Development of a methodology for the non-linear dynamic characterization of suspension seats under real-life exposure conditions

Keywords
nonlinear vibration, nonlinear dynamics, suspension seats, experimental methods, nonlinear model, whole-body vibration exposure, whole-body biodynamics.

Project description

Drivers and operators of vehicles used in various sectors of activity in Quebec are exposed to whole-body vibration (WBV). Depending on the cumulative vibration dose, WBV is associated with an increased risk of developing low-back pain and spinal degeneration. Suspension seats, see fig. 1(a), are the most practical and commonly used means of intervention in vehicles to safeguard workers' health. However, the available suspension seats are rarely adapted to the host vehicles, in which case they offer little to no WBV attenuation. Nonlinear effects can arise if the seats come into contact with the endstops.

The standards for testing suspension seats are relatively demanding in terms of time and resources, require human participation and must be repeated for each target vehicle. They currently consider only one axis (vertical), which may be insufficient for some vehicles.

The main objective of this research project is to develop a methodology for the nonlinear dynamic characterization of suspension seats in the laboratory (a multi-axial, non-human method applicable to any vehicle). The project is defined in four main parts: 1) development of the experimental methodology, 2) development of a non-linear dynamic suspension seat/human model, 3) validation/adaptation of the methodology through comparisons with the developed model and vibration measurements carried out on seats with humans, 4) application of the methodology on several types of suspension seats.

The proposed methodology will consider the coupled inert mass/seat dynamic behavior for different conditions: vibration direction, frequency and amplitude, suspension height, and different inert masses placed on the seat cushion. The methodology will include vibration measurements on seats using a multi-axis platform, see Fig. 1(b), which can reproduce real mechanical excitations according to the six degrees-of-freedom. It will be applicable to all types of suspension seat and will enable the prediction of vibratory responses for any conditions of use.

Figure 1 – Example of (a) a suspension seat and (b) a multi-axis platform for vibratory characterization

The research project will take place in Montreal at McGill University and will be carried out in collaboration with the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (https://www.irsst.qc.ca/)

Application deadline

December 1, 2023 (https://www.mcgill.ca/mecheng/grad/admission/date)

Academic profile

This research project welcomes applicants with a background in either Mechanical Engineering or Biomechanics. The candidate should have experience in nonlinear structural dynamics, vibration analysis, large-scale finite element methods, numerical methods, and signal processing analysis. Programming skills in Python is an advantage.

Conditions

The start date for the position is at the latest September 1st, 2024. Research will be conducted in the Structural Dynamics and Vibration Laboratory at McGill University, downtown campus. Some time might be spent on site at IRSST or Ecole de Technologie Supérieure, both located in Montréal.

Application

To apply, the candidate should use the Contact tab available on the website https://structdynviblab.mcgill.ca and provide a brief text summarizing their expertise and research interests. They should also provide the names of two referees who will be contacted if the candidate is short-listed.

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