DIGITAL SHAPING OF SPATIAL STRUCTURES

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Publications and/or *Exhibitions*:
1. Rebielak Janusz: Bar Space Structures - Rules of Shaping, in: Symmetry: Natural and Artificial, Proceedings of the Third Interdisciplinary Symmetry Symposium and Exhibition, Washington, USA, August 14-20, 1995, Symmetry: Science & Culture, Quarterly of the ISIS-SYMMETRY, Vol. 6, No 3, pp. 442-445.
2. Rebielak Janusz: Space structures shaping and visualisation of their digital models by means of Formian, in: Proceedings of the Fifth Interdisciplinary Symmetry Congress and Exhibition, Sydney, Australia, July 8-14, 2001, Symmetry: Art and Science, Quarterly of the ISIS-SYMMETRY, pp. 158-161.
3. Rebielak Janusz: Structural systems of cable domes composed of concentric spatial hoops, in: ed. H. Kunieda, IASS 2001 Extended Abstracts, International Symposium on Theory, Design and Realization of Shell and Spatial Structures, October 9-13, 2001, Nagoya, Japan, pp. 328-329.
4. Rebielak Janusz: General morphology of new types of tension-strut systems, Lightweight Structures in Civil Engineering, Local Seminar of IASS Polish Chapter, Micro-Publisher Jan B. Obrebski Wydawnictwo Naukowe, Warsaw- Wroclaw, 7th December, 2001, pp. 50-55.
5. Rebielak Janusz: Prismatic space frames as the main support structures for high-rise buildings, Lightweight Structures in Civil Engineering, Local Seminar of IASS Polish Chapter, Micro-Publisher Jan B. Obrebski Wydawnictwo Naukowe, Warsaw-Wroclaw, 7th December, 2001, pp. 81-89.

Abstract: *The paper will present the proposals of the space structure shaping as the structural systems for lightweight roofs of large spans and as the main support for the high-rise building. It will be presented the concept of the special type of the retractable dome. The author recently invented some new types of these systems are by and for the main types of them he has prepared several programmes written in the programming language Formian. These programmes determine the digital models of the proposed forms of the space structures systems. Owing to the suitable application of the systems the buildings designed by means of them may obtain the interesting and the individual architectonic views.*

1 INTRODUCTION

The aesthetic perception of the form of many types of buildings has been radically changed after the wide application of the space structures in architecture and in the civil engineering during the 20th century. The specific way of the arrangement of the component parts in spaces of these structures causes, that they have their own homogeneous architectonic views having an extremely great imprint to the architecture of the objects, in which they are applied. It is one of the most important factors justified the highest interest of many architects in processes of their shaping. Many evidences show that the develop potential of the space structures is very great and makes possible to discover their new and numerous applications in the future. Because of the basic rules of the theory of structures the general aspects of symmetry or sometimes asymmetry have to be taken into consideration during the design processes of the space structures.
The are many propositions given by the author in the area of shaping of the structural systems devoted for various types of the roof covers and for the high-rise buildings. Many of them are of very complex shape therefore the design process of them is complicated and it needs special tools. One of the very useful and powerful tool in this field is the programming language Formian, Nooshin & others (1993). It is invented by Professor Hoshyar Nooshin and developed by his team in the Space Structures Research Centre at the University of Surrey in England on the basis of the ***r a bra*** , also developed by Prof. H. Nooshin, Nooshin (1984). It was intended as a tool for improving these processes easier and faster and in order to make the better co-operation between the architects, the civil engineers and the other designers involved in the project. Formian makes possible the fluently changes of the geometry of the structure at any stage of the design. The visualisation of any, even the very complex form of a space structure, is by means of Formian relatively simple.

2 SHAPING OF TENSION-STRUT SYSTEMS

The tension-strut structures are in the last few decades used in the design and realisations of various types of the lightweight roof covers. Some types of these covers, particularly the cable domes developed by D. Geiger, are of the significant importance in the developing of the structural solutions in this domain of the engineering activity. The structural systems, proposed by the author for these purposes, were developed as a result of suitable transformations of the bar arrangement of the dome, the structural form of which was proposed earlier by the author, Rebielak (1996). The tetrahedron and the octahedron were assumed as the bases in these processes, Rebielak (1999, 2001). One on the results of the shaping processes presents Figure 1. The digital model of this structure was defined by means of Formian and than it was transported to Corel, the software designed for preparing the visualization processes. The proposed structural system may be applied for the designing of very lightweight covers s of large spans.

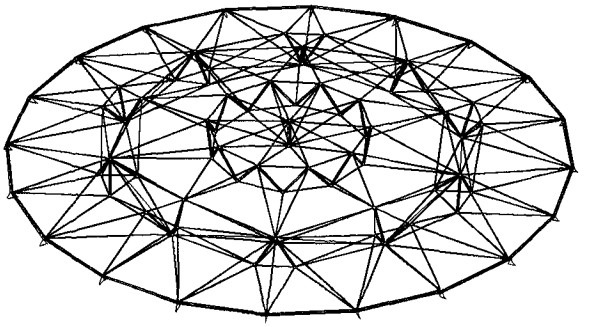

Figure 1: Perspective view of the one of the tension-strut systems proposed by the author for the lightweight structures of large span covers.

The appropriate usage of the symmetry formulas make the processes of preparation of the digital models of these structure much easier and shorter than before. The structure as itself and its digital model have to be built according to the basic rules of symmetry.

3 RETRACTABLE AND FOLDABLE ROOF STRUCTURE

Figure 2 shows the basic schemes of the structural system proposed by the author for the foldable and retractable structure of e.g. the dome cover. The system consists of the triangular bar sets, see Figure 2a. The chosen bars, marked there by grey colour, build the main girders located onto the perpendicular surface marked by the dash lines. These

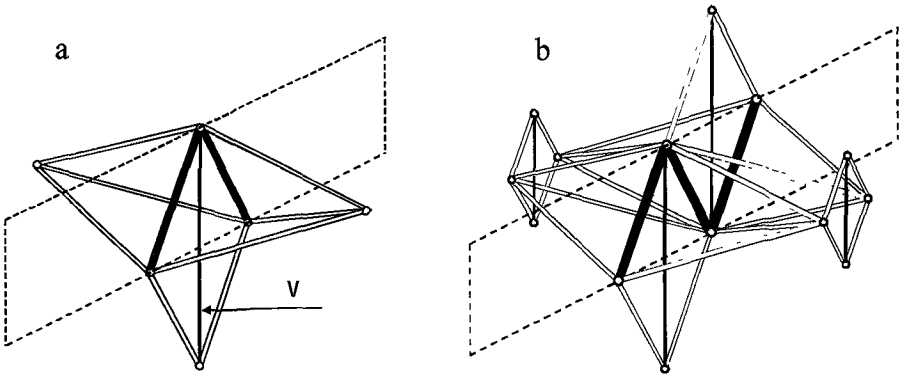

Figure 2: General schemes of structural system proposed by the author for the foldable and retractable structures of e.g. the dome cover.

girders are the main ribs of e.g. the dome cover and they are focused in its crown-node. This basic configuration of the structural module shows Figure 2b. Almost all of these bars are of the fixed lengths, only the vertical, marked in Figure 2a by the letter symbol V, have to be able to change their lengths. These bars can be made as the struts of equal lengths with the appropriate screws, what enables the necessary changing of the bar set shapes. The mechanisms of the retractable and foldable covers are of the high technical requirements, Ishii (2000). These types of structures and the assembly processes of them have to be designed according to the rules of symmetry. The special bars, marked by symbol V in Figure 2a, are perpendicular to the middle surface of the planned roof. Owing to the suitable length changes the entire space structure can be folded and refolded. By means of the length controlling of these bars the structure is retractable and it can obtain the planned shape. The proposed system can be used in the design and in erection of the structure being at the same time the foldable and the retractable structure. The digital models of these systems, prepared in Formian, will be used to carry on many comprehensive analyses in order to estimate their suitability to the proposed purposes.

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