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The Evolution of Green Cladding Technology for Architectural Facades and its Role in Achieving Environmental Integration

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Abstract

The world is currently witnessing interest in environmental issues and awareness of the environment, sustainable development systems and green buildings, with the aim of making the most of the environmental resources, rationalizing energy consumption, and obtaining a clean environment and the materials of cladding play a role in achieving this, where the materials of the cladding provide comfort to the residents and protection of the building in addition to achieving the aesthetic value of the interface. The goal of the research: To Spotlight on the development of technology and specifications in the building. The importance of green cladding materials and their role in achieving the integration of the building's façade with the environment. Provide a classification of the products of green facades and developed from them. Research methodology: The research is based on the theoretical approach in explaining the theoretical material provided and the experimental method in providing a technological idea for an experimental product of paint products and external cladding. Research structure: The research is divided into three parts related to the technology of materials and products of interface suppositions: building materials and traditional and upgraded cladding. Elements of the integration of the façade of the building with the environment (comfort, beauty, protection, and preservation of the safety of the environment). Attention to the complementary environmental elements, including (plants and trees) and the rationalization of the consumption of irrigation water.

Keywords: Tech Green Cladding, Building Waste Products, Environmental Chromatic Integration, Grey Water

1 Introduction

With the growing interest in the environment and the development of building technology and attention to green products and green materials that do not pollute the environment can be defined as "green cladding materials" as: are natural materials or manufactured from natural materials and follow the systems of sustainability, as well as manufactured materials with environmental efficiency and manufactured materials that work to conserve energy and are not polluting the environment. Green products are products made of natural materials, in addition to industrial products that are used in recent facades and have varying effects on the environment.

1.1 First green building materials

Told by "Hassan Fathy": "When the Arabs moved to stability, they began to drop their philosophy in architectural metaphors, reflecting their vision of the universe, and so the sky appeared as a dome supported by four columns." This concept, which gives symbolic value to the home as a miniaturization of the universe, thus subjecting technology to the economics of poor people (2).

This reflects the importance of using environmental cladding materials manufactured from local natural materials, and is considered the best where it fits and corresponds to the ecosystems and climatic conditions in which it is located, as it reduces the energy consumption inside the building, such as the clay used in the manufacture of bricks used in the construction of bricks, and of the oldest types of bricks, "brick milk" made of clay, sand, and straw, which has proved strong and strength in construction throughout history for more than 2500 years, used in the construction of building walls and separation of interior areas in the building. It has many environmental advantages in terms of thermal storage properties and moisture balance as it works on thermal insulation. Moreover, one of the most famous types of clay bricks (clay red bricks).

- **Red clay bricks**: considered from the green building products and it consists of a variety of clay types, and is mainly composed of a combination of sand, silt and clay, in addition to water and poured into molds and leaves to dry, and is still used as red bricks and is produced in standard dimensions 12×25×6 cm. Mud generally has many environmental specifications and features, including a natural, environmental and non-polluting substance, and provides a healthy residential environment.

1. It can be reused by recycling, grinding dry clay, mixing it with water and then using it again.
2. It's an obtainable Local material, which save the cost of construction and the energy consumption during manufacturing.

- It has a high ability to form, as it has varied sizes and products whether as a building material or cladding and one of its disadvantages is: (a) the weakness of the clay in general, and it must be protected from rain; (b) shrinking in size during the dry process; and (c) it is burned for more hardness, causing severe pollution of the environment.

Communities have developed their own techniques and

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architectural methods suitable for their environments in using clay as building materials and cladding, but the interest in it as a building material has increased significantly since the mid-20th century. Many brick products have been developed, in order to improve the properties of the product, and to maintain the cleanliness and safety of the environment, through the selection of other materials suitable for the manufacture of brick construction with better properties such as white limestone:

- **White limestone bricks**: It is called (white light insulating bricks) is one of the types of bricks made from local materials, the most important of which is lime, silica sand, and a ratio of cement with water and bonding chemicals working on the hardness of the brick, after mixing the components are poured into large basins and after hardening and removing, the mass is cut to the required sizes with a special wire saw. This brick is characterized by its light weight and durability at the same time, and one of its most important features is thermal insulation as the thermal insulation ratio of white limestone bricks represents the highest rate of thermal insulation from other types of bricks, in addition to its ease of use and regular smooth form. There are also types of development that depend on maintaining the cleanliness of the environment by taking advantage of the waste of demolition and construction, and recycling them in the production of new building materials with better industrial and environmental specifications.

Figure 1: White limestone bricks are lightweight

2. Methodology

Following the spread of global awareness about the damage of waste to the environment, and how to benefit from it by spreading the culture of waste recycling in a way that contributes to reducing the burden on natural resources and damage to the environment. Many wastes, such as agricultural waste, have been utilized through the manufacture of new products that work to reduce the consumption of natural environment resources, such as rice straw residues and palm leaf in the manufacture of wood panels and carton industry (3), in addition to the use of waste demolition and construction of buildings by recycling, and for that process has many industrial and environmental benefits, including:

- Working to clean the environment
- Rationalize the consumption of natural resources.
- A renewable resource for the construction and maximizing economic benefit.

This process is carried out through the use of the remaining materials of building materials and cladding such as stone dust, marble, soft and rough debris resulting from the concrete of buildings and breaking bricks, in the production of environmentally friendly concrete or the manufacture of ready-made wall panels, solid and hollow concrete bricks, as it can be used in the basic layer of paving roads, and also can be exploited debris from porcelain residues in the production of reproduced bricks And other building materials products, in order to provide the products needed by the Egyptian real estate market, and conform to specifications and at reasonable prices.

For example, concrete residues like "rubble" are the most important remnants of construction that are recycled and reused again in the production of new concrete (Recycled debris, produced from the demolition of buildings, as an al) which is:

Green concrete: an environmentally friendly concrete made from concrete waste, dust resulting from breaking stones and marble, breaking concrete, and cement is added as a bonding material for all those materials. Green concrete has many industrial and environmental advantages including:

- Reducing CO_2 emissions in large quantities resulting from cement processing.
- Reduces the percentage of water used in the processing of ordinary concrete.
- Lightweight compared to the usual concrete.
- Durability and fire resistance.
- Soundproof and require less maintenance.

Cheaper in terms of cost and also saves from the energy consumed in production (https://alborsaanews.com/2016/01/19/796680). Green concrete is used in pouring roofs and floors. Other products manufactured from the recycling of demolition wastes:

- **Concrete bricks:** consists of construction debris, sand and gravel, and reduces its weight by half if using light debris, which is different from solid cement bricks, which consists of cement, sand, water, lime and gypsum, although it is characterized by durability and thermal and acoustic insulation and fire resistance, but it consists mainly of making it polluted the environment unlike recycled cement bricks.

- **Recycled clay bricks**: is an advanced product of ordinary clay bricks, and is produced from recycling of red clay bricks with factory waste from the clay and waste from the demolition of buildings, it's considered from green construction products; besides, it contributes to the preservation of the environment from the remnants of manufacturing, buildings, and reproduction, in addition to it the new concrete, began to rebuild Britain and Germany after World War II through waste recycling plants, which include the presence of crushers, sieves, transport equipment and equipment for the separation of foreign materials. It needs less energy during manufacturing compared to the normal bricks, as it is characterized by better environmental specifications than Red clay bricks: soundproof, fire-resistant, more regular in form than normal clay bricks It is produced in standard dimensions 12×25 x 6 cm, 12 x 25 x 10 cm. Its disadvantages: its week resistance for rain or wind, if it is not strengthened, as it is poor heat insulator.

Figure 2: Recycled cement bricks, from construction debris, sand and gravel

The green buildings aim to achieve the comfort of the residents and reduce energy consumption inside the building by reducing the temperature entering the building, which works on environmental integration, through the use of insulation

materials.

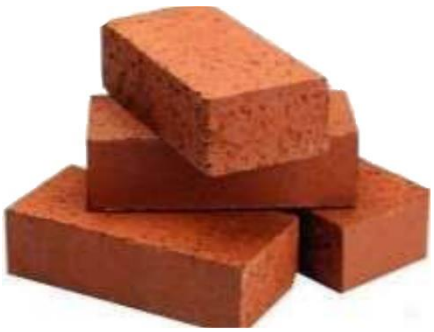

Figure 3: Recycled clay bricks, with better environmental

2.1 Insulating materials

The term insulation is a new-old term developed by man since his first attempts to protect his residence, where natural materials such as bitumen, tar and asphalt were used in the painting of arcades. Insulation materials have evolved to their importance in buildings where they work to protect the building from the dangers of rain and fire.

2.2 Advantages of using the thermal insulation materials

(a) Rationalization of the consumption of electric power. (b) The building maintains the temperature for a long time without the need of air conditioners long periods. (c) Raising the level of comfort for the users of the building. (d) Reduces the use of air conditioners, which reduces their negative effects on humans. (e) Providing the burden on power plants and distribution networks. Insulation products vary according to (waterproof, thermal or acoustic insulation) as there are also natural environmentally friendly insulation materials (ecowool): cellulose insulator of environmentally friendly insulation materials, cellulose consists of recycled cardboard, paper, and other similar materials, in addition to anti-mold and fungal materials. Cellulose benefits: lightweight, fire resistant. Cellulose defects: Needs skilled technicians, humidity absorbable, weaker than industrial materials in insulation capacity.

Figure 4: Mineral wool is used for thermal
Specifications: Nonflammable

Mineral Wool: Considered more advanced and efficient within organic insulation materials. Mineral wool or rock wool is used to thermally insulate walls, with a density of 29-120 kg/m3, and a thermal conductivity coefficient of 0.051 w/m. Kelvin (14).

- Used as an acoustic insulator.

Be in the form of rollers, used directly by installing it on the walls of the building.

Its disadvantages: it is absorbable water, water vapor and provides an environment for mold growth. Therefore, it is preferable to choose the type of efficient insulation materials, as it is considered to reduce the amount of heat entering the building, which works on the comfort of residents, rationalize the consumption of electrical energy, and not affected by the time range, and from the types of modern industrial insulation materials which are characterized by high insulation capacity: polyurethane, granular polystyrene panels, polystyrene exudation, light concrete, etc. Each of them varies in its specifications in terms of density, absorption of water and water vapor, as well as the strength of insulation for each of them and the temporal effect of the strength of insulation; however, the best is polystyrene.

2.3 Extrude Polystyrene

Extrude Polystyrene is a high-end insulation material and the most effective insulator in the world, and multi-insulation is a waterproof material, used in waterproofing? It a thermal insulator due to its cellular composition, which works to eject heat, which depends on its density, it is also considered an acoustic insulator, relative to the absorption of shocks and leads to decreased sound force refraction. It is in the form of solid tiles of various sizes, and is installed on horizontal and vertical surfaces. The smooth polystyrene panels are suitable for walls and floors.

Figure 5: Polystyrene is a thermal and waterproofing insulation

Specifications: The density in the walls of 26-28 density in the floors of 32-35 and thermal conduction factor in the walls and floors 0.0288. The percentage of water absorption is 0.3. The permeability of water vapor of 4. - 1.4 and the pressure bearing strength of 240 -2000. There are types covered on both sides with a layer of special polymer cement mortar and fiberglass, which are lighter in weight than cement panels and characterized by their ability to insulate heat and water. Applied during finishing the building before the placement of the cladding materials. The insulation materials must be: (light weight, high resistance to humidity, fungi, and insects). There is also high flexibility in providing good thermal insulation by providing a ventilated air for the external walls exposed to continuous sunlight and as in the figure (6). There are types of liquid insulation with "bitumen" compounds, they are organic matter sticky (solid, liquid) used for water insulation in various types of surfaces, whether flat or zigzag, as they work to resist fungi (11). Trees are considered natural insulation materials, where trees are planted with large leaves for acoustic insulation, they isolate the source of noise or reduce it by absorbing them, and the shelterbelt planting next to the building acts as wind repellents and dust blocking as figure (7), in addition to purifying the environment from carbon dioxide gas, as well as

they are thermal isolation by placing them on the sun- facing side with covering the roof of the building with plants.

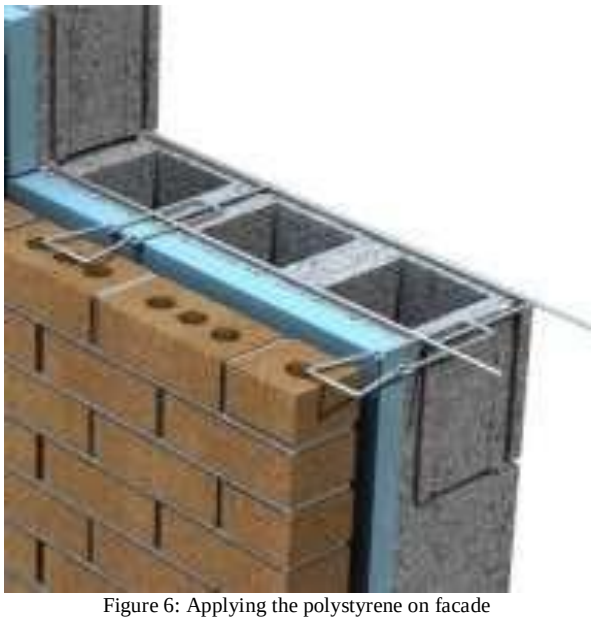

Figure 6: Applying the polystyrene on facade

2.4 Fourthly, the materials of cladding and finish

The materials of the cladding protect the facades, in addition to giving them a good appearance. They are including natural materials such as stones or marble, products made from natural materials such as ceramic and thermal bricks, as well as manufactured materials such as coatings. Both natural and manufactured cladding materials have been developed by technological methods to improve industrial and environmental specifications.

Figure 7: Shelterbelt planting works as sound proofs, and wind repellents

Natural cladding materials: are natural environmental materials that do not manufacture from basic components, or change in the final form, but they only processing the material for implementation with refinement in form, such as cutting the stone to the required scales and forms or random forms. Green cladding is characterized by its environmental appearance and does not pollute the environment during the manufacturing stages. Since it is part of the environment so it merges with it in color and texture. Stones, marble and granite are the most famous natural cladding materials.

Stones: Natural stone is used in the cladding of facades, entrances, in the stairs, and interior extracted from the mountains, especially the Helwan Mountains south of Cairo.

Figure 8: Natural Pharaonic Stone, façade cladding, random pieces, shows the harmony of the house with the environment, the village of Tunis, Fayoum

Figure 9: Pharaonic stone, mechanical geometrical cut, is combined with other cladding materials

The stones are characterized by durability, strength and resistance to weather factors. The stones add an authentic environmental character as well as the aesthetic value of its appearance. It can be combined with insulation materials. It is importance to know before implementing:

The specifications of the stone used, the shape of the tile, the style of the façade. One of the most famous types of local stone is Pharaonic stone and Hashemite stone. Pharaonic stone is characterized by its strength, ease of formation, and its white color slanted to cream, which can be combined with other materials of cladding. The Hashemite stone is known for its rigidity and its ochre color in various degrees. The implementation of stones cladding is divided into two types: - the first is manual: which the stone is installed over the facades using a mortar of cement, sand, water and chemicals that increase the strength of the stick of stone to the walls, The second is mechanical: The stone is installed using iron corners, screws, wires, and strong adhesive to ensure the quality of the installation, that method is considered successful and effective with large sizes of stone and heavy weight, but its increase the cost of installation. The stones must be kept intact and cracks or fall over time should be avoided. By doing regular maintenance.

Marble and granite: marble and granite extracted from Sinai, and Aswan. In addition to being local natural materials, they gave appearance the classic and luxury to the facades, they are characterized by the strength and durability. they are cut with developed technological computer machines, to adjust and accurate the pieces. Marble and Granite are installed over the facades either cement mortar or mechanical way.

Manufacture Products: These products are made from local natural materials such as: ceramic thermal bricks and decorative red bricks and are used in the cladding of facades, fences and flower beds The decorative red bricks are made of

”terracotta ", thermal bricks of clay Disadvantages: weak brick, irregular shapes. The technological development in the manufacture of clay cladding bricks have emerged products with better industrial and environmental specifications.

Figure 10: Façade of decorative red bricks, of terracotta clay

Clinker bricks :is a type of ceramic brick with high density, clinker bricks are produced from ceramic clay, it is burned at a temperature between 1000:1400 °C to become a solid mass characterized by solid bricks with durability, and physical characteristics And the chemical is better than traditional ceramic bricks, good protection specifications for facades like : sound proof, corrosion resistant, water proof, good appearance, varied in color from yellow to dark brown , gives the facades an environmental character in colors and texture as the shape (11,12).

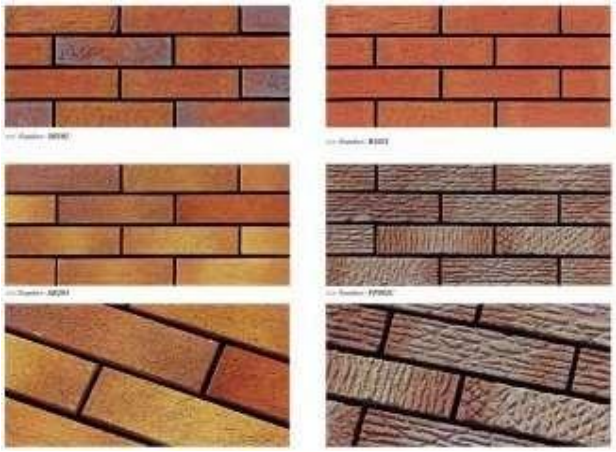

Figure 11: Color and texture of clinker bricks

- **Ceramic Tiles:** it can be used externally but necessary select the appropriate tiles for the type and area of the required cladding, in addition to ceramic tiles must be functionally and aesthetically in harmony with the other materials in the façade. Ceramics are characterized by its forms and decorations, especially after the development of manufacturing technology by "Ink jet" machines, which made it possible to form natural effects such as, wood, rocks and stones, which gives an environmental impression of the building. Ceramics are installed on the walls by cement mortar, or with polymer adhesive. Specifications is: resistance to water or vapor, acoustic insulation. Porcelain is a type of ceramic which is characterized by the hardness more than the ceramic, that its pores reach less than 0.1 and its absorption of moisture less than 0.5 and fire resistance up to 1200 degrees Celsius, It can be used on the facades by using aluminum structures installed on the wall, by installation screws from the tile sides above the structure.

Figure 12: clinker bricks in Façades

Figure 13: Ceramic and porcelain, cladding tiles for facades, with natural effects

Figure 14: Ceramic and porcelain, cladding tiles for facades, with natural effects

Paints are cladding facades, which protect and give good appearance, as well as, integrate with the environment, especially environmental paints and their role in reducing the environmental impacts of traditional paints.

3 Result and discussion

Paints work to improve the appearance of the building, as it preserves it from weather factors. Historically it has been manufacturing paints and equipped manually from local materials, the most important of which are "lime paints" made of Inert lime, oxidant color, salt to fix paint on the walls, this paint is considered an ecofriendly paint where, it works on the non-growth of bacteria and resistant to insects and does not emit odors, and is still used in villages and resorts With technological development, many modern paint products have been produced, some of which cause negative effects on the environment, such as volatile solvents' odors or carbon dioxide from the main paints components, as " Special chemicals " that give paint certain properties.

pigments and bonding materials, each of these components has a role in the effect of paint on the environment, so it is preferable to use organic pigments, as they are brighter and stable after exposure to light and heat, while inorganic dyes consist of metal oxides that contain toxic compounds such as "cadmium". It is preferable to use paint containing acrylic polymers where water is used as solvent in those coatings, which causes no emissions. Paints containing Alkyd polymers are used a solvent like Ethyl alcohol or thiner. Natural materials in coatings are also characterized by antibacterial and fungal properties, unlike synthetic substances, which cause the spread of bacteria and fungi that negatively affect human health. Based on the guidelines of the World Health Organization (WHO), that prefer to use water-mediated paints, as well as using paints that resist the moisture and mold.

3.1 Textured exterior paints

Prefer coarse outer painting than smooth exterior coatings for their durability. It has a variety of forms.

Quartz paint: is made of sand with cement and pigments, as a dry powder Paint. It is mixed with water when operating, the facades gain a rough surface with a variety of texture depending on the degree of mitigation, this paint has got durability and resistance to rain, mold and resistance to combustion, as the size of roughness can be controlled to reach the best environmental impact required by water mitigation.

Figure 15: Quartz painting on facades

There is another type of decorative paint characterized by being more practical and easy to operate which is liquid paints based on " acrylic polymer", and fit for use On concrete surfaces, and various surfaces of building It is colored ready, it is leaved 15 minutes after paining to dry, then a second face to reach to the final appearance (longitudinal, transverse or circular touch), Water dilution is done when using a spray gun according to the require texture and shape, the consumption rate is 2: 4 kg/m². Decorative paints are characterized by resistance to extreme weather factors, salts, humidity and UV rays. It gives high strength in coverage; it is more practical compared to cement types.

Granulites: is included in the work of decorations of facades and entrances, granulites consists of sand granules or of artificial polymer granules colored, they are inside a paste of adhesive polymer. The final appearance of granulites depends on the type of gravel used and, on its size, the most common are: tiny granulites with a natural pebble of about 3mm thick. The tiny granulites with a soft industrial pebble no more than 3 mm in diameter, and a large industrial pebble with a diameter of no more than 7 mm. it is painted just one face and left to dry. The disadvantages of granulites: requires skill and experience in implementation. Its industrial appearance is far from the natural materials.

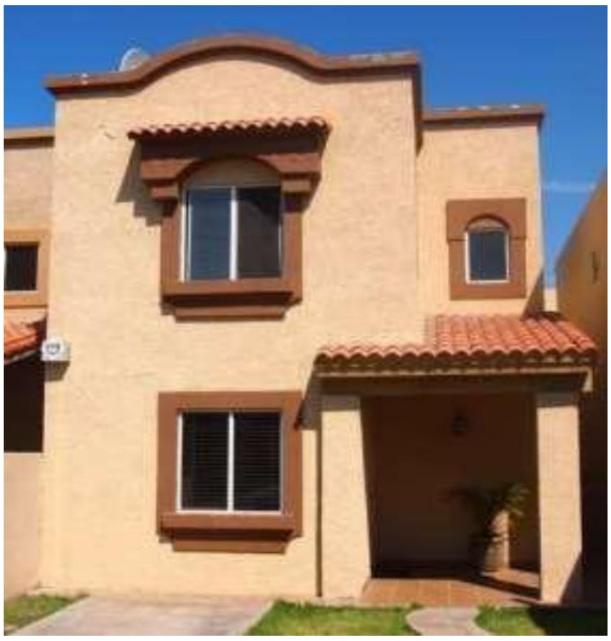

Figure 16: Detail of final texture of paint

Figures 17, 18, and 19: Types of decorative paints, with of various patterns by dilution

Stone-breaking paint: this type of facades cladding depends on breaking of natural stones, It has got natural appearance than granulites, the technique is divided into two separate parts, first is a paste powder softened with water in caliber ratios, It is painted over the walls with 5 mm thickness and it is settled, then the breaking stones are sprayed above it when, the paste is still wet, then pressed and settled on the wall then left to dry, after the drought acquires the wall has got natural appearance as in form (21) , these cladding is characterized by good protection, durability and resistance of rain and humidity, etc. It is used as cladding walls, fences, and entrances. Disadvantages: some granules may fall.

The same technique can be applied using broken marble or granite: it can apply, as an experiment as follows: the breaking of stones or the break of marble and granite is sorted in the form of small granules not more than 7mm for the size of the granules.

- The granules are washed and filtered from dust and left to dry.

- Pigments can be added to the required color, and depending on the added materials.
- The wall should be divided into spaces.
- The adhesive paste is settles over the surface with a thickness of 5 mm.
- Marble granules are sprayed strongly over the past, as they must be pressed until they stick to the surface well, then leave to dry.

Figure 20: Samples of granulate paints with adhesive polymer paste


Figure 21: The final form of stone-breaking paint, with durability and resistance of rain and humidity

-A varnish can be added to the cladding after the drought, to add a natural shine to the granules on the surface. Broken granules can be processed manually, but using machine is better, for sorting and cleaning to get a high-quality product. It has the same specifications as stone-breaking paint, it does not affect the environment, and can decorate facades with the same technique. In addition to the importance of the materials of cladding and paints in protecting the facades of the building and giving them the aesthetic appearance, you must choose colors and touch the cladding so that the interface is color-resistant with the surrounding environment.


Figures 22: The granite break, (23) the marble break, and (24) the broken stones

Fifth, the integration of the facades with the environment: not only the facades have to gain good appearance, but they must be harmonious with the surrounding environment, by choosing the appropriate colors of the facades, which is harmony with the environment. The colors of the facades correspond to the colors of the environment in which they are located, and the choice of the appropriate color helps to link the façade of the building with the environment (11) in the inthe desert environment the colors of the sand and the rocks are dominated by degrees of (ochre) , cream , brown degrees from light to dark and reddish brown, shown as in the colors of Nubian houses and the buildings of the artist "Hassan Fathi" where they were harmonious with the colors of the desert environment as it was part of that environment. While in the coastal environment prefers blue degrees with light tones, this can be chosen one color often on the façade with some other colors derived from the same predominant color, and because the desert environment is predominant in Egypt so it is preferable to choose environmental colors with moderate degrees of color intensity.

Such as "beige", where moderate-intensity colors have a great ability to reflect (reverse solar radiation) (13) and neutral colors moderate intensity such as "gray" degrees, and it is not preferable to use colors such as white or black on facades, especially in large areas. Therefore, the choice of light colors, such as (beige) and its tones, is a suitable choice, with light brown or (café) as described figure (25). The companies of coatings provide a wide range of colors that help the client to choose color- harmonious tones with the colors of the surrounding natural environment. The beauty of the facades is not complete except with the environmental complementary elements such as green areas, plant elements and water elements, which give the facades aesthetic value as well as environmental benefits.

3.2 Sixth environmental complementary elements

The green areas with trees and plants aim to spread the comfort, visual beauty and to create a clean environment,

Green areas: characterized by, additional protection and thermal isolation from sunlight which reduce the energy needed to cool the building, as well as the cultivation of green areas adjacent to the façade or from the front of the building. The green areas are grown with perennial grass plants to cover the surface of the soil in green color, and occupy the largest area of the land in the form of a green grass, and grow the by seed or rolls, the rolling grass are more practical than seeds, because it is easy to carry and move. They are extended on the whole land, and settle it well (13).

Specifications: The thickness of the slide does not exceed 5 cm (includes soil, roots and vegetative total), it is 100 cm long and 30-35 cm wide, they stacked next to each other without leaving spaces. They are appearance a green area after finished immediately. Create green areas in limited areas or on slopes.

Plant elements (trees and plants): The aesthetic appearance of the facade is not complete without the availability the plant elements (trees, shrubs, and flowers). The ecosystems are generally interested in plant and aquatic elements because of their biological importance to the environment and visual enjoyment in addition to the physical benefit, as the cultivation of fruit trees.

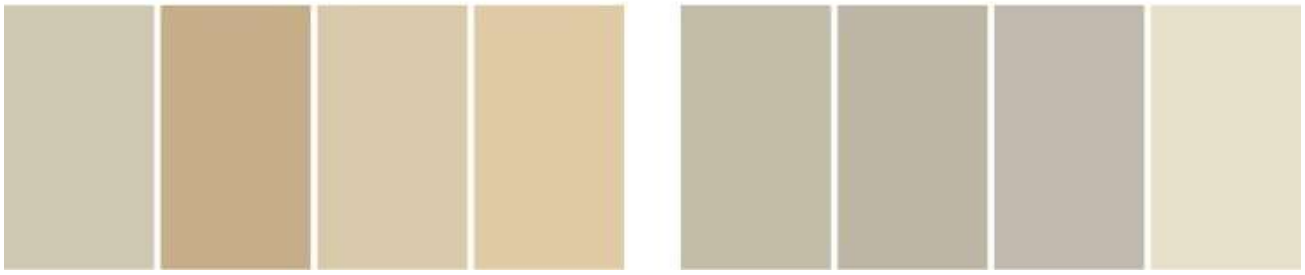

Figure 25: Samples of color grades derived from the environment (dust, beige and brown), figure (26) neutral colors of gray

Figure 27: The interface colors are derived from the environment colors

Form 28: The installation of ready-made nigella slices, to get a green flat immediately

The trees have multiple environmental benefits including: (a) purification of the atmosphere of carbon dioxide and oxygen supply, (b) provision of shadows and protection from the wind, and (c) provide privacy as plant fences and barriers between Buildings, as an ecosystem integrated with the environment prefer trees that do not consume large amounts of water, such as (olive trees, cedars and neem), as well as the cultivation of shrubs and plants with aromatic scents, which benefits the inhabitants and the environment permanently (17). The technology also introduced "grey water", which is the recycling of drinking water supplied by buildings. Grey water comes from drains, laundries and bathtubs, where it is of a gray color when it stagnates. This water is treated through processes based on mechanical means and biological filters, the water produced from the building is collected after consumption and treated with filters to be irrigated by the plant, the gray water is considered a milestone in the green building as it constitutes about %40 of the total water produced by the building. Advantages of the grey water: Take advantage of the water consumed from the buildings.

-Providing plants with nutrients by irrigating plants. It can be used for other uses such as car wash stations. - There is a great abundance of clean drinking water that is wasted daily, especially with the challenges of water shortages that our country faces these days, thus maintaining clean drinking water.

Grey water hazards: Grey water contains a percentage of microbes and chemicals from the sources from which they come. It should not be stored but use as quickly as possible, as they rot if stored and stagnate for long periods. It should not be used in the irrigation of plants that are eaten raw (19).

- Water elements: are used in front of buildings or nearby and in gardens in various forms, and be in the form of water formations such as fountains, artificial waterfalls, or ponds and industrial lakes, and this diversity in the use of water products is for visual pleasure and possible environmental benefit, in addition to contributing to the softening and humidity of the atmosphere, this is required in the water products: - Rationalizing consumption and using as little water as possible. Taking advantage of the water consumed by reused it.

Seventh, manufactured complementary elements: they are cladding alternative products for natural materials characterized by: strength, durability and insulation capacity and vary in their impact on the environment, including products like glass reinforced concrete (GRC), glass reinforced plastic (GRP). These products depending on the components, manufacturing technology, where the materials are good industrial specifications, with limited effects on the environment. (GRC) products like: plant pots, handrails, domes, industrial rocks, frames around windows, and balconies.

The methods of installation vary according to the product with cement mortar, mechanical method, or over the metal installation structures. GRC's toughness and lightweight. Resistant to corrosion and combustion. Less polluting the environment because it contains less cement. GRC reinforced concrete material was developed in the 20th century as an alternative to natural cladding materials such as stone, marble and others, which reduces the consumption of natural environment resources. The manufacturing tech is based on molds, they can be colored, in colors proportional to the facades (20).

Environmental integration elements: Through the above, environmental integration elements for architectural facades are (protection, comfort, beauty), it can be achieved through facade cladding materials, improved products as well, their environmental impact, as the following table (Table 1). Therefore, the building facades can be integrated with the environment by green cladding materials and their developing products.

Figure 29: Advantages of the grey water

Figure 30: Products cladding facades of GRC, artificial stone tiles and decorative facade units

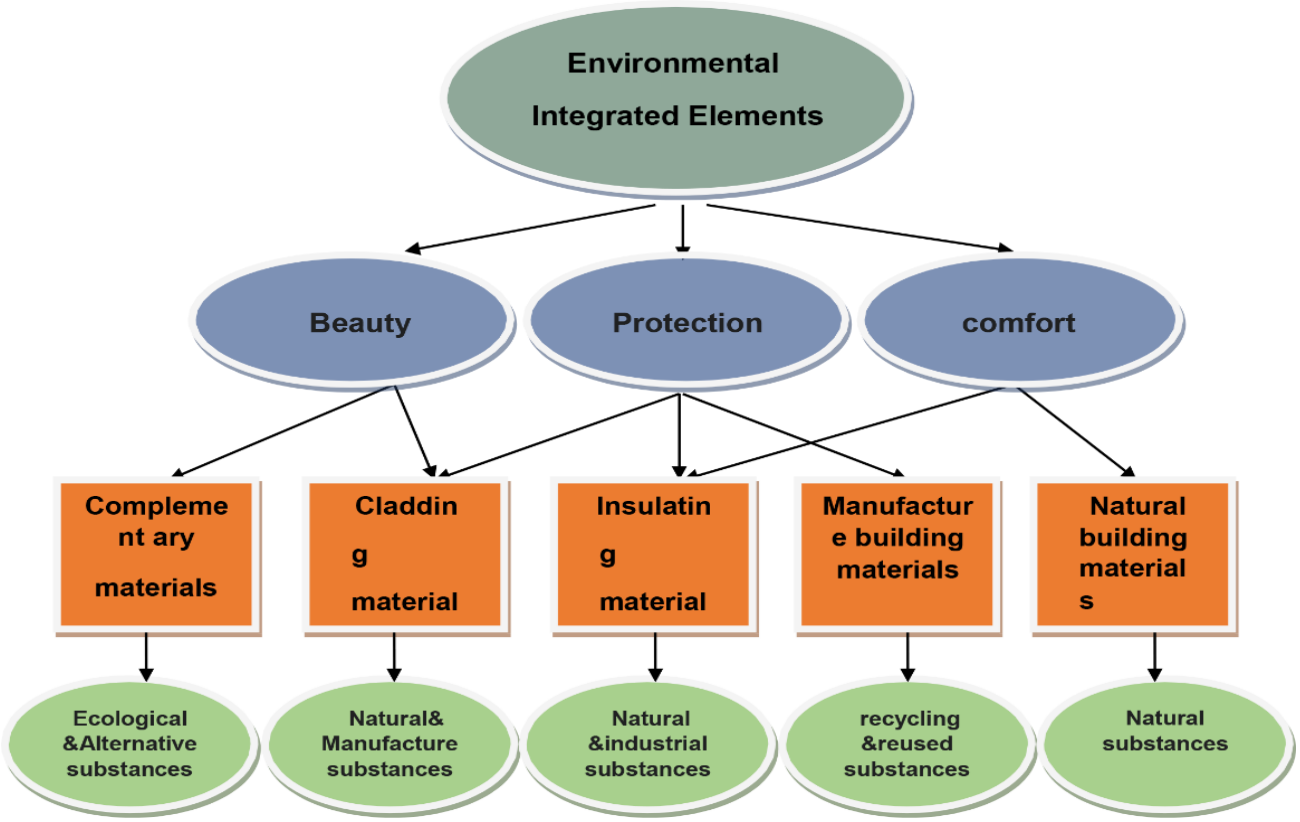

Figure 31: A diagram for the elements of environmental integration of facades through building materials and cladding

Table 1: Achieving through facade cladding materials, improved products as well, their environmental impact

No.	Green facade components	Building and cladding façades materials	Improved products	Environmental impact
1	Building materials made of natural materials	Red clay and clay bricks Ordinary concrete	White lime brick Green concrete	Less effective than clay brick. Less effective than regular concrete
2	Building materials made from recycled materials.	- Cement bricks. - The usual clay bricks.	Recycled cement bricks from construction waste. Recycled clay bricks	Less effective than cement bricks Better than regular clay bricks
3	Insulation materials (energy saving)	Organic insulation materials Manufactured organic insulation materials. Manufactured materials.	Ecowool Rock wool Polystyrene particle board, Extruded polystyrene sheets	Better than organic insulation materials. Better than organic material and effective Environmental properties
4	Natural cladding materials	The stones Marble and granite	Stones, marble and granite cutting by computer and machine devices.	It does not affect the environment.
5	Manufacture cladding materials made by natural materials. Paint products	Thermal bricks and decorative red bricks Ceramic, porcelain tiles Plastic paints, oil paints	Clinker bricks for cladding facades, Ceramic looks like natural materials by ink jet. Environmental paints, textured decorative paints.	Better at protecting and building appearance Better than the usual paints Good industrial and environmental properties
6	Environmental Complementary materials	Green areas. Plants, trees and Shrubs. - Water forming	. Ready grass sheets Fruitful trees, water saving trees, aromatic flowering plants Ponds and artificial waterfalls.	Cleaning and purifying the atmosphere, visual enjoyment. Provide shade and wind protection. Sound insulation for the building, provide privacy.
7	Manufacturing Complementary materials	Reinforced cement Reinforced plastic Artificial stone	Glass fiber reinforced cement (GRC) with the effect of natural materials Reinforced plastic (GRP) Artificial stone is an alternative to natural materials	Varying, According to the materials and manufacturing method.

Conclusion

1) The technological development of facade cladding materials integrates with the environment by achieving comfort, protection and beauty.
2) Green cladding materials are natural or manufactured materials form natural renewed materials, as well as environmentally efficient manufactured materials and eco-friendly manufactured materials.
3) The environmental insulations vary in green facades, preferably efficient and multi- insulation types such as "polystyrene insulation.
4) Not only" Green cladding materials protect the facades of buildings, but as well give them a good appearance.
5) The choice of the right color derived from the environment, helps to link and integrate the building's façade with the environment.
6) The beauty of the facades is not complete environmentally except with the presence of environmental complementary elements such as: green areas, plant elements and water elements, which give the facades aesthetic value as well as environmental benefits.
7) Alternative complementary elements products vary in their impact on the environment, depending on the components, manufacturing and production style.

3 Recommendations

1) Following the sustainability systems and utilizing the waste by reuse or recycling.
2) Rationalizing energy by using insulation materials on facades.
3) Taking advantage of advanced technology, in improving the cladding products.
4) Applying modern technology in energy saving.
5) The expansion of gardens in Egyptian environments.

Ethical issue

Authors are aware of, and comply with, best practice in publication ethics specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests and compliance with policies on research ethics. Authors adhere to publication requirements that submitted work is original and has not been published elsewhere in any language.

Competing interests

The authors declare that there is no conflict of interest that would prejudice the impartiality of this scientific work.

Authors' contribution

The author of this study has a complete contribution for data collection, data analyses and manuscript writing.

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