Durability of GFRP strengthening under environmental degradation

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Summary

Degradation of properties of (i) laminated plates of polymeric matrix and (ii) RC members with GFRP as their outer reinforcement, due to artificially accelerated aging, is described and interpreted. The effects of environmental exposure on bond between GFRP strips and concrete are examined, namely the ensuing decrease of the structural strength of the beams.

Cycles of environmental aggression are shown to reduce the tensile strength of GFRP flat coupons testing, but to have relatively scarce consequences on the overall capacity of confined concrete columns. The comparison of different aging processes shows, e.g., that salt fog cycles reduced the compressive strength of the columns, and that a further reduction resulted from immersion in salt water.

RC beam specimens with external tensile reinforcement of GFRP were subjected to bending along stages of artificial aging to study the effects of the latter on bond. Failure took place, most often, by rupture of concrete at a short depth from the interface with the GFRP reinforcement. Preliminary computational modeling is described that utilizes experimental data generated in the study.

Keywords: composite laminates; concrete; artificial aging; bond

1. Introduction

Strengthening of reinforced concrete structures is a major source of activities in civil engineering and fiber reinforced plastics (FRP) has become one of the solutions often selected. The degradation of concrete and the insufficient knowledge about lifetime of FRP led to intense research, but aspects remain that require further studies. The aging of GFRP reinforcement, as well as of members with outer reinforcement of glass FRP (GFRP) are the object of this note. Meanwhile, life span of structures has become of public concern partially due to the effects of chemically aggressive environments compromising the estimated life-span of reinforced concrete structures. The study of the causes subjacent to loss of structural capacity, as well as structural rehabilitation, require participation of several disciplines, experiments under various environmental conditions, and the use of specialized techniques to gain understanding of the processes [1].

Attack of GFRP by moisture diffusion and salt fogging cycles, e.g., may substantially reduce their strength. Salts can originate from building materials and inadequate treatments, air pollution, de icing and soil [2]. Moisture and ground water rising from foundations are also sources to consider, while marine aerosol may be the main factor along coast lines. Accelerated artificial aging of FRP is a standard procedure to study the effects of environmental effects [3] despite the difficulty to validate results and predict natural aging. Chlorides are harmful to reinforcing steel and to GFRP. The appearance of chloride ions, Cl^-, destroys the passive film of iron oxides, resulting from the natural alkaline environment of the concrete, and causes corrosion.

The deterioration of FRP is triggered by the diffusion of OH^- and Cl^- ions and water molecules into the polymeric matrix. Absorption accelerated by the cracks and voids in the matrix, may cause

https://doi.org/10.2749/222137809796078711
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