ETHIOPIAN INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

eISSN: 2349-5715 pISSN: 2349-5707

Volume: 12, Issue 02, February-2025 SJIF 2019: 4.702 2020: 4.737 2021: 5.071 2022: 4.919 2023: 6.980 2024: 7,662

УДК 38.71.72.(624)

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TAKING INTO ACCOUNT THE STAGE OF THE OPERATIONAL CONDITION OF LARGE-SPAN HANGING SHELLS

Annotation: Studying the stress-strain state of hanging systems of support contours in the stages of pre-tensioning of cables, as well as in installation and operational states. The nature of the operation of hanging systems and support rings is revealed depending on the type and level of loading, the moment-free or bending state of the ring, as well as the mutual connection of the cable belts. The structural safety of suspended systems has been studied under random impacts beyond the design, leading to overloading of individual sections, breakage of cables, failure of anchors, compliance of supporting contours, and changes in the initial geometric shapes of the ring.

Key words:suspension system, stages of work, reference circuit.

1.Introduction

The development of suspended systems depends on the solution of the problems of choosing the optimal structural scheme of the roof shells and choosing the optimal support contour.

Let us consider self-balanced suspended structures, the shape of their surface is obtained naturally or as a result of preliminary stressing of the structure. Compliance with these conditions determines the advantages of suspended roofs.

Although we have divided the problems of choosing optimal solutions, they are closely interrelated, therefore, no clear boundaries are drawn between them [1-4].

2. Research objectives.

- study of real states of cable-stayed systems with different outlines of the support contour in plan, selection of the optimal form of a curvilinear support contour with radial and cross cable-stayed systems;

- identify the features of the operation of external and internal support rings at the stages of pre-tensioning of cables and the transition of the structure to the installation and operational state;

- identify the nature of the operation of external and internal support rings, from the mutual connection of cable chords with different loading schemes, from breakage of cable chords and from failure of anchor fastenings of cables to roof rings;

- identify the nature of the operation of the entire spatial system from the flexibility of support rings in the horizontal and vertical directions;

3. Operation of supporting contours of suspended roofs depending on the type and level of loading.

The peculiarity of support contours is the perception of chain forces from the coating, the horizontal components are 4-5 times greater than the vertical ones.

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The horizontal components of the force from the coating significantly complicate the design of the support contour, since its specific weight in terms of material consumption is always more than 50%, increases its material consumption and leads to a significant impact on technical and economic indicators. Therefore, when designing a structure, it is necessary to strive to create the most favorable operating conditions for the supporting structure. For buildings of a round or elliptical plan, the best and almost the only form of supporting structure for a suspended roof will be reinforced concrete and metal rings lying on columns (Fig. 1). Such rings are capable of perceiving horizontal components of chain forces from the coating, localizing them in the plane of the coating and transmitting only vertical forces to the underlying structure [8, 10]. In this case, the external load to the contour rings can be uniformly distributed,one-sided, local, concentrated, etc., having an arbitrary nature of the impact (Fig. 1).

Considering the schemes of contour structures of hanging roofs, it can be noted that the most favorable efforts for their operation are created in closed round rings located on columns at the roof level. Such rings have the least architectural and technological limitations in the solutions of the entire building and have the best technical and economic indicators.

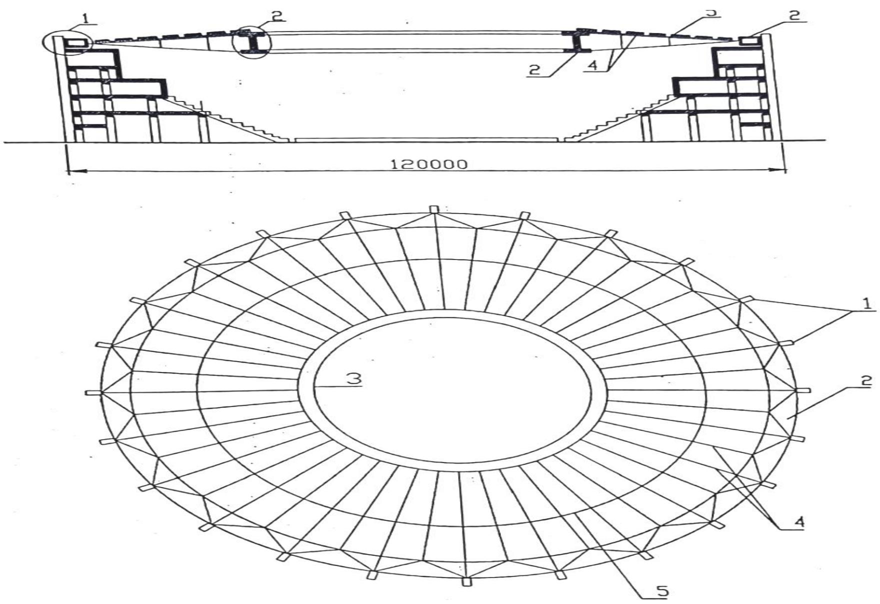

Fig. 1. Loading schemes for single-belt and double-belt suspended roofs with small and large internal support rings

Both of these circumstances ensured their most frequent use in suspended roofs, especially for large sizes.

For technological reasons, the sizes of the internal rings of a suspended roof can be small or large.

In technical literature, coatings with large-sized average support rings are usually called coatings with large openings. The presence of openings of various sizes mainly affects the nature of the distribution of external loads on the coating. (Fig. 1).

4. Research results

In the technical literature there is no clear definition for assessing the size of the rings for the work of a

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spatial suspended roof. In this regard, we will assume that the size of the middle ring r0 = 0.05 R0 is less than 5% of the radius of the outer ring of the roof R0, the distribution of loads can be calculated according to the triangular law. It should be noted here that with an increase in the size of the middle ring, its weight increases, which should be taken into account as a concentrated force (mass) [1, 3].

In the work of L.N. Pokrovsky [2], it is shown that the concentrated mass in dynamic calculations should be taken into account when the concentrated mass is comparable to the mass of the entire roof of the building.

The nature of the work of the support rings in two-belt suspension systems depends on the mutual connection of the upper and lower chords of the cables under various loading schemes (Fig. 1).

With the connection of the upper and lower chords along the entire span of the roof (Fig. 1, a), the deflections of the upper and lower chords will be the same. This promotes uniform distribution of horizontal thrust from cable chords to upper and lower support rings. In this case, the stabilization of the roof from asymmetric loadings is sufficiently increased.

When the upper and lower chords are connected only in the central zone using the middle two-chord ring (drum) (Fig. 1 b), the maximum deflection of the lower chord of the cables will be equal to the deflection of the lower chord of the middle ring. In this case, the lower chords of the cables will be concentratedly loaded from the load transmitted through the middle ring. The supporting middle rings of the lower chord and the outer ring experience concentrated loading.

At the stages of preliminary tension of the cables and uniform loading of the roof, the support rings experience uniform compression or tension from the efforts (thrusts) of the cables. In two-chord cable-stayed systems, the upper chord of the inner ring experiences compression from the efforts of the cables, the lower chord of this ring experiences tension. In this case, the outer ring of the roof is in a complex stress-strain state from the efforts of the cables. From the force of the upper chord of the cables, the outer ring experiences tension, from the force of the lower chord of the cables, it experiences compression. Moreover, through each cable, the tension and compression forces alternate evenly. Which create favorable working conditions in the outer support ring [3, 8].

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2024 Second International Conference on Sustainable Technologies in Civil and Environmental Engineering (ICSTCE 2024) https://www.e3s-conferences.org/.

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