Feasibility of Nano Graphene Oxide Powder With Concrete - A Review

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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 GOaslittleas 0.1wt% ,0.13wt%, 0.15wt%, 0.17wt%, 0.20wt%, 0.23wt%, 0.25wt%, 0.27wt%, 0.30wt% to measuring compressive strength, flexural strength, workability, durability, permeability of mix design of concrete M40, M5O (standard concrete) and M60 (high strength 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 temperaturewas 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 structuralmaterials 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 asNano 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.

[5] Jose Luis Fraga, Jose María del Campo, and Juan Ángel García (2014) Carbon nanotubes have extraordinary properties and thus they are considered as major candidates for diverse applications in nano technology Carbon nanotubes have been widely used with polymers in composite materials in order to improve their mechanical and electromagnetic properties They are also known to be adequate for the development of structural materials, and can be used in cement and reinforced concrete. Carbon nanotubes have been shown to reduce the occurrence of cracks, decrease their porosity, and improve their mechanical properties, thus lengthening their durability. The present study comprehensively reviews the feasibility of developing new cements with a maximum carbon nanotube content of 0.5% in order to provide large increases in flexural strength and in compressive strength, along with a reduction in porosity. The paper analyzes different research cases that have been carried out with cementitious materials to date and reviews the current state of the art and some future trends for these composites.

[6] S.H. Lv, L.J. Deng, W.Q. Yang, Q.F. Zhou, Y.Y. Cui (2016) Polycarboxylate (PC)/graphene oxide nano sheet (GON) composites are prepared by copolymerization ofgraphene oxide nano sheets (GONs) and PC's monomers of methacrylic acid, sodium allyl sulfonate and methacrylate polyoxyethylene ether. The test results indicate that GONs in the PC/GON copolymeric composites have smaller size and uniformly dispersed. Using of PC/GON composites in cement paste can achieve uniformly disperse GONs and eliminate the effects of GONs on the cement paste fluidity. The GONs from the composites can regulate the cement hydration products to form ordered microstructure and have significantly reinforcing and toughening effects. Meanwhile, the results research indicate that GONs have self-repairing effects for the holes and cracks for cement composites. The results have a very positive to application of GONs for improving the strength/toughness and extensing the service life of cement composites

[7] A. Mohammed, J.G. Sanjayan, W.H. Duan, A. Nazari (2015) This paper aims to investigate the transport characteristics of graphene oxide reinforced cement composites that can be translated to concretes made with similar constituents. Transport characteristics determine the long term durability of concrete structures. Tests such as water sorptivity, chloride penetration and mercury intrusionporosimetry were performed to observe the effect of graphene oxide addition into cement matrix and its transport properties. Graphene oxide was dispersed into cement mortar to produce graphene oxide cement composite using additions of 0.01%, 0.03% and 0.06% by weight of cement. Experimental results indicate that incorporation of very low fraction of graphene oxide (0.01%) can effectively hinder the ingress of chloride ions. Additionally, the sorptivity are significantly enhanced by adding graphene oxide with a moderate fraction of 0.03%. It can be concluded that graphene oxide addition to cement matrix can effectively improve the cement matrix transport properties which subsequently improve its durability.

[8] Ahmadreza Sedaghat1, Manoj K. Ram, A. Zayed, Rajeev Kamal, Natallia Shanahan (2014) The hydration of cement generates heat due to the exothermic nature of the hydration process. Poor heat dissi- pation in mass concrete results in a

temperature gradient between the inner core and the outer surface of the element. High temperature gradients generate tensile stresses that may exceed the tensile strength of concrete thus leading to thermal cracking. The present paper is an attempt to understand the thermal (heat sink property) and microstructural changes in the hydrated graphene-Portland cement composites. Thermal diffusivity and electrical conductivity of the hydrated graphene-cement composite were measured at various graphene to ce- ment ratios. The mass-volume method was implemented to measure the density of the hydrated graphene-ce- ment composite. Particle size distribution of Portland cement was measured by using a laser scattering particle size analyzer. Heat of hydration of Portland cement was assessed by using a TAMAIR isothermal conduction calorimeter. Scanning electron microscopy (SEM) was implemented to study microstructural changes of the hy-drated graphene-cement composites. The mineralogy of graphene-cement and the hydrated graphene-cement composites was investigated by using X-ray diffraction. The findings indicate that incorporation of graphene enhances the thermal properties of the hydrated cement indicating a potential for reduction in early age thermal cracking and durability improvement of the concrete structures.

[9] Abolfazl Hassani, Babak Fakhim, Alimorad Rashidi, Parviz Ghoddousi (2014) the performance of graphene oxide (GO) in improving mechanical properties and subsequently reducing the permeability of cement composites used in concrete pavement, is studied. A polycarboxylate superplasticizer was used to improve the dispersion of GO flakes in the cement. The mechanical strength of graphene-cement nanocomposites containing 0.1–2 wt% GO and 0.5 wt% superplasticizer was measured and compared with that of cement prepared without GO. We found that the tensile strength of the cement mortar increased with GO content, reaching 1.5%, a 48% increase in tensile strength. Ultra high-resolution field emission scanning electron microscopy (FE-SEM) used to observe the fracture surface of samples containing 1.5 wt% GO indicated that the nano GO flakes were well dispersed in the matrix, and no aggregates were observed. FE-SEM observation also revealed good bonding between the GOsurfaces and the surrounding cement matrix. In addition, XRD diffraction data showed growth of the calcium silicatehydrates (C-S-H) gels in GO cement mortar compared with the normal cement mortar. Growths of the calcium silicatehydrates (C-S-H) gels causes reduce in permeability and consequently improvement in durability of the cement composite.

III. CONCLUSIONS

1. Both GOCC0.01 and GOCC0.05 suggest the notion of heterogeneous nucleation by FWHM and crystallite size analysis. The reactive functional groups of GO act as heterogeneous nucleation sites-thus, the activation energy of formation of stable nuclei of jennite/tobermorite-9Å decreased, resulting in formation of finer particles, Both specimens showed that crystallite sizes of jennite and tobermorite-9Å increased from 3-day to 28-day, which is evidence of growth process. GOCC0.05 showed higher compressive strength because of its higher surface area due to finer particle size as evident by XRD analysis.

2. Inclusion of nanomaterial often degrades the workability of cement pastes, which may be attributed to the adsorption of free water onto the surface of nano materials. The use of compatible admixture is one of the feasible ways for addressing this issue. Nanomaterials are highly reactive and could accelerate the hydration of cement by providing attachment sites for the C–S–H gel. The seeding of C–S–H gel onto the large surface of the nanomaterials is the major incentive for using them.

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Agglomeration of nanomaterials hinders their potential to improve the properties of concrete. In this regard, the dispersion mechanism of nanomaterials is yet to be developed. Although GO appears to be well-dispersed in water, there is no such guarantee of good dispersion in the cement matrix.

Admixtures play an important role to preserve the cement workability when nanomaterials are added. However, detailed studies on the role of nanomaterials on the hydration and interaction with the various phases of cement, including admixtures require attention.

The durability aspect of cement and mortar containing nanomaterial provides an interesting avenue for research. The behavior of such composite under degradation such as decarbonation, acid resistance, sulfate resistance should be analyzed.

3.Reinforcing cement with low additions of MWCNTs, ranging from 0.05 to 0.5 weight %, can produce a remarkable enhancement of the mechanical properties of cement. Incorporation of CNTs into concrete thus has the potential to overcome its mechanical limitations, i.e., low tensile strength, low strain capacity, and brittleness With long mixing time of concrete, the pores in concrete are increased. That is why the water absorption and the chloride ion permeability increase with increase in mixing time.

4. By using concrete of higher strength, the weight of the structure could be reduced, which would lead to a saving of

resources and may compensate economically for the currently high cost of CNT synthesis. concrete as a key material along with energy saving in construction and building technology.

Graphite oxide nanosheets (GONs) are prepared by oxidization of graphite and ultrasonic processing. PC/GON copolymeric composites were prepared by copolymerization of GONs with PC's monomers of MAA, SAS, and MPE. Using of PC/GON copolymeric composites to cement paste can uniformly disperse GONs in cement paste and eliminate the effects of GONs on the cement paste fluidity.

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”