# TUC RAIL


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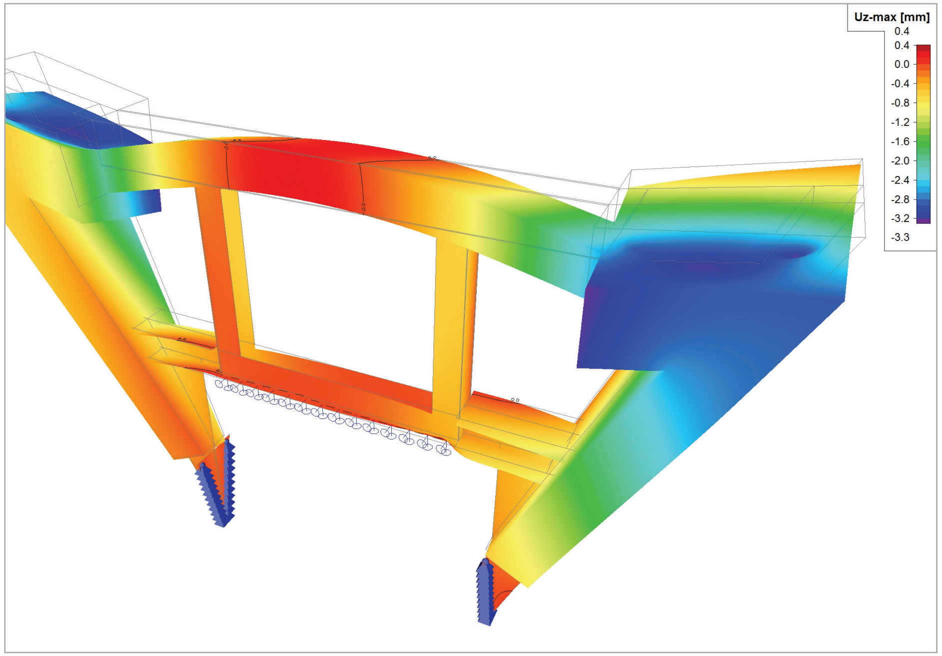
TUC RAIL was established in 1992 as a subsidiary of the Belgian national railway company (NMBS/SNCB). In 2005, the railway company's shares in TUC RAIL were taken over by Belgian railway infrastructure manager Infrabel. TUC RAIL's core competencies include project management, design and execution of the work, both in constructing new rail infrastructure and in adapting existing infrastructure. On the Belgian market, this means working on large and complex projects in order to extend and modernise one of the world's busiest railway networks situated at the heart of Europe. TUC RAIL also offers its services and competencies to foreign projects, enabling it to capitalise on acquired knowledge, to face new challenges and to diversify its experiences.

The company has more than 900 employees and achieved a turnover of almost € 81 million in 2009. TUC RAIL can boast 18 years of experience and is therefore able to offer its clients reliable, tailor-made, high quality solutions, from the design stage up to the realisation of the project.




**Software: ESA-Prima Win, Scia Engineer**

## Extension of a Historic Multiple-Arch Concrete Viaduct - Dilbeek, Belgium

The existing railway line between Brussels and Ghent crosses the valley of the Pede by a 523 m long historic viaduct. This structure of the 1930's consists of 16 three-hinged reinforced concrete arches of 32 m span, reaching a maximum height of 40 m and supported by hollow concrete piers. The railway company started infrastructure works in increasing the number of tracks of the railway line from 2 to 4 tracks. Widening of the structure by two additional lateral viaducts was only acceptable if these new constructions are respectfully integrated in the historic work of art.

### Final design

The final design consists of a steel superstructure having variable hollow sections. The box section also is continuous over 4 spans and it is characterised by waving patterns, both in the plan as in the cross-sections. The upper flange of the box section is constant and stays horizontal along the structure's length. The lower flange has variable width, minimum 3.65 m at the piers and maximum 5.15 m at the span centre. In addition, the lower flange climbs according to a sine wave from the supports towards the span centre obtaining less height and is twisted about a horizontal axis as it becomes wider. As a result, the vertical box web near the existing concrete arches has variable height, whereas the outer web incidentally shows torsion along the bridge axis. This created a waving pattern of the steel structure, complying with the existing arches, both in a horizontal plane as in the front view. These waving patterns match with the concrete arch repetition. This solution is qualified as being an honest structure, showing as much respect for the historic viaduct.

Since a steel structure is used for the bridge deck as well as for the piers, a contrast of materials is being created between the rough concrete and the smooth modern steel construction. The new superstructure is supported by a steel corbelling construction, fixed to the existing piers. The steel piers are joined by a steel transversal beam, located in the hollow parts of the existing piers. The vertical pier has a conical shape and fades into the lower part of the concrete pier. In 2008, the works have started. In advance, the existing foundation slabs were extended considerably and were reinforced by additional grouting piles. In a second phase, the construction of the steel piers and superstructure has started at the end of 2009.

### Design criteria

The conceptual design of this pier has to deal with both severe vertical and horizontal forces as well as railway structures. At first for horizontal stability in transverse direction, a transverse steel connection structure between the two cantilever piers and located in the hollow parts of the existing piers is needed. As for the horizontal stability in longitudinal direction, the horizontal traction and braking forces of the new structure on each cantilever pier is incompatible with the slender design. Therefore, the new structure is made continuous over 4 spans. This makes it possible to lead the high horizontal forces to the piers with higher thickness. In designing the piers, the limitation of the transverse distortion of the pier is decisive. A stiff internal framework to be placed in the internal hollow part of the existing pier is used.

As for the design of the superstructure, restrictions in vertical deformations for safety purposes, but also the transverse deflections, especially the twist of the deck, and the end rotations of the deck are decisive. In the configuration of the superstructure, the restriction of the vertical deflection $\delta/L$ to a maximum value of 1/1090 for a train speed of 160 km/h and the restriction of the rotations at the end of the deck to 6.5 10-3 radians for ballasted track can be fulfilled. This is made possible due to the continuity of the superstructure over 4 spans and the use of a concrete deck-plate.

An additional stiffness is realised by providing a concrete deck plate of a thickness of 0.25 m. Due to the restricted construction height, the slender cross-section at mid span has limited strength to torsion effects. This brings concerns about the transverse distortion, such as the twist of the deck which must be strictly limited for railway bridges. To raise the torsion stiffness, internal stiffening is used. The use of longitudinal stiffening by internal webs as well as the use of diaphragms on very short distances has been investigated.

# Extension of a Historic Multiple-Arch Concrete Viaduct

## Dilbeek, Belgium

### Project information

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| Owner | Infrabel |
| Architect | TUC RAIL |
| General Contractor | Iemants, Belgium |
| Engineering Office | TUC RAIL |
| Construction Period | From September 2009 to June 2011 |
| Location | Dilbeek, Belgium |

### Short project description

*In increasing the number of tracks from 2 to 4 ones, a 523 m long historic viaduct for a railway has been extended. The existing structure consists of 16 three-hinged reinforced concrete arches of 32 m span, reaching a maximum height of 40 m and supported by hollow concrete piers. The widening structure consists of new steel viaducts supported on steel hollow ribs, which are fading gradually into the existing piers. The superstructure itself has the shape of a steel box with a variable hollow section, creating a waving pattern of the steel structure, complying with the existing arches, both in a horizontal plane as in the front view.*