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Effect of temperature on the mechanical behaviours of a single-ply weave-reinforced shape memory polymer composite

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Abstract

Single-ply weave-reinforced shape memory polymer composites (SpWR_SMPCs) are promising materials for deployable space structures because they have high deformability, stiffness and strength and exhibit variable mechanical properties at different external temperatures. Thus, understanding their sensitivity to temperature has been a significant concern for better application. This paper presents comprehensive experimental investigations of temperature effects on the mechanical behaviours of a recently developed SpWR_SMPC. With the aid of newly modified compressive and shear test fixtures, the mechanical behaviours dissimilar to those of laminated composites were experimentally investigated: below the glass transition temperature (Tg), the composite was in a solid state, and the modulus relationship was observed as tension > compression > flexural > shear; however, above Tg, the relationship changed significantly due to the transition to a rubbery state and the obvious existence of weft skew. During tension and compression, a large geometric deformation was easily exhibited owing to the weave microstructure. All the mechanical properties showed decreasing trends with the rise in temperature, and the most decline was shown in the resin-dominated compressive and shear properties. Based on the test data, Correia's empirical formula was validated to characterize the thermo-mechanical behaviours as an explicit function of temperature. In general, the present work provides basic observations and comprehensive test guidelines for understanding the effects of temperature on the mechanical properties of SpWR_SMPCs.

Keywords

Temperature effect; Shape memory polymer; Single-ply woven composite; Correia's empirical formula.