The ultimate strength of the skid frame on Mooring Support Structure (MSS)

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Abstract. The Mooring Support Structure (MSS) structure has a function as a provider of pipelines and cables between the Hose Deck of the Mooring Tower and MSS. The pipes and cables serve to export crude oil and other exploration products such as water and gas from Mooring Tower to the FSO. During the construction process in the fabrication field, the MSS is supported by skid frames. The skid frames are assembly structures that consist of beams with various shapes and dimensions. The skid frame strength calculation is performed to ensure that the designed skid frame can resist the load of the MSS structure above it. This study aims to analyze the ultimate strength of the skid frame response of Mooring Support Structure (MSS), and the result is presented in terms of stress and interaction ratio.

1. Introduction

Skid frames are assembly structures that consist of beams. The beams have varied shapes and dimensions. Parts used have the same dimensions and shape, or a combination can be used to get an optimal strength and weight. Skid frames can be subjected to gravity from all components installed. The ultimate strength analysis of skid frame strength is done to ensure that the design of the skid frame can resist the load of the existing MSS structure. In contrast, it is essential to support construction activities and different analysis during the fabrication, weighing, and load-out processes. Therefore, the skid frame design must be analyzed for the operation and safety of usages in any condition.

Skid frame, like other offshore structures, has been studied by some researchers. Muis Alie [1] discussed the configuration effect of fixed offshore structure with symmetrical and unsymmetrical shape toward buckling failure. Two kinds of the offshore structure were analyzed. The numerical analysis was adopted to calculate buckling failure under axial and lateral load. Yang [2] conducted the seismic collapse performance of jacket offshore platforms with a time-variant zonal corrosion model. Eldin [3] conducted the sensitivity analysis on the seismic life-cycle cost of a fixed-steel offshore platform structure. The sensitivity analysis was performed using different methods such as tornado diagram analysis, first-order second moment, and Latin hypercube sampling. Muis Alie [4] analyze the effect of symmetrical and unsymmetrical configuration shapes on buckling and fatigue strength analysis of the fixed offshore platform. Two models of the fixed offshore structure were taken to be analyzed with the same dimension but different configuration shapes. The numerical calculation was performed to investigate the buckling and fatigue strength of both structures. Guede [5] presented a method for risk assessment and inspection plan development as part of the risk-based structural integrity management of the offshore jacket platform. Hezarjaribi [6] performed the nonlinear response of jacket-type platforms against extreme waves that were examined utilizing sensitivity
analyses. The influence of the brace structure on the bearing capacity and load transfer mode from the top to bottom of the jacket structure was studied Zhang [7] using numerical simulation. A structural optimization design method for jacket platform structure has been developed by Tian [8] based on topology optimization theory.

The objective of the present study is to analyze the ultimate strength of the skid frame on Mooring Support Structure (MSS). The analysis is conducted using the finite element method. The result obtained by the finite element method is presented in terms of stress and deformation.

2. Methodology
The skid frame model of Mooring Support Structure (MSS) using the finite element model is illustrated in figure 1. The legs of the MSS structure at the bottom part are assumed to be fixed support. The value of material properties is 210000 N/mm\(^2\), 690 N/mm\(^2\), and 938 N/mm\(^2\) for elastic modulus, yield strength, and ultimate tensile strength, respectively.

![Figure 1. Skid frame FE model.](image)

3. Results and discussion
The unity check or interaction ratio between axial and bending stress is shown in figure 2 and summarized according to table 1. The stress distribution on the skid frame is shown in figure 3. Table 1 shows the interaction ratio of the model between axial and bending stress. The elements are shown in group ID, where the interaction ratios are obtained. The critical member and loading combinations are also plotted in Table 1.

| Group ID | Critical Member | Load Condition | Maximum IR |
|----------|-----------------|----------------|------------|
| 25       | 0212-0210       | COMB           | 0.17       |
| 252      | 0088-0089       | COMB           | 0.04       |
| 256      | 0051-0048       | COMB           | 0.13       |
| 260      | 0087-0090       | COMB           | 0.05       |
| 29       | 0063-0204       | COMB           | 0.12       |
| 3        | 0103-0034       | COMB           | 0.04       |
4. Conclusion
The ultimate strength analysis of the skid frame on Mooring Support Structure (MSS) is performed using the finite element method. It is found that the interaction ratios of the skid frame on MSS structure between axial and bending stress are smaller than 1. It is concluded that the skid frame is safe for the load acting on the skid frame of the model.
References

[1] Muis Alie M Z 2015 The Effect of Symmetrical and Asymmetrical Shape in Buckling Strength on Fixed Offshore Platform Proceedings of the Twenty-fifth (2015) International Ocean and Polar Engineering Conference vol 7 p 1107

[2] Yang Y, Wu Q, He Z, Jia Z and Zhang X 2019 Seismic Collapse Performance of Jacket Offshore Platforms with Time-Variant Zonal Corrosion Model Applied Ocean Research 84 268–278

[3] Nour Eldin M and Kim J 2016 Sensitivity analysis on seismic life-cycle cost of a fixed-steel offshore platform structure Ocean Engineering 121 323–340

[4] Muis Alie M Z 2016 The Effect of Symmetrical and Asymmetrical Configuration Shapes on Buckling and Fatigue Strength Analysis of Fixed Offshore Platforms International Journal of Technology 7 1107-1116

[5] Guédé F 2019 Risk-based structural integrity management for offshore jacket platforms Marine Structures 63 444-461

[6] Hezarjaribi M, Bahaari M R, Bagheri V and Ebrahimian H 2013 Sensitivity analysis of jacket-type offshore platforms under extreme waves Journal of Constructional Steel Research 83 147–155

[7] Zhang P, Li J, Gan Y, Zhang J, Qi X, Le C and Ding H 2020 Bearing capacity and load transfer of brace topological in offshore wind turbine jacket structure Ocean Engineering 199 107037

[8] Tian X, Wang Q, Liu G, Liu Y, Xie Y and Deng W 2019 Topology optimization design for offshore platform jacket structure Applied Ocean Research 84 38–50