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"Analysis and Result of Horizontal Hydraulic Press Machine."

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Abstract: The repair, maintenance and overhauling of heavy engineering equipment's such as driveshaft's and gearbox of heavy machinery. There is a need for a partial or complete disassembly and assembly of large components and subassemblies. These assemblies and subassemblies have large dimensions and weight, they operate in dynamic conditions and very hard environments and that is the reason why large forces of separation or pressing appear during assembling and disassembling. To perform these operations, the most acceptable solution is a horizontal hydraulic press with a hydraulic table to hold the components and parts in the axis of pressing or separation.

By the application of CAD/CAM/CAE (CATIA, Pro/ Engineer, Solid Works, Inventor, etc.) software it is possible to quickly obtain a geometric model of a part or assembly (of a product), which gives a physical form in space as a mechanical part and assembly, an abstract form in the form of drawings for manufacturing. In this research we design and analyse the horizontal press machine for assembling and dismantling heavy components.

I. INTRODUCTION

The hydraulic press is one of the oldest of the basic machine tools. In its modern form, is well adapted to presswork ranging from coining jewellery to forging aircraft parts. Modern hydraulic presses are, in some cases, better suited to applications where the mechanical press has been traditionally more popular.

Hydraulic press is a tool to produce compressive force by means of fluid. The very basic working principles of the hydraulic press are easy and simple, and depend on differences in fluid pressure. Fluid is pumped into the cylinder below the piston; this causes the fluid pressure under the piston to maximize. At the same time, fluid is pumped out of the top channel, resulting the fluid pressure above the piston to decrease. A higher pressure of the fluid below the piston than the fluid over it causes the piston to rise. In the later step, fluid is pumped out from below the piston, causing the pressure under the piston to decrease. Simultaneously, fluid is pumped forcefully into the cylinder from the top; this increases the fluid pressure above the piston. A higher pressure of the fluid above the piston, than the fluid below it, moves the piston downward.

Horizontal Hydraulic Press

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II. DATA ACCUMULATION

A. Minimum weight of the job: 25 KGS
B. Maximum weight of the job: 1500 KGS
C. Maximum length of the job: 1.8 M
D. Minimum length of the job: 200 MM
E. Mode of operation: Manual
F. Number of labour: 5
G. Time for completing one job: 1 to 4 hours
H. Maximum pressing force of the machine: 200 tons

III. CAD MODELLING

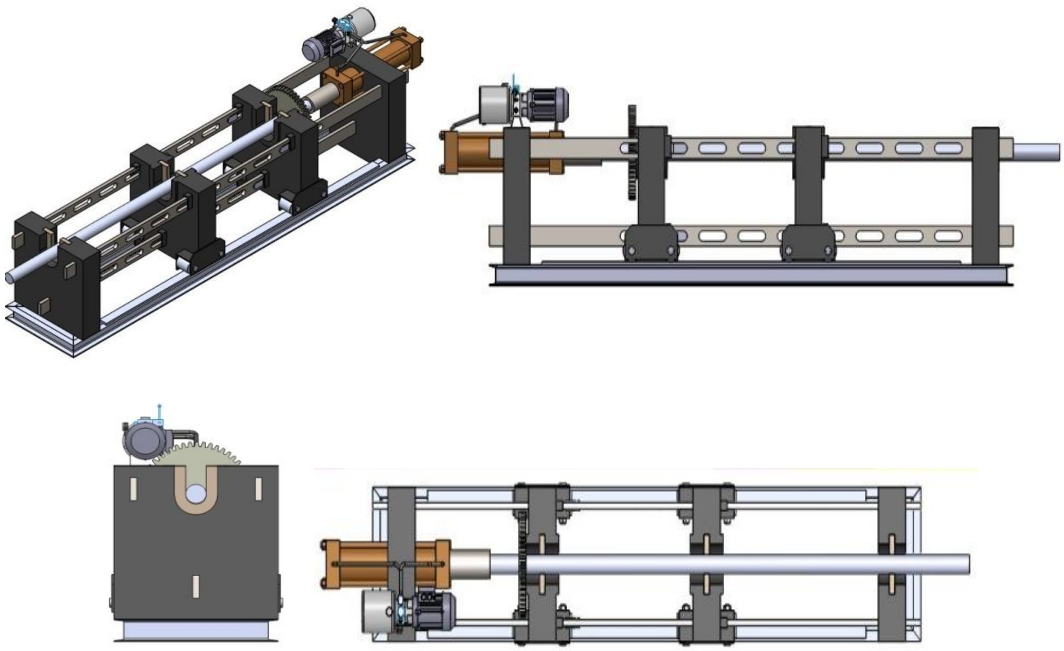
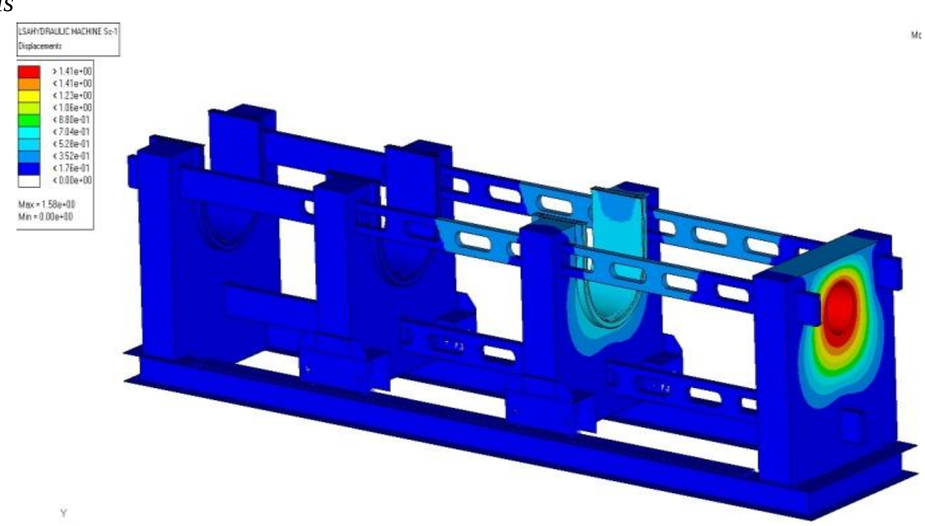


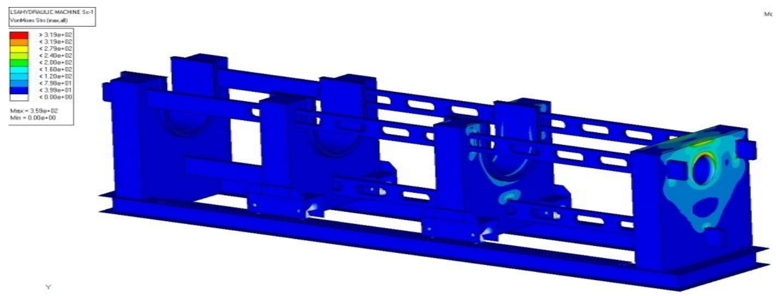
Fig: CAD Model of Horizontal Hydraulic Press

IV. FEA RESULTS

A. Linear Static Analysis

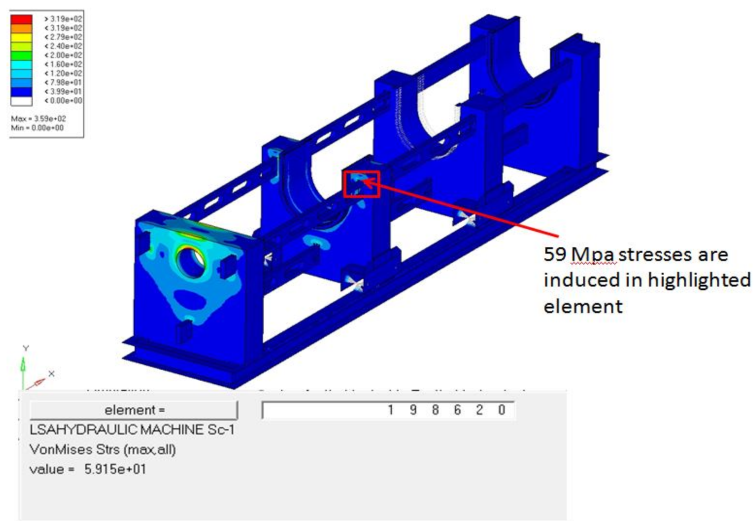


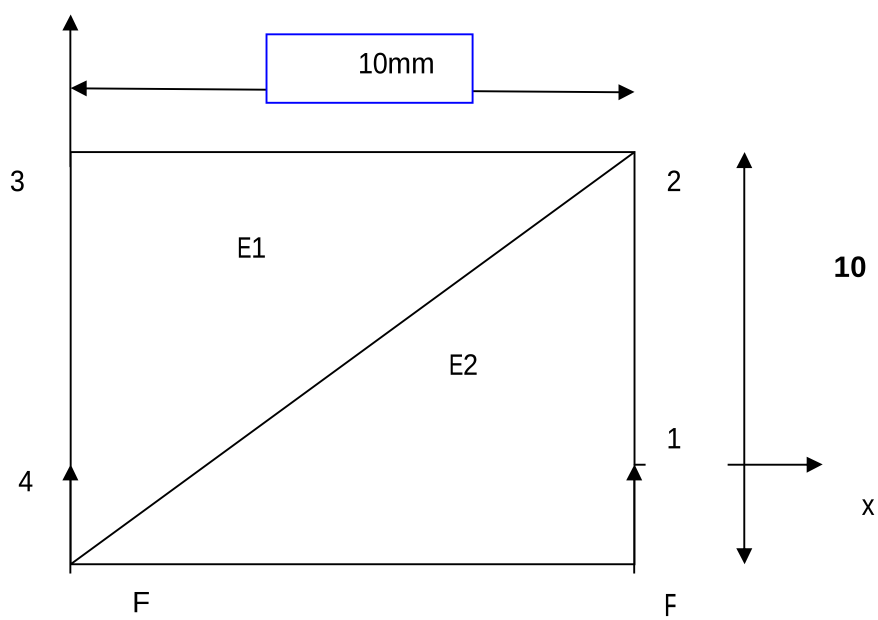
DISPLACEMENTS = 1.58 mm



STRESSES = 359MPa

V. FEA RESULT VALIDATION





Node 1 :Fixed in X direction and Free in Y
Node 2: Fixed in both direction

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Node 3 : Fixed in both direction
Node 4: Fixed in X direction and Free in y direction.
2 Degree of freedom at each node .one in X and in Y direction
For element 1,nodes are 1,2,4 and for element 2, node are 3,4,2.

Element No.	Nodes		
	1	2	3
1	1	2	4
2	3	4	2

$$D = \frac{E}{1-\mu^2}\begin{bmatrix} 1 & \mu & 0 \\ \mu & 1 & 0 \\ 0 & 0 & \frac{1-\mu}{2} \end{bmatrix}$$

$$D = \frac{210000}{1-0.3^2}\begin{bmatrix} 1 & 0.3 & 0 \\ 0.3 & 1 & 0 \\ 0 & 0 & \frac{1-0.3}{2} \end{bmatrix}$$

$$D = 10^6\begin{bmatrix} 0.23 & 0.07 & 0 \\ 0.07 & 0.23 & 0 \\ 0 & 0 & 0.08 \end{bmatrix}$$

Now,Calculate matrix B as shown in below:

$$B_e = \frac{1}{\det J}\begin{bmatrix} y24 & 0 & y41 & 0 & y12 & 0 \\ 0 & x42 & 0 & x14 & 0 & x21 \\ x42 & y24 & x14 & y41 & x21 & y12 \end{bmatrix}$$

$$\det J = x14 \times y24 - x24 \times y14$$

$$\det J = 10 \times 10 - 10 \times 0 = 100$$

$$B_e = \frac{1}{100}\begin{bmatrix} 10 & 0 & 0 & 0 & -10 & 0 \\ 0 & -10 & 0 & 10 & 0 & 0 \\ -10 & 10 & 10 & 0 & 0 & -10 \end{bmatrix}$$

$$B_e = \begin{bmatrix} 0.1 & 0 & 0 & 0 & -0.1 & 0 \\ 0 & -0.1 & 0 & 0.1 & 0 & 0 \\ -0.1 & 0.1 & 0.1 & 0 & 0 & -0.1 \end{bmatrix}$$

Now ,Calculate DB_1 and this will be used later in Stress Calculation

$$DB_1 = 10^3\begin{bmatrix} 23 & -7 & 0 & 7 & -23 & 0 \\ 7 & -23 & 0 & 23 & -7 & 0 \\ -8 & 8 & 8 & 0 & 0 & -8 \end{bmatrix}$$

$$DB_1 = 10^3\begin{bmatrix} -23 & 7 & 0 & -7 & 23 & 0 \\ -7 & 23 & 0 & -23 & 7 & 0 \\ 8 & -8 & -8 & 0 & 0 & 8 \end{bmatrix}$$

Now, element stiffness matrix can be calculated by:

$$Ke = te \times Ae \times Be^T \times DBe.$$

Where, t is thickness and A is area of element

$$K1 = 10^4\begin{bmatrix} 31 & -15 & -8 & 7 & -23 & 8 \\ -15 & 31 & 8 & -23 & 7 & -8 \\ -8 & 8 & 8 & 0 & 0 & -8 \\ 7 & -23 & 0 & 23 & -7 & 0 \\ -23 & 7 & 0 & -7 & 23 & 0 \\ 8 & -8 & -8 & 0 & 0 & 8 \end{bmatrix}$$

1 2 3 4 7 8

$$K2 = 10^4 \begin{bmatrix} 31 & -15 & -8 & 7 & -23 & 8 \\ -15 & 31 & 8 & -23 & 7 & -8 \\ -8 & 8 & 8 & 0 & 0 & -8 \\ 7 & -23 & 0 & 23 & -7 & 0 \\ -23 & 7 & 0 & -7 & 23 & 0 \\ 8 & -8 & -8 & 0 & 0 & 8 \end{bmatrix}$$

$$\begin{matrix} 5 & 6 & 7 & 8 & 3 & 4 \end{matrix}$$

In previous element matrix, the global degree of freedom association is show that at the bottom of matrix in the problem undeconsideration Q1,Q3,Q4,Q5,Q6,Q7 all are zero.

It is now sufficient to consider the stiffness associated with degree of freedom Q2,Q8.

Global stiffness matrix :

$$K\ global = 10^3 \begin{bmatrix} 31 & -8 \\ -8 & 31 \end{bmatrix}$$

Force : Total force acting on 1.145m length is 1962 N

Now, Force acting on 2mm length of selected element

$$F = \frac{1962}{1145} \times 20 = 3420\ N.$$

$$F1 = F2 = 3420/2 = 1710\ N$$

$$K \times Q = F$$

$$`10^4 \begin{bmatrix} 31 & -8 \\ -8 & 31 \end{bmatrix} \times \begin{bmatrix} Q2 \\ Q8 \end{bmatrix} = \begin{bmatrix} 1710 \\ 1710 \end{bmatrix}$$

$$Q2 = 7.43 \times 10^{-3}\ mm$$

$$Q8 = 7.43 \times 10^{-3}\ mm.$$

Element nodal displacement vector is given by

$$q1 = 10^{-3}[\ 0, 7.43, 0, 0, 0, 7.43\ ]\ mm$$

$$q2 = 10^{-3}[\ 0, 0, 0, 0, 0, 7.43\ ]\ mm$$

Stress in element are given by

$$\sigma 1 = D\ B1.q1^T$$

$$\sigma 1 = [\ -52.01, -170\ ]\ Mpa$$

$$\sigma 2 = DB2.q2^T$$

$$\sigma 2 = [59.44\ ]Mpa$$

Comparison of results: (analytical and computational)

Analytical	Computational
59.44MPa	59.1 MPa

VI. CONCLUSIONS

To address the problem they want to design a horizontal hydraulic press machine which can assemble and dismantle parts of heavy machineries such as couplings, shafts, bearings and gears which are more than 3 meters in lengths and about 1.5 meters in diameter will be solved.

It reduces labour time of manual assembling and dismantling of heavy parts such as large industrial couplings, shafts and bearing etc.

By designing this horizontal press machine G.S. Industries will be hugely benefitted in terms of saving of labor, time and resources.

It will help the company G.S. INDUSTRIES to launch better product in the market, also being an optimized HORIZONTAL PRESS MACHINE, the cost will be less, which will make it more affordable. Analysis of the design will be the part of our next article.

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