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CORROSION BEHAVIOUR OF CORROSION RESISTANT STEELS IN CONCRETE MIXED WITH SEAWATER

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Introduction: The use of seawater and salt-contaminated aggregates is prohibited for reinforced concrete structures, since it can promote steel corrosion. However, environmental benefits, due to the save of natural resources, could be reached from their use for the production of concrete. Within the framework of ERA-NET Plus Infravation 2014, the SEACON project "Sustainable concrete using seawater, salt-contaminated aggregates, and non-corrosive reinforcement" was recently started. This project, that involves six academic and industrial partners, is aimed at demonstrating the safe utilization of seawater and salt-contaminated aggregates for a sustainable concrete production when combined with non-corrosive reinforcement (FRP and stainless steel bars). This paper focuses on the preliminary results of tests aimed at assessing the corrosion behaviour of stainless steels of different grade embedded in concretes made with fresh water and seawater.

Materials and Methods: Concrete was made with water/cement ratio of 0.52, 335 kg/m^3 of Portland-limestone cement, 30 kg/m^3 of coal fly ash, 1824 kg/m^3 of siliceous aggregate and 175 l/m^3 of water, respectively deionized (*Ref*) and seawater (*Sea*). A superplasticizer was added to achieve a slump of 160-210 mm.

Compressive tests were carried out after 1, 7 and 28 days of curing. Electrochemical measurements of corrosion potential and corrosion rate were carried out on three replicate $250\times50\times100$ mm prismatic specimens, with embedded bars of: carbon steel, two austenitic stainless steels (1.4307 and XM-28) and two duplex stainless steels (1.4362 and 1.4462). After 7 days of moist-curing they were exposed to unsheltered conditions in Milan for about two months.

Results and discussion: The compressive strength of the *Ref* concrete increased from about 14 to 50 MPa from 1 day to 28 days of moist curing. Slightly higher values were measured during the first week (e.g. around 16 MPa at 1 day) on the *Sea* concrete, showing a slight accelerating effect of seawater. After 28 days of curing strength of *Sea* concrete was comparable to the *Ref* concrete, suggesting that seawater is not harmful for concrete.

Of course, the effect of chlorides present in the *Sea* concrete (about 1% vs mass of cement) was observed on the embedded steel. During the outside exposure, carbon steel bars embedded in the *Ref* concrete showed the expected passive behavior, whilst in the

Sea concrete corrosion initiation was shown since the beginning by higher corrosion rates and lower corrosion potentials in comparison to those of the *Ref* concrete. As expected the results confirmed that carbon steel is unsuitable when seawater is used as mixing water. Conversely, all the stainless steel bars showed a similar corrosion behavior both when embedded in the *Ref* and *Sea* concretes. This indicated that during this initial exposure period of a few months and with mild temperatures (spring season, with outside temperature never exceeding 25°C), even the less alloyed stainless steels embedded in the *Sea* concrete maintained passive conditions and hence they could be suitable in *Sea* concrete. The effect of higher temperature as well as of the further chloride penetration is under study with specific ponding tests.