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Electrical resistance and compressive strength properties of cement composites using MWCNT dispersed in polycarboxylic acid superplasticizer

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INTRODUCTION & AIM

- Multi-walled carbon nanotubes are the most widely used high-conductivity materials applied to cement composites.
- However, carbon nanotubes are hydrophobic materials, and when they come into contact with water, they tend to agglomerate, which can form microscopic defects within the cement composite and actually reduce its performance, as reported in numerous studies.
- One effective method for mitigating the aggregation of carbon nanotubes is reported to be the functionalization of carbon nanotubes with carboxyl groups.
- In this study, polycarboxylic acid water reducers(PCE) used for concrete were used as dispersants for CNTs, and the electrical resistance and compressive strength of cement composites mixed with dispersed CNTs were evaluated.

METHOD

- The cement used in this study had a density of 3.15 g/cm^2 and a Blaine fineness of 3,560 cm^2/g.
- Carbon nanotubes used were multi-walled carbon nanotubes with a surface area of 221 m^2/g, a purity of 97.88%, and a density of 0.094 g/ml.
- Table 1 shows the experimental mixtures used in this study, with a water-cement ratio fixed at 50%. The measured items were surface electrical resistance at 28 days of age and compressive strength at 28 days of age.
- For multi-walled carbon nanotubes, the concentrations used were 0, 0.25, 0.5, 0.75, and 1.0 wt% relative to water weight, while the dispersant PCE was used at a fixed concentration of 1% relative to water weight.
- Specimens were prepared as 20x20x200 mm prismatic test specimens to evaluate surface electrical resistance and as 50x50x50 mm cubic test specimens to evaluate compressive strength.
- The samples used for electrical resistance measurement were cured in an atmospheric environment of 20°C and 40% RH to minimize the influence of moisture, while the cubic specimens were cured underwater.

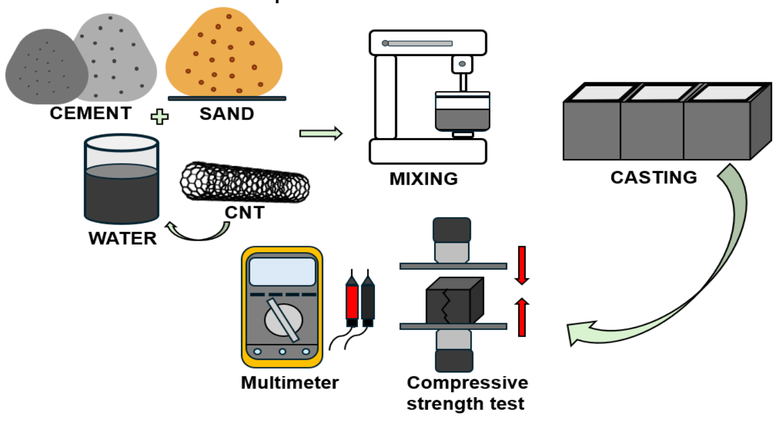

Figure 1. Experimental procedure

(a) SEM image of MWCNT (b) Natural sand (c) Specimen

Figure 2. Materials used and test specimens

Table 1. Mixing proportions of mortars

Type	CNT (W*wt%)	CNT (g)	Water (g)	Cement (g)	Sand (g)	PCE (g)
20x20x200 mm (prismatic) 50x50x50 mm (cubic)	0	0	76.5	153	333	0.77
	0.25	0.19	76.3	153	333	0.77
	0.5	0.38	76.1	153	333	0.77
	0.75	0.57	75.9	153	333	0.77
	1.0	0.76	75.7	153	333	0.77

RESULTS & DISCUSSION

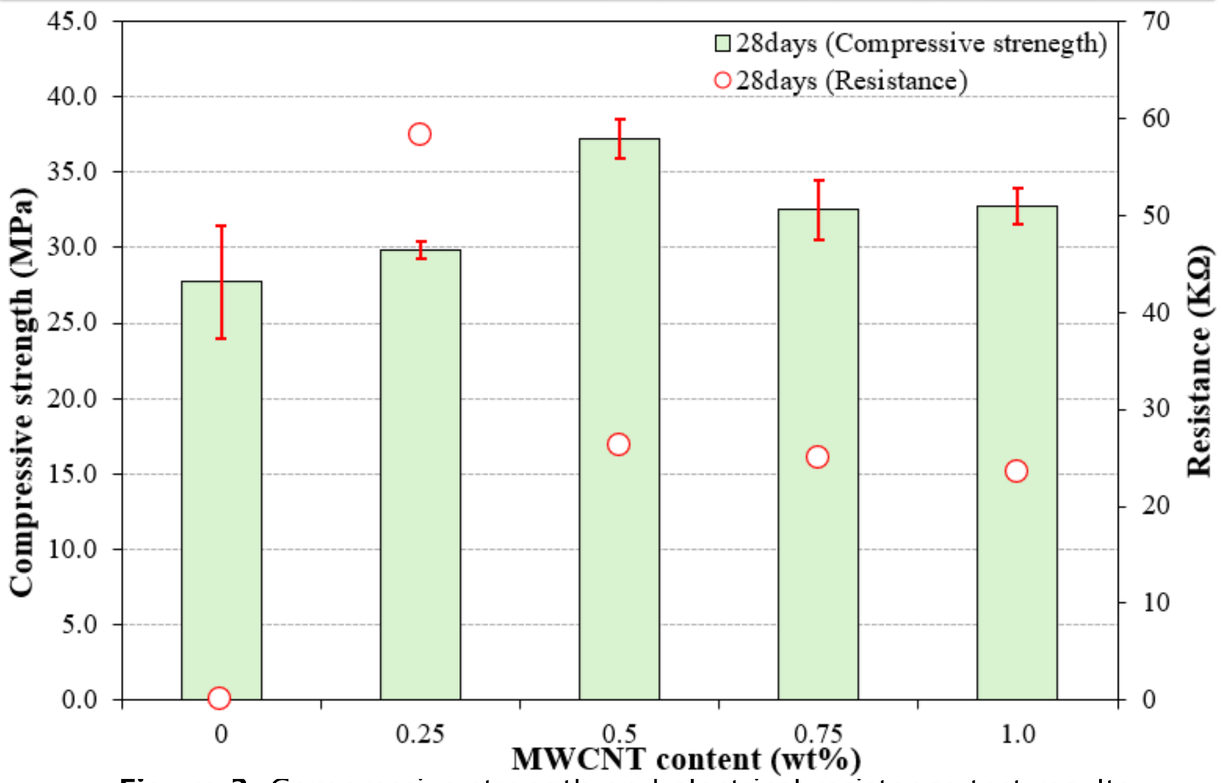

Figure 3. Compressive strength and electrical resistance test results

- Figure 3 shows the compressive strength and electrical resistance after 28 days of aging, with the plain sample having the lowest compressive strength.
- The compressive strength of the samples using CNT increased up to a CNT content of 0.5 wt%, but decreased when the content exceeded 0.5 wt%.
- When CNT was used at 0.75 and 1.0 wt%, the compressive strength decreased by 12.1–12.7% compared to the CN0.5 sample.
- These results suggest that the optimal CNT content is 0.5 wt%, and exceeding this causes CNT agglomeration, leading to a decrease in compressive strength.
- Electrical resistance was not measured for the Plain sample, and the highest resistance was observed at 0.25 wt% CNT, and similar at 0.5 to 1.0 wt%.
- The insignificant change in electrical resistance is believed to be due to the aggregation of CNTs, as shown in Figure 4.

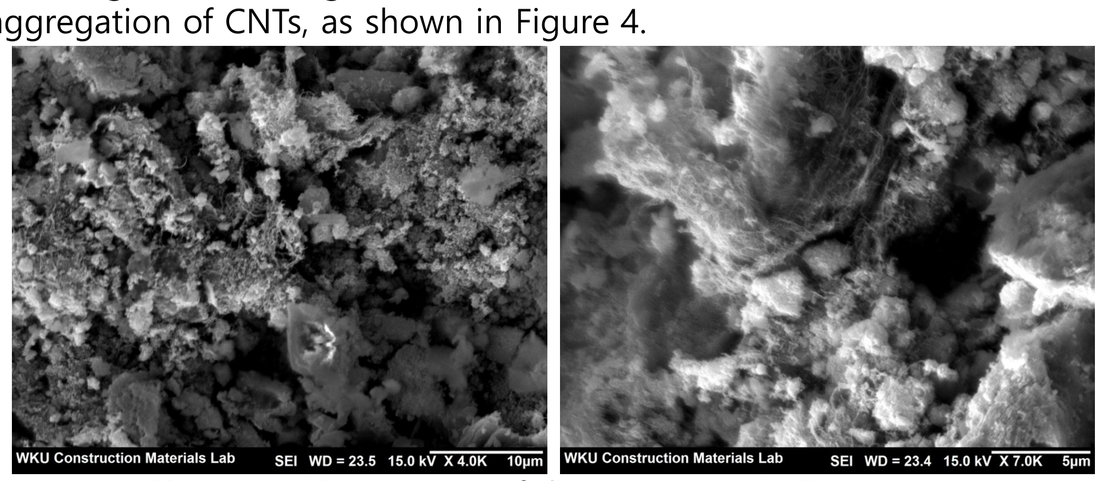

Figure 4. SEM images of the specimen(CNT 1.0wt%)

CONCLUSION

- In this study, the compressive strength was optimal at 0.5wt% CNT, and decreased at concentrations higher than that.
- Similar to compressive strength, electrical resistance did not show significant differences at concentrations higher than 0.5wt% MWCNT.

REFERENCES

References
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