Nonlinear Thermoelastic Analysis of Nylon Springs with Negative Thermal Expansion

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Abstract. A new geometrically nonlinear nylon spring finite element with negative thermal coefficient (artificial muscle) is established in this article. This straight two-node finite element represents one spring in the initial unloaded state that is characterized by its initial measured parameters like the length, spring constant, compressive prestress and negative thermal coefficient. The unknown quantities are nodal displacements and internal axial nodal forces. Nodal loads are prescribed with mechanical and thermomechanical forces as well as prescribed displacements of nodal points. The geometrically nonlinearity (large elongations) of the Nylon Twisted Coiled Springs (NTCSs) is taken into account. This finite element is verified by the elastic and thermoelastostatic analysis of the selected NCTSs. The results of the analysis are verified by experimental measurements. A very good agreement between the computational and experimental results was achieved.