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DESIGN ANALYSIS & OPTIMIZATION OF AUTOMOTIVE ENGINE MOUNTING BRACKET

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Abstract— Due to increasing global competitive market, automotive designs are pushed to the limits to decrease the cost and at the same time increase the stiffness to mass ratio and performance. Above all, the biggest constraint has been to achieve all these with reduced design time. Optimization techniques are useful in validation and optimizing the design to get new size and shape. These techniques surely will reduce the design time, when compared to the experimental testing. In this project an Automotive engine mounting bracket is selected for analysis; there will be four mounting brackets to mount the engine on chassis. This is a very important component as the product market life is reducing and there is a need to get more new and better designs with less time to decrease the cost and at the same time increase the stiffness to mass ratio and performance. In this project I have reduced the mass in 0.34kgs per component and as per the cost wise in the year 375000 Rupees saved.

Keywords— FEM,Egine mounting Bracket, Design, Analysis, Mass, cost

I.INTRODUCTION

The automobile industry is one of the most important industries in the world, affecting not only the economy but also the cultures of the world. The auto industry has reduced the overall cost of transportation by using methods such as mass production (making several products at once, rather than one at a time), mass marketing (selling products nationally rather than locally), and globalization of production (assembling products with parts made worldwide). Between 1886 and 1898, about 300 automobiles were built, but there was no real established industry.
Automotive engine brackets in automobiles are used to support and fix the engine. This mounting brackets are mostly manufactured with the materials which are having high toughness to sustain fluctuating loads of the engine. And these materials also should have high weldablity. These brackets manufactured by metal based alloys and composite materials with high strength. Nowadays Automobile components are flooded with revolutionary and improved engine brackets made from different materials like aluminum, polypropylene, fiberglass, mild steel, and stainless steel.
The design of an engine mounting brackets involves the following considerations: (1) location of engine center of gravity (C.G.) and its orientation, (2) location and orientation of individual mount, (3) selection of stiffness coefficients of each mount.

1.1 Process Methodology

Topology optimization is a method which distributes the density of an initially homogenous volume to achieve a certain objective function while observing the defined constraints. Drawback of the traditional design method is the fact that engineers tend to think intuitively. Sometimes the optimum solution can be quite counterintuitive, and thus a great solution can go justifiably overlooked because it does not seem plausible or reasonable. Minimize volume is usually considered as an objective function, while the stress acts as a constraint and with manufacturing constrain such as draw direction. Topology optimization is often used in the early design process to define the optimum part layout.
The optimized models performance in the form of stiffness and strength evaluation is done and parametric study is carried out using Hyper Study according to fulfill the design and testing standard values. Initially it needs to collect the information regarding different loads acting on the bracket and the packaging data for fixing design space. The base bracket results from testing and finite element analysis (FEA) point of view for evaluating final optimized design

II.DESIGN OFAUTOMOTIVE ENGINE MOUNTING BRACKET

Unigraphics (UG NX 9.0).is used to create the 3-D modeling of automotive engine mounting Bracket. The automotive engine mounting Bracket is provided with three holes for mounting the engine and on the other side, there is one hole provided which is fixed to the body frame and the load is applied on this hole as shown in fig.2.1. The design of the mounting bracket was done in 3 different shapes to analyse for which the optimum values are obtained.
After the design of automotive engine mounting bracket in Unigraphics (UG NX 9.0) it is converted to the file formats such as STEP, IGES which are essential for importing in to the other meshing software like Ansys and Hypermesh.And the anlysid of the bracket has been done.

The material used to made the automotive Engine Mounting Brackets Alloy steel because of its high strength and high specific heat capacity. The material is applied to each of the models and their corresponding weight is calculated. The density of Alloy steel is taken to be 8.2 g/m^3.

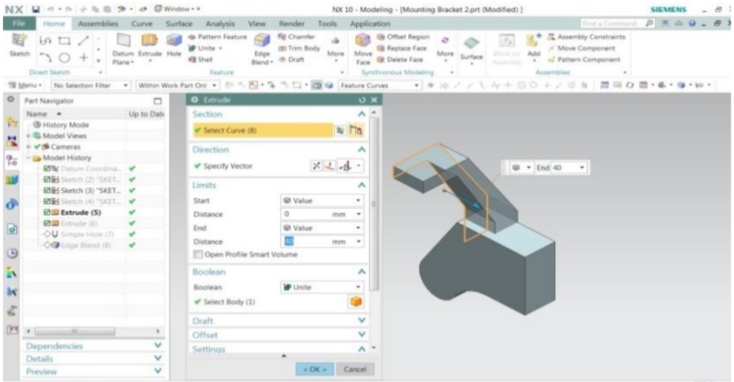

Fig 2.1 Design of Automotive Engine Mounting Bracket (NX CAD)

III.ANALYSIS AND RESULTS

After preparing the models of Automotive Engine mounting in Unigraphics they are taken in to the Ansys software in which the meshing and analysis are done on the mounting bracket and preprocessed for solving the problem by applying the material properties and loading conditions etc. as shown in fig.3.1

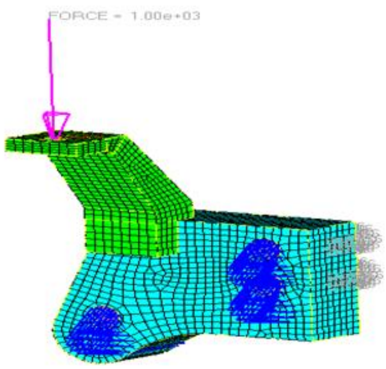

Fig 3.1 Applying Analysis on Engine Mounting Bracket

The analysis has been done by applying different loads on the Automotive engine mounting bracket. The weight of the engine mounting bracket has been changed by changing the shape of the mounting bracket. And the analsys for different weight is as shown below figures .

3.1 Results Before Optimisation

3.1.1 Displacement

From structural analysis, deformation of the automotive engine mounting bracket has been found by applying loads and boundary conditions before optimization, the Total Deformation of the bracket is 0.866m this has indicated in red color as shown in below figure 3.2

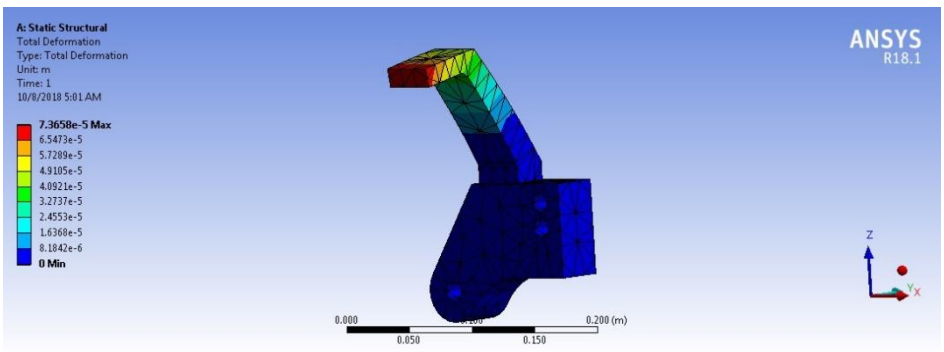

Fig.3.1.1 Deformation in the bracket before optimization

3.1.2 Stresses

The maximum principle stresses in the Automotive engine mounting bracket by applying loads and boundary conditions before optimization, The maximum principle stress of the bracket is 82.12N/mm^2 this has indicated in red color as shown in below figure 3.3

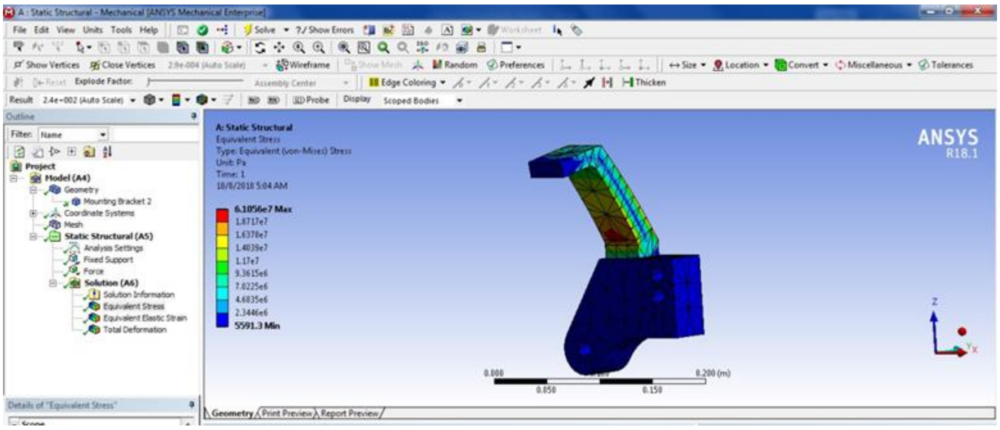

Fig 3.1.2 Maximum principle stresses in the automotive mounting bracket before optimization

3.2 Results after Optimization(changing the shape)

3.2.1 Displacement

Case 1: the weight of the mounting bracket has been reduced by 0.42kg by removing some material in the mounting bracket, The displacement of the mounting bracket is as shown in the below figure 3.2.1.After applying the loads on the bracket it tends to fail as the material is removed to reduce the weight of the bracket and hence the bracket has not able to withstand for applied loads as shown below fig 3.2.1

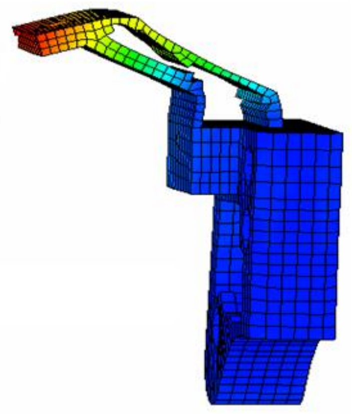

Fig.3.2.1 Displacement of the bracket after reducing the weight of 0.42kgs

Casw 2: the weight of the mounting bracket has been reduced by 0.50kg by removing some material in the mounting bracket, The displacement of the mounting bracket is as shown in the below figure 3.2.2.After applying the loads on the bracket it tends to fail as the material is removed to reduce the weight of the bracket and hence the bracket has not able to withstand for applied loads as shown below fig 3.2.2

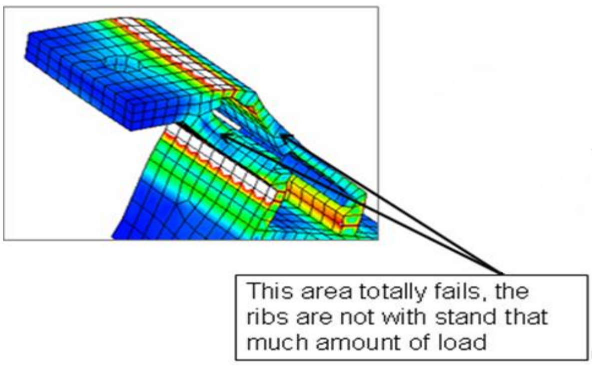

Fig 3.2.2 Displacement of the bracket after reducing the weight by 0.50kg

Case 3: the weight of the mounting bracket has been reduced by 0.34kg by removing some material in the mounting bracket, The displacement of the mounting bracket is as shown in the below figure 3.2.3. the maximum displacement of the mounting bracket after optimization by applying loads and boundary conditions, is 0.357 mm, for this the removal of material is very less and hence the bracket is withstand the loads applied on it.

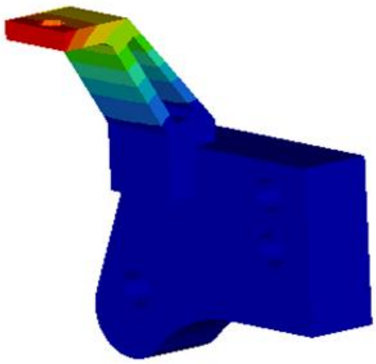

Fig 3.2.3 Displacement of the bracket after optimizing the weight by 0.34kg

3.2.2 Stresses

Case 1: By removing the material, the weight of the mounting brakcte has reduced by 0.42kg.The stress in the bracket is as shown in the below figure. The stress obtained after applting loads on the mounting bracket as indicated in red color and is 115 N/mm^2. For this weight bracket has tend to failed under applied load because the material saving is more but the component cannot be with stand as shown in figure 3.2.4.

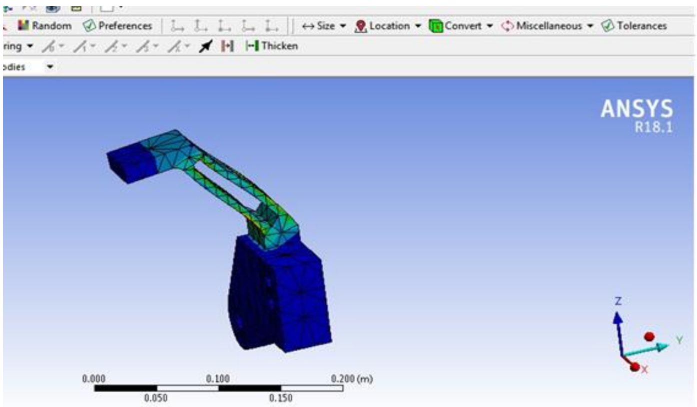

Fig 3.2.4. Stress in the mounting bracket after removing weight of 0.42kgs

Case 2: By removing the material, the weight of the mounting brakcte has reduced by 0.50 kg.The stress in the bracket is as shown in the below figure. The stress obtained after applting loads on the mounting bracket as indicated in red color and is 121 N/mm^2. For this weight bracket has tend to failed under applied load because the material saving is more but the component cannot be with stand as shown in figure 3.2.5.

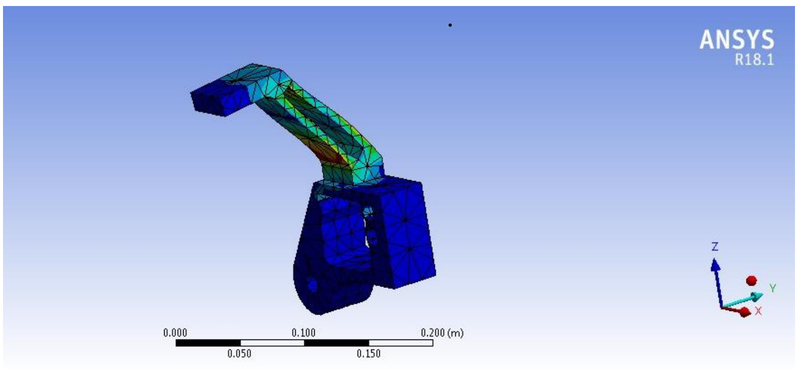

Fig 3.2.5. Stress in the bracket after reducing the weight of 0.45kg

Case 3 : By removing the material, the weight of the mounting brakcte has reduced by 0.34kg.The stress in the bracket is as shown in the below figure. The stress obtained after applting loads on the mounting bracket as indicated in red color and is 85 N/mm^2, in this case the material is saved by 0.34kg and also the component can be with stand to applied loads as shown in below figure 3.2.6.

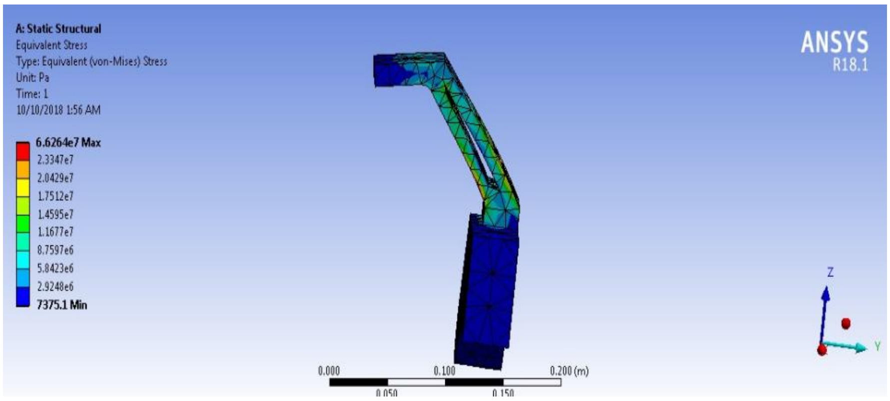

Fig 3.2.6. Stresses in the bracket after reducing weight of 0.34kg

IV.CONCLUSION

By observing the all the above cases, one can know that the case-3 is more suitable for automotive engine mounting bracket because it can to withstand the loads applied on it, results obtained after topology optimizations are: Stress is 85 N/mm^2 and displacement is 0.357 mm, the cost of the bracket also saved By optimizing the weight of the mounting bracket.

From the above results one can says that Optimization of the Automotive Engine mounting bracket is done by changing the weight of the bracket by removing material and also it can reduce the cost of the material by reducing the weight of the bracket.

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