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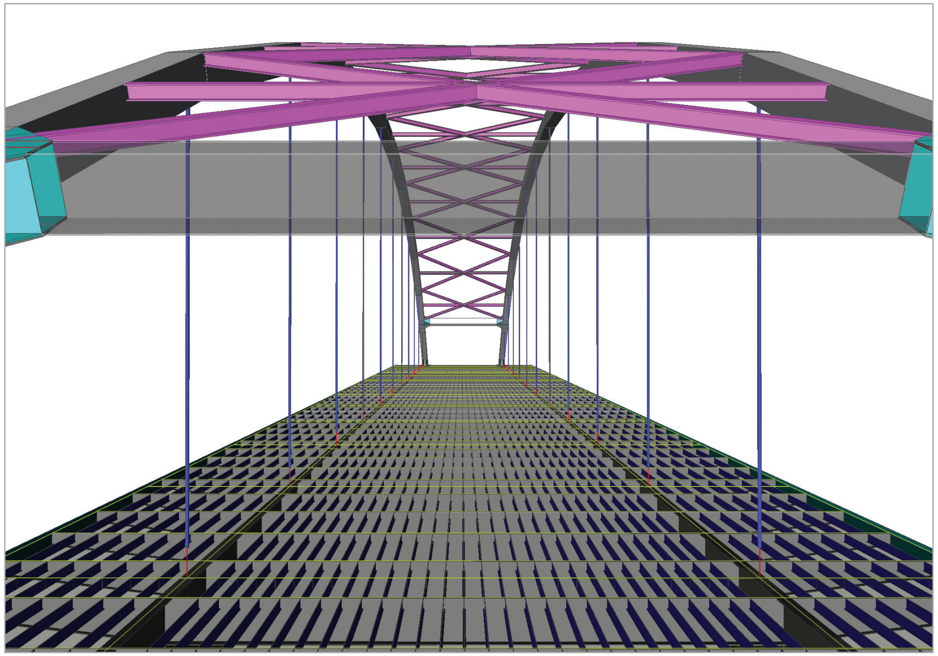
Iv-Infra is a division of the Iv-Groep, a group of professional engineering companies with approximately 800 employees. Iv-Groep was founded in 1949 as a design and drawing office for steel structures. Through the years the company has developed itself into a sparring partner for clients that need independent advice or a constructive solution.
Iv-Infra provides multidisciplinary services in the field of the realization and maintenance of national and international infrastructure work. Iv-Infra's engineers are active in planning, concrete structures, steel and movable bridges, ports and waterways, railway and maintenance sectors.
Iv-Infra is active in large-scale infrastructure projects and eagerly accepts the challenge of solving municipal problems. Besides its design skills, Iv-Infra offers support skills in the fields of risk analysis, systems engineering, space rental, construction monitoring, contract management - supervision and geo-technology. Iv-Infra is involved as a specialist in international projects such as movable bridges and locks, with the most prominent project that of the design of the new Panama Canal Lock Gates.



Software: Scia Engineer

Nine Bridges Project KARGO - Amsterdam, The Netherlands

A large number of the traffic bridges in the Netherlands were constructed during the early second half of the previous century. Since then, the traffic loading has met a tremendous increase in size and intensity; the inevitable deterioration and damage due to environmental and traffic reasons, moreover, have left their mark on the bridges. The inspection and the recalculation of the static adequacy of these structures is therefore a definite necessity.

In this framework, the project 'KARGO' was initiated by Rijkswaterstaat (part of the Dutch Ministry of Transport, Public Works and Water Management). Its objective was the analysis of the structural integrity of eight steel arch bridges and one movable (double-bascule) bridge, and, if needed, the retrofit of the bridges so they can again withstand the contemporary traffic loadings for more than 30 years.

Description of the structures

The bridges under investigation are located over the Amsterdam Rijnkanaal, the Lekkanaal and the Buiten IJ in the Netherlands, and were constructed between 1936 and 1971. The span of the arch bridges varies from 86.00 m to 140.40 m, the width (between the main girders) from 7.60 m to 11.40 m, and the height of the arch from 10.90 m to 18.35 m.

The time span of 35 years between the construction of all the bridges was reflected in various parts of the static system; the hangers are either steel cables (Schellingwouderbrug) or steel profiles (rest of the bridges), the approach bridges are either steel or concrete bridges, the deck is either orthotropic, reinforced concrete or timber (double-bascule bridge) and the connections are riveted or bolted.

Modelling approach

First, detailed finite element models for all the bridges were developed; traffic loadings according to modern codes (NEN6706-2007 and EC-3, Part1-9) were then applied, by making use of the module mobile loads; the members and structural details were checked according to NEN6770/6771, and finally retrofit measures were proposed.

Special attention was paid to correct modelling of various structural details. The connection of the arch to the main girder and end-transverse beam was modelled with the use of rigid elements ("dummy" elements - beam elements with high cross-sectional dimensions and Young's modulus) to model the stiff behaviour of the detail; a sensitivity analysis was carried out for the correct input of the relevant parameters.

Haunch beams were applied to the ends of the portal horizontal beams; haunch beams were also applied for the modelling of the cantilever cross beams extruding perpendicular to the external side of the main girder.

The correct orientation of the beams of the arch wind bracing members was calculated by using a specially developed simple trigonometry program.

Construction stages were also modelled for the bridges where relevant data was available, while the prestressing of the steel cables of Schellingwouderbrug was modelled by using thermal loads.

The orthotropic deck of Schellingwouderbrug was modelled by using the module plate with beams. The concrete deck of the rest of the bridges was modelled by using shell elements. Attention was paid to the connection of the deck to the cross-girders; relevant degrees of freedom had to be released.

The double-bascule bridge was modelled in three different phases, namely closed, just opening, and fully open; in the case of the closed position both parts of the bridge were modelled, since the two parts are not static independent; they are connected to each other with the use of a locking beam and a loading on the one part of the bridge produces stresses on the other.

All the relevant loads (traffic, wind, thermal, braking, fatigue loadings) that were applied to the models were determined according to modern codes.

Nine Bridges Project KARGO

Amsterdam, The Netherlands

Project information

Owner	Rijkswaterstaat
Construction Period	From 1936 to 1971 - Renovation from 2011 to 2016
Location	Amsterdam Rijnkanaal, The Netherlands

Short project description

The objective of the 'KARGO' project was the analysis of the structural adequacy of eight traffic steel arch bridges and one movable (double-bascule) bridge in Amsterdam, on the basis of material research and structural calculations. The structures were modelled, contemporary traffic loads were applied, and strength, stability and fatigue check was carried out. Depending on the outcome of the analysis, retrofit measures were proposed. Scia Engineer was used exclusively for the modelling, analysis and member check of the bridges.