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Design and Modelling of Subsea skid for Equipment Deployment (SSED)

Kushal Deepak Bokam[1], Usha Kiran Beesetti[2], Veda Vyas Vasupalli[3], Sai Sudheer Chintala[4], Venkata Surya Vaddadi[5], Seeta Raghuram Kandregula[6]

Department of Mechanical Engineering, Vignan's Institute of Information Technology, Visakhapatnam, India[1-6]

Abstract: The main objective of this project is to design and model a frame for SSED in order to carry Subsea equipment like Back pressure regulator-Skoflo, Meg filters and replace the damaged ones which are under a sea depth of 2km as per DNV guidelines. Analyze the static structural stability of the frame. Using SSED frame, the maintenance operational time can be reduced to 3-4 hours. Thus saving the loss of production costs. The equipment can be safely deployed into subsea unlike the conventional retrieval system.

Keywords: Subsea, SSED frame, operational time, retrieval system, stability, DNV guidelines.

I. INTRODUCTION

SSED frame is off shore marine structure used for equipment deploying into the deep sea. The purpose of SSED frame has to deploy the two main equipments Meg Filters (injection valves) and back pressure regulator which are used in undersea pipe lines. MEG Filter: MEG (Mono Ethylene Glycol) is a chemical substance generally used as temperature hydrate inhibitor so as to balance the reactions between hydrocarbons and water that result in the formation of crystalline compounds when extracting natural gas from a reservoir. Low temperatures prevails in deep waters its quite common that subsea oil or gas pipelines get exposed to lower temperatures so MEG is used for Hydrate inhibition. Hydrate formation temperature is lowered than the working temperature by injecting the MEG, thus avoids hydrate formation. Skoflo back pressure regulator: The back pressure regulator is purely a mechanical device, it doesn't require any electrical power for operation and maintaining a same pressure in discharge lines of pump that send to the chemical injection system. As pressure increases in the discharge line, the regulator will possess pressure levels at a Set Point while accepting the unused fluid to return to the tank that is holding the chemicals. Over a period of time Meg filters, Backpressure regulators get damaged, immediate maintenance is to be done. For doing so they need to be brought to the rig platform and after getting repaired again they need to fix in their subsea facility to continue the production process .Generally this conventional retrieval process usually takes 74-92 hours. Moreover the process need to be stopped until the maintenance work is completed, this increases the production costs , the resource gets wasted. The gas will be leaking out into the sea damaging the surrounding ecosystem. Also during the deployment, there are high chances of losing the equipment into the subsea. In order to avoid this problem can be SSED frame used to complete the task easily. SSED frame is designed in such a way that the, it allows the provision to carry the new equipment into the deep sea production facility, removing the damaged equipment from pipe line facility attaching to the SSED frame and replacing the new ones immediately.

II. METHODOLOGY

Process of the Work:

- The Subsea skid for Equipment Deployment (SSED) frame is designed based on DNV (Det Norske Veritas) rules and standards.
- Design of SSED frame for carrying Meg filter and Skoflo-Back pressure regulator is done as per DNV-OS-C101 guidelines. For Safety principles and arrangement as per DNV-OS-A 101 and DNV-OS-E21. Structure components and sub components for frame chosen as per DNV-OSF 101. In order protect the SSED frame from corrosion and surrounding working environment cathodic based design is done as per DNV-RP-B401.
- The total design load is 8 tons
- Material: Generally Structural steels like A36 mild steel is most commonly used. ASTM A 36 mild steel is a low carbon steel which has ultimate tensile strength of 58000 psi, Yield strength of 36300 psi and elongation of 20%.

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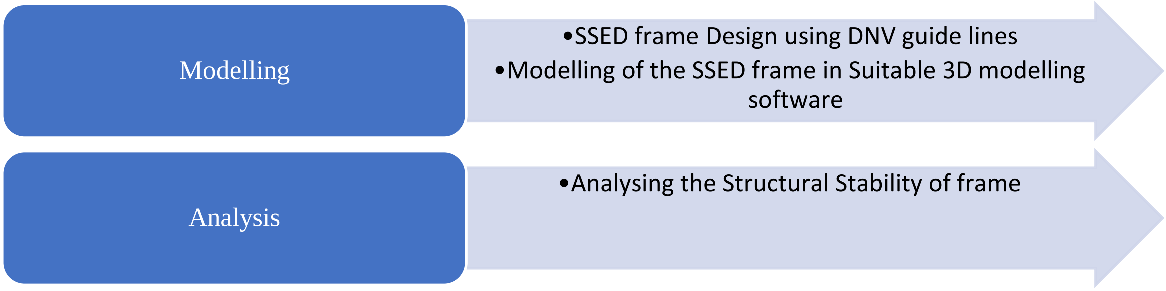

III. DESIGN AND MODELLING

All the parts were modelled using CATIA v5 R20 by following the same procedure with changes in design parameters. The design parameters with design standards are considered with Input Data provided and DNV guidelines. The SSED frame has the four subassemblies like Bottom frame, Base plate ,Carriage ,Tower. And these elements are modelled and assembled in DS CATIA software. The Base plate is placed on the Bottom frame and the carriage is placed on casting boxes of the bottom frame. Finally the tower is held on the base plate assembly as per calculated distances from edges of the base plate.

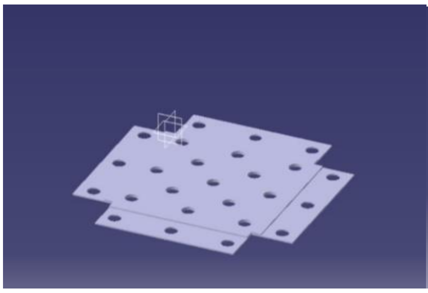

Fig.1 Base plate subassembly

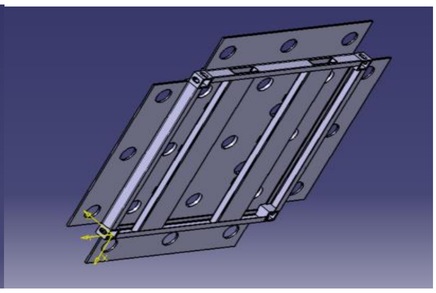

Fig.2 Bottom frame subassembly

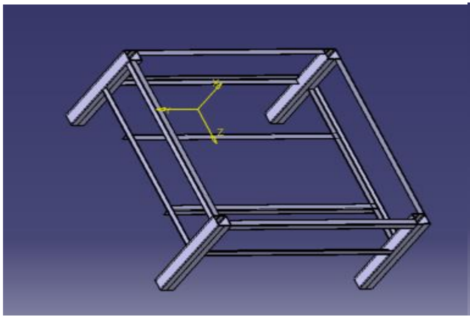

Fig.3 Carriage subassembly

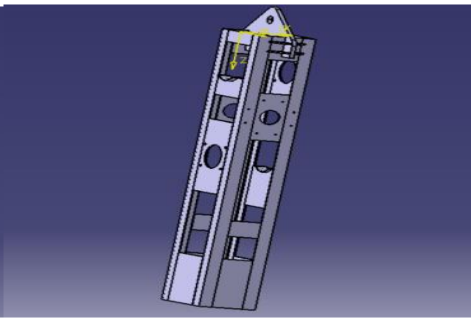

Fig.4 Tower subassembly

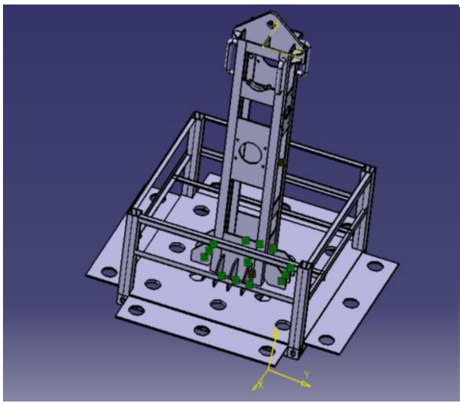

Fig.5 Final assembly of SSED frame

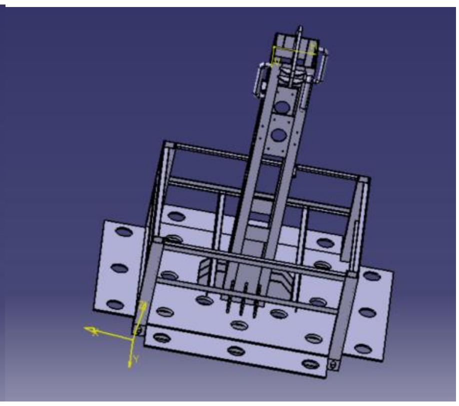

Fig6. Final assembly of SSED frame

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IV. ANALYSIS

In order to check the structural stability of the SSED frame, it is being analyzed under various conditions specified in the Ansys 19.2 software.

- **Optimization of the base plate thickness**

Base Plate strength analysis varying its thickness to find out the optimum base plate thickness value from 30mm to 50mm.Firstly plate thickness value is 50mm and designated load is applied on top side of base plate and fixing the bottom side of plate. Stress value obtained is within the elastic limits.

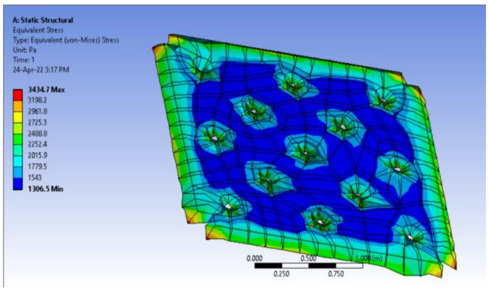

Fig.7 Base plate with 50mm thick

Same procedure is followed for plate thickness value of 40mm, 30mm. For this also the values lies in elastic limits .

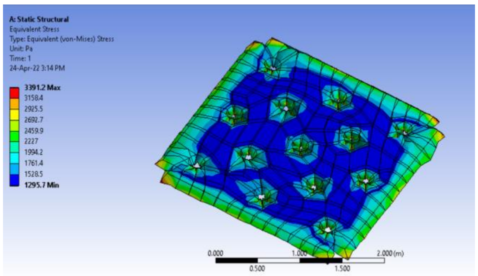

Fig.8 Base plate with 40mm thick

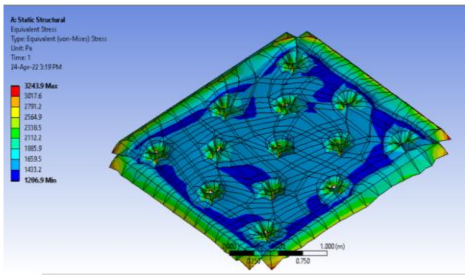

Fig.9 Base plate with 30mm thick

The optimal thickness valve of the base plate is 40mm as per DNV rules and standards- DNV-OS-C101 for design guidelines because more safer than 30mm plate and less material required than 50mm. So that weight can also be reduced. Moreover 40mm value is approx to calculated thickness value.

- **Shear strength of anchor hole in lifting lug:**

When the SSED frame is lifted using crane for moving it from one place to another place , it freely hangs in the air such that pressure acts upon inside surface of hole of lifting lug. The hole should not shear due to weight of frame. So this analysis is done.

The maximum force that can be used to lift is applied on the inside surface of hole and hole is fixed as it freely hangs when it is lifted.

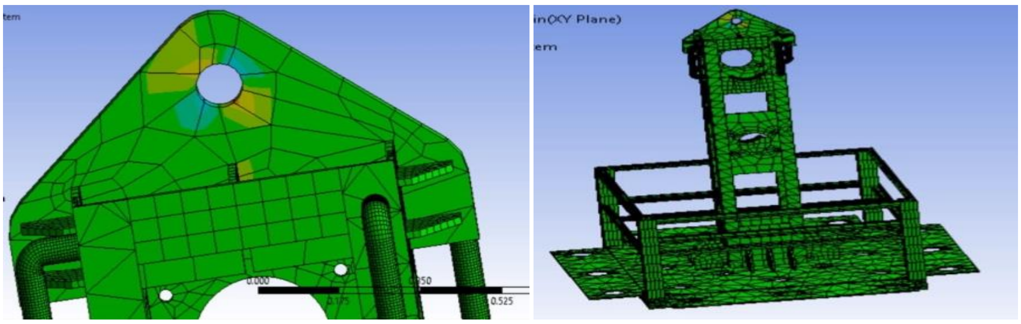

Fig.10 shear analysis of anchor hole of lifting lug

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The shear stress value obtained is within the limits. So it doesn't undergo any shear till the limit of design load. Thus the design of Subsea skid for Equipment Deployment frame is safe in considered aspects.

V. CONCLUSION

As discussed before conventional retrieval process usually takes 74-92 hours. Moreover the process need to be stopped until the maintenance work is completed, this increases the production costs , the resource gets wasted . The gas will be leaking out into the sea damaging the surrounding ecosystem. Also during the deployment, there are high chances of losing the equipment into the subsea. By using SSED frame we can complete the task easily. SSED frame is designed in such a way that , it allows the provision to carry the new equipment into the deep sea production facility, removing the damaged equipment from pipe line facility attaching to the SSED frame and replacing the new ones immediately. The process can be completed within 3-4 hours. This saves production costs. The resource will not be wasted and marine ecosystem will not get damaged. The equipment is safe during the deployment.

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