Periodic Limit Cycle of a Blade Forced against a Rigid Casing of a Turbomachine

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Abstract

This work summarises a study of structural interactions between the blade-tip and the casing of a turbomachine. In modern aircraft engines, the blade-tip nominal clearances tend to be reduced to minimise parasitic tip leakage flows in order to improve aerodynamic efficiency and performance. The blade-tip and the casing inner surface rubs (interactions) may occur and thus generating transient blade vibrations. If the blade dynamics contain significant tip radial displacement component due to blade curvature or lean angles then, the friction forces can sustain the blade vibratory motion, leading to a periodic nonlinear limit cycle response.

A frictional impact oscillator consisting of an inclined beam forced against a rigid belt is used here to model the blade behaviour. A frequency-domain approach based on FET, time finite element method, is adopted to evaluate the periodic response involving contact-separation and stick-slip transitions. Parametric continuation with respect to the excitation frequency is performed to analyse the stability and bifurcations of the forced response.

Keywords:

Rub induced vibrations, Time finite element method, Periodic response, Stability