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NOISE &VIBRATIONS IN AUTOMOBILES: REVIEW AND DIAGNOSTICS

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Abstract

There are many issues and concerns raised in many of the previous studies, related to the noise coming from the automotives in form of vibrations. Such noises and vibrations may affect the value of vehicle at the first-hand life of the vehicle at the second. As a matter of fact, many of the agencies had laid down different rules and regulations for such emitting noises and vibrations. This present study will depict the causes of such vibrations and noises and will also present respective remedies for the same.

Key Words: Noise, Vibration, motor vehicles.

Introduction

Sound is generally considered as a form of energy that use to travel with a given velocity through a medium, it is also considered as a sound. As far as vibration is concerned, it is also known as displacement of a body with certain mass and movement of that body is in specific reference of time. **Raju et al (2004)** This movement is bigger or smaller than the reference of time. When vibration is actually sensed with some audibility it is considered as harshness, in case of automobiles the tires use to interact with the road and its harshness (irregularities) and creates vibration in the structure above the road and related components. **Karanath et al (2005)** As far as consumption of energy is concerned, most of the times it is consumed for transportation. In case of automobiles, the environment is affected to a detrimental level and more that 20% of the emission of green gases is contributed by the movement of automobiles. As far as noise is considered, in the present scenario it is considered as a type of pollution i.e., noise pollution and the same is increasing by every passing year in the urban areas of the country. Some major standards were laid down by the national & international agencies in this regard and limits are imposed for noise pollution in residential areas, as we can see sign boards of 'no honking' near school and hospitals. Such noises created by the way of transportation were divided in two parts i.e., PBN (*passby noise*) and SN (stationary noise). in this regard, it is a known fact that the thickness of engine oil plays a vital role in the determination of the engine's vibration and its related features. Then on the other hand the vibration of the vehicle is directly related to the comfort of the user i.e., lesser the noise greater the price and vice versa. It can also be stated that the vibration of a given vehicle and its structure is related to the inner comfort of the vehicle. The levels of sound energy and structural excitation inside the vehicle

compartment measures the amount of annoyance in terms of quality and comfort. As far as structure of the vehicle is concerned, noise may have various sources like sounds from various components of the vehicle, leakages from the different body panels in different quantities, noise created in shifting of gears, steering wheel movement, etc. Such quantifiable vibrations can become points of comparison for selecting a particular vehicle as noise from interior structure can become the basis of judgement regarding operational performance and quality of the vehicle. In the present scenario, especially after the international trade became liberal in India (after 1991) competition in the motor vehicle market has increased to a substantial level and the demand of vehicles with higher comfort and quality increased. From this point of time, it became difficult for the market competitors to attain leadership in the given automobile market.

Sources of Noise in Motor Vehicle

If there is noise in the vehicle then the comfort of the rider decreases; the compactness of the present-day vehicle has moved from bigger power units to compact power units that leads to increased noise from the inner body and panels of the vehicle. Also, this gives rise to the vibrations in the inner body of the vehicle.

In a given vehicle, vibrations in the engine of a motor vehicle is created because of the reciprocating mechanism liable to convert fuel energy in motion of the vehicle. Some of the forces that use to produce vibration in the vehicle are as follows:

- Combustion
- Reciprocating, and
- Rotational Forces.

A downward force is generated during combustion stroke on the piston which due to geometrical construction of connecting rod and crankshaft generates a torque around crankshaft axis. Torsional vibrations are generated due to the torque variation.A multicylinder engine can be compared with a system of masses rotating on a single crankshaft in single and different planes. The primary & secondary forces as well as couples generate vibrations due to reciprocating unbalance. Significant inertia effects are generated due to small unbalance of rotating masses in highspeed engines. Rotating unbalance generates unacceptable levels of vibrations and stresses in individual and supporting structures.

Some of the different noises created in the motor vehicle are like noise of induction, noise of exhaust system, accessories implanted in the motor vehicle; here the noise of induction is created by the opening and closing of valves. **Hussaini (2006)** The inlet air column is ought to oscillate because of the intense pressure. When the valve closes forced vibrations are produced. Then the noise from exhaust valve also produces vibrations which is forced and undamped. Some of the external accessories installed in the motor vehicle creates many sounds like the engine fan which is used to keep the radiator cool and is wind driven, this noise is created when the motor vehicle is in motion. Pressure fluctuations result in generation of noise. Combustion process of the vehicle also produces vibrations i.e., by the distortion of engine. Alternating inertia loads and mechanical impacts of the engine mechanism produces noise. Often it is very difficult to sort out which force is the cause of excitation of engine structure.

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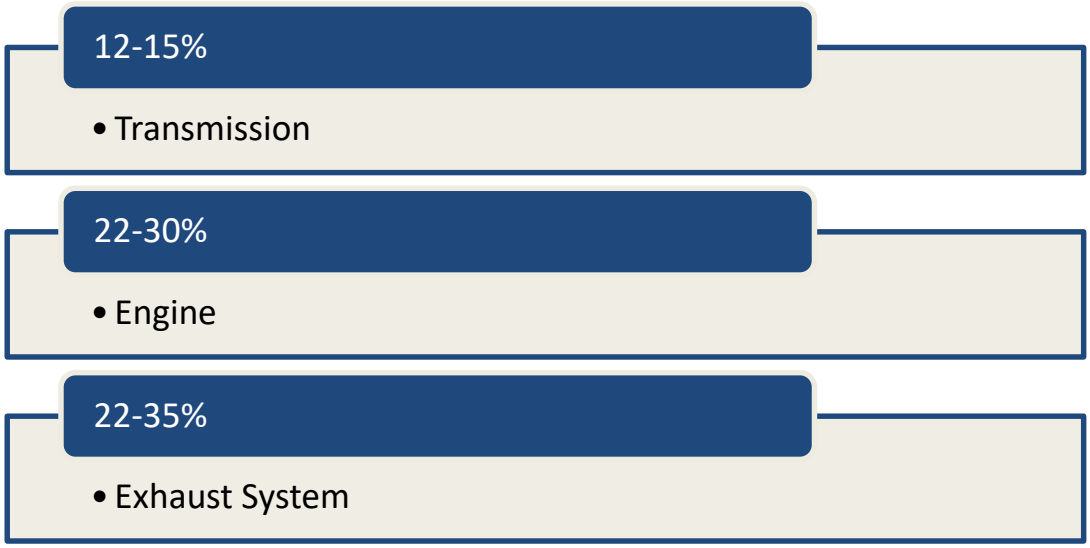

Figure 1: Percent contribution of sources to total noise

Driveline of the motor vehicle also produces noise as well as vibrations due to transmission of power from engine to wheels. Here the make of front wheel drive and propeller shaft of rear wheel drive creates noise as well as vibrations. Many noises are created in the gear transmission system, these are created due to propeller shaft. Some of the other noises are created in the driveline due to noise of axle, noise of tires, noise from aerodynamics, noise from wind and even the noises from interior sections. Generation of noise & vibrations from gears results due to improper bending dynamics of gear toothand both torsional and bending characteristics of shafts. Propeller shaft generatesexcitation at elemental speeds.

In addition, most modern vehicles create a constant velocity clutch in the center of the two-piece drive shaft, which results in noise. Axle noise is caused by the reaction of the rear axle to the vibrations generated by the axle gear transmission. The noise created in this way causes irritation even in the interior of the squatting car. Tire noise is caused by tribology between the tire and the road. The mechanics of tire noise can be a combination of crushing vibrations (the primary source of noise) that exist due to uneven road surfaces, curved tread leading to lateral vibrations, and the generation of noise spectra. The sliding/aerodynamic noise created by the chaotic airflow around the tire contributes to tire noise. The tire is fed in a variety of ways, including uneven wear, radial or lateral deflection, road roughness, road surface roughness, road surface roughness causing bumps, bumps, etc., which contribute to vehicle noise and vibration. Wind noise is superficial and can be felt inside the car. Air flow outside the vehicle and air flow in and out of the cabin due to imperfect sealing of door and window frames are the cause of wind noise.

At certain points the noise coming from the interior of the motor vehicle is being connected to the comfort of the passengers and it keeps increasing and decreasing because of various reason. To identify and quantify the sounds coming from interior parts of a given motor vehicle each vehicle component is determined by keeping check on the parts like panel acoustic leakages, panel vibrations gear shifting, and steering wheel vibrations. Engine being the main source of noise, the noise from the engine is transmitted in two ways viz. direct infiltration & structural vibrations.

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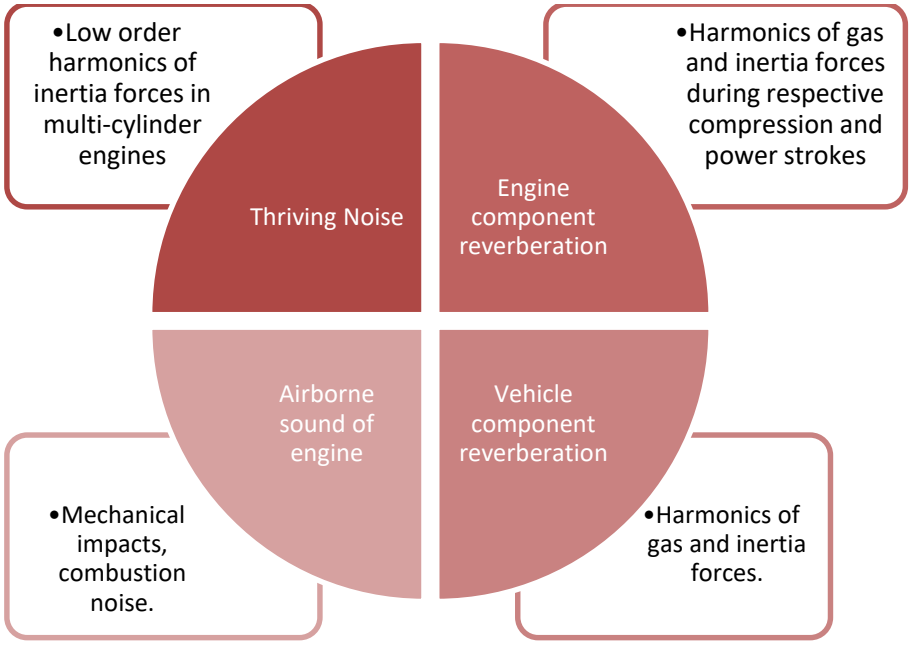

Figure 2: Engine noise, phenomenon and sources

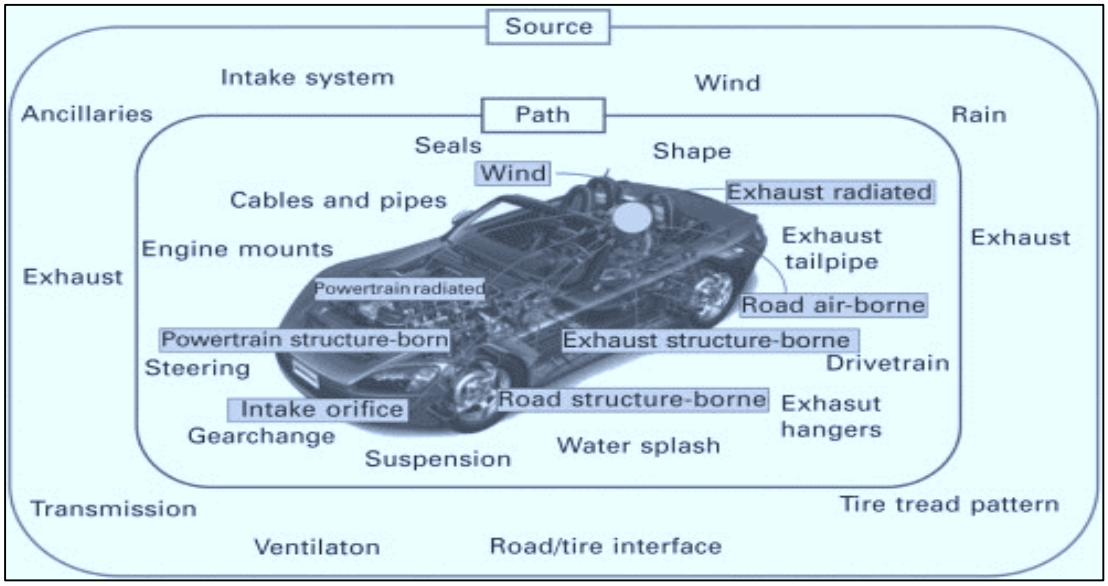

Figure 3: Sources of Noise in Motor Vehicle

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S.No	Type of Vehicle	Sound level dB(A)
i.	Personal car	74
ii.	Bus and truck weighing between3.5 to 2 tonesand below	76
iii.	Bus with total weight above 3.5 ton and enginepower below 15kW	78
iv.	Bus and truck weighing in between 2 to 3.5 toton.	77
v.	For engine power 150kW or above	80

Techniques to Reduce Noises in Motor Vehicle

A. Engine Flow Path

The vibration modes of the structure of motor vehicle are used to determine the properties of transmission path then on the other hand the properties of outer surface influences the sound emitting out of the same. The ways in which the resulting engine noise emission can be influenced or controlled are to reduce the source of combustion forces and mechanical forces, to reduce the transmission of vibrations between the source and the external surface, to reduce the external surface radiation of sound, to control or reduce the combustion pressure, to reduce piston knock by redesigning the piston and cylinder or by injecting an oil film, the improved design reduces the noise of the gearbox and bearings e.g. gear tooth profiles and bearing clearances, more advanced redesigns can be made via simulating the dynamics.

B. Exhaust and Intake Noise Control

The noise created from the exhaust and system and intake system comes from the pressure fluctuations of the additional flow generation and engine. Here the emitting noise can be controlled by making changes in the process of combustion, this will certainly impact the performance of the engine and even the performance of the exhaust gas emissions. Here the silencers can be used within the flow duct so as to reduce the sound i.e., it will not reach the duct opening. Infused silencers reflect the sound back to the source which means the silencers reduce sound by absorbing material. Basic requirements for a modern exhaust system; compact outer geometry, sufficient attenuation and low pressure drop.

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Damping of Vibration

The use of viscoelastic materials increases the damping of the structure in three different ways, i.e. Damping treatment with a free layer, Damping treatment with a limited layer, Tuned viscoelastic damping treatment. The filler material is sprayed onto the frame or glued to the loose filler layer with a pressure-sensitive adhesive. An interesting feature of the free layer processing is that the damping characteristics are independent of the vibration mode. The limited suspension layer consists of a sandwich of two elastic outer layers with a viscoelastic material as the core. This damping is more effective than the free layer design because more energy is consumed and dissipated than heat when work is done by the shear mode in the viscoelastic layer. TVDs are useful for reducing vibration/noise associated with a single frequency or a narrow frequency band. Properly tuned TVDs eliminate unwanted resonance by splitting the original peak into two, one below and one above the system's original resonant frequency.

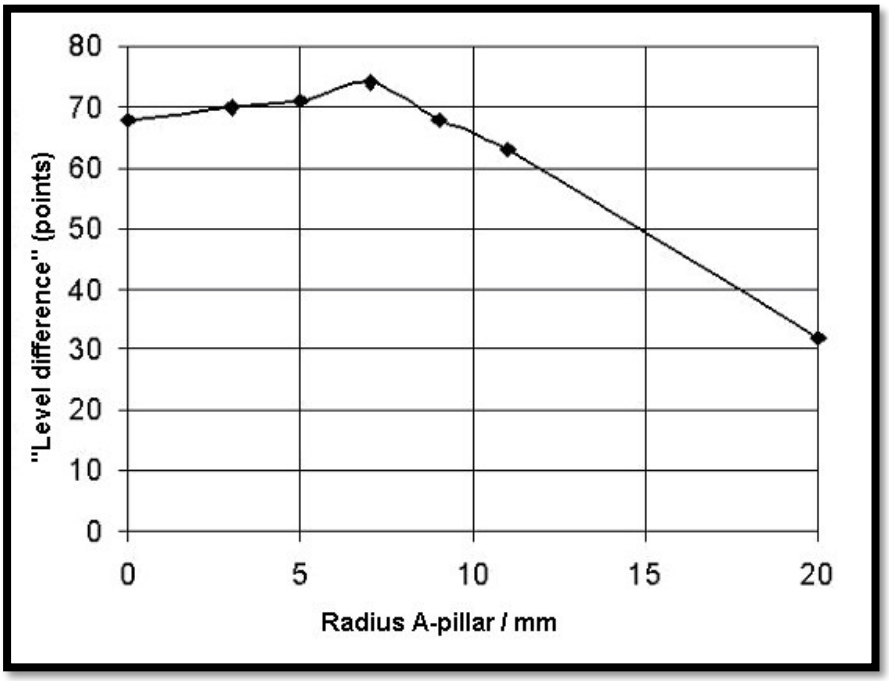

Figure 4: Difference in sound pressure level of the interior noise between 0° and 10° yaw angle, with different A-pillar radii

Conclusion

In a given motor vehicle various vibrations use to occur from the engine of the vehicle and reaches the driveline of the vehicle, the researcher had tried to evaluate the causes the characteristics of these vibrations and presented remedies for the same. Vibrations coming from the engine may result from the various sources like the combustion process, where the rotational value is reduced by the way of balancing methods. These methods are used to balance the influence of noise and vibration at the time when the designers are processing the motor vehicle. Heresy the sources of noise are quantified and determined in number of terms, after these techniques are used to reduce these noises; this adds value to the design of the vehicle and increase comfort for the driver operating or driving the vehicle. As a matter of fact, the energy flow method us used to check any vibration issues and related problems of vibration, this method checks the inner and external linear vibrations. The internal noise of the vehicle

can be reduced by the manufacturers via using the materials that can absorb sounds then the basic openings and sealings can be checked and rechecked; there can be a possibility that there is some chance of leakage and filtration from the same. Then on the other hand viscoelastic materials can be used for damping vibrations.

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