Effect of bond in the development length of CFRP pretensioned beams

Eleni Toumpanaki [1], Janet M. Lees [2]

[1]Department of Architecture, [2]Engineering Department, University of Cambridge, Cambridge, UK

Giovanni P. Terrasi

Swiss Federal Laboratories for Materials Science and Technology (EMPA), Laboratory for Mechanical Systems Engineering, Dübendorf , Switzerland

Contacting author: et343@cam.ac.uk

Abstract

Carbon Fibre Reinforced Polymer (CFRP) tendons present an alternative material that can mitigate steel corrosion problems in concrete bridges. The use of CFRP prestress tendons can result in more durable prestressed concrete structures. However, the potential matrix plasticisation of CFRP tendons in humid environments and their inherent lack of ductility need to be considered in the design process. A tension stiffening analysis is undertaken to study the effect of variations in bond strength parameters on the cracking behaviour, deformability and structural performance of CFRP prestressed beams. The bond strength scenarios under consideration reflect either low or high bond conditions. The former could be associated with epoxy plasticisation and bond degradation due to moisture ingress at a crack location. A low bond performance results in a smaller number of cracks and higher deflections at failure compared with high bond tendons.

Keywords: Composites, Concrete, Long-term effects, Durability, Deformability

1. Introduction

Incidents of severe corrosion in steel prestressing tendons have been reported in structural applications such as bridges (e.g. Hammersmith Flyover [1]). The FHWA (Federal Highway Administration) has estimated that the annual direct cost estimate of steel corrosion in highway bridges is $8.3 billion dollars [2] and £200 million has been invested by TFL for the strengthening and repair of bridges and tunnels [3]. Due to the encasement of the steel tendons in concrete, inspection of internal steel tendons can be difficult. Concrete cracks act as paths for corrosive materials and can be a sign of construction deficiencies and impending corrosion problems. Steel corrosion can lead to high repair and maintenance costs and traffic disruption problems and, in extreme cases, to catastrophic brittle failures (e.g. Genoa Bridge 2018 [4]). Steel corrosion can be particularly critical in prestressed structures, where the tendons are loaded up to 70% of their ultimate tensile strength. This leaves a limited margin for any increase in steel stress as a result of a reduction in the effective cross-sectional area due to corrosion.

Carbon Fibre Reinforced Polymer (CFRP) tendons present an alternative material that can mitigate steel corrosion problems. The corrosion-free

https://doi.org/10.2749/guimaraes.2019.0635
Distributed by structurae