

Design and Fabrication of Hydraulic Stirrups Making Machine

Vilas Shinde¹, Darshan Adhav², Suraj Jadhav³, Afsar Attar⁴, Sandip Gorde⁵

Associate Professor, Department of Production Engineering, AVCOE Sangamner, Maharashtra, India¹

U.G. Student, Department of Production Engineering, AVCOE Sangamner, Maharashtra, India^{2,3,4,5}

ABSTRACT: Present scenario since day by day technology is goes on developed everybody is looking forward to reduce human operators that is labour cost and adopting automation. Any type of human work is reduced by the machines. In certain areas like construction sites usage of machines for bending bars to make stirrups which are used to withstand loads in beams and columns are still done by manually because the machines available in market are very expensive and need skilled labours to operate it. So this project is aimed to bend round bars for making stirrups using hydraulic force and named as design and fabrication of stirrups making machine. Stirrup is square or rectangular shape element required for reinforcement in concrete. These stirrups are used for strengthening columns, beams, to avoid the buckling of long columns and to avoid sagging of horizontal beams. Traditionally stirrups are made on a wooden platform providing with pins and the rod is bend with the help of lever. This hydraulic stirrup making machine consist of direction control vale, freewheel, and fixture main mechanism here in the stirrup is made with the help of hydraulic force.

KEYWORDS: Stirrup, manual stirrup making, thermo-mechanically treated bar, hydraulic system, fixture

I. INTRODUCTION

Since long time ago the labour work has essential role in constructions including mixing coarse aggregate-sand-water-cement, ramming sand, land levelling, and digging the foundation for base of structure, cutting rod in required length, rod bending and pouring the mixture of concrete in columns and beams. Now days, due to development in technology it is required to reduce the labour work and time since there are lot of available resources. As population increasing very rapidly, demand of the construction to build the buildings for industries, overhead bridges, human livings and population is continuously increases. Several problems come in to the picture when we consider human work with respect to automation. By using conventional method it is not possible to reduce construction time and building it as early as possible. So, Automation in construction system is requires.

The project is designed based on the principles of Hydraulics and the system is semi-automatic type. The hydraulic load has more power if we compare it with other type of actuation systems such as mechanical presses, pneumatic actuators and electric drives. By using heavy loads the productivity of the product can be increase.

II. CONSTRUCTION AND WORKING

The rod is bent with the help of hydraulic force, because hydraulics generates large force but gradually hence in this project hydraulic system is taken in consideration to increase the productivity so with the help of hydraulic force we can able to bend near about 3 to 5 rods at a time depending upon the diameter. The bar which is to be bend is placed over the top surface of the fixture, as motor starts hydraulic cylinder actuates. During the extension stroke of hydraulic actuator the rack moves horizontally in forward direction since it is connected by means of lever arrangement with hydraulic rod. Freewheel is engaged and rotates freely as there is clearance between shaft and pinion rack moves forward and the vertical rod attaches to the hydraulic rod bends the bar against stud. During the retraction of hydraulic actuator shaft rotates counter clockwise with the help of rack and pinion mechanism

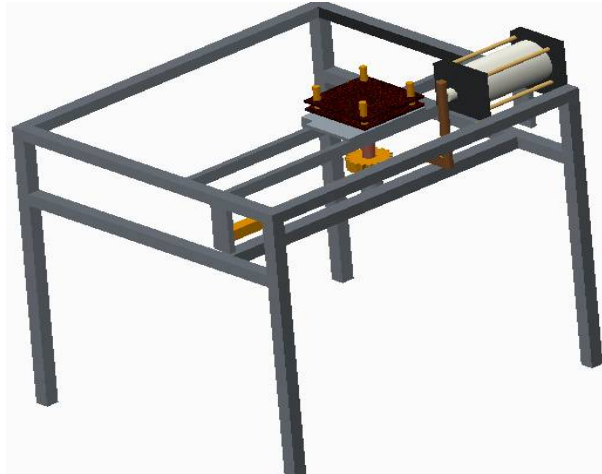
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III. SOLID CAD MODEL AND DESIGN

Solid CAD model:



Bending stress calculations:

For 8mm diameter rod:

Allowable stress:

$$\text{Area} = \pi/4 \times d^2 = \pi/4 \times 8^2$$

$$= 50.265 \text{ mm}^2$$

$$\sigma_a = \sigma_{\text{synt}} / \text{f.o.s} = 678/1.5$$

$$= 452 \text{ N/mm}^2$$

Force:

Generated by 2T Hydraulic Cylinder,
2T = 19.62 KN

$$\sigma_b = \text{Force} / \text{Area} = (19.62 \times 10^3) / 50.265$$

$$= 390.34 \text{ N/mm}^2$$

For 10mm diameter rod:

Allowable stress:

$$\text{Area} = \pi/4 \times d^2 = \pi/4 \times 10^2 = 78.54 \text{ mm}^2$$

$$\sigma_a = \sigma_{\text{synt}} / \text{f.o.s} = 500/1.5 = 333.34 \text{ N/mm}^2$$

Force:

Generated by 2T Hydraulic Cylinder,
2T = 19.62 KN

$$\sigma_b = \text{Force} / \text{Area} = (19.62 \times 10^3) / 78.54 = 250 \text{ N/mm}^2$$

Fixture and stud size:

$$\text{Fixture size} = \text{Width} \times \text{height} \times \text{Thickness}$$

$$= 250\text{mm} \times 250\text{mm} \times 40\text{mm}$$

$$\text{Stud size} = \text{Diameter} \times \text{Height}$$

$$= 16\text{mm} \times 40\text{mm}$$

Shaft size calculations:

Stress due to torsion:

$$\tau_{xy} = 16T / [\pi d^3 (1-k)]$$

Where,

d: diameter of shaft = 50mm

T: Torque on the shaft,

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τ_{xy} : Shear stress due to torsion,

k: Ratio of inner to outer diameters of the shaft (k = 0 for a solid shaft because Inner diameter is zero) = 0

$$T = \text{Force} \times \text{radius} = 19.62 \times 10^3 \times 125 \text{ (Since fixture size is 250mm)}$$

$$= \mathbf{2.452 \times 10^6 \text{ N-mm}}$$

Therefore,

$$\tau_{xy} = 16T \div [(\pi d^3 (1-k))] = (16 \times 2.452 \times 10^6) \div (\pi \times 50^3) = \mathbf{99.90 \text{ N/mm}^2}$$

For mild steel shaft,

Max shear Stress sustainability = 400-560 N/mm²

Here,

$$99.90 \text{ N/mm}^2 < 400 - 500 \text{ N/mm}^2 \quad \text{i.e. } \tau_{xy} < \tau_{\max}$$

Therefore, The **diameter = 50 mm** selected.

Bearing selection:

Bearing number is 6210 (Standard size bearing)

Internal diameter = 50mm

External diameter = 80mm

Width = 20mm

Cylinder specifications:

Bore diameter = 80 mm

Wall thickness = 5 mm

Length = 160 mm

Piston thickness = 25 mm

Stroke length = 160 mm

Pump specification:

Max. Pressure = $\mathbf{175 \times 10^5 \text{ N/m}^2}$

Force calculation:

$$\text{Area, } A = \pi r^2 = \mathbf{4.53 \times 10^{-3} \text{ m}^2}$$

$$\text{Force or load} = P \times A = 175 \times 10^5 \times 4.53 \times 10^{-3} = \mathbf{79.275 \text{ KN}}$$

This maximum load helps to find out how many bars can be bent per operation, the rod specimen has been tested in the Universal Tensile Testing Machine and observed.

IV. RESULT AND DISCUSSION

Since testing the stirrup making machine it is observed that how much time is required to make single piece of stirrup by effective working. The detail description is given as below:

Loading and unloading combining clamping the bar to fixture it almost takes only 5 to 6 seconds. Time required to forward and backward stroke is about 10 to 11 seconds during which stirrup is made. Considering machine ergonomics that is interaction of human operator with machine, it is very easy to operate it because operating switch is provided at suitable place of machine. Again loading and unloading is not complicated since not very specialized tooling is used it is very simple structure. Counting overall time let us assume that one stirrup takes approximate 20 seconds, so in one hour 180 stirrups can be made. Hence after effective working for 8 hours we can produce about 1500 stirrups.

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Obtained Results:

No.	Parameters	Results
1	Loading and unloading time	5 sec.
2	Operating and bending time	15 sec.
3	Total Lead time required for single piece	20 sec.
4	Number of pieces in an hour	180 pieces
5	Effective working of 8 hours (Production rate)	1500-1600 pieces

Table. Results obtained

V. CONCLUSION

- 1) In latest attempt a successful solution for the manual stirrup making is obtained.
- 2) By using various fixtures in the table we can able achieve different shapes and sizes of the stirrups.
- 3) Instead of complicated designs the simple rack and pinion mechanism is used.
- 4) The system can be handled by any operator very easily.
- 5) Since it is cheap and simple design this machine can be sell to anywhere across the nation.

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BIOGRAPHY



Associate Professor. Vilas B Shinde is currently HOD of Department of Production Engineering, Amrutvahini College of Engineering Sangamner District: Ahmednagar, Maharashtra, India. He has done B.E.in Production Engineering. And M.Tech. (CAD/CAM). He has one years of industrial experience and twelve years of teaching experience.



Mr. Darshan Adhav is pursuing Bachelor degree (Final Year) in Production Engineering at Amrutvahani College of Engineering Sangamner



Mr. Suraj Jadhav is pursuing Bachelor degree (Final Year) in Production Engineering at Amrutvahani College of Engineering Sangamner

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Mr. Afsar Attar is pursuing Bachelor degree (Final Year) in Production Engineering at Amrutvahani College of Engineering Sangamner



Mr. Sandip Gorde is pursuing Bachelor degree (Final Year) in Production Engineering at Amrutvahani College of Engineering Sangamner