Multiphysics CAE of Shock Absorber

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Introduction: A Shock absorber is a mechanical device engineered to absorb impact load and provide ride comfort. This experiment deals with the development of Shock absorber to operate under critical loading conditions. A Conical compression spring is developed to generate negative solid-height, constant spring rate, smooth oscillation and better physical stability. A comparative study is made to distinguish mechanical advantages of Conical spring from Cylindrical compression springs.

Figure 1. CAE Simulation of Shock absorber

Computational Methods: A Mathematical model is developed and solved in COMSOL 5.1 Solid Mechanics interface. The Linear-Static study environment is assigned to calculate desired results. Both models are simulated parametrically under various loads of 100 N to 2000 N.
Governing Equations:-

$$\frac{d^2x}{dt^2} + \frac{k}{m}\,x = 0$$

Where

x = Displacement
k = Spring Stiffness
m = Loaded Mass

Results: Simulation results shows maximum deflection in both models for specified load parameters. The Cylindrical spring design shows limited deflection of 45 mm at 700 N [Figure 2], while Conical spring operates at 2000 N with 80 mm deflection [Figure 3]. The Conical spring shows maximum compression, negative solid-height and better performance compared to Cylindrical spring.
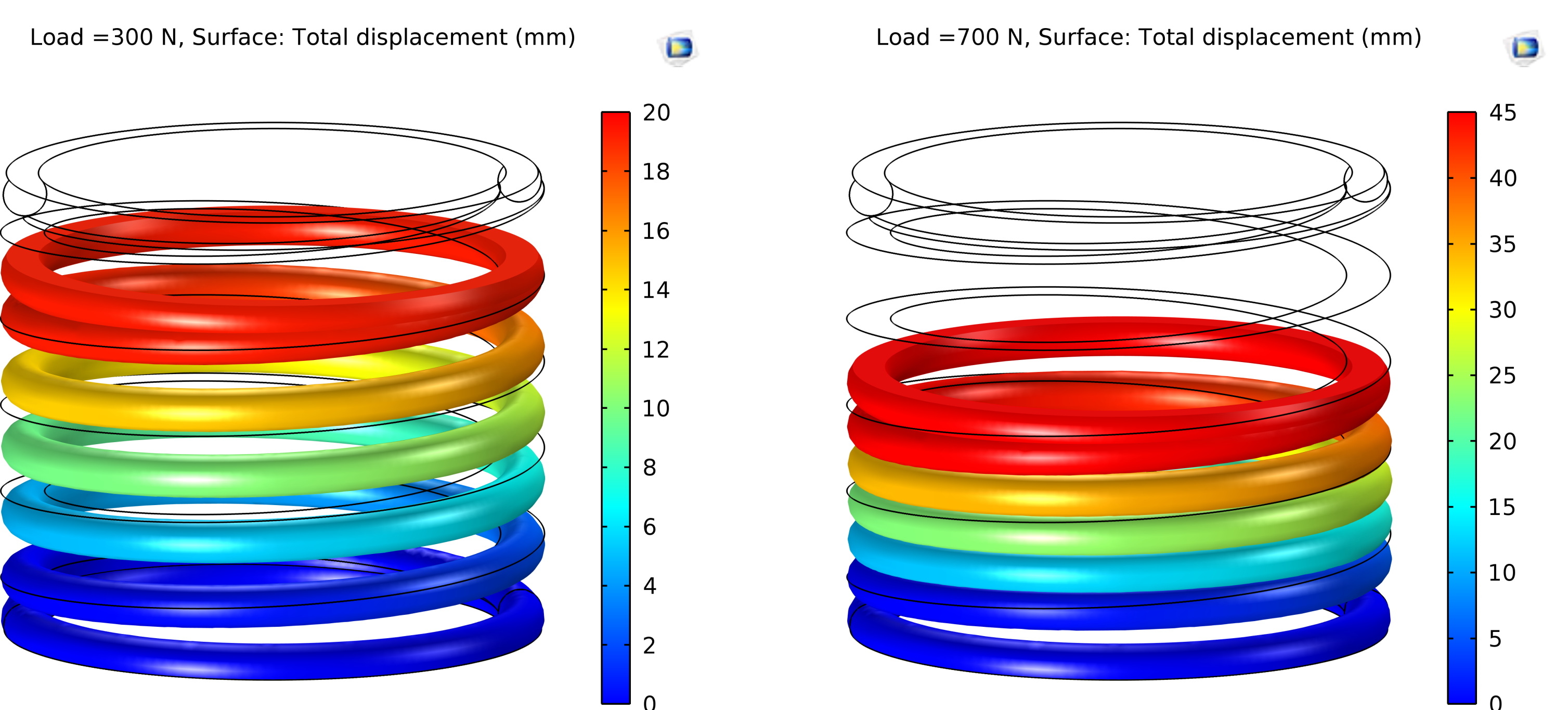

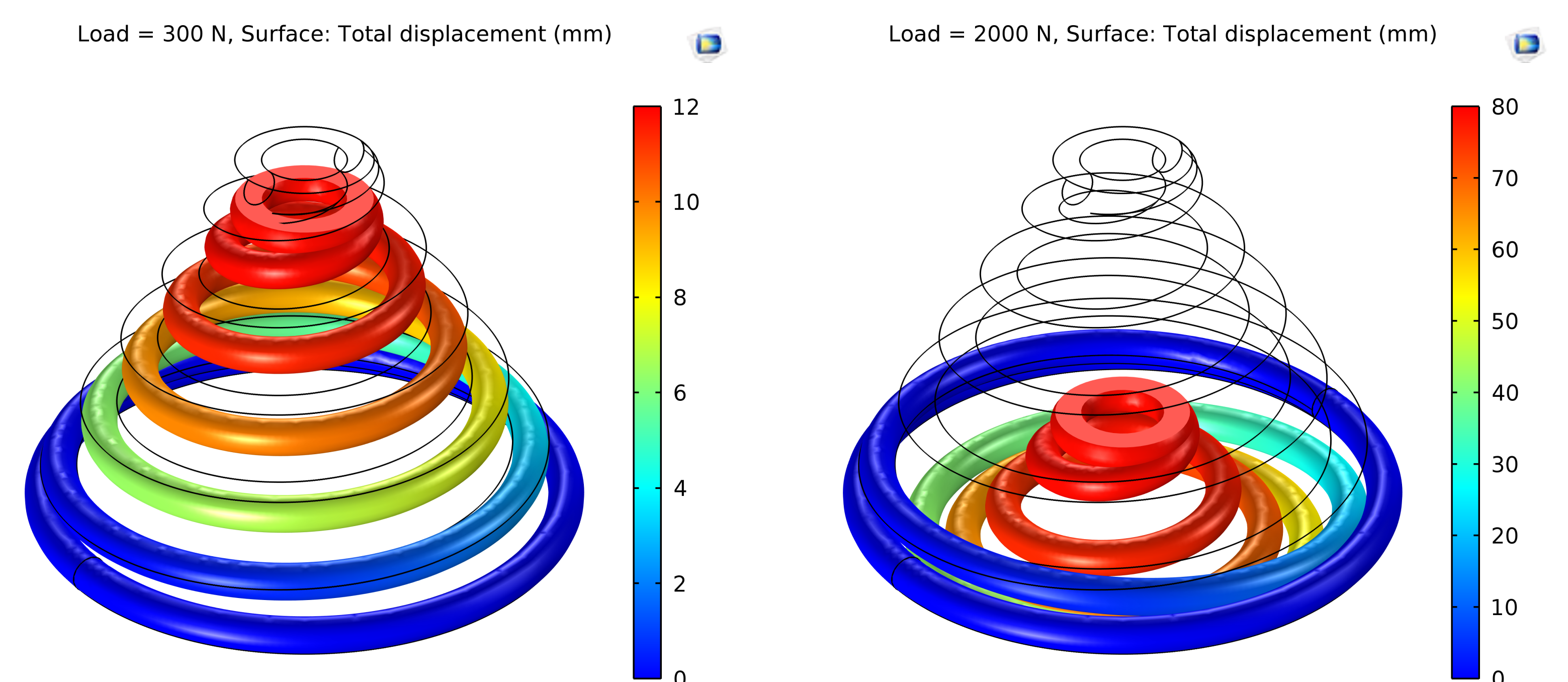**Figure 2**. Cylindrical Spring Displacement.

Figure 3. Conical Spring Displacement.

Conclusions: This optimized Conical spring design shows potential to operate in harsh condition compared to regular springs in a Shock absorber. This Conical compression spring design can offer superior lateral stability and ride comfort. Nonlinear multiphysics study will be performed, for structural design optimization and development of energy harvesting, low cost, high performance Shock absorber.