

## POLYMER ACTION ON CORROSION RATES OF STEEL IN CEMENT MORTAR

Polymer cement mortars (PCM) have been used within the scope of the repair of concrete structures, which has made it possible to obtain a good knowledge about the benefits of adding polymers to improve mortar performance. In general, polymer modification increases the cost of cement mortar and affects the fresh properties of mortar by enhancing its workability, extending the setting times, delaying the cement hydration and by causing heavy air entrainment in the absence of antifoaming agents. Also, the addition of polymer may lead to an improvement in the hardened mortar properties, such as lower water absorption, higher adhesion, higher chemical resistance and increased tensile and flexural strengths, though generally no improvement in compressive strength is observed.

At the National Laboratory of Civil Engineering (LNEC), Portugal, and with financial support from Fundação para a Ciência e a Tecnologia (FCT) given to the research project PTDC/ECM/101810/2008 – Polymer-modified Cement Mortars for the Repair of Concrete Structures, an ongoing study aims to assess the possible prevention of steel corrosion induced by carbonation in PCMs and to set new research topics based on the results, due to the potential effect of polymers on the properties of cement mortar that have been shown to influence the corrosion of embedded steel, such as the reduction of water absorption and ionic mobility and the increase in electrical resistivity and resistance to CO<sub>2</sub> uptake. The action of styrene-butadiene and acrylic-styrene polymers on steel corrosion in cement mortars was assessed after steel depassivation was induced by carbonation in an environment meeting the required conditions for progression of steel corrosion.

PCMs modified with 15% (of the mass of cement) acrylic (PCM-AS) and styrene-butadiene (PCM-SB) polymers were studied and compared with a reference cement mortar (CM-1) using a fixed 0.4 W/C ratio. A second unmodified cement mortar (CM-2) with higher air content was also studied.

Corrosion of steel rebars embedded in the mortar specimens was promoted by depassivation due to carbonation, achieved in a carbonation chamber with 5% CO<sub>2</sub>, 65% R.H. and 21±2 °C, followed by exposure to a 90% R.H. and 38±2 °C environment in a humidity chamber. Control specimens were exposed to the same carbonation inducing environment and their carbonated depth was assessed frequently to assure that before being exposed to the high R.H. environment, the steel rebars were fully depassivated. Corrosion products were observed in a scanning electron microscope (SEM).

According to previous experience with corrosion rate determination based on galvanic current intensity monitoring in macrocells, it was considered that for values in the order of magnitude of 1x10<sup>-9</sup> A corrosion is halted. For higher values of current intensity, the onset of corrosion occurs and corrosion rates increase with the increase in current intensity.

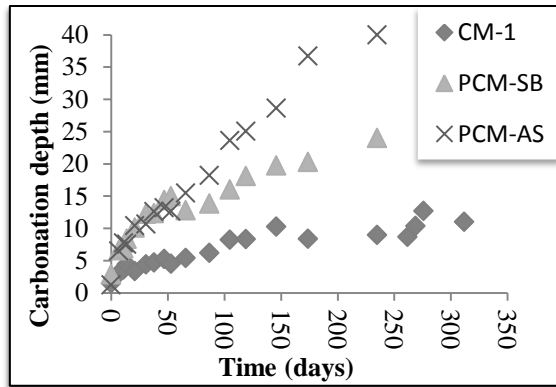


Figure 1 – Carbonation depth at carbonation chamber

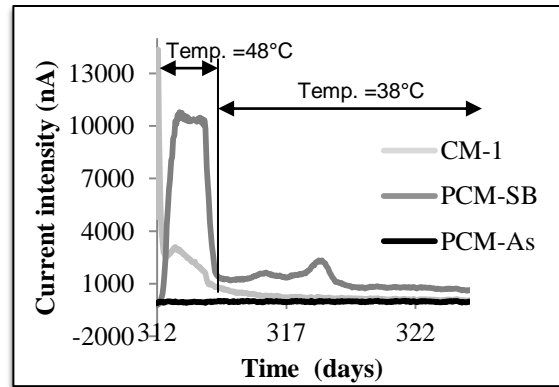


Figure 2 - Details of the current intensity in the humidity chamber of CM-1, PCM-SB and PCM-AS

Figures 1 illustrate the evolution of carbonation depth at carbonation chamber and Figure 2 the evolution of current intensity only in the humidity chamber. The lower current intensity in PCM-AS might have been linked to the fact that carbonation of the entire test specimens was achieved before exposure to the humidity chamber, with carbonation products possibly plugging the pore network of mortar, thus hindering water mobility. The polymer-cement co-matrix of PCM-AS could also have more effectively hindered ionic mobility, as both water absorption under atmospheric pressure and capillary water absorption were the lowest of all mortars studied.

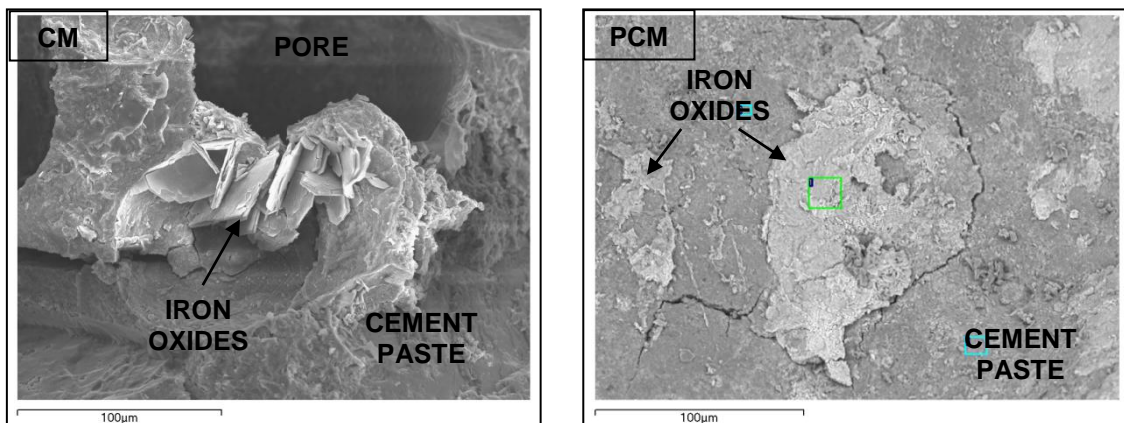


Figure 3 – Iron oxides on CM e PCM

The results of the corrosion inducing test thus suggested a greater efficiency of the AS polymer in the prevention of corrosion of steel in cement mortars due to carbonation, even in a moist and oxygen rich environment. SEM observations also showed larger iron oxide formations in CMs than in PCMs, as shown in Figure 3.

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