

## AUTOMATED DESIGN AND STRENGTH ANALYSIS OF SINGLE-COCONTOUR GEODETIC SHELLS COMPOSED OF FLAT ELEMENTS

The article is a brief review of the research of the stress-deformation state of a structure that represents a hemispherical geodetic dome exposed to the dead load. Single-contour geodetic domes composed of flat plates are the subject of the research. The process of their design has two stages: (a) design of geometric models of geodetic domes and (b) analysis of domes.

The authors demonstrate that the first stage can be implemented through the employment of the library of ArchiCAD objects. Supplementary research is needed to have the second stage implemented. The objective of this research is to present the results of the research using computer-aided methods of modeling of metal structures. The analysis of smooth hemispherical domes is performed using analytical and finite-element methods within the Patran/Nastran environment. The authors demonstrate that the results of the finite-element method analysis converge with the results of the analytical method analysis.

Conversion of geometric models of geodetic domes into the format that satisfies Patran pre-processor requires the employment of the Visual Basic software. Ultimately, comparison between the results obtained in respect of the geodetic dome and the analytical results obtained in respect of the smooth dome exposed to the dead load is performed. The conclusion is that the maximal stress experienced by a single-contour geodetic dome, in the event of reduction of sizes of plates, converges with the maximal stress of similar smooth domes.

**Key words:** method of design and analysis, analytical research, numerical modeling, analysis, distribution of deformation/pressure.

### References

1. Tupolev M.S. *Novye arkitekturnye tipy svodov i kupolov dlya massovogo stroitel'stva* [New Architectural Types of Vaults and Domes for Large-scale Construction]. Moscow, 1951.
2. Fuller R.B. Geodesic Dome. *Perspecta* Publ., 1952, no. 1, pp. 30—33.
3. Pavlov G.N., Suprun A.N. *Avtomatizatsiya arkitekturnogo proektirovaniya geodezicheskikh kupolov i obolochek* [Automation of Architectural Design of Geodetic Domes and Envelopes]. Nizhniy Novgorod, NNGASU Publ., 2006, 162 p.
4. Suprun A.N., Pavlov G.N., Lakhov A.Ya., Tkachenko A.K. Avtomatizatsiya arkitekturnogo proektirovaniya i prochnostnogo rascheta geodezicheskikh obolochek [Automation of Architectural Design and Strength Analysis of Geodetic Domes]. *Privolzhskiy nauchnyy zhurnal* [Privolzhskiy Scientific Journal]. Nizhniy Novgorod, NNGASU Publ., 2008, № 23(7), pp. 15—19.
5. Lakhov A.Ya., Suprun A.N. SVN — trekhmernye graficheskie interfeisy na osnove DirectX i VC# dlya vizualizatsii rezul'tatov raschetov bezopasnosti stroitel'nykh konstruktsiy [SVN — Three-dimensional Graphic Interfaces on the Basis of DirectX and VC # for Visualization of Results of Analysis of Safety of Building Structures]. *Privolzhskiy nauchnyy zhurnal* [Privolzhskiy Scientific Journal]. Nizhniy Novgorod, NNGASU Publ., 2010, no. 2, pp. 10—15.
6. Lakhov A.Ya. *Raschet dvukhkonturnykh geodezicheskikh kupolov sistemy «P» metodom konechnykh elementov v sisteme Patran/Nastran* [Analysis of Dual-contour Geodetic Domes of P-System Using Method of Finite elements within the Patran/Nastran System]. *Informatsionnaya sreda vuza* [Information Medium of an Institution of Higher Education]. Proceedings of the 17<sup>th</sup> Scientific and Technical Conference. IGASU Publ., 2010, pp. 121—125.
7. Lakhov A.Ya. *Translyator geometricheskikh modeley odnokonturnykh geodezicheskikh obolochek ArchiCAD — Patran* [ArchiCAD — Patran Translator of Geometric Models of Single-contour Geodetic Domes]. Proceedings of KOGRAF 2012 Scientific and Technical Conference. Nizhniy Novgorod, 2012, pp. 155—159.
8. Karpov Yu.G. *Teoriya i tekhnologiya programmirovaniya. Osnovy postroeniya translyatorov*. [Theory and Technology of Programming. Basics of Constructing of Translators]. St.Petersburg, BHV-Peterburg Publ., 2005, 272 p.
9. Vinogradov G.G. *Raschet stroitel'nykh prostranstvennykh konstruktsiy*. [Analysis of Spacial Structures]. Moscow, Stroyizdat Publ., 1990, 264 p.
10. Shimkovich D.G. *Raschet konstruktsiy v MSC.visualNastran for Windows* [Analysis of Structures in MSC.visualNastran for Windows]. Moscow, DMK Press Publ., 2004, 704 p.
11. Ohmori H., Yamamoto K. Shape Optimization of Shell and Spatial Structure for Specified Stress Distribution. *Memoires of the School of Engineering, Nagoya University*, vol. 50, no. 1(1998), pp. 1—32.
12. Loganathan S., Morgan R.C. Snap-through Buckling Analysis of Shallow Geodesic Dome Using MSC/Nastran. The Fifth Australian MSC Users Conference, Sydney, Australia, November, 1991.

13. Anders M., Harte R. Buckling of Concrete Shells: a Simplified Numerical Approach. Journal of the International Association for Shell and Spatial Structures. IASS Publ., vol. 47(2006), no. 3.

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