

# Advancement of Concrete Using Nano Materials: A Brief Review

Manish Pratap Singh

Assistant Professor, Department of Civil Engineering, Motihari College of Engineering, Motihari, Bihar, India-845401

**Abstract:** Nano concrete is that type of concrete in which particles of Nano size are used to fill the voids of concrete to enhance its mechanical and engineering properties. Construction industry is emerging day by day and in between there is vast improvement in quality of concrete also. From millimeter era to micrometer era and now concrete are studied at Nano level that can be said as Nano era and the concrete is called Nano concrete. Recently many researchers have shown keen interest to study the core of concrete at Nano level so that engineering and mechanical properties of concrete like workability, strength, durability, permeability etc. may be enhanced. In this paper a brief report has been summarized from some research work of researchers on use of nonmaterial in concrete. Various Nano particles like Nano silica, Nano lime, carbon Nano tube, carbon Nano fibers, Grapheme, Nano Titanium, Nano clay and many other Nano particles having required engineering properties are studied by many researcher and an overview of that studied are presented in this paper. Various properties of Nano particles and their impact on properties of concrete after treating with these particles are studied and summarized. Here also discussion is made on principle and application of nonmaterial that are used in concrete, advantages of Nano concrete, difficulties arises while using Nano materials in concrete, their possible short out technique and future scope.

**Keywords:** Nano-material, Interfacial Transition Zone, Advance Concrete.

## 1. Introduction

Since Roman time's concrete is used as a building material comprising mainly four ingredients i.e. coarse aggregates, fine aggregates, cement, and water. A large number of different types of structure using concrete are constructed every year in the world. Due to change in recent trends in construction industry, ordinary concrete cannot give a needful result. For constructing heavy structure like bridges, multistoried building, sea shore structures and many more structure where there is high rise use of very advance concrete is needed. The demand of construction of a better infrastructure are increasing rapidly now-a-days due to fast growing population. Concrete is an ideal building material for construction of any type of structure due to its ability to be easily molded in any shape and its strength and durability and this is the reason, the rate of production of concrete and its constituents are increasing rapidly. Therefore cement had become the source of about 8 % world's Carbon dioxide emission [1]. The need of cement cannot be reduced in this situation, but if the strength and other properties is improved, its quantity can be reduced. For this purpose, the macrostructure and microstructure of concrete are being studied by different researchers. In ordinary concrete, four ingredients that is cement, sand, gravel and water are used. Here all the ingredients are of minimum size in millimeters. After this researcher go for high performance concrete in which micro silica are also used other than above ingredients. In recent ultra-high-performance comes in market where attempt are made to modify the concrete at Nano level. The emergences of Nano technology comes in picture in 1980s. Since then lot of work are carried in this area. Despite of this use of nanotechnology for advancing concrete are not much popular in India. Nanotechnology is one of the advanced multidisciplinary technology, which are being used in various fields like Nano medicine, (ii) Environment, (iii) Energy (iv) Nano batteries, (v) Information and communication (vi) Heavy industry etc.

Nanotechnology. One of the most important requirement for the Nano material used in concrete should have higher strength and lower density. Properties of the particle changes as they approach the Nano size. At Nano level the gravity forces become less influential, electrostatic forces become more important and quantum effect rises as particle becomes Nano sized, the proportion of atoms on the surfaces increases relative to those inside which causes Nanoeffects. It is believed that finer particles i.e. particle of micro size or Nano size have large surface area per unit volume which is important for cement and concrete. Large surface area of binder results in high early strength and also helps in increasing ultimate strength due to faster and more effective hydration reaction. Using reaction of Nano silica with concrete ingredients, one can set the example for utility of nanomaterial in Nano concrete. Following pozzolonic reaction take place in concrete using Nano silica.

$$C_3S + H_2O \rightarrow CSH + Ca(OH)_2 + \text{Heat Exhausted}$$

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The addition of Nano silica particles in concrete mix converts the weak  $Ca(OH)_2$  into strong CSH gel. Hence it can be said that Nano particles fills the void at Nano level and form extra more solidify CSH gel.

## 2. Application of Nano Particles

Due to self-cleaning, self-vibration, damping, structural health monitoring and self-healing properties of Nano concrete making it huge space for research in the field of construction industry. Following are some Nano parties and their application:

- 1) Nano Aluminum oxide ( $Al_2O_3$ )- It also work as a filler material for filling voids at Nano level. Addition of Nanoaluminum oxide in the concrete mix also converts the weak  $Ca(OH)_2$  into strong CAH gel i.e. Calcium Aluminum Hydrate. If there is gap of order Nano size, these materials can be used as filler materials.

- 2) Carbon Nano Tubes: Young's modulus elasticity of nanotubes is 1.8 tetra Pascal having density  $1.4 \text{ g/cm}^3$  and tensile strength of 63GPA. It is approx. 120 times stronger than steel and is much lighter. Because of high strength of CNTS, paints with much larger hardness and scratch resistance have been made. Adding 0.005% CNTS in concrete results in lower density, increased compressive strength, lower thermal conductivity, lower average pore diameter and structure have more homogenous pores.
- 3) Carbon Nano Fiber (CNFs): This fibers is proved to have very high electrical conductivity, heating capacity at low voltage and resistance to corrosion. It is proved to be very good substitute for deicing salt that is used to melt ice on road during snowfall in snowy areas. 7. 8. Nano  $\text{Al}_2\text{O}_3$  and Nano  $\text{ZrO}_2$ .9.Nano Clay and Reactive Powder Concrete (RPC):
- 4) Nanosilica fume or micro silica is an industrial by-product from electric arc furnace. Many researches shows that if silica fumes is added in concrete, it increases the density, compressive strength, tensile strength, abrasion resistance and also resistance against chemical attack. These effects on concrete is caused due to the ability of silica fume to fill voids and improve interfacial transition zone. While its particle size is in range of 100-200 nm and surface area  $20 \text{ m}^2/\text{g}$ . similarly Nano-Silica, which is finer than silica fume, can show a better result in the enhancement of the properties of concrete.
- 5) NanoTitania (Nano Titanium Oxide)-  $\text{TiO}_2$  Converts toxic ( $\text{NO}_x$ ) i.e. oxide of nitrogen into Nitrogen and oxygen. It is also called self-cleaning compound or photocatalytic concrete. It disintegrates organic pollutants into harmless  $\text{CO}_2$  and water in presence of light. Products of reaction can be easily removed by water and thus also help in preventing deterring color of the building.
- 6) Polymer Fiber matrix using Nano Silica: This Nano particle helps in self-structural health monitoring system in repair and rehabilitation. Hence help in maintaining of structure for long time.

Nano technology also find its way for utilization in the field of highway keeping in view point of safety, durability, financial aspect and maintainability of the transportation frame work of India. Following are some of utilization in the field of Transportation Engineering.

- a) High volume fly ash concrete when incorporated with Nano silica, there is significant increase in strength and improvement in pore size distribution of concrete. Fly ash is initially low active but after mixing little Nano silica, the pozzolanic activity significantly increases.
- b) The abrasion resistance of concrete pavement may be improved with the addition of Nano particles.
- c) Macro texture can be enhanced by utilizing nanomaterial and hence it delayed the crack propagation.



### 3. Future Scope and Challenges

There is lot of scope in the field of Nano material and their application in construction industry. Every day new material and instruments for carrying various test for advancing concrete is developed. For studying Nano technology various types of instrument are needed so there is a very nice scope for developing various instrument and to handle it for their in very efficient manner. Apart from benefit there is some serious risk also with nanoparticles when it is exposed. As the particles are of Nano size hence they are highly airborne and water borne. Nanotitania particles as reported by USA health department may be of toxic nature. It should be confirmed for health hazards before its use. As the

particles are very fine hence it may also be not easy to handle. Production of Nano material requires high energy. Use of Nano material causes environmental challenges to the construction industry. Lack of adequate research and development funding and low level of collaboration for multidisciplinary problems. Various nanotechnology based device such as Nanoelectro mechanical system (NEMS), Microelectrode mechanical system are already developed but technical improvement may be awaited. Various locally material should be improved so that they can be used as nanoparticles in construction industry and avoid unnecessary transport. Attempt should be made to make nanotechnology sustainable as well as cost and energy effective. With more research and practice efforts, smart design and planning,

construction project can be made sustainable and avoid damage to the environment.

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