Material Selection and Computational Analysis on DOHC V16 Engine's Mounting Bracket Using COMSOL Multiphysics Software

M.V. Aditya Nag*[1]
[1] Gokaraju Rangaraju Institute of Engineering and Technology
*Corresponding author: Nizampet Road, Bachupally, Hyderabad 500013 India; nagaditya88@yahoo.com

Abstract: Reduction of the engine vibration and the dynamic forces transmitting from engine to the automotive body structure has always been an important part of automotive research. Automobile engineers face the task of creating a mechanism to absorb these vibrations and provide a smooth ride. The usage of Motor Mounts is the best solution for dampening the effects of vibrations and oscillations. This paper deals with the material selection and finite element analysis for the engine accessory component. This main objective of the analysis is to minimize the weight of the mount bracket. This paper also deals with overall weight reduction of vehicle's engine mounting bracket using different types of materials. The main parameter considered for variation in the behavior of the bracket is material variations. For different materials, the stresses are computed and compared to arrive for the best model under prescribed conditions. In the process of simulation, first the CAD model is created using CATIA V16 tool. The model will be imported to Comsol Multiphysics Software for performing F.E.A. analysis on the model for suitable loading conditions and constraints. The results obtained are used for evaluation of best suitable material for the engine's mounting bracket using the D.F.M.A. methodology.

Keywords: Bracket, Material Selection, Optimization, Analysis, weight reduction.

1. Introduction

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. Vibrations are annoying and their origin can be difficult to detect. An engine mounting system includes a front mount, a rear mount, an engine mount, and a transmission mount. Installation heights and spring constants of each mount are predetermined such that the majority of the weight of the power train is supported by the front and rear mounts. Mounting axes of the engine mount, front mount, and rear mount are vertical while the mounting axis of the transmission mount is lateral. The transmission mount may include bridges which vary its spring constant during vehicle roll. There are many good reasons to resiliently mount an engine and/or transmission one increasingly important reason is to reduce structure bone noise and vibration generated by the engine and transmitted to the vehicles operator compartment. Resilient mounting will also provide longer life for frame and engine block mounting brackets, suspended components and transmission by attenuating transient shock inputs and operating torque loads. The paper also summarizes engine disturbances looks at several ideal practical mounting approaches and points out important limiting considerations. Finally, selection criteria and required data for proper engine mounting are outlined.

A structure for mounting an engine for a vehicle comprising: a front engine mount for mounting the engine on a front side of the engine in a longitudinal direction of the vehicle, the front engine mount including an engine mount bracket which is fixed on one end thereof to a suspension member and has an insulator held on the other end thereof, the front engine mount mounting the engine with the insulator interposed between the engine and the engine mount bracket, the insulator supporting an engine bracket fixed to the front side of the engine, wherein a space is provided between the front side of the engine and the engine mount bracket; and an auxiliary equipment disposed in the space between the front side of the engine and the engine mount bracket, wherein the front engine mount has a strength against a load applied thereto in the longitudinal direction of the vehicle less than that of the auxiliary equipment. In this paper the front engine mount bracket as shown in figure 1 is taken under consideration.

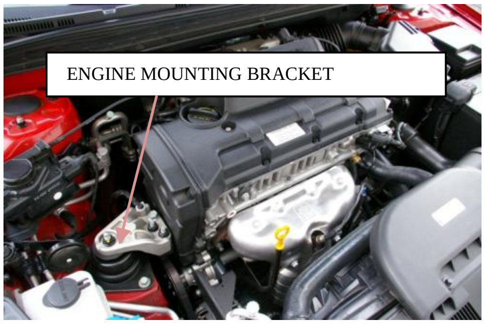

Figure 1. Location of engine mounting bracket [2]

2. Research Methodology

The location of the AlSiC MMC composite material made Engine mounting bracket used for the analysis can be seen in the figure 1. The 3-D modeling of the engine mount has been is designed using CATIA V5 software (figure 2). The computational testing on the component is done at isotropic state through the application of Thermo-mechanical Vibration Analysis using the Comsol Multiphysics 4.2 version software. The analysis is done as per the standards mentioned by Yunhe Yu et al [1]. The results are obtained by this simulation are analyzed and modified design is further compared with the preliminary design using the Thermo-mechanical Vibration analysis. The main objective of the research is to reduce weight without changing impact of the component.

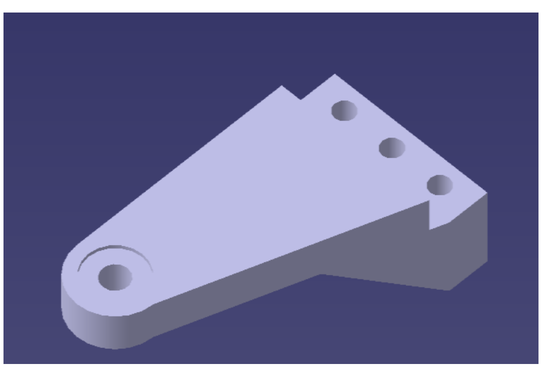

Figure 1. Preliminary model of Engine Mounting Bracket

3. Results & Discussions

The Engine Mounting Bracket is modeled and analyzed accordance to the standards given by the Yunhe Yu et al [1] and V.Ratna Kiran et al [2]. The model is kept under the force of 150N and fixed on the other end. The experimentation is done in the isotropic state. The testing is done on varying frequencies (0-1000 Hz) and at constant time (10 seconds). It is also observed that the usage of Grey Cast Iron is very recommendable to the present day requirements and also the usage of the steel although give the greater stability to the product but give a very heavy weight to the product. It is also made to know that the usage of the AlSiC Materials give the Greater Stability to the component. This paper gives the detailed analysis about the applicability of AlSiC Composite Material in comparison with that of the Conventional Grey Cast Iron. The Engine mounting bracket was optimized to the proper dimensions and load of 150N is applied on system. The system is kept of the isothermal condition and the operated at different frequencies for 10 seconds. The system is maintained at 25^{o}C and external temperature is maintained at 100^{o}C. The observations made from the simulations made using the above mentioned situation are discussed below:

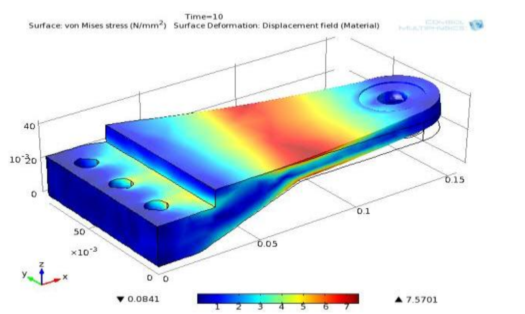

Figure 3. Model under the Thermo-Mechanical Vibration stress Analysis

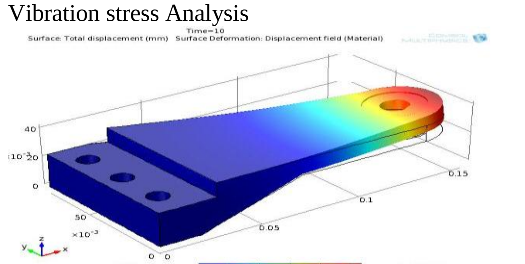

Figure 4. Model under the Thermo-Mechanical Vibration Displacement Analysis

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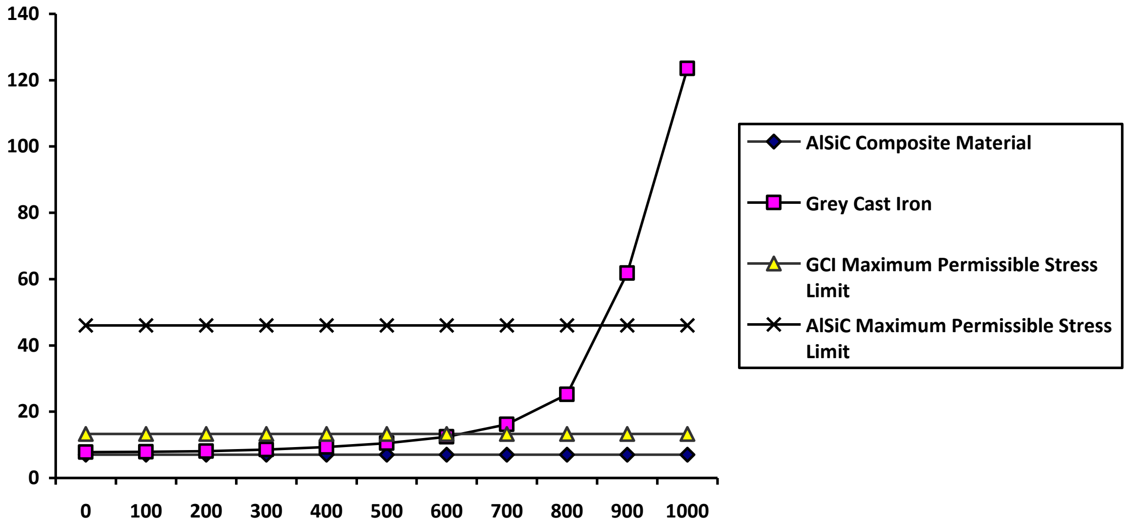

Figure 5. Relationship between the stress and the frequency obtained to during the thermo- mechanical vibration analysis using comsol multiphysics software

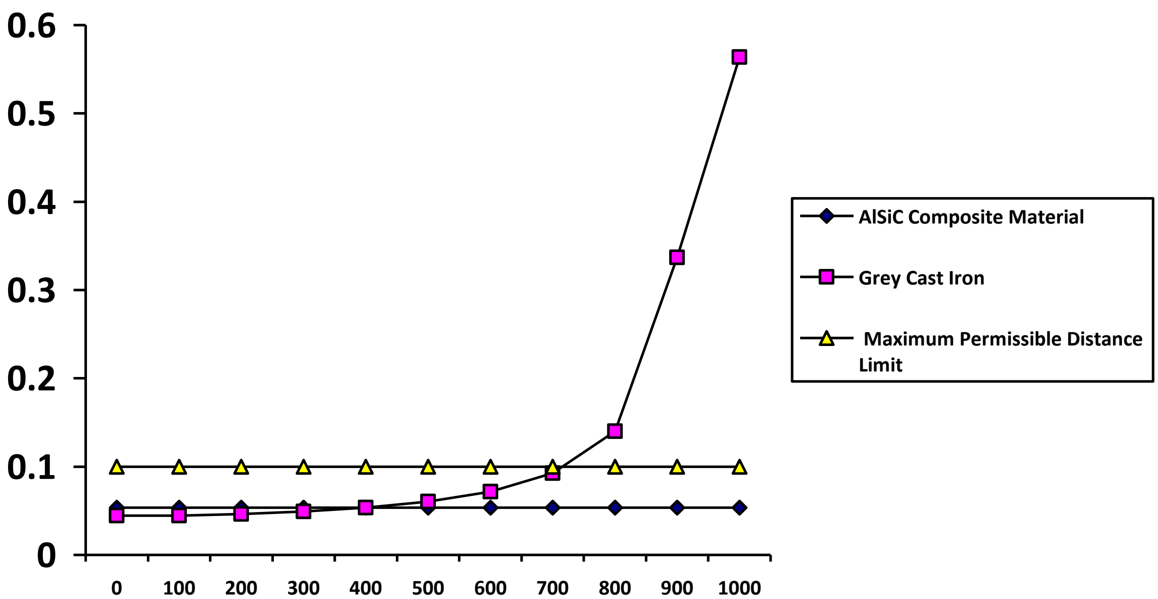

Figure 6. Relationship between the displacement and the frequency obtained to during the thermo-mechanical vibration analysis using comsol multiphysics software

Hence, from the figures 4, 5, 6 it is observed that although the GCI is proven very effective in regards of the AlSiC Material it fails at the higher frequency and is not recommendable for the higher grade engines. The AlSiC material provides the greater stability and consistent material behavior. Hence, the applicability of the AlSiC material on the Engine Mounting Bracket gives the better performance but also helps in the weight reduction of the component by 60%.

4. Conclusion

The Engine mounting bracket is been used to reduction of the vibration created by the engine. The engine mounting bracket is generally made up of grey cast iron. In this paper the weight reduction engine mounting bracket is taken under the consideration without varying the performance of the component. The bracket has further undergone weight reduction using the material selection through the usage of Comsol Multiphysics software. The results obtained states that 60% of the weight reduction is done to the component. Hence in this paper we have seen that the weight is reduced 60% through the usage of the optimized AlSiC MMC composite material made component. The future work focuses on the cost reduction of the material without varying the weight of the component.

5. References

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