1.1 DESIGNING CONSTRUCTION AND WORKING OF MACHINE

1.1.1 DESIGNING

Machine is designed with 3 conveyor belts and a shaker. Also, for the collection of separated scrap we have designed 4 different containers. Machine is containing 3 conveyor belt cases. 4 motors are installed for the operation of conveyor belts.

1.1.2 CONSTRUCTION

Construction of machine is designed in 3 stages containing 27 parts. In the first and second stage, conveyor belt is placed on the conveyor belt stand. Case is later fixed on top of the conveyor belt for the better function of separation. Container is welded at the bottom of the stand.

We are taking Shaker of Goudsmit Magnetics.

1) Cases: Cases are being manufactured by the company.
2) Conveyor belt: Conveyor belts will be taken from the market. Depending upon the availability of belts.
3) Containers and stand: Both are manufactured in the company.
4) Motor: Motors are readymade installed from the spaceguard company.

In the third stage, z type conveyor belt is installed. For the better separation case is installed in front of the eddy current separator.

1.1.3 WORKING

Function of the machine is to separate Iron (Fe), Steel, Aluminium (Al) and Copper (Cu) of small 2-3 mm scrap. Machine is functioning in three stages. In the first stage, all scrap coming from shredder is fed on the first conveyor belt. Then with the help of natural magnets iron will get separated by using AC motor of 1 HP with speed of 22 meter/min.

In second stage, remaining 3 metal scraps (steel, Al, Cu) are fed to second belt and then steel will get separated by using electromagnet roller with 1 HP motor speed of 25 meter/min.

In the third stage, Al and Cu are left with some impurities like sand and plastic. In third stage eddy current separator is installed. Al and Cu are getting separated with the help of eddy current separator. Eddy current separates these two metals by the concept of density to conductivity ratio. In eddy current magnet, when with the electric conductive non-ferromagnetic metal passes through the alternating magnetic field, the eddy current will be produced in the metal conductor.

1. Full Machine

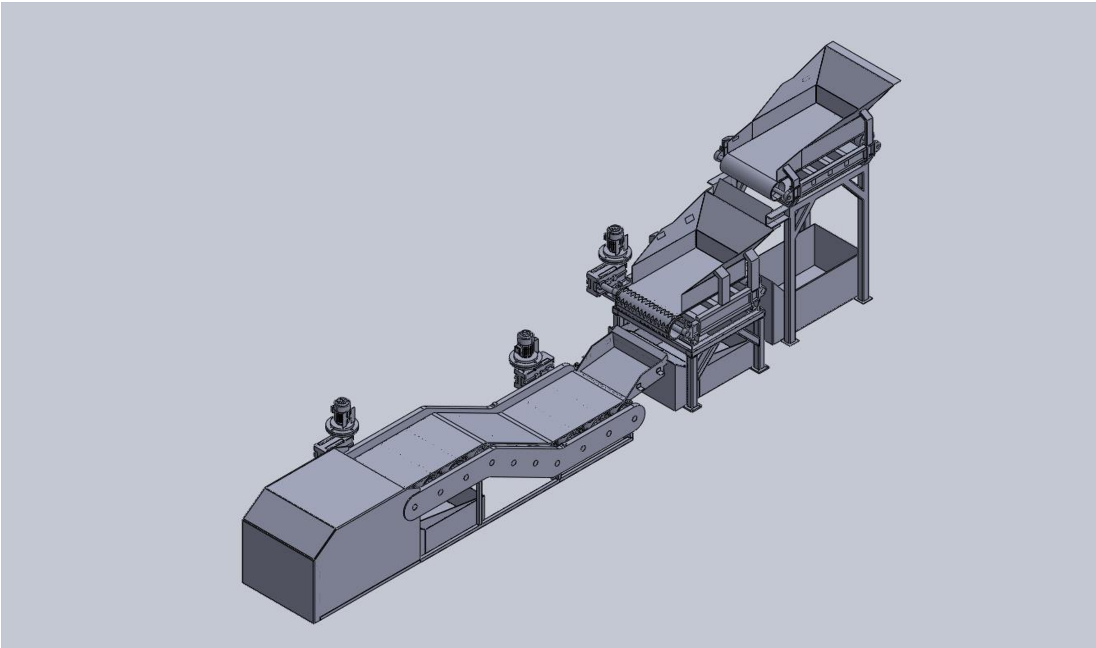


Fig. 4.1 Full Machine

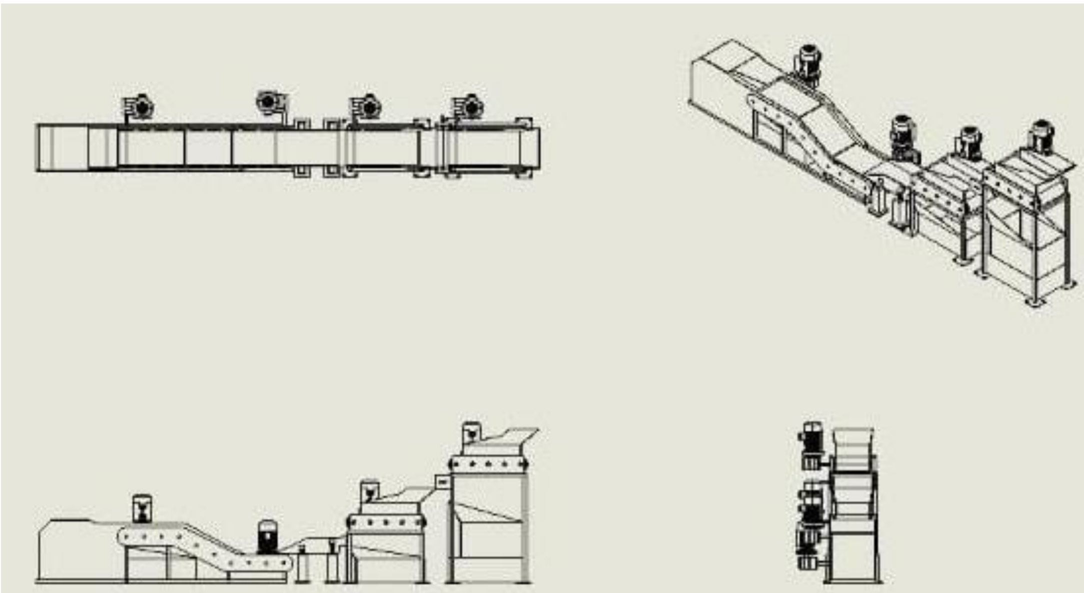


Fig. 4.2 2D Sketch of Full Machine

Dimensions

i. Side View

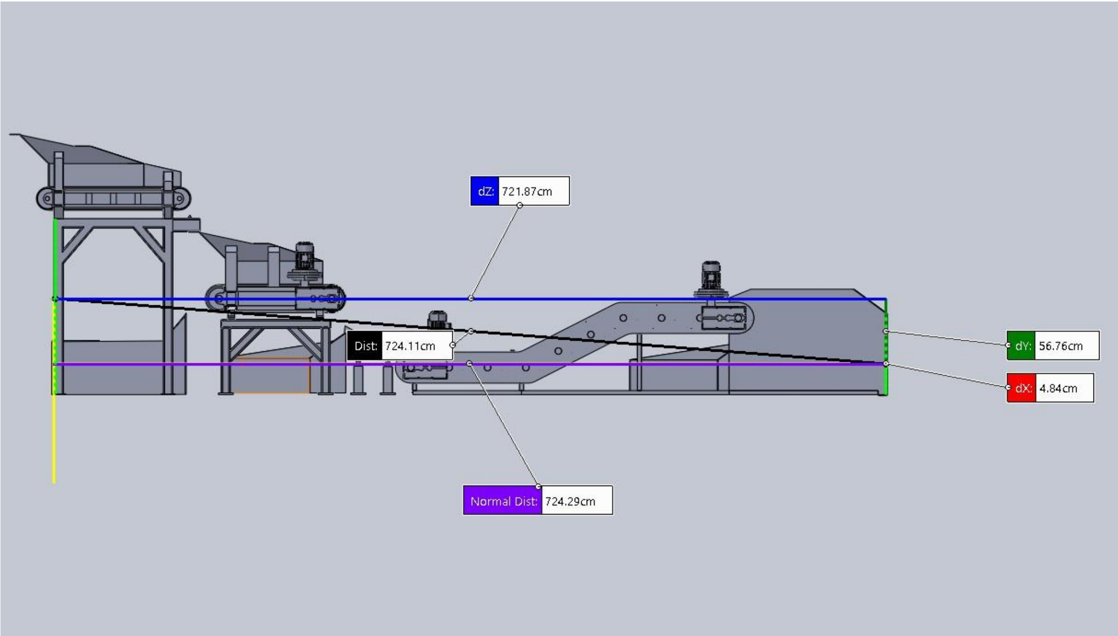


Fig. 4.3 Side View of Full Machine

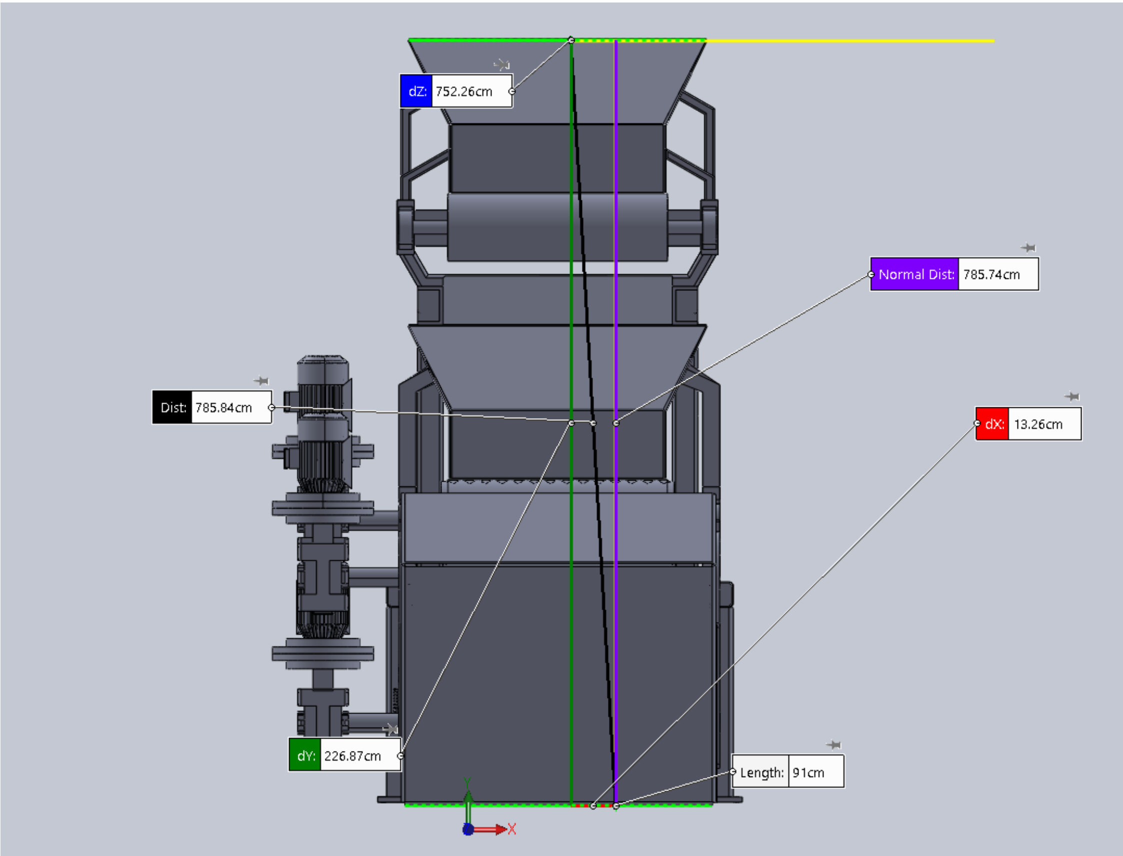
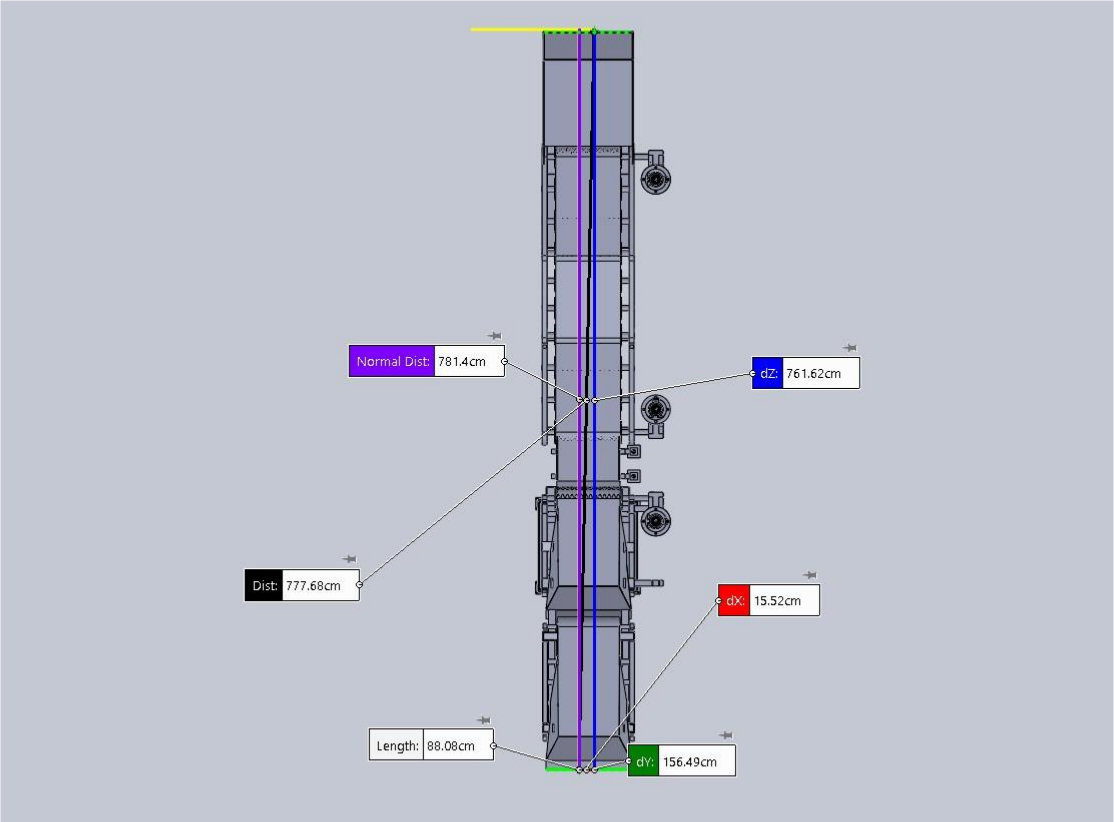


Fig. 4.4 Front View of Full Machine

iii Top View



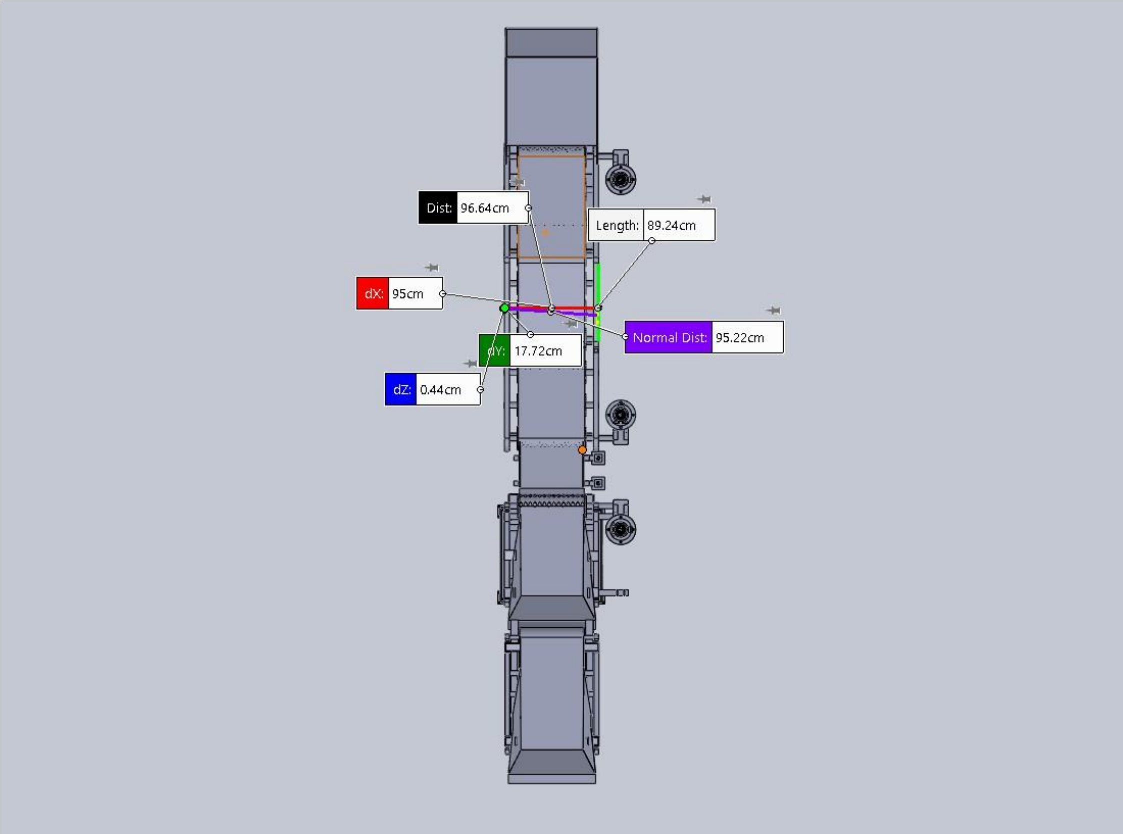


Fig. 4.5 Top View of Full Machine

2. Part No.1

Top View Side View Isometric View

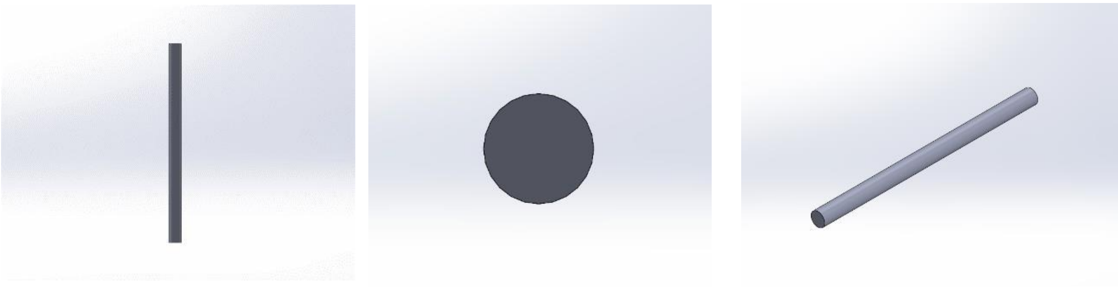


Fig. 4.6 All views of Part No.1

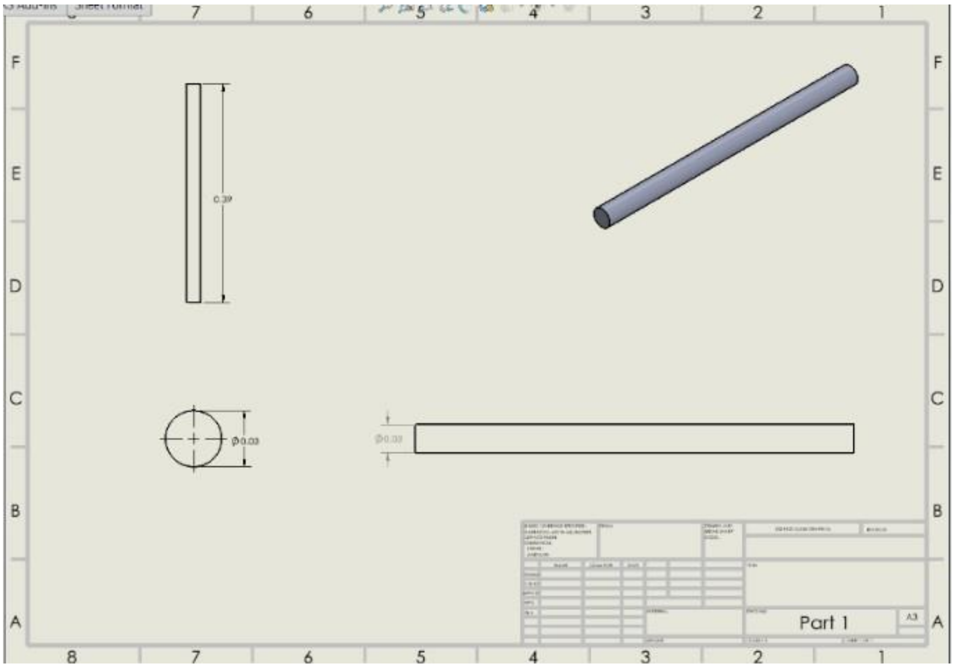


Fig. 4.7 2D Sketch of Part No.1

The term shaft usually refers to a component of circular cross section that rotates and transmits power from a driving device, such as a motor or engine, through a machine and helps to rotate rollers. This shaft having length of 390mm with diameter of 25 mm. purpose of the shaft is move the material forward.

3. Part No.2

Top View Side View Isometric View

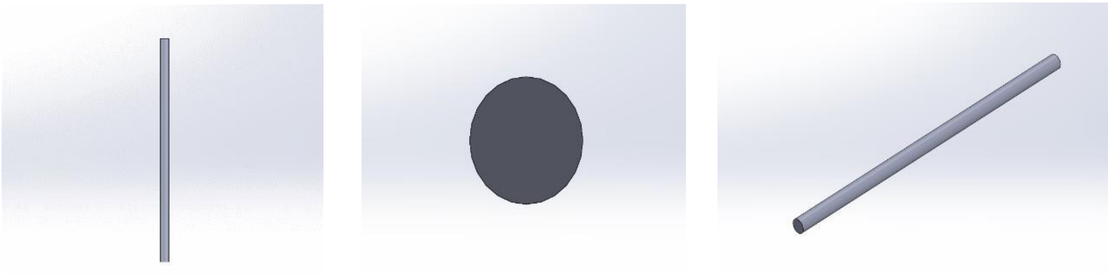


Fig. 4.8 All Views of Part No.2

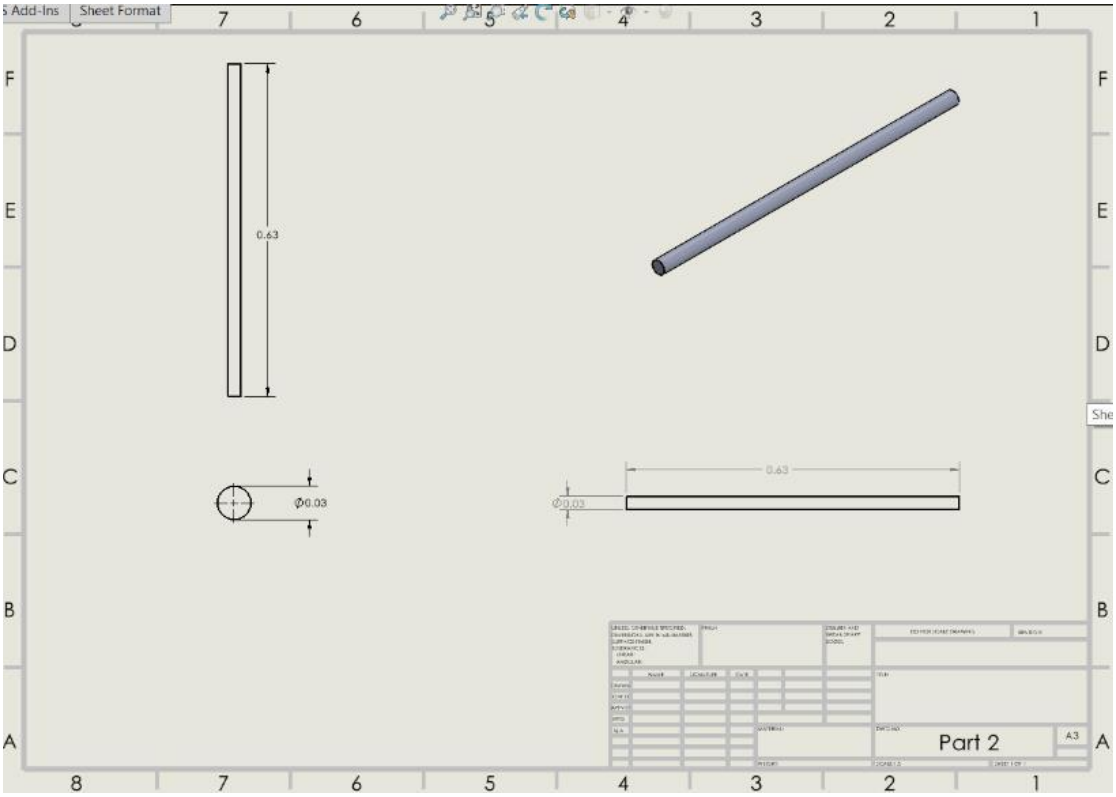


Fig. 4.9 2D Sketch of Part No.2

The term shaft usually refers to a component of circular cross section that rotates and transmits power from a driving device, such as a motor or engine, through a machine. This shaft having length of 625 mm with diameter of 25 mm. purpose of the shaft is to convert energy from the motor into the end use application.

4. Part No.3

Top View Side View Isometric View

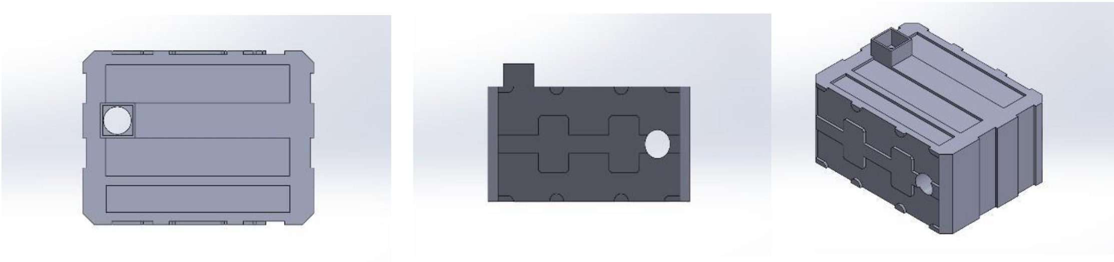


Fig. 4.10 All Views of Part No.3

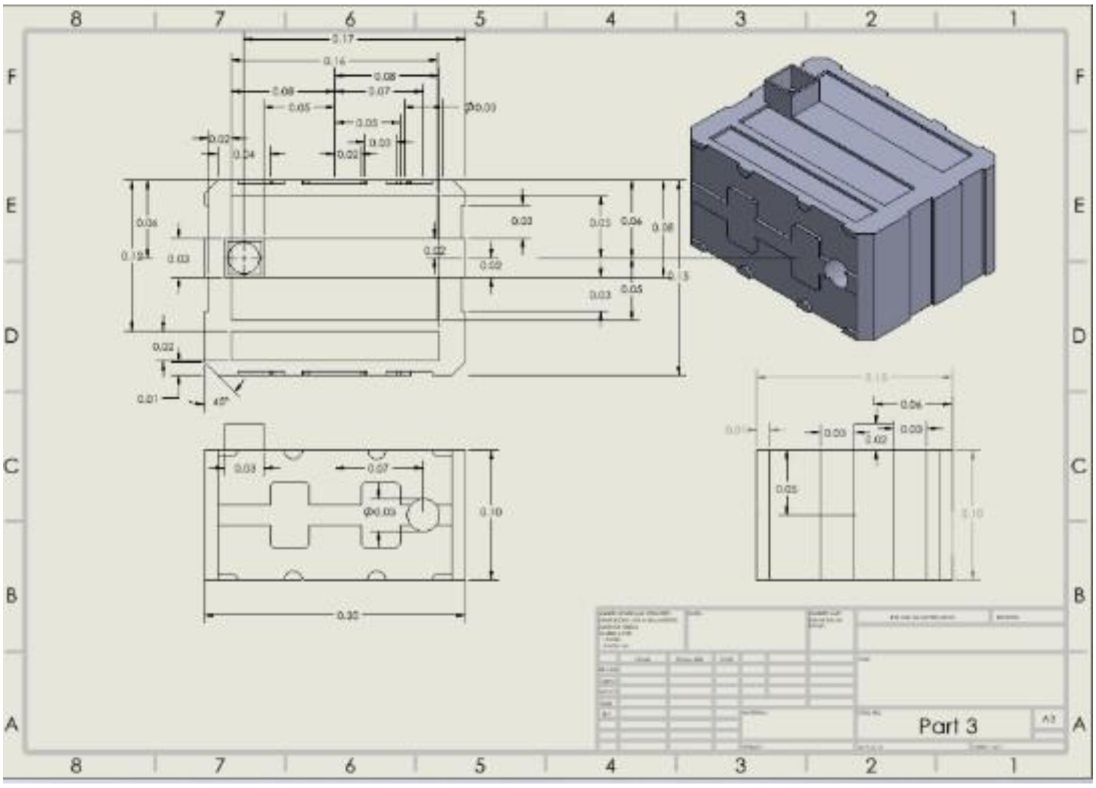
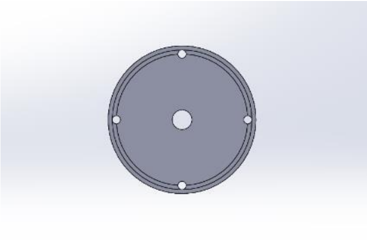


Fig. 4.11 2D Sketch of Part No.3

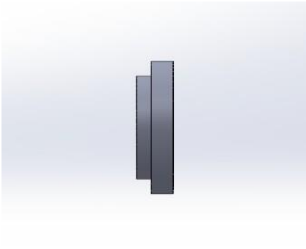
This is the internal mechanism of motor known as motor mechanism. Here it can change the speed of motor with respect to requirement.

5. Part No.4

Top View



Side View



Isometric View

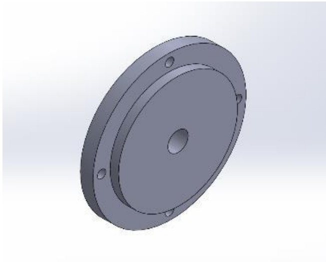


Fig. 4.12 All Views of Part No.4

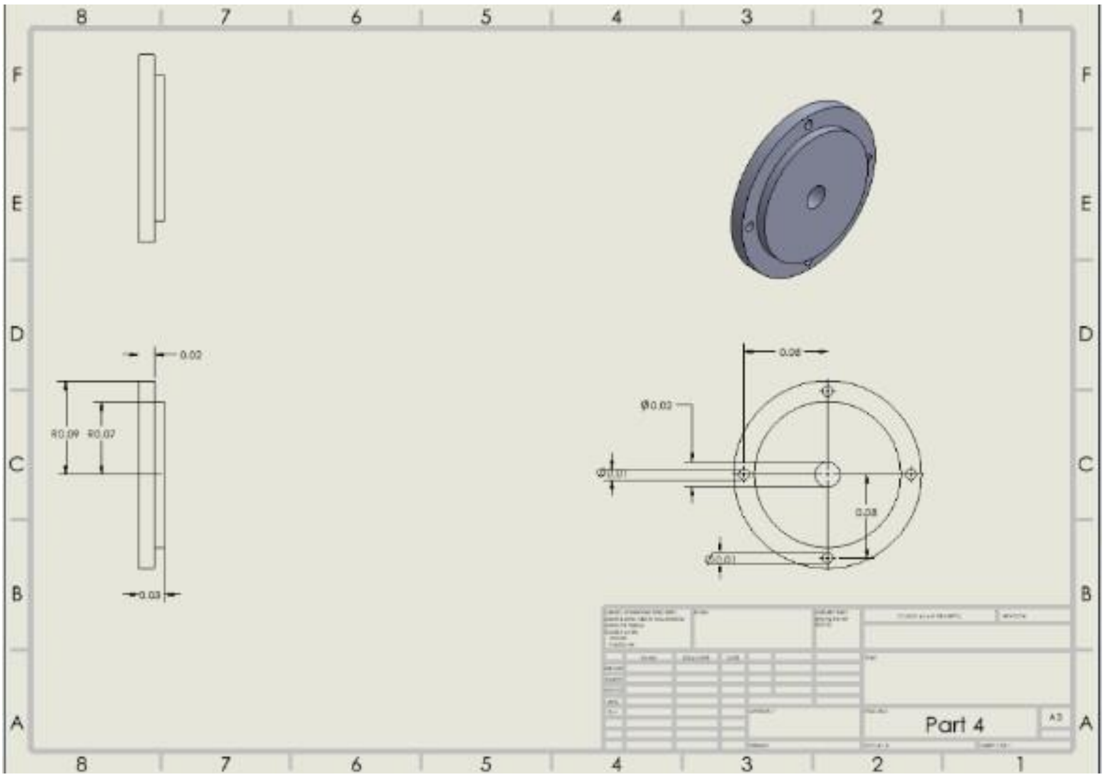


Fig. 4.12 2D Sketch of Part No.4

This is the motor ring , used to clamp the motor mechanism and rotor together for efficient working.

It also reduces some loss of power trasmission and hold the mechanism connected.

6 Part No.5

Top View Side View Isometric VIew

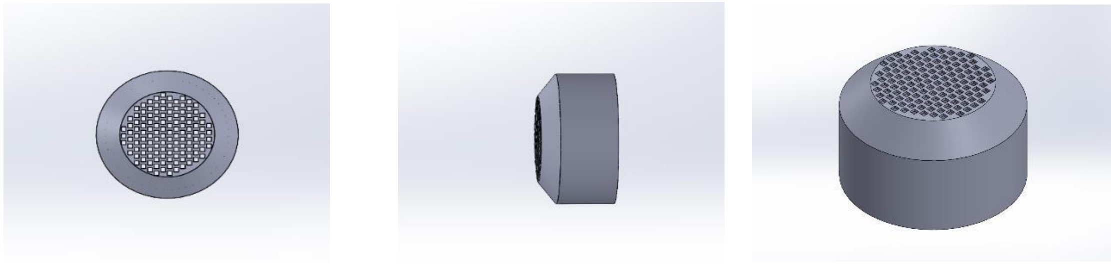


Fig. 4.13 All Views of Part No.5

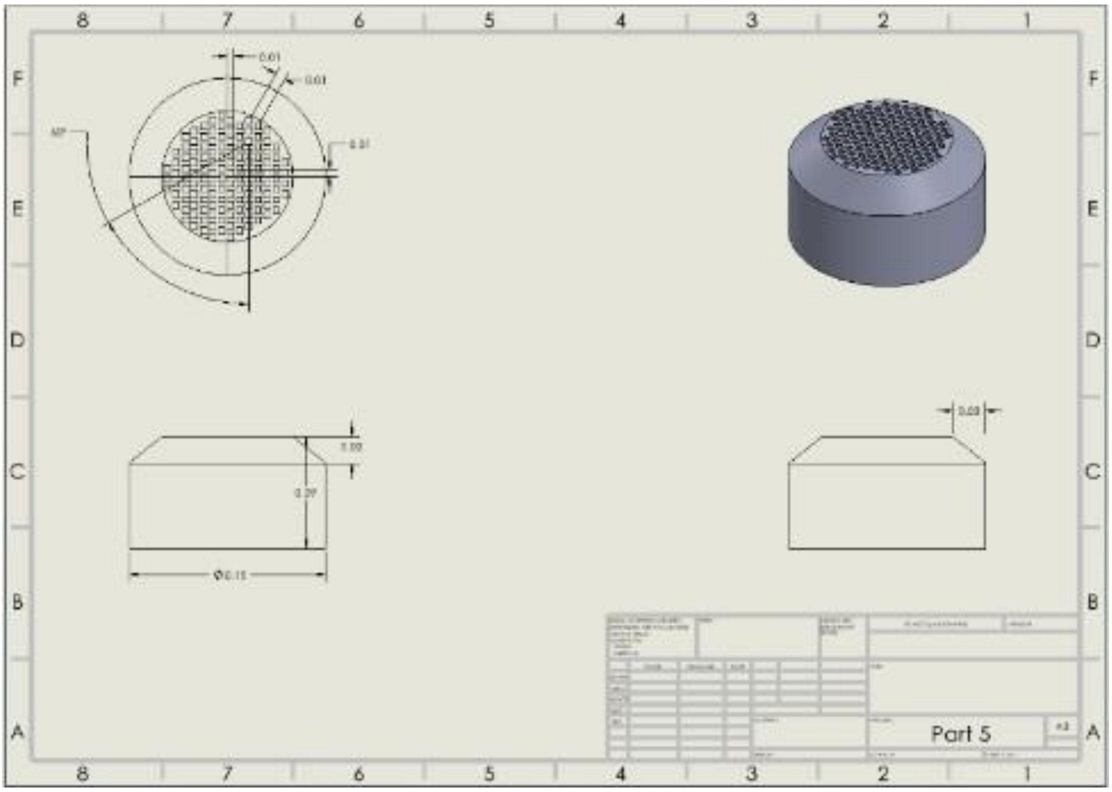
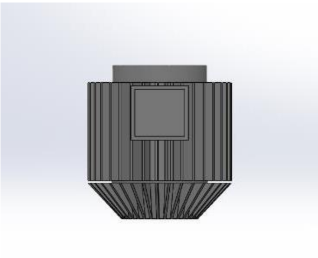


Fig. 4.13 2D Sketch of Part No.5

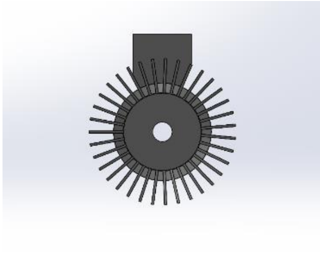
This is the motor backcase, general pupose of this is to have access of air flow to cool down elevated rotor temparature.

7. Part No.6

Top View



Side View



Isometric View

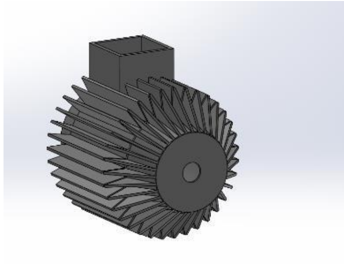


Fig. 4.14 2D All Views of Part No.6

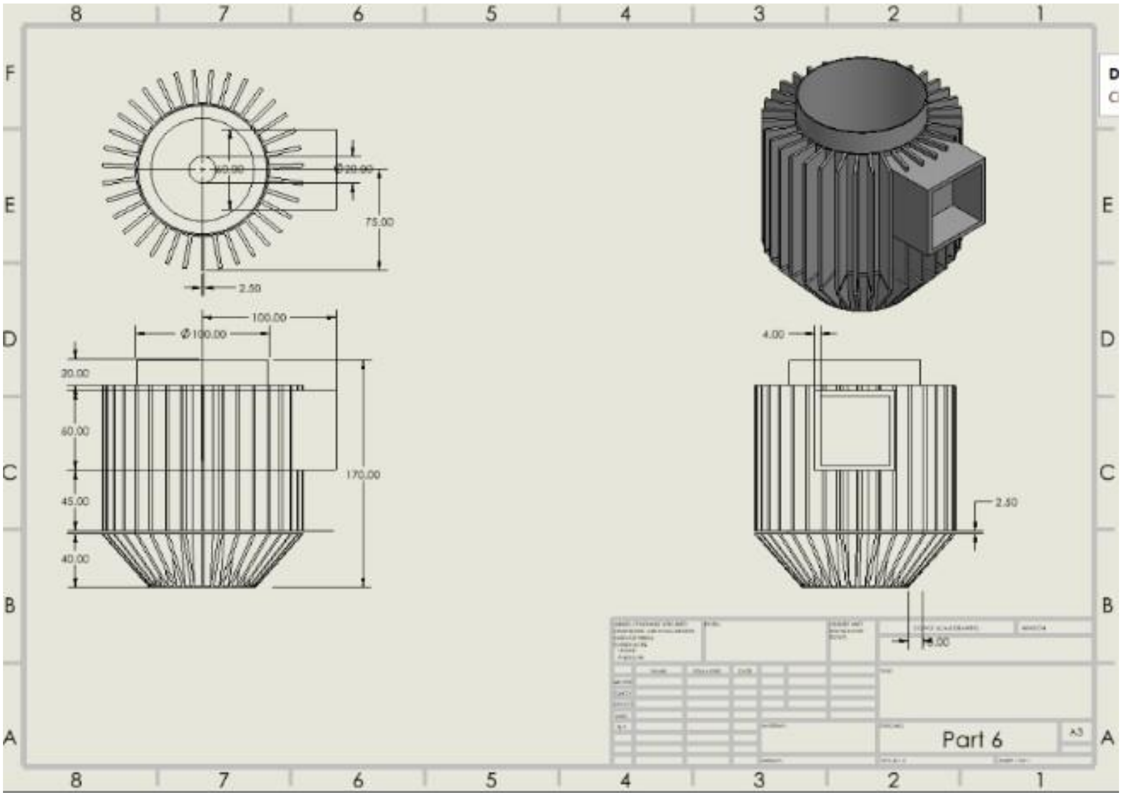


Fig. 4.15 2D Sketch of Part No.6

Motor Frontcase , main body of internal shaft. With the combination of rotor and stator.

8. Part No.7

Top view Side View Isometric View

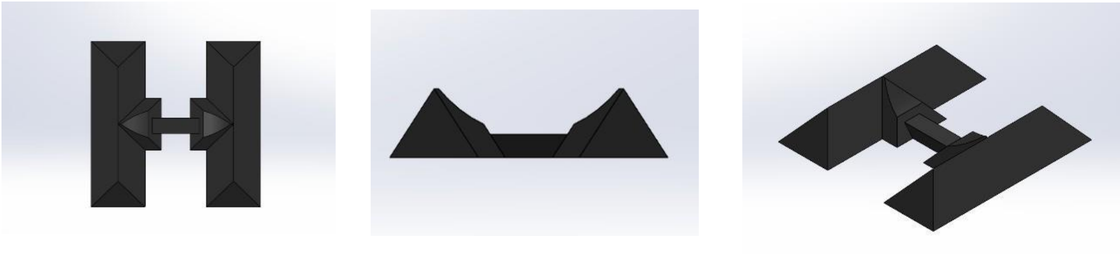


Fig. 4.16 2D All Views of Part No.7

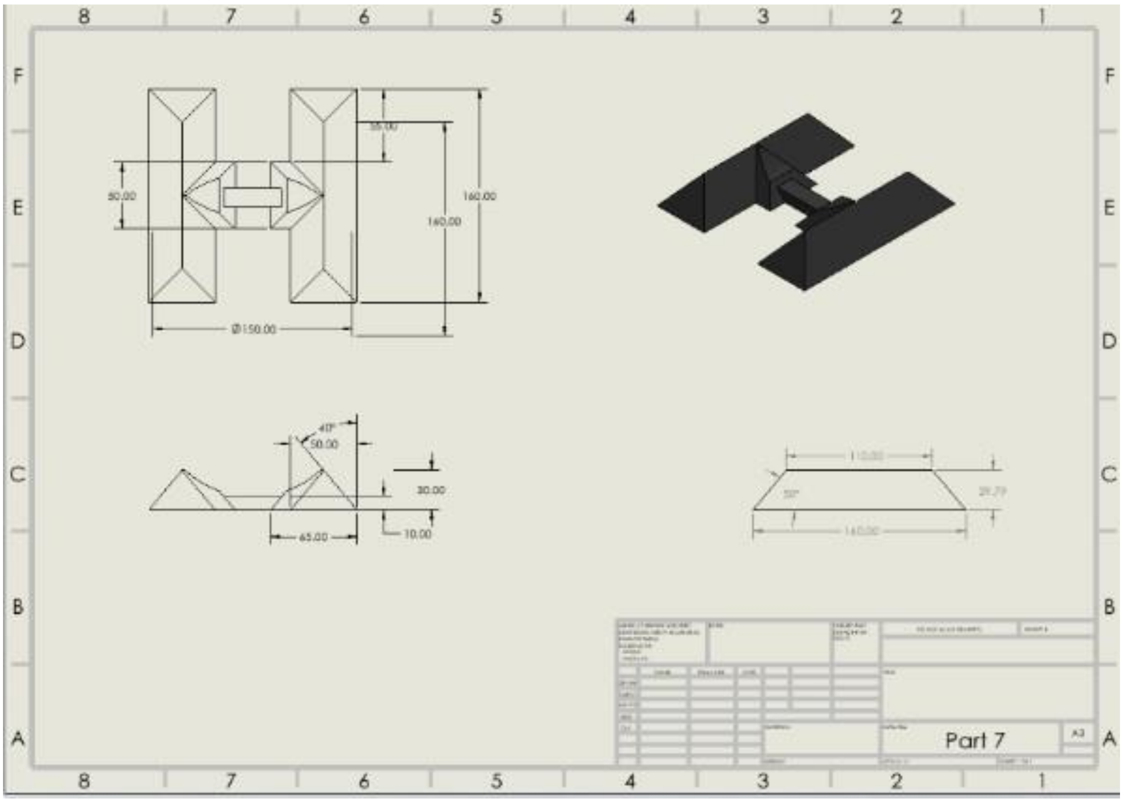


Fig. 4.17 2D Sketch of Part No.7

This is the motor base. This holds the whole motor body and assembly vertically. It can be used if motor is planted on the ground.

9. Part No.8

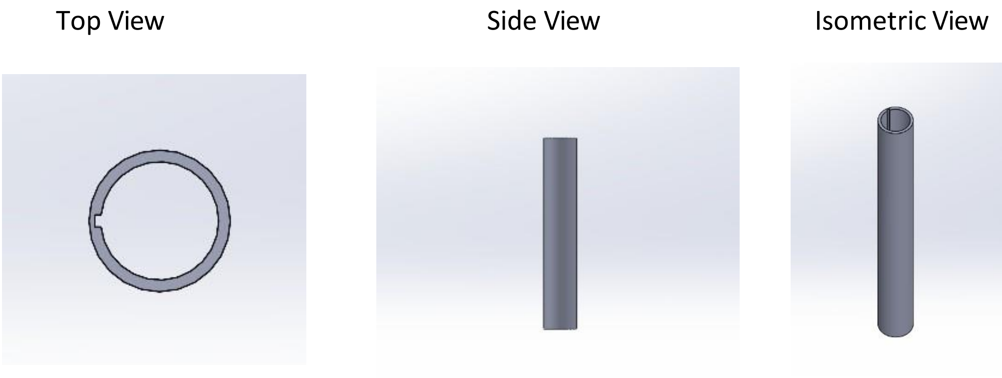


Fig. 4.18 2D All Views of Part No.8

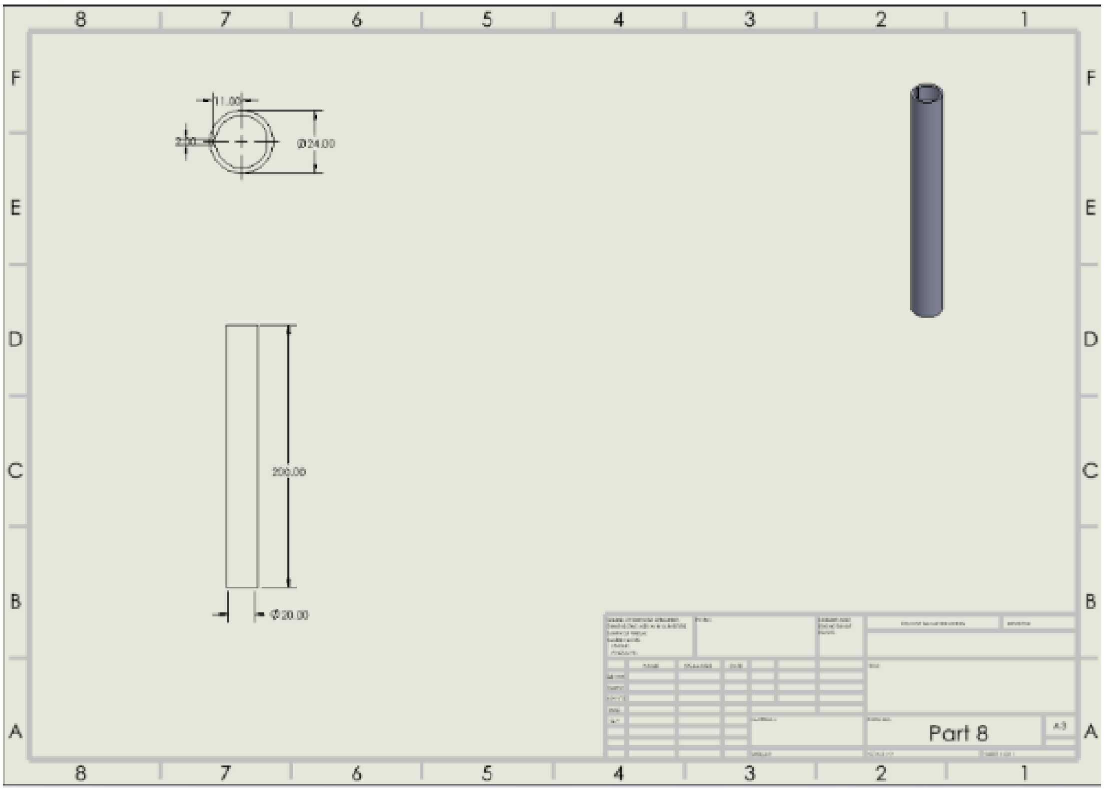


Fig. 4.19 2D Sketch of Part No.8

This is the motor shaft, used for internal mechanism working. It is with the dimension of length 200 mm

And diameter of 24 mm.

10. Part No.9

Top View | Side View | Isometric View

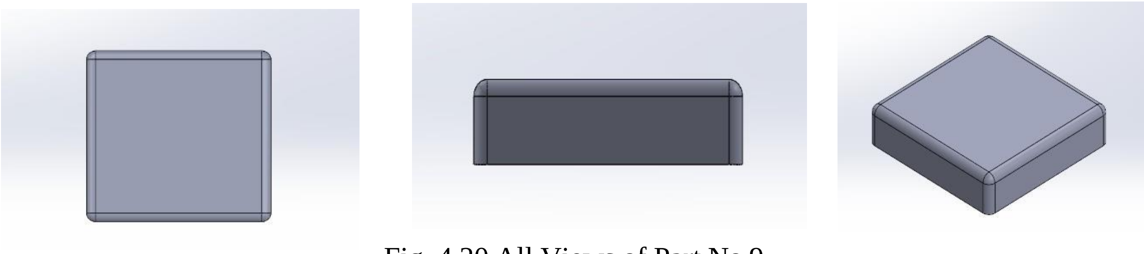


Fig. 4.20 All Views of Part No.9

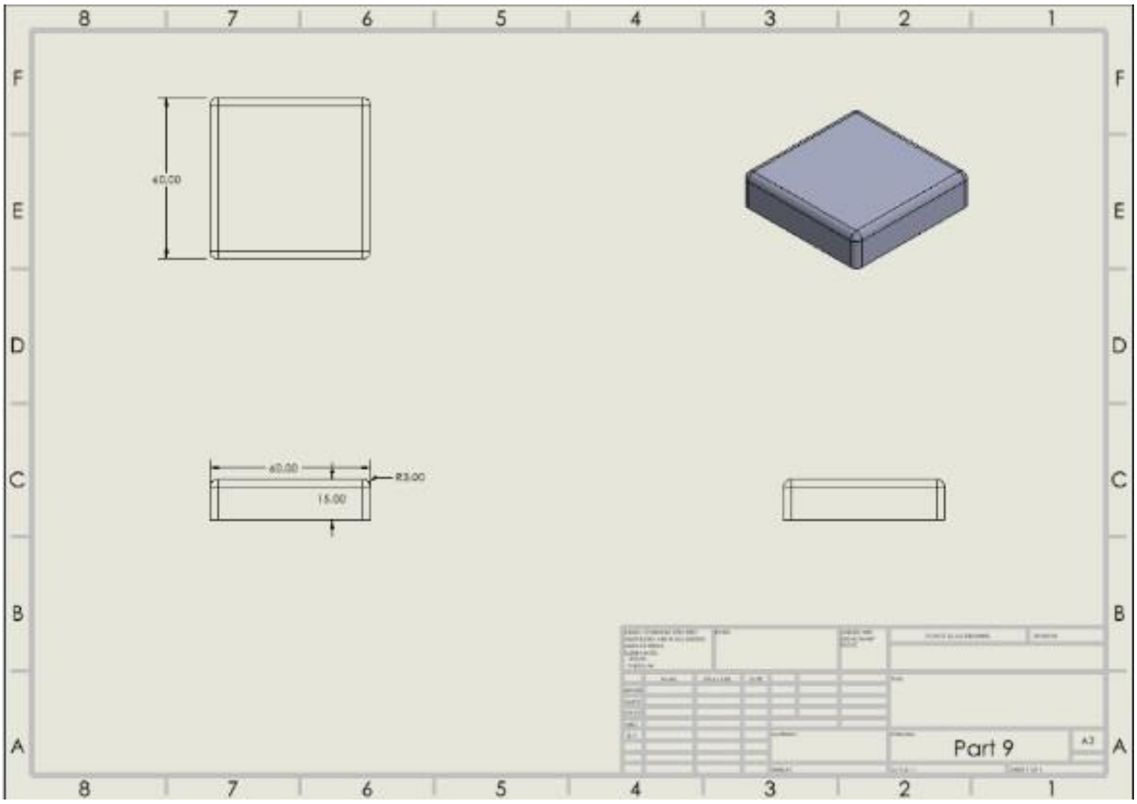


Fig. 4.21 2D Sketch of Part No.9

This is the part of motor , known as topcase. Purpose of this part is to protect the motor assembly from unwanted dust and other materials.

11. Part No.10

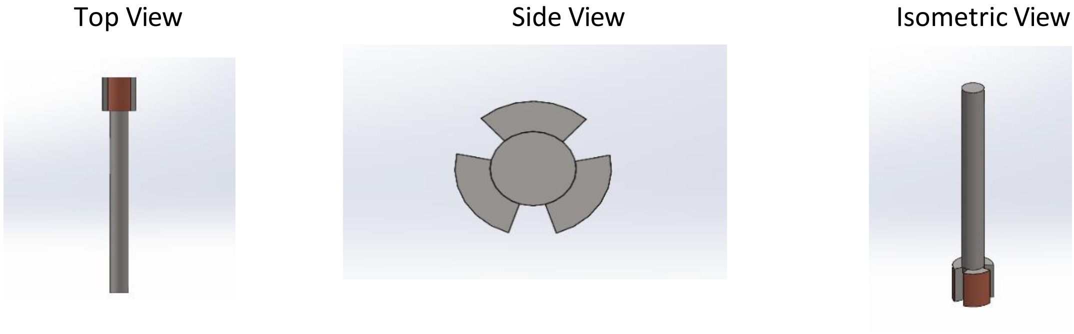


Fig. 4.22 All Views of Part No.10

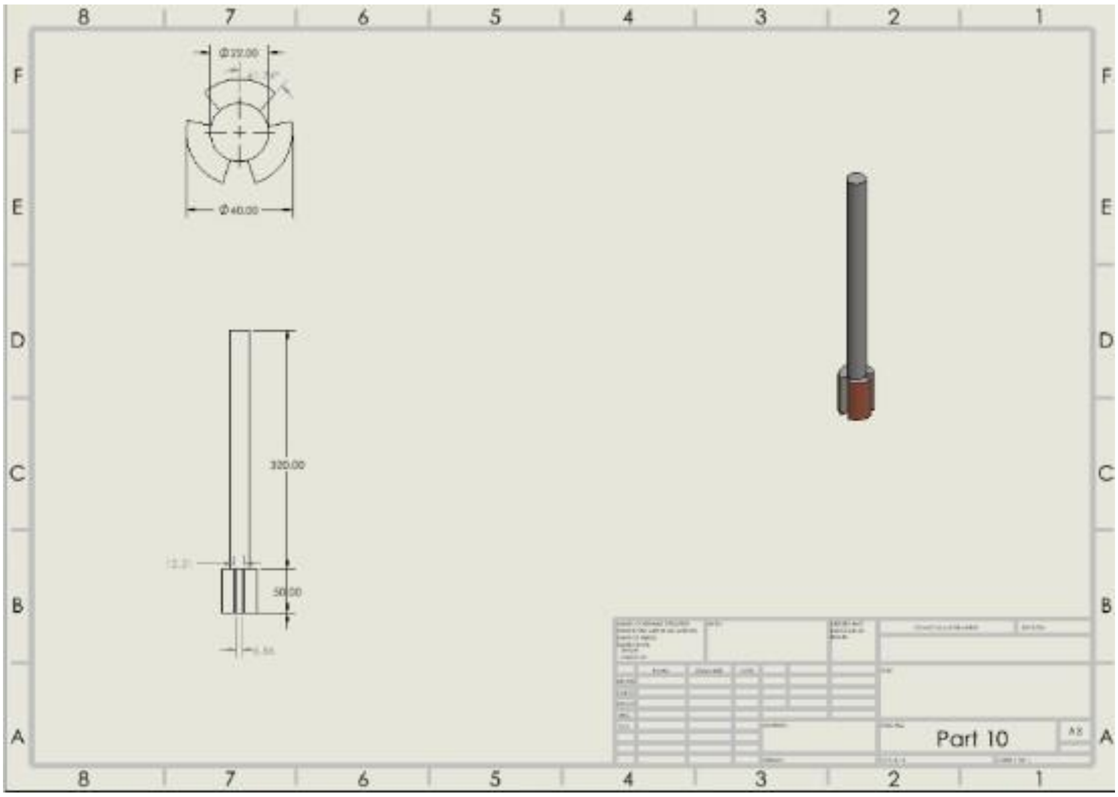


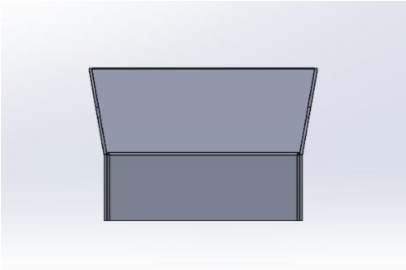
Fig. 4.23 2D Sketch of Part No.10

This is the main part of motor. It is the rotor cause of internal working of motor with the use magnetism principle. It has length of 320 mm and diamter 22 mm.

12. Part No.11

Top View

Side View



Isometric View

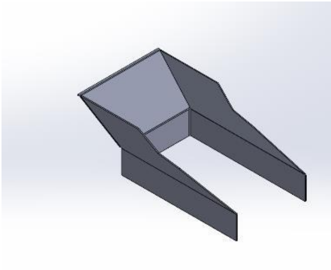
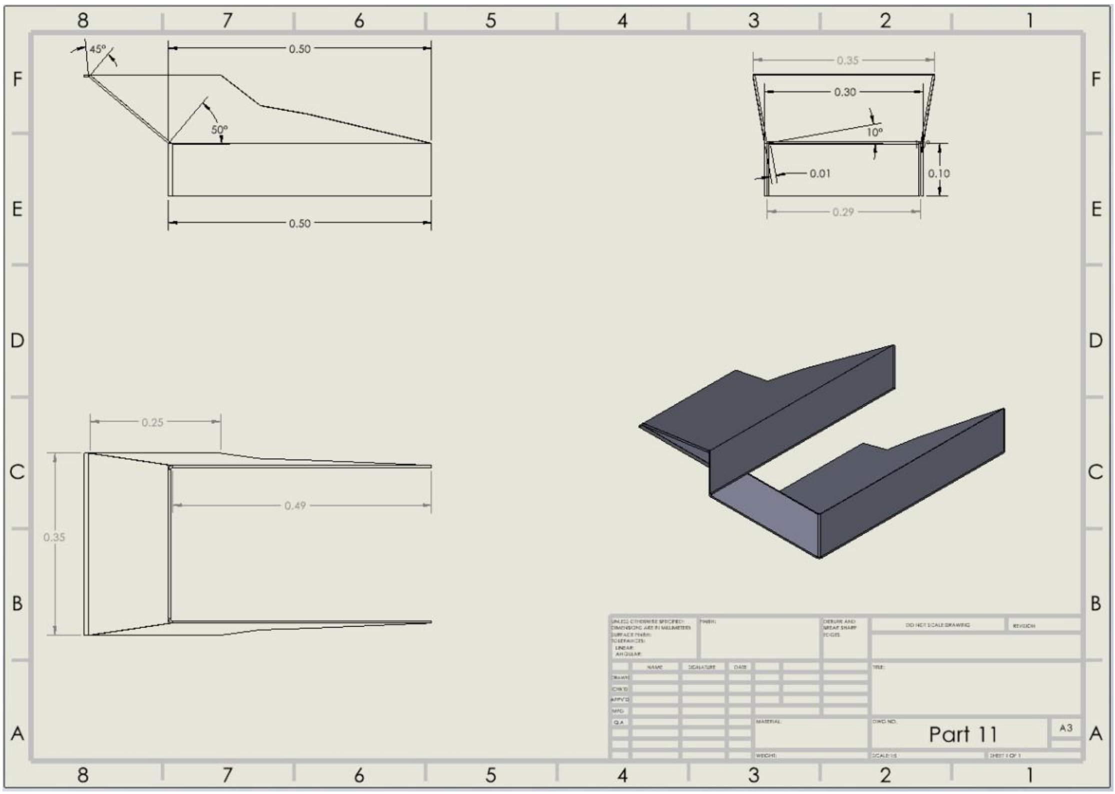


Fig. 4.24 All Views of Part No.11



This part is the Above-case for belt. Purpose of this case is to channelize the flow of particles from shradder on to the belt. It has customized dimensions and design.

13. Part No.12

Top View Side View Isometric View

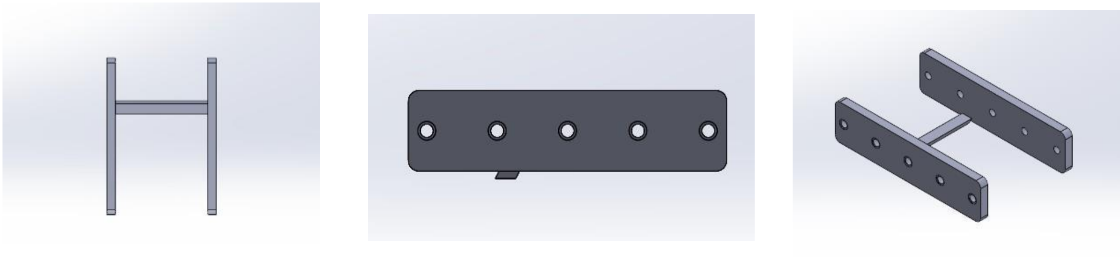


Fig. 4.26 All Views of Part No.12

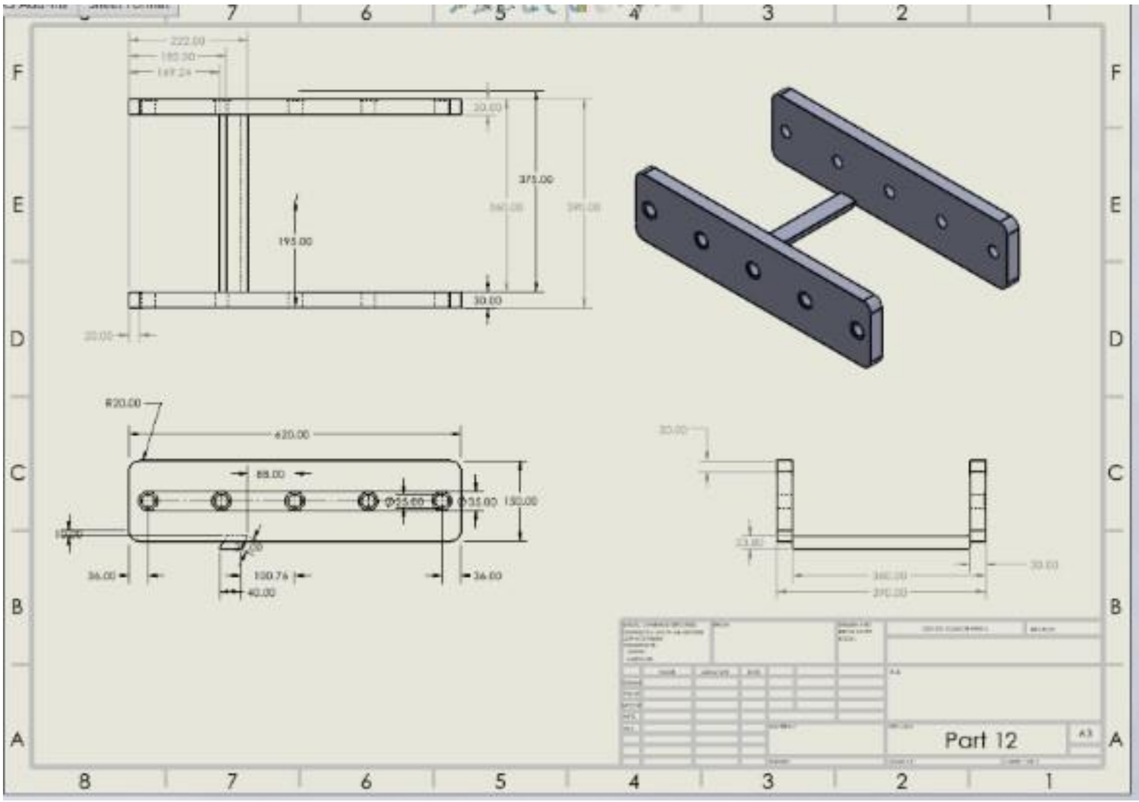


Fig. 4.27 2D Sketch of Part No.12

This is the main part of conveyor belt. It contains rollers , belt and on it particles, to move ahead with the use of external supply of motor .

14. Part No.13

Top View　　Side View　　Isometric View

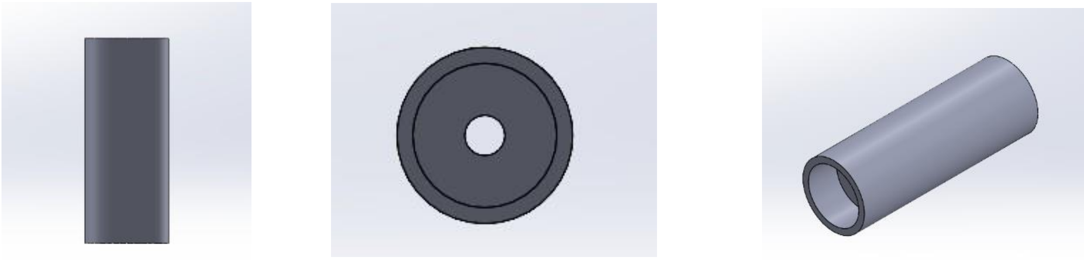


Fig. 4.28 All Views of Part No.13

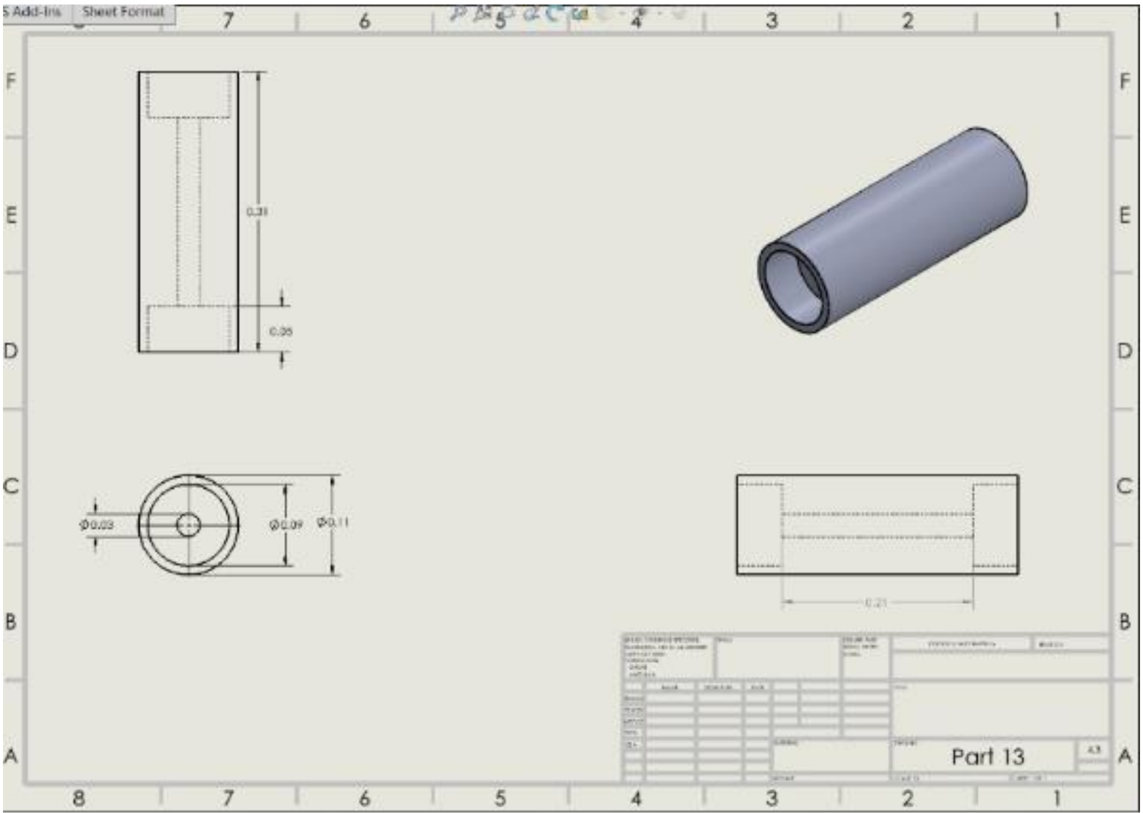


Fig. 4.29 2D Sketch of Part No.13

This is roller. It is the cause of particles to move ahead. With rotating on the axis of rotation, makes the Belt to carry forward the load to the next stage. It has dimension of length of 310 mm and diameter of 110 mm.

15. Part No.14

Top View Side View Isometric View

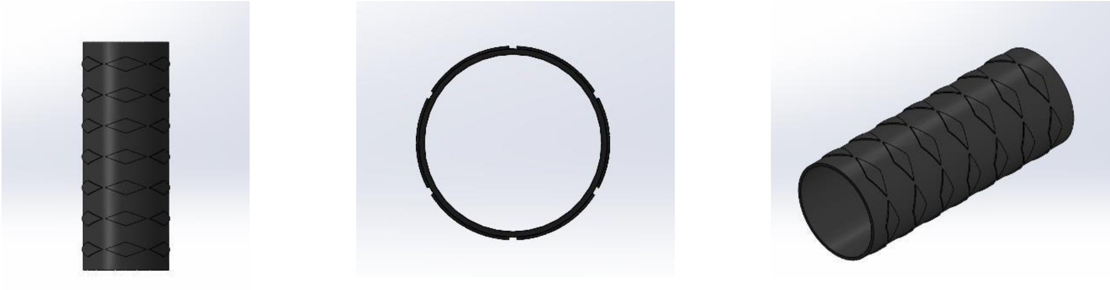


Fig. 4.30 All Views of Part No.14

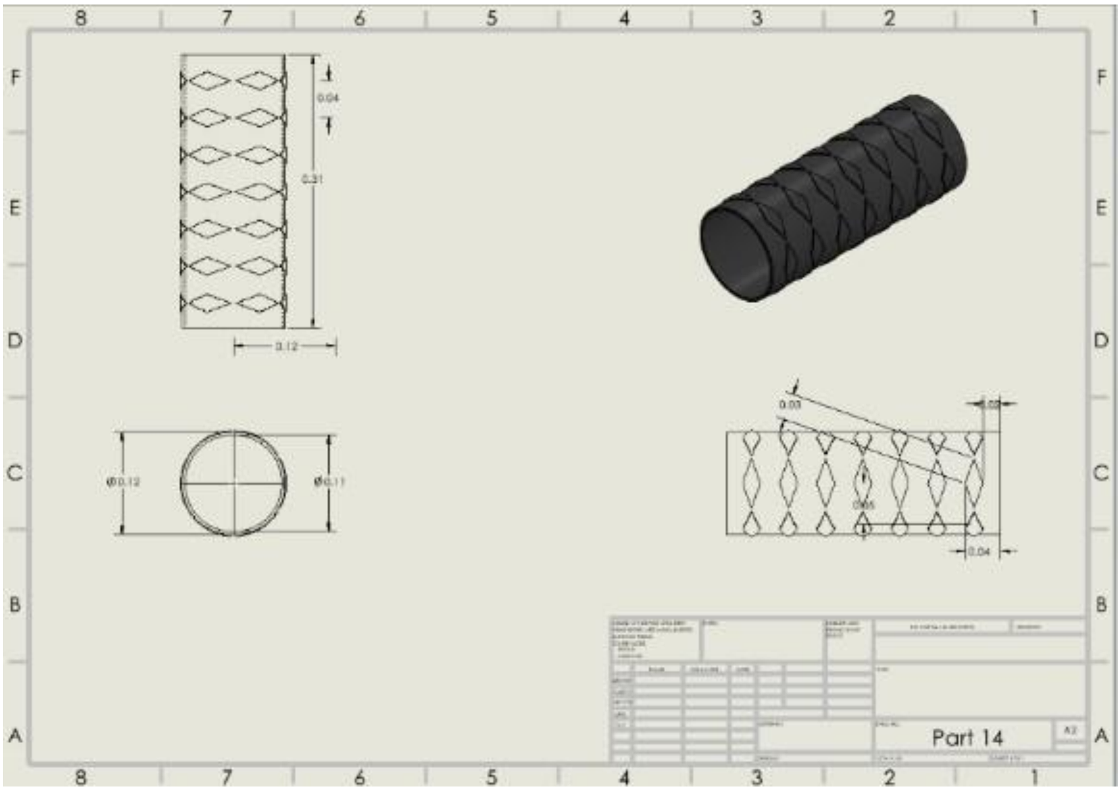


Fig. 4.31 2D Sketch of Part No.14

This is the cover of roller. It is used to protect the roller and also to have some grip on the inner part of belt. It has thickess of 7 mm.

16. Part No.15

Top View | Side View | Isometric View

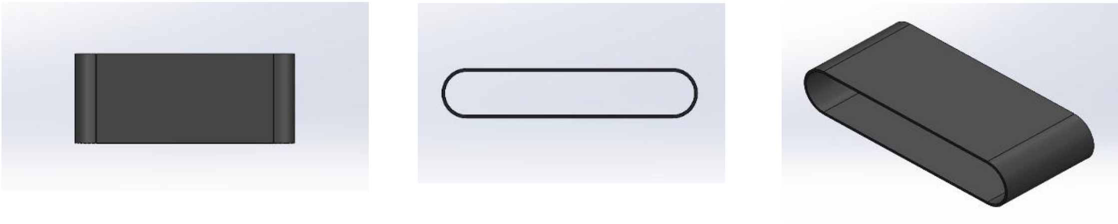


Fig. 4.32 All Views of Part No.15

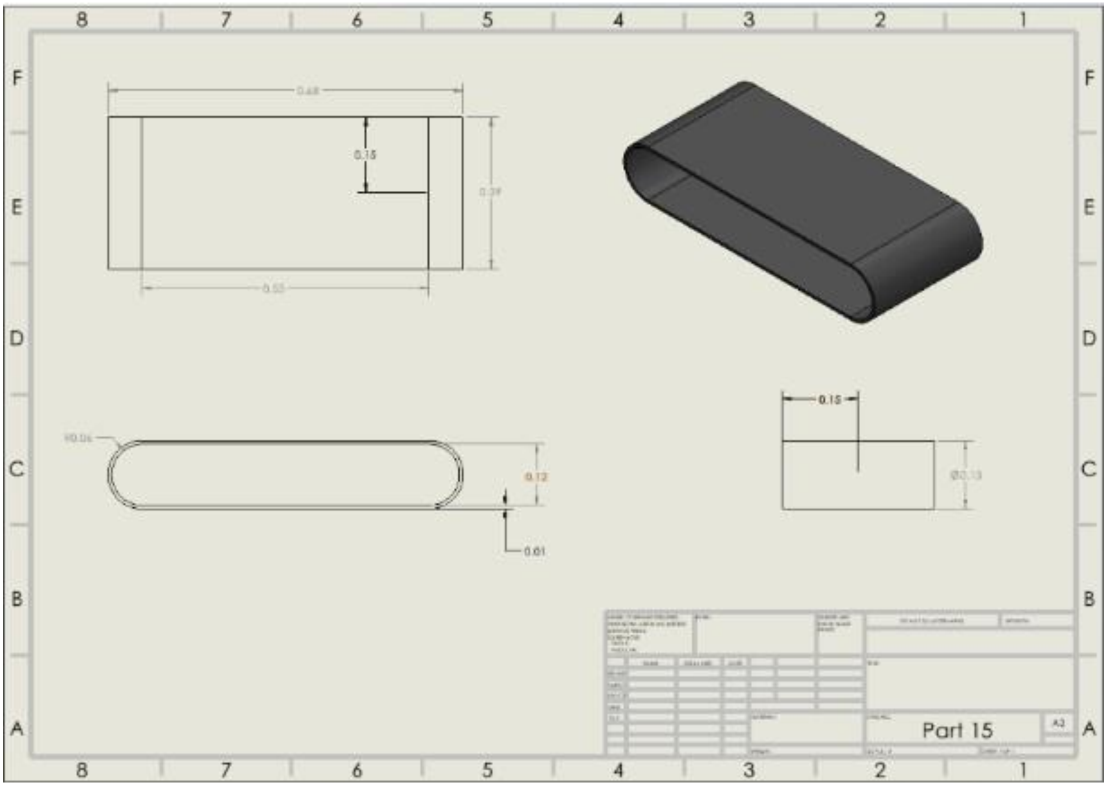


Fig. 4.33 2D Sketch of Part No.15

This is belt. It is composed of material PVC . Belt conveyors can be used to transport products in a straight line or through changes in elevation or direction.

17. Part No.16

Top View Side View Isometric View

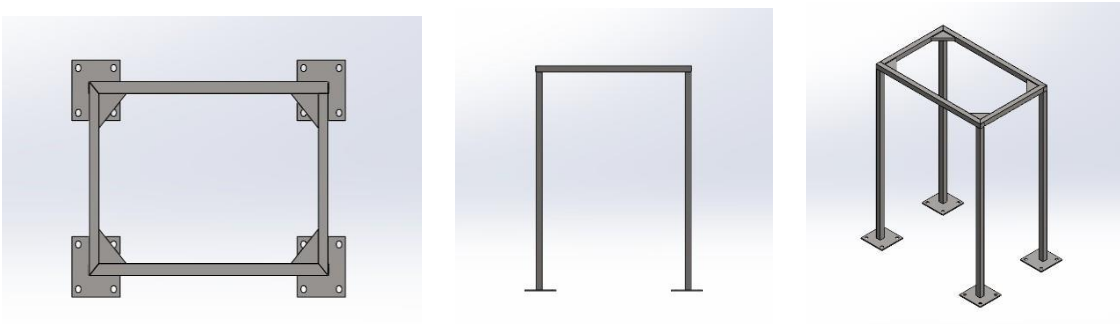
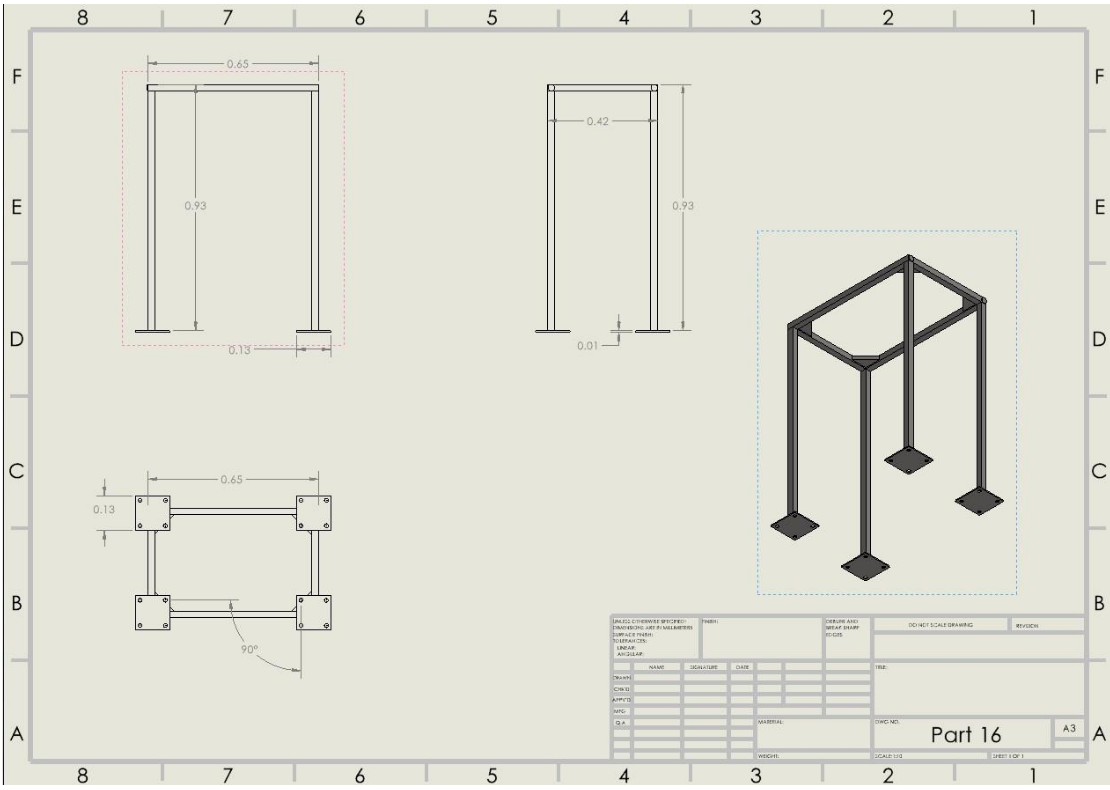


Fig. 4.34 All Views of Part No.16



This is the stand of conveyor system. It is the bottom support of the system , to protect the system from unwanted vertical forces, it can be fitted .

18. Part No.17

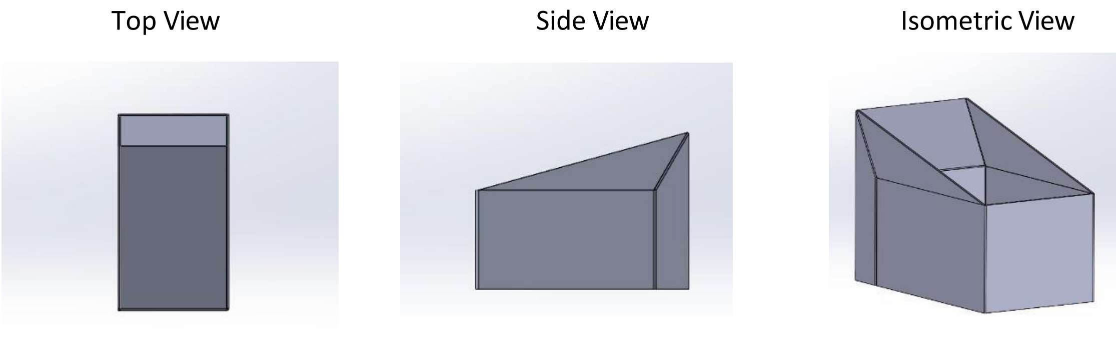


Fig. 4.36 All Views of Part No.17

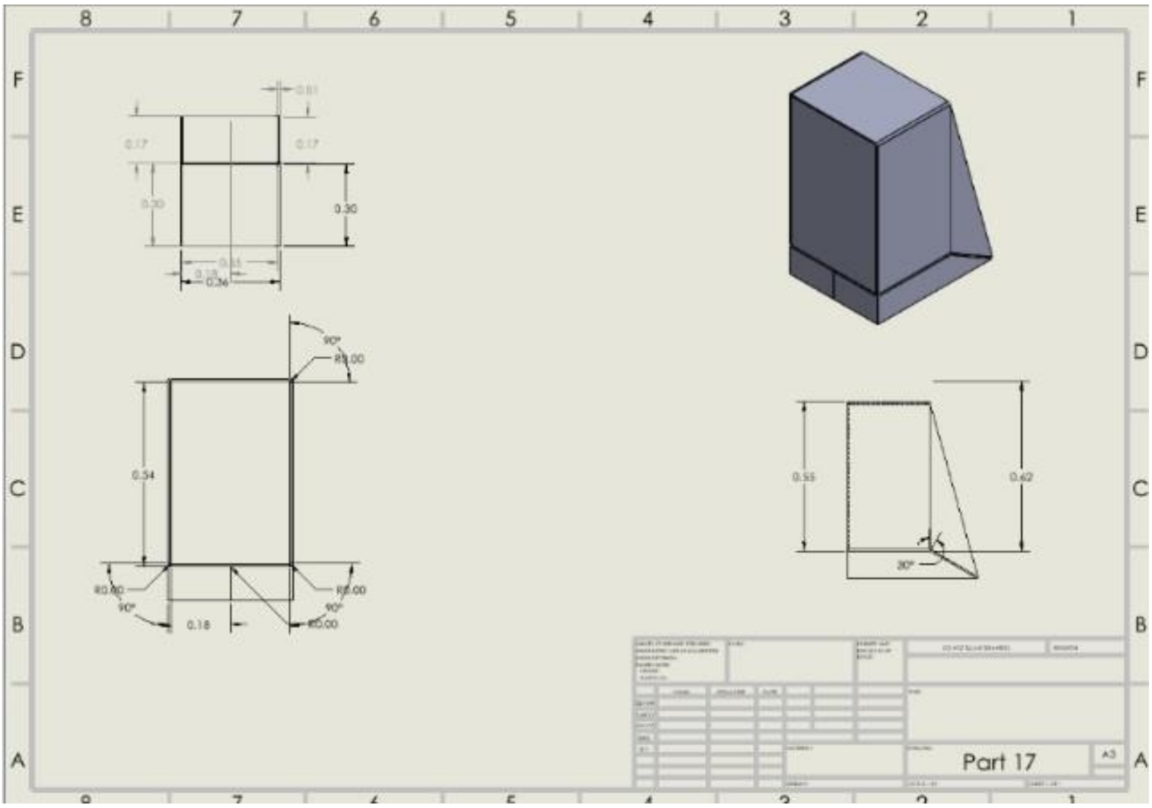


Fig. 4.37 2D Sketch of Part No.17

It is container. Pupose of this is to store all respective particles in each stage. In assembly, there is only one container we have used.

19. Part No.18

Top View   Side View   Isometric View

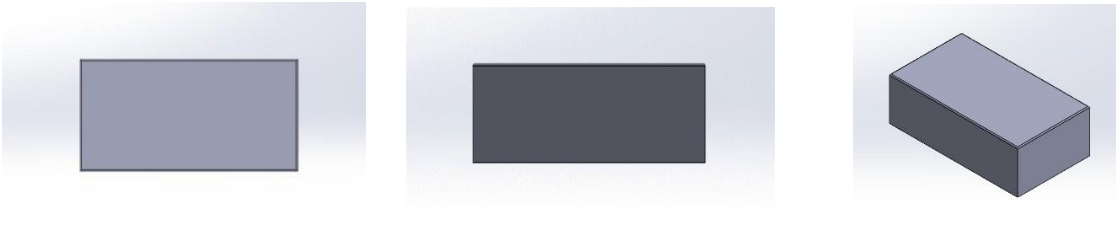


Fig. 4.38 All Views of Part No.18

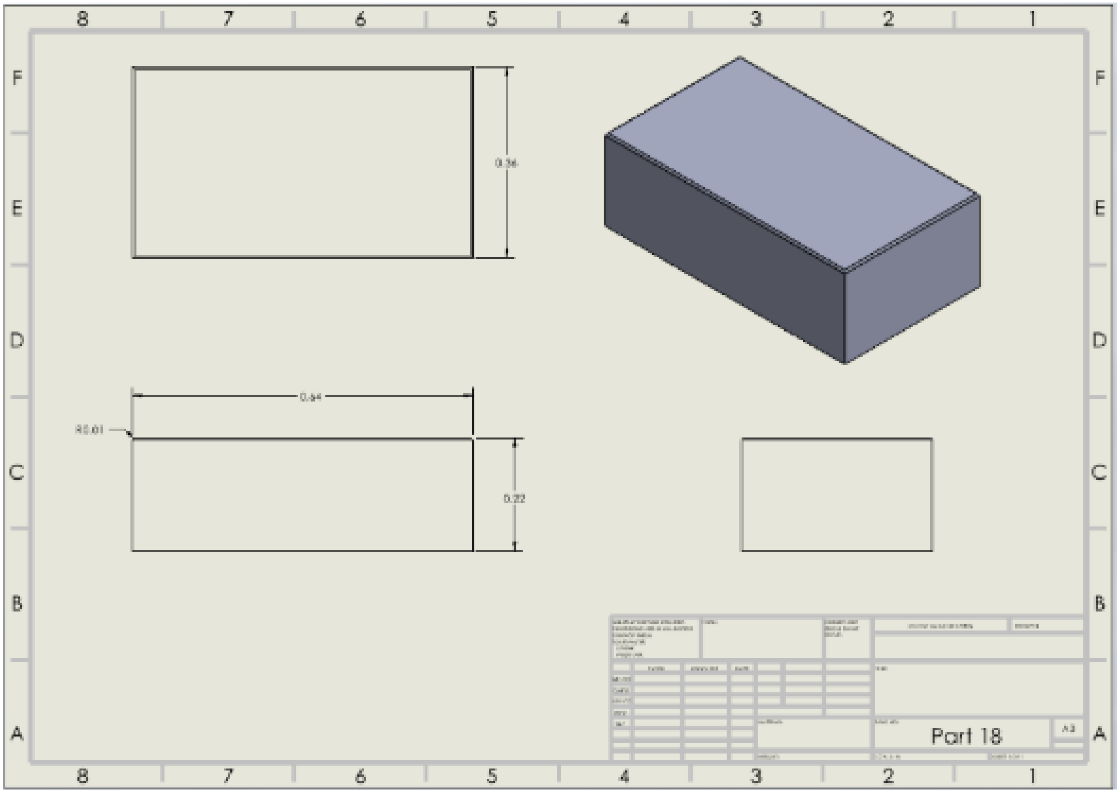


Fig. 4.39 2D Sketch of Part No.18

This is the block . it’s been used in first stage of assembly. Purpose of this is to give some height to container.It has area of 232766 mm^2.

20. Part No.19

Top View | Side View | Isometric View

Fig. 4.40 All Views of Part No.19

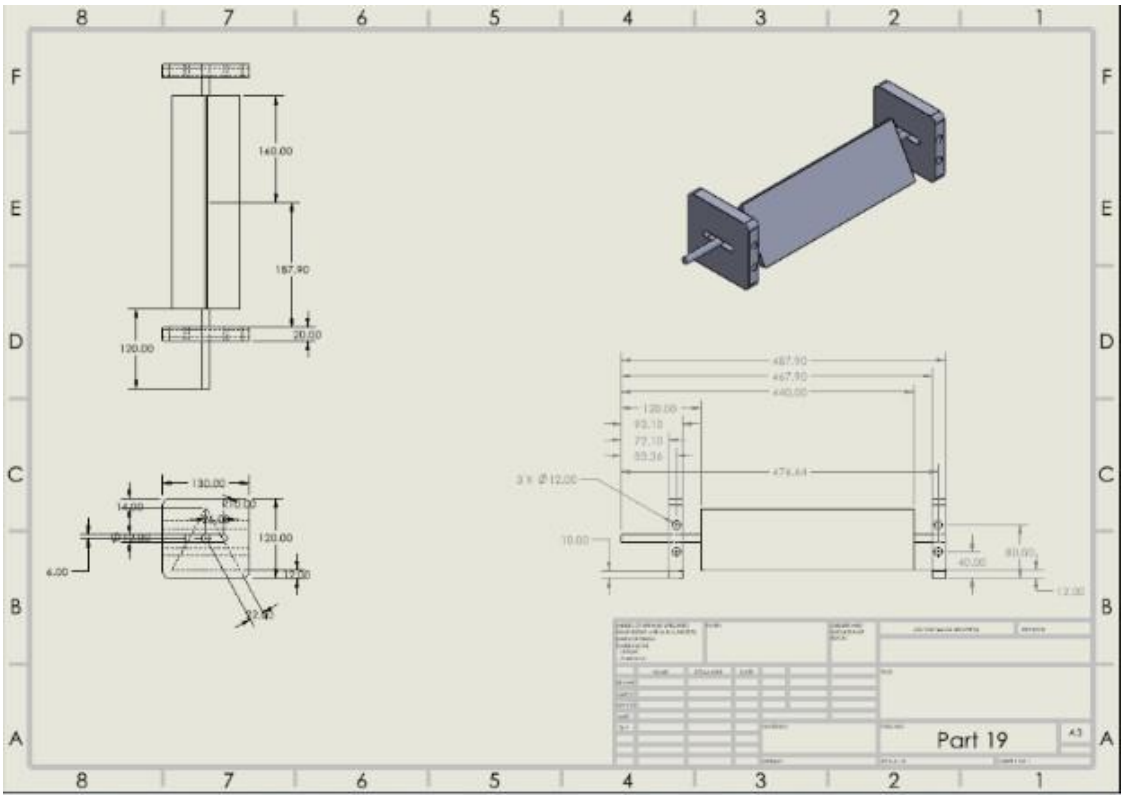


Fig. 4.41 2D Sketch of Part No.19

This is slider . Purpose of this is to deviate the flow of particles with requirements. It has only linear movement.

21. Part No.20

Top View Side View Isometric View

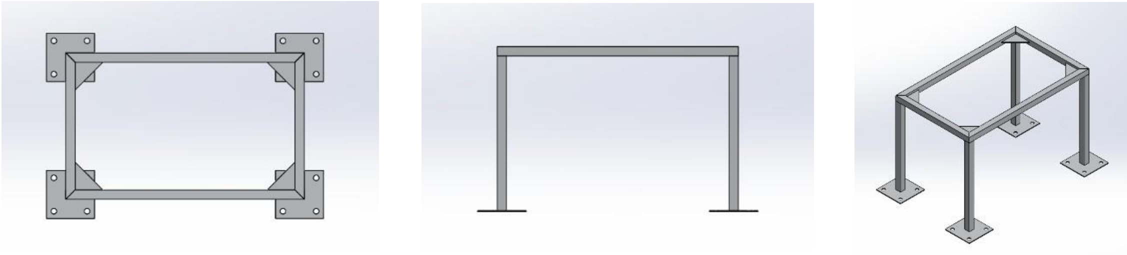


Fig. 4.42 All Views of Part No.20

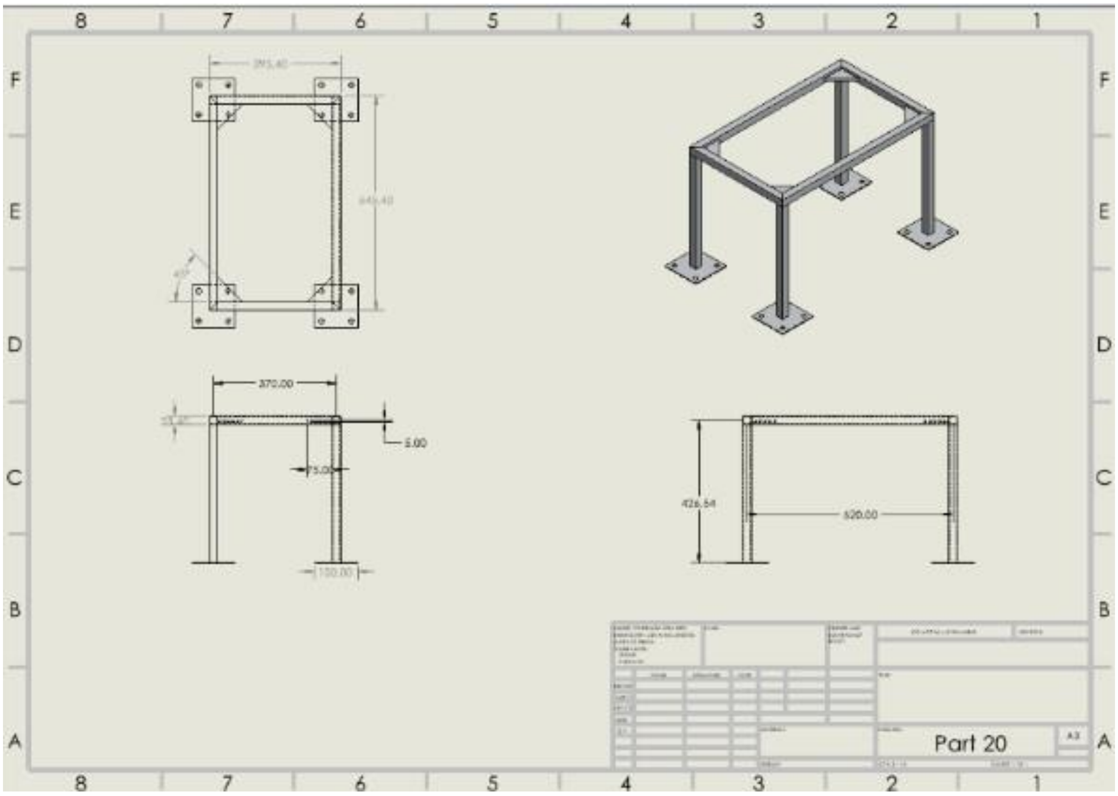


Fig. 4.43 2D Sketch of Part No.20

This is also another stand . It is used for second stage, to have bottom support. It is having dimensions according to second stage conveyor system.

22. Part No.21

Top View | Side View | Isometric View

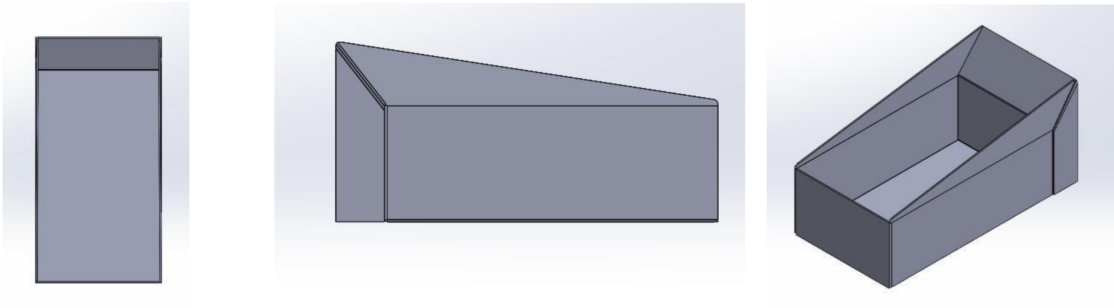


Fig. 4.44 All Views of Part No.21

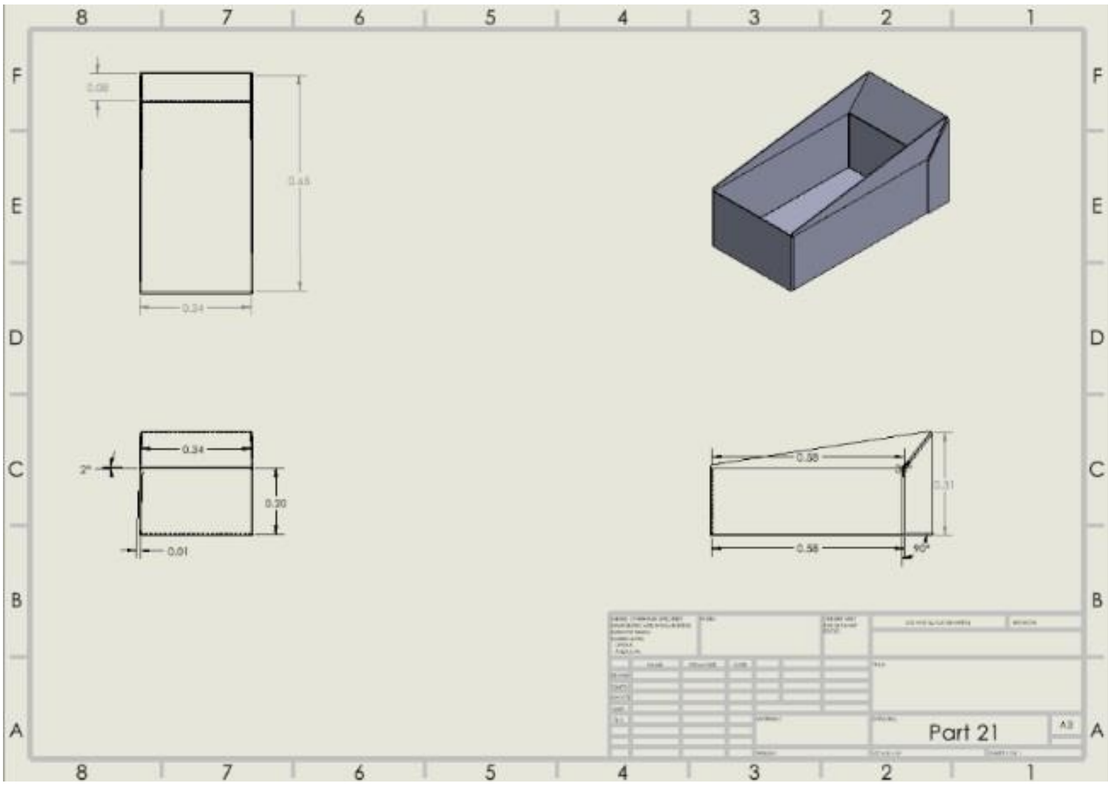


Fig. 4.45 2D Sketch of Part No.21

This is second container used in second and last stage of assembly. Pupose of this to store Al Cu and SS in respective stages.

23. Part No.22

Top View Side View Isometric View

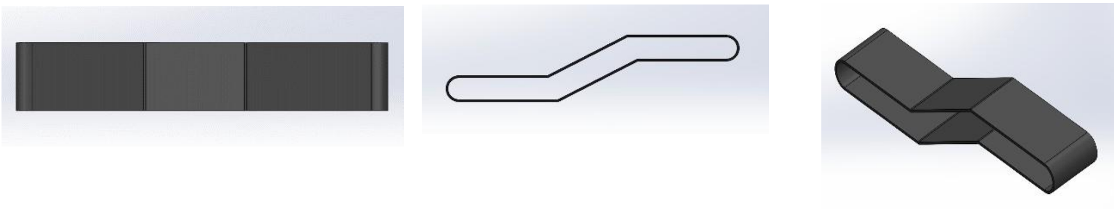


Fig. 4.46 All View of Part No.22

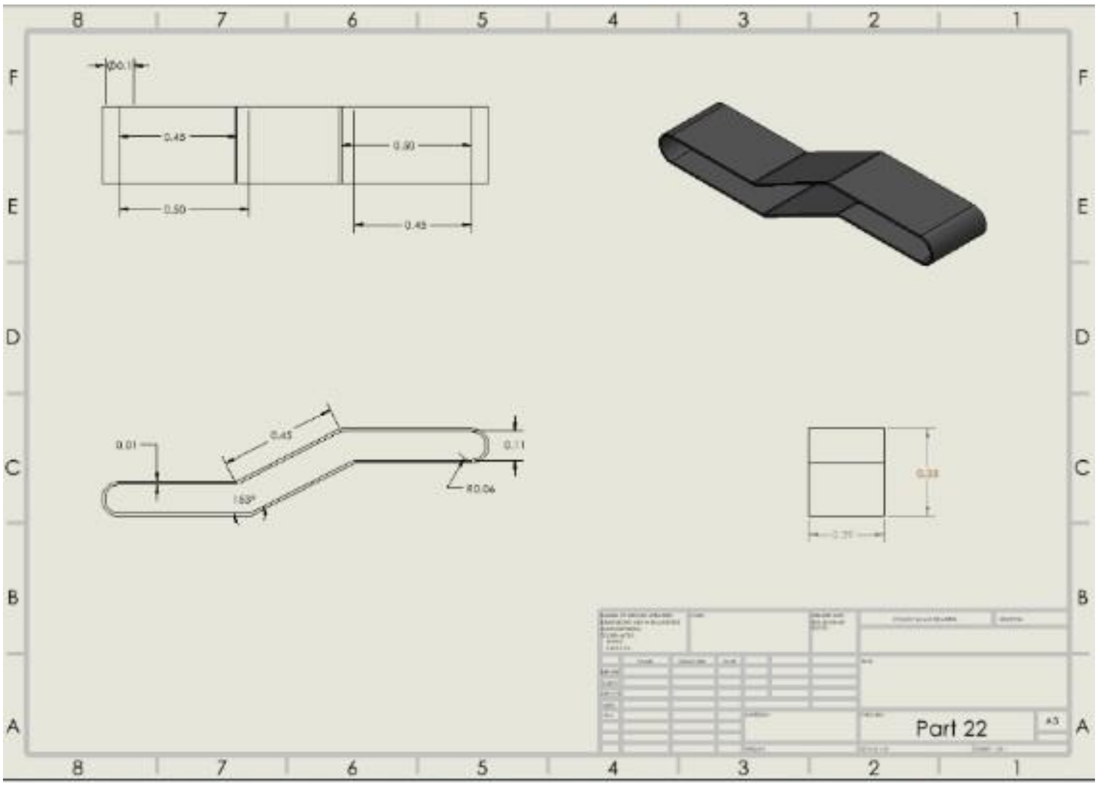


Fig. 4.47 2D Sketch of Part No.22

This belt is used in last z type conveyor system. It is also having same material of PVC with industry's requirement dimension. On this belt Al and Cu is moved to separate out.

24. Part No.23

Top View Side View Isometric View

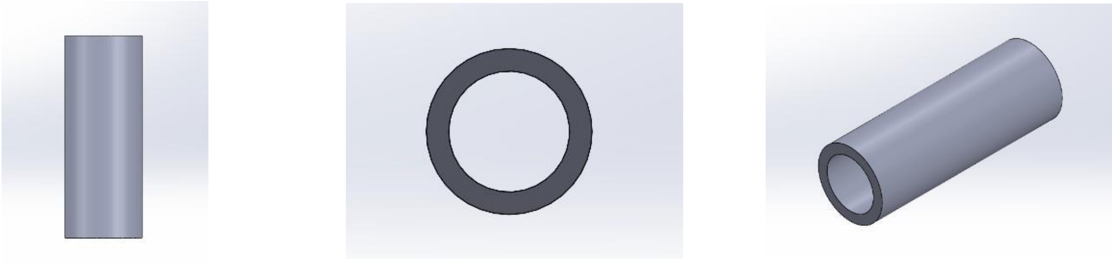


Fig. 4.48 All View of Part No.23

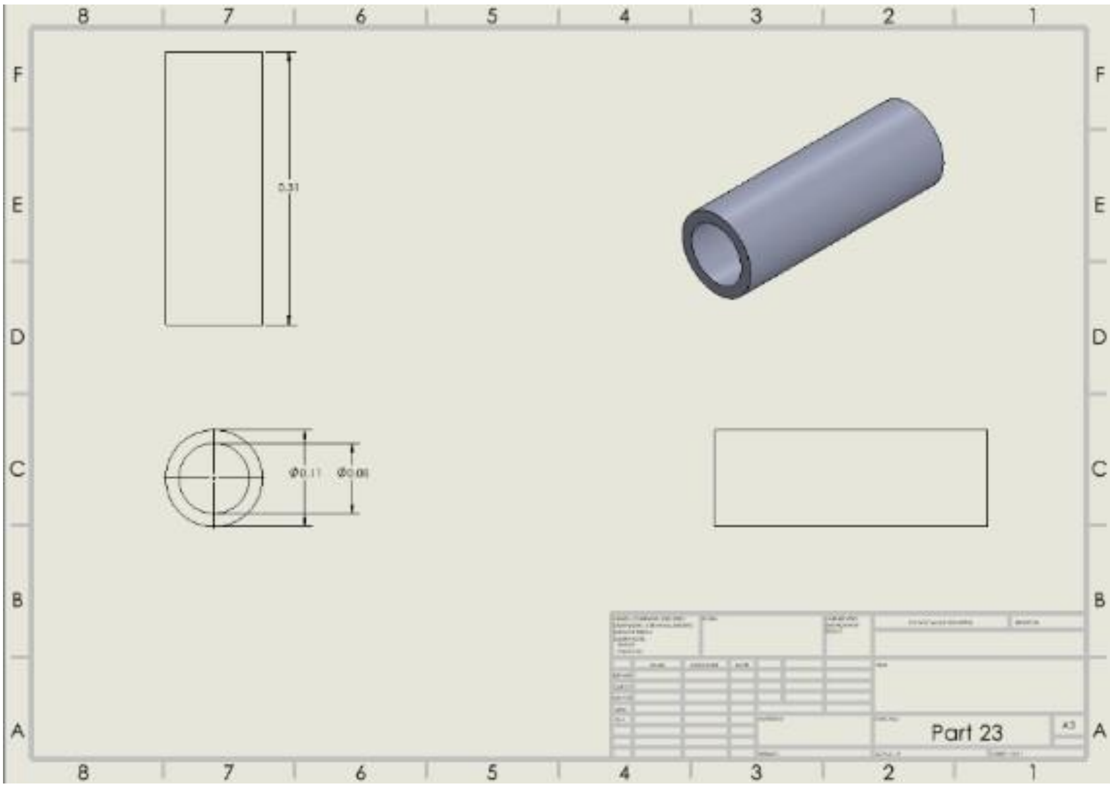
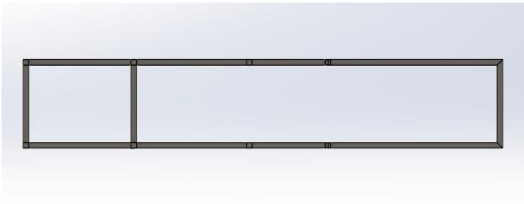


Fig. 4.49 2D Sketch of Part No.23

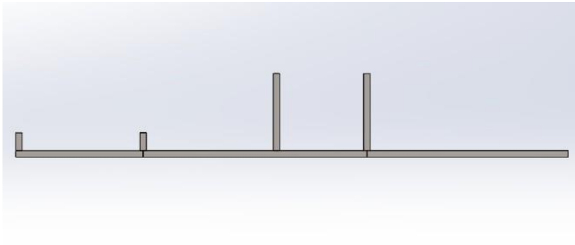
This outer roller of eddy current separator mechanism. In the inner side eddy current mechanism is used. It is used in the last of c type conveyor system to separate out Al and Cu.

25. Part No.24

Top View



Side View



Isometric View

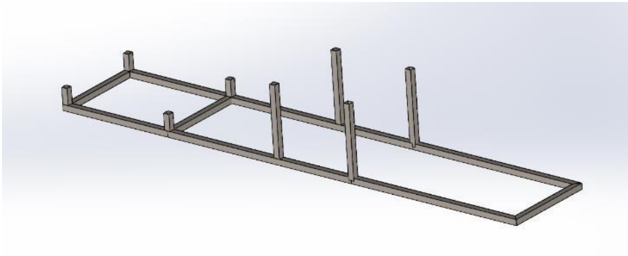


Fig. 4.50 All View of Part No.24

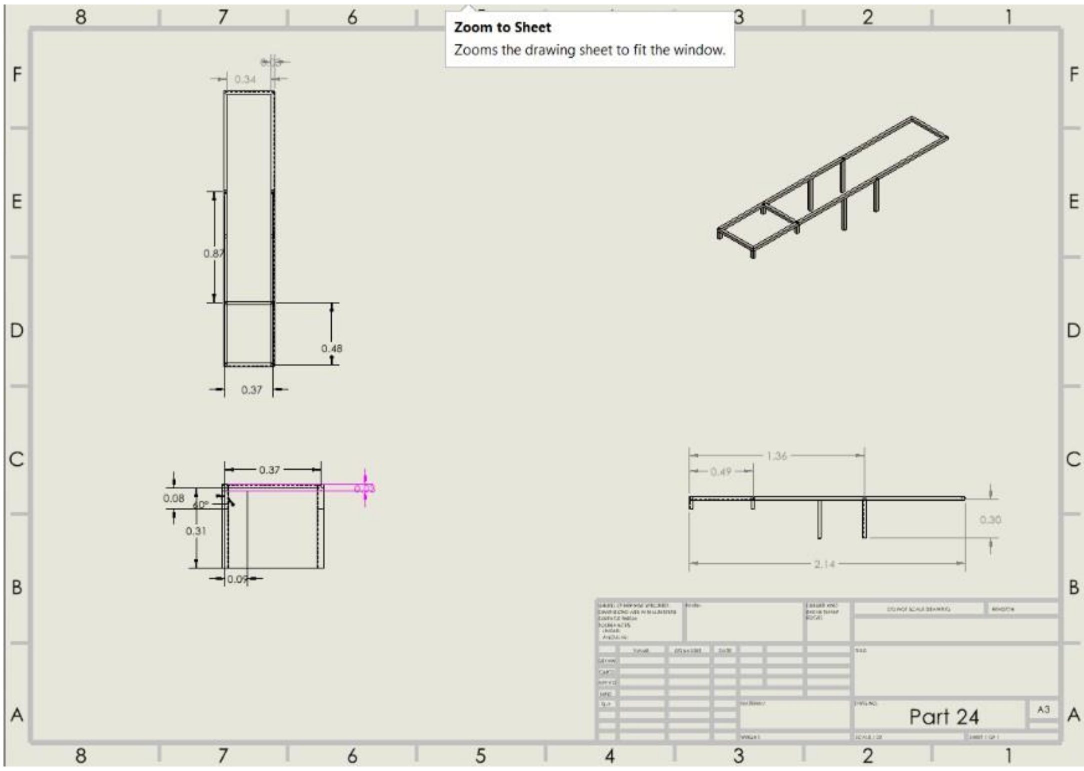


Fig. 4.51 2D Sketch of Part No.24

This is the stand of z type conveyor system. It holds the whole assembly with 2 containers. It also contains some structure to examine the process of separation.

26. Part No.25

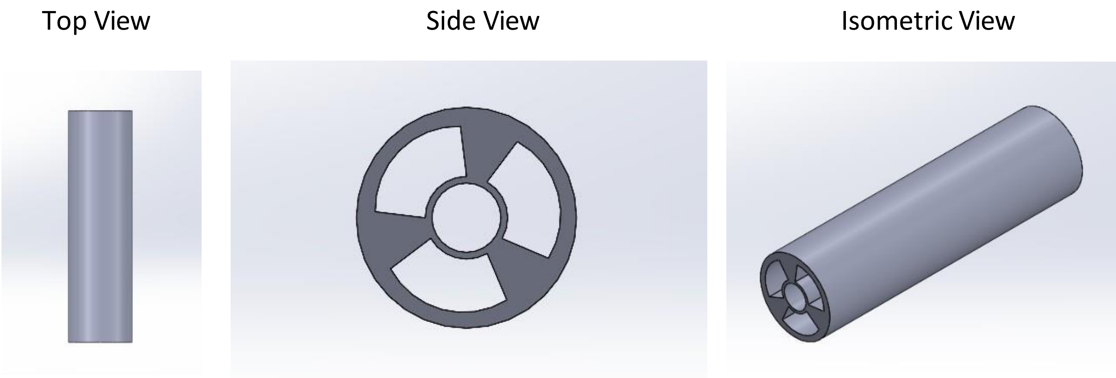


Fig. 4.52 All Views of Part No.25

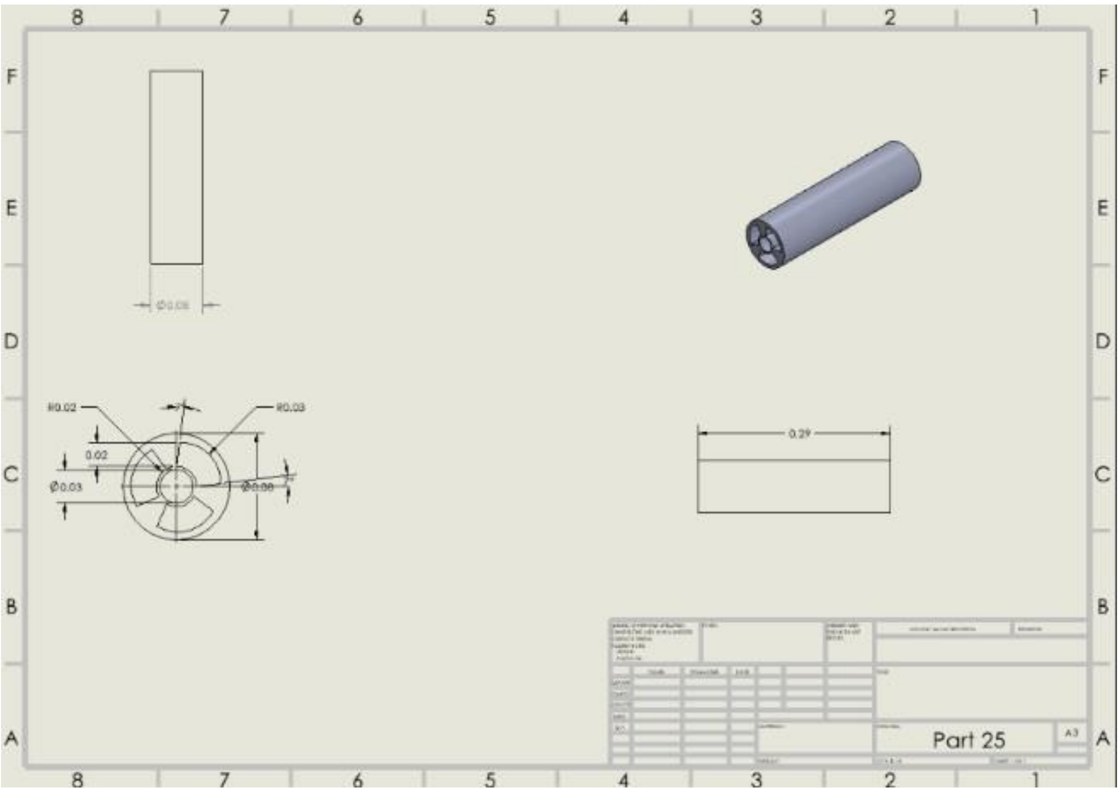


Fig. 4.53 2D Sketch of Part No.25

The inner roller of eddy current separator mechanism. It has magnetic coils which is used to separate Al and Cu based on their magnetism properties.

27. Part No.26

Top View　　　　　　　　　　Side View

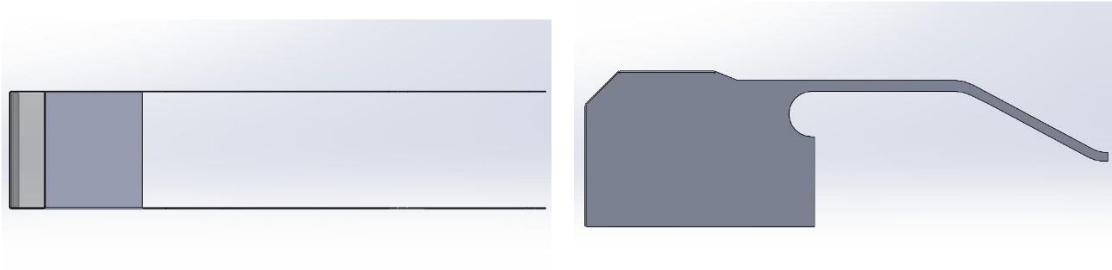


Fig. 4.54 All Views of Part No.26

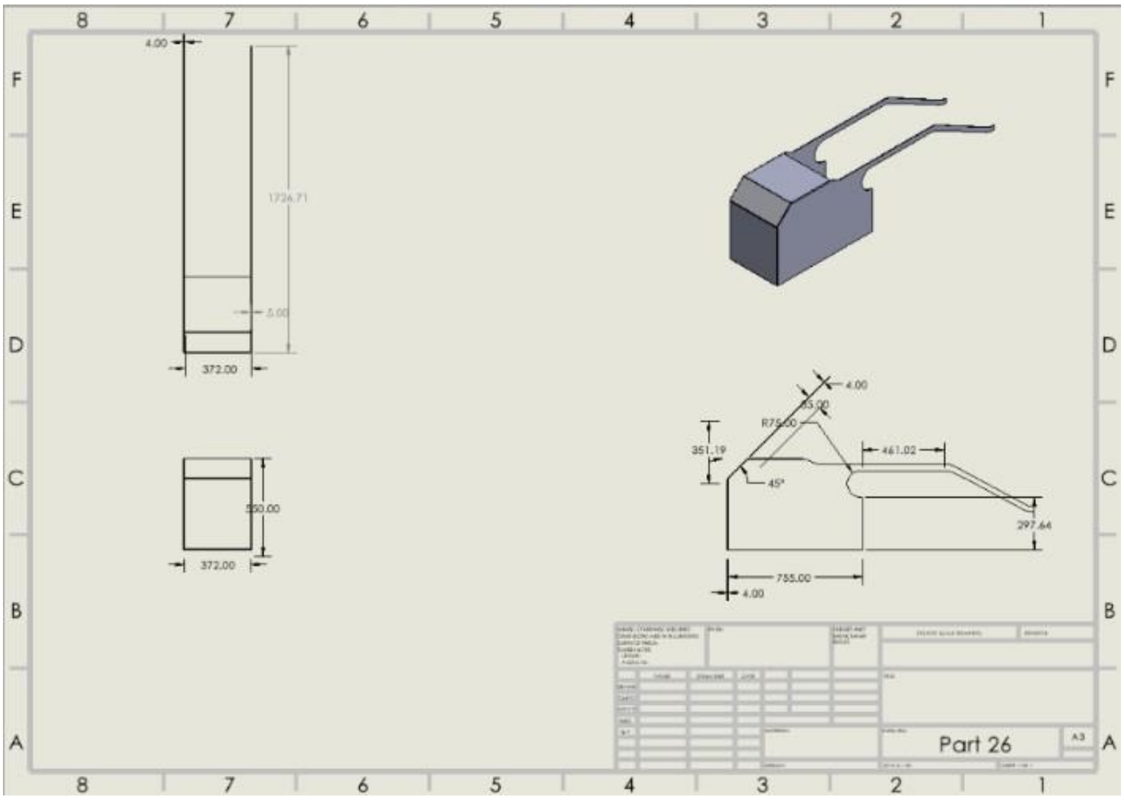
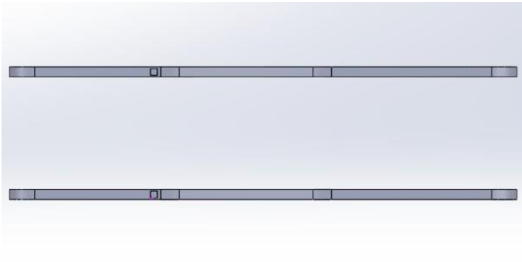


Fig. 4.55 2D Sketch of Part No.26

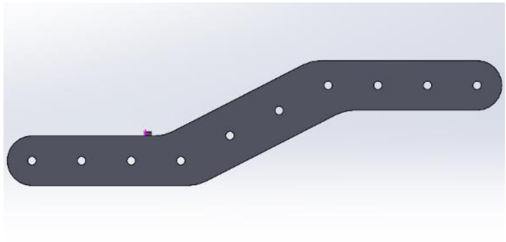
This is the customize structure for conveyor system.Is is designed in way that it can have human examination time to time.

28. Part No.27

Top View



Side View



Isometric View

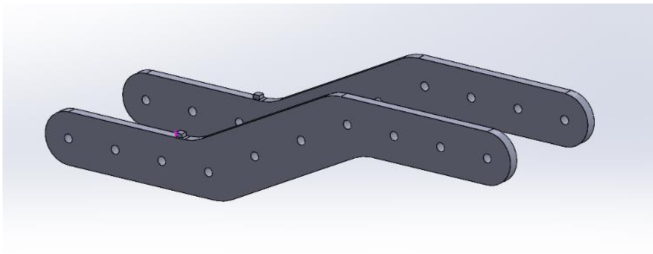


Fig. 4.56 All Views of Part No.27

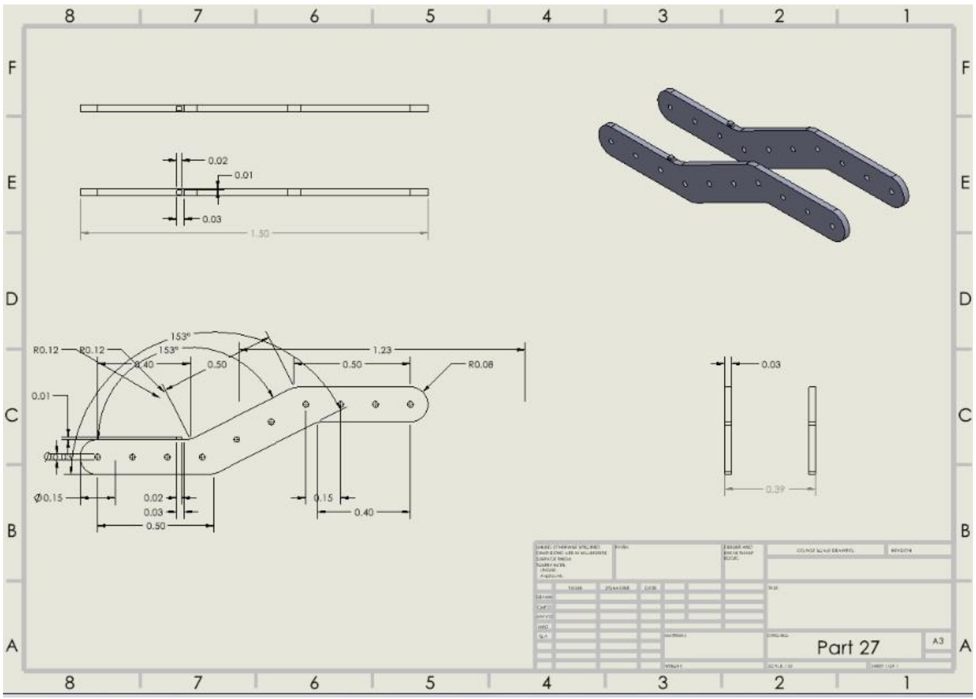


Fig. 4.57 2D Sketch of Part No.27

This is the main part of z type conveyor belt. It contains rollers , belt and on it particles, to move ahead with the use of external supply of two motors.

29. Assembly No.1

Top View Side View Isometric View

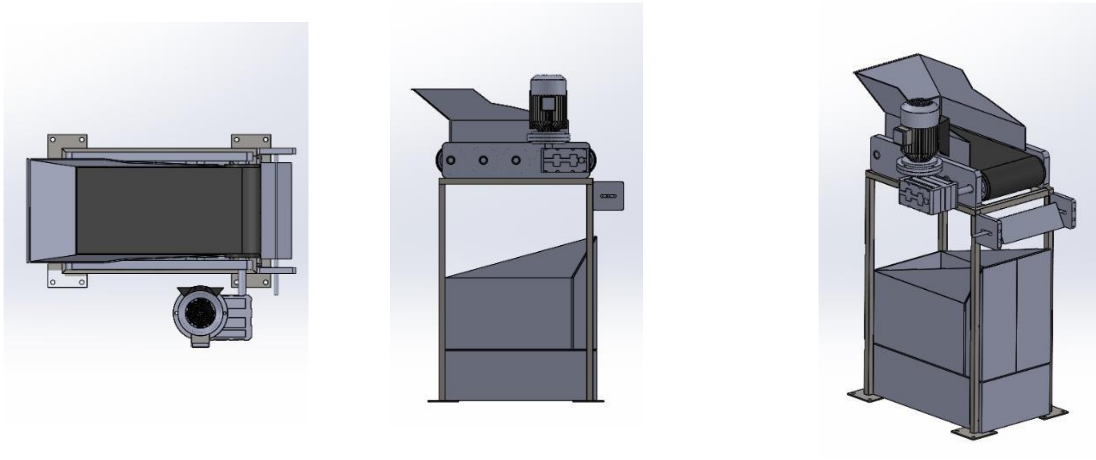


Fig. 4.58 All Views of Part No.27

Exploded View

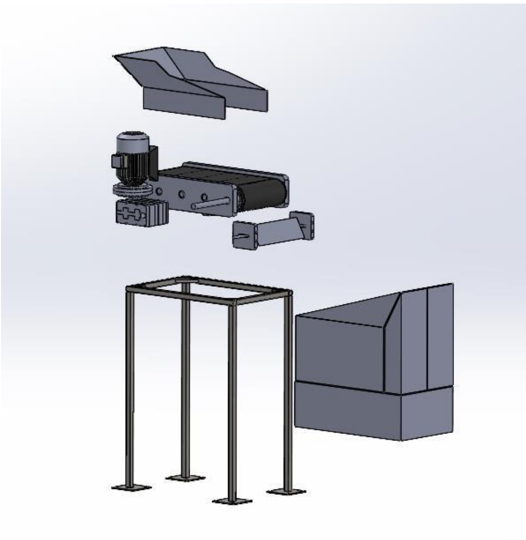


Fig. 4.59 Exploded View of Assembly No.1

30. Assembly No.2

Top view Side View Isometric View

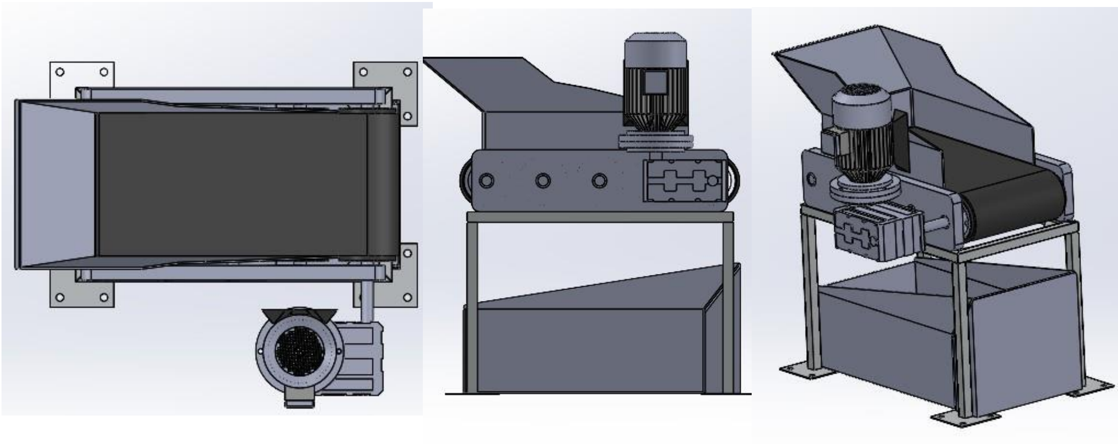


Fig. 4.60 All Views of Assembly No.2

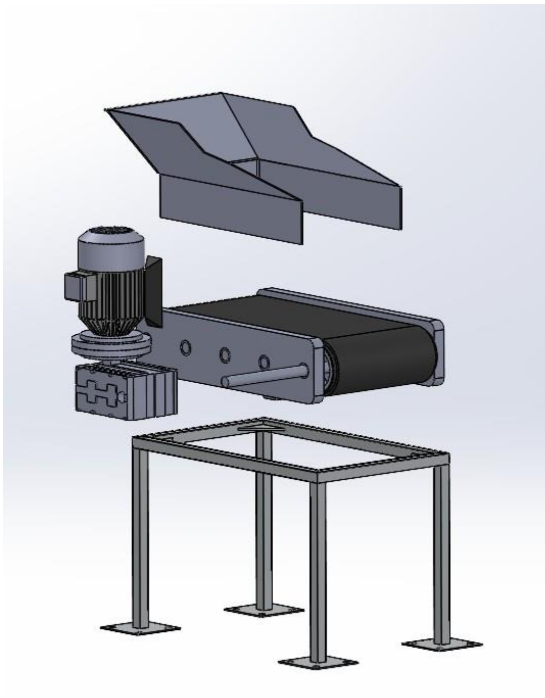
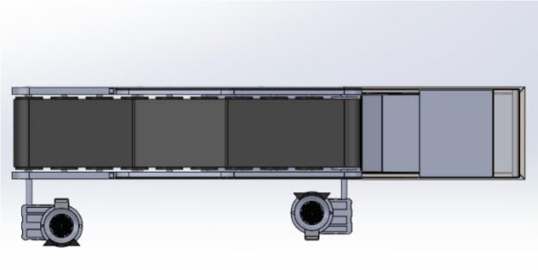


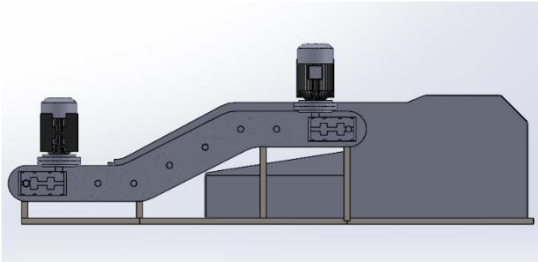
Fig. 4.61 Exploded View of Assembly No.2

31. Assembly No.3

Top View



Side View



Isometric View

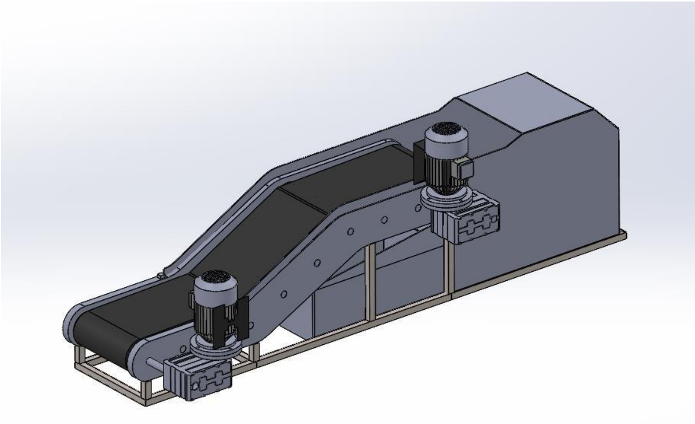


Fig. 4.62 All Views of Assembly No.3

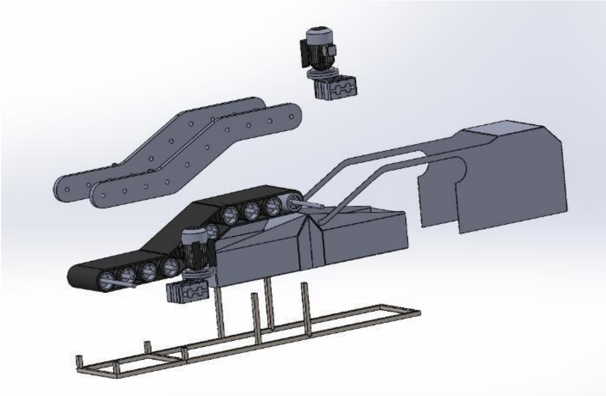
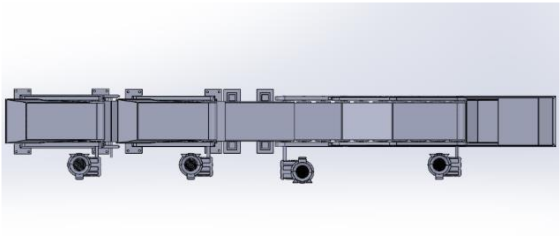


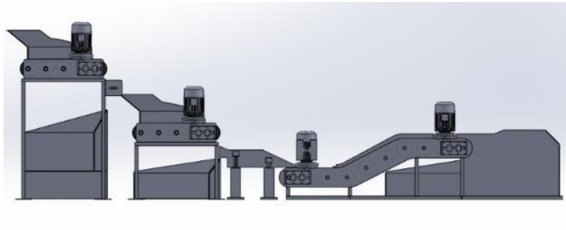
Fig. 4.63 Exploded View of Assembly No.3

32. Complete Assembly

Top View



Side View



Isometric View

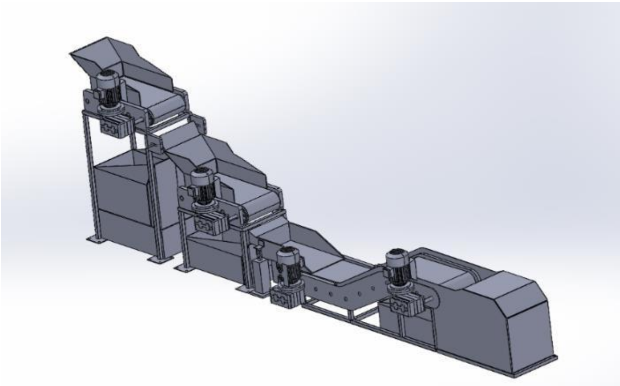


Fig. 4.64 All Views of Complete Assembly

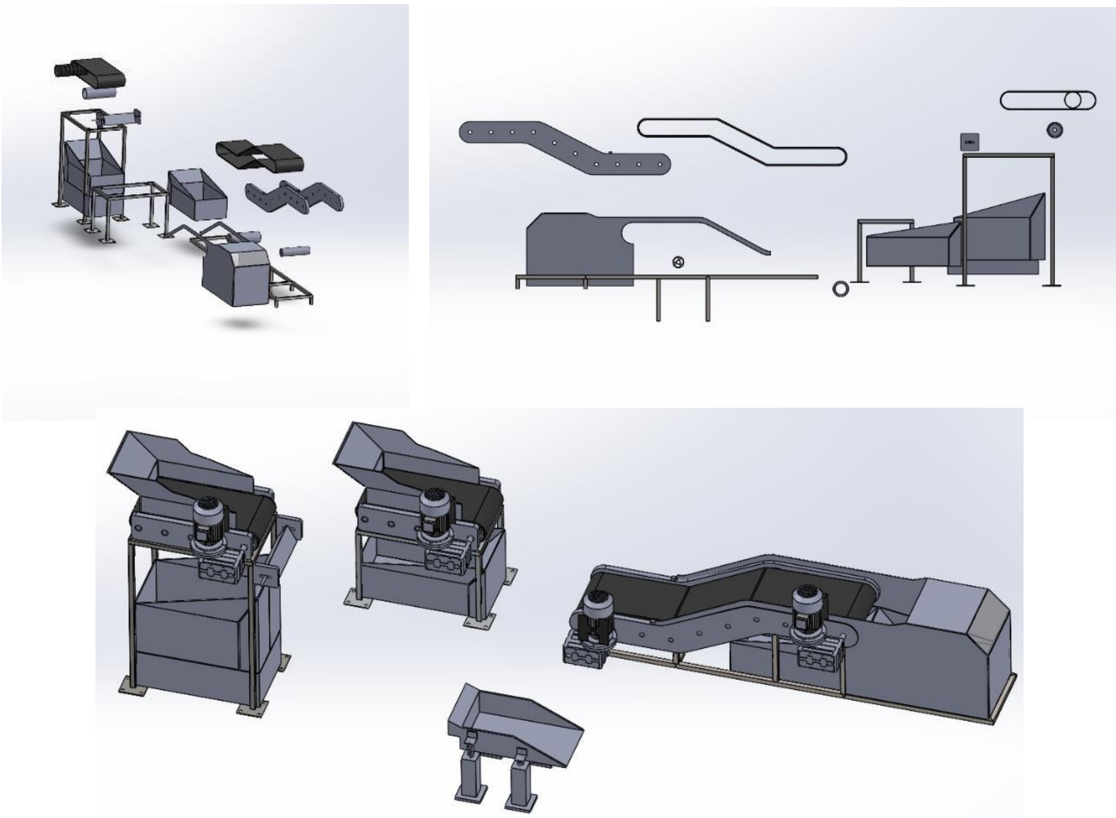
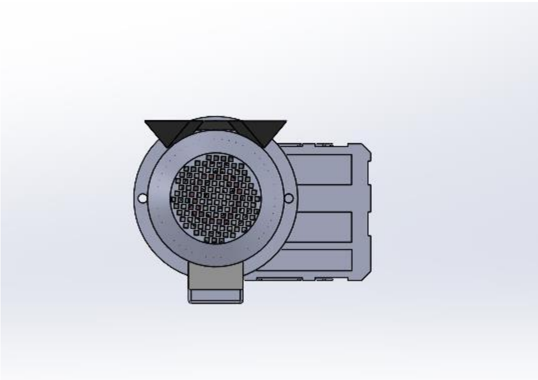


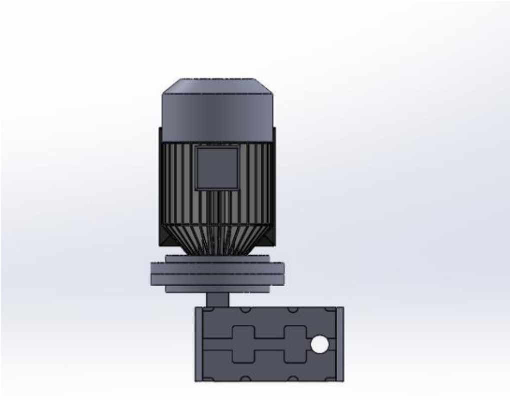
Fig. 4.65 Exploded View of Complete Assembly

33. Motor Assembly

Top View



Side View



Isometric View

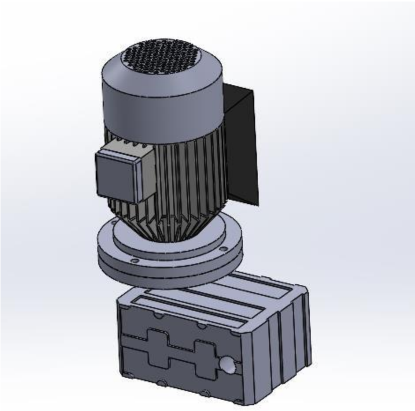


Fig. 4.66 All Views of Motor Assembly

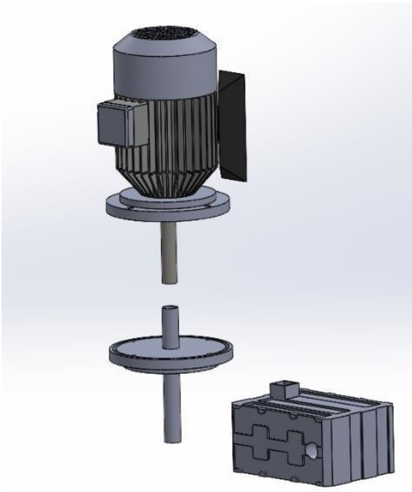


Fig. 4.66 Exploded View of Motor Assembly

CHAPTER – 5

COSTS INVOLVE IN LIFECYCLE OF PROJECT

5.1 Life Cycle Cost

The life cycle cost of a piece of equipment is defined as the sum of all costs associated with that equipment from the day it is purchased throughout its entire operating life. To the engineer specifying drives, costs of items such as spare parts inventory, maintenance personnel training and downtime may not seem as important as acquisition costs and efficiency. Major items to be considered when evaluating life cycle cost are:

1) Acquisition costs
2) Operating costs
3) Maintenance and repair costs

5.1.1 Acquisition Cost

The acquisition cost of the drive system is generally the easiest to identify. The specifying engineer must be certain, however, to include the cost of all components of the drive system.

5.1.2 Operating Costs

The cost of electric power is an important item to consider when evaluating the operating costs of various types of drives. The efficiency at each point in the operating profile must be considered for each drive type. Eddy Current drive systems for a typical speed range of 70 to 100%. Even though the Adjustable Frequency drive system has the highest average efficiency.

5.1.3 Maintenance and Repair Costs

Maintenance and repair costs are major contributors to the cost of downtime. In order to properly evaluate these costs, the following items must be considered for each drive type.

1. Cost of spare parts inventory

2. Skill level of repairmen
3. Equipment needed for repair
4. Complexity of drive components
5. Ease of trouble shooting and repair

5.2 Manufacturing Cost of Metal Separator

A manufacturing cost comprises all costs associated with producing a product or service, such as the resources acquired during production. The manufacturing costs include labor, materials and overhead. Here are the categories in further detail:

The formula used to calculate manufacturing cost is:

Manufacturing cost = Raw materials + Labor costs + Allocated manufacturing overhead

5.2.1 Determine the cost of raw materials

Start by determining the cost of all the raw materials. You can determine this using the following formula:

Cost of raw materials = Beginning inventory + Purchases added - Ending inventory

For example, if the raw materials total is INR 19,000 at the beginning and the company purchased an additional INR 20,000 in materials, the new raw materials total is INR 39,000. If at the end of the production cycle, the raw material inventory of INR 17,000, that means the total cost of the raw materials is INR 22,000.

Cost of raw materials =Rs 19,000 + Rs 20,000 - Rs17,000 = Rs 22,000

5.2.2 Readymade procurement costs

Readymade procurement costs of metal separators are in between INR 1,00,000 to INR 7,00,000.

CHAPTER - 6

STATISTICAL ANALYSIS

6.1 Calculating Energy Costs

As every engineer knows, energy calculation is straightforward. The unit of electrical energy is the kilowatt-hour (kWh), found by multiplying the power use (in kilowatts, kW) by the number of hours during which the power is consumed. Multiply that value by the cost per kWh, and you have the total energy cost.

Total energy cost = (Power in watts/1000) × hours operating × cost per kWh

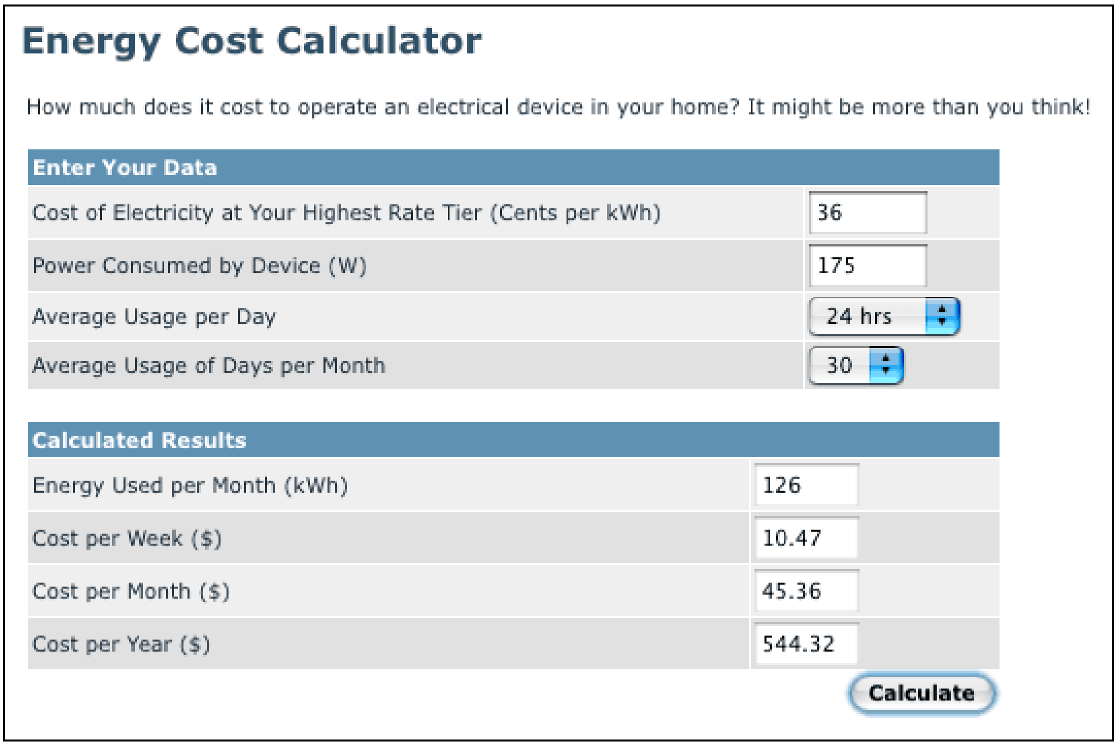
Maxim's Energy Cost Calculator makes the calculation even easier.

Figure 1. Energy cost calulator.

While the energy calculation is straightforward, there are variables to consider.

You need to account for:

- Varying electric rates
- Differences between labeled and actual power
- How many hours a day the device operates
- Different operating modes (e.g., operating and standby)



6.2 Annual Savings Comparison

1. HP Rating: 100
2. Constant for KW per HP: .746
3. Operating Hours/Year: 12 $hrrrr/dddddd$ × 260 $dddddddd/yyyy$ = 3120
4. Operating load: 85%
5. KW Rate/Hr.: Assume rate fee is INR 50 Rs per KW hour
6. % Efficiency Difference: AF System Average Efficiency - EC System Average Efficiency: $86.65 - 78.57 = 8.1\%$

Calculation:100 × .746 × 3120 × .85 × 50 × .081 = Rs 801250

6.3 Manufacturing Time Cycle

Manufacturing cycle time, or throughput time, is typically a KPI used in measuring the total time taken to transform raw materials into finished goods.

6.3.1 The cycle time formula

From the explanation of how to calculate cycle time in manufacturing, we can draw our formula as follows:

Cycle time = Net production time (per product)

however, the formula above may seem too complicated to grasp. A straightforward formula to consider is:

Non-productive hours + Productive hours (per product) = Cycle time

or

Process time + Inspection time + Movement time + Queue time (per product) = Cycle time

CHAPTER - 7

PARTS SEPARATION (BILL OF MATERIAL)

There is total 33 parts that modelled to build the final model of the machine. In which 10 parts are bought out parts and the remaining 16 parts will be manufactured and assembled in factory. Testing will give us the result on how precisely machine is working but after increasing the precising if required machine is ready to separate 2-3 tons of metal scrap per hour.

Most of the parts are in the manufacturing list so exact price we can't reveal at the moment but availability of MS (mild steel) to manufacture these components is required.

Sr. No.	Part No.	Description	Quantity	Dimensions (mm)
1	3	Motor Mechanism	4	l=200; b=150; h=100
2	4	Motor Ring	8	d=180; t=25
3	5	Motor Back case	4	d=150; t=85
4	6	Motor Front case	4	d=150; t=170
5	7	Motor Base	4	l=160; b=65; h=30
6	8	Motor Shaft	4	l=200; d=24
7	9	Motor Top base	4	l=60; b=45; h=60
8	10	Motor Rotor	4	l=320; d=22
9	15	Belt 1	2	l=679; b=290; t=7
10	25	Eddy Current Roller	1	l=290; d=80

- **Material Selection**
    1) Belt Material – PVC
    2) Belt Stand – MS
    3) Rollers – Al or MS
    4) Stand, Slider, Containers – MS
    5) Cases and Shafts – MS or Fe
    6) Motors – (availability in the market)

Manufacturing Parts				
Sr. No.	**Part No.**	**Description**	**Quantity**	**Dimensions (mm)**
1	1	Shaft 1	16	l=390; d=25
2	2	Shaft 2	4	l=625; d=25
3	12	Side Case (Complete)	2	l=620; h=150; t-30; Distance b/w 2=390
4	13	Roller	19	l=310; d=110
5	14	Roller Cover	20	l=310; d=117
6	17	Container 1	1	l=629.8; b=364.6; H=471.81; h=350.55; A=185995.53; P=1764.3; V=80495071.794 mm^3
7	18	Container Base	1	l=643.46; b=362.26; h=215.10
8	19	Mobilizer (Triangle)	1	l=415.8; b=130; h=120
9		Triangle	1	l=320; side=107.03
10	20	Stand 2 (Steel)	1	l=620; b=370; h=429.54; t=25.4
11	21	Container 2	3	l=662.29; b=335.6; H=315.7; h=200; A=36218.79; P=1406.59; V=44452904.8 mm^3
12	22	Belt 2 (Z Type)	1	l=1471.95; b=290; h=336.30
13	23	Eddy Roller Cover	1	l=310; d=110
14	24	Stand 3 (Steel)	1	l=2110.71; b=370; h=310.64; t=25.4
15	26	Case (Z Type) Front	1	l=754; b=372; h=550; A=397089.1
16	27	Side Case (Z Type)	1	l=1495.50; h=377; t=30; Distance b/w 2=390

CHAPTER – 8

RESULT AND DISCUSSION

8.1 Calculations –

8.1.1 Overall weight of metal separator-

Weight of metal separator – 2.36 ton

8.1.2 Rate of mild steel in the market –

Brands	8mm (Fe 500)	10mm (Fe 500)	12mm (Fe 500)	16mm (Fe 500)
Tata Tiscon	274 /piece	518/piece	630/piece	1322/piece
JSW Steel	44/kg	35000/ton	62000/ton	66/kg
Kamdhenu	62/kg	43000/ton	68000/metric ton	76/kg

8.1.3 Labour cost (Manual process) –

Approximately 500 Rs/ hr for separation of 5 kg of scrap, so to separate 1 ton of scrap machine requires Rs 100000 of labour cost also some additional overhead cost and takes 200 hrs.

8.1.4 Automatic Metal Separator Machine-

Metal separator machine separates 1 ton of scrap in one hour, which takes much less time with respect to conventional labour method.

Sr. No.	Description	Rate per Hour (Amount Rs.)
1	Turning	150
2	Milling CNC	170
3	Turning CNC	450
4	Milling	450
5	Jig Boring	450
6	Jig Grinding	450
7	Surface Grinding	225
8	Cylindrical Grinding	450

8.1.5 Manufacturing cost of metal separator-

Considering JSW steel rate for 10 mm is 35000Rs

Weight * rate of mild steel = 2.36* 35000 = 82600 Rs

Also considering Average CNC machine operating cost for different parts operation, By It costs approximately 350 Rs

So, for 27 parts it costs up to

27 parts * 350 Rs = 9450 Rs

In bought out parts we have 4 motors and all other parts are in customized dimensions as per the requirement.

Total manufacturing cost of metal separator = 82600 + 9450

= 92050 Rs (Approx.)

Total manufacturing cost of metal separator is still less than conventional method and it is one time investment

Hence Automatic metal separator machine is more efficient than conventional method.

For example, we had found that our system had a HC (hourly cost) of 400 Rs per hour. If the Overhead cost repartition is 250 Rs per hour and we want to have a margin of 15%, the final hourly price results in:

(Hourly price) = (400 + 250) / (100-15) * 100 = 765 Rs per Hour.

(Monthly price) = 765*25 = 19125 Rs

(Yearly price) = 300* 19125 = 57,37,500 Rs. (Approx.)

The metal separator manufacturer should also be informed on the pricing that is generally applied in the market for the same machine type and consider this in his final decision.

CHAPTER - 9

CONCLUSION

Automated system based on the existing technology, it is imperative to carry out theoretical and applied research. Same with magnetic separation it is very useful to use these techniques in the machine to help the workers to save time of workers. This machine will help so many industries to separate metals right at one location in four containers. Very useful very convenient.

In Manual process, Separation of some types of waste, carried out by mechanical means loading of the waste on a second conveyor belt, which takes them to an elevated platform where the operators in charge of their manual separation are placed. Manual separation of waste, carried out by specialized operators who remove specific materials from the undifferentiated mass.

Although above conventional process has some advantages but its very time consuming and lengthy, for replacement of this system. Automated system has plenty of benefits like system meets the demand of high-speed production using the least mechanism requirements. The system also provides high accuracy and precision of incoming metals or any other non-metallic products. We can use PLC's, I/O module supply, Power supply, sensors to make process very efficient.

Machine saves the annual power up to Rs 8,01,250.

Machine saves the labour costs annually up to INR 4,80,000 roughly.

Approximately 52 % of labour cost of two labours we can save by using automated machine.

As compare to manual process approximately 83 % of time we can save by using automated machine.

Roughly 89 % production of metal separation will improve by using metal separator automated machine.

Considering fixed cost, variable cost and price of each part, Break-even point of investment through profit by using automated machine will be after 13 months.

It also has low maintenance due to its compact size, easy service as compared to manual work. The design protects recycling equipment with negligible wear and tear.

CHAPTER – 10

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