Vibration Analysis on Car seats due to Rough and Smooth Road conditions

1V.velmurugan, [2]l.chandra sekhar, [3]b.sai ganesh,[4]d.upendra,[5]p.sumanth,[6] v.ram abhishek

[1]Associate Professor, Department of Mechanical Engineering
Saveetha School of Engineering, Saveetha University, Chennai. India.

1 profvel@gmail.com

#2,3,4,5,6fourth year student, Department of Mechanical Engineering
Saveetha School of Engineering, Saveetha University, Chennai. India.

[2]chandrasekharnaidu1118gmail.com,[3]saiganesh0638@gmail.com,[4]upendra143@gmail.com

[5]psumanth.bobby@gmail.com,[6]ramabhishek111@gmail.com

ABSTRACT

In general four wheeler vehicles are one of the popular vehicles in city transport. Four wheeler vehicles are exposed to vibrations due to irregular surface of roads. This affects the health as well as discomfort of the driver and passengers. The oscillations are transferred into the body of driver and passenger through the body tissues, organs and systems of the individual causing various effects on the structures within the body before it is dampened and dissipated. From literature survey reveals that vibrations are most hazardous to the health if it exceeds the limit. In the present work the experimental analysis is carried out. To measure the magnitude of the vibrations acting on driver as well as passenger for the different road profile at different speed.

INTRODUCTION

The investigation of excitation and vehicle body movements acting on the two front wheel of the vehicle due to the road profile and driving manoeuvres based on the experiments on two vehicles.

General Introduction

Cars are generally used for the comfortable journey. The design and testing of a car is so critical that they should ensure both safety and comfort. The design and fabrication of a car is generally divided into eight sub system design. They are

a) Body and frame

b) Wheels and Tyres

c) Engine

d) Transmission

e) Suspension system

f) Steering system

g) Braking system

h) Ergonomics

After designing a car many tests are done on it before releasing it into the market. Also the tests are done on the vehicles at various stages of manufacturing, developing and using. The common tests on any vehicle are done to ensure that the safety of the vehicle. Tests are comfort levels of the vehicle. Now-a-days it is most important to ensure that different vibrations and noise present in the vehicle must be controlled. For this NVH testing is done on different parts of a vehicle.

NVH Testing

NVH (noise, vibration and harshness) performance directly affects a customer's perception of vehicles. It directly impacts vehicle's sales, durability, warranty costs and customer driving comfort. A good vehicle NVH design needs to start from a well thought NVH development process, and to follow system engineering principles. It needs to balance many different attributes such as vehicle dynamics, vehicle brand image, vehicle market position, target customer groups. It needs to be designed based on the above parameters, plus having a NVH further reserve to make sure the vehicle still meets its engineering targets when it is delivered to market. Engineering considerations on target cascading, separation of structural modes, separation of different sound and vibration transmission paths, vehicle hardware design principles for NVH, and finally NVH vehicle level deliveries are all of great interest to automotive industries

NVH (Noise, Vibration and Harshness) is one of the most important indicators of riding comfort. With the rapid development and fierce competition of the automotive industry, customer's requirement on NVH is increasing. Steering wheel vibrations not only seriously affect NVH performance, but also have negative impact on the stability and safety. Control of the steering wheel vibrations is critical to improve vehicle performance.

Seating dynamics, specifically the human perception of the dynamic comfort of a seat, is an area that is of increasing importance to automotive
manufacturers catering for a market becoming more and more competitive and sophisticated. A major portion of the vibration experienced by the occupants of an automobile enters the body through the seat. To date significant attention has been paid to the static comfort of seats while work on dynamic seat comfort is limited.In India cars are one among the major automobiles used by people for transportation. Apart from pollution and performance, economy, safety and comfort are major factors to consider. Comfort of the driver plays a vital role in the passenger safety, fatigue during long drive, and drivability in heavy traffic. Comfort means absence of any discomfort[1]. A car driver often drives the vehicle through all types of road conditions. While considering the comfort, the seat is one of the main components, which has direct contact to the driver. Seat provides support to the driver, such that the pressure distribution of the seat should be uniform everywhere on the seat. Seat must avoid the vibration transmitted from the road surfaces and power train, in order to avoid back disorder, hand eye coordination, vision impairment etc. Also the prolonged exposure to vibration causes fatigue to the passenger. So to avoid this vibration we require a vibration isolator - seat. Seat should durably serve its intended purpose for its lifetime. To quantify the vibration isolation efficiency of the seat the term Seat Transmissibility is used. It is the ratio of vibration at the top of the seat to the vibration at the frame.

Transmissibility = vibration of seat / vibration at

the frame

The transmissibility of the seat will tell us the behavior of the seat at different road condition with different frequency inputs. Transmissibility varies as frequency changes.
The work is an attempt towards studying dynamic characteristics of passenger seat for comfort through objective evaluation [3]. For objective evaluation, the transmissibility and ride comfort Index were found under two different conditions on four different cars. For better understanding the vibration transmissibility key points taken for analysis are: 1. Transmissibility values at different conditions 2. Comfort index as per ISO 2631 for different conditions

SEAT EFFECTIVE AMPLITUDE TEST SEAT

Experimental analysis is carried out on driver seat to evaluate gains, seat effective amplitude transmissibility, and is an attempt to understand seating systems damping characteristics under real time conditions. A mass load of 60 kg is used during the test. The vehicle was tested in two road terrains, rough and smooth. The instrumentation and setup used for the experiment is as follows

1. Vehicle under study

2. Accelerometers 2 No's

Position 1 - Seat base Position 2 - Seat mount

3. Data Acquisition Unit

4. Post processor

5. Rigid dummy (60 kg – equivalent to seating weight)

Input data was obtained from the accelerometer installed at the seat mounts, whereas output data would be obtained from the seat pad accelerometer put on the seat base. The acceleration results are listed as per different experimental conditions. The test was carried out on seat with dummy loaded on it. Output graphs in terms of accelerations vs time (time domain output), accelerations vs frequency (frequency domain output), and transmissibility vs frequency are plotted.

Transfer path of vibrations to the steering wheel

The main excitation sources are commonly engine and road roughness in may passenger cars. In some cases there are vibrations due to some additional parts like cooling fans etc. Engine is the main cause of vibration of vehicle in the stationary condition. But while moving the road unevenness causes somewhat high amplitude vibrations and these vibrations are even amplified by the speed of the vehicle. From the excitation sources the vibrations transfer through different paths to steering wheel, the paths are as shown in the Figure. In the passenger cars evolving into the market it is necessary to make sure that there is no such steering play and also if any of steering play exists it can be detected without any equipment. So it is much required to concentrate on the remaining two directions.

Vibration measurement sensors

Many types of sensor can be used for this purpose. The most commonly used ones are piezoelectric sensors and IEPE sensors (with integrated signal conditioning). There are other brands for low frequencies (like piezo-resistive, capacitive or MEMS sensors) and non-contact probes (eddy current probes and laser sensors).

Piezoelectric Sensors

Piezoelectric sensors work on the principle that a piezoelectric material is built between the bottom of the sensor housing and the seismic mass. When a sensor is moved, this mass compresses the piezoelectric material which produces very small voltages. To transfer those small electrical values through the cables require lots of knowledge and expensive cabling, therefore lately these sensors have often been replaced with the IEPE sensors with integrated amplifiers. However, there are still applications areas where these sensors are very useful. These fields are especially high acceleration and high temperatures. The amplitude measurement range of such sensors can be thousands of g. One can find single axis as well as tri axial sensors.

Problem Statement

Generally, automobile frame and the body can be supported by suspension. Besides that the suspension mechanism is allowing the wheels to “soak up” wrong-doing on the road surface. The consequence is the wheels will tend to stay in contact with the road, and the passengers of the vehicle enjoy a ride that is protected from road shock.

The front suspension need to focus on support the weight of the front end of the vehicle, absorb road shocks and cushion the passengers and load against those shocks, provide steering control and alignment and maintain steering control during severe braking. Notionally, if a road were perfectly flat, with no abnormality, suspensions wouldn't be necessary. Unfortunately, roads are far from flat. Without suspension, a motor vehicle travelling at today speeds would not only be uncomfortable, it would be virtually uncontrollable. Steering wheel vibrations are noticed when vehicle speed changes, as when starting out from a stop, passing, and slowing down or coasting. The perception of ride quality is corrupted by virtually any disturbance experienced by the drivers or passengers. Human sensitivity varies according to the nature of the disturbance. Therefore, a good Ride not just depends on the overall design of the vehicle, but also the design of the suspension system. Even freshly paved highways have understated imperfections that can interact with the wheels of a car.

Instead of carry the load from engine compartment, different road condition will gives different outcomes for the front suspension system. The front suspension system was designated to perform at certain range of vibration. Yet the drivers and passengers, certain of them not only used the vehicle on the smooth road but then

on the various kind of road which sometimes the front suspension does not perform on that kind of road. Thus, the project will investigate the benchmarking of steering wheel vibrations on passenger car

fig:1 Accelerometer sensor

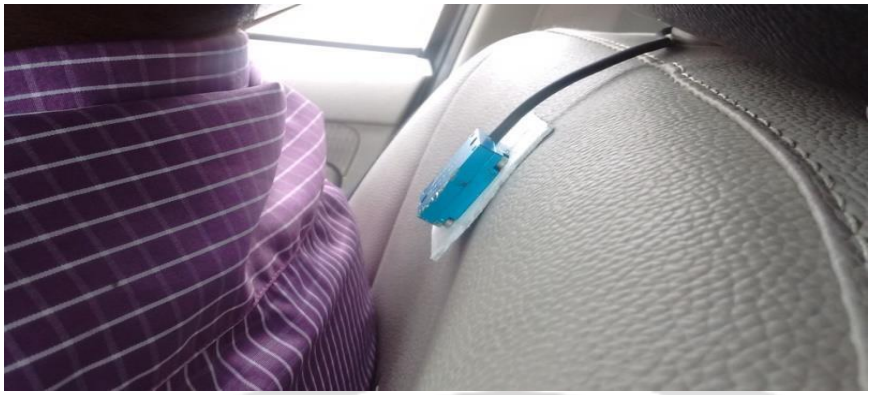
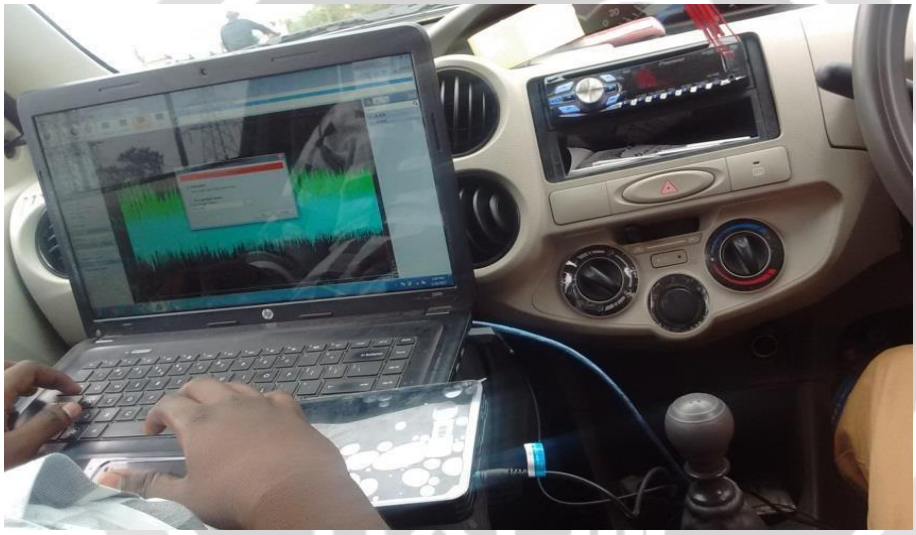


Fig2: Testing accelerometer sensors



Accelerometer is a Piezo-electric accelerometer and it is considered as the standard vibration transducer for machine vibration measurement. Data capture regarding the vibration emitted by a machine, or other body, begins with the sensor. The accelerometers shown in Fig consist of a piezoelectric crystal which has a mass attached to one of its surfaces. When the mass is subjected to a vibration signal, the mass converts the vibration (acceleration) to a force, this then being converted to an electrical signal. This is the basis of the "accelerometer". The accelerometer output may then be processed to provide the instantaneous vibration and displacement signals.

Low Impedance. Ceramic Shear accelerometers designed similar to the quartz-based K-SHEAR line. Rugged, hermetic, lightweight with low sensitivity to base strain, thermal transients and transverse accelerations. These units are ideal for single to multi-channel modal

Conclusion

In the horizontal direction the vibration variation in seats wheel for indica is more than etios at different speeds. Such that it can be thought as the two vehicles have nearly same physical dimensions and same suspension so the vibrations in the vertical direction are same.

The competition in the market is ever increasing and the need for betterment of products is essential. In the field of automobiles especially in cars the most important feature is comfort. So the NVH testing is important. The two main areas of driver comfort are steering and seat. So the testing and benchmarking the steering wheel vibrations is necessary.

Also whenever certain modifications or new components installed in a car which may cause vibrations it is necessary to conduct these kind of tests to check whether it is feasible or not. After knowing the vibrations of the vehicle it is the next step to do the enquiry for the causes. Then any modifications in the design or remedies for the vibrations are to be done.

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