Coupled Vibration Analysis of an Industrial Gas Turbine Engine & Drivetrain - Analysis and Testing

A. Surial
Rolls Royce Canada, Montreal
ayman.surial@Rolls-Royce.ca

Dr. A. Kaushal
Rolls Royce Canada, and Concordia University, Montreal, Canada
ashok.kaushal@Rolls-Royce.ca

ABSTRACT

The need for higher speed, yet reliable operation of rotating machinery continues to increase. Over the past years, there has been considerable research activity in the area of modeling and analysis of dynamic behavior of rotating structures. Some of the dynamic characteristics of interest are critical speeds, system stability and response to unbalance excitation. In the design and retrofit process, it is frequently desirable and often necessary to adjust some system parameters in order to obtain a more favorable design or to meet the operating requirements.

The structural integrity assessment of gas turbines rotating parts including the drivetrain requires the ability to predict its dynamic behavior accurately and demonstrate the ability to withstand steady and vibratory stresses. It is important that the dynamic model of the engine be as fully representative as possible. It should also include all rotating and static components, and allow for the coupling between the various rotating systems through casings, inter-shaft bearings and drivetrain couplings. This requires complex and sophisticated modeling of the engine spools rotating at different speeds, static structures like casings and frames, and elastic connections simulating bearings. Drivetrain rotors downstream of the engine should also be modeled, including any stiffness and damping properties at the bearings.

A finite element model of an industrial gas turbine engine including the drivetrain has been developed and tested at Rolls Royce Canada. Due to the complexity of the engine structure the model has been divided into several substructures modeled separately. Such a division facilitates the implementation of any design changes to the engine and the drivetrain.

Rotor dynamic analyses of the engine model with the full drivetrain were carried out to determine critical speeds and the forced response due to unbalance. Engine vibration tests were also conducted to validate the analytical models.

The approach presented in this paper will give an overview of the dynamic analysis of gas turbine engines including the drivetrain to perform the critical speed and forced response analysis (unbalance response). Comprehensive testing validated the analytical models.