

Comparative Study and Optimization of Hydraulic Press with Different Materials

Kailash Rai^{1*} Mohit Kumar Agrawal² Umesh Gupta³

¹ Assistant Professor, Global Engineering College, Jabalpur, India

² Associate Professor, Vaish College of Engineering, Rohtak, India

³ Associate Professor, Vaish College of Engineering, Rohtak, India

Abstract – Metal forming is a procedure which is finished by deforming metal work pieces to the ideal shape and size utilizing squeezing or pounding activity. Water powered presses are being utilized for forming and squeezing activities with wide scope of limits. Water driven press machine works under ceaseless effect load. In view of this constant burden, ductile and compressive stresses are knowledgeable about different pieces of machine. These stresses cause lasting misshapening in certain pieces of machine. This work depends on enhancement of a 250-ton four column type pressure driven press considering imperatives like plan, weight and cost. The work is centered around generally reasonable and improvement of top plate of the press machine. Top plate holds the water powered chamber and is one of the most basic pieces of the machine. The outcomes are approved by Finite Element Method with legitimate limit conditions. The CAD demonstrating has been done by CATIA and for FEA, ANSYS programming is utilized. Plan Optimization of Hydraulic Press Plate utilizing Finite Element investigation.

Keywords: CAD, Finite Element Analysis, Hydraulic press, Optimization.

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I. INTRODUCTION

Press work is a method of large scale manufacturing including the virus working of metals, generally as slender sheet or strip. Press working is one of the widely utilized methods of manufacturing portions of complicated shapes with meager dividers. Press working procedures utilize huge powers by press instruments for a brief span interim which brings about cutting or melding the sheet metal. Since, press working doesn't include warming of the parts, close resilience's and high surface completion can be acquired on the part. Since presses can deliver segments at genuinely quick rates, the unit cost of work for working the press is genuinely low.

A water driven press creates a lot of power from the use of a limited quantity of power to the little cylinder. A water driven press is a press that utilizations fluid pressure to make a little power applied to a little cylinder produce an enormous power on a bigger cylinder.

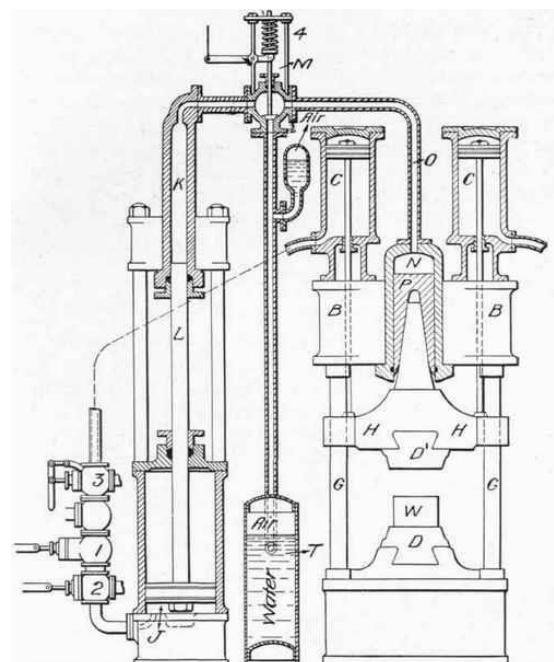


Figure 1 hydraulic press

1.1 Working principle

The working drive of press has developed from Mechanical to Hydraulic and even Pneumatic. With

the headway in innovation, joining of hardware and electrical gadgets with mechanical gadgets has now been conceivable. These new Hydraulic and Pneumatic presses have better limit and are unmistakably progressively dependable and simple to keep up [1]. Basically because of high working limit of these presses, they are universal and favored over mechanical presses. Additionally viability is one of the key factors behind the best possible usefulness of these presses.

Hydraulic press deals with Pascal's law as per this law "In a liquid very still in a shut holder, a pressure change in one section is transmitted without misfortune to each part of the liquid and to the dividers of the compartment".

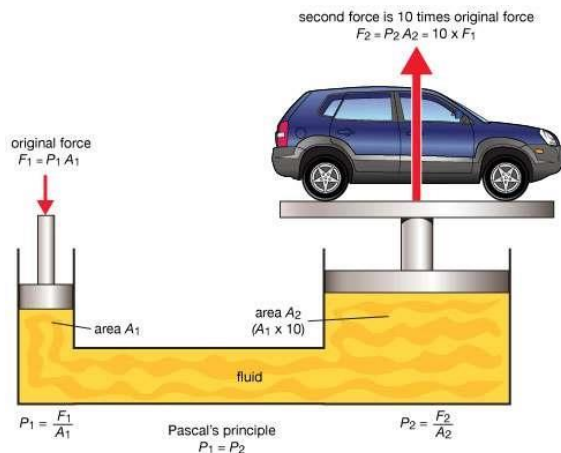


Figure 2 Pascal's law

Hydraulics utilizes incompressible fluids so the applied pressure from one end (little bolt) is equivalent to the ideal pressure on the opposite end (enormous bolt).

The enormous bolt is highlighting a cylinder that is allowed to move, and is now and again associated with a pole. At the point when the power is applied, the cylinder goes up or down.

The equations are:

Pressure 1 = pressure 2

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_2 = \frac{F_1 A_2}{A_1} \dots\dots\dots (1)$$

Pressure is equivalent to the power isolated by the zone on which it acts. As indicated by Pascal's rule, in a hydraulic framework a pressure applied on a cylinder creates an equivalent press another cylinder in the framework. In the event that the subsequent cylinder has a region multiple times that of the primary, the power on the subsequent cylinder is multiple times more prominent, however the pressure is equivalent to

that on the principal cylinder. This impact is exemplified by the hydraulic press.

Where,

F -is the force applied

P -is the pressure transmitted

A -is the cross sectional area

1.2 Types of presses

Presses are categorized into various types

- ▶ Power press
- ▶ Mechanical press
- ▶ Eccentric press
- ▶ Pneumatic press
- ▶ Arbor presses
- ▶ Laminating presses
- ▶ C- frame presses
- ▶ Assembly presses
- ▶ H- frame presses

1.3 Hydraulic press vocabulary

- 1) Cylinder - Cylinder get together comprises of a cylinder, cylinder, smash, pressing, and seals. Cylinder inner diameter across and oil pressure decide the power (tonnage) that a given press can convey.
- 2) Frame - The main structure of the press containing the cylinder(s) and the working surfaces.
- 3) Stroke Control - Stroke length can be set for any separation inside the stroke furthest reaches of the cylinder. Changes include: top of stroke, pre-log jam point, and base of stroke.
- 4) Throat Clearance - The good ways from the vertical centreline of the slam to the casing part behind the bed. This separation decides the biggest breadth piece that can be situated with the part centerline under the focal point of the smash.
- 5) Daylight - The vertical freedom from the highest point of the reinforce to the underside of the smash in its greatest up position. This term now and then is

mistaken for the mechanical press term "shut tallness". Close stature is the freedom over the bed with the smash full down. "Sunlight" portrays the most extreme vertical limit of the press.

- 6) Bolster - A plate or structure mounted on the bed. Hydraulic press manufacturers provide a removable bolster on most models.
- 7) Bed - Flat, stationary machined surface that supports the bolster or dies.
- 8) Dual Palm Button Controls - A typical strategy for activating hydraulic presses. The two catches must be discouraged simultaneously to cut the slam down requiring the administrator to utilize two hands. Control circuits incorporate non-rehash and hostile to secure highlights.
- 9) Work Height - The distance from the floor to the top of the bolster.

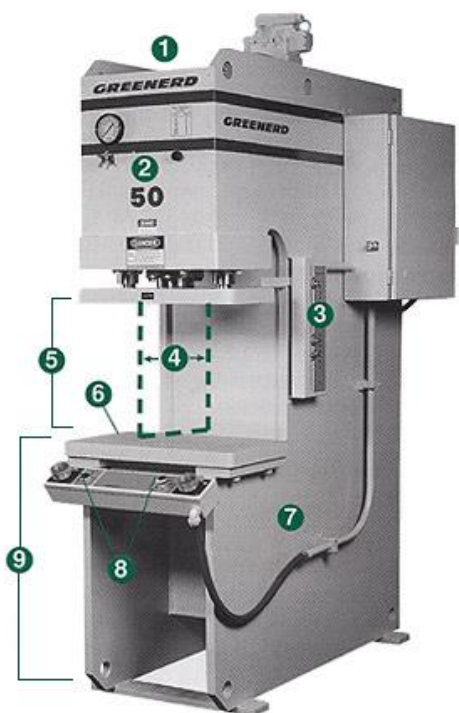


Figure 3 part of hydraulic press

II. LETRATURE REVIEW

1. **Akshay Vaishnav (2016)** clarify the metal framing is a procedure which is finished by disfiguring metal work pieces to the ideal shape and size utilizing squeezing or pounding activity. Hydraulic presses are being utilized for shaping and squeezing activities with wide scope of limits. Hydraulic press machine works under consistent effect load. As a result of this ceaseless burden, malleable and compressive anxieties are knowledgeable about different

pieces of machine. These burdens cause lasting twisting in certain pieces of machine. This work depends on streamlining of a 250-ton four column type hydraulic press considering imperatives like plan, weight and cost. The work is centered around plan and advancement of top plate of the press machine. Top plate holds the hydraulic cylinder and is one of the most basic pieces of the machine. The structure depends on measuring advancement strategy and the outcomes are approved by Finite Element technique with legitimate limit conditions. The CAD displaying has been completed by PTC CREO and for FEA, ANSYS programming is utilized.

2. **Gebremichael Tasew (2014)** depicts Hydraulic twisting machine is a typical apparatus in the machine shop that is utilized to twist a bit of plate. Twisting machines in various kind found in little and enormous scale enterprises which have restriction on using cylinder power, that whole machine loses cylinder power with no capacity. The principle target of this venture is to create one hydraulic cylinder driven 5mm thickness tempered steel plate bowing machine with minimal effort and light weight. For lessening the weight and the expense of the machine utilize just a single hydraulic cylinder and amplify the hydraulic cylinder bowing burden by the assistance of right edge switch. In this paper create an inventive thought for taking care of loss of cylinder power. Accordingly the machine become low in cost and light in weight basic activity and high aggressive attractive machine. The primary part of the machine is switch, lower pass on, punch, edge, table and twofold acting hydraulic cylinder.

3. **G. C. Mekalke (2017)** centers around mechanization of a press device for creation of sheet metal segments. The activity of press device comprises of grouping of tasks. This arrangement of activities needed to computerize for increment in efficiency. For that reason, PLC is utilized from Bosch Rexroth, Germany made. With the assistance of DTMF module it was made conceivable to work the press by utilizing versatile calling from remote areas. In this article, the press along these lines structured filled for the need with 73% decrease underway time, with upgraded quality and aided in empowering large scale manufacturing by disposing of a few procedures, for example, stamping, cutting finished with the assistance of a shaper, molding, etc.

4. **N. A. Anjum (2017)** clarify distinctive mechanical presses used to distort or press the material through passes on to change over into valuable item by applying various conditions like temperature, pressure, speed of slam and so on. These material twisting methods used to deliver completed items as well as to build the quality of the material by presenting serious plastic distortion. Equivalent channel precise squeezing (ECAP) is a system used to expand the quality of materials by presenting extreme plastic misshapening through grains refinement. The ECAP bite the dust comprising of two channels meeting at 90 degree was structured and made to perform precise expulsion. The heap was determined through scientific displaying. A hydraulic press furnished with traditional temperature control heater, sensor based point of confinement switches, pressure controlled system and with variable speed control was planned, created and fabricated at UET Taxila. The material utilized for the manufacture reasons for existing is mellow steel. The significant structuring parameters included stroke length, greatest burden, pressure, cylinder bore, fixing instrument and volume stream pace of working liquid.
5. **Bhushan V.Golechha, (2017)** additionally said about virus stepping process. The machine utilized for press working is known as press. This Project work manages the plan, Finite component examination and auxiliary enhancement of 10 Ton Pneumatic Press Machine. The point is to lessen the weight and cost of the Pneumatic press without diminishing the nature of the yield. Utilizing the most ideal assets in configuration can influence decline in the weight and cost of the press machine. One method for doing it is the upgrading the volume of material used for building the total structure of machine .Here we have consider a mechanical application venture comprising of mass minimization of a Pneumatic press. For examination Purpose ANSYS Software has been utilized.
6. **Gourav Suresh Kanhe (2017)** Twisting of plates and sheets are widely used to deliver the parts, for example, ribs, points and so on. In twisting activity a level sheet metal is framed into a bended by the applying the bowing pressure. By the assistance of kick the bucket the punch sheet gets twist plastically without change in thickness. This venture is established on the desire of Daulat Industries, Nagpur. The point of the undertaking is to structure a sheet twisting machine which is equipped for bowing 5mm thick hardened steel sheets of 8ft wide and 4ft length in size. In this examination we will build up a CAD model of sheet bowing machine and advancement of

machine utilizing FEA. This paper is significantly founded on the writing survey, and furthermore contains necessities to configuration, look into procedure of the task. Of the present examination is the approval and use of a CFD-based philosophy to measure the hydrodynamic unpleasantness delivered by any surface, including gooey oil coatings and befouled surfaces.

III. PROPOSED METHODOLOGY

The hydraulic press is read for two arrangements. In first setup utilizing base Plate plan and in second arrangement is top plate structure. The CATIA gives the accompanying ways to deal with model age: Creating a strong model inside CATIA. The ANSYS programming is utilized for the basic investigation of the base plate and top plate. The conditions to relentless is comprehended when static or dynamic burden is applied on any piece of hydraulic press, at that point along basic pressure, compressive pressure, shear pressure and furthermore created bowing pressure.

In light of the hypothetical counts and plan, we can demonstrate and mimic the framework into different programming bundles for approval. The hypothetical counts depend on customary machine configuration utilizing a lot of conditions. This gives the fundamental thought of the plan of the item.

The following methodology steps are,

1. Collecting information and data related to the hydraulic press plate.
2. A fully parametric model of the hydraulic press plate is generated using catia v5
3. Model obtained in Step 2 is analysed using ANSYS 15.
4. Manual calculations are done.
5. Finally, we compare the results obtained from ANSYS

The hypothetical counts and plan, we can display and reenact the framework into different programming bundles for approval. The hypothetical figurings depend on traditional machine configuration utilizing a lot of conditions. This gives the fundamental thought of the structure of the item.

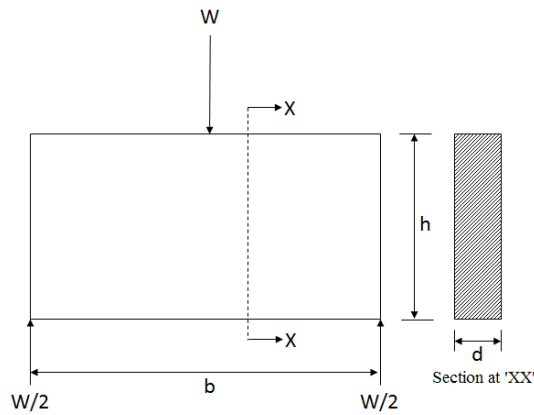


Figure 4 Load case

When a static or dynamic load acts on any part of hydraulic press, then along with simple, tensile, compressive, shear stress, it also develops bending stress.

Consider a beam subjected to a bending moment M ,

The bending equation is given by,

$$\frac{M}{I} = \frac{\sigma b}{Y} \quad \text{..... (1)}$$

Where,

M = Bending moment at the given section

σ_b = Bending stress

I = Moment of inertia of the cross-section about the neutral axis.

y = Distance from the neutral surface to the extreme fiber

Bending moment is given by,

$$M = \frac{W \times b}{4} \quad \text{..... (2)}$$

$$M = \frac{2500000 \times 860}{4} = 5.375e8 \text{ N-mm}$$

Moment of inertia of the cross-section about the neutral axis

Moment of inertia of the cross-section about the neutral axis,

$$I = \frac{db^3}{12} \quad \text{..... (3)}$$

$$I = \frac{60 \times (558.6)^3}{12} = 8071e8 \text{ mm}^4$$

$$Y = \frac{b}{2} \quad \text{..... (4)}$$

$$Y = \frac{558.6}{2} = 279.3 \text{ mm}$$

Putting these values in Eq. (1)

$$\sigma_b = \frac{M \times Y}{I} \quad \text{..... (5)}$$

$$\sigma_b = \frac{5.375e8 \times 279.3}{8.91e8}$$

$$\sigma_b = 172.09 \text{ N/mm}^2$$

The ultimate tensile strength of mild steel is,

$$\sigma_{Uts} = 460 \text{ MPa},$$

Considering Factor of Safety = 2.5 for the given structure.

According to Maximum Principal stress theory

$$\sigma_{allowable} = \frac{\sigma_{uts}}{FOS} \quad \text{..... (6)}$$

$$\sigma_{allowable} = \frac{460}{2.5}$$

$$\sigma_{allowable} = 184 \text{ Mpa}$$

$$\text{So, } \sigma_b = \sigma_{allowable}$$

3.1 Material property

Mild steel is use to design analysis of hydraulic plate due to height strength property.

Table 1. Material properties

Material	Mild Steel	Aluminum	Gray Cast iron	Stainless Steel
Density(Kg/m^3)	7850	2770	7200	7750
Young's modules (GPa)	210	71	110	193
Poison ration	0.3	0.33	0.28	0.31

3.2 Building the model

The CATIA gives the accompanying way to deal with model age: Creating a strong model inside CATIA. Each structure begins with the customary estimations by applying different basics of plan. The top plate is exposed to unadulterated twisting worry during the activity. Along these lines, structure contemplations are basic for plates exposed to twisting pressure. The components of base plate, utilized for top plate.

Table 2. Geometrical dimensions

Constraint	Value
Breath (b)	860 mm
Height (h)	558.6 mm
Depth (d)	60 mm
Maximum applied load	250 ton

Here the bending stress following up on the base plate is not exactly the suitable stress of the plate material. Consequently, we can presume that the given structure of base plate for configuration top plate is protected.

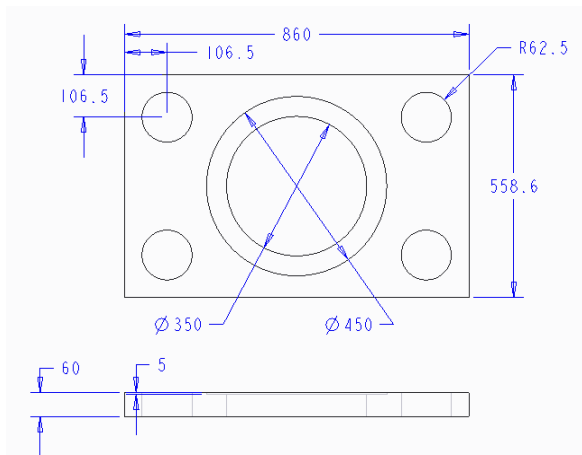


Figure 5 Base plate sketch

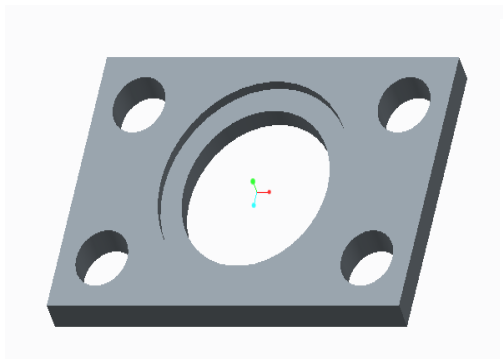


Figure 6 Base plate CAD model

3.3 Top plate design

The top plate has been planned by putting rib structure onto the base plate. The plan of rib structure depends on examinations and practice. In present work, the structure is done to withstand the greatest distortion of 0.3 mm/m. This worth is taken according to the prerequisite of industry and from different benchmark information. Here, three unique plans of top plate are exhibited utilizing estimating improvement technique.

Here, the greatest limit of the machine is 250-tonns. In this way, the structure of all parts will be founded on most extreme applied burden. The hydraulic cylinder is mounted onto the top plate so it will convey that measure of power at the time. The structure of top plate is based to a few material is chosen.

In all plan emphasess the shape and size of rib structure is changed by structure prerequisites.

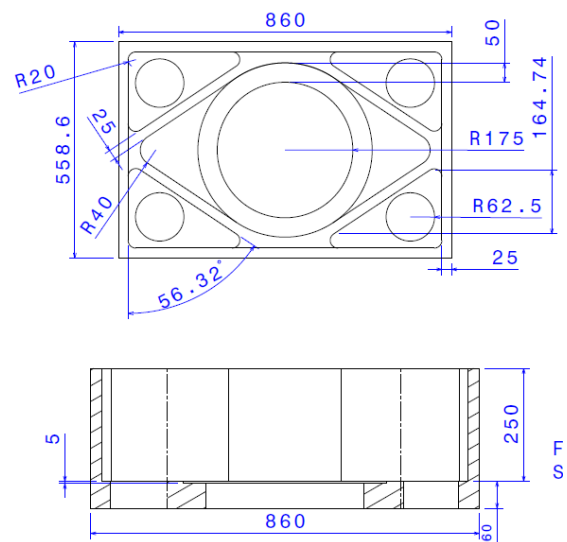


Figure 7 Hydraulic Plate sketch

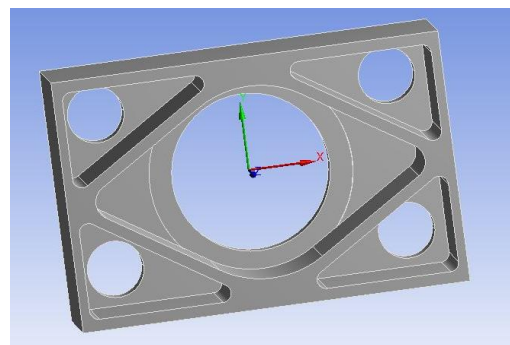


Figure 8 Hydraulic Plate CAD model

3.4 Meshing

ANSYS Meshing incorporates keen, universally useful, computerized superior sort of item. It conveys the most appropriate work for definite, capable Multi material science courses of action. A work suitable for a specific examination can be

made with a lone mouse click for all parts in a model. For the ace customer who needs to change on it give full powers over the options used to make the work are open. The vitality of parallel planning is thusly used to diminish the time you need to hang tight for work age.

1) Meshing

The mesh created in this work is shown in figure No.9. The total Node is generated 6534 & Total No. of Elements is 3356 for Hydraulic plate.

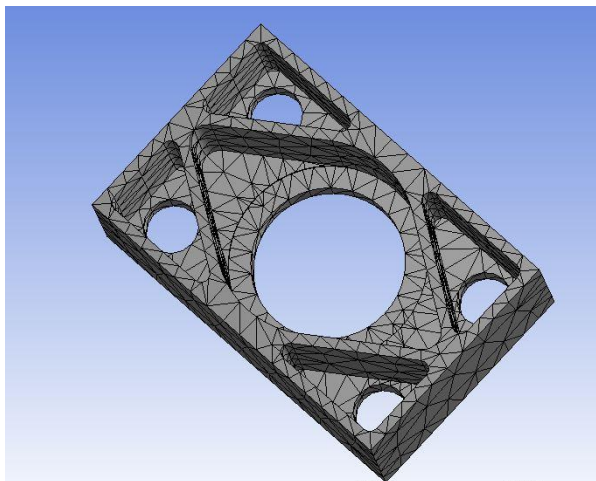


Figure 9 meshing

3.5 Boundary condition

1) Fixed support

After applying meshing use fixed support command, the fixed support show in figure 10.

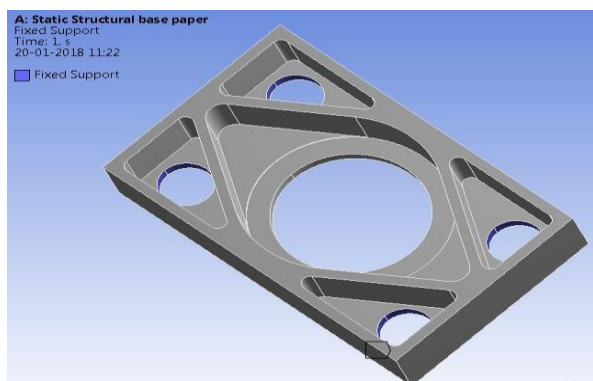


Figure 10 fixed support

2) Force

Maximum load apply on top plate is 250 ton in middle of plate and all four hole are fix.

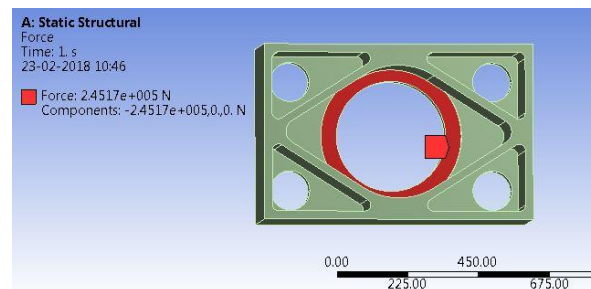


Figure 11 Applying force

IV. RESULTS

For arrangement of the above issue explanation the Finite Element Analysis strategy is utilized. This technique is favored in light of the fact that it permits an a lot nearer topological likeness between the model and the machine. With improvement of cutting edge PCs and FEA programming bundles, it is presently simple to execute this technique extensively.

For this situation, a 250-ton of burden is applied at the center of the plate, where the cylinder is refreshed. Every one of the four openings at the corner will stay fixed, in light of the fact that it is upheld by columns in genuine machine. For FEA reenactment, ANSYS programming bundle is utilized.

Here, essentially two outcomes are acquired in ANSYS, all out twisting and most extreme von-Mises stress. In light of these outcomes, the ideal structure is chosen. These outcomes can be acquired by applying legitimate limit conditions in ANSYS Workbench.

The re-enactment is performed by taking 250 mm of rib stature for every one of the Four Material. For all plans, the outcomes are acquired as follows

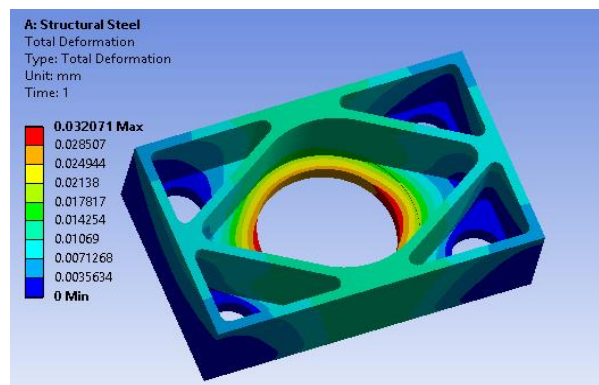


Figure 12 Deformation in Structure steel Material

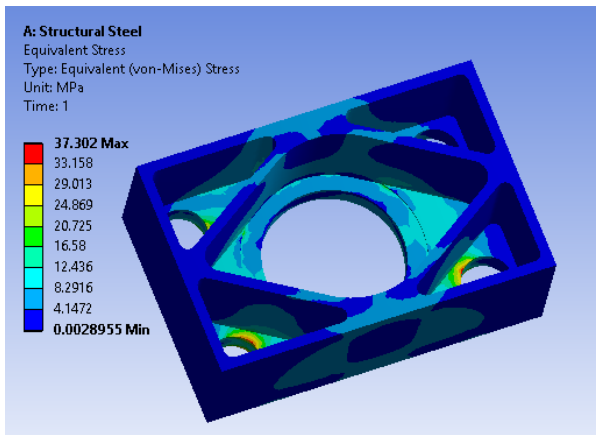


Figure 13 Stress in Structure steel Material

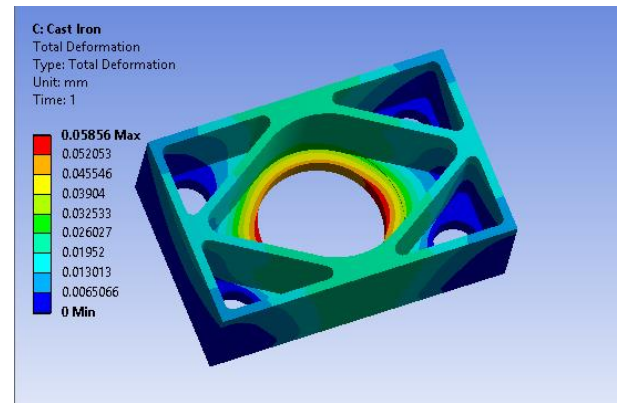


Figure 16 Deformation in cast iron Material

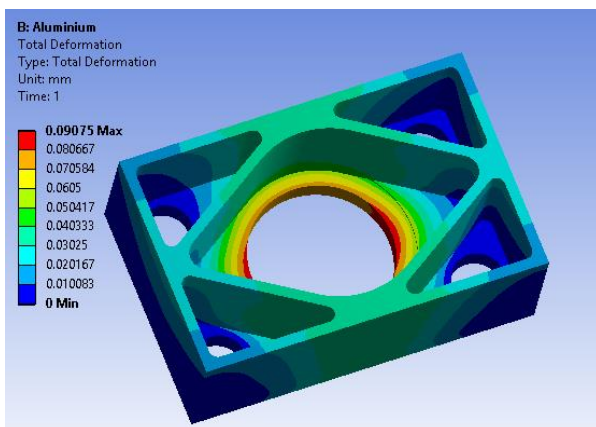


Figure 14 Deformation in Aluminium Material

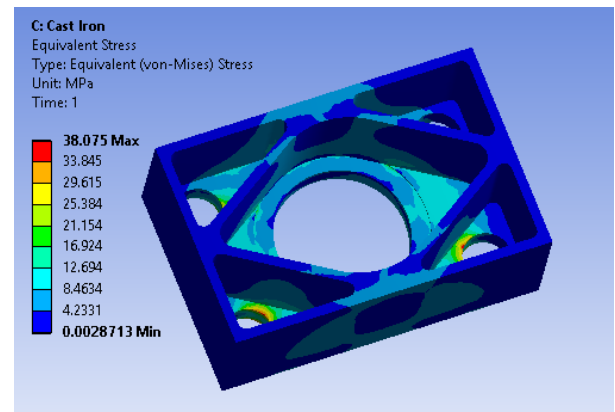


Figure 17 Stress in cast iron Material

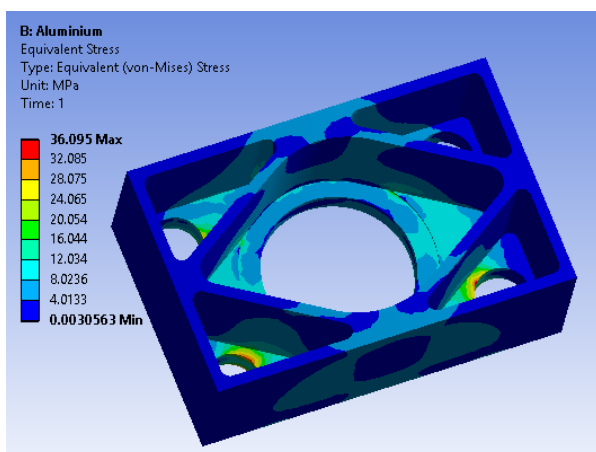


Figure 15 Stress in Aluminium Material

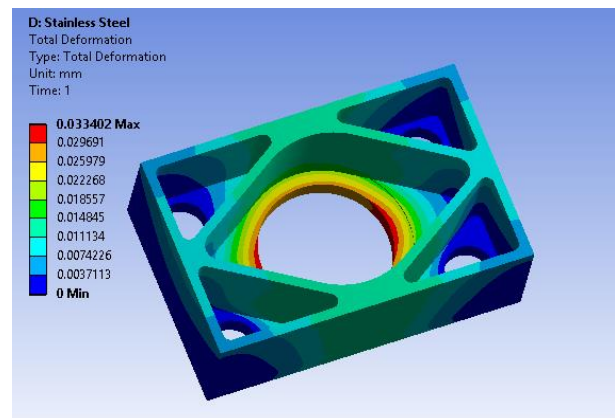


Figure 18 Deformation in Stainless Steel Material

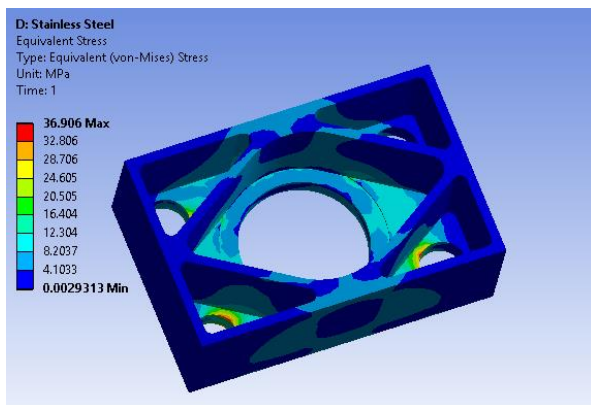
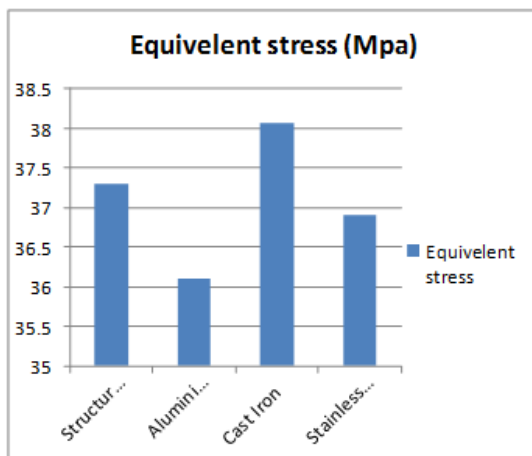


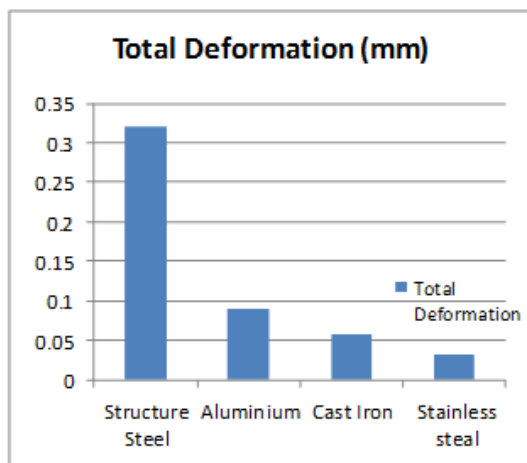
Figure 19 stress in Stainless Steel Material

Table 3 ANSYS Result

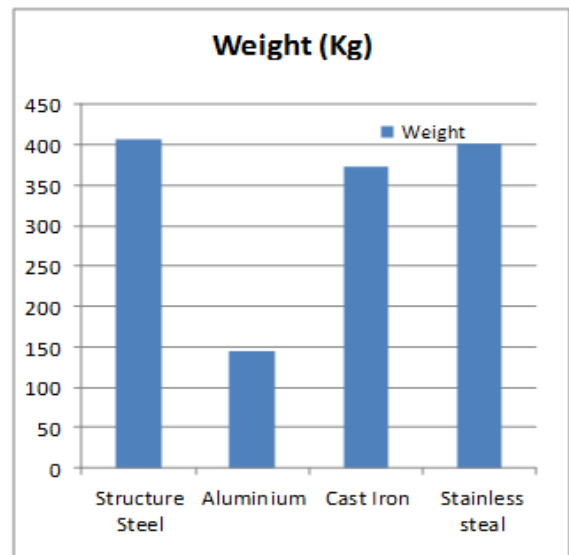
Plate Material	Max. Stress (von-Mises) MPa	Deformation (mm)	Weight (Kg)
Structure Steel	37.302	0.320	407.58
Aluminium	36.095	0.090	143.82
Cast Iron	38.075	0.058	373.83
Stainless steel	36.906	0.033	402.38



Graph 1 Comparing equivalent stresses



Graph 2 Comparing Total deformations



Graph 3 Comparing Weight

V. CONCLUSION

From material advancement technique, the plan is altered by gradual material methodology. For 250 mm of rib stature, the FEA results were acquired. It is discovered that Aluminum is ideal plan and has disfigurement under wanted qualities. Additionally the greatest von-Mises stress for that plan is not exactly a definitive pliable stress of the material, so this structure is protected.

The above outcome can be show that Aluminum material given greatest identical stress is under a definitive stress and complete disfigurement is less at that point structure steel, and weight of plate is additionally less in other plan. The most extreme equal stress is Aluminum is 36.095 MPa, all out disfigurement of is 0.090 and weight of 143.82.

Along these lines, from the above outcomes, it is presumed that aluminum can be proposed for assembling. It has a lot of lower weight contrasted with different plans, so material expense can be spared. Likewise it satisfies all the plan limitations. It very well may be fabricated by throwing strategy.

VI. FUTURE SCOPES

Hydraulic plate are used in all industries, the new design is more durable, light weight and also cost effective.

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Corresponding Author**Kailash Rai***Assistant Professor, Global Engineering College,
Jabalpur, India