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Characteristics of Fishing Vessels Owned by fishermen from the Ujong Baroh Fish Landing Base (PPI) West Aceh Regency

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ABSTRACT Fishing vessel is one of an important thing among a fishing unit. All fishing activities are carried out on fishing vessel. In Indonesia, the shape and size of fishing vessels are vary, depending on the habits of the fishers and the area where the fishing vessels are built and operated. In West Aceh Regency, there are fishing vessels with various sizes. This study aims to identify the shape of fishing vessels measuring less than 10 gross tonnages (GT) at the Fish Landing Base (PPI) Ujong Baroh, West Aceh Regency. This identification is intended as a basis for reference in formulating fishing vessel design that follows the local wisdom of fishers in West Aceh Regency. This reference fishing vessel design can help the government and other parties provide aid fishing vessel for fishers in West Aceh Regency. The direct observation and measurement of fishing vessels were used in this research. Descriptive and numerical method used in analysis data. The number of sample was 27 fishing vessels consist of 10 sample with size of 1-5 GT and 17 with a size of 6-10 GT. The result show that fishing vessels in Aceh Barat District have a transom shape longitudinally and a round bottom or a round flat bottom shape transversely. All fishing vessels in West Aceh have a raked bow and a cruiser-shaped stern. The main dimensions ratio of group 6-10 GT is smaller than group 1-5 GT. The stability parameters of the two forms of fishing vessels follow the stability parameter values recommended by the International Maritime Organization (IMO). The static stability of fishing vessels with round flat bottom is better than round bottom.

Keywords: Fishing vessel; local wisdom; Main dimension ratio; PPI Ujong Baroh

INTRODUCTION

Fishing vessels are one of the important factors for fishermen to conduct fishing business. As a factor of fishing, various activities are carried out on a fishing vessel to catch fish in some waters. These activities include storing marine supplies, storing and operating fishing gear, resting places for crew members, and serving as storage and transportation of caught fish. Based on the Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia number 58/PERMEN-KP/2020 of 2020 concerning the capture fisheries business, what is meant by fishing vessels are fishing vessels used to catch fish, including storing, storing, cooling, and/or preserving fish, and have fishing gear.

Fishing vessels in Indonesia have various shapes and dimensions, depending on the area and fishing gear used (Rouf *et al*., 2006). Differences in the shape of the ship's hull also occur because the construction of fishing vessels is carried out in traditional shipyards in each area (Rouf *et al*., 2006). Traditional shipyards in every region in Indonesia still rely on abilities passed down from generation to generation (Marjoni, 2009; Azis MA *et al*., 2017).

The shape of the fishing vessel's hull affects the seaworthiness. Fyson (1985) stated that the choice of the shape of the hull of the ship must be in accordance with the fishing gear and the operating area. Ship performance related to stability, speed, longitudinal strength, maneuverability, and ship motion resistance can be known from the values generated on the ratio of the main dimensions of the ship (Palembang *et al*., 2013; Hardjono, 2010). The difference in the shape of the ship's hull also causes differences in the motion resistance of the ship, which will affect the ship's speed (Novita *et al*., 2008).

Only now is more information about the diversity of fishing vessels owned by fishermen in West Aceh. Therefore, a study must be conducted to determine the diversity of fishing vessels and fishing gear used by fishermen in the West Aceh District. The results of this study are intended as a basis of reference in formulating local wisdom ship designs for fishermen in the West Aceh District. Existence of reference ship design This can assist the government and other parties in providing aid boats for fishermen in West Aceh District that are in accordance with the needs and habits of the fishermen themselves. This fishermen's habit is usually called local wisdom. Local wisdom is thoughts and actions that have become standard values or guidelines in all forms of activity and have become a legacy from generation to generation (Niman, 2019); Apriana, 2015). Factors of local fishermen's habits or local wisdom (the shape of the boat, the dimensions of the boat, and fishing gear) must be taken into account. Because this significantly affects the utilization of aid ships (Mira, 2013). This study aims to 1) identify the diversity of shapes and calculate the ratio of the main dimensions of fishing vessels owned by fishermen from PPI Ujong Baroh, West Aceh Regency, and 2) calculate the stability parameters of the vessel. Owned by PPI fisherman Ujong Baroh, West Aceh Regency.

MATERIALS AND METHODS

Location and time of research

This research was conducted at the fish landing base (PPI)

Ujong Baroh, West Aceh Regency. Data collection was carried out from July to September 2021.

Figure 1. Research locations at the fish landing base (PPI) Ujong Baroh, West Aceh Regency.

This study used several pieces of equipment, which consists of ruler, pendulum, waterpass and software for calculate ship stability. Data collection is done by determining the number of samples that are the object of research. The object of research is fishing vessels belonging to fishermen at PPI Ujong Baroh, West Aceh District. Ships that are the object of research are ships with sizes of one to ten Gross Ton (GT), which are then divided into two groups, namely ships with sizes of 1-5 GT and 6-10 GT. Each sample group will be taken as much as 10% (ten percent) as a sample. The sample was determined using the accidental sampling technique, in which the ships that became the research sample were ships with the size according to the target, which were anchored or docked at the port and had no other activities in its ship.

Based on data obtained from PPI Ujong Baroh, there are 270 fishing vessels measuring 1-5 GT and 161 fishing vessels measuring 6-10 GT. Based on these data, data collection was carried out on 27 units of fishing vessels with a size of 1-5 GT and 17 units of vessels with a size of 6-10 GT. Data collection on ship samples is carried out by direct observation at the field related to the shape of the bow and stern of the ship, the shape of the ship transversely and longitudinally, the ship's steering system, and the fishing gear used. In addition, measurements were also carried out on the main dimensions of the ship consisting of the length of the ship (LOA), width (B), depth (D), and draft t (d).

Data analysis

Data analysis was carried out descriptively, numerically, and qualitatively to describe the condition and diversity of fishing vessels in the Ujong Baroh PPI, West Aceh District. Data on the main dimensions of the ship, such as the overall length of the ship (LOA), the width of the ship (B), and the height of the ship (D), will be compared to get the ratio values of the main dimensions of the ship (L/B, L/D, and B/D). Furthermore, the shape and dimension ratio of fishing vessels will be compared with the shape and dimensions of fishing vessels in the same group, which exist in other areas based on data from the results of a literature study. Ship static stability parameters, which consist of a range of stability, floating angle, maximum $(GZ)^{-}$ value, and tilt angle at $(GZ)^{-}$ maximum. It is carried out using the PGZ software to obtain the ship stability parameter values, and the results will be compared with the ship stability values suggested by the International Maritime Organization (IMO). Figure 2 presents a stability chart as a reference in analyzing ship stability parameter values suggested by IMO.

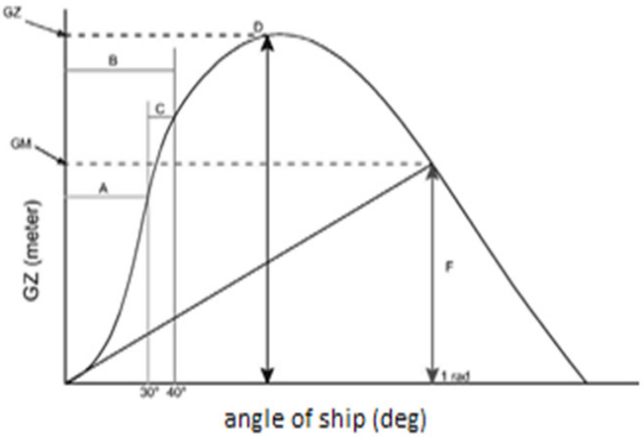

Figure 2. Stability curve ship stability parameter values.

Caption:

A. The area under the curve up to an angle of 30° shall not be less than 0.055 meter radians.
B. The area under the curve up to X cannot be less than 0.09 meter radians.
C. The area between 30° to X cannot be less than 0.03 meter radians, where the value of X is 40° or less than the minimum limit for water to enter the hull.
D. The maximum GZ value should be achieved at an angle of not less than 30° and a value of not less than 0.20 meters.
E. The maximum angle of stability should be more than 25°.
F. The initial GM value may be at least 0.35 meters for fishing vessels.

RESULTS AND DISCUSSION

Hull shape of ship

Identification of the shape of the ship's hull was carried out at two cross-sectional positions, namely the cross-section at the midship section of the ship and the longitudinal section of the ship. The results of observing the shape of the ship's hulls owned by fishermen at PPI Ujong Baroh, West Aceh Regency, show that there are two types of ships transversely, namely *round bottom* and a round *flat bottom*. Meanwhile, the shape of the ship's hull longitudinally is in the form of a *transom*. The shape of the ship's hull transversely and *longitudinally* can be seen in Figure 3, 4, 5 and 6.

The round and round bottom shapes of the ship's hull are showed in Figure 3, 4, 5 and 6. The difference in shape between round bottom and round flat bottom is at the bottom of the vessel. Where in the round flat bottom shape, the bottom part is flatter than the round bottom shape. The transom shapes of the ship are showed in half breadth plan, where the stern part of ship does not form an angle, but a vertical line.

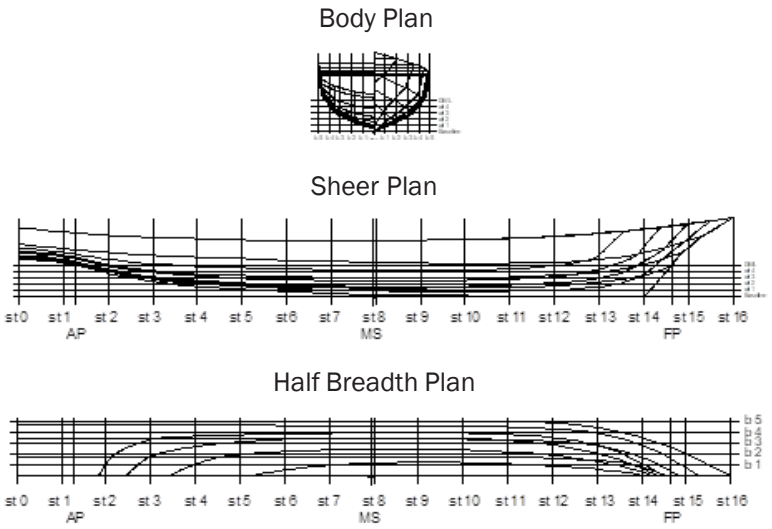

Figure 3. Ship with round bottom shape, 1-5 GT.

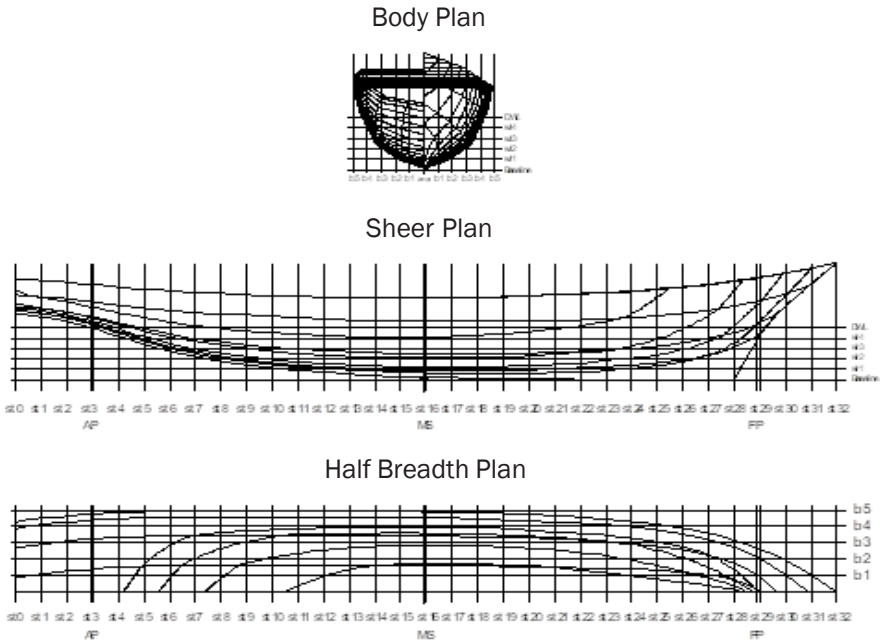

Figure 4. Ship with round bottom shape, 6-10 GT.

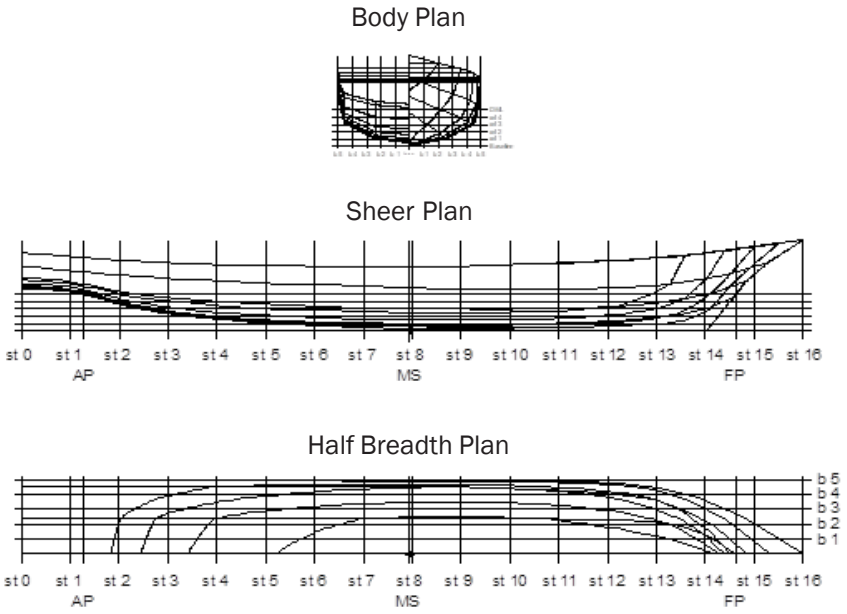

Figure 5. Ship with roundflat bottom shape, 1-5 GT.

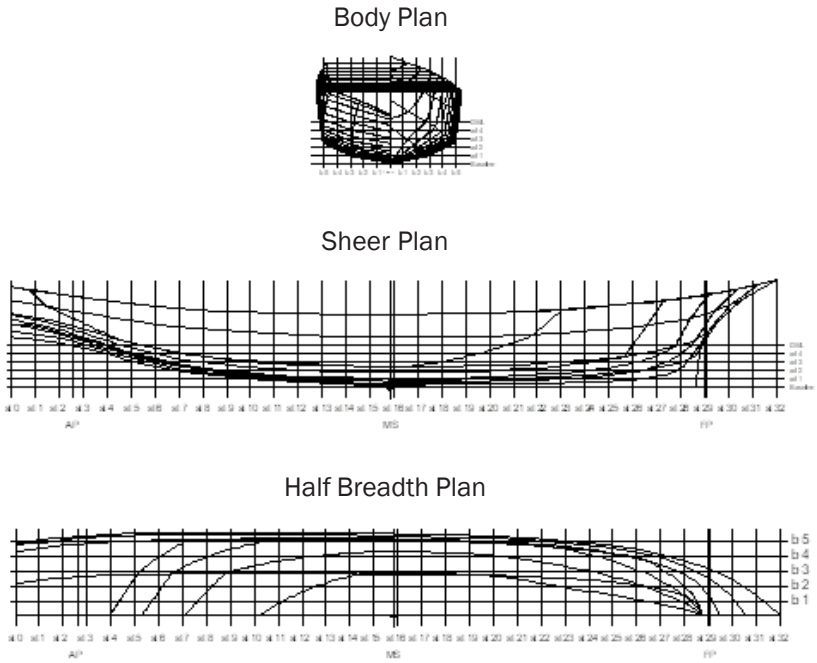

Figure 6. Ship with roundflat bottom shape, 6-10 GT.

Observations were also made on the shape of the bow height of the ship. The result is that all fishing boats at PPI Ujong Baroh, West Aceh Regency, have a raked bow shape (Figure 7) and the stern of the shaped "cruiser" (Figure 8).

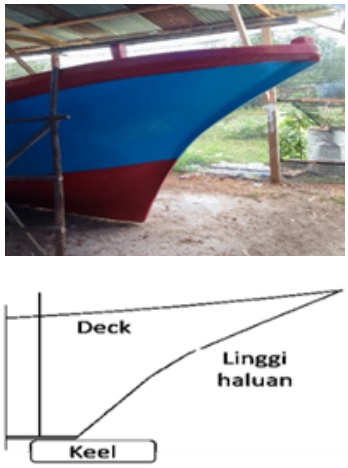

Figure 7. Longbow " rakedbow ".

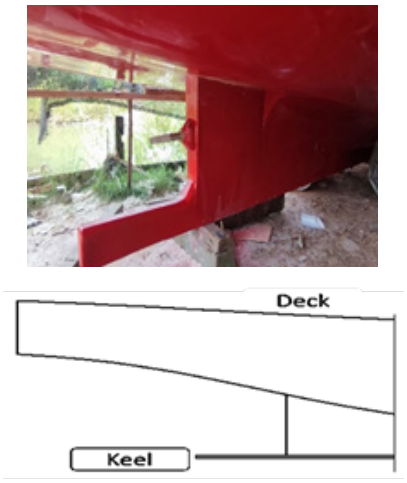

Figure 8. The stern of the " cruiser."

The ratio of the main dimensions of the ship

Data from the measurement of the main dimensions of the ship, such as the length of the ship (L OA), Width (B), depth/height (D), and the draft t/load of the ship (d) for the sample vessels in each group are presented in Table 2.

Table 2. The main dimensions of the ship, 1-5 GT.

Ship Group	Main dimension(m)			
	LOA	B	D	d
1-5 GT	7.0-14.9	1.0-2.6	0.5-1.0	0.3-0.6
6-10 GT	14.0-16.9	2.4-3.1	0.9-1.2	0.6-0.9

Based on the data on the ship's main dimensions in Table 2, the ratio of the ship's main dimensions (L/B, B/D, and L/D) is calculated. The results of these calculations are presented in Table 3.

Table 3. The main dimensions of the ship, 6-10 GT.

Ship Group	Primary dimension ratio (m)		
	L/B	B/D	L/D
1-5 GT	4.4-7.9	1.5-2.8	10.0-17.6
6-10 GT	5-6.1	2.2-3.1	12.7-16.7

Ship stability

Ship stability is the ability of a ship to return to its original position after experiencing a wobble. Ship stability is closely related to the distribution of cargo on board. The study of ship stability was carried out on both forms of ship rafters (round bottom and round flat bottom). Calculation of stability parameters is carried out on three shipload conditions. Namely, the condition I cargo when the ship departs to the fishing ground (fishing ground), condition II cargo when the ship is at the fishing ground with fish caught and supplies 50%, and condition III cargo when moving back to port (fishing base). The condition of the load on each form of ship rafters is presented in Table 4.

Based on several loading conditions in Table 4, the ship's

Table 4. Conditions of cargo on the ship.

Items	Condition I	Condition II	Condition III
Lightships	1	1	1
FOT	100%	50%	10%
hatch 1	20%	50%	100%
hatch 2	20%	50%	100%
Accommodation	100%	50%	10%
Crew	3	3	3

static stability analysis was carried out using computer software commonly used in shipping engineering to obtain a static stability curve. The stability curves of the two forms of ship rafters under three loading conditions can be seen in Figure 9-11.

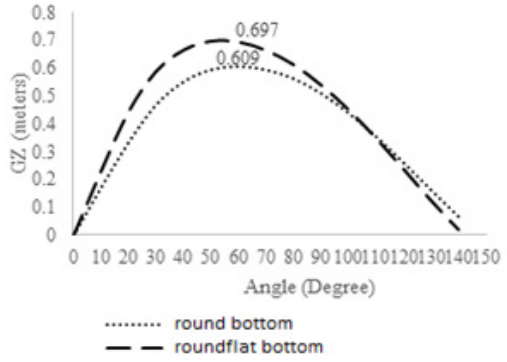

Figure 9. Stability curve of condition I.

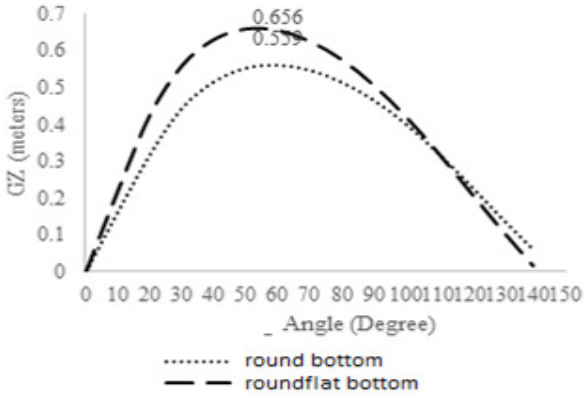

Figure 10. Condition II; stability curve.

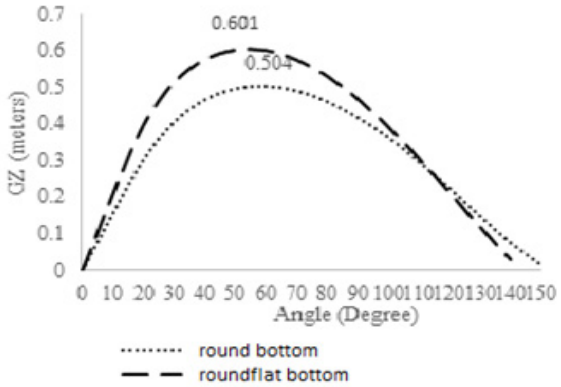

Figure 11. Condition III; stability curve.

Based on the stability analysis of three loading conditions, the values of the static stability parameters of the two forms of ship rafters are presented in Table 5-7.

Table 5. Stability parameters values for round and round flat bottom of ship hull shape: Condition I.

Criteria	Units	Value	
		Round bottom	Round flat bottom
Areas 0 to 30	m.rad	0.131	0.172
Areas 0 to 40	m.rad	0.221	0.282
Areas 30 to 40	m.rad	0.090	0.111
Max GZ at 30 or greater	m	0.609	0.702
The angle of maximum GZ	deg	60,000	54,500
Initial GMt	m	1.018	1.339

Table 6. Stability parameters values for round and round flat bottom of ship hull shape: Condition II.

Criteria	Units	Value	
		Round bottom	Round flat bottom
Areas 0 to 30	m.rad	0.123	0.164
Areas 0 to 40	m.rad	0.207	0.268
Areas 30 to 40	m.rad	0.084	0.105
Max GZ at 30 or greater	m	0.560	0.662
The angle of maximum GZ	deg	58,200	53,600
Initial GMt	m	0.953	1,278

Table 7. Stability parameters values for round and round flat bottom of ship hull shape: Condition III.

Criteria	Units	Value	
		Round bottom	Round flat bottom
Areas 0 to 30	m.rad	0.117	0.152
Areas 0 to 40	m.rad	0.193	0.247
Areas 30 to 40	m.rad	0.077	0.096
Max GZ at 30 or greater	m	0.505	0.604
The angle of maximum GZ	deg	58,200	54,500
Initial GMt	m	0.897	1,198

Fishing gear

The fishing gear commonly used by fishermen at PPI Ujong Baroh, West Aceh Regency, are gillnets and fishing rods. The type of gillnet that is widely used in West Aceh is the millennium gillnet, with a mesh size of 4-6 inches. The fishing gear consists of handlines, line rods, and longlines.

Ship steering system

Ship steering system is a device used on ships to steer the ship. Either to move straight or to turn. Fishing vessels belonging to fishermen usually use a system of steering with a single iron plate (Trimulyono *et al.*, 2013). The results of observations on the steering system of fishermen's ships consist of an iron plate with a rectangular shape as the steering leaf, which is connected to an iron pipe rod to move it. The fishing boat steering system is presented in Figure 12.

Figure 12. Steering system.

The shape of the rafters for fishing vessels owned by fishermen in West Aceh Regency has a V bottom shape at the bow of the ship, round bottom, or round flat bottom in the middle to the stern of the ship. Such rafters were found in both groups of vessel sizes (1-5 GT and 6-10 GT) and in all types of fishing gear. The V shape at the bow of the boat is a common shape owned by fishing vessels in Indonesia (Rouf *et al*., 2006). The V shaped of hull at the bow of the ship can reduce the value of the ship's resistance (Putra, 2018; Dhana, 2018).

Based on a study by Rouf & Novita (2004), there are five forms of fishing vessel hulls in Indonesia, namely U-bottom, round bottom, round flat bottom, Akatsuki bottom, and hard chin bottom. Based on the results of a study by Dariansyah *et al*. (2020), it is stated that the round bottom and round flat bottom cascading forms are more appropriate for encircling gear group ships. This is because the two forms of the cascading have a more hydrodynamic shape.

In theory, the shape of the round bottom and round flat bottom hull is not optimal to be used as the hull form of ships operating gillnets and line fishing gear. However, the form of round bottom and round flat bottom have become commonly used by fisher communities in West Aceh.

Comparison of the ship's main dimensions (L/B, B/D, and L/D) has an influence on the motion resistance, stability, and longitudinal strength of the ship. Ayodhyoa (1972) states that the ratio of the main dimensions of the ship must be taken into account to obtain optimal ship capabilities. If the ship has a small L/B ratio, then the ship will have a large motion resistance, which will adversely affect the ship's speed. According to Fyson (1985), the size of the ship's main dimensions can determine a ship's ability when operating. The ratio of L/D and B/D of the ship will affect the stability of the ship. The greater the value of the ratio of L/B and B/D, the better the quality of the ship's stability. The L/D ratio is getting bigger, which will affect the ship's longitudinal strength, which is getting worse.

Referring to Table 3, it can be seen that the group of vessels measuring 6-10 GT has a smaller L/B value when compared to the group of vessels measuring 1-5 GT. This shows that ships measuring 6-10 GT have a larger B. Referring to the L/B value, it can be said that ships measuring 6-10 GT have more excellent resistance to motion than ships measuring 1-5 GT. B wider vessels positively impact the stability of ships in the 6-10 GT size group. It can be seen that the B/D value of vessels measuring 6-10 GT tends to be higher than the group of vessels measuring 1-5 GT. As for the longitudinal strength of the two groups of ship sizes, they have relatively the same capability when referring to the L/D ratio value. This condition is recommended for fishing vessels in West Aceh Regency. However, they have a rafters shape that does not optimally support static gear fishing gear operations. However, it can be assisted by the value of the B/D ratio as owned by a group of vessels measuring 6-10 GT, which ranges from 2.2 to 3.1.

Ship stability is a condition where the ship can return to its original position after experiencing forces from outside and from inside the ship, causing the ship to wobble (Soegiono *et al*., 2006). Factors that affect the stability of a ship are the center of gravity and the center of buoyancy. According to Kok (1983), the center of gravity is the resultant point of the overall gravity of the ship and the cargo that pushes down. At the same time, the floating point is the geometric center of gravity of the submerged part of the ship that works vertically to push the ship up. If the center of gravity and the floating point is not vertically aligned, then this will result in a moment when the ship moves in the direction the moment moves (Pangalila, 2010). The value of the return/coupling arm (GZ) will then be a ship's stability parameter, which will be presented in the form of a curve. The curve illustrates the relationship between the value of GZ and various angles of the ship's tilt in tons of constant displacement (Derrett & Barras, 2006).

Figure 8-10 shows the static stability curve of each form of ship rafters having a positive GZ value at each loading condition. A positive GZ value indicates that the ship can return to its original position after a wobble (Novita *et al*., 2014). The maximum GZ value on a ship with round, flat bottom rafters is greater than the maximum GZ for a ship with a round bottom hull. This indicates that the rafters form a round flat hull. The bottom has a better level of stability than the round bottom rafters. The study conducted by Dariansyah *et al*. (2020) showed the round bottom and round flat bottom shapes. However, they have a poor level of stability, have a small resistance to motion.

Several studies related to the shape of ship hulls and their stability show that the cascading shapes that have high stability are U-bottom, Akatsuki bottom, and Hardchin bottom (Tandipuang *et al*., 2015; Azis *et al*., 2017; Dariansyah *et al*., 2018; Putra *et al*., 2020). The determination of the shape of the hull of a fishing vessel in Indonesia is not determined based on consideration of the ship's operational needs in terms of naval architecture but rather on the habits of shipbuilders stated by Rouf & Novita (2006) which states that in Indonesia, there is no tendency for a particular form of fishing vessel hull based on the method of operating the vessel or fishing gear.

The static stability parameter values from the analysis in Table 5-7 will be compared with the static stability parameter values suggested by IMO 1995. A comparison of these values is presented in Table 8 and Table 9.

Table 8. Comparison of ship static stability values of round bottom with IMO criteria.

Criteria	Units	Value			
		IMO	Condition I	Condition II	Condition III
A	m. rad	> 0.055	0.131	0.123	0.117
B	m. rad	>0.09	0.221	0.207	0.193
C	m.rad	> 0.03	0.09	0.084	0.077
D	m	> 0.2	0.609	0.560	0.505
E	deg	> 25	60	58,200	58,200
F	m	> 0.15	1.018	0.953	0.897

Table 9. Comparison of ship static stability of round flat bottom with IMO criteria.

Criteria	Units	Value			
		IMO	Condition I	Condition II	Condition III
A	m. rad	> 0.055	0.172	0.164	0.152
B	m. rad	>0.09	0.282	0.268	0.247
C	m.rad	> 0.03	0.111	0.105	0.096
D	m	> 0.2	0.702	0.662	0.604
E	deg	> 25	54,500	53,600	54,500
F	m	> 0.15	1.339	1,278	1,198

In Tables 8 and 9, it can be seen that the boats owned by fishermen in PPI Ujong Baroh, West Aceh Regency, have a static stability parameter value above the value suggested by IMO, meaning that the fishing boats are at a good level of stability. Changes in the values of the static stability parameters are influenced by changes in the weight of the ship's load or cargo, which can be seen from changes in cargo (condition I, condition II and condition III). The heavier the load, the lower the value of the ship's static stability.

The steering system of fishing vessels generally uses a single plate (Trimulyono *et al*., 2013). Putra (2019) stated that the use of the fishing boat steering system is also influenced by the habits of fishermen, such as fishermen at the Brondong Archipelago Fishery Port, East Java, who still use wooden rudders.

All fishing boats owned by fishermen at PPI Ujong Baroh use a single plate rudder with a stick as a tool to move it. According to local fishermen, this steering system has been used for a long time. The reason is that the steering system is easy to maintain and operate.

The fishing gear used by fishermen at PPI Ujong Baroh is in the form of gill nets, longlines, handlines, and trolling lines. When viewed from the way of operation, gill nets, longlines, and handlines are included in the static gear group, while the towed fishing line is included in the towed gear group (Fyson, 1985). The static gear group of ships is required to have high ship stability. This is because, during the operation of the fishing gear, the ship tends to move at a low speed or stay still (engine off) during the operation of the fishing gear. This condition causes the performance of ships at sea to be significantly influenced by waves.

CONCLUSION AND RECOMMENDATION

Conclusion

The fishing vessel used by fishermen at PPI Ujong Baroh, West Aceh Regency, has a relatively similar shape to the rafters in terms of the shape of the bow and stern crests and the shape of the longitudinal and transverse sections. However, the transverse shape of the ship used is of two forms, namely round-bottom and round-flat- bottom.The ratio of the main dimensions of the ship in the two groups of ships has differences in L/B and B/D. The group of 6-10 GT vessels has a smaller L/B ratio and higher B/D compared to the group of vessels 1-5 GT.

Recommendation

The results of this study can be used as one of references for the government in determining the size of fishing vessels in the fishing vessel assistance program to fishermen in Aceh region.

AUTHOR'S CONTRIBUTIONS

The contributions of the authors in this study are as follows, JJ contributed in data collecting, method, formal analysis, visualization and writing original draft. YN contributed in conceptualization, method, formal analysis and writing original draft. BHI contributed in conceptualization, formal analysis and reviewing original draft.

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