DESIGN AND ANALYSIS OF ENGINE MOUNTING BRACKET USING ANSYS TOOL

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ABSTRACT
Engine mounting bracket plays very significant role in reducing noise, vibration and harshness caused due to engine and thus has very effective role in improving vehicle comfort. This current article accounts for the investigation of engine mounting bracket by using ANSYS. Static and modal analysis of engine mounting bracket was done in order to investigate whether the current natural frequency of engine mounting bracket is lower than that of self excitation frequency of bracket. The obtained results were also examined for cross section of bracket. It was found that circular cross section having stress induced 128.47MPa is more reliable than square cross section. The results were analyzed for stresses and deformations. The design was tested for different materials like Magnesium, ERW-1 and ERW-3 along with suitability of material. Stresses induced in magnesium bracket were 64.07 MPa with the deformation of 1.20 mm. It can be anticipated that magnesium brackets are corrosion resistant and can be considered for desired application.

KEY WORDS: ANSYS, ERW-1, ERW-3

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 [1]. Engine mounts have great effect on the noise and vibration harshness (NVH) characteristic and has to withstand large levels of vibration due to the nature of the use of the machine[2]. Engine Mounting Bracket is prone to failure since it has to withstand heavy dynamic loads of the engine when the machine is in operation. 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[3]. 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.
The need for light weight structural materials in automotive applications is increasing as the pressure for improvement in emissions and fuel economy increases. The most effective way of increasing automobile mileage while decreasing emissions is to reduce vehicle weight[1,4]. The noise and vibration occur because the power that is delivered through bumpy roads, the engine, and suspension result in the resonance effect in a broad frequency band. The ride and noise characteristics of a vehicle are significantly affected by vibration transferred to the body through the chassis mounting points from the engine and suspension.
In diesel engines the engine mounting is one of the major problems. Due to the Un-throttled condition, and higher compression ratio of the diesel engine, the speed irregularities particularly at low Speed and Low load conditions and are significantly higher than gasoline engines. By optimizing the thickness and shape of major mounting points made it possible to design a vehicle with optimized weight and performance at initial designing stages.
It is known that body attachment stiffness is an important factor of idle noise and road noise for NVH performance improvement. The problem of vibration has two classes, first is of forced isolation and other is of motion isolation. In later one, blunders can be avoided by controlling natural frequency of bracket lower than the self excitation frequency. So as a counter part of this law of transmissibility is taken into account.

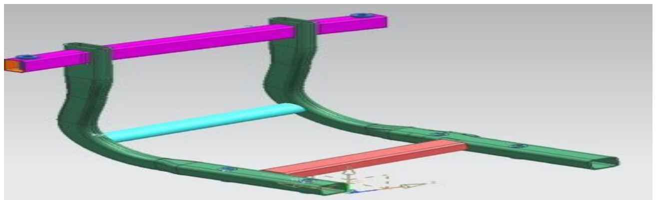

Fig 1: Isometric view of the mounting bracket

However in this work, the engine mounting bracket was analyzed for different stress analysis, shape optimization and alternative material optimization using ANSYS software.

EXPERIMENT

A. STATIC STRUCTURAL ANALYSIS OF ENGINE MOUNTING:

Static Analysis deals with the conditions of the equilibrium of the bodies acted upon by forces. A Static analysis is used to determine the displacements, stresses, strains and forces in structures and components caused by loads that do not induce significant inertia and damping effects. The kind of loading that can be applied in static analysis includes External applied forces, pressures and moments Steady state inertial forces such as gravity and spinning imposed non-zero displacements.

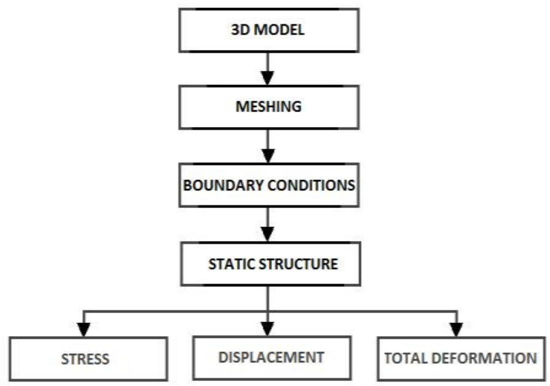

Fig 2: Flow chart for Static Structural analysis

B. ALTERNATIVE MATERIAL FOR ENGINE MOUNTING BRACKET: A] MAGNESIUM:

1. Magnesium is the lightest of all metals used as the basis for constructional alloys.
2. It is this property due to which automobile manufactures has to replace denser materials, not only steels, cast irons and copper base alloys but even aluminum alloys by magnesium base alloys.
3. The requirement to reduce the weight of car components as a result in part of the introductions of legislation limiting emission has triggered renewed interest in magnesium.
4. The advantages of magnesium alloys are listed as follows, lowest density of all metallic constructional materials.
5. It posses high specific strength, good cast ability, which suitable for high pressure die casting good welding properties, higher corrosion resistance.
6. Also compared with polymeric materials it posses better mechanical properties, better electrical and thermal conductivity and it is recyclable.

a] ERW-1: Electric resistance welded or high frequency induction welded steel tubes designated as ERW. It comprises of 0.15%C, 1%Mn, 0.04%S and 0.04%P. This ERW-1 steel contains following mechanical properties (Table-1);

Table-1 Mechanical Properties of ERW-1

Designation	Tensile Strength (MPa)	Yield Strength (MPa)	% Elongation on (Gauge length)
ERW-1	310	160	20

b] ERW-3: This ERW-3 steel contains 0.35%C, 1.60%Mn, 0.04%S and 0.04%P. These steel tubes shall be made from steel strip and resistance welded continuously by the passage of an electric current across the abutting edges/high frequency current is induced in the open seam tube by an induction coil located ahead of the weld point and shall comply in all respects. It possesses following mechanical properties (Table-2);

Table-2 Mechanical Properties of ERW-3

Designation	Tensile Strength (MPa)	Yield Strength (MPa)	% Elongation on (Gauge length)
ERW-2	435	270	10

RESULTS AND DISSCUSSION

A. MODAL ANALYSIS: Modal analysis was done for obtaining the different frequencies for Magnesium, ERW-1, and ERW-3 materials (Table 3);

Table 3: Frequency ERW-1 v/s Magnesium v/s ERW-3

Frequency	ERW-1 (Hz)	Magnesium (Hz)	ERW-3 (Hz)
1	68.897	70.165	45.86
2	87.596	90.235	88.56
3	106.05	106	85
4	195.83	188.46	153.53
5	266.74	279.23	220
6	520.41	548.23	445.20

As the mode of frequency was changed, initially no change was observed in ERW-1 and Magnesium material. But ERW-3 shows large variation in frequency as compared to ERW-1 and Magnesium. This is probably due to the varying composition and superior mechanical properties of ERW-3 material(figure 3).

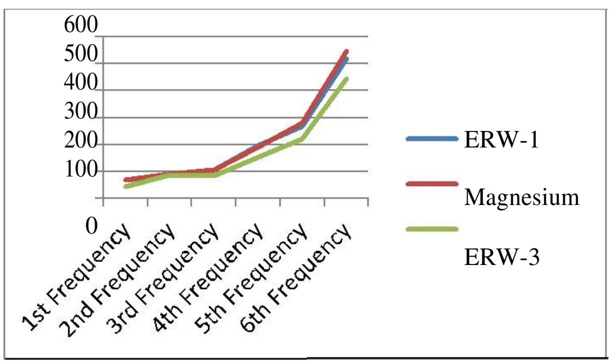

Fig.3 Frequency ERW-1 v/s Magnesium v/s ERW-3

Table 4 Maximum displacement ERW-1 v/s Magnesium v/s ERW-3

Maximum displacement	ERW-1 (mm)	Magnesium (mm)	ERW-3 (mm)
First Mode	29.19	28.02	23.23
Second Mode	31.13	29.20	25.86
Third Mode	33.22	30	30.10
Fourth Mode	34.84	31.50	30.89
Fifth Mode	47.38	36.80	28.23
Sixth Mode	35.51	34.36	29.56

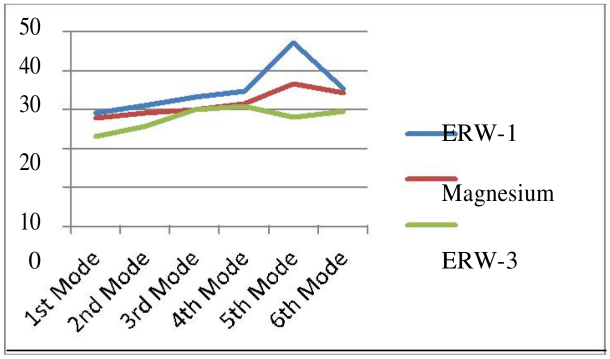

Fig.4 Maximum displacement ERW-1 v/s Magnesium v/s ERW-3

The convergence of frequencies for ERW-3 material is good. The first excitation frequency value for ERW-3 is higher than that of excitation frequency range of engine. The values of frequencies are nearly same for ERW-1 and Magnesium bracket.

B. ALTERNATIVE MATERIAL FOR ENGINE MOUNTING BRACKET:

ANSYS software was used for stress analysis and results are tabulated in Table-5;

Table 5: Stress Distribution among ERW-1, Magnesium and ERW-3

	ERW- 1	Magnesium	ERW-3
Von-Mises stress(max) (MPa)	82.96	64.07	68.87
Total deformation (mm)	1.086	1.20	1.90

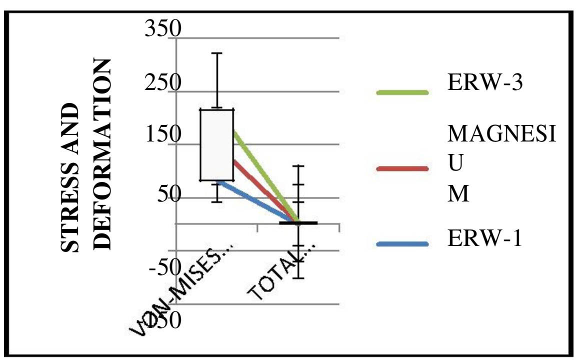

Fig.5 Comparison between ERW-1, Magnesium and ERW-3

It can be anticipated that magnesium is the best for the desired application.

CONCLUSIONS

1. Engine mounting bracket plays very significant role in reducing noise, vibration and harshness caused due to engine and thus has very effective role in improving vehicle comfort.

2. The Computational fluid dynamics tool, ANSYS has been used to analyze the engine mounting bracket. The results

obtained from the static structural and modal analysis shows that Magnesium is better than ERW-1 steel. From the results it can be said that the ERW-3 steel bracket is safe for the required application.

3. The design was tested for different materials like Magnesium, ERW-1 and ERW-3 along with suitability of material. Stresses induced in magnesium bracket were 64.07 MPa with the deformation of 1.20 mm. It can be anticipated that magnesium brackets are corrosion resistant and can be considered for desired application.

4. This work also contributes to the defining alternative material engine mounting bracket, in which aluminum alloy were studied along with ERW-1 and ERW- 3 steel. After analyzing the results, it can be anticipated that Magnesium can be proffered over ERW-3 and ERW-1.

5. Stiffness of ERW-3 found better than Aluminum, so it may be used for required application of engine mounting bracket.

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ISSN No - 2394-3696

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