# Spatial System Sampling Method for Calculating Joint Positions of Existing Spatial Structures

Xu YANG*, Yongfeng LUO [a], Jun LIU[b]

* Department of Structural Engineering, Tongji University
1239, Siping Road, Shanghai, China
1610196@tongji.edu.cn

## Abstract

In the process of inspection and safety evaluation of existing structures, obtaining accurate and comprehensive data of structural configuration is necessary, especially for lattice shell structures which are sensitive to geometric imperfections. However, architectural ornaments and inspected cost make it difficult to measure the coordinate information of all joints of a structure.

According to randomness and inherent correlation of joint position deviations of existing spatial structures, a spatial system sampling (SSS) method is proposed to calculate all joint positions and to reckon the geometric shapes in this paper. Based on the distribution pattern of structure joints and spatial sampling theory, sampling principles and an approach to calculating minimum sample size in the SSS are presented. On account of the theory of testing hypothesis of non-independent samples under normal population, a statistical inference method considering sample correlation is presented, which can infer the probabilistic distributions of the joint position deviations by inversion of partial coordinate information. Finally, a procedure for constructing the existing structural numerical model with prior accuracy is proposed.

In order to verify the applicability of this method, a single layer reticulated shell structure was designed and set up. In view of the testing data of the joint positions, a variety of numerical modeling methods are used to construct the computation model of the structure. By carrying out comparative analysis of the ultimate bearing capacity of each computation model, it proves that the joint positions calculated by the SSS is closer to the actual structure.

## References

[1] X. Chen, and SZ. Shen, "Complete load-deflection response and initial imperfection analysis of single-layer lattice dome", *International Journal of Space Structures*, vol. 8, no. 4, pp. 271-278, Dec. 1993.

[2] G. Chen, H. Zhang, KJR Rasmussen, and F. Fan, "Modeling geometric imperfections for reticulated shell structures using random field theory", *Engineering Structures*, vol. 126, pp. 481-489, Nov. 2016.

[3] YF. Luo , and J. Liu, "Stochastic deviation method of reckoning geometric shapes of existing spatial structures", *Journal of Tongji University (Natural Science)*, vol. 45, no. 6, pp. 791-798, Jun. 2017.