BACHELOR THESIS & COLLOQUIUM – ME141502

COMPARISON OF ACTIVE TANK AND PASSIVE TANK FOR STABILIZER SYSTEM IN A LANDING SHIP TANK

RIZQULLAH ACARYATAMA
NRP. 04211641000010

Supervisor
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DOUBLE DEGREE PROGRAM
DEPARTMENT OF MARINE ENGINEERING
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
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FAKULTAS TEKNOLOGI KELAUTAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
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VALIDITY SHEET

Comparison of Active Tank and Passive Tank for Stabilizer System in a Landing Ship Tank

Submitted to fulfill the requirement
a Bachelor's Degree in Engineering
on
Field Studi *Marine Machinery and System* (MMS)
Department of Marine Engineering S-1 Double Degree Program
Faculty Marine Technology
Institute Technology Sepuluh Nopember

By:
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   NIP. -

Surabaya, 19 Agustus 2020

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SURABAYA
AGUSTUS 2020

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COMPARASION OF ACTIVE TANK AND PASSIVE TANK FOR STABILIZER SYSTEM IN A LANDING SHIP TANK

Nama mahasiswa : Rizqullah Acaryatama
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2. Achmad Baidowi, S.T., M.T.

ABSTRACT

Landing Ship Tank is a Ship which can sailing in every weather condition at sea. This ship is carrying a cargo for navy. As specialy a Tank. So, this ship must be stable. In the ship have many ways to make the ship stable, and we called stablilizer. Stabilizer system can be an active tank, passive tank or using finds. In here I wanna have a active tank and passive tank to be analysis. I'm not using finds causes the cost is high. About active tank and passive tank they have a advantage and disadvantage. Active tank have good point for stable in the sea because the tank can be stable use a pump in the middle but the mins is higher cost to buy a pump and also high risk for leaking, for maintenance this tank more complex than the passive tank. Passive Tank is a nice stabilizer causes easy to build, fix water in side the tank. But the disadvantage is have noise in the tank which can be to noisy because of sloshing. So, I choosing this topic causes stabilizer in this ship is very important and interest to comparision two type of this tank. The function to compare this tank is I wanna to know which more better to use for aspect stable in the sea weather contition (significant wave high). For the data I analyse can be usefull for the ship. For all examination result I recommend to choosing case A to build causes that nearby the real design that also make more stable than case 5. In case A have respons time which roll velocity is value in every condition have this value: Quarter Wave equals 0.07245 rads/s, Side Wave equal 0.17554 rads/s, and for Front Wave equals 0 all case. And pitch velocity value case A is : Quarter Wave equal 0.01912 rads/s, Side Wave equals 0.02509 rads/s, and for Front Wave equals 0.04714 rads/s.

Keywords : Landing Ship Tank, Stabilizer, Active Tank, Passive Tank, Respons Time

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PREFACE

Praise is merely to the Allah SWT because of His grace, the author can finish this bachelor thesis with the title “Active Passive Tank” in order to fulfill the requirement of obtaining a Bachelor Engineering Degree on Department of Marine Engineering, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember.

The author realizes that this writing can not be solved without the support of various party for supporting the author morally and financially. Therefore, the author would like to thank to all people who has support, cheer the author, give the spirit mentally and spiritually for accomplishing this final project:

1. My lovely family whose already supports the author. My Father’s name Dr. Yusaq Tomo Ardianto, S.E., M.M. and My Mother’s name Trisnasari, S.H., M.Hum. whose always support, pay for author study and prayer to author. Also Satria Pinandita as author brother who give the author supports. All big family from father and mother grandparents who give pray to the author to make it done this major. As Specialy my great grandfather IR. Daryono and dr. Marditomo, S.THT. which support author never end.

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9. Ahmad Baihaqi as author friend and assist the love for him also the give support from the author.

10. Great amounts of friends that can’t be mentioned, for their support, help and ideas for this thesis.

The author realizes that this bachelor thesis remains far away from perfect.

Finally, may Allah SWT bestow His grace, contentment and blessings to all of us. Hopefully, this bachelor thesis can be advantageous for all of us particularly for the readers.

Surabaya, January 2020

Rizqullah Acaryatama

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CHAPTER I
INTRODUCTION

1.1 Background Overview

Ship Design is important to build a ship. Therefore the builder must know the part of the ship clearly and take a model of the ship nicely. In the ship it self have to much system. The example: electric sytem, ballast system, navigation system, pipe system, machinery system, fuel system, and so on.

Ship have to many system and component to make a ship float an that not make a ship be drowned. To make ship not be drowned have system called ballast system also make a ship balance. Ballast system is an important part in the ship causes the fuction of make a balance of the ship. The ballast system it self allows a ship to pump water for in and out in very large tank to compensate for a change in cargo load, shallow draft conditions, or the weather condition.

This capacity of ballast water is carrying millions of gallons on the tank. That allows vessels to carry a light or heavy load while maintenance ideal buoyancy and handling condition in all situation. The ship can be discharge all the ballast water tanks to pass shallow area or make the forward tanks only to raise the bow in rough open seas.

In this vessel it self is LST (Loading Ship Tank) which is the function of the car to a tank also can carry a soldier. LST itself can go through a battlefield with a large capacity of ship engine power as well.

Active and passive tank they have plus and minus. Active tank have good point for stable in the sea because the tank can be stable use a pump in the middle but the minus is higher cost to buy a pump also high risk for leaking, for the maintenance this tank more complex than the passive tank. Passive tank is a nice stabilizer causes easy to build, fix water in side the tank. But the minus is have noise in the tank which can be to noisy when sailing in the high wave sea weather condition.

I choosing this topic causes stabilizer in this ship is very important and I interest to comparasion two type of this tank. The function to compare this tank is I wanna to know which more better to use for the aspect stable in the sea weather condition (significant wave high). For the data I analyse can be usefull for this ship.

1.2 Reasearch Problem

Based on the background above the problem are:

1. How to compare technology between active and passive stabilizer system to landing ship tank

1.3 Reasearch Limitation

This final Project Limitations are:

1. Output Based on Standard

2. Variation high wave (Sea State 5)
3. Respons Time

1.4 Reseacrh Objectives

Based on problems mention above, the objectives of this project are:

1. LCT 90m
2. This research use Maxsurf modeller and Maxsurf Stability

1.5 Research Benefit

This final project is expected to give benefits for the various kind of parties. The benefit that can be obtained are:

1. Providing a stabilizer system in LCT which efficient to use.
2. To compare 6 passive tank and 3 active tank which solve another place to take stabilizer tank.

CHAPTER II
LITERATURE STUDY

2.1 Problem Overview

Landing Ship Tank (LST), known alternatively by its users as "large slow target","long slow target","large stationery target". It is largest beaching vessel capable of discharging cargo directly ashore and extracting itself.

Figure 2.1 of LST 90 m (Sister Ship)

Books Landing Ship, Tank (LST) 1942 – 2002

This Stabilizer system based of Hoppe Marine Technology. In Hoppe is a family owned group of companies with global presence and activities focused and dedicated to the maritime market. It's passion for Technology has been the company's key of success in more than six decades with the permanent motivation to deliver customer-oriented products and services.

Starting with the business idea to deliver precise instruments and measuring equipment for seagoing vessels (ship speed and power), Hoppe Bordmesstechnik was founded in 1949 by the German engineer Dipl.-Ing. Hans Hugo Karl Hoppe. The work life of Hans Hoppe was characterized by many technical inventions and patents for on-board measuring systems. After 35 years of successful work life Hans Hoppe passed away and his colleague Jürgen Haas took over the company and put things on the right track for the future of Hoppe. Four years later (1990) Helmut Rohde joined Hoppe as partner before finally taking over all shares of the company in 1997. The Hoppe era of the Rohde family business started.

Besides many years of organic growth the Rohde family established business in further maritime markets to follow the globalization of the shipbuilding business. In 1997 Hoppe Korea was established, followed by Hoppe China in 2010 and Hoppe Singapore in 2017. In parallel, strategic investments were made with the acquisitions of Meramont Automatyka (Poland), MAIHAK Marine (Germany), Flume Stabilization (USA) and INTERING ship stabilization systems (Germany). Combined with many new inventions and patents Hoppe has established a leading position in several maritime business areas.

The passion for technology is still unbroken and all Hoppe products are fully designed in Germany by our skilled engineers. This means that Hoppe has the full technical control over its portfolio and remains dedicated to quality, accuracy and reliability. With this approach Hoppe has maintained a very good market reputation ever since.

Being a fully independent family-owned company Hoppe is well known in the market as a reliable long-term partner. Hoppe combines decades of engineering know-how, sustainable on-board experiences with the continuous development of new technologies and innovations. Based on the strategic product- and service-focus approach Hoppe is a key player also in the digitalization process of the marine industry.

2.2 Passive Tank

Is tank which the position for the stabilizer sytem in the main deck and also the function for stability. The larger in the main deck of the ship and no pump for this ballast.

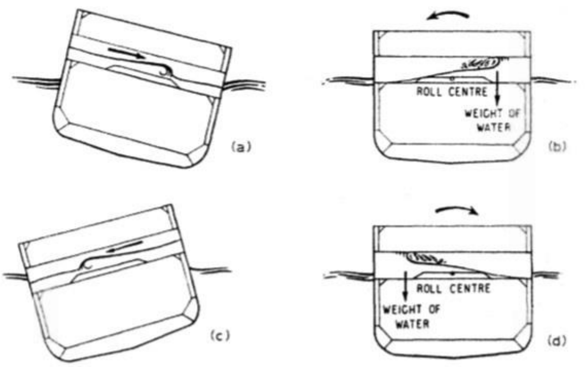

Figure 10.15 *Brown-NPL passive tank stabiliser: (a) Stern view of ship with passive tank rolled to starboard. The water is moving in the direction shown; (b) Ship rolling to port. The water in the tank on the starboard side provides a moment opposing the roll velocity; (c) Ship at the end of its roll to port. The water is providing no moment to the ship; (d) Ship rolling to starboard. The water in the tank on the port side provides a moment opposing the roll velocity.*

Figure 2.2 of Passive Tanks Works

2.3 Active Tank

In a simplified version of an active system, an accelerometer senses the rolling motions, and signals are sent from this roll-sensing device to a variable pitch pump, which controls the liquid flow between the tanks.

The device can be either a simple accelerometer or a complicated gyroscopic sensing system that detects even a small angle of the roll by the gyroscopic precession.

the device can be used to control ship motion due to every single wave. Depending on the sophistication of the system active tank stabilizers have been found to leave an efficiency of 80% or more in motion stabilization.

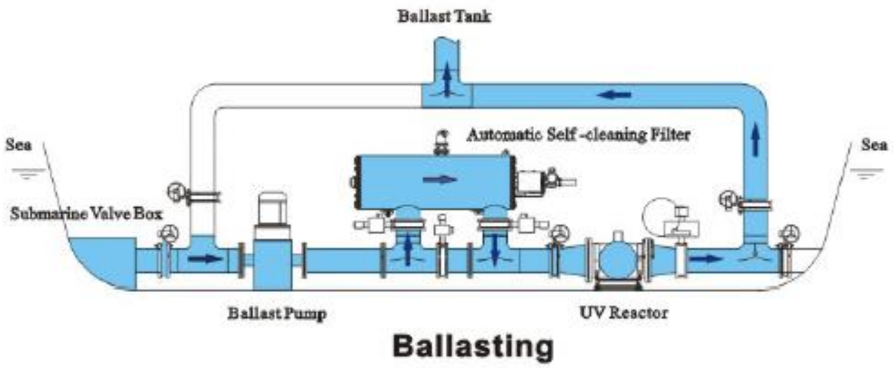

Figure 2.3 of Ballasting System

2.3.1 Heel Control

The portfolio ranges from cost-effective standard solutions to tailored and highly sophisticated systems for complex and specialized applications. Heel Control systems are designed to keep any kind of vessel or offshore structure upright with respect to the permissible heel angle limit. The righting moment arising, causing the heel angle, is compensated by shifting ballast water between a set of heeling tank pairs located vis-a-vis on starboard and portside within the ship. The water transfer is achieved by utilizing centrifugal, reversible propeller, or screw-pumps and even air-blower units. The standard control system offers MANUAL, AUTOMATIC or BALLAST mode operation via HMI – touch screen of PLC unit HOMIP or central PC-Station as well as connections to the alarm and monitoring system (IAS/AMS). In AUTOMATIC mode the system starts to compensate the heel angle when the threshold value exceeds ±0.5 degrees heel. Sophisticated systems, required for loading operations at sea or offshore lifts, are controlled by measuring the actual heel moment generated and adjusting the individual flow rates. Then the control software offers additional operational modes such as ZERO FLOW, FLOW CONTROL and LOAD MOMENT CONTROL. Unique in the market is Hoppe's ability to combine heel compensation with roll damping functionalities in the same ballast water tank.

2.3.2 Ant Heeling

The heel compensation moment is achieved by transferring ballast water or other fluids between the heeling tank pairs using reversible propeller, centrifugal or screw pumps. Hoppe's reversible axial propeller pumps are an in-house design especially suitable for bidirectional water shift as required for Heel Control
systems.

Three different pump sizes are available for vertical and horizontal installation as well as ex-proof execution. The pump performance is selected for each individual application by varying the gear set and motor type. Flow rates of up to 2,500 m^3/h per unit can be provided.

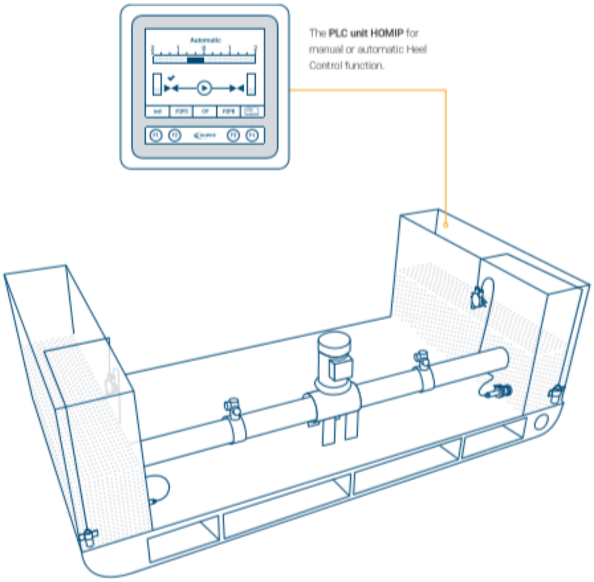

Figure 2.4 of Anti Heeling

2.3.3 Blower Anti Heeling

The closed system consists of one or more ballast water tank pairs which are connected with air-pipes on the top and water pipes close to the bottom. The compressed air from the blower unit(s) is used to shift the water between the tank pairs to generate the compensating moment. The direction of the air-flow is controlled by a valve group to the tank and back to the atmosphere via a silencer. The system has extremely short response times in combination with high compensation rates. Blower Heel Control systems can be combined with U-Tank Roll Damping Systems and Ice-Heeling operational modes can be provided as additional option.

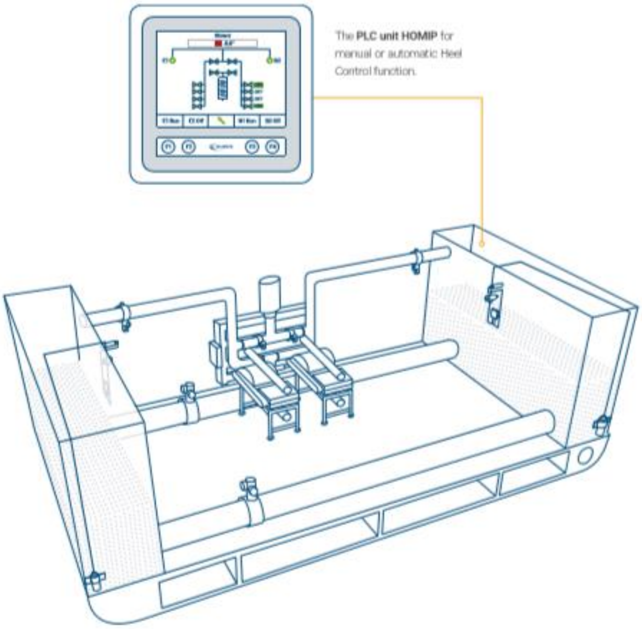

Figure 2.5 of Blower Anti Heeling

2.3.4 Roll Dampin

As the world market leader in the design and supply of passive roll damping tanks Hoppe provides a large variety of tailor made solutions for all kinds of merchant ships and offshore vessels. Roll damping tanks use a hydrodynamically controlled flow of liquid within a specially designed tank, generally filled with ballast water, to create a stabilizing moment opposing the wave moment that is causing the ship to roll. The amount of stabilizing moment created depends on several factors, such as size and location of the roll damping tank, as well as hull form and loading condition of the particular ship. At Hoppe experienced Naval Architects individually design each roll damping tank for each specific application. In order to verify the performance scaled model tests of the particular tank under realistic sea conditions are undertaken. Our more than 3,000 installations have been proven to be the most effective in the market for more than 60 years. With the acquisition of FLUME® Stabilization System (present in the market since 1957) and INTERING (present since 1969) Hoppe allocates the experiences of decades of know-how in the form of design, data and employees of the former two major players in the passive stabilizer market. In addition, the company is constantly developing the technology further using state-of-the-art simulation and testing equipment.

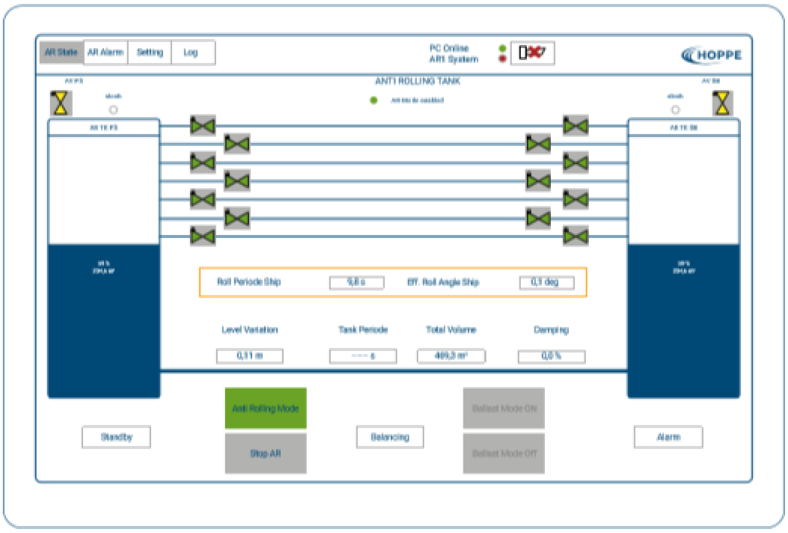

Figure 2.6 of Roll Damping System

2.4 Knowing Subject

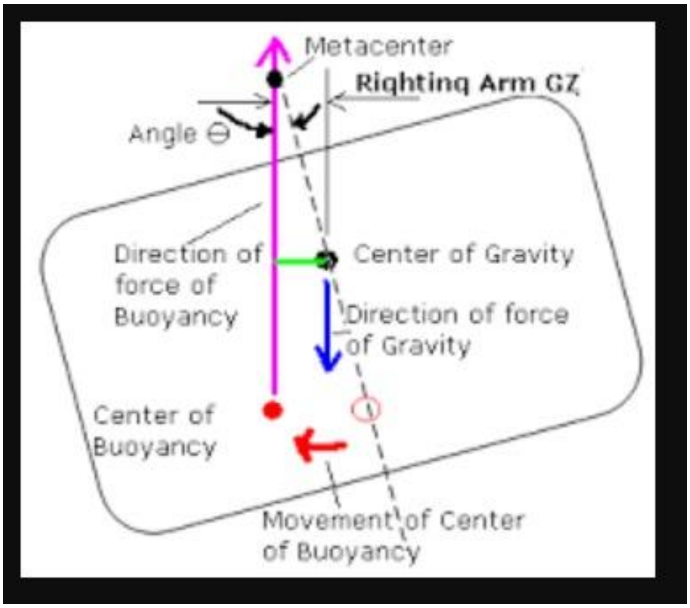

Figure 2.7 of Stability Aspect in Ship

Metacenter

the point of intersection between a vertical line through the center of buoyancy of a floating body such as a ship and a vertical line through the new center of buoyancy when the body is tilted, which must be above the center of gravity to ensure stability. (Wikipedia)

Angle

In plane geometry, an angle is the figure formed by two rays, called the sides of the angle, sharing a common endpoint, called the vertex of the angle. Angles formed by two rays lie in a plane, but this plane does not have to be a Euclidean plane.

Force of Buoyancy

In simple terms, the principle states that the buoyancy force on an object is equal to the weight of the fluid displaced by the object, or the density of the fluid multiplied by the submerged volume times the gravitational acceleration, g.

Center of Buoyancy

The center of buoyancy is the point where if you were to take all of the displaced fluid and hold it by that point it would remain perfectly balanced, assuming you could hold a fluid in a fixed shape. This point is also called the center of mass.

Center of gravity

The center of gravity is the average location of the weight of an object. We can completely describe the motion of any object through space in terms of the translation of the center of gravity of the object from one place to another, and the rotation of the object about its center of gravity if it is free to rotate.

Force of Gravity

Gravity, also called gravitation, in mechanics, the universal force of attraction acting between all matter. ... On Earth all bodies have a weight, or downward force of gravity, proportional to their mass, which Earth's mass exerts on them. Gravity is measured by the acceleration that it gives to freely falling objects.

2.5 Ship Motion

Rotational Motions

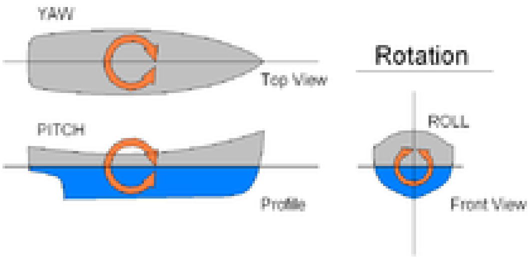

Figure 2.8 of Rotational Motions

Axes of a ship and rotations around them For other uses, see Euler angles § Tait–Bryan angles. There are three special axes in any ship, called longitudinal, transverse and vertical axes. The movements around them are known as roll, pitch, and yaw respectively.

Pitch

The up/down rotation of a vessel about its transverse/Y (side-to-side or port-starboard) axis. An offset or deviation from normal on this axis is referred to as trim or out of trim.

Roll

The tilting rotation of a vessel about its longitudinal/X (front-back or bow-stern) axis. An offset or deviation from normal on this axis is referred to as list or heel. Heel refers to an offset that is intentional or expected, as caused by wind pressure on sails, turning, or other crew actions. The rolling motion towards a steady state (or list) angle due to the ship's own weight distribution is referred in marine engineering as heel. List normally refers to an unintentional or unexpected offset, as caused by flooding, battle damage, shifting cargo, etc.

Yaw

The turning rotation of a vessel about its vertical/Z axis. An offset or deviation from normal on this axis is referred to as deviation or set. This is referred to as the heading of the boat relative to a magnetic compass (or true heading if referenced to the true north pole); it also affects the bearing.

Translational Motion

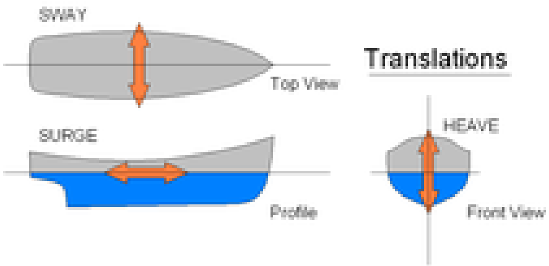

Figure 2.9 of Translational Motion

Heave

The linear vertical (up/down) motion; excessive downward heave can swamp a ship.

Sway

The linear transverse (side-to-side or port-starboard) motion. This motion is generated directly either by the water and wind currents exerting forces against the hull or by the ship's own propulsion; or indirectly by the inertia of the ship while turning. This movement can be compared to the vessel's drift from its course.

Surge

The linear longitudinal (front/back or bow/stern) motion imparted by maritime conditions.

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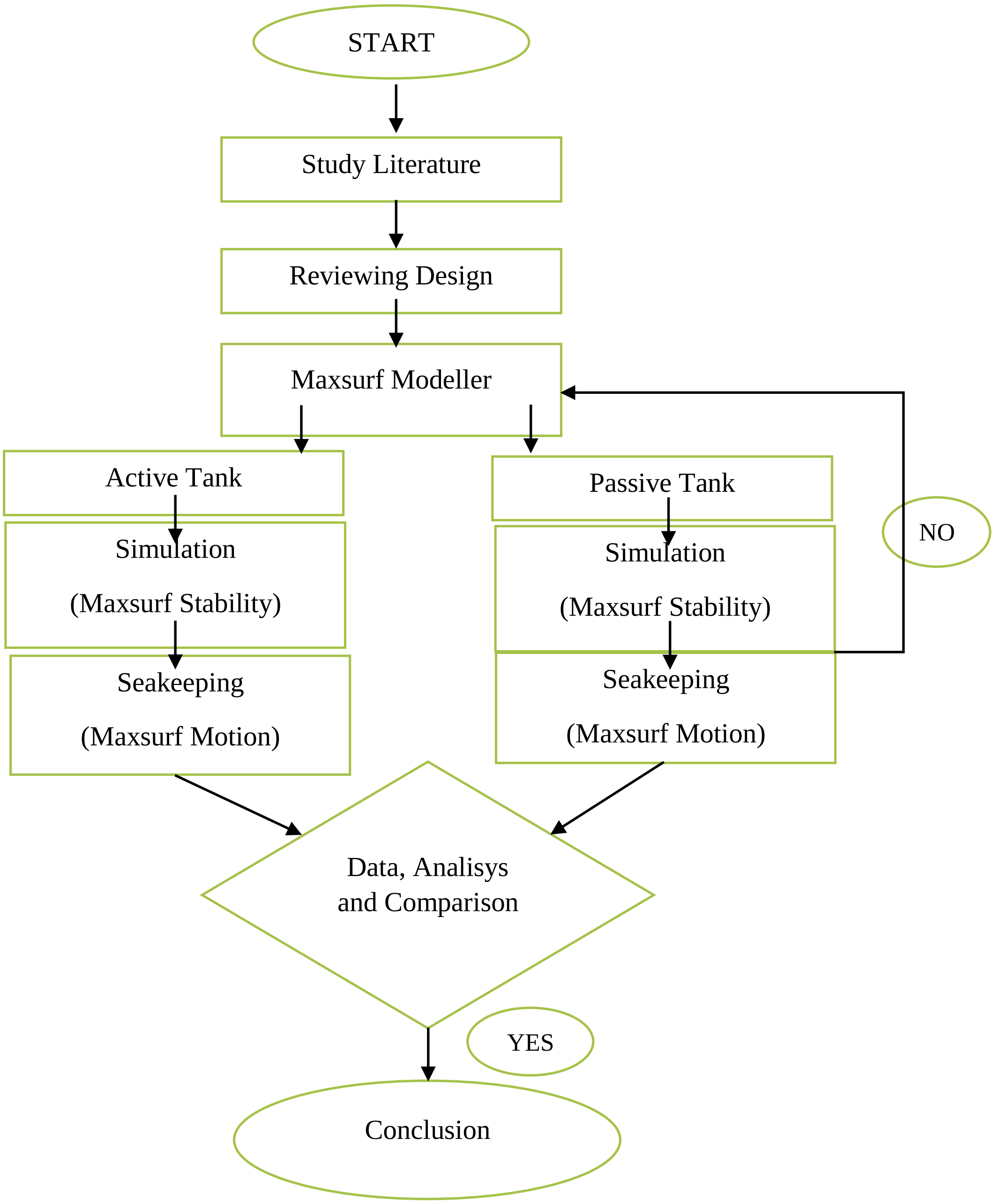
CHAPTER III
METHODOLOGY

3.1 Methodology Flow Chart

The methodology flow chart shows all of steps for this final project research. The steps of this methodology are shows as in here:



3.2 Study Literatur

The basic knowledge to research the subject

3.3 Review Design

In this part the design using autocad for the general arrangement and the basic to designing using autocad too.

3.4 Maxsurf Modeller

The design of LCT or LST it self to know the stabilizer part whose place want to build and can be trial to research. The software to draw the design for active tank and passive tank in the ship LCT.

3.5 Active Tank

Active tank have good point for stable in the sea because the tank can be stable use a pump in the middle but the minus is higher cost to buy a pump also high risk for leaking, for the maintenance this tank more complex than the passive tank.

3.6 Passive Tank

Passive tank is a nice stabilizer causes easy to build, fix water in side the tank. But the minus is have noise in the tank which can be to noisy when sailing in the high wave sea weather condition.

3.7 Maxsurf Stability

To simulate the knowing subject about equilibrium in that ship after designing in maxsurf modeler also knowing every simulation for stability.

3.8 Maxsurf Motion

To knowing respons time the ship when sailing. In this software I use to know roll velocity and pitch velocity

3.9 Data,Analisys, and Comparasion

Collect data from maxsurf stability and calculate it. After that anlisys which more stable.

3.10 Conslusion

At this last stage of this research.

CHAPTER IV
DATA ANALISYS

4.1 The Ship Design

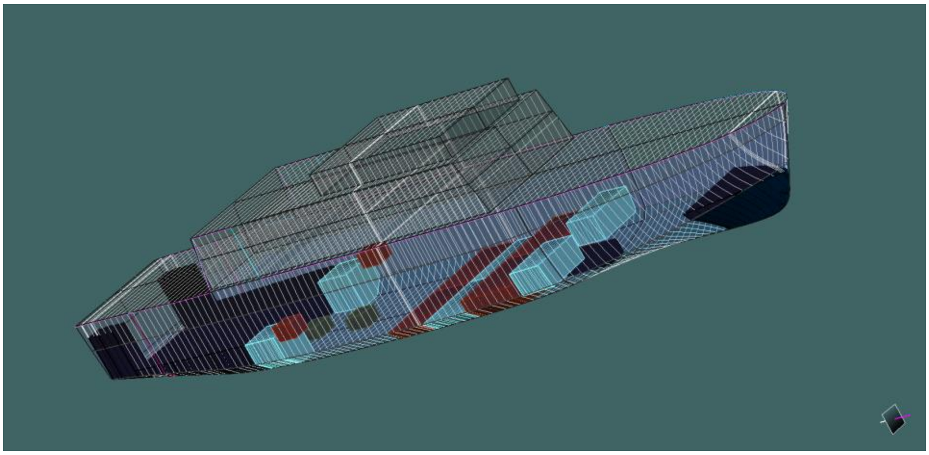


Figure 4.1 Picture Real Design and full tank equipment

Table 4.1 Table Maxsurf Stability

Draft Amidships m	3.073
Displacement t	2774
Heel deg	0
Draft at FP m	2.243
Draft at AP m	3.904
Draft at LCF m	3.196
Trim (+ve by stern) m	1.661
WL Length m	86.846
Beam max extents on WL m	15.919
Wetted Area m^2	1404.902

Waterpl. Area m^2	1133.857
Prismatic coeff. (Cp)	0.651
Block coeff. (Cb)	0.608
Max Sect. area coeff. (Cm)	0.938
Waterpl. area coeff. (Cwp)	0.82
LCB from zero pt. (+ve fwd) m	38.549
LCF from zero pt. (+ve fwd) m	38.852
KB m	1.89
KG fluid m	6.119
BMt m	7.459
BML m	197.404
GMt corrected m	3.228
GML m	193.173
KMt m	9.347
KML m	199.256
Immersion (TPc) tonne/cm	11.622
MTc tonne.m	62.621
RM at 1deg = GMt.Disp.sin(1) tonne.m	156.264
Max deck inclination deg	1.1119
Trim angle (+ve by stern) deg	1.1119

Table 4.2 data using Maxsurf Motion

Quarter wave 45°	Real Design
Roll velocity (rad/s)	0.0734
Picth velocity (rad/s)	0.0192
Side wave 90°	Real Design
Roll velocity (rad/s)	0.17815
Picth velocity (rad/s)	0.02517
Front wave 180°	Real Design
Roll velocity (rad/s)	0

4.2 Data for Active Tank

4.2.1 Case A

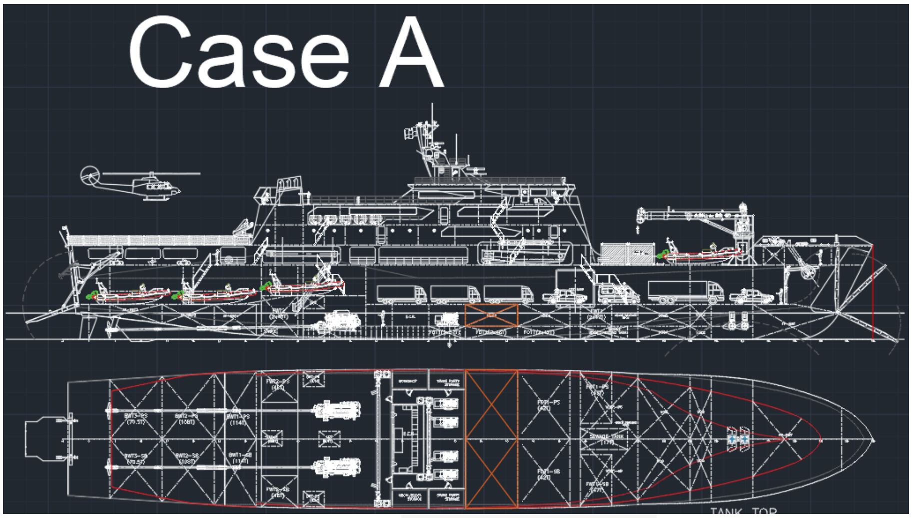


Figure 4.2 places of tank Case A

position information: on the Tank Top, and it is located at frame 72 – 82
known aspect :

- Length of tank : 2.9836 m
- Breadth of tank : 8 m
- Height of tank : 2.5109 m

4.2.2 Case B

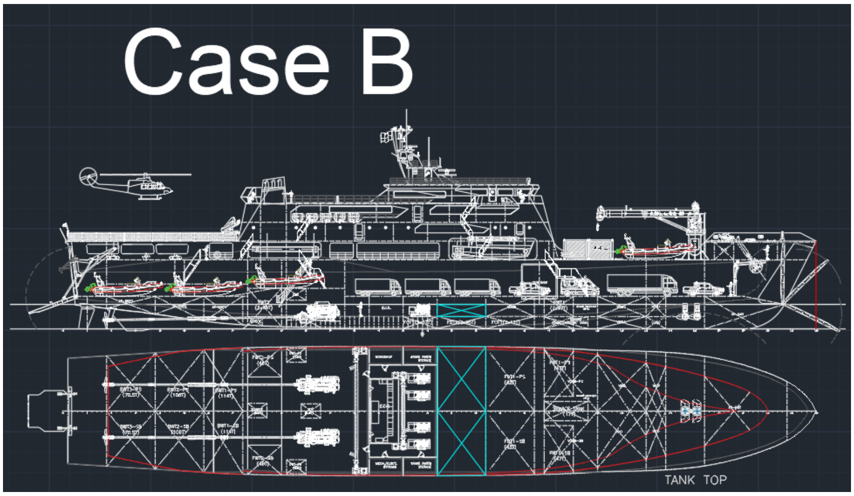


Figure 4.3 places of tank Case B

position information: on the Tank Top, and it is located at frame 72 – 82
known aspect :

- Length of tank : 2.9836 m
- Breadth of tank : 8 m
- Height of tank : 1.447 m

4.2.3 Case C

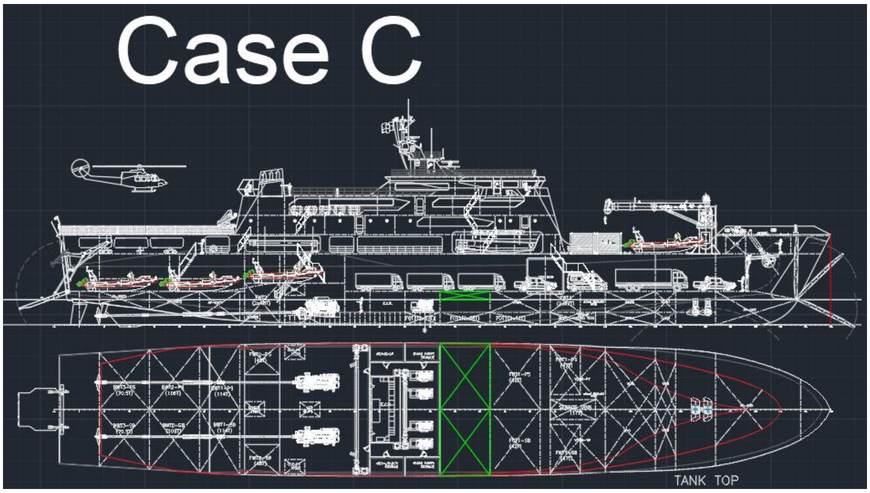


Figure 4.4 places of tank Case C

position information: on the Tank Top, and it is located at frame 72 – 82
known aspect :

- Length each tank : 2.9836 m
- Breath each tank : 8 m
- High each tank : 1.0044 m

4.3 Data for Passive Tank

4.3.1 Case 1

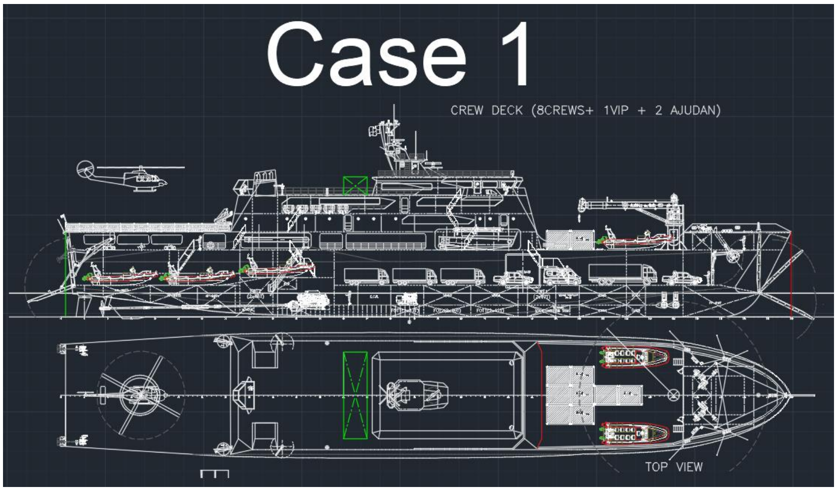


Figure 4.5 places of tank Case 1

position information : : in the navigation deck and in what tanks between frames 55 – 60 known aspect :

- Length of tank : 2.9836 m
- Breadth of tank : 5.5241 m
- Height of tank : 2.3042 m

4.3.2 Case 2

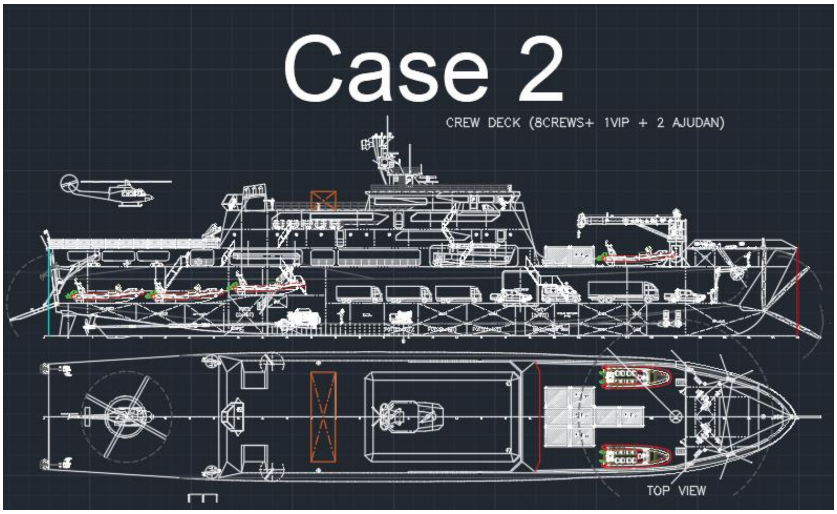


Figure 4.6 places of tank Case 2

position information : in the navigation deck and in what tanks between frames 50 - 55 known aspect :

- Length of tank : 2.9836 m
- Breadth of tank : 5.5241 m
- Height of tank : 2.3042 m

4.3.3 Case 3

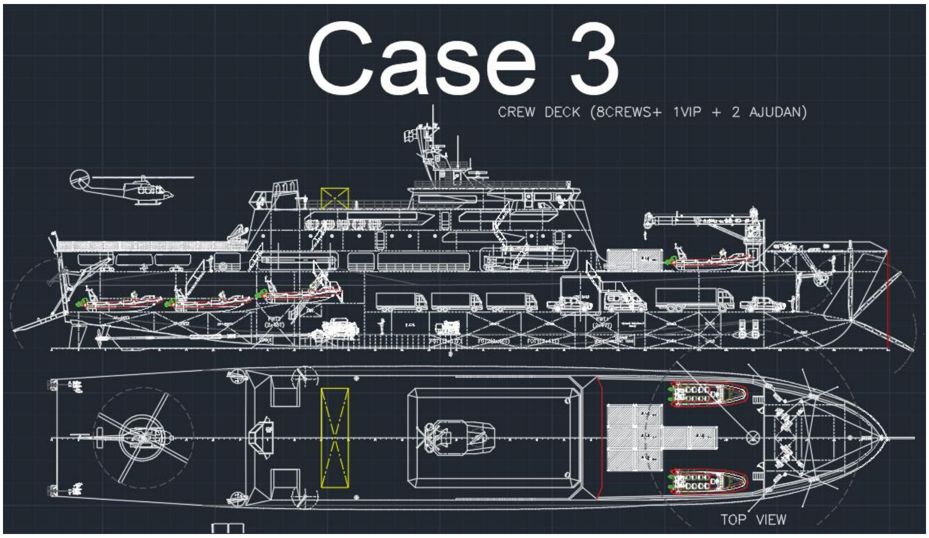


Figure 4.7 places of tank Case 3

position information: in the navigation deck and in what tanks between frames 45 - 50 known aspect :

- Length of tank : 2.9836 m
- Breadth of tank : 5.5241 m
- Height of tank : 2.3042 m

4.3.4 Case 4

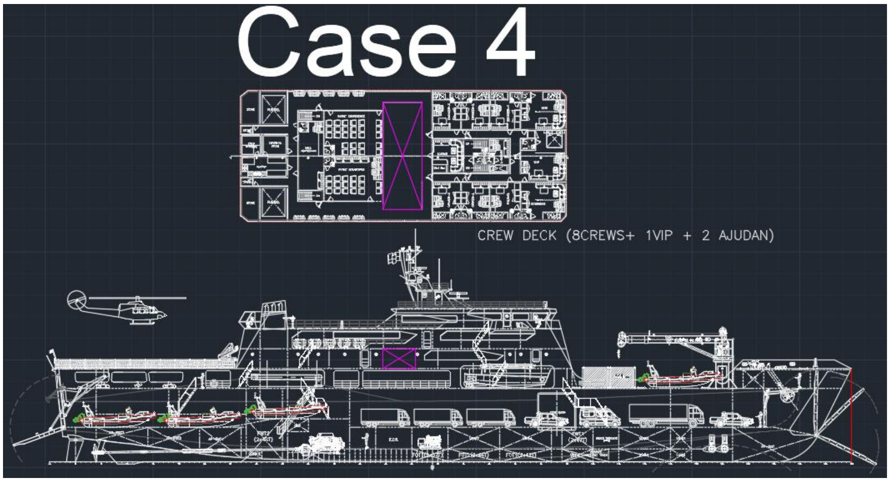


Figure 4.8 places of tank Case 4

position information: on the Crew Deck and what tanks between frames 59.5 – 67 known aspect :

- Length of tank : 4.5492 m
- Breadth of tank : 6.2035 m
- Height of tank : 2.3632m

4.3.5 Case 5

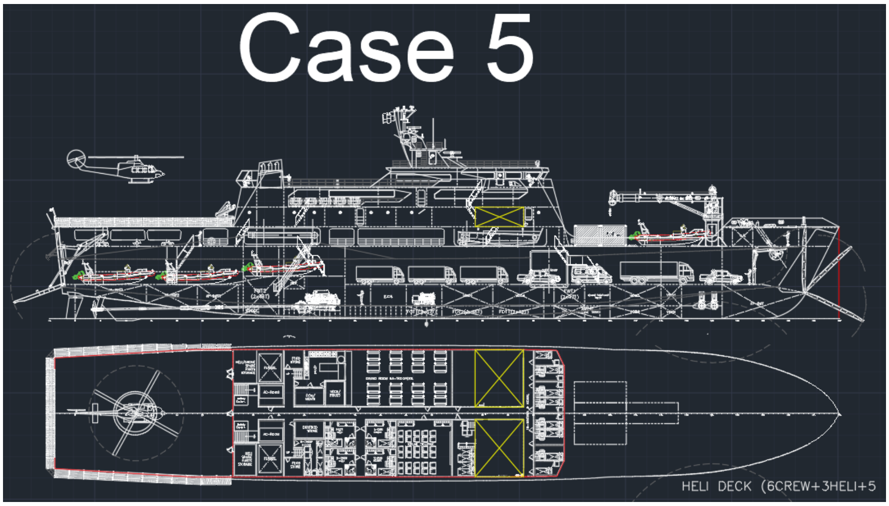


Figure 4.9 places of tank Case 5

position information: on the Heli Deck and which tanks between frames 78.5 – 88 known aspect :

- Length of tank : 5.7013 m
- Breadth of tank : 6.7648 m
- Height of tank : 2.3042 m

4.3.6 Case 6

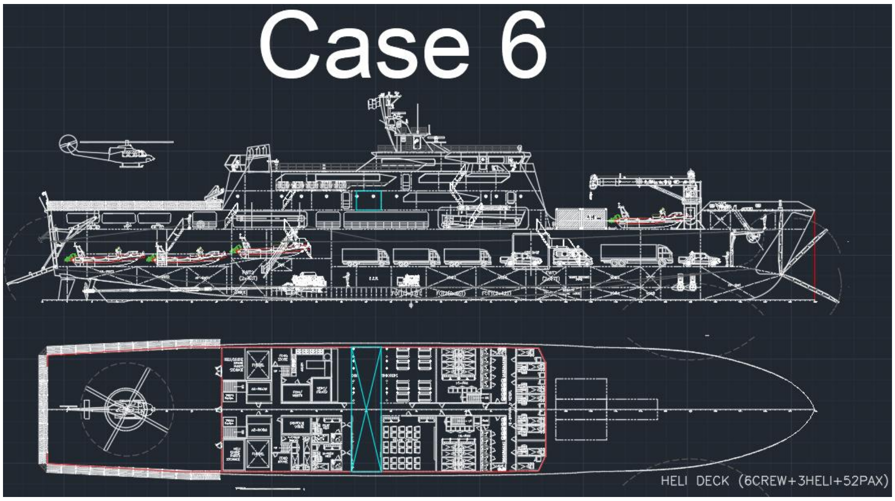


Figure 4.10 places of tank Case 6

position information: on the Heli Deck and which tanks between frames 58-63 known aspect :

- Length of tank : 2.9836 m
- Breadth of tank : 7.5033 m
- Height of tank :. 2.3042 m

4.4 Data 9 Case which result of Maxsurf Stability

no	type knowing	Real Design	Case 1	Case 2	Case 3
1	Draft Amidships m	3.073	3.047	3.045	3.044
2	Displacement t	2774	2752	2752	2752
3	Heel deg	0	0	0	0
4	Draft at FP m	2.243	2.163	2.153	2.142
5	Draft at AP m	3.904	3.93	3.938	3.946
6	Draft at LCF m	3.196	3.179	3.179	3.18
7	Block coeff. (Cb)	0.608	0.605	0.605	0.605
8	Max Sect. area coeff. (Cm)	0.938	0.938	0.938	0.938

9	Waterpl. area coeff. (Cwp)	0.82	0.819	0.819	0.819
10	LCB from zero pt. (+ve fwd) m	38.549	38.3	38.259	38.216
11	LCF from zero pt. (+ve fwd) m	38.852	38.769	38.758	38.748
12	KB m	1.89	1.884	1.885	1.886
13	KG fluid m	6.119	6.377	6.376	6.378
14	BMt m	7.459	7.504	7.504	7.501
15	GMt corrected m	3.228	3.011	3.012	3.009
16	Trim angle (+ve by stern) deg	1.1119	1.1832	1.1951	1.2077
17	GZ	1.402	1.267	1.268	1.268

Case 4	Case 5	Case 6	Case A	Case B	Case C
3.074	3.1	3.057	3.131	3.085	3.062
2781	2798	2763	2833	2785	2762
0	0	0	0	0	0
2.204	2.311	2.179	2.345	2.264	2.222
3.944	3.889	3.935	3.917	3.906	3.902
3.203	3.216	3.188	3.245	3.206	3.187
0.607	0.611	0.606	0.613	0.609	0.607
0.939	0.938	0.938	0.938	0.938	0.938
0.82	0.821	0.819	0.822	0.82	0.82
38.368	38.741	38.327	38.757	38.592	38.505
38.814	38.922	38.787	38.96	38.874	38.83
1.897	1.897	1.889	1.914	1.894	1.885
6.428	6.475	6.336	6.09	6.134	6.188
7.435	7.405	7.478	7.321	7.431	7.486
2.903	2.826	3.031	3.144	3.191	3.182
1.1649	1.0568	1.1758	1.0527	1.0997	1.1243
1.23	1.194	1.286	1.404	1.391	1.366

The Result needed to know after simulation stability

4.4.1 Draft Amidships

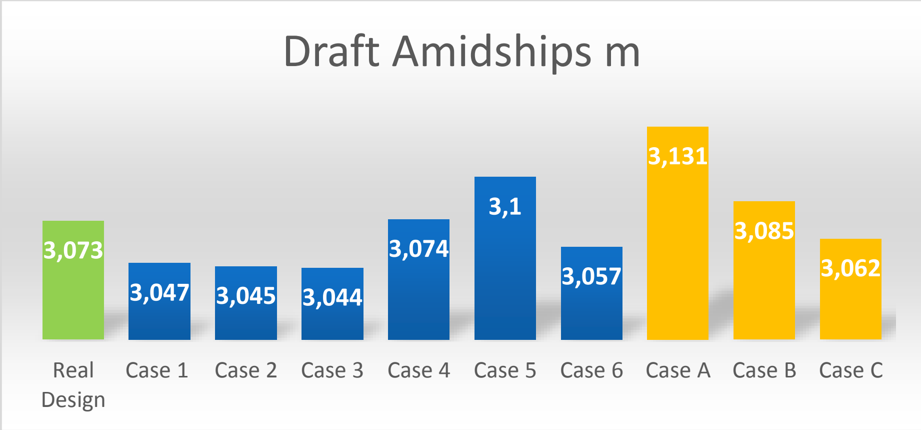


Figure 4.11 Graphic of Draft Amidships

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing draft Amidship which in this chart good case in case 3 causes more low value that make the ship can load more than other but the case under real design is good position for case 1,2,3,4,6,c. and for case 5,A,B is not possible to good position causes that case make the load of the ship will be just fill some load for the ship. That also make decrease the volume of the ship. Or it can say over draft load.

4.4.2 Displacement t

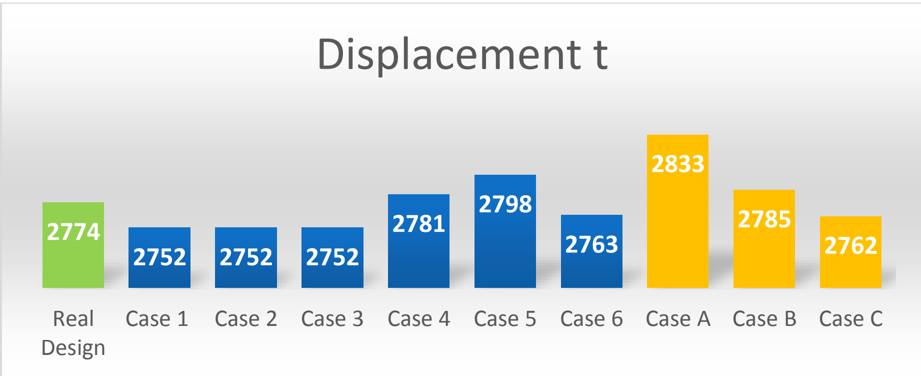


Figure 4.12 Graphic of Displacement

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing displacement (t) which in this chart good case is case 1,2,3 causes more low value that make the ship can load more than other but the case under real design is good position for case 6 and c but for case 4,5,A, and B is not accepted to use.

4.4.3 Draft at FP m

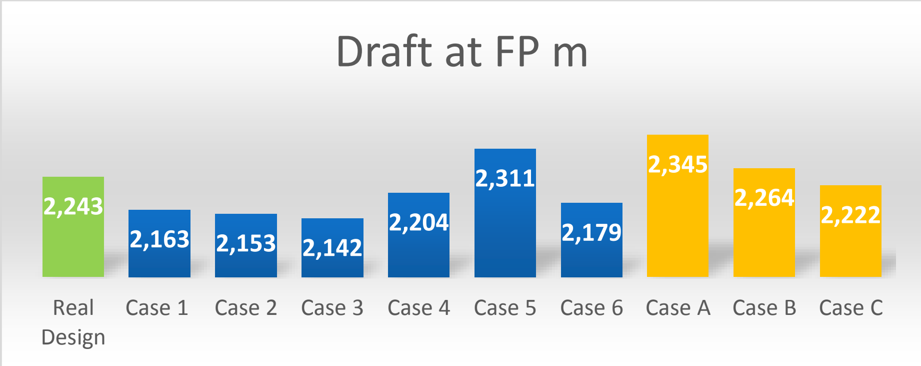


Figure 4.13 Graphic of Draft at FP

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing draft at FP which in this chart good case is Under the real design Which is case 1, case 2, case 3, case 6 and case C. and the other case 5, case A and case B.

4.4.4 Draft at AP m

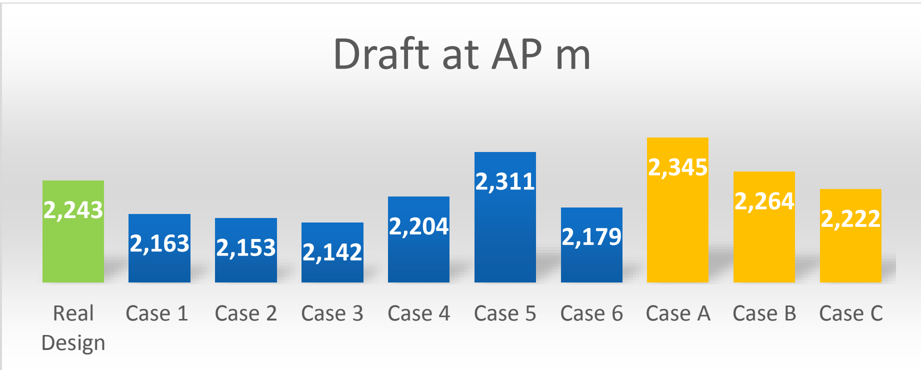


Figure 4.14 Graphic of Draft at AP

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing draft at AP and the result is case1, case 2, case 3, case 4, case 6, and case C is under the real design model which that lower draft than that and good value because can make load more but the worst case is make rolling faster. And the heavy one is case A causes case A more higher than real design.

4.4.5 Draft at LCF m

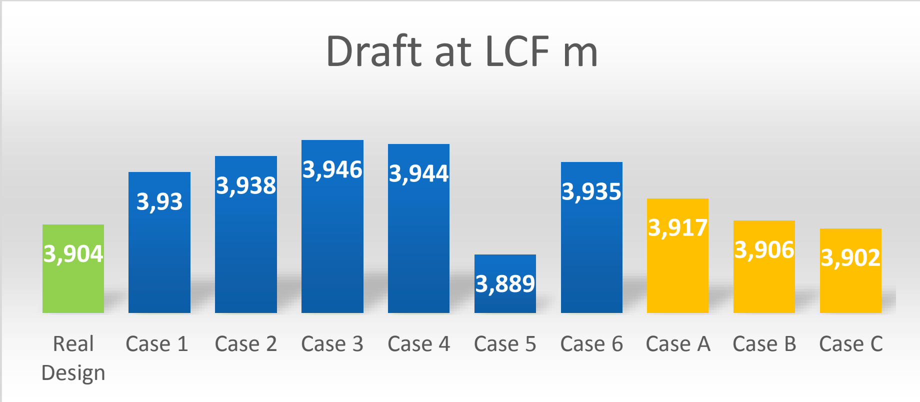


Figure 4.15 Graphic of Draft at LCF

4.4.6 Block Coeff. (Cb)

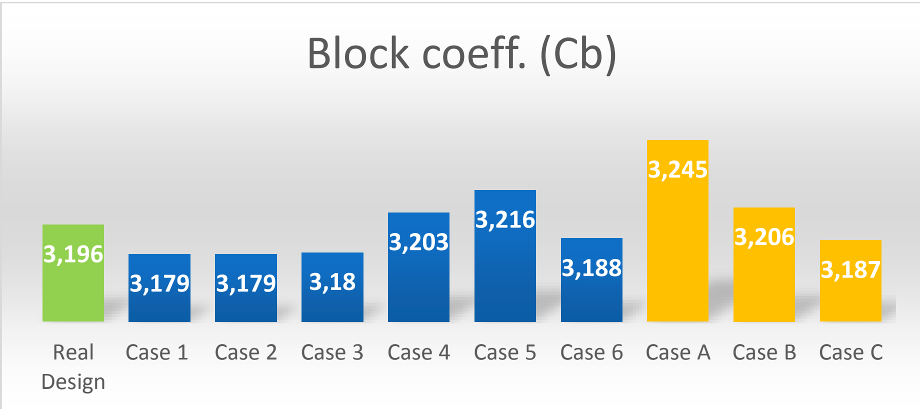


Figure 4.16 Graphic of Block Coefficient (Cb)

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing CB is the best in case 1, and 2 causes make the load is light weight for it and the heavy one in case A causes to heavy than the real design.

4.4.7 Max Sect. area coeff. (Cm)

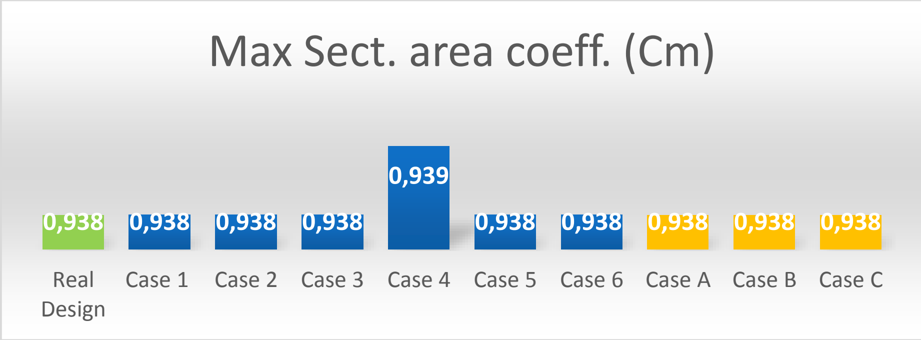


Figure 4.17 Graphic of Max Section Area Coefficient (Cm)

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing Max sect. area coeff. (cm) which in this chart usually same but just case 4 is better than the other value in 0.001 cm

4.4.8 Waterpl. Area coeff. (Cwp)

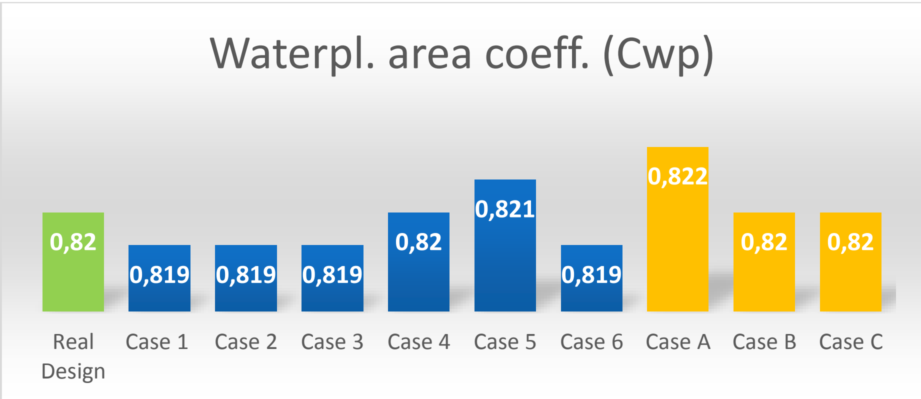


Figure 4.18 Graphic of Waterplan area coefficient (Cwp)

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing draft waterplan area coefficient good value in case 4, case B, case C. because it same with drill design And the lower case become case 1, case 2,case 3, case 6 .other value make higher then the real design is case 5 and case A.

4.4.9 LCB from zero pt. (+ve fwd) m

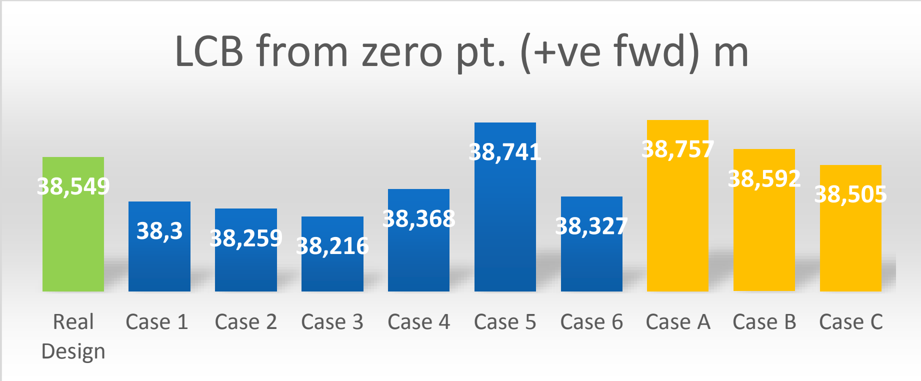


Figure 4.19 Graphic of LCB from zero pt. (+ve fwd)

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing LCB from zero which the lowest value we got in case 3 and the good one in case A cause higher than the real design. And the other for case 1,2,4,6,C is the lower than the real design.

4.4.10 LCF from zero pt. (+ve fwd) m

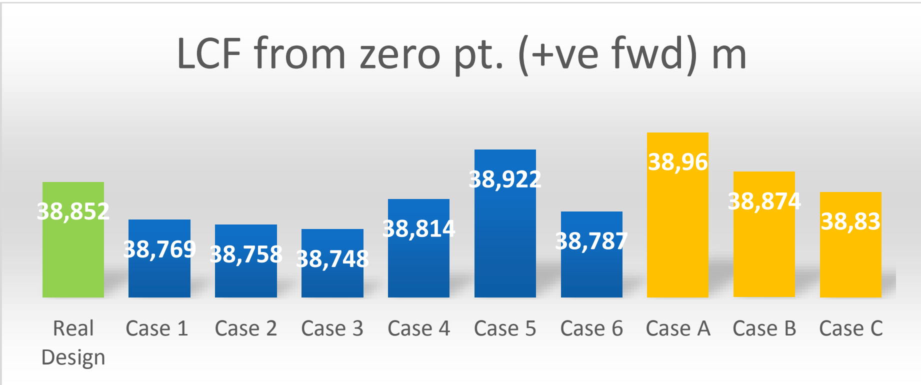


Figure 4.20 Graphic of LCF from zero

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing LCF the result case 5,A,B is higher than real design that’s good one and the other is lower than the real design.

4.4.11 KB m

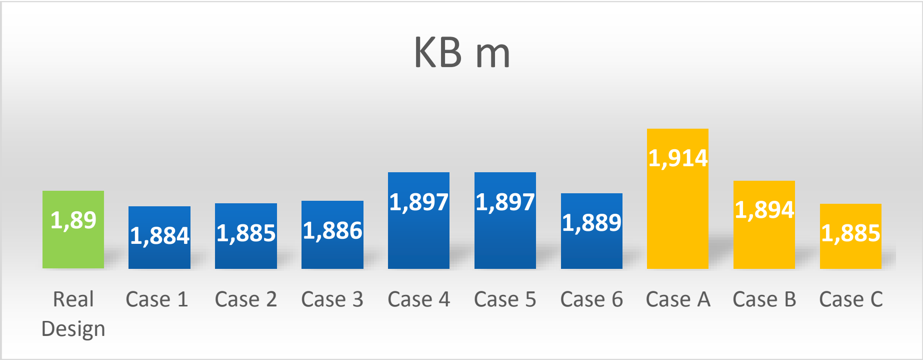


Figure 4.21 Graphic of KB

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing KB which that is case 1 is the lowest value which that bad tank, and the good tank is case A fot active tank and the passive tank is case 4 and case 5.

4.4.12 KG fluid m

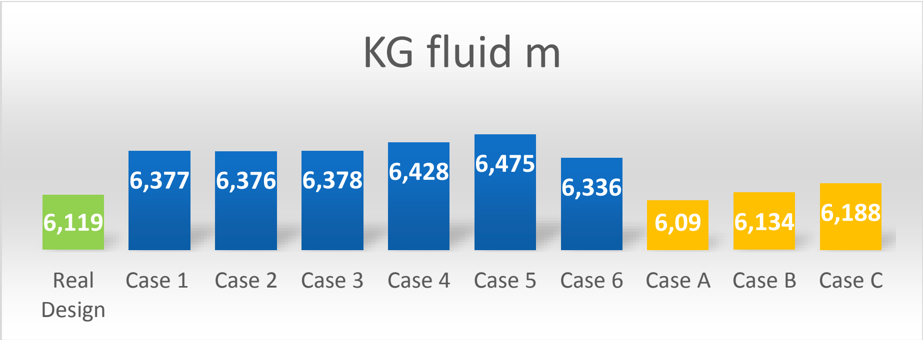


Figure 4.22 Graphic of KG fluid

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing KG fluid which case A is the best one cause make it good and the case 5 is so high value dan the passive tank all is higher than real design one.

4.4.13 BMt m

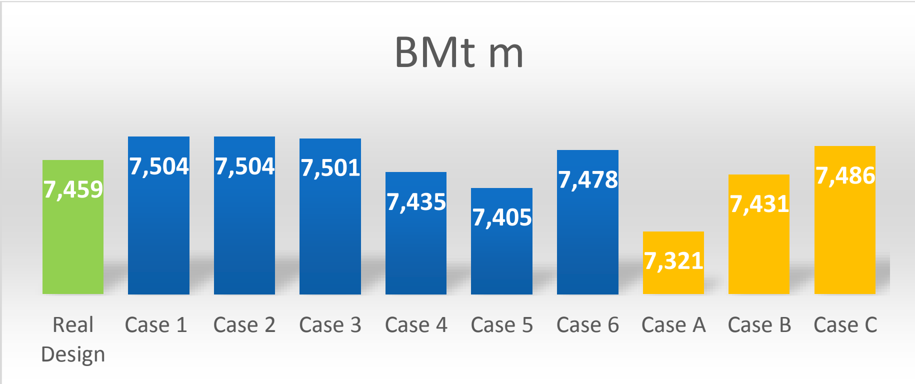


Figure 4.23 Graphic of BMt

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing BMt which case A is good value and the passive tank one in case 5 is good and the case 1,2,3,6,C is higher than real design.

4.4.14 GMt corrected m

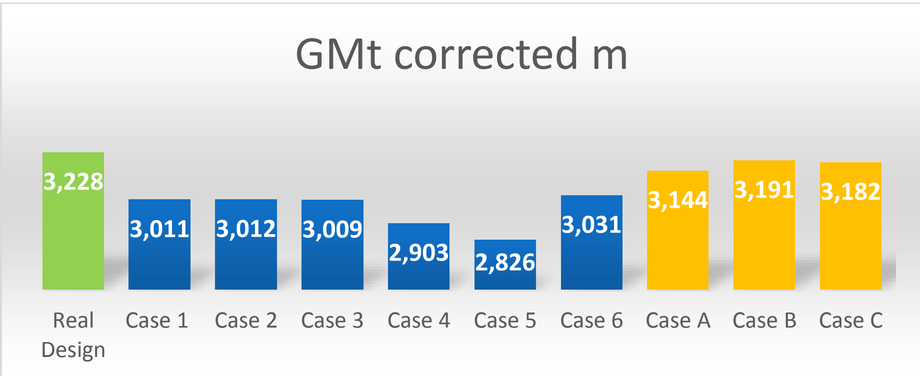


Figure 4.24 Graphic of GMt corrected

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing GMT which the chart case 5 is low that can be good and all of case is under the real design.

4.4.15 Trim angle (+ve by stern) deg

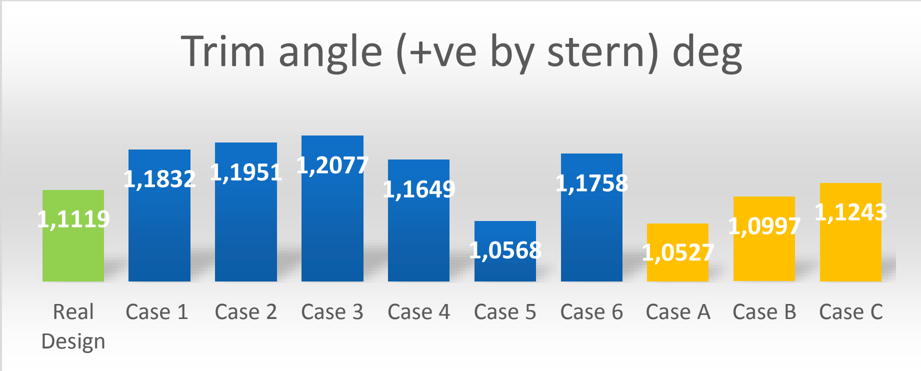


Figure 4.25 Graphic of Trim Angle (+ve by stern)

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing Trim angle is more goo under the real design which good result is case 5 and case A and the other is higher than the real design except the case B.

4.4.16 GZ

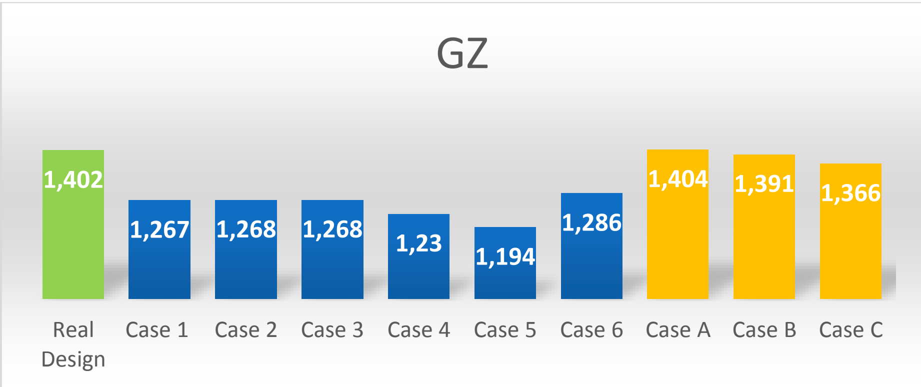


Figure 4.26 Graphic of GZ

This chart showing 3 colour of chart which green for real design, blue colour for passive stabilizer tank and orange colour for active stabilizer tank. This showing GZ is low in case 5 and near same as real design in case A. an all the other is under real design.

4.5 Data 9 Case which result of Maxsurf Motion

Table 4.3 result of respons time using roll velocity and pitch velocity

No.	Quarter wave 45°	Real Design	Case 1	Case 2	Case 3	Case 4
1	Roll velocity (rad/s)	0.0734	0.06977	0.06977	0.06973	0.06848
2	Picth velocity (rad/s)	0.0192	0.01921	0.01924	0.01921	0.01918
No.	Side wave 90°	Real Design	Case 1	Case 2	Case 3	Case 4
1	Roll velocity (rad/s)	0.17815	0.17213	0.17212	0.17207	0.16951
2	Picth velocity (rad/s)	0.02517	0.02516	0.02523	0.02519	0.02518
No.	Front wave 180°	Real Design	Case 1	Case 2	Case 3	Case 4
1	Roll velocity (rad/s)	0	0	0	0	0
2	Picth velocity (rad/s)	0.04714	0.04724	0.04727	0.0473	0.04727

Case 5	Case 6	Case A	Case B	Case C
0.06779	0.07012	0.07245	0.07292	0.07266
0.01916	0.01921	0.01912	0.01918	0.01921
Case 5	Case 6	Case A	Case B	Case C
0.16781	0.17258	0.17554	0.1769	0.17666
0.0251	0.02519	0.02509	0.02514	0.02517
Case 5	Case 6	Case A	Case B	Case C
0	0	0	0	0
0.04706	0.04725	0.04714	0.04714	0.04713

4.5.1 Quarter wave 45 Roll velocity (rad/s)

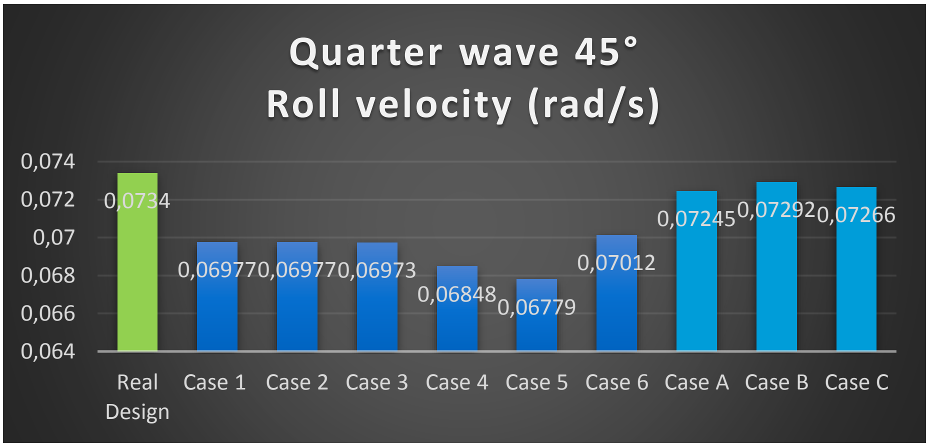


Figure 4.27 Graphic of Quarter wave 45 degree Roll Velocity

This chart showing 3 colors of chart which is green color for real design, Dark blue color for passive stabilizer tank and light blue color is the active tank. This showing result of roll velocity (rad/s) in quarter wave 45 degree which is case 5 is good rolling cause can more stable than the other also the other case for passive tank can be stable enough. For case A in active stabilizer tank is stable enough than the other.

4.5.2 Quarter wave 45 Pitch velocity (rad/s)

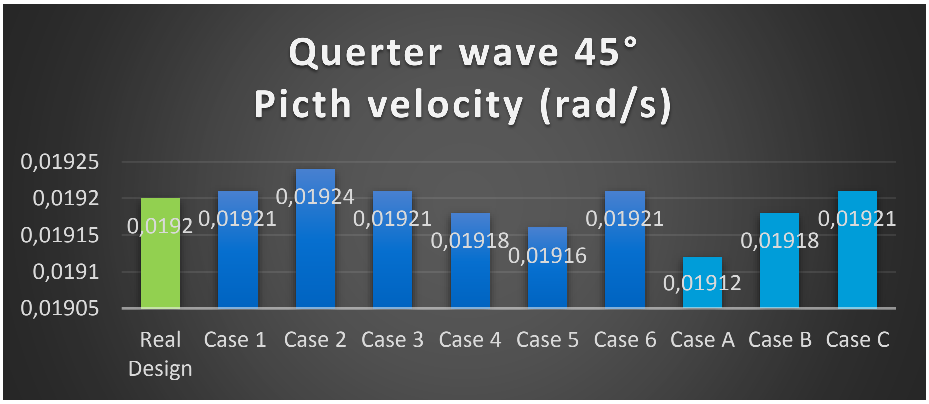


Figure 4.28 Graphic of Quarter wave 45 degree Pitch Velocity

This chart showing 3 colors of chart which is green color for real design, Dark blue color for passive stabilizer tank and light blue color is the active tank. This chart showing pitch velocity in quarter wave 45 degree & the result is case A is stable position for pitch velocity which is more than the real design & the other for case 4, 5, A, and B is pass for this result and the case 1,3,6 and C is fail because it is not stable.

4.5.3 Side wave 90 Roll velocity (rad/s)

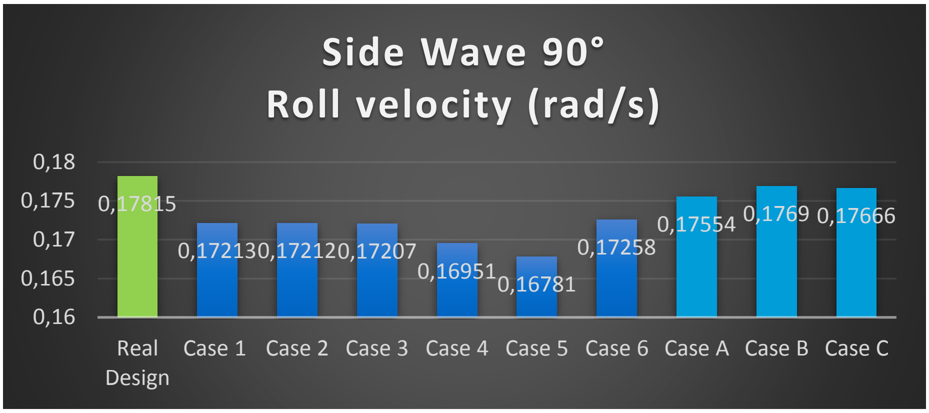


Figure 4.29 Graphic of Quarter wave 90 degree Roll Velocity

This chart showing 3 colors of chart which is green color for real design, Dark blue color for passive stabilizer tank and light blue color is the active tank. For this chart showing roll velocity in side wave 90 degree which is the very good one is case 5 for passive stabilizer tank and the active stabilizer tank is case A.

4.5.4 Side wave 90 Pitch velocity (rad/s)

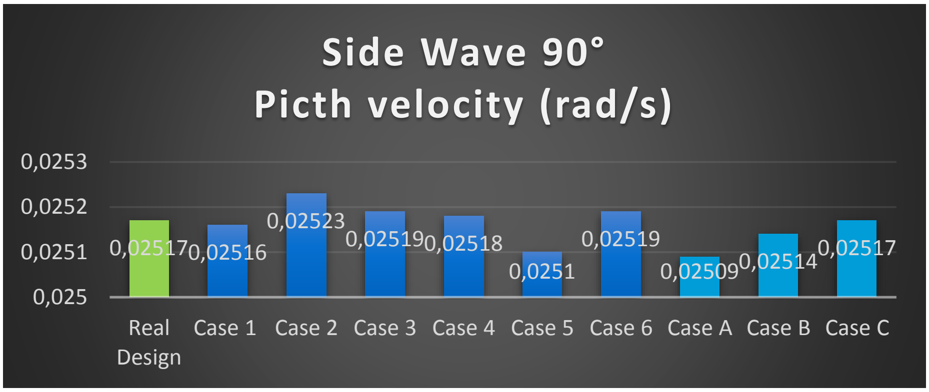


Figure 4.30 Graphic of Quarter wave 90 degree Pitch Velocity

This chart showing 3 colors of chart which is green color for real design, Dark blue color for passive stabilizer tank and light blue color is the active tank. This chart showing pitch velocity in quarter wave 90 degree & the result is case 5 and case A is very good one than the other but tha case 1 and case B also pass the lower than real design one but the other is fail because to higher than the real design.

4.5.5 Front wave 180 Roll velocity (rad/s)

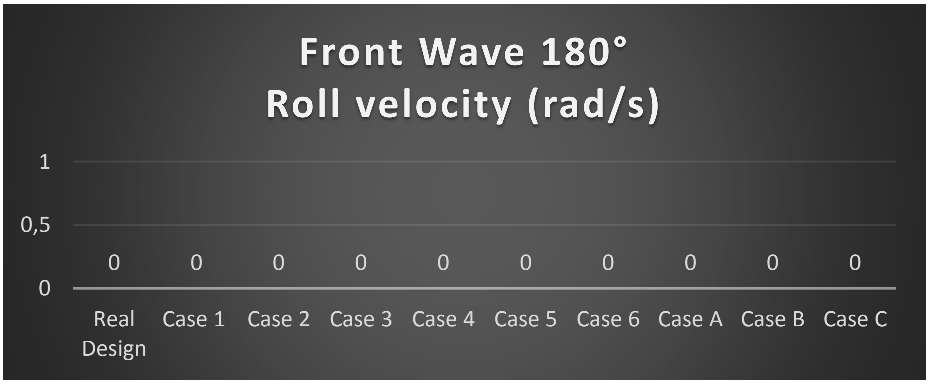


Figure 4.31 Graphic of Quarter wave 180 degree Roll Velocity

This chart showing 3 colors of chart which is green color for real design, Dark blue color for passive stabilizer tank and light blue color is the active tank. On this chart all value is the same is zero rolling causes from front wave

4.5.6 Front wave 180 Pitch velocity (rad/s)

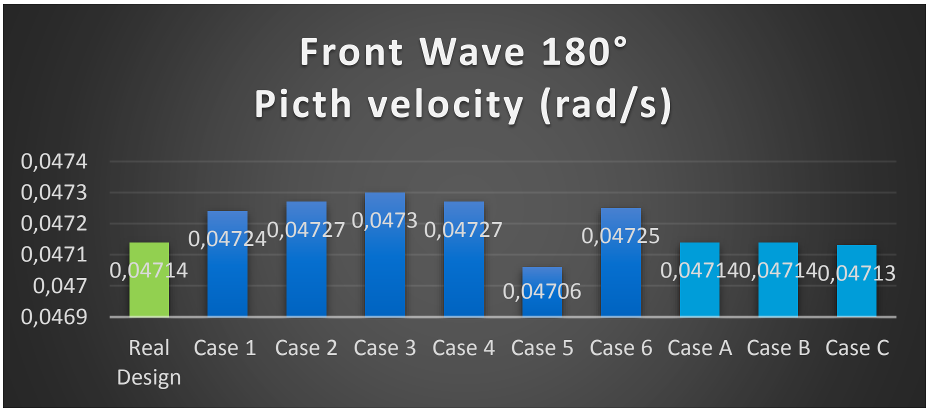


Figure 4.32 Graphic of Quarter wave 180 degree Roll Velocity

This chart showing 3 colors of chart which is green color for real design, Dark blue color for passive stabilizer tank and light blue color is the active tank. This chart showing picth velocity from front wave which the result is case 5 is good havdle for that which 0.04 rad/s only than other in passive stabilizer tank and the other is case C is good from the active stabilizer tank. But other tank in the active is good because is same and under the real design.

4.6 Comparation while seekeping

4.6.1 Quarter Wave 45 degree comparation

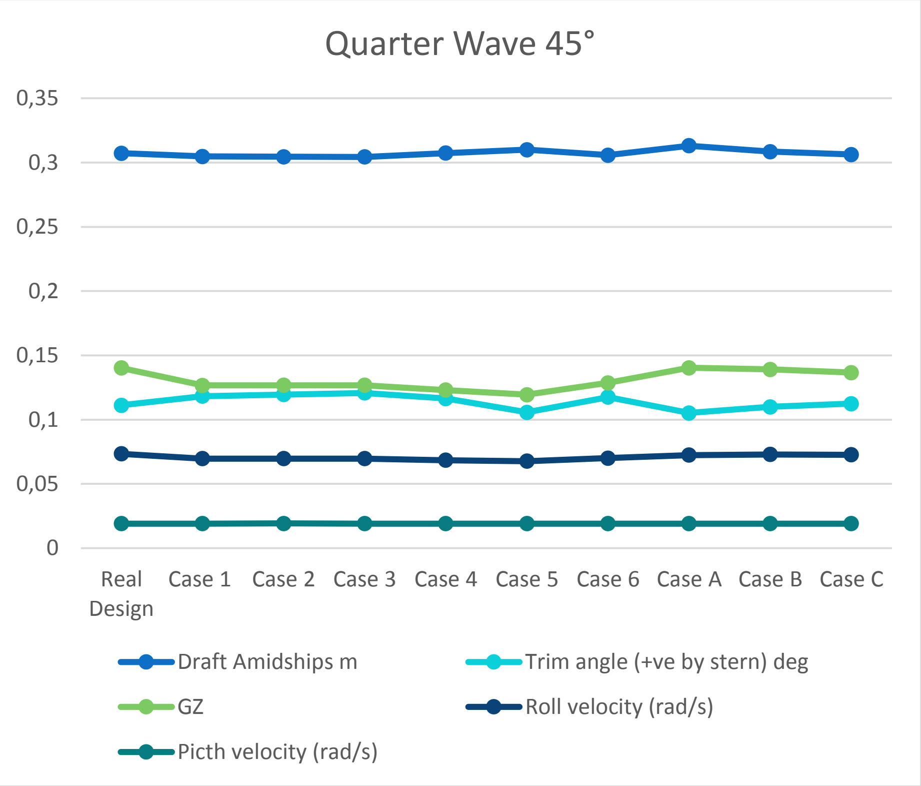


Figure 4.33 Graphic of Quarter wave 45 degree Roll Velocity

In this graphic comparing all case and based on Draft Amidship, GZ, Trim Angle which scale 1:10 and roll velocity also picth velocity in this graph known. Case 5 and case A in quarter wave 45 degree so good value than *other*.

4.6.2 Side Wave 90 degree comparation

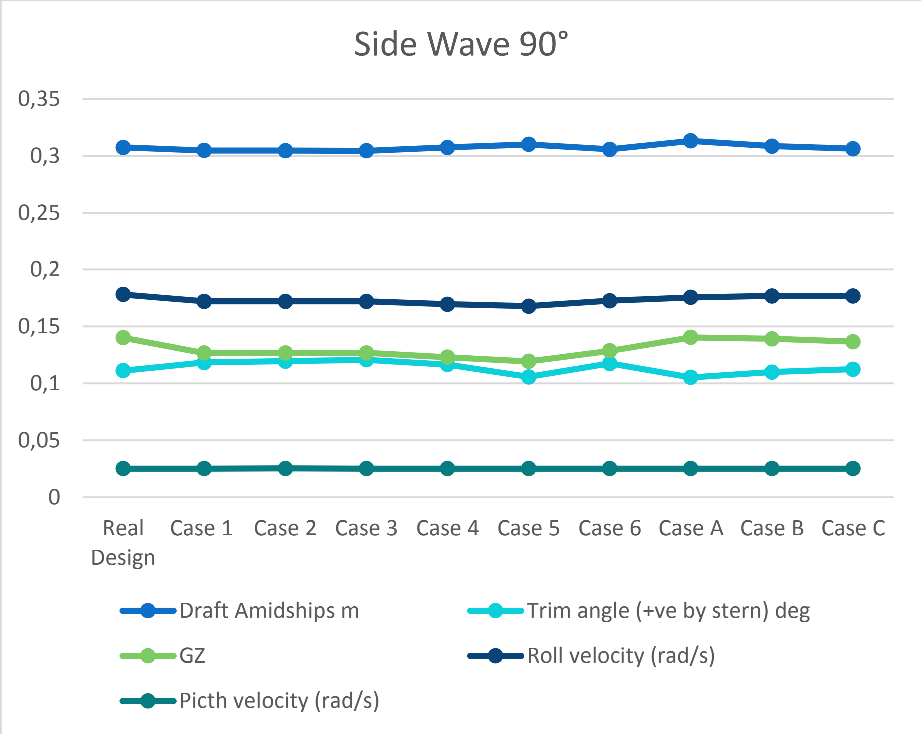


Figure 4.34 Graphic of Quarter wave 45 degree Roll Velocity

In this graphic comparing all case and based on Draft Amidship, GZ, Trim Angle which scale 1:10 and roll velocity also picth velocity in this graph known. Case 5 and case A in side wave 90 degree so good value than other.

4.6.3 Front Wave 180 degree comparation

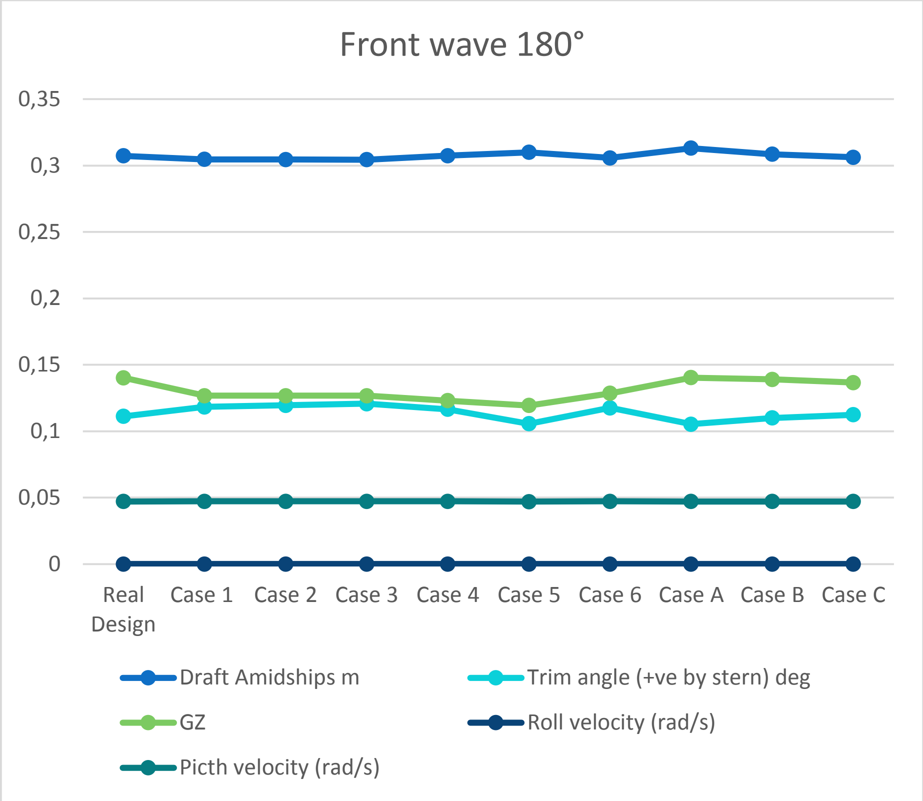


Figure 4.35 Graphic of Quarter wave 45 degree Roll Velocity

In this graphic comparing all case and based on Draft Amidship, GZ, Trim Angle which scale 1:10 and roll velocity also picth velocity in this graph known. Case 5 and case A in front wave 180 degree so good value than other.

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CHAPTER V
CONCLUSION

- Active tank have good point for stable in the sea because the tank can be stable use a pump in the middle but the mins is higher cost to buy a pump and also high risk for leaking, for maintenance this tank more complex than the passive tank. Passive Tank is a nice stabilizer causes easy to build, fix water in side the tank Ship have to many system and component to make a ship float an that not make a ship be drowned. Active tank have good point for stable in the sea because the tank can be stable use a pump in the middle but the minus is higher cost to buy a pump also high risk for leaking, for the maintenance this tank more complex than the passive tank. The result for simulation the best places to have passive tank in case 5 and the best places to have active tank in case A but to choosing one the place to build the stabilizer tank that the result more good the active stabilizer tank so the best case in this simulation is in the case A.

- The result for simulation the best places to have passive stabilizer tank in case 5 with roll velocity value in every condition have this value: Quarter Wave equals 0.06779 rads/s, Side Wave equals 0.16781 rads/s, and for Front Wave equals 0 all case. And pitch velocity value case 5 is : Quarter Wave equals 0.01916 rads/s, Side Wave equals 0.0251 rads/s, and for Front Wave equals 0.04706 rads/s which that is better result condition than the other passive stabilizer tank.

- the best places to have active stabilizer tank in case A with roll velocity value in every condition have this value: Quarter Wave equals 0.07245 rads/s, Side Wave equal 0.17554 rads/s, and for Front Wave equals 0 all case. And pitch velocity value case A is : Quarter Wave equal 0.01912 rads/s, Side Wave equals 0.02509 rads/s, and for Front Wave equals 0.04714 rads/s which that is better result condition than the other Active stabilizer tank.

- For all examination result I recommend to choosing case A to build causes that nearby the real design that also make more stable than case 5.

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[1] Hoppe, Motion Control, Hamburg: Hoppe, 2017.

[2] G. L. Rottman, “Landing Ship, Tank,” in *Landing Ship Tank* , OSPREY, 1942 - 2002 , p. 7.

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