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MULTIPLE SOLUTIONS IN THE FORCED RESPONSE OF TURBINE BLADES WITH WEDGE FRICTION DAMPERS.

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In order to assess the High Cycle Fatigue (HCF) stress levels in turbine blades, numerical models are developed to simulate the effect of friction contacts on the dynamics of the bladed disks. These models are based on the Harmonic Balance Method in order to reduce the large calculation times typical of the Direct Time Integration (DTI) methods.

While the Finite Element (FE) model of the bodies in contact (blades, disk, underplatform dampers, ring dampers, etc..) allows taking into account the bulk elasticity, the local compliance of the contact region is modelled with a layer of contact elements placed between the contact interfaces to couple the contact pairs. The state-of-the-art contact element is a node-to-node element ([1],[2]) where the normal and tangential contact stiffness are modelled as spring elements and the Coulomb friction law relates the maximum value of the tangential force to the value of the normal force.

The classical approach (hence called uncoupled method) used to compute the periodical contact forces in these contact elements relies on a preliminary static analysis, whose result is the static normal load acting on the contact element, and then on the dynamic analysis of the system. An alternative approach ([3]), proposed by the authors of this paper, is based on a coupled static/dynamic method for both underplatform dampers and blade root joints with the Single-HBM.

In this paper, the uncoupled and the coupled methods are used in the Multi-HBM frame to solve the problem of a wedge pressed against two vibrating bodies (i.e. a simplified version of a system made of two blades with an interposed wedge damper), to investigate the differences between the two approaches and to highlight the existence of multiple solutions for some of the analyzed configurations. In detail, when the uncoupled method is used, multiple solutions in the static analysis produce multiple solutions in the system dynamics, while if the coupled method is used a unique solution can be computed in most cases but multiple solutions may still occur for specific configurations.

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