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Fabrication and Analysis of Mechanical Lawn Mower

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ABSTRACT: Technology has been developing from so many years, because the world is getting globalized. Even cost of maximum cutting equipment's is very high. Because every company and every brand of cutters has its own cost. It is somewhat difficult to middle class people. And from other side, most of the equipment's are the harmful and heavy. The environment also damage and harmful to humans. It's the major problem to everyone as well as to the world. In order to reduce the cost of cutting equipment's and working high efficiency and more accurately.

In current days, Lawn mowers machines are operated by fuel and electrical energy which are costly and require high maintenance. Hence, in this study, a hand-held operated machine for grass cutting was fabricated by using locally available materials. Important aspects such as durability, strength, and light weight were taken into design considerations for better performance characteristics. The lawn mower was powered by a Honda engine which drives the vehicle with the help of gear box. The engine power is 1.3 kW and the rotational speed is 4,200 rpm. As a result, the generated torque 3.9 N-m and 3,000 rpm will be transferred to the cutting head mechanism for efficient grass cutting. The entire configuration set up was mounted on a iron base which attached together with a iron frame specially designed frame and a set of wheels are arranged by this frame. This portable lawn mower can be used to maintain and trim grass in gardens, home, colleges, schools or yards.

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I. INTRODUCTION

The presence of our dexterous engineers, we have been able to manufacture and supply a superlative range of combine harvester blades. These blades are widely acclaimed for sharp edges and smooth cutting motion. These are ergonomically designed and developed using best available technologies and using finest quality components. Owing to rust resistance and durability, these blades are extensively acclaimed by large number of clients. These blades are fixed in an iron bar with the help of rivets. Two strips are arranging in a same manner, But opposite to each other. Bottom strip is fixed in a frame and other strip is reciprocating in a horizontal direction with the help of engine and gear box. Then the grass is cutting.

HISTORY: In 1826 in Scotland, the inventor Reverend Patrick Bell designed (but did not patent) a reaper machine, which used the scissors principle of plant cutting – a principle that is still used today. The Bell machine was pushed by horses. A few Bell machines were available in the United States. In 1835, in the United States, Hiram Moore built and patented the first combine harvester, which was capable of reaping, threshing and winnowing cereal grain. Early versions were pulled by horse, mule or ox teams. In 1835, Moore built a full-scale version with a length of 52 mm, cut width of 4570 mm and by 1839. This combine harvester was pulled by 20 horses fully handled by farmhands. By 1860, combine harvesters with a cutting, or swathe, width of several meters were used on American farms

CONSTRUCTIONAL DEATAILS OF LAWN MOWER

The parts of lawn cutters are discussing the below;

1. Chassis
2. Engine
3. Gear box
4. Cutter
5. Blades

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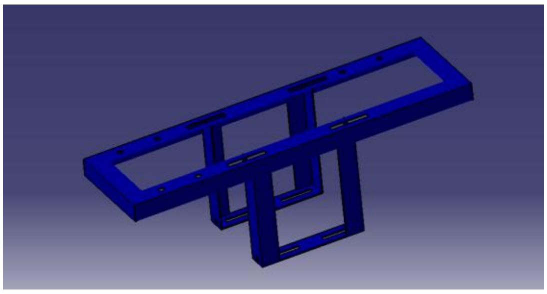
CHASSIS: We have taken two pieces of 37mm angular iron bar of length is 915mm. The iron bar is placed in parallel to each other and both plates are assembled with the help of other angular plates. And all the iron bars are welded with the help of arc welding After that again we have taken two pieces of 25.4 mm diameter pipe and length of pipes are 915 mm of each length. The pipes are bending at one end and other end is fixed with the angular bars with the help of bolts. All the brake and clutch and cutter levers are fixed at this handle with the help of bolts.



1. Fig: Chassis

ENGINE: The engine is the power plant of the vehicle. In general, internal combustion engine with petrol or diesel fuel is used to run a vehicle. An engine may be either a two-stroke engine or a four-stroke engine. An engine consists of a cylinder, piston, valves, valve operating mechanism, carburettor, fuel feed pump, etc. Besides this, an engine requires ignition system for burning fuel in the engine cylinder.

ENGINE PARAMETERS

Engine type	4 - Stroke, single cylinder, horizontal shaft
Displacement	120 CC
Engine net power	1.3KW @ 4200RPM
Engine maximum net torque	3.9 NM @ 3000 RPM
Fuel tank capacity	2 lit
Ignition system	Transistor type magneto ignition
Air cleaner	Semi dry
Dry weight	10.5 KG
Dimensions L×W×H	275×263×340
Engine Cooling	Air cooling

GEAR BOX The gear box is specially designed for reducing the speed from engine to drive wheels. The gear box is constructed by one neutral gear and one driving gear. The driving gear speed is increased and decreased by using the engine acceleration. The engine is automatic governed engine. So the engine acceleration will be increased, speed of the driving wheel also increased.

CUTTER: Cutter is fabricated by horizontal way because; the grass is cutting widely at a time vehicle moving in a forward direction. We are prepared that cutter is four feet's widely because at a less time more working is possible. The cutter prepared by two strips. One strip is placed on the bottom side; another strip is placed on the above of bottom strip. Bottom strip is a fixed strip; it is fixed in an engine frame. The Second strip is movable strip.

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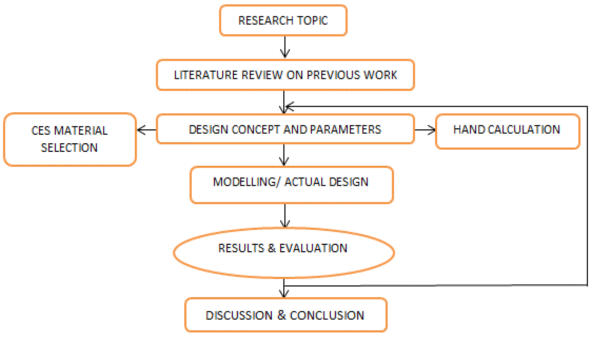
Fig: blades with rivet

BLADE: Owing to the presence of our dexterous engineers, we have been able to using a superlative range of combine harvester blades. These blades are widely acclaimed for sharp edges and smooth cutting motion. These are ergonomically designed and developed using best available technologies and using finest quality components. Owing to rust resistance and durability

Fig: Blade

ANALYSIS:
DESIGN METHODOLOGY FLOW CHART:



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DESIGN OF CHASSIS:

The following steps are required to complete this tutorial:

a. Start CATIA V5 and then start a new CAT part file.
b. Draw the sketch of the model using the Line, Arc, and Circle tools, refer to Figures 1-35 and 1-36.
c. Save and close the file.

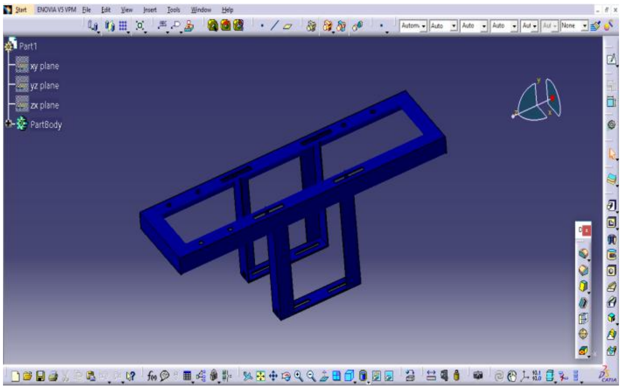

Fig: Design of chassis

HAND CALCULATIONS OF DESIGN PARAMETERS

The following are the parameters used for the calculation of stress and strain on the chassis:

- Total Length of required chassis bar, L_1=730mm, i.e. 0.73 m
- Attachable driving chassis, L_2=1430mm, i.e. 1.43 m
- Total Surface Area of chassis, A=2160 x 220 =$4.752\times10^5$$mm^2$, i.e. 0.4752 m^2
- Material: Iron
- Density of the material, ρ = 7874kg/m3
- Young modulus of the material, E= 204 GPA
- Yield strength: 275 MPA
- Weight of the chassis, W= 147.15 N
- Mass of the chassis, M = 15 kg
- Approximated total weight on the chassis,W=40kg = 392 N

The engineering stress and strain on the chassis were

□□□□□□□□ $\frac{W}{A}$ □□□

□□□□□□□□□ $\frac{\sigma}{E}$ □□□

Treating the chassis as uniformly distributed load to calculate for deflection, y

$$y = \frac{5WL^4}{384\times EI} \quad (3)$$

The Factor of safety was calculated according to

$$FOS = \frac{\text{Ultimate Stress}}{\text{Actual Stress}} \quad (4)$$

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DESIGN OF PISTON:

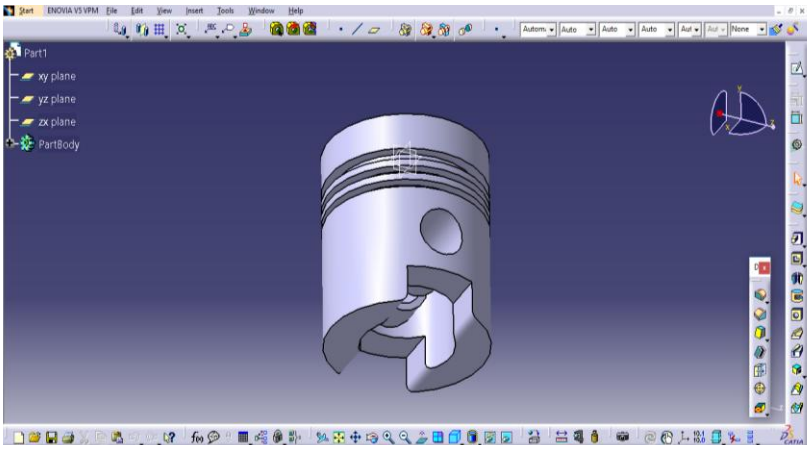

Fig: Design of piston

The most commonly used materials for piston of I.C engine are cast iron, cast aluminium, forged aluminium, cast steel and forged steel. The cast iron pistons are used for moderately rated engines with piston speeds below 6 m/s and aluminium alloy pistons are used for highly rated engines running at higher piston speeds.

For a cast iron piston, the temperature at the centre of the piston head (T_C) is about 425^0C to 450^0C under full load conditions and the temperature at the edges of the piston head (T_E) is about 200^0C to 225^0C.

For aluminium alloy piston, the temperature at the centre of the piston head (T_C) is about 260^0C to 290^0C under full load conditions and the temperature at the edges of the piston head (T_E) is about 185^0C to 215^0C.

The thickness of the piston head (t_H), according to Grashoff's formula is given by

$$t_H = \sqrt{\frac{3p.D^2}{16\sigma_t}} \text{ (in mm)} \qquad (1)$$

Where, p = maximum gas pressure in N/mm^2,
D = cylinder bore in mm,
σ_t = permissible bending (tensile) stress for material of the piston in MPa or N/mm^2.

It may be taken as 35 to 40 MPa for grey cast iron, 50 to 90 MPa for nickel cast iron and aluminium alloy and 60 to 100 MPa for forged steel.

The radial thickness (t_1) of the ring

$$t_1 = D\sqrt{\frac{3\,p_w}{\sigma_t}} \qquad (2)$$

Where, D = cylinder bore in mm,
p_w = pressure of gas on the cylinder wall in N/mm^2,
Its value is limited from 0.025 N/mm^2 to 0.042 N/mm^{2},
σ_t = allowable bending (tensile) stress in MPa.
Its value taken from 85 MPa to 110 MPa for cast iron rings.

The minimum axial thickness (t_2) of the ring

$$t_2 = \frac{D}{10n_R} \qquad (3)$$

Where, n_R = Number of rings

The maximum thickness (t_3) of the piston barrel may be obtained from the following relation

$$t_3 = 0.03D + b + 4.5 \text{ mm} \qquad (4)$$

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(or)

$t_3 = 0.03\,D + t_1 + 4.9$ mm

Maximum side thrust on the cylinder

$$R = \frac{P}{10} = 0.1\,p \times \frac{\pi D^2}{4} \qquad (5)$$

(or)

$$R = p_b \times D \times l$$

Where, p_b = bearing pressure,

D = bearing diameter,

l = length of the piston skirt in mm.

Piston pin diameter is

$$d = 0.02\,D \text{ to } 0.04\,D \qquad (6)$$

Section modulus of piston pin

$$Z = \frac{\pi}{32}\left[\frac{(d_0)^4 - (d_i)^4}{d_0}\right] \qquad (7)$$

Maximum bending moment is

$$M = Z \times \sigma_b = \frac{\pi}{32}\left[\frac{(d_0)^4 - (d_i)^4}{d_0}\right]\sigma_b \qquad (8)$$

Where, σ_b = allowable bending stress for material of the piston pin. It is usually taken as 84MPa, for 100 MPa carbon steel and 140 MPa for heat treated alloy steel.

DESIGN OF RIVET JOINT:

A single riveted joint is that in which there is a single row of rivets in a lap joint. We are using snap head rivets the joint parameters are following below:

a) **Pitch :** It is the distance from the centre of one rivet to the centre of next rivet measured parallel to the seam. It is denoted by '*p*'

b) **Back pitch:** It is the perpendicular distance between centre lines of the successive rows. It is denoted by 'P_b'.

c) **Diagonal pitch** It is the distance between the centres of the rivets in adjacent rows of zig-zag riveted joint. It is denoted by 'P_d'.

d) **Margin:** It is the distance between the centre of rivet hole to the nearest edge of the plate. It is denoted by '*m*'.

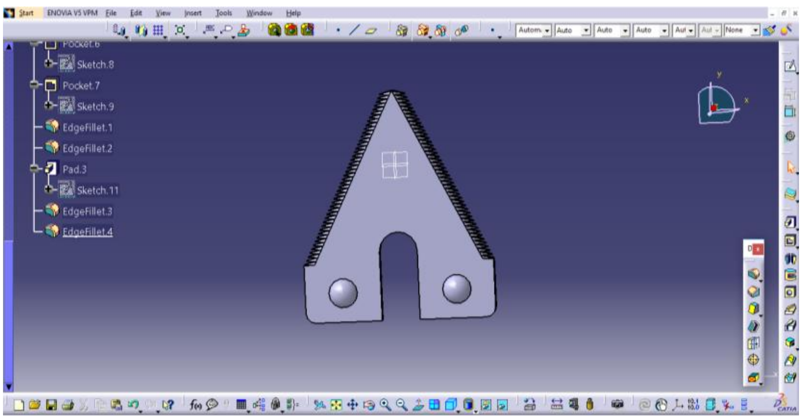

Fig: Design of rivet joint

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DESIGN OF CUTTER:

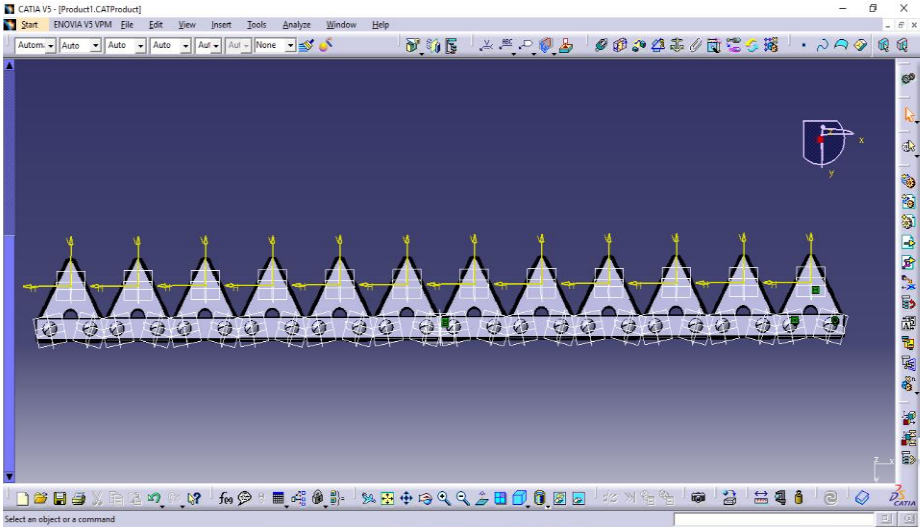

Fig: Cutter topstrip design

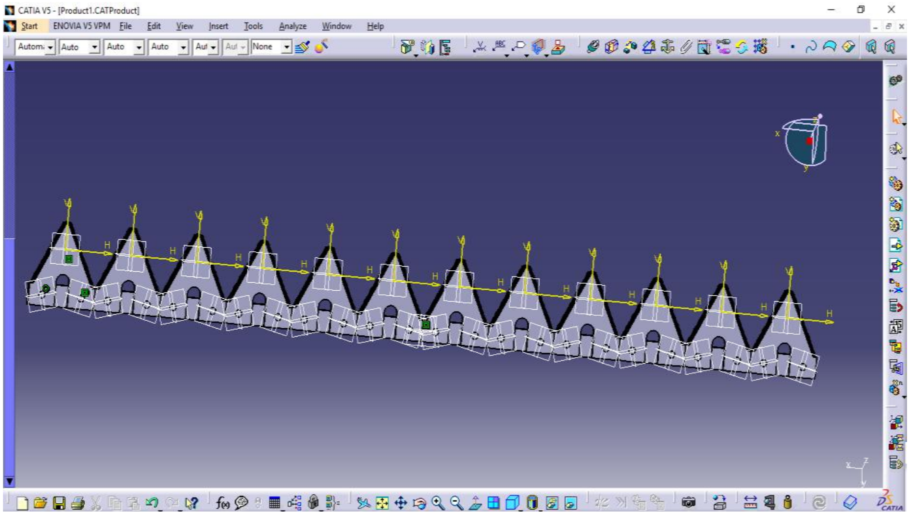

Fig: Cutter bottom strip design

TYPES OF ANALYSIS APPLIED OF BLADE:

1. Meshing
2. Stress Acting
3. Load Acting
4. Deformation

Meshing analysis applied on cutting blade: ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Metaphysics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the

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options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

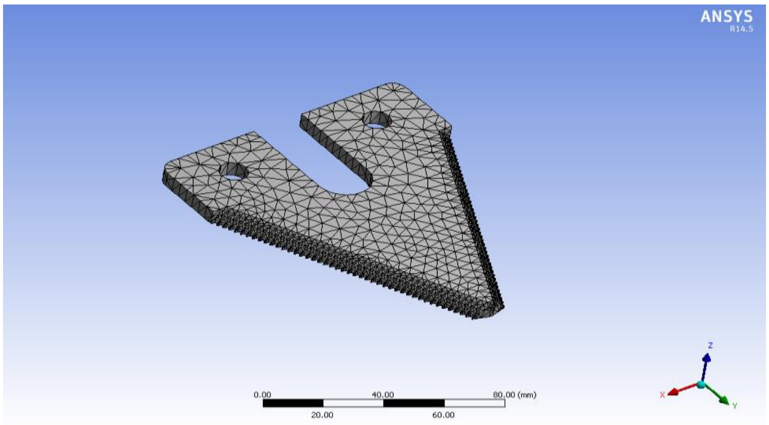

Fig: Meshing of blade

STRESS ACTING ON BLADE: The term stress analysis is used throughout this article for the sake of brevity, but it should be understood that the strains, and deflections of structures are of equal importance and in fact, an analysis of a structure may begin with the calculation of deflections or strains and end with calculation of the stresses.

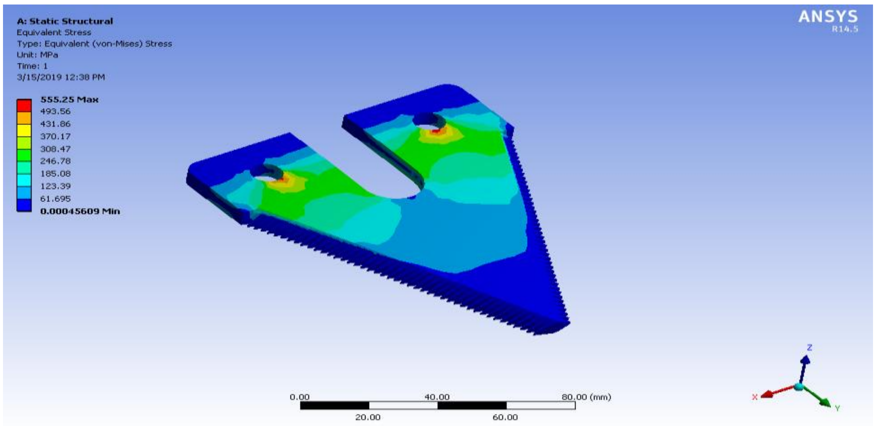

Fig: Stress acting on blade

LOAD ACTING ON BLADE: Mechanicalstructures,suchas aircraft, satellites, rockets,space stations, ships, and submarines, have their own particular structural loads and actions. Engineers often evaluate structural loads based upon published regulations, contracts, or specifications. Accepted technical standards are used for acceptance testing and inspection.

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DEFORMATION OF BLADE:

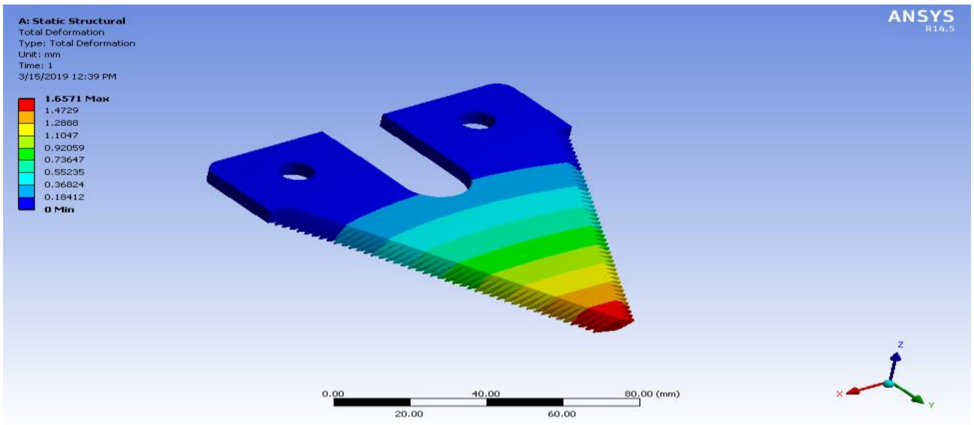

Fig: Deformation of blade

ANSYS Workbench as total deformation or directional deformation. Both of them are used to obtain displacement-from stresses. Directional deformation calculates for the deformations in X, Y, and Z planes for a given system.

AUTOMATED MESH GENERATION

- Auto meshing exists for 2D and 3D systems.
- Intelligent meshing systems consider geometry and topology of model.
- Some systems support bi-directional associatively.
- Changes in model geometry will produce changes in mesh.
- However, changes in topology (additional edges) would require re-meshing.
- Different mesh cases may be defined for some model.
- Early analysis may involve coarse mesh – low mesh density – faster computation time.
- Mesh is refined for further analysis.

BOUNDARY CONDITIONS AND LOADS

- Much of specification is automated.
- Specification not limited to nodal.
- Possible to specify restrains and loads for high level geometric entities. (edges, faces)
- System applies appropriate nodal properties.

STRUCTURAL ANALYSIS:
Designers and engineers primarily use structural simulation to determine the strength and stiffness of a product by reporting component stress and deformations. The type of structural analysis you perform depends on the product being tested, the nature of the loads, and the expected failure mode:

- A short/stocky structure will most likely fail due to material failure (that is, the yield stress is exceeded).
- A long slender structure will fail due to structural instability (geometric buckling).
- With time dependent loads, the structure will require some form of dynamic analysis to analyse component strength.

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The component material you use can also influence which type of analysis perform:

- Metallic components, under moderate loads, generally require some form of linear analysis, where the material has a linear relationship between the part deformation and the applied load below the materials yield point.
- Rubber and plastics require a nonlinear analysis, as elastomers have a nonlinear relationship between the part deformation and the applied load. This is also the case for metals beyond their yield point.

II. CONCLUSION

If the component having good material properties, load carrying capability then it certainly enhance the performance of the grass cutter.

The cutting effectiveness of the blade can be increased by improving slice to push and obtain good strength. Furthermore, there should be minimum welding joints in the design.

From above analysis we concluded that conventional lawn mower occurring more vibration.

So we need to damp by using vibration isolation materials and by locating the place where to damp or fabricate the mower fully balanced.

This research has clearly demonstrated that it is quite possible to design for manufacture of a grass cutter aimed at solving farmer's problem of cutting of grass for cleaning the ground. The calculated results obtained showed that the chassis was able to withstand the design load the cutter may be subjected to as long as high strength material is used for the chassis construction. The result also revealed a cutting of 25.4mm.Finally, the materials that have been carefully selected for the grass cuter design were those available locally. Low price iron bars have been used in the designed for construction of chassis. Other materials selected namely: iron, GI, and stainless steel for vehicle body and single cylinder engine to drive the cutter could be sourced locally for manufacturing. All these were attempted to ensure the cost of production was significantly reduced and the grass cutter is readily accessible to small scale farmers.

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