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The Ratio of Storage Volume to Cubic Number for Rampus Nets at the Karangantu Archipelago Fishery Port-Banten

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ABSTRACT The Banten Province Maritime Affairs and Fisheries Service plans to standardize the hold volume for fishing vessels in its management area. The management plan is still challenging to implement because there is no information about the vessel storage volume. In addition, small fishing vessel fishers still store their catch in boxes made of fibre-reinforced plastic (FRP). That box is often placed on the deck floor, causing decreased vessel stability. The size of the available storage volume on the vessel must be ideal, so it needs to be compared with the cubic number. This research aims to determine the optimal storage volume to cubic number ratio for rampus net vessels with the best stability conditions. The sampling technique used was accidental sampling with a total sample of 10% from 72 fishing vessels. Data processing used mathematical calculations and stability simulation with the GZ program. Analysis of the data used is descriptive analysis. The results showed that the optimal ratio of storage volume to cubic number for vessels with sizes 3-5 GT ranged from 5.03 - 8.55%. That ratio was a storage condition designed inside the hull construction, and the catch is directly put into the store without using the FRP box. From the stability point of view, condition 3 is the best for the quality of fishing vessel's stability. This due to the lowest value of KG in condition 3 comparing to other conditions.

Keywords: Cubic number; hold volume; rampus net; ship; stability

INTRODUCTION

The Banten Province Maritime Affairs and Fisheries Service plans to standardize the hold volume for fishing vessels in its management area. That is intended to facilitate fisheries management based on fishing capacity in Banten Province. Fishery management based on fishing capacity is urgently needed to control fishery resources that limit fishing effort capacity (Nugraha & Hufiadi, 2016). This information will predict the fishing capacity of each fishing fleet. In addition, standardization of the storage volume is also intended to ensure the seaworthiness of the fishing vessel from the perspective of the stability of the fishing vessel (Susanto *et al.*, 2011).

The capture fisheries management plan by the Banten Maritime Affairs and Fisheries Service is tricky because there is no information about the size of the hold volume available on board. That is because the storage volume is determined by the habits of fishing vessel builders in an area. According to Tangke (2010), almost 85% of fishing vessels in Indonesia are made in traditional fishing vessel yards, based on hereditary expertise. Mainly to get the optimal hold volume for fishing vessels because small vessels still store their catch in boxes made of FRP (Fiberglass Reinforced Plastics). The box is often placed on the floor deck. According to Novita *et al*. (2014), placing cargo above the fishing vessel's deck floor can worsen fishing vessel stability. So, it is necessary to do a research to obtain the optimal storage volume on fishing vessels. The optimal volume of the storage is the volume of the storage that can accommodate optimal catches and still has good fishing vessel stability. DKP Banten Province will use this research to calculate a fishing fleet's fishing capacity and productivity.

Fyson (1985) states that the available storage volume in the fishing vessel must be ideal. The storage size that is too large or too small will result in inefficient distribution of space on the fishing vessel so that the volume of the hold on a fishing vessel needs to be compared to the size of the fishing vessel, which is called the cubic number (CUNO). CUNO is the multiplication of rectangular space obtained by multiplying the fishing vessel's length, width, and height in cubic meters (m3). This comparison value will later produce a ratio value used to determine the storage volume for a particular fishing vessel size.

This research was conducted at the PPN Karangantu, the only Type B fishing port in Banten Province. PPN Karangantu is the supplier of most fish needed in Banten Province. According to Diniah *et al*. (2012), PPN Karangantu is a vital capture fisheries centre in Serang City. So, PPN Karangantu has a significant role in determining fishing capacity in Banten Province.

There are quite a variety of fishing vessels in PPN Karangantu. Among them are fishing vessel lift nets, Share *Operated Stationary Lift Nets*, rampus nets, crab nets, payang nets, dogol nets, sero, fishing rods, and other fishing gear (PPN Karangantu, 2018). The rampus net fishing vessel is the fishing vessel that has the most dominant number of fish storage. Nevertheless, in the storage system, the rampus net fishing vessels use boxes made of FRP to store their catch and then put them on hold. It makes the rampus net fishing vessel became the subject of this research. The process of operating the rampus net is only on one side of the fishing vessel. So, it takes good stability for lean net fishing vessels.

This research aims to: 1) calculate the storage volume ratio and CUNO on rampus net fishing vessels at PPN Karangantu, 2) assess the stability quality of each hold volume ratio value to CUNO for rampus net fishing vessels, and 3) recommend the optimal ratio of Storage volume and CUNO.

MATERIALS AND METHODS

This research was conducted in April 2020. The location of data collection was carried out at PPN Karangantu, Serang City, Banten Province. The research subject used is a 3-5 GT rampus net fishing vessel based at PPN Karangantu and has the shape of transom rafters. The number of transom-shaped vessels is the most dominant among other completed nets, about 86% of the population of rampus nets at PPN Karangantu. Based on PPN Karangantu, the rampus net fishing vessels in transoms amounted to 72 units. The sample used is as much as 10% of the rampus net fishing vessel population in the form of a transom. Determination of the sample is done by purposive sampling. That is because not all populations have the same opportunity to be selected as samples. After all, some fishing vessels are in difficult locations to reach. The sample criteria used through this purposive sampling method must meet the standards, which are between 3-5 GT in size, transom in shape, and have storage. Based on the above criteria, the number of samples obtained in as many as eight fishing vessel samples.

The data collected includes data on the main dimensions of the fishing vessel consisting of length (LOA, Length Over All), width (B), and height (D) of the fishing vessel; dimensions of the storage consisting of length (p), width (l) and height (t) of the storage. The dimensional data is obtained by directly measuring the object using a measuring instrument and assisted with a water pass as a benchmark for the object's position evenly over the water. This research also required data related to weight, dimensions, and cargo position on the fishing vessel. The data was obtained through observation and interviews with fishers, especially data related to the weight of the cargo.

Data processing is carried out to obtain the optimal value of the storage volume ratio and CUNO with the best stability quality for the rampus net fishing vessel. The treatment given in the stability simulation is as follows: Condition 1: the use of 2 fibre boxes placed in the hold and two fibre boxes each in the bow and stern; Condition 2: the use of 2 fibre boxes placed in the hold; Condition 3: the storage is designed and constructed in the hull, where the storage size can accommodate the catch, which is stored in 4 fibre boxes. The dimension of FRP box is 0.81 × 0.51 × 0.58 (m^3).

Some of the equations used in processing research data include:

1) Calculation of storage volume

- Calculate the area of the perpendicular side using the Simpson's I formula:

$$A\ (m^2) = \frac{1}{3} \times h\ (y_0 + 4y_1 + 2y_2 + 4y_3 + 2y_4 + 4y_5 + y_6)$$

with:
$A = A_0 = A_1$

- After the value of the cross-sectional area is obtained, the volume of the storage can be calculated using the formula:

$$V_{storage}\ (m^3) = A \times p$$

with:
p = length of storage (m)

- Stowage Factor (Fyson, 1985)

$$SF\ (\ ton/m^3) = \frac{\text{Catches loading capacity (ton)}}{\text{Storage Volume } (m^2)}$$

2) Calculation of CUNO (Cubic Number) using the formula (Fyson, 1985):

$$CUNO\ (m^3) = LOA \times B \times D$$

with:
LOA = length of the ship between the bow and stern ends (m); B = ship width (m); D = ship height (m)

1. Calculation of the storage volume ratio to CUNO using the following equation

$$\text{Percentage } (\%) = \frac{V_{storage}}{CUNO} \times 100\%$$

2. The calculation of GT (Gross Tonnage) according to Ministerial Regulation Number PM 8 of 2013 uses the formula:

$$GT = 0{,}25 \times V$$

with:
V = volume of space below deck (V_1) and volume of space above closed deck (V_2)

- Volume of space under the deck of the fishing vessel (V_1)

$$V_1\ (m^3) = p \times l \times d \times f$$

with:
p = LOA (m); d = D (m); l = B (m)
f = factor determined according to the shape and type of fishing vessel

a. 0,85 (barge)
b. 0,70 (motorboat)
c. 0,50 (sailing boat/motor sailing boat)

- Volume above the deck of the fishing vessel (V_2)

$$V_2\ (m^3) = p \times l\ (r) \times t\ (r)$$

with:
p = length of room (m); l = average width (m); t = mean height (m).

3. Calculation of stability based on load distribution according to Fyson (1985):

Moment (kg) = Weight (kg) × Position of center of gravity (m)

$$KG = \frac{\text{Moment of } \Delta}{\Delta}$$

with:
KG = distance of point G vertically from the top of the keel (m); Moment of Δ = moment (kg.m); Δ = weight (kg)

4. The relationship of stability parameter and storage volume

In a fishing vessel there are various storage rooms. Each room has specific function for storage, such as to store supplies, fuel oil, fresh water, fishing gear, equipment and room for crews as well. These room has its center of gravity and for all rooms in a fishing vessel, there will be one centre of gravity as a resultant of those each centre of gravity. The value of a fishing vessel's centre of gravity is represented by KG value. This value can be used as initial assessment of stability quality of a fishing vessel by comparing to depth of a fishing vessel. When the kg value is less than the depth, the stability is better.

The analysis used to answer all the objectives of this research is descriptive analysis. Descriptive analysis can provide an overview of the problem based on existing data. In this method, the researcher collects data processed to obtain a clear picture of the relation between fishing vessels between the variables studied (Marlina & Danica, 2009). The data that has been processed is then compared with the literature obtained through literature research. This analysis can conclude the problems studied (Lasena, 2013).

A descriptive analysis of the first objective determines the ratio of storage volumes and CUNO for rampus net fishing vessels, beginning with describing the main dimensions of rampus net fishing vessels and then comparing them with the literature. Furthermore, to describe the storage volume in conditions two and condition 3, the size of the CUNO fishing vessel and the ratio of the volume of the hold to the CUNO of the rampus net fishing vessel.

Descriptive analysis for the second objective is to assess the stability quality of each volume ratio value to the CUNO for the rampus net fishing vessel. First, describe the stability quality of the fishing vessel in the three conditions, namely conditions 1, 2, and 3, which were previously simulated using the GZ program. Then, the quality of the fishing vessel's stability is best among the three conditions.

A descriptive analysis of the third objective, which recommends the optimal storage volume ratio and CUNO, is carried out by describing the most optimal ratio based on the storage volume ratio obtained in destination one and the quality of stability obtained in destination 2.

RESULTS AND DISCUSSION

Slim mesh fishing vessel design

The rampus net is one of the dominant fishing gears in PPN Karangantu. The rampus net fishing vessels are usually moored in the river along the Karangantu PPN around Kapuran Village. Kapuran Village is a village where most of the population makes a living as fishermen from rampus nets. So, it can be said that fishers from Kapuran Village dominate the net fishers operating in PPN Karangantu.

Rampus nets are included in the classification of bottom gillnets. The mesh size used by fisher is 2 inches. According to Iskandar & Pujiati (1995), gillnet fishing vessels are included in the group of fishing vessels operating at rest in the middle of the waters (fixed gear). The rampus net is also included in the static gear fishing vessel group. The Rampus net fishing gear is usually used to catch demersal fish and small pelagic fish. The main catch of the rampus net is mackerel. The catch can reach 400-500 kg for Rp. 20,000/kg during the peak season. Meanwhile, mackerel catches are tiny during the famine season, with only 30-50 kg or no results. The by-catch of the rampus nets is tengkek, layur, and tuna.

The Mesh nets fishing vessel is the only fishing vessel that uses a hold to store its catch. The number of rampus net fishing vessels is 72 vessels with sizes between 3-5 GT (Figure 1). The rampus net fishing vessels at PPN Karangantu consist of 2 types, namely Kasko and Jhonson vessels. The difference between the two types of fishing vessels is seen in the shape of the fishing vessel's stern, the wheelhouse, and the presence of the storage. Kasko type fishing vessel has a transom stern model and is equipped with steering housing. The Jhonson-type fishing vessel has a double-pointed stern model and is not equipped with a steering wheel. Kasko and Jhonson-type fishing vessels both have storage constructions. The difference is that the storage of the Kasko fishing vessel is equipped with a storage cover made of wood and its shape protrudes above the deck floor.

Meanwhile, the storage on the Johnson fishing vessel has a lid parallel to the deck floor and sometimes does not have a storage cover. The catch is not stored directly into the hold but is first put into an FRP (Fiberglass Reinforced Plastics) box, referred to as "box fibre," as many as two pieces. Furthermore, the fibre box is placed under the floor deck. Apart from the dimensions of the fishing vessel, the Kasko fishing vessel has a larger size than the Johnson model fishing vessel.

Side view

Front view

Figure 1. The rampus net fishing vessels.

The range of the main dimensions of the rampus net fishing vessel sampled (Table 1) with a size of 3-5 GT, namely LOA (Length Over All) or vessel length of 10.74-12.83 m, B (Breadth) or vessel width of 1.95 -2.56 m, and D (Depth) or vessel height of 0.7-0.9 m. The absence of standard vessel sizes causes the main dimensions of the very diverse netting fishing vessel because this shipbuilding is still made in traditional shipyards based on experience. The average length of the sample vessels is 11.72 m, with an average vessel width of 2.32 m. According to Susanto *et al*. (2011), the parameter that can be used to determine the quality of the vessel to be built is the ratio of the main dimensions. The primary dimension ratio is used to see the strength of the construction, resistance to motion, and the vessel's manoeuvrability. Vessels with an ideal primary dimension ratio will have good ship performance (Istiqomah *et al*., 2014). The sample ship has a range of values for the primary L/B dimension ratio, 4.20 - 5.80. According to Fyson (1985), the value of the ratio of length and width (L/B) affects the resistance of motion and vessel speed. The range of L/B ratio values is close to the lower limit of the reference value. That shows that the resistance to motion experienced is quite significant, harming the vessel's speed.

The ratio between length and height (L/D) is a factor that affects the longitudinal strength of the vessel. According to Ayodyoa (1972), the vessel's longitudinal strength indicates the possibility of longitudinal fracture of the vessel. The ratio values obtained on the sample vessels ranged from 12.54 to 16.66 and were close to the upper limit of the reference value. So that the sample ship has a longitudinal strength that is still quite good with the length and height of the vessel, which is quite ideal as a static gear ship, the value of the ratio of width and height (B/D) can affect the stability of the vessel and the vessel's manoeuvrability. The range of the B/D ratio value on the sample ship is 2.52 - 3.55, meaning that the stability of the vessel and the vessel's manoeuvrability are still relatively good because it is in the range of the reference

Table 1. Main dimension and ship's primary dimension ratio.

Sample ship	GT	Main Dimension			L/B	L/D	B/D
		L	B	D			
Ship 1	4	12.83	2.23	0.89	5.75	14.50	2.52
Ship 2	4	10.91	2.38	0.87	4.58	12.54	2.74
Ship 3	4	12.24	2.30	0.85	5.32	14.39	2.71
Ship 4	3	10.74	2.56	0.72	4.20	14.92	3.55
Ship 5	3	11.28	1.95	0.70	5.80	16.11	2.78
Ship 6	3	12.29	2.18	0.74	5.64	16.66	2.95
Ship 7	5	11.50	2.50	0.90	4.60	12.78	2.78
Ship 8	5	12.00	2.50	0.90	4.80	13.33	2.78
Range	3.0-5.0	10.74-12.83	1.95-2.56	0.7-0.9	4.2-5.8	12.54-16.66	2.52-3.55
Median	4	11.72	2.32	0.82	5.09	14.4	2.85
			Reference value[1]				
				Static Gear	2.83-11.12	4.58-17.28	0.96-4.68

Note: [1]The range of the ratio values of the main dimensions of the static gear ship (Iskandar & Pujiati, 1995) is referred to in (Rahman & Novita, 2006).

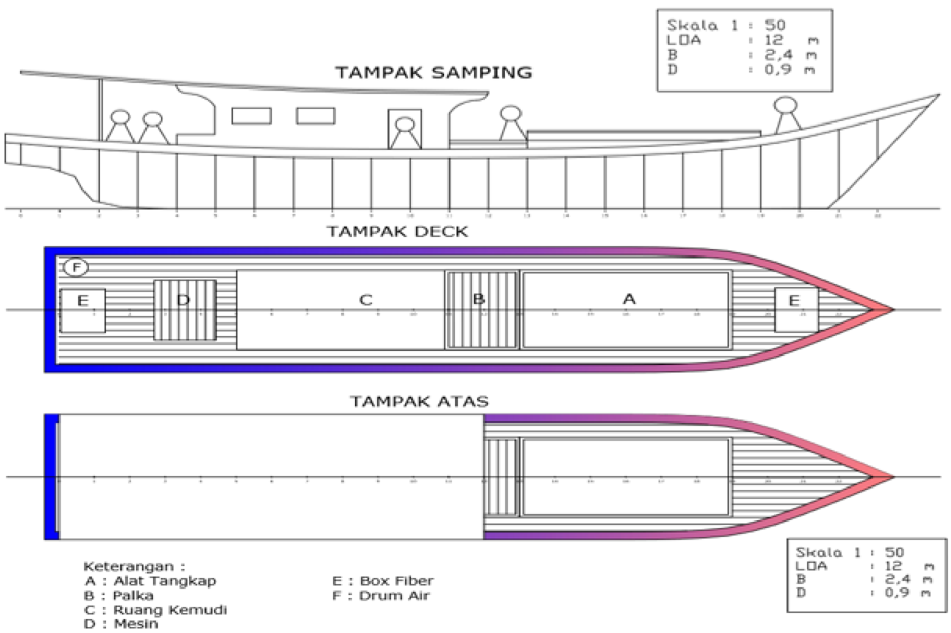

Figure 2. General arrangement for rampus net fishing vessel.

value of the static gear ship. The value of this ratio is still included in the range of the primary dimension ratio valuesof the static gear ship group in Indonesia, according to Iskandar & Pujiati (1995) (Table 1). That shows that although the vessel construction is carried out traditionally when viewed from the ratio of its main dimensions, it is still suitable as a static gear ship.

Freeboard can be interpreted as part of the hull that is not immersed in water. The freeboard helps hold water from entering the vessel, so the height of the freeboard is closely related to the flooding angle (FA) value. FA is the angle formed between the position of the hull in an upright position and the tilt of the vessel when water begins to enter the deck floor (Tawada, 2014). The highest flooding angle value (Table 2) of the 8 sample vessels is Ship 5, which is 24°, while the smallest flooding angle value is Ship 4, which is 18.5°. According to Tawada (2014), the smaller of FA value, the smaller the slope tolerance of the hull and the greater chance for water to enter the vessel. In Figure 2, the general arrangement of the rampus net fishing vessel at PPN Karangantu.

Table 2. Floading angle from samples.

Sample ship	D	Freeboard	FA
Ship 1	0.66	0.42	21°
Ship 2	0.74	0.45	21°
Ship 3	0.64	0.41	20°
Ship 4	0.66	0.42	18.5°
Ship 5	0.70	0.43	24°
Ship 6	0.55	0.38	19.5°
Ship 7	0.68	0.43	19°
Ship 8	0.68	0.43	19°

The general arrangement shows the space's layout and cargo on board, below and above the vessel's deck floor. Figure 2 shows that above the floor deck, there is a wheelhouse, a lidless box for placing fishing gear, and a storage cover protruding slightly above the deck. As for the space below the deck floor, there is a storage that is only half its height and the vessel's engine room. The storage usually contains two fibre boxes. Then for cargo on the deck floor, fibre boxes are placed on the bow and stern of the vessel, each of which is one piece. The drum filled with clean water is usually placed next to the fibre box at the vessel's stern. About one crew member is sitting in the midship area, one person in the bow, one in the wheelhouse, and two in the stern.

A good ship design is also supported by the size of the work area above the vessel's deck. The deck area on the sample ship is 22.05 m^2, and the working area is 10.15 m^2. So, the percentage of the work area to the vessel's deck area is 46%.

The transverse shape of the rafters of the rampus nets can be seen in the body plan image presented in Figure 3. From Figure 3, it can be seen that the rafters studied have a V-shaped rafter in the bow and a U-shape in the midship to the stern. Kasko with a V shape in the bow serves so that the vessel can split the water well when sailing. According to Rahman & Novita (2006), the U-bottom kasko form has higher stability than other forms of kasko. Rahman & Novita (2006) also added that the static gear ship group needs high stability because its operation is silent mainly in the middle of the waters and is often exposed to sea waves. Based on the method of operation of the vessel, the rampus net ship is included in the static gear ship group.

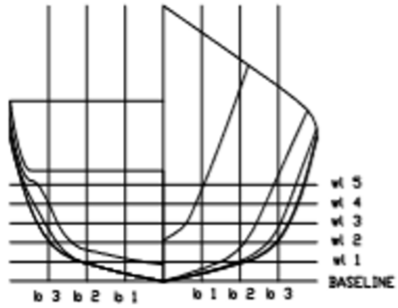

Figure 3. The shape of the rampus net's kasko.

The shape of the bow height on the rampus net vessel is a raked bow with a slope angle of 60º - 66º (DKP Banten, 2018). Based on the angle of inclination of the bow, the shape of the bow is included in the raked bow sloping (RBL) because it has a slope angle of more than 45º. Following the research results by Bangun *et al*. (2017), fishing vessels in Indonesia, especially gillnet vessels, are generally dominated by the shape of the bow ridge in the form of a raked bow.

The rampus net vessel storage

The research vessel has storage located in the vessel's hull in a position between the wheelhouse and the fishing gear. The storage construction follows the curvature of the hull. The hold only has a barrier wall or transverse bulkhead installed from the top to the bottom of the vessel's hull. However, when fish were in the storage, two fibre boxes with a size of 0.81 × 0.51 × 0.58 m were inserted with a volume of 0.24 m^3. The capacity of this fibre box is 0.13 tons when filled with mackerel and ice. The use of box fibre in the store makes it easier for fishers to load and unload their catch. In addition, it is also intended that the ice used does not melt quickly. The stowage factor for mackerel storage systems in bulk or bulk is 0.54 ton/m^3. This value is 0.04 greater than the value of the stowage factor for tuna storage systems using bulk, according to Fyson (1985), which is 0.5 tons/m^3.

The catch storage system using two fibre boxes inserted into a constructed storage is a storage system in the existing condition of the vessel (condition 2). The storage volume in the storage of catches in fibre boxes is 0.48 m^3 (2 fibre boxes) with a maximum capacity of 0.26 tons with ice. Then if the catch storage system is directly inserted into the constructed storage (condition 3) on board, the hold volume ranges from 0.81 to 2.11 m^3 which can accommodate catches ranging from 0.44 to 1.15 tons. In discussing the ratio of the storage volume to the vessel's cubic number, the storage volume used is the volume of the storage when the catch is stored in the hold without additional box fibre. So that the volume of the storage used is only in conditions two and condition

Table 3. The ratio of storage volume to CUNO.

Sample ship	CUNO	Volume and Storage Capacity				The Ratio of Storage Volume/CUNO	
		Condition II		Condition III			
		V (m^3)	Max capacity (ton)	V (m^3)	Max capacity (ton)	In the box fibre	On storage construction
ship 1	25.33	0.48	0.26	1.28	0.69	1.89%	5.03%
ship 2	22.58	0.48	0.26	1.93	1.05	2.12%	8.55%
ship 3	23.92	0.48	0.26	1.84	1.00	2.00%	7.71%
ship 4	19.78	0.48	0.26	1.49	0.81	2.42%	7.52%
ship 5	15.36	0.48	0.26	0.81	0.44	3.12%	5.28%
ship 6	19.78	0.48	0.26	1.57	0.85	2.42%	7.91%
ship 7	25.88	0.48	0.26	1.68	0.92	1.85%	6.51%
ship 8	27.00	0.48	0.26	2.11	1.15	1.77%	7.81%
Range	15.36-27	-	-	0.81-2.11	0.44-1.15	1.77%-3.12%	5.03%-8.55%
Median	22.45	-	-	1.59	0.86	2.20%	7.04%

3, this is used to compare the most optimal storage system.

Based on the calculation of the ratio of the storage volume to the cubic number (CUNO) of vessels as presented in Table 3, it can be seen that the cubic number of the eight samples of rampus net vessels is in the range of 15.36 - 27 m^3. Then the ratio of storage volume to CUNO in condition two ranges from 1.77 - 3.12%, and in condition 3 is 5.03 - 8.55%. The ratio value indicates that the percentage of space used from the volume of the rectangular space below the vessel's deck is used as a hold.

According to Fyson (1985), the hatch volume in the vessel must be of ideal size. If the storage volume is too large, it can result in inefficient space distribution on the vessel. In addition, it affects the vessel's stability and speed due to overload because more catches are accommodated. The storage volume that is too small results in inefficient fishing operations because the catch that can be accommodated is small compared to the operating costs incurred (Iskandar & Mawardi, 1997).

The stability of the leaning net ship

The suitability of the load on the vessel must be considered to keep the vessel stable and prevent the vessel from entering water quickly due to the freeboard height being too low. The placement of cargo on the vessel will affect the location of the centre of gravity on the vessel. Hind (1982) states that the addition, subtraction, or displacement of cargo will affect the existence of point G. If the distance from point G to point K (Keel, keel) is getting smaller. The vessel is in a stable equilibrium position, whereas if the distance from point G and point K is getting smaller, the vessel is in an unstable equilibrium position.

The cargo usually onboard the vessel is the engine, fishing gear, fishers, diesel fuel, freshwater, catch and box fibre to store the catch. The payload that changes frequently is the catch. Fishers often use additional fibre boxes on the boat deck to accommodate excess catch during peak season. Whereas according to Novita *et al*. (2014), placing cargo under the deck floor of the vessel can increase the stability of the vessel. In this case, stability simulation is

Table 4. Determination of KG point in condition 1.

Tipe of Loadcase	Amount	Weight (kg)	The position of Gravity point	*Moment*
Ship		2000	0.27	540
Ship machine	1 unit	185	0.3	55.5
The rampus net	1 unit	1500	0.67	1005
Fisher	5 peoples	325	0.825	268.125
Fuel oil	40 liter	33	0.25	8.25
Fresh water	1 drums	100	0.9	90
Fiber box + fishing gear is below the deck	2 box	292	0.68	198.56
Fiber box + fishing gear at the bow	1 box	146	0.8	116.8
Fiber box + fishing gear at the stern	1 box	146	0.8	116.8
	Δ=	4727	*Moment of* Δ=	2399.035

KG = 0.508 m

Tabel 5. Determination of KG point in condition 2.

Tipe of Loadcase	Amount	Weight (kg)	The position of Gravity point	Moment
Ship		2000	0.27	540
Ship machine	1 unit	185	0.3	55.5
The rampus net	1 unit	1500	0.67	1005
Fisher	5 peoples	325	0.825	268.125
Fuel oil	40 liter	33	0.25	8.25
Fresh water	1 drums	100	0.9	90
Fiber box + fishing gear is below the deck	2 box	292	0.68	198.56
Fiber box	1 box	16	0.8	12.8
Fiber box	1 box	16	0.8	12.8
	Δ=	4467	*Moment of* Δ=	2191.035

KG = 0.49 m

Table 6. Determination of KG point in condition 3.

Tipe of Loadcase	Amount	Weight (kg)	The position of Gravity point	Moment
Ship		2000	0.27	540
Ship Machine	1 unit	185	0.3	55.5
The rampus net	1 unit	1500	0.67	1005
Fisher	5 peoples	325	0.825	268.125
Fuel oil	40 liter	33	0.25	8.25
Fresh water	1 drums	100	0.9	90
Fishing gear on the storage		520	0.58	301.6
	Δ=	4663	*Moment of* Δ=	2268.475

KG=0.486m

carried out by comparing conditions 1, 2, and 3 to see the best ship stability (Table 4-6).

KG point is the distance of point G vertically from the top of the ship's keel. The most significant KG point is produced in condition 1 of 0.508 m. The minor KG point is produced in condition 3, 0.486 m. So it can be said that according to the distribution of cargo on board, the best condition is in condition 3 when all the catch is put into a constructed hatch without using fibre boxes and without any additional fibre boxes on the ship's deck floor. This condition has the best stability because the distance between point G and point K is getting smaller due to the large cargo distribution under the ship's deck (Farhum, 2010). Figure 4 shows the ship's stability curve in 3 hatch placement conditions.

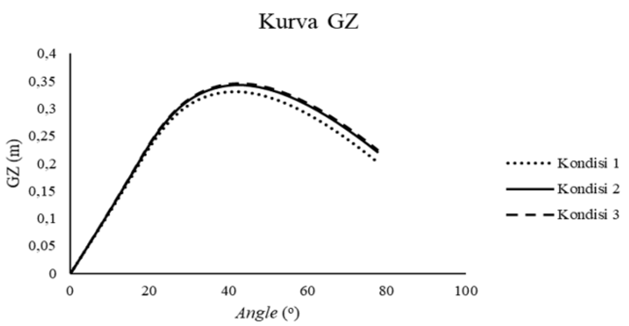

Figure 4. Stability curve on the third condition.

A stability curve can be generated based on the KG points obtained from the three conditions above, as shown in Figure 4. The curve in condition 3 has a higher stability curve than the other curves. The difference in curves in each condition did not experience a significant difference. Especially in condition two and condition three, the curves coincide.

The stability parameter in the stability curve is the value of GZmax of the vessel's tilt angle when GZmax is formed and the large area under the curve up to the vessel's tilting angle when GZmax is formed. Table 7 shows the parameter values obtained from the three conditions. The GZmax value on the three curves is 0.3303, 0.3425, and 0.3452 m. Then the angle of sway formed when GZmax in the three conditions has the same value, which is 42.5°.

Although the three conditions have good stability, condition 3 has the best stability. Because when viewed from the catch that can be accommodated, conditions one and three can accommodate the same catch. However, in condition 1, the weight of 4 fibre boxes is added, each weighing 16 kg. The load of the catch becomes 584 kg. In addition, two fibre boxes in condition one are placed on the floor of the vessel's deck, which according to Hind (1982), if the load on the deck floor can cause the point of gravity to shift away from the keel. So that the height of the KG point is getting bigger, and its stability is decreasing. It is different in condition 3, and all catches are directly put into the hold without using a fibre box. Also, there is no fibre box located on the deck floor. The catch load that is accommodated is only 520 kg or even more without being added to the weight of the fibre box. So, condition 3 is the best stability and ability to accommodate catches. Besides, the KG value in condition 3 is the lowest value of KG among others condition.

Recommended optimal storage and CUNO volume ratio

The recommended ratio of storage volume to CUNO for lean net vessels is 5.03-8.55% for 3-5 GT vessels. This ratio value is obtained if the storage is designed to be constructed inside the hull. Then the catch storage system is directly inserted into the constructed storage without using a fibre box and not using an additional fibre box on the deck floor (condition 3).

This storage system also has the best stability conditions when using fibre boxes compared to the catch storage system. The values of KG, GZmax and the angle at GZmax are 0.486 m, respectively; 0.345 m and 42.5°.

The use of the constructed storage must be under the proper function of the storage. KEPMEN KP RI Number 52A/KEPMEN-KP/2013 concerning quality assurance and safety requirements of fishery products in the production, processing, and distribution processes. Fishing vessels designed to keep fish fresh for more than 24 hours must be equipped with holding equipment for storing fish and keeping the coolant temperature at the melting point of ice. Then to prevent contamination, the hold must be separated from the engine room and crew and must ensure that the storage conditions can maintain the freshness of the fish and meet the hygienic requirements. Lean net ships equipped with constructed storage can later be equipped with insulated storage. The storage can use styrofoam and wood to coat the storage walls, such as the cantrang ship storage, according to Erincasari (2014).

CONCLUSIONS AND RECOMMENDATION

Conclusion

The ratio of the storage volume to the CUNO of the rampus net boats ranged from 1.77 - 3.12% in condition two, and condition 3 ranged from 5.03 - 8.55%. Stability in conditions 1, 2, and 3 has a KG point of 0.508; 0.490; 0.486 m and GZmax of 0.330; 0.343; 0.345 m, and the swing angle at the same GZmax is 42.5º. But condition 3 has the best stability. The optimal ratio of storage volume to the cubic number of rampus net vessels for sizes 3 - 5 GT is in the range of 5.03 - 8.55% (1/19.78 - 1/11.69).

Recommendation

Further research is needed to compare the quality of the catch when using fibre boxes and constructed storage on ships.

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