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Dispersion of Multi - Walled Carbon Nanotubes on Foam Concrete

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Abstract

Light weight concrete with performance is getting popular now-a-days. It is a versatile material with 20% of air in concrete. The dry density of foam concrete varies from 50MPa to 160MPa& compressive strength varies from 1MPa to 15MPa. This low compressive strength can be improved by adding fibres to foam concrete. This experimental study involves dispersion of multi walled carbon nanotubes 0.3% in foam concrete to attain a compressive strength of M25. The results are comparable with conventional concrete of M25 strength.

Keyword:*MWCNT,super plasterices,*

1. Indroduction

Builders throughout the world are paying an increasing attention in the use of foam concrete normally referred as cellular concrete (Hassan et al 2011). Generally concrete can be categorized into two, one is conventional concrete and the other is light weight concrete. Foam concrete comes under the category of light weight concrete.

Foam concrete is a type of porous concrete produced by mechanical mixing of foam. Foam is also a macro porous material and comes in many forms, such as polystyrene shock absorbers, dish-washing sponges and foam board insulation.

Foam concrete is also known as foamed concrete, foamcrete, cellular lightweight concrete or reduced density concrete, is defined as a cement based slurry, with a minimum of 20%(per volume) foam entrained into plastic mortar.

Foam concrete comprises of cement, sand, water and mechanically generated foam in the form of gel. Foam is prepared in a special device called foam generator and later mixed by using special mixer (P.Prabha et al 2015). By controlling the dosage of foam, foam concrete of different densities ranging from 300 to 1800kg/m^3 are prepared and are studied. Because of the integration of air-pores into the base matrix, the foam concrete gives low self-weight, high workability and excellent insulating values and compressive strengths varying from 2MPa to 16MPa, foam concrete can be produced providing flexibility for various applications such as structural, partition element and insulation material. Foam concrete is a free flowing, self-leveling; material that does not require compaction. This type of concrete is particularly suitable for high-technology special structures where, apart from the response to reduce the cost, environmental impact is also considered.

Although foam concrete possesses a great number of benefits, its compressive strength & split tensile strength are low. Attempts have been made to improve the properties of foam concrete by adding Nano materialmulti-walled carbon nanotubes (P.Prabha et al 2015).

Since nanotechnology is gaining popularity in the field of civil engineering and construction which deals with particle at Nano-scale (ie) 0.001$^{\mu}$m. One of the methods recently employed to improve the technical characteristics of concrete is the use of additives consisting of Nanodispersive particles (T.Sivakumar et al 2104).

Concrete can be tailored by the incorporation of nanotubes to control material behavior and add novel properties by the grafting of molecules into cement particles, cement phases, aggregates and additives to provide surface functionality. Nano sized particles have a high surface area to volume ratio providing the potential for chemical reactivity when it is admixed. Several challenges will need to be solved to realize its full potential, including the proper dispersion of the Nano-scale additives, implementation on larger scale and a lowering of the cost benefit ratio (Ameer. A et al 2015).

2. Materials used

2.1 AGGREGATES

Generally aggregates occupy 70% to 80% of the volume of concrete and have natural rock and sands. In foam concrete fine aggregate only plays a major role and there is no use of coarse aggregate. In order to maintain the physical properties of the foam concrete, proper gradation of the fine aggregate is important. In this study the fine aggregates were tested as per IS:383-1970 &Sand used in this study passes through 2.36mm sieve and retained in 4.75mm sieve.

Table 1: Properties of fine aggregate

Material	Value
Specific gravity	2.66
Water absorption	3.09%
Bulk density	1706kg/m^3

2.2 CEMENT

OPC 53 grade is a high strength cement to meet the needs of the consumer for high strength in the concrete. The different laboratory tests were conducted on the cement to determine standard consistency, initial setting time and final setting time as per IS 403:1 and IS269-1967. The results confirms tothe IS recommendations.

Table 2: Properties of cement

Material property		Values
Specific surface area		293mm^2
Specific gravity		3.15
Compressive strength	7thDay	40.9 MPa
	28thDay	56 MPa

2.2 SUPER PLASTICIZER

Unfortunately, different super plasticizer will be having quite different reactions with different cements. This is because of the variability in the minor components of the cement and in part to the fact that the acceptance standards for super plasticizers themselves are not very tightly written. Thus, some cement will simply be found to be in compatible with certain super plasticizers.

Properties of super plasticizer Glenium B233are as follows:

- Chemical content–Poly Carboxylic Ether
- Specific gravity – 1.08
- Chloride content -<0.3%
- Solid content – 35.46%
- Compatibility– All types of cement
- Ph – 7.02
- Viscosity– 50-150NS/m^2

2.3 FOAM

The foam is the main constituent of the foam concrete. Foam is the coarse dispersion of gas (normally air) in liquid. The density of the foam is about 110kg/m^3. The preformed foam consists of aqueous solution (1 part of foaming chemical with 40 parts of water) and compressed air of pressure 5kg/cm^2.

2.4 CARBON NANOTUBES

Carbon nanotubes are an allotropes of carbon. They take the foam of cylindrical carbon molecules. In particular owing to its high tensile strength they are used as reinforcement in the cement mortar. There are two main types of carbon nanotubes based on number of grapheme walls.

- Single walled carbon nanotubes
- Multi walled carbon nanotubes

Properties of MWCNT

- Diameter – ranges from <1nm to 50nm
- Length – ranges from 100 micrometre onwards.
- Very high aspect ratio
- Specific gravity - 1.3 to 2
- Young's modulus - 1000 GPa
- Very high strength i.e., 100 times more than that of steel
- Very high tensile strength of 200 GPa.

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3. EXPERIMENTAL PROGRAM

Foam concrete was produced in a laboratory using a paddle mixer by adding the preformed foam to a base mix. The foam concrete produced was divided into five series. Series I–0.1% weight of cement replaced by MWCNT & series II, III, IV & V –0.2, 0.3, 0.4 & 0.5% weight of cement replaced by MWCNT respectively. After that the dispersed MWCNTs were added to the base mix. Cubes 150 x 150 x 150mm size were used for testing the compressive strength. Cylinders 150mm diameter and 300mm height were used for finding split tensile strength.

3.1Casting

M25 grade concrete is used. Ordinary Portland cement of 53 grade is used and river sand passing through 4.75 mm sieves. Potable water was used for both mixing and curing. Water cement ratio 0.5 and mix ratio is 1:1.53:3.15.

4. Test Results and Discussions

The foam concrete specimens cast were tested and their results are given in the fig.1& 2. The results of the control specimens of foam concrete reinforced with multi-walled carbon nanotubes (MWCNTs) are compared with that of the conventional foam concrete.

4.1 COMPRESSIVESTRENGTH

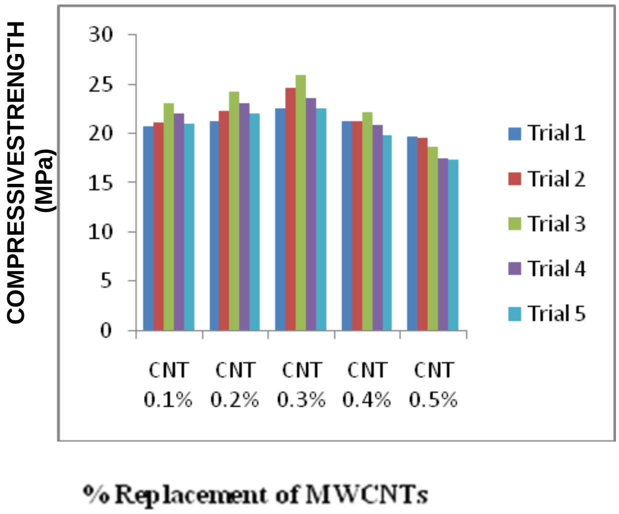

Fig.1 Comparison of compressive strength of foam concrete specimens

4.2 SPLIT TENSILE STRENGTH

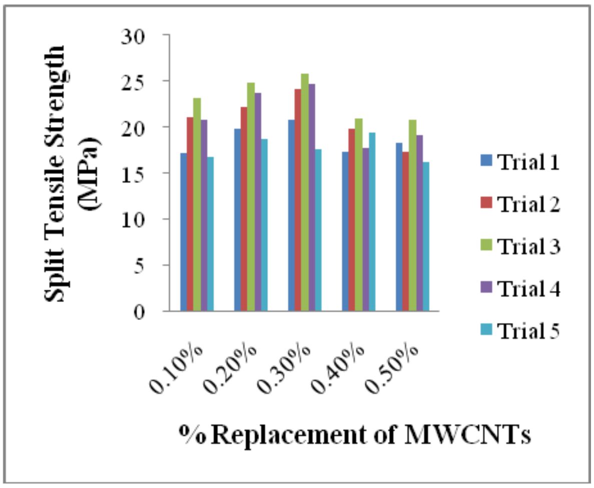

Fig.2 Comparison of split tensile strength of foam concrete specimens

5. FLEXURAL STRENGTH OF FOAM CONCRETE BEAMS BY USING SAP 2000 SOFTWARE

Three different concrete beams of size 150mm x 200mm x 1800mm were modeled using SAP 2000 software. The three different concrete beams include:

I. Normal concrete beam of M25 grade (B1)
II. Foam concrete beam (B2)
III. Foam concrete reinforced with multi-walled carbon nanotubes (B3)

5.1 LOADINGAND BOUNDARY CONDITIONS

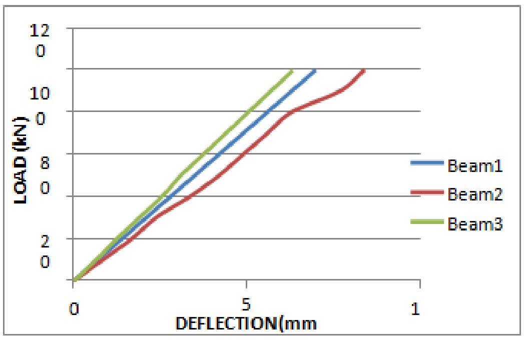

Fig.3 Load vs.deflection graph

Specimens	Experimental Load (kN)
Beam (B1)	70
Beam (B2)	99
Beam (B3)	89

Table 1: Ultimate load capacity of beams

6. CONCLUSION

The properties of control specimens of foam concrete reinforced with multi-walled carbon nanotubes (MWCNTs) includes compressive strength and split tensile strength. It has been inferred that there was an improvement in the properties of foam concrete when it was reinforced with multi-walled carbon nanotubes (MWCNTs). The properties of foam concrete like compressive strength and tensile strength get increased up to 40% when it was reinforced with multi-walled carbon nanotubes. The optimum Nano material content was also been identified for which the concrete yields high compressive strength (25.90MPa) and split tensile strength (25.90MPa). After optimum point the strength gets reduced up to 20% based on the fact that accumulation of nana material in the small liquid medium.

The validation of experimental results of three different concrete beams with the SAP 2000 results has been made. It has been inferred that the conventional foam concrete beams (7.5mm) shows maximum deflection compared with normal concrete beam (6.3mm) and foam concrete beam reinforced with multi-walled carbon nanotubes (6mm). So the deflection of the foam concrete beam get reduced up to 20% when it was reinforced with Nano material MWCNTs.

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