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Experimental NVH Analysis on a Minitruck

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Abstract:- Automobile the most economical way of transportation of both goods as well as peoples from one place to another. But the noise generated inside the cabin of the truck during running condition is very much disturbing and hazardous to the health of both driver and passengers. Hence, reducing the noise and its cause is very important to the extent. Heavy truck produce more noise compared to minitrucks as they are having heavy duty engine below the cabin. But still working of minitrucks to reduce noise level is a challenging task. In this study acoustic materials are used to reduce the noise level inside the Tata Ace mini truck of 702 CC engine and the results are discussed.

***Keywords*:-** *Noise, Vibration, Frequency, Harshness, Vibro-Acoustic Materials, Density, Hardness, Sound Pressure, Truck Cabin, Damping Etc.*

I. INTRODUCTION

Many peoples are affected by noise in homes, auditoriums, seminar halls and in transport vehicles. Noise impacts more people than any other source in the environment. Noise affects the ability to work, learn, rest, relax, sleep, think etc. Excessive noise can harm to mental and lead to physical health problems. There are basically four options for controlling noise: constructing a barrier wall, increasing the isolation quality and property of the cabins, masking the noise, or controlling the noise directly at the source. Low noise level in the cabins is highly preferred parameter. Hence, reduction of noise inside the cabin is a challenging task.

II. ACOUSTIC MATERIALS

Sound-absorbing materials absorb most of the sound energy striking them. They can be used in a variety of locations – close to sources of noise, in various paths, and sometimes close to receivers. Once noise and vibration sources have been identified, the use of vibration isolation, barriers, sound-absorbing materials, used to protect passengers. Sound-absorbing materials should always be used in combination with barriers and inside enclosures to improve their effectiveness.

A wide range of sound-absorbing materials exist; they provide absorption properties dependent upon frequency, composition, thickness, surface finish, and method of mounting. However, materials that have a high value of sound absorption coefficient are usually porous in nature. Figure 1 shows a cross-section of a porous solid material.

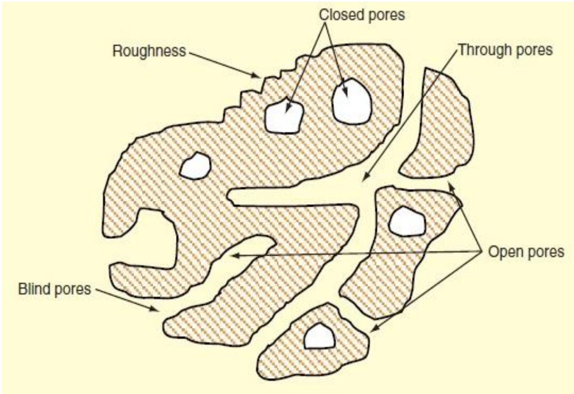

Fig.1 Cross section of a porous solid material

Porous absorbing materials can be classified into cellular, fibrous, or granular. Figure 2 shows the main types of porous sound absorbing materials [2].

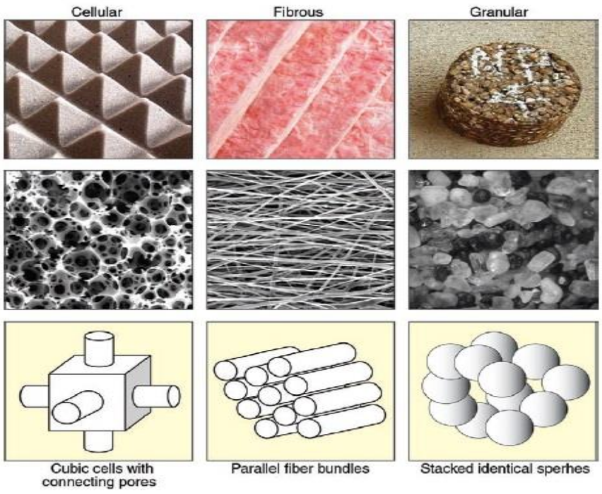

Fig 2:- Three main types of porous absorbing materials

A working knowledge of acoustical materials is essential for noise control engineer. Without this knowledge, cost-effective control of noise becomes more a matter of chance than of intelligent design. The major characteristics for each of categories are summarized in table 1. The first three categories function is to absorb or attenuate airborne sound waves. The last category function– vibration isolation- is to minimize the transmission of shaking forces into a floor or other solid structure. This force, if not reduced, can cause vibration of the structure and consequent spreading and generation of sound waves. The fourth category function– damping treatments - is to reduce the amplitudes of resonant vibrations that generate airborne sound and or to minimize the transfer of vibratory energy at panel edges or attachment points to adjoining structural elements [3].

Category	*Description of*	*Purpose of*	*Representative uses of*
Absorptive materials	Relatively lightweight; porous, with inter-connecting passages; poor barrier	Dissipation of acoustic energy, through conversion to minute amounts of heat	Reduction of reverberant sound energy; dissipation of acoustic energy in silencers
Silencers	Series or parallel combination of reactive elements	Dissipation of acoustic energy in the presence of steady flow	Duct silencers in inlet and exhaust silencers for engines, fans, turbines
Barrier materials	Relatively dense, nonporous	Attenuation of acoustic energy	Containment of sound
Damping treatments	Viscoelastic materials with relatively internal losses	Dissipation of vibratory energy	Reduction of acoustic energy
Vibration isolators	Resilient pads; metallic springs	Reduction of transmitted forces	Mounts for fans, engines, machinery

Table 1:- Materials and structures for noise control

The experimental study uses following four different types of acoustic materials inside the cabin.

Sl. No	Material	Thickness (mm)	Weight
1	Vinyl Noise Barrier	2	4 kg/m^2
2	Polyester Wadding	10	1000 gsm
3	Polyethylene Foam	15	500 gsm
4	Wool Foam	20	1500 gsm

Table 2:- Materials used for experimental noise control

III. EXPERIMENTAL STUDIES

The noise and vibration studies on minitruck cabin is performed in following stages under engine started idle mode and full acceleration mode conditions.

a. Before treatment
b. After treatment no 1. : Applying Vinyl Noise Barrier
c. After treatment no 2. : Applying Polyester Wadding
d. After treatment no 3. : Applying Polyethylene Foam
e. After treatment no 4. : Applying Wool Foam

Fig 3 to 7 shows the cabin of a minitruck vehicle before treatment and after different treatments inside the cabin.

Fig 3:- Before treatment

Fig 4:- Cabin after treatment no 1

Fig 5:- Cabin after treatment no 2

Fig 6:- Cabin after treatment no 3

Fig 7:- Cabin after treatment no 4

IV. RESULTS AND DISCUSSIONS

The engine having two cylinders and 702 CC capacity is being started in idle mode and in full acceleration mode. The noise levels are measured using array microphone sensor and data are stored for full 20 seconds of operation using 8 channel data acquisition system and computer.

The graphs found from the software provided by the DEWESoft are as shown below.

A. Before Treatment

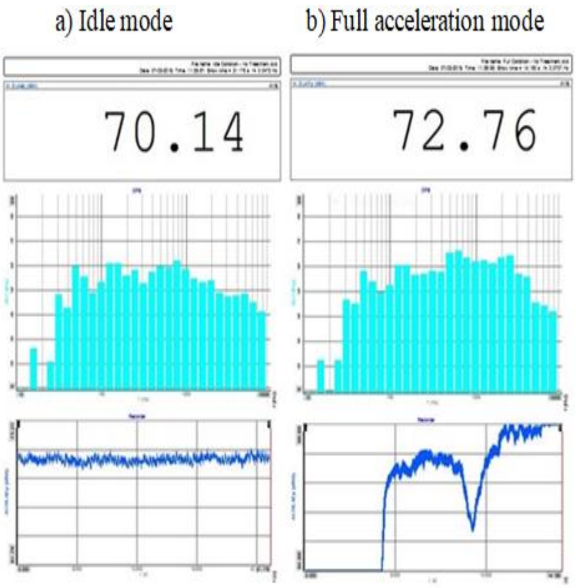

Fig 8:- SPL before treatment

From above graph it is found that the SPL inside the cabin noted was 70.14 dB in idle mode and 72.76 dB in full acceleration mode before any treatment was done.

B. After Treatment: Vinyl Noise Barrier

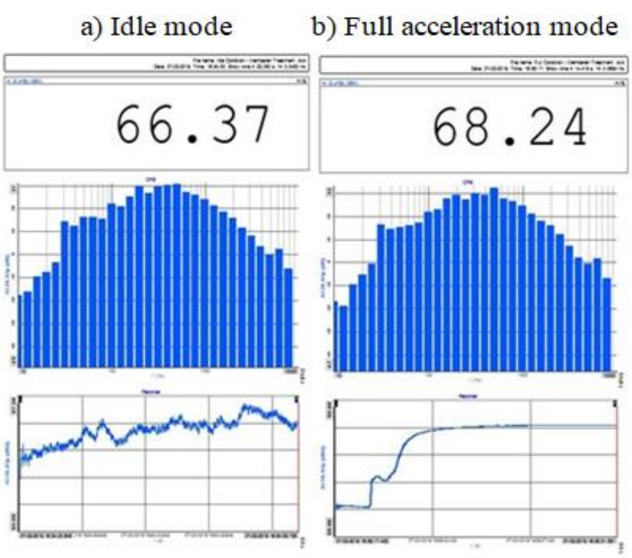

Fig 9:- SPL after treatment no 1

From above graph it is found that the SPL inside the cabin noted was 66.37 dB in idle mode and 68.24 dB in full acceleration mode after treatment no 1 vinyl noise barrier was applied inside the cabin.

C. After Treatment: Polyester Wadding

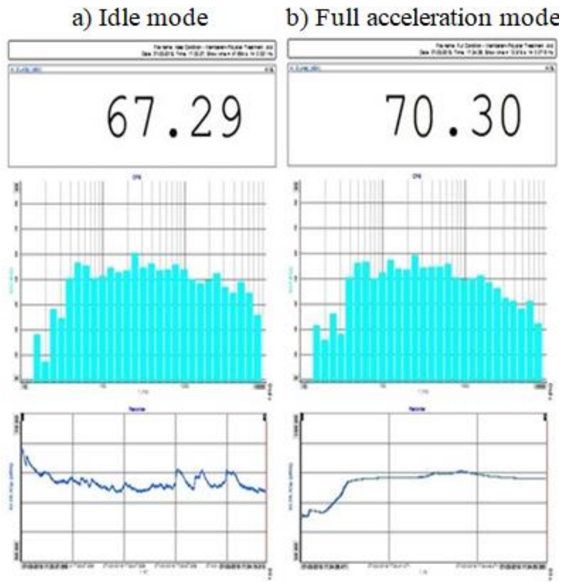

Fig 10:- SPL after treatment no 2

From above graph it is found that the SPL inside the cabin noted was 67.29 dB in idle mode and 70.30 dB in full acceleration mode after treatment no 2 Polyester wadding was applied inside the cabin.

D. After Treatment: Polyurethane Foam

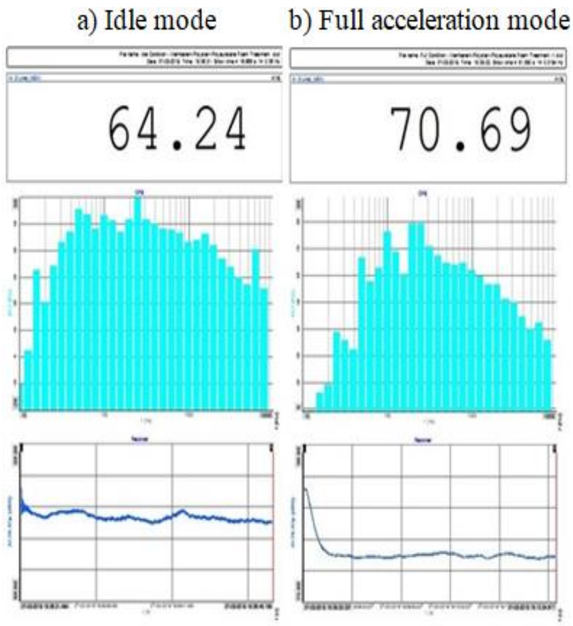

Fig 11:- SPL after treatment no 3

From above graph it is found that the SPL inside the cabin noted was 64.24 dB in idle mode and 70.69 dB in full acceleration mode after treatment no 3 Polyurethane Foam was applied inside the cabin.

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E. After Treatment: Wool Foam

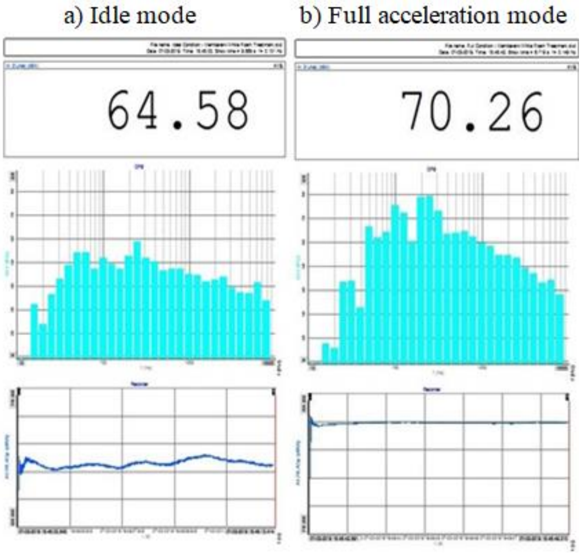

Fig 12:- SPL after treatment no 4

From above graph it is found that the SPL inside the cabin noted was 64.58 dB in idle mode and 70.26 dB in full acceleration mode after treatment no 4 Wool Foam was applied inside the cabin.

Sl. No	Treatment Type	SPL @ Idle (dB)	% Reduction	SPL @ Full acceleration (dB)	% Reduction
1.	Before Treatment	70.14	---	72.76	---
2.	**Vinyl Noise Barrier**	**66.37**	**4.89**	**68.24**	**6.21**
3.	Polyester Wadding	67.29	**4.06**	70.30	3.38
4.	Polyurethane Foam	64.24	**8.40**	70.69	2.84
5.	Wool Foam	64.58	**7.93**	70.26	3.43

Table 3:- Comparison of SPL inside the cabin on various treatments

V. CONCLUSIONS

- The Noise barrier treatment found to be most ergonomic and effective way of reduction of noise inside the cabin compared to other treatments.
- Treatments like polyester wadding, polyurethane foam and wool foam do not reduce the noise level as that of noise barrier even though they are absorbers.
- Combinations of treatments may give better results.
- Noise deadening paints can be used for coating of sheet metal surfaces and may yield good results.
- Newest barrier material and other noise reducing methods can be tried for further scope of work.

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