

Modeling and Analysis of V6 Engine Mount Bracket

P.Lakshmi Kala¹, V.Ratna Kiran²P.G. Scholar, Department of Mechanical Engineering, VNR Vignana Jyothi Institute of Engineering and Technology,
Hyderabad, Telangana, India¹Assistant Professor, Department of Mechanical Engineering, VNR Vignana Jyothi Institute of Engineering and
Technology, Hyderabad, Telangana, India²

ABSTRACT: Engine is one of the most important components of a road vehicle such as bus. High performance vehicles has their engine supported by bracket. The engine mounting plays an important role in reducing the noise and vibrations, improving the comfort and work environment of a bus. Engine mounting bracket has been designed as a framework to support engine. The first and foremost function of engine mounting bracket is to properly balance the power pack (engine and transmission) on the vehicle chassis for good motion control as well as good isolation. Present work deals with FE analysis of engine mounting bracket. It includes the modeling of engine mount bracket using CAD software. FE analysis of a typical engine mount bracket of a bus will be carried out and natural frequency will be determined.

KEYWORDS: Engine mounting bracket, Modeling, Modal analysis, Frequency.

I. INTRODUCTION

Engine is one of the most important components of a road vehicle such as bus. High performance sports vehicles has their engine supported by bracket. It plays an important role in improving the comfort & work environment of a bus. The improvement of engine bracket system has been the subject of intense interest for many years. It is necessary to design proper engine bracket for a bus. As such, engine bracket has been designed as a framework to support engine. Vibrations and fatigue of engine bracket has been continuously a concern which may lead to structural failure if the resulting vibrations and stresses are severe and excessive. Prolonged exposure to whole-body vibration in the working environment may lead to fatigue and in some cases it damages the vehicle. Generally, the most important vibration relevant excitations in an engine can be identified as follows:- combustion force; main bearing reaction forces including mass forces damper function and flywheel whirling, modified by the front-end damper; piston side forces including secondary motion; camshaft bearing reaction forces including mass forces, opening and closing impacts and bearing impacts; valve opening and closing impacts; valve train forces caused by chain/belt movement or gear drive; gear train forces inside the transmission; drive train reaction forces and moments. It is well-known from basic Non-linear vibration theory; improvement in the vibration control can be achieved by determining the natural frequency of the engine bracket System well below the frequency band in which excitation exhibits most of the vibratory energy. It is in this context, the development of engine bracket can make the engine capable of absorbing vibration. Automotive engine mounting system must satisfy the primary tasks such as engine movement, engine rigidbody dynamic behaviour, and vibration isolation. Limits over the development of the mounting systems due to drivability and NVH concerns, provides savings in design resources. The main role of engine mounting system as one of the principle vehicle vibration isolating systems, besides suspension system, is to reduce the noise and vibration perceived by driver and to improve the ride comfort. NVH is an important vehicles characteristic motivating to achieve overall customer satisfaction. Engine is mostly mounted to the front sub frame and once installed in a vehicle, engine mounting has a significant task in decisive the vehicle vibration characteristics.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

The main objectives of his paper are modelling in CAD software and modal analysis of the engine mount bracket to find the natural frequency.

II. BRIEF OVERVIEW OF LITERATURE

A. Prasad Babu *et al.* [1], presented the topology optimization approach to create an innovative design of an engine mount bracket using Altair Opti-struct software. Materials selected were aluminium alloy, aluminium silicon carbide and grey cast iron. The structural analysis of the basic model has done by using Radioss tool and weight reduction through the usage of Altair Opti-struct software. The results obtained from the structural and modal analysis have shown that the weight is reduced by 54% through the usage of optimized aluminium silicon carbide MMC composite material.

V. Ratna Kiran [2], optimized the weight of V6 engine mount bracket by varying the rib thickness. Material selected is aluminium alloy. The bracket is modelled by 6mm, 7mm and 8mm rib thickness. Analysis of engine mount bracket is done and the results obtained from static structural and modal analysis have shown that the model with 7mm rib thickness is best suitable. The weight of the component is optimized up to 50-60% with 7mm rib thickness.

Umesh S.Ghorpade *et al.* [3], proposed the analytical method to determine the non-linear vibrations for Magnesium, Aluminum & GCI and to reduce the excessive computation time. In this paper 3D model of non-linear materials is analyzed. Some simplification with an appropriate idealization process including changing material and reduced mesh size in the FE model is done. Meshing of different material mount brackets is done at the mid-surface using Hex Dominant Quadrilateral and Triangular elements. By this experimental process and comparisons it is concluded that Magnesium alloy is best suitable and exhibits better damping characteristics than Aluminum alloy

Sahil Naghate *et al.* [4], used finite element analysis tool to analyze the engine mounting bracket using FEA Package. Materials selected were aluminium alloy and magnesium alloy. The results obtained from the static and dynamic analysis have shown that the magnesium is better than aluminium. The main advantage of the magnesium engine mounting bracket was its light weight, which can increase fuel efficiency. The main problem of using magnesium instead of aluminium was its higher cost. Thus, it can be concluded that magnesium and aluminium both preferred as a material for an engine mounting bracket.

Mr. Pramod Walunje *et al.* [5], proposed the algorithm known as Fast Fourier Transform (FFT) to find the natural frequency for different material mount brackets and compared with the Ansys software. Materials considered were grey cast iron, aluminium and magnesium. The results obtained from static structural and modal analysis have shown that aluminium alloy is best suitable for engine mount bracket and has mass of 0.55kg. Further the weight optimization has done by reducing the thickness of 2mm. Thus, it can be concluded that by using light weight material aluminium weight has been reduced up to 0.43kg.

III. LOCATION OF BRACKET INSTALLATION

The engine mount assembly includes a support member arranged to be attached to a vehicle frame component. A pair of elastomeric engine isolators positioned relative to each other on the support member, and a pair of engine mounting brackets arranged to be positioned on the isolators and attached to an engine component, where in the engine isolators are arranged to maintain the engine mounting brackets in spaced relation to the support member thereby dampening engine vibration and controlling engine movement relative to the vehicle. An engine mounting system is often a primary path for noise.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015



Fig.2 (a)



Fig.2 (b)

Fig. 2(a), 2(b). Location of Engine Mount Bracket

Figure 2(a), 2(b) shows the location of engine mount bracket which is attached to the engine. The vehicle's structure at the mounting location is crucial in regard to noise transmission, durability and crash worthiness. The upper bracket attaches to the transmission by use of two horizontal fasteners. A limited vertical space is available for both the rubber mount and bracket. With limited rubber volume it is not possible to allow the rubber to be as soft as it is desired for maximum isolation of vibration. Therefore the bracket must be designed to be as stiff as possible. Through the use of Computer Aided Engineering, an optimized bracket design for stiffness, strength and mass is obtained while still supporting a shortened development cycle. Engine mount brackets must support the engine (withstanding stress,

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

temperature, and corrosion as the essential product, requirements), and are not to decrease the mount performance thus meet first mode resonance and stiffness requirements.

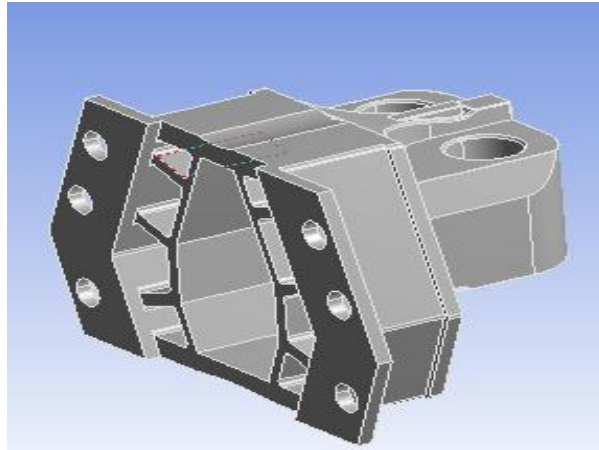


Fig.1. Engine Mount Bracket

Figure 1 shows the shape of engine mount bracket of a V6 engine. The retaining bracket is mounted on the vehicle body. In such an automobile engine supporting structure, a cut-out portion is formed at either a bolt insertion-hole of the supporting bracket or a bolt insertion-hole of the retaining bracket for permitting the engine to be turned on an axis extending in a transverse direction of the vehicle in proportion with impact loads. The impact loads are imposed on the engine upon a collision of the vehicle. As a result, the engine is prevented from horizontal movement in a rearward direction of the vehicle upon a frontal collision of the automobile.

IV. PROPOSED METHODOLOGY

At first the theoretical study of bracket is done. The overall purpose of engine mounting bracket is to support the engine and sustain the vibrations caused by engine as well as bumps from tires due to uneven road surfaces.

The analysis for the engine mount bracket will be done as follows:

1. CAD model was generated with the help of reverse engineering (i.e.,) through manual measuring instruments of engine mounting bracket (physical part).
2. Pre-processing in a CAE software
 - Discretization and meshing of the geometry.
 - Application of the boundary conditions (taken from standard testing conditions in the automotive industry).
3. Solution for normal modes and frequency response analysis.

V. OBJECTIVE

To carry out the modal analysis for finding the natural frequency & mode shapes and Frequency response analysis to analyze the response of the structure in terms of displacements and stresses.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

VI. MODELING OF ENGINE MOUNT BRACKET

The base model is designed in Creo software for creation of 3d model, and then it is converted to the intermediate file formats such as STEP, IGES which are essential for importing in to the other meshing software.

A. Reverse engineering

As computer-aided design (CAD) has become more popular, reverse engineering has become a viable method to create a 3D virtual model of an existing physical part for use in 3D CAD, CAM, CAE or other software. The reverse-engineering process involves measuring an object and then reconstructing it as a 3D model. The physical object can be measured by using 3D scanning and manual measuring.

Reverse engineering of the engine mounting bracket, shown in Fig. 1, is done by using manual measuring devices.

CREO is a powerful software used to create complex designs with great precision. The design intent of any three-dimensional (3D) model or an assembly is defined by its specification and its use. The parametric nature of this software helps preserve the design intent of a model with tremendous ease.

B. Steps in Modeling of Engine Mount Bracket

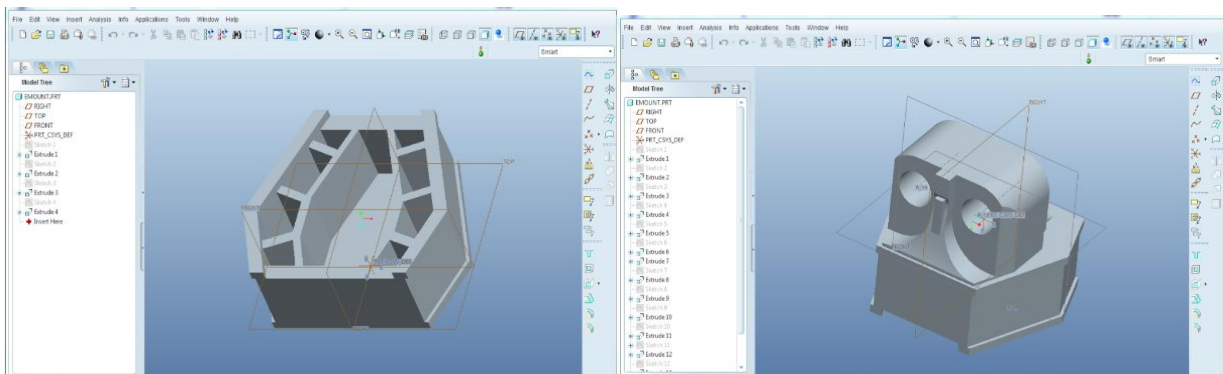


Fig.3(a)

Fig.3(b)

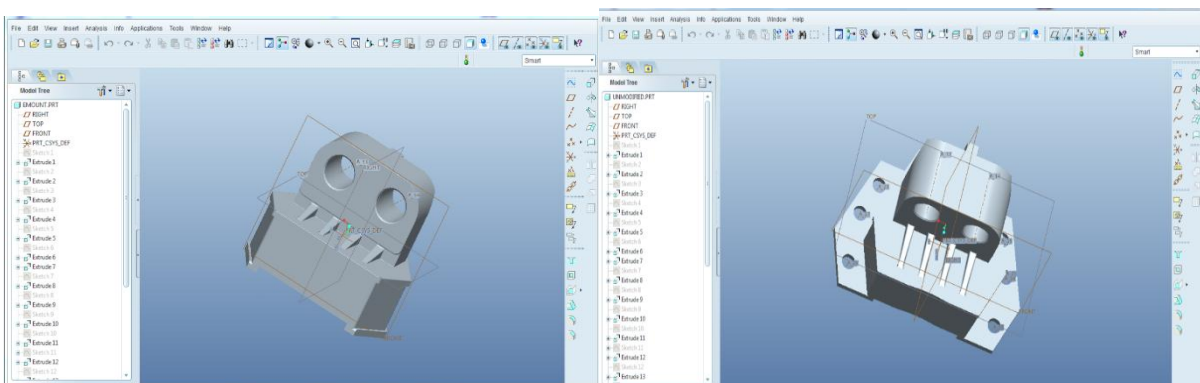


Fig.3(c)

Fig.3 (d)

Fig. 3(a), 3(b), 3(c), 3(d). Modeling of Engine Mount Bracket

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

The above figures shows the step by step modeling of engine mount bracket in Creo software. The 3D modelled engine bracket is then analyzed.

VII. ANALYSIS OF ENGINE MOUNTING BRACKET

Finite element analysis (FEA) is one of the most popular engineering analysis methods for Non-linear problems. Aluminum alloy material is selected from the engineering data sheet of the FEA package software. FEA requires a finite element mesh as a geometric input. This mesh can be generated directly from a solid model for the detailed part model designed in a three-dimensional (3D) CAD system. The importance of the meshing in the whole process of analysis is very important from the point of result implementation. By size and shape of the meshing accurate results can carry out.

Aluminum alloy under consideration has the following material properties:

$$\begin{aligned} \text{Young's modulus} &- 7.1e^{+10} \text{ N/m}^2, \\ \text{Poisson's ratio} &- 0.33, \\ \text{Density} &- 2770 \text{ Kg/m}^3, \\ \text{Yield strength in tension \& compression} &- 2.8e^{+8} \text{ N/m}^2. \end{aligned}$$

A. Modal analysis

The modal analysis of the engine mounting bracket is carried out for determining natural frequencies and shapes of the natural vibration modes. These frequencies are the outputs given by the analysis of the engine mounting bracket. The frequency range of engine is 0-1500 Hz.

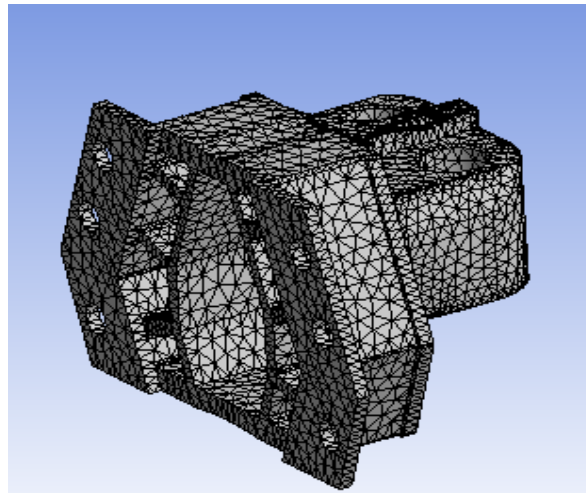


Fig.4. Meshed Model

Figure 4 shows the meshed model of the engine mount bracket. The meshing is done by importing the CAD model in CAE software in the step file format. Meshing of the engine mounting bracket was done according to the geometry.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

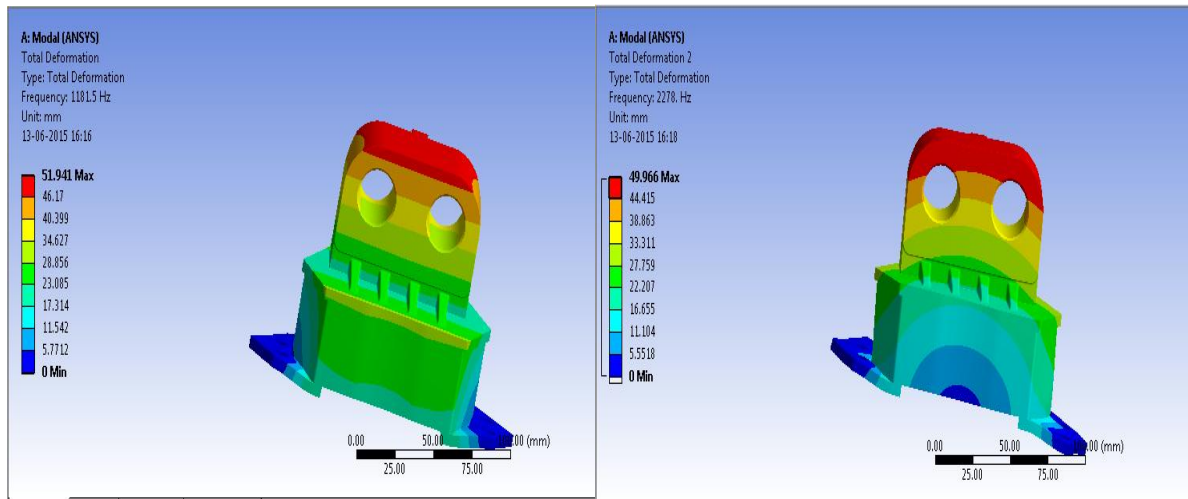


Fig.5. First mode of vibration Fig.6. Second mode of vibration

Figure 5 and figure 6 shows the natural frequency with first mode and second mode of vibrations. From the above plot of the total deformation of the engine mounting bracket we can conclude that maximum value of deformation is taking place at the place that is connected to the engine. The frequency of vibration is 1181.5 Hz. The values of deformation increasing from minimum to maximum from the bottom which is connected to the vehicle structure to the end of engine.

VIII. RESULT AND CONCLUSION

From the modal analysis results of Engine Mounting Bracket of V6 engine made of Aluminum alloy has the natural frequency of 1181.5 Hz. Thus, the use of CAE tools leads to an easy visualization and thereby helping in the detection of problems early in the design cycle, reduced number of physical prototypes resulting in significant saving of time and cost and last but not the least, more design iterations by incorporating simulation techniques.

Future Scope

- The proposed analysis procedure will be used to study the effects of different materials and features like ribs in the bracket for improvements like increasing the natural frequency and lowering the stress levels.
- Mass optimization of the mounting bracket and cost reduction of the material.

ACKNOWLEDGEMENT

We would like to thank the Volvo bus servicing centre management and management of VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad for their consistent support in execution of this work.

RERERENCES

- [1] Prasad Babu, Y.Vijaya Kumar and Dr.C.Udaya Kiran, "Topology optimization in design of engine mounting bracket", International Conference on Emerging Trends in Mechanical Engineering, Vol. 1, 2014.
- [2] V. Ratna Kiran, "Design optimization for engine mount bracket for V6 engine", Proceedings of 2nd International Conference on Advances in Mechanical and Building Sciences, V.I.T.U., India, pp. no 814-819.
- [3] Umesh S.Ghorpade, D.S.Chavan, Vinaay Patil and Mahendra Gaikwad, "Finite Element Analysis and Natural Frequency Optimization of Engine Bracket", International Journal of Mechanical and Industrial Engineering (IJMIE), Vol. 2, 2013.
- [4] Sahil Naghate and Sandeep Patil, Modal Analysis of Engine Mounting Bracket Using FEA, International Journal of Engineering Research and Applications (IJERA), Vol.2, 2012, pp.1973-1979.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 7, July 2015

- [5] Mr. Pramod Walunje and Prof. V.K.Kurkute, Optimization of Engine Mounting Bracket Using FEA, PARIPEX-Indian Journal of Research, Vol. 2,2013.
- [6] Yunhe Yu, Nagi G.Naganathan, and Rao V.Dukkipat, A Literature review of automotive vehicle engine mounting systems, PERGAMON-Elsevier, Mechanism and Machine Theory, 2001, pp.123-142.

BIOGRAPHY



Ms P.Lakshmi Kala received her B.Tech in Mechanical Engineering from PRRM Engineering College, India, in 2013. She is currently an M.Tech student at VNRVJIET, Hyderabad, India. Her research interests include CAD/CAM, Modeling and Finite Element Analysis (FEA).



Mr. V. Ratna Kiran received his B.Tech in Mechanical Engineering from Vazir Sultan College of Engineering, Khammam, India, in 2000 and M.Tech from Regional Engineering College, Warangal, India, in 2001. Mr. V. Ratna Kiran is currently an Assistant Professor at VNRVJIET, Hyderabad, India. His research interests include CAD/CAM, Finite Element Analysis (FEA) and Composite Materials.