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Freeboard And Trim Measurement: A Case Study Of Landing Craft Tank Conversion To Ship Power Plan

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Abstract

In This research aims to design a ship power plant that is the result of a conversion from a landing craft tank to meet the electricity needs in areas affected by disaster or electricity crisis. The background of this research is the need for a ship power plant that can be sent to areas that need it, considering that the Indonesian government has rented a similar ship from Turkey. This research uses a numerical calculation method to calculate the freeboard and trim values of the ship after conversion according to applicable standards. The data used are the specifications of the landing craft tank and the ship power plant rented from Turkey. The results of the research show that the freeboard value of the ship is still safe, with the actual freeboard value being greater than the required freeboard (0.8 m > 0.44 m). For ship trim, the bow trim condition is obtained with a smaller LCG-LCB difference than the 0.05% LPP value (0.912 < 0.923). The conclusion of this research is that the freeboard and trim conditions of the ship are still in a fairly good category even though it has been converted from a landing craft tank to a ship power plant. This research contributes to the design of a ship power plant that can be applied in Indonesia. Suggestions for further research are to conduct a direct ship trial to verify the results of the numerical calculations.

Keyword: Ship Conversion, Ship Power Paln, Freeboard, Trim.

1. INTRODUCTION

In Indonesia, many ships have changed specifications even though the ship has been made and has been sailing for years. Changes in these specifications are due to market needs and changes in functions and regulations that apply so that the ship must go through a redesign process [1]. When redesigning, several main factors must be considered, such as the value of resistance and ship stability after changing the design must be better than the previous design [1]. With a high resistance value, it will affect the amount of engine power used [2]–[4] , besides that it will also greatly affect the value of fuel consumption because the amount of power is directly proportional to the rate of fuel consumption [5]. Several cases of ship redesign or commonly called ship conversion have also been carried out in related research studies. A study that conducted a review related to rede ship resistance has been carried out where re-planning the shape of the ship's hull obtained a smaller resistance value of up to more than 30% compared to the initial ship design [6]. Subsequent research is related to the strength of the ship's deck where in the conversion of landing craft tanks (LCT) ships into passenger ships where to increase the value of the longitudinal strength of the ship, it is necessary to increase the thickness of the ship's deck plate [7]. Ship redesign is not impossible to do to achieve a more optimal ship design.
The energy problem is a global problem that is the main focus to be solved. Studies related to the use of the latest energy from sunlight and wind energy to produce electrical energy on ships have also been used [8]. this is a form of conversion in terms of energy on board. Specifically, in this study, the research object was

taken from the conversion of landing craft tanks into a ship power plan or marine vessel power plan with the initial aim of utilizing LCT vessels which have advantages such as a wider main-deck shape and low draft to be converted into generator transport ships [9]. This research is based on the crisis of electrical energy in the area of East Java, especially the coast of Kagean Island with the result of a conversion of a ship capable of transporting 8 units of generators with specifications capable of producing 1,320 kW of electric power or being able to illuminate 1,439 houses [10]. The ship's deck which was originally used for transporting heavy vehicles was converted into a deck that carried 8 units of generators with the initial modification, namely the creation of a special machine foundation in the ship's deck area.

When carrying out a ship conversion, the important thing that must be done is to re-measure whether, after the conversion the ship can provide good performance, the intended performance is whether The ship's trim and freeboard values are still in the safe category or not. Freeboard greatly affects the ship's maneuverability because it also greatly affects the stability of the ship when maneuvering at sea the definition of a freeboard is the vertical distance of the freeboard deck line downwards to the top of the load line measured amidships [11]. The second thing to note is the trim of the ship, trim itself can be defined as the tilt angle of a ship lengthwise. Changing the building and shape of the hull as well as the position of the cargo on board will also affect the trim of the ship. The even keel condition is optimal in a ship because it will affect the drag and speed of the ship's maneuvers. There are three general conditions when a ship is sailing, namely even keel, trim by head, and trim by stern. Ships that experience abnormal trim will worsen conditions while sailing [12]. So that fatal losses in the ship-building process can be avoided as early as possible, namely by conducting a study of the freeboard and trim of converting ships, the hypothesis of this study is to calculate the two values (freeboard and trim) of conversion ships and assess whether they are still included in the standard of a decent ship or not.

2. METHOD

2.1. Ship Power Plan (conversion from LCT)

In the previous discussion, it was explained that this ship is a conversion ship from LCT to Ship Power Plan or commonly known as Marine Vessel Power Plan (MVPP). The main concept of this ship is to change the function of the LCT vehicle deck into a generator engine deck (putting a power generator on the main deck). Distributed electricity is electricity that is commonly used for homes, namely 220 volts. This generator will produce electrical energy which will then be channeled to the Main Switch Board (MSB) and the final stage is distribution to residents' houses on the coast. The LCT was chosen because the main deck of this ship is quite wide and the LCT ship is also known to have a low draft compared to other ships so that it can reach shallower coastal areas, swamps, and rivers [13][14]. The ship uses the main engine as a propulsion (diesel engine) with a power of 320 hp, 1950 rpm [15], This engine is capable of providing optimal power to the ship at a speed of 4.1 knots. This speed is indeed not too big considering the main concept of this ship is a generator ship that will operate more in areas affected by disasters and electricity crises and is different from other ships which must always move from one pier to another. Table 1 shows the main dimensions of the ship power plant.

Table 1. Main Dimention of Ship Power Plan [10]

Ship Power Plan	Unit
Length Overall (LOA)	57.6 meters
Ship width (BMLD)	7.50 meters
Draugth (TMLD)	2.25 meter
Height (HMLD)	4,72 meters
LWT+DWT	1085.145 tons

The shape of the Ship Power Plan ship design can be seen in Figure 1.

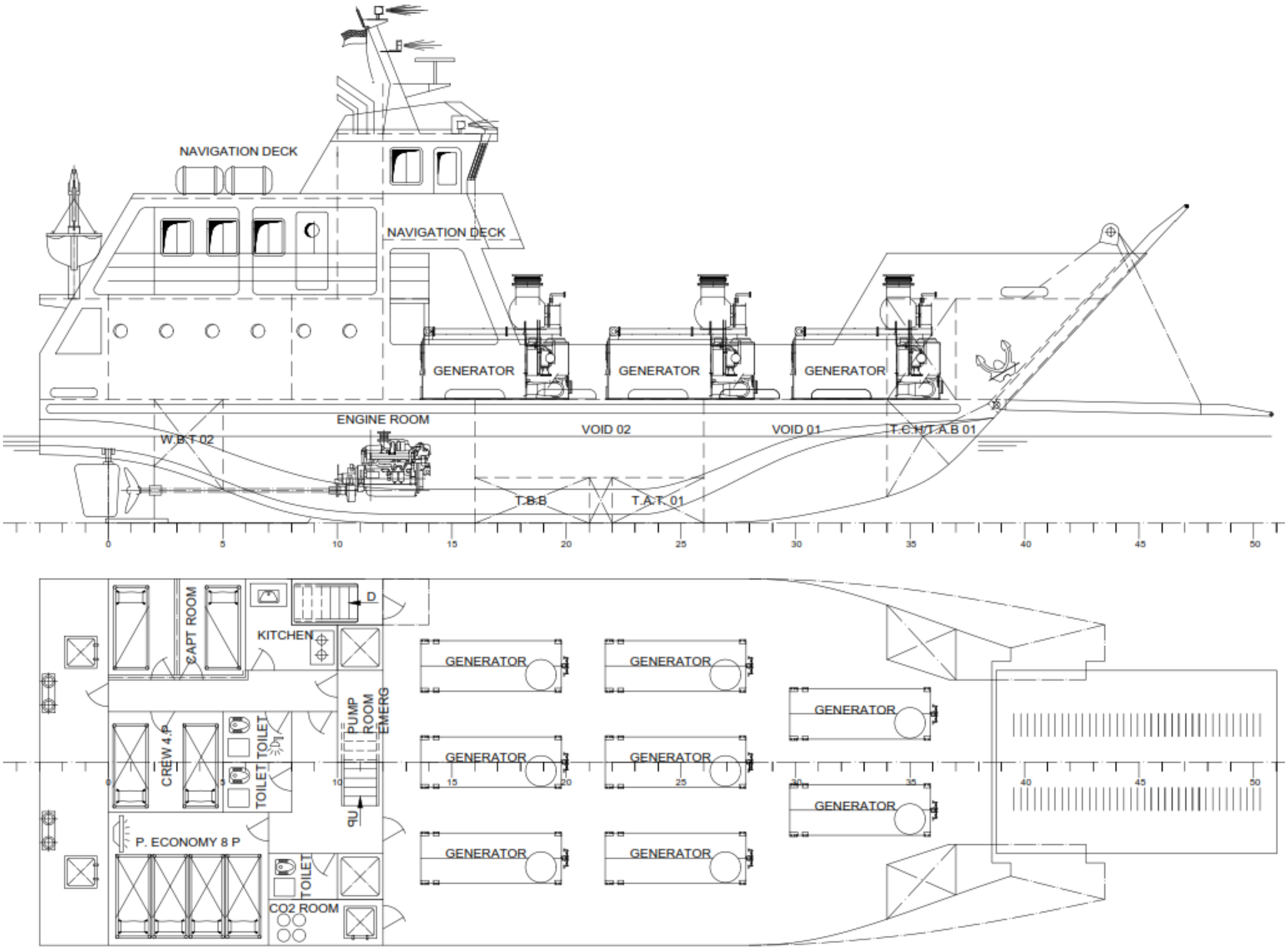

Figure 1. General Arrangement of Ship Power Plan [10]

2.2. Trim

Trim is the condition of the ship's hull caused by cargo and other factors that affect the position of the ship. Optimization of trim, can be done in two ways, namely changing the shape of the hull or not changing the shape of the hull but modifying the ship's cargo such as ballast and load distribution on board[16]. In the case of this ship, hull modifications were not used, but the effect of changing the ship's load from previously being a vehicle to a generator row is feared to affect the trim of this ship.

To find the trim value of a ship, you can use the following calculation:

$$\text{Trim} = T_A - T_F \tag{1}$$

Where Ta is the trim after peak condition and Tf is the trim for peak condition while the desired condition is that the Ta value minus the Tf value is zero, so this condition is commonly called an even keel.

2.3. Freeboard

Freeboard can also be referred to as a comparison or difference between the height of the ship and the drag of the ship where the freeboard functions as a backup buoyancy for the ship so that it will have a strong effect on the condition of stability, resistance and also the safety of the ship while at sea[17]. Freeboard defined is the distance measured vertically downwards amidships from the top edge of the deck line to the top edge of the load line [18]. According to ILCC 1966, the designed diesel power generator ship is included in the category of B-type ships. So for further calculations using the B-type ship calculation reference, to calculate the ship's freeboard value, you can use the following simple equation using the following equation.

$$Fba = H - T \tag{2}$$

Where Fba is the actual freeboard, H is the ship's height and T is the ship's draft

3. RESULTS AND DISCUSSION

Based on the main problem above which consists of two, namely finding the freeboard value of the ship and also looking for the trim value of the conversion ship. These two things are considered very important for the safety and comfort aspects of the ship while operating at sea.

3.1. Freeboard Calculation

The ship power plan or also commonly called the Marine Vessel Power Plan as a result of the conversion of this LCT ship is included in the B ship category. Meanwhile, to get the freeboard value of the ship, first, look for the standard freeboard value. For this ship, the standard freeboard value based on regulation 28 table 28.1 is 1030 mm. Then a correction is made for the depth and correction of the ship's superstructure.

For ships with prices D > L/15, the correction is as follows:

Fb3 = R(D-L/15) mm
R = L/0.48 m (for L<120 m)
= 110.42 m
Fb3 = R(D-L/15) mm (if D < L/15 no correction)

The next step is to correct the ship's super structure when the acctual freeboard is as follows:

Fb4 = -319 mm

the total value of freeboardD') is known from the following formula

F' = Fb3 + (-Fb4)
F' = 1.35 m

so the total freeboard value of the ship is as followsFba = H - T m

Fba = 1.92 m

so that the above conditions are accepted because the value of Fba is greater than the value of the total freeboard (Fb')

3.2. Trim Calculation

The second calculation is to find the trim value of the ship. The trim value is sought to predict the condition of the ship when operating at sea. If the condition of the ship is in an unreasonable trim, repairs will be carried out immediately because if it is forced, it will have a bad impact on the ship when the ship is finished being built. The first step in determining the trim value is to calculate the ship's hydrostatic curve value.

KB or vertical center of buoyancy above baseline (m)

KB/T = 0.90 – 0.30Cm – 0.1Cb
KB = 2.17 m

B_{MT} or transverse metacenteric radius (m)

B_{MT} = 1.1 m

B_{ML} or longitudinal metacenteric radius (m)

B_{ML} = 50.27 m

so the trim value of the ship

Trim = (LCG – LCB).L / GML
Trim = 2.79 m (Trim by stren condition)

Trim Limit

LCG - LCB = 2.52
0.05%Lpp = 2.65

Total Condition is accepted because the difference between LCG and LCB < 0.31% Lpp

4. CONCLUSION

Based on the comprehensive analysis results derived from the calculations outlined above, the trim calculation yields a length of 1,021 m, well within the established maximum trim limit of 2,650 m. This fulfillment of trim calculations ensures a safe operational range for the ship, even after undergoing conversion from a landing craft tank (LCT). Concurrently, the freeboard calculation produces a freeboard limit of 1.92 m, while the actual freeboard measures 1.35 m. These findings affirm that the conversion from LCT to ship power plan does not pose concerns regarding the ship's freeboard and trim, maintaining parameters within normal limits. The calculated results for trim and freeboard offer valuable insights, providing recommendations and initial references for future ship conversions. The implication is that ships undergoing conversion should not immediately alter their functions without a meticulous recalculation, particularly concerning trim and freeboard. This approach is imperative to guarantee the safety and stability of the converted ship. The successful analysis of trim and freeboard in the context of ship conversion underscores the importance of precision and thorough evaluation in ensuring the seaworthiness and integrity of repurposed vessels.

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