Tire Cord Dynamic Properties Measured for FEA Model

The Challenge:

Measure Loss and Storage Modulus for Tire Cord up to 200 Hz in Force Control

Background

Textile cords in a rubber matrix are an important class of composites. Applications of such composites can be found in tires, air springs, shock isolators, and hoses. The most complicated of these designs is the modern automobile tire. The development process for a new line of tires is expensive and long, often consuming 18 months or more.

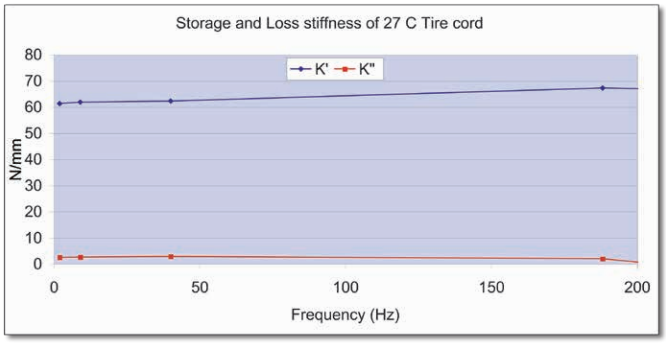
Finite Element Analysis (FEA) is one tool used to model the tire as a structure to reduce the cost and time to market for new tire designs. For example, Ohtsu Tire Company reported that it eliminated 200 physical tests per month and 10% of its tire development cycle time by implementing tire modeling and simulation. Accurate models require accurate properties of individual materials, components, and structures. One of the components that has been difficult to characterize under appropriate conditions is the tire cord.

Meeting the Challenge

A major tire manufacturer supplied a tire cord specimen that consisted of two strands of tire cord embedded in rubber tabs at both ends to facilitate gripping without damaging the tire cord.

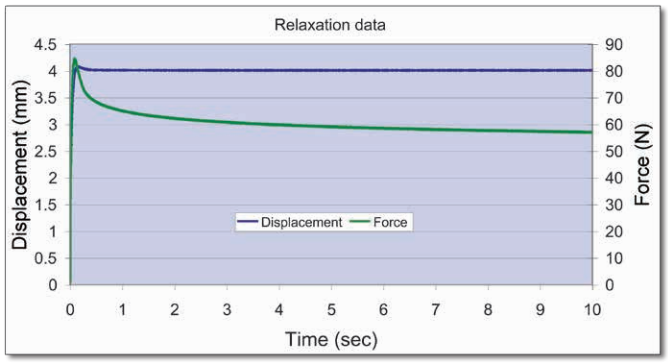
Tests were conducted in an ElectroForce® 3200 test instrument with a hot/cold chamber at room temperature and at 250°F (121°C) over a frequency range from 2 to 200 Hz in force control. The requested mean value correlated to 58 N per cord with a dynamic amplitude of 8.9 N per cord.

The material exhibits extensive creep behavior at this level of mean force so a precondition was set to cycle for 35,000 cycles at 10 Hz prior to collecting any dynamic data.



The modulus at 250°F was approximately 50% of the modulus at room temperature. The measured phase angle (tan delta) was the same at either temperature.

The ElectroForce® 3200 instrument was also used to conduct a traditional stress relaxation test on the tire cord to a displacement that produced an initial force of 42 N per cord.



This test showed a reduction in force to 28.5 N per cord after 10 seconds. Level crossing data acquisition was used to optimize the data file size for this test.

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