Review and Design of Elliptical Shape Composite Spring Mount for Agriculture Engines

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ABSTRACT

An engine mount is a application component that connects the engine bracket to the machine frame of agriculture equipment .The engine is connected to the application body by several mounts, which are important for smooth operation of the application. An engine mount is used to isolate the body from engine-generated noise and vibration during working . Different types of engine mounts are used in agriculture machinery and vehicles. Elastomeric mount are low cost and the simplest type of mounts they suppress engine force/torque and vibrations through heat dissipation. A elastomeric mount can provide the required stiffness for the resonance control and shock absorption, but the rubber damping in low frequencies is not sufficient. Moreover, the isolating characteristic of the rubber mount is not good because the transmitted force increases in higher frequencies due to the constant damping (.

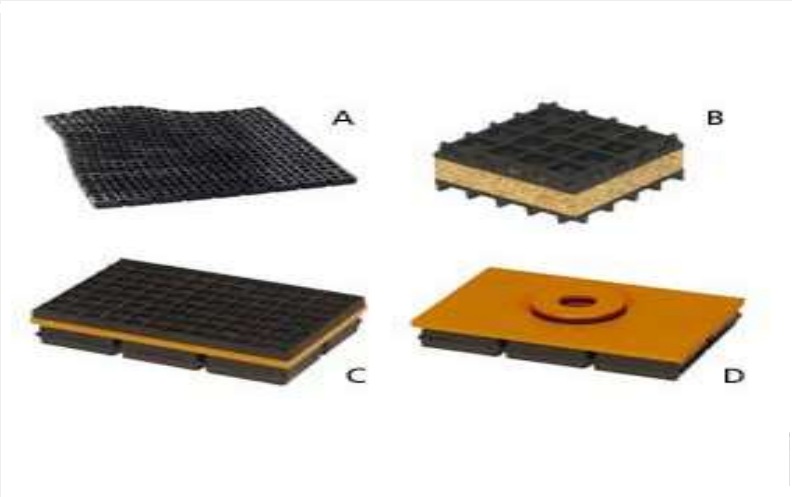
Elliptical shape spring mount is a vibration and shock isolator designed specifically for back mounted engine applications and is suitable to protect the application user against shock and vibration in the back held agricultural application such as engine sprayers , trimmers and utters . Material selected for the form spring is SS304 (0.3to 0.8 mm) thick and Polymer material as backing in spring. Both materials are resistant to corrosion and operate efficiently under wide range of temperature. Basic design employs high tensile stainless steel SS 304 formed leaves on each side with the polymer sheet of 6 mm thickness . Unigraphix Nx-8.0 is used for 3-d modeling and Analysis of critical component and meshing using Ansys Work-bench 16.0. The experimental results are derived part of the vibration reduction by implementation of Composite half elliptical leaf spring engine isolation mount will be done using a test rig developed for this trial purpose

Key words : *Agriculture engine , Vibration reduction , SS304 , Polymer*

1. Introduction

Some common passive isolation technologies include cork, elastomers, springs, and airbags as stiffness elements. Cork is an industrial material that can withstand substantial compressive load. Vibration isolators that use cork usually have a natural frequency of 50-60 Hz; diagnostic testing shows that this could be high for Edwards's system. Cork has air pockets inside the material and can exhibit high internal damping. Cork can be combined with neoprene to give large deflection, hence a lower natural frequency. This material is cheap and has a long service life (Baker, 1975).

Elastomers are rubberlike materials that possess internal damping and very low stiffness. The stiffness and damping properties of an elastomer depend on the particular material, the type of fiber reinforcement, and geometrical configuration. A typical elastomer is rubber. Natural rubbers are susceptible to temperature effects, oxidants, sunlight, and liquid contamination, especially from machine oil. For Edwards's system, machine oil would be the only possible issue. Synthetic rubbers like neoprene and silicone rubber possess higher damping and better resistance to environmental factors (Baker, 1975). A drawback to using an elastomer as a vibration isolator is that the machine weight can initiate a drifting effect, which is a continuous deformation of the material under constant load (Baker, 1975). Figure shows a variety of cork and elastomer vibration isolators.



2. Literature review :

1. Umesh S. Ghorpade, D. S. Chavan, Vinaay Patil, Mahendra Gaikwad[1] has studied the engine mounting bracket. Vibration and fatigue analysis has been carried out to know the structural failure. Structural failure will occur if vibrations and stresses are excessive and severe. Prolonged exposure to whole-body vibration in the working environment may lead to fatigue and in some cases it damages the car. Generally, the most important vibration relevant excitations in a car engine can be identified as follows:- combustion force; main bearing reaction forces including mass forces damper function and flywheel whirling, modified by the front-end damper; piston side forces including secondary motion; camshaft bearing reaction forces including mass forces, opening and closing impacts and bearing impacts; valve opening and closing impacts; valve train forces caused by chain/belt movement or gear drive; gear train forces inside the transmission; drive train reaction forces and moments. Automotive engine mounting system must satisfy the primary tasks such as engine movement, engine rigid body dynamic behavior, and vibration isolation. The design and development of mounting bracket through use of Ansys software to achieve the requirements for mounting system and optimize the mount.

2. Lakshmi Kala, V.Ratna Kiran[2] With the above stated work done by the previous authors, these authors have taken non-linear vibrational theory into consideration. Improvement in the vibration control can be achieved by determining the natural frequency of the engine bracket. To achieve isolation, natural frequency must be away from the excitation energy to avoid resonating condition. Also, NVH is an important vehicles characteristic motivating to achieve overall customer satisfaction. The main role of engine mounting system as one of the principle vehicle vibration isolating systems, besides suspension system, is to reduce the noise and vibration perceived by driver and to improve the ride comfort.

3. Abdolvahab Agharkakli, Digvijay Pradip Wagh[3] The engine mount and body mount is a complex joint assembly comprising of rubber bushings on the top and bottom of the frame bracket, a bolt, and retainer. The engine/body mounts are designed to carry the horizontal impact load in an impact and to isolate the noise, vibration and harshness (NVH), occurring during driving from entering the passenger compartment. The authors in this paper have studied mathematical model and compared its results with MATLAB simulations. The mounts are treated at the component level, and mathematical models for the same are evaluated to get the required characteristics. The mounts are modelled as spring and damper system subjected to impact loading that occurs during crash events. The approximation of input pulse has been described mathematically, which then serves to find the characteristics of the mounts. The change in the characteristics of mounts with the change in the velocity of impact has also been studied.

4. Dr.Yadavalli Basavaraj, Manjunatha.T.H[4] These authors have focused more on avoiding resonance and damping of frequency. If there exist unbalanced loads in engine body, resonant vibration occurs. This resonant vibration increases if chassis has unitary or frameless construction. This has forced designers to direct their attention to the development of high quality engine mounting devices in order to ensure that improved

comfort in riding and silencing shall not be offset by fatiguing vibration effects. In this paper an engine mounting bracket is designed to reduce the transmission of engine vibration to the chassis

2.1 Literature Gap

After careful review of the literature on the various engine mounts and vibration reduction techniques it is clear that majority of the research has being limited to vehicle engine mounts . Although no specific research on vibration reduction of small engines was observed.

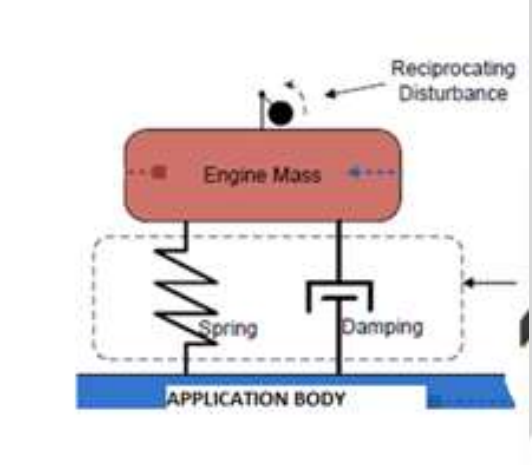
Small engines are in application sprayers , tillers, hedge trimmers which are normally back-mounted and used by small farmers. The use of engines in the heavy vibration condition can lead to harm to the health of the farmers and also lowers the efficiency of the farmer .

The conventional rubber mounts fail to damp the vibration to a great degree and hence it is necessary to develop an effective vibration damping mount for the appications

PROBLEM DESCRIPTION :

. The huge power generated by the engine must transfer smoothly to the application without rattling the application too much or twisting the engine as a result of the generated torques on the crankshaft. The engine must be kept tightly in place and not move excessively due to the inertial loadings (e.g. turns) or the road inputs (e.g. road bumps). An engine mount is a application component that attaches the engine bracket to the chassis. The engine is connected to the application body by several mounts, which are important for smooth operation of the application. An engine mount should isolate the passengers' cabin from engine-generated noise and vibration. The engine mount must also hold the engine in place and restrict it from moving.

Engine vibrations have two major sources: (1) intermittent pulsing due to ignition in the engine cylinders, and (2) inherent unbalances in the reciprocating components of the engine. The frequency of the vibration depends on the number of cylinders, stroke number, and engine speed.

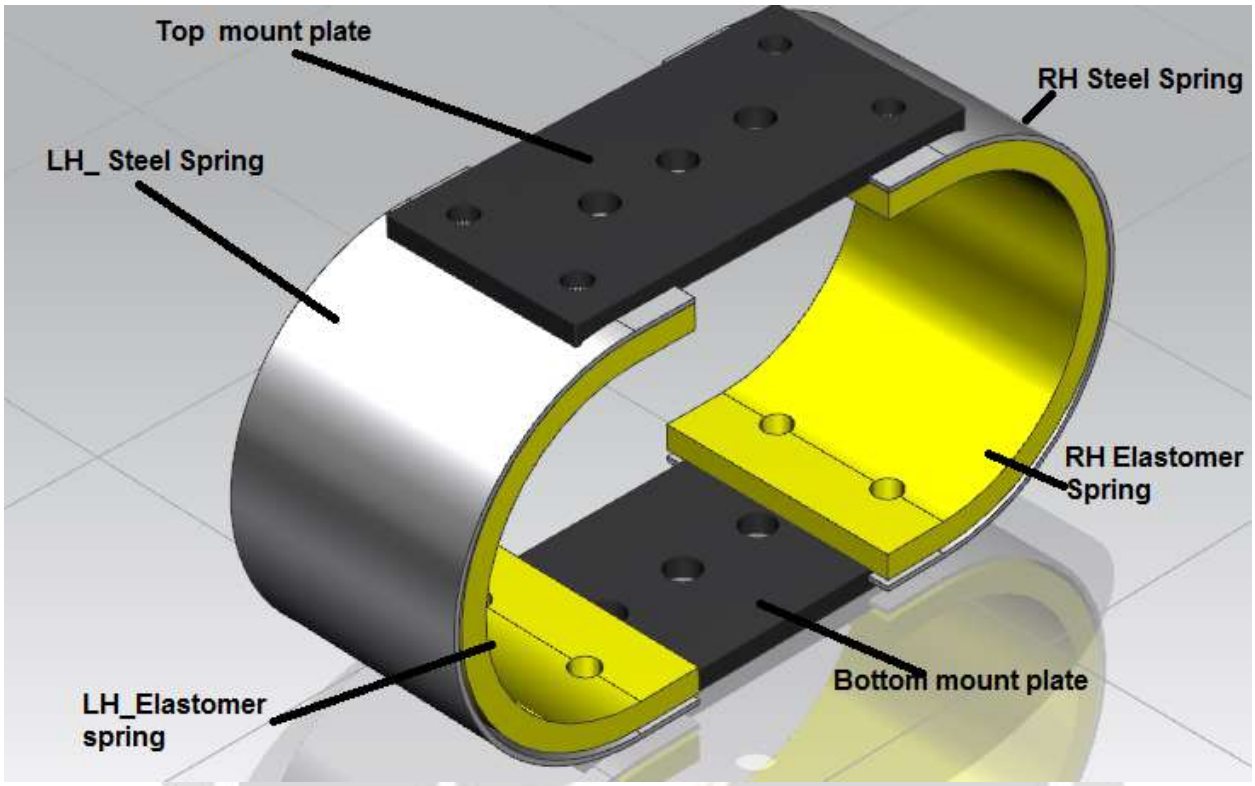


Multiple studies have shown that regular and frequent exposure to HAV can lead to permanent adverse health effects, which are most likely to occur when contact with a vibrating tool or work process is a regular and significant part of a person's job.

Hand-arm vibration can cause a range of conditions collectively known as hand-arm vibration syndrome (HAVS), as well as specific diseases such as white finger or Raynaud's syndrome, carpel tunnel syndrome and tendinitis. Vibration syndrome has adverse circulatory and neural effects in the fingers. The signs and symptoms include numbness, pain, and blanching (turning pale and ashen).

A rubber mount can provide the required stiffness for the resonance control and shock absorption, but the rubber damping in low frequencies is not sufficient. Moreover, the isolating characteristic of the rubber mount is not good because the transmitted force increases in higher frequencies due to the constant damping (high stiffness and high damping force in the isolation zone). So that the rubber mount somehow satisfies the fixture zone requirement but cannot address the soft state (low damping low stiffness) requirements in higher frequencies for isolation

CONSTRUCTION AND WORKING



The parts of the Composite elliptical leaf spring
The main parts are as follows :

1. LH_Steel Spring
2. RH_ Steel Spring
3. LH_Elastomer spring
4. RH_ Steel Spring
5. Top Mount Plate
6. Bottom Mounting plate

The composite spring is a elliptical shape mount developed to be mounted below the engine bracket and onto the machine frame. The top mount is coupled to the engine frame using bolts . The Left hand and right hanf steel springs come on the outside of the mount where as the Left hand and Right hand elastomer mounts are mounted below the steel spring such that they as backing liners to the steel spring . The other open end of the springs are connected to the bottom mounting plate .

The material of the steel spring is SS304 where as the material for the elastomer liners is Eartlon and the to and bottom mounts are made from Nylon 6 material.

The engine is mounted on the frame with the support of the mount and the engine shaft is coupled to the output shaft which is held in the ball bearing support and it carries the dynamometer pulley to apply the load.

The testing is done in such that the engine is started and the vibration measurement of displacement , velocity and acceleration parameter is done using a vibrometer VB-06 with its probe engaged in the p[robe holder mounted on the engine bracket.

Initially the engine is run at no load and the engine speed is changed by using accelerator and the vibration parameters are measured at each speed.

Next the engine is set a particular speed and then the load is applied to the engine using the dynamometer pulley and the vibration readings are take at different engine loads.

DESIGN - ANALYSIS OF TOP MOUNT PLATE ;

MATERIAL SELECTION :-

Ref :- (PSG 1.10, 1.12 & 1.17)

DESIGNATION	TEXTILE STRENGTH N/mm^2	YEILD STRENGTH N/mm^2
Nylon	72	56

Mounting plate is subjected to direct compressive load under action the of weight of engine and accessories which is not to exceed 4 kg Hence the load on plate = Total load/ No of plates

No ofplates = 2 ---(top and bottom plates included)

Hence load on top plate = 2kg = 19.6N

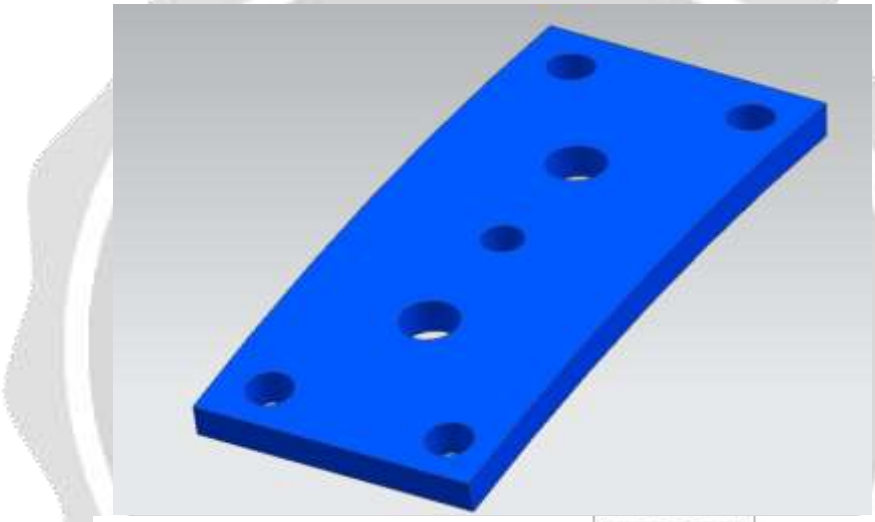
Direct Tensile or Compressive stress due to an axial load :-

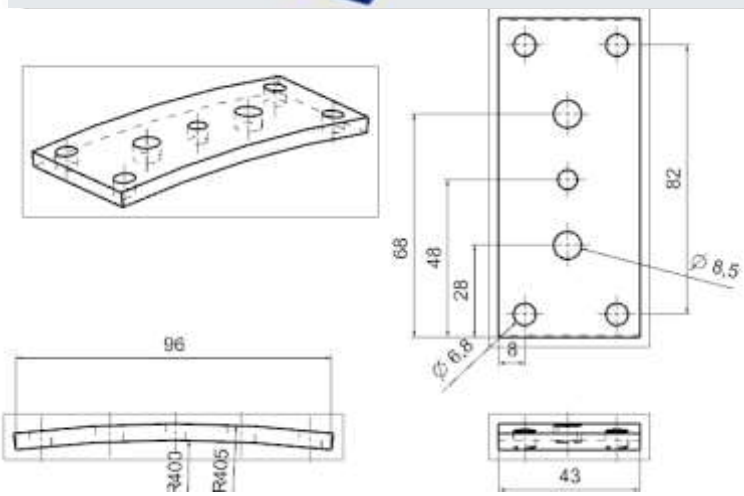
$$fc_{act} = \frac{W}{}$$

$$\Rightarrow \underline{fc_{act} = 0.004\ N/mm^2}$$

As $fc_{act} < fc_{all}$, Top plate is safe i $(100 \times 50 - \{4[(\pi/4)\,6.8^2] + 3\,[(\pi/4)\,8.5^2]\}$

Note the low stress value is owing to size of the engine bracket.



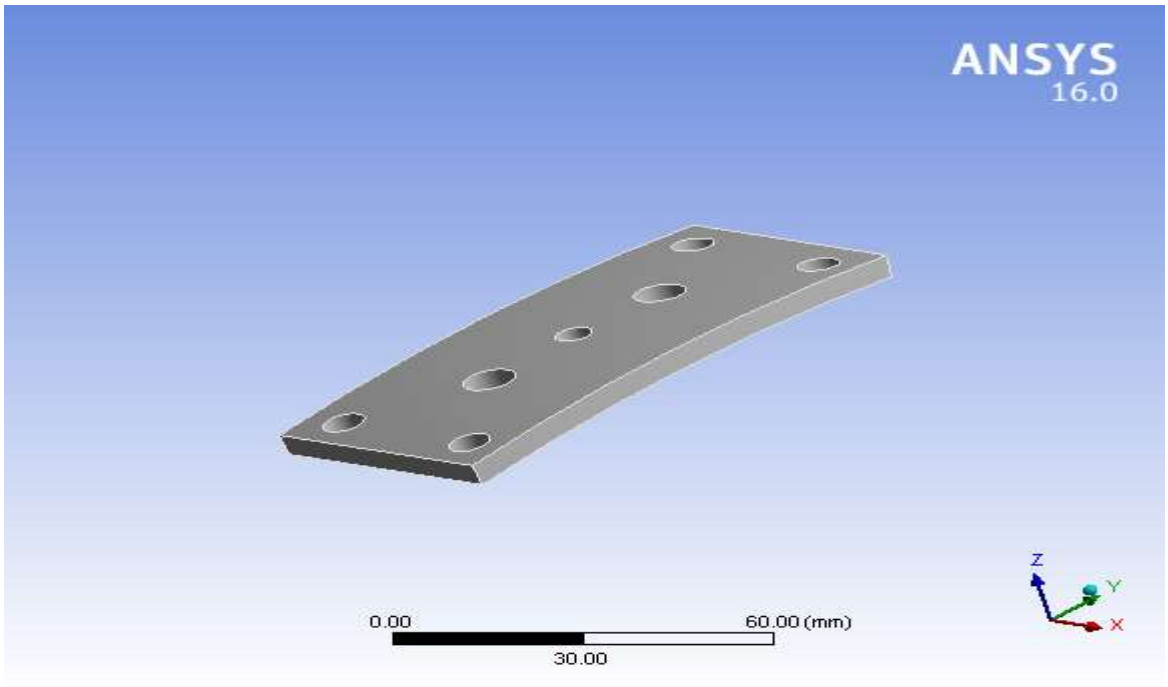


Material of component : NYLON

Allowable stress in material : 36 N/mm2

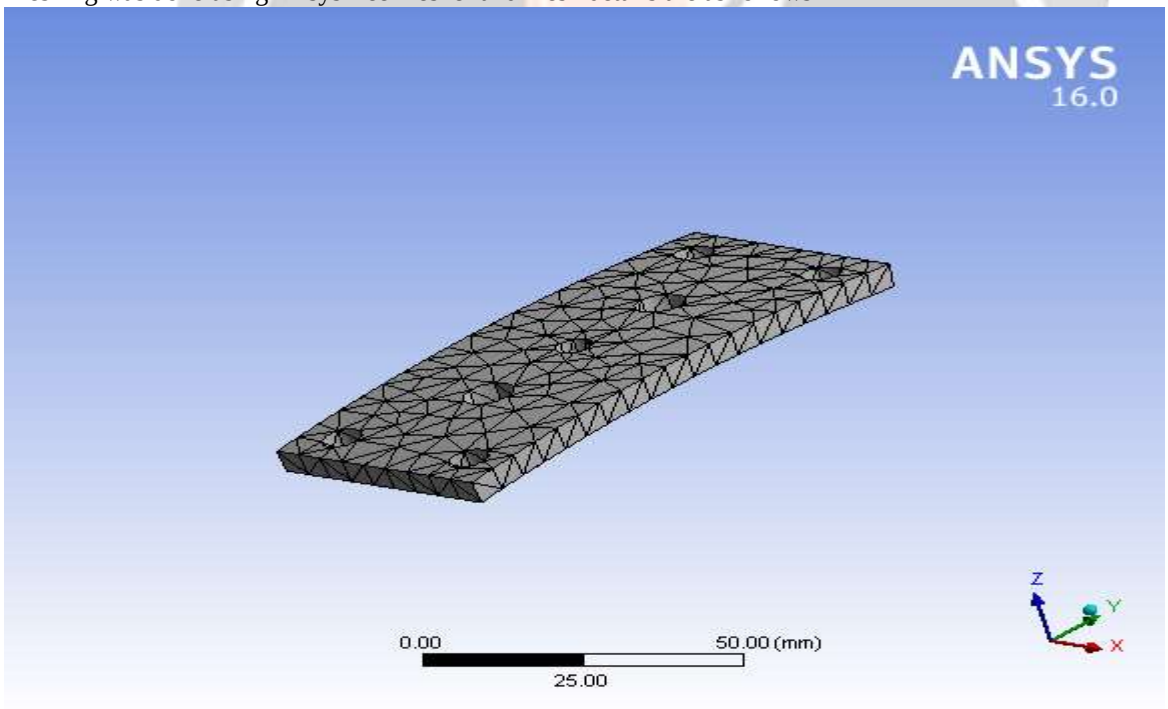
Geometry

Geometry was developed using Unigraphix Nx-8 software and the step file was used as input to Ansys



Meshing :

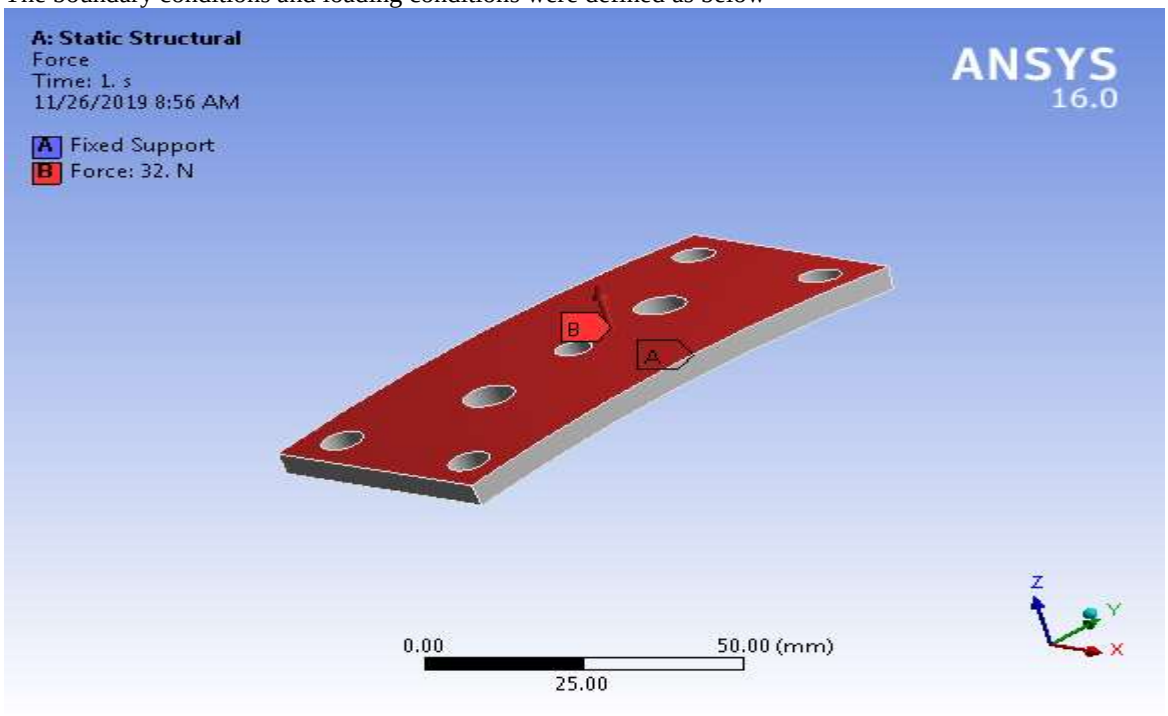
Meshing was done using Ansys free mesher and mesh details are as follows



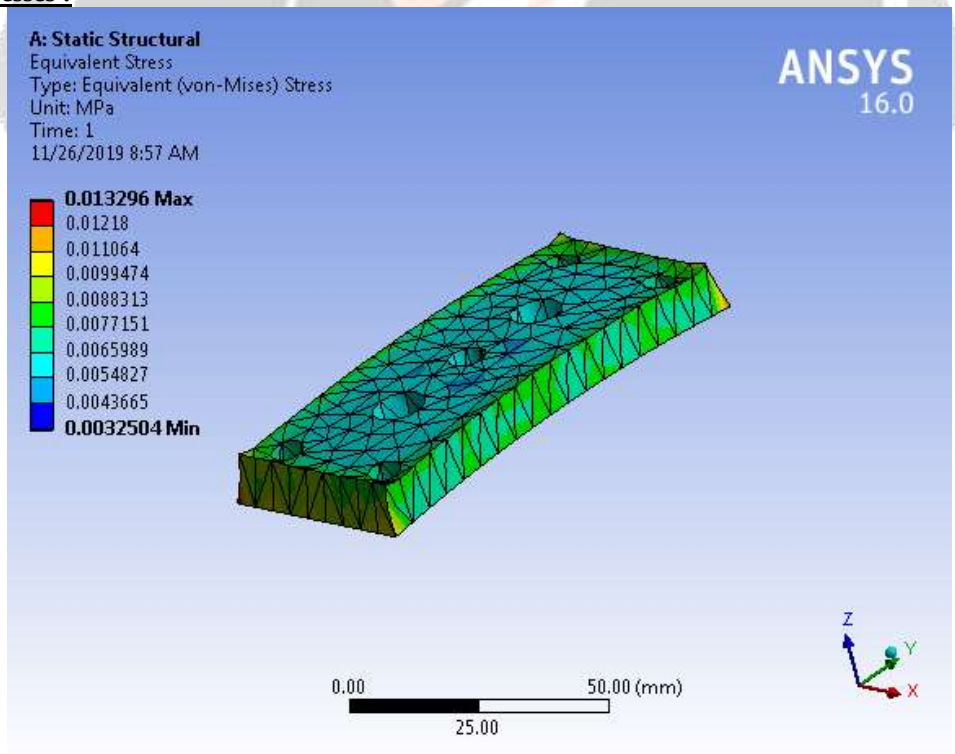
Statistics	
Nodes	2114
Elements	991
Mesh Metric	None

Boundary Conditions:

The boundary conditions and loading conditions were defined as below



Von-mises Stresses :



The maximum Von-misses stresses in the part are 0.0133 MPa which is far below the allowable value 36 MPa hence the part is safe under given loading conditions

Maximum deformation :

The maximum deformation in the part is -----mm , which is very negligible hence the part is safe.

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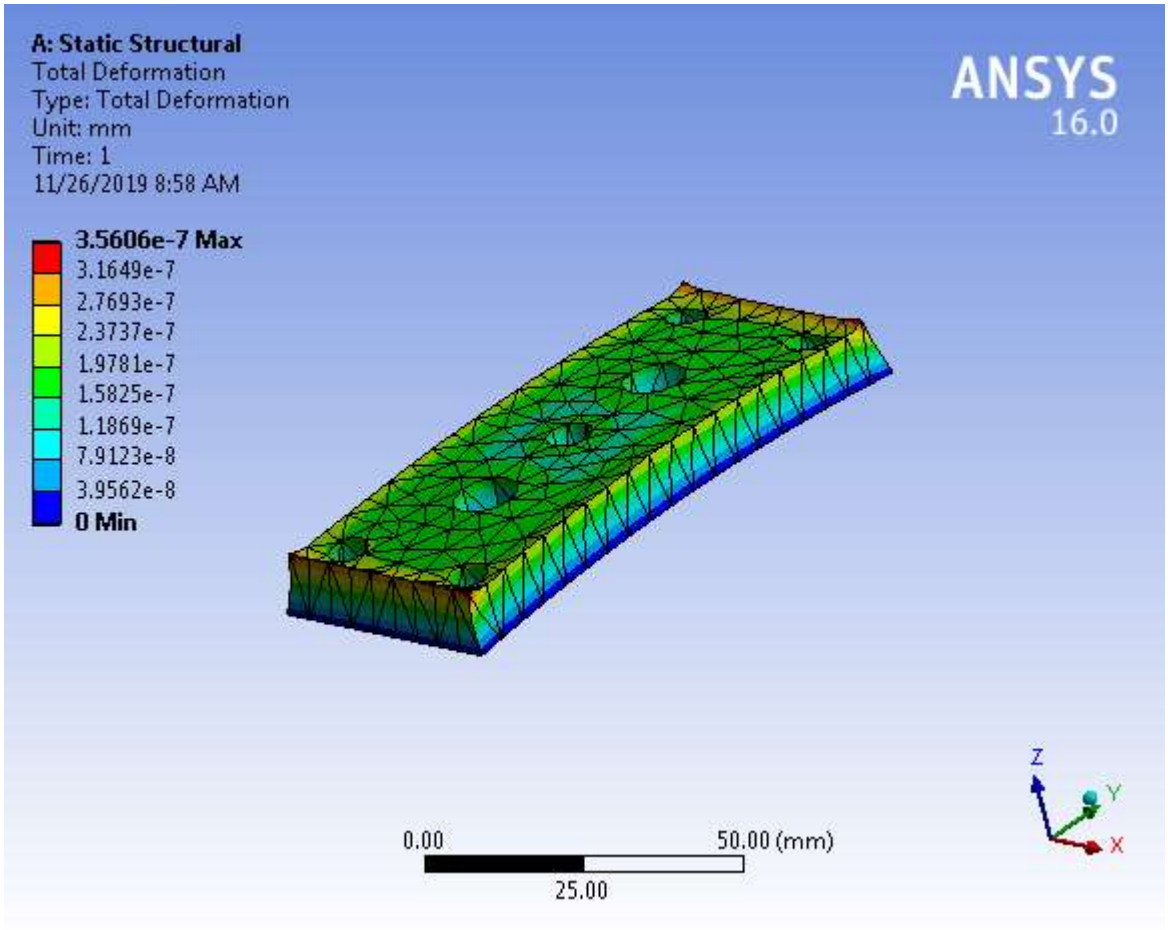

Maximum deformation under the action of weight of engine is negligible hence the part is safe

3. CONCLUSIONS

After careful review of the literature on the various engine mounts and vibration reduction techniques it is clear that majority of the research has being limited to vehicle engine mounts . Although no specific research on vibration reduction of small engines was observed.

Small engines are in application sprayers , tillers, hedge trimmers which are normally back-mounted and used by small farmers. The use of engines in the heavy vibration condition can lead to harm to the health of the farmers and also lowers the efficiency of the farmer .

The conventional rubber mounts fail to damp the vibration to a great degree and hence it is necessary to develop an effective vibration damping mount for the applications . The Elliptical spring mount with elastomer is introduced as a solution to the problem and the mount plate is designed both byu theoretical method as well as static structural analysis is done and the part is found to be safe by both methods

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4. ACKNOWLEDGEMENT

In the due course of project with the valuable guidance of Guide. Dr. R. R. Arakerimath. the papert was completed as per schedule and desirable results were achieved.

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