Eco. Env. & Cons. 27 (3) : 2021; pp. (1199-1203)
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ISSN 0971–765X

Alternative building materials and construction techniques that can change traditional methods in South Asia to make the construction Industry Sustainable – A Literature Review

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(Received 27 September, 2020; Accepted 8 January, 2021)

ABSTRACT

South Asia is currently witnessing increasing population growth and rapid urbanization. The implication of these demographics change is the increase in demand for buildings and infrastructure. All metros are already facing environmental impact issues such as destruction of the ecology, changes in weather patterns, and more. The solution lies in sustainable development. Building materials are essential components of building construction and they largely determine the environmental impacts and energy consumption of buildings. The sustainability of buildings depends on the building materials and construction technologies. Therefore, the purpose of this paper is to highlight various sustainable building materials and construction techniques that are useful for the nation's sustainable development.

Key words : *Sustainable development, Sustainable building materials, Sustainable construction.*

Introduction

Sustainability is a comprehensive approach. Today everyone is talking about a period when environmental problems due to various human activities require serious solutions. Sustainability is a synergy between society, economy, and the environment, which means it must benefits society, must be economically viable, and must not create irreversible changes. It is a well-known fact that the construction industry contributes to socio-economic development in most countries, as it provides many opportunities for people to get employment.

South-Asia is currently witnessing increasing population growth and rapid urbanization. The implication of these demographics is the increase in demand for buildings and infrastructure, which results in large-scale construction and environmental degradation. However, Companies in South Asia engaged in sustainable building materials and techniques to save the environment, to reduce the consequences of global warming, increasing the value and marketability of their projects, and achieving the reducing lifecycle costs.

The infrastructure industry is currently booming. The current scenario in the fast-growing industry has faced many challenges due to excessive pollution and some volatile aspects of the nature of the building materials. Globally, the infrastructure industry uses about half of the world's natural resources and about 40% of energy and produces 50% of overall waste. At the same time, they emit large

numbers of harmful emissions during their operation, which is about 30% of the total greenhouse gases and an additional 18% indirectly induced by physical adsorption and transport.

Due to the high consumption of raw materials and energy, building construction has a significant impact on the earth's environment. And if we ignore it, the building will become a source of pollution, excess energy consumption, and even deforestation. Sustainability aims to achieve efficient use of resources with minimal impact on the environment. The key to promoting sustainability is to unify it into the curriculum of life for citizens, builders, developers, industrialists, decision-makers, students, and teachers who are torches for the future.

Objective of the Study

The study reviews the development of technology as inspired by nature to help sustainable innovation and design. Research has been carried out with emphasis on the amalgamation of the approach of the construction industry with sustainable development and includes the following:

- To examine the advanced methods of building construction for sustainability and innovation.
- To examine the effects of the use of sustainable construction in modern technology.
- To understand the scope and role of sustainable construction in achieving sustainable development.
- To understand the problems and issues encountered while implementing ideas.

Literature review

South Asia included Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. South Asia is the most densely populated geographical region in the world, with a population of one-quarter of the world's population.

The meaning of sustainability in building and construction keeps on developing from year to year. The initial focus was on dealing with limited resources, particularly the issue of energy, and minimizing impacts on the natural environment. Various technical issues were also emphasized, such as design concepts related to materials, construction components, manufacturing techniques, and energy (Akadiri *et al*., 2012).

Many studies show that the construction industry consumes the most energy and generates the most greenhouse gases. Alternative building materials and construction technologies will reduce energy consumption and the energy intensity of construction materials. It also shows that consuming less energy will not impact the life cycle of the building (Song and Zhang, 2018).

Governments of different countries focus on changing the country's infrastructure through various projects and missions so that stability remains per current principles. Fortunately, significant progress in construction has been achieved through research and development, and building sustainable infrastructure is possible today. Also, the difference in demand and supply of building materials has led to the rise of unconventional and innovative resources, as well as opportunities for energy-efficient and economical construction methods (CSIS, 2019).

Several studies have confirmed that the uses of lime to replace cement in building construction, environmentally friendly tile, bamboo (alternatives to steel reinforcement in concrete, roof, and floor systems), Ferro cement, and various durable constructions technique minimize the environmental impacts of buildings without compromising the strength and life cycle (Patil and Patil, 2017).

In general, sustainable construction will provide waste reduction during construction, reduce energy usage and running costs, and minimize the environmental impacts of buildings throughout life.

Methodology

The study uses available secondary data in the form of published articles, research papers, books, theories, and miscellaneous literature from various sources. The study uses documents from old as well as new literature to study trends and patterns in the field of study. Since this is a literature review, the study will be qualitative, providing data and literature in a concise form. The study will focus on the following points:

- How the concept of sustainable construction technology evolved over the years
- How technology is playing an important role in achieving sustainable development
- How sustainable manufacturing has helped to increase the efficiency of products.
- How sustainable construction reduces the use of materials without compromising the quality of construction.

Major Principles of Sustainability. To make the

industry sustainable, waste has to be minimized and this can be done by using major principles of sustainability:

- Refuse
- Reduce
- Reuse
- Recycle
- Recover

Sustainability goals in construction sites can be stated to optimize energy, materials, and water.

Sustainable Building Materials. Sustainable building materials are those that are locally produced. These materials include recycled and industrial waste materials and by-products, which have little impact on the environment and are thermally efficient. The production of these building materials requires significantly less energy than conventional building materials. They are not only economically viable but also reduce toxic emissions, reducing overall environmental impact (Akadiri *et al.,* 2012). Some of these materials are as follows:

Slag, Shale, perlite, and vermiculite: The backbone of infrastructure is aggregate. They are cheap and readily available, but are non-renewable. Aggregates extraction and processing cause environmental impacts, and generates wastes. Some substitute for aggregates are slag (a by-product of iron and steel refining), shale, perlite, and vermiculite, that can use as a lightweight aggregate. Additional materials that can use as a substitute include rubber tires, broken glass, sea shells, coconuts shells, and coal clinkers.

Fly ash: It is a waste from the power plant and can use as a recycled material. They are usually spherical and reduces the water requirement. The spherical shape reduces friction between the aggregate and the concrete, therefore, increases the work efficiency and improve the pumping capacity of the concrete. Reduction in water requirement improves cohesiveness and reduces both isolation and bleeding. But fly ash cannot replace cement completely as it increases the settling time and reduces its strength in the initial stages, that is why it replaces only 15 to 20% cement. By doing so, it increases strength, reduces permeability, reduces hydration heat and alkali-aggregate reaction, increases resistance to sulfate attack and corrosion, hence making concrete strong and durable.

Ground Granulated Blast-furnace Slag: It is a by-product of heating iron-ore, coke, and limestone from blast furnaces. It improves durability, reduces hydration heat and permeability of concrete, and can use as 20–50% by mass of cement content (Siddique and Khan, 2011).

Fly ash bricks: Fly ash bricks are less porous as they absorb very little water. These bricks have water absorption of about 6 - 12% and have a compressive strength of 7.5 to 10 N/mm^2; therefore, the compressive strength of fly ash is high as compared to the red-bricks. They are lighter in weight when compared to clay bricks, and weighs is varying from 2.5 to 3 kg, whereas red-brick weighs 3.5 kg, so fly ash brick will reduce the load on the structures. They consume only 65 kgs of cement for the construction of 1m3 of brickwork, which is less compared to the red-brick (Sumathi *et al.,* 2015).

Autoclaved Aerated Concrete and Compressed Stabilized Earth Blocks: The material used in the production of AAC blocks are green products and environmentally friendly. These blocks are also lightweight with high thermal insulation and fire resistance and have good strength and durability. Due to high thermal insulation capacity, it helps the interior to remain cooler during summer and warmer during winter (Wang *et al.,* 2018). Lime and Cement are used for CSEBs production.

Porotherm bricks: Made up of natural resources and weigh about 60% lesser than the conventional clay bricks. It also has thermal insulation capacity. They are eco-friendly as they built up of natural clay combined with the other natural addictive-like coal ash, rice husk, sawdust. They are recyclable bricks. (Suseelan and Singh, 2020).

Sustainable Light Weight Concrete: The density of coconut shell aggregates varies from 550 to 600 kg/m3, so the use of coconut shell aggregates in the production of concrete leads to lightweight concrete. It also found that after 365 days, coconut shell gains strength without any biological decay. Various tests and results show that the specific gravity of the coconut shell is 1.34, and that of aggregates is 2.77. Besides, the water absorption of coconut is 0.22, and that of aggregates is 0.66 (Gunasekaran and Kumar, 2008).

Sustainable Construction Techniques

Retrofitting Techniques: The demolition of an old building requires a lot of effort and also generates construction demolition waste. The proper planning of new construction and maintenance of old estab-

lishments to extend its life can minimize this problem. It can perform by the retrofitting technique. It is the process of improving, recasting, reshaping, or reforming something after completion of construction. It reduces maintenance charge, increases reliability, and reduces emissions that can be caused by the demolition of old buildings. This process strengthens older buildings to make them earthquake-resistant (Paradis, 2016).

Pre Engineered Buildings: In these buildings, the built-up sections are developed in a plant and held together on-site with bolt connection. The use of these buildings in place of the traditional building design concept led to several advantages, including easy construction and economy. Quality control is the main advantage as all structural members are pre-engineered. It is possible to consider the proper examination and standards of different codes. Factory manufactured components under the supervision of a quality control engineer. Costs are lower due to savings in design, manufacturing, and on-site construction costs. It minimizes the maintenance and construction time, and the use of standard quality increases the carrying capacity.

Pre-fabricated buildings: In this technique, various building components or the entire building are manufactured at the plant and then assembled on-site. It is a green, environmentally friendly, energy-saving construction system extensively used in residential and commercial construction projects. This method overcomes the drawbacks of traditional construction modes. This system provides a good quality structure, shortens the construction period, saves material, and is also free from noise and dust pollution.

Carbon fiber reinforced polymer: It consists of polymers and carbon fiber and produces in the form of bars, strips, and sheets. CFRP materials have high strength, better stiffness, corrosion resistance, low density, high ultimate stress, vibration resistance, low thermal conductivity, and high fatigue resistance. The CFRP provides solutions for many problems related to the disintegration and boosting the strength of infrastructures such as buildings and bridges and eliminates potential erosion problems. Effective use can extend the life of structures, reducing maintenance requirements (Liu *et al.*, 2015).

MIVAN Technique: It is an advanced formwork system made of aluminium components, which is simple to install, customizable, and used in the construction of residential units and large-scale residential projects. This technique prominently applies in places where there are entire structures made of concrete. In this technique, prefabricated room-sized wall panels and floor slab panels are produced in the required sizes and then placed on site simultaneously. Windows, ducts, doors, staircases are also integrated into them. These various forms joined together using a pin and wedge system, and high-quality concrete

poured, and it takes the form and shape of the cast. After the construction of the concrete structure, these various forms can quickly dismantle. This technique requires relatively less labor, as well as a lower number of joints and less leakage. As it gives smooth finishing of the wall and slab, there is no need for plastering. It has strength, seismic resistance, durability, good quality construction work, faster completion, and lower maintenance costs.

Tunnel Form Construction Technique: This technique is very systematic that solves problems such as voice transmission and is earthquake proven. This technique uses in the construction of cellular structures with recurrence. It comes in the form of an inverted "L" tied together to form a tunnel. It can reuse that makes the method extremely economical and very versatile. This method of construction can produce strong and durable in-situ cellular structures with up to 25% time savings and 15% cost savings. In this technique, post-construction trades such as plasterers and electrician reduces and known to be environmentally friendly as there is no requirement of wooden material.

Results and Discussion

Today everyone wants to know what is the solution to the environmental problems happening around us, which is being spread by many activities done by humans. Due to the high consumption of raw materials and energy, building construction has a significant impact on the earth's environment. There has been increasing concern in most countries over the inefficient use of resources for building construction, which necessitates alternative building materials and construction technologies.

Over two to three decades, the construction industry in South Asia faces challenges in finding suitable solutions to address many environmental

issues due to its activities. In areas such as raw material use, energy consumption, CO_2 emissions, water consumption, and waste generation, its mode of operation needs to change to minimize its adverse effects on the environment. Although alternative building materials and construction techniques aim to promote locally available natural resources and preserve excessive use of resources, balancing and using them to protect resources is not easy for many.

The choice of building materials that reduce the impact on our environment proves to be effective in sustainable development, and the selection of such building materials increases the environmental performance of any building. However, there are several challenges regarding the use of alternative building materials and construction techniques. Most developing countries pay attention to the economic, technical, and institutional factors affecting the stakeholders. An obstacle in the use of alternative building materials is the rising cost of alternative building materials and construction techniques for their manufacture. In addition to this factor, there are other hidden costs associated with equipment used for material production, as well as maintenance costs in most countries. In addition to cost, the lack of technical knowledge also limits the possibility for professionals and developers to build. The lack of information spreading in the use of such materials is responsible for this.

The growing concern over the inefficient use of natural resources has resulted in policy and regulatory reforms in recent years to address problems. In most developing countries, further changes need to create, not only to address environmental issues but also to meet growing needs.

Conclusion

Sustainable construction practices is a way to move towards protecting the environment. It maintains a balance between economic, social, and environmental performance. They require significantly less energy than conventional construction practices, increases the building strength and life cycle. Although awareness of sustainable building materials and construction technologies is generally low, some progress has already been achieved. There has a long way to address environmental issues affected by its activities, but technology can make it possible to achieve sustainability.

Acknowledgement

The research work was carried out within the framework of the project under the Symbiosis International University.

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