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Design and Analysis of Organic Waste Crushing Machine

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Abstract: **Crushers may be used to reduce the size, or change the form, of waste materials so they can be more easily disposed of or recycled, or to reduce the size of a solid mix of raw materials (as in rock ore), so that pieces of different composition can be differentiated. Crushing is the process of transferring a force amplified by mechanical advantage through a material made of molecules that bond together more strongly, and resist deformation more, than those in the material being crushed do. Crushing devices hold material between two parallel or tangent solid surfaces, and apply sufficient force to bring the surfaces together to generate enough energy within the material being crushed so that its molecules separate from (fracturing), or change alignment in relation to (deformation), each other. The earliest crushers were hand-held stones, where the weight of the stone provided a boost to muscle power, used against a stone anvil. Querns and mortars are types of these crushing devices. We are designing and analyzing a special kind of crushing machine which is connected to the flywheel of a tractor by means of PTO shaft (power takeoff shaft). This machine is intended to crush the organic material such as bio-waste. While the tractor on moving the machine can work through PTO shaft. Thus the degradation and disposal of bio waste become in simple manner.**

Keywords: **Gear design, Sprocket design, PTO Shaft, Solidworks, Ansys, Analysis.**

1. INTRODUCTION

In the present condition the global population is increasing day by day but the food production rate is not growing up related to this. Also now large amount of pesticides and fertilizers are using in the farm fields to increase the production rate . But due to the application of such poisonous things the food products are absorbing the toxic contents from these pesticides and fertilizers. This is the main reason to the innovation of new diseases due to their activities in our body which is resulting in genetic mutation. So as to increase the production of organic fertilizers by reducing the organic components degradation time, the development of special purpose crusher machines are very useful. The crushing machines are always helping in the organic waste management thus to provide agricultural improvements and also for a better cleaning practices of organic waste by using lower power consumption concepts

1.1 Crusher:

A crusher is a machine designed to reduce large solid material objects into a smaller volume, or smaller pieces. Crushers may be used to reduce the size, or change the form, of materials so they can be more easily and efficiently used in the purpose intended to. Crushing is the process of transferring a force amplified by mechanical advantage through a material made of molecules that bond together more strongly, and resist deformation more, than those in the material being crushed do. Crushing devices hold material between two parallel or tangent solid surfaces, and apply sufficient force to bring the surfaces together to generate enough energy within the material being crushed so that its molecules separate from (fracturing), or change alignment in relation to (deformation), each other. The earliest crushers were hand-held stones, where the weight of the stone provided a boost to muscle power, used against a stone anvil. Querns and mortars are types of these crushing devices.

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1.2 PTO – Shaft:

A **power take-off** or **power takeoff** (**PTO**) is any of several methods for taking power from a power source, such as a running engine, and transmitting it to an application such as an attached implement or separate machines. Most commonly, it is a system comprising a splined output shaft on a tractor or truck, designed so that a *PTO shaft*, a kind of drive shaft, can be easily connected and disconnected, and a corresponding input shaft on the application end. The power take-off allows implements to draw energy from the engine. Semi-permanently mounted power take-offs can also be found on industrial and marine engines. These applications typically use a drive shaft and bolted joint to transmit power to a secondary implement or accessory. In the case of a marine application, such shafts may be used to power fire pumps. In aircraft applications, such an **accessory drive** may be used in conjunction with a constant speed drive. Jet aircraft have four types of PTO units, internal gearbox, external gearbox, radial driveshaft, and bleed air which are used to power engine accessories. In some cases, aircraft power take-off systems also provide for putting power *into* the engine during engine start

1.3 Material properties:

Carbon steels which can successfully undergo heat-treatment have a carbon content in the range of 0.30–1.70% by weight. Trace impurities of various other elements can have a significant effect on the quality of the resulting steel. Trace amounts of sulfur in particular make the steel red-short, that is, brittle and crumbly at working temperatures. Low-alloy carbon steel, such as A36 grade, contains about 0.05% sulfur and melts around 1,426–1,538 °C (2,599–2,800 °F). Manganese is often added to improve the harden ability of low-carbon steels. These additions turn the material into a low-alloy steel by some definitions, but AISI's definition of carbon steel allows up to 1.65% manganese by weight. High carbon steel will be any type of steel that contains over 0.8% carbon but less than 2.11% carbon in its composition. The average level of carbon found in this metal usually falls right around the 1.5% mark. High carbon steel has a reputation for being especially hard, but the extra carbon also makes it more brittle than other types of steel. This type of steel is the most likely to fracture when misused

1.4 Gneral design procedure:

Successful designs begin with a logical and systematic plan. With a complete analysis of the machines' functional requirements, very few design problems occur. When they do, chances are some design requirements were forgotten or underestimated. The gears, shafts, bearings and gear drive system may affect the extent of planning needed. Preliminary analysis may take from a few hours up to several days for more complicated designs. The design is a five step problem-solving process. The following is a detailed analysis of each step.

Step 1: Define Requirements:

To initiate the design process, clearly state the problem to be solved or needs to be met. State these requirements as broadly as possible, but specifically enough to define the scope of the design project. The designer should ask some basic questions: Is the new design required for first-time production or to improve existing production?

Step 2: Gather/Analyze Information:

Collect all relevant data and assemble it for evaluation. The main sources of information is machine specifications. Make sure that part documents and records are current. Check with the design department for pending part revisions. An important part of the evaluation process is note taking. Complete, accurate notes allow designers to record important information. With these notes, they should be able to fill in all items on the "Checklist for Design Considerations." All ideas, thoughts, observations, and any other data about the part or fixture are then available for later reference. It is always better to have too many ideas about a particular design than too few. Four categories of design considerations need to be taken into account at this time: work piece specifications, operation variables, availability of equipment, and personnel. These categories, while separately covered here, are actually interdependent. Each is an integral part of the evaluation phase and must be thoroughly thought out before beginning the fixture design.

Step 3: Develop Several Options:

This phase of the design process requires the most creativity. The natural tendency is to think of one solution, then develop and refine it while blocking out other, perhaps better solutions. A designer should brainstorm for several good alternatives, not just choose one path right away. During this phase, the designer's goal should be adding options, not discarding them. In the interest of economy, alternative designs should be developed only far enough to make sure they are feasible and to do a cost estimate. The designer usually starts with at least three options: permanent, modular, and general-purpose work holding.. The exact procedure used to construct the preliminary design sketches is not as important as the items sketched.. The required locating and supporting elements, including a base, should be the next items added. Then sketch the machine main parts. Finally, add the machine assembly Sketching these items together helps identify any problem areas in the design of the complete structure.

Step 4: Choose the Best Option:

The total cost to manufacture a part is the sum of per-piece run cost, setup cost, and tooling cost. Expressed as a formula:

Step 5: Implement the Design:

The final phase of the crushing machine process consists of turning the chosen design approach into reality. Final details are decided, final drawings are made. The following guidelines should be considered during the final-design process to make the fixture less costly while improving its efficiency.

2. LITERATURE REVIEW

For the purpose of effective completion of our project on 'DESIGN AND ANALYSIS OF ORGANIC WASTE CRUSHING MACHINE', we gathered information on crusher design. A literature search is performed to understand the crushing machines systems. These studies give a great insight into various crushing operations. 3D Modelling software's which is suitable for developing the designed model was decided in this phase. We also studied the various heat operation condition for the use of preparing the process layout of the crushing machine. The summary of the knowledge that we gathered from our reference journals along with information on the above mentioned areas.

3. GEAR DESIGN FOR CRUSHING MACHINE

3.1 Customer requirement:

a. The requirement is blade gears and spur gears

b. 6 Gears components loading at a time

c. Rotation as well as crushing force are loading at a time

3.2 Solid modelling:

A solid model is a digital representation of the geometry of an existing or envisioned physical object. Solid models are used in many industries from entertainment to healthcare. They play a major role in the discrete part manufacturing industries where precise models of parts and assemblies are created using solid modelling software or general computer aided design systems (CAD). The solid modelling technology is implemented in dozens of commercial solid modelling software systems, which serve a multi billion dollar market and have significantly increased design productivity, improved product quality and reduced manufacturing and maintenance costs . Solid modelling impacts a great variety of design and manufacturing activities . Examples include early sketches, design decisions, space allocations negotiation detailed design drafting , interactive visualization of assemblies maintenance process simulations, usibility studies , engineering chang3es , reusability of design components and analysis of tolerance

3.3 Assembly view:

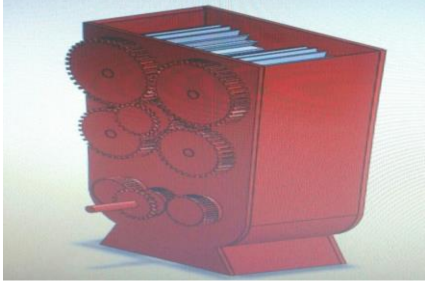

Figure 3.1 Isometric view of crushing machine

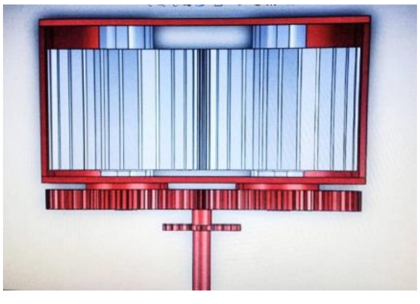

Figure 3.2 Isometric view of crushing machine

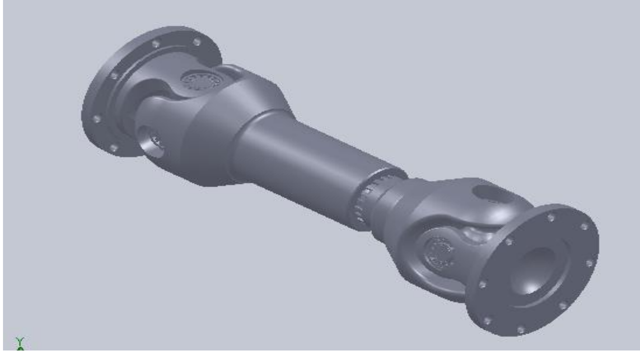

Figure 3.3 Isometric view of power take off shaft (PTO)

4. CALCULATION

4.1 General assumption:

Input available from tractor flywheel: 12HP

RPM available: 1500

Component Material: Hi carbon steel

4.2 Component 1 -Blade gear:

Pitch diameter = 400 mm

Number of tooth = 76

Module = 5.33 mm

Outside diameter = 410.4 mm

Diameter pitch = 4.76 mm

Circular pitch = 9.63 mm

Addendum = m =5.33

Whole depth = 11.65 mm

Thickness of teeth = 3.49 mm

Dedendum = 6.32

Root diameter = 387.1mm

Tooth radius =12.56 mm

RPM : 500

4.3 Component 2 – Second stage gear:

Pitch diameter = 400 mm

Number of tooth = 76

Module = 5.33 mm

Outside diameter = 410.4 mm

Diameter pitch = 4.76 mm

Circular pitch = 9.63 mm

Addendum = 5.33

Whole depth = 11.65 mm

Thickness of teeth = 3.49 mm

Dedendum = 6.32

Root diameter = 387.1mm

Tooth radius = 12.56 mm

RPM : 1000

4.4 Component 3 – First stage gear:

Pitch diameter = 400 mm

Number of tooth = 130

Module = 3.07 mm

Outside diameter = 405.24 mm

Diameter pitch = 8.27 mm

Circular pitch = 9.63 mm

Addendum =3.07

Whole depth = 6.71 mm

Thickness of teeth = 4.837 mm

Dedendum = 3.64

Root diameter = 391.82 mm

Tooth radius = 7.22 mm

RPM : 1200

4.5 Component 4 – Gear drive sprocket 1:

Pitch diameter = 324mm

Number of tooth = 40

Module = 8.075 mm

Outside diameter = 339.15 mm

Diameter pitch = 3.145 mm

Circular pitch = 25.355 mm

Addendum =8.075

Whole depth = 17.66 mm

Thickness of teeth = 12.720 mm

Dedendum = 9.589

Root diameter = 323 mm

Tooth radius = 6.05 mm

RPM - 1200

4.6 Component 5 – Gear drive sprocket 2:

Assume

Pitch diameter = 258mm

Number of tooth = 48

Module = 5.375 mm

Outside diameter = 268.75 mm

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Diameter pitch = 4.72 mm

Circular pitch = 16.887 mm

Addendum = 5.375

Whole depth = 11.755 mm

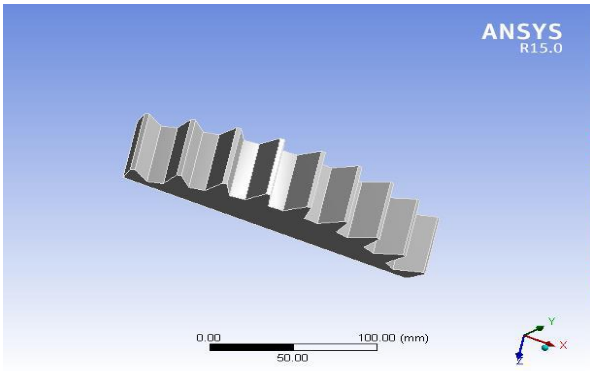
Thickness of teeth = 2.25 mm

Dedendum = 6.38

Root diameter = 245.24 mm

Tooth radius =12.65

5. RESULT OF ANALYSE



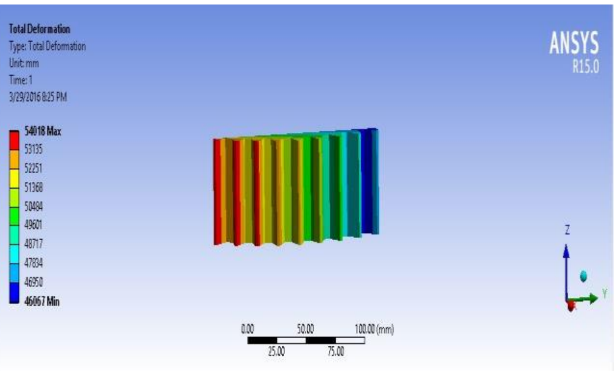
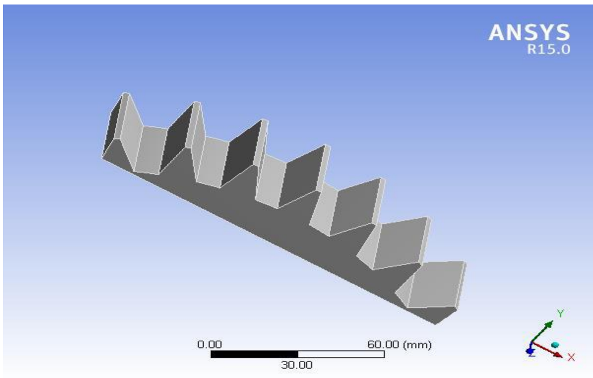


Figure 5.1 First stage gear tooth **Figure 5.2 Total deformation result**



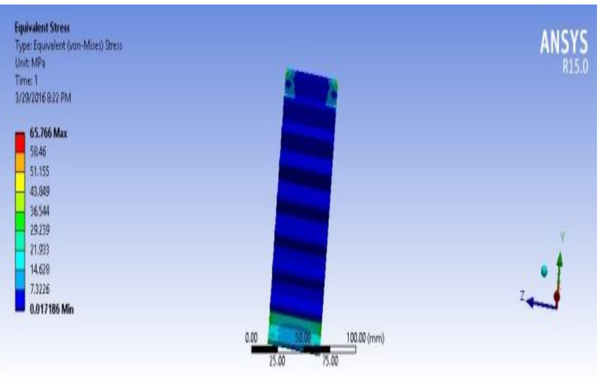
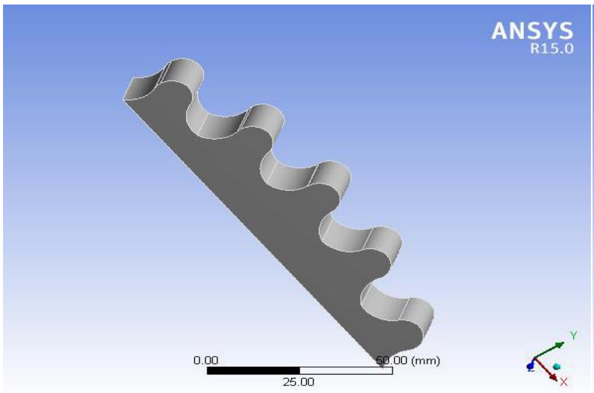


Figure 5.3 Blade gear tooth **Figure 5.4 Equivalent stress result**



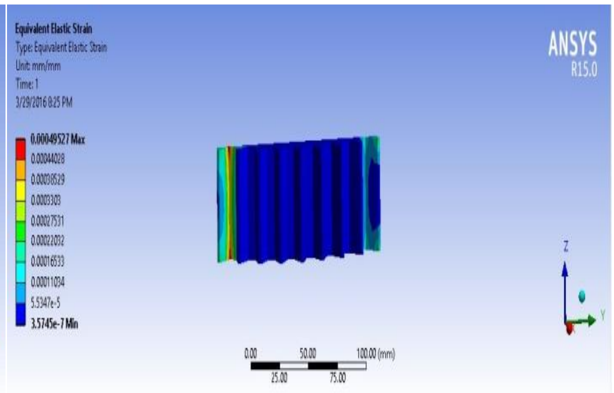


Figure 5.4 Second stage gear tooth **Figure 5.5 Equivalent Strain**

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6. CONCLUSION

The project is intended to empower the agricultural field. The main stages of the project can be classified into 3 categories study design and analysis and at each categories there are so many activities required to complete this project. Determine a specific set of crushing process parameters and the corresponding crushing process forces to best represent a crushing machine in the industry. Design a crushing machine which have high crushing rate at minimum production cost based up on the design considerations and accessibility. Analyze the major components of the machine and how much fulfilment is achieved by the design. After the actual calculations and designing process we obtain the result in safe operation conditions while analyzing the major components through the analyzing software. The budget of this machine will be up to 20000Rs

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