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Abstract

The Effect of pH and Fly Ash on the Electrochemical Performance of Stainless-Steel Concrete Reinforcement in Harsh Environments †

Sofia Tsouli [1], Christos Nikolaidis [1], Spyridon Kleftakis [1] and Angeliki G. Lekatou [1,2,*]

[1] Laboratory of Applied Metallurgy, Department of Materials Science and Engineering, School of Engineering, University of Ioannina, 45110 Ioannina, Greece; stsouli@uoi.gr (S.T.); chrisnikolaid@hotmail.com (C.N.); skleftak@uoi.gr (S.K.)

[2] Institute of Materials Science and Computing, University Research Center of Ioannina (URCI), 45110 Ioannina, Greece

* Correspondence: alekatou@uoi.gr; Tel.: +30-26510-07309

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Abstract: The corrosion of steel reinforcement is the most significant factor responsible for the premature deterioration of the durability and seismic resistance of reinforced concrete structures. As such, the main objective of the present study is the investigation of the effect of fly ash (FA) as a corrosion inhibitor and pH on the electrochemical behavior of 316L and 304L concrete reinforcement in a simulating concrete pore solution exposed to aggressive environments, i.e., acid rain. The corrosion performance of 316L and 304L stainless steel rebars was examined by means of cyclic (reverse) polarization in order to evaluate the susceptibility of the rebars to localized corrosion. Two types of electrolyte were used. The first electrolyte was a highly alkaline solution simulating fresh concrete exposed to acid rain (pH ≈ 12), while the second electrolyte was a mildly alkaline solution simulating corroded concrete cover that exposed the reinforcement to direct acid rain attack (pH ≈ 8). Both solutions contained $Ca(OH)_2$, an acid-rain-simulating solution, and FA (replacing 0–25 wt.% of $Ca(OH)_2$) as a corrosion inhibitor. In both electrolytes, the beneficial effect of FA replacing up to 20 wt.% of $Ca(OH)_2$ on the corrosion resistance of both 316L and 304L rebars was manifested. However, this trend was reversed at the 25 wt.% replacement of $Ca(OH)_2$ due to the localized presence of agglomerates of FA on the surface of the steel. The above finding was confirmed by SEM/EDX examination of cross-sections after cyclic polarization. An important conclusion of this study was the feasibility of replacing 316L stainless steel with 304L (at pH ≈ 12) in critical applications, such as the restoration of ancient monuments, provided that FA is included in the concrete mixture, even at low contents (10 or 15 wt.% of cement).

Keywords: AISI 316L rebars; AISI 304L rebars; fly ash; acid rain; cyclic potentiodynamic polarization

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