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Design of Floating Terminal for Coal Transportation Optimization

Kukuh Izatullah[1], Arif Fadillah[1*], D N Theresiana[1]

[1]Department of Naval Architecture Darma Persada University, East Jakarta.
[*]Corresponding author. Email: arif_fadillah@ftk.unsada.ac.id

ABSTRACT
Indonesia is known as one of the largest coal producing countries in the world, especially on the island of Kalimantan. With coal reserves of ± 16,627 million tons. With such abundant coal reserves, Kalimantan uses rivers as the main means of transportation for coal distribution. However, the distance between the stockpile on the ground and the place where the Mass Carrier carries out long-distance retrieval, so that supporting infrastructure is needed. One of them is by using the Floating Terminal as a means of transshipment of coal from the barge to the mother vessel. For this reason, the Floating Terminal is designed with a length of 220 m and has a displacement of 118911 tons. This Floating Terminal is equipped with a loader capability to the mother vessel of up to 4x2000 tons and an unloader from barges to the Floating Terminal of 4x2000 tons. This Floating Terminal design has criteria that meet six ship standards with a GM value of 14,487 m. As a transhipment of coal from barges to Bulk Carriers in the waters of Taboneo Anchorage. The calculation of the dimensions of this Floating Terminal uses the method of comparison or comparison with other Floating Terminals that are already operating

Keywords: *Floating Terminal, Coal Transportation, Optimization, Trans-shipment*

1. INTRODUCTION

Coal is one of the most energy resources in Indonesia [5]. With such a large reserves and distribution of coal potential in Indonesia. Making Indonesia one of the largest coal producing countries in the world. This makes coal one of the largest contributors to the Indonesian economy. Where the island of Kalimantan became the largest coal producer in Indonesia judging by the amount of reserves that reached ± 16,627 million tons, while the amount of coal reserves on the island of Sumatra ± 13,284 million tons.

One of the common problems that occur in the process of managing coal in Kalimantan is the distribution process. Where the location of mines and stockpiles in the middle of the forest provides access that is difficult to achieve. But with the characteristic island with a large river, this makes an advantage where distribution is done by barge through the river as the main means of transportation to get to the sea. Proses loading from barges to mother vessels can only be done a few miles from the shoreline.

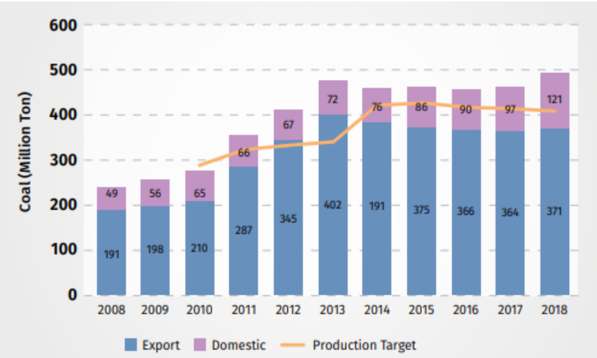

Figure 1. Indonesia Coal Target and Production Chart.

To solve the problem, trans-shipment process is carried out, where coal is sent from one mode of transportation to another mode of transportation in the middle of the sea. Where this study designed floating terminal as a means of transportation in the middle of the sea. Floating Terminal is a valid alternative, considering the reduced cost and installation time required. In addition, floating terminals are flexible solutions, can be used wherever needed and have limited environmental impact [6].

To optimize the function of Floating Terminal required a qualified supporting facilities in the form of loading capability -unloading large coal. So that the distribution process can accommodate coal production capacity in the mine, and finally it can gave big contribution for Indonesia's Economy Development [6]. Therefore it is necessary to support optimal coal transport [7].

2. METHODS

Floating Terminal in this study was designed using maxsurt enterprise software. Where used three types of software maxsurf, namely maxsurf modeler, maxsurf resistance, and maxsurft stability. By using regulatory standards from IMO to calculate the stability of the Floating Terminal.

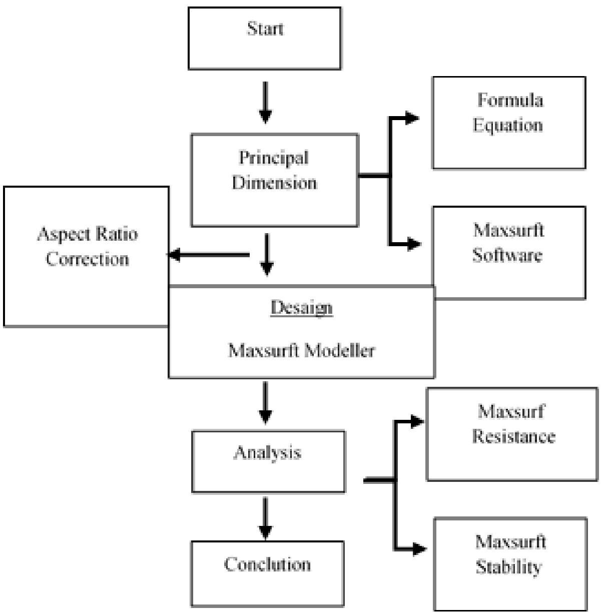

Figure 2. Methodology of the research.

2.1 Design

Floating Terminal design by Maxsurf Modeller software. This software is used to form a hull model based on the principal dimension of Floating Terminal and coefficients based on the standards of the equation below.

$$Cb = 0.70 + 0.125 \tan^{-1} \frac{23 - 100\ Fn}{4} \quad (1)[3]$$

$$Cm = 0.977 + 0.085\ (Cb - 0.60) \quad (2)[3]$$

$$Cw = \frac{C_b}{0.471 + 0.551\ C_b} \quad (3)[2]$$

$$Cp = \frac{C_b}{C_m} \quad (4)[1]$$

Information:
Cb= Koefisien Blok
Cm= Koefisien Midship
Cp = Koefisien Prismatik
Cw = Koefisien Waterline
Fn = Froude Number
$= \frac{V}{\sqrt{gL}}$
V = Perencanaan Kecepatan $\left(\frac{m}{s}\right)$
L = Panjang Kapal (m)
g = Percepatan Gravitasi $\left(\frac{m}{s^2}\right)$
tan = Tangen

2.2 Maxsurft Stability

Maxsurft Stability is used to analyze the stability of Floating Terminal that has been designed on Maxsurf Modeller using standard of MARPOL regulation 27 intact stability [10], namely:

- The area below the GZ stability curve from a 0° angle to a 30° angle is not less than 0.055 m.rad.
- The area below the GZ stability curve from a 0° angle to an x -40°) angle should not be less than 0.09 m.rad.
- The area between the angle of oleng 30° to the angle of oleng x is not less than 0.03 m.rad, where the value of x is 40° or less until the minimum limit of water can enter the body of the ship. The calculation value in this area can be calculated by subtracting point 2 subtracted by 1 point.
- The maximum value of GZ should be achieved at an angle of no less than 30° and a minimum value of 0.20 m.
- Maximum oleng angle of stability should be more than 25°.
- Initial metacentre value (GM) should not be less than 0.15 m.

3. RESULTS AND DISCUSSION

3.1 Floating Terminal

From the calculation of the main dimensions of Floating Terminal, it is necessary to optimize by comparing the aspect ratio value of the calculation result of the aspect ratio of the comparison, below:

Table 1. Principal Dimension of Floating Terminal

Item	Calculation	Design	units
Length Perpendicular (LPP)	220	220	m
Length Water Line (LWL)	224,4	224,4	m
Breadth (B)	57,4	57,4	m
Height (H)	17,2	17,2	m
Draft (T)	10,5	10,5	m
Speed (V)	7,5	7,5	*knots*
Side Board (T)	7	7	m
Displacement	118911,00	119635,12	t
Volume Displacement	116011,04	116717,19	m^3
LWT	13902,12		Ton
DWT	105008,88		Ton
Prismatic Coefficient. (Cp)	0,861	0,864	
Block Coefficient. (Cb)	0,858	0,863	
Max Sect. Area Coefficient. (Cm)	0,996	0,999	
Waterpl. Area Coefficient. (Cwp)	0,963	0,912	

From the calculation of the dimensions of the design results above, it is necessary to calculate the aspect ratio of the dimensions obtained to find out whether it meets the appropriate design standards in the book "Principles of Naval Architech" [9]. From the results of principal dimension calculations and aspect ratio correction, continued by designing Floating Terminal using Maxsurf Modeller, and obtained lines plan consisting of Body Plan, Sheer Plan, and Half Breadth Plan, as below.

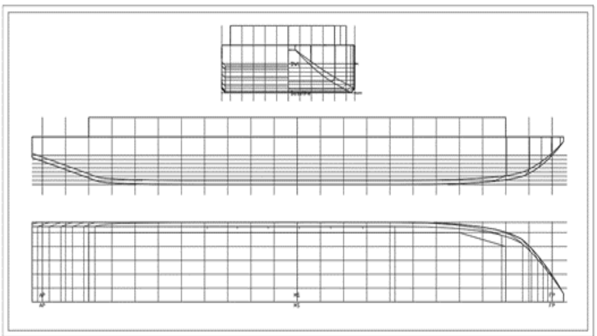

Figure 3. Lines Plan Floating Terminal.

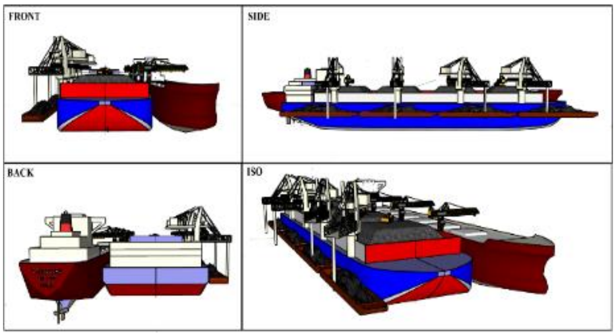

Figure 4. 3D Floating Terminal Design.

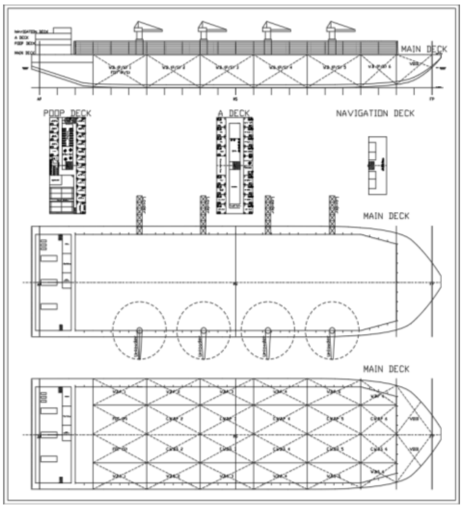

Table 2. Floating Terminal Aspect Ratio

Item	Aspect Ratio			
	L/H	L/B	L/T	B/T
Design	12,79	3,83	20,95	5,46
Standard	7-17	3,5 - 10	10 - 30	2,4-10

Figure 5. General Arrangement Floating Terminal.

Table 3. Floating Terminal Support Equipment.

Item	Value	Units
Stocpilling	90000	metric ton
Unloading Grab Crane	4 x 2000	metric ton
Shiploading	4 x 2000	metric ton
Reclaming	4 x buldozer	unit
Propulsion	3 x thruster	unit
Complement	51	person

Table 4. Resistance and Power Floating.

Speed	Froude No. LWL	Froude No. Vol	Kr Barge Resist (kN)	Kr Barge Power (kW)
7,5	0,082	0,176	2684,8	10358,9
10	0,11	0,235	4773	24554,4

Projection 2D General Arrangement Floating Terminal is equipped with all supporting equipment to carry out loading or unloading floating terminal work, along with floating terminal accommodation building as a supporting means for Floating Terminal workers. The floating terminal support equipment contained in the General Arrangement above can be seen below. Linesplan obtained from the results of the design using maxsurf modeler, obtained 3D form floating terminal design. The following is seen 3D Floating Terminal after being equipped with supporting equipment to do floating terminal support work.

Table 5. Floating Terminal Stability Criteria.

Criteria	Value	Units	Actual	Status	Margin (%)
Area under GZ curve from 0 to 30	31.513	m.deg	764,32	Pass	+2325.40
Area under GZ curve from 0 to 40	51.566	m.deg	1.285,39	Pass	+2392.70
Area under GZ curve between 30 to 40	17.189	m.deg	521,07	Pass	+2931.43
MAX GZ	0.200	m	5,41	Pass	+2605.50
Max GZ Angle	25.0	deg	43,60	Pass	+74.54
Max GM	0.150	m	14,49	Pass	+9558.00

3.2 Maxsurf Resistance

Floating Terminal resistance analysis uses KM Barge method in Maxsurf Resistance using a maximum speed limit of 10 knots. Floating Terminal resistance analysis shows that the resulting wave is turbulent, where the continuous wave resulting from the Floating Terminal has an irregular shape.

3.3 Stability

Stability calculation with Maxsurf Stability using criteria from MARPOL regulation 27 – intact stability. This is based on the regulation of MSC 267-85 "Ships with block coefficients of more than 0.9 are analyzed with barge provisions" while the Cb value obtained is less than 0.9 [11].

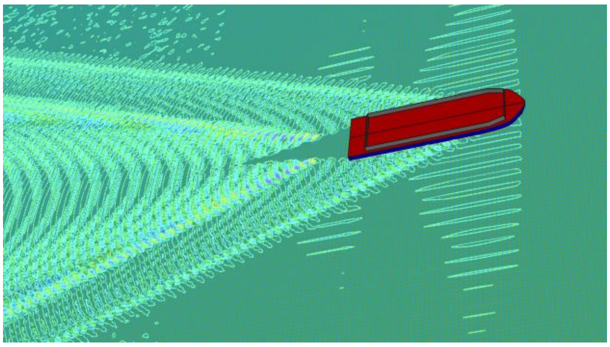

Figure 6. Wave Canal Floating Terminal

4. CONCLUSION

The results of the analysis showed that the design of floating terminal meets the stability standards set by IMO in MARPOL regulation 27 – intact stability,and floating terminal is not recommended for public sailing, due to the large size of the almost boxy shape, so that when sailing will produce irregular turbulent waves and can harm the cruise around it.

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