TOPOLOGY OPTIMIZATION OF LEAF SPRING BRACKET FOR LIGHT DUTY VEHICLES

Design, Analysis and Optimization

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Abstract: The suspension system plays very important role in automobile engineering. It carries the vehicle weight at static condition and it subjected to various load condition while vehicle travelling or in moment. It feeds smooth travelling motion to driver and passenger. A leaf spring bracket is main part used to sustain the load or any attachment pair which is fixed to chassis. It is attached by bolted or rivet joint to the chassis with subjected to various shock and load condition, but static load is mostly affect of bracket to increase the stress and chances of failure there is need to minimize failures and stress concentration of bracket it is most effective by failure analysis. A support load to structural element used now in automobile field increases demand of optimized and sustainable product. A load spring bracket is used to support load which is fixed chassis to sustain the load for vehicle.

***Keywords*: L**ight Duty Vehicle, Bracket, Mild Steel, FE Model, CATIA, ANSYS, Deformation, Stress, Hyper mesh.

I. INTRODUCTION

Now a days in automobile field increase the demand of atomized product with having sustainable capacity and different high functionality. There is 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 suspension system is required for produce smoother travelling experience to driver and passenger convenient ride and greater shocks absorptive with several road conditions.
Mounting bracket plays most important role in suspension system. The leaf spring bracket used to support load which is fixed to chassis to sustain several load condition for vehicle suspension system consist leaf spring, brackets, U-bolt, rods. Etc.
This leaf spring is attached to the chassis with bracket. This bracket having high load sustain capacity and shocks absorptivity at various road conditions. Bracket places at end leaf spring. There is required to increase the capability of bracket for several functions with less weight. Since the topolo0gy 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.
3. Structural 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/m^3

STRESS ANALYSIS OF EXISTING BRACKET-

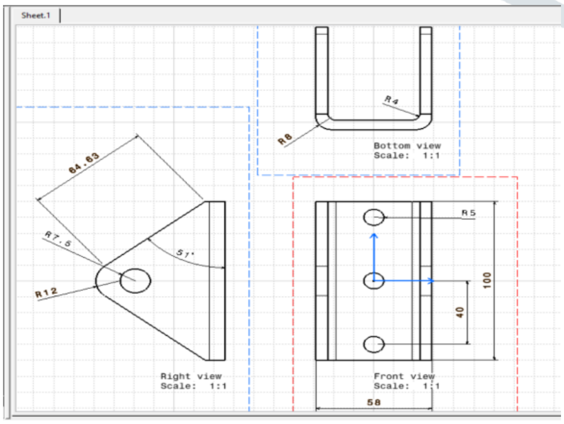


Fig.1 Catia Drafting

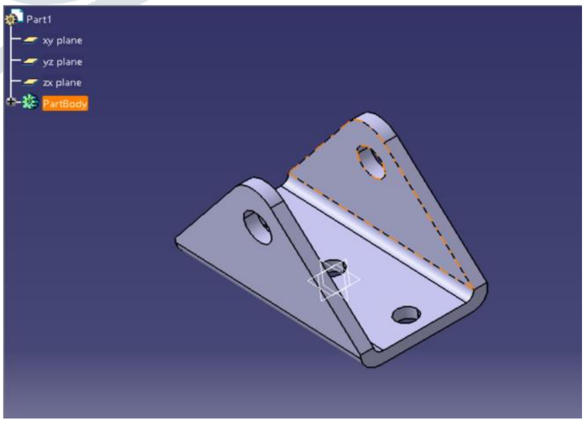


Fig.2 Catia Part Model

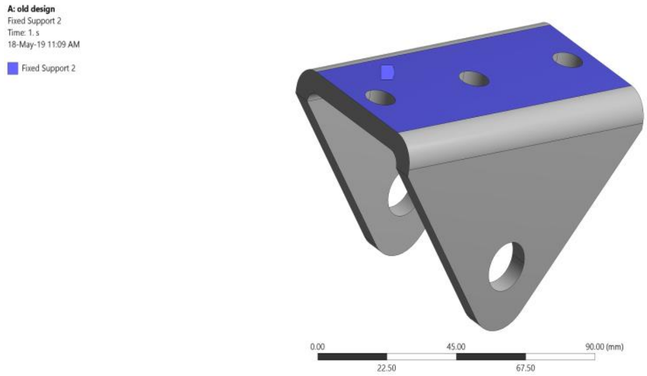


Fig.3 Fix Support of Bracket
Boundary Conditions should be fixed, as top surface with DOF in direction x, y, & z =0

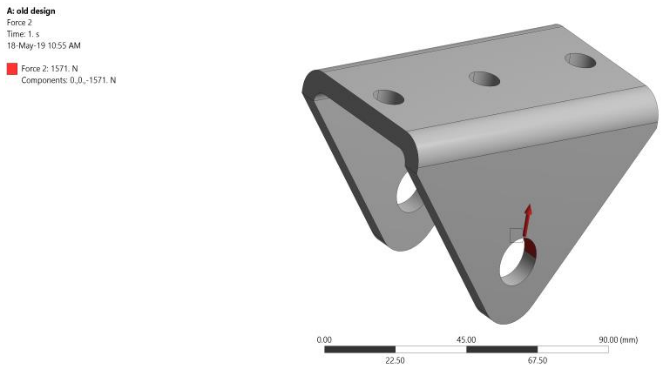
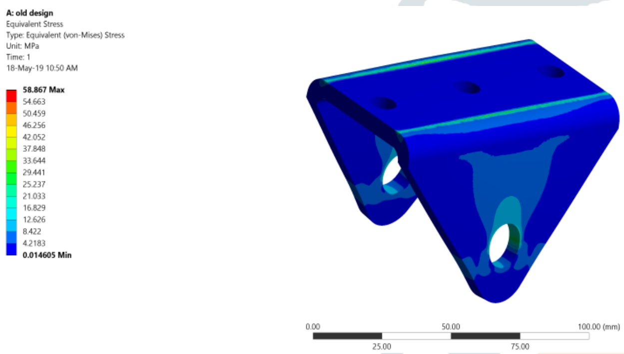


Fig.4 Applying Load Condition
Force acting on the bracket inside the hole in Z-direction as -1571N



Article I.

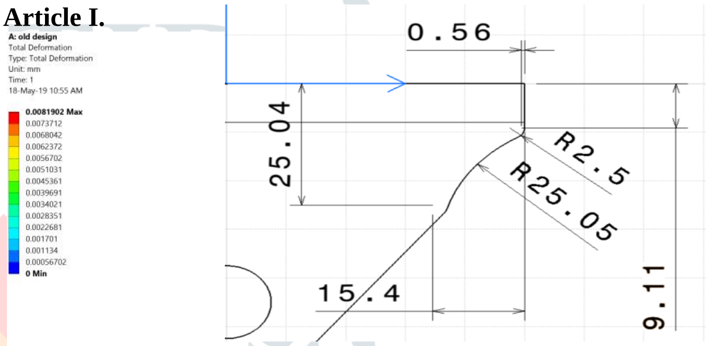


Fig.5 Equivalent Stress (Von-Mises) of Parent Model

Fig.6 Total Deformation of Parent Model

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-
  By considering top right corners as a origin-
  - 1st point co-ordinates (x, y) = (0.5, 9.0)
  - 2nd point co-ordinates (x, y) = (15, 25)
  - Radius of arc R= 25.05mm

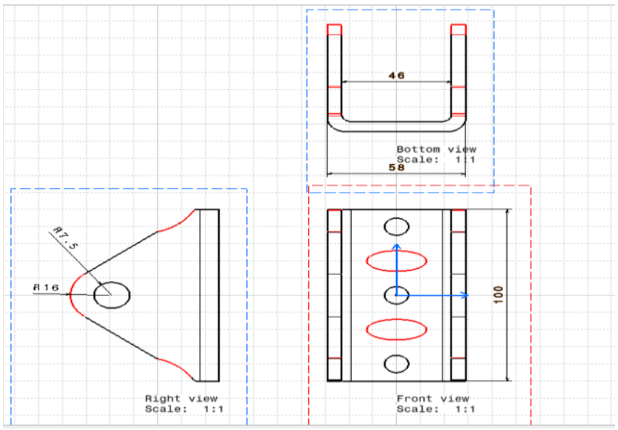


Fig.7 Drafting of Modified Bracket

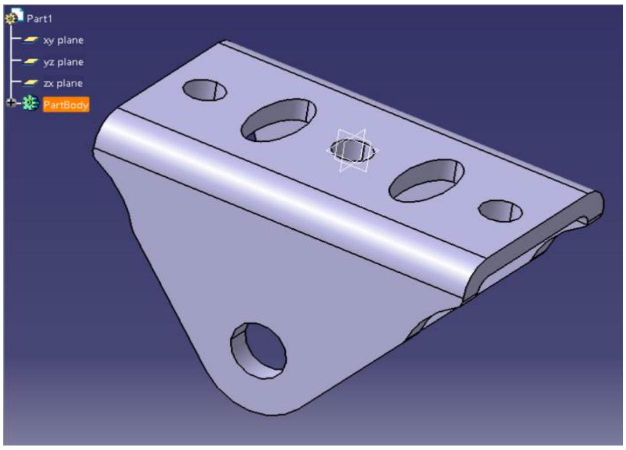


Fig.8 Modified Catia Part Model

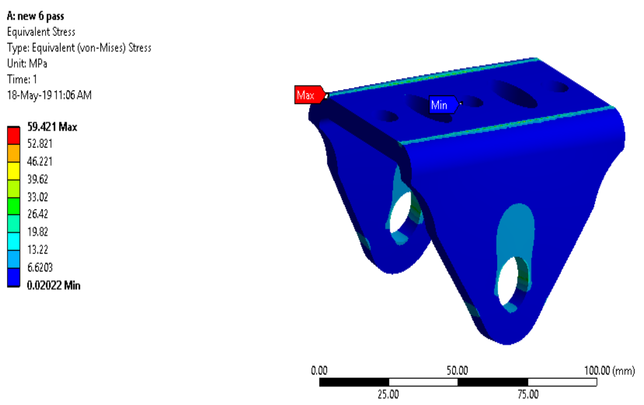


Fig.9 Equivalent Stress (Von-Mises) Of Modified Model

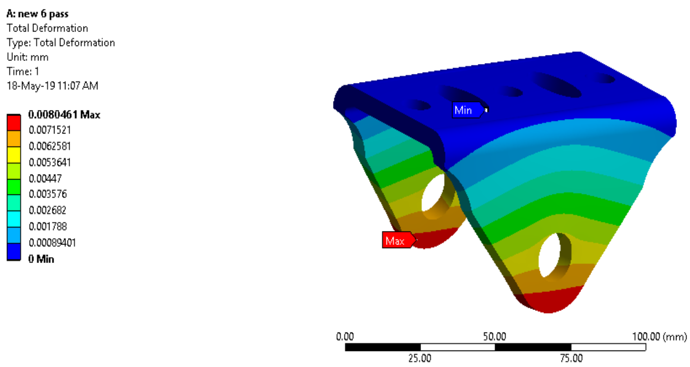


Fig.10 Total Deformation Of Modified Model

V. RESULTS AND DISCUSION-

The optimization is carried out for the leaf spring bracket. 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.

Table No.1 Comparison of Result Table

Sr. No.	Parameters	Value of Parent Bracket	Value of Optimized Bracket	Difference
1.	**Total Deformation**	0.00819mm	0.00804 mm	0.00015 mm
2.	**Equivalent Stresses (Von-Mises)**	58.867 Mpa	59.421 MPa	0.554 MPa
3.	**Factor of Safety**	4.246	4.2073	0.0394
4.	**Mass of Bracket**	0.553kg	0.522kg	0.031kg (31gm)

VI. 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. 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 actor of safety. So the modified bracket is safe or static stability.

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