Stress Analysis of Helideck Structures on Offshore Patrol Vessel

Achmad Zubaydi[1], Septia Hardy Sujiatanti[1] and Refdi[1]
[1]*Department of Naval Architecture, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia*

Keywords: Helideck, Offshore Patrol Vessel

Abstract: The helicopter deck structure plan should be able to guarantee a structure with a stress not exceeding the permissible stress. A helideck structure analysis is carried out based on the loading conditions obtained from helicopter landing variations to calculate maximum load, maximum stress, and deformation. The results obtained are von misses stress and deformation values for various loading condition. The maximum stress generated under condition 1 is 109 MPa with a deformation value of 2.015 mm. The maximum value of the maximum stress for condition 2 is 135 MPa with a deformation value of 2,069 mm. The maximum value of the maximum stress for condition 3 is 174 MPa with a deformation value of 4,161 mm. The maximum value of the maximum stress for condition 4 is 223 MPa with a deformation value of 5,969 mm. It can be concluded that condition 1 is the most optimum helicopter landing conditions with the lowest stress and deformation among all load conditions.

1 INTRODUCTION

Republic of Indonesia Marine Security Agency (BAKAMLA RI) requires a large and sophisticated fleet of patrol boats to defend the Indonesian border. One of the sophistication is helideck for global monitoring. The helideck construction planning is to make a construction that has a stress level at the limits permitted. Planning a helideck construction must be able to guarantee a structure with a stress no more than the clearance stress. Helideck construction must be designed to avoid excessive elastic deformation which can result in changes in geometry due to the load received. These parts must be measured appropriately for the actual or charged styles.

To ensure the helideck can be used safely and function properly, it is necessary to conduct research as an effort to identify any hazards that might threaten, the main purpose is to verify the strength of the helideck structure when subjected to a load with the condition of the helicopter remaining on the runway and landing. The design of the helideck must be able to anticipate the occurrence of emergency landings by helicopters. Emergency landings can be located around the helideck area, inside or outside the helipad.

This research was conducted to calculate the maximum loading value, maximum stress, deformation by using finite element method. Calculating the level of security in the helideck construction, calculating the level of safety (safety factor) in the construction of the helideck and knowing the most critical components and need to get more attention.

2 LITERATURE REVIEWS

Helicopter deck known as helideck is a landing area for specially built helicopters on ships including all structures, firefighting equipment and other facilities needed for safe operation of helicopters. Other facilities include refueling facilities and hangar facilities. Helicopter landing areas must be designed for emergency helicopter landings. The helicopter landing area must be on the topmost deck and have a large manouver zone, and most importantly the helicopter landing area must be close to the side of the ship.

Helideck is a deck of a ship or an offshore structure built for landing or taking off a helicopter as shown in Figure 1. Landing areas must have the widest possible area to provide safe access to helicopters upon landing (DNV, 2010).

Zubaydi, A., Sujiatanti, S. and Refdi, .
Stress Analysis of Helideck Structures on Offshore Patrol Vessel.
DOI: 10.5220/0008375501060110
In *Proceedings of the 6th International Seminar on Ocean and Coastal Engineering, Environmental and Natural Disaster Management (ISOCEEN 2018)*, pages 106-110
ISBN: 978-989-758-455-8

Figure 1: Helideck on the Bakamla 110 m

The helipad is a landing area for helicopters. A helipad is made by hardening a surface away from obstacles so that the helicopter can land. The helipad is generally constructed of concrete and is marked by a circle or a letter "H" to be visible from the air. Some factor considered in planning a helipad, including namely the type of helicopter that involves the weight of the helicopter with full fuel and rotor diameter, environmental conditions, and signs designed for visual pilot (Sutehno, 2014).

Von Mises stress is a combination of all stress components, which consist of normal stress on three axes, and shear stresses, which react at certain places. Von misses stress is suitable for the ductile material. The stress chosen in this analysis is von Mises stress. Von Mises stress is used to predict the material elongation on certain loading conditions (Sanjaya, et.al, 2017).

The von misses stress that produces a value above the material yield strength, the material will provide a power response equal to the value of the yield strength of the material itself. If the von misses stress produces a value exceeding ultimate strength, the material will break (Hoque, 2013).

3 METHODOLOGY

3.1 Finite element modelling

Helideck modelling is made using finite element software. The finite element model must be made in order to represent the actual conditions so that the analysis process can provide results that are in accordance with the conditions experienced by the structure.

The pre-processor is the initial stage in the process of structural analysis where data model preparation is done and in this process, the structure is divided into finite small elements called mesh making. Then the boundary conditions are applied to the structure which has been divided into small elements (meshing) to determine the degree of freedom of the structure analyzed. Calculation phase in the process of structural analysis. The boundary and load conditions that have been applied to the model will be calculated using the finite element equation.

The post-processor is the last stage of structural analysis that displays the output of the calculation can be the solver stage into the graphic form according to the interpretation chosen. The finite element model of helideck as shown in Figure 2.

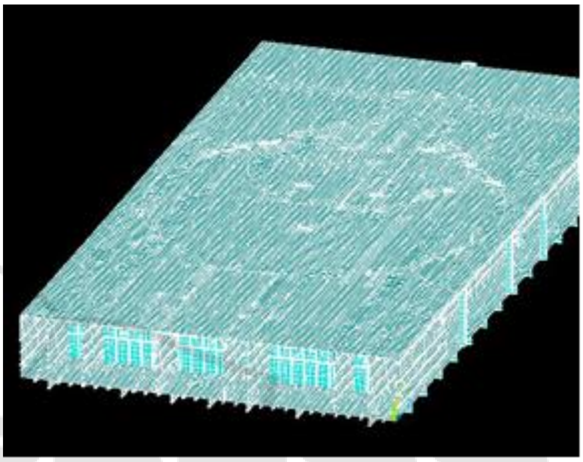

Figure 2: Finite element model of helideck

3.2 Loading Condition

The variation in this study is a different landing on the loading location given to the helideck model that is made. Variations in the landing location needed to analyze landings that may occur. For each specific helideck loading, there are 4 types as shown in Figure 3 to Figure 6.

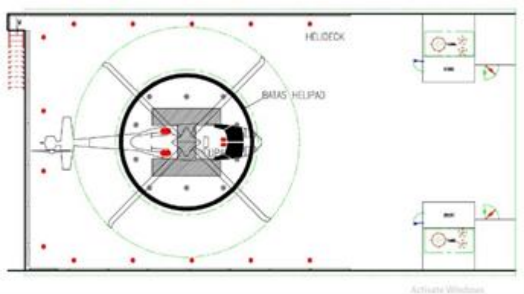

Figure 3: Helicopter position on loading condition 1

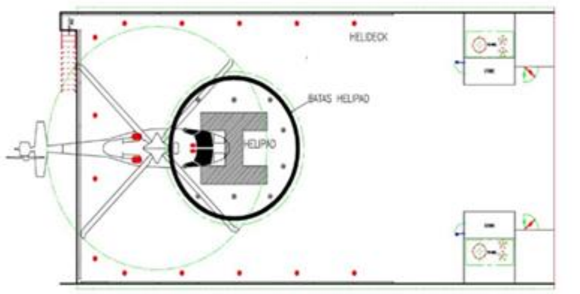

Figure 4: Helicopter position on loading condition 2

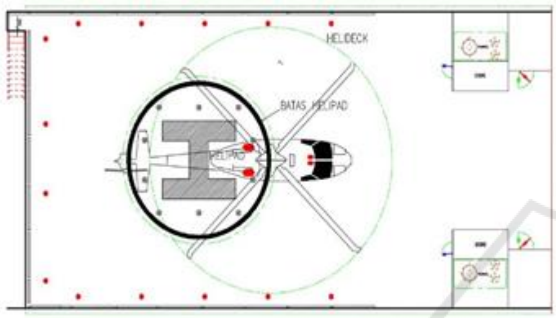

Figure 5: Helicopter position on loading condition 3

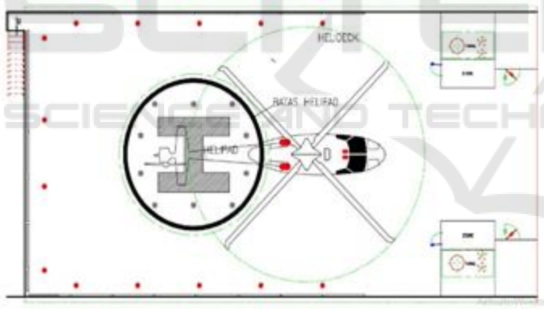

Figure 6: Helicopter position on loading condition 4

Resume of the loading condition as shown in Table 1.

Table 1: Loading condition on the helideck structure

No	Load Conditions	Explanation
1	Condition 1	All wheels are in the helipad circle
2	Condition 2	One wheel (front wheel) is inside the helipad circle, two wheels (rear wheel) are outside the helipad circle
3	Condition 3	Two wheels (rear wheel) are inside the helipad circle, two wheels (front wheels) are outside the helipad circle
4	Condition 4	All wheels are outside the helipad circle

To perform a strength analysis using finite element software, the load experienced by the structure must be applied to the model. Loading must be applied according to the conditions experienced by the structure. Loading uses a static load due to the load which is a helicopter load. The load applied to the helideck can be seen in Table 2.

Table 2: The load applied on the helideck

No	Load Type	Load Value
1	Landing force	57.330 kN
2	Wind load	64.479 kN
3	Enviromental loads	0.5 kN/m^2

The load is applied to the model in the form of pressure on the helicopter wheel area. Landing force loading is distributed to each helicopter wheel. For wind load loading distributed in areas that get wind pressure caused by the rotation of the helicopter blades. Environmental loads are distributed in the helipad area.

4 Result and discussion

4.1 Maximum stress

According to the results of the helideck model simulation, the maximum stress values that occur in each variation of the helideck model are obtained. The stress chosen in this analysis is von misses the stress. Von Mises stress is used to predict the level of material elongation on certain loading conditions. The maximum stress value on the entire model can be seen in Figure 7 and Table 3.

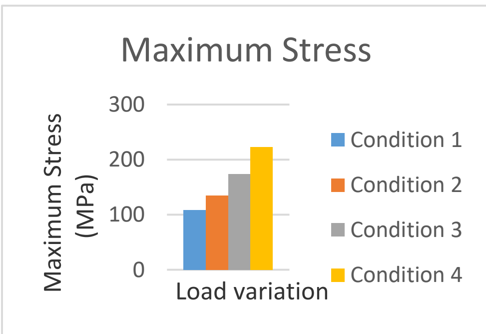

Figure 7: Maximum stress for various loading condition on the entire model

Figure 7 shows that the stress model condition 1 has a stress value of 109 MPa. In condition 2, the maximum stress value is 135 MPa. In condition 3 the maximum stress value is 174 MPa. The maximum stress in condition 4 is 223 MPa. Resume of maximum stress is given in Table 3.

Table 3: The load applied on the helideck

No	Load Variation	Maximum Stress (MPa)
1	Condition 1	109
2	Condition 2	135
3	Condition 3	174
4	Condition 4	223

The maximum stress must be compared to the price of the stress permitted by regulation. According to BKI regulations (2017), the determination of permissible stress is divided according to the related structure.

4.2 Maximum stress on the stiffeners

Figure 8 shows that all conditions produce stress stiffeners under stress permits for stiffeners. First condition experienced a maximum stiffeners stress of 15.27 MPa. In the second condition, the maximum stiffeners increased to 36.86 MPa. In condition 3, the maximum stiffeners decreased to 24.26 MPa. In condition 4 experienced a maximum stiffeners stress of 49.25 MPa. It can be stated that all four conditions have met the maximum standard of permit stress on stiffeners.

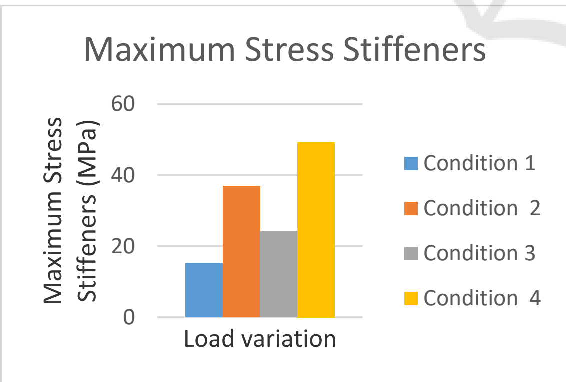

Figure 8: Maximum stress for various loading condition at the stiffener

Resume of the maximum stress on the stiffeners for the various condition is given in Table 4.

Table 4. Maximum stress for various loading condition at the stiffener

Load Variation	σ_{max} (MPa)	σ_{perm} (MPa)	$\sigma_{max} \leq \sigma_{perm}$
Condition 1	15.27	213.63	Accepted
Condition 2	36.86	213.63	Accepted
Condition 3	24.26	213.63	Accepted
Condition 4	49.25	213.63	Accepted

4.3 Maximum stress on the main girder

Figure 9 produces the main girder stress under the main girder clearance stress. In condition 1, the maximum stress of the main girder is 99.86 MPa. In condition 2, the maximum stress of the main girder is 109 MPa. In condition 3 the maximum number of main girders is 130 MPa. In condition 4, the maximum value of the main gear between the three other models is 140.8 MPa.

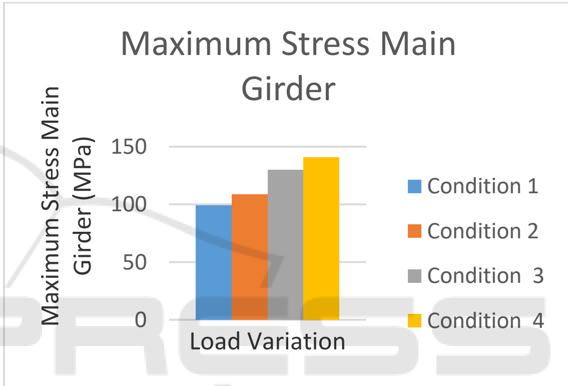

Figure 9: Maximum stress for various loading condition at the main girder

Resume of the maximum stress on the main girder for the various condition is given in Table 5.

Table 5: Maximum stress for various loading condition at the main girder

Load Variation	σ_{max} (MPa)	σ_{perm} (MPa)	$\sigma_{max} \leq \sigma_{perm}$
Condition 1	99.38	162.069	Accepted
Condition 2	109.00	162.069	Accepted
Condition 3	130.00	162.069	Accepted
Condition 4	140.80	162.069	Accepted

4.4 Maximum deformation

Figure 10 shows the results of the maximum deformation that occurs in the model for each condition. In condition 1, the maximum deformation value is 2.015 mm. In condition 2, the maximum deformation value increases to 2.069 mm. In condition 3, the maximum deformation value increased to 4.161 mm. In condition 4 has the largest maximum deformation value among the three other conditions which is 5.969 mm.

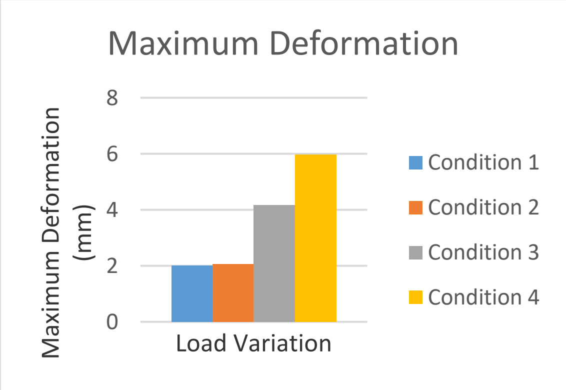

Figure 10: Maximum deformation for various loading condition on the entire model

Resume of the maximum deformation for the various condition is given in Table 6.

Table 6: Maximum deformation for various loading condition on the entire model

No	Load Variation	Maximum deformation (mm)
1	Condition 1	2.015
2	Condition 2	2.069
3	Condition 3	4.161
4	Condition 4	5.969

5 CONCLUSION

According to the analysis and results, this research can be concluded as follows:

1. Highest maximum stress occurs in condition 4 with a maximum stress value of 223 MPa. The smallest maximum stress value occurs in condition 1 with a maximum stress value of 109 MPa,
2. All conditions reach maximum stress on each component of the structure under the permit stress of the structural component,
3. The deformation value is directly proportional to the maximum stress value, the maximum deformation value occurs in condition 4 which is 5,969 mm. The smallest maximum deformation value occurs in condition 1 which is 2,015 mm,
4. The most optimum condition used by helicopter landing is condition 1 by considering the value of the smallest maximum stress and the smallest maximum deformation

REFERENCES

DNV, 2010. Rules for classification of Ships-New buildings-Special Equipment and Systems.

D. D. Sanjaya, S. H. Sujiatanti, T. Yulianto, 2017. Jurnal Teknik ITS 6 (2), G277-G281, ISSN 2337-3539.

K. Hoque., 2013. Analysis of Structural Discontinuities in Ship Hull Using Finite Element Method, Bangladesh.

W. Sutehno, 2014. Jurnal Teknik Sipil dan Lingkungan Universitas Sriwijaya.