

# 1. Introduction

The complex distribution of oscillatory motion and force within the body during whole-body vibration produces complex sensations. The location and character of the sensations vary greatly according to the vibration frequency, axis and other factors. The term “iscomfort” is applied to the sensations arising directly from the vibration. A wider term is sometimes used in transportation systems to include reactions to other aspects of the environment (e.g. vibration, noise) and the effects of motion on common activities. Whether a degree of discomfort is acceptable will depend on many factors. Vibration is the mechanical phenomena caused by machines in operation. Generally the vibration is undesirable, wasting energy and creating unwanted effects. The vehicle vibration are one of the most important unwanted effects. It causes decrease of safety and comfort factors and increase of fuel consumption. Vibration transmission to human has a large influence on comfort, performance and health. Comfortable ride is essential for a vehicle in order to obtain passenger satisfaction.

Ride quality and comfort increasingly begins refer to vibration and noise in terms of sensation or feel of the passengers. Lower range of vibration frequencies mostly are correlated to vibration comfort and higher (more than 80 Hz) to noise [137, 155]. Vibration and noise are perceived differently by humans, so there is a need to adopt methods that help quantify and control them. Independent of method it is important to define the sources of these phenomena.

Group of interesting problems are relating to the understanding of vibration in complex mechanical structures such as means of transport. One of the usual reason to seek such understanding is to control the vibrations. The book presents research on identification of sources, propagation and structure of vibration in complex mechanical structure of passenger car. The vehicle vibration are results from many kind of dynamic interactions. The proper identification of the vibration is very difficult research and scientific problem. It requires good knowledge fundament and correct measurement tools and signal processing. An automotive vehicle, being a complex mechanical system, includes a set of specific natural vibrations frequencies depending on the direction of the oscillatory wave propagation.

Model representation of an automotive vehicle as a complex mechanical object requires that various aspects should be taken into consideration from the perspective of statics and dynamics, bearing the random phenomena in mind as well. In the study discussed in the monograph, the author focused on non-linear vibration related phenomena occurring in vehicles [34, 35, 63, 70-72, 74, 80, 114, 115, 133]. What is characteristic about dynamic vehicle models is that they entail a set of simplifications, applied across quartile models, several point masses, to finally mention full vehicle models of numerous degrees of freedom and non-linear characteristics.

The main areas of the author’s interest under the past studies undertaken included an assessment of vibration damping from the perspective of safety and comfort based on vibration signals recorded in a direct vicinity of shock absorbers, at points of shock absorber mounting to both unsprung and sprung masses [56]. Furthermore, the author conducted a series of studies pertaining to identification of other vibration sources occurring in vehicles, such as the engine and the power transmission systems. The range of impacts vibrations exert on a vehicle driver is very broad, starting from the feeling of discomfort to safety hazards caused by vibrations at resonant frequencies of specific organs, thus affecting the driver’s responses. Therefore, it is important to study the routes of vibration propagation from their sources to the human organism and to assess

the vibration exposure for different input function conditions. The studies discussed in papers [39, 47] illustrate the outcomes of the influence of input parameters on the distribution of the vibrations being generated as well as their propagation.

The scope of studies of vehicle vibration dynamics, identification of sources and propagation paths have to be extended by stationary empirical tests of oscillatory wave propagation in a vehicle structure as well as identification of natural vibrations. One must also bear in mind that a detailed analysis of vibration related phenomena requires that other properties and mechanical phenomena taking place in the course of degradation as well as the impact of external factors should be taken into consideration.

During operating of vehicles there are many vibration generated by the different sources. Motor engine should be considered as the vibration generator as well. This kind of machine generate a disturbing force of one sort or another, but the frequency of the disturbing force should not be at, or near, a natural frequency of the structure otherwise resonance will occur, with the resulting high amplitudes of vibration and dynamic stresses, and noise and fatigue problems. There are two basic types of structural vibration: steady-state vibration caused by continually running machines such as engines, air-conditioning plants and generators either within the structure or situated in a neighbouring structure, and transient vibration caused by a short-duration disturbance such as a lorry or train passing over an expansion joint in a road or over a bridge. Vibration from engines can agitate the body to the point of causing micro fractures in the vertebrae, disc protrusion, nerve damage and acute lower back pain.

Ride comfort is extremely difficult to determine because of the variations in individual sensitivity to vibration. Therefore many researchers have concentrated their efforts on reducing the amount of vibration from vehicles. Some interesting researches were conducted for the low frequency discomfort for human analysed [88, 89]. Ride vibrations are transmitted to the driver buttocks and back by the seat. The floor panel, pedal and steering wheel transmit additional vibrations to the feet and hands of the driver. These vibrations are producing a level of discomfort for driver and passengers.

With advancements in transportation, we often travel longer distances at faster speeds. Whole-Body vibration research is now focusing on determining the vibration and exposure levels that initiate physical and mechanical changes in the body. The results of current research could provide helpful guidelines for vehicle manufacturers. To reach this purpose it is extremely important to define all sources of vibration in driving vehicle and paths of propagation into the occupants.

The book address the results of large scope research on identification of sources, propagation paths and structure of vibration affecting on human in means of transport. According to scope of the research others authors and the current state of art the book is focused on consideration on combustion engine as source of vibration affecting on occupants. For fulfilment of the engine working condition during drive the investigation were conducted on vibration generated by working engine and powertrain system with different gear ratio. For the identification of vibration propagation paths there were developed some estimators of vibration energy dissipation. As the second main source of vehicle vibration the impact of vertical movement of wheels on vibration propagation into car-body were investigated. The influence of technical condition of suspension system and operating parameters of the vehicle on vibration caused by forcing a wheel were described in the book. The author discussed the influence of vibration sources on exposure to whole-body vibration.

Basing on the conclusions some mathematical and software application for vehicle vibration comfort and safety were developed. Thus it allowed to describe the systems for monitoring and control of vibration propagation in means of transport in terms of comfort and safety.