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Improving The Properties Of Concrete Using Multiwall Carbon Nanotube (MWCNT)

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ABSTRACT:

This paper discusses the effect of Multiwall Carbon Nanotubes (MWCNT) on compressive strength of mortar. The carbon nanotubes also be used as a conductive material and that could be used for developing a sensing property of mortar. Dispersion of MWCNT with cement is done by Sonication process. Same amount of surfactants is added for good dispersion of MWCNT with Cement. The compressive strength is increase by adding 0.75 % MWCNT by weight of cement. Results shows of 7 days compressive strength of MWCNT mortar mix is similar to 28 days compressive strength of conventional mortar mix, and a good conductivity achieved by carbon nanotubes.

Keywords*: Cement, Mortar,* ***MWCNT, Sonication, Compressive Strength, Sensing***

I. INTRODUCTION

Carbon nanotubes are the nanoparticles. They are having 12 to 15 nm diameter and 0.5 to 5 µm and 8 to 15 layers. There are two types of Carbon Nanotubes. Singlewall carbon nanotubes and multiwall carbon nanotubes. Tensile strength of multiwall carbon nanotube is higher than single wall carbon nanotubes, so multiwall carbon nanotubes used in this research work. Carbon nanotubes have good mechanical and electrical properties, so that it is improve compressive strength and conductivity of mortar cube.

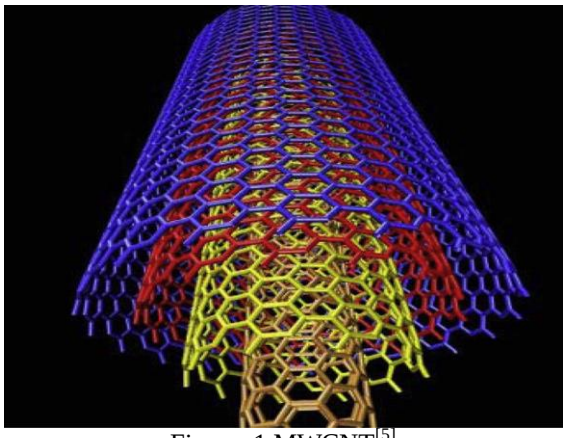


Figure. 1 MWCNT[5]

Multiwall Carbon nanotubes are in nano size so that its proper dispersion with cement is difficult. For proper mixing of MWCNT with cement different methods are available such as, physical method and chemical method. Physical method like sonication and chemical method enhance solubility of MWCNT in water. In this research work, physical method such as sonication process is used for good dispersion of MWCNT.

Electrically conductive cement-based composites doped with carbon nanotubes possess the functional properties of being strain- and damage-sensitive, thus providing a cost-effective solution for monitoring of concrete structures.[6] MWCNT is conductive material so allows electricity to pass through it due to this a network is created. When changes occur in such a network sensing properties can be achieved. For passing electricity electrodes are used. Electrodes can be of different types such as a pair of electrode or wire mesh as electrodes. The resistance changes irreversibly upon damage, as shown for damage inflicted by compressive load. Recent advances in the field of Nanotechnology have led to the development of new multifunctional and smart materials that used as a construction material.

II. MATERIAL

The material used for experimental setup is cubes with the size of 70*70*70 mm made of mortar & mixed with 0.75% with respect to the weight of cement. Portland pozzolana cement, Fine grain sand and distilled water are used. The nanotubes used as nanofiller for cementious mixture are Industrial Grade Multi Walled Carbon Nanotube MWCNT (90%) and their properties given in Table 1.

Material	***Multi- Walled Carbon Nanotubes***
Length	*0.5-5μm (Average)*
Diameter	*12-15nm (Average)*
Layer	*8-15*
Purity	*> 97%*
Surface Area	*231.85m^2/g*
Tensile Strength	*10-60 GPa*
Electrical Properties	*Conductivity - 106 Ω/M*

Table 1 Properties of MWCNT

The quantity of material used for 1 cube of mortar is given in Table 2. According to literature the quantity of surfactant is equal to the MWCNT. In this work Sodium Lignosulphonates used as a surfactant, it is cheap and easily available material.

Mortar proportion (1:2)	***Without MWCNT***	***With MWCNT***
cement	*300*	*300*
Water	*135*	*135*
Sand	*600*	*600*
MWCNT	-	*2.25*
Surfactant	-	*2.25*
W/C ratio	*0.45*	*0.45*

Table 2 Proportion of Mortar Cube With or Without MWCNT

III. METHODOLOGY

In this work carbon nanotubes are used in nanoparticles and cement are in micro particles. This nanoparticleis difficult to mix with microparticles. Initially this nanoparticle mixed with water, then surfactant and a solvent is prepared. This mix is then sonicated for 30 min for complete blend of mix. Afterward, the sonicated mixture is further mixed with cement. Once such a mixture is properly obtained then it will be readily mixed with sand.

The above prepared cementinous mixture is then filled in mould then place electrode and is kept in 1 day for proper setting. After setting in mould, the mixture is unmoulded and kept in water for 7 days for curing purpose. Successfully cured in water it is kept in oven for 12hrs for fully dry mortar cube. The compressive strength test is carried out after completion of dry mortar on Universal Testing Machine. To know the conductivity in mortar cube, pass 5V DC power supply through electrode placed in mortar cube.

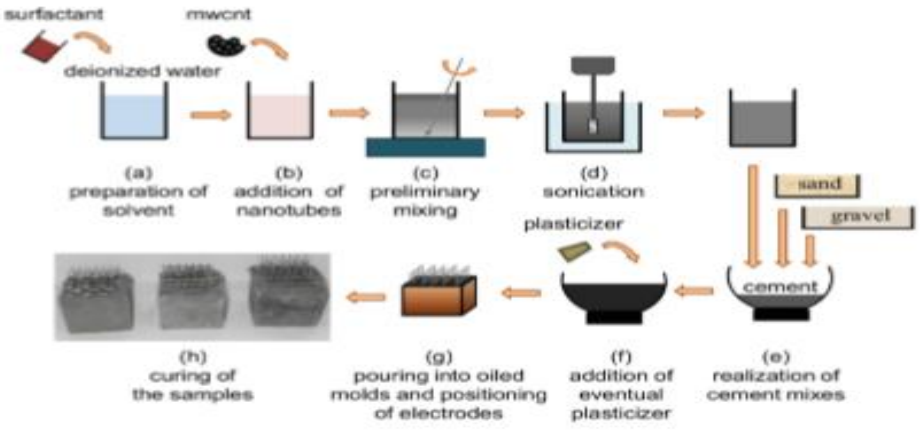


Figure 1 Preparation process of mortar cube with MWCNT [1]

IV. RESULT AND DISCUSSION

The test is conducted as per 416- 1959 on cubes of size 70*70*70 mm after 7 days of curing till failure shown in figure 2. The maximum failure load and results are presented in Table 3.The compressive strength of 0.75%MWCNT at 7 days is higher than the Conventional mortar. For achieving conductivity two digital multimeters are connected parallel to each other and obtained data for conductivity which shown in figure 3.

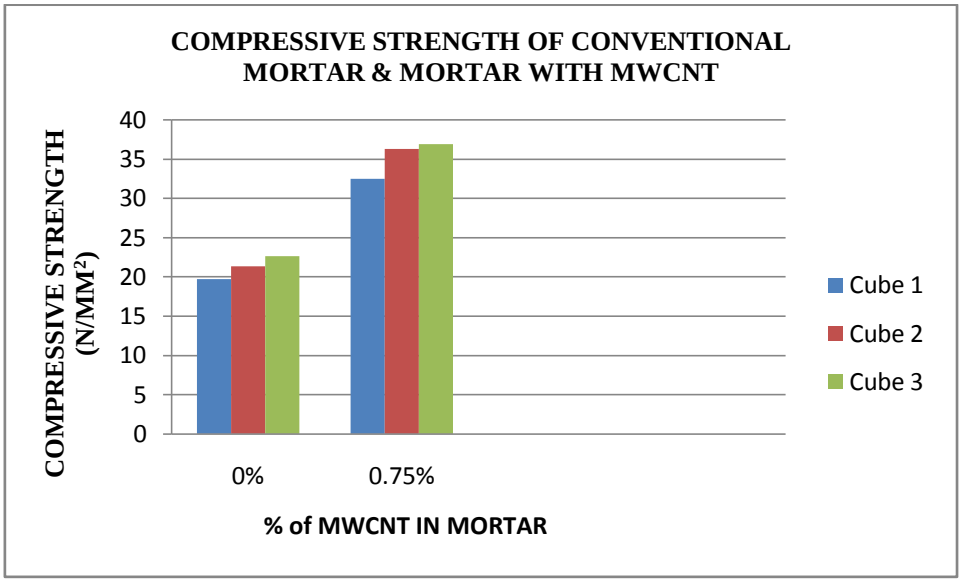
Figure. 2 Testing For Compressive Strength

Figure. 3 Testing For Conductivity

When pass 5V voltage from DC power supply constantly the changes occur in current value. This changes current value put in below equation.

$$R = V/I$$

Where, R = Resistance, V = DC power supply, I = current. According to research when load is applied resistance are changed and that resistance value gives sensing data. In this paper 2 sets of results were carried out for conductivity. Conductivity values before loading is 2, after loading it was 1.5. This shows MWCNT is a conductive material and it can help to pass electricity from mortar. Due to this sensing properties can be attained.



Specimen Type	Compressive load (KN)	Compressive strength (N/mm^2)
Conventional mortar	104.33	21.25
0.75% MWCNT	172.86	35.27

Table 3 Compressive Strength of Mortar

V. CONCLUSIONS

From the results, it is understood that the MWCNT mortar gives higher strength compare to conventional mortar and MWCNT mortar also has the ability to pass electricity and give conductivity. For good conductivity, it is necessary to have a complete dispersion of MWCNT into cement particles. Sodium Lignosulphonates surfactant is cheap and easily available material and gives good solubility with water.

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