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Durability Assessment of GFRP Rebars Exposed to High pH-Seawater

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1 Introduction

Coastal structures are one of the principal applications of GFRP rebars as internal reinforcement for concrete structures. Concrete is considered a highly alkaline material, with typical pH values for freshly placed concrete above 12.5 to 13.9 for concrete made with high alkaline cement (Grubb, Jennifer A., *et al.*, 2007). When using steel reinforcement, the high alkalinity of the concrete provides corrosion protection to the steel by providing a passive layer of iron oxide (Fe_2O_3). With GFRP rebars, however, it appears to affect the durability of the rebars in a negative way instead. The effect of the high alkalinity and the seawater in the durability of GFRP rebars has been evaluated in the literature independently (Robert and Benmokrane, 2013; Wang, X.-L. Zhao, *et al.*, 2017; Ruiz Emparanza *et al.*, 2018). However, a research gap exists on the durability of GFRP rebars subjected to both high pH and seawater, which would simulate the condition experienced by coastal structures. Therefore, this study is comprised by the evaluation of the durability of three different commercially available GFRP rebars exposed to a combination of high pH and seawater.

2 Experimental Program

Three types of GFRP bars, denoted as A, B and C, were tested for comparison purposes due to diversity of the products in the GFRP rebar market (Ruiz Emparanza, Kampmann and De Caso Y Basalo, 2017) (see Figure 1).

The focus of this study was to assess the mechanical performance of three GFRP bar types before and after being aged in simulated seawater concrete pore solution. Four different mechanical properties such as tensile strength, modulus of elasticity and transverse and horizontal shear strength were evaluated. For every property and exposure condition, a minimum of three specimens were tested.

Figure 1. GFRP rebars Type A, B and C (from left to right).

3 Results and Discussion

Among the tested properties, the tensile strength was the most affected mechanical property, with a reduction of 20 and 41%, followed by the elastic modulus, which decreased between 5% and 13%. Finally, the horizontal and transverse shear strength capacities were almost unaltered after the aging process. These preliminary results were aligned with the findings reported by other researchers in the literature.

4 Conclusions

The combination of high alkalinity and seawater degrades GFRP rebars, being this effect most noticeable in the tensile strength reduction. However, to assess the impact of this decrease in capacity in real life, long-term performance prediction models should be used. The durability prediction values should be then compared to results obtained from existing structures, to calibrate the durability models.

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