TRC
TURBOMACHINERY RESEARCH CONSORTIUM

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Half page Synopsis of Reports for website

Title of Report:
High Fidelity, Shaft Dynamics, Stress and Thermal Modeling (Project # 00071)

Summary:
This project aims to provide TRC members with a stand-alone 3D solid finite element multi-physics rotordynamics software which runs under the new EXCEL system umbrella without any other software (Matlab, Fortran, ANSYS ...) installation. Theory for a refined structural model of a Hirth coupling and test data are provided for validation. New feature of calculating equivalent Young's modulus at the contact surface where local lateral shaft stiffness changes is added.

Users are able to generate high-fidelity 3D solid finite element rotor-bearing systems. Multi-domain, asperity contact, flat-surface coupling, and Hirth/Curvic couplings modeling features such as coupling parameters geometrical constraint are provided. With the high-fidelity rotor model, thermal, structural and rotordynamic analysis can be conducted. The code provides rotordynamic modeling and simulations with structural meshes composed of linear hexahedron and quadratic tetrahedral finite elements. Temperature and stress are calculated with a single rotor-bearing system model. Stress stiffening effect due to centrifugal, preload, and thermal and spin softening effects are included in the rotordynamic simulations. Simulations include rotordynamic stability, parametric stability, natural frequencies and mode shape. Guyan and modal reductions are available to reduce model size and computation time.

The Hirth coupling experimental test demonstrates the need of taking into account the decrease in local lateral stiffness of the shaft as a function of preload owing to interface contact. This has an impact on critical speed locations as well as the overall rotordynamic response. The test data and simulation results are available from the annual TRC report.

Deriving equivalent Young's modulus vs. preload at the mating surface of the coupling where local lateral stiffness changes is provided by matching natural frequency from the 3D solider modeler with the beam model and implemented internally so that the user can utilize it in XLTRC2 as well as in other beam codes.