Application potential of textile reinforcement in concrete construction for infrastructure buildings: environmental performance and availability

Sara Reichenbach, Benjamin Kromoser

University of Natural Resources and Life Sciences, Vienna, Austria

Philipp Preinstorfer, Tobias Huber

TU Wien, Vienna, Austria

Contact: sara.reichenbach@boku.ac.at

Abstract

With the building industry being one of the main sources of carbon dioxide emission worldwide and concrete being the main construction material, new strategies have to be developed to reduce the carbon footprint thereof. The use of high-performance materials in structural concrete, as for example textile-reinforced concrete (TRC), seems to allow for a reduction of the resource consumption and the carbon emissions. The present paper addresses potential applications of TRC examining the global warming potential (GWP) of a rail platform barrier. The resource consumption is depicted in a parametrical study in terms of the necessary component height and reinforcement area considering both the serviceability limit state (SLS) as well as the ultimate limit state (ULS). The results clearly indicate an achievable reduction of the GWP during construction when using textile reinforcement made of high-performance fibres. Furthermore, an analysis of the European market was conducted to prove the availability of this new reinforcement type. Keywords: Textile-reinforced concrete; global warming potential; European market; optimisation; parametric study.

1 Introduction

An evaluation of the building industry shows low efficiency regarding material use. The combination of three major facts gives the re-evaluation of reinforced concrete (RC) design, reinforcement and construction the utmost relevance, not only from an economical but also from an environmental point of view. The three major facts speaking for a change in the handling of RC are; (1) The construction sector is one of the largest of the world economy (13% of gross domestic product (GPD)) [1], (2) Buildings alone account for 39% of the energy-related carbon dioxide (CO2) and more than 36% of the energy consumption [1], and (3) Alone in 2015, of the 47.5 gigatons raw material consumed worldwide, 30 gigatons (63%) were attributed to concrete construction, raising the total concrete stock to approx. 428 gigatons [2]. The share of global CO2 emissions is estimated at 9% and 8% according to [3] and [4], respectively.

Typical RC-structures are reinforced with steel rebars and meshes. To ensure the durability of the structure and avoid corrosion of the reinforcement, the steel reinforcement has to be protected by a sufficient concrete cover. For construction in aggressive environments (e.g. close to the sea or part of infrastructure buildings) this often results in a high concrete cover. Research shows that even with sufficient concrete cover chloride ingress and concrete carbonation can occur. A recent study estimates that about 50% of the maintenance costs in infrastructure in Switzerland are directly related to corrosion [5]. A solution for the problem could be the substitution of the steel reinforcement in specific cases by fibre-reinforced polymer (FRP) reinforcement. FRP reinforcement is at no risk of rusting, has

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