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Durability in Marine Environment of High-performance Concrete with Electric arc Furnace Slags and Cupola Slag Admixture

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1 Introduction

Obtaining high-performance self-compacting concrete (SCC) with EAFS is a novelty, and its durability plays an important role in its application as a structural material. As a novelty as well, it is proposed to determine its response to the chlorides penetration in a marine environment, and to check the corrosion conditions of the rebar under the same conditions.

Four SCC mixes incorporating natural and siderurgical aggregates will be tested, in addition to traditional and siderurgical admixtures. Reinforced concrete conical specimens of 28 days of age have been submerged for 10 months, then they were sectioned and the depth of the chlorine ion and the degree of corrosion in the reinforcement have been assessed.

2 Materials and Methods

2.1 Materials

Four concrete mixes have been manufactured, using CEM I 52.5 R, sand 0/6 (diabase and EAFS), coarse 6/12 (diabase and EAFS) and silica sand 0/2, to compare the behavior of the siderurgical aggregate with the natural aggregate. In addition, three different filler materials (limestone, fly ash and cupola slag) have been used. A SCC has been designed with a 2% of a superplasticizer additive, in a 120 l rotating drum mixer with a kneading time of 12 min.

2.1 Methods

For the manufacture of each specimen, an Abrams cone with the face of smaller diameter as a base, has been used to facilitate filling of the specimen, inserting two corrugated bars of diameter 10 mm placed vertically. After keeping 28 days in the humidity chamber, one of each mix was transferred to the port of Bilbao (Figure 1). There they were distributed on two metal grids together for a period of 10 months. After 10 months, the specimens were removed and moved back to the laboratory. During the visual inspection, abundant presence of mollusks adhered to the surface of the concrete specimens have been reported. After breaking the specimens into two halves, we first proceeded to observe the state of the bars mainly to assess the appearance of pitting along them.

One of the halves was divided by a cross-section in order to extract a subsample with different coating thicknesses, which is used to determine, in the scanning electron microscope, the penetration depth of the chloride ion by dispersive spectroscopy of X-rays (EDX).

Figure 1. Arrangement and location of test samples in tidal race in the port of Bilbao.

3 Results, Discussion and Conclusions

The absence of pathologies on the outside of the cone trunks can be verified as chipping or loss of material, while, the intact state of the bars inside the concrete can be seen.

Figure 2 shows the chloride concentration in the concrete obtained by microanalysis carried out from the generatrix to the area where the steel bars are. The highest concentration is found on the surface and the mix with EAFS and cupola slag admixture (SCC-SC-CS), which has a much higher concentration of chlorides than other mixes.

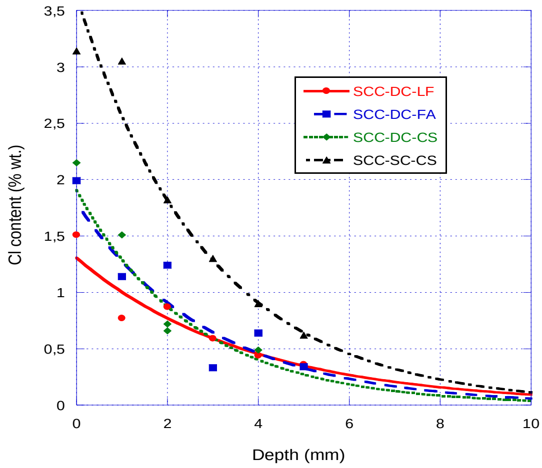

Figure 2. Penetration of chlorides in concrete.

In all the cases analyzed, it can be seen that, after 6 mm, the concentration of the Cl^- ion is less than 0.3%, which is at the limit of the detection capacity of the scanning electron microscope for this element.

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