

# Design of Jig and Fixtures for Productivity Improvement of Stirrup Making Activity

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**Abstract**— The successful running of any mass production depends upon the interchangeability to facilitate easy assembly and reduction of unit cost. Mass production methods demand a fast and easy method of positioning work for accurate operations on it. Jigs and fixtures are production tools used to accurately manufacture duplicate and interchangeable parts. Jigs and fixtures are specially designed so that large numbers of components can be machined or assembled identically, and to ensure interchangeability of components. The activity which we are considering is the “Stirrup Manufacturing”. Stirrups are the rectangular or square shaped frame which bounds the rods in the foundation pillars and beams. Traditionally stirrups are manufactured on a wooden platform provided with pins with respect to which the rod is bent with the help of lever. The force is applied in the form of torque and the pin works as a fulcrum point for the torque. So a special platform is being designed with jig and fixtures to improve the production rate, accuracy and comfort of the activity.

**Key words:** Stirrups, Jig, Fixture, Metrological Accuracy, Mechanical Jack, Anthropometry

## I. INTRODUCTION

The activity which is considered is the “Stirrup Manufacturing”. Stirrups are the rectangular or square shaped frame which bounds the rods in the foundation pillars and beams. Stirrups are used in the pillars and beams to increase its strength. The framework is made up by the mild steel rods and then the concrete mortar material is filled in it which provides the strength to the construction.

This type of stirrups are used which are manufactured by manual bending of mild steel rod in required size. Let us study more about stirrup manufacturing process and related information.

## II. OBJECTIVES

- To improve the per hour production rate of stirrups by reducing production cycle time
- To improve the metrological accuracy of the stirrups by proper setting of work piece
- To reduce efforts of marking and measuring
- To reduce the defectives and maintain the quality

## III. DESIGN OF JIG AND FIXTURE

The overall design of the model consists of the design of following elements.

### A. Design of Bending Pin:

The force required for bending the different size of rod for different type of conditions is to be calculated. These forces are for different type of steel, these are as following.

Rod Dia	Material	Range of Force
6 mm	MS	1050 N to 2500 N
6 mm	TMT	1500 N to 2700 N
8 mm	Torr	2500 N to 5000 N

Now we have,  $F_{max} = 5000\text{ N}$

Let,

$S_1$  = Height of pin above the wood board

$S_2$  = Depth of pin inside the wood board

$d$  = Diameter of bending pin

$F$  = Maximum shear force acted on pin

As  $S_1 = S_2$  i.e. Height of pin above the board equal to depth of pin, the force acted on upper side of pin will be equal to the reaction force acted on the pin inside the wood board. Then,

$$\text{Shear Stress} = \text{Force} / \text{Area}$$

$$105 = 5000 / (\pi/4 d*d)$$

$$d = 7.788\text{ mm} = 8\text{ mm}$$

### B. Design of Mechanical Jack:

The total weight on jack will contain the weight of wooden platform, weight of upper part of assembly and half weight of the concentric pipes (columns).

Weight on jack = wood + upper part of assembly + 1/2 \* concentric pipes

$$= 4 + 16 + 8 = 28\text{ kilograms}$$

To calculate: Input Force

Given: Output Force = 1200 N

Lever length = 500mm = 0.5 m

One rotation of screw raises the jack by 4mm. And the jack have the efficiency of 40%.

Let Input Force =  $F\text{ N}$

Input energy =  $F \times 0.5 \times 2\pi$

Output Work done =  $1200 \times 0.004 *$

As we know,

Efficiency = Work done output / input energy

$$0.4 \times F \times 0.5 \times 2\pi = 1200 \times 0.004$$

$$F = 3.82\text{ N}$$

So, maximum force required to raise the platform will be 3.82 N

Now, work done =  $1200\text{ N} \times 0.004\text{m}$

$$\text{W.D} = 4.8\text{ Nm}$$

As efficiency of jack is 40%

Input work done =  $4.8 / 0.4$

$$\text{Input W.D} = 12\text{ Nm}$$

But as, input work done = input force  $\times$  displacement

The angle of rotation in full round i.e.  $2\pi$  radian and length of lever in 0.5m

$$\text{Input W.D} = F \times 2\pi \times 0.5$$

Hence equating the both sides

$$12 = F \times 2\pi \times 0.5$$

$$F = 3.83\text{ N}$$

For 1st Boom,

Outside circumference =  $c = 115\text{ mm}$ .

(Outside diameter) = OD1 = 37 mm  
 Lift of 1st Boom = 4 inch = 10 cm.  
 Inside Dia = ID2 = OD1 = 37 mm  
 Outside circumference = c2 = 135 mm  
 Outside Dia = OD2 = 43 mm  
 Lift of 2nd Boom = 4" = 10 cm  
 For Housing  
 Inside Dia = ID3 = OD2 = 43 mm  
 Outside circumference = c3 = 165 mm  
 Outside Dia = 52.5 mm  
 Total lift including 1st and 2nd Boom = 14.5 inch = 37 cm  
 Effective lift = 8.5 inch = 21.5 cm (1st and 2nd Boom)  
 Diameter of base = 5 inch  
 For screw  
 Circumference = Cs = 105 mm  
 Diameter = Ds = 33.5 mm  
 Length of elevating lever = 500 mm  
 (Jack lever) = 0.5 m  
 Height of base support = 8 inch

C. Design of Wheels:

As the total weight of assembly model is about 67 kg and the weight of all four wheels is 2 kg. i.e. 0.5 kg per wheel. i.e. total weight ( excluding wheels ) = 67-2 = 65 kg  
 Weight of each wheel = 16. 25 kg

The wheel is made up of fibre plastic having higher coefficient of friction, so that wheel do no slip on the surface to avoid the misbalance of the machine. The diameter of wheel is about 2.5 inch which is perfectly suitable for any type of rough and smooth surface. The foot operated external shoe brake is employed to lock the wheels. This type of brake provide very strong and effective braking to the wheels to avoid slipping and skidding of the machine.

- Weight on each wheels = 16.25 kg
- Weight of each wheel = 0.5 kg i.e. 2 kg for all four wheels
- Diameter of wheels = 2.5 inch
- Height of wheels with supports = 4 inch
- Width of wheels = up to 1 inch
- Brakes = foot operated external shoe brake
- Material of wheels = plastic fibre wheels having higher coefficient of friction
- Support = roller ball bearing to move the wheels in any horizontal direction and also to turn the wheel.

D. Design of working platform (Based on Anthropometry):

- Total machine height  
 Maximum = 38 inch  
 Minimum = 30 inch
- Length = 30 inch
- Width = 18 inch
- Wheel height = 4 inch
- Maximum machine height [ Excluding wheel ] = 34 inch
- Effective Lift = 8 inch
- No. of supporting column [concentric pipes ] 4  
 Inner circumference of pipe = 165 mm  
 Inner Diameter = 52.5 mm  
 Outside circumference pipe = 185 mm  
 Outside diameter = 59 mm

- No. of mechanical jack used = 1
- No. of wheels used = 4
- Type of wheel = foot operated external shoe brake, plastic fibre wheel
- Diameter of wheel = 2.5 inch
- No. of bending pin = 1
- No. of supporting pin = 3
- Diameter of pin = 8 mm

IV. ACTUAL VIEW OF FABRICATED PLATFORM WITH JIG AND FIXTURES



Fig. 1: Platform with Jig and Fixture with Height Adjustment and Provision for Marking and Measuring

V. CONCLUSION

Thus on the basis of above design procedures, a platform is designed with jig and fixtures for manual stirrup making activity. The improvement in production rate after using this platform is observed.

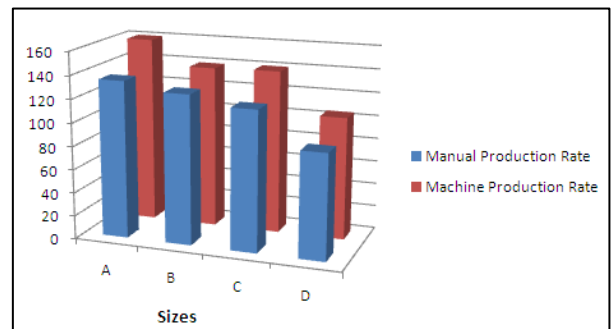


Fig. 2: Graph for Traditional Production Rate v/s Platform Production Rate

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