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Application of laser scanning technology in geotechnical works on reconstruction of draw spans of the Palace Bridge in Saint Petersburg

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Abstract

The article describes the experience of applying technology of terrestrial laser scanning in geotechnical works while reconstructing the Palace Bridge in St. Petersburg. Engineering-geodetic work required the survey of draw span pier including its external elements and internal space with all equipment and machines, as well as the coordination of control points of the equipment attaching the truss about wing axis. The survey network included 2 stages. At the first stage we created its geodetic quadrangle framework the points of which were fixed by marks of temporary fixation – dowels driven into the draw span piers. For the survey extension was performed which required coordinates transmission (done by using polar resections) into each pier through their technological windows and passages. The survey network points inside the piers were fixed by scanner benchmarks. The survey was performed by terrestrial laser scanners. The main aim of the survey was 3D models of the structures. Modeling of the structure elements was done by integrating rigid-body geometric primitives into the point model being the result of the survey. Rigid-body geometric primitives were created as a pattern of one of Autodesk AutoCAD elements.

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Introduction

The Palace Bridge represents a big engineering construction, consists of 5 spans, the central of which is a draw three-pinned arch span (Fig.1).



Fig. 1. The Palace Bridge view.

Other spans are riveted continuous truss with curved bottom chords. The draw span wings are balanced with counterweights hinged to its lower part according to Strauss principle. While drawing the bridge the counterweights are lowered into special wells, provided in the piers. The weight of the span wing is 700t, whereas the weight of the counterweights is 1400t. The total length of the bridge is 250m, and its usable width is 27,7m. The bridge piers are built on the caisson foundations lowered to the depth of 25m. The bridge was opened December 23 in 1916. Considering unsatisfactory condition of unique for their time structures and draw span machines as well as draw pier excavations, in 2012 a complex of geotechnical works was done to reconstruct the structure, including engineering-geodetic works performed to create 3D models of the bridge piers.

1. Survey network creation

Engineering-geodetic works while reconstructing the bridge required the survey of the draw span pier including its external elements and internal space with all the equipment and machines, as well as the coordination of control points of the equipment attaching the truss about wing axis. The main aim of the survey was obtaining their 3D models. With tight deadlines of works as well as difficulty of geometry of the equipment and machines that had to be modelled, the survey of the span structure was performed with method of terrestrial laser scanning. In general, terrestrial scanning survey is nowadays widely-used in solving applied problems [1-5], however, in this case during the work performance we had to take a number of peculiarities into consideration:

- we had to survey both external elements and internal span structures, which made us carry out the survey both from the either banks of the Neva river and inside the piers. Consequently, we had to use scanners of different range of action;
- we had to present digital 3D models of the pier structures in St. Petersburg coordinate system MSK-64 and in Baltic height system 77;

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