Identification of Vibration Transfer to Car-Body from Road Roughness by Driving Car

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Abstract. The article presents results of the research on identification of vibration transfer to car-body from road roughness by driving car. It is the case study of multiple sources of vibration generate on vehicle and transfer to driver and passengers. During the research the passenger car was driven on special test track and vibrations in 3 octagonal axes of the floor panel were recorded at locations where the vibrations were transferred into the human organism. The analysis of time-frequency distribution of the vibration allows to separate the main components of the signal.

1. Introduction

The vehicle vibration are one of the most important unwanted effects, causes decrease of safety and comfort factors and increase of fuel consumption. The vibroengineering is widely used in automotive industry. Starting from modelling, designing through production to service and diagnostics of car vehicles [1-4]. 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. 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 [5, 6]. 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 [7]. The studies discussed in papers [8, 9] illustrate the outcomes of the influence of input parameters on the distribution of the vibrations being generated as well as their propagation.

The paper presents some results of identification of vibration transfer to car-body from road roughness by driving car. It is the case of multiple sources of vibration generate on vehicle and transfer to driver and passengers. In order to examine vibration related phenomena occurring in a moving vehicle or a stationary one with its engine on, one should start with identification of vibration sources. Vibration sources in a vehicle are dynamic forces but also free vibrations as well as forced, self-induced, parametrical, non-parametrical, random and stationary ones, all generated by the driving unit, the power transmission system and the road. The large scope of the vehicle vibration determinant include materials, services and construction (frame) production and repairs [10, 11].

2. Research method

The research studies discussed in the article were conducted on an actual object. The passenger car was driven on special test track, without any turns. The profile of the test track, as the road roughness, was set as concrete slab connected each 5 meters. It was prepare as simulation of driving shock impulse.

Vibrations of the floor panel were recorded at 4 points. In order to refer the results obtained to the analysis of the passenger exposure to vibrations, the measuring points were arranged at locations

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where the vibrations were transferred into the human organism, i.e. where feet rested.

The measurement chain consisted of the ADXL piezoelectric sensors, a measuring unit, the μDAQ USB-30A16 data acquisition card and a computer featuring the software. The testing diagram have been depicted in figure 1.

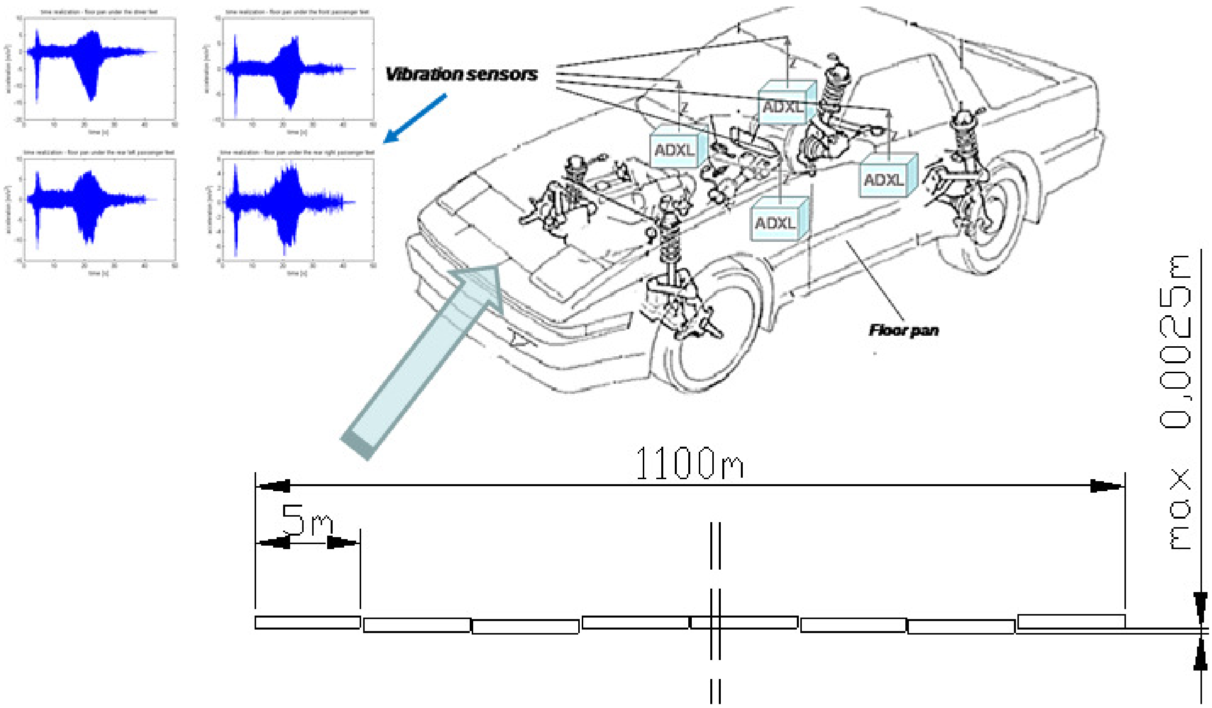

Figure 1. Research and testing diagram and location of the vibration sensors.

3. Research results

For the purpose of identification of vibration transfer to car-body from road roughness by driving car the transformation of signals in time and frequency domains have been analysed.

The figure 2 shows example of identification of vibration increase caused by impulse of road setoff. The analysis of time-frequency distribution of the vibration allows to perfect separate the related component of the signal. During the test the speed of the vehicle was constant so the vibration generated from the engine and powertrain was assumed as constant.

Human perception of vibration is depend on the direction of the exposition. The exposure to vibration has to be consider in 3 octagonal axes: X – horizontally along the vehicle axis, Y – horizontally crosswise the vehicle axis, and Z – vertically and perpendicularly towards plane XY. The acceleration of vibration under the driver feet in 3 axis have been illustrated in figure 3.

For the identification of vibration transfer to car-body the time-frequency distribution of the vertical signals recorded on the floor panel have been depicted in figure 4. It shows the main components of the energy of the vibration and frequency bands of exposure. It can be very helpful for the engineers of design of vibration isolation and control systems in vehicle.

4. Conclusions

The main goals of the engineers of vehicles vibration are isolation from vibration of road roughness by spring and damping system of the suspension. For the comfort of the passengers the perception of vibration is very important as well. The goal of prevention from vibration in passenger cabin is very difficult to reach. The isolation of chosen frequency bands of the vibration can be much easier. The proper identification of vibration transfer to car-body is fundamental. All vibration sources have to be consider as generators during car driving. The results of the research shows that structures of the vibration are different for the directions and localization in the vehicle structure. To complete the research on vibration transfer to car-body by driving car there have to be conducted many more research on different vibration generators or driving speed.

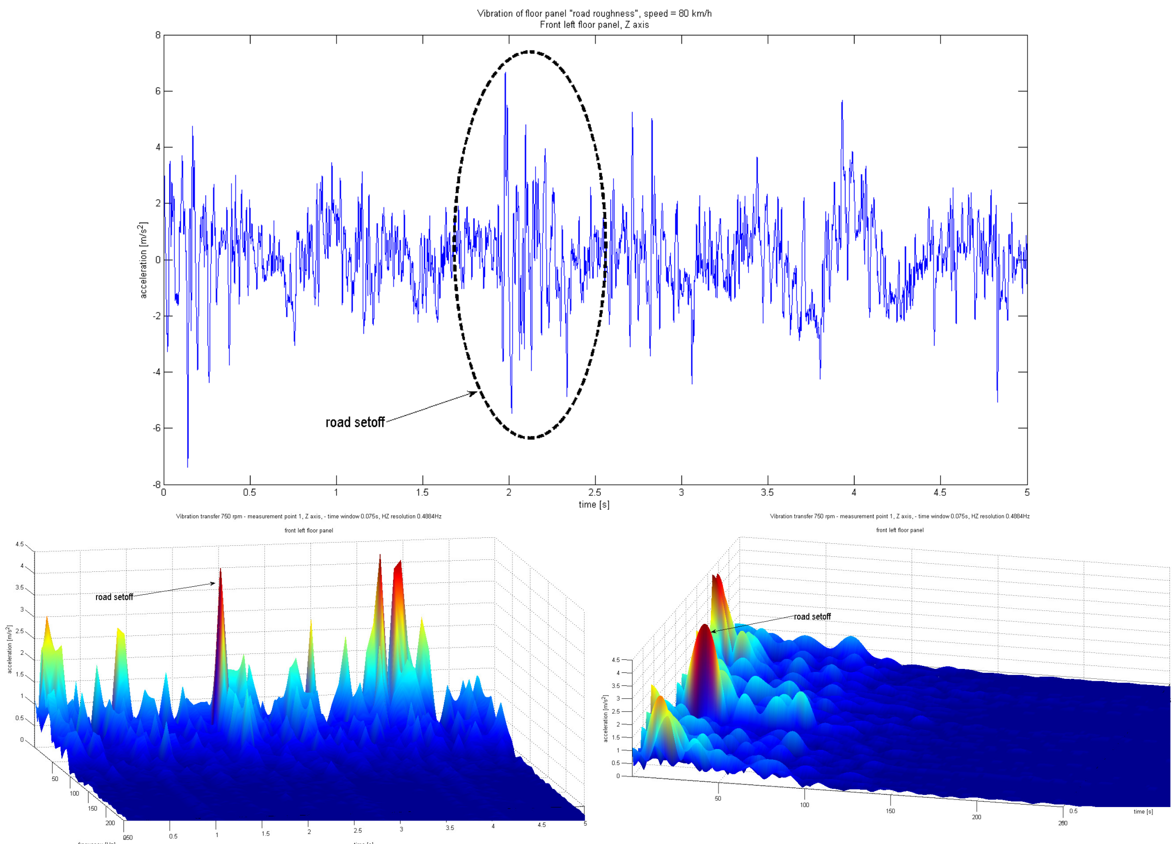

Figure 2. Identification of structure of vibration on front left floor panel (under the driver feet).

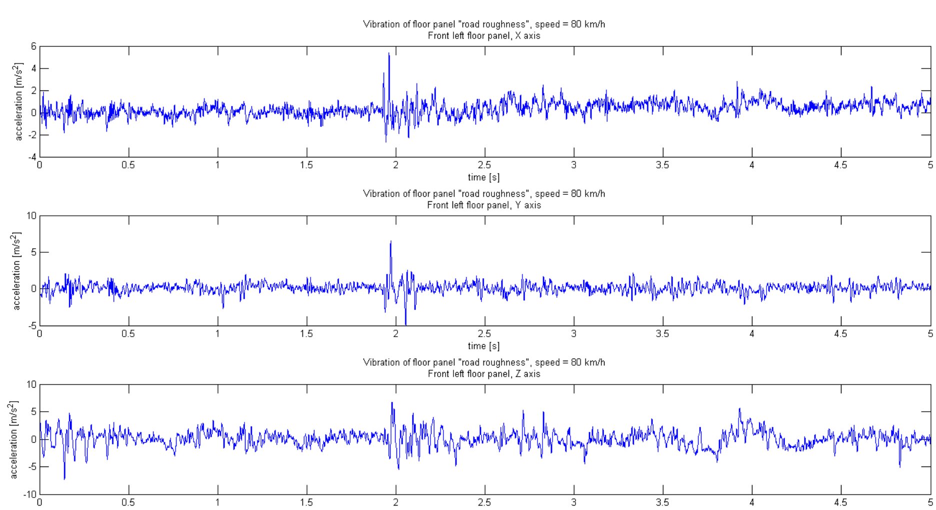

Figure 3. Acceleration of vibration registered on front left floor panel (under the driver feet) in 3 octagonal axes.

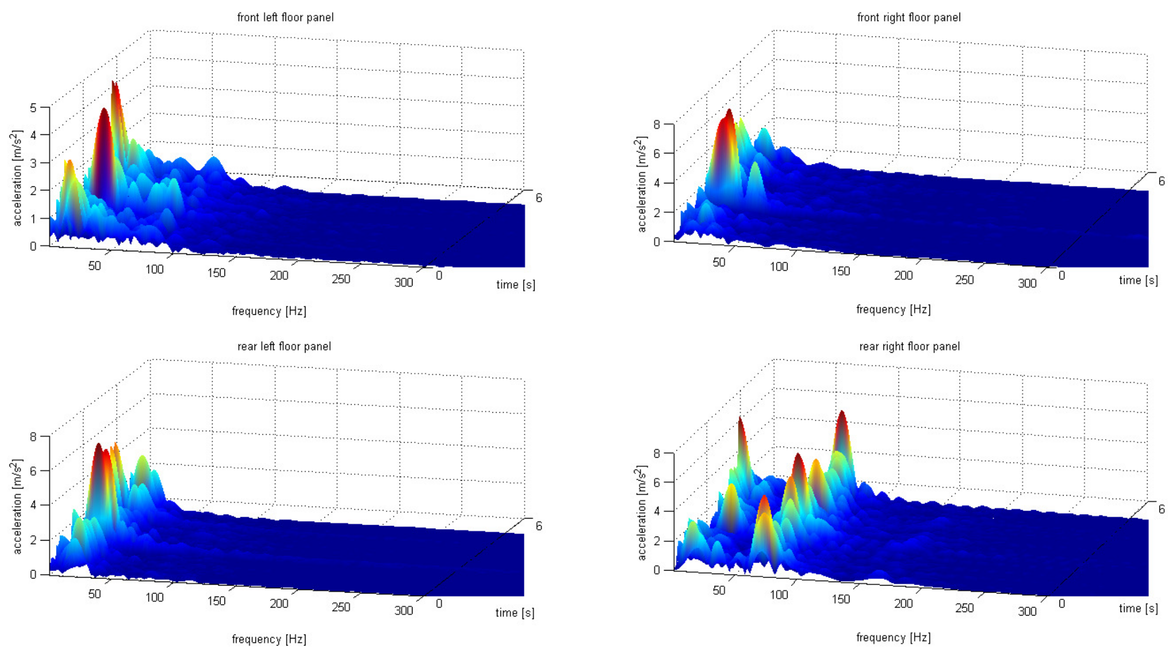

Figure 4. Distribution of acceleration of vertical vibration of floor panel under the feet of passengers.

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