DOI: https://doi.org/10.24113/ijoscience.v5i7.238

Design of Engine Mount Bracket for a FSAE Car for Deferent Loading Condition

Sanskar Singh
Research Scholar
Department of Mechanical Engineering,
College of Engineering Science & Technology
Lucknow, India
shivpandit0121@gmail.com

Vandana Singh
Research Scholar
Department of Mechanical Engineering,
College of Engineering Science & Technology
Lucknow, India

Kajol Kumari
Assistant Professor
Department of Mechanical Engineering,
College of Engineering Science & Technology
Lucknow, India

Abstract: **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 amount of vibrations. Hence, dissipating the vibrational energy and keeping the stresses under a pre-determined level of safety should be achieved by careful designing and analysis of the mount brackets. Keeping this in mind the current paper discusses the modeling, Finite Element Analysis, Modal analysis and mass optimization of engine mount brackets for a FSAE car. As the brackets tend to undergo continuous vibrations and varying stresses, the fatigue strength and durability calculations also have been done to ensure engine safety.** **Keywords: FEA; Modal Analysis; Static Analysis; Optimization; Mounting Bracket**

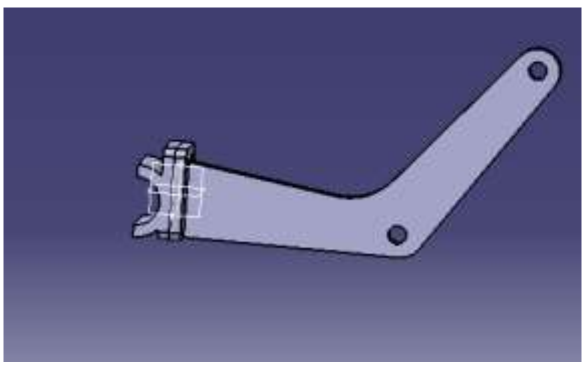
1.1 INTRODUCTION

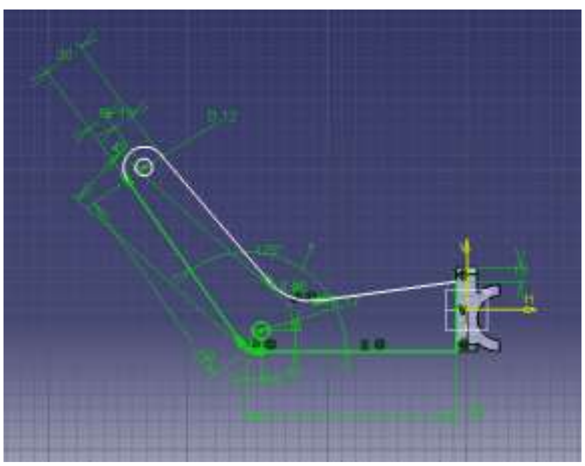
In an automotive vehicle, the engine rests on brackets which are connected to the main-frame or the skeleton of the car. Hence, during its operation, the undesired vibrations generated by the engine and road roughness can get directly transmitted to the frame through the brackets. This may cause discomfort 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. This phenomenon is called as resonance. This magnification is most severe in low frequency ranges up to 50Hz. Also, at high operating frequencies noise becomes a serious concern. Hence, damping of these engine vibrations becomes an important function of the mount brackets. The Noise & Vibration Harness analysis (or NVH) is one the most important considerations in automotive designing today. If the brackets have their resonance frequencies close to the operating engine frequencies, then the large amplitude of vibration may cause its fatigue failure or breakage, thus reducing its estimated or desired life. Vibration damping can be either provided by using separate dampers (anti-vibration mounts) or by suitably deciding the material and dimensions of the brackets. Moreover, the brackets also undergo deflection under static and dynamic loads. This deflection should be under permissible limits. A Formula Student car is required to be highly maneuverable and quick with high rates of acceleration and deceleration. Hence the mounting of the engine should be well constrained and the mount brackets need to be light-weight and designed to safely bear the inertial loads and maximize vibration transmission. FEA has been done to check the frequency and loading response of the brackets before finalizing the design. Mass optimization has been carried out to save material and reduce the weight. The modified designed has been re-analyzed using FEA before finalization. The design of the brackets has been experimentally validated after the actual implementation and testing of the vehicle. [1]Karl D. Hammond have investigated that the amplitude of vibration at constant frequency changes after prolonged exposure to same vibration at the same frequency. [2] The natural frequency of a material decreases as additional load is applied to the system or increase in mass or thickness of the material.[3]The response of vibrating system can be in the form of displacement, velocity, acceleration or sound. These have to be kept under safe or acceptable limits while designing. [4]The bracket should be designed to keep the resonance frequency (or frequencies) out of operating range.

1.1 DESIGN STAGES

a. PRE-PROCESSING

i) CAD Modelling This stage involves making the basic model based on the engine positioning on the chassis. The entire modeling is done using Catia Parametric. Since the geometry suggested a long bracket, material selection became an important consideration due to its weight. One part would be welded on the chassis and the other would be bolted to the engine.





ii) MESHING

It was decided to 3-D mesh the two component CAD models. Ansys software was used for meshing and Analysis. Tetra-mesh is done because the dimensions of the bracket are comparable to each other and also in-order to obtain accurate results.

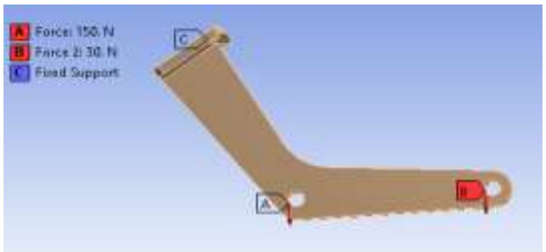
iii) MATERIAL SELECTION

Mild Steel: Component 1 was made of mild steel as it was to be welded on the tubular
Steel chassis.
Young’s modulus,
E= 2.1 e+05 MPa
Poisson’s ratio, u = 0.3
Density, rho = 7.9e-09 tonnes/mm^3 Aluminium 6063: Component 2 was decided to be of this material due to its light weight.
Young’s modulus, E= 7.8 e+04 MPa Poisson’s ratio, u = 0.33
Density, rho= 2.1e-09 tonnes/mm^3 Yield Strength = 214 MPa
Changes in material-selection could be made once the analysis was done.

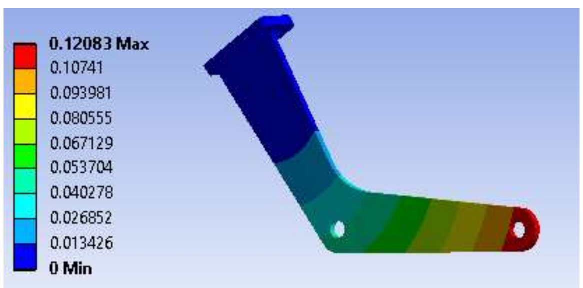
iv) Boundary conditions:-

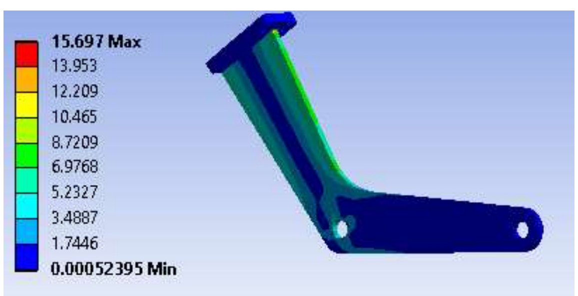
Apply boundary condition according pervious study. A, B is forces and C is the fixed support. The forces that act upon externally when the system
Is not under motion are applied in static analysis.
This involves weight of the engine distributed on each of the mounting brackets, manually applied loads and thermal stresses. The deflection and strains in the bracket components are then checked for safety. A FSAE Suzuki Car 600cc, 4-cylinder engine has been used for our car. The weight of the engine is 67 kgs. There are a total of four mounting positions for the engine on the chassis. According to the position of the center of gravity of the engine from the bracket positions the static weight transfer on the current bracket was theoretically calculated to be 190 N. This weight is further distributed on the two bolting positions available on the engine. Performance of aluminum at high temperatures up to 110 degree
Celsius was also checked.

Dynamic forces involves those experienced by the vehicle in motion and which vary with time. For this,
the maximum G-forces during acceleration, braking and cornering are considered.
Acceleration loading= 1 G
Cornering loading = 1.2 G's
Vibrational acceleration loading was checked using an accelerometer.



Results:-
Total deformation and equivalent stress under different boundary condition.





Loading Point B	Loading Point A	Total deformation (mm)	Stress (Mpa)
30	150	0.120	15.6
40	150	0.143	17.5
50	150	0.163	19.2
60	150	0.175	21.3
30	160	0.124	16.378
30	170	0.126	17.5
30	180	0.128	18.3

v) CONCLUSION

The final outcome of the study find out the total deformation and equivalent stress at different loading condition. The value of defamation increase with increasing load at point B so total deformation at 60N is maximum. But the value of total deformation not much change at apply load at point A. The final conclusion of the study the point the point A can capable at higher loading condition but point B is not capable at higher loading condition.

REFERENCES:

[1] Karl D. Hammond, "Frequency Response Analysis", January 2008.
[2] Rogers Corporation," Materials Design: Understanding Load Vs Frequency Curves".
[3] Nitin S Gokhale, Sanjay S Deshpande, Sanjeev V Bedekar, Anand N Thite, - "Practical Finite Element Analysis".
[4] Umesh S. Ghorpade, D. S. Chavan, Vinaay Patil & Mahendra Gaikwad, "Finite Element Analysis and Natural Frequency Optimization of Engine Bracket", International Journal of Mechanical and Industrial Engineering (IJMIE) ISSN No. 2231 – 6477, Vol-2, Issue-3, 2012.
[5] Sahil Naghate, Sandeep Patil, "Modal Analysis of Engine Mounting Bracket Using FEA", International Journal of Engineering Research and Applications (IJERA), Vol. 2. Issue 4. July-August-2012, pp.1973-1979.
[6] Koushik S.," Static and Vibration Analysis of Engine mounting Bracket of TMX-20-2 using Opti Struct", Altair Technology Conference, India -2013.
[7] R Singh, "Dynamic Design of Automotive Systems: Engine Mounts Structural Joints", SaÅdhana Å, Vol. 25, Part 3, June 2000, pp. 319±330.
[8] Dr. N. K. Giri, "Automobile Mechanics", Khanna Publications, ISBN No. 81-7409- 216-1, Edition-2006.