# Comparison Study of Structural Strength between Longitudinal and Transverse Modulus on The Hatch Cover using Finite Element Method

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Abstract: Container ship carries cargo that mostly container, so cargo hold be designed with the large enough hatchway to making easy loading and unloading container. Owners usually want to optimize space on cargo hold. Optimizing space on cargo hold means that if cargo hold is fully loaded by the container, the owner can still put the container above hatch cover. There are 2 construction members which influence hatch cover strength, longitudinal & transverse. Finite element method is used to compare strength between longitudinal & transverse of the hatch cover. The analysis was performed by changing ± 10% & ± 20% longitudinal modulus and transverse modulus of the model hatch cover. As a result, due to increase 20% longitudinal modulus, stress is reduced -9.903%, while adding 20% transversal modulus only reduces -5.31% stress. Reducing 20% longitudinal modulus increase 5.47% stress, while reducing 20% transversal modulus only increases 4.94% stress. According to the analysis result, it can be inferred that changing the longitudinal modulus is more influential than changing transversal modulus. e

## 1 INTRODUCTION

The function of hatch cover on container ships generally has the same working system and function, which is used to cover the part of the hatch on the container ship. However, what distinguishes between hatch cover on cargo ships and container ships is that container ships carry commonly called containers, so container ship must have a wide hatch for loading space. Owners usually want to optimize space on cargo hold. Optimizing space on cargo hold means that if cargo hold is fully loaded by the container, the owner can still put the container above hatch cover (Keith, 2001). Hatch cover must have enough strength to hold the load from the container.

Previous study an analysis was carried out by comparing 3 variations of hatch cover model. The first model hatch cover is divided into 3 transverse partitions. Second model hatch covers without partition. The third model hatch cover is divided into 5 longitudinal partitions. From three types of hatch cover, model hatch cover 3 transverse partition is the most effective model (Fikri and Kurniawati, 2016). In this comparison study between longitudinal & transverse construction, most affect construction to hatch cover stress will be searched with 3 transverse partitions as a model. The analysis is performed by changing the longitudinal modulus and transverse modulus of the hatch cover. From the comparison of the stress result, the construct will be obtained which is the most influential to the hatch cover

## 2 LITERATURE REVIEWS

Hatch cover is a very important equipment in the ship, which construction and mechanism must follow Classification rules and International Load Line Convention (ILLC) 1966. The purpose of the hatch cover and hatch coaming are to prevent water from entering through the opening (loading) of the loading space on the ship deck.

One type of hatch cover is a lift-away hatch cover (Fikri and Kurniawati, 2016). Hatch cover using pontoon or lift away hatch cover makes it easier for the loading and unloading system. Hatch cover type Lift away hatch cover is good for ships



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that have multilevel goods (Dewangga and Yulianto, 2012).

Figure 1: Lift-Away Hatch Cover.

## 2.1 Finite Element Method

Von misses stress is stress that obtained through calculations involving strains in all axes (x, y, and z) (Rabbani, et.al, 2017). The theory of the collapse of von misses yield criterion is used in this study as a reference in the analysis of stress used. The following equation for von misses:

$$\sigma' = \frac{1}{\sqrt{2}}\sqrt{(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_x - \sigma_z)^2} \quad (1)$$

Where,
σx = x-axes stress
σy = y-axes stress
σz = z-axes stress
σ' = equivalent von misses stress

Finite element method is a numerical calculation technique that results obtained is the value of the approach of the actual results. As the size of the element decreases, the results obtained will be different and sequential. The calculation approach will produce a convergent value with the actual results when the mesh quality is added and the elements are formed more and smaller in size (Biro Klasifikasi Indonesia, 2016).

## 2.2 Hatch Cover Conversion

Hatch cover is considered to have sufficient strength if the stress value that occurs in each structure does not exceed the value of equivalent stress σv given by ship classification for the minimum hatch cover (Pramono, et.al, 2016).

$$\sigma v \leq 0.8\, ReH \quad (2)$$

Where,
σv = equivalent stress hatch cover
ReH = minimum nominal upper yield point, 235 N/mm²

Model for this research requires modulus conversion to get the variation. To find the modulus can be found by the moment inertia calculation tabulation which will be divided by the value of the neutral axis point.

# 3 METHODOLOGY

In this study, the effectiveness between the longitudinal and the transversal will be compared. The analysis is carried out by changing the modulus of the transverse and longitudinal support of ± 10% & ± 20%. The next step is modelling. The hatch cover model is drawn from the deck to the hatch cover. After modeling, the next step is element convergence. After obtaining the converging element size of each model, the model is given a load and boundary conditions. Stress must be checked with stress permission from BKI based on formula (2). Finally, effective construction can be determined.

## 3.1 Finite Element Modeling

Finite element models are made from ship decks to hatch cover. Because the model is complex, then modeling of hatch cover using CAD (Computer-Aided Design) assist software.

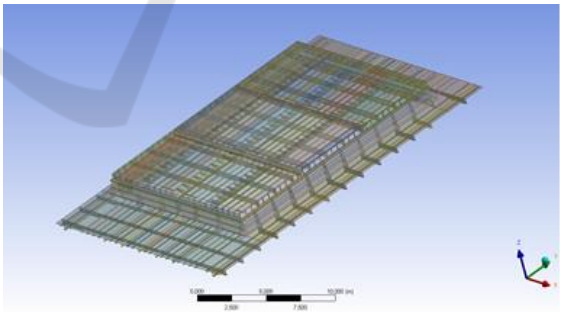

Figure 2: Geometric Model.

Locking and damping systems are not modeled. The locking system requires a very detailed model which can cause an error model. For locking system modelling and damping systems, it is carried out in accordance with Figure 3.

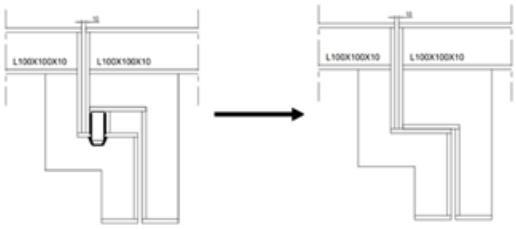

Figure 3: Locking and Damping System.

Meshing is a process of finite elements to divide the whole system into smaller elements to obtain a detailed analysis of the entire system. In this study, the element types used are solid elements of Tetrahedron and Hex Dominant because there are parts of construction that are simple and complicated, in addition to the geometry modeling has been given thickness. Solid elements have quadratic displacement properties and good for modeling irregular mesh shapes.

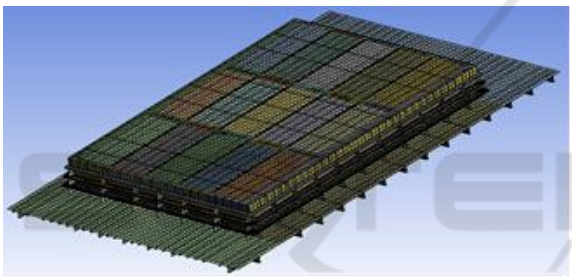

Figure 4: Finite Element Model.

Variation of the model is given to compare the analysis results and get the most effective construction (longitudinal or transversal). The analysis is carried out by comparing the construction hatch cover model as shown in Table 1.

Table 1: Variation of Hatch Cover Model.

| Construction | Initial Profile | Modulus Change | Profil after Change |
|---|---|---|---|
| Longitudinal | L 100x100x10 | +20% | L 100x100x12 |
| | | +10% | L 100x100x11 |
| | | -10% | L 100x9+90x10 |
| | | -20% | L 100x8+100x9 |
| Transversal | T 450x9 + 100x10 | +20% | T 450x11 + 100x11 |
| | | +10% | T 450x10 + 100x11 |
| | | -10% | T 450x8 + 125x8 |
| | | -20% | T 450x8 + 125x7 |

## 3.2 Loading and Boundary Condition

The type of load applied is a force, which is a static load on the legs of the container. The amount of the load is affected by the type of container weight and container tier placed on the hatch cover. In this case, containers use BAY 13 where the hatch cover transports a maximum of 3 tier containers with a maximum load of 38 tons. The load used is a force by multiplying gravity becomes 372.4 kN. The container feet are 4 so that the weight of 372.4 kN is distributed on 4 feet of the container, 1 container foot gets a load of 93.1 kN.

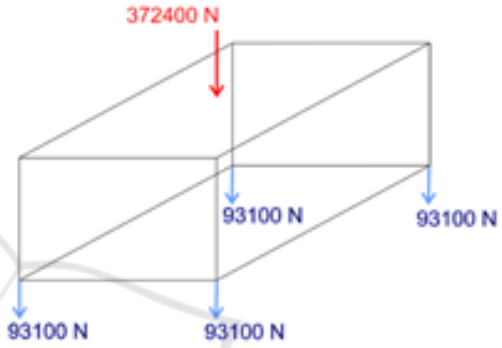


Figure 5: Load Distribution.

The parts that are given a support are the ends of the deck and the deck part that is welded with the bulkhead. This is done because geometry modeling for analysis is carried out only on the deck until the hatch cover.

Table 2: Applied Boundary Condition.

| Axis | Displacement | Rotation |
|---|---|---|
| X | 0 | Free |
| Y | 0 | Free |
| Z | 0 | Free |

# 4 RESULT AND DISCUSSION

Longitudinal and transverse effectiveness are tested with the hatch cover model according to the data. The tests are carried out by reviewing the von misses model voltage due to changes in modulus of the transverse and longitudinal.

# 5 CONCLUSIONS

According to the analysis and results, this research can be concluded that longitudinal construction is more influential than transverse construction because of a load of containers. Container load on the hatch cover is symmetrical so that torque loads are not too significant. So that transverse construction has no major effect, while construction has a big influence.

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