MODELLING PEDESTRIAN INTERACTION WITH LIVELY FOOTBRIDGES

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Vibration serviceability problems due to vertical component of the walking force are often encountered in slender structures (such as footbridges and long-span floors) made of light high-strength materials. Traditionally, the vibration serviceability assessment is based on modelling the pedestrian loading as a predefined time domain function independent from the vibration of the structure under consideration. However, this approach of separately modelling structures and the dynamic loads does not account for the change in the pedestrian's behaviour caused by the perceived structural vibration. A better strategy would be to model the load and the structure as two components interacting with each other. To achieve this aim, pedestrian stepping behaviour on a lively supporting surface should be included into the modelling.

The aim of this project is to implement a simple Rocker Foot Model (a point mass supported by two rigid massless legs with rocker feet), used in the research field of biomechanics to model walking locomotion on flat rigid ground, onto a lively footbridge deck. The model possesses simplicity of the Inverted Pendulum Model, but it has an advantage of providing a more representative value of the vertical excursion of the body during walking and therefore a better description of the force induced into the walking surface.

The project will start with implementing the model, in a form of a differential equation, for walking over a rigid ground. Then parametric scan of the model should be performed to identify those initial conditions for which the model will produce a combination of pacing frequency, forcing amplitude and walking speed that are seen in real life. Next stage will be to add a differential equation of motion of the structure into the model, and investigate the effects of pedestrian-structure interaction on the structural vibration level. Some experimental data from real bridges are available and they can be used for evaluation of the performance of the model.

The project requires understanding of human motion and differential equations as well as good programming skills, preferably in MATLAB. Successful completion of the project has potential to result in a conference or journal publication. The main users of the model developed would be structural engineers dealing with vibration serviceability assessment of structures exposed to walking-induced dynamic loading.

The model can be extended during a course of a PhD to a model that accounts for leg stiffness. The PhD project would also include collection of experimental data on a lively Laboratory bridge in the School of Engineering for the purpose of model verification. In addition, the model can be extended to include multi-person traffic on footbridges, and evaluated against multi-person traffic data that are already available.