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Redesign of the Fish hold on the Pure Seine 30 Gross Tone Ship as a Safety Device

Moch Ricky Dariansyah[a]*, Yopi Novita[b],Budhi Hascaryo Iskandar[c], Indra Jaya[d], Vita Rumanti[e]

[a,b,c,d,e]Department of Fishery Resource Utilization, Faculty of Fisheries and Marine Science, Bogor Agricultural University, Bogor 16680, Indonesia

[a]Email: ricky.nautical@yahoo.com

[b]Email: yopi_novita@apps.ipb.ac.id

[c]Email: budhihascaryo@apps.ipb.ac.id

[d]Email: indrajaya@apps.ipb.ac.id

[e]Email: vitarumanti@apps.ipb.ac.id

Abstract

This research aims to redesign the hatch on a 30 GT pure seine fishing vessel made from fiberglass. The hatch is designed using a separate hatch construction system from the ship's construction, so that when the ship has an accident and sinks the hatch can be separated from the ship's rafters and used as a safety device. The method used in this research is the numerical simulation method. The calculations carried out include calculating the volume of the hold, the total weight of the hold construction materials when empty, the maximum capacity of the hold to accommodate caught fish and the buoyancy capacity when the ship's crew (ABK) rests on the hold. The construction calculations used use the Indonesian Classification Bureau (BKI) class calculations which include dividing the distance between the transverse trusses as reinforcement for the hatch walls. The research results show that fish hatches can be used as additional safety equipment on ships using the principle of buoyancy possessed by these hatches.

Keywords: Life craft; fishing vessel; fish Hold.

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* Corresponding author.

1. Introduction

Fishing vessels operating in Indonesian waters vary greatly, including the basic type of vessel material, the shape of the raft, the main size of the vessel, and the type of fishing gear [1]. However, in terms of the safety of a ship and its crew (ABK), safety is an integral part that must be met by a fishing vessel regardless of the type of ship or fishing gear. Apart from that, ships are one of the main supporting tools in fishing businesses. The size of the ship will affect the distance of the fishing area, apart from affecting the distance of the fishing area, it will also affect the large or small number of caught fish that can be accommodated, namely the fish hatch. Storage of caught fish cannot be separated from one of the most important parts of the ship, where fish storage standards have been regulated as a source of animal protein [2]. We can see that the fish hold is the most important facility available on a ship as a storage container for caught fish as a reference that influences the operational profits of catching the catch. Apart from being a storage container for caught fish, the hatch can function to maintain the quality of the fish so that it remains hygienic and prevent the fish from getting damaged. Apart from that, the size of the hatch is also influenced by the shape of the ship's rafters (coefficient block). In general, fishing vessels during construction must follow recognized construction standard rules (Indonesian Classification Bureau/BKI) until the vessel is launched [3], apart from that the number of safety equipment or other supporting safety equipment must be in accordance with the number of crew (ABK) on board the vessel [4] and fulfill several requirements for seaworthiness and maintenance of safety instruments on board [5], so that if an accident occurs, the crew can save themselves with the help of available safety equipment. However, in practice, many ship crews are still reluctant to pay attention to the presence of safety equipment, for the reason that it reduces the work area of the ship during storage and increases operational costs by providing safety equipment when operating the ship in fishing. Therefore, in the design of fishing vessels, the main equipment part of the vessel, namely the fish hatch, will be utilized as an additional safety device without reducing the main function of the hatch as a storage place for caught fish.

2. Material and Method

This research was carried out from October 2023 to December 2023. The ship design used in the research used a fishing vessel assisted by the government under the supervision of the Ministry of Maritime Affairs and Fisheries (KKP), namely the Inka Mina vessel >30 GT, a type of purse seine fishing gear made from fiberglass (figure 1) and the main dimensions can be seen in table 1.

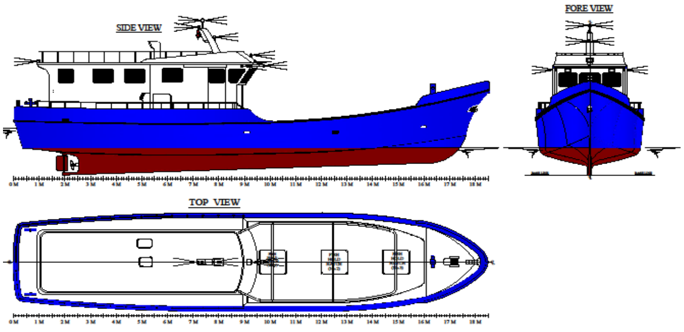


Figure 1: General Arrangement

Table 1: Main sizes of Pure seine vessels

Main Size	Size
Length Over All (*Loa*)	18,50 meter
Breath (*B*)	4,20 meter
Heigth (*H*)	2,00 meter
Draft (*D*)	1,20 meter

The tools needed to create a hatch design concept, apart from being a place to store caught fish, are also used as additional safety equipment, namely 1 PC unit equipped with ship design application software and ship simulation applications for data processing. Tools and materials are also needed to make prototype ships and hatches that are integrated into fishing vessel prototypes. The tools and materials used to make prototype ships and hatches are presented in Table 2 and Table 3.

Table 2: Tools for making dual-function ship and hatch prototypes.

No	Tool's name	Utility
1	Scale ruler or meter	To measure mall length units and models.
2	Paintbrush	For application use resin and gelcoat.
3	Saw hand	Cutting plywood in making a prototype mall.
4	Thread	As a measure of the center / center line of the prototype
5	Sandpaper	Smooth the surface of models and prototype molds.
6	Scissors	Cutting paper malls from printed prototypes.
7	Pencil or marker (*marking)*	Ordinal markers on the prototype mall.

Table 3: Materials for making dual-function ship prototypes and hatches.

No	Material name	Utility
1	Resin	The liquid ingredient in holding the meth together
2	Catalis	Resin hardener mixture
3	Mirror glaze	Smoothing the surface of the prototype mold
4	PPA (polyphthalamide)	Mall coating materials with prototype results
5	Met 300 gram and Ropping	Fibers in molds and prototype base materials
6	Gel coat (resin, aerosol, Cobalt)	Layer for smoothing the surface of the mold and prototype base material
7	Tripleks 9 mm	Creation of a prototype mall
8	Talk putty	Smoothing the surface of molds and prototypes

3. Data Colleting Method

The work procedure that will be carried out is by collecting technical data in the form of ship data with a size of 30 gross tons, consisting of the main dimensions of the ship (LOA, B, D, d) [6] and consisting of ship lengths which are divided into lengths of the tusk lengths. (frame) [7] Next, it is designed by taking into account several criteria, for example hatch construction using 2-dimensional software tools and ship design. Data types, data collection and processing are presented in Table 4.

Table 4: Types of data collection and processing for each research objective

Research purposes	Data type	Data collection	Data processing
Identify the need for a dual-function hatch so that it can work as a storage medium for caught fish and as a safety device.	Ship Dimensions (L_{OA}, B, D, d) Hatch dimensions The height of the ship's sheer from the deck floor Maximum number of catches Water pressure entering the ship's deck floor	Principle Dimension General Arrangement stability calculations	- Calculation of the total weight of the hatch - Calculation of minimum buoyancy requirements
Formulate design and construction concepts for dual-function hatches	- buoyancy requirements - weight of hatch and cargo		- Engineering design concept - Animation simulation experiments on software and experimental pool media with several standard calculation limitations *(naval architect)*

3.1. Data analysis

The research uses quantitative descriptive analysis to describe or describe the research object through predetermined fishing vessel data and the dimensions of the hold space as a storage place for caught fish, collecting, processing and interpreting data using numbers or numerical values.

4. Results and Discussion

The hatch is used as an alternative means of safety for a ship when it sinks during fishing operations at sea. Basically, the use of the hatch does not reduce the main function of the hatch, namely as a storage area for caught fish, but can be used as a safety device by detaching the hatch from the ship's construction like a lifeboat that can float on the surface of the water like a lifecraft. In this study, using a 30 GT vessel, the fishing time was 2 to 4 days depending on the fishing area and the number of fish filling the hold. The number of crew members operating is between 12 and 14 people. In table 5, the individual weights are based on the average individual height, especially the height of fishermen taken from data from the Ministry of Health of the Republic of Indonesia (Kemenkes RI) [8]. The average height of Indonesian fishermen ranges from 165 cm to 170 cm so that the total weight of the crew can be calculated as a maximum of 65 kg to 73 kg, amounting to 1,022 kg or the equivalent of 1,022 tons. From the calculation of the construction weight of the fish hold and the weight of the number of crew members on board the ship, it can be seen that the total weight of the hatch construction plus the total weight of the crew members is 1,325.88 kg or 1.325 tons.

Table 5: Ratio of height to weight

Height (cm)	**Body Weight (Kg)**		
	Small	**Medium**	**Big**
157	51 - 53	54 - 59	57 - 64
160	52 - 56	55 - 60	59 - 66
162	54 - 57	56 - 62	60 - 67
165	55 - 59	58 - 63	61 - 69
168	56 - 60	60 - 65	63 - 71
170	58 - 62	62 - 68	65 - 73
173	60 - 64	63 - 69	67 - 75
175	62 - 66	65 - 71	69 - 77
178	64 - 68	66 - 73	71 - 79
180	66 - 70	68 - 75	72 - 81

Source : P2PTM Kemenkes RI

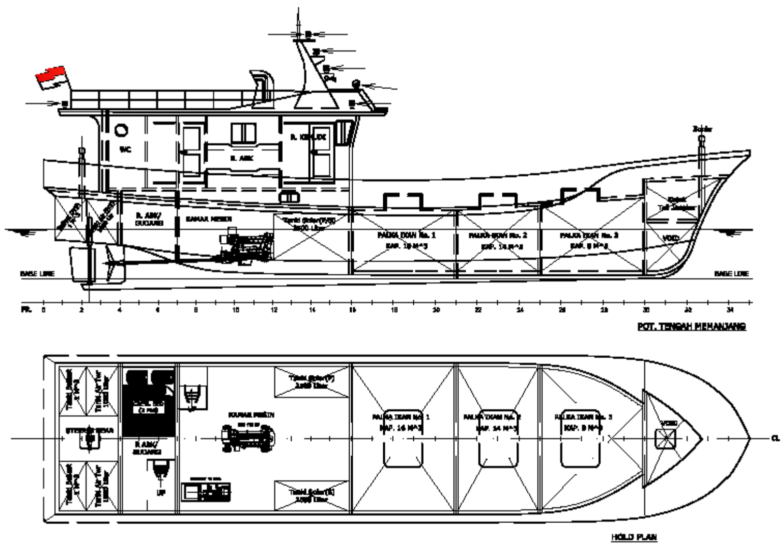
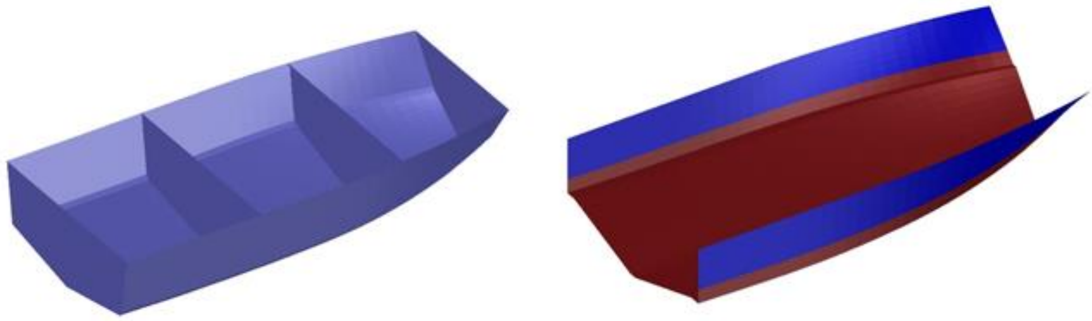


Figure 2: General Arrangement of the ship

The ability of the hatch to float on the surface of the water depends on the size of the load on the hatch, including the weight of the hatch material, the number and weight of each crew member and the number of fish caught. The design of the hold volume is influenced by the ship's rafter hull, which limits the distance between the inner wall of the ship's rafters and the outer wall of the hold, so that there is a cavity or confferdam for the entry of water into the dividing space (figure 3).



(a) (b)

Figure 3: Hold (a) and Hull (b)

The area of the hatch in the ship's rafters is calculated from the frame coordinates determined in the ship's planning design. In this experimental ship design, it is located in frames 9 to frame 16.2. So the two tusks are used as seats or hatch pads in the ship's rafter hull (figure 4).

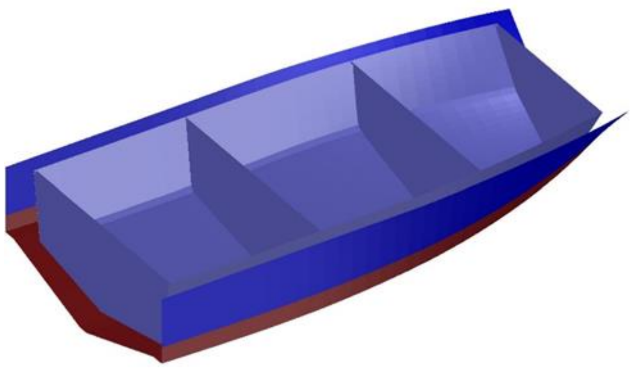


Figure 4: Hatch placement area in the ship's hold

The hatch is made of fiberglass (use standard marine) [9] which is equipped with several ivory parts as reinforcement and the seat in the hatch construction is equipped with a watertight hatch door with a high sill on the hatch. The area of the hatch wall in Figure 5 can be determined by using ship design software data on the maximum base area (WSA) as the area of the outer hull side of the hatch, which is found to be 35,274 m² and calculating the area of the hatch deck using the Simpson 1 and Simpson 2 area formulas [10], the area is 23,075 m². . Planning for the total weight of the hatch can be calculated from the thickness of the hatch walls by calculating the area of the hatch walls and deck as well as the hatch cover with a density of 2.48 gr/cm³ (can be seen in table 6).

Table 6: fiberglass characteristics

Material	Tensile modulus (GPa)	Tensile strength (MPa)	Density (g/cm3)
Fiberglass	85,5	4600	2,48

58,349 m² = 58.349 gr/cm³

Thickness of inner and outer hatch bindings 0,5 cm= Total 1 cm.

The weight of the hatch walls = Total area(cm³) x Density fiber glass(g/ cm³)

= 58.349 X 2,48

= 144.705,52 g

= 144,705 kg

The addition of tusks as construction is 10% of the weight of the hatch walls 144,705 kg = 14,470 kg

Total hatch weight = 2 (weight of the hatch walls) + frames

= 2 (144,705 kg) + 14,470 kg

So, the weight of the hatch = 303,88 kg

The hatch dimensions obtained from the design results of the experimental ship can be seen in table 8 and the hatch image in figure 5.

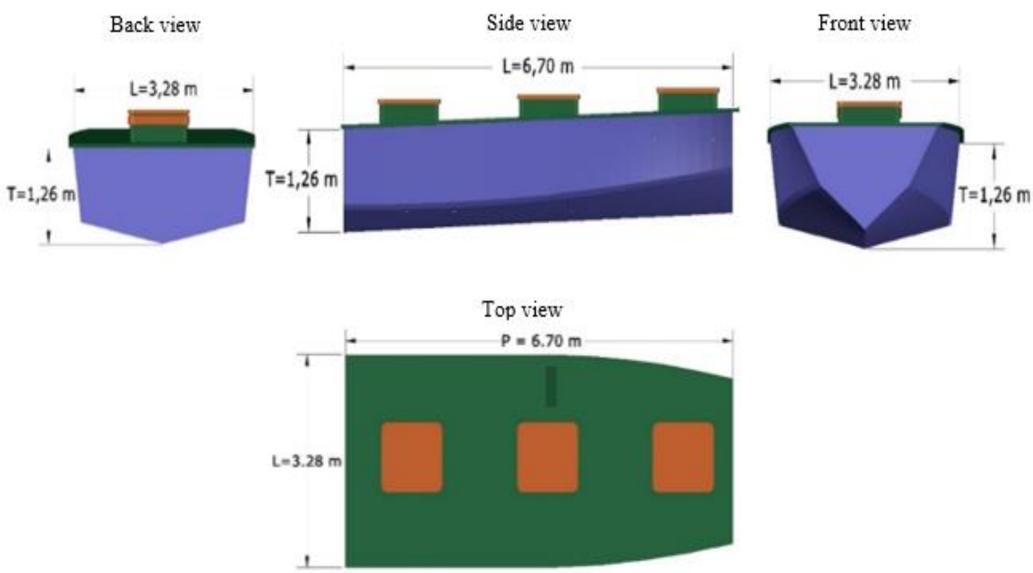


Figure 5: Fish hatch

Measuring the dimensions of the length, width and height of the hatch, it was found that the hatch formation value (Cb) was 0.700, the maximum volume was 19,388 m³, the displacement was 19,873 tonnes with tons per centimeter (TPc) of 0.212 at a hatch height of 1,260 meters. The hatch height division has displacement, volume and TPc values because the hull has an asymmetrical shape (following the shape of the ship's rafters) so that the hatch height has different measurement values. The measurement value for ship height divided into 0.26 meters can be seen in table 7 and in Figure 7 the graph shows the displacement, volume and TPc values.

Table 7:.Measurement of the hatch height value

Dratf hatch (m)	**1,260**	**1,250**	**1,200**	**1,150**	**1,000**	**0,500**
Displacement (tonne)	19,873	19,639	18,582	17,533	14,433	4,673
Volume (m³)	19,388	19,16	18,129	17,106	14,081	4,559
Immersion (TPc) (tonne/cm)	0,212	0,212	0,211	0,209	0,204	0,18

Table 8: Coefficient Value

Coefficient	**Draft Hatch (m)**	
	1,260	**1,000**
Prismatic coefficient (Cp)	0,830	0,796
Block coefficient (Cb)	0,700	0,656
Midship coefficient (Cm)	0,843	0,825

It can be seen from (Graph 6) that the maximum capacity of the hatch at the highest draft of 1,260 m is 19,873 tonnes where the surface of the hatch is parallel to the water surface, therefore the load set to obtain the threshold at the water surface is 1,000 meters with a capacity of 14,433 tonnes to obtain the threshold of the hatch of 0.260 meters.

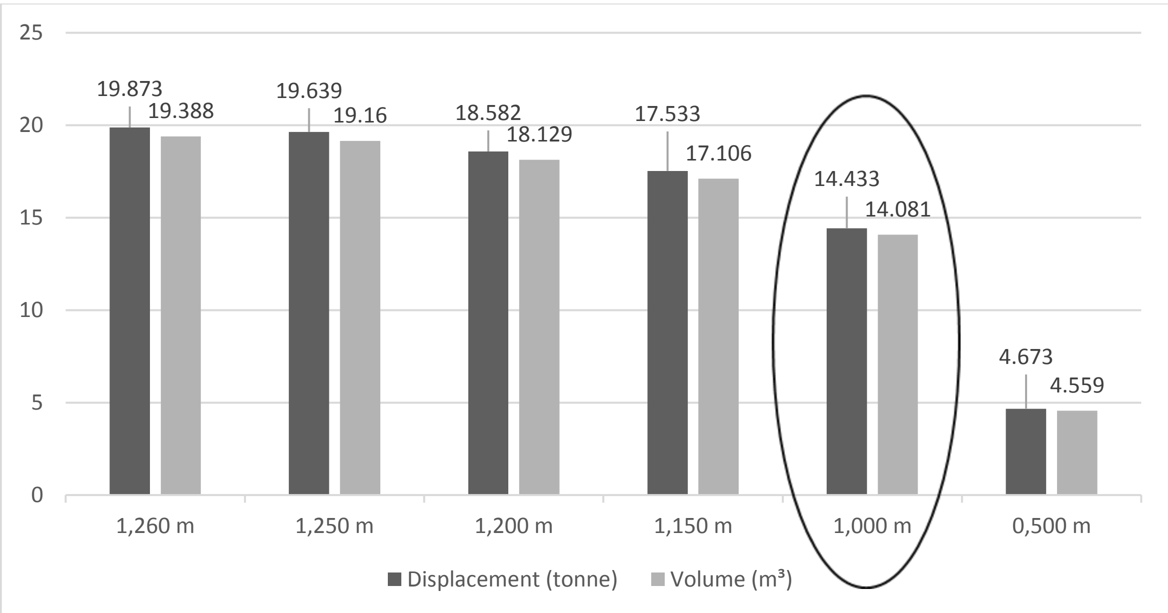


Figure 6: Graph measuring the height of the hatch against displacement

Hatch design as an alternative safety device

The hatch's ability to accommodate caught fish can be calculated from the difference in construction weight and the number of crew members on board as the face weight. At an altitude of 1,000 meters, it has a hatch volume area of 14,081 m³. However, if the hatch is used as a safety device, the capacity of the fish caught in the hold will be reduced, to obtain a floating point (Bouyancy) in the hold. So the maximum total hatch weight limit is 14,433 tons at 100% load capacity. The weight of the fish caught must be multiplied by the stowage factor value [11], the stowage factor value for the hold is = 0.5 ton/m because there is ice to cool the caught fish in the fish hold.

fixed weight= (construction weight + weight of number of crew members)
= 1,325 ton

Table 9: Measurement of the hatch height value

Hatch Volume Capacity (%)	caught fish (tons)	hatch construction + crew (tons)	Total Weight (tons)	Draft (m)
100%	7,216	18,582	14,081	1,20
50%	3,608	10,019	8,541	0,78
30%	1,082	6,594	3,489	0,58

In table 9 you can see the hatch's ability to accommodate caught fish at the maximum hatch volume. The number of fish accommodated will affect the hatch draft when it is above the water surface, where the total weight will affect the displacement of the ship. which can be seen in (Figure 7 hydrostatic curve) so that the hatch draft can be known.

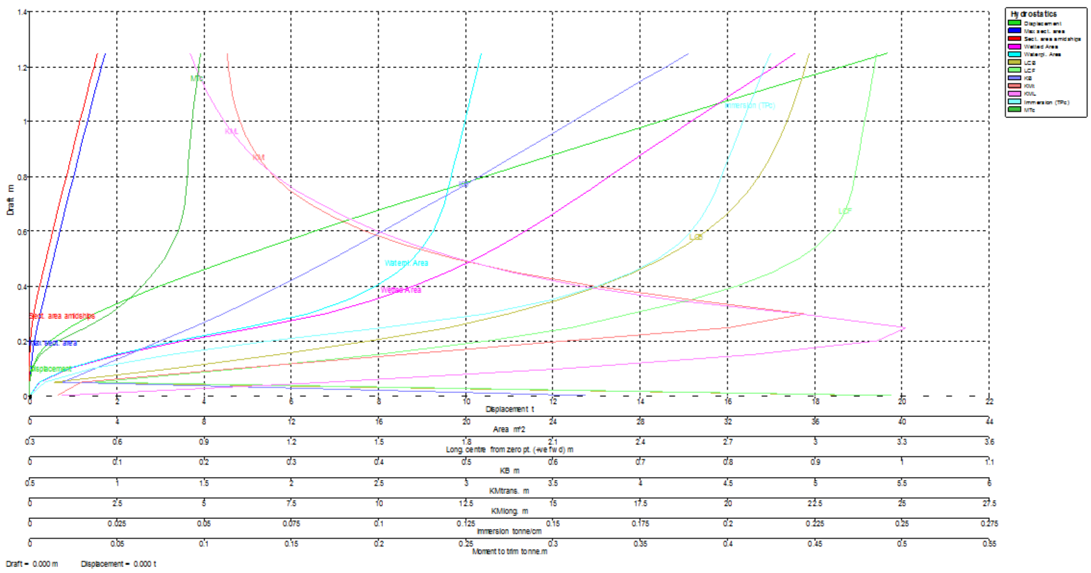


Figure 7: *Hydrostatic Curve Hatch*

The hatch will be released from the ship's rafters when the ship sinks completely below the water surface. The sinking of the ship will have a dominant center of gravity at the back of the ship without any external influence of the ship (Figure 8) due to the presence of the main propulsion engine and the superstructure of the ship as accommodation for the ship's crew.

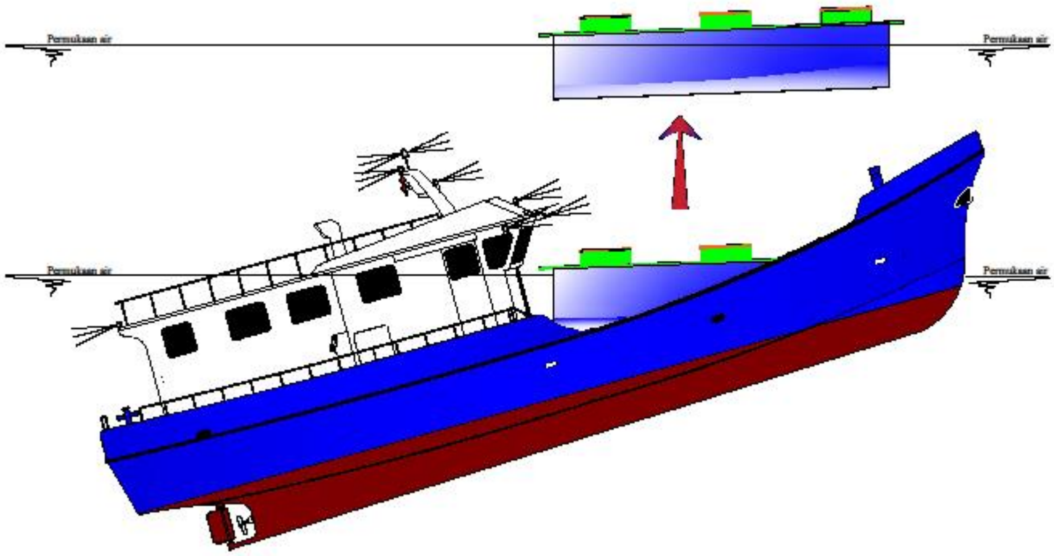


Figure 8: Release of the hatch in the ship's hull

5. Conclusions

1. The size of the hatch depends on the shape of the ship's rafters on the frame ordinates and the shape of the space volume (Block Coefficient) of the ship's rafters.
2. The use of the hatch system must pay attention to the free space in the hatch release area so that when the hatch is removed from the rafters there are no obstructions or binding parts. And the crew can lean on the hatch when the hatch is above the water to reduce the lifting load when removing the hatch from the ship's rafters.
3. The hatch can be used as an assembly point during an evacuation, without the crew being separated and scattered from one another.
4. Apart from additional safety equipment, it can reduce the level of losses due to accidents, because there are still fish caught that can be saved.

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