Feasibility of Nano Graphene Oxide Powder With Concrete

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Abstract- *Engineered nano materials exist in three principal shapes, namely 0D nanoparticle, 1D nano fiber and 2D nano sheet. The application of 0D nanoparticle and 1D nano fiber, such as nano silica and carbon nanotubes (CNTs). The discovery of 2D nano sheet known as graphene oxide (GO) provides an extra dimension to interact with cement and concrete matrix and has yet to gain widespread attention. Also highlighted herein are the effect of incorporating nano materials in low dosages to the fabrication, workability, hydration, microstructure, and mechanical properties of cement-based composites. Starting from graphite powder we performed a chemical oxidation using sulfuric acid (H2SO4), sodium nitrate (NaNO3) and potassium permanganate (KMnO4) following the Hummer's method. The graphene oxide sludge has been washed several times and then sonicated to ensure the complete exfoliation of the platelets. The unique features of the two-dimensional GO such as its rough surface and functional group have a favorable influence on the mechanical behavior of cement. Introducing small quantities of GO as little as 0.5 wt %, 1.0wt%,1.5wt%,2.0wt%,2.5wt%,3.0wt%,3.5wt%,4.0wt% to measuring compressive strength, flexural strength, durability, permeability of mix design of concrete M30, M35 and M40 (standard concrete).*

Keywords- Graphene oxide powder, Graphene oxide concrete, Concrete, Compressive Strength, Flexural strength, Nano concrete.

I. INTRODUCTION

There have been many recent studies on newly produced nanomaterials such as nanosilica, nanotitanium oxide, nanoiron oxide, carbon nanotubes (CNTs) and graphene oxide (GO) sheets.These nanomaterials may be classified according to their shape or morphology: zero-dimensional (0D) particles, one-dimensional (1D) fibers and two-dimensional (2D) sheets. Nanomaterials are treasured for their large surface areas that can be exploited for reaction with cement paste. Unlike 0D nanoparticles, 1D fibers and 2D sheets behave as reinforcing materials to bridge cracks. Hence, it is essential for 1D fibers and 2D sheets to have high aspect ratios and intrinsic strength.

CNTs have very large aspect ratios (length to diameter ratio), typically higher than 1000 and reaching up to 2,500,000, which render their nanostructure quasi-one-dimensional (1D). Their ends can be open or capped by a half of a molecule of a fullerene. which defines the rolling direction of a hypothetical graphene layer, its diameter, and its length, along with the characterization of its terminations or caps, while the different possible combinations of walls a MWCNT can have give rise to infinitely more forms of CNTs

a) PREPARATION OF GONS:

A three-necked flask was placed in an ice bath (5 _C), and 3 g powered graphite, 60 g concentrated H2SO4, and 3 g NaNO3 were added and mixed well. Then, 12 g KMnO4 was slowly added to the flask over 15 min under stirring. The reaction temperature was kept at 5 _C for 1 h, then at 35 _C for 6 h. Then 200 mL deionized water was put to the flask and heated to 70 _C, following which 30 g H2O2 was dripped into the flask over 60 min. The final product was purified by centrifugation precipitation and washing repeatedly with deionized water until the washing water had a pH of 7.0. Then ultrasonic processing graphite oxide aqueous may obtain grapheme oxide nanosheets (GONs).

II. LITERATURE SURVEY

[1] M. Devasena and J. Karthikeyan (2015) said that aims to find out the optimum quantity of graphene oxide required to achieve maximum compressive, tensile and flexural strength of concrete. Graphene oxide was added to the concrete in three mix proportions. **Graphene oxide content were varied by 0.05%, 0.1%, 0.2% of cement content. 7, 14 & 28 days before crushing. Tests were performed at the age of 7, 14 & 28 days**

[2] Mohammad A. Rafi ee , Tharangattu N. Narayanan , Daniel P. Hashim , Navid Sakhavand , Rouzbeh Shahsavari , Robert Vajtai , and Pulickel M. Ajayan (2013) GO is utilized to bridge the cement surfaces while h-BN is used to mechanically reinforce the composites and adsorb the oil. Introduction of these fillers even at low fi ller weight fractions increases the compressive strength and toughness properties of pristine cement and of porous concrete signifi cantly, while the porous composite concrete illustrates excellent ability for water separation and crude oil adsorption. Experimental results along with theoretical calculations show that such nano engineered forms of cement based composites would enable the development of novel forms of multifunctional structural materials with a range of environmental applications**.**

[3] Samuel Chuah, Zhu Pan, Jay G. Sanjayan, Chien Ming Wang, Wen Hui Duan (2014) Engineered nano materials exist in three principal shapes, namely 0D nanoparticle, 1D nano fiber and 2D nano sheet. The application of 0D nanoparticle and 1D nano fiber, such as Nano silica and carbon nanotubes (CNTs), respectively, has been reported in literature. The discovery of 2D nano sheet known as graphene oxide (GO) provides an extra dimension to interact with cement and concrete matrix and has yet to gain widespread attention. In this paper, recent research studies in developing cement and concrete nano composites are comprehensively reviewed. Also highlighted herein are the effect of incorporating nano materials in low dosages to the fabrication, workability, hydration, microstructure, and mechanical properties of cement-based composites**.**

[4] Baig Abdullah Al Muhit, Boo Hyun Nam, Lei Zhai, Joseph Zuyus (2015) Investigation of the mechanical properties of cement paste incorporating graphene oxide (GO) with 0.01% and 0.05% dosages was performed and compared with pristine cement paste. Compressive strength tests for Graphene Oxide Cement Composite (GOCC) were carried out on 3, 7, 14, and 28 days. It was observed that GOCC0.05 showed highest compressive strength in all curing ages. It has been assumed that heterogeneous nucleation of C-S-H was responsible for the higher strength gain of GOCC0.05 samples. It was found from XRD analyses that smaller crystallite sizes of C-S-H and portlandite were responsible for the faster and numerous heterogeneous nucleation and higher compressive strength.

III. NANOTECHNOLOGY IN CONCRETE

Concrete, the most popular construction material in the world is a nano structured material itself. It has multiple. Concrete is composed of an amorphous paste phase, aggregate phase, interfacial transition zone and bound water. Calcium-silicate-hydrate (C-S-H gel) is an amorphous phase and is responsible for holding the aggregates together. The C-S-H gel is a nano material. The molecular structure, the bond length, strength and density of the chemical bonds forming during hydration can be studied by using nanotechnology. Concrete is coated with protective barrier to protect it from abrasion and chemical attack. Generally these coatings are in a range of micro scale, but new technologies have being developed to use these materials at a Nano scale. These coatings have successfully known to improve the properties of concrete like friction resistance, abrasion resistance and durability of the coating. Carbon nano tubes are one of the promising developments made through nanotechnology. Carbon nano tubes are long fiber like structures with either a single wall or multiple walls. Carbon nano tubes are flexible molecular scale tubes and are proved to show extraordinary properties. These nano tubes can be used in concrete to improve the properties of concrete like strength. A example single walled and double walled carbon nano tubes are shown in the figure below.

IV. GRAPHENE OXIDE BASE MATERIAL

The basic structural unit are graphite stack of graphene layer carbon nanotubes graphene layers rolled up in a cylinder and fullerenes wrapped graphene sheet with the introduction of pentanes on the hexagonal lattice. Ordinary Portland cement (OPC) is more used in construction. Due to its tensile stress reduced and strain capacity it must be reinforced with steel bars. In added, fibres of various types may be added to delay the development of micro-cracks and increase resistance to tensile stress. The major disadvantage of concrete is its brittle nature which is attributed to its poor resistance to crack formation, low tensile strength and strain capacities. Depending on the mix proportions of aggregates, cement and water, the tensile strength of concrete lies in the range of 2–8 MPa. Workability is a main parameter to gauge the ease of transport and placement of fresh concrete. The added to nano silica into the cement matrix caused a noticeable reduction in flow spread, increase cohesion and increased yield stress. The unique 2D grapheme oxide sheet being a double-edged sword, motivate C–S–H nucleation at the expense of a lower workability .The hydrophilic graphene oxide has a large surface area to adsorb water molecules present in the mix to its surface. As a result of the lack of free water, the frictional resistance among the cement particles and the sheets is increas without ample lubrication. This inter-particle friction has been identified as the root cause for exacerbated workability. The mini-slump are test shows a 50 percent reduction in workability whille the viscosity test confirms the result. The viscosity increases with the size of graphene oxide, confirming the influence of geometry on the workability. The larger sized graphene oxide experiences intermeshing, leading to a higher frictional resistance. The unique features of the two-dimensional graphene oxide such as its rough surface and functional group have a favorable influence on the mechanical behavior of cement. Introducing small quantities of graphene oxide as little as 0.04% weight of cement increases the compressive strength by 15–30 percentage and the flexural strength by 41–57 percentage, respectively. The compressive and flexural strengths of graphene oxide cement outperform its plain cement counterpart encompassing all ages till 56 days. The modulus of elasticity gathered from the stress–strain curve depicted in moderate increase to 3.6 MPa from 3.53 MPa. The strain capacity increased can be explained from the delayed micro crack initiation. In a separate investigation of the effect of 0.03% weight of cement of graphene oxide, the compressive strength improved by 45.2% alongside increased failure stress and strain. Graphene oxide shows a better gain in compressive strength at a lower concentration when compared to Carbon nano tube reinforced cement. The gain is attributed to the excellent reinforcement provided by graphene oxide.

Table: 1 Chemical Properties of Grapnene oxide

ELEMENT	CARBON	NITROGEN	HYDROGEN	SULFUR	OXYGEN
%	49-56	0-1	0-1	0-2	41-50

FIG 1 Graphene oxide

The reaction are complete within few minite. Potassium chlorate (kclo3) are replaced by potesiume permengenet improve the reaction safely explosive clo2 are avoiding. sodium nitrate (nano3) nitric acid instand of fuming. Acid fog are Aliminate.

V. GRAPHENE OXIDE WITH CEMENT CHEMICAL COMPOSITION

The structure are hydrated cement shows the foormation of the needle-like ettri-ngite and the sheet-like habit of calciam hydroxide. Mix of 1% grapheme oxide and 99% cement in the hydrate form. The structre of the 1% grapheme oxide and 99% cement mix found to be differant from the hydrate cement samples.showing the hydrated sample of 5% graphene oxide and 95% cement mix is more compact, with less needle-like formations, grown in the hydrated samples

Chemical composition of graphene oxide cement:

1) $2C_2H + 9H = 3CaO.2SiO_2.8H_2O + CH$
2) $2C_3H + 11H = 3CaO.2SiO_2.8H_2O + 3CH$
3) $2C_2A + 3CSH_2 + 9H = 6CaOAl_2O_3.3SiO_2.32H_2O$

The hydration process $3CaO.2SiO_2.8H_2O$+ CH are resposibale for high early strength and more heat of hydration generate. The hydration process $3CaO.2SiO_2.8H_2O$ + 3CH are resposibale for ultimate strength and less heat of hydration generate. CaSO4 + H2O (gypsum) can make steel slag-cement complex binders, which can fill in the cracks and increase the strength of the pastes. Ca(NO3)2 (calsiam nitrate) Was improve the strength of the concrete. Ca(NO3)2 Content was increased increase the initial setting time but decrease the final setting time of the graphene oxide concrete. The effect of cement k2so4 (potesium sulphate) properly choose of the gypsum(caso4) content early strength increase but content(3%) of k2s04 increase after 28 days cement strength sligthtly decrease. The use of Portland cement reaction between calcium carbide (cac2) increase the strength of concrete.

Table 2: Material properties of Graphene oxide

material	elastic moduls (Gpa)	tensile strength (Gpa)	elongation of break (%)	density kg/m3	diameter/ thickness (nm)	surface area (m2/gm)
graphene	1000	130	0.8	2200	0.08	2600
graphene oxide	23-42	o.13	0.6	1800	0.67	700-1500
cnt$_s$	950	11-63	12	1330	15-40	70-400

VI. CONCLUSION

(1) compressive strength:

(a) M30 grade of concrete (Mpa):

mix	7 days	28 days
Normal concrete	22.61	33.45
0.5% (Graphene oxide)	23.38	34.65
1.0% (Graphene oxide)	24.47	36.26
1.5% (Graphene oxide)	25.82	38.56
2.0% (Graphene oxide)	27.57	40.85
2.5% (Graphene oxide)	29.20	43.26
3.0% (Graphene oxide)	30.18	44.72
3.5% (Graphene oxide)	30.31	44.89
4.0% (Graphene oxide)	30.54	44.97

Compressive strength of normal concrte are adding of graphene oxide to increase the strength respectively. For M30 grade concrete to adding the 0.5% of graphene oxide strength are increased 3.58% as compare to normal concrete. Similarly for (1.0%, 1.5%,2.0%,2.5%,3.0%,3.5%,4.0%) adding in concrete in increase strength are (8.40%,15.27%,22.10%,29.32%,33.65%,34.11%,34.41%).

(b) M35 grade of concrete (Mpa):

mix	7 days	28 days
Normal concrete	24.67	38.60
0.5% (Graphene oxide)	26.85	39.83
1.0% (Graphene oxide)	27.75	41.08
1.5% (Graphene oxide)	29.40	43.61
2.0% (Graphene oxide)	31.15	46.15
2.5% (Graphene oxide)	32.85	48.7
3.0% (Graphene oxide)	33.80	50.21
3.5% (Graphene oxide)	34.0	50.45
4.0% (Graphene oxide)	34.15	50.60

For M35 grade concrete compressive strength to adding the 0.5% of graphene oxide strength are increased 3.18% as compare to normal concrete. Similarly for (1.0%, 1.5%,2.0%,2.5%,3.0%,3.5%,4.0%) adding in concrete in increase the strength are (6.21%,12.97%,19.32%,26.16%,30.11%,30.69%,31.08%).

(c) M40 grade of concrete (Mpa):

mix	7 days	28 days
Normal concrete	28.80	42.67
0.5% (Graphene oxide)	29.75	44.11
1.0% (Graphene oxide)	31.05	46.10
1.5% (Graphene oxide)	33.6	49.00
2.0% (Graphene oxide)	34.9	51.83
2.5% (Graphene oxide)	37.1	54.84
3.0% (Graphene oxide)	38.25	56.61
3.5% (Graphene oxide)	38.40	56.83
4.0% (Graphene oxide)	38.43	56.90

For M40 grade concrete compressive strength to adding the 0.5% of graphene oxide strength are increased 3.37% as compare to normal concrete. Similarly for (1.0%, 1.5%,2.0%,2.5%,3.0%,3.5%,4.0%) adding in concrete in increase strength are (8.08%,19.83%,21.46%,28.52%,32.64%,33.11%,33.30%).

(2) flexural strength :

(a) M30 grade of concrete (Mpa):

mix	28 days
normal concrete	3.95
0.5% (Graphene oxide)	4.04
1.0% (Graphene oxide)	4.22
1.5% (Graphene oxide)	4.45
2.0% (Graphene oxide)	4.75
2.5% (Graphene oxide)	5.11
3.0% (Graphene oxide)	5.53
3.5% (Graphene oxide)	6.03
4.0% (Graphene oxide)	6.19

For M30 grade concrete flexural strength to adding the 0.5% of graphene oxide strength are increased 2.27% as compare to normal concrete. Similarly for (1.0%, 1.5%,2.0%,2.5%,3.0%,3.5%,4.0%) adding in concrete in increase strength are (6.83%,12.15%,20.25%,29.36%,40%,45.68.69%,52.63%).

(b) M35 grade of concrete (Mpa):

mix	28 days
normal concrete	4.23
0.5% (Graphene oxide)	4.34
1.0% (Graphene oxide)	4.45
1.5% (Graphene oxide)	4.66
2.0% (Graphene oxide)	4.92
2.5% (Graphene oxide)	5.25
3.0% (Graphene oxide)	5.62
3.5% (Graphene oxide)	6.09
4.0% (Graphene oxide)	6.62

For M35 grade concrete flexural strength to adding the 0.5% of graphene oxide strength are increased 1.87% as compare to normal concrete. Similarly for (1.0%, 1.5%,2.0%,2.5%,3.0%,3.5%,4.0%) adding in concrete in increase strength are (5.20%,10.16%,16.31%,24.11%,32.86%,43.97, 56.50%).

(c) M40 grade of concrete (Mpa):

mix	28 days
normal concrete	4.51
0.5% (Graphene oxide)	4.60
1.0% (Graphene oxide)	4.78
1.5% (Graphene oxide)	5.01
2.0% (Graphene oxide)	5.27
2.5% (Graphene oxide)	5.60
3.0% (Graphene oxide)	5.99
3.5% (Graphene oxide)	6.45
4.0% (Graphene oxide)	6.97

For M40 grade concrete flexural strength to adding the 0.5% of graphene oxide strength are increased 1.99% as compare to normal concrete. Similarly for (1.0%, 1.5%,2.0%,2.5%,3.0%,3.5%,4.0%) adding in concrete in increase strength are (5.98%,11.08%,16.85%,26.16%,33.81%,44.57%, 55.35%).

REFERENCES

[1] M. Devasena and J. Karthikeyan (2015)."investigation of strength properties of graphene oxide concrete"

[2] Mohammad A. Rafi ee , Tharangattu N. Narayanan , Daniel P. Hashim , Navid Sakhavand , Rouzbeh Shahsavari , Robert Vajtai , and Pulickel M. Ajayan (2013)."hexagonal boron nitride and graphene oxide reinforced multifunctional porous cement composite"

[3] Samuel Chuah, Zhu Pan, Jay G. Sanjayan, Chien Ming Wang, Wen Hui Duan (2014) " nano reinforced and concrete composite and new perspective from graphene oxide"

[4] Baig Abdullah Al Muhit, Boo Hyun Nam, Lei Zhai, Joseph Zuyus (2015) **"** effect of microstructure on the compressive strength of graphene oxide cement composites"

[5] Jose Luis Fraga, Jose María del Campo, and Juan Ángel García (2014). "carbon nanotube cement composite in the construction industry : 1952-2014. A state of the art review"

[6] S.H. Lv, L.J. Deng, W.Q. Yang, Q.F. Zhou, Y.Y. Cui (2016). "fabrication of polycarboxylate/graphene oxide nanosheet composite by copolymerization for reinforcing and toughing cement composites"

[7] A. Mohammed, J.G. Sanjayan, W.H. Duan, A. Nazari (2015) " incorporating graphene oxide in cement composite : a study of transport properties"

[8] Ahmadreza Sedaghat1, Manoj K. Ram, A. Zayed, Rajeev Kamal, Natallia Shanahan (2014) "investigation of physical properties of grephene cement composite for structural application"

[9] Abolfazl Hassani, Babak Fakhim, Alimorad Rashidi, Parviz Ghoddousi (2014) " The influence of graphene oxide on mechanical properties and durability increase of concrete pavement"