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HARDENED PORTLAND BLAST-FURNACE SLAG CEMENT PASTES

II. THE CORROSION BEHAVIOR OF STEEL REINFORCEMENT

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ABSTRACT

The corrosion behavior of reinforcing steel embedded in various slag cement pastes was studied using the galvanostatic polarization technique. The corrosion resistance is appreciably affected by the degree of fineness of the dry slag cement. In pastes produced from high Blaine area cement, the behavior of embedded steel was very close to that in normal or type I portland cement paste, and is much better than a low Blaine area cement. W/C ratios of 0.25 and 0.50 provided a better passivating medium as compared with W/C ratios of 0.18 and 0.70. Effects of lime or gypsum addition were also investigated and comparatively studied for their action on the corrosion of embedded steel. The results obtained were supported by corrosion rates obtained using the linear polarization technique.

Das korrosive Verhalten von Beton-Stahl, das in verschiedenen Hochofen Zementpaste eingesetzt ist, wurde durch galvanostatische Polarisationsmethode untersucht. Man fand, dass der korrosive Widerstand von der Teilchengrösse des trockenen Zement abhängig ist : In Zementpaste von einer höheren ausseren Zementoberfläche ist das korrosive Verhalten des Zements hahe zu dieser von Portland-Zement, und besser als das Zement mit kleinerer oberfläche. W/C Verhältniss von 0,25 und 0,4 ergibt ein besseres passives Medium in vergleich zu W/C Verhältniss von 0,18 und 0,7. Der Beeinflussung von Addition von Kalk oder Gips wurde ebenfalls untersucht. Die Ergebnisse wurden durch Untersuchung der Korrosionsgeschwindigkeit mit linearer Polarisations methode weiter befestigt.

Introduction

Part I[1] of this series describes the specific surface areas and the pore structures of hardened slag cement pastes mixed with various water/cement ratios. This paper reports mainly on the role of the initial Blaine area of the dry cement, presence of additives, and the water/cement ratio in relation to the corrosion behavior of embedded reinforcing steel.

It is a well-known fact that the corrosion of steel in alkaline media and especially in concrete is slow. Previous work[2-3] indicated that, anodic galvanostatic polarization technique at very low current densities is a reliable accelerated test for the prediction of the corrosion behavior of steel embedded in concrete. This method has been applied in the present study.

Experimental

Slag cements used were of Blaine area 3600, 4200 and 6535 cm^2/g, and the water cement ratios were 0.18, 0.25, 0.40 and 0.70. Another series of experiments was carried out with normal portland cement of Blaine area 3780 cm^2/g, for comparison. The effect of admixing slag cement with 20% gypsum or with 10 and 20% lime on the corrosion behaviour of reinforcing steel was also investigated.

The galvanostatic polarization technique, the pretreatment of the electrodes and the preparation of pastes are identical with those described elsewhere[3,4].

The corrosion rate of embedded reinforcing steel in the different cement pastes was determined using the linear polarization resistance technique. A manually operated Winking electronic standard potentiostat, Model 11-TS3 was used. The procedure of Stern and Geary[5] was adopted.

The reinforcing steel used throughout the present work was a product of the Delta Company. Its Chemical analysis is as follows: C 0.2, S 0.07, Mn 0.5, P 0.057%.

Results and Discussion

A - The corrosion behavior of steel reinforcement in slag cement pastes in absence of $CaCl_2$.

Figure (1) is an example of the anodic polarization curve at a constant c.d.of 30 $\mu A/cm^2$ obtained for embedded steel in slag cement pastes in absence of Cl^- ions. The corresponding curve obtained for portland cement is included. It can be seen that all the curves have the same characteristic form.