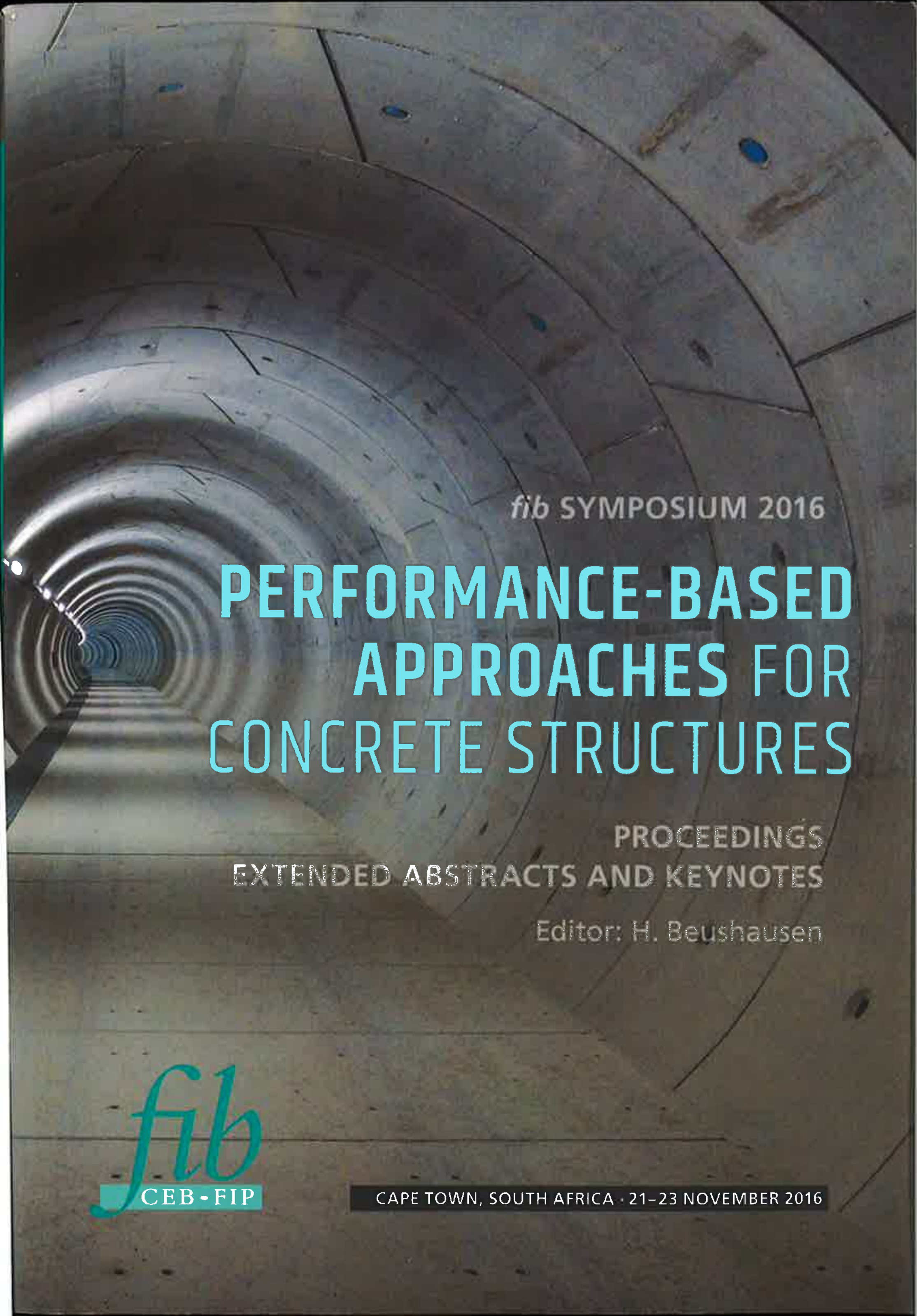


fib SYMPOSIUM 2016

PERFORMANCE-BASED APPROACHES FOR CONCRETE STRUCTURES

PROCEEDINGS
EXTENDED ABSTRACTS AND KEYNOTES

Editor: H. Beushausen

fib CEB-FIP

CAPE TOWN, SOUTH AFRICA · 21–23 NOVEMBER 2016

Improving the Quality of Prediction Models for Concrete Creep and Shrinkage

Dominik Suza[1] · Johann Kollegger[2]

Department of Structural Engineering, Technische Universität Wien, Vienna, Austria

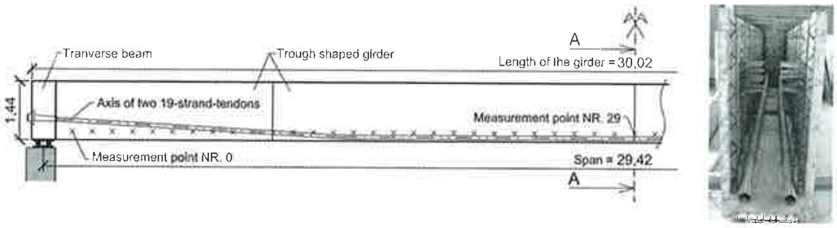
Abstract

In order to design sustainable and economically valuable engineering and architectural structures out of reinforced or prestressed concrete it is necessary to create realistic and practical models for the material behaviour. The appropriate modelling of the processes, initiated by the discharge of hydration heat, shrinkage and creep, that occur in young concrete, are crucial for the subsequent durability of engineering structures. Even though the Eurocode and Model Code are nowadays available to the design engineers, the real behaviour of concrete in engineering structures is not always described with sufficient accuracy. In order to obtain accurate rheologic models of actual structures it is of great importance to develop models and methods by using specific experimental measurements on specimens with dimensions that are commonly used in the field and to compare the obtained results from the large–scale specimens to the data measured on concrete cylinders in the laboratory.

Keywords: balanced lift method · bridge · construction sequence · creep · numerical analysis

1. Introduction

A stress redistribution experiment in a 30 m long precast girder was started in October 2010. The girder is a large-scale test of a real bridge girder used for the Balanced Lift Method (BLM). The cross-section, pre-stressing force and construction sequence used during the production of this girder was simulating the construction phases of a real bridge constructed using the BLM. 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 behaviour of the thin-walled elements under the load of the cast in-situ concrete and, at a later stage, the stress redistribution between prefabricated girder and filler concrete due to creep.



(a) Longitudinal section of test beam.

(b) Cross-section of the prefabricated girder.

Figure 1. Test girder – 30,02 m long.

A longitudinal section of the left half of the 30,02 m long test girder is shown in Figure 1 (a). The test girder consisted of three prefabricated parts. The thickness of the wall elements was equal to 70 mm. The overall dimensions of the section amounted to a width of 700 mm and a height of 1440 mm. The experimental girder was prestressed by two 19-strand-tendons (see Figure 1 (b)). Within a time difference of 24 hours, the filling concrete was placed in four layers with a thickness of 0,31 m. During the pouring of the concrete, the post-tensioning force was increased stepwise up to 5300 kN. For more than five years the concrete strains of the experimental beam were measured using a mechanical extensometer with an accuracy of 0,001 mm (Kromoser 2011).

2. Numerical simulations and comparison with experiment

The measured concrete strains were compared with the results of three independent soft-ware calculations using the same Code (EN 1992-1-1) and material model. The task was designed in two commercial programmes – Sofistik 2014 from Germany and Midas Civil 2016 v2.1 from South Korea. The third program – TDA (Time Discretisation Analysis) was programmed by the first author in Visual Basic for Application. A comparison of measured concrete strains and calculated concrete strains was carried out in order to assess the quality of the numerical simulations of the test girder. The analysis results are shown in Figure 2. The vertical axis displays total concrete strain [‰]. The dashed red line shows the average measured values. The displayed data are only from the centre of the span (+/- 2 m).

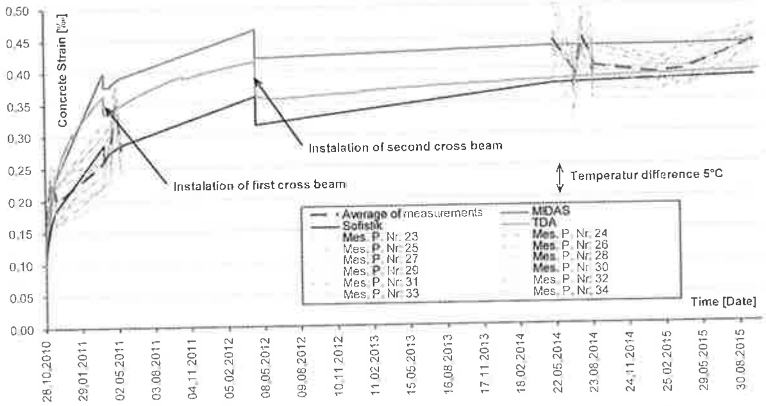


Figure 2. Five year measurement: comparison of measured and calculated concrete strains of test girder.

All three programmes proved good correlation of theoretical concrete strain evolution with the actual construction. Even though the initial cross-section stresses were similar, and even though the programmes used the same material models provided in the Eurocode 2 and the concrete strain developments were similar reaching a strain of 0,40 ‰, the stresses calculated by the programmes did show some differences. The Sofistik results show, that the initial upper stress of the through shape precast girder have decreased by almost 50% to this day and expects that, redistribution will continue infinitely (100 Years) and will further decrease. The Midas and TDA results have a good correlation with each other. The initial stresses of the through shape precast girder decrease up to 20–30% to this day and both models show that the present stresses of the girder should be similar to the stress at infinite time (100 Years) (see Figure 7 full paper version).

3. Conclusions

All three programmes Sofistik, Midas and TDA, provided a good match with measured strain values. Even though the results of Sofistik stresses are different to those of Midas and TDA, it is not unequivocally possible to determine which solution approximates the construction more accurately. It is important to know, that by using the same material models and the same codes; we do not have to get the same results with different programmes. It is good, if the user knows the calculation method and the limits of the programmes.

References

Kromoser, B. "Brückenbau mit Fertigteilen – Großversuch zur Herstellung und zum Torsionswirkungsverhalten", Master thesis, 2011, Vienna, Austria.