



# Design and Development of Multi-Operational Rolling Machine

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## Abstract

The ultimate purpose of ongoing work is to clarify the concept of multi-operational rolling machine which is used for the manufacturing purpose (metal forming work) in an industry or workshops. We have developed a conceptual model of machine which can accomplish performing different operation simultaneously like rolling, bending and riveting and it should be economically efficient and compact. The conceptual design of the proposed machine has been decided after the comprehensive comparison between all the machines of metal forming on every aspect like scope, required cost and etc. This is preliminary concerned with the transmission of power through chain drive arrangement. It is designed as portable one which can be used for the metal forming operation in a compact space. Since the machine uses less human effort for performing various operations at a time and the cost is admirable. The aim of our project is to design and fabrication of multipurpose machine, structure which is used for performing the multiple operation like drilling bending threading and rolling. Develop a machine which can do multiple operation in same frame structure, reduce the floor surface area and reduce material handling time and increase production efficiency.

**Keywords:** *Rolling, Bending, Riveting, Economical, Multi-operational;*

## 1. Introduction

The manufacturing process refers to the steps that raw materials go through to become a semi-finished or finished product. The first steps in the manufacturing process are the product design and material specifications from which the product is made [1]. The required product is then created by modifying these materials during the manufacturing process. Machines play an important role in the manufacturing process, and they employ a wide range of machines to transform raw materials into the required component, depending on the industry's needs. To increase the productivity and gain of the industries, manufacturing machinery and equipment should be properly designed and produced [2]. By combining the three metal forming processes into a single unit, the multipurpose machine design approach aims to minimise the time it takes to design and manufacture production equipment [3]. The latest approach to conceptual design, as described in this article, can be used at any stage of the idea generation process, whether for the entire design or a single part. Since they are already part of the device assembly, improvements to component design are not necessary [4]. To produce various sheet metal pieces, however, a number of metal processing machines have been produced and manufactured. The majority of the computers, on the other hand, are mainly used for single operations and have minimal processing power. In many industries, this can reduce efficiency, output, versatility, and competitiveness since only a few functions can be performed on a single machine. Single-function devices, on the other hand, have two major drawbacks: their initial cost and the amount of floor space they need [5]. As a result, a multipurpose sheet metal machine must be designed and constructed in such a way that machine costs are reduced while sheet metal process efficiency is increased [6]. Since the study's main aim is to design, test, and fabricate a multipurpose sheet metal machine in order to improve sheet metal manufacturing efficiency and lower product costs [7]. The design and analysis process included selecting suitable materials for the construction of a multipurpose sheet metal machine, mathematical design, testing, and fabrication of a multipurpose sheet metal machine, as well as efficiency and economic analysis [8]. A rolling machine is a piece of machinery that feeds raw metal between two or more rollers. When it comes to sheet metal production, rolling machines compact raw metal into a lighter, more uniform shape [9]. As the raw material is pumped into the unit, at least one pair of rollers compresses it. The metal that comes out of the rollers is lighter and has a more consistent shape [10]. Rolling is the process of transferring metals between rollers to form semi-finished or finished shapes [11]. The most popular method of metal forming is rolling. It's used to make blooms, billets, slabs, boards, frames, and strips, among other items, from metal ingots [12]. During rolling, the metal is deformed plastically by moving it between rollers that rotate in opposite directions [13]. Rolling's primary purpose is to

reduce the thickness of the metal. Since the increase in width is typically minimal, the decrease in thickness results in a length increase [14].

## 2. Methodology

A review of research papers, books, journals, manuals, and electronic sources that addressed design, production, and mechanics of the sheet metal manufacturing process was conducted as part of the study. The study used statistical methods and included efforts to analyse and evaluate the best multipurpose sheet metal machine capability in order to improve the performance and competitiveness of sheet metal manufacturing industries. The deflection, material shapes, and stress effects were all studied using mathematical analysis in this thesis (bending stresses, moment under subjected loads) [15]. Since the project's design, production performance, economic analysis, and evaluation were all based on empirical research, Catia V5 is also used to create the machine's detailed and assembly drawings. Finally, the conclusions and recommendations of the study were completed.

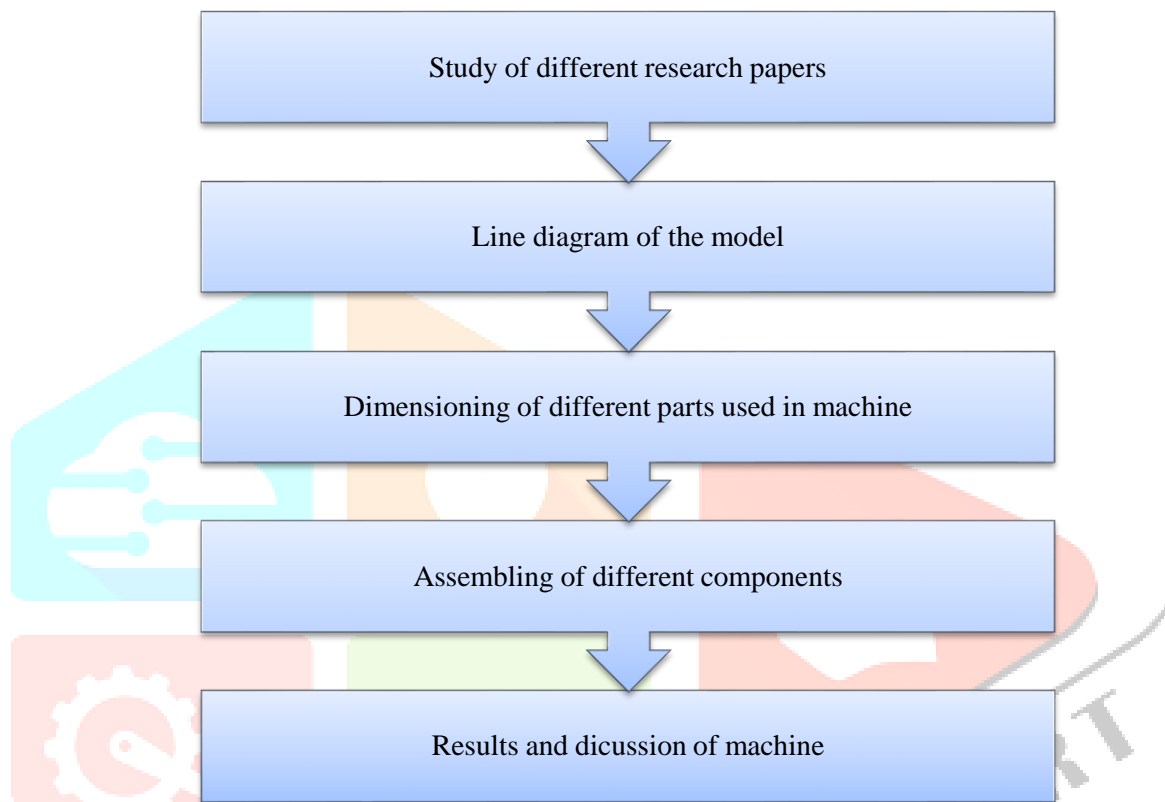


Fig. 1. Methodology to develop Multi-operational Rolling Machine

The design method is basically a test of applied ingenuity. Various design processes have been established to aid in the organisation of attacks on unconstructed problems for which many solutions exist. Recognize the need: It implies anyone acknowledging that a problem exists and that corrective action should be taken. The issue may be the discovery of a flaw in existing machinery or the need for a new product on the market. Issue definition: It entails defining the item to be modelled by specifications [16]. Physical or functional characteristics, expense, efficiency, and operating performance are all included in this specification. Synthesis: In this process, we establish preliminary (basic) ideas about the problem's topology and geometry, i.e., the form, size, and connectivity of the product's various parts. A prototype model is developed during this process. To conduct a feasibility analysis, a prototype model is analysed by applying various boundary conditions and constraints, as well as subjecting the model to various temperatures and loads. If the product fails at this stage, the design is reverted to the synthesis process once more. The measurement phase's end products are compared to the destination phase's end products [17]. If any changes are needed, the design is returned to the synthesis process. Presentation involves design documents such as drawings, material descriptions, bill of materials, views, tolerances, and so on.

## 3. Design Calculation

### 3.1 Design of Power Screw

Table 1. According to IS-4694-1968 (Reaffirmed 1996) from R.S. Khurmi

Nominal Diameter (d <sub>i</sub> )	Major Diameter		Minor Diameter (d <sub>o</sub> )	Pitch (p)	Depth of Bolt Nut		Area of core (A <sub>c</sub> )
	Bolt (d)	Nut (D)			Bolt (b)	Nut (b <sub>1</sub> )	
12 mm	12 mm	12.5 mm	10 mm	2 mm	1 mm	1.25 mm	78.5 mm <sup>2</sup>

$\mu$  = Coefficient of Friction = 0.15

w = weight of roller  
 $\alpha$  = Helix Angle  
 $\phi$  = Friction Angle  
 $d_c$  = Major Diameter = 12 mm  
 $d_o$  = Minor Diameter = 10 mm  
 Pitch = 2 mm

Torque required lifting the load,

Lead = 3\*pitch (Single Trapezoidal Thread) ..... From V.B. Bhandari at pg. no .69

$$= 3*p$$

$$= 3*2$$

$$= 6 \text{ mm}$$

$$d = d_o - \frac{p}{2}$$

$$= 10 - \frac{2}{2}$$

$$= 8 \text{ mm}$$

Helix Angle ,

$$\tan \alpha = \frac{\text{lead}}{\pi * d}$$

$$= \frac{6}{\pi * 8}$$

$$\alpha = 12.95$$

$$\tan \phi = \mu$$

$$\phi = \tan^{-1} \mu$$

$$\phi = \tan^{-1}(0.15)$$

$$\phi = 8.53$$

Torque required to raising the load, For Mild Steel Rod

B = width of sheet metal = 400 mm = 0.4 m

$\rho$  = density of mild steel = 7850 kg/m<sup>3</sup>

V = Volume of sheet metal

$$V = \pi r^2 B$$

$$= \pi * 19 * 10^{-4} * 0.5$$

$$= 4.53 * 10^{-4} \text{ m}$$

$$\rho = \frac{m}{v}$$

$$m = \rho * v$$

$$= 7850 * 4.53 * 10^{-4}$$

$$= 3.35 \text{ kg}$$



$$W = m \cdot g$$

$$= 3.35 \cdot 9.18$$

$$= 32.8635 \text{ N}$$

$$M_t = W \cdot \tan(\varphi + \alpha) + \frac{d}{2}$$

$$= 32.8635 \cdot \tan(8.53 + 12.95) + \frac{8}{2}$$

$$= 16.93 \text{ N mm}$$

Torque required to lower the Load,

$$M_t = W \cdot \frac{d}{2} \cdot \tan(\varphi - \alpha)$$

$$= 32.8635 \cdot \frac{8}{2} \cdot \tan(8.53 - 12.93)$$

$$= -10.11 \text{ N mm}$$

The negative sign indicates that the screw is self-locking.

The Force  $P_i$  at the radius of 19mm is given by

$$P_i = \frac{M_t}{\text{radius}}$$

$$= \frac{16.93}{19}$$

$$= 0.89 \text{ N}$$

$$\begin{aligned} \text{Efficiency of Screw } (\eta) &= \frac{\tan \alpha}{\tan(\alpha + \varphi)} \\ &= \frac{\tan 12.93}{\tan(8.53 + 12.93)} \\ &= 0.58 \\ &= 58\% \end{aligned}$$

### 3.2 Force Analysis

Maximum Torque required for a cylinder rolling Specifications,

$\sigma_s$ : Material yield limit = 370 N/mm<sup>2</sup> (from data hand book)

B: maximum width of rolled shield = 250mm

$\delta$ : Thickness of rolled sheet in mm

$$M_t = \int_0^{\frac{\delta}{2}} \sigma y = 2 \cdot \int_0^{\frac{\delta}{2}} \sigma y \cdot B y \cdot dy = \sigma s \cdot \frac{B \cdot \delta^2}{4}$$

I. For thickness  $\delta = 2 \text{ mm}$

$$M_t = K \cdot \sigma s \cdot \frac{B \cdot \delta^2}{4}$$

K = Reinforcement Coefficient = 1.15

$\delta = 2 \text{ mm}$

$$\begin{aligned} (M_t)_{\text{max}} &= 1.15 \cdot 370 \cdot \frac{250 \cdot 2^2}{4} \\ &= 106375 \text{ Nmm} \end{aligned}$$

Similarly, for

II. For thickness  $\delta = 3 \text{ mm}$

$Mt = 239343.75 \text{ Nmm}$

III. For thickness  $\delta = 4 \text{ mm}$   
 $Mt = 425500 \text{ Nmm}$

IV. For thickness  $\delta = 5 \text{ mm}$   
 $Mt = 664843 \text{ Nmm}$

3.3 Force Condition

When rolling steel plate, the force condition is shown in above Figure. According to the force balance, the supporting  $F_2$  on the roll plate can be obtained via the following formula.

$$F_2 = \frac{M}{R \sin \theta}$$

$\theta$  = the angle between defined line 001 and 002.

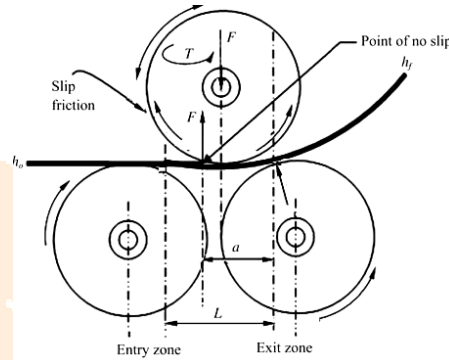


Fig. 2. Raw plate between three roller

$a$  = lower roller centre distance in mm.  
 $d_{min}$  = minimum diameter of the rolling plate in mm = 400mm.  
 $d2$  = lower roller diameter in mm = 25mm.

$$\theta = \sin^{-1} \frac{b}{d_{min} + d2}$$

$$= \sin^{-1} \frac{201}{400 + 25}$$

$$= 28.22'$$

- For thickness  $\delta = 2 \text{ mm}$

$$F_2 = \frac{M}{R \sin \theta}$$

$$R = 0.5 * d_{min}$$

$$= 0.5 * 400$$

$$= 200 \text{ mm}$$

$$F_2 = \frac{10.63 * 10^3}{200 * \sin(28.22)}$$

$$= 112.40 \text{ N}$$

$$F_1 = 2F_2 * \cos \theta$$

$$= 2 * 112.40 \cos(28.22)$$

$$= 198.07 \text{ N}$$

- For thickness  $\delta = 3 \text{ mm}$

$$F_2 = \frac{23.93 \times 10^3}{200 \times \sin(28.22)}$$

$$= 253.03 \text{ N}$$

$$F_1 = 2F_2 \times \cos\theta$$

$$= 2 \times 253.03 \times \cos(28.22)$$

$$= 445.90 \text{ N}$$

- For thickness  $\delta = 4 \text{ mm}$

$$F_2 = \frac{42.55 \times 10^3}{200 \times \sin(28.22)}$$

$$= 449.92 \text{ N}$$

$$F_1 = 2 \times F_2 \times \cos\theta$$

$$= 2 \times 449.92 \times \cos(28.22)$$

$$= 792.88 \text{ N}$$

- For thickness  $\delta = 5 \text{ mm}$

$$F_2 = \frac{66.48 \times 10^3}{200 \times \sin(28.22)}$$

$$= 702.95 \text{ N}$$

$$F_1 = 2 \times F_2 \times \cos\theta$$

$$= 2 \times 702.95 \times \cos(28.22)$$

$$= 1238.79 \text{ N}$$

### 3.4 Calculation of Driving Torque

The Upper roller of the plate of plate rolling machine is the driving roller and the driving torque on the upper roller is used to overcome the deformation torque  $T_{n1}$  and friction torque  $T_{n2}$ .

$$T_{n1} = \frac{M \times d_1}{2R} \dots\dots\dots \text{(From 2mm MS plate)}$$

$$= \frac{10.63 \times 10^3 \times 25}{2 \times 200}$$

$$= 665 \text{ Nmm}$$

The friction torque includes the rolling friction torque between the upper and lower roller and steel plate, and sliding friction torque between the roller neck, and shaft sleeve which can be calculated as follows.

$$T_{n2} = f(F_1 + 2F_2) + \mu \left( F_1 \times \frac{D_1}{D_2} + \frac{d_1}{d_2} \times F_2 \times D_2 \right) \text{ (N-mm)}$$

In the above formula,

$f$  = co-efficient of rolling friction =  $0.008 \times 10^3 \text{ mm}$

$\mu$  = co-efficient sliding friction

$d_1, d_2$  = upper roller and lower roller diameter (mm)

$D_1, D_2$  = upper roller and lower roller neck diameter (mm)

$D_i = 0.5d_i$

$D_1 = 0.5d_1$

$D_1 = 0.5 \times 25 = 12.5 \text{ mm}$

$D_2 = 0.5 \times 50 = 25 \text{ mm}$

$$T_{n2} = 0.008 * 10^3 * (198.07 + 2 * 112.40) + 0.15 (198.07 * \frac{12.5}{25} * \frac{25}{50} * 112.40 * 25)$$

$$= 24254.58 \text{ N mm}$$

$$\text{Total Torque (T)} = T_{n1} + T_{n2}$$

$$= 665 + 24254$$

$$= 24919 \text{ N mm}$$

### 3.5 Shaft Analysis

Specification, From Azo material

Shaft Material = Mild Steel

Tensile strength of the material (Sut) = 440 N/mm<sup>2</sup>

Yield stress of material (Syt) = 370 N/mm<sup>2</sup>

Fs = factor of safety = 2

$$\tau_{\max} = \frac{0.5 * Sut}{fs}$$

$$= \frac{0.5 * 440}{2}$$

$$= 110 \text{ N/mm}^2$$

Calculating Torque required

$$T = 0.18 Sut$$

$$T = 0.18 * 440$$

$$T = 79.2 \text{ N/mm}^2$$

79.2 < 110 N/mm<sup>2</sup>, Hence design is safe

### 3.6 Design of Bearing

#### 3.6.1 Bearing for the 50 mm diameter of roller,

Assume the rolling contact bearing i.e., Deep Groove Ball Bearing  $L_{10}h = 30,000 \text{ h}$

Main diameter of Shaft (d) = 50mm

Following Parameters are taken from SKF bearings

$$D = 52\text{mm} \quad \& \quad w = 15\text{mm}$$

Radial Force ( $F_r$ ) = 3600 N

No. of Revolution (n) = 2 rpm

The bearing is subjected to Pure Radial load

$$P = F_r = 3600 \text{ N}$$

$$L_{10} = \frac{60 * n * L_{10}h}{10^6}$$

$$= \frac{60 * 2 * 30000}{10^6}$$

$$= 3.6 \text{ million revolution}$$

Selection of Bearing

$$C = P (L_{10})^{\frac{1}{3}}$$

$$= 3600 (3.6)^{\frac{1}{3}}$$

$$= 5517.42 \text{ N}$$

Six bearing are available for 50 mm diameter the designation available are 61805, 16005, 6005, 6205, 6305, 6403.....

Out of this we have selected the designation 6005, for that

$C = 7205$        $C_o = 4012$

3.6.2 Bearing for 25 mm diameter of roller,

Assume the rolling contact bearing i.e., Deep Groove Ball Bearing  $L_{10}h = 30,000$  h

Main diameter of Shaft (d) = 25mm

Following Parameters are taken from SKF bearings

$D = 47\text{mm}$       &       $w = 8\text{mm}$

Radial Force ( $F_r$ ) = 3600 N

No. of Revolution (n) = 2 rpm

The bearing is subjected to Pure Radial load

$P = F_r = 3600$  N

$$L_{10} = \frac{60 * n * L_{10}h}{10^6}$$

$$= \frac{60 * 2 * 30000}{10^6}$$

= 3.6 million revolution

Selection of Bearing

$$C = P (L_{10})^{\frac{1}{3}}$$

$$= 3600 (3.6)^{\frac{1}{3}}$$

$$= 5517.42$$
 N

Six bearing are available for 25 mm diameter the designation available are 61805, 16005, 6005, 6205, 6305, 6403.....

Out of this we have selected the designation 16005

$C = 7610$        $C_o = 4000$

3.7 Bending of Strip

The Torque Required for Bending of mild steel Strip

$$T = \frac{\pi}{16} * \tau * d^3$$

$$= \frac{\pi}{16} * 80 * (25 * 10^{-3})^3$$

$$= 2.45 * 10^{-4} \text{ Nm}$$

$$= 0.245 \text{ Nmm}$$

The power required For Bending of Strip

$$P = \frac{2\pi NT}{60000}$$

$$= \frac{2\pi * 2 * 2.45 * 10^{-4}}{60000}$$

$$= 5.13 * 10^{-8} \text{ W}$$

Power in HP



$$= \frac{5.13 \times 10^{-8}}{745.5}$$

$$= 6.88 \times 10^{-10} \text{ HP}$$

### 3.8 Riveting Process

Selection of rivet, to rivet the sheet of 3mm thickness sheet [Assume]

Diameter of Rivet = thickness of sheet\*3

$$= 3 \times 3$$

$$= 9 \text{ mm [3/8" rivet i.e., 9.52 mm]}$$

Metal thickness = 3+3

$$= 6 \text{ mm}$$

Allowance = 1.5\*3

$$= 4.5 \text{ mm}$$

Total length would have to be = 6+4.5

$$= 10.5 \text{ mm rivet}$$

### 3.9 Design of Spring

Material = Stainless Steel (SUS316) = G = 78500 MPa

Coil Diameter = 20 mm

Coil inner Diameter = 17mm

No of coils = 17

Weight = 20 kg

Tensile Strength = 290 Mpa

Force (P) = Mg Sin(θ)

$$= 20 \times 9.81 \times \sin(6)$$

$$= 20.50 \text{ N}$$

$$d^3 = \frac{8DP}{\pi \tau}$$

$$= \frac{8 \times 20 \times 20}{\pi \times 290}$$

$$= 1.52 \text{ mm}$$

Stiffness of spring (K) = 1.732 N/mm.

$$K = \frac{G d^4 \delta}{8 N s D^3}$$

$$1.732 = \frac{78500 \times 1.53^4}{8 \times N s \times 20^3}$$

$$N s = 3.78$$

$$N s = \frac{G \cdot d^4 \cdot \delta}{8 \cdot D^3 \cdot P}$$

$$\delta = \frac{3.78 \times 8 \times 20^3 \times 20}{78500 \times 1.53^4}$$

$$\delta = 11.5 \text{ mm}$$

### 3.10 Bending of Handle

Material = Mild steel

Tensile strength of the material (Sut) = 440 N/mm<sup>2</sup>

Yield stress of material (Sy) = 370 N/mm<sup>2</sup>

Ultimate strength = 840 Mpa

$$\frac{M}{I} = \frac{\sigma}{y}$$

$$\frac{M}{\frac{25 * 5^3}{12}} = \frac{370}{400}$$

$$M = 240.88 \text{ N/mm}^2$$

240.88 840 N/mm<sup>2</sup> so the handle is safe in the bending.

#### 4. Components of Machine

##### 4.1 Roller

The roller of Nickel Chromium sheet of 25 mm shaft (2 pieces) is used as a roller by which the main operation i.e., rolling is performed and further it extended in both the sides so that the operations should be performed on the left-hand side it is attached to the cam for the riveting operation and on the right hand it are attached to the bender for the bending operation of aluminium sheet.



Fig. 3. Pic of Roller used in Machine

##### 4.2 Bearing

The bearing of designation is 16005 of 25 mm diameter and 3.6 million revolution and the radial force acting on the bearing is 3600 N. 4 pieces are used to rotate the roller at a speed of 2 rpm. The no. of bearing used in the machine is 6.

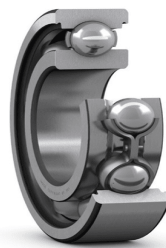


Fig. 4. Pic of Bearing used in Machine

##### 4.3 Power Screw

Power screw dc = 8mm and the d = 10mm used to apply the force acting on the roller in order to reduce the thickness by 0.2 mm in pass and the pitch = 2 mm attached on each side of column lead of the power screw is 6 mm.

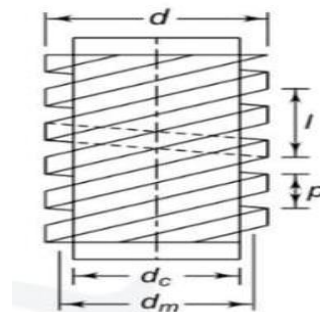


Fig. 5. Pic of Power Screw used in Machine

##### 4.4 Bender

It is a part of metal almost 50mm thickness in which we have made special type of locus according to the operation or the function that we have to be performed. As we bend the aluminium strip for various components such as flat bars, square bar, round bar, and round wire, which are very useful in the fabrication of grills and other products, Bending equipment refers to a group of machine tools and automated systems that are used to solid-draw base metal without the use of welding [18], [19]. Items made of stainless steel, iron, copper, aluminium, and various alloys are bent using industrial and automatic machines and other machinery

[20]. Cold and hot bending are the two types of metal bending technologies. Steelwork that is bent from a solid plate has higher longevity, monolithic construction, and corrosion resistance. Bending equipment may make cylinders, closed-loop components, and complex and irregular sections [21].

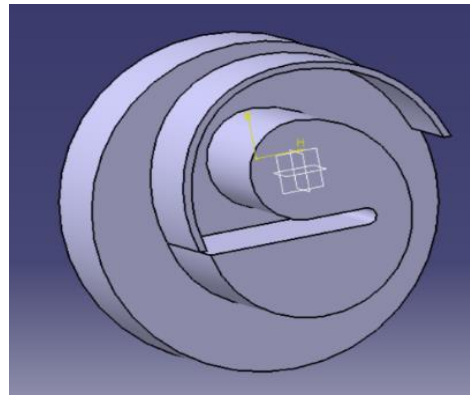


Fig. 6. CAD model of Bender used in Machine

#### 4.5 Handle

The handle is used as driving torque which is used to revolve the upper roller of the machine. The upper roller is attached to the bender.

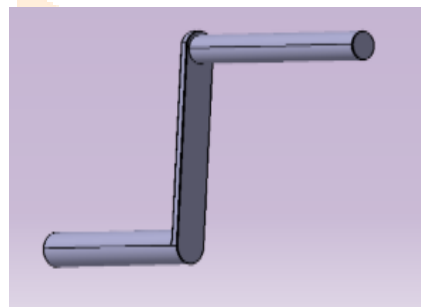


Fig. 7. CAD model of Handle used in Machine

#### 4.6 Base Frame

The Base Frame is the Body of Machine in which the three roller, one bender, handle and all the essential elements which are required for the machine is attached on this base frame.

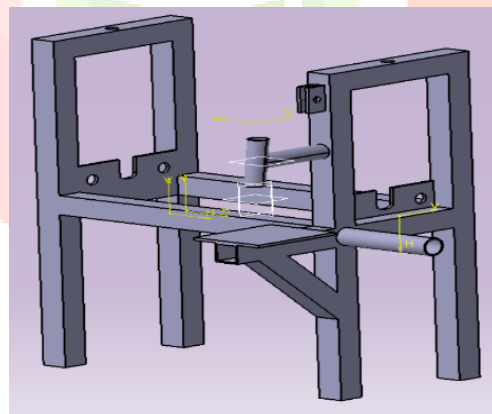


Fig. 8. CAD model of Base frame used in Machine

### 5. Working

The machine consists of multiple operation such as rolling bending and riveting the main function of the machine is to change the straight sheet metal into the curved sheet in which the three mild steel rollers are attached and are mounted on the clamp with one on each side in which the bearing is attached to mount the roller shaft. Among the three shafts the upper shaft/roller is driving by a handle and the lower two shaft/roller in a machine is idle.

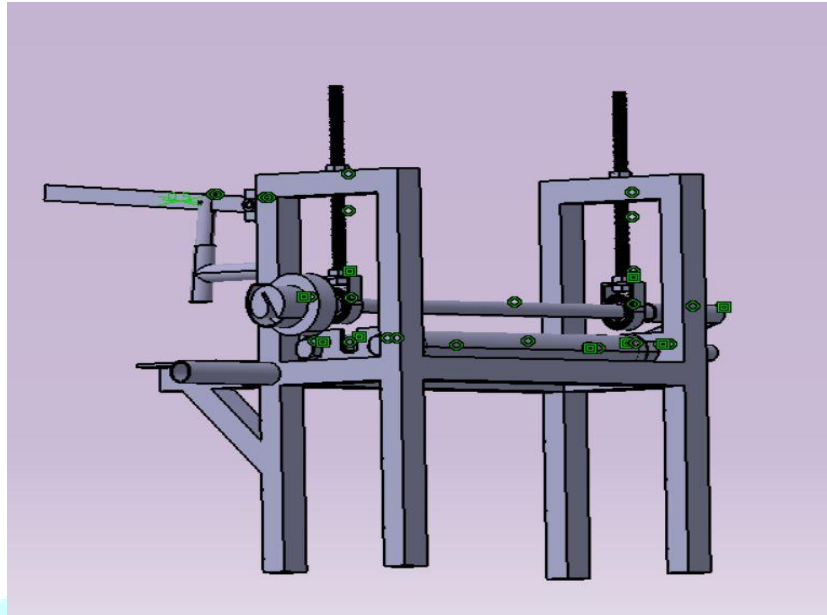


Fig. 9. CAD model of Multi-operational Rolling Machine

When we move the handle in a clockwise direction the sheet starts to rolls and the rolling on the sheet and the diameter of the sheet metal is adjusted by the power screw according to the need we raise and lower the power screw and obtained the defined diameter or of sheet metal having small curvature in the sheet can be made in a straight sheet metal. The secondary operation and tertiary operation in the machine will be more useful in the small workshop welding and sheet metal workshop. The secondary operation that we are performing on the machine is the meaning of operation in which the shaft which is driving by the handle is extended in the right and side if the machine where we are attaching the Bender a small something mm thickness of circular for solid shaft in which we had made a special type of locus. According to the operation that we are going to perform on the vendors so that by using the bending function of useful tool for the shape of all the manner of component likes LED strip round wire which are using very useful in making the staircase grill and etc.

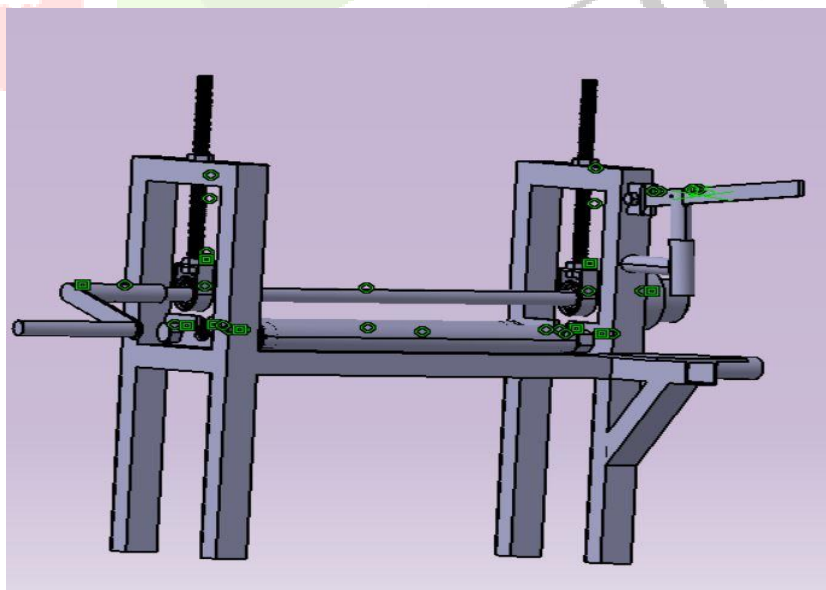


Fig. 10. Another CAD model of Multi-operational Rolling Machine

**6. Advantages**

- Multiple operations can be performed at a home due to which the actual cost of product decreases.
- It is a portable machine [portable] so that it can move from one place to another.

- As it does not require any electricity it can be operated on a remote place.
- When we compare the three different machines cost the cost of our machine is very less.
- Supports a Variety of Soft Metals
- Very useful for fabrication

**7. Disadvantages**

- As it does not operate on electricity more human efforts are required due to which productivity may affects.
- As it is a prototype model, here bending is limited up to the thickness of 4mm. For higher thickness of specimen this machine size should be increased.

**8. Applications**

- Sheet Metal Pipe.
- Riveting of sheets.

**9. Future Scope**

- Pipe as well as strip bending can be performed simultaneously.
- Renewable source of energy can be used.
- More operation can be attached.

**10. Result**

The given graph is of thickness v/s time graph for length 500mm of both Aluminium and steel sheet. According to above graph the aluminium sheet required less time for rolling operation while steel sheet required more time for rolling operation.

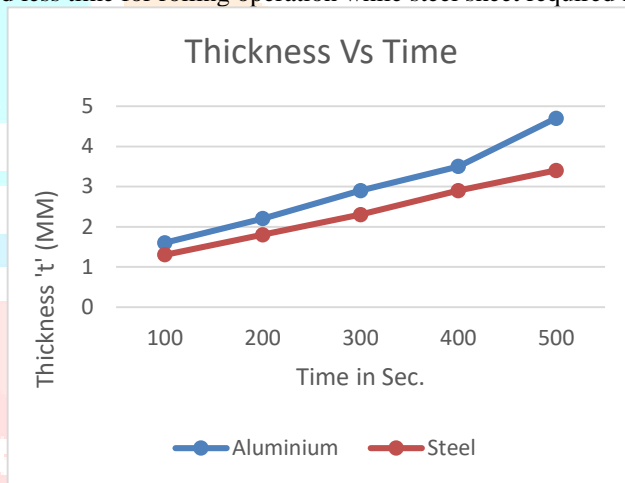


Fig. 11. Graph of Thickness and Time

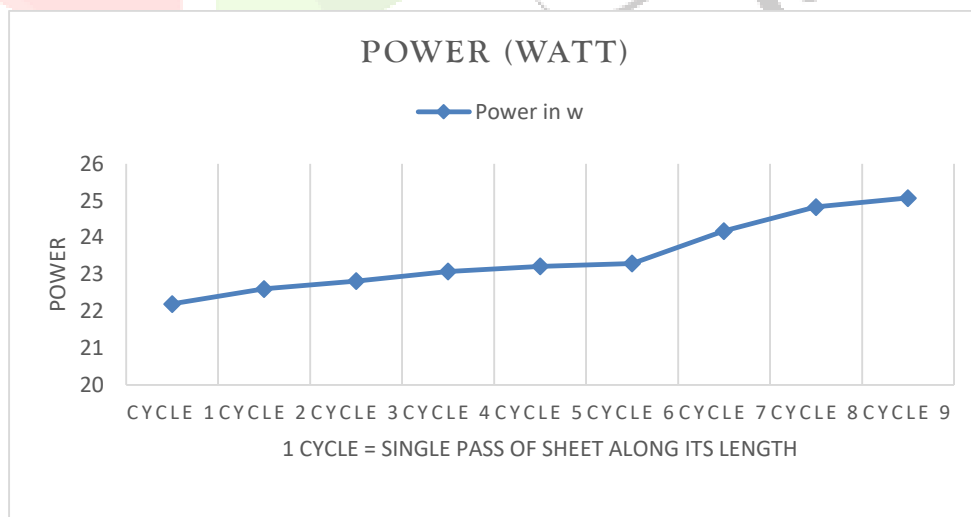


Fig. 12. Power and Cycle

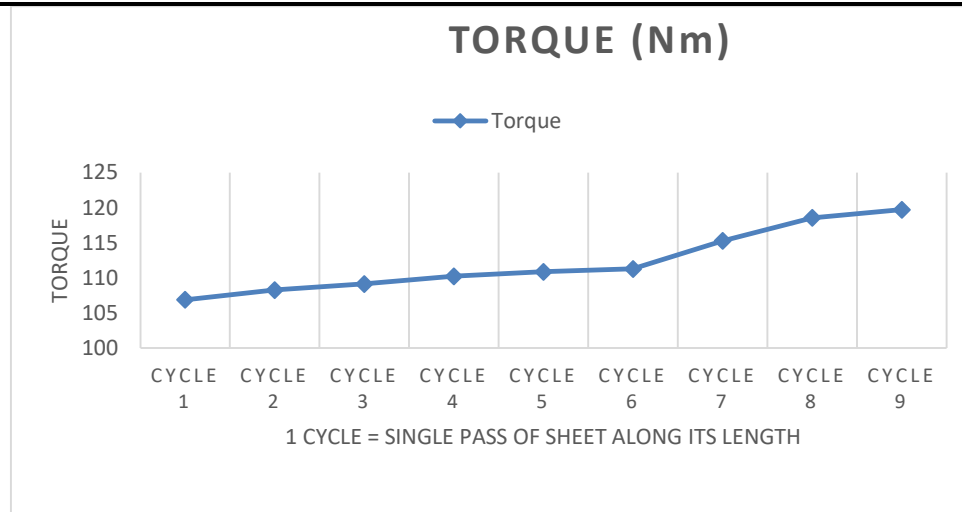


Fig. 13. Torque and Cycle

## 11. Conclusion

Such bending machines are more important for small-scale manufacturing and small workshops because they are less expensive and more precise. The machine's capability can be expanded to meet the demands of industry or the workshop. The main aim of our project is to improve the machine's productivity and efficiency during this research. The unit is cost-effective due to the materials used in its construction and the simplicity of the component parts' design. The results show that our machine's productivity meets the reliability standards that we must achieve. Since the study's design and review were thorough, the goals were met. Since the use of multipurpose machines rather than single purpose machines improves the financial efficiency and productivity of sheet metal manufacturing industries.

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