Effects of Structural Forces on the Dynamic Performance of High Speed Rotating Impellers.

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Introduction: Traditional rotor dynamics is based on dominant linear structural dynamic loads. Inclusion of nonlinear, fluidic and thermal force contributions are increasing due to micro and high performance turbines.

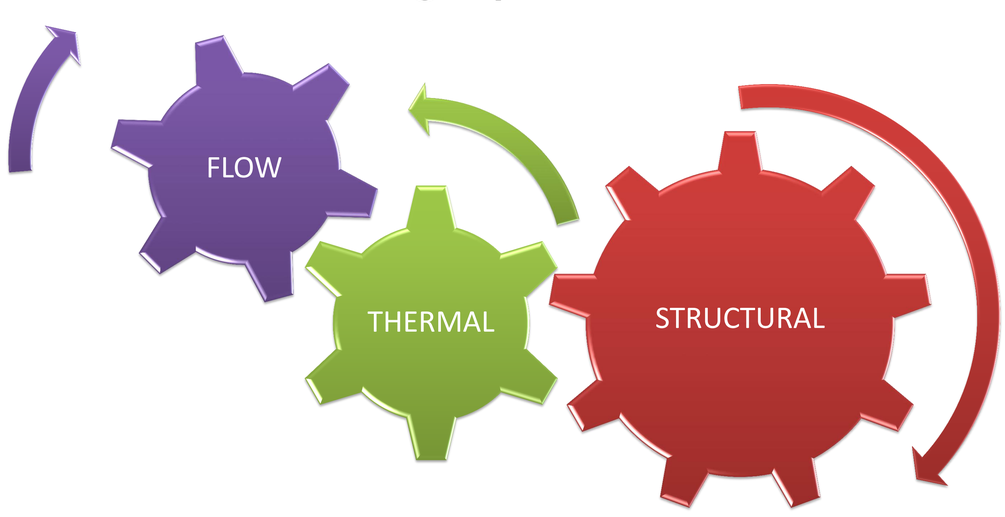

Figure 1. Rotor Dynamic Forces

Governing Equations and DoE: The equation of motion governs the vibration and dynamics of a linear system.

$$m\ddot{x} + c\dot{x} + kx = f(t)$$

Acceleration of the system in a rotating coordinate system with the centrifugal force $\mathbf{F}_{cent}$ and the Coriolis force $\mathbf{F}_{cor}$ are,

$$F_{cent} = -\rho\Omega^2\mathbf{e}\times\mathbf{e}\times(\mathbf{r}-\mathbf{r}_0)$$

$$F_{cor} = -2\rho\Omega\mathbf{e}\times\mathbf{v}$$

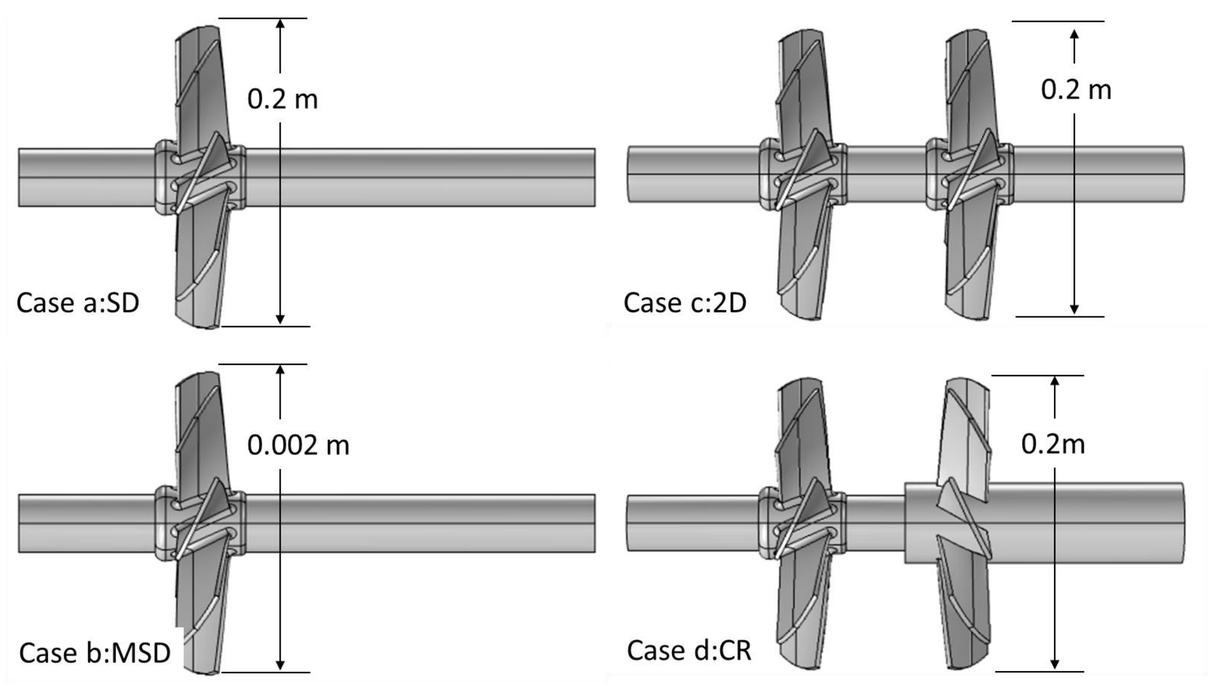

Figure 2. CAD model of the Rotors

Results: The first step in rotor dynamic analysis is the determination of the natural frequency and mode shape extraction.

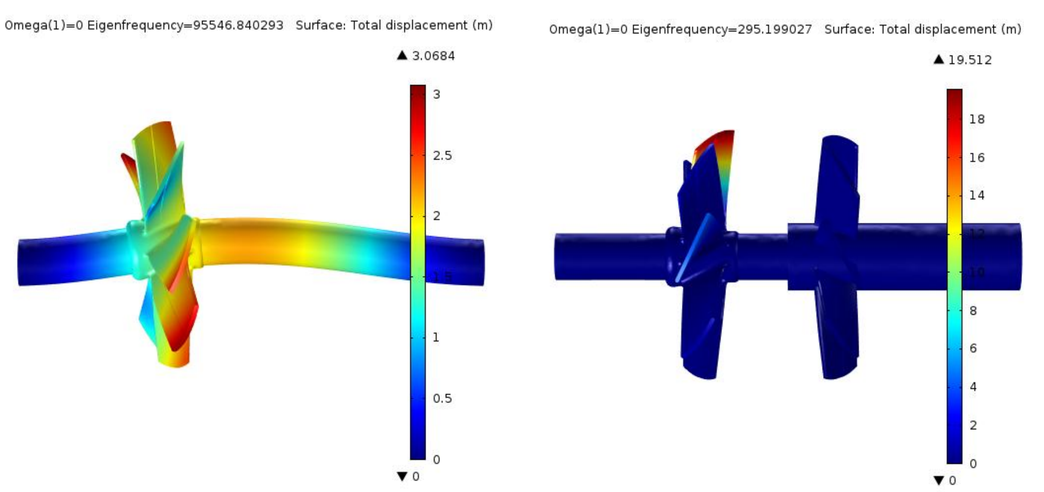

Figure 3. Typical Mode Shapes of singe disk and counter rotating rotor

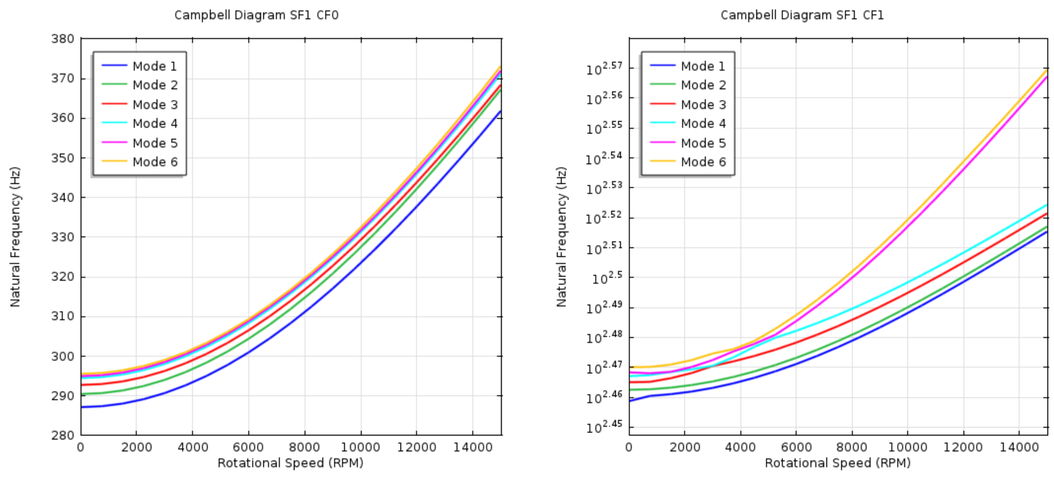

Figure 4. : Single Disk Rotor without and with Coriolis Forces

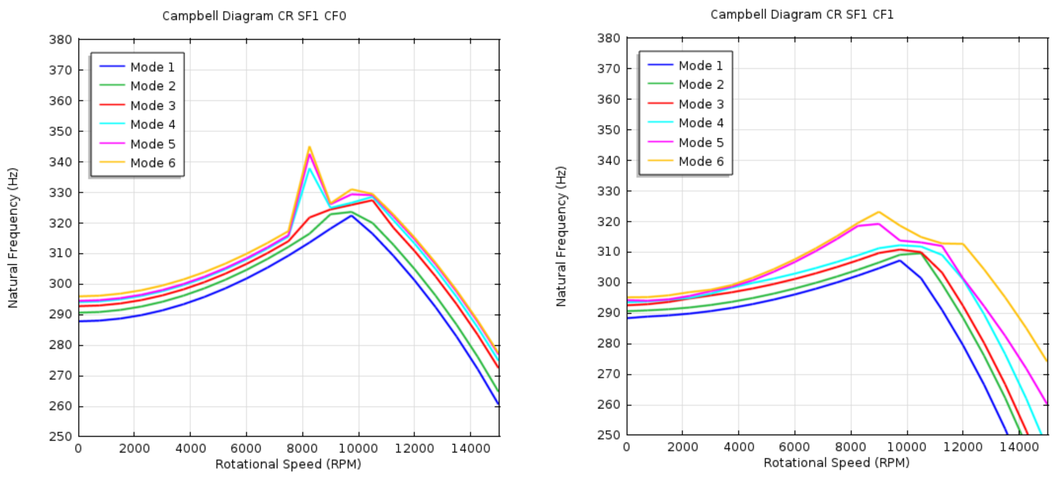

Figure 5. : Counter Rotating Rotor without and with Coriolis Forces

Conclusions: Vibration dynamics as a f(structural forces with Coriolis effects)
Future work: Structural, Flow&Thermal.

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