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Deformation-Compatibility of Steel Truss and High-Strength Concrete Girders

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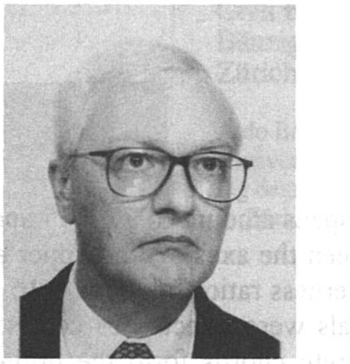

Philippe Van Bogaert, born 1951, received his civil engineering degree from Ghent University in 1974 and PhD in 1988. He is currently head of bridge design office with TUC Rail Cy - Brussels and professor of Bridge Engineering at Ghent Univ.

Summary

The railway fly-over at Lot, was built for the crossing of the high-speed railway line from Brussels to Paris over domestic tracks. Its superstructure consisting of lateral composite girders with steel truss elements bolted to the upper flanges, required geometric compatibility of the composite girders and the truss elements. The influence of a set of parameters was examined. From the recordings of all deformation steps, it was found that the composite girders with high-strength concrete showed little time-dependent deformations.

1. Structural concept

The railway fly-over at Lot (see fig 1) is located some 7 km to the south of Brussels. It was built for the crossing of the high-speed railway line from Brussels to Paris over domestic tracks. It consists of 16 spans of 42.60 m, the total length of the fly-over becoming 682 m. The fly-over had to be prefabricated entirely, since it was designed to be built over tracks remaining in service. The design of the superstructure is remarkable in this sense that a complete composite structure was built (see the superstructure cross section fig 2). The piers have alternatively a triangular or straight shape. The triangular piers comply with the truss shape of the superstructure and are composite members, resisting the braking and acceleration forces of trains. Two lateral composite girders are equipped with an intermediate reinforced concrete deck plate and transverse stiffening ribs. Steel truss elements are then bolted to the upper flanges of the composite girders.

The lateral girders consist of welded steel I-beams of 2.2 m depth. These are encased in high-strength precast concrete C 80/95. While producing the girders, they were subjected to a succession of stress and deformation states. At first, the steel beams were fabricated with a predetermined initial rise and precambered by concentrated forces, thus compensating the rise. After stressing of bonded tendons, a lower concrete flange was cast. Releasing the precambering forces and cutting of the tendons initiated again a rise of the girders. Casting of the upper concrete part, encasing the steel girder's web, and stressing of 4 additionnal post-tensioning cables caused subsequent deformation. The composite girders were then transported by train to the building site. After concreting of the stiffened slab the geometry of the bridge decks had to similar to the truss geometry, which were allready fabricated.

2. Deformation-compatibility and effect of high-strength concrete

The most difficult part was to predict the deformation state of the composite girders at the construction stage where the truss elements were presented. From laboratory tests a secant deformation modulus of the concrete was determined. However, all parameters, governing creep and deformation were not kept under control. As the girders were placed on the piers, the concrete age varied from 43 to 210 days. The values of concrete resistance varied from 93 to 119 MPa. In addition, the relative concrete strength at which the precambering was loosened, the strands where cut, or the post-tensioning was applied varied considerably too. From the recordings of all deformation steps, the influence of these parameters was examined (see fig 3 for charts of deformations as a function of f_{c28} and concrete age). Due to the use of high-strength concrete the time factor and other creep factors were almost insignificant. Eventually the fabrication tolerances of the steel beams were found to be the most significant parameter for determining the deformations of the girders. Thanks to this the deformation steps were predicted accurately, thus achieving the required geometric compatibility.

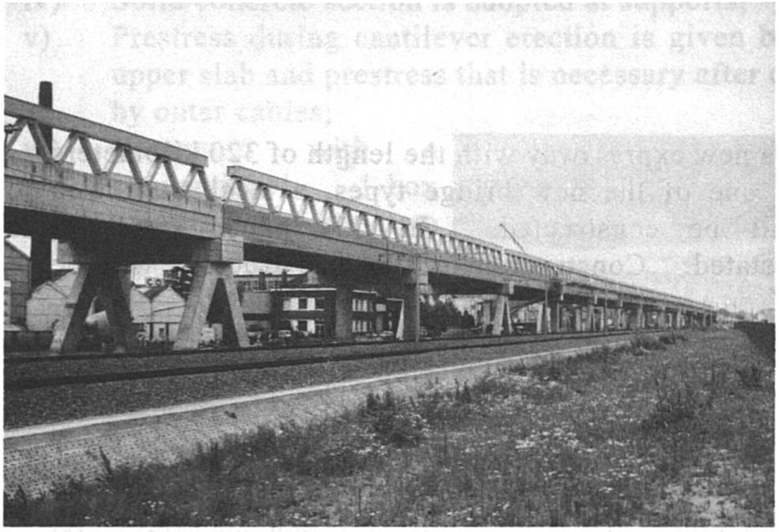

Fig. 1 Overall-view of fly-over

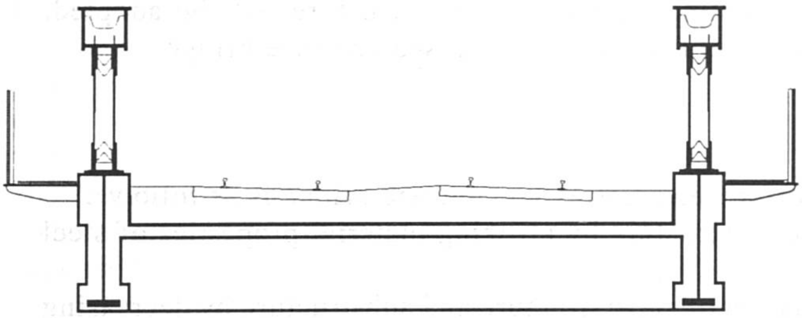

Fig. 2 Superstructure cross section

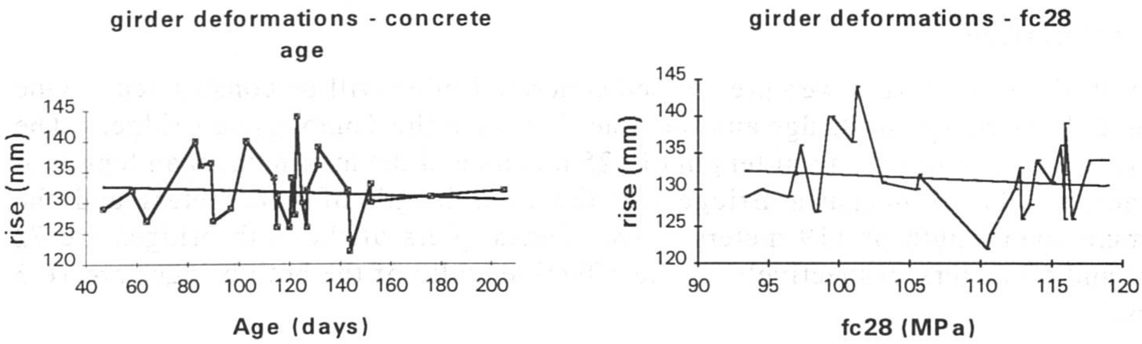

Fig 3 : Composite girder deformations versus factors