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Abstract of PhD Thesis of Eng. Maryna Solovei

Title of dissertation thesis in English: Dynamic stability analysis of tensegrity domes

Title of dissertation thesis in Polish: Analiza stateczności dynamicznej kopuł typu tensegrity

The dissertation thesis concerns the dynamic stability analysis of tensegrity domes. The consideration includes the most known tensegrity domes, i.e., Geiger dome and Levy dome. These structures are distinguished from the traditional cable-strut steel domes by the presence of some unusual features. These domes are characterized by the presence of a self-equilibrated set of forces (the initial prestress), that stabilize the infinitesimal mechanisms. The analysis of tensegrity domes includes the influence of the initial prestress level on structure response. Considered domes with different structural modifications to compare their behaviour are presented. The modifications include different types of upper sections (open or closed upper sections) and additional circumferential cables (only in the case of the Geiger domes). Three types of analyses are performed, i.e., static, dynamic, and dynamic stability analysis. The influence of the initial prestress level on the static parameters (displacements, stiffness, and maximum effort), dynamic parameters (natural and free frequencies), and most importantly, the distribution and range of the unstable regions are considered.

The analysis proved that the ability to control static and dynamic parameters with initial prestress is possible only in the case of the existence of an infinitesimal mechanism or mechanisms. Additionally, structures with a larger number of infinitesimal mechanisms are more sensitive to the change in the initial prestress level. In the case of the Geiger domes, structural modifications caused reducing a number of mechanisms, thus influence of the initial prestress level. For the Levy dome, the change of the upper section (from a closed one to an open one) resulted in the appearance of one local infinitesimal mechanism, however, the behaviour is similar to the structure without the mechanism.

The analysis of the unstable regions showed, that the widest unstable regions appear at the minimum prestress level. Nonetheless, the increase in the initial prestress level results in the complete or partial narrowing of unstable regions. Additionally, the shape and range of the unstable region are also connected to the external load situation.

The thesis concluded with answers to the questions asked at the beginning of the consideration and summarized with advantages and disadvantages of the considered structures. The summary includes the authors' design guidelines for the future application of tensegrity domes in civil engineering.

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