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Composite steel and concrete large-span constructions for airport structures

The new composite constructions for airport structures are proposed. Feature of the construction is original structural concept. The construction combines the advantages of the best-known spatial structures, enables efficient use of building materials at sufficiently low complexity, and consists of space modules and flexible bottom chord.

Introduction

An infrastructure development of airports except machinery and equipment modernization needs modernization, changes or rebuild existing structures and construction new buildings. Structures that completely satisfy the demanding requirements of buildings of modern airports are composite structures that are a combination of steel space trusses, steel cables or bars and slabs that used for not only cover or protect from aggressive external factors, rain, snow and other atmospheric influences but also used as bearing element. The slab for composite construction can be made from concrete, glass, plastic and other modern materials, choice material depends on building function.

These composite structures have been designed by the authors at the Department of structures from a metal, wood and plastics of the Poltava National Technical Yuri Kondratyuk University (Poltava city, Ukraine) and have been patented. They were called Composite Steel and Concrete Grid-Cable Constructions.

Structural concept

The purpose of the study is to present the new kind of spatial composite structure made from modern and strength materials for civil construction in particular to cover halls, hangars for aircraft and other vehicles, garages for a large machinery, large-span buildings and structures of airports, etc.

Novelty of the composite steel and concrete grid-cable constructions lies in effective application properties of materials [1]. The composite steel and concrete grid-cable construction as noted earlier consists of the three different kinds of structural elements: slabs, steel space trusses and steel cables. The steel space trusses are made from segments of steel tubes or rods. The slabs are used as the top chords, steel space trusses are used as diagonals and steel cables or bars are used as flexible bottom chords. The diagonals and slab create space module (Fig. 1) that is main element of the composite steel and concrete grid-cable construction. The space module can has different size A, h and height H (see Fig. 1) but recommended size slab A=3 m or 1.5 m with a height H=0.7072A.

The composite steel and concrete grid-cable constructions are assembled on construction site from space modules and the flexible chords. The structural members

are routinely joined at Node 1 and Node 2 (see Fig. 1) by bolted connections but sometimes in specific case can be joined by welded connections.

Choice of a connection type are routinely depend on buildings function, their span and shape but preference is given to bolted connections because they are relatively easy to assemble, maintain, and they are able to carry the high loads that typically appear in structural members of civil structures.

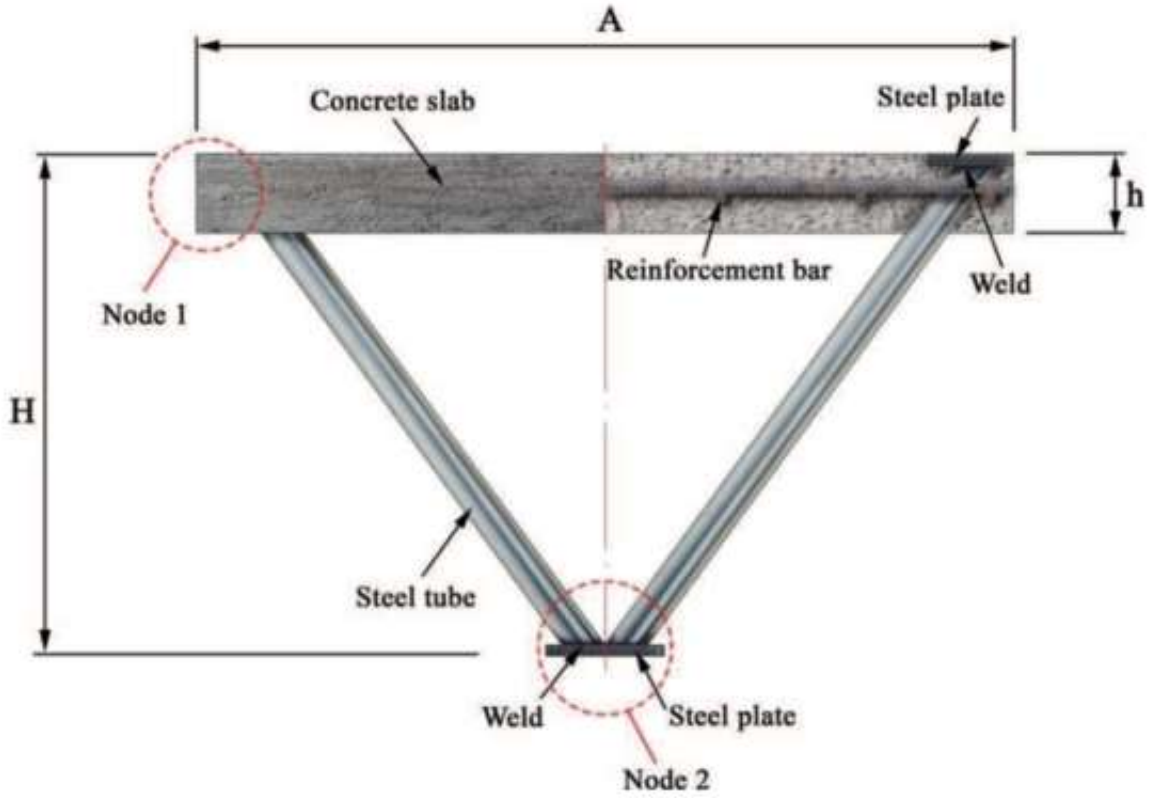

Fig. 1. Space module of the composite steel and concrete grid-cable constructions

Besides, Node 1 and Node 2 can have different designs (Fig. 2) depend on the forces that appeared in the structural members [1, 2].

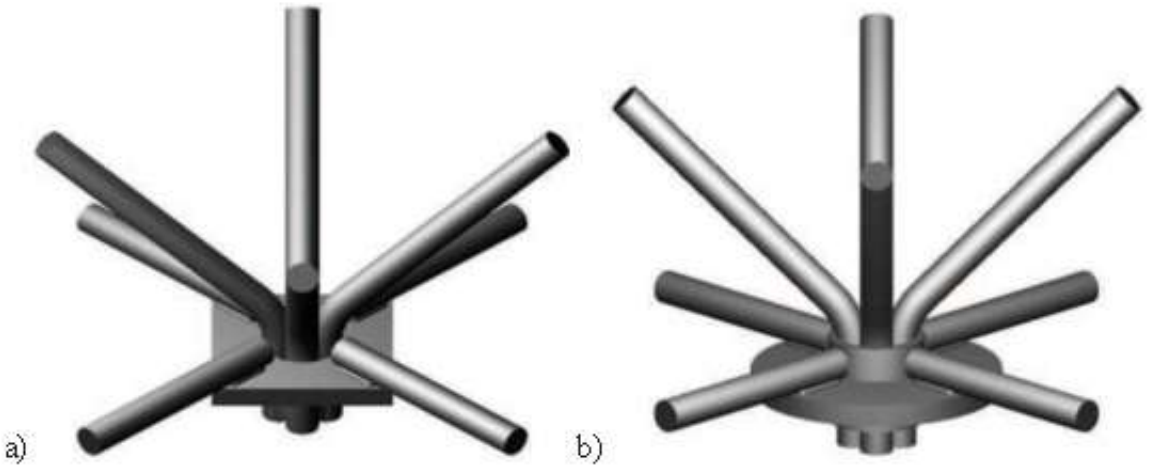

Fig.2. Kinds of node connection (Node 2) of structural members made from rods and steel plate

Shaping structures

The composite steel and concrete grid-cable constructions have various shapes and contours. Curvature of the composite steel and concrete grid-cable constructions is achieved by the segments length L changing of the bottom flexible chord (Fig. 3).

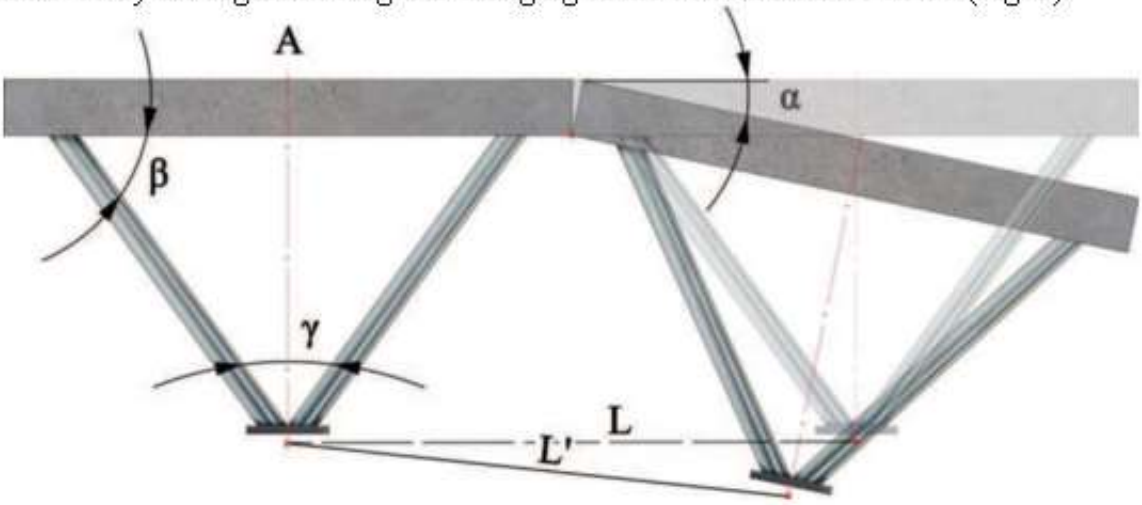

Fig. 3. Scheme to determine the length L of the bottom flexible chord

The length of the segments of the bottom flexible chord L depend on angle α and the size of the slab A (Fig. 4).

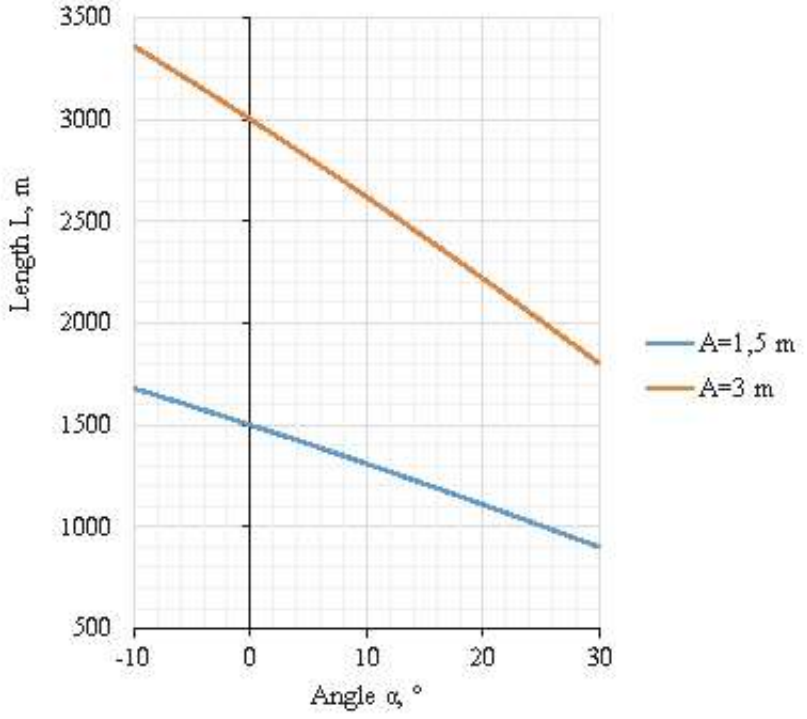

Fig. 4. The length determination L of the bottom flexible chord

The space modules are used for assembly various structures including flat double-layer grids (Fig. 5, a), single-span shells (Fig. 5, b) and other [3]. Distances that are covered with these structures reaches 200 m.

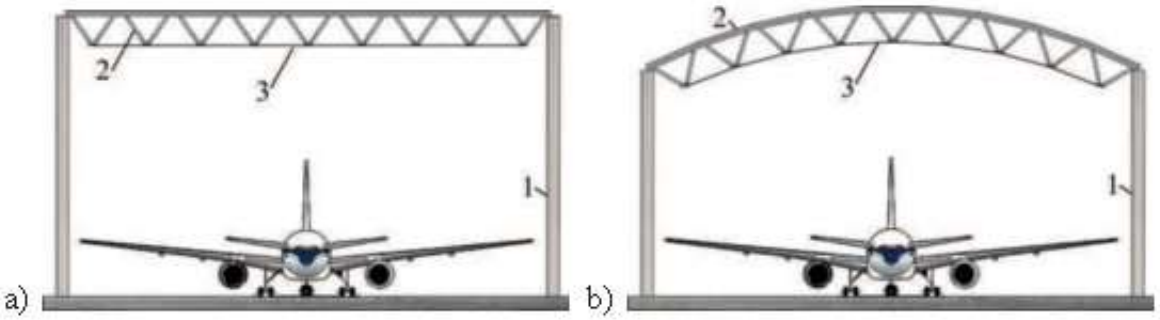

Fig. 5. Large-span structure systems
a) flat double-layer grids; b) single-span shell; 1 – support; 2 – the space module; 3 – bottom flexible chord

The composite steel and concrete grid-cable constructions may also be used to assembly cantilever covers for small-span areas (Fig. 6).

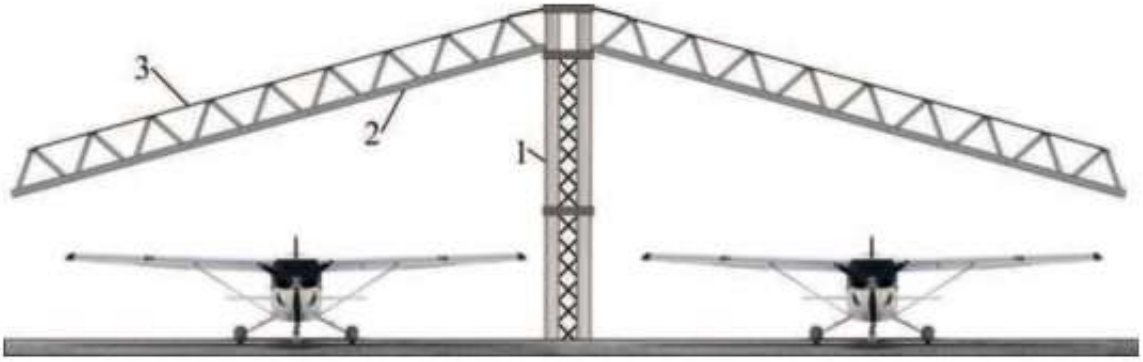

Fig. 6. Cantilever structure systems
1 – support; 2 – space module; 3 – flexible chord

In general, the curvature of the composite steel and concrete grid-cable shell (see. Fig. 5, b) depends on constrains. If the structure is fixed or pinned from both side the angle α is limited [4] but if it has roller connection, at least from one side the angle α can be as shown in Fig. 4.

Manufacturing and construction of the structures

Production of space modules can be performed in the plants that produce steel building structures, and other plants that have the equipment for processing steel and concrete casting of products. Technologies of processing, assembly, welding, loading and unloading of steel structural member of the composite steel and concrete grid-cable constructions are similar to the technology of production of conventional steel structures and concrete structures. Manufacturing technology of the composite steel

and concrete grid-cable constructions is divided into two separate processes: fabrication of a steel lattice (frame) and the making of slab.

Construction of the composite steel and concrete grid-cable constructions is perform by the methods described in [5].

Conclusions

The composite steel and concrete grid-cable constructions are the new kind of large-span structures, which have significant advantages; in particular, they are lighter and have lower complexity of manufacturing and assembly than analogues. The composite steel and concrete grid-cable constructions consist of bottom flexible chords and space modules, which combine slabs and rods made from steel tubes. This structural concept makes it possible to save materials due to the rational using of them. The conclusion that this type of constructions is reliable and efficient in exploitation, allows to save materials was made based on experimental, theoretical and analytical studies and the stress-strain state numerically investigation.

In conclusion, it should be noted that the composite steel and concrete grid-cable constructions have different forms and shapes. This allows to use structures successfully in construction of buildings and airports of structures.

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