A Preliminary Assessment of Modeling Friction/Damping at Blade/Disk Interfaces

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ABSTRACT

Friction induced vibration at blade/disk interfaces is one of the major sources of HCF related failures both in the attachment areas and along blade boundaries. Beyond the classic Coulomb friction law, a more precise friction model for more physically perceptive consideration at blade/disk interfaces is presented, including the elastic-plastic deformation, adhesive (micro-friction) and third body effects which come from wear debris or microscopic coatings at blade/disk interface (mating surface). The third body at blade/disk interfaces may be important in mitigating wear and friction induced dynamics due to shear energy dissipation.

The basic problem is to determine the vibration induced dynamic response of a turbine engine blade root, but at the present time how the frictional forces interact with the blade root is not well understood. This makes the calculation of the dynamic response of a blade resulting from frictional forces challenging task. Therefore, we do need to develop a fundamental understanding of the essential friction and damping phenomena at the blade/disk interfaces. Cantilever beam / plate are used to simulate the blade attachment. Different boundary conditions (fixed end, clamped end and oscillation with friction) are studied. FEA was employed to predict the displacement, stress distribution, natural frequency, mode shape and nonlinear dynamic analysis results. Considering the blade/disk interfaces as a 3D contact problem with nonlinear dynamic behavior, solid element and gap element are all employed with material stiffness and damping. Both precise friction model and FEA model will later be verified by experimental investigation.