SHAFT MODE SHAPE DEMONSTRATION

Robert Grissom
Bently Nevada Corporation
Minden, Nevada 89423

The dynamic response of a rotating machine is directly influenced by its geometric configuration and all aspects of the rotor construction. These determine two significant parameters, mass distribution and stiffness, which yield a spectrum of natural frequencies and mode shapes. The mode shapes can be presented as "snapshots" of the characteristic amplitude/phase response patterns of the shaft, due to the major forcing function of unbalance, at different rotative speeds (Figure 1).

OBJECTIVE

To demonstrate the three shaft mode shapes of the rotor rig using the Shaft Mode Demonstrator and oscilloscopes. The synchronous (1X) amplitude and phase of the rotor vibration in the vertical direction from several points along the shaft is displayed on corresponding points of the demonstrator. Unfiltered vibration from vertical and horizontal probe pairs is displayed on the oscilloscopes in orbit format for a dynamic presentation of the mode shape.

ROTOR RIG

The rotor rig consists of a flexible, three-disk rotor supported in relatively rigid, oil impregnated, sintered bronze bearings. The disks are symmetrically placed on the shaft, which is driven by a variable speed (0-12,000 rpm) electric motor through a flexible coupling.

INSTRUMENTATION

The instrumentation consists of x-y proximity probes mounted next to each disk observing shaft vibration, and a Keyphasor probe for speed and phase measurement. The Shaft Mode Demonstrator, a three-channel vector filter, measures the 1X phase and amplitude at each vertical probe, and converts it from polar to cartesian format to drive the servo-controlled x-y positioners at each display location. The plastic shaft presents an amplified version of the shaft mode "snapshot." Oscilloscopes display the corresponding orbit (shaft precessional motion).

Vertical 1X amplitude and phase at each measurement location as a function of rotative speed. Corresponding orbital motion. Relative amplitude/phase and phase change at each location through the three balance resonance speeds.

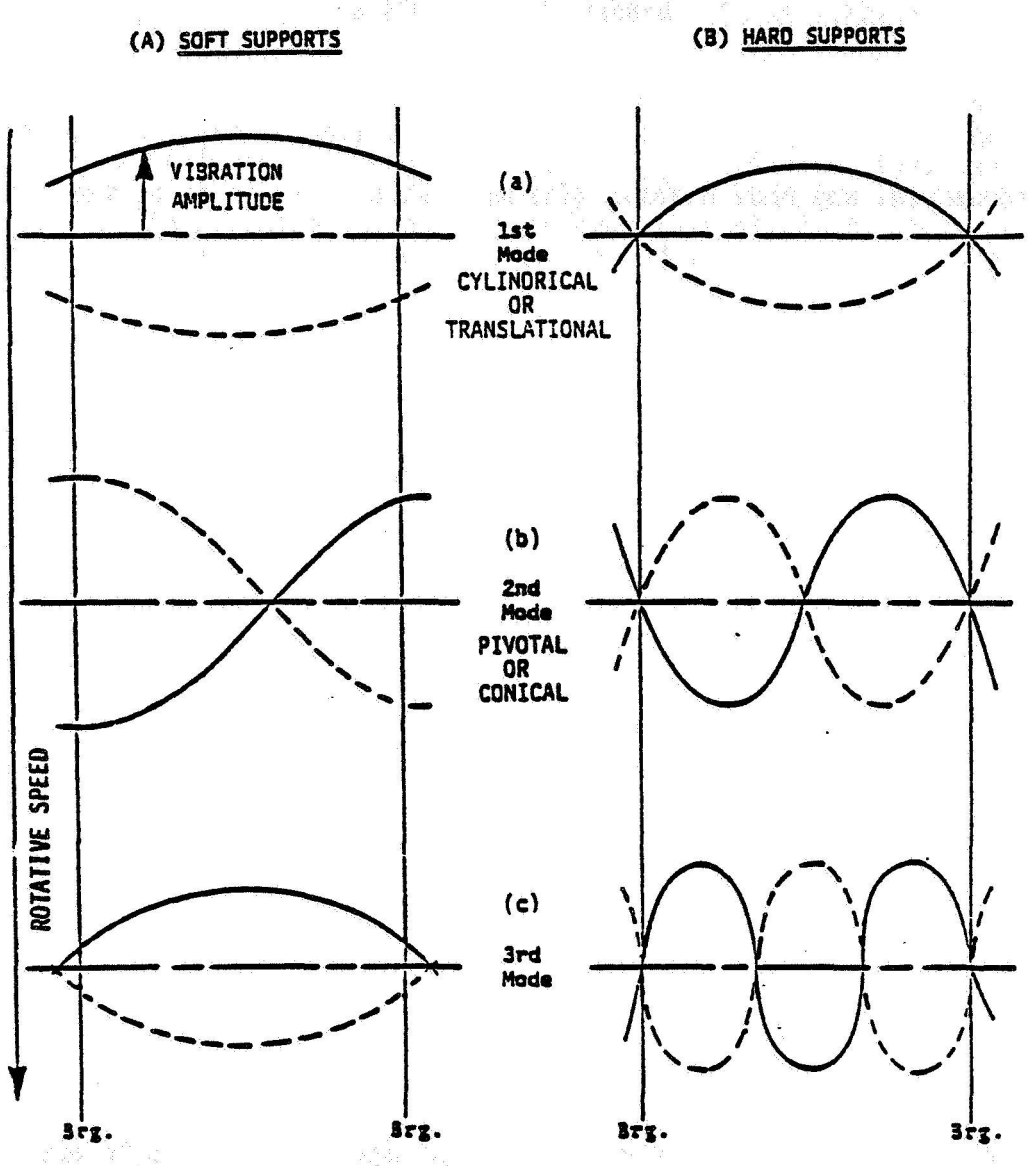

Figure 1. Modal shapes of a shaft in soft supports (A) and hard supports (B).