

2013/14 Undergraduate Research Grant Scheme – Executive Summary

Project title:

Dynamic loading of floors in entertainment venues due to multiple active occupants

University:

University of Sheffield

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Project summary:

Accurately modelling the dynamic loads caused by rhythmic loading in entertainment venues has proven challenging; current guidance does not consider group effects on the loading. This project aims to further research into rhythmic loads generated by bouncing groups, notably the levels of coordination achievable at different frequencies, in order that more accurate equations predicting these loads can be formulated.

A novel experiment involving eighteen participants simultaneously bouncing to six frequencies of popular songs between 1.0Hz-3.5Hz has been undertaken. Their bouncing accelerations are recorded by Opal motion monitoring devices strapped to the participants' waists.

The correlations between participants are measured; the optimum song frequency inducing the most coordinated bouncing is 1.5Hz. This differs from previous studies where the optimum frequency is around 2.0Hz and may be due to the different experimental procedures or differences between the movements of jumping and bouncing.

However, the crowd's dominant bouncing harmonic tends towards the 2.0Hz-3.0Hz region, suggesting that a crowd incites the greatest vibration response in this frequency range. It would, therefore, be advisable to avoid designing stadia with natural frequencies within this range. Research into coordination at frequencies around 1.5Hz will be required to see if this result can be validated and to confirm the optimum bouncing frequency.

The chance of a crowd not being significantly correlated can be taken as a worst case of approximately 6% of the time. This could be helpful when determining more efficient equations which incorporate group effects.

It is surmised that the standing position within the crowd has no effect on the coordination ability of individual participants. This would suggest that there are not any areas of entertainment venues which would be subject to worse correlations and hence loadings than others. This disagrees with other research and the experiment undertaken could be developed to investigate this result further.