Towards the development of a new joint element which incorporates bolt looseness and nonlinear contact behaviour.

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Many engineering structures are composed by substructures assembled with bolted joints [1] [2]. The dynamic behavior of structures with joints can be modeled with standard finite elements (such as beam elements), but these elements cannot reproduce the phenomenon of bolt looseness and friction between joint components which appear in real joints. Models of joints consisting of detailed 3D meshes have been developed [3], but they can be prohibitively costly in terms of computational effort – especially with structures which incorporate many joints. Simplified joint models [4] [5] have been introduced, which can address some of the problems aforementioned.
In this paper three computational models are presented towards an understanding of the dynamic behavior of bolted joints. These simplified beam models simulate the interaction between the bolt and the clamped members of a joint when the structure is excited with a harmonic load, incorporating the nonlinearities generated by the contact condition and friction. Due to these nonlinearities, harmonic distortion arises in the analysis. A heuristic formulation was developed for the prediction of the amplitude of the harmonic distortion induced excitations, given the physical parameters of the system and the amplitude and frequency of the excitation.
This heuristic calculation can be applied in the future to develop simplified joint elements able to model bolt looseness and other nonlinear behaviors.

References

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