Carbon reinforced concrete in construction practice

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Abstract

One of the world's largest R & D projects within the construction industry focuses on carbon reinforced concrete technology. Civil engineering is an old-fashioned industry with very slow innovation strength. Despite this difficulty, a new method of construction, planning and industrial production shall be established to solve most pressing foreseen problems. The new composite material made of carbon and concrete is leading the way to establish a new durable, lightweight and resource efficient building method. Furthermore, the use of carbon reinforced concrete in single construction projects has increased in the last years. The purpose of this paper is to show the range of application that is already possible in carbon reinforced concrete.

Keywords: Carbon concrete composite, carbon reinforced concrete, textile reinforced concrete, durability, rehabilitation, strengthening, fibre reinforced concrete

1 Introduction

Concrete is an excellent building material. It can be formed in many shapes, can carry high compression forces, is impermeable to water and can be used to sustain wide temperature ranges for an extended amount of time. In reinforced concrete, steel bars and grids are embedded in the concrete matrix so that such steel reinforced concrete (RC) components can also carry tensile stresses. Today, steel reinforced concrete is the most widely used building material worldwide.

But there is one problem: the steel reinforcement can corrode. In most cases, due to long-term carbonation, the concrete suddenly loses its alkaline nature, which is essential for the protection of the steel reinforcement, or it is exposed to corrosive substances (e.g. de-icing salts, seawater). Corroded reinforcement can result in massive structural damage because of the volume increase, which in turn is associated with an increase in maintenance costs. To counteract this effect, depending on the component's exposure conditions, the protective layer (concrete cover) is now considerably thicker than what it was many years ago. In this manner, the protective alkaline environment around the reinforcement is maintained for longer period of time.

The other path that has been pursued for decades—especially within the scientific community—is the search for alternative, non-corroding reinforcement materials. Stainless steel, bamboo, and wood, as well as fibres made of basalt, glass and carbon have been investigated. In Germany, the current main focus of research is on alkali-resistant (AR) glass and carbon fibre reinforcements. Combining such fibres with concrete produces high-performance composites, also known as textile reinforced concrete (TRC), carbon (reinforced) concrete or carbon concrete composites. This article provides an overview of the development, material, manufacturing processes, practical applications and current research activities related to carbon concrete composites. In Figure 1, some definitions are shown.

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