DESIGN OF AN EXPERIMENTAL ARCH PEDESTRIAN BRIDGE MADE OF UHPC

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SUMMARY

This paper presents the design of an experimental arch pedestrian bridge made of ultra-high performance concrete (UHPC). The structure is designed as a permanent single-span bridge. The span of the bridge structure is 10.00 m, the total width of shell structure is 0.03 m, and the clearance width of the pedestrian bridge is 1.50 m. The main structure of the bridge is one prefabricated arch shell structure made of UHPC with dispersed steel fibres without conventional reinforcement. Simultaneously with the designing of the bridge, computer analyses were created in which optimization of the material and geometric parameters of the structure were carried out. The presentation on the conference will contain also production and assembly of the pedestrian bridge. The presentation will include also long-term monitoring of the specimen of the shell structure in 1:1 scale and finally experimentally obtained load bearing capacity of the specimen. Production and testing of the bridge is scheduled for April 2016.

Keywords: *Ultra-high performance concrete, arch bridge.*

1. INTRODUCTION

The bridge to span of 10 m will be made from ultra-high performance concrete (UHPC) class C110 / 130. The bridge should serve as a pedestrian bridge. The bridge is designed with double curvature. In the vertical and transverse direction it is a circular arc with a camber of 0.4 m. The cross section of the bridge has a width of 1.5 m and it is U-shaped. The bridge deck consists of a bottom plate with only 30 mm thickness and 30 mm thick side desks which serve as railings. Railing height is 1.1 m in the middle bridge span. In place of the anchor zones is the bridge reinforced with rebar networks B500B. The rest of the bridge has no reinforcement and it is only reinforced by fiber reinforcement in the form of steel wires.

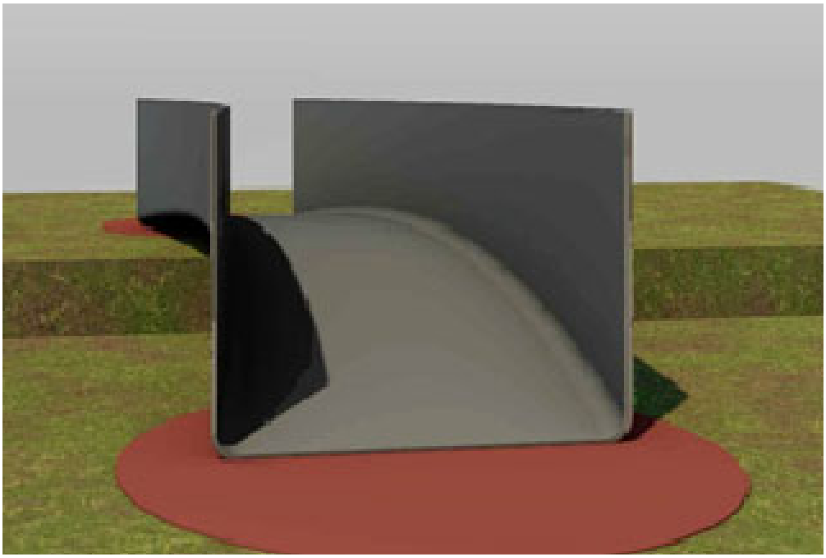

Fig. 1. *Visualization of the bridge.*

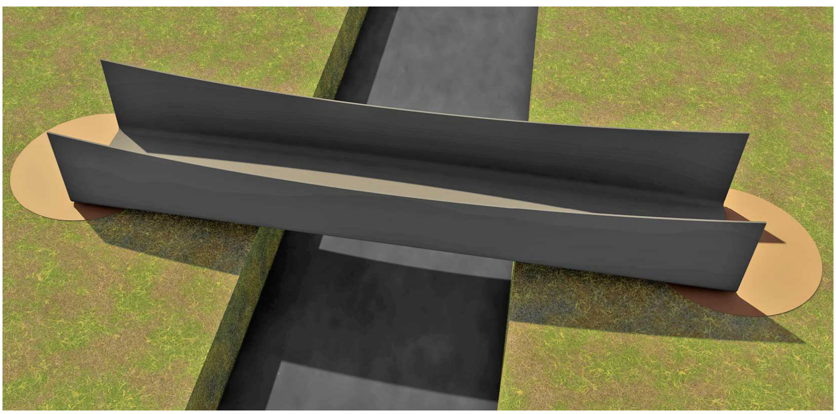

Fig. 2. *Visualization of the bridge.*

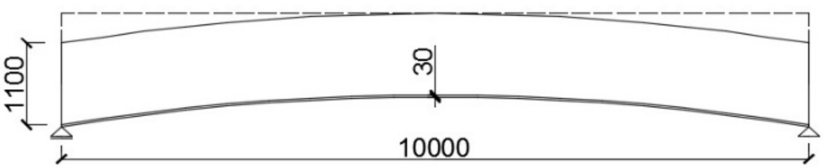

Fig. 3. *Scheme of the bridge for numerical model.*

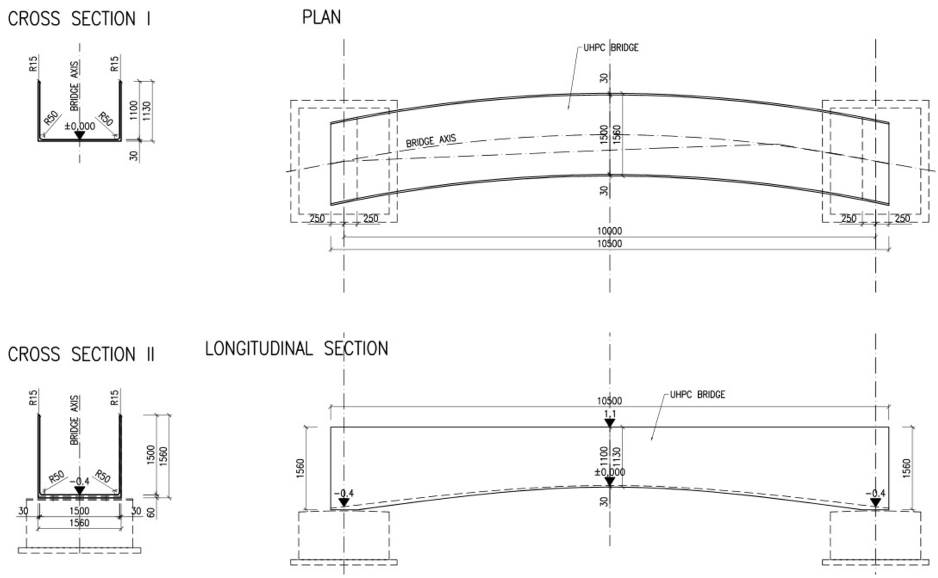

Fig. 4. Plan, longitudinal and cross section of the bridge.

2. COMPUTER MODEL

Bridge model was created and counted in a computer program Atena 3D. The model is made by 3 standard macro elements (bottom plate and two railings), which are structured to simulate the curvature of the bridge. These macro elements have specified material item 3D Nonlinear Cementitious 2 with parameters of UHPC concrete class C110/130 blended with scattered reinforcement. The tensile strength of concrete is considered as a value of 10 MPa. Other macro elements form surfaces for distributing the load and support elements. They consist of material 3D elastic. In anchor areas is also inserted a rod reinforcement. Material item for steel reinforcement was chosen as reinforcement with parameters for reinforcing steel B500B.

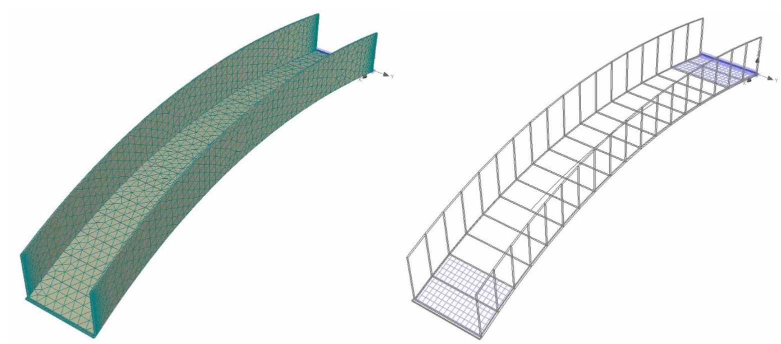

Fig. 5. Finite element mesh on the left and on the right: Segmentation of macroelements to surfaces and reinforcement of the anchoring area.

The bridge is supported by the distributing macroelements, whose lower surface is divided by the line on which are applied such conditions that simulate fixed joint at one end and movable at the other end. Loading the bridge is except the load of the railings on the lateral force via the surface load applied to the appropriate areas of individual macro elements forming the bridge structure. The bottom plate of the bridge was loaded with whole surface load of 4.2 kN /m^2, and subsequently up to structural failure, further part with the greatest eccentricity to cause torque to structural failure. Railing was loaded with a force corresponding to 1 kN /m at the top edge and vertical force until failure of the whole structure. The whole bridge was also loaded temperature change of + 40 ° C and -35 ° C. The model was meshed by tetrahedra elements with an edge length of 0.2 meters. In place of supports was the mesh refined to elements with an edge length of 0.025 m. The bearing stripe for horizontal load of the railings was set for mesh elements with an edge length of 0.1 meters.

2.1. Analysis results

As seen in Figures 6, 7, the bearing capacity of the construction achieves satisfactory values (18.9 kN/m^2), which are well above the required load capacity (4.2 kN/m^2), despite its subtlety.

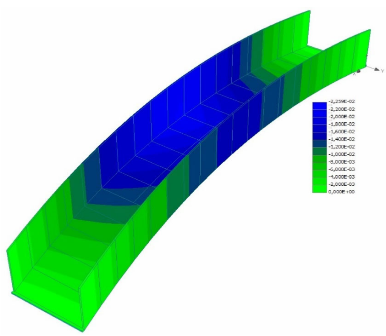

Fig. 6. *Vertical deflection of the structure before failure, the applied force of 18.9 kN /m^2, the maximum deflection value -22.59 mm.*

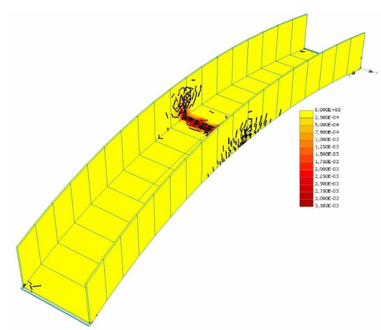

Fig. 7. *Cracks on the structure prior to the failure, the applied force of 18.9 kN /m^2, the maximum crack width 3.18 mm.*

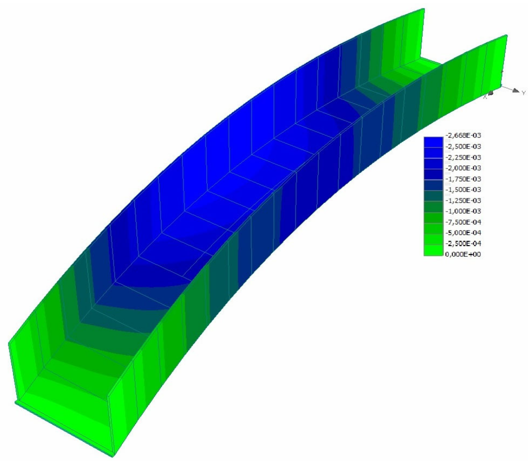

Fig. 8. *Vertical deflection of the structure, the applied force of 4,2 kN /m^2, the maximum deflection value -2.66 mm.*

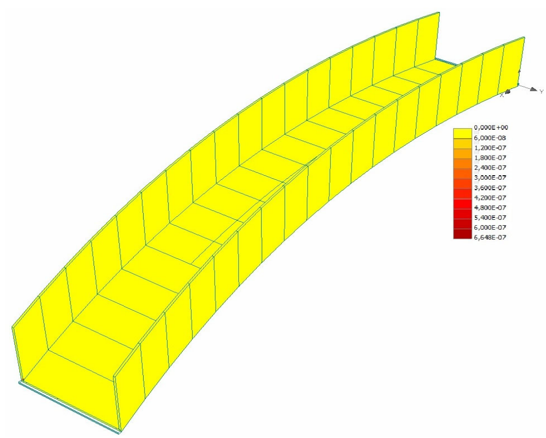

Fig. 9. *Cracks on the structure, the applied force of 4,2 kN /m^2, the maximum crack width 0,0006 mm.*

3. CONCLUSIONS

The paper presents the design of the bridge with U-shaped cross-section of ultra-high performance concrete (ultra-high performance concrete - UHPC). The bridge deck consists of a bottom plate with 30 mm thickness and 30 mm thick side desks which serve as railings. By calculation it was shown that the resistance of the structure has a value of 18.9 kN/m^2 of continuous surface load which are well above the required load capacity (4.2 kN/m^2), despite the subtlety of the construction. The continuation of theoretical design will be the manufacturing and experimental validation of the model of the bridge in 1:1 scale, which will be presented at the conference. Production and testing of the bridge is scheduled for April 2016.

ACKNOWLEDGEMENTS

This research has been supported by Czech Science Foundation, project GAČR No. 104/15-22670S and by CTU in Prague, project No. SGS15/176/OHK1/2T/31.

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