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Design and fabrication of Portable manual Roller Bending machine

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Abstract— **The aim of this project is to design and fabricate a roller-bending machine, which is useful for bending a metal rods and sheets/plates. The size of machine is very convenient which makes it portable and easy to use. It is fully made of mild steel. It reduces human efforts and require less skills to operate, which can save costs for fabrication shops and construction industries. the roller-bending machine is made up of two lower rollers, one upper roller mounted on ball bearings, an elevating screw, a rotating lever, and supporting frame. This machine works on simple kinematic system that is four bar chain or Quadric cycle chain as it contains four links and each of them form a turning pair with each other instead of complicated design like the chain and sprocket-based roller mechanism to bend rods. Due to its portability, it can be used by small workshop or fabrication shop. Bending machine is a common tool in all mechanical workshops. The paper also describes the process and operations employed for the fabrication of roller bending machine.**

Keywords— Problem statement, Fabrication of manual bending machine (3-D modelling of Machine)

I. INTRODUCTION

In metalworking, rolling is a metal forming process in which a metal plate is passed through a pair or more rolls. Rolling is a complex process, determined by the properties of the material being rolled; its thickness being a major factor. The parameters used in designing and fabricating the three-rolls bending machine depends on these properties and the corresponding thickness of the material in use. In this process, the diameter of the metal rod or thickness of sheet being rolled does not change after the rolling. Generally bending is a process that produces U-shape, V-shape, or channel shapes in ductile materials, most commonly in sheet metal as per requirement on different types of bending machines. There are two different machines available in market for bending of sheet and bending of rod. There is no single machine available which bends rod as well as sheet in a single unit. Roller bending process can be used to deform a sheet, plate or rod. Rolling machines with three rollers are used to bend mild steel rod and sheet metal with various curvatures. According to **Gadekar, (2017**), the metal forming is a process to obtain the desired shape and size of plastic deformation without loss of materials. The forming is done by bending or transforming the straight metal into a curved shape with the help of rollers. The time taken for shapes will depends on the material and thickness of sheet, and it can be done on a sheet, metal tube, and rod and angle. Nevonproject, **(2018)** designed and fabricated a mini manual roller-bending machine assisted by chain and sprocket roller mechanism. The rollers are fitted with bearings to achieve the smooth motion. One of the rollers is integrated with a hand driven spindle to drive it manually and simultaneously connected to the other rollers using a chain sprocket mechanism to obtain the same rotation with the rotation of hand drive spindle. Similarly, **Kannan et al. (2019),** studied on manual hydrulic roller bending machine. It consist

of screw adjustable roller to lower manually and forced against the rod, so that the rod undergoes both plastic and elastic deformation to change the shape. The portion of the rod between the rollers will take on the shape of a cubic polynomial. Later, Soother, **(2019),** designed manual roller-bending machine, that rolls freely about three parallel axes, with uniform horizontal spacing. In this mechanism, after the bar is initially inserted into the jig, middle roller is manually lowered and forced against the bar, so that rod undergo plastic and elastic deformation. However, the obstruction with the machine required high pressure, strength as well as accuracy to be bent. Upon the literature review, it was also observed that most of the roll bending machines are either big or electrically operated, which makes it difficult to use and consume electric energy. Besides, it consumes high power, machines are quite expensive and complicated in construction. To address these issues, it was decided to design and fabricate a manual roller bending machine that is compact in size for easy transportation, easy operation with no skills and convenient use at any place.

II. METHODOLOGY

AutoCAD software is used to design the rolling machine then followed with the fabrication of the designed elements. The materials used for fabrication is mild steel, which is commonly available in the market. The materials were selected to meet the machine requirements of strength, machine accuracy and reliability. The various machining processes used in this fabrication are, cutting, turning, drilling and lathe operation, and appropriate joining methods viz, welding and screw joints. The following procedure was incorporated to complete the entire mechanism.

A. 3D Model

It is a complete 3D model. It ferries real imagination and reinstate the presentation of architecture drawing (Figure 1).

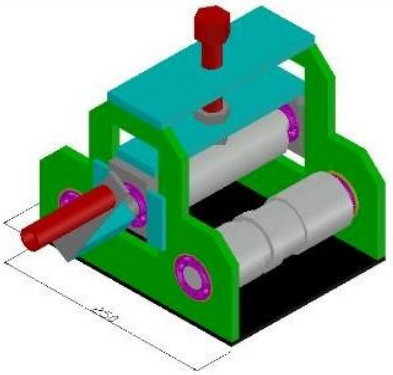

Fig 1: 3D Modelling of Manual Roller Bending Machine

B. Detail Drawing

In order to supplement 3-D drawing, it has shown the orthographic views of designed works, which describes true size and shape of the various features as 3D model simply depicts the visual presentation, which does not suffix in the process of developing the product and fabrication as shown in figure 2.

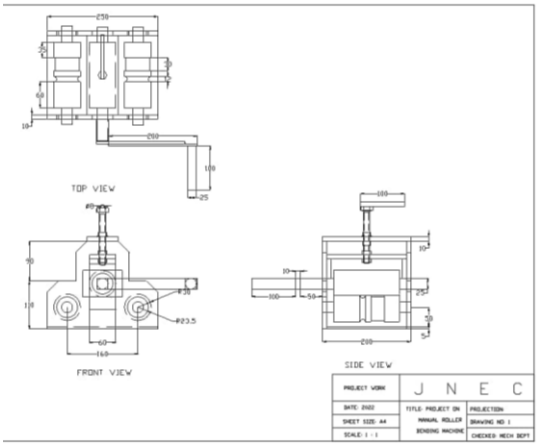

Fig 2: 3D Modelling of Manual Roller Bending Machine

C. Calculation of torque required

The following figure 3: reflect the roller mechanism to calculate the torque.

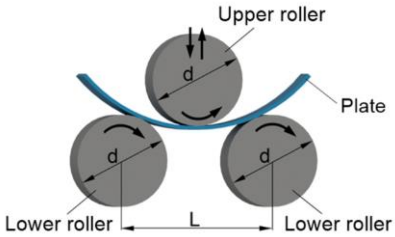

Figure 3: Roller position

Maximum torque required for cylinder rolling

$M_t = K\sigma_s\left(\frac{B\delta^2}{4}\right)$… (Ajmani, 2019)

Where;

$M_t = M$aximum torque

$K =$ Reinforcement co-efficient

$\sigma_S = Material\ yeild\ limit$

$B = Length\ of\ the\ rolled\ rod$

$\delta = Thickness$

$F = \frac{M}{\mathrm{R}\sin\theta}$ … ..(Almohamad,2020)

$\theta = \sin^{-1}\frac{a}{d_{min} + d_2}$

where;

$L =$ lower roller center distance in mm

$d_{min} =$ Minimum diameter of rod (mm)

$d_2 =$ lower diameter (mm)

Therefore, $\theta = \sin^{-1}(201/(300 + 60))$

$\theta = 30°$

D. Working principle

With regard to the principle of three-point forming circle, the relative position change and rotational motion of the working roll make the metal sheet produce continuous plastic deformation to obtain the predetermined shape of the work piece. Three rolls bending machine usually take two lower rollers as active rolls and can realize positive and reverse rotation. The upper roller is a follower roll which can move vertically up and down. When rolling, rod is placed between the upper and lower rollers and the three contacting points that are exposed to the metal rod by three rolls can make the rod behind into a curved closed circle. Therefore, the forming process of sheet metal can be regarded as the three-roll bending machine to make a continuous three-point bending process. During processing, one end of the metal rod is feed into three rollers between the upper and lower rollers, and then top roller is brought downward with the help of elevating screw on top of the upper roller which make the rod/plate under it to undergo a certain plastic bending deformation due to compression. When the roller is rotated, there is friction between the rod/plate and rolls. So, when the roll is rotated, the rod/plate also moves along its longitudinal direction. Lower roller under positive and negative rotation alternately and rolled rod move back and forth, two lower roller rotation and the friction drive move. Meanwhile, the upper roller can be moved to add downward pressure on the rod/plate. When the rod passes the bottom of upper roller (the roller deformation zone) in turn, and stress exceeds the yield limit, it will produce rod/plate deformation along the full length, and it is processed into the required shape. By adjusting the relative position between the upper and lower rolls properly, and the rod can be bent to a radius not less than the radius of the upper roller. This portable manual roller-bending machine can be used to even bend other materials such as sheet metal and metal plate.

III. CONCLUSION

The dimension of the roller machine is 250mm in length, 200mm in width, and 200mm in height. It has capacity to bend 10 mm diameter of mild steel rod, 5mm thick mild steel plate and 2.5mm thick mild steel sheet. The main components of machine include, rollers, supporting frame, elevating screw and handle.

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V. RECOMMENDATION

Since this machine can bend material in only circular shape, there are some constructions that requires materials to be bend in different shapes like cone and at some angle. So to use this machine in different locality for different construction; the bending roller needs to be set at an angle. Therefore, we recommend the next group to fabricate the machine in such a way that the bending roller can be set at some angle to get different shape. We would like to recommend the next group to come up with a new design, which can be used to bend not only MS rod but also even the mild steel pipe.

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