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Development of a modular footbridge system with pre-tensioned CFRP reinforcement

Sophia Perse, Alexander Stark, Norbert Will, Josef Hegger

Institute of Structural Concrete, RWTH Aachen University, Germany

Contact: sperse@imb.rwth-aachen.de

Abstract

A common problem of concrete bridges are corrosion damages of the steel reinforcement. The related loss of capacity as well as visual effects often require expensive and elaborate refurbishment or even reconstruction. To overcome these drawbacks, a modular footbridge system without steel reinforcement is developed. The application of non-corrosive carbon fiber reinforced polymer (CFRP) reinforcement is suitable for building slender constructions which are durable and long-lasting. To enhance the durability and reduce costs, high strength concrete (HSC) with high density is applied. Hence, no additional surface is required. The modular construction method allows for fast assembly and disassembly of the footbridge. This paper presents the dimensioning and flexural pre-design of the modular footbridge system.

Keywords: bridges; CFRP; new materials; pre-tensioning; durability; sustainability.

1 Introduction

In-situ casted reinforced concrete is commonly used for road and pedestrian bridges due to simple construction and versatility in design. Nevertheless, the formwork and casting on site causes great economic effort. Due to corrosion issues, the installed steel reinforcement requires thick concrete covers resulting in massive members [1],[2],[3]. However, corrosion damages, e.g. caused by chloride penetration, often cannot be excluded. The related loss of bearing capacity as well as visual effects require expensive and elaborate refurbishment or even reconstruction. Thus, a modular footbridge system without steel reinforcement is developed, that provides the basis for sustainable and economical footbridges that provide high load capacity. To realize this project, the application of carbon fiber reinforced polymer (CFRP) reinforcement is suitable due to its corrosion resistance. Furthermore, the required concrete cover can be minimized leading to a slender and lightweight construction, since only bond requirements have to be fulfilled. To enhance the durability and reduce costs, a high strength concrete (HSC) with high density is applied. Hence, no additional asphalt surface is required.

A pilot project was started in 2010 in Albstadt, Germany to build a footbridge with a superstructure made of precast textile-reinforced concrete (TRC) elements [4],[5]. The bridge with a total length of 97 m consists of six precast bridge elements with a maximum length of 17.2 m and spans of 15 m. The cross-section of the superstructure is a T-beam with seven webs (Figure 1). The footbridge is reinforced with textile reinforcement (AR-glass) and prestressed with coated steel strands (unbonded post-tensioning). As a result of the required minimum concrete cover for the steel strands, a web width of 120 mm is necessary.

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