

## EXPERIMENTAL INVESTIGATION OF DISPLACEMENT OF THE SUPPORT NODES OF THE STEEL AND CONCRETE COMPOSITE CABLE SPACE FRAMES

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***Abstract.** The results studies of the steel and concrete composite cable space frames are presented. The steel and concrete composite cable space frames were patented. There are studies that cover both experimental testing and numerical investigation of the steel and concrete composite cable space frames. The experimental samples were designed and tested. Displacement of nodes of the structure under load was studied. Also, have been conducted numerical investigations. In the result of numerical investigations data were obtained, which have high convergence with experimental results. In general, the studies showed efficiency of the steel and concrete composite cable space frames.*

***Key words:** structure, module, composite, cable, node, displacement.*

### 1. Introduction

Review of recent publications and sources has shown that among nowadays existing composite solutions of structures, it often are highlighted steel and concrete composite space structures, a feature of which is a combination of concrete slabs and steel rod elements [1-4].

Considering the above, the idea to combine traditional elements like slabs and rods for a structure by a new way is original. The structure that was developed does not have drawbacks, which are inherent for counterparts [5]. The concept of the proposed structure lies in the synthesis of experience and new developments, the use of modular elements, lesser complexity of technology manufacture, assembly and installation than counterparts [6].

The effectiveness of the solution steel and concrete composite cable space was investigated and substantiated [7, 8].

The steel and concrete composite cable space frame is a new type of a space roof system that was designed in Poltava National Technical Yuri Kondratyuk University and fully patented. The steel and concrete composite cable space frame consists of steel and concrete composite space modules, which are combined with each other via single-bolt connections. The space steel and concrete composite module consists of monolithic reinforced concrete slab and a structural lattice that is made from steel tubes.

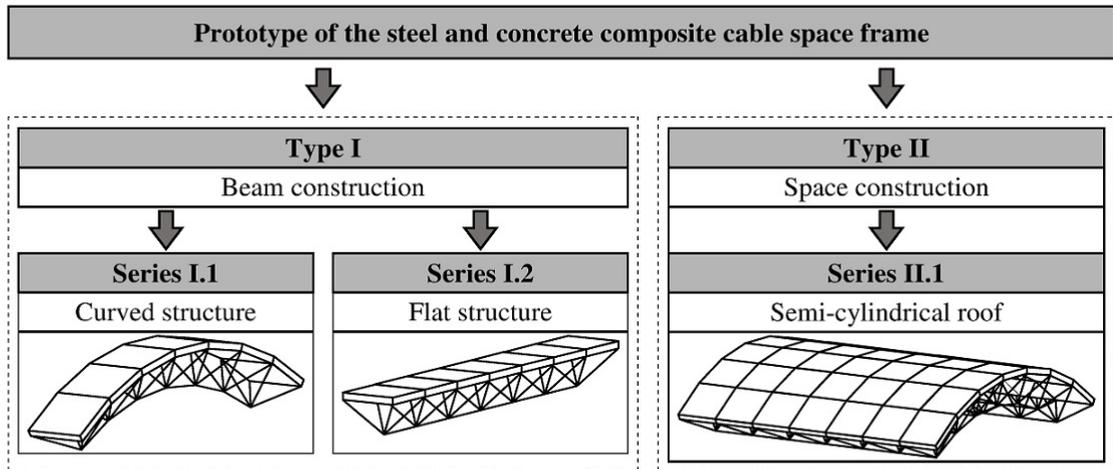
**The purpose of study is** to experimental research of nodes displacement of the steel and concrete composite cable space frames.

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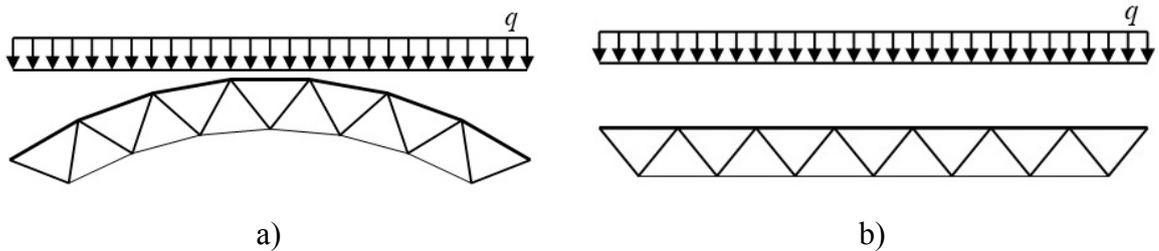
## 2. Research result

Prototype of the steel and concrete composite cable space frame consists of space modules [9]. For experimental investigation have been developed experimental samples of the steel and concrete composite cable space frame (Fig. 1).

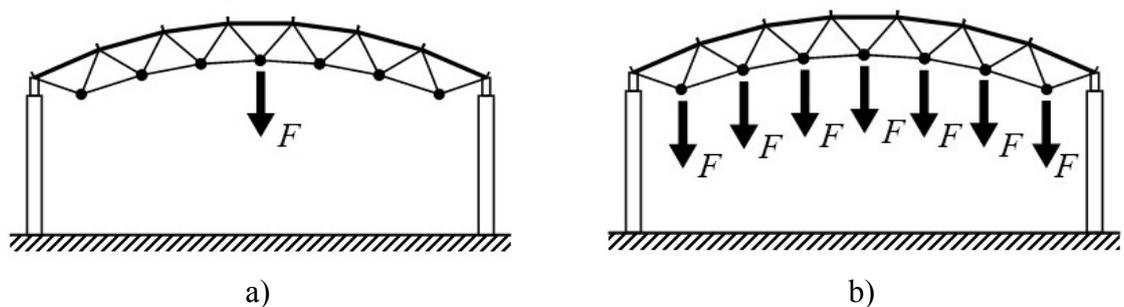


**Fig. 1.** The experimental samples of the steel and concrete composite cable space frame

In order to identify the characteristics of the steel and concrete composite cable space frame was developed methodology of experimental research. The technique consisted in test of models of the steel and concrete composite cable space frame under a uniformly distributed load and nodal forces. In uniformly distributed load were tested models of the first group (Fig. 2), and the nodal force were tested models of the second group (Fig. 3).

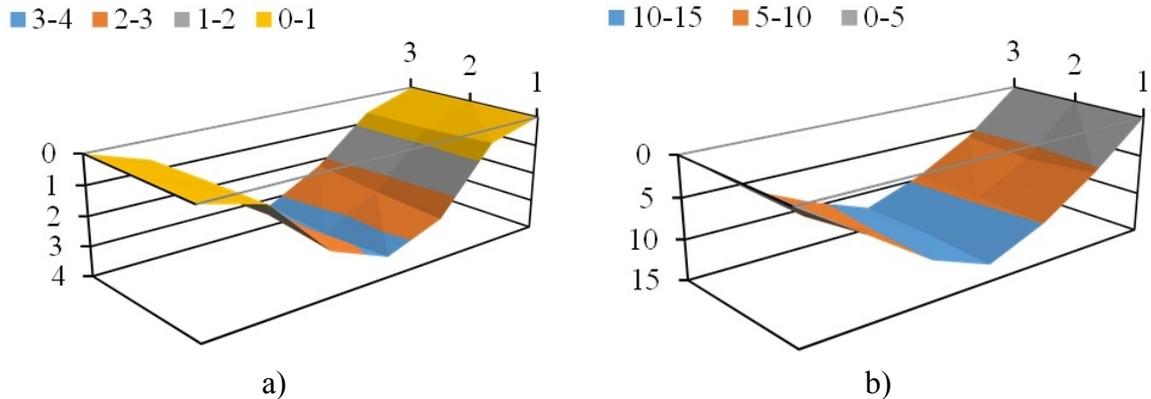


**Fig. 2.** The scheme of loading the first group of models:  
 a) curved structure; b) flat structure



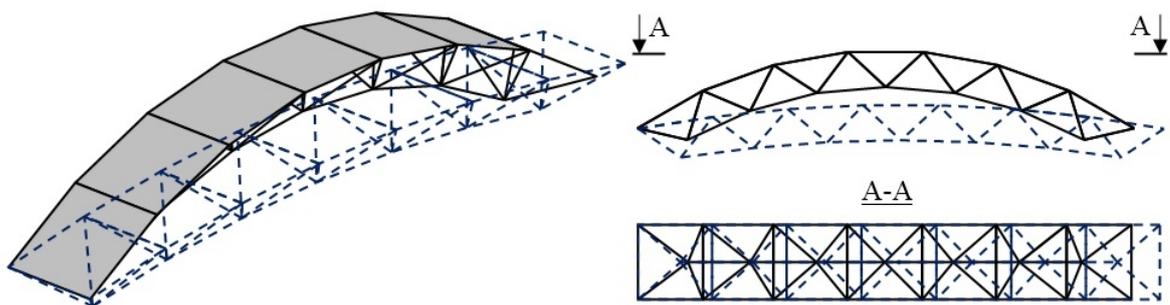
**Fig. 3.** The scheme of loading the second group of models:  
 a) scheme 1; b) scheme 2

As a result of testing og models of the steel and concrete composite cable space frame were obtained the load-deflections curves (Fig. 4).



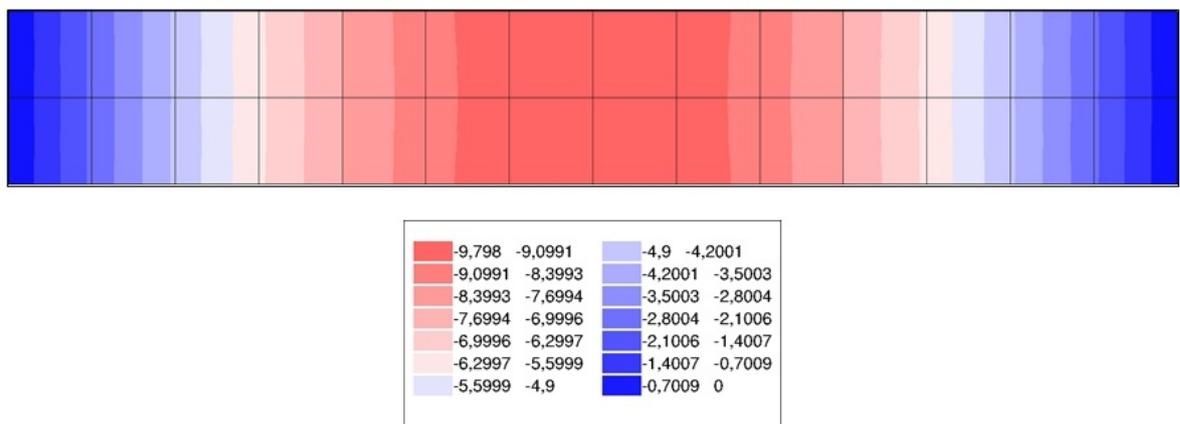
**Fig. 4.** Buckling of semi-cylindrical roof:  
a) scheme 1; b) scheme 2

As a result, numerical studies have provided schemes deformation of models of of the steel and concrete composite cable space frame (Fig. 5).



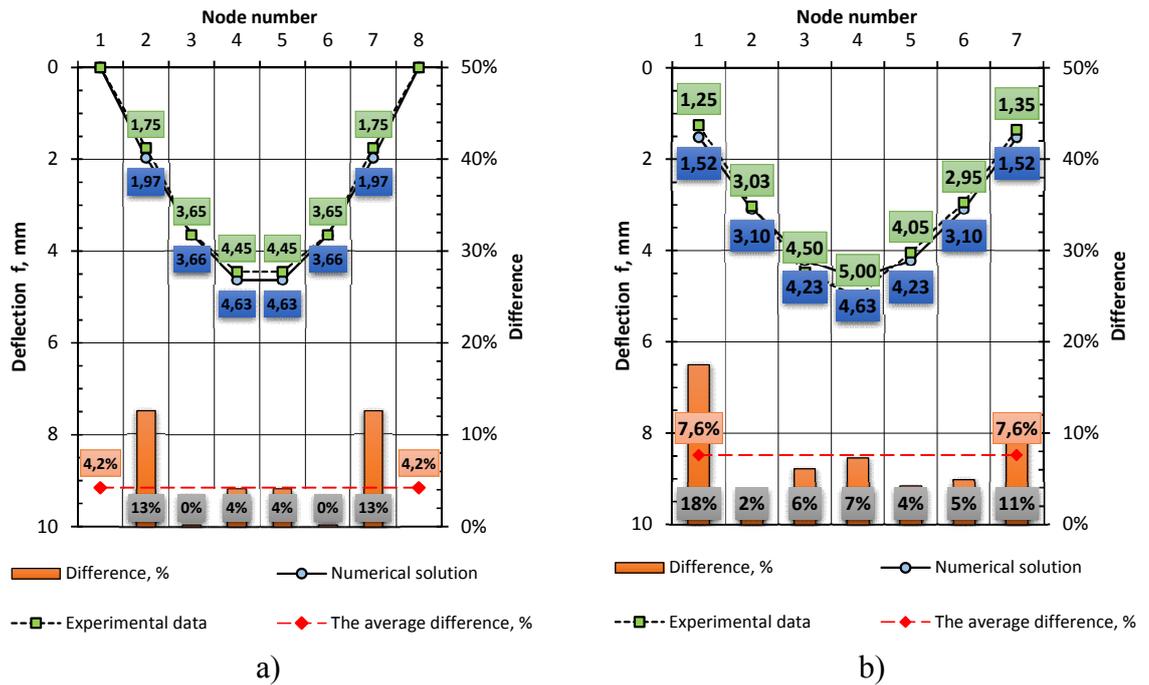
**Fig. 5.** Scheme deformation of the steel and concrete composite cable space frame

Also were obtained stress distribution diagrams and displacement diagrams of the steel and concrete composite cable space frame (Fig. 6).



**Fig. 6.** Diagram of vertical displacements of the top chord of the flat structure

Comparison of experimental and numerical data showed good coinciding (Fig. 7).



**Fig. 7.** Comparison of experimental and numerical data for curved models of the steel and concrete composite cable space frame: a) top chord; b) bottom chord

### Conclusion

As a result of experimental research of the models of the steel and concrete composite cable space frame under a uniformly distributed load and nodal forces, data were obtained on the basis analysis of which the following conclusions:

1. Program of experimental research was designed so as to obtain data that clearly describe the deformation features and behavior of the steel and concrete composite cable space frame under a uniformly distributed load and nodal forces;
2. Physical and mechanical properties of the materials used for the manufacture of experimental models were similar to the properties of materials commonly used for making building structures;
3. Measuring instruments and devices that have been applied in experimental investigations have provided evidence that objectively describe the behavior of the steel and concrete composite cable space frame under a uniformly distributed load and nodal forces;
4. The experimental models of the steel and concrete composite cable space frame during the whole test showed joint operation of all components;
5. Data that were obtained an experimental way, demonstrate good operation of models, which proves the efficiency of the solution proposed structures;
6. Computer modelling that was done allowed us to obtain more information about the stress-strain state of the proposed structures and their individual components;
7. During the modelling the optimal size of finite element were obtained for proposed structures by gradually increasing density finite element mesh and establishing coincident of results;
8. With the help of numerical calculations schemes deformation of the proposed structures were identified. The results are coincident with experimental data. The average difference between the results of physical experiments and the computer simulation does not exceed 7,6%;

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