

# Design and Fabrication of Waste Collecting Machine

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**Abstract** - Our project mainly concentrates on offering an easy, safety, reliable solution to the common problem of inefficient garbage disposal. The world today faces major garbage crisis the product of rapid economic growth, overcrowding, poor urban planning, corrosive corruption and political dysfunction. The present tried and tested methods of garbage collection have so far been proven ineffective. And the world today is looking at smarter ways of overcoming the garbage collection problem. Main users of our product would be corporate workers, footpath sweepers, home servants etc. This paper presents the Semi-automatic waste collector machine for foot paths. The machine is built on a metallic base which is powered by battery. The machine movement is controlled by remote or by mechanically (push or pull). The machine is designed to collect Garbage at foot path, public places (parks, schools and colleges), mostly cemented paths and beaches.

The Machine consists of a roller with brushes and many steel plates attached to the axis. While it is started the motor with high speed rotates, which pushes the solid wastes to get into conveyor belts, since the conveyor belts. This is then moved to the bin attached in back of the body. When the drum is filled, we can remove the drum and unload the waste collected.

**Key Words:** Conveyor belt, Brushes, Rollers, Chassis, Wheels, Bearings.

## 1. INTRODUCTION

Waste management (or waste disposal) are the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process.

Waste can be solid, liquid, or gaseous and each type has different methods of disposal and management. Waste management deals with all types of waste, including industrial, biological and household. In some cases waste can pose a threat to human health. Waste is produced by human activity, for example the extraction and processing of raw materials. Waste management is intended to reduce adverse effects of waste on human health, the environment or aesthetics. Waste management practices are not uniform among countries (developed and developing nations); regions (urban and rural areas), and residential and industrial sectors can all take different approaches

Currently, in India, roads require cleaning by brooms and other hand-held devices. This is inefficient due to the amount of time it takes and the health effects such as dust inhalation and dehydration of the operators. Recently, the Indian government has launched an initiative known as the "Clean India Mission." Due to this mission, there is a need for a more efficient and healthy way to pick up the trash in the form of a device attached to a human pedal-powered tricycle. This device will allow the operator to pick up the trash and place it into a temporary storage unit without actually touching the trash. In order to navigate the sometimes rough terrain on the roadways in India, the device must be durable and stable. This manual powered street-cleaner will allow much more efficient and sanitary means of cleaning the streets of India. To begin effectively accomplishing this goal, the team met with a project representative to discuss the project scope, problem definition, design specifications, and design parameters. It is critical that all of these are defined properly so that the device being made will effectively accomplish the goal of the project, which is ultimately to remove trash from the streets of India. With this, numerous factors had to be taken into consideration to ensure that the device is fully functional and operates safely. For example: verifying how the device functions, seeing what the terrain conditions are like, who will be using it, and if it will need to be reproduced by people in similar areas across the world. By understanding these factors, the team is able to better plan for and design the device. Below, the parameters have been separated into different categories with additional details. The team has ranked this in matter of importance to create a clear focus of what key design factors we will be considering when starting the creativity phase of the design process.

## 2. LITERATURE REVIEW

### Dr. D V Patil Vidyapeeth, Rajesh Panchal Design of Rocker Bogie mechanism [1]

The motive of rocker bogie mechanism was to understand mechanical design and its advantages over the efficiency and maintenance related expenses of conventional suspension system.

Rocker bogie mechanism which was currently NASA's approved design (Mars Exploration Project) because it has studied /resilient capacities to deal with obstrucles and it uniformly distribute the load over its 6 wheels all the time. The important factor in manufacturing rocker bogie mechanism is to determine the dimension of rocker bogie

linkages and angle between them, (length and angle between the mechanisms can be changed as per the requirements).

The design of rocker bogie increases reliability, stability and efficiency. It has become a proven mobility application known for its vehicle stability and obstacles climbing and also moves through any terrain areas like sandy or hard surfaces. The disadvantage is the rotation is possible by providing individual motors to individual wheels which arises in cost and complicated design and programming.

### **S A Karande, S W Thakare, S P Wankhede Automatic Garbage Collector Machine [2]**

In this project review the proposal concept is to reduce the human effort in garbage cleaning in sea ways by automated system. The machine is placed in the drain, so that the solid waste like bottle, clothes which floats on water gets lifted by teeth connected to the chain. The waste materials are stored in the collector.

This system is powered by hydraulic turbines which generate electricity for the running of motor attached to the chain. The chain is connected with wire mesh filters for easy flow liquid (waster) this helps in separation of solid and liquids.

### **M Ranjit Kumar and N Kapilan Conventional floor cleaning machines [3]**

The conventional floor cleaning machines is most widely used in airport platforms, railway platforms, hospitals, bus stands, and malls and in many other commercial places. These devices need an electrical energy for its operation and not user friendly. In India, especially in summer, there is power crisis and most of the floor cleaning machine is not used effectively due to this problem, particularly in bus stands. In this work, modeling and analysis of the floor cleaning machine was done using suitable commercially available software. From the finite element analysis, we observe that the stress level in the manually operated floor cleaning machine is within the safe limit

## **3. SURVEY REPORT**

### **Survey Conducted at Kottayam Municipal Corporation, Kerala, India**

The survey includes the issues faced by the cleaning labours working at municipal office, Kottayam, Kerala, India on 19/02/2019 to identify the major problems during waste collection and to rectify them with suitable measures.

The survey conducted among five daily employers at kottayam municipality corporation, we found that the major collecting wastes are plastic bottles and covers, dried leaves wasters, plastic wastes from shops consist of covers,

ropes etc. Mostly seen wastes are plastic wastes and dried leaves wastes found on road side and foot path. The major waste collecting areas are road side, foot path, shops etc. The waste is mainly collected with the help of broom, hand picking method, a trolley. Waste collection from foot path and narrow areas are more difficult. Since the foot path is not in parallel all time it make much difficulties in waste collection because the trolley has to be lifted up and down in certain conditions. It is very difficult to maintain the operation of trolley in such situations where we don't get a smooth path to run the trolley during cleaning the foot path. The operation of trolley is one of the major problem faced by the labours. The major time consuming process among waste collection is road side and foot path cleaning and operation of trolley. If we find a suitable option to collect the waste from foot path and narrow areas and maintaining the handling of trolley work effort can be reduced considerably

### **Survey Conducted at Ernaulam Municipal Corporation, Kerala, India**

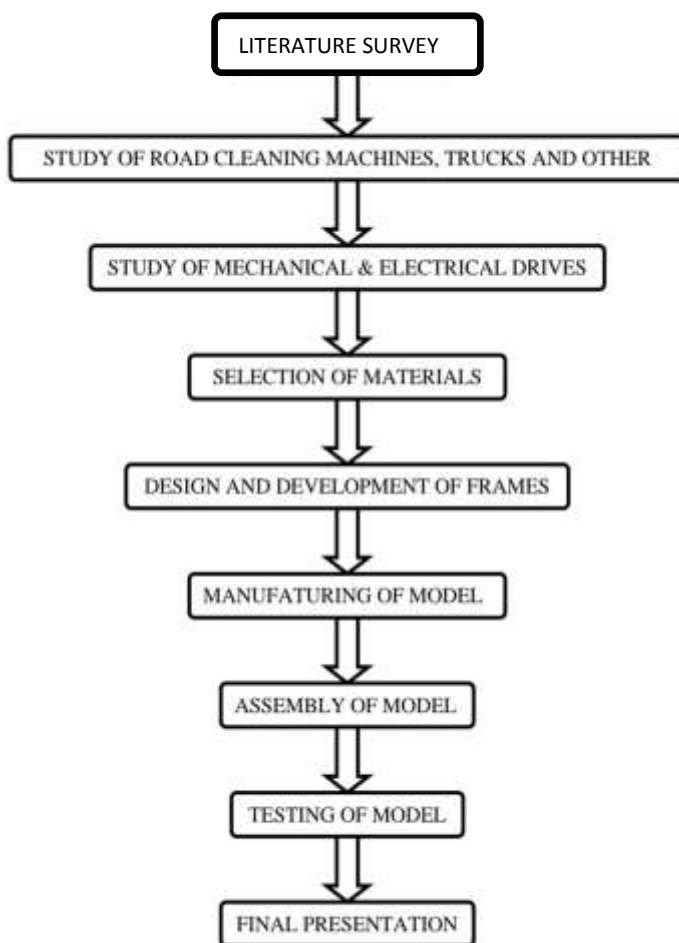
The survey was conducted on 13 February 2019 at corporation zonal office vtyilla. The main purpose of the visit was regarding the usefulness of the project, understand the difficulties faced by workers while cleaning and to make them know about our project and would they accept in taking our project into action after a working model is manufactured. While enquired about the difficulties they had told that they are facing many problems during cleaning or in field work. While at field work there are some types of glass wastes that are causing wounds and injuries to them. Certain allergies are also a major problem faced by the workers. This type of glass materials are damaging there safety gloves and safety shoes and thereby piercing them into their safety materials and causing injuries and allergies. These types of injuries are dangerous and they can be septic if the wounds are not spotted by the workers. They told about the needfulness of new safety equipments by replacing damaged ones. We ensured their problems can be minimized by knowing our project. They had shown interest in our work and enquired its working and quality of the equipment. When enquired about how we can apply our project in there sector they told us to contact the officer and told he can only take decisions regarding that. We had contacted the zonal officer and he had ensured proper usage of the project after getting necessary permissions for the usage from higher authorities.

### **Conclusion**

If we can develop a suitable method to collect and store the waste in a trolley like waste collecting machine we can reduce the effort by the labours during operation of work. If the system consist both collection and storage in a single unit the waste collection from difficult areas can be done easily with less amount of time. The developing system must be able to travel in up-down areas like steps seen in foot paths so that transportation of waste must be very easy

through the narrow difficult areas. The machine should have less weight most probably equals to a man's weight so that it can be handled smooth and will be able to operate with a single person. Maximum utilization of space have to be done in the machine so that large amount of waste can be stored within a small machine structure. To reduce the use of space we can implement a system to crush the wastes so that to reduce the space usage. These are the conclusions that are shared and found out from the workers who shared information with us.

#### 4. METHODOLOGY



#### 5. DESIGN AND SPECIFICATIONS

##### 5.1 DEEP GROOVE BALL BEARING

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads.

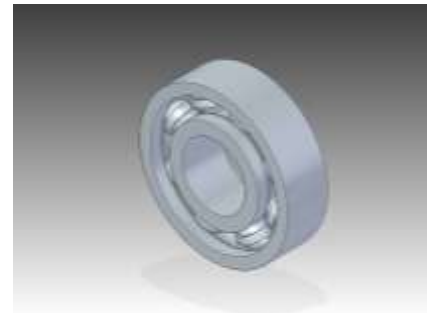


Fig 5.1: Design of deep groove ball bearing

##### Specifications:

Material	: Stainless Steel
Outside diameter	: 35 mm
Inside diameter	: 15 mm
Width	: 10 mm

##### Basic load rating,

Dynamic Loading	: 9.95 KN
Static Loading	: 4.75 KN
Limiting Speed	: 19000 rpm
Total number of bearing	: 10 nos.

##### 5.2 GEARS

A gear is a rotating machine part having cut teeth. Teeth of two or more gears which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source.

In this gears are used for transmitting the torque equally to each conveyor belt.

##### Specifications:

Pitch diameter	: 116 mm
Number of teeth	: 58
Material	: Mild Steel
Model No.	: S2058B
Outside diameter	: 120 mm
Weight	: 2.00 Kg

##### 5.3 D C MOTOR

A DC motor is a rotary electrical machine that converts direct current electrical energy into mechanical energy. They work from the forces that are produced by magnetic fields. All types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor.

For the waste collecting machine we use 2 motors. One is for high torque used for running conveyor belts and the other is a high speed motor used for the rotation of front blades.

##### Specification and calculations:

Voltage	= 12 V
Current	= 30 A

##### High speed motor,

$$\text{Power} = V \times I = 12 \times 30 = 360W = 360/746$$

$$= 0.482 \text{ HP}$$

$$\begin{aligned} \text{Torque} &= (\text{power in HP} \times 9550) / (\text{Speed in rpm}) \\ &= (.482 \times 9550) / (2500) \\ &= \underline{1.8412 \text{ Nm}} \end{aligned}$$

High Torque motor

$$\begin{aligned} \text{Torque} &= (\text{power in HP} \times 9550) / (\text{Speed in rpm}) \\ &= (0.482 \times 9550) / (750) \\ &= \underline{6.137 \text{ Nm}} \end{aligned}$$

### 5.3 CONVEYER BELT

A conveyor belt is the carrying medium of a belt conveyor system. There are 2 conveyor belts used which is placed parallel. It is placed one over the other with a small clearance. The belt clearance can be adjusted according to the materials to be collected. The conveyor belt also helps in crushing the solid waste like bottles, paper bolls, or any type of air filled or compressible ones. This helps in the increase collecting the particles. Nylon is the major content of this conveyor belt along with PVC coating. The main reason behind selecting this belt was due to its long lasting nature, adjustability, availability etc. It has fibrous like projections on its surface which provides friction on the surface with carries the waste components. When comparing with ordinary rubber conveyor belts it has more durability and wear is much less. Probably there is only less chances for damages.

Specifications:

Length	= 2200 mm
Width	= 310 mm
Thickness	= 1.5 mm

### 5.4 CHASSIS

It is the back bone of the system. All the systems and parts are attached to it. The main part for the waste collector is the structural base. It is made up of mild steel L angler. The major purpose for using this mild steel bar is because it is widely available at low cost and provides much strength to carry the weight of the whole system. The L angler is used for avoiding buckling of the bar at heavy weight. The L angler is much stronger than usual mild steel bars. Carbon fiber is much suitable for the construction of this structure but it is very costly because molding is needed. It is less weight than mild steel.

Specifications:

Total length of chassis	: 1250 mm
Total width of chassis	: 500 mm
Total height of chassis	: 640 mm
Material used	: Mild Steel or Carbon Fibre

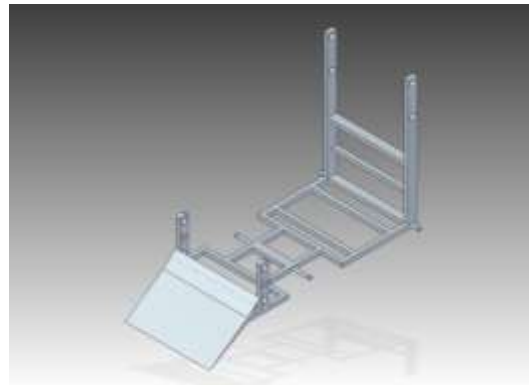


Fig 5.2: Chassis

### 5.5 BRISTLE BRUSH

A bristle brush is a mass or a bundle of straight narrow abrasive threads, which is placed around the surface of a cylinder. It can be used for collecting the solid waste from the ground and pushes in between the conveyor belts. It can also be used for light rust removal. For a strong fixing of the number of threads, there is a thin aluminium plate to a height, which helps to with stand the impact force and also to push the bottles inside the conveyor belts. The plate also helps to improve the lifespan of the nylon threads.

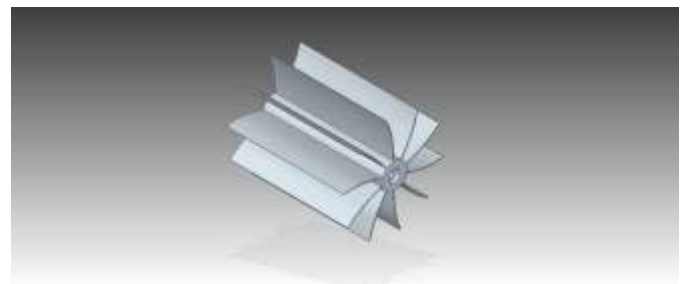


Fig 5.3: Roller Blades

Specifications:

Cylindrical roller dia.	: 100mm
Brush Length	: 140mm
Brush material	: Abrasive-impregnated nylon
Plate material	: Aluminium plates

### 5.6 COLLECTING TANK

Collecting tank is used for collecting the solid waste which is passed from the conveyor belts. It is made o aluminium sheets, because it is corrosive resistant, less weight, and good strength. In some cases high quality plastics like PET (Polyethylene Terephthalate), HDPE (High-Density Polyethylene), can also be used according to the production cost, and the load to be carried. PET, HDPE plastics have an advantage of good strength, long lasting and also it can be recycled easily.

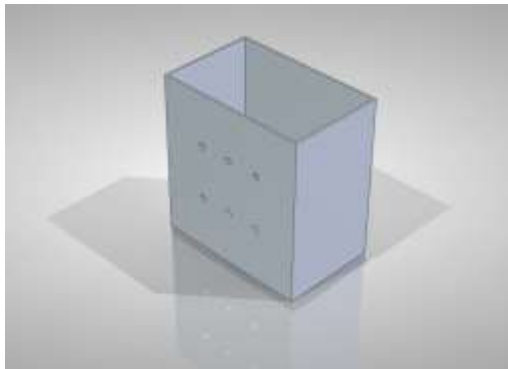


Fig 5.4: Basket or Collecting Tank

### 5.7 WHEELS

A wheel is a circular block of a hard and durable material at whose centre has been bored a circular hole through which is placed an axle bearing about which the wheel rotates when a moment is applied by gravity or torque to the wheel about its axis, thereby making together one of the six simple machines.

For the prototype on the waste collecting machine there are 4 wheels which support and transfer the load to the ground. For the future production, using of rocker bogie needs 6 wheels, these 6 wheels need separate motors and speed controllers which is expensive.



Fig 5.5: Wheel

Specifications:

Wheel diameter	: 305mm
Wheel width	: 40mm

## 6. DESIGN AND WORKING

The figure shows the basic 3-D representation of the semi automatic waste collector. It has a roller attached to a high speed motor in front of the chassis. It runs at a high speed rpm which helps in the efficiency of collecting the solid waste from the ground to inside the conveyor belt. The roller consists of many plates attached to the axis and many fibre threads. The advantage of the thread is it improves the efficiency of pushing the waste inside the conveyor belt. And also it will not get beaked since it has high elasticity. This takes the solid waste is there is an irregular surface.

The conveyor belt is fixed in a manner that the front portion near the roller is having more clearance than nearer the collecting tank. This is used to make a crushing action of solid waste. Like in case of bottles filled with air the space on the collecting tank can be wasted. By crushing the waste management gets improved. The conveyor belt is attached in rollers where they are connected to gears. This gear helps in the rotation to opposite direction (parallel) of two belts. The gears are attached to the rollers made of mild steel. The conveyor belt which is rotated on the surface of the rollers is been driven by a high torque motor. Waste from the conveyor belt is then crushed and passed between the two conveyor belts to the storage tank. The 2 motors are connected to a lithium lead polymer battery of 12V (battery used in automobiles).

The body is moved by two methods by manually or by remote controller. Rocker bogie mechanism can be used if better improvement in motion is needed. The in rocker bogie mechanism their needs 6 motors with different rotations if needed. This makes the design makes it complicated and expensive. It has an advantage that the machine can be moved through any terrain areas.

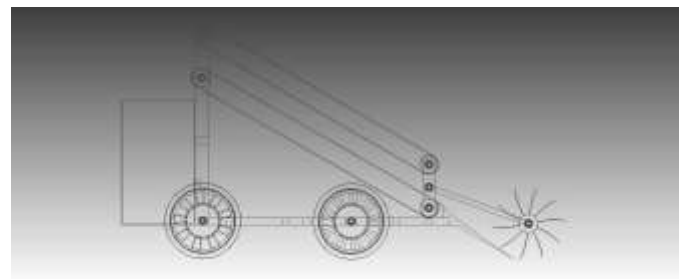


Fig 6.1: CAD Drawing of waste collecting machine (side view)



Fig 6.2: 3D Structure of waste collecting machine

**Final construction:**



Fig 6.3: Final prototype

**7. ANALYSIS AND RESULT**

Static structural analysis and MODAL analysis is done on ANSYS Workbench version 16.0. Materials used in arm are stainless steel, and the roller with plates is aluminium alloy.

A static structural analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time.

A modal analysis determines the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component. It can also serve as a starting point for another, more detailed, dynamic analysis, such as a transient dynamic analysis, a harmonic analysis, or a spectrum analysis. The natural frequencies and mode shapes are important parameters in the design of a structure for dynamic loading conditions. You can also perform a modal analysis on a pre-stressed structure, such as a spinning turbine blade.

If there is damping in the structure or machine component, the system becomes a damped modal analysis. For a damped modal system, the natural frequencies and mode shapes become complex. The size of the meshing is 5mm

**RESULT**

Structural analysis done using ansys workbench the input parameter used was force of 60N and output is shown in terms of deformation. The meshing given was coarse

meshing. Result shows that the design is safe under respective forces.

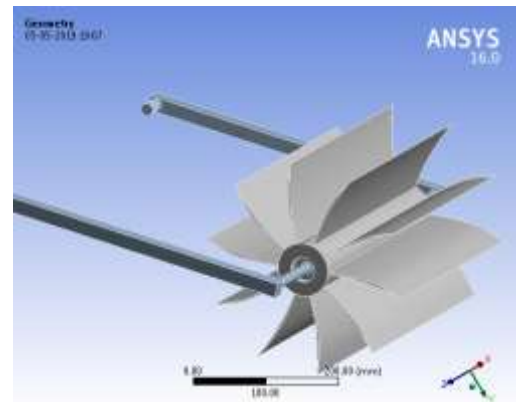


Fig 7.1: Geometry

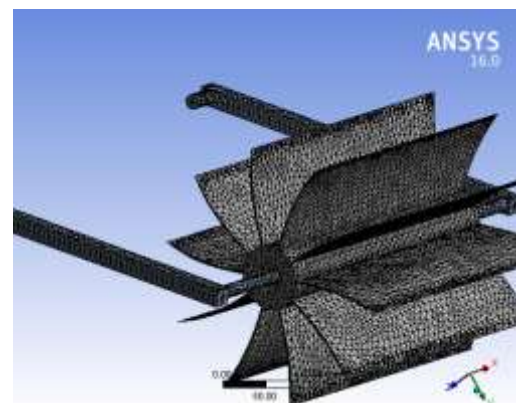


Fig 7.2: Meshing done in ansys Workbench

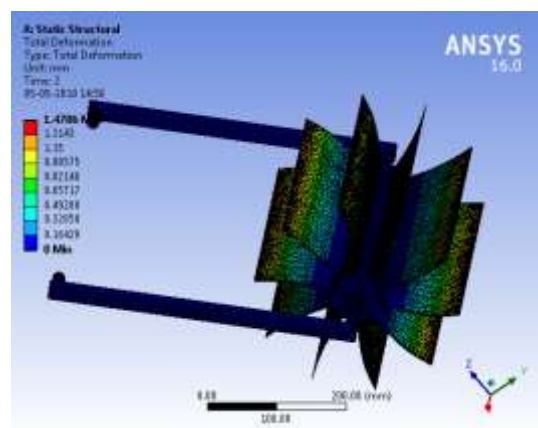


Fig 7.3: Total Deformation

**9. CONCLUSIONS**

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution

to bridge the gates between the institution and the industries

The use of innovative technology not only reduces cost significantly but also reduces the human effort while increasing the effectiveness of the semi automatic waste collector. Reduced human effort means more frequent cleaning which results in increase in overall cleanliness and supports healthy well-being. Small steps in technological advancement like this will have higher impact in long run in future, making India a better country.

After studying the various research papers we have concluded that there are certain limitations in cleaning machines which can be worked upon. Our cleaning machine is safe, easy, efficient and cheaper than the work done by the workers. The cost of production can again be reduced if there is a bulk production. The weight and strength can also be made while using carbon- fibres.

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