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Design of T-Stiffener Welding Station

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Abstract— In this paper designing of welding station for welding of flange and web of T-stiffener is presented. Various difficulties faced currently with the existing set-up has been studied. After identifying the difficulties a new model is conceptualized incorporating the modification and eliminating the problems faced earlier. Detailed design is carried out and a model was made and design of proposed T-stiffener welding station is verified using CAE software.

Key Words— *T-stiffener; flange; web.*

I. INTRODUCTION

T-stiffeners are a kind of stiffening ring which wraps around pressure vessels from inside or outside depending upon the nature of application and helps in providing additional stiffening to the object. Currently several research is going on like where and how much stiffeners are sufficient to control the deflection and how much deflection can be controlled. The effect of stiffening rings on the deflection of circular isotropic plates under static loading by approximating the varying thickness by a Fourier series has been done by [1] and result showed the role of the stiffening rings in minimizing the deflection of the plate and eventually the induced stresses under the action of external pressure. Analytical study of desirable proportions of corrugated ring-stiffened cylinders are presented in [2] and study indicates that the corrugated wall should be constructed of elements which have width-thickness ratios as large as possible without introducing local buckling of the elements. The rings should have a mass of approximately 30**%** percent of that of the corrugated wall. Moreover, the rings should normally be spaced as far apart as possible without introducing wall failure between rings. Experimental investigation of stresses, noise & flow in centrifugal fan impeller in [3] shows the stresses and deflections have been considerably reduced due to stiffening rings. It was found that, the impeller rotating at 735 rpm can be rotated safely at 910 rpm, using the stiffening rings. Thorough study has been conducted on all types of heads including toro-spherical heads, with external and internal pressure to reduce their thickness using stiffening rings by finite element technique is presented in [4] and the result showed that using suitable stiffening ring may reduce up to 30% of the head thickness by determining the best location, most suitable height and most suitable width for the ring.

T-stiffeners are made up of two parts:
a) Flange
b) Web.
These two parts have to be welded together to form a complete T-stiffener.

I.I. PRESENT METHODOLOGY

Current facility for welding T-stiffener is a temporary structure which has to be assembled again and modified as per the need to manufacture internal or external T-frame stiffener as shown in Fig.1.

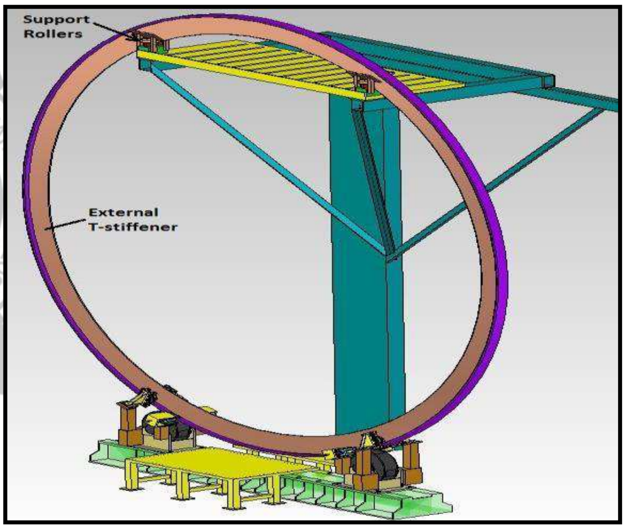

Figure 1a External T-stiffener set-up

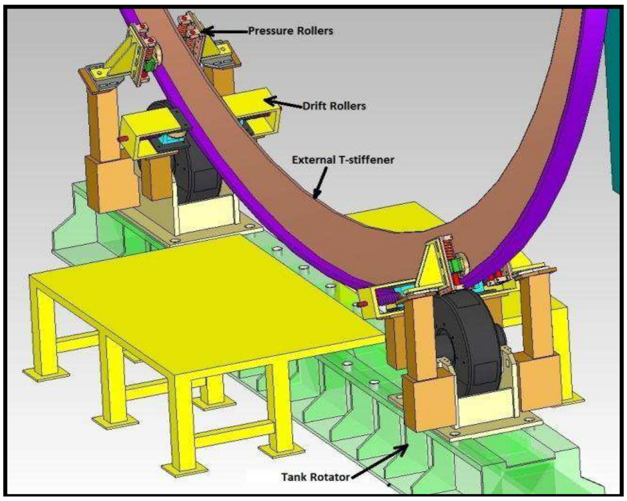

Figure 2b Various mounting arrangements

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It consists of a tank rotator where tag welded flange and web are positioned. T-stiffener are supported by means of guiding rollers which help them to be oriented vertically for allowing welding in the direction of gravity required for doing 'Submerged Arc Welding'.

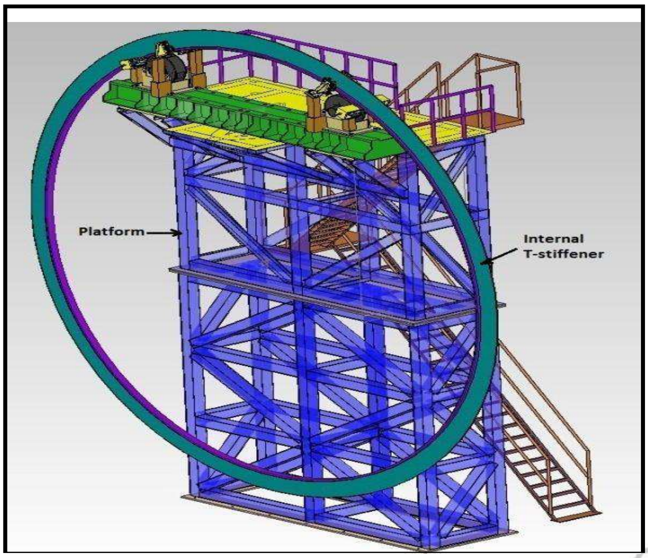

Figure 3a Internal T-stiffener set-up

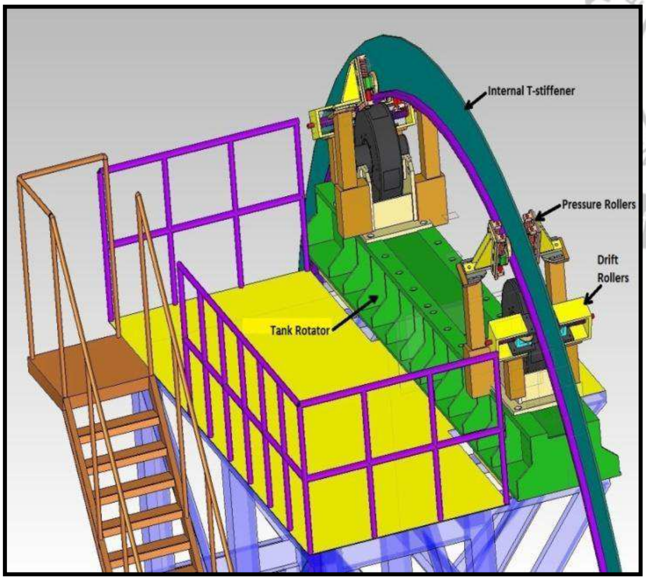

Figure 4b Various mounting arrangements

As seen in the Fig. 2a and 2b, different set-ups are to be made for both external and internal T-stiffeners. Various disadvantages of current methods are:

i. Requires lot of time to assemble the whole set-up i.e. by assembling scaffoldings and frames.
ii. Further it has to be calibrated thoroughly and inspected to check different mountings and orientations.
iii. Then orientation of T-stiffener requires lot of time for centering and attachment of different rollers to different corners to prevent it from tilting or any kind of disorientation.

I.II. PROPOSED SOLUTION

Proposed solution overcomes short-coming which earlier model had. Some of the salient features are:-

- Self centring.
- Single set-up for both external as well as internal set-up.
- No additional clamping required .
- Reduction in set-up time.
- Provision to allow welding shrinkage.

I.III. DESCRIPTION OF PROPOSED SOLUTION

The set-up will consist of an arm of rectangular box section which is bolted to hydraulic actuator to allow for the much needed flexibility and self-centering. Then at end, a gripper will be connected to the linear actuator so as to provide gripping and end support for the T-stiffener as shown in Fig.3a.

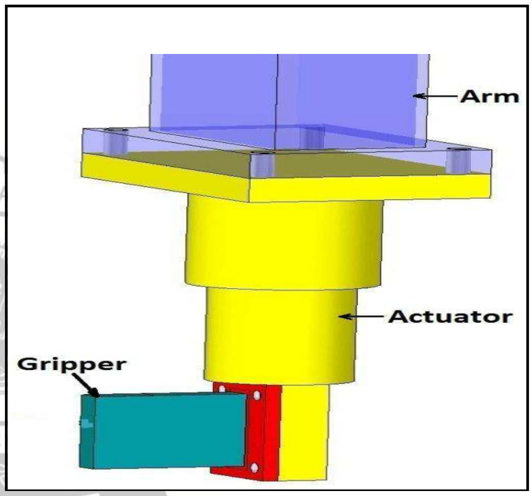

Figure 3a Mounting arrangement

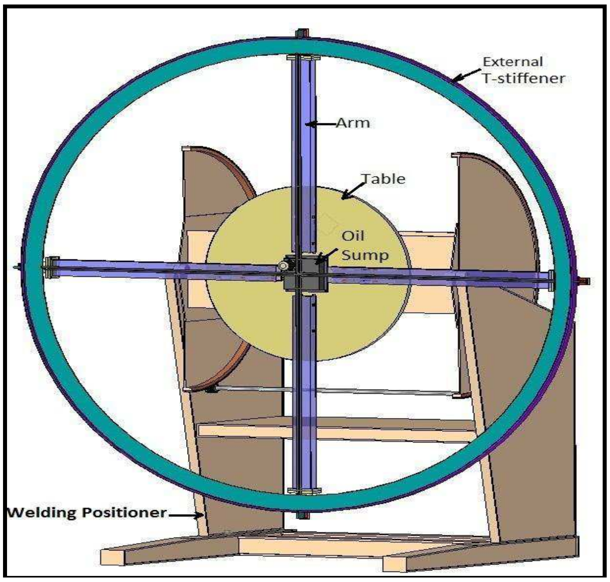

Figure 3b External T-stiffener mounted on welding positioner

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In This whole set-up has to be bolted with the table which will be mounted on the slewing bearing of welding positioned as shown in fig 3b. In case of external T-stiffener welding set-up, external T-stiffener is gripped from outside, with the flange part of T-stiffener resting on the gripper.
In case of internal T-stiffener welding set-up, internal T-stiffener is gripped from inside, such that flange part of T-stiffener is resting on the gripper.

II. DESIGN AND ANALYSIS OF WELDING STATION

Calculations have been done to find out the required dimensions of various parts so as to carry the loads effectively. Then the finite element analysis has been performed on the designed model with the help of "Computer Aided Engineering" software.

II.I. SELECTION OF MATERIAL

Structural Steel has been selected for designing as it posses significantly high strength and capable of bearing critical loading condition. It is also easily available and has yield strength of 240 MPa [5].
Designing has been done as per IS 800:2007 according to which material is safe as per the following relationship:

- Shear stress = 0.4 x yield stress
- Bending stress = 0.66 x yield stress
- Tensile or compressive stress = 0.6 x yield stress

II.II. LOADING CONDITION

There are four arms perpendicular to each other which are bolted to the bed of welding positioner. Whole load is taken by the single arm when arm is in vertical condition as shown in fig 4a.

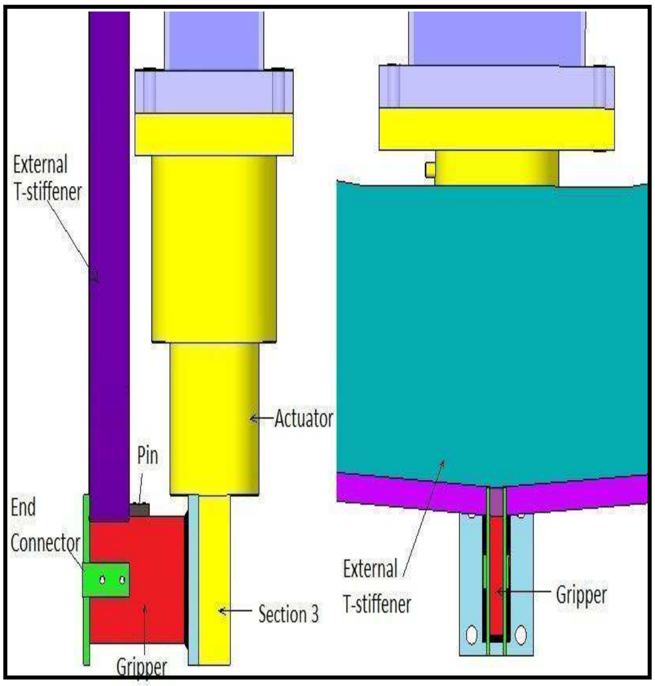

Figure 4a Arm in vertical condition

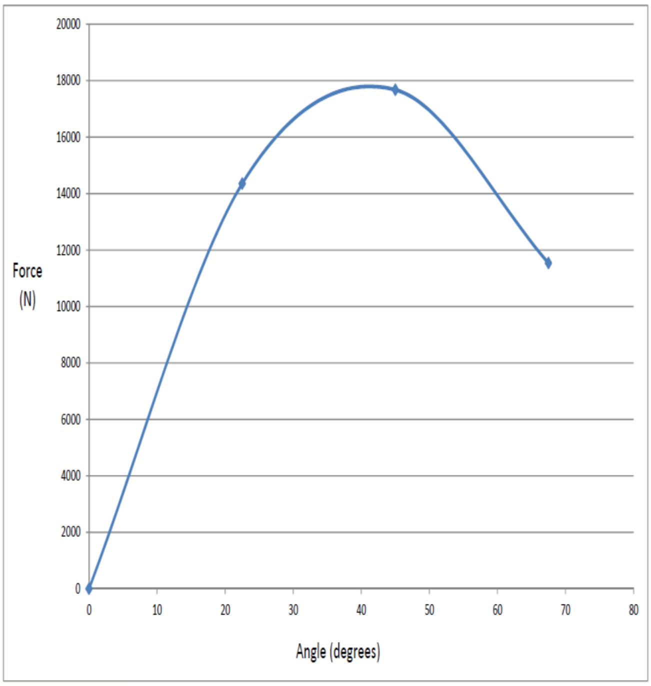

Figure 4b Variation of tangential component of force with change in arm orientation

As the arm rotates load distributes between two arms until one arm comes in bottom most position and the whole load shifts on it. Due to rotation of arm there will be radial as well as tangential component generated. As radial component has already been calculated for maximum loading condition therefore only tangential component has been checked and a graph has been plotted between tangential component of force with change in orientation, as seen from the Fig.4b. Maximum tangential load comes out at 45 degrees. Tangential component of force at 45° comes out to be 1.76 Ton. Fig. 5a and 5b shows the position of the arm where maximum loading will be there.

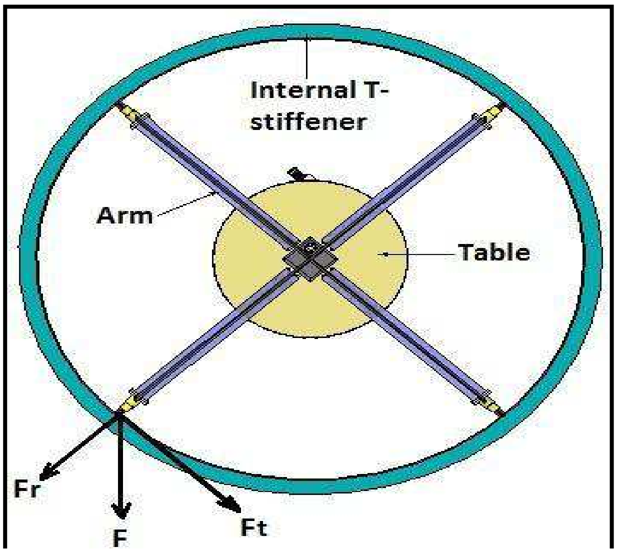

Figure 5a Arm at 45 degrees

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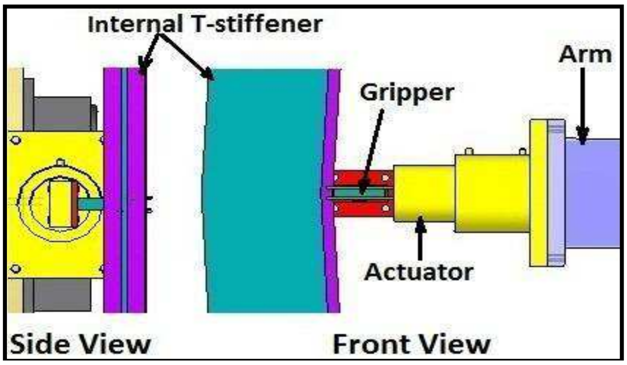

Figure 5b Tangential component of force when arm at 45°

II.III. Design Of Gripper

Gripper is taken as plate of cross- section 200 x150x 40thick. Vertical load of 5 Ton is applied by the T- stiffener on the gripper having uniformly distributed load over 80 mm length (refer Fig.6a). This load will cause bending stress as well as shear stress.

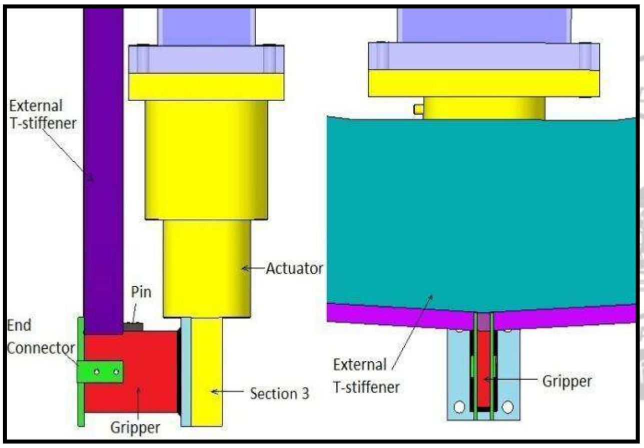

Figure 6a Arm in vertical direction

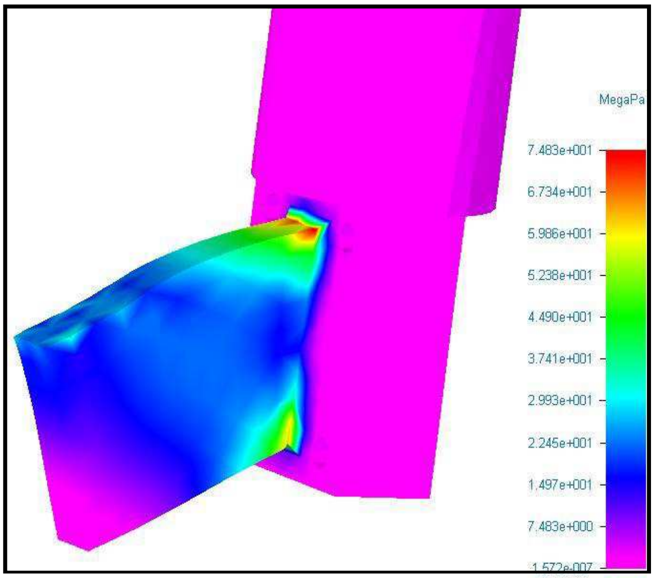

Figure 6b Stress in gripper

Maximum bending stress comes out to be 54.6MPa and maximum shear stress is equals to 28MPa. For which we get factor of safety of 2.9 and 3.4 respectively. Maximum stress through finite element analysis comes out to be 51MPa (refer Fig.6b). Thus results are validated and are under safe limits. Here 8mm continuous fillet weld is taken as constraint. Similarly gripper is checked when at an angle of 45 degree and results are validated using finite element analysis.

II.IV. Design Of Actuator Extension

Actuator extension (Section-3) is taken as plate of cross-section 200x150x64 thick and material is Structural Steel (IS 2062-Grade-B) having yield stress of 240MPa. Vertical load of 5 Ton is applied by the T-stiffener on the gripper having 'UDL' of 80 mm (refer Fig.7a). This load will cause bending stress as well as tensile stress.

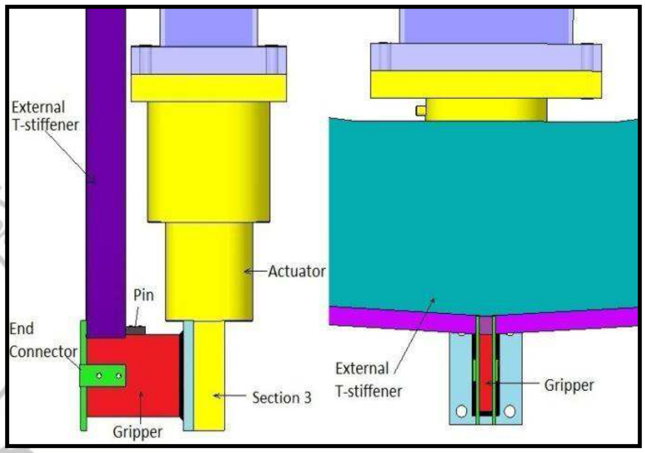

Figure 7a Arm in vertical direction

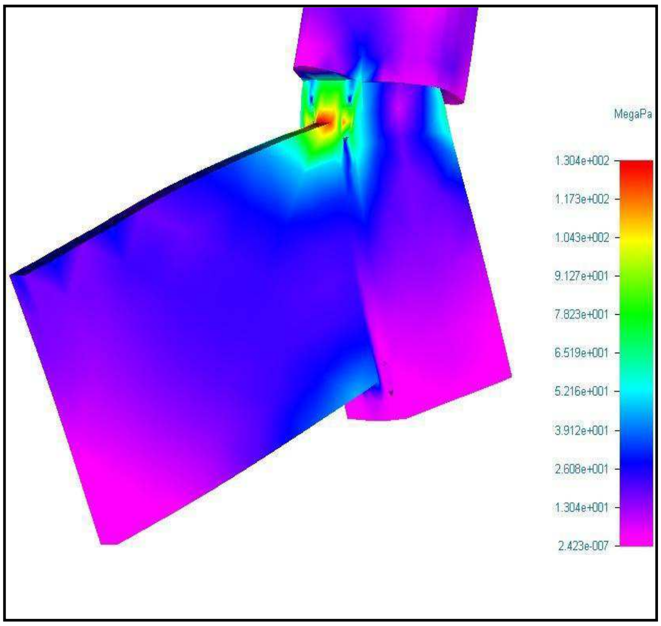

Figure 7b Stress in actuator extension

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We get maximum stress for bending through manual calculation equals to 104MPa, for which we get factor of safety of 1.5 and maximum stress through finite element analysis equals to 105MPa(refer Fig.7b). Thus results are validated and are under safe limits. Similarly gripper extension is checked when at an angle of 45 degree and results are validated using finite element analysis.

II.IV. Design Of Arm

Also because of load at distance 'Le' there will be a couple acting which will be causing twisting to the arm. Thus considering the case of combined bending and twisting moment, Equivalent bending stress through calculation comes out to be 86 MPa and through FEA comes out to be 91 MPa (refer Fig.8b), for which we get Factor of safety 1.8. Hence the results are verified and are under the safe limit. Similarly arm is checked in vertical condition and results are validated both by calculation and using finite element analysis.

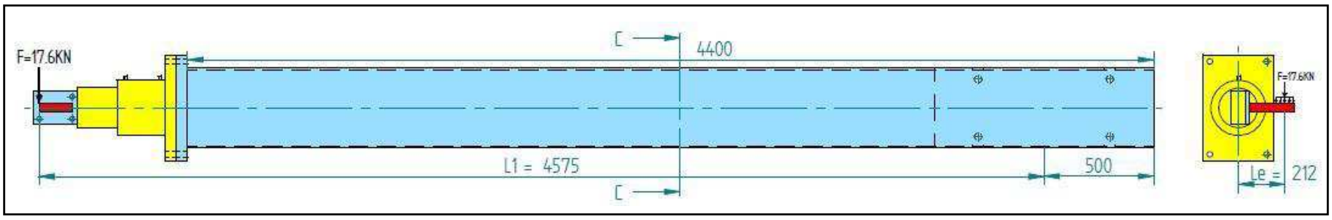

Figure 8a Tangential component when arm at 45 degrees

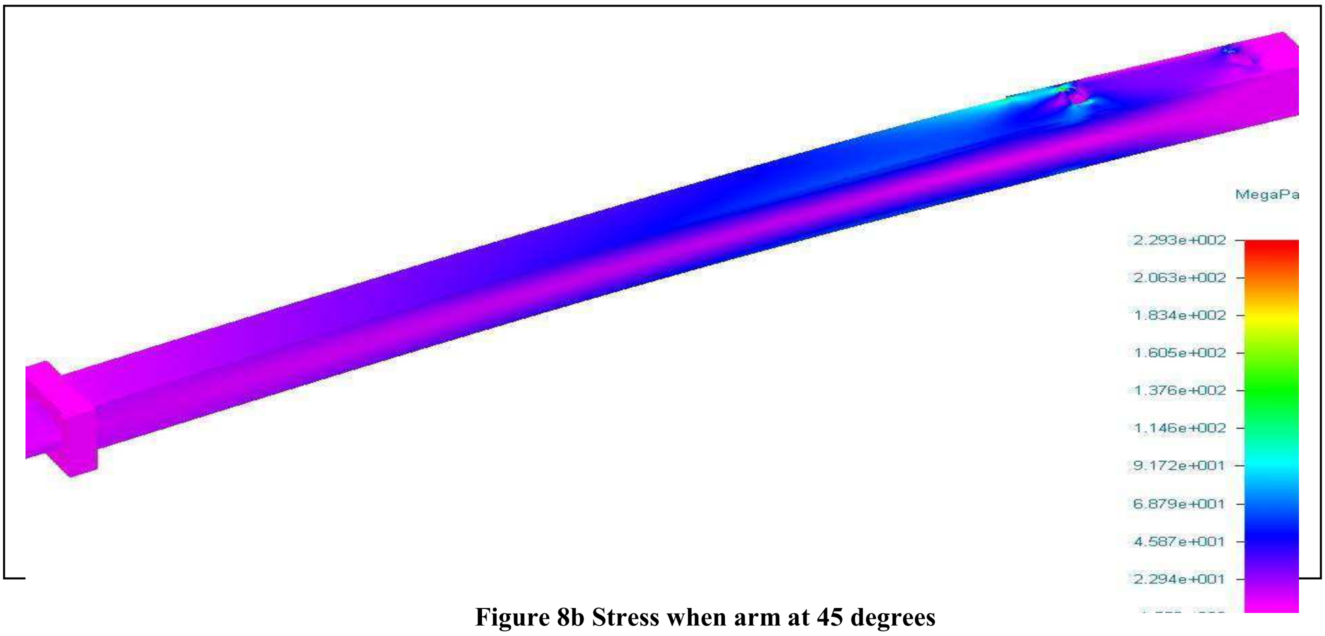

Figure 8b Stress when arm at 45 degrees

Tangential load of 1.76 Ton is applied by the T-stiffener on the gripper having uniformly distributed load of 80 mm. This load at distance 'L1' will be causing combined bending and shear stress (refer Fig.8a).

Further, Table1 shows maximum stresses in different parts, with its Finite Element Analysis value, factor of safety and the orientation of parts in which stresses are maximum.

S. no	Parts	Max. Stress	FEA Result	F.O.S.	Orientation
1	Gripper	74 MPa	71 MPa	2.1	45 degrees
2	Actuator Extension	104 MPa	105 MPa	1.5	vertical
3	Arm	87 MPa	91 MPa	1.8	45 degrees

Table 1 : Stress in various parts at different orientations

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III. CONCLUSION

The solution for external and internal T-stiffener welding station has been proposed with hydraulic arrangement. Various parts like gripper, actuator and arm have been designed and various connections needed to join them i.e. design of bolt and welding has been done. Each part is designed by considering maximum load in worst situation. Further analysis has been carried out to validate the model with the help of CAE software and results shows stresses within allowable limit.

REFERENCES

[1] Fawaz Abbas T. Nazim and Mohammed N. Al- Dawoodi, "The Effect of Stiffening Rings on the deection of Circular Isotropic Plates under static loading", pp: 33-37.

[2] James P. Peterson, "Structural Efficiency of Ring-stiffened corrugated cylinders in axial compression", pp- 18-24.

[3] D.V. Bhope and P.M. Padol,(1999),"Experimental Investigation Of Stresses, Noise and Flow In Centrifugal Fan Impeller ", International conference ECCM99, Munich, Germany.

[4] Sa-id Golabi,Ali Ghorbanpour-Arani and Arash Zamani (2008),"Experimental and numerical study of the effect of stiffening rings on reducing the thickness of tori-spherical heads with pressure on their concave side", Indian Journal of Science and Technology, Volume-32, pp-425-436.

[5] IS2062, "Steel for general structural purposes-specication,(Grade B), pp:5.

[6] IS800 : 2007,"General construction in steel-code of practise", Third Revision.

[7] Joseph Edward Shigley, Charles Russell Mischke, Richard Gordon Budynas(2005),"Mechanical Engineering Design", Volume1, McGraw-Hill Publication LTD., pp:361-364.

[8] Machine Tool Design Handbook (CMTI, Bangalore), TMH Publication.