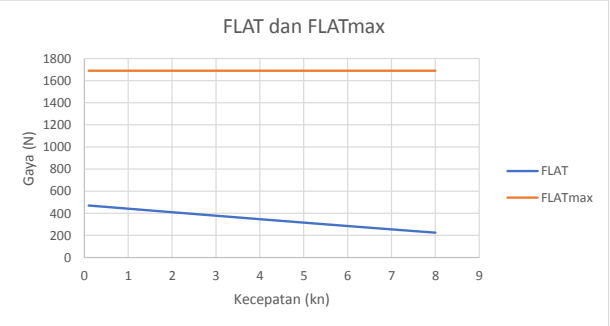
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000 kn
	7,716 m/s
γ	170 °
V_A	5,701 m/s
β	166,407 °
V_S	**2,675 m/s**
	5,200 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

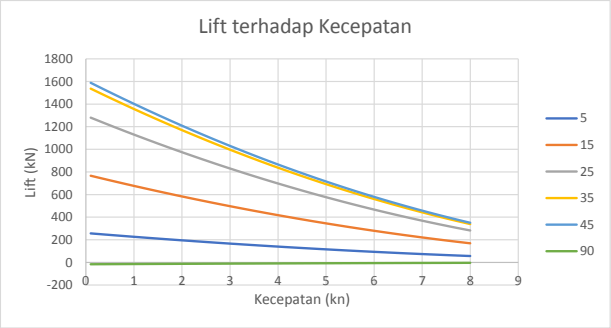
KOEFISIEN MAIN SAIL

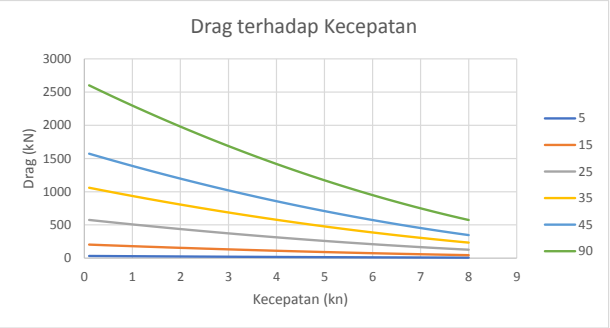
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

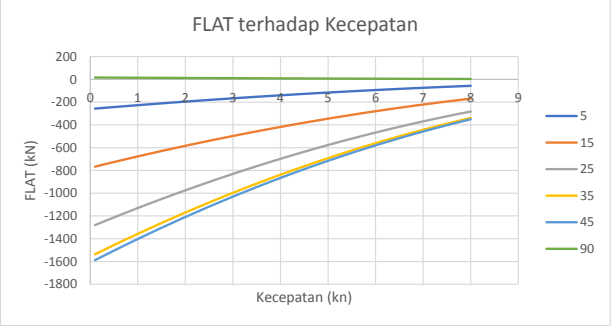
KOEFISIEN MIZZEN SAIL

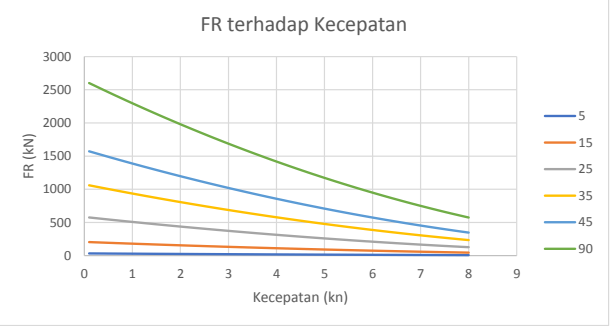
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

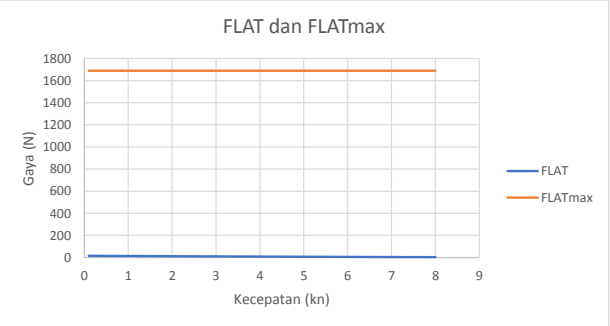
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	15,000	kn
	7,716	m/s
γ	180	°
V_A	5,658	m/s
β	180,000	°
V_S	**2,675**	**m/s**
	5,200	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

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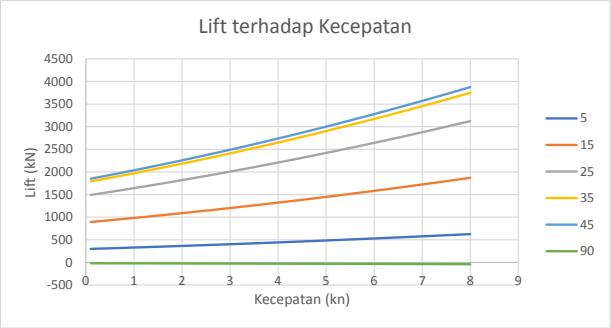
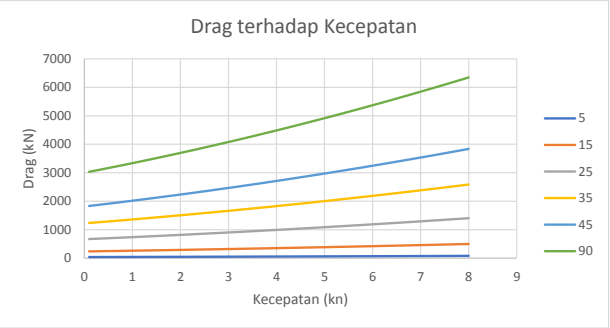
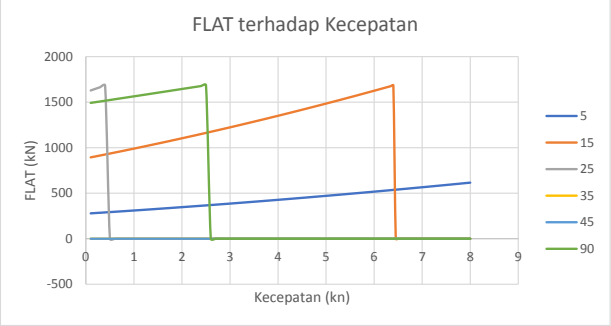
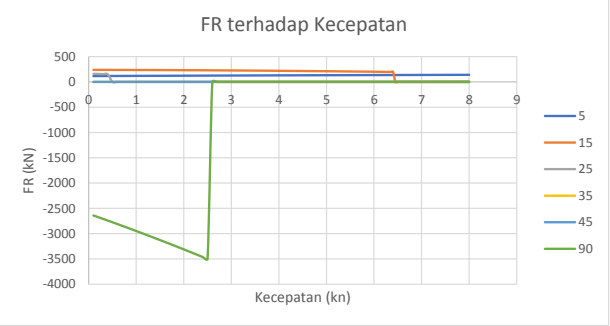
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

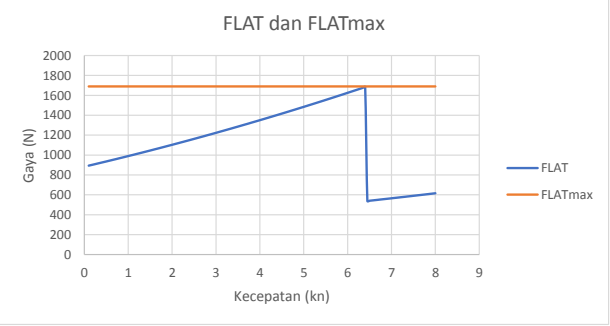
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	30 °
V_A	9,320 m/s
β	26,202 °
V_S	**1,235 m/s**
	2,400 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
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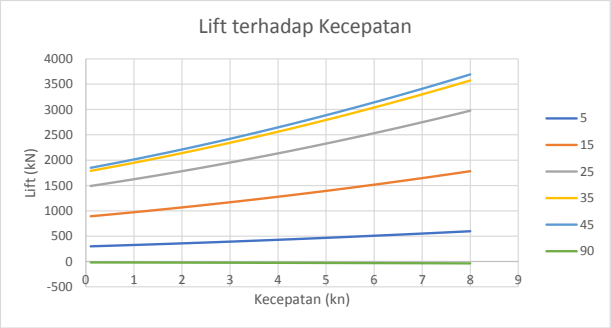
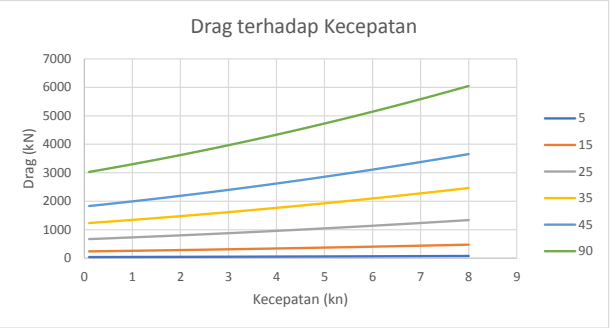
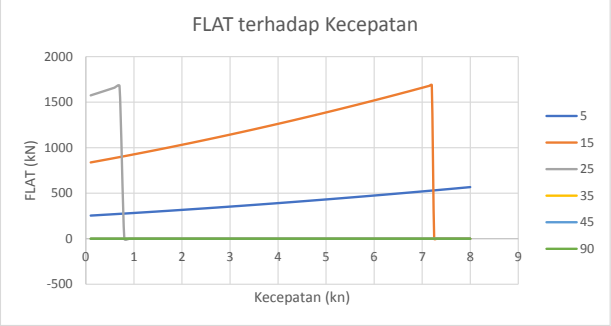
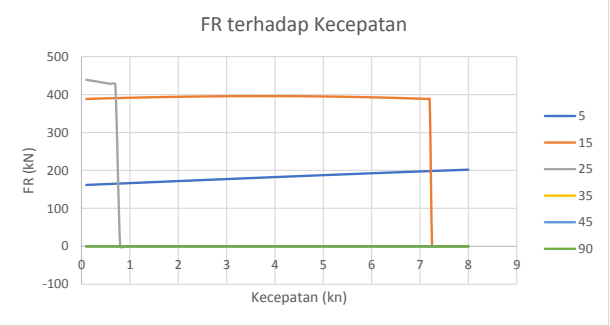
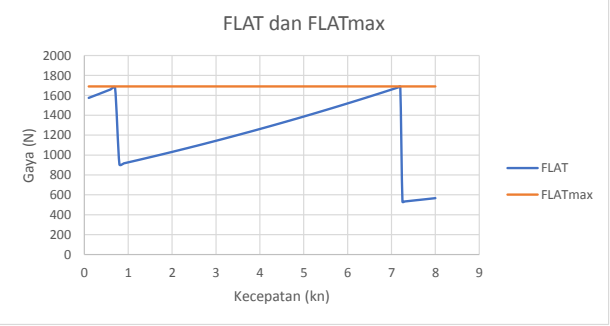
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	40	°
V_A	9,550	m/s
β	33,639	°
V_S	**1,646**	**m/s**
	3,200	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
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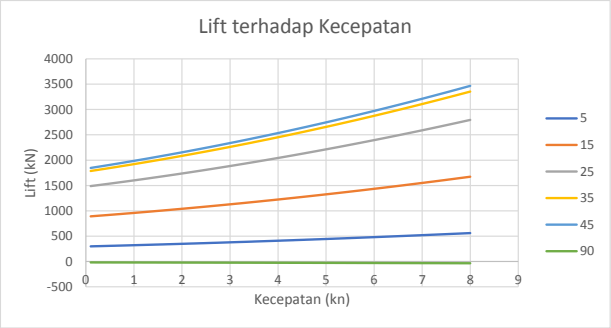
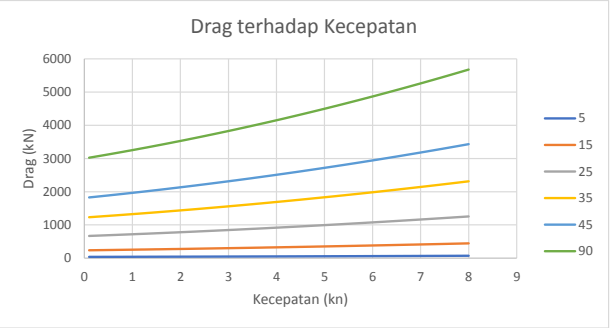
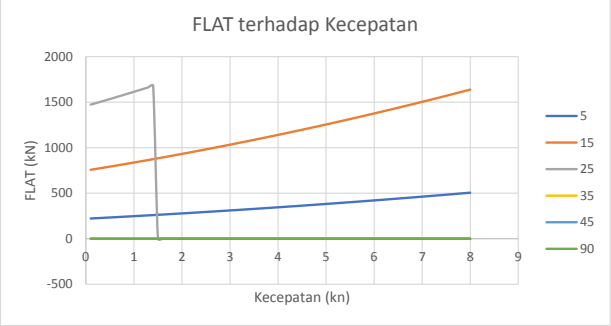
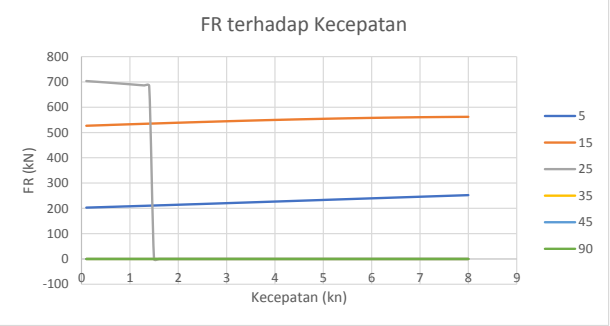
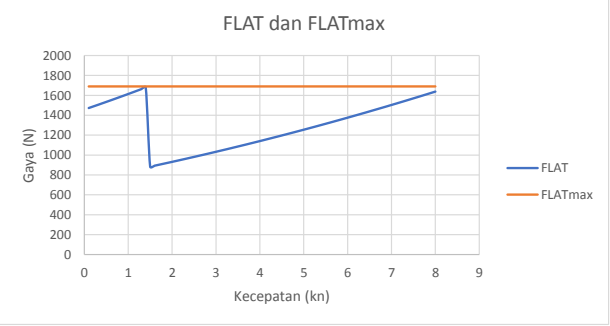










V_T	16,000	kn
	8,230	m/s
γ	50	°
V_A	9,604	m/s
β	41,030	°
V_S	**1,955**	**m/s**
	3,800	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

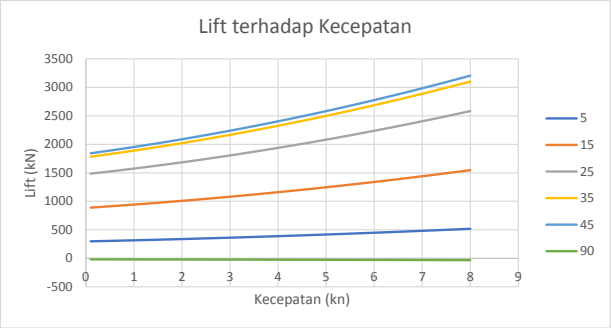
KOEFISIEN MAIN SAIL

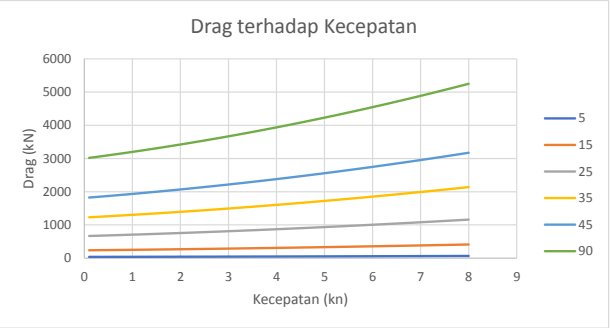
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

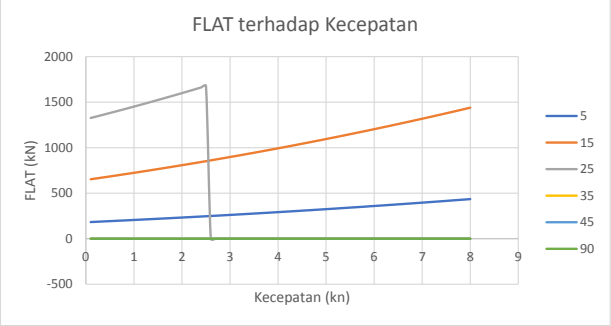
KOEFISIEN MIZZEN SAIL

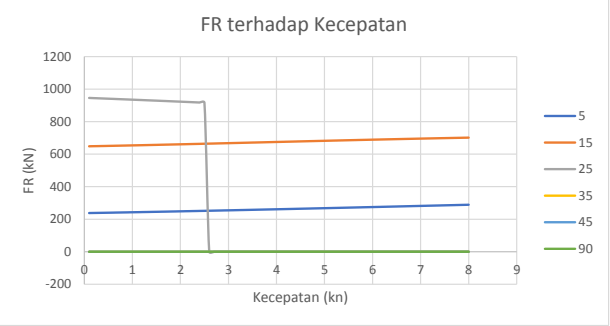
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

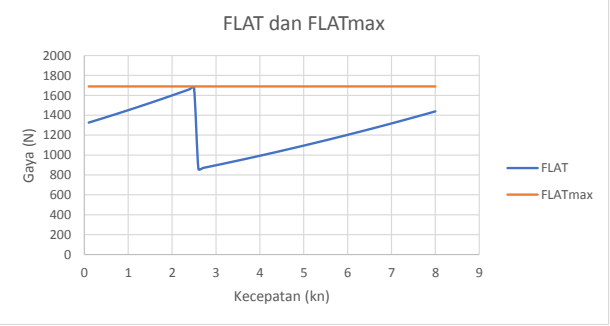
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	60	°
V_A	9,429	m/s
β	49,107	°
V_S	**2,160**	**m/s**
	4,200	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

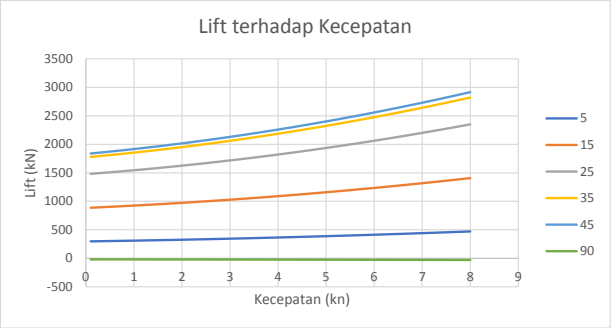
KOEFISIEN MAIN SAIL

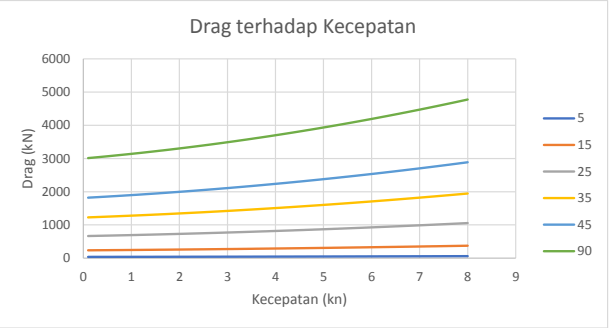
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

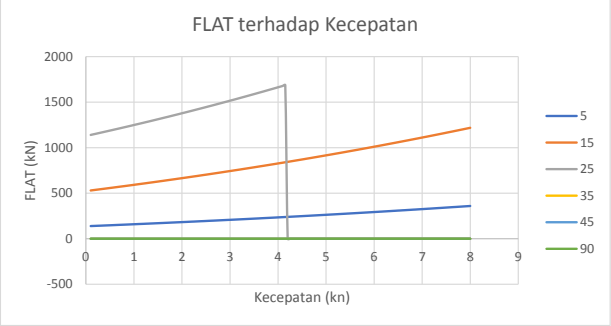
KOEFISIEN MIZZEN SAIL

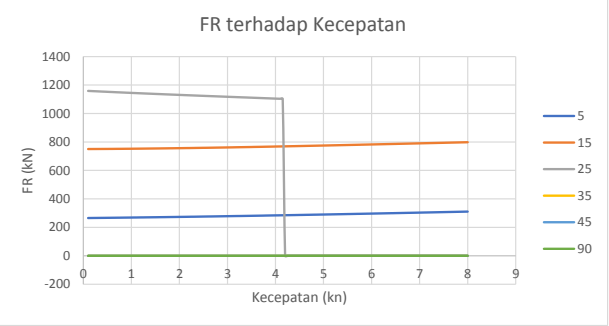
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

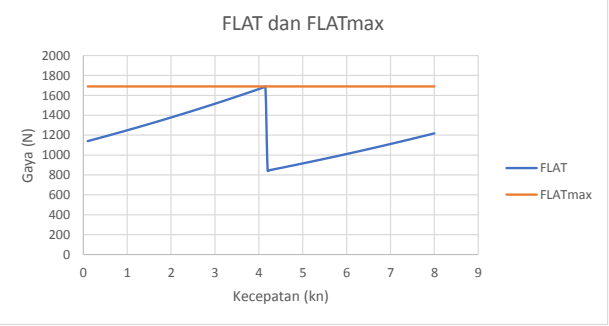
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	70	°
V_A	9,141	m/s
β	57,788	°
V_S	**2,289**	**m/s**
	4,450	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

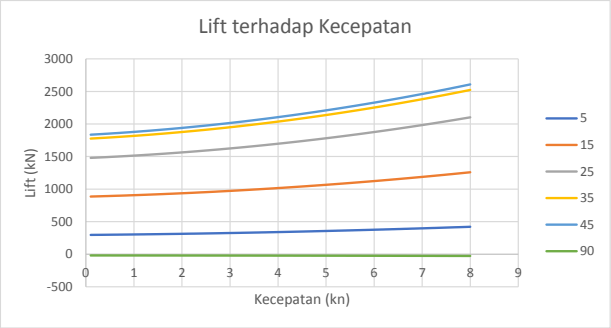
KOEFISIEN MAIN SAIL

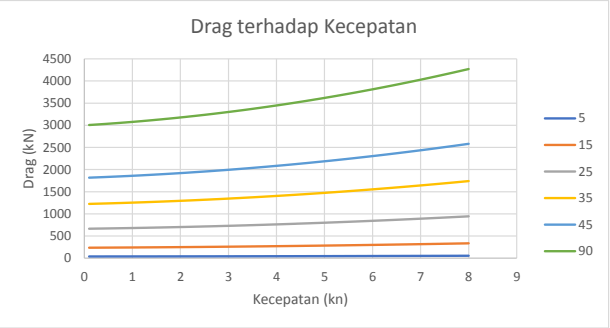
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

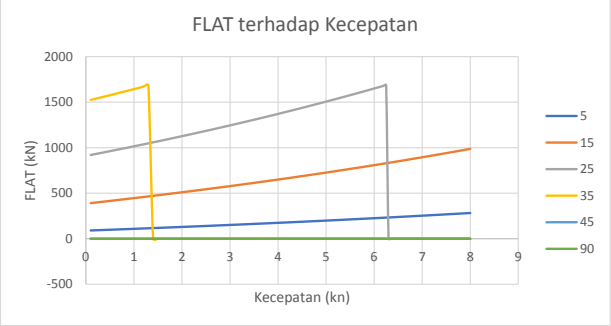
KOEFISIEN MIZZEN SAIL

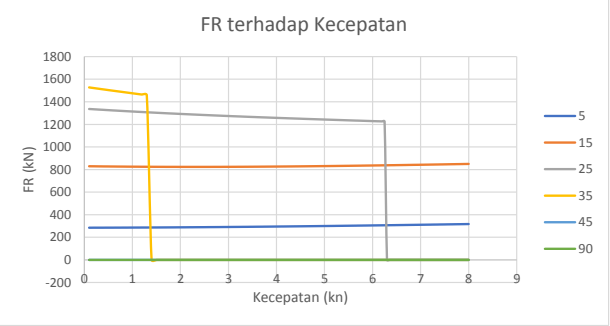
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

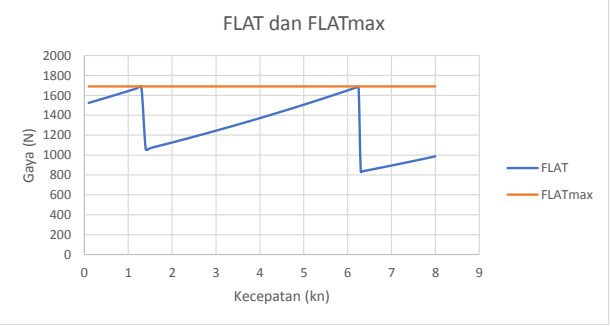
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	80 °
V_A	8,824 m/s
β	66,723 °
V_S	**2,778 m/s**
	5,400 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

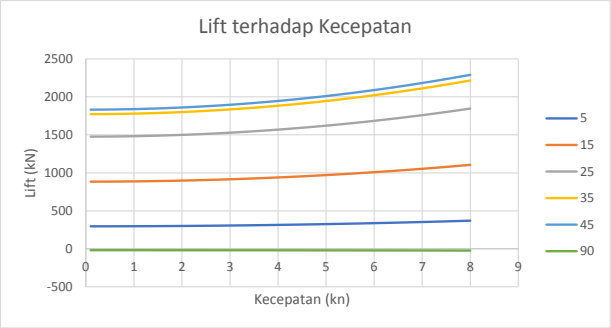
KOEFISIEN MAIN SAIL

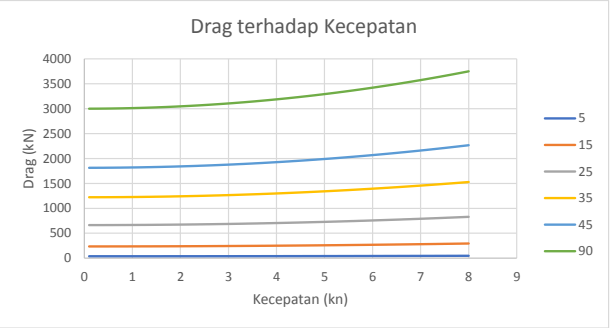
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

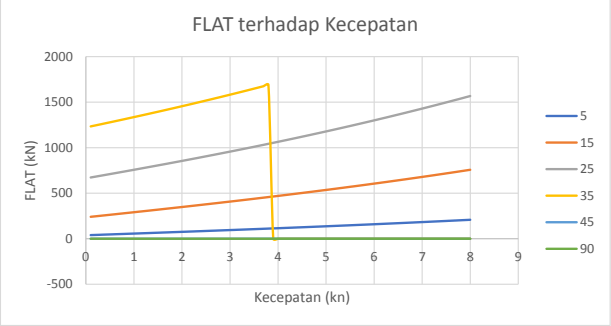
KOEFISIEN MIZZEN SAIL

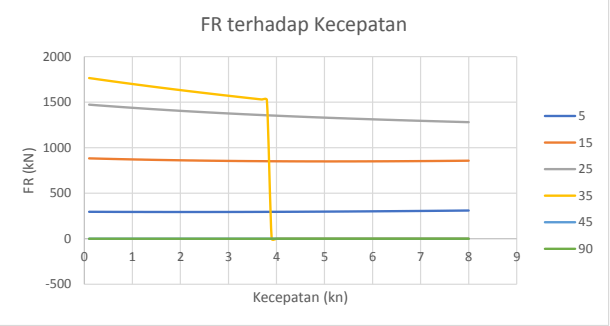
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

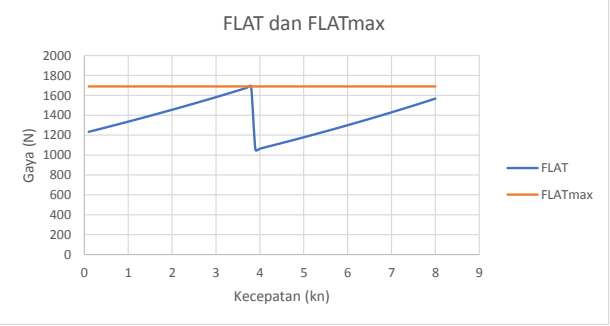
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	90 °
V_A	8,484 m/s
β	75,964 °
V_S	**2,829 m/s**
	5,500 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

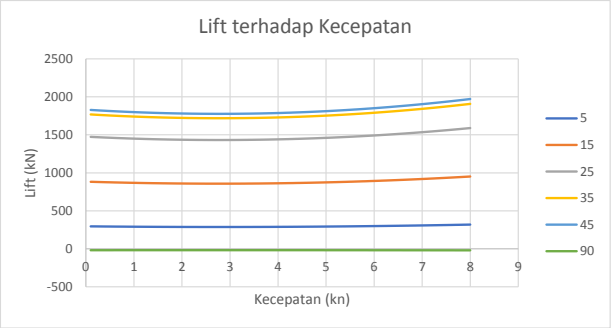
KOEFISIEN MAIN SAIL

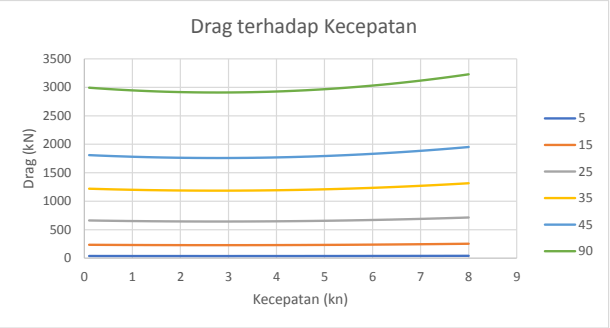
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

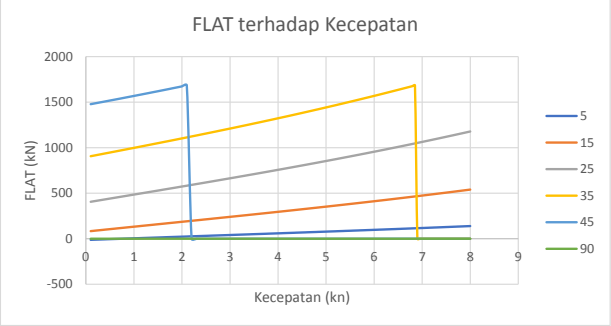
KOEFISIEN MIZZEN SAIL

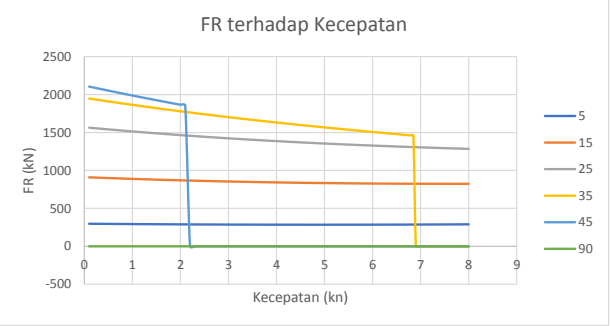
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

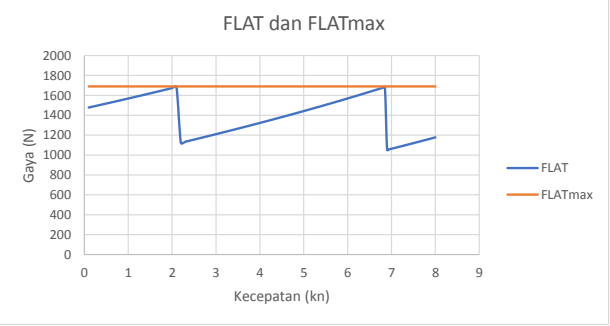
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	100	°
V_A	8,130	m/s
β	85,567	°
V_S	**2,984**	**m/s**
	5,800	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

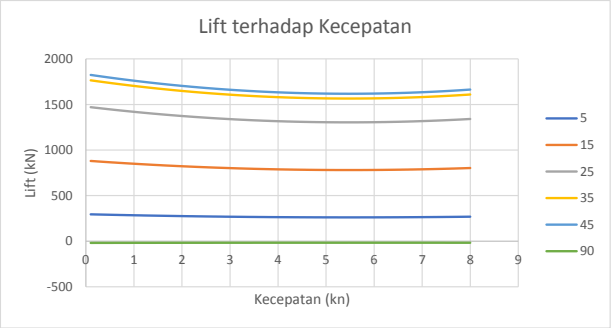
KOEFISIEN MAIN SAIL

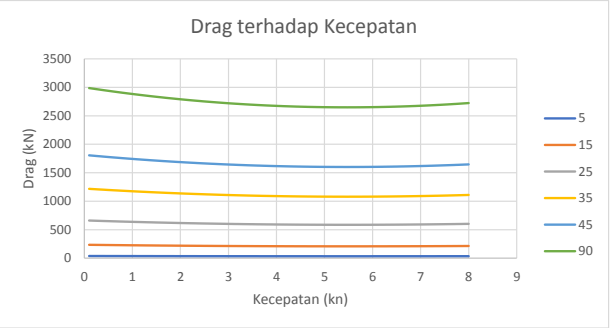
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

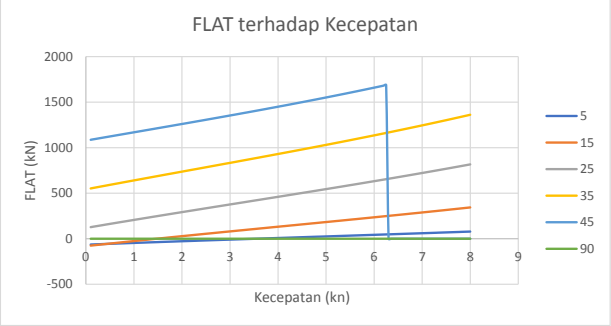
KOEFISIEN MIZZEN SAIL

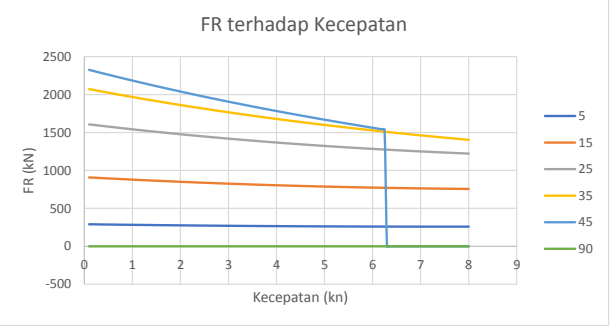
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

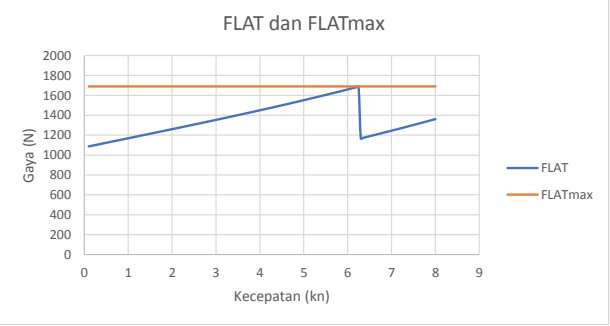
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	110	°
V_A	7,771	m/s
β	95,593	°
V_S	**3,009**	**m/s**
	5,850	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

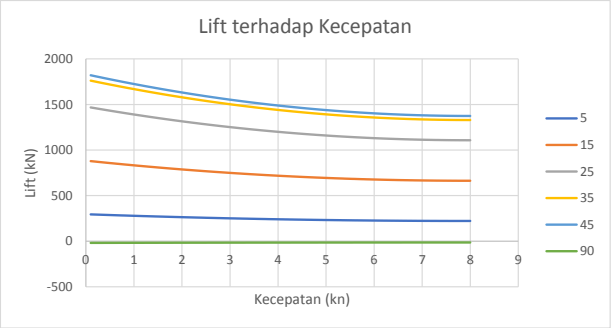
KOEFISIEN MAIN SAIL

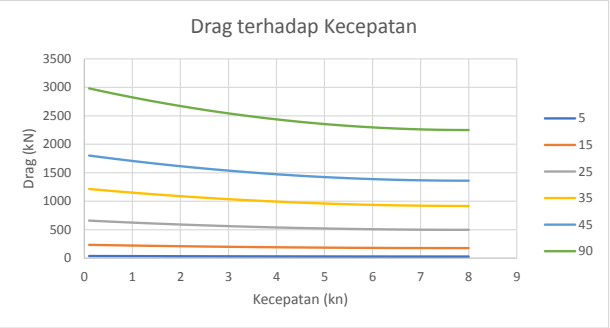
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

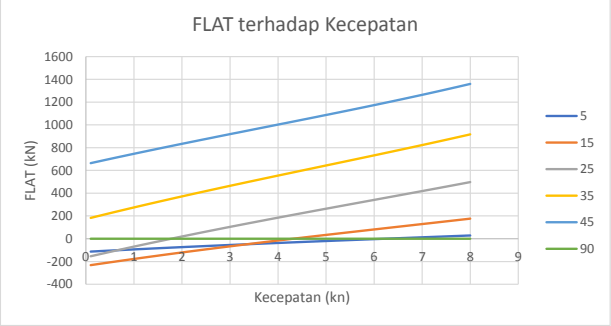
KOEFISIEN MIZZEN SAIL

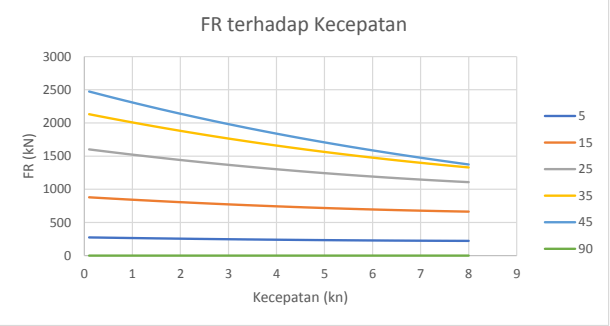
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

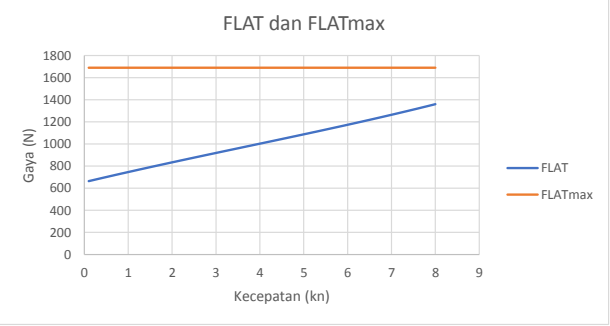
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	120	°
V_A	7,419	m/s
β	106,102	°
V_S	**3,009**	**m/s**
	5,850	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

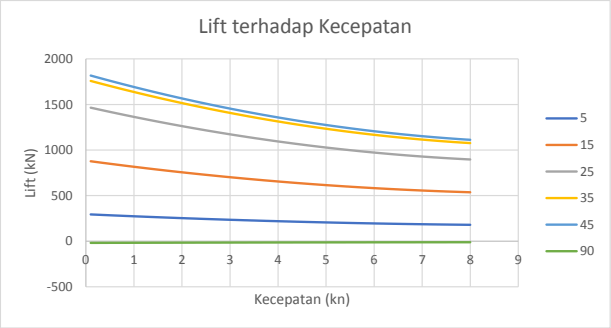
KOEFISIEN MAIN SAIL

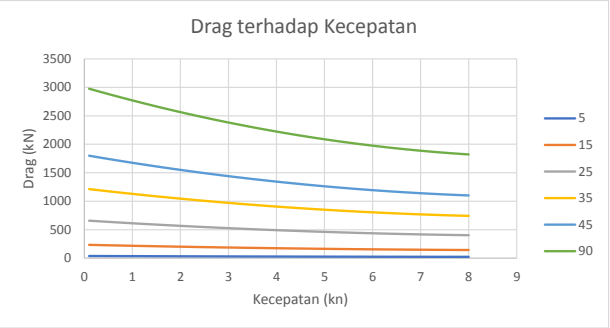
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

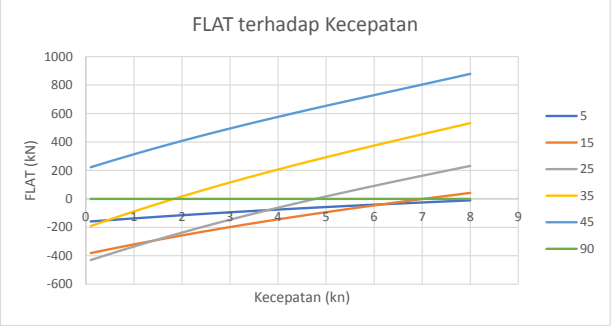
KOEFISIEN MIZZEN SAIL

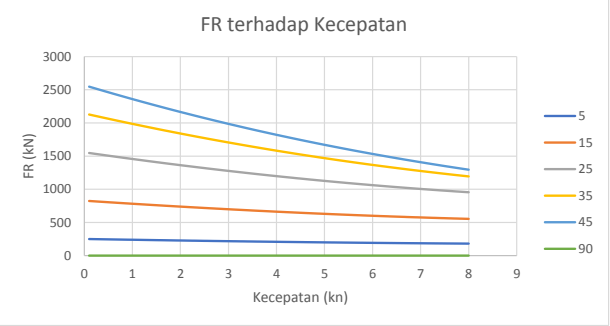
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

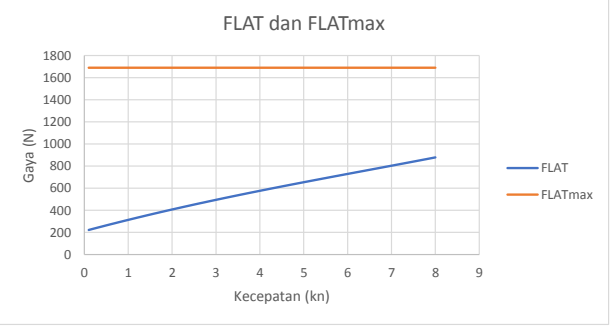
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	130 °
V_A	7,085 m/s
β	117,146 °
V_S	**2,984 m/s**
	5,800 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

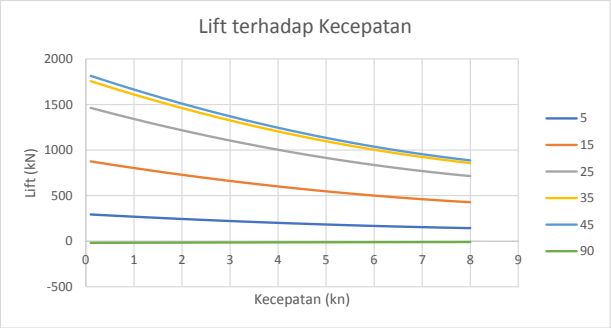
KOEFISIEN MAIN SAIL

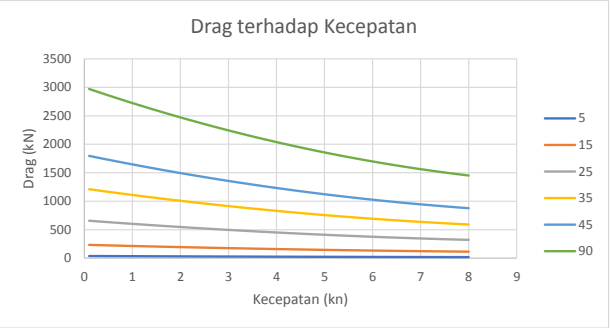
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

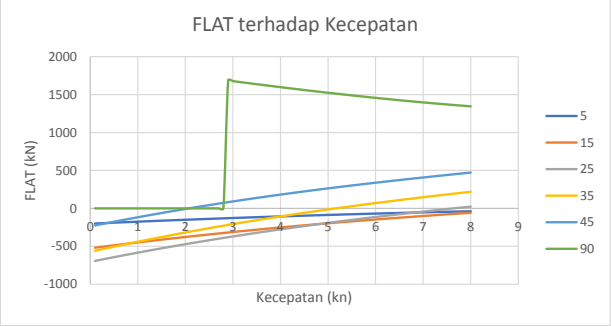
KOEFISIEN MIZZEN SAIL

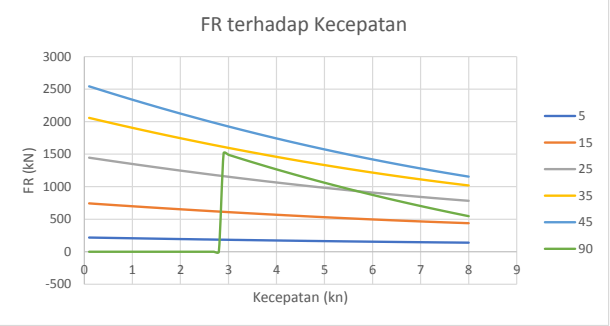
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

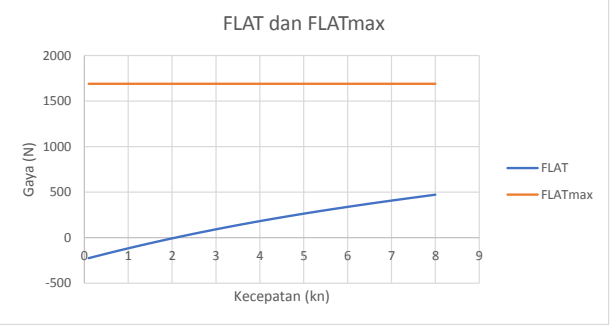
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	140	°
V_A	6,784	m/s
β	128,758	°
V_S	**2,932**	**m/s**
	5,700	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

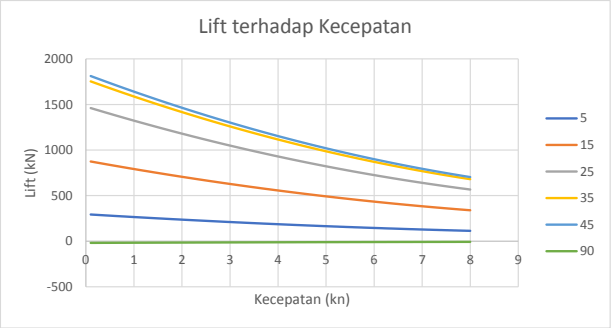
KOEFISIEN MAIN SAIL

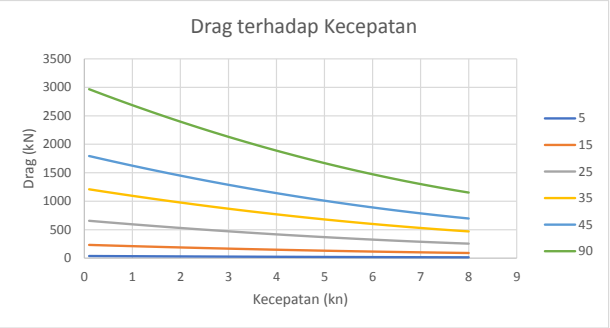
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

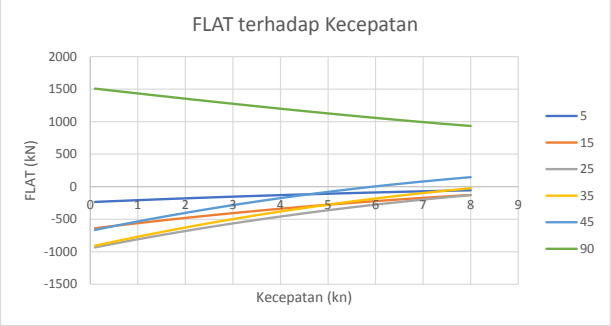
KOEFISIEN MIZZEN SAIL

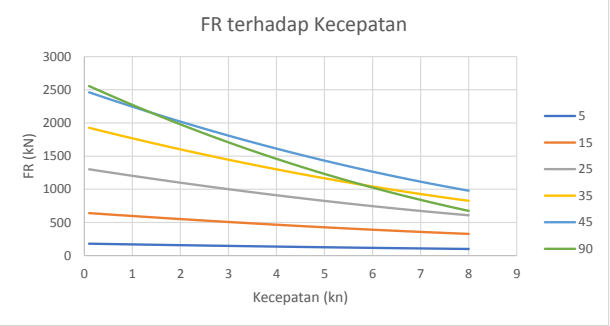
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

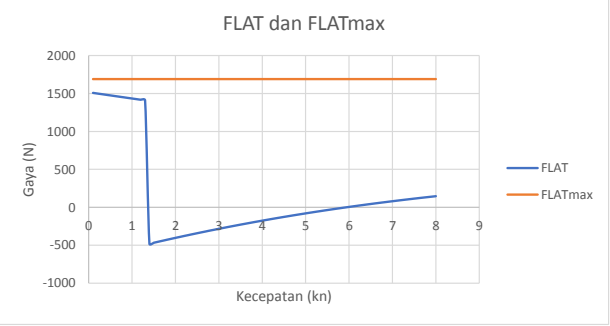
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	150 °
V_A	6,530 m/s
β	140,935 °
V_S	**2,855 m/s**
	5,550 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
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KOEFISIEN MIZZEN SAIL

α (°)	5	15	25	35	45	90
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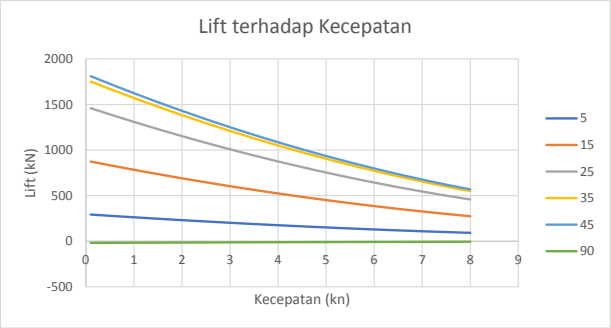
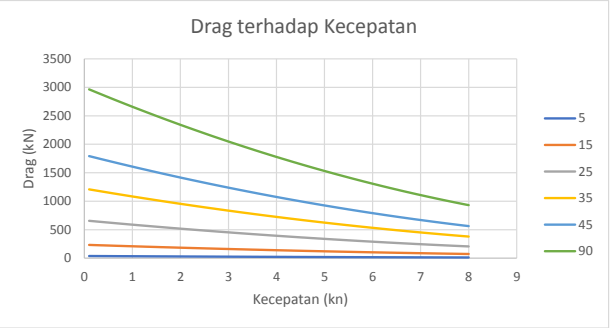
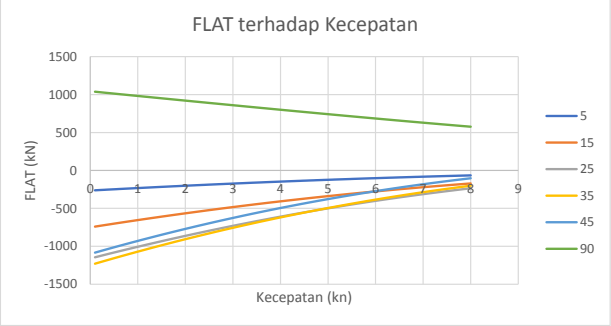
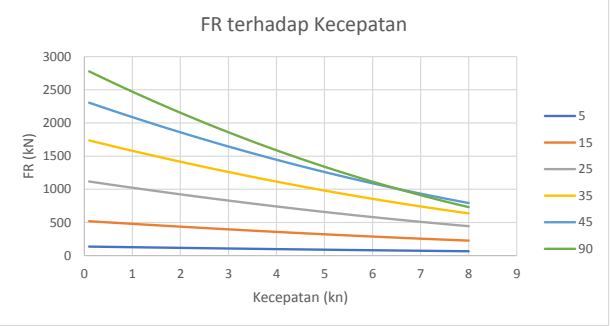
C_D	0,030	0,198	0,499	0,978	1,452	2,399

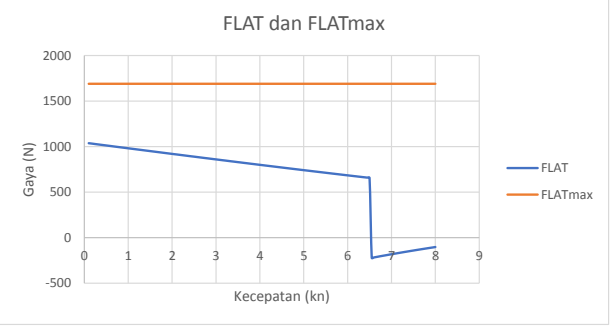
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000	kn
	8,230	m/s
γ	160	°
V_A	6,336	m/s
β	153,623	°
V_S	**2,778**	**m/s**
	5,400	**kn**

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

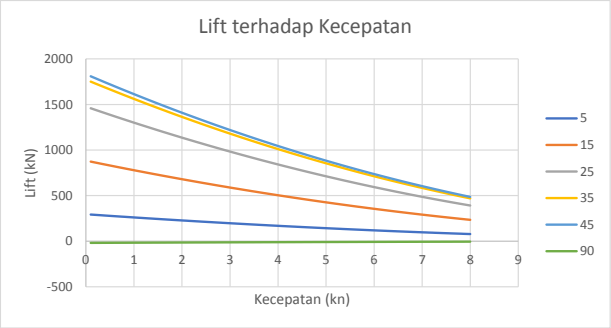
KOEFISIEN MAIN SAIL

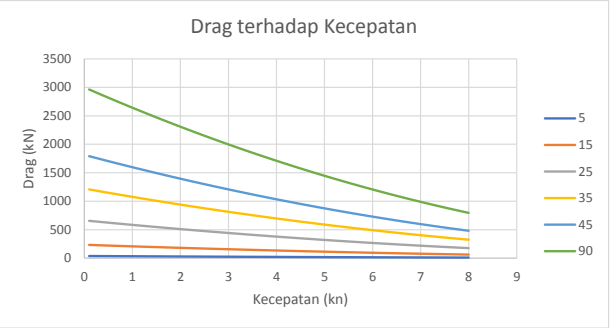
α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

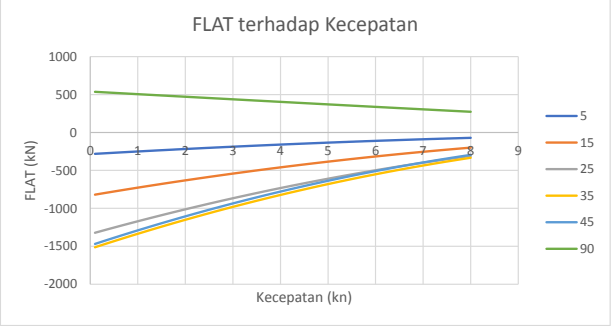
KOEFISIEN MIZZEN SAIL

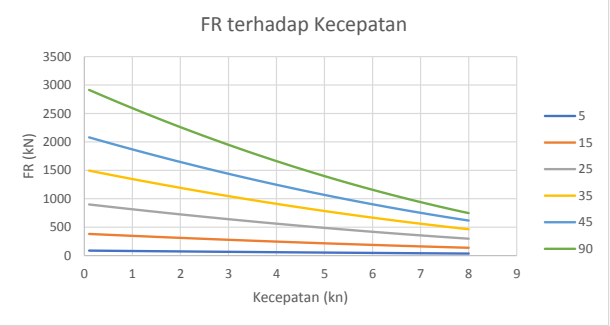
α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
C_D	0,030	0,198	0,499	0,978	1,452	2,399

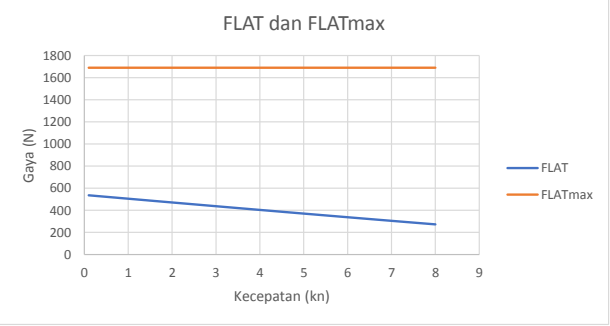
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	170 °
V_A	6,214 m/s
β	166,704 °
V_S	**2,803 m/s**
	5,450 kn

SPESIFIKASI LAYAR

Model	Vinta	MAIN	MIZZEN
Span (m)	Yard	5,639	3,536
	Boom	6,400	4,013
Chord (m)		3,658	2,294
Area (m^2)		22,019	8,656

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,241	0,710	1,213	1,423	1,470	-0,015
C_D	0,030	0,185	0,545	0,981	1,456	2,409

KOEFISIEN MIZZEN SAIL

α (°)	5	15	25	35	45	90
C_L	0,227	0,707	1,111	1,419	1,466	-0,015
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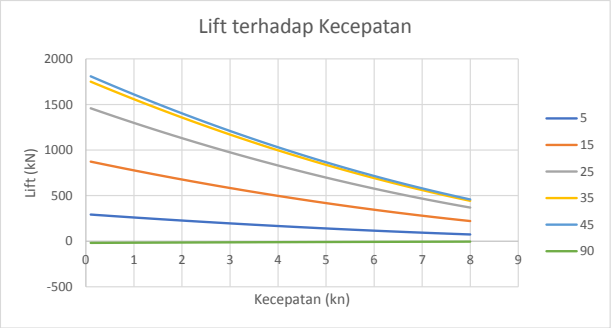
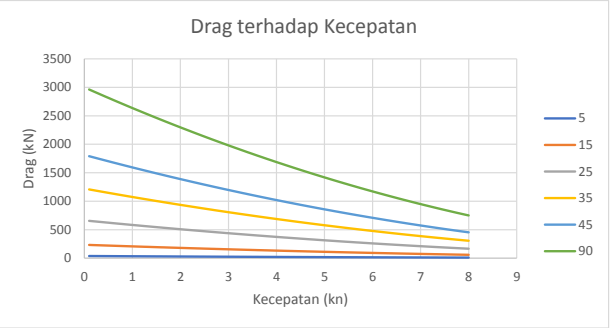
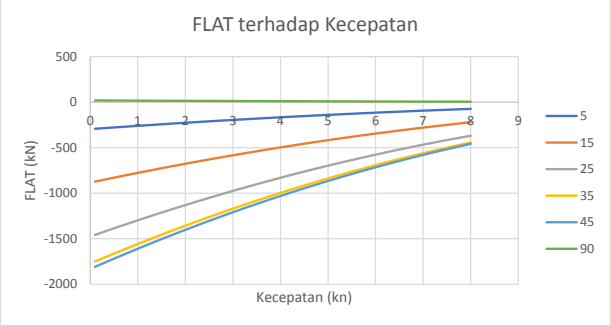
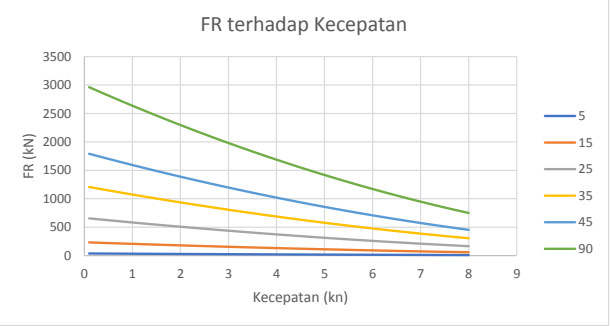
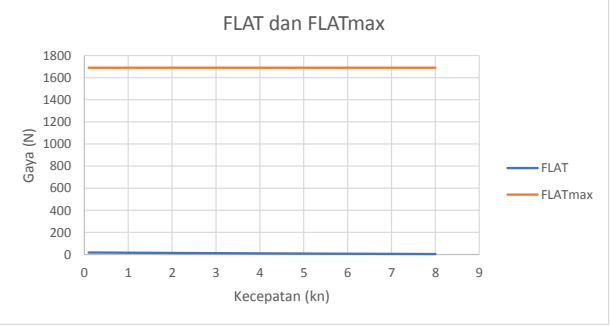
MUATAN	θ_{max}	11 °	h	4,156 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1689,735 N











V_T	16,000 kn
	8,230 m/s
γ	180 °
V_A	6,173 m/s
β	180,000 °
V_S	**2,829 m/s**
	5,500 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

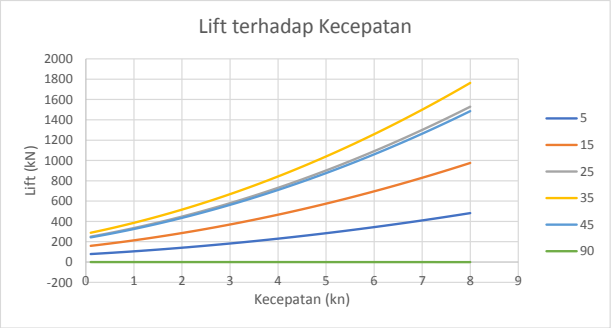
KOEFISIEN MAIN SAIL

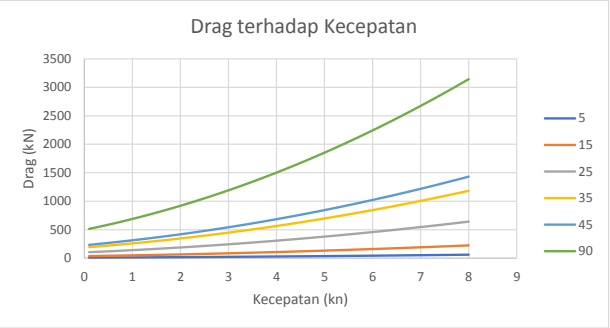
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

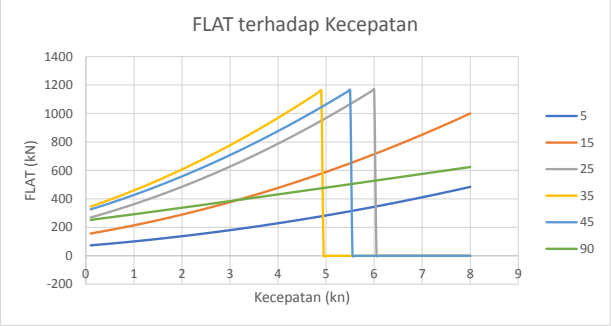
KOEFISIEN MIZZEN SAIL

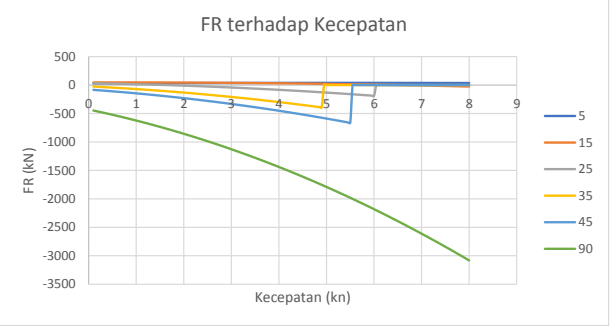
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

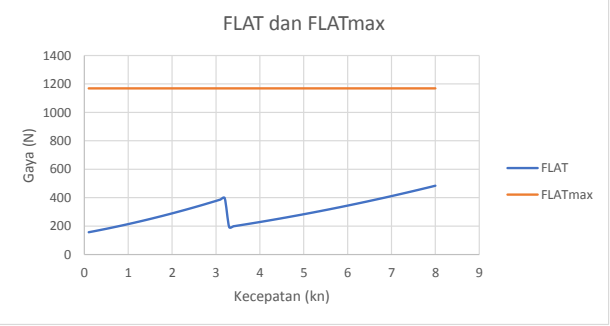
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	30 °
V_A	3,028 m/s
β	25,128 °
V_S	**0,514 m/s**
	1,000 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

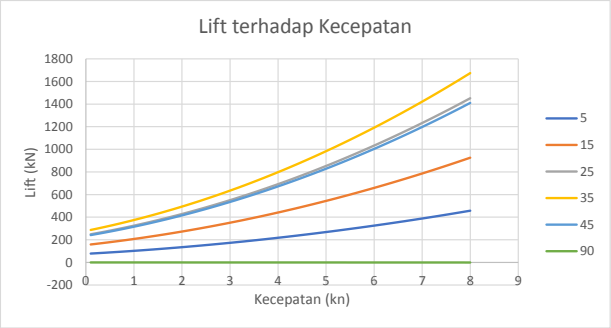
KOEFISIEN MAIN SAIL

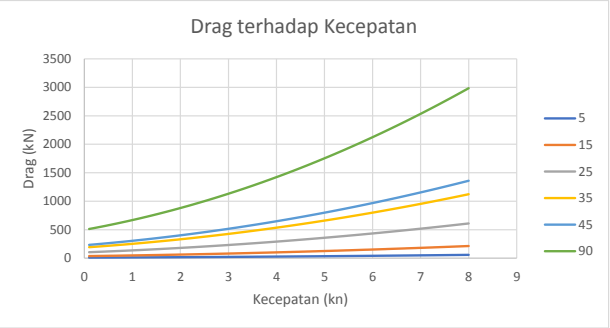
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

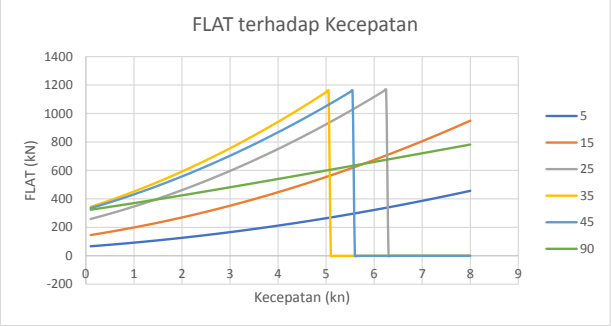
KOEFISIEN MIZZEN SAIL

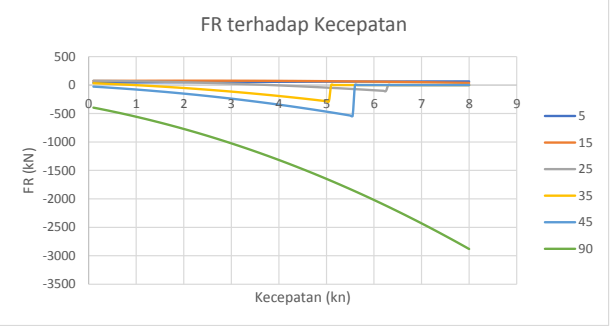
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

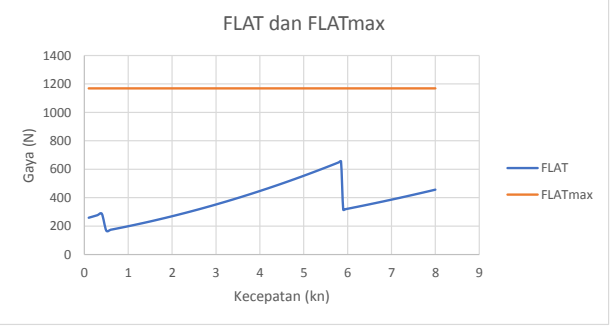
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	40 °
V_A	3,114 m/s
β	32,066 °
V_S	**0,669 m/s**
	1,300 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

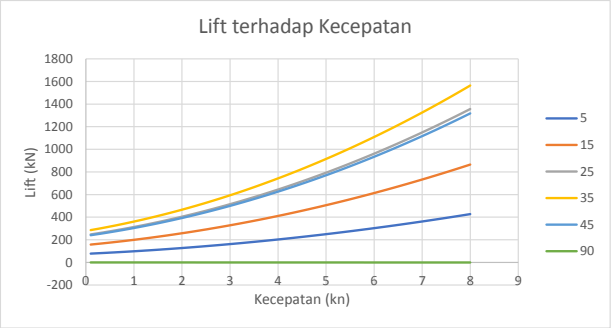
KOEFISIEN MAIN SAIL

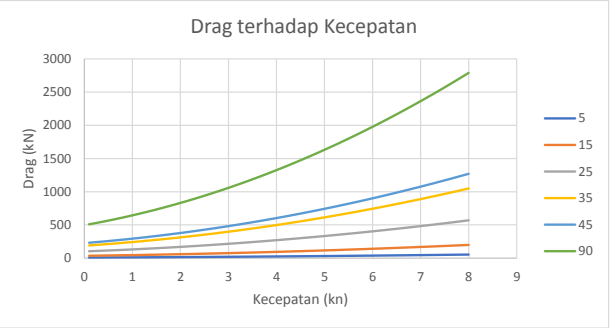
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

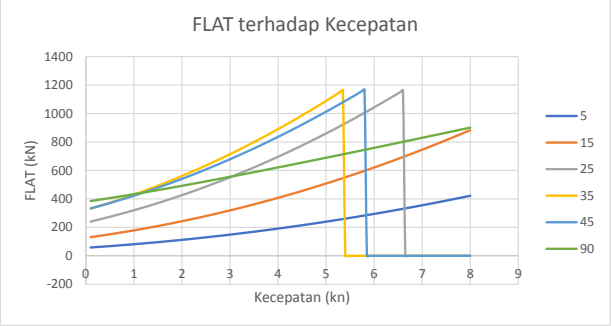
KOEFISIEN MIZZEN SAIL

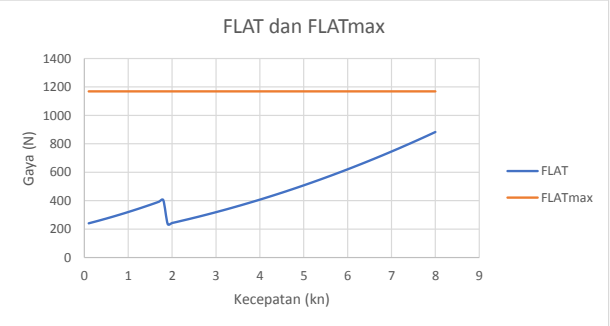
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N









V_T	5,000 kn
	2,572 m/s
γ	50 °
V_A	3,164 m/s
β	38,508 °
V_S	**0,823 m/s**
	1,600 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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α (°)	5	15	25	35	45	90
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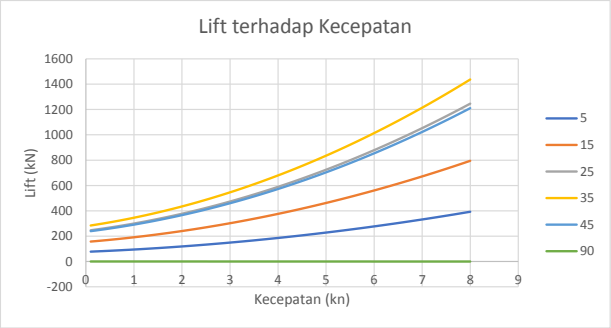
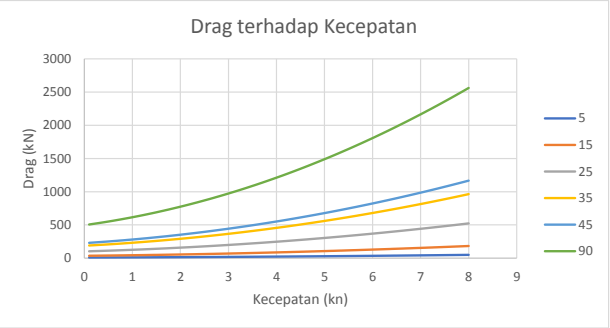
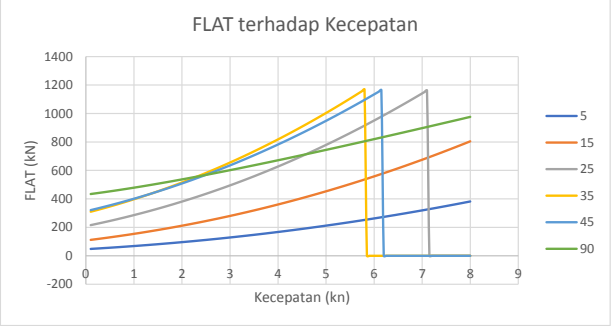
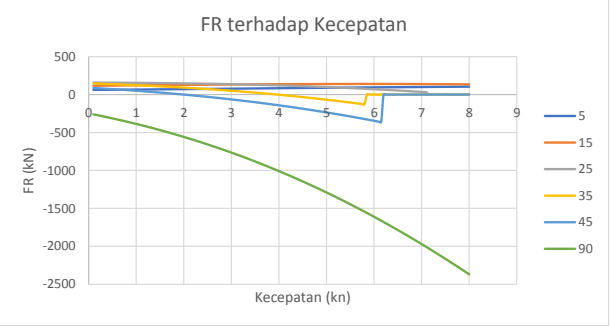
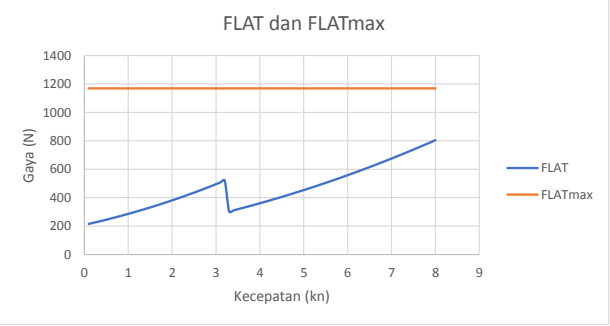
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	60 °
V_A	3,176 m/s
β	44,541 °
V_S	**0,977 m/s**
	1,900 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

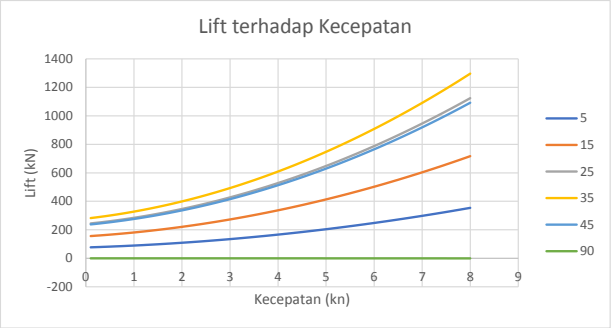
KOEFISIEN MAIN SAIL

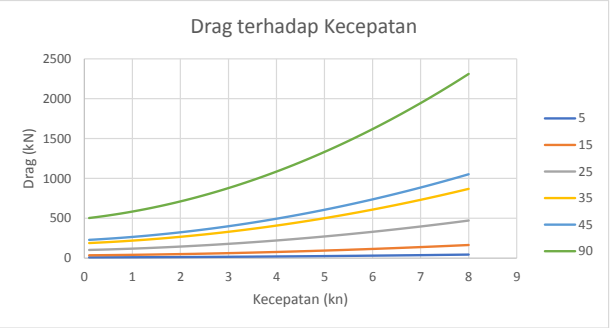
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

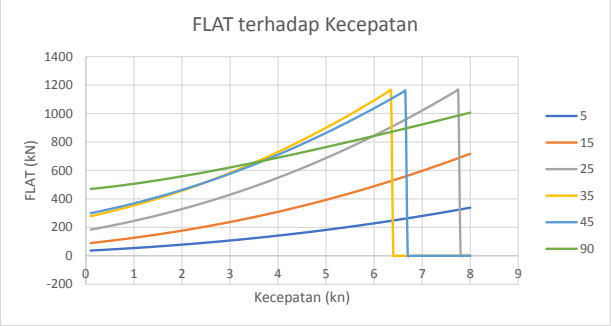
KOEFISIEN MIZZEN SAIL

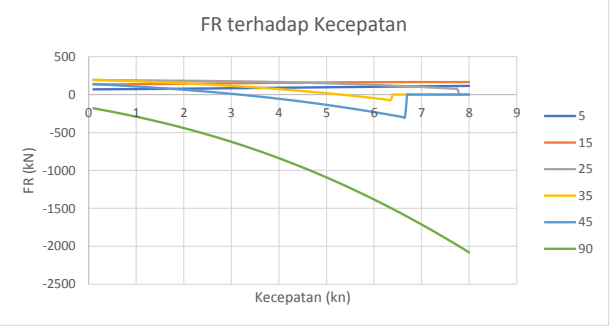
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

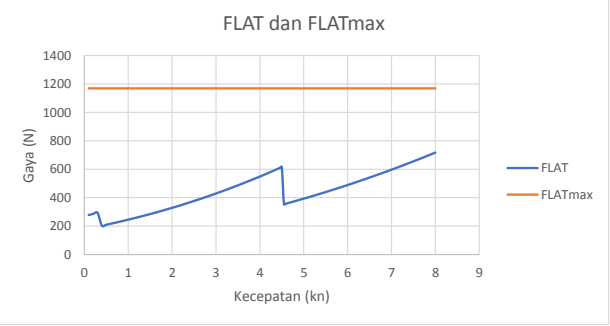
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	70 °
V_A	3,112 m/s
β	50,961 °
V_S	**1,080 m/s**
	2,100 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

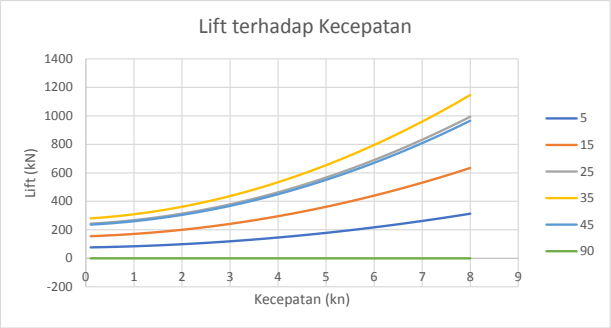
KOEFISIEN MAIN SAIL

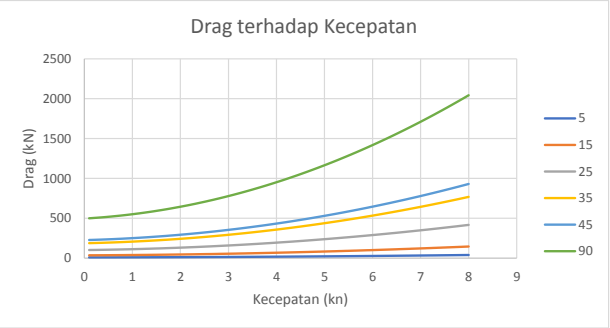
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

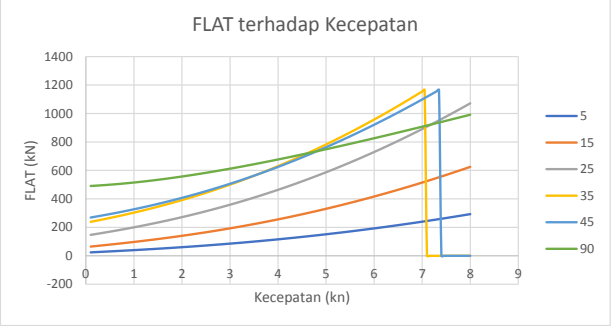
KOEFISIEN MIZZEN SAIL

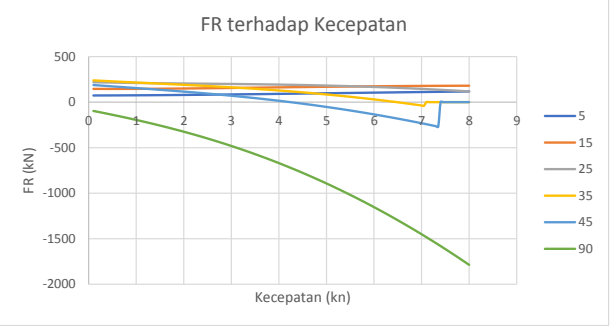
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

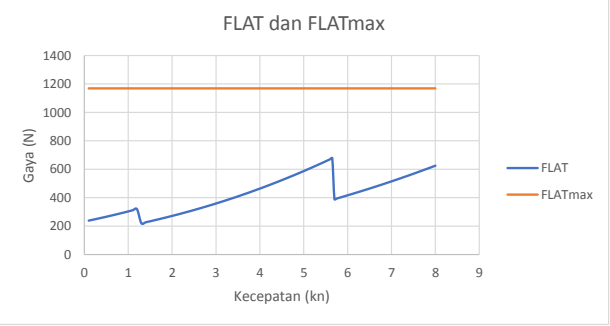
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	80 °
V_A	2,984 m/s
β	58,072 °
V_S	**1,132 m/s**
	2,200 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

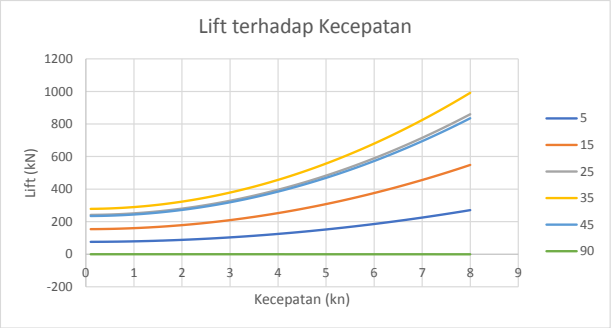
KOEFISIEN MAIN SAIL

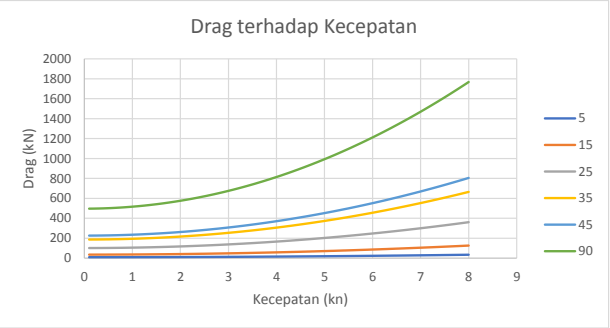
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

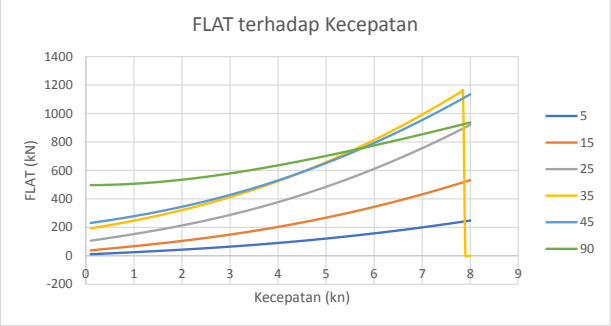
KOEFISIEN MIZZEN SAIL

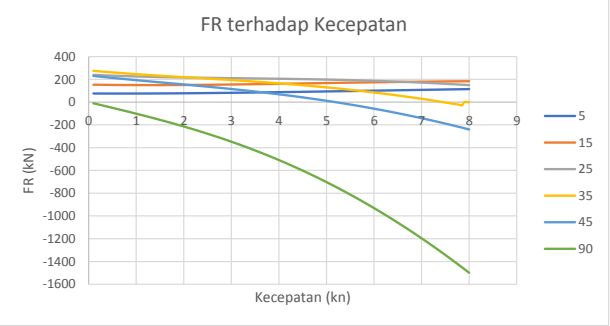
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

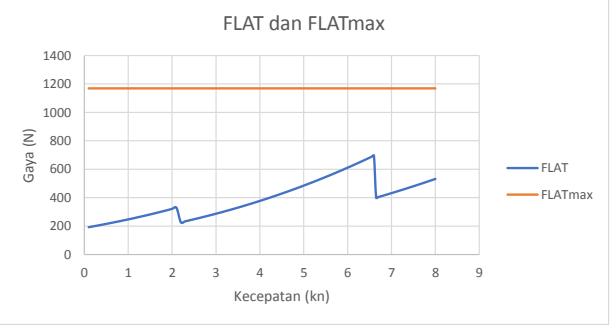
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	90 °
V_A	2,831 m/s
β	65,298 °
V_S	**1,183 m/s**
	2,300 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

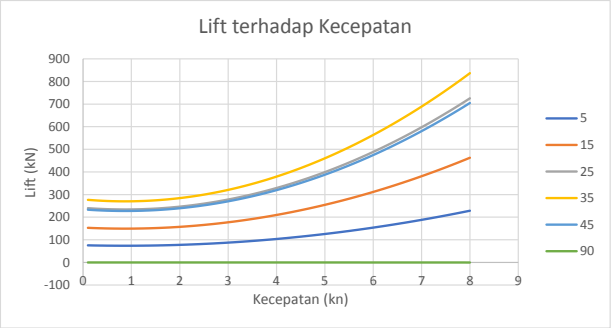
KOEFISIEN MAIN SAIL

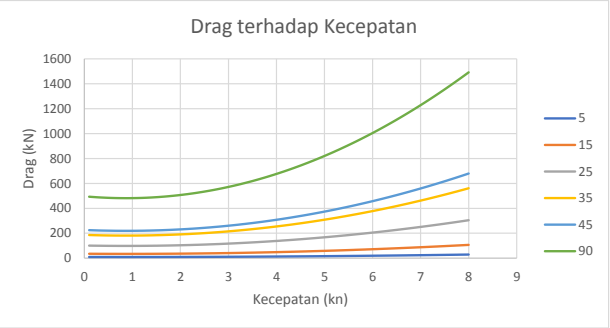
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

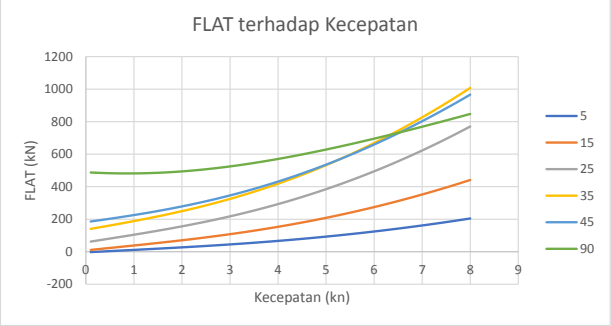
KOEFISIEN MIZZEN SAIL

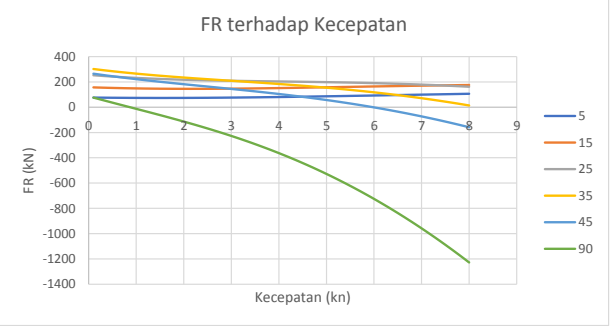
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

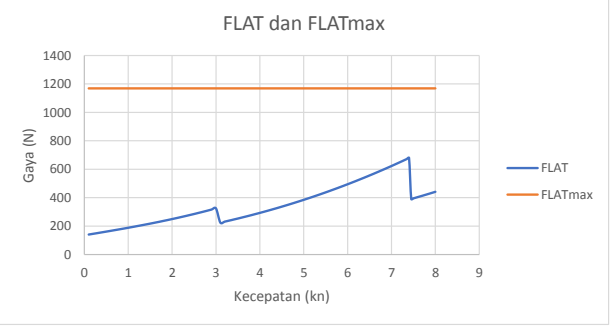
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	100 °
V_A	2,638 m/s
β	73,787 °
V_S	**1,183 m/s**
	2,300 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

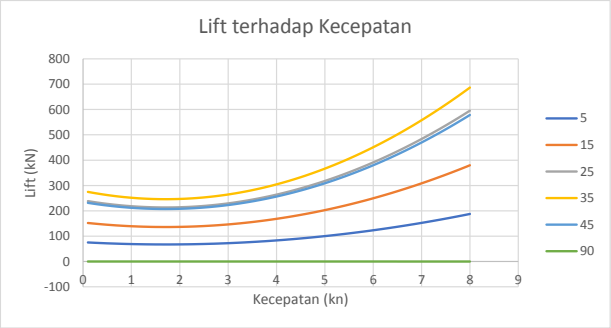
KOEFISIEN MAIN SAIL

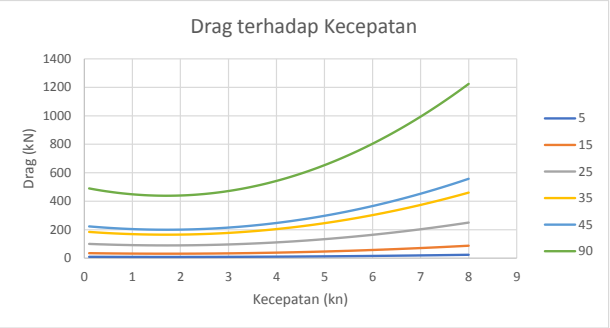
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

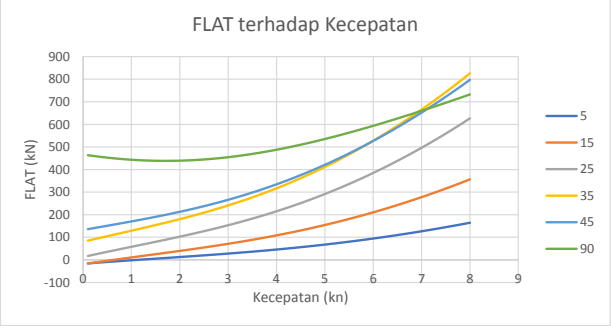
KOEFISIEN MIZZEN SAIL

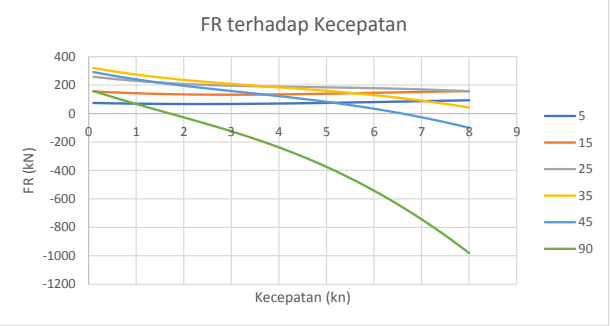
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

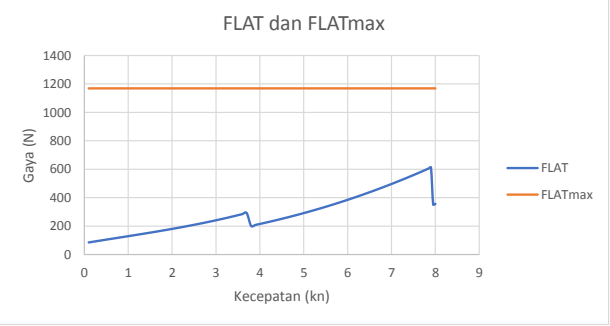
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	110 °
V_A	2,436 m/s
β	82,844 °
V_S	**1,183 m/s**
	2,300 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

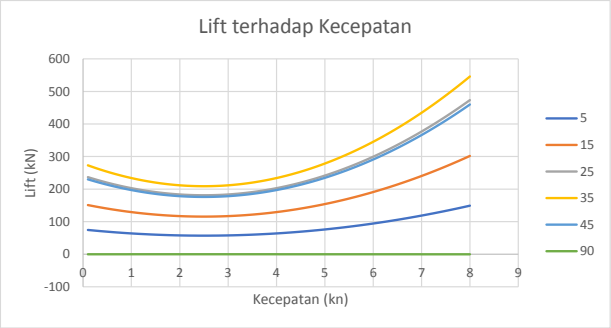
KOEFISIEN MAIN SAIL

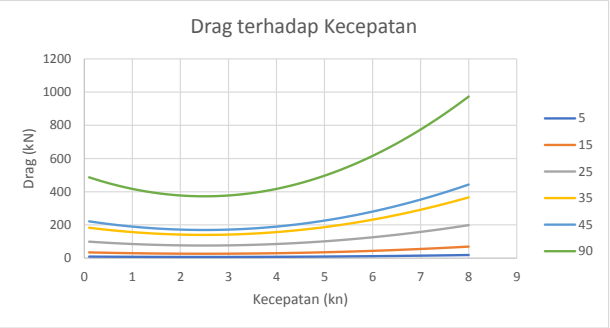
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

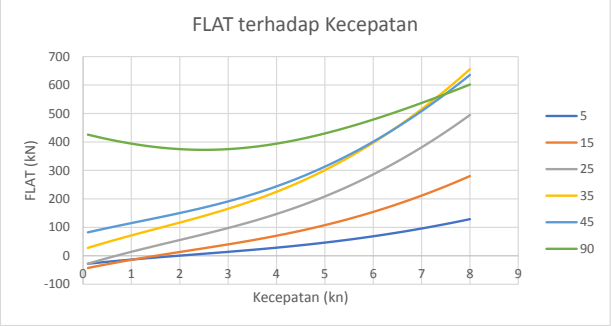
KOEFISIEN MIZZEN SAIL

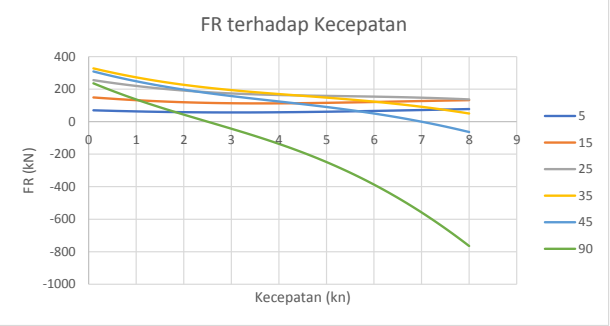
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

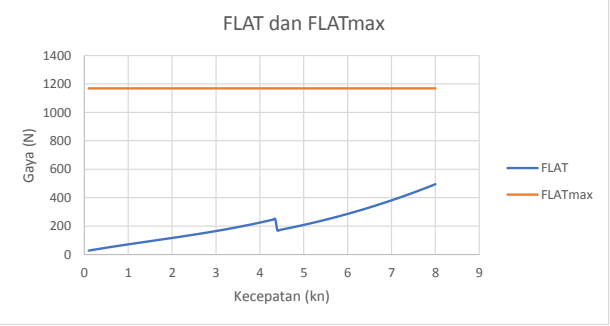
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	120 °
V_A	2,230 m/s
β	92,644 °
V_S	**1,183 m/s**
	2,300 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

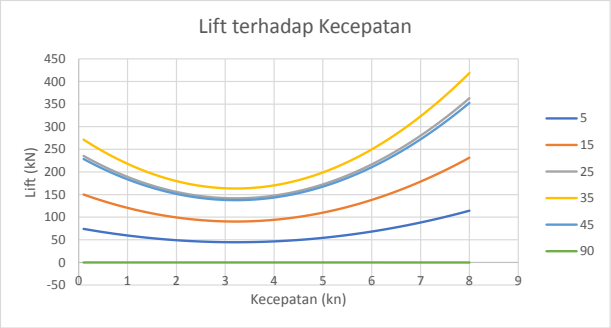
KOEFISIEN MAIN SAIL

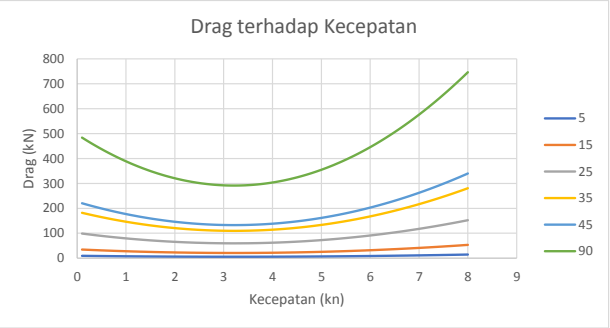
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

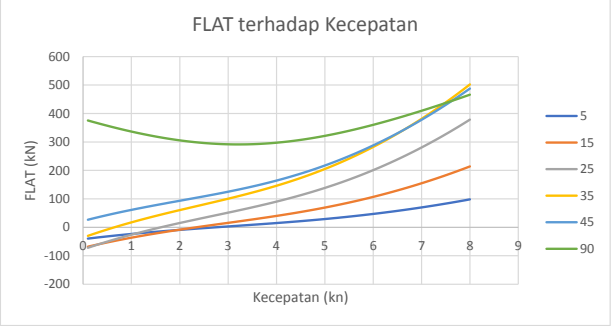
KOEFISIEN MIZZEN SAIL

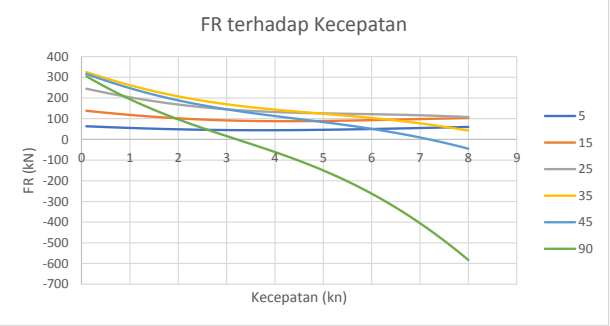
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

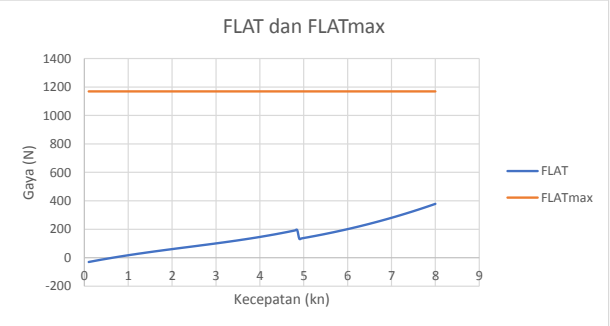
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	130 °
V_A	2,038 m/s
β	104,827 °
V_S	**1,132 m/s**
	2,200 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

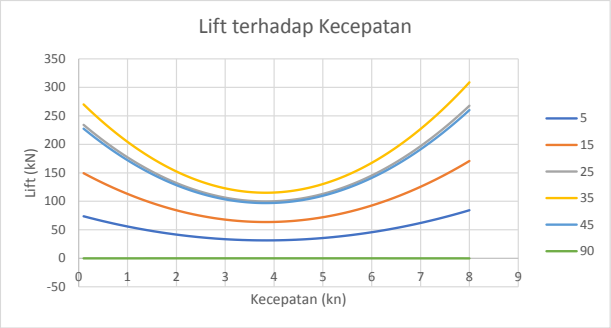
KOEFISIEN MAIN SAIL

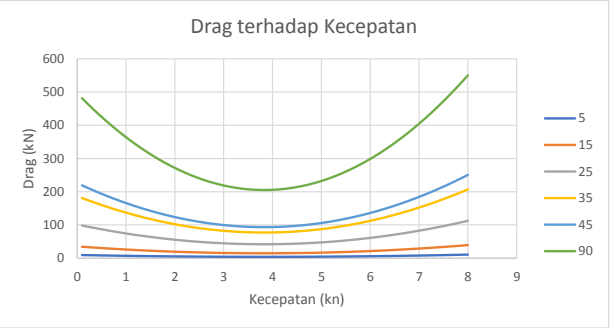
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

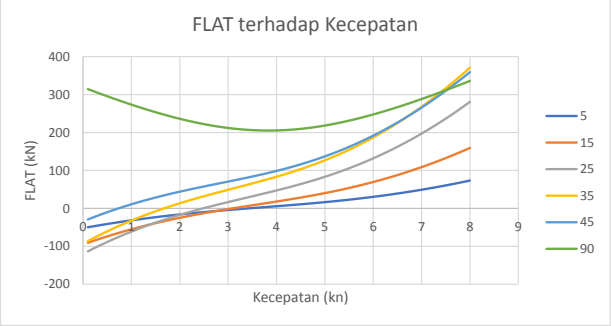
KOEFISIEN MIZZEN SAIL

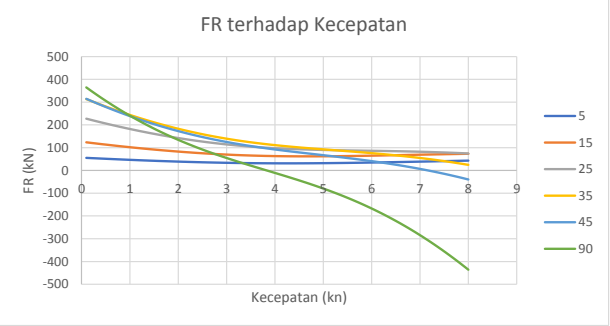
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

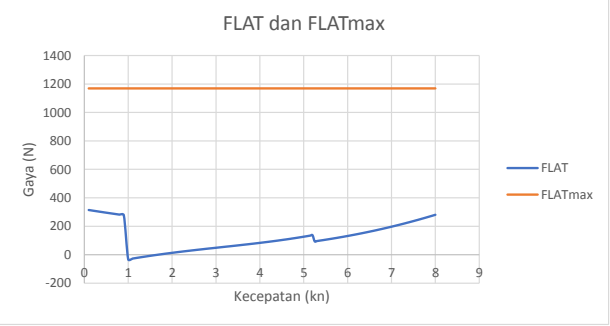
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	140 °
V_A	1,878 m/s
β	118,296 °
V_S	**1,080 m/s**
	2,100 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

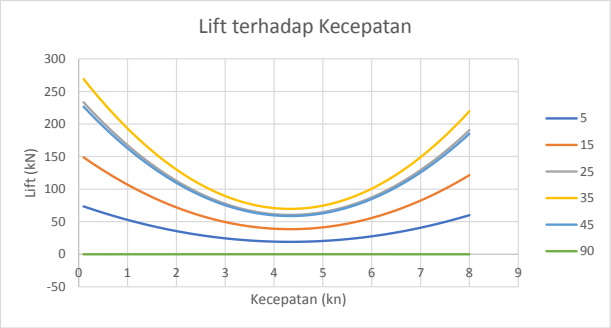
KOEFISIEN MAIN SAIL

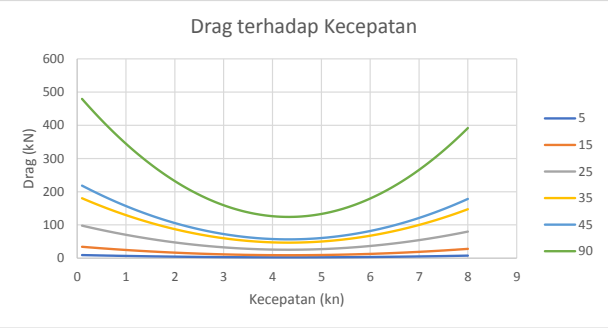
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

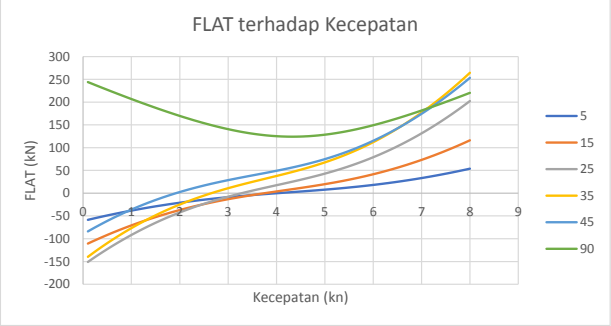
KOEFISIEN MIZZEN SAIL

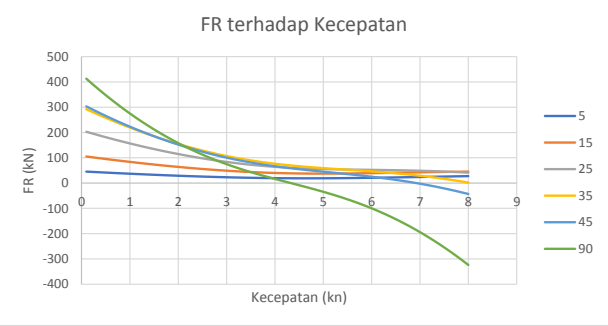
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

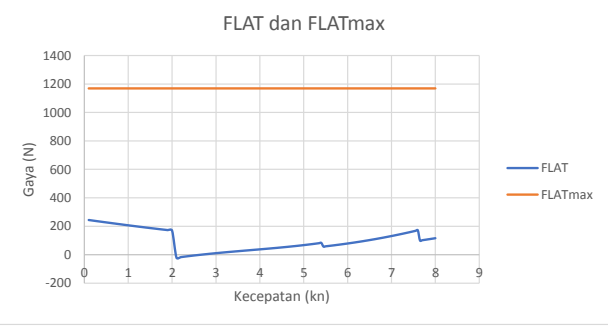
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	150 °
V_A	1,758 m/s
β	132,986 °
V_S	**1,029 m/s**
	2,000 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

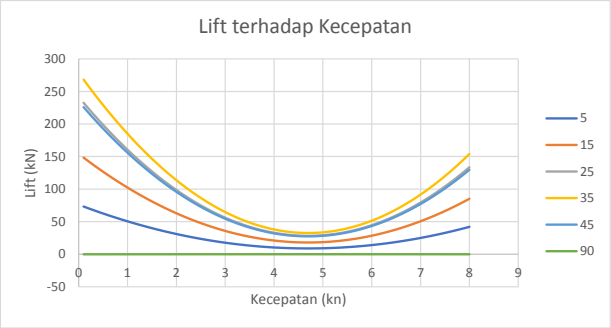
KOEFISIEN MAIN SAIL

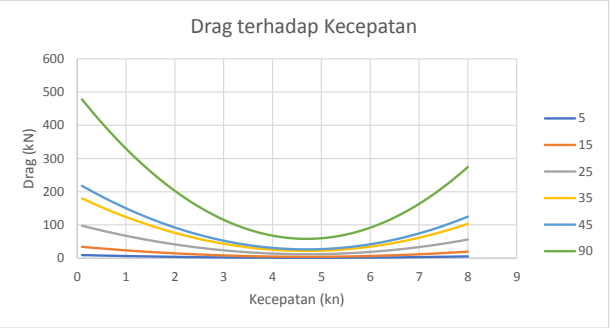
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

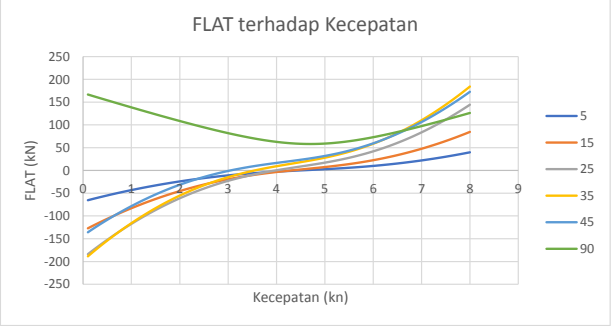
KOEFISIEN MIZZEN SAIL

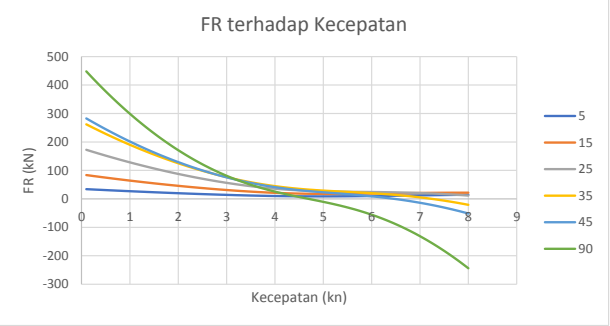
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

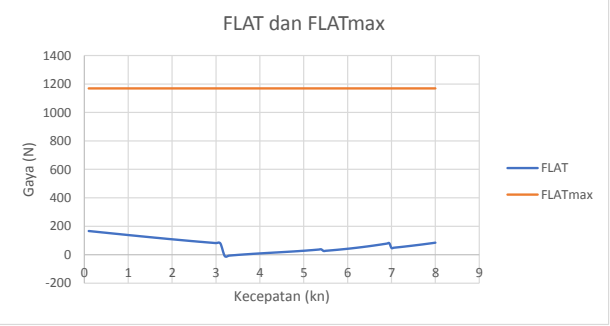
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	160 °
V_A	1,643 m/s
β	147,636 °
V_S	**1,029 m/s**
	2,000 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

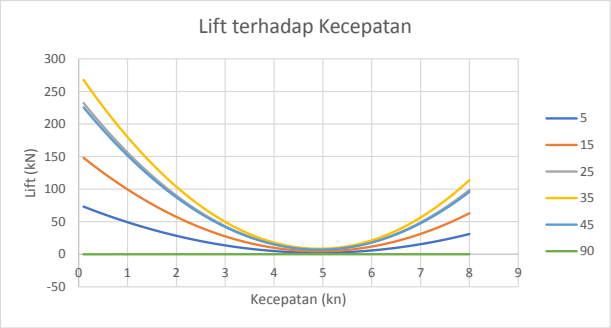
KOEFISIEN MAIN SAIL

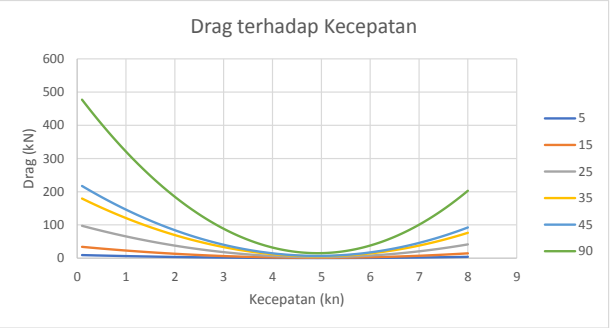
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

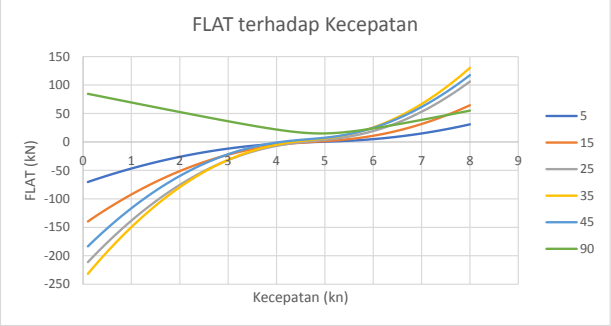
KOEFISIEN MIZZEN SAIL

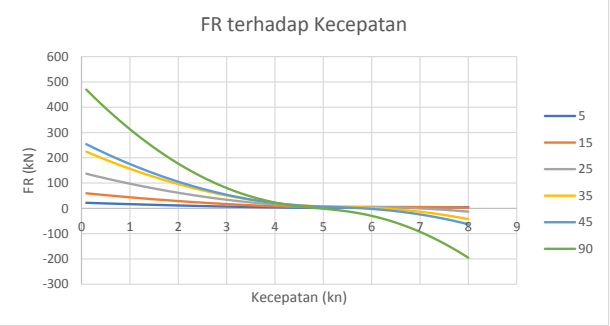
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

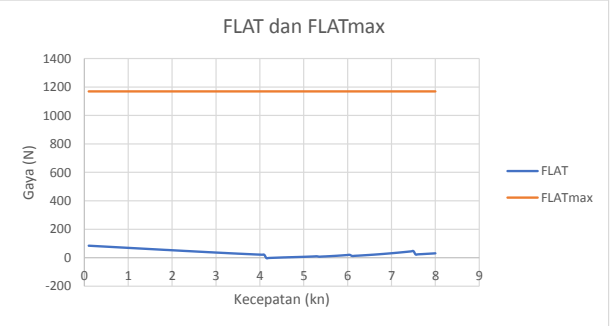
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000 kn
	2,572 m/s
γ	170 °
V_A	1,569 m/s
β	163,462 °
V_S	**1,029 m/s**
	2,000 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

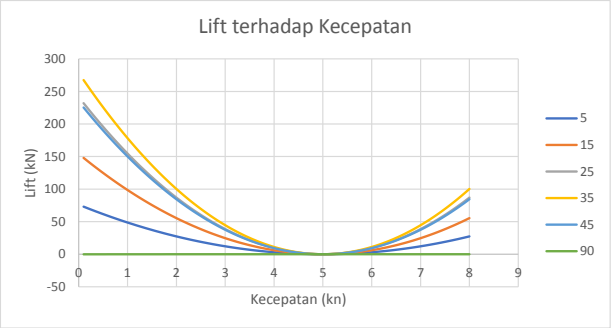
KOEFISIEN MAIN SAIL

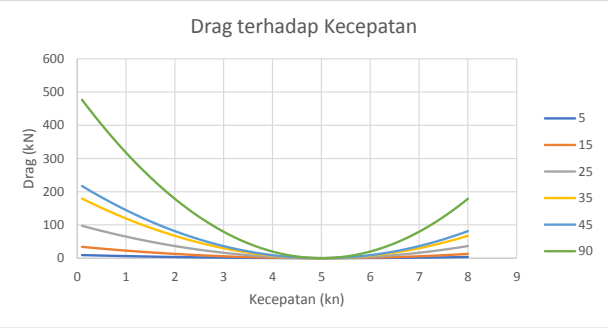
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

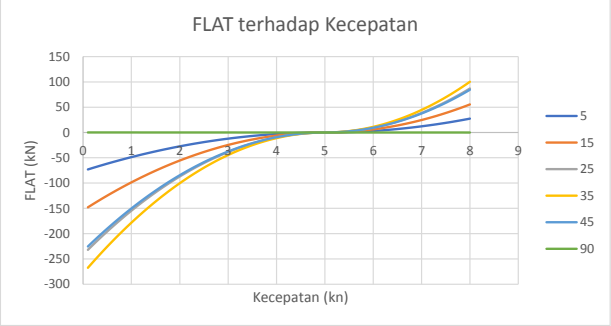
KOEFISIEN MIZZEN SAIL

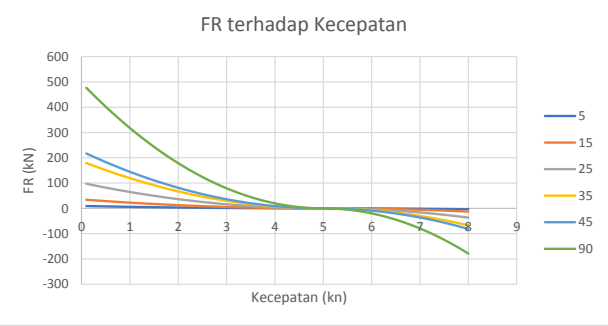
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

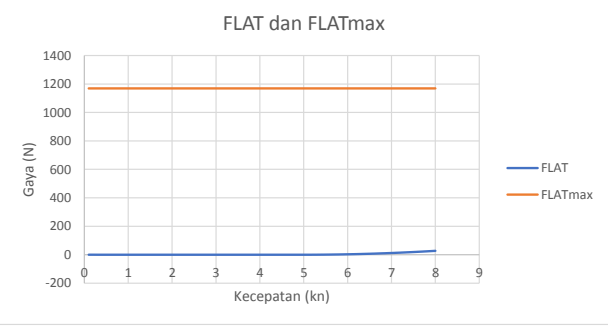
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	5,000	kn
	2,572	m/s
γ	180	°
V_A	1,543	m/s
β	180,000	°
V_S	**1,029**	**m/s**
	2,000	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

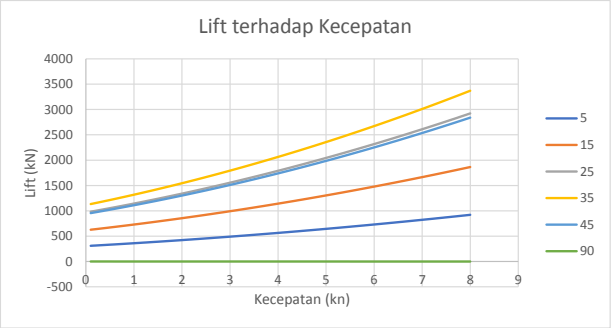
KOEFISIEN MAIN SAIL

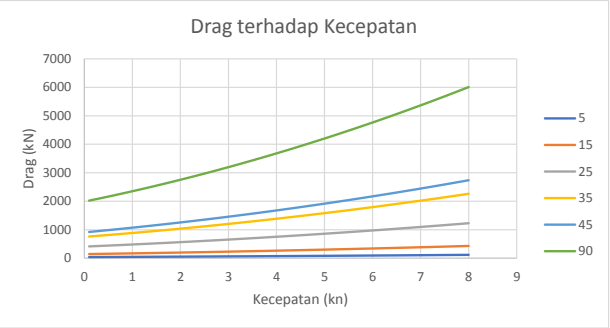
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

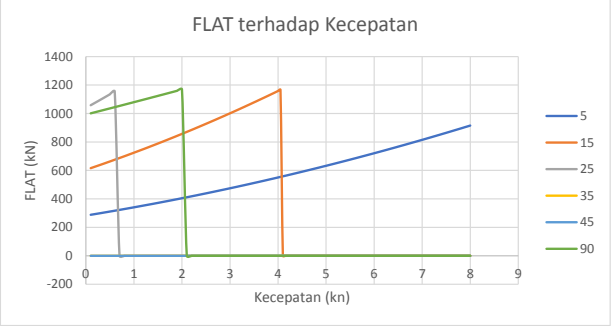
KOEFISIEN MIZZEN SAIL

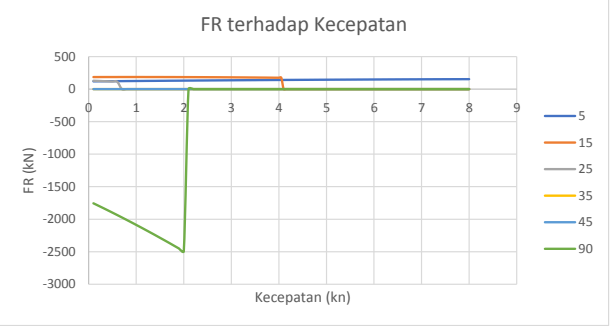
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

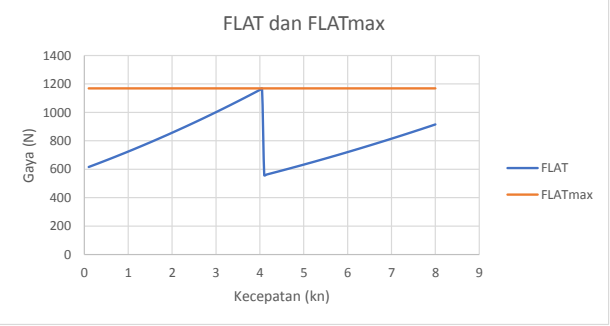
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000	kn
	5,144	m/s
γ	30	°
V_A	6,103	m/s
β	24,923	°
V_S	**1,080**	**m/s**
	2,100	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

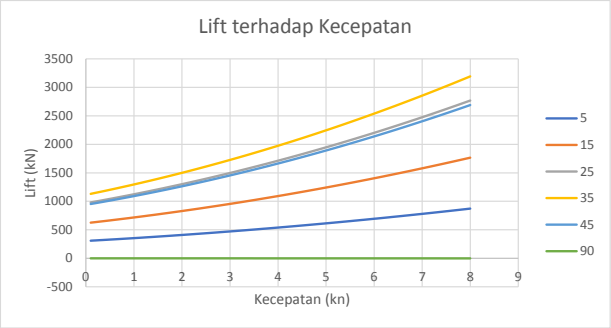
KOEFISIEN MAIN SAIL

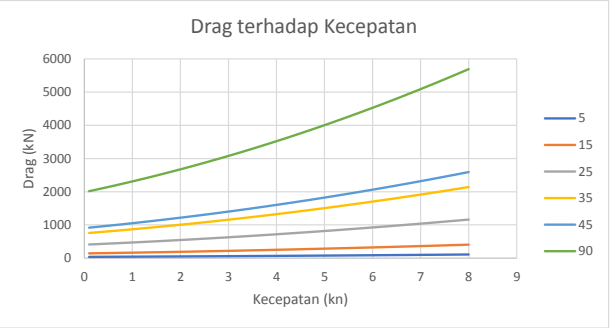
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

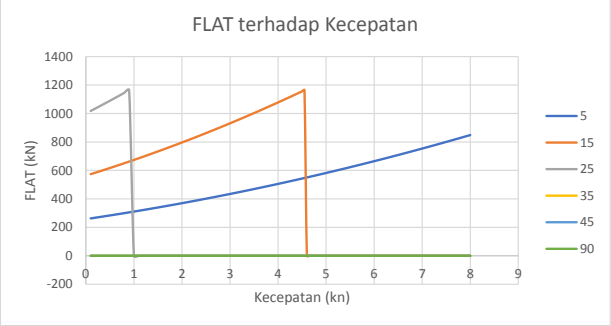
KOEFISIEN MIZZEN SAIL

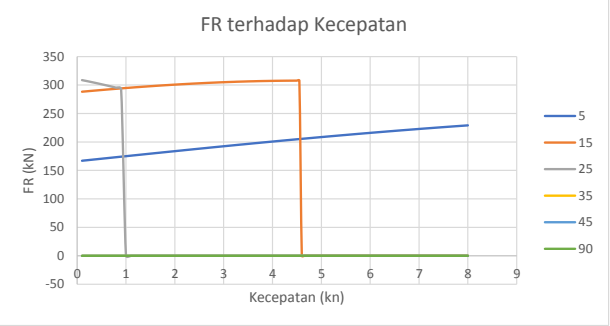
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

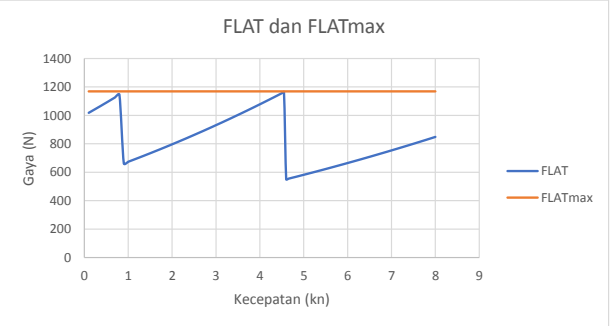
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	40 °
V_A	6,272 m/s
β	31,816 °
V_S	**1,389 m/s**
	2,700 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

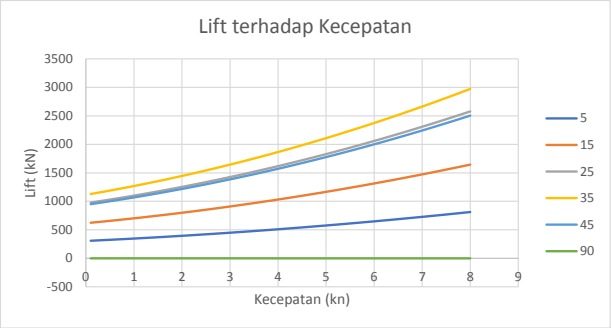
KOEFISIEN MAIN SAIL

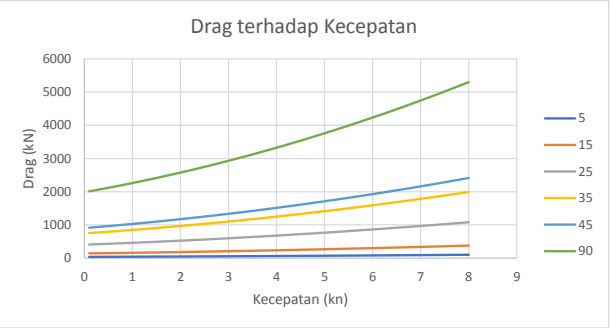
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

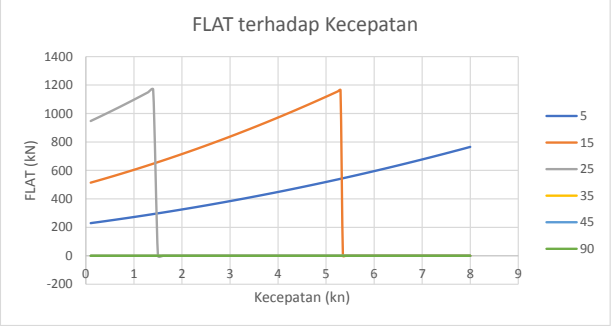
KOEFISIEN MIZZEN SAIL

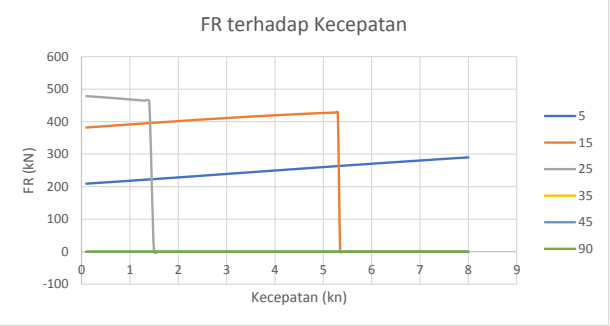
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

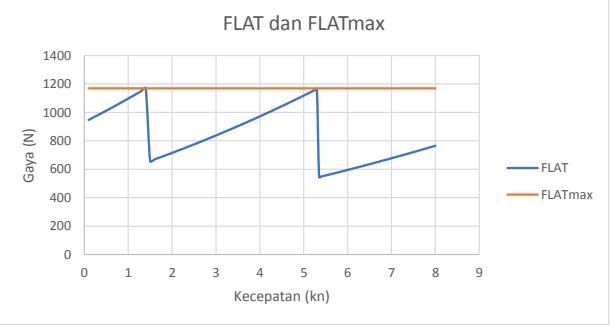
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	50 °
V_A	6,329 m/s
β	38,508 °
V_S	**1,646 m/s**
	3,200 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

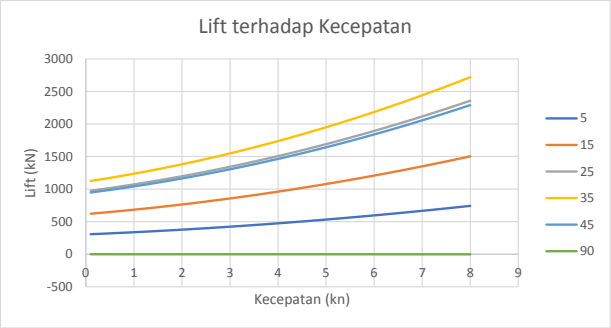
KOEFISIEN MAIN SAIL

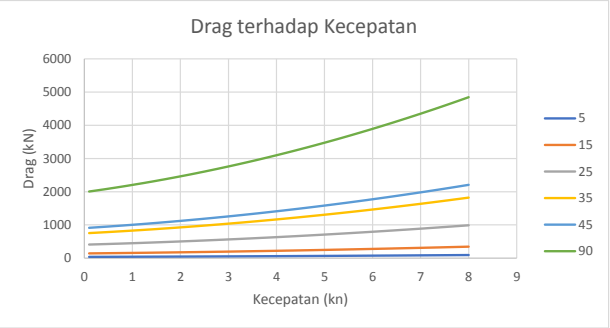
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

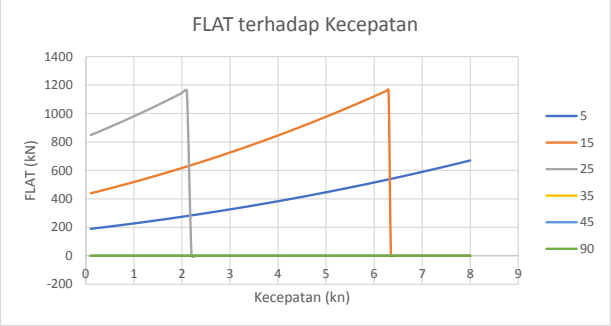
KOEFISIEN MIZZEN SAIL

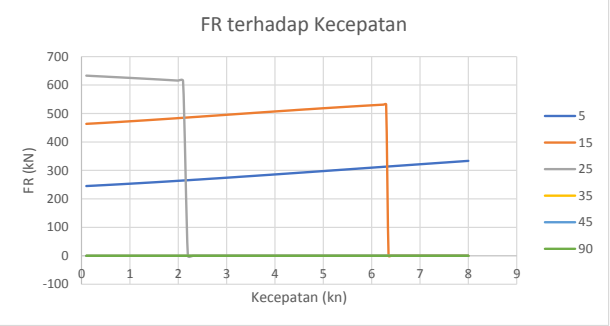
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

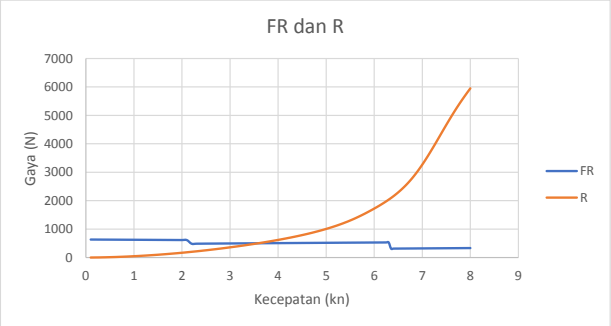
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N

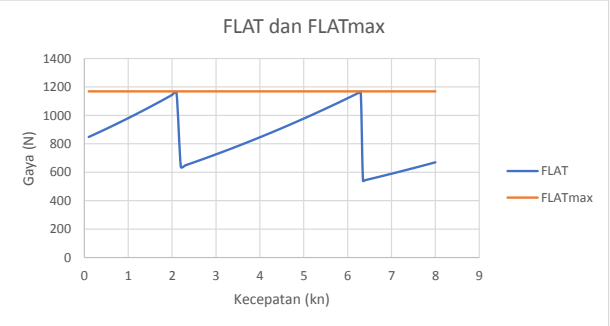












V_T	10,000 kn
	5,144 m/s
γ	60 °
V_A	6,278 m/s
β	45,200 °
V_S	**1,852 m/s**
	3,600 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

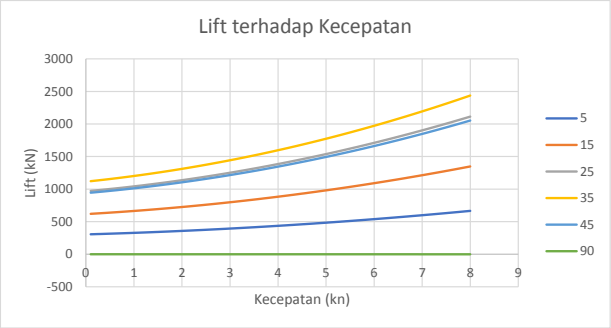
KOEFISIEN MAIN SAIL

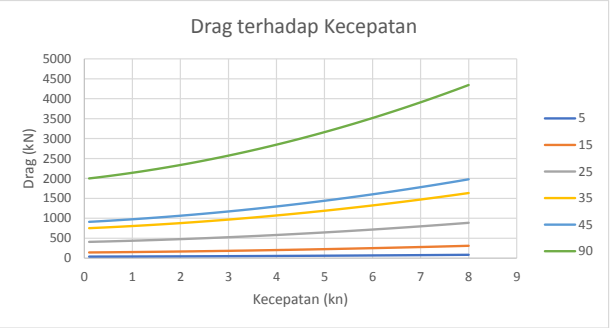
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

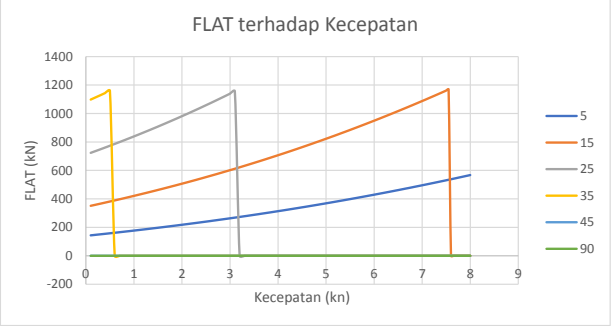
KOEFISIEN MIZZEN SAIL

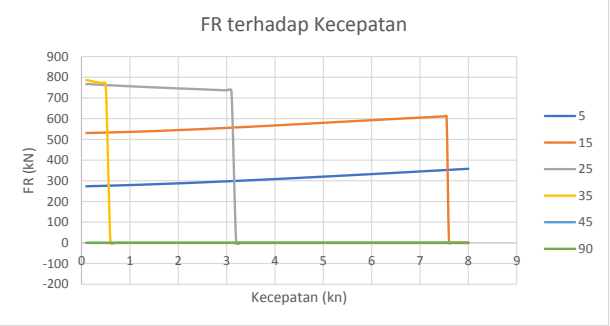
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

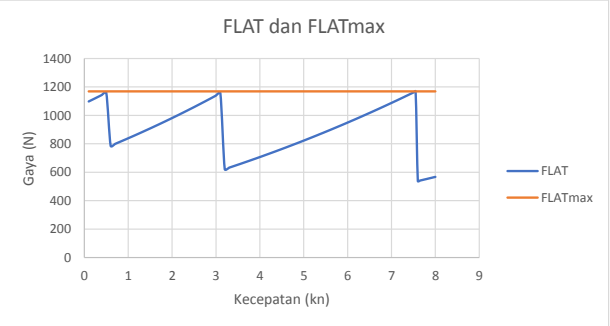
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	70 °
V_A	6,096 m/s
β	52,463 °
V_S	**1,955 m/s**
	3,800 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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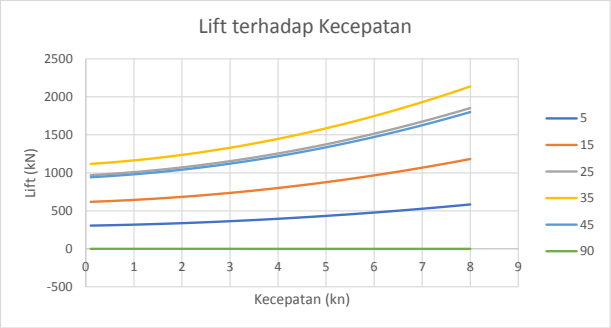
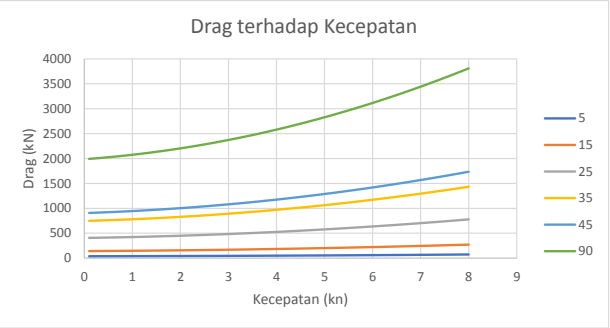
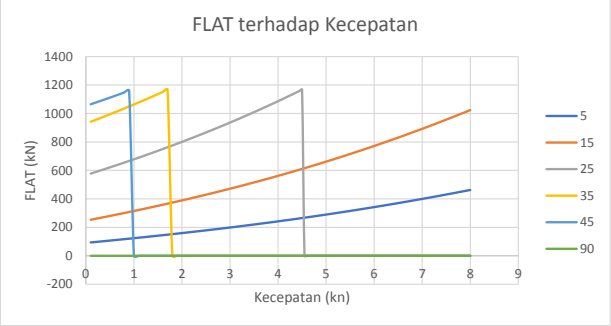
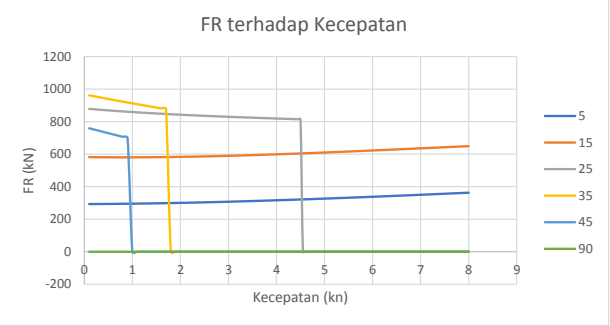
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

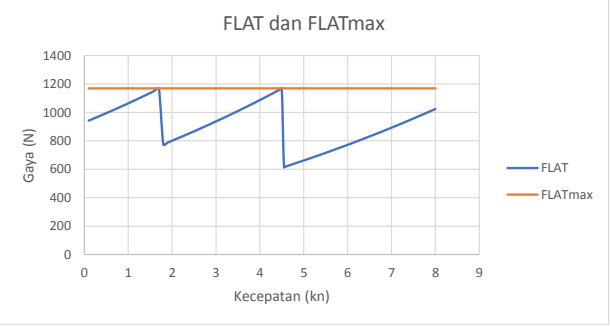
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000	kn
	5,144	m/s
γ	80	°
V_A	5,863	m/s
β	59,779	°
V_S	**2,315**	**m/s**
	4,500	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

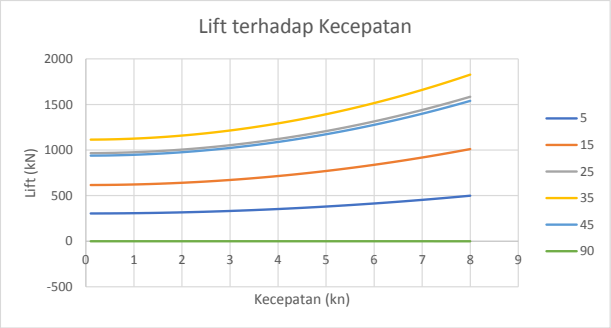
KOEFISIEN MAIN SAIL

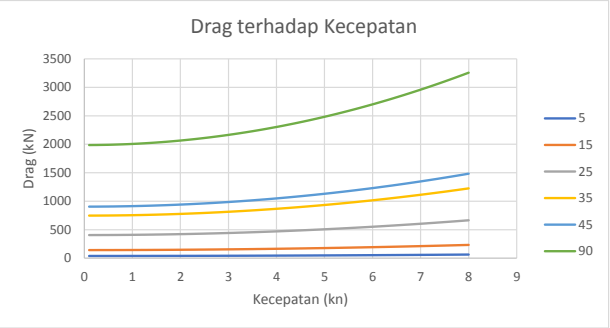
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

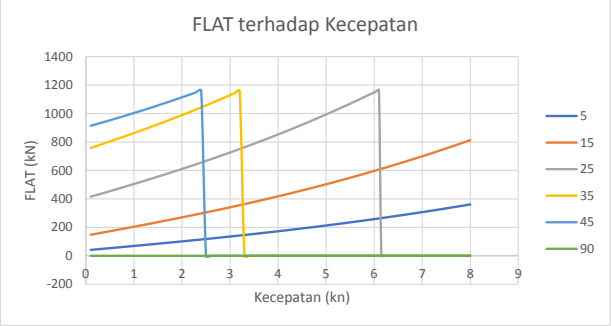
KOEFISIEN MIZZEN SAIL

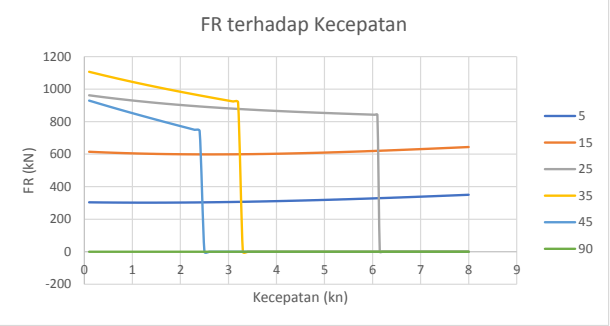
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

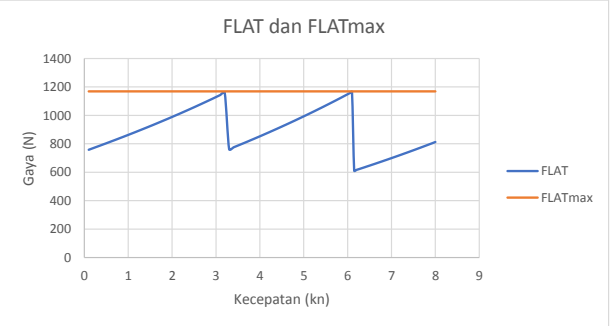
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	90 °
V_A	5,540 m/s
β	68,199 °
V_S	**2,392 m/s**
	4,650 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

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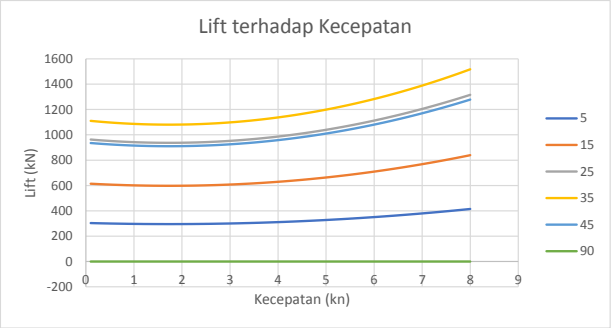
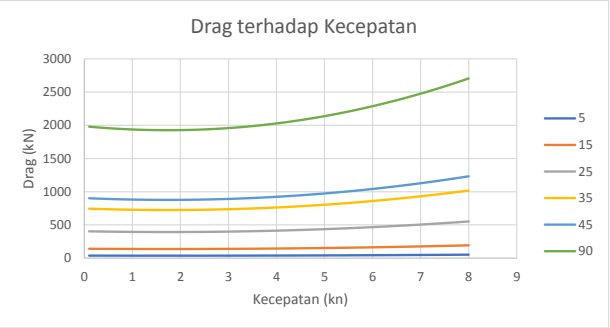
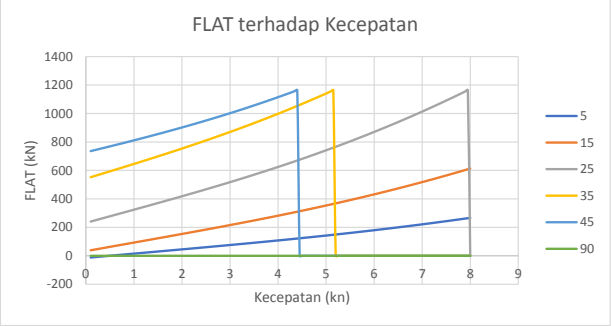
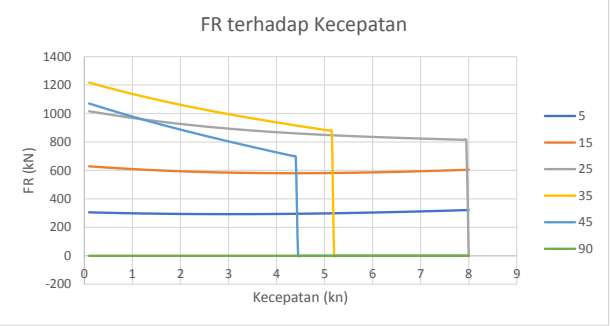
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

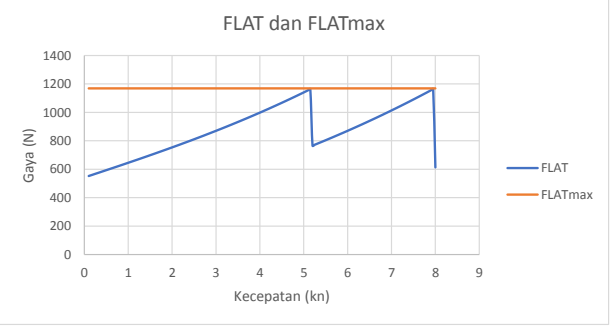
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000	kn
	5,144	m/s
γ	100	°
V_A	5,198	m/s
β	77,056	°
V_S	**2,443**	**m/s**
	4,750	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

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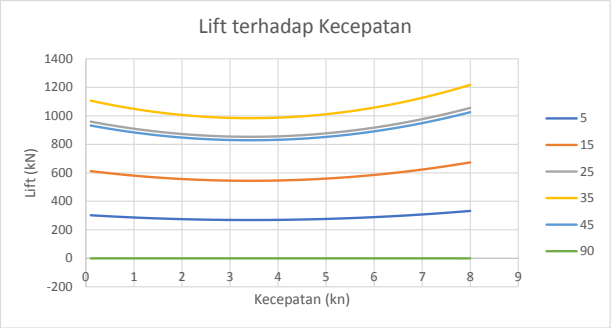
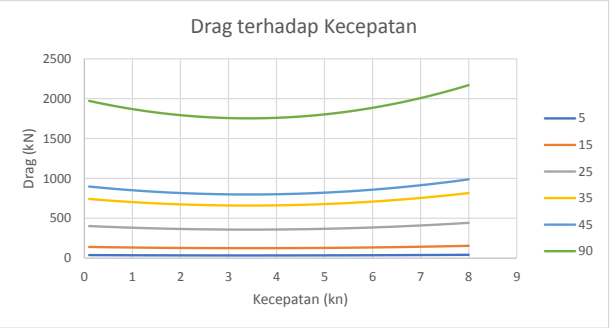
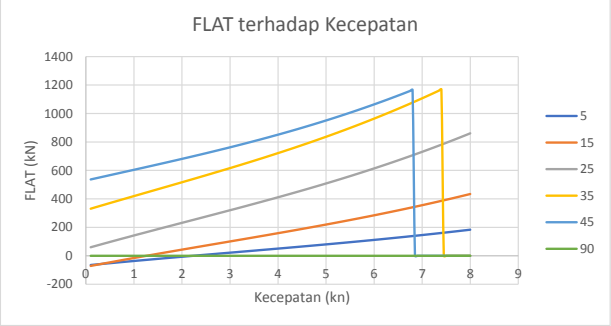
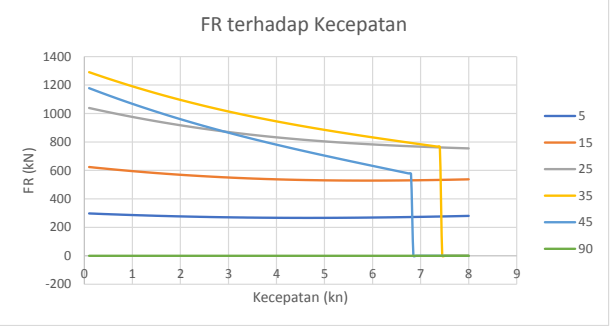
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

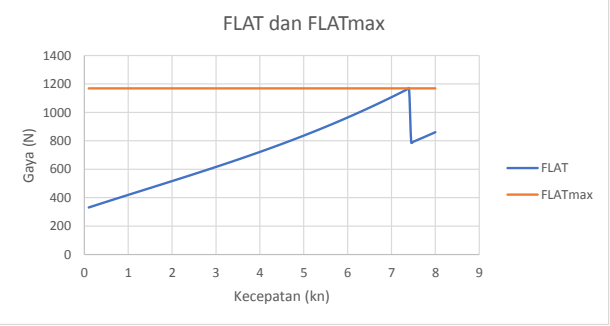
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000	kn
	5,144	m/s
γ	110	°
V_A	4,843	m/s
β	86,469	°
V_S	**2,443**	**m/s**
	4,750	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

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MUATAN	θ_{max}	11 °	h	6,007 m
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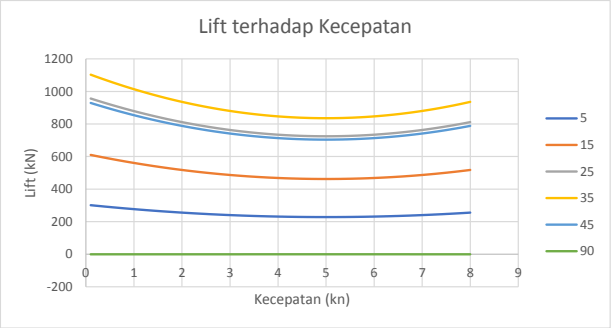

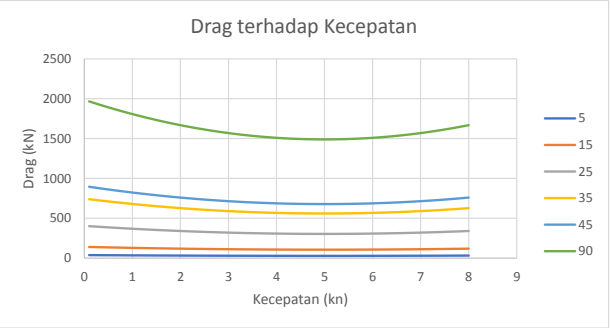

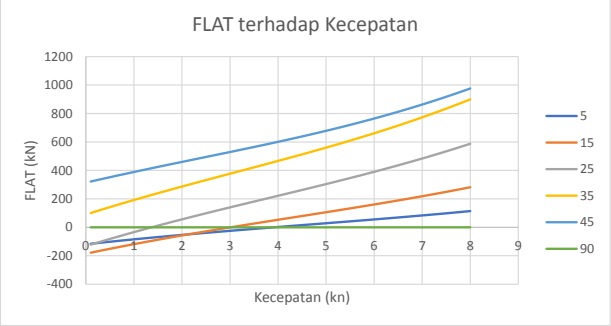

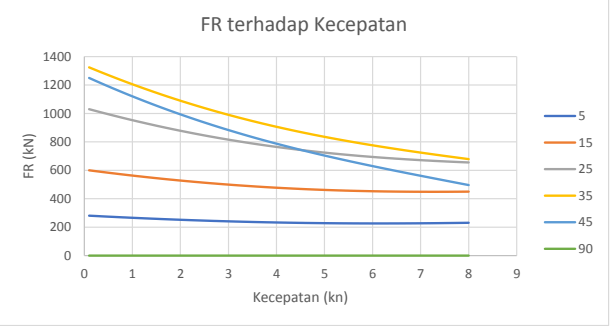

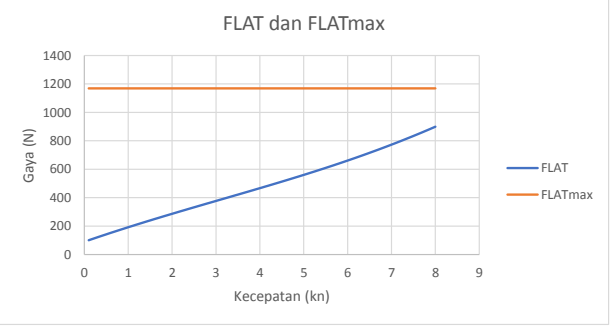

V_T	10,000 kn
	5,144 m/s
γ	120 °
V_A	4,484 m/s
β	96,587 °
V_S	**2,392 m/s**
	4,650 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

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HEELING MOMENT

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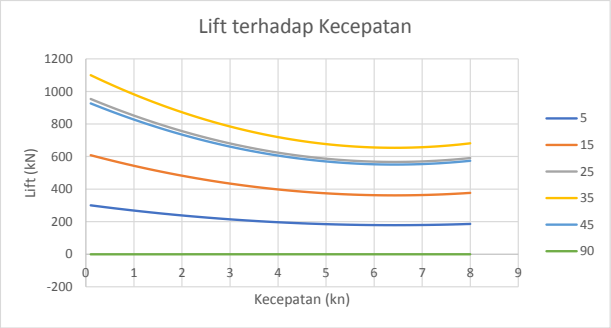

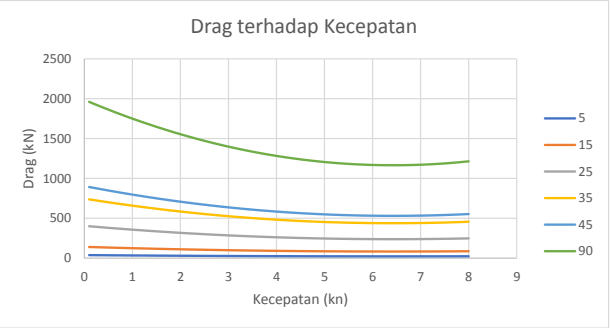

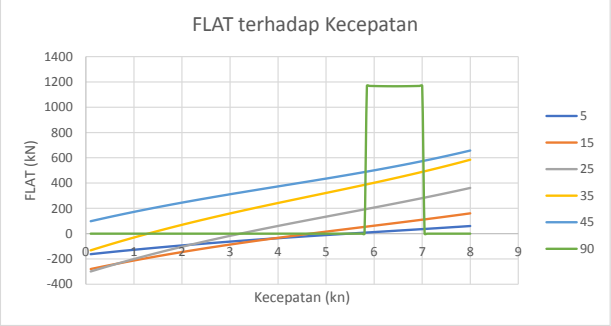

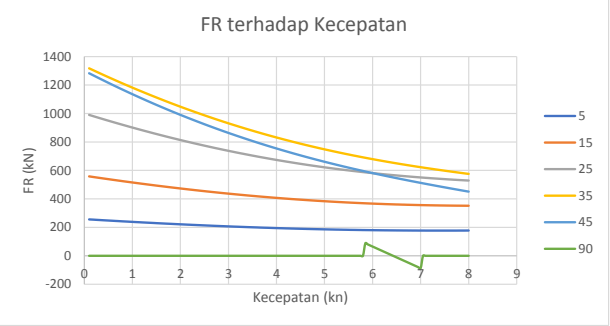

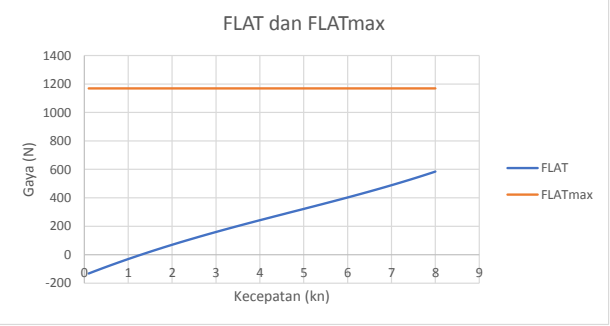

V_T	10,000 kn
	5,144 m/s
γ	130 °
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V_S	**2,315 m/s**
	4,500 kn

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Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

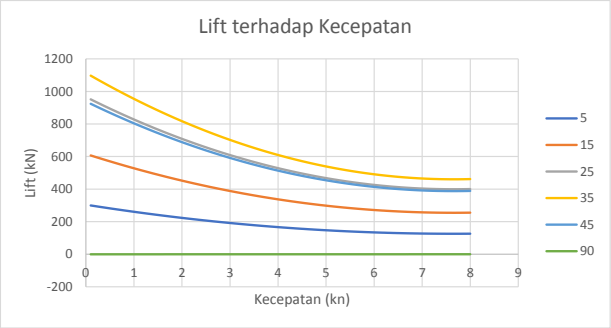
KOEFISIEN MAIN SAIL

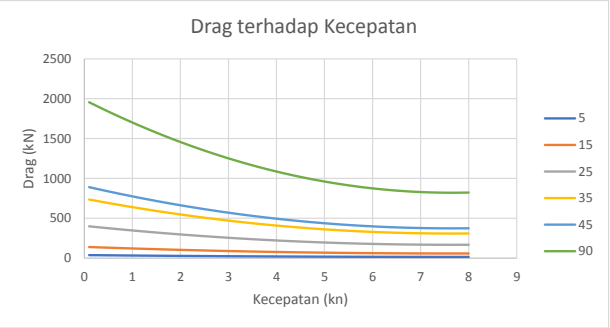
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

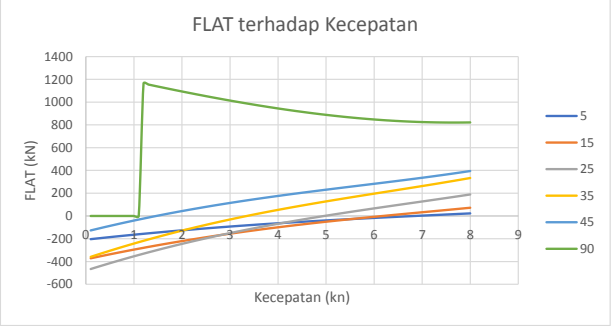
KOEFISIEN MIZZEN SAIL

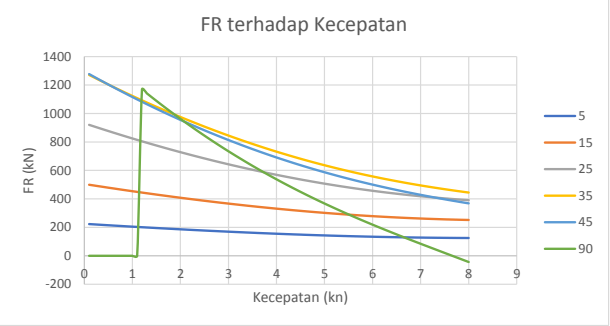
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

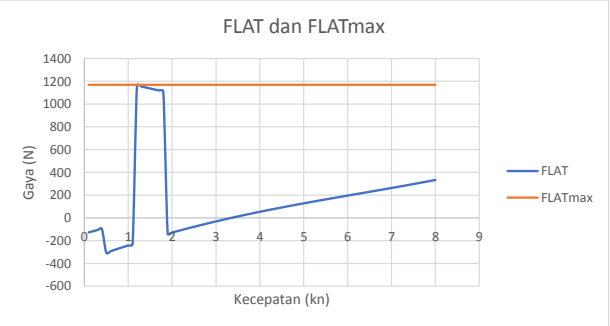
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000	kn
	5,144	m/s
γ	140	°
V_A	3,805	m/s
β	119,660	°
V_S	**2,186**	**m/s**
	4,250	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

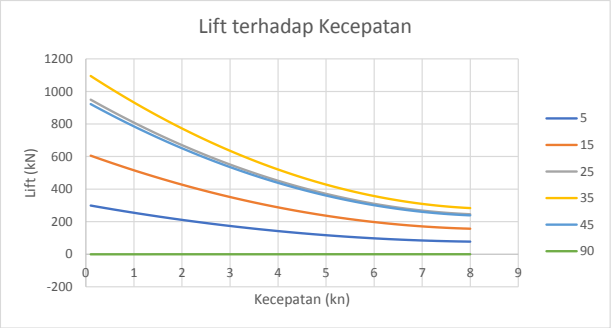
KOEFISIEN MAIN SAIL

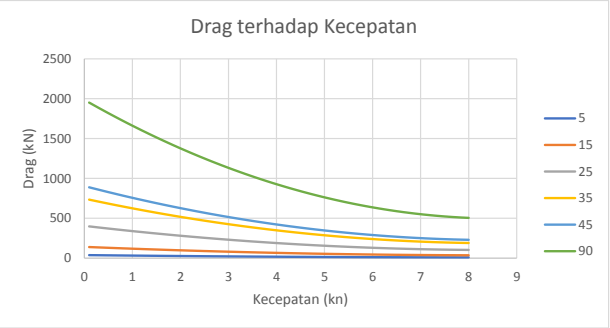
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

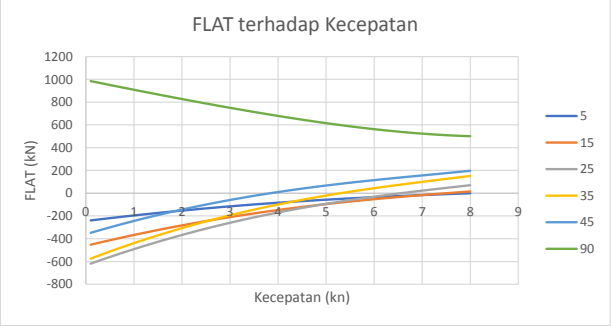
KOEFISIEN MIZZEN SAIL

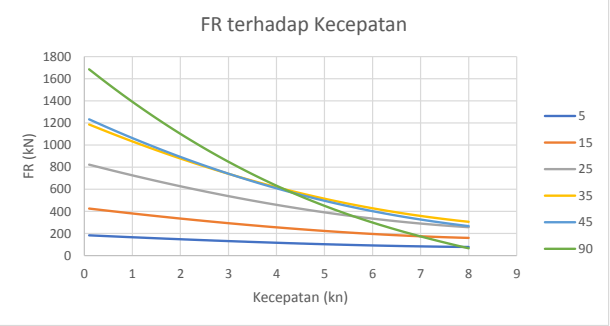
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

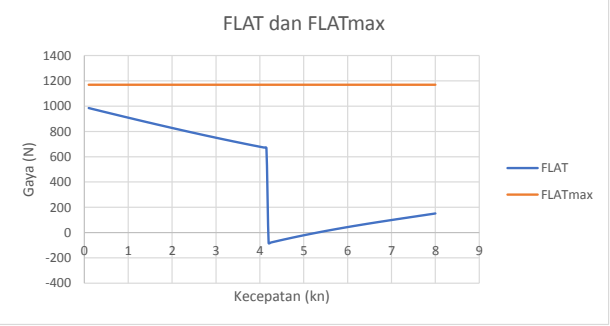
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	150 °
V_A	3,516 m/s
β	132,986 °
V_S	**2,058 m/s**
	4,000 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

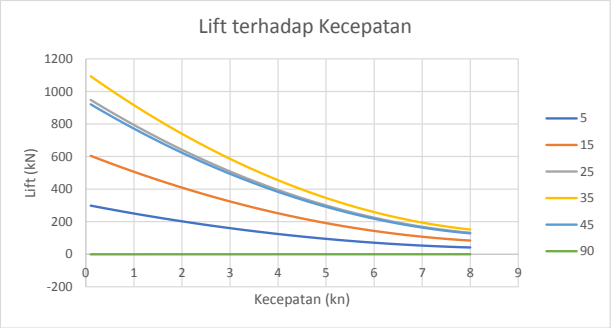
KOEFISIEN MAIN SAIL

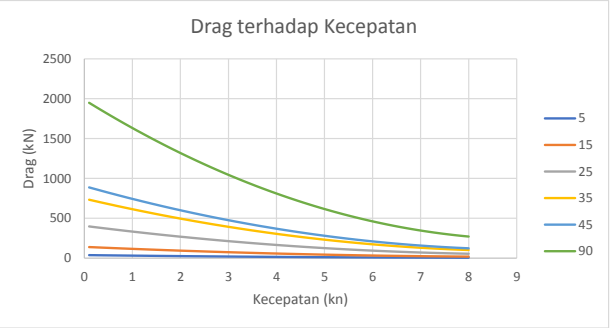
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

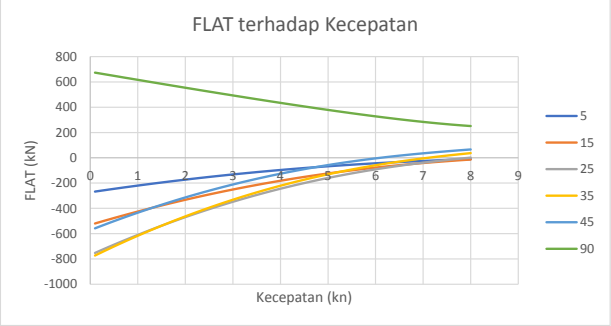
KOEFISIEN MIZZEN SAIL

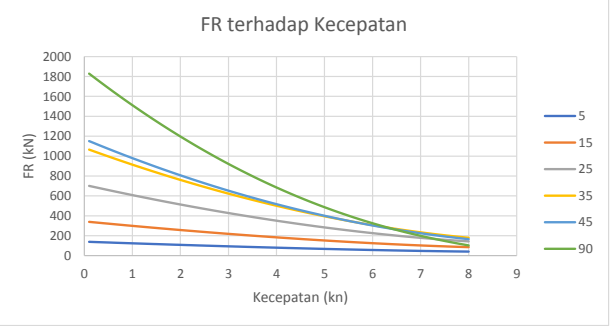
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

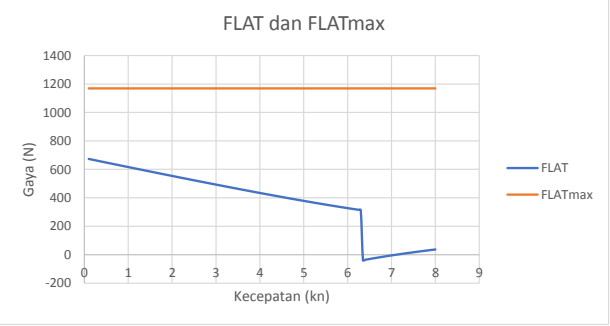
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	160 °
V_A	3,287 m/s
β	147,636 °
V_S	**2,109 m/s**
	4,100 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

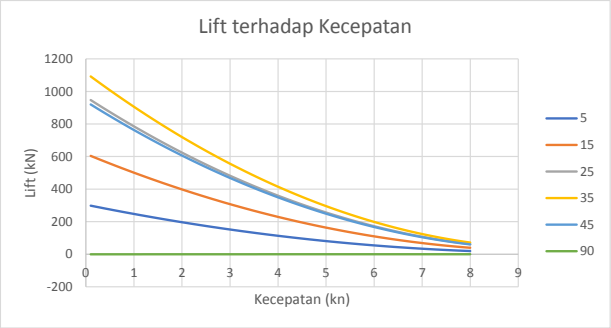
KOEFISIEN MAIN SAIL

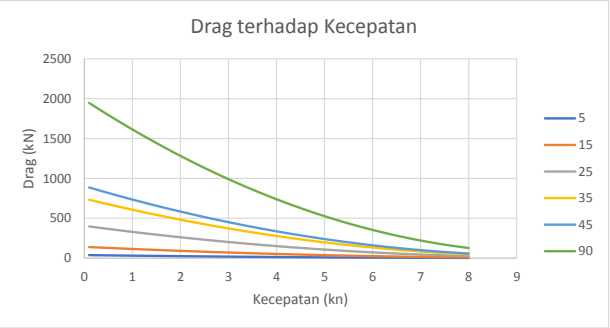
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

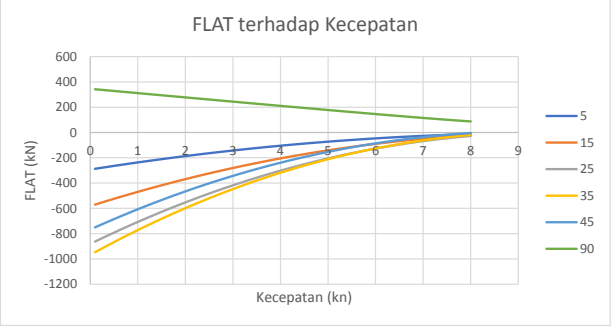
KOEFISIEN MIZZEN SAIL

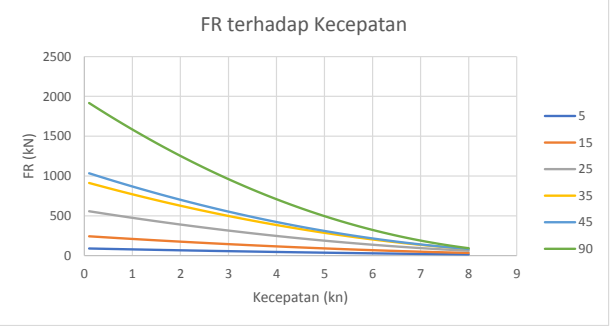
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

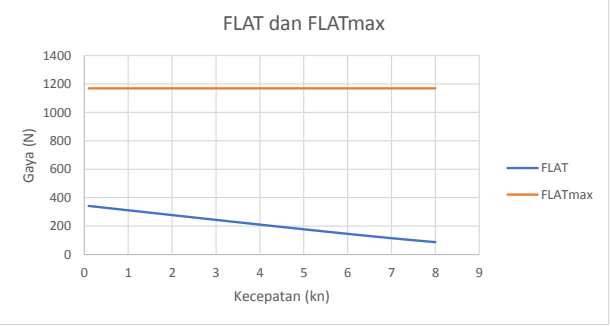
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	170 °
V_A	3,138 m/s
β	163,462 °
V_S	**2,135 m/s**
	4,150 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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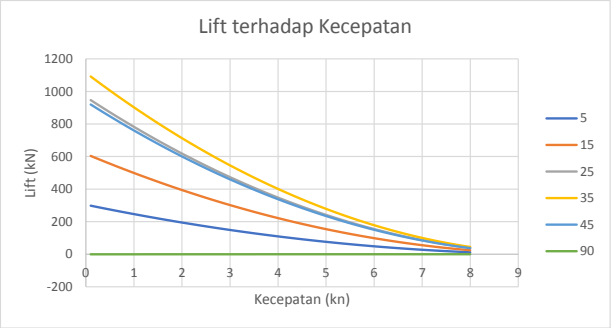
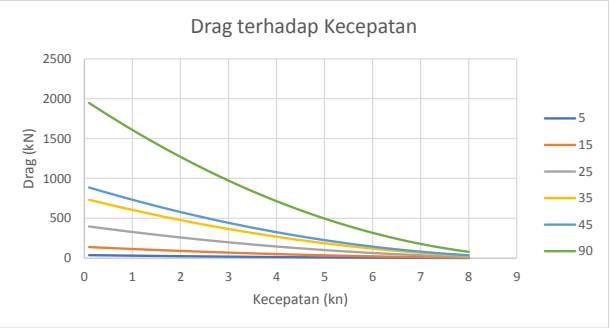
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

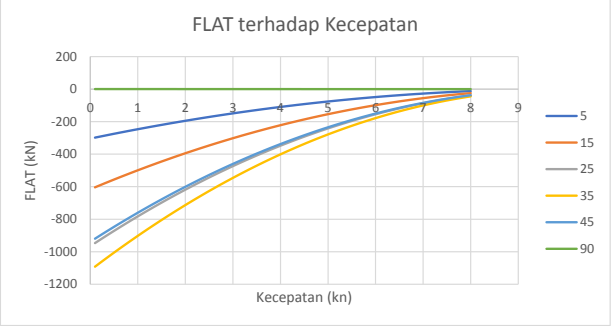
KOEFISIEN MIZZEN SAIL

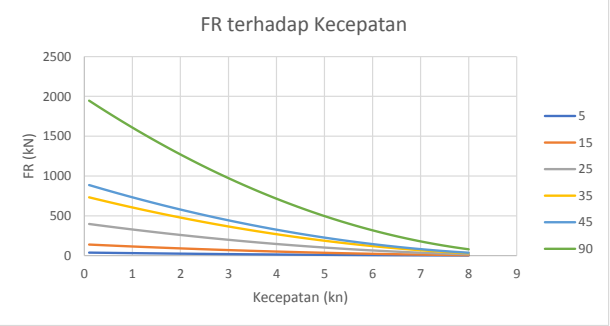
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

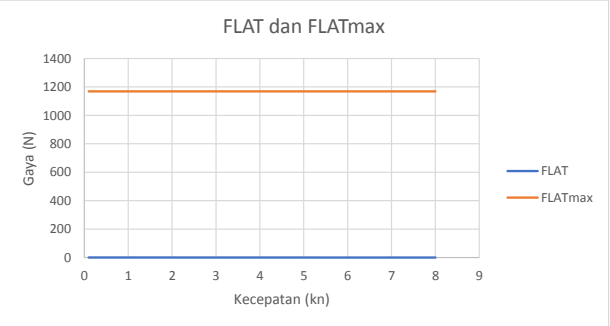
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	10,000 kn
	5,144 m/s
γ	180 °
V_A	3,086 m/s
β	180,000 °
V_S	**2,135 m/s**
	4,150 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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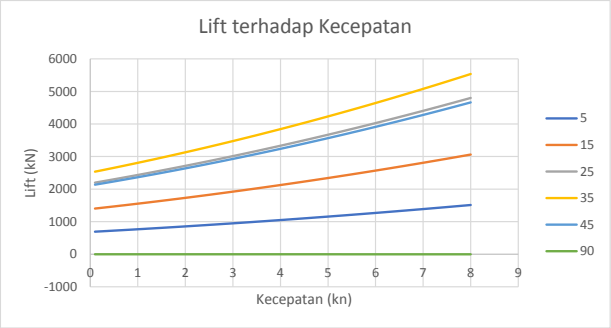
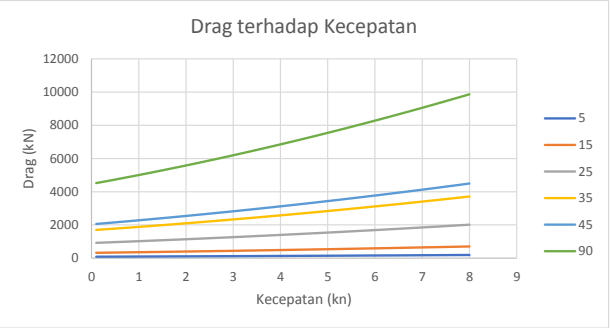
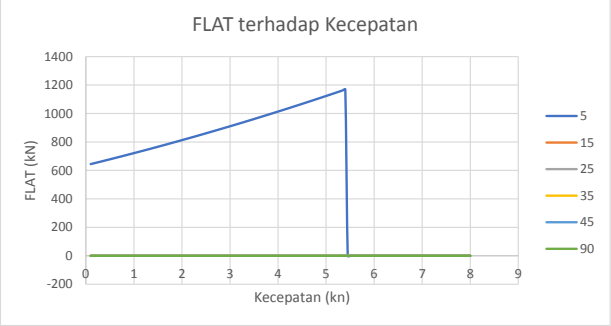
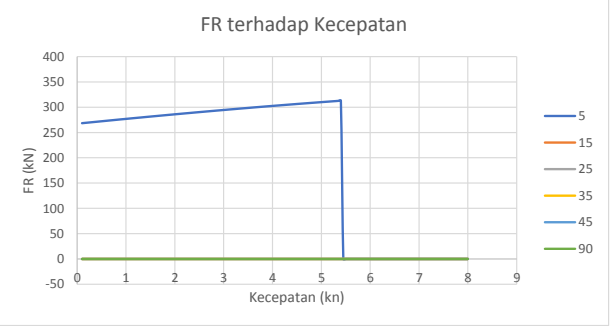
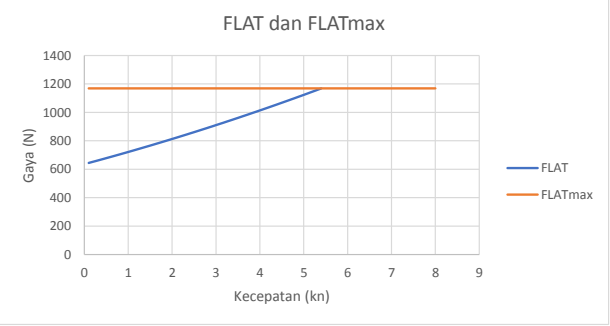
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	30	°
V_A	8,946	m/s
β	25,548	°
V_S	**1,389**	**m/s**
	2,700	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

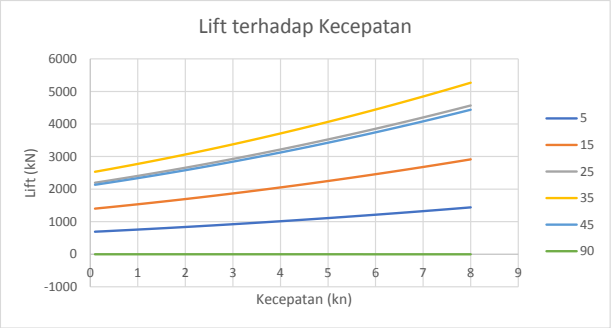
KOEFISIEN MAIN SAIL

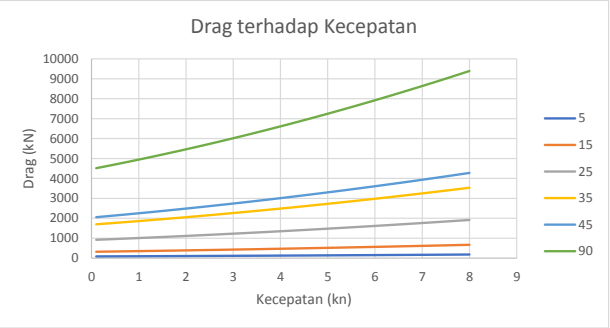
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

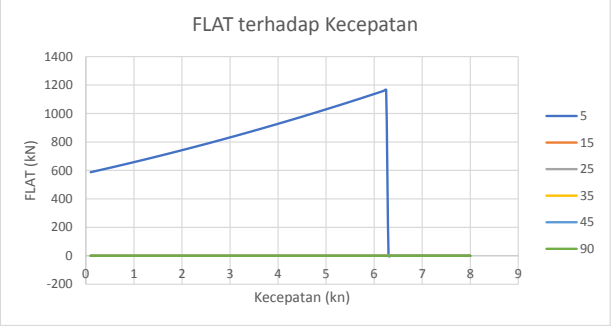
KOEFISIEN MIZZEN SAIL

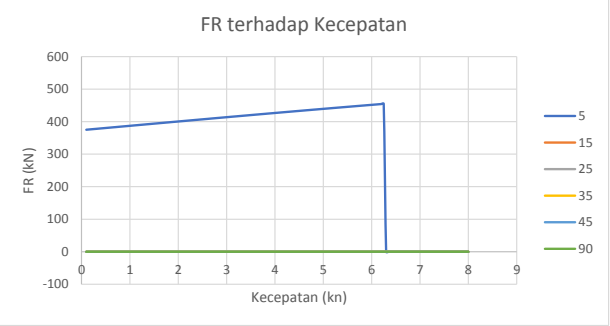
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

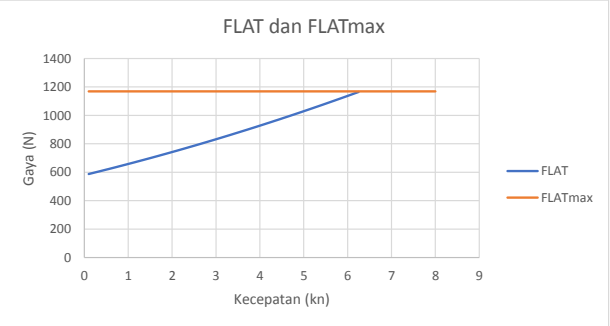
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	40 °
V_A	9,039 m/s
β	33,278 °
V_S	**1,646 m/s**
	3,200 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

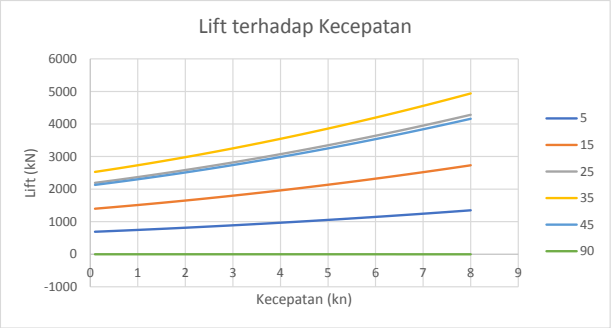
KOEFISIEN MAIN SAIL

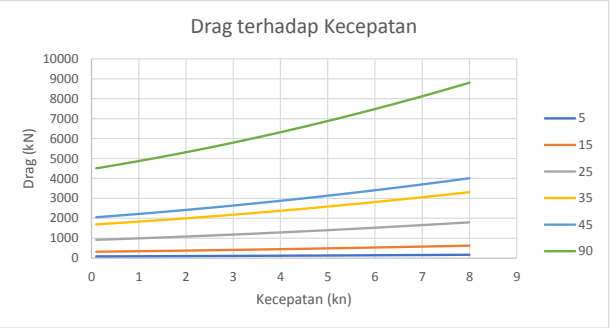
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

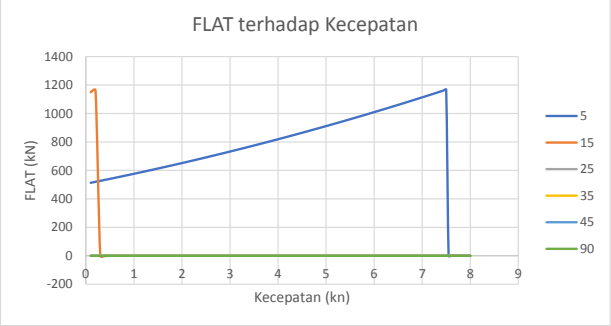
KOEFISIEN MIZZEN SAIL

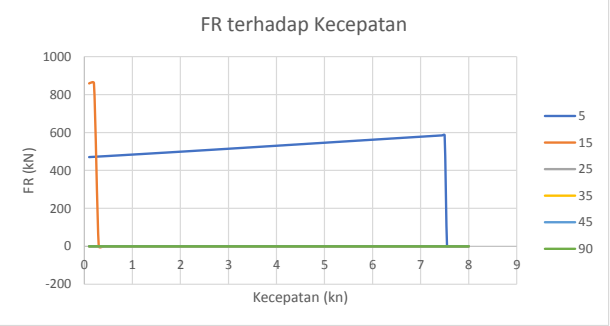
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

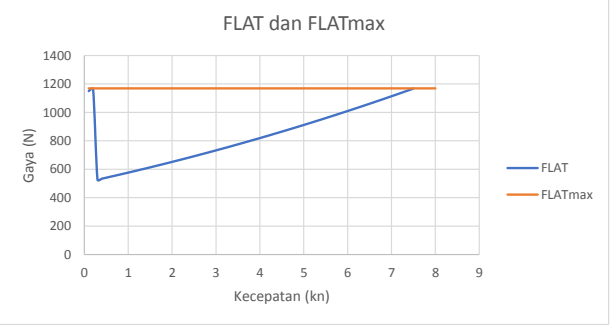
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	50	°
V_A	9,058	m/s
β	40,737	°
V_S	**1,903**	**m/s**
	3,700	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

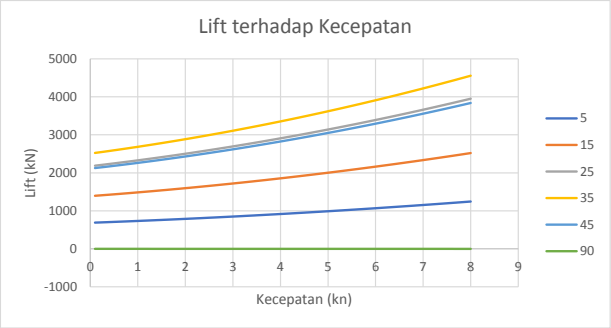
KOEFISIEN MAIN SAIL

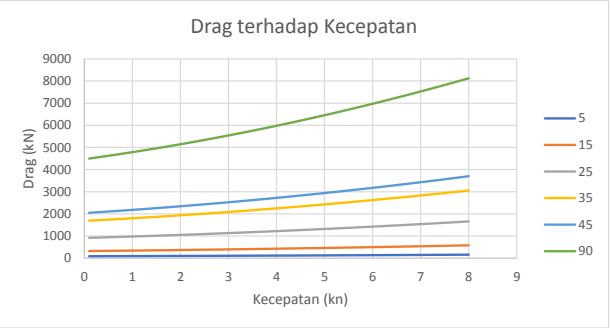
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

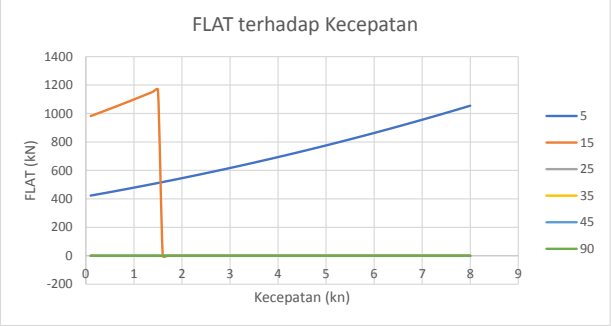
KOEFISIEN MIZZEN SAIL

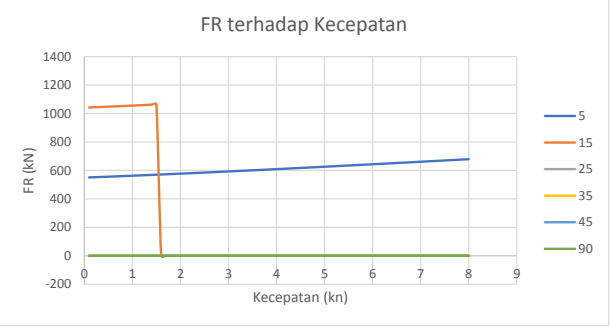
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

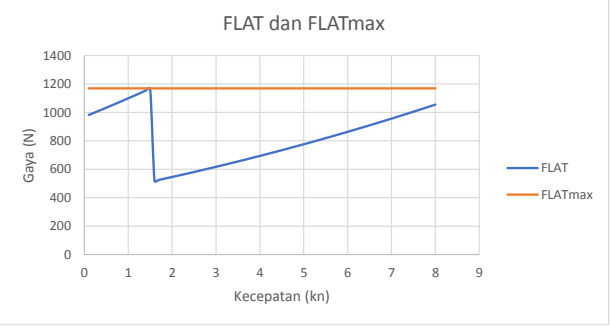
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	60	°
V_A	8,925	m/s
β	48,482	°
V_S	**2,058**	**m/s**
	4,000	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

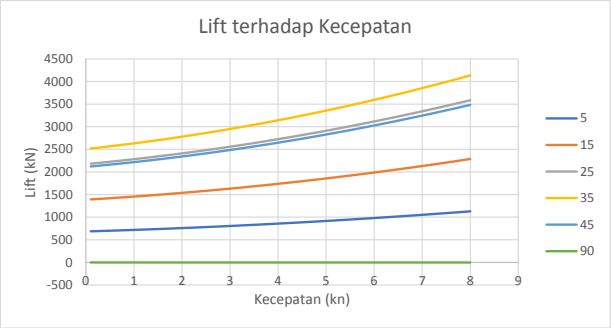
KOEFISIEN MAIN SAIL

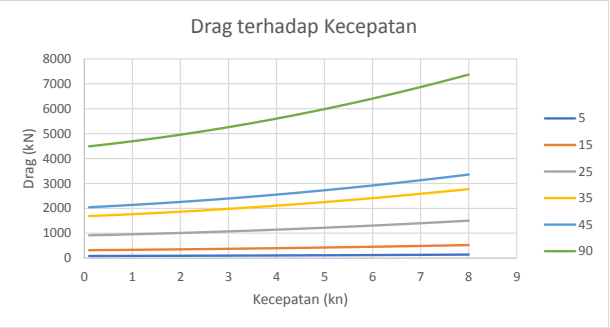
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

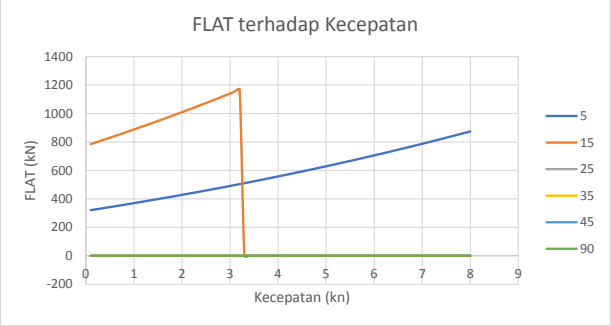
KOEFISIEN MIZZEN SAIL

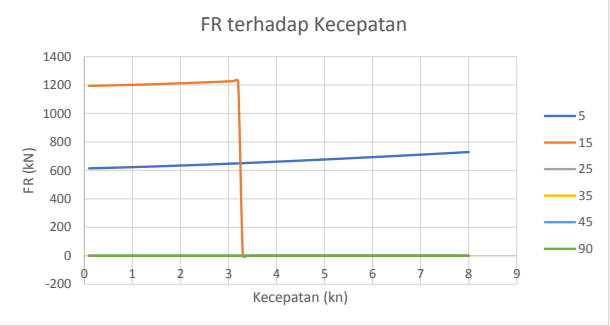
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

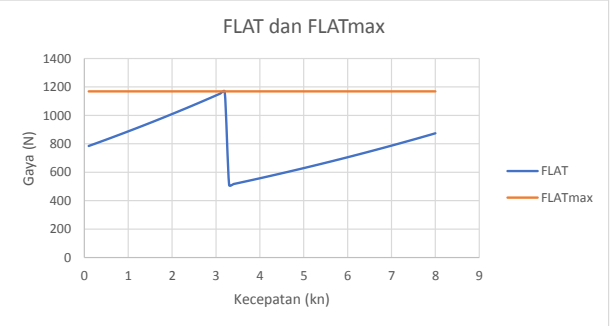
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	70	°
V_A	8,639	m/s
β	57,067	°
V_S	**2,135**	**m/s**
	4,150	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

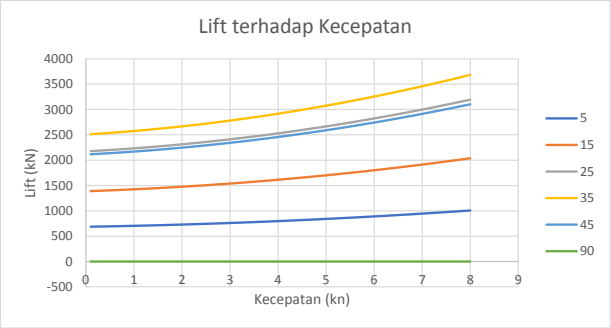
KOEFISIEN MAIN SAIL

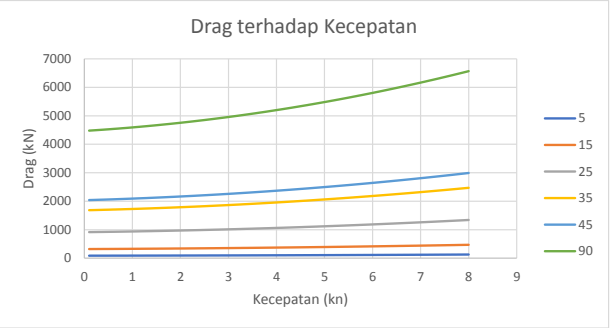
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

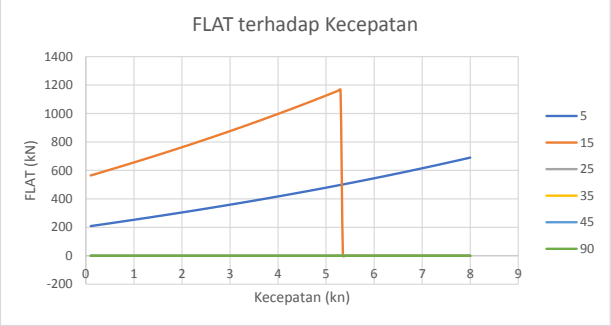
KOEFISIEN MIZZEN SAIL

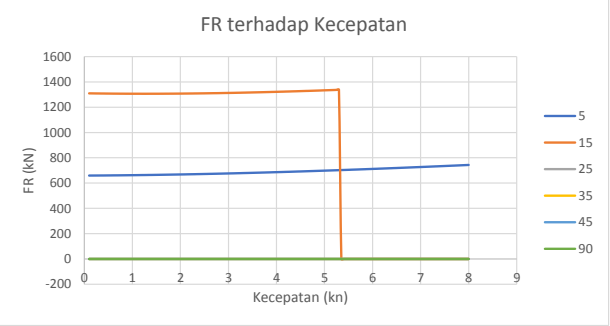
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

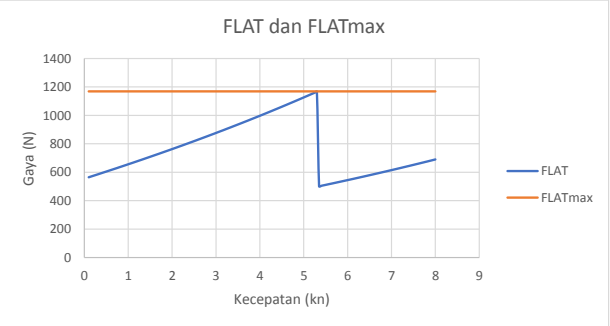
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	80	°
V_A	8,324	m/s
β	65,910	°
V_S	**2,726**	**m/s**
	5,300	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

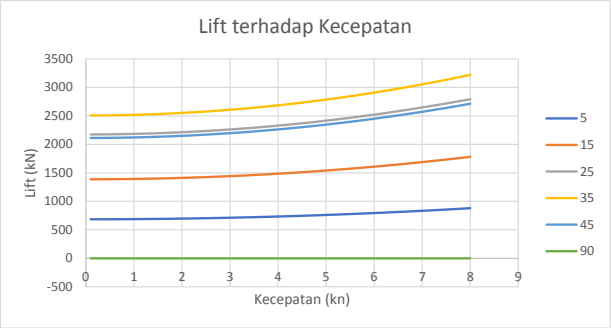
KOEFISIEN MAIN SAIL

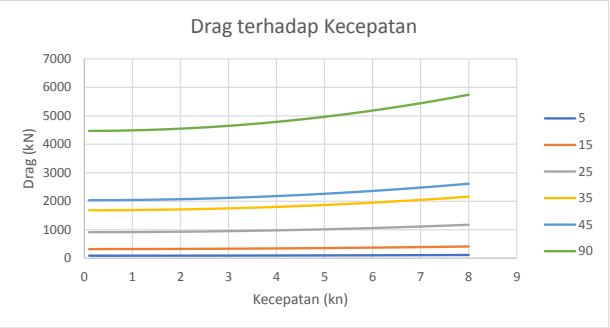
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

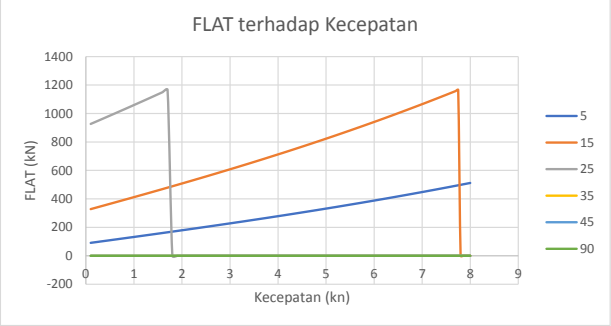
KOEFISIEN MIZZEN SAIL

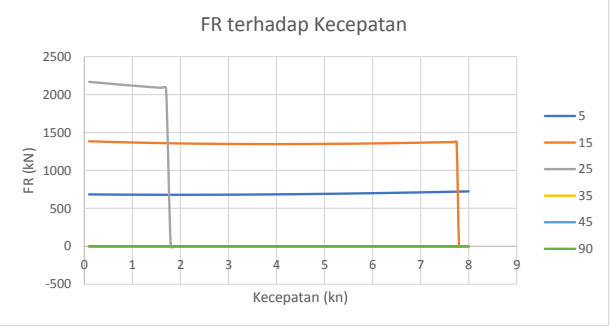
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

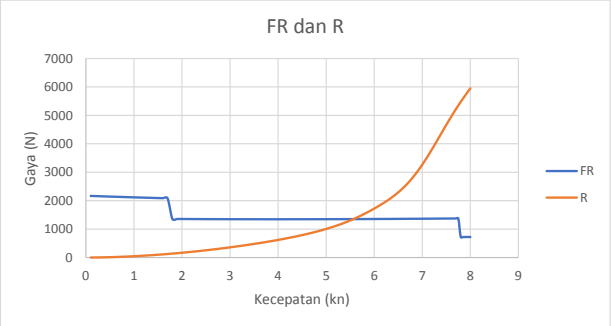
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N

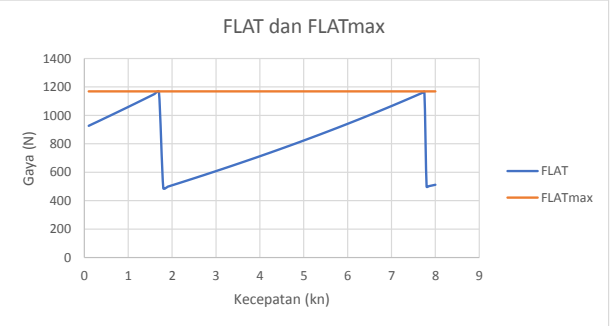












V_T	15,000	kn
	7,716	m/s
γ	90	°
V_A	7,986	m/s
β	75,069	°
V_S	**2,855**	**m/s**
	5,550	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

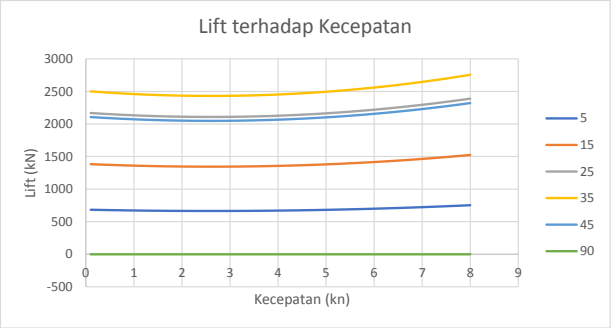
KOEFISIEN MAIN SAIL

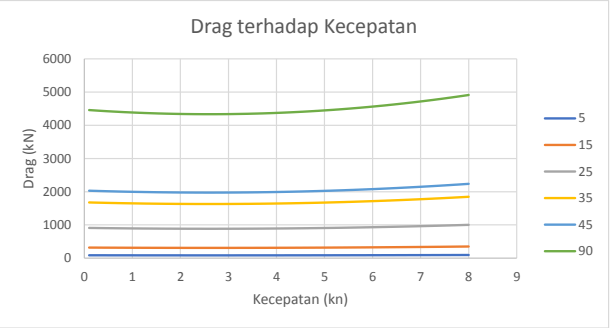
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

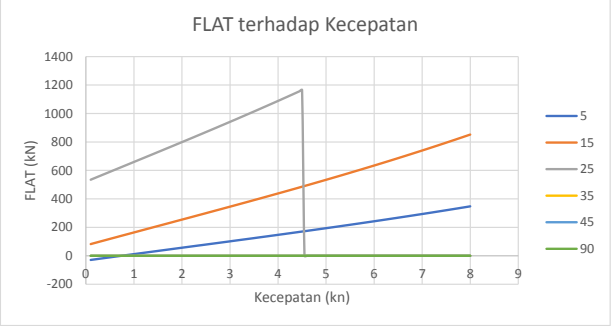
KOEFISIEN MIZZEN SAIL

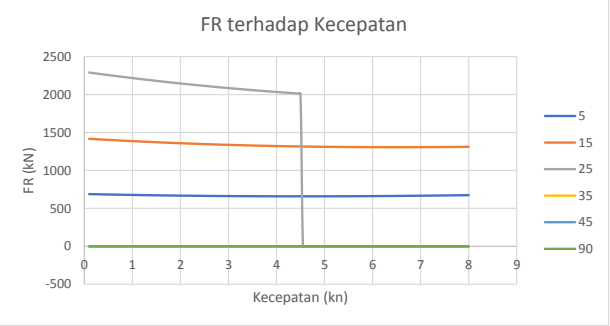
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

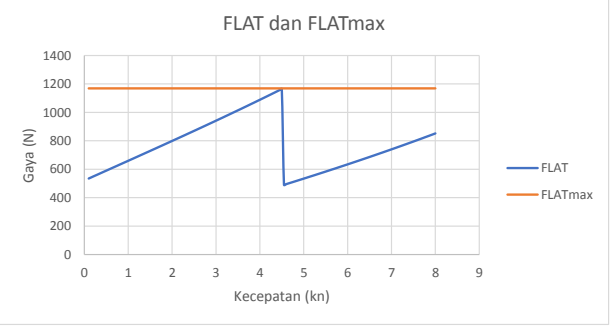
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	100	°
V_A	7,633	m/s
β	84,604	°
V_S	**2,829**	**m/s**
	5,500	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

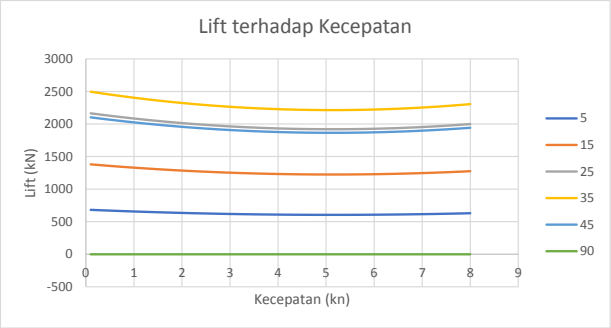
KOEFISIEN MAIN SAIL

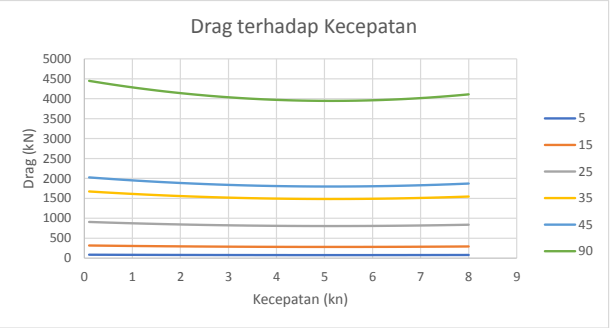
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

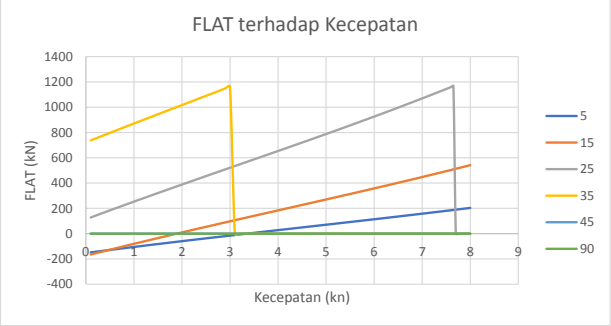
KOEFISIEN MIZZEN SAIL

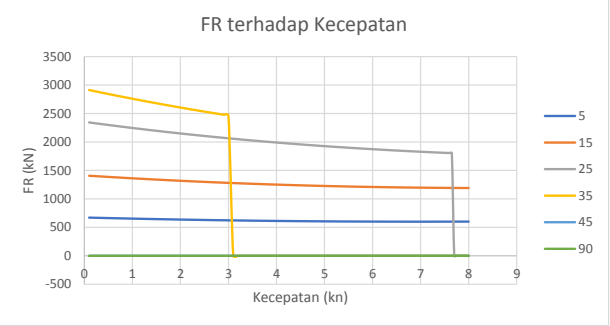
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

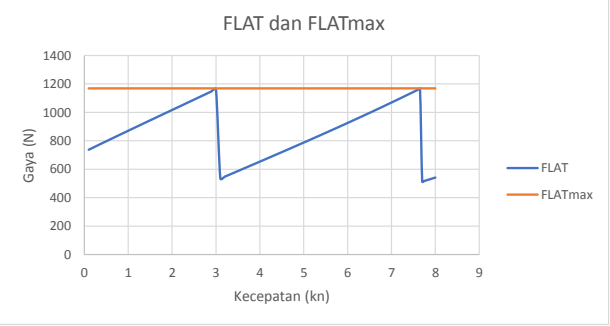
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	110 °
V_A	7,274 m/s
β	94,585 °
V_S	**3,164 m/s**
	6,150 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

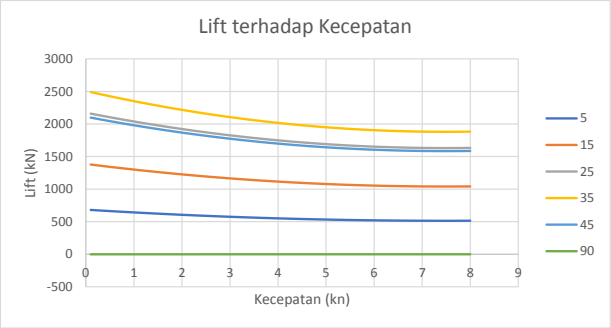
KOEFISIEN MAIN SAIL

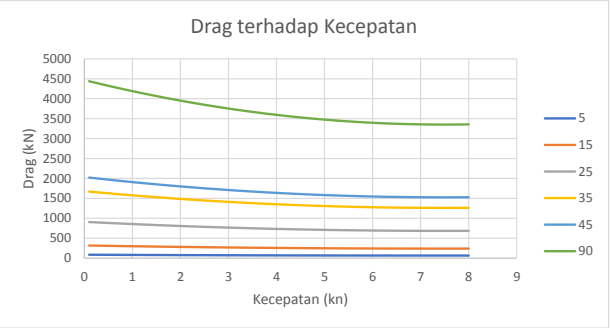
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

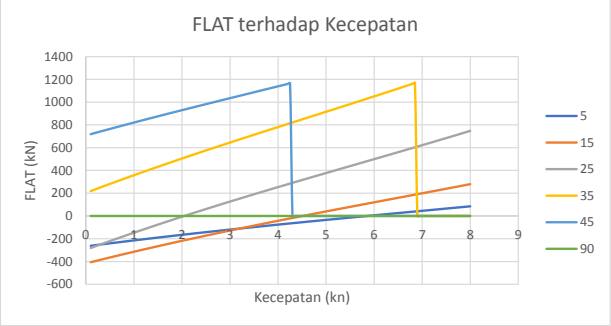
KOEFISIEN MIZZEN SAIL

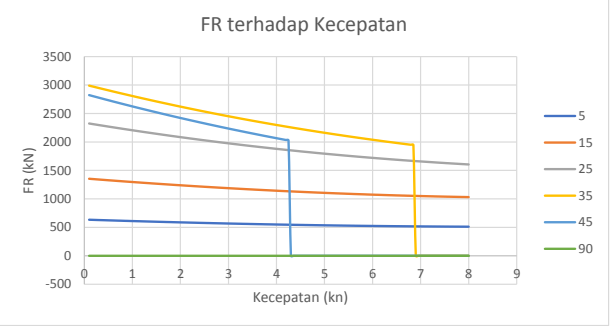
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

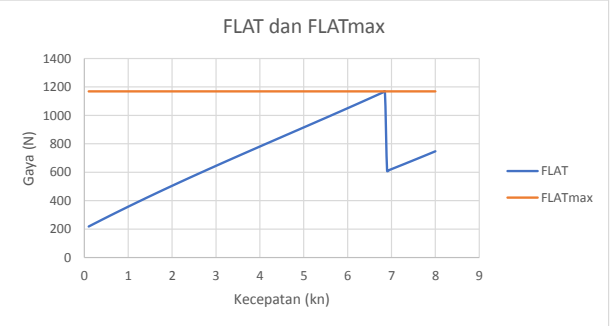
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	120	°
V_A	6,921	m/s
β	105,079	°
V_S	**3,241**	**m/s**
	6,300	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

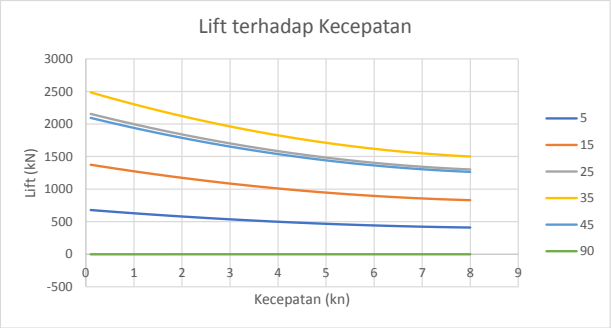
KOEFISIEN MAIN SAIL

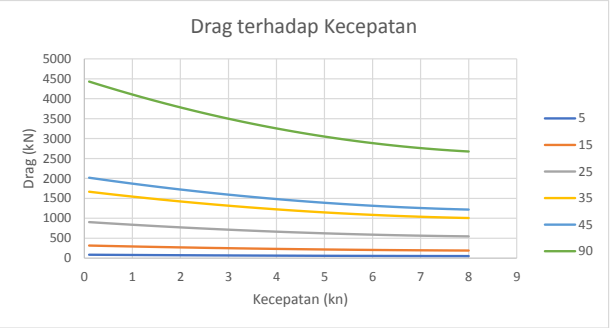
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

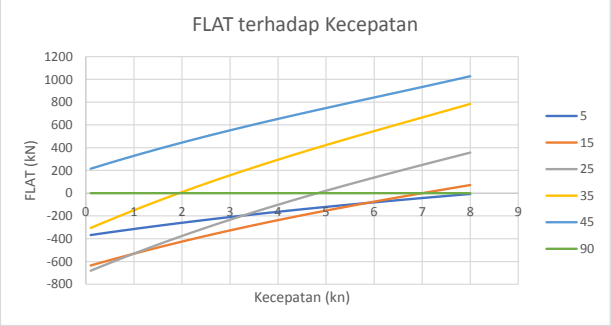
KOEFISIEN MIZZEN SAIL

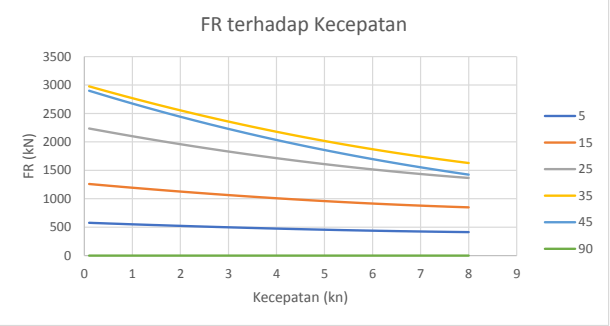
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

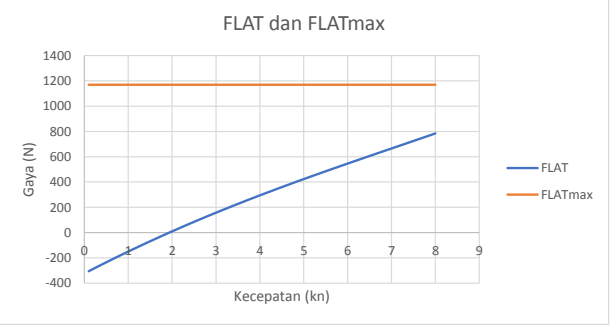
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	130 °
V_A	6,585 m/s
β	116,151 °
V_S	**3,164 m/s**
	6,150 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

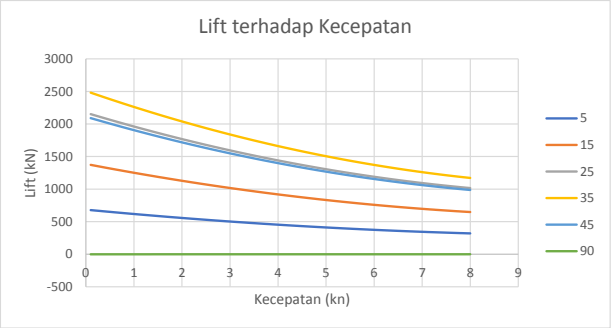
KOEFISIEN MAIN SAIL

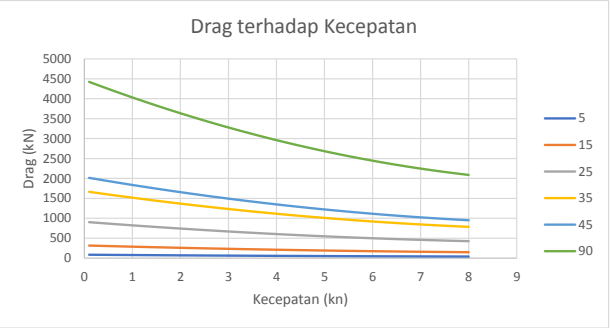
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

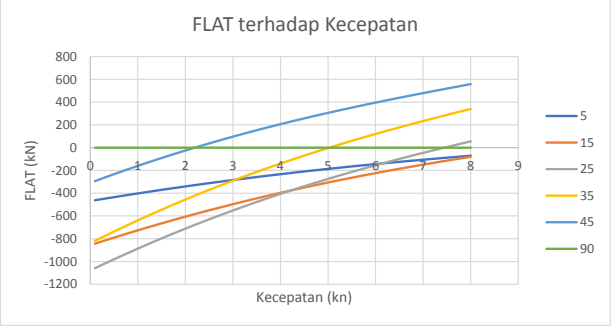
KOEFISIEN MIZZEN SAIL

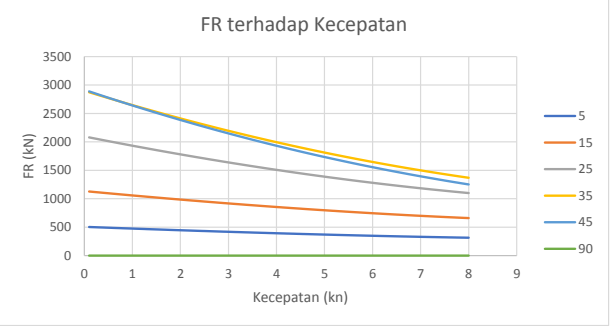
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

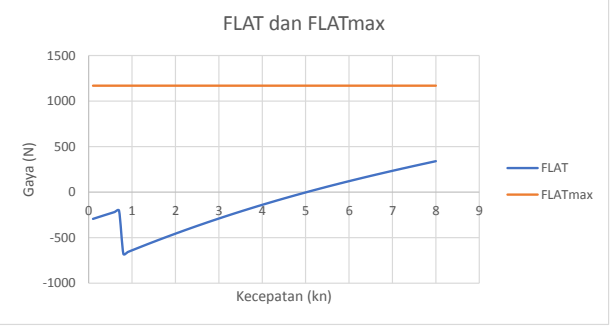
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	140 °
V_A	6,281 m/s
β	127,843 °
V_S	**3,061 m/s**
	5,950 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
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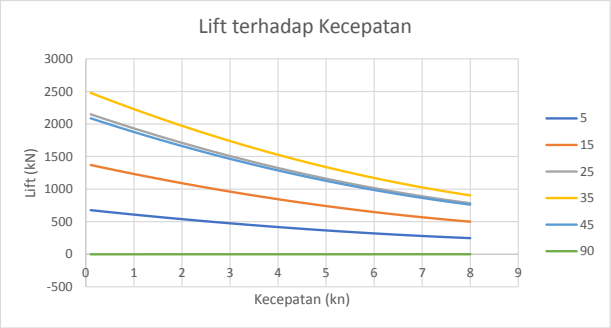
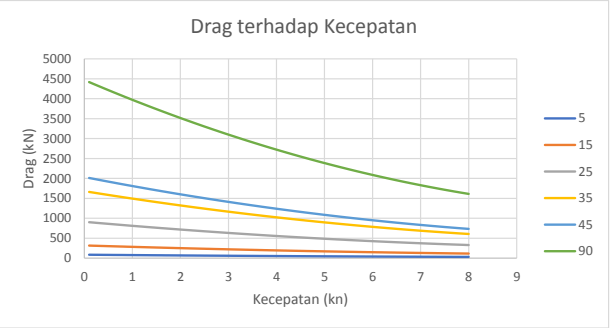
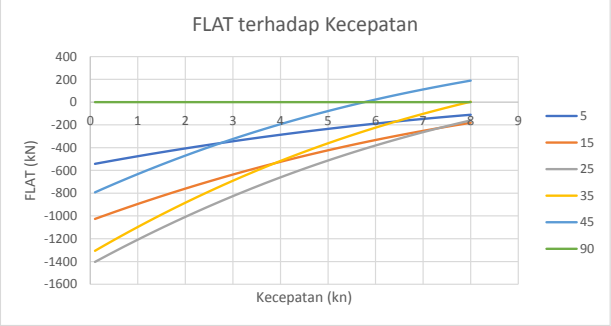
KOEFISIEN MIZZEN SAIL

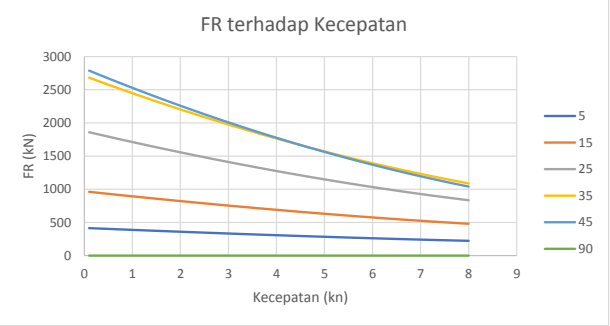
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

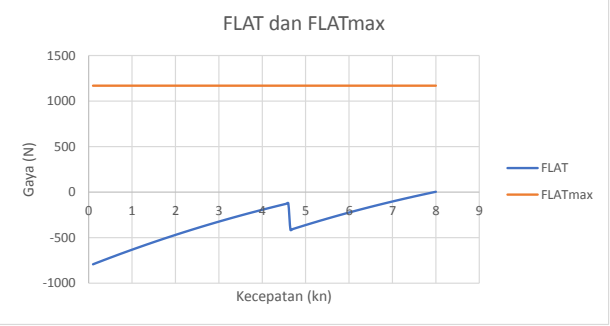
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	150 °
V_A	6,023 m/s
β	140,164 °
V_S	**2,932 m/s**
	5,700 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

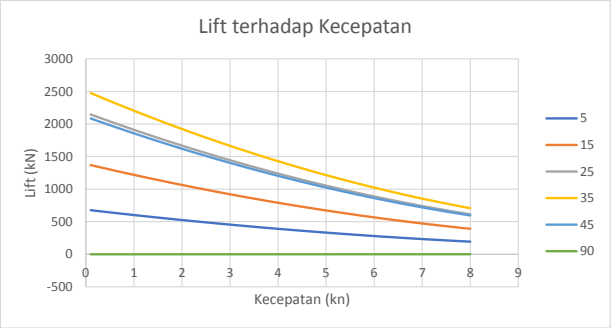
KOEFISIEN MAIN SAIL

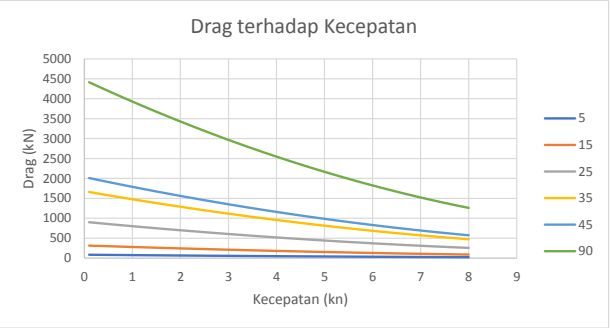
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

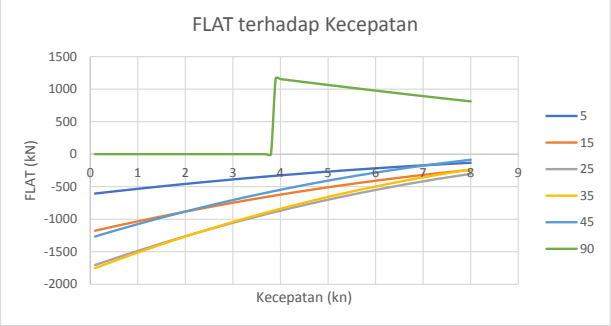
KOEFISIEN MIZZEN SAIL

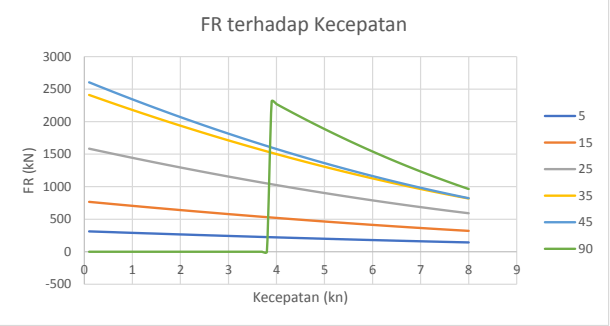
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

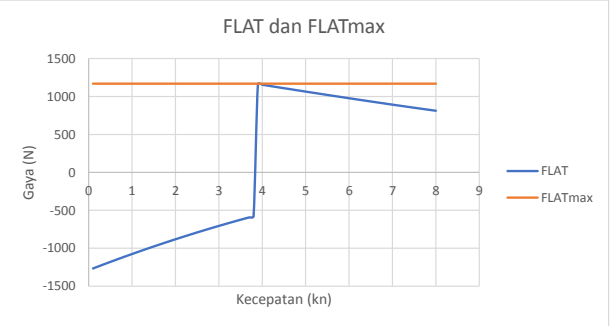
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000 kn
	7,716 m/s
γ	160 °
V_A	5,917 m/s
β	153,512 °
V_S	**3,009 m/s**
	5,850 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

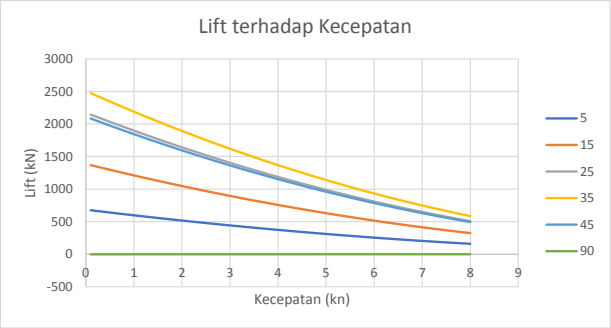
KOEFISIEN MAIN SAIL

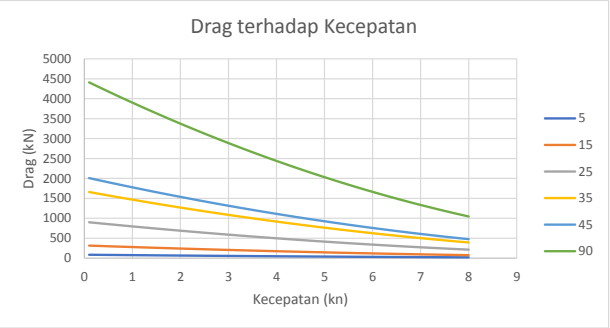
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

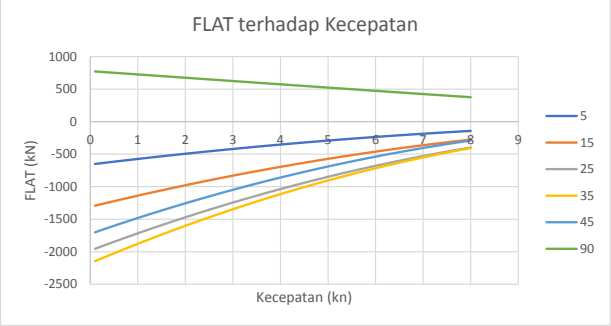
KOEFISIEN MIZZEN SAIL

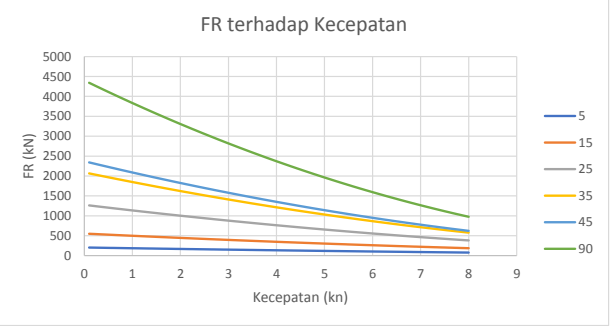
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

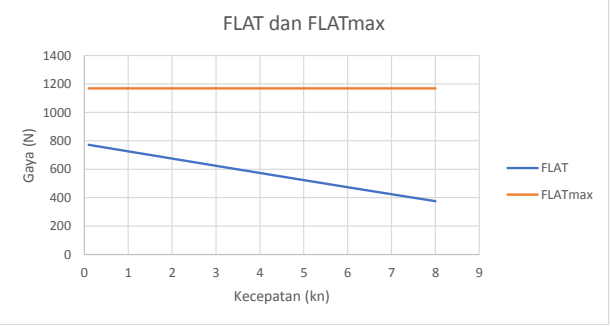
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	170	°
V_A	5,701	m/s
β	166,407	°
V_S	**3,035**	**m/s**
	5,900	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	15,000	kn
	7,716	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

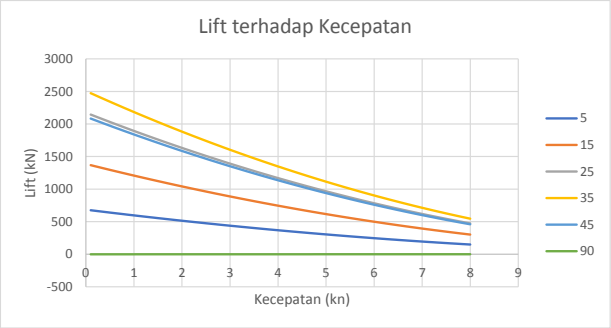
KOEFISIEN MAIN SAIL

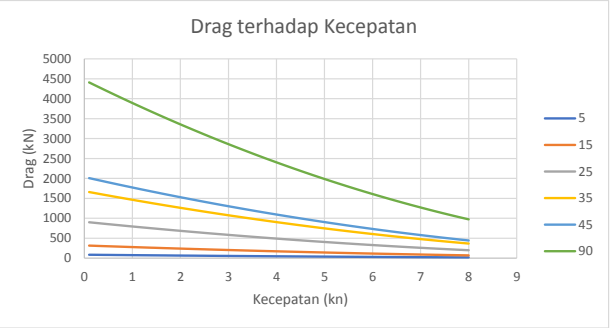
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

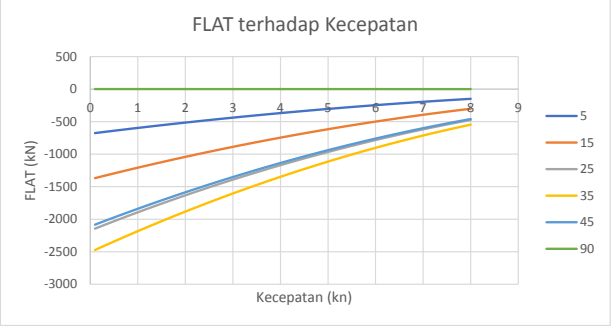
KOEFISIEN MIZZEN SAIL

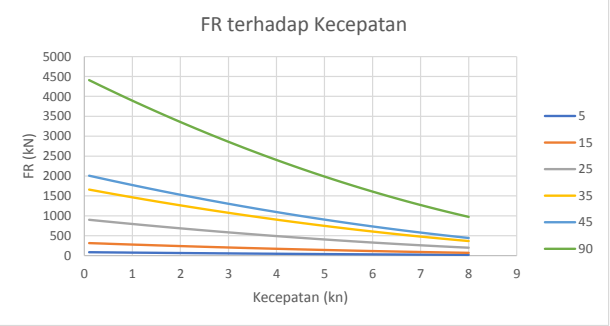
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

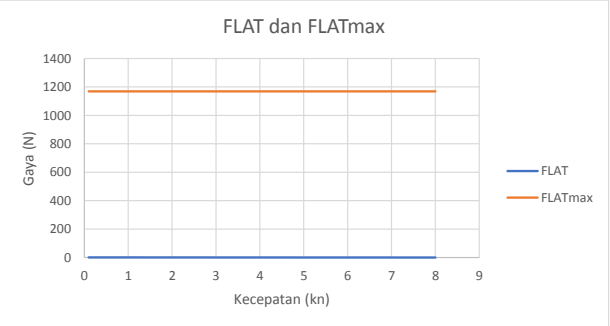
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	15,000	kn
	7,716	m/s
γ	180	°
V_A	5,658	m/s
β	180,000	°
V_S	**3,035**	**m/s**
	5,900	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

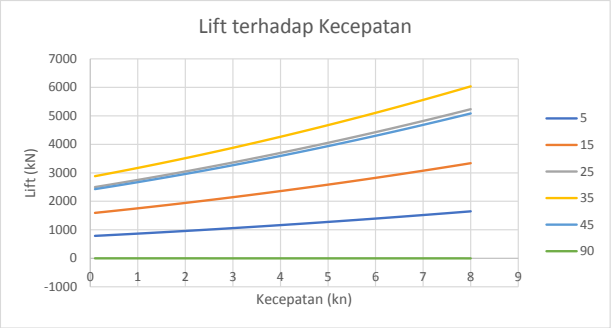
KOEFISIEN MAIN SAIL

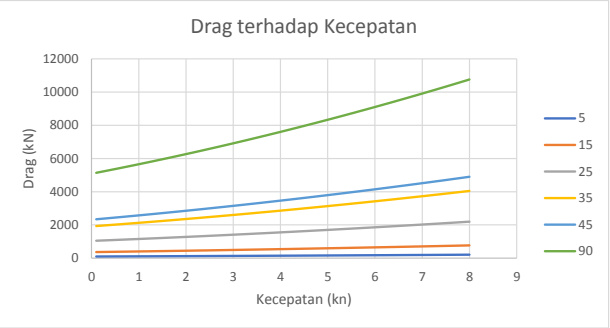
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

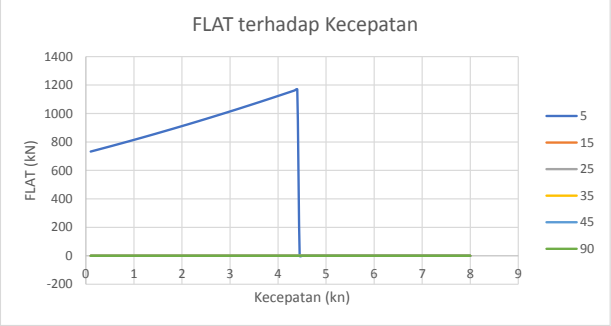
KOEFISIEN MIZZEN SAIL

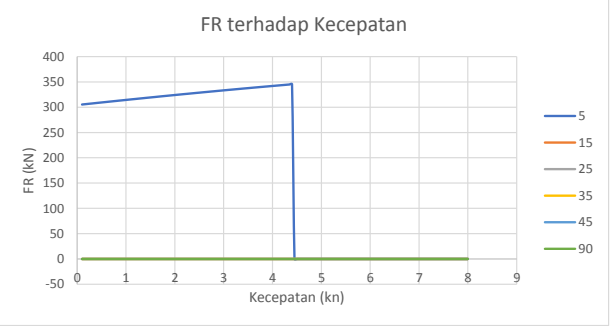
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

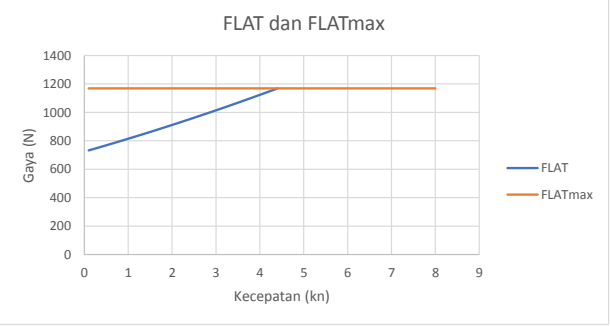
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	30	°
V_A	9,551	m/s
β	25,521	°
V_S	**1,492**	**m/s**
	2,900	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

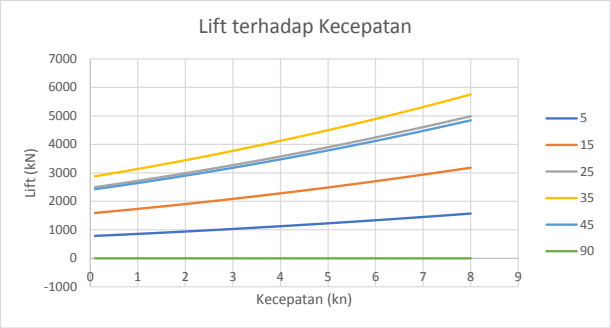
KOEFISIEN MAIN SAIL

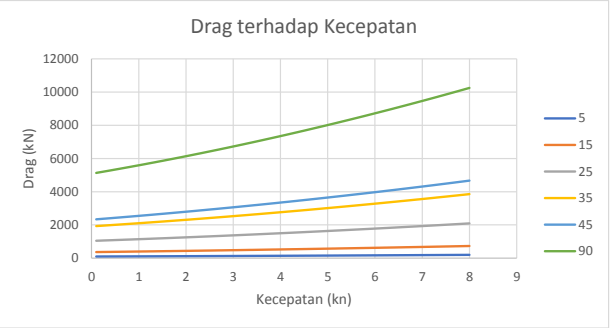
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

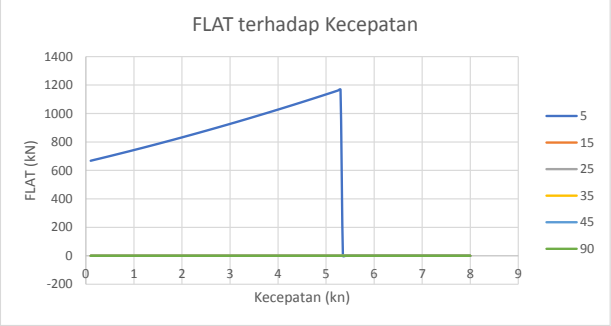
KOEFISIEN MIZZEN SAIL

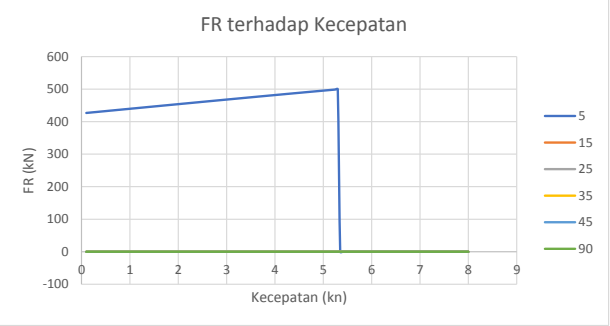
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

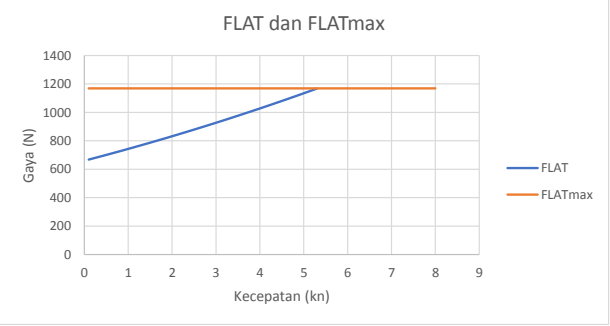
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	40	°
V_A	9,679	m/s
β	33,133	°
V_S	**1,800**	**m/s**
	3,500	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

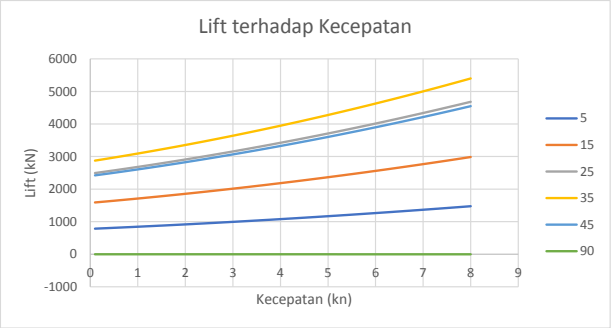
KOEFISIEN MAIN SAIL

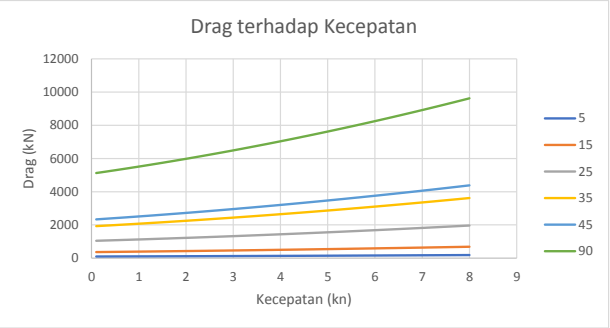
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

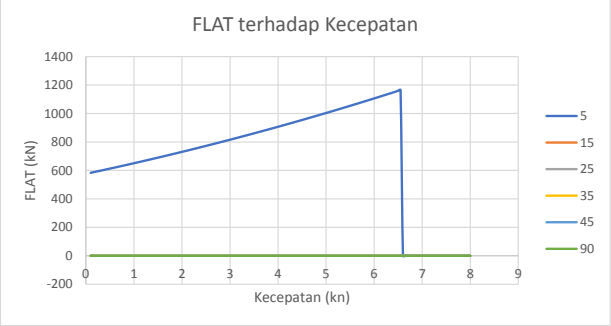
KOEFISIEN MIZZEN SAIL

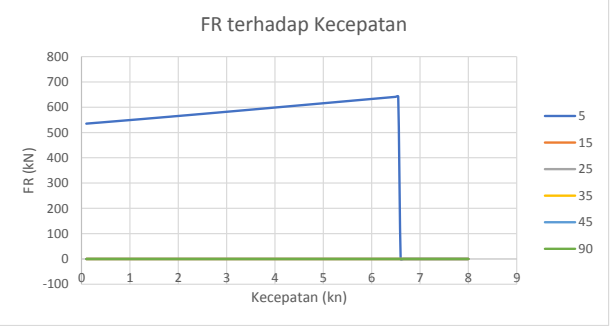
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

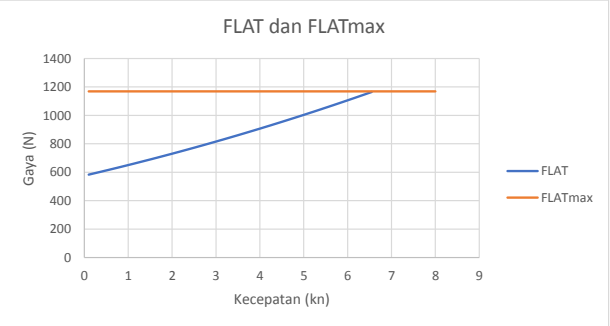
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	50	°
V_A	9,643	m/s
β	40,830	°
V_S	**2,006**	**m/s**
	3,900	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

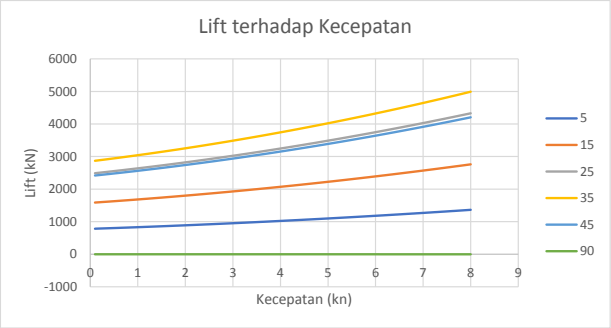
KOEFISIEN MAIN SAIL

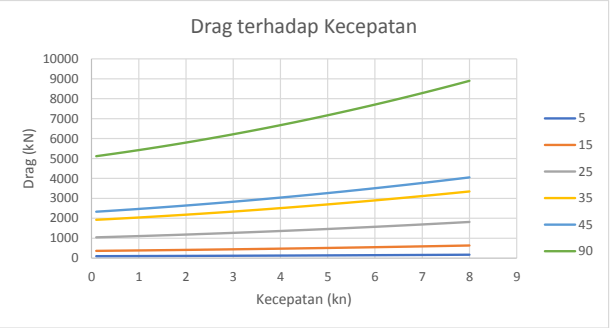
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

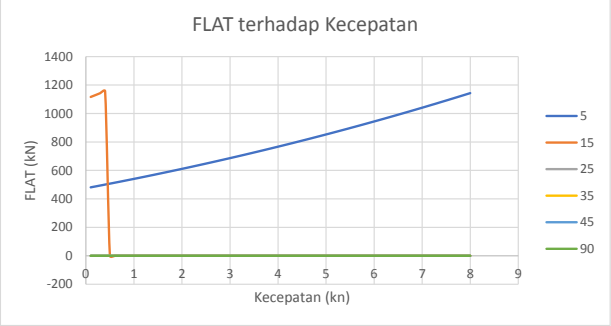
KOEFISIEN MIZZEN SAIL

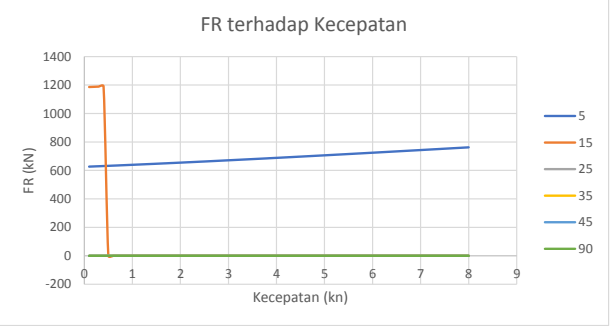
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

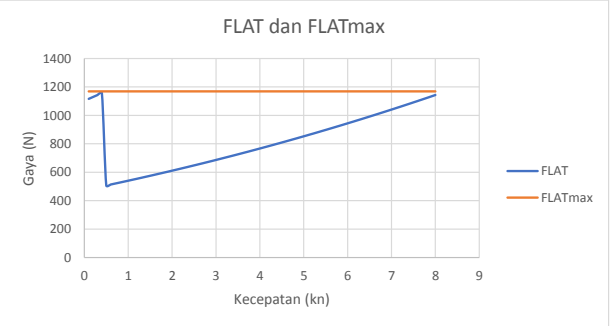
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	60	°
V_A	9,429	m/s
β	49,107	°
V_S	**2,186**	**m/s**
	4,250	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

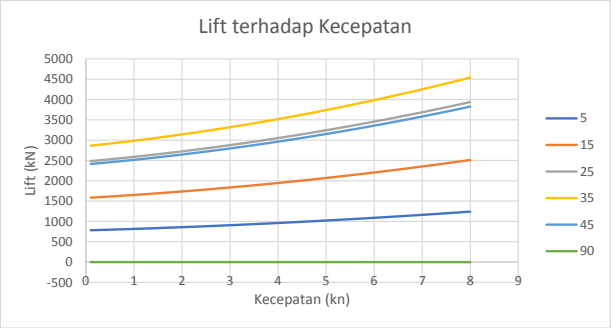
KOEFISIEN MAIN SAIL

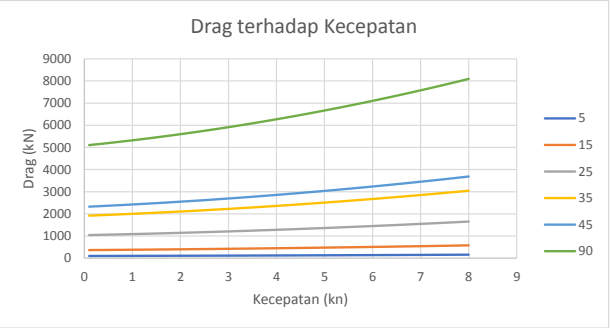
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

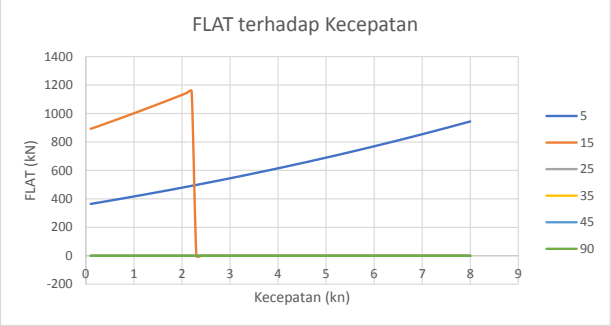
KOEFISIEN MIZZEN SAIL

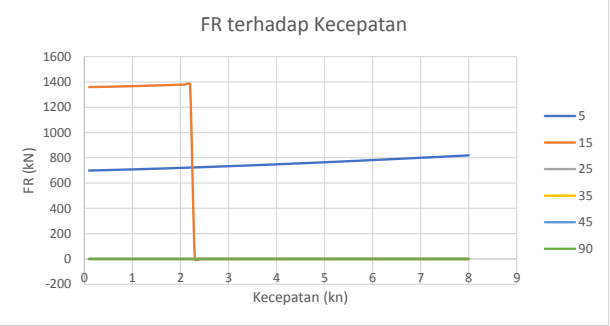
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

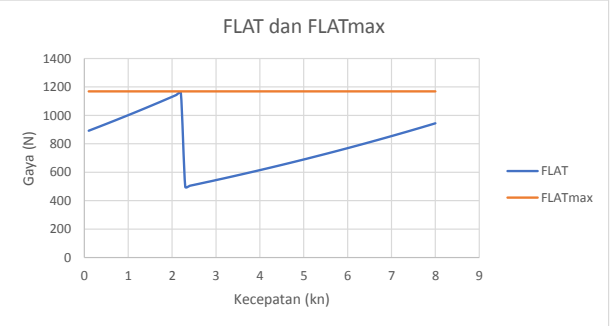
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	70 °
V_A	9,141 m/s
β	57,788 °
V_S	**2,263 m/s**
	4,400 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

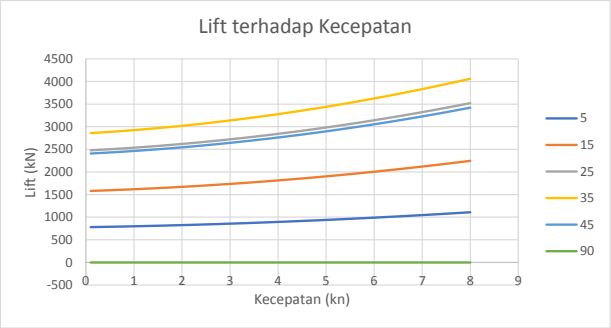
KOEFISIEN MAIN SAIL

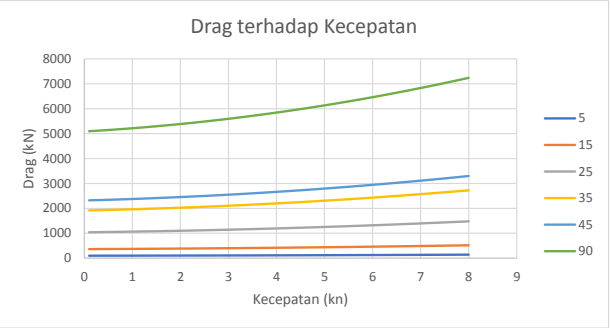
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

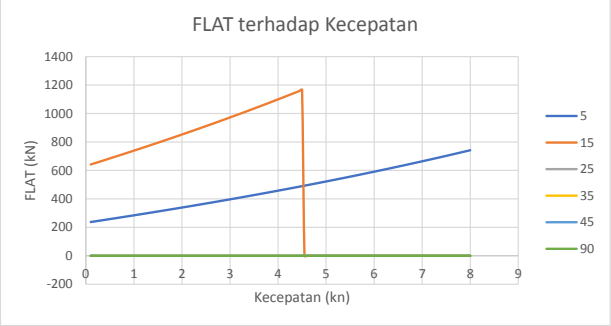
KOEFISIEN MIZZEN SAIL

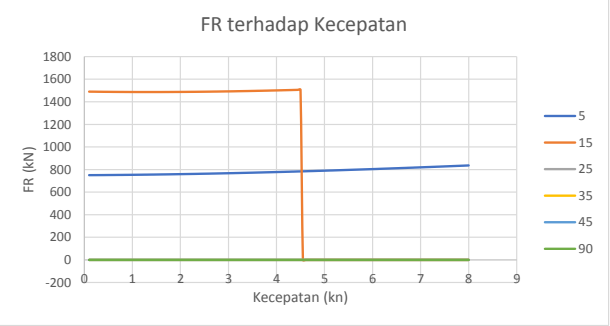
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

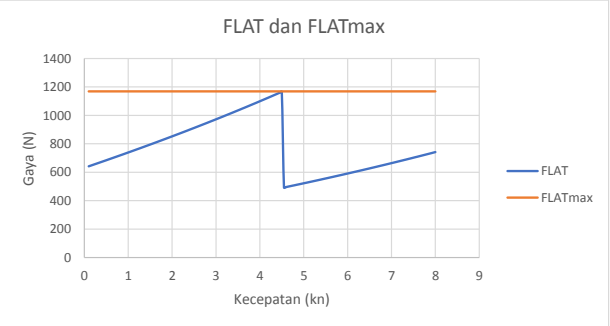
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	80 °
V_A	8,824 m/s
β	66,723 °
V_S	**2,341 m/s**
	4,550 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

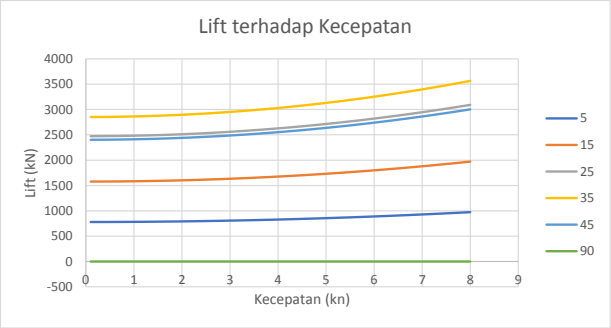
KOEFISIEN MAIN SAIL

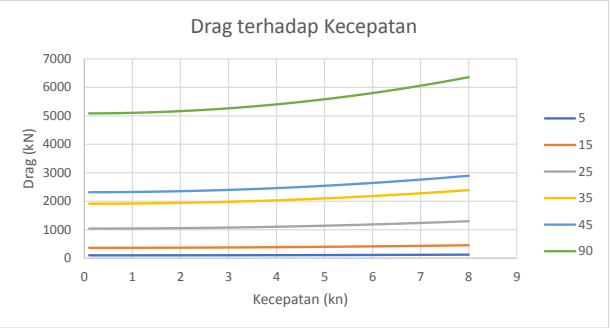
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

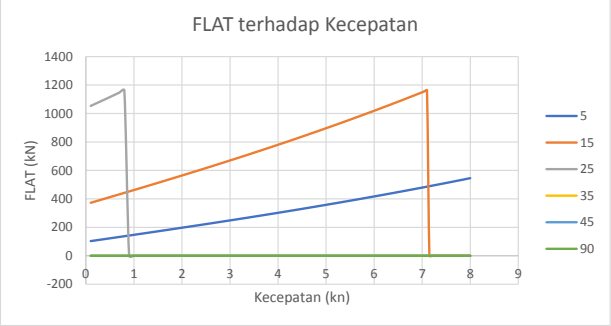
KOEFISIEN MIZZEN SAIL

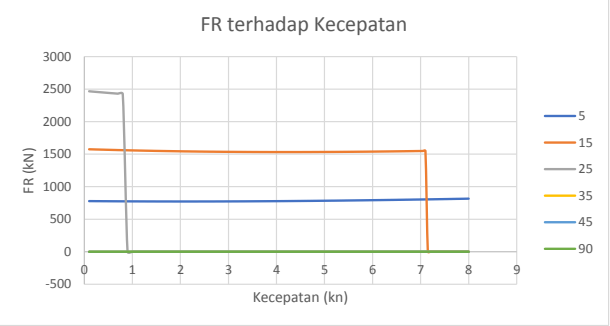
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

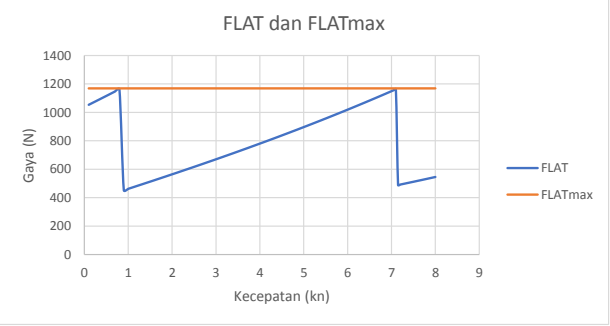
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	90 °
V_A	8,484 m/s
β	75,964 °
V_S	**2,984 m/s**
	5,800 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

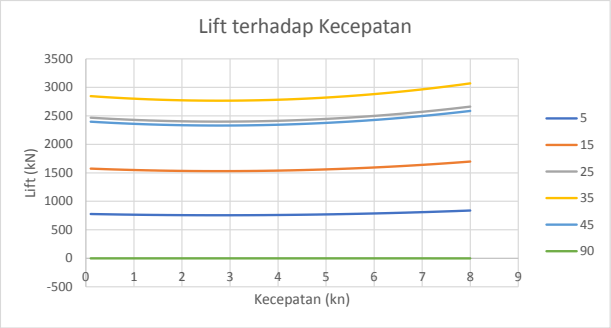
KOEFISIEN MAIN SAIL

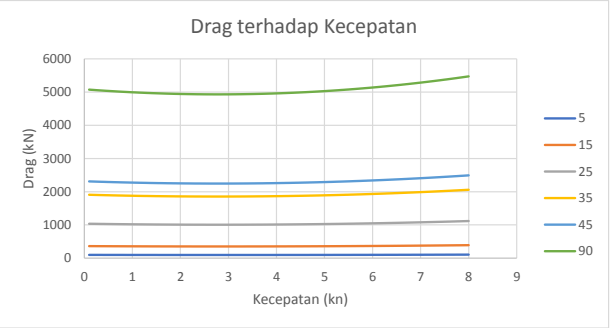
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

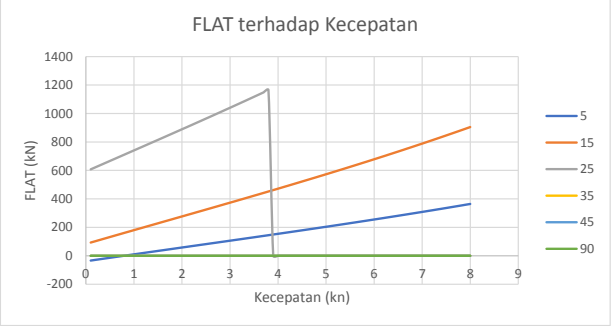
KOEFISIEN MIZZEN SAIL

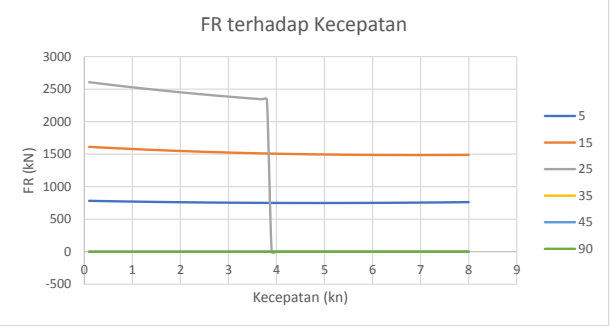
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

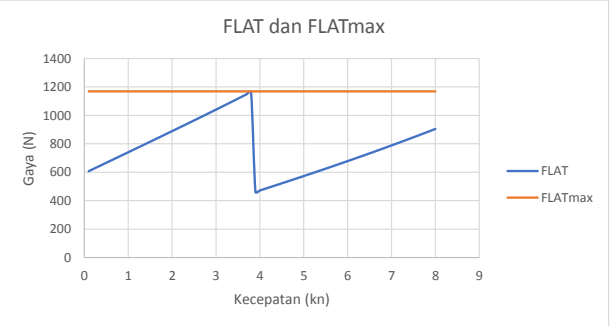
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	100	°
V_A	8,130	m/s
β	85,567	°
V_S	**2,958**	**m/s**
	5,750	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

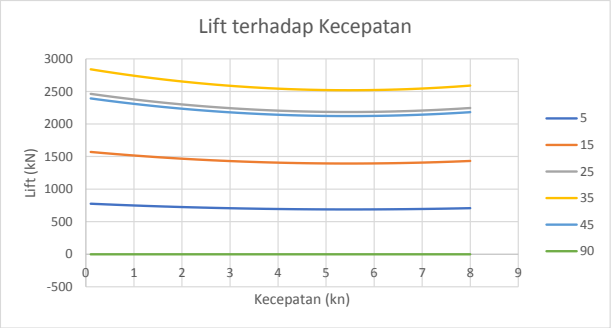
KOEFISIEN MAIN SAIL

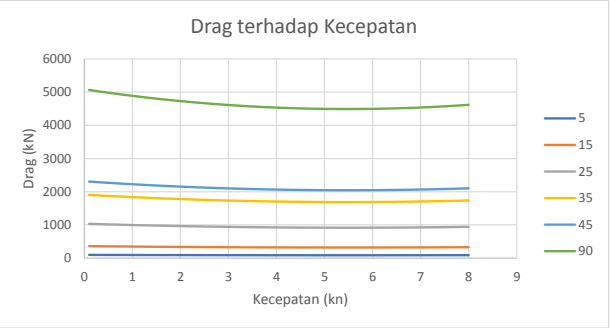
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

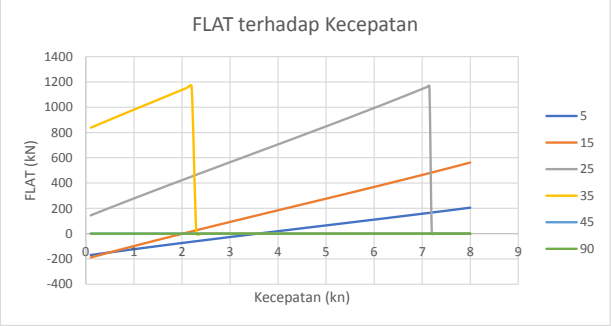
KOEFISIEN MIZZEN SAIL

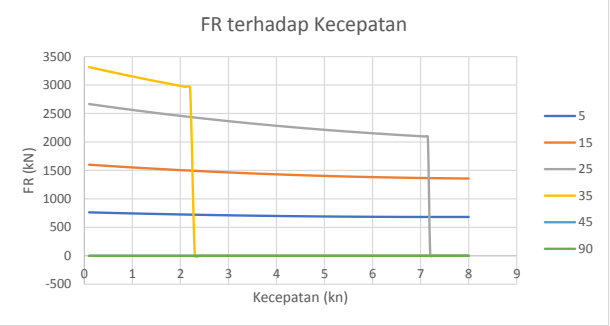
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

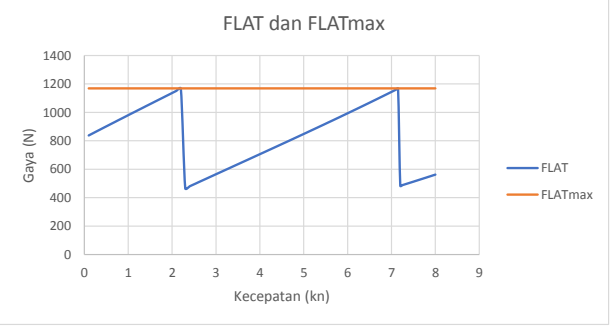
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	110 °
V_A	7,771 m/s
β	95,593 °
V_S	**3,292 m/s**
	6,400 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

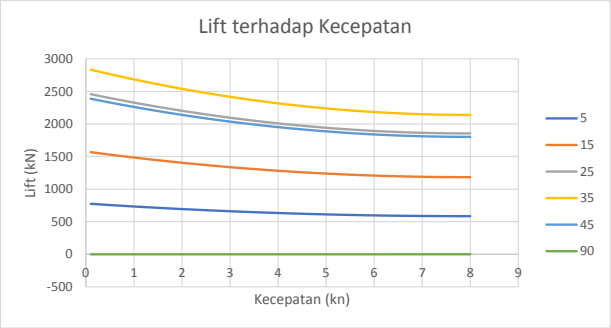
KOEFISIEN MAIN SAIL

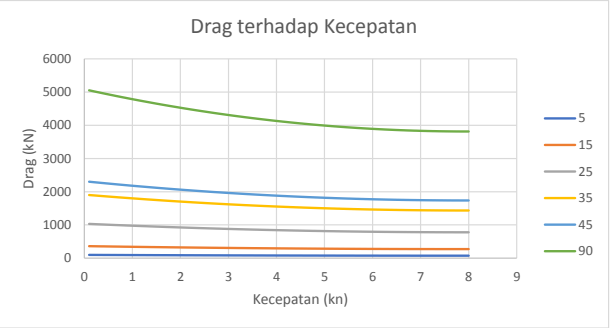
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

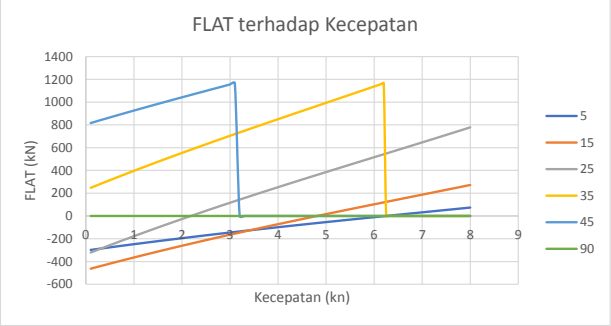
KOEFISIEN MIZZEN SAIL

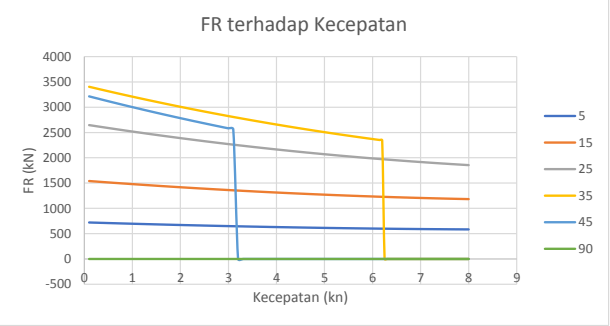
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

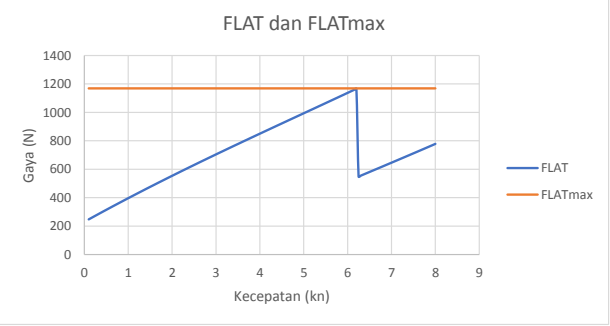
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	120	°
V_A	7,419	m/s
β	106,102	°
V_S	**3,215**	**m/s**
	6,250	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

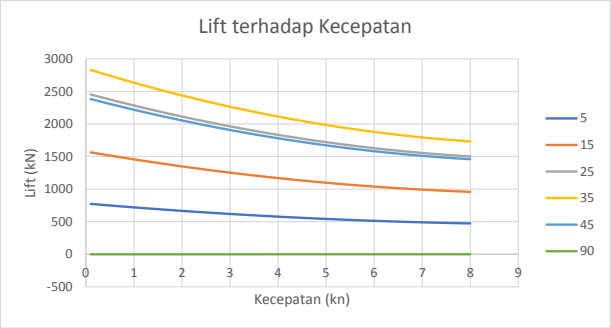
KOEFISIEN MAIN SAIL

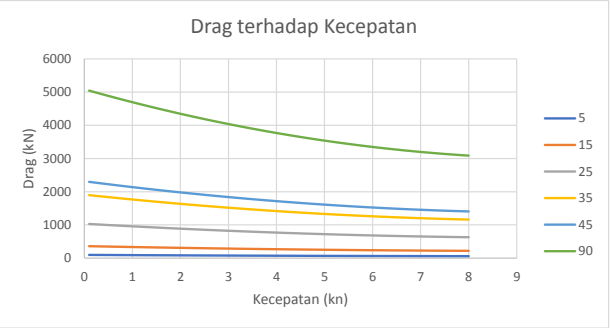
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

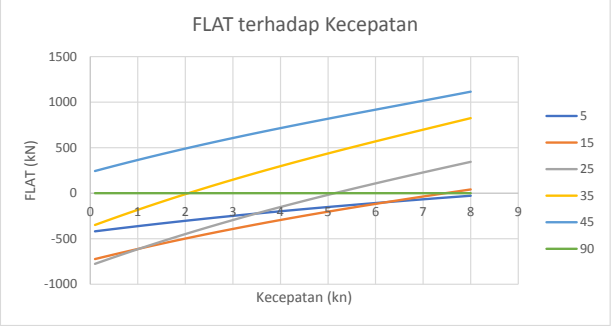
KOEFISIEN MIZZEN SAIL

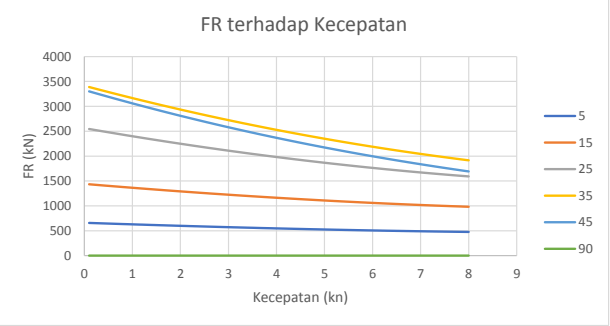
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

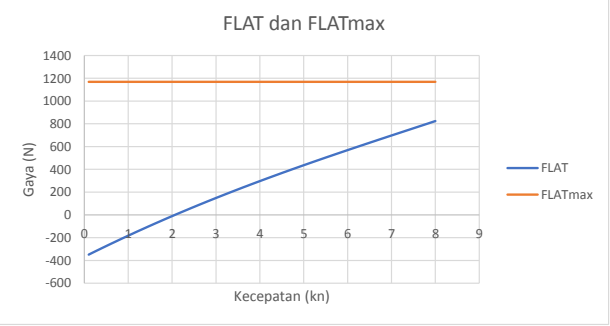
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	130 °
V_A	7,085 m/s
β	117,146 °
V_S	**3,292 m/s**
	6,400 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

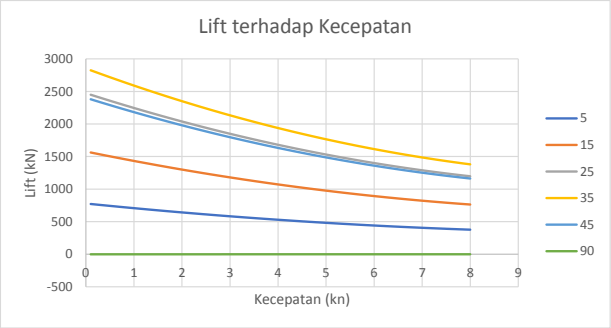
KOEFISIEN MAIN SAIL

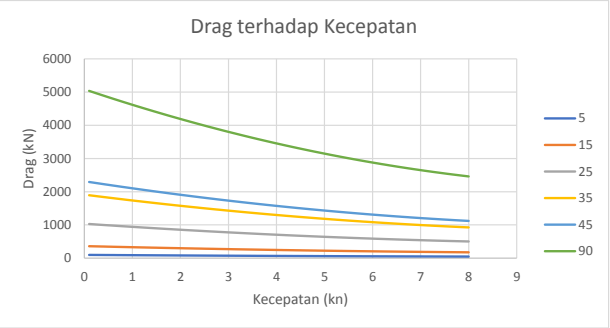
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

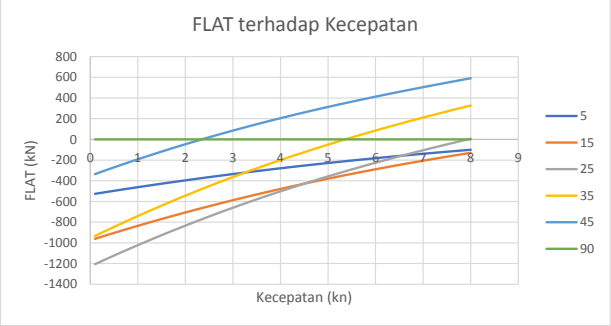
KOEFISIEN MIZZEN SAIL

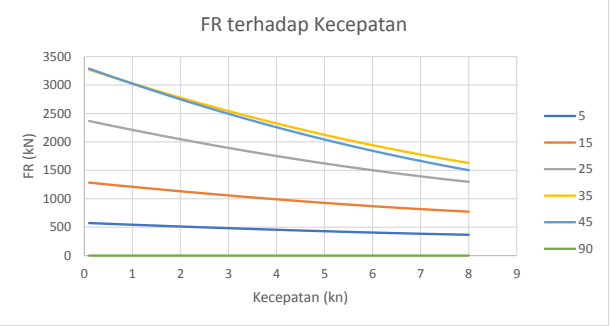
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

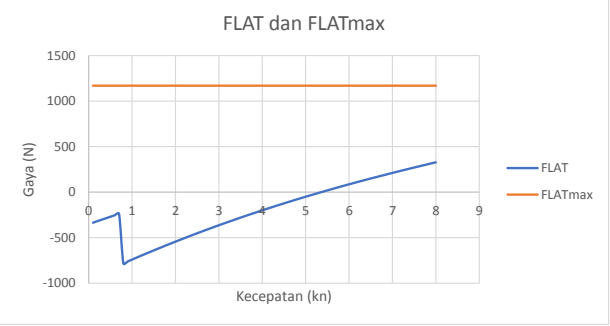
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	140 °
V_A	6,784 m/s
β	128,758 °
V_S	**3,189 m/s**
	6,200 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

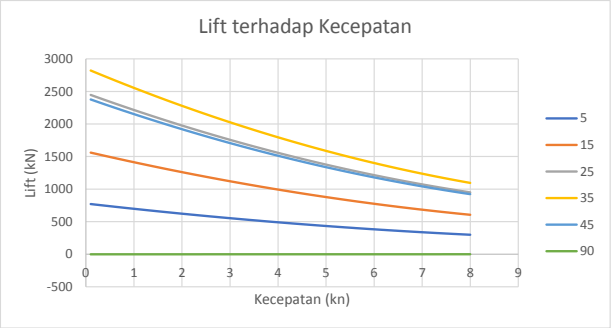
KOEFISIEN MAIN SAIL

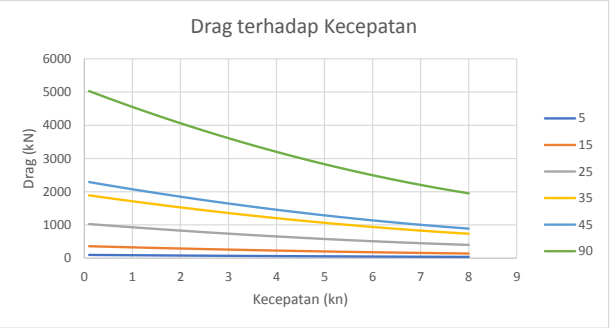
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

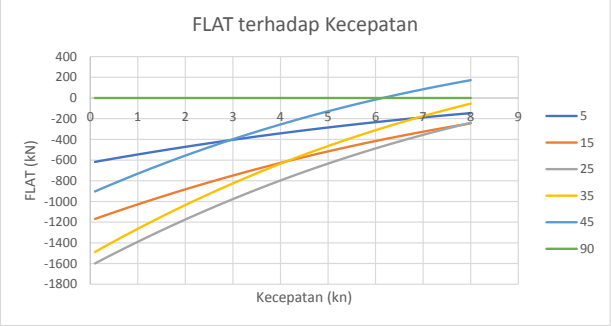
KOEFISIEN MIZZEN SAIL

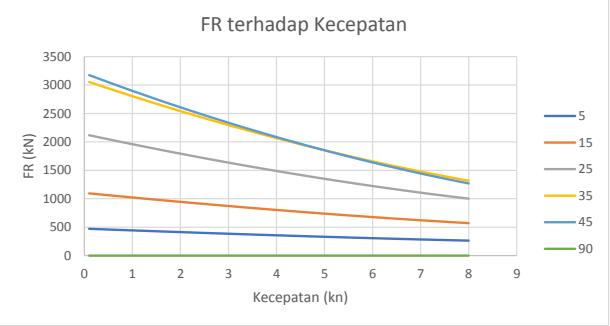
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

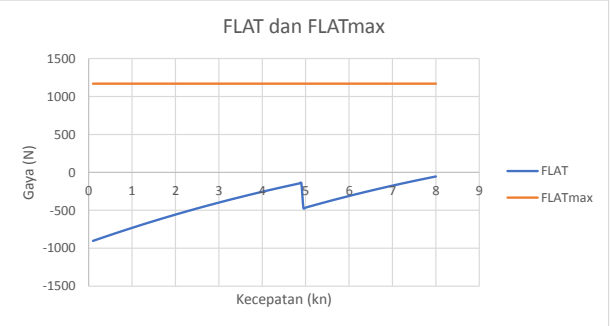
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	150	°
V_A	6,530	m/s
β	140,935	°
V_S	**3,061**	**m/s**
	5,950	**kn**

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
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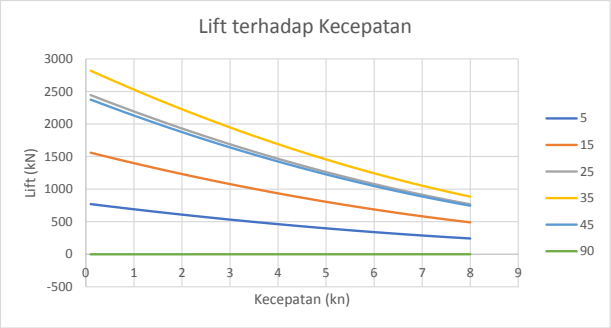
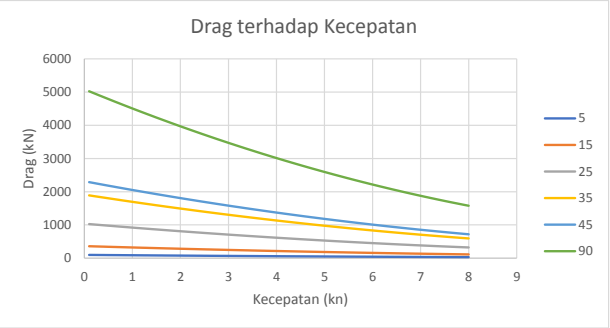
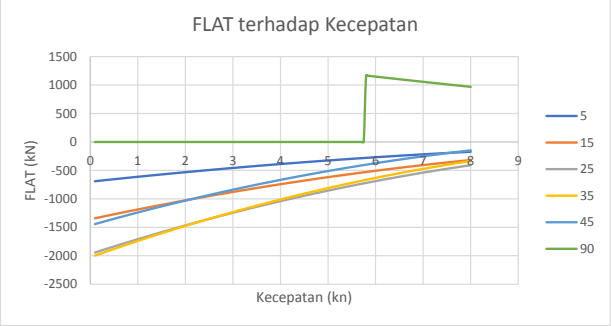
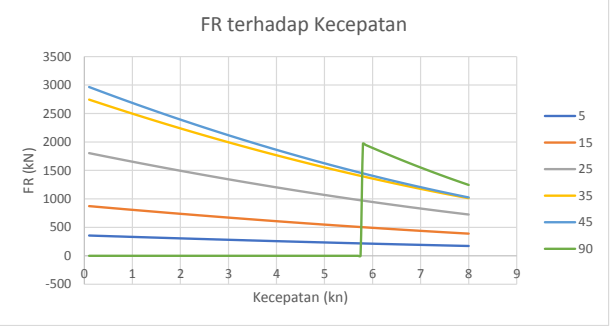
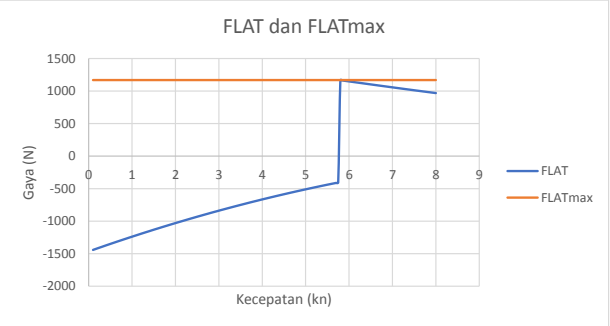
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	160 °
V_A	6,336 m/s
β	153,623 °
V_S	**2,932 m/s**
	5,700 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

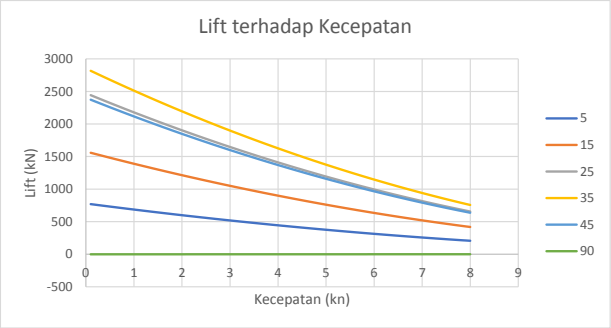
KOEFISIEN MAIN SAIL

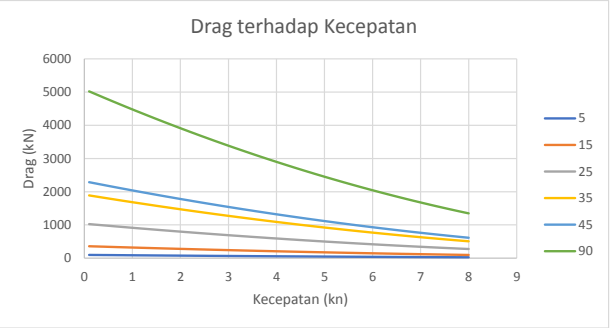
α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
C_D	0,058	0,207	0,574	1,041	1,202	2,808

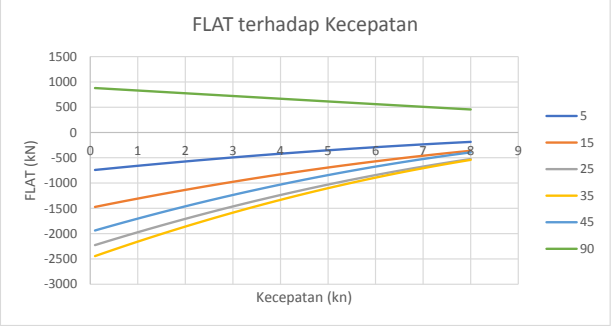
KOEFISIEN MIZZEN SAIL

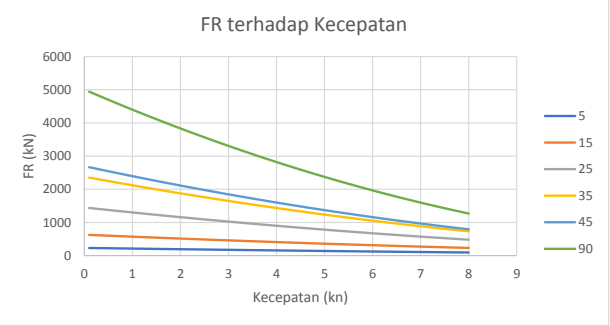
α (°)	5	15	25	35	45	90
C_L	0,365	0,833	1,360	1,580	1,527	-0,001
C_D	0,044	0,183	0,571	1,092	1,473	2,802

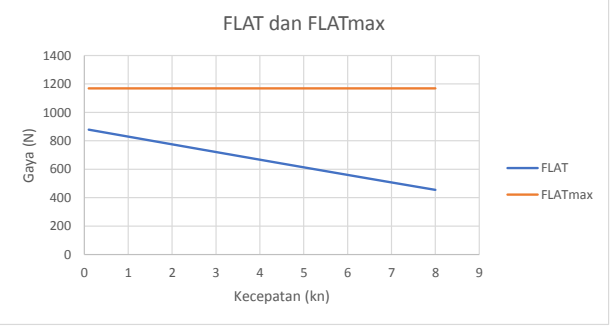
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000 kn
	8,230 m/s
γ	170 °
V_A	6,214 m/s
β	166,704 °
V_S	**3,189 m/s**
	6,200 kn

SPESIFIKASI LAYAR

Model	Peledang	MAIN	MIZZEN
Span (m)	Yard	8,000	5,016
	Boom	8,000	5,016
Chord (m)		4,000	2,508
Area (m^2)		32,000	12,580

TRUE WIND

ρ	1,2	kg/m^3
V_T	16,000	kn
	8,230	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,456	0,886	1,367	1,572	1,247	-0,001
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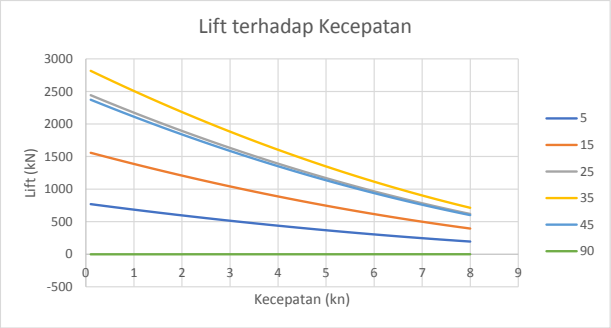
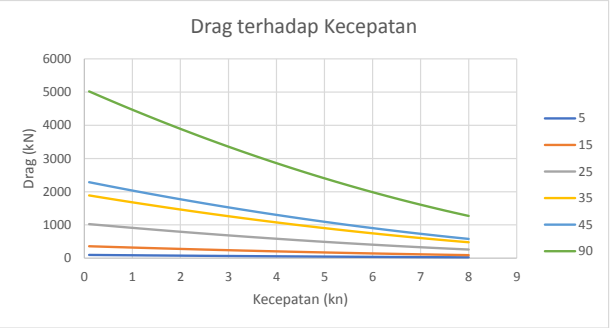
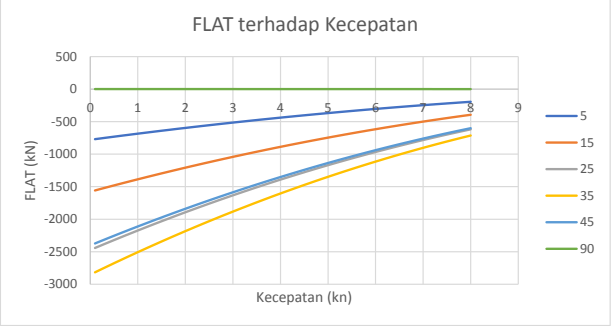
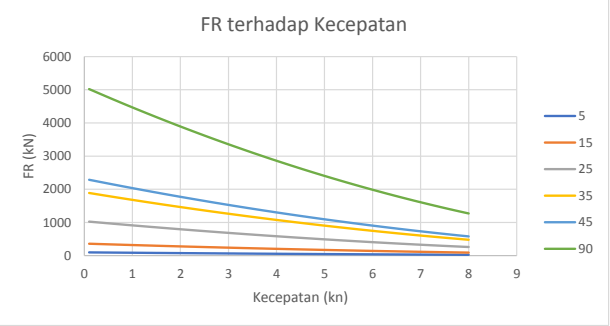
C_D	0,044	0,183	0,571	1,092	1,473	2,802

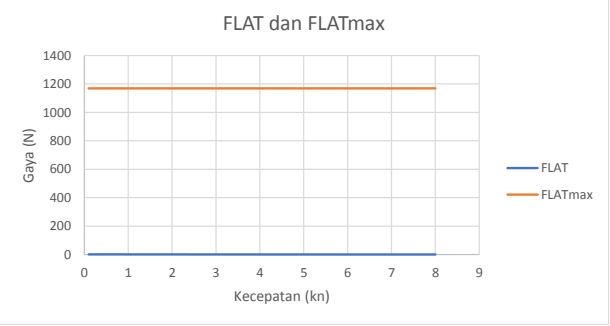
MUATAN	θ_{max}	11 °	h	6,007 m
PENUH	M_H	6,894 kNm	F_{LATmax}	1169,084 N











V_T	16,000	kn
	8,230	m/s
γ	180	°
V_A	6,173	m/s
β	180,000	°
V_S	**3,189**	**m/s**
	6,200	**kn**

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	30	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

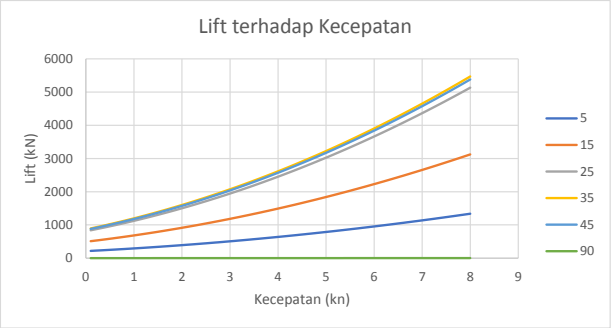
KOEFISIEN MAIN SAIL

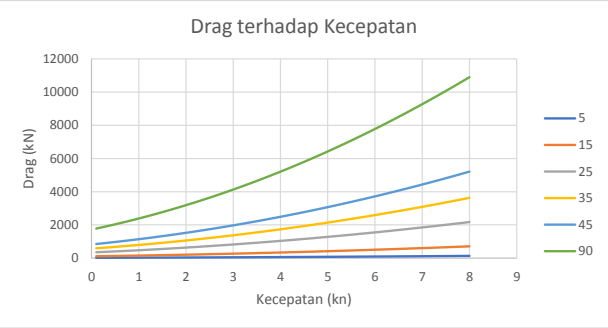
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

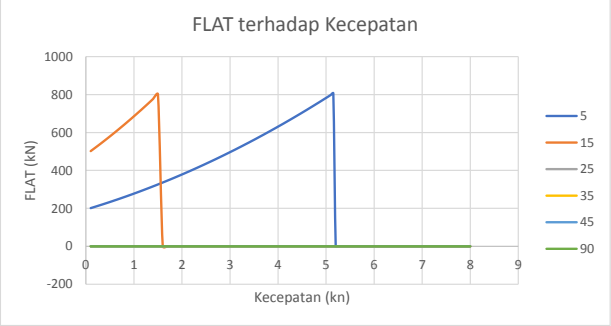
KOEFISIEN MIZZEN SAIL

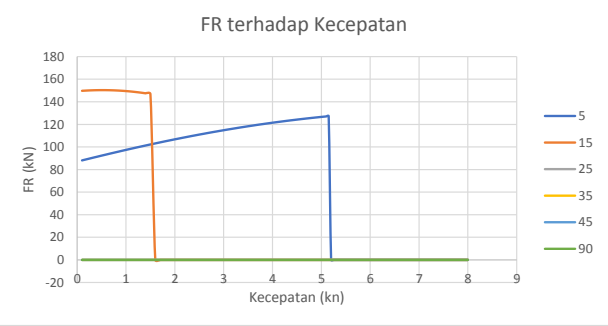
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

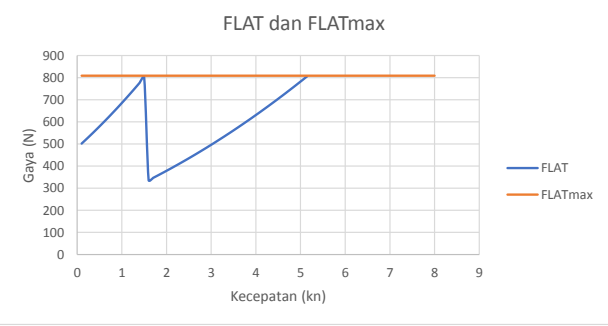
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000	kn
	2,572	m/s
γ	30	°
V_A	3,310	m/s
β	22,859	°
V_S	**0,823**	**m/s**
	1,600	**kn**

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	40	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

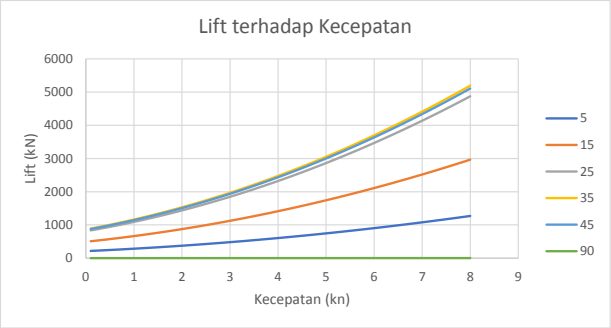
KOEFISIEN MAIN SAIL

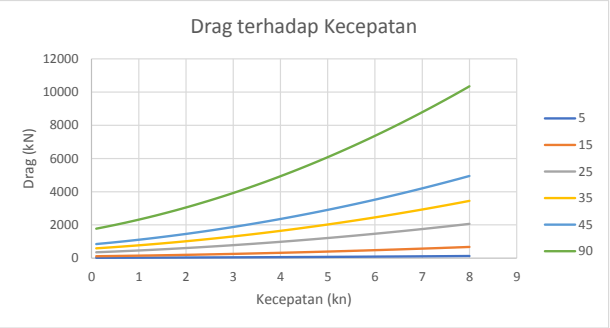
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

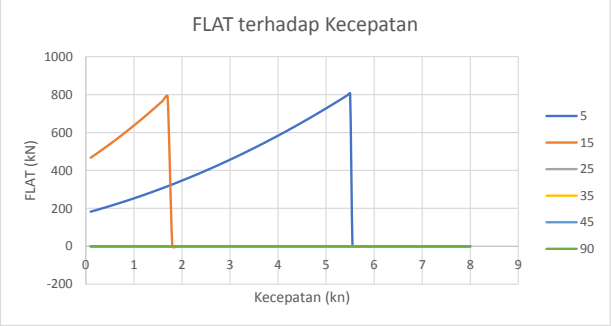
KOEFISIEN MIZZEN SAIL

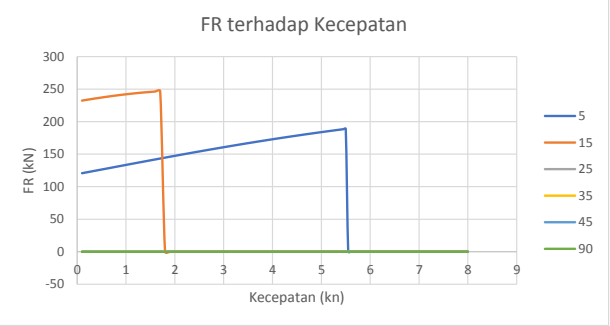
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

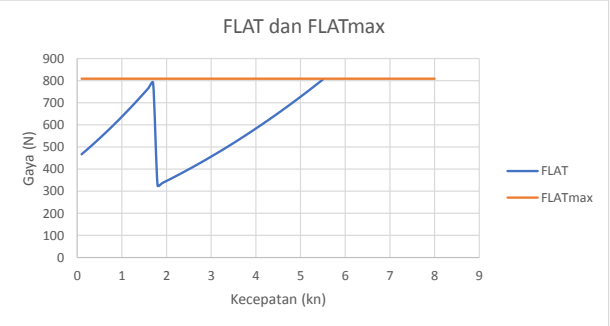
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	40 °
V_A	3,335 m/s
β	29,719 °
V_S	**0,926 m/s**
	1,800 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	50	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
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α (°)	5	15	25	35	45	90
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MUATAN	θ_{max}	11 °	h	8,683 m
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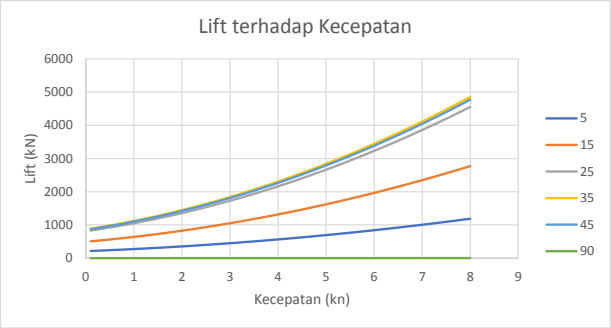

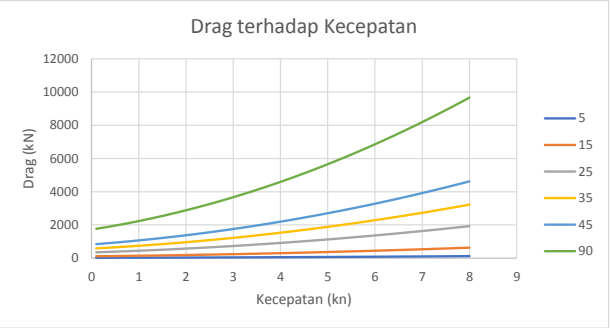

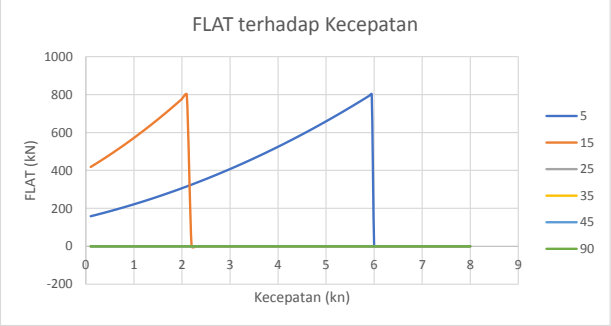

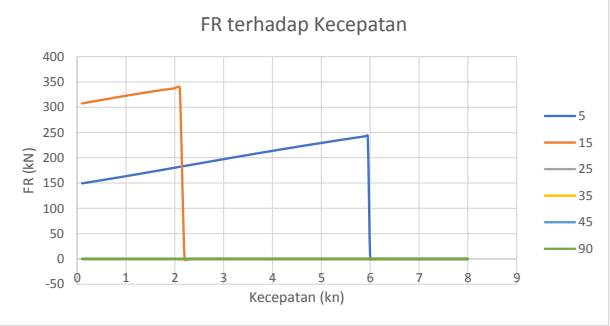

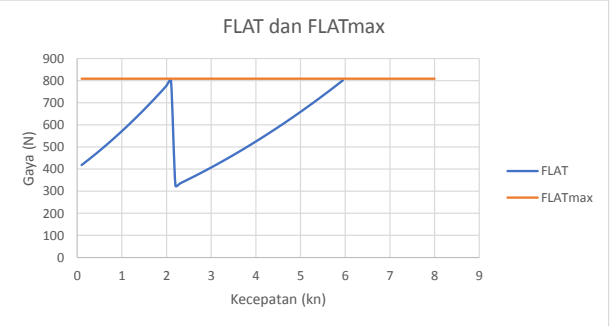

V_T	5,000 kn
	2,572 m/s
γ	50 °
V_A	3,411 m/s
β	35,278 °
V_S	**1,132 m/s**
	2,200 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	60	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

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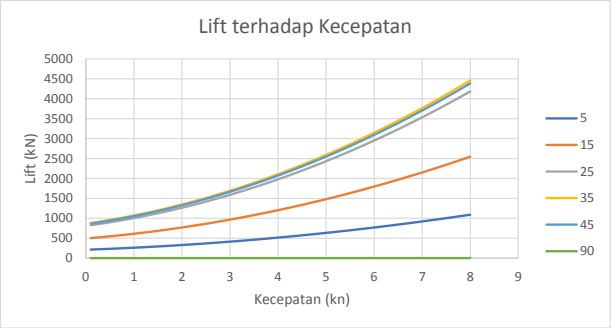
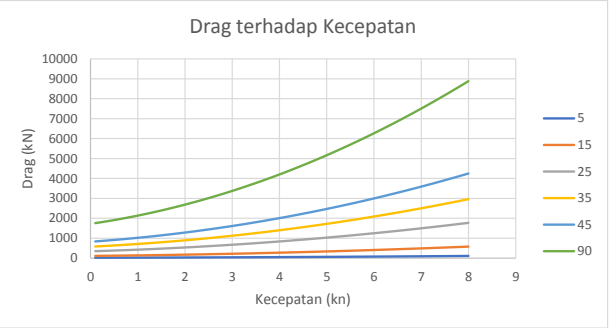
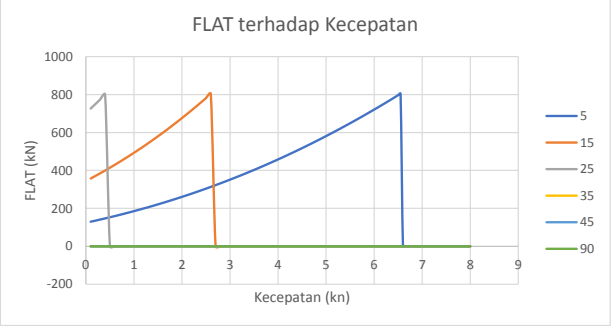
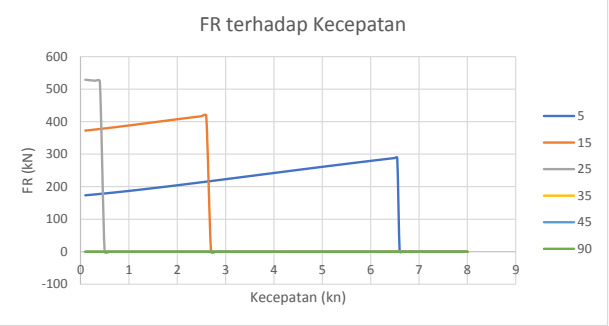
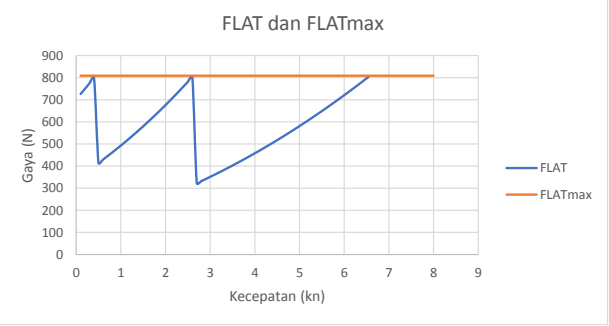
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	60 °
V_A	3,481 m/s
β	39,785 °
V_S	**1,389 m/s**
	2,700 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	70	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

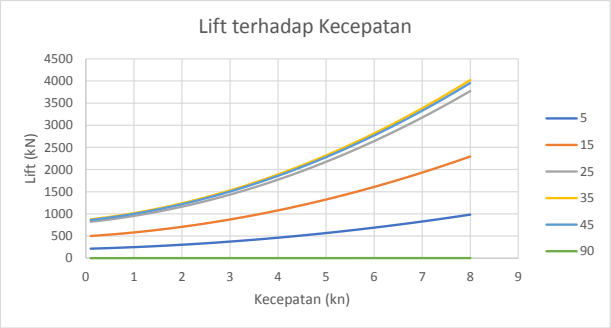
KOEFISIEN MAIN SAIL

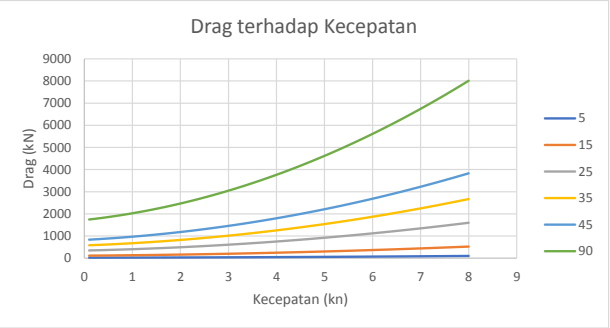
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

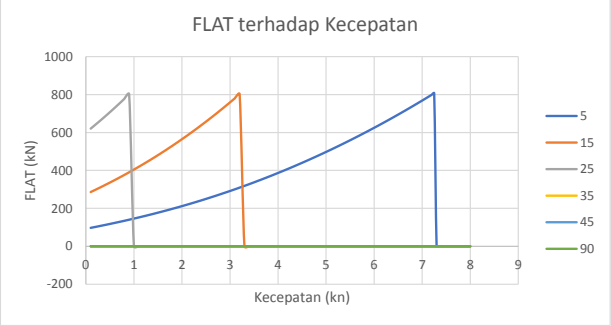
KOEFISIEN MIZZEN SAIL

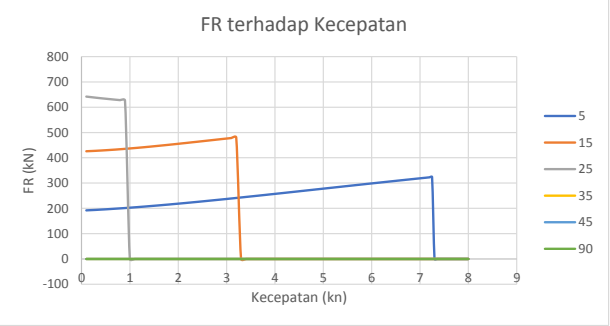
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

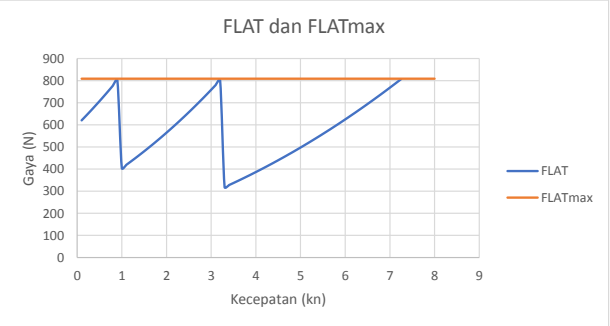
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	70 °
V_A	3,496 m/s
β	43,738 °
V_S	**1,646 m/s**
	3,200 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

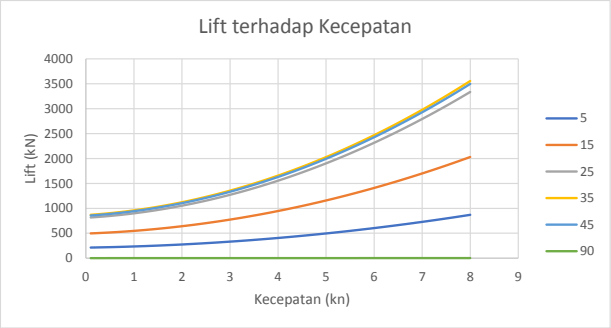
KOEFISIEN MAIN SAIL

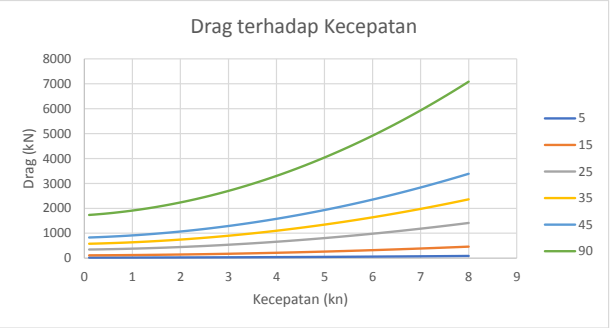
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

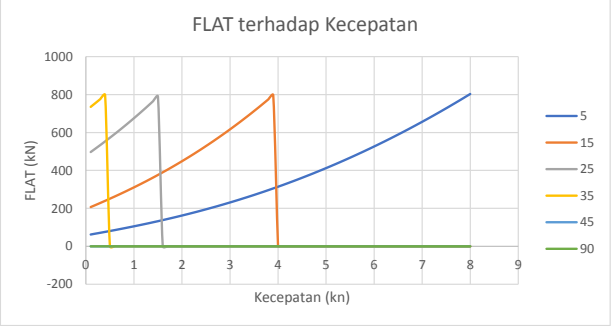
KOEFISIEN MIZZEN SAIL

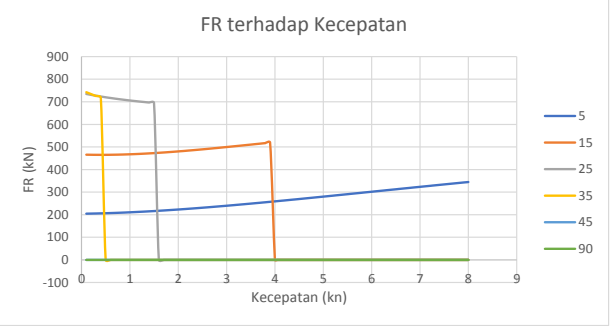
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

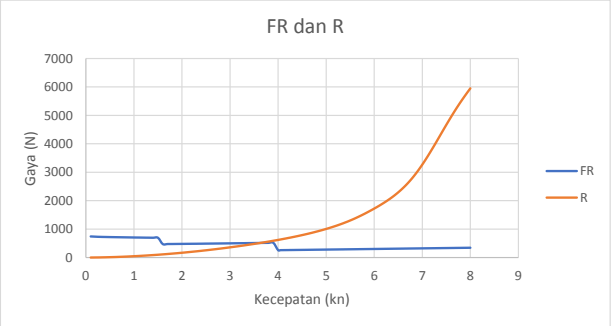
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N

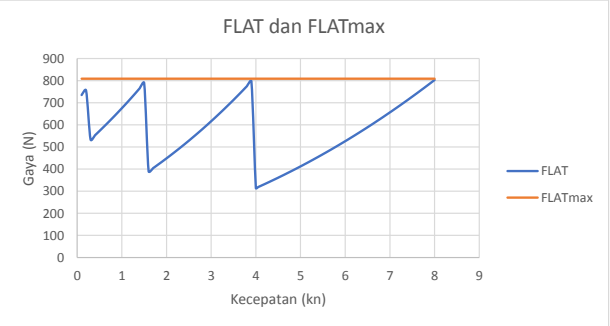












V_T	5,000 kn
	2,572 m/s
γ	80 °
V_A	3,420 m/s
β	47,778 °
V_S	**1,852 m/s**
	3,600 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

KOEFISIEN MIZZEN SAIL

α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
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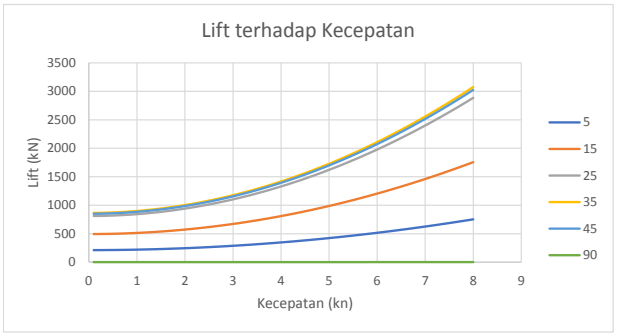
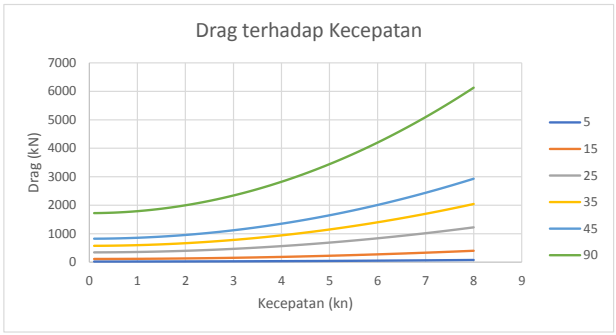
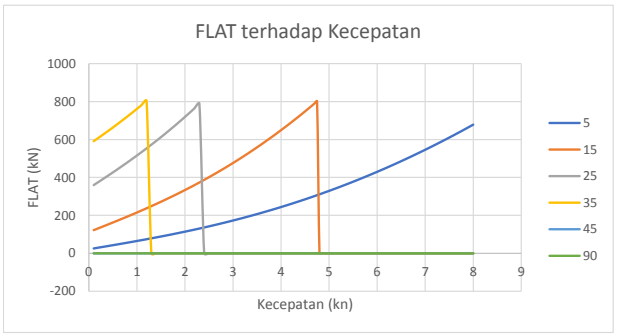
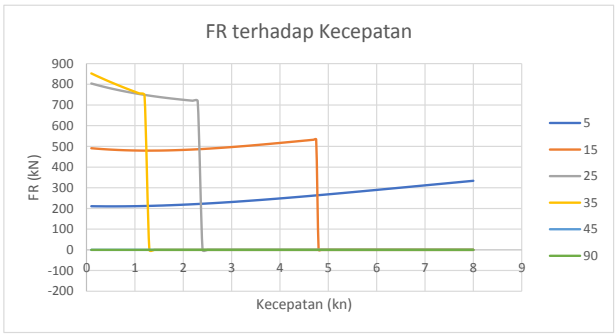
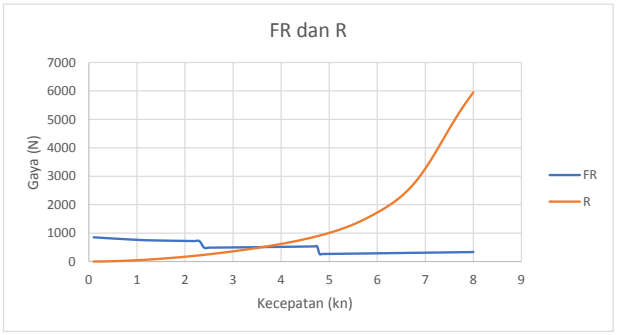
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N

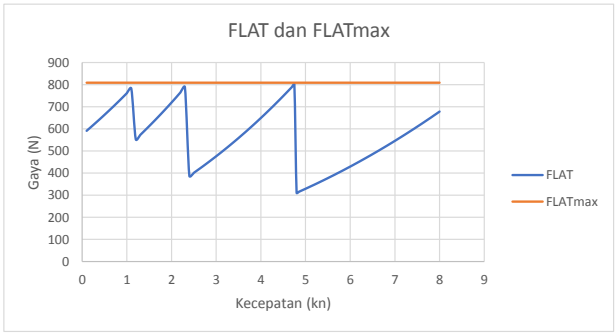












V_T	5,000 kn
	2,572 m/s
γ	90 °
V_A	3,169 m/s
β	54,246 °
V_S	**1,852 m/s**
	3,600 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

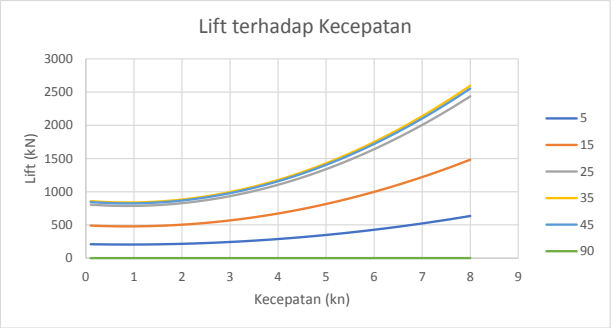
KOEFISIEN MAIN SAIL

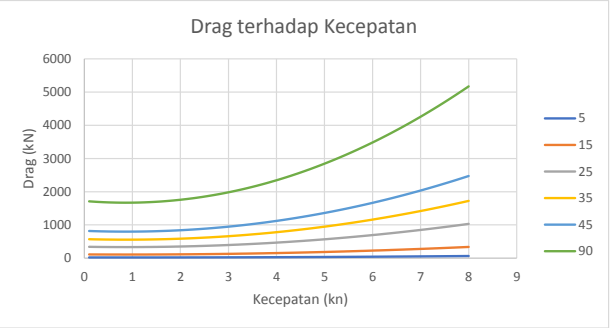
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

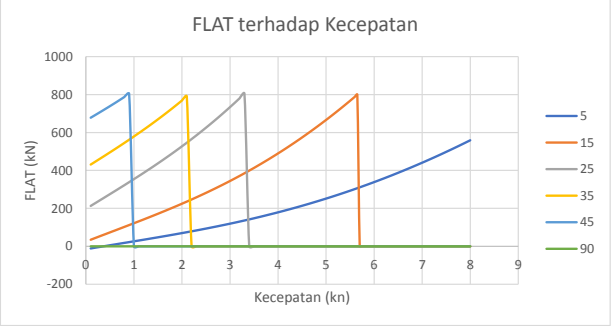
KOEFISIEN MIZZEN SAIL

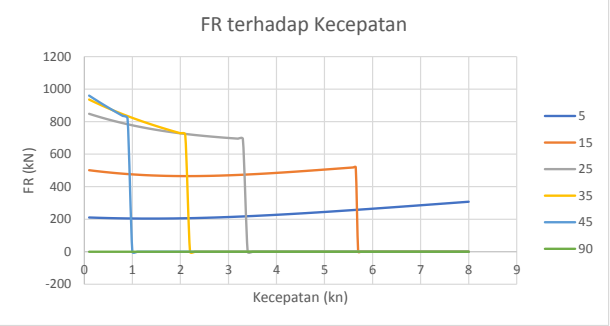
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

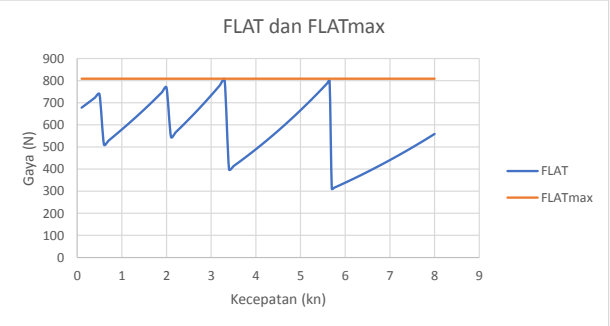
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	100 °
V_A	2,872 m/s
β	61,877 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

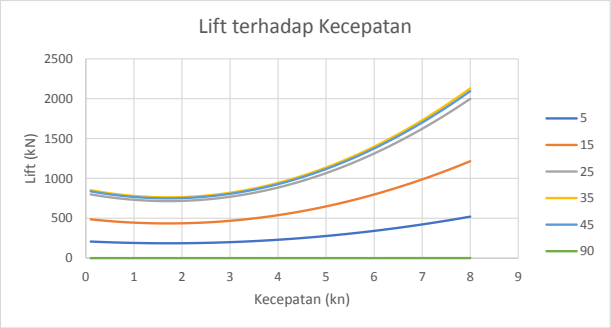
KOEFISIEN MAIN SAIL

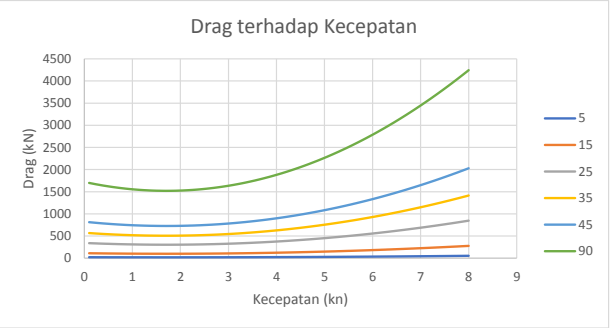
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

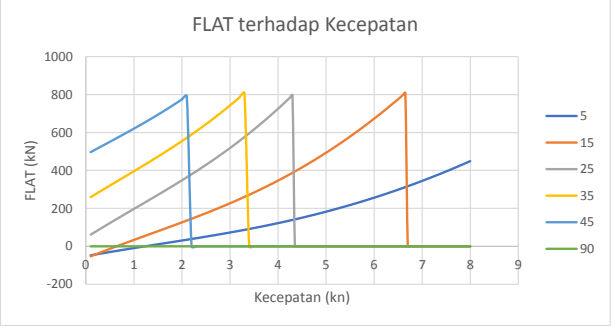
KOEFISIEN MIZZEN SAIL

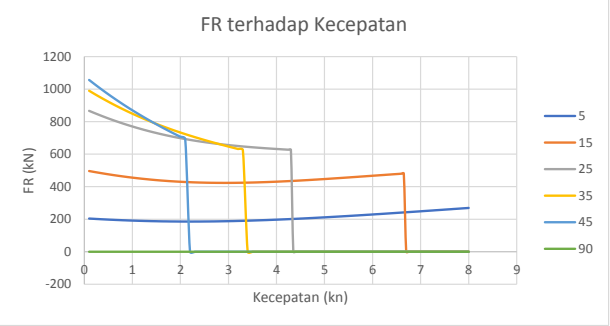
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

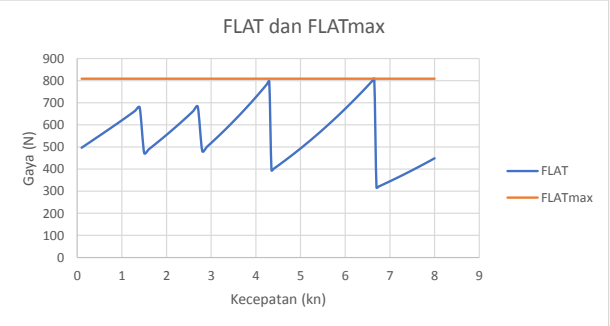
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	110 °
V_A	2,689 m/s
β	64,017 °
V_S	**2,083 m/s**
	4,050 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

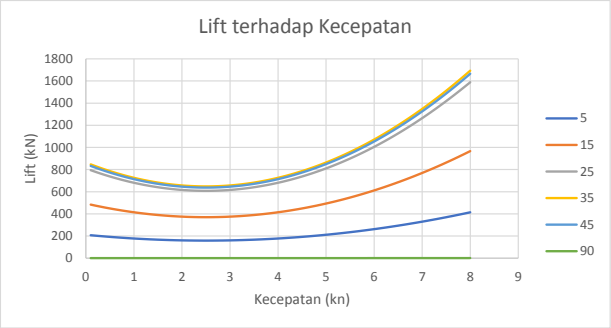
KOEFISIEN MAIN SAIL

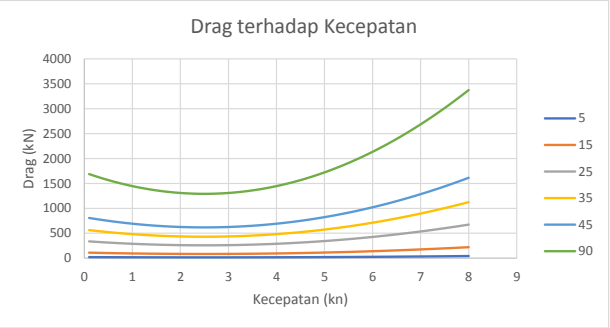
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

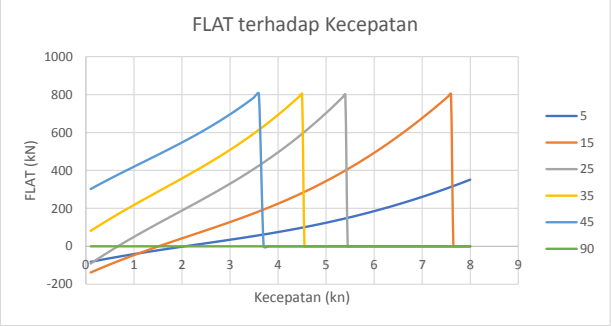
KOEFISIEN MIZZEN SAIL

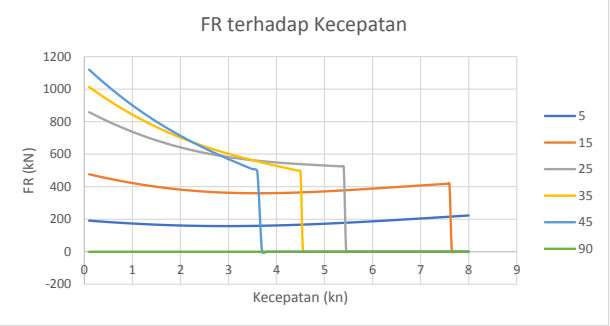
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

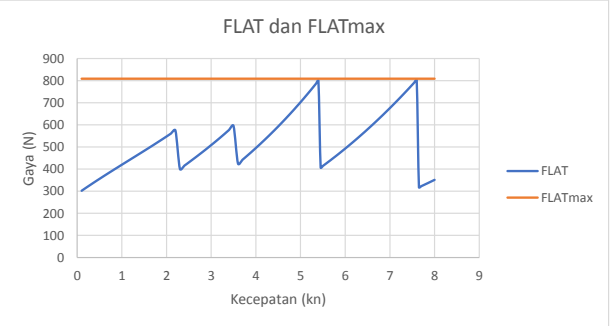
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	120 °
V_A	2,326 m/s
β	73,289 °
V_S	**1,955 m/s**
	3,800 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

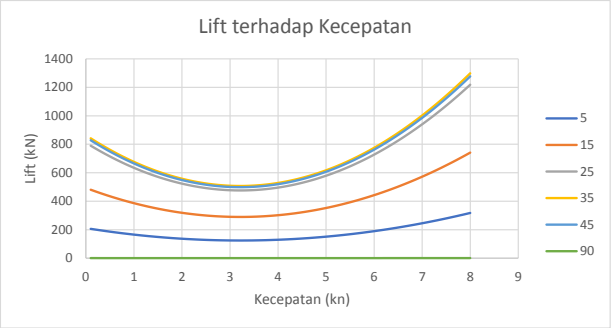
KOEFISIEN MAIN SAIL

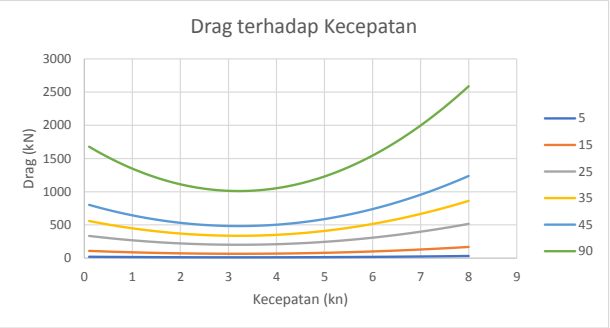
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

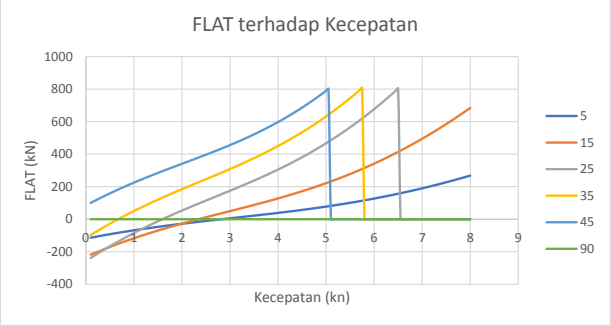
KOEFISIEN MIZZEN SAIL

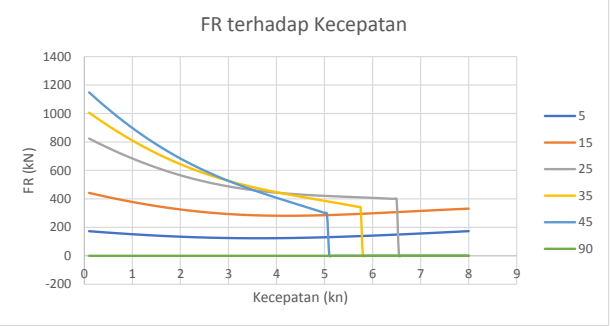
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

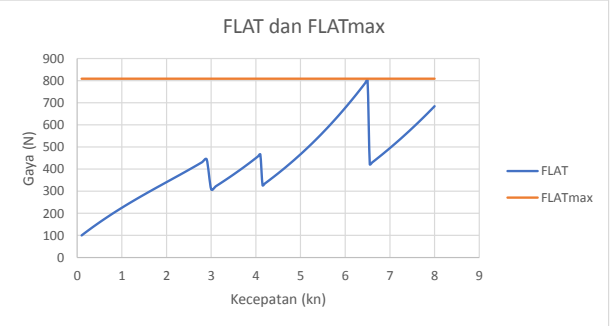
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	130 °
V_A	1,976 m/s
β	85,729 °
V_S	**1,800 m/s**
	3,500 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

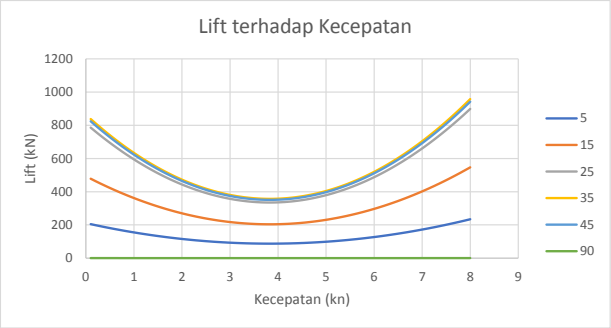
KOEFISIEN MAIN SAIL

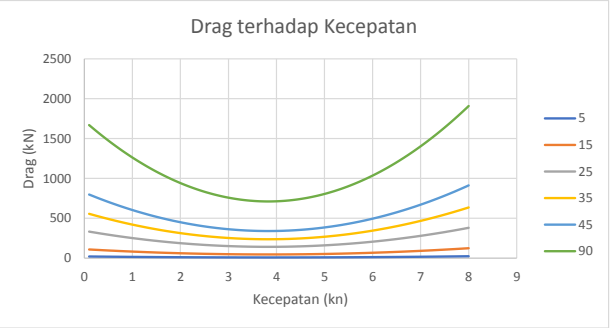
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

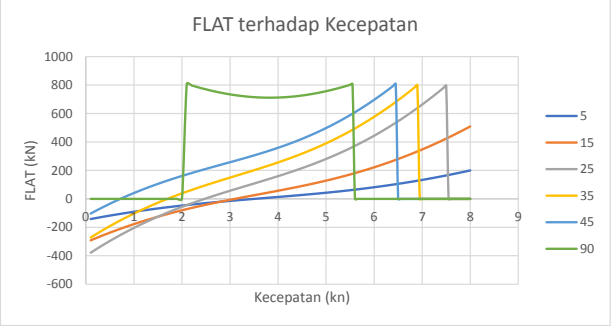
KOEFISIEN MIZZEN SAIL

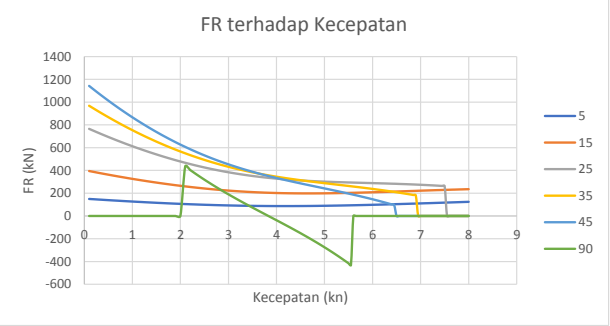
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

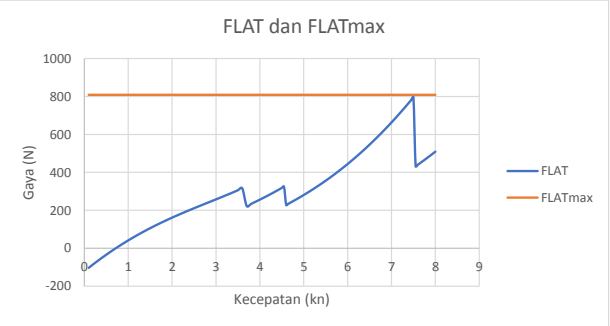
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	140 °
V_A	1,676 m/s
β	99,368 °
V_S	**1,698 m/s**
	3,300 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

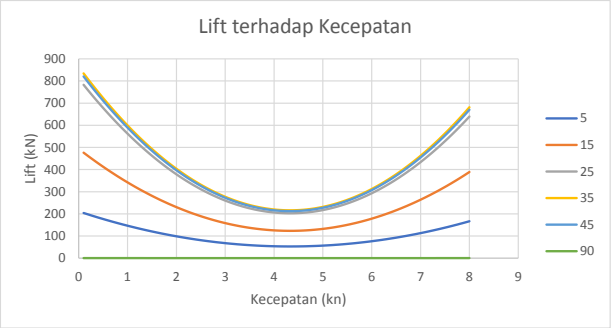
KOEFISIEN MAIN SAIL

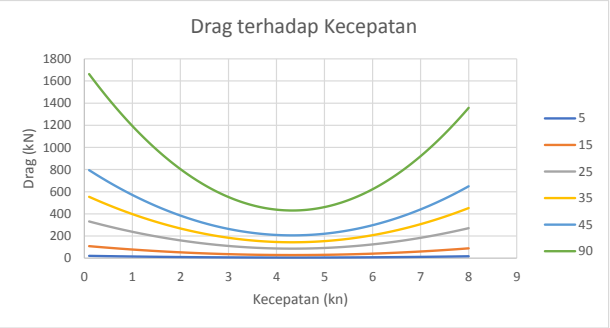
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

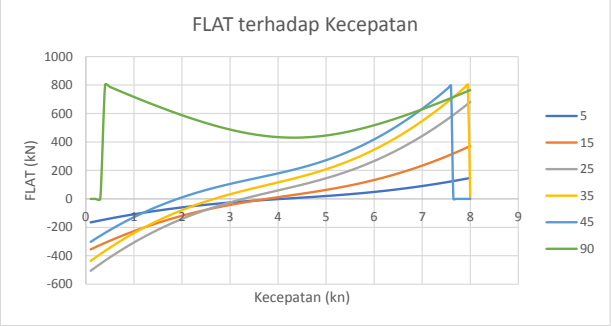
KOEFISIEN MIZZEN SAIL

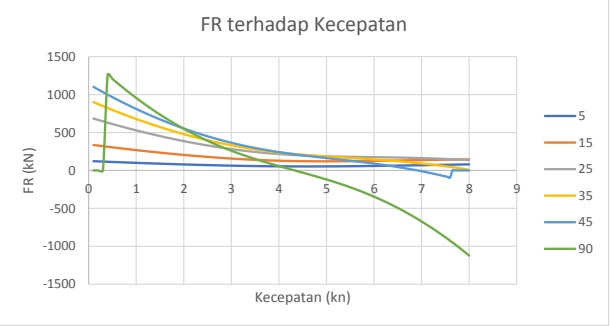
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

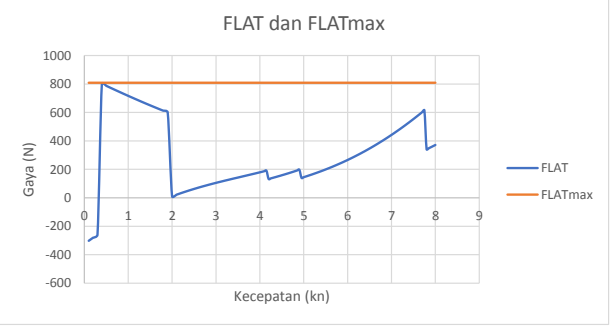
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	150 °
V_A	1,457 m/s
β	118,015 °
V_S	**1,543 m/s**
	3,000 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

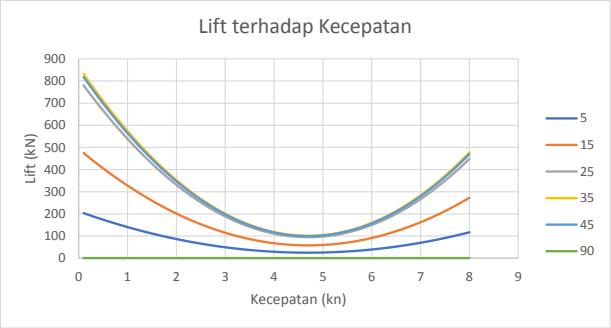
KOEFISIEN MAIN SAIL

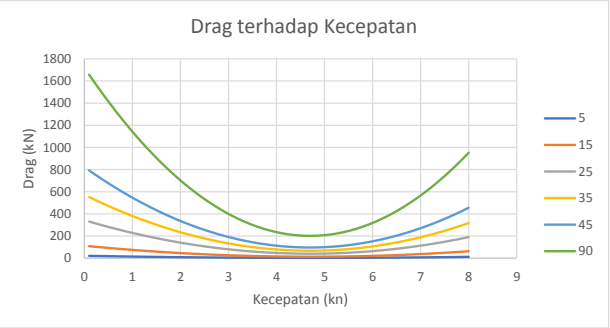
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

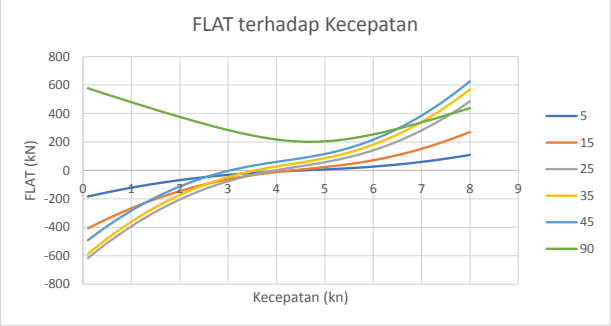
KOEFISIEN MIZZEN SAIL

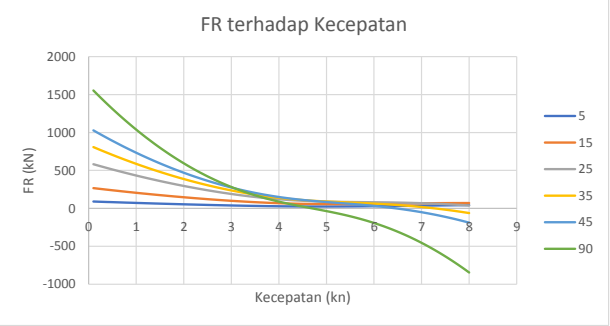
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

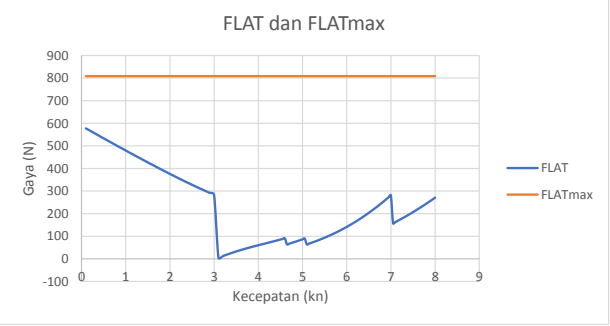
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	160 °
V_A	1,314 m/s
β	137,988 °
V_S	**1,440 m/s**
	2,800 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

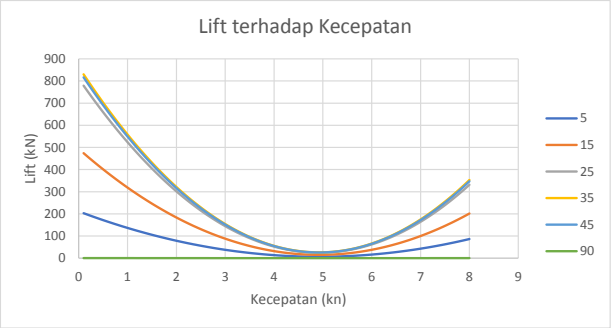
KOEFISIEN MAIN SAIL

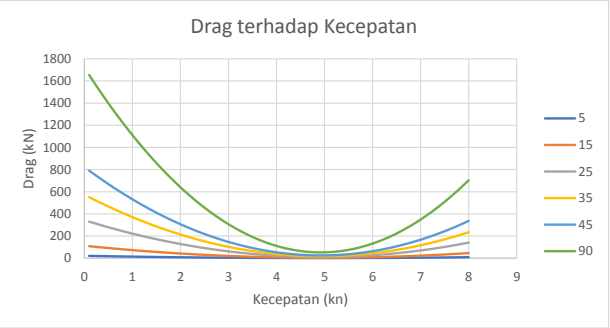
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

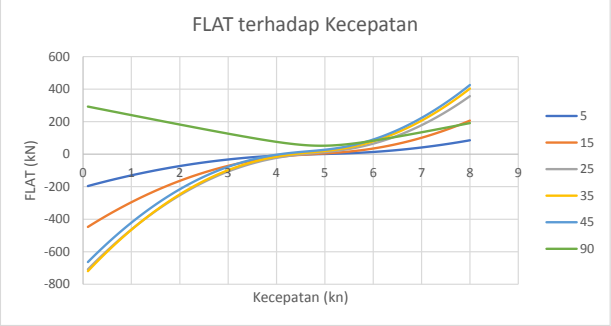
KOEFISIEN MIZZEN SAIL

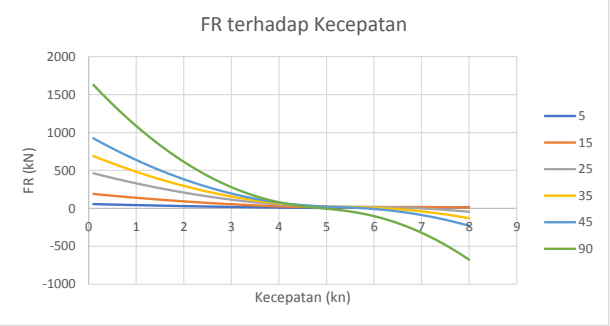
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

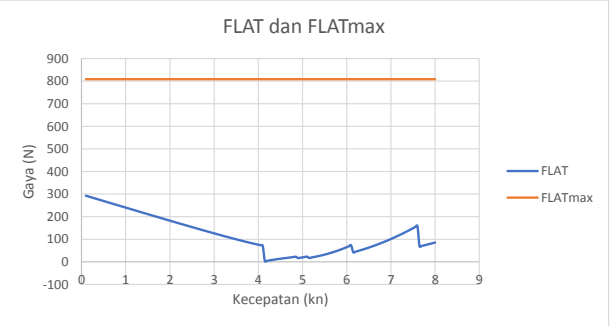
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	170 °
V_A	1,180 m/s
β	157,767 °
V_S	**1,440 m/s**
	2,800 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	5,000	kn
	2,572	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

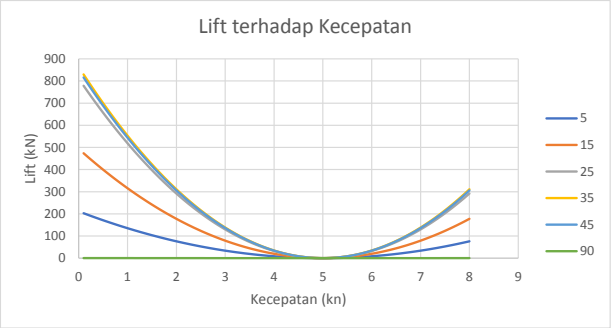
KOEFISIEN MAIN SAIL

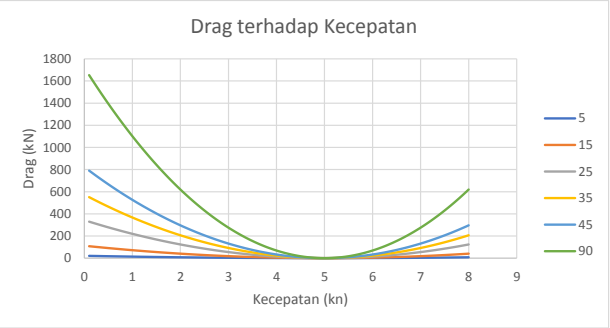
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

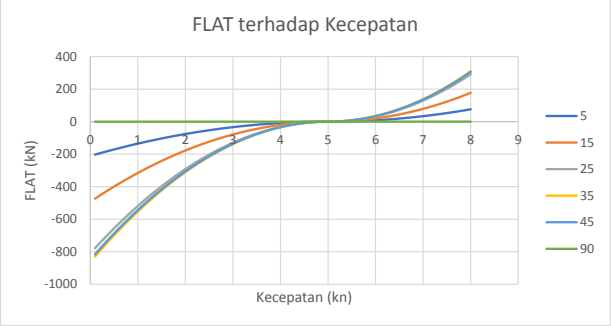
KOEFISIEN MIZZEN SAIL

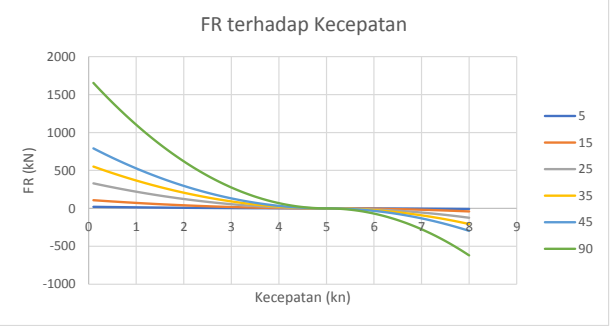
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

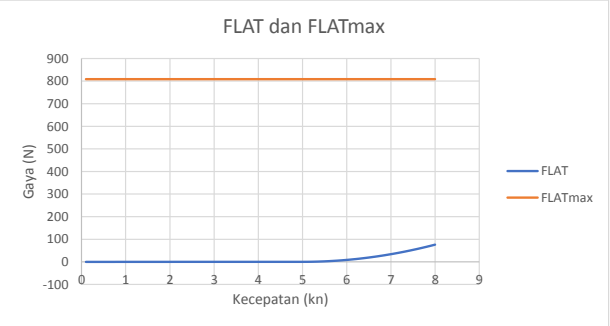
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	5,000 kn
	2,572 m/s
γ	180 °
V_A	1,132 m/s
β	180,000 °
V_S	**1,440 m/s**
	2,800 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	80	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

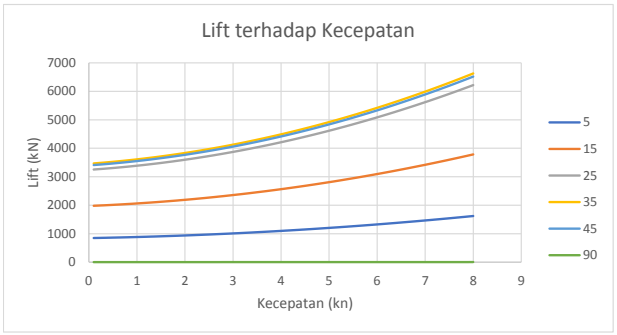
KOEFISIEN MAIN SAIL

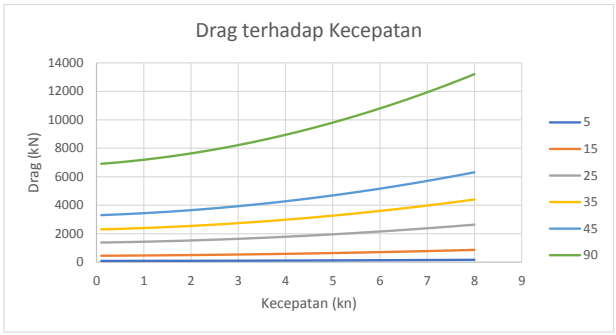
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

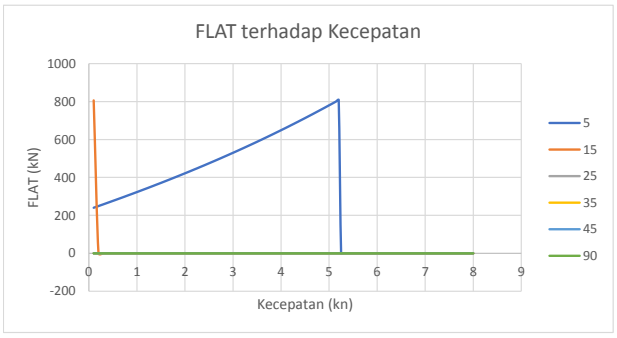
KOEFISIEN MIZZEN SAIL

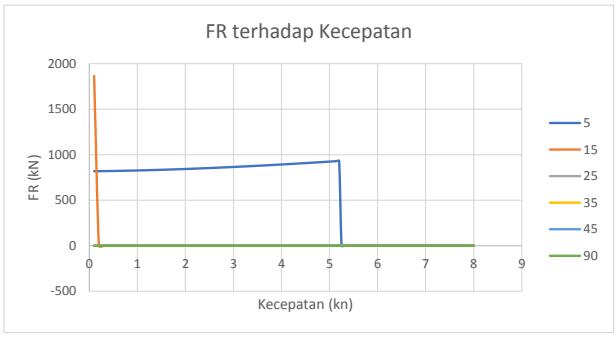
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

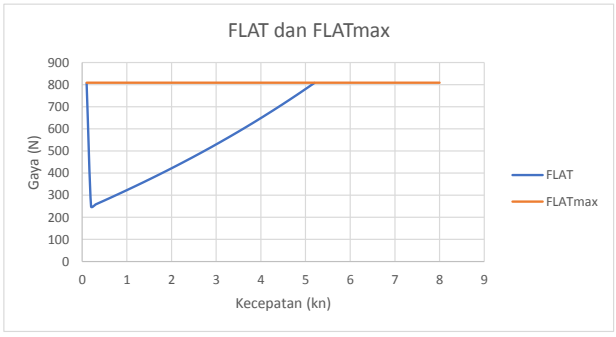
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000	kn
	5,144	m/s
γ	80	°
V_A	5,863	m/s
β	59,779	°
V_S	**2,469**	**m/s**
	4,800	**kn**

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	90	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
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C_D	0,040	0,217	0,672	1,078	1,546	3,232

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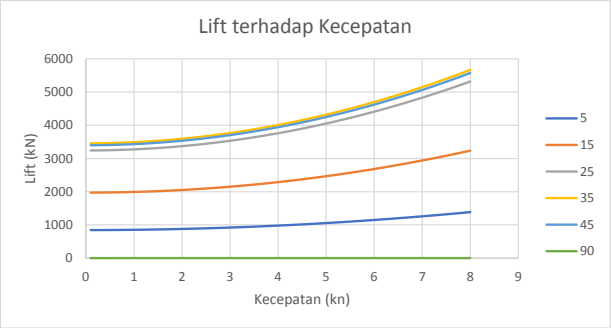
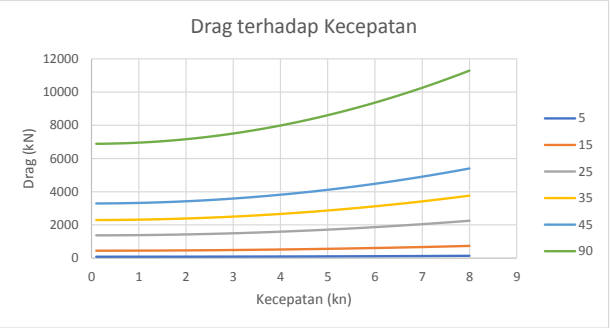
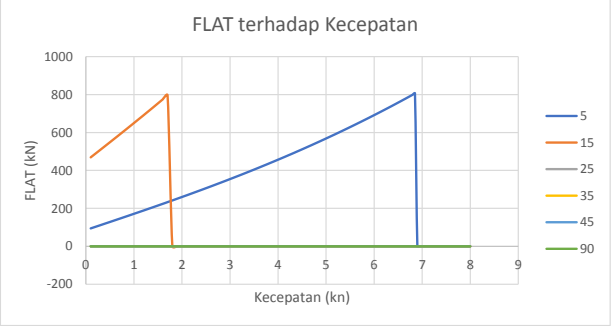
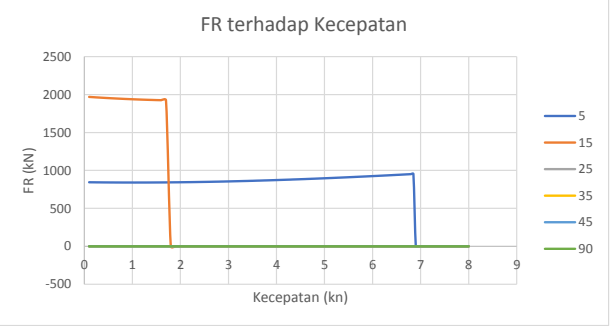
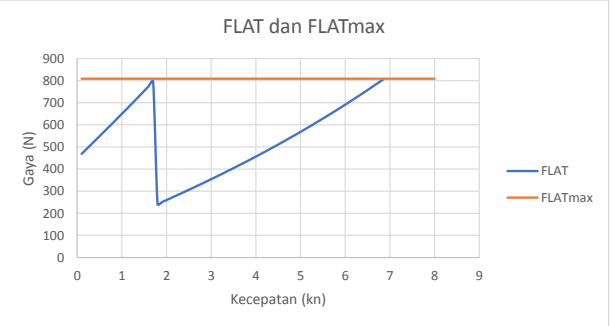
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000	kn
	5,144	m/s
γ	90	°
V_A	5,540	m/s
β	68,199	°
V_S	**2,443**	**m/s**
	4,750	**kn**

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	100	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
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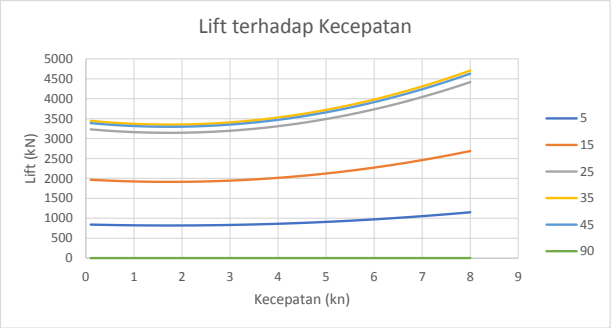
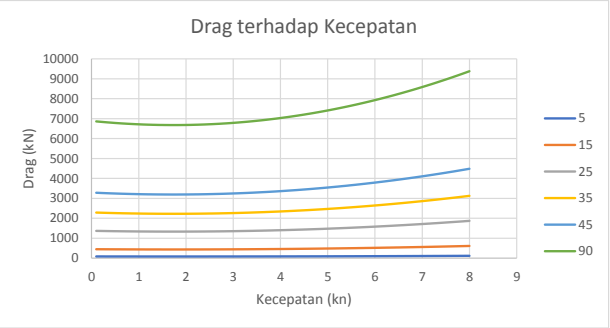
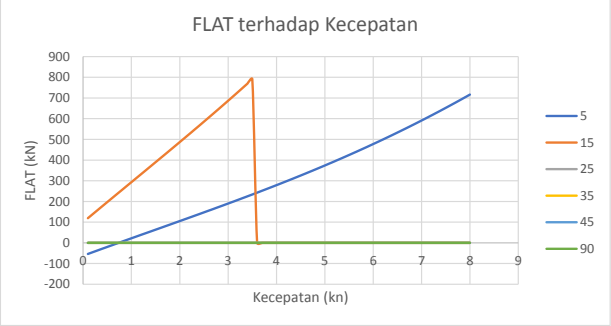
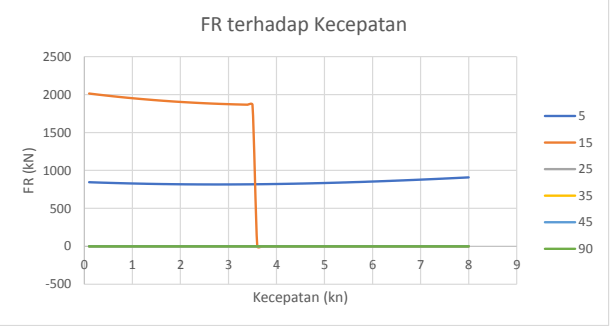
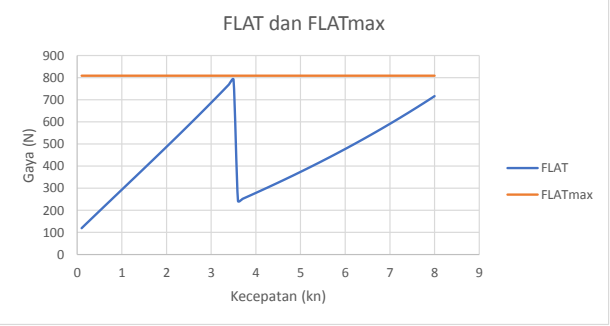
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	100 °
V_A	5,198 m/s
β	77,056 °
V_S	**2,366 m/s**
	4,600 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	110	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
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MUATAN	θ_{max}	11 °	h	8,683 m
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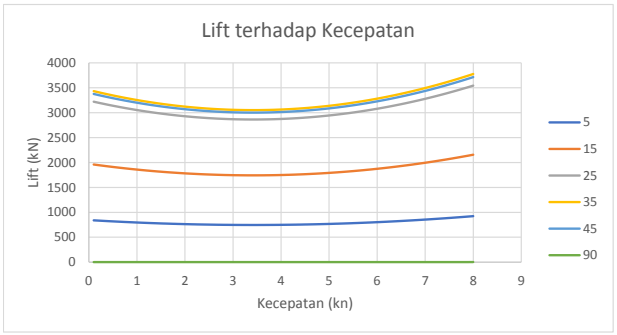

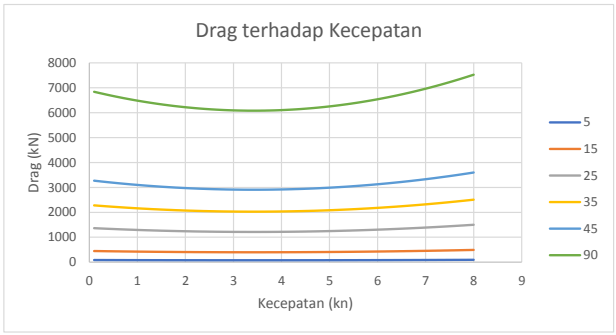

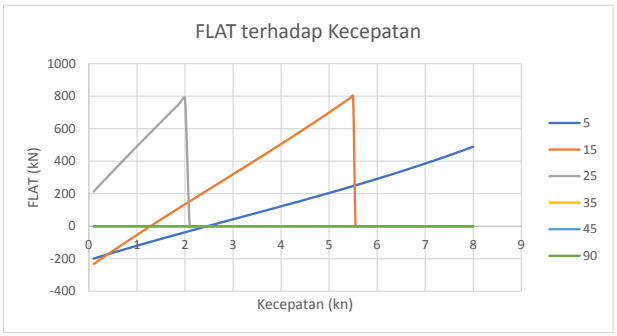

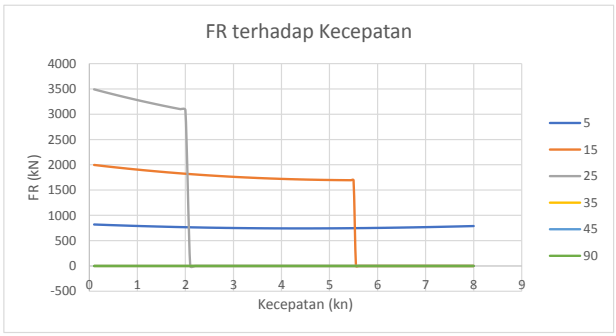

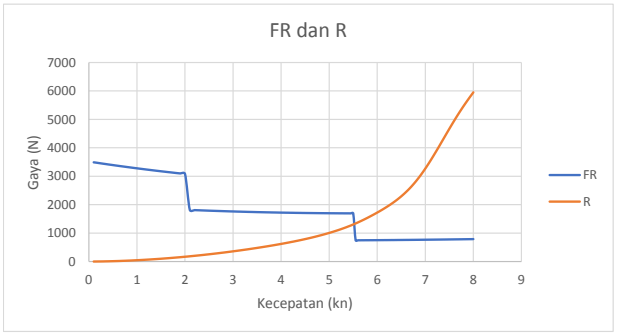

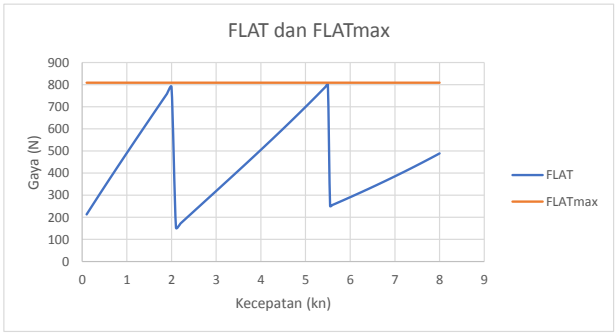

V_T	10,000	kn
	5,144	m/s
γ	110	°
V_A	4,843	m/s
β	86,469	°
V_S	**2,829**	**m/s**
	5,500	**kn**

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
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	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	120	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

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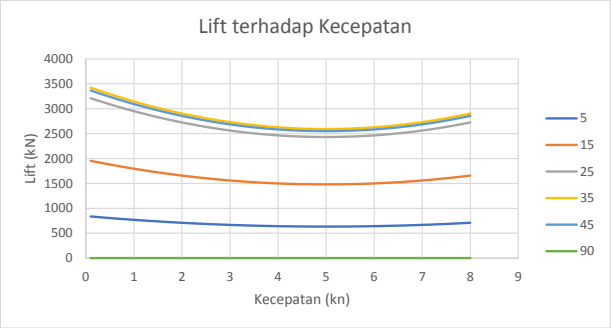
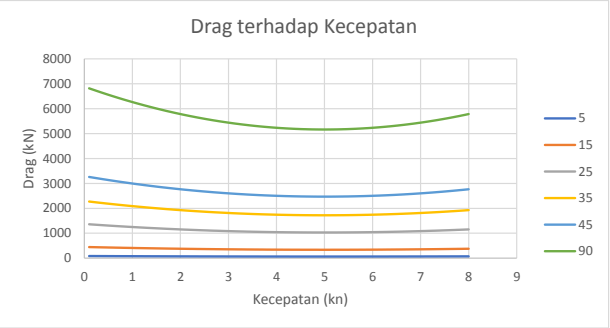
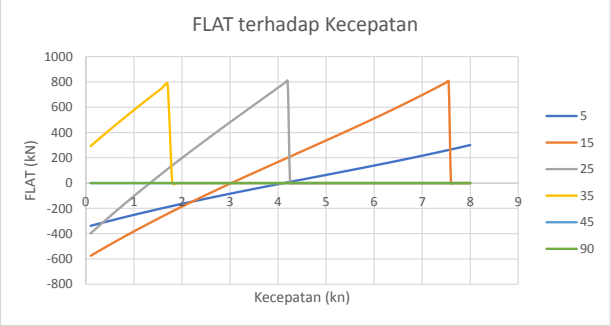
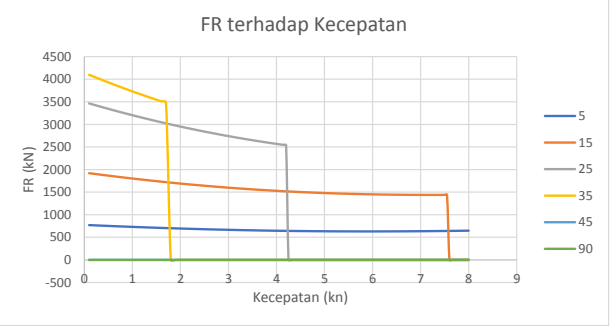
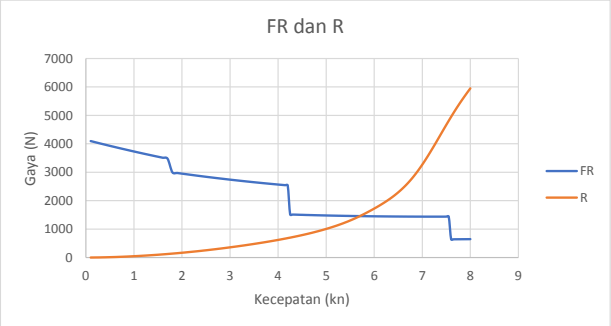
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N

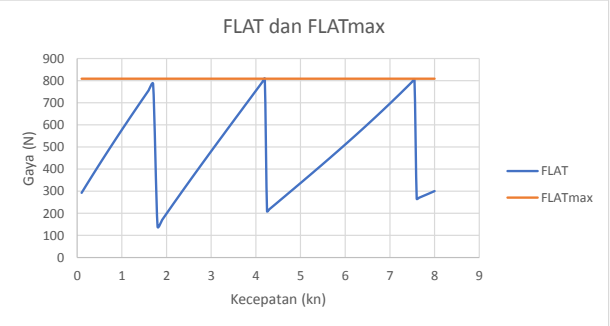












V_T	10,000	kn
	5,144	m/s
γ	120	°
V_A	4,484	m/s
β	96,587	°
V_S	**2,932**	**m/s**
	5,700	**kn**

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	130	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

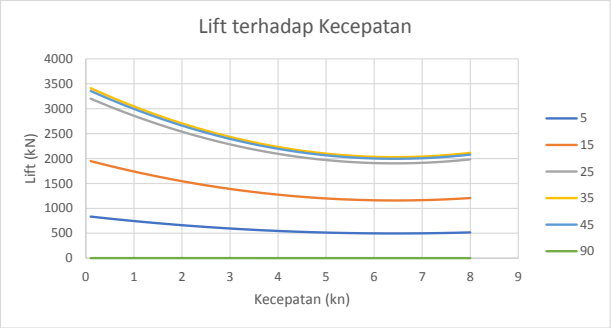
KOEFISIEN MAIN SAIL

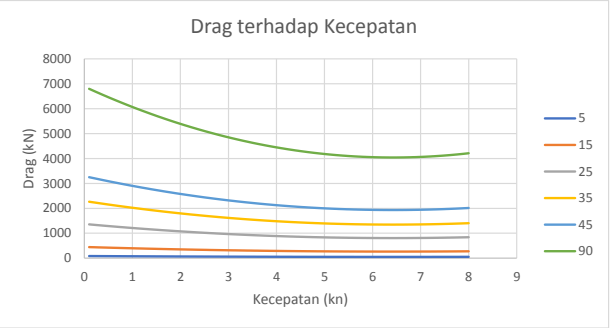
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

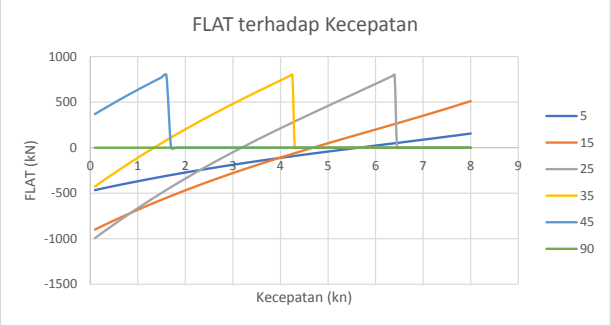
KOEFISIEN MIZZEN SAIL

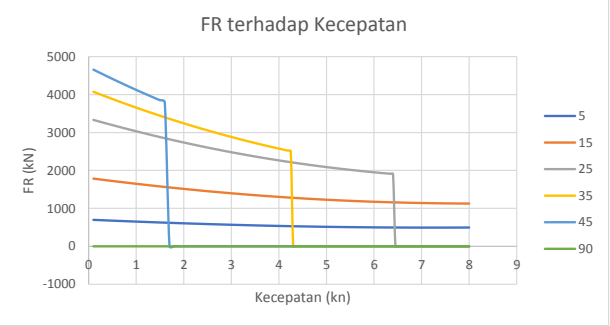
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

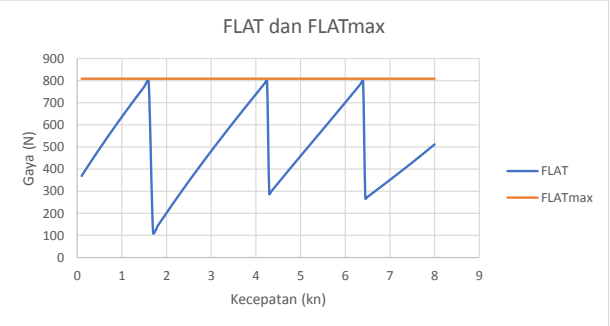
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	130 °
V_A	4,134 m/s
β	107,585 °
V_S	**3,189 m/s**
	6,200 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	140	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

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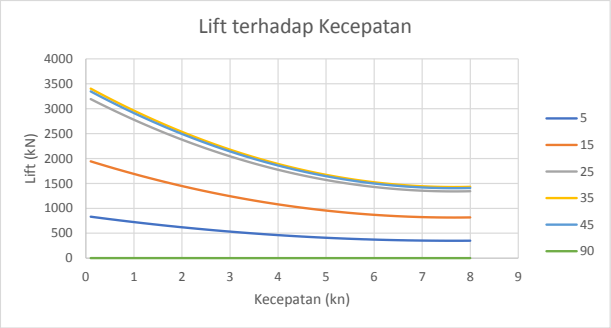
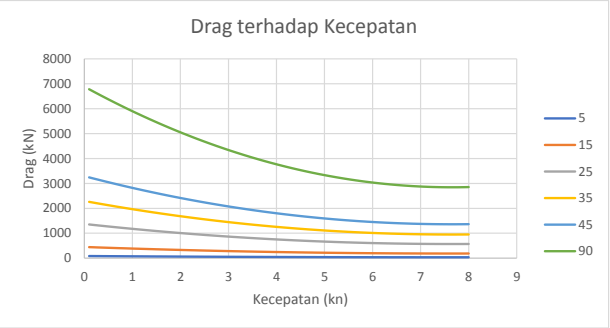
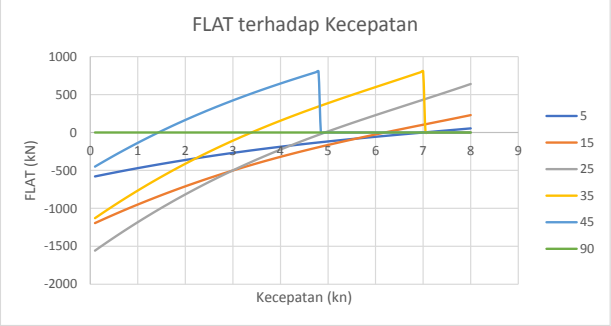
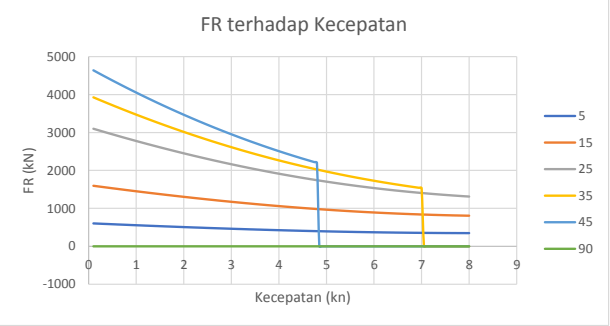
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

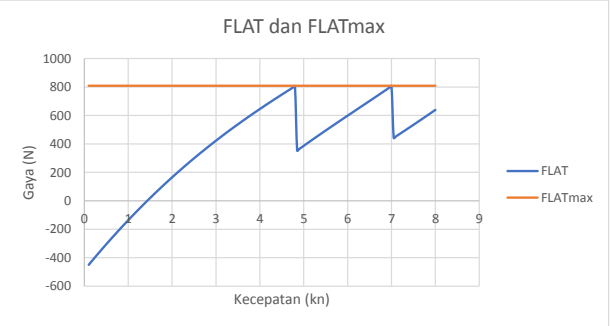
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	140 °
V_A	3,805 m/s
β	119,660 °
V_S	**3,086 m/s**
	6,000 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	150	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

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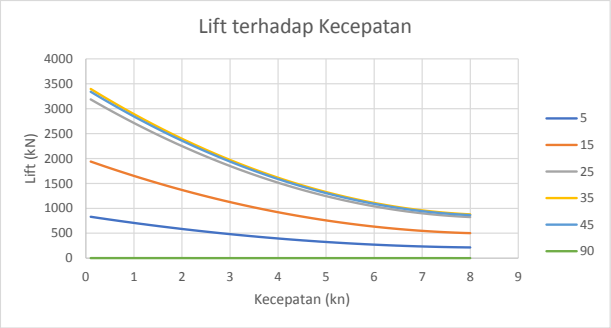
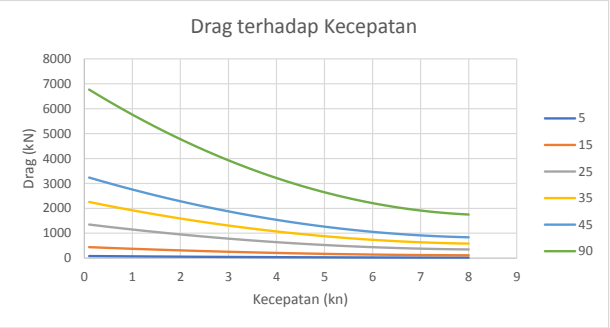
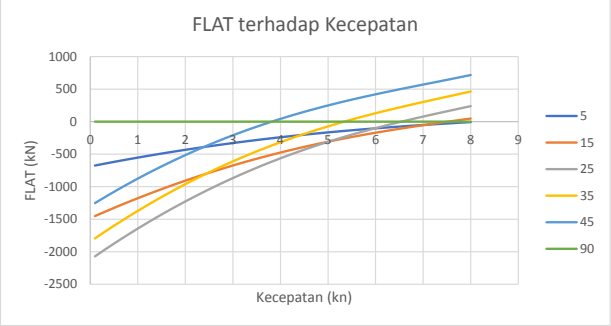
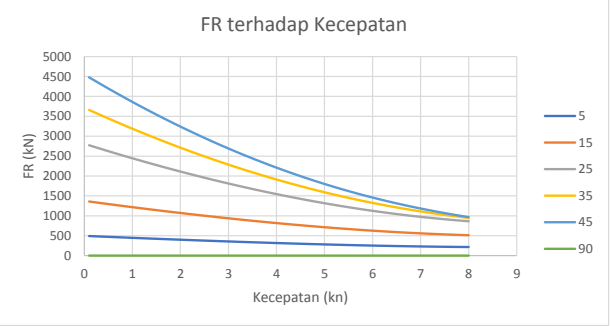
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

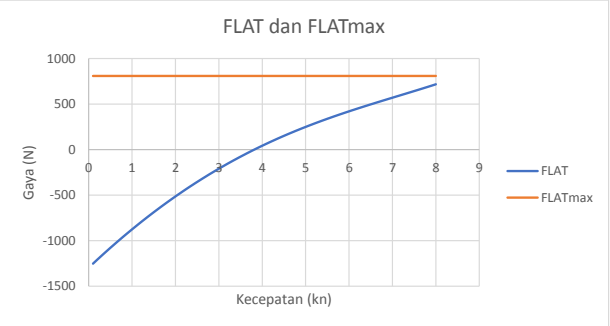
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N











V_T	10,000 kn
	5,144 m/s
γ	150 °
V_A	3,516 m/s
β	132,986 °
V_S	**2,984 m/s**
	5,800 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	160	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

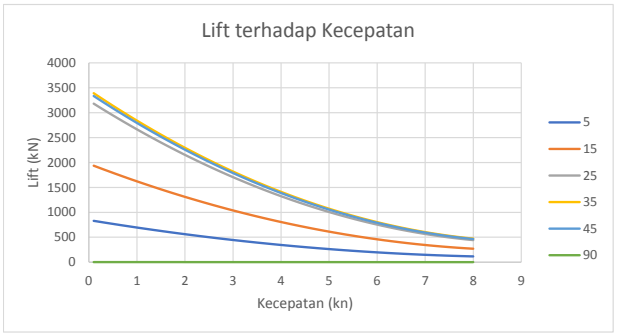
KOEFISIEN MAIN SAIL

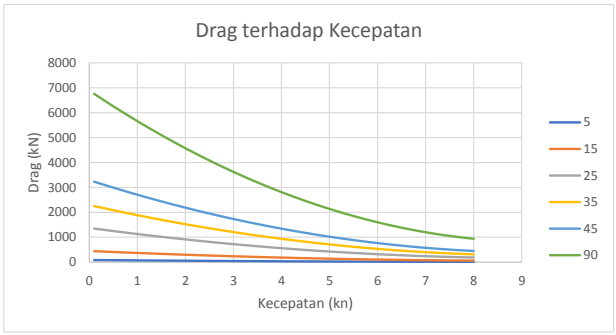
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

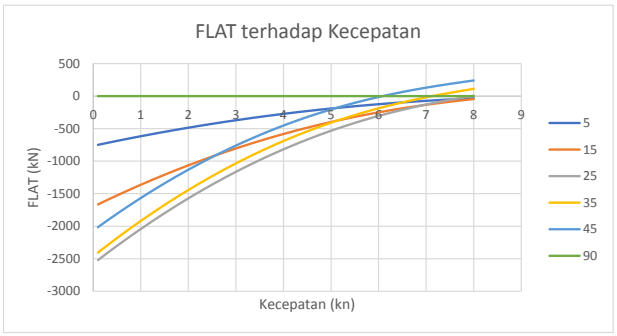
KOEFISIEN MIZZEN SAIL

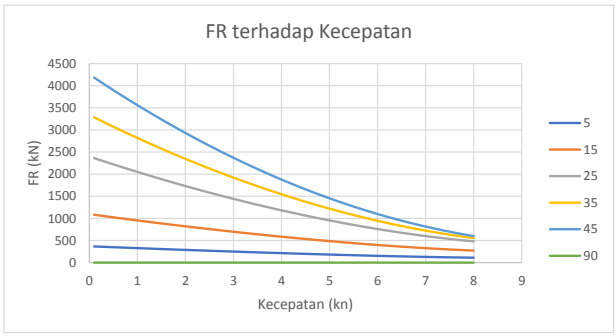
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

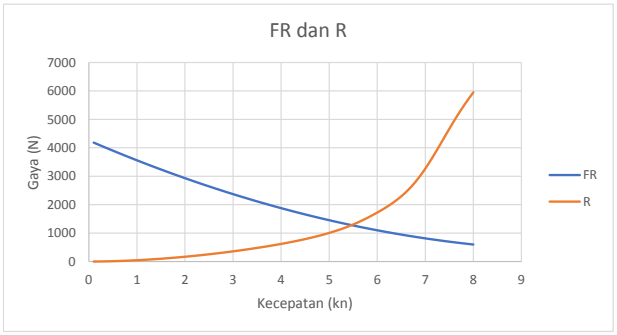
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N

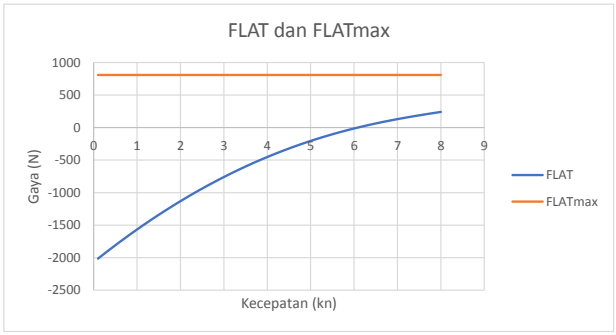












V_T	10,000 kn
	5,144 m/s
γ	160 °
V_A	3,287 m/s
β	147,636 °
V_S	**2,803 m/s**
	5,450 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
Span (m)	Yard	16,454	10,317
	Boom	16,454	10,317
Chord (m)		5,854	3,670
Area (m^2)		96,322	37,867

TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	170	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

KOEFISIEN MAIN SAIL

α (°)	5	15	25	35	45	90
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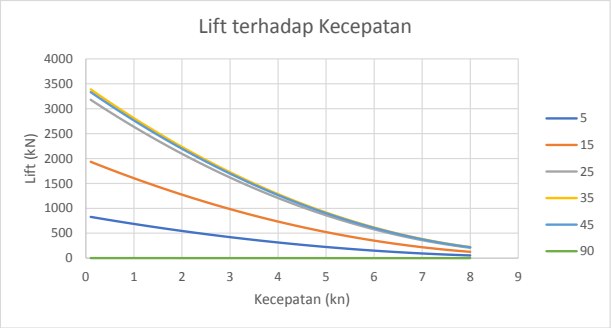

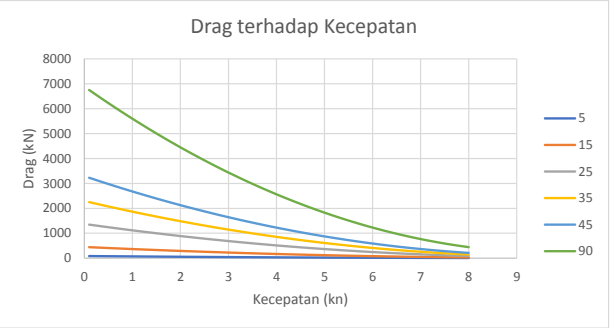

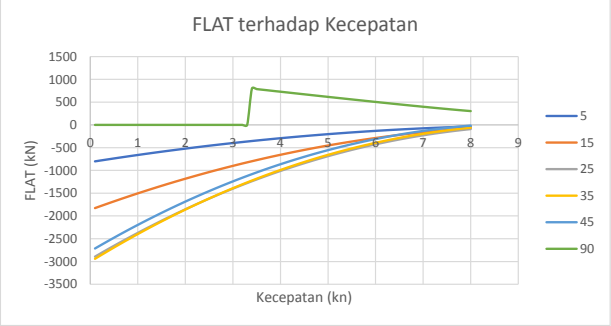

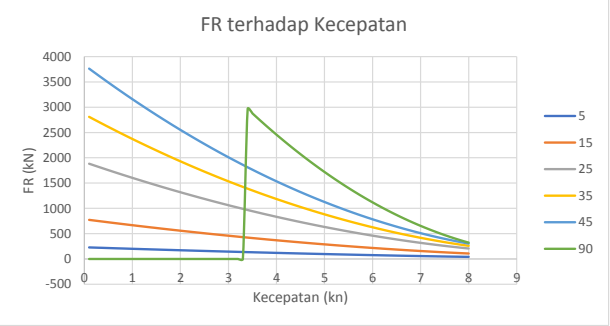

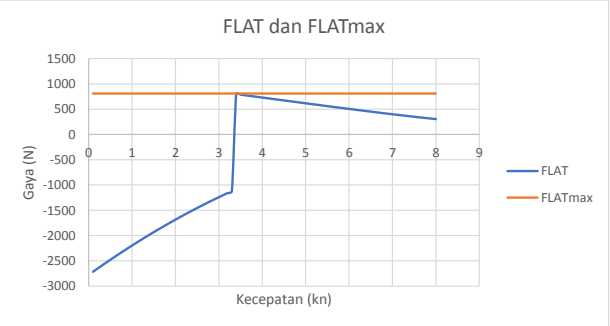

V_T	10,000 kn
	5,144 m/s
γ	170 °
V_A	3,485 m/s
β	165,148 °
V_S	**2,855 m/s**
	5,550 kn

SPESIFIKASI LAYAR

Model	Padewakang	MAIN	MIZZEN
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	Boom	16,454	10,317
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TRUE WIND

ρ	1,2	kg/m^3
V_T	10,000	kn
	5,144	m/s
γ	180	°

APPARENT WIND SPEED

$$V_A = \sqrt{{V_S}^2 + {V_T}^2 + 2V_S V_T \cos(\gamma)}$$

APPARENT WIND ANGLE

$$\beta = \cos^{-1}\left(\frac{{V_S}^2 + {V_A}^2 - {V_T}^2}{2V_S V_A}\right)$$

LIFT

$$F_L = \frac{C_L}{2}\rho A {V_A}^2$$

DRAG

$$F_D = \frac{C_D}{2}\rho A {V_A}^2$$

LATERAL FORCE

$$F_{LAT} = F_L \cos\beta + F_D \sin\beta$$

DRIVING FORCE

$$F_R = F_L \sin\beta - F_D \cos\beta$$

HEELING FORCE

$$F_H = F_{LAT} \cos\theta$$

HEELING MOMENT

$$M_H = F_H \times h$$

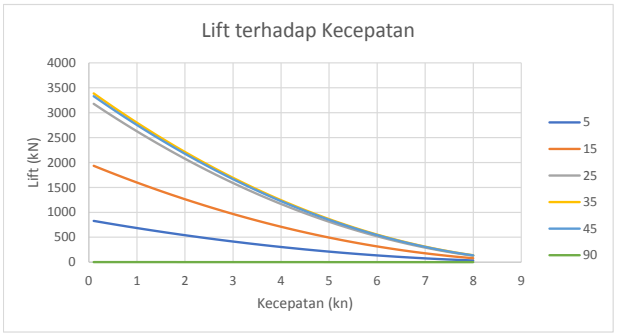
KOEFISIEN MAIN SAIL

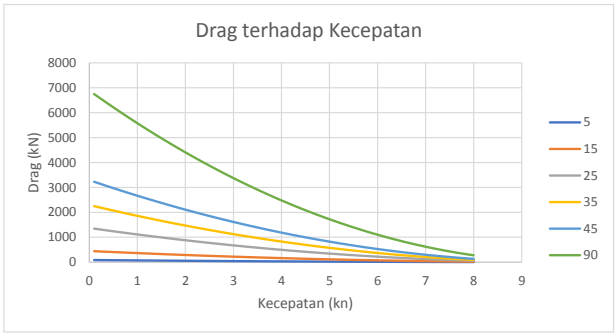
α (°)	5	15	25	35	45	90
C_L	0,405	0,955	1,582	1,624	1,596	0,001
C_D	0,040	0,217	0,672	1,078	1,546	3,232

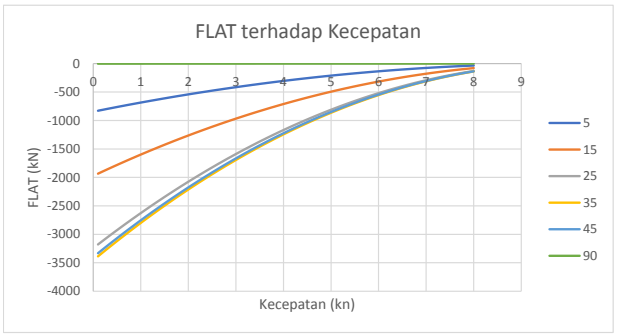
KOEFISIEN MIZZEN SAIL

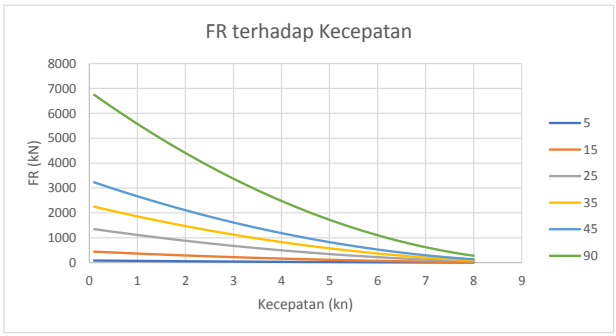
α (°)	5	15	25	35	45	90
C_L	0,375	0,853	1,369	1,618	1,593	0,001
C_D	0,040	0,196	0,576	1,075	1,544	3,232

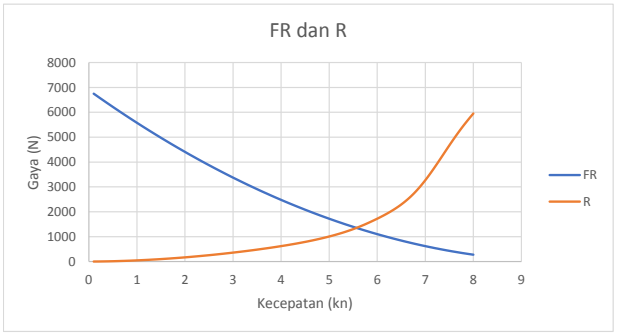
MUATAN	θ_{max}	11 °	h	8,683 m
PENUH	M_H	6,894 kNm	F_{LATmax}	808,798 N

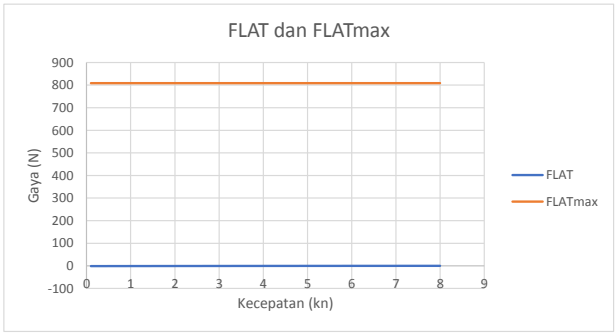












V_T	10,000	kn
	5,144	m/s
γ	180	°
V_A	3,086	m/s
β	180,000	°
V_S	**2,855**	**m/s**
	5,550	**kn**

REKAPITULASI KECEPATAN

Satu Layar

5 kn

γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	0.600	0.800	1.600
40	0.800	1.100	2.100
50	1.000	1.300	2.500
60	1.200	1.600	2.800
70	1.300	1.700	3.000
80	1.400	1.900	3.100
90	1.500	1.900	3.400
100	1.600	2.000	3.600
110	1.600	2.000	3.500
120	1.600	2.000	3.300
130	1.600	1.900	3.100
140	1.600	1.800	2.900
150	1.500	1.800	2.700
160	1.500	1.800	2.600
170	1.500	1.800	2.600
180	1.500	1.800	2.600

10 kn

γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	1.200	1.800	1.900
40	1.600	2.300	2.500
50	2.100	2.800	3.300
60	2.500	3.300	3.900
70	2.800	3.700	4.100
80	3.000	3.900	4.100
90	3.200	4.050	4.050
100	3.300	4.150	4.900
110	3.400	4.150	5.450
120	3.400	4.100	5.750
130	3.400	3.900	5.750
140	3.300	3.700	5.600
150	3.200	3.600	5.350
160	3.100	3.700	5.050
170	3.100	3.800	5.250
180	3.200	3.800	5.200

15 kn

γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	1.200	1.800	
40	1.600	2.300	
50	2.100	2.800	
60	2.500	3.300	
70	2.800	3.700	
80	3.000	3.900	
90	3.200	4.050	
100	3.300	4.150	
110	3.400	4.150	
120	3.400	4.100	
130	3.400	3.900	
140	3.300	3.700	
150	3.200	3.600	
160	3.100	3.700	
170	3.100	3.800	
180	3.200	3.800	

16 kn

γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	2.000	2.500	
40	2.700	3.000	
50	3.500	3.400	
60	4.100	4.200	
70	4.550	5.050	
80	4.800	5.200	
90	5.050	5.550	
100	5.200	5.900	
110	5.300	5.800	
120	5.350	6.000	
130	5.300	5.850	
140	5.200	5.650	
150	5.050	5.450	
160	4.950	5.700	
170	5.000	5.750	
180	5.000	5.750	

Dua Layar

5 kn

γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	0.700	1.000	1.600
40	0.900	1.300	1.800
50	1.200	1.600	2.200
60	1.400	1.900	2.700
70	1.600	2.100	3.200
80	1.700	2.200	3.600
90	1.800	2.300	3.600
100	1.900	2.300	3.750
110	1.900	2.300	4.050
120	1.900	2.300	3.800
130	1.900	2.200	3.500
140	1.800	2.100	3.300
150	1.700	2.000	3.000
160	1.700	2.000	2.800
170	1.700	2.000	2.800
180	1.700	2.000	2.800

10 kn

γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	1.400	2.100	
40	1.900	2.700	
50	2.500	3.200	
60	2.900	3.600	
70	3.300	3.800	
80	3.500	4.500	4.800
90	3.800	4.650	4.750
100	3.900	4.750	5.050
110	3.900	4.750	5.500
120	4.000	4.650	5.700
130	3.900	4.650	6.200
140	3.800	4.250	6.000
150	3.600	4.000	5.800
160	3.500	4.100	5.450
170	3.500	4.150	5.550
180	3.500	4.150	5.550

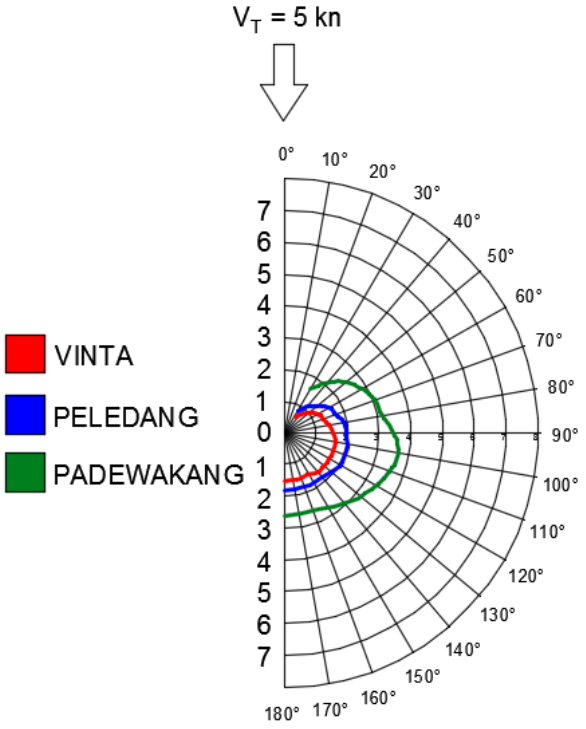
15 kn

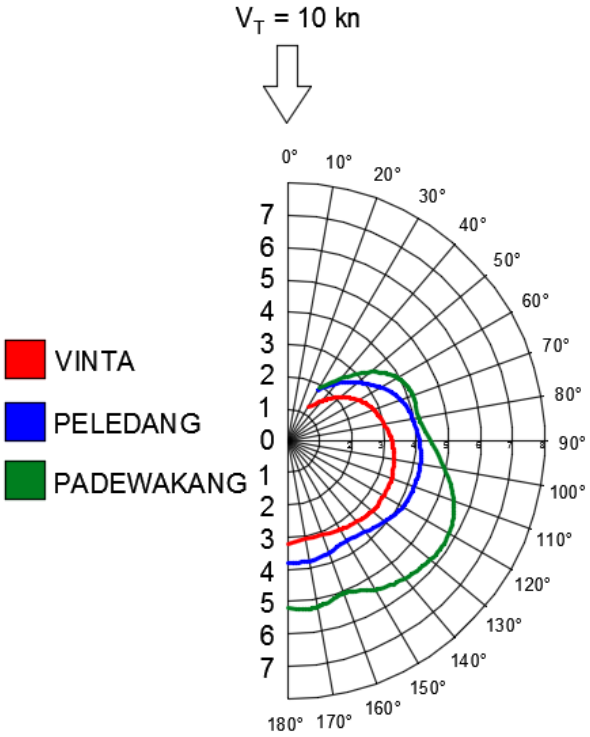
γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	2.200	2.700	
40	2.900	3.200	
50	3.500	3.700	
60	3.900	4.000	
70	4.900	4.850	
80	5.150	5.300	
90	5.300	5.550	
100	5.550	5.900	
110	5.600	6.150	
120	5.600	6.300	
130	5.550	6.150	
140	5.450	5.950	
150	5.300	5.700	
160	5.150	5.850	
170	5.200	5.900	
180	5.200	5.900	

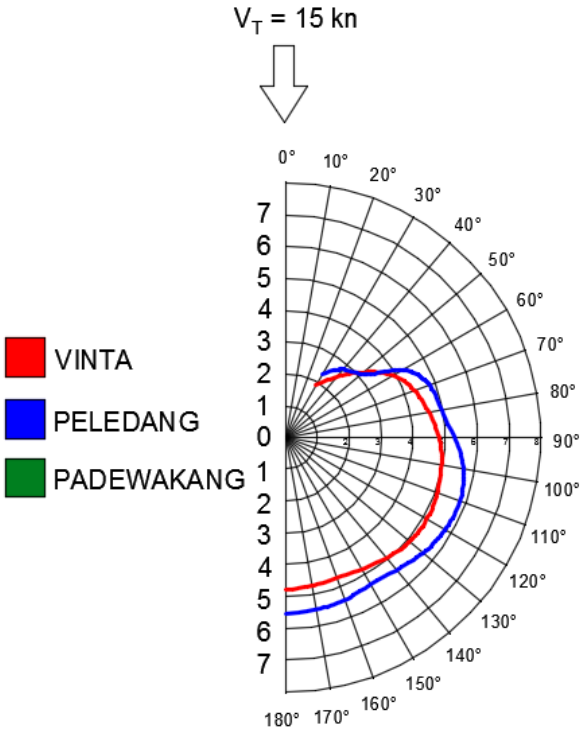
16 kn

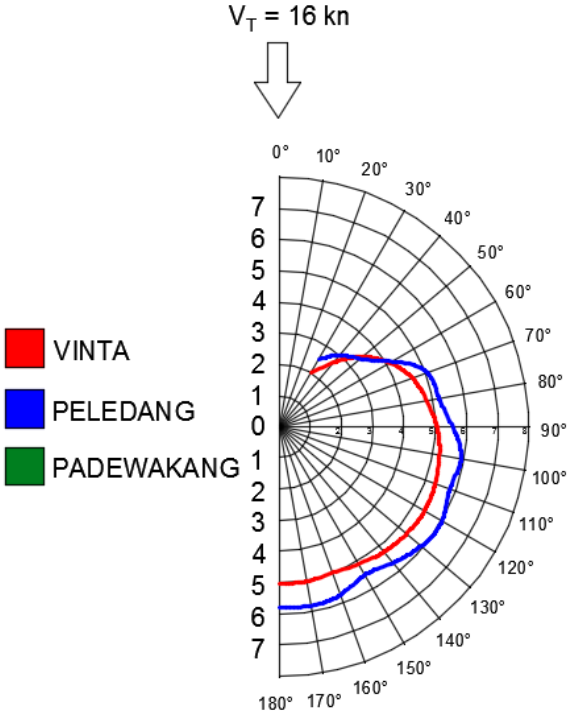
γ	V_S (kn)		
	Vinta	Peledang	Padewakang
30	2.400	2.900	
40	3.800	3.500	
50	4.200	3.900	
60	4.450	4.250	
70	5.400	4.400	
80	5.500	4.550	
90	5.500	5.800	
100	5.800	6.100	
110	5.850	6.400	
120	5.850	6.250	
130	5.800	6.400	
140	5.700	6.200	
150	5.550	5.950	
160	5.400	5.700	
170	5.450	6.200	
180	5.500	6.200	

SAIL PLAN SATU LAYAR









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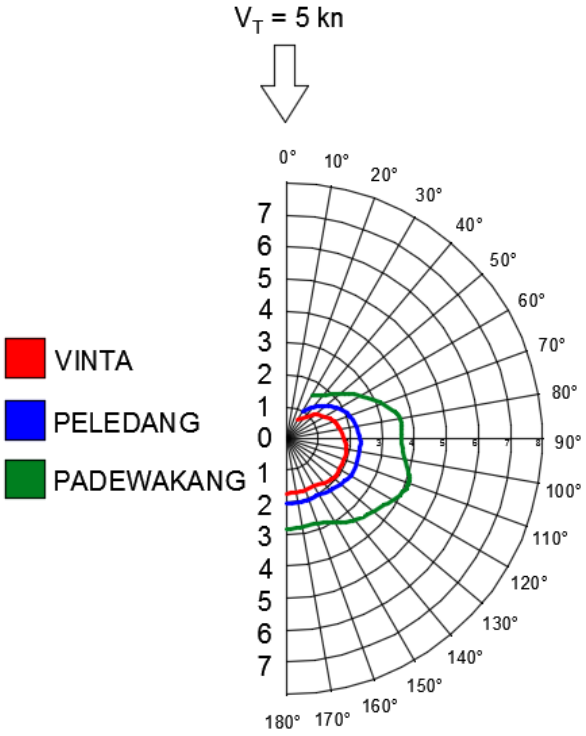
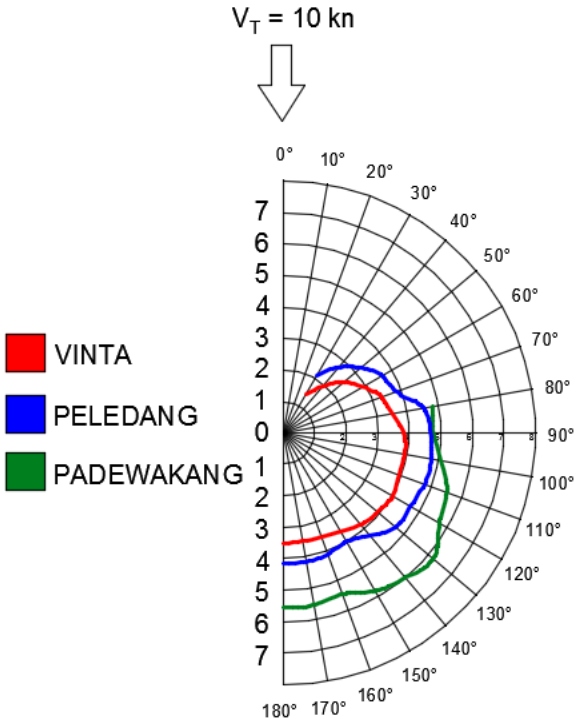
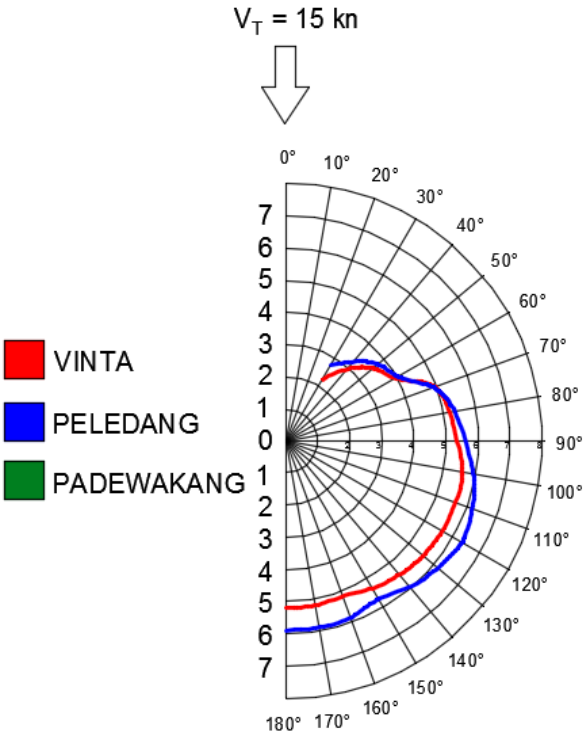
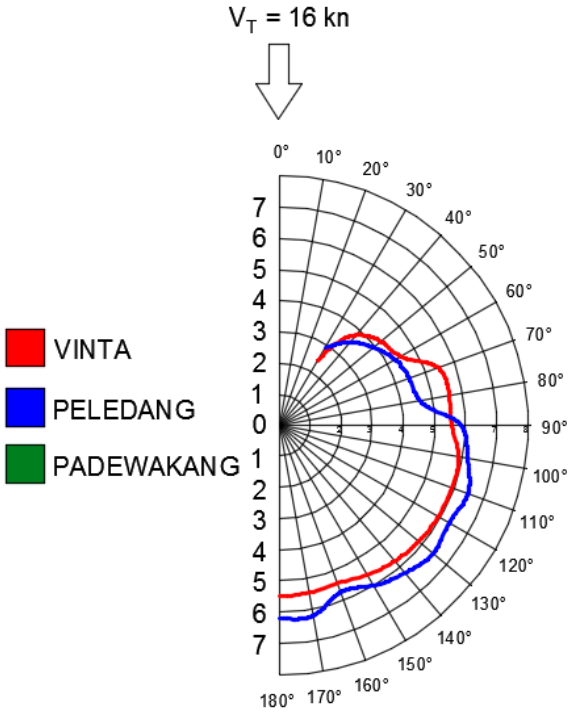


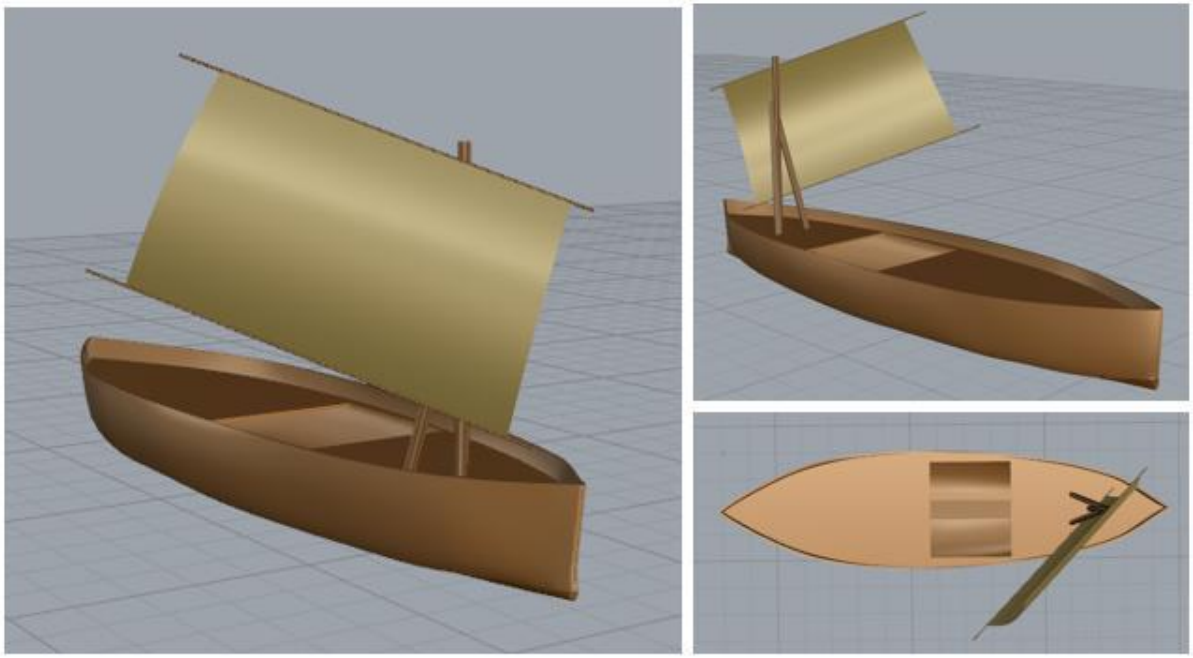






LAMPIRAN D
MODEL TIGA DIMENSI *SAIL PLAN*

MODEL TIGA DIMENSI VINTA-1



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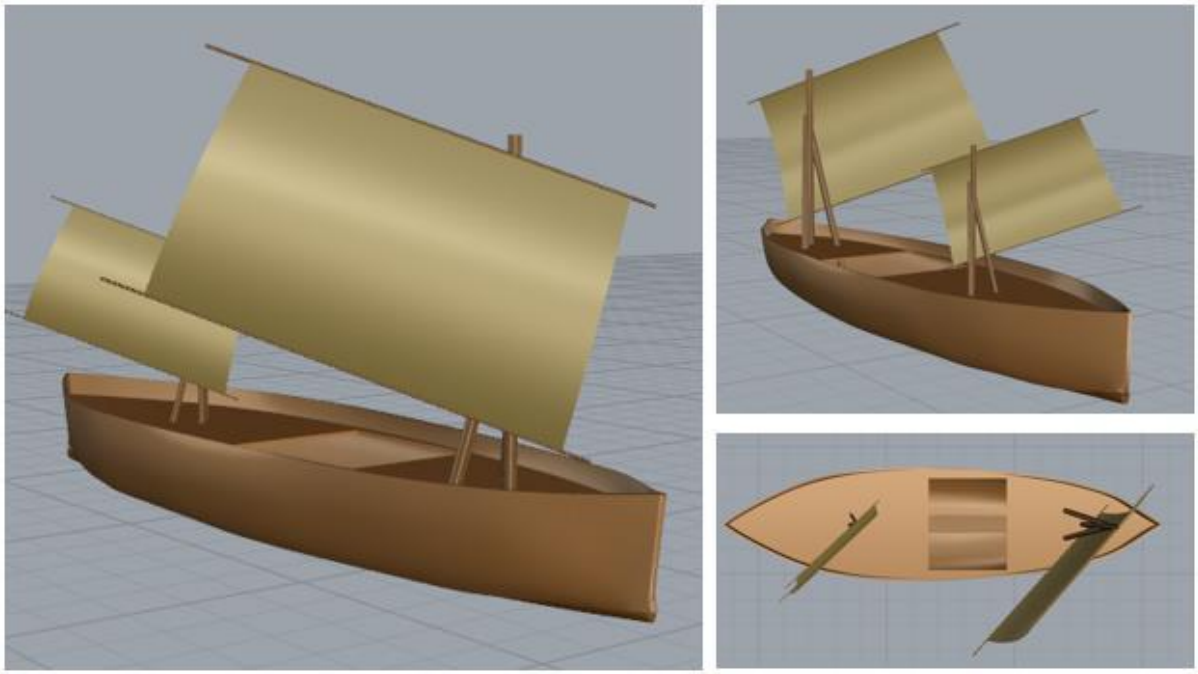

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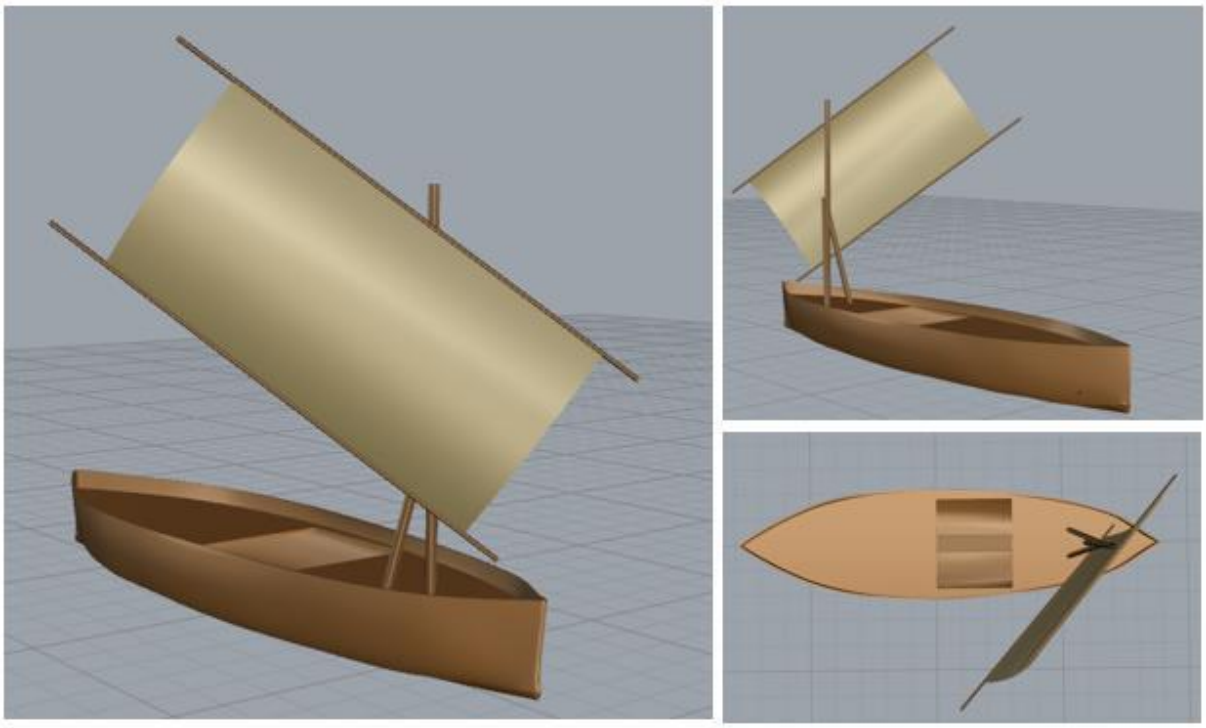

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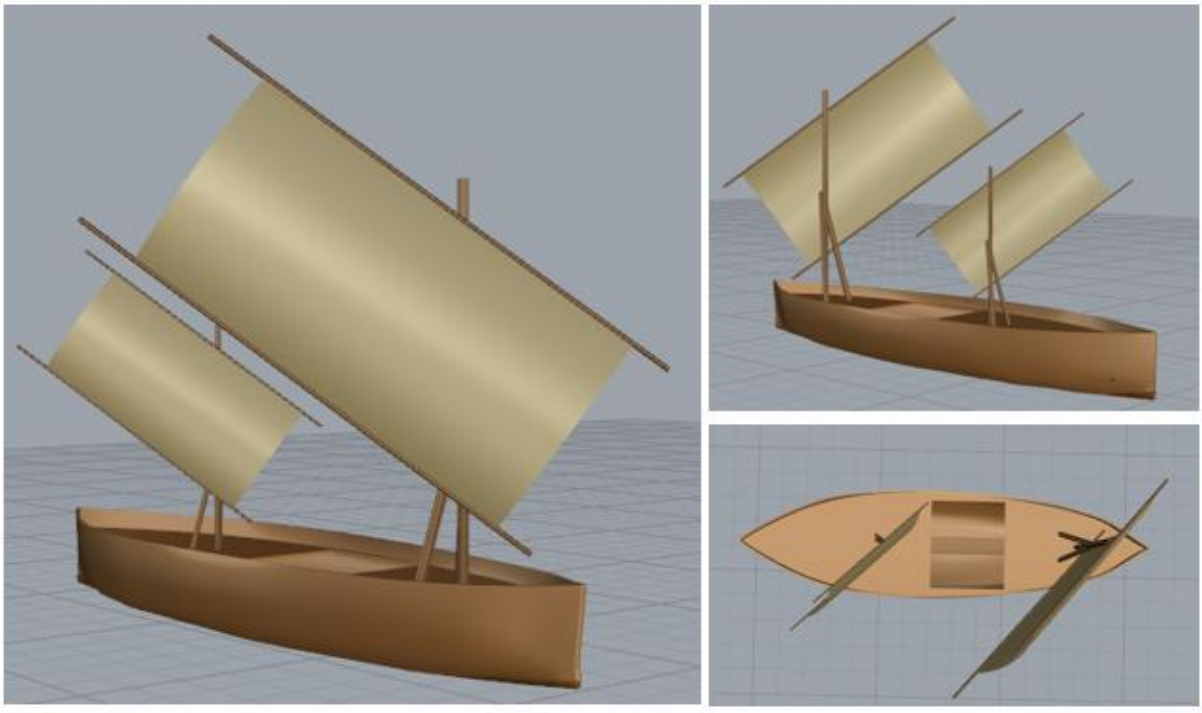
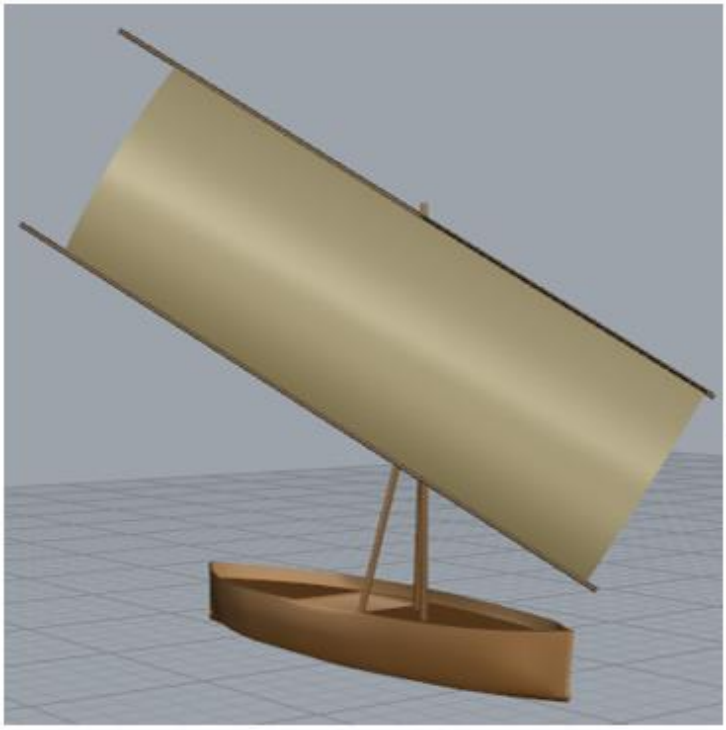
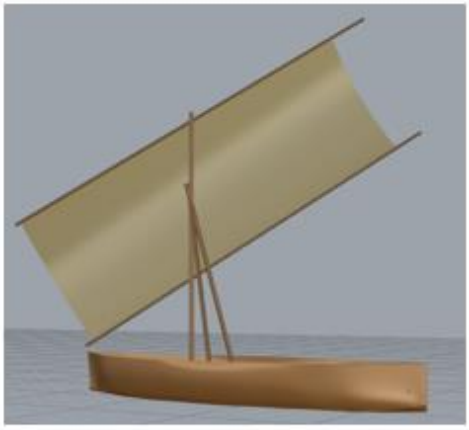
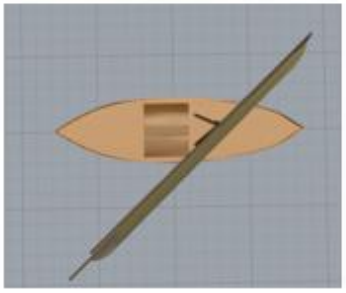


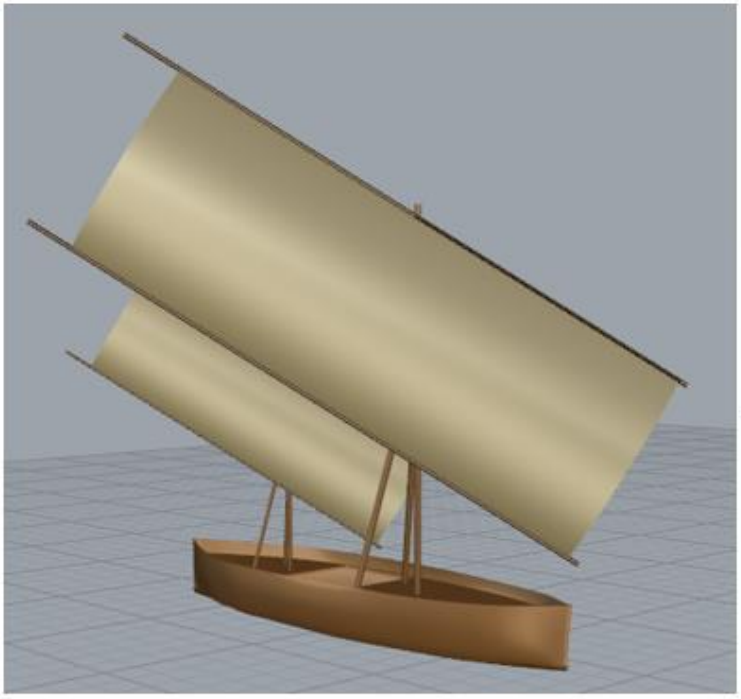
MODEL TIGA DIMENSI PADEWAKANG-1

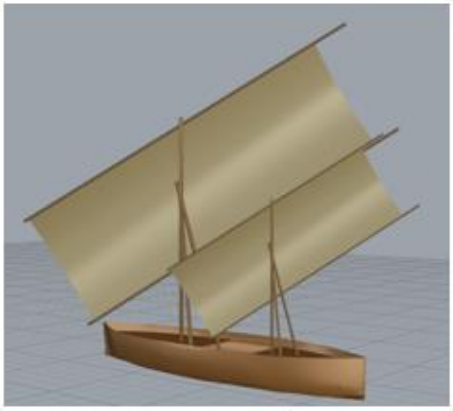


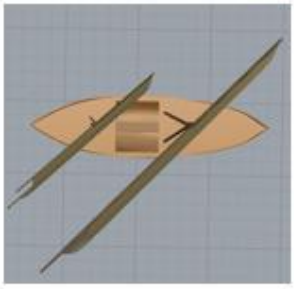




MODEL TIGA DIMENSI PADEWAKANG-2







BIODATA PENULIS

Zulfikar Bisma Wicaksana adalah nama lengkap penulis. Penulis dilahirkan di Malang pada 19 Mei 1998 dan merupakan anak pertama dari dua bersaudara. Penulis dibesarkan di Bandung dan Surabaya. Penulis menempuh pendidikan formal tingkat dasar di SD Mutiara Bunda Bandung, kemudian melanjutkan ke SMP Mutiara Bunda Bandung dan SMP Alam Insan Mulia Surabaya, dan SMA Negeri 16 Surabaya. Setelah lulus SMA, Penulis diterima di Departemen Teknik Perkapalan FTK ITS pada tahun 2016. Di Departemen Teknik Perkapalan, Penulis mengambil Rumpun Mata Kuliah Desain Kapal. Selain mengikuti kegiatan perkuliahan di ITS, Penulis aktif mengikuti kegiatan keorganisasian seperti pengurus UKM Marching Band ITS dan pengurus Kewirausahaan Himpunan Mahasiswa Teknik Perkapalan sejak tahun 2017 hingga tahun 2019.

Email: bisma.wicaksana@yahoo.co.id