UPGRADATION IN HYDRAULIC PRESS MACHINE

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ABSTRACT

Hydraulic Press is one of the oldest basic machine tools. In its modern form, is well adapted to press work ranging from coining jewelry to forging aircraft parts. Hydraulic Deep Drawing Presses are widely used for industrial sheet metal forming today. Small manufacturers of drawn parts and suppliers of the automotive industry especially appreciate these machines because of their high flexibility in process design. As wide range in shapes of products is manufactured, so for this application different forces are required. Due to continuous change in these forces there is change in deformation and Equivalent stresses of machine frame which affect the maintenance of machine. To overcome this optimization of machine frame is required which can be done by using CAD tool such as Pro Engineer and analyzed it in CAE tool such as ANSYS.

Keyword: Hydraulic Press Machine, Optimization, Analysis of Machine Frame, Frame Modeling, Stresses in Machine Frame.

I. INTRODUCTION

The mechanical press has been the first choice of many press users for years but now a day by increasing demand of product. As modern hydraulic presses offer good performance and reliability, the use of Hydraulic Press is increased. As Hydraulic press machine use several load capacity to convert sheet metal into desired product. These presses come in manual mode of operation as per user requirement[1].

There are variations in load capacity of Hydraulic Deep Drawing Press Machines. Such as 30-ton Hydraulic press, 60-ton Hydraulic press and depend upon user requirement. So by applying this load capacity on sheet metal desired output is obtained but this capacity also has adverse effect. We worked on 40-ton Hydraulic Press Machine in the INDUSTRY.

There are various products which are manufactured by the machine of different shape and size, so there is variation in the forces which are acting on machine structure. Due to such variation there are certain deformations and equivalent stresses acting on the machine structure. So our aim is to reduce these deformations and equivalent stresses. This can be achieved by optimizing machine frame parameters such as frame thickness or providing extra support to bottom. The design of the machine frame is done using PRO ENGINEER WILDFIRE 5.0. All the

dimensions which were required during designing were taken directly from the machine itself. Then we imported the design to ANSYS. In ANSYS there are mainly three processes, which are-preprocessing, solution and post processing. Preprocess consists of Material Selection, Geometry, Meshing of Frame. In solution step it computes the unknown values. Post processing includes plotting the result obtained from finite element solution

II. PROBLEM STATEMENT

Many Industries are mostly concern with manufacturing of houseware utensils. They manufacture houseware utensils of different shapes and sizes using same machines. Due to variation in shapes of product, force of different magnitude is required. Due variation in forces, there is deformation and change in equivalent stresses which produce more maintenance cost of machine and produce defect in product.It is required to eliminate this effect and reduce the maintenance cost of machine as well as product defect. So we have to redesign the machine frame where more defect is observed and optimized it.

III. MATERIAL PROPERTIES

Table 1. Material Properties

SR.NO.	PARAMETER	DESCRIPTION
1	MATERIAL	GREY CAST IRON(GRADE 25)
2	YOUNGS MODULUS(E)	$1.1X10^{5}$ MPa
3	DENSITY	$7.2X10^{-6}Kg/mm^{3}$
4	POISSON'S RATIO	0.28
5	ULTIMATE TENSILE STRESS	250 a

IV. MODELING OF MACHINE FRAME

Pro/ENGINEER Wildfire enables you to create solid model representations of your part and assembly models. Pro/ENGINEER Wildfire 5.0 is powerful software used to create complex designs with great precision. The design intent of any three-dimensional (3D) model or an assembly is defined by its specification and its use. You can use the powerful tools of Pro/ENGINEER Wildfire 5.0 to capture the design intent of any complex model by incorporating intelligence into the design.

Once you understand the feature-based, associative and parametric nature of Pro/ENGINEER Wildfire 5.0, you can appreciate its power as a solid modeler. For modeling of Machine Frame we prepared component of the machine model in Pro/ENGINEER Wildfire 5.0 by taking its original dimensions. We modeled following component in Pro/ENGINEER Wildfire 5.0.

(1) Frame

(2) bolts

(3) machine table

Then these parts assembled in Pro/ENGINEER Wildfire 5.0. We took the actual dimensions of model from the Company. The machine dimensions are 750mm x 500mm x 1855mm. The machine frame thickness is 20mm. From dimensions, we generated the 3D Model in Pro/ENGINEER Wildfire 5.0. It has four supports on which machine rest on the floor. Frame has fillets at each corner. Also the two guideways on which machine ram slide which is fitted by means of nut and bolts. We saved the IGS file of prepared model for analysis

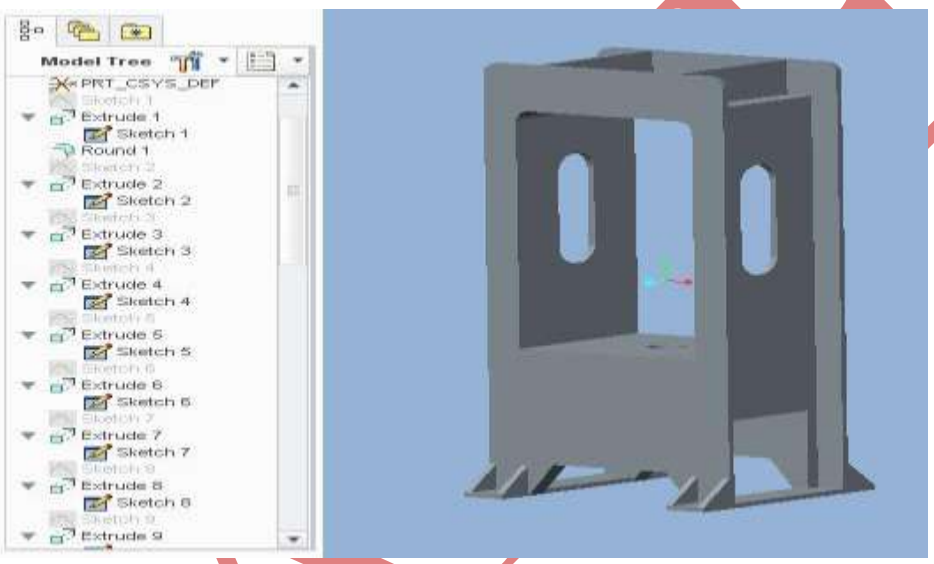

Fig.1 Machine Frame CAD Model

V. ANALYSIS OF MACHINE FRAME

We analyzed model in ANSYS Workbench 13.0. We followed the following sequence:

- First we imported the CAD model in ANSYS Workbench 13.0.
- Applied 3 Main steps of Analysis in ANSYS
  - Pre Processing
  - Solution
  - Post Processing

In preprocessing step we meshed the frame by using tetrahedron patch conforming meshing method as well as we applied boundary condition. In solution phase solver solves the given model and compute the result required. In Post processing phase we get graphical representation of found solution.

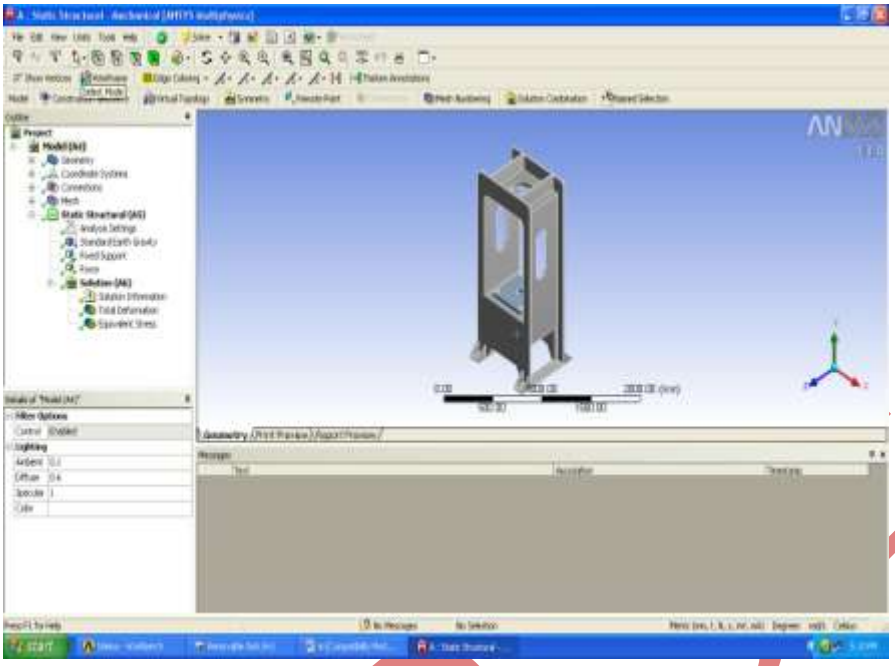

Fig. 2. Geometryimported in ANSYS Workbench 13.0 for Analysis

5.1 Meshing Details

Meshing is important steps in FEA as discretize the model. We had applied Tetrahedron Patch [3] Conforming Method. The tetrahedron has 10 nodes in each element. The Element size was taken as 10mm and relevance was taken as medium in order to have good mesh. Element Solid 187 is used for meshing.

Table 2. Meshing Details

Element Type	Tetrahedron Solid 187
Element Size	10mm
Relevance Type	Medium
Smoothing	Medium
Transition	Fast
No. of Element	121664
No. of Node	215964

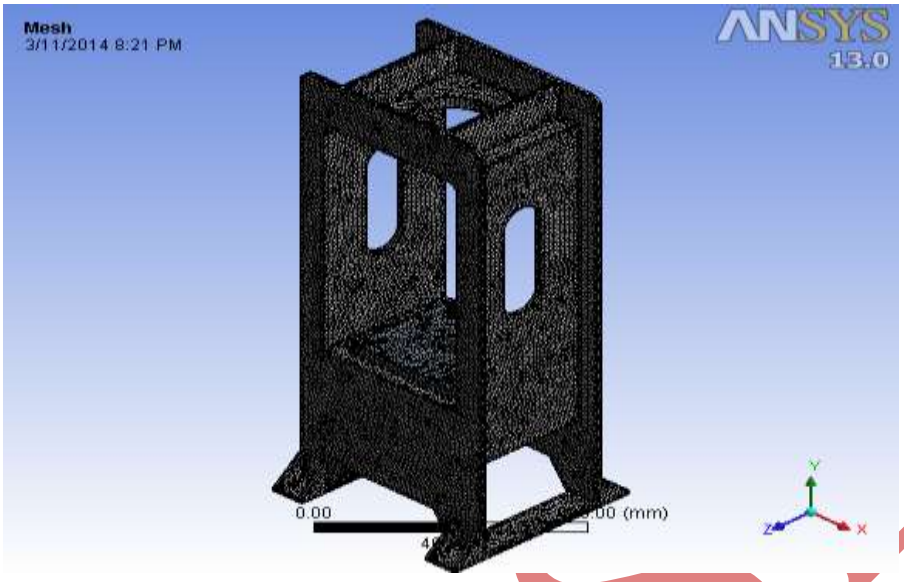

Fig.3. Meshing of Model

5.2 Boundary Conditions

Frame Assembly has been analyzed under 112KN Static force. That 112KN force applied on the machine table which is uniformly distributed on the table.

Self-weight of the assembly is considered to be a standard Earth gravity load and is applied through the Center of Gravity of the assembly. Fixed support is given to the bottom surface of the frame and guide ways slot where the guide ways are fixed to the frame with fixed connections.

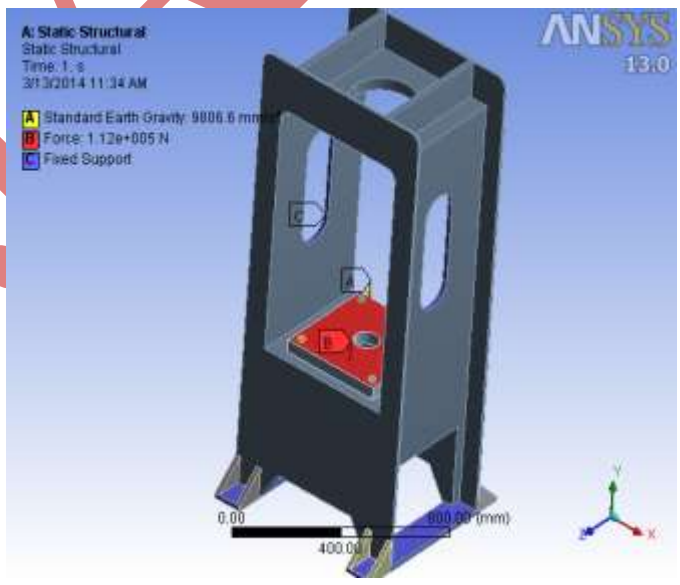

Fig. 4. Boundary Conditions

5.3 Static structural analysis result

It shows the graphical representation of Equivalent stress and Total Deformation in Colors. It shows the blue color at safe region where as red color on critical region. Also it shows the animation of how the frame is going to deform under the load or how Stresses induced in frame. A static load of 112kN is applied on machine table in Fy direction and uniformly distributed on table. Following results are obtained

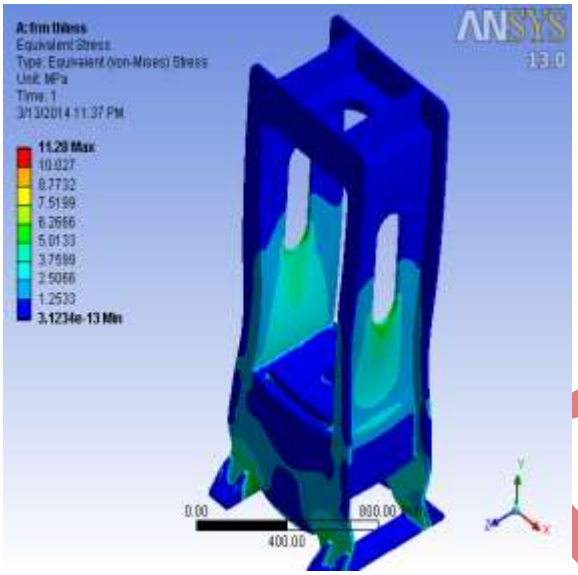

Fig. 5. Equivalent Stress in Original Frame

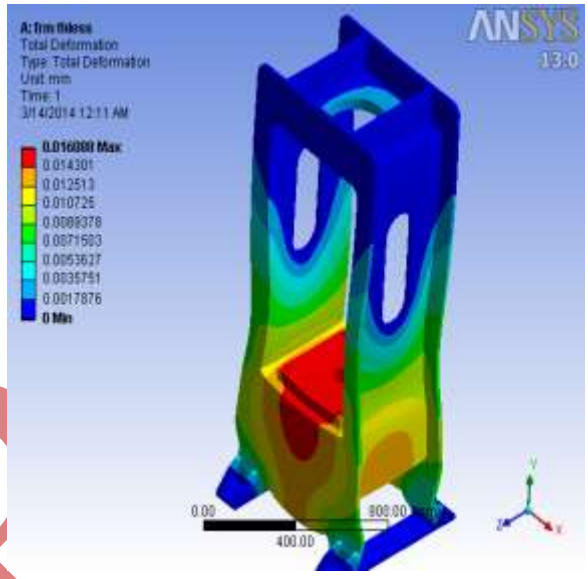

Fig. 6. Total Deformation in Original Frame

The maximum Total deformation is 0.016088 mm and maximum Equivalent stress at frame is 11.28 MPa.

Fig. 7. Press Machine

The Red Circle shows area of maximum equivalent stress and the Blue circle shows maximum total deformation area.

VI. DESIGN MODIFICATION

The existing frame shows the maximum total deformation 0.016088 mm and maximum equivalent stress is 11.28 MPa. So the modification is done by reducing the frame thickness as well as providing supports.We redesigned the model by reducing the machine frame thickness to 15mm and then by reducing frame thickness to 10mm. We saved the .IGS file of that model for analysis.

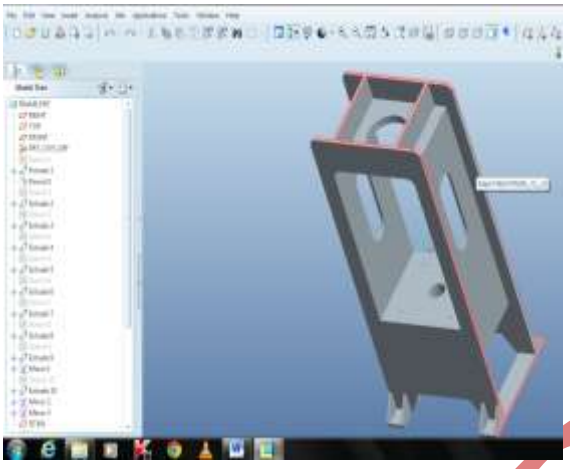

Fig. 8 modified Thickness of Frame

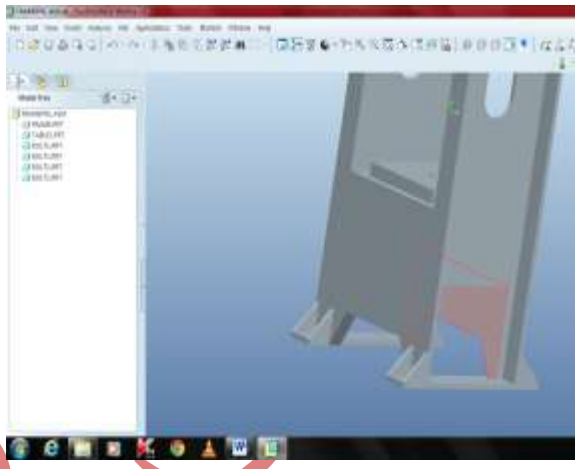

Fig. 9. Extra Support to Frame at Bottom

And further we applied the extra support at the bottom of frame. We observed the Machine deformation at bottom and which we considered in redesigning and we chosen the parameter extra support to the frame. So by applying extra support to frame, it yielded good result for optimization of frame.

6.1 Design Modification Results for static structure analysis

Design Modification 20 mm thickness with support shows maximum total deformation of 0.011056 mm and maximum equivalent stress of 10.554 MPa.

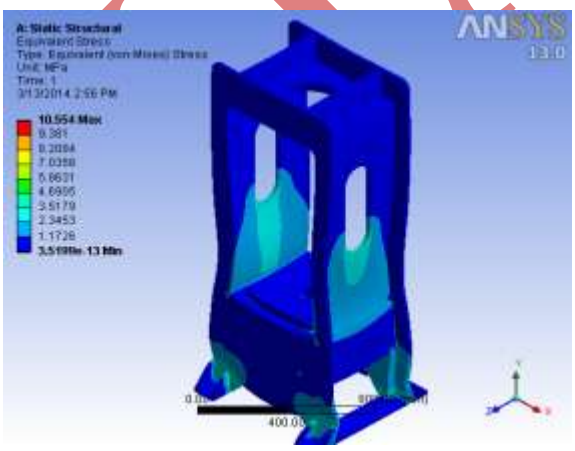

Fig. 10. Equivalent stress

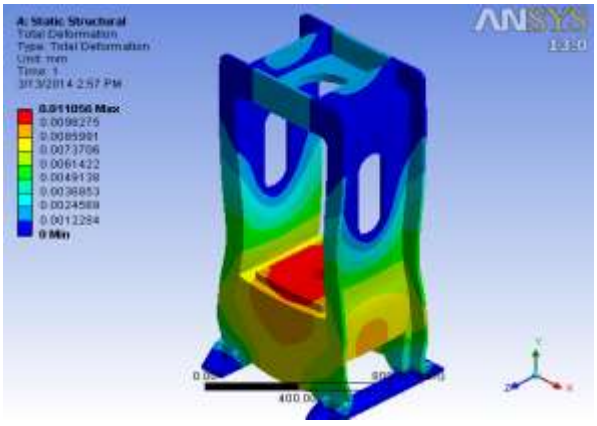

Fig. 11. Total Deformation

VII. OBSERVATIONS

Table 3. Observation Table

Model	Maximum Equivalent Stress at machine frame (MPa)	Maximum Total Deformation of machine frame (mm)
20mm thickness	11.28	0.016
15mm thickness	10.169	0.017
10mm thickness	10.724	0.0204
20mm thickness with support	10.554	0.01105
15mm thickness with support	13.534	0.01178
10mm thickness with support	15.526	0.01265

VIII RESULTS

- Existing Machine frame assembly shows maximum the total deformation of 0.016mm
- Maximum Equivalent stress in original machine frame is 11.28 MPa.
- Modified design of 10mm thickness shows maximum total deformation of 0.0204 mm of machine frame.
- Modified design of 10mm thickness with support shows maximum Equivalent stress of 15.526 MPa of machine frame.

IX CONCLUSIONS

- Maximum von misses stress is well within the acceptable stress value that is 250 MPa therefore Deformation corresponding to it is also permissible.
- The modified frame design shows deformation as well as von misses stress within the acceptable limit of requirement.
- As frame with 20mm thickness with support shows safe result among all modifications so frame model 20mm thickness with support is the optimized & safe model.

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