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SIMPLE SHAPE FINDING FOR SPHERICAL TENSEGRITY BASED ON ROTATIONAL LOCATION

Abstract

Spherical tensegrity structures are lightweight and have potential applications in various fields. This study presents a simple method to model them. The nodal coordinates of the spherical tensegrity are systematically determined based on rotational symmetry and regular polyhedral configuration. This method allows to systematically obtain nodal coordinates for spherical tensegrities of any size using a three-dimensional rotation matrix and the dihedral angle of the regular polyhedron. The prestress ratio is then determined iteratively. A nonlinear analysis with prestressing is required for the stability analysis of the spherical tensegrity. In this study, a tangent stiffness matrix is used for the analysis that considers prestress. The simple determination method allows the modeling of spherical tensegrity. Frequency analysis identifies the natural frequencies and mode shapes of the tensegrity. This paper presents a simple method for determining the nodal coordinates of spherical tensegrity structures. The method uses a three-dimensional rotation matrix and the dihedral angle of the regular polyhedron and can be applied to structures of any size. It is largely effective for structures corresponding to regular polyhedrons. To achieve this, a method for iteratively obtaining the prestress ratio is developed. In this paper, the prestress ratio is defined as the relative prestress of the members forming the symmetric tensegrity. The tangential stiffness matrix of the spherical tensegrity takes into account the prestressing effect. To determine the prestress of the spherical tensegrity, we use the measured stress of the fabricated structure and the prestress ratio. By determining both the nodal coordinates and the prestress ratio, we can analyze the frequency of the spherical tensegrity. This work presents three novel aspects. First, it exploits the rotational symmetry of a spherical tensegrity and introduces a three-dimensional rotation matrix to produce a simple method for determining nodal coordinates. Second, it considers the similarity between the configurations of a spherical tensegrity structure and a polyhedron and introduces the dihedral angle of the regular polyhedron to obtain nodal coordinates. Finally, it iteratively determines the prestress ratio and introduces the prestress using a fabricated structure. These three new features make it possible to calculate nodal coordinates in a complex spherical tensegrity structure and analyze its dynamic behavior. The analysis of spherical tensegrity based on experiment will greatly enhance its practical usability.