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Towards Advanced Sustainable Building Materials

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ABSTRACT: The research study made an actual contribution in the field of building materials by offering alternatives to the most important sustainable building materials without favouring one of them or distinguishing them. Plant or animal and describe these resources as renewable related to the possibility of their growth as a component of a living organism that reproduces itself through relatively short natural cycles, and it is clear through research that the most important characteristic of sustainable building materials is regeneration, as it is linked to the possibility of renewing these resources through cycles that can be measured on the scale of human time. The sustainable use of renewable material resources is in line with the concept of sustainable development, which means development that meets the needs of the present, compromising the ability of future generations to meet their needs. 40 Mining resources are on their way to run out, such as copper, lead, zinc, gold, mercury, tin and others

KEYWORDS: Sustainability - sustainable building materials - traditional energy sources - renewable energies.

I. INTRODUCTION

The dispute is still related to the eligibility of materials from natural sources versus manufactured and composite materials from a different group of materials. Some environmental scientists believe that manufactured building materials do not represent a problem in themselves, as materials from natural sources may be less sustainable, for example, recycled plastic is more sustainable than Cotton collars, which are used in the manufacture of some building materials, whose cultivation requires large amounts of energy, water, pesticides, herbicides and fertilizers. However, the efficiency issues of manufactured materials versus materials that come from nature continue to be studied.

II. RELATED WORK

Research problem:

The lack of clear boundaries and methodology of a standard model on the diverse and multiple aspects of building materials and sustainable espoused by the architecture of sustainable currently in the design and implementation of several projects located within the functions and competence of the architect, he is also a lack of knowledge and clear in this area at the academic level or professional especially within modern societies Covenant on sustainable building materials.

The aim of the research:

Access to a scientific methodology that includes an inventory and study of the most important sustainable building materials, how to use them, and the criteria and sustainable strategic and evaluation foundations that achieve sustainable urban development in order to reach a new sustainable urban community.

III. THE CONCEPT OF SUSTAINABLE BUILDING MATERIALS

Sustainable building materials are defined as those materials that use the earth's resources efficiently and are environmentally responsible materials that respect the limits of non-renewable materials as in mineral ore and petroleum materials integrate with ecosystems and natural cycles of non-toxic materials and are made from recycled materials and are themselves recyclable and reuse efficient in Consumption of energy and water is environmentally friendly and non-polluting. It is manufactured in an environmentally friendly manner and the method of its use is environmentally compatible, as well as it can be recovered after use[1].

IV. THE DIFFERENCE BETWEEN SUSTAINABLE BUILDING MATERIALS AND PRODUCTS

Sustainable building materials:

Refers to the basic materials that may be a component of the product or used separately in the building and that have lower environmental characteristics and environmental impacts compared to counterpart materials such as wood as a sustainable building material as in the figure (1) It is from a renewable source and also comes from forests that use sustainable methods in their management to maintain a rapid growth rate as a renewable source of raw materials. In short, wood is a sustainable building material that meets all sustainability criteria as a raw building material that is included in manufacturing processes [2].



Figure 1 : Wood is a sustainable building material

Sustainable building products:

It refers to the building components that carry a set of environmental characteristics that make them preferable to their counterparts, for example, the least radiation glass, a type of glass that uses openings that allows the passage of visible light through it and prevents the passage of harmful infrared rays from the light spectrum. energy As in Figure (2), this point depends on how to define sustainable building products, which not only come from sustainable building materials, but can also come from non- sustainable traditional materials such as less radiation glass used in lighting openings, as it is one of the difficult materials to recycle or even impossible. Recycled as it contains a film layer that has been glued between the layers of glass to enable it to separate the light spectrum, unlike ordinary glass, which can be easily recycled for several times. In terms of the same material, ordinary glass is more sustainable than glass products. The previous example illustrates the difficulty and complexity in the process of choosing materials and products Selection of building materials and products for high-efficiency buildings.



Figure 2: Least radioactive glass is shown as sustainable building products.

V. CRITERIA FOR EVALUATING SUSTAINABLE BUILDING MATERIALS:

By studying the environmental considerations of sustainable building materials, it has become necessary to classify them into three basic groups as in Table (1), which are the efficiency standards for materials sources, internal environmental quality standards, as well as efficiency standards as in form. These three groups contribute to evaluating and comparing the extent of building materials compatibility with environmental considerations. As well as comparing them with each other.



Efficiency Standards	Indoor environment quality standards	Sources Efficiency Standards
- resource vortex - Energy Efficiency - water efficiency - recyclability - reusability - degradability	- Reduce construction waste. - Use of saline - Toxicity - Renewable energy sources	- Waste Reduction - pollution prevention - Combined energy - Rotate components - Natural materials

Table 1 : shows the criteria for evaluating sustainable building materials, source: the researcher.

Sources Efficiency Standards:

A - Reducing waste: The property of reducing waste during the manufacturing process of building materials refers to achieving the efficiency of the production process by reducing the waste of materials that come from the processes of forming, cutting and finishing damaged or defective materials or products that can be used on site or introduced into some other industries. Disposal, thus increasing the efficiency of material sources.

b- Preventing pollution: The property of preventing pollution during the manufacturing process greatly contributes to the sustainability of the sources and the preservation of the surrounding environment. The awareness of manufacturers of the sources of materials used in the manufacture of building materials greatly helps in achieving their sustainability. The selection of building materials produced by environmentally responsible companies encourages efforts to prevent pollution, even if the cost The principle of the products seems somewhat higher and by applying the law of supply and demand to materials that produce higher pollutants, by reducing the demand for these materials, the production will decrease and by reducing the production, the waste and energy decreases, and therefore environmental pollutants, as well as encouraging the use of sustainable materials and their characterization in buildings encourages their production and marketing .

C- Reducing the combined energy :The combined energy of the building material refers to the total energy needed to produce it, including the energy needed to extract raw materials, manufacturing energy, and the energy of transporting materials to the places of operation. This energy often comes from burning petroleum oils as limited non-renewable sources and the accompanying burning of environmental pollutants. The greater the combined energy of the material means Increasing the energy needed to produce the material and thus increasing the polluting emissions of the environment resulting from it. By recycling building materials, the energy integrated within them can be preserved, as the energy required to rotate some materials is much less than the energy needed to produce them from their primary sources, as in aluminium, where only 10: 20 of the energy needed To produce it from bauxite ore.

E- Use of natural materials :Natural materials are generally characterized as being lower in integrated energy, relatively easy to manufacture, and have fewer negative effects on the environment compared to manufactured building materials. By using natural materials, building materials become more sustainable [3].

Environmental Quality Standards:

1- Reducing construction waste :Reducing solid waste during the construction and installation phase contributes to reducing the areas of waste burial places and reduces costs, as well as achieving compatibility with standards, reducing waste in materials and reducing operating and construction costs.

2- Use of local materials :The use of local building materials achieves reducing transportation distances between manufacturing, distribution and construction sites, and thus reducing air pollution associated with the use of transportation for fossil fuels. The salt production of building materials contributes to reducing transportation distances, and local materials often fit with local climatic conditions, and thus the purchase of these materials supports The local economy and it is not always possible to find all building materials locally, so it is necessary to choose the materials that you import and in the least possible quantities. Importing iron for use in construction work for its strength and durability may be justified use, and it is usually made away from construction sites.

C- :Toxicity:Many of the building materials used represent a danger to construction workers and building users and to indoor air quality. Therefore, the effects of toxicity must be taken into account when choosing building materials and calculating air change rates. By using non- toxic or less toxic materials, we can avoid environmental and health problems.

D- Renewable Energy Systems :It means replacing traditional building systems that depend on energy produced outside the site such as electric energy, fossil fuels, solar energy and wind by using natural and available sources on the site and systems that encourage the falsification of daylight, passive solar heating and on-site energy generation [4].

Efficiency criteria:

1- durability :Refers to materials that have a longer period of use compared to other materials designed for the same purpose and that need less replacement during the period of their use in the building, which reduces the natural resources used and the cost of installation and labor. The durability factor is one of the important factors in evaluating the cost cycle during the life of the building, as it becomes The most durable materials are the most economical compared to the materials that need to be replaced several times during the period of use. In view of the durability factor, it is possible to compare the more expensive materials compared to the period of their use.

2- Energy Efficiency :Sustainable materials slow the transfer of heat through the building shell, which reduces the need for heating and cooling. The thermal properties of materials are the most important criteria for choosing materials used in construction, especially in the outer casing. It has been possible to control the properties of materials that affect energy efficiency and determine their suitability to the insulation properties. The comparison between them and thus through several criteria, including the thermal insulation coefficient, which helps in determining the thermal insulation properties of materials, and the material with the highest value is the most insulating, and the least insulating material must be used in thick layers to reach the same value, and the shading coefficient expresses the percentage of heat gain of the sun through the particles of the material and it allows Comparing its efficiency in blocking sunlight for different lighting from glass and shading systems to take advantage of sunlight in lighting and blocking heat associated with unwanted solar rays, especially in hot areas.

C- Water Efficiency :Sustainable materials are characterized as they encourage efficient water use during the extraction, construction and use processes and help to achieve efficiency in construction. Water use efficiency can be achieved through rationalizing consumption within the site and collecting rainwater for reuse or recycling water for treatment.

D - Reuse :The most closely related materials may remain usable for several more years, while the period of use of the building itself can expire and can be reused by dismantling it from the buildings and installing it in another location, for example, timber that is dismantled from old buildings and reused in new construction operations

E - Recycling :Recycling measures the ability of a material to be used again as a source for the production of new materials. Many materials that cannot be reused in their original form can be broken into recyclable components, and recycling operations often face difficulty in separating materials from reduced construction and glass, for example, from materials that are easy to recycle But the difficulty of separating it from construction waste prevents the process of recycling, as it enters the manufacture of new glass, bricks, ceramics, as well as iron from materials that can be easily separated by special magnetic

And the- : biodegradabilityIt means the possibility of the natural dismantling of materials after their final disposal by burial. Natural materials return to the ground easily and other materials need a longer time, while manufactured materials It is not impossible to decompose and some of them produce many environmental pollutants [5].

VI. STRATEGIES TO ACHIEVE SUSTAINABILITY OF BUILDING MATERIALS

It is suggested to reduce the environmental impact of building materials used in the implementation of architectural projects to follow the following strategies, arranged according to their importance.

- Reuse of the existing structure:

We can make some modifications to the existing building to reuse the largest possible amount of the existing structural structure and systems, which contributes greatly to reducing the use of new materials and the subsequent effects that result from extraction, production, transportation, operation, waste and many other effects.

- Rationalization of materials used in construction:

By using the least amount of materials required for the construction of the project, it also reduces the environmental impacts resulting from the production of building materials from their primary sources. In general, the process of



rationalizing the use of materials in the building is very difficult due to considerations of building systems and the desire of users and achieving the requirements of sustainable buildings, which has become the integration of control devices and systems Refrigeration, air conditioning and others, which are not available in traditional buildings, which makes us need to modify the design of existing buildings and incorporate new strategies that allow the building to be decomposed and re-used after its end of life, such as design methods for dismantling as part of the building design strategies as a whole and the use of recyclable materials.

- Use of materials from renewable sources:

Materials manufactured from renewable sources provide opportunities to achieve sustainable construction through organic recycling processes. This principle applies to materials manufactured from plant sources such as wood, wool and cotton, in addition to some types of industrial polymers that are not biodegradable, but can be recycled [6].

VII. EXAMPLES APPLIED TO SUSTAINABLE BUILDING MATERIALS (ALTERNATIVES TO USED BUILDING MATERIALS)

Sustainable building materials alternative to traditional reinforced concrete and its components:

1. High-quality concrete: It can be obtained using raw materials from Egyptian quarries. It was possible to produce high-quality concrete using ordinary Portland cement, and it was also possible to reduce water penetration into concrete by up to about 75%, ie reducing its water permeability.

2. High-strength concrete: It is used in construction projects with its huge facilities efficiently to obtain smaller concrete sections for high loads, which leads to a reduction in the required production capacity as well as the energy of transportation and implementation and leads to a sound and durable concrete over time without compromising the safety of the facility. High-strength concrete is characterized by pressure resistance After 28 days, it reaches 1100 kg / cm², and the required pressure resistance can be obtained, which is early for the tensile strength without re-reinforcing them, which saves the implementation time in addition to saving in concrete and the proportion of reinforcing steel.

3. Foamed Concrete: It is produced using light cement added to it with foaming materials, so that it became possible to achieve the provisions of the density of the materials with extreme accuracy, amounting to 400: 1700 kg / m³. It was also possible to obtain a stable foam material free of chloride, depending on the engineering of mature machines, which at the same time ensures its durability. For materials, light concrete is characterized by its good heat insulation compared to ordinary concrete due to the increase in porous spaces, which causes a decrease in its apparent density.

4. Pre-stressed concrete: The researchers developed this trend and resulted in reaching suitable figures for concrete strength after 28 days up to 700 kg / cm³ and it was possible to reach lightweight concrete weighing between 16: 18 tons / m³ and used in insulation.

5. Reinforced stone: Reinforced stone replaces concrete in the prevailing walls, where the prevailing walls of reinforced stone were used by one of the companies and it was a better alternative than regular reinforced concrete with a cost reduction of 40: 60%, in addition to the ease of maintenance and aesthetic appearance, which saves energy Finishing and ease of construction and installation compared to reinforced concrete materials. It is also characterized by its long life span, as it can remain safely for a very long time. It was built in this way in Egypt with a height of up to 20 m [7].

Alternative and sustainable materials for aggregates in reinforced concrete:

1- Milcelle rubble: The tendency was to use blown glass pebble by manufacturing it using the millesl technology to form a pebble called the millesil rubble. Concrete industry, as it is lighter in weight and less water-absorbing, and its resistance to breakage can be adjusted to suit different uses.

2- Iron filings: The use of iron filings produces heavy-weight concrete, the density of which can be produced from 2500 kg / m³ to 4500 kg / m³ according to customer requirements. Heavy aggregates are used to produce heavy concrete with the required density and pressure resistance required after 28 days according to specifications [8].



Alternative and sustainable materials for cement in reinforced concrete:

1. Resins: Resins are used in concrete works as a binder instead of cement paste for aggregates to produce what is called resinous concrete.

2. Liquid cement: Liquid cement appeared for the first time at the Bateman Exhibition for Building Materials in France. It is a new innovation for a type of cement that is used in a liquid state and does not require labor or effort to use, and is transported to work sites in liquid to save time and effort.

3. Rice husk ash: Rice husk ash can be used as a partial replacement for cement in concrete mixtures to reduce the pollution resulting from these materials, in addition to reducing the energy required for the cement industry. Each rice husk gives about 40 kg of the pozzolanic material alternative to cement. By conducting laboratory experiments on a paste Cement, mortar and concrete in which rice husk ash is used as a substitute for part of the cement. He determined that the optimal ratio of rice husk ash in mortar mixtures depends on the ratio of water to cement in the mixture. The use of 20% rice husk ash is appropriate in all ratios of water to cement used [9].

Alternative and sustainable materials for mixing water in reinforced concrete:

1- Magnetized water: The use of magnetized water on ready-made concrete mixtures led to obtaining a concrete that was much stronger than the normal case by up to 40%, in addition to the possibility of saving 15% of the amount of cement needed for the mixture while maintaining the same strength and providing 5% of the necessary water To mix as well as extend the life of the concrete structures of the buildings that use this technique by doubling and increasing the plasticity at least twice.

Alternative and sustainable materials for steel reinforcement in reinforced concrete:

1. Resins: Reinforced concrete was produced with plastic fibers, the most famous of which are polypropylene and glass fibers. Research extended to the production and use of fiberglass and polyethylene skewers. These skewers began to take the world's attention, especially in areas that suffer from collapses due to the rust of the reinforcing bars. The economies are noted The huge value provided by the use of resins over steel reinforcement while achieving high resistance and durability over time to all the surrounding and destructive factors of concrete with savings in maintenance work.

2. Plastic rods reinforced with radiant fibers with resins: These rods are called C-bar rods. It is noted that the manufacturing method and the materials that make up this compound determine its properties and durability in the long run. The ability to bend, improve and fit in mechanical properties, proper selection of resins, composition and quality control of these rods are factors.

3. Natural fibers: Many researchers have developed the idea of using natural fibers instead of steel reinforcement, in addition to the fact that many researchers have developed composite materials from natural fibers such as palm fibers, bananas, jute and others. Palm fibers were thought of as a source of natural fibers in Egypt, as it is local. The use of the stems of the Sabat cluster or the date arjun locally in applications to high tensile resistance as well as bearing harsh conditions and has proven that it is highly efficient, which suggests that it will work to reinforce concrete and this is in addition to experiments with many natural fibers such as reed and bamboo. Composite materials of jungle and plastic have also been developed. The composite material is made of bamboo and epoxy to give better strength than that given by ordinary fiberglass, with which the composite materials are reinforced, and it is 3 to 4 times mild steel, and the results taken from the samples in tensile, pressure and bending ensure its use in construction.

4. Bamboo: Bamboo is a locally available material in Egypt. Bamboo is characterized by that it grows very quickly and does not require special care in most rural areas and along the banks of the Nile and the Canal. Extensive research has proven its suitability for safe use as an alternative to steel reinforcement in concrete used in a number of Construction purposes The process of preparing bamboo for use does not require more than cutting into strips and treating it with a water-insulating material. It can be used in concrete floors and covering ceilings, walls and columns for dwellings subject to reasonable loads and for all pre-fabricated concrete elements.

A sustainable alternative building material for red bricks:

1. Clay bricks: The desert girl has an average of 36 million cubic meters and covers about 5 km². The clay brick has shown good potentials for the production of solid bricks, hollow blocks and ceiling tiles. The brick produced from the



clay brick is better than the red brick produced from indigo silt in terms of strength and use, especially in load-bearing walls. Which may reduce the need for the use of structural buildings in the case of building housing units not exceeding seven floors. This is in addition to the reduction in the electrical energy required for production, as natural drying leads to a saving in the amount of fuel consumed by approximately 40%.

2. Light bricks: Light bricks are characterized by their light weight, as their density ranges from 600: 650 kg / m³. It is also characterized by being a good thermal insulator and easy to form. It also uses one third of the mortar used in the rest of the bricks, which is happy to accomplish in the construction process and save time due to the large The size of one block is equivalent to 8 times the size of normal bricks, and two workers can build about 30: 40 square meters of wall molds per day. Using a saw, axe, or any sharp tool, the brick can be cut easily or spread it to different sizes.

3. Light concrete blocks: Light concrete blocks are produced in molds in the form of reinforced slabs or unreinforced blocks. These units are characterized by light weight, as they are 450: 500 km: m³, which helps to reduce the size of the foundations and the consequent excavation and backfilling, and the number of The times of transferring the units to the site are much less than the traditional units, and they are characterized by high efficiency in thermal insulation and characterized by dimensional stability during manufacturing processes, as they reach 0.2%, and they are highly resistant to fire.

4. Gypsum boards and blocks: The recent discovery of large quantities of gypsum in Egypt is a reason to use this local material in the walls and ceilings of residential units instead of limiting its use to white, as it could be used in many construction fields. It has smooth surfaces and is ready for painting without the need for whitewashing, and its defects can be overcome as it transmits sound and is easy to break. The work of these panels is hollow in full thickness. This type of block is an excellent heat insulator in addition to its high resistance to fire. It is noted that the possibility of saving energy as a result of low specific weight and its effect on building elements The construction and each block has protrusions and protrusions for installation by clicking and tongue method.

5. Polyurethane bricks: Plants needed for the manufacture of polyurethane are grown in large commercial quantities in Sudanese and Egyptian lands similar to them. These natural raw materials have not yet been used in this construction field. They are never exhausted resources. A single technician can run a mobile plant on the back of a truck produced in A day, a quantity of bricks is sufficient to build 15 housing units, each of 170 square meters, but it depends on advanced technology in manufacturing.[10].

Sustainable building materials alternative to timber:

1. Date palm leaf: The trend came to the use of palm tree timber, especially date palm, in the Arab countries, including Egypt, due to its abundance. Egypt enjoys a large share of date palm trees, amounting to 10.5 million trees that can be pruned regularly to produce annually the equivalent of 200 thousand tons of dry timber. Annually in the form of clouds to be used in the manufacture of countertops, while the manufacturing waste is used in the manufacture of chopped and granular wood panels. The design of a simulation model for drying date palm leaves was studied to determine the thermal behavior of it using industrial drying in a tunnel-type dryer and it was found that it can be dried in open air conditions by exposure Direct solar radiation, which contributes to the exploitation of natural energy.
2. Agricultural waste: There has been a boom in recent years in the interest in the industrial use of what is called agricultural waste, and the more correct name is agricultural residue, which is what remains of the resource after the fruits or the main product. North America occupies the leadership in the production of panels composed of these waste, which some estimate at 300 million tons Monthly dry weight. There are also many products in many other countries using these wastes, and Egypt should move quickly towards using its agricultural waste to reduce its burden on the environment and provide the necessary raw materials for some industries.
3. Resins: Reinforced plastic can be used in the chopping work of concrete works, especially those with special shapes, instead of wood. Biological plastic appeared from the shredded shredder, which is subject to analysis, which reduces the pollution resulting from the manufacture of plastic [11].

VIII. RESULTS

- Inventory and study of the new sustainable building materials.
- Identify the most important strategies to achieve the sustainability of building materials.



- Reducing waste during the manufacturing process of building materials leads to achieving the efficiency of the production process by reducing the waste of materials and can be used on site or entered in some other industries, thus increasing the efficiency of materials sources.
- Pollution prevention during the manufacturing process greatly contributes to the sustainability of resources and the preservation of the surrounding environment.
- Awareness among manufacturers of the sources of materials used in the building materials industry greatly helps in achieving its sustainability, and the selection of building materials produced by environmentally responsible companies encourages efforts to prevent pollution.
- Reducing the combined energy, because the greater the combined energy of the material, the more energy needed to produce the material, and thus the increase in polluting emissions to the environment resulting from it.
- The recycling of building materials can conserve the energy integrated within them, as the energy required to rotate some materials is much less than the energy needed to produce them from their primary sources, as in aluminum, where only 10:20 of the energy needed to produce it from bauxite ore is used.
- The use of natural materials, as natural materials are generally characterized as lower in integrated energy, relatively easy to manufacture, and have fewer negative effects on the environment compared to manufactured building materials. By using natural materials, building materials become more sustainable.
- Achieving environmental quality standards by reducing construction waste. Reducing solid waste during the construction and installation phase contributes to reducing the areas of waste burial places and reduces costs as well as achieving compliance with standard standards.
- The use of local building materials reduces transportation distances between manufacturing, distribution and construction sites, and thus reduces air pollution associated with the use of fossil fuels for transportation.
- Many of the building materials used pose a risk to construction workers, building users, and indoor air quality, so toxicity effects must be taken into account when choosing building materials to avoid environmental and health problems.
- The replacement of traditional building systems, which depend on energy produced outside the site, such as electric energy and fossil fuels with solar and wind energy, using natural resources available on site and systems that encourage on-site energy generation.
- The durability factor is one of the important factors in evaluating the cost cycle during the life of the building, where the most durable materials become the most economical compared to materials that need to be replaced several times during the period of use.
- The efficiency of water use during extraction, construction and use processes and helps to achieve efficiency in construction. Water use efficiency can be achieved through rationalizing consumption within the site and collecting rainwater for reuse or recycling water for treatment.
- The recycling factor measures the ability of a material to be used again as a source for the production of new materials. Many materials that cannot be reused in their original form can be broken down into recyclable components.

IX. RECOMMENDATIONS

- The need for the architect to keep pace with the massive digital development in the field of sustainable building materials so that the architect is an influential, effective and powerful element in the modern architectural and executive design process, and not just imposing solutions on him.
- The need to work on more academic research in the field of sustainable building materials , and to develop architectural engineering curricula in universities to include these topics and for the student to have strong knowledge of them.
- The importance of inventorying and studying the specifications for the establishment of sustainable building materials , because it is the backbone and the basis upon which the sustainable design process is based.



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