Ultimate strength analysis of stiffened plate variation on the longitudinal bulkhead of Double Hull Oil Tanker

U Q Parantean¹, Juswan¹, M Z M Alie¹ and K A Rahangmetan²

¹Department of Ocean Engineering, Engineering Faculty, Universitas Hasanuddin, Makassar, Indonesia
²Department of Mechanical Engineering, Faculty of Engineering, Universitas Musamus, Merauke, Indonesia

Email: zubair.m@eng.unhas.ac.id

Abstract. Loongitudinal bulkhead also gives significant effect to the longitudinal strength of double hull oil tanker. The stiffened plate attached at the longitudinal bulkhead must have enough strength to withstand the liquid oil which has an impact to the longitudinal bulkhead correspond to longitudinal strength. The objective of the present study is to analyze the ultimate strength of stiffened plate on the longitudinal bulkhead of double hull tanker. The small section of stiffened plate with attached plating at the longitudinal bulkhead is considered to the analyzed. The numerical analysis is adopted to analyze the model. The stiffened plate is variated with the distance in terms of model breadth. The boundary condition is applied to the model including axial compression load. The behavior of the model is represented by stress and deformation. For the simple analysis, the welding residual stress, crack, and initial imperfection are not taken. The result obtains by the numerical analysis is presented together with the behavior in term of stress and deformation.

1. Introduction

Generally, the ship contains many structural elements connected with one another for local and global, particularly, the double bottom structure of the ship. The pressure load from the outer bottom and side shell, including inner bottom represented by cargo load acting together on the hull structure. The impact of these loads may hull girder becomes degrade and could collapse when the load acts extremely large. Therefore, all the component of the hull girder, especially the bottom area, must be analyzed and evaluated.

The ultimate strength analysis of ship hull girder has been presented by some papers. The residual strength of an Aframax-class double hull oil tanker damaged in the collision had been assessed by Parunov [1] by considering the influence of the rotation of the neutral axis. The influence of nonlinear finite element method models on the ultimate bending moment for hull girder was studied by Xu [2]. There was two analysis performed; those were implicit static analysis and explicit dynamic analysis. A structural reliability analysis model based on a Bayesian belief network was proposed by Li and Tang [3] for the hull girder collapse risk after accidents. The Bayesian belief network was used to represent random states of variable risk events after accidents, as well as the dependencies between events, and the structural reliability analysis was used to evaluate the failure probability hull girder for each possible accident conditions. The incidence of collision damage models on an oil tanker and bulk carrier reliability was investigated by Campanile [4] considering the IACS deterministic model against
GOLADS/IMO database statistics for collision events, substantiating the probabilistic model. Reliability of an oil tanker in intact condition was performed by Campanile [5] to investigate the incidence of load combination methods on hull girder sagging/hogging time-variant failure probability. The simplified approach on the ultimate hull girder strength of asymmetrically damaged ships was conducted by Muis Alie [6] considering the critical element under sagging condition. The residual hull girder strength in intact and damage condition under longitudinal bending moment using nonlinear finite element was conducted by Muis Alie [7], and damages were modeled simply by removing the element on the damaged part. The ultimate hull girder strength considering section modulus under longitudinal bending was analyzed by Muis Alie and Latumahina [8] and the cross-section of Ro-Ro ship was taken to be analyzed.

The objective of the present study is to analyze the ultimate strength of stiffened plate on the longitudinal bulkhead of the double hull oil tanker. The small section of stiffened plate with attached plating at the double bottom is considered to the analyzed. The numerical analysis is adopted to analyze the model. The stiffened plate is varied with the distance in terms of model breadth. The boundary condition is applied to the model including the liquid oil pressure to the longitudinal bulkhead. The behavior of the model is represented by stress and deformation. For the simple analysis, the welding residual stress, crack, and initial imperfection are not taken. The result obtained by the numerical analysis is presented together with the behavior of the model in term of stress and deformation.

2. Methodology
The midship section of floating production storage offloading is shown in figure 1. The target of the stiffened plate is located at the longitudinal bulkhead and zooming denoted as shown in figure 1 (b). The cross-section and model of the stiffened plate variation and boundary condition are presented in figure 2 and 3, respectively.

![Figure 1](image-url)
Figure 2. The cross-section of the stiffened plate

(a) Model 1
(b) Model 2
(c) Model 3
(d) Model 4
Figure 3. The stiffened plate model with boundary conditions

3. Results and discussion
Figure 4-11 show the deformation and Von-Mises stress distribution of the stiffened plate of all models. The stiffened plate of all models deforms at the left and right side, while the stiffened plate at the center part does not have significant influence of the deformation as shown in figures 4, 6, 8 and 10. It is also found that the stress concentration takes place around the edge of the stiffened plate.
Figure 4. Deformation of the stiffened plate model-1

Figure 5. Von-Mises of the stiffened plate model-1
Figure 6. Deformation of the stiffened plate model-2

Figure 7. Von-Mises of the stiffened plate model-2
Figure 8. Deformation of the stiffened plate model-3

Figure 9. Von-Mises of the stiffened plate model-3
Figure 10. Deformation of the stiffened plate model-4

Figure 11. Von-Mises of the stiffened plate model-4
4. Conclusions
The ultimate strength of stiffened plate with some variations of distance using finite element analysis has been done. The following conclusion are; the stiffened plate at the center of the model does not have any significant influence to the deformation. The stress distribution takes place around the edge of the stiffened plate.

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