Influence of the local bond stress distribution of FRP rebars on the anchorage in concrete

Christian Caspari, Matthias Pahn

Technische Universität Kaiserslautern, Kaiserslautern, Germany

Contacting author: christian.caspari@bauing.uni-kl.de

Abstract

Poor durability of building structures leads to high repair costs. The durability of reinforced concrete structures is largely dependent on the corrosion resistance of the reinforcing steel. For applications which are highly endangered by corrosion, fibre-reinforced plastic (FRP) offer a solution. A basic prerequisite for the long-term functionality of a composite material is the bonding of the individual components. The lower modulus of elasticity and the different surface geometry of glass fibre-reinforced plastic (GFRP) reinforcement compared to steel reinforcement lead to a change in the bond stress distribution. This results in different bond splitting effects and load introduction lengths. In this paper, the bond stress distribution over the bond length of steel bars and FRP bars is compared. For this purpose, pull-out tests with short and long bond lengths are investigated. The force transmission from FRP to the concrete is measured by means of a fibre-optic measurement of pull-out tests with long bond lengths and compared with results from the literature.

Keywords: FRP reinforcement; bond strength; bond behaviour; anchorage.

1. Introduction

High durability is one of the basic requirements of building structures. This describes the resistance of the building structure to physical and chemical effects. The resulting requirements must ensure load-bearing capacity and serviceability over the entire service life [1]. The durability of reinforced concrete is primarily dependent on the corrosion resistance of the steel reinforcement. The corrosion protection is ensured by the high alkalinity of the surrounding concrete. Environmental influences such as humidity, temperature, air and water pollution, chemical and biological media can influence the alkalinity of the concrete and thus reduce the durability of reinforced concrete [3]. A possible solution to the problem of limited durability due to corrosion is use of a non-metallic reinforcement. This enables high resistance to aggressive media, which is why this reinforcement is mainly used in structures with a high risk of corrosion, e.g. bridges near the sea [2].

There is currently a large number of FRP products on the market. These differ not only in their optical appearance (Figure 1), but also in their mechanical properties. Some international design guidelines and codes are available for structural design of FRP reinforced members. The design models adopted there are usually based on those for reinforcing steel and are adjusted for FRP rebars. In [3] it is shown that this assumption can lead to conservative results due to the different material behaviour.

The good bond of concrete and reinforcement is the most important requirement for the effective use of a composite material [4]. One of the most significant differences between steel reinforcement and FRP is the surface design. This has a direct influence on the bond behaviour and thus also on the serviceability and load-bearing capacity a structure.

https://doi.org/10.2749/guimaraes.2019.0884
Distributed by structurae