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Design of the Roof Structure for the 2000-Seat Tribune of the Rowing Channel

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ABSTRACT

The main goal of this article is to research and effectively design the roof construction options for the 2000-seat tribune of the rowing canal, which is widely used in the construction industry of our Republic today, to solve the current problems, and to create the optimal forms of metal roof constructions, modern truss and arch structural forms. consists of improvement and calculation.

KEYWORDS: *Roof structure, tribune, rowing, trusses, LIRA-SAPR, angular, single-angle, tubular, cross-section*

The design of metal structures consists of the following stages: selection of a structural form; drawing up the calculation scheme of the building according to the selected structural form; collection of impact loads; determination of stresses generated in structural elements; selection of cross-sections of structural elements; checking the stability of the selected elements, general and local priorities.

When designing metal structures, first of all, the effective structural form of the building is selected. In this case, the selected structural form should be economical in terms of steel consumption, as well as the labor required for construction and assembly should be minimal. Different structural forms, cross-sections of structural elements and variants of nodes are compared for the implementation of the given task.

The price of the metal construction in the installed state consists of the following costs: steel price - 60-65%; factory preparation 16-22%; assembly works 5-20%; operating costs 2%. Usually, for the selected structure to be efficient, the amount of steel used in its construction should be minimal. Therefore, the main task of the designer should be aimed at designing a structure that is economical in terms of material consumption, maximally prepared in factory conditions, and requires little labor for assembly.

Reducing the amount of steel used in construction, increasing labor productivity, and industrializing production, which is an urgent issue for construction, has led to the establishment of new types of farms and the widespread use of these farms. Such trusses include trusses consisting of single-angle, square, bent-welded profiles, and wide-slab double trusses. In them, the rods can be joined together without fascicles, or the number of fascicles may be very small (Fig. 1). This, in turn, leads to an average 12-15% reduction in farm weight.

Farms with cross-sections are 12-15% cheaper than double-cornered farms in terms of steel consumption. In such farms, the elements of the fence can be connected to the strip wall directly (Fig. 1 a) or with the help of steel frames welded to the strip wall three-by-three (Fig. 1 c).

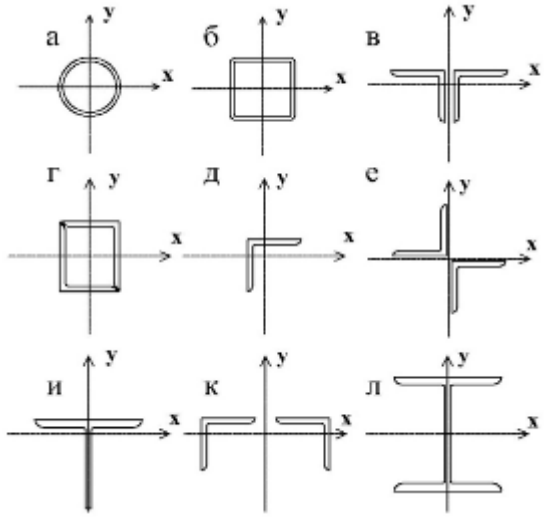
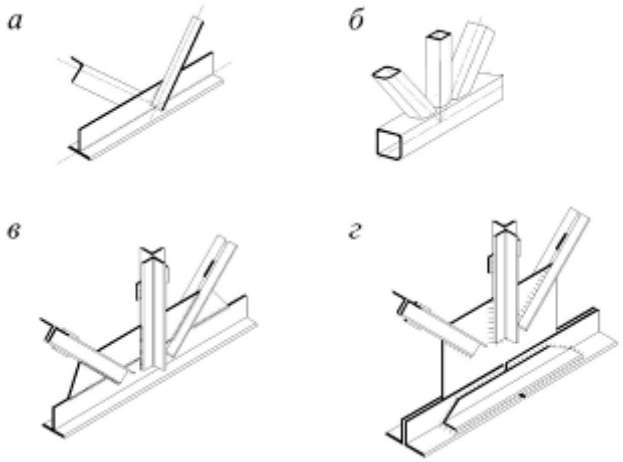


Figure 1. Cross-sections of trusses

Modern tomyopma farms are different (Fig. 1), their structural forms are trapezoidal, parallel strip, triangular, polygonal, segment; the geometric structure of the lattices is mortared, mortared and columned, elongated mortared and columned, cross-shaped, sprengel; according to the type of cross section of the sterns, they can be divided into double-angled, single-angled, tubular, rectangular, and right-angled profiles.

Triangular trusses are used in beam and cantilever systems, when the accumulated loads are in the middle of the arch, and in cases where a large slope is required for the roof covering. Triangular trusses have a number of disadvantages. The support nodes of such trusses are complicated and can only be hinged to the column. This condition reduces the stiffness of the truss in the transverse direction. In addition, since the bars in the middle parts of the farm are long, their sections are selected from the condition of flexibility, and the amount of steel used in the farm increases.



Rice. 2. nodes.

a, b - direct connection, v, g - connection through fasonkas

Compared to triangular trusses, trapezoidal trusses have simpler support nodes and can be connected to the column. Such trusses are economical in terms of material consumption compared to parallel strip trusses and require more labor to manufacture.

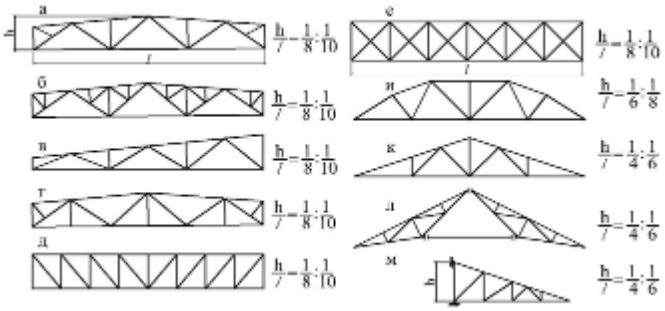


Figure 3. Geometric shapes of trusses

The cross-sections of the trusses are double-angled, single-angled, tubular, cross-section, bent-welded profile and cross-section with a wide shelf.

Pipe (Fig. 3a) farms have a number of advantages:

- Since the section is symmetrical with respect to the orthogonal axis, its priority is equal on both axes, and steel is saved;
- Smooth surfaces do not retain moisture, so they are considered corrosion resistant;
- Anti-corrosion, painting surfaces are few compared to other profiles;
- The value of the aerodynamic coefficient is small.

The disadvantage is that it is complicated and labor-intensive to connect the trusses in knots, and to join the progon and fasteners.

Farms with a bent welded profile (Fig. 3. b) have a number of advantages, like tubular farms, namely corrosion resistance, equal priority to arrows, less paintable surfaces. Another advantage of bent-welded profiles is that truss bars are welded directly to strips without formwork, connecting progons and ties to the truss is easier than tubular trusses. Right-angled profiles with the same cross-section as the pipe have a higher priority over tubular booms because the radii of inertia are slightly larger.

Calculations were performed by LIRA-SAPR software package.

The calculation is based on the finite element method in displacements. The displacements of the following nodes are taken as the main unknowns:

X is linear on the X-axis

Linear Y on the Y axis

Z linear Z

UX is the angle around the x-axis

UY is the angle around the Y axis

Angled UZ around the Z axis СП

LIRA-SAPR implements the provisions of the following legal documents:

SNiP 2.01.07–85*. Loads and impacts.

SNiP 2.03.01–84*. Concrete and reinforced concrete structures.

SNiP II-25–81*. Steel structures.

SNiP 2.02.01–83*. Foundations of buildings and structures.

KMK 2.01.03-96*. Construction in earthquake-prone areas. Uzbekistan.

The finite element types used are shown in Document 1.

In this document, in addition to the number of nodes belonging to the corresponding element, the numbers of stiffness types are also indicated.

The design scheme includes the following types of elements:

Type 42. Universal triangular FE shell.

Type 44. Universal rectangular FE shell.

The calculation is carried out for the following loads:

load condition 1 - static load condition (Constant load).

load case 2 - static load case (Snow load).

load case 3 - static load case (Wind load)

load 4 - dynamic (seismic KMK 2.01.03-96, along the "X" axis)

Design combinations of stresses for plate elements are selected according to the criterion of extreme stresses, taking into account the direction of the main fields.

When choosing a combination of design forces, the following characteristics of loads are taken into account:

Load 1 is a static load. This load condition is considered as a constant load.

2nd load - static load. This load condition is considered as a short-term load.

3rd load - static load. This load condition is considered as a short-term load. This loading icon is variable.

Load 4 - dynamic (seismic KMK 2.01.03-96). This load condition is considered as a seismic load. This loading icon is variable.

Load 5 - dynamic (seismic KMK 2.01.03-96). This load condition is considered as a seismic load. This loading icon is variable.

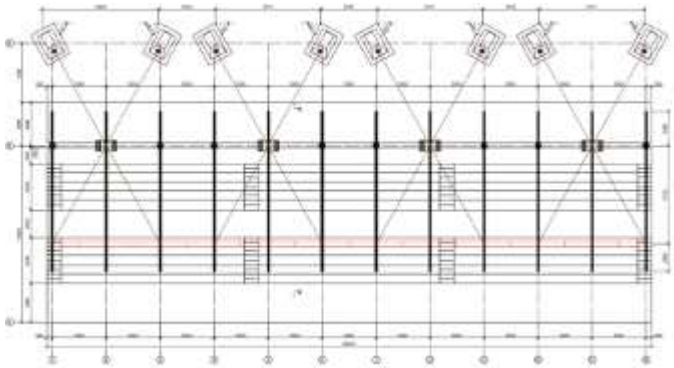


Figure 4. Turibuna roof plan.

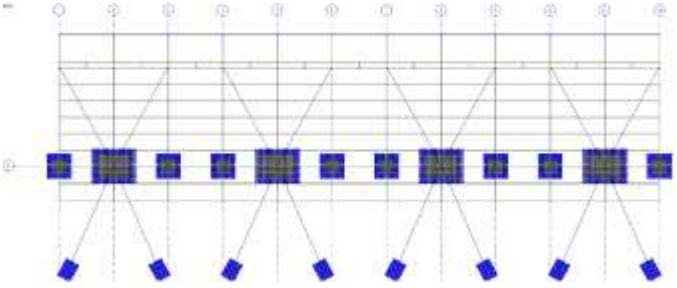


Figure 5. Construction plan

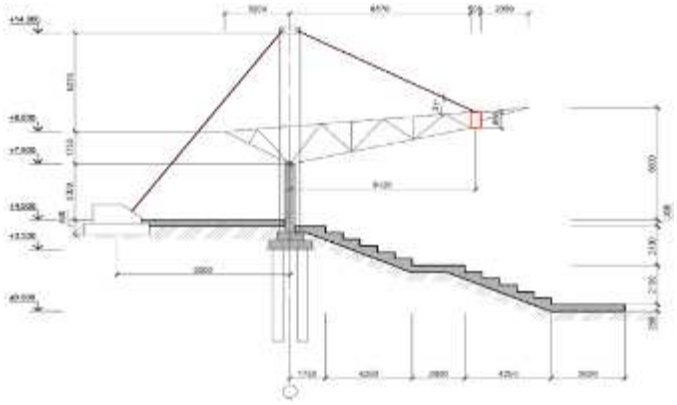


Figure 6. Trubina constructive cut.

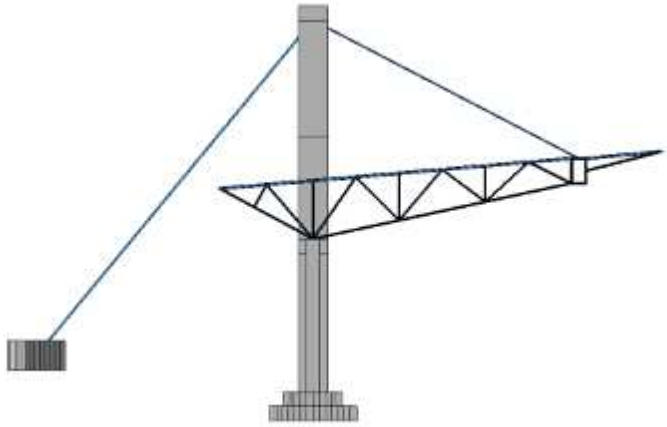


Figure 7. Trubina 3D Rama view.

Calculations were made based on the requirements of the first and second limit states.

As can be seen from the given histograms of the elimination of design options, a group of elements fail at a certain stage of additional loading with a real load on the roof.

occurs in lick. After that, the movements in the construction are limited, the system stabilizes and the additional load is applied again. After additional loading, in all the considered options, a displacement-like deformation begins. Moreover, at a certain stage, the system stabilizes again and the next stage of additional growth is required.

CONCLUSION

The following conclusions should be acknowledged Including:

- it was analyzed that the strength and efficiency of metal truss trusses largely depends on their geometric shape, type of cross-section and other indicators;
- Complete information on the materials and structures used in the design of the roof structure for the 2000-seat tribune of the rowing channel was provided;
- Work was carried out on the selection of the calculation scheme of the roof structure for the 2000-seat tribune of the rowing channel and the procedure for calculation.
- Methods of experimental implementation of roof construction options for the 2000-seat tribune of the rowing channel were developed and recommended.

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