

Prosiding_ICROEST_2020_Muhammad_Zubair_Muis_Alie.pdf

by

Submission date: 04-Jul-2021 07:26AM (UTC+0700)

Submission ID: 1615384769

File name: Prosiding_ICROEST_2020_Muhammad_Zubair_Muis_Alie.pdf (863.82K)

Word count: 2590

Character count: 14645

PAPER · OPEN ACCESS

Effect of longitudinal bulkheads to longitudinal strength on double hull tanker

To cite this article: Muhammad Zubair Muis Alie *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **575** 012202

View the [article online](#) for updates and enhancements.

Effect of longitudinal bulkheads to longitudinal strength on double hull tanker

Muhammad Zubair Muis Alie, Juswan, Wahyuddin Mustafa, Zulfikar, and Andi Muh Arie Yusuf

Department of Ocean Engineering, Engineering Faculty, Universitas Hasanuddin, Makassar, Indonesia

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

Abstract. The longitudinal bulkhead also plays an essential rule in dividing the cargo hold into several compartments. Besides, the longitudinal bulkhead is one of the construction elements which to strengthen the longitudinal strength of the ship, and it is always used primarily for a tanker. In the present study, the effect of the longitudinal bulkhead is investigated to the longitudinal strength under a vertical longitudinal bending moment. Two ships of double-hull tankers are considered having the same dimension but different for the number of longitudinal bulkheads. The force rotation is applied one side, and the other side is constrained. The result obtained by the numerical method is compared to the analytical method. It is observed that double bulkheads have larger longitudinal strength than a single bulkhead.

1. Introduction

The longitudinal bulkhead is one of the most essential aspect for ship construction, especially for tankers. The longitudinal bulkhead also plays an essential role in the longitudinal strength and reduces the movement of liquid inside the cargo tank. The analysis of longitudinal strength considering longitudinal bulkhead for tanker is minimal. Campanile [1] investigated the collision damage on an oil tanker and bulk carrier considering the IACS deterministic model against GOALDS/IMO database statistics for collision events, substantiating the probabilistic model. Statistical properties of hull girder residual strength were determined Monte Carlo simulation, based on random generation of damage dimensions and a modified form, to account for neutral axis rotation and equilibrium of horizontal bending moment due to cross-section asymmetry after collision events. Reliability analysis was performed to investigate the incidence of collision penetration depth and height statistical properties on hull girder sagging/hogging failure probabilities. The progressive collapse analysis of local elements and the ultimate strength of the ship was conducted by Muis Alie [2]. The probabilistic characteristic of the hull girder target safety level of a Suezmax tanker derived from a cost-benefit analysis was assessed by Guia [3]. The target safety level was obtained considering as risk control option the change in the cross-section scantlings of the tanker and its effect on risk reduction expressed by the total expected cost of the hull girder failure. The effect of initial imperfections and corrosion wastage on the age-related strength degradation of the bulk carrier was studied by Van [4], a simplified method was also proposed to determine the ultimate vertical bending moment of ship hull girder subjected to initial imperfections and corrosion wastage. The experimental and finite element simulation studies on scaled double-hull side structures quasi-statically punched at the mid-span by conical and knife-edge indenters to examine their fracture behaviors, and energy dissipation



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

mechanism was done by Zhang [5]. The simplified approach to the ultimate hull girder strength of asymmetrically damaged ships was conducted by Muis Alie [6]. Reliability analysis of an oil tanker in intact conditions was performed by Campanile [7] to investigate the incidence of load combination methods on hull girder sagging/hogging time-variant failure probability.

Also, a new procedure to determine the FE datum based on box girder Finite Element Analysis (FEA) results were presented by Downes [8], the simple box girder collapse test results were compared with FEA results of same box girders. Also, the assessment of the ultimate residual strength of Aframax-class double-hull oil tanker damaged in the collision was done by Parunov [9], taking the influence of the rotation of the neutral axis and performed by imposing appropriate boundary condition. Reliable and suitable FE modeling in the explicit dynamic method, which could keep the balance of the acceptable accurate results and computation resources, was performed by Xu [10]. The influence of geometrical imperfection modes on the ultimate strength of a ship's hull was studied by Estefen [11] with a focus on the buckling behavior of stiffened panels that initiated the structural hull failure, using a numerical model of a Suezmax tanker and performed finite element method considering both geometric and material nonlinearities. A simplified analytical method to examine the energy absorbing mechanism of double-hull ship structures subjected to a flat edge indenter was conducted by Liu and Soares [12]. To validate the method, a numerical simulation was conducted on a structural module derived from an experimental scaled stiffened panel. Among them, the influence of longitudinal bulkhead to the longitudinal strength, particularly for tanker, are not clearly described. Therefore, the present study is to analyze the effect of the longitudinal bulkhead to the longitudinal strength of a double hull tanker.

5 Modeling

A double hull tanker with single and double longitudinal bulkheads is represented in Figs. 1 and 2. The single longitudinal bulkhead is located at the centerline while the double longitudinal bulkheads are placed between two side girders perpendicular of the vertical direction.

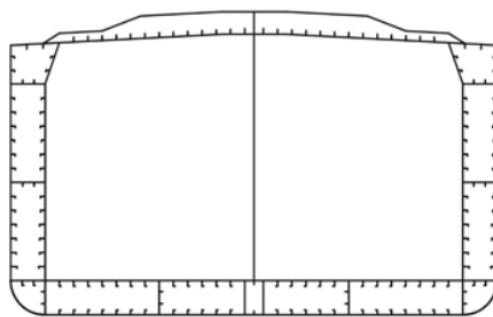


Figure 1. Single longitudinal bulkhead.

The previous studies had been analyzed for the ultimate strength considering the cross-section of the ship, for example (Muis Alie, [5]; Tekgoz, [13] and Campanile, [1]). The cross-section was assumed to remain plane taking the translation and rotation of the neutral axis position. The breadth and depth of the ship are constant. There are six girders in double bottom construction for the single longitudinal bulkhead. On the other hand, eight girders in double bottom construction for double longitudinal bulkhead. In the present study, the longitudinal strength of double hull tanker considering the longitudinal bulkhead is conducted under hogging and sagging conditions.

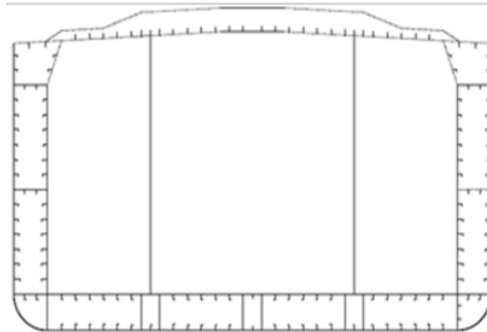


Figure 2. Double longitudinal bulkhead.

The finite element model, load, and boundary conditions are illustrated in Figs 3 and 4, respectively. The cross-section is modeled by shell element, both single and double longitudinal bulkheads. The application of the finite element method was also used to analyze the ultimate strength of the ship's hull girder, such as (Kim, [14]; Cui, [15]; Xu, [10]). The Multi-Point Constraint is applied to both sides of the cross-section. One side is given force rotation, and the other side is constrained.



Figure 3. Finite element model.

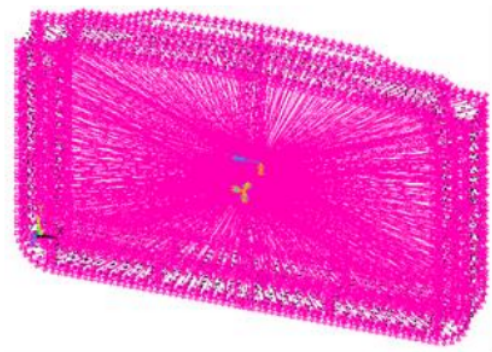


Figure 4. Load and boundary condition.

3. Results and discussions

The ultimate strength of ship hull girder, especially for double hull tanker considering the influence of longitudinal bulkhead, has been conducted using the numerical method, and those results are compared to the analytical method. Figs. 5 and 6 show the comparison of the longitudinal strength for single and double longitudinal bulkhead obtained by the numerical and analytical method under hogging condition.

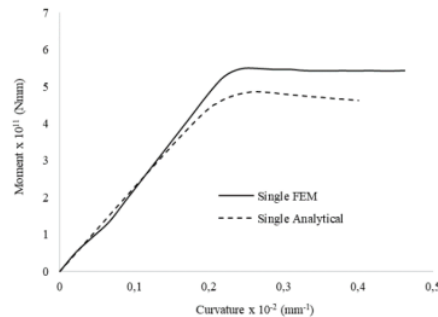


Figure 5. Comparison of longitudinal strength between FEM and Analytical method for single longitudinal bulkhead.

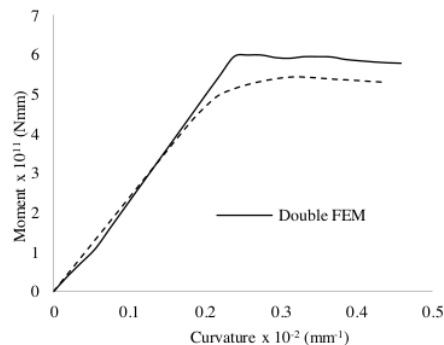


Figure 6. Comparison of longitudinal strength between FEM and Analytical method for double longitudinal bulkhead.

The reductions of the comparison of the longitudinal strength for single and double longitudinal bulkhead obtained by the numerical and analytical method under hogging condition are 1.13 and 1.09, respectively. It is observed that the longitudinal strength produced by the numerical method, both single and double longitudinal bulkhead is larger than the analytical method. Such kind of the ultimate residual strength of double hull tanker had been analyzed, but those for damaged cases, for example, collision or grounding where the damages were asymmetrically position (Muis Alie, [6] and Parunov, [9]). Both translation and rotation of the neutral axis were taken into account.

Figure 7 and 8 describe the comparison of the longitudinal strengths between single and double longitudinal bulkheads produced by numerical and analytical methods. The comparison reduction of

the longitudinal strength between single and double longitudinal bulkheads is 1.12 produced by the analytical method under hogging condition. In the case of the comparison reduction for longitudinal strength obtained by numerical method between single and double longitudinal bulkhead is 1.09 under hogging condition.

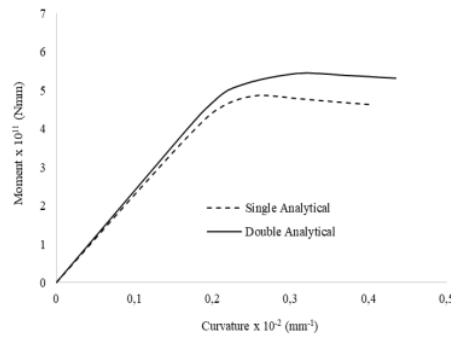


Figure 7. Comparison of longitudinal strength single and double longitudinal bulkhead produced by analytical method.

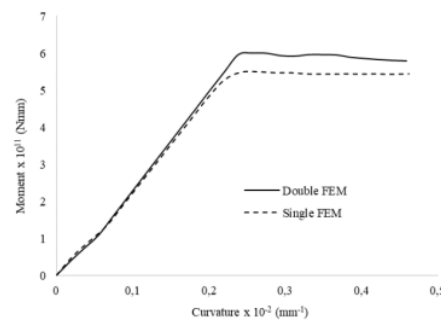


Figure 8. Comparison of longitudinal strength single and double longitudinal bulkhead produced by numerical method.

It is described that the longitudinal strength of double longitudinal bulkheads is a larger produced both numerical and analytical method than longitudinal strength for single longitudinal bulkhead obtained both numerical and analytical method under hogging condition. The longitudinal strength of double longitudinal bulkheads is larger than single longitudinal bulkheads for four kinds of the comparison under hogging condition, neither for the numerical method nor analytical method. This also may be caused by the bottom construction where the number of girders between the cross-section of single and double longitudinal bulkheads is totally different from one another.

The longitudinal strength of single and double longitudinal bulkheads are also performed under sagging condition. Figure 9 and 10 express the comparison of the longitudinal strength between the numerical and analytical method of single and double longitudinal bulkheads under sagging condition. The comparison of the longitudinal strength for single and double longitudinal bulkheads obtained by

the numerical method is larger than an analytical one. The reduction of longitudinal strength, both single and double longitudinal bulkheads between numerical and analytical methods are 1.08 and 1.008, respectively.

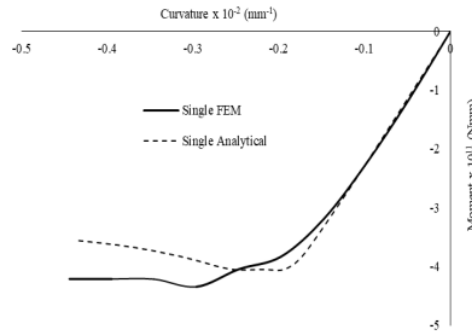


Figure 9. Comparison of longitudinal strength between FEM and Analytical method for single longitudinal bulkhead.

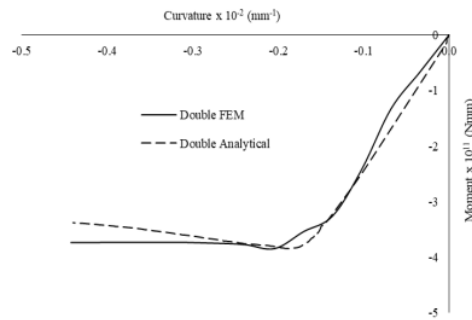


Figure 10. Comparison of longitudinal strength between FEM and Analytical method for double longitudinal bulkhead.

The reduction comparison of the longitudinal strength between numerical and analytical methods, both single and double longitudinal bulkheads, are shown in Figs 11 and 12, respectively. The numerical method shows that the curve is not a smooth line. This probably due to the cross-section at deck part since the ship is under sagging condition.

The reduction of the longitudinal strength between the numerical method and the analytical method is 1.08 for a single longitudinal bulkhead, while the reduction of the longitudinal strength between the numerical method and analytical method is 1.008 for double longitudinal bulkheads. According to Figure 11 and 12 that the longitudinal strength of double bulkheads is larger than single longitudinal bulkhead numerical and analytical methods under sagging condition. This confirms that double longitudinal bulkheads are stronger than a single longitudinal bulkhead.

This should be stated that the longitudinal strength of double longitudinal bulkheads is larger than single longitudinal bulkheads for four kinds of the comparison under sagging condition, neither for the numerical method nor analytical method.

The influence of longitudinal bulkhead for the analytical and numerical method is about 10.7% and 7.7%, respectively, under hogging condition. In the case of the sagging condition, the influences are about 5.5% and 11.8%, respectively.

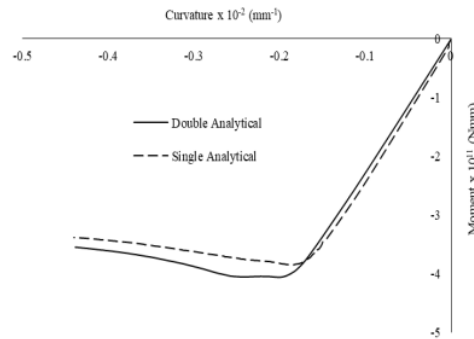


Figure 11. Comparison of longitudinal strength single and double longitudinal bulkhead produced by analytical method.

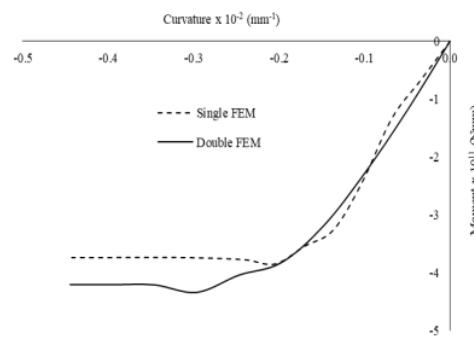


Figure 12. Comparison of longitudinal strength single and double longitudinal bulkhead produced by numerical method.

4. Conclusion

The longitudinal strength analysis of double-hull tankers has been performed using the numerical and analytical method for single and double longitudinal bulkheads under hogging and sagging conditions. The results obtained by both methods are compared with one another. The following conclusions can be drawn. For the case of the subject ships taken in this study, the influence of the longitudinal bulkhead to longitudinal strength is about 10.7% and 7.7%, respectively, under hogging condition. In case of sagging condition, the influences are about 5.5% and 11.8%.

References

- [1] Campanile A, Piscopo V and Scamardella A 2018 Conditional reliability of bulk carriers damaged by ship collisions *Marine Structures* **58** 321–341
- [2] Muis Alie M Z and Latumahina S I 2019 Progressive collapse analysis of the local elements and

- ultimate strength of a Ro-Ro Ship *International Journal of Technology* **10** 1065–1074
- [3] Guia J, Teixeira A P and Guedes Soares C 2018 Probabilistic modelling of the hull girder target safety level of tankers *Marine Structures* **61** 119–141
- [4] Vu Van T, Yang P and Doan Van T 2018 Effect of uncertain factors on the hull girder ultimate vertical bending moment of bulk carriers *Ocean Engineering* **148** 161–168
- [5] Zhang M, Liu J, Hu Z and Zhao Y 2018 Experimental and numerical investigation of the responses of scaled tanker side double-hull structures laterally punched by conical and knife edge indenters *Marine Structures* **61** 62–84
- [6] Muis Alie M Z 2018 Simplified approach on the ultimate hull girder strength of asymmetrically damaged ships *International Journal of Offshore and Polar Engineering* **28** 200–205
- [7] Campanile A, Piscopo V and Scamardella A 2017 Incidence of load combination methods on time-variant oil tanker reliability in intact conditions *Ocean Engineering* **130** 371–384
- [8] Downes J, Tayyar G T, Kvan I and Choung J 2017 A new procedure for load-shortening and -elongation data for progressive collapse method *International Journal of Naval Architecture and Ocean Engineering* **9** 705–719
- [9] Parunov J, Rudan S and Bužančić Primorac B 2017 Residual ultimate strength assessment of double hull oil tanker after collision *Engineering Structures* **148** 704–717
- [10] Xu M C, Song Z J and Pan J 2017 Study on influence of nonlinear finite element method models on ultimate bending moment for hull girder *Thin-Walled Structures* **119** 282–295
- [11] Estefen S F, Chujutalli J H and Guedes Soares C 2016 Influence of geometric imperfections on the ultimate strength of the double bottom of a Suezmax tanker *Engineering Structures* **127** 287–303
- [12] Liu B and Guedes Soares C 2016 Assessment of the strength of double-hull tanker side structures in minor ship collisions *Engineering Structures* **120** 1–12
- [13] Tekgoz M, Garbatov Y and Guedes Soares C 2018 Strength assessment of an intact and damaged container ship subjected to asymmetrical bending loadings *Marine Structures* **58** 172–198
- [14] Kim D H and Paik J K 2017 Ultimate limit state-based multi-objective optimum design technology for hull structural scantlings of merchant cargo ships *Ocean Engineering* **129** 318–334
- [15] Cui J, Wang D and Ma N 2017 A study of container ship structures' ultimate strength under corrosion effects *Ocean Engineering* **130** 454–470

ORIGINALITY REPORT

21 %
SIMILARITY INDEX

11 %
INTERNET SOURCES

17 %
PUBLICATIONS

5 %
STUDENT PAPERS

PRIMARY SOURCES

1 dspace.brunel.ac.uk **2** %
Internet Source

2 Submitted to International Maritime College,
Oman **2** %
Student Paper

3 Segen F. Estefen, John H. Chujutalli, C. Guedes
Soares. "Influence of geometric imperfections
on the ultimate strength of the double
bottom of a Suezmax tanker", Engineering
Structures, 2016 **2** %
Publication

4 linknovate.com **2** %
Internet Source

5 Artjoms Kuznecovs, Jonas W. Ringsberg,
Erland Johnson, Yasuhira Yamada. "Ultimate
limit state analysis of a double-hull tanker
subjected to biaxial bending in intact and
collision-damaged conditions", Ocean
Engineering, 2020 **2** %
Publication

6	Internet Source	1 %
7	creativecommons.org Internet Source	1 %
8	Muhammad Zubair Muis Alie, Juswan, Wahyuddin, Taufiqur Rachman. "Study on ultimate strength of ship's hull considering cross section and beam finite element.", MATEC Web of Conferences, 2018 Publication	1 %
9	Ming Cai Xu, Zhao Jun Song, Jin Pan. "Study on influence of nonlinear finite element method models on ultimate bending moment for hull girder", Thin-Walled Structures, 2017 Publication	1 %
10	Qinghu Wang, Deyu Wang. "Ultimate strength envelope of a 10,000TEU large container ship subjected to combined loads: From compartment model to global hull girder", Ocean Engineering, 2020 Publication	1 %
11	www.onepetro.org Internet Source	1 %
12	A. Campanile, V. Piscopo, A. Scamardella. "Time-variant bulk carrier reliability analysis in pure bending intact and damage conditions", Marine Structures, 2016	1 %

13 Submitted to University of Newcastle upon Tyne 1 %
Student Paper

14 Matthew Terracciano, Sujit Purushothaman, Francisco de León. "Calculation of cable thermal rating considering non-isothermal earth surface", IET Generation, Transmission & Distribution, 2014 1 %
Publication

15 V. Piscopo, A. Scamardella. "Sensitivity analysis of hull girder reliability in intact condition based on different load combination methods", Marine Structures, 2019 1 %
Publication

16 www.bib.irb.hr 1 %
Internet Source

17 ijtech.eng.ui.ac.id <1 %
Internet Source

18 Van Tuyen Doan, Bin Liu, Y. Garbatov, Weiguo Wu, C. Guedes Soares. "Strength assessment of aluminium and steel stiffened panels with openings on longitudinal girders", Ocean Engineering, 2020 <1 %
Publication

19 www.iieta.org

Internet Source

<1 %

20

"Design of Ship Hull Structures", Springer
Science and Business Media LLC, 2009

Publication

<1 %

Exclude quotes On

Exclude matches < 5 words

Exclude bibliography On