International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

Design Analysis and Optimization of Engine Mounting Bracket

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Abstract - *Engine mounts themselves are small parts that are meant to stabilize, as well as properly align, a vehicle's engine. So, even though these mounts are small, they play a large role in the overall functionality of the heart of your vehicle. Moreover, when these supposedly small and minor aspects of the vehicle go bad. An automotive engine-body-chassis system is typically subjected to unbalanced engine forces, uneven firing forces especially at the idling speeds, shaking forces and torques due to reciprocating parts, dynamic excitations from gearboxes and accessories, and road excitation. These tendencies give rise to undesired vibrations which lead to an uncomfortable ride and also cause additional stresses in the automobile frame and body.*

Brackets plays a vital role when the vibrations are produced it helps engine to maintain a static hold so their far no failure should occur and also while accidents take place it protects them from major damage. If engine brackets are not provided vibration takes place and may fail engine while driving the vehicle. This paper helps in studying the fatigue life and free body analysis of engine at different materials and also optimization to reduce the mass and weight too.

Key Words: Engine Mount, Optimization of Bracket, Static Structural Analysis of Bracket

1. INTRODUCTION

In this automotive era the need for light weight structural materials is increasing as there is a more focus on fuel consumption reduction and improvement in decreasing the emission. The magnitude of production volumes has traditionally placed severe requirements on the robustness of process used in the manufacturing. The manufacturers have strong importance on the cost has the demand for the component to improve the material performance and to deliver these materials at low cost is the requirement.
In automobile sector the extremely competitive automotive business needs manufactures to pay a lot of attention to travelling comfort. Resonant vibration is from unbalanced masses exist within the engine body; this is causing the designers to direct their attention to the event of top-quality engine mounting brackets so as to confirm that there is improvement in riding comfort. The demand for higher play-acting engine mount brackets should not be offset by arise within the production prices and/or development cycle time. In diesel engine, the engine mounting bracket is the major problem as there is unthrottled condition and higher compression ratio and even there are more speed irregularities at low speed and low load when compared to gasoline engines. So due to this there are more vibration excitation. By this vibration engine mount bracket may fail, so by optimizing the shape and thickness of engine mount bracket we can improve the performance at initial design stages. By some studies it is observed that brackets saved 38% of mass. Structural optimization is an important tool for an optimum design; comparison in terms of weight and component performance structural optimization techniques is effective tool to produce higher quality products at lower cost.

2. Literature Review

Umesh S Ghorpade[1] In this paper they have designed engine mount bracket of a car and focused on to determine natural frequencies of car engine mount bracket. They have considered the three materials for engine mount bracket that is aluminum alloy, magnesium alloy, gray cast iron when modal analysis is carried out, it is found natural frequencies of gray cast iron is low which will prove more hindrance in vibration of engine mount bracket so they have eliminated gray cast iron, in terms of analysis aluminum alloy and magnesium alloy are showing almost near value of natural frequency in practical terms as magnesium alloy is having better strength that is low stress value, so preferably magnesium alloy is selected as better material by study.

Mr. Pramod Walunje[2] In this work they have mainly focused on the use of light weight material for bracket and also to reduce the weight of the bracket. Here the weight of the material is reduced and preprocessing and post processing is carried out and even with this an experimental setup is also used to find the stress level of the materials they have observed that aluminum alloy have good natural frequency and stresses are also within the yield strength, so by considering the aluminum and reducing its thickness further by 2mm than original component, they found that now von misses stresses are also with in yield stress so they have achieved reduction in the mass of bracket up to 0.43kg when compared to previous one.

P.D. Jadhav[3] This work is a contribution to the development of new material for engine mounting bracket. The results obtained for the static structural and modal analysis have shown that the magnesium is better than aluminum. From the results it can be seen that the magnesium bracket is safe for the required application. It will help in decreasing the weight of the power train assembly, which can increase fuel efficiency

Sagar V. Birari[4] Design and Analysis of Engine Mounting Bracket Engine mounting bracket plays very significant role in reducing noise, vibration and harshness caused due to engine and thus has very effective role in improving vehicle comfort. This current work accounts for the investigation of engine mounting bracket by using Hyper mesh and Opti struct approach. Static analysis of engine mounting bracket was done in order to check design of existing and modified bracket. The results were analysed for stresses and deformations. The design was tested for different design of Mild Steel with different thickness. From Design and analysis, it is considered that stresses induced in the bracket were 262.00 Mpa and deformation 9.5 mm. It can be anticipated that modified brackets can be considered for desired application.

Mr. Sagar B. Awate[5] Experimental Validation & Testing of Brake Chamber Mounting bracket Experimental validation & testing is one of the important parts in design finalization. Now a days advances software's are developed to virtually test & validate the design of component but still physical validation & testing is necessary in order to check reliability, maintainability, performance of the designed component. This paper is about, physical validation & testing of newly designed brake chamber mounting bracket.

Jasvir Singh[6] Design of Engine Mount Bracket for a FSAE Car Using Finite Element Analysis Engine mounts have an important function of containing firmly the power-train components of a vehicle. Correct geometry and positioning of the mount brackets on the chassis ensures a good ride quality and performance. As an FSAE car intends to be a high-performance vehicle, the brackets on the frame that support the engine undergo high static and dynamic stresses as well as huge number of vibrations.

Rajath J K[7] Dynamic Response Analysis of Compressor Mounting Bracket of an Automobile Vehicle for Aluminum 6061T6 The compressor plays a vital role in the air conditioning system of an automobile. The compressor mounting bracket is a rigid structure which is used to mount the compressor to the engine. Design includes modelling of the bracket by considering all the constraints. Analysis comprises of normal modes analysis and frequency response analysis for aluminium 6061T6. The aim of this work is to find the natural frequency of the bracket for the self-weight by modal analysis and the stresses induced in the bracket due to external excitation by frequency response analysis using FEA method. The analysis is performed using ABAQUS tool and the results are interpreted.

Tushar P. Kamble [8]Optimization & Modal Analysis of Engine Mounting Bracket for Different Materials by Using Finite Element Analysis The Engine in the vehicle is one of the most important components of on road vehicle such as car. High performance sports car has their engine component supported by the mounting bracket to its chassis frame. It plays a very much important role in improving the comfort & work environment of a car as well as the engine component. The improvement of the engine bracket system has been the subject of intense interest for many years. It is required to design the proper engine mounting bracket for a road vehicle.

Sahil Naghate[9]Modal Analysis of Engine Mounting Bracket Using FEA The engine mounting plays an important role in reducing the noise, vibrations and harshness for improving vehicle ride comfort. The first and the foremost function of an engine mounting bracket is to properly balance the power pack (engine &transmission) on the vehicle chassis for good motion control as well as good isolation. Present work deals with FEA analysis of engine mounting bracket. It includes the modeling of the engine mounting brackets by changing the material of component.

Lv Lin[10] Strength Performance Analysis and Improvement of Engine Mounting Bracket for a Commercial Vehicle With the rapid development of the automotive industry and the increasing demand of consumers for the quality of automotive products, improving the reliability of automotive products has become the "top priority" of enterprises. While improving the reliability level of engine mounting bracket for commercial vehicles, it can not reduce the mechanical strength performance of the structure

A.S.Adkine[11] Static Behaviour of Engine Mounting Bracket In an automotive vehicle, the engine rests on brackets which are connected to the main-frame or the skeleton of the car. Hence, during its operation, the undesired vibrations generated by the engine and road roughness can get directly transmitted to the frame through the brackets[1]. This may cause discomfort to the passenger(s) or might even damage the chassis. When the operating frequency or disturbance approaches the natural frequency of a body, the amplitude of Vibrations gets magnified. The first and the foremost function of an engine mounting bracket is to properly balance (mount) the power pack (engine & transmission) on the vehicle chassis for good motion control as well as good isolation[2]. The need for light weight structural materials in automotive applications is increasing as the pressure for improvement in emissions and fuel economy increases.

Dipali T. Bendarkar Design and Weight Optimization of Fuel Tank Mounting Bracket for HCV 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. This work is aimed at on design and weight optimization of HCV fuel tank mounting bracke

3. PROBLEM STATEMENT

Engine mounting bracket is one of the main considerations while the vehicle is running when the vehicle dis-passes from the road brakers there may be a chance of

displacement in the engine due to high vibrations. To make it rigid or hold it this project helps in various considerations.

The present design was developed for the test rig of bh4 engines for the attempt same bracket was use for bh6 engine too. But unfortunately, the design failed due to overloading and engine vibration so new design is needed for the test rig with 1252.5 N approx. loading condition.

4. OBJECTIVES

1. To design and manufacture air cooler.
2. Modeling current bracket.
3. Analyzing for stresses and deformation.
4. To keep the mounting condition as reference and design a new bracket which can sustain the condition.
5. Analysing for stresses and deformation.
6. Experimental testing and correlating results.

5. METHODOLOGY

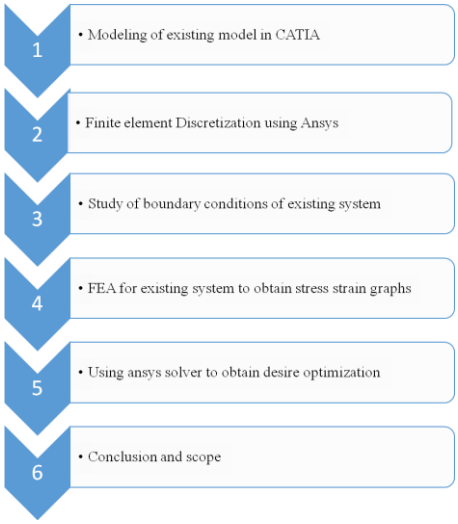


Table: Methodology

6. Requirement of Engine Mounting Bracket

The mounts can cause a variety of problems for your vehicle.

1. Engine Vibration: The first symptom to note is an excessive amount of engine vibration. Because motor mounts are meant to keep an engine secure, bad mounts will lead to an insecure engine that will bounce about. At times, there may be a sound emitting from the engine hinting of vibration, however, the more common symptom is a felt vibration on the passenger's side. If you do not often have visitors sitting on the passenger's side that can tell you something is wrong, place your hand on the passenger's seat from time to time to check for excessive vibration.
2. Misalignment: Securing a motor not only fastens an engine, but aligns it, meaning that the engine's height is ensured to be equal on all sides. If the motor mounts are in fact bad, the engine will sag and droop to one side. Again, there may be noises emitting from the engine that do not sound quite right. Inspect the engine to see if it is tilted. If so, your mounts aren't doing their job.
3. Engine Damage: The third symptom is an extreme case. If motor mounts break off completely from an engine, and are not just loose or cracked, an engine can shift from one side to another, bouncing about. This presents a safety hazard if you are driving your vehicle in high speeds; the engine may shift and bounce about so violently that various parts will fly off.
4. Broken Belts and Hoses: Besides indirectly breaking engine parts, bad mounts can lead to damaged belts and hoses. Again, these various engine fan belts and radiator hoses will be damaged only during high speeds.
5. Excessive Noise: Earlier symptoms include parts that are simply not working, from engine parts to belts and hoses. However, the most common symptom is just excess noise. Note any knocking or clanking, as this general noise means something is wrong. It may mean one of the previous symptoms, or something completely new, but regardless of what the problem is, it means that you know something is wrong and to take your vehicle in for repairs immediately.

6. DESIGN CONCEPT

There are two types of 3D Solid Modeling

1. Parametric modeling allows the operator to use what is referred to as "design intent". The objects and features created are modifiable. Any future modifications can be made by changing how the original part was created. If a feature was intended to be located from the center of the part, the operator should locate it from the center of the model. The feature could be located using any geometric object already available in the part, but this random placement would defeat the design intent. If the operator designs the part as it functions the parametric modeler is able to make changes to the part while maintaining geometric and functional relationships.
2. Direct or Explicit modeling provide the ability to edit geometry without a history tree. With direct modeling, once a sketch is used to create geometry the sketch is incorporated into the new geometry and the designer just modifies the geometry without needing the original sketch. As with parametric modeling, direct modeling has the ability to include relationships between selected geometry (e.g., tangency, concentricity).

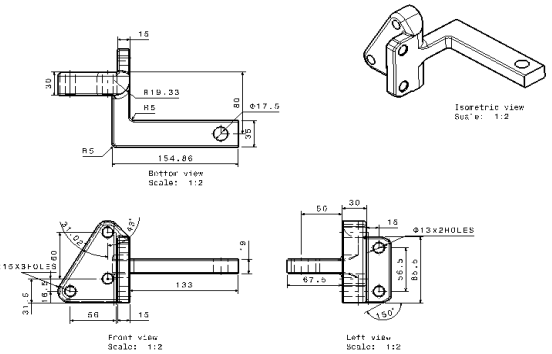


Figure1: Drafting of Engine Bracket

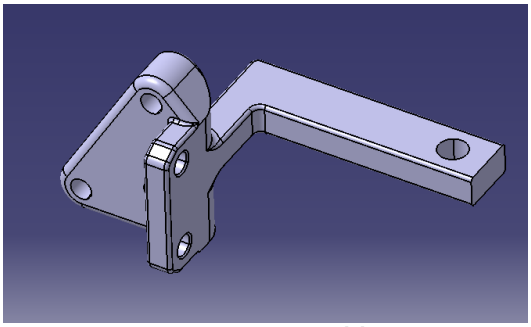


Figure2: CATIA model

8. STATIC STRUCTURAL ANALYSIS THROUGH FEA

Mesh Generation:

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient multiphysics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

Creating the most appropriate mesh is the foundation of engineering simulations. ANSYS Meshing is aware of the type of solutions that will be used in the project and has the appropriate criteria to create the best suited mesh. ANSYS Meshing is automatically integrated with each solver within the ANSYS Workbench environment. For a quick analysis or for the new and infrequent user, a usable mesh can be created with one click of the mouse. ANSYS Meshing chooses the most appropriate options based on the analysis type and the geometry of the model. Especially convenient is the ability of ANSYS Meshing to automatically take advantage of the available cores in the computer to use parallel processing and thus significantly reduce the time to create a mesh. Parallel meshing is available without any additional cost or license requirements.

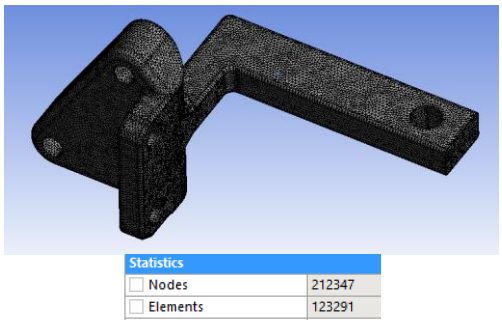


Figure3: Meshing of Engine Bracket

Loading Condition:

Loads: Specific values of load are implemented for a typical mounting bracket. The load is taken as 1252.5N. Load is applied at the two holes of the engine mounting bracket, which are connected to the engine structure with the help of rigid elements such as nut and bolts(as shown in fig.4)

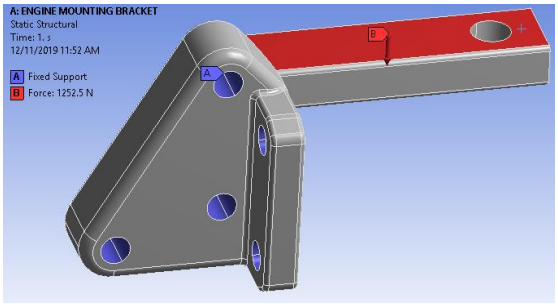


Figure4: Boundary Condition to Engine Bracket

Total Deformation:

The total deformation & directional deformation are general terms in finite element methods irrespective of software being used. Directional deformation can be put as the displacement of the system in a particular axis or use defined direction. Total deformation is the vector sum all directional displacements of the systems.

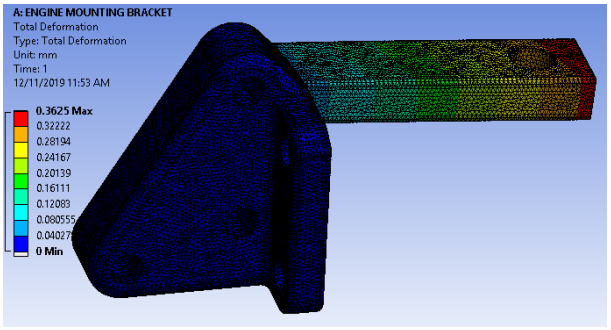


Figure5: Total Deformation of Engine Mounting Bracket

Equivalent Stress

Equivalent stress is related to the principal stresses by the equation:

$$\sigma_e = \left[\frac{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2}{2} \right]^{1/2}$$

Equivalent stress (also called *von Mises stress*) is often used in design work because it allows any arbitrary three-dimensional stress state to be represented as a single positive stress value. Equivalent stress is part of the maximum equivalent stress failure theory used to predict yielding in a ductile material.

The von Mises or equivalent strain ε_e is computed as:

$$\varepsilon_e = \frac{1}{1+\nu}\left(\frac{1}{2}\left[(\varepsilon_1-\varepsilon_2)^2+(\varepsilon_2-\varepsilon_3)^2+(\varepsilon_3-\varepsilon_1)^2\right]\right)^{\frac{1}{2}}$$

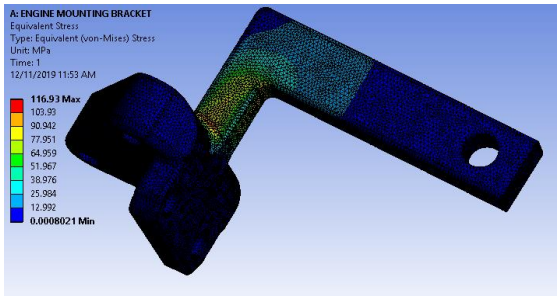
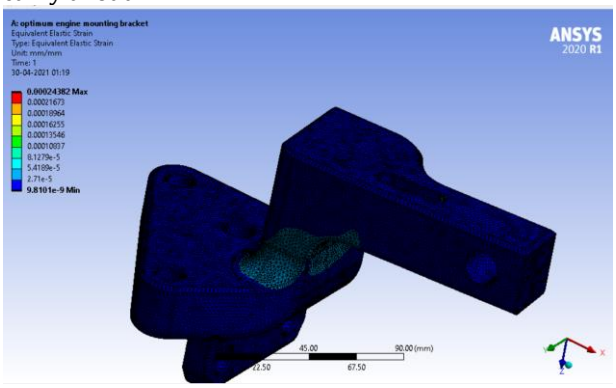
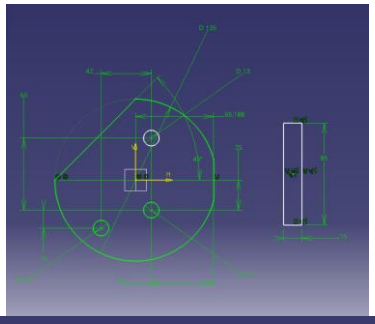


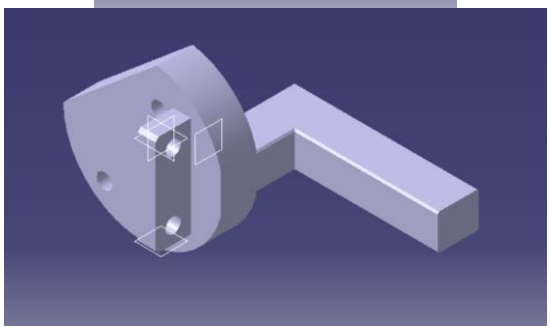
Figure6: Equivalent stress on Engine Bracket

As seen from above figure stresses acting at joint is 116.93Mpa which are not capable to carry a load acting on it, so further work is to design a bracket which will be capable to carry a load.

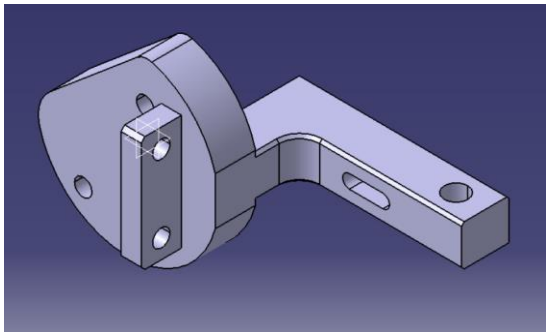


Our Optimized Results

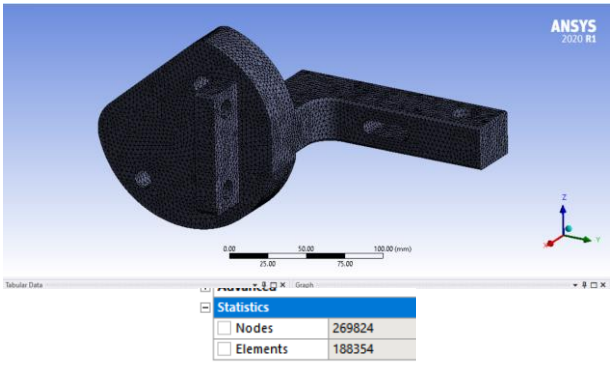




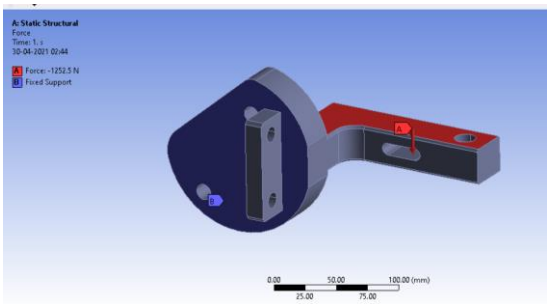
Without reduction

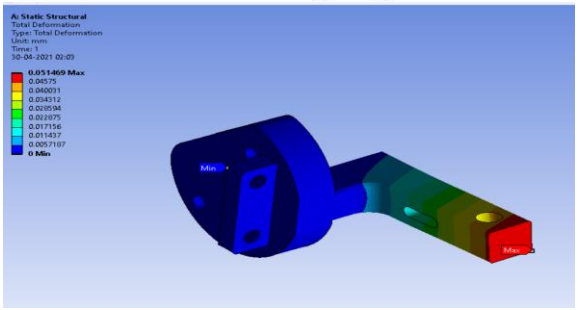


With reduction

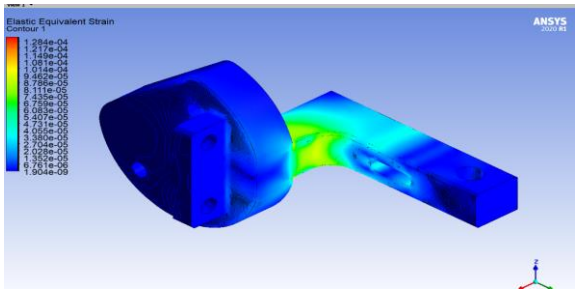


Patch configuration Tetrahedron method
Mesh size 3mm

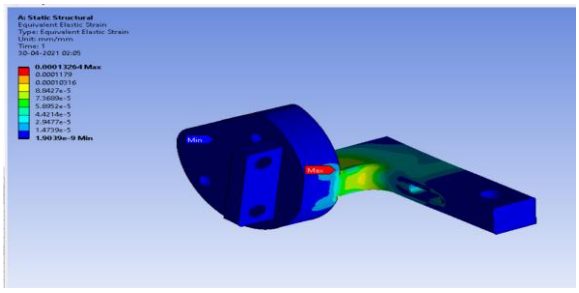




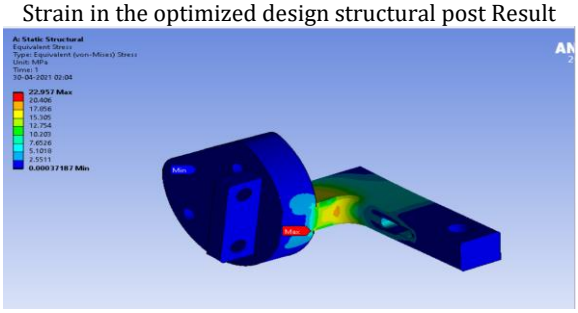
Deformation in the optimized design



Strain in the optimized design CFD post Result



Strain in the optimized design structural post Result



Stress in the optimized design

6. RESULTS

Sl No	Source	Dimensions	Material	Deformation in MM	Strain in MM	Stress in Mpa
1	RP	Drafting file 1 parameters	Structural Steel	0.3625	0.00024382	116.93
2	Optimized	Drafting file 2 parameters	Structural Steel	0.0514	0.00013264	22.957

7. CONCLUSIONS

- Until now I have referred several research papers from which I have got idea to implement engine bracket.
- From considering some of the input parameters for design and boundary condition I have designed 3D modal in CATIA v5.
- And studied the stress strain and deformation obtained in the designed product.
- These 1st iterations of my study further I will make use of different materials and simulate the results.
- From the efficient result till choose the better one finally optimizes the product for mass reduction and cost efficient.
- The result obtained from above simulation does not be able to carry the engine so in the next simulation I vary the parameters and material and simulate for the same boundary condition and observe the results.
- We have simulated a failed Engine Mount Bracket as we have discussed the results.
- In this duration I have designed a Engine Mount Bracket using CATIA v5 soft with change in parameters.
- Simulated the optimized one for better results in FEM structural system and obtained the results which are much better than the previous one.

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