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Analysis of Elliptical Shape Composite Spring Mounting

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Abstract — **A motor mounting is an application segment that interfaces the motor section to the machine edge of unit. Motor is connected with the machine body by a few mounts, which are significant for smooth activity of use. A motor mount is utilized to confine body from vibration during working and motor created commotion varying sorts of mounts are use in apparatus and vehicles. Varying kinds of mounts are use in apparatus and vehicles. Elastomeric mount are minimal effort and least complex kind of mounts, they smother motor power/torque and vibrations through cooling. An elastomeric mount can give the predetermined solidness to the reverberation control and stun retention; however elastic damping in low frequencies isn't adequate. Circular shape spring mounting might be a vibration and stun isolator planned explicitly for back mounted motor applications and is reasonable to watch the apparatus client against stun and vibration in back held application like motor sprayers, trimmers and expresses. Material chose for spring is SS304 (from 0.3 ~ 0.8mm) thickness and polymer material as support in spring. The two materials are resistant to consumption and work productively under wide choice of temperature. Essential structure utilizes high pliable hardened stainless-steel SS304 framed leaves on all sides with the polymer sheet of 6mm thickness. Unigraphics Nx-8.0 is used for 3D modeling and Analysis of component and meshing is completed with the help of Ansys work Bench16.0.**

Index terms - Force/torque, polymer, SS304, Unigraphics Nx-8.0, Ansys Work-Bench 16.0

I. Introduction

Some of passive isolation technology including elastomer, springs, cork/plug and airbags has stiffness elements. Plug is a mechanical material that can withstand generous compressive burden. Vibration isolators that utilization plugs for the most part having normal frequencies 50-60 Hz; diagnostic grilling shows rove this could be high for Edwards's system. Plug has air pockets inside the material and can display high interior damping. Plug can be joined with neoprene to give huge redirection, henceforth a lower normal recurrence. This material is modest and has a long help life [1].

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Elastomers are elastic like materials that have inward damping and truly low firmness. The firmness and damping properties of an elastomer relies upon genuine material, the kind of fibber support, and geometrical arrangement. A regular elastomer is elastic. Characteristic rubbers are powerless against temperature impacts, oxidants, daylight, and fluid tainting, particularly from machine oil. For Edwards's system, machine oil would be the sole possible issue.

Manufactured rubbers like neoprene and engineered elastic have higher damping and better protection from natural variables A disadvantage to utilizing an elastomer as vibration isolator is that the machine weight can start a floating impact, which might be a persistent twisting of texture under steady burden. Figure shows a spread of stopper and elastomer vibration isolators.

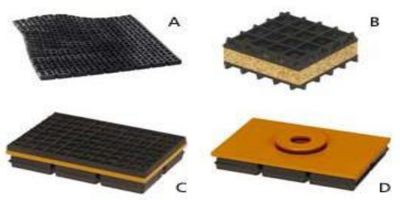


Figure-1 types of cork and elastomer vibration isolators [1]

Literature review carried out in the area of analysis on elliptical spring composite spring mounting in context to the present work is presented.

A fatigue and vibration examination are directed for getting failure of motor placing frame. Basic disappointment happens if stress and vibration are extreme and serious. For most of the part, the chief significant vibration pertinent excitations during a motor are regularly recognized as ignition power; primary bearing response powers capacity spinning, changed damper; cylinder powers including auxiliary movement; crankshaft response powers, open or close effects and bearing effects; valve open and close effects; valve train powers brought about by chain/belt development and apparatus gear train; drive powers inside the transmission; driving train response powers also minutes. The improvement of plate section utilization has been carried out with Ansys program [2].

Lakshmi Kala, V. Ratna Kiran [3] have communicated work done by the past makers. These makers have taken non-straight vibrational speculation into thought. Advancement in vibration control can be cultivated by choosing the normal repeat of engine area. To achieve detachment, typical repeat must be away from excitation essentialness to go without resonating condition. In like manner, NVH might be a significant vehicles trademark rousing to comprehend by and large consumer loyalty. The chief job of motor mounting framework together of rule vehicle vibration isolating structures, other than suspension, decrease uproar and vibration saw by driver and to strengthen for ride comfort.

Motor mounting could likewise be rich bond get together involving elastic bush with absolute best or base for edge section, jolt. Motor intended for convey level effect loading effect or seclude commotion, oscillation and cruelty, happening while driving with traveler compartment. Creators considered scientific prototype also contrasted outcomes and MATLAB recreations. Mountings are handled segment extent also numerical examples for equivalent is assessed to encourage necessary attributes. Mountings demonstrated as damper and spring framework exposed with affect stacking causes at crash occasions [4].

These creators have concentrated more on keeping away from reverberation and damping of recurrence. On the off chance that there exist uneven loads in motor body, thunderous vibration happens. These full vibration increments if undercarriage has unitary or frameless development. These constrained planners for guide focus toward occasion for top motor gadgets so as to guarantee that improved solace in hushing will not balance with exhausting oscillation impacts. During motor mount section intended for downsize transfer for motor oscillation to application body. Project modeled and planned a transport joyfulness coupler and analyzed for rendition languid conglomeration. Aside from, modal dissection was administered as a result as to plan away up quantity of locomotive rise. If this artless number were to weigh back agitation incidence, sound color would manifest. This command is reel by utilizing aluminum, magnesium, ERW 1 and ERW2 combinations for the motor car stand up district. The matters are analyzed for stresses and deformations [5].

The creators have considered motor mounting section produced using three unique materials for example less-carbon steel, Fe and CI. Most goals are to pick easiest material which got outcome below endorsed states. Modular investigation or steady examination directed by which greatest von-misses pressure and common recurrence are processed [6].

Creators has examined consonant reaction and vibration damping of a motor mounting section. In the event that the sections have their reverberation frequencies nearby edge of working motor frequencies, at that point the monstrous adequacy of vibration get produced which can cause its exhaustion disappointment or crack, narrative lessening it's assessed or wanted life. What's more, if the symphonious reaction estimations of section are very satisfactory range it prompts to age of clamor [7].

II. PROBLEM DISCRIPTION

The large power generated by the engine must transfer smoothly to the appliance without rattling the appliance an excessive amount of or twisting the engine as results that torque is generated on crankshaft. The engine must be kept tightly in situ and not move excessively thanks to the inertial loadings or the machine load inputs. A motor mount might be an application segment that appends the motor section with the case. The motor is associated with the apparatus body by a few mounts, which are significant for smooth activity of the machine apparatuses.

A motor mounting has separated the machine outline from motor produced commotion and vibration. The motor mount must hold the motor in situ and limit it from moving. Motor vibrations have two significant sources: (1) irregular beating because of start inside the motor chambers, and (2) inborn unbalances inside the responding parts of the motor. The recurrence of motor vibration relies upon measure of chambers, number of Stroke and motor speed.

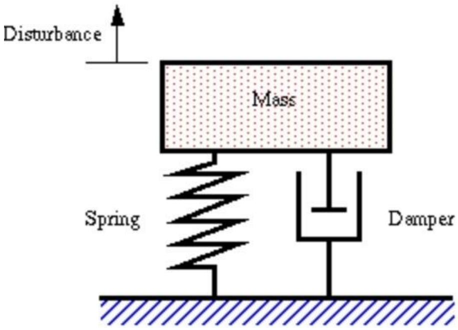


Figure 2. Spring, mass and damper system [1]

Various examinations have exhibited that conventional and ceaseless introduction to HAV can incite invariable ominous prosperity results, also bound to happen when connect with oscillating mechanical assembly and work process are standard and basic bit person's movement.

HAV vibration will cause scope of conditions can full referred to HAV vibration disorder (HAVS), even as specific ailments, as an example, white finger or Raynaud's disorder, pistil burrow disorder and tendinitis. Vibration condition has neural impacts and unfavorable circulatory within the fingers. The aspect effects incorporate deadness, torment, and lightening.

An elastic mount can give the predefined solidness to the reverberation control and stun retention, yet the elastic damping in low frequencies isn't adequate. Additionally, the disconnecting normal for the elastic mount isn't acceptable on the grounds that the transmitted power increments in higher frequencies on account of the consistent damping (high damping power and high solidness inside the segregation zone). in order 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.

III. CONSTRUCTION

The main parts required to prepare an elliptical shape composite spring mounting are LH_steel spring, RH_ steel spring, LH_elastomer spring, RH_ elastomer spring, top mounting plate and base mounting plate. An assembly is shown in figure 3.

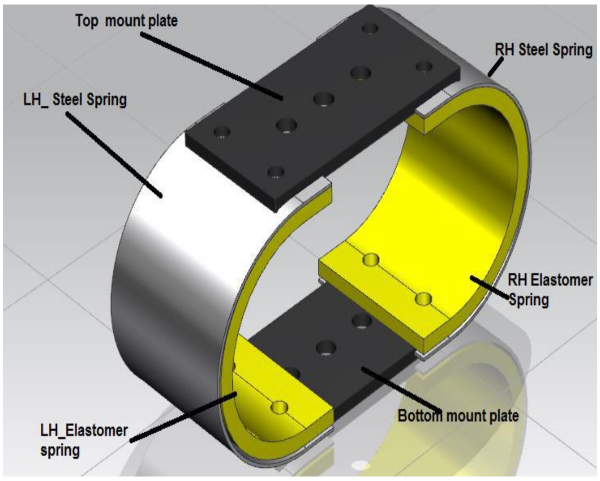


Figure-3 composite elliptical spring Parts [1]

The LH and RH steel springs come on the outside of the mount whereas the LH and RH elastomer mounts are mounted below the steel spring such way that they are backing liners to the steel spring. The either ends of the springs are connected with top and bottom mounting plates using bolts. The material of the steel spring is SS304 whereas the material for the elastomer liners is Ertalon and the top & bottom mounts are made from Nylon material.

IV. Design And Analysis Of Parts

For design and finite element analysis of various parts of spring mounting, the material properties are given in table 1.

TABLE -1

PART, MATERIAL AND ITS PROPERTIES

Part	Material	Tensile Strength N/mm^2	Yeild Strength N/mm^2
Top & Bottom Plates	Nylon	72	56
LH & RH side springs	SS304	840	760
LH & RH side elastomer	Eartlon	66	54

A. Design analysis of top mounting plate

Mounting plate is exposed to coordinate compressive burden under the activity of weight of motor and extras which is not to surpass 4 kg.

Consequently, Load on plate = Total load/ No of plates

No. of plates = 2 (top and bottom both plates) Hence load on top plate = 2kg = 2 x 9.1 =19.6 N

Compressive or Tensile stress due to an axial load,

$$fc_{act} = \frac{W}{(100\times 50) - [4(\frac{\pi}{4}\times 6.8^2) + 3(\frac{\pi}{4}\times 8.5^2)}$$

$$fc_{act} = 0.004 N/mm^2 \qquad (1)$$

As fc_{act} is less than fc_{all}, top mounting plate is safe in compression. Note the low stress value is owing to large area of mounting plate which is decided by mounting whole size of the engine bracket.

Material of component: NYLON

Allowable stress in material: 36 N/mm^2

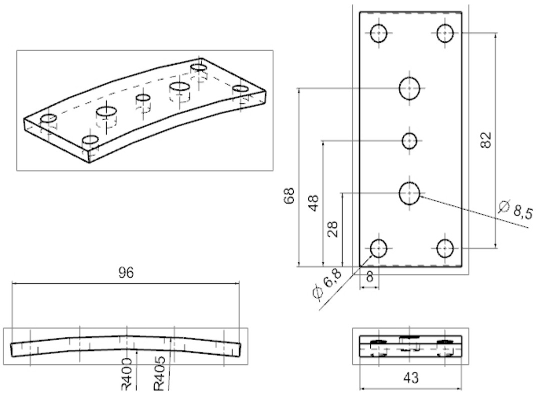


Figure 4. Top plate detail drawing

Based on the dimension of plate, a three-dimensional model has been developed using Unigraphics NX-8 software as shown in figure 5 and the step file was used as input to an analysis software, Ansys 16.0 as shown in figure 6. Meshing was done using Ansys free mesher with the help of solid 187 tetrahedral element. Mesh model of plate is shown in figure 7 and details of mesh is given in table 2.

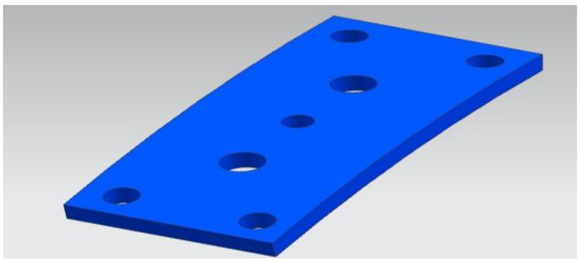


Figure 5. Top Plate 3d View

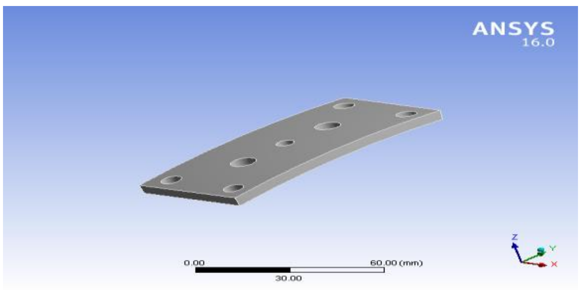


Figure 6. Geometry input to Ansys

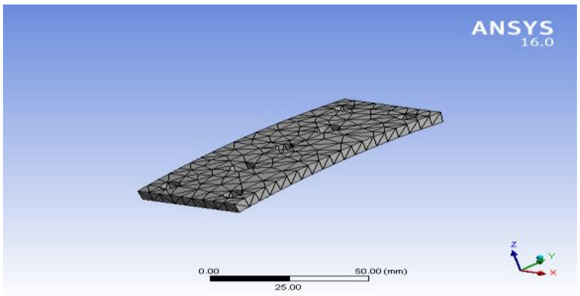


Figure 7. Meshing result

TABLE 2
MESHING STATISTICS

Nodes	2114
Elements	991
Mesh Metric	None
Type of Element	Solid 187 tetrahedral element

A boundary condition is applied to the plate by applying load on upper face and fixed at bottom surface. The boundary condition of plate is shown in figure 8.

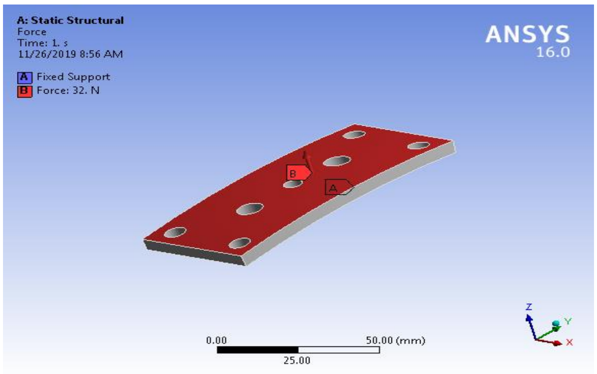


Figure 8. Applying boundary conditions

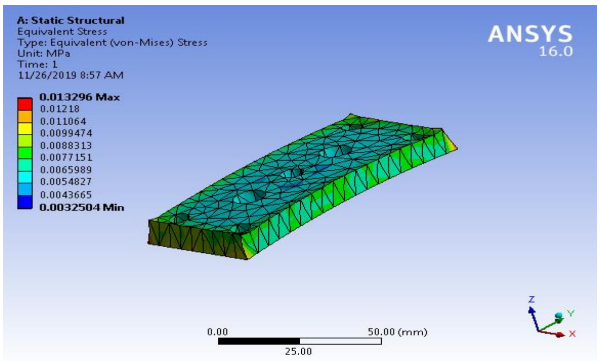


Figure 9. Stresses developed

The maximum Von-misses stresses in the part are 0.0133 MPa is shown in figure 9 which is far below the allowable value 36 MPa hence the part is safe under given loading conditions. Maximum deflection under the action of weight of engine is less hence the part is safe.

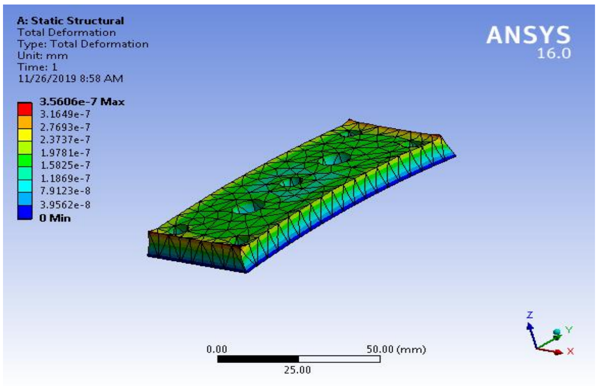


Figure 10. Deformation obtained

B. Design Analysis Of Bottom Mounting Plate

The design of bottom plate is similar to top plate. Hence finite element analysis bottom plate is exactly similar and results are also same for both the plates.

C. Design Analysis Of LH_Elliptical SS304 Spring

By Curved beam formula of bending moment

Bending moment, $M_b = 19.6 \times 15 = 294$ N-mm

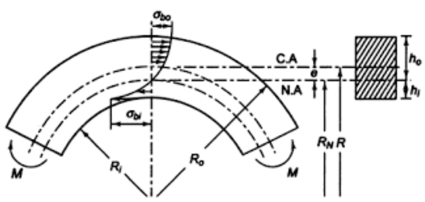
Area of cross-section, a = 60 x 0.8 = 48 mm2

Neutral radius, $r_n = 45$ mm

distance of fibre from neutral axis, y=e= 0.4

The maximum stress induced in the elliptical leaf spring

$$= 294 \times 0.4 / 48 \times 0.4(45-0.4) = 0.13 \text{ N/mm}^2$$



Bending stress, $$\sigma_b = \frac{M_b y}{ae(r_n - y)} \qquad (2)$$

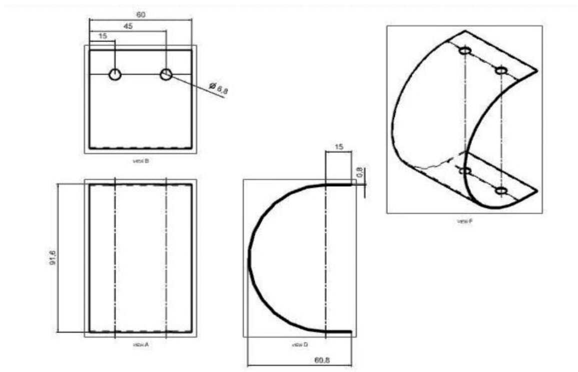


Figure 11. LH_elliptical spring detail drawing

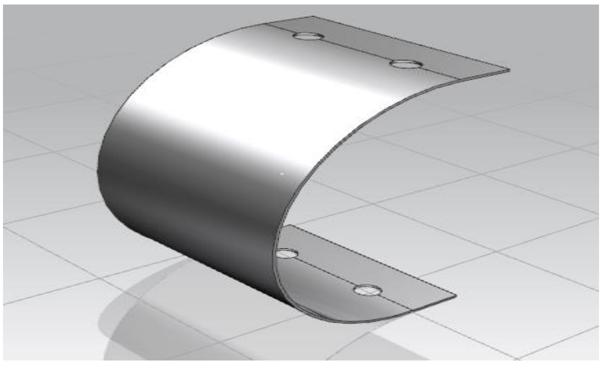


Figure 12. 3D view of LH_elliptical spring (SS304)

Based on the dimension of elliptical spring, a three-dimensional model has been developed using Unigraphics NX-8 software as shown in figure 12 and the step file was used as input to an analysis software, Ansys 16.0 as shown in figure 13. Meshing was done using Ansys free mesher with the help of solid 187 tetrahedral element. Mesh model of LH_elliptical spring is shown in figure 14 and details of mesh is given in table 4.

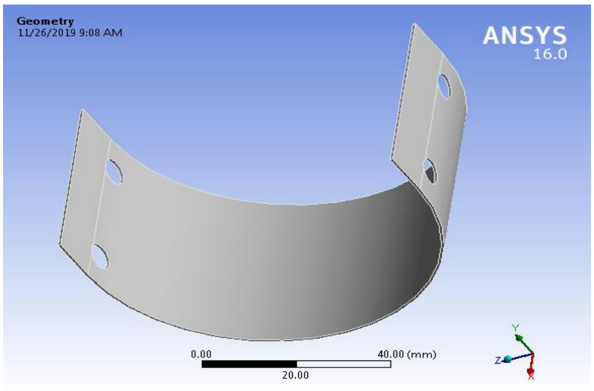


Figure 13. Geometry input to Ansys

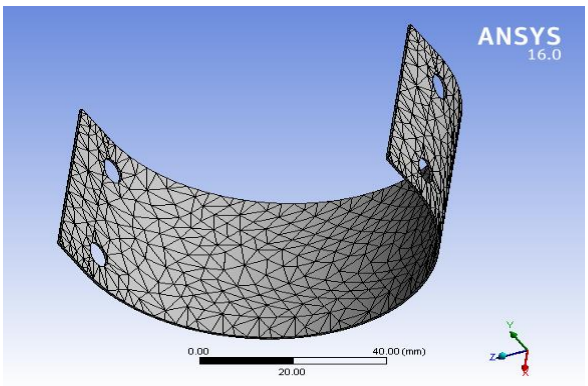


Figure 14. Meshing result

TABLE 4.
MESHING STATISTICS

Nodes	6235
Elements	2867
Mesh Metric	None
Type of element	Solid 187 tetrahedral element

A boundary condition is applied to an elliptical spring by applying moment at upper surface and fixed at both the end. The boundary condition of elliptical spring is shown in figure 15.

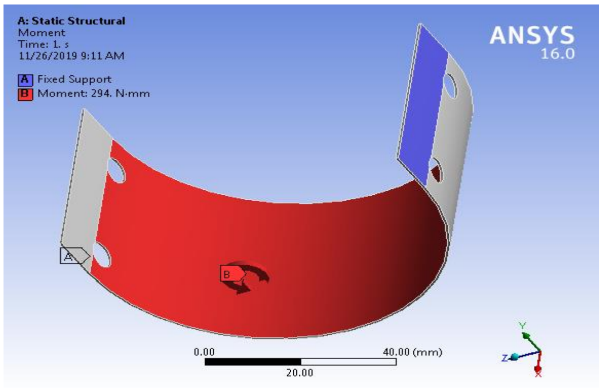


Figure 15- Applying boundary conditions

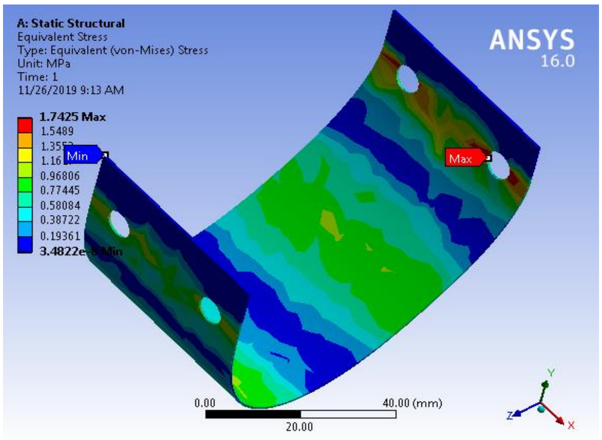


Figure 16. Stresses developed

The maximum Von-misses stress in the part is 1.745 MPa is shown in figure 16 which is far below the allowable value 150 MPa hence the part is safe under given loading conditions. The maximum deflection in part is 0.006 mm as shown in figure 17, which is very less hence the part is safe.

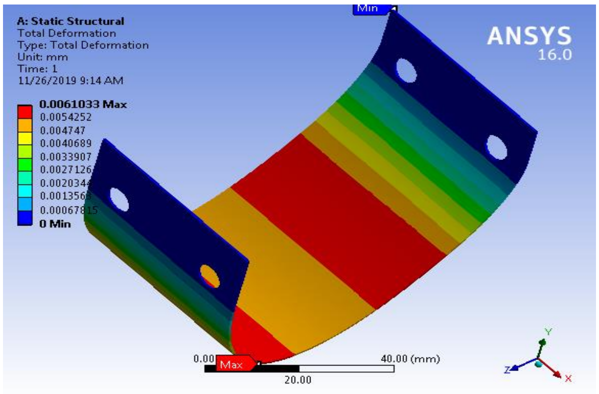


Figure 17- Deformation obtained

D. Design Analysis Of RH_Elliptical SS304 Spring

The design of RH_elliptical spring is similar to LH_ spring. Hence finite element analysis RH_elliptical spring is exactly similar and results are also same for both the spring.

E. Design Analysis Of LH_Eartron Liner

Again, by Curved beam formula of bending moment,

Bending moment, M_b= 19.6 × 15 = 294 N-mm

Area of cross-section, a= 60 × 5 = 300 mm^2

Neutral radius, r_n = 45 mm

distance of fibre from neutral axis, Y=e= 2.5

The maximum stress induced in the eartron liner

$$= 294 \times 2.5 / 300 \times 2.5(45-2.5) = 0.023 \text{ N/mm}^2$$

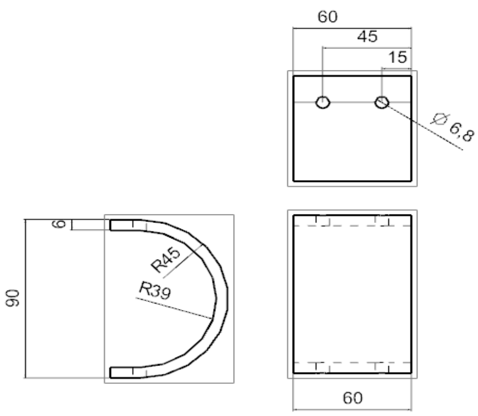


Figure 18. LH_eartlon liner detail drawing

Based on the dimension of LH_eartron liner, a three-dimensional model has been developed using Unigraphics NX-8 software as shown in figure 19 and the step file was used as input to an analysis software, Ansys 16.0 as shown in figure 20. Meshing was done using Ansys free mesher with the help of solid 187 tetrahedral element. Mesh model of LH_eartron liner is shown in figure 21 and details of mesh is given in table 5.

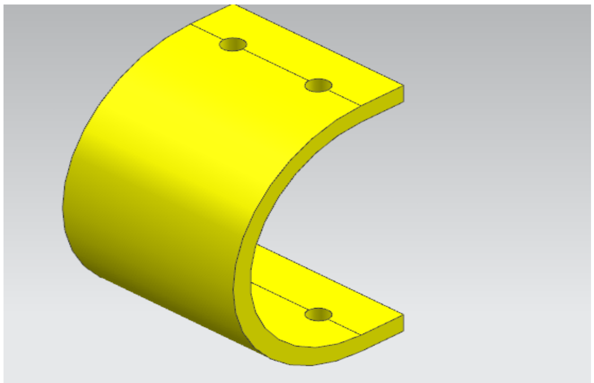


Figure 19. 3D view of LH_eartron liner

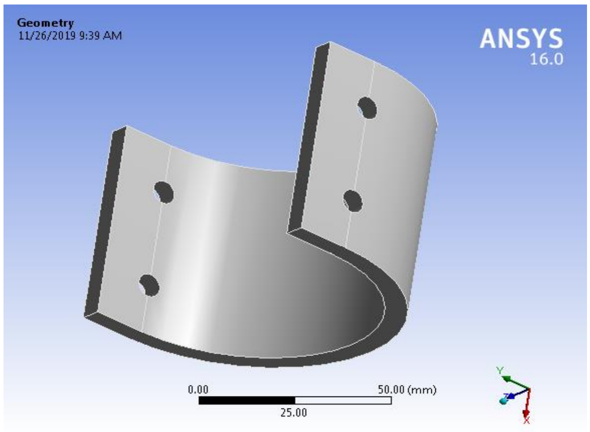


Figure 20. Geometry input to Ansys

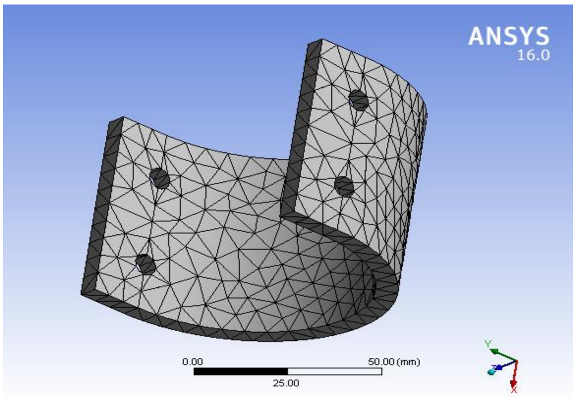


Figure 21. Meshing result

TABLE 5
MESHING STATISTICS

Nodes	3125
Elements	1465
Mesh Metric	None
Type of element	Solid 187 tetrahedral element

A tetrahedron has 4 vertices, 6 edges, and is bounded by 4 triangular faces. In most cases a tetrahedral volume mesh can be generated automatically hence tetrahedron type of meshing is used.

A boundary condition is applied to an eartron liner by applying moment at upper surface and fixed at both the end. The boundary condition of eartron liner is shown in figure 22.

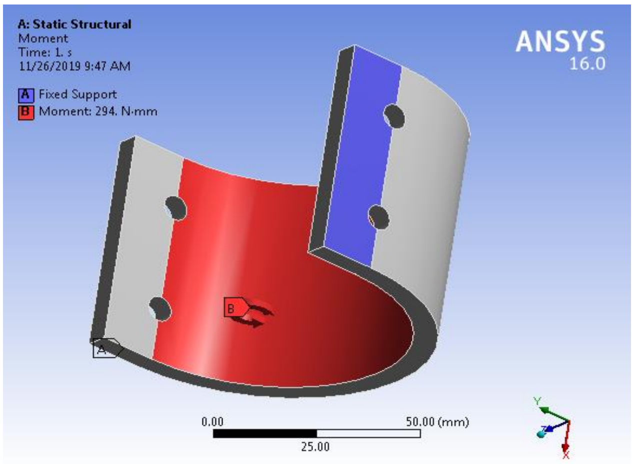


Figure 22. Applying boundary conditions

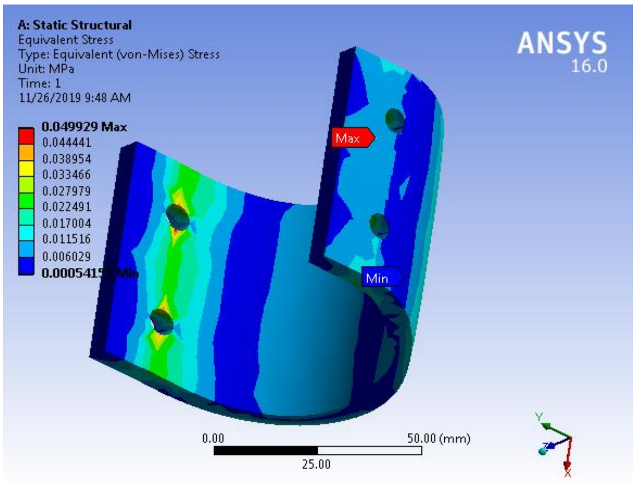


Figure 23- Stresses developed

The maximum Von-misses stresses in the part is 0.049 MPa as shown in figure 24 which is far below the allowable value 36 MPa hence the part is safe under given loading conditions. The maximum deflection in part is 0.002 mm as shown in figure 24, which is very less hence the part is safe.

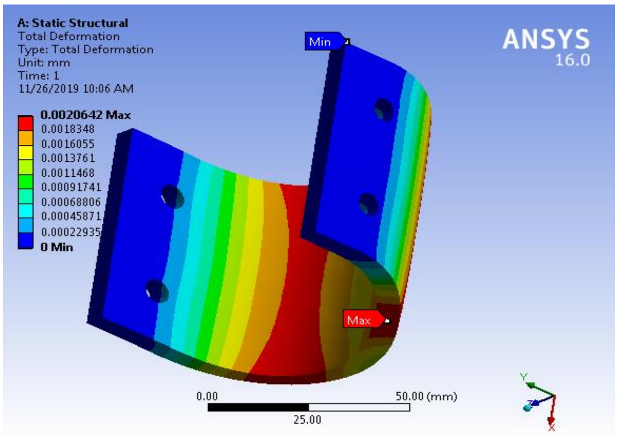


Figure 24. Deformation obtained

F. Design Analysis Of RH_Eartron Liner

The design of RH_ Eartron Liner is similar to LH_ Eartron Liner. Hence finite element analysis RH_ Eartron Liner is exactly similar and results are also same for both the liner.

V. Result And Discussion

The top/bottom clamp bracket analyzed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.

The spring steel leaf analyzed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.

The Ertalon liner analyzed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.

VI. Conclusions

Fundamental structure utilizes high tractable tempered steel SS-304 framed leaves on all sides with the elastomer sheet of 6 mm thickness. Unigraphics Nx-8.0 is utilized for 3-D displaying, additionally Analysis of segments and cross section utilizing Ansys Work-bench 16.0. The top/base clip section structured and investigated utilizing ANSYS shows pressure well underneath admissible breaking point and twisting is unimportant henceforth it is sheltered under given arrangement of burdens. Steel spring leaf structured and examined utilizing ANSYS shows pressure well underneath reasonable cutoff and twisting is immaterial thus it is protected under given arrangement of burdens. Ertalon liner analyzed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.

Materials are impervious to consumption and work productively under wide scope of temperature. The planned spring is anything but difficult to introduce with low space necessity. Curved shape spring mounting is a vibration and stun isolator structured explicitly for back mounted engine applications.

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