New Zealand Mathematical Society

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WARWICK THE UNIVERSITY OF WARWICK

LMS – NZMS AITKEN LECTURE

Monday 2nd October 2017 ; 4.00 pm

Room B3.03, Mathematics Institute, University of Warwick

Professor Hinke Osinga (Auckland)

Shaken but not stirred: using mathematics in earthquakes

Abstract: Earthquakes can cause substantial damage to buildings in ways that are still not well understood. The amplitude and principal frequency of an earthquake are two primary components that affect the extent of the damage, and they are the basis for many design specification guidelines. We investigate how an external force with varying amplitude and principal frequency affects structural stability. As an example we consider a model of a planar, post-tensioned frame that exhibits dynamics quite similar to the experimental measurements of a scaled model on a shake table. The frame remains structurally sound as long as the tilt angle of the frame does not exceed a certain maximum. Many results in the literature are obtained from performing a large number of simulations over a range of amplitudes and frequencies. Such a brute-force approach establishes a region in the frequency-amplitude plane for which the structural stability of the frame eventually fails. Our approach is much more efficient and uses a novel computational method that approximates the failure boundary directly. This method is based on continuation of a suitable two-point boundary value problem. Our computations demonstrate that the failure boundary is only piecewise smooth and the results highlight further interesting details of how the dynamics is organised in the frequency-amplitude plane. We find that failure can occur in profoundly different ways, due to inherent nonlinearities in the system. Stability is particularly affected in a nonlinear way if the natural frequency of the structure is close to that of the external forcing.

The Society is delighted to announce that the 2017 LMS-NZMS Aitken Lecturer is Professor Hinke Osinga FRSNZ (University of Auckland). Hinke Osinga, Professor of Applied Mathematics at the University of Auckland in New Zealand, is the fourth Aitken Lecturer to visit the UK. She is an expert in dynamical systems and its applications. Her publications, illustrations, animations and outreach activities have made her famous worldwide in the mathematics and arts communities.

Professor Hinke Osinga FRSNZ

The Aitken Lectureship scheme is part of Forder-Aitken Lectureship exchange, which is a collaboration between the London Mathematical Society and the New Zealand Mathematical Society. Each Society invites an eminent mathematician from the other country to give lectures at different universities around the country. The Aitken Lectureship, named after Professor A. Aitken - one of New Zealand's great mathematicians, is a Lecture Tour around the UK undertaken by a mathematician from New Zealand. The Forder Lectureship, named after Professor H. G. Forder (formerly of the University of Auckland and a benefactor of the London Mathematical Society) is a Lecture Tour around New Zealand undertaken by a mathematician from the UK.