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Full spectrum analysis for studying the backward whirl in accelerated rotor systems

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Abstract: The backward whirl (BW) phenomena in intact and cracked rotor systems that exhibit recurrent acceleration and deceleration during startup and coast down operations has not been well-studied in the literature. However, for startup and cost down operations during which a frequent passage through critical forward whirl speeds takes place, the BW orbits are found to be immediately captured after the passage through the critical FW rotational speeds. The zones of BW orbits are observed to be significantly affected by the appearance of crack damages that are accompanied with using isotropic or anisotropic bearings at the shaft supports. The finite element model of the cracked rotor-bearing-disk system is employed to obtain the system linear-time-variant (LTV) equations of motion for the numerical simulation. The obtained LTV mathematical model of the system represents a nonlinear dynamical model of the considered systems. Consequently, the full spectrum analysis (FSA) is successfully employed here to the numerical simulation response of the considered systems to verify the existence of these BW zones of shaft rotational speeds after the passage through the critical and subcritical FW whirl rotational speeds. The obtained results for the intact shaft with anisotropic bearing, cracked shaft with isotropic bearings and the cracked shaft with anisotropic bearings verify the robustness of the FSA as a powerful tool of capturing the BW zones in the cracked rotor systems.

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