# Design and manufacture of Portable Automatic Plastic Shredder

**Nikitha Sri N[1], Supriya K [2], Tamanjeet Singh[3], Ravi Kiran T[4], CH Ranga Rao[5]**

*[1,2,3,4]B. Tech-Mechanical Final Year Students, St. Martin's Engineering College, Secunderabad, Telangana, India*
*[5]Associate Professor, Department of Mechanical Engineering, St. Martin's Engineering College, Secunderabad, Telangana, India*

---

**Abstract -** *Disposable waste plastic bottles are cumbersome procedures in Schools, Colleges, and Community colonies. Single-use plastic is banned in recent times due to pollution. Most plastic shredder machines available now are neither low cost nor portable. Our project aims to design a Portable Automatic Plastic Shredder for shredding the waste bottles generated at various workplaces, which is cost-effective and also where we can sell it to the reseller for recycling of the plastic. This paper highlights the design and manufacturing of Portable Automatic Plastic Shredder. This entire concept is based on wealth from waste.*

***Key Words***: **Plastic Shredder, PET Bottles, Green Manufacturing, Automation, Wealth from Waste.**

## 1. INTRODUCTION

Plastic has become a part of our day to day life since their introduction decades ago. It is one of the most commonly used materials in the world today. Plastics are synthetic organic materials produced by polymerization of compounds. They are typically high molecular mass and may contain other substances other than polymers. These chemically non-biodegradable plastics are very harmful to the environment hence the shredder will help for the crushing of the waste bottles and then for recycling. Unlike the large shredders used for shredding car wastes, pipes, drums, etc. The idea is about making a mini version of it for domestic and commercial use which can shred plastic bottles, milk cans, etc. There are mainly six types of plastic out of which our version will be able to shred two types of plastic.

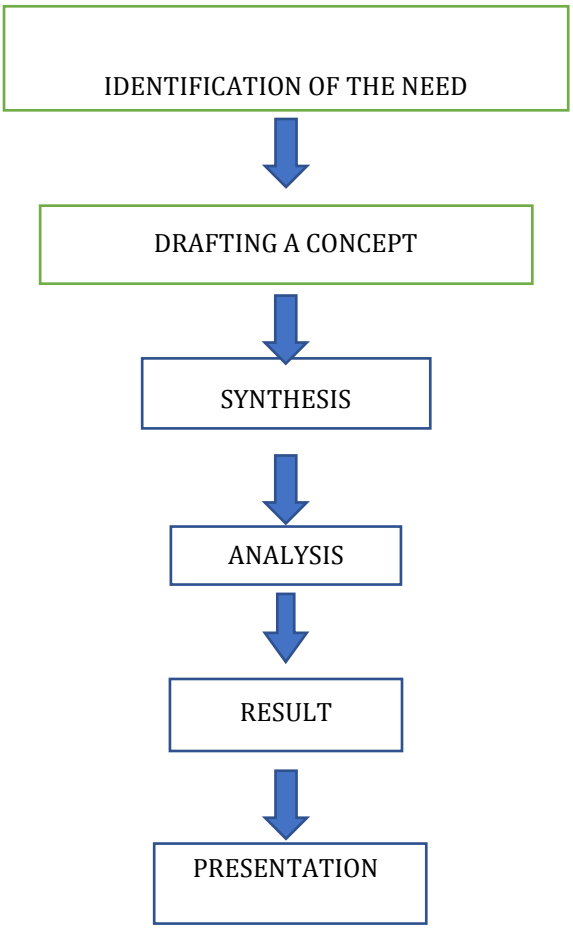
## 2. LITRATURE REVIEW:

Many people are attempted for the design and manufacturing of plastic shredder. Sudhakar Reddy and Thunga Raju (1) have designed and fabricated the machine with belt drive which is a disadvantage of the slip of the belt in ever time and the torque is also low i.e. 7.4 Nm. There is a possibility of increasing the torque to crush the bottles at minimal time. They are used Mild steel as a frame that does not contribute anything to the crushing of the bottles. There is a possibility of alternative thinking of the frame. They are used Mild steel blades where life is minimal. There is a possibility of a better selection of the blade. S.B. Satish et al explained the design of the Portable Bottle crushing machine (2). Yeswanth Met all explained about the design of a Plastic Bottle crusher (3). They also fabricated the machine with various types of gears and loss of power due to various transmission (4). We have designed our machine taking all the previous versions design and our design is supposed to be simple in construction, portable and there is a provision to collect the waste materials at the bottom. The collected materials can be some value from resellers which are manufacturing the plastic bottles.

## 3. MATERIALS USED:

1. Wooden box
2. Iron frame
3. Blades
4. Square shaft
5. Bearings
6. Motor
7. Gear box
8. Couplings
9. Gears
10. Arduino UNO
11. IR sensor

## 4. METHODOLOGY




## 5. EXPERIMENTATION:

Before finalizing the design and mechanism of the shredder to a torque-based shredder a speed type shredder was designed and made which could not shred the plastic to the required standards. It was a speed-based model. The blade design of the speed-based model was completely different when compared to that of the standard shredder blade. It is a wood cutting blade of diameter 100mm and the thickness of the blade was too small. Another drawback of the machine is that the blades were attached to the shaft by arc welding hence dismantling of the machine was not possible. As it was the speed which was given importance and for easy installation, the motor was connected to the shaft by using a belt drive mechanism. The automation was given by using Arduino programming and by using an IR sensor. experimentation with the speed for the speed-based model was made as tabulated below:

**Table 1:** Speed analysis for machine

| SPEED BASED MODEL TEST | |
|---|---|
| **SPEED** | **PLASTIC SIZE** |
| 1300 | The plastic waste got stuck |
| 1100 | Plastic waste was not shredded accurately |
| 1000 | Shredding was done easily |

For the first trial, we put the speed of the machine at 1300 rpm by which the plastic waste was not get cut by the blades and was getting stuck in the blades. The pieces were not getting cut.
The thickness of plastic: 2mm
Type of plastic: pet plastic of 100 microns
For the second trial, we used the rpm of 1100 rpm the plastic pieces were getting cut but still, the pieces were not getting cut to the required size, the plastic pieces should to made into pieces which will make the heating process easier but at this speed, the pieces were not accurate.
The thickness of plastic: 2mm
Type of plastic: pet plastic of 100 microns
For the third trial, we used the rpm 1000 the plastic pieces were cut into strips accurately. Which will make it easier for the heating process.
The thickness of plastic: 2mm
Type of plastic: pet plastic of 100 microns

Note: The entire testing of the machine was done using plastic bottles without the cap.

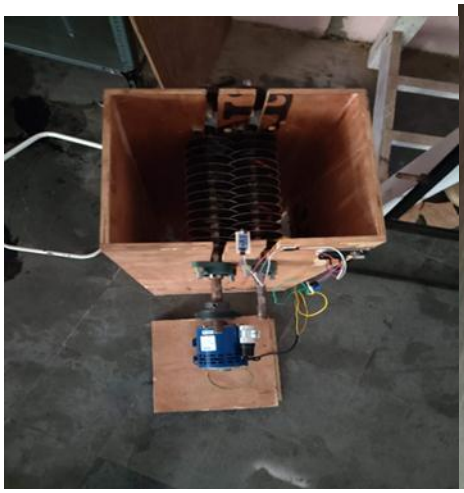



**Fig 1:** Old version **Fig 2:** Wood cutting blade

Though the plastic shredding was done easily at 1000rpm and the entire machine cost Rupee 20000 only the outcome of the shredded plastic was not matching the required industry standards. Hence design changes were made in most sections of the machine i.e., in the blade, the torque considerations, motor power calculations. Thereby new design and new considerations were assumed to make the new version of the shredder bin.

## 6. DESIGN:

The design of the torque-based shredder is different when compared to the speed-based shredder machine. The outer box is made of wood to sustain the vibrations caused by the rotation of the blades. The blade chosen for the shredder is similar to that of the conventional shredder blade, it had six cutting edges but has a carbide tip in addition to it for the better cutting action. A motor and a gearbox are used as high torque required for the cutting action. The gearbox reduces the speed of the motor and increases the torque which initiates high torque for shredding the plastic. All the free rotating components will be covered to ensure safety. The IR sensor will be employed at the opening of the machine or easy activation, once the sensor is activated the motor is switched on and off automatically. The main problem with the existing plastic shredding machine is the cost and machining difficulty. This machine is eco-friendly and cost-effective. While making the machine we have experiment with the speeds of the motor to get accurate results. By considering PET (Polyethylene Terephthalate) plastic and by calculations, the motor to be used was between 1 to 2hp I .e.1hp produced lesser torque compared to 2hp but we considered PET we used a 1HP motor, the speed required for shredding PET plastic is 70 to 100rpm and the motor produced 1440rpm hence a 15:1 ratio gearbox is selected to reduce the speed and increase the torque. The torque required to shred the plastic was 300 Nm. The blade used for this shown in Fig.1. and the box is designed in a 3D drawing and fabricated by using a Plywood as shown in Fig.3. The automation is provided by using an IR sensor and Arduino Uno. Where the sensor is placed at the opening of the bin.

**Fig 3:** Blade

**Fig 4**: wooden box

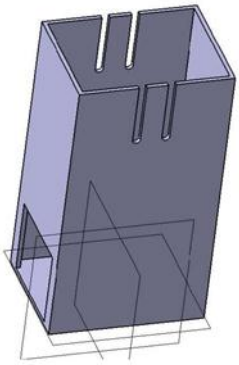


**Fig 5:** Cad design of box

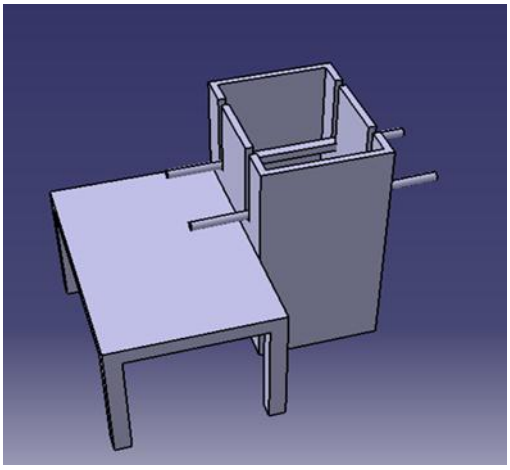


**Fig 6:** Cad design

## 7. MANUFACTURING:

The inner shape of the blades is square hence a square rod is used onto which the blades are mounted and fixed. They are tightened using bolt and nut. Welding is avoided for easy removal and addition of blades. The shafts are placed into the box which is attached to bearing and gears. This is further attached to the gearbox and motor by using a chain coupling and finally, the sensors are attached to finish the complete shredder bin. Fig 7 shows the mounting of the blades in a wooden box. The geared motor used for this machine is shown in Fig. 8. The final assembly of the machine is shown in fig 10 and the Arduino UNO circuit (Fig 9) is attached at the opening for easy detection of plastic. Even though the machine is on the shredder does not run the plastic is placed inside the shredder. Once the sensor detects the plastic, the shredder is switched on and the shredding takes place. Automatically the shredder is switched off after the shredding is completed.

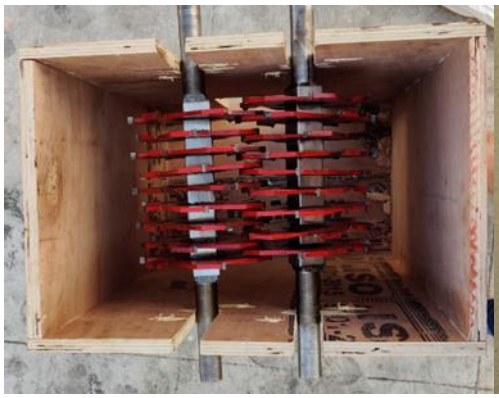


**Fig 7:** Blade assembly

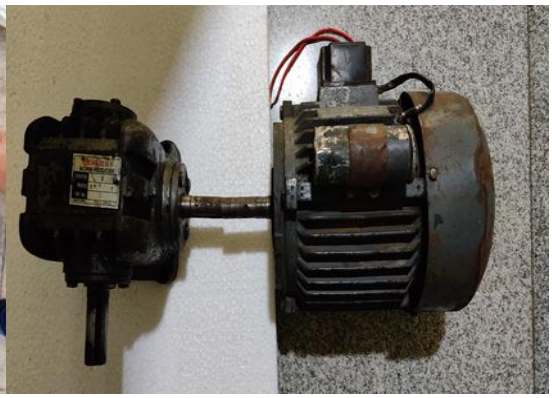


**Fig 8:** Gearbox and motor assembly

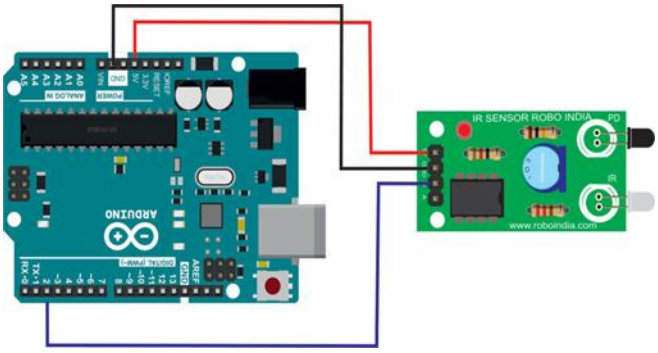



**Fig 9:** Arduino UNO and IR sensor circuit

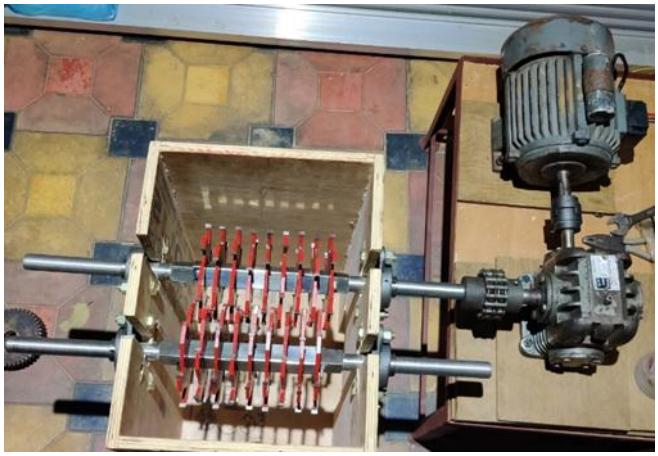


**Fig 10:** The final assembly of shredder

## 8. CONCLUSIONS:

1. We have designed and manufactured a Portable Plastic Shredder for cutting and transporting the waste plastic bottles.
2. The machine was tested by using pet bottles (250ml) and the results were satisfactory. Collected plastics wastes were shredded with the machine and the results obtained reveal that the machine performance is satisfactory
3. The developed machine is cost-effective, easy to operate, portable, and can be installed in Shopping malls, Schools, Colleges, Community residential buildings for easy disposable of the waste plastic bottles.
4. This bin is completely eco-friendly and will be helpful to save the environment and ecosystem by reducing the recycling cost.
5. The waste can be collected at the bottom and can be resell to the reseller and can get some return on the waste generated called “Wealth creation from waste”.

## 9. REFERENCES:

[1] Design and development of mini plastic shredder machine: Sudhakar Reddy, Thunga Raju, ICAAMM, 455,2018,012119.
[2] Designing a Portable Bottle Crushing machine, S.B. Satish et all, IJSRD, Vol 4, Issue 7,2016
[3] New Design of a plastic bottle crusher, Yeswant M S et all IJSTR, Vol 3, Issue 7, July,2014
[4] Design and Development of a Plastic Bottle Crusher, Yeswanth M Set all, IJERT, Vol 3, Issue 10, October-2014