Blade Fundamentals to Avoid

Critical plant equipment such as steam turbines, are designed to achieve a long lifetime (20 years per API 611). Given to the demanding level of stresses that the steam turbine blades experience, assurance against fatigue is imperative. The first step to evaluate blade fatigue condition, is to identify its resonant modes and frequencies.

Turbine Blade Modal Analysis

KHE was requested to perform a modal analysis on a steam turbine blade, that showed signs of premature blade fatigue failure. FEA modal analysis provides a proven remedy for this problem, having no limitations in identifying the excited modes, under centrifugal stiffening and thermal loadings. The analysis can be further supplemented with a harmonic analysis, for the excited modes, to form a Goodman diagram and estimate the fatigue life of the blades.

To accomplish this task, KHE produced a CAD model of the blade using 3D scanning which was imported to an FEA model. By accounting for clamping conditions, centrifugal stiffening and damping effects, accurate predictions of the natural frequencies and the mode shape were obtained. KHE further cross-checked the results with simple theories and ring test results.

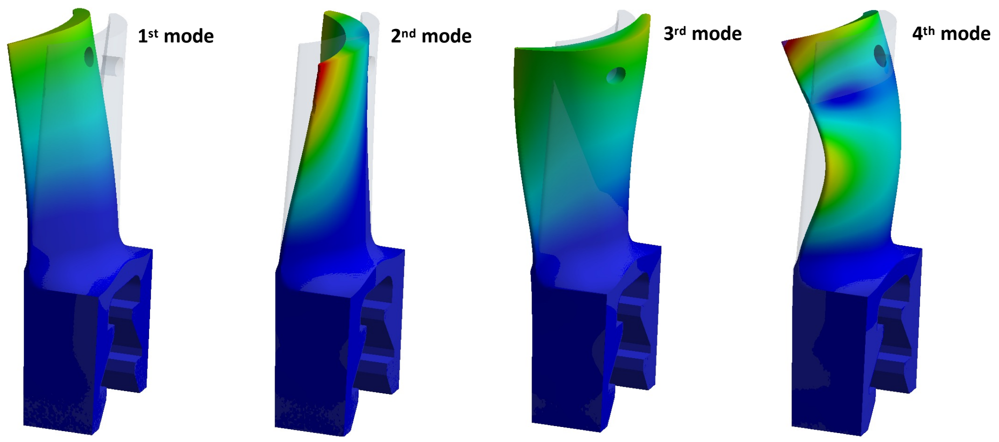

Figure 1: Blade natural frequencies from FEA modal analysis

Steam turbine blades can be excited through harmonics of running speed, blade pass, nozzle pass, partial admission, segment pass disturbances or other sources. KHE generated a Campbell diagram to identify likely sources of excitations in the operating range of the steam turbine. Results showed several troublesome interferences that contributed to the early failure of the blades.

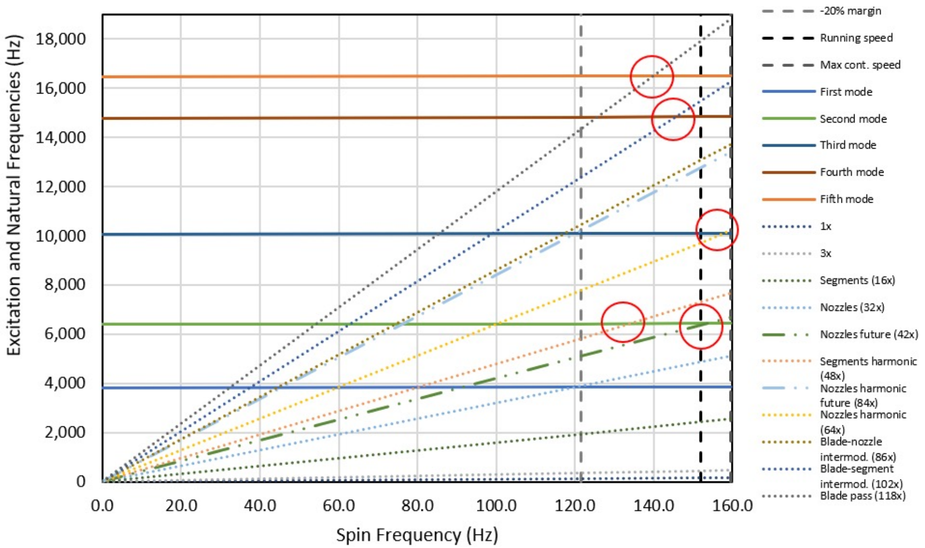

Figure 2: Campbell (interference) diagram for steam turbine blade

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