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Structure Analysis of Masthead Light Using Finite Element Method

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***Abstract*— Ship Navigation System is a very important in determining the direction of the ship. And it is a ship communication tool used to connect between the crew on different ship and communicate with the port. Moreover, if there are two ships that meet, the navigation light system is a communication tool that will prevent the accident of the both. In the design of each ship component must comply with predetermined standards and specifications, as well as in designing a masthead light. In this section, it is also necessary to analyze the load of navigation lamp post due to the loading. In the design of ship structures must be calculated each component with the rules according to regulatory standards that have been established BKI (Classification Bureau of Indonesia). That make every size and material used must also be in accordance with the provisions and classification of BKI. The analysis used in the structure using finite element method. By structure analysis depends on the load of the navigation lights as static loads. In the design analysis of masthead light need to be included security factor so that the stresses and deformation of the structure that is still permitted can be considered, so the strength analysis of the structure with finite element is not excessive and it can reduce of failure structure.**

Keywords— Navigation system, strength analysis, Finite element method

I. INTRODUCTION

Indonesia is the largest archipelagic country in the world. Indonesia has an area of 5.193.252 km2, two thirds of the area is an ocean, which is about 3,288,683 km2 so it is not a strange thing that Indonesia called a Maritime Country. Currently the marine transportation system in Indonesia is growing rapidly. There are always cargo ships and passenger ships always cross the Indonesian sea every day.

Ship navigation is the most important system on board. In ancient times people will use the sky object like the sun and constellations to determine the direction of the voyage. This method certainly requires knowledge that not everyone can understand and do. In addition to the navigation system also serves as a means of communication of the ship to connect with other ships and communicate with the port.

At this time research has been done to be able to navigate well and effectively. The use of navigation is not only in the sea, but also on land and in the air. Every place of course has positive and negative factors for effective navigation.

Night cruises are frequent, so the navigation light system should always be in good condition. In the design of the masthead light must be able to withstand the static load and dynamic load. The static load comes from the load due to navigation lights. Effect of ship speed as dynamic load. Total loading from the navigation lights is 0.065 ton (65 kg) with each weight of 0.0065 ton (6.5 kg). In addition, the load due to the speed of the vessel with Vs = 12. The design of each part of the ship must comply with the applicable standard and classification rules.

In the behavioral analysis of this structure will be discussed and analyzed the design of the masthead light structure on the Fast Ferry 150 Pax vessel using the Finite Element Method. Design analysis in this loading includes loading, among others: static load, dynamic, and impact and included values of security factors. It aims to anticipate the possibility of structural failure in the navigation light pole that can interfere with the communication between ships and keep the structure safe but the strength of the structure is not excessive. Therefore, the structure of the masthead light of the Fast Ferry 150 Pax vessel using the Element Method Up to the form of stress distribution and structural deformation is still permitted.

II. BASIC THEORY

A. Navigation System

First Navigation is a process of controlling the movement of transportation equipment either in the air, on the sea or river or on land from one place to another smoothly, safely and efficiently. Along with the times, modernization of

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navigation equipment greatly helps the accuracy of ship positioning on the surface of the earth.

This navigation system serves as instructing the ship about directions, ship position information. This navigation system consists of several components, among others, ultrasonic sensor as a measure of the distance of the ship with the object in front, the compass sensor as a direction the ship.

B. Mast

The mast or pole on the ship functions as a place of navigational lights, flags, daytime cues, radar, GPS, radio antennas, and forg horn or as a placeholder of lifting equipment (derrick)

The mast on the deck serves as the seat of the lift devices (derrick). While the mast is located on the roof of the wheelhouse serves as a place of navigation lights, navigation tools and so forth. The location of this mast must be at the highest point of all the existing ships on board (excluding funnel), it is intended that all navigation lights can be seen clearly.

C. Navigation Lamp

The Navigation lights are the source of colored lighting on ships or aircraft, used to notify the position, post, and status of the vehicle. Generally, these lamp placements are mandated by international conventions or authorities.

The navigation lights are mounted on board according to Rules regulations (Collision Regulation 1972) and ignited in dark weather to determine the direction of the ship, ship type and ship size as follows:

- Front masthead (masthead light fore)
- The main masthead (main masthead) for the ship over 50 m long.
- Left and right side lamps (Portside and Starboard light).
- Stern light (stern light)
- Led light (towing light)
- Front-back anchor light or anchor light
- The main engine light is off (not under command light).

D. Effect of Air Pressure on the Sea on Ship Speed

Air and wind resistance on the vessel is the resistance experienced by the part of the main body of the ship that is above the water surface and the superstructure due to the movement of the ship that also travels through the air and the wind blowing [3].

The ship that moves on a calm sea, will experience air resistance due to movement of the upper body of the ship's water through the air.

Blowing wind will generate wind resistance which depends on the speed of the wind blow and the direction it comes.

E. Loads

In this case the navigation light pole has two kinds of loading, that is Static loads are a fixed load, both the magnitude (the intensity), the point of work and the direction of the line is fixed. In this case it is the weight of the navigation lights assuming the weight does not change.

F. Loads

In this case the navigation light pole has two kinds of loading, that is Static loads are a fixed load, both the magnitude (the intensity), the point of work and the direction of the line is fixed. In this case it is the weight of the navigation lights assuming the weight does not change. Dynamic load is a load whose magnitude (intensity) varies with time, so it can be said that the load is a function of time. Although working only for a certain time span, but the resulting impact can damage the structure of the building, therefore this burden must be taken into account in planning the building structure.

Dynamic loads can cause an inertial force at the center of the mass that is opposite to the direction of motion. Dynamic loads are more complex than static loads, both in terms of their load functionality and the resulting effects.
Because the dynamic load causes response that change over time, the corresponding structure will vibrate. In this case the dynamic load on the structure of the navigation lamppost is assumed to be the speed of the vessel that has been affected by the air pressure over the calm sea.

Air and wind resistance on boats moving in calm water can be written as follows:

Since the dynamic load is a function of time, its effect on the structure will also change over time. Therefore, the solution of dynamic issues must be done repeatedly following the existing loading. If the solution of static problem is single solution, then in solving the dynamic problem is multiple solution.

Because the dynamic load causes response that change over time, the corresponding structure will vibrate. In this case the dynamic load on the structure of the navigation lamppost is assumed to be the speed of the vessel that has been affected by the air pressure over the calm sea. Air and wind resistance on boats moving in calm water can be written as follows:

$$RAA = \text{coefficient} \tfrac{1}{2} \rho AT V^2 \quad \ldots\ldots\ldots\ldots \quad [1]$$

Based on the experimental results, Taylor obtained a large coefficient of air and wind resistance of 1.28. So:

$$RAA = 1.28 \tfrac{1}{2} AT (VR)^2 \quad \ldots\ldots\ldots\ldots \quad [2]$$

G. Stresses

The uniform load and the voltage that occurs in the structure of the navigation lamppost on the Fast Ferry 150 Pax is analyzed by calculating the structure components. To calculate the value of bending moment can be used:

$$Mmax = 1/12\ q\ \ell^2 \quad \ldots\ldots\ldots\ldots \quad [3]$$

The value is used to calculate the maximum voltage value that occurs in the structure with the equation:

$$\Sigma = My / Ixx \quad \ldots\ldots\ldots\ldots \quad [4]$$

Stresses is the moment bending multiplied by the distance of the center point of the cross section of the y-axis and divided by the moment of inertia against the x-x axis in the direction of the loading direction. Stresses is a measure of the intensity of loading expressed by the force divided by the magnitude of the area in which it works. Strain (elongation) is form without dimension to declare changes in form (deformation).

H. Safety factor

The general principle for governing the safety factor is defined as behavioral analysis and structural resistance due to the load acting on the structure [1]. The development of planning methods based on security factors can be sorted as follows:

Working Stress Method.
Plastic Method (Plastic Method) and Ultimate Stress Method (Ultimate Stress Method) Method.

Limit Stress Method.
Method of working voltage or often referred to as the voltage tension method, this is because the use of voltage permit which is the melting stress (collapsed) material divided by a certain number called the safety factor (SF) like the following equation:

SF = Fu / Fi ..... [5]

SF: Safety Factor
Fu: Melt / Ultimate Voltage
Fi: Permission Voltage

Security Factors can also be obtained from the Indonesian Classification Bureau for the construction of steel vessels as follows:

SF: Safety Factor
: 1,1 (in general)
: 1,2 (for construction that only accepts local load)
: 1.05 (for free static load combinations)

It can be concluded that the commonly used security factor is 1.1. So the safety factor used to analyze the behavior of the pole structure of the Navigation Lights is with a value of 1.1.

III. METHODOLOGY

In the stress analysis that occurs on the structure used Finite Element Method, which can be done with the following steps:

A. Design model
The design of the navigation lamppost on the Fast Ferry 150 Pax vessel to be analyzed is modeled first with the AutoCAD software [2]. Then exported with ACIS file type (.sat).

B. Determination of the type of design by study
Should be done the determination of the problem (study) and the type of analysis (analysis type) before the analysis process.

C. Determination of material type
Based on BKI Vol. II Year 2016 material used is marine used with maximum tensile pressure 400N / mm^2. In this step enter the mechanical properties to determine the voltage constraints possessed by the material.

6. Load determination
The specified charge must match the actual situation. The load on the behavior analysis of the navigation light pole structure is a static load, and assumed as a uniform load. In this analysis, dynamic loads are assumed to have no effect on the structure

7. Determination of boundary conditions
The boundary conditions in the structure of the navigation lamppost connected to the roof of the wheelhouse are given the boundary condition of the platen, thus resembling the actual conditions [5].

8. *Meshing*
Model of navigation lampposts made in the form of three-dimensional given solid mesh form which is the recommended meshing type. Analysis of the behavior of the navigation light pole is using fine mesh for accurate results [4]. The method allows for discontinuities, internal to the elements, in the approximation across the interface [6].

9. Analysis
In the behavior analysis of navigation lampposts, post-processing analysis was performed with stability and dynamic load simulations that occurred in the structure.

IV. ANALYSIS AND DISCUSSION

The following step shows the sequence of workmanship in conducting analysis of the strength of fixed fender structure, they are

- Study literature
- Scantling Calculation
- Design fixed fender
- Additional reinforcement
- Finite element analysis
- Post Processing
- Analysis and Discussion

Based on the analysis VonMises value of the maximum stress that occurs with static load conditions by the position of the lamp is 4.5636 N / mm^2. If the value of VonMises stress is compared with allowable stress of 363 N / mm^2 far enough difference. Since the load received by the Navigation Lights is just a load of navigation lights that are placed on the Navigation Light spots. Please see bellow figure:

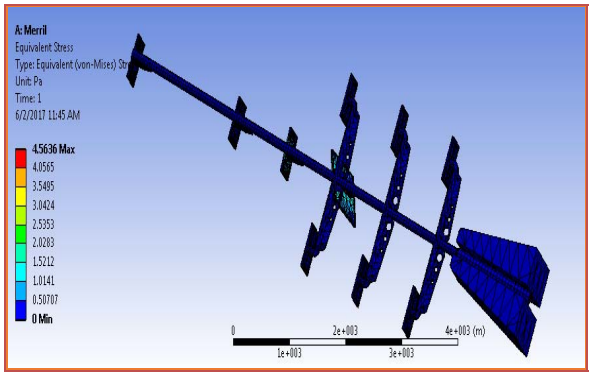

Fig. 1 VonMises Stresses

V. CONCLUSION

Based on the analysis VonMises value of the maximum stress that occurs with static load conditions by the position of the lamp is 4.5636 N / mm². If the value of VonMises stress is compared with allowable stress of 363 N / mm² far enough difference. Since the load received by Navigation Lights is just a load of navigation lights that are placed on the Navigation Lights post

1. Design of the navigation lamppost structure on Fast Ferry 150 Pax vessel with static load is in accordance with Indonesian Bureau of Classification standards.

2. The difference in VonMises maximum stress with allowable stress very far, because the load received is very light.

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REFERENCES

[1] Budianto, M. T Wahyudi, U Dinata, Ruddianto and M.M. Eko P. “Strength Analysis on Ship Ladder Using Finite Element Method.”, Journal of Physics: Conference Series, Volume 953, conference 1, 2018

[2] Budianto, B. "Penentuan Ukuran Utama dan Rencana Garis Fast Ferry 150 Pax Untuk Penyeberangan Rute Gresik-Bawean." Kapal 14.1 (2017): 1-6..

[3] Marine structures." U.S. Patent No. 5,018,471. 28 May 1991.

[4] Dhatt, Gouri, Emmanuel LefranÃ, and Gilbert Touzot. Finite element method. John Wiley & Sons, 2012.

[5] Knight, Katrina, Pamela Moalli, and Steven D. Abramowitch. "Preventing Mesh Pore Collapse by Designing Mesh Pores with Auxetic Geometries: A Comprehensive Evaluation via Computational Modeling." Journal of biomechanical engineering (2018).

[6] Hansbo, Anita, and Peter Hansbo. "An unfitted finite element method, based on Nitsche’s method, for elliptic interface problems." Computer methods in applied mechanics and engineering 191.47-48 (2002): 5537-5552.