Liquid Transport into Coated Concrete

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ABSTRACT
The penetrability of coating film is an important factor that determines the corrosion rate of coated concrete substrate under acidic environments. In this study, a numerical model was developed to predict the absorption of coatings, weight changes in coated concrete and degradation rate of concrete. Results show that the numerical model is in good agreement with experimental data.

INTRODUCTION
Microbially Induced Concrete Corrosion (MICC) caused many sewer pipes corroded throughout United States. Coating concrete sewer facilities can protect the concrete from sulfuric acid attack. The effectiveness of coatings for protecting sewer concrete pipes is under investigation. Based on Liu [1], sulfuric acid still can penetrate through coating film into concrete substrate. The properties of coatings determine sulfuric acid transport speed and further determine corrosion rate of concrete. In this paper, a numerical model was developed to predict liquid transport into coating coated concrete.

NUMERICAL MODEL
1. Physical Model of Liquid Transport into Coated Concrete
When coated concrete specimens come in contact with liquids, liquid will penetrate through coating film into concrete. If the liquid does not react with either coating film or concrete, the physical model of liquid penetrating into coated concrete specimens can be represented as shown in Fig. 1. If the liquid reacts with concrete, concrete will corrode layer by layer from the surface. The physical model can also be represented by Fig. 1.

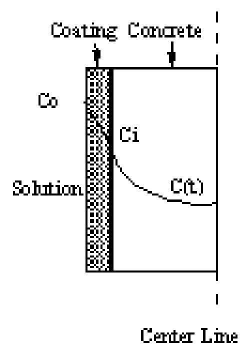


Figure 1 Physical Model for Solution Uptake

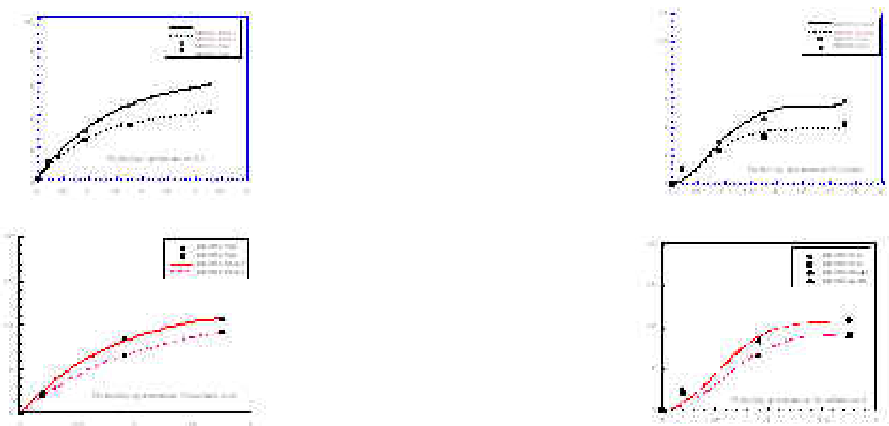
2. Numerical Model
Assumptions: (1) the process can be modeled by Fick's Second law. (2) the absorption coefficient is a constant in coating film. (3) there is no concentration gradient between bulk liquid and coating surface. (4) coating film and concrete surface are in good contact; (5) liquid diffuses in reacted concrete zone and (6) Coating film does not react with the liquid.

2.1 Liquid transport through coating film (Film Diffusion Model)

The coating film on concrete cylinder can be treated as a thin plane sheet. The concentrations of liquid on coating surfaces of liquid side and concrete side are and respectively (Fig. 1). The flux of the liquid transport at time t through coating film can be written as . Assume the concentration on the coating/concrete interface . Then . The accumulated amount of liquid transported through coating film from time 0 to t is (1)

2.2 Liquid absorption in concrete cylinder (Concrete Diffusion Model)

For absorption in coated concrete cylinder with surface concentration of liquid changes with time. If the concentrate at the concrete surface is , the sorption-time curve is given [2] by (2) Considering an exponential approximation function of the form (3) where and are constants. Then the curve fit of the standard sorption-time curve gives and .Fig. 2 shows the prediction of weight change by using Eq. 1 and Eq. 3.



(a) Film Model (Eq. (1)) (b) Concrete Model (Eq. (3))

Figure 3. Weight Change Prediction for Coated Concrete Cylinders

SUMMARY

Film absorption model and concrete absorption model have been developed to predict weight change of coated concrete under non-corrosive and corrosive solutions. The absorption coefficients of different coatings were obtained. Long term performance of coatings and scale effects can be predicted by using the film absorption model and the concrete absorption model.

ACKNOWLEDGMENT

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REFERENCE

[1] Jie Liu and C. Vipulanandan, "Testing Epoxy Coatings for Dry and Wet Concrete Wastewater Facilities," JPCL (1999), Vol. 16, No. 12, pp. 26-37.

[2] J. Crank, The Mathematics of Diffusion, Oxford University Press. Second edition (1975).

If you have any questions, please contact Dr. C.Vipulanandan