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Application of Prestressed CFRP Textiles for the Development of Thin-Walled Concrete Structural Elements

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1 Abstract

The success story of prestressed concrete is based on the utilization of high-strength prestressing steel which enables large compressive forces to be introduced into the concrete. However, thin-walled concrete structures often require considerable thicknesses for the sole purpose of preventing corrosion of the steel elements. In this paper the use of prestressed Carbon Fiber Reinforced Polymer (CFRP) for the development of thin-walled concrete structural elements is briefly presented. The transition of material to stronger, lighter and corrosion-resistant CFRP represents a significant improvement in concrete construction. Prestressing with CFRP elements leads to more slender and thereby more economical and durable structural elements. Through the additional prestressing of a reinforcement mesh, very light and highly rigid surface structures can be constructed. Prestressing technologies have been developed and adapted for specific applications i.e. slabs and doubly curved structural elements and validated by experimental tests. This paper shows that prestressed carbon reinforced concrete can be used for more durable and efficient thin-walled structures, allowing for more sustainable construction.

Keywords: CFRP, prestressing, concrete, thin-walled structural element

2 Introduction

The usage of carbon fiber reinforced polymer as reinforcement is a further development of reinforced concrete, in which the corrosion-susceptible steel reinforcement is replaced by the stronger and non-corrosive material CFRP, in the form of textiles, straight reinforcement bars and tendons. With carbon reinforcement, the durability of concrete structures can be significantly increased, especially if they are exposed to more vulnerable situations such as freezing and thawing cycles or cyclic loads. Since the concrete cover is only needed for the bond and not as corrosion protection, carbon fiber reinforced concrete can be very slender and thus resource-efficient.

Prestressing reduces the deformation of the slender carbon fiber reinforced concrete elements and hence, results in reduced crack widths. In addition, the use of high-strength concretes allows an introduction of particularly high prestressing forces. The combination of carbon reinforcement, prestressing and high-strength concrete results in a highly efficient and sustainable composite material [1].

Prestressed carbon concrete is currently being investigated at the TU Berlin within the „C³-V4.2“-project as part of the joint project "Carbon Concrete Composite (C³) – Rethink building". On one hand,

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