

ANALISA PERBANDINGAN *FATIGUE* ANTARA *HULL-V* DAN *HULL-U* AKIBAT BEBAN *SLAMMING* DENGAN METODE ELEMEN HINGGA

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Dosen pembimbing :

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JURUSAN TEKNIK PERKAPALAN

FAKULTAS TEKNOLOGI KELAUTAN

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

SURABAYA 2015

Latar Belakang

Variasi bentuk lambung → mempengaruhi →

- Perancangan
- Hidrodinamika
- Struktur
- Produksi.

Lambung → olah gerak kapal di laut → slamming → beban *impact* dinamis

Bentuk lambung → bentuk konstruksi → kekuatan → tegangan

Beban dinamis → tegangan → fatigue

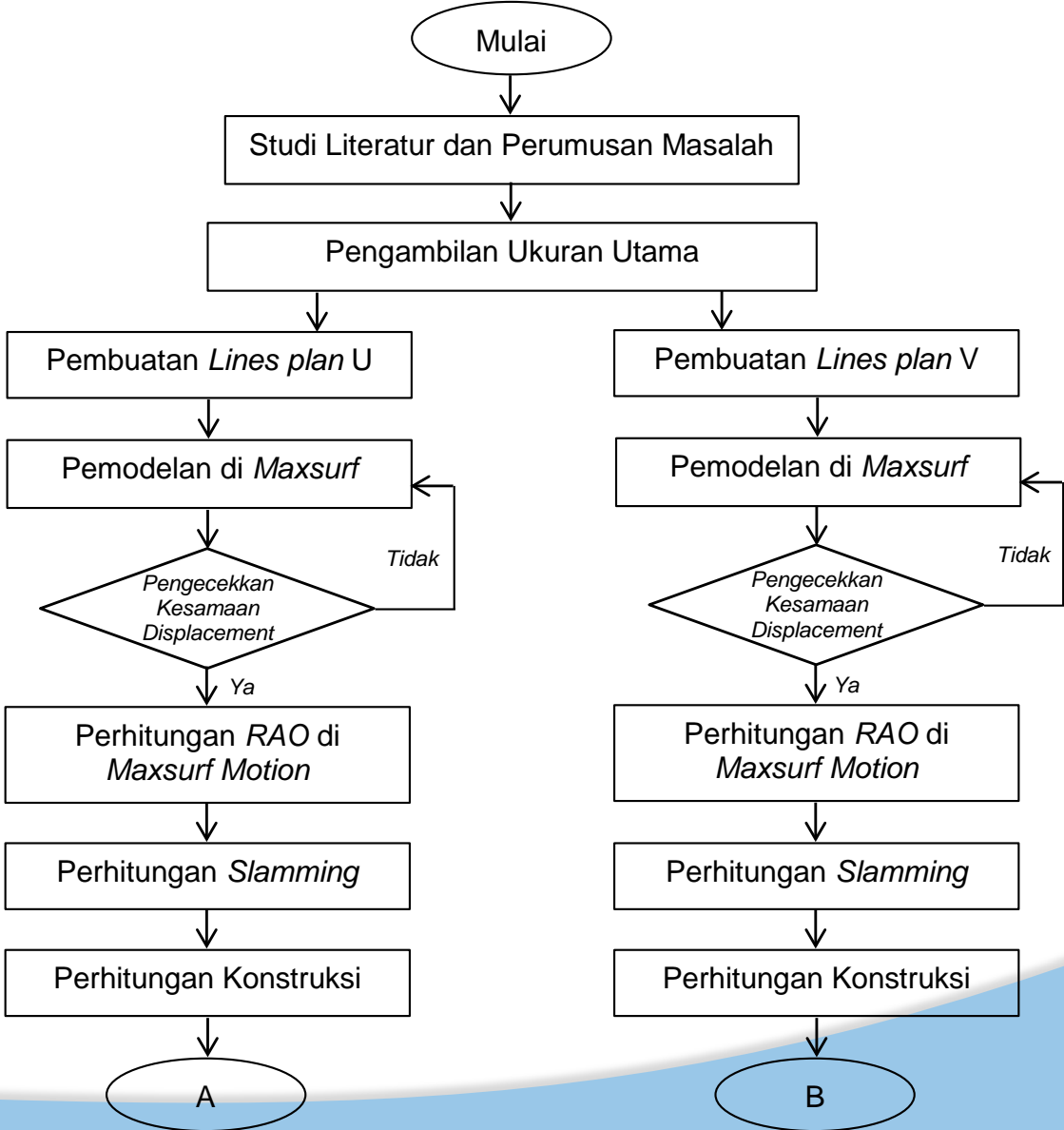
Variasi bentuk lambung → perbedaan slamming → perbedaan tegangan → perbedaan fatigue



Tujuan

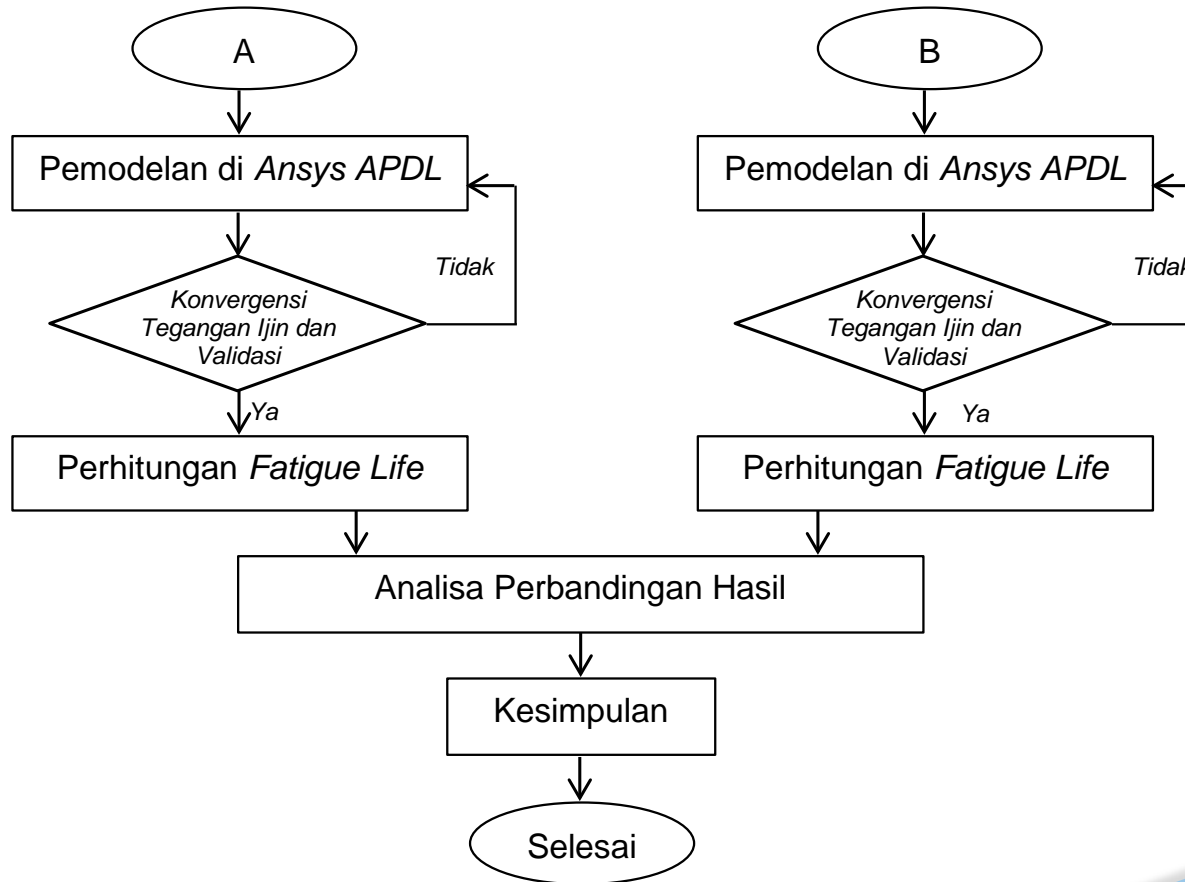
1. Untuk mengetahui perbedaan peluang, jumlah dan tekanan *slamming* antara lambung kapal berbentuk V dan lambung kapal berbentuk U.
2. Untuk mengetahui perbedaan tegangan struktur akibat beban *slamming* antara lambung kapal berbentuk V dan lambung kapal berbentuk U.
3. Untuk mengetahui perbedaan *fatigue life* akibat beban *slamming* antara lambung kapal berbentuk V dan lambung kapal berbentuk U.

METODOLOGI PENELITIAN



METODOLOGI PENELITIAN

lanjutan...

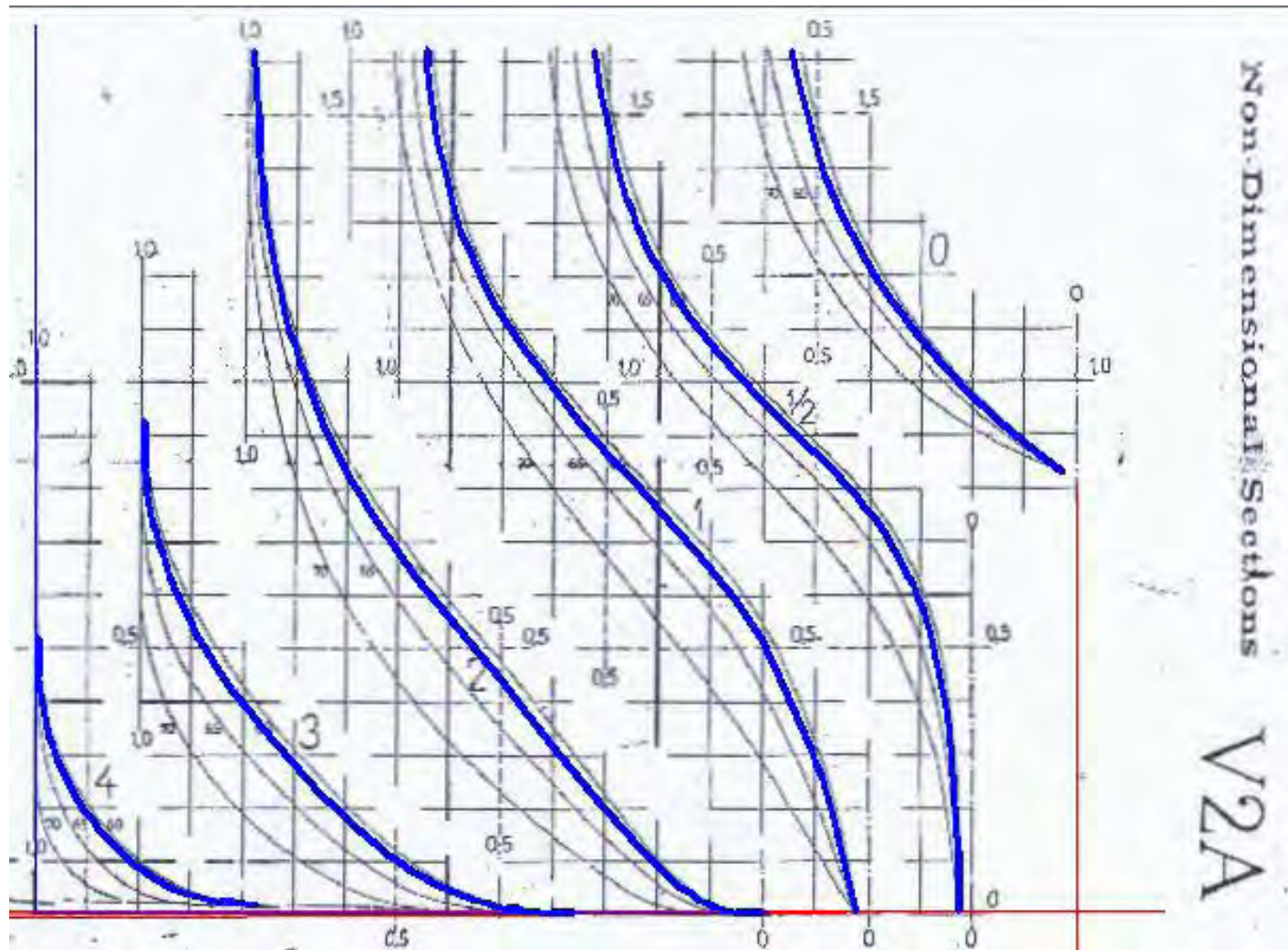


Pengambilan Ukuran Utama Kapal

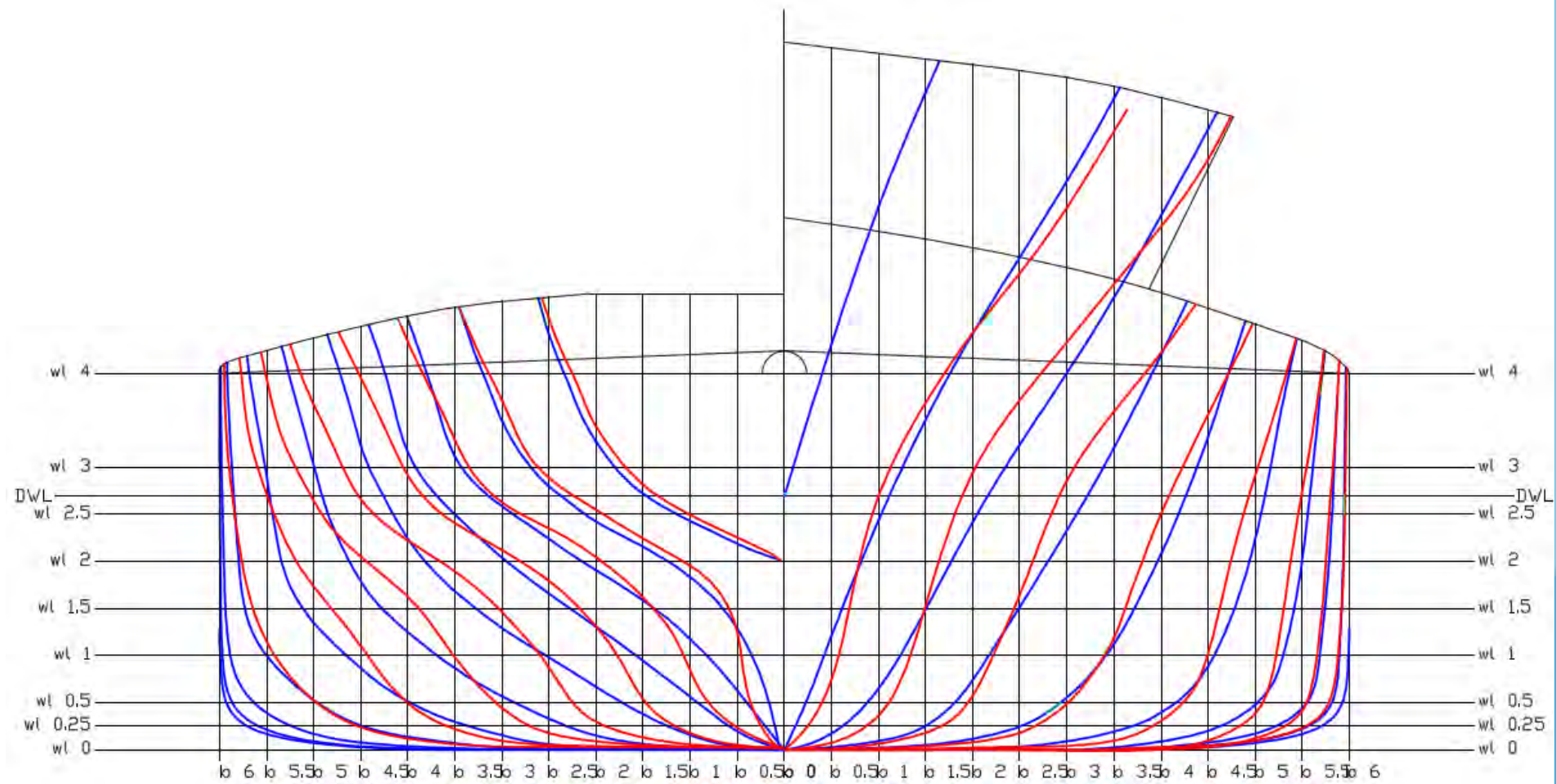
KM. Sabuk Nusantara 41

<i>LPP</i>	59	meter
<i>B</i>	12	meter
<i>H</i>	4	meter
<i>T</i>	2.7	meter
Kecepatan	12	<i>knots</i>
<i>CB</i>	0.6	

Pembuatan Body Plan Lambung U dan V

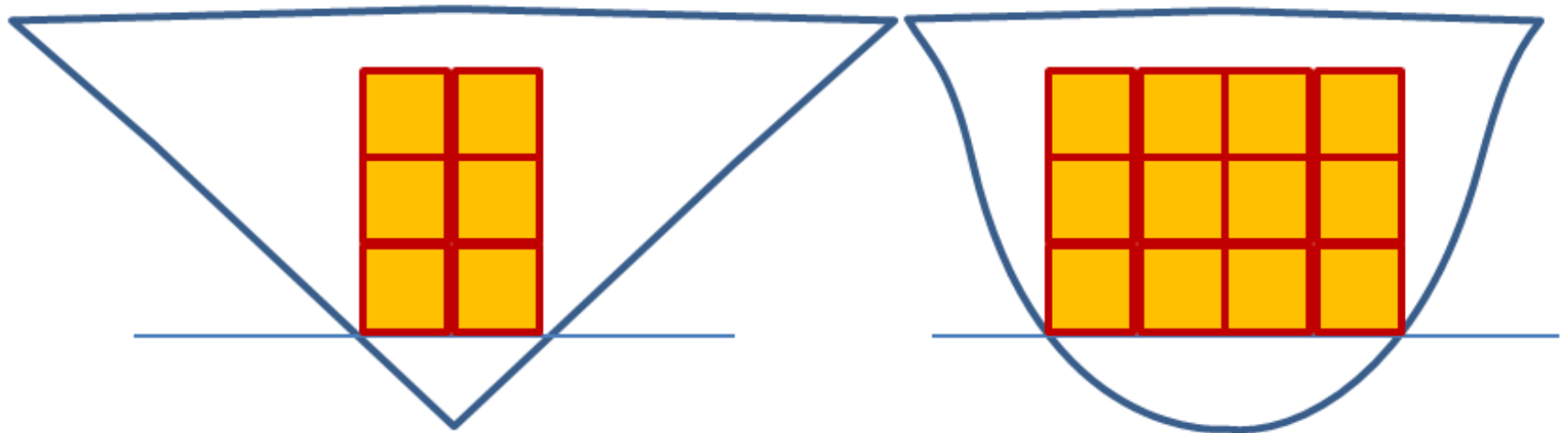


Perbandingan Lines Plan U dan V

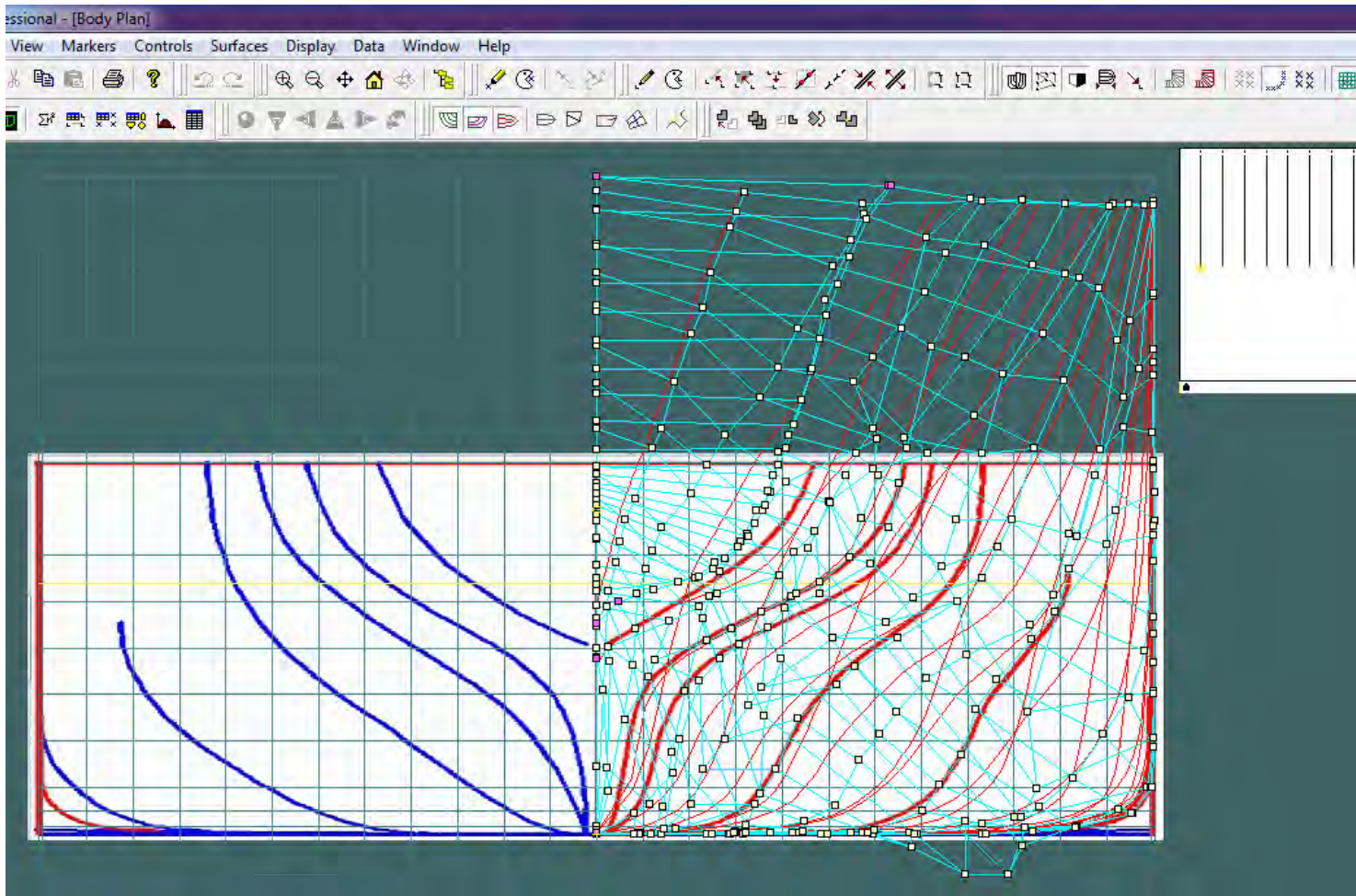


Perbandingan Lines Plan U dan V

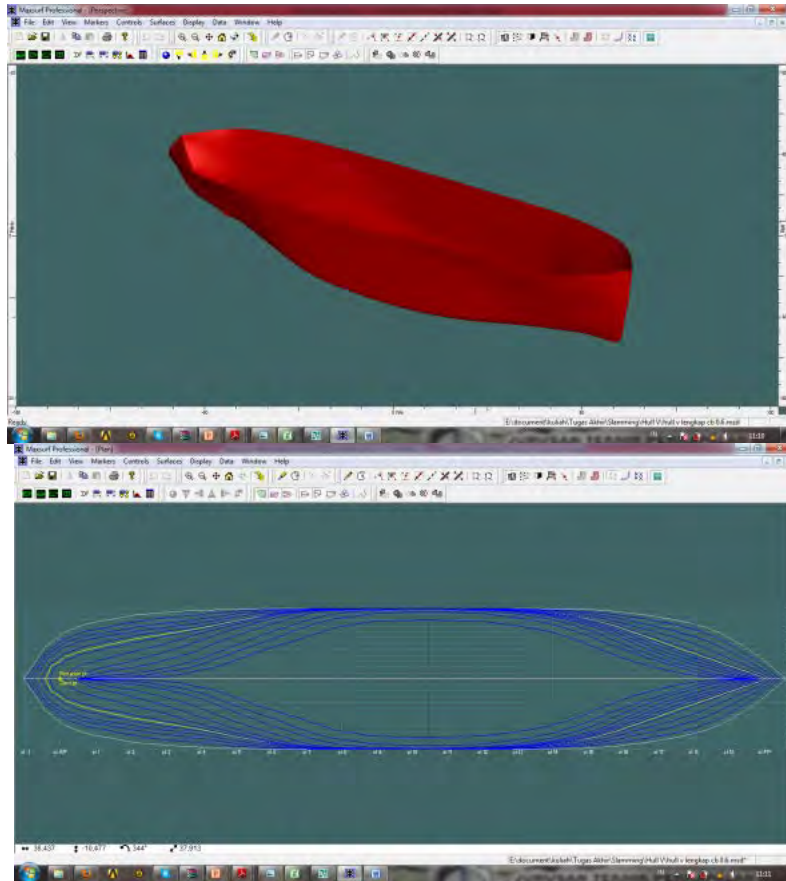
lanjutan...



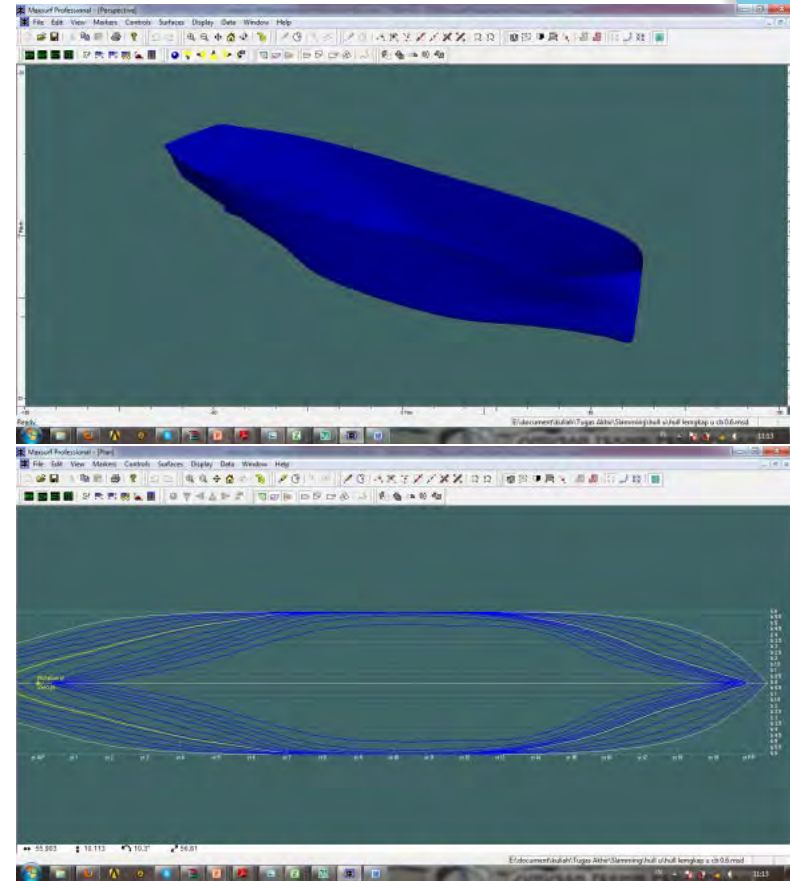
Pembuatan *Lines Plan* dan Model di *Maxsurf*



Perbandingan Hidrostatik Lambung U dan V



Hull-V



Hull-U

Perbandingan Hidrostatik Lambung U dan V

lanjutan...

	Measurement	Value	Units
1	Displacement	1219,998	tonne
2	Volume	1190,242	m ³
3	Draft to Baseline	2,7	m
4	Immersed depth	2,716	m
5	Lwl	61	m
6	Beam wl	12	m
7	WSA	726,396	m ²
8	Max cross sect area	31,873	m ²
9	Waterplane area	529,639	m ²
10	Cp	0,612	
11	Cb	0,599	
12	Cm	0,984	
13	Cwp	0,724	
14	LCB from zero pt	30,36	m
15	LCF from zero pt	28,91	m
16	KB	1,458	m
17	KG	0	m
18	BMt	3,96	m
19	BMI	89,993	m
20	GMt	5,419	m
21	GMI	91,451	m
22	KMt	5,419	m
23	KMI	91,451	m
24	Immersion (TPc)	5,429	tonne/cm
25	MTc	0	tonne.m
26	RM at 1deg = GMT.Di	115,374	tonne.m
27	Precision	Highest	200 statio

Density Recalculate

VCG Close

Hidrostatik V

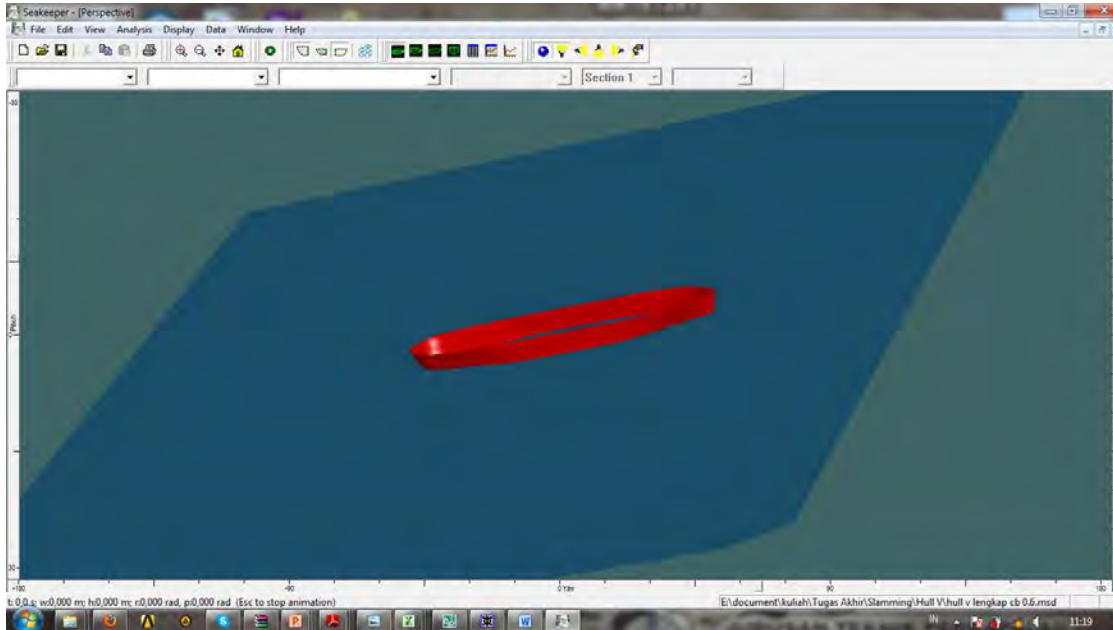
	Measurement	Value	Units
1	Displacement	1218,537	tonne
2	Volume	1188,817	m ³
3	Draft to Baseline	2,7	m
4	Immersed depth	2,711	m
5	Lwl	61	m
6	Beam wl	11,999	m
7	WSA	730,466	m ²
8	Max cross sect area	31,818	m ²
9	Waterplane area	523,846	m ²
10	Cp	0,613	
11	Cb	0,599	
12	Cm	0,98	
13	Cwp	0,716	
14	LCB from zero pt	30,267	m
15	LCF from zero pt	28,598	m
16	KB	1,441	m
17	KG	0	m
18	BMt	3,929	m
19	BMI	87,026	m
20	GMt	5,37	m
21	GMI	88,467	m
22	KMt	5,37	m
23	KMI	88,467	m
24	Immersion (TPc)	5,369	tonne/cm
25	MTc	0	tonne.m
26	RM at 1deg = GMT.Di	114,194	tonne.m
27	Precision	Medium	50 station

Density Recalculate

VCG Close

Hidrostatik U

Perhitungan *RAO* dengan *Maxsurf Motions*



Input :

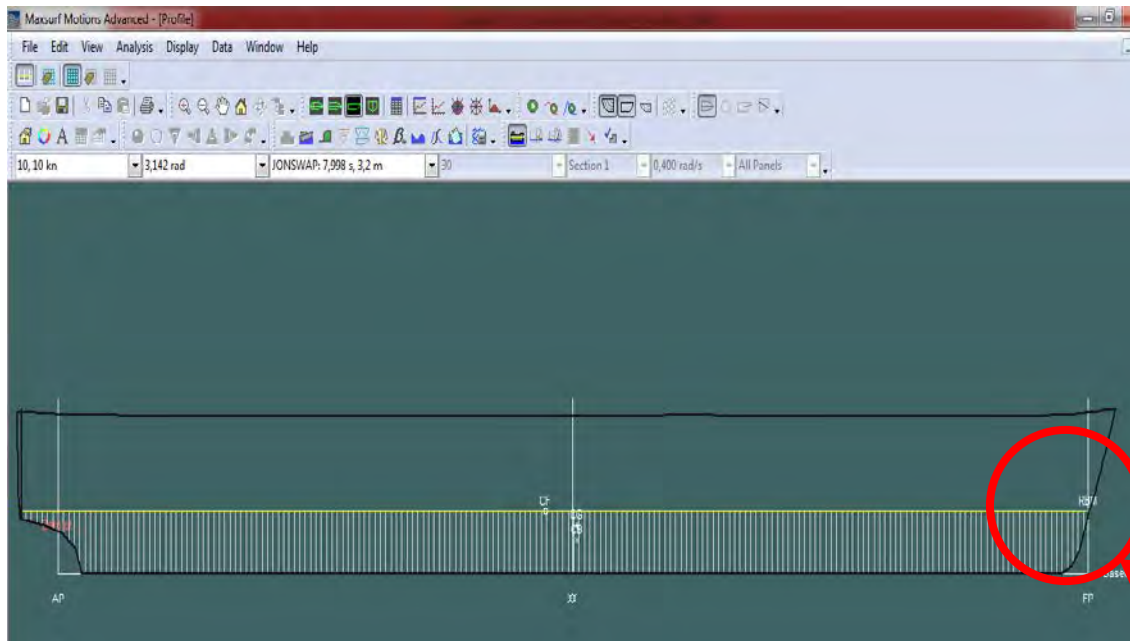
remote locations,

Speeds (8 knots, 12 knots dan 16 knots)

Headings (180°)

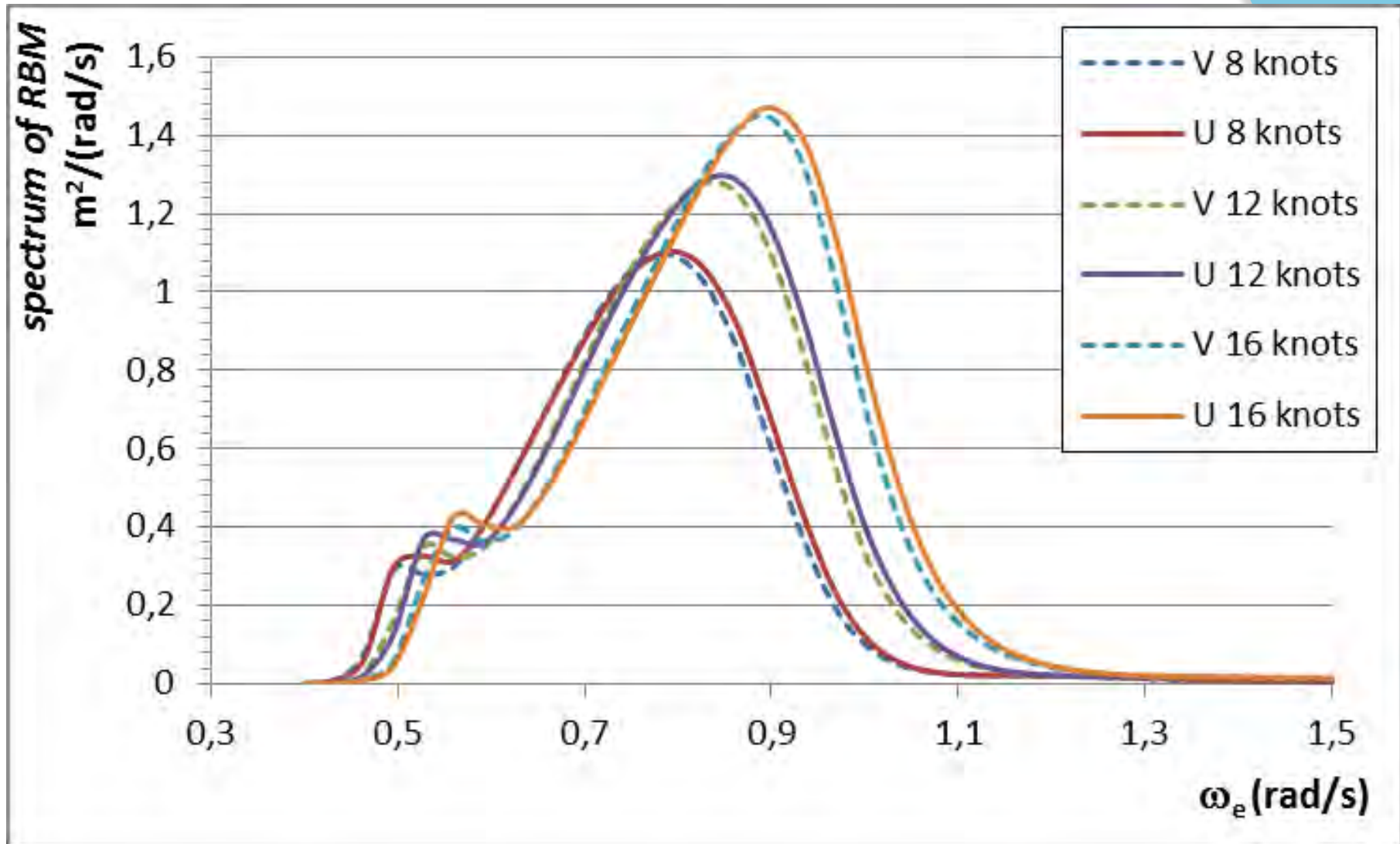
spectra gelombang (Jonswap, H = 3 meter)

Perhitungan *Slamming*



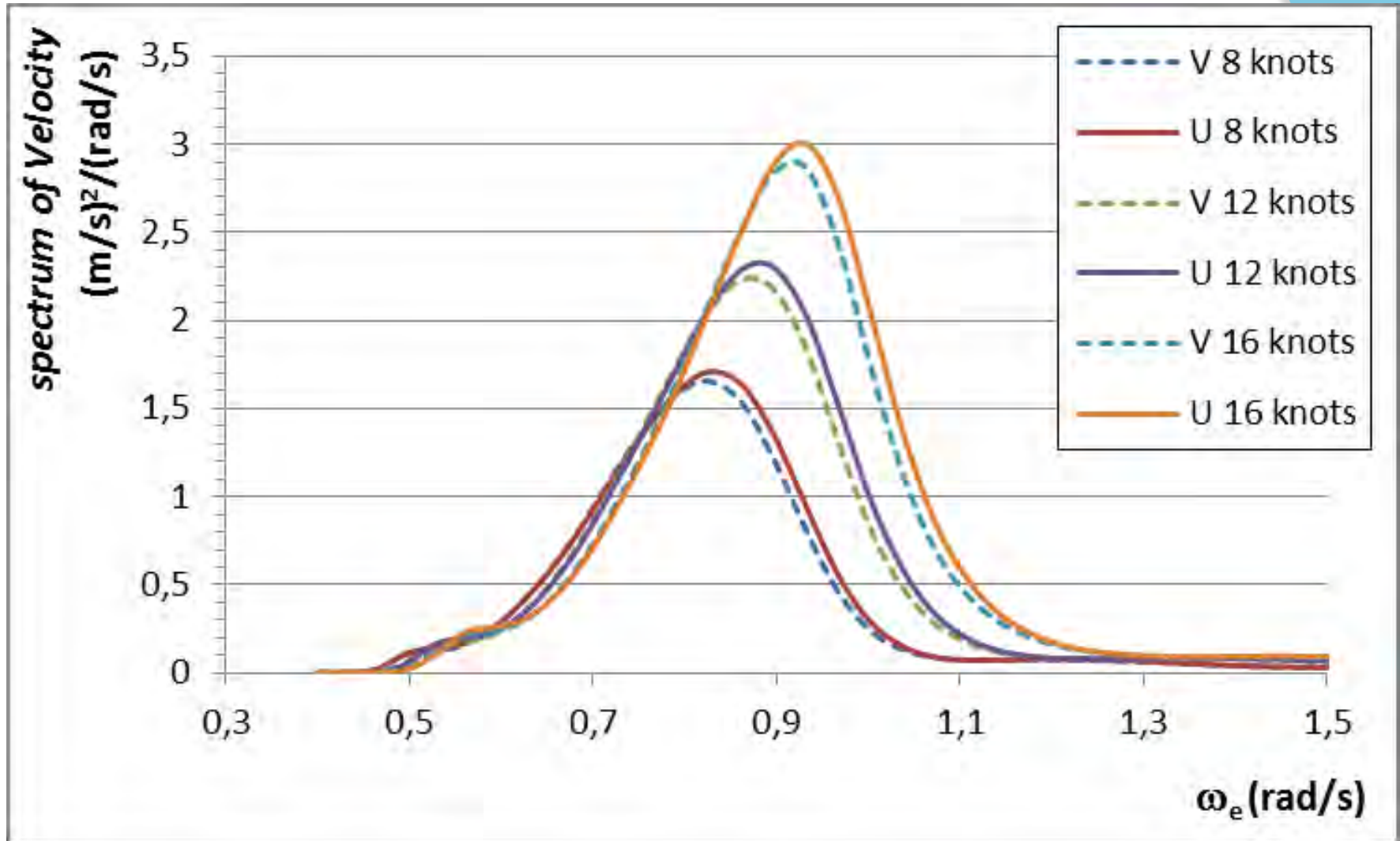
remote locations,

Perbandingan Spectrum *RBM* Lambung U dan V



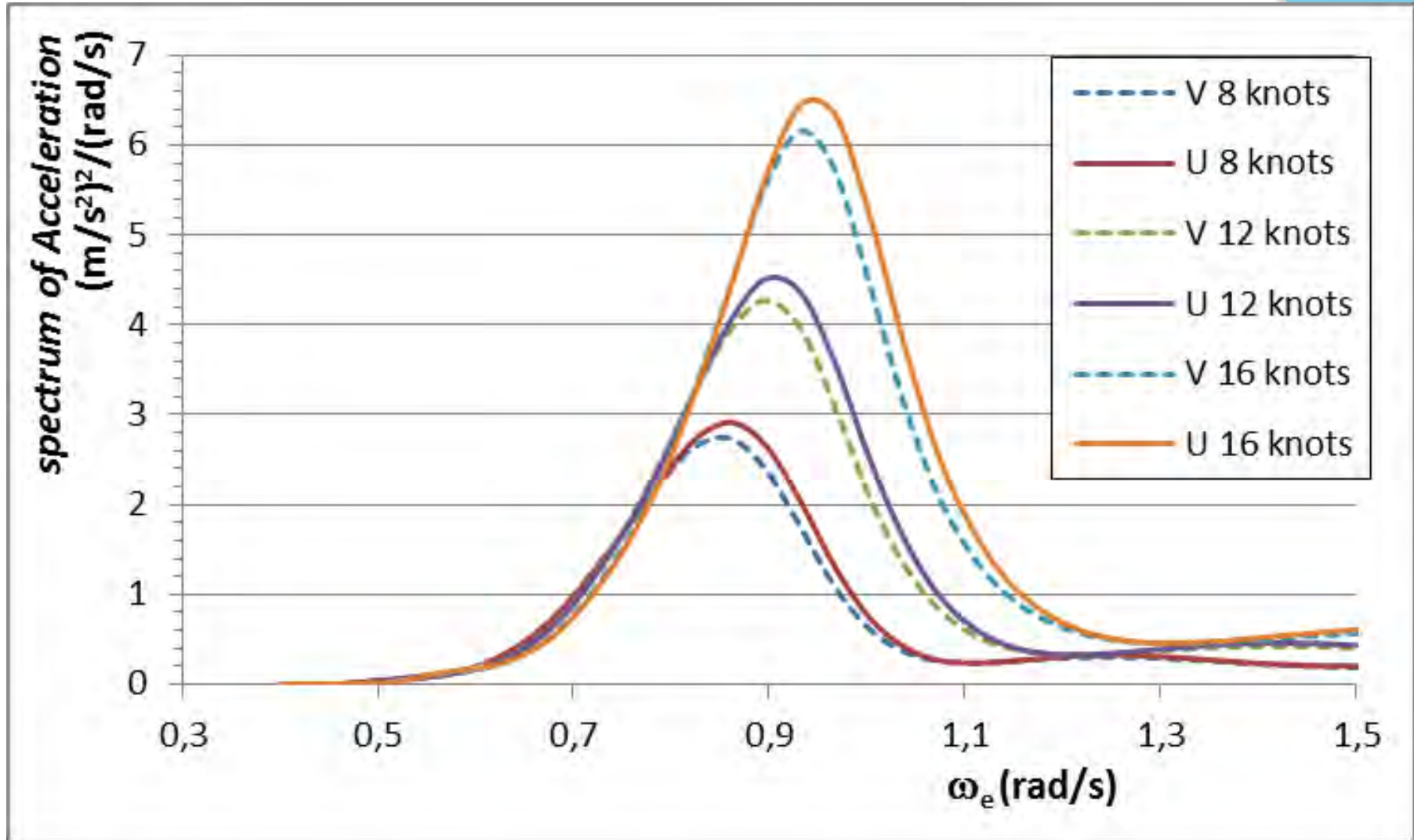
Perbandingan RAO Lambung U dan V

lanjutan...



Perbandingan RAO Lambung U dan V

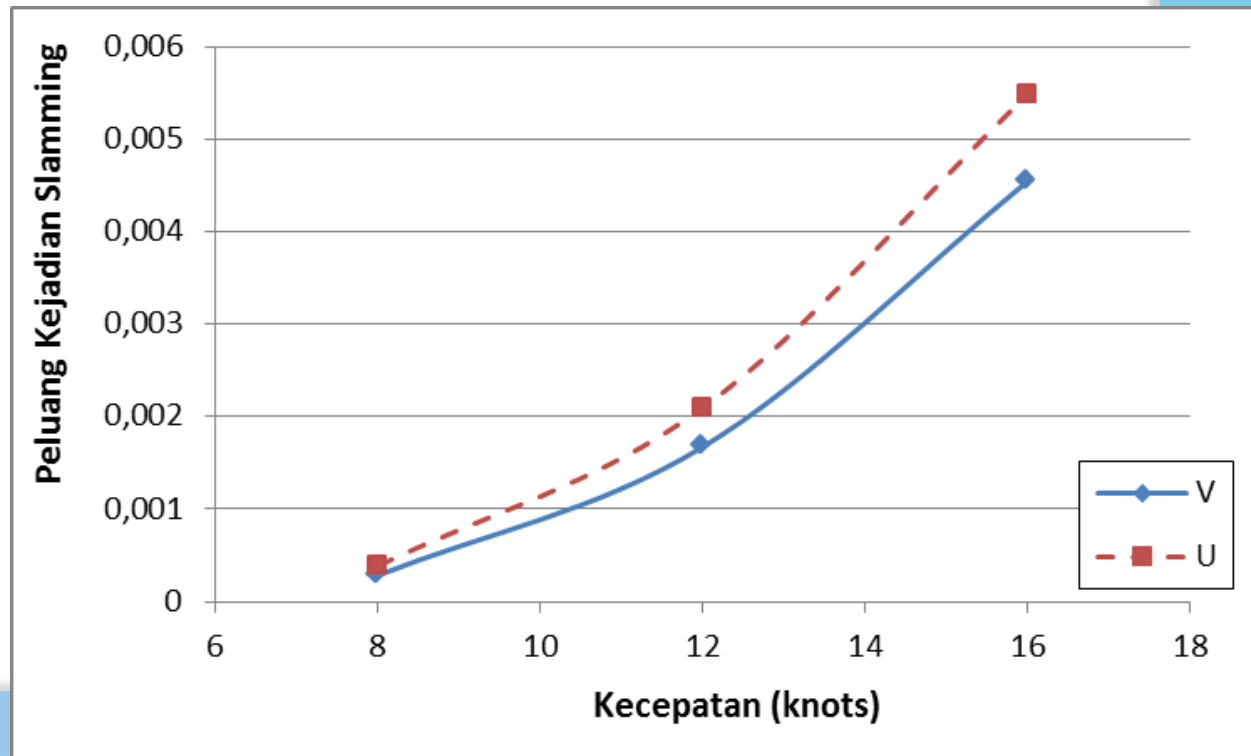
lanjutan...



Perbandingan Probabilitas Slamming

$$\Pr(\text{slam}) = \Pr(Z_{br} > T_b \text{ dan } V_{br} > V_{th}) = \exp\left(-\frac{T_b^2}{2m_{0Zbr}} - \frac{V_{th}^2}{2m_{0Vbr}}\right)$$

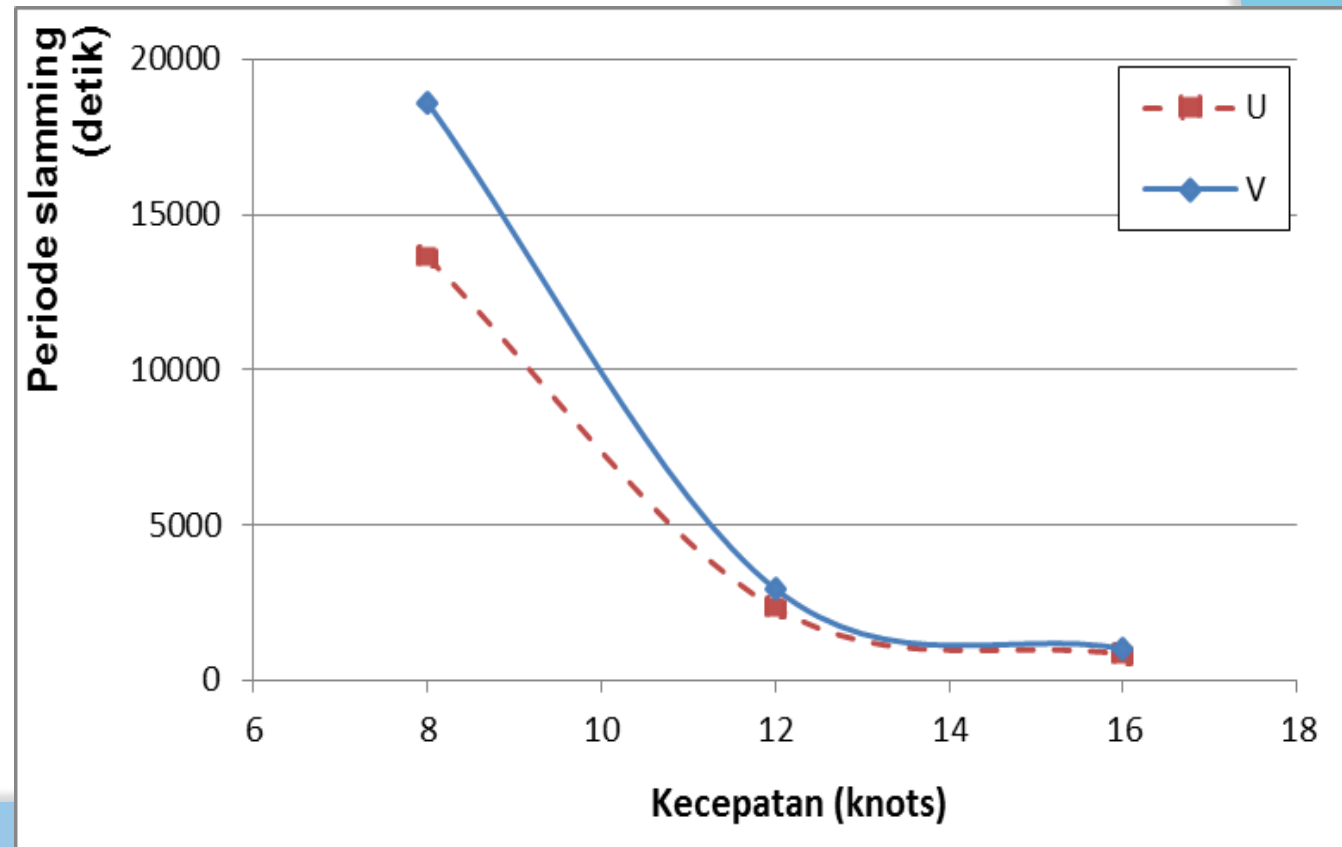
Kecepatan (knots)	m_{0Zbr} (m ²)		m_{0Vbr} ((m/s) ²)		Pr (slamming)	
	hull-V	hull-U	hull-V	hull-U	hull-V	hull-U
8	0,668	0,690	0,936	0,983	0,00029	0,00039
12	0,813	0,838	1,326	1,393	0,00167	0,00210
16	0,930	0,958	1,718	1,808	0,00455	0,00549



Perbandingan Intensitas Terjadinya *Slamming*

Kecepatan (knots)	Periode (detik)		Periode (jam)		<i>Slamming</i> / tahun	
	<i>hull V</i>	<i>hull U</i>	<i>hull V</i>	<i>hull U</i>	<i>hull V</i>	<i>hull U</i>
8	18611,373	13628,325	5,16983	3,78565	1694	2314
12	2941,633	2325,326	0,81712	0,64592	10721	13562
16	1017,072	833,857	0,28252	0,23163	31007	37819

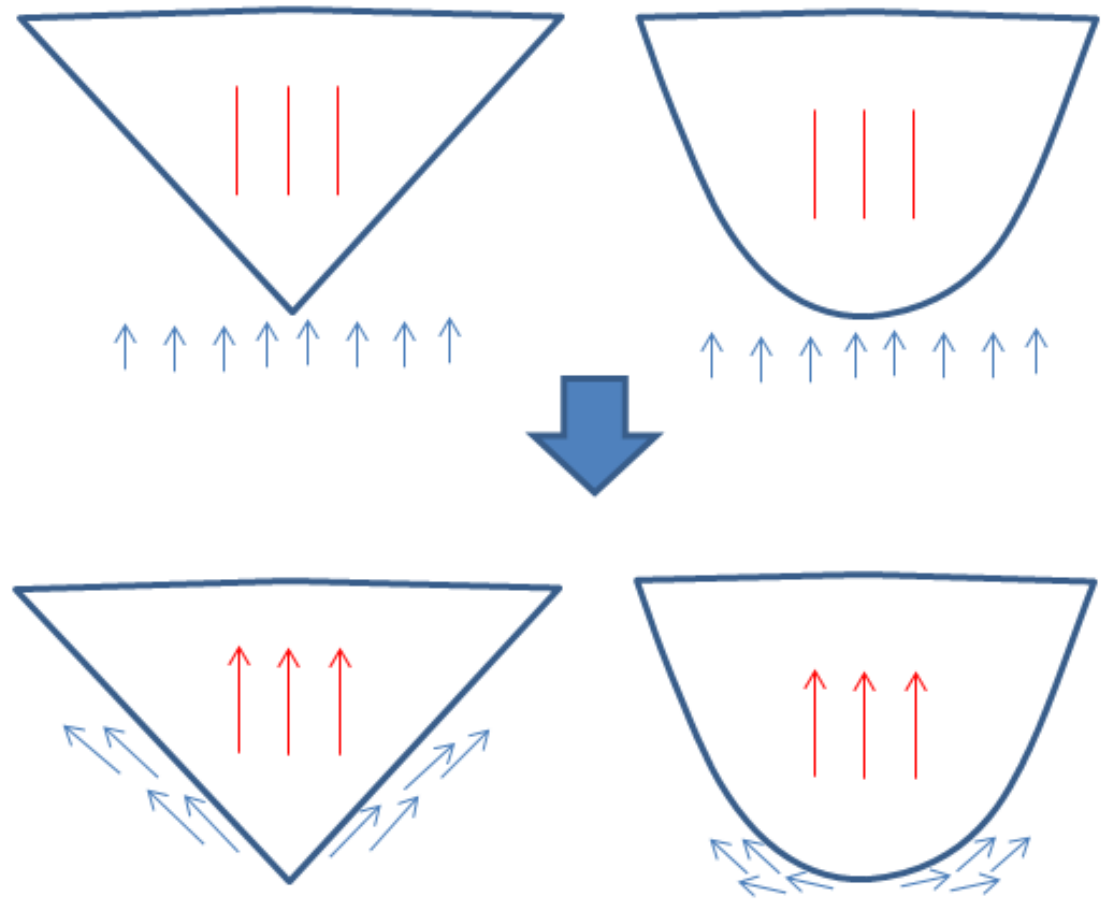
$$N_{slam} = \frac{1}{2\pi} \sqrt{\frac{m_{2Zbr}}{m_{0Zbr}}} \times \Pr(slam)$$



Perbandingan Intensitas Terjadinya *Slamming*

lanjutan...

lambung berbentuk U lebih sering mengalami *slamming* dari pada lambung berbentuk V

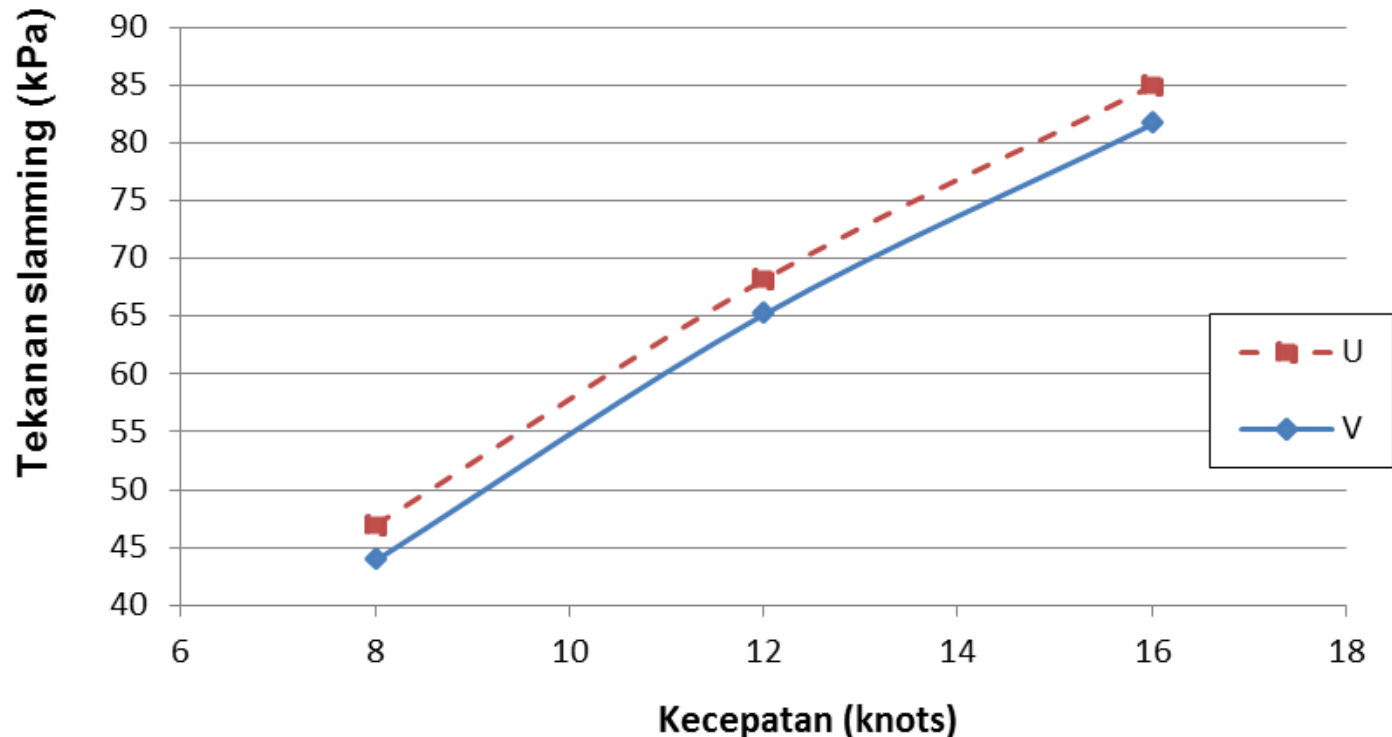


Perbandingan Besarnya Beban Slamming

$$P_s = \frac{1}{2} \rho k V_{br}^2 \text{ (kPa)}$$

$$V_{br} = \sqrt{2x \ln \left\{ \frac{3600xT_0}{2\pi} \exp \left(-\frac{T_b^2}{2m_{0zbr}} - \frac{V_{th}^2}{2m_{2zbr}} \right) \right\}} \sqrt{\frac{m_{2Vbr}}{m_{0Vbr}}} x \sqrt{m_{0Vbr}}$$

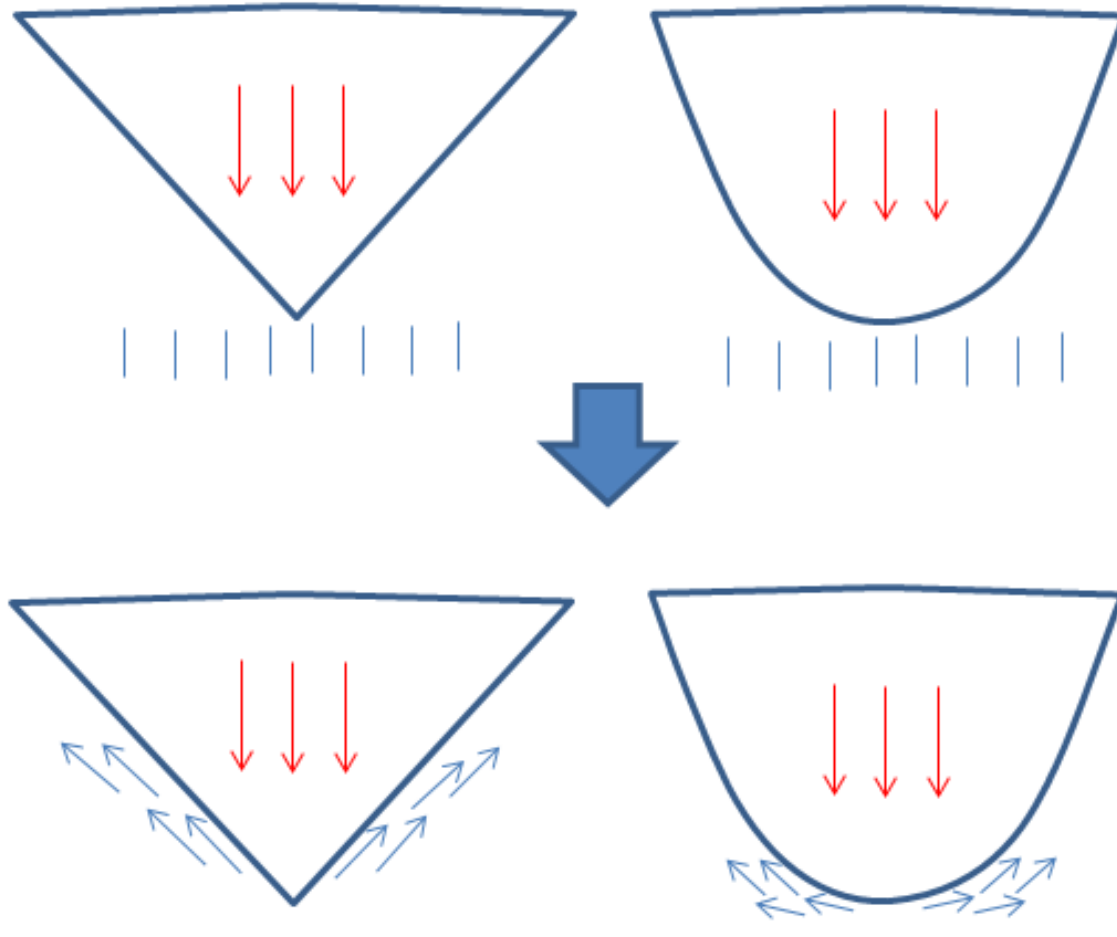
Kecepatan (knots)	ρ (ton/m ³)	k	m_{0zbr} (m ²)		m_{0Vbr} ((m/s) ²)		m_{2Vbr} ((m/s ²) ²)		Slamming Pressure (kPa)	
			hull-V	hull-U	hull-V	hull-U	hull-V	hull-U	hull-V	hull-U
8	1,025	9	0,668	0,690	0,936	0,983	2,233	2,429	43,829	46,916
12	1,025	9	0,813	0,838	1,326	1,393	3,892	4,169	65,147	68,167
16	1,025	9	0,930	0,958	1,718	1,808	5,696	6,115	81,612	84,964



Perbandingan Besarnya Beban *Slamming*

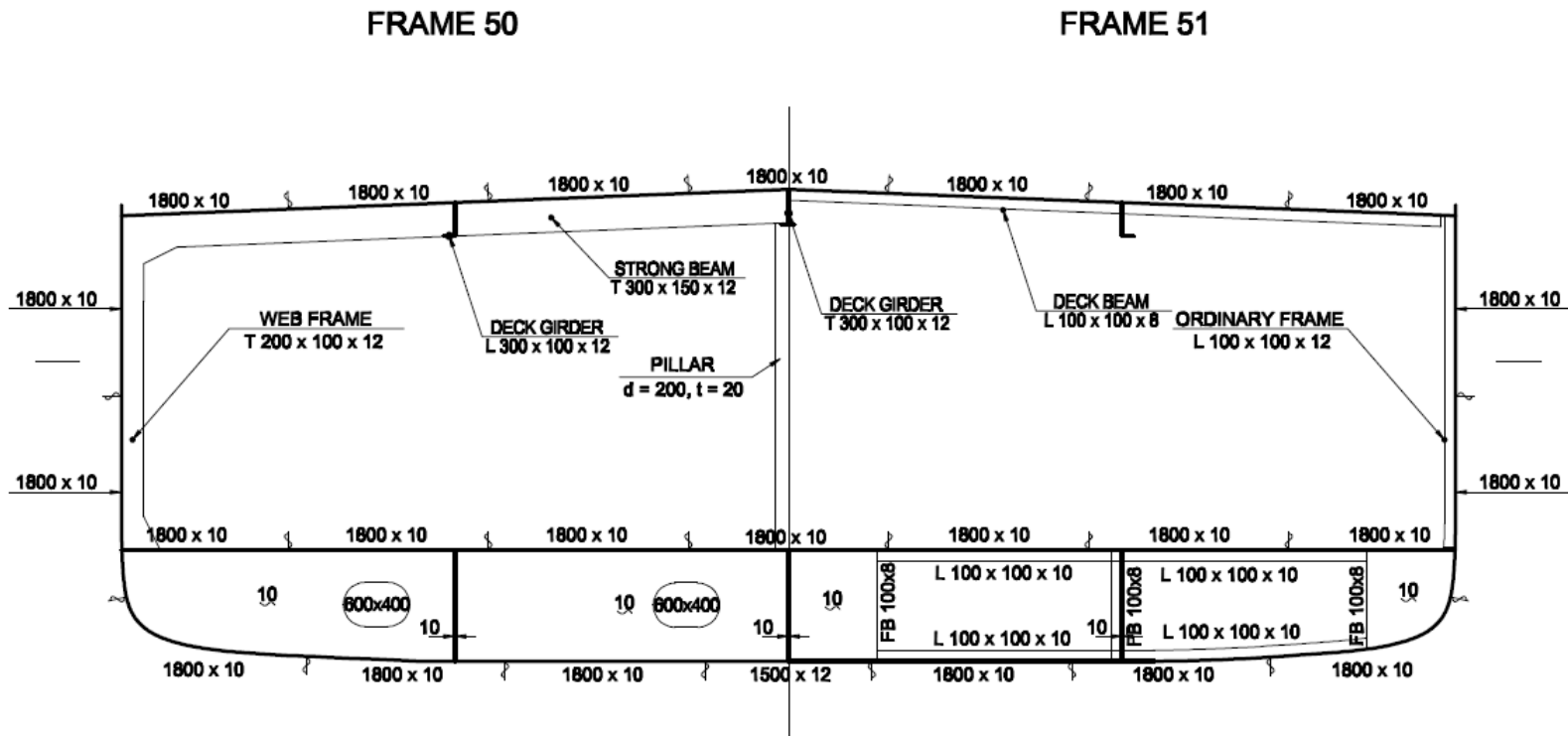
lanjutan...

lambung berbentuk U mempunyai beban *slamming* lebih besar dari pada lambung berbentuk V



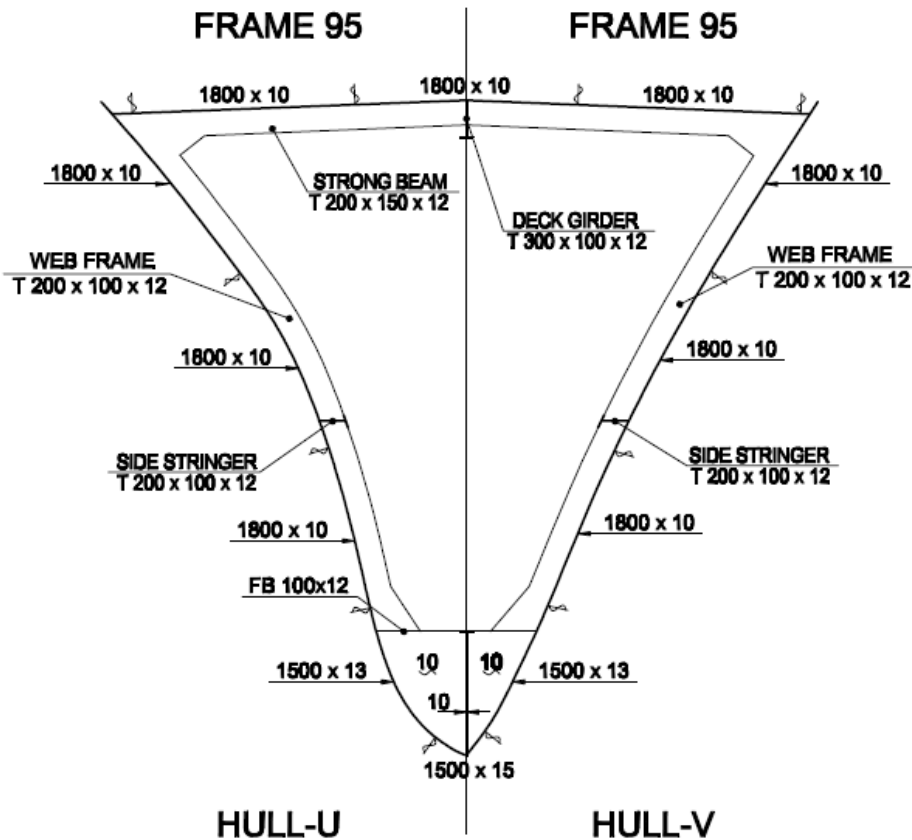
Perhitungan Konstruksi

Biro Klasifikasi Indonesia Volume II *Rules for Hull* (2014)



Perhitungan Konstruksi

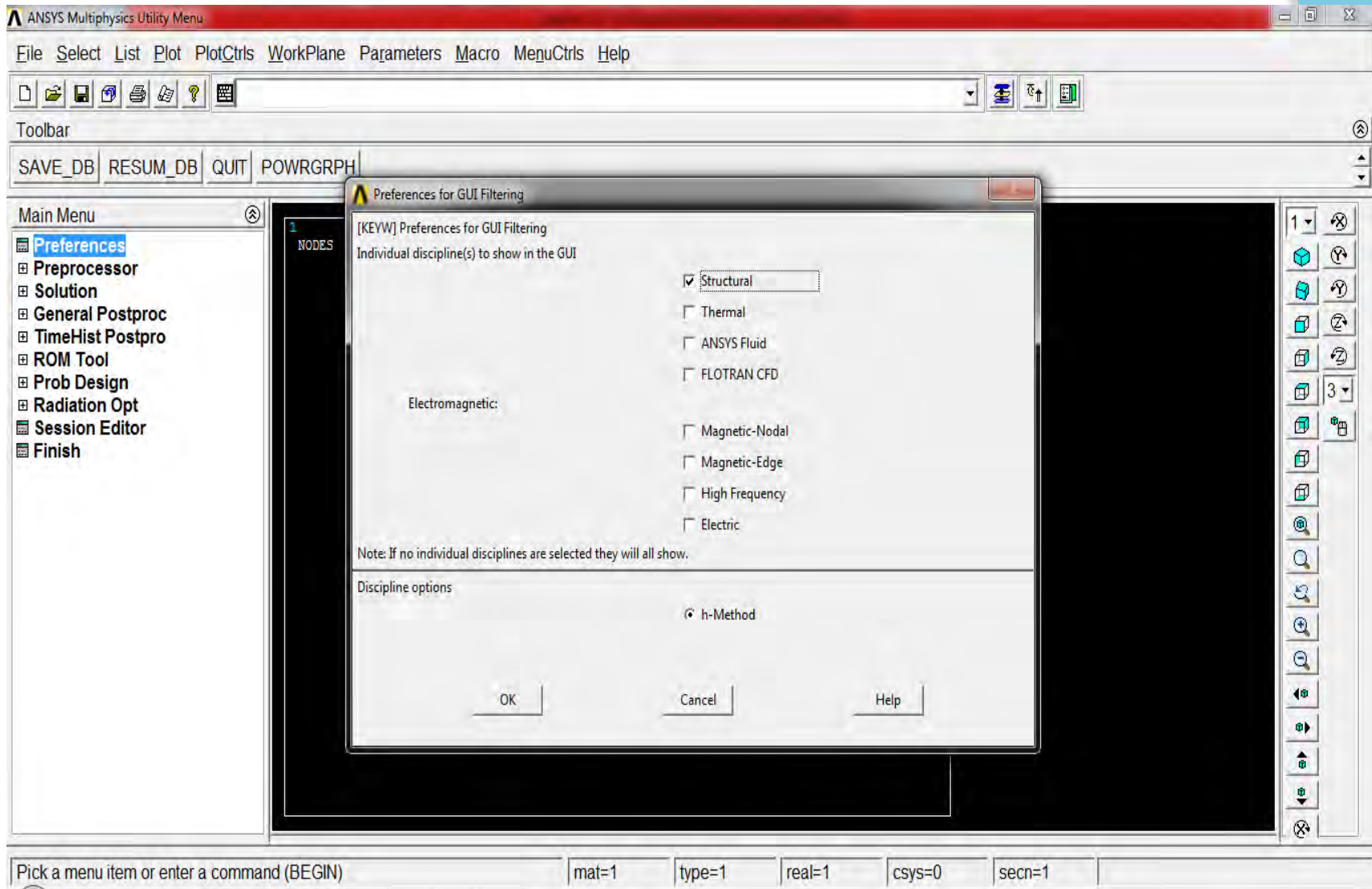
lanjutan...



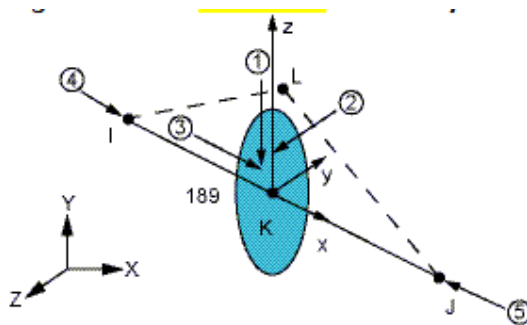
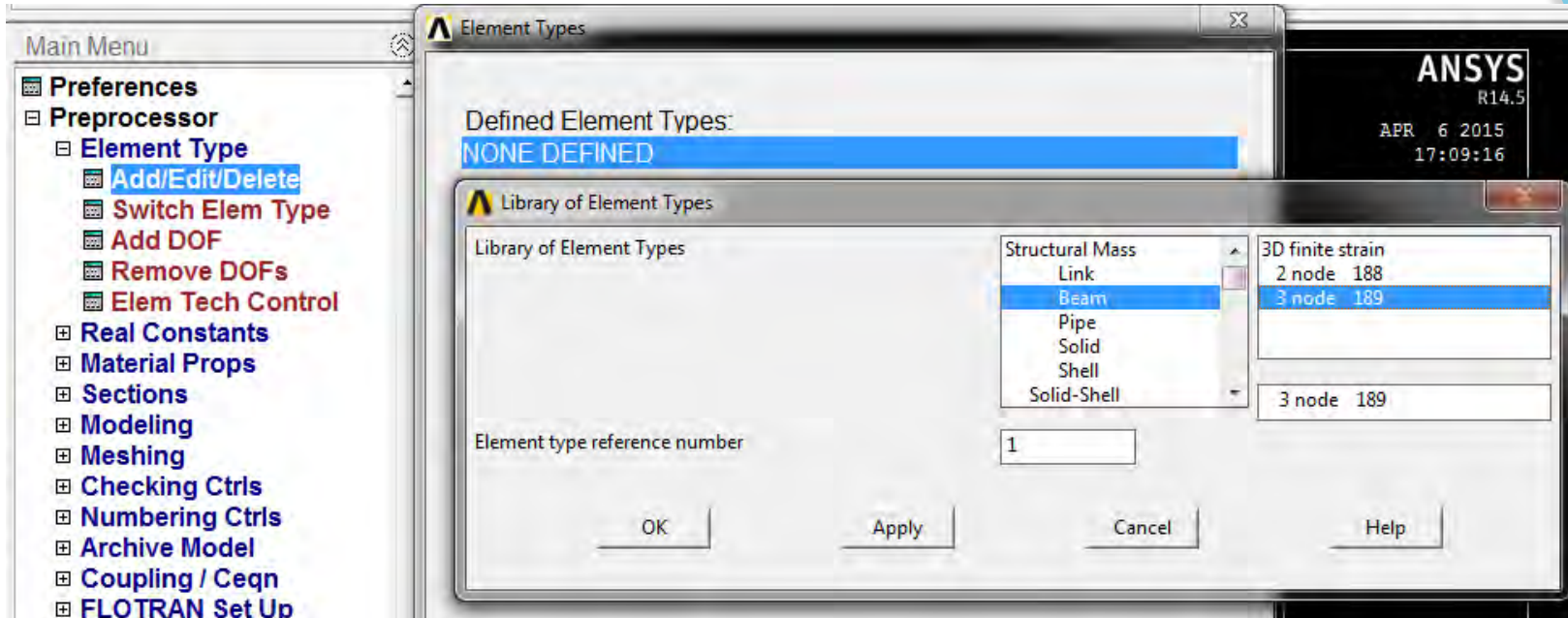
penguatan untuk daerah
0,7 L kedepan, kapal
dibawah 100 meter

1. wrang plat dipasang setiap satu kali jarak gading.
2. Jarak antar *girder* tidak boleh lebih dari $L/250 + 0,9$ meter.

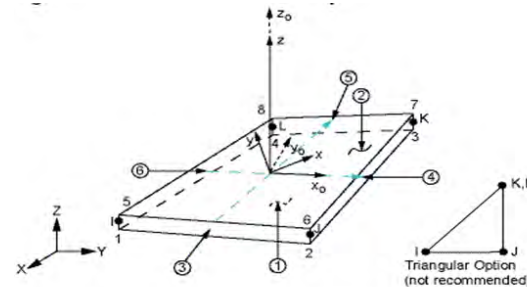
Pemilihan Tipe Analisa



Pemilihan Tipe Elemen



Element Beam189

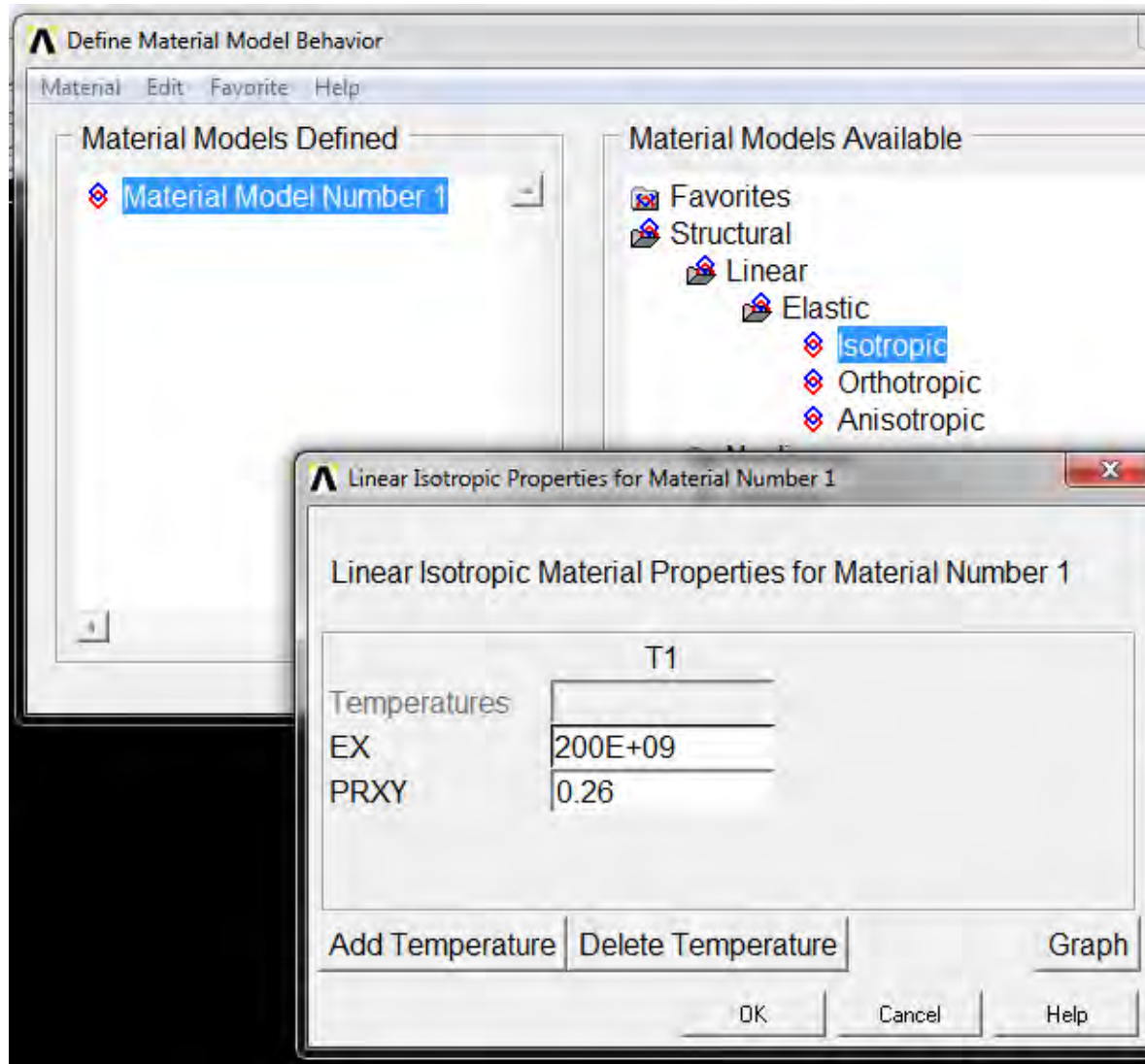


x_o = Element x-axis if ESYS is not provided.

x = Element x-axis if ESYS is provided.

Element Shell181

Penentuan *Material Properties*



Penentuan Ukuran *Section* (profil dan plat)

The screenshot displays the Ansys Mechanical APDL interface. On the left, a 'SECTION PREVIEW' window shows a grid with a vertical profile. The legend indicates 'x = Centroid' and 'o = ShearCenter'. The 'SECTION PREVIEW DATA SUMMARY' lists the following properties:

- Area = .0019
- Iyy = .180E-05
- Iyz = -.107E-05
- Izz = .180E-05
- Warping Constant = .467E-10
- Torsion Constant = .637E-07
- Centroid Y = .023684
- Centroid Z = .023684
- Shear Center Y = .354E-03
- Shear Center Z = .354E-03
- Shear Corr. YY = .4419
- Shear Corr. YZ = -.00504
- Shear Corr. ZZ = .4419

On the right, the 'Beam Tool' dialog is open, showing the following settings:

- ID: 1
- Name: deckbeam
- Sub-Type: L
- Offset To: Location
- Offset-Y: 0
- Offset-Z: 0.96
- W1: 0.1
- W2: 0.1
- t1: 0.01
- t2: 0.01

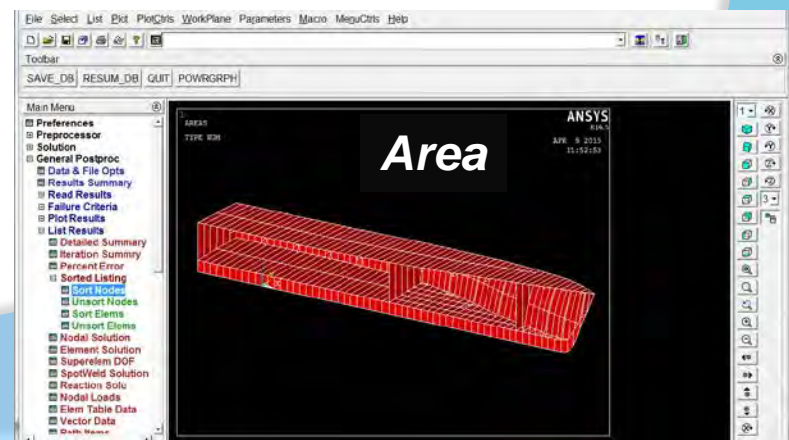
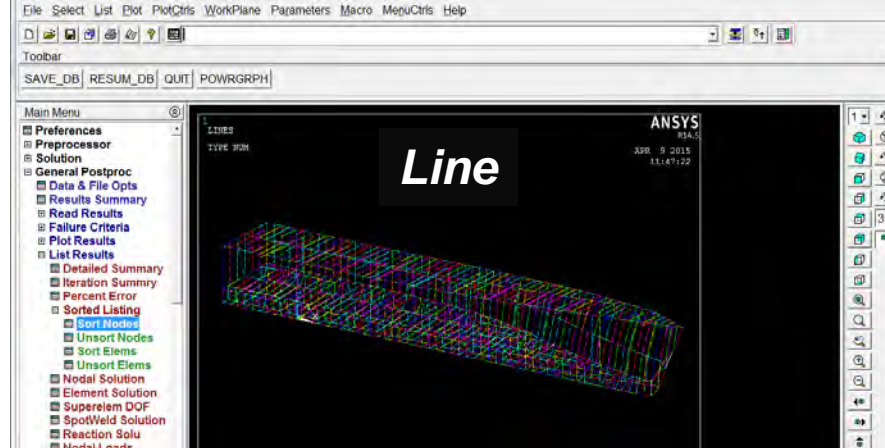
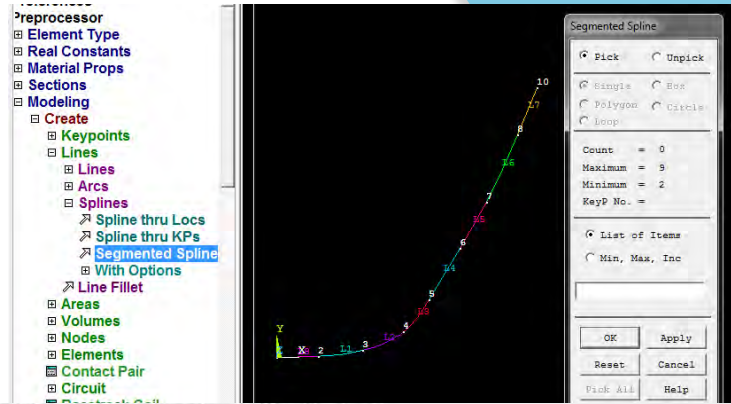
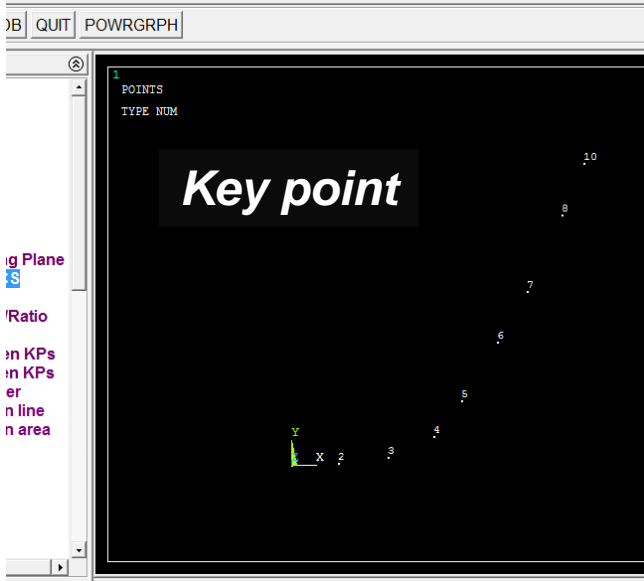
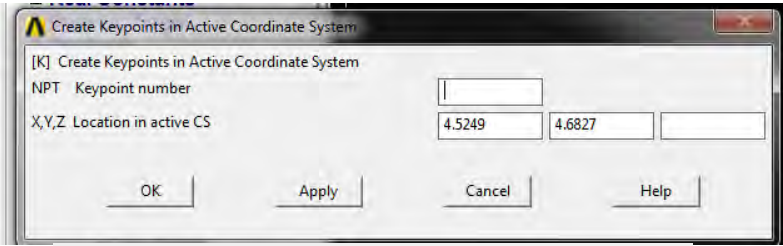
The dialog also includes a diagram of an L-section with dimensions W1, W2, t1, and t2, and buttons for 'Coarse', 'Fine', 'OK', 'Apply', 'Close', 'Preview', 'Help', and 'Meshview'.

The screenshot shows the 'Create and Modify Shell Sections' dialog box. The 'Layup' tab is selected, and the 'Section Controls' sub-tab is active. The dialog is titled 'Create and Modify Shell Sections' and has the following fields and controls:

- Name: plat bottom
- ID: 1
- Table with columns: Thickness, Material ID, Orientation, Integration Pts, Pictorial View
- Buttons: Add Layer, Delete Layer
- Section Offset: Mid-Plane (dropdown), User Defined Value: []
- Section Function: None defined (dropdown), KCN or Node: []
- Buttons: OK, Cancel, Help

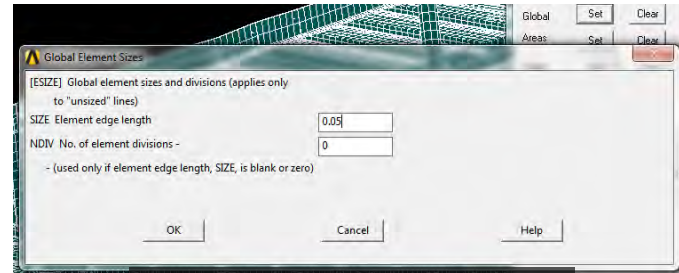
	Thickness	Material ID	Orientation	Integration Pts	Pictorial View
1	0.01	1	0.0	3	

Modeling

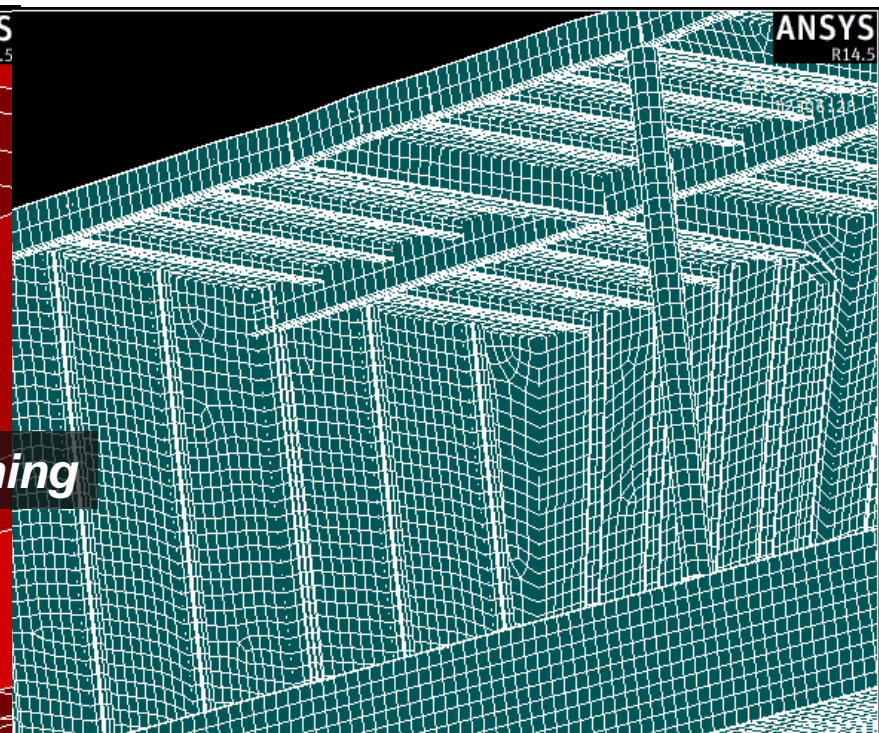
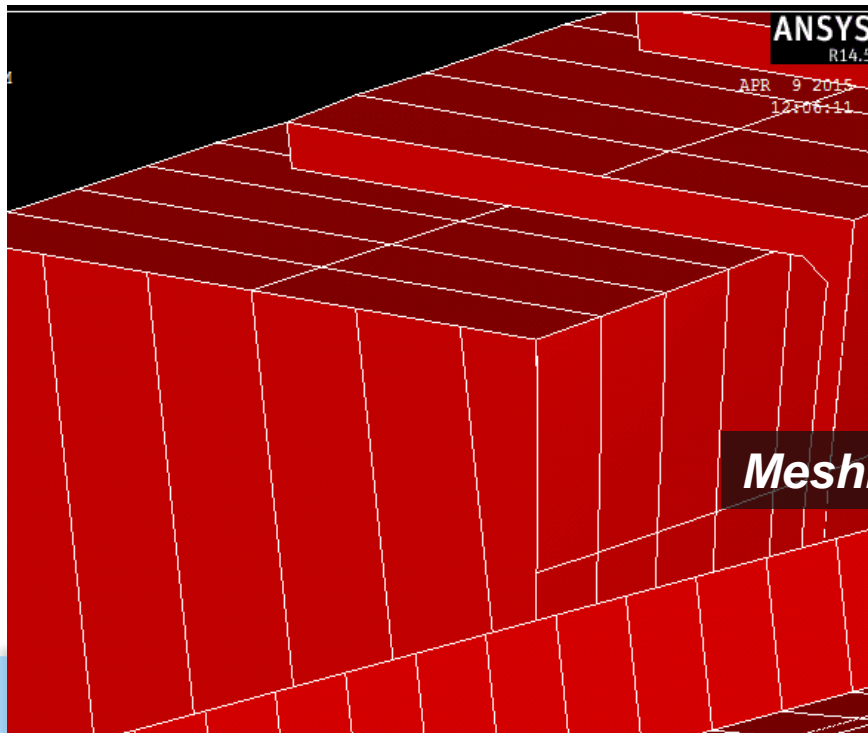


Meshing

Mesh attribute



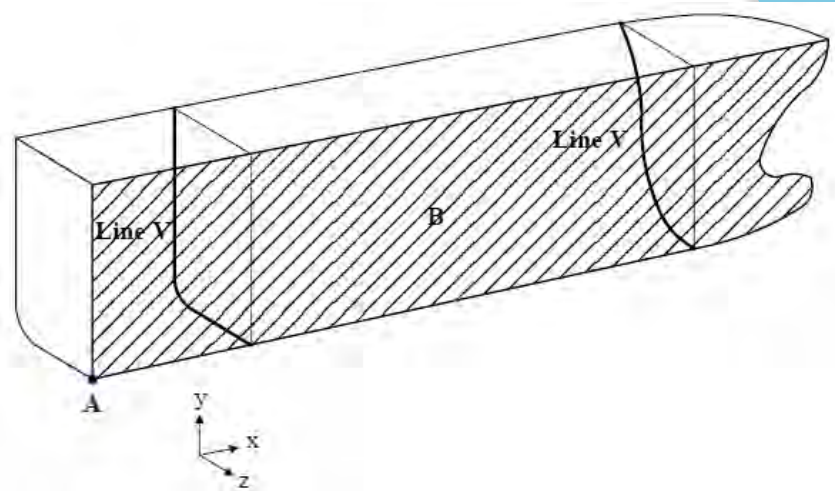
Mesh size control



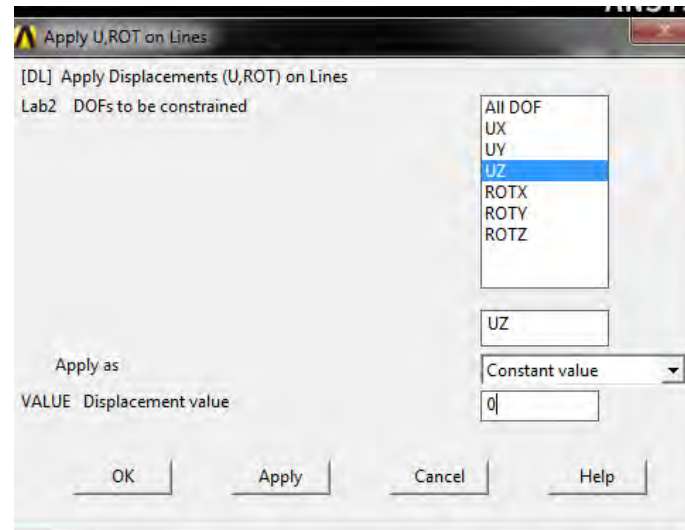
Meshing

Penentuan Kondisi Batas

Point A	$UX = 0, UY = 0$
Line V	Attach spring rod elements
Section B	$UZ = 0, RX = 0, RY = 0$



Guide for Slamming Loads And Strength Assessment For Vessels (2013) - ABS



Input Beban

Class Lloyd's Register - Rules and Regulations for the Classification of Special Service Craft, July 2014

$$P_{dh} = \Phi_{dh} \left(19 - 2720 \left(\frac{T_x}{L_{WL}} \right)^2 \right) \sqrt{L_{WL} V} \quad \text{kN/m}^2$$

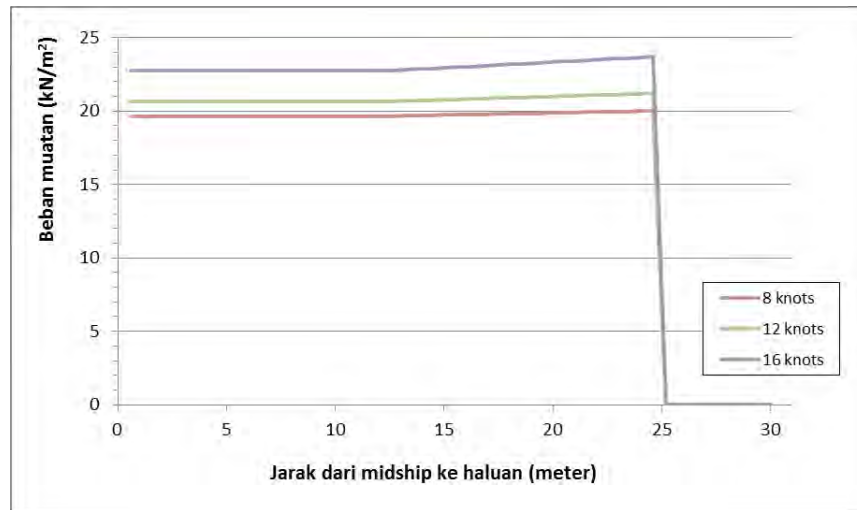
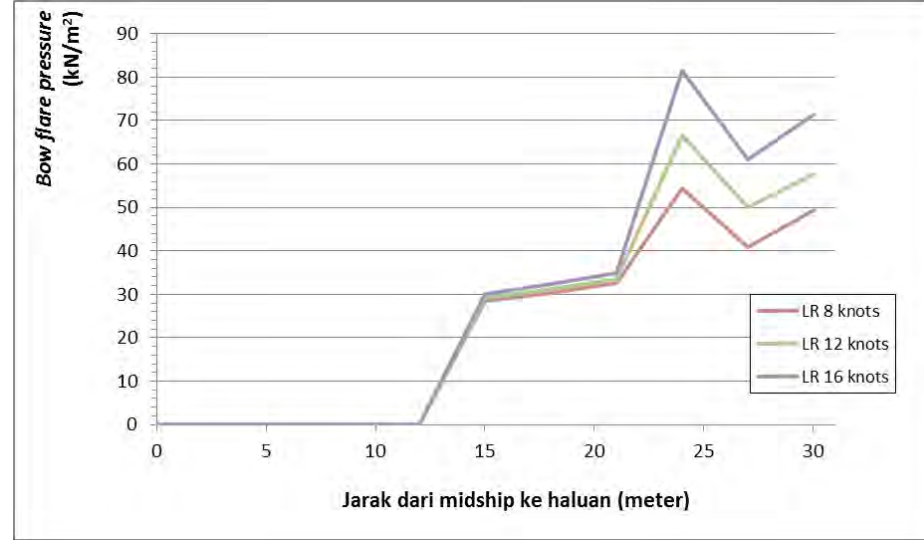
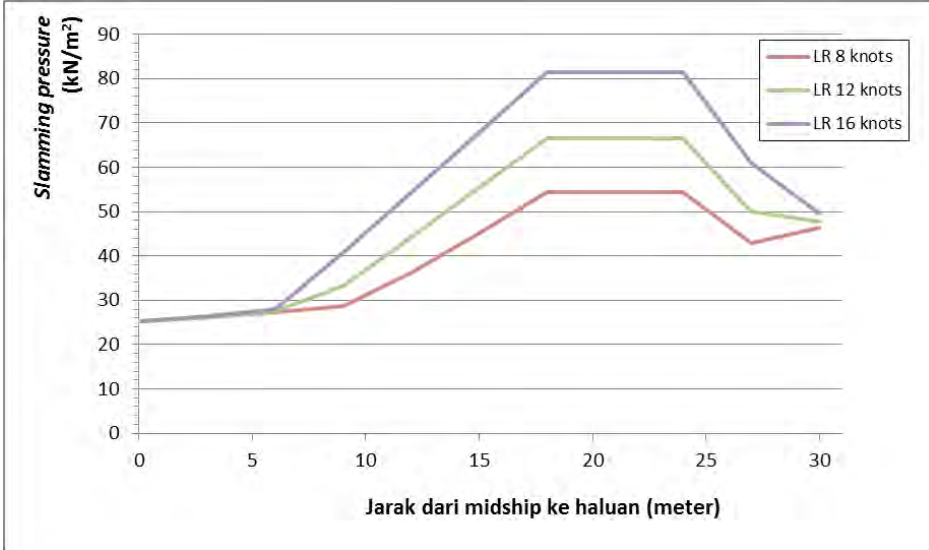
$$\begin{aligned} \Phi_{dh} &= 0,09 \text{ at } L_{WL} \text{ from aft end of } L_{WL} \\ &= 0,18 \text{ at } 0,9L_{WL} \text{ from aft end of } L_{WL} \\ &= 0,18 \text{ at } 0,8L_{WL} \text{ from aft end of } L_{WL} \\ &= 0,0 \text{ between aft end of } L_{WL} \text{ and } 0,5L_{WL} \text{ from aft end} \\ &\quad \text{of } L_{WL} \end{aligned}$$

Beban muatan berdasarkan *Class Biro Klasifikasi Indonesia – Rules for The Classification and Contruction of Seagoing Steel Ships, Volume II (2014)*.

$$P_i = 9.81 \cdot (G/V) \cdot h \cdot (1 + a_v)$$

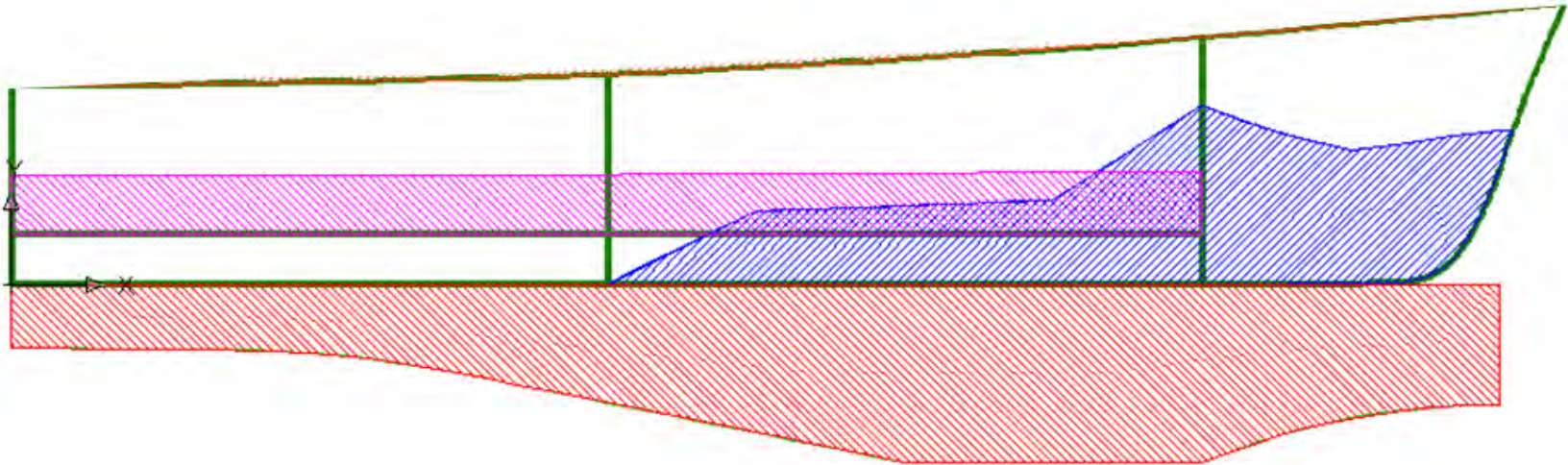
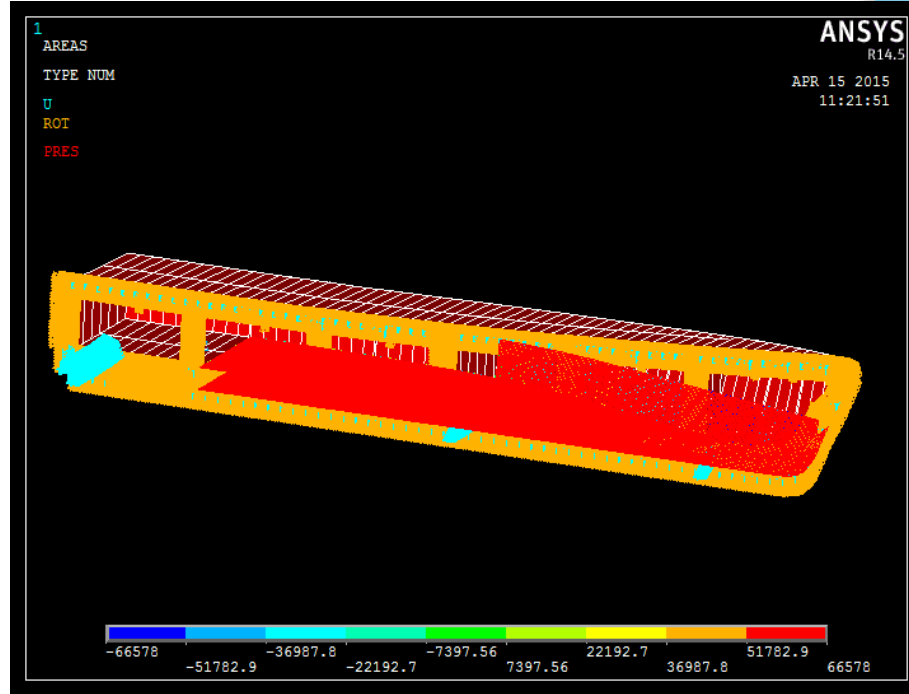
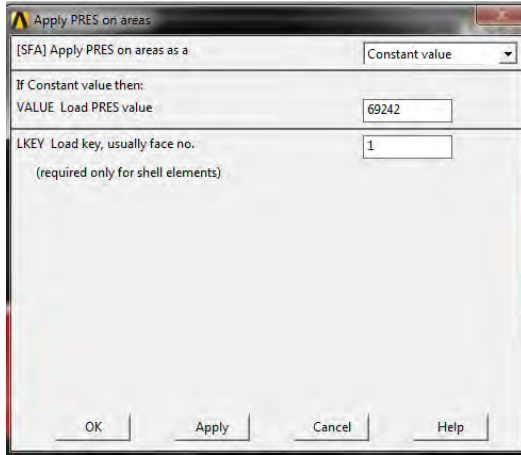
Input Beban

lanjutan...

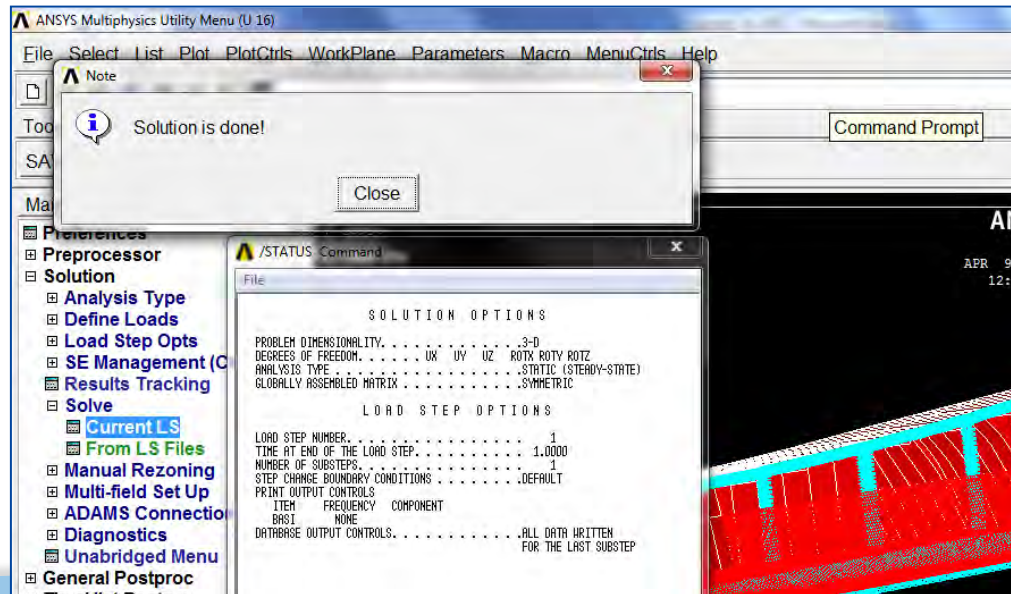
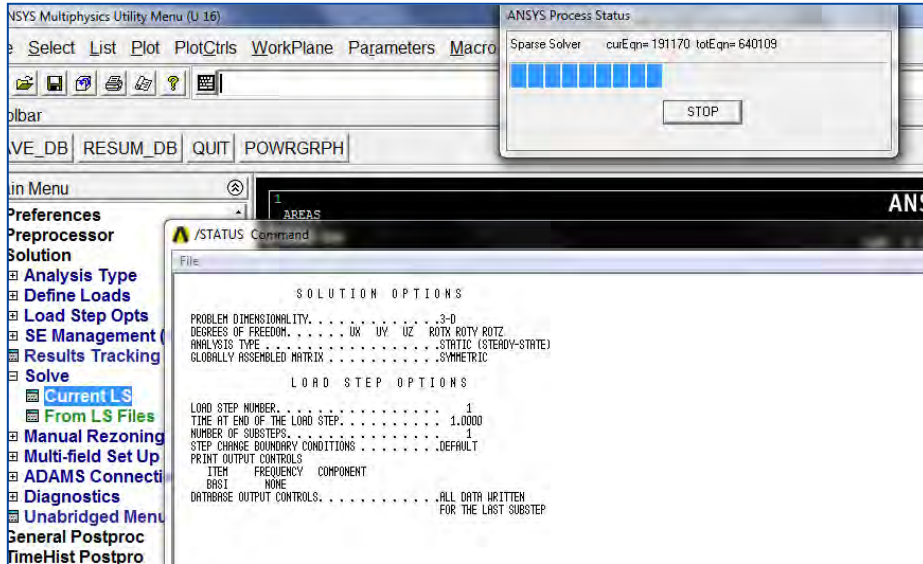


Input Beban

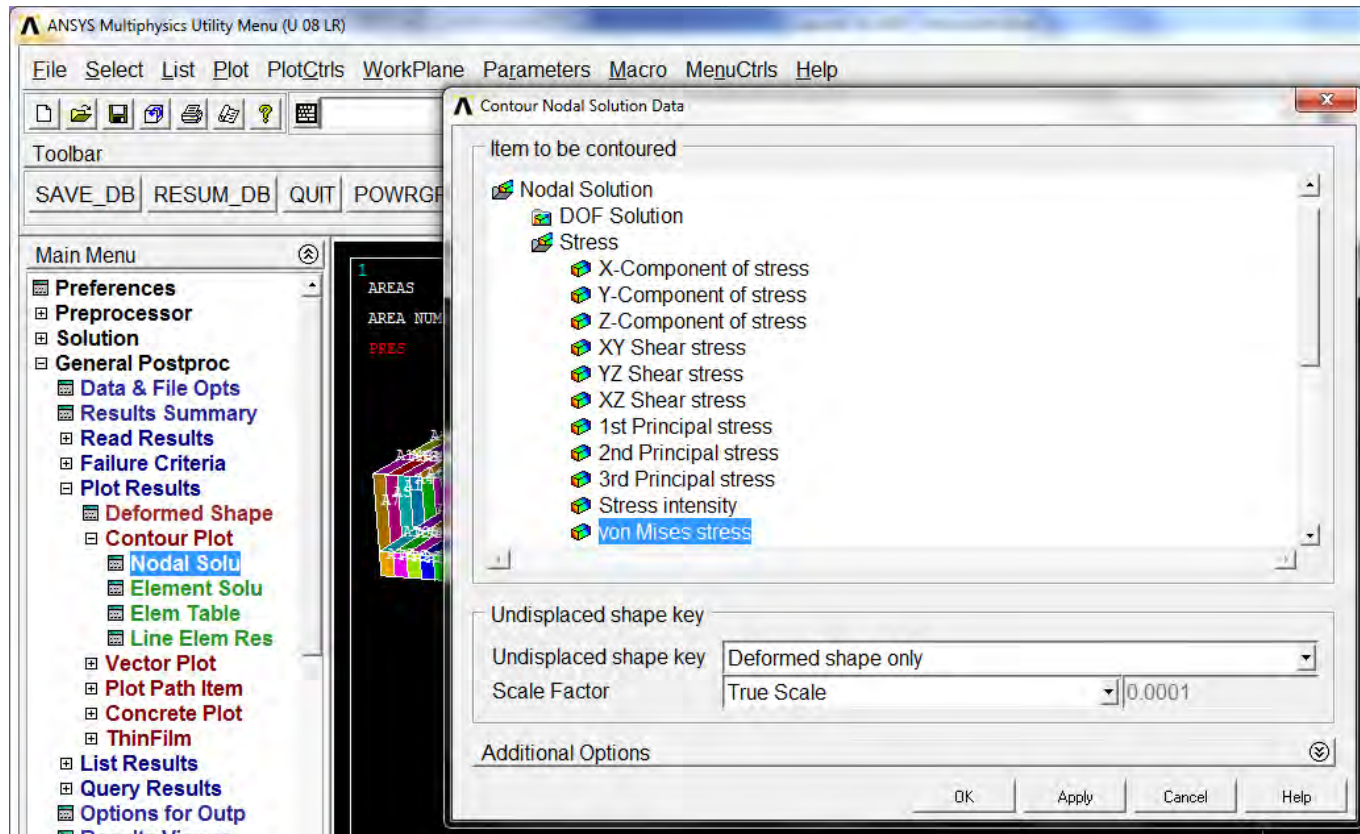
lanjutan...



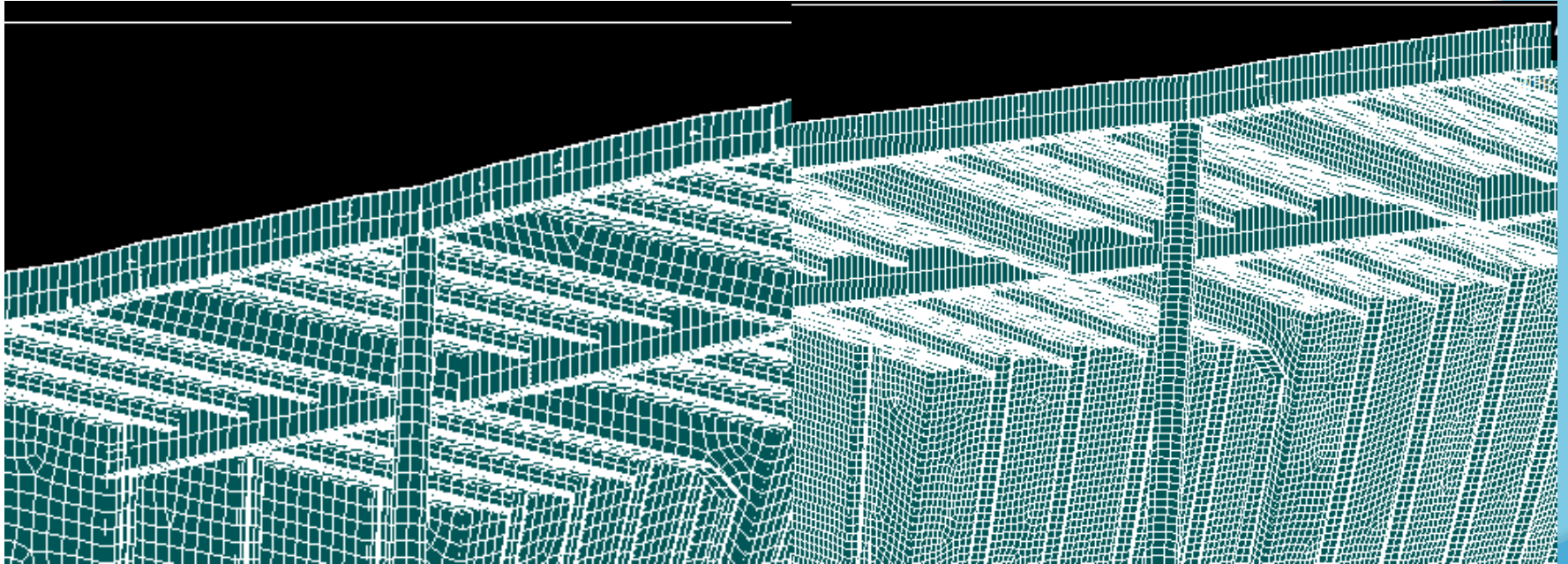
Running



Pembacaan Hasil



KONVERGENSI

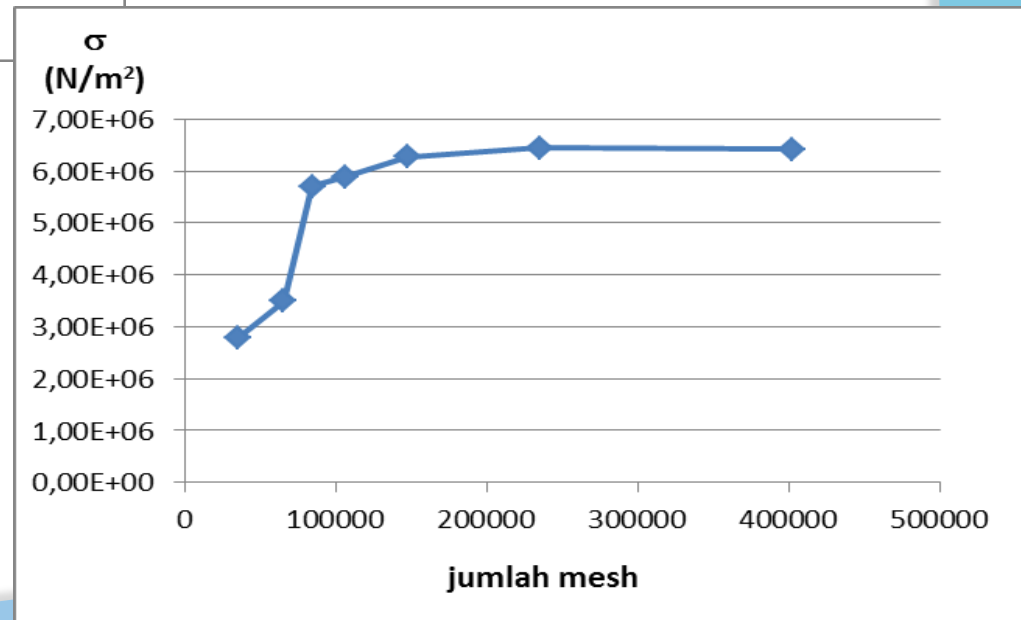
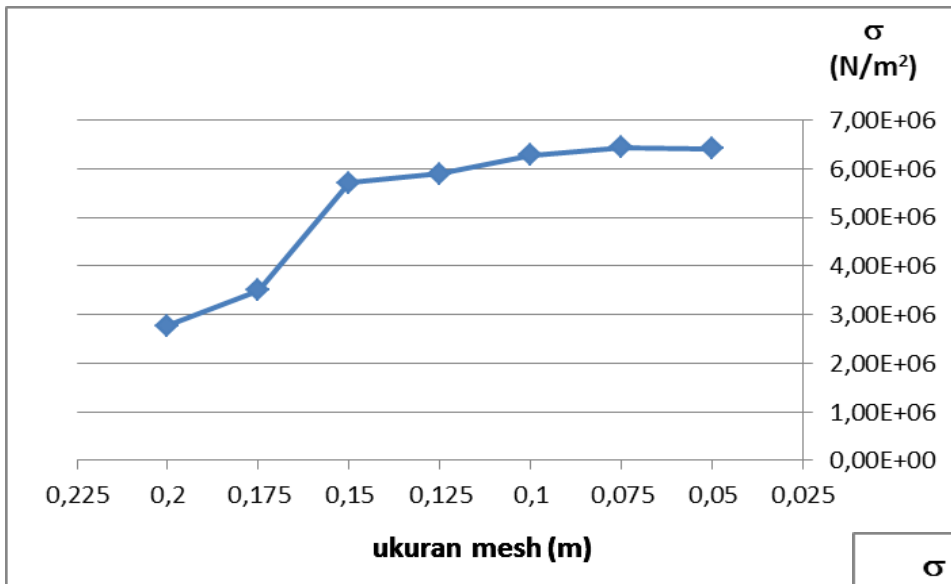


0,1 meter

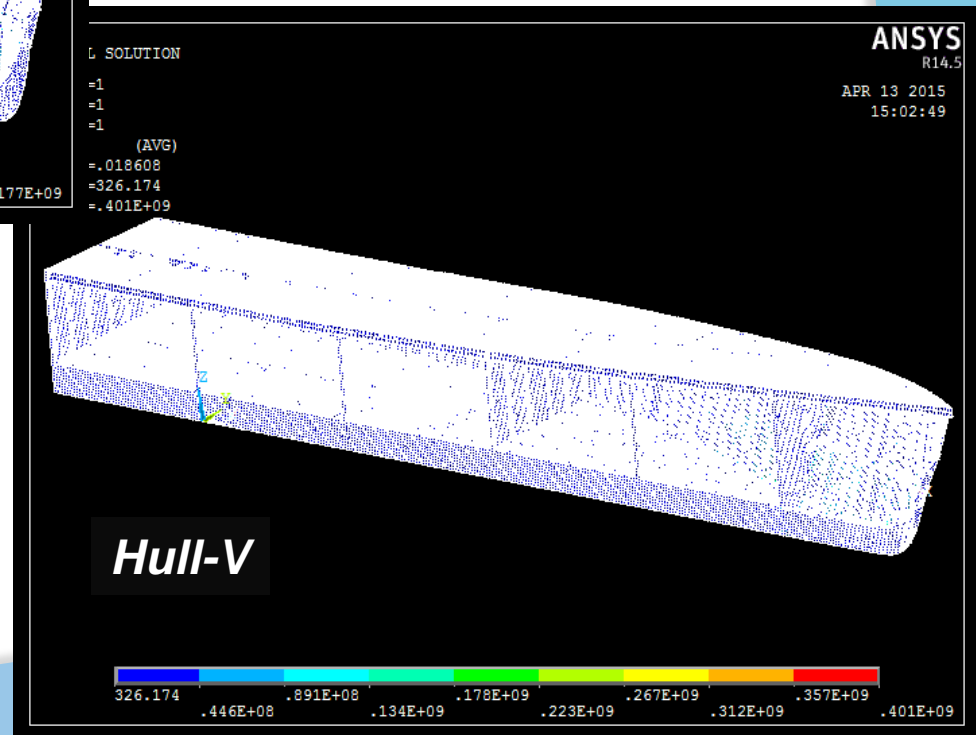
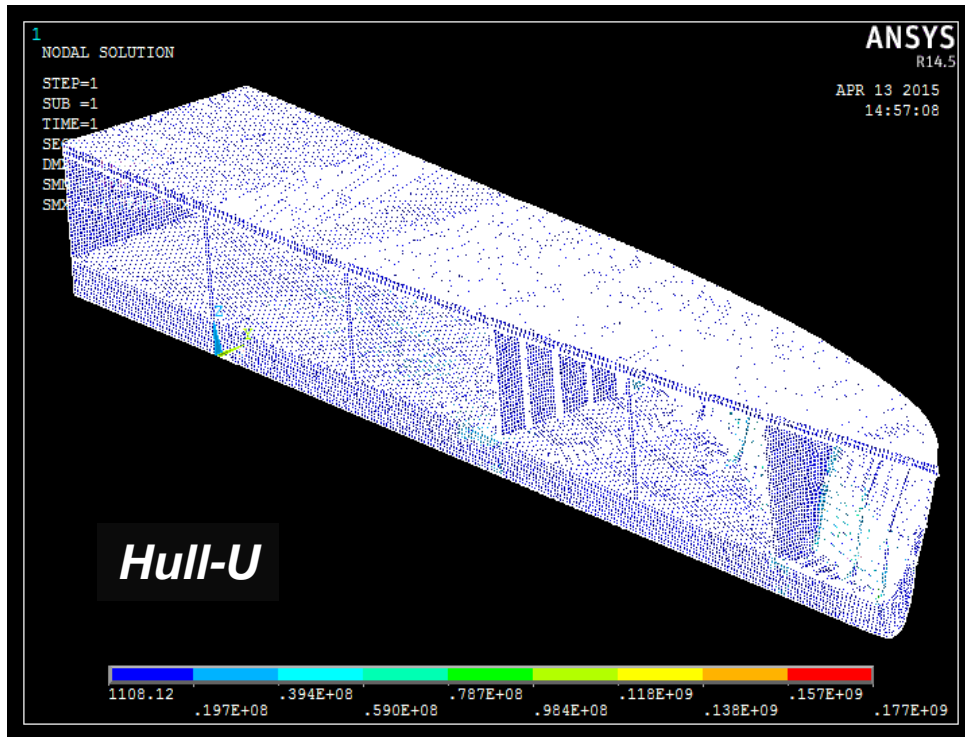
0,05 meter

KONVERGENSI

lanjutan...

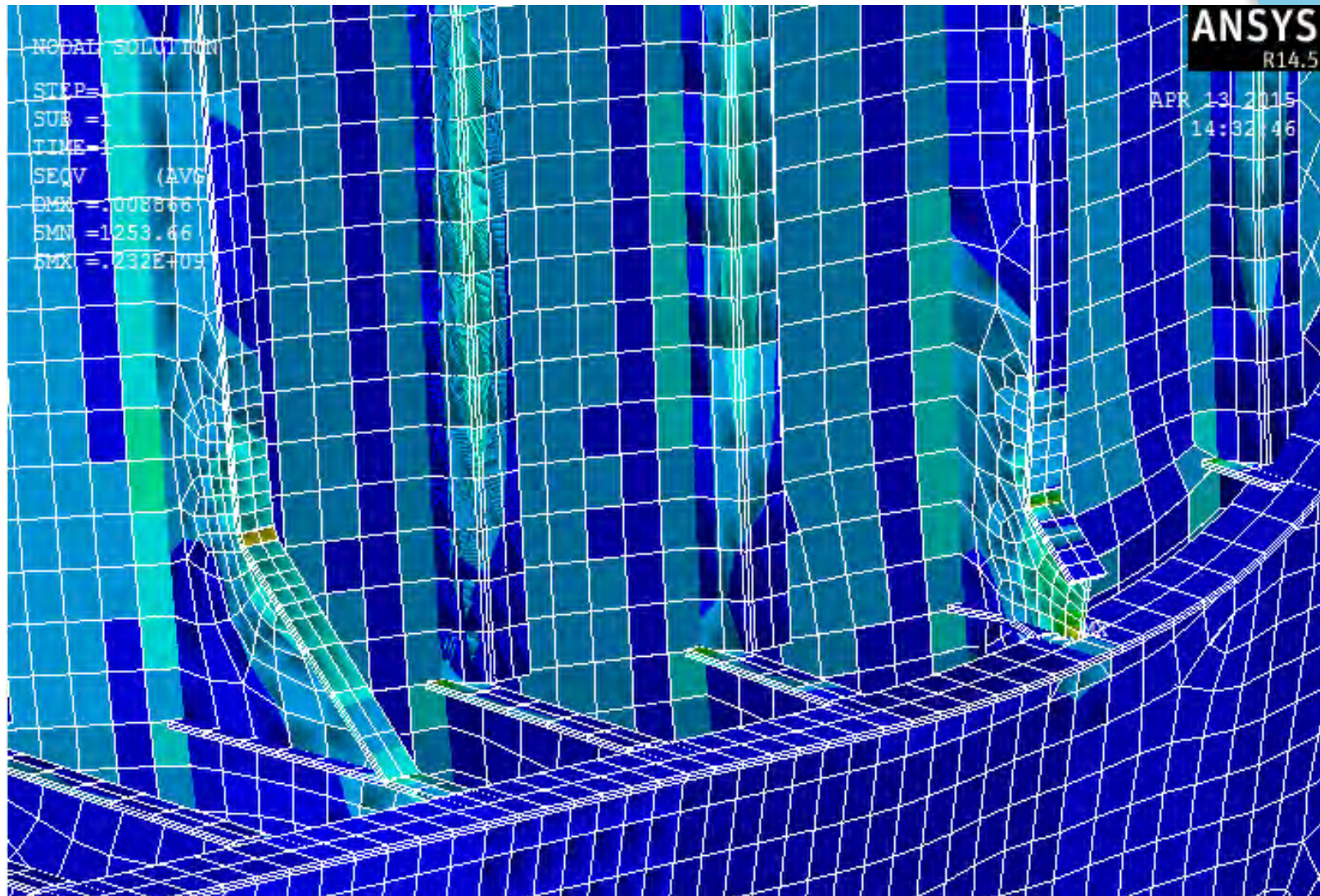


Perbandingan Hasil Tegangan



Perbandingan Hasil Tegangan

lanjutan...



Pembacaan Hasil

lanjutan...

The screenshot displays the ANSYS Multiphysics Utility Menu (U 08 LR) interface. The main menu on the left includes options like Plot Results, List Results, and Query Results. The PRNSOL Command window is open, showing the output of the POST1 NODAL STRESS LISTING command. A black box with the text 'List Result' is overlaid on the command window. The output text includes parameters like LOAD STEP= 1, TIME= 1.0000, and a table of nodal stress results for various nodes.

File Select List Plot PlotCtrls WorkPlane Parameters Macro MenuCtrls Help

Toolbar

SAVE_DB RESUM_DB QUIT POWR

Main Menu

- Plot Results
- List Results
 - Detailed Summary
 - Iteration Summary
 - Percent Error
 - Sorted Listing
 - Sort Nodes
 - Unsort Nodes
 - Sort Elems
 - Unsort Elems
 - Nodal Solution
 - Element Solution
 - Superelem DOF
 - SpotWeld Solution
 - Reaction Solu
 - Nodal Loads
 - Elem Table Data
 - Vector Data
 - Path Items
 - Linearized Strs
- Query Results
- Options for Outp
- Results Viewer
- Nodal Calcs
- Element Table
- Path Operations
- Surface Operations

PRNSOL Command

File

**** POST1 NODAL STRESS LISTING ****

LOAD STEP= 1 SUBSTEP= 1
TIME= 1.0000 LOAD CASE= 0
SHELL NODAL RESULTS ARE AT TOP

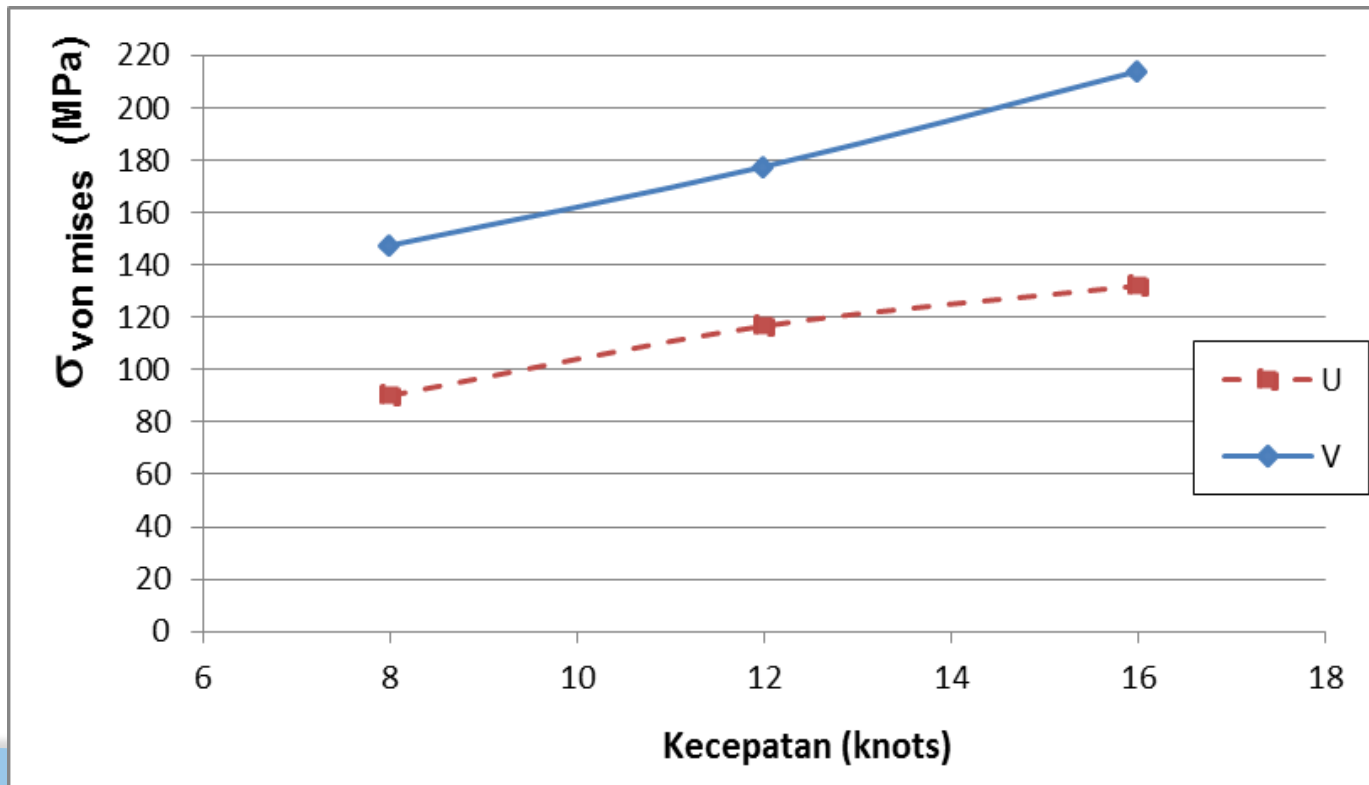
List Result

NODE	S1	S2	S3	SINT	SEQV
113289	0.54137E+07	0.23057E+02	0.11391E+09	0.11933E+09	0.11671E+09
5305	-0.82484E+03	-0.25393E+08	-0.11831E+09	0.11831E+09	0.10787E+09
5304	-0.89082E+03	-0.18628E+08	-0.11436E+09	0.11436E+09	0.10628E+09
5490	0.57970E+07	0.14210E+02	0.93691E+08	0.99488E+08	0.96720E+08
107048	0.67240E+08	473.76	-0.37461E+08	0.10470E+09	0.91888E+08
110468	0.73243E+08	0.59668E+06	-0.27371E+08	0.10061E+09	0.89952E+08
110469	0.69833E+08	0.50465E+06	-0.30715E+08	0.10055E+09	0.89358E+08
99982	0.53241E+08	-0.21641E+07	-0.48826E+08	0.10207E+09	0.88500E+08
107042	0.57061E+08	-269.10	-0.44426E+08	0.10149E+09	0.88117E+08
107043	0.44033E+08	-495.19	-0.55962E+08	0.99994E+08	0.86803E+08
5488	0.16243E+08	0.36086E+03	-0.77323E+08	0.93566E+08	0.86595E+08
110470	0.61390E+08	-0.16963E+07	-0.37318E+08	0.98708E+08	0.86580E+08
100634	0.44864E+08	-7043.2	-0.54884E+08	0.99748E+08	0.86529E+08
113310	-0.16061E+01	-0.49795E+06	-0.86578E+08	0.86578E+08	0.86330E+08
110467	0.75400E+08	0.23624E+07	-0.19840E+08	0.95240E+08	0.86308E+08
107047	0.77204E+08	960.28	-0.15444E+08	0.92648E+08	0.85972E+08
107037	0.32880E+08	-432.98	-0.64379E+08	0.97259E+08	0.85688E+08
5491	-0.10544E+02	-0.82115E+07	-0.89358E+08	0.89358E+08	0.85548E+08
100628	0.40842E+08	-105.44	-0.57130E+08	0.97971E+08	0.85235E+08
107049	0.62537E+08	446.44	-0.34467E+08	0.97004E+08	0.85173E+08
100640	0.47962E+08	-4142.9	-0.50164E+08	0.98126E+08	0.84987E+08
107026	0.15467E+08	-56.093	-0.75958E+08	0.91425E+08	0.84757E+08
107020	0.12365E+08	28.490	-0.77597E+08	0.89962E+08	0.84461E+08
108622	-3533.8	-0.48041E+08	-0.97076E+08	0.97072E+08	0.84068E+08
25024	0.74100E+08	14473.	-0.16819E+08	0.90920E+08	0.83781E+08
108616	-3105.5	-0.43980E+08	-0.96479E+08	0.96476E+08	0.83659E+08
107032	0.18815E+08	-235.22	-0.72476E+08	0.91291E+08	0.83489E+08
107014	0.92873E+07	18.602	-0.78121E+08	0.87408E+08	0.83154E+08
107031	0.24805E+08	-204.73	-0.67825E+08	0.92630E+08	0.83054E+08
25026	0.73351E+08	15520.	-0.16827E+08	0.90178E+08	0.83048E+08
108628	-3430.1	-0.50664E+08	-0.95812E+08	0.95809E+08	0.83019E+08
92460	0.59969E+08	-0.14609E+07	-0.34059E+08	0.94029E+08	0.82697E+08
110479	0.40809E+08	-11943.	-0.54005E+08	0.94863E+08	0.82419E+08
92459	0.60900E+08	-0.15558E+07	-0.32388E+08	0.93287E+08	0.82322E+08
78658	0.92577E+08	0.28562E+08	0.76542E+03	0.92577E+08	0.82110E+08
93955	0.53855E+08	-280.42	-0.40642E+08	0.94467E+08	0.82078E+08
110466	0.76282E+08	0.45373E+07	-0.13143E+08	0.89426E+08	0.82027E+08

Perbandingan Hasil Tegangan

lanjutan...

Hull	U			V		
Speed (knots)	8	12	16	8	12	16
Tegangan max (Mpa)	90,112	116,7	132,11	147,5	177,6	214,05
Node number	113289			114183		
Posisi	Sambungan Webframe dengan wrang pada 0,97 L					



Perbandingan Hasil Tegangan

lanjutan...

Rule – BKI Vol II *Rules for Hull* (2014) memberikan batas tegangan ijin untuk kapal $L < 90$ m

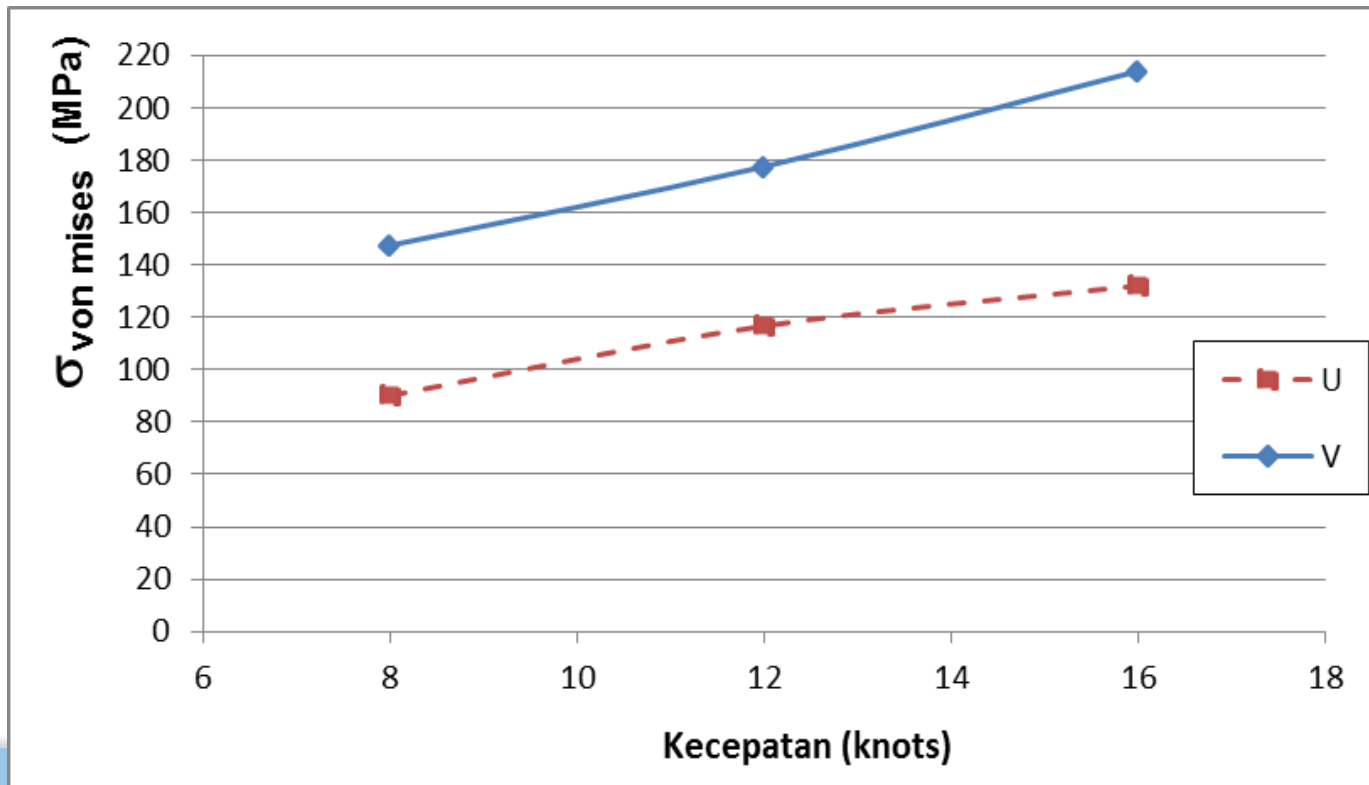
$$\begin{aligned}\sigma_{\text{ijin}} &= 18,5 \frac{\sqrt{L}}{k} \\ L &= 60 \text{ meter} \\ K &= 1 \\ \sigma_{\text{ijin}} &= 18,5 \cdot (60)^{(1/2)} / 1 \\ &= 143,3 \text{ Mpa}\end{aligned}$$

lambung **U memenuhi** kriteria tegangan ijin untuk semua kondisi kecepatan dinas. Untuk lambung **V**, nilai tegangan ijinnya **tidak memenuhi** untuk semua kondisi kecepatan

Perbandingan Hasil Tegangan

lanjutan...

Hull	U			V		
Speed (knots)	8	12	16	8	12	16
Tegangan max (Mpa)	90,112	116,7	132,11	147,5	177,6	214,05
Node number	113289			114183		
Posisi	Sambungan Webframe dengan wrang pada 0,97 L					



Perbandingan Hasil Tegangan

lanjutan...

Lambung **V** adalah lambung yang mempunyai bentuk **lebih mematah**. Hal tersebut yang menyebabkan **tegangannya** lebih **tinggi** dari pada lambung berbentuk **U**. Seperti halnya mendesain sebuah **terowongan**, kebanyakan lebih memilih bentuk **tumpul** atau **circular** dari pada bentuk yang memiliki **sudut**.

Perbandingan *Fatigue*

Hull	U			V		
Speed (knots)	8	12	16	8	12	16
S_0 (Mpa)	90,112	116,7	132,11	147,5	177,6	214,05
Node number	113289			114183		
Posisi	Sambungan Webframe dengan wrang pada 0,97 L					
SCF	1,1	1,1	1,1	1,1	1,1	1,1
$S_1 = S_0 \times SCF$ (Mpa)	99,1232	128,37	145,321	162,25	195,36	235,455
K	1,57E+11	1,57E+11	1,57E+11	1,57E+11	1,57E+11	1,57E+11
m	3	3	3	3	3	3
Log K	11,197	11,197	11,197	11,197	11,197	11,197
m Log S	5,988526	6,325391	6,486985	6,630554	6,872507	7,115724
Log N	5,208479	4,871614	4,71002	4,566451	4,324498	4,081281
N_0	161613,9	74407,05	51288,45	36851,11	21110,46	12058,16
Tebal Plat	10	10	10	10	10	10
N	291941,5	134409,9	92648,12	66568,32	38134,21	21782,01
Jumlah Slamming / tahun	2314	13562	37819	1694	10721	31007
Umur (tahun)	126,1631	9,910769	2,449777	39,29653	3,556964	0,702487

Perbandingan *Fatigue*

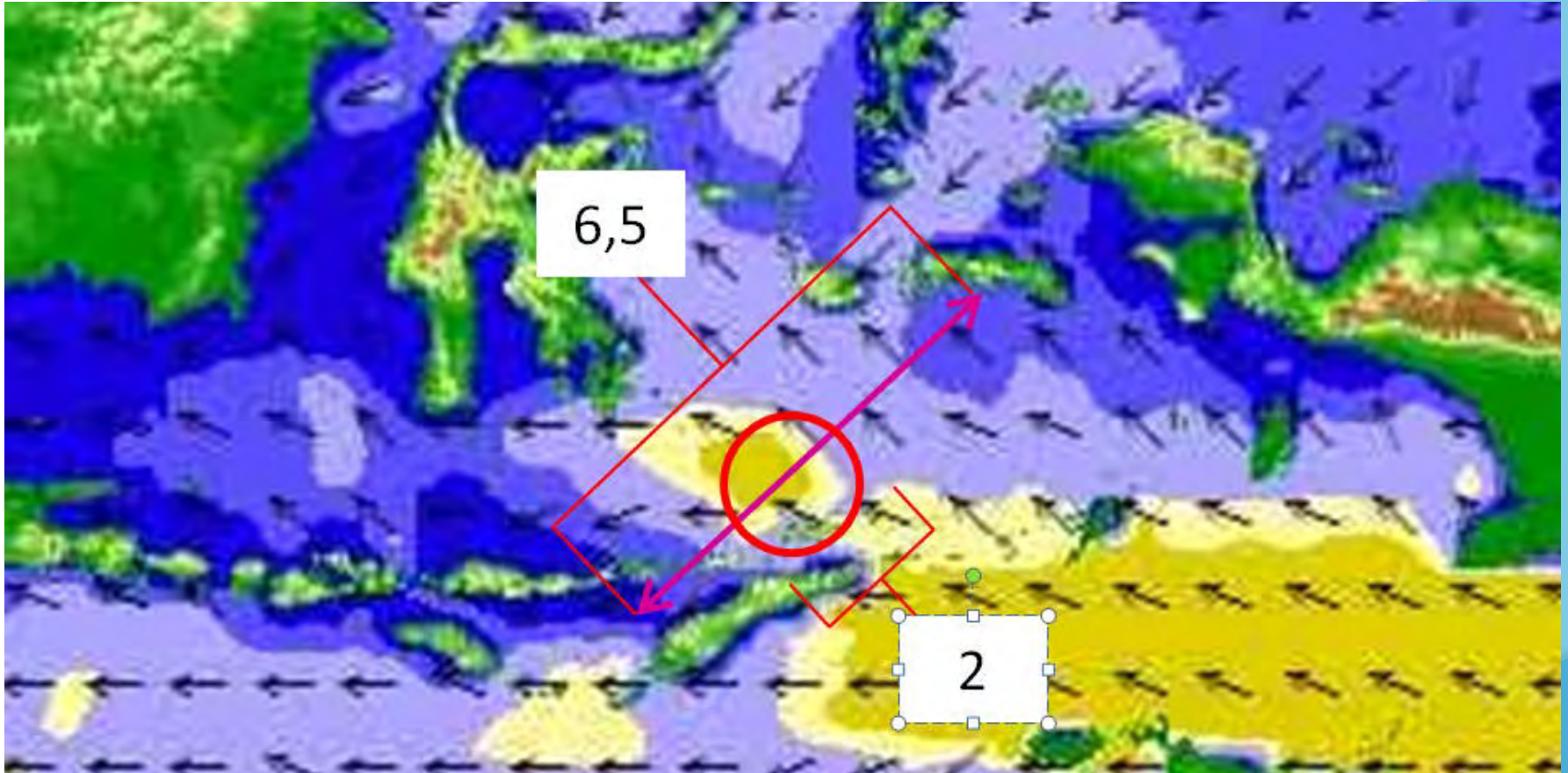
lanjutan...

Jika kapal diperhitungkan waktu pelayarannya dengan asumsi sebagai berikut :

1. Rute : Kupang – Ambon – Kupang
2. Jarak : 2 x 487 nm
3. Jadwal pelayaran : seminggu satu kali rute pulang pergi
4. Waktu docking : 1 bulan = 4 minggu
5. Areal bergelombang : 2/6,5 rute
6. 1 tahun : 52 minggu

Perbandingan *Fatigue*

lanjutan...



Perbandingan *Fatigue*

lanjutan...

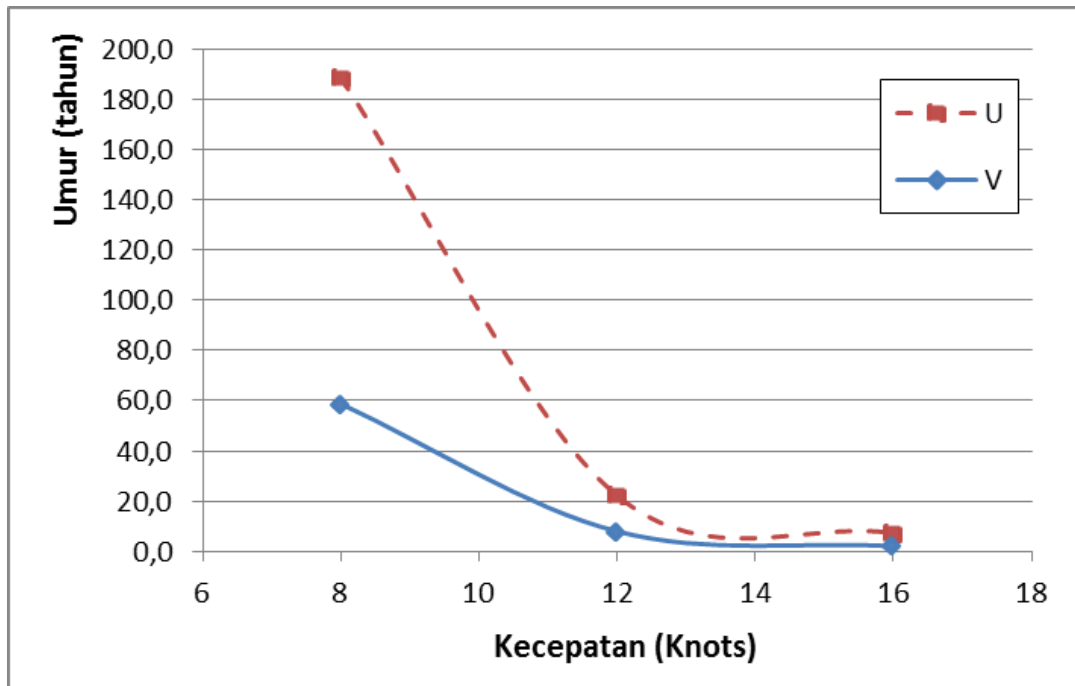
jumlah *slamming* per tahun =

jumlah *slamming* pertahun awal x $\left[\frac{52 \text{ minggu} - 4 \text{ minggu}}{2 \times 487 \text{ nm} / (\text{kecepatan kapal} \times 24 \text{ jam} \times 7 \text{ hari})} \right]$
/ 52 minggu

Perbandingan *Fatigue*

lanjutan...

Lambung	U			V		
Kecepatan (knots)	8	12	16	8	12	16
Jumlah <i>slamming</i> / tahun awal	2314	13562	37819	1694	10721	31007
Jumlah <i>slamming</i> / tahun setelah diasumsi	1548	6048	12650	1134	4781	10371
N	291941,5	134409,9	92648,12	66568,32	38134,21	21782,01
Umur (tahun)	188,6	22,2	7,3	58,7	8,0	2,1



Lambung **V** harus diberi **penguat tambahan** agar tegangannya tidak terlalu besar

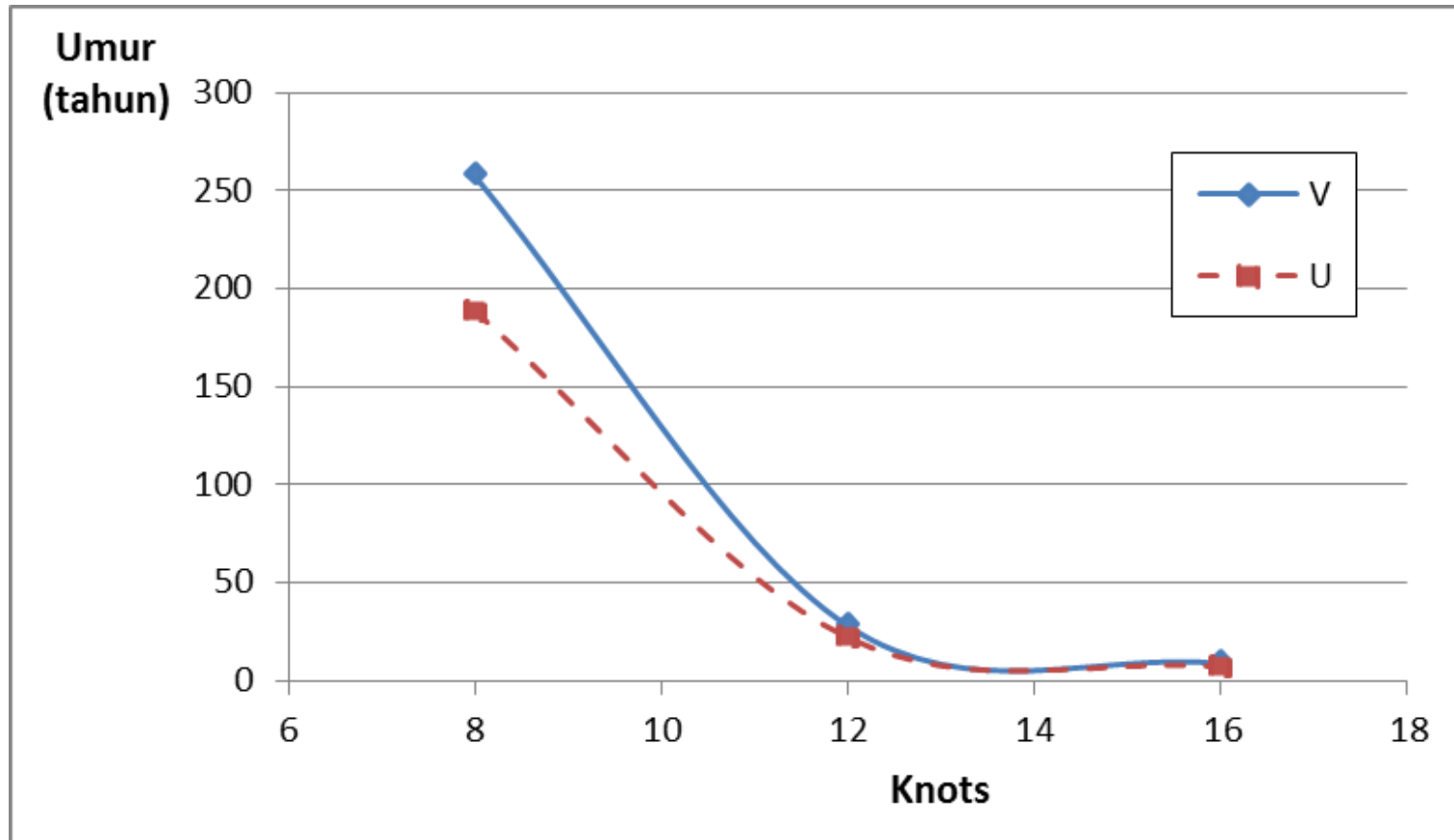
Perbandingan *Fatigue*

lanjutan...

Hull	U			V		
Speed (knots)	8	12	16	8	12	16
S_0 (Mpa)	90,112	116,7	132,11	90,112	116,7	132,11
Node number	113289			114183		
Posisi	Sambungan Webframe dengan wrang pada 0,97 L					
SCF	1,1	1,1	1,1	1,1	1,1	1,1
$S_1 = S_0 \times SCF$ (Mpa)	99,1232	128,37	145,321	99,1232	128,37	145,321
K	1,57E+11	1,57E+11	1,57E+11	1,57E+11	1,57E+11	1,57E+11
m	3	3	3	3	3	3
Log K	11,197	11,197	11,197	11,197	11,197	11,197
m Log S	5,988526	6,325391	6,486985	5,988526	6,325391	6,486985
Log N	5,208479	4,871614	4,71002	5,208479	4,871614	4,71002
N_0	161613,9	74407,05	51288,45	161613,9	74407,05	51288,45
Tebal Plat	10	10	10	10	10	10
N	291941,5	134409,9	92648,12	291941,5	134409,9	92648,12
Jumlah Slamming / tahun	1548	6048	12650	1134	4781	10371
Umur (tahun)	188,5927	22,22385	7,323962	257,444	28,11334	8,933383

Perbandingan *Fatigue*

lanjutan...



KESIMPULAN

1. Lambung kapal berbentuk **U** mempunyai **peluang**, **jumlah** dan **tekanan *slamming* lebih besar** dari pada lambung kapal berbentuk **V**.
2. Untuk beban yang sama, lambung kapal berbentuk **V** memiliki **tegangan lebih besar** dari pada lambung kapal berbentuk **U**.
3. Untuk beban yang sama namun intensitas berbeda, lambung kapal berbentuk **U** mempunyai harga ***fatigue life* lebih lama** dari pada lambung kapal berbentuk **V**.

Terima Kasih