

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



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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

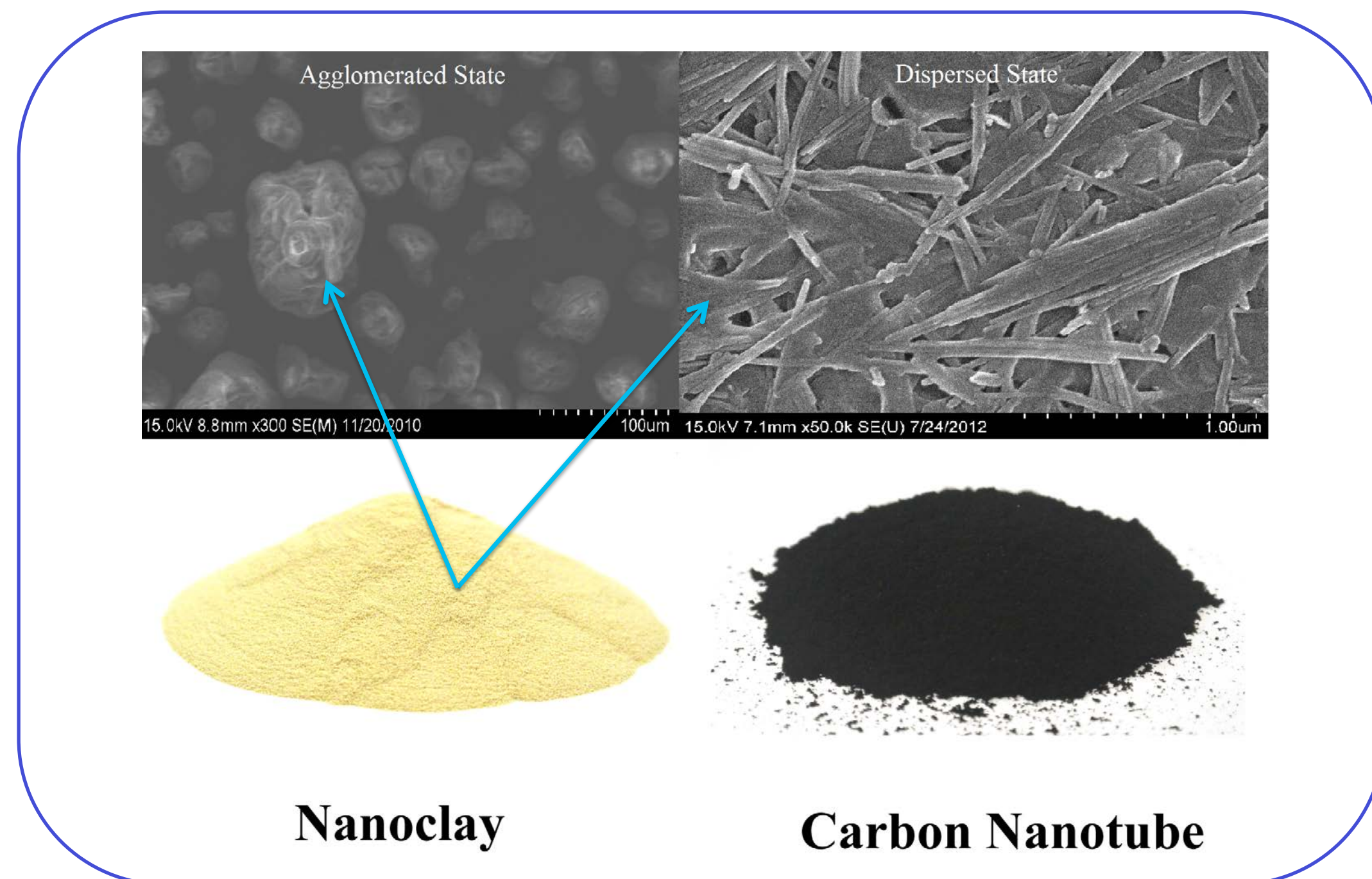


Figure 1. Nanomaterials



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

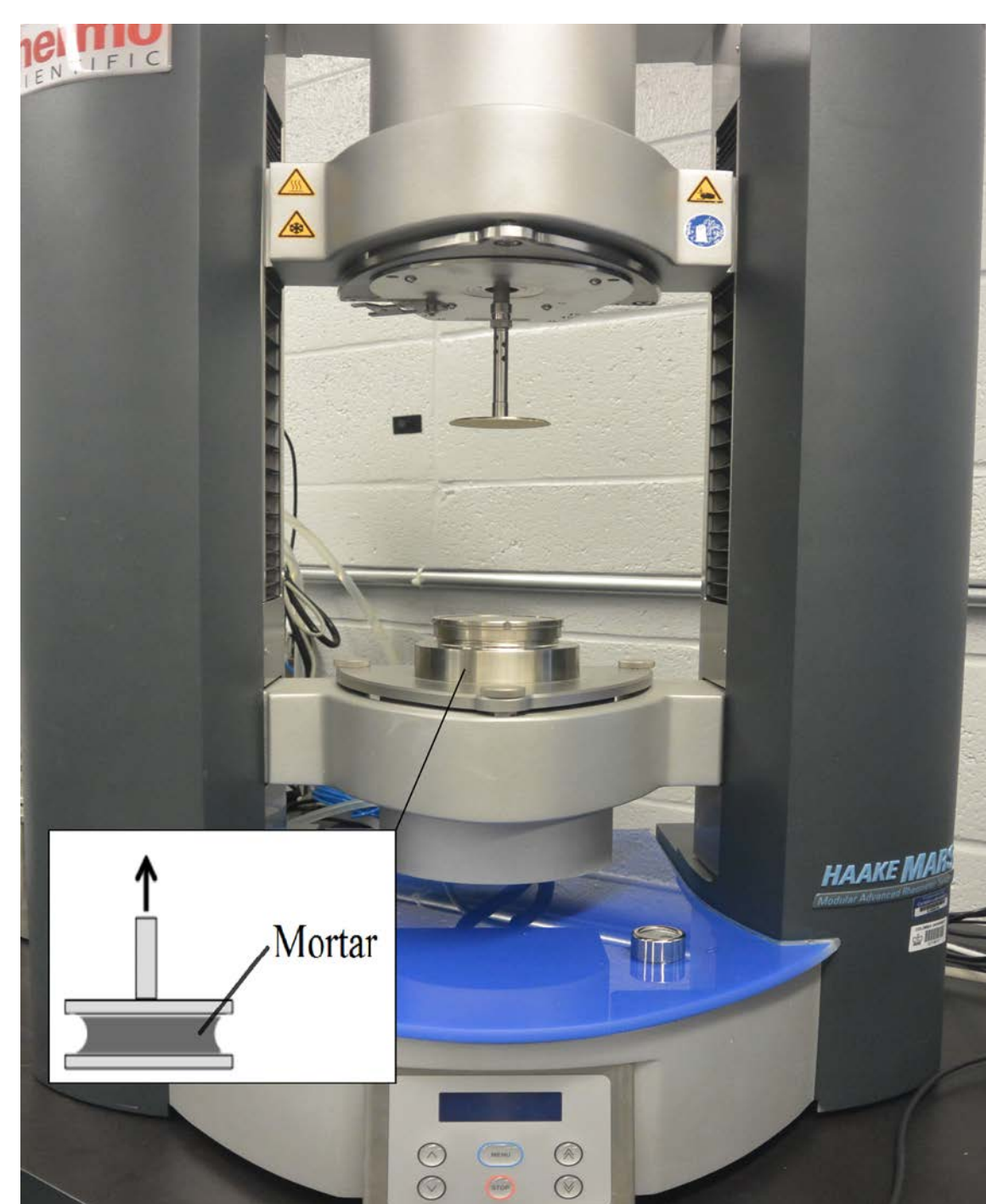


Figure 3. Rotational rheometer for performing the tack test



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

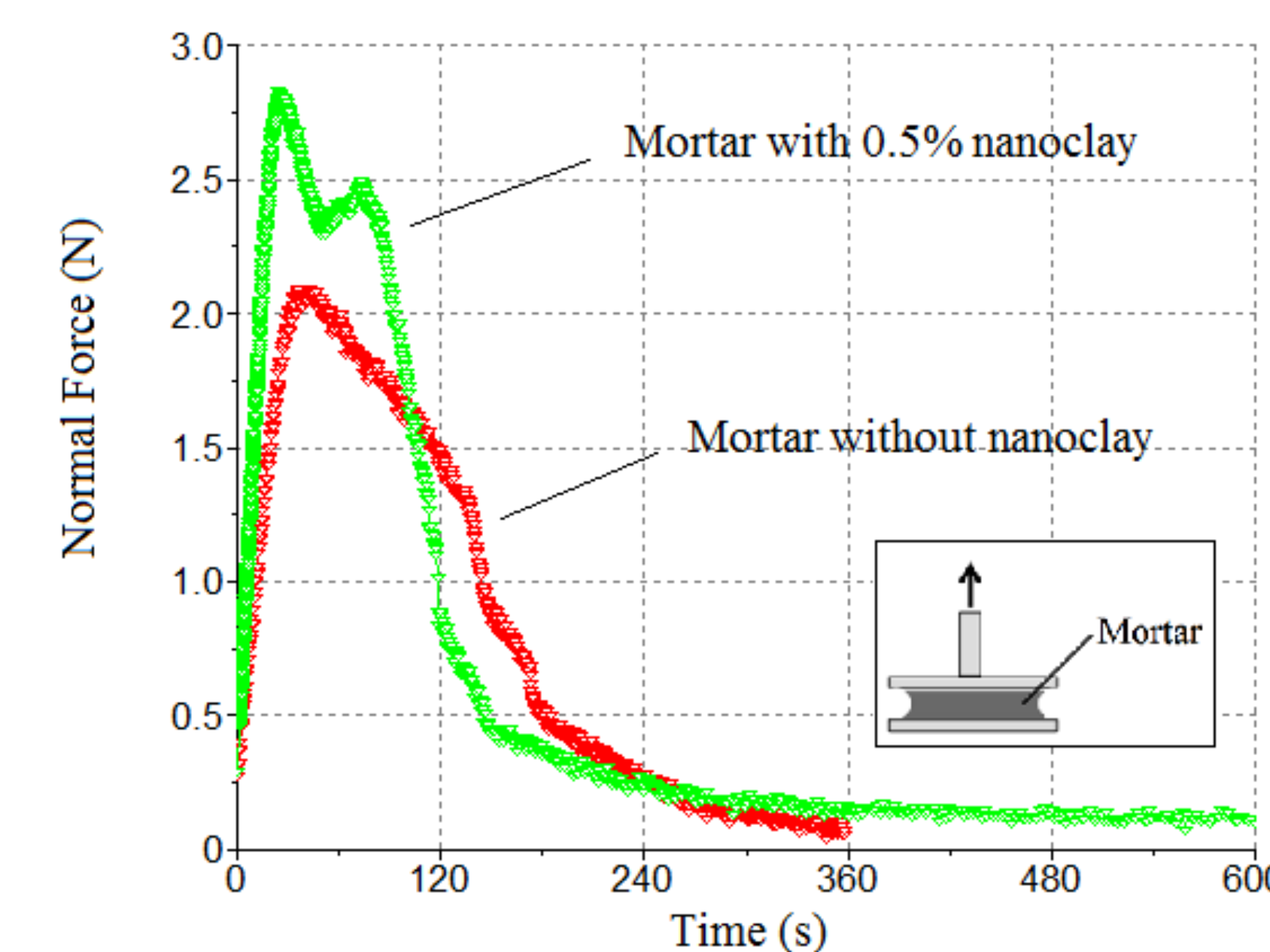


Figure 5. Tack test results for cement mortars.

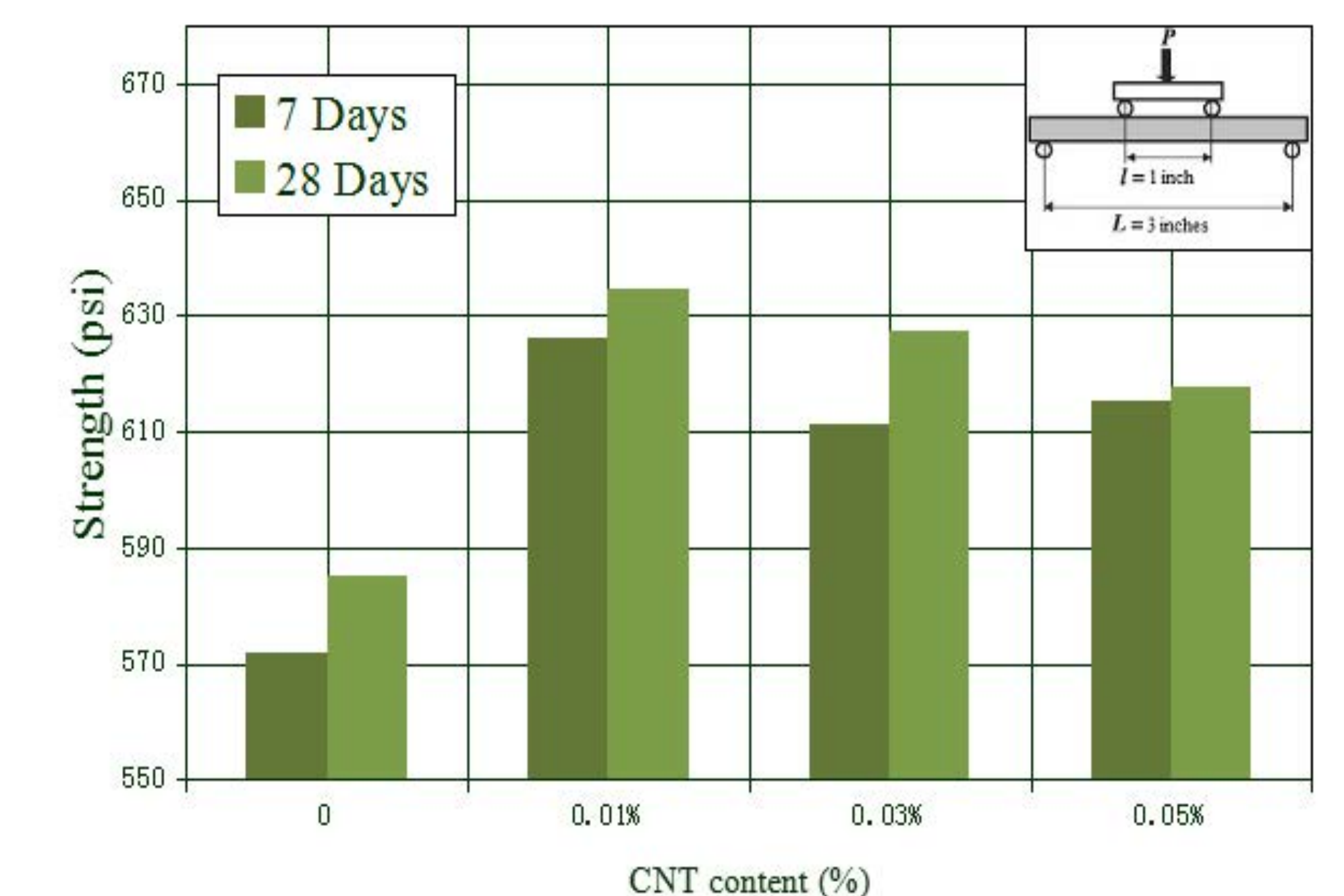


Figure 6. Flexural strength results.

Acknowledgments

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Public Project Page

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