

Proceedings of International Conference on Ship and Offshore Technology

"Developments Marine Design, Construction and
Operation"

Vol. 2, November 2019

Organized by :



Diponegoro
University



Royal Institution of
Naval Architects (RINA)

November, 25th - 26th 2019

Diponegoro University (UNDIP) - Semarang
Indonesia



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Welcome Message From Chair



On behalf of the Committee, it is our great pleasure to welcome you to the sixth International Conference on Ship and Offshore Technology – Indonesia (ICSOT Indonesia 2019). This year, the conference is jointly organized by Diponegoro University (UNDIP) and the Royal Institute of Naval Architects (RINA).

The conference theme is “Developments Marine Design, Construction, and Operation”. Although the theme is limited to developments marine design, construction, and operation, but the theme can be related and developed to other aspects such as hydrodynamics, marine safety, environment, material, construction aspects, maritime logistics, fishing vessel, etc. The program committee accepted 14 of those papers to be presented in this conference.

We are honored to have outstanding speakers. And also, special thanks to the Keynote Speakers: Prof. Dr. Hirotada Hashimoto, and Prof. Dr. Ir. Muljo Widodo Kartidjo. We appreciate to the Royal Institute of Naval Architects (RINA) as supporting organization in this conference, especially Vice President RINA, Prof. Ir. I Ketut Aria Pria Utama, MSc, PhD, Ceng, FRINA.

We welcome you to Semarang, and we very much hope you enjoy the conference.

Dr. Eng. Deddy Chrismianto, ST, MT
Chair of ICSOT Indonesia 2019

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ICSOT 2019 Agenda

Monday, 25th November 2019

Time	Agenda
07.30 - 08.30	Registration
08.30 - 09.00	Welcome Remark
09.00 - 09.15	Opening Speech (Vice President Asia Region : Prof. Ir. Ketut Aria Pria Utama, M.Sc, PhD, C. Eng, FRINA
09.15 - 09.30	Greeting of Dean of Engineering Faculty
09.30 - 09.40	Opening Ceremony ICSOT 2019
09.40 - 10.00	Coffee Break
10.00 - 10.30	Keynote Speaker 1 : Prof. Dr. Eng Hirotsada Hashimoto (Kobe University, Japan)
10.30 - 12.00	1st Session of Conference (3 presenters)
12.00 - 13.00	Lunch
13.00 - 14.30	2nd Session of Conference (3 presenters)
14.30 - 15.00	Coffee Break
15.00 - 16.00	3rd Session of Conference (2 presenters)
18.30 - 20.00	Dinner

Tuesday, 26th November 2019

Time	Agenda
08.00 - 09.00	Registration
09.00 - 09.30	Keynote Speaker 2: Prof. Mulyo Widodo Kartidjo (Mechanical Engineering, ITB)
09.30 - 10.00	Coffee Break
10.00 - 11.30	4 th Session of Conference (3 presenters)
11.30 - 13.00	Lunch
13.00 - 14.30	5 th Session of Conference (3 presenters)
14.30 - 15.00	Closing Ceremony

Technical Program Schedule

No.	Title	Time	Session
1.	A Review State Of The Art Crew Boat Improving Fuel Efficiency Based On Operational Data Motion Using Artificial Intelligence	10.30 - 11.00	1st Session of Conference
2.	Experimental And Numerical Study Of Ship Resistance Due To Variation Of Hull Vane Positioning In The Longitudinal Direction	11.00 - 11.30	1st Session of Conference
3.	Numerical Investigation Into The Pressure Distribution And Form Factor Effect Of Slender body Catamaran	11.30 - 12.00	1st Session of Conference
4.	Study On The Environmental Condition Of Indonesia's Ports Anchoring Area	13.00 - 13.30	2nd Session of Conference
5.	The Optimization Of Anchor Equipment Due To The Specific Anchoring Area	13.30 - 14.00	2nd Session of Conference
6.	The Hull Girder Strength Analysis Due To Equipment Load Under Longitudinal Bending	14.00 - 14.30	2nd Session of Conference
7.	Geometry Optimization Of Centre Bulb To Reduce Wave Resistance On Catamaran Ship	15.00 - 15.30	3rd Session of Conference
8.	Toward Green And Sustainable Ship Recycling Industry In Indonesia	15.30 - 16.00	3rd Session of Conference
9.	A Model Scale Of Unsinkable Small Passenger Speed-Boat	10.00 - 10.30	4th Session of Conference
10.	The Development Of Intact Stability Criteria : The Work On Small Ship Up To 24 M In Operate In Indonesian Waterways	10.30 - 11.00	4th Session of Conference
11.	Application Of The Second Generation Intact Stability Criteria To An Indonesian Ro-Ro Ferry Supported By Model Experiment	11.00 - 11.30	4th Session of Conference
12.	Stability Assessment Of Hatch Coverless River-Sea Cargo Ship	13.00 - 13.30	5th Session of Conference
13.	Study On The Alternative Method Of Non-Destructive Testing For Fibre Reinforced Polymer	13.30 - 14.00	5th Session of Conference
14.	Comparative Study Of Straightening Method Using Oxy-Acetylene Carburizing With Tungsten Inert Gas On Aluminium 5083-H116	14.00 - 14.30	5th Session of Conference

THE HULL GIRDER STRENGTH ANALYSIS DUE TO EQUIPMENT LOAD UNDER LONGITUDINAL BENDING

Muhammad Zubair Muis Alie, Juswan, Wahyuddin Mustafa, Kevin Gabriel Pangalinan and Nurul Inda Pratiwi, Universitas Hasanuddin, Indonesia

SUMMARY

The objective of the present study is to analyze the hull girder strength due to the equipment load of FSO after being converted into FPSO under longitudinal bending. There is no change of the ship's construction; however, much additional equipment after conversion is conducted. One of them is the processing module, where the equipment is placed at the deck part. This additional equipment should be analyzed including their influence to the ultimate strength. The cross-section of FPSO is taken by considering one-frame space. The application of Multi-Point Constraint (MPC) in the numerical method is used. The MPC is placed at the neutral axis position as a reference point on both sides of the cross-section. The cross-section is assumed to remain plane. The midship section is modeled with one frame space. The element type of shell 181 is used on the model. As a simple calculation, the initial imperfections, cracks, and residual welding stress are not taken in the analysis. The ultimate strength obtained by the numerical method is therefore compared with the analytical method and the behavior of the ship in terms of stress distribution and deformation are also presented in this study.

1. INTRODUCTION

The conversion of a ship is now implemented primarily for offshore structure, namely Floating Storage Offloading (FSO) or Floating Production Storage Offloading (FPSO). The purpose of the conversion is to obtain the advantage of the ship payload. Besides, the conversion is also conducted to change the ship function. One of the ship conversion, which is commonly performed, is the ship conversion from FSO to FPSO. Nowadays, about 70% of FPSO is produced from the conversion result. Time-consuming is shorter than a new design that is one of the reasons. Due to this reason, the analysis of the ultimate strength of being converted from FSO to FPSO must be taken into consideration.

The ultimate strength analysis of the ship had been presented by some papers like; 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 impact 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 activities, 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. The safety 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 to 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 modelled simply by removing the element on the damaged part. The ultimate hull girder strength considering section modulus under longitudinal bending was analysed by Muis Alie and Latumahina [8] and the cross-section of Ro-Ro ship was taken to be analysed.

In the present study, the analysis of hull girder strength due to the equipment load of FSO after being converted into FPSO under longitudinal bending is conducted. There is no change of the ship's construction, but much additional equipment after conversion. One of them is the processing module, where the equipment is placed at the deck part. For the simple calculation, the one-frame space of FPSO's cross-section is considered. The cross-section is assumed to remain plane. The element type of shell 181 is used on the model. The initial imperfections, cracks, and residual welding stress are not taken into account. The ultimate strength obtained by the numerical method is therefore compared with the analytical method and the behavior of the ship in terms of stress distribution and deformation are also shown in this study.

2. FINITE ELEMENT MODELING

In the present study, the numerical method to analyze the hull girder strength due to load equipment of change

function from FSO to FPSO before and after being converted is conducted. The ship has 172 m, 30 m and 18.4 m of length, breadth, and depth of ship, respectively. The midship section consists of two kinds of longitudinal stiffeners those are flat-bar and angle-bar. There is also the inner hull in the cross-section. The element type is shell-181. The shell-181 element applied to all of the cross-section as shown in figure 1.



Figure 1. Finite element model of cross section

According to figure 1, there are two points located at the neutral axis. These two points are placed at both sides of the cross-section, and those are used to place the MPC (Multi-Point Constraint) for representing the behavior of the cross-section. The ultimate strength analysis, including the effect of change function from FSO to FPSO, is calculated using the numerical method under sagging condition. The rigidly linked corresponding with the boundary condition where MPC is applied to both sides of the cross-section, as shown in figure 2.

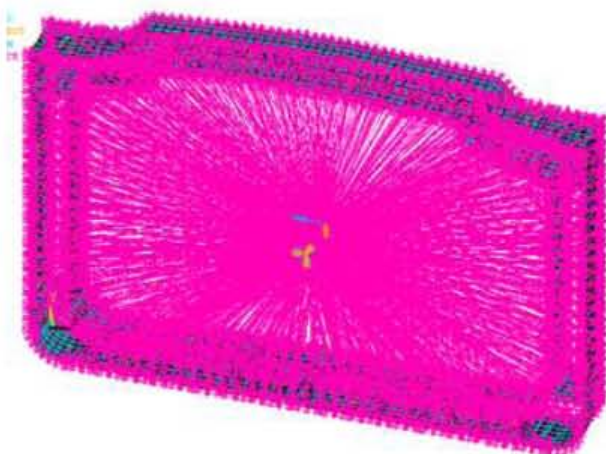


Figure 2. Boundary condition

3. RESULTS AND DISCUSSIONS

The behavior of the ultimate strength analysis is described in terms of working stress distribution. Figures 3 and 4 show the working stress and deformation under the sagging condition. The tension and compression take place at the deck and bottom part since the hull cross-section is under sagging condition.

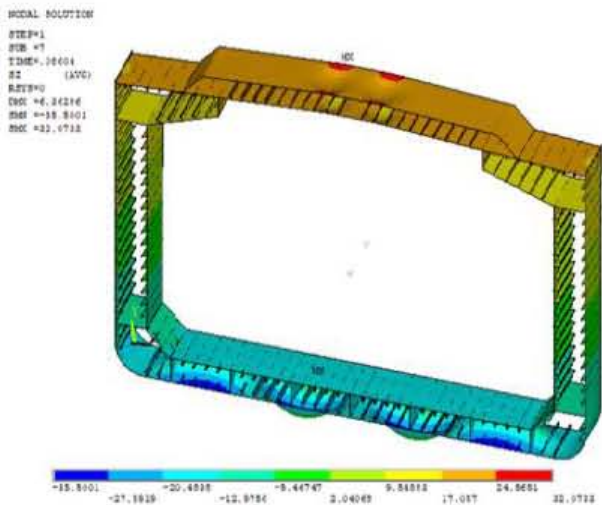
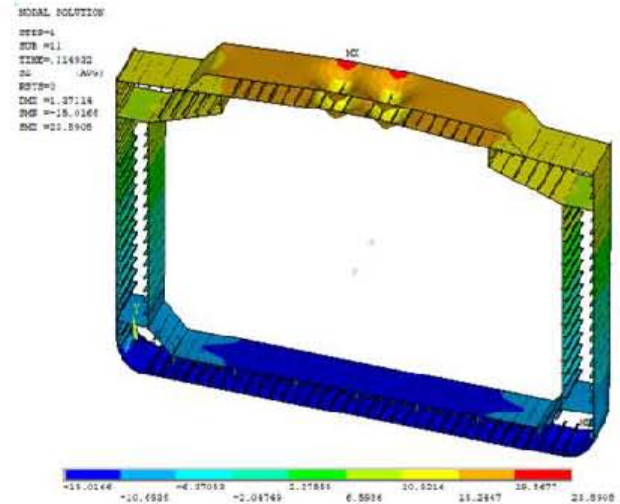


Figure 3. Working stress in sagging

Figure 4. Deformation in sagging

According to figures 3 and 4, the maximum stress and deformation are located in the middle of the cross-section. There are two layers at the deck part of the ship's cross-section. This will be contributed to the ultimate strength since the cross-section is under hogging or sagging condition.

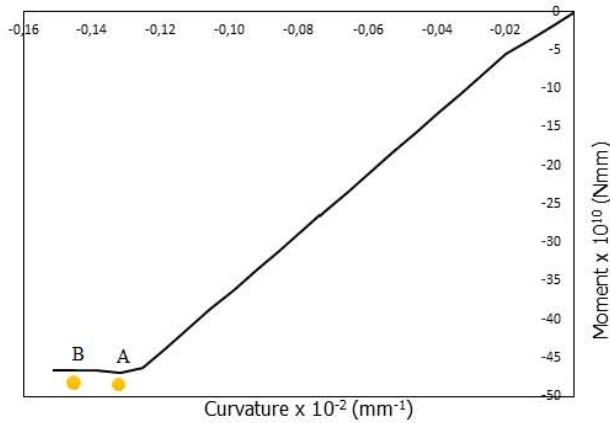


Figure 5. Moment-curvature relationship

Figure 5 shows the moment-curvature relationship of FSO under sagging condition. There are two points at the line, and those point A and B at the ultimate strength and collapse stages. Figures 6 and 7 show the deformation of FSO at point A and B on the ultimate strength and collapse regime, respectively.



Figure 6. Deformation of FSO at ultimate strength

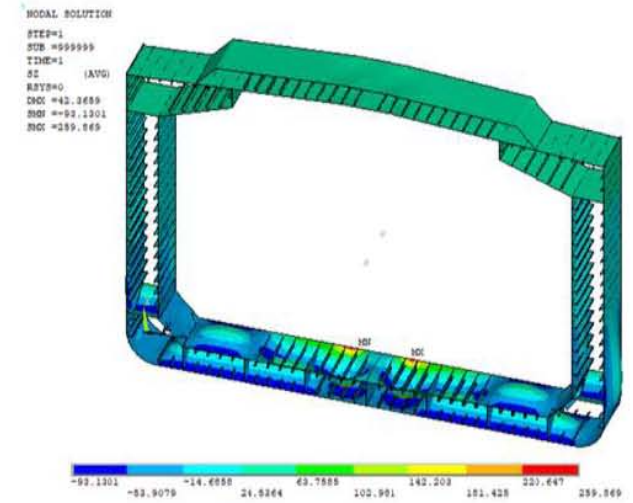


Figure 8. Deformation of FPSO at ultimate strength

According to figures 6 and 7, it is observed that the behavior of deformations is almost similar. It can be seen from figure 5 for the relationship of the moment-curvature curve, where points A and B are almost in a straight line. Therefore, the hull girder behavior of the cross-section at those points is almost similar. Figures 8 and 9 show the deformation of FPSO at ultimate and collapse stages. It is observed that the behavior of the FSO is completely different with FPSO after being converted with additional equipment.

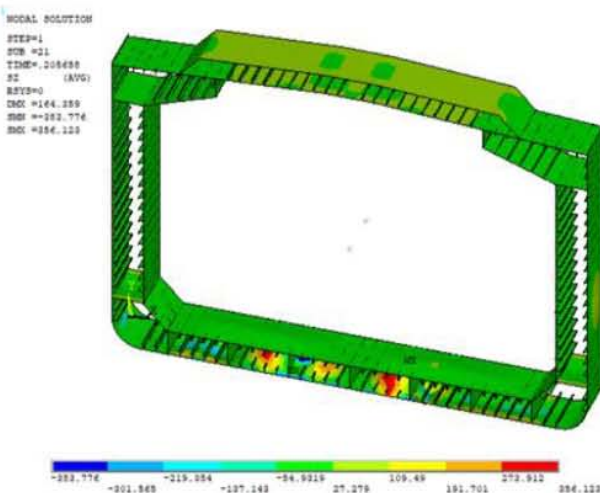


Figure 7. Deformation of FSO at the collapse

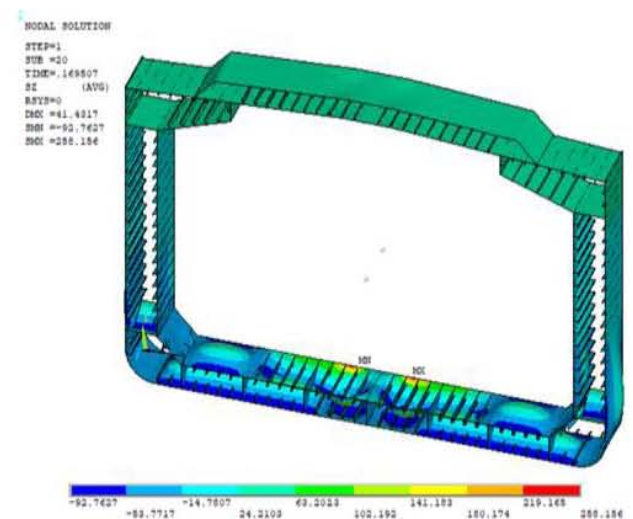


Figure 9. Deformation of FPSO at the collapse

Figure 10 shows the moment-curvature relationship of FPSO under sagging condition. Points A and B are the ultimate strength and collapse regime, respectively.

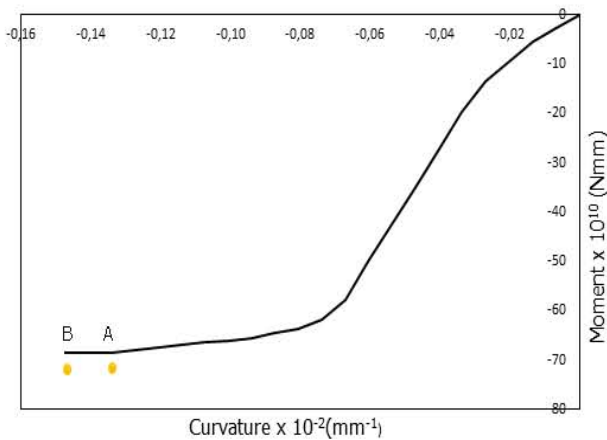


Figure 10. Moment-curvature relationship of FPSO

Figure 11 describes the comparison of the moment-curvature relationship between the analytical method and FEM of FSO under sagging condition. The dashed line represents the result obtained by the analytical method, while a solid line for FEM.

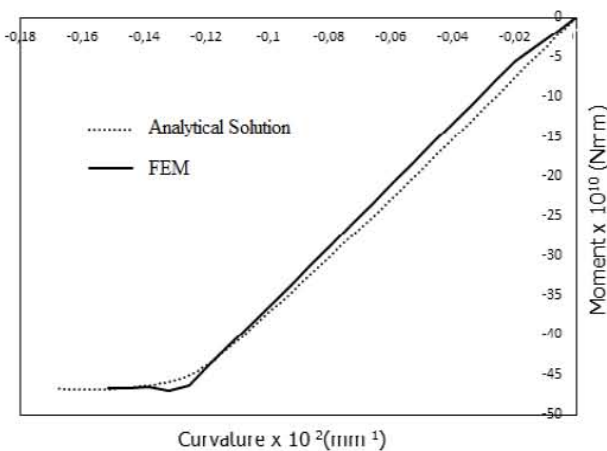


Figure 11. Comparison of moment-curvature FSO

According to figure 11 that the ultimate strength obtained by FEM is a little bit larger than the analytical method. This may be due to the constraint at the cross-section and the load redistribution that is effect to the stress in the elements.

Figure 12 shows the comparison of the ultimate strength obtained by FEM between FSO and FPSO. The solid line represents the ultimate strength of FSO, while FPSO is represented by the dashed line. According to figure 12 that the bending stiffness of FSO and FPSO is different from one another. This behavior is due to the effect of additional equipment and change function where the FSO

is converted to FPSO. The effect of the additional equipment which corresponds to loading gives significant influence to the ultimate strength before and after being converted from FSO to FPSO.

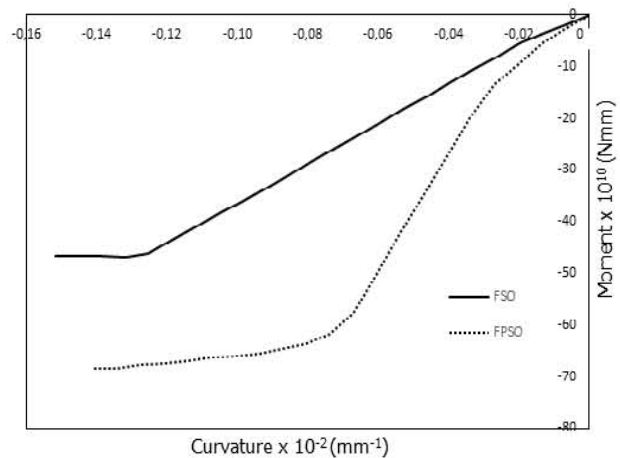


Figure 12. Comparison of moment-curvature between FSO and FPSO

4. CONCLUSIONS

The effect of change function to the ultimate strength from FSO to FPSO is conducted using the nonlinear finite element analysis. The following conclusion is summarized; the impact of change function, namely additional equipment after being converted from FSO to FPSO, is significant to the ultimate strength under sagging condition. Due to additional equipment, the bending stiffness is different between FSO and FPSO. Also, the ultimate strength obtained by nonlinear finite element analysis for FPSO is larger than FSO.

5. REFERENCES

1. Parunov J, Rudan S and Bužančić Primorac B, 'Residual ultimate strength assessment of double hull oil tanker after collision', *Eng. Struct*, 2017.
2. Xu M C, Song Z J and Pan J, ' Study on influence of nonlinear finite element method models on ultimate bending moment for hull girder', *Thin-Walled Struct*, 2017.
3. Li X and Tang W, 'Structural risk analysis model of damaged membrane LNG carriers after grounding based on Bayesian belief networks', *Ocean Eng*, 2019.
4. Campanile A, Piscopo V and Scamardella A, 'Conditional reliability of bulk carriers damaged by ship collisions', *Mar. Struct*, 2018.
5. Campanile A, Piscopo V and Scamardella A, 'Incidence of load combination methods on time-variant oil tanker reliability in intact conditions', *Ocean Eng*, 2017.
6. Muis Alie M Z, 'Simplified approach on the ultimate hull girder strength of asymmetrically

- damaged ships', *Int. J. Offshore Polar Eng*, 2018.
7. Muis Alie M Z, Sitepu G, Sade J, Mustafa W, Nugraha A M and Bin Muh. Saleh A, 'Finite Element Analysis on the Hull Girder Ultimate Strength of Asymmetrically Damaged Ships', 2016.
 8. Muis Alie M Z and Latumahina S I, 'The Ultimate Hull Girder Strength Analysis Considering Section Modulus Under Longitudinal Bending', 2018.

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