Design and Fabrication of Hydraulic Rod Bending Machine

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Abstract- Now a days for construction works bending of rods is necessary for constructing the pillars. Bending of such rods is done manually by setting angle plates. This wastes lot of labour power and time. It is proposed to replace the manual work and reduce time taken for bending by designing an alternative machine to replace the manual work which works by the principle of hydraulic system and indexing mechanism. This will reduce the time taken for bending operation and more than one rod can be bent at a same time. Bending can be done with required dimensions and accuracy is maintained during the entire operation. "By" changing the dimensions of the die required bents are made on the rods. Along with the ease of operation use of hydraulics also makes it more precise, economical and compact. The entire machine is easily portable and having nice aesthetics as well.

Keywords: *Hydraulic System, Indexing mechanism, Bending operation.*

1. INTRODUCTION

The project is designed based on the principle of Hydraulic system. The hydraulic load has more power compare to the other type of load like pneumatic and electric. By using heavy loads we can increase the productivity of the product. The manual stirrup making process suffers from the many drawbacks. The construction worker not only subject their hands to hours of repetitive motion but also sometimes suffers internal injury to his body organ i.e., disorder carpal tunnel syndrome CTS, slipped disc problem etc.

2. LITERATURE REVIEW

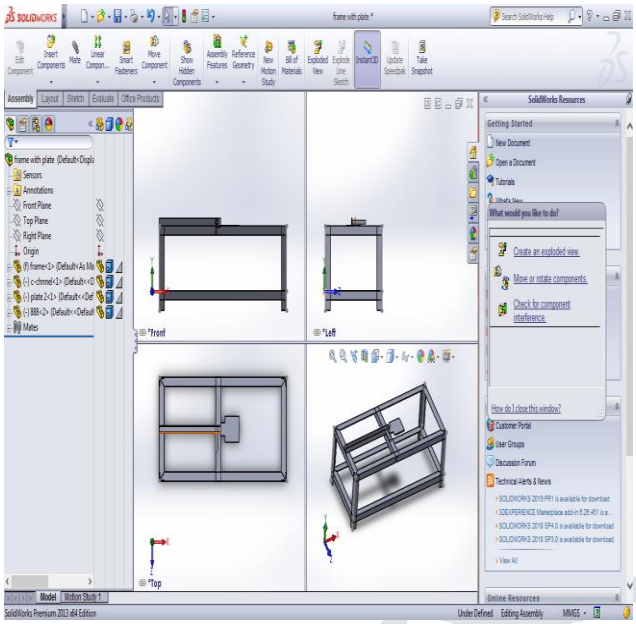
Prof. I. Muhammed Hanoof, S. Ravi Vishwanth (April 2014) Research in a paper Design and Fabrication of Hydraulic Rod Bending Machine, Now days the world is focusing into automation. Every work of human is reduced by a machine, but few areas like construction the usage of machines for bending rods for stirrups which are used to withstand loads in beams and columns are not done by machine because the cost of machine is high need skilled labours to operate it. So this project is aimed to do bending operation for stirrups using hydraulics and named as hydraulic rod bending machine. The main objective of our project is to implement the hydraulic rod bending machine in construction sites with less cost compared to existing bending machine, and increasing the productivity of the stirrups. [8]

Prof. Nikunj Gevariya, Vadaliya Darshit (April 2018) Research in a paper Design and Analysis of Bar Bending Machine, In traditional method bending of straight reinforcement bar is done with hand operated mechanism. Whole accuracy of bend is depends on skill and experience of worker. So our project is to design and develop bar bending machine. Which is used to bend bar of any free size with higher speed and desired accuracy. There is a machine work pneumatic and hydraulic are also used for making stirrups but those machine has major disadvantage of requirement of large space for storage tank and compressor which makes machine heavy and in mobiles. Presently, stirrups are made manually, which suffers from many drawbacks like lack of accuracy, low productivity and resulting into severe fatigue in the operator. Bar-bending machine is a semi-automatic type of machine which utilizes less man-power. This reduction in manual work result increased output.[2]

Prof. Pankaj Kumar Pandey, Prof. Arjun Kumar Nishad(April 2018) Research in a paper Design and Fabrication of Hydraulic Bending Machine, The hydraulic metal bending machine is planned to do bending activity for utilizing a hydraulic power pressure. This bending machine bends a small piece of sheet metal, plates, pipes, bars, rods. The motto of this project is to develop a portable low cost bending machine. This project comprises a hydraulic jack, pedestal bearings, basic casing, driving and driven rollers, metal shaft, nut and bolts. The fundamental favorable position of our venture is Metal bar are twist fit as a fiddle (U-shape, circle twist) constantly and less human exertion in a task. This investigation is all about working and designing of bending machine. This bending machine can bends a small plate, rods, pipes, tubes. This kind of metal has its own particular thickness.[3]

Prof. Somnath B. Deshmukh (May 2017) Research in a paper Design Analysis and Fabrication of Hydraulic Bar Bending Machine, The project is designed on the basis of principle of hydraulic system. Here the use of principle of hydraulic system is to increase the productivity. Now a days it is very essential to use this system in order have a higher reliability. As rod bending is extensively in the construction of buildings and fabrication. There we need variety of bends of bar like V-shape, U-shape and many more. This can be achieved by using this hydraulic system based bar bending machine. Same bending machine can be manufactured by using a pneumatic system. The reason behind using hydraulic system instead of pneumatic system is that hydraulic system has many more advantages over pneumatic system. [5]

3. FRAME MODEL



4. DESIGN

4.1 Selection of components:

Table No: 4.1 Selection of Reservoir

Model	Capacity (Lit)
T1	**40**
T2	100
T3	250
T4	400
T5	600

Table No: 4.2 Selection of DCV

Model	Pressure (bar)	Delivery (Discharge m^3/s)
D1	100	$12*10^{-3}$
D2	90	$2*10^{-3}$
D3	**80**	**$6*10^{-3}$**

Table No: 4.3 Selection of PRV

Model	Pressure (bar)	Delivery (lpm)
R1	100	12
R2	110	2
R3	**105**	**6**

Table No: 4.4 Selection of pump

Model	Delivery in lpm		
	At 0 bar	At 35 bar	At 70 bar
P1	**8.5**	**7.1**	**5.3**
P2	12.9	11.4	9.5
P3	17.6	16.1	14.3
P4	25.1	23.8	22.4
P5	39.0	37.5	35.6

Table No: 4.5 Selection of motor

Model	Pressure (bar)	Volume(displacement m^3/rev)
M1	**70**	**$0.5*10^{-4}$**
M2	70	$2*10^{-4}$
M3	70	$5*10^{-4}$

Table No: 4.6 Selection of cylinder

Model	Pressure (bar)	Bore diameter(mm)	Rod diameter(mm)
A1	25	25	12.5
A2	**40**	**40**	**16**
A3	50	50	35
A4	75	75	45
A5	100	100	50

4.2 Design procedure:

4.2.1 Force required to bending the rod (Assume maximum diameter of rod=20mm)

Bending equation are,

$M/I=\sigma b/y$

……..(a)

M=W*L/4 = W*105/4 ……(Assume L=105mm)
……..……..(1)

$I=\pi/4*(d)^4 = \pi/4*(20)^4 = 7853.98\ mm^4$
……...(2)

σb=93.33 N/mm
…….....(3)

y = d/2 = 20/2 = 10 mm
……(4)

So,put equation 1,2,3,4 in equation (A), we get,

$$\frac{W * 105/4}{7853.98} = \frac{93.33}{10}$$

W = 2792.42 N
……(b)

Selection of cylinder,

Now, maximum working pressure = 210 bar

P = F/A

By equation (B)

$$210 * 10^5 = \frac{2792.42}{\frac{\pi}{4} * d^2}$$

d = 13.01 mm.

Hence, rod diameter = 13.01 mm.

But, from above table no: 4.1.6 standard rod diameter (d) = 16 mm. & bore diameter (D) = 40 mm.

So, A2 model of cylinder is selected.

…..(A)

Since total stroke of cylinder = (200+100) mm = 300 mm

Full bore area = $\pi/4*D^2 = \pi/4*(0.04)^2 = 1.25*10^5\ m^2$

Anulus area = $\pi/4*(D^2-d^2) = \pi/4*(0.04^2-0.016^2) = 1.05*10^{-3}\ m^2$

Since, maximum working pressure,

P_{max} = Load/Area = $2792.42/1.25*10^5$ = 22.33 bar

Now, flow requirement calculation,

For rapid approach 200 mm distance in 3 sec.

Velocity of piston needed = $200*10^{-3}/3$ = 0.066 m/s

Q = A * V = $1.25*10^{-3}$ * 0.066 = $8.23*10^{-5}\ m^3/s$ or 4.95 lit/min

Now, selection of pump

Maximum flow requirement in hydraulic circuit is 4.95 lpm & maximum pressure is 22.33 bar. Hence, pump must provide the required flow against the required pressure. From data of vane pump at 22.33 bar pressure. (i.e. 35 bar pressure) from table no : 4.1.4 i.e. at 35 bar pressure 7.1 lpm discharge.

Hence, P1 model of vane pump is selected because this satisfy our requirement

.....(B)

Now, selection of DCV & PRV for discharge of $8.25*10^{-5}\ m^3/s$ or 4.95 lpm.

Hence, D3 model of DCV is selected from table no: 4.1.2 with discharge $6*10^{-3}\ m^3/s$ & pressure 80 bar.& R3 model of PRV is selected from table no: 4.1.3 with discharge 6 lpm & pressure 105 bar because of this satisfy our requirement.

…..(C)

Now, selection of motor for pressure 22.33 bar.

Hence, M1 model of motor is selected from table no: 4.1.5 with pressure 70 bar & volume (displacement m^3/rev) $0.5*10^{-4}$.

…..(D)

Now, selection of reservoir

Sizing of reservoir from thumb rule formula is (3 to 4) * pump discharge per minute

= 3*Q = 3*4.95 = 14.85 lit.

Hence, T1 model of reservoir is selected from table no: 4.1.1 with capacity 40 lit...(E)

4.2.2 Analysis of rod on Ansys software:

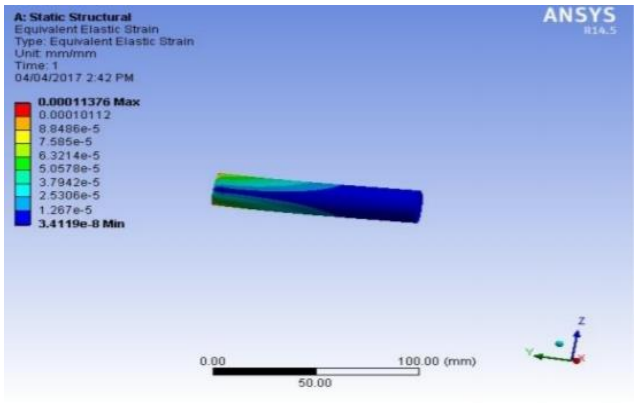


Fig No.4.1 Ansys strain result

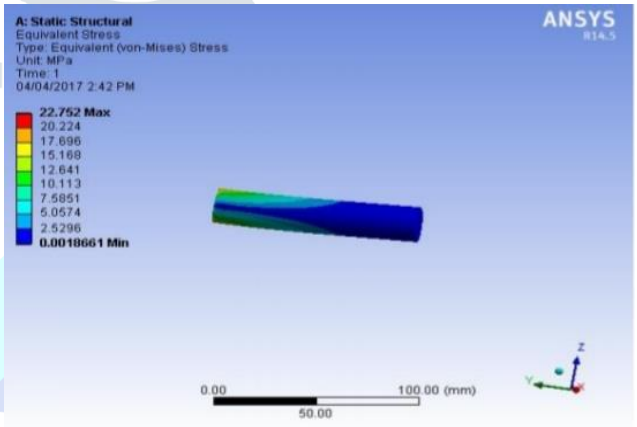


Fig No.4.2 Ansys stress result

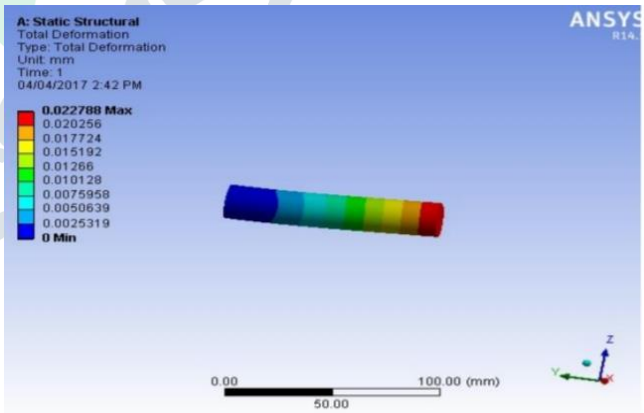


Fig No.4.3 Ansys deformation result

Table No: 4.7 Max. & Min Strain, Stress, Deformation

Strain	**0.00011376 (max)**	**3.4119 (min)**
Stress	**22.752 (max)**	**0.0018661 (min)**
Deformation	**0.022788 (max)**	**0 (min)**

5. SCOPE

- This machine is expected to introduce new technology of bending.
- This project will also help in devlopment of constructional stirrup.
- This innovation has made the more desirable and economical.
- This hydraulic and controlling system is totally environmentally friendly and contains no hazardous.

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