CERIS : Civil Engineering Research and Innovation for Sustainability

Durability of all-composite civil engineering structures in service conditions. Development of an inspection and diagnosis system.

Summary

The use of fibre reinforced polymer (FRP) composites in civil engineering has become increasingly popular due to their high strength-to-weight ratio, corrosion resistance and durability. However, despite the empirical evidence of their good performance, even in relatively harsh environmental conditions, there is a lack of information on their long-term durability, which is essential for their acceptance as a mainstream structural material. This thesis intends to comprehensively understand the behaviour of glass-FRP (GFRP) composite materials throughout their service life. The thesis consists of two parts: (i) development of an inspection, diagnosis, and rehabilitation system, and (ii) evaluation of the durability of pultruded GFRP profiles for civil engineering purposes.

The inspection, diagnosis, and rehabilitation system developed in the first part of the thesis comprises four groups of entities: anomalies, probable causes, diagnosis methods, and rehabilitation techniques. A data analysis based on a field study of 31 infrastructures containing 410 GFRP substructures allowed identifying the most common anomalies that can be detected during the in-service stage of GFRP constructions. The type, age, and location of the substructures proved to be relevant to the type of anomalies detected.

The second part of the thesis evaluated the durability of GFRP elements made of polyester (UP) and vinylester (VE) resins under different environmental conditions, including chemicals (water, acidic and alkaline) and weathering (natural and accelerated). The results obtained show that, among the various chemicals, immersion in an alkaline environment caused the highest reduction in mechanical properties, while exposure to water vapour resulted in a higher reduction in comparison to the other vapour environments. For weathering, the results confirmed that VE specimens exhibited better performance than UP specimens. The use of a surface veil and surface protective coatings did not have a clear influence on strength retention. The incorporation of UV stabilizer additives improved the mechanical properties of UP specimens.

Keywords

GFRP, inspection system, durability, chemical environments, weathering.

Biological colonization | *Fibre blooming* | *Corrosion of bolted elements* | *Cracking*

Common anomalies in GFRP elements.

Natural ageing (top) and QUV chamber (bottom).

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