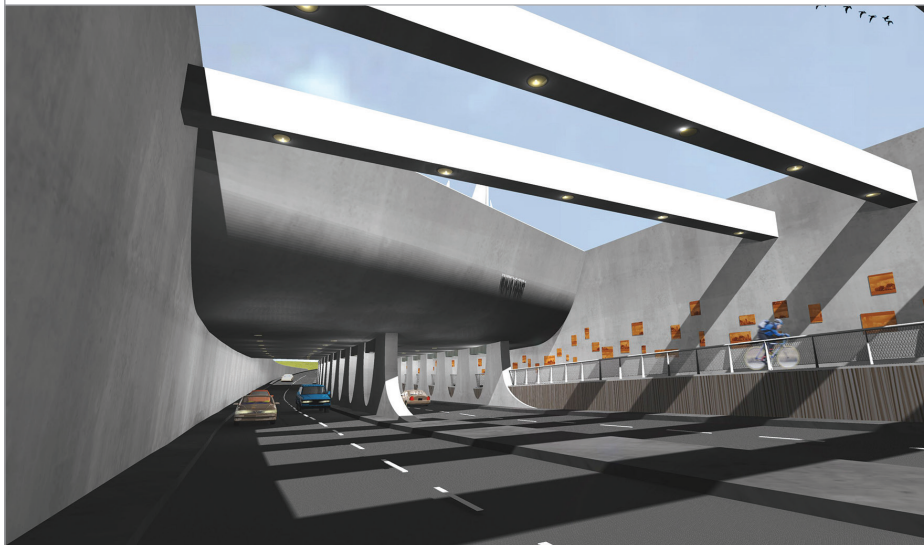
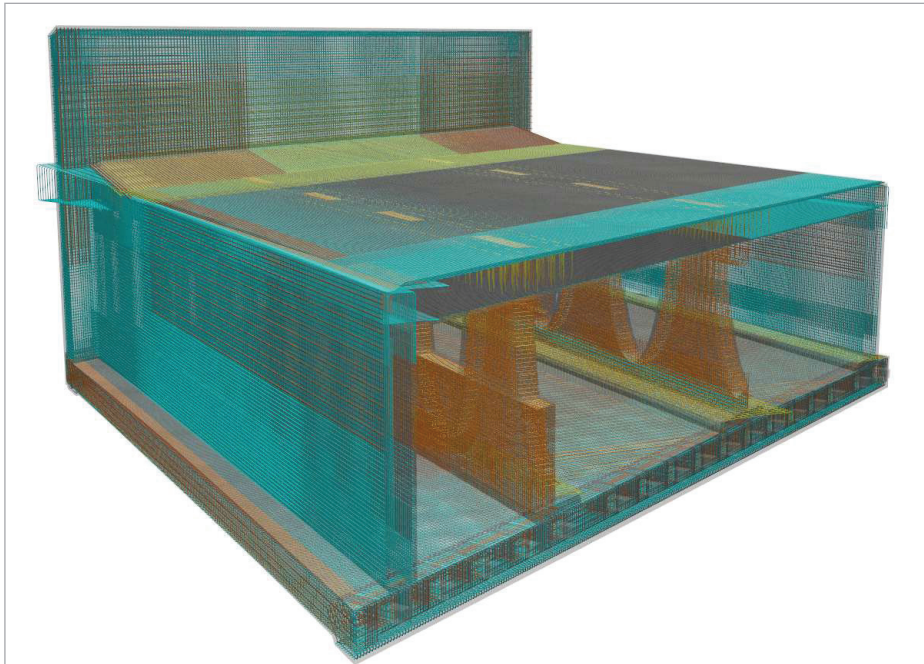


## Nomination Category 2: Civil Structures



### Detail engineering, Aqueduct Westelijke Invalsweg

Based on the architectural requirements, the front wall of the aqueduct at the East and West entrance should have a rounded shape with the radius of 5 m. There were two different structural options available.

The first option was a complex round shape with in-situ concrete. This option would lead to very large dimensions and complex formwork.

The second option was a simpler rectangular aqueduct with prefab concrete shell parts. The extra space on the surface level can be used for the service path.

The second option was chosen since from the design point of view it was less complex and easier to construct.

For the dividing walls beneath the aqueduct, the architect had the design requirement that 60% of the area be “gaps”. So the choice was made to make the dividing walls upside down ellipsoid shapes. This was meant to evoke the image of Roman-era aqueducts.

### Pergola construction

The horizontal struts near the East Entrance should be made in concrete and create a lamella roof impression according to the architectural requirements.

With the presence of the permanent struts in the deepest part of the access ramp, the choice for a pergola construction was obvious.

The struts are made from pre-cast pre-tensioned girders with the dimensions of 800 mm width and 1,350 mm height.

Centre-to-centre: 5,000 mm.

Because of the regularity of the supports, a slim deck slab with the thickness of 400 mm could be made.

### Ingenious poldering

The West Entrance should be made with an open green character. In the preliminary design an artificial polder containing a geomembrane was foreseen.

After the soil and geotechnical research had been carried out, a strong water-resistant loam layer was identified at the West Entrance. Based on this layer, the design was optimised.

### The project in Allplan Engineering

We started from scratch with three MX-axes.

One for the cycle path and one for each carriageway. With the design constraints in mind, the model was generated using the Bridge and Tunnel Modeler.

After its completion, the model was checked thoroughly by examining the design constraints one by one.

When the main model was finished, the aqueduct casing, water cellar and the horizontal struts were modelled separately.

We chose a separate design option because the last 3 parts of the model were not curved design-wise. For the main tunnel the segmentation was 2.5 m. This was chosen as it was the segmentation by which the building tolerance was within prescribed measures.

When the model was ready, dimension drawings were made. For this the model had to be divided into separate tunnel sections, each section as a separate dimension drawing.

After completing the calculation, the rebar modelling could start.

All rebar was modelled in 3D.

### Summary

- Total sections: 19
- Length of concrete sections 2-20: approx. 390 m
- Length of polder section, west side: approx. 195 m
- Closed part: approx. 55 m (sections 6-7)
- Internal height, closed sections: 5.3 m
- Internal width: 22.6 m
- Number of drawings: approx. 120

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Witteveen+Bos offers its clients value-added consultancy and top-quality designs for water, infrastructure, spatial development, environmental and construction projects. We deliver reliable solutions based on the knowledge, experience, social insight and intellect of our employees. At Witteveen+Bos we maintain an inspiring working environment from where we tackle the fascinating challenges that the future holds. Professionalism, respect and integrity are our core values. A multidisciplinary project approach characterises our way of working.

### Infrastructure

Over the years, road, rail and hydraulic engineering have created national and international infrastructures characterised by their large scale on the one hand and their sophistication on the other. Witteveen+Bos has contributed to this development at numerous levels.

### Project information

Owner	Provincie Friesland
Architect	Penta Architecten
General Contractor	Ballast Nedam
Engineering Office	Witteveen+Bos & Grontmij
Location	Leeuwarden, The Netherlands
Construction Period	03/2012 to 05/2013

### Short description | Aqueduct, Part of the “Westelijke Invalsweg” Project

The Westelijke invalsweg has 2 x 2 lanes between the highway (A31, “Haak om Leeuwarden”) and the city of Leeuwarden. At the Westelijke Invalsweg junction with the “van Harinxmakanaal” an aqueduct is foreseen with a lower level road over about 600 metres.

There are structural challenges and also design requirements. Because of the overall scale of the project, design requirements (also known as “beeldambitie document”) were set up.

Within this document, the requirements for the architecture and finishing of the aqueduct are determined, such as the surface and look of the walls, the appearance of the horizontal struts in the East Entrance, and also the requirements concerning the “Green Entrance” at the west side.

