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On the Investigation of the Optimal Housing Pattern Using Nanotechnology Approach

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ABSTRACT

One of the current problems of the third world countries is the lack of enough attention to the principled construction applying the approach of sustainable development. Rapid population growth and the growing volume of construction as well as the limited amount of construction resources and materials available have caused the demand for consuming new materials in the construction industry to be increased. Attempting to come up with some resolutions in order to modify the quality of construction materials, increase the efficiency of construction materials, and reduce the consumption of raw materials and energy, has resulted in the use of new technologies in the industry. In this regard, one of the approaches to set up optimization strategies for housing is considered designing buildings using nanotechnology approach. An approach that has proven results in realizing sustainable development goals. Among the advantages of using this technology, an increase in quality of construction materials, energy saving, and consequently financial savings can be mentioned. This paper, through library research method and note taking tool, aims to investigate the optimal housing pattern using nanotechnology approach.

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INTRODUCTION

The world today is faced with two great crises regarding the energy which are the environmental pollution caused by burning of fossil fuels and the finite nature of such fuels. In this respect, one of the main causes of environmental pollution in the world, and especially in our country, is consuming fossil energy in residential areas to produce hot water, and supply the apartment space heating, which goes up in amount with increasing migration from rural to urban areas and a growing number of consumers of fossil fuels. In the next 30 years, the global emissions of carbon dioxide [CO2] from energy production and consumption will grow with a faster rate than the basic consumption growth. The emission rate of this gas, with a steady growth rate of 1.8% per year, will ultimately reach 38 million tonnes per year between the years 2000 to 2030, which means 70 percent increase as compared to the current annual emissions [2]. Due to increasing consumption of energy in Iran, having limited natural resources available, moving in the direction of sustainable development plan and protecting the environment, wasting and losing energy must be prevented to the extent possible. To this end, some steps should be taken toward optimal use of energy resources in the country, while identifying appropriate approaches to reduce energy consumption. Given the crucial role of energy for human societies, and the very influential role it plays in the sustainable development of countries, the efficient use of energy resources to meet the needs of human society in today's world requires application of energy management and optimization of its use [3]. The average growth rate of energy is about 4.0 in the world, while this figure is estimated more than 6.0 in the country of Iran; thus, it can be concluded that there is the potential in Iran in optimizing and reforming the energy consumption pattern in different sectors up to one-third [33%], the annual revenue of which is estimated to be approximately $ 5 billion, equivalent to all of the country's development budget. While, over the last two decades, electrical energy use Intensity has been approximately 0.7 annually in our country, statistical comparison indicates that energy use Intensity is twice as much as energy growth Intensity in the world. Therefore, the importance of energy management and the consumption pattern reform in the energy section of the country is evident and undeniable [7].

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One of the factors that can be involved in reducing the energy consumption is how the buildings are designed. In designing the buildings, materials and tools are considered two important factors that affect various aspects of the project [13]. In this regard, the nanotechnology is the fundamental change of a way which will results in making materials and tools with the required characteristics. The nanotechnology Influences architecture, design, and even design ideas in the world mainly through the introduction of new materials and the proper ways of energy consumption; with the correct use of the produced materials by nanotechnology, sustainable architecture can be achieved [10]. This paper seeks to examine the impacts of nanotechnology on architecture and its future. For this purpose, firstly, we present the definition of nanotechnology and its broad applications in the field of architecture, then we introduce the materials made by this technology which are used in architecture.

An Introduction to Nanotechnology:

Nanotechnology has the ability to build, manage and use the material at Nano dimensions. The particle size is greatly important in nanotechnology and that is because at the nanoscale, the dimensions of material has major impact on its properties, and physical, chemical and biological properties of individual atoms and molecules differ from the properties of bulk matter. The size varies in different materials, however, normally nanomaterials are materials that at least one of their dimensions is smaller than 100 nm. The high surface to volume ratio of nanomaterials is one of the most important properties of materials produced at the nanoscale. At such a scale, the behavior of the surfaces dominates the mass behavior of material. At Nano dimensions, the laws of quantum physics make it possible for the material properties such as melting temperature, magnetic properties, and color to be altered [5].

Sustainable Development Approach in the Construction Industry:

Today, the need to find ways to convert an incremental path to path of highly advanced technologies of nanotechnology is being considered. The concept of green buildings, basically, is the idea of how energy can be saved in buildings and carbon dioxide emissions can be reduced. Buildings have a major effect on energy use and the environment. Buildings have a major effect on the use of energy and the environment. Residential and commercial buildings use almost 40% of primary energy along with nearly 70% of the electricity in in the United States. Global warming, today, is a global environmental issue, thus, all countries, especially the industrialized countries must see the problem beyond their limits [8].

The concept of nanotechnology in recent decades has covered many sciences. The concept in designing buildings refers to an approach, according to which building design is practiced based on the use of the best technology in the world and by following the principles of sustainable development, along with the aim of optimizing energy consumption and minimizing environmental pollution. Optimization refers to the fact that nanotechnology does not oppose the energy consumption, however, it attempts to avoid wasting energy. Furthermore, in nanotechnology, the efficient use of energy, and not the reduction of energy consumption is considered as a goal. Of all the amounts of energy being consumed in the world, the shares of buildings, industry and transportation have been 50%, 25% and 25%, respectively. It should be noted that the energy in buildings is consumed in four total sections of lighting, heating and cooling, the equipment, and the energy losses with the estimated percentage of 25, 45, 15, and 15 respectively [11]. The architect is responsible to find a balance between art and science, thus, architectural structure should be pondered upon using an innovative approach in the field of renewable energies. The application of nanotechnology in architecture, widely from the initial planning stages until the end, is totally different in buildings. Nanotechnology helps us overcome the environmental problems, and take great steps in the field of sustainable architecture by reducing a large amount of CO2 emission from the produced material as well as cleansing environmental areas. Architects must predict that new technology is needed in the twenty-first century, and we need to direct it properly in architecture in order to contribute to the development of future and humanity, and also to achieve the renewable energies.

Applications of Nanotechnology in Construction Industry:

With regard to the applications of nanotechnology in the construction industry the following can be summarized:

Improving the Properties of Cement and Concrete:

Using nanoparticles improves the mechanical properties of cement and concrete and raise their qualities. Moreover, nanoparticles and nano-coatings prevent external destructive elements, which reduces the durability and reliability and increases degradation speed, from penetrating into the concrete. Among other applications of nanostructures in concretes, using them in high-performance concrete and self-compacting concretes can be mentioned. Adding nano silica improves particle density, increases concrete strength and also prevents the penetration of water into the concrete. Many researchers have used various oxides at nanoscale to improve the physical, mechanical properties as well as durability of concrete. Among them, nano silica [nano-SiO2], nano

iron oxide [nano-Fe2O3], carbon nanotubes, nano titanium oxide [nano-TiO2], nano aluminum oxide [nano-Al2O3], and others can be named.

Due to nano size, specific surface, and reactivity of these particles as well as their great ability to be activated on the one hand, and porous structure of concrete and the existence of nanoscale cavities on the other, utilizing such particles in concrete can help its properties to get improved. The use of titanium dioxide causes self-cleaning and disinfecting properties to be created in concrete, and makes concrete bright and white in color. Although, carbon nanotubes, as other concrete additives, have a density about one-sixth of the density of steel, their Young's modulus as well as their strength are five times and eight times greater than steel, respectively. Such a nano additive can be used as a suitable reinforcement, with the ability to bridge cracks, reduce the dimensions, and deform cracks. Hematite nanoparticles also increase the strength of concrete [15].

Application of Titanium Dioxide in Mortar or Concrete:

Photocatalysis is a photochemical reaction, which generally occurs at the surface of a semiconductor. This process occurs during two reactions of oxidation- reduction simultaneously:

Oxidation is a process in which chemical species lose electrons, and in order for a system, which has lost electrons, to remain in balance, it gets electrons, and makes Redox "oxidation-reduction» reaction complete.

These reactions are carried out exactly at the same time, so that no changes happen in the semiconductor material itself over time.

The study on the phenomenon began when chalking phenomenon was observed on colors with titanium base, when exposed to sunlight, and later on, such phenomenon was observed in various fields of water treatment, air purification and solar cells. Photocatalysts are metal oxides semiconductor that are activated when exposed to light, and during these heterogeneous processes, including semiconductor and UV radiation, the degradation of pollutants occurs.

One of the elements with high photocatalystic property is titanium dioxide [TiO2] which mainly exists in rutile and anatase crystal shapes. Applications of nano titanium oxide have been developed based on the special properties of this material. Properties such as being antibacterial and photocatalystic are considered as the most important characteristics of this material.

Air purifier nano coatings can be utilized on the external surfaces of buildings and roads, especially in crowded and polluted areas. Applying such coatings is one way of reducing the damage caused by air pollution, and reducing the percentage of VOCs and NOX, in particular . Currently, such coatings are produced in the form of organic and inorganic coatings. Important influential factors in the performance of these smart coatings are metal oxide semiconductor and photocatalysts such as ZnO, WO3, TiO2, Cds, among which using TiO2 is common due to the high chemical stability, low toxicity, and low cost [14].

Generally, the cleansing process of building facades, glasses, and some other internal components is highly time and cost consuming. In this regard, application of coatings which provide self-cleaning surfaces, is very useful. Reaction products, after raining and or water washing, are wiped off the surface. Although, the produced co2 is considered as a greenhouse gas, the production percentage of this byproduct is negligible compared to what the pollutants produce. The speed of a reaction depends on the intensity of sunlight, environmental conditions such as temperature and relative humidity, rate of TiO2 nanoparticles under light exposure, and also absorption rate of NOX through coatings. Furthermore, this category of self-cleaning coatings with anti-fog and cleaning purposes can be used on surfaces of car glasses and body [4].

Self-cleaning Surface:

Titanium oxide is found in three structures of anatase, rutile and brookite. Among these, anatase phase has the highest photocatalytic property. The surfaces containing titanium dioxide, being under the sunlight, can keep themselves clean. The self-cleaning ability can be strengthened by flowing water on the surface [this water can be caused by natural phenomena such as rainfall]. Such an increase in the amount of cleaning is due to the hydrophilicity of TiO2 surfaces. Water penetrates into the molecular surface between the hydrophilic surfaces of TiO2 and pollutions, and displaces the remaining pollution which is still on the surface [6] [Fig. 1].

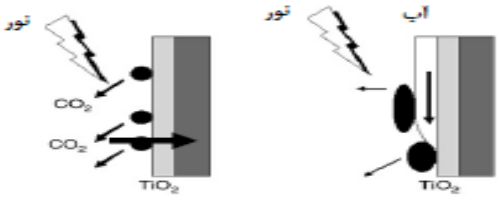

Fig. 1: schematic representation of self-cleaning mechanism from the hydrophilic surface of titanium dioxide.

Such coatings [usually used for exterior surfaces], in addition to their impact on air purification, cause the surface to remain clean at a low cost, and ultimately, the city to have an immaculate face. An instance of the application of TiO2 as a coating is presented in figure 2.

Fig. 2: A view of the church Dives in Misericorida made with cement with self-cleaning capability.

Nanotubes:

Fibers are usually used to reinforce concrete and modify its mechanical performance. Today, different material fibers such as metal, glass, polypropylene, carbon, etc. are used to reinforce concrete. Carbon nanotubes as construction materials with multi-purpose high-performance can play an important role. Carbon nanotubes have extremely lower density comparing to steel and aluminum. The tensile and compressive strength of carbon nanotubes is very high compared to other construction materials.

Nano-coatings:

Among different nano-coatings one can refer to stone and wood coatings, bricks coatings, ceramic and tile coatings, concrete surfaces coatings and fiber cement coatings. The most important advantages of using nano-coatings include creation of proper insulation coating, lack of corrosion penetration into these coatings, increased heat transfer resistance, increased resistance to corrosion, abrasion, and decay, and property of self-cleaning surfaces.

Nano Waterproofing Materials:

Water absorption causes several irreparable damages to an unprotected building. Efflorescence, bowing walls or flaking paint, molds and fungi growth, stain and sludge attraction, creation of premature crack and wear, reduced concrete strength, and corrosion of ironware are among physical and structural damages to a building. Applying waterproofing materials is an effective method to prevent damages caused by water penetration into the building. Waterproofing materials made from nanoparticles provide long-term protection for surfaces through proper penetration into the materials. Applications of waterproofing materials in buildings include newly constructed buildings, old buildings, cement and concrete components, tiles, and stones. It is noteworthy that waterproofing buildings is possible in different parts such as foundations and columns, interior walls, exterior coatings and walls, bathroom services, interior wirings and ducts, aerial and ground water storage tanks, and the roof.

Nano Glass:

Among different applications of nanotechnology in glass manufacturing industry are developing products such as self-cleaning glass, energy controlling glass, and fire protection glass. Nanoparticles of titanium dioxide are used in manufacturing self-cleaning glass which have anti-stain and disinfecting nature. Fire resistant glasses are made by placing a transparent layer containing silica nanoparticles between two glass plates. Energy controlling glasses causes ultraviolet and infrared radiation transmission to be reduced, and visible light transmission to be regulated, and also prevents wasting of indoors energy.

Clay Nanocomposites:

Among the advantages of using clay nanocomposites in different construction materials are improved mechanical properties, increased hardness without any decrease in the amount of ductility, resistance to heat and chemical factors, appropriate applicability, recyclability and fire resistance. The ability of delaying flame effects has led to the application of these substances in fire resistant coatings in products such as floor mats, insulations and construction panels. Reduction in transmission of various gases such as oxygen, water vapor and carbon dioxide are also some other advantages of using nanocomposites. These materials are optically transparent and almost colorless.

Application of Nanotechnology in Air Infiltration of Residential Areas:

Air inside buildings and houses can be much more polluted than outdoor air. Since people spend most of their time in indoor spaces where they live, it is more likely for their health to be jeopardized by the polluted indoor air than outdoor air. Indoor air pollution is a dangerous problem for which a solution must be found.

Today, this problem has been solved by making a device which purifies air inside the rooms through using some sort of photocatalytic nanoparticles, called nano-breeze. This device decomposes harmful gases caused by the fuel or tobacco smoke, allergens, moldy and musty smell, smoke from plastics, colors, perfumes and cleaners. This product oxidizes volatile organic chemicals [VOCs] and biological aerosols [HEPTA]. The concentration of these volatile organic chemicals can be up to ten times higher inside houses than the outside.

Semi-conductive titanium oxide crystals that are only 40 nanometers in size, are charged by ultraviolet photons and produce free radicals that change organic pollutants into carbon dioxide and water. This process is known as oxidation with photo catalysts. The device has no filters to be replaced and no collector plates to be cleaned and also does not produce ozone. Hypa filters trap contaminants, but they don't oxidize them. Moreover, their filters need to be replaced, which is extremely costly

Air electronic decontaminators also include ionizers and produce ozone. Ionizers charge dust particles that accumulate in rooms or on metal plates, and usually need to be cleaned. The ionizers cannot fix gases or odors and may also generate ozone. Oxidization power of ozone is not as much as oxidization power of titanium oxide photocatalysts, it is toxic and can cause acute dyspnea. The nano breeze does not produce any hazardous substances to the skin and eyes. Filters that use ultraviolet light, apply ultraviolet radiation type C to kill bacteria by destroying their DNA which is very dangerous for all living organisms. The nano breeze, however, uses ultraviolet light tubes type A. The outer surface of these tubes is coated with a thin layer of photo catalytic titanium oxide, which absorbs all ultraviolet light.

The mentioned points that show the benefits of using titanium oxide instead of electric treatment, indicate the importance of using nanotechnology to purify the air in residential areas.

Examples of Nanotechnology in Building and Housing Research Center:

Building and Housing Research Center is an institution that started its activities in application of nanotechnology in construction industry since 1387 by endorsing memorandum of understanding with nanotechnology initiative presidential campaign. This center has done a lot of activities with regard to the application of nanotechnology in construction industry, among which are studies regarding the use of TiO2 in self-cleaning surfaces, nanocoatings, nanosilica applications, carbon nanotubes, nanoclays, hematite nanoparticles and etc. Most of this research has led to the production of high quality products.

Researchers of Building and Housing Research Center were able to build a nano house [Figure 3]. Among the nanotechnology samples used in the house are aerated concrete blocks, double glazed Low-E glass, heat insulation nano paints, bacteria and virus intrusion-resistant nano-filters, antibacterial tiles, and waterproof nano coatings. All of these materials are produced by domestic companies in order to build the nano house including concrete construction companies of Alvand, Baspar Nanobon, Kimia Vira, Kaveh Float Glass, Sina Tile and Havaresan Sanat Mehr which are active in supplying construction materials.

Fig. 3: A Nano House. Source: (www.civilmaster.ir).

Conclusion:

Nanotechnology is among new technologies that have important and valuable applications in various industries including construction industry. Knowledge of production and application of nano-products is developing and progressing increasingly. Among nano-technology applications in the construction industry, as already mentioned, are concrete admixtures, glasses, water treatment and surface coatings. This technology improves the properties of construction materials and provide desirable features in them. In many cases, the use of this technology is economically justified. Some types of nano-products exist in the country and can be easily purchased and used. However, as with all new technologies, before use, they must be adequately investigated to be in compliance with international standards regarding choosing acceptable material types and proper application methods.

Since most cities are industrialized and environmental contaminations, particularly air pollution, are increasing, applying nanotechnology with the benefit of titanium oxide crystals and nano breeze photo catalytic nano-particles is a vital approach to clean up areas of residence. Besides, using nanotechnology in making self-cleaning glasses, air sterilizers and heat absorbance is considered a step in line with the objectives of sustainable development. Nano aluminum could also be used to increase tensile, compressive and bending strength of the concrete, and nano silica can be utilized to help to make recycling construction waste possible in order for the

construction industry to be accommodated with the environment. It At the first glance, due to the high price, using nanomaterials in the construction industry might not have economic justification. But, through looking deeply at the issue, one can see that the use of nanoparticles in construction industry is economically affordable. For example, by examining the fact that economic costs of reconstructing a building is much more than costs of using nanoparticles for strengthening and retrofitting of buildings under construction. Similarly, costs of collecting and destructing construction debris are far more than costs of reusing them with the help of nano materials.

REFERENCES

[1] Arbabian, H., 2001. Optimization of energy consumption in buildings. Iran third national conference of energy. Tehran, Islamic Republic of Iran's National Energy Committee, Deputy of Power and Energy Affairs, Ministry of Energy.
[2] Alvin, G., 2006. Application and risks of nanotechnology in construction. Translated by Ebrahim Enayati. Nano Technology Magazine, 113.
[3] Special campaign of nanotechnology development, 2009. Nanotechnology and construction industry. Building and Housing Research Center.
[4] Soltani, M., 2007. Review of applications of nanotechnology in the construction industry. Nanotechnology Monthly Magazine, 122.
[5] Eshghi, M.B., 2005. Proceedings of the Second National Conference on prevention methods of wasting national resources. Tehran: Iran's Academy of Sciences, 613 -618.
[6] Gorgi, M.Y., 2010. Sustainable Architecture and its review in the field of environment. Iranian Journal of Architecture and Urban Planning Scientific Association, 1(1): 91-100.
[7] Mohammadi, A.M., 2003. Concepts of optimizing energy consumption. Journal of Energy Economics.
[8] Moghadam, M.R., 2004. Modification of Iran's energy portfolio until 1400. Tehran: Negah e Sharghi Sabz Press.
[9] Mousavi, N., M. Razavi, 2011. nanotechnology and sustainable architecture. The first conference on climate, building and optimization of energy consumption.
[10] Hashemi, F., 2010. Optimization of energy consumption in cold climate with reviewing experiences of developed countries [Case Study: the city of Ardabil]. Master of Architecture Thesis, Faculty of Fine Arts, Tehran University.
[11] Yegdely, A., Ali, P. Kh, 2009. Nanotechnology and nano-structured coatings: the best solution for reducing energy consumption in buildings. Surface Coatings Journal, 28.
[12] Apergis, N., J.E. Payne, 2010. Renewable Energy Consumption and Growth in E urasia. Energy Economics, 32.
[13] Alnaser, N.W., 2008. Towards Sustainable Buildings in Bahrain, Kuwait and United Arab Emirates. The Open Construction and Building Technology Journal, 2: 30-45.
[14] Goldemberg, J., O. Lucon, 2010. Energy, Environment, and Development. 2nd Edition, Earthscan.
[15] Hodgson, P.E., 2010. Energy, the Environment and Climate Change. Imperial College Press.
[16] Surinder, M., 2006. Nanotechnology and Construction. European Nanotechnology Gateway.