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Influence of superplasticizer/surfactant aided aqueous dispersion of multi-walled Carbon nanotubes and its impact on workability and mechanical properties of cementitious composites

By

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Introduction

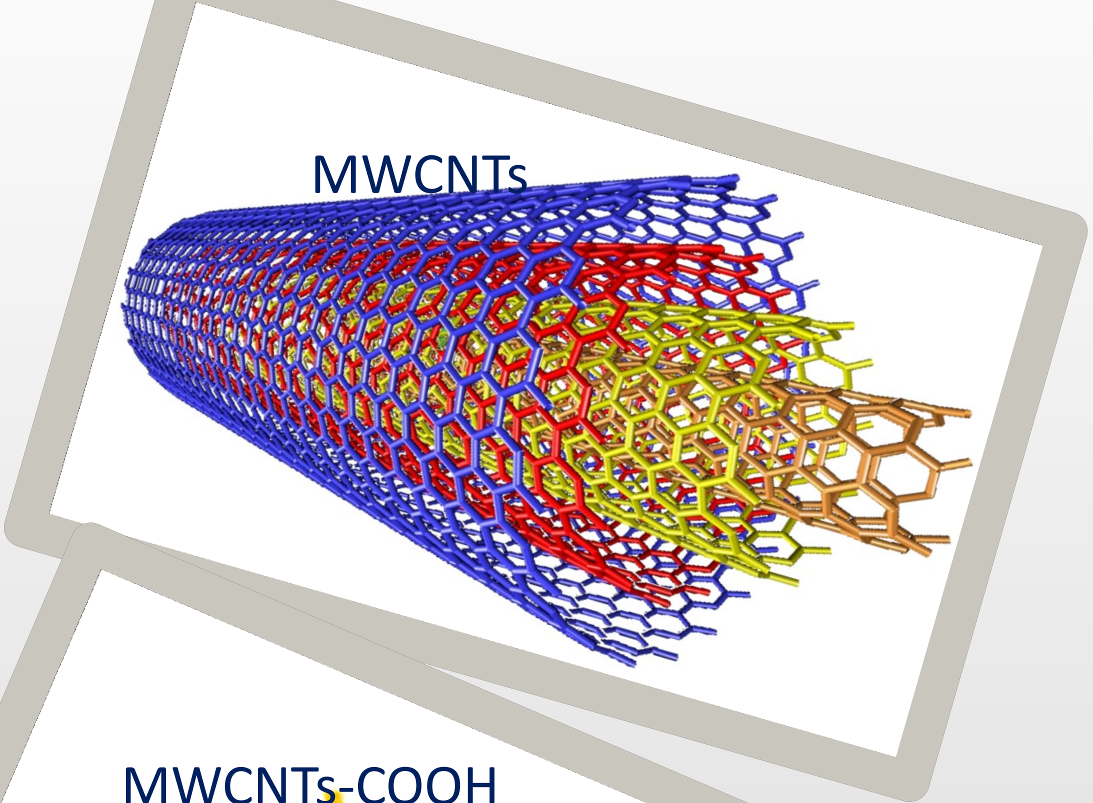
- Characterisation of carbon nanotubes

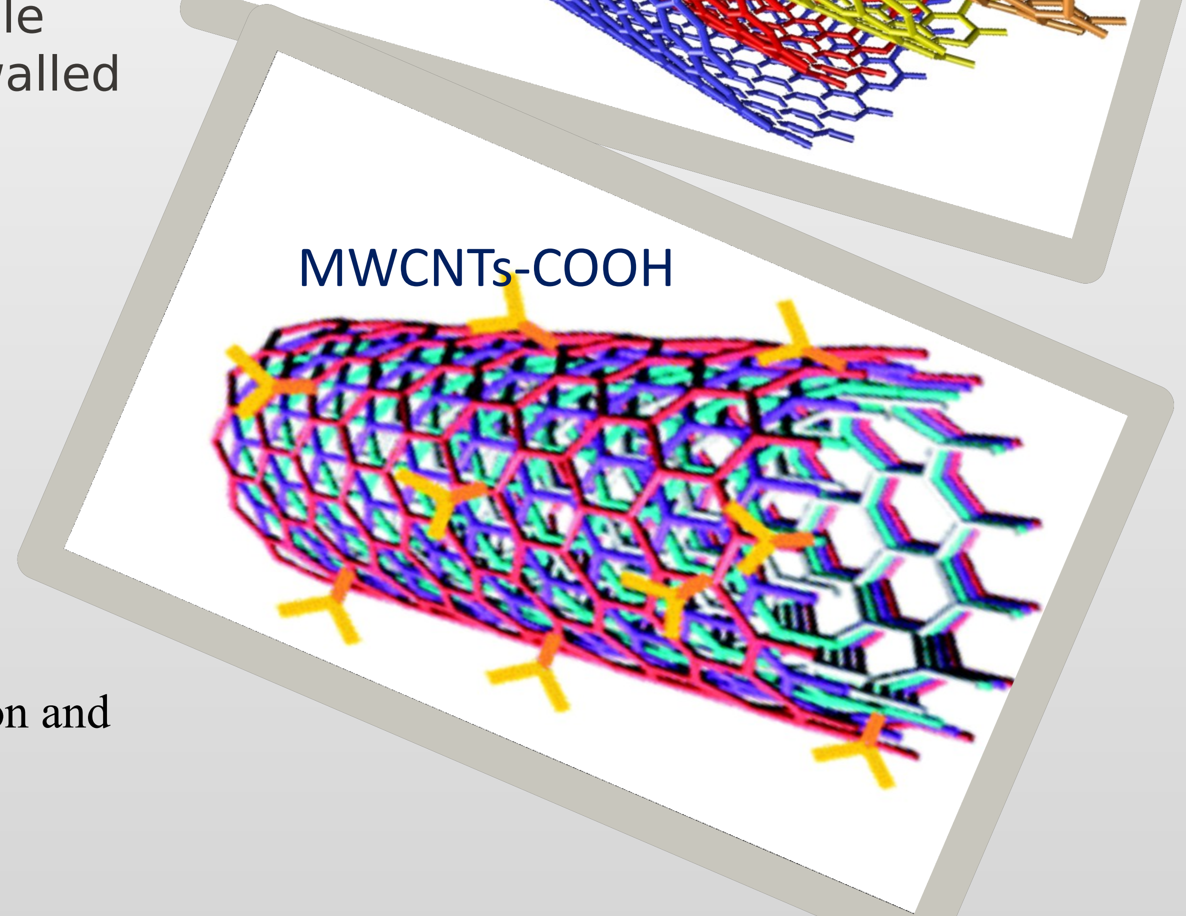
Carbon nanotubes are molecular-scale tubes of graphitic carbon with can have one “layer” (single walled nanotube) or more than one wall (multi walled nanotube).

- Geometry
- Mechanical properties
- Comparison with mild steel

- Challenges related to incorporate them with a cementitious composite.

- Proper dispersion of carbon nanotubes in aqueous solution and through the cementitious composites.
- Bond of nanotubes with the surrounding matrix.





Background

Different approaches have been proposed to disperse the nanotubes in aqueous suspensions.

limited published studies on the optimization of the effect of agents on the dispersion of CNTs in nano-cementitious composites

Authors	**Methods**	**Finding of the study**
Trettin and Kowald [2]	polycarboxylate-based superplasticisers as surfactants	High dispersion of CNTs led to significant improvement in bending and compressive strength.
Collins et al. [3]	Air entrainer. Polycarbonate Lignosulfonate	the addition of an ionic surfactant, greatly enhanced the dispersion an maintain a good mixtures fluidity.
Cwirzen et al. [4]	Polyacrylic acid polymers as a surfactant	Significant improvement in compressive strength (up to 50%).

Research significance

Needs for a reliable dispersion of CNTs in water, and improvement in the fluidity and mechanical strength of cementitious composite.

various types of stabilization agents

- surfactants
  1- Polycarboxylate ether (PCE)
  2- naphthalene based super plasticizer (NPH)

- Triton X-100,
- Methylcellulose (MS)

The above agents have been examined to qualify/quantify their effect on dispersion of CNTs in water, compatibility in cementitious composite.

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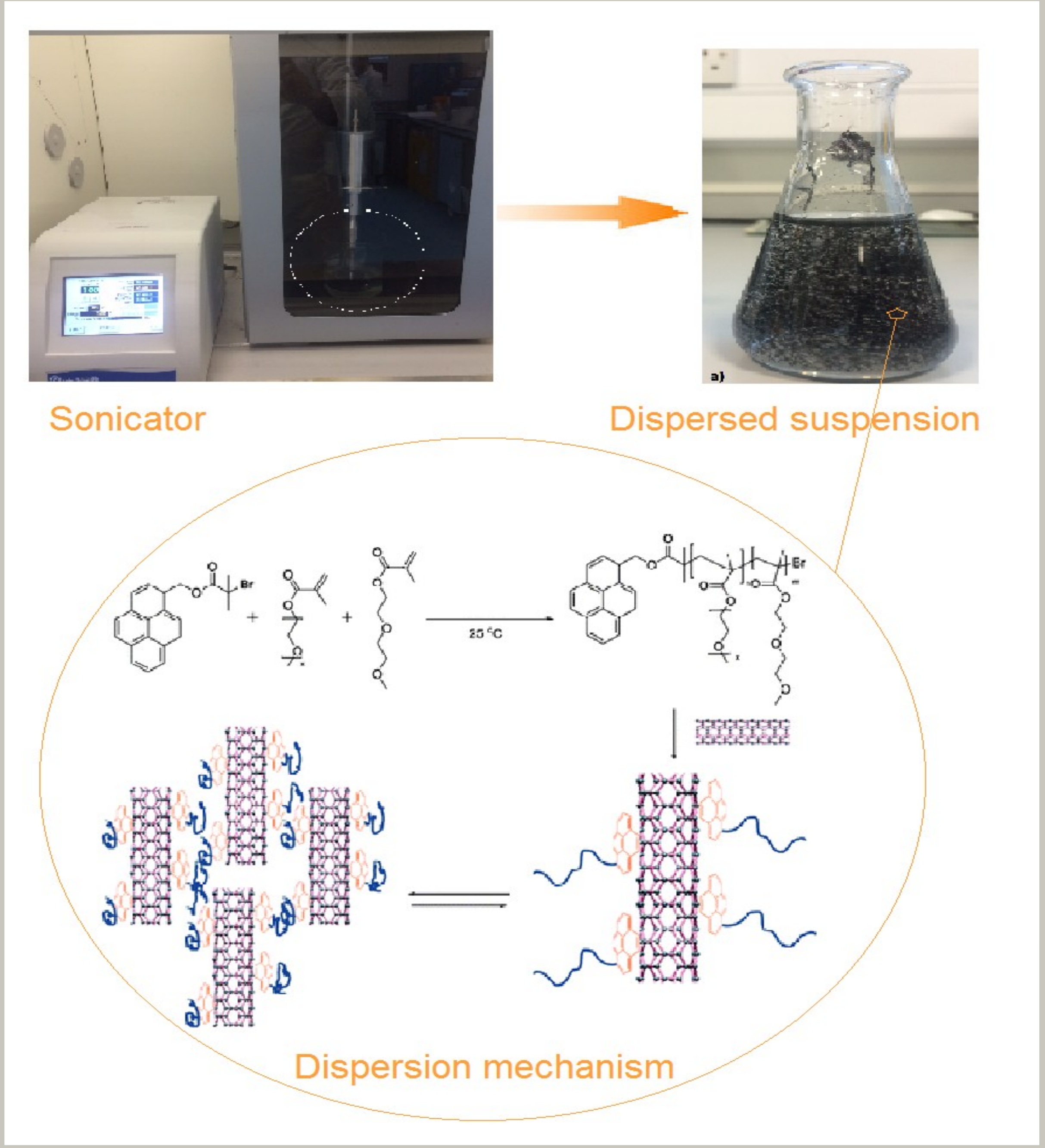
Experimental Programme

- PCE
- NPH
- MC
- TX-100

\+ 0.025 wt. % (by cement weight) MWCNTs/F-MWCNTs

Mixed in 100ml of water and treated for 5 minute under extensive sonication intensity

- Dispersion was assessed using UV- vis absorbance spectra



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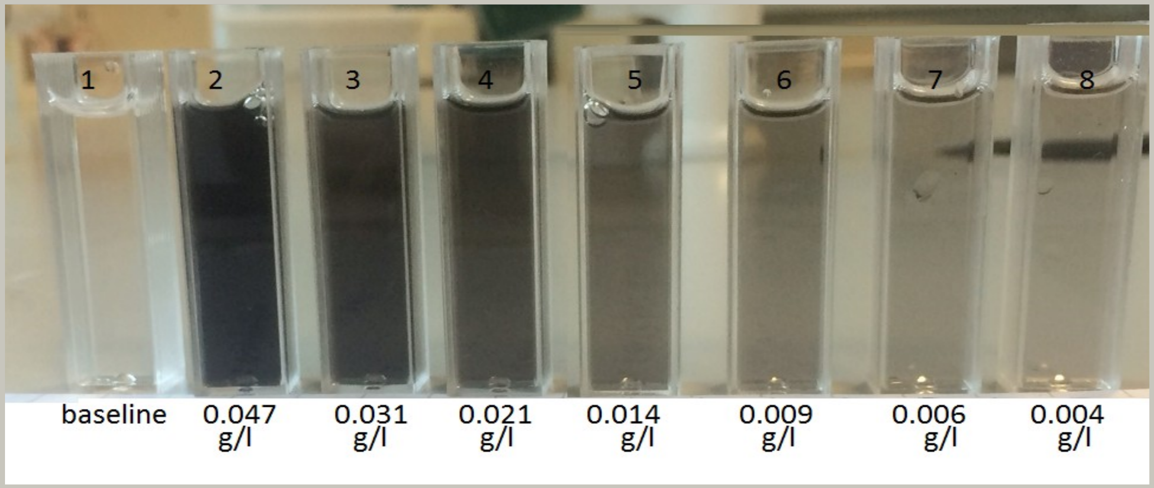
Results

Dispersion characterisation

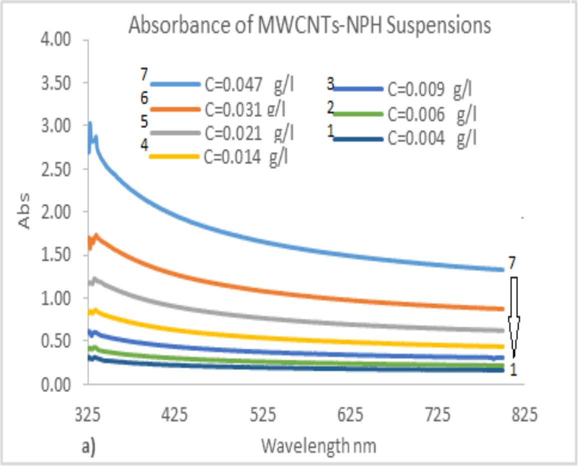
UV–vis spectra were conducted for seven different concentration of nanotubes suspensions

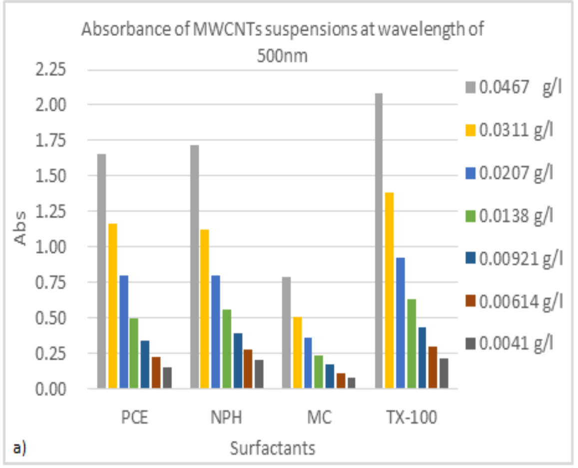


A total of nine nano- cementitious cement composites were prepared to test:

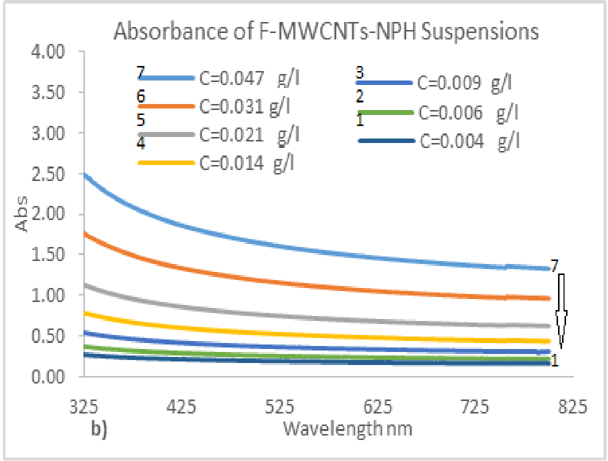
1- workability
2- Compressive strength at various ages
3- SEM

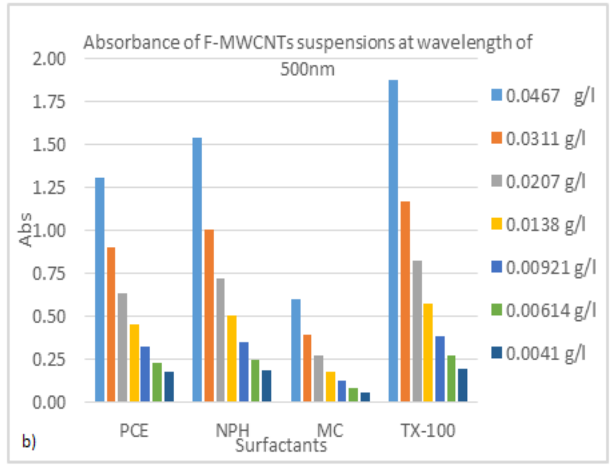
MWCNTs





F-MWCNT

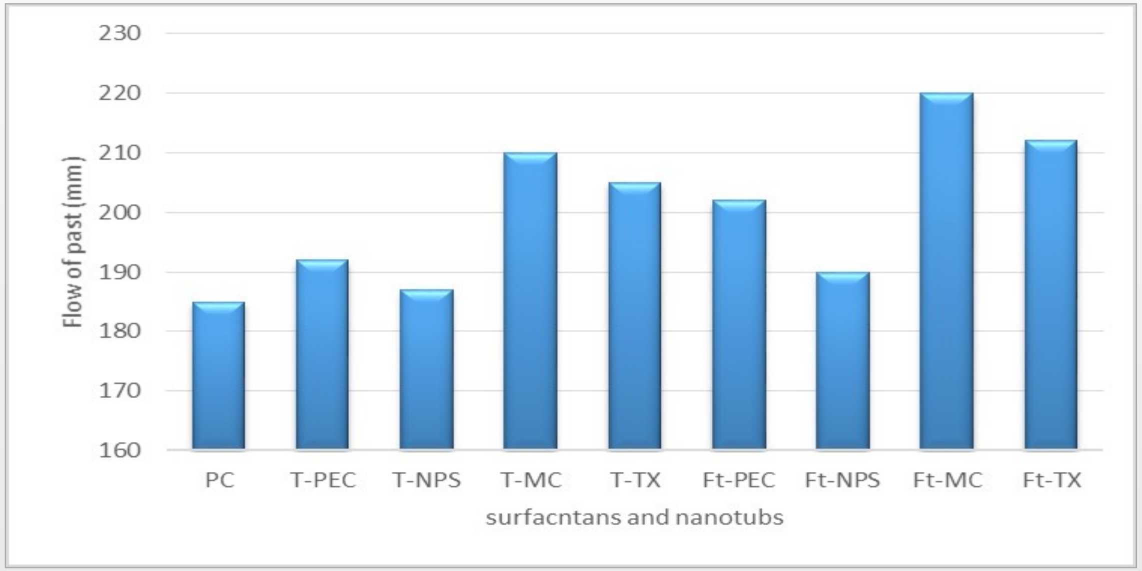


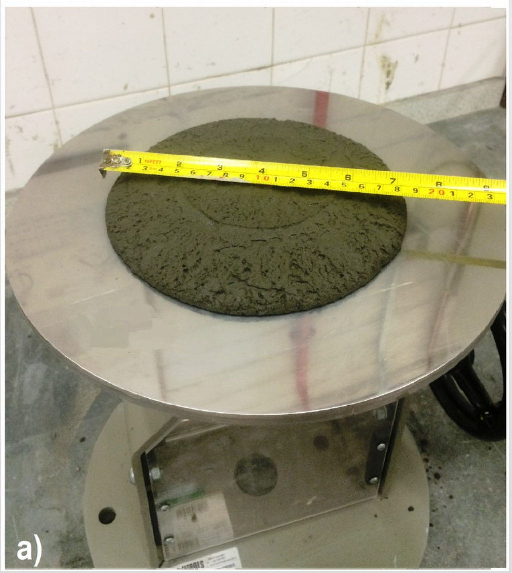


1- workability of the Nano Composites

Effects of carbon nanotubes-surfactants/dispersion agents on the flow of nano cementitious composites

- hydrophobic and hydrophilic nature are contributes to a reduction in the viscosity of the mix.
- formation of a large volume of stable air bubbles.
- absorption of Carboxylic acid (–COOH) groups on the walls of the functionalised nanotubes improves the dispersion of the tubes in water



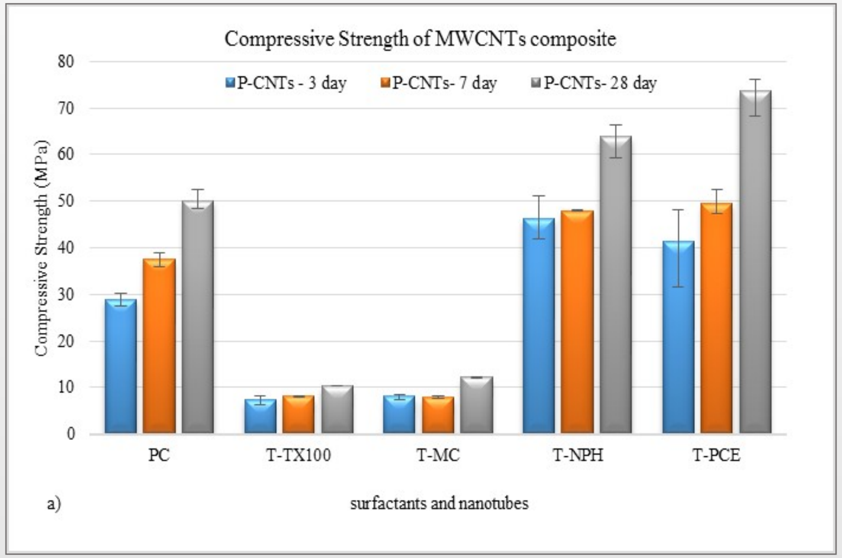


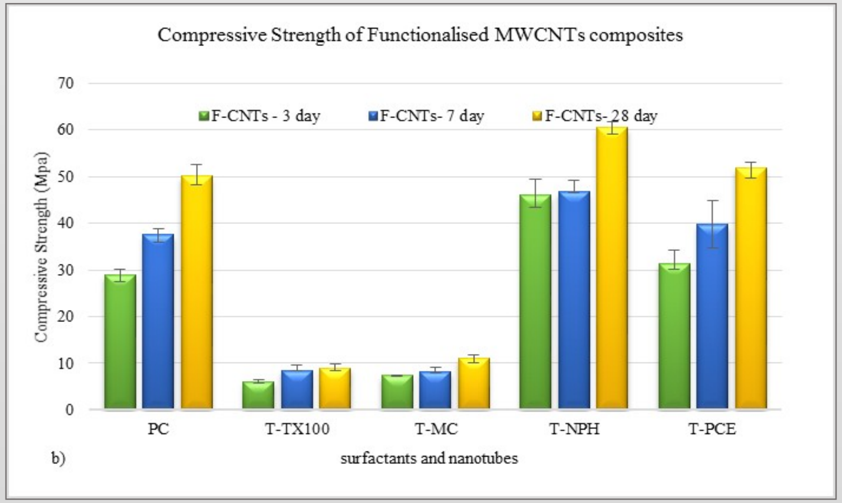
2- Compressive strength of the Nano Composites

- Strength of specimens containing MWCNTs / F-MWCNTs dispersed using Naphthalene based superplasticizer was improved by 63% and 27 % at early and late ages, respectively.

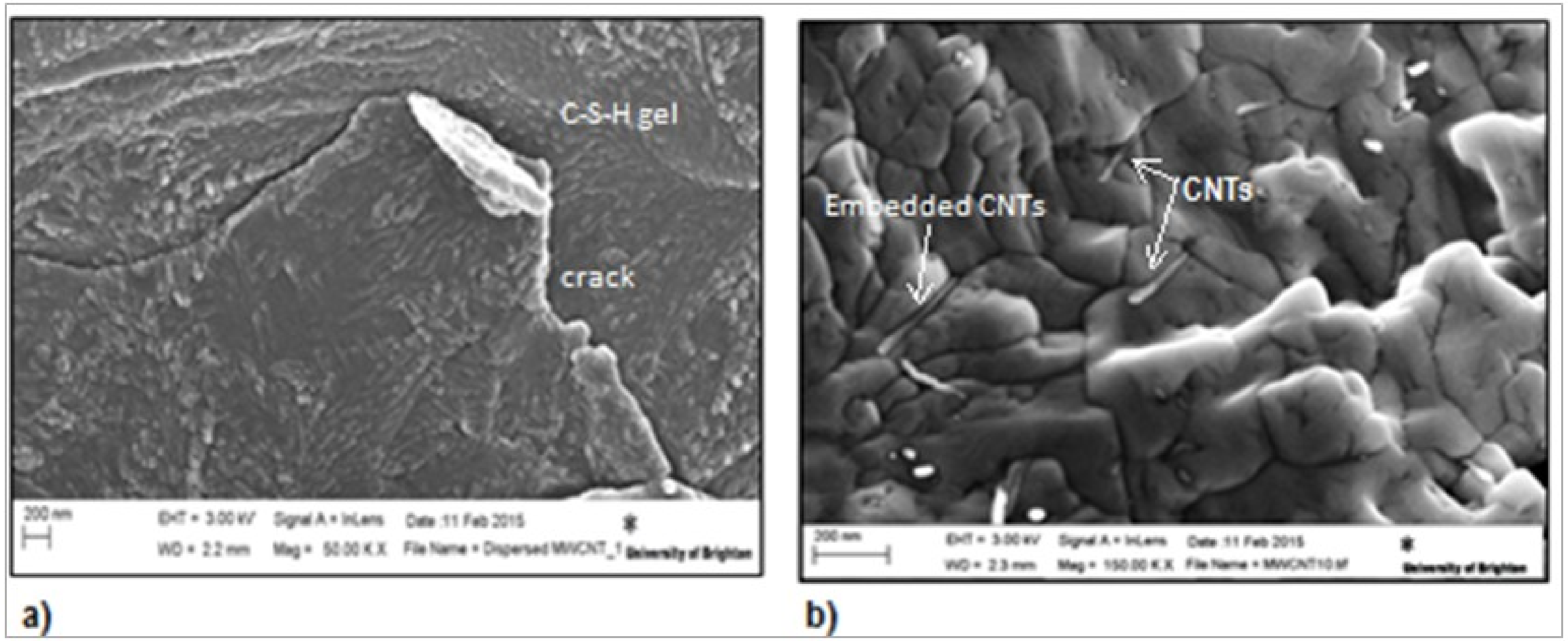
- MC, and TX-100 have improved the dispersion of nanotubes, but the compressive strength of the specimens containing these suspensions is significantly reduced.

- These agents are incompatible with the cement hydration process leading to a delay in cement hydration





3-Scanning electron microscopy (SEM



- SEM images show that the nanotubes are dispersed uniformly
- CNTs were found to be embedded as individual fibres and acted as bridges between hydrates and across cracks.
- This results ensures good load-transfer efficiency from the cement matrix to the nanotubes.

Conclusion

This study presents the results of investigations the effect of four dispersion/ surfactant agents on dispersion, workability, and compressive strength of composite containing MWCNTs / F-MWCNTs

1. Dispersion efficiency NPH < PCE < MC < TX-100
2. Effect on workability NPH < PCE < TX-100 < MC
3. Effect on strength TX-100 = MC < PCE < NPH

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[4] Collins, F., J. Lambert, and W.H. Duan, The influences of admixtures on the dispersion, workability, and strength of carbon nanotube–OPC paste mixtures. Cement and Concrete Composites, 2012. 34(2): p. 201-207.

Thanks for listening!

Any Questions