# Enhancing Concrete Strength: The Role of Nano $Tio_2$ In Mechanical Performance

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***Abstract*—Concrete is the material which is been used in the construction field from the very long time. Before the use of cement various other materials are used for the construction purpose, but after the invention of the cement a durable and physically strong concrete is created. There are various grades of the concrete like, M20, M25, and M30 etc. Here 30 represent the strength of the concrete in MPa. It is very difficult to achieve the compressive strength in the concrete containing cement. To overcome this problem, we use different kinds of materials. Nano materials are one of the materials. In recent times a new branch of science is put in focused by many research scholars. This is Nano technology. Nano technology is used in wide range in the research and now days in regular life. There are various fields where the nano materials are used for the better results and performance of the subject. Some of these fields are electronics, construction, packaging, food, energy, health care, automotive, and defense**

## 1. INTRODUCTION

Nanotechnology is an emerging field of science related to the understanding and control of matter at the Nano scale, i.e., at dimensions between approximately 1 and 100 nm. At the Nano scale, unique phenomena enable novel applications. Nanotechnology encompasses Nano scale science, engineering, and technology that involve imaging, measuring, modeling, and manipulating matter at this length scale. Just how small is "Nano"? In the serviceability index system of units, the prefix "Nano" means 1-billionth or 10–9. Therefore 1 nm is 1-billionth of a meter. It's difficult to imagine just how small that is, so here are some examples.

- A sheet of paper is about 100,000-nm thick.
- A strand of human DNA is 2.5 nm in diameter.

There are 25,400,000 nm in 1 in.

- A human hair is approximately 80,000 nm wide.

On a comparative scale, if the diameter of a marble was 1 nm, then diameter of the Earth would be about 1 m.

Nano scale particles are not new in either nature or science. Recent developments in visualization and measurement systems for characterizing and testing of materials at the Nano scale have led to an explosion in nanotechnology-based materials in areas such as polymers, plastics, electronics, car manufacturing, and medicine Matter can exhibit unusual physical, chemical, and biological properties at the Nano scale differing in important ways from the properties of bulk materials and single atoms or molecules. Some nanostructured materials are stronger or have different magnetic properties compared to other forms or sizes of the same material. Others are better at conducting heat or electricity. They may become more chemically reactive or reflect light better or change color as their size or structure is altered.

A. Form of Titanium Dioxide

Nanotechnology use in design and construction process with unique properties, lighter and composite material, sound absorber, fire resistance, water repellents, air cleaners, self-disinfecting surfaces, low maintenance coating. Titanium Dioxide (TiO2) is very well known and well researched material. The titanium atomic number is 22 and atomic weight is 47.86.

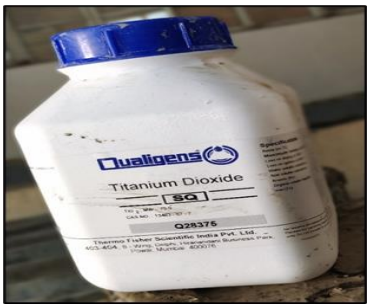


Fig 1 - Titanium Dioxide [TiO2]

## 2. STATE OF DEVELOPMENT

There have been various experimental and theoretical investigations performed on the topic of Nano material using titanium dioxide. Some of the experimental studies performed in this field are presented in the following literature review.

Mao-hua Zhang, HuiLi (2006) has studied the effect of nano material by adding 1%, 3% and 5% TiO2 per cement weight in the concrete and water reducing agents added. It was derived that the reduction in the workability with the inclusion of NT, the reduction in the slump values was 54.54% with the inclusion of 1% or 3%NT, and 72.75% with the inclusion of 5% NT., Concrete after 28 days Increase Compressive strength was18.03%, 12.76%, and 1.55% respectively its original strength.

DoladoCampillo et al., (2007) has studied the effect of nano material by adding different nanoparticles to belite cement and both the early-age mechanical properties and microstructure modification were studied. Results showed that the addition of nanoparticles can overcome the drawback of this type of eco-friendly cements, which will enable them to be competitive to OPC. Nano-SiO2 could significantly increase the early-age compressive strength of high-volume fly ash concrete, which has early age strength gain characteristics similar to that of belite cement concreteto it

AliNazariet.al. (2010) Studied the effects of Al2O3 on the workability and compressive strength of binary blended concrete have been studied. The Nano Al2O3 particle size employed was 15 nm. Two series of concrete mixes were made, one as a control specimen (without Nano particles) and the other with Nano Al2O3 as a cement replacement of 0.5, 1.0, 1.5, and 2.0 percent by weight. It was determined whether fresh concrete was workable. The concrete mixture containing Nano Al2O3 has a low slump, which reduces as the Nano Al2O3 level increases. It was explained that the substitution of cement with a fine powder raises the water demand due to increase in surface area. At 7, 28, and 90 days, the concrete cubes were cast, cured, and evaluated for compressive strength. The compressive strength increases with Nano Al2O3 particle replacement up to 1.0 percent and subsequently falls. However, even with 2.0 percent replacement, the result was still better than the control specimen. It was shown that concrete containing Nano Al2O3 particles had significantly higher compressive strength than concrete containing no Nano Al2O3 particles, and that cement could be replaced with Nano Al2O3 up to a maximum of 2.0 percent with an average particle size of 15nm.However, with 1.0 percent replacement, the ideal level of Nano Al2O3 particles content was achieved. Because partial cement replacement with Nano Al2O3 particles reduces the workability of fresh concrete, a superplasticizer is necessary.

Ali Nazari et al (2010**)** Studied the impact of Nano TiO2 particles on cement paste composites has been investigated. The material used was nano TiO2 with an average particle size of 15nm. Two concrete mix series were created. One series served as control specimens, while the other contained varying amounts of Nano TiO2 particles with cement replacements of 0.5, 1.0, 1.5, and 2.0 percent by weight. The slump test was used to assess the workability of fresh concrete. Concrete with Nano TiO2 particles had a very low workability, which was unacceptable. The concrete with a higher concentration of Nano TiO2 particles had a worse workability. The concrete cubes were cast and cured until they were tested for compressive strength at 7 days, 28 days, and 90 days of age. The results revealed that compressive strength rises with Nano TiO2 particle replacement up to 1.0 percent, then falls. The compressive strength of 2.0 percent replacement concrete, on the other hand, was still higher than plain cement concrete. It was determined that Nano TiO2 particles, with an average particle size of 15nm, may be used to substitute cement up to a maximum of 2.0 percent. However, with 1.0 percent replacement, the ideal amount of Nano TiO2 particles content was achieved. The use of a superplasticizer was also required since the partial replacement of cement by Nano TiO2 particles reduced the workability of fresh concrete.

U. R. Kawade, S. B. Gagare (2010) Concrete is the most widely used building material, and it uses a lot of cement. Nano-concrete is a type of concrete that is becoming increasingly popular in recent years, and our research focuses on how Nanomaterials such as Nano-silica, when added in specific quantities to a regular M40 Grade concrete, can improve a variety of qualities. The five varied contents of 1.5 percent, 3 percent, 4.5 percent, 6 percent, and 7.5 percent by weight were employed with CNS nanoparticles

having an average diameter of 5-40 nm. The results showed that using CNS particles up to a maximum replacement level of 3% and 4.5 percent improves the strength of concrete. Increasing the concentration of CNS particles in fresh concrete reduced its workability. Various tests were performed, including compressive strength, flexural strength, and split tensile strength. It has been determined that partially replacing cement with Nano-phase CNS particles improves concrete strength.

M. Nilia et.al. (2010) has focused on the study of different amounts of micro silica and colloidal Nano silica were utilised as partial replacements for cement in concrete mixtures with 0.45 water-cement ratios. The results showed that using 6 percent micro silica and 1.5 percent Nano silica as partial cement replacements enhanced compressive strength and electrical resistance, as well as significantly reducing capillary absorption in concrete specimens. Nanotechnology, as one of the most recent branches of science, offers enormous commercial and economic promise. The demand for research in the field of nanotechnology is increasing all the time. This research programme intends to 1) better understand the behaviour of cementitious materials when Nano scale modifications are made, and 2) investigate the impact of these modifications on the microstructure of cement matrix. This research could be viewed as a significant step toward a better understanding of nanosilica's application. in the concrete the study's major purpose is to look at the effects of colloidal nanosilica. on the mechanical characteristics, durability, and transportation of iv concrete microstructure, and characteristics

Porro et al. (2010) presented an overview of how nanotechnology could be applied to concrete technology, emphasizing the multidisciplinary approach needed for successful breakthroughs leading to ultra-high-performance materials and new multistate models that enable the prediction of bulk material properties from composition and processing parameters.

G.Quercia andH.J.H.Brouwers(2010) has shown that the nanotechnology has the ability to influence concrete performance at both the micro and macro levels, making it the next big thing in the concrete business. Materials with nano-sized particles exhibited significantly different behaviour than materials with larger particle sizes that had the same chemical makeup. As a result, several materials should be researched as concrete additives in the nano particle arena. When employed to manage the strength gain rate and durability of concrete, nano-silica can be both cost-effective and environmentally friendly. Increasing the cementitious materials content with this new material could be a clean and cost-effective option. Significantly high cement content is typically employed in applications like as pavements and overlay repairs for the express aim of generating extremely high strength in order to open roads for traffic. In these circumstances, nano-silica may be able to lower the amount of cement required since it can manage the strength gain rate by adjusting the added dosages. Testing nano-particles with various types of pozzolans, particularly those known to have issues with performance, strength gain rate, or durability, should be the next step in nano-silica in concrete research. In addition, nano-silica might be studied in conjunction with materials that have ASR concerns, such as recycled concrete and Class C fly ash.

Bjorn Birgisson Chair, Task Force on Nanotechnology (2012) has studied the ability of Nano technology to target material modification at the nanostructure level promises to deliver the optimization of material behavior and performance needed to improve significantly the mechanical performance, volume change properties, durability, and sustainability of concrete. This synopsis is written to assist in the identification of promising new research and innovations in concrete materials using nanotechnology that can result in improved mechanical properties, volume change properties, durability, and sustainability. This publication was developed both for the practitioner who wants a general knowledge of how nanotechnology can shape and is shaping the future and for the academician who is interested in a compilation of the latest research including detailed references related to Nanotechnology in concrete.

## 3. SUMMARY OF LITERATURE

For getting in depth knowledge of the Nano materials literature review is performed. From the survey of the literature, it is found that various numbers of Nano materials are used by the researchers for enhancing the strength of the concrete. Various Nano materials

which are used by the researchers are micro silica and colloidal Nano silica, Fly ash (FA), Alccofine(ALC), etc. Many research scholars have also used Titanium Di-oxide as the Nano materials for studying its behavior on the concrete. When a thorough reading is performed on the research paper it is observed that Nano materials do perform good and it does enhance the various properties of concrete but only up to some extent. Also, enhancements in the properties of concrete depends on type of Nano material used, grade of concrete, and all the other parameters on which strength of concrete depends.

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