

PLASTIC WASTE MANAGEMENT BY MECHANICAL SHREDDER MACHINE

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ABSTRACT

The plastic has become vital asset for humanity. Plastic have been used widely in both water and food packaging industries. Plastic waste is not homogeneous so special attention has to be taken for managing plastic waste. Plastic continue to threaten the quality of our land, water and air. More than 40% of this quantity is disposed unsafely. Unsafe disposal of plastic in rural areas is becoming prevalent and will come at massive cost to the rural ecology and economy. Plastic do not decompose at all; others could take up to 450 years to breakdown. Hence in our project we choose to design and development of the plastic shredder Machine. This machine is used for cutting the plastic in to small pieces, which are in irregular shaped flakes which can be fed in to extrusion machine where it can form filament and further used in 3D printing machine. Hence it reduces the dumping of waste plastic on earth's environment. Our shredder project involves sharpened blades made up of case-hardened steel which shreds plastics.

Key Words: Plastic Shredder, Thermosetting, Thermo Plastics, Case Hardened Steel, 3D Printing.

INTRODUCTION

It would be difficult to imagine our modern world without plastics. Today they are an integral part of everyone's lifestyle with applications varying from common place domestic articles to sophisticated scientific and medical instruments. Plastic can take more than 500 years to decompose. plastics are composed of major toxic pollutants, it has the potential to cause great harm to environment in the form of air, water and land pollution. Hence it creates negative impact on the natural environment and creates problems for plants, wildlife and even on human beings. Hence; there is the need to promote the recycling of plastic materials. Plastic recycling is bound to realize a lot of savings in production costs, conserve limited resources, and alleviate environmental pollution.

Machinery available to for nylon and plastic recycling is usually of very high cost, and bulky. This, to a great extent, imposes serious restrictions to the recycling of nylon and plastics in the developing countries. Therefore, in order to overcome these shortcomings, it was necessary to develop a machine specialized in its application in order to achieve the set objectives of reduced cost and size optimally using locally available materials.

Plastic shredder is the machine designed to cut or reduce large materials into tiny pieces for easy handling. The materials that can be shredded include syringe, glucose bottles, water bottles, pure water nylon, and many other items. Shredder is an integral part of any Plastic Recycling Plant.

LITERATURE REVIEW:

ND Jadhav, [1] proposes the available machines used to recycle plastic waste are very costly. A cutting machine is designed to reduce large plastic material objects into a smaller volume or small pieces so aim is to process the plastic waste as cheap as possible by cutting where it is made for reducing of labour work which results in cost reduction. **Dr.M. Muthukumaran, [2]** proposed to design and development of Shredder machine focus on plastic wastes to prepare the new product. Concept was developed considering the safety factor users operating environment and maintenance. Considering the user's needs and buying capacity, a prototype was fabricated. The shred particle can be converted into the new product. The main drawback of this machine is the efficiency and the outcome of the shredder machine was less than what was expected. The reason for less efficiency and the outcome are Blades of the shredder machine are not perfect .The blades are not machined in a

CNC machine. It was wound with hands on gas cutting process. So blades are not tight. The blades generated less torque over the plastic waste and it will not be as strong as expected. There were some misalignments and it caused a drop in output. **Adepo, S. O., [3]** proposes the design and construction of a plastic shredding machine which is an integral part of plastic recycling process. The machine is designed using locally available raw materials which make it cheap and easy to maintain and repair. The machine test results at various speeds using the same amount of input, gives the best output at a speed of 11.5m/s. With this shredding efficiency of 96.9%.

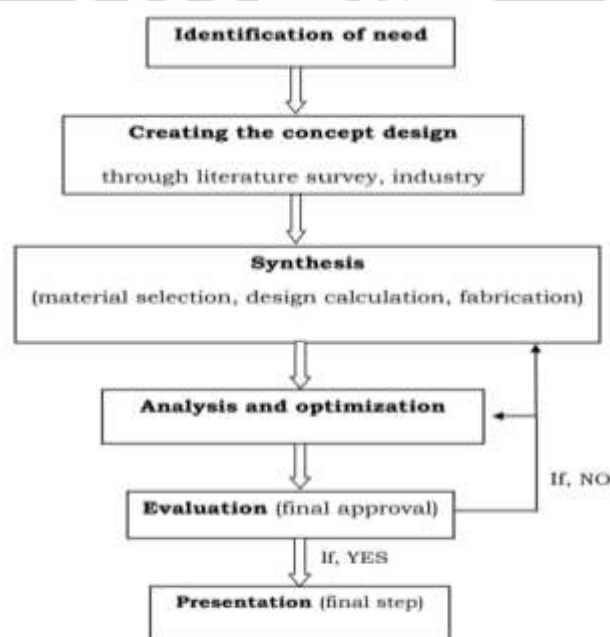
PROBLEM STATEMENT:

Plastic waste is not homogenous. Different types of plastics demand special attention from a waste management point of view. Most commonly found plastics in rural areas (polythene bags, bottles, etc.) are thermoplastics. Unsafe disposal of plastics in rural areas is becoming prevalent and will come at massive costs to the rural ecology and economy. As population in India is forecasted to experience an unprecedented growth from currently 1.31 billion to 1.65 billion by 2030, the management of plastic waste in rural areas needs innovative solutions to address the challenge. There needs to be a development of plastic waste management in order to stop unsafe and hazardous methods to dispose plastic waste. There is more than 15,000 tons of plastic waste generated in India daily; more than 40% of this quantity is disposed unsafely. Only 9,205 tonnes of plastics, which correspond to approximately 60% of the total quantity generated, are recycled daily.

OBJECTIVES:

- The objective of a project is to recycle plastic to reduce the burning solid plastic waste and control the environmental pollution.
- To develop cost effective shredder machine, with less labour work.
- By using gear drives instead of belt drive safety is more & power transmission will be efficient and very compact in design.
- This machine will be able to shred all the types of plastic waste with increasing in overall productivity

METHODOLOGY



- **IDENTIFICATION OF NEED:**

The existing shredders are heavy ones and these shredders are excessively used for shredding materials at big industries and manufacturing plants for shredding cars, stones, metal components etc. Moreover, these shredders are hydraulically and pneumatically operated and are feasible if very high amount of cutting forces are required for shredding a material. The operating costs of these shredders are very high as it requires continuous power, continuous maintenance as this involves hydraulic fluid or compressors kits etc., this type of high end shredders are not necessary for small recycling plants and is not affordable to many people. It requires proper maintenance as the hydraulic fluid needs to be changed constantly on time basis. It also requires skilled labor for operation.

- **CREATING THE CONCEPT DESIGN:**

We have come up with a concept of designing a shredder in such a way that even a layman can operate it. We are making this project model for recycling of plastic wastage in domestic area, industries etc. in these areas the plastic waste is present in large quantity. But the available machines used to recycle this waste are very costly. So, our intension this project is to process the plastic waste as cheap as possible by shredding. Benefits of this machine are the reduction of labor work which results in cost reduction.

- **DESIGN CALCULATIONS:**

Motor HP Calculation:

i. Cutting area made by edge of the blade:

$$A = W \times T$$

$$A = 7\text{mm} \times 7\text{mm}$$

$$A = 49 \text{ mm}^2. 7 \text{ mm}$$

Where, A = cutting area made by edge of the blade.

W = width of cutting edge.

T = thickness of cutting edge.

ii. Force acting on edge of the blade:

Shear strength of PET bottles = 51.71 MPa.

Shear strength = Force ÷ Area

$$51.71 = \text{force} \div 49$$

$$\text{Force} = 2533.79 \text{ N.}$$

iii. Torque exerting on the blade as well as shaft:

Torque (T) = Force × perpendicular distance

$$\text{Torque} = 2533.79 \times 50 \times 10^{-3}$$

$$\text{Torque (T)} = 126.689 \text{ Nm.}$$

iv. Power required:

Required speed, N = 60 rpm

$$P = (2 \times \pi \times N \times T) \div 60000$$

$$P = (2 \times 3.143 \times 60 \times 126.689) \div 60000$$

$$P = 0.79 \text{ kW.}$$

$$\Rightarrow P = 1 \text{ HP.}$$

CHECK FOR DESIGN SAFETY:

Blade material: mild steel [ultimate shear strength = 580 Mpa]

Assume factor of safety [FOS] = 3

FOS = ultimate tensile shear strength ÷ working shear strength

$$3 = 580 \div \text{working shear strength.}$$

$$\text{i.e.; working shear strength} = 193.33 \text{ Mpa} > 51.71 \text{ Mpa.}$$

Hence design is safe.

SHAFT DIAMETER CALCULATION:

Solid shaft diameter:

$$\text{Shear strength} = (16 \times T) \div (\pi \times d^3)$$

$$193.33 = (16 \times 237.36 \times e3) \div (3.143 \times d^3)$$

$$d = 18.42 \text{ mm}$$

For safe design take 1.5 times the diameter hence $18.42 \times 1.5 = 27.63 \text{ mm}$

Hence shaft diameter (d) = 30 mm.

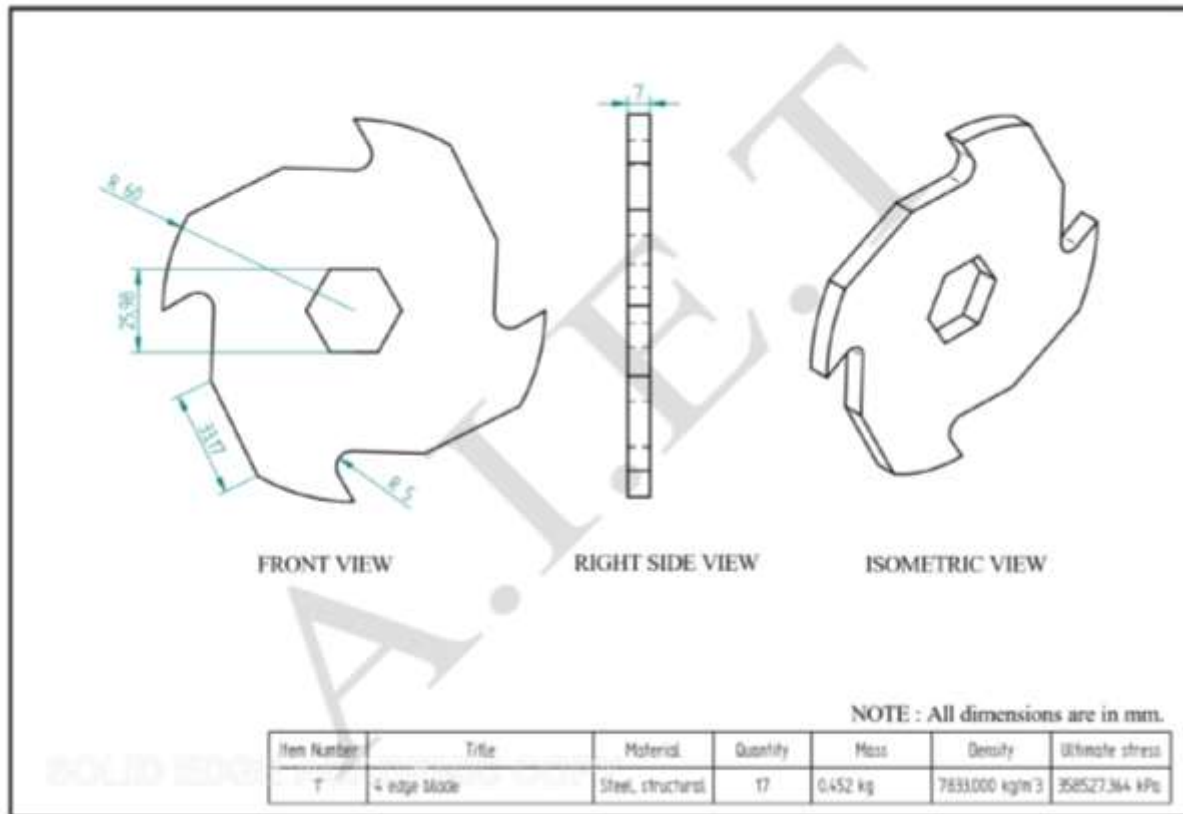


Fig 1 Cad Model.

RESULT:**ANALYSIS REPORT:**

The blade is analyzed by the help of the Ansys software using static structural method. Initially the blade is meshed by tetrahedral meshing type for more accuracy. The blade is meshed and then the parameter such as specific cutting force is applied. The properties of the material of the blade are preselected. The static structural method gives the stress, strain acting on the body and the total deformation of the body when it comes in contact with the material that is to be shredded.

Table 1. Results obtained by Static structural method for mild steel.

Type	Total Deformation	Maximum Shear Stress	Maximum Shear Elastic Strain
Minimum	0. m	4892. Pa	6.3596e-008 m/m
Maximum	3.0727e-004 m	3.6005e+008 Pa	4.6806e-003 m/m
Average	1.5215e-004 m	1.8596e+007 Pa	2.4175e-004 m/m

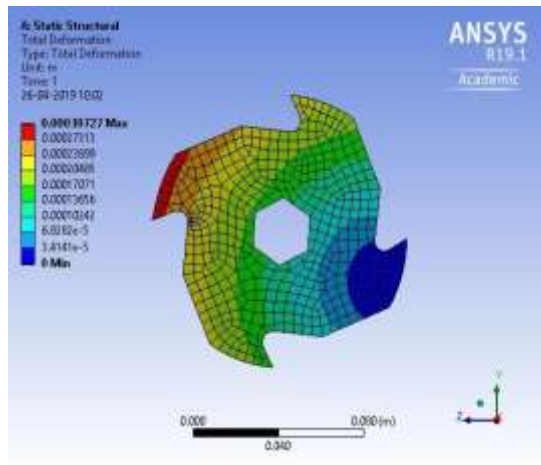


Fig 2: Total Deformation

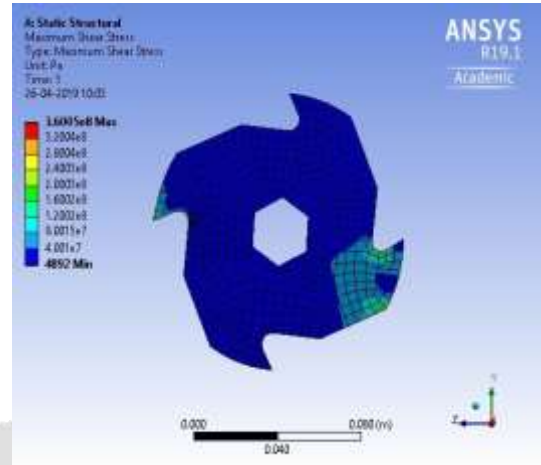


Fig 3: Maximum Shear Stress

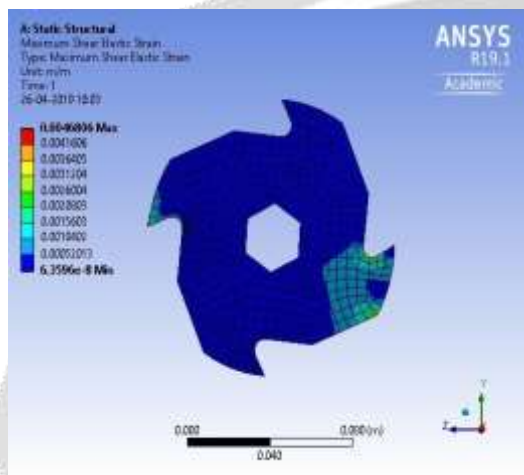


Fig 4: Maximum Shear Strain

- **PROJECT/ EXPERIMENT RESULT:**



Fig 5 Blade Assembly & blade.



Fig 6 Final model

- Our shredder will be able to cut all different types of plastic having thickness 7mm.
- Shredder will shred the plastic with less amount of time. E.g. plastic bottle -5sec.

CONCLUSION

Plastic is essential part of our day to day life. But there is a big disadvantage of plastic that is plastic is difficult to decompose. So we have to recycle the plastic and there are various methods for plastic recycling. So Plastic Waste Management has assumed great significance in present day context. Various schemes are being implemented to mitigate the impacts of plastic waste in India. Recycling is one such scheme for waste management of plastic products. Recycling of waste plastics is an efficient way to improve the environmental performance of the polymer industry. We can conclude that plastic is shredded with the help of plastic shredding machine. Hence we designed and manufactured plastic shredding machine.

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