Design & Development of Hydraulically Dowel Pin Pressing Machine

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Abstract - Hydraulic Pin Press is one of the basic machine tools. Hydraulic Pin Press machine works under impact load condition. Because of continues impact load some parts of machine experience the compressive stress and some parts experience tensile stress. To overcome this problem optimization of machine is required which can be done using CAD tool and analyzed in FEA tool such as ANSYS. Thus with the aid of atomization, the production time can be reduced as well as higher degree of accuracy can be achieved as the human efforts will be alleviated. Thus an attempt has been made to provide the smooth and rapid functioning of press work with the help of hydraulic system.

Keywords: Introduction, Analysis, Automation, Optimization, Hydraulic Circuit

Introduction

A hydraulic press is a machine with the help of a hydraulic cylinder to generate a compressive force. Frames, column and supporting structure as well as cylinder are the main components of the hydraulic press. The conventional hydraulic press consists of a pump which provides the acceleration for the fluid, the fluid itself which is the medium of power transmission through hydraulic pipes and manifold, control devices and the hydraulic motor which converts the hydraulic energy into useful work at the point of load resistance.

In this project, hydraulic pin press was designed and constructed using sourced materials. The principal parameters of the design included the maximum load for four numbers of cylinders, for dowel pin-4(Qty 1) ,for dowel pin-5 (Qty 2), the distance the load resistance has to move (piston stroke for all, **100 mm**, the system pressure (**50 bar**), the cylinder area (piston diameter for clamping cylinder = **80 mm**, for dowel pin-4(Qty 1) = **40 mm**, for dowel pin-5 (Qty 2) = **25 mm** and the volume flow rate of the working fluid. The major components of the press designed include the cylinder and piston arrangement, the frame and the hydraulic circuit.

Hydraulic Pin Press

Dowel Pin

Dowel pin are industrial fasteners that are used to join two or more items together. They are short, cylindrical rods made of various materials including wood, metal and plastic. It use for proper alignment of two products. As per project, dowel pin material and mechanical properties observation as follows,

Table 1. Material Properties

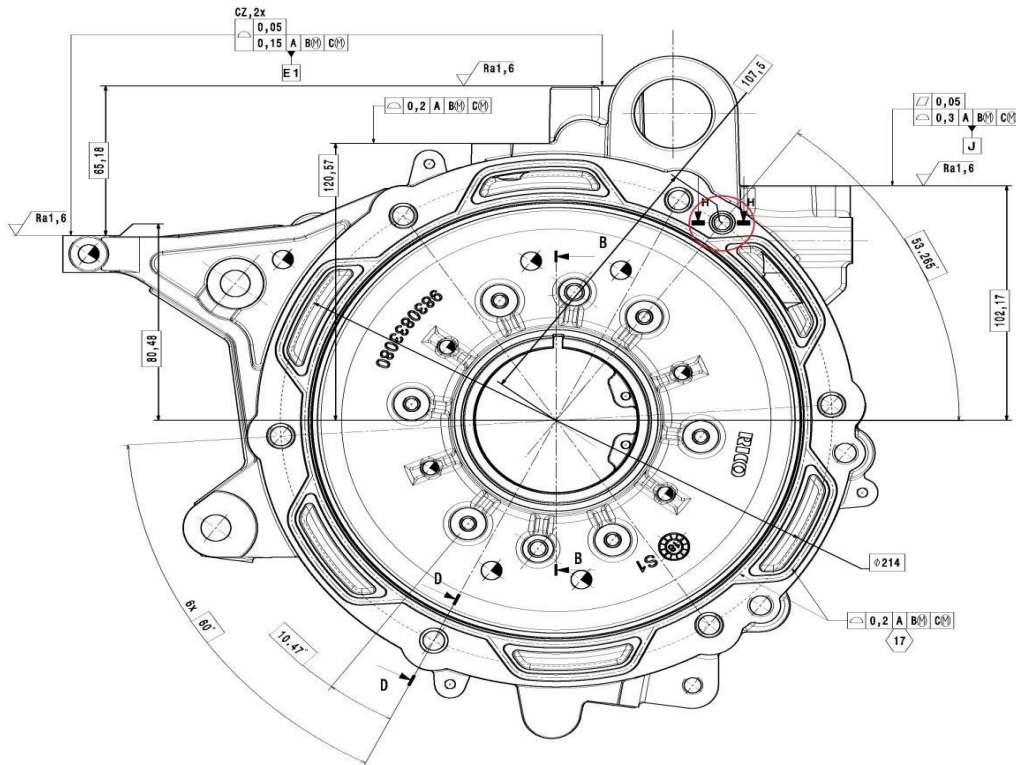| Material of dowel pin	SUS 304 (Stainless steel)
Density (kg/m³)	8000
Young's Modulus (GPa)	190
Tensile Strength (MPa)	520
Yield Strength (MPa)	240
Poisson Ratio	0.27-0.30

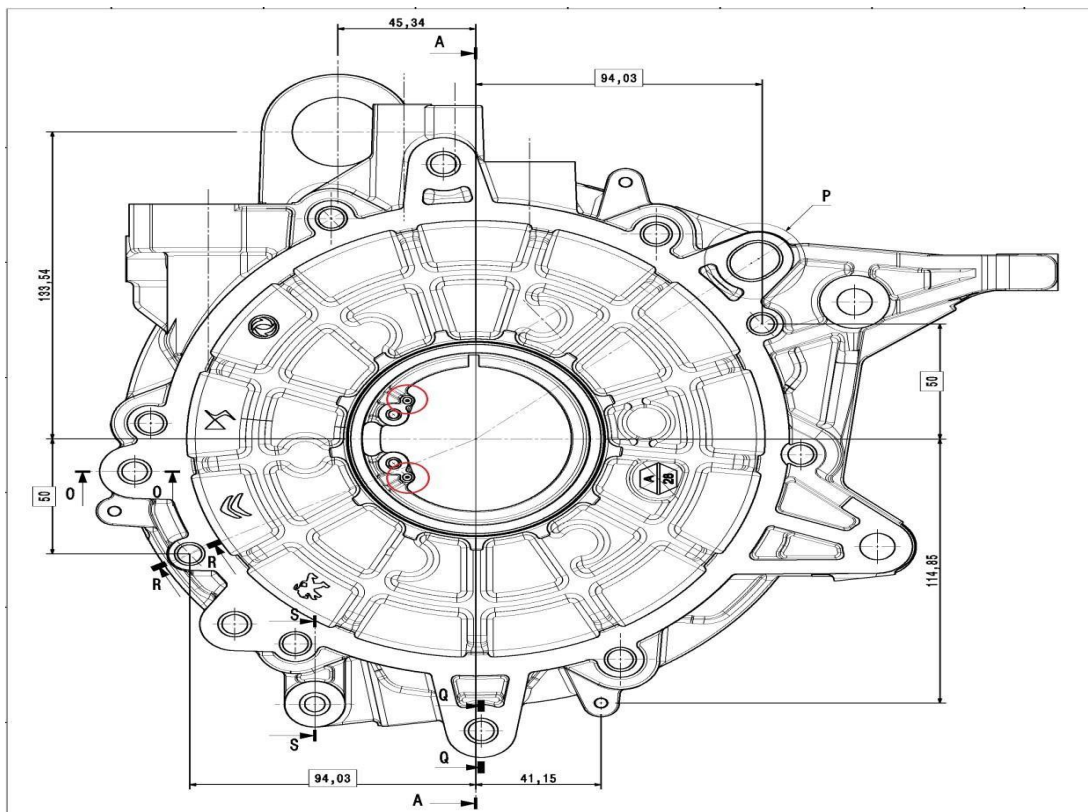**Fig.1 Red mark component where dowel 4 pin pressing (Top View)**

Fig.2 Red mark component where dowel 5 pin pressing (Bottom View)
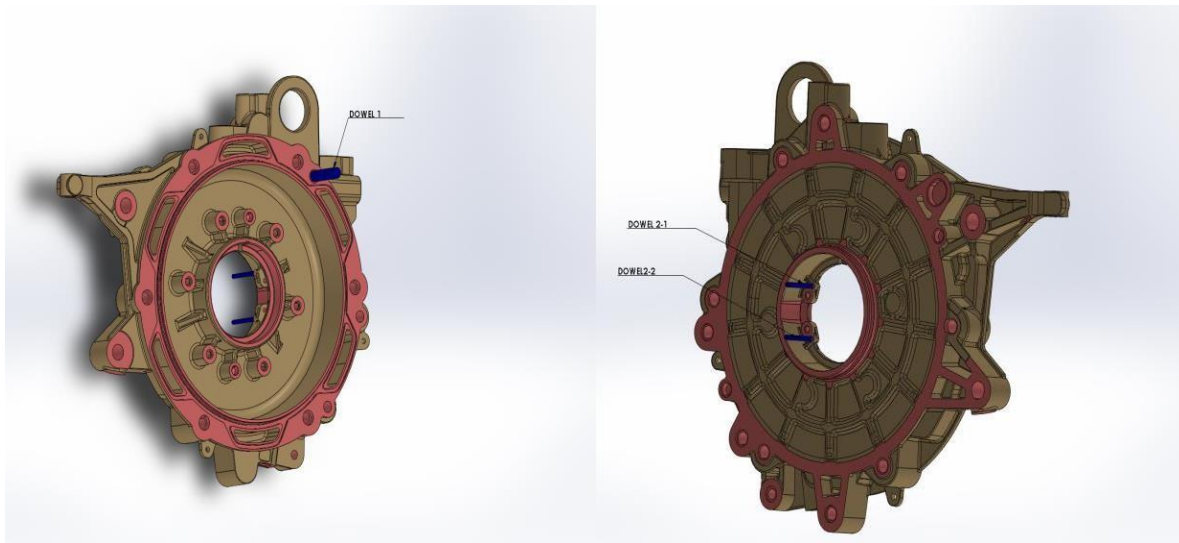
Fig.3 Three Dimensional working component (Top and Bottom View)

Structural Machine Model

In this system, four numbers of hydraulic cylinders are used. Master cylinder act as a clamping cylinder which is clamping the work with the help of clamping plate which is attached or fix with piston rod of clamping cylinder. Guide rods are mounted on clamping plate and moves vertically as per motion of clamping plate. All cylinders are moves vertically which is operates with pressurized oil. Load cell, Programmable Logic Controllers (PLC) and Human Machine Interface (HMI) also used in this system. Working cylinder 1 is mounted on clamping plate for pressing the pin of dowel 4 and working cylinder 2 that is for dowel pin 5, which is act from bottom side of supporting plate for pressing the pin of dowel 5. In the mounting structure, top plate is fix with supporting plate with the help of tie rods as well as fixture is mounted on supporting plate which is fixed with bottom plate.
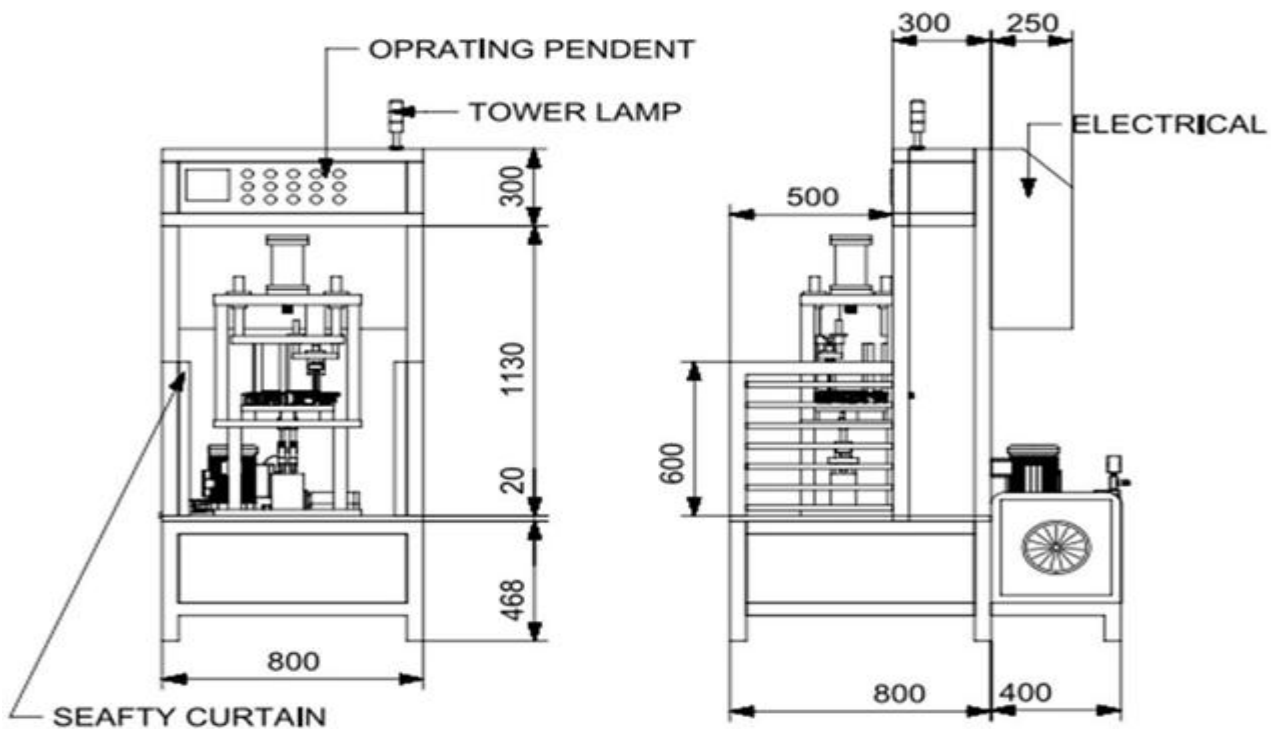

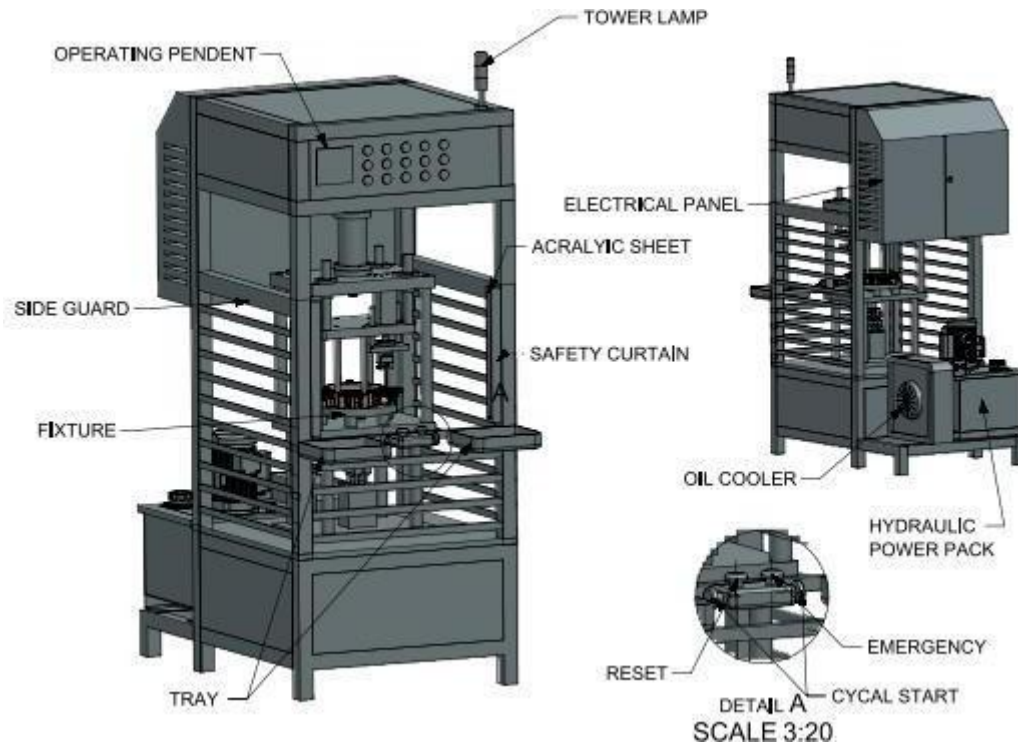**Fig.4 structural machine with Front Housing 3 Pin Insert Fixture**

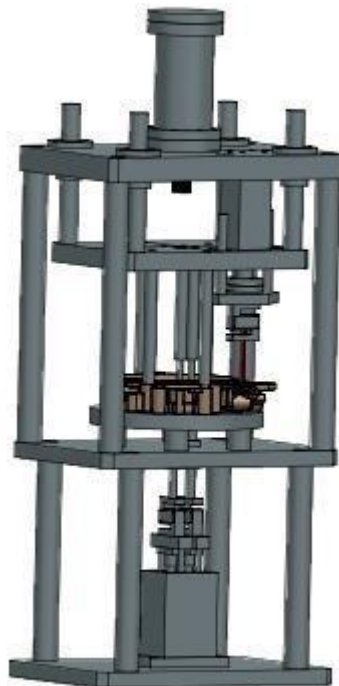**Fig.5 Three Dimensional structural machine with Front Housing 3 Pin Insert Fixture**

Fig.6 Front Housing 3 Pin Insert Fixture

Analysis

Generally Annoys is the field of Mechanical Engineering provides solutions for many types of analyses including structural, thermal, modal, linear buckling and shape optimization for studies. The output of the simulation can be observed in many ways like deformation and strength values.

Applied loads are act on pressing component, so analysis of pressing component are done to find factor of safety, deformation, von misses stresses with the help of ANSYS software.
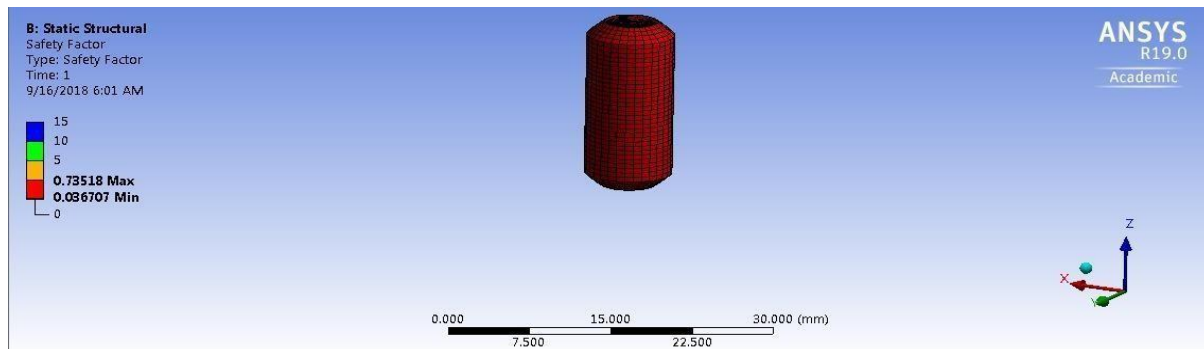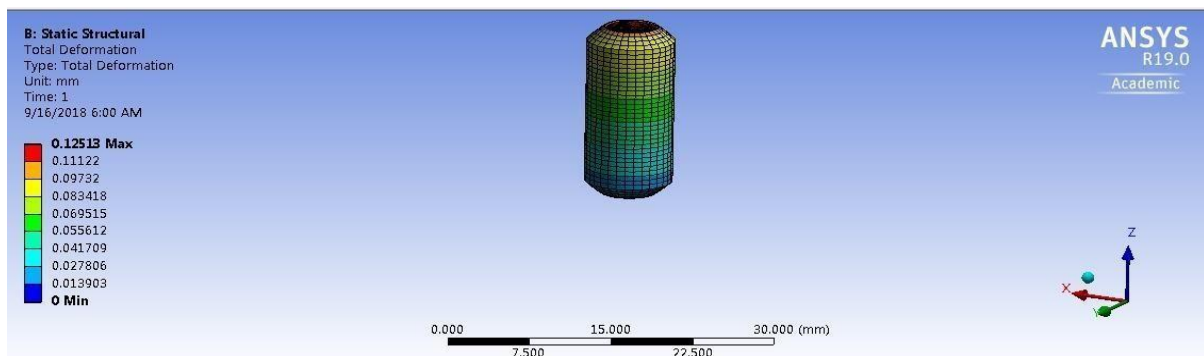
For Dowel-4

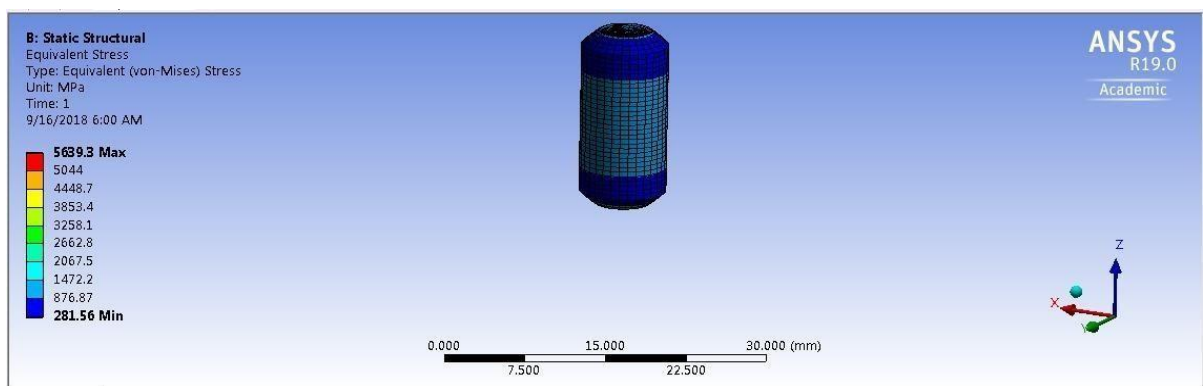
Fig.7 Factor of Safety

Fig.8 Total Deformation

Fig.9 Equivalent (Von-Misses) Stress
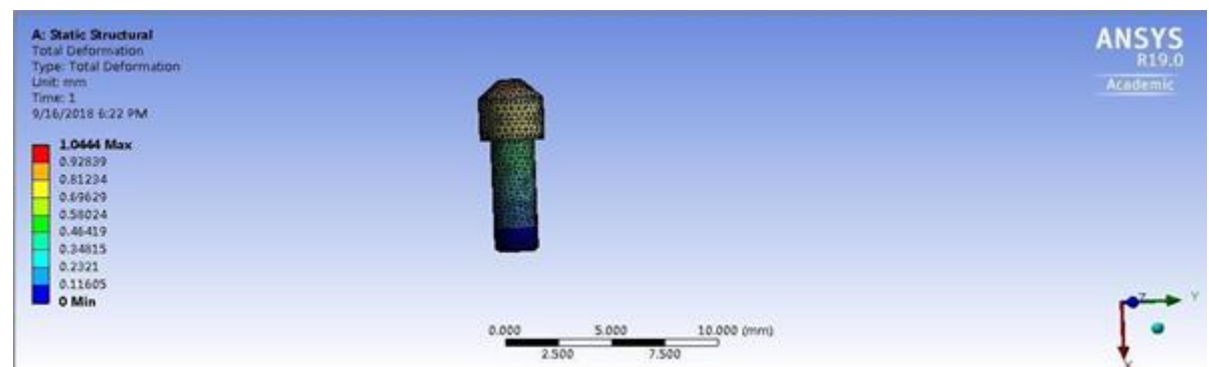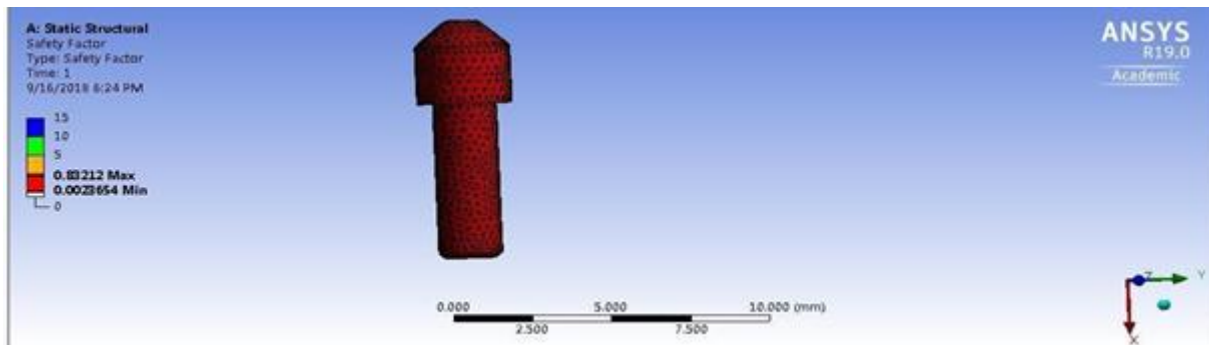
For Dowel-5

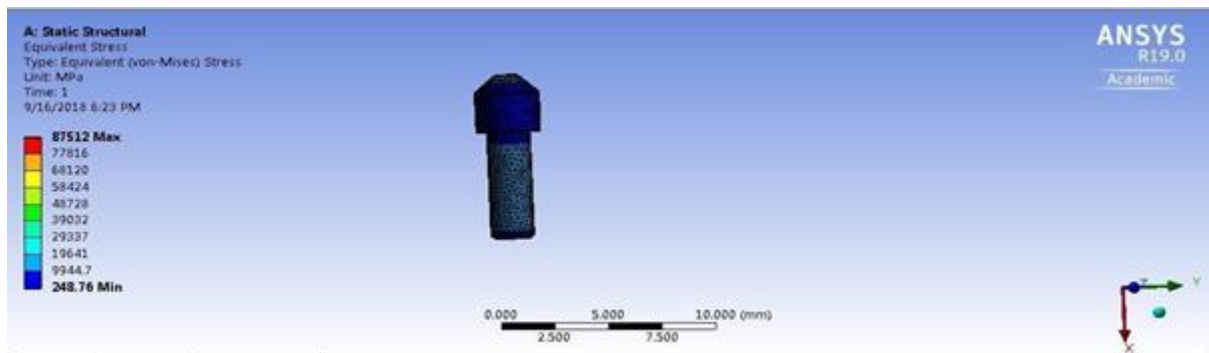**Fig.11 Total Deformation**

Fig.12 Equivalent (Von-Misses) Stress

PLC

A Programmable logic control (PLC) is a controller which controls various output devices as per the given inputs based on a logic which has been programmed into the PLC by the user. Thus it is a controller which can control a number of output devices as per any given logic. This logic which is used to control the output devices can be changed by the user by programming. That is, the logic is programmable. Thus the name came as Programmable Logic Controllers. Many manufacturers refer to it as Programmable Controllers or PC. But the term PLC is found to be more appropriate, as it avoids the confusion with Personal Computer (PC).

Various inputs can be given to the PLC. These inputs may be manual switches, limit switches, proximity switches, sensors, relays, contacts etc.

Based on these inputs the PLC will give a set of desired output as per the user programmed which will operate the concerned output devices. The output devices may be relay coils, motors, solenoids, alarms, indicator lamps etc.

For PLC to give the desired output corresponding to give input, the PLC has to be programmed and the programmed has to be stored in the memory. Then only, when the programmed is executed by the CPU, the PLC can give the desired output. Hence programming the PLC is the most important task of PLC operation.

LOAD CELL

It is a device which is used to convert a force into electrical signal. There are many types of load cells such as hydraulic (or hydrostatic), Pneumatic load cells, Piezoelectric load cells, Capacitive load cells, Piezo-Resistive load cells etc.

Load cells are not only used for quick measurement but also precise measurements. If we compared with other sensors, load cells are relatively more affordable and have a longer life span. There are two types of Load Cell configuration, the "metal-wire" load cell and the "metal foil" load cell. Both types of load cells have same basic characteristics.

LINEAR VARIABLE DIFFERENTIAL TRANSFORMER (L.V.D.T.)

Linear Variable Differential transformer, which is based on a variable-inductance principle, are also used to measure displacement. The most popular use of variable-inductance sensor for linear displacement measurements is the Linear Variable Differential Transformer (LVDT).

The LVDT, consists of three symmetrically spaced coils wound on to an insulated bobbin. It consist of a magnetic core, which moves through the bobbin without contact, provides a path for magnetic flux linkage between coils.

The position of the magnetic core controls the mutual inductance between the centre or primary coil and the two outer or secondary coils. LVDT is used because of having good characteristics such as Linearity, High Output, High Sensitivity, Less Friction, Low Hysteresis, and Low Power Consumption.
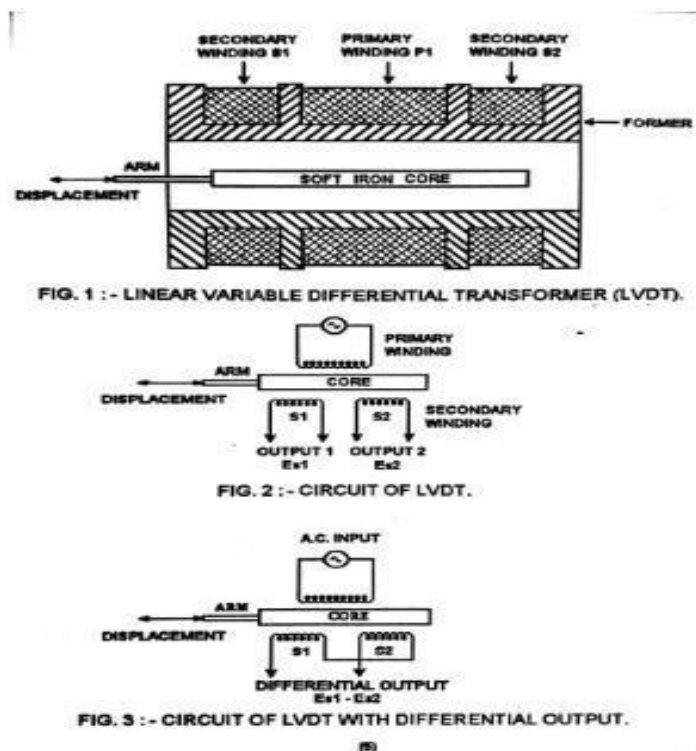

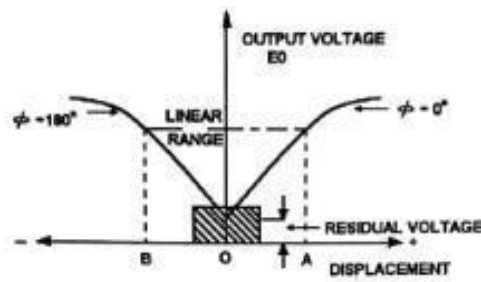**Fig.13 LVDT and its circuits with & without differential output**
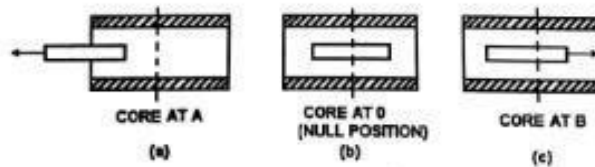
Fig.14 Voltage variation of LVDT and its various positions

HUMAN MACHINE INTERFACE (HMI)

Communications between processor and HMI (human machine interface) is an important subject as well as constructing an operator interface.

The design of an operator panel requires much coordination with the programming of the PLC and the design of the machine being controlled. Before the computer-designed systems, there were individual component systems that were hard-wired to the control devices inside the panel.
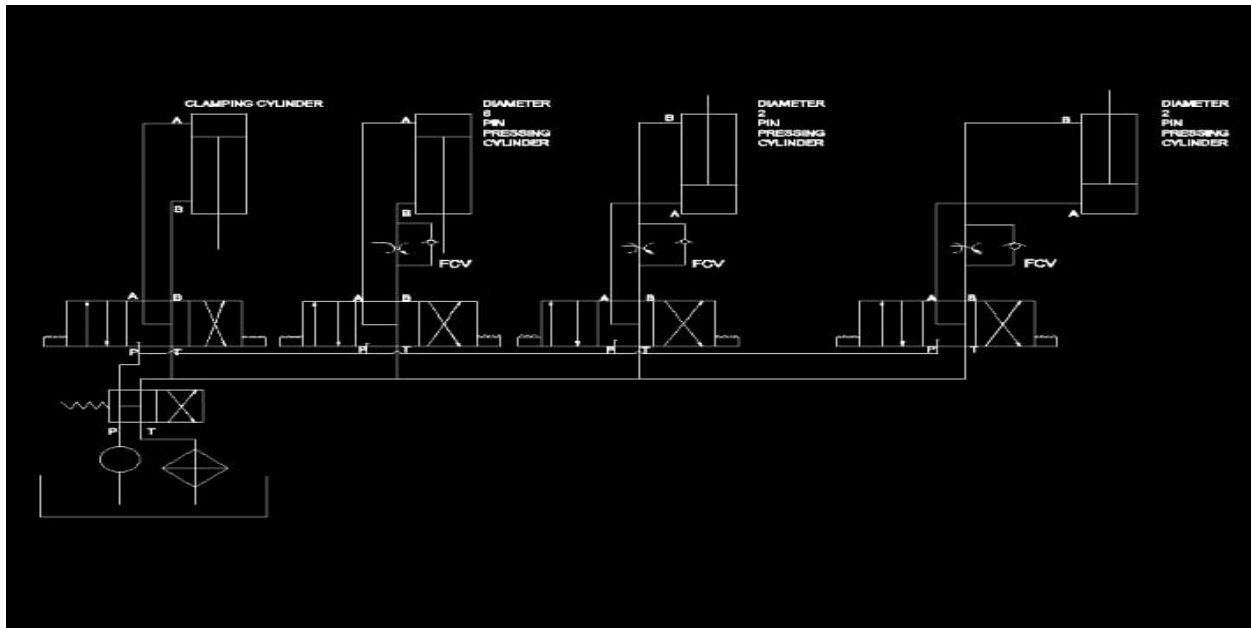

Fig.15 A Simple Control Panel with Push Buttons and Switches with Indicator Lights

Need of optimization

To optimize geometric structure of columns, frame and other components of hydraulic pin press machine. To reduce the unwanted stresses causing failure of frame and other components. To reduce the cost and improve the safety.

Hydraulic Circuit

Conclusion

In this paper attempt has been made to analyze and optimize the existing press by using Finite Element Software. After the Design and Analysis the new hydraulic pin press it has been observed that, design of Existing Hydraulic Pin Press by using the standard components to manufacture. The stresses induced in the new hydraulic pin press in within the limit. So the New hydraulic pin press is safe to use in industries.

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