Nonlinear elasticity and buckling in the simplest soft -strut tensegrit paradigm

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Abstract: Tensegrity systems occur when self-equilibrated states are achieved through the interplay of pretensed (cables) and precompressed (struts) elements. The principles that govern these types of structures have been widely observed in many living systems across the scales and recently recognized, with soft or buckling bars, in the cytoskeleton as well as within single protein architectures as associated with key cellular and subcellular processes. To properly model these mechanical phenomena, some limitations dictated by the mostly linear approaches –used in literature when dealing with tensegrity structures – need to be overcome. To this aim, the present work provides a novel 2-element soft -tensegrity paradigm that includes, for the first time, (neo-Hookean) finite hyperelasticity for cable and strut, the latter potentially undergoing both contraction and buckling at each prestressed equilibrium stage. It is finally shown that constitutive properties, instability and bar deformability cooperate to determine unusual form-finding results, providing peculiar overall mechanical responses as external forces are applied.