

## 2013/14 Undergraduate Research Grant Scheme

**Project title:** Dynamic loading of floors in entertainment venues due to multiple active occupants

**University:** University of Sheffield

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**Student:** tba

### **Aims of research:**

There has been a rapidly growing number of reported problems related to excessive vibrations of floors occupied by active groups of people. For example, in November 2003 Leeds Town Hall had to be evacuated after only 30 minutes of a rock concert as a 1000-strong crowd of fans was moving in sync with the music causing vibrations so large that the floor occupied visibly cracked.

This project focus on dynamic loads induced by groups bouncing and aims to:

1. gather a number of measured bouncing force records from groups of various sizes and establish a viable database of them
2. develop their mathematical model which can be used to predict reliably vibration response of floors

### **Description of method:**

There are three key stages of the project:

1. Data collation of bouncing force records: The student will be given access to a unique force measuring floor, so called a "smart floor", which is permanently installed in the Centre for Sports Engineering Research in Sheffield Hallam University. The smart floor is a large scale (3m x 3m) network of instrumented force platforms that detect the magnitude and position of vertical forces applied by multiple people standing and bouncing on them. Moreover, there is a possibility to project graphics and videos onto a front screen and the floor to provide an immersive interface to maximise enjoyment and motivation of participants. This makes possible to investigate the effect of different external stimuli (e.g. visual and audio) on the synchronisation between group members.
2. Development and calibration of force models: The database established will be used to develop the corresponding forcing model. The key modelling parameters will be bouncing rate, group/crowd size and different combinations of the external stimuli.
3. Application and verification of the model: Synthetic group loads will be used to assess vibration serviceability of a lively pre-stressed concrete slab available in the University of Sheffield.

### **Benefits to structural engineering:**

As the project would potentially have a profound effect on more reliable design of floors, 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 floors, which are typically overdesigned to prevent vibration serviceability problems. The Government pledges to cut carbon emissions by 80% by 2050, 50% coming from building environment.

**Proposed finish date:** June 2014