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Saddle Strength Analysis on Jacket Structure During Roll Up Procedures in Fabrication Phase

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ABSTRACT

Offshore platform is a structure that serves as a well drilling facility to explore, extract, store and process petroleum and gas located under the seabed. There are several phases in the construction of offshore structures (fixed jacket platform) from preparation to construction. Fabrication phase is the earliest stage in the manufacture of a fixed offshore platform (jacket structure) which is carried out by the fabricator. One of the procedures at the fabrication phase is roll up procedure. In this final project research, an analysis will be carried out regarding the configuration of the rigging, crane, and sadle support used in the jacket structure during roll up procedure. After the analysis of jacket structure modeling using the SACS software, the results of rigging configuration can be obtained, which were the slings spesifications used to connect the structure with cranes, with sling diameter of 2.75 inch and SWL value of 64 MT. As for the sling used to connect the jacket with winch has a diameter of 1.5 inch snd SWL value of 18 MT. Furthermore, the cranes used have a capacity of 75 and 78 MT, respectively. In the load analysis of the jacket structure, it was found that saddle support received the largest reaction when the jacket was at an 80-degree slope with the largest reaction value of 102.74 MT. In the saddle support local analysis, the result of maximum equivalent von-mises stress obtained was 43,486 MPa, with the saddle allowable stress of 345 Mpa, therefore the UC value of 0.24 can be obtained.

Keywords: *Jacket Structure, Lifting, Roll Up, Saddle Support*

1. INTRODUCTION

Offshore structure is a structure used to conduct oil and gas search activities at sea. There are several stages in fixed offshore structure construction phase, from preparation to construction stage. The fabrication activities are the earliest stages in the manufacture of fixed offshore platforms (jacket) carried out by the fabricator. The technique of building the main structure of the offshore bridge is carried out separately based on the main modules of the structure such as jacket, pile, boatlanding, riser, and others. The two *codes* that are widely recognized and used to establish general requirements are the API RP 2A WSD Recommendation Practice for Planning, Design and Construction of fixed offshore *structures,* and the ASD AISC Specification for Design, Fabrication and Installation of Structural Steel for Buildings.

At the fabrication stage there are many procedures that must be performed, one of which is the is the roll-up procedure. The roll up procedure is one of the stages of fabrication that is used to help avoid the work to be done at high height that can be difficult and dangerous. In the roll up stage, the main activity is the lifting process. Lifting is the activity of raising or lowering a structure using the help of cranes. The use of cranes in lifting operations is divided into two categories, namely heavy lifting and light lifting [7]. The purpose of the lifting analysis is to find out how the initial and final condition of the structure, *crane arrangement* used, the location of *lifting points* and *hook points,* and *rigging equipment* used for the lifting process.

In this study, saddle *support* analysis will be conducted on *jacket* structure to determine the reaction style, strength, and qualification of the *saddle.* In addition, according to [2], *roll up* or *saddle support* is the main component on the *jacket* structure that serves to hold the structure of *the jacket* during the *roll- up* from the 0 degrees position to 90 degrees or the final position. But the rigging configurations and *crane arrangements* used must be determined first. During this study, the authors used SACS 12.0 software to model the main structure of the jacket as well as perform lifting analysis. It will then be inputted to ANSYS software to perform local analysis on the used saddle *support.*

2. RESEARCH METODOLOGY

2.1 Literature Studies

Literature study is an early stage that strongly supports the scope of this research process. At this stage, the collection of journals, supporting books, or previous research that discusses the subject matter that still has a relationship with this research. Literature studies are used as the basis of theory in problem solving.

2.2 Data

The collection of key data is necessary to be able to work on research. The needed data, such as the structure data, sling data, crane catalog data, and saddle support data were provided by PT. Gunanusa Utama Fabricator.

2.3 Jacket Structure Modeling

The jacket structure is modeled using SACS 12.0 software. Modeling is done in the form of jacket structure as a whole in geometric and material form based on the image data that has been obtained.

2.4 Calculation (structure weight, center of gravity, lifting point, saddle point, unity check, loading conditions, and saddle support reaction)

The calculation of the load structure is obtained from the overall static load of the structure itself. The position or position of the CoG can be obtained using mathematical formulas. Member unity check on the structure to see if all unity check ratios are below one. While the lifting weight on the structure is obtained after the lifting point is determined on the modeling performed.

2.5 Static and Dynamic Analysis of Jacket Structure

The structure that has been completed through the next stage of modeling will be analyzed. The load analysis of modeled structure will be carried out when the roll up procedure will start. From the results of the analysis, the value of the lifting load on the crane and the maximum reaction that occurs in the saddle will be obtained.

2.6 Validation

The completed structure is further validated based on the unity check value. If the validation does not meet the criteria, then the rework step is repeated to step 2.3.

2.7 Sling Component Determination

The determination of the sling component can be determined based on the lifting weight value of the structure analysis results. The sling configuration used must meet the security standards that have been determined.

2.8 Manual calculation on Saddle

Before performing local analysis on saddle support, manual calculation is performed first using microsoft excel. Manual calculations are performed to get a definitive answer of the strength of the saddle support used during the roll up procedure.

2.9 Saddle Strength Analysis with Local Analysis

At this stage, local analysis is performed to determine the maximum stress that occurs in the saddle. The method used in the analysis performed is the finite element method. While the software used to perform local analysis is ANSYS.

2.10 Conclusions and Suggestions

Once all the stages have been worked out, the last step to do is to draw the right conclusions. Then, advice is given as a form of input if the same research topic will be done by others in the future.

3. RESULTS AND DISCUSSION

3.1 Study Cases

The case study that became the final task research is one of the procedures in the fabrication stage jacket structure, which is a roll up procedure. The roll up procedure is to rotate the jacket from a position of 0° to 90° so that the jacket stands vertically. The roll up procedure uses a crane to lift the jacket as well as a winch as a back-holding load when the jacket leg will hit the saddle support.

The jacket structure that became the module for the roll up procedure has three legs, with a total of four panels and a height of 35 m, then the jacket is designed to last for approximately 15 years. In this final task research, the main topic is saddle support used during the roll up jacket procedure. Saddle support is a saddle made of plates that serves as a pedestal that holds the structure of the jacket when the roll up process is carried out from a position of 0 degrees to 90 degrees.

The total number of saddle support used is five support and all saddles are located in panel four (section A). Please note that knowing the rigging and crane configuration used in the roll up procedure becomes the first goal in this case study, the rigging configuration in question is the number of slings used as well as the number of cranes, determining the lifting point is the initial stage to answer the formulation of the problem. Furthermore, the ultimate goal of the research is to know the strength and spesifications of the saddle support used. The data used for the completion of this final task research is the WHP-C data jacket owned by PT. PGN Saka conducted by PT Gunanusa Utama Fabricators.

3.2 Jacket Structure Modeling

Modeling the structure of jacket WHP-C using the help of Sacs 12.0 software. Modeling is done on each member and includes load factor in modeling. For nongenerated deadload applied in the form of load on modeling. There are three load cases in jacket structure modeling, the first is deadload which is the load of the jacket structure itself. The second case is the weight of the structure coupled with the nongenerated deadload factor and contingency factor. The last load case is the second load case plus the dynamic amplification factor (DAF) used for the roll up procedure. Factors used such as DAF, *contingency factor,* and skew load factor refer to DNV GL-ST-N001 *codes.* Structural modeling will be done every 10° degree from 0° to 90°. Slings used for connection with cranes and winches are modeled with tubular joints with very small densities. While saddle support is modeled in the form of roll joint on modeling that only accepts load from z axis.

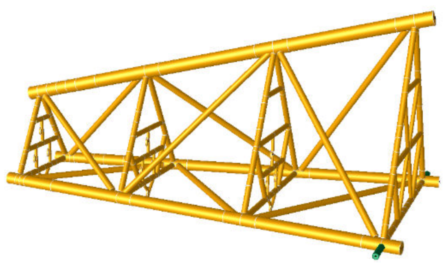


Figure 1. Jacket structure modeling results using SACS software

Further validation is performed for the weight of modeling, whether the weight result of modeling can accurately represent the weight of the actual structure or not. Validation is done by finding the difference from the weight of modeling by weight based on weight control report and then compared to the weight of weight control report. If the correction result does not exceed 5% of the model weight, it can be said that the model can represent the actual structure weight.

Table 1. Validation of Jacket Structure Weight Comparison

WCR based jacket weight (MT)	Jacket model weight (MT)	Difference (MT)	Correction (%)	Description
197.523	204.165	6.64	0.033	OK

3.3 Determination Of Lifting Point

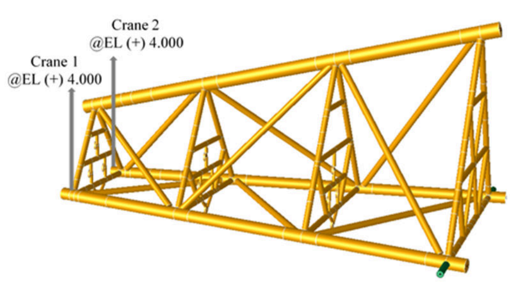


Figure 2. Location of Lifting Point on Jacket Structure

Lift point is a point that becomes a link between rigging and the structure to be lifted. Lift point used on jacket structure that will be performed roll up procedure is in the form of trunnion. Lift points should be well considered in order for stability to be acceptable for these conditions, allowing vertical and horizontal balancing at the center of gravity position to keep the structure lifting balanced and tiltless. From the results of modeling done using SACS software, we can obtain the jacket structure weight and the lifting load. Furthermore, the Center of Gravity (COG) obtained from this structure can be used to determine the location of lift point.

3.4 Structure CoG Location

The position and displacement of the structure COG during the roll up process should be determined and observed to calculate the movement of the jacket and withstand the required load after the CoG passes through the pivot point. The reference point for the CoG is measured from the center position, and due to the symmetrical jacket shape makes the Y axis of the CoG at each slope of 0.01 (See chart below). Then it can be seen that the shift of CoG passes through the pivot point after a slope of 70°. Therefore, winch began to be used on this slope to hold the jacket so the structure did not experience shock load when touching the support.

Table 2. CoG Location At Every Degree Of Tilt

Axis	0°	10°	20°	30°	40°	Unit
X	-16.82	-15.89	-14.47	-12.62	-10.38	M
Y	0.01	0.01	0.01	0.01	0.01	M
Z	3.90	6.77	9.42	11.79	13.80	M
	50°	60°	70°	80°	90°	Unit
X	-7.82	-5.03	-2.09	0.92	3.90	M
Y	0.01	0.01	0.01	0.01	0.01	M
Z	15.40	16.52	17.14	17.25	16.83	M

3.5 Member Unity Check

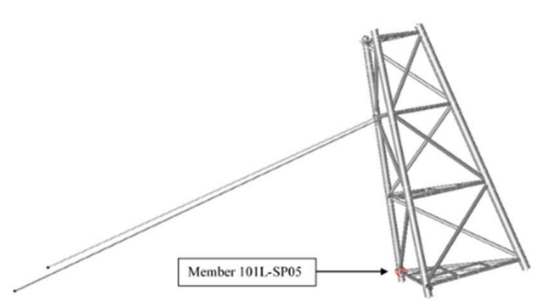


Figure 3. Location of member 101L-SP05 on UC results

At this stage, a static analysis is carried out on the structure of the WHP-C jacket in order to obtain a member unity check ratio. This is done so that the critical member critical and its location can be found. Member is declared safe if UC value ≤ 1, UC value is a comparison between the stress that occurs in the member and the allowed stress. The table below is the UC value at each degree of inclination.

Table 3. Member Unity Check at Every Degree Of Tilt

Degree	Member	UCR	Description
0°	101L - SP05	0.26	OK
10°	101L - SP05	0.27	OK
20°	101L - SP05	0.29	OK
30°	101L - SP05	0.30	OK
40°	101L - SP05	0.32	OK
50°	101L - SP05	0.33	OK
60°	101L - SP05	0.36	OK
70°	101L - SP05	0.41	OK
80°	101L - SP05	0.49	OK
90°	101L - SP05	0.31	OK

3.6 Load on Jacket Structure

The load value is obtained from static analysis results in SACS software. The weight of the jacket structure to be lifted is the basis of the analysis in the WHP-C roll up jacket process. Therefore, it is necessary to calculate the load on each slope of the jacket structure to know the crane capacity needed at each angle, the winch capacity used when the position is 80 to 90 degrees, and the load or reaction on the saddle support. When the jacket position is standing upright or at 90 degrees position, jacket leg C already occupies the prepared saddle support.

3.7 Reaction on Saddle

After conducting load analysis on the WHP-C jacket structure, the saddle support reactions that work to hold the structure at every degree of inclination can be known. Five saddle support were used and all saddles are located in panel four (Section A). Furthermore, the table below show the biggest reaction saddle support at every degree variation of the jacket structure. The largest reaction is found when the structure is at 80 degrees in tilt, the largest reaction will be used for the next analysis, which is local analysis. From the result of local analysis, we can expect that all saddle support used for the roll up process can hold the jacket structure from 0 degrees to 90 degrees, because the results shows that the saddle support can withstand the biggest load exerted on it.

Table 4. Biggest Saddle Reaction at Every Degree of Tilt

No	Degree	X Axis Reaction	Y Axis Reaction	Z Axis Reaction	Unit
1.	0°	0.0	0.0	53.16	MT
2.	10°	0.0	0.0	49.83	MT
3.	20°	0.0	0.0	53.16	MT
4.	30°	0.0	0.0	56.52	MT
5.	40°	0.0	0.0	60.08	MT
6.	50°	0.0	0.0	64.45	MT
7.	60°	0.0	0.0	71.25	MT
8.	70°	0.0	0.0	83.38	MT
9.	80°	5.46	15.76	102.74	MT
10.	90°	2.04	4.99	66.03	MT

3.8 Analysis of the sling used in roll up procedure

The sling to be analyzed in this sub-chapter is the sling used to connect the jacket structure with the crane. Two slings were used for roll up procedure, which amount to one sling for each crane. The selection of sling design used refers to the results of load analysis obtained from SACS software. From the catalog of slings used, we can obtain:

Sling diameter	:	2.75 inch
Sling length	:	12 meters
SWL	:	64 ton
Minimum Breaking Load	:	360.20 ton

Then, we can perform the analysis for sling capacity check. The value entered in the calculation is the largest sling tension, which can be found at the slope of 0 degrees. Tension value obtained from end force members in SACS software. Sling can be considered as safe if the value of safety factor obtained is more than 1. Furthermore, no calculation is done for the other degrees of slope, because the largest sling tension was already calculated. Therefore, the sling is considered able to withstand other stress at every degree of slope until the roll up process is completed.

Sling Capacity Check Crane 1 (0 degree tilt)

Pmax value

= *(Load x Contingency Factor x DAF x SKL Factor)*

= 50,55 x 1,1 x 1,1 x 1,25

= 76,457 T

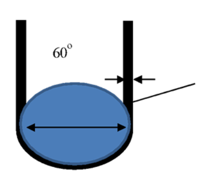
Bending Efficiency

$E_b = 1 - \frac{0,5}{(D/d)^{0,5}}$

$= 1 - \frac{0,5}{2,70}$

$= 1 - 0,19$

$= \mathbf{0,81}$



d = diameter = 2,75 in

D = Pipe Diameter = 20,00 in

Finding Load Capacity for basket hitch wire rope slings

Load capacity = SWL x Reduction Factor x Bending Efficiency

= 64 x 1,7 x 0,81

= 88,6 T

Sling Safety Factor value (Crane 1)

$SF = \frac{Load\ Capacity}{Pmax}$

$SF = \frac{88,6}{76,5} = \mathbf{1,16}$ **Secure !**

Sling Capacity Check Crane 2 (0 degree tilt)

Pmax value

= *(Load x Contingency Factor x DAF x SKL Factor)*

= 47,58 x 1,1 x 1,1 x 1,25

= 71,965 T

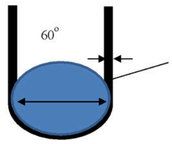
Bending Efficiency

$E_b = 1 - \frac{0,5}{(D/d)^{0.5}}$

$= 1 - \frac{0,5}{2,70}$

$= 1 - 0,19$

$= \mathbf{0,81}$



d = diameter

= 2,75 in

D = Pipe Diameter

= 20,00 in

Finding Load Capacity for basket hitch wire rope slings

Load capacity = SWL x Reduction Factor x Bending Efficiency

= 64 x 1,7 x 0,81

= 88,6 T

Sling Safety Factor value (Crane 2)

$SF = \frac{Load\ Capacity}{Pmax}$

$SF = \frac{88,6}{72} = \mathbf{1,23}$ **Secure !**

3.9 Analysis of Crane and Winch Used during Roll Up Procedure Winch (slope at 80 degree)

Known : W = 247.049 MT

$X = 920\ mm$

$h = 29260.4\ mm$

$\alpha = 30°$

$\theta = 17°$

Solution:

$M = (W \times X2) - (PH \times h) = 0$

$PH = \frac{W \times X}{h} = 7.7677MT$

$PT = \left(\frac{PH}{2}\right) / (cos\alpha \times cos\theta) = 4.297$ MT

Winch Capacity Check (slope at 80 degree)

Checking to ensure the winch used can withstand COG shifting for slope at 70 to 90 degrees. Here is the calculation for winch capacity check:

Known:

Sling diameter (D) = 1.5 inch

Safe Working Load (SWL) = 18 .5 MT

Total Load (PT) = 4 MT

Mech. Advantage Ratio (R) $= \frac{PT}{SWL} = 0.2$

Actual Part Line (N) = 4

Single Line Tension (T) $= \frac{PT}{N} = 1 < 18.5$ MT.....

OK!

Winch (slope at 90 degree)

Known : W = 247.049 MT

$X = 3900\ mm$

$h = 29625.0\ mm$

$\alpha = 30°$

$\theta = 17°$

Solution:

$M = (W \times X2) - (PH \times h) = 0$

$PH = \frac{W \times X2}{h} = 32.523MT$

$PT = \left(\frac{PH}{2}\right) / (cos\alpha \times cos\theta) = 17.989$ MT

Winch Capacity Check (slope at 90 degree)

Needs checking to ensure the winch used can withstand COG shifting for slope at 70 to 90 degrees. Here is the calculation for winch capacity check:

Known:

Sling diameter (D) = 1.5 inch

Safe Working Load (SWL) = 18 .5 MT

Total Load (PT) = 18 MT

Mech. Advantage Ratio (R) $= \frac{PT}{SWL} = 1.0$

Actual Part Line N = 4

Single Line Tension (T) $= \frac{PT}{N} = 4.5 < 18.5$

MT.....**OK!**

Crane Configuration Analysis

There are two lifting points used for the roll up procedure, and it can be interpreted that the number of cranes used is 2 crawler cranes. Load calculation is required for crane removal to be performed effectively. The selection of the type and number of cranes is adjusted to the analysis that has been done. After knowing the amount of load at each degree of slope, it is found that the largest total load value at a slope of 0 degrees is 126.54 MT and the load is used to find the right type of crane.

From catalog, crawler crane used were CKE2500 and IHICCH2800:

Crane 1 = IHICCH2800

Crane capacity = 75 MT

Working radius = 12 m

Boom length = 54 m

Crane 2 = CKE2500

Crane capacityy = 78 MT

Working radius = 12 m

Boom length = 54.9 m

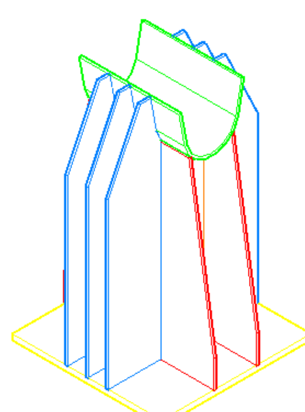


Figure 4. Saddle support modeling results using Autocad 3D

Crane Ratio Check

Ratio checking is done to determine the effectiveness of the crane while performing the lifting. If the lifting ratio obtained is less than 100%, then the crane is ensured safe, and vice versa. Below is a calculation to find the lifting ratio. To find out the results of crane and winch capacity check on each slope can be seen in the table 5.

$$Lifting\ Ratio = \frac{Total\ Load}{Crane\ Capacity} \times 100 = \ldots\ \% \quad (1)$$

Table 5. Crane Capacity Check at Every Degree of Tilt

Degree	Description	Load (MT)	Crane Capacity (MT)	Ratio (%)	Desc.
0	Crane 1	59.91	75.00	79.88	OK
	Crane 2	56.60	78.00	72.56	OK
10	Crane 1	62.56	75.00	83.41	OK
	Crane 2	59.12	78.00	75.79	OK
20	Crane 1	59.91	75.00	79.88	OK
	Crane 2	56.60	78.00	72.56	OK
30	Crane 1	56.86	75.00	75.81	OK
	Crane 2	53.76	78.00	68.92	OK
40	Crane 1	53.09	75.00	70.79	OK
	Crane 2	50.33	78.00	64.53	OK
50	Crane 1	47.98	75.00	63.97	OK
	Crane 2	45.72	78.00	58.62	OK
60	Crane 1	40.17	75.00	53.56	OK
	Crane 2	38.64	78.00	49.54	OK
70	Crane 1	25.81	75.00	34.41	OK
	Crane 2	25.01	78.00	32.06	OK

3.10 Saddle Support 3D modeling using AutoCad 3D

Before doing finite element analysis using ANSYS software, saddle support modeling is first done in 3d using the Autocad software. If the modeling is correct and in accordance with the required file, then it will be exported from Autocad so that it can be used for further analysis using ANSYS software. Modeling is performed based on the drawing saddle support data. The image below is the result of the 3d modeling.

3.11 Saddle Support modeling using Ansys software

This stage can be done after modeling from Autocad software and obtained saddle support geometry shapes that will be used for further analysis. According to the source of the introduction of the finite element method [6]. The types of elements available in the analysis using finite element method (FEM) is one elemen line (1D) used for analysis on spring, beam, and pipe. Then, there is the second elemen field (2D), which is used for membrane and plate analysis. Lastly, there is elemen space (3D), which is used on 3-dimensional structures for analysis such as stress, flow speed, etc. Furthermore, element modeling in ANSYS software have several types, such as solid elements, *shell* elements, and *truss* elements. However, for modeling saddle support structure used is a solid 3d element.

Next apply boundary condition on the saddle support. In the structure to be analyzed there are 2 boundary conditions, namely:

- Label A (fixed support), because the base plate of the actual structure that supports the plates above it is attached and welded.
- Label B (pressure), given pressure on the structure is due to doubler plate that experienced direct contact with the jacket structure (panel 4 jacket structure), pressure value of 1.4584 MPa obtained from the largest reaction from the analysis conducted in the previous SACS software, then divided by the area affected by direct contact with panel 4 jacket structure.

If the saddle structure modeling on the ansys software is completed, the next step is to perform a meshing sensitivity analysis. Changing the size of the mesh on the saddle structure can produce a different total number of elements, the analysis of meshing sensitivity aims to get accurate results from ANSYS modeling as a result of the correct number of elements. To achieve a chart with convergent results, the result of equivalent von misses stress obtained must have less than 5% difference to the actual value (Hilal, 2020). Table 6 shows the result of a comparison between the size of the mesh, the number of elements and the stress that occurs. While the graphic form is presented in Figure 5.

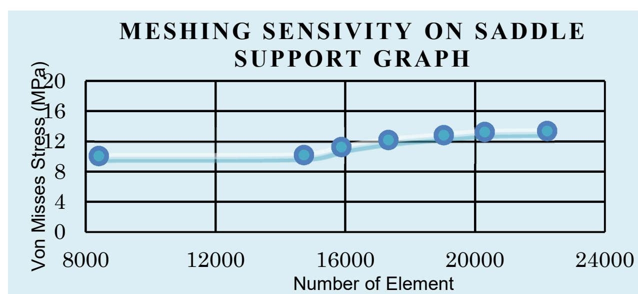


Figure 5. Graph of meshing sensitivity comparison results

Table 6. Meshing Sensitivity Comparison Results

Mesh Size (mm)	Nodes	Elements	Von Misses Stress	Differences (%)
55	12694	8406	10,03	0
50	14119	14726	10,17	0,134
45	14866	15885	11,23	1,065
40	15440	17329	12,16	0,931
35	16220	19040	12,81	0,648
30	17355	20299	13,23	0,413
25	17572	22223	13,35	0,123

Based on the results of the meshing sensitivity analysis that has been done with a total of 7 variations of different mesh sizes starting from sizes 55 mm, 50 mm, 45 mm, 40 mm, 35 mm, 30 mm, and 25 mm. The calculation result shows that the differences are less than 5%.

3.12 Saddle Support Modeling Analysis on ANSYS Software

After obtaining a convergent graph result from the meshing sensitivity analysis, a meshing size of 25 mm will be used to see the results of other analyses. At the size of meshing 25 mm, von mises stress of 13.35 Mpa is obtained. The von mises stress obtained from ANSYS need to be compared with the manual calculations, which based on the value of normal stress and shear stress obtained from the analysis of stress probes. This is performed to validate the calculations accuracy in the ANSYS software. The comparison results can be seen in the table 7.

Results of stress probe analysis:

σx = -2,389 Mpa
σy = -2,7186 Mpa
σz = 10,761Mpa
τxy = 0,4123Mpa
τyz = 0,29815 Mpa
τxz = -0,049437 Mpa

The formula to calculate von mises stress is as follows.

$$\sigma_{VM} = \sqrt{\frac{(\sigma_{xx}-\sigma_{yy})^2+(\sigma_{yy}-\sigma_{zz})^2+(\sigma_{zz}-\sigma_{xx})^2+6(\tau_{xy}+\tau_{yz}+\tau_{xz})}{2}} \quad (2)$$

Table 7. Von Mises Stress Comparison Result

Manual Von Misses (Mpa)	ANSYS Von Misses (Mpa)	Diff (%)
13,37	13,35	0,01698

Final output from finite element method until ANSYS software analysis is equivalent von mises stress. The result of equivalent von mises stress can be seen in Figure 6. The equivalent von mises stress function is to determine the critical stress that occurs in the analyzed structure. Therefore, it is expected that the result of the stress that occurs does not exceed the material's allowable stress. In the analysis conducted, the result of maximum equivalent von mises stress of 43,486 Mpa is obtained. Furthermore, it is necessary to carry out stress validation by performing the unity check on the saddle support to know the ability of the saddle to withstand the maximum stress based on the existing allowable stress. From the analysis, we obtain UC value of 0.24 which is less than 1, therefore it is stated that the design saddle support used can withstand the largest stress that exists during the roll up process. More details can be seen in Table 8.

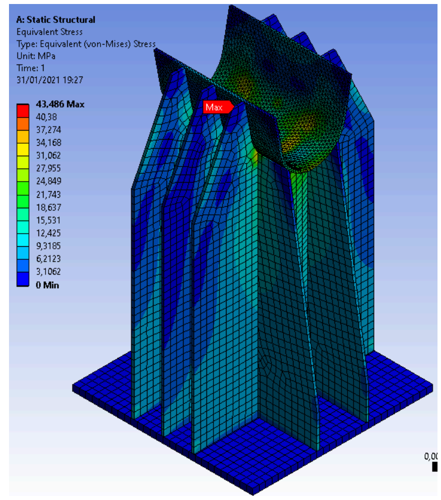


Figure 6. Equivalent Von Mises Stress Result on Saddle Support

Formula for UC value [5] :

$$UC = \frac{\sigma_{VM(Max)}\ x\ SF}{0,67\ x\ \sigma_{yield}} \quad (3)$$

Description :

σ_{VM} : Von Mises stress (MPa)
SF : *Safety Factor*
σ_{yield} : Material allowable stress (MPa)

Table 8. Unity Check Result on Saddle Support

Saddle Support Material	σ_{yield} (Mpa)	Safety Factor	σ_{VM} Max (Mpa)	UC
API 2H GR 50	345	1,30	43,486	0,24

4. CONCLUSION

The conclusions obtained from the research that has been done are:

1. Rigging and cranes used in carrying out the procedure of roll up the wellhead jacket structure of platform C are the first for the sling design used to connect the jacket with the crane that has a diameter of 2.75 inch with a safe working load of 64 MT. Then the sling design used to connect the jacket with the winch has a diameter of 1.5 inch sling and safe working load of 18 MT. While the crane used to perform the procedure of roll up jacket structure were 2 cranes with crane 1 capacity of 75 MT and has a working radius of 12 m and crane 2 with a capacity of 78 MT and working radius as far as 12 m. Capacity checks have been performed on both crane configurations and rigging used, and secure or "OK" results are obtained at all degrees of slope which means that the cranes and slings used can perform roll up procedures from start to finish.
2. After performing load analysis on the jacket structure using the SACS software, it was found that saddle

support received the greatest reaction when the jacket was at 80 degree slope roll up procedure with the largest reaction value of 102.74 MT.

3. Knowing the strength and qualifications of the saddle support used to perform the roll up procedure by performing a local analysis on the saddle support structure. By using the ANSYS software, it is obtained that the maximum equivalent von-mises stress of 43,486 MPa, the saddle structure itself has allowable stress of 345 Mpa, therefore UC value of 0.24 (less than 1) can be obtained. It can be stated that the strength of the saddle support design used can withstand the largest stress available during the roll up process.

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