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Experimental Validation of Human Body Models in Structural Vibration

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It has been widely accepted that a stationary human body, such as a person sitting or standing, acts as at least a single degree-of-freedom (SDOF) system in structural vibration. However, it is not clear what form the SDOF models should take and what are the appropriate parameters of the model. The most frequently used human body models may be those from body biodynamics studies in which the patterns of the models were assumed while their parameters were determined through a curving fitting of the measured and calculated apparent masses. The newly proposed human body models were derived based on the study of human-structure interaction in which a continuous human body is placed on a SDOF structure system. Thus forms of the SDOF and two DOF human body models derived are qualitatively correct and accurate while the parameters of the models need to be determined using other methods, in particular experimental methods. When a SDOF human body model is placed on a SDOF structure model, it forms a TDOF human-structure system. Figure 1 shows two human-structure interaction models to be studied.

This paper presents experimental and theoretical studies to validate the human body models derived from human-structure interaction. The responses of a conventional TDOF human-structure system (Fig. 1a) and the newly proposed TDOF human-structure system (Fig. 1b) are theoretically studied using Fourier Response Function (FRF). The basic vibration characteristics of the two systems can be revealed in the frequency domains. The theoretical study can be ideally realised in experiment by applying a controlled harmonic load on the SDOF structure system while a person stands on the structure system. The test rig was set at the natural frequencies of 7.05 Hz and 5.66 Hz respectively. Four subjects participated in the tests, forming four different human masses, i.e. one subjects, two subjects, three subjects and four subjects. These comparative studies between two different models and between both experimental and theoretical methods help to gain a better understanding of human-structure interaction and validate the newly developed human body model. The comparison shows that: 1) the predicted FRFs of the human-structures system using the interaction body model are more close to the measured FRF than that using the conventional body model; 2) The study of eight cases helps to identify two parameters used in the analysis.

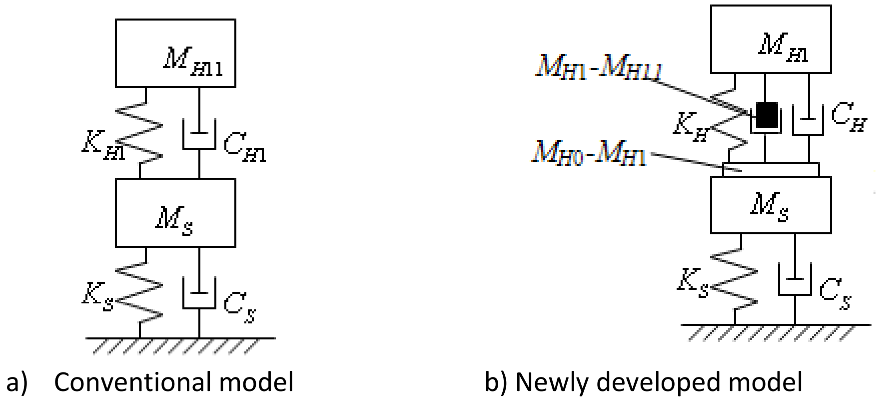

Figure 1: Human-structure systems with different body models