Collapse resistance analysis of Tensairity dome with a multi-chambered cushion subjected to local leakage

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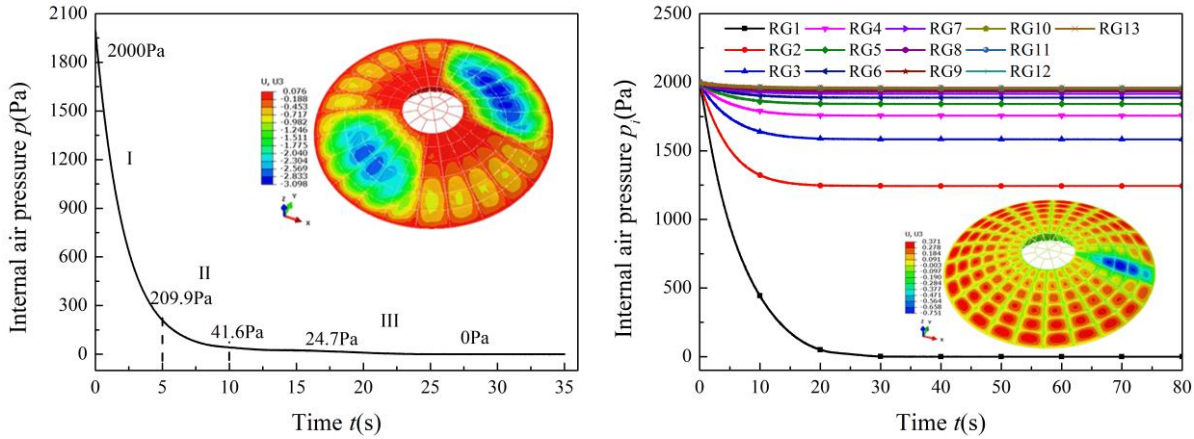
Abstract

Maintaining the required internal air pressure in the cushion at a certain level is very critical for the stability and safety of inflatable membrane structures. So far, very few researchers studied the deflation behavior of inflatable structures. Based on Tensairity concept [1], a pneumatic dome with a span of 80 meters is designed the same as the one in Ref. [2]. In order to improve the reliability of the structure, some webs are specially arranged inside the cushion to divide the cushion into several separate chambers to avoid the loss of the pre-stress of the whole structure caused by local leakage. Based on the theory of fluid mechanics, the numerical simulation of the air leakage process of the cushion is carried out. The deflation behaviors of the two domes with a single-chambered cushion and with a multi-chambered cushion under the action of external load are analyzed and compared. The damage modes of the structure with different number of chambers are revealed by studying the change of the internal pressures after the membrane breakage. The results show that the cushion will undergo three stages after the local leakage: rapid descent stage, transition stage, and stablization stage. As shown in Fig. 1, the local leakage will cause the failure of the upper chord of the single-chambered-cushion dome under snow load, but for the dome with a multi-chambered cushion, only partial collapse occurs in the upper membrane. The webs to divide the cushion into separate chambers can effectively reduce the effect of air cushion leakage on the structure, and greatly improve the robustness of the structure.



a) dome with a single-chambered cushion b) dome with a multi-chambered cushion

Fig. 1. Change of internal pressure in Tensairity dome due to local leakage.

References

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[2] Z. Cao, Z. Wan, Y. Sun and F. Fan, "Numerical simulation study on structural behavior of Tensairity domes with annular airbags", *Thin-Walled Structures*, vol. 117, pp. 155-164, 2017.