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Parametric Study of Mechanical Properties of Concrete and Cement Mortar Prepared using Multi-Walled Carbon Nanotubes

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Abstract: ***Nanotechnology and Nano materials have much more advantages compare to conventional materials and are also helpful to overcome certain limitations of conventional materials. Among some of the nano materials Carbon Nanotubes are found to be useful in Construction industries along with construction materials thereby increasing and improving concrete properties. This experiment is based on usage of Multi-walled carbon nanotubes (MWCNT) in particular proportions by weight of cement in preparation of M25 grade Concrete and 1:3 cement mortars. For effectively using MWCNT in concrete and cement mortar, Polycarboxyl ether superplasticizer was used in (0.4)% proportion as a surfactant in water with MWCNT to dispersed them. The Compression test and Durability Test (Acid Test and Sorptivity Test are conducted at 90 days).Cubes of (150 x 150 x 150) mm are used for concrete and (50 x 50 x50) mm are used for mortar. Cylinder of 200mm height and 100mm dia. is use for split tensile testing for mortar.***

Keywords: ***Nanomaterials, Multi-walled Carbon Nanotubes, Polycarboxyl ether, Superplasticizers***

I. INTRODUCTION

The extraordinary Physical and chemical properties of materials at the nanometer scale enable new applications ranging from structural strength enhancement to self-cleaning properties. Consequently, various nanomaterials have been used in the concrete to make it a real “smart” material. CNT also have tremendous range of applications in concrete structures depending upon the size and morphology of the fibrous carbons. As the size of CNT particles is finer than cement particles, so these can be used in concrete as void filler. CNTs are effectively used in various research works which effectively improves the mechanical properties of concrete and mortar, when single-walled CNTs or multi-walled CNTs are added into concrete mixtures, the reduction in cracks generation or elimination of cracks can be done. If a crack that is generated and started propagating inside nano composite concrete material, it will encounter carbon nanotubes, and the propagation of crack will stop, and it will not propagate due to all other carbon nanotubes surrounded.

II. MATERIALS

A. Cement

The cement used in this experimental investigation was OPC 53 grade cement, manufactured by Sanghi Cements company, Conforming to I S:8112-1989 having density 1440 kg/m^3.

B. Aggregate

The coarse aggregates used in this experiment were 20 mm and 10 mm. The Coarse Aggregates from crushed basalt rock, conforming to IS: 383 were used. The Flakiness and Elongation Indices were maintained well below 15% having density 1400 - 1450kg/m^3.

C. Fine Aggregate

The fine aggregates used in this experiment were fraction from 4.74 mm to 150 micron. The river sand used conforming to IS: 383-1970, zone-II. The sand was screened before use and having density of sand is 1650 kg/m^3.

D. Fly ash

Fly ash used here is Class C, and was industrially manufactured in grey powder form Fly ash. Fly ash used here is Class C, and was industrially manufactured in grey powder form.

E. Polycarboxyl Ether Superplasticizer

The Polycarboxyl Ether was used as a surfactant in this project. It is brownish colour liquid having density 1.02Kg/L. It is a water reducing agent.

F. Multi-walled Carbon Nanotubes

The MWCNT are physically in black powder form. It is produced via a modified catalytic carbon vapor deposition process. They have high purity of carbon, narrow range of outer diameter and ultra-high aspect ratio. The properties of MWCNT are as follows:

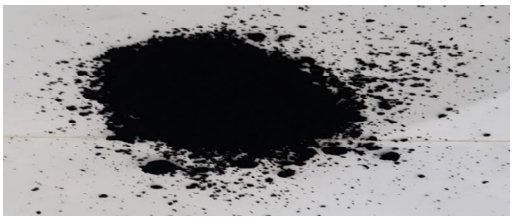

Fig. 1. Multiwalled carbon nanotubes

TABLE I PROPERTIES OF MWCNT

Length	0. 5- 5μm (average)
Diameter	12- 15nm (average)
Layer	8-15
Tensile Strength	10-60GPa
Thermal Properties	Conductivity>3000w/mK

III. METHODOLOGY

In this paper Multi-walled carbon nanotubes (MWCNT) were used in different proportions (0.01%, 0.015%, 0.02%, 0.025%, 0.03%, and 0.035%) by weight of cement in M25 grade concrete and (0.008%, 0.0175%, 0.026%, 0.035%, 0.044%) proportion for (1:3) Mortar. They are insoluble in all organic solvents and aqueous solutions, and thus they are dispersed by using super plasticizer as surfactants in (0.4) % proportion by weight of cement.

IV. RESULTS AND DISCUSSION

A. Compression Strength

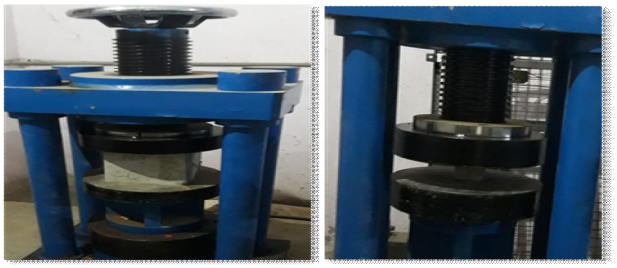

Fig. 2. Compression Test for Concrete Specimen and Mortar Specimen

For concrete load is applied continuously at the rate of 5.15 kN/s, and for Mortar cubes load is applied continuously at the rate of 3 kN/s until the specimen fails. The results for compression strength at 7,28and 90 days are as follows for both concrete and Mortar specimens

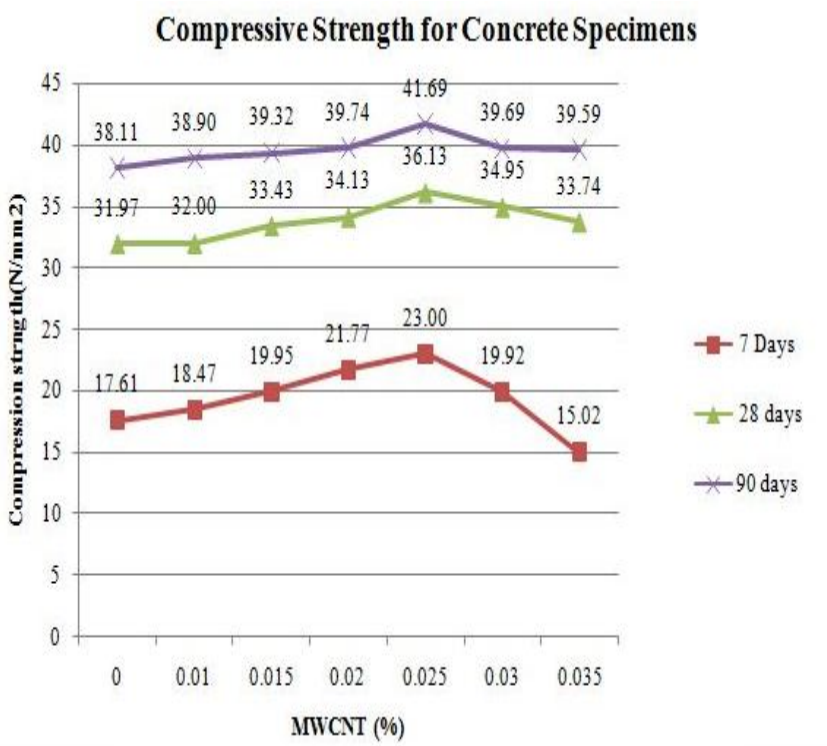

Fig. 3. Results for concrete specimen

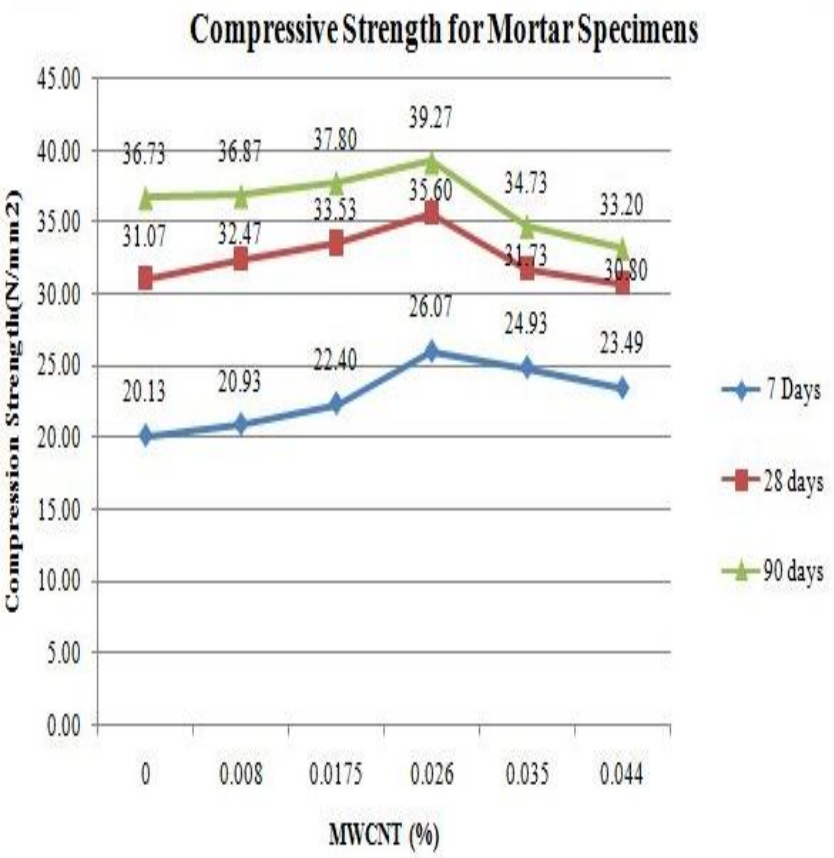

Fig.4. Strength results for mortar specimens

B. Split Tensile Strength

The Split Tensile test was conducted at 28 and 90 days. The results obtained are as follows:

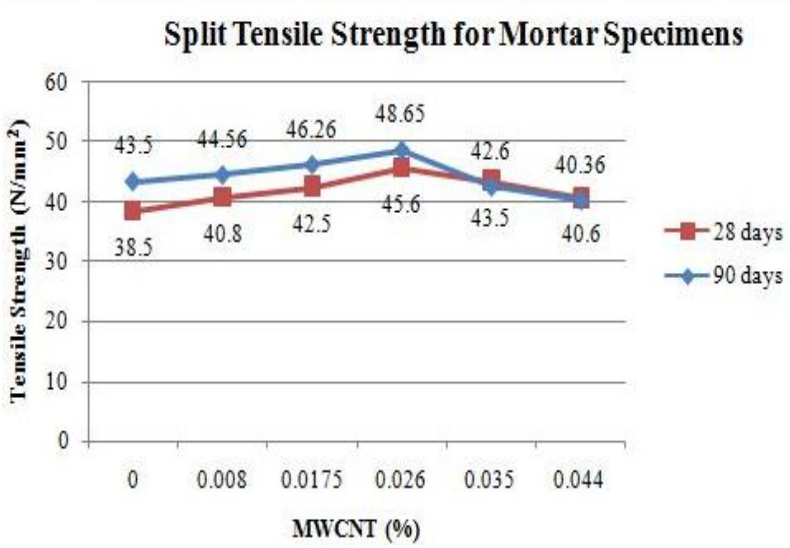

Fig. 5. Split tensile strength result

C. Acid Attack Test

After 28 days of water curing, the concrete cube specimen to be tested was kept in atmosphere for 2 days for constant weight. Weighted of specimens are first noted and the specimens were immersed in acidic water containing in 3% sulphuric acid (H2SO4 and allowed to cured by acidic water for 90 days. The PH value of acidic media was regularly checked and maintained between (0.2-0.3).

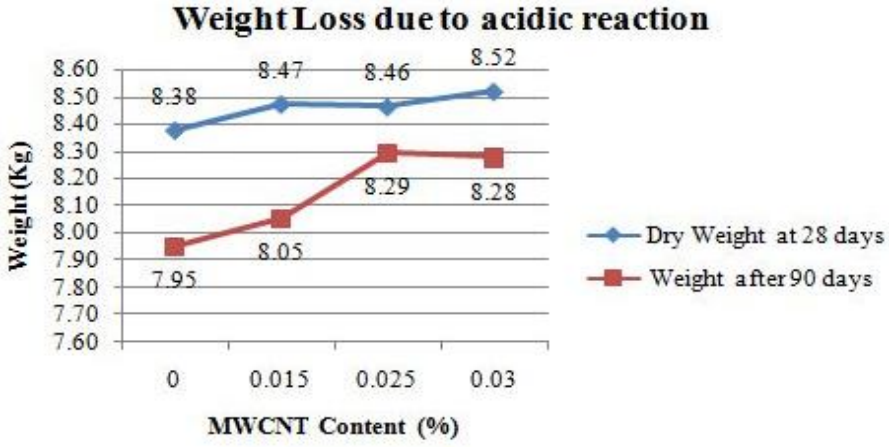

Fig. 6. Results of acid attack test at 90 days

V. CONCLUSIONS

For concrete, the maximum Increase in compression Strength by MWCNT was observed for different dosage rates, 12% strength was increase at 28 days, 8.5 % strength was increase at 90 days compared to traditional mix design.

For Mortar, the maximum increase in compressive strength by MWCNT was 13% at 28 days and 6.5% at 90 days compare to traditional mix design.

The Acid Attack test for concrete shows a 5.13% decrease in weight for traditional concrete and 2.8% decrease in strength than concrete with MWCNT, thus MWCNT containing concrete was found good resistance to acid attack test.

VI. FUTURE RESEARCH

Sorptivity test would be conducted for the same design mix for concrete.

Cost comparison, Economic Factors, and Applications of MWCNT will be included.

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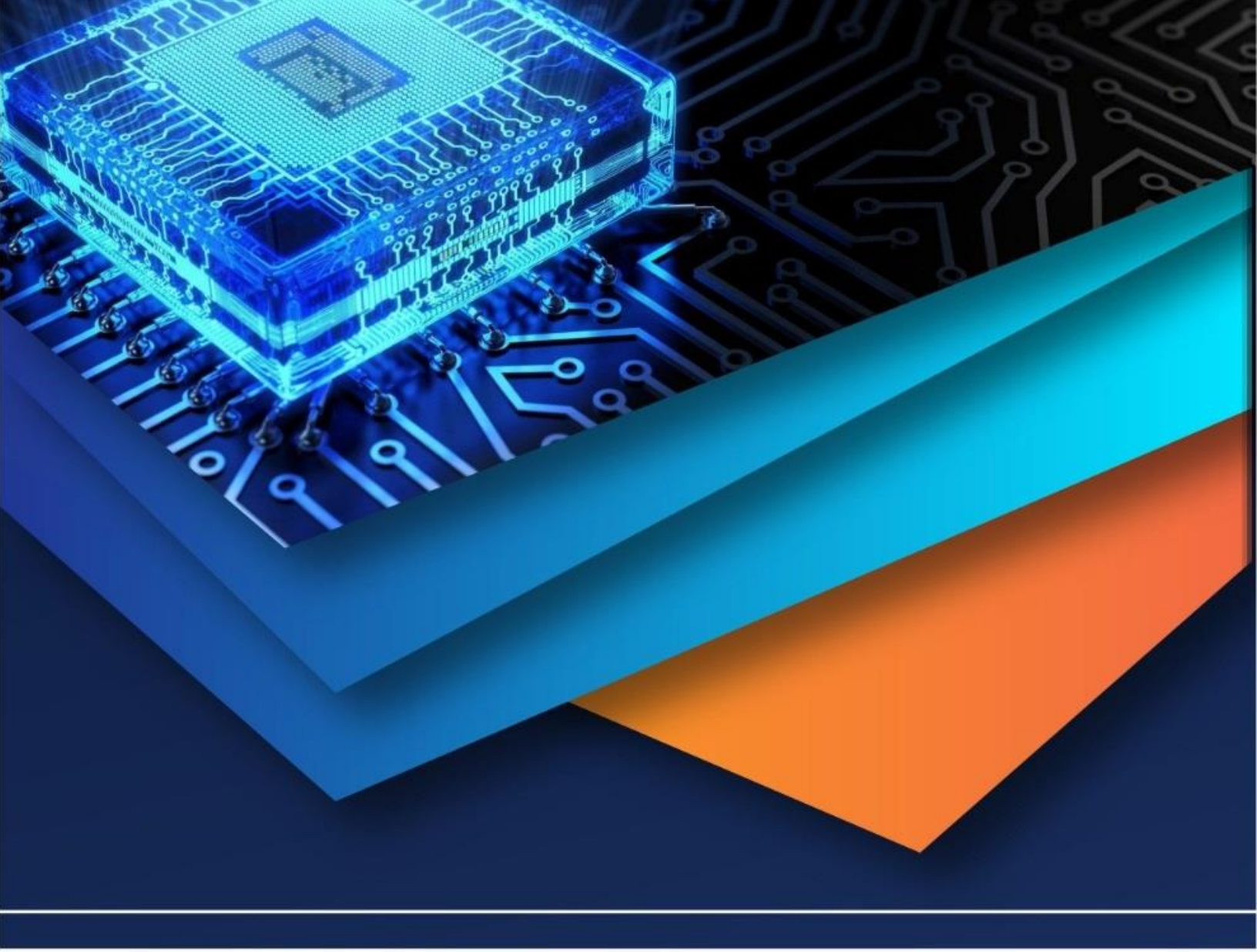

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