Study on the non-uniform temperature filed and the effect on ice shell under solar radiation

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Abstract

Ice structures which use ice or snow as construction materials are widely constructed in cold regions as landscapes or shelters. With the development of composite materials and new structure systems for ice structures, the research on relevant structural design theories and structural analysis methods needs to be further explored. Due to the significant temperature sensitivity of ice materials, the temperature field distribution and structural response of ice structures are closely related to solar radiation and ambient temperature. The temperature effect is even a controlling factor for the long-term mechanical properties and durability of ice structures.

In this paper, a 31m high ice composite tower is taken as the research object. By using Grasshopper and Abaqus, a preliminary analysis method considering the effects of solar radiation and ambient temperature is established. The instantaneous temperature field and structural response of the ice shell structure under the action of non-uniform temperature are obtained, and the long-term mechanical properties of the ice tower are explored. The results show that the local temperature of the ice tower is obviously higher than that of the air temperature, and the maximum temperature difference is nearly 5 degrees Celsius. The vertical displacement of the tower can reach 30.4 mm under the action of solar radiation, which is 10 times more than that of 3.2 mm when the tower is only affected by self-weight. Compared with the influence of self-weight, the temperature variation and the solar radiation are the control actions of the principal stress of the ice tower, and the maximum principal stress is not more than 0.8 MPa, which satisfies the safety limit requirement.

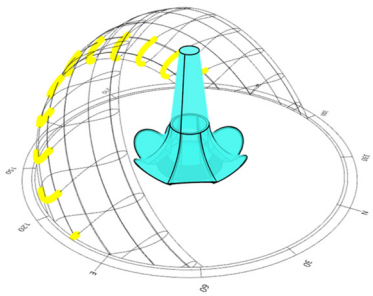

Fig.1 The solar radiation analysis model

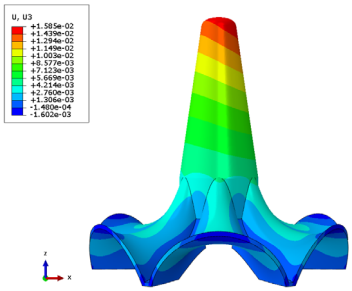

Fig.2 The displacement nephogram

References

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