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Chloride Diffusity in Red Mud added-Concretes Determined by Migration Tests

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Abstract – A large quantity of red mud (RM) has been disposed to form hills from the Brazilian sintering production alumina process. These storage areas are generally bare of vegetation and subject to wind and water erosion, posing serious threats to the environment. No sintering, drying or grinding pre-treating requirements of a recycling alternative are suitable indicators for its potential implementation. In addition, no emission of polluting gases and huge consumption levels are additional benefits associated to the use as component of concrete. The present work shows results of an experimental investigation about the chloride diffusivity obtained from steady-state migration and non-steady-state migration techniques, on red mud containing concretes. Due to superfine particle-size distribution and the "filler" effect, the red mud addition seems to assure lower chloride diffusivity of tested mixtures.

In recent years, migration tests have been widely used as accelerated testing of chloride diffusivity in concrete, covering steady-state and non-steady-state migration regimes [1]. In junction with measurements of electrical conductivity [2], it can give an accurate evaluation of chloride diffusivity in concrete. Due to the complexity of the transport mechanisms involved, however, a theoretical correlation between results obtained from distinct methods is still lacking. In the literature, experimental data for establishing such a correlation are also very limited. It is widely accepted that chloride ions are responsible for causing local passive layer breakdown and subsequent corrosion of reinforcing steel bars (rebars).

Alkaline red mud (RM) is a waste from extracting alumina from bauxite with caustic soda in the Bayer process. Approximately 35–40% of bauxite ore will be lost and disposed as strongly alkaline RM slurry [3]. The solid content of such mud is about 60 vol. % and is made by superfine particles. As a consequence, the surface area is large and it shows strong water absorbing capacity, and long-term alkalinity persistence.

Concrete mixtures having red mud (up to 30 wt %) and a fixed water/cement ratio showed lower ionic flux in the steady-state regime and higher *time-lag* values when compared with reference concretes (RM-free) – see Figure 1.

These observations agree with previous studies [4, 5], suggesting a significant reduction of chloride ions mobility in the concrete. This result reflects the effect of increased tortuosity and better distribution of pore diameters (higher compacity) caused by the filler and also induced by pozzolanic reactions that might occur. As a consequence, ion mobility decreases. Diffusion coefficients also tend to diminish, due to the decrease of pores volume and their size refinement.

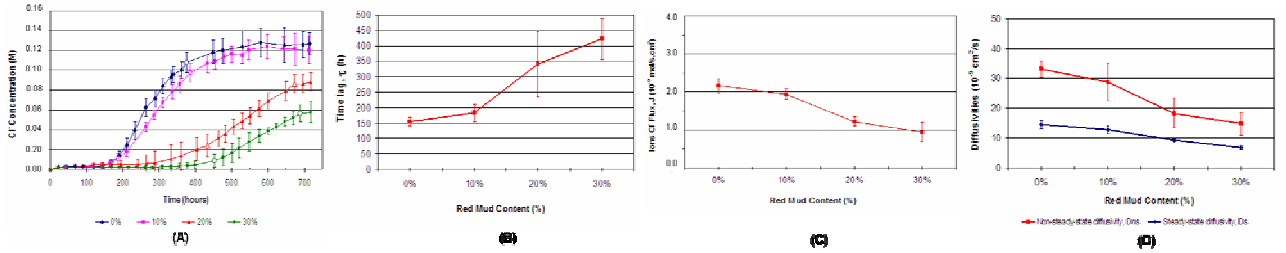

Figure 1: (A) Chloride concentration in the anodic cell, (B) Time-lag, (C) chloride ions flux and (D) diffusivity obtained from steady-state migration and non-steady-state migration, obtained by migration testing as a function of red mud content.

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