



ROLE OF SOME NANO STRUCTURED BUILDING MATERIALS: A REVIEW

Mohan Kantharia¹, Pankaj Kumar Mishra²

¹Department of Civil Engineering, Amity School of Engineering and Technology, Amity University Madhya Pradesh, India

²Department of Applied Physics, Amity School of Engineering and Technology, Amity University Madhya Pradesh, India

Email: mkantharia@gwa.amity.edu¹

Abstract

Cement is most commonly used material in construction. Some time it is said its consumption is next to water .main function of cement in concrete is as a binder. in concrete to bind the coarse and fine aggregate. But in terms of green houses gases, the production of cement also affects our environment too much(one ton of cement also produces one ton green house gases CO₂) and the energy required for its production is approximately next to steel and aluminium production . therefore researcher are trying to find alternative of cement continuously so that its adverse affect on environment can be reduced.

Low calcium Fly Ash, silica fume, based Geopolymer Concrete, Acrylic polymer fiber reinforced concrete epoxy resin concrete, glass fiber, and carbon nanotubes

.are new names in construction industry. new materials can make concrete more durable, more flexible, light , strong. Some nano materials are playing key role in enhancing the properties of concrete. Such as nano silica, nano ZnO, nano Cao, etc.

Key words: geopolymer concrete, carbon nano tube ,epoxy resin concrete, nano materials in concrete.

Introduction

Building construction is the biggest industry and it requires huge amount of building materials including aggregates, bricks, cement, sand, water and some of the other materials such as Aluminium, Glass, paints, timber etc. Today the

materials required should not only possess the good strength, durability, and workability. It should affect the environment least. Normal strength is not sufficient, higher and higher strength is required because of sky scrapers. Nano materials and composites are providing new opportunity in invention of new materials. The researchers are trying to reduce the consumption of cement so as to reduce the green house impact of it. Some new materials with nano particles are discussed here.

Description

Geopolymer concrete

Approximately half of the electricity is generated by thermal power stations, which is produced by burning coal. Fly ash is generated as a by-product in tremendous quantity at these stations. Its disposal in storage lagoons requires too much land and cost. Sometime this waste land fill causes environmental hazard problems also. [1] And this can become a substitute for cement. Geopolymer concrete is an emerging cementitious composite and a kind of replacement for cement in concrete. Metakaolin and Fly ash are natural materials of geological origin containing silica and alumina. And in the presence of highly alkaline solutions, polymers of alumina silicates are generated, and hardened like cement. This special kind of cementitious material is highly corrosion resistant, acid resistant, and sulphate resistant, and the mechanical properties are also improved, i.e. compressive and flexural strength. Shrinkage is reduced because of geopolymers of alkaline silicate. This material is inert for alkali aggregate reaction. Geopolymers

are polysialates of alumina-silicates. Chemically can be written as $(-Si-O-Al-O-)_n$ where n is the degree of polymerization. [2][3]

Polymer concrete (or Epoxy resin concrete).

The air voids present in the concrete reduces the strength of concrete, if the voids can be filled by some suitable materials then the strength of concrete can be increased. In polymer concrete the slight percentage of low viscosity polyster resin is introduced which fills the micro level voids and concrete is tightly packed and so that the strength of concrete get increased.[7] The percentage of resin vary from 5% to 15 %. This concrete is specially suitable. for using as high grade dielectric materials in electrical appliances for high voltage. Till now porcelain is used which is costlier than polymer concrete. In making polymer concrete knowledge of nano technology have been applied;[4] Epoxy resin concrete is new experimentation in concrete to improve the properties of cement concretet. We know that cement concrete has good compressive strength but poor in flexural strength so it gets cracked due to any tensile stress. By using epoxy resin the flexural strength can be increase also called high performance epoxy resin concrete.[5] In china the experiment has been done with it,where steel manhole covers were replaced by epoxy resin concrete. This was not only cost effective but flexural strength wise also improved also. And the problem of theft of steel cover was stopped. The chemical resistance of this concrete is also better than opc concrete.[6]

Carbon-notubes:

The new material which have got too much attentation is Carbon nano tube. At present this is not used in structural elements but very soon it will be involved into structural elements.at present two type of CNT are discussed SWCNT and MWCNT.The singled walled carbon nanotube(SWCNT) tensile strength is about 13-53 GPa while multiwalled carbon nanotube (MWCNT) is upto 150 GPa, SWCNT Youngs Modulus is about 1-5 TPa while MWCNT is about 0.2 to 0.95 TPa.it all depends upon the internal arrangement of MWCNT.we can see that for steel the tensile strength is about 0.38 to 1.55 GPa and youngs modulus is about 0.06 to 0.18 TPa.this all discussion is when axial properties of CNT are considered. It is too much

stronger than steel and lighter than aluminium[9-12].

Nano materials in Modification of the strength of steel bars .

Steel is important part of construction industry. With use of some nano materials in steel, the properties of steel can be improved .its resistance to corrosion, strength is improved by nano materials,carbon nano tubes and nano copper. Steel cables are used in various civil structures, in prestressed concret and bridges can be strengthened using carbon nanotubes. Fracture resistance is increased in Steel fixers like bolts can be reduced by use of molybdeneum and vanadium.steel structures such as bridges are subjected to dnamic loading and cyclic loading and so subjected to fatigues stresses. nano particleles addition of magnesium and calcium helps in solving the problem of heat affected zone in weldings etc.[1][14]

Nanoclays:

Clay nano-composites have improved physical and engineering properties, this is One of the most focus area in construction. Research on clay has received great attention in the area of nanocomposites. It offers tremendous improvement in a wide range of physical and engineering properties for clay polymers with lower percentage of filler.these nano fillers increase in density, compressive strength , young's modulus ,along with the filling in of air gaps. nanoclays like metallic nano-kaolin is used with cement.[9]

Surface treatment of hardened concret and glass by Nano-Coatings :nano coatings

Protect the structures/components from various weathering agents i.e. abrasion, chemical attack and hydro-thermal attack., to improve aesthetics, various chemical coatings are generally and routinely used. Now the thickness of coatings reduced from micro coating to nano coatings. Many reports are there which shows that various nanoparticles used in binders improves the effectiveness on key properties related to deterioration and it is reported that a paints and solvent with low molecular weight epoxy resin and nano-clay particles are showing promising results. [12]

Titanium dioxide (TiO₂) in glasss coatings.

Titanium dioxide (TiO₂) posses very good sterilizing property and antifouling properties.By

photo-catalytic process number of air pollutants present in air (organic and inorganic) captures and breaks down because of TiO₂ coating[11]. Glass is now an important component of every building. Now a days nano-Titanium dioxide (TiO₂) is being used to coat the glasses. This coating of TiO₂ makes the glass surface self-cleaning, because TiO₂ is hydrophilic and its attraction to water forms sheets out of rain drops. Nanometer thick coatings are durable and could have self-cleaning and self-healing properties. Nano scale roughness of the coatings will have the property to repel water and dirt and can outdate the existing 'non-stick' technology. Self-cleaning properties of a coating made using nano-particles would also help to keep the coated surface totally free of dirt and dust.

Aluminum Oxide (Al₂O₃)/ Zinc Oxide (ZnO)/and CaCO₃ Nanoparticles.

The addition of nano-Al₂O₃ improves the mechanical properties of concretes, in terms of higher split tensile and flexural strength. Alumina (Al₂O₃) component reacts with calcium hydroxide produced from the hydration of calcium silicates. We know that the rate of the pozzolanic reaction is proportional to the surface area available for chemical reaction. In cement 2% nano-Al₂O₃ can be replaced in the concrete mixture (with average particle sizes of 15 nm). Zinc oxide exhibits semiconducting and piezoelectric dual properties. It is a multipurpose material. Generally it is added into various materials industries and products, in civil engineering products such as, ceramics, glass, cement, paints, sealants also used. In cement concrete, addition of ZnO improves the processing time and the resistance of cement concrete against water. CaCO₃ Nanoparticles: experiments show that addition of CaCO₃ reduces the strength but by adding nano particles of CaCO₃ improves the strength. It has been reported that in Microhardness significant improvement in the strength is found when nano-CaCO₃ is added to cement. When 20% nano-CaCO₃ was added to the OPC microhardness value increased.[9]

Conclusions:

In finding the alternative solution of cement concrete and for enhancing the properties of existing materials Nano technology and nano materials providing new composites with enhanced properties such as light weight, more flexibility, more compressive and tensile

strength, corrosion resistant, and cost effective also. Some of the identified new materials are Carbon nanotubes, nano particles of ZnO, Al₂O₃, CaCO₃, and polymers. Some of the natural materials such as Geopolymers and nano clay are important upcoming materials. These all materials are slowly changing the construction methodology, and planning and designing criteria which are currently dependent present OPC cement.

References

- [1]. Samuel Demie, Muhd Fadhil Nuruddin, Memon Fareed Ahmed and Nasir Shafiq Effects of Curing Temperature and Superplasticizer on Workability and Compressive Strength of Self-Compacting Geopolymer Concrete. 2011 IEEE.
- [2]. E.I. Diaz¹, E.N. Allouche^{2*} Recycling of Fly Ash into Geopolymer Concrete: Creation of a Database. 2010 IEEE.
- [3]. Raijiwala O.B.* Patil H. S.** Geopolymer Concrete A Green Concrete. 2010 IEEE pp202-206
- [4]. Huthian Cunasekaran NEW concepts in polymer concrete insulation. IEEE 1988. Pp292-295.
- [5]. D.S. Hazim^{#1}, S. Mohd^{*2} 'Mechanical Characterization of Acrylic -Emulsion Polymer-Modified Concrete Reinforced with Steel Fibre by Taguchi Application' 2011 IEEE
- [6]. Yujie Jin Xinsheng Yin Liguang Xiao .Application and Research of High Performance Polymer Concrete in Covers. 2011 IEEE 3366-3369.
- [7]. Muthian Gunasekaran, Lightweight Partially Nano-Particled Polymer Concrete: A New Concept for Electrical Insulation 2007 IEEE 172-174
- [8]. LI Jing, QIAN Jiaru, JIANG Jianbiao Strength and Deformation of Axially Loaded Fiber-Reinforced Polymer Sheet Confined Concrete Columns* IEEE 2004-pp130-137
- [9]. B. B. Das and Arkadeep Mitra "Nanomaterials for Construction Engineering-A Review"
- [10]. Saurav "Application Of Nanotechnology In Building Materials", IJERA ISSN: 2248-9622, 2012, pp.1077-1082
- [11]. Ali Akbar Firoozi, Mohd Raihan Taha, Ali Asghar Firoozi, "Nanotechnology in Civil Engineering" eJge, 2014, pp4673-4682
- [12]. Kaizar Hossain^{1*} & Shaik Rameeja² "Importance of Nanotechnology in Civil

Engineering” European Journal of Sustainable Development, ISSN: 2239-5938, 2015 pp 161-166

[13]. radu olar “nanomaterials and nanotechnologies for civil engineering” 2011, pp109-116

[14]. Konstantin Sobolev^{1,2}, Ismael Flores², Roman Hermosillo², Leticia M. Torres-Martínez² “Nanomaterials and nanotechnology for high-performance cement composites” ACI Session,2006 pp91-118