Evaluation of Steel Corrosion Propagation in Blended Cements Using Multiple Corrosion Characterization Techniques

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Mineral admixtures can refine the pores and change the pore solution composition in cementitious materials. Pore refinement is a well-known beneficial effect that can slow down chloride penetration and the carbonation progression. Both mentioned parameters can postpone corrosion initiation times, reduce corrosion rates of embedded steel, and influence the type of corrosion attack. Long term impact of these effects on steel corrosion is not yet well understood.

In this study, mortar specimens with embedded steel rebars were made from multiple cements blended with natural pozzolana, fly ash and blast furnace slag. Half of the specimens were carbonated naturally, while the other half were exposed to accelerated carbonation. The specimens were additionally exposed to cyclic wetting with 3.5% sodium chloride solution to initiate the corrosion processes. Cement, mortar and pore solution properties were examined using the following techniques: XRD, XRF, Hg porosimetry, phenolphthalein test and ion chromatography. Throughout the 1-year chloride exposure period, corrosion processes were monitored using embedded ER sensors and the galvanostatic pulse technique. After the exposure, the corrosion damage of embedded steel was examined with optical microscopy and the microCT technique.

Using multiple complementary characterisation techniques, and doing statistical evaluation from 6 identical specimens per mortar, allowed us to get a more accurate long-term evaluation of corrosion behavior in various types of mortars[1]. The results showed that both porosity and carbonation had a significant impact on corrosion behavior, with carbonated mortars showing shallower damage over a larger surface area. This effect was more pronounced for blended cements that exhibited greater susceptibility to carbonation, while OPC was prone to localised corrosion damage, regardless of carbonation[2]. Eventual impact of these parameters to the service life of reinforced concrete structure was also addressed.

1. Miha Hren, Violeta Bokan-Bosiljkov, Andraž Legat, *Cement and concrete research*, **2021**, *vol 145*, p. 1–15.
2. Miha Hren, Tadeja Kosec, Andraž Legat, *Cement and concrete research*, **2023**, *vol 168*, p. 1–12.