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ScienceDirect
Cement and Concrete Research 36 (2006) 2103
Cement and Concrete Research

Discussion

A reply to the discussion by S. Chatterji of the papers "A novel method for describing chloride ion transport due to an electrical gradient in concrete" Parts 1 and 2☆

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Received 17 July 2004

The authors would like to thank Dr. Chatterji for his constructive insights into the problem of chloride ion migration into concrete. The parallels he draws with movement of water into soils do certainly illustrate the difficulties that are encountered in predicting fluid and ionic movement into a porous medium. The very difficulty of providing closed formed mathematical solutions that account for all the possible mechanisms that could occur during the migration of chloride ions during a test are what lead to the development of this form of solution. The inclusion of just some of the effects discussed, for example ion–ion interaction as implemented by Truc (Ref. [5] in Part 1), does not change the shape of the predicted curve to match more closely what is seen experimentally.

The procedure used to saturate the samples was the vacuum saturation procedure prescribed by ASTM C1202 and used by Tang for the nonsteady state migration test (Ref. [2] in Part 2). The samples, which had been continuously stored after casting in the moist curing room (100% RH), were placed under vacuum for 3 h at which time the water was introduced and the vacuum was maintained for an additional hour. The vacuum was then released and the samples were allowed to soak for 18 h. While it is commonly assumed that this procedure will produce saturated samples, it is acknowledged that this may not be the case for lower permeability concretes. Assuming that the degree of saturation of the samples varies with depth is not a sufficient explanation for the phenomenon observed, however. This discrepancy between the theoretical chloride profile and experimental profile has also been seen in higher permeability concrete, which would have been uniformly saturated [1].

It may be pointed out that the model proposed predicts the situation described by Prof. Chatterji of a region of constant chloride concentration preceded by a region of varying concentration. This can be seen most clearly in Fig. 8 of Part 1, where one of the curves depicts a constant initial region and then a transition portion, although the constant initial region is present in all of the curves in Figs. 5–8 of Part 1 to a lesser degree. The size of this saturated portion depends upon the duration that the concrete has been exposed to the chloride solution.

Dr. Chatterji has certainly brought up some relevant information regarding the migration of chloride ions in concrete. It is certainly true that the prediction of chloride ion profiles under these conditions is a challenge that has not been completely met at this point. Any discussion on this topic is always fruitful and is appreciated.

References

[1] K. Stanish, R.D. Hooton, M.D.A. Thomas, Prediction of Chloride Penetration in Concrete, Publication No. FHWA-RD-00-142, US Department of Transportation, Federal Highway Administration, McLean, VA, USA, 2001.

☆ CCR 34 (1) (2004) 43–49 and 51–57.

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0008-8846/$ - see front matter
doi:10.1016/j.cemconres.2004.07.027