11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

An adaptive contact area approximation for bi-linear modal reduction of structures with intermittent contacts

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Key Words: *nonlinear dynamics, intermittent contacts, reduced order models, harmonic balance method*

The dynamic analysis of structures with nonlinearities such as intermittent contact can significantly benefit from the use of reduced order models, due to the prohibitive calculation time needed by high resolution finite element models.
Recently, bi-linear modes (BLMs) have been successfully used to represent the spatial coherence of structures with intermittent contacts [1-2]. In the original formulation of the method, BLMs have been computed by assuming an alternating fully open and fully closed contact during vibration. Nevertheless, in many cases the intermittent contact is only partially open and partially closed during vibration and, furthermore, the actual contact area at any given time can be significantly smaller than the area of the contact at static equilibrium.
In this paper, BLMs are defined for the case of partial contact conditions (i.e. neither fully open nor fully closed contact). In particular, an adaptive process is developed to accurately model the actual contact area during vibration.
The proposed method is validated by means of two numerical test cases, namely a cracked plate, and two coaxial cylinders. The forced response is computed in the frequency domain by using a harmonic balance method, and the contact forces are modeled by using penalty elements (which couple node pairs lying on the contact surfaces).
Results show that the proposed BLMs vectors are able to represent the spatial coherence of the system, and that correctly modeling the contact area significantly affects the accuracy of the BLM-based reduced model.

ACKNOWLEDGEMENTS

This research was supported by a Marie Curie International Outgoing Fellowship within the 7th European Community Framework Programme (UPGRADE Research Project - Grant agreement no. PIOF-GA-2011-299771).

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