

Modeling and Weight 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..

Keywords: Engine, reciprocating parts, dynamic excitations, vibrations

I. INTRODUCTION

During design of vehicle structures, it is always challenging to achieve higher stiffness and strength and simultaneously reduce weight, that is to say, to optimize the structures. There have been various types of the optimization methods that were developed and have successfully been used in the vehicle structure design.

The engine mount system includes an engine, three to four engine mounts and a foundation (vehicle body). Since the engine is the largest concentrated mass in the vehicle and if it is not properly constrained and isolated, it will cause vibrations in the vehicle body and front end sheet metal. The behaviour of the engine mount systems not only depends on the performance of individual mounts, but also on the complete system as well. The design of an engine mount system involves the following: (1) location of engine centre of gravity (C.G.) and its orientation, (2) location and orientation of individual mount, (3) selection of stiffness coefficients of each mount.

1.1 Engine Mounting System

The structure for mounting an engine comprises a first bracket which is fixed to the engine at a first point on the front side of the engine and is supported by the front engine mount at a second point lower than the first point. The engine mount bracket is formed in a channel shape open frontward. The engine mount bracket is provided with a fragile portion which reduces the strength of the front engine mount against the load to the front engine mount in the longitudinal direction of the vehicle.



Fig 1: Location of engine mounting bracket of Hyundai car



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II. LITERATURE SURVEY

Pravin Gudale and Dr. Vinayak Naik [4][2014]- Failure Modes and Effects Analysis (FMEA) is used to analyzed the reliability in development cycle, due to these enhancing the reliability with the help of design. For engine cylinder block, the development of semi-automatic fixture is designed in the paper. The issue which is related to engine block fixture is resolved with methodology FMEA, the priority risk number is identified and minimized. Due to these cost saving in term of quality improvement is done.

Sahil Naghate and Sandeep Patil[5][2012] - For reducing noise, vibrations and harshness engine mounting is used and also it allows comfort also. The main function of an engine mounting bracket is to balance the vehicle chassis for control motion. In paper, modelling and analysis of engine mounting bracket is done with different material component. Analysis is done on square cross-section in form of static and modal analysis. Also weight reduction is due component to standard material engine alloy material and also stresses is withstand

III. METHODOLOGY

The frequency range is 20±200 Hz for an engine speed range from 600 to 6000 rpm. For an eight-cylinder engine, the frequency of the disturbance torque is at the fourth orders of the engine speed and the frequency range is 40±400 Hz for the same engine speeds. In general, at low engine speeds (near idle) the engine disturbance will result in an annoying shaking of the vehicle. At higher speeds, a booming sound is created inside the vehicle compartment when the engine disturbance force coincides with an acoustic resonance of the passenger compartment. To isolate the vibration caused by the engine unbalanced disturbances, low elastic stiffness and low damping is needed as the forces transmitted to the structure are proportional to the stiffness and damping of the mounts. This indicates the effect of frequency and damping on the force transmissibility through the typical two element Voigt mount model. In order to obtain a low transmissibility, the natural frequency of the mounting system in a certain direction should be below the engine disturbance frequency of the engine idle speed to avoid excitation of mounting system resonance during normal driving conditions. The frequency of engine disturbance of mounting system natural frequency ratio should be maximized. This means that the engine mount stiffness coefficient should be as low as possible to obtain a low transmissibility. Lighter damping is also desirable for a low transmissibility at high frequency range.

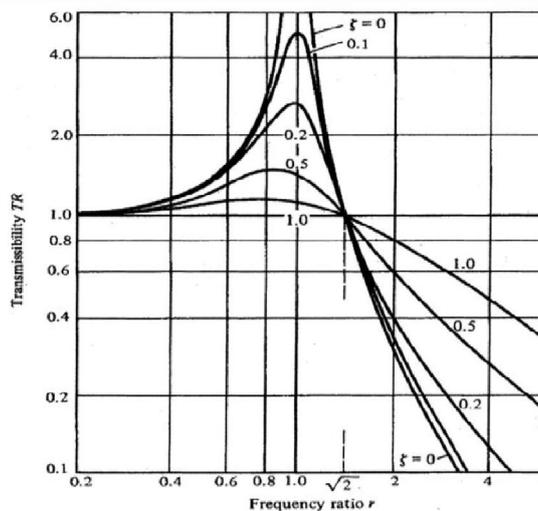


Fig: 2- Frequency ratio

3.1 Design Considerations of Engine Mounting Bracket

The following are the Design considerations to be made modelling engine mounting Bracket:-

**Engine Mounting Methods**

Most of the engine mounts are located at the bending nodal points of the engine.

Industrial Vehicles: Three point mounting

This system was designed to accommodate easy engine removal and maintenance. Due to a badly coupled condition, the roll frequency is increased and poor isolation results at idle and low operating speeds.

Automotive: Focused Three Point Mounting

System Focused mounts provides decoupled stable response but the mount locations do not limit engine bending.

Mounting Considerations**Mount Locations**

The engine is not a rigid mass but actually a free-free beam in space. Mounts should be positioned at the nodal points.

Stability

Mounts should provide stability for the following conditions

Fore – aft: up to 7g

Lateral: 1g

Vertical: 3-4g

Torsional: engine manufacturer's rated torque X 2

Selection of Engine Mounts

There are three normal loading conditions which must be considered when designing engine mounts. They are:

Static loads – weight of engine and accessories

Dynamic loads – transient shock levels,

Torque loads – manufacturers ratings

Torque loads can be determined from the following formulae, if manufacturer's ratings are not available:

T (in-lbs) = 63,000 X HP/RPM HP= engine horse power

RPM = output of transmission

Disturbances

Torsional dynamic pulses due to variations in cylinder gas pressure o 2cycle engine -fd (disturbing frequency) = RPM X no. of cylinders o 4 cycle engine – fd (disturbing frequency) = RPM X no. of cylinders/2 o For practical mounting solutions isolate the fundamental first order or RPM.

2 cycle – isolate RPM

4 cycles – isolate RPM/2

Imbalance forces due to reciprocating or rotating masses within the engine

1 cylinder engine- isolates the primary vertical and horizontal inertia forces

2 cylinder engines -isolate the secondary rotating inertia forces

Data required for modelling engine mount design

- Engine data
- Total weight of engine and accessories
- Moments of inertia for complete engine for roll, pitch, and yaw modes
- Engine operating speeds
- No. of cylinders
- Firing order
- Crank shaft arrangement
- Developed engine torque

IV. MODELLING AND STRUCTURAL OPTIMIZATION

The 3-D modelling of the engine mount has been completed in CATIA V5 Software. There are three models that have been basically designed and improved using this design package. The engine mount model usually is provided has three holes for fixed in the body frame, there is one slot which mounts the engine and the load is applied on this slotted part of the bracket. The modelling of mounting bracket was designed by Chevrolet Motors.

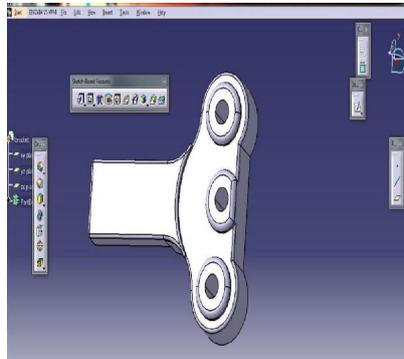


Fig:-3 Engine mounting Bracket in Catia

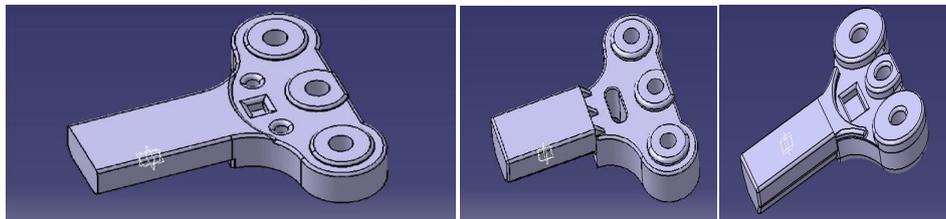


Fig:-4 Engine mounting Bracket in Catia three different models

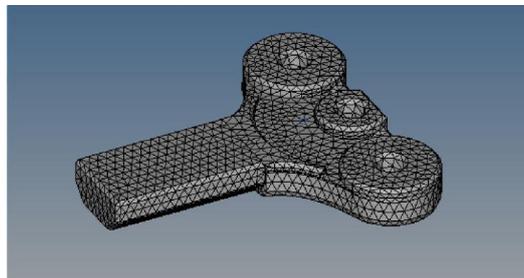
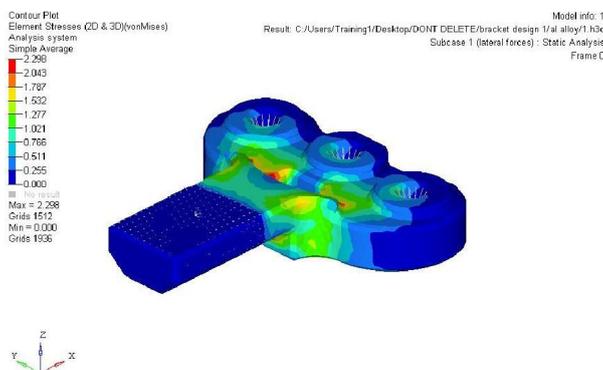


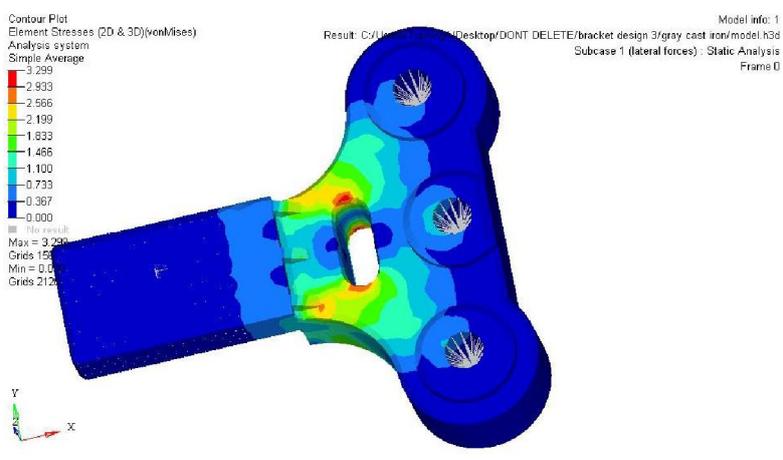
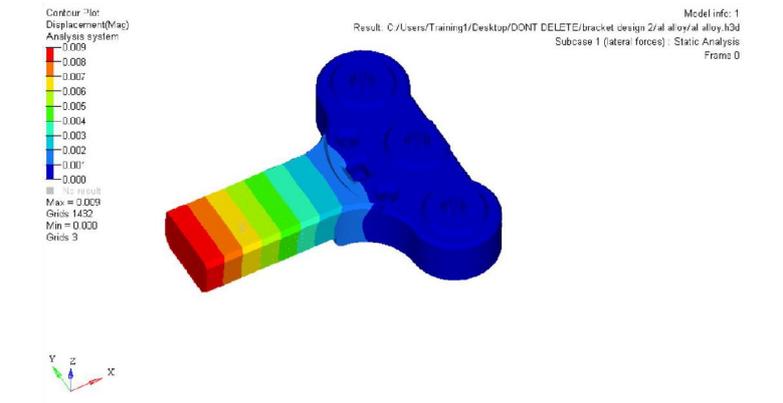
Fig:-5 Meshed Model in Hypermesh

V. OPTIMIZED DESIGN AND FE ANALYSIS

Material: aluminum alloy

Stress = 2.298mpa



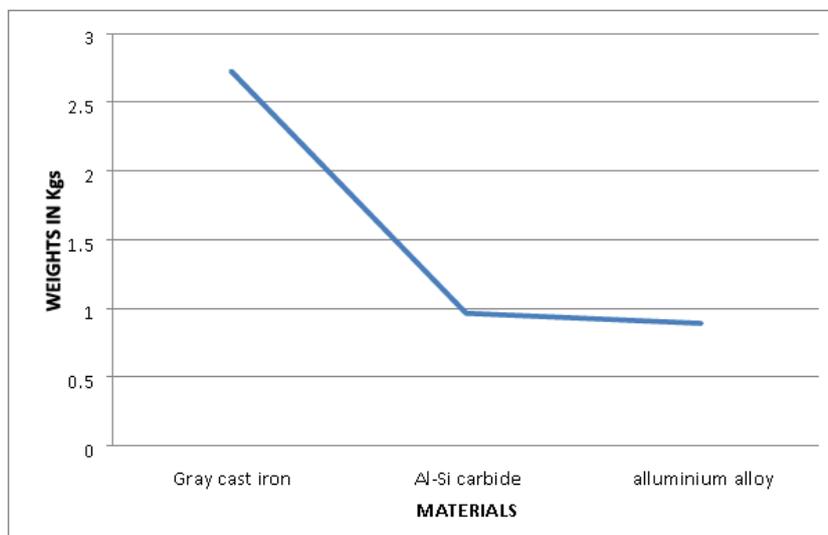


Comparison of weight reduction percentage

S.no	Design	initial weight of the component (In gms)	final weight of the component(In gms)	weight reduction percentage
1	Design 1	2395	881.9	63.17%
2	Design 2	2370	894.6	67.23%
3	Design 3	2413	884.4	63.18%

Table 1: Comparison of weight reduction percentage

Weight comparison graph for three materials



Graph 1: Weight comparison graph for three materials

V. CONCLUSION

The Engine mounting bracket is been used to reduction of the vibration created by the engine. The engine mounting bracket is made up of different materials Aluminium alloy, Aluminium Silicon Carbide and Grey Cast Iron. In this project the weight reduction engine mounting bracket is taken under the consideration without varying the performance of the component. Firstly the process of the structural optimization involves the variation of Rib thickness which resulted to the 67.23% weight reduction of the existing industrial component.

The bracket has further undergone weight reduction using the material selection through the usage of OPTISTRUCT SOFTWARE. The results obtained states that 67.23% of the weight reduction is done to the component. Hence, in this project we have seen that the weight is reduced 67.23% through the usage of the optimized Aluminium alloy made component.

The component (Aluminium alloy) has further undergone the structural optimization using the Hyperworks 13.0 software the observation mane from the results stated that the reduction of the weight by 67.23 %.

Finally we are consider Aluminium alloy is best and perfect suitable model for our thesis. Future work is cost analysis of materials, which is having less cost that material is applied for the physical model.

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BIOGRAPHY



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