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Selection Of Profiles In Midship Vessel Structure Operating The Regulations Of The Indonesian Classification Bureau

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Abstract

Shipbuilding generally consists of two main parts, namely the hull and the superstructure or deck house. Several factors must be considered in the construction of a ship. In addition to planning the characteristics of the ship's hull, it also analyzes the strength and structure of the ship itself. Midship construction is a construction that must receive serious attention in calculating the ship structure. In this section there are many forces acting so that the risk of structural failure is relatively large. One of the world'sclassification institutions is BKI, which provides rules for selecting structural profiles. Based on these rules, theload on the side of the ship is 71,284 KN/m^2. The load on the bottom of the ship is 76,795 KN/m^2, the load onthe deck on the top of the deck is 32,581 KN/m^2, the load on the cargo deck is 57,330 KN/m^2, the load on thebottom is 68,212 KN/m^2, the load on the accommodation deck is 3,981 KN/m^2.

Keywords: BKI, Ship construction, Midship, Regulation.

1. Introduction

General Cargo Ships are ships that carry various types of cargo in the form of goods transported, usually packaged goods. General Cargo ships are equipped with cargo cranes to facilitate the loading and unloading of cargo. Several factors must be considered in the construction of a ship. General Cargo is a ship that carries cargo in the form of goods. Hence, the conditions required by a ship also apply to General Cargo ships. However, unlike other types of general ships, such as fishing vessels, tanker ships have different operational functions. Therefore the construction and design of general cargo ships differ from the construction of fishing vessels and tankers. In general, cargo ships, especially General Cargo, can carry class passengers up to 12 and are still called General Cargo ships. General Cargo ships have speeds ranging from 8 to 25 knots. [1][2].

Cargo ship construction is the most important in supporting the shape, reinforcement, and shipbuilding. A ship with its shape and construction has a function that depends on the type of cargo carried, the ship's raw materials, the shipping area, the required engine power, and others. The characteristics of a ship will affect the construction of the ship. In connection with the construction of the ship, there is a very close relationship between the framework's structure. Construction ability is defined as using construction knowledge and knowledge in planning and design [3][4].

Ship construction is generally a group and shipbuilding design that becomes the final or final product design. Various components are united into a ship. One to another is closely related, even if it is just a porthole and a door. Prevalent its existence is very much needed. Each arrangement must meet standards and ship components from bottom to top, like the ship's hull, to the part of the superstructure known as the superstructure [5]. The space at the bottom end of the ship in front of the transverse watertight bulkhead wall and behind the rearmost waterproof bulkhead wall is called the forepeak and after the peak.

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The bulkhead wall that limits the space in front is called theCollision bulkhead wall, and the one behind is called the rear peak bulkhead wall after peak bulkhead. Most ships at the bottom between the fore peak bulkheads have a double bottom spacethat increases the ship's safety if there is bottom damage, a ballast water area when the ship is unloaded, and fuel and freshwater storage. The number of bulkheads depends on: the length of the ship, location of the engine room, maximum length of the hold.

Fig. 1. Ship construction manufacturing process.

1.1. Construction Strength

Ship construction is generally a group and shipbuilding design that becomes final product design. Various components are united into a ship. One to another is closely related, even if it is just a porthole and a door. Prevalent its existence is very much needed. Each arrangement must meet standards and ship components from bottom to top, like the ship's hull, to the part of the superstructure known as the superstructure [4].

Generally, the hull has construction components that are transverse and elongated and arranged in such a way as to be strong. Materials and sizes are calculated to get the desired strength.In the preparation of the ship's construction as a whole, it is known that the transverse constructionframe. The transverse truss system on the ship is a construction where the workload in the construction is received on the plate and the longitudinal beams. The beams that cross the ship's construction are very important as strength. The various construction designs certainly have advantages and disadvantages. However, in terms of strength, everything has been calculated. The advantages of a transverse turning ship are that it ensures a stable arch shape of the main transverse beam, is easy to build ship construction and is simple. The strength of the ship is good because of the main tusks. The number of transverse bulkhead walls is minimized.

It is exploitation, experiencing forces acting on them in opposite directions, namely gravity, and buoyancy. Gravity is the sum of the weight of the empty ship (LWT) and the dead weight of the ship (DWT). The transfer of the weight and volume of the ship to the water creates a buoyant force which is the reaction of the water. The magnitude of this buoyant force is proportional to the weight of the floating ship. The difference between the gravity curve and the buoyant force will result in a loading curve. Gravity, buoyancy, and loading curves are stairs per ivory space. If the gravity and buoyancy curves are the same, then the area representing the combined excess gravity and buoyancy must be the same [5].

The cross-sectional modulus is the value of a ratio between the moment of inertia of a cross-section about the axis that through the center of gravity of the cross-section (neutral axis) with the furthest distance from the end of the cross-section to the center of gravity of the cross-section. In calculating the modulus of the cross-section of a ship, it must first be known the total moment of inertia of the cross-section. Calculating the moment of inertia at each cross-section or construction element is necessary. The benchmark to determine the strength of a ship's construction structure is stress. The stress value can be obtained if the magnitude of the bending moment that acts along the ship and the ship's cross-sectional modulus are known [4][5].

In this case, to ensure the safety of the ship in its operation, in the calculation of the steel to be used, attention must be paid to the quality of the ship's steel, which includes the calculation of the tensile strength of the steel to be used as well as everything related to the steel material following the permitted requirements. by the World

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Classification Bureau, before being used to build new ships. In the completion stage of the construction calculations, all strength calculations must be reviewed by the forces and loads acting on each component of the ship's hull. Step-by-step planning of the calculation of the hull construction [5].

The selected construction system must e able to withstand and be strong against the influence of forces from inside the ship and the influence of forces from outside the ship. The force from inside the ship is the weight of the empty ship and the weight of the carrying capacity, while the influence of the force from outside the ship is the condition of the waves of seawater and the wind blowing the hull of the ship while sailing. Theoretically, the influence of the wind is not considered, but the influence of sea waves is very important. For the influence of sea waves in the calculation of construction and strength, the ship is assumed to be in 2 (two) wave conditions extreme conditions, namely, the first ship sailed on one wave crest (hogging). The engine room was located in the middle of the ship, and both ships sailed in two conditions. Wave crest (sagging), the engine room is located at the stern [6], as shown in the following picture.

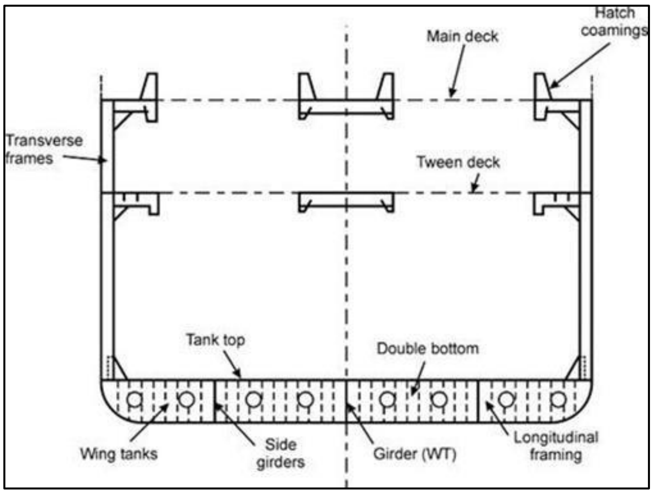

Fig. 2. Midship construction sketch

1.2. Indonesian Classification Bureau

The Indonesian Classification Bureau (BKI) is the fourth classification body in Asia after Japan, China, and Korea. It is the only national classification agency tasked with classifying Indonesian- flagged commercial vessels and foreign-flagged vessels that regularly operate in Indonesian waters. BKI classification activity is a classification of ships based on the construction of the ship's hull, machinery, and electricity to provide a technical assessment of whether the ship is worthy of sailing. In addition, BKI is also trusted by the Government to carry out statutory surveys and certifications on behalf of the Government of the Republic of Indonesia, including Load Line, ISM Code, and ISPS Code. BKI was formed by applying technical standards in design, construction, and marine survey activities related to floating facilities, including ships and offshore construction. This standard was prepared and issued by BKI as a technical publication. Ships designed and built according to BKI standards will receive a Classification Certificate from BKI where the certificate is issued after BKI has completed a series of required classification surveys. As an independent and self-regulating Classification Board, BKI has no interest in commercial aspects related to shipping design, shipbuilding, ship ownership, ship operations, ship management, ship maintenance/repair, insurance, or chartering. BKI also conducts research and development to improve the quality and technical standards published to parties interested in ship classification services [7].

Based on the BKI rules, it is necessary to calculate the various loads with the following equations to find out the loads acting on the ship. The load calculation used is shown in the following table.

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Table 1. Load equation [7]

Load calculation	Equation	
Weather deck.	$Pd = \frac{Po \times 20 \times T}{(10+z-T)H \times C_d}$ Where z is the vertical distance from the load center of thestructure calculated from the base distance.	(1)
Center below the waterline.	$Ps = 10 \times (T - Z2) + Po \times C_f \times (1 + (Z2/T))$	
Centers above the waterline.	$Ps = Po \times C\_f \times (20 / ((10 + z - T)))$	(3)
Of the base of the ship.	$Pb = (10 \times T) + (Po \times Cf)$	(4)
Superstructures and deck houses.	$PDA = PD \times n$	(5)
Deck.	$PL = Pc(1 + Av)$, Where Pc Is The StaticLoad And H Is The Average HeightOf The Twin Deck.	(6)
Accommodation deck and service room.	$P = 3.5 \times (1 + Av)$	(7)
Machine deck.	$P = 8 \times (1 + Av)$	(8)
Construction *bottom plate,* for ships with a length of more than 90 m.	$tB = 121 \times a \times \sqrt{PB} \times k + tk$	(9)

Determination of the thickness of the plate used for each construction component is alsoregulated in the BKI rules. The equations used can be seen in the following table.

Table 2. Thickness equation [8]

Thickness calculation	Equation	(10)
Bilge strip plate	B = (Side Plate + Bottom Plate)/2	(11)
Keel plate	tFK = tB + 2.0	(12)
Side shell plate	t minimum = 1.21 × a × √Ps × k + tk	(13)
Side plate	ts = 1.21 × nf × a × √Ps × k + tk	(14)
Sheer strake	B = 800 + 5L	(15)
Bulwark	t = 0.65 × √L	(16)
Lightening hole	$r = 0.25 \times Hdb$	(17)
Inner bottom plate	ti = 1.1 × a × √P × k + tk , where p isthe design pressure	(18)
Center girder	h = 350 + 45 × B t = (h/100 +1) √k	(19)
Side girde	t = (hdb/120 +1) √k	(20)
Plate floor	$t = (tm - 2) \times \sqrt{k}$	(21)
Man hole	$length\ (L) = 0.75 \times Hdb height\ (H) = 0.5 \times Hdb$ $radius = 1/3 \times Hdb$	(22) (23)

The calculation of ship construction in general will produces the midship cross-sectional modulus with values above the minimum. This excess value is based on regulations. It is allowed aslong as it is not below the minimum limit. However, from an economic point of view, these advantages are not good because the construction is more significant, causes an increased heavy, and requires a higher cost. As long as there is still a distance between the calculated values of the modulus midship cross section with a minimum limit, there is still an available possibility to save expenses. Based on the BKI rules, the formula used is shown in the following equation:

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Table 3. Modulus equation [8]

Modulus calculation	Equation	
Bulwark	$4 \times P \times e \times \ell^2$	(24)
Reverse frame	$n \times c \times a \times \ell^2 \times P \times k$	(25)
Bottom frame	$n \times c \times a \times \ell^2 \times P \times k$	(26)
Main frame	$n \times c \times a \times \ell^2 \times Ps \times Cr \times k$	(27)
Web frame	$0{,}6 \times e \times \ell^2 \times Ps \times n \times k$	(28)
Stifner	$0{,}061 \times e \times l \times ps \times n$	(29)
Deck beam	$c \times a \times l^2 \times P \times K$	(30)
Girder transver deck beam	350 × 90 x 16	
Hatcway beam	$125 \times C_1 \times a \times l^2 \times P$ x σ_b	(31)
Stay bulkwark	$0{,}35 \times a \times l^2 \times Pa \times k$	(32)

2. Materials and Methods

The research was conducted by calculating the modulus of each construction element using the BKI equation. The modulus is adjusted to the profile list in the BKI Annex -A1. Then make a model of the midship section of the ship using CAD software. In this study, the general cargo ship model will be used, with the basic ship sizes as follows:

Table 4. Ship Main dimention

Type of ship	General Cargo
Length Between Perpendicular (LBP)	92.15 m
Length Water Line (LWL)	94.45 m
Breath (B)	16.5 m
Defth (H)	7.8 m
Draft (T)	5.4 m
Speed (Vs)	12 knots

The following shows the modulus graphs of various profiles in the BKI Annex A-1.

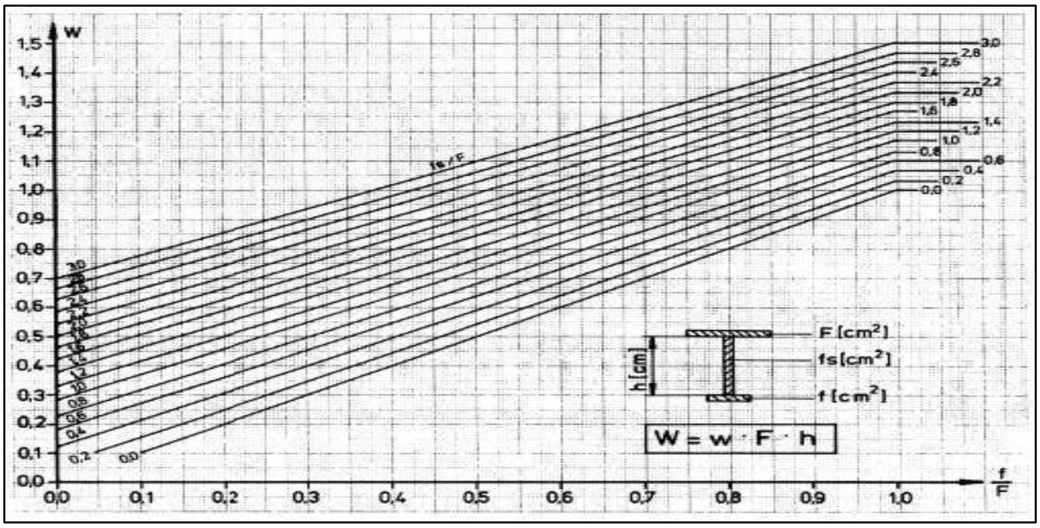

Fig. 3. Modulus graph of I and T [8]

4. Result

Based on the above equation and the modulus graph, a suitable profile for Midsipdevelopment can be obtained. The results of the modulus analysis can be seen in the followingtable.

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Table 5. Modulus and profile

Modulus calculation	Modulus Value	Profile dimension	Bracket
Bulwark	499,81 cm	150 × 100 × 12 mm	-
Reverse frame	95,88 cm^3	150 × 100 × 10 mm	-
Bottom frame	137,39 cm3	180 × 90 × 14 mm	-
Main frame	294,12 cm^3	200 × 100 × 10 mm	290 × 9,5 mm
Web frame	622 cm^3	250 × 90 × 14 mm	350 × 11,5 mm
Stifner	648,000 cm^3	250 x 120 x 14 mm	-
Deck beam	223,98 cm3	160 × 80 × 14 mm	270 × 9,0 mm
Girder transver deck beam	1019,74 cm3	350 × 90 x 16 mm	360 × 12 mm
Hatcway beam	1217,2 cm^3	370 x 18 mm	490 × 15,5 mm
Stay bulkwark	239,72 cm^3	150 × 100 × 12 mm	270 × 9,0 mm

3.1. 3D Design of midsip section

Based on the calculation of the cross-sectional modulus and the selection of suitable profilesand brackets in the BKI annex, the next step is to draw the profile in the 3d structural application. The midship section can be seen in the following figure display.

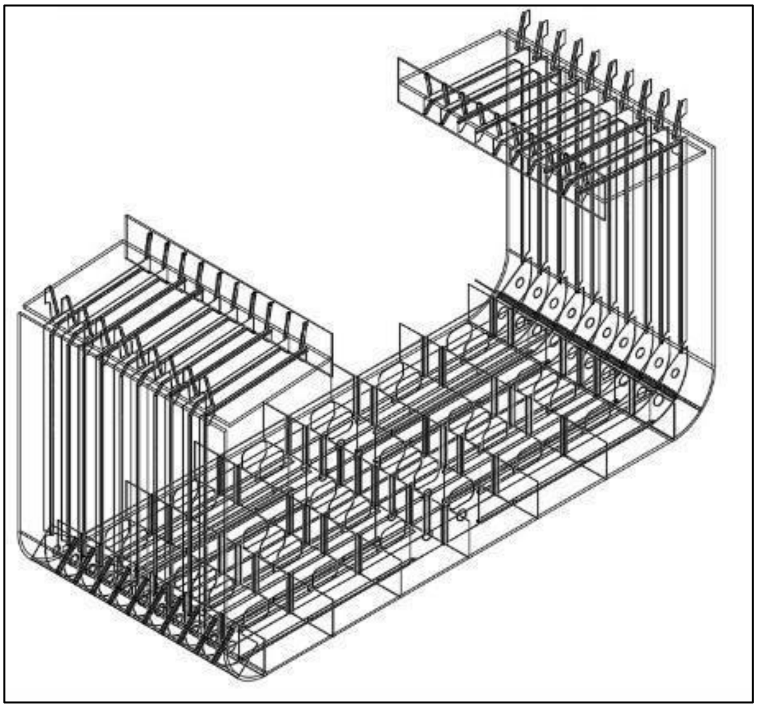

Figure 4. Midship section in 3D

4. Conclusions

The midship section is the middle section of the ship showing the elements or parts that form the basis of the ship's strength. Based on the above analysis, this study's general cargo ship construction uses a transverse construction system. All modulus meet BKI rules. The selection of construction profiles is carried out using the rules of BKI Annex-A1.

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