Design and Analysis of C Frame for Hydraulic Press

[1]Gaurav P. Kakkad
[1] Assistant Professor
[1]Mechanical Engineering Department
[1]V.V.P. Engineering College, Gujarat, India

Abstract: The objective is to design c frame model for assembly operation known as hydraulic press machine. Using the concept of reverse engineering, by knowing the dimensions of the piston cylinder assembly and the product to be assembled, the C-frame has been designed keeping in mind the design specification, stress distribution, deflection. C frame is comprised of a base plate and a reciprocating piston fitted on top plate which exerts force upon component through special tool mounted on the piston. The initial modeling of the C- frame was carried out in Unigraphics software. The 3D model of the C frame is analyzed in static condition to find the stresses and deflections in the structure. By optimization, material utilized for building the structure has been reduced to decrease the volume of material utilized taking into consideration the resources available in market. Here we consider an industrial application project consisting of mass minimization of C-frame type assembly press. Solid Thinking has been used for this analysis, aim is to reduce the cost of the system, stresses, material and deflection without compromising on the quality of the output.

Keywords: analysis of c frame; modelling; reduction in material weight; optimisation; analysis in static condition

I. INTRODUCTION

In fluid transmission system power transmission takes place through fluid medium. This is convenient and very efficient. Present conventional power transmission systems are being replaced and being changed over to fluid power based systems as they are more efficient. Power losses are comparatively less. In this system the mechanical energy supplied to the system by prime mover is converted to pressure energy by pump and stored in fluid. This pressurized fluid is transmitted to different parts of system through pipes or tubes .The mechanical energy supplied is recovered back in a convenient form and required operations are carried out depending on the application. Pascal's law is the basis of all hydraulic systems. It states that "Pressure applied to a confined fluid at any point is transmitted undiminished throughout the fluid in all directions and acts up on every part of the confining vessel at right angles to its interior surface and equally up on equal areas." Modern machine tools make use of such systems in majority applications. Hydraulic press is one such application

II Literature reviews:

One of the earliest applications of hydrostatic system is the hydraulic press. A hydraulic press is a machine using a hydraulic cylinder to generate a compressive force. Frames, column and cylinder are the main components of the hydraulic press. A hydraulic press consists of a pump which provides the energy to the fluid, the fluid is the medium of power transmission through hydraulic pipes, control devices and the hydraulic motor which converts the hydraulic energy into useful work at the point of load requirement. The main advantages of hydraulic presses are, they compatible to changes in input pressure, the force and pressure can accurately be controlled, and the entire magnitude of the force is available during the entire working stroke of the ram travel. Hydraulic presses can be easily designed for large values of forces with minimum moving parts. **Applications** In its modern form hydraulic press is well adapted to press work of

- Forging presses
- Stamping machines
- Rolling presses
- Riveting machines
- Blanking and punching machines

Structure:
Depending on application different frame structures are available while performing the operation 1. 'H' TYPE OR fabricated 4-column type 2. 'C' type 3. 4-pillars (Hard chrome pillars type)

Source of the Project:
The dimensions and specifications of a 1 ton capacity are provided by the company. The hydraulic jack is device which is used in our project as hydraulic cylinder, commonly used in marine applications for lifting and lowering of journal bearing. **C- frame presses**

These presses have a 'C' like shape, which is specifically designed to maximize the floor space for the workers in order to move around easily at the workplace. Unlike other presses that have multi-processes, the **C- frame presses** only include a single press application. Its application includes straightening, drawing and mostly includes assembling work. C-frame presses come in a variety of weights. The C-frame presses are also available with extra features such as wheel stands and pressure gauges.

III Methodology

The dimensions and specifications for hydraulic jack are provided by manufacturer. Using the specifications and dimensions a C frame assembly press is modeled in NX and then the model is tested in Solid Thinking for stress analysis. The static load condition is considered for analysis. As per the specifications the load is applied on the frame and the deflections and stresses acting on the structure are calculated. The design of the frame is further modified to reduce material required without compromising the design specifications. The objective is to make use of minimum available resources, to maximize profit without affecting the quality, durability, operation of the system.

Design Specifications Outer diameter of the Ram - 55mm Inner diameter of the Ram - 43mm
Stroke Length - 260mm
Weight of hydraulic press-18kg

Design Check for Top Plate
OVERALL SPECIFICATIONS OF BASEP LATE Material : MS (EN24)
Dimensions : (200 x150 x10)

INPUT DATA
Outer diameter of piston rod = 55mm
Inner diameter of piston rod = 43mm

$fc_{all} = S_{UT}$

Material selection: Designation	Tensile Strength N/mm^2	Yield Strength N/mm^2
EN24	800	680

Direct Tensile or Compressive stress due to an axial load:-
fc_{act} = W A (1) fc_{act} = 18x9.81 250x150
$fc_{act} = 4.7088x10^{-3}$ N/mm^2
$fc_{all} = S_{UT}$ Factor of Safety (2) = 800 4
$fc_{all} = 200$ N/mm^2
As $fc_{act} < fc_{all}$ $4.7088x10^{-3} < 200$ Top plate safe in compression.
Hence material selected is Mild Steel.

DESIGN CHECK FOR BASE PLATE :
OVERALL SPECIFICATIONS OF BASEP LATE
Material : MS (C40)
Dimensions : (350 x350 x10)

MATERIAL DESIGNATION	TENSILE STRENGTH N/mm2	YEILD STRENGTH N/mm2
C40	600	380

Direct Tensile or Compressive stress due to an axial load :-
fc_{act} = W A (1)
fc_{act} = 3016 350x350
$fc_{act} = 0.02462$ N/mm^2
Factor of Safety
= 600 4 $fc_{all} = 150$ N/mm^2
As $fc_{act} < fc_{all}$ $0.02462 < 150$

As $fc_{act} < fc_{all}$; Base plate is safe in compression.

Component List COMPONENTS	DIMENSIONS	
1	C Channel	100*50*5
2	Ribs	150*100*8
3	Top Plate	250*150*10
4	Base Plate 1	350*350*10
5	Base Plate 2	290*290*10
6	Fixture Plate	50*20*20
8	Fixed Plates	140*120*10
9	Ears	25*25*10

Hydraulic Circuit

The counter balance valve is used. This is a pressure control valve. Counterbalance or back-pressure is used to keep the vertically mounted hydraulic cylinder in upward position while pump is idling. It prevents the vertical cylinder from descending due to weight of its load.

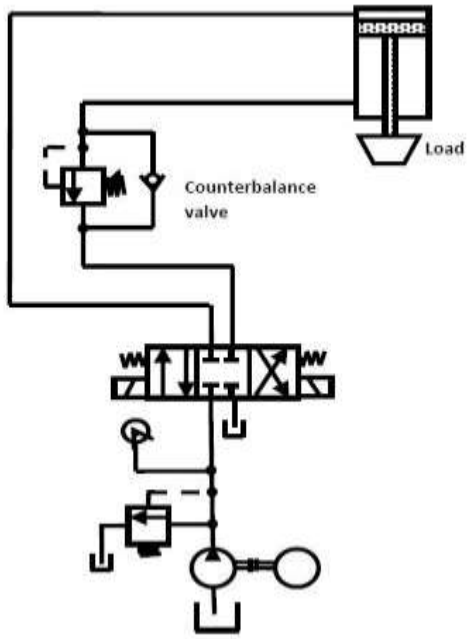

Fig.1 Hydraulic circuit with Counterbalance valve

The final modeling was done taking into consideration the design, functional and material specifications. The availability of standard sizes of components in market was taken into consideration and accordingly changes in design were made without compromising the quality of the product. The C frame is designed to provide maximum efficiency at time of operation without causing interference and hindrance to workers. The top plate is fixed at the base of supporting C channels to avoid the dead stroke of the piston as the piston cylinder arrangement is mounted on the top plate. This ensures that entire stroke of piston is utilized. The stress analysis on C frame was done in Solid Thinking software.

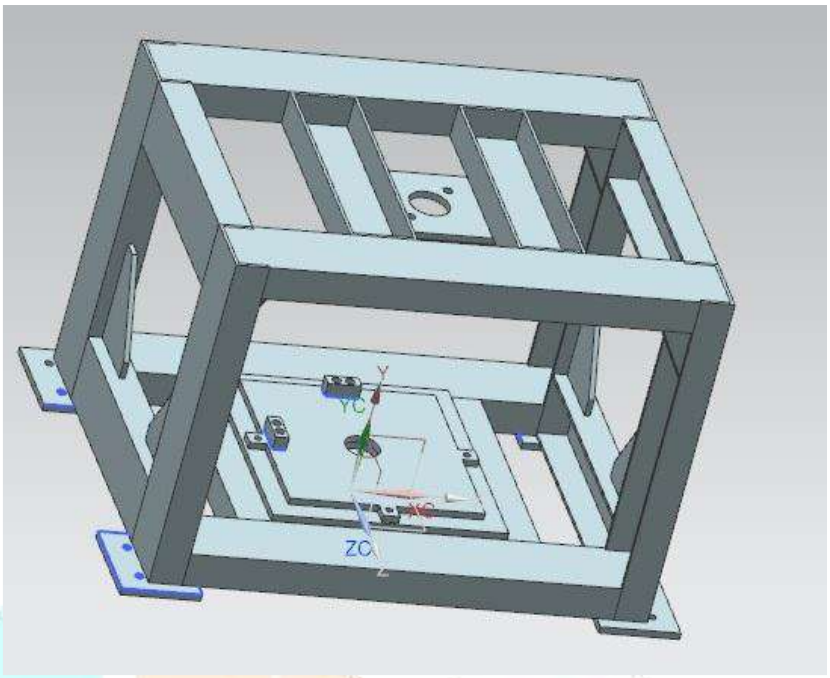

Fig.2 Model in Unigraphics

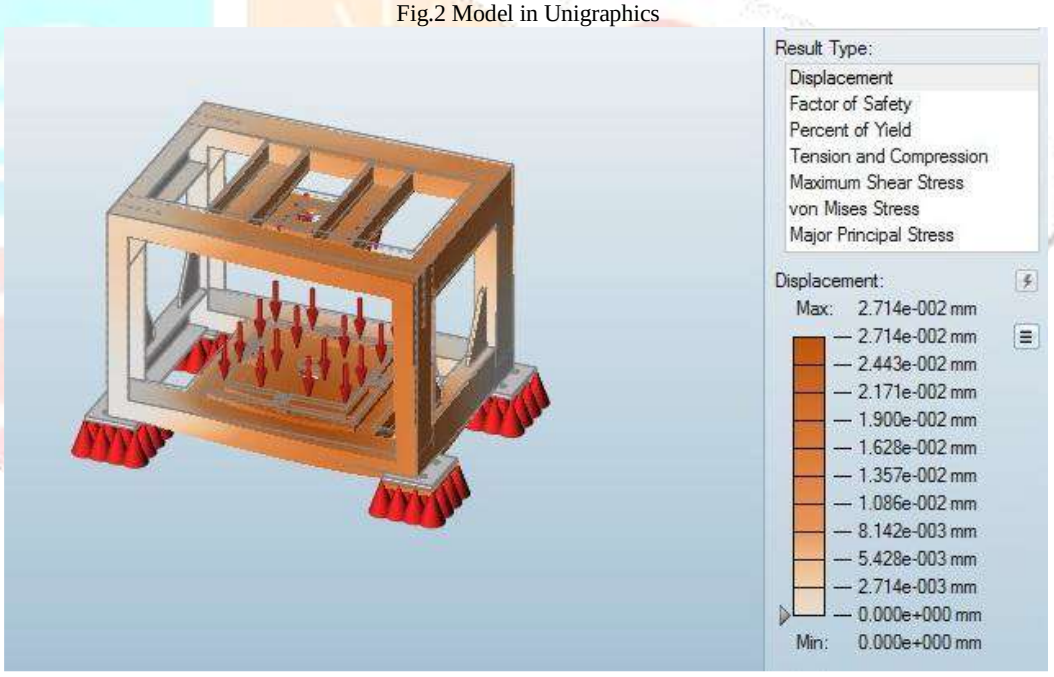

Fig.3 Result: Safe against Displacement

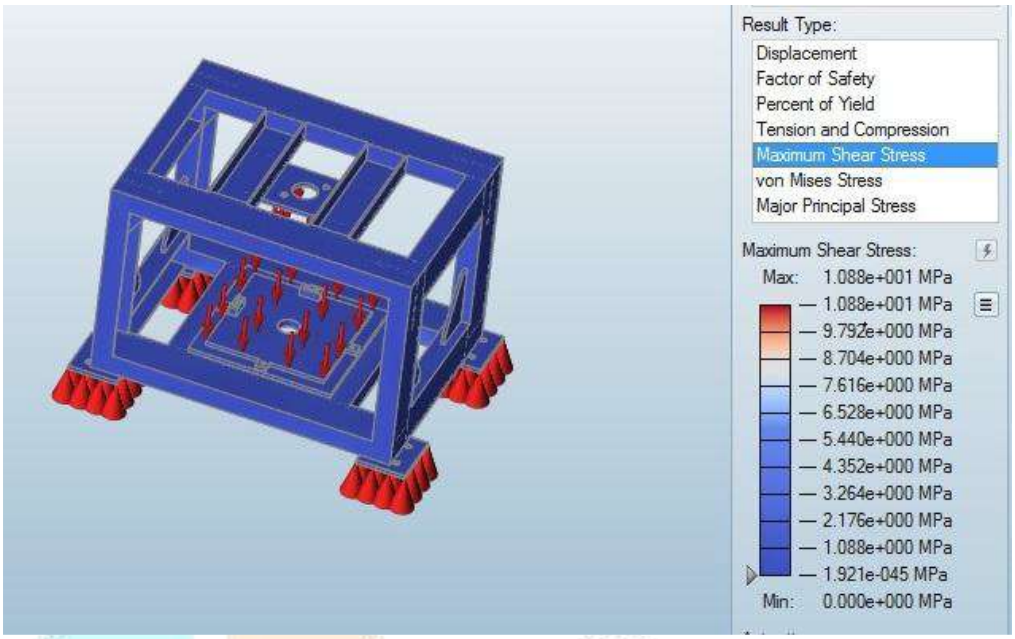

Fig.4 Result: Safe against Shear Stress

IV. CONCLUSION

In this project the Hydraulic Press is studied and the design of the C frame is done as per the requirements by following the process of Reverse engineering. The modeling of the C frame was done in Unigraphics software. The analysis of the assembly press is carried out using Solid Thinking software. Analysis was done for the C frame by reducing its material used, without causing wastage of material. The C frame was designed to provide maximum efficiency at time of the operation without interfering with operation. The positions where the stresses were not acting the extra material was removed thus optimizing the design without compromising quality. The result obtained from analysis software is within the limit.

REFERENCES

[1] Unigraphics Verification Manual version 8.5.
[2] Psg design data book, DPV printers reprinted in May
[3] Fluid Power with applications Anthony Esposito VI edition
[4] Design of Machine Elements (THIRD EDITION Modal Publications) V.B.Bhandari
[5] Analysis of Hydraulic Press Frames for Open Die Forging Martin Zahalka* International Symposium on Intelligent Manufacturing and Automation, 2013
[6] ANALYSIS AND STRUCTURAL OPTIMIZATION OF 5 TON H-FRAME HYDRAULIC PRESS Santoshkumar S. Malipatil1, Prof. Yogita N. Potdar2, Prof. A. C. Mattikalli3
[7] Middle-East Journal of Scientific Research 20 (10): 1239-1246, 2014 ISSN 1990-9233 © IDOSI Publications, 2014 Corresponding Author: D. Ravi, Associate Professor, Mechanical Engineering Department, Bharath Unicersity Chennai, India Computer Aided Design and Analysis of Power Press D. Ravi