Geometric features and parameter sensitivity analysis for the prestressed state of the innovative honeycomb multi-post cable dome structures

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Abstract

Abandoning Buckminster Fuller's initial tensegrity concept of continuous tension and discontinuous compression, the circular multi-post cable dome structure was carried out with all ridge cables framing a honeycomb-shaped net, multiple posts connected at each lower and upper node. Regard to all kinds of cable-post layout, cable dome structures related in research and practical projects can be classified into 13 types, including Geiger type, Levy type, Kiewitt type, bird nest type, et al. The newly proposed type has desirable geometric features in its multi-post setting and innovative honeycomb ridge cable unit shape, thus being particularly advantageous over the existing ones above in terms of structural properties, complexity of construction, costly cable consuming and thus economic benefits. There is no cable dome structure without prestress. Based on the former derivation of the general recursive formulas for the internal forces, this paper carries out new initial prestress design table with shifted parameter. Comparative analyses show more detailed prestress distribution regulations and demonstrate the exact significance of depth-to-span ratio. This study provides a new solution for the selection, design and construction of cable domes.

Keywords: honeycomb cable dome structure, multi-post setting, new structure, geometric feature, prestressed state, mechanical properties, parameter sensitivity analysis, design table.

References

[1] D.H. Geiger, A. Stefaniuk, D. Chen, "The design and construction of two cable domes for the Korean Olympics," *in Structural Engineering: Proceedings of IASS Symposium on Shells, Membranes and Space Frame, IASS 1986, Osaka, Japan, September 15-19, 1986*, Kōichirō Heki, Eds. New York: Elsevier, 1986. pp. 265-272.

[2] M.P. Levy, "The Georgia Dome and beyond: achieving lightweight-long span structures" *in Structural Engineering: Proceedings of IASS-ASCE International Symposium on Spatial, lattice and, tension structures, IASS-ASCE 1994, Atlanta, Georgia, USA, April 24-29, 1994*, J.F. Abel, J.W. Leonard, and C. U. Penalba, Eds. New York: ASCE, 1994. PP. 560-562.

[3] L.M. Chen, X.F. Yuan, S.L. Dong, "Self-stress mode analysis and optimal design of Kiewitt domes," *Journal of Zhejiang University: Engineering Science*, vol. 40, pp. 73-77, 2006.

[4] C.R. Calladine, "Buckminster Fuller's 'Tensegrity' structures and Clerk Maxwell's rules for the construction of stiff frames," *International Journal of Solids & Structures*, vol. 14, pp. 161-172, 1978.

[5] R.B. Fuller, "Tensile-integrity structures," U.S. Patent 3063521, Nov 13, 1962.

[6] S.L. Dong, Y. Tu, "Configuration and prestress distribution of honeycomb-type cable dome with four struts," *Spatial Structures*, vol. 24, pp: 3-12, 2018.

[7] A. Hanaor, "The concept of structural depth as applied to certain bar-tendon assemblies," *Space Structures* 5, 2002. Thomas Telford, London, vol. 1, pp. 11–20.

[8] M. Kawaguchi, B. Ikuo Tatemichi, P.S. Chen, "Optimum shapes of a cable dome structure," *Engineering Structures 21*, pp: 719–725, 1999. Kiewitt, G., 1960. The new look of lamella roofs. Architectural Record, February 1960, p. 226.

[9] S.L. Dong, Y. Tu, "Research on the system of honeycomb-type cable dome structures," in *Structural Engineering: Proceedings of 18th national modern structure Symposium, TJU 2018*, Changzhou, Hebei, CHN, July 20-22, 2018. pp: 10-15.

[10] S.L. Dong, Y. Tu, "Structural system innovation of cable dome structures," *Journal of Building Structures*, vol. 39, pp: 85-92, 2018. https://doi.org/10.14006/j.jzjgxb.2018.10.010