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VIBRATIONS IN PASSENGER BUS AND ITS ANALYSIS

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ABSTRACT

Vibration is always present in any operating machine and a vehicle is not an exception. Focusing on ride comfort of Occupants in a Bus, the vibration inputs coming directly from seat as well as the rattling body interiors are a major contributor to discomfort and fatigue. Issues like shaking rear view mirror combined with this fatigue, are also frustrating for Driver and is potential contributor to the accidents. Main objective in this paper is to study the points where the vibration in a passenger bus is occurring and how it gets transmitte

KEYWORDS: Vibration, Operating Machine, Focusing, Discomfort & Fatigue

INTRODUCTION

All physical bodies, and structures, posses the mass and stiffness and are also subjected to motion which causes vibration. In certain engineering cases vibration plays a paramount role, in others it is negligible and is of no interest from a technical point of view. To decide which type is the problem under consideration is a matter of vibration analysis and fine engineering judgment An automobile, is a combination of various dynamic systems that too working together under highly dynamic inputs. It is combination of tires, wheel and un-sprung masses, suspension, followed by flexible strength member like frame and body. Additionally there are internal inputs generators like engine and driveline. This complex system produces a vibration response based on road inputs, varying torque inputs and overall dynamic interaction of various element , which is finally perceived by subject receiver i.e. driver and passenger.

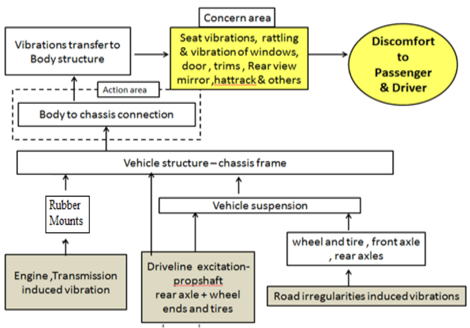


Figure 1: Schematic of Vibration Transfer Path in a Bus

Figure 1 represents a schematic showing the flow of vibration in a bus. In the bottom are shown the sources like road inputs, engine and driveline components that induce vibration in the system. While the road and rear axle and tyre wheel vibration area filtered to some extent by suspension properties, the engine vibration are filtered through the rubber mounts used for installations. Based on response of these rubber mount and suspension the vibration inputs are transferred to the bus frame from where it is transferred to the body welded /mounted to same.[1]

Based on the mass and stiffness property and thus the natural frequency of body plus chassis frame structure and the internal/external components mounted on it like floor , seats ,windows , hat track and rear view mirrors etc., the vibration level are amplified and thus finally perceived by the Occupant – driver and passenger. Figure 2 shows the various points in a bus through which noise and vibration observed by passenger. [1]

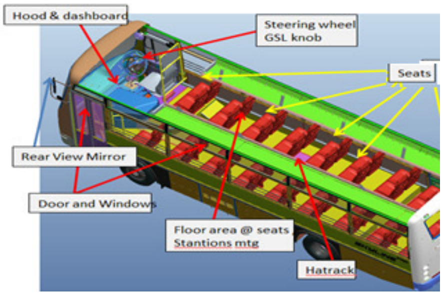
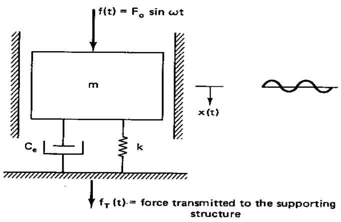


Figure 2: Bus Tactile Points

VIBRATION AND TRANSMISSIBILITY BASICS

Transmissibility [2] in the case of force-excited system is defined as the ratio of the force transmitted to the foundation to that of impressed force upon the system. Consider a system of mass ‘m’ supported on the foundation by means of an isolator having equivalent stiffness and damping coefficient ‘K’ and ‘c_e’ respectively as shown in figure 3.



$$T = \frac{F_T}{F_o} = \frac{\sqrt{1 + \left(2\xi \frac{\omega}{\omega_n}\right)^2}}{\sqrt{\left[1 - \left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(2\xi \frac{\omega}{\omega_n}\right)^2}}$$

Figure 3: Force Transmissibility to Foundation with Sinusoidal Input on Mass

Transmissibility is given by the formula as shown in the figure 3, where f(t) is the harmonic force acting on the system and $f_T(t)$ is the force transmitted to the supporting structure, ω_n is the natural frequency of the system, ω is the excitation frequency at the supporting structure and ξ is the damping factor. In the region of attenuation, isolation is the term used instead of transmissibility as a measure of reduction in vibration input and is given as a percentage value occurring for a particular disturbing frequency. Isolation efficiency=%Isolation= [1-T] ×100.

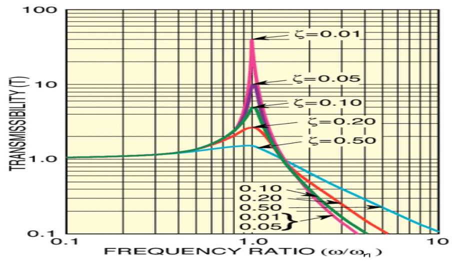


Figure 4: Transmissibility Vs Frequency Ratio Curve

The curve of transmissibility V/s frequency ratio is the vibration transmission chart (Figure 4). All the curves start from unit value of transmissibility, pass through the unit transmissibility at $(\omega/\omega_n) = \sqrt{2}$ and after they tend to zero as (ω/ω_n) tends ∞. These curves can be divided into three different frequency regions. The isolation is effective at the higher frequency ratio range i.e $(\omega/\omega_n) >= \sqrt{2}$ and is known as mass controlled region because larger mass gives us the higher frequency ratio. The region with $(\omega/\omega_n) << 1$ and is known as stiffness controlled region because larger stiffness gives high value of natural frequency and consequently low value of frequency ratio. The middle region is damping controlled region and it involves the frequency ratio of $(\omega/\omega_n) = 1$,this is possible if the natural frequency of the mount is close to the input frequency to the system, resulting in the resonance and leads to the transmissibility of greater than 100%.This is obviously undesirable. This is the region where frequency isolation is not possible and the amplitude reduction is done by increasing the damping values.[3]

Normally if the transmissibility (T) is <0.3 then no action needed, but if T >0.3 then - Calculate the frequency ration (ω/ω_n), for this value of transmissibility and taking suitable damping factor value (= 0.05 for welded steel or 0.1 for rubber mounts)

Then based on figure 4, following are the recommendations while designing a mount for vibration isolation:- .[3]to[6]

If **ω/ω_n>=1 and < 1.414,** then decrease Stiffness & increase damping.

If **ω/ω_n< 1** then decrease stiffness sufficiently so that **ω/ω_n>1.414** , OR if not possible then reduce stiffness to cross the peak and achieve lesser T ,and combined with increased damping ,otherwise vibration amplitudes can increase .If both option not feasible then increase stiffness maximum possible so as to reach T =1.

If **ω/ω_n>1.414 &< 0.3** Then decrease both stiffness and damping and increase mass if feasible – like increasing the clamping force of connection

CONCLUSIONS AND FUTURE SCOPE

This paper dealt with the vibration transfers from Bus chassis frame to Bus body. Chassis to body is connected through the welded out-trigger connections. Vibrations from sources including-the road input, engine excitation forces and driveline vibrations reaches the passenger through the out-trigger. Vibration mapping is performed at the all out-triggers, giving the information of cumulative excitation frequencies as input from frame and response of body structure (measured at outrigger tube).Seat excitation frequencies measured from the frequency spectrum are analyzed for acceleration value limit of $0.315 m/s^2$[10]. Frequency spectrum at the out-triggers is analyzed for the critical seat excitation frequencies. This way the critical frequencies are identified based on the human comfort through mapping on seat, and other parameters include resonant frequencies for bus components and frequencies with high transmissibility at chassis to body connection.

REFERENCES

1. VE Commercial Vehicles ltd , Light Duty bus design CAD data , 2014
2. G K Grover , Mechanical Vibration , 2000
3. Thomas D Gillespie , Fundamental of Vehicle dynamics , 2002
4. VE Commercial Vehicles ltd , RLDA-2014-10-014, Vibration measurement data of JNnurm midi Bus ,October 2014
5. J S Lamancusa , Vibration Isolation 12.1 , 2002
6. Katu U.S., Desavale R.G. and Kanai R.A.”Effect Of Vehicle Vibration On Human Body – RIT Experience”, 2002.