DOI: 10.24904/footbridge2017.09700

FULLY BIO-BASED-COMPOSITE FOOTBRIDGE: STRAIN MONITORING DURING USE PHASE

Rijk BLOK

Assistant Professor
TU/e Eindhoven University of Technology, Netherlands

R.Blok@tue.nl

Patrick M. TEUFFEL

Professor
TU/e Eindhoven University of Technology, Netherlands

P.M.Teuffel@tue.nl

Keywords: footbridge; innovative structural design; new materials; bio-composites; fibre brag optical sensors; bio-based structures

1. Introduction

In November 2016 the world's first fully Bio-based Bridge was installed at the TU/e University Campus in Eindhoven, Netherlands over the river Dommel. Figure 1a shows the bridge at its opening event in October 2016. The bridge has length of 14 mand uses hemp and flax fibres in a bio-based epoxy resin around a core of PLA bio foam. The bridge is the result of a so-called 4TU Lighthouse project.

For the unit Structural Design at TU/e, the main research question was whether and how these bio-based composite materials could be used in structural loadbearing (bridge and building) applications. A bridge fully made out of bio-based composite materials had until this project not yet been realised.

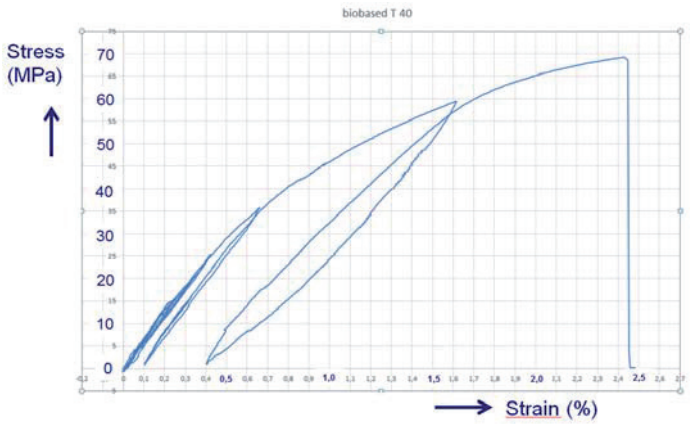

Figure 1 a: Impression Bridge after opening b: Typical load test result woven Flax composite.

2. Design and monitoring structural behaviour of the Bio-based bridge

Flax and hemp fibres in a bio-based resin and round an internal shape of PLA bio-foam form the basis of the structural design. Figure 1b shows a typical result of a (repeated) tension test on a woven Flax fibre composite. Optical Fibre Bragg Grating sensor technology (FBG) has been incorporated to further monitor the bridge during its service. The paper compares these monitoring data with earlier material tests and modelled structural behaviour during design.

Figure 2 shows test results obtained from an in situ load after installation of the bridge by carrying in total 6,0 kN in weights onto the bridge. The results show a good correlation with the material tests and with the modelled structural behaviour. Not all observed phenomena can be fully explained though.

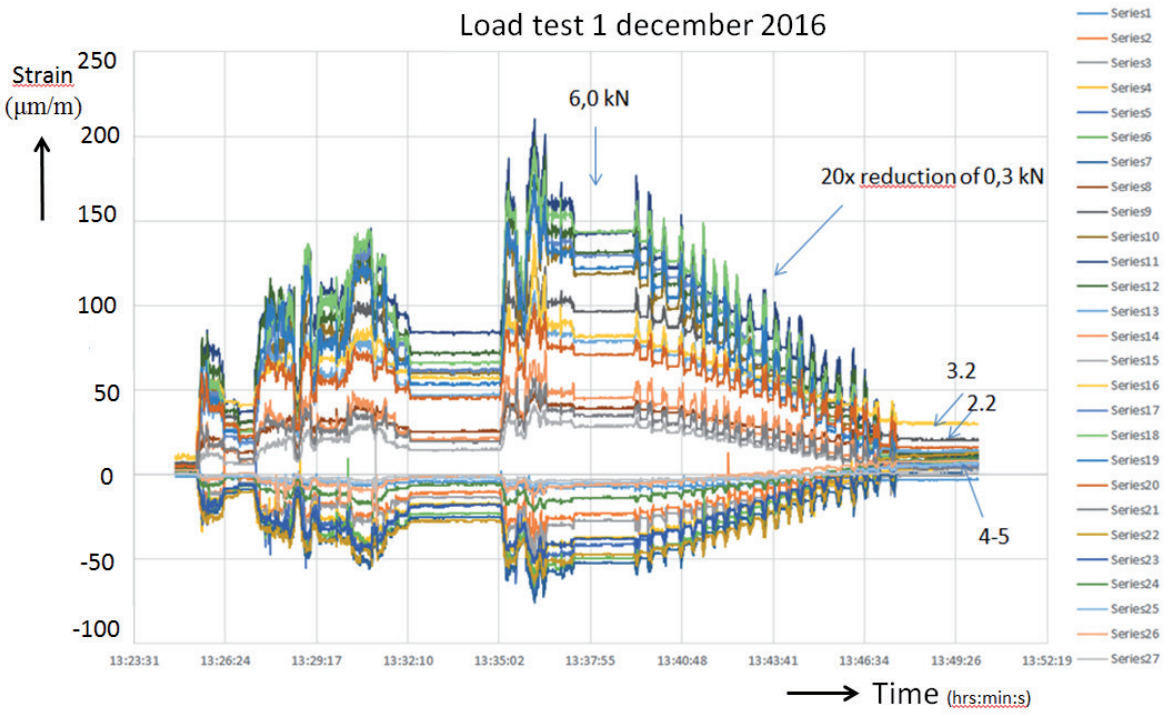

Figure 2. Resulting strains of load test 1-12-2016.

The observed non-elastic time dependent behaviour, creep, as well as temperature and moisture influences are further topics of ongoing research.

3. Conclusions

The measured strains in the load test at the test facility and after the initial installation of the bridge show a good correlation with elastic models. The measured strains, especially at the tension side of the bridge, almost exactly match the elastic behaviour. Further tests show elastic results during these tests but when compared with the other test they show a long term behaviour over time that cannot be explained by elastic models. Influences of creep, moisture and temperature are , also based on additional tests performed at TU/e are all expected to contribute to this time dependent behaviour.

4. References

[1] SMITS, JORIS, GKAIDATZIS, RAFAIL, BLOK, RIJK & TEUFFEL, PATRICK M. (2016). *Bio-based composite pedestrian bridge. Part 1: design and optimization*. In M. Ohsaki, K. Kawaguchi & T. Takeuchi (Eds.), Proceedings of the IASS Annual Symposium 2016 “Spatial Structures in the 21st Century”, 26–30 September, 2016, Tokyo, Japan (pp. 1-10).

[2] LEPELAAR, MARK, HOOGENDOORN, ALWIN, BLOK, RIJK & TEUFFEL, PATRICK M. (2016). *Bio-based composite pedestrian bridge. Part 2: materials and production process*. In M. Ohsaki, K. Kawaguchi & T. Takeuchi (Eds.), Proceedings of the IASS Annual Symposium 2016 “Spatial Structures in the 21st Century”, 26–30 September, 2016, Tokyo, Japan (pp. 1-10)

[3] COM&SENS http://www.com-sens.eu, company FBG Gent Belgium

[4] AL-BAHADLY, E. (2013). *The mechanical properties of natural fiber composites.* Faculty of Engineering Swinburne University of Technology.