Carbon Nanotube Reinforced Concrete

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ABSTRACT

Concrete is a well proportionate mixture of cement, fine aggregate, coarse aggregate and water. Concrete without any fiber gives more strength in compression as compared in tension. Because of this deficiency of concrete some extra materials having some specific properties are added in concrete. With this addition tensile property of concrete is increased. Recent trend of adding this fiber is nanomaterials. Nanotechnology is advanced field for concrete industry. Some nanomaterials like Nanosilica, Nanoclay, and Titanium- Dioxide etc. are having good properties. In this experiment Carbon Nanotubes are used in concrete. These Carbon nanotubes are used in varying percentage of weight of cement in concrete. Mechanical properties of Carbon nanotube reinforced concrete are tested.

Keyword: *Nanotechnology, Strength, Splitting tensile strength. Flexural strength Carbon nanotube · Cement · Multiwall nanotube · Dispersion*.

1. INTRODUCTION

In fact the term nanotechnology offers very much elaborate meaning and vast scope that may be changes from field to field. According to survey conducted it came to know nanotechnology has been emerged as best technology in the construction industry. Carbon nanotubes, long, thin cylinder of carbon were first discovered by Iijima in 1991. Carbon nanotube is a distinctive type of carbon which has high aspect ratio as well as extremely high strength. Carbon nanotube also has very high modulus of elasticity. Nanotechnology is very vast area of study. Many researcher have study on nanotechnology to find new nanomaterials which are useful for human. New nanomaterials which find by scientist are Nanosilica, Nanoclay, Titanium Dioxide, Carbon Nanotubes etc. all these materials having their own specific properties in mechanical, electrical, thermal. Carbon nanotube is also one nanomaterial which having great advantage because of their mechanical properties, their very high form factor (length/diameter ratio) and their electrical property. Carbon nanotubes have drawn tremendous interest from fields ranging from condensed matter physics to chemistry and from both academia, and industry, because of the unique properties enabled by their Nano scale structure.[1]

From the above discussions of researcher we come to know that carbon nanotubes are the best alternative to the common fibers. To study the strength properties of concrete in this report carbon nanotubes was used. Carbon nanotubes are having two type, single walled and multiwalled. . Nanotubes are known to be composed of a single sheet called as single-walled nanotubes (SWNT) and of several concentric sheets called multi-walled nanotubes (MWNT).

OBJECTIVES

- In this study an attempt has been made to recommend a tentative optimum mix ratio to develop CNT cement composite based on experimental investigation.
- To compare the performance (flexural, compressive and spilt tensile strength) of the CNTs with plain concrete.
- To create an awareness of carbon nanotube how their use in future application within the field of construction and Nano technology can benefit to our society.
- To identify potential application of CNTs in everyday life.

MATERIAL USED

Ultratech Portland Pozzolana cement (P.P.C) of grade 53 was used in this study. Natural river sand of grading zone II was utilized. 20mm size aggregates are used. MWCNTs which are purchased from supplier having black powder form, of 10-15 μm diameter. This carbon nanotubes are in powder form so it can not able to directly mix in concrete. We have to first disperse this tubes.

Fig No.1 MWCNT (Powder Form)

2. Dispersion of Carbon Nanotubes

CNTs because of their hydrophobicity, lack of solubility present great challenge in mixing effectively in cement matrix. The very high specific surface area of CNTs poses a problem in dispersion because they tend to reunite and bundle up owing to the high surface energies particularly in the case of MWCNTs. Also even the effectively dispersed CNTs pose a problem of adhesion since it has been observed that finely dispersed MWCNTs are pulled out of the matrix under tension because of the lack of adhesion. Commercial grade MWCNT was procured in powder form. Therefore, ultrasonic vibration was utilized to split agglomeration of nanotubes and distribute them across the cement grains.

Dispersion of Carbon nanotubes is very important for addition into the concrete. For this experiment dispersion of carbon nanotubes is done by Bath Sonicator. Dispersion of CNT is done in water. These samples are placed in ultrasonic bath for 30 minutes after that samples are removed and cooled to room temperature.

Fig No.2 MWCNT (Dispersion)

3. TESTING PROGRAM

3.1 Testing procedures

Mix design is prepared having w/c ratio 0.35 and 30 MPa characteristic compressive strength. Carbon nanotubes are added in 0.015, 0.020, 0.030, 0.040 weight percent of cement. Three type of test were conducted on concrete. Compressive strength test is conducted on concrete cubes of 150x150x150 mm size. Split tensile strength test is conducted on 300mm length, 150mm diameter cylindrical specimens. Flexural test is conducted on beam samples of 700mmx 150mm, 150mm. these test are conducted on calibrated compression testing machine and universal testing machine.

4. EXPERIMENTAL RESULTS AND DISSCUSSIONS

- **Mechanical properties**

The casted samples are tested for their strength. Below table shows the percentage increase of strength than plane concrete. From the result compressive strength, flexural Strength, split tensile strength are increased by addition of carbon nanotubes. Compressive strength is increased up to 21 %. Split Tensile strength is increase up to 36 %. Flexural strength is increased up to 15%. For 0.030% concrete gives highest strength, above it reduces slightly.

Table no. 1 percentage increase of strength

Sr.no	sample	Compressive Strength	Split Tensile Strength	Flexural Strength
2.	CNT 0.015%	5.28	8.4	5.72
3.	CNT 0.020%	12.74	16	7.80
4.	CNT 0.030%	20.80	35.20	14.24
5.	CNT 0.040%	15.25	32.80	10.58

5 CONCLUSION

After studying the several test results of different specimens ranging in Carbon Nanotubes content from 0.015% to 0.040% by weight of cement, the following conclusions are deduced,

1. Addition of carbon nanotubes increase the mechanical properties of concrete effectively.
2. From the result optimum mix ratio for addition of carbon nanotube in concrete is 0.030%
3. Effect of carbon nanotubes is more for split tensile strength than compression and flexural strength.
4. Carbon nanotubes are the best alternative for fiber.

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