An experimental and theoretical analysis of a foil-air bearing rotor system

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Although there is considerable research on the experimental testing of foil-air bearing (FAB) rotor systems, only a small fraction has been correlated with simulations from a full nonlinear model that links the rotor, air film and foil domains, due to modelling complexity and computational burden. An approach for the simultaneous solution of the three domains as a coupled dynamical system, introduced by the first author and adopted by independent researchers, has recently demonstrated its capability to address this problem. This paper uses this approach, with further developments, in an experimental and theoretical study of a FAB-rotor test rig. The test rig is described in detail, including issues with its commissioning. The theoretical analysis uses a recently introduced modal-based bump foil model that accounts for interaction between the bumps and their inertia. The imposition of pressure constraints on the air film is found to delay the predicted onset of instability speed. The results lend experimental validation to a recent theoretically-based claim that the Gümbel condition may not be appropriate for a practical single-pad FAB. The satisfactory prediction of the salient features of the measured nonlinear behavior shows that the air film is indeed highly influential on the response, in contrast to an earlier finding.