Nanomaterial for Construction Engineering-A Review

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ABSTRACT:

The National Science Foundation is a major source of support for fundamental research in civil engineering. In the past five years, the Engineering Directorate of NSF was extensively reorganized. In particular, the Civil and Environmental Engineering program was discontinued and its research support activities divided among a number of new or continuing programs. This paper examines trends in NSF support for civil engineering research, especially in light of the recent reorganization and inauguration of new programs. The amount of research support for civil engineering has continued to grow, although not as fast as for other engineering disciplines. However, the focus of some research support has been changing.

INTRODUCTION

In the past five years, the Engineering Directorate of the National Science Foundation (NSF) has been extensively reorganized. Many existing research programs disappeared, and a variety of new support programs emerged. Of particular interest to civil engineers, the former Civil and Environmental Engineering program was discontinued, and its research support activities divided among a number of new or continuing programs. As a result, there is no single program or administrative division devoted to civil engineering research within the NSF. Table 1 lists the major divisions within the NSF Engineering Directorate prior to and after the reorganization. While organizational changes have occurred in each of the past five years, the major reorganization of divisions shown in Table 1 was complete by fiscal year (FY) 1985.

The principal motivation for this study was concern that civil engineering research might become an orphan in the new NSF organization. The study was undertaken at the request and initiative of the National Policy Committee on Education and Research of the American Society of Civil Engineers (ASCE), under the leadership of Russel C. Jones, and originally appeared as a report to the National Policy Committee. The focus of this report is an analysis of the changes that have occurred in the level of support for civil engineering research as a result of the NSF reorganization.

—Nanotechnology is not new and is known to exist for ages, be it in the sword of tipu sultan or in the windows of the medieval churches in Europe. A common question in the minds of all of us living in today's world is about how the mechanism of nanotechnology can be used in the healthy compatibility with the constructional structures like that of massive buildings and bridges, which have been thought to encroach upon huge masses of land, leading to the destroying of homes of wildlife and putting pressure in the limited reserves of energy. This review paper focuses on the sustainable usage of nano based materials like carbon nanotube, electrochromic windows, nanoclays, sandviknanoflex™, nanowires, titanium dioxide, nanoceramic coating, nanocrystalline materials, nanosilica, nanocomposites, MMFX2 steel, nanometals, nanofibres, nanomyte™ mend MW, nanocement, which could be used for providing singular or multiple functions of potential reinforcement, corrosion resistance, insulation, fire protection, temperature resistance, reducing air conditioning loads, pollution control, UV ray absorption, lighting, when used as a part of building materials.

Nanotechnology concerns with the usage of materials falling in range of few to less than 100 nanometers [1]. Constructional structures form a very important part while contributing to the GDP of any economy by rendering services ranging from transportation to living to producing useful products to earning livelihood, and at the same time also commanding a very dominant share of the energy produced for utilization, no wonder that it has been estimated by a certain source that construction industry involving nanotechnology will occupy the eighth position out of the ten, having an impact on the world's development [2]. The usage of nanotechnology materials while being incorporated in constructional structures would not only help in prolonging their lifetime, but would also keep a check on the energy spent by them and at the same time gauging their reactions and reacting to different agents like fire, corrosion, water penetration, fractures, cracks, etc. Hence the literature segment of this review paper provides a list of nano-materials that can be used for these varied tasks

ELECTROCHROMIC WINDOWS

Gauging the intensity of light during alternate hours of darkness and sunlight transparency characteristics to the window are provided when removal of ions takes place due to application of high voltage and transmittance characteristics to the windows are provided with the release of chromogens and ions at low voltage due to different chromogen colors present in the tungsten oxide that acts as the electrochromic layer, from the valence band of the nickel oxide electrons escapes and the electrons jump to the W 5d states of tungsten oxide when a charge is applied, thereby helping in the color changing process to take place, capacitance is provided by the counter electrode and porous semiconductor containing working electrode is separated by the insulator layer, conducting oxides (such as In2O3: Sn) layer are sandwiched between two layers of glass that constitute the electrochromic windows. Between the layers of conducting oxides are squeezed more three central layers [20]-[23]. The room is bought to alternate dimness (opaque) and alternate brightness (transparency) by the mode of switch and intelligent control system, which constitutes the operation of these windows. Due to the mode of working the following chemical reactions [20] takes place:

SANDVIK NANOFLEX

With a high corrosion resistance, high temperature resistance (Sandvik 12R10/ASTM 302 has a service temperature in range of - 2000C to 2500C), high ductility, high tensile strength (1700 MPa-2000 MPa), good responding capability to stress and strain, followed by an occupancy of less area makes SandvikNanoflex™ , a stainless steel product developed by Sandvik Materials Technology, a perfect material to be used in fire-proof fixtures and in the doors and windows of a building, thus providing more space and light. Being mechanically strong, chemical and bacteria resistant, recyclable and environment friendly makes this material quite suitable to be incorporated in the construction of sanitary areas and swimming pools

NANOCLAYS

An increase in density, compressive strength (Right PU foam employing nanoclays exhibit strength of 210 KPa), young's modulus (4.18 GPa at 5% loading of nanoclay particle) and tensile strength (20.8763±0.789 MPa) along with the filling in of air gaps is reported when a combination of ordinary portland cement and nanoclays like metallic nano-kaolin is used and the same is presented in Fig. 2 and Fig. 3, respectively. Detioration of the structures is prevented by the presence of negative charges and separation of layers due to cleavages caused by penetration of water thus leading to an increase in the surface area (700-800 m2 /gm), in the volcanic ash and smectite type clays [24]-[25].

NANOWIRES SEM

TEM (transmission electron microscopy) and scanning probe techniques are the means by which nanowires

can be classified. The conductance properties, localization effects vary according to the thickness of the material, which also decides on the metal to insulator transition of the nanowires. With an increase in length presence of a higher percentage of metal in the semiconductor carbon matrix is reported which helps us to conclude that above a length of 50 nm the nanowires behave as metals [27]-[29]. Physical, thermodynamical and electron International Journal of Materials, Mechanics and Manufacturing, Vol. 2, No. 1, February 2014 42 transport properties are dependent on the diameter of the nanowires. Ultraviolet nanowire lasers, bar coding, magnetic information storage are some of the effective optical applications that nanowires like ZnO (poisson's ratio=0.349) can be put into. Linear or non-linear characteristics are exhibited by the nanowires. By acting as a fuse against higher voltages and currents, nanowires can be an indispensable of the lighting section of construction engineering [30]-[31]. The metal to insulator transition can be calculated by using the following formula [29]:

CONCLUSION

An extensive literature review was conducted into the properties and applications of nanomaterials that make them useful as a part of the construction materials. This would significantly help the readers such as civil engineers, architects, contractors for quickly getting an idea of the availability of the nanomaterials that can be considered in the design of sustainable and durable structures.

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