Design and Analysis of Hydraulic Press using ANSYS

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Abstract

The Seperation of cotton seed from cotton is very important for the further use of the cotton for varies industries. The process of separating the cotton seed from cotton is called ginning and converting the cotton lint into bail is know as pressing. The machine which is used for the pressing operation is known as hydraulic press as it is powered by hydraulic liquids. The frame structure has to withstand the the forces generated while pressing operation and it is essential to calculate mechanical properties like total deformation and stress developed on the machinery. Hence, here the work has been being carried out on 10 TON press machine .Design is done in CATIA V5 and analysis is carried out in ANSYS workbench 14.5.
Keywords: Hydraulic Press, H Frame, Catia v5, ANSYS

I. INTRODUCTION

The final step in processing cotton at the gin is bale packaging. The baling system consists of battery condenser, lint slide, lint feeder, tramper, bale press and bale type mechanism. And some suppliments like conveyers, weighers and wrappers can be used for the purpose. The bale press machine consists of frame, rams hydraulic operated and power system.[10]

Bale presses are primarily described by the density of bale that they can produce. Density, other descriptions include up-packing, down-packing, fixed boxes, and door less. The hydraulic press is a hydraulic force applied to lift or apply compressive forces. The hydraulic equivalent of a mechanical lever is named after the inventor, Joseph Bramah of to get the England. He studied the motion of fluids and put this knowledge into development of hydraulic press. [1]The hydraulic press depends on the pascal's principle, the pressure in the system is constant. At one end of the system is a piston with the small cross sectional area driven by the a levr to increase the force driven in small diameter tubing a fluid such as oil is displaced wen piston is pushed inward. The small piston, for a given distance of movement, displaces a smaller amount of volume than the large piston, which is proportional to the ratios of areas of heads of the piston. Therefore the small piston must be moved a large distance to get the large piston move significantly. The distance the large piston will move is the distance that small piston is moved divided by the ratio of the areas of the heads of the piston. This is how the energy is converted in the form of work.[1] The transmission, generation and amplification are achieved through fluid under pressure. The liquid can show the properties of solid and produces a very positive and rigid medium of transmission and amplification of power. Very low inertia effect can be felt.[3]

II. OBJECTIVE

The main objective of the work carried out is to find the stress distribution and total deformation. Here we consider two case studies one is with plate and one is without plate.10 ton load hydraulic press machine is considered for the project. The plate that is at the middle will experience maximum stress. These conditions will be analyzed by finite element method and the design is optimized.

Table - 1
Properties of Materials Used

Material used	*Structural steel*
Young's modulus	*200 GPa*
Poison's ratio	*0.3*
Share modulus	*75 GPa*
Ultimate tensile strength	*400 to 550 MPa*

III. METHODOLOGY

- The study has been carried out of existing 10 ton hydraulic press in geometric modeling software.
- To carry out the analysis of the press in finite element software
- To rectify the problems and errors in the present model.
- Designing the critical parts of the press to optimize the cost without effecting the efficiency the machine.
- Reviewing the model and redesigning the same with geometric modeling software.

- To carry out the analysis in ANSYS to check the deformation and stress developed in the machine.
- To manufacture the 10 ton press precisely.

IV. FLOW CHART INDICATING STAGE OF THE METHODOLOGY

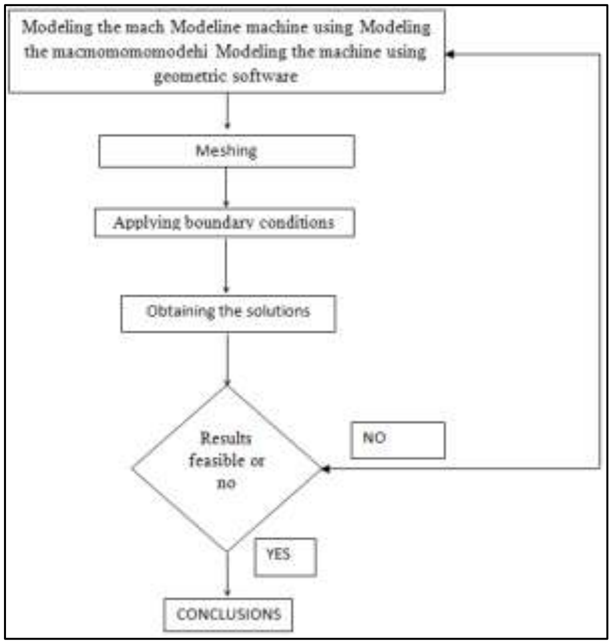

Fig. 1: Flow Chart Indicating Stage of the Methodology

V. DRAFTING OF THE 10 TON HYDRAULIC PRESS

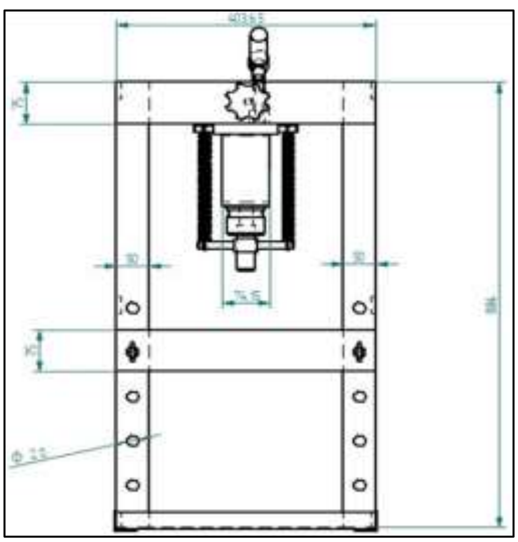

Fig. 2: Front view of H-frame hydraulic press

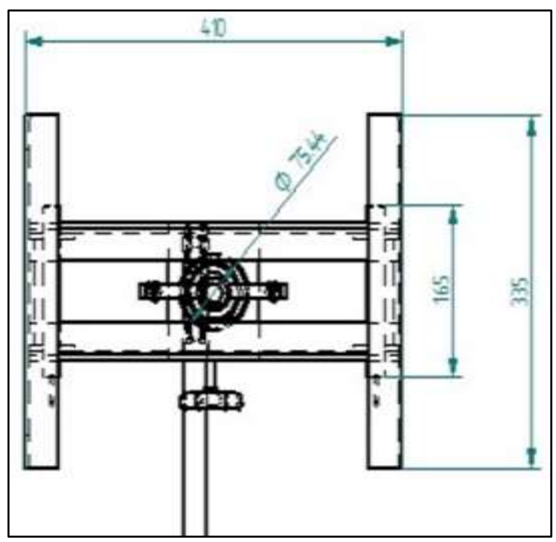

Fig. 3: Top view of H-frame hydraulic press

VI. ANALYSIS

A. *Boundary Conditions Applied*

The study is made with the ANSYS workbench software, which offers a wide range of advanced type analysis. Here, in this study a comparison is made by changing the thickness of the blade and taking two case studies.

- Fixed type constraint applied to base of the column, which imposes 0 values to the translations and rotation to selected entities.
- A pressure of 10 ton is applied on the frame.

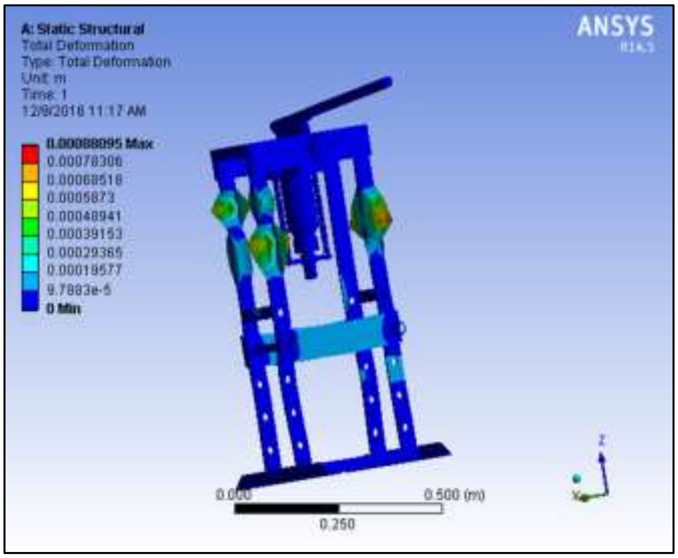

Fig. 4: Total deformation for 2 ton applied pressure

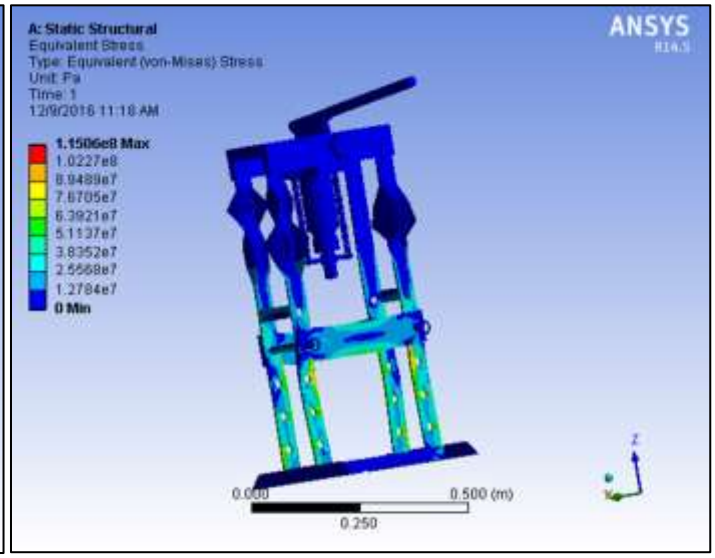

Fig. 5: Von-mises stress for 2 ton applied pressure

Table – 2
Stress generated in frame at varies loads in the frame with plate

Load (Ton)	*Von-mises stress (Mpa)*
1	*25.1*
2	*50.2*
3	*75.3*
4	*100.4*
5	*125.5*

Table - 3
Stress generated in frame at varies loads in the frame without plate

Load (Ton)	*Von-mises stress (Mpa)*
1	*61.1*
2	*115*
3	*183.3*
4	*244.4*
5	*305.6*

VII. COST ANALYSIS AND CALCULATION OF COST REDUCTION

The mass for optimized design of material is calculated as below
Volume of column without hole consideration

$$V_1 = L*B*H \quad (1)$$

$= 50*12*804 = 482400 mm^3$

$$V_2 = \pi*102*12 \quad (2)$$

$= 3769.91 mm^3$
For 5 holes in column
$V_2 = 18849.55 mm^3$
Volume of column with hole

Table – 4
Cost Analysis

Sl. No	*Component*	*Original Weight(Kg)*	*Optimized Weight(Kg)*	*Reduction(Kg)*
1	*Vertical column*	*47*	*14.46*	*32.5*
2	*Plate*	*2.26*	*2.26*	*Nil*

$$V_c = V_1 - V_2 \quad (3)$$

$= 463550.45 mm^3$
We know that density is mass/volume

$$m = 7801*463550.44*(10^{-3})^3 = 3.61 kg$$

For four column its mass is m=14.46kg
Percentage of weight reduction = (Weight reduction / Original design weight)* 100 = (32.54 / 49.26) *100 = 66.05%
Percentage of weight reduction we found up to 66.05%

VIII. CALCULATION OF COST REDUCTION FOR H-FRAME TYPE HYDRAULIC PRESS

A. *Total cost before optimization*

Material cost per kg = Rs.60
Fabrication cost per kg = Rs.40
Material cost for 49.26 kg = Rs.2955.6
Fabrication cost for 49.26 kg = Rs.1970.4
Total = Rs.4925.4

B. *Total cost after optimization*

Material cost per kg = Rs.60
Fabrication cost per kg = Rs.40
Material cost for 16.72 kg = Rs.1003.2
Fabrication cost for 16.72 kg = Rs.668.8
Total = Rs.1672

C. *Cost reduction of hydraulic press*

Percentage of material cost reduction
= (4925.4 – 1672) / 4925.4 * 100 = 66.058%
Percentage of cost reduction 66.058%

IX. CONCLUSIONS

The maximum stress induced in the machine frame with plate is 251Mpa at 10 Ton and the maximum deformation for this load is 2.5mm.The maximum stress induced which is almost same as yield stress of the mild steel(250Mpa).Factor of safety is 0.99.Design is not safe for the particular load applied. The maximum stress induced in the machine frame without plate is 611.3Mpa.The maximum deformation for this load is 3.3mm.The maximum stress induced in the machine is (611.3Mpa) which is almost same as yield stress of the mild steel.(250Mpa).Factor of safety is 0.409.Design is not safe for the particular load applied.

According results obtained the design frame can withstand the maximum stress upto 3 Ton without plate. The hydraulic frame will fail if its more than 3 ton as the factor of safety will be less than 2. From table no.3 we can see that the stress developed is 115Mpa and deformation is 0.8mm.The factory of safety for the 2 ton load will be 2.17 and hence the desgn is said to be safe. The project carried over has been compared to the old hydraulic press. The total cost of hydraulic press before optimization is Rs.4925 and after optimization the cost the hydraulic press frame is reduce to Rs.1672. Percentage of cost reduction 66.058%.

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