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Utilization of Recycled and Waste Materials in Architecture: A Green Concept in Egypt

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ABSTRACT:

Waste materials are a serious environmental issue and an enormous problem for the environment. This material's discharge and reuse have become necessary. Reusing components and recycling waste into raw materials for the making of building materials are the two ways waste in the construction industry can be recycled. Building industry has incorporated wastes for energy, economic and environmental protection. The most recent type of construction materials that are mixed with different kinds of waste (By-product, Agricultural, Construction and demolition (C&D) materials, Transportation industry waste, etc.) can propose a probability of consuming disposal materials and lessen the environment pollution. Recycled materials in Egypt have potential to improve the environment and construction sector according to Egypt Vision 2030, but need further investigation. In order to manage waste effectively and sustainably, this study investigates how different kinds of recyclable materials may be used in building initiatives as a green concept that eventually minimizes environmental pollution. The results confirm by implementation of recycled materials in Architecture is of a great benefit towards a greener future.

KEYWORDS:
Building construction, Wastes**,** Architecture Form, sustainability, friendly environment building materials, Recycling.

INTRODUCTION:

Technological and industrial advancements led to an increase in the quantity and type of waste. Everywhere, the challenge of annual waste accumulation remains. Byproducts, such as tires, rice husk ash, fly ash, cement dust, slag, glass, and brick dust, are among these industrial and agricultural wastes. Because they cause air pollution and harmful substances to leak when they are disposed in landfills, quarries, rivers, or seas, wastes pose a serious threat to the environment. The heterogeneity of wastes and its unknowable qualities over time make capitalization of waste challenging.
Recently, environmental sustainability emerged as a significant issue from the perspectives of wastes and natural resources [Niedziólka et Al., 2023]. Both processes include the construction and building materials industries since the building sector is the greatest consumer of natural resources and because the demolition of buildings generates a lot of waste.

Researchers have attempted to create new construction materials utilizing wastes in the building material sector, which is an area of interest for utilizing wastes. The development of the next generation of building materials is based on many ideas that support environmental sustainability.

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The replacement materials made from wastes were investigated as a means of minimizing the consumption of natural resources, preserving the energy, and consuming the huge quantities of wastes. Building materials are made from waste, including bricks, pavements, roof tiles, prefabricated units, claddings, high strength concrete, asphalt concrete, etc.

Some building materials, such as "green" materials, are entirely made from waste. More energy and resource efficiency is offered by the new idea of green buildings. This idea refers to the greening of the construction sector through the use of purely green materials. Although there are technologies for getting green materials, they are not widely used in the building industry.
One of the main uses of wastes in the activities to locate materials, to construct bridges or highways, etc., is the construction sector. Sustainability concerns support the use of all types of waste in construction, regardless of some types of waste may be unsafe.

The research aims to reach ideas that can be applied in Architecture by utilizing the concepts of recycling or reuse, in a way that benefit the environment and rationalizes energy consumption to achieve a healthy environment for humans, and to raise awareness of selection of recycled materials in Architecture in Egypt.

The research methodology relied on two approaches as follows:

- Analytical approach to examine the classification of wastes (by-product waste, mineral waste, agricultural wastes, construction and demolition (C&D) materials, transportation waste, and other types of wastes used in building), as well as a variety of common building applications for waste materials; analysis of a few applications for the use of recycled and reused materials in architecture. A study evaluates the usage of recycled materials in building design using analysis of some models.
- The applied study in Egypt: using the idea of reusing wastes in El Nasr Park, it is a small park in Heliopolis-El Hegaz Street, Cairo, for the construction of seats, paths, and other application to landscape the space.

2. Classification of waste

The most obvious environmental issue among several in metropolitan areas in Egypt is the development of rising volumes of diverse solid waste as a result of the country's growing population, industrialization, urbanization, and changing consumer habits. Based on EEAA statistics for the years 2001, 2006, and 2012, Fig. (1) Displays the equivalent estimated data for the wastes that were created during those years.

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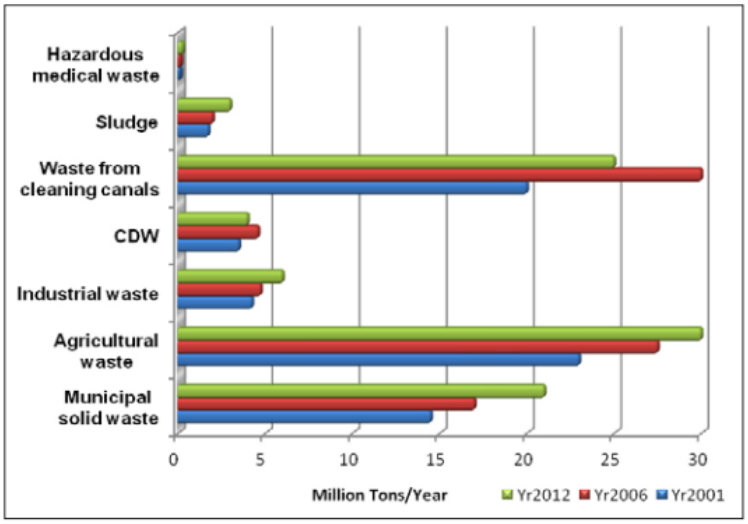

Fig. (1) Generated solid waste in Egypt, 2001, 2006 and 2012
Source: [Annual report for solid waste management in Egypt, 2013]

One option for keeping the environment clean is the utilization of wastes in the building materials and construction sector. There are several waste kinds utilized in the construction materials, which may be categorized as follows:

2-1. By-product waste is the waste produced by industry, which includes some plant, mill, and mining material that becomes unusable during a production process. They are frequently maintained in dumps. Industrial waste includes things like silica fume, sludge, fly ash, metal, sand paper, and glass, among others [Maczulak Anne Elizabeth.2010]. Table (1) demonstrates the beneficial effects of byproduct reuse through sustainability.

Table (1) advantages associated with byproduct reuse through sustainability. Source: [Amina Mahmoud Karem, 2019]

Environment	Lessening Spills	**Social**	Defend Workers
	Reduction Accidents		Lessen Accidents
	Reduction Emergencies		Lessen Risks of Lawsuits
	Lessen use of Landfills		Decrease Risks
	Diminish Creation of Landfills		Rise Employment Rate
	Lower amounts of raw materials used		Preparation of Employees
	Cleaner Production		Decrease Health Risks
Economic	Reduction Waste disposal costs	**Technology**	Innovative Technology
	Reduction Operational costs		Novel
	Generate another source of income		Fewer Energy Consumed
	Cut cost of raw materials used		New Approaches
	Lessening amounts of lawsuits		

- **Steel slag** It is an outcome of the iron and steel industry and includes several of the cement's ingredients, though in varying amounts. The production of nearly a million tons of (steel slag) from the iron and steel industry each year, which is a national issue, as well as the pollutants that result from the buildup of slag [Ashkar Rahman Aquibet et al., 2023].

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The diverseusages of slag throughout the world change, but as shown in Fig. (2), the main use of slag is road construction at 48%. It is utilized for a variety of engineering reasons, including: as a heap in traditional and light-production concrete works, and varieties of cement (Ferro-cement, which has high iron slag content and a strong resistance to sulfate).

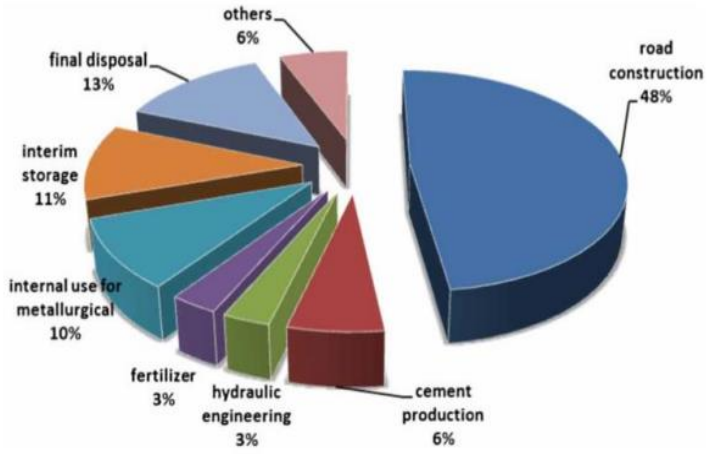

Fig. (2) Slag's Uses around the World [Maghool, F., et al., 2016]

- **Foundry Sands** The cores and moulds are made out of sand during the metal casting process. While foundry sand can often be recycled internally by the foundries, 3–4 million tons of material are still discarded each year [A. Deng,Y.-T. Hung, 2013].Recycling non-hazardous, used foundry sand has the potential to save costs for both manufacturers and end users by reducing the requirement to mine virgin resources.

The used foundry sands have applications in masonry mortar configurations, asphalt mixtures, Portland cement concrete, as a basis for the manufacturing of Portland cement, and in many different kinds of other purposes.

- **Coal combustion products** the following materials are included in CCPs: Flue Gas Desulphurization Material (FGD), Fly Ash, Ash, Boiler, and Other Types of Material, such as Scrubber Remains and Fluidized Bed Combustion Ash.

  CCPs have a variety of traits and physical attributes. The useful reuse of these materials as a component of building supplies or as an alternative to other virgin materials like sand, gravel, or gypsum is typically determined by their size, shape, and chemical composition [Rafat Siddique, 2010].

In place of the Portland cement that binds conventional concrete mixtures, fly ash can be used. Approximately 8% of all carbon dioxide emissions from human sources are attributed to the production of Portland cement, which requires enormous energy inputs. Incorporating fly ash into concrete is a resource-efficient substitute for the approximately 75% of fly ash produced each year that is disposed of in landfills.

- **Pulp and paper byproducts** the paper industry produces two significant byproducts: boiler ash and wastewater treatment plants residuals (WWTP) [TefyRaoelivololona et al., 2020]. Fig. (3) Uses for biocomposites made from pulp and paper mill waste.

There are countless instances of further usage. Building material, additive for concrete or brick, either lightweight aggregate or glass.

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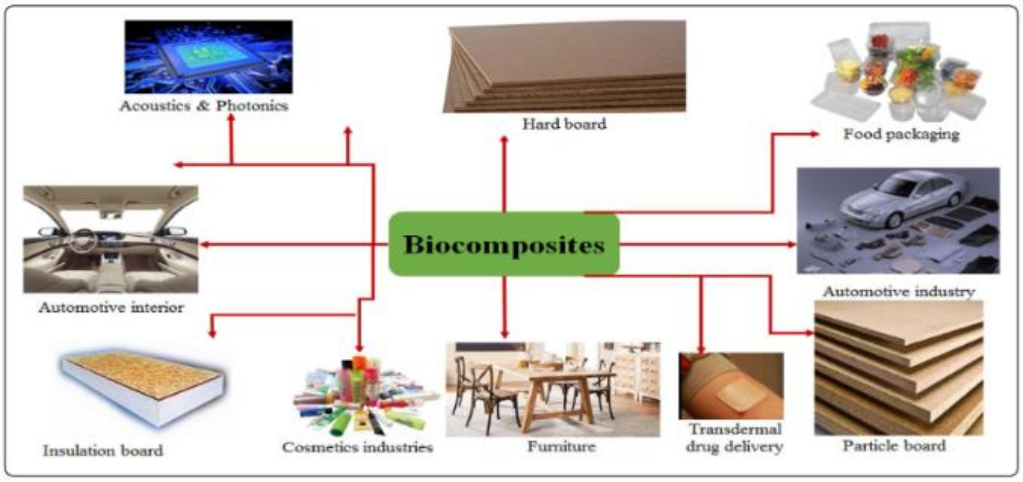

Fig. (3) Uses for biocomposites made from pulp and paper mill waste [Adane Haile et al., 2021].

- **Fly ash** is a byproduct of power plants or other solid-material combustion operations. The landfill is where the fly ash is dumped [Dai, S.et al., 2010]. Despite the expensive expense of storing this waste, fly ash causes environmental harm by heavily polluting the air and water. Calcium sulphoaluminate cement, which has identical qualities to the control cement, may be made using fly ash as a raw material [XiaoluGuo et al., 2014].

The production of lightweight aggregates, the making of bricks, tiles, and pavements, as well as the manufacture of cement and concrete. all employ fly ash. Fig. (4) shows Fly Ash Utilization in China, India for example.

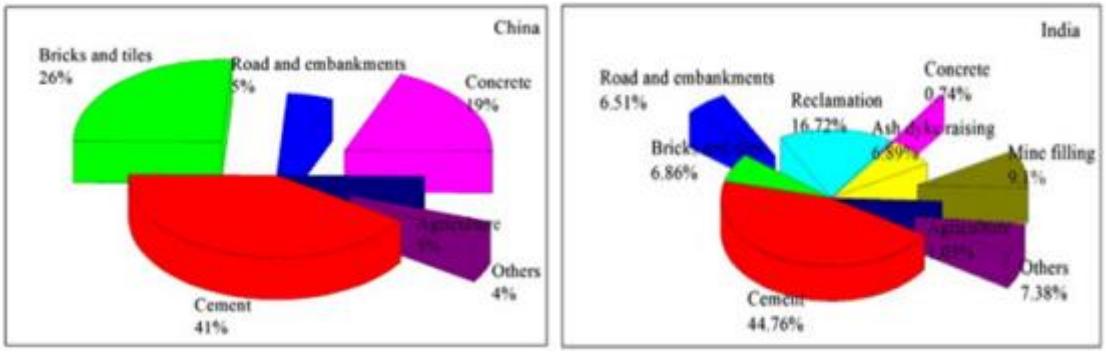

Fig. (4) Fly Ash Utilization in China, India [Yao ZT et al., 2015].

2-2. Mineral waste Mineral wastes are a byproduct of industrial operations that turn natural resources into finished goods. Many natural raw materials are utilized in their natural condition in the construction industry. Exploration through closure, mining has a negative influence on the environment.

The environment and community life are significantly impacted by all technical phases of the mining process; the fine particle and poisonous ingredients in the dust waste make it extremely aggressive in the air, water, and soil. The community finds the enormous noise produced by modern operations to be disruptive [Twerefou D.K. Mineral Exploitation, 2009].

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In order to produce building materials and construction products, it is possible to use inert mineral waste from quarries and industrial operations as an aggregate or a fine component [Hebhoub H.et al., 2011].

2-3. Agricultural wastes Agricultural waste is a byproduct of the agricultural industry. Although they can eventually be biodegraded, they must be kept in particular locations while doing so. Typically, these wastes are burnt to remove them, and the resulting powder can be employed as a fine component in construction.

Agricultural wastes used in building material especially in some regions of the world, agricultural wastes are produced in extremely large numbers. As a result of their buildup in landfills and unrestrained burning, agricultural wastes are another source of environmental damage and societal issues.

- **Rice husk** The process of milling rice yields 22% of the weight as husk, with the remaining 78% consisting of rice, broken grains, and bran. The burning of certain rice husk contributes to environmental pollution. There is around 20% silica in rice husk, and heat processing transforms it into a crystalline structure with a large surface area, exceptional quality, and ideal reactivity. For the production of high-strength concrete, rice husk silica can be used in place of silica fume because of its powerful pozzolanic activity. Because of its cementing abilities, rice husk may be used as a cementations material in regular concrete, in place of cement, or to create more cement [Khan R.et al., 2012]. Among its additional applications are as a filling in polymer concrete, green concrete or the production of green construction materials. Fig. (5)

Fig. (5)Rice Husk Ash (RHA) Stabilized Sample Block.[MonjurParvez , et al., 2020]

- **Rice straw** is a byproduct of rice production and is used as a construction material. The alternative to clay blocks or wood that is waterproof, fungus-resistant, and mud-proof is called Green Wood. It also entails lowering or perhaps stopping the burning of rice straw, which increases particle pollution and CO2 emissions. By using recycled chopped rice straw for aggregates in bricks, Egypt has a huge opportunity to improve the environmental effect of those materials, Fig. (6) Depicts an example.

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Fig. (6) Sustainable building: Straw bale [Edwin R.P. Keijsers, Sustainable building materials from rice straw]

2-4. Construction and demolition (C&D) materials they are made up of the waste materials left over after building, remodeling, and demolishing structures like roads and bridges. Bulky, heavy materials like concrete, wood, metals, glass, and reclaimed building materials are frequently found in C&D materials.
10,000 tons of construction and demolition (C&D) debris are generated every day in Egypt. That corresponds to 1/3 of the total amount of municipal solid waste produced daily in Egypt [KageishienyNadarason et al., 2018].

The shattered bricks and broken ceramics may be used to create a variety of goods, including solid cement bricks, hollow bricks, and paving stones.
Get a light concrete as soon as can by substituting all or part of the part or complete ruins of the great utilized in industry with shattered bricks. The leftover concrete and debris from the rounding heap can also be used to make concrete that is appropriate for the different structural components. Circular economy involves reusing waste to create new building materials with improved properties, Fig. (7).

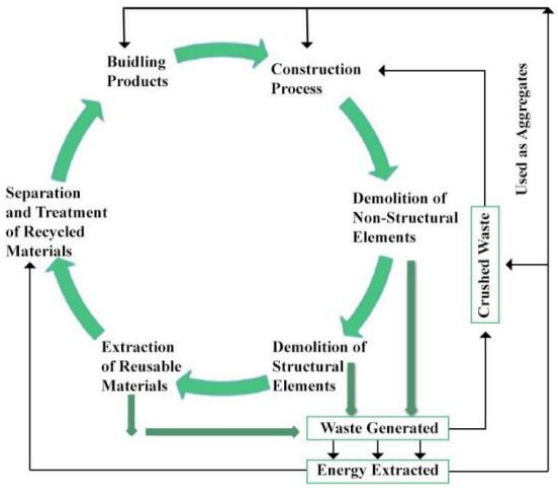

Fig. (7) Recycled materials and the circular economy concept in the construction process [Niedziólka et al., 2023].

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2-4-1. Building Applications for Industrial Materials and by-product wastes

The beneficial use of industrial materials has been developing with a variety of applications getting market and regulator recognition. Fig. (8) &Table (2) shows a variety of typical building applications for industrial materials.

Fig. (8) Building Applications for Industrial Materials [U.S. Environmental Protection Agency, 2008]

Table (2) a variety of common building applications for industrial materials

(1&2) Landscape Design & Green Roofs	Green roofs are roofs covered in vegetation; they reduce storm runoff while providing insulation. Rubber tiles for walkways can be made from used tires. Ash from the bottom can be used for bedding. Green roofs and landscaping projects can both benefit from the use of ground-up clean wood, recycled gypsum wallboard, and cardboard as soil amendments.
(3) Landscape Furniture	Benches can be made from recycled C&D wood or plastic lumber, including fly ash.
(4) Building Facing Material	Building face materials like manufactured stone, which is made of concrete combined with aggregates, are widely utilized. Manufactured stone can be produced using fly ash.
(5) Sidewalks	Concrete sidewalks can be made from industrial materials, and rubberized sidewalks can be made from recycled tires. Asphalt concrete can be used to create sidewalks, as well as recycled asphalt shingles and pavement.

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(6) Ceiling Tile	Ceiling tiles may be made from gypsum from flue gas desulfurization (FGD), fly ash, recovered gypsum wallboard, or air-cooled blast furnace slag.
(7) Flooring	Different flooring applications can make use of industrial materials. (7a) Fly ash, reclaimed carpet, or tires used as carpet backing. (7b) Wood flooring made from recycled or salvaged wood. (7c) Fly ash and blast furnace slag flooring tiles. (7d) Fly ash underpayment for tiles.
(8) Backfill (Foundation Support)	The building's foundation is surrounded by backfill, which supports it and provides drainage. Tire scraps offer improved wall pressure relief, drainage and insulation. For drainage, you may also utilize reclaimed concrete and blast furnace slag.
(9) Foundation Structural Fill	Engineered fill known as structural fill is built in layers and compacted to the required density. Slag, bottom ash, leftover foundry sand, and coal fly ash can all be utilized as structural fill. Crushed concrete can be utilized as structural fill on-site.
(10) Poured Concrete Foundation	Cement, aggregate, and water are the main ingredients of the construction material concrete. There are several techniques to recycle industrial materials in concrete& cement. Here are some illustrations: Fly ash and crushed, granulated blast furnace slag serve as a component of cement. substitutes that can be employed. Concrete can be made stronger and last longer by using the following materials:Crushed concrete, blast furnace slag, foundry sand, bottom ash—all used as aggregates in concrete. Fly ash, FGD gypsum, foundry sand, recycled gypsum wallboard, and steel slag are all ingredients in the production of Portland cement.
(11) Insulation	Blast furnace slag that has been air-cooled can be used to create mineral or rock wool insulation, also known as slag wool insulation.
(12)Drywall/Wallboard	Plasterboard may be made from FGD gypsum and recycled gypsum wall board.
(13) Mortars, Grouts, Stucco	Sand, a binder, and water are the three main components of mortars, grouts, and stucco. Partially substituting cement is possible using fly ash, foundry sand, silica fume, and slag cement.
(14) Masonry Blocks	Concrete and aggregate are used to make masonry blocks. Cement can be partially replaced by fly ash, silica fume, or slag cement. In place of newly mined minerals, recycled concrete aggregate, bottom ash, and blast furnace slag can be used.
(15) Base Material	Instead of using natural soil as the foundation material for the construction site, leftover foundry sand can be used. Concrete that has been recycled is frequently utilized as base material.

2.5. Transportation industry waste The old tires are taking up a lot of waste area and posing serious issues for society. The used tire waste can be utilized whole, crushed into aggregates, or ground into powder, Fig. (9). for making lightweight concrete or paving roads, rubber aggregate is commonly utilized in construction. [Moriconi G., 2007].

Numerous studies have shown how using used tires may improve the sustainability of the building and construction sector. Utilizing used tires also helps to reduce costs, the demand for natural resources, and environmental impact. For a smooth and organic appearance that integrates into the surroundings, tires can be piled and then coated in adobe, Fig. (10). or it may be left in its current state for a more Mad Max appearance.

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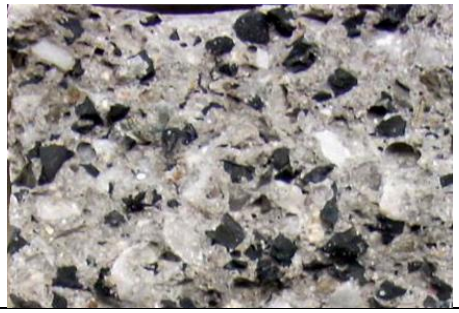

Fig. (9) The Rubber distribution in concrete mixture [N. Oikonomou and S. Mavridou, 2009].

Fig.(10) Wastes tires as a building materials [Jeremy Williams,2017]

2.6. Other types of wastes used in building

There are a number of different recycled materials that can be used as efficient alternatives to frequently used conventional building materials with a better impact on the environment and health.

2.6.1 soda cans facade

Egypt has a lot of potential to utilize recycled plastics instead of regular plastics, which would have a greater effect on the environment. The production of aluminum cans results in a number of negative environmental effects, including:

- The smelting of aluminum releases toxic waste as well as greenhouse gases and toxins such carbon dioxide, fluoride, sulphur dioxide, dust, and polycyclic aromatic hydrocarbons.
- The production of merely 1 kilogram (2.2 pounds) of aluminum uses 15kWh of electricity [Andreas Detzel,JonasMönckert, 2009].

Without the need for recycling or additional energy-saving procedures, it is possible to reuse the cans as they currently stand. Mixing sustainable uses Located in Shanghai, Can Cube Design is a cutting-edge residential and office structure. Fig. (11). The Can Cube's facade is a system of aluminum cans, keeping the system lightweight and easily modifiable by the occupants.

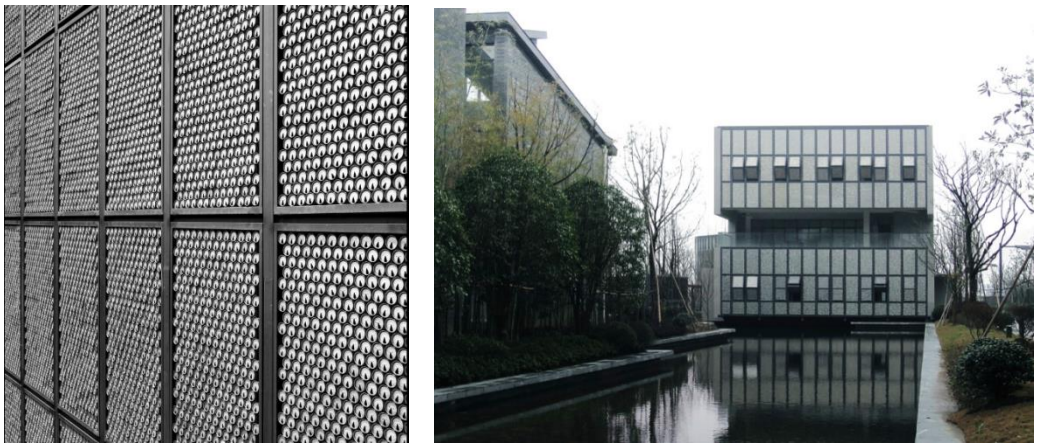

Fig. (11) Soda cans office buildings-Shanghai, China. Source: Can Cube / Archi-Union Architects https://www.archdaily.com/85278/can-cube-archi-union-architects-inc

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2.6.2 Container House

There are numerous environmental consequences caused by the steel producing process, including: -

The largest energy-intensive manufacturing sector in the world is the iron and steel sector.

Carbon is used as a reducing agent to turn iron ore into metallic iron, which contributes to global warming caused by CO2 emissions [Toshio Isohara, 2022].

Shipping Containers have been viewed as prefabricated modular units. It could be considered a kind of sustainability as it is coming from recycling process [Rania El Messeidy, 2018]. Through architectural intervention, the old cargo containers can be upcycled and repurposed for dwelling, as seen in Fig. (12). It can function as prefabricated units that are ready to assemble and can be rapidly disassembled and repurposed elsewhere after the project is complete. Modifications can be made to repurposed steel shipping containers to make them mold-, fire-, termite-, and structurally sound. Thus, extending the life of steel containers decreases their environmental impact while also saving money, time, and resources during construction [SharveyDhongde,VaishaliAnagal, 2020]. Most containers come in 20- and 40-foot models. High Cube models with ceilings that are 9'6" or above are suitable for residential construction. Fig. (13) Shows the first container residential compound in Egypt. Design and Build by QUBIXUpcycling shipping containers into colorfully modular and playful customizable complexes.

Fig.(12) The Redondo Beach Container House - United States.[House Tour: Redondo Beach Container House]

Fig. (13) Saddle Grounds [Saddle Grounds by QUBIX: the first pre-Fab Homes in Egypt]

2.6.3 Bottle Wall Construction

Egypt has a lot of potential for using recycled glass instead of regular glass, which would have better effects on the environment. Many effects that occur throughout the glass manufacturing process have a negative impact on the environment, including:

• Energy consumption: It takes a lot of energy to heat something up to the necessary temperature, which is around 1425 °C. A metric ton of glass requires between 3.7 and 6.0 kilojoules of energy to make [Glass Manufacturing, 1998].

• Water consumption: To lower the temperature, the cooling process uses a lot of water. [L. Ravenhall, 2020].

• Air pollution: Burning fuels during the melting process releases nitrogen oxides (NOx) and sulfur oxides (SO2), which can contribute to the development and acidity of SMOG.

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• Carbon Emissions: Burning fuels during the heating process results in CO2 emissions, which have a greenhouse gas effect in addition to causing the degradation of the raw materials. Decomposition of the raw materials accounts for 20% of the CO2 released, while energy use accounts for the remaining 80% [Environmental and Social Data Sheet, 2017].

Bottle construction is a plan to build a house with bottle [Mohammed Jalaluddin, 2017], It takes approximately 14,000 bottles of the same size to construct a two-bedroom bottle home. The idea of bottle construction can be used to build entertainment places like clubs, coffee houses, restaurants, resorts etc as this can also add to the aesthetic view of that place [Saariya Fatima, 2017]. Due to its great moldability, discarded glass can be recycled numerous times. Its chemical characteristics are not altered by repeated processing. It lessens the quantity of energy and raw materials needed in the furnace [Niedziólka et al., 2023].

2.6.4 Plastic wall construction

There are several negative environmental repercussions associated with the plastic production process that should be considered.
One of the most enduring images of modern industrial invention is plastic [Kamal et al., 2022]. Since a fifth of all plastic is used in the construction of buildings, the building and construction industry is regarded as the second-largest consumer of plastics. Modern buildings require a variety of crucial technical and functional features; which plastics help to attain.
• Fossil fuel consumption: 1.1 tons of fossil fuel is needed for every ton of plastic [P. G. Levi and J. M. Cullen, 2018].
• For every ton of plastics produced, around 2.5 tons of carbon dioxide (CO2) emissions are produced. In addition to the about 2.7 tons of embedded carbon, which are released in different amounts depending on how the polymers are handled at the end of their useful lives [N. H. Sandberg et al., 2016].
• Green House Gases (GHG) emissions: According to the used type of plastics, production process of plastics resulted in greenhouse gases emissions ranging from 1.6 metric tons per ton of plastics to 4.8 tons [M. Hestin et al., 2015].
• Plastics require a very long time to degrade; on average, it takes 500 years [M. Jalaluddin, 2017].

Plastics are extremely adaptable, and their characteristics have made them beneficial in a wide range of purposes. Plastics can be utilized in places that are very reactive, like the seashore, because they are extremely robust and corrosion-free. Furthermore, they are excellent sound, heat, and cold insulators and are lightweight, impermeable, and simple to maintain. Plastics often have very high energy effectiveness compared to their lifespan, lasting 30 to 50 years in construction.
Without undergoing additional processing, plastic forms can be utilized for many uses, Fig. (14).The Protiro Orange Crate Façade by NOWA uses recycled plastic as its primary material, Fig. (15). In order to recycle plastic, this idea employs orange crates to make a perforated façade that is both visually appealing and dynamic.

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Fig.(14)bottle wall construction [Recycled Building Materials]	Fig.(15)Protiro Orange Crate Façade by NOWA[Emerging materials: recycled plastic]

3. The use of recycled waste in a sustainable house design

Many people may have trouble imagining that beautiful buildings can be built from recycled materials, but many experiments have proven that using them achieves amazing results.

3.1 Modern house in Mumbai made of recycled windows and doors

This Mumbai home's appeal is provided by its vintage doors, windows, old wooden columns, and metal drain pipes, Fig. (16). The architects constructed a concrete frame that wraps around the façade and gives it a sense of separation from the other structures in order to juxtapose the old, recycled parts with more modern ones. Fig. (17). The property also has flooring, colonial furniture, antique cement tiles, Fig. (18&19), carved wooden moldings, and numerous historic things that have been adapted for modern usage. Table (3) shows the analysis of the design from the environmental, aesthetic and technical aspects.

	
Fig.(16)Salvaged windows, doors, shutters open for views and fresh air.	Fig.(17)Doors and windows from destroyed buildings join to create living room.

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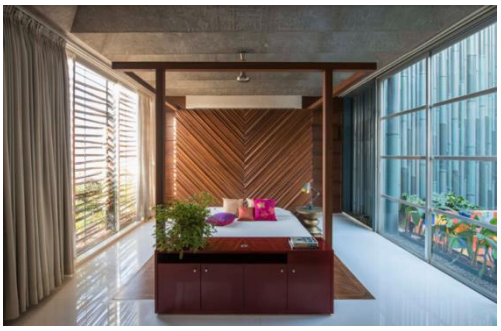	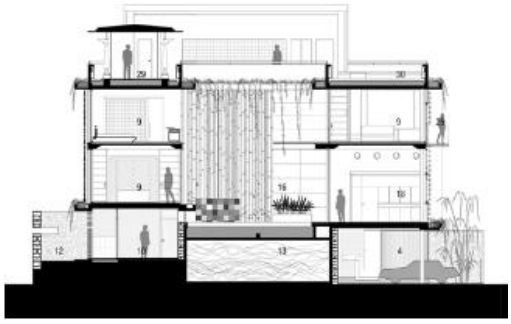
Fig.(18)Rusted metal plates form cladding, planter with tile samples and stone slivers.	Fig.(19)Section of the building [Alyn Griffiths, 2016]

Table (3) shows the analysis of the design from the environmental, aesthetic and technical aspects.

Environmental aspect	-An inner courtyard provides ventilation, natural lighting, and privacy. - Some of the recycled windows are still operable, allowing them to be used to ventilate the interior spaces. - Blocks and hollow areas create shadow areas and soften interior spaces. - Roof cultivation works to reduce temperatures.
aesthetic aspect	- The building balances traditional and contemporary architecture and makes consistent use of recycled materials. - Facades made of windows and doors give a feeling as Islamic architecture - the use of colors consistent with the color of warm brown wood - the use of a lot of green areas that give an aesthetic touch to the building.
technical aspect	- Materials available in surrounding areas reduce transportation time. - Reusing materials reduces cost - The project area is 520 square meters. It was built on 350 square meters, and the remaining space was used as green areas and water surfaces.

3.2 Homes Made of Plastic Waste

Recycled plastic houses provide environmentally friendly housing, Fig. (20&21). In the factory, Plastic is processed into beams, pillars and blocks. Homes can be assembled quickly, fireproof, earthquake-resistant, easy to maintain and cost-efficient. Low-cost homes created by Othalo and UN Habitat. In the project, it is studied People's housing, jobs, and interactions. Table (4) shows the analysis of the design from the environmental, aesthetic and technical aspects.

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Fig.(20) The structures have terraces and covered areas [Cajsa Carlson ,2020]	Fig.(21)Low-cost homes will be made from recycled plastic.

Table (4) shows the analysis of the design from the environmental, aesthetic and technical aspects.

Environmental aspect	-Recycled plastic will be used to construct a house (60 square-meters) with eight tons of waste. -A load-bearing structure and a sustaining and insulating structure are both present in the project [Shaileyee Das, Biswajit Das, 2017]. -The process is sustainable and safe.
aesthetic aspect	-The structures have terraces and covered areas in order to allow for regional adaptation. -Instead of just stacking up individual apartments, it aims to create varied neighbourhoods. - The use of a lot of green areas that give an aesthetic touch to the buildings.
technical aspect	-Plastic is gathered from the area around construction sites. - All houses are made onsite.

4. Matrix for evaluation of recycled materials in building

Through the models that were studied, a study was developed to evaluate the use of recycled materials in the design of building.

evaluation		**Yes**	**No**
environmental requirements	Are details on the recycled material's environmental qualities available?		
	Exist adequate environmental standards for the product for the planned application?		
	Are environmental details regarding past usage and experiences available?		
	Have the methods of producing and using the product had a low impact on the environment and conserved resources?		
	Is the product of great importance to the user and suitable for the environment?		
Technical requirements	Can the product be disassembled into parts that can be used and recycled?		
	Are the recycled materials in the product easy to sort?		
	Are the ingredients in the product good?		
economic requirements	Is it OK to alter the design in order to lower the price?		
	Exist any obvious financial restrictions?		

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Public Health	Do the recycled materials have any Materials Safety Data Sheets?		
	Have studies on the potential health effects of the material's use been conducted?		
Safety	Has OSHA previously raised concerns about the creation, processing, storage, and use of this data?		
Recycling	Exist any potential recycling or life-cycle issues?		
	Has the recycled material or the way it was utilized in other places been recycled?		

5. Environmentally friendly landscape by recycled materials-A Green Concept in Egypt

It is intended to raise public awareness of the importance of sustainability through the use of recycled waste materials in park landscape design. In order to benefit future generations, this strategy will protect natural resources. Through the research survey, we observed that most parks in Egypt nonexistence of colors except green, natural wood color, and dark metals. The research aims to apply the idea of reusing waste in landscape El Nasr Park, Fig. (22), it is a small park in Heliopolis-El Hegaz Street,Cairo,it is Surrounded by a number of residential blocks, government schools, and Al-Nasr Sports Club.
The furniture of park using Recycled materials were used to create sculpture parks, public settings, tables, waterfalls, lights, and other landscape features. These materials included plastics, crushed glass, steel, timbers, concrete, tires, recycled concrete, and wood.

5.1 The main ideas

- To increase social understanding of sustainable development through the use of recycled materials in the environment, Fig. (23 & 24)
- Investigate the value of design in creating landscapes from recycled or used materials to protect natural resources and support a healthy ecological system.

Fig. (22) Location ofEl Nasr Parkin Heliopolis-El Hegaz street –Cairo-Egypt, Source: (google earth)

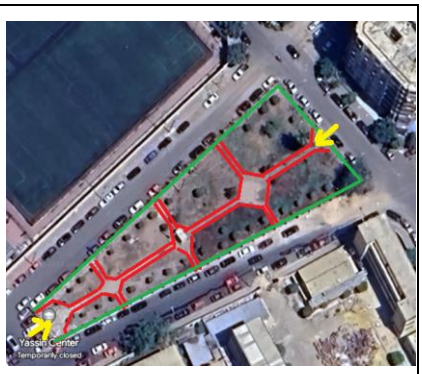

Fig.(23) The current design

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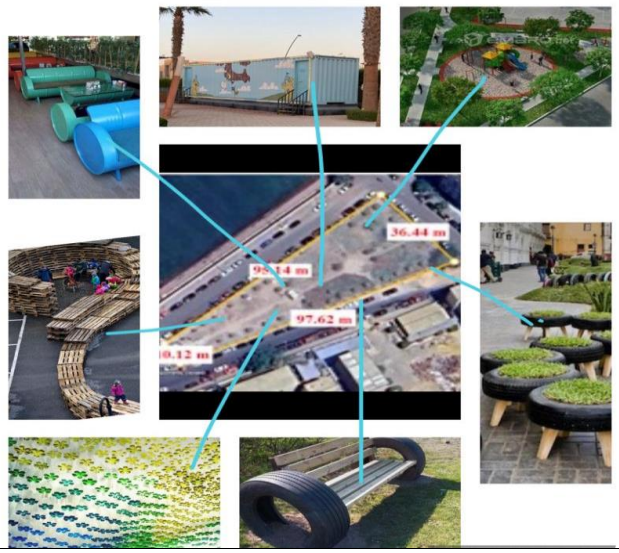

Fig.(24) The suggested design elements using recycled materials, such as plastic ,bricks ,wood ,recycled tires ,scrap metal , and drainage pipes mixed with recycled concrete.

Conclusions

Increased population, consumption energy, pollution, and industrial processes have caused environmental degradation due to lack of protection. To minimize raw material consumption, produced waste, and needed costs in the construction sector, it is constantly necessary to identify alternative building materials with higher environmental performance.

An intriguing idea that would address energy and environmental problems concurrently is the production of building materials from waste. Recent developments in getting eco-materials and protecting natural resources have led to the development of new construction materials.
Wastes can enhance or detract from certain qualities when added to building materials, so a combination of wastes and other materials are often used to compensate for any disadvantages.
Egypt's long-term strategy plan, known as Vision 2030, aims to implement and locally scale up the ideals and objectives of sustainable development across all spheres of endeavor. It reveals the three pillars of sustainable development: the economic dimension, the social dimension, and the environmental dimension. Also, gives importance to confronting the effects of climate change through the presence of an integrated and sustainable ecosystem that enhances resilience and the ability to confront natural risks. Utilizing waste products and materials in Architecture tackles Environmental Sustainability: An integrated and sustainable environmental system aims to protect development and the environment simultaneously through the wise use of resources in order to safeguard the rights of future generations in a more secure, sufficient future and sustainable production.
-Recycling is one of the important practices in Architecture

<u>Results of the application study are as follows:</u>
Reused and recycled materials in Architecture are extremely important especially when considering sustainability.

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-It is of a great benefit to the environment, by which recovering products and components and the reused of materials for recycling purposes fosters sustainable development as it reduces the need to use natural resources and raw materials.
-There are many issues to tackle to make the world more sustainable and efficient. Design flexibility and material reuse are essential
-Using recycled materials can reduce a building's original embodied energy by more than 60%.
SWOT Analysis of the proposed ideas:
Strengths: recycling raises environmental consciousness, reduces the energy used, eco-friendly approach, benefit to incorporate the circular economy, innovative design and untraditional
Weakness: durability, may be costy due to maintenance, visual appeal to some users
Opportunities: creates new jobs, producing economic benefits
Threads: Sustainability can be achieved in Architecture through utilizing waste materials and products in building sector.

Innovative ideas battered by getting new ideas on the building unit or landscape elements using reusing and recycling concept.
-The proposed concepts open horizons for users of different spaces to raise their awareness towards their environment.
It is recommended that through increased education and environmental awareness, the link between art and environmental sustainability using waste and repurposed materials may be deeper.

List of abbreviations

CCPs	Coal combustion products
(C&D) waste	Construction and Demolition waste
FGD	Flue Gas Desulphurization Material
GHG	Green House Gases
SWOT Analysis	Strengths , Weakness , Opportunities , Threads Analysis
WWTP	Wastewater treatment plants.

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