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SUSTAINABLE MATERIALS AND ROLE OF PROFESSIONALS IN BUILT ENVIRONMENT SUSTAINABILITY

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Environmental sustainability challenges in maintaining a balance between 'greening' and environmentalism is fast becoming a major feature of modern building designs. Materials and other human factors that contribute to global warming are now being given the much needed attention in achieving environmental sustainability, in consonance with construction related sustainable development goals (SDGs). Material can be said to be a matter which may be shaped or manipulated in production or otherwise, particularly in the built environment. In recent times, sustainable Materials covers the sourcing, processing and characterization. It also deals with building materials in relation to ecosystem, the implications of materials choice at the design stage and, sometimes, the impact of materials on building users and their sustainability. Metals; Ceramics and Polymers; and the Alloys and Composites of these materials are the three categories discussed in this paper. The paper presented an overview of issues associated with the role of professionals in the selection of materials for sustainable construction. The strengths of Leadership in Engineering and Environmental Design (LEED), Excellence in Design for Greater Efficiencies (EDGE) and Building Information Modelling (BIM) in direct relation to innovative application of material, especially in the built environment were also reviewed.

Keywords: BIM, EDGE, ""green buildings"", LEED, polyvinyl, sustainability

INTRODUCTION

From time immemorial, materials have been a significant determinant of the effectiveness of the built environment. On the other hand, the professional input of the various stakeholders and decision makers also cannot be overemphasized. The Architect may design a functional building, but a lot lies with his choice of materials in actualizing the actual building which consequently determine its

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functionality, structural stability, aesthetics, social standards, cost effectiveness and overall environmental sustainability.

The built environment is said to be all the physical things constructed by humans as aids to living.

According to Collins English dictionary, it comprises buildings and all other things constructed by human beings. Material, on the other hand, is having to do with matter or consisting of matter. The term **matter** refers to anything that occupies space and has mass (Raven, Johnson, Mason, Losos, and Singer, 2014). It is the basic structural component of the universe. Therefore, for construction, of any sort, to be possible, materials must be in place, and of course, the person (trained worker) who would undertake the different aspects of construction – the professionals. This study is focused on the inter-relationship between the professional, available materials, innovations in materials and the methods employed in the process of construction for the purpose of environmental sustainability.

Innovation in materials are now being tailored to meet specific applications that address pressing individual, industrial and general challenges in the built environment and the contemporary world, (Robert, 2010). Just recently, the United Nations Environmental Assembly, held in Nairobi, Kenya between 11th and 15th of March 2019 rose with the resolution of 2035 target for ridding the built environment of plastics. Plastic is the single, world's most rampant environmental pollutants of the 21st century, (http//: www.tvcnews.ng).

Environmental sustainability challenges in maintaining an equilibrium between green buildings and environmental pollution has become a major feature in modern building designs. Materials and other human factors that contribute to global warming are also given the much needed attention in achieving environmental sustainability (Mehdi, 2015).

This paper seeks to highlight an overview of the issues associated with the role of professionals in the selection of materials for sustainable construction designs so as to reduce the overall negative impact of the built environment on human health and natural resources throughout the life-cycle of the building from planning stage through to demolition (if need be). The scope of this paper is delimited to sustainability in the area of materials, selected building designs and the choice of eco-friendly materials by the built environment professionals for environmental sustainability.

Sustainable Development Goals (SDGs) and Millennium Development Goals (MDGs)

Sustainable Development Goals (SDGs), set by the United Nations were goals built on the Millennium Development Goals (MDGs) of 2000 – 2015; targeted at eradicating poverty, hunger, illiteracy and disease. The SDGs were part of a wider 2030 Agenda for Sustainable Development set out to tackle 17 range of issues, some of which were climate change; **environmental degradation;** affordable and clean energy; Industry; Innovation and Infrastructure; and sustainable cities and communities, (Stephanie, 2015).

The built environment and the sustainable development goals

One of the accents of SDGs was tackling climate change based on human activities in the built environment. It also evolved with a practical guide for reduction in the negative impact of the built environment activities on human health and natural resources. This was targeted among other things, to ensuring that professional build sustainable cities and communities with robust infrastructure that promote sustainable industrialization and foster sustainable innovation. The gains would enhance adaptation to climate change, resilience to disasters, development and implementing sustainable buildings using environmentally friendly materials, (#Envision2030 Goals).

The technology of "green buildings" and ecological balance

A green building is one which has been designed, constructed and is being operated to minimize resource use, reduce waste and negative environmental impacts, maximize the health and productivity of occupants and to decrease life cycle costs. It is a building that makes efficient use of land, materials, energy, and water; generates minimal or no waste; provides a healthy indoor environment for its occupants; and one that restores, improves, or enhances the natural environment, (Linda, 2013). As opined by Farham & Mohammad (2014), green buildings are such that by their design, choice of materials and construction, have been adapted with the environment and have the capacity to conserve land resources. In green buildings, all related subjects such as designing, construction, maintenance and demolishing are considered and consciously made compatible with the environment. Architects, engineers and other built environment professionals, in each step of green construction, spend ample efforts to develop and complete classic designing in order to provide economic and durable residents to live in, by their complimentary activities. Green building helps build environment and provide safety and health for residents by taking cognizance of efficient usage of water energy and other resources; protecting environment and improving the efficiency of users; and deceasing waste, pollution and demolishing environment.

On the other hand, survival of all living organisms is realized as a result of ecological balance. The term ecological balance is used to describe the equilibrium between human being, plants, and animals as it relates to their environment.

Human beings play a key role to maintain ecological balance because they have the highest thinking capacity as compared to other living organisms. Therefore, this balance is very important as it ensures survival, existence and stability of the environment. Harmonious relationships reflect healthy and desirable ecological balance.

As human population increases over time, so does the need to develop more land. Many ecosystems are destroyed in order to clear land for housing developments and roads, agricultural uses and raising livestock, (Tamara, 2018). These activities should be checked to prevent excessive destruction of the forests, this is the role of the built environment professionals, being that deforestation leads to drought. Drought reduces food production resulting to insufficient food. Insufficient food leads to starvation and later death occurs, hence reducing the existence of some species. A major human activity impact worthy of note for ecological balance is the design specification, choice of materials and the construction methods deployed

by the built environment professionals. With consciously planned ecological balance, conducive green environment is maintained therefore, living organisms multiply and thrive.

OVERVIEW OF SOME SELECTED BUILDING MATERIALS AND THEIR APPLICATIONS

In Australia, during the Sustainable Built Environment 2016: International High-Performance Built Environment Conference, both academics, researchers and practitioners gathered and discussed ways to make construction more sustainable. During the proceedings, a number of materials were brought to the fore as innovations and improvements on existing ones, (Rachel, 2016).

Ceramic materials

Ceramics are inorganic, non-metallic and largely polycrystalline materials that may be shaped at room temperature from a selection of raw materials. They obtain their typical properties by sintering at high temperatures (Robert, 2010). Ceramics are used for wall decoration and cladding. Wall cladding could be used internally or externally depending on what purpose they serve, the functions cladding serves ranges from sound proofing, muffing, padding and the likes. The adoption of tiles replaced the advent of wooden floors, concrete floors, polyvinyl carpets and rugs. The main problem with most of the floors before the adoption of tiles was their durability, cost and degree of ease of cleaning. More so, polyvinyl carpets have been discovered to be non-biodegradable and to give off cancerous fumes when ignited. Wall tiles prevent the walls of washrooms, laundries, kitchens, etc., from soaking up water which encourages the growth of algae that could portend health challenges to inhabitants of the built environment. Sanitary wares are ceramic wares often found in bathrooms and toilets, they include water closets, sinks, urinals, bidets, wash hand basins, etc. Their use is employed because of their ease of cleaning and ability to separate man from solid and liquid wastes of the built environment.

Composite materials

Diverse classes of materials can be combined to achieve some other materials with properties and performance that are exceptional. These resultant materials are called composites. In general terms, all materials are composites except elements. A mixture of two elements can be considered to be a composite in structure on an atomic scale, but on a larger scale, composites comprise of crystals, phases and compounds. Therefore, it can be said that steel, which is an alloy of carbon and iron, is a composite. Brass, on the other hand, is a single-phase alloy and not a composite.

In essence, composites are special material brought about by combining materials differing in composition or form on a macro scale for the purpose of obtaining specific characteristics and properties (Brian, 2004). Constituting parts of a composite always retain their identity such that they can be physically identified and they exhibit an interface between one another. A composite has two main parts. The matrix and the reinforcement. The matrix is the body part that gives the composite its bulk form, while reinforcement part is what determines the internal structure of the composite. This could also be referred to as fiber (Schwartz, 1992).

Researchers have tested lightweight materials that are composed of sand, cement, and even the fiber of waste from young coconut and durian for strength and bulk density. Their studies have shown that these materials are good for the construction of walls and roofs, thereby saving energy and reducing waste from the fruit industry, (Anton, 2016). With growing need for stronger but lighter-weight materials in the construction industry today, more and more composite materials are being developed and discovered. Composite materials often matched material strength, flexibility and attractiveness aside cost concerns.

Polymers

Polymer is a compound word which derives from poly, meaning many, and mer, meaning unit. (Reece, 2011). Polymers can be classified either by physical properties, formability, and reactivity; or according to their chain chemistry. Polymers that can be repeatedly shaped and reshaped are called thermoplastics, whereas those that cannot be reshaped at any temperature once they are set are termed thermosets.

Application of polymers in buildings

Environmentally sustainable materials are a major focus of this paper, due to the raising environmental issues of degradation, depletion and pollution (Aihua, et al., 2014). Environmentally friendly polymers include biodegradable and bio based (from renewable resources). In everyday life, polymer applications are as follows: polyethylene are used for electrical insulations; polyvinyl chloride (PVC) is used in pipes, and flooring; polyvinyl acetate is used in adhesives and latex paints; nylon is used in textile and fabrics; bekalite is used for electrical non-conductivity and heat resistant properties in electrical insulators, radio and telephone casing and divers other applications. The main set back with polymers is that most variations of it are non- biodegradable. A disadvantage of the use of polymers, especially (PVC), asbestos and the likes in the built environment.

21ST CENTURY BUILDING DESIGN AND THEIR ENVIRONMENTAL IMPACT

Building materials and their production process are important factors that impact directly on the environment. However, this impact differs from place to place, according to ecological applications of such buildings, (Tulay, 2007). Impact on environment during production of building materials is reduced especially in production of materials at production plants.

In the year 2000, Adalberth Karinin in a research investigation titled: Energy Use and Environmental Impact of New Residential Buildings, where seven (7) authentic buildings built in the 1990s in Sweden were sampled. They were analysed according to energy use and environmental impact during their life cycle, under the following indices: manufacture of building materials, transport of building materials and components to the building site, erection to a building, occupancy, maintenance and renovation, and finally demolition and removal of debris. Results showed that approximately 85 percent of the total estimated energy use during the life cycle was used during the occupation phase. The energy used to manufacture building and installation materials constitutes approximately 15 percent of the total energy use. Between 70 to 90 percent of the total

environmental impact issues arises during the occupation phase, while the manufacture of construction and installation materials constitutes 10 to 20 percent. In conclusion, the energy use and environmental impact during the occupation phase make up a majority of the total, (Adalberth, 2000). This leads to the following 21st century environmental-friendly design applications:

i. Leadership in energy and environmental design (LEED)

Leadership in energy and environmental design is a program that provides a framework for green buildings that can identify and implement measurable design, construction, maintenance and operations solutions. LEED measures nine (9) key areas: regional priority, sustainable sites, innovations in design, materials and resources, energy and atmosphere, water efficiency, indoor and environmental quality, awareness and education and finally, locations and linkages.

There are benefits derivable from LEED. First, it gives projects a positive image. Green building practices can help in significant cost and energy savings. It promotes clean and renewable energy. The indoor air and daylight provide better quality of life to those in the buildings. It indirectly helps to increase the productivity of building occupants and their environs, (Farham & Mohammad, 2014).

ii. Excellence in Design for Greater Efficiencies (EDGE)

Already more than half of all resources consumed globally are used in construction and almost half of all energy generated across the world is used to cool, light, and ventilate our buildings. Meanwhile, buildings account for 15 percent of worldwide greenhouse gas emissions—a number that is expected to climb higher as more people migrate to urban centres for work in coming decades. With this in mind, developing country governments are focusing on the building sector as an area for reform and innovation.

According to International Finance Corporation (IFC, 2015) EDGE encourages sustainable architecture. Building design should at least demonstrate a minimum 20 percent efficiency saving in energy, water and embodied carbon, that is, professionals looking for innovative ways to help adapt and promote more affordable, energy-efficient designs and specifications.

Going green in the building sector, by sustainable materials, can save investors serious money through lower energy and water bills. Until now, going green in the building business seemed a luxury for the wealthy or for select multinational companies looking to make a branding statement. However, as professional are more grounded in these approaches, even the low and medium income buildings can also now adopt this environmentally sustainable designs.

iii. Building Information Modelling (BIM)

Building Information Modeling (BIM) is one of the most promising developments in the built environment (Salman, et al., 2008). It simulates the construction project in a virtual environment such that an accurate virtual model of the building is digitally constructed. When completed, the computer-generated model contains precise geometry and relevant data needed to support the construction, fabrication and procurement activities required to realize the building (Eastman et al., 2008).

At this point it would be easy for environmentally sustainable materials to be selected. It is important to note that a building information model characterizes the geometry, spatial relationships, geographic information, quantities and properties of building elements, cost estimates, material inventories and project schedule. This model can be used to demonstrate the entire building life cycle (Bazjanac, 2006). As a result, quantities and shared properties of materials can be readily extracted with considerations on environmental sustainability concerns.

CONCLUSION

The role of professionals in building environmental sustainability cannot be overemphasized. They work hand in hand from start of any building project to the end at different stages for the one big purpose of creating a conducive built environment. The choice of materials is also a shared responsibility. The choice of materials is often guided by the function to which they are to serve. Apart from cost consideration, other considerations that could determine the selection of materials are heath, aesthetics, environment, etc. With the advent of LEED, EDGE and BIM in this 21st century, innovation has taken centre-stage in the built environment and is still pushing up its frontiers with multiple function sustainable materials and designs for development.

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