DESIGN OF SPECIAL PURPOSE HYDRAULIC PRESS MACHINE

Joshi Ameya1, Kamble Sanket2, Parvatikar Darshan3

1Student, Mechanical Engineering, LGNS College Of Engg, Maharashtra, India
2Student, Mechanical Engineering, LGNS College Of Engg, Maharashtra, India
3Student, Mechanical Engineering, LGNS College Of Engg, Maharashtra, India

ABSTRACT

A hydraulic press is a device using a hydraulic cylinder to generate a compressive force. Hydraulic presses are commonly used for forging, clinching, molding, blanking, punching, deep drawing, and metal forming operations. A special purpose hydraulic press is suggested for press fitting two child parts of muffler used in silencers of automobile and marine industry. After observing the drawbacks in manual process of press fitting, hydraulic press needs to be designed. Thus the project is to design, analysis and fabrication of special purpose hydraulic press machine of required tonnage.

Keywords- *Hydraulic press, special purpose machine, press fitting, muffler, silencer*

1. INTROCUCTION

A muffler is a device for decreasing the amount of noise emitted by the exhaust of an internal combustion engine. Mufflers are installed within the exhaust system of most internal combustion engines, although the muffler is not designed to serve any primary exhaust function. The muffler is engineered as an acoustic soundproofing device designed to reduce the loudness of the sound pressure created by the engine by way of acoustic quieting. The majority of the sound pressure produced by the engine is emanated out of the vehicle via the same piping used by the silent exhaust gases. The emitted noise is abated by a series of passages and chambers lined with insulation and/or resonating chambers harmonically tuned to cause destructive interference, wherein opposite sound waves cancel each other out. Aim of this project is to design a hydraulic press machine for assembly of two components of muffler i.e. Shell and stuffing.

1.1 Problem Statement

Design, development and analysis of the special purpose hydraulic power press suitable for assembly of Shell and Stuffing, used in Mufflers for silencers.

1.2 Objectives

According to the problem statement, our objectives are as follows

- Design of special purpose hydraulic power press machine of capacity 15 Ton, according to customer requirement.
- Modelling of hydraulic press using suitable CAD software.
- Fabrication of hydraulic press.

2. DESIGN OF HYDRAULIC PRESS MACHINE

2.1 Assumptions

- The load is consider as a perfectly vertical.
- Frame material is homogeneous and isotropic.
- As the frame is having the symmetrical cross section area, one side is to be consider for the purpose of analysis.

2.2 Material Selection

While selecting the material for frame of hydraulic press, Cast iron and Mild steel are taken into consideration. MS ha some advantages over Cast iron. Mild steel (steel containing a small percentage of carbon, strong and tough but not readily tempered), also known as plain-carbon steel and low-carbon steel, is now the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. Mild steel contains approximately 0.05‑0.25% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form; surface hardness can be increased through carburizing. In applications where large cross sections are used to minimize deflection, failure by yield is not a risk so low carbon steels are the best choice, for example as structural steel. The density of mild steel is approximately 7.85 g/cm3 (7850 kg/m3 or 0.284 lb/in3) and the Young's modulus is 200 MPa (29,000 psi). Low-carbon steels suffer from yield point run out where the material has two yield points. The first yield point (or upper yield point) is higher than the second and the yield drops dramatically after the upper yield point. If a low-carbon steel is only stressed to some point between the upper and lower yield point and the surface develop Lüder bands. Low carbon steels contain less carbon than other steels and are easier to cold-form, making them easier to handle.

Element	Content
Carbon	C 0.14 - 0.20 %
Iron, Fe	98.81 - 99.26 % (as remainder)
Manganese, Mn	0.60 - 0.90 %
Phosphorous, P	≤ 0.040 %
Sulfur, S	≤ 0.050 %

Table-1: Chemical composition of mild steel

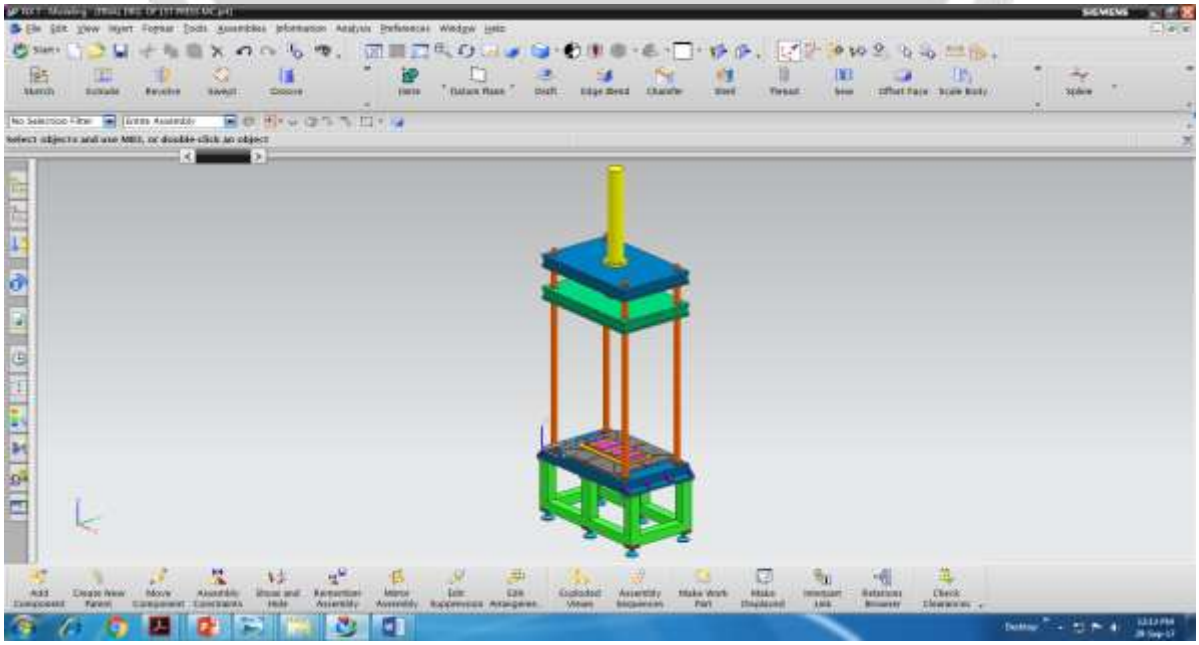

Fig-1: Unigraphics drawing of hydraulic press machine

2.3 Design Calculations

For machine design purpose, need to provide some input parameters for calculation:-

- Tonnage requirement= 15 ton
- Stroke length = 1200mm
- Pressure required=30-32psi.
- Length required on plate for ram spacing= approx. 1000mm

Calculation/ design for work bed (plate):-

As suggested a four column hydraulic press for purpose, will have 3 rectangular plates namely- top plate, sliding plate, bottom plate. All 3 plates are identical in dimension to maintain uniformity and convenience in installing guide pillars. While selecting the material for plate, must consider that it is going to take perfectly vertical load of 15 Ton. Hence MS (AISI/ASTM No.1020) is preferred for plates. Following are some properties of mild steel-

Yield strength = 30Mpa-520Mpa.
Shear strength = 180-210Mpa.
For tonnage Calculation of General Hydraulic press for press fitting Operation-

$$\text{Force required} = \frac{\text{Pressure required (psi) X Working area (inch}^2)}{2000}$$

15 = 32 X A/2000
A = 937.5Inch^2
= **604837 mm^2**

As Plates are rectangular-
Working area (A) = l X B where l-length, B-Width.
604837 = 1000X B
B = **604.837 = 600mm**

For Plate thickness-

$$\tau = P / A$$

Where τ= shear strength, P= force (vertical), A= Area (length X thickness)
Need to convert force (load) into Newton
.:. **T = 121.9805 = 125mm**

Calculations for guide pillars:-
Designing all 4 Pillars for maximum Critical Load I.e. 15ton, so that doesn't need cross check with factor of safety
Stroke length is given = 1400mm.
Total length of pillar = Stroke length + thickness of slider plates+ thickness of top plate+ margin between top plate & slider plate
= 1400 + 125 + 125 +200
= 1850mm.
To install brass, should provide same extra length to pillar.
.:. Final length for pillar **= 2000mm**
For Carrying vertical axial load, prefer EN-81 material which has modulus of elasticity = 42461.98 N/mm^2.

For Buckling of circular column under vertical axial load-

$$Pcr \text{ (Newton)} = \frac{n \pi^2 E A}{(l/k)}$$

Where Pcr -Critical load, N -end fixing coefficient, E- Modulus of Elasticity, A-Area of cross sectional, (l/K) - Slenderness ratio, K- radius of gyration = d/4, l-length.
For column/ beam fixed at both ends, n=4
Pcr = (4 X π^2 X 42461.98 X π¼ d^2) / (2000/d4)
d = **55.864mm = 60mm**
Dimension for guide pillar Diameter **(d):- 60mm, Length (l) = 2000mm**

Design calculation for hydraulic cylinder:-
For cylinder diameter, using the formula for pressure

Pressure (P) = Force (F) / Area (A)
.:. 120 kg/cm^2 = 15000 kg / A
.:. A = 15000 kg / 120 kg/cm^2
.:. A = 125 cm^2
But A = π/4*d^2
.:. π/4*(D1) ^2 = 125
.:. D1 = 12.61 = 12 cm = 120mm
Nearest standard value for cylinder diameter is 100mm
.:. Cylinder diameter **(D1) = 100 mm**

For rod diameter, using the formula for force
F = (π (D1^2 – D2^2) /4) * P
Where,
F = force
D1 = diameter of cylinder
D2 = diameter of rod
P = pressure
.:. 15 (Ton) = (3.14 (100^2 – D2^2) /4) * 20
.:. D2 = 60 mm
.:. **Diameter of cylinder rod = 60 mm**

3. CONCLUSION

The project is developed with the motive of press fitting the two components of muffler used in silencer viz. shell and stuffing. The machine is decided around the provided tonnage (15 Ton). Base plate, guide pillars, and cylinder specification are calculated from the same. It is found that calculated values and design of hydraulic press machine meets the requirements of process of press fitting.

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