Experimental Evaluation of the Durability of Adhesively Bonded CFRP/Steel Joints in Bridges

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Abstract

Strengthening, repair and retrofit of existing bridges using adhesively bonded fibre reinforced polymers (FRP) composites have attracted a great deal of attention over the past four decades. Despite numerous studies that have been conducted to evaluate the short-term behaviour of FRPs bonded to steel members, the subject of durability is by far less researched. To date, concerns about the long-term performance presents a major obstacle to the widespread application of FRPs in steel bridges. The aim of this work is to identify the most damaging environmental factors and to experimentally investigate the effects of them on mechanical behaviour of Carbon-FRP/steel joints. In this regards, after a review of the literature, both bulk material and bonded specimens were exposed to a number of aging scenarios and tested. The results indicate the deleterious effects of de-icing salts on joint strength by degrading the interlaminar shear strength of FRPs.

Keywords: Fibre reinforced polymer; durability; long-term performance; adhesively bonded joints.

1 Introduction

Carbon fibre reinforced polymer (CFRP) materials offer superior properties such as high specific strength and stiffness, rusting resistance and lightweight. The advantages of CFRP composites in combination with adhesive bonding, as the preferred joining technique, leads to easy and fast assembly and cost efficiency. In the past four decades, applications involving CFRP materials have been increasingly substituted for the traditional methods of strengthening and repair of concrete structures. In addition, Young's modulus of CFRP is often close to or even higher than that of steel, which makes the strengthening and repair of steel bridge girders using externally-bonded CFRP laminates very advantageous. However, their application in steel structures is only limited to the past decade [1].

One major drawback when it comes to using CFRP composites for strengthening and repairing steel bridges is the lack of knowledge relating to the long-term performance and durability properties of CFRP/steel bonded joints. Even though the short-term behaviour of CFRP-strengthened steel members has been studied extensively, the subject of the durability and long-term performance of adhesively bonded joints in civil engineering applications has not been researched to the same degree. The lack of knowledge regarding the long-term performance is currently compensated by applying a multiple of large safety factors to the strength of FRP materials, which dramatically increases the material usage and reduces the design efficiency.

A number of environmental parameters are known to affect the long-term characteristics of

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