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Analysis of Seakeeping And Motion Sickness Incidence (MSI) Prediction Of The Ship's Bow When Sailing In Cilacap Sea

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Abstract

The waves are quite large, and the ship's movement continues to be a barrier tossed about or up and down on the high seas. It can result in symptoms of illness or an uncomfortable atmosphere for passengers on board. This symptom is often referred to as seasickness or motion sickness. The main cause of seasickness is the absence of similarity of excitability or conformity between the stimulus, eye and ear labyrinth the human brain receives. Usually, people who get seasick are on closed decks because their eyes cannot see any movement. At the same time, the ear labyrinth responds to the ship's movement so that thereis a conflict between the stimuli received by the eyes and the ear labyrinth, which is responsible for body balance, causing nausea. In severe cases, passengers or crew must be taken to the hospital. Modelling MSI on Finite Element Method Software, it can be seen that passengers experience ship sickness or, in this case, experience MSI at what time on a cruise on the Cilacap sea lane processed to determine the condition of theship's MSI to passengers by the acquisition of 6 degrees of freedom where various components that affect such as wind, the main current is a wave it occurs 6 degrees of freedom, i.e. Surging is a translational movement along the X axis, Rolling is the movement of the ship around the X axis, Swaying is the translationalmovement of the ship that occurs when the ship moves along the Y axis, Pitching is the movement of the shiparound the Y axis, Heaving is the movement of the ship along the Z axis. A ship with a speed of 12.5 knots sailing in the Cilacap sea with a wave height reaching an average wave of 2.5 meters, the MSI of the ship occurs, namely the effect of sea conditions on the movement of the ship indicating that the ship's response to the sea is at 90 degrees. In the opposite direction of the wave, MSI occurs in 20% of passengers after 2 hours on the vehicle deck at the bow point. At that time, the magnitude of the encounter frequency was 2.137Hz.

Keywords: Seakeeping, Motion Sickness Incidence, MSI Modeling, Degrees of Freedom, Heading Seas

1. Introduction

Cargo Ship is any ship that carries goods and cargo from one port to another. This cargo ship has much space, including cargo space, passengers, and space for the crew of the ship itself. The building on the cargo ship, such as the bow, can be occupied by passengers to rest to enjoy the sailing trip. However, when the ship is sailing, there is a movement of a ship caused by various components such as wind, the main current of the wave is 6 degrees of freedom, namely Surging is the translational movement along the X axis, Rolling is the movement of the ship around the X axis, Swaying is the translational movement of the ship. What happens when the ship moves along the Y axis? Pitching is the ship's movement around the Y axis, Heaving is the ship's movement along the Z axis, and Yawing is the ship's movement around the Z axis [1].

During the ship, there will be movement, which is influenced by sea conditions, especially the size of

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the waves. The ship's movement due to waves needs to be taken into account. The calculation of the ship is designed not to be slow in its movement on the surface of the water. In order to be able to move quickly and agilely, the most important requirement for this type of ship is its manoeuvrability [2][3].

This research was conducted with a case study, Motion Sleckness Incidence, which aims to find how MSI at the ship's bow when sailing in the waters of Cilacap with an average wave height of 2 meters. Analysis of data obtained from literature reviews and several articles on the internet relating to MSI ships and processing data using the Finite Element Method software.

2. Materials and Methods

Data were obtained by reviewing the literature in the library and on the Internet by accessing articles related to the Motion Stickness Incident of ships. The data obtained is done using the Finite element method software based on the ship data studied from the ship's initial planning data. Following is the ship data analyzed by Motion Sickness Incidence (MSI) when operating in the Cilacap sea.

Table 1. Main Dimensions

Main Dimensional	Value
Type of	General Cargo
LBP	84.98 m
B (Width)	14.4 m
T (Load)	5.79 m
H (Height)	7.35 m
V (Speed)	12.5 knots

2.1. Seakeeping

Today the design of ship planning is developing rapidly to create an optimal ship. Apart from economy and performance, the shipping process must also consider the comfort and safety of the ship when sailing, which can be caused either by the ship's motion itself or from outside. Movements originated from external factors such as unfavourable climate and causing big waves and storms that are very dangerous for crew and ships.

Ship motion is the ability of a ship to survive at sea under any conditions. Therefore this capability is an important aspect in terms of ship design. The basis of Seakeeping Calculation is that a ship sailing in water will experience movement according to the wave conditions at that time. In planning the shape of the ship's hull, the quality of the performance of the hull shape is the part that explains the circumstances in which the ship will sway or sink (Ultimate Loss of Performance) in each wave condition, so that performance must be known with certainty even in extreme conditions. Three ship movements influence ship seakeeping: heaving, rolling and pitching. This motion shows the quality of the ship in responding to the wave spectrum. Water conditions (sea state conditions) refer to conditions that have been determined by the world meteorological organization with a review of three categories of waves, namely small (slight), moderate, and large. The geographical location of Cilacap directly facing the Indian Ocean makes tuna fisheries resources have a bright future. Cilacap tuna production is 26% of the total fish production in Cilacap, or 1225 tons per year. Tuna in Cilacap is quite potential, and its growth is developing. Tuna production from 1999 to 2009 increased by an average of 10%. As for the potential of the marine waters of Cilacap Regency, which includes the territorial area and the Indonesian Exclusive Economic Zone (ZEE), the potential for marine fisheries in Cilacap Regency is quite large, reaching
865,100 tons [4][5].

Tides strongly influence current conditions in Cilacap waters. At high tide, seawater will flow from the Indian Ocean into the strait between Java and Nusakambangan through the east canal gate (Java Island Beach) and the west canal gate (Nusakambangan). At low tide, the mass of water flows back into the Indian Ocean through the same path. The period of mass flow of water out is longer than the period of mass flow of water in. Surface currents in the Cilacap waters range from 3.5 knots to 4 knots. In the upper reaches of the Donan River, the current velocity tends to be small because these waters are not river waters.

Seismic activity in the southern part of Java

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Island is dominated by the northward subduction of the Indo-Australian plate under the Eurasian plate in a direction close to the normal trough. This subduction has a depth of 100 ± 200 km below the island of Java and 600 km to the north of the island of Java. The effect of the existence of the subduction resulted in a high level of seismicity and more than 20 active volcanoes in this zone.

The depth in the waters of Segara Anakan Cilacap varies, ranging from less than one meter to more than 20 meters. The shallowest waters are found in the lagoon waters to the east of Karanganyar, followed by the waters of Tritih Kulon. The lagoon waters east of Karanganyar are calm bodies of water and receive sediment from the Citanduy River. Therefore, new land is continuously formed at this location, followed by the growth of mangroves, especially starting with the type of Rhizophora sp.

When the ship moves and is subjected to wave loads, the ship will respond or move according to the contours as written on the graph in the form of the ship's heading angle and speed. The lineson the polar plot show the ship's response according to its operations so that the operator can determine a comfortable ship operation from the graph [6].

2.2. Motion Sickness Incidence On Ship

Motion sickness incidence is the standard term for discomfort and vomiting caused by various conditions of movement: on ships, in aeroplanes, in cars, in agility games, under conditions of zero gravity (space) pressure and in elevators/lifts. Other indications include yawning, irregular breathing, drowsiness, headaches, and feelings of indifference to the fate of others. Eventually, theaccumulation of these symptoms usually results in vomiting. Research on ships or in the laboratory has been carried out to determine the effect of ship movement (roll, pitch and heave), the frequency of movement and acceleration, and the duration of the incident.

The term motion sickness on ships, also known as seasickness, is a symptom of illness caused by the ship's movement, which results in uncomfortable physical symptoms characterized by difficulty breathing, dizziness, nausea, paleness and vomiting. In severe cases, passengers or crew must be taken to the hospital. The main cause of seasickness is the absence of similarity of excitability or conformity between the stimulus, eye and ear labyrinth the human brain receives. Usually, people who get seasick are on closed decks because their eyes cannot see any movement. At the same time, the ear labyrinth responds to the ship's movement so that there is a conflict between the stimuli received by the eyes and the ear labyrinth, which is responsible for body balance, causing nausea. Calculations and simulations are carried out at several points on the ship to see the vertical acceleration. The simulation results obtained the influence of the measurement location, duration and direction of the waves on the percentage of passengers who experience seasickness or motion sickness incidence (MSI).

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The main cause of seasickness is the absence of similarity of excitability or conformity between the stimulus, eye and ear labyrinth the human brain receives. Usually, people affected by seasickness are on a closed deck because the eyes cannot see any movement. At the same time, the ear labyrinth responds to the ship's movement so that there is a conflict between the stimuli received by the eyes and the ear labyrinth, which is responsible for body balance, causing nausea.

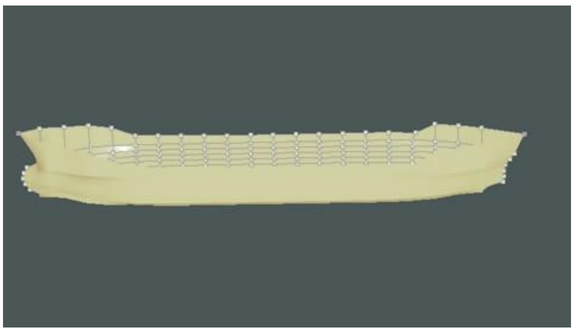

Fig. 1. Ship model

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Table 2. MSI data modelling

Data	Value
Analysis Type Irregular	Strip Theory
wave surface	2
Draft at midship	8.82 (m)
VGC	-0.655 m
Water density	1.025 ton/m^3
RAOs	91
Wave	height 2.50 m
Location of Long Post on the deck of the bow of the ship	68.00

The above data are data modelling on the MSI of the ship's deck at the bow point of the ship using important data such as VGC on the ship -0.655, wave height of 2.50 and RAOs, it can be seen when the MSI condition of the ship occurs when sailing on the Cilacap sea lane. The following is Figure 2. MSI modelling on a ship:

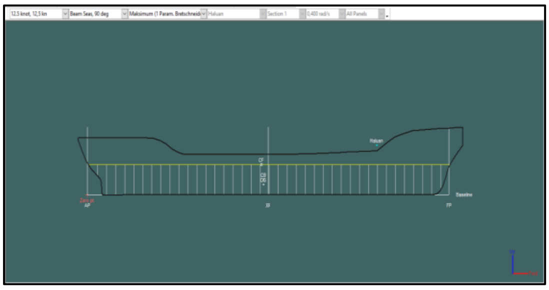

Fig. 2. Ship modelling on Software Motion

3. Result

3.1. Ship Movement Response

RAO is a transfer function that describes how a ship's response varies with wave frequency. Usually displayed in a non-dimensional graph with a function of the height and slope of the wave. The RAO equation is practically presented as a transfer function equation in various motions. In addition, RAO is a transfer function used to determine sea conditions' effect on ship movement. So from there, whether a ship requires a design change to increase stability. The use of RAO in the design phase of a ship makes it possible to determine the modifications needed to the design to meet safety criteria and improve the ship's performance. RAO shows the trend of the ship's movement against the waves. To analyze ship motion and so effect on the MSI index, it is necessary to calculate the added mass, damping factor, inertia of the ship's movement, and the restoring force of the ship. Using the Software; Maxsurf – Seakepper then, the ship is modeled in 3 dimensions, and the parameter values needed for calculating the MSI index above willbe calculated using strip theory.

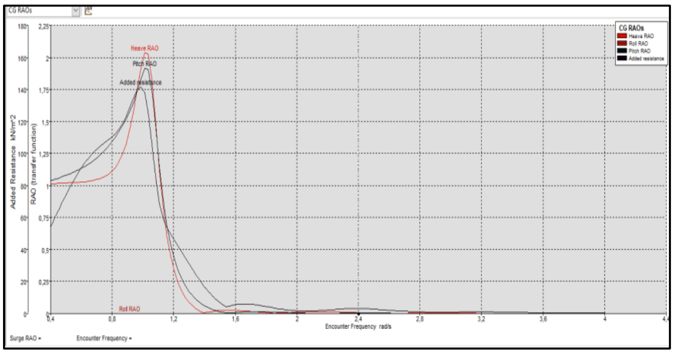

Fig. 3. CG RAO

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By using headings data or the direction of the arrival of a wave where there are 0 degrees following seas conditions, 45 degrees quartering seas conditions, 90 degrees beam seas conditions, and 180 degrees head seas conditions, the response of the ship's motion at the bow. The following is a picture of a ship's ROA with a speed of 12.5 knots.

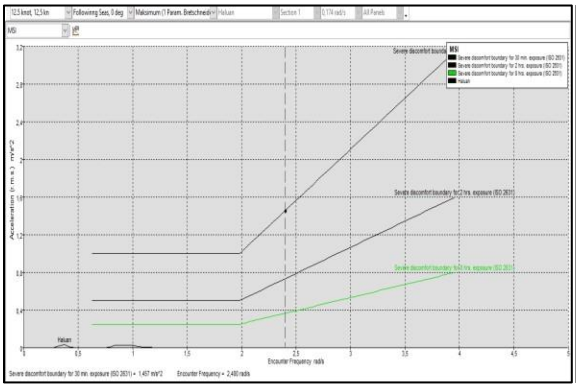

Fig. 4. 0 Degrees following sea conditions.

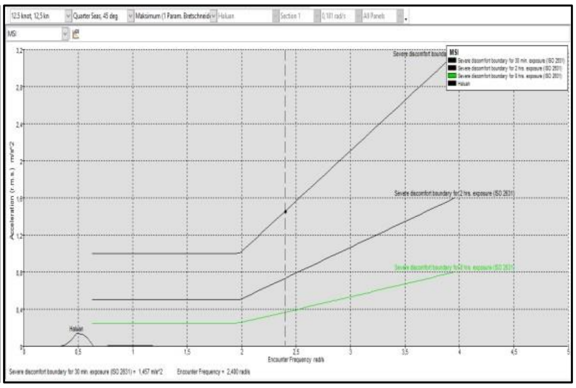

Fig. 5. 45 Degrees quartering sea conditions.

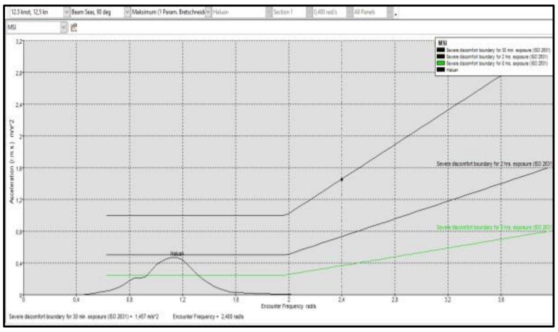

Fig. 6. 90 degrees beam seas conditions.

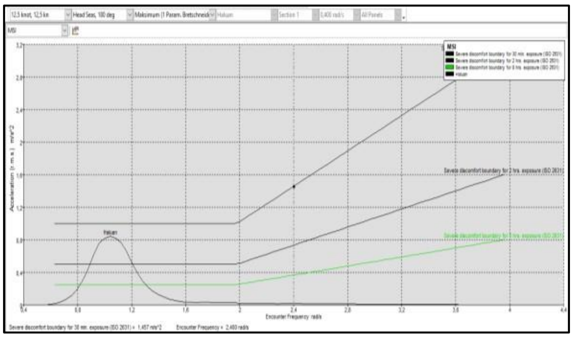

Fig. 7. 180 degrees head seas conditions.

In this condition, the waves coming from the front or 180, the ship in this condition is very unstable, and it is predicted that passengers will experience seasickness after 2 hours of travel. In this condition, the highest Encounter Frequency is 0.35 Hz or 2.4 rad/s with an acceleration of 1.457. Figures 3, 4, 5, and 6 show ROA on the ship's MSI, where ROA is used as a transfer function to determine the effect of sea conditions on ship movement showing the ship's response to the sea is at 90 degrees. In the opposite direction of the wave, MSI occurs in 20% of passengers after 2 hourson the vehicle deck at the bow point.

4. Conclusions

Cargo Ship is any ship that carries goods and cargo from one port to another. This cargo ship has a lot of space, including cargo space, passengers, and space for the crew of the ship itself. The term motion sickness on ships, also known as seasickness, is a symptom of illness caused by the ship's movement, which results in uncomfortable physical symptoms characterized by difficulty breathing, dizziness, nausea, paleness, and vomiting. In severe cases, passengers or crew must be taken to the hospital. When the ship moves and is subjected to wave loads, the ship will respond or move according to the contours as written on the graph in the form of the ship's heading angle and speed. The lines on the polar plot show the ship's response according to its operations so that the operator can determine a comfortable ship operation from the graph. A ship with a speed of 12.5 knots sailing in the Cilacap sea with a wave height reaching an average wave of 2.5 meters occurs MSI of the ship, namely the effect of sea conditions on ship movement, indicating that the ship's response to the sea is at 90 degrees. In the opposite direction of the wave, MSI occurs in 20% of passengers after 2 hours on the vehicle deck at the bow point. At that time, the magnitude of the encounter frequency was 0.35 Hz or 2.4 rad/s.

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