Applications of Nano Technology in Civil Engineering:
A Review

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ABSTRACT

This article presents the recent trends in the field of civil engineering with an emphasis on the applications of nano materials and their beneficial effects at nano scale. The role and utilization of nanoparticles such as nano silica, carbon nano tubes, graphene, nano clays, nano $CaCO_3$, nano TiO_2, etc., is sharply increasing with the passage of time for achieving high performance composites. These nano materials not only enhance the mechanical properties of the resulting composites but also produce multifunctional characteristics. In this review, the authors have highlighted the various types of nanomaterials being used in the field of civil engineering and the performance improvements achieved by their utilization. Besides the potential benefits of Nano materials, they may pose some health and environmental concerns. A brief discussion is also provided on this issue.

KEYWORDS

Characterization, Health Concern, High Performance, Multifunctional, Nano Materials, Nanotechnology

INTRODUCTION

"There is plenty of room at the bottom" are the famous words of Feynman that marked the beginning of an era with special focus on the nanotechnology (Feynman, 1959). Nanotechnology is an auspicious field of material science that deals with the manipulation of materials having at least one characteristics dimension in the range of 1-100 nm (Shi, Magaye, Castranova, & Zhao, 2013; Silvestre, Silvestre, & de Brito, 2016). Nanocomposites are produced by adding nanoparticles into the bulk materials to obtain improved physical, mechanical and microstructural properties. Nanotechnology is not an extension of the existing science and technology, but it is a complete new world, where laws of quantum physics and the role of particle's surfaces dictate the behavior of the materials.

The nanoscale particles may produce materials with superlative characteristics, such as carbon nanotubes (CNTs), firstly discovered by Iijima in 1991 (Iijima, 1991) may exhibit tensile strength and young's modulus in the range of 63 GPa and 0.95 TPa, respectively (Coleman, Khan, Blau, & Gun'ko, 2006). The idea of utilizing very fine materials is not new, as the nature has been manipulating the potential of nanomaterials for billions of years. Similarly, the humankind has also been using nanomaterials to produce high quality pottery and glass since ancient times without knowing the hidden science and mechanism behind them. However, in the last century, the development of latest techniques and instruments has enabled the researchers and scientists to study and control the materials properties at the nanoscale. Due to the huge potential of nanotechnology, now a day, it is gaining importance in all field of life such as nano structural modifications of ceramics, glass, steel, polymers, alloys etc., development of coatings and thin films with multifunctional characteristics, synthesis of high performance devices, sensors and intelligent structures etc. (Afify, Ahmad, Khushnood, Jagdale, & Tulliani, 2017; Khushnood, Ahmad, Ferro, et al., 2015; Liang et al., 2009; Rizwan & Bier, 2012; Ziegler, Formia, Tulliani, & Palmero, 2016).

Construction and building industry that is the largest industry around the globe, has great potential for the application of nanotechnology. The application of new advance technology may improve the characteristics of building materials and impart unique functionalities. These characteristics and functionalities can significantly fix current construction problems, and may change the requirement and organization of construction process. The potential of nanotechnology to improve the performance of concrete and lead to the development of novel, sustainable, advanced cement based composition with unique thermal and electrical properties is promising and many new opportunities are expected to arise in coming years (Lin et al., 2016). In this research paper, the recent trends in civil engineering related to the application of nanotechnology with special focus on the construction materials is presented. The beneficial role of nanotechnology is also elaborated along with its limitations and difficulties to spread awareness about the utilization of nanoparticles in the field of civil engineering.

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