

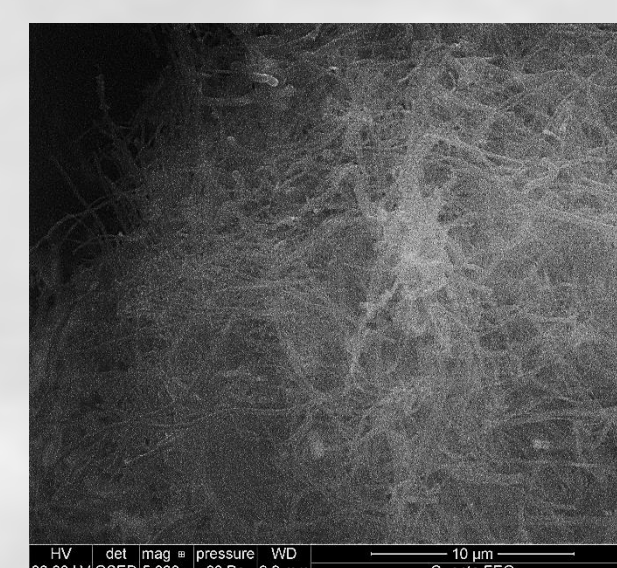
Effect of C-S-H Coated CNFs on the Performance of Cement Paste

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I. Motivation

- Carbon nanofibers (CNFs) have a tensile strength greater than that of steel
- CNFs and carbon nanotubes (CNTs) have the potential to enhance the mechanical performance of cement-based composites
- Unfortunately, dispersion of CNFs within the cement matrix remains a major challenge



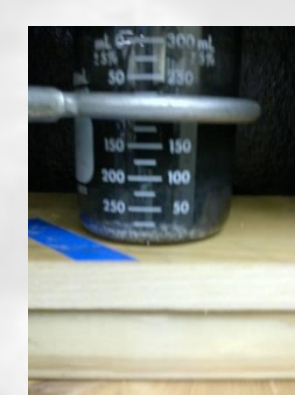
"as received" CNFs

II. Objectives

- Synthesize C-S-H (Calcium Silicate Hydrate) in the presence of CNFs to make CNFs more receptive to the cement matrix
- Characterize the coating of CNFs with C-S-H and dispersion effect by examining the microstructure and testing the macroscale mechanical properties

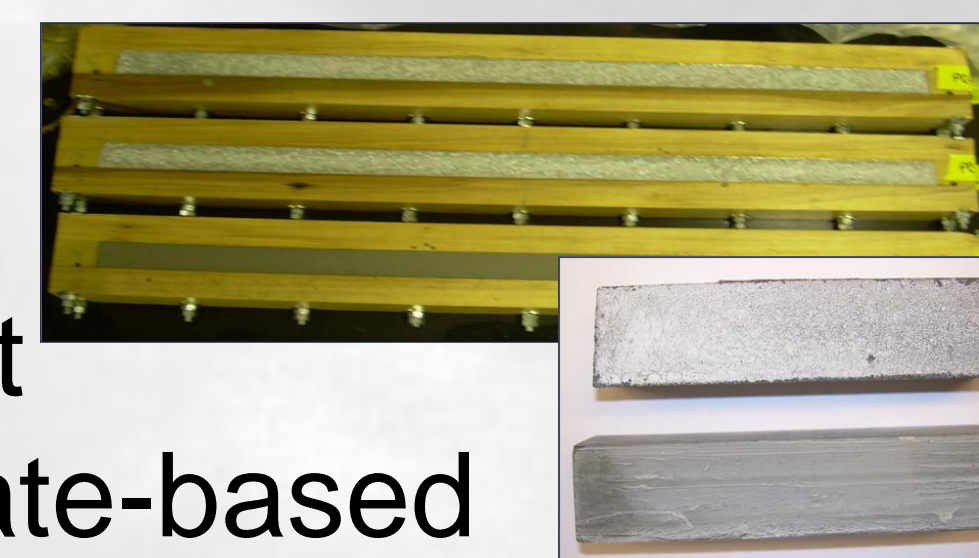
III. C-S-H synthesis with CNFs

- CNF dispersion
 - Sonicated with water and superplasticizer using a probe sonicator
 - Total sonication time: 15 mins
- C-S-H synthesis
 - Calcium nitrate tetrahydrate + Sodium meta-silicate pentahydrate added to CNF solution
 - Total sonication time: 20 mins
- Sonication settings
 - 50% amplitude
 - 20 second on/ 20 second off pulses
 - 3/4" solid probe used



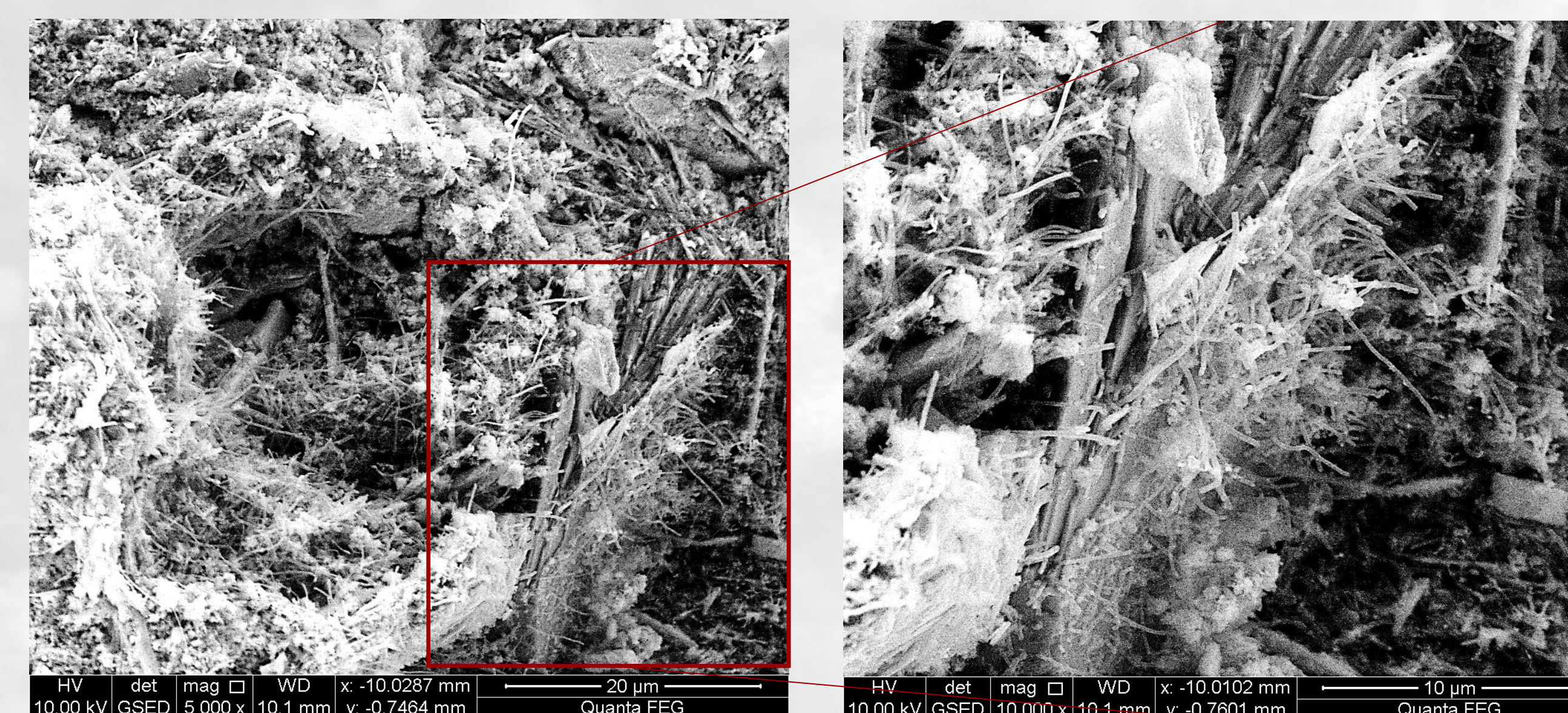
IV. Composites

- Portland Cement Pastes
- Water to cement ratio = 0.28
- CNF loading: 0.2% by wt. cement
- CNF incorporation: polycarboxylate-based superplasticizer with sonication; CNFs with and without synthesized C-S-H
- Solutions made were added to cement and then poured into three beams from which samples were cut

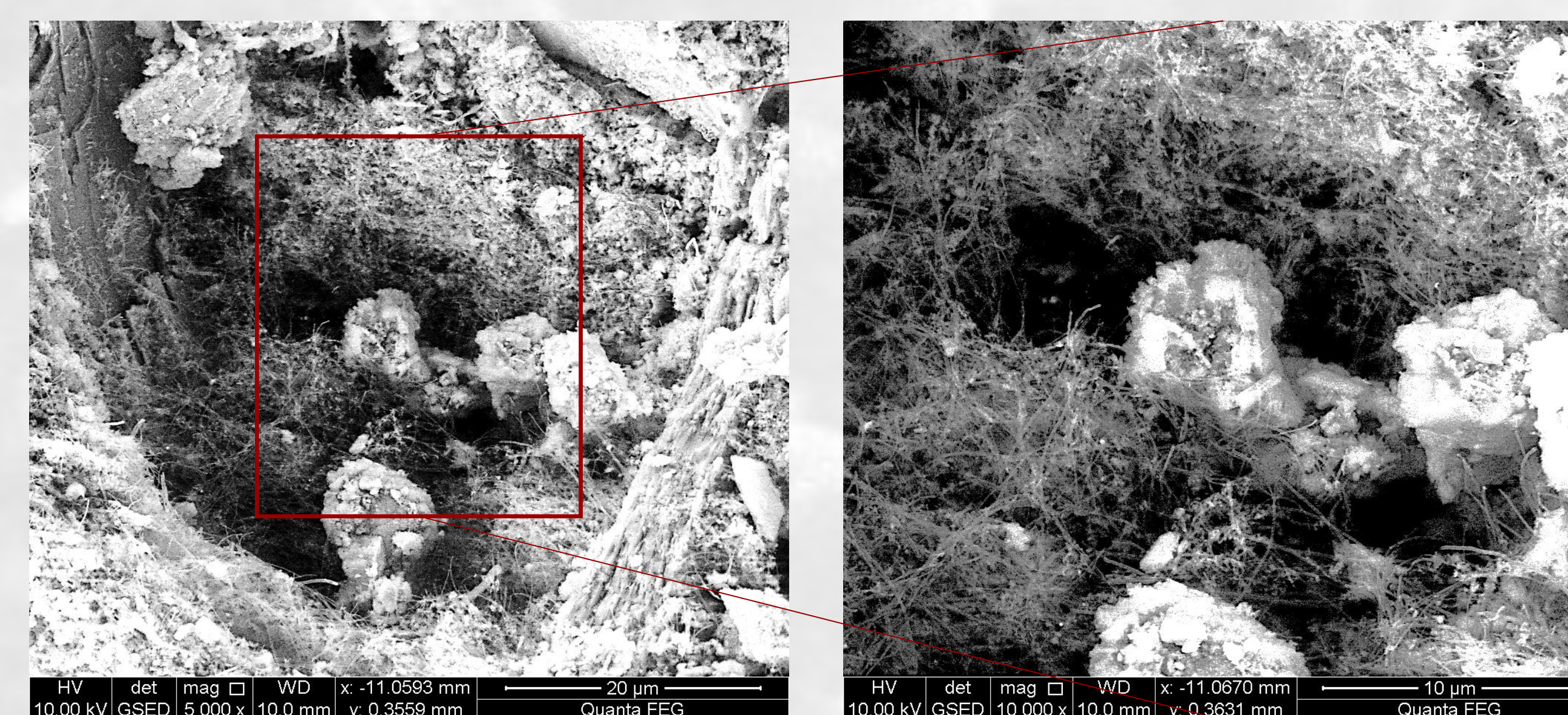


Mix	Cement (g)	H2O (g)	SP (g)	CNFs (g)	Ca(NO ₃) ₂ · 4H ₂ O (g)	Na ₂ SiO ₃ · 5H ₂ O (g)
PC-M8	2700	756	27	5.4	16.2	16.2
PC-CNF	2700	756	27	5.4	0	0
PC	2700	756	27	0	0	0

V. Microstructure



PC-M8 fracture surface



PC-CNF fracture surface

- CNFs synthesized with C-S-H led to CNF microscale agglomerates in cement pastes that were less dense and more infiltrated by the cement phases

VI. Macroscale Mechanical Properties

- Mechanical Testing Methods

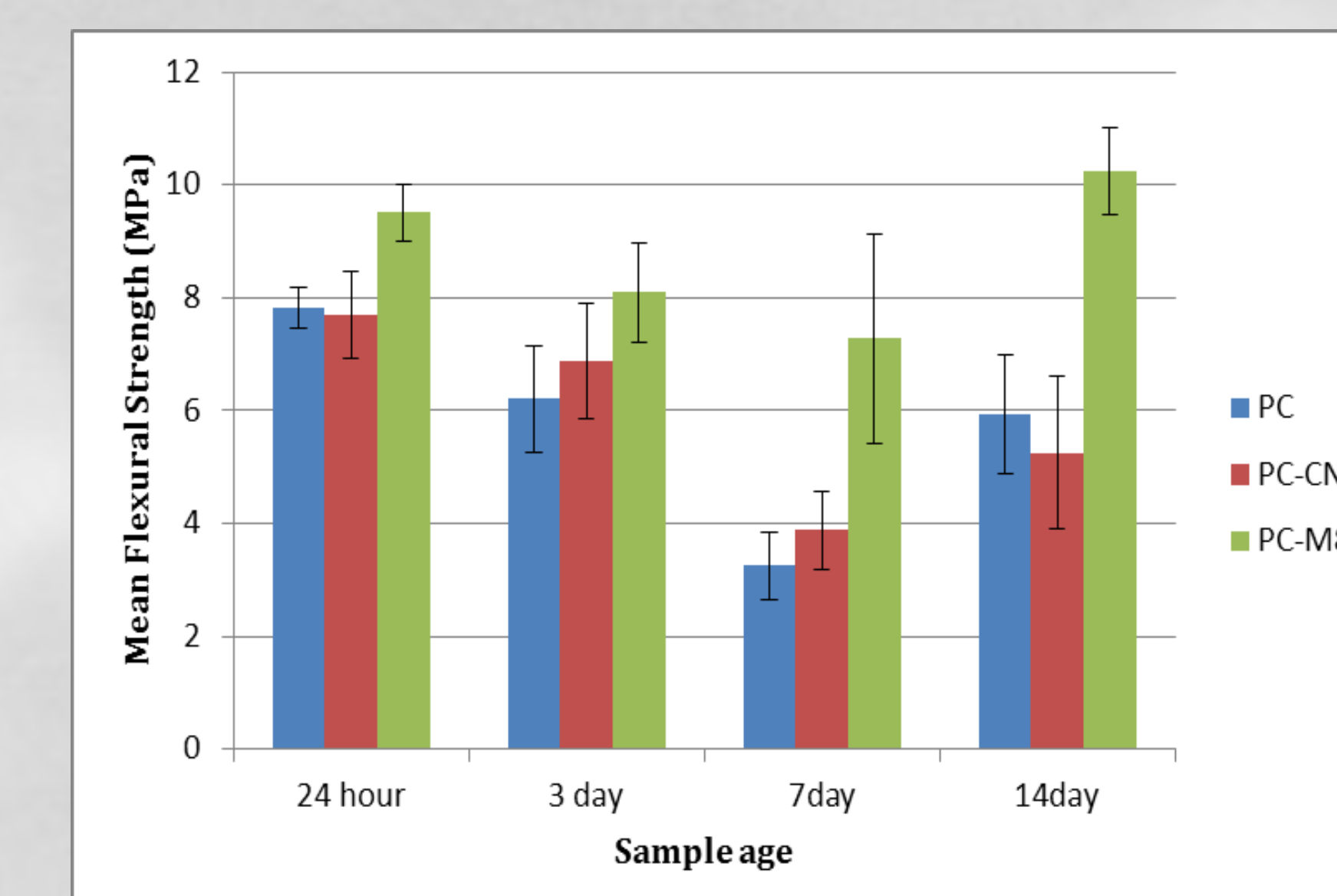


3 point bending flexural test



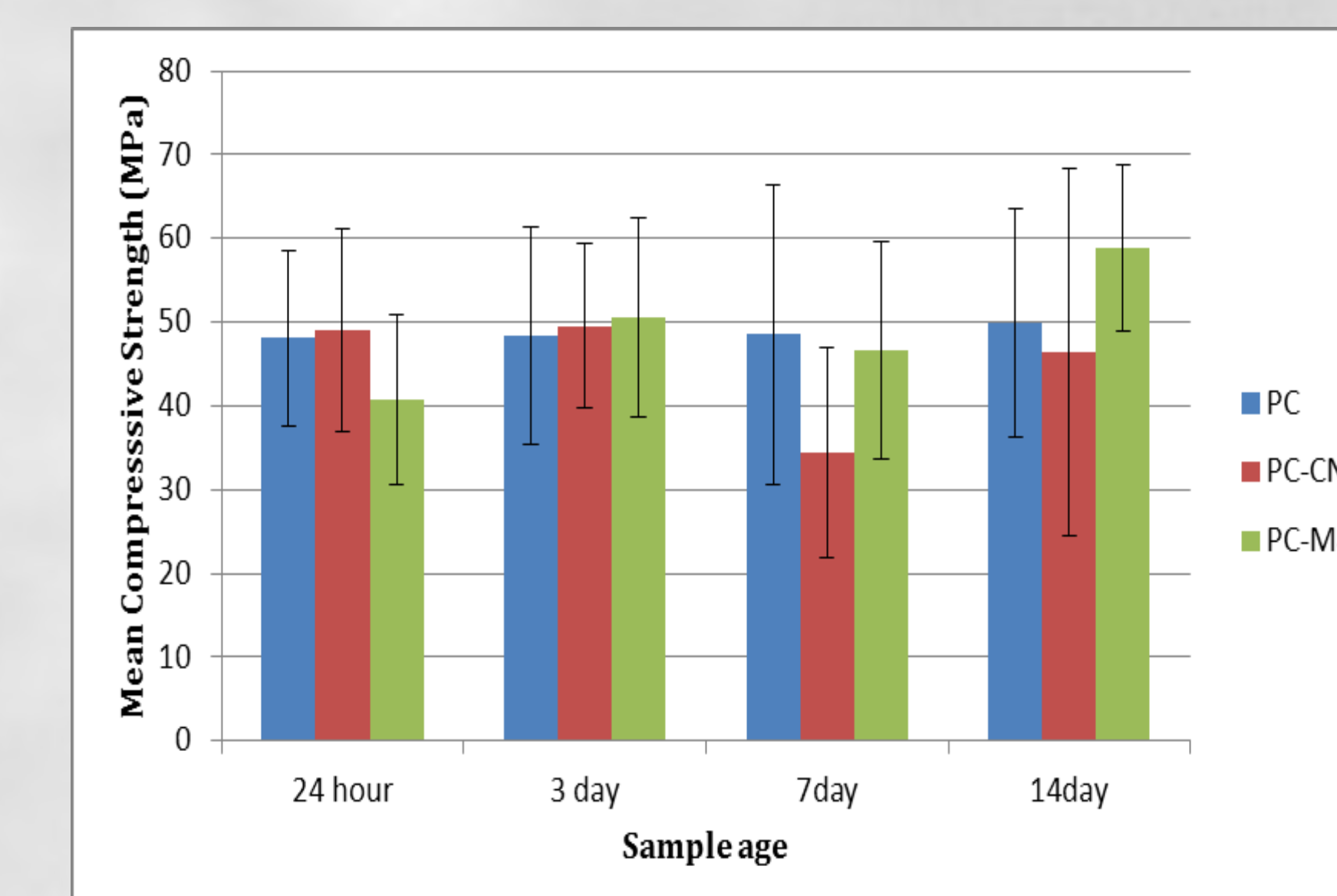
Compression beam testing

- Flexural Strength



- CNFs with synthesized C-S-H (PC-M8) improved the flexural strength at all ages

- Compressive Strength



- No significant effect of CNFs (PC-CNF) or CNFs with synthesized C-S-H (PC-M8) on the compressive strength at all ages