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Design, Analysis and Development of Shredder Machine for Mild Steel Scrap Application

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ABSTRACT: The need for better and more affordable waste management has led to the creation of a double-shaft shredder machine for mild steel. This project aims to make the base frame lighter, increase the machine's capacity from 1.2 TPH to 2 TPH, and speed up the crushing process. By using cost-effective materials and manufacturing methods, the machine will be affordable. The project has completed all necessary steps, including choosing materials, design calculations, costing, 3D modelling, creating a Bill of Materials, and running simulations. This sets the stage for building and testing the machine. Additionally, the design focuses on using sustainable materials to reduce environmental impact. This shredder will help the waste management industry by reducing landfill waste and encouraging more sustainable practices.

KEYWORDS: Shreddermachining, Capacity, sustainable, Cost effective.

I. INTRODUCTION

A double-shaft shredder, also known as a twin-shaft shredder, is a powerful industrial machine that is used to reduce a wide variety of materials into smaller pieces. It consists of two parallel shafts that are equipped with rotating cutting teeth. As the material is fed into the shredder, it is torn apart by the teeth and reduced in size until it reaches the desired particle size.

It is designed for mild steel scrap application to decrease the size of metal waste, easy to handling, transportation, and recycling. This process involves breaking down large metal pieces into smaller pieces size of(8mm×12mm), more manageable, which can be efficiently reprocessed through methods such as remelting in new manufacturing activities. The primary benefits of shredding include the conservation of raw materials and a significant reduction in environmental impact. This is achieved by minimizing the volume of waste directed to landfills and reducing the necessity for mining new metal ores.

II. OBJECTIVES

Objectives for double shaft shredder machine project are as follows

- 1.Reduce Base Frame Chassis weight.
- 2.To increase capacity from 1.2 TPH (Tonne per hour) to 2 TPH.
- 3.To reduce crushing cycle time.
4. To construct a Cost-Effective Shredder Machine.

III. RELATED WORK

Sudhakara Reddy1 ,Thunga Raju2[1].Has been explained about This project describes a low-cost, easy-to-use plastic shredder for recycling. It uses a single-shaft design and a common motor to create flakes from plastic waste. The focus was on affordability, user-friendliness, and safety, making it a good option for individual recycling efforts.

I.M.Sanjay Kumar1, DR. T.R. Hemanth Kumar2[2]This project tackles agricultural waste by shredding it into fertilizer. Traditional methods take too long and pollute the environment. This machine is designed to be affordable,

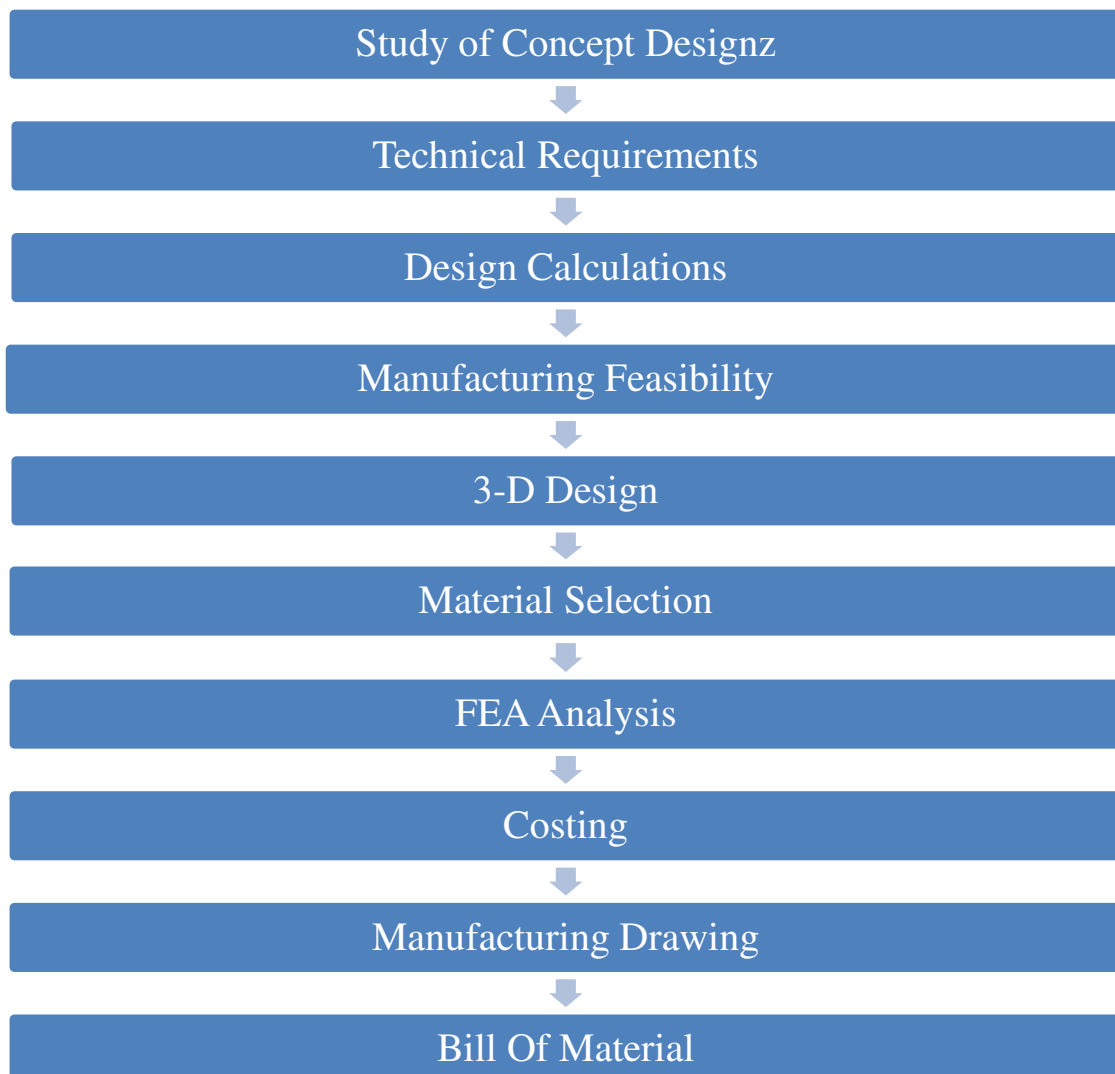
user-friendly, and safe, focusing on shredding coconut palm waste in Kerala and Karnataka to create valuable fertilizer from what was previously burned.

Atadious David1, OyejideOluwayomi Joel2[3]This project describes the design and construction of a plastic shredding machine to address the growing problem of plastic waste in Nigeria. The machine is intended to tackle the improper disposal of plastic solid waste, a significant concern for the government, institutions, and society as a whole. The increasing population and economic factors exacerbate the issue. The machine was successfully built and tested, demonstrating satisfactory performance in shredding collected plastic waste. When commercially available, this machine has the potential to meet the demands of plastic waste management in Nigeria

Malina Vatskicheva1, Irena Grigorova2 [4] The industrial production generates waste that can be recycled and reused instead of using virgin materials. Crushing recycled materials like concrete railway sleepers is a vital part of the process. Shredders are a good option for this task, with two-shaft shredders being the most economical choice due to their simpler drive system compared to single-shaft or four-shaft designs.

IV. METHODOLOGY

Project Flow Chart: From the flow chart, this project started with the study of concept design of the project. Then follow up with technical requirements. This includes data for calculations, potential materials for material selection. These tasks have performed with the help of trainings given by company head, study on the internet, books and other resources. After all trainings, the project continued with the design calculations and material selection. All the knowledge and lessons had been applied to choose proper material and completion of design calculations. Solid modelling an engineering drawing is done by using solid works software.



V. MATERIAL SELECTION

Sr. No.	Item Name	Material
1.	Shaft	Carbon steel, AISI 1095, tempered at 205°C & oil quenched
2.	Cutting Blade	Tool steel, molybdenum alloy, AISI M43 (high speed)
3.	Spur Gear	AISI 4140 tempered at 205C & oil quenched

Table.5.1. Material selection

Shaft: In Shredder machine, the shafts are like the axles of a powerful pair of shredding gears. Each shaft spins independently, but with blades or interlocking teeth strategically positioned along them. These teeth act like scissors, grabbing and tearing the scrap material as the shafts rotate towards each other.

Cutting Blade: In Shredder machine, the cutting blades are the workhorses. Mounted on opposing shafts that spin towards each other, these blades are like rows of sharp teeth. As the material enters the shredding chamber, it gets caught between these intermeshing blades. The powerful rotation of the shafts forces the blades to rip and tear the material, effectively shearing it into smaller pieces. This shearing action continues until the material reaches the desired size, transforming bulky scrap into manageable pieces for further processing or recycling.

Spur Gear: In a Shredder machine, spur gears are the unsung heroes that synchronize the powerful chomping action. These gears, resembling interlocking cogwheels, are mounted on the ends of each shredder shaft. As the motor drives one gear, it meshes with the teeth of the opposite gear, forcing the other shaft to rotate at the same speed and direction. This synchronized rotation ensures the knives on each shaft intermesh precisely, delivering clean and efficient shearing of the scrap material.

VI. EXPERIMENTAL RESULTS

FEA Analysis for frame body:

For FEA analysis Solid works software is used. All steps of FEA analysis are done in Solid works.

Stepwise approach for FEA analysis

The following are the steps involved in analysis.

1. Geometry modelling:

For creation of geometry, I have used Solid Works Software.

2. Apply material:

Here we apply plain carbon steel material to the geometry

3. Apply Boundary conditions:

According to condition we apply fixtures and external loads on geometry here we apply 4000 N external load in geometry. The external load is a combination of assembly load that mount on the frame body and material that we give to the machine.

4. Meshing

5. Simulation run:

Once everything is set up, the software uses complex algorithms to calculate the response of the model under the defined conditions.

6. Result:

After the simulation, we can visualize the results in various ways, like plots of stress, Displacement and factor of safety. This helps you understand how the object will perform in real life.

Model name: Frame body SOLID
Study name: Static 1(-Default-)
Plot type: Static nodal stress Stress1
Deformation scale: 2,998.89

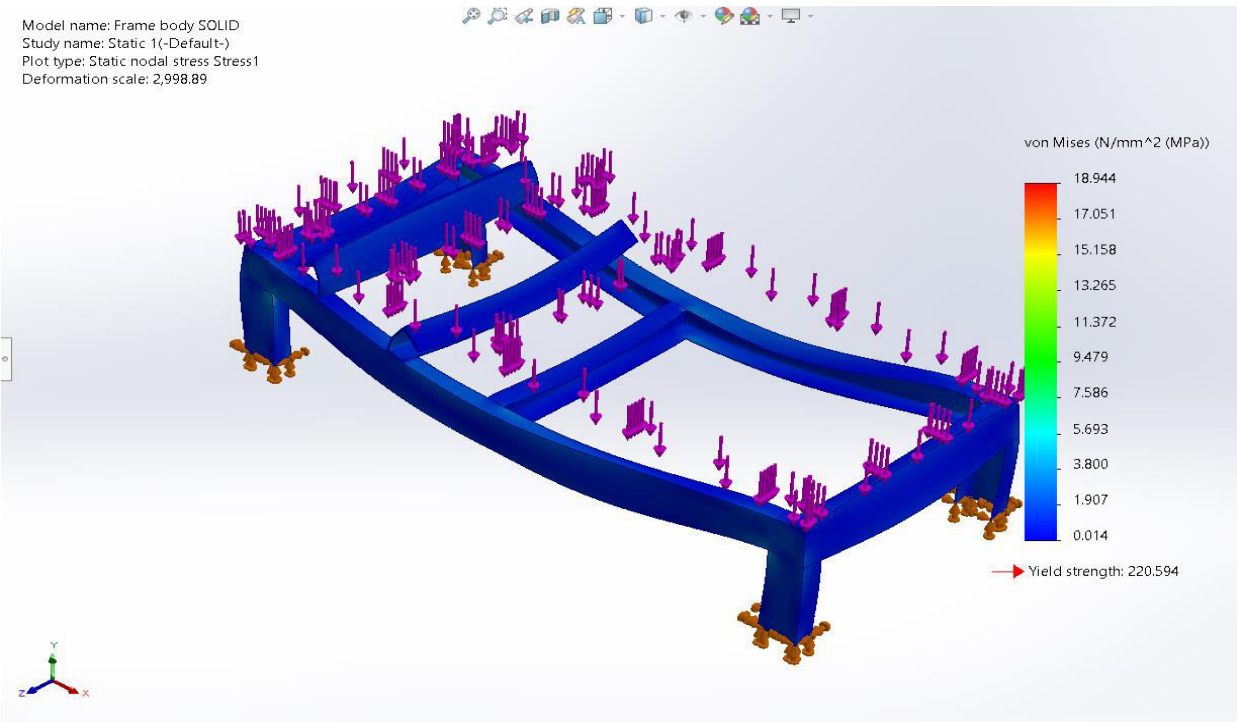


Fig.6.1. Stress Analysis

Model name: Frame body SOLID
Study name: Static 1(-Default-)
Plot type: Static displacement Displacement1
Deformation scale: 2,998.89

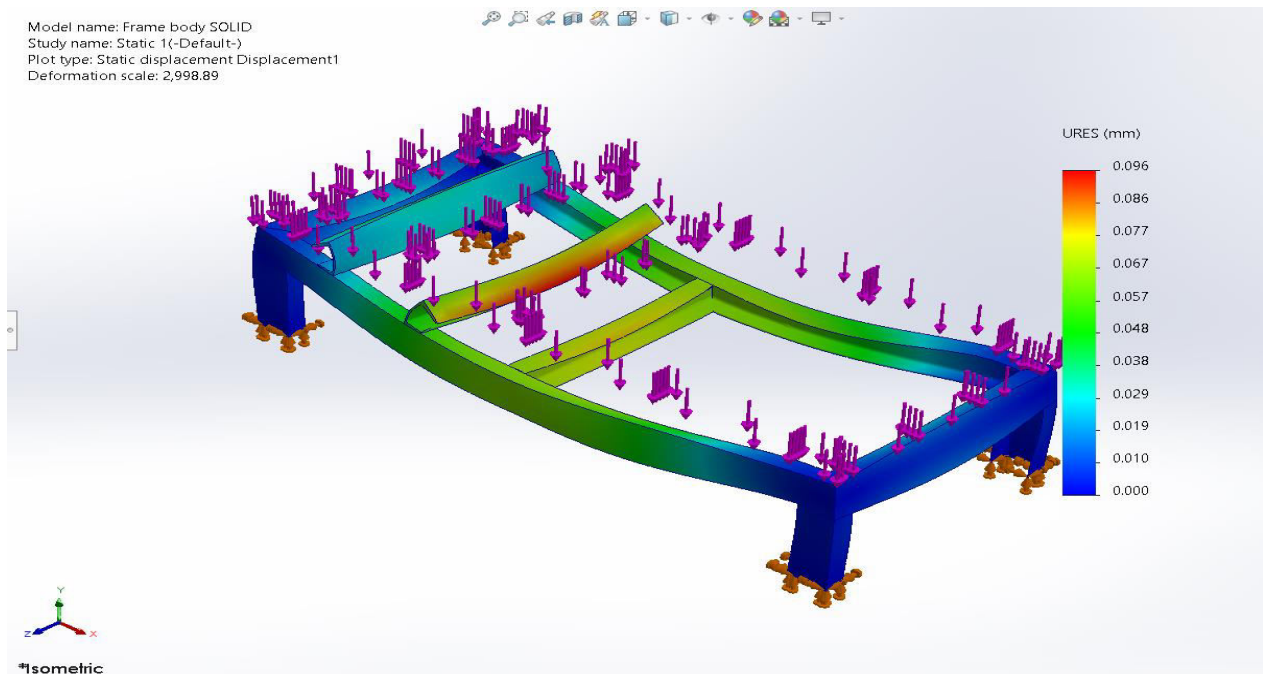


FIG.6.2. Static Displacement Analysis

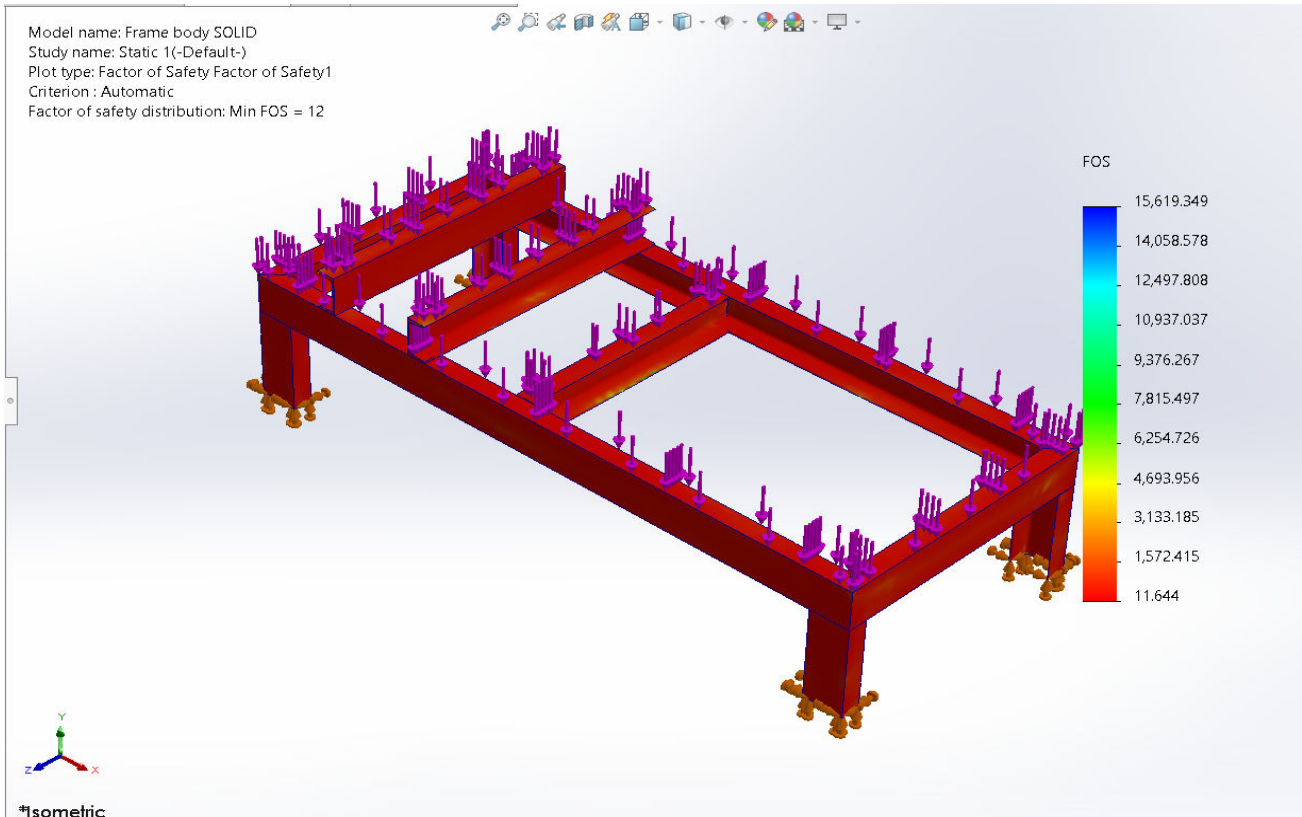


Fig.6.3. Factor of Safety

ANALYSIS OF FRAME		
SR. NO	Parameter	Result
1.	Yield strength	220Mpa
2.	displacement	0.096 mm
3.	factor of safety	10

Result and Discussion:

The frame body was initially overweight; however, we were able to reduce the weight by using appropriate material and the ideal weight is attained. The capacity of shred at the outlet is increased due to design modifications. Since the frame body was initially overweight, we were able to decrease it to 50 kg through weight optimization, thus completing the project's goals.

VII. CONCLUSION

This project successfully addressed the challenge of creating a medium-duty, cost-effective shredder with optimal processing capacity. By achieving the project objectives of reducing base frame weight, increasing throughput from 1.2 TPH to 2 TPH, and optimizing crushing cycle time, the resulting shredder offers significant advancements over previous models. This translates to a more efficient and powerful machine capable of handling a higher volume of mild steel scrap while maintaining a budget-friendly design. This innovative shredder presents a valuable solution for

industries dealing with mild steel scrap and contributes to a more sustainable approach to waste management through efficient processing and recycling.

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