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On the effects of roughness on the nonlinear dynamics of a bolted joint: a multiscale analysis

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Abstract

Accurate prediction of the vibration response of friction joints is of great importance when estimating both the performance and the life of build-up structures. The contact conditions at the joint interface, including local normal load distribution and contact stiffness, play a critical role in the nonlinear dynamic response. These parameters strongly depend on the mating surfaces, where the surface roughness is well known to have a significant impact on the contact conditions in the static case. In contrast, its effects on the global and local nonlinear dynamic response of a build-up structure is not as well understood due to the complexity of the involved mechanisms. To obtain a better understanding of the dependence of the nonlinear dynamic response on surface roughness, a newly proposed multiscale approach has been developed. It links the surface roughness to the contact pressure and contact stiffness, and in combination with a multiharmonic balance solver, allows to compute the nonlinear dynamic response for different interface roughness. An application of the technique to a single bolted lap joint highlighted a strong impact of larger roughness values on the pressure distribution and local contact stiffness and in turn on the nonlinear dynamic response.

Keywords: bolted joint, elastic rough contact, nonlinear dynamics

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