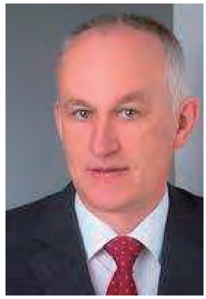
# Stress redistribution in bridges built using the balanced lift method

**Dominik Suza**
Research Assistant
Vienna University of Technology
Vienna, Austria
*dominik.suza@tuwien.ac.at*

Dominik Suza, born 1985, received his civil engineering degree from the Brno University of Technology, Czech Republic.

**Johann Kollegger**
Professor
Vienna University of Technology
Vienna, Austria
*johann.kollegger@tuwien.ac.at*

Johann Kollegger, born 1956, received his civil engineering degrees in Graz, Berkeley and Kassel.



## Summary

The balanced lift method for bridge construction was developed at Vienna University of Technology. This method proposes to build the bridge girders in a vertical position and to rotate them into the final horizontal position with the aid of compression struts.

During the construction process, when the bridge girders are rotated from the initial vertical position into the final horizontal position, it is of utmost importance for an economic application of the balanced lift method that the structural members are as light as possible [1].

In the course of research project a 30m long test beam was built to experimentally prove the applicability of such a construction procedure. It could be shown in the experiment and also in concurrent numerical analyses that stress redistribution between the highly stressed prefabricated girder and the filler concrete occurs. Considerable economic advantages can be achieved by taking these stress redistribution into account in the final design of bridges designed according to the balanced lift method.

**Keywords:** Balanced lift method, bridge, building stages, deep valley, innovation,

## 1. Introduction

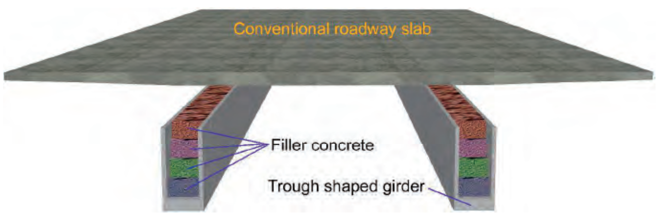



*Fig. 1: Schematic sketch of bridge with trough shaped precast girders*

The objective was the development of precast concrete girders light enough for transport and erection by conventional transport and lifting equipment. The trough-shaped precast elements are intended to be used as formwork for the filler concrete and will be cast at the construction site to considerably reduce the use of formwork and scaffolding Fig. 1.

The required reinforcement and the ducts for the tendons can be installed at the precast plant. It is also possible to supplement the appropriately cast girders with a conventional roadway slab, similar to the steel girders in composite steel-concrete construction.

In order to demonstrate the feasibility of building bridges with thin precast concrete elements, a field test was realized with the aim of testing the behavior of the thin-walled elements under the load of the cast in-situ concrete and, at a later stage, of measuring the stress redistribution between prefabricated girder and filler concrete due to creep [2], [3].

## 2. Numerical simulation and comparison with experiment

An important feature of the numerical analyses was the modeling of the incremental production of the test beam. Also the increase of the modulus of elasticity of concrete and the time dependent creep behavior was taken into account. The test beam is always in a compressed state. This is also true for all other cross-section of the test beam. This fact is of utmost importance at the joints between the individual precast elements.

A comparison of measured concrete strains and calculated concrete strain was carried out in order to assess the quality of the numerical simulation of the test beam. 58 measurement points had been fixed close to the bottom fibre in the longitudinal direction of the test beam. With the aid of an extensometer the relative displacement between the measurement points could be determined. The results of the strain measurements from October 2010 to August 2014 are shown in Fig. 2. The calculated strains are also shown in Fig. 2 with solid lines. A good correlation of measured and calculated strains can be noted from the results displayed in Fig. 2.

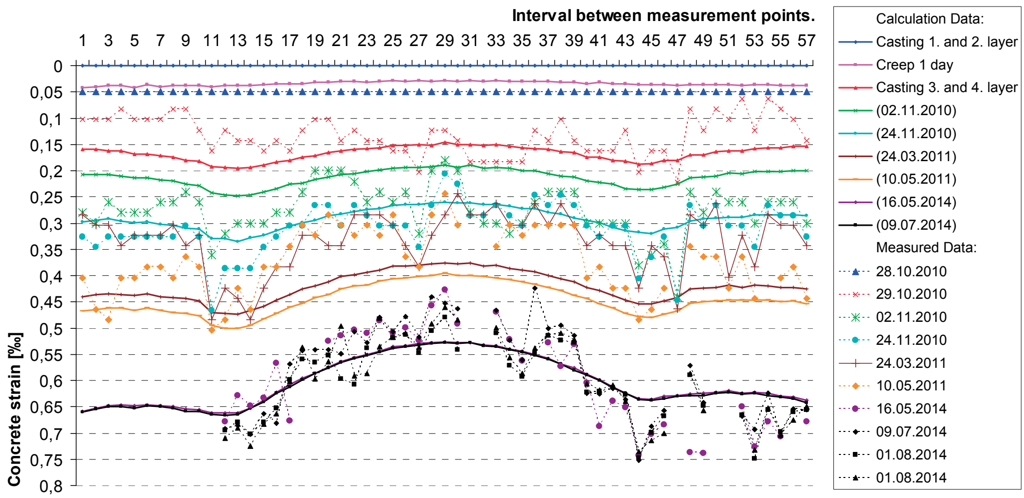



*Fig. 2: Comparison of measured and calculated concrete compressive strains of test beam*

### 2.1 Conclusions

A careful and meticulous analysis of the different construction stages is required for designs based on this method, because light structural elements are used during the balanced lift. These light elements subsequently filled with in-situ concrete, which leads to many different construction stages and structural elements with changing cross-section. It could be shown in this paper that a considerable redistribution of concrete stresses does occur, which should be taken into consideration in the design calculation for economic reasons.

### 2.2 References


[1] KOLLEGGER J., FOREMNIAK S., SUZA D., WIMMER D. and GMAINER S., “Building bridges using the balanced lift method”, *Structural concrete: journal of the fib*, Vol. 15, No. 3, 2014, pp. 281-291.

[2] WIMMER D., “Thin-walled precast concrete girder for bridges construction and civil engineering”, *Concrete Plant + Precast Technology*, Vol. 79, 2013, pp. 44-51.

[3] KROMOSER B., “Brückenbau mit Fertigteilen Großversuch zur Herstellung und zum Torsionswirkungsverhalten”. *Masterthesis – Vienna University of Technology*, 2011.