Torsional beam analysis subjected to static load on offshore structure deck

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Abstract. The jack-up is one of the fixed typical offshore structures consists of many elements such as beams, plates, braces and so on. Those elements play an important role to strengthen the structure locally and globally from internal and external loads. Such kind of loads eventual act on element like beam and make torsionally. This phenomenon must be analyzed because the beam is connected to other element. The objective of the present study is to analyze the torsional beam subjected to static load on offshore structure deck. The jack-up structure particularly beam element located on the deck is selected to be analyzed. Two cases of beam model are taken. The numerical method is performed to analyze the beam. The result obtained by numerical method for two beam model si compared with one another.

1. Introduction
One of the offshore structure type is jack-up which is almost identic with jacket structure where the legs are also fixed at sea bottom. The deck structure is constructed with complex elements and connected to other elements. Beam element at deck structure functioned to support the construction at deck part including all the activities. On the other hand, the element at deck component such as beam element must also be evaluated to ensure the deck structure is safety from loading condition. Therefore, the beam element of deck struture must be analyzed from any kind of loading including torsional.

Fixed offshore structures such as jacket, jack-up, and concrete gravity platform have been studied by some researches. 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. Muis Alie [3] 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. Eldin [4] 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. 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. The numerical calculation was performed to investigate the buckling and fatigue strength of both...
structures. Hezarjaribi [6] performed the nonlinear response of jacket-type platforms against extreme waves that were examined utilizing sensitivity analyses.

The objective of the present study is to analyze the torsional beam subjected to static load on jack-up structure deck. The jack-up structure particularly beam element located on the deck is selected to be analyzed. Two cases of beam model are taken. The numerical method is performed to analyze the beam. The result obtained by numerical method for two beam element is then compared with one another.

2. Methodology
The beam element is modeled by finite element method is shown in figure 1 and 2 for extrude view. The WF section is selected to analyze the torsion. There are two cases of beam analysis those are 6000 mm and 3000 mm in length, respectively. One of the end of element beam is fixed and the other one is free and given rotational force. The quadrilateral mesh is applied to whole model. The material and section properties both two models are constant.

![Figure 1. Beam element model](image1)

![Figure 2. Beam element model with extrude view](image2)
3. Results and discussion

Figure 3 shows the stress-strain relationship of two beam element under rotational force. It is observed that the bending stiffness is identical for two model cases. The ultimate stress for case 1 is higher than case 2. Also, the plastic behavior for case 1 is longer than case 2. This behavior is caused by the dimension of the length between two models. Because the model 1 is longer than case 2. The critical buckling load is obtained using equation 4 and the result is compared to the numerical method. The critical buckling load of fixed jacket structure is shown in table 1 as follow,

![Figure 3. Comparison of stress-strain between two models](image_url)

![Figure 4. Deformation for case 1](image_url)

![Figure 5. Deformation for case 2](image_url)
Figures 4 and 5 show the deformations of torsional beam subjected to static load. It is observed that the maximum deformation takes place at the end of beam both two model caused by torsional load. The maximum and the minimum of deformation are denoted by the red and blue color. It should be noted that the stress contributes to deformation since both parameter is direct relationship with constant young’s modulus.

4. Conclusion
The analysis of torsional beam on jack-up deck structure subjected to static load has been performed using numerical method. It is found that the maximum deformation is located at the support condition. The comparison of the stress-strain relationship both two models are different especially for the plastic deformation due to length between case 1 and case 2.

References
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