The analysis of occurring process to the deformation and the bending plats from the right hand of the hull plates of LCT Malela Raja III ship for economical management

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Abstract. The introduction of the research, this is a ship carrying liquid cargoes for the trayek Namlea and arround Buru Island. Gross tonnage (GT) are 86 tonnes and the weight. Displacement are 43,522 tonnes. Beside that the ship is used with the engine of Mitsubisi Merk, type 6 D15 with engine power 2 x 90 HP and the engine rotation are 2 x 1500 RPM (4 Tak of the engine), with reduction ratio 1 : 4. The trayek around Buru Island (in Moluccas) in the rain condition, the climate condition is necessary to change ie in the rain season, the sea condition causes waves and pressures the hull plate with wave flow. In addition with the spreading vibration from the Main Engine of this ship will occur the curvature and the deformation. The purpose of this research; 1. To know how many thick of the strength right hull plates. 2. To know the influence of the vibration spread of the main engine and the ship Hull plate that to analyses the frequencies of the main engine vibratory and the ship Hull vibration. The result that we can find in this research with natural frequency analysis is $N_{2\nu} = 453.48$ cpm, while $N_{3\nu} = 919.62$ cpm dan $N_{4\nu} = 1390.66$ cpm, the ship operate 75% from 2 engine is 2250 cpm, while the ship operates with a machine speed of 75% for 2 pieces of machinery = 2250 cpm and 60% = 1284.84.

1. Introduction
This Landing Craft Tanker (LCT) Malela Raja III is a ship Tanker that is carryius liquid cargoes for the trayek Namlea and arround Buru Island. This ship has Gross Tonnage (GT) are 86 Tonnes and the weight. Displacement are 43,522 Tonnes. Beside that the ship is used with the engine of Mitsubisi Merk, type 6 D15 with engine power 2 x 90 HP and the engine rotation are 2 x 1500 RPM. (4 Tak of the engine), with reduction ratio 1 : 4 and it used 2 peopellers. In the trayek around Buru Island (in Moluccas) in the rain condition, the climate condition is necessary to change ie in the rain season, the sea condition causes waves and pressures the hull plate with wave flow. In addition with the spreading vibration from the main engine of this ship will occur the curvature and the deformation [1].

The purpose of this research that will recive in this research are:
1. To know how many thick of the strength right hull plates for KM. Malela Raja III.
2. To know the influence of the vibration spread of the main engine and the ship Hull plate that to analyse the frequencies of the main engine vibratory and the Ship Hull vibration.
From the purpose of the research, then the analysis is used with the frequency of main engine of the KM Malela Raja III.
The methode is used as follows:
1. To make the survey and to get data for KM. Malela Raja III when this ship is docking in the PT. Perikani Galala Ambon.
2. To make the analysis of the ship data.
3. To use the library science in order to analyse the bent and the deformation that are occured to this ship.

The purposes are in this research being to know how many thick of the strength of the right ship hull plate with the ordinary plate type in the (LCT) Malela Raja III by analysing the frequencies of hull and the main engine.

2. Method

2.1. The analysis of the ship vibration

The result that would ben gotten in disresearch was analysed the resonance because the frequency of the ship hull and the frequency of the 2nd order engine excitation from the landing Craft Tanker KM Malela Raja III. By using the formulae of Todd is the natural frequency for 2nd node to Tanker [2]:

\[ N_{2nv} = 52000 \sqrt{\frac{BD^3}{(1,2 + \frac{B}{2T}) \Delta l^3}} + 28 \text{ (cpm)} \]  

(1)

While the frequency of 3rd node and 4th node using the amperical formulae by Johannessen and Skaar [1]. are :

\[ N_{nv} = N_{2nv} (n - 1)^{1.02} \ldots \text{ (cpm)} \]  

(2)

While the frequency of 2nd order engine excitation is

\[ f_{\text{main engine}} = 2x \text{ propeller speed} \text{ (cpm)} \]  

(3)

Then to happen the resonance is :

\[ \frac{N_{2nv}}{N_{3nv}} \text{ must be in the range of } f_{\text{main engine}} \text{ by Otto Schlick} \]

Figure 1. For the vibration of the vertical ship hull.

2.2. Basic theory of vibration frequency calculation

The effect of the existence of the shear stress in the beam is explained by the linear flexural stress theory which is linear and modified so that the voltage is not far in proportion to the distance from the neutral axis, and the increased beam deflection will occur as a shear deflection.

This vibrational frequency is closely related to the deflection and the effect of the shear deflection can be illustrated by the approach that the W tratic force has deflection through the flex theory of \( \delta_{mn} = \frac{W^2}{48EI} \), whereas a beam with solid rectangular cross section has a deflection because only shear is

\[ \delta_{s} = \frac{W^2}{6bd^3} \]  

where \( b \) and \( d \) are the width and height of the block and \( g \) is the modulus of rigidity of the material.

\[ \delta_{mn} + \delta_{s} = \frac{W^2}{48EI} + \frac{3W^4}{10bdG} \]  

(4)

With approach \( r_s = \frac{6E \cdot d^2}{5G \cdot b^2} \) then,

\[ \delta_s = \frac{W^2}{48EI} \left( 1 + r_s \right) \]  

(5)

So the static style becomes...
in accordance with the beam vibration then the differential equation for the beam becomes....

$$M \frac{d^2 y}{dt^2} + \frac{48EI}{\rho (1+r)} y = 0$$

(7)

The solution for frequency is

$$N = \frac{1}{2\pi} \sqrt{\frac{48EI}{MI^3 (1+r)}}$$

(8)

If Nm is a frequency based on the theory of bending then the frequency through shear correction is:

$$N = \frac{Nm}{\sqrt{(1+r)}}$$

(9)

The portion of the stomach that is submerged in seawater is expressed by:

$$\text{Total AVM} = \Delta_1 = \Delta (1 + kB/d)$$

(10)

And

$$\text{TVM} = \Delta (1.2 + B/3d)$$

for Todd

While the value of the moment of inertia (I) is determined by the following principal measures of ship size

$$I = C_2 BD^3$$

It should be mentioned here that the units L, B, D, in feet I in ft4 and deplants in tones (english) and todd applies the empirical formula to the value of natural frequency for 2nd nodes as follows

$$N_{2\text{nd}} = C_1 \left[ \frac{BD^3}{(1.2+\frac{B}{2T})\Delta} \right]^{0.5} + C_2$$

(11)

For the Tanker ship then $C_1 = 52000$ and $C_2 = 28$

$$N_{2\text{nd}} = 52000 \left[ \frac{BD^3}{(1.2+\frac{B}{2T})\Delta} \right]^{0.5} + 28 \ (\text{cpm})$$

(12)

3. Analysis of vessel vibration testing

To test the velocity of the vessel to determine the resonance occurring due to the interval of the natural frequency for the two Nodes for the bending moment of the hull and the frequency of the 2nd order engine extension of the vertical moment for the excitation diesel engine shall be within the 10% interval [2]. Todd formula for tanker ship in natural frequency calculation for 2 nodes:

$$N_{2\text{nd}} = 52000 \left[ \frac{BD^3}{(1.2+\frac{B}{2T})\Delta} \right]^{0.5} + 28 \ (\text{cpm})$$

(13)

where: $L_{BP} = 28.50 \ m = 93.50393686 \ ft$

$B = 6.0 \ m = 19.68503934 \ ft$

$T = 1.2375 \ m = 4.06002698 \ ft$

$D = 1.65 = 5.413388581 \ ft$

$CB = 0.80$

$\Delta = 173.522 \ ton \ metric = 157.41568796 \ tonnes \ (England)$

so:

$$N_{2\text{nd}} = 52000 \left[ \frac{BD^3}{(1.2+\frac{B}{2T})\Delta} \right]^{0.5} + 28 \ (\text{cpm})$$
Diesel engine from Mitsubishi brand type 6 D15 with motor speed 2 x 1500 RPM (4 Tak machine), reduction ratio 1:1.4.

When operating with engine speed of 75% RPM then propeller rotation becomes $N = 1125$ RPM. So the frequency of 2nd order engine excitation from the engine becomes $2 \times 1125$ RPM = 2250 cpm.

When operating in poor weather with a 60% RPM engine speed the propeller turns to $N = 642.42$ RPM. So the frequency of 2nd order engine excitation from machine becomes $2 \times 642.42$ RPM = 1284.84 cpm.

Because the difference from $N_{4nv}$ to ship hull and $N_{nd}$ of ship engines is within 10% of the velocity of the vessel will cause resonance (2 vibration mix) so as to damage the construction of the connection plate with welding joints [3], coupled with the collision of sea waves due to bad weather it will cause flexibility and shape changes in the hull of the ship.

4. Conclusion

The ship with the full loaded will departure condition at bad climate with an engine speed 60% RPM, so that the propeller speed occurs 642.42 RPM, then the frequency of 2nd order engine excitation of the engine are 1284.84 cpm, will close with $N_{4nv} = 1390.66$ cpm., that happened the resonance where could broke welding between the plate of the ship hull and the frames, beside of the impact of the sea waves because the bad climate so that could occur the banding plate and deformation of the plate from the ship hull.

References

[1]  Johannesssen H and Knut T M 1980 Trans. of NAME 88.
[2]  Todd F H 1961 Edward Arnold (Publishers) Ltd.
[3]  Pettersen J W F and Vedeler E 1971 First Edition. Joint Meeting with RINA.