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A MECHANICS-BASED DERIVATION OF THE SHELL-LIKE BUCKLING LOAD OF ISOTRUSS STRUCTURES SUBJECT TO UNIAXIAL COMPRESSION

Abstract

The purpose of the current study is to derive a mechanics-based analytical expression that predicts the shell-like buckling load of 8-node IsoTruss® composite lattice structures subject to uniaxial compression. The configurations analyzed herein are designed with inner longitudinal members and are approximately 3 m (10 ft.) long and 0.14 kg (0.3 lb.). The four primary failure modes observed in these structures are: 1) local material failure; 2) global column buckling; 3) shell-like buckling within a two bay-length segment of a longitudinal member; and, 4) local longitudinal strut buckling between two adjacent helical struts. An overview of these failure modes and the geometric nomenclature of the structural configuration is provided in the present work. The derivation of the shell-like buckling mode implements energy methods to define the minimum energy state of a longitudinal segment that is approximately two bay-lengths long and incorporates the stiffness of helical struts that intersect the longitudinal member. The study follows the derivation process suggested by Sui et al., but includes an explanation of each step to clearly indicate the assumptions and limitations of the resulting expression. The final expression incorporates a refinement in the calculation of the equivalent planar stiffness of the intersecting helical struts.