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Design & Analysis of Cabin Mounting Bracket

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Abstract : Today automobile sector is one of the largest growing technological fields and which is continuously striving for weight reduction of vehicles as the today's major need of fuel economy and emission reduction demands it. To reduce weight engineers have either to search for better and better materials or to do the optimization. Out of various structural optimization techniques like size, shape & topology optimization, application of Topology Optimization (TO) in automotive structure design is overviewed in this project and using Evolutionary Structural Optimization (ESO) method driver cabin mounting bracket of a heavy commercial vehicle is optimized here. With the objective of mass reduction and compliance minimization topology optimization is performed using Catia tool.

1.INTRODUCTION

An Automobile is a self-propelled vehicle which is used for transportation of goods and passengers. The motor vehicles, both passengers' car and trucks are generally considered to be made up of two major assemblies: Body and Chassis. Chassis is a frame or main structure of a vehicle. The chassis contains all the major units necessary to propel the vehicle.Their weight will be mainly on the floor where it should withstand many loads coming from different ways in different directions. This makes the driver seated without any vibrations and distractions. The aim of weight reduction without compromise in strength can also be fulfilled by the optimization technology (along with material variation), structural optimization plays vital role in it. There are about three important methods of structural optimization; Sizing, Shape and Topology Optimization (TO). At various design stage these can be used separately or in combination to optimize the structural component. Sizing optimization keeps the original shape of the component while it changes the size of it as per the space constraints available. Shape Optimization has the freedom in the shape alteration but in the given size only. Whereas, Topology Optimization (TO) is a scientific method of finding best material layout in the given set of constraints. It changes the density of the structure (not the material density) and reduces the unwanted material from the structure for specific boundary and load conditions. Various software packages like Ansys 18.0 and above, Altair Optistruct etc. are available today for the assistance.

1.1 Problem Statement

The objective of this work is to newly design an existing component and compare out best material and most suitable design assembly with the constraints of maximum shear stress, equivalent stress and deflection of the bracket under different load condition. The problem to be dealt with for this work is that, the mounting bracket thickness should be optimized for its minimum weight and also be taken care that stress should be below yield stresses. In India no of trucking is done, with 24 hours of running with uneven and worst road conditions due to which there are always possibilities of being failure/fracture in the mounting bracket. Therefore brackets with high strength cross section is needed to minimize the failures including factor of safety in design.

1.2 Scope

Automobile sector is one of the largest branch of mechanical engineering industry. It consumes a lot of fuel while transporting goods and people from one place to other by road. Reducing automobile weight for better economy is the challenge industry faces right now. Project work is focused on design and weight optimization of HCV truck's front Cab mounting bracket. Study will be focused on finding alternative design or material for cab mounting bracket of the truck. So main scope for the project is: To obtain more strength from the bracket after optimization by means of design. To maintain the cost and better safety design. To obtain design stability with superior material performance.

2. Literature Review

Many research scholars have studied and proposed various methods of Topology Optimization for optimizing different structural components of automobile since longer time. They have found topologas very effective and powerful tool for structural optimization. The primary purpose of many experiments is found to be weight reduction. Topology Optimization is becoming more important instructural design which also can solve multiple loading condition problems. Basic formulation of TO problem can be found in SAE paper.

[1] Mayur Jagatap and Ashvin Dhoke,
Two CAE engineers from TechMahindra have used Altair Optistruct as tool for design and optimize cast iron Exhaust mounting bracket. Topologically Optimized design was finalized based on manufacturing feasibility and other practical constraint. They have achieved 45% mass reduction and 50% of design cycle time and without compromising in strength and fatigue life criteria. In future they are going to consider shape optimization for design.

[2] Y. S. Kong, S. Abdullah, M. Z. Omar and S. M. Harisin
Their paper published in LAJSS (2016), have ptimized automotive Spring Lower Seat using topological and topographical techniques. In their work 36.5% mass reduction and 27% compliance increase was achieved.

[3] Subhash Sudalaimuthu, Barry Lin, Mohd. Sithik and Rajiv Rajendramin
Their SAE International. Paper (2016) have explained process of designing lightweight track bar bracket right from the scratch. Design of Experiments (DOE) and topology optimization is used to decide bolt location and critical load path and followed shape optimization to finalize the shape.

[4] Suresh Kumar Kandreegula, Naveen Sukumar, Sunil Endugu and Umashanker Gupta
Published a SAE International paper in 2015 in which they have provided a forum to present new developments in structural Non-linear topology optimization. By this method structural optimization on irregular design domains can be carried out easily. Transmission Housing has been optimized using Non-linear Topology Optimization technique with the help of Simulation tool Altair OptiStruct & verified experimentally. They achieved cost reduction without sacrificing performance & safety.

2. Selection Of Material

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The Choice of material for engineering purposes depends upon the following factors:

1. Availability of the materials.
2. Suitability of materials for the working condition in service.
3. The cost of materials.
4. Physical and chemical properties of material.
5. Mechanical properties of material.

3. Material for New Bracket

New Material Details: CARBON FIBRE2

Properties:-

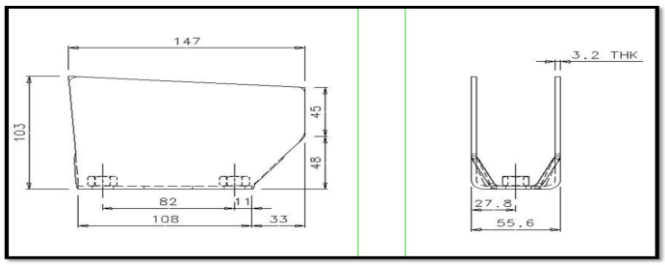
1. High Strength to weight ratio
2. Rigidity
3. Corrosion resistance
4. Electrical Conductivity
5. Fatigue Resistance
6. Good tensile strength but Brittle
7. Fire Resistance/Not flammable
8. High Thermal Conductivity in some forms
9. Low coefficient of thermal expansion
10. Non poisonous

New Material Details: ALUMIUM/EN8

Properties:-

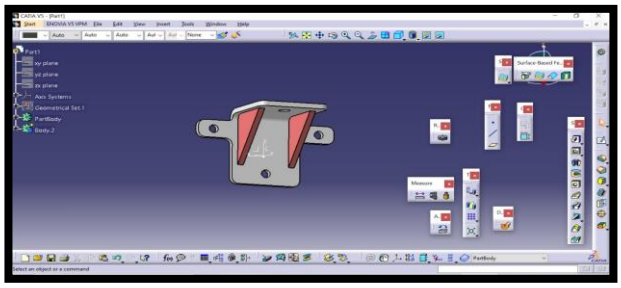
- EN8 carbon steel is a common medium carbon and medium tensile steel, with improved strength over mild steel, through-hardening medium carbon steel. EN8 carbon steel is also readily machin- able in any condition. EN8 steels are generally used in the as supplied untreated condition.
- Steel EN8 materials in its heat treated forms possesses good homogenous metallurgical structures, giving consistent machining properties

4. Design of Existing Bracket



5. Design of New Bracket

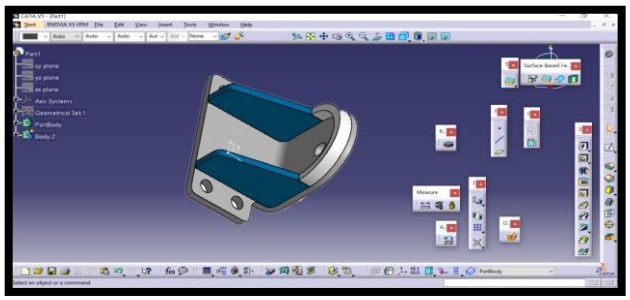
A. Concept 1



Software Used: CATIA V5

- Three point mounting to chassis
- Highlighted black lines welding line
- White bracket : Single part Main chassis mounting bracket
- Red Ribs : Ribs welded on white color bracket

B. Concept 2



Software used: CATIA V5

- Four point mounting to chassis
- Highlighted black lines welding line for ribs to bracket
- Grey color Main chassis mounting bracket : Single part
- Blur color rib : Ribs welded on grey bracket
- White rib: Rib welded on grey bracket

6. CONCLUSIONS

Design and analysis of the cabin mounting bracket for steel and other suitable materials are in process.With objective of mass, stress and weight reduction this work was started. Catia V5 is used for designing and creating models. During research work various boundary conditions were studied and one selected applying general technical logics. On the basis of selected one further work was continued.Cost of the Mounting bracket remains same when the optimized design compared with Existing Design. However the safety of optimized design is increased. Weight of the both the Optimized design and Existing Design is same. From the dynamic point of view the amplitudes are well within limits, hence the design is safe for the dynamic stability. Results will be validated using experimental analysis for static and modal values. Further extension for this work will be validating fatigue values and using this technique for other automobile structural components to reduce overall weight of the vehicle and ultimately increasing the fuel economy, reducing emissions, etc.

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