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A Novel Reduced Order Modelling Method for Dynamic Analysis of Assembled Structures with Localized Nonlinearities

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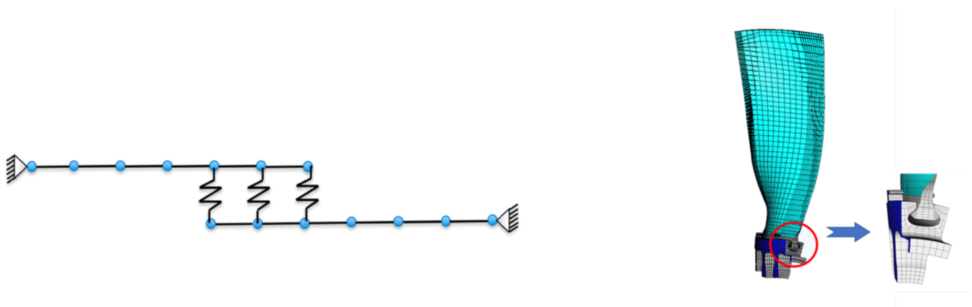
This work proposes a novel reduced order modelling method to enhance the computational efficiency for the frequency domain dynamic analysis of an assembly structure with localized nonlinearities. The proposed method consists in the reformulation of the dynamic governing equation based on the linearized system with the contact friction stiffness and the nonlinear compensation penalty that take into account the effects of interface separation or slip phenomenon. The Galerkin projection method is then applied for the model order reduction of the reformulated governing equation. The reduced basis projection is made up of the vibration modes of the linearized system, static modes and also the trial vector derivatives [1]. The idea of this approach is inspired by the previous observations that the state of joint interface contact, e.g. the dovetail between a blade and disc, are mainly in elastic stuck condition during the structural vibration. Despite this, the classical formulation tends to employ the linear modes of separated components and then integrate the nonlinear force independently into the linear system. Using the proposed approach, one of the main advantages is being that the number of reduced basis can be significantly reduced that leads to much higher computational efficiency. We consider two finite element joint models as the test case: one with 2D jointed beam model with elastic coulomb friction model (Figure 1-a) and the other one with 3D bladed disc sector (Figure 1-b). The CMS based Craig-Bampton (CB) and Rubin methods are used to benchmark the computational efficiency and accuracy of the proposed method. The initial results indicate the proposed method can reduces the size of model by one third while achieving similar accuracy comparing to the references.



(a) (b)

Figure 1 (a) 2D jointed beam model with coulomb model (b) 3D bladed disc sector model

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