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Parametric Studies on the Propagation of Local Collapse in Tensegrity Grids

B. Shekastehband [a], K. Abedi [b]

[a] *Assistant Professor, Department of Civil Engineering, Urmia University of Technology, Urmia, Iran, Email: b.shekastehband@uut.ac.ir*
[b] *Professor, Department of Civil Engineering, Sahand University of Technology, Tabriz, Iran, Email address: k_abedi@sut.ac.ir*

Abstract
In this paper, parametric studies on the propagation of local collapse in continuous struts tensegrity grids has been investigated taking into account both geometric and material nonlinearities. When a local collapse, e.g. member snap through, occurs in these systems, some amount of kinetic energy may be released. This released energy giving an initial velocity to adjacent part of the system, causes the local collapse to have dynamic nature. Modeling the dynamic effects of local collapse may lead to collapse of additional part of the system and even the occurrence of progressive collapse. Therefore, a comparative numerical study into the propagation of local collapse in these grids is performed using nonlinear static and dynamic analysis to determine nodal displacements responses of the systems. Results of the present study evaluate the effects of various design parameters such as self-stress levels, effective length factor of struts, damping characteristics, etc. on the propagation of snap-through buckling in these structures. The conclusions, drawn from this study, lead to the suggestion of some guidelines and recommendations for the design of such structures.
Keywords*:* Tensegrity systems, nonlinear dynamic analysis, self-stress levels, progressive collapse

1. Introduction
Tensegrity structures are mainly statically and kinematically indeterminate structures. It was recognized that the behavior of members has a dominant effect on the overall collapse behavior of these structures [1, 2, 3]. This is normally due to the fact that in these structures with usual proportions of the members used, load is primarily transmitted as axial forces. A member may suddenly fail in tension or compression. Moreover, behavior of struts under compression such as snap-through (dynamic jump) and cable ruptures under tension may also result in the abrupt structural collapse [4, 5]. In fact, the member failure has a dynamic effect on the behavior of the whole system; and consequently a large amount of kinetic energy is released at a local region of the structure. Therefore, it is important to account for dynamic effects, namely the rapid redistribution of member forces and the inertia forces caused by the member failure, in the evaluation of response of these structures under member failure phenomenon [4, 5].
According to the experimental and numerical results, the load level at which member failure is occurred has a commanding influence on the dynamic propagation of local collapse. Self-stress level, slenderness ratio, effective length factor of the struts and damping ratio of the structure are other important parameters on the propagation of local collapse in tensegrity systems [4, 5]. The buckling loads and post-buckling behavior of the struts are strongly dependent on the end rotational rigidity induced by the ball joint systems. This semi-rigidity of the connections should be accounted for by defining effective length factor for the struts [4].
The main aims of the present study are as follows:

1. Assessing vulnerability of tensegrity systems due to snap-through buckling;
2. Evaluation of the effects of various design parameters such as self-stress level, slenderness ratio of struts and damping ratio on the progressive collapse behavior of these structures;
3. Putting forward some recommendations for the design of these tensegrity structures considering propagation of snap-through buckling.