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Design Of Efficient Cross-Beam Spatial Structures

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Abstract

Cross-beam constructions are one of the main structural solutions of spatial constructions. When designing buildings equipped with this type of structures, it is important to pay attention to their dimensions, placement of temperature, deformation and anti-seismic joints in the building. In the article, the results of the research are analyzed and relevant conclusions are summarized.

Keywords: Spatial structures, cross-beam, shape and size of buildings, temperature, deformation and anti-seismic joints, stress transfer, technical and economic indicators, efficiency

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Introduction

Today, in the design of closed buildings with cross-beam spatial constructions, structural solutions of symmetrical - right-angled, polygonal, square, circular and other forms are used in the plan. At the same time, in the design of spatial constructions with crossed rods of a complex shape, it was possible to bring them to convenient sizes by means of anti-seismic joints due to their dimensions.

To take measures to reduce their weight due to the use of effective and light materials in load-bearing and supporting structures, to pay special attention to detailed solutions in the design of buildings, to take measures to use high-strength materials in the preparation of vertical load-bearing elements, to design spatial structures with intersecting rods in the main two and three directions organization of the same work method, arrangement of their elements in rigid spatial constructions, overall composition of the building, taking measures to ensure even distribution of weight and thickness when placing walls and internal walls, etc. [1].

When designing buildings with cross-beam spatial structures, it is recommended to design their dimensions up to 100 meters on average. When designing seams, they should be placed separately, that is, along the entire height of the building, together with temperature and deformation seams and anti-seismic seams. When determining the dimensions of anti-seismic seams, the height and other parameters of the buildings should be taken into account, and in their design it should be ensured that individual sections work as integrated structures.

In the design of cross-beam spatial structures, special attention is paid to ensuring the perfection and reliability of the system of transferring existing stresses from the cover to the column and from it to the foundation. When checking structures for strength, special attention is paid to the direction of loads, the location of engineering, technological and plumbing systems, their fastening between the upper and lower belts of the cover, ensuring the strength of structural nodes when connecting. It is selected based on the plan and its dimensions, volume-planning, constructive solutions and calculation of technical and economic indicators of the building with a cross-sectioned beam. Determining technical and economic indicators is carried out by selecting the column step, building form and other parameters, comparing different parameters of several solutions [2].

Anti-seismic seams should be designed in the spatial constructions with a beam in such a way that they separate the adjacent units of the buildings along the entire height. It is carried out by placing columns in pairs at anti-seismic joints or by joining the cantilever parts of the coverings of adjacent sections.

Anti-seismic joints should be located and designed in such a way that they do not prevent the mutual movement of units.

The dimensions of spatial constructions with cross-beams are determined based on the results of the justification of technical and economic indicators, planning of selected solutions and the selection of structural solutions of the building. The layout of the columns, the choice of the distance between them, should be determined according to their geometric appearance and functional purpose. In the design of spatial constructions with crossbars of the "MArhI" type, the best efficiency is shown in square or near-square lattice solutions, which ensures the same operation of the structure in two or three directions.

From the point of view of saving metal in constructions, it was recommended to place separate sections along its perimeter in the ratio of 1/3 - 1/4 arch spacing.

In earthquake regions, the system of mixed placement of columns is effective. The system of free placement of columns has a number of advantages depending on the arrangement of rooms inside the buildings. This constructive solution allows to save 30% of metal materials compared to placement along the contour. This not only saves materials, but also significantly increases the dynamic stability of the structure [3].

In the design of multi-arch one-story buildings, the use of multi-arch non-shearing spatial

constructions and capitals with an increased size of the cantilever provides an opportunity to increase the value of maximum stresses. In this case, it is appropriate to take the length of the capital in the proportion of 1/3-1/4 of the arch. By introducing this solution, the use of tension-reducing cables in structures with dimensions of 18x18, 24x24, 30x30 m will reduce its weight by 1.1 kg / m2.

It is recommended to use multi-arch non-shearing closed structures and to use longitudinal fasteners when placing columns along the contour of the building with a step of 6 meters. The layout of connectors is shown in Figure 1.

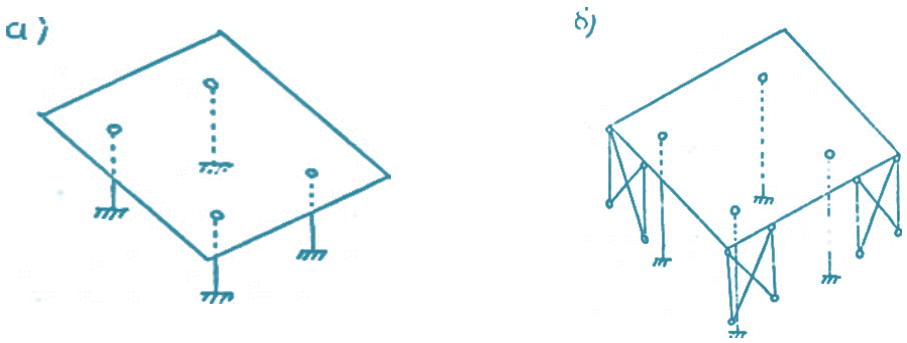


Figure 1. Longitudinal placement of fasteners on columns

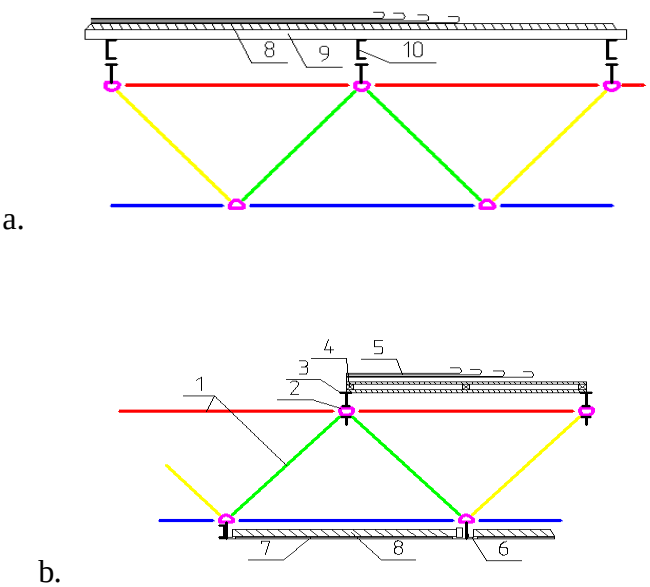
Schemes:

a - KSFK and load-bearing columns; b - with additional virgin connectors.

In order to ensure single-story seismic and non-seismic integrated construction, mainly 4 types of principle options are used to connect individual sections.

For the Republic of Uzbekistan, including Samarkand, which is considered a seismic zone, the first and fourth options are especially effective.

Today, the work carried out on reducing the mass of the closures of spatial structures with intersecting beams is considered important. For this, options have been developed for the use of lightened roof elements provided with profnastyles. These options are designed to ensure the lightness of the roof of the building and consist of a set of materials of the following sizes and thicknesses (Fig. 2).



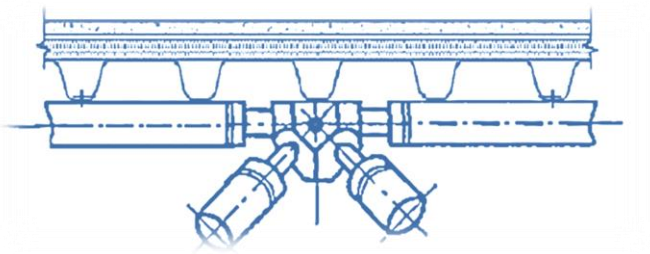
a.

b.

Figure 2. Designed for spacial constructions with a beam roof options.

a-light coating of profiled steel; b-light suspended ceiling construction.

In the variants presented in the upper picture, steel profiles are installed directly on the upper beams of the KSFK roof structure and are attached to the upper girders of the structure with the help of rivet nails at every 500 mm step



along the length (Fig. 3).

Figure 3. Spatial construction with intersecting stern roof solution without roofing.

In order to compare the above solutions, calculations performed on the basis of the LIRA-CAD program showed a 15% reduction in material consumption, a 20-25% reduction in bending and a 15% reduction in material costs. At the same time, it showed a decrease in the volume of assembly work and construction time and metal consumption. The economic efficiency and prospects of this solution are primarily due to its low weight compared to traditional structures and its resistance to seismic loads.

Determining the effectiveness of this type of construction, we will consider the example of the kitchen and other furniture production workshop buildings in the following two production buildings. The roof coverings of the plant are made of mixed constructions, of which 15,600 m2 or 71% of it is covered with "MArhI" type construction and 6,500 m2 or 29% of it is covered with 18-meter steel trusses. A comparison of various technical and economic indicators of the structures was carried out for the roof surface of 1 m2.

Siyob bazaar, designed to replace 450 shops, was built in Samarkand city. In this construction, the use of new progressive structures of the "MArxI" type made it possible to reduce the consumption of materials and labor costs in the construction, as a result, the standard construction period was 8 months, and the market pavilion was completed in 5 months. The use of this type of construction in the building in question led to a reduction of material consumption by 10-20%, labor costs by 15-25%, a significant reduction in construction time and construction costs. At the same time, the direct saving of metal provided indirect savings due to the lighting of the roof, the minimum number of supports and foundations for them, the decrease in the construction height of the buildings, etc.

According to the experimental and theoretical results of the economic efficiency of the use of "MArxI" constructions in the construction of the kitchen furniture factory, it was confirmed that they are 19% more economical than other constructions.

Table 1

Т/н	Technical and economic indicators	Unity.	Cross-section steel truss, 18 m	Cross-section steel truss, 18 m	Cross-section steel
1.	Metal construction. spending	kg	55	43	-12
2.	(cover 1 m2)	t	858	657	-187
3.	Cost of metal constructions for the	m3	0,026	0,066	-0,020
4.	T/b construction. spending	per	0,134	0,063	-0,071
5.	(cover 1m2)	day	410	681	+271
6.	Costs for 1 m2 of surface	kg	3,28	5,59	+2,31
7.	Productivity of 1 worker per shift.	tn	2090,4	982,8	1107,6

Thus, the integrity, lightness and singleness of this type of constructions determines the prospects of their effective use.

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