Numerical analysis of historical reinforced concrete shell

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ABSTRACT

This article is focused on the numerical analysis of the historical structure of the reinforced concrete shell. Shells form the roof of the tram depot. It was built in the 50s of the 20th century. The depot is 114x95 m large and it is covered by 65 shells in total.

The shells are conoid shaped with a control curve in the form of a catenary. The thickness of the shells should be 50 mm. The size of one shell is 18.8x8.75 m. They are supported by a frame system. The frames form straight beams of variable height and width in the longitudinal direction - forms the support of the shorter edge of the shell. In the transverse direction, the frame is formed by an arched truss.

The construction of the depot began to show excessive deformation and lose its stability. At present, the depot is out of service and the shells are temporarily supported. This prompted the commissioning of a diagnostic survey and numerical analysis of the structure.

The diagnostic research revealed the quality and strength of the concrete, the reinforcement of the structure, the actual thickness of the shells, the structure of the roof cladding and defects in the structure (cracks, etc.) At the same time, the bottom surface of the whole structure was scanned with a 3D scanner and selected points of the structure were measured by geodetic methods.

Numerical analysis focused on one shell at the edge of the depot structure. The model was created in Atena 3D software. Model geometry was taken from the histrorical documentation. Material characteristics and composition of the roof cladding are determined from realised diagnostic of the entire structure. The model was additionally loaded with temperature (both positive and negative) and snow (uniform and wind-blown) in addition to dead loads.

The main aim of the analysis was to determine the behavior of the structure under load and to predict the ways of its deformation for different loading methods. Consequently, compare these predicted behaviors with the real deformed structure, whether its deformation corresponds to normal behavior.

From the comparison of these data, we conclude that the behavior of the real structure is not consistent with the predictive way. As a result, tensile stresses occur on which the structure was not dimensioned and could collapse.

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