DIAGNOSIS OF CRACKED SHAFTS USING ANGULAR MOMENTUM CHANGES CALCULATED FROM DIRECTIONALLY FILTERED ORBIT DATA

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ABSTRACT

This study addresses the problem of online prediction of the presence and severity of shaft cracks using changes in angular momentum as a shaft crack indicator. Angular momentum calculations are made using readily available orbit data and are shown using parametric studies, numerical simulations, and experiments to indicate a shaft crack. A parametric model of a cracked system published by the Bently Rotor Dynamic Research Corporation (BRDRC) is extended to predict the changes in angular momentum that occur with a transverse crack. The closed form solution of rotor lateral response is directionally filtered to remove the effect of support asymmetry. The forward components of the response are used to calculate the corresponding angular momentum spectrum, hnx(forward). h1X(forward) consists of two terms associated with the presence of a crack: one term is coupled to imbalance and the other to a constant radial load. Without a crack, h1X(forward) is theoretically zero. This is an improvement over using 1X or 2X response as a crack indicator where the imbalance or the radial load is inseparable from and dominates the crack response. Simulations with cracked shaft stiffness determined from Finite Element Analysis, and experiments performed on slotted shafts, show good agreement with the closed form solution. h1X(forward) increases proportionally to the crack severity between 1/2X and the critical speed with a plateau in between, which offers a broad band measure of a shaft crack

Keywords: cracked shaft, angular momentum, full spectrum, directional filtering, orbit