BACHELOR THESIS – ME141502

# TECHNICAL STUDY OF BALLAST EFFECT ON PITCHING RESPONSE OF PATAMARAN

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Supervisor :
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2017

**TUGAS AKHIR – ME141502**

# KAJIAN TEKNIK PENGARUH PERUBAHAN BALLAST TERHADAP RESPON ANGGUKAN PADA PATAMARAN

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SURABAYA
2017

# APPROVAL SHEET

## TECHNICAL STUDY OF BALLAST EFFECT ON PITCHING RESPONSE OF PATAMARAN

**FINAL PROJECT**
Submitted to Comply One of The Requirements
to Obtain a Bachelor Engineering Degree
on
Laboratory of Marine Manufacture and Design (MMD)
Bachelor Degree Program of Marine Engineering Department
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember

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INSTITUT TEKNOLOGI SEPULUH NOPEMBER
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Dr. Eng. M. Badrus Zaman, S.T., M.T.
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# DECLARATION OF HONOUR

I hereby who signed below declare that :

This final project has written and developed independently without any plagiarism act. All contents and ideas drawn directly from internal and external sources are indicated as such cited sources, literatures, and other profesional sources.

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Surabaya, Januari 2017

Lenny Rahmawati

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## TECHNICAL STUDY OF BALLAST EFFECT ON PITCHING RESPONSE OF PATAMARAN


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### ABSTRACT

Indonesia is a country with abundant natural resources including energy potential in it. Utilization of energy resources will greatly assist in the development of energy-based technologies. In this final project will be analyzed use in response ballast patamaran by analyzing movem pitching that is one of the six kind of the movement of a ship the ocean currents .In this analysis , needed data wind speed and tide in the nusa penida , bali or bmkg .With additional ballast patamaran system in response amplitude operator could get from moses shows that large amplitude narrowed , so patamaran be quieter when exposed currents especially in the movement of pitching.



**Keywords: 4 Haul, Ballast System, RAO ( Response Amplitude Operator)**

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## KAJIAN TEKNIK PENGARUH PERUBAHAN BALLAST TERHADAP RESPON ANGGUKAN PADA PATAMARAN


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## ABSTRAK


Indonesia merupakan negara dengan sumber daya alam yang melimpah termasuk potensi energi di dalamnya. Pemanfaatan sumber daya energi tersebut akan sangat membantu dalam pengembangan teknologi berbasis energi. Tugas akhir ini akan melakukan analisa response penggunaan ballast pada patamaran dengan menganalisa gerakan *pitching* yang merupakan salah satu dari enam macam gerakan kapal akibat arus laut. Analisa ini, dibutuhkan data kecepatan angin dan gelombang laut di wilayah Nusa Penida, Bali yang didapatkan dari BMKG. Penambahan system ballast pada patamaran *response amplitude operator* yang bisa didapatkan dari moses menunjukkan bahwa besar amplitude mengecil, sehingga patamaran menjadi lebih tenang bila terkena arus terutama pada gerakan *pitching*.



**Kata kunci: Patamaran, Ballast, RAO( Response Amplitude Operator)**

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# PREFACE

The author is grateful to The Almighty God, Allah SWT who has given His grace and blessing so the thesis entitled **"Kajian Teknik Pengaruh Perubahan Ballast Terhadap Respon Anggukan Pada Patamaran"** can be well finished.

This final project can be done well by author because the support from my family and colleague. Therefore, the author would like to thank to:

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3. All of my friends Baracuda'13 who have given many stories over the author completed education in the Department of Mechanical Systems shipyard FTK - ITS.
4. Special thanks to Angga, Mas Fandhika, Mas Pandhika, Jangka, Isti, Fitri, Mba Arin, Mas Syafi.

The author realizes that in the writing of this final project is still far from perfect. Therefore, any suggestions are very welcomed by the author for the improvement and advancement of this thesis. Hopefully, this final project report can be useful for the readers and reference to write next final project.

Surabaya, January 2017
Lenny Rahmawati

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# TABLE OF CONTENTS

# LIST OF FIGURES

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# LIST OF TABLES

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# CHAPTER 1
# INTRODUCTION

## 1.1. Background

In the condition of the crisis energy like now, every country in the world given to find and utilizing the energy an alternative to maintain security the availability of energy source. One source of energy an alternative is by using tidal current power generation, or usually call pltal.

Technology development of tidal current power generation ( pltal ) is one form of activities ' energy resources to ensure the availability of energy .Besides , energy ocean currents as one of the new energy and renewable can be used for solving the problem of energy electricity islands in areas so it can support the business become manifest indonesia archipelago independent and forward.

Tidal current power generation is using the system structure platform turbine plt ocean currents with type patamaran. But type this platform still have several weaknesses among them is the absence of arrangement patamaran in terms of system ballast, while ocean currents always different condition if in pairs and after the sea in condition recede, offsetting patamaran need to avoid excessive on trim hull as a result of the movement of the ocean currents .

Therefore need for device that could used to regulate patamaran was due to the balance of the ship by the style , one of them to the system ballast that can be used to get patamaran more balanced and effective.

## 1.2. Statement of Problems

According to the background of the study, this final project has the following statement of problems.

a) How the analysis RAO( Response Amplitude Operator) at Patamaran?
b) How the effective ballast system design at Patamaran?
c) How ballast effect for pitching motion?

## 1.3. Scope of Problems

According to the research problem, this final project has the following scopes.

a) The calculation just in pitching motion, not in six motion haul.
b) The analysis will only focused on the RAO (Response Amplitude Operator), not about stability of haul.

## 1.4. Research Objectives

In accordance with the background of the study, this final project has these following objectives.

a) To analys RAO (Response Amplitude Operator) in patamaran with ballast and without ballast.
b) To design and to analyze the system ballast in Patamaran
c) To know the influence of the use of ballast system to balance of the hull a consequence of the motion by ocean currents.

## 1.5. Research Benefits

This final project will be able to give these following benefits.

a) Knowing Benefits obtained from the study was to get effective performance patamaran by regulating effective system so getting pattamaran get the power is produced by the ballast system.

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# CHAPTER 2
# STUDY LITERATURE

## 2.1 Basic Theory

Energy is a crucial issue for the world community, especially since the oil crisis in the world and ultimately minyakpun prices soared. Under these conditions, the current countries in the world are racing to find and utilize alternative energy sources to maintain the security of the availability of energy resources. as well as Indonesia. Source: Wikipedia 2015

The energy sector is one of the most important sector in Indonesia because it is the basis of all other development. There are many challenges associated with energy, and one of the things that concerned the government is how to extend the electricity grid, particularly by building the infrastructure of power supply to various areas.

The energy of the earth is extremely diverse. Energy is divided into two categories namely renewable energy and non-renewable energy. Renewable energy is not limited in number so that the energy is so nice to be utilized as a source of energy, particularly electricity generation. Ocean currents can be another option to produce energy that is renewable.

## 2.2 Sea Flow Definition

Ocean current is the movement of water mass vertically and horizontally so towards balance, or movement of water that is happening throughout the world's oceans.Flow is also a movement of a mass flow of water due to wind or difference density or long wave movement. Source: Wikipedia 2014

### 2.2.1 Factors that cause ocean currents

The currents in the ocean caused by two main factors, namely:

- Internal factors, such as differences in density of sea water, horizontal pressure gradient and friction layer of water.
- External factors such as sun and moon gravity is affected by the detainee seabed and the Coriolis force, the difference in air pressure, gravity, tectonic, and wind.

### 2.2.2. Types of Sea Flow

a. **Based on the Process of:**

- Ekman Flows: Flows were affected by wind.
- Termohaline Flow: Flow is affected by the density and gravitas.
- Tidal current: The current that is influenced by the tide.
- Geostrophic currents: currents that are affected by the pressure gradient and the horizontal corolis style.
- Wind currents driven current: The current that is affected by the wind and movement patterns occur in the surface layer.

b. **Based Depth:**

- Surface currents: Occurs in a few hundred meters from the surface, moving the horizontal direction and is influenced by the distribution pattern of the wind.
- Flows in: There was deep in peraran column, the direction of movement is not affected by the distribution pattern of the

wind and brings the mass of water from the polar regions to the equator.

**2.3. Understanding Ballast System**

Ballastt system is a system used to maintain balance (stability) ship / floaters in case of trim or list (roll), especially during loading and unloading (for boats).In addition ballastt system is used to maintain the balance necessary to charge and discharge of seawater in the tanks ballastt, so as to maintain the center of gravity as low as possible and persevering aboard the vessel position is always under certain conditions. Process water ballastt divided into two ballastting (water filling ballastt) and deballastting (drainage ballastt). Ballastt system components such as the main pipe, branch pipes, valves and fittings, pumps, and tanks ballastt. Source: Wikipedia 2015

There are some calculations performed to obtain the appropriate ballast system, along with the size of the pipe and the pump needs to be used in the system of ballasts in this patamaran. Here are some calculations that cultures do.

**2.3.1. Calculation Algorithms**

- Calculation of volume displacement
- Calculation of displacement
- Calculation capacity ballast pump
- Calculation of the diameter of the main ballast pipe
- Calculation of ballast pump head
    - ➢ Calculation of installation in the engine room.
    - ➢ Calculation of head in the suction pipe
    - ➢ Calculations head in discharge pipe

- Calculation of total head losses
- Calculation of pump power (Pw) and motor power (Pm)

**2.3.2. input parameters**

a. Calculation of volume displacement

Volume displacement can be calculated using the equation:

L x B x T x Cb

where:

LWL = length of waterline patamaran

B = width patamaran

T = draft patamaran

Cb = coefisien block

b. Calculation of displacement

▼x p

Where:

▼ = volume of displacement

P = density of seawater

c. Calculation capacity ballast pump

Q = V / t

Where?

V = volume of displacement

t = time needed to empty the ballast tank

d. Calculation of the diameter of the main ballast pipe

$dH = (4 \times Q) / (v \times \pi)^{0.5}$

Where:

Q = capacity ballast pump

v = velocity flow

e. Calculation of ballast pump head

- calculation of installation

H = Hs + Hp + Hv + total Head-loss

where:

hs = static pump head

hp = head pressure difference

hv = head speed difference

h1 = head in the suction pipe

h2 = head in the discharge pipe

v = viscosity

Rn = Reynolds number

λ = frictional losses

f. Calculation of pump power (Pw)

Hl = total head losses

ρ = density of water bilga

Q = pump capacity

$\eta$ = pump efficiency

g. Calculation of motor power (Pm)

Pw = pump power

$\eta$ = pump efficiency

## 2.4. Ballast System Main Components

In a ballast system, there are several components into a system that can run well.Here are some of the ballast system components along with its usefulness.

### 2.4.1. Ballast pumps

The pump is a component that is used to move water out of the tank or tang ki.The pump used is a type of centrifugal pump with a debit considerations take precedence over headnya. Pump specification will be described in the next chapter. Selection of the pump itself has been mentioned steps.

### 2.4.2. Ballast tanks

At tank ship ballast normally functions to maintain stability both when sailing ships and ships load and unload time.At the time of sailing ships, ballast tanks in an empty condition, while the current load and unload ships, ballast tanks filled to maintain the stability of the ship. For tank that exist in this patamaran, tank also serves as a ballast to maintain a balance patamaran himself from the movement of ocean currents from different directions.

**2.4.3. Pipe Ballast**

Pipe ballast is the entrance of seawater into the tank or out of the tank. For ballast pipe size is as follows:

$$D = \sqrt{\frac{4Q}{v\pi}}$$

in which:

- $D_{in} = f(Q_{ballast}, V\ stream)$
- Q = <u>Vol ballast tanks total</u> discharge time tank
- Ballast tank volume = 10% - 15% Volume Displacement
- Time of discharge = f (time loading and unloading)
- $V_{flow} = 2 \sim 4$ m / s

**2.4.4. Valve**

Valves is a useful tool to disconnect, connect, and change direction gets another of the pipeline system and also to control the flow and pressure of the fluid.Valves are used in Bilga system include:

- Elbow 90 valve

Figure 2. 1 Elbow 90

Source: **http://stocktonvalve.com**

- Filter

Figure 3. 1 filter

Source: **http://stocktonvalve.com**

- SDNRV

Figure 2. 3 SDNRV

Source: http://stocktonvalve.com

- Gate valve

Figure 2. 4 Gate Valve

(source: http://stocktonvalve.com )

- connection T

Figure 2. 5 Connection T

source: **http://stocktonvalve.com**

- Butterfly valve

Figure 2. 6 Butterfly Valve

source: **http://stocktonvalve.com**

**2.4.5**. **outboard**

Outboard function is to remove the water that's already unused.This utboard laying o be above the waterline or WL and should be given a SDNRV type valve. ,Located outboard laying guess about 011 mm above the waterline mark.

Figure 2. 7 Outboard

source: **http://www.academia.edu**

**2.4.6 Seacheast**

Seachest a place in the hull, where there is a sea chest p ipa channel sea water intrusion.S Elain the pipeline, on seachest there are also two other channels. namely the blow pipe and pipe 6ent. blow pipe is used as an air duct for menyempro t impurities in seachest.While v ent pipe used for ventilation duct in seachest.S eachest to this vessel is placed in the stomach in the engine room.

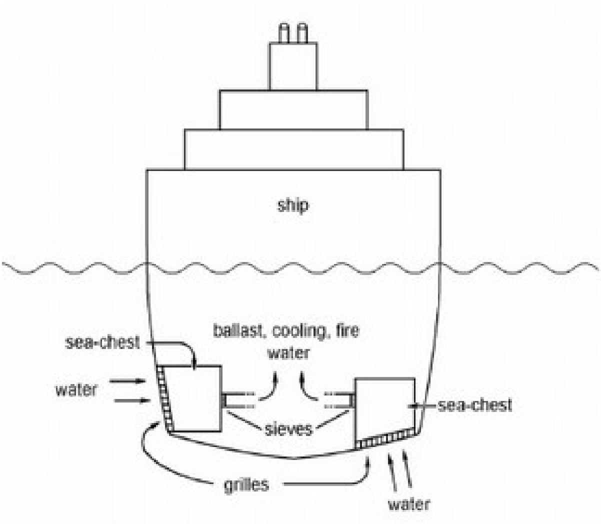



Figure 2.8 Sea Chest

source: **http://www.academia.edu**

**2.4.7. How it Works Ballast System**

In general it is to fill the ballast tanks are located in the double bottom, with sea water, which is taken from seachest. % hrough ballast pump, and an Salur main pipe and branch pipes.S ystem ballast pump is shown to adjust the slope and draft vessel, as a result of changes in cargo ship so that the stability of the ship can be maintained.Pipes installed in the ballast tank niche niche bow and stern tanks, double bottom tanks, deep tanks and tank side (side tank). 'allast are positioned in niche bow and stern tanks are used to serve kondis i trim the desired vessels.S ecara general of labor a ballast system is divided into three, the first how the ballast tank filling system from the outside in, and then how to dispose of ballast water from the tank to the outside, and how to move water ballast from tank to tank

## **2.5**. **Ship Stability**

The stability of the ship is a vessel's ability to uprise again while the ship at the time floated, not tilted left or right, as well as at the time of sailing, caused by outside influences exerted on it by the time the ship diolengkan by waves or wind, can ship up again.

### **2.5.1**. **Types of vessel stability**

The stability of the ship can be classified in two types, namely stability vessel stability Transverse and longitudinal stability of the ship.

- **Transverse stability of the vessel** is a vessel's ability to uprise again while the ship slant in the transverse direction caused by external influences acting on it.
- **Longitudinal stability of the ship** is a vessel's ability to uprise again while the ship slant in the longitudinal direction caused by external influences acting on it.

### **2.5.2**. **Initial Stability ship**

Initial stability is the ability of a vessel to ship it back into its original upright position when the ship slant on small corners (= 60 degrees).In general, initial stability is limited to a discussion on the transverse stability alone. In discussing the initial stability of a ship, then points *(crucial* point in kapa stability l) determines the size of the initial stability values are:

#### **2.5.2.1**. **The weight of the vessel (G)**

The weight of the ship is a point in the ship which is the point of the resultant catch all the gravity working on the ship, and influenced by the construction of the ship. *directions labor force of gravity ships* is perpendicular down.The weight of the ship from a ship that lies in the field symmetrical upright vessel that field created by

Linggi Linggi front and rear keel kapal.Letak / notch *gravity aboard* a ship will remain if there is no increase, decrease, or shift the weight on board and will move its place when there are addition, subtraction or shift the weight of the vessel.

- If there is additional weight, the center of gravity will move towards the ship / direction and parallel to the point of heavy weights are loaded.
- If there is a reduction in weight, the *center of gravity of the ship.* will move towards the opposite and the center of gravity weight dismantled.
- If there is a weight shift, then the *center of gravity of a ship* will move in the same direction and aligned with the center of gravity of the weight digeserkan.titik this is a point that greatly affects the stability of the ship.

**2.5.2.2. Point Press ship / vessel Floating point (B)**

Ship floating point is the point of stability of the ship Centre of buoyency a point on a ship that is the point of capture resultant upward pressure water all styles that work on parts of the ship that sank in the water.Directions operation of the compression force is perpendicular upwards. Position the point hit a ship always move to move in the direction of menyengetnya *ship,* meaning that the position of the pressure point will move to the right when the *ship* slant to the right and will move to the left when the ship slant to the left, because the focus of part of the ship that sank move in accordance with the directions sengetnya ship.So by switching their mobile notch hit points of a ship as a result menyengetnya the ship will take as a result of change-unlike the stability of the ship.

### 2.5.2.3. Metasentrum point (M)

The stability of the vessel is a vessel which is the point of the arc breaking point swing is the path traversed by a press point kapal.Titik Metasentrum a ship with a small slanting angles perpotomgam lies on the axis line and, toward the line of compression force as the ship slant upward.For angles smaller slanting position Metasentrum held constant, even if the actual kekududkan that point varies according to the direction and magnitude of slanting angle. Therefore, very small changes in the location, it is considered permanent.

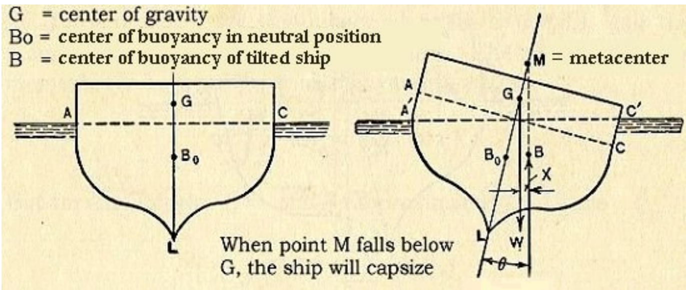



Figure 2. 9 Stability notch ship titk weight of the vessel, the vessel floating point, and the point of the ship metasentrum

source: **https://vandiaz89.wordpress.com**

With the transfer of the position of the point hit a ship as a result menyengetnya the ship will take as a result of change-unlike the vessel's ability to uprise back.The size of the ship's ability to uprise something back is a measure of the size of the vessel's stability.So by switching their mobile notch hit points of a ship as a result of menyengetnya vessels will carry due to change-unlike the stability of the ship.

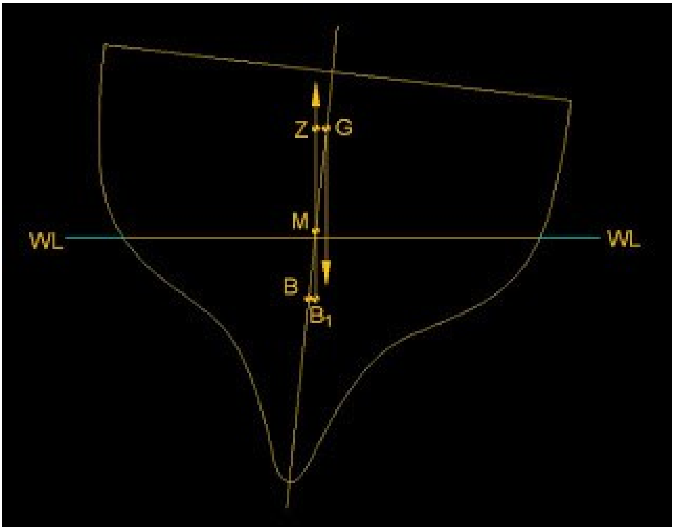



Figure 2. 10 Diagram stability of the ship

source: **https://vandiaz89.wordpress.com**

Diagram of vessel stability, the center of gravity (G), the center of buoyancy (B), and Metacenter (M) on *the ship's* position upright and tilted.As the note G in a fixed position while the B and M move when the ship tilted.) With the transfer of the position of the point press B on the position originally perpendicular below the center of gravity G would cause the pair Koppel, the two forces of equal magnitude but opposite directions, one being the gravity of the ship itself while the other is a pressure force upward which is the resultant upward pressure force acting on the part of the ship is in the water that dot tankpnya is a pressure point. With the formation of the pair Koppel will occur the moment that is equal to the weight of the vessel multiplied by the distance between the gravity ships and force upward pressure vessel stability.

**2.5.3**. **Stability Ship Equipment**

There are several devices atu tool in gunkan to keep the ship stbilitas namely fin hull, balancing tanks (ballast the ship), and the fin stabilizer.

- Fin hull: fin keel or also known as Bilge keel serve to increase ship transverse friction making it more difficult to reverse and maintain the stability of the ship.Typically used in vessels with hull shape V.
- Balancing tank is a tank that serves to stabilize the position of the ship with ballast water flowing from left to right the ship when the ship tilted left and sebalikanya when tilted to right. This tank serves to maintain the stability of the ship.
- Fin stabilizer fins on the keel to adjust the position at the time the ship swerved so as to maintain the stability of the ship

Explanation of ballast and stability of the system as described above is a theory that is usually used in the field of shipping, patamaran here to do the same theory as well patamaran ships and ocean current power plant is a floating building.

## 2.6. RAO (Response Amplitde Operator)

In the field of ship design and other floating structures design, response amplitude operator (RAO) is statistically engineered, or sets of these statistics, which are used to determine the behavior of the possibility of the ship when operating at sea. Known by the acronym of RAO, response amplitude operators are usually obtained from the proposed model of ship design was tested in a model basin, or from special running CFD computer program.

### 2.6.1 Ship Manouver Theory Causes Wave Excitation

1. Translational motion mode
   - *Surge,* motion transversal direction of the x-axis
   - S *way,* motion direction transverse axis y
   - *Heave,* motion transversal direction of the axis z
2. Rotational motion mode
   - *Roll,* rotational motion direction jest x
   - *Pitch,* the rotational direction of the y-axis motion
   - *Yaw,* rotational motion of the z-axis direction

Definition movement ship in en a m level freedom could be explained by figure 2.2. With using conversion axis hand right three movement translation in direction axis x, y and z, that is *surge* (Z 1), *sway* (Z 2) and *heave* (ζ 3), while for rotational movement to third axis is *roll* (Z 4), *pitch* (ζ 5) and *yaw* (ζ **6).**

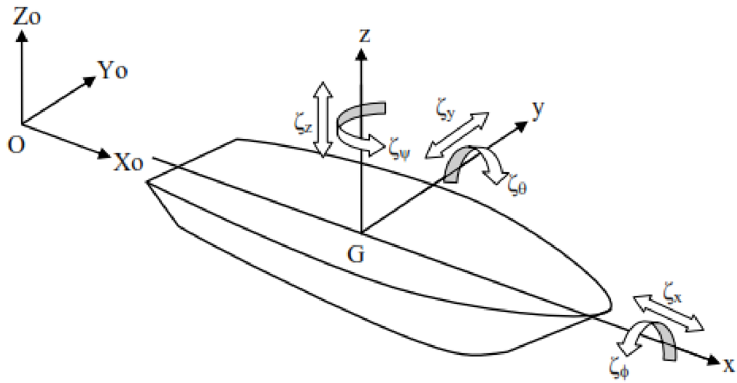



Figure 1. Transasi motion and rotation on a ship

**2.7 Use of Software maxsurf dongle and MOSES**

Academic maxsurf dongle is a software-based modeling of the hull surface .Modeling the hull in academic maxsurf dongle is divided into several surface combined (bounding). Surface on Professional maxsurf dongle didenifisikan as a collection of control points that make up the nets - nets control point. In obtaining the desired surface, the control point slide - slide it until it reaches the optimum shape. Fitness process modeling using the outline plan maxsurf dongle design is understanding how the control points used to reach the surface shape to be achieved.

Moses is one of the software used in the marine field, especially for floating buildings.I nterface moses no less than others.In the process of designing the structure 1 EPAs beach floating structure determination of ability to work is affected by the load acting on the structure.In addition, one of the most important factors is to determine the characteristics of the floating structure movement due to environmental burdens that affect him.To know the characteristics of the movement of floating structures, we can use the help of software.One of the software that is often used is produced by Ultramarine MOSES Inc.

# CHAPTER 3
# RESEARCH METHODS

## 3.1.Metodology

To solve the problem in this research , the method used is approach computational fluid dynamics ( cfd ) .Software used is solid work .The following is a step in construction research carried out.

## 1.2 Identification The Formulation Problem

Determine beforehand problems will be the analysis consistent with the objectives of doing research.To further focuses on research purposes, hence in formulating identification this problem determined the problem.All written here still in the form of temporary allegation and necessary further study to get results maximum research is done before.

## 1.3 Literature Study

Literature study was performed by collecting various references to support this final project. The media that will used is :

a. Books;
b. Journals;
c. Engineering Report;
d. Thesis

The primary concern for this literature study is transmission shaft for vertical axis turbine, design of shaft, calculation of shaft and other support component, and finite element methods.

## 1.4 The Collection of Data

The data can be obtained from sources or reference anything to do with the plane of duty end of this .These other sources among others of book , journal , articles , the internet or a piece of writing as duty the end .In this work also take data from meteorology and geophysics ( BMKG ) for data high ocean currents and the period ocean currents.

## 1.5 Modeling

At this stage, modeling will perform using mautocad to draw the ballast system at patamaran and using Autocad 3D plan for drawing 3D ballast system.

## 1.6 Running Simulation

After model made and determined variations limitation and that will be given , next phase is to test model .In this research methods used is with the approach of computational fluid dynamics ( CFD ) , then on the model of testing done in three stages pretax pocessor namely, solver post processor and .After three of the process is done, whether next results obtained could be accepted or not based on the data generated compared with the conditions should be .If the results can be accepted by, then the next process can be done .If the result is unacceptable, then the next process not be continued and steps should be taken is find and fix errors ranging from the manufacture of model.

## 1.7 Data Analysis

The last of testing model is post detector processor , where the end of this process result of testing model have been found .With the data available still have not said the existing problems , this needs to be analysis data and discussion on the outcome of testing model based on the and how to solving problems that gained when literature study .Data analysis and discussion aims to determine the decision making process to get answers from existing problems consistent with the objectives of doing research.

## 1.8 Conclusion & Reporting

In observance of some consideration, from analysis data and the next can be done the decision to draw conclusions all the yield tests has done.Conclusions obtained is the problem in this study.This conclusion is the end result of research

In the process of the research , the possibility of obstacles or something which has not been running in research for a limited .So that required suggestions on processes and results obtained from the study to the development of further research to have a better again.

## 1.9 METHODOLOGY FLOW CHART

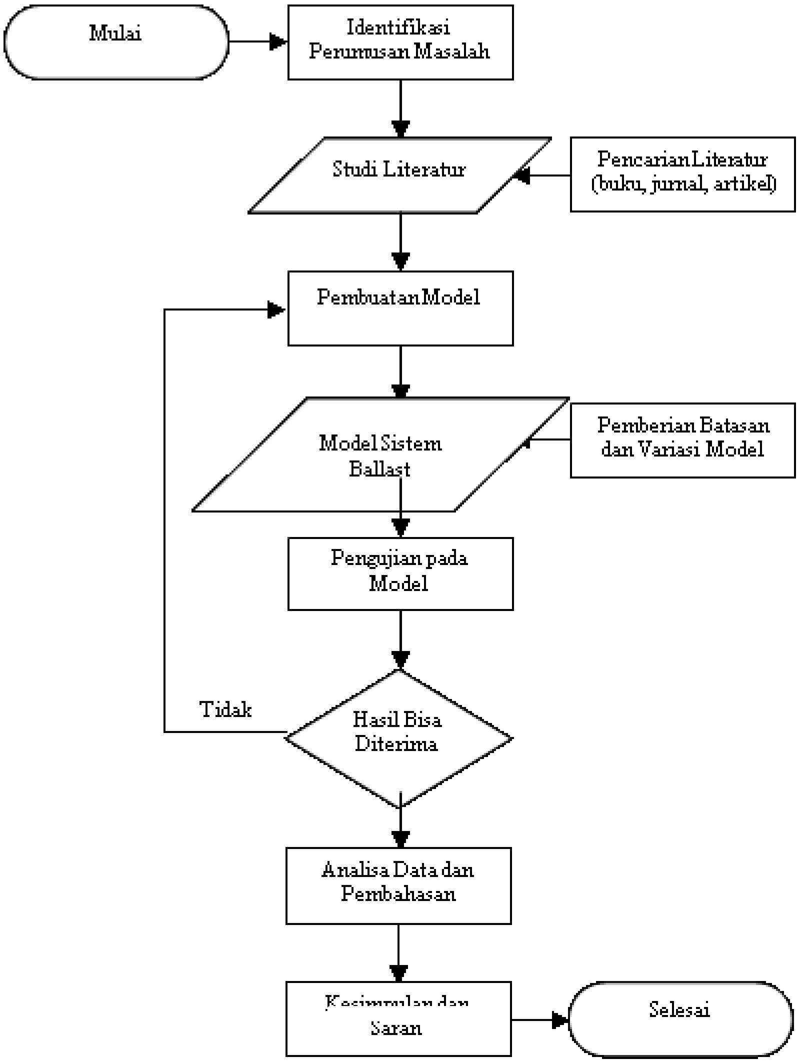



**Figure 3.1** Research Methods

# CHAPTER 4
# DATA ANALYSIS AND DISCUSSION

## 4. 1. Mooring System

### 4.1.1. Determining of Location

Ballast system on pattamaran that located on Nusa Penida will be analyzed on this research. Nusa Penida located on Klungkung District on Bali Province. Klungkung area is one of the seceond smallest district after Denpasar City by the large of area are 315 $km^2$ or 5,99% of the total area on Bali. Toyopakeh Strait located besides on Nusa Penida, Nusa Peningan and Nusa Lembongan which have 6 km long and have 1,5 km wide of starit on East area, 700 meters on the middle and 1 km on Southwest. Morphology on Toyopakeh Strait are relatively steep. Detail of area are describing on picture (4.1.1.)


Picture 4.1.1. Current Power Plant Location Project on Toyopakeh Strait, Nusa Penida Island, Bali

In shoreline area has a very tight contour pattern and the central part is being deep morphology. Nusa Penida coastal have strong current, and by this opportunity research regarding to current power plant sets out on that area. Trenchs on Nusa Penida Strait have temperature on 14°C-31°C ranges. The types of coral reefs are fringing reef that spread of Nusa Penida, Nusa Ceningan and Nusa Lembongan by 1.419 Ha area (CTC, 2010).

### 4.1.2. Determining Platform Installation Coordinat Position

By the current location on Google Earth, determination coordinates are on the table (4.1.2.) below.

4.1.2. Platform Coordinates Installation of Current Power Plant (PLTA) Project

| Location | South | East |
|---|---|---|
| Platform PLTA | 8°40`25.68"S | 115°29`15.70"E |


Picture 4.1.2. Platform Installation Location

### 4.1.3. Environmental Data

On ballast system analysis, external force are the main factor data as one of requirement that called Metaocean Data (Meteorology and Oceanography) are on list below.

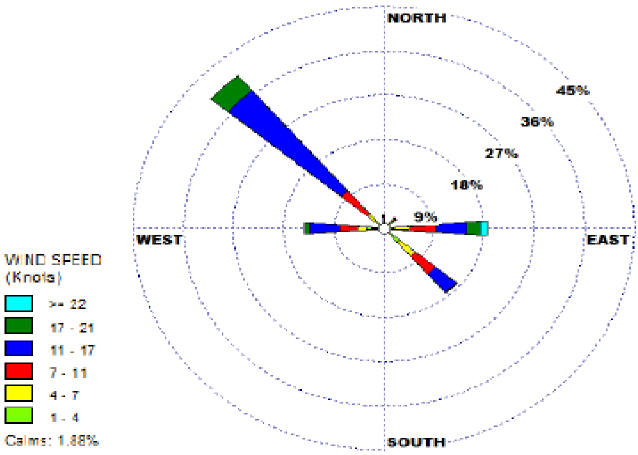
a. The wind speed at a reference elevation
b. The significant wave height
c. Data Tidal

d. Current velocity at an elevation of reference
e. The map bathymetric operating locations

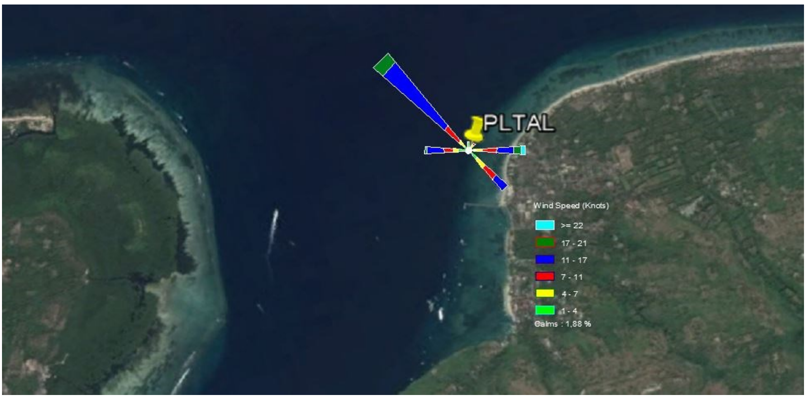
#### 4.1.3.1. The Wind Speed Data

Wind speed obtained from BMKG data as a value of wind speed in knots and direction are calculated every hour for 12 years, ie from 2004 to 2015. The position coordinate data collection is located in the waters of Nusa Penida in the strait Toyopakeh, ie 8 ° 63'79.70 "S and 115 ° 49'91.47" east of the north island of Nusa Penida, as well as 8 ° 72'84.30 "S and 115 ° 42'83.54 "BT's south island of Nusa Penida.
Based on wind speed data analysis, the conclusion are on below.

a. The most dominant wind direction is northwest by the frequency of occurrence of 40%
b. The wind speed with a range of 17-21 knots have a frequency of 4%, 11-17 knots have a frequency of 6%, and 4-7 knots have a frequency of 5%




Picture 4.1.3.1. Windrose diagram of wind speed on Toyopakeh Starit on 2004-2005




Picture 4.1.3.2. Windrose on Platfor Location

### 4.1.3.2. The significant wave height

To find the significant wave height, using wind induced wave methode. Basicly this methode convert the wind speed to be height of wave. Beside the wind speed, this methode observe the length of the fetch on location point. After calculate the growth of wave, then the results are on table 4.1.3.2. below.

Table. 4.1.3.2. The significant wave height on wind direction

| Wind Direction | The significant wave height (m) | The significant wave periode (s) |
|---|---|---|
| West | 0.7 | 3.77 |
| Northwest | 1.08 | 4.85 |
| East | 1.45 | 5.93 |

### 4.1.3.3. Tidal Data

Tidal data observed based on elevation calculation on water survace every 1 hour for 30 days. Tidal data results are on the table 4.1.4.1. below.

Table 4.1.4.1. Tidal data calculation for 30 days

| Tanggal | Waktu | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0:00 | 1:00 | 2:00 | 3:00 | 4:00 | 5:00 | 6:00 | 7:00 | 8:00 | 9:00 | 10:00 | 11:00 | 12:00 | 13:00 | 14:00 | 15:00 | 16:00 | 17:00 | 18:00 | 19:00 | 20:00 | 21:00 | 22:00 | 23:00 |
| 9/8/15 | 4.95 | 5.15 | 5.29 | 5.35 | 5.30 | 5.20 | 5.05 | 5.00 | 4.70 | 4.49 | 4.32 | 4.28 | 4.36 | 4.45 | 4.55 | 4.65 | 4.70 | 4.79 | 4.82 | 4.78 | 4.80 | 4.78 | 4.70 | 4.85 |
| 10/8/15 | 4.82 | 5.00 | 5.15 | 5.30 | 5.39 | 5.41 | 5.35 | 5.12 | 4.90 | 4.76 | 4.60 | 4.45 | 4.31 | 4.24 | 4.24 | 4.34 | 4.50 | 4.65 | 4.75 | 4.95 | 5.05 | 4.95 | 4.95 | 4.85 |
| 11/8/15 | 4.80 | 4.80 | 4.80 | 4.85 | 5.00 | 5.05 | 5.35 | 5.45 | 5.50 | 5.40 | 5.25 | 4.90 | 4.70 | 4.25 | 4.10 | 4.15 | 4.20 | 4.35 | 4.55 | 4.80 | 4.85 | 5.05 | 5.10 | 5.10 |
| 12/8/15 | 4.95 | 4.90 | 4.85 | 4.80 | 4.80 | 4.90 | 5.20 | 5.35 | 5.45 | 5.50 | 5.40 | 5.23 | 4.91 | 4.53 | 4.24 | 4.02 | 3.96 | 4.08 | 4.39 | 4.68 | 4.89 | 5.02 | 5.13 | 5.11 |
| 13/8/15 | 5.02 | 4.87 | 4.70 | 4.56 | 4.56 | 4.70 | 4.93 | 5.23 | 5.46 | 5.60 | 5.63 | 5.43 | 5.12 | 4.76 | 4.39 | 4.01 | 3.85 | 3.84 | 4.08 | 4.43 | 4.80 | 5.06 | 5.18 | 5.24 |
| 14/8/15 | 5.13 | 4.99 | 4.79 | 4.59 | 4.46 | 4.52 | 4.70 | 5.02 | 5.39 | 5.66 | 5.72 | 5.63 | 5.41 | 5.06 | 4.66 | 4.25 | 3.98 | 3.77 | 3.89 | 4.21 | 4.63 | 4.99 | 5.20 | 5.27 |
| 15/8/15 | 5.24 | 5.06 | 4.86 | 4.61 | 4.41 | 4.27 | 4.39 | 4.67 | 5.03 | 5.38 | 5.58 | 5.63 | 5.50 | 5.19 | 4.80 | 4.40 | 4.00 | 3.76 | 3.75 | 3.99 | 4.39 | 4.85 | 5.17 | 5.33 |
| 16/8/15 | 5.29 | 5.15 | 4.92 | 4.68 | 4.45 | 4.29 | 4.22 | 4.44 | 4.78 | 5.17 | 5.48 | 5.63 | 5.55 | 5.32 | 4.98 | 4.57 | 4.21 | 3.88 | 3.74 | 3.84 | 4.19 | 4.68 | 5.10 | 5.35 |
| 17/8/15 | 5.39 | 5.28 | 5.05 | 4.79 | 4.54 | 4.33 | 4.16 | 4.20 | 4.52 | 4.95 | 5.30 | 5.54 | 5.59 | 5.43 | 5.13 | 4.75 | 4.38 | 4.03 | 3.83 | 3.82 | 4.06 | 4.53 | 4.99 | 5.28 |
| 18/8/15 | 5.41 | 5.31 | 5.15 | 4.90 | 4.61 | 4.35 | 4.18 | 4.10 | 4.27 | 4.69 | 5.05 | 5.36 | 5.50 | 5.42 | 5.21 | 4.88 | 4.53 | 4.22 | 3.90 | 3.83 | 3.99 | 4.37 | 4.84 | 5.23 |
| 19/8/15 | 5.44 | 5.43 | 5.32 | 5.08 | 4.77 | 4.50 | 4.25 | 4.08 | 4.15 | 4.48 | 4.87 | 5.18 | 5.39 | 5.43 | 5.30 | 5.03 | 4.70 | 4.44 | 4.17 | 3.98 | 3.96 | 4.22 | 4.68 | 5.14 |
| 20/8/15 | 5.42 | 5.46 | 5.34 | 5.17 | 4.91 | 4.63 | 4.39 | 4.12 | 4.08 | 4.22 | 4.61 | 4.95 | 5.18 | 5.28 | 5.22 | 5.08 | 4.83 | 4.55 | 4.37 | 4.21 | 4.17 | 4.23 | 4.58 | 5.01 |
| 21/8/15 | 5.32 | 5.46 | 5.43 | 5.31 | 5.08 | 4.80 | 4.57 | 4.33 | 4.16 | 4.20 | 4.43 | 4.73 | 4.99 | 5.12 | 5.14 | 5.05 | 4.88 | 4.66 | 4.49 | 4.34 | 4.26 | 4.32 | 4.48 | 4.82 |
| 22/8/15 | 5.15 | 5.35 | 5.43 | 5.35 | 5.19 | 4.97 | 4.74 | 4.51 | 4.29 | 4.19 | 4.28 | 4.47 | 4.69 | 4.91 | 5.01 | 5.00 | 4.89 | 4.76 | 4.65 | 4.54 | 4.40 | 4.43 | 4.57 | 4.81 |
| 23/8/15 | 5.09 | 5.32 | 5.41 | 5.37 | 5.29 | 5.14 | 4.94 | 4.73 | 4.49 | 4.30 | 4.29 | 4.36 | 4.52 | 4.70 | 4.82 | 4.84 | 4.80 | 4.79 | 4.71 | 4.65 | 4.61 | 4.58 | 4.62 | 4.78 |
| 24/8/15 | 4.99 | 5.18 | 5.30 | 5.36 | 5.31 | 5.21 | 5.09 | 4.92 | 4.73 | 4.53 | 4.37 | 4.31 | 4.34 | 4.45 | 4.58 | 4.64 | 4.71 | 4.76 | 4.78 | 4.75 | 4.77 | 4.76 | 4.75 | 4.82 |
| 25/8/15 | 4.87 | 5.01 | 5.15 | 5.24 | 5.29 | 5.30 | 5.27 | 5.17 | 5.03 | 4.84 | 4.61 | 4.46 | 4.35 | 4.29 | 4.35 | 4.45 | 4.54 | 4.64 | 4.74 | 4.84 | 4.90 | 4.92 | 4.91 | 4.90 |
| 26/8/15 | 4.89 | 4.92 | 4.98 | 5.06 | 5.19 | 5.30 | 5.36 | 5.34 | 5.27 | 5.12 | 4.95 | 4.70 | 4.38 | 4.24 | 4.17 | 4.20 | 4.31 | 4.48 | 4.63 | 4.77 | 4.91 | 5.00 | 5.01 | 4.98 |
| 27/8/15 | 4.89 | 4.83 | 4.80 | 4.81 | 4.97 | 5.14 | 5.33 | 5.45 | 5.48 | 5.41 | 5.24 | 4.96 | 4.65 | 4.33 | 4.10 | 4.00 | 4.08 | 4.25 | 4.54 | 4.79 | 4.97 | 5.10 | 5.14 | 5.13 |
| 28/8/15 | 5.00 | 4.84 | 4.72 | 4.66 | 4.73 | 4.91 | 5.18 | 5.46 | 5.62 | 5.66 | 5.55 | 5.28 | 4.94 | 4.54 | 4.21 | 3.93 | 3.84 | 3.99 | 4.31 | 4.66 | 4.96 | 5.12 | 5.24 | 5.22 |
| 29/8/15 | 5.10 | 4.90 | 4.67 | 4.52 | 4.44 | 4.54 | 4.81 | 5.17 | 5.52 | 5.74 | 5.78 | 5.59 | 5.26 | 4.87 | 4.42 | 4.05 | 3.77 | 3.78 | 4.07 | 4.54 | 4.96 | 5.15 | 5.36 | 5.32 |
| 30/8/15 | 5.22 | 5.01 | 4.74 | 4.49 | 4.33 | 4.25 | 4.43 | 4.80 | 5.23 | 5.60 | 5.81 | 5.81 | 5.52 | 5.10 | 4.68 | 4.27 | 3.87 | 3.67 | 3.76 | 4.13 | 4.69 | 5.14 | 5.37 | 5.43 |
| 31/8/15 | 5.36 | 5.17 | 4.88 | 4.52 | 4.27 | 4.04 | 3.99 | 4.29 | 4.82 | 5.29 | 5.64 | 5.79 | 5.66 | 5.34 | 4.91 | 4.53 | 4.09 | 3.80 | 3.66 | 3.88 | 4.32 | 4.91 | 5.36 | 5.56 |
| 1/9/15 | 5.55 | 5.39 | 5.07 | 4.72 | 4.37 | 4.08 | 3.86 | 3.93 | 4.33 | 4.87 | 5.33 | 5.62 | 5.72 | 5.50 | 5.11 | 4.71 | 4.37 | 4.03 | 3.81 | 3.80 | 4.13 | 4.65 | 5.24 | 5.54 |
| 2/9/15 | 5.70 | 5.58 | 5.30 | 4.97 | 4.60 | 4.27 | 3.93 | 3.73 | 4.00 | 4.42 | 4.91 | 5.27 | 5.50 | 5.54 | 5.25 | 4.88 | 4.54 | 4.27 | 3.95 | 3.86 | 3.97 | 4.34 | 4.91 | 5.40 |
| 3/9/15 | 5.66 | 5.73 | 5.51 | 5.19 | 4.84 | 4.51 | 4.18 | 3.87 | 3.79 | 4.07 | 4.46 | 4.93 | 5.23 | 5.31 | 5.25 | 5.03 | 4.79 | 4.45 | 4.20 | 3.95 | 3.92 | 4.20 | 4.70 | 4.74 |
| 4/9/15 | 5.40 | 5.50 | 5.32 | 5.20 | 4.95 | 4.70 | 4.42 | 4.20 | 4.09 | 4.19 | 4.58 | 4.91 | 5.20 | 5.30 | 5.25 | 5.00 | 4.79 | 4.53 | 4.40 | 4.23 | 4.20 | 4.21 | 4.60 | 5.05 |
| 5/9/15 | 5.39 | 5.47 | 5.40 | 5.30 | 5.05 | 4.79 | 4.50 | 4.30 | 4.19 | 4.16 | 4.40 | 4.75 | 5.00 | 5.10 | 5.15 | 5.05 | 5.02 | 4.66 | 4.51 | 4.32 | 4.28 | 4.30 | 4.50 | 4.75 |
| 6/9/15 | 5.05 | 5.30 | 5.45 | 5.34 | 5.20 | 4.90 | 4.72 | 4.49 | 4.25 | 4.20 | 4.31 | 4.50 | 4.70 | 4.89 | 5.00 | 4.97 | 4.80 | 4.75 | 4.62 | 4.50 | 4.41 | 4.42 | 4.60 | 4.78 |
| 7/9/15 | 5.12 | 5.36 | 5.40 | 5.33 | 5.25 | 5.12 | 4.90 | 4.69 | 4.51 | 4.31 | 4.29 | 4.38 | 4.55 | 4.69 | 4.80 | 4.82 | 4.80 | 4.75 | 4.67 | 4.60 | 4.59 | 4.60 | 4.65 | 4.80 |

To determine characteristic of the tide, then do constant calculation based on harmonic measurement data tides. Here are the results of the calculation of the harmonic constants.

Table 4.1.4.2. Tidal harmonic constant value

| Symbol | Description | g° phase | H=Amplitude (m) |
|---|---|---|---|
| $Z_0$ | | | 4.79 |
| $M_2$ | semi diurnal | 71.72° | 0.51 |
| $S_2$ | | 1.44° | 0.4 |
| $N_2$ | | 97.42° | 0.07 |
| $K_2$ | | 1.44° | 0.09 |
| $K_1$ | diurnal | 275.2° | 0.16 |
| $O_1$ | | 96.83° | 0.16 |
| $P_1$ | | 275.20° | 0.05 |
| $M_4$ | quarterly | 116.66° | 0.02 |
| $MS_4$ | | 144.54° | 0.06 |

Formzahl value calculation is calculated based on the values of harmonic constants. Numbers Formzahl identify the type of the tides on the location, whether diurnal or semi-diurnal type. Formzahl of numbers that shows the number 0:35, then the type of ups and downs that occur is predominantly semi-diurnal mixture of different heights. In one day, going 2 times hight tide and 2 times tide low tide with different heights and periods. Here are the results of the tides data.

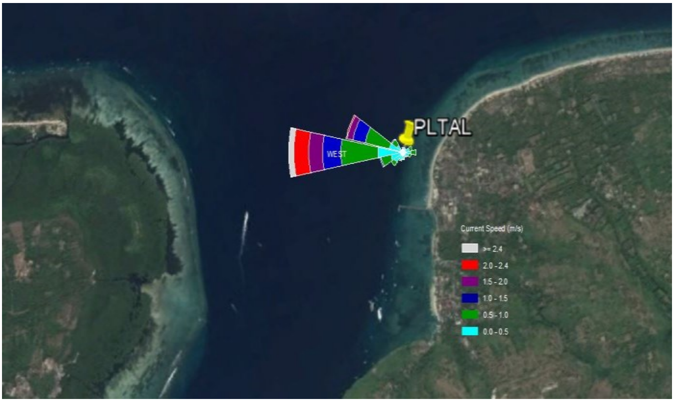
Table. 4.1.4.3. The results of the tides data

| The types of tides | Height Level Difference (Meters) |
|---|---|
| MSL (Mean Sea Level) | 4,79 m (dari lwl) |
| HAT (High Astronomical Tide) | 6,02 m (dari lwl) |
| LAT (Low Astronomical Tide) | 3,55 m (dari lwl) |
| MHHWS (Mean Highest High Water Spring) | 5,69 m (dari lwl) |
| MHHWN (Mean Highest High Water Normal) | 4,9 m (dari lwl) |
| MLLWN (Mean Lowest Low Water Normal) | 4,67 m (dari lwl) |
| MLLWS (Mean Lowest Low Water Spring) | 3,87 m (dari lwl) |

#### 4.1.3.4. Current Velocity Data

Current velocity observerved by measurement on two different points and conducted on August, 12$^{nd}$ until September 8$^{th}$ 2015. Two location of current velocity observation are on [Coordinate 1] 08° 40’ 29.6” LS dan 115° 30’ 53.6” BT on ± 25,5 meters deep. And [Coordinate 2] 08° 40’ 25.2” LS dan 115° 29’ 16.2” BT on ± 33,5 meters deep whch on MWL (Mean Water Level) position. Resulted data based on measurements of current velocity are below.

a. Maximum current velocity is 2,4 m/s on 5.5 meters deep on two location.
b. Average current speed have ranges 0,2-0,7 m/s




Picture 4.1.3.3. current rose on platfor location

#### 4.1.3.5. Environment Data on Maximum Condition

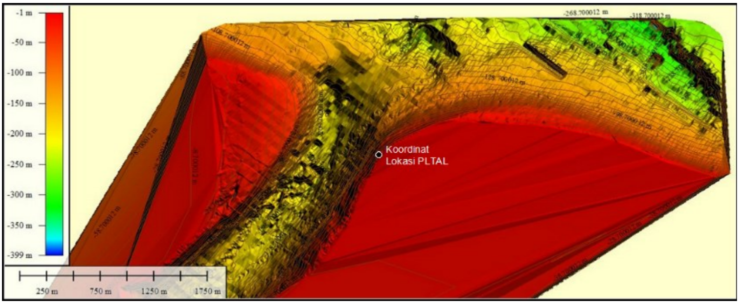
Based on measurements of metaocean data, maximum of significant wave height and wind speed, here are the conclusion rusults of environment on maximum condition.

Table 4.1.4.4. Maximum value of Metaocean data

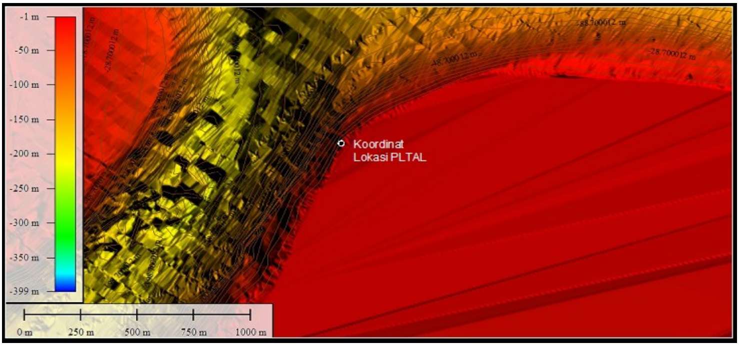
| Significant Wave Height | Wind speed | Current | Water Depth |
|---|---|---|---|
| 1.45 m | 22 knot | 2.4 m/s | 30 m |

#### 4.1.3.6. The map bathymetric operating locations

Bathymetric map showing the depth of the seabed in an area that is reviewed. At the mooring analysis, please note the depth and slope of the area where PLTAL operates, especially in the area where the anchor is placed. Here is a bathymetric map locations PLTAL operation, namely Strait Toyokapeh:




Picture 4.1.6.1. Bathymetric maps on Toyokapeh Strait




Picture 4.1.6.2. Bathymetric maps on Toyokapeh Starit

## 4.2. Structure Design

### 4.2.1. Structure Data

Main dimension of hull platform are on below.

| | | |
|---|---|---|
| Length Between Perpendicular (LPP) | = | 20 m |
| Lebar (B) | = | 1,25 m |
| Depth (H) | = | 2 m |
| Draught (T) | = | 1,25 m |
| Coefficient Block (Cb) | = | 0,125 |

Main dimension of stager platform are on below.

| | | |
|---|---|---|
| Length Between Perpendicular (LPP) | = | 8 m |
| Lebar (B) | = | 0,85 m |
| Depth (H) | = | 1,28 m |
| Draught (T) | = | 0,28 m |
| Coefficient Block (Cb) | = | 0,059 m |

### 4.2.1.1. Structure Calculation Results

Table 2.6. Structure Calculation Results of main hull platform PLTA

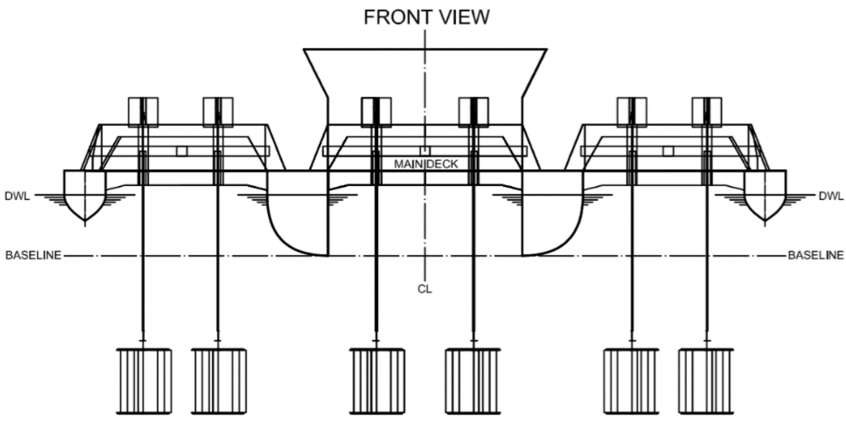
| | | REKAPITULASI PERHITUNGAN STRUKTUR KAPAL | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO | ITEM | 0 ≤ x/L < 0.2 [ A ] | | | | 0,2 ≤ x/L < 0.7 [ M ] | | | | 0,7 ≤ x/L < 1 [ F ] | | | |
| | MAIN HULL | | | | | | | | | | | | |
| 1 | Pelat lunas Lebar | 897.00 | mm | 1000 | mm | 897.00 | mm | 1000 | mm | 897.00 | mm | 1000 | mm |
| | Tebal | 5.42 | mm | 6.0 | mm | 5.59 | mm | 6.0 | mm | 5.42 | mm | 6.0 | mm |
| 2 | Pelat Alas | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm |
| 3 | Pelat Bilga | 897.0 | mm | 1000 | mm | 897.0 | mm | 1000 | mm | 897.0 | mm | 1000 | mm |
| | | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm |
| 4 | Pelat sisi | 897 | mm | 1000 | mm | 1000 | mm | 1000 | mm | 1000 | mm | 1000 | mm |
| | | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm |
| 5 | Pelat lajur | 897 | mm | 1000 | mm | 897 | mm | 1000 | mm | 897 | mm | 1000 | mm |
| | | 6.00 | mm | 6 | mm | 6.00 | mm | 6 | mm | 6.50 | mm | 6 | mm |
| 6 | Pelat Geladak | 5.89 | mm | 8.0 | mm | 5.89 | mm | 8 | mm | 5.89 | mm | 8.0 | mm |
| 7 | Pelat Sisi Dinding Main Deck | - | | - | | 6.00 | mm | 6.00 | mm | - | | - | |
| 8 | Pelat Dinding Main Deck (Depan) | - | | - | | 6.00 | mm | 6.00 | mm | - | | - | |
| | (Belakang) | - | | | | 6.00 | mm | 6.00 | mm | - | | - | |
| 9 | Gading biasa | 29.39 | cm3 | 35.0 | cm3 | 28.29 | cm3 | 35.00 | cm3 | 29.25 | cm3 | 35.00 | cm3 |
| | | L 75 x 50 x 7 | | L 75 x 50 x 7 | | L 75 x 50 x 7 | | L 75 x 50 x 7 | | L 75 x 50 x 7 | | L 75 x 50 x 7 | |
| 10 | Gading Besar | 67.07 | cm3 | 78 | cm3 | 108.92 | cm3 | 110.00 | cm3 | 55.86 | cm3 | 57 | cm3 |
| | | L 100 x 75 x 9 | | L 100 x 75 x 9 | | L 130 x 75 x 8 | | L 130 x 75 x 8 | | L 90 x 60 x 8 | | L 90 x 60 x 8 | |
| 11 | Penegar Dinding Superstructure | | | | | 20.34 | cm3 | 21.00 | cm3 | | | | |
| | | | | | | L 65 X 50 X 5 | | L 65 X 50 X 5 | | | | | |
| 12 | Penumpu Dinding Superstructure | | | | | 214.27 | cm3 | 230.00 | cm3 | | | | |
| | | | | | | L 150 x 90 x 12 | | L 150 x 90 x 12 | | | | | |
| 13 | Balok geladak Superstructure | | | | | 4.39 | cm3 | 5.00 | cm3 | | | | |
| | | | | | | I 50 x 5 | | I 50 x 5 | | | | | |
| | Balok besar geladak superstructure | | | | | 25.27 | cm3 | 27.00 | cm3 | | | | |
| | | | | | | L 75 x 50 x 5 | | L 75 x 50 x 5 | | | | | |
| 14 | Balok geladak Deck | 4.63 | cm3 | 16 | cm3 | 5.83 | cm3 | 16.00 | cm3 | 4.63 | cm3 | 16.00 | cm3 |
| | | L 60 x 40 x 5 | | L 60 x 40 x 5 | | L 60 x 40 x 5 | | L 60 x 40 x 5 | | L 60 x 40 x 5 | | L 60 x 40 x 5 | |
| 15 | Balok besar geladak Deck | 25.27 | cm3 | 27 | cm3 | 31.78 | cm3 | 35 | cm3 | 25.27 | cm3 | 27 | cm3 |
| | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 50 x 7 | | L 75 x 50 x 7 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | |
| 16 | Penumpu Tengah geladak 1 | 30.08 | cm3 | 35 | cm3 | 30.08 | cm3 | 35 | cm3 | 30.08 | cm3 | 35.00 | cm3 |
| | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | |
| 16 | Penumpu Tengah geladak 2 | 30.08 | cm3 | 35 | cm3 | 30.08 | cm3 | 35 | cm3 | 30.08 | cm3 | 35.00 | cm3 |
| | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | | L 75 x 55 x 5 | |

| NO | ITEM | 0 ≤ x/L < 0.2 [ A ] | | | | 0,2 ≤ x/L < 0.7 [ M ] | | | | 0,7 ≤ x/L < 1 [ F ] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **MAIN HULL** | | | | | | | | | | | | |
| 17 | Bracket untuk gading biasa 1 | 6.00 | mm | | | | | | | | | | |
| | dengan gading biasa 2 | 152.00 | mm | | | | | | | | | | |
| 18 | Bracket untuk gading biasa 1 | 6.50 | mm | | | | | | | | | | |
| | dengan balok deck | 117.00 | mm | | | | | | | | | | |
| 19 | Bracket untuk deck dengan gading | 6.50 | mm | | | | | | | | | | |
| | biasa 2 | 117.00 | mm | | | | | | | | | | |
| 20 | Bracket untuk gading biasa 1 | | | | | 6.50 | mm | | | | | | |
| | balok geladak | | | | | 84.00 | mm | | | | | | |
| 21 | Bracket untuk main deck dengan | | | | | 6.50 | mm | | | | | | |
| | gading biasa main deck | | | | | 84.00 | mm | | | | | | |
| 22 | Bracket untuk gading biasa main | | | | | 6.50 | mm | | | | | | |
| | deck dengan balok main deck | | | | | 84.00 | mm | | | | | | |
| 23 | Bracket untuk main deck dengan | | | | | | | | | 7.00 | mm | | |
| | frame | | | | | | | | | 80.00 | mm | | |
| 24 | Bracket untuk frame dengan balok | | | | | | | | | 6.50 | mm | | |
| | main deck | | | | | | | | | 80.00 | mm | | |
| 25 | Bracket untuk frame 1 dan frame 2 | | | | | | | | | 6.50 | mm | | |
| | fore peak | | | | | | | | | 152.00 | mm | | |
| 26 | Bracket untuk web frame 1 dan | 7.00 | mm | | | | | | | | | | |
| | web frame 2 | 177.00 | mm | | | | | | | | | | |
| 27 | Bracket untuk strong beam dengan | 6.50 | mm | | | | | | | | | | |
| | web frame 1 | 177.00 | mm | | | | | | | | | | |
| 28 | Bracket untuk web frame 2 dengan | 6.50 | mm | | | | | | | | | | |
| | strong beam | 139.00 | mm | | | | | | | | | | |
| 29 | Bracket untuk web frame 1 dan | | | | | 8.00 | mm | | | | | | |
| | web frame 2 | | | | | 222.00 | mm | | | | | | |
| 30 | Bracket untuk web frame 1 dengan | | | | | 6.50 | mm | | | | | | |
| | strong beam | | | | | 152.00 | mm | | | | | | |
| 31 | Bracket untuk web frame 2 dengan | | | | | 6.50 | mm | | | | | | |
| | strong beam | | | | | 152.00 | mm | | | | | | |
| 32 | Bracket untuk web frame 1 dan | | | | | | | | | 7.00 | mm | | |
| | web frame 2 | | | | | | | | | 178.00 | mm | | |
| 33 | Bracket untuk web frame 1 dan | | | | | | | | | 6.50 | mm | | |
| | strong beam | | | | | | | | | 139.00 | mm | | |
| 34 | Bracket untuk web frame 2 dan | | | | | | | | | 6.50 | mm | | |
| | strong beam | | | | | | | | | 139.00 | mm | | |
| | **Bracket Superstructure** | | | | | | | | | | | | |
| 35 | Bracket untuk frame 1 dan balok | | | | | 6.50 | mm | | | | | | |
| | geladak | | | | | 80.00 | mm | | | | | | |
| 36 | Bracket untuk web frame 1 dan | | | | | 6.50 | mm | | | | | | |
| | balok geladak besar | | | | | 139.00 | mm | | | | | | |
| 37 | Bracket untuk web frame 1 dan | | | | | 6.50 | mm | | | | | | |
| | balok geladak besar main deck | | | | | 152.00 | mm | | | | | | |
| 38 | Bracket untuk frame dan balok | | | | | 6.50 | mm | | | | | | |
| | geladak main deck | | | | | 84.00 | mm | | | | | | |
| 39 | tebal sekat | 6 | mm | | | 6.00 | mm | | | 6.00 | mm | | |
| | **Penegar Sekat** | | | | | | | | | | | | |
| 40 | Frame 8 | 4.77 | cm3 | 5 | cm3 | | | | | | | | |
| | | **I 50 x 5** | | **I 65 X 6** | | | | | | | | | |
| 41 | Frame 16 | | | | | 9.54 | cm3 | 10 | cm3 | | | | |
| | | | | | | **I 60 x 8** | | **I 60 x 8** | | | | | |
| 42 | Frame 24 | | | | | 9.54 | $cm^3$ | 10.0 | $cm^3$ | | | | |
| | | | | | | **I 60 x 8** | | **I 60 x 8** | | | | | |
| 43 | Frame 32 | | | | | | | | | 4.77 | cm3 | 5.0 | cm3 |
| | | | | | | | | | | **I 50 x 5** | | **I 65 X 6** | |

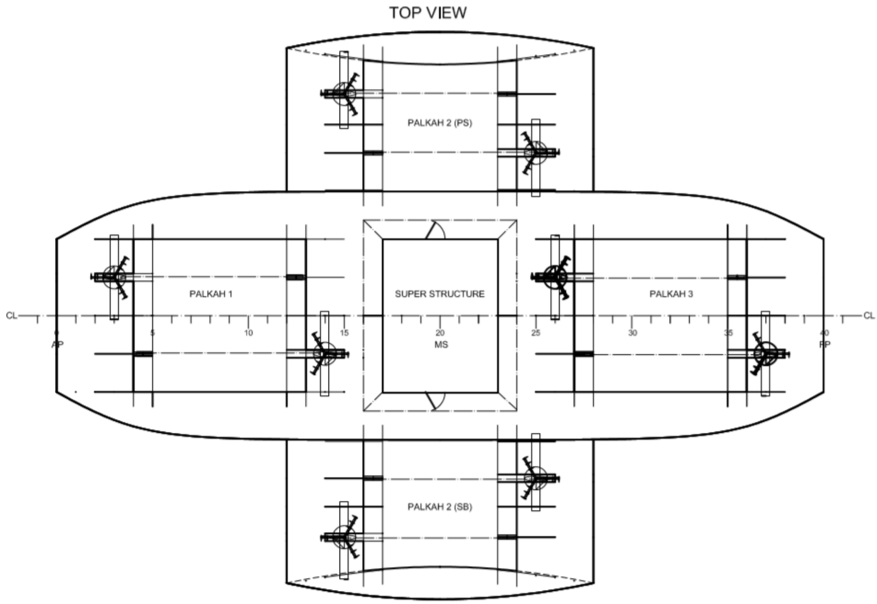
Table 2.7. Calculation of stager platform PLTA

| NO | ITEM | $0 \leq x/L < 0.2$ [ A ] | | | | $0,2 \leq x/L < 0.7$ [ M ] | | | | $0,7 \leq x/L < 1$ [ F ] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **STAGER** | | | | | | | | | | | | |
| 1 | Pelat lunas Lebar | 838.80 | mm | 1000 | mm | 838.80 | mm | 1000 | mm | 838.80 | mm | 1000 | mm |
| | Tebal | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm | 6.00 | mm | 6.0 | mm |
| 2 | Pelat Alas | 4.00 | mm | 4.0 | mm | 4.00 | mm | 4.0 | mm | 4.00 | mm | 4.0 | mm |
| 3 | Pelat Bilga | 838.8 | mm | 1000 | mm | 838.8 | mm | 1000 | mm | 838.8 | mm | 1000 | mm |
| | | 4.00 | mm | 4.0 | mm | 4.00 | mm | 4.0 | mm | 4.00 | mm | 4.0 | mm |
| 4 | Pelat sisi | 839 | mm | 1000 | mm | 839 | mm | 1000 | mm | 839 | mm | 839 | mm |
| | | 4.00 | mm | 4.0 | mm | 4.00 | mm | 4.0 | mm | 4.00 | mm | 4.0 | mm |
| 5 | Pelat lajur | 839 | mm | 1000 | mm | 839 | mm | 1000 | mm | 839 | mm | 1000 | mm |
| | | 4.48 | mm | 5 | mm | 4.48 | mm | 5 | mm | 4.48 | mm | 5 | mm |
| 6 | Pelat Geladak | 5.00 | mm | 8.0 | mm | 5.00 | mm | 8 | mm | 5.00 | mm | 5.0 | mm |
| 7 | Gading biasa | 0.31 | $cm^3$ | 6.0 | $cm^3$ | 0.32 | $cm^3$ | 6.00 | $cm^3$ | 0.17 | $cm^3$ | 5.00 | $cm^3$ |
| | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | |
| 8 | Gading Besar | 6.11 | $cm^3$ | 9 | $cm^3$ | 6.13 | $cm^3$ | 9.00 | $cm^3$ | 6.11 | $cm^3$ | 9 | $cm^3$ |
| | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | |
| 9 | Balok geladak Deck | 0.03 | $cm^3$ | 6 | $cm^3$ | 0.02 | $cm^3$ | 6.00 | $cm^3$ | 0.02 | $cm^3$ | 6.00 | $cm^3$ |
| | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | | **I 50 x 6** | |
| 10 | Penumpu Tengah geladak | 2.45 | $cm^3$ | 9 | $cm^3$ | 2.45 | $cm^3$ | 9 | $cm^3$ | 2.45 | $cm^3$ | 9 | $cm^3$ |
| | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | | **I 65 x 6** | |
| 11 | Center Girder | 7.60 | mm | 8 | mm | 8.00 | mm | 8 | mm | 8.00 | mm | 8.00 | mm |
| | | 388.25 | mm | 400 | mm | 388.25 | mm | 400.00 | mm | 388.25 | mm | 400.00 | mm |
| 12 | Bracket untuk frame 1 dan balok geladak | 4.00 | mm | | | | | | | | | | |
| | | 80.00 | mm | | | | | | | | | | |
| | Penegar sekat | 5.00 | | | | | | | | | | | |
| | | **I 50 x 5** | | | | | | | | | | | |
| 13 | Wrang | 6.00 | mm | | | | | | | | | | |

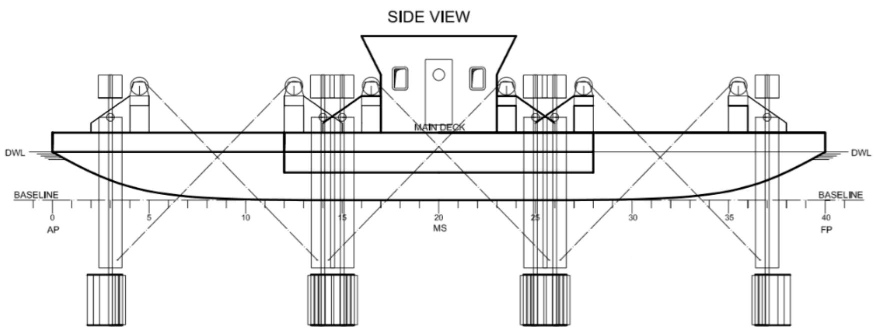
## 4.2.1.2 General arrangement of The Structure




Picture 2.8. Front View PLTA structure scale 1:200

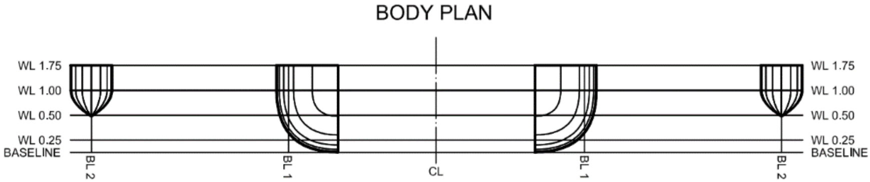



Picture 2.9. Top View  PLTA Structure Scale 1:200

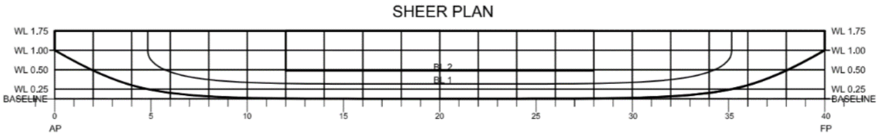



Picture 2.10. Side View PLTA Structure Scale1:200

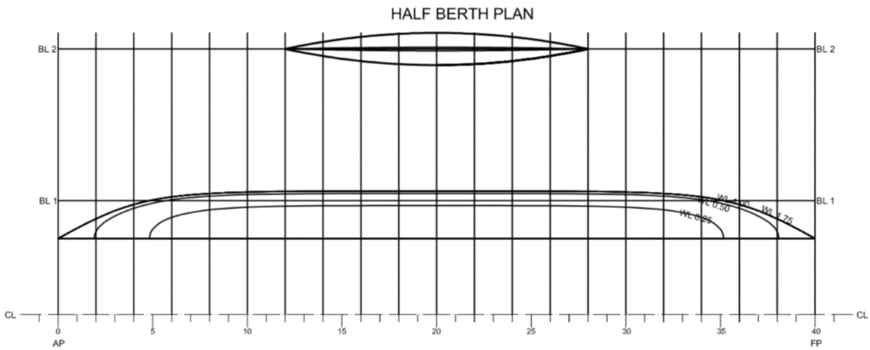
### 4.2.1.3 Platform Lines Plan




Picture 2.11. Body plan scale 1:200

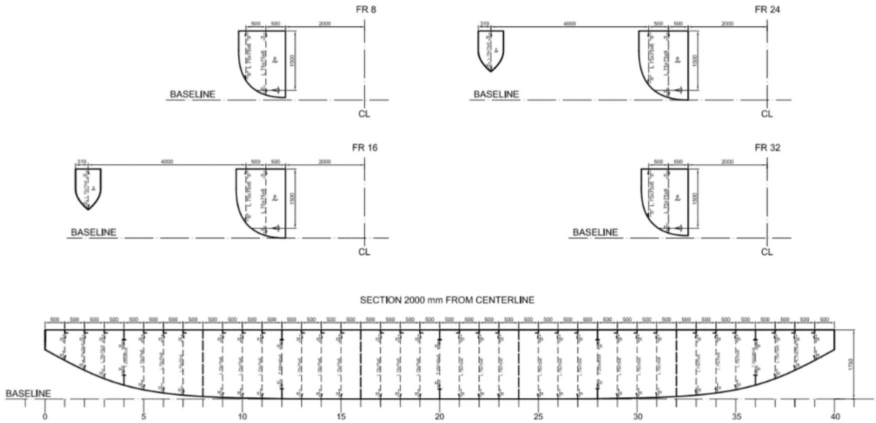



Picture 2.12. Sheer Plan scale 1:200



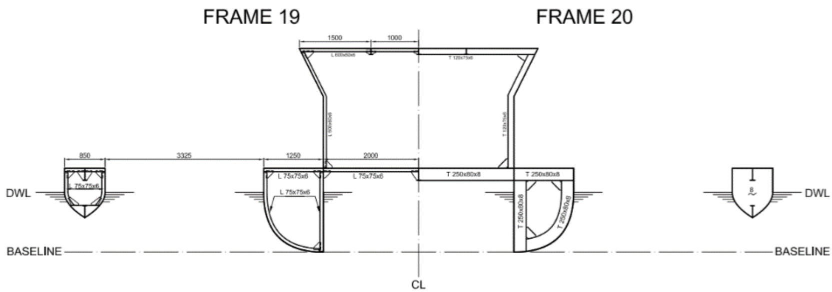

Picture 2.13. Half Breadth Plan scale 1:200

## 4.2.1.4. Bulkhead Structure



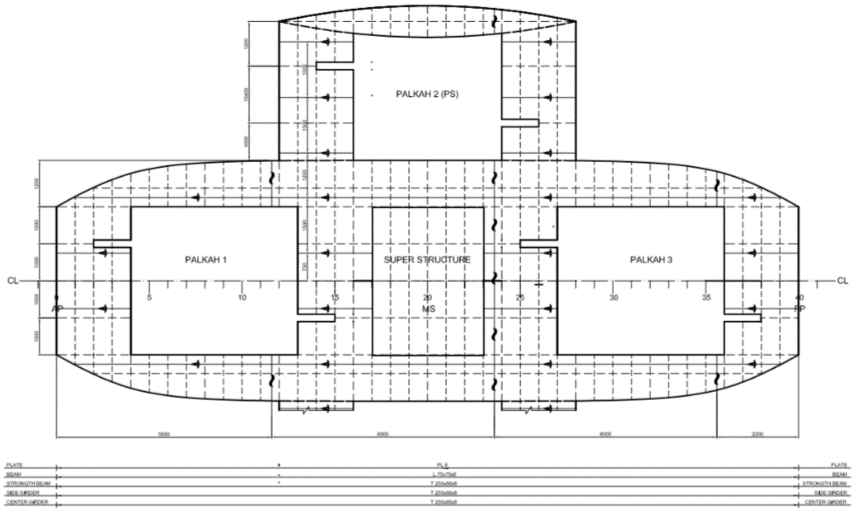

Picture 2.14. Bulkhead PLTA structure scale 1:200

## 4.2.1.5 Midship Structure

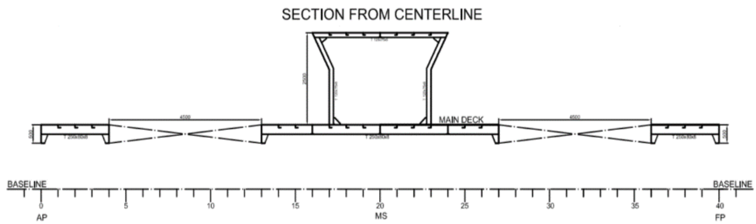



Picture 2.15. Midship structure PLTA scale 1:200

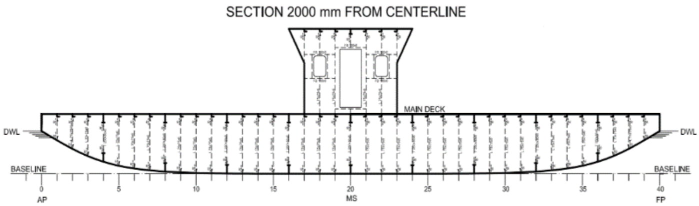
#### 4.2.1.6 Structure Profile Construction



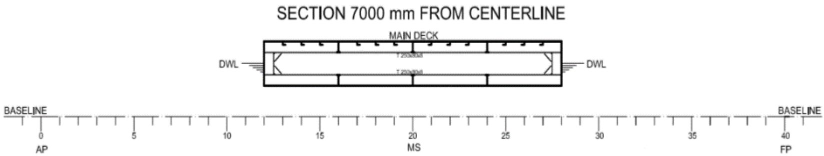

Picture 2.16. Top View Construction Scale 1:200




Picture 2.17. Centerline View Construction Scale 1:200



Picture 2.18. Cutting Construction Profile 2000mm form centerline scale 1:200

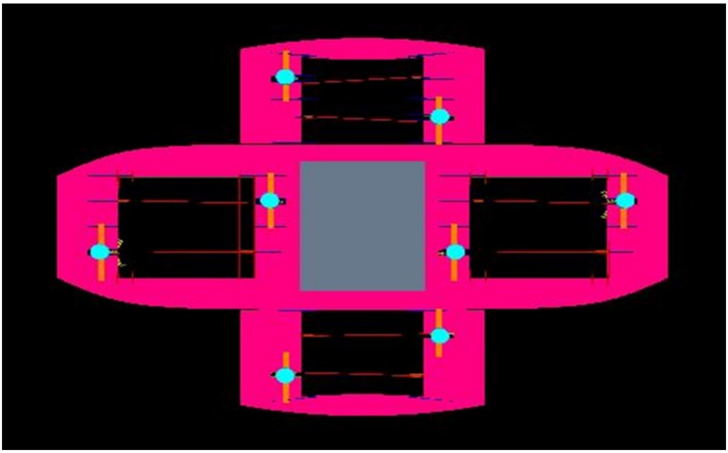



Picture 2.19. Cutting Construction Profile 7000 mm form centerline

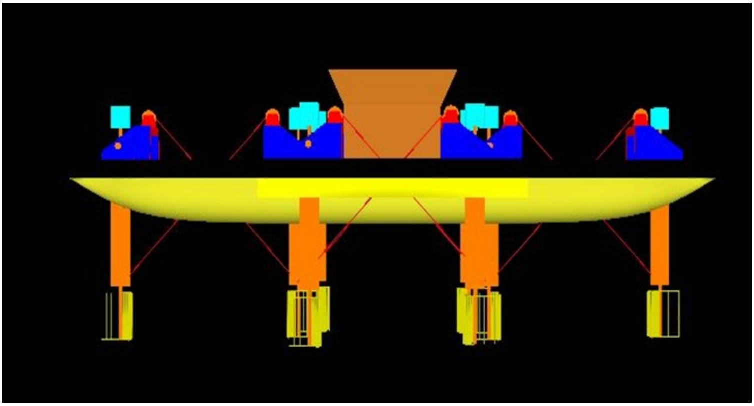
## 4. 2. Hasil Permodelan dan Analisa Struktur Plta

### 4.2.1. Permodelan struktur dengan menggunakan Maxsurf dan Moses

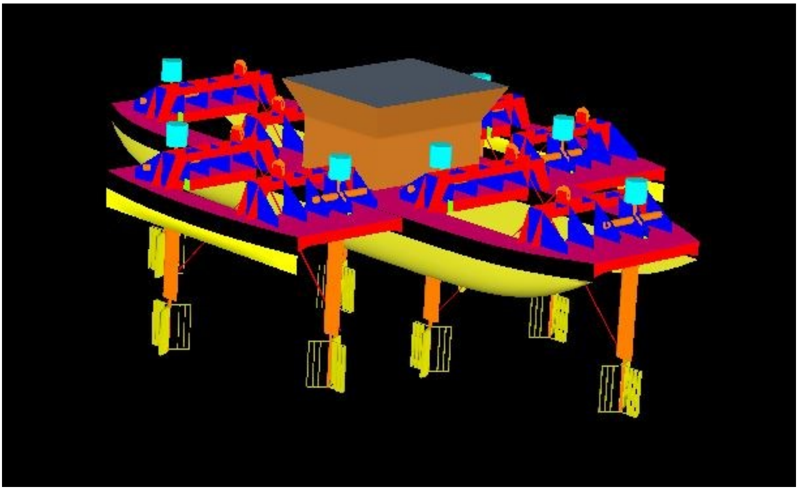
PLTA Structure that has been planned in accordance with the original structure modeled using software maxsurf dongle. All the structural components such as the main hull, triger, blade, and others modeled in detail in maxsurf dongle. From this maxsurf dongle that can be achieved hydrostatic components of the structure and validated by the results of numerical analysis of whether it is appropriate or not. If the validation meets the model can be used for further analysis such as the analysis of stability until tension mooring analysis used.



Picture 4.3.1. Maxsurf  Modelling on Platform Top View Structure

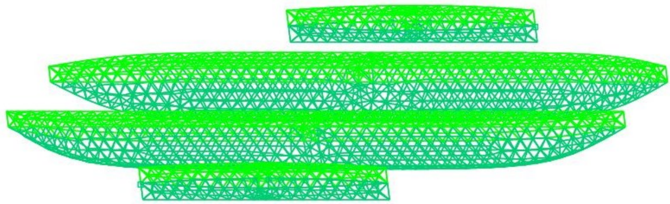


Picture 4.3.2 Maxsurf Modelling on Platform Side View Structure

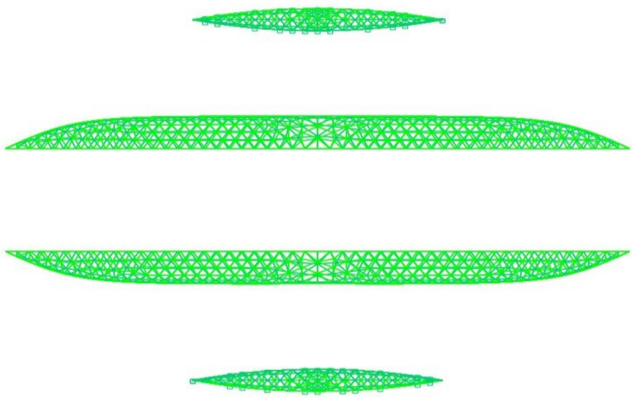


Picture 4.3.4. Maxsurf Modelling on Platform Isometri View Structure

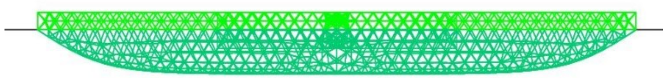
Then, from this Maxsurf can be taken markers contained in maxsurf model to moses for motion analysis of the structure. Markers were used to model the structure of the moses which can use the method of meshing (model di analyzed by finite element so that the model can be analyzed in high accuracy) or by the method of strip. Model retrieved the marker using the meshing method for more detailed results of which are modeled here hull structure.



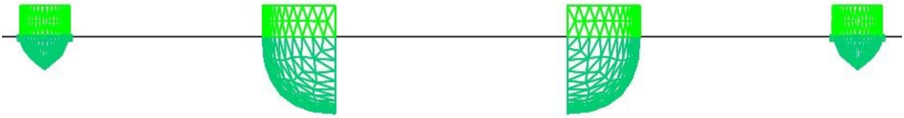
Picture 4.3.5 Structure Model Results on Moses Software Isometri View



Picture 4.3.6 Result of Structure Model by Moses Software Top View



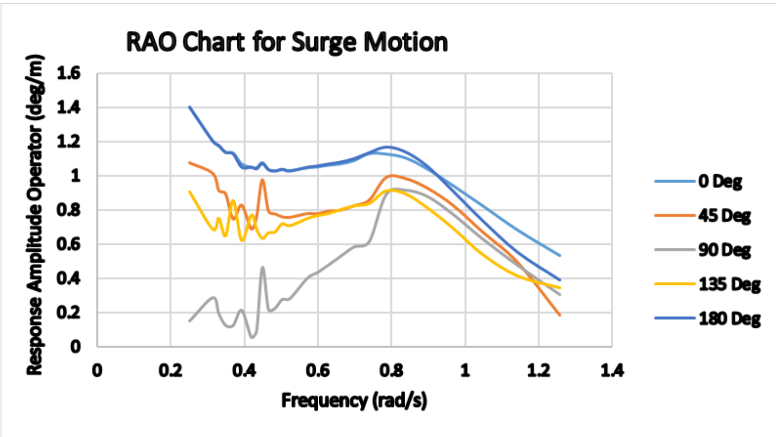
Picture 4.3.7 Moses Model Structure on Side View



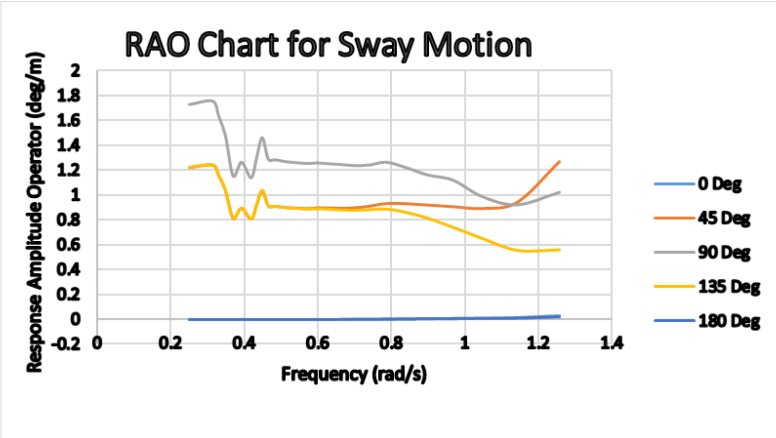
Picture 4.3.8. Moses Model Structur Front View

### 4.4. Results Analysis The Movements of The Structure

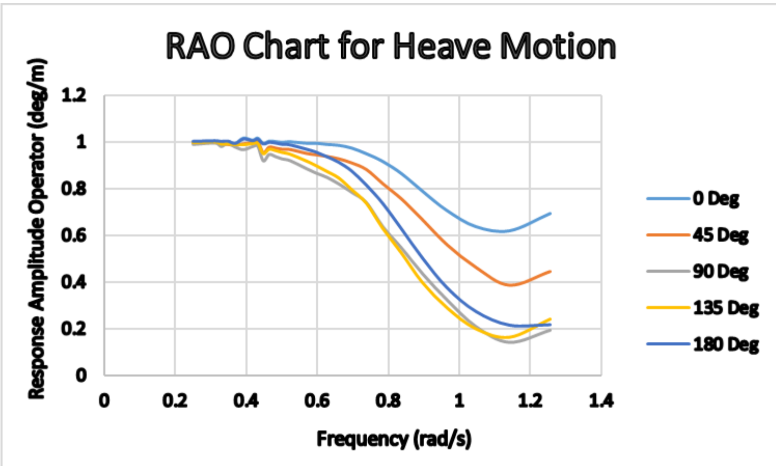
By Moses Software, Response of Amplitude Operator for the platform are on below:



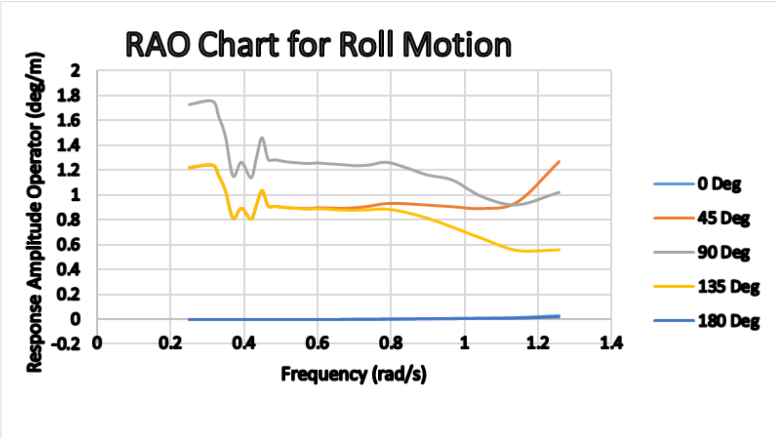

Picture 4.4.1. RAO for translati surge movements on structure of PLTA on free floating condition



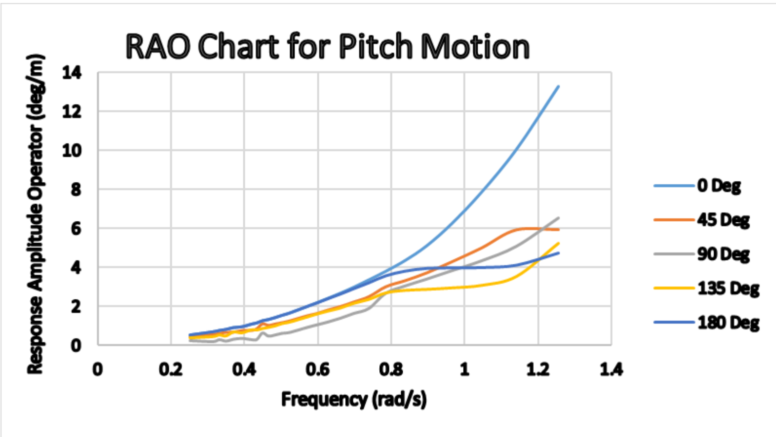

Picture 4.4.2. RAO for translation sway movements on structure of PLTA on free floating condition



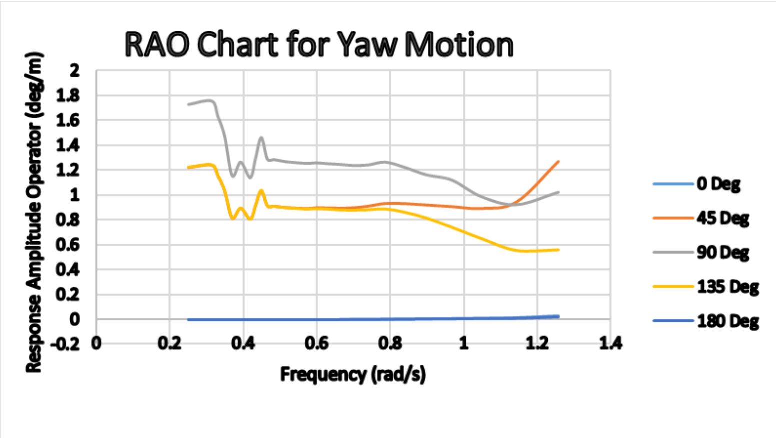

Picture 4.4.3. RAO for translation heave movements on structure of PLTA on free floating condition




Picture 4.4.4. RAO for rotational roll movements on structure of PLTA on free floating condition




Picture 4.4.5. RAO for rotational pitch movements on structure of PLTA on free floating condition




Picture 4.4.6. RAO for rotational yaw movements on structure of PLTA on free floating condition

## 4.5. Data

Requirements data on this final project are on list below.

1. Displacement Volume of patamaran
2. Existing Spare part List on Patamaran
3. Tidal Data

## 4.5.1. Draught Variation and Displacement Data

| **Draft Amidships m** | **0.750** | **1.000** | **1.250** | **1.500** | **1.750** |
|---|---|---|---|---|---|
| Displacement kg | 31818 | 44562 | 58497 | 72672 | 88345 |
| Heel deg | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Draft at FP m | 0.750 | 1.000 | 1.250 | 1.500 | 1.750 |
| Draft at AP m | 0.750 | 1.000 | 1.250 | 1.500 | 1.750 |
| Draft at LCF m | 0.750 | 1.000 | 1.250 | 1.500 | 1.750 |
| Trim (+ve by stern) m | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| WL Length m | 18.200 | 19.100 | 20.000 | 20.000 | 17.006 |
| Beam max extents on WL m | 13.699 | 14.450 | 14.450 | 14.450 | 10.650 |
| Wetted Area m^2 | 97.526 | 129.014 | 156.725 | 192.498 | 310.453 |
| Waterpl. Area m^2 | 44.571 | 54.205 | 54.430 | 59.245 | 21.280 |
| Prismatic coeff. (Cp) | 0.906 | 0.826 | 0.750 | 0.722 | 0.817 |
| Block coeff. (Cb) | 0.056 | 0.063 | 0.072 | 0.082 | 0.147 |
| Max Sect. area coeff. (Cm) | 0.183 | 0.191 | 0.155 | 0.174 | 0.783 |
| Waterpl. area coeff. (Cwp) | 0.179 | 0.196 | 0.188 | 0.205 | 0.117 |
| LCB from zero pt. (+ve fwd) m | 0.000 | 0.000 | 0.000 | 0.000 | -0.002 |

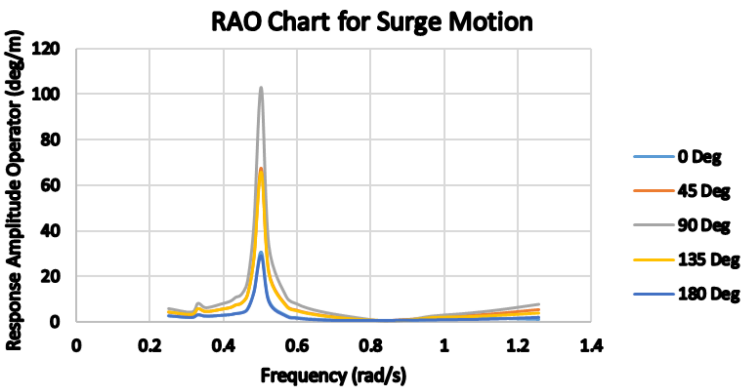
| | | | | | |
|---|---|---|---|---|---|
| LCF from zero pt. (+ve fwd) m | 0.000 | 0.000 | 0.000 | -0.010 | 0.000 |
| KB m | 0.382 | 0.524 | 0.667 | 0.806 | 0.951 |
| KG m | 1.250 | 1.250 | 1.250 | 1.250 | 1.250 |
| BMt m | 10.044 | 16.775 | 12.793 | 11.113 | 2.156 |
| BML m | 35.622 | 27.470 | 21.297 | 17.449 | 1.654 |
| GMt m | 9.176 | 16.049 | 12.210 | 10.668 | 1.857 |
| GML m | 34.754 | 26.744 | 20.714 | 17.004 | 1.356 |
| KMt m | 10.426 | 17.299 | 13.460 | 11.918 | 3.107 |
| KML m | 36.004 | 27.994 | 21.964 | 18.254 | 2.606 |
| Immersion (TPc) tonne/cm | 0.457 | 0.556 | 0.558 | 0.607 | 0.218 |
| MTc tonne.m | 0.553 | 0.596 | 0.606 | 0.618 | 0.060 |
| RM at 1deg = GMt.Disp.sin(1) kg.m | 5095.547 | 12481.418 | 12465.423 | 13530.373 | 2863.123 |
| Max deck inclination deg | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Trim angle (+ve by stern) deg | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

## 4.6. Ballast Water Minimum Requirement on Several Draught.

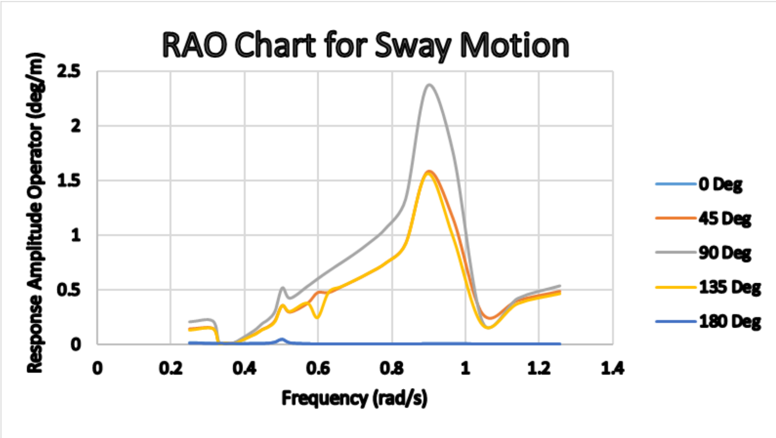
| Draft (m) | Air Ballast (kg) |
|---|---|
| 0.75 | 12727 |
| 1.00 | 17825 |
| 1.25 | 23399 |
| 1.50 | 29069 |
| 1.75 | 35338 |

### 4.6.1 Draft 0.75 m

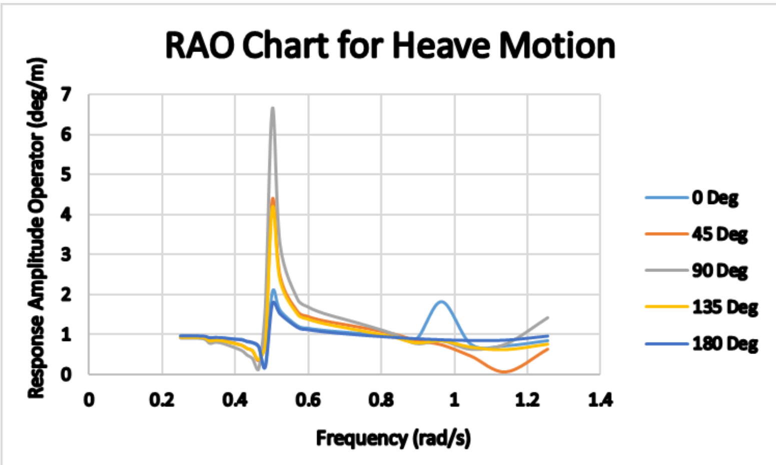
Analysis from moses software, RAO for the patamaran will show with this chart:



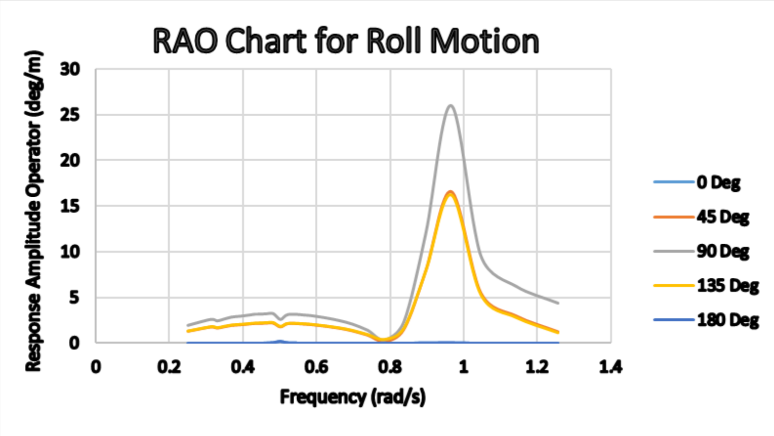

Picture 4.6.1.1 RAO for rotational surge movements on structure of PLTA on free floating condition



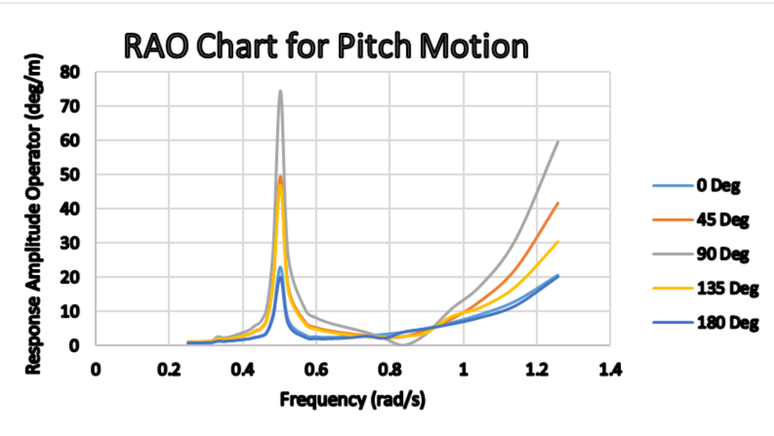

Picture 4.6.1.2. RAO for rotational sway movements on structure of PLTA on free floating condition



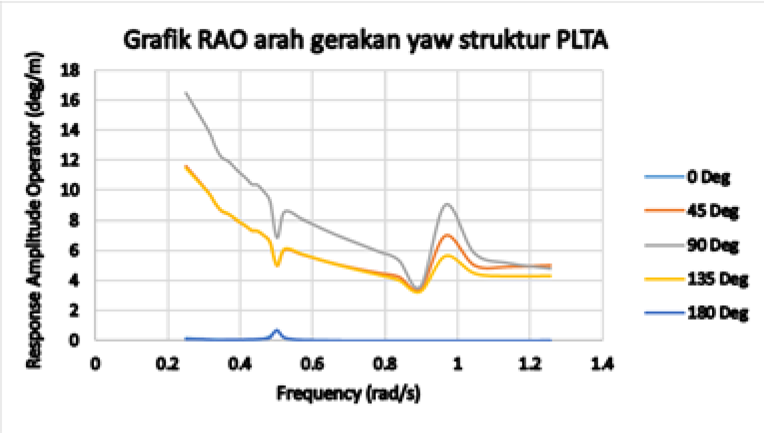

Picture 4.6.1.3. RAO for rotational heave movements on structure of PLTA on free floating condition




Picture 4.6.1.4. RAO for rotational roll movements on structure of PLTA on free floating condition



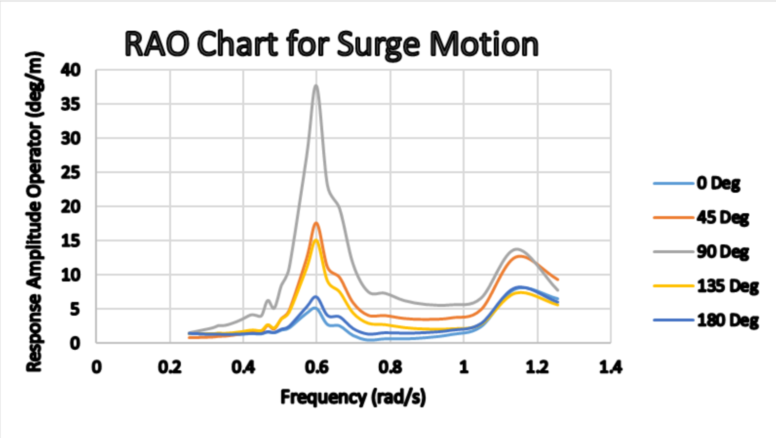

Picture 4.6.1.5. RAO for rotational pitch movements on structure of PLTA on free floating condition



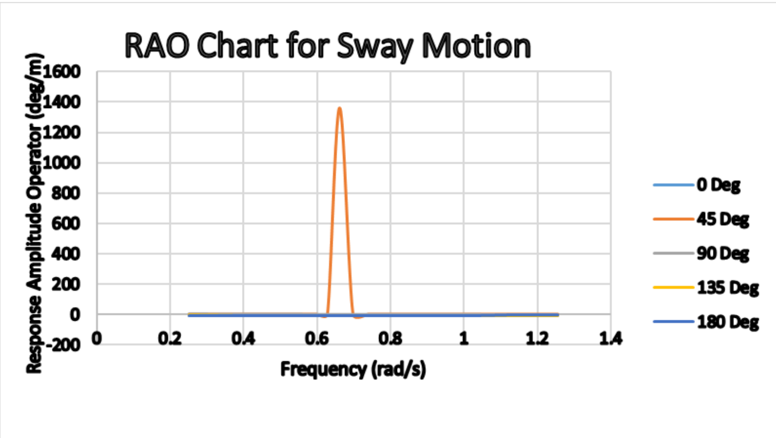

Picture 4.6.1.6. RAO for rotational yaw movements on structure of PLTA on free floating condition

### 4.6.2 Draft 1.00 m

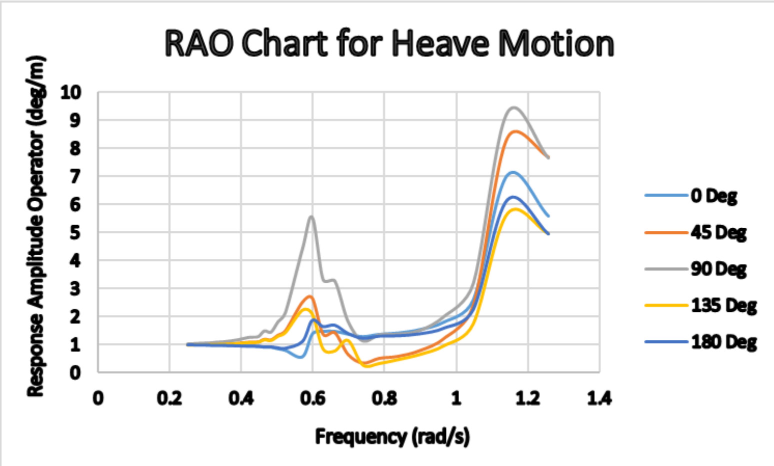
Analysis from moses software, RAO for the patamaran will show with this chart:



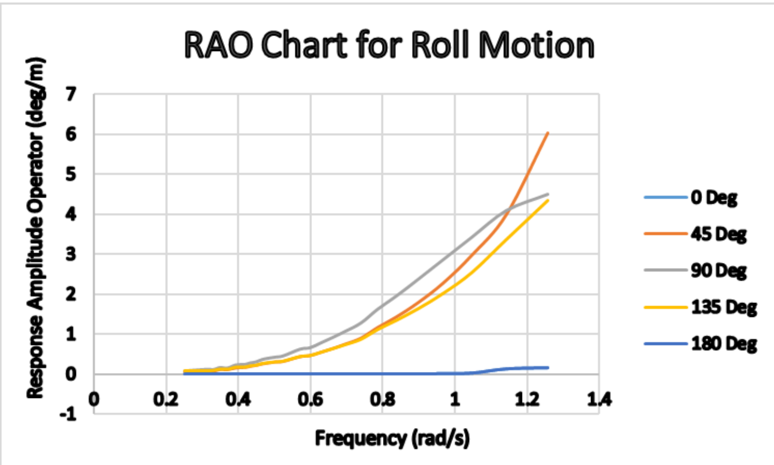

Picture 4.6.2.1. RAO for rotational surge movements on structure of PLTA on free floating condition



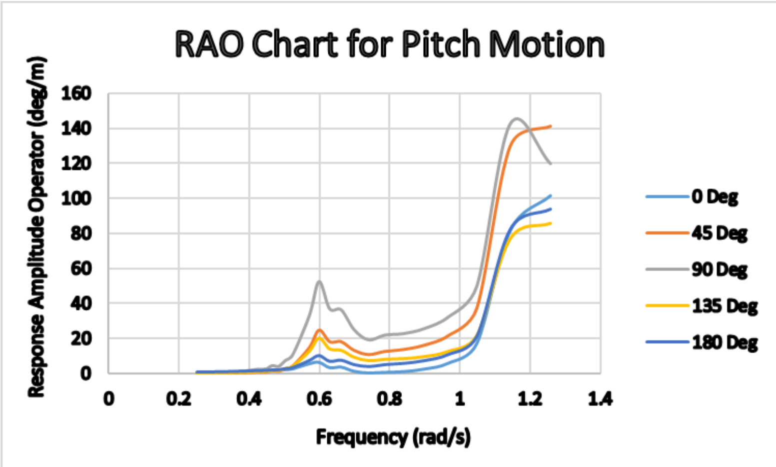

Picture 4.6.2.2. RAO for rotational sway movements on structure of PLTA on free floating condition



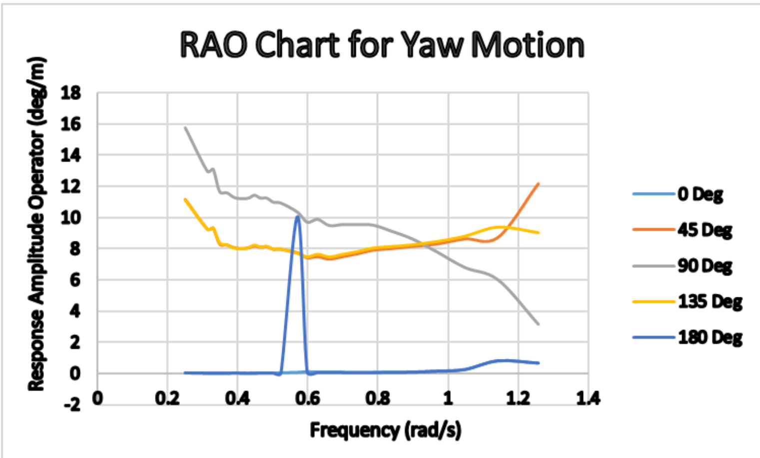

Picture 4.6.2.3. RAO for rotational heave movements on structure of PLTA on free floating condition




Picture 4.6.2.4. RAO for rotational roll movements on structure of PLTA on free floating condition

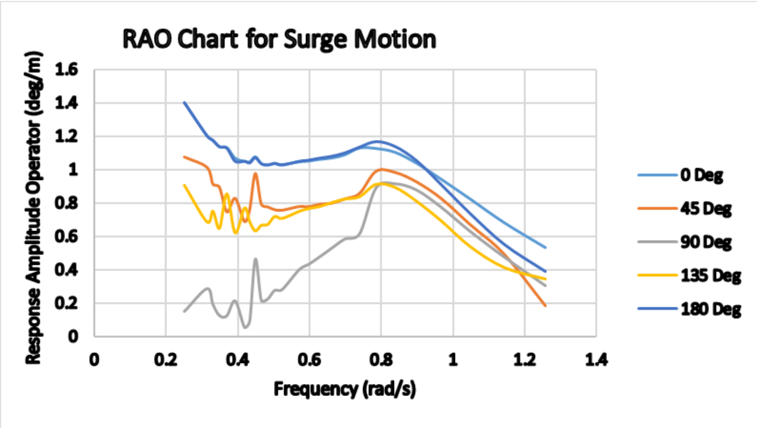



Picture 4.6.2.5. RAO for rotational pitch movements on structure of PLTA on free floating condition

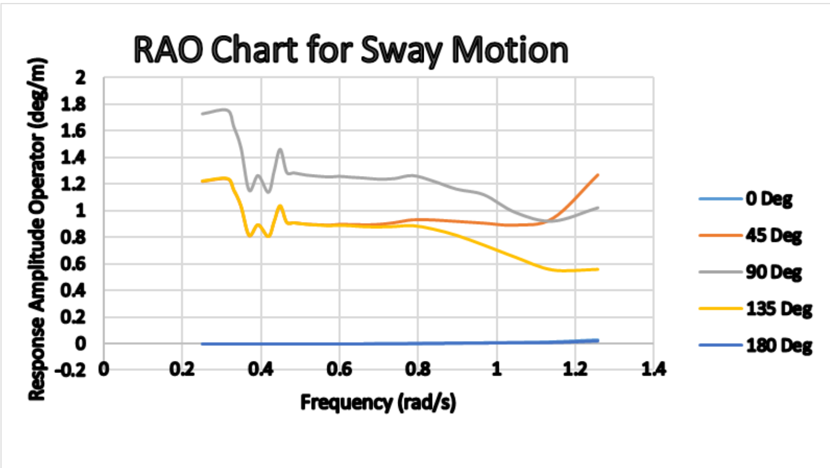



Picture 4.6.2.6. RAO for rotational yaw movements on structure of PLTA on free floating condition

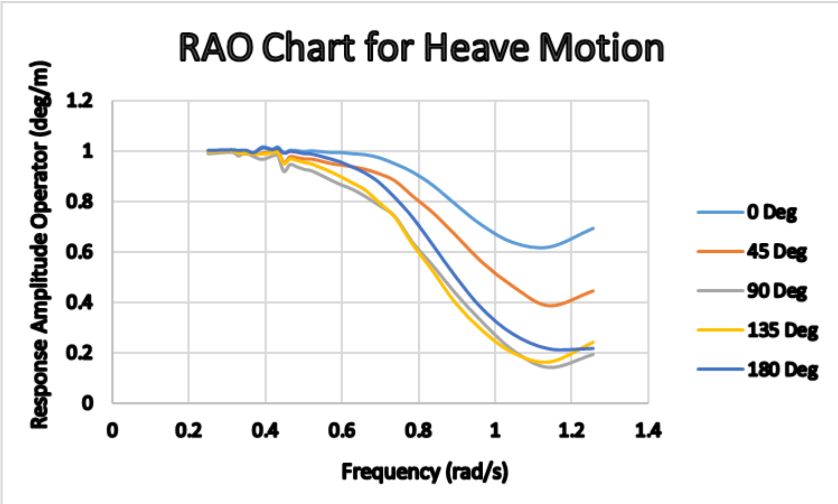
### 4.4.3 Draft 1.25



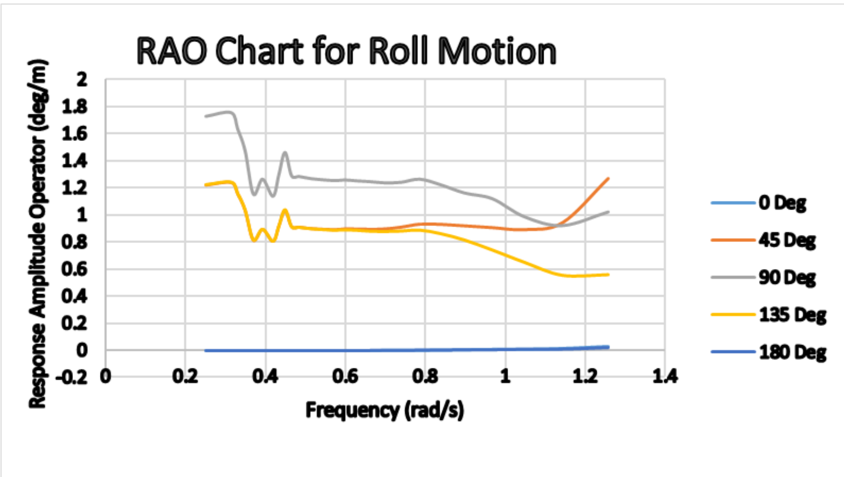

Picture 4.6.3.1. RAO for rotational surge movements on structure of PLTA on free floating condition



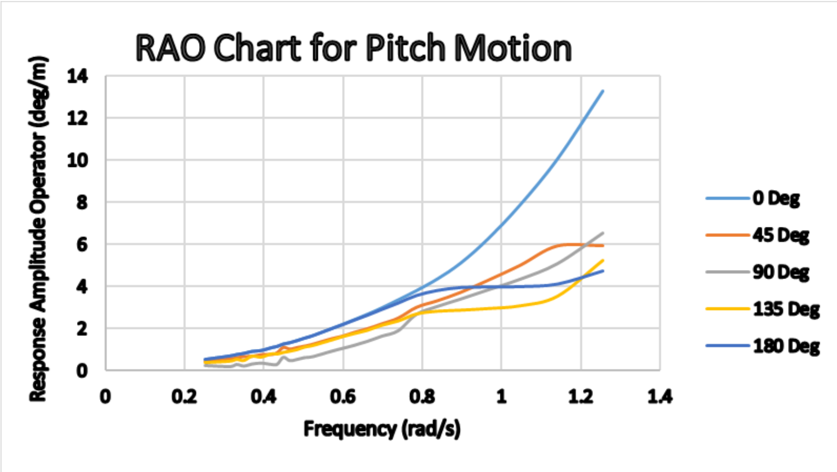

Picture 4.6.3.2. RAO for rotational Sway movements on structure of PLTA on free floating condition



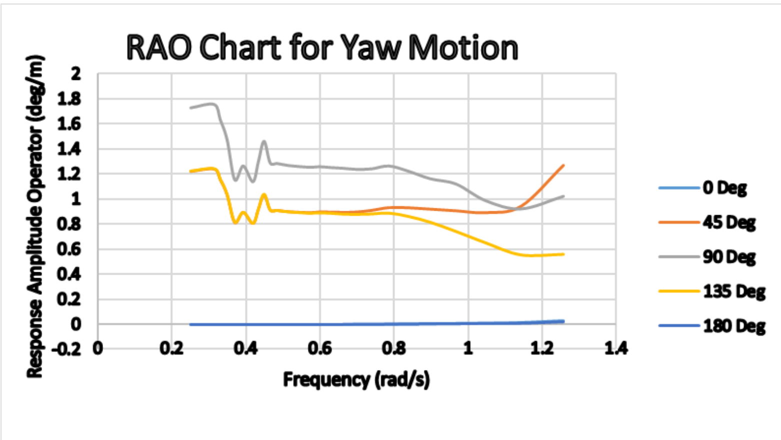

Picture 4.6.3.3. RAO for rotational Heave movements on structure of PLTA on free floating condition




Picture 4.6.3.4. RAO for rotational roll movements on structure of PLTA on free floating condition

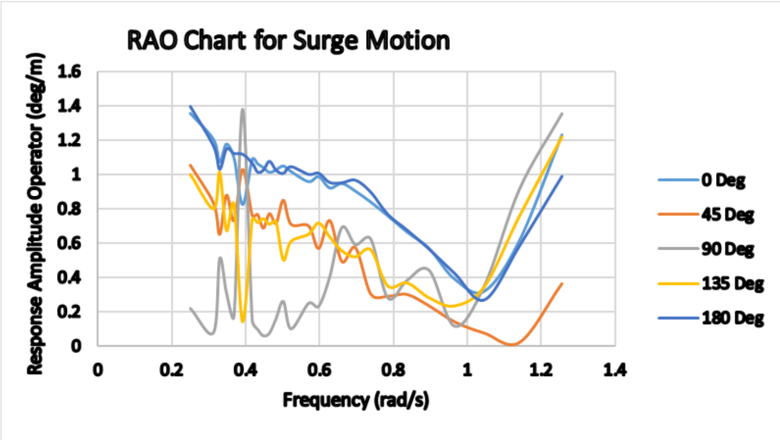



Picture 4.6.3.5. RAO for rotational pitch movements on structure of PLTA on free floating condition

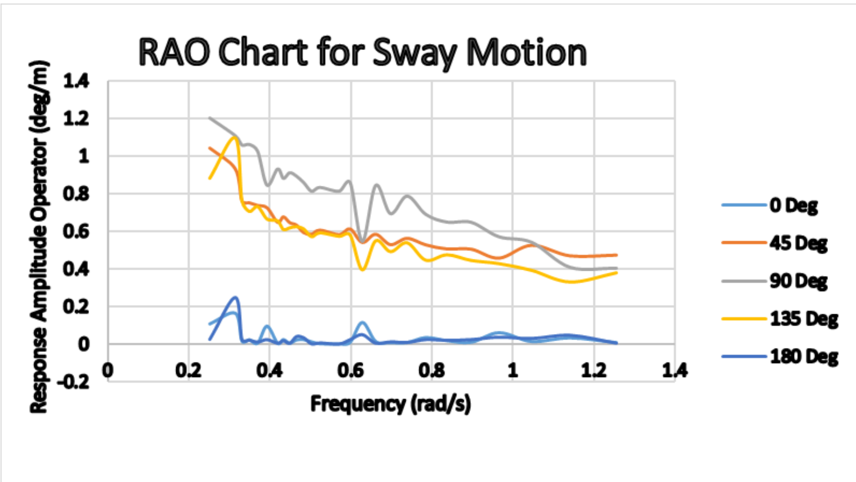



Picture 4.6.3.6. RAO for rotational yaw movements on structure of PLTA on free floating condition

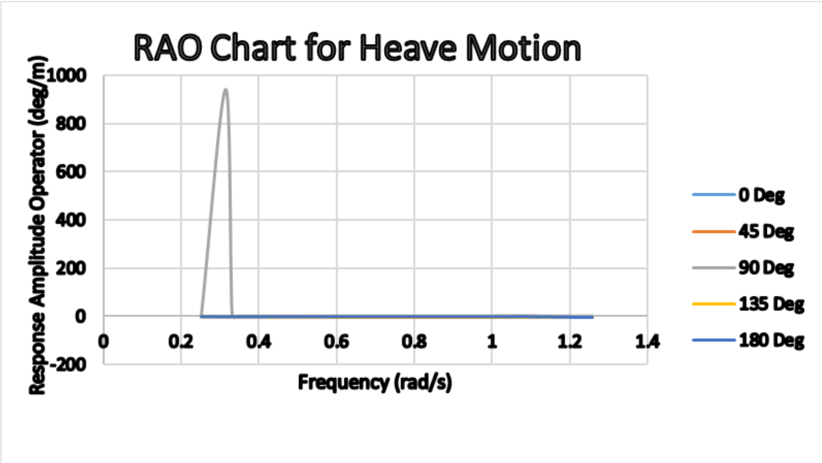
### 4.6.4 Draft 1.50 m



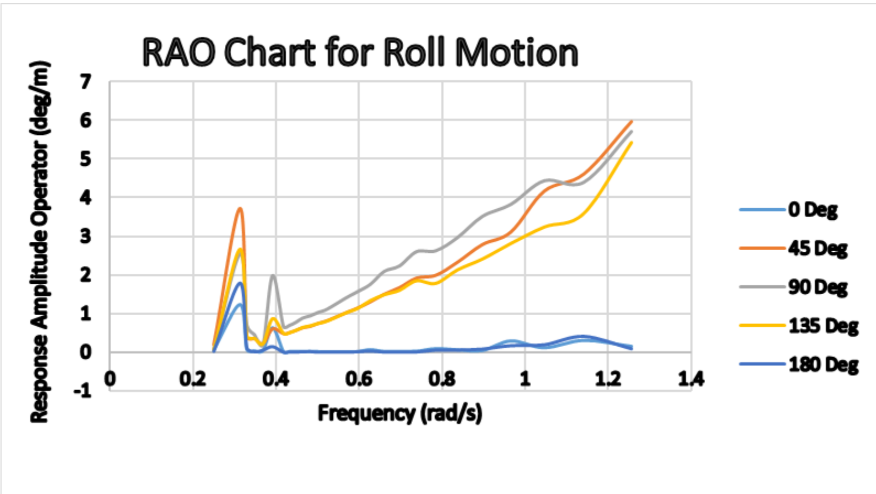

Picture 4.6.4.1. RAO for rotational surge movements on structure of PLTA on free floating condition



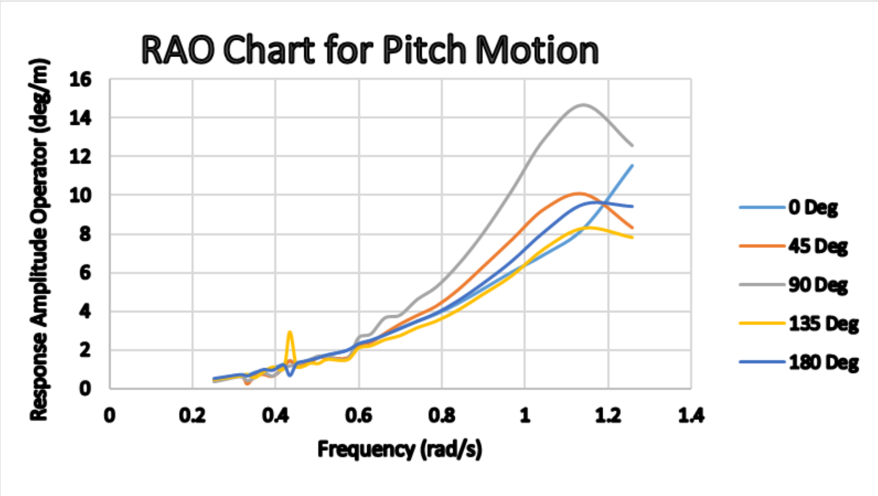

Picture 4.6.4.2. RAO for rotational sway movements on structure of PLTA on free floating condition



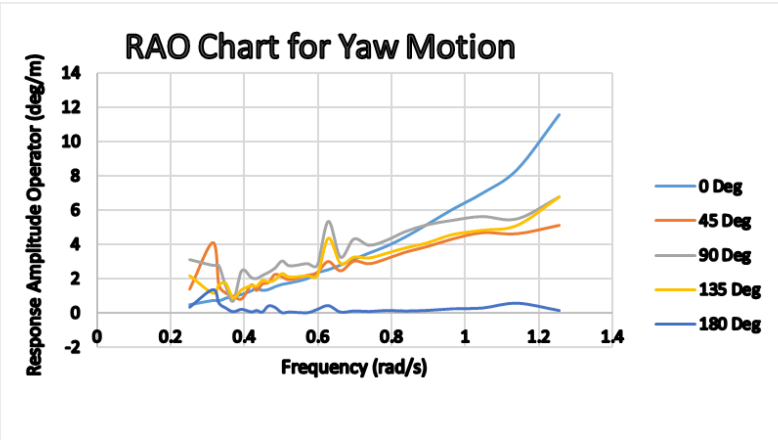

Picture 4.6.4.3. RAO for rotational heave movements on structure of PLTA on free floating condition




Picture 4.6.4.4. RAO for rotational roll movements on structure of PLTA on free floating condition

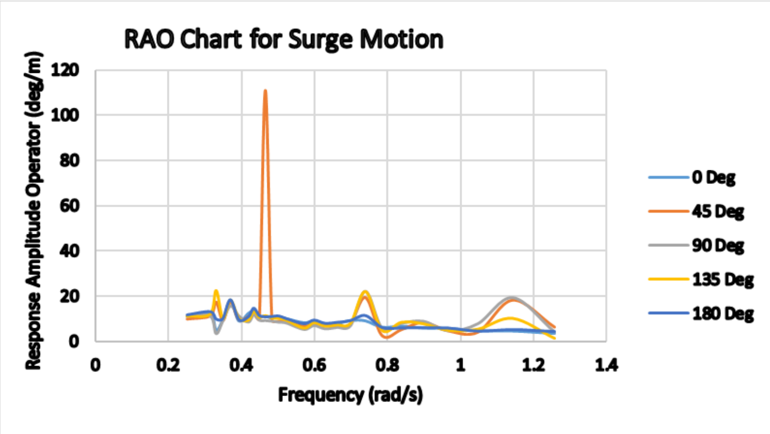



Picture 4.6.4.5. RAO for rotational pitch movements on structure of PLTA on free floating condition

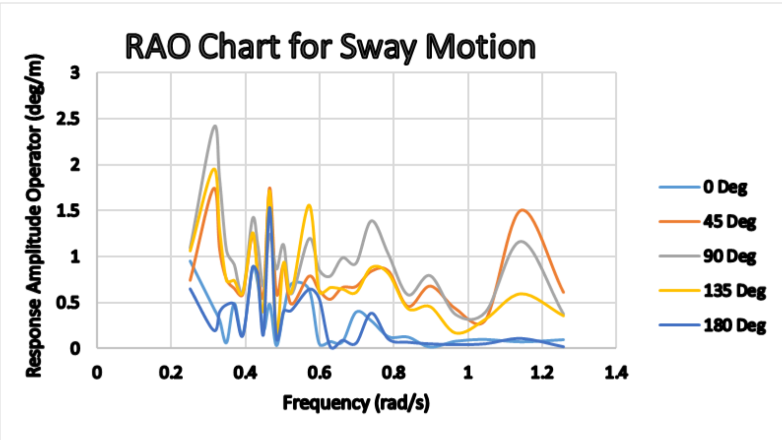



Picture 4.6.4.1. RAO for rotational surge movements on structure of PLTA on free floating condition

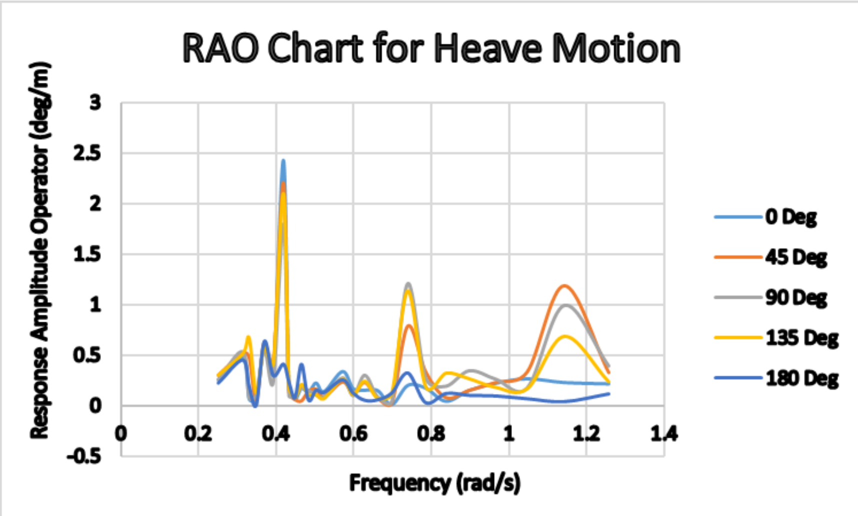
### 4.6.5 Draft 1.75



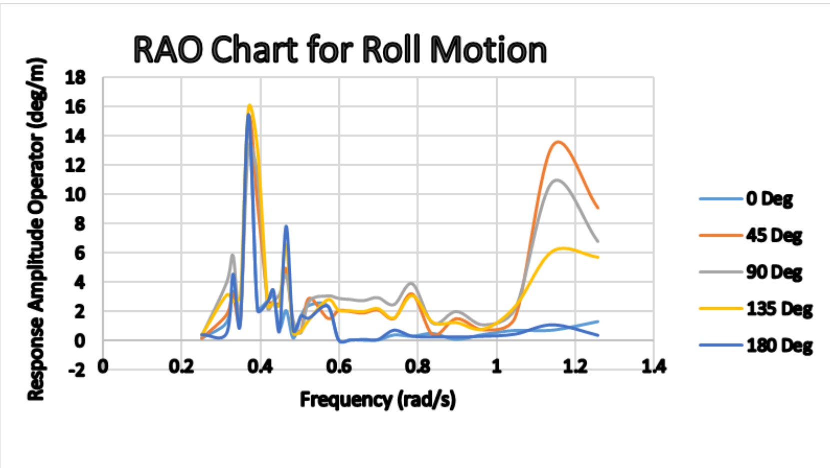

Picture 4.6.5.1. RAO for rotational surge movements on structure of PLTA on free floating condition



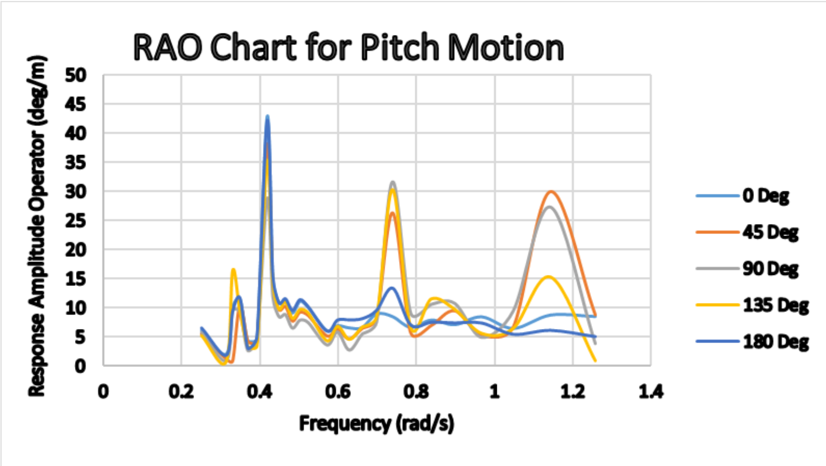

Picture 4.6.5.2. RAO for rotational sway movements on structure of PLTA on free floating condition



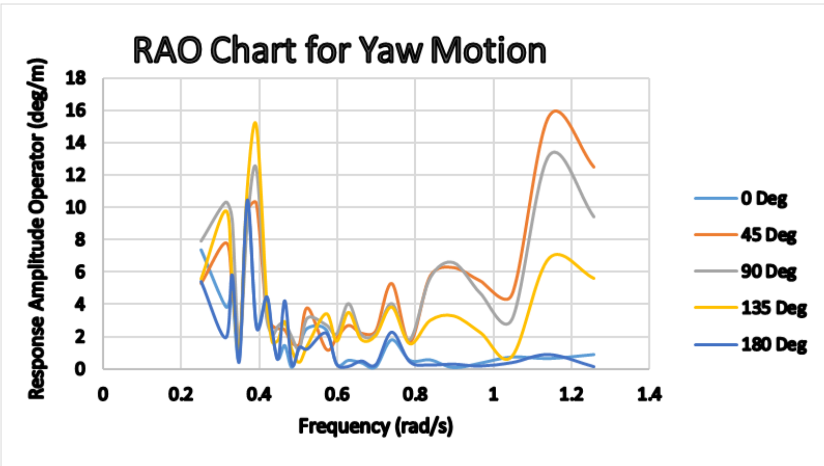

Picture 4.6.5.3. RAO for rotational heave movements on structure of PLTA on free floating condition




Picture 4.6.5.4. RAO for rotational roll movements on structure of PLTA on free floating condition

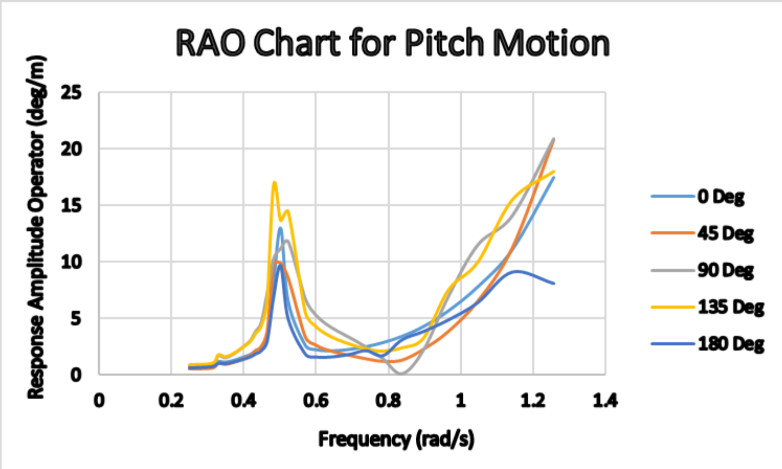



Picture 4.6.5.5. RAO for rotational pitch movements on structure of PLTA on free floating condition

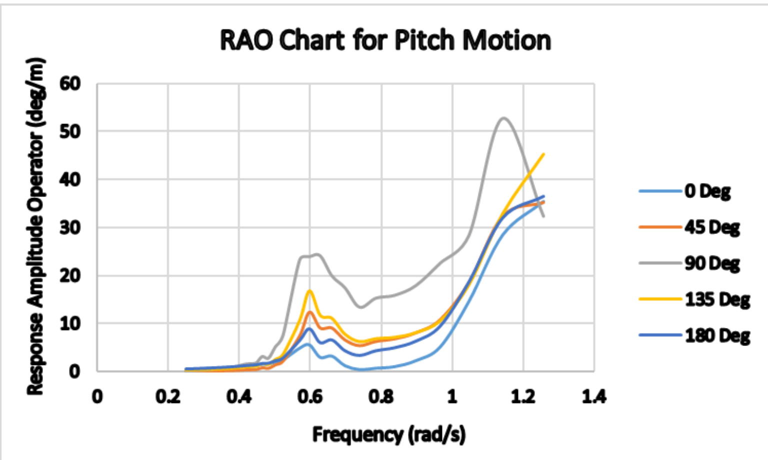



Picture 4.6.5.6. RAO for rotational yaw movements on structure of PLTA on free floating condition

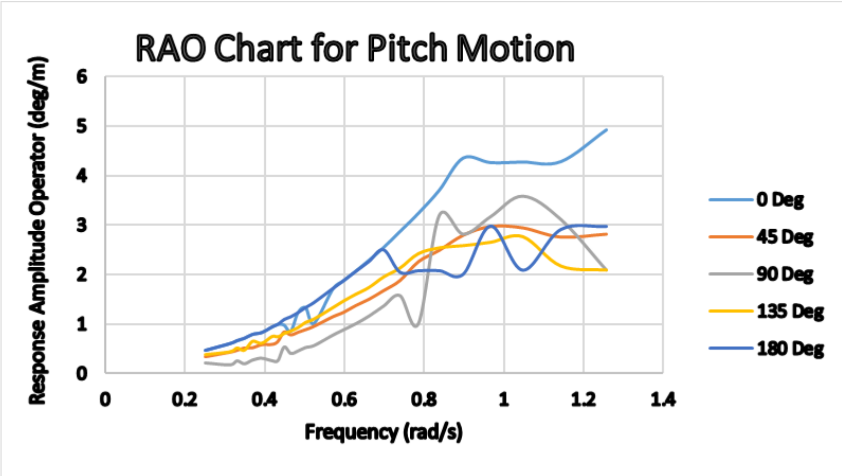
### 4.7. Perbandingan Pitching pada setiap Draft



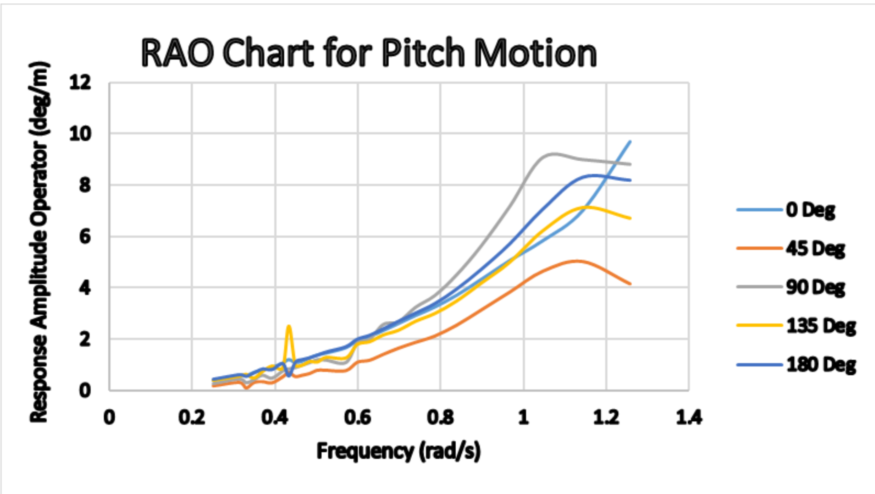

Picture 4.7.1. RAO for rotational surge movements on structure of PLTA in 0.75 m



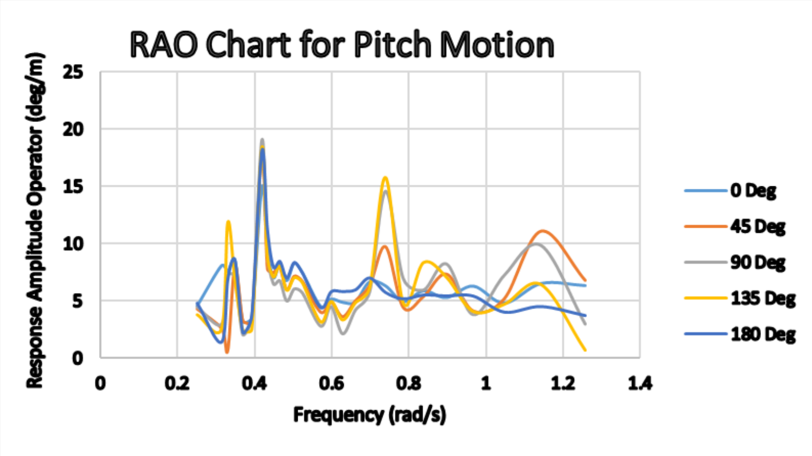

Picture 4.7.2. RAO for rotational surge movements on structure of PLTA in 1.00 m




Picture 4.7.3. RAO for rotational surge movements on structure of PLTA in 1.25 m

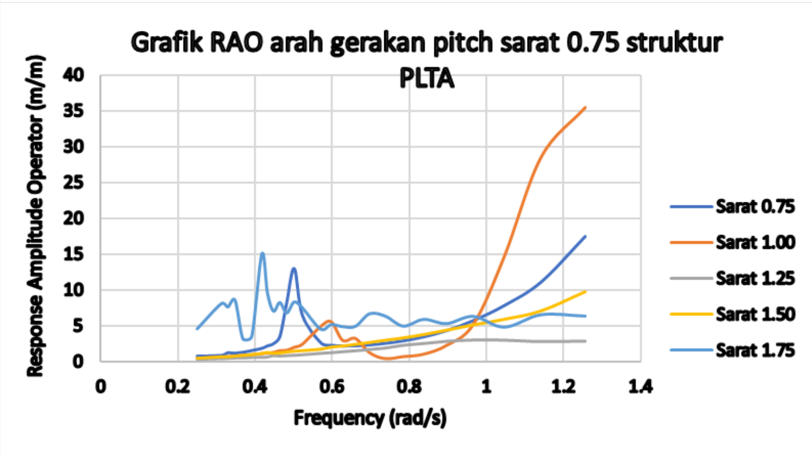



Picture 4.7.4. RAO for rotational surge movements on structure of PLTA in 1.50 m



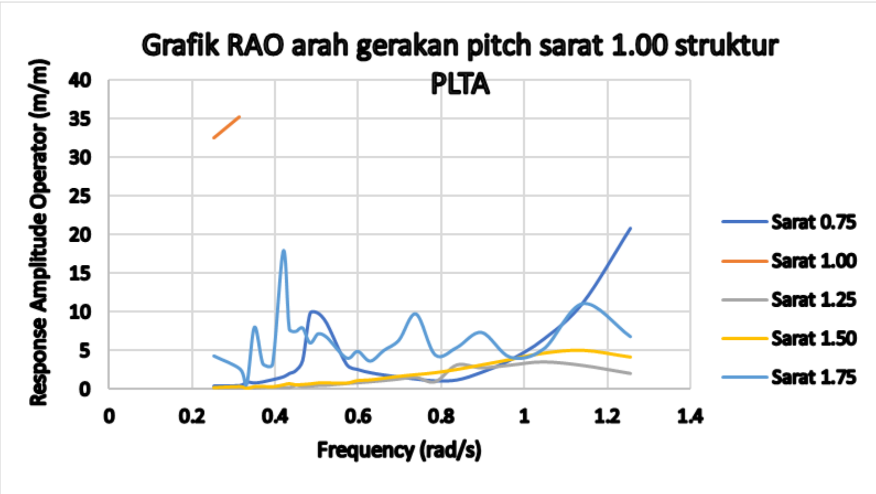

Picture 4.7.5. RAO for rotational surge movements on structure of PLTA in 1.75 m

**4.8. Response untuk pitching pada setiap Sudut**



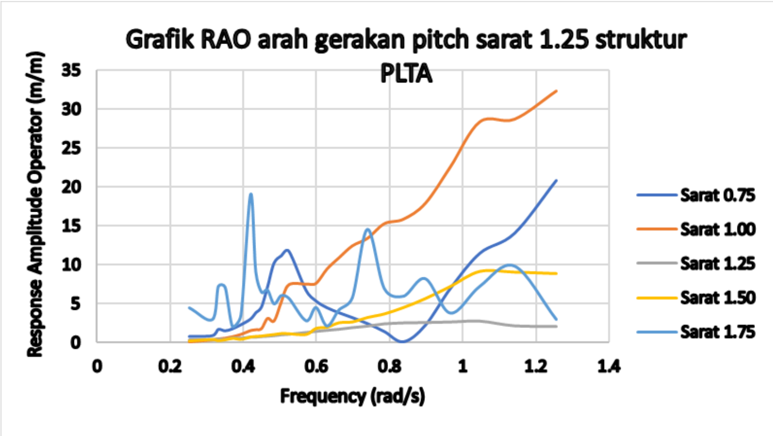

Picture 4.8.1. RAO for rotational surge movements on structure of PLTA in 0 degre

Dari grafik diatas dapat diketahui secara lebih spesifik bahwa pada sudut 0 derajat, dengan berbagai macam syarat air. Diketahui pada syarat 0.75 rao cenderung naik pada frekuensi yang telah ditentukan. Pada sarat air 1.00 m tepatnya saat frekuensi 1.3 terdapat kenaikan rao sampai mencapai 35. Pada sarat air 1.75 respon cenderung rendah dan konstan.



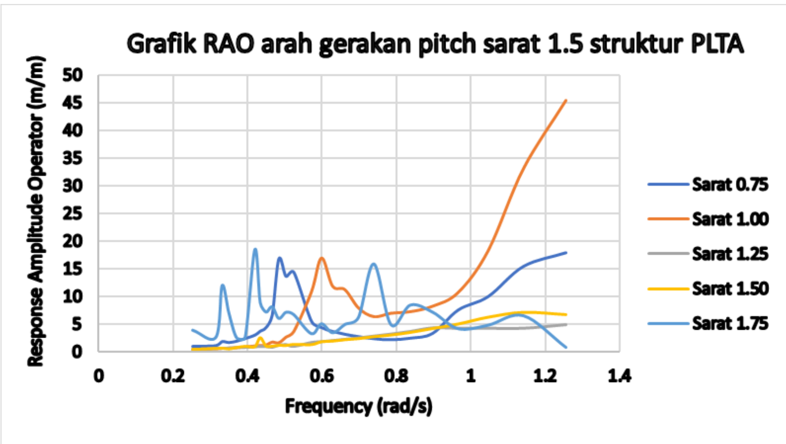

Picture 4.8.2. RAO for rotational surge movements on structure of PLTA in 45 degre

Dari grafik diatas dapat diketahui hasil dari RAO pada masing-masing sarat air. RAO paling tinggi terdapat pada sarat air 0.75m dimana rao mencapai angka 21. Kondisi paling rendah dan cenderung kontan terdapat pada sarat air 125 m. Untuk sarat air 1.75 m rao tinggi pada frekuensi 0.4 dengan rao mencapai 18.

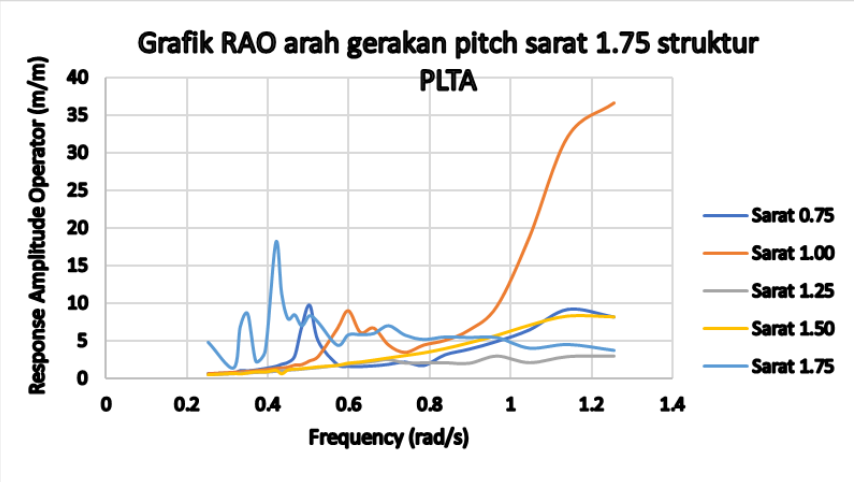



Picture 4.8.3. RAO for rotational surge movements on structure of PLTA in 90 degre

Dari grafik diatas dapat kita ketahui bahwa rao paling tinggi berada pada sarat 1.00 dan paling rendah pada kondisi sarat 1.25m




Picture 4.8.4. RAO for rotational surge movements on structure of PLTA in 135 degre




Picture 4.8.5. RAO for rotational surge movements on structure of PLTA in 180 degre

## 4.9. Calculation of Volume Displacement

Weight ballast which must be carried by the ship displacement weight of the vessel. Thus the need is calculated *displacement* weight of the vessel.Heavy *displacement* boats have been known which is 44.93 tons, with the following explanation:

W ballast = □□ x 15%
= 44.9 x 15 %
= 6.74 ton

which:

Wballast = weight ballast

$\Delta$ = weight displacement

Once known ballast weight, then calculate the volume by multiplying the weight ballast ballast to the future of sea water, following :

Vballast = Wballast/ p air laut
= 44.93/ 1.025
= 6.58 m3

## 4.8.1 Calculation and Selection of Pumps

Selection of pump is influenced by the volume of fluid to be moved, the static *head, pressure head, velocity head,* and total *head loss.Steps in the pump selection is as follows:*

a. Calculating the capacity of the pump
Pump capacity can be calculated using the following equation:

$$Q = \frac{V}{t}$$

Where?

Q = pump capacity (m / sec)

V = volume of ballast (m3)

t = time needed to fill or empty the tank (dt) t takes 0.5 hours

so we get:

Q = 13.150 $m^3/h$

= 0.004 $m^3/s$
= 3.66 liter/s

b. Calculate the diameter of the pipe
Diameter pipe can be calculated using the following equation:

$D^2$ = Q / (1/4 x π x vb )
= 0.001551102 m
D = 0.0393
= 39.38 mm

in which:

Vb = estimate fluid velocity

= 3 m/s

Selection is based on standard ASME pipe B36.10M / 19m-2004, to the appropriate dimensions are:

Inside diameter = 40.94 mm

Thickness = 3.68 mm

Outside diameter = 48 mm

Pipe size = 40

Schedule Number = 40

c. Calculating pump head

1.Head Static

Head static defined as the difference in height between suction and discharge.The amount of static head is:

$$
\begin{aligned}
Hs &= T + 0.75 \\
&= 8.8 + 0.75 \\
&= 9.55 \text{ m}
\end{aligned}
$$

2. Head Pressure

Head pressure is defined as the difference in pressure (pressure) on the suction and discharge side.Because of the pressure on the discharge and suction sides are equal, so:

$$Hp = 0 \text{ m}$$

3.Head Velocity

Head velocity is defined as the difference in speed (velocity) on suction and discharge side.Because the speed of the discharge and suction sides are equal, so:

$$Hv = 0 \text{ m}$$

4.Head Loss

Head loss can be divided into two, namely the head loss loss of major and minor head.In calculating the head loss pipe, it must be calculated the amount of the major and minor head loss in the suction and discharge side.

5. Head in the suction pipe

| | |
|---|---|
| n | = kinematic viscocity |
| n | = 0.000000894 m2/s |
| dH | = diameter dalam |
| | = 40.94 inchi |
| | = 1.039876 m |
| | |
| Rn | = (v*dH)/n |
| | = (3*0.9738)/ 0.000000849 |
| | = 344098.9 |
| | |
| l | = 0.02+0.0005/ dH |
| | = 0.02+0.0005/ 0.09738 |
| | =0.025 |

| No | Types | n | k | nxk |
|---|---|---|---|---|
| 1 | Elbow 90º | 1 | 0.57 | 0.57 |
| 2 | T-join | 2 | 1.14 | 2.28 |
| 3 | Filter | 1 | 1.5 | 1.5 |
| 4 | Butterfly valve | 14 | 0.86 | 12.04 |
| 5 | Gate valve | 7 | 0.15 | 1.05 |
| 6 | SDRNV | 1 | 1.23 | 1.23 |
| | | | total | 18.67 |

Major losses (hf)

Hf = l * L * v2 / (D * 2g)

in which:

L = length of suction

= 2m

Hf = l*L*v2/(D*2g)
= 0.025 x 2 x (3^2) / (0.09738 x 2 x 9.8)
= 0.24 m

Minor Losses (hl)

From the above table are used to determine the amount of head loss is minor, with the formula:

$$hl = \frac{(\sum n\ x\ k)\ x\ v^2}{2g}$$

$$= \frac{18.6\ x\ 3^2}{2\ x\ 9.8} = 3.421 \text{ m}$$

- Calculating the total head loss in the suction side

hl = head loss major + head loss minor

= 15.41 m

a. Head loss on the discharge side
Head loss is affected by the minor accessories contained in the pipe at the discharge. Here's a table showing the number and value of each pipe accessories

| No | Types | n | k | nxk |
|---|---|---|---|---|
| 1 | Elbow 90° | 2 | 0.57 | 1.14 |
| 2 | T-join | 4 | 1.14 | 4.56 |
| 3 | Filter | 1 | | |
| 4 | Butterfly valve | 14 | 0.86 | 12.04 |
| 5 | Gate v/v | 7 | 0.2 | 1.4 |
| 6 | SDRNV | 1 | 1.23 | 1.23 |
| | | | total | 20.37 |

From the above table are used to determine the amount of head loss is minor, with the formula:

$$hl = \frac{(\sum n\ x\ k)\ x\ v^2}{2g}$$

= 15.19*(3^2)/(2*9.8)

= 6.975 m

b. Calculating the total head of the suction and discharge line

H = Hs + Hp + Hv + Pw head loss ( suction + discharge)

= 20.188

c. Select and determine the specifications of pumps

Based on the above calculation, the selected pipe ballast with the following specifications:

| | |
|---|---|
| Head | : 20.18 m |
| Capacity | : 13.150 $m^3$/hr |
| Merk | : JD 3 |
| Frekuensi | : 50 Hz |
| Power | : 0.65 Kw |

# CHAPTER 5
# CONCLUSION

## 4.1 Conclusion

After working on this thesis can be concluded as follows:

1. Utilization ballast system in the development of pontoons patamaran very useful, it is because with the addition of ballast water, using the motion response RAO (Response Amplitude Operator) can be reduced in accordance with existing graphics.
2. Utilization of ballast on patamaran have different results on each motion of the ship.For pitching motion can be seen from the graph that the most optimum conditions exist in water laden 1:25 am and most extreme on the water laden 1:00 am.
3. Utilization of the ballast system on the pontoon patamaran using a system that is supported by a pump which pumps capasitas require approximately 13 150 $m^3$ / hr.
4. RAO condition of average height at 1:00 laden condition and always low on the condition of water laden 1:25 m.

## 4.2 Recommendation

Recommendation that can be given by the author for further research are :

1. The result of this final project can be used as a reference to the detail design of mechanical transmission system such as gearbox system.
2. Calculation and simulation of vibration that occur need to be done, in order to get the efficiency and more accurate.

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The author, Lenny Rahmawati was born in Kediri, 20 December 1994, the autror is the first child of two in his family and taken formal education at Blimbing 1 Primary School, Grogol 1 Junior High School, Kediri 1 Senior High School. The author was graduater from Kediri 1 in 2013, then continuing to bachelor degree and accepted at Institut Teknologi Sepuluh Nopember, Faculty of Merine Technology in Departement Marine Engineering. The author registered with student number 4213 100 033 in Department of Marine Engineering.

The authorhas keen of learning, not only in classes but also by doing intership, proved by the intership at shipyard company, PT. Dok dan Perkapalan Surabaya in 2015 and PT.Antakesuma Inti Raharja in 2016. The author take a bachelor thesis in *Marine Manufacturing and Design* (MMD).

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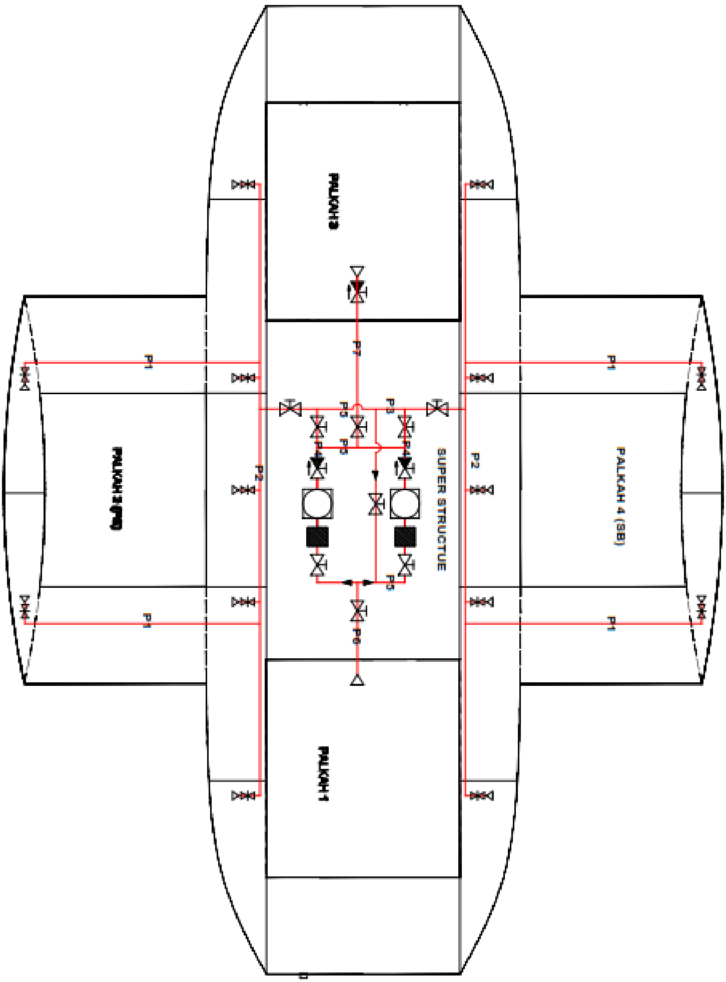
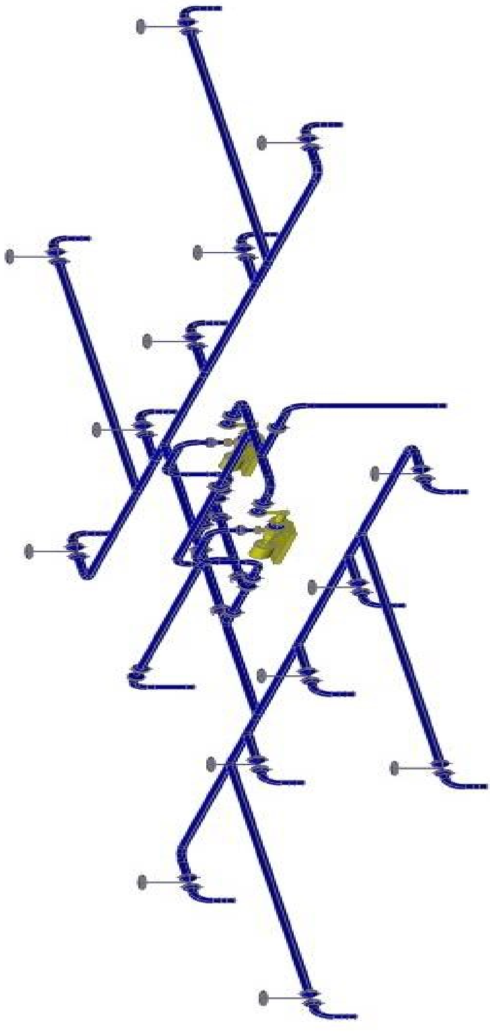
# ATTACHMENT

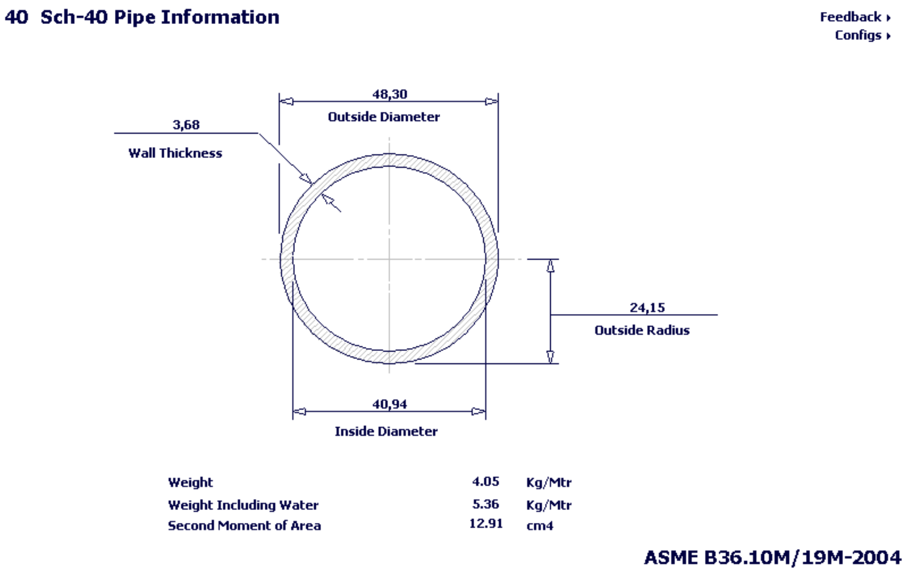
Ballast System Design of Pattamaran



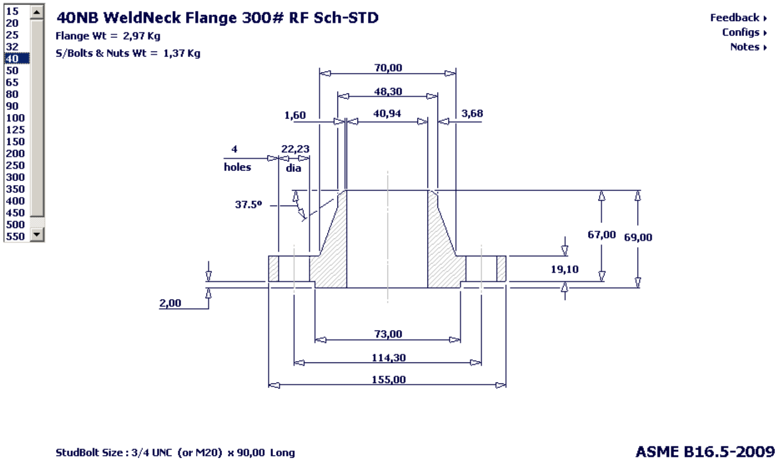


Spesifikasi Pompa dan acsesorisnya

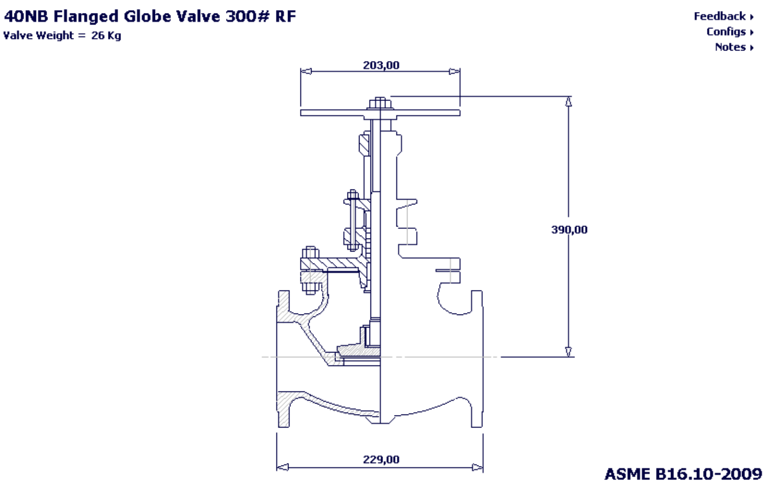
1. Spesifikasi Pipa yang Dipakai




2. Spesifikasi Flange



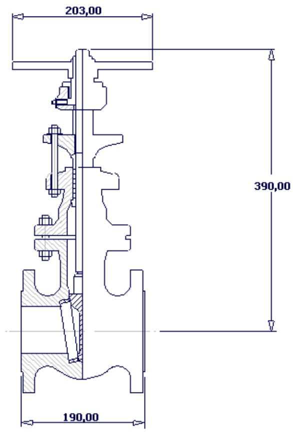

3. Spesifikasi Valve



## 40NB Flanged Gate Valve 300# RF

Valve Weight = 26 Kg

Feedback ▸
Configs ▸
Notes ▸

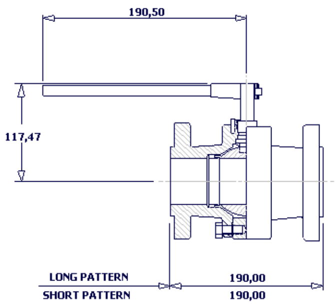



ASME B16.10-2009

## 40NB Flanged Ball Valve 300# RF

Valve Weight = 26 Kg

Feedback ▸
Configs ▸
Notes ▸

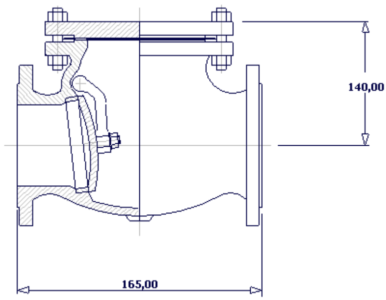



SECTION THROUGH FULL BORE VALVE

ASME B16.10-2009

**40NB Flanged Swing Check Valve 150# RF**
Valve Weight = 18 Kg

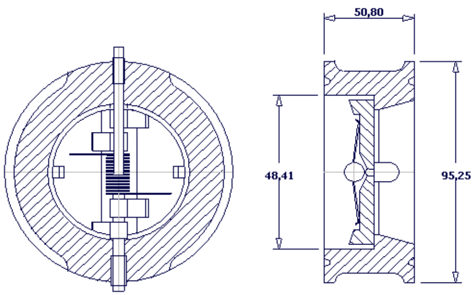
Feedback ▸
Configs ▸




**ASME B16.10-2009**

**40NB Flanged Wafer Check Valve 600# RTJ**
Weight = 2 Kg

Feedback ▸
Configs ▸




VIEW LOOKING UPSTREAM

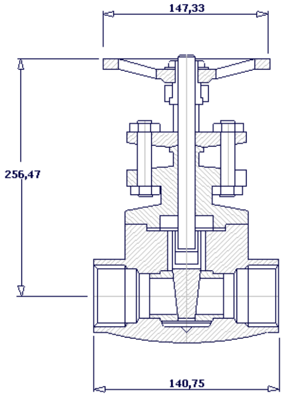
SECTION PLAN

StudBolt Size : M20 (or 3/4 UNC) x 165,10 Long

## 40NB Threaded Gate Valve 1500#

Weight = 10,87 Kg

Feedback ▸
Configs ▸

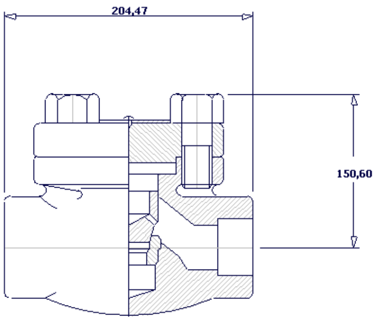



**API 602**

## 40NB SW Horizontal Check Valve 1500#

Weight = 14,56 Kg

Feedback ▸
Configs ▸




**API 602**

4. Spesifikasi Pompa

## Type: JD Basic 3

Diameter Pipa Hisap: 1" & 1,25" (inc)
Diameter Pipa Dorong: 1" (inc)
Panjang Pipa Hisap: 30 (meter)
Maksimal Level Air: 18 (meter)
Optimal Level Air: 15 (meter)
Total Head: 15 - 20 - 25 (meter)
Kapasitas: 20 - 14 - 9 (liter/menit)


power: 1x220-240V /0.65kw