Field and Laboratory Performance of Coatings Used in Wastewater Systems

J. Liu and C. Vipulanandan

Center for Innovative Grouting Materials and Technology (CIGMAT)
Department of Civil and Environmental Department
University of Houston, Houston, TX 77204-4003
Tel: (713) 743-4291 E-mail Address: jliu5@mail.uh.edu

ABSTRACT

Polymer and cement based coatings are used to protect concrete against corrosive environments, and hence the performances of commercially available coatings were evaluated under controlled conditions for over five years in the CIGMAT laboratory. Based on the preliminary results, the appearance of the coatings in the laboratory tests was comparable with the field observation.

INTRODUCTION

Cement concrete is extensively used in the construction of buildings, transportation facilities and sewage systems. It is highly alkaline and can easily deteriorate under acidic environments. The sulfuric-acid-producing bacteria found on sewer crowns thrive at low pHs which are inhibitory to most competitors. Islander (1991) reported that the concentration of sulfuric acid for the worst case in sewer environments was pH 0.5 (close to the pH of 3% sulfuric acid solution).

To protect concrete facilities from sulfuric acid attack, coating the concrete is one method now being adopted. Liu and Vipulanandan (1999) studied coated concrete specimens immersed in 3% sulfuric acid. Their results showed that for specimens without pinholes on the coating film, the weight gain was only about 1% after three years and the probability of failure increased with the increase in weight for coated concrete in 3% sulfuric acid. Generally, lab tests are easier to be carried out than the field tests. In this paper, a comparison of the lab test results and field data is presented.

OBJECTIVE

The objective of the research is to evaluate the applicability of the laboratory test methods developed at the CIGMAT laboratory, University of Houston in evaluating coatings for wastewater systems.

TESTING PROGRAM

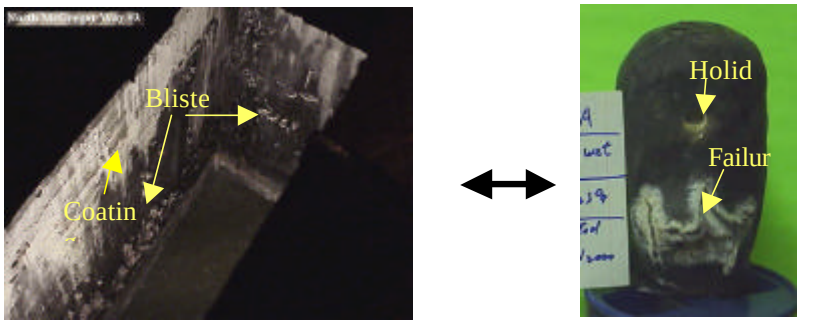
Coating Materials In this study, commercially available polymer and cement based coatings were evaluated. It must be cautioned that the results from this study cannot be generalized to apply to all epoxy and polyurethane coatings available in the markets.

Chemical Test In order to study the chemical resistance of coated cement concrete, the ASTM G 20 test was modified to use with coated concrete. In this test, the changes in (1) weight of the specimen and (2) appearance of the specimen was monitored at regular intervals. The two test reagents selected for this study are (1) deionized (DI) water (pH =

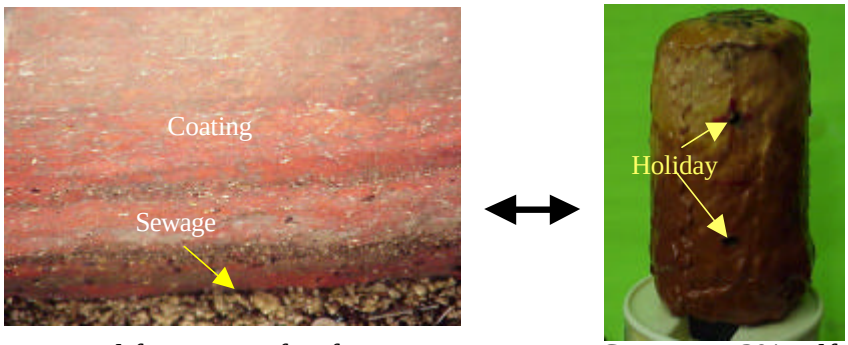
5 to 6) and (2) 3% sulfuric acid solution (pH = 0.45; representing the worst reported condition in the wastewater system). Control tests were performed without pinhole.

RESULTS AND DISCUSSIONS

When coated concrete specimens were immersed in sulfuric acid solutions, acid will penetrate through the pinhole, coating film and interface (exposed at the pinholes) and reacted with the $Ca(OH)_2$ and other complexes in the cement. Based on the pH and sulfate concentration in the specimen, gypsum and/or ettringite were formed. Ettringite expands and causes coating cracking and blistering. Failure types observed when sulfuric acid attacked the coated concrete specimens include blistering at the pinhole and cracking of coating starting from the pinhole, or on the surface of the specimens. A number of lift stations were inspected and the conditions of the coatings were evaluated. The results showed that the performances of the coatings in 3% sulfuric acid lab test represented the performance of the coatings in the field (Fig.1).



(a)



Coating in lift stations after five years

Coating in 3% sulfuric acid in lab test after five years

(b)

Figure 1 Comparison of Laboratory Test and Field Test

CONCLUSION

Based on limited field inspections, it can be concluded that laboratory tests simulated the field conditions (visual inspection).

ACKNOWLEDGEMENT

This project was supported by the CIGMAT under grants from the City of Houston, National Science Foundation (CMS-9526094, CMS-9634685), and various industries.

REFERENCES

[1] Islander, R. L., Devinny, J. S., Mansfeld, F., Postyn, A. and Shih, H.. "Microbial Ecology of Crown Corrosion in Sewers." Journal of Environmental Engineering, Vol. 117, No. 6, 1991, 751-770.

[2] Liu, J. and Vipulanandan, C., "Testing Epoxy Coatings for Dry and Wet Concrete Wastewater Facilities", Journal of Protective Coatings and Linings, Vol. 16, No. 12, 2000, pp. 26-37.