Effect of Electric Arc Furnace Bag House Dust on Concrete Durability

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Introduction

Corrosion of reinforcing steel is recognized to be the major cause of deterioration of concrete structures in many parts of the world and the costs of dealing with it have been estimated to run to many billions of dollars annually. While steel is normally protected from corrosion in concrete by a passive film of oxide stabilized by the alkalinity of the cement matrix this protection can break down if the depth of carbonation of the concrete reaches the embedded steel or if significant concentrations of chloride ions penetrate the cover zone. The forms of damage that result from reinforcement corrosion include rust staining, cracking and spalling of the concrete cover (see figures 1 and 2) which imply a loss of serviceability and reduced structural capacity.

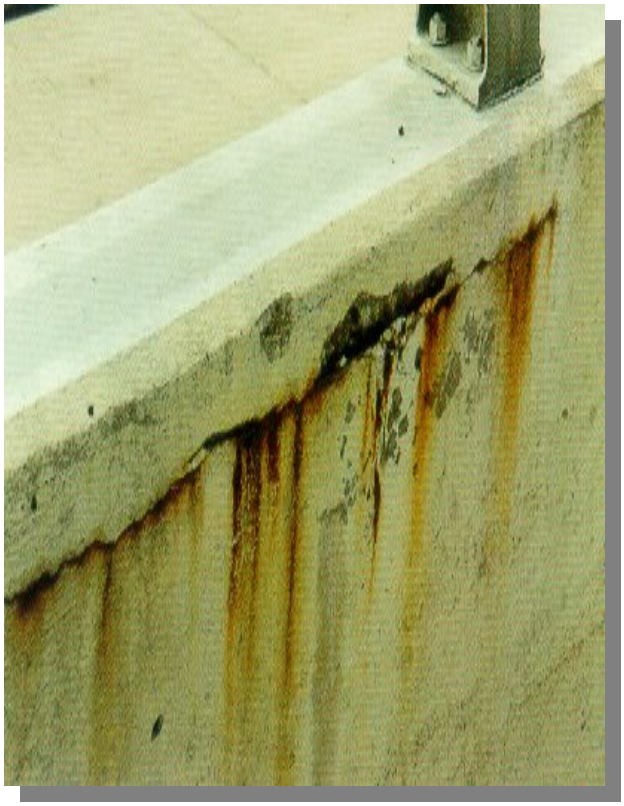

Figure 1: Cracking and rust staining of concrete due to corrosion of reinforcing steel.

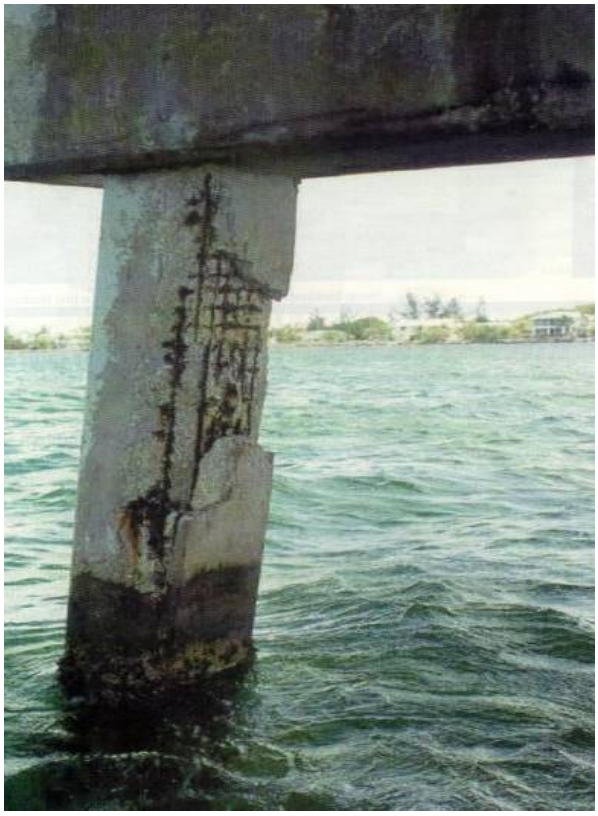

Figure 2: Spalling of concrete cover due to corrosion of reinforcing steel.

Since rates of ingress of aggressive agents such as Cl^-, CO_2 etc. from the environment depend on the 'permeation capacity' of the concrete cover (Diamond, 2007) efforts have been made to reduce this by incorporating various 'supplementary cementitious materials' (SCMs) or 'mineral admixtures', such as fly ash, ground granulated blast furnace slag and condensed silica fume, into the material. These have often proved to be successful and they can also have significant environmental benefits since they allow partial substitution of Portland cement clinker, which has high CO_2 emissions generated during manufacture, with industrial by-products that were formerly regarded as waste materials. There is believed to be considerable need for further research into the possibility of applying alternative by-product materials as SCMs or mineral admixtures in concrete.

Research Summary

The overall objective of this recently initiated research project is to study some of the effects of addition of Bag House Dust (BHD) on aspects of concrete durability. BHD is a fine powder that is generated as a by-product of the electric arc steel making process. It is produced in fairly large quantities in Saudi Arabia causing environmental pollution, handling and storage problems. The literature on BHD is very limited but recent work done in Saudi Arabia (Al-Zaid et al, 1997) has suggested that the incorporation of BHD in concrete can improve its durability.

One of the main concrete durability problems in Saudi Arabia is chloride-induced corrosion of reinforcing steel due to the aggressive environmental conditions, as high levels of chloride combined with large diurnal temperature ranges and high humidities are encountered. Therefore, the use of BHD in concrete as a mineral admixture and its effects on concrete properties that influence chloride-induced corrosion of reinforcing steel embedded in concrete are to be evaluated. The initial stages of this work have involved developing experimental techniques that will be used throughout the research project, in particular methods required for electrochemical monitoring of the corrosion rates of embedded steel bars in specimens of concrete exposed to chloride ingress and techniques for measurement of simultaneous changes in the pore solution phase composition throughout the cover zone of the exposed concrete. The influence of macroscopic defects in the interfacial zone of the concrete adjacent to the embedded steel will also be examined.

References

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Al-Zaid, R.Z., Al-Sugair, F.H. and Al-Negeim ish, A.I. (1997) "Investigation of potential uses of electr ic arc furnace dust (EAFD) in concrete", *Cement and Concrete Research*, 27(2), 267-278.