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A REVIEW ON LIFTING BEAMS

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ABSTRACT

This work deals with Lifting beams design and analysis. This is important to minimize unwanted erection stresses or to prevent reversal of stress in certain portions of the lifted object. So the design of lifting beams plays a crucial role in the wellness of the lifted object. The objective is to perform the design calculations for the lifting beams considering for a capacity of 350 Tones as per the specifications and then Create 3Dmodel as per the design calculations in UNIGRAPHICS and Perform Structural analysis on the 3D model with Symmetric Loading of 350 Tones using Ansys And Perform Structural analysis on the 3D model with Asymmetric loading of 350 Tones using Ansys.

Keywords: erection stresses, design calculations, Structural analysis, Symmetric Loading, ASymmetric Loading of 350 Tones.

I. INTRODUCTION

A lifting beam is a solid or fabricated metal beam, suspended from a hoist/crane or from forks of a forklift, designed to provide multiple lifting points. The lifting beam enables the user to attach the load at more than one point therein securing and controlling the load's movement. Lifting beams are designed to be loaded in bending. A simple lifting beam will have an eye or link on the top side to connect to the lifting machine hook and two or more lifting points on the underside to connect to the load. They are ideal for lifting loads which are too weak or flexible to be lifted without support. For example they are often used in combination with vacuum lifters or lifting magnets to support long thin sheets or plates. They are also used when the headroom available is insufficient to accommodate slings, about which, more later.

1.1 'lifting beam' and 'spreader'

The terms 'lifting beam' and 'spreader' are often used interchangeably but they do have specific meanings and different applications. A spreader is designed to be loaded as a strut in pure compression. It gets its name from the earliest designs which were used, quite literally, to spread the legs of a sling. Typically a simple spreader for a chain sling comprised a bar with a fork at each end. The fork engaged with the chain and held the bar in place. It could be used, for example, with a two leg sling to lift a cable reel by its axle and hold the legs apart to prevent the reel flanges being crushed. **Lifting beams** and **spreaders** can facilitate the lifting of loads not possible by any other means but there are some limitations and pitfalls to watch out for. One major consideration is load stability. Usually, with a sling, the connection to the load is made at or near the top of the load or by wrapping around or passing through the load. This generally means that the connections are above the load's Centre of gravity, thus ensuring stability. Lifting beams and spreaders enable the connection to the load to be made to the sides or even the base of the load at points below the Centre of gravity .This might seem an

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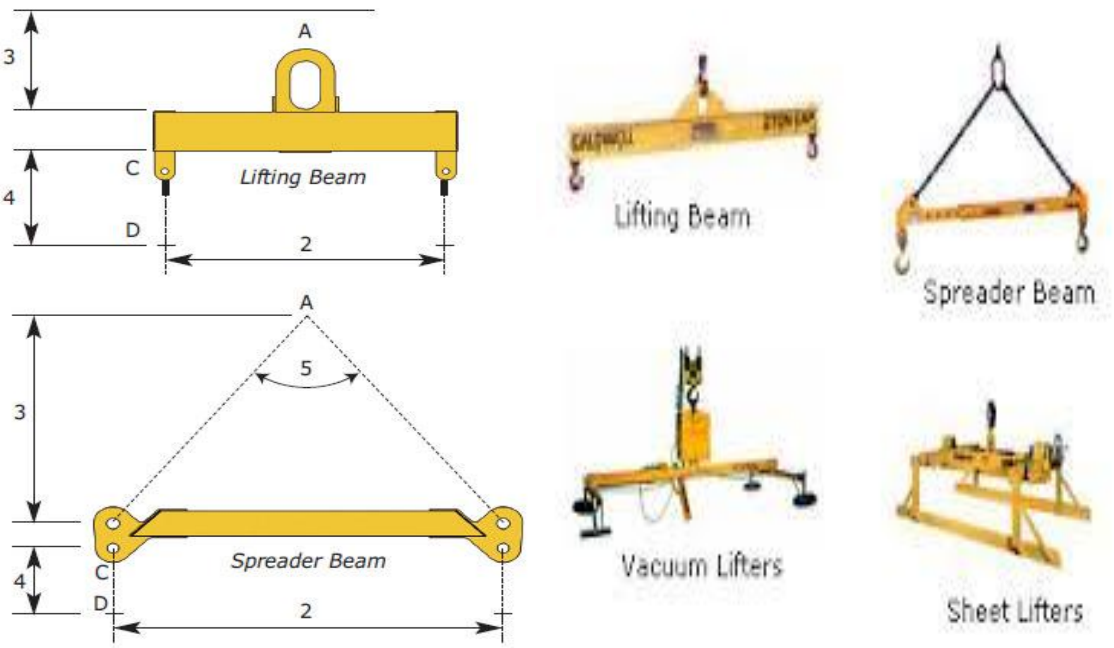
attractive option for any load with upper parts which might be easily damaged, such as a machine tool or a skid mounted generator. However caution is required. First there needs to be at least three connection points and, when viewed in plan, the centre of gravity must lie within the area bounded by them. When viewed from either side, the load, the lifting beam or spreader and the slings which connect them form four sides of a rectangle. we mentioned earlier that lifting beams are often used when the headroom available is limited. Another major consideration is load distribution. Whenever a load is supported at several points there is likely to be a degree of inequality in the share of load imposed on each. The likely variation should be taken into account when specifying or selecting the equipment. If the load is rigid, then some flexibility of the lifting beam may be desirable unless fine adjustment of the connections, such as may be achieved with rigging screws, is included. Lifting beams designed for multiple applications may have adjustable lifting points. The adjustment can be either in fixed increments or variable. Whichever method is used it should incorporate a suitable means of locking them into position when they are under load. If the locking is done manually, there should be a clear visible indication of whether the lock is engaged or not.



1.2 Lifting beams, and to some extent spreaders, may be designed to facilitate orientation of the load. It may be as simple as lifting upright a load stored flat or it may require an additional mechanism to generate the required movement. Whichever is the case, the design should allow for a tolerance on the intended orientation. Even a load intended to be lifted level cannot be expected to be perfectly level at all stages of the operation. As a general rule, an error of up to 6 degrees from the intended orientation should be allowed for. This is sufficient to be clearly visible to the operator in time to take corrective action before it is exceeded.

1.3. These and other design requirements for lifting beams are specified in the European standard, EN 13155 for non-fixed load lifting attachments, A few other points to consider, When lifting beams or spreaders are set down after use, they should be stable and it should be possible to disconnect them safely from the crane hook. Lifting beams with an integral lifting eye in particular are vulnerable to falling on their side during this operation unless supported. Depending upon the weight of the beam and its shape, special storage stands may be necessary.

While considering the weight, remember that it is part of the total load the crane will lift. It is good practice that, as well as marking the beam with its working load, it is also marked with its own weight. Lifting an unladen lifting beam or spreader can also bring its own risks, particularly if it is not balanced in the unladen state. Long beams in particular may need a tag line to keep them under control. When using a lifting beam or spreader with an overhead crane, beware of fouling the crane bridge, especially on double girder cranes where the hook rises between the girders. It may be necessary to set the upper limit switch accordingly or fit a secondary switch. Similarly, when used with a mobile crane, if the load rotates, the beam may strike the jib if not restrained by a tag line.Despite these few limitations, lifting beams and spreaders can provide an efficient and safe method of handling many loads which would otherwise prove impossible to lift.

II. DESIGN OF A LIFTING BEAM FOR 350 TONNES

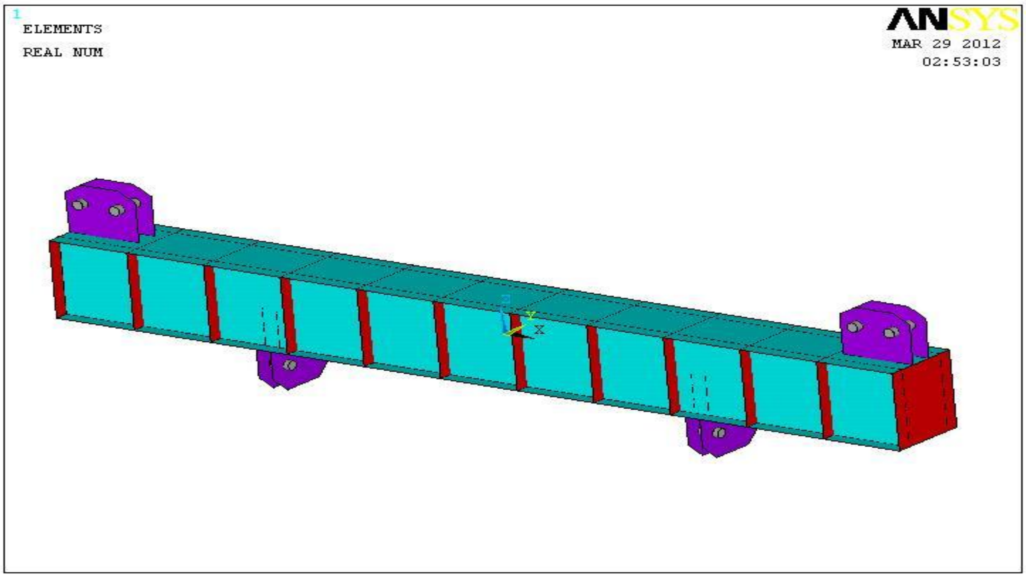
The objective is to design a lifting beam for a weight of 350Tonnes. UNIGRAPHICS software shall be used to create a 3d model of the lifting beam. Finite element analysis shall be carried out using Ansys software to validate the design.

2.1 Design of A Lifting Beam

The lifting beam is designed for a weight of 350Tonnes.

Here the lifting beam is designed for lifting of a material of 350 Tonnes. The design is also validated by performing finite element analysis using Ansys software.3d model is created using UNIGRAPHICS software.

Fig shows the 3d model of the Lifting Beam



2.2. Structural Analysis of A Lifting Beam

Objective:The objective of our study is to perform structural analysis of the lifting beam for a load of 350Tonnes.Analysis is performed for for both symmetric loading and asymmetric loading.The main areas of interest of the above analysis is to observe the deflections and stresses developed on the structure because of applied load.

2.3. Material Properties of the Lifting Beam

The material used for the construction of Lifting Beam is IS :2062 grade steel.The mechanical properties are mentioned below

Young's Modulus (Ex) =2e5N/mm2, Poisson's Ratio = 0.3, Density = 7850Tons/mm^3

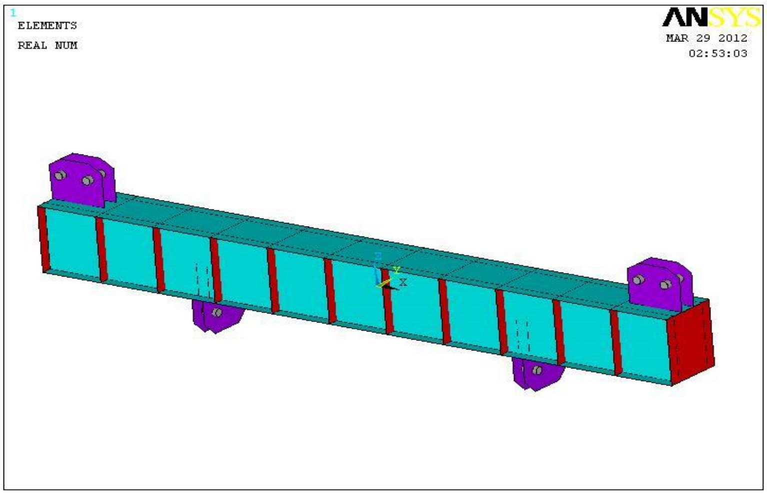
Yield Strength =240 N/mm^2, Weld Strength = 0.7 x 240 = 168 N/mm^2

Weld Shear Strength =0.5 x 168 = 84 N/mm^2

2.4 Element Type Used

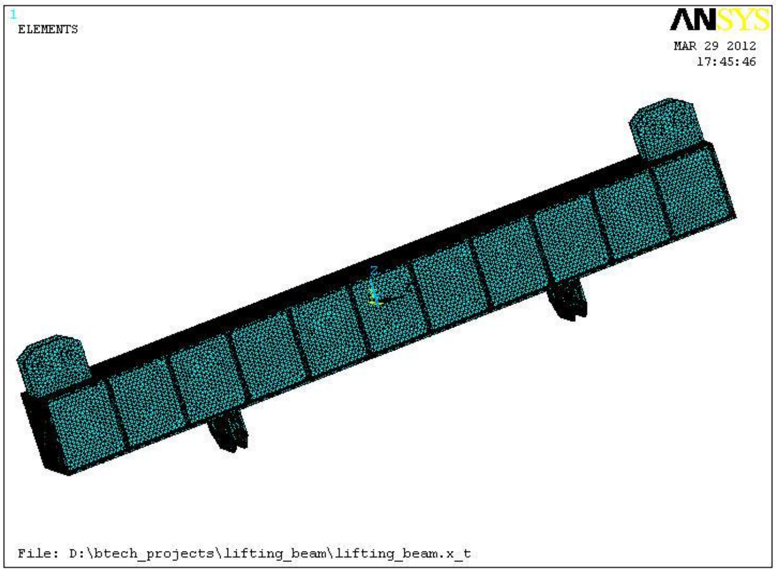
10 Node Solid 92, Number of Nodes: 10, Number of DOF: 3 (Ux, Uy, Uz)

The below figure shows the 3D model of the Lifting Beam:

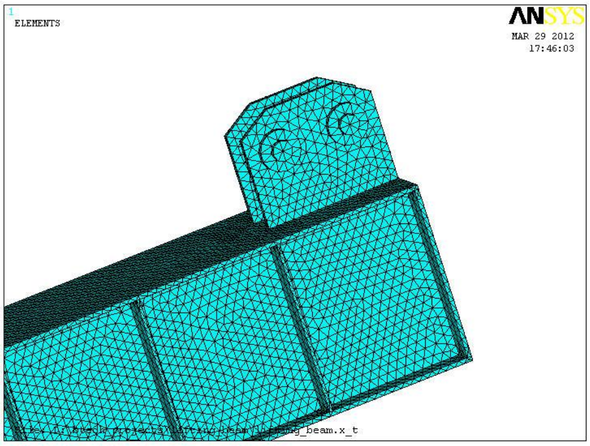


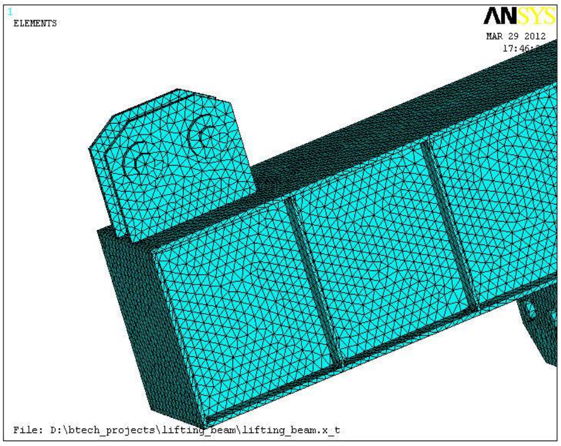
Finite Element Model of the pressure vessel:The Lifting Beam is meshed using solid 92 element type.It is a tetrahedral 10 node element.

The below figure shows the Finite Element Model of the Lifting Beam

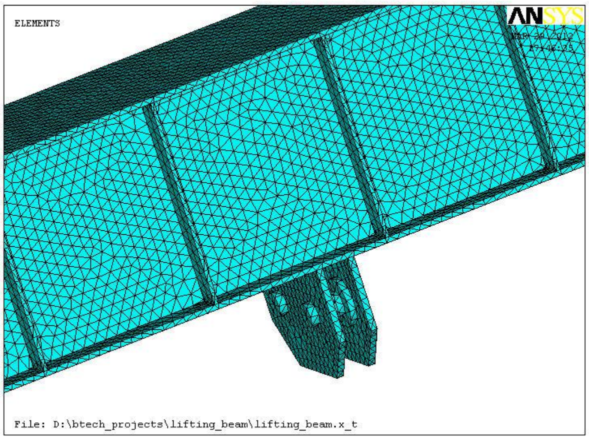


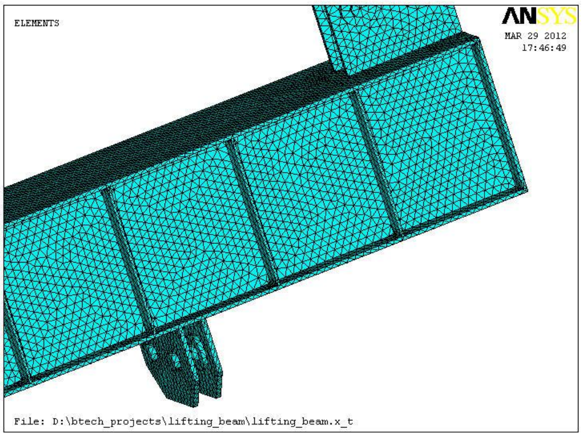
The below figure shows the Finite Element Model of the top supports of Lifting Beam





The below figure shows the Finite Element Model of the bottom supports of Lifting Beam





2.5 Boundary Conditions for Symmetric Loading

The boundary conditions applied on the Lifting Beam are as follows:

1. Total load = 350 + 21 Tonnes
2. Load is applied as distributed on a span of 180 mm on the 4 Top Pins
3. Bottom Pins constrained in all DOF

The below figures shows the Symmetric Boundary Conditions applied on the Lifting Beam.

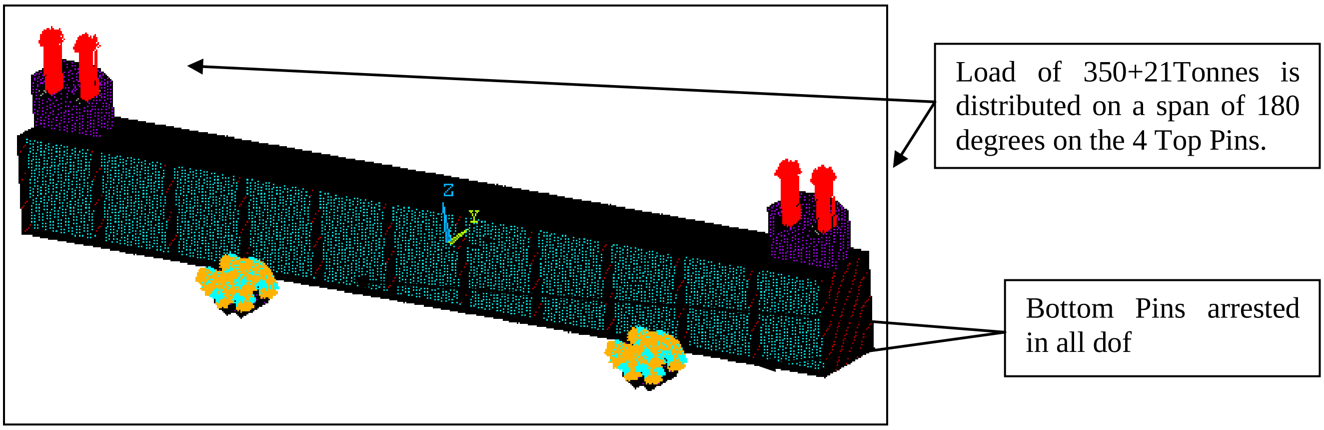


Fig .shows the load applied on top pins

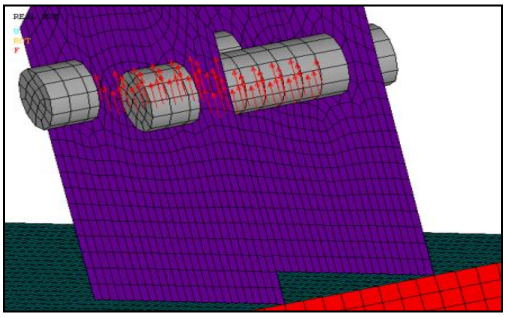
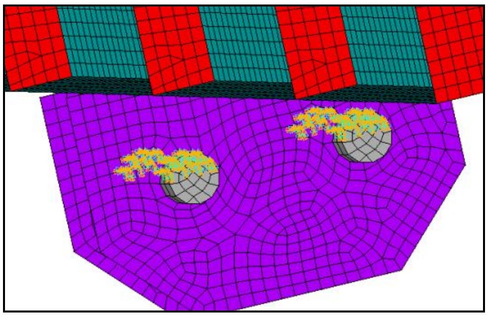
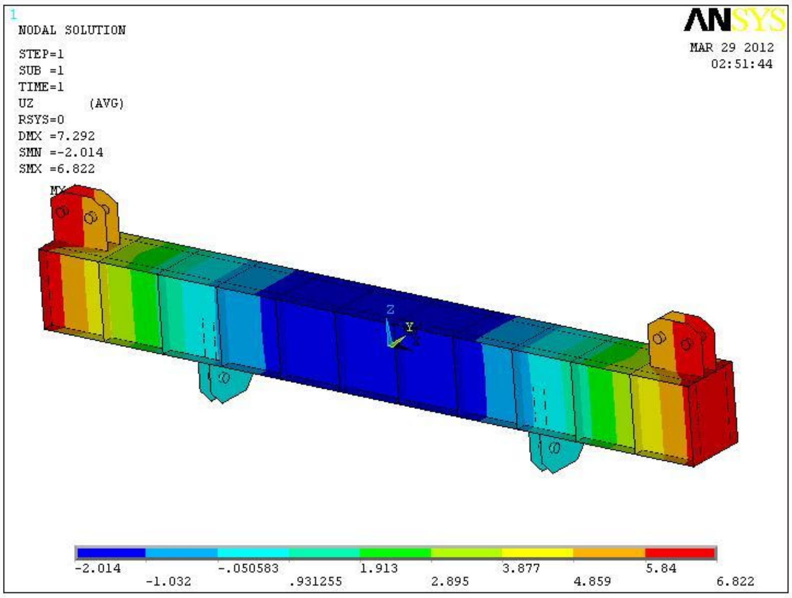


Fig. shows the constraints on bottom pins

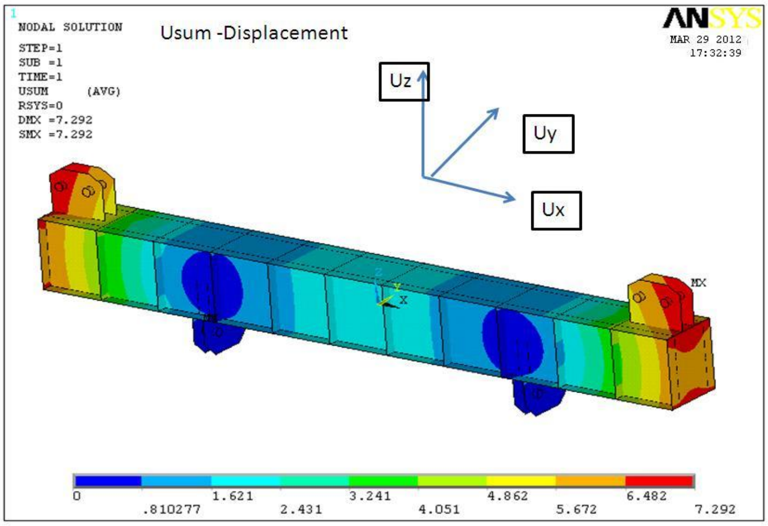


III. RESULTS FOR SYMMETRIC LOADING

The fig. below shows the deflection of Lifting Beam in Z-direction (Uz)



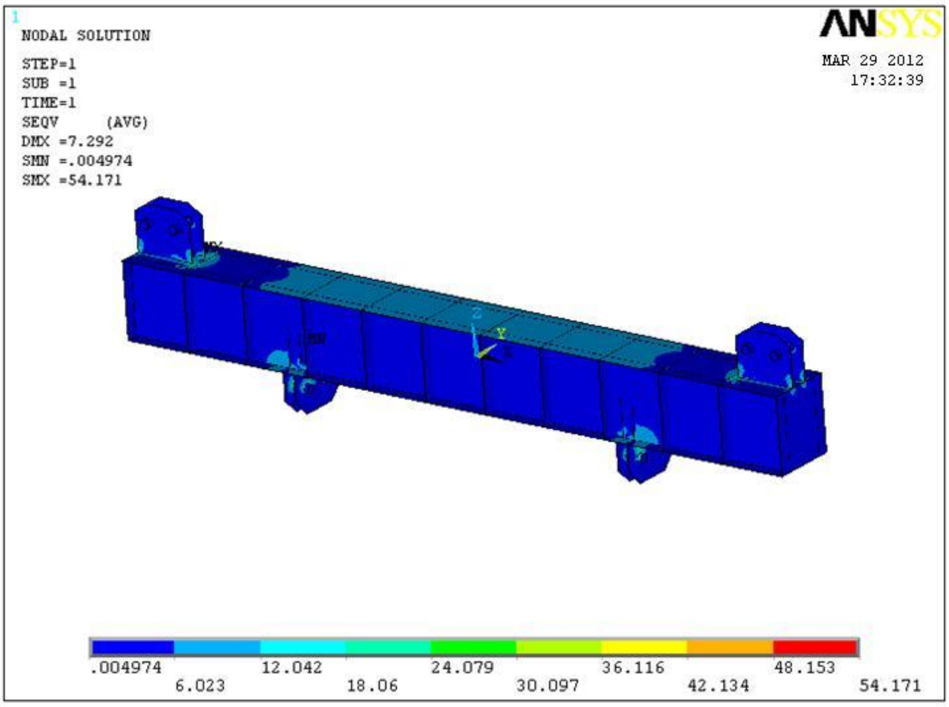
The fig. below shows the Total deflection (Usum) of Lifting Beam



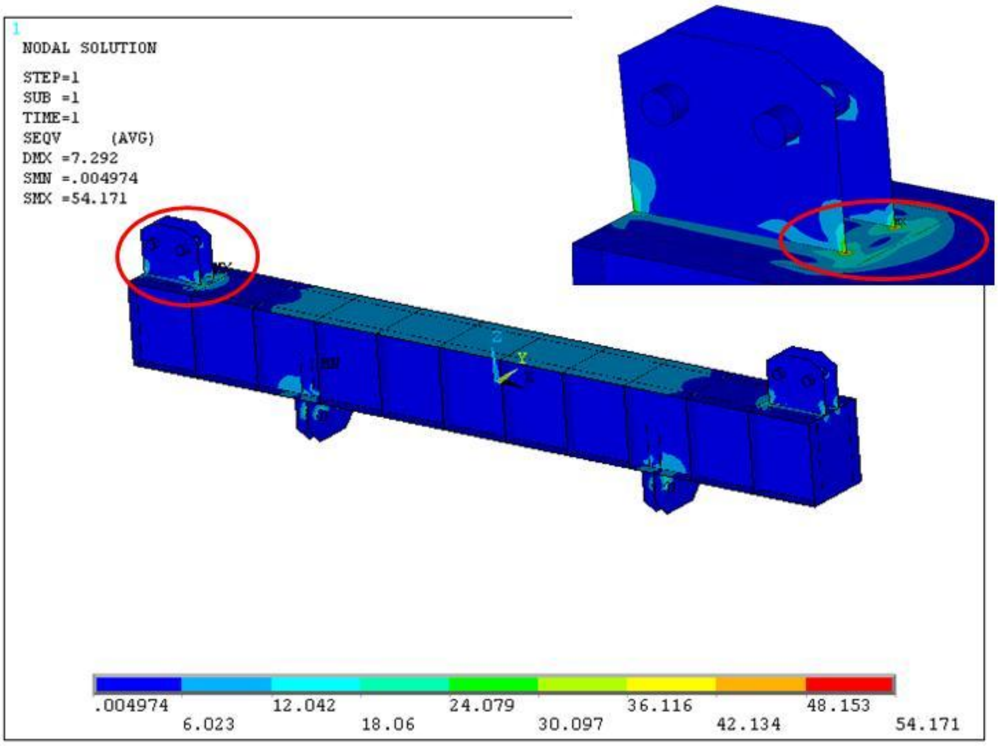
From the above results the maximum deflection observed is 7.2mm

3.1 VonMises Stress

fig. below shows the VonMises Stress (SEQV) of Lifting Beam for Symmetric loading



The fig. below shows the VonMises Stress (SEQV) of Lifting Beam on the top support



From the above results the maximum VonMises stress observed is 54.17N/mm2.This is a singular stress and can be neglected.

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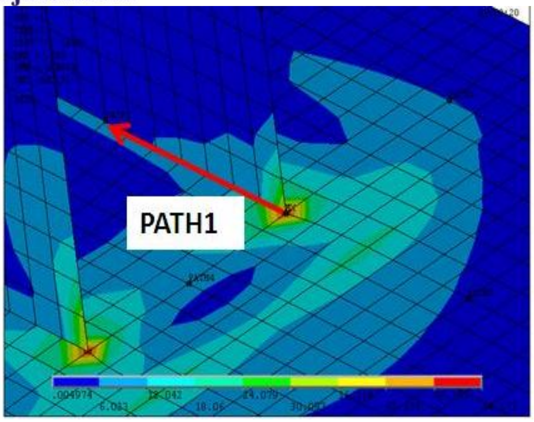
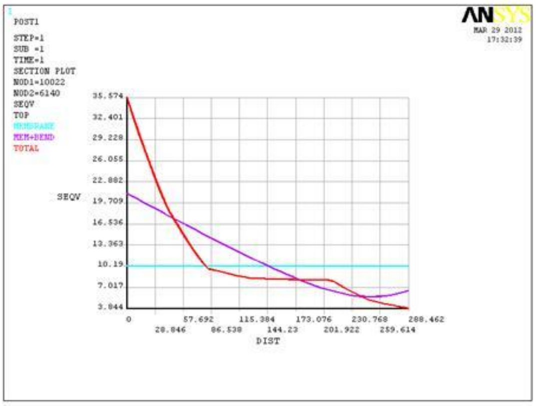
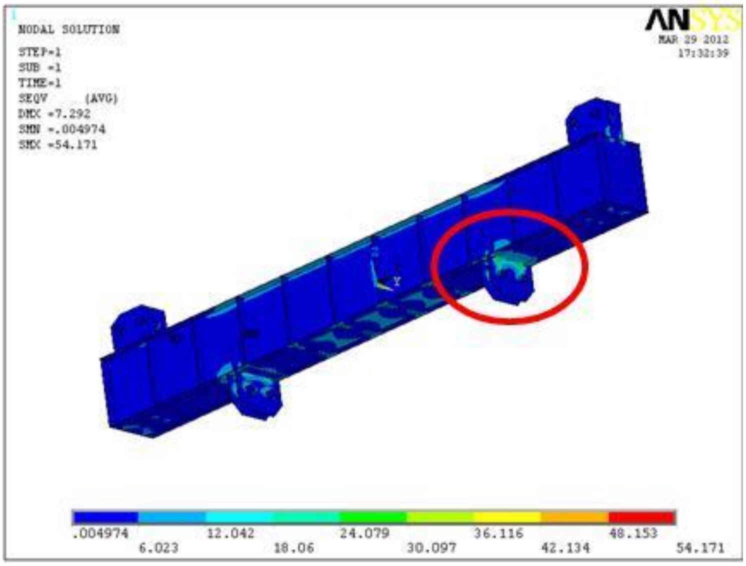


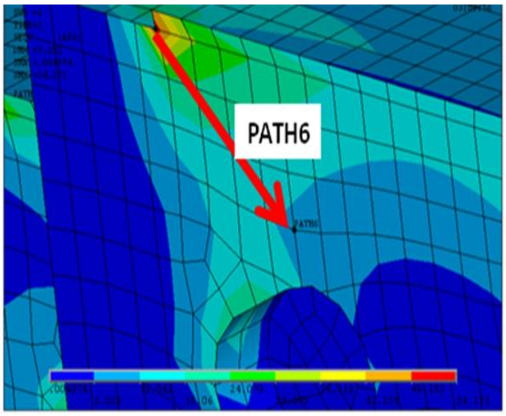


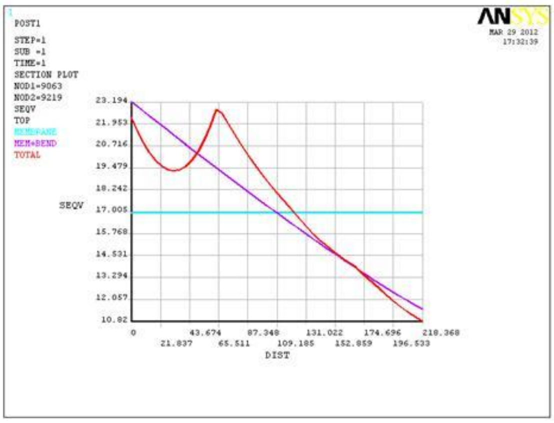
From the above results the avg. stress observed is 19Kgf/mm2 on the top support plates.

fig. below shows the VonMises Stress (SEQV) of Lifting Beam on the Bottom support



From the above results the maximum VonMises stress observed is 54.17N/mm2.This is a singular stress and can be neglected.





From the above results the avg. stress observed is 23N/mm2 on the bottom support plates

Fig. below shows the VonMises Stress (SEQV) of Lifting Beam on Top & Bottom Pins

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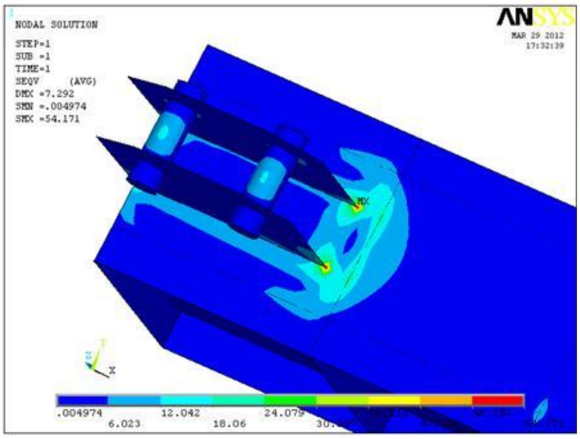
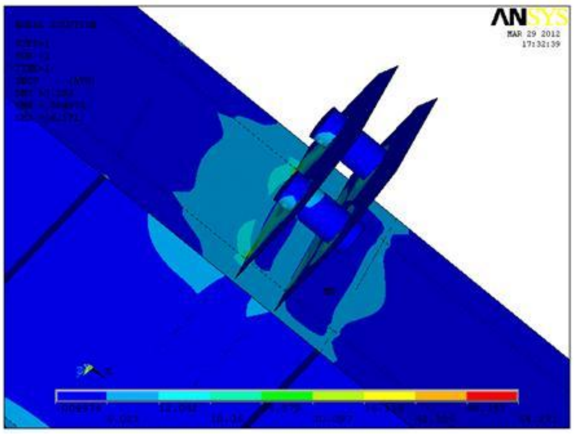




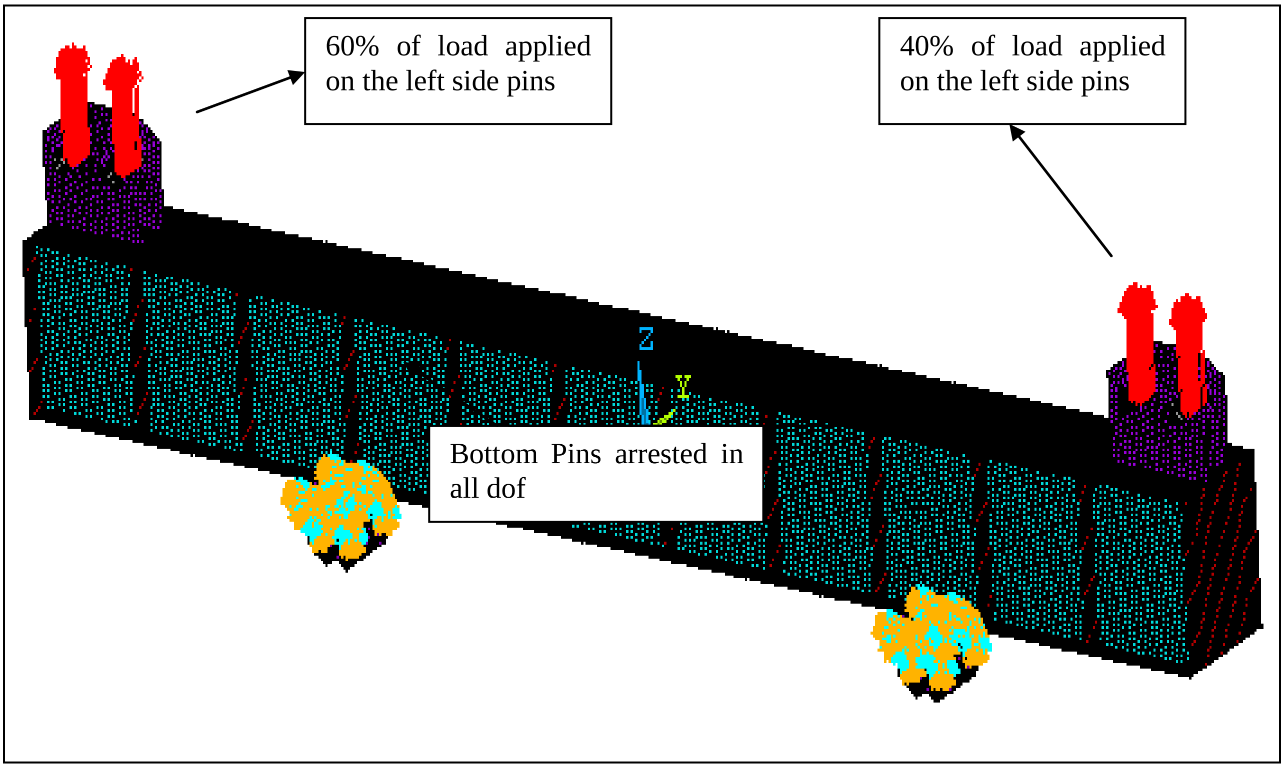
From the above results the avg. stress observed is 15N/mm2 on the top & bottom pins

3.2 Boundary Conditions for Asymmetric Loading

The boundary conditions applied on the Lifting Beam are as follows:

1. Total load = 350 + 21Tonnes
2. Load is applied as distributed on a span of 180 degrees on the 4 Top Pins.
3. Left side pins are loaded with 60% of the total load and right side pins with 40% of total load to simulate the asymmetry.
4. Bottom Pins constrained in all Dof.

The below figures shows the Asymmetric Boundary Conditions applied on the Lifting Beam.



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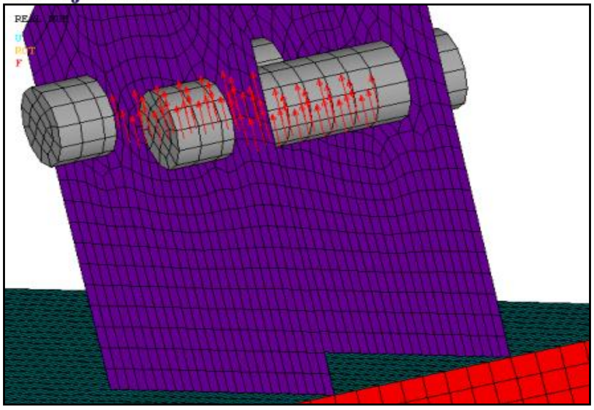


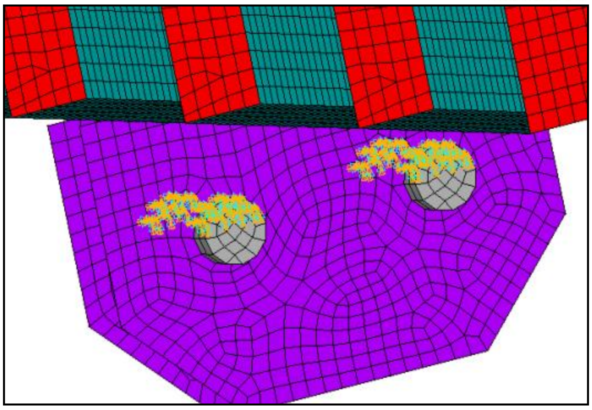
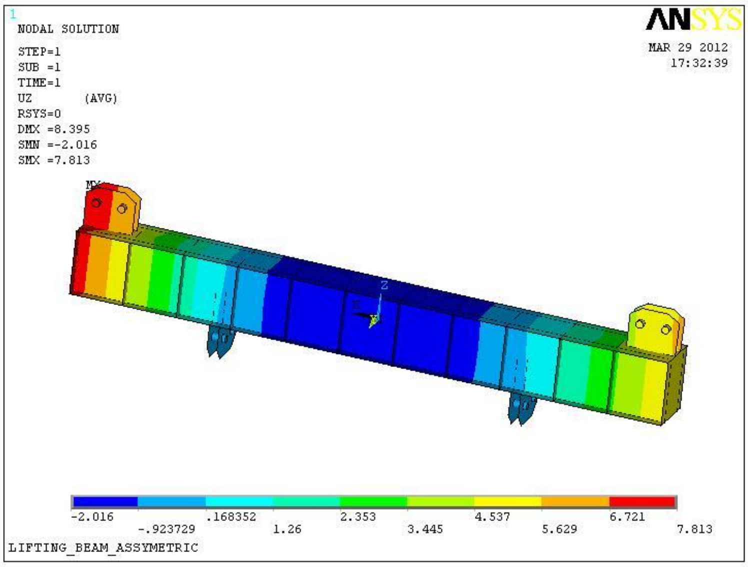


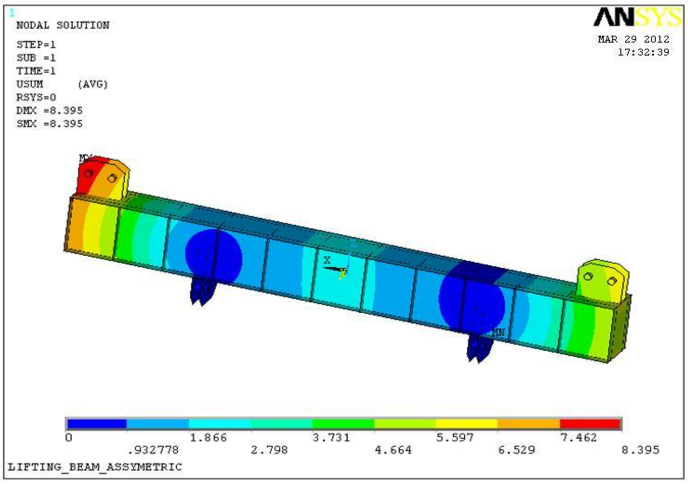
Fig .shows the load applied on top pins **Fig. shows the constraints on bottom pins**

IV. RESULTS FOR ASYMMETRIC LOADING

The fig. below shows the deflection of Lifting Beam in Z-direction (Uz)



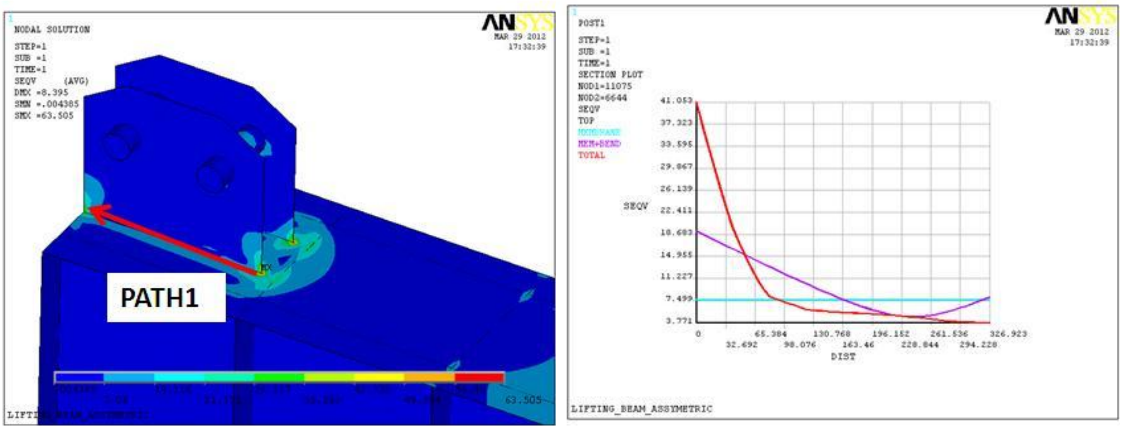
The fig. below shows the Total deflection (Usum) of Lifting Beam



From the above results the maximum deflection observed is 8.3mm

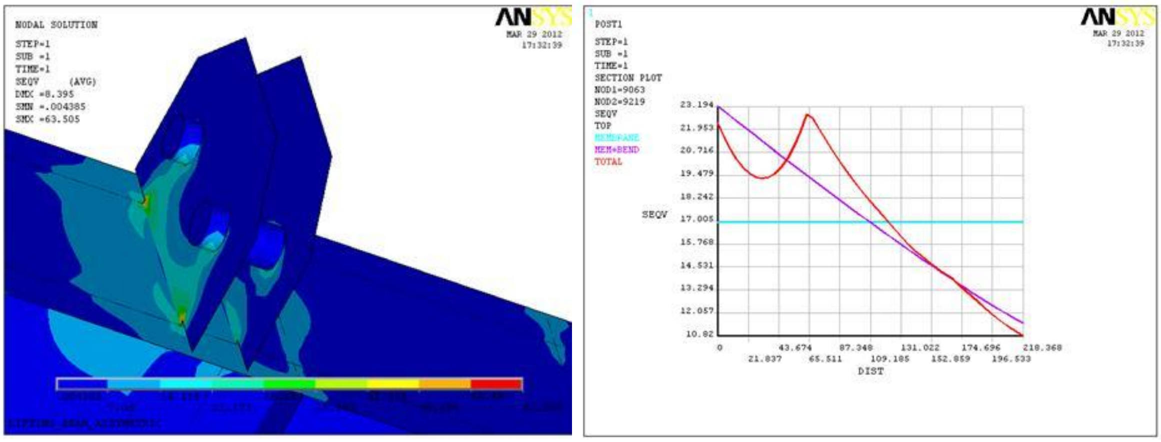
4.1 VonMises Stress

fig. below shows the VonMises Stress (SEQV) of Lifting Beam for Asymmetric loading on the top supports



From the above results the avg. stress observed is 18N/mm2 on the top support plates

Fig. below shows the VonMises Stress (SEQV) of Lifting Beam for Asymmetric loading on the bottom supports



From the above results the avg. stress observed is 22N/mm2 on the bottom support plates

Fig. below shows the VonMises Stress (SEQV) of Lifting Beam for Asymmetric loading on the Top Pins

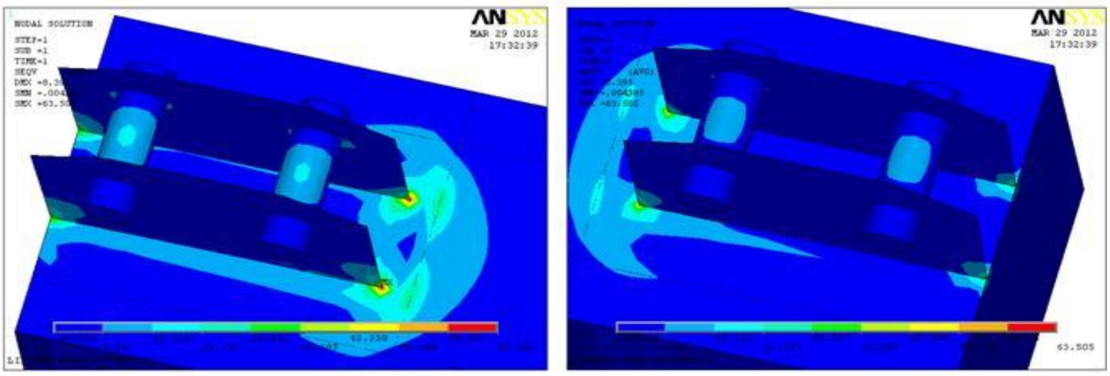
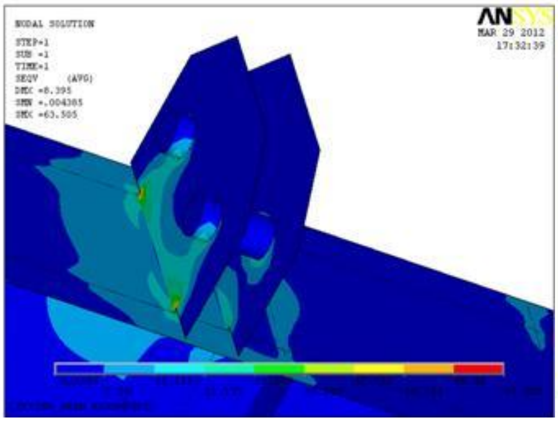
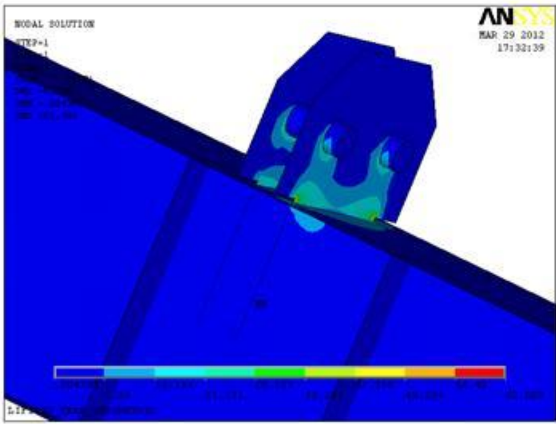


Fig. below shows the VonMises Stress (SEQV) of Lifting Beam for Asymmetric loading on the Bottom Pins

From the above results the avg. stress observed is 18N/mm2 on the Pins

V. RESULTS

Table For Symmetric Loading of A Lifting Beam For 350 Tones

	DESIGN CALCULATIONS	RESULTS OBTAINED FROM ANSYS
VONMISES STRESSES(N/mm^2)	BENDING STRESS ON THE BEAM FOR SYMMETRICAL LOADING = 71.9 N/mm^2	AVG VONMISES STRESS OBSERVED ON THE LIFTING BEAM FOR SYMMETRICAL LOADING IS 23N/mm^2
DEFLECTION(mm)	DEFLECTION OF THE BEAM =7.864mm	DEFLECTION OBSERVED ON THE LIFTING BEAM FOR SYMMETRICAL LOADING IS 7.2mm

Table For Asymmetric Loading of A Lifting Beam For 350 Tones

	DESIGN CALCULATIONS	RESULTS OBTAINED FROM ANSYS
VONMISES STRESSES(N/mm^2)	BENDING STRESS ON THE BEAM FOR ASYMMETRICAL LOADING = 79.7 N/mm^2	AVG VONMISES STRESS OBSERVED ON THE LIFTING BEAM FOR ASYMMETRICAL LOADING IS 22N/mm^2
DEFLECTION(mm)	DEFLECTION OF THE BEAM =8.59mm	DEFLECTION OBSERVED ON THE LIFTING BEAM FOR ASYMMETRICAL LOADING IS 8.3mm

VI. CONCLUSIONS

Until recently the primary analysis method had been hand calculations and empirical curves. New computer advances have made finite element analysis (FEA) a practical tool in the study of Lifting Beams, especially in determining stresses.In this paper we have used Ansys software to do the analysis on the Lifting Beam.

Performed design for Lifting Beam for a weight of 350 Tonnes.

Performed 3d modelling of the Lifting Beam using UNIGRAPHICS software.

Performed Finite Element analysis of the of the Lifting Beam for a Symmetric and Asymmetric loading.

The Max Deflection observed on the Lifting Beam for Symmetric loading is 7.2mm.

The Max Avg.VonMises Stress observed on the Lifting Beam for Symmetric loading is 23 N/mm^2.

The Max Deflection observed on the Lifting Beam for ASymmetric loading is 8.3mm.

The Max Avg.VonMises Stress observed on the Lifting Beam for ASymmetric loading is 22 N/mm^2.

From the above results it is concluded that the Lifting Beam structure is safe under the given operating conditions proved that the vonmisses stress and deflection is less than the Design parameters.

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