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Mechanical behavior of adhesive anchors under high temperature exposure: Experimental investigation

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Abstract

The improvement in mechanical and adhesion properties of polymer resins have allowed to progressively substitute cast-in place rebars by polymer-based anchors in some applications, by providing equivalent or even higher mechanical properties at ambient temperature. However, a temperature increase has the effect of weakening the bond and leads to a significant decay in the bearing capacity of the adhesive anchors.

This paper presents a study of the phenomena that occur at high temperature in an adhesive anchor when exposed to high temperatures by means of two pull-out test procedures and by thermomechanical characterization of the polymer resin. Results showed that the resin glass transition is the responsible for the decay in the fire resistance of adhesive anchors. The paper highlights the non-conservative aspect of the current design method used to calculate the fire resistance of chemical anchors and proposes to consider the pull-out curves as input data.

Keywords: Chemical anchor; Fire resistance; Epoxy adhesive; Glass transition temperature; Pull-out tests; Design method.

1. Introduction

The epoxy resin was discovered for the first time by Pierre Castan in 1936 . Its applications were restricted to industrial purposes until 1955. Since then, epoxy resins were used in almost every industrial purposes and even in bridges construction in USA and then in Paris in 1963 . Over the years, the use of epoxy resins in concrete structures was constantly increasing for different applications such as cracks and joints filling, bonding concrete to concrete, metal to metal and steel to concrete . The use of epoxy resins in bonding steel to concrete, and more specifically in bonding steel rods into already existing reinforced concrete, had offered a multitude of possibilities for retrofitting, extension and reparation of existing structures . Post-installed rebars using epoxy resins have then allowed to substitute cast-in-place rebars by offering equivalent or even higher bearing capacities at service temperature.

Over the past two decades, several experimental research work has been conducted in order to determine the different parameters affecting the mechanical properties of bonded post-installed rebars by means of pull-out tests . Numerous researchers were interested in the study of the relationship between the geometry of the chemical anchor and its mechanical behavior. These studies showed that the load bearing capacity increases linearly by increasing the embedment length up to 75 mm for anchors diameter equal to 10 mm and that the bond strength reaches its maximum when the bond

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