Original Article

Purse Seine Vessel Stability Analysis Due To Fish Hatch Redesign On Consideration Of Local Wisdom Di Sinjai Regency

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Abstract

Stability is an important indicator in the construction and operation of ships, especially on purse seine ships . In Sinjai Regency, South Sulawesi, information was obtained related to the design of kapal purse seine located in Sinjai Regency. The purse seine ship located in Sinjai Regency has a fish hatch on the deck of the ship, this was done because of the low draft of the ship. This phenomenon means that the stability of ships in sinjai district is still not taken into account. This study aims to design a purse seine ship in Sinjai which has a hatch building on the deck of the ship without changing the shape of the bow, stern and hull of the purse seine so that local wisdom regarding the shape of the bow and stern is maintained and has better stability in two cargo conditions, namely empty cargo and full cargo of the ship. The time and place of this study was carried out in January-June 2022 in Sinjai Regency. The sampling method used is the sampling method intentionally. The results of the stability analysis obtained are the the purse seine ship after the redesign taking into account local wisdom has a better stabiltas arm than the stabiltas arm of the purse seine ship model before the redesign.

Keywords: Purse Seine, Redesign, Fish Hatch, Stability

INTRODUCTION

In supporting the operation of purse seine fishing gear, vessels built must be in accordance with the operating techniques and standards of fishing vessels that apply, especially in Indonesia, are needed. According to the IMO, 80% of accidents, are caused by human error and most of these errors can be attributed to management deficiencies that create pre-conditions for the occurrence of accidents. In addition to the safety aspect, the hydrodynamic aspect, especially on the stability value for fishing vessels in this case, is that purse seine vessels are also a serious concern in the construction process even though they are built traditionally.

Several studies related to the stability of fishing vessels have been carried out including, analyzing the Stability of small fishing vessels in the southern waters of the peninsula, where the Assessment shows that although there are two vessels that have complied with static stability requirements, one of the vessels can only operate in a limited place of operation with sea conditions. maximum (Yaakob et al., 2015). Research regarding the analysis of stability and resistance based on the dimensions of the 30 GT ship obtained information, namely the roll and pitch movements on ships with U-type hulls will be better than those with deep V-type hulls (Manullang et al., 2017). Areview of the stablity of two charges, namely empty load and full load has also been carried out, in the study produced good stability in both charges, the maximum GZ obtained at full load conditions is about 1.2 m and at empty load conditions is about 0.4 m. (Putranto et al., 2018).

In Indonesia, precisely in East Java, the stability test of traditional fishing boats has also been carried out with reference to the International Maritime Organization Standards, the results of the study show that ijon-ijon, boats, purse seine meet the stability criteria of IMO standards. Whereas ethek-ethek fails the stability test. Comparison of ship stability between catamarans and monohull ships has been studied where the results of research say that catamaran (Praharsi et al., 2019) ships have a unique characteristic ka unique stability because the overall width of the catamaran is greater than that of the monohull, so this ship has better transverse stability(Santosa et al., 2014). In addition, research on the stability and dynamic effects of water on the deck on small fishing vessels explains that the wetness of the deck and the presence of fishing nets against waves are the causes of the possibility that the ship may capsize (Francescutto et al., 2009).

Previous experiments Not only analyzed stability, but also monitored the transverse stability of fishing vessels where the monitoring results obtained on awareness indicators that resulted in detailed changes in the stability of the vessels, but were more susceptible to inaccuracies in estimates (Caamaño et al., 2019). In addition to stability analysis. p original design of the ship, it turns out that an analysis has also been carried out on the results of this l redesign l ambung p rototype kapal purse seine in Manado, this study found that the hull of the PKU-4 ship in reddesign has higher stability than the PKU-1 prototype ship and the hulls of the PKU-2 and PKU-3 ships that were redesigned In coastal waters South Kalimantan, has also carried out stability testing and redesign of sungkur vessels with the crane method by, the results were obtained descriptively where the stability of the breech boat design with the crane method has met the minimum standard value of IMO(DCh Pamikiran et al., 2020; Rosadi, 2019)

From previous research, it was found that the main problem of tardisional fishing vessels to be able to survive, develop, and be sustainable in the future, where traditional fishing vessels should consider hydrodynamic aspects including aspects of ship stability, and aspects of redesign with consideration of local wisdom. However, it is very important to conduct research on the stability of the results of the fish hatch redesign. In Sinjai Regency, South Sulawesi, a pre-survey has been carried out and information has been obtained related to the design of purse seine vessels located in Sinjai Regency. The purse seine ship located in Sinjai Regency has a ship design that has a fish hatch placement design that is on the deck of the ship, this is done because of the low draft of the ship. The phenomenon explains that the stability of ships built in Sinjai district still does not understand the loading spatial arrangements that greatly affect the stability of ships. From the study, it was stated that the placement of the catch on the (Ramadhanti, 2017) deck of the ship caused the stability of the ship to decrease.

Methodology

The materials and tools used start from the process of retrieval, collection to the data processing process and ship modeling during research in the Sinjai Regency, Province This South Sulawesi can be seen in (Tables 1).

Table 1. Materials and Tools used when measuring purse seine vessels and make ship models

Materials and Tools used when measuring purse seine vessels		
No	**Materials and Tools**	**Uses**
1	Capture unit	*Purse seine* capture unit as a material
2	roller meter	To calculate the main length of the purse *seine* ship
3	Camera	Documentation during the research activity
4	Writing Stationery	Record the data obtained
5	*water pass*	Measuring balance
6	Computer or laptop with *Microsoft Excel a*nd *Maxsurf* Programs	For the completion of mathematical calculations on the motion resistance of the ship under study
7	Crossbar	Measuring parts of *purse seine* vessels
8	Rope and Pendulum	Measuring the depth of *a purse seine* vessel
Materials and Tools used to make ship models		
No	**Materials and Tools**	**Uses**
1	Digital scales	To weigh ballast
2	Thermometer	Measuring temperature
3	Plywood	Ship sample building materials
4	Wood glue/adhesive	Adhesive of some parts of the ship model
5	Wall plamur	Closing the holes of some parts or skeletons of the vessel
6	White cement	Leveling parts of each ship
7	Rubbing paper/sandpaper	Smoothing the parts of the vessel
8	Oil paint	To paint the outside of the ship model

The data collected is by taking direct measurements in the field. Purse seine sampling uses the sampling method intentionally.

The analysis used is stability analysis using the Maxsurf Stability Application. Which, for all the adjustment ratio criteria, the angle angle is adjusted based on the IMO criteria presented in table 3.

Table 2. IMO criteria standards

Criteria	Value
Area 0 to 30	3,1513
Area 0 to 40	5,1566
Area 30 to 40	1,7189
Max GZ at 30 or greater	0,200
Angle of maximum GZ	25,0
Initial GMt	0,150
Initial GMt for vessels >= 24m in length	0,350
Initial GMt for vessels >= 70m in length	0,150

Results

Ship Redesign

Before modeling on maxsurf, measurements of purse seine vessels are first carried out directly. The measurement results are presented in table 3.

Table 1. Dimensions and Value of the ratio of the dimensions of the purse seine ship at TPI Lappa

Dimensions of the main dimensions of the purse seine ship at TPI Lappa				
Ship	L(m)	B(m)	D(m)	d(m)
Sample	21.19	4.27	1.57	1.10
Value of the ratio of the main dimensions of the purse seine ship at TPI Lappa				
Ship	**L/B**	**L/D**	**B/D**	
Samples	4.96	13.49	2.72	
Ayodhya	4.30 – 4.50	10.00 – 11.00	2.10 – 2.15	

Based on data on the size of the dimensions of the ship obtained in the field with a length of 21.19 meters; width 4.27 meters, height 1.57 meters and the draft ranges from 1.10 meters.

In the purse seine vessel samples studied at TPI Lappa, Sinjai Regency, it can be seen that it has not been in accordance with the statement (Ayodhyoa, 1972). In this case, the L/B ratio value of the purse seine ship studied is bigger than the set standard value, in accordance with the Ayodhya standard, namely with the L/B ratio value of 4.30 – 4.50, this means that the ship's speed performance is quite good, because if the L/B value decreases, it will have a bad effect on speed and vice versa.

For the L / D ratio value, from the purse seine ship sample, has a greater value than the Ayodhya standard, which means that the sample ship has a weak elongated ship strength because the value of the L/D ratio is greater, the strength of the long ship will be weaker.

The value of the main dimensional ratio of B/D obtained in the purse seine vessel sample does not correspond to the figure set by [1] where the B/D value is greater than suggested. this happens because the depth value (D) is low enough that it does not match the width of the ship(Sutrawan Nurdin et al., 2017). In purse seine ships studied, stability will rise but the longitudinal strength of the ship will weaken, which is in accordance with the statement that if the B / D value increases, stability will improve but the (Ayodhyoa, 1972) longitudinal strength of the ship will deteriorate. For adjustment to the standard value of the B / D ratio, it is necessary to add a depth value (D) with an adjustment to the B value to obtain a good longitudinal strength of the ship with good stability. From the results of the sample ship ratio value obtained Incompatibility of ratio values with standard values, (Fyson, 1985) this happens because shipbuilding is not based on naval architect calculations. In addition, the lack of knowledge of ship craftsmen regarding the suitability of the size of the ship with the fishing gear used will affect the determination of the main size of the ship to be made.

Purse Seine Ship Lines Plan

A line plan is a drawing in the form of a ship line plan made on each waterline and ordinate using the maxsurf application. The lines plan of the purse seine ship under study is generally divided into several longitudinal ordinates along the ship's body with a distance of each ordinate, which is one meter long. The purse seine vessels studied are also divided into five water lines, namely from the lowest water line (base line) to the highest water line (draft). The ship's lines plan drawings on each waterline and ordinates are projected into three drawings, namely; (1) The body plan is a drawing of the ship's line plan from the forward direction (the transverse wedge of the ship appears front); (2) The profile plan is a picture of the shape of the elongated wedge of the ship looking side; (3) The half breadth plan is an image of a transverse wedge half the width of the ship looking up.

In this figure, the buttock line is also shown, which is a line parallel to the center line. The results of the depiction of the purse seine ship line plan can be seen in Figure 2. The picture shows the shape of the ship's body on the V-shaped bow where the shape of this bow is slim. This can make it easier for the ship to split the water mass in front of the ship while traveling so that the ship can go at high speed. On the stern of the U-shaped vessel, this shape allows the ship to have not too large resistance, the ability to split waves quite well, and allows for the maximum volume of space.

Pictures of the ship's lines plan both before and after the redesign can be seen in figures 1 & 2.

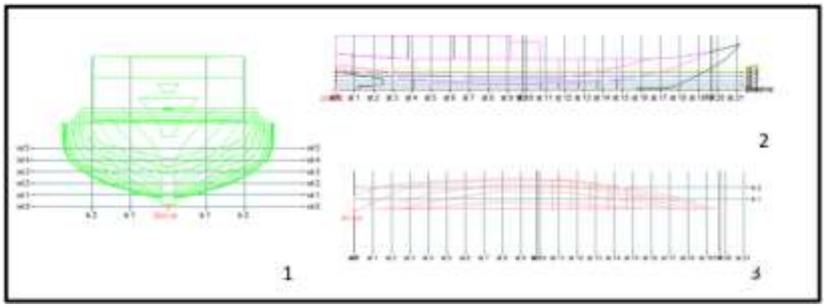

Figure 1. Lines plan ship before reddesign front view (1) Side view (2) and Top view (3)

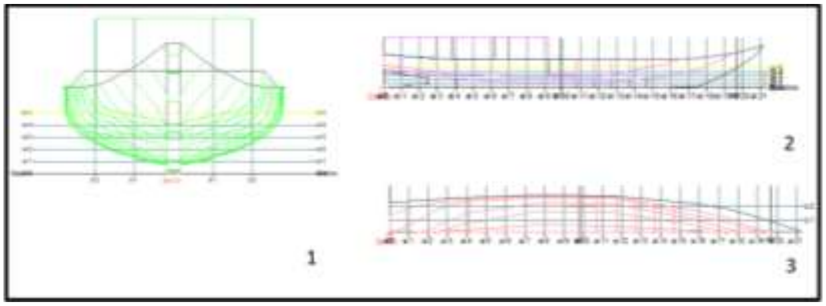

Figure 2. Lines plan ship before reddesign front view (1) side view (2) and top view (3)

From the two pictures of the lines plane above both before the design and after the design there are only differences in the hatch building that is above the deck of the ship. This is because there is no change in the dimensions carried out on the ship so that the shape of the stern and bow of the ship remains the same, namely the shape of the ship body on the V-shaped bow and at the stern of the U-shaped ship.

Hydrostatic magnitude of purse seine vessels

The values of such hydrostatic parameters include the value of the volume of displacement, tons of displacement, waterplan area, midship area, coefficient of fineness, tons per centimetre immersion, longitudinal centre of buoyancy etc. The values of these hydrostatic parameters describe the static solidity of the vessel, (Fyson, 1985) the values The hydrostatic parameters of the vessel have been presented in Table 6-7.

Table 2. Hydrostatic parameters of the sample vessel before redesign on empty cargo

Parameter m	**WL 1**	**WL 2**	**WL 3**	**WL 4**	**WL 5**
Displacement t	0,3709	1,844	5,68	11,56	19,65
Waterpl. Area m^2	3,752	14,058	25,603	36,441	48,299
Prismatic coeff. (Cp)	0,953	0,75	0,665	0,626	0,605
Block coeff. (Cb)	0,953	0,291	0,297	0,315	0,333
Max Sect. area coeff. (Cm)	1	0,388	0,446	0,504	0,55
Waterpl. area coeff. (Cwp)	0,988	0,649	0,646	0,669	0,707
LCB from zero pt. (+ve fwd) m	9,108	9,507	9,669	9,686	9,54
LCF from zero pt. (+ve fwd) m	9,382	9,731	9,776	9,601	9,111

KB m	0,051	0,184	0,321	0,447	0,573
KG m	1,188	1,188	1,188	1,188	1,188
BMt m	0,047	0,804	1,601	1,922	2,093
BML m	224,552	100,024	57,724	47,012	46,161
GMt m	-0,744	0,145	1,08	1,527	1,825
GML m	223,762	99,366	57,203	46,617	45,892
KMt m	0,098	0,987	1,922	2,369	2,667
KML m	224,604	100,208	58,045	47,459	46,734
Immersion (TPc) tonne/cm	0,038	0,144	0,262	0,374	0,495

Table 3. Hydrostatic parameters of the sample vessel before redesign at full load

Parameter m	**WL 1**	**WL 2**	**WL 3**	**WL 4**	**WL 5**
Displacement t	0,3709	2,91	9,55	20,05	34,06
Waterpl. Area m^2	3,752	18,385	32,86	48,802	59,344
Prismatic coeff. (Cp)	0,953	0,706	0,64	0,605	0,632
Block coeff. (Cb)	0,953	0,285	0,312	0,334	0,394
Max Sect. area coeff. (Cm)	1	0,403	0,487	0,552	0,623
Waterpl. area coeff. (Cwp)	0,988	0,646	0,659	0,708	0,773
LCB from zero pt. (+ve fwd) m	9,108	9,596	9,694	9,531	9,27
LCF from zero pt. (+ve fwd) m	9,382	9,745	9,699	9,095	8,781
KB m	0,051	0,233	0,409	0,579	0,743
KG m	1,252	1,252	1,252	1,252	1,252
BMt m	0,047	1,165	1,836	2,094	1,732
BML m	224,552	80,838	47,824	46,174	41,837
GMt m	-1,002	0,299	1,145	1,573	1,376
GML m	223,504	79,972	47,133	45,654	41,48
KMt m	0,098	1,398	2,245	2,673	2,476
KML m	224,604	81,072	48,233	46,753	42,58
Immersion (TPc) tonne/cm	0,038	0,188	0,337	0,5	0,608

Based on the hydrostatic value obtained that Ton displacement (Δ) indicates the magnitude of the ship's body weight below the waterline or describes the weight of the water displaced by the sunset ship's body. The greater the value of tons of displacement of a ship, the higher the part of the ship immersed below the water level. The value of tons of displacement at the time of empty load conditions was 19,65 and for the value of tons of displacement at the time of full load conditions was 34,06 tons at WL 5. These values represent the maximum load capacity that the ship can accommodate. Tons per centimeter (TPc) indicates the weight required to change the draft by 1 cm. The TPc value on an empty loaded sample vessel is 0,495 while a fully loaded sample vessel is 0,608 tons/cm, which means that adding or subtracting a load of that value to or from within the vessel will increase or decrease the ship's water load by 1 cm.

From the results of hydrostatic analysis, both the sample vessel before the redesign and after the redesign have the same hydrostatic value under the two loading conditions. Except for the KG value, this is because in the redesign process the kapa only moves the loading space on the ship to the bottom of the deck of the ship without changing the shape of the hull, so that what makes the hydrostatic value different is only because of the influence of the transfer of loading space and cargo on the ship.

The coefficient of fineness, commonly referred to as the coefficient of vessel fatness, is one of the hydrostatic parameters that reflect the shape of the ship's body. According to (Ayodhyoa, 1972) stated that the vessel can be slim or grease, depending on the magnitude of the ship shape coefficient such as beam coefficient (Cb), middle cross-sectional coefficient (Cm), waterline coefficient (Cw) dan prismatic coefficient (Cp). The values of the sample ship shape coefficient are presented in tables 10-11.

The value of Cb moves from 0 – 1, the closer the value of 1, the vessel is said to be fatter and vice versa it is said to be slim if it approaches the value of 0. The Coefficient block (Cb) value on the empty cargo sample ship is 0,333 and at full load of 0,394 at WL 5, it describes the sample ship as having a slim hull shape so that it is advantageous in terms of ship speed.

Coefficient of midship (Cm) is a comparison of the area between the cross-section of large submerged ivory with the area of a cross section whose width is B and height D. Coefficient value of midship (Cm) L\ on the sample ship for empty cargo is 0.55 and at full load of 0.623 at WL 5, this indicates that in the midship part of the sample ship has a fat or round buttom shape.

The coefficient water plan (Cw) shows the size of the mid-range cross-sectional area compared to the rectangular plane surrounding the area, where the Coefficient water plan (Cw) value on the sample vessel with empty load conditions is 0.751 and the full load pad is 0.792 at WL 5, this shows that the sample ship has a cross-sectional shape of the waterline that is close to the shape of four squares, thereby improving the stability of the ship.

Coefficient of Prismatic (Cp) is a comparison between the volume of the ship's body below the water surface and the volume of a prism with the cross-sectional area of the midship area and the length of the ship. The Coefficient of Prismatic (Cp) value on the sample vessel in empty cargo conditions was 0.605 and in full load conditions was 0.632 at WL 5. Based on the Cp value of the sample ship is known to have a widened body shape on the stern.

Comparison of Lwith the stability of traditional purse seine vessels before and after redesign according to kapal load conditions

The stability arm comparison curve that has been obtained has been presented in figures 3&4.

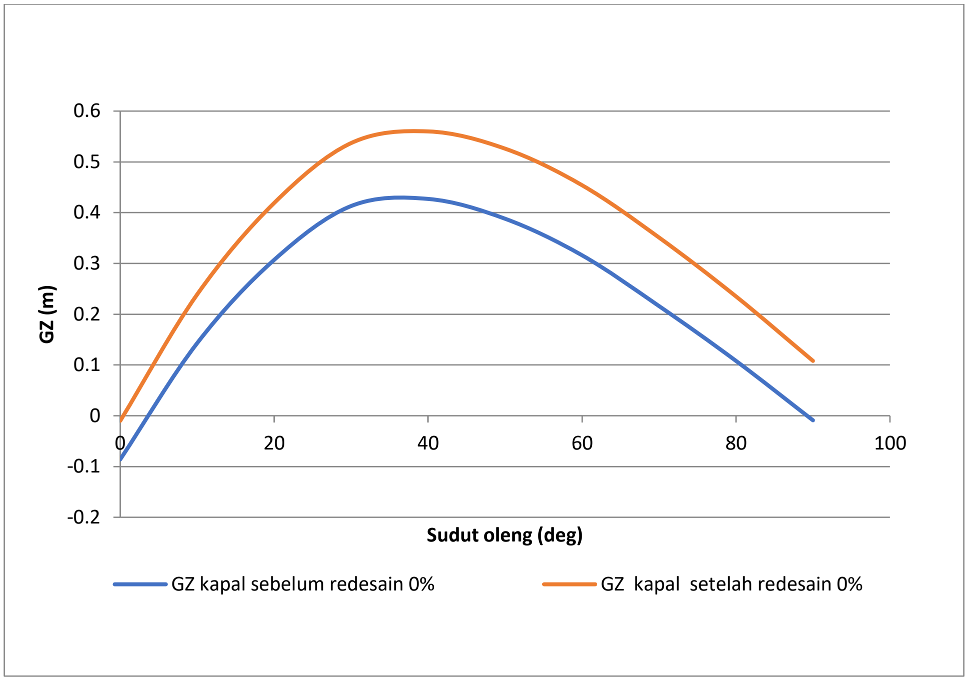

Figure 3. Purse Seine vessel stability arm before and after redesign at 0% charge

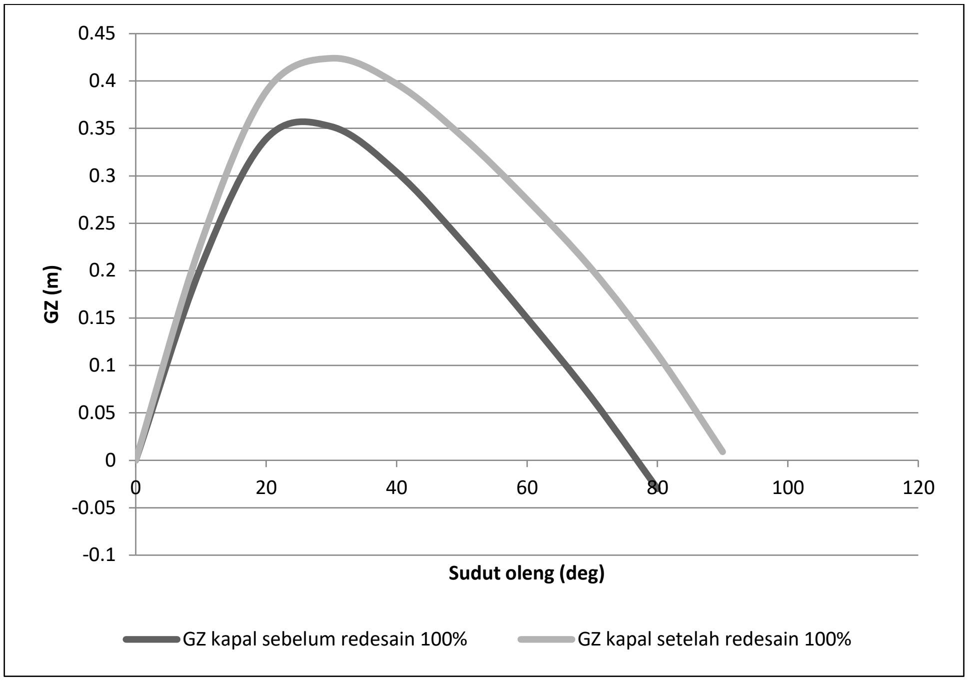

Figure 4. Purse seine vessel stability arm before and after redesign at 100% charge

The GZ curve of the sample ship obtained either with a load of 0% or 100% illustrates that the sample ship after redesign has a better GZ curve compared to the sample ship before the redesign, because the range stability of the ship after the redesign is wider than the range stability of the ship before the redesign. (Iskandar & Rahayu, 2008) suggests that the smaller the KG value, the greater the GZ value. This fact also corresponds to the results of research (Sutrawan Nurdin et al., 2017) for modified purse seine vessels.

Purse Seine Ship Stability Condition Based on Payload Conditions that Meet IMO Criteria

The sample vessel stability criteria analyzed using the Maxsurf application can be seen from the comparison of GZ enforcer arm values with IMO standard values as shown in tabel 6.

Table 4. Value of Ship Stability Criteria before and after redesign at 0% and 100% Sample load versus IMO Standard Value

Stability Criteria before redesign at 0% Sample load versus IMO Standard Value				
Criteria	Value	Units	Actual	Status
Area 0 to 30	3,1513	m.deg	6,2914	Pass
Area 0 to 40	5,1566	m.deg	10,5566	Pass
Area 30 to 40	1,7189	m.deg	4,2652	Pass
Max GZ at 30 or greater	0,200	m	0,431	Pass
Angle of maximum GZ	25,0	deg	36,4	Pass
Initial GMt	0,150	m	1,469	Pass
Initial GMt for vessels >= 24m in length	0,350	m	1,469	Pass
Initial GMt for vessels >= 70m in length	0,150	m	1,469	Pass
Stability Criteria before redesign at 100% Sample load versus IMO Standard Value				
Criteria	Value	Units	Actual	Status
Area 0 to 30	3,1513	m.deg	7,3900	Pass
Area 0 to 40	5,1566	m.deg	10,6988	Pass
Area 30 to 40	1,7189	m.deg	3,3088	Pass
Max GZ at 30 or greater	0,200	m	0,352	Pass
Angle of maximum GZ	25,0	deg	25,5	Pass
Initial GMt	0,150	m	1,222	Pass
Initial GMt for vessels >= 24m in length	0,350	m	1,222	Pass
Initial GMt for vessels >= 70m in length	0,150	m	1,222	Pass
Stability Criteria after redesign at 0% Sample load compared to IMO Standard Value				
Criteria	Value	Units	Actual	Status

Area 0 to 30	3,1513	m.deg	9,3683	Pass
Area 0 to 40	5,1566	m.deg	14,9233	Pass
Area 30 to 40	1,7189	m.deg	5,5550	Pass
Max GZ at 30 or greater	0,200	m	0,562	Pass
Angle of maximum GZ	25,0	deg	38,2	Pass
Initial GMt	0,150	m	1,585	Pass
Initial GMt for vessels >= 24m in length	0,350	m	1,585	Pass
Initial GMt for vessels >= 70m in length	0,150	m	1,585	Pass
Stability Criteria after redesign at 100% Sample load compared to IMO Standard				
Criteria	Value	Units	Actual	Status
Area 0 to 30	3,1513	m.deg	8,5000	Pass
Area 0 to 40	5,1566	m.deg	12,6364	Pass
Area 30 to 40	1,7189	m.deg	4,1364	Pass
Max GZ at 30 or greater	0,200	m	0,424	Pass
Angle of maximum GZ	25,0	deg	29,1	Pass
Initial GMt	0,150	m	1,366	Pass
Initial GMt for vessels >= 24m in length	0,350	m	1,366	Pass
Initial GMt for vessels >= 70m in length	0,150	m	1,366	Pass

Based on the specified IMO criteria values, the sample ship before redesign and after redesign has met the standards that have been set, but the value of the ship criteria after redesign is greater than the value of the sample ship criteria before redesign in both cargo conditions. Thus, the stability possessed by the ship after redesign is better than the stability of the sample ship before the redesign which is due to the transfer of the hatch space from the top of the ship's deck to the bottom of the ship's deck which causes a change in the distance of the weight point or KG of the ship.

Conclusion

Based on the results of the research obtained, it can be concluded that; (1) Redesign of the ship is carried out only by moving the hatch space above the deck of the ship to the bottom of the deck of the ship without changing the shape of the stern, bow and hull; (2) The hydrostatic quantity obtained from the ship after redesign has the same value as the hydrostatic magnitude of the ship before the redesign, in addition to the KG value of the ship in the empty state and the cargo condition in full state; (3) The stability arm obtained by the ship after the redesign, either in empty cargo or full load is greater than the stability arm on the ship before the redesign.

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