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Harmonic balance of a Bouc-Wen model for describing a structure assembled with a bolt joint: An experimental study

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Abstract: Assembled structures are essential due to the full range of real structures which posse joint interfaces, such as gas turbines, automotive vehicles, aerospace structures, and civil applications. However, the friction effects in the joint interface are challenging to predict and depend, for instance, on the interaction which occurs on the contact surface, the presence of hysteresis effect, and so on. Hence, a practical strategy is to manipulate it with simple experimental cases to adequately explain the influence of the joint, and then, to enlarge these methodologies for industrial cases. In this context, this paper proposes a nonlinear modal analysis of an assembled structure, through the framework of the harmonic balance method and a smoothing procedure in the hysteretic restoring force. The procedure adopted here breaks it into smooth polynomial intervals. An experimental setup composed of two beams, as substructures, made of aluminum and connected with a bolted joint is utilized to demonstrate the strategy. The bolted structure examined presents full hysteretic damping induced by stick-slip characteristics depending on the excitation amplitude level. A Bouc-Wen model was adequated to describe the measured hysteresis loops and utilized to identify and to fit the parameters by optimization. Consequently, the updated numerical model is compared with experimental data. The harmonic balance method, applied along with the smoothing procedure, shows to be a straightforward, simple, and attractive alternative for handling this type of problem.

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