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Assessing the branching behaviour of periodic solutions in finite-element models

*** Gräbner, Nils[1], Tiedemann, Merten[2], Hoffmann, Norbert[3] and von Wagner, Utz[1]**

[1]Chair of Mechatronics and Machine Dynamics, TU Berlin, Germany
[2]Dynamics Group, Hamburg University of Technology, Germany
[3] Mechanical Engineering Department, Imperial College London, UK

*Corresponding author: nils.graebner@tu-berlin.de

Experts from industry and academia agree that brake squeal is a nonlinear phenomenon. Consequently, using linear finite-element (FE) models and assessing the tendency of a brake system to squeal on the stability of the trivial solution is not sufficient for the whole picture. However, the latter approach - in the brake community known as complex eigenvalue analysis (CEA) - is extensively used in industry. Until now, nonlinear simulation approaches considering existence and stability of periodic solutions are limited to minimal models with few degrees of freedom. There are still various unanswered questions concerning the nonlinearities which should be considered in FE simulations, their parameters, the integration of nonlinearities in FE-models and also the simulation approach.

This contribution discusses a novel simulation approach for systems subject to friction induced vibrations which are modelled with finite-element methods. The approach is based on a subspace projection of the high-dimensional problem. To study the branching behaviour of the periodic solutions, the projected problem can be solved via time integration or a normal form transformation. Studies are conducted for minimal models with FE generated system matrices (dim >102). The considered nonlinearities are structural nonlinearities which represent joints and contact interfaces. Periodic solution are calculated and their bifurcation behaviour is analysed. The results reveal that the presented method is feasible for studying the branching behaviour of nonlinear equations.

Keywords: Finite-Element, nonlinear Simulation, Bifurcation Behavior, new Approach