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Experimental Evaluation of Contact Interface Stiffness and Damping to Sustain Transients and Resonances

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Abstract : ABB offers range of turbochargers from 500 kW to 80+ MW diesel and gas engines. Those operate on ships, power stations, generator-sets, diesel locomotives and large, off-highway vehicles. The units need to sustain harsh operating conditions, exposure to high speeds, temperatures and varying loads. They are expected to work at over-critical speeds damping effectively any transients and encountered resonances. Components are often connected via friction joints. Designs of those interfaces need to account for surface roughness, texture, pre-stress, etc. to sustain against fretting fatigue. The experience from field contributed with valuable input on components performance in hash sea environment and their exposure to high temperature, speed and load conditions. Study of tribological interactions of oxide formations provided an insight into dynamic activities occurring between the surfaces. Oxidation was recognized as the dominant factor of a wear. Microscopic inspections of fatigue cracks on turbine indicated insufficient damping and unrestrained structural stress leading to catastrophic failure, if not prevented in time. The contact interface exhibits strongly non-linear mechanism and to describe it the piecewise approach was used. Set of samples representing the combinations of materials, texture, surface and heat treatment were tested on a friction rig under range of loads, frequencies and excitation amplitudes. Developed numerical technique extracted the friction coefficient, tangential contact stiffness and damping. Vast amount of experimental data was processed with the multi-harmonics balance (MHB) method to categorize the components subjected to the periodic excitations. At the pre-defined excitation level both force and displacement formed semi-elliptical hysteresis curves having the same area and secant as the actual ones. By cross-correlating the terms remaining in the phase and out of the phase, respectively it was possible to separate an elastic energy from dissipation and derive the stiffness and damping characteristics.

Keywords : contact interface, fatigue, rotor-dynamics, torsional resonances
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