Building Materials and the Future of Alternative Solutions

Materialele de construcție și viitorul soluțiilor alternative

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Abstract: While conventional materials like hemp could be employed as a lowcost, low-carbon method of reinforcing concrete, building intelligent materials are the future of efficient manufacturing.A new breakthrough in the industry is currently being promised by at least 10 novel construction materials, including plastic that is stronger than steel and 3D-printed mushroom columns.A lot of effort was put into developing biochar cladding, carbon-fiber reinforced concrete, super-strong plastic, and 3D-printed mycelium with the goal of preventing issues like corrosion and fire as well as prolonging the lifespan of concrete structures.Additionally, materials like green charcoal loofah make it possible for the bricks to serve as a habitat for both plant and animal life, boosting the biodiversity of cities.

Keywords: building materials, alternative solutions

1. Introduction

The incorporation of sustainable solutions into architectural design is one of the essential elements in achieving the shift to sustainability. The variety of structural components, the availability of sustainable materials, and the diverse tastes of clients, architects, and structural designers make the decision-making process difficult [1]. All across the world, alternative building materials and methods are used. Soil is the most basic building material, other than wood and stone. Soil, which may be recycled, can be used to build structures. Soil is the best form of passive air conditioning since it can adapt to any environmental factor.

While using less energy, employing dirt as a building material can benefit the environment. Mud houses are used often all around the world [2].

The Building Research Establishment Environmental Assessment Method (BREEAM), the Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB), the Leadership in Energy and Environment Design (LEED) and Green Globes in the United States, the Building Environmental Assessment Method (BEAM Plus) in Hong Kong, and the Comprehensive Assessment System for Built Environment Effi. These, however, take a

long time to implement and don't take the economic side into account, which goes against the fundamental tenet of sustainable development. The investor aspires to pursue cost-effective projects while also pursuing ecologically friendly solutions with low energy usage and waste output [3]. Due to the documented flaws in sustainability evaluation tools, it may be concluded that sustainable product design tools are still in their infancy [4]. Numerous scientists have proposed theoretical developments in sustainable design and construction, but more research, including testing, is required. Before investors find the green project financially appealing, this area requires a lot of development. The observed flaws in design and sustainability assessments led researchers to the conclusion that quick, easy, and trustworthy methodologies were required to evaluate the sustainability of structural solutions at the outset of design [1].

2. Methods

Numerous studies have been carried out by the scientific community worldwide in pursuit of low-tech and alternative sustainable building materials, which results in a more sustainable and affordable construction meeting comfort standards. Using environmentally friendly building materials is a fantastic way to accomplish this. The least harmful to the environment construction materials can be employed because of their importance in a nation's sustainable development [5]. Choosing environmentally friendly building materials and reusing and recycling trash as or to generate construction materials are effective ways to improve a building's performance and decrease its detrimental effects on the environment and human health [6].

Buildings are the world's largest energy consumers, according to the United Nations Environment Program [7]. Residential energy use makes up a sizeable share of overall national energy use in the majority of countries [8]. International activities have increasingly centered on reducing building carbon emissions [9]. Operational energy reduction has been the industry's top focus since it has a bigger impact on carbon emissions over the course of a building's lifetime and is easier to predict than embodied energy [10]. Typically, the building performance research should be carried out while taking into account the construction documents and the architectural blueprints [11]. Access to specific data, such as material quality, U-values, and technical systems, is required for early design stage energy performance study of a building. This information is one of the elements influencing a building's energy efficiency [12]. The geometric information of buildings is often extracted from architectural drawings. An energy analyst can then, based on their knowledge, expertise, and experience, define the thermal perspective of the building utilizing this information [13].

Affordable green roof designs, the use of alternative building materials for liners and substrates, the integration of solar energy generation with green roofs, and the establishment of multipurpose recreation areas have all seen an increase in interest

recently (Figure 1). Many cities are adopting the EU Research and Innovation policy agenda, which promotes renaturing cities and territorial resilience for communities that are socially and environmentally responsible (EU 2015). Each city, however, has a different vision for the application and promotion of green roofs, depending on regional circumstances. Subject to the accomplishment of a set of sustainable development goals, policies are necessary to encourage the use of green roofs by law or financial incentives (such as a reduction in water or property costs). This is because green roofs are sustainable over their full life cycle [14].

Figure 1 The Praça de Lisboa in Porto, Portugal, has a green roof as an example of how cities and vegetation coexist (photo: Cristina Calheiros).

3. Results

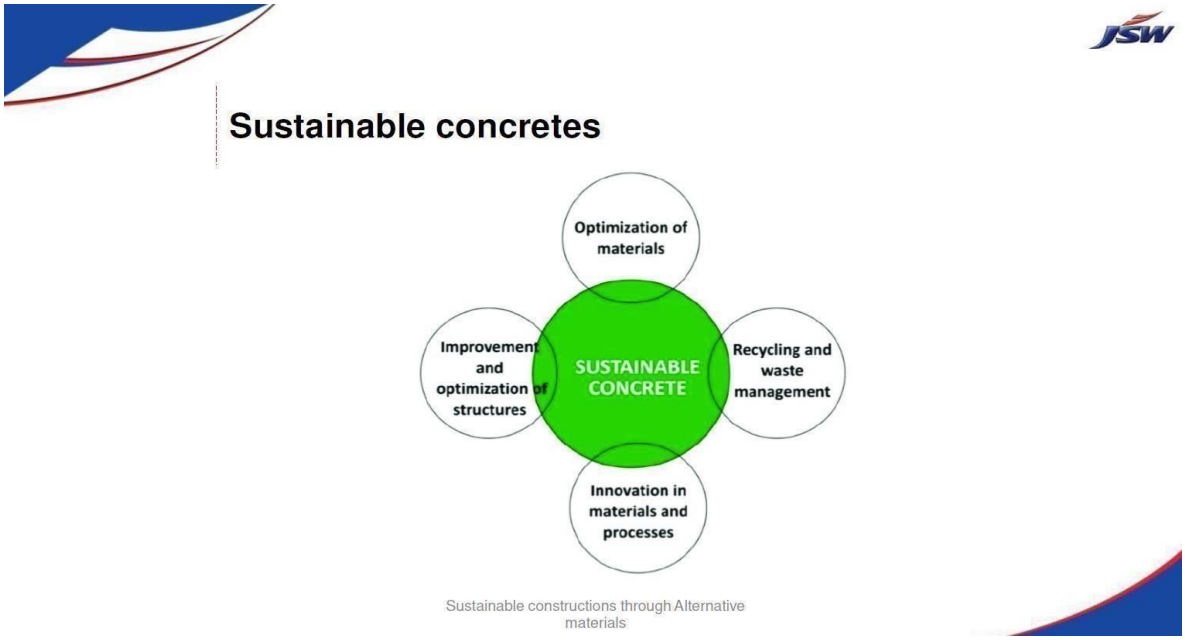
The chosen building and city models are no longer useful and practical because they were built 50 years ago disregarding nature. Finding ways to deal with urban issues and adapt to or mitigate the consequences of rising temperatures is essential. The building industry in most countries is responsible for between 30 and 40 percent of both energy use and carbon emissions. Reducing the carbon footprint of the building sector by creating sustainable, energy-efficient structures is the main goal of worldwide environmental policy. Utilizing zero-impact or at the very least low-impact technological solutions, the building envelope should be built.

In addition to the numerous social, economic, public health, and environmental advantages, green roofs can also help to improve building thermal performance, especially in the summer, and to optimize urban stormwater management, which could

play a significant role in the field of green infrastructures as a whole. This is significant because space is often an issue in cities. In order to combat climate change, green roofs must be adapted to local conditions and incorporated into urban green infrastructure plans. However, these components continue to be subject to constraints that affect energy modeling and environmental and economic evaluations [15].

The appropriate and contextual use of a sustainable building material is necessary for any community development. In addition to lowering material prices, carbon emissions, and transportation costs by using sustainable building materials, doing so also gives local residents job and training opportunities. As an alternative criterion, functional, technical, and financial considerations are frequently utilized to choose sustainable construction materials.

The environmental impact of building materials has, however, grown in importance as a vital factor as sustainability has become a significant issue in recent years, particularly in industrialized nations. Construction accounts for 22% of annual environmental damage, hence it has a duty to identify more ecologically friendly building and construction techniques in order to promote sustainable growth. Some of the approaches for discovering solutions include the usage of new material applications, recycling and reuse, the production of sustainable products, or the utilization of green resources [16].



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It is common knowledge that the building's perimeter walls make up the building's envelope, which serves as a barrier between the interior and outer climates. Conduction, convection, and radiation are three heat transfer mechanisms that work together on location to move heat from a building's interior to its exterior [18]. Three crucial material factors define the thermal insulation capacity of building materials:

1.the coefficient of thermal conductivity (W/mK), which measures how much heat moves through a material having a surface area of 1 m2 and a thickness of 1 m over the course of an hour with a temperature difference between the two surfaces of 1 K (or 1ºC see [19]).

The density and humidity of the substance have a clear link with this variable. It has been shown in steady state experiments that the lower the thermal conductivity and the drier the material, the better it functions as a thermal insulator (other parameters are constant).

2. **R** - resistance to heat transfer by conduction in a steady condition, as per [20-21] .

$$R = \sum \left(\frac{d}{\lambda} \right) \left[m^2 k / W \right] \quad (1)$$

3. **R_0** - global thermal resistance, [m2k/W], for global heat transmission at the element's external and interior surfaces by convection and radiation, as well as over the thickness of the element by conduction. global thermal resistance, [m^2k/W], for global heat transfer, over the thickness of the element, by conduction, as well as at the external surface of the element (Rse) and the internal surface of the element (Rsi) by convection and radiation [2021].

$$R_0 = Rsi + \sum \left(\frac{d}{\lambda} \right) + Rse \left[m^2 k / W \right] \quad (2)$$

In order to maintain an indoor environment that adheres to the passive home concept, the corrected thermal resistance is computed using the correction coefficients stated in the C1073/2005 and C107-5/2005 regulations [22].

The building industry is among Europe's top resource consumers in terms of both material and energy use during all stages of a construction project. Actually, one-third of the waste created in Europe comes from materials from construction and demolition waste (CDW see [23]). To fully comprehend, it's critical to keep in mind that the European Union generates roughly 3 billion tons of waste every year. Construction and demolition activities account for about 1 billion tons of this, with a considerable amount of CDW materials ending up in landfills with little possibility of recovery or reuse [24]. As a result, the building industry is a top priority of the EU's plan to reduce waste production and decarbonize the European economy [25]. Innovation in end-of-life material management must be in line with the Waste Framework Directive 2008/98/EC's mandate that 70% of CDW be ready for reuse, recycling, and other types of recovery by 2020 [26]. The efficiency of the current quality assurance and control systems for recycling

construction materials (as the European Quality Association for Recycling see [27]) creates a product of excellent quality with possibilities for sale [28].

4. Discussion

Alternative Building Materials (ABM) are defined differently by different researchers in the construction business, who also employ distinct terminology and definitions of ABM.

ABM is a generic term that, without being particularly precise, refers to a class or group of building materials.

It includes building and construction materials and supplies that go by a variety of names in literature, including alternative materials, local building materials, unusual building supplies, alternative residential construction supplies, sustainable building supplies, indigenous building supplies, vernacular building supplies, green building supplies, environmentally responsible building supplies, eco-friendly building supplies, etc. The study's methodology included a systematic examination of the literature and content analysis to compile and assess all the crucial information. In order to reduce costs, address environmental concerns, or deal with a lack of conventional materials, "alternative building materials" are defined as "building materials that are an alternative to conventional building materials in the form of total or partial substitution of the materials or its constituents" (working definition, operational). According to research, the qualities of ABM include, among others, low or no chemical emissions that can lead to poor indoor air quality, recycled content (post- and preconsumer), a lack of CFC, HCFC, or other ozone depleting substances, low embodied energy, local production, the capacity to repair and replace the product using local resources, and social acceptability. Some benefits of using ABM include ease of construction, wide availability, low cost, and low embodied energy (which typically results in lower greenhouse gas emissions see [29]). In the construction industry, recycling waste materials not only reduces project costs but also safeguards the environment by reducing the amount of waste dumped in landfills, the consumption of natural resources, and carbon emissions [30].

In this age, energy conservation and economic energy use have become complicated issues. It is one of the main causes of the high inflationary tendencies seen around the world and developed nations have already begun to take effective conservation measures. India, meanwhile, appears to be falling behind in this area. Today, coal, nuclear power, oil, and natural gas are the primary energy sources. Alternative energy sources must be developed quickly while also conserving and expanding the current energy supply to the greatest extent possible due to the global depletion of oil and natural gas reserves [31].

Using environmentally friendly materials may not always result in sustainable building. The pursuit of sustainability cannot be effective by concentrating only on

environmental issues. It is necessary to balance the former with the economic and social problems [32]. Adopting sustainable practices necessitates the participation of all accountable stakeholders and the integration of all sustainable principles throughout the project life cycle [33]. When designing sustainable buildings that comply to the many sustainability categories, the job of the structural engineer is especially important. Structural engineers hardly ever consider the environmental dimension in the conventional approach to building design, in contrast to the new integrated building design process, which acknowledges it as one of the most important factors [34]. Decisions made on structural engineering have a substantial impact on environmental emissions, water use, energy use, and waste generation [35]. By incorporating sustainable construction principles into the design process, projects can become more sustainable [36]. However, major barriers were found, including greater costs, longer wait times, and a lack of information and suppliers for green goods [37]. Making choices can be challenging due to the availability of a large variety of sustainable construction materials, client preferences, architectural styles, and structural designs, as well as the wide range of sustainable structural components [38]. Sustainability is a complex phenomenon with many conflicting objectives [1].

5. Conclusions

The incorporation of sustainable solutions into architectural design is one of the essential elements in achieving the shift to sustainability. Due to the variety of structural elements, the availability of sustainable materials, and the diverse tastes of clients, architects, and structural designers, the selection process is difficult. Choosing environmentally friendly construction materials and reusing and recycling trash as or to manufacture building materials are fantastic ways to increase a building's performance and lessen its detrimental impacts on the environment and people's health. Buildings are the world's largest energy consumers, according to the United Nations Environment Program. Interest in developing more economical green roof designs, using alternative building materials for substrates and liners, combining green roofs with solar energy production, and developing multipurpose recreation areas has recently increased. All responsible parties must be involved in adopting sustainable practices, and all sustainable principles must be used throughout the project life cycle. Energy conservation and wise energy use are complex concerns in the modern world. One of the key reasons for the high inflationary tendencies observed globally, industrialized countries have already started to implement efficient conservation measures.

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