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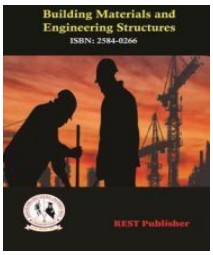

A Study on Building Materials used in Construction and its Classification

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Abstract: *Selection of materials for constructing a building plays a crucial role in determining its environmental impact. This impact extends locally, involving activities like quarrying; globally, through the release of carbon dioxide during material manufacturing; and internally, affecting the health of occupants. The Technical Committee on "Microbial Impact on Building Materials" conducted a review of current research on Impact of microorganisms on construction materials. In architecture, the term "life cycle" refers to the period during which building materials function as intended, ideally with no significant performance loss in the operational phase Currently, there is a trend towards recycling construction materials at the end of their life cycle. The recycling processes employed for numerous contemporary building materials result in a reduction in their energy. Genuine recycling should not involve a continuous decrease in energy with each cycle. Scientific literature extensively covers topics such as durability, life cycle, and sustainability related to building materials. Many projects, driven by a commitment to prolong their longevity beyond a single human generation, find it almost obligatory to incorporate a transcendental dimension to their design.*

1. INTRODUCTION

In recent times, there has been a significant upsurge in public awareness of environmental issues such as global warming and ozone depletion. The importance of energy conservation in buildings is now widely recognized. In the U.K., approximately 50% of all primary energy is consumed in servicing buildingsFurthermore, an estimation suggests that the energy utilized in the manufacturing and transportation of building materials accounts for an additional 8% (350 PJ per year), equivalent to approximately 6 tonnes of building material per capita. Nanotechnology holds the promise of revolutionizing the construction and building materials industry, offering the potential for a new era. While replicating natural systems stands out as a highly promising aspect of this technology, scientists are grappling with the intricate complexities involved. Analyzing the hydration products of Portland cement at the nano scale could lead to the development of more durable binders, although the timeline for such advancements remains uncertain. The current obstacle lies in the cost inefficiency of nano particles, hindering their widespread commercial applications in the near future. Energy usage in buildings can be categorized into two primary segments: the energy essential for continual maintenance and servicing throughout a building's useful life, and the energy capital expended in the building's production, commonly referred to as embodied energy. . Energy consumption in buildings can be divided into two main categories: the energy required for the maintenance and service of a building throughout its useful life and the energy capital invested in the production of a building, known as embodied energy. Top of Form The integration of photocatalysts with building materials commenced in the early 1990s. The multifunctionality of TiO2, capable of serving as both photocatalytic and structural materials, has facilitated its incorporation into A variety of key construction components using TiO2 include various materials for both exterior construction and interior decoration. These include materials such as cement mortar, exterior tiles, paving blocks, glass and PVC fabric. The benefits associated with incorporating TiO2 into these materials have garnered significant attention from various industries.[4]As advanced building materials, including dry-mix mortars, become increasingly prevalent in Eastern Europe and China, there is a continuous expansion expected for current products in the market. Bio admixtures are anticipated to play a role in this growth. Further technological advancements will be necessary to enhance existing systems, with a focus on improving cost-effectiveness, reducing labor time, enhancing workability, and addressing environmental concerns such as volatile organic compound emissions and biodegradability.Thomas Jester has brought together a distinguished team of seasoned scholars and professionals specializing in the history and conservation of building materials. Their collaborative efforts have resulted in a valuable addition to the literature in these fields. Starting

with vibrant, full-color reproductions of advertisements and photographs showcasing modern building materials and their architectural uses in the introduction, the book proves to be a delightful resource for both dedicated scholars of construction technology and architectural preservationists, extending all the way to the final endnote.[9]Microorganisms, Microorganisms, being organisms too minuscule to be observed without a microscope, can play a role in the deterioration of building materials. This degradation can occur either directly through the microorganism as a nutrient (assimilative process) or through metabolites produced by the microorganism (immobilization process). .It is crucial to identify the specific activities of microorganisms that result in the biodeterioration of various building materials, along with the types of microorganisms exhibiting these activities. Importantly, these factors will vary depending on the specific building material being investigated.[10]Linoleum is a common flooring choice in public buildings and schoolsCeramic tiles find extensive use in Southern countries, particularly in public buildings and schools. On the other hand, wooden floors, carpets, and rugs are commonly found in residential houses.Gypsum boards are predominantly present in Southern European countries, typically employed in residential houses. Furniture in all instances is crafted from comparable wood-based panels, including MDF, covered particleboards, or wood.Public buildings commonly feature printing equipment, while schools often utilize markers for painting. the building materials identified at each measurement site can act as potential sources of emissions for all priority pollutants.Building materials can be prohibitively expensive, especially when reliant on imports. Opting for locally available materials, even if they have limited durability, is preferable as it makes construction more affordable for rural communities. In tropical climates, the design of suitable and cost-effective housing must account for the significant factor of heat. Earth blocks, a long-standing choice in home construction across various countries, have proven to be a viable option. Studies suggest the possibility of providing construction materials and techniques that are not only suitable but also economically accessible for such environments .[12] The primary goal of this research is to evaluate the suitability of thermography for analyzing the properties of building materials. To achieve this, experiments were conducted at the Building Physics Laboratory (LFC) located at the Faculty of Engineering of the University of Porto (FEUP). Despite the substantial potential of thermography as a non-destructive testing technology, A thorough review of the application of thermography to building materials is lacking. Research conducted at the Building Physics Laboratory (LFC) underlines the importance of emissivity as an important parameter that affects thermographic measurements and limits the applicability of the technology in the context of buildings. This study seeks to present innovative concepts related to materials and building elements that have completed their initial life cycle. Additionally, it aims to assess their recyclability potential. The research methodology employs an inverted hierarchical pyramid, prioritizing the reuse and recycling of materials. Subsequently, it establishes recyclability levels for both materials and elements. The subsequent sections introduce novel ideas concerning the recycling of building materials[15].Following an extensive and systematic review of literature, 24 sustainable assessment criteria (SAC) were identified, drawing on the triple bottom line and the requirements of building stakeholders. To gauge the importance of these criteria, a survey was conducted among UK architects and designers. A total of 490 questionnaires were distributed for completion, resulting in an overall response rate of 20.2% through initial and follow-up administrations of the postal survey. The criteria were then grouped into assessment factors using factor analysis to model the sustainability of building materials[16].As the awareness of their substantial effects on resource depletion and pollutant emissions increases, there is a growing demand for environmentally friendly buildings. Consequently, there is a heightened emphasis on environmentally friendly or 'green' building materials as a key area for environmental improvement. However, challenges arise due to the lack of a consensus on the definition of 'green' materials and an agreed-upon method for To Assess the environmental impacts of building materials and components throughout their life cycle Researchers have proposed a general theoretical framework for life cycle analysis (LCA).)[18].Existing literature predominantly focuses on the mechanical behavior of cementitious building materials reinforced with plant-based fibers. However, further research is essential to address several aspects that remain unclear based on current knowledgeFor example, the delayed effects of fiber supplementation have recently received due attention. Considering that fiber degradation is mainly the result of alkali degradation, thorough research on the chemical interaction between cement matrix and natural fibers is needed. The search for effective treatments to improve the compatibility between fibers and cement matrix is crucial remains an ongoing challenge. Additionally, methods to control the quality and minimize variations in the properties of natural fibers require development. Investigations into durability-related issues are also warranted. Concrete structures reinforced with bamboo fibers show promise for advancing sustainable construction, but more research efforts are needed to better understand the mechanical performance of bamboo reinforcement and ensure its durability within a cement matrix[19].Fluctuations in population size are associated with an upswing in atmospheric emissions, consequently affecting the durability of building materials. While While natural emissions exceed the combined anthropogenic emissions of substances such as CO, NOx, SO2, HC and particulate matter, challenges related to atmospheric pollution are mainly related to concentrated and temporary levels rather than the total amount released.Urban environments significantly contribute to the formation of these concentrations. Cities also play a role in other global environmental challenges, encompassing

the heat generated by vehicle exhaust pipes, deforestation driven by the demand for wood in construction, posing a threat to biodiversity. Furthermore, substantial municipal water consumption contributes to concerns about water scarcity[20]. Changes in population size are associated with an upsurge in atmospheric emissions, which, in turn, have adverse effects on the durability of building materials. While natural emissions exceed combined anthropogenic emissions in estimating Cumulative atmospheric release of substances such as CO, NOx, SO2, HC and particulates, issues related to atmospheric pollution predominantly stem from localized and temporary concentrations rather than the overall quantity released. Urban atmospheres play a pivotal role in the formation of these concentrations. Cities also contribute to broader global environmental challenges, encompassing the heat generated by vehicle exhaust pipes and deforestation driven by the demand for wood in construction, which poses a threat to biodiversity. Furthermore, the substantial municipal water consumption adds to concerns about water scarcity[20].

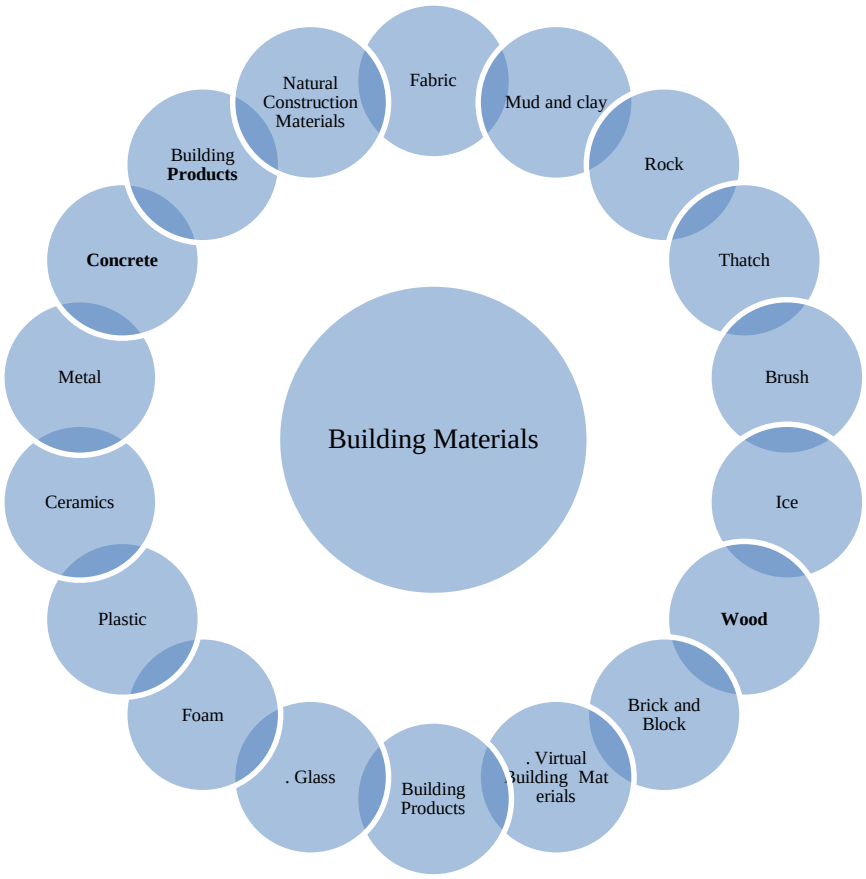

FIGURE 1. Building Materials

Natural building materials Building materials are divided into two categories: natural and synthetic. Natural materials, like lumber or glass, are either unprocessed or minimally processedConversely, synthetic materials such as petroleum-derived plastics and paints are produced in industrial settings with substantial human intervention. Mud, stone, and fibrous plants, along with flexible materials like cloth or skins, have historically been used to construct homes adapted to local climates. These structures often feature stone and brush as primary structural components, with mud filling the spaces to act as a form of concrete and insulation. Wattle and daub, for example, functioned as permanent homes in tropical regions or as summer structures in ancient northern societies.

2. BUILDING MATERIALS

1. Fabric: Historically, nomadic groups globally favored the tent as their dwelling, with notable examples being A conical teepee and a round yurt . The concept of using tents has experienced a resurgence as a significant construction technique, thanks to advancements in tensile architecture and The traditional tent, once the preferred dwelling of nomadic groups worldwide, has experienced a revival in construction techniques The advent of tensile construction and the availability of synthetic fabrics. Modern buildings now use flexible materials such as steel cables or fabric membranes supported by internal pneumatic systems.

2. ***Mud and clay:*** The choice of building materials significantly influences the architectural style of structures, with soil quality being a crucial determinant. Higher clay content typically leads to the use of the cob/adobe style, while regions with low clay soil often favor sod building. Additional key ingredients include varying proportions of sand/gravel and straw/grasses. Rammed earth, an ancient and modern wall construction method, has evolved from hand-compacting clay soils between planks to the contemporary use of forms and mechanical pneumatic compressors. Soil, especially clay, serves as effective thermal mass, adept at maintaining consistent temperatures. Dwellings constructed with earth materials tend to naturally stay cool in summer and warm in colder weather. Clay exhibits excellent heat retention and release characteristics, similar to stone. Earthen walls undergo temperature changes gradually, resulting in a more sustained heat or coolness. While adjusting the temperature in a clay-built house may require more resources compared to a wooden house, the retained heat or coolness persists longer.Throughout history, people in Western and Northern Europe, as well as globally, have constructed homes primarily using dirt and clay in styles like cob, sod, and adobe. These architectural forms have persisted in construction, albeit to a lesser extent, over the centuries. Some earthen dwellings are habitable for hundreds of years

3. Rock: Rock structures have a historical longevity, being the oldest and most enduring building material throughout history.Rocks are widely available, with numerous types around the world, each possessing unique attributes influencing their suitability for specific purposes. Despite providing substantial protection due to its density, rock's main drawbacks are its weight and unwieldiness. Additionally, its energy density poses challenges, as maintaining warmth in stone structures requires significant heating resources.The construction of dry-stone walls, dating back to the early stages of human history, has involved stacking stones without mortar. Over time, various forms of mortar, with cement being the most common today, have been employed to bind the stones together. Dartmoor National Park in the United Kingdom, with Its granite-strewn uplands provided abundant Materials for early settlers building round settlements in the Stone Age and Early Bronze Age were obtained from the environment. Evidence of about 5,000 huts still exists today. Granite has been in use not only in medieval times but also in modern times.as seen in structures like Dartmoor longhouses.Slate, another type of stone, finds widespread use as A widely used roofing material in the United Kingdom and other accessible areas is stone. Stone constructions are common in major cities and some civilizations.such as those of ancient Egypt, the Aztecs, and the Inca, exclusively constructed with stone, evident in iconic structures like the Pyramids and Aztec pyramids.

4. Thatch: Thatch is among the earliest known building materials, utilizing grass as it offers effective insulation and is readily harvested. Numerous African tribes have traditionally inhabited homes constructed entirely from grasses throughout the year. In Europe, thatched roofs were once common on homes but declined in popularity with the rise of industrialization and improved transportation, enabling greater access to alternative materials. However, there is currently a resurgence of interest in thatching practices. In places like the Netherlands, even new builds feature thatched roofs, often adorned with special ridge tiles.

5. Brush: In tropical and subtropical regions such as rainforests, brush structures built entirely of plant material, with substantial leaves, are frequently encountered. Abundant and utilized in construction.Native Americans commonly employed brush structures for temporary shelter and dwelling, using branches, twigs, leaves, and bark, resembling the construction of a beaver's lodge. These structures went by various names, including wickiups and lean-tos.

6. Ice: The Inuit have traditionally used snow to build igloos, and in some northern regions where winter tourism is limited, snow is used to build snow hotels, making them a unique tourist attraction.

7. Tree: Wood obtained from trees and sometimes other fibrous plants is used in construction when it is cut or processed into lumber and timber such as boards and planks.It is a versatile building material employed in the construction of various structures across diverse climates. Wood exhibits remarkable flexibility under loads, retaining strength while bending, and boasts exceptional vertical compression strength. Different types of wood vary significantly in quality, even within the same tree species, making certain species better suited for specific purposes. The growing conditions also play a crucial role in determining the wood's quality.In historical contexts, large structures were often built using unprocessed wood in the form of logsThe trees were cut to the desired length, occasionally stripped of bark, and then either sawn or hammered together. In some regions and earlier times, many country homes or communities maintained a personal wood-lot where families or communities would cultivate and harvest trees for construction purposes, akin to tending a garden. The advent of mechanized saws revolutionized the process, enabling Mass production of dimensional lumber, made possible by mechanized saws, accelerated construction processes, and introduced greater uniformity, paving the way for the modern Western-style home.

8. Brick and Block: A brick is usually a block formed from clay or shale and occasionally from low quality mud. Shaping clay bricks involves the soft clay method using a mold or, in commercial production, the more common extrusion of clay and wire cutting (hard clay process) to achieve the desired size. Bricks were extensively utilized as a construction material during the 1700s, 1800s, and 1900s, likely because they offered greater fire resistance

than wood in the increasingly congested cities and were relatively cost-effective. In the late 20th century, another type of block, the Cinder block, largely made of concrete, replaced clay In developing countries, sandcrete blocks serve as an important economic commodity. Although they are less strong than fired clay bricks, sandcrete blocks are a more economical option.

9. Concrete: oncrete is a composite construction material made by mixing aggregate (a mixture of materials) with a binder such as cement. The most common type is Portland cement concrete, which includes a mineral mixture (usually gravel and sand), Portland cement, and water. Upon mixing, the cement undergoes hydration, ultimately solidifying into a substance with stone-like characteristics. In a broader context, this solidified material is commonly known as concrete.. For larger concrete constructions, as the material has relatively low tensile strength, reinforcement is typically added using steel rods or bars, commonly known as rebars, resulting in reinforced concrete. To minimize the presence of air bubbles, which could weaken the structure, a vibrator is employed to remove entrapped air when pouring the liquid concrete mix around the ironwork. Due to its durability, malleability, and ease of transportation, concrete has become the predominant material in contemporary construction.

10. Metal: Metal serves as the foundation structure for tall structures such as skyscrapers. , and is also used as exterior surface cladding. While many different types of metals are used in construction, steel, primarily an alloy containing iron, is the main choice for metal structural construction.It is known for its strength, flexibility and, when refined or adequately treated, long-lasting properties. Corrosion is a significant threat to metal longevity. The reduced density and better corrosion resistance of aluminum alloys and tins can sometimes justify their higher costs. Although brass was widely used in the past, its current use is limited to specific applications or specialty materials. . Metal plays an important role in prefabricated constructions such as Quonset huts and is frequently used in urban metropolises. Metal production requires a significant amount of human labor, especially when the construction industry requires a significant amount.

11. Glass: Since the introduction of glass, transparent windows have been used to cover modest openings in buildings. These windows offer the dual benefit of allowing natural light into rooms while shielding inhabitants from adverse weather conditions. Glass, typically produced from mixtures of sand and silicates, is inherently brittleContemporary architectural designs often feature glass "curtain walls," capable of enclosing entire building facades. Glass is also employed in constructing expansive roof structures known as "space frames."

12. Ceramics: Ceramics encompass items like tiles and fixtures, commonly employed in buildings. They serve various purposes such as flooring, wall coverings, countertops, and even ceilings. Ceramic roofing tiles are extensively used in many countries for covering buildingsWhile ceramics initially encompassed specialized forms of Kiln-fired clay pottery has evolved into a more advanced and technological application of the discipline.

13. Plastic: The use of plastic materials is exemplified by the addition of plastic pipes passing through a concrete floor in a high-rise residential building in Canada. The term "plastics" covers a range of synthetic or semi-synthetic organic materials formed by condensation or polymerization processes. These materials may be molded, extruded or formed into objects, films or fibers. Derived from the ability to exhibit plasticity .Plastics exhibit significant variations in heat tolerance, toughness, and elasticity.Their adaptability, along with their uniform composition and lightweight nature, makes them suitable for a wide range of industrial applications today..

14. Foam:Foamed plastic sheeting is used to provide support for firestop mortar at CIBC Bank in Toronto. In recent applicationsTo a limited extent, synthetic materials such as polystyrene or polyurethane foam find use. These materials are lightweight, easily molded, and offer excellent insulation. They are typically assembled as components of structural insulated panels, where foam is sandwiched between layers of wood or cement.

Top of Form

15. Construction materials in modern industry: The contemporary construction industry is a robust and lucrative sector that operates globallyIt plays an important role in the extraction and production of essential raw materials for various construction applications

This industry often serves as a pivotal point in governmental and trade relations between nations. Concurrently, environmental considerations have emerged as a significant global concern, focusing on The industry faces challenges related to the accessibility and sustainability of specific materials, especially considering the significant quantities needed for human habitation.

16. Virtual Building Materials: Certain elements such as photos, images and text can be considered virtual. Although these elements usually have a physical presence in the substrate of the natural material

, their significance undergoes a transformation through the process of representation, distinguishing them from natural materials.

17. Building Products: When discussing building products, we are referring to pre-fabricated components designed for integration into various architectural and decorative elements of a building. This classification expressly excludes materials used in the construction of a building's architectural elements and ancillary equipment such as windows, doors and cupboards.

Building products are distinct from the materials used in constructing the architectural framework, such as windows, doors, and cabinets. Instead of forming integral parts of the building, these products support and facilitate its functioning.

3. CONCLUSION

This classification expressly excludes materials used in the construction of a building's architectural elements and ancillary equipment such as windows, doors and cupboards. , arise primarily from local and temporary concentrations rather than the overall amount released. This concentration is mainly generated in the urban atmosphere . Cities also contribute to additional global environmental challenges, including the warming effect caused by vehicle exhaust pipes, deforestation due to the demand for wood in construction, posing a threat to biodiversity, and high municipal water consumption. The paper initiates by outlining Energy content of building materials and consequent carbon dioxide emissions .. It compares wood production for construction materials with other wood flows from the world's forests and examines The study examines the energy and carbon dioxide impacts involved in the processing of wood products. The findings of the research are derived from Life Cycle Assessment (LCA) , which considers three distinct impact categories and differentiates frequently used construction materials with certain environmental materials. The objective is to enhance the understanding Its aim is to improve the understanding of energy and environmental specifications related to building materials
analyze potential for improvement, and provide guidelines for material selection in the environmental design of new constructions and renovation of existing buildings

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