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TOWARDS THE ADAPTATION OF GREEN BUILDING MATERIAL SYSTEMS TO THE EGYPTIAN ENVIRONMENT

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ABSTRACT

This research briefly reviews the definition and the principles of green architecture, making a comparison between the global green building rating systems in respect to materials only. These systems are the [1, 2]Green Pyramid, BREEAM (Building Research Establishment Environment Assessment Method), [3] LEED (Leadership in Energy and Environmental Design) and the [4] Green Star in the form of Credits %, importance and its Requirements.

The research Aims to evaluate the green building material systems in Egypt and propose the suitable score and elements to the Egyptian society to evaluate materials that suit available technology in the Egyptian environment.

Keywords: Green architecture, Green building rating systems, Material selection, Adaptation, Egyptian environment.

1. INTRODUCTION

Buildings have an enormous and continuously increasing impact on the environment, using about 40% of natural resources extracted in industrialized countries, consuming nearly 70% of electricity and 12% of potable water, and producing between 45% and 65% of the waste disposed in landfills.[5] Moreover, they are responsible for a large amount of harmful emissions, accounting for 30% of greenhouse gases, due to their operation, and an additional percent of 18% caused indirectly by material exploitation and transportation[5].

The green building movement emerged to mitigate these effects and to improve the building construction process, so this paradigm shift should bring significant environmental, economic, financial, and social benefits.

In order to gain previous benefits efforts should be focused on the selection of appropriate technologies and techniques for choosing proper materials. Although selecting inappropriate materials may increase the overall costs, it will achieve the desired environmental goals.

This study proposes a methodology to evaluate materials in the Egyptian environment by analyzing green building material's rating systems.

2. GREEN BUILDING DEFINITION

Definitions of green buildings are concerned with the building impact on the environment therefore it ranges from average buildings, to other buildings that may represent a regenerative process that can actually improve and restore the site and its surrounding environment.

Green building works through the whole building's life cycle starting from creating the structure and all processes that are concerned with the environment and resource efficiency therefore it takes place during design, construction, operation, maintenance, renovation and deconstruction. That means that green buildings have its impact on the classical building design concerns of economy, utility, durability, and comfort.[6]

The ideal “green” project preserves and restores sustainability turning the building to be an exporter of resources, materials, energy and water rather than being a net consumer. That means that green buildings during its construction and lifetime assure the healthiest possible environment using the most efficient and least disruptive use of land, water, energy and resources.Paul and Zeigler [7]

Accordingly green architecture can be defined as "architecture compatible with the environment, to reduce the negative impact, check the efficiency of energy use, best use of renewable energy sources, in addition, the efficient use and reuse of materials, resources, with respect to the site, adapt to the climatic conditions, and the convenience of users" this definition helps know the main component of green architecture.

3. GREEN BUILDING PRINCIPLES

3.1. Site Design Sustainability
3.2. Water Efficiency
3.3. Energy Efficiency
3.4. Quality of Indoor Environment
3.5. Usage and sources of Materials and Resources

3.1. Site Design Sustainability

The impact of site selection and design is no less important than the sustainable design of the building process itself. The two issues that should be considered regarding sustainable sites are: Sustainable Site Selection, Sustainable Site Design.

3.2. Water Efficiency

High efficiency system for drinking water, Rain water recuperated on the roof and used to flush toilets, and if necessary irrigate the garden, in addition to, Waterless urinals.

3.3. Energy Efficiency

Reversible geothermal heat pump, Heating and cooling through thermal mass concrete, Production of hot water through recuperation of heat from Refrigerators, the energy consumption comes from renewable.Building Green Standards [8]

3.4. Quality of Indoor Environment

A building and site that explicitly support a healthy work and Life style, interaction and innovation, controlled air supply system, and reduce CO2.

3.5.Usage and sources of Materials and Resources

Minimal use of materials, recycle and reuse, and locally sourced materials.

3.5.1. Importance of Materials

As a result of the increased use of some materials they are threatened to depletion. In addition the unwise use of materials can increase cost of projects, so there is a bad need for rationalization of the use and maintain of materials.

So this study will focus on developing criteria for evaluating and maintaining materials to achieve the requirements of green buildings.

3.5.2. Key Principles

Minimize the use of nonrenewable construction materials and other resources such as energy and water through efficient engineering, design, planning and construction and effective recycling of construction debris.

- Maximize the use of recycled content materials, modern resource efficient engineered materials, and resource efficient composite type structural systems wherever possible.
- Maximize and benefit from the wise use of reusable, renewable, sustainably managed, and bio-based materials. Considering that human creativity and our abundant labor force is perhaps our most valuable renewable resource. In order to achieve the best solution it should be clear that it is not necessarily the one that requires the least amount of physical work.

3.5.3. Strategies and Technology techniques

- Optimizing the use of engineered materials which provide high strength and durability with the least amount of material and benefit out of proven engineering principles such as structural systems (concrete/steel, other…), insulated concrete forms, engineered trusses, composite materials and structural insulated panels (stress skin panels), and frost protected shallow foundations.
- Identify ways to reduce the amount of materials used and reduce the amount of waste generated through the implementation of a construction waste reduction plan.

- Adopt a policy of "waste equals food" whereby 75% or more of all construction waste is separated for recycling and used as feedstock for some future product rather than being land filled.
- Implement an aggressive construction waste recycling program and provide separate, clearly labeled dumpsters for each recycled material.
- Train all crews and subcontractors on the policy and enforce compliance.
- Identify ways to use high recycled content materials in different parts of the building structure and finishes.
- Consider all types of recycled materials such as blended concrete using fly ash, slag, recycled concrete aggregate, or recycled content materials such as structural steel, carpet padding, sheathing, ceiling and floor tiles, carpeting, and gypsum wallboard.
- Explore the use of some structural insulated panels made from bio-based materials and the use of bio-based materials and finishes such as various types of agriboard (sheathing and or insulation board made from agricultural waste and byproducts, including straw, wheat, barley, and other materials).
- Use lumber and wood products from certified and well controlled forests where the forest is managed and lumber is harvested using sustainable practices.
- Evaluate all products and systems to be recycled at the end of their useful life.
- Paying attention to products and systems that facilitate easy, non energy intensive separation and recycling with minimal contamination by foreign debris.
- Recognize the role of transportation which forms part of a product or building materials embodied energy.
- Where practical, specify and use locally harvested, mined and manufactured materials and products to support the regional economy and to reduce transportation, energy use and emissions.Paul and Zeigler [7]

4. RATING SYSTEMS FOR GREEN BUILDINGS

Many international and local methodologies have been developed to establish the degree of buildings accomplishment to the environmental goals, guiding the planning and design processes. In these earlier stages decisions by planners can improve building performance at very little or no cost, following the recommendations of the decision making tool.

The first of such tools was the Building Research Establishment Environmental Assessment Method (BREEAM).Lee and Burnett [9]

After that, other methodologies, such as Green Star from Australia, the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) from Japan, the Building and Environmental Performance Assessment Criteria (BEPAC) from Canada and the Leadership in Energy and Environmental Design (LEED) From the United States were developed and are currently widely applied.

Very comprehensive inventories of available tools for environmental assessment methods can be found in the Whole Building Design Guide, and the World Green Building Council. Ding [10] Although the existing methods and tools have an extended use, LEED has established strong

credibility among the experts increasing its affiliates.

According to Bowyer, in April of 2007, the LEED system was comprised of 7500 companies and organization members, validating its importance as the standard environmental performance measure of a building and becoming a reference system for design, construction, and operation of GBs beyond the U.S

Adaptations of the LEED system have been applied or are in the process of implementation in Brazil and Mexico, two of the largest developing economies in the Western hemisphere. Daniel Castro-Lacouture, et al. [11]

Furthermore, the LEED system is being proposed as a reference framework for countries in which there is no current method of building environmental assessment, such as the case of Colombia, where a national council for sustainable construction has been formed in 2008.

Similar to many available rating systems, the LEED rating system is based on credits and points. Through each credit, the system evaluates the candidate building performance and awards points if the requirements are reached in a variety of areas such as indoor environmental quality, sustainable sites, and materials and resources. USGBC (United States Green Building Council) [12]

4.1. Comparison between Green Building Rating Systems

- (Table 1.1) shows a comparison between the various green building rating system like [1-4] in Requirements

To understand the comparison we should take into consideration that :

1. Some elements have the same means in a different vocabulary, such as Local Sourcing equal to Regional Materials equal to Regionally procured materials.
2. Similar means have same colors and numbering shows the importance of the requirement in the various rating systems.
3. All systems include elements about Local Sourcing reduction and recycle.
4. All systems include elements about the reuse of materials except the green pyramid.
5. BREEAM included Hard landscaping and boundary protection, therefore it suits better sustainable sites instead of materials.

(Table 1.2) Shows the comparison between various green building rating system like ***Green*** *Pyramid*, *BREEAM*, *LEED* and *Green Star* in Credits% & importance.

It appears from the comparison that:

1. The evaluation range between elements in different systems are very small.
2. Green pyramid and LEED have obligatory required elements.

Requirements	*Green Star*	*LEED*	*BREEAM*	*Green Pyramid*
Regional Materials	Local Sourcing (3)	Regional Materials (2)		Regionally procured materials (3)
Use of Wood	Sustainable Timber (3)	Certified Wood (3)	Responsible sourcing of materials[1] (2)	
Reuse	Building Reuse (1)	Building Reuse Maintain Existing Walls, Floors and Roof (2)	Reuse of building façade (3)	
	Reused Materials (4)	Building Reuse—Maintain Existing Interior Nonstructural Elements (2)	Reuse of building structure(3)	
		Materials Reuse (2)		
Recycling	Recycling Waste Storage (3)	Storage and Collection of Recyclables (1)		Use of recycled materials (2)
		Recycled Content (2)		
Reduce toxic materials	Concrete (2)			Elimination of exposure to hazardous and toxic materials (1)
	Steel (2)			
	PVC Minimization (4)			
Reduce materials	Dematerialization (4)			
Prefabricated elements	Design for Disassembly (4)			Use of prefabricated elements (3)
Renewable Materials		Rapidly Renewable Materials (3)		Use of readily renewable materials (3)
Durability materials			Designing for robustness (3)	Use of higher durability materials (4)
Management		Construction Waste Management (2)		Presentation of a Schedule of Principal Project Materials(1)
			Hard landscaping and boundary protection (3)	
Materials specification			Materials specification (major building elements) (1)	Materials fabricated on site (4)
			Insulation(3)	Use of salvaged materials(4)
				Use of lightweight materials (4)

(Tab 1-1) Comparison between the various green building rating system like ***Green Pyramid***, ***BREEAM***, ***LEED*** and ***Green Star*** in Requirements

Requirements		*Green Pyramid* [11]			*LEED* [13]			*Green Star* [12]			*BREEAM 11*		
		Credits	Credit %	Priority	Credits	Credit %	Priority	Credits	Credit %	Priority	Credits	Credit %	Priority
Elimination of exposure to hazardous and toxic materials		Required	Required	1									
Recycling	Recycling Waste Storage	4	21%	2	Required	Required	1	2	9%	3			
	Recycled Content				1-2	7.5:15%	3						
	Building Reuse				2-3[15]	14:22.5 %	2	5	22.5%	1	1	7%	3
	Reused Materials				1-2	7.5:15%	3	1	4.5%	4	1	7%	3
Reduce material								7-8[16]	31.8 : 36.3%	2			
Use of prefabricated elements		3	15.7 %	3				1	4.5%	4			
Certified Wood					1	7.5%	4	2	9%	3	4	28.5%	2
Construction Waste Management		Required	Required	1	1-2	7.5:15%	3						
Hard landscaping and boundary protection											1	7%	3
Materials	Materials										5	35.7%	1

Requirements		*Green Pyramid* [11]			*LEED* [13]			*Green Star* [12]			*BREEAM 11*		
		Credits	Credit %	Priority	Credits	Credit %	Priority	Credits	Credit %	Priority	Credits	Credit %	Priority
specification (major building elements)	specification												
	Local Sourcing	3	15.7 %	3	1-2	7.5:15%	3	2	9%	3			
	Rapidly Renewable Materials	3	15.7 %	3	1	7.5%	4						
	Insulation	3	15.7 %	3							1	7%	3
	Use of higher durability materials	1	5.2 %	4							1	7%	3
	Use of lightweight materials	1	5.2 %	4									
Materials fabricated on site		1	5.2 %	4									
Shell and Core or Integrated Fit-out								1	4.5%	4			
Total score		19 points	100%		13 points	100%		22 points	100%		14 points	100%	

(Tab 1-2) Comparison between the various green building rating systems like ***Green Pyramid***, ***BREEAM***, ***LEED*** and ***Green Star***

- (Table 1.3) includes the Requirements in various green building rating systems like [1-4] after Exclusion of requirements with similar meanings, andIncluding the range of score for each element, and proposing the suitable score to the Egyptian society.

It is important to mention that Some Requirements are not suitable in Egypt because of:

1. The Limitation of industry in Egypt in some requirements like Recycling Waste Storage.
2. Some materials are not found in Egypt like Certified Wood.

In addition other Elements were given bonus points to Encourage applying it in Egypt like Building Reuse and Recycled Content.

Table-1.3. Range of score for each element, and proposing suitable score to the Egyptian society.

Requirements		**Score range in other systems**	***Comment***	**Score proposed for Egypt**
Elimination of exposure to hazardous and toxic materials		Required	Very necessary to save the environment	Required
Recycling	Recycling Waste Storage	Required 9:20 %	Limited industry in Egypt	5%
	Recycled Content	7.5:15%	No industry in Egypt	Bonus 5%
	Building Reuse	22.5%	Not necessary having High score	Bonus 5%
	Reused Materials	4.5:15%	Very necessary to reduce the waste of material	10%
Reduce material		4.5:13.5%	Very necessary to save the material	10%
Use of prefabricated elements		15%&4.5%	1- Wide range because of : different country 2-High cost in Egypt	10%
Certified Wood		7.5:9 % & 28.5%	Not available locally therefore not suitable	0%
Construction Waste Management		7.5:15% Required	Very necessary	10%
Hard landscaping and boundary protection		7%	In sustainable site not in material	0%
Materials specification (major building elements)	Materials specification (major building elements)	35.7%	Include using of Local Sourcing & Insulation	10%
	Local Sourcing	9:15 %	Very necessary to reduce the cost	10%
	Rapidly Renewable Materials	7.5:15%	Very necessary	10%

Requirements		Score range in other systems	*Comment*	Score proposed for Egypt
	Insulation	7%	Moist Insulation in Moist areas thermal Insulation in hot areas	10% for thermal and Moist Insulation
	Use of higher durability materials	5% - 7%	Very necessary	10%
	Use of lightweight materials	5%	Good requirement	5%
Materials fabricated on site		5%	Good requirement	Bonus 5%
Total score				100% + 15% Bonus

5. CONCLUSIONS AND RECOMMENDATIONS

1. Material rating systems help the designer to choose the right materials.
2. Evaluation criteria in different systems are specific to each state individually and are difficult to be circulated from one country to another because of the different economic conditions and local materials availability.
3. Using additional points in the evaluation helps to encourage the provision of certain industries unavailable.
4. Draft of green pyramid rating system in Egypt ignores some important elements, such as the reuse of materials, so it has to be developed.
5. All rating systems having points to evaluate the use of local materials, indicating its importance.

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