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# Design and Analysis of Bar-Bending Machine

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***Abstract**--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 results increased output. The Principle advantages are less time consuming, production of identical stirrups, higher production rate than old traditional method.*

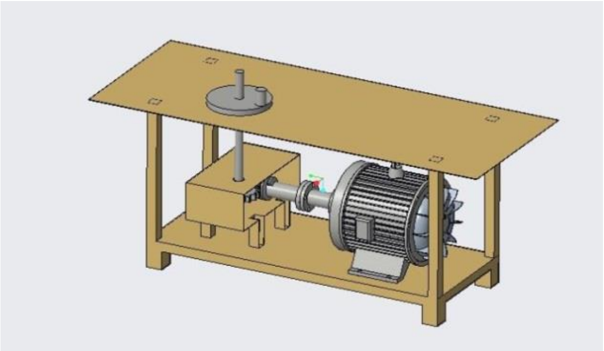
*Our goal is to develop & design a machine to achieve high production rate with less man power & of desired accuracy.*

***Keywords:-*Bar, Bending, Machine, Semi-automatic, Electrically operated**

## 1. INTRODUCTION

In traditional method bending of straight reinforcement bar is done with hand operated mechanism. Whole accuracy of bend is depend on Skill & 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 are machine works on 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 immobile.

## 2. OVERVIEW OF BAR-BENDING MACHINE



Bar bending machine is consist of electric motor, coupling, circular plate, worm gear drive, extended shaft. Electric motor transmits power to gear box where speed is decreased and torque is increased. Which is used to bend bar with the help of circular plate. Bend at any required angle for bar having dia. 6 to 16mm. we also used small electric system for auto reverse and auto forward mechanism which consist of contactor and limit switch. Which is readjustable because of spring back effect of bar.

## 3. ADVANTAGE

- low cost as compared to hydraulic and pneumatic machines.
- Less skilled and uneducated worker can also operate this machine.
- Less time consuming.
- Less effort required.
- Higher production rate with desired accuracy
- It is portable

## 4. DISADVANTAGE

- Chances of accident due to improper concentration on work.
- It totally stops functioning in absence of electricity.

## 5. APPLICATION

- It is specially developed for making stirrups for beam and column.

## 6. DESIGN

### 6.1 COMPONENT

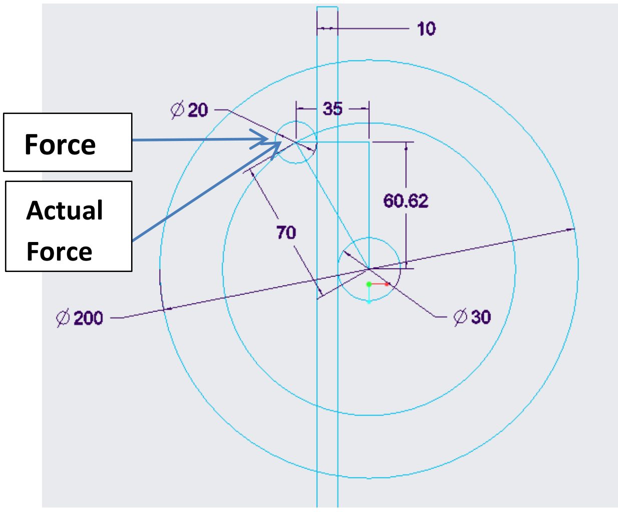
1. Motor
2. Coupling
3. Worm gear drive
4. Shaft
5. Circular plate

- PROPERTY TABLE

| COMPONENT | MATERIAL | PROPERTIES |
|---|---|---|
| SHAFT | CARBON STEEL 40C8 | Ultimate tensile strength 560-670 MPa<br>Yield strength 320 MPa<br>Shear strength IS 60% of min. tensile strength |

| | | |
|---|---|---|
| KEY & COUPLING | CAST IRON | Shear strength 42MPa<br>Tensile strength<br>151 to 427 MPa<br>Compressive strength<br>572 to 1289 MPa |
| BOLT | Medium carbon steel, quenched and tempered | Yield strength 640 MPa<br>Min. Tensile strength<br>800 MPa |
| CIRCULAR PLATE | Mild steel AISI 1018 | Tensile strength 440 MPa<br>Yield strength 370 MPa |

### 6.2 MOTOR




- Force required to bend bar
  m = moment about neutral axis
  $\sigma_b$ = bending stress
  y = perpendicular distance to neutral axis
  I = moment of inertia about neutral axis

$$\frac{m}{I} = \frac{\sigma_b}{y}$$

$$I = \frac{\pi}{64} \times D^4$$

D=10mm dia. Of bar

$$I = \frac{\pi}{64} \times 10^4$$

$$I = 490\ mm^4$$

For SI Grade 20 Bar Yield strength is given below

$$S_{yt} = 271\ \frac{N}{mm^2} \qquad \textit{(from Research paper)}$$

*Factor of safety = 3 (assumed )*

$$y = \frac{D}{2} = \frac{10}{2} = 5mm$$

$$\sigma_b = \frac{S_{yt}}{3} = \frac{271}{3} = 90.33\ N/mm^2$$

$$M = \frac{I \times \sigma_b}{Y}$$

$$= \frac{490 \times 90.33}{5}$$

$$M = 8868.05\ N.mm$$

L = Length of bar from where bend is required
L = 250 mm (app.)

Considering simply supported beam with point load at center
w = F = force

$$M = \frac{w \times L}{4}$$

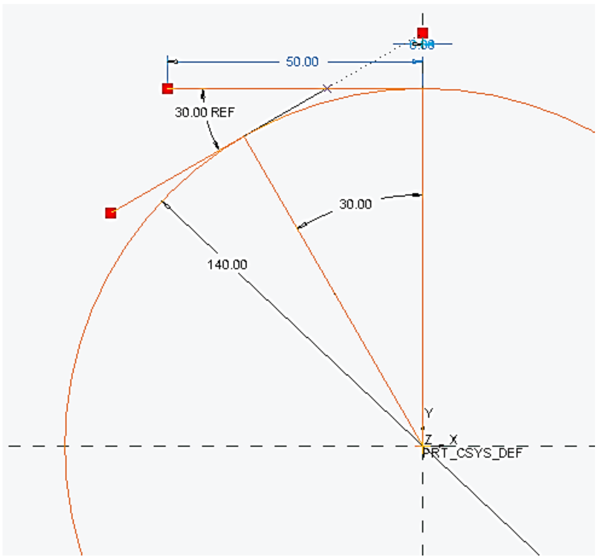
$$w = \frac{4 \times M}{L}$$

$$= \frac{4 \times 8868.05}{125}$$

$$W = 283\ N$$

$$W \cong 285\ N$$

- Above calculated force is considered as it acts in perpendicular direction to Bar so we have to calculate actual force and its direction.




$$cos\theta = \frac{adjacent\ side}{hypotenuse}$$

$$cos\theta = \frac{60.62}{70} = 0.866$$

$$\theta = 30°$$

$F_t$ = actual force

$$\cos 30° = \frac{F}{F_t}$$

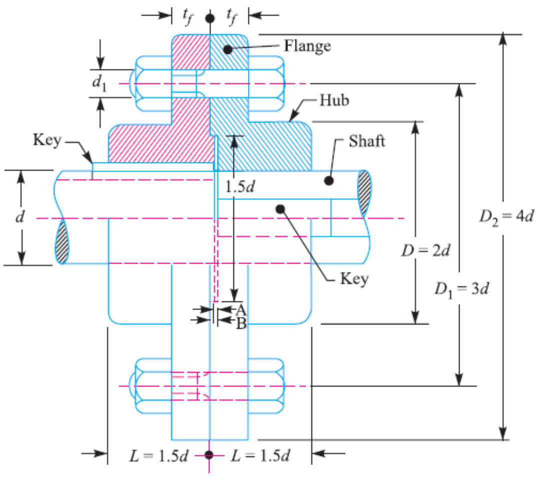
$$= \frac{285}{F_t}$$

$$F_t = 330\ N$$

$$T = F_t \times R$$

$$= \frac{330 \times 70}{1000}$$
$$T = 23.1\ N.m$$
$$P = \frac{2\pi NT}{60}$$
$$P = \frac{2\pi \times 90 \times 23.1}{60}$$
$$= 217.71\ watt$$
$$P = 0.22\ Kw$$

### 6.3 Design of coupling




#### 6.3.1 Design of hub

P = 0.22 Kw

Here we have not considered friction and ideal power to run machine without load and also due to unavailability of above power rating motor so we consider motor of 2 Kw

Assumed data
P = 2 kw
N = 90 rpm
τ = 42 Mpa
for shaft with allowance key ways

$$P = \frac{2\pi NT}{60}$$

T = 212.20 N.m = 212200 N.mm

d = diameter of shaft

$$T = \frac{\pi}{16} \times \tau \times d^3$$
$$d = 29.52\ mm \cong 30\ mm$$
$$D = 2d$$
$$= 2 \times 30$$
$$= 60\ mm$$

$$L = 1.5d$$
$$= 45\ mm$$

Checking in shear failure

$$T = \frac{\pi}{16} \times \tau \times \left(\frac{D^4 - d^4}{D}\right)$$
$$\tau = 5.33\ N/mm^2$$

5.33 < 42 So design is safe

- Design of key

$$w = \frac{d}{3} = \frac{30}{3} = 10\ mm$$
$$t = \frac{d}{3} = \frac{30}{3} = 10\ mm$$
$$l = L = 45\ mm$$

Checking in shear failure

$$T = l \times w \times \tau \times \frac{d}{2}$$
$$\tau = 31.43\ N/mm^2$$

31.43 42 so design is safe
31.44

#### 6.3.2 Design of flange

$t_f$ = thickness of flange

$$t_f = \frac{d}{2} = \frac{30}{2} = 15\ mm$$

$$T = \frac{\pi \times D^2}{2} \times \tau \times t_f$$

$$\tau = 2.50\ N/mm^2$$

2.50 < 42 so design is safe

#### 6.3.3 Design of bolt

$D_1$ = pitch circle dia.
$d_1$ = dia. of bolt
n = no. of bolt

$$D_1 = 3d = 3 \times 30 = 90\ mm$$

*NOTE*:- Here strength of bolt should be less than shear strength of flange so if failure occurs in bolt due to overload, bolt fails first. Whose replacement is economical rather than replacement of whole coupling. So we assumed $\tau_b = 35\ Mpa$

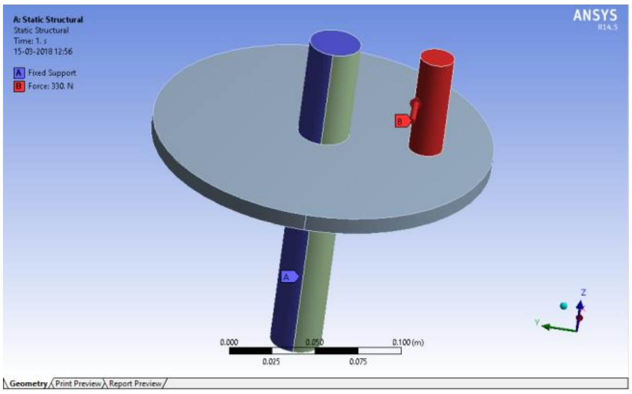
$$T = \frac{\pi}{4} \times {d_1}^2 \times \tau_b \times n \times \frac{D_1}{2}$$

$$d_1 = 6.54 \cong 8\ mm$$

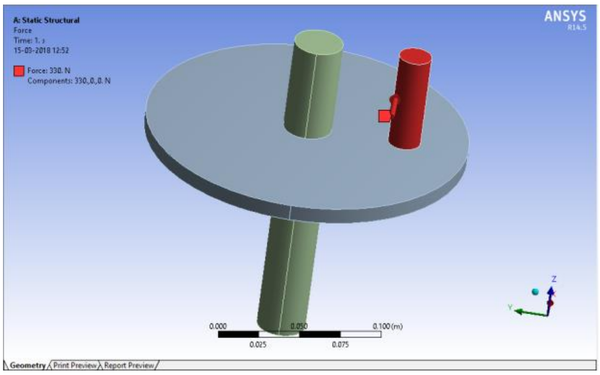
$$D_2 = 4d = 4 \times 30 = 120\ mm$$

## 7.ANALYSIS

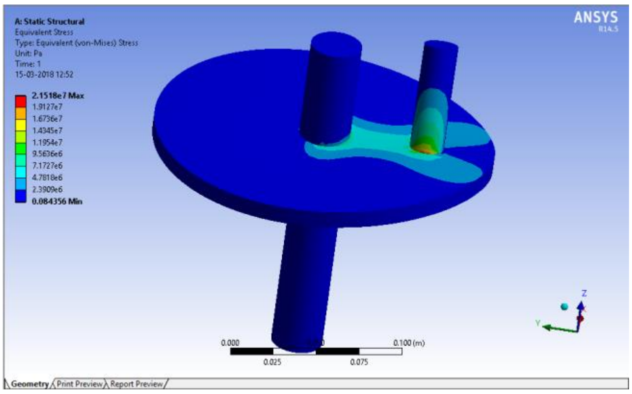
1.FIXED SUPPORT & MATERIAL ARE APPLIED




2.LOAD APPILIED ON MOVING COMPONENT




3. FINAL RESULT & EQUIVQLENT STERSS

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## 9. CONCLUSION

Bar bending machine to produce stirrup of desired accuracy the main advantage of machine over the previously used manual process is that it is man power independent and secondly the accuracy of the output job. the machine is portable & can be installed and operated where electricity is available.

## 10. REFERENCE

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