ABSTRACT:
The suspension system plays a very important role in automobile engineering. It carries the vehicle weight at static condition and it is subjected to various load conditions while the vehicle is travelling or in motion. It feeds the smooth travelling motion to the driver and passenger. A leaf spring bracket is a main part used to sustain the load or any attachment pair which is fixed to the chassis. It is attached by bolted or rivet joint to the chassis and subjected to various shock and load conditions, but static load is mostly effective on the bracket to increase the stress and chances of failure. There is a need to minimize failures and stress concentration of the bracket. It is most effective by failure analysis. A support load to the structural element used now in the automobile field increases demand of an optimized and sustainable product. A load spring bracket is used to support load which is fixed to the chassis to sustain the load for the vehicle. Fatigue is the condition whereby a material cracks or fails because of repeated (cyclic) stresses applied below the ultimate strength of the material. Fatigue failure often occurs quite suddenly with catastrophic results. Reasonable fatigue prediction for design or analysis can only be done if fatigue is viewed not only as an engineering problem but also as a material phenomenon that involves an invisible micro-scale crack initiation till a macro-scale fatigue failure.

Keywords: Light Duty Vehicle, Bracket, Mild Steel, FE Model, CATIA, ANSYS, Deformation, Stress, Fatigue, Hyper-mesh.

I. INTRODUCTION
Nowadays in the automobile field, the demand of atomized products with having sustainable capacity and different high functionality. There is a requirement of weight reduction, cost reduction, saving in time; it is possible with optimization and analysis by using Ansys, Hyper-mesh, and Optistruct etc. conventional Ansys software.

Light duty vehicles are mostly used for travelling or commercial use. In these vehicles, the suspension system is required for producing a smoother travelling experience to the driver and passenger for a convenient ride and greater shock absorbency with several road conditions.

Mounting bracket plays the most important role in the suspension system. The leaf spring bracket used to support load which is fixed to the chassis to sustain several load conditions for the vehicle. The suspension system consists of leaf spring, brackets, U-bolt, rods, etc.

This leaf spring is attached to the chassis with bracket. This bracket has high load sustain capacity and shock absorbency at various road conditions. Bracket places at the end leaf spring. There is required to increase the capability of the bracket for several functions with less weight. Since the topology optimization
is require with experimental test to optimize the bracket. To find out the developed stress or failure condition there decide to refer FE techniques and those techniques are most useful to improve function ability of automobile part. There are different types of optimization, weight optimization mounting bracket is already small in size so shape optimization techniques is most convenient to reduce the weight of bracket first decide to do shape optimization to improve design of bracket. There is required fixed support and load condition for analysis. Also decide meshing method element size, element order and their needs material properties.

II. METHODOLOGY

The load is transmitted through chassis to leaf spring and stress developed in mounting bracket at various load and several road shocks condition developed stress and bearing load causes of that bracket to get deform and produce chances of braking.

1. Experiment-
   a. Leaf spring bracket
   b. Machining For Optimized Material
   c. Fixture Preparation
   d. Strain gauging & UTM Testing
   e. Data Collection
2. FEA-
   a. 3D Part Modelling
   b. Assembly
   c. Material & Property
   d. Meshing
   e. Boundary Conditions (Loads, Constraints)
   f. Results- Stress & Strain Plots
   g. Topology Optimization (Removal Of Material)
   h. Results- Stress & Strain Plots
   i. Comparison & Conclusion

III. OPTIMIZATION:

This is the process of designing various models and forms, from these designs choosing one more accurate design. This process of selecting the good design is called optimization. Types of optimization

1. Topology optimization.
2. Homogeneous optimization.
   (i) Size and shape optimization.
   (ii) (BESO) Bidirectional structural optimization.
   (iii) (ESO) Evolutionary structural optimization: Evolutionary structural optimization method of design optimization that removes the un-efficient material from minimum stress region. The basic principle of topology or removal material of derived shape is the subtract material from minimum stress region and add the material if needed in maximum stress region.

IV. SPECIFICATION AND MATERIALS

The bracket of leaf spring is main part which is used to attach the leaf spring to chassis and its capital
function is to carry the vehicle load and transmits to the leaf spring. Mainly it absorb several road conditions, weight of vehicle and shocks impact at static condition of vehicle around 3 KN weight is applied on each section of bracket dimensions. The light Duty C-channel bracket is the back support of the light motor vehicles like jeeps. Its function is to support and carry the maximum load where requires. When the vehicles start moving on the road, because of uneven road condition shocks stress is applied on bracket because of vehicle weight and passengers weight.

MATERIAL DATA - Height – 64.5mm  
Width – 58mm  
Length- 100mm  
Thickness – 6mm  
3 Small holes diameter –  
10mm 2 Big holes diameter –  
15mm Top radius of circle – 12mm

PROPERTIES OF MATERIAL OF BRACKET -  
Mild Steel  
Young’s modulus =  
210 G-pa  
Yield strength =  
460 M-pa  
Poisson’s ratio = 0.3%  
Carbon content =  
0.9% Density =  
7850 kg/m³

STRESS ANALYSIS OF EXISTING BRACKET-

Fig.1 Catia Drafting  
Fig.2 Catia Part Model
Condition
Boundary Conditions should be fixed, as top surface Force acting on the bracket inside the hole with DOF in direction x, y, & z =0 in Z-direction as -1571N

STRESS ANALYSIS OF MODIFIED BRACKET:

- Bracket with two elliptical holes at fixed Support region-(D-25mm, d-6mm)
- Radius at top edge- R=16mm
- Fillets at 4 edges= 2.5mm
- As the part of topology the shape of material Removal geometry is arc (of a circle) has a
coordinate 1st and 2nd pt. with a radius of R which mention below-

- 1st point co-ordinates (x, y) = (0.5, 9.0)
- 2nd point co-ordinates (x, y) = (15, 25)
- Radius of arc R = 25.05mm

By considering top right corners as a origin-

V. FATIGUE ANALYSIS

Fatigue is the condition whereby a material cracks or fails because of repeated (cyclic) stresses applied
below the ultimate strength of the material. Fatigue failure often occurs quite suddenly with catastrophic result. When a structure is loaded, a crack will be nucleated (crack nucleation) on a microscopically small scale, this crack then grows (crack growth), then finally complete failure of the specimen. The whole process constitutes the fatigue life of the component in question. Reasonable fatigue prediction for design or analysis can only be done if fatigue is viewed not only as an engineering problem but also a material phenomenon that is a process involving an invisible micro scale crack initiation till a macro scale fatigue failure.

Microscopic investigation in the 20th century has revealed that the nucleation of fatigue cracks occurs at a very early stage of fatigue life. The crack starts as a slip band within a grain. The cyclic slip occurs as a result of cyclic shear stress, this slip leads to formation of slip steps, in the present of oxygen, the freshly exposed surface of the material in slip steps get oxidized, which prevents slip reversal. The slip reversal in this case occurs in some adjacent slip plane, thereby leading to formation of extrusions and intrusions on the surface of the material as shown in the figure below.

Fig. 11 Survey of the various aspects of fatigue of structures

Fig. 12 Formation of intrusion and extrusion marks on the material surface
Fig. 13 Different phases of the fatigue life

Fig. 14 Constant Amplitude load - fully reversed of Original Bracket

Fig. 15 Default co-ordinate system selection (Original Bracket)

Fig. 16 Generation of Mesh (Tetrahedrons) (Original Bracket)
Fig. 17 Fatigue life (Original Bracket)  
Fig. 18 Factor of safety (Original Bracket)  
Fig. 19 Default co-ordinate system selection (Modified Bracket)  
Fig. 20 Generation of Mesh (Tetrahedrons) (Modified Bracket)
VI. RESULTS AND DISCUSSION

The optimization is carried out for the leaf spring bracket\(^{10}\). The results are shown in the form of stresses and the weight for the weight reduction purpose. The deformation is shown in the leaf spring bracket while 1571N load is applied on both sides of the bracket and equivalent stresses are induced in the leaf spring bracket. A fatigue analysis is carried out for the leaf spring bracket. The results are shown in the form of fatigue life (No of cycles), Alternating stress, factor of safety and the shape finder for the weight reduction purpose. A fatigue life and alternating stress is same for both parent and optimized leaf spring bracket while 1571N load is applied on both sides of the bracket.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters</th>
<th>Value of Parent Bracket</th>
<th>Value of Optimized Bracket</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Total Deformation</td>
<td>0.00819mm</td>
<td>0.00804 mm</td>
<td>0.00015 mm</td>
</tr>
<tr>
<td>2.</td>
<td>Equivalent Stresses (Von-Mises)</td>
<td>58.867 Mpa</td>
<td>59.421 MPa</td>
<td>0.554 MPa</td>
</tr>
<tr>
<td>3.</td>
<td>Factor of Safety</td>
<td>4.246</td>
<td>4.2073</td>
<td>0.0394</td>
</tr>
<tr>
<td>4.</td>
<td>Mass of Bracket</td>
<td>0.553kg</td>
<td>0.522kg</td>
<td>0.031kg (31gm)</td>
</tr>
<tr>
<td>5.</td>
<td>Fatigue life (no of cycles)</td>
<td>1.e+006</td>
<td>1.e+006</td>
<td>NA</td>
</tr>
</tbody>
</table>
VII. CONCLUSION
From the existing analysis of bracket which is having 553gm of weight, with its original dimensions and after optimization the modified bracket having weight of 522gm. The weight reduction between existing brackets to modified bracket is 30gm. This modified leaf spring bracket achieved the same strength as compare to existing bracket. It also sustains the same existing bracket load and stress which acts on it. Some deflection is occurs in both modified and without modified bracket. This also reduces required material from existing bracket, so, material cost of modified bracket is reduced with as compare to existing bracket. The material of bracket is removed by using the evolutionary structural optimization method. This material is removed from where the minimum stress is induced or occurred. CATIA part is designed and optimized by using the ansys software. Fatigue life and fatigue stress is same in both cases. The modified leaf spring bracket is achieved the some static conditions of existing leaf spring bracket. The modified bracket is achieved the better strength and results, as well as maintain the same factor of safety. So the modified bracket is safe or static stability.
REFERENCES


