Stress analysis bottom plate block B-03 on patrol ship construction using finite element methods

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Abstract. On the process of constructing ships with the block system has a tendency to dealing time production process for assembly. The waiting time makes the construction of the bottom plate to receive the burden during the waiting time so that the deformation often occurs due to excess stress received. The purpose of this study to know the stress value of the bottom construction of a block due to the static load on the ship building process. The method used is the Finite Element method is a form of the approximation method commonly used to solve an equation numerically in a stress analysis. The variables used in this study are the different types of meshing, the number of focuses on stop block. Based on the results start of the construction stress analysis Plate Bottom block B-03 on the construction of patrol ship. Obtained the highest stress value in the use of 4 stop block so, it is advisable to increase the number of stop blocks in order to reduce the results of excessive deformation.

Keywords: patrol ship, stress analysis, construction, bottom plates, finite element methods

1. Introduction
Indonesia is country areas that are mostly oceans up to 78 % of its territory. Based on the statistics of the number of the return of approximately 17,506 islands, which is geographically strategic because it is in the cross, namely between the continent of Asia and Australia and between the Indian Ocean and the Pacific. Potential sea in Indonesia can be utilized optimally to improve the welfare of the nation [1,2]. To support the need for the means of Transportation as a to bring sectors of this tourist attraction with the world of maritime Indonesia. Patrol ships have size characteristics including the speed ship. This ship aims to do Indonesian sea guard accompanied by security and care of ships that perform its activities in Indonesian sea. This type of ship has a shape hull construction. Figure 1 shows the block construction on the ship building process.
Figure 1. Block division of ship
Strength analysis of the construction can be described from the stress received from the constant. Such as normal and shear stress example that works in cross section. When Hooke’s law applies [3,4], we can obtain the normal stress and shift from the bending formula and shear (equation 1).

$$\sigma = \frac{M y}{I}$$  \hspace{1cm} (1)

Inside the bending formula, is a normal stress that works in cross section, M is a bending moment, Y is the distance from the neutral axis, and I is the moment of inertial cross section of the neutral axis (equation 2).

$$\tau = \frac{VQ}{lb}$$  \hspace{1cm} (2)

The shear stress formula [5,6] is a sliding stress at a point at the cross section, V is a shear stress, Q is the bending moment (static moment) of the area of the outer cross section of the point at the cross where the stress is being sought, and the cross the normal stress obtained from the bending formula has a maximum price in the farthest location of the neutral axis, while the shear stress obtained from the shear formula usually has the largest value in the neutral axis. In many ways, this is the only stress needed for design purposes [7]. Normal stress is calculated in the cross section of the maximum bending moment, and the shear stress is calculated in the section with the maximum shear force (Figure 2).

Figure 2. Deformation of plate

Previous research contact between the hull with the sea waves has been learned based on linear and nonlinear modelling. The approach to wave theory with FEM simulation shows a comparison of the resulting wave frequency affecting the shape of the hull structure affected by the sea waves. The calculation of the mathematical simulation with the numerical method gives the characteristic of the vessel's hull plate to the pressure of the waveform resulting from the box with seawater, so it can be an observation and a continuation of the research for other types of ship models [2,3]. The ultimate stress research on the hull of the vessel that experienced corrosion fittings also shows there is a difference of character from the numerical calculation value [10,11]. The result of the stress indicates the difference between the corrosion affected area and the area around the corrosion [12,13]. Then, every plate thickness can be predicted ultimate stress tang
occurs on the hull, to predict material damage from the composition of the hull plate [14]. In line with the research calculation of the establishment at the meeting between the vessel plate with sea waves, with the impact of corrosion, then has been done also a study between the hull of the vessel with ice on the cruise area of the ocean. From the results of the analysis of influence and variation of construction in the hull of the vessel indicates the character of the stress generated from the collision between the hull plate with ice [15,16]. The results showed that there was a good performance assumption on the use of thickness of the plate of interaction between the stress occurring. The calculated Data can be used as a parameter based on the size scale of the icebreaker, for consideration of the construction of new ships on the cruise route [17]. The study of the plate deformation was also carried out against warships, considering that this type of ship underwent many voyages that allowed gastric damage due to impact by other vessels or by other warship bullets. The change of meshing and the seam distance on the vessel resulted in a calculation formula of stress calculations on the hull to the deformation[5,6]. The results of this study showed a dynamic response to the hull based on the impact that occurred so as to show a complex and sustainable analysis in the world of ship structure Engineering [18,19]. Based on the Research Gap, research on the response that occurred hull plate at the bottom of the static load against the stop block must performed. A characteristic study describing the standing of the bottom plate indicates the strength of the vessel structure at the bottom and the deformation can be defined.

The purpose of this study gained the stress characteristic of Von Mises is one way to target the safety factor value of a construction. This stress can be added to the Yield stress to obtain a safety factor, and then to know the extent force of the bottom plate ship when it gets a static load against its own construction load against a stop block.

2. Method

The evaluation method using the Finite Element method is shown based on the groove in Figure 3. The field data is then poured into model form. From the model in this study is focused on the bottom plate construction where the contact with the stop block. Furthermore, the model was made the limit condition and done analysis with load on block B-03. The method used is the Finite Element method is one form of the Approximation method commonly used to resolve a partial differential equation or commonly referred to as a Partial Differential Equation (PDE) in a numerical analysis of the structure [20]. Results obtained from the calculation of value von Misesstress then compared with the Yield stress to know the Safety Factor of the construction.

![Figure 3. Flow chart of the study](image-url)
Contact stop block with construction section on the ship base then defined to be like model (Figure 4). The contact stop block with the construction part on the base of the ship then defined to be a model of geometry with the variative meshing determination of the boundary conditions see from the actual field conditions. The condition limit that occurs into 2 part where fixed support condition is present in each joint of the bottom plate welding so that the plate can't shift towards the axis x, y, z. In the meeting with the angle bar profile and T-bar profile is a focus (Figure 5).

![Figure 4. Representation of bottom plate construction](image)

![Figure 5. Boundary condition](image)

Loading conditions are reviewed based on the number of Stop block contact points of the constant. Each contact point consists of a boundary condition and there is a burden as a result of the weight of the block itself (Figure 5). The weight of block B-03 is 14.07 tons, so if the study is
differentiated into 2 namely 4 focus in one block then each of 34.47 kN and 6 focus in one block then each of the growth of 22.98 kN.

3. Results and discussion
Main dimension patrol ship:
   Ship name: Patrol ShipClass A2- 55 Meter
   Class : BKI
   LOA : 55.00 m
   LPP : 50.76 m
   B   : 8.20 m
   H   : 4.50 m
   T   : 2.00 m
   Vs  : 22.00 Knots
The Model used in this study is the B-03 block included in the block of the area of the parallel middle body on the ship (Figure 6).

Simulated stress analysis results using element methods to the form of von Misses stress, normal stress, shear stress and deflection as well as some other parameters. Von Misses stress is the calculation result stress between the normal stress and the shear stress so that the values are more comprehensive than the other stress [6], so it is used as a parameter to evaluate the construction of the bottom plate on the patrol vessel (Figure 7).

The complete amount of tension in the bottom plate construction for each of its growth which can be seen in Table 1. The result showed 6 focus points have a more relatively small value compared with 4 focus points. And then, if viewed according to conditions in the field in 1 block there are 6 stops block as its growth. This states that if the focus condition is ideal enough in a block is a total of 6 stops block with the size of the vessel width more than 8 meters.
Figure 7. Stress distribution Von Mises on plate bottom block B-03 Construction Patrol Ship

Table 1. Safety factor result

| Meshing Size (m) | Von Misses Stress (Mpa) | Yield Stress (Mpa) | Safety Factor |
|------------------|-------------------------|-------------------|--------------|
|                  | Gravity Force (4 stop block) | Gravity Force (6 stop block) | Gravity Force (4 stop block) | Gravity Force (6 stop block) |
| 0.05             | 281.28                  | 220.05            | 400          | 1.42          | 1.81          |
| 0.04             | 321.46                  | 278.46            | 400          | 1.24          | 1.43          |
| 0.02             | 376.30                  | 313.30            | 400          | 1.06          | 1.27          |
| 0.01             | 386.23                  | 372.10            | 400          | 1.03          | 1.07          |

Figure 8. Displacement with the number of stop blocks
Based on the comparison of safety factor values, it is known that the construction design based on the maximum stress received is still in a safe condition for many stop block focus conditions. Where if seen from the results of the deflection is known to be smaller size thick plate then it indicates the possibility of the resulting deflections is large enough. It also applies to the number of stop block focus the more the number of focus then it occurs also increasingly reduced because of the load block received every stop block is placed by a number of stops block (Figure 8).

4. Conclusion
Based on the results of a simulated construction stress analysis Plate Bottom block B-03 on the construction of patrol boats. Hence the conclusion of the most important thing to the magnitude of the stress received by the construction of a block there is a heavy burden of construction itself. The stress and deformation that occurs in a construction depends heavily on the material characteristics as well as the weight of the planned plates. An experimental simulated calculation with the Finite Element (FEM) method is required to determine and correct a planned construction design to be aware of the strength of the ship's construction structure.

From the results of the highest stress value in each focus still enter into safety factor criteria. The highest stress is in the use of 4 stop block focus, so it is advisable to increase the number of stopblocks in order to reduce the result of excessive deformation. Stop block placement is very influential to the plate column that has the largest risk of experiencing the highest level of the potential to suffer plate deformation. The application of thickness variation and type of construction on the ship plate can show the character of the ship's stand based on the size and weight of the vessel block based on the focus used. The simulation is very helpful in planning and detail calculations based on the structure response to the stress received.

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