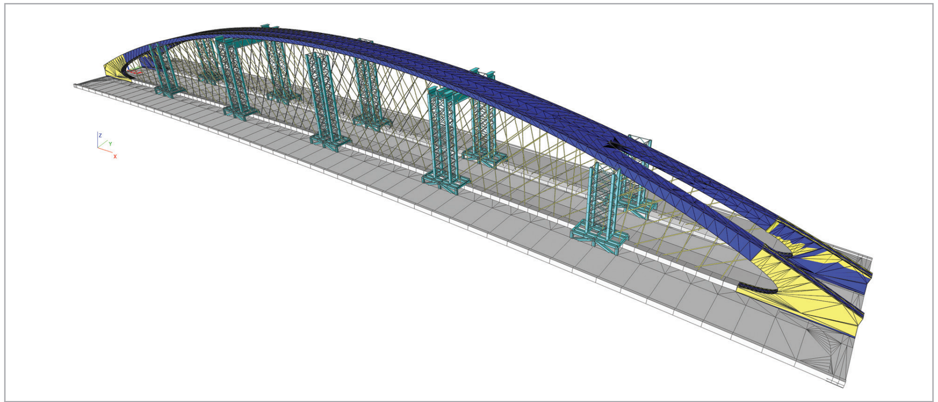
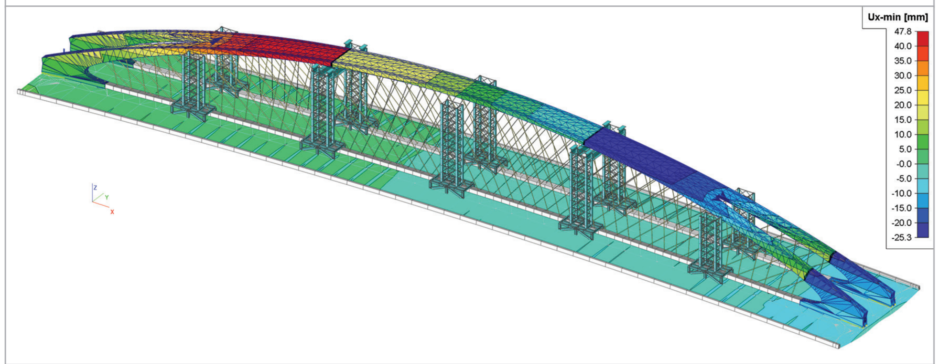
New Troja Bridge over Vltava River - Prague, Czech Republic





Software: Scia Engineer

Introduction and description of the bridge

The client, the City of Prague, announced the architectural competition in 2006. The winning project was submitted by the Mott MacDonald company together with the Roman Koucký architectural office. The construction process for this structure began in the summer of 2010. The general contractor for the bridge was Metrostav a.s., while the designer of the steel structure was Excon a.s. Novák & Partner Ltd. company was the designer of the incremental launching of the construction process and the temporary structures used for the construction process. Under the terms of the project supervision for the contractor, we also performed a lot of computational analysis of the structure with respect to all the construction stages.

The structure of the new Troja Bridge crosses the Vltava River in a northern part of Prague city centre. It connects the central part of the city with the city ring road. The bridge has two spans. The main span, 200.4 m in length, crosses the river, while there is a side span of 40.4 m in length. The bridge should open in 2013. The main span is crossed by a steel network arch, which is extremely flat (the rise/span ratio is 1/10), and by the suspended tied concrete deck. The bridge carries two tram tracks, four road lanes and two pedestrian lanes. The steel arch has a multiple box section at the midspan. The section splits into two legs close to the supports. The arch footings are fixed to the concrete deck and to the last massive in situ cast transversal beam. Due to the extreme load, the footings are filled with self-compacting concrete. The main span concrete deck is composed of a thin in situ cast slab, with a typical thickness of 280 mm. The deck is stiffened by precast prestressed transversal beams, which are only 500 mm wide and almost 30 m long, with a weight of 50 tonnes. They are suspended by tied network hangers. In the longitudinal direction, the deck is only stiffened by two arch ties with a composite cross section. The inclined hangers are in the diameter range of 76-105 mm. They have a pin and fork connection at the ends to the tie and to the arch. Each transversal precast beam is prestressed by two cables with nine strands. The concrete bridge deck is heavily prestressed. The transversal prestressing tendons are composed of four strands (15.7 mm) in flat ducts. The longitudinal prestressing is rather complex. Six cables with 37 strands are located in each composite tie. The slab is prestressed by a number of cables with 7 to 22 strands. The pedestrian stripes are located on the steel cantilevers, which will be attached to the edge stiffening concrete beam of the bridge deck.
The side span is a single span completely in situ cast prestressed concrete structure.

Construction stage analysis and global supervision analysis

For the understanding of the response of the structure during the construction process several mathematical models were compiled. The simplest 2D beam model, where all the structure parts were modelled by the beam elements, was primarily used for TDA module analysis of the construction process, taking into account the effect of creep and shrinkage. The other models were rather more complex. In the case of the main 3D model, it was mainly planar 2D elements that were used; only for hangers and the temporary truss beam elements were used. For this model, 11,569 planar elements, 4,719 beam elements with 107 cross sections, 19,089 nodes, 7 materials and 107 load cases were defined. This model was used for the global static, dynamic, non-linear (geometric and material non-linearity) and non-linear stability analysis. The model served also as the basis for the detailed design of the structure's aerodynamic stability. In the calculations of geometric nonlinearity, a solution was considered according to the theory of the second order. The nonlinear solution of suspension elements with an axial tensile force was made with respect to the tension stiffening theory. All the results were compared with simplified calculations on models for which exact analytical solutions are known. Bridge hangers were modelled as nonlinear beam elements with sag able to only transmit tensile axial forces. The main 3D mathematical model of the bridge structure was also used for the analysis of the dynamic effects of moving loads.

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INŽENÝRSKÁ
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Novák & Partner Ltd. was founded in July 1992 and initially dealt with bridge design only. Later on, the company expanded its engineering activities with general and special structural analysis, the design of road structures and environmental studies. The company provides full design and engineering services from conceptual preparation up to the provision of implementing documentation, the author's supervision, engineering activities, negotiation with public authorities, and expert consulting and bridge inspection services. We provide services to customers from the Czech Republic, Slovakia, Germany, Denmark, the Netherlands, Austria, the USA and Russia. Since 2003, the company has operated as part of the VALBEK Design group. At present, more than 30 employees work for the company as well as a number of permanent external specialists and students from CTU in Prague, including those specialised in foundation engineering, general engineering activities and budgeting. The company has won many awards, e.g. "The Dancing House of Prague", "Tramway Bridge Hlubocepy - Barrandov, Prague", "Bridge over Berounka valley, Prague".

Project information

Owner	Capital City Prague
Architect	Roman Koucky, Libor Kabrt
General Contractor	Metrostav a.s.
Engineering Office	Mott MacDonald a.s.; Excon a.s.; Novak&Partner Ltd.
Location	Prague, Czech Republic
Construction Period	09/2010 to 12/2013

Short description | **New Troja Bridge over Vltava River**

The structure of the new Troja Bridge crosses the Vltava River in the northern part of the city centre. The bridge has two spans - the main span that crosses the river is 200.4 m in length and the side span is 40.4 m in length. The main span is crossed by a steel network arch, which is extremely flat (the rise/span ratio is 1/10), and by a suspended tied concrete deck. The side span is a single span completely in situ cast prestressed concrete structure.
The conclusive structural behaviour and construction process of the bridge is very complex and difficult. It was necessary to deploy many computational models for simulation and the prediction of structural behaviour. The results from mathematical simulations were continuously compared with the results of measurements and computational models were continuously updated.