Free vibration characteristic of single-layer spherical aluminium alloy latticed shells

Li. Wang*, Xiaonong. Guo, Shuyu. Gao, Qiang. Zeng

*Department of Structural Engineering, Tongji University
No.1239 Siping Road, Yangpu District, Shanghai, China
1810025@tongji.edu.cn

Abstract

With the wide application and rapid development of the aluminum alloy structure in China, the insufficiency of study on its dynamic characteristic becomes increasingly prominent. Moreover, the free vibration characteristic is the research foundation of its dynamic characteristic.

In order to study the free vibration characteristic of K6 and K8 aluminum alloy single-layer spherical latticed shells with gusset joints, large amount of finite element (FE) analysis was carried out using ANSYS. In the established models, various parameters including rise-span ratio, span, roof load, span-thickness ratio, grid density and support boundary conditions were considered.

Based on the FE results, the formula to estimate the fundamental frequency of single-layer spherical latticed shells was derived, without considering the effects of joint stiffness. Subsequently, by introducing the amplification factor, the formula of the fundamental frequency of aluminum alloy shells with gusset joints was proposed.

Finally, the proposed formulae were validated against the experimental values of an actual shell. The theoretical values agreed well with the test results, indicating the proposed formulae are with good accuracy.

The research results indicate the following:

(1) The rise-span ratio, span, roof load, span-thickness ratio and grid density are the main factors influencing the fundamental frequency of single-layer spherical latticed shells. The shells with larger rise-span ratio demonstrate horizontal low-order vibration modes mostly, while those with lower rise-span ratio show vertical low-order vibration modes mainly.

(2) Without considering the joint stiffness, the fundamental frequency of aluminum alloy latticed shell can be estimated by the proposed formula.

(3) When the stiffness of gusset joints is taken into account, the fundamental frequency of latticed shell will increase, and the amplification factor can be captured by the modifier formula.

References

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