Analyses on helicopter deck under axial and bending

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Abstract. Helicopter deck is one of the structural components on offshore structures. It is very important to transfer especially workman from the land to sea and vice versa. The helideck must be strongly designed for safety not only for human but also for the structure itself. The objective of the present study is to analyze the helicopter deck under axial and bending including the behavior. The nonlinear finite element is adopted to analyze the helicopter deck under axial and bending. The helicopter deck consists of four legs and the plate of the deck is supported by these legs. Three kinds of helicopter, namely Dauphin, Super Puma and EH101 having weight 4.3 ton, 9.3 ton and 14.6 ton, respectively. It is found that the stress on the helicopter deck varies for every load pressure of the helicopter.

1. Introduction

Generally, a fixed offshore platform like the jacket, jack-up, and concrete gravity and other offshore platform consists of some decks such as main, accommodation, drilling and production including helicopter decks. Particularly helicopter deck also plays an important role in the transportation of human and other things where other transportation cannot do like a helicopter. Therefore, the helicopter deck must also be strongly designed not only for the function but also the structural strength due to axial, compressive, and bending loads.

The structural integrity of a fixed offshore platform had been investigated by some researches. Hezarjaribi [1] performed the nonlinear response of jacket-type platforms against extreme waves was examined utilizing sensitivity analyses. Buldgen [2] presented a simplified analytical method for estimating the crushing resistance of an oblique cylinder impacted by the stem of a striking ship. The collision angle of the vessel is arbitrary, i.e., oblique collisions are also considered in the study. Muis Alie [3] discussed the configuration effect of fixed offshore structure with symmetrical and unsymmetrical shape toward buckling failure. Two kinds of offshore structure were analyzed. The numerical analysis was adopted to calculate buckling failure under axial and lateral load. Eldin [4] conducted the sensitivity analysis on seismic life-cycle cost of a fixed-steel offshore platform structure. The sensitivity analysis was conducted using different methods such as tornado diagram analysis, first-order second moment and Latin hypercube sampling. Muis Alie [5] 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 analyze the buckling and fatigue strength of both structures. Guede [6] presented a method for risk assessment and inspection plan development as part of the risk-based structural integrity management.
of offshore jacket platform. Yang [7] conducted the seismic collapse performance of jacket offshore platforms with time-variant zonal corrosion model.

The objective of the present study is to know the behavior of the helicopter deck due to axial and bending. The nonlinear finite element is adopted to analyze the helicopter deck under axial and bending. The helicopter deck consists of four legs and the plate of the deck is supported by these legs. Three kinds of helicopter, namely Dauphin, Super Puma and EH101 having weight 4.3 ton, 9.3 ton and 14.6 ton, respectively. It is found that the stress on the helicopter deck varies for every load pressure due to the helicopter.

2. Methodology
The structural integrity of the helicopter deck can be seen in figures 1 and 2 as follow,

![Figure 1. Helipad](image1)

![Figure 2. Helicopter deck structure](image2)

Load pressure is distributed on three nodes based on the helicopter tires. The deck is designed by plate and stiffened plate and modeled by shell element. The deck structure is supported by four legs. All components of the deck structure have meshed. The leg is assumed to be fixed at the bottom. The
nonlinear finite element is used to analyze the helicopter deck under axial and bending. The material grade of the helicopter deck is summarized in table 1 as follow,

**Table 1. Material steel grade**

| Description                        | Yield Stress (ksi) |
|------------------------------------|--------------------|
| Piles                              | 50                 |
| Jacket leg excluding can           | 36                 |
| Jacket leg can                     | 50                 |
| Deck leg can                       | 50                 |
| Deck leg excluded can              | 36                 |
| Topside Braces                     | 36                 |
| Deck main frames                   | 36                 |
| Deck Secondary frames              | 36                 |
| Grillage beams and sea fastening   | 36                 |

Figure 3. Helicopter deck structure

Figure 3 shows the boundary condition for the helicopter deck structure. The helideck structure is connected with the four legs. It is assumed that the top and bottom of the ends support condition are fixed. The pressure loads act on the helideck structure are shown in figure 4 as follow,
The pressure load is given on the three tires of the helicopter. It is absolutely different depending on the weight of the helicopter. Then, the helicopter weight is divided into six by assuming that every tire to land on two plates with the tire of the dimension area is $2540 \times 1740$ mm. The pressure load acts in the vertical direction, including bending and neglecting any crack, residual welding stress, and initial imperfection of the plate structure. To calculate the structure of the helideck, numerical analysis is performed.

3. Results and discussion

The behavior of structure due to loadings such as axial compression or axial tension, bending, and so on may be represented like a stress-strain relationship, moment-curvature, deformation, etc. In this case, the behavior of the helicopter deck is expressed by the curve of the stress-strain relationship. The equivalent stress of three types of helicopter, namely Dauphin, Super Puma, and EH101, respectively are described in figures 3-5.

Figures 5-7 show the maximum stress of helideck structure for three kinds of the helicopter. It should be noted that the load acts in a vertical direction, including bending. The end support of the helideck structure is fixed at the top and bottom part. The dimension of the helideck and legs are constant. According to figures 5-7 that the maximum stress is located among in front of the helicopter tires, this is because due to the load pressure on that area. Hence, there is concentration and makes the
stress becomes higher. It is observed that the stress concentration on the helicopter deck of Dauphin is larger than Super Puma and EH 101.

**Figure 5.** Equivalent stress for Dauphin

**Figure 6.** Equivalent stress for Super Puma

**Figure 7.** Equivalent stress for EH 101
4. Conclusion
The analyses of helicopter deck under axial and bending has been done using the nonlinear finite element. The following conclusion can be drawn; the axial pressure and bending give significant influence to the equivalent stress distribution on the helicopter deck; this is also caused by the weight of the helicopter. The stress concentration on the helicopter deck of Dauphin is larger than Super Puma and EH 101.

References
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