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DESIGN AND ANALYSIS OF ENGINE MOUNT FOR ENGINE VIBRATION CONTROL

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ABSTRACT: The highly competitive automotive business industry requires manufacturers to pay more attention to passenger comfort and riding quality. This has forced designers to direct their attention to the development of high quality engine mountings. In this particular study, different designs of the engine mount system have been evaluated for damageability starting from the base model. In the process of optimizing the damageability, study has been performed repetitively on engine mount with design configurations. In this work, special attention is given to the accurate modeling of nonlinear effects on the dynamic behavior of the engine mount using LS-Dyna simulation. Based on the finite element model created, the mounts frequency response function curves are determined and multi-dimensional effects in the mounts response are observed. The overall results indicate that the modeled engine mount i.e. Four arm symmetry has an acceptable performance in both isolating engine induced vibration and suppressing high amplitude engine shake movement. Finally, some remarks are made about the use of parallel associated rubbers and nonlinear dynamic properties as a mean for improving the mounts dynamic behavior.

I. INTRODUCTION

An engine mount structure has two crucial limits, one is to reinforce the largeness of the engine and the other is to withdraw engine vibrations. In vehicles, there are two imperative vibration sources, vibrations from the engine and vibrations beginning from the most punctual stage, should be reduced to enhance the comfort

1.1 Engine mounts requirements:

There are for the most part three to four motor mounts that associate the motor and transmission get together to the Chassis and body in white (BIW). During frontal accident crash, the mount unsurprising close unsuccessful in this way when close allow the train close jump descending with avoid harm inside the individual in the interest of personal entertainment area. The back mount be experienced utilized for divergent configuration through apply quality inside the X with Z general course close run over its suitability towards the vital Force-Displacement bend inside the examination domino impact. The suitable outline is undaunted utilize an iterative strategy.

1.2 Types of engine mounts:

Two-fold shear combined sandwich mounts
Two-fold slanted wedge mounts
Two-fold slanted wedge with longitudinal control mounts
Slanted interleaf rectangular sandwich mounts
Metaxentric sort shrub mounts

1.3 Metaxentric sort shrub mounts:

Made out of an inward and outer steel sleeves arranged inconsistently in the exhausted state and appended to a versatile focus (which has an opening to keep malleable nerves from rising), this sort of greenery mounts gives a considerable measure of vertical redirection with beside no fore and toward the back advancement as showed

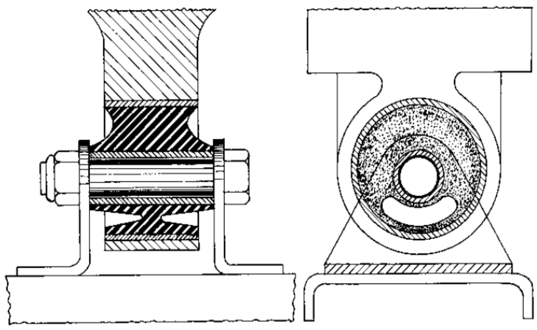


Fig 1.1. Metaxentric sort shrub mount

1.4 Effects of bad engine mounts:

Engine mounts can be filled with a solid or a fluid and can be made of metal, plastic or rubber. These simple vibration damping mounts can have a drastic effect on a vehicle's ride, acceleration, handling and braking performance.

Acceleration effects: Motor mount failure often manifests itself as a sudden jerk or lurch while you accelerate a vehicle from a standstill.

Fluid Leak Symptoms: A leaking fluid-filled mount will manifest itself with a noticeable engine vibration and harshness under acceleration.

Chassis Effects: Because most cars use the engine as a major structural member, failing mounts can result in rattles and squeaks when you encounter bumps. Long-term engine mount failure can result in broken and cracked suspension components or mounts and leaking weather stripping

1.5 Engine mounts criteria

The energy absorption characteristics of the engine mount are mainly influenced by two variables, the material and the design. In real world automotive manufacturing there is a fewer chances of the material changes for any subsystem as the material procurement is bulk order process. Hence the design of the engine mount becomes the critical aspect in terms of Vehicle crashworthiness. In this particular study performed different designs of the engine mount system have been evaluated for damageability starting from the base model. In the process of optimizing the damageability, study has been performed repetitively on engine mount with design configurations.

II. METHODOLOGY

The finite element model of enginemount is created using CAD & Hypermesh and simulation of the engine mount is carried out using LS-Dyna. A non linear steady-state dynamic analysis is performed using dynamic properties for six different designs of commercially available rubbers and the results compared to the ones obtained using a hysteretic damping material model suggested by the automotive constructor. The present work is focused on representing the engine mount components via 3-D finite element model and performing iterative analysis using a commercial package LS-DYNA. The analysis is run for 20 ms time frame which captures the complete deformation of the engine mount. During impact, the mounts are expected to fail so as to allow the engine to drop down and avoid injury in the passenger compartment. The rear mount is tested for different designs by applying force in the X (+ ve X and – ve X direction) and Z (+ ve Z and – ve Z directions) global directions to find its suitability towards the required Force-Displacement curves in the test results. The suitable design is determined using an iterative procedure.

Model setup

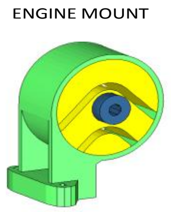


Fig 1.2. engine mount assembly

The model set up is as shown in figure 1. The base model consists of the engine mount assembly made up of the outer aluminium bracket which is fixed and the rubber is press fitted but in between that a steel ring is fitted. Then another aluminium bracket (inner bracket) is fitted in that a steel ring is present. The assembly is fixed at one end with a fixed rigid wall which simulates the welded components attaching to the engine mount assembly. The impact is simulated using the moving rigid wall which crushes the rubber. The moving rigid wall is given motion by means of a prescribed boundary motion as indicated in load-curve, which is illustrated in Fig

2.1 FE methodology:

2.1.1.CAD Model and material details:

The CAD modelling of die geometry is created and also modified by using software CATIA V5.

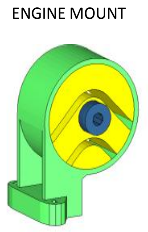


Fig 1.3. modal set-up

- Modeling of individual components.
- Meshing of individual components.
- Assembly of individual components to form continuum model.
- Load case set up.
- Using the solver to solve.
- Post Process the results from the solver.

2.1.2. Meshed model details:

Meshing is the operation in which the continuum is discretised in to number of smaller regions called elements which are interconnected by nodes, from which infinite degrees of freedom is converted to finite degrees of freedom. The choosing of element types in the meshing is depends on.

- Type of analysis
- Time allotted for project
- Computer configuration availability.
- Degree of accuracy of result.

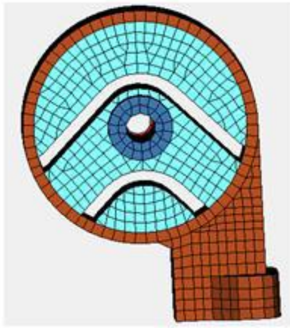


Fig 1.4. meshed assembly

- Easy to mesh for complex geometries.
- First order elements doesn't require much time solving the problem compared to second order.
- And also availability of the computer configuration.

2.1.3 Mesh Convergence

It is the method used to observe that outcomes acquired from a FE programming are right. In Finite Element Method the outcomes are reliant on element size and number. Increasingly the quantity of elements more will be the precision of results. In any case, if the quantity of elements are expanded the computational time increments and the setup of the framework must be improved which builds the expense of work. The outcomes will likewise relies on upon the element measure so before we can accept on results we should make certain that the outcomes are not any more subject to the element size.

The model set up is as shown in above fig 4.2. The base model consists of the engine mount assembly made up of the outer aluminium bracket which is fixed and the rubber is press fitted but in between that a steel ring is fitted then another aluminium bracket is fitted in that a another steel ring is present. The assembly is fixed at one end with a fixed rigid wall which simulates the welded components attaching to the engine mount assembly. The impact is simulated using the moving rigid wall which crushes the rubber. The moving rigid wall is given motion by means of a prescribed boundary motion which refers to a load-curve.

2.1.4. Solver details:

1. LS-DYNA

LS-DYNA is a program with capabilities to solve multi-physics problems such as solid mechanics, heat transfer, and fluid dynamics. Moreover, these problems could be solved either as separated phenomena or as couple physics. LS-DYNA is nonlinear finite element analysis software used to analyze the nonlinear dynamic response of three-dimensional inelastic structures. Its fully automated contact analysis capability and error-checking features have enabled users worldwide to solve successfully many complex crash and forming problems. LS-DYNA is an advanced general-purpose multiphysics simulation software package that is actively developed by the Livermore Software Technology Corporation (LSTC). While the package continues to contain more and more possibilities for the calculation of many complex, real world problems, its origins and core-competency lie in highly nonlinear transient dynamic finite element analysis (FEA) using explicit time integration.

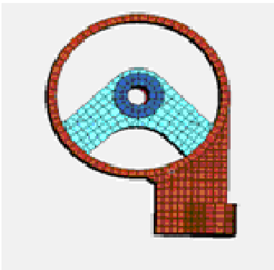


Fig 2.1 Design of Two Arm Engine Mount

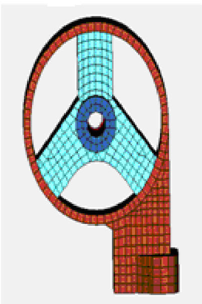


Fig 2.2 Design of Three Arm Engine Mount

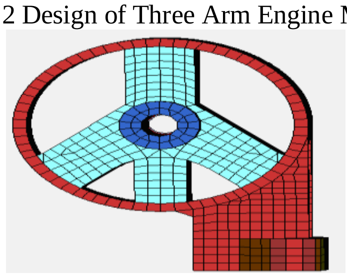


Fig 2.3 Design of Four Arm Engine Mount

III. RESULTS AND CALCULATIONS

To carry out the analysis a force of 30kN is applied to the rigid pin of engine mount in positive and negative X directions and positive and negative Z directions. The Force displacement curve which is a measure of the energy absorbed by the engine mount is obtained and this curve needs to match with experimental set up curve within 20 ms for representing the better energy absorption. During impact, the mounts are designed to fail within 20 ms so as to allow the engine to drop down and avoid injury in the passenger compartment but in this design the curve obtained from LS-Dyna approach does not follows the experimental test curve within 20 ms so this design is not suitable. Analysis is carried out for engine mount. Fig 4(a) and Fig 4(b) shows the basic design of engine mount and force v/s displacement curve in positive and negative X-direction curve for basic model of engine mount respectively. Similarly the results are obtained for two arm, three arm, four arm, filler arm and four arm symmetry engine mounts and they are illustrated in Fig.5 to Fig.13. Among all iteration the design of four arm symmetry engine mount curve obtained from LS-Dyna approach follows exactly the experimental test curve within 20ms and also this design has the highest natural frequency,

ITERATION	Mode 1 in Hz	Mode 2 in Hz	Mode 3 in Hz	Mode 4 in Hz	Mode 5 in Hz	Mode 6 in Hz
2 Arm	1.1100	1.1220	1.1300	1.1403	1.1500	1.1510
3 Arm	1.0012	1.0221	1.1431	1.1453	1.1810	1.2501
4 ARM	1.0601	1.0650	1.1300	1.1750	1.2120	1.2321

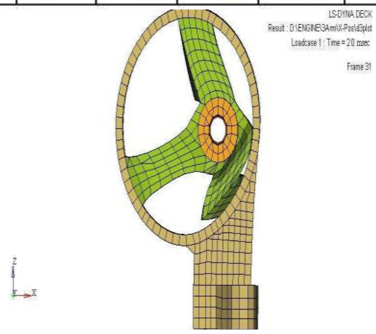


Fig 3.1 Displacement of model in X-directions at 20 ms

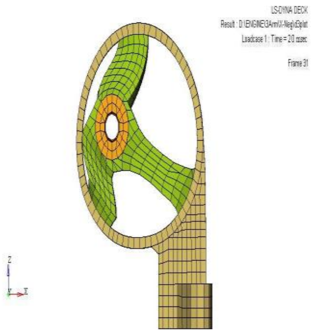
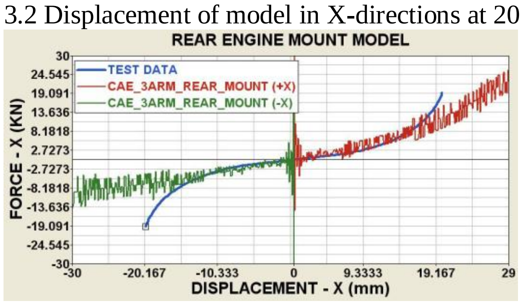


Fig 3.2 Displacement of model in X-directions at 20 ms



In this design the curve obtained from LS-Dyna approach follows the experimental test curve within 20 ms and also this design has the highest natural frequency amongst all design iterations. Hence we conclude that this design is best suited.

IV. CONCLUSION

The finite element model of engine mount is created using CAD & Hypermesh and simulation of the engine mount is carried out using LS-Dyna. The analysis results which are obtained from two arm, three arm, four arm, filler arm and four arm symmetry engine mounts in which the design of four arm symmetry engine mount curve obtained from LS-Dyna approach follows exactly the experimental test curve and also this design has the highest natural frequency amongst all design iteration. The results indicated that the rubber used in the engine mount had increased the frequency from 1.2Hz (basic design) to 1.8Hz (four arm symmetry). As the design is changing in rubber, the mode of frequency increases and it has found that 1.8Hz is the frequency for the four arm symmetry mount design.

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