The Institution of Structural Engineers

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2012/13 Undergraduate Research Grant Scheme

Project title: Dynamic loading of footbridges due to people running

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Aims of research:
Marathon events in urban environments are becoming increasingly popular, creating a growing demand for models of running loading which can be used reliably in vibration serviceability assessment of bridges. While the loads induced by walking and jumping have been intensively studied in the last decade, reliable and practical descriptions of running forces (including jogging and sprinting) are still very rare and limited.

This project aims to address the issue by:
1. establishing a viable database of vertical running force records generated by individuals,
2. developing their mathematical model which can be used to predict reliably bridge dynamic response.

Description of method:
There are three key stages of the project:

1. Data collation, establishing and growing the database of running time series: Continuous running forces will be collected for many individuals running on the state-of-the-art instrumented treadmill available at the University of Sheffield. The test protocol will include running at a range of speeds controlled by the rotation of treadmill belts. Pacing rate will not be prompted by any stimuli such as metronome, but it will be determined only from subsequent analysis of the generated force signals.

2. Development and calibration of running models: The database established will be used to develop a forcing model, similar to models already existing in the literature and design guidelines pertinent to walking and jumping loading.

3. Application and verification of running model: Synthetic running loads will be used to assess vibration serviceability of a footbridge model available in the University of Sheffield. The test structure is a lively 11m long pre-stressed concrete slab having natural frequency 4.4 Hz.

Benefits to structural engineering:
As the project would potentially have a profound effect on more reliable design of bridges, the main direct beneficiaries are consulting engineers and government agencies responsible for preparation of design guidelines. Long term, reliable design will help reduce the carbon footprint of new structures, which are typically overdesigned to prevent vibration serviceability problems. This is also in line with the Government pledges to cut carbon emissions by 80% by 2050, 50% coming from building environment.

Proposed finish date: June 13