11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

THE NUMERICAL COLLAPSE ANALYSIS OF TENSEGRITY STRUCTURES

B. Shekastehband[1] and K. Abedi[2]

[1] Assistant Professor, Civil Engineering Department, Urmia University of Technology, Urmia, Iran, b.shekastehband@uut.ac.ir

[2] Professor, Civil Engineering Department, Sahand University of Technology, Tabriz, Iran, k_abedi@sut.ac.ir

Key Words: *Self-stress, Nonlinear Static and Dynamic Analysis, Progressive Collapse, Snap-Through.*

A complete analysis of the tensegrity system comprises three steps: the first one is form finding which is performed without loading or self-stress, the second concerns the implementation of self-stress and the last one is the study of behavior under external actions. Form finding leads to ‘null self-stress equilibrium geometry’. Application of self-stress must verify node equilibrium. Once the self-stress implementation is achieved, it is possible to load the system, and thus to study its behavior. A particularity of these systems concerns magnitude of displacements, which can be large, even if deformations are small. Therefore, both geometrical and material nonlinearities must be taken into account in the numerical analyses [1].

To evaluate the possibility of progressive collapse due to buckling of struts and rupture of cables in tensegrity systems the following procedure is pursued. At the first step, a nonlinear static collapse analysis is then performed to find the load-deflection responses of the tensegrity system. To trace the equilibrium paths through limit points into the post-critical range, the ‘Arc-Length-Type Method’ is used. If the response of the system is “overall instability”, it indicates that progressive collapse has occurred in the system and static analysis is adequate to evaluate the response of the system. Otherwise, local instability has occurred in the system which in some cases may associated with snap-through phenomena. When snap-through phenomenon is occurred, the system experiences a 'dynamic instability coupling phenomenon'. The kinetic energy released during this phenomenon which applies an initial velocities to the nodes of the system at the end of snap-through in the direction of dynamic jump [2].

At the second step, if the response of the tensegrity system is local collapse with dynamic effects, then in the strained configuration, an eigenvalue analysis was performed to determine incremental time step and damping ratios. At the third step, a nonlinear dynamic analysis is carried out to evaluate the possibility of progressive collapse of the tensegrity system [2]. The aforementioned procedure is implemented on a sample tensegrity grid and verified experimentally.

REFERENCES

[1] K. Kebiche, M.N. Kazi-Aoual and R. Motro, Geometrical non-linear analysis of tensegrity systems. *Eng. Struct.*, Vol. **21**, pp. 864–876, 1999.

[2] B. Shekastehband, K. Abedi, N. Dianat and M.R. Chenaghlou, Experimental and numerical studies on the collapse behavior of tensegrity systems considering cable rupture and strut collapse with snap-through. *Int. J. Non-Linear Mech.*, Vol. **47**, pp. 751–768, 2012.