Development of timber–UHPC composite bridge system

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Abstract

This paper describes the development of an innovative timber–concrete composite (TCC) bridge system. The optimization of TCC bridge structures using the application of a precast bridge deck made of ultra-high-performance concrete (UHPC) was studied in this research program. The first part of research program was focused on the verification of mechanical characteristics of the proposed shear connection system. Another part of the experiments was focused on the verification of the load-bearing capacity of thin slabs made of a local mixture of UHPC. Finally, a full-scale experimental structure was built. The load-bearing structure was designed as glue-laminated timber beams connected with only 60-mm-thick precast bridge deck segments made of UHPC. The overall load test of experimental structure until failure was performed. The results of the experiments were evaluated in detail and compared with analytical calculations and numerical simulations.

Keywords: UHPC; timber-concrete composite; pedestrian bridge; experimental development.

1 Introduction

Currently, there is a tendency for the efficient use of the resources in the Czech Republic as well as abroad, which includes the sustainable material management and the production with minimal impact on the environment. The effort to use renewable materials leads to a more frequent application of timber for load-bearing structures.

Composite bridge structures made of timber and concrete represent an environmental benefit because they allow the application of renewable natural material timber, effectively using the properties of both materials and are architecturally interesting. The concrete bridge deck protects the timber beams against direct weather influences.

The bridge deck made of UHPC is much slender compared to the bridge deck made of normal-strength concrete. Due to the use of UHPC, the dead load is significantly reduced and the effects of creep and shrinkage are reduced especially in the case of prefabrication. The prefabrication represents the benefits of generally higher quality of the structure and higher speed of the construction. There is no need to assemble the falsework and the formwork in situ.

The main goals of the development of an innovative timber–concrete composite (TCC) bridge system using precast bridge deck segments made of UHPC were the efficient use of materials and the acceleration of the construction process on site.