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SELECTION ALGORITHM FOR BILINEAR MODES

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The forced response analysis of structures with intermittent contact is a computationally challenging task because high resolution finite elements (FE) models require very long calculation time. Recently, a technique based on bi-linear normal modes has been successfully applied to piecewise-linear oscillators [1] and intermittent friction contacts [2]. The main idea of that approach is to represent the system dynamics with two sets of normal modes with special boundary conditions, referred to as bi-linear modes (BLMs). It has been observed that a frequency-based algorithm for selecting BLMs is not able to select all the necessary modes to accurately predict the nonlinear dynamics of the system. Thus, a novel selection algorithm has been developed and it is described herein. The new algorithm is based on a two-step process. First, a frequency based approach is used to select a set of BLMs that represent the already selected modes. Second, the algorithm operates individually and in sequence on all the other BLMs. Specifically, the first mode is projected onto the already selected modes and if the residual of the projection is lower than a user-specified threshold, the mode is added into the set of selected modes. The procedure is then applied to the remaining BLMs. Finally, the selected BLMs are used to reduce the matrices of the FE model and the nonlinear forced response is computed in the frequency domain by means of the harmonic balance method. A nonlinear system composed of two co-axial cylinders in contact, with their edges partially overlapped as shown in Fig. 1-A, is used to validate the algorithm. By using 12 modes selected by the new algorithm, a BLM forced response curve is produced and has 0.28% error in amplitude, and 0.11% error in frequency when compared to a reference curve, as shown in Fig. 1-B.

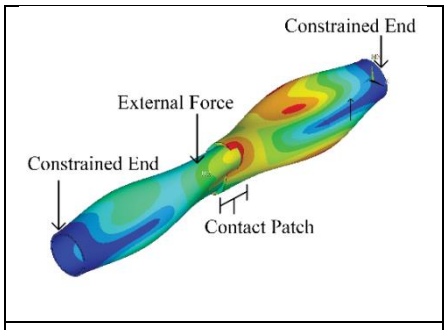

Fig. 1-A: Non-linear System Model

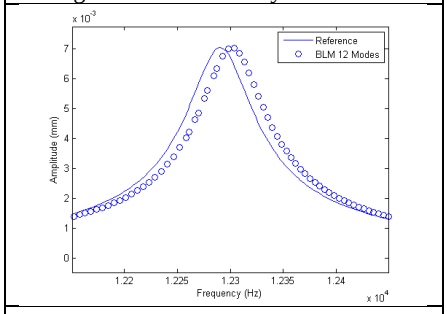

Fig. 1-B: Non-linear Response Curve

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