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Design and Development of Automatic Grinder for Band Saw Blade

Blade sharpening machine

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Abstract — *The following paper describes the design and development of automatic grinder for band saw machine blade. This paper resolves problem of Continuous use of band saw blade for cutting of bar stocks and pipes, etc. it gets worn out so performance of blade getting weaker due to the wearing, so our aim is how we can sharpen the blade. If we are able to sharp the blade then performance of blade gets improved. Another challenge for us is to make fully automatic machine. We are making this special purpose machine in mechatronics which operates efficiently and consistently and it should be compact and cost effective. Drafting of various parts were done by SOLIDWORKS software.*

Keywords *- Automation, Mechatronics, Band saw, Sharpening, Lead Screw, Stepper motor, Arduino UNO board.*

I. INTRODUCTION

The typical metal cutting horizontal band saw Machine is a floor mounted machine used for Simple cutting of solid steel, tubing, and odd shaped material. By continuous use of band saw blade for cutting of bar stocks and pipes, etc. it gets worn out so performance of blade getting weaker due to the wearing so our aim is to sharpen the blade. Mechanically operated band saw blade grinding machine are available in market. Weight, cost and maintenance of these machines is very high so we are making this special purpose machine in mechatronics. This special purpose machine working on two stepper motors, these motors are drive using the Toshiba drivers (TB6560) and controlling is done with the help of Arduino UNO board.

II. MATERIAL SELECTION

As per the market study for material selection on the basis of Strength, Hardness, Weldability, Availability, Machinability and cost it was found out that the Mild Steel (MS) is suitable material for all sheet metal working. Also Brass material was used for making bush having low coefficient of friction. Stainless steel rods are also used for sliding body. Rollers are made up of the Nylon due to its less weight and better grip.

III. DESIGN

3.1 Design of base plate:

The base plate in a machine only provides proper balance to the structure. Considering the size constraints, the dimensions of the base plate were taken as under. Also it had been found that not much of the stresses are developed in the base frame. The dimensions of base frame are 300mm x 400mm

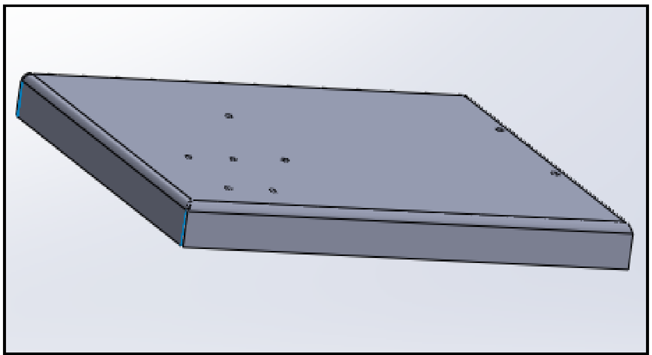

Fig 3.1 Base plate

3.2 Design of lead screw:

For design and selection purposes, the mechanical analysis of lead screws usually is limited to the factors affecting their static or quasi-static performance, such as efficiency, driving torque requirements, and load capacity. Outer diameter of lead screw is 12mm. Pitch of lead screw is 1.5 mm and material used for lead screw is hardened steel

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and material of bush is brass. There are Dimensions of screw threads Screws with various numbers of starts. Numerous important aspects involved in the successful design of a lead screw drive system.

Force Analysis -Trapezoidal Threads
Case 1: Lifting Load

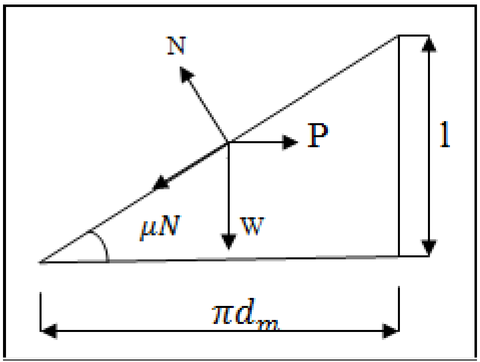

Fig. 3.2 Force diagram for Lifting Load

1. Horizontal Force = P = $\frac{W(\mu \sec\theta + \tan\alpha)}{(1-\mu\sec\theta\tan\alpha)}$
2. Helix angle =α $= \tan^{-1}(\frac{l}{\pi d_m})$
3. Torque required to raise the load = M_t= P$\left(\frac{d_m}{2}\right)$= W$\left[\frac{d_m}{2}\frac{(\mu\sec\theta+\tan\alpha)}{(1-\mu\sec\theta\tan\alpha)}\right]$
4. Efficiency of the screw=η = $\frac{\tan\alpha(1-\mu\sec\theta\tan\alpha)}{(\mu\sec\theta+\tan\alpha)}$

Where,

For **ISO** Metric trapezoidal thread, $\theta = 30^\circ$
Taking load = 5Kg = 5$\times$ 9.81= 49.05N
Horizontal force at the time of grinding = 10N
Total load = 49.$05 + 10$ = 59.05= 60N
Coefficient of friction at starting = 0.08

- **Lead Screw** is taken as follows**:**
  - Mean diameter = d_m $=$ 12mm
  - Pitch = l = p = 1.5mm

- **Helix angle** $= \alpha = \tan^{-1}(\frac{l}{\pi d_m})$
  $= \tan^{-1}(\frac{1.5}{\pi\times 12})$
  $= \tan^{-1}(0.0397)$
  = **2.27** $^\circ$
- **Horizontal Force** = P = $\frac{W(\mu\sec\theta+\tan\alpha)}{(1-\mu\sec\theta\tan\alpha)}$
  $= \frac{60(0.08\sec 30^\circ+\tan 2.27^\circ)}{(1-0.08\sec 30^\circ\tan 2.27^\circ)}$
  $= \frac{60(1.73205+0.0397)}{(1-1.73205\times 0.0397)}$
  $= \frac{106.305}{0.93124}$
  = **114.15** N
- **Torque required** =M_t= P$\left(\frac{d_m}{2}\right)$
  $= \frac{114.15\times 12}{2}$

= 684.92 N-mm
= 0.684 N-m
We know that, 1 N-m = 10.19Kg-cm
So 0.684 N-m = 6.9748 Kg-cm
Taking stepper motor 2 as follows,
Voltage = 12V
Current = 2A
Torque = 10.2Kg-cm Bipolar

- **Efficiency of the screw** $= \eta = \dfrac{\tan\alpha(1-\mu \sec\theta \tan\alpha)}{(\mu \sec\theta + \tan\alpha)}$

$$= \tan 2.27^{\circ}\left[\frac{(1-0.08 \sec 30 \tan 2.27)}{(0.08 \sec 30^{\circ} + \tan 2.27^{\circ})}\right]$$

$$= \frac{0.03963(1-0.08(1.1547)(0.03963)}{0.08(1.1547)+0.03963}$$

$$= \frac{0.03949}{0.132015}$$

= 0.2991 or **29.91%**

3.2 torque calculation of stepper motor for roller:
Force Analysis- Friction between Nylon and steel (Blade):

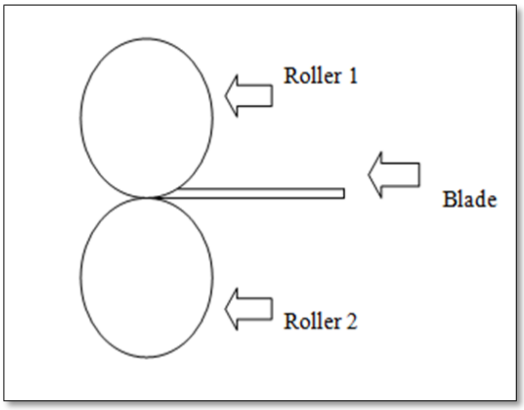

Fig. 3.3 Nylon rollers

Friction coefficient between nylon roller and band saw blade $\mu = 0.35$
Taking the holding force = 30N
So Normal Reaction $R_N =$ 30N
Frictional Force

$F_f = \mu R_N$
$= 0.35 \times 30$
= 10.5 N

For both pulleys,
Total Frictional Force = $F_t = 10.5 \times 2$
= 21 N

Holding Torque = T = Total frictional force $\times$ Radius of pulley
= $21 \times 20/2$
= 210N-m
= 2.15 Kg-cm

So, Stepper motor 1 torque must be greater than **2.15** Kg-cm

3.3 Bearing selection
Determine diameter of the shaft where the bearing is to be fitted.
Diameter of the Shaft = 8mm
Type of the Bearing: 608z, Rolling contact bearing are used.
Applications:
1. Machine tool spindle
2. Small size electric motors
3. Gear boxes

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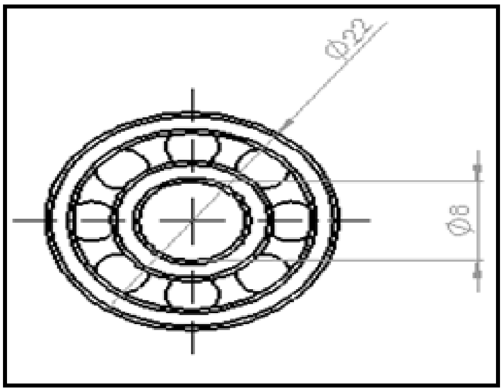

Fig. 3.4 Roller bearing

IV. MICROCONTROLLER

A microcontroller is a small computer on a single integrated circuit containing a processer core, memory and programmable input output peripherals. In our project, we will use "Arduino Board" for microcontrolling. It is open source electronic prototyping platform enabling users to create interactive electronic objects. For software, we should have knowledge of 'C' language.

Arduino is an open source electronic platform based easy to use hardware and software. It's intended for anyone making interactive projects. The Arduino Uno is a microcontroller board on the ATmega328 (datasheet). It has 14 digital input output pins (of which 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, a ICSP header, and a reset button. It contains everything needed to support the Microcontroller; simply connect it to a computer with a USB cable or power it With a AC-to-DC adapter or battery to get started.

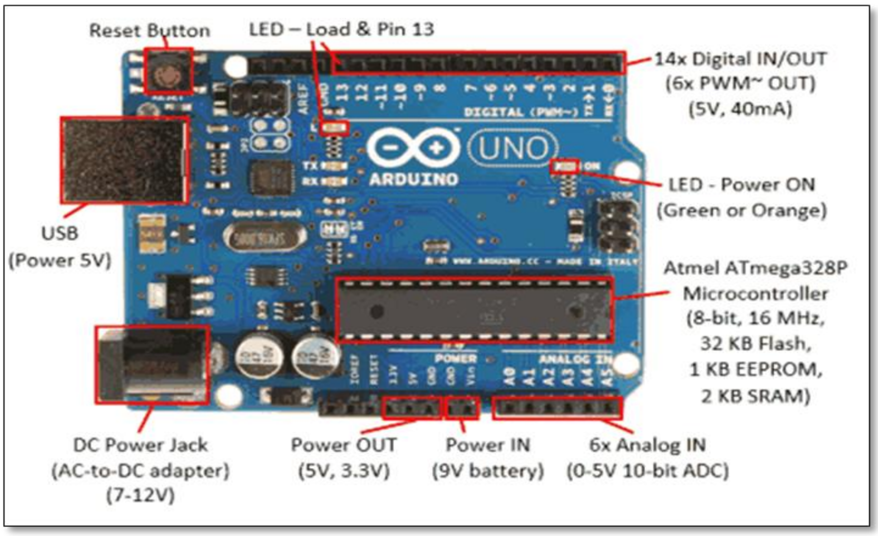

Fig. 4.1 Arduino board

TB6560 Driver:

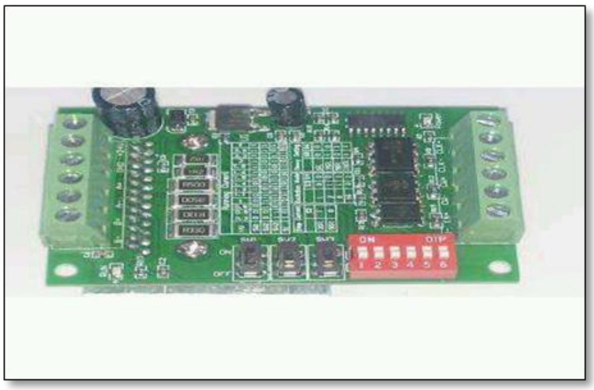

Fig. 4.2 Toshiba driver

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Stepper motor:

The stepper motor is a device that produces rotation through equal angles also called steps, for equal digital pulse supplied to it as input. The hybrid stepper motor combines the features of both the variable reluctance and permanent magnet motors. It has a permanent magnet motors encased in irons caps, which are cut to have teeth .the rotor sets itself in the minimum reluctance position in response to a pair of stator coils being energized. The typical step angle is 0.9 degree and 1.8 degree. Such stepper motors are used in high accuracy positioning applications.

Fig.4.3 stepper motor SM42STH47-1004a

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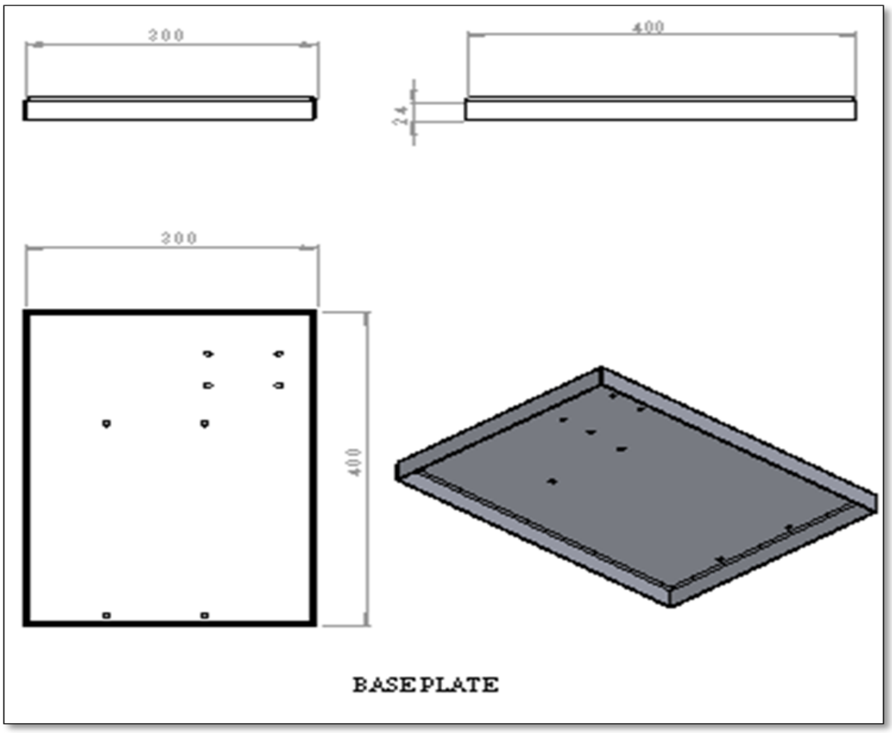
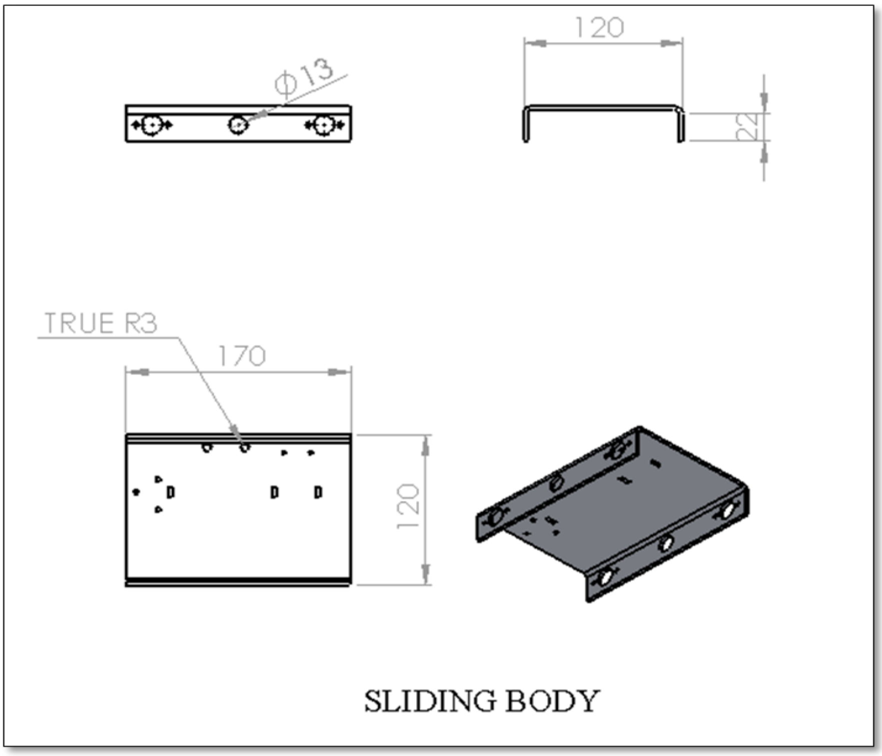
Final programme of project:

```
#include <Stepper.h>
const int motor1 =2800;
// for your motor
Stepper myStepper2(motor1, 8, 9);
Stepper myStepper1(motor1, 10,11);
int MOTOR1[15] = {490,482,478,465,300,300,445,450,440};
int MOTOR2[15] = {10000,10000,9000,8000,8000,8000,9000,9000,9000};
void setup()
{
  myStepper1.setSpeed(80);
  myStepper2.setSpeed(80);
  Serial.begin(9600);

}
  void loop()
{



for(int i=0; i<=9 ; i++)
 {

  myStepper2.step(-MOTOR2[i]);
  delay(700);
  myStepper1.step(-MOTOR1[i]);
  delay(300);
  myStepper1.step(0);
  delay(300);
  myStepper2.step(MOTOR2[i]);
  delay(1500);

 }

}
```

V. DRAFTING OF VARIOUS PARTS





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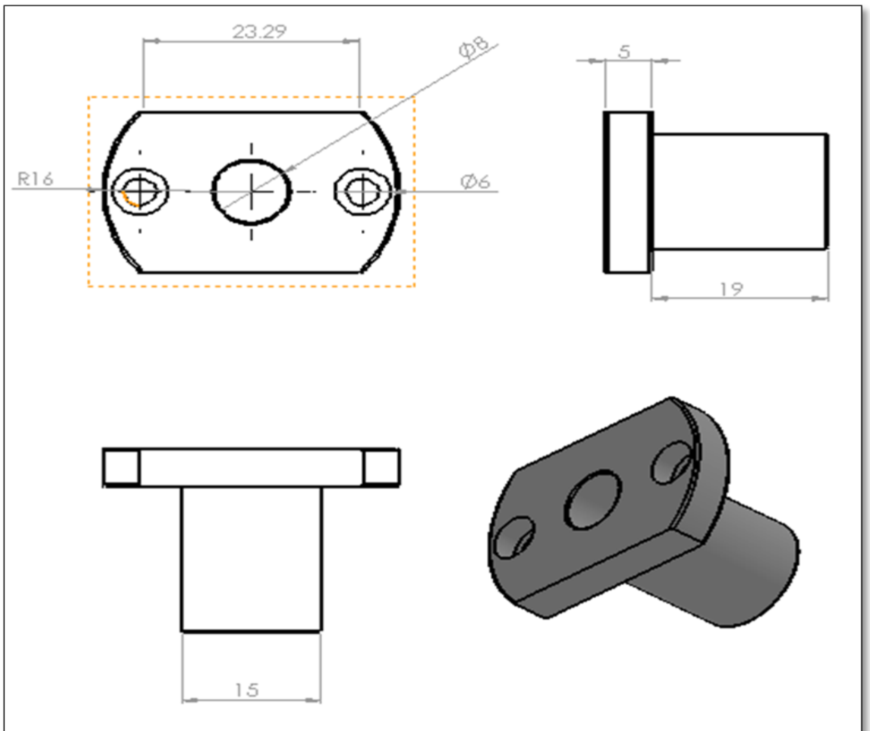
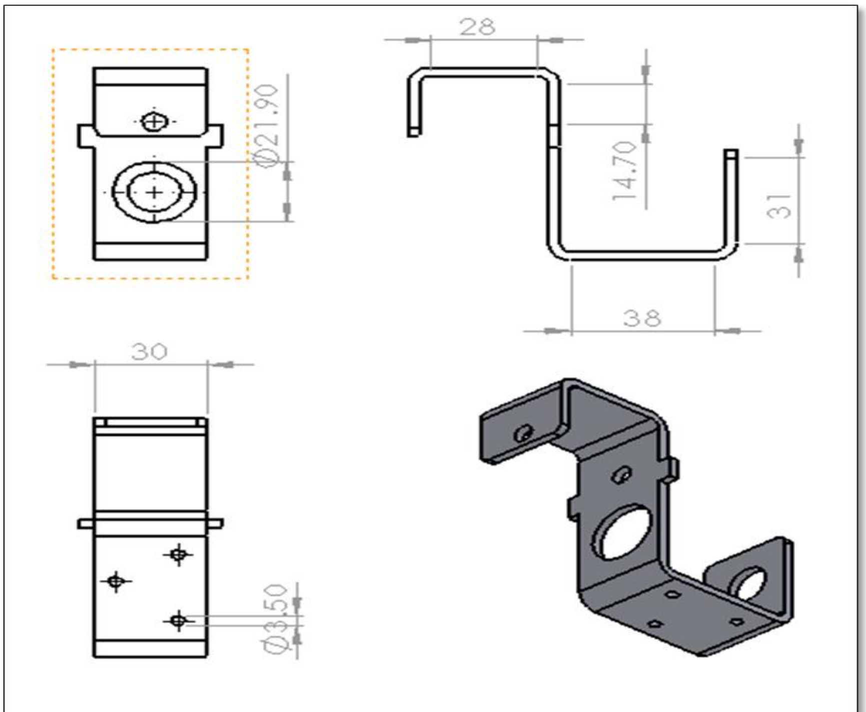


LINEAR BUSH



ROLLER HOLDER

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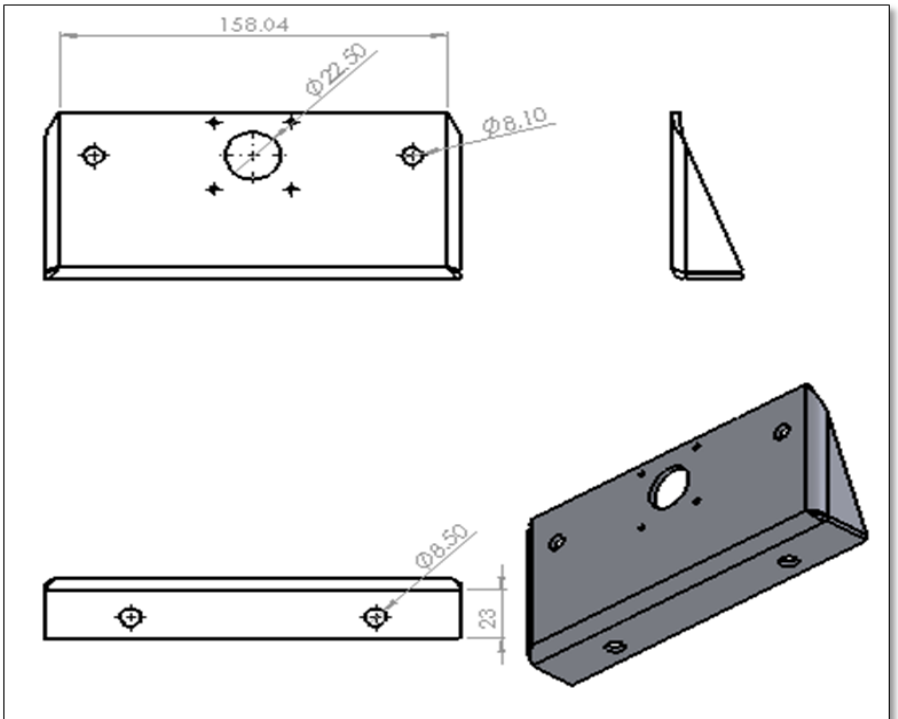
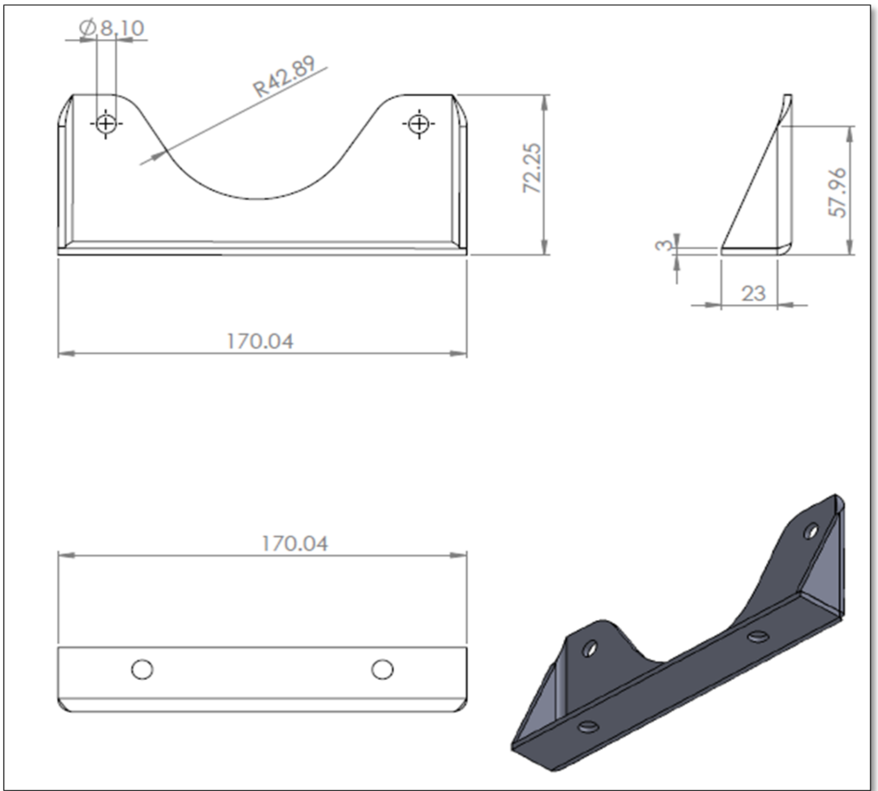


SLIDER SUPPORT 1



Project Assembly:

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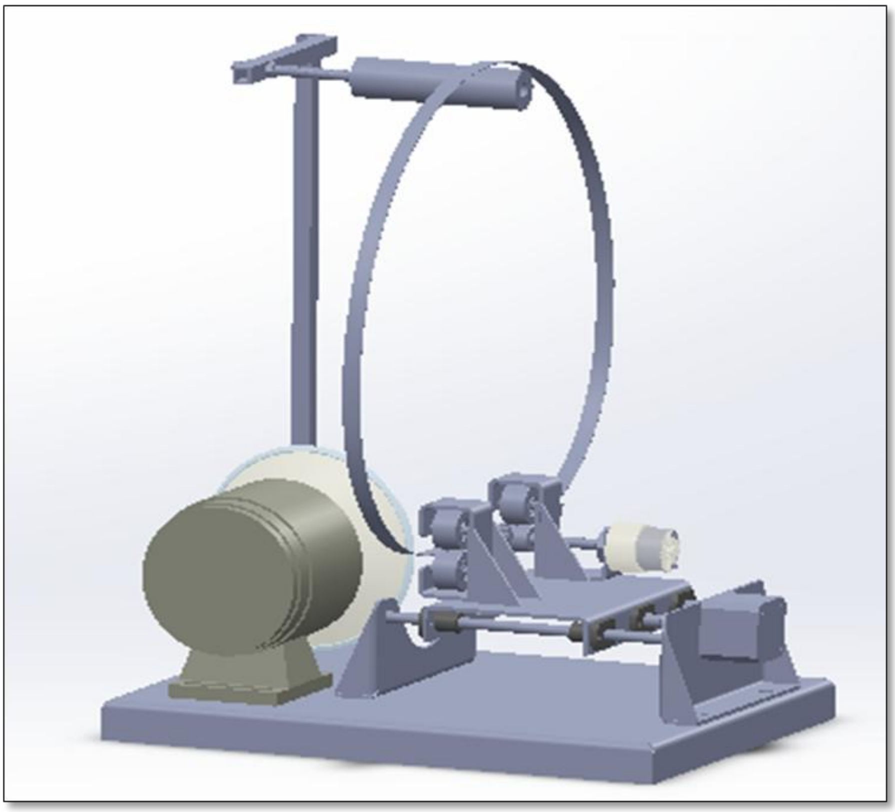

Conclusion:

Project making was completely new experience for us. The project enabled us to know much about the industry. It was challenging when we had to complete this project with the given time. All things concerned with project such that as selection of project design was successfully completed by us. Finally we are able to make a special purpose machine successfully.

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