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EFFECT OF ADMIXTURES ON REINFORCED CONCRETE CORROSION ASSESSED THROUGH PULL-OUT TESTS

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ABSTRACT

This work investigates the influence of mineral and chemical admixtures in reinforcement corrosion through pull-out tests. Chloride induced corrosion was fomented and pull-out tests were carried out. Pull-out testing is shown to be a suitable approach to assess corrosion level in reinforced concrete. The used chemical admixture has proven to perform better than the mineral admixture regarding corrosion resistance.

Keywords: corrosion, concrete, steel, bond.

INTRODUCTION

In reinforced concrete structures one of the most common factors determining the end of service life is deterioration by reinforcement (steel) corrosion. For this particular deterioration mechanism, service life is usually divided in two periods: initiation and propagation (Tuutti 1982). The frontier between the two periods is the moment when aggressive agents reach the steel embedded in concrete. Mineral and chemical admixtures are used to extend initiation period, propagation period or both. The admixtures influence on the duration of the initiation period is commonly assessed through durability indicators such as carbonation and chloride diffusion coefficients, determined in accelerated testing conditions. To assess the influence of admixtures in the propagation period different tests are required, usually encompassing electrochemical techniques and equipment, with whom designers are not very familiar.

This study addresses the assessment of admixtures (mineral, chemical and both) influence on reinforced concrete corrosion, using another test procedure which is claimed to be more user-friendly to designers than the usual electrochemical techniques. Reinforcement corrosion in concrete is a destructive oxidation of steel that occurs at steel surface, i.e. at steel-concrete interface, therefore affecting bond between both materials. Thus, pull-out test is considered promising to assess corrosion effects/intensity, avoiding electrochemical techniques.

EXPERIMENTAL

A concrete mix with a water-cement ratio of 0.7 and a cement content of 280 kg/m^3 was used as reference concrete (O). The remaining mixes were modifications of O, by adding: spent fluid cracking catalyst (SFCC), mix Z; a liquid corrosion inhibitor, based on dimethylaminoethanol (DMEA), mix I; SFCC and DMEA, mix H. Test specimens were cubes with 150 mm edge, cast with an incorporated 120 mm diameter and 500 m length smooth

steel rebar at their center. Specimens were demolded 24 hours after casting and water cured for 6 days. Then they were subjected to 7 dry-wetting cycles using a Nacl saturated solution to induce rebar corrosion. The pull-out test setup was similar to the one defined in EN 10080-Annex D.

RESULTS AND CONCLUSIONS

Load-slip relationships were established from the test data (Fig. 1). The highest ultimate load was for mix O, while the lowest ultimate load is disputed between mixes I and ZI.

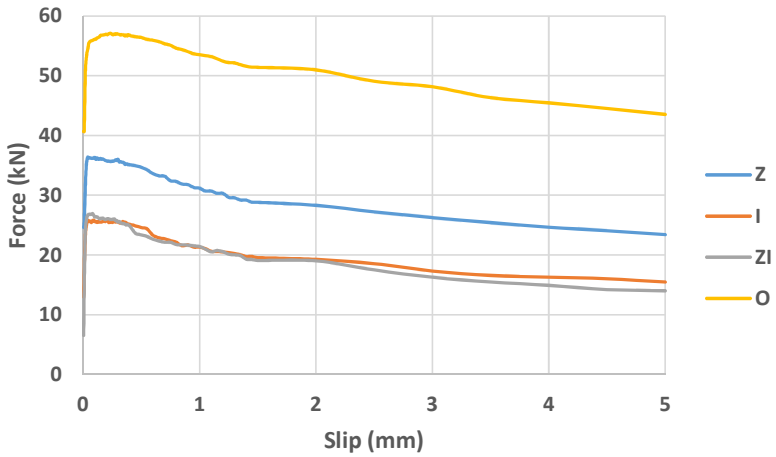

Fig. 1 - Relationship between load and slip

According to Fang et al. (2004), for smooth reinforcing bars, at low to medium corrosion levels, bond strength increases as the corrosion level increases. Therefore, the pull-out test results indicate that the most affected by corrosion is the reinforcement in mix O, while the reinforcement in mixes I and ZI are the least affected. These can be explained by the positive impact of SFCC and corrosion inhibitor on prolonging the initiation period (Neves et al. 2015) and by the effect of the corrosion inhibitor in the propagation period. As for chloride induced corrosion the propagation period is significantly shorter than the initiation period, the beneficial impact of SFCC on the initiation period is negligible when this mineral admixture acts together with the corrosion inhibitor.

This study shows that a pull-out test is suitable to compare corrosion levels in reinforced concrete. Furthermore, the corrosion inhibitor has shown to be more effective than SFCC in decreasing corrosion level. Nevertheless, the use of SFCC is also beneficial.

REFERENCES

[1]-Fang C, Lundgren K, Chen L, Zhu C. Corrosion Influence on Bond in Reinforced Concrete. Cement and Concrete Research, 2004, 34(11), p. 2159-67.

[2]-Neves R., Vicente C, Castela A, Montemor MF. Durability Performance of Concrete Incorporating Spent Fluid Cracking Catalyst. Cement and Concrete Composites, 2015, 55, p. 308-14.

[3]-Tuutti K. Corrosion of Steel in Concrete." Swedish Cement and Concrete Research Institute, 1982.