Where the Rubber Hits the Runway

Experimental 3-D Scanning Vibrometer Measurements on a Complete A320 Aircraft Wheel

Aircraft tires are critical components that must meet very high quality standards. Low frequency tire vibrations can affect aircraft handling while moving on the airport tarmac and may induce undesired fatigue-inducing vibrations (shimmy) in the landing gear. Vibration analysis can characterize the tire dynamics, determine the fundamental frequencies and define a complete modal model of the tire. From this model, engineers can objectively evaluate their concerns about the impact of vibrations on adjacent aircraft components. These concerns have very real consequences since excessive vibrations can lead to premature component fatigue and failure.

Experimental Setup

A complete A320 aircraft wheel was prepared with reflective spray and mounted on a shaker that was driven by a white noise excitation signal. The vibration response was measured in the radial, tangential and axial directions by a 3-D Scanning Vibrometer located 2.5 m from the wheel.

A high measurement point density was used with over 100 points on the tire and hub (Figure 1). Because of the non-periodic nature of white-noise excitation, a Hanning window with 66 % overlap was used. Operational deflection shapes (ODS), frequency response functions (FRF) and coherence were measured from 30 to 400 Hz. Operational deflection shapes (ODS) were then constructed from the data. For more complete analysis and model verification, this experimental data can be passed to modal analysis software.

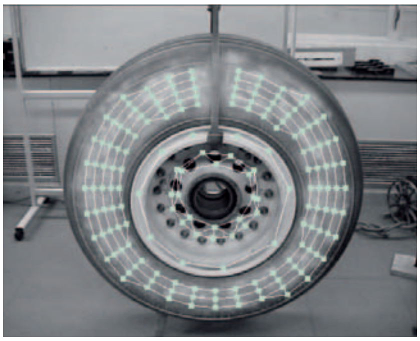
Results

Main resonances occurred at 37, 69 and 353 Hz. The ODS at 37 Hz shows a pure tire bending (Figure 2 a). At 353 Hz, a hub bending oscillation is combined with a higher tire bending shape (Figure 2 b). The FRFs (Figure 3) were clean and the deflection shapes were spatially well resolved. The coherence was reduced at frequencies between resonances, but in the regions around the peaks it was sufficient for operational modal analysis verification.

Summary

The 3-D Scanning Vibrometry improves the quality of experimental modal analysis of aircraft wheels by combining a simple setup procedure with a high measurement point density. Good deflection shapes are quickly and easily obtained without perturbing the structure. While only one example, this measurement represents a growing trend within the aerospace industry to perform 3-D tests on aircraft components.

Figure 1: Experimental setup and scan grid on the A320 wheel (courtesy Groupe SOPEMEA, Vélizy, France).



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The complete measurement setup (including shaker and shaker controller) was provided by SOPEMEA. The aircraft wheel was supplied by Messier-Bugatti.

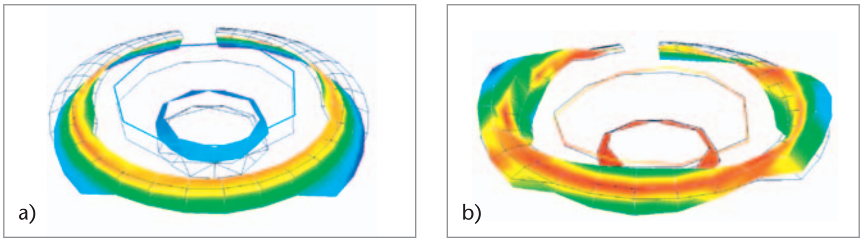

Figure 2: Operational deflection shapes at 37 Hz (a) and 353 Hz (b).

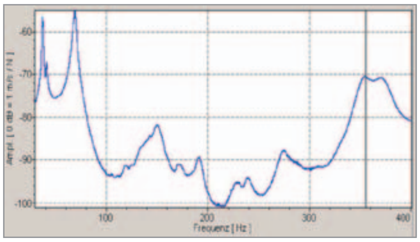

Figure 3: Average frequency response function