International Journal of Advanced Science and Technology
Vol. 28, No. 16, (2019), pp. 546-553

EFFECT OF NANO SILICA AND MULTI WALLED CARBON NANO TUBES ON MECHANICAL PROPERTIES OF CONCRETE

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Abstract:
Efforts are made to improve the mechanical properties of M30 grade of concrete by the application of multi walled nano carbon tubes and nano silica. Very small particle sizes of nano materials can alter the properties of concrete. An experimental study is conducted by substitution of cement with nano silica of 0.3,0.6 and 1% by weight of cement and multi walled nano carbon tubes 6 nm diameter of 0.03, 0.045 and 0.06% by weight of cement. 0.3&0.03%,0.6&0.045%,1and0.06% replacing nano silica and multi walled carbon nano tubes by weight of cement. While performing compressive strength test, split tensile strength test, ultra-pulse velocity test, showing a significant increase in compressive strength in early age.Reinforcing concrete with multi-walled carbon nano tubes usually resulted in enhancing the mechanical properties of concrete nano composites relative to the reference samples.

Key words- Compressive strength,Multi walled carbon nano tubes, Nano silica,Split tensile strength, Ultra pulse velocity.

I. INTRODUCTION

Concrete is a composite material, consisting mainly of Portland cement with or without mineral admixture, water and aggregates (fine and coarse aggregate). The materials are mixed together in order to form a paste for workable which then gradually hardens over time. Carbon nano tubes and nano silica attract the researches,because nano materials small sized particles are very effective in improving the mechanical properties only small percentage of cement can be replaced for attaining the desired strength. Nano materials are any type of material of nano sized thickness, i.e. Less than 100 nm in thickness(the usual definition of nano scale).some people define the nano material range as 1- 1000nm.

Nano silica used in concrete mix could significantly increase the compressive, tensile and flexural strength of concrete. For early strength to be achieved then admixtures play a major role. Cement mixed with nano silica mixed cement generates nano-crystals of C-S-H gel during hydration. These nano crystals in the micro pores of the cement concrete improves permeability and strength of concrete. Carbon nano tubes having cylindrical shape and hence the name derived from nano metre diameter. Their lengths are several milli metres and one “layer” or wall called as single walled nano tube and if more than one wall then it is multi walled nano tube.

II. MATERIALS

a) Cement :

ISSN: 2005-4238 IJAST

Ordinary Portland Cement (OPC) of 53 grade used. Tests were conducted on cement. Test results are presented in Table 1.

Table 1. Physical properties of cement

Fineness	8%
Initial setting time	36minutes
Final setting time	425 minutes
Specific gravity	3.112
Normal consistency	32%

b) Fine aggregate

Particle size which is less than 4.75mm is used as fine aggregate. Different tests were conducted on fine aggregate. Test results are presented in Table 2.

Table 2. Physical properties of fine aggregate

Specific gravity	2.55
Water absorption	0.45%
Fineness modulus	2.46

c) Coarse aggregate

Particle size which is greater than 4.75mm is used as coarse aggregate.Different tests were conducted on coarse aggregate. Test results are presented in Table 3.

Table 3. Physical properties of coarse aggregate

Nominal size used	20mm
Specific gravity	2.81
Fineness modulus	8.62

d) Nano Silica

The average size of nano silica was found to be 236 nm from Particle Size Analyzer as shown in Fig.1. The report of which has been presented in the Table 4.

Table 4: Properties of nano silica

Test items	**Standard requirement**	**Test results**
Specific surface area	200 ± 20	202
pH value	3.7 – 4.5	4.12
Loss on drying@105 DEG.C (5)	≤ 1.5	0.47
Loss on ignition @ 1000 DEG.C (%)	≤ 2.0	0.66
Sieve residue (5)	≤ 0.04	0.02
Tamped density (g/L)	40 – 60	44
Sio_2content (%)	≥ 99.8	99.88
Carbon content (%)	≤ 0.15	0.06
Chloride content (%)	≤ 0.0202	0.009
Al_2O_3	≤ 0.03	0.005
TiO_2	≤ 0.02	0.004
Fe_2O_3	≤ 0.003	0.0001

Fig 1.Nano silica

e) Multi Walled Carbon Nano Tubes

Carbon nano tubes are molecular-scale tubes of graphitic carbon with outstanding properties.They can be several millimetres in length and can have one "layer" or wall (single walled nano tube) or more than one wall (multi walled nano tube). Carbon nano tubes are available mainly in two forms, viz., single-walled (SWCNTs) or multi-walled (MWCNTs) are presented in Table 5 and Fig.2.

Table5: Properties of multi walled carbon nano tubes

MWCNT	**Description**	**Characterization Method**
Production method	**Chemicalvapordeposition(cvd)**	**Closedcontrolled method**
Available form	Black powder	Visual
Diameter	10 nm	SEM,TEM
Length	6-9 micron	SEM,TEM
Nano tubes purity	>98%	TGA,RAMAN
Metal particles	<1%	ICP-MS
Amorphous carbon	<1%	HRTEM
Specific surface area	250-300 m^2/gram	BET
Bulk density	0.10-0.06 gram/cm^3	Pycnometer

Fig 2.Multi walled carbon nano tubes

IV. TESTS AND CALCULATION

The tests that are conducted on hardened concrete are

1. CONCRETE WITH NANO SILICA REPLACEMENT

A) Compressive Strength

The compressive strength of cubes determined by testing the specimen in compression testing machine is presented in Table 6 and Fig.3.

Table 6: Compressive strength test of concrete cubes replacing the cement with nano silica

S.No	% of Nano Silica	Compressive Strength(N/mm^2)	
		7 days	28 days
1	0	26.17	40.05
2	0.3	29.61	43.63
3	0.6	33.93	45.01
4	1	36.44	47.63

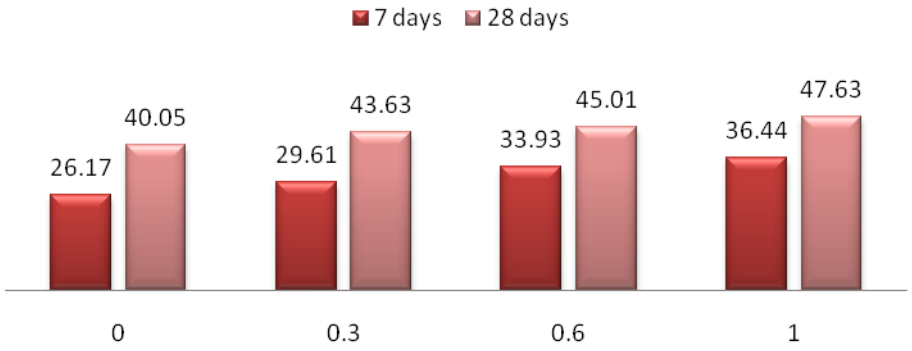

Fig. 3: Compressive Strength of concrete replacing the cement with nano silica

B) Split tensile strength

The split tensile strength of cylinder determined by testing the specimen in compression testing machine is presented in Table 7 and Fig.4.

Table 7: Split tensile strength test of concrete cubes replacing the cement with nano silica

S.No	% of Nano Silica	Split tensile strength(N/mm^2)	
		7 days	28 days
1	0	1.96	3.35
2	0.3	2.23	3.81
3	0.6	2.58	4.11
4	1	3.60	4.97

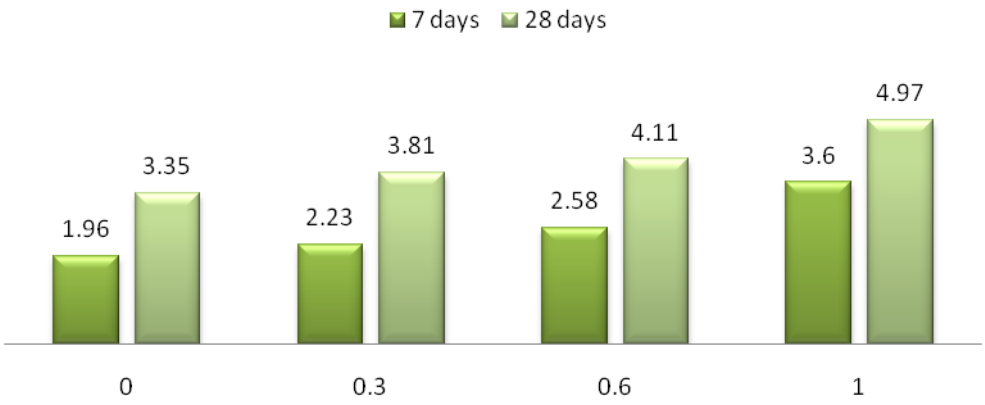

Fig. 4: Split Tensile Strength of concrete replacing the cement with nano silica

2. CONCRETE WITH MWCNT(Multiwall Carbon Nano Tubes) REPLACEMENT

C) COMPRESSIVE STRENGTH

The compressive strength of cubes determined by testing the specimen in compression testing machine is presented in Table 8 and Fig.5.

Table 8: Compressive strength test of concrete cubes replacing the cement with MWCNT

S.No	% of MWCNT	Compressive Strength(N/mm^2)	
		7 days	28 days
1	0	26.17	40.05
2	0.03	26.57	44.61
3	0.045	29.46	47.23
4	0.06	31.03	50.64

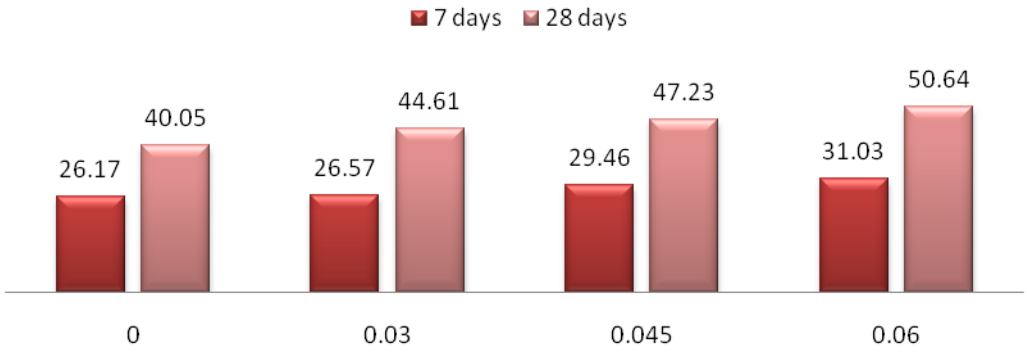

Fig. 5: Compressive Strength of concrete replacing the cement with MWCNT

D) SPLIT TENSILE STRENGTH

The split tensile strength of cylinder determined by testing the specimen in compression testing machine is presented in Table 9 and Fig.6.

Table 9: Split tensile strength test of concrete cubes replacing the cement with MWCNT

S.No	% of MWCNT	Split Tensile Strength(N/mm^2)	
		7 days	28 days
1	0	1.96	3.35
2	0.03	2.13	3.68
3	0.045	2.62	4.31
4	0.06	2.97	4.77

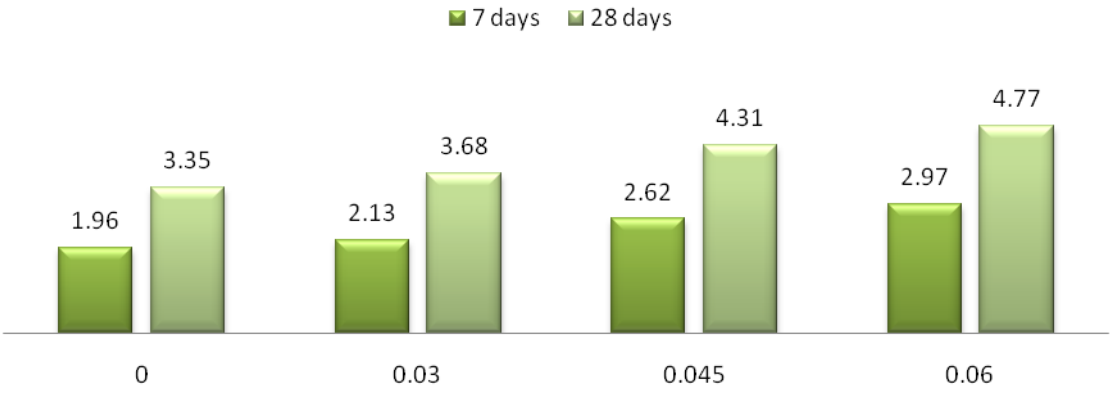

Fig. 6: Split Tensile Strength of concrete replacing the cement with MWCNT

3. CONCRETE WITH NANO SILICA & MWCNT REPLACEMENT

E) COMPRESSIVE STRENGTH

The compressive strength of cubes determined by testing the specimen in compression testing machine is presented in Table 10 and Fig.7.

Table 10: Compressive Strength Test of Concrete Cubes replacing the cement with Nano Silica & MWCNT

S.No	% of Nano Silica& MWCNT	Compressive Strength(N/mm^2)	
		7 days	28 days
1	0+0	26.17	40.05
2	0.3+0.03	31.48	45.27
3	0.6+0.045	35.55	50.12
4	1+0.06	37.72	55.21

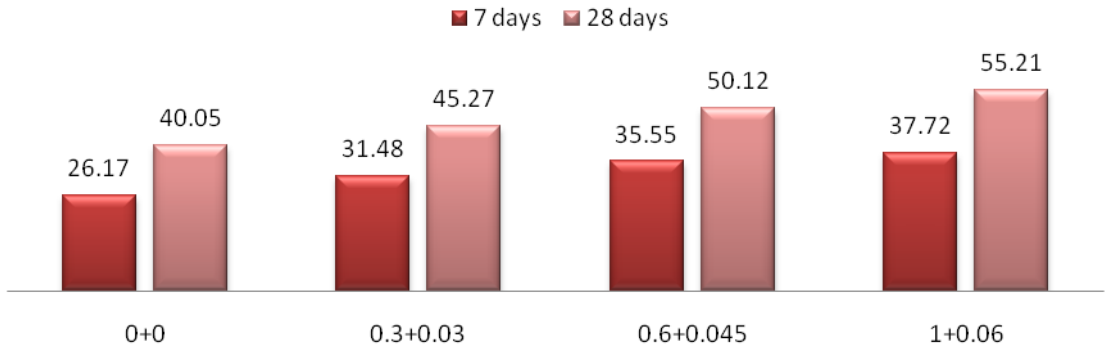

Fig.7 : Compressive Strength of concrete replacing the cement with Nano Silica & MWCNT

F) SPLIT TENSILE STRENGTH

The split tensile strength of cylinder determined by testing the specimen in compression testing machine is presented in Table 9 and Fig.6.

Table 11: Split Tensile Strength Test of Concrete Cubes replacing the cement with Nano Silica & MWCNT

S.No	% of Nano Silica& MWCNT	Split Tensile Strength(N/mm^2)	
		7 days	28 days
1	0+0	1.96	3.35
2	0.3+0.03	3.33	5.54
3	0.6+0.045	3.53	6.05
4	1+0.06	3.72	6.41

Fig. 8: Split Tensile Strength of concrete replacing the cement with Nano Silica & MWCNT

V.CONCLUSION

1. Partial replacement of cement with both nano silica and multi walled carbon nano tubes used in the preparation of concrete specimen shows increase in percentage of NS and MWCNT.
2. Maximum increase in splitting tensile strength 28-days observed with specimens concrete with (0.03%, 0.045%, 0.06% MWCNT) about (9.85%,28.65%,42.38%) respectively more than normal concrete specimen.
3. Maximum increase in splitting tensile strength 28-days observed with specimens concrete with (0.3%, 0.6%, 1% NS) about (13.73%,22.68%,48.35%) respectively more than normal concrete specimen.
4. Maximum increase in splitting tensile strength 28-days observed with specimens concrete with NS & MWCNT (0.3%+0.03%, 0.6%+0.045%, 1%+0.06%) about (65.37%,80.59%,91.34%) respectively more than normal concrete specimen.
5. Maximum increase in compressive strength 28-days observed with specimens concrete with (0.03%, 0.045%, 0.06% MWCNT) about (11.38%,17.92%, 26.44%) respectively more than normal concrete specimen.
6. Maximum increase in compressive strength 28-days observed with specimens concrete with (0.3%, 0.6%, 1% long NS) about (8.93%,12.38%, 18.92%) respectively more than normal concrete specimen.
7. Maximum increase in compressive strength 28-days observed with specimens concrete with (0.3%&0.03%,0.6%&0.045%,1%&0.06% both NS&MWCNT) about (13.03%,25.14%,37.8%)

respectively more than normal concrete specimen.

8. The highest increment of compressive strength nano silica addition of 1% i.e. 39.24% @ 7 days &18.92% @28 days.
9. The highest increment of compressive strength multi walled carbon nano tubes addition of 0.06% i.e. 18.57% @ 7 days &26.44% @28 days.
10. The highest increment of compressive strength occurred at the combined percentage of NS&MWCNT of 1+0.06 % i.e. 44.13% @ 7 days and 37.8% @ 28 days.
11. The highest increment of Split tensile strength nano silica addition of 1% i.e. 83.6% 7 days &48.35% @28 days.
12. The highest increment of split tensile strength multi walled carbon nano tubes addition of 0.06% i.e. 51.53% @ 7 days &42.38% @28 days.
13. The highest increment of split tensile strength occurred at the combined percentage of NS&MWCNT of 1+0.06 % i.e. 89.79 % @ 7 days and 91.34% @ 28 days.

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