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Design and Modification of Foremost Element of Hydraulic press Machine

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Abstract:The target of structure optimization is to decrease all of hydraulic press while assuring adequate stiffness. Structural optimization tools and computer simulations have gained the overriding significance in industrial applications as a result of original designs, low weight and cost effective products.

A process of structure optimization for hydraulic press is planned in order to reduce mass while assuring adequate stiffness. Key geometric parameters of plates which have relatively bigger impacts on mass and stiffness are extracted as design variables. In order to research relationship between stiffness, mass and design variables, common batch file is built by CREO and analysis is done in ANSYS. Analysis of movable design.

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INTRODUCTION TO HYDRAULIC PRESSES

Main Cylinder: -

Main cylinder is the most main part of a hydraulic press. Cylinder develops pushing or pulling force required to carry out most wanted operation using under pressure hydraulic fluid.

Blank Holding Cylinder: -

Blank holding cylinders are used in those hydraulic presses in which raw material which is to be pressed must be detained firmly in position, at the time of pressing operation by main cylinder. For example, in deep drawing press, blank is held by block holding cylinder at the time of deep Drawing operation.

Ejector Cylinder: -

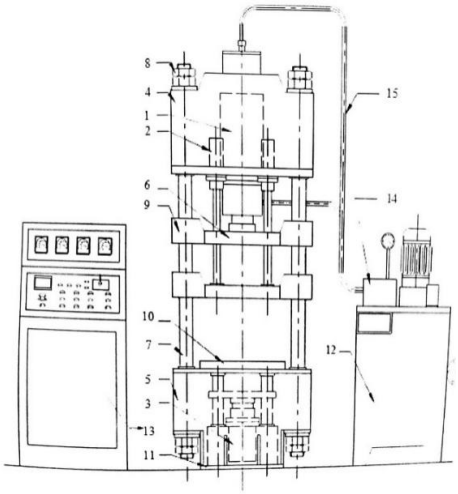
These hydraulic cylinders are usually mounted below the bottom platen, and used to eject component which are already pressed by main cylinder, and requires some force to get removed from die in which they get pressed. For example pressed component stuck in die after cold forming ejected by ejector cylinder.

Top Platen: -

Top platen is a steel fabricated or steel cast structure located upper side of a vertical press, and withstand compressive and bending load developed by hydraulic cylinder.

Bottom Platen: -

Bottom platen is a steel fabricated or steel cast structure located lower side of a vertical hydraulic press, and withstand compressive and bending load developed by hydraulic cylinder. It is also used as a press-table in down-stroke presses.



(1) Main Cylinder
(2) Blank Holding Cylinder
(3) Ejector Cylinder
(4) Top Platen/Top Cylinder
(5) Bottom Platen/Bottom Frame
(6) Moving Platen
(7) Columan Pillars
(8) Nut & Check-Nuts
(9) Side Guides (for column)
(10) Press-Table
(11) Foundation Plate
(12) Power Pack Unit
(13) Control Panel
(14) Manifold Block

(15) Hydraulic Piping

Moving Platen (Pressing Platen|)

Moving platen is also a steel fabricated or cast structure, Located between main hydraulic cylinder and pressing table. It is attached to Ram of cylinder and guided by side columns of press. Moving platen

Column, Nut & Chuck-nut: -

Columns are round Bar or fabricated structure. It binds top and bottom platen together firmly. Round bars are threaded at ends and nuts are provided to hold platen in situation, check- nuts are provided to avoid loosening of main nuts.

Guides : -

Guides are provided to ensure ideal parallel and vibration free movement of moving platen. Guides may be Round, V-Type, or flat, depending upon use and type of columns.

Press Table :-

Press-Table is a thick steel plate either integral part of bottom platen or separately bolted to it. It is rightly machined and provided with T-slots or tapped holes for mounting of dies and fixtures. Moving platen attached to ram travel further and exert force on jobs placed on this press-table to carry out the pressing operation.

Power Pack Units : -

This is most significant part of machine. It pumps oil under control pressure and flow in to the cylinder to impart it preferred speed and to develop desire force. Power pack consists of hydraulic valves, pump, oil tank, cooler, hydraulic accessories, manifold block and piping etc. Hydraulic pump may be driven by electric motor or l.C. engine.

Control Panel: -

It controls overall operation and performance of hydraulic press, by controlling power pack unit. It consists of motor starter, push-button, indicator lamp, current and voltage indicator, contactor, timer etc. Control panel gets it feedback from hydraulic press by means of limit switch, pressure switch, proximity-switch, thermo couple etc.

1 SPECIFICATION OF PRESS MACHINE

PROJECT	200 Ton 4 Column Hydraulic Press	Unit
Application	Metal Forming	
Power source:	hydraulic	
Nominal pressure	2000	KN
Max Working pressure	25	MPa
Effective stroke	600	Mm
Max opening	900	Mm
Return Force	240	KN
Area of working table	1000 X1000	Mm
Speed of slide		
Fast down	150	mm/s
Work	6-18	mm/s
Return	120	mm/s
Ejection	400	KN
Ejection stroke	250	mm
Motor Power	11	KW

Layout of Press Machine

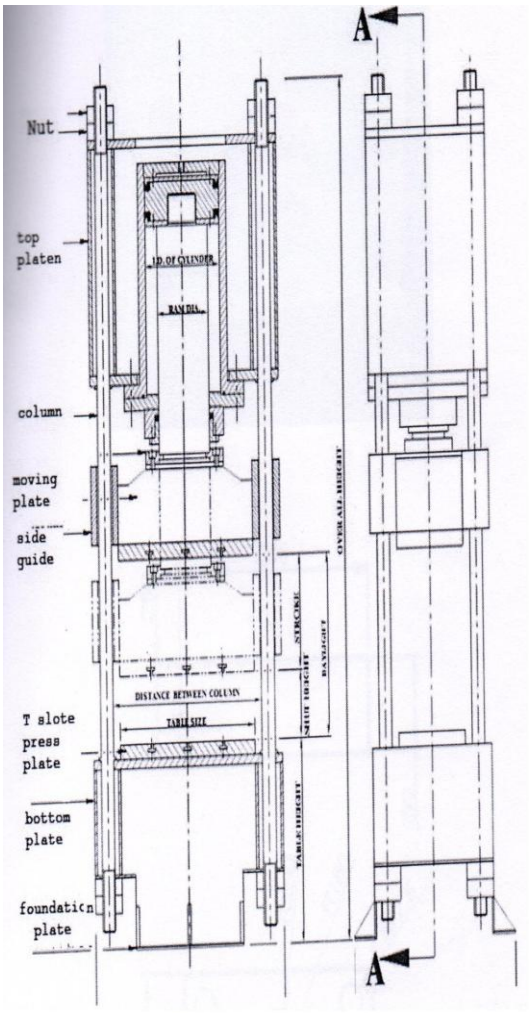
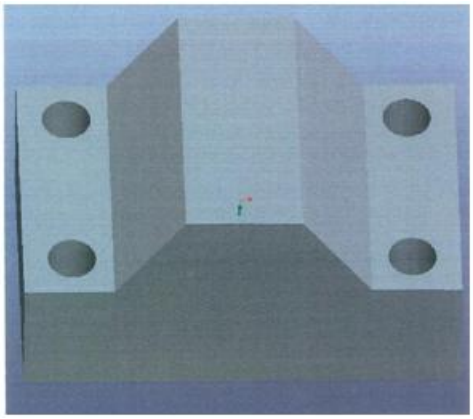


Figure :Layout of Press Machine



In the hydraulicmachinetopplaten ,bottomplaten ,movingplaten,Tslotplaten and column are the major component of machine. Before doing optimization of component is required to do force analysis of compone

Analysis of Movable Platen

Moving platen is also a cast structure. Located between main hydraulic cylinder and pressing table. It is attached to Ram of cylinder and guided by side columns of press. Moving platen exert force on the job placed on press-table.

Drawing view of Movable platen

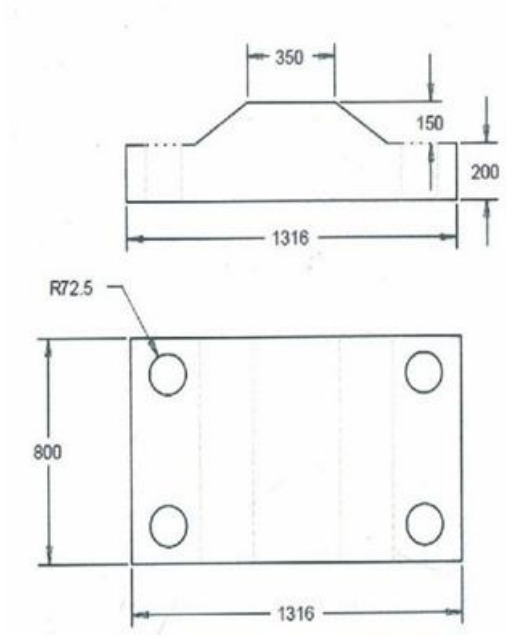


Figure : Drawing View of Movable Platen

3-D view of Movable

As shown in figure 4,10, ram force 3000 KN of cylinder is acting on the movable plate. Plate is sliding at four columns. So force is acting on 320 diameter at top part of movableplaten.Consider this plate is fixed at bottom side.

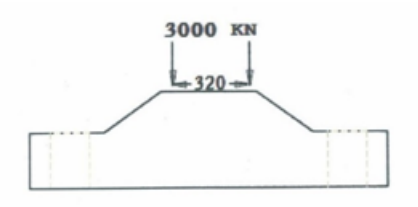


Figure : Force acting On movable platen

FEA of Movable plate

As shown in figure 4.11, Movable plate is fixed at bottom side because die is placed at bottom side of plate.

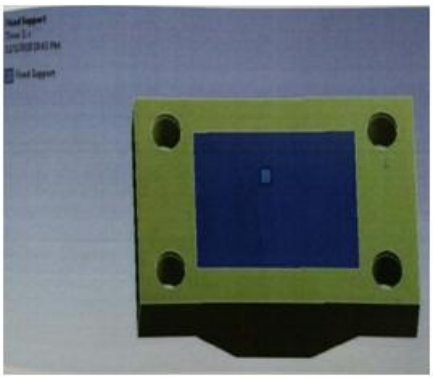


Figure Fixed support of movable platen

Figure under shows cylindrical support at four Holes because movable plate b guided by four columns.

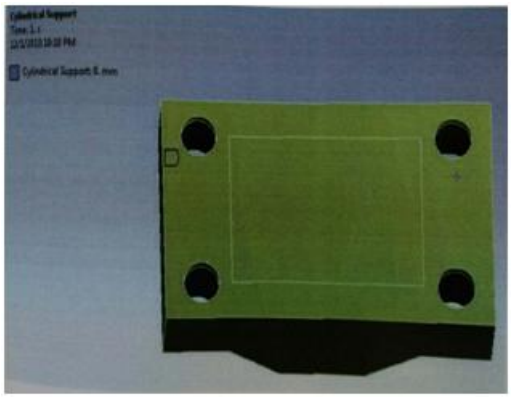


Figure : cylindrical support

Figure shows stress von-Mises stress. Maximum von-Mises stress is induced at the fixed support is approximate 30 Mpa.

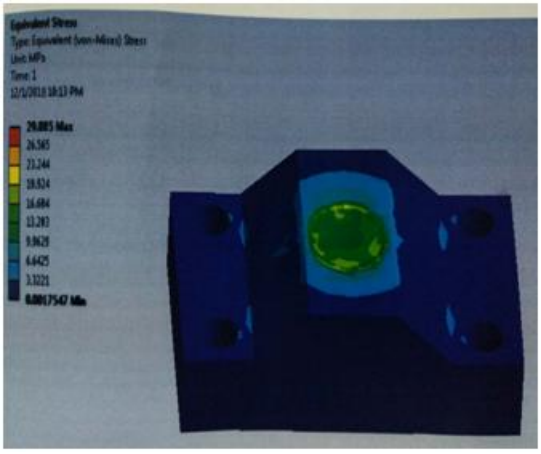


Figure von-Mises stress of movable plate

Total deflection of movable plate

Figure shows total deflection is almost 0.04 mm which is within permissible limit.

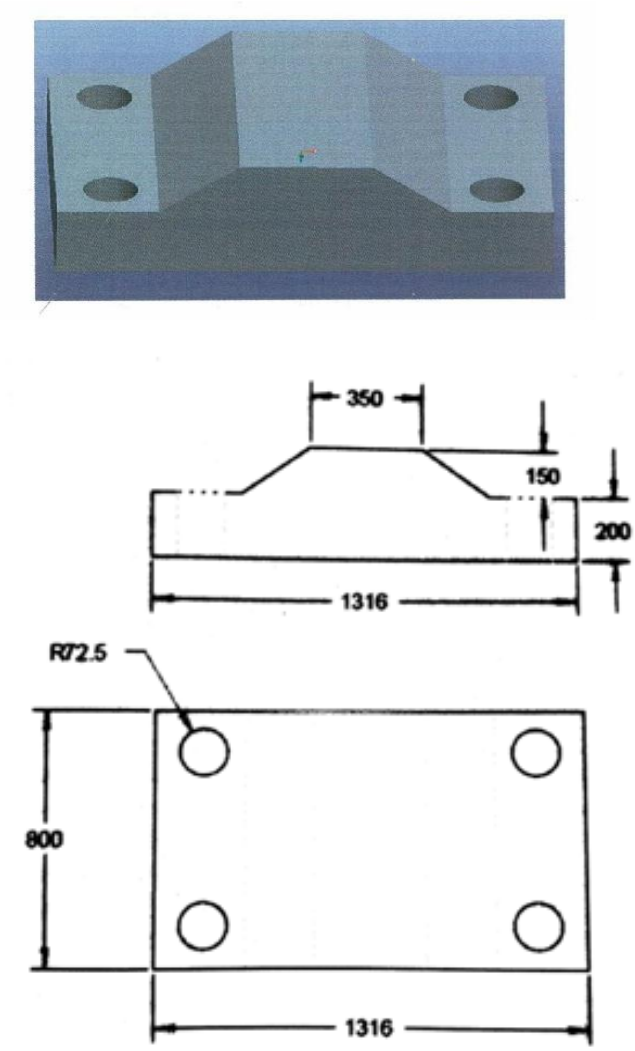
INTRODUCTION OF OPTIMIZATION

An urgent and realistic need in designing structures, e.g., top platen, movable platen, column and bottom platen is to find an optimal design for minimizing weight and deflection , maximizing safety, minimizing the cost of products, etc. The need is constantly enforced in the process of contemporary commodity competition. Thus, structural optimization techniques have been developed rapidly to deal with these issues in recent years.

The simplest idea for optimizing a structure is to modify the sizes of structural members, i.e., use size parameters (plate thicknesses, bar cross-sectional areas, etc.) as design variables in the optimization process. This approach is called the sizing optimization method. Using the sizing optimization method one can improve the design of a structure in order to reduce weight and deflection, etc. But, if a structure was well designed by an experienced designer, then just limited improvement may be obtained by changing sizes.

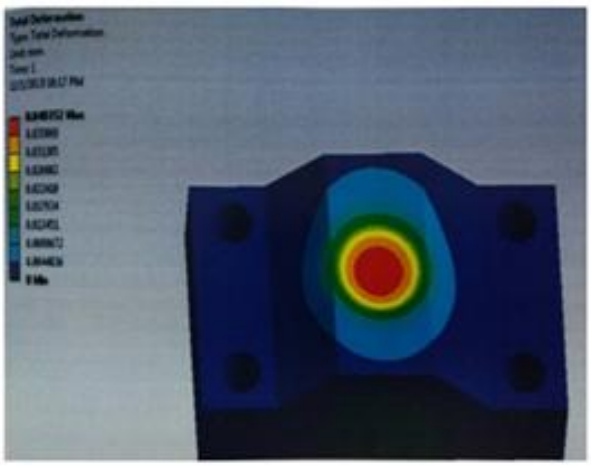
The components of press machine are manufactured by casting method. Casting method is costlier because it need separate die for each component s so the aim is to convert casting component in to the fabricated component by using sizing optimization technique.

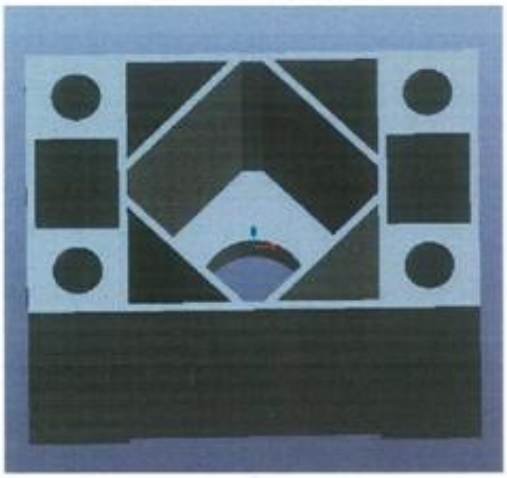
OPTIMIZATION OF MOVABLE PLATEN Initial dimension of Movable platen is shown in figure 5.30 which is fully solidcomponent.

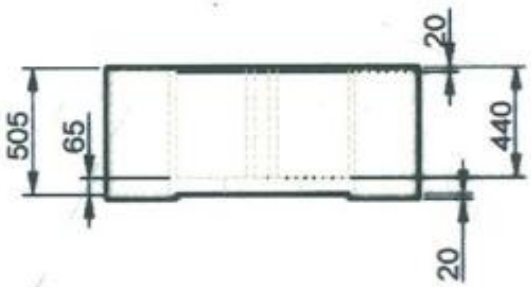


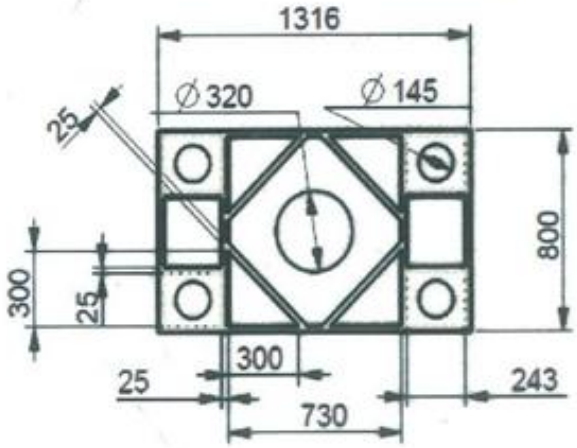
Modified dimension of Movable platen 1

Now modified dimensions for sizing optimization as shown in figure 5.34. Here box Is made of 25 mm of rib plate thickness and 65 mm of bottomplate thickness.





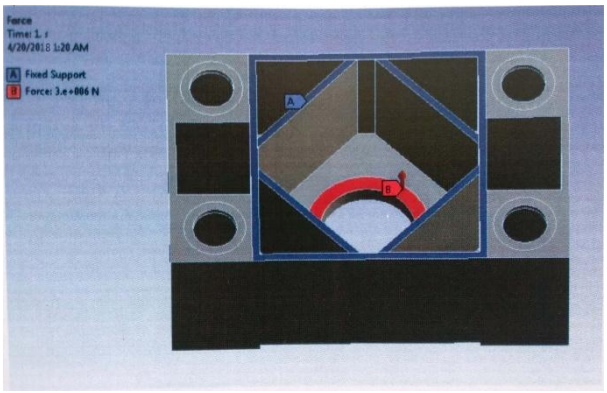




Drawing view of modified Movable platen 1

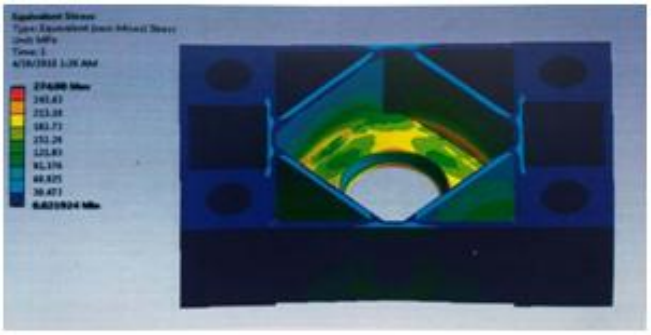
FEA of Movable platen 1

Apply fixed support at rib portion. Also apply 3000000 N of force at top surface as shown in figure 5.3



Fixed support and load application of Movable platen

As shown in figure 5.36 the equivalent stress is approximate 275 Mpa which is more than safe limit and shown in figure 5.37 the total deflection is about 0.97 mm.

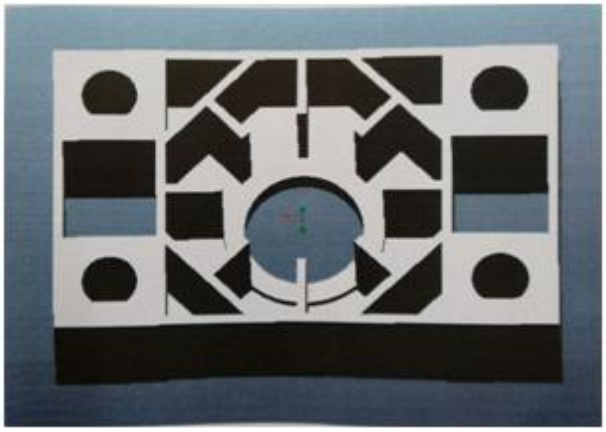


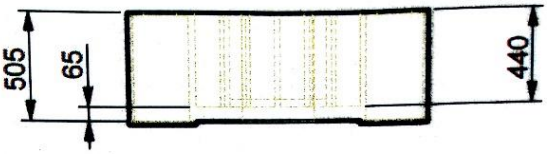
Von-mises stress of Movable platen

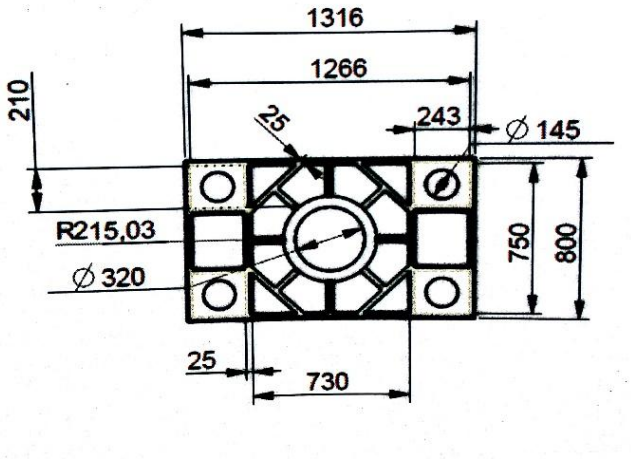
Total deflection of Movable platen I

4 Modified dimension of Movable platen2

Now modified dimensions for sizing optimization as shown in figure 5.38. Here boxIs made of 25 mm of rib plate thickness and 65 mm of bottom plate thickness. Int this rib apply on T shape to get ore strength.



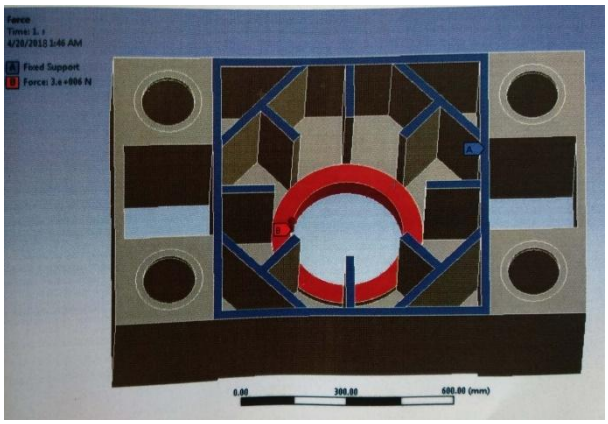




Drawing view of modified Movable platen

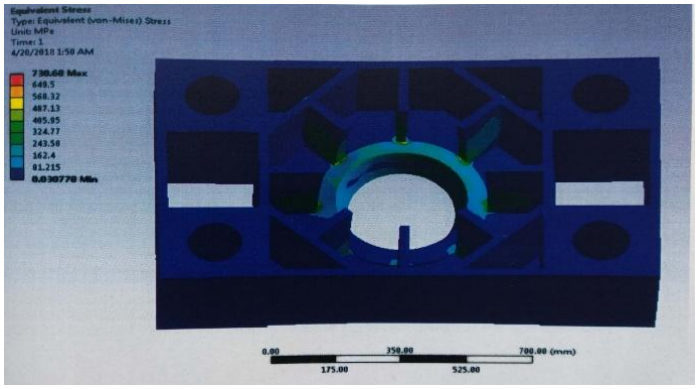
FEA of Movable platen 2

Apply fixed support at rib portion. Also apply 3000000 N of force at top on round surface as shown in figure 5.7

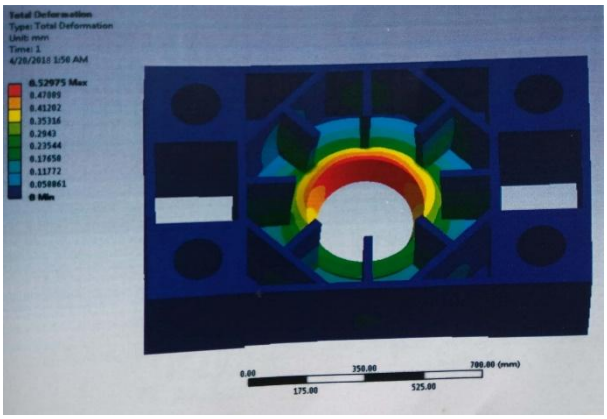


Fixed support and load application of Movable platen 2

As shown in figure 5.8 the equivalent stress is approximate 731 Mpa which is morethan safe limit and shown in figure 5.9 the total deflection is about 0.52 mm.



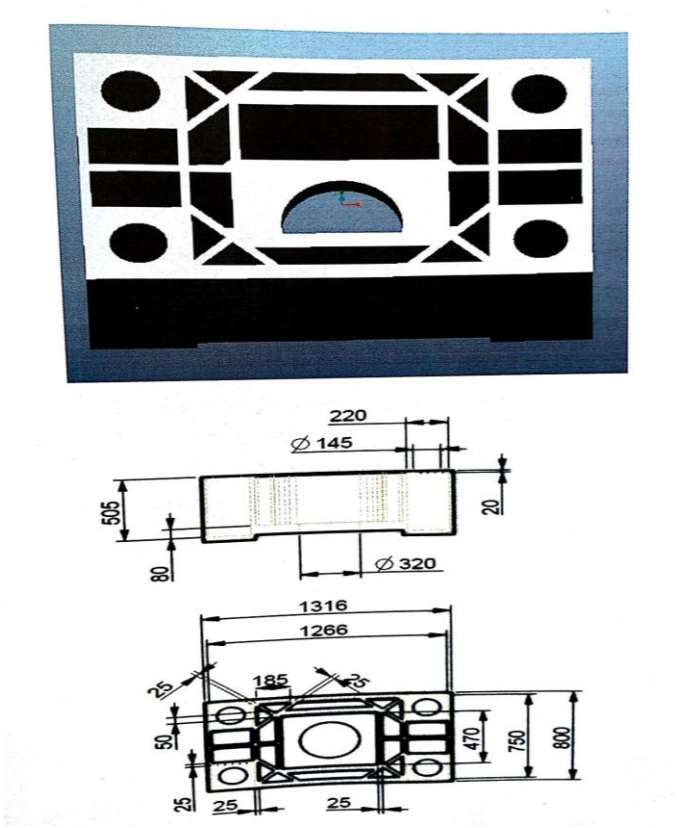
Von-mises stress of Movable platen 2



Total deflection of Movable platen

Modified dimension of Movable platen3

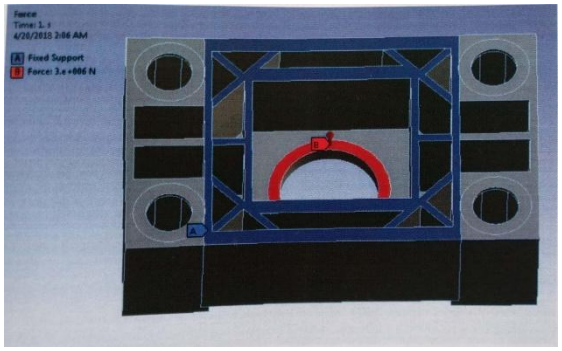
Now modified dimensions for sizing optimization as shown in figure 5.10. Here boxis made of 25 mm of rib plate thickness and 65 mm of bottom plate thickness and puthorizontal plate of 50 mm thickness.



Drawing view of modified Movable platen

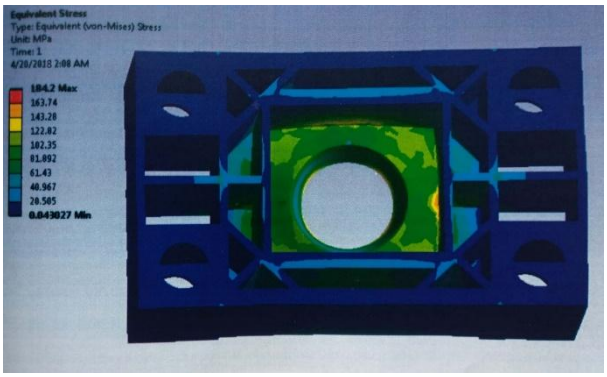
FEA of Movable platen 3

Apply 3000000 N of force at top surface shown in figure 5.11 and apply fixed Support at bottom of plate.

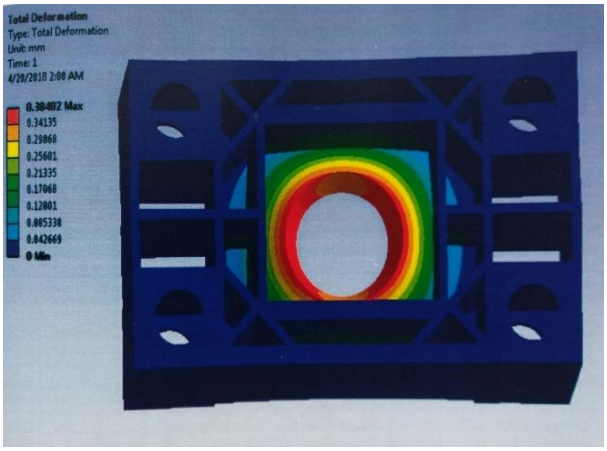


Fixed support and load application of Movable platen 3

As shown in figure 5.11 the equivalent stress is approximate 184 Mpa which is safer i.e. it possible to use of plate as shown in figure 5.12 the total deflection is about 0.38 mm.



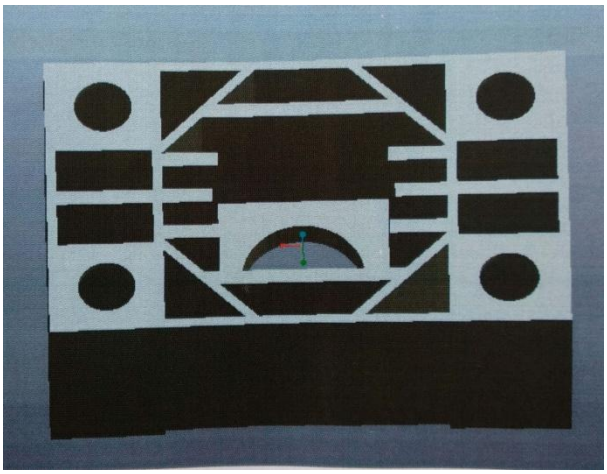
Von-mises stress of Movable platen 3

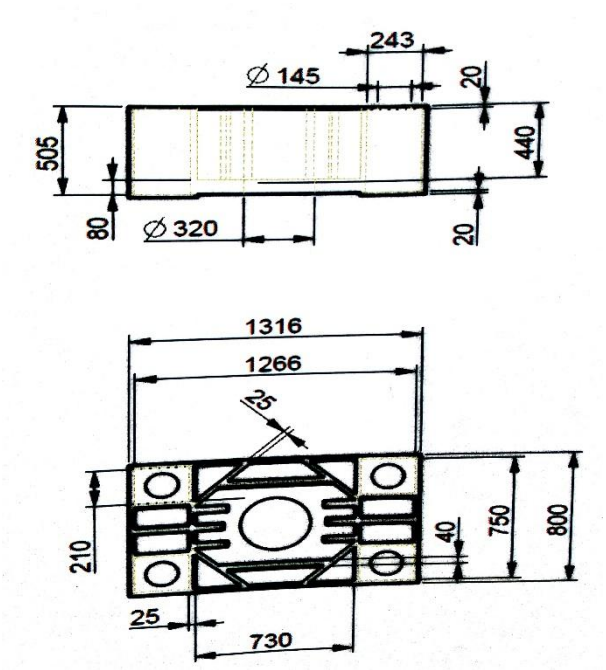


Total deflection of Movable platen 3

Modified dimension of Movable platen4

Now modified dimensions for sizing optimization as shown in figure 5.13. Here box is made of 25 mm of rib plate thickness and 80 mm of bottom plate thickness and ribalso in this of 25 mm thickness.

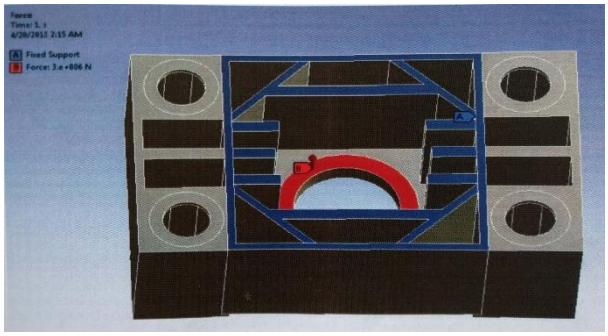




Drawing view of modified Movable platen 4

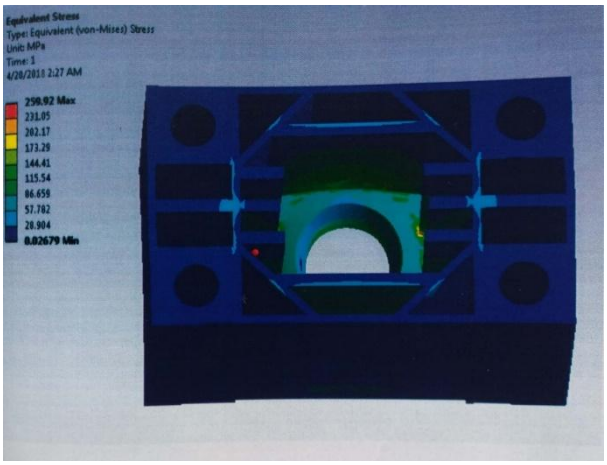
FEA of Movable platen 4

Apply fixed support at rib portion. Also apply 3000000 N of force at top surface as shown in figure 5.14.

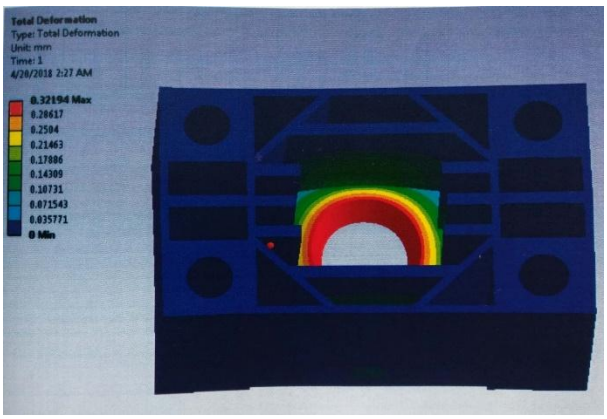


5.14 Fixed support and load application of Movable platen 4

As shown in figure 5.15 the equivalent stress is approximate 260 Mpa which is more than safer limit. As shown in figure 5.16 the total deflection is about 0.32 mm.



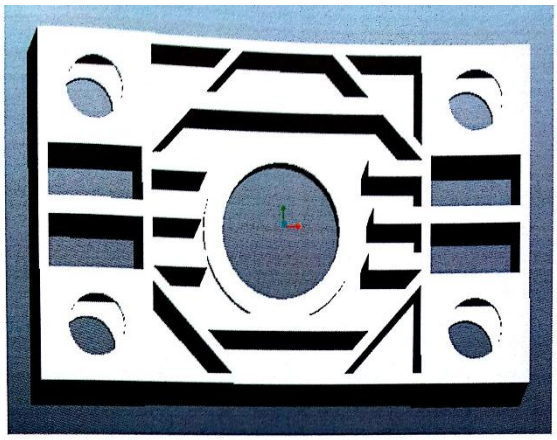
Von-mises stress of Movable platen 4

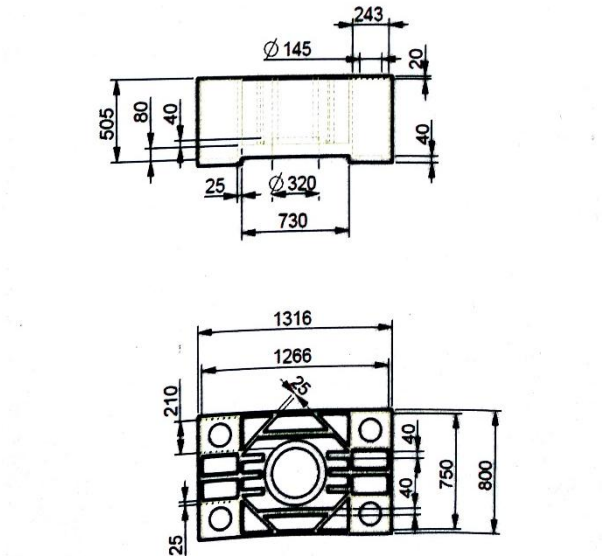


Total deflection of Movable platen 4

Modified dimension of Movable platen5

Now modified dimensions for sizing optimization as shown in figure 5.17. Here box is made of 25 mm of rib plate thickness and 80 mm bottom plate thickness and 40 mm vertical plate thickness.

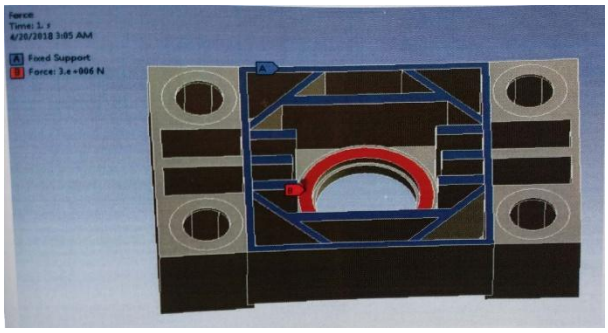




Drawing view of modified Movable platen

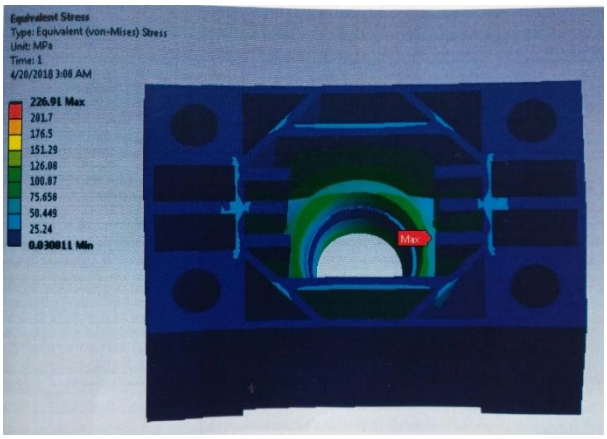
FFA of Movable platen 5

Apply 3000000 N of force at top surface as shown in figure 5fixed support as shown at rib portion.

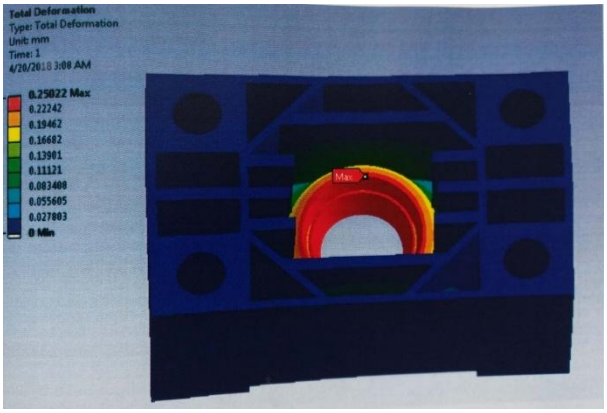


Fixed support and load application of Movable platen 5

As shown in figure 5.19 the equivalent stress is approximate 227 Mpa which is safer limit. Also this is use as a top plate. As shown in figure 5.20 the total deflection is about 0.25 mm.



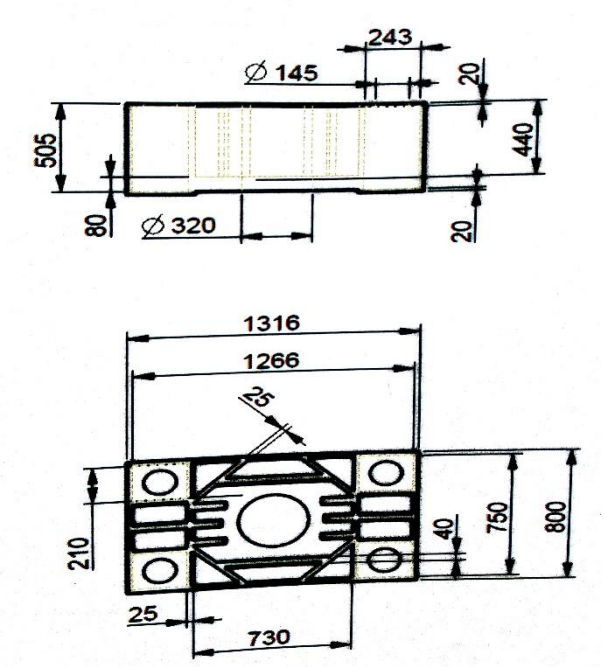
Von-mises stress of Movable platen 5



Total deflection of Movable platen 5

Modified dimension of Movable platen6

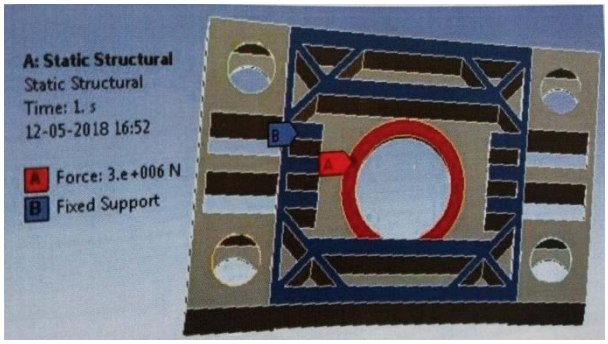
Now modified dimensions for sizing optimization as shown in figure 5.21. Here box is made of 25 mm of rib plate thickness and 80 mm of bottom plate thickness 50 mm of vertical plate thickness.



Drawing view of modified Movable platen

FEA of Movable platen -6

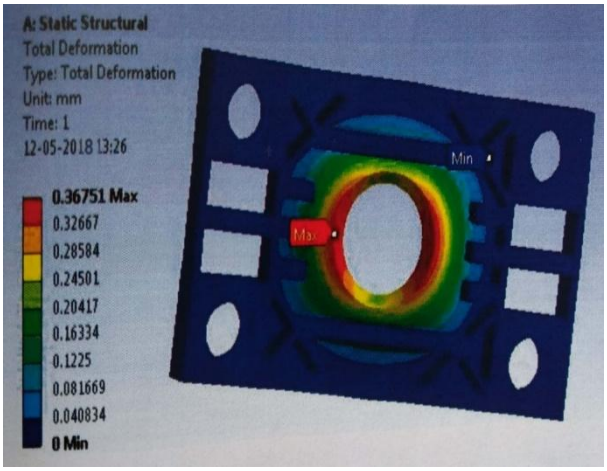
Apply fixed support at rib portion as shown. Also apply 3000000 N of force at top surface as shown in figure 5.22



Fixed support and load application of Movable platen 6

As shown in figure 5.23 the equivalent stress is approximate 265 Mpa which is morethan safer limit. As shown in figure 5.24 the total deflection is about 0.3mm.

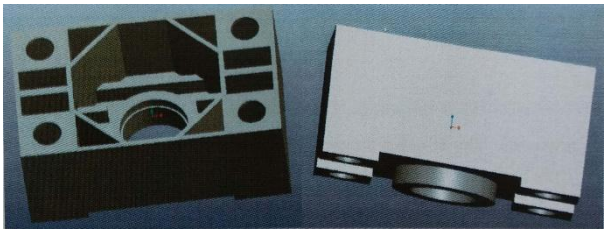
Von-mises stress of Movable platen 6

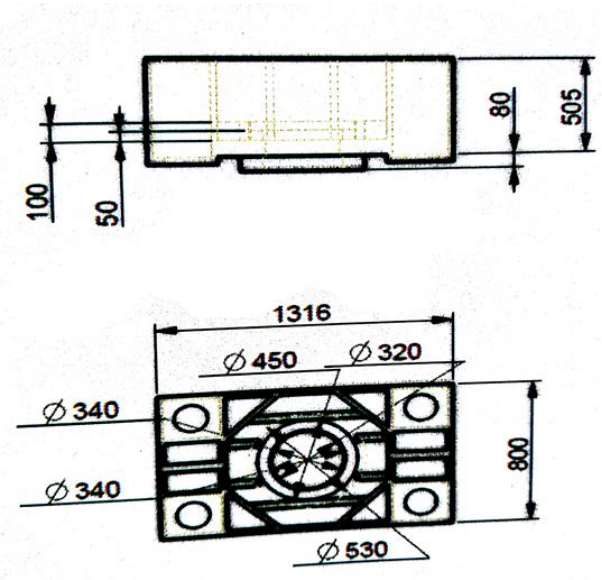


Total deflection of Movable platen 6

Modified dimension of movable platen7

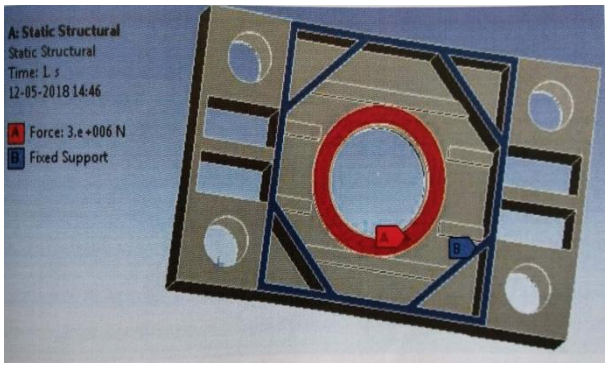
Now modified dimensions for sizing optimization as shown in Figure 5.25. Here boxis made of 25 mm of rib plate thickness and 80 mm of bottom plate thickness.





Drawing view of modified Movable platen 7

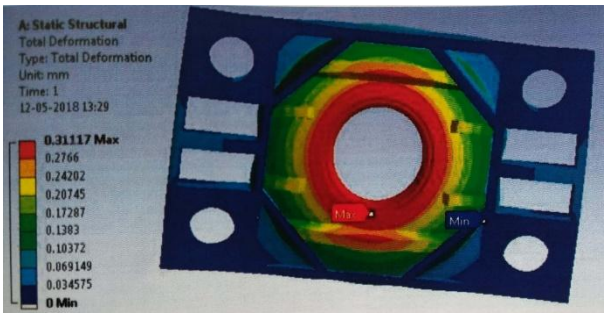
FEA Movable platen 7



Fixed support and load application of Movable platen7

Apply fixed support at rib portion. Also apply 3000000 N of force at top surface As shown in figure 5.26As shown in figure 5.27 the equivalent stress is approximate 191 Mpa which is safeand also use as movable platen. As shown in figure 5.28 thetotal deflection is about0.31mm

Von-mises stress of Movable platen 7



Total deflection of Movable platen 7

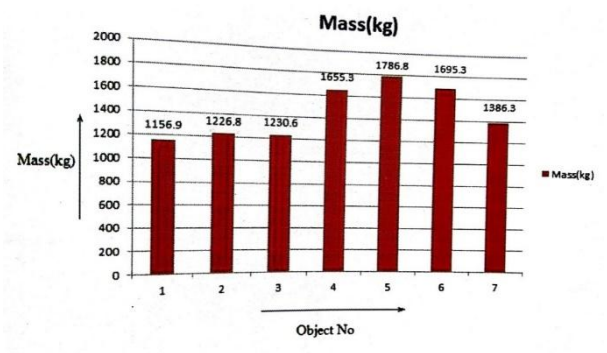
For the sizing optimization of movable platen more than twenty analysis are carriedout by using different orientation and size of rib. Out of twenty analysis only seventypes of analysis of movable platen are mention over here. And finally, movableplaten 3 is selected as best optimizes solution

FINAL RESULT OF ALL MOVABLE

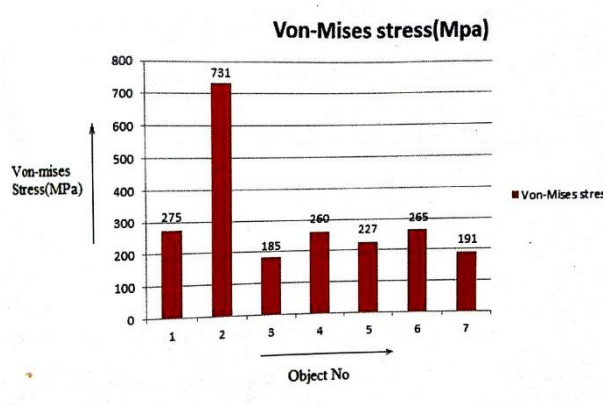
PLATEN

Sr. No.	Mass(kg)	Von-Mises stress (Mpa)	Deflection (mm)
1	1156.9	275	0.97
2	1226.8	731	0.52
3	1230.6	185	0.38
4	1655.3	260	0.32
5	1786.8	227	0.25
6	1695.3	265	0.36
7	1386.3	191	0.31

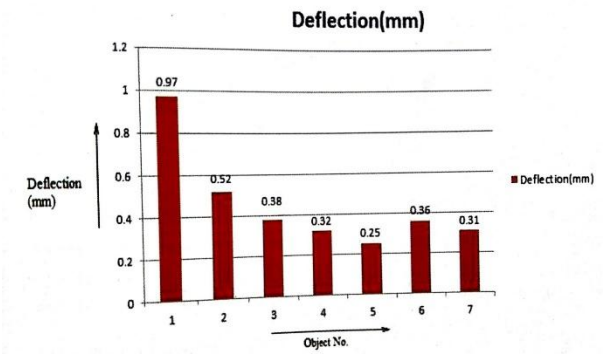
COMPARISON OF MASS IN CHART



COMPARISON OF VON-MISES STRESS IN CHART



COMPARISON OF DEFLECTION IN CHART



COMPARISON OF MOVABLE PLATEN

Sr No	Parameter	Old Movable Platen	Modified Movable Platen 3
1	Von-mises Stress	30 Mpa	184Mpa
2	Total deflection	0.04 mm	0.38 mm
3	Weight	2210kg	1625kg

CALCULATION FORMULA

Von mises stress calculation hydraulics press machine

$$\sigma = \sqrt{\frac{1}{2}(\sigma 1-\sigma 2)^2+(\sigma 2-\sigma 3)^2+(\sigma 3-\sigma 1)^2}$$

Find out $\sigma 1, \sigma 2, \sigma 3$

$\sigma 1$ = X direction

$\sigma 2$ = Y direction

$\sigma 3$ = Z direction

σ = Load / Area

Area = $x(r_2+r_1)(r_2-r_1)$

Weightcalculation hydraulics press machine

- Volume of plate = length * width * hight
- Weight = Volume * Density
- **CONCLUSION**
- The Finite Element Analysis using ANSYS software for the movable plate of hydraulic machine was made for determination of stress and deformations. Good agreement between predicted and measured results was obtained for hydraulic cylinder establishing the finite element method as an accurate analysis tool.
- After sizing optimization of movable plate 586 kg for weight is reduced.

FUTURE WORK

Further topology and shape optimization of leading components like top plate movable plate would be done.

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USER GUIDE

ANSYS 14.0 Help, sizing optimization

PRO-E WILDFIRE 5 HELP, design model