Acid-treated carbon nanotubes and their effects on mortar strength

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Background

Dispersion of Carbon nanotubes (CNTs) in mortar is a challenging task as they tend to agglomerate forming clusters.

SEM image of entangled CNTs

To improve dispersion:

a) Dispersion agents, e.g. surfactants. Main disadvantage is introduction of air voids.
b) Acid-treatment of CNTs in order to introduce functional groups onto the walls of CNTs, a process called functionalization. Main disadvantage is excessive treatment degrade the CNTs.

Methodology

Acid-treatment using sulfuric and nitric acid solution

Duration =100 min

Duration =180 min

Characterization of acid-treated CNTs

Fourier Transform Infrared (FTIR) to assess functionalization

Control (No CNTs)

With CNTs treated for 100 min

With CNTs treated for 180 min

Casting Mortar Specimens

Testing compressive strength at 28 days

Results and Discussion

FTIR Spectroscopy

- Peak-intensity at 2400 cm⁻¹ increases with treatment denoting effective functionalization

Raman Spectroscopy

- An increase in the intensity at 1350 cm⁻¹ marks more defects with treatment

Compressive Strength

- Mortar strength increases with acid-treatment time

Conclusions

The main findings of the study are:

- Defects on CNT produced by acid treatment were evidenced by FTIR Spectra.
- Strength of mortar containing CNTs treated with the acidic solution increased by 40% as compared with the mortar without CNTs.
- Increase in treatment duration from 100 min to 180 min slightly enhanced mortar strength, resulting from improved CNT dispersion.

Recommendations

A comprehensive study needs to be performed to investigate the effect of a wide range of treatment durations, possibly leading to an optimum treatment duration. A set of other factors like temperature, acid type and acid molarity could also be considered.

References


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