Mitigating External Corrosion of Pipelines through Nano-modified Cement-based Coatings

Siwei Ma / Shiho Kawashima
Department of Civil Engineering and Engineering Mechanics
Columbia University, New York, NY, USA

Main Objective

This project was awarded to Columbia University in order to engineer a cement-based material that exhibits enhanced properties considered relevant for coating applications, i.e. rheology, porosity, and crack resistance, by utilizing nanomaterials and supplementary cementitious materials

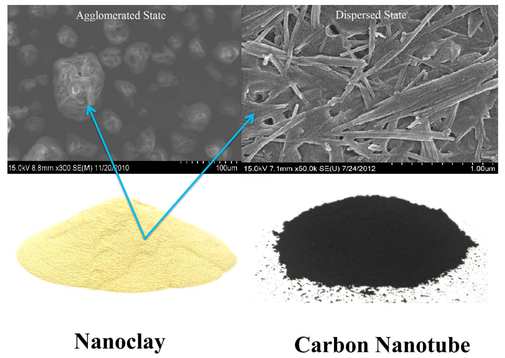

Figure 1. Nanomaterials

Figure 2. Supplementary cementitious materials

Project Approach/Scope

Major tasks to achieve the objective of the proposed work are as follows:

- Select materials, i.e. carbon nanotube and supplementary cementitious material (SCM) types, and develop a processing technique to produce the cement-based coating material
- Characterize key fresh-state (rheological) properties for ease of implementation: rate of structural rebuilding and adhesive properties
- Characterize key hardened properties for enhanced sealing performance: porosity and crack resistance

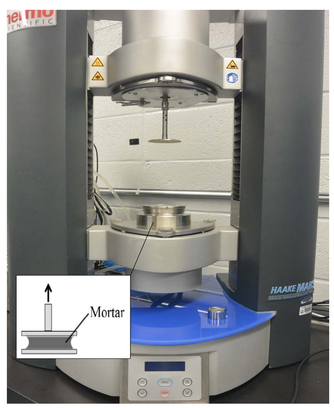

Figure 3. Rotational rheometer for performing the tack test

Figure 4. Test setup for measuring porosity

Expected Results/Results to Date

Materials

- *Portland Type I cement, Grade 120 slag cement, Type F fly ash*
- *Highly-purified attapulgite clay (nanoclay) and carbon nanotubes (CNTs)*

Tack test

- *Preliminary results show that 0.5% addition of nanoclay by mass of cement can enhance both adhesive properties and rate of structural rebuilding (Figure 5)*
- *SCMs are expected to further enhance each of these rheological properties*

Porosity

- *Combination of CNTs, nanoclays, and SCMs are expected to refine the pore structure of the material to decrease permeability*

Flexural strength

- *Preliminary results show the potential of CNTs at small additions (up to 0.05% by mass of cement) to improve flexural strength (Figure 6)*
- *SCMs are expected to further improve mechanical properties by improving the dispersion of CNTs and participating in pozzolanic reaction*

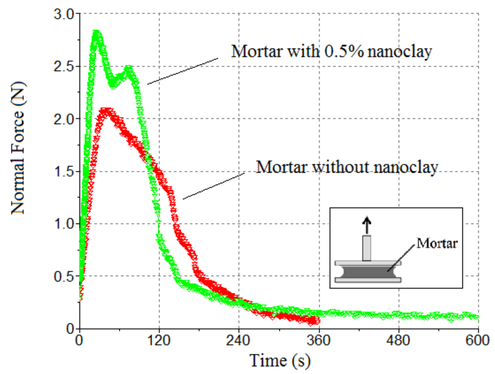

Figure 5. Tack test results for cement mortars.

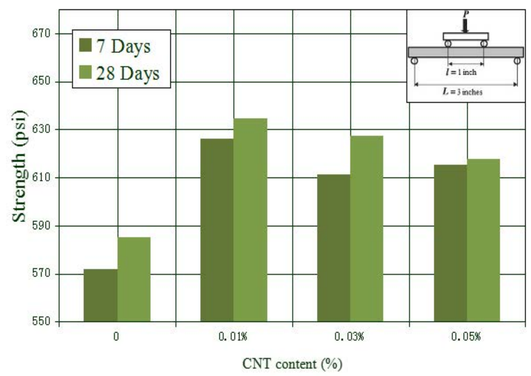

Figure 6. Flexural strength results.

Acknowledgments

This project is funded by DOT/PHMSA's Competitive Academic Agreement Program. The authors would also like to acknowledge Active Minerals, Grace, Nanocyl, Lafarge and Separation Technologies for providing materials.

Public Project Page

Please visit the below URL for much more information:
https://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=510