NUMERICAL ANALYSIS SEAKEEPING AND MOTION SICKNESS INCIDENCE (MSI) ON HOSPITAL SHIPS BY ADDING FINS STABILIZER

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ABSTRACT

The development in maritime technology to improve ship performance and operations are growing and diverse. One of the developments carried out is the addition of fin stabilizers to improve ship safety as support for comfort and ships. This research analyzes the effect of variations in the shape of the fin stabilizer on the seakeeping and Comfort Index for Hospital Ships using Maxsurf Modeler software. The parameters used in this research are fins stabilizer Gemini 30, Gemini 50, and modular NR 30. While the variation of ship speed 0, 14, and 18 knots. The direction of the arrival of waves 0, 45, 90, 135, and 180 degrees. Based on data analysis carried out on ship motion, the NR 30 type fin stabilizer is far superior to the others with a maximum value of 4.04- degree roll movement, 0.543- degree pitch movement, and 0.4116 heave acceleration movement. Type NR 30 also has the best comfort on the moderate Motion Sickness Incidence (MSI) Criteria.

Keyword: Hospital Ship, Fin Stabilizer, Seakeeping, Ship Stability, Motion Sickness

Introduction

The territory of our country consists mostly of the sea with islands. Some of these small islands are inhabited and some are not, the long distances and the lack of means of transportation, information, and communication have caused them to lag in all aspects. One of the serious problems is related to access to health services, where it is not easy for the people there to seek treatment at a referral hospital and the additional costs that arise during the treatment process. Some of the serious cases that ended in death were one of them because there was not enough time to reach referral homes in big cities. Of course, the solution to providing a floating hospital or hospital ship is a brilliant idea for better medical services (Abdillah et al., 2020).

As stated by (Suastika et al., 2021), (Niklas & Pruszko, 2019) (Ar Rozi et al., 2021) sea keeping is the ability of the ship to maneuver and survive with the conditions and influences around it in all. The seakeeping should be considered from the beginning design stage. There are six kinds of ship movements at sea, namely surging, swaying, and heaving as translational movements and rolling, pitching, heaving as three rotational movements. However, only three movements can be responded to by the ship, namely heaving, pitching, and rolling. Planning the shape of the ship's hull is the main thing because it determines the ship's performance will sway or even sink in variations in waves. Conditioning of sea keeping generally aims for three things, namely habitability, operation, and safety.
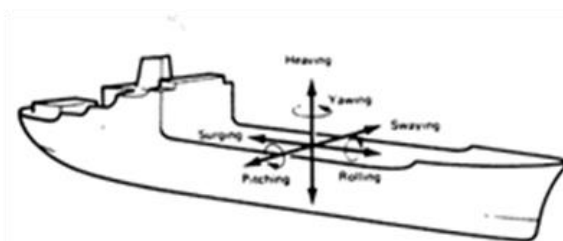

Figure 1. Six degress of movement

A Hospital Ship is a ship used as a relief hospital or a floating hospital to help remote areas that lack hospital facilities in a disaster. The design of the fin stabilizer can affect the ship's motion, fin stabilizer with a certain shape works by accelerating the flow of fluid in the surface area above the fin, causing an area of low pressure on the surface of the fluid. The low-pressure area then reacts with the wave pressure that occurs is to reduce the effect of the waves coming from the bow.

(Aprilia et al., 2018) said that Fin Stabilizer on a ship is used to dampen the rocking motion of the ship from the hull caused by waves, wind, and sea currents by generating a torque around the roll axis (shaking) which is proportional to the opposite direction of the wobble motion received by the hull. As said by (Patil et al., 2019) (Surendran & Kiran, 2007) The fin is driven by a control system and works with the principle of hydrodynamic lift to produce a moment to stabilize the ship's movements caused by the interaction between the waves and the ship. The attached fin stabilizer aims to provide comfort for passengers or ABK (Ship's crew) and the safety of the equipment in increasing the accuracy of weapons systems, for example on warships.

Motion Sickness or seasickness on a ship is an inconvenience experienced by the body because there is no similarity in stimulation between the stimulus, eye and ear labyrinth received by the human brain. Symptoms that arise and are felt physically are difficulty breathing, dizziness, nausea, paleness, and vomiting. One of the causes is the dissimilarity of excitability between the stimulus, the eye and the ear larynx received by the human brain. According (O'Hanlon & McCauley, 1974) the vertical acceleration of the ship

is the main thing that causes seasickness, while rolling and pitching are just give a little influence.

In this research, we analyze variations in the shape of the fin stabilizer on the response of the ship's movement (seakeeping) and the Comfort Index for Hospital Ships using the Maxsurf Modeler software. In this study, we use several variations were carried out, namely three variations of the

type of fin stabilizer, three-ship speeds, and five directions of wave arrival

Methodology

The ship used in this study is a hospital ship with humanitarian purposes as a floating hospital to reach remote islands that may lack health facilities in the disaster. This shipping route covers all Indonesian waters. The following is the technical data of the ship.

Table 1. The data of ship

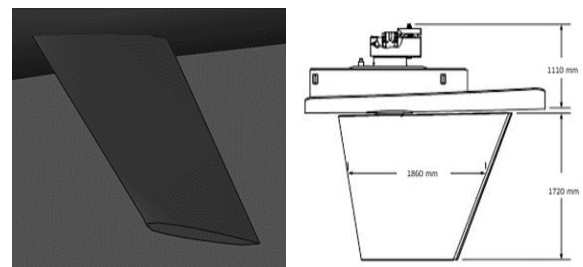| Spesification (units)	Value
LOA (m)	124
LPP (m)	107,45
B (m)	21,8
H (m)	6,7
T (m)	5
Vs (knot)	18
RT (KN)	491

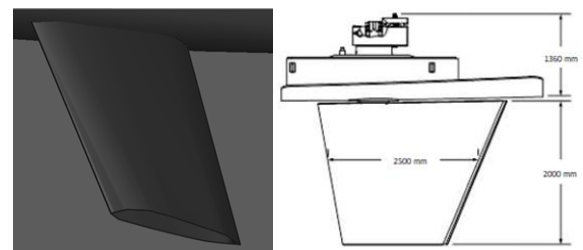**Figure 2.** Gemini 30 Fins modeling and dimensions

Figure 3. Gemini 50 Fins modeling and dimensions
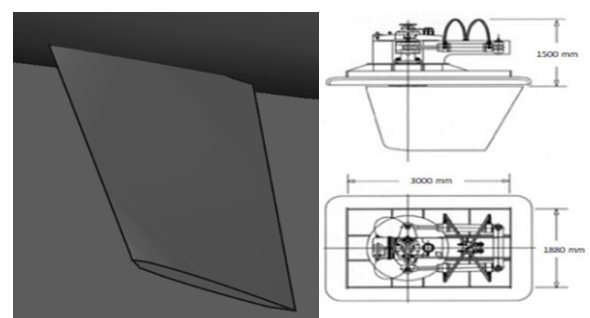

Figure 4. NR 30 modular Fin modeling and dimensions

The ship modeling using Maxsurf Modeller software based on the data obtained using five surface plate water lines then given nodes or points to form the ship into a ship adjusted to the background, namely a ship image from Cadmatic software. The variations used are Gemini 30 fins, Gemini 50 fins, and NR 30 modular fins.

After models have been created and have gone through the model quality check stage, the validated model using Maxsurf Motion software with the following input data:

1. Vessel speed (0, 14,18 knot)

2. Wave Heading (0º, 45º, 90º, 135º, and 180º)

3. Ship condition (normal load)

4. Wave height (Hs = 5 m)

After entering the data, meshing is done with 41 stations and then running using the strip theory method.

The MSI index was calculated in 2 rooms, the emergency room and sterile surgical room. The variation of speed 14 and 18 Knots vessel in variations angle of incidence. The MSI index is used to assess the likelihood of seasickness. The MSI index can be calculated using the following equation (Giron-Sierra et al., 2003)

$$MSI : 100\left[0,5 \pm \mathrm{erf}(\frac{\pm log_{10}\frac{a_v}{g} \pm \mu MSI}{0,4})\right]$$

Result and Discussion

Significant amplitudes on hospital ships were analyzed with three types of fin shapes and variations in speed. This analysis pays attention to the three amplitudes of ship motion that occur, namely roll angle, pitch angle and heave angle.

From the four variations of the fin stabilizer, based on the simulation results under normal load conditions, NR 30 fin stabilizer has the smallest roll angle with a maximum value of 4.043º. NR30 fin stabilizer has the best sea keeping. Meanwhile, for the worst seakeeping of the three forms, namely a ship without a fin stabilizer with a maximum roll angle of 10,108º, exceeding the criteria with a maximum roll angle of 4º.
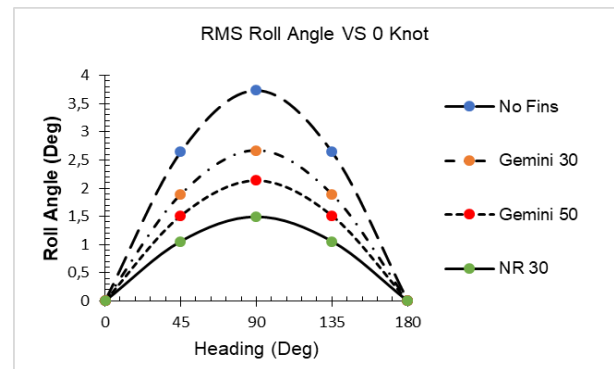
(a)
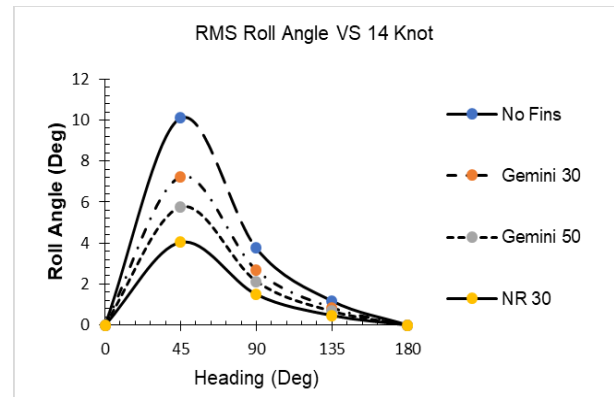
(b)
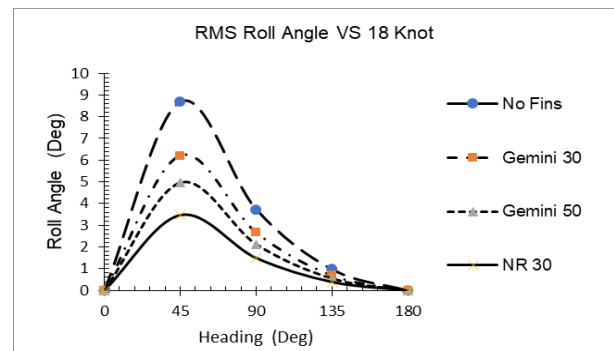
(c)

Figure 5. RMS Roll angle at 0 (a), 14 (b) and 18 knots (c)

In the pitch angle motion, the fin stabilizer with the NR30 form has the smallest value with the value of 0.5432º, the ship without fin stabilizer gets the highest pitch angle from the simulation results, which is 1.148º, this value meets the criteria of the pitch angle, namely of 1.5º.
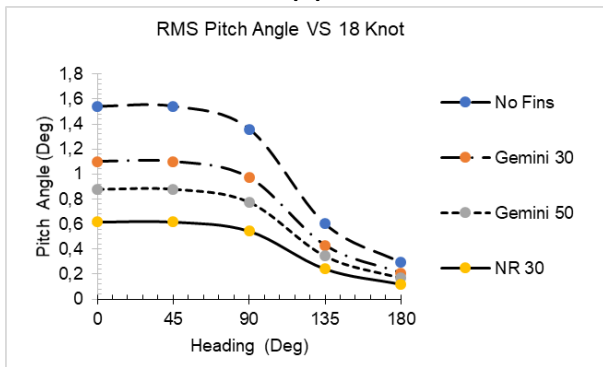
In heave acceleration, the fin stabilizer with the shape of NR30 has the smallest value, while No fins get the highest heave acceleration from the simulation results. The NR 30-shaped fin stabilizer finds very low heave acceleration without any amplification of motion in the 90-degree incident wave direction.
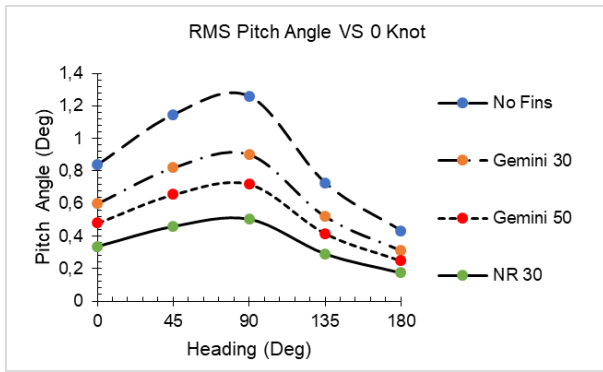
(a)
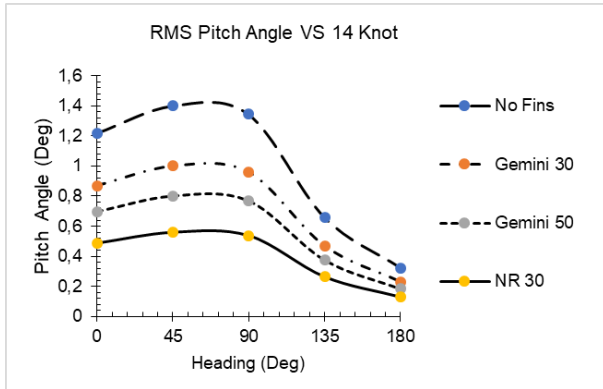
(b)

(c)

Figure 6. RMS Pitch angle at 0 (a), 14 (b) and 18 knots (c)

The response of the significant amplitude of ship movement with the modular fin stabilizer NR 30, in general, has the best or the smallest value compared to the fin stabilizer with other types.
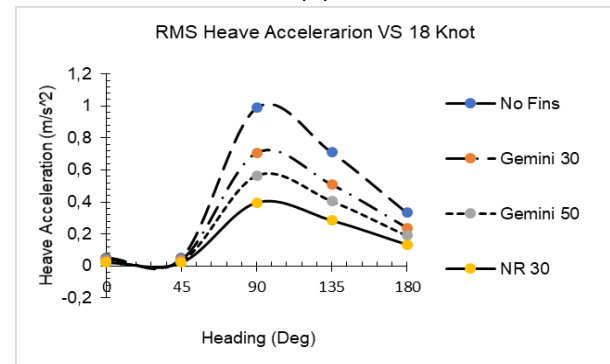
The roll value for the modular fins stabilizer NR 30 is 8.0864 and 20.216 for without fin at heading 45 deg and speed 14 knots, the pitch value for the modular fin stabilizer NR 30 is 0.9849 while for no fins it is 2.814 at heading 45 deg and speeds 14 knots.
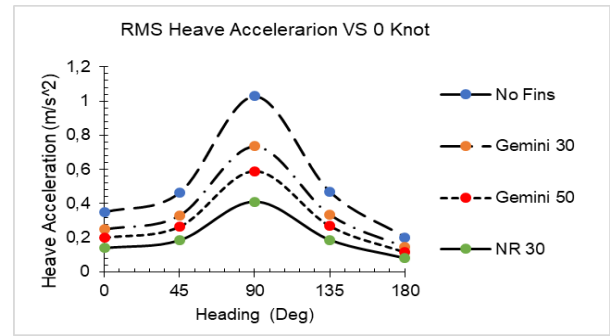
(a)
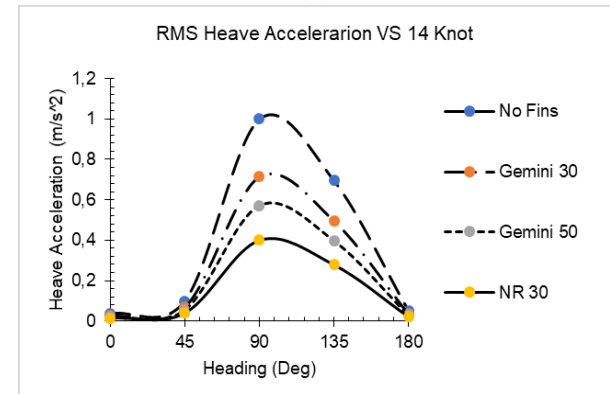
(b)

(c)

Figure 7. RMS Heave angle at 0 (a), 14 (b) and 18 knots (c)

The heave value for the modular fin stabilizer NR 30 is 1.3748, while for without fins it is 3,0282 at heading 90 deg and speed 14 knots.

Based on the above simulation results in the ER and SR, the fin stabilizer NR 30 is better than the others. Ships with fin stabilizer modular NR 30 have the best comfort because the value has a moderate MSI value (scale 0-5). The other stabilizer fins tend to have serious MSI values (scale 5-10). As can be seen in the graph, the fin stabilizer NR 30 has a smaller MSI value in all wave directions.
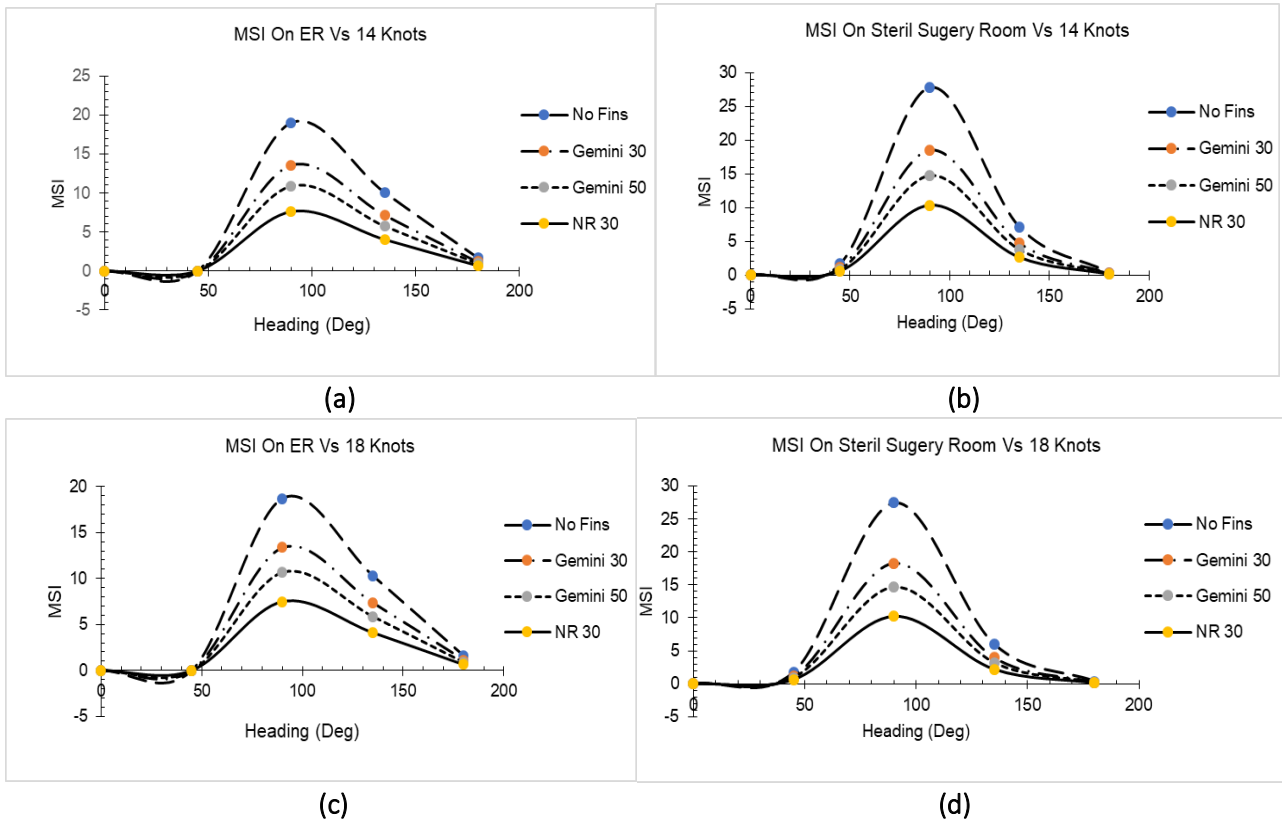
Figure 8. MSI Index ER (a)(b) and Surgery room (c)(d)

Conclusion

This study showed that Fin stabilizer modular NR 30 has the best ship maneuvering because it meets all the criteria. While other types of fin stabilizers have a value that exceeds the maximum criteria, namely the roll movement. The researcher also found that the fin stabilizer NR 30 has a smaller MSI value in all wave directions. Besides, the addition of a fin stabilizer can affect the motion of a ship because it can affect the direction of the waves that hit the side of the ship.

Acknowledgement

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