eISSN: 2721-5717; pISSN: 2747-2124 https://journal.unhas.ac.id/index.php/zonalaut

ZONA LAUT

JOURNAL OF OCEAN SCIENCE AND TECHNOLOGY INNOVATION

Motion Sickness Incidence (Msi) Study on Patrol Vessels (Kal-28) Catamaran

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Abstract

On a Ship seasickness (motion sickness) is a condition caused by the movement of a ship that results in dizziness, nausea, and vomiting. The Motion Sickness Incidence (MSI) Study on the Patrol Catamaran (KAL-28) aims to evaluate the comfort level of passengers and the safety of the ship's crew during operations, following the ISO 2631/1997 standards. The evaluation is conducted on the vertical acceleration response of the ship under various wave conditions, speeds, and wave directions. Mapping is performed in various areas of the ship, including the deck, navigation room, and engine room, considering wave heights of 0.875 meters and 2 meters at speeds of 15 knots, 22.5 knots, and 30 knots. The research results indicate that at a speed of 15 knots, the deck area, navigation room, and engine room meet the criteria from comfortable to somewhat uncomfortable. However, at speeds of 22.5 knots and 30 knots, these areas are rated as somewhat uncomfortable to very uncomfortable. This study emphasizes the need for ship design that considers both passenger comfort and safety, especially for patrol catamarans.

Keywords: Motion Sickness Incidence, MSI index, patrol vessel, catamaran.

1. INTRODUCTION

In the fields of transportation, defense and maritime economy, ships are a very important piece of infrastructure. In designing the ship, it is necessary to consider comfort and safety when the ship is operating at sea. One of the factors that influences the comfort and safety aspects of a ship is the shape of the ship's hull, where there are two types of ship hull shape based on the number of hulls: monohull and multihull. According to Budiman et al. (2022) catamarans are a form of multihull that has a better level of comfort compared to the monohull hull form [1]. Movement on the ship is caused by internal and external factors, but the dominant factor is external factors which greatly influence it, one of which is large waves [2]. So the comfort and safety of a ship when operating against external forces (waves & wind) is influenced by the shape of the ship's hull. The large waves cause movement in the ship which results in symptoms of pain and discomfort such as nausea, dizziness, paleness and vomiting [3]. For crew members, this movement is known as motion sickness. Vertical ship movements cause higher motion sickness compared to rolling and pitching movements [4].

According to Molland et al. (2011) Patrol vessels are vessels whose function is to secure and guard Indonesia's territorial waters [5]. Considering that Indonesia is a maritime country consisting of many islands with a land area of 1,913,578.68 km2 and a water area of 6,653,341.439 km2. With the sea area being wider than the land area, to protect the territory, a patrol boat is needed which functions as a patrol facility in the waters, with high speed, good maneuvers and maneuvers so that the crew can work optimally and in accordance with their function, namely protect maritime areas. According to Piscopo et al. (2015) a catamaran type ship is a multi-hull (double hull) type ship which is good for patrolling Indonesian waters, apart from that it is a type of ship which has good maneuverability to operate, has good speed and maneuverability [6]. To get an idea of how comfortable the patrol boat is, a motion sickness study was carried out on the patrol boat.

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According to the MSI (Motion Sickness Incidence) standard, determining vertical motion acceleration depends on position, so under these conditions of course each position/area on the ship has a different MSI index. To find out this, mapping was carried out in each area of the ship to find the ideal position for the crew, with the aim of finding out the areas that had the highest and lowest MSI levels. Mapping is carried out by calculating the MSI index in the main deck area, navigation room and engine room, with the direction of the wave coming Head seas (180°), Bow seas (135°), Beam Seas (90°), Quarter Seas (45°), Following Seas (0°), at speeds of 15, 22.5 and 30 knots.

2. RESEARCH METHOD

2.1. Ship KAL – 28

The object of research in the Motion Sickness Incidence study is the KAL-28 patrol ship owned by the Indonesian National Army (TNI), in this case the Navy (AL), which will be operated by the Banyuwangi, Nias and TNI Main Bases. AL-II (Lantamal-II) Padang. The KAL-28 Patrol Ship has the main dimensions in table 1. and the shape of the ship's hull is as depicted in figure 1.

Table 1. Main Dimensions of Patrol Vessel KAL-28

Main Size	**Unit**
LWL	30 m
Height (H)	2.65 m
Sarat (T)	1.5 m
Speed(Vs)	30 m
Volume Displacement	74.673 m^3

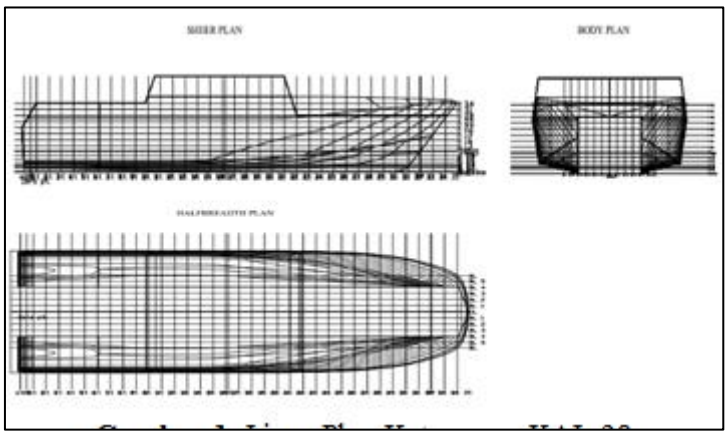

Figure 1. Lines Plan of Catamaran KAL-28

2.2. Motion Sickness Incidence

Menurut Griffin (1990) Motion sickness incidence adalah istilah standar rasa tidak nyaman dan rasa muntah yang disebabkan oleh berbagai kondisi gerakan seperti di kapal, pesawat, mobil, dan di elevator/lift, dalam stui gejala tipe lain seperti menguap, sulit bernapas, mengantuk, sakit kepala, dari akumulasi gejala tersebut menghasilkan rasa muntah [7]. Penelitian telah dilakukan Mc Caunley dan O' Hanlon (1974) di kapal dan dilaboratorium dilakukan untuk menentukan pengaruh gerakan kapal (roll, heave, pitch). meneliti hubungan frekuensi gerakan percepatan vertikal dengan motion sickness incidence [8]. MSI index pada umumnya digunakan untuk menilai kemungkinan terjadinya mabuk laut. Indek MSI dihitung menggunakan persamaan (1) sedangkan Parameter MSI dihitung dari persamaan (2) berikut ini;

$$\mathrm{MSI}(\omega_{e\,\mathrm{centre}}) = \int_{\omega_{e\,1}}^{\omega_{e\,2}} S_{\mathrm{vert\,accel}}(\omega e)\,d\omega e \quad (1)$$

$$\mu\mathrm{MSI} = -0{,}819 + 2{,}32\,(\log_{10}\omega_e)^2 \quad (2)$$

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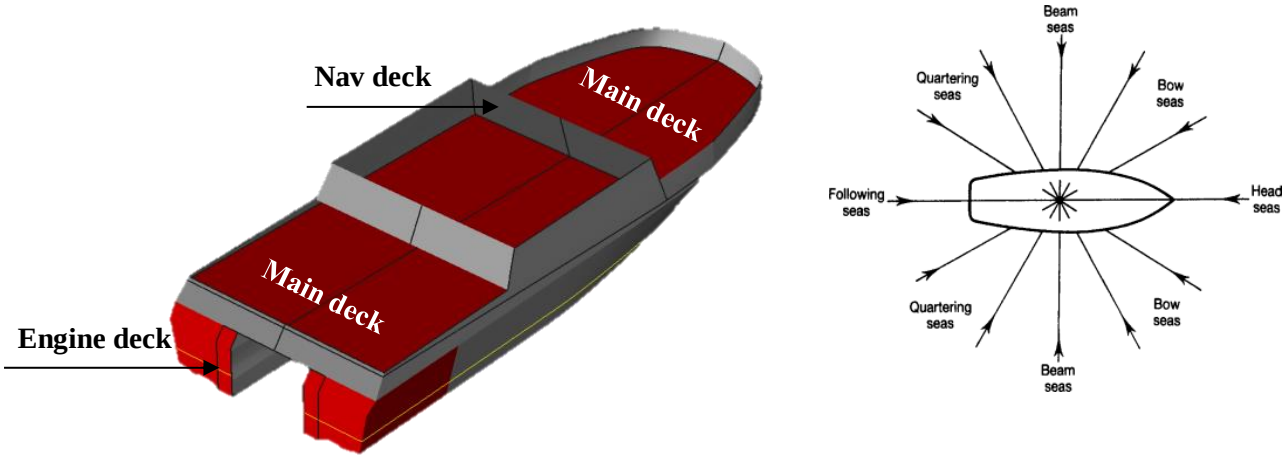
Where MSI is the MSI Index, while S_(vert accel) is the average vertical acceleration at a predetermined point or location, then $\int_{\omega_{e\,1}}^{\omega_{e\,2}}$ is the interval frequency, and ωe is the frequency of the impact wave (rad/sec). In this research, Maxsurf software was used to analyze and determine the position of a location. This position is known as a remote location which is a measurement point for the level of seasickness or motion sickness which refers to the vertical acceleration parameter in table 2.

Table 2. Comfort level

Habitability acceleration (RMS)	Criteria	Colour
< 0.315 ms^{-2}	Comfortable	
0.315 - 0.63 ms^{-2}	A little uncomfortable	
0.63 – 1.0 ms^{-2}	Quite uncomfortable	
1.0 – 1.6 ms^{-2}	Uncomfortable	
1.6 – 2.5 ms^{-2}	Very uncomfortable	
> 2.5 ms^{-2}	Not safe	

Simulation on Maxsurf Motion to find out the MSI index, inputting the measurement location or remote location. The KAL 28 patrol ship has 3 decks where, in this research, 3 locations were determined, namely the main deck, navigation room and engine room as in Figure 2 (a). Next determine the speed of the ship, and the angle of direction of the wave. In this study, speeds of 15, 22.5, and 30 knots were used and wave direction angles were Head Seas (180°), Bow Seas (135°), Beam Seas (90°), Quarter Seas (45°), and Following Seas (0°) as in figure 2 (b). Using the JONSWAP SPECTRUM wave spectrum.



(a) (b)

Figure 2. Remote location point

3. RESULT AND DISCUSSION

3.1. Model of the KAL-28 Catamaran Patrol Ship

From the existing data, a lines plan was created in AutoCAD, after which it was imported into Maxsurf Modeler Advanced to model the hull of the KAL-28 catamaran. For modeling results as in Figure 3.

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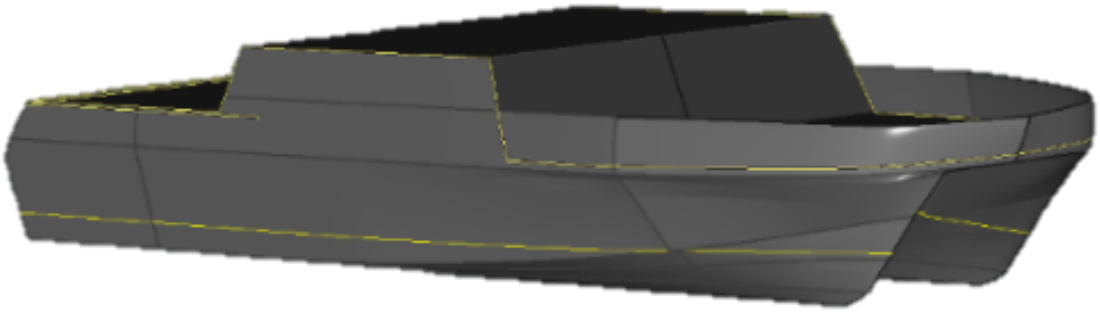


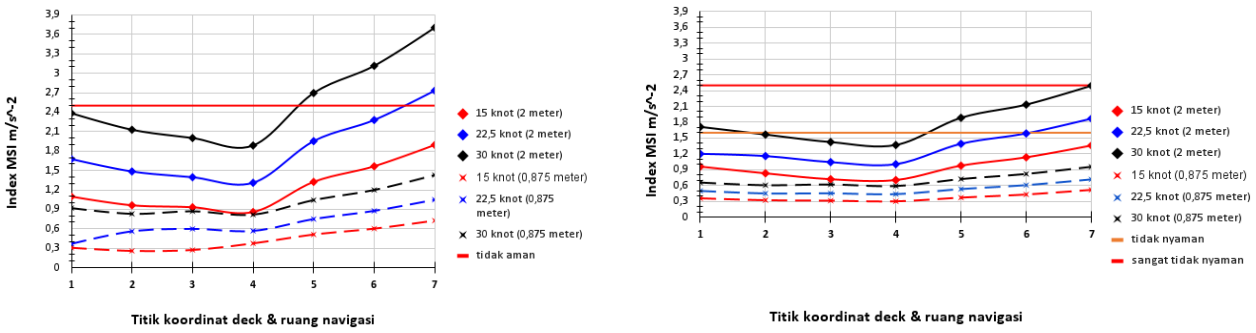
Figure 3. Model of the KAL-28 catamaran ship

3.2. Motion Sickness Incidence simulation results

At this stage, analysis is carried out by simulating a model using Maxsurf Motion in the main deck area, navigation room and engine room with ship speeds of 15, 22.5 and 30 knots and wave direction angles Head seas (180°), bow seas (135°), Beam Seas (90°), Quarter Seas (45°), and Following Seas (0°) and wave heights of 0.875 meters (marked with a dotted line) and 2 meters (marked with a continuous line).

3.2.1. Main deck & navigation room Head Seas (180^{o})

In Figure 4 (a) you can see a graph of motion sickness incidence in the direction of head seas wave arrival (1800) where the value of motion sickness incidence increases when the ship speed increases and there is a significant increase when the wave height is 2 meters. Where the highest MSI value at a wave height of 0.875 meters, namely 1.429 m/s-2, occurs when the ship speed is 30 knots, which is included in the uncomfortable criteria, while at a wave height of 2 meters, the highest MSI value is 3.706 m/s-2 at a speed of 30 knots. and it can be seen on the graph that coordinates 5, 6 and 7 have crossed the unsafe limit line for crew members.



(a) (b)

Figure 4. MSI value graph ((a) head seas wave direction (1800), (b) bow seas wave direction (135^{0})

3.2.2. Bow Seas main deck & navigation room (135^{o})

In Figure 4 (b) you can see a graph of motion sickness incidence in the direction of the bow seas wave (1350) where the value of motion sickness incidence increases when the ship speed increases and there is a significant increase when the wave height is 2 meters. Where the highest MSI value at a wave height of 0.875 meters, namely 0.955 m/s-2, occurs when the ship speed is 30 knots, which falls within the criteria of being quite uncomfortable, while at a wave height of 2 meters the highest MSI value is 2.498 m/s-2 at a speed of 30 knots and can be seen on the graph at coordinates 5, 6, and 7 have crossed the uncomfortable limit line for the crew.

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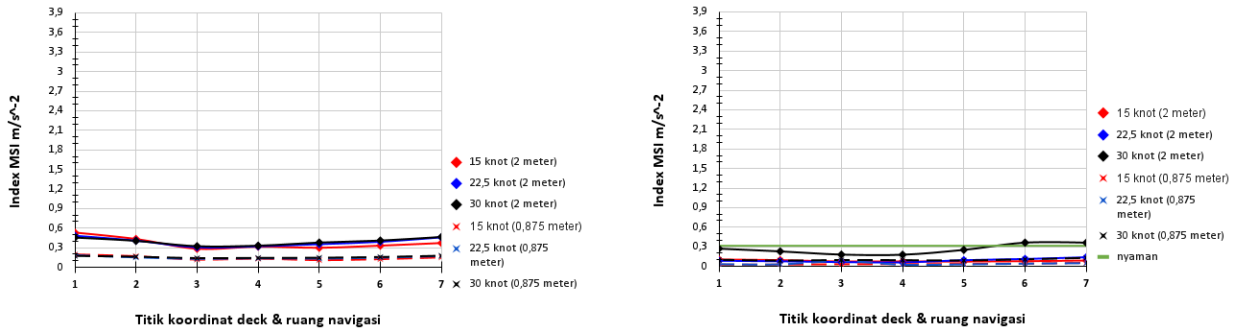
3.2.3. Main deck & navigation room Beam Seas (90)

In Figure 5 (a) you can see the graph of motion sickness incidence in the direction of beam seas wave arrival (90o) at a stable wave height of 0.875 meters where the average MSI value is below 0.315 m/s-2 which is classified as a comfortable area for crew members, and in When the wave height is 2 meters, there is an increase where the average MSI value exceeds the comfort line so that it falls into the criteria of being slightly uncomfortable for the crew.



(a) (b)

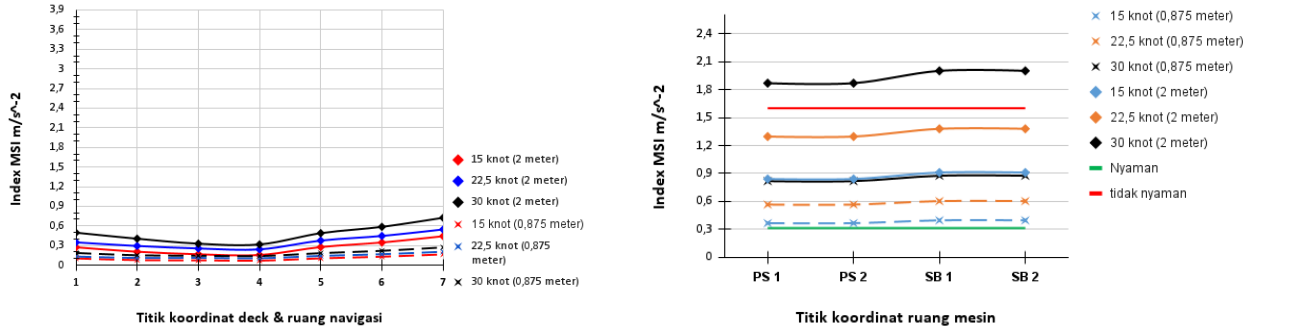
Figure 5. Graph of MSI values (a) beam seas wave direction (90^0); (b) quater seas wave direction (45^0)

3.2.4. Main deck & navigation room Quarter seas (45^0)

In Figure 5 (a) you can see a graph of motion sickness incidence in the direction of quarter seas wave arrival (45o) at a stable wave height of 0.875 meters where the average MSI value is below 0.315 m/s-2 which is classified as a comfortable area for crew members, and in When the wave height was 2 meters, there was an increase in coordinates 5, 6 and 7, which crossed the comfort line so that it fell into the criteria of being slightly uncomfortable for the crew.

3.2.5. Main deck & navigation room Follow seas (0^o)

In Figure 6 (a) you can see a graph of motion sickness incidence in the direction of follow seas wave arrival (0o) at a stable wave height of 0.875 meters where the average MSI value is below 0.315 m/s-2 which is classified as a comfortable area for crew members, and in When the wave height was 2 meters, there was an increase in coordinates 5, 6 and 7, which crossed the comfort line so that it fell into the criteria of being slightly uncomfortable for the crew.



(a) (b)

Figure 6. Graph of MSI values (a) follow seas wave direction (00), (b) head seas wave direction (180^0)

3.2.6. Engine room head seas angle (180^o)

You can see the graph of motion sickness incidence in the direction of the head seas wave (1800) Figure 6 (b) where the value of motion sickness incidence increases when the ship speed increases and there is a significant increase when the wave height is 2 meters. Where the highest MSI value at a wave height of 0.875 meters, namely 0.876 m/s-2, occurs when the ship speed is 30 knots, which falls within the criteria of

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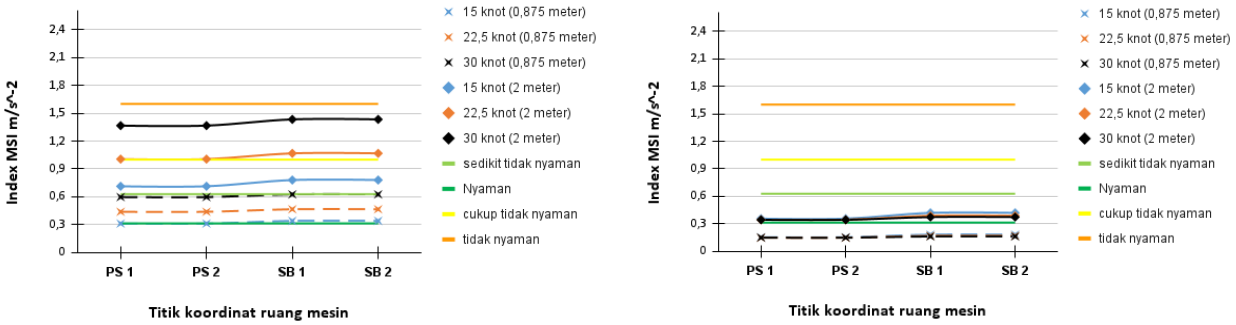
being quite uncomfortable, while at a wave height of 2 meters the highest MSI value is 2 m/s-2 at a speed of 30 knots and can be seen on the graph are above the line very uncomfortable.

3.2.7. Machine room bow seas angle (135^o)

You can see the graph of motion sickness incidence in the direction of the bow seas wave (1350) Figure 7 (a) where the value of motion sickness incidence increases when the ship speed increases and there is a significant increase when the wave height is 2 meters. Where the highest MSI value at a wave height of 0.875 meters, namely 0.627 m/s-2, occurs when the ship speed is 30 knots, which falls within the criteria of being quite uncomfortable, while at a wave height of 2 meters the highest MSI value is 1.433 m/s-2 at a speed of 30 knots and can be seen to be below the line which is uncomfortable for the crew.



(a) (b)

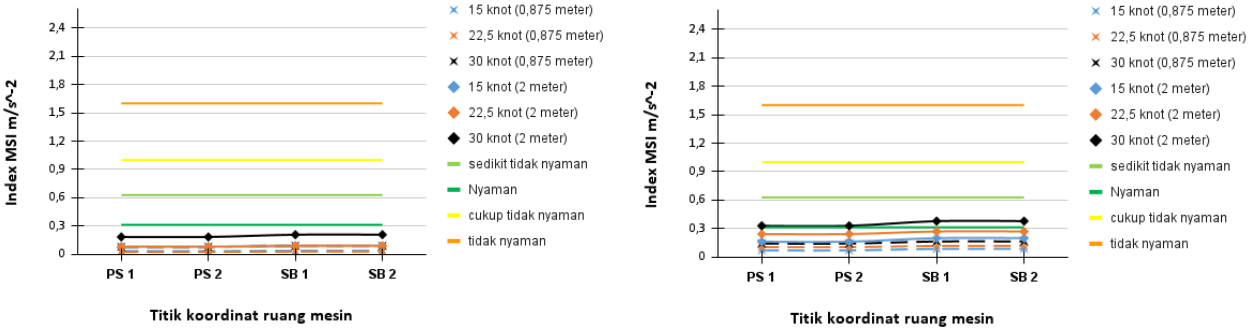
Figure 7. MSI value graph (a) bow seas wave direction (135^0), (b) beam seas wave direction (90^0)

3.2.8. Machine room beam seas angle (90^o)

It can be seen from the graph in Figure 7 (b) that at a wave of 0.875 meters it is stable where the average MSI value is below 0.315 m/s-2 which is considered a comfortable area for crew members, and when the wave height is 2 meters there is an increase where the average The MSI value exceeds the comfort line so it falls within the criteria of being slightly uncomfortable for crew members.

3.2.9. Engine room quarter seas angle (45^o)

It can be seen from the graph in Figure 8 (b) that at a wave of 0.875 meters it is stable below the comfort line where the average MSI value, namely below 0.315 m/s-2, is classified as a comfortable area for crew members, whereas at a wave of 2 meters the MSI value crosses the line. comfortable, which is said to be a little uncomfortable for crew members.



(a) (b)

Figure 8. MSI value graph (a) quarter seas wave direction (45^0), (b) follow seas wave direction (0^0)

3.2.10. Machine room follow seas angle (0^o)

It can be seen from the graph in Figure 8 (b) that at a wave of 0.875 meters it is stable below the comfort line where the average MSI value, namely below 0.315 m/s-2, is classified as a comfortable area for crew

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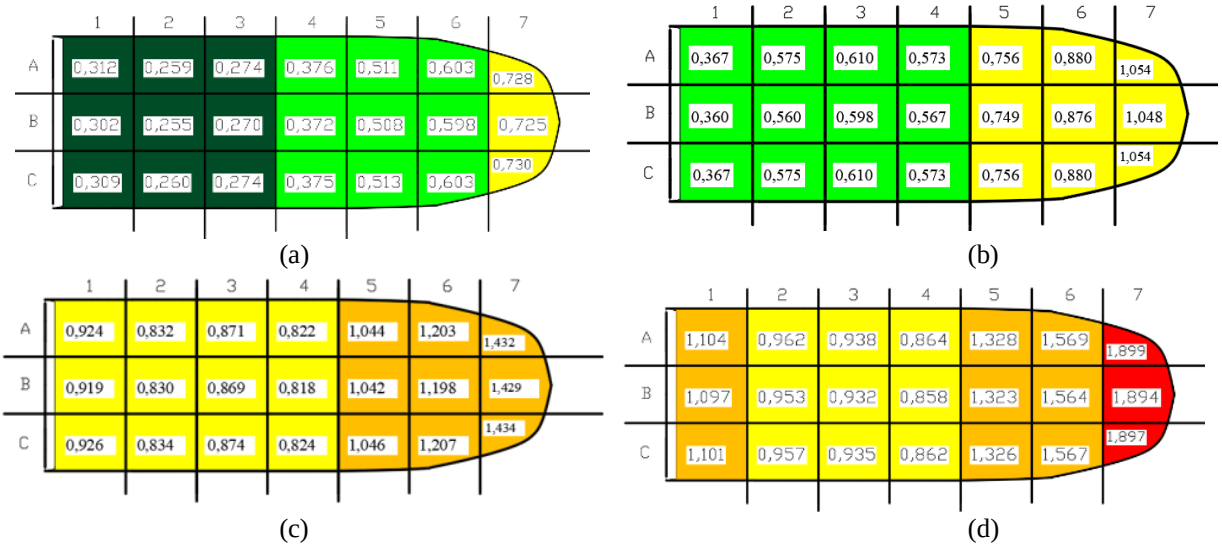
members, whereas at a wave of 2 meters the MSI value crosses the line. comfortable, which is said to be a little uncomfortable for crew members.

3.3. Discussion of MSI results

The table above shows the MSI values at the remote location measurement position when the ship is hit by waves with a height of 0.875 meters and 2 meters at ship speeds of 15 knots, 22.5 knots and 30 knots. From the table above, it can be seen that the MSI value is the highest (indicated by the dark red table or Extremely uncomfortable) and the MSI value is the lowest (indicated by the dark green color or not uncomfortable). Next, the table will be detailed again in the form of mapping of measurement areas or positions in accordance with the ISO 2631/1997 habitability acceleration classification in (table 2). In mapping there are 7 coordinates, coordinates 1, 2, 5, 6 and 7 are the deck area, while coordinates 3 and 4 are the navigation space area. The engine room is marked with coordinates PS (port side) 1 and 2 and SB (starboard side) 1 and 2. The coordinate numbers are divided into 2 parts, where the left side is a wave of 0.875 meters and the right side is a wave of 2 meters.

3.3.1. Deck area mapping

In Figure 9, when the direction of the wave head seas is 180o, at a speed of 15 knots at coordinate points 1 and 2 at a wave of 0.875 marked with a light green color it is categorized as slightly uncomfortable, when the 2 meter wave changes to orange it is categorized as uncomfortable. Coordinates 3 and 4 at waves of 0.875 and 2 meters are marked in dark green with comfort criteria. At coordinates 5,6, and 7 at a wave of 0.875 meters it is marked in yellow with the criteria being quite uncomfortable.
At a speed of 22.5 knots at coordinate point 1 it is marked in light green when the 0.875 meter wave is labeled as slightly uncomfortable, after being hit by a 2 meter wave it changes to orange with the criteria of being uncomfortable. At coordinate 2 it is marked in yellow when a wave of 0.875 meters is said to be quite uncomfortable, when a wave of 2 meters is considered to be uncomfortable. At coordinates 3 and 4 it is marked in light green when the 0.875 meter wave is labeled as slightly uncomfortable, when the 2 meter wave changes color to red with the criteria being very uncomfortable. at coordinate 5 it is marked in yellow when the wave is 0.875 meters with the criteria being quite uncomfortable, when the wave is 2 meters it turns red with the criteria being very uncomfortable. at coordinates 6 and 7 it is marked in orange when the wave is 0.875 meters with the criteria of being uncomfortable, when the wave is 2 meters it becomes dark red with the criteria of being unsafe.
At a speed of 30 knots coordinates 1,2,3,4 and 5 are marked in orange when the wave is 0.875 meters with uncomfortable criteria, while coordinates 6 and 7 are marked in red with uncomfortable criteria. when the wave is 2 meters all areas are marked in dark red with unsafe criteria,



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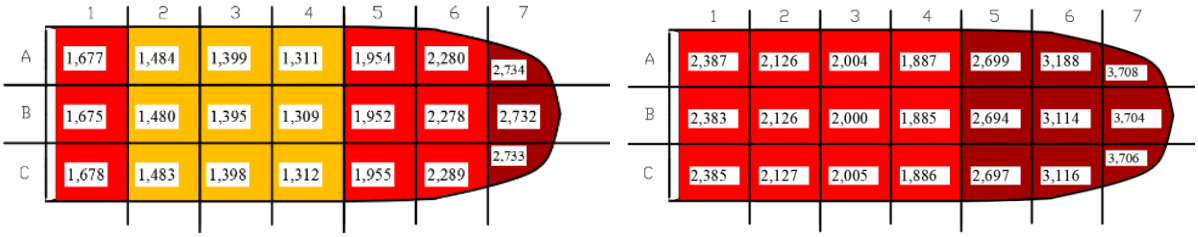


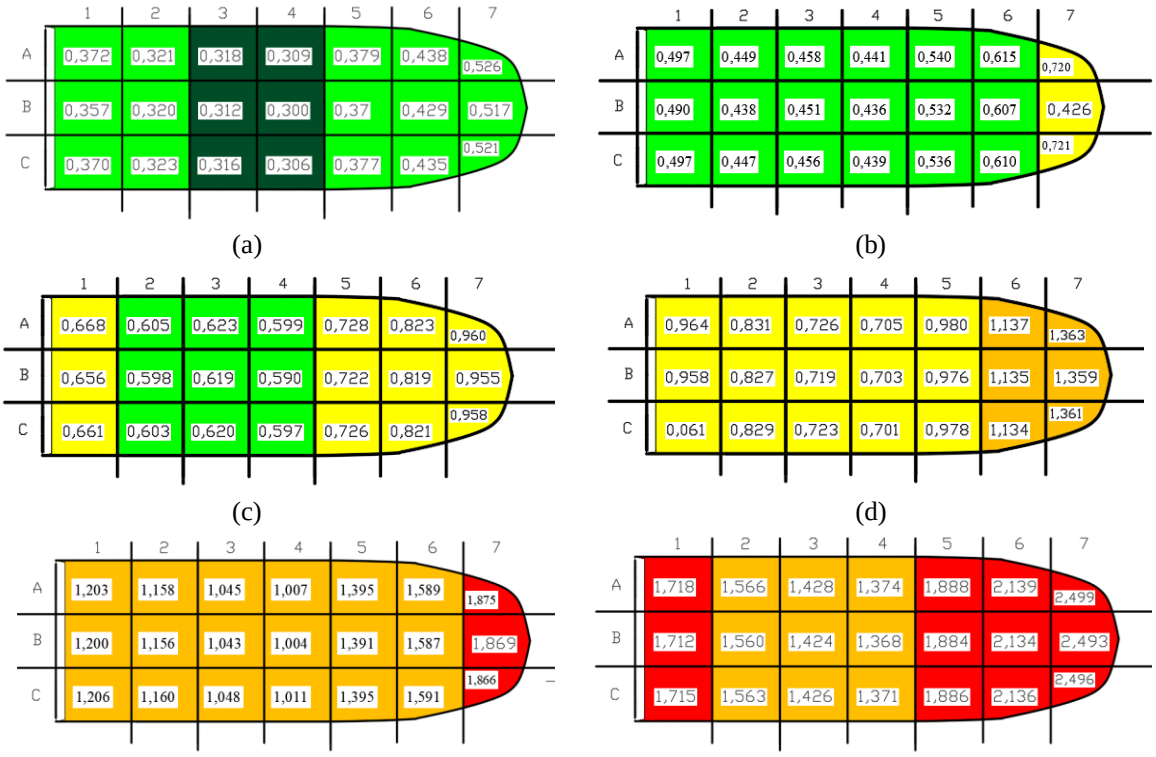
(e) (f)

Figure 9. Mapping when the head seas wave direction is 180o (a). 15 knots (0.875 meters), (b). 22.5 knots (0.875 meters), (c). 30 knots (0.875 meters) (d). 15 knots (2 meters), (e). 22.5 knots (2 meters), (f). 30 knots (2 meters))

In Figure 10, when the direction of the bow seas wave is 135o, at a speed of 15 knots coordinates 1 and 2 are marked with a light green color which is considered to be slightly uncomfortable, when the wave is 2 meters it becomes orange (uncomfortable), at coordinates 3 and 4 marked in dark green with a comfortable classification, when the 2 meter wave changes to yellow (quite uncomfortable), at coordinates 5 and 6 when the wave is 0.875 meters it is marked in light green with the criterion of being slightly uncomfortable, when the 2 meter wave changes color orange becomes uncomfortable, at coordinate 7 when the wave is 0.875 meters it is marked yellow with the criteria being quite uncomfortable, when the wave is 2 meters it becomes orange (uncomfortable).

At a speed of 22.5 knots at coordinates 1, 2, 3, and 4 marked in light green when the waves are 0.875 meters which are classified as slightly uncomfortable, while coordinates 5, 6 and 7 are marked in yellow which are categorized as quite uncomfortable . Meanwhile, when the wave is 2 meters, all areas are marked with orange which is categorized as uncomfortable.

At a speed of 30 knots at coordinates 1, 2, 3, 4, and 5 at waves of 0.875 meters it is marked with the color yellow which is characterized as quite uncomfortable, while at coordinates 6 and 7 it is marked with the color orage with the criterion of being uncomfortable. when the wave is 2 meters, all areas are colored red with the criteria being very uncomfortable.



(a) (b)

(c) (d)

(e) (f)

Figure 10. Mapping when the bow seas wave direction is 135o (a). 15 knots (0.875 meters), (b). 22.5 knots (0.875 meters), (c). 30 knots (0.875 meters). (d). 15 knots (2 meters), (e). 22.5 knots (2 meters), (f). 30 knots (2 meters)

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In Figure 11, when the beam seas wave direction is 90o, at a speed of 15 knots when the waves are 0.875 meters, all areas on the ship are marked in dark green which is considered comfortable, when the waves are 2 meters at coordinates 1, 2, 6, and 7 are marked with light green where the criteria are slightly uncomfortable, while coordinates 3, 4, and 5 are comfortable criteria.
At a speed of 22.5 knots, when the waves are 0.875 meters, all areas do not experience a change in color, which is marked with dark green with the criterion of being comfortable, whereas when the waves are 2 meters at coordinates 5, 6 and 7, the color changes to light green, with the criteria being slightly uncomfortable. .
At a speed of 30 knots when the waves are 0.875 meters, all areas are marked in dark green with a comfortable classification, and when the waves are 2 meters they change to light green with the criteria being slightly uncomfortable.

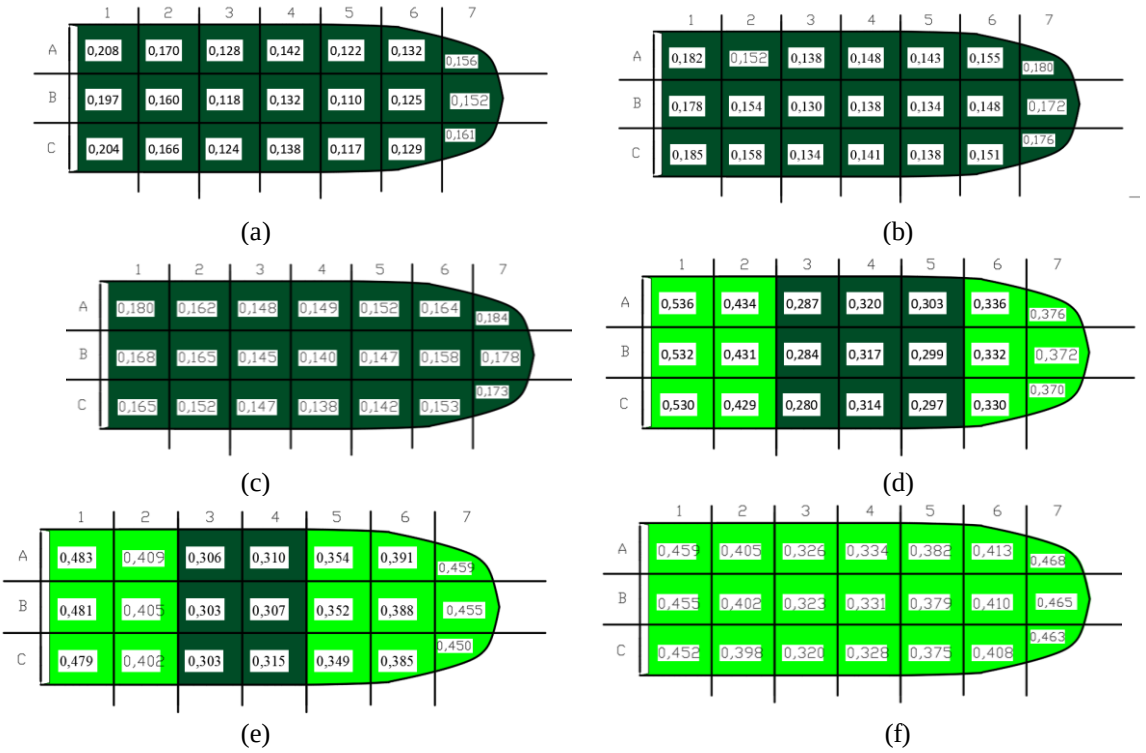
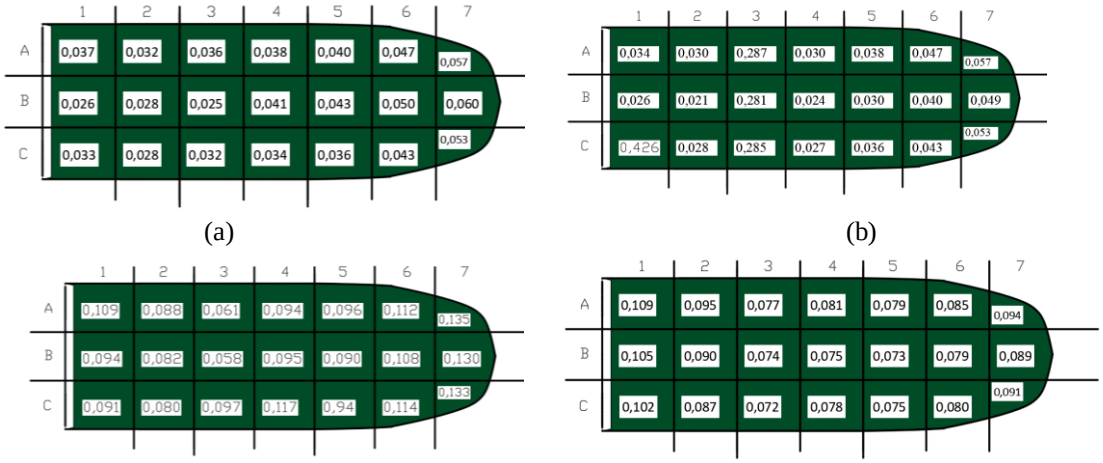


Figure 11. Mapping wave direction beam seas 90o(a). 15 knot (0.875 meters), (b). 22.5 knot (0.875 meters), (c). 30 knot (0.875 meters), (d). 15 knot (2 meters), (e). 22.5 knot (2 meters), (f). 30 knot (2 meters)

In Figure 12, the quarter seas wave angle is 45o when the waves are 0.875 meters and 2 meters at speeds of 15, 22.5 and 30 knots. All areas do not experience color changes and are considered comfortable for crew members.



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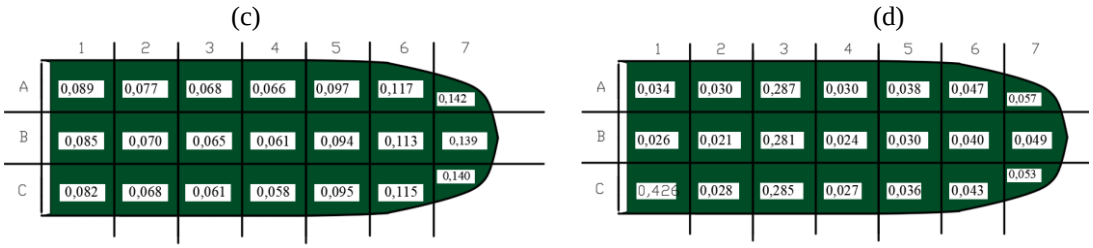


Figure 12. Mapping wave direction quarter seas 45o (a). 15 knot (0.875 meters), (b). 22.5 knot (0.875 meters), (c). 30 knot (0.875 meters), (d). 15 knot (2 meters), (e). 22.5 knot (2 meters), (f). 30 knot (2 meters)

In figure 13, the follow seas wave angle is 0o when the waves are 0.875 meters and 2 meters at speeds of 15, 22.5 and 30 knots, all areas do not experience color changes and are considered comfortable for crew members.

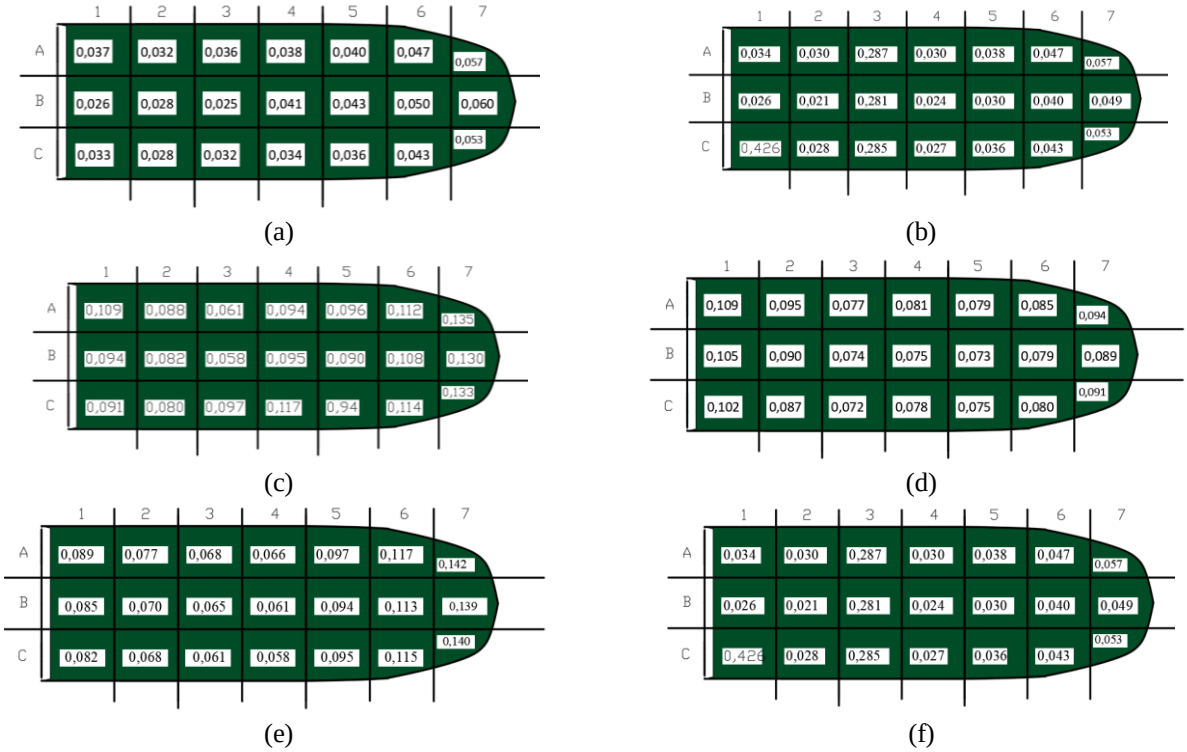
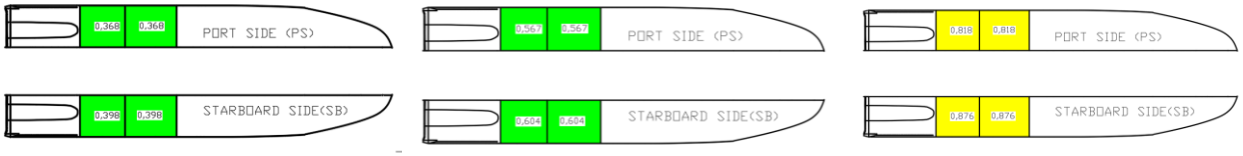


Figure 13. Mapping wave direction follow seas 0^{o} (a). 15 knot (0,875 meter), (b). 22,5 knot (0,875 meter), (c). 30 knot (0,875 meter) (d). 15 knot (2 meter), (e). 22,5 knot (2 meter), (f). 30 knot (2 meter)

3.3.2. Mapping the engine room area

In Figure 14, the mapping of the engine room area when the direction of the head seas wave is 180o, at a speed of 15 knots at coordinates PS and SB 1 and 2 is marked with light green which is categorized as slightly uncomfortable, when the wave is 2 meters it changes to orange which is categorized as uncomfortable. At a speed of 22.5 knots the coordinates of PS and SB 1 and 2 when the wave is 0.875 meters become yellow which is categorized as quite uncomfortable, and when the wave is 2 meters it becomes red which is categorized as very uncomfortable. When the speed is 30 knots, PS and SB 1 and 2 coordinates, when the wave is 0.875 meters, it becomes orange, which is considered uncomfortable, when the wave is 2 meters, it becomes red, which is categorized as very uncomfortable for the crew..



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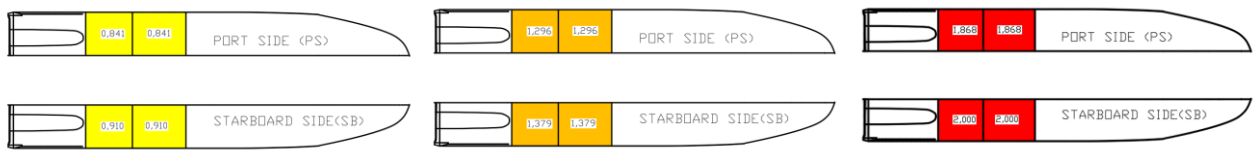
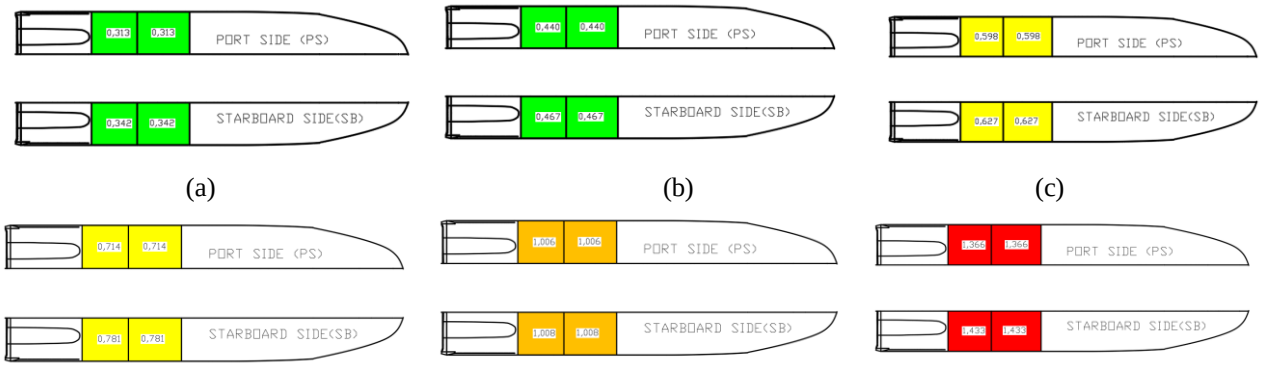


(a) (b) (c)

(d) (e) (f)

Figure 14. Mapping wave direction head seas 180^{o} (a). 15 knot (0,875 meter), (b). 22,5 knot (0,875 meter), (c). 30 knot (0,875 meter) (d). 15 knot (2 meter), (e). 22,5 knot (2 meter), (f). 30 knot (2 meter)

In Figure 15, when the direction of the bow seas wave is 135o, at a speed of 15 knots at coordinates PS and SB 1 and 2 marked with light green it is categorized as slightly uncomfortable, when the wave is 2 meters yellow it is categorized as quite uncomfortable. At a speed of 22.5 knots, PS and SB 1 and 2 coordinates, when the wave was 0.875 meters, were still light green, which was categorized as slightly uncomfortable, and when the wave was 2 meters, it became orange, which was categorized as uncomfortable. A speed of 30 knots for PS and SB 1 and 2 coordinates when waves of 0.875 meters are marked yellow is categorized as quite uncomfortable, when waves of 2 meters are colored red which is categorized as very uncomfortable.

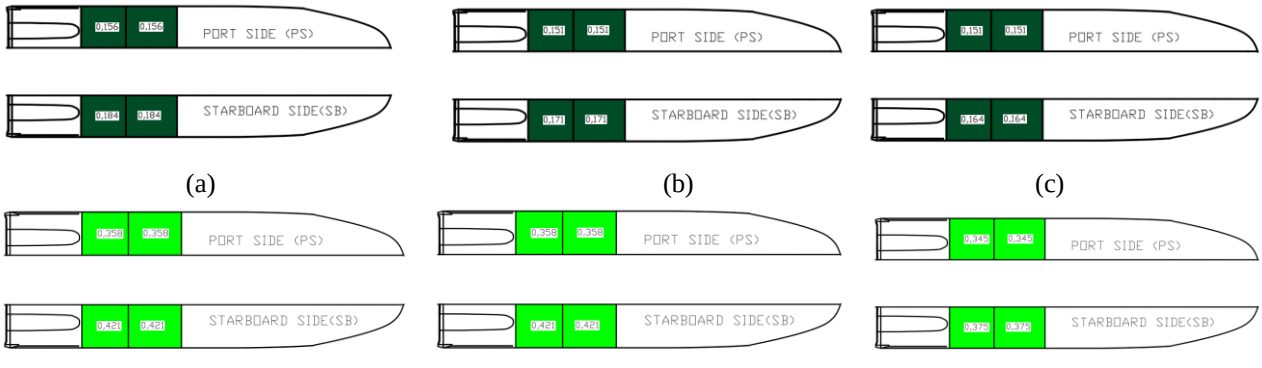


(a) (b) (c)

(d) (e) (f)

Figure 15. Mapping wave direction bow seas 135^{o} (a). 15 knot (0,875 meter), (b). 22,5 knot (0,875 meter), (c). 30 knot (0,875 meter) (d). 15 knot (2 meter), (e). 22,5 knot (2 meter), (f). 30 knot (2 meter)

Figure 16, when the direction of the wave beam seas is 90o, when the speed is 15, 22.5, and 30 knots, the wave is 0.875 meters, all areas in the engine room are marked in dark green which is considered comfortable. when the wave is 2 meters, all areas marked with light green are categorized as slightly uncomfortable.



(a) (b) (c)

(d) (e) (f)

Figure 16. Mapping wave direction beam seas 90^{o} (a). 15 knot (0,875 meter), (b). 22,5 knot (0,875 meter), (c). 30 knot (0,875 meter) (d). 15 knot (2 meter), (e). 22,5 knot (2 meter), (f). 30 knot (2 meter)

Figure 17 When the direction of the quarter seas wave is 45o, at waves of 0.875 and 2 meters all areas in the engine room are dark green which is considered comfortable for crew members

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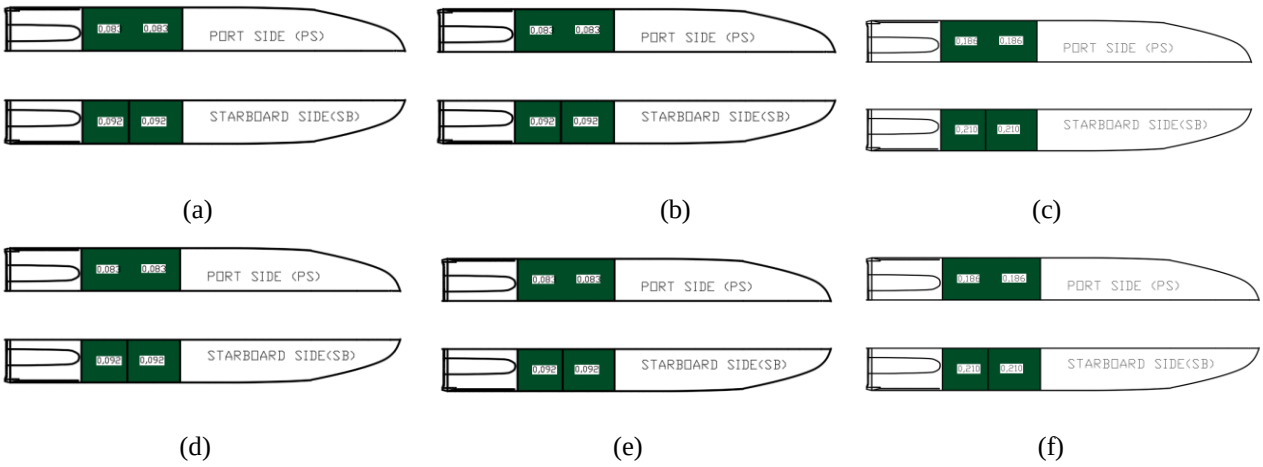

Figure 17. Mapping wave direction quarter seas 45^o (a). 15 knot (0,875 meter), (b). 22,5 knot (0,875 meter), (c). 30 knot (0,875 meter) (d). 15 knot (2 meter), (e). 22,5 knot (2 meter), (f). 30 knot (2 meter)

Figure 18. When the direction of the follow seas wave is 0o, at waves of 0.875 and 2 meters all areas in the engine room are dark green which is considered comfortable for crew members

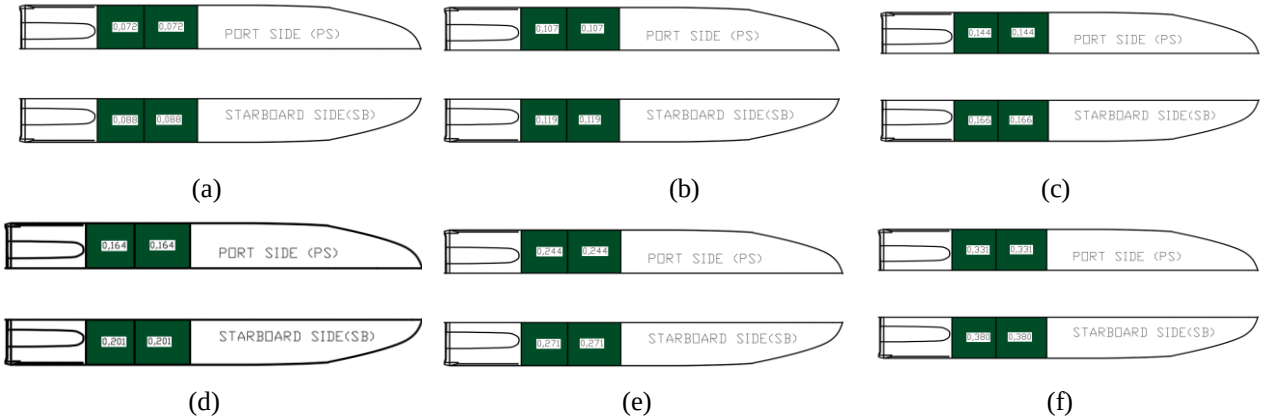

Figure 18. Mapping wave direction quarter seas 0^o (a). 15 knot (0,875 meter), (b). 22,5 knot (0,875 meter), (c). 30 knot (0,875 meter) d). 15 knot (2 meter), (e). 22,5 knot (2 meter), (f). 30 knot (2 meter)

4. CONCLUSION

Based on the analysis of the KAL-28 catamaran patrol boat, it can be seen that the KAL-28 patrol boat has the highest vertical acceleration response when the ship moves against the direction of the waves (heading seas), where when the ship speed is 30 knots, a wave height of 2 meters causes motion. The highest vertical acceleration in the deck area and navigation room is 3.706 m/s2 at coordinates 6 and 7 in the deck area, while the highest vertical acceleration movement is in the engine room, namely 2 m/s2. Referring to the ISO 2631 standard, the ship's condition is stable at a speed of 15 knots in the direction of the quarter seas and follow seas wave angles. The KAL-28 catamaran patrol boat is more efficient when operating at waves of 0.875 meters, but a wave height of 2 meters is not recommended because of the extreme wave height. And the more the ship's speed increases, the MSI value increases.

REFERENCES

[1] Budiman, Y., Romansyah, F., Rochim, M. N., Akmal, M. S., Solikin, M., & Yudianto, A. (2022). Seminar Nasional Ilmu Teknik dan Aplikasi Industri (SINTA) Perancangan bodi kapal patroli lepas pantai : analisis numerik hidrodinamika bodi deep v-hull , bulbous hull , dan catamaran melalui simulasi

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software maxsurf. 5.
[2] Ishak Bawias, F. L. R. (2022). Analisis Prediksi Motion Sickness Incidence (Msi) Pada. Zona Laut, 3(2), 2747–2124. https://journal.unhas.ac.id/index.php/zonalaut
[3] Khristyson, S. F., & Laksono, S. H. (2020). Analisa Joint Erection Konstruksi Baja Block B05 & B07 Kapal Patroli Polisi 63 Meter Dengan Mobile Crane 72.000 Ton. Jurnal Proyek Teknik Sipil, 03(1), 10–17.
[4] Putra, Dian P., Deddy C., & Muhammad Iqbal , Analisa Seakeeping Dan Prediksi Motion Sickness Incidence (Msi) Pada Kapal Perintis 500 Dwt Dalam Tahap Desain Awal (Initial Design). Jurnal Teknik Perkapalan, 4(3), 343–354. https://ejournal3.undip.ac.id/index.php/naval/article/view/13830
[5] Molland, A. F., Turnock, S. R., & Hudson, D. A. (2011). Ship resistance and propulsion: Practical estimation of ship propulsive power. In Ship Resistance and Propulsion: Practical Estimation of Ship Propulsive Power (Vol. 9780521760). https://doi.org/10.1017/CBO9780511974113
[6] Piscopo, V., & Scamardella, A. (2015). The overall motion sickness incidence applied to catamarans. International Journal of Naval Architecture and Ocean Engineering, 7(4), 655–669. https://doi.org/10.1515/ijnaoe-2015-0046
[7] Griffin, M. J. 1990 Motion sickness. Handbook of Human Vibration, Academic Press, New York.
[8] O'Hanlon, J. F., and McCauley, M. E. (1974). "Motion sickness incidence as a function of the frequency and acceleration of vertical sinusoidal motion," Aerosp. Med. 45, 366-369
[9] Santoso, M. (2015). Analisis Prediksi Motion Sickness Incidence (Msi) Pada Kapal Catamaran 1000 Gt Dalam Tahap Desain Awal (Initial Design). Kapal: Jurnal Ilmu Pengetahuan dan Teknologi Kelautan, 12(1), 42–49. https://ejournal.undip.ac.id/index.php/kapal/article/view/8346

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