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Structural analyses of compliant tensegrity towers

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Abstract: Tensegrity Structures were originally established in the fields of architecture and modern arts. Due to their structural assembly, those prestressed structures are filigree and enable an immense weight-to-load ratio. These features allow the development of large sculptures or buildings, e.g. Needle Tower. However, due to their advantageous properties, tensegrity structures are also suitable for applications in engineering. In this work, various pattern principles to realize such chain-like tensegrity-based systems by cascading modular substructures are presented. In order to evaluate the structural dynamics, the equations of motion are derived. The equilibrium configurations and the corresponding stiffness properties are evaluated. In particular, the deformation capability, as well as the physical limits due to external loads and dead weight, are considered. Subsequently, modal analyses of the linearized systems are performed. The vibration modes and the corresponding eigenfrequencies of tensegrity towers with various topologies are compared. Based on these results constructive guidelines regarding the development of chain-like cascaded tensegrity structures are defined.

Keywords: Compliant tensegrity structure, non-linear dynamics, modal analysis