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Unique Rating System for Green Building: By Comparing Various Existing Rating Systems

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ABSTRACT
The construction industries are known to be the pioneer of a country's development. In modern days the infrastructure of a country defines its true development, thus making construction sector more prominent. Countries like India are thus solemnly dependent on its construction sector for its rapid development. In 21st century, one of the major challenges faced by mankind is that of global climate change, which has highly alerted to the concern for conservation of nature. In a way, making environmental sustainability to be of much more importance in actual execution of work is the focus.
World-wide there are various building evaluation tools that focus on different areas of sustainable development and are designed for different types of projects. This research attempts to understand the various Green building rating system assessment criteria that need to be considered during comparison. Finally based on comparative study an attempt is made to recommend one unique rating system which will cover each and every aspect required for assessment and certification for any green building. This system would be comparatively less complex and able to provide the necessary perception about the project with ease.
KEY WORDS: Green building, LEED, BREEAM, GREEN STAR, GREEN MARK, HK-BEAM

I. INTRODUCTION

The construction sector in India contributes 10% of GDP and it is growing at an average of 9% against a world average of 5.5% (Vijayadas, January 2011). The construction sector poses major challenges to the environment. Globally, buildings are responsible for at least 40 % of energy use. An estimate says that 42 % of global water consumption and 50 % of the global consumption of raw materials is consumed by building when taking into account the manufacture, construction and operational period of building. In addition, building activities contribute an estimate 50 % of world's air pollution, 42 % of its greenhouse gases, 50 % of all water pollution, 48 % of all solid waste and 50 % of all CCs to the environment (Gupta, March 2013).

The building which utilizes less external energy and is capable of producing ample amount of energy for its intended use itself without causing harm to the environment is known as Green Building. In order to achieve green features of green building there is necessity of proper guideline and assessment of such features and to know how effective a particular building is in term of its environment friendliness. Thus to achieve this guidelines, assessment and effectiveness, certain rating system have been developed.

Worldwide various rating systems have been developed. The first environmental certification system was created in year 1996 the Building Research Establishment's Environmental Assessment Method (BREEAM) in UK. In year 1996 the Hong Kong Building Environmental Assessment Method (HK-BEAM) was introduced in Hong Kong. In year 1998 the Leadership in Energy and Environmental Design (LEED) green building rating system was introduced in US. In year 2002 Green Building Council of Australia introduced the GREEN STAR rating system. In year 2005 the Building and Construction Authority of Singapore introduced GREEN MARK rating system.

The focal comparison of this research is centred on LEED, BREEAM, GREEN STAR, GREEN MARK and HK-BEAM. This study is a comprehensive assessment of every category and sub-category associated with each system. The system comparison is completed by an assessment of the incorporation of life cycle thinking. This research recommends unique green building rating system by comparing all above exiting rating system which covers each and every aspect required for the assessment and certification for green building. This unique rating system is comparatively less complex and provides the necessary perception about the project with ease. This research will focus largely on the way in which users are likely to interpret and implement the system, as opposed to focusing on requirements of system overall.

II. GREEN BUILDING

A green building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resource. The decision to build green should be made before the site is selected, as many of the green criteria are affected by site characteristics and some sites are inappropriate for certain green projects. One of the first steps in the green design process is to establish firm environmental goals for the project like energy efficiency, water conservation, onsite treatment of rain water and storm water, material and resources management, construction waste management, and to assign responsibility for meeting these goals to specific members of the design team. Each goal needs a champion who will see that objective through to the end.

The benefits of building green includes cost saving from reduced energy, water and waste, lower operation and maintenance cost, and enhance occupants productivity and health. However, it may include higher initial cost, but higher ROI and return on assets are key benefits. (Pimplikar & Moakher, 2012)

Five Elements of Green building design

1) Sustainable Site Design 2) Water Quality and Conservation 3) Energy and Environment 4) Indoor Environmental Quality 5) Materials and Resources

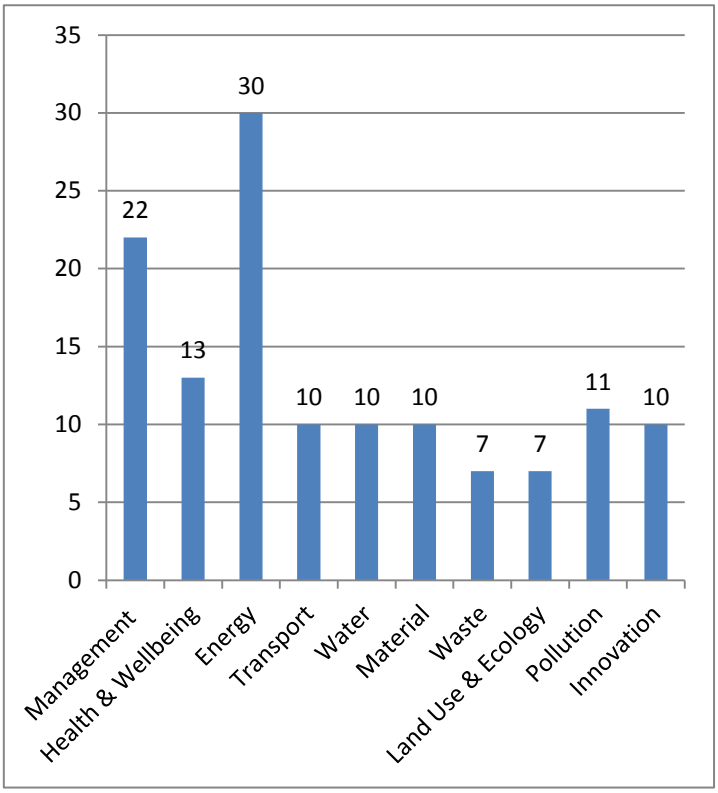
III. GREEN BUILDING RATING SYSTEM

The sustainable building rating system is defined as tools that examine the performance or expected performance of a building and translate that examination into an overall assessment that allows for comparison against other buildings. For a rating system to add value to the sustainable design and/or operation of a building it must offer a credible and consistent basis for comparison, evaluate relevant technical aspects of sustainable design and it should avoid complexities. All Green Rating systems provide guidelines on how to make a building "green" and some of them provide certification process, while other provides opportunities for voluntary compliance. For this research following green rating systems are used.

BREEAM (Building Research Establishment's Environmental Assessment Method) is established in year 1990 in UK. It covers Courts, Homes, Industrial building, Multi-residential building, Prison, Offices, Retail and School buildings. BREEAM rating system is relevant, measurable, applicable and available during assessment. Registration and Certification fees for BRREAM are INR 10,912 and INR 1, 06,399. Table no. 01 and Graph no. 01 shows Assessment criteria and score for BREEAM.

CATEGORY	SCORE
Management	22
Health & Wellbeing	13
Energy	30
Transport	10
Water	10
Material	10
Waste	7
Land Use & Ecology	7
Pollution	11
Innovation	10
Total	**130**
Unclassified	<30
Pass	30
Good	45
Very Good	55
Excellent	70
Outstanding	85

Table No. 01

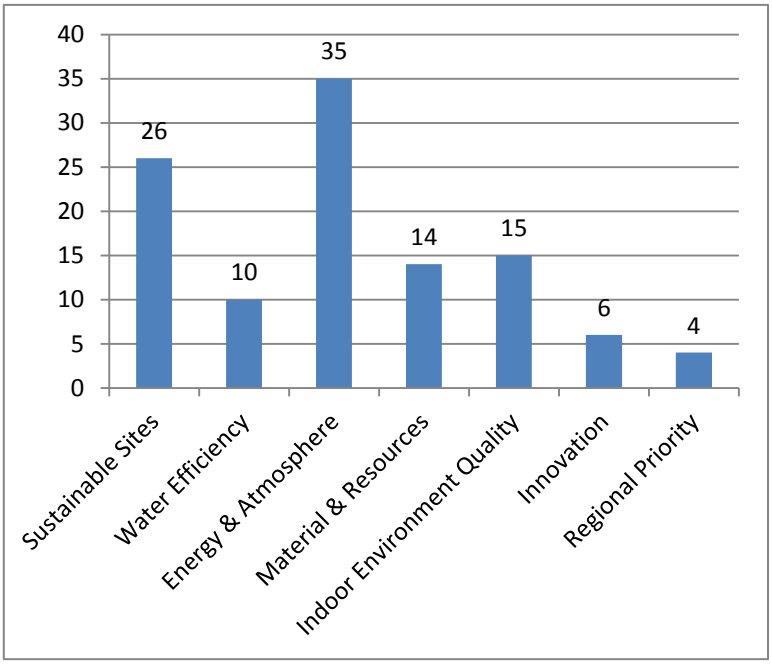


Graph No. 01

LEED (Leadership in Energy & Environmental Design) is established in 1990 in US. It covers Homes, New Commercial buildings, New Construction & Major renovations, Existing buildings, Commercial interiors, Core & Shell development, Schools building, Retail, and Health care facilities buildings. LEED rating system is relevant, measurable, applicable and available during assessment. Registration fee for LEED is INR 52,312 (USGB members)/ INR 69,756 (Non-members) and INR 1, 06,399. And Certification fee included in assessment review fee. Table no. 02 and Graph no. 02 shows Assessment criteria and score for LEED.

CATEGORY	SCORE
Sustainable Sites	26
Water Efficiency	10
Energy & Atmosphere	35
Material & Resources	14
Indoor Environment Quality	15
Innovation	6
Regional Priority	4
Total	**110**
Certified	38
Silver	48
Gold	57
Platinum	75

Table No. 02



Graph No. 02

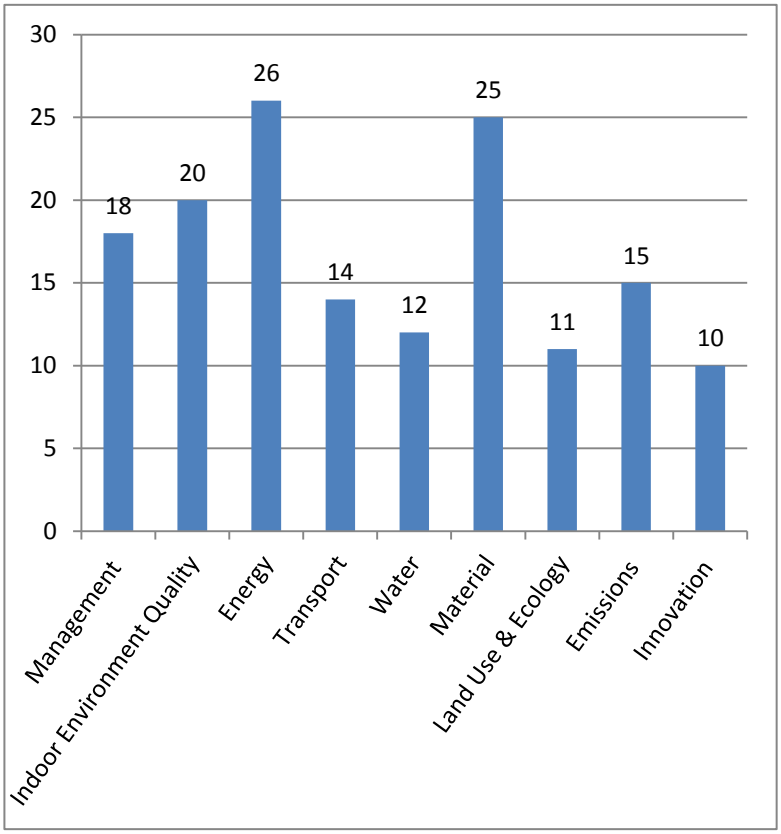
GREEN STAR is introduced in year 2002 by Green Building Council of Australia. It is based on BREEAM and LEED systems. It covers Commercial office design & construction, Shopping centres, Healthcare facilities buildings, Education facility buildings, mixed use/ Multi unit residential buildings, Industrial buildings, and Public buildings. GREEN STAR rating system is relevant, measurable and available during assessment. A certification fee for GREEN STAR is INR 2, 94,312 to INR 8, 29,398. Table no. 03 and Graph no. 03 shows Assessment criteria and score for GREEN STAR.

GREEN MARK is introduced in year 2005 by Building and Construction Authority of Singapore. It covers Commercial buildings, Institutional buildings, Industrial buildings, Residential buildings, Hotels, New buildings and Existing buildings. GREEN MARK rating system is relevant, measurable, applicable and available during assessment. Table no. 04 and Graph no. 04 shows Assessment criteria and score for GREEN MARK.

HK-BEAM (Hong Kong-Building Environmental Assessment Method) is established in year 1996 in Hong Kong. It covers Commercial buildings, Institutional buildings, Residential buildings and Industrial buildings. HK-BEAM rating system is relevant, measurable, applicable and available during assessment. Table no. 05 and Graph no. 05 shows Assessment criteria and score for HK-BEAM.

CATEGORY	SCORE
Management	18
Indoor Environment Quality	20
Energy	26
Transport	14
Water	12
Material	25
Land Use & Ecology	11
Emissions	15
Innovation	10
Total	**151**
One Star	10
Two Star	20
Three Star	30
Four Star-Best Practices	45
Five Star-Australian Excellence	60
Six Star-World Leader	75

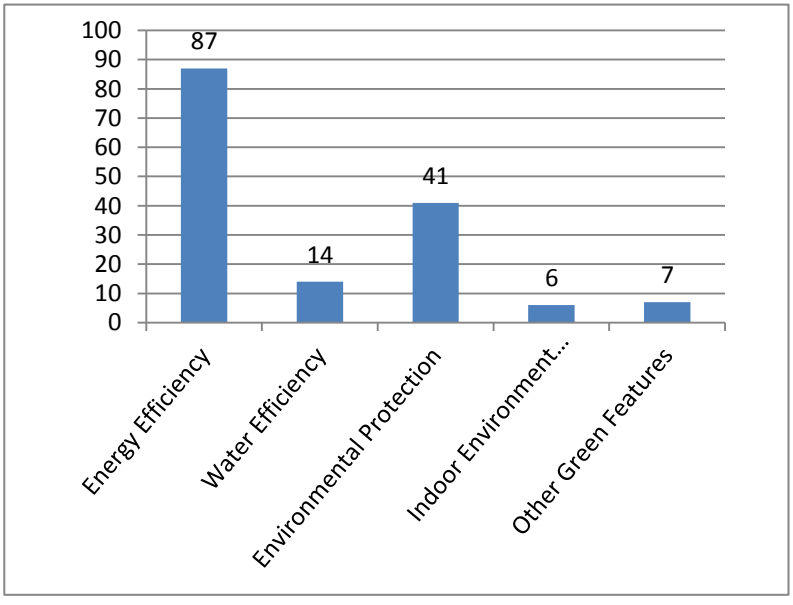
Table No. 03



Graph No. 03

CATEGORY	SCORE
Energy Efficiency	87
Water Efficiency	14
Environmental Protection	41
Indoor Environment Quality	6
Other Green Features	7
Total	**155**
Certified	50-74
Gold	75-84
Gold Plus	85-89
Platinum	90&Above

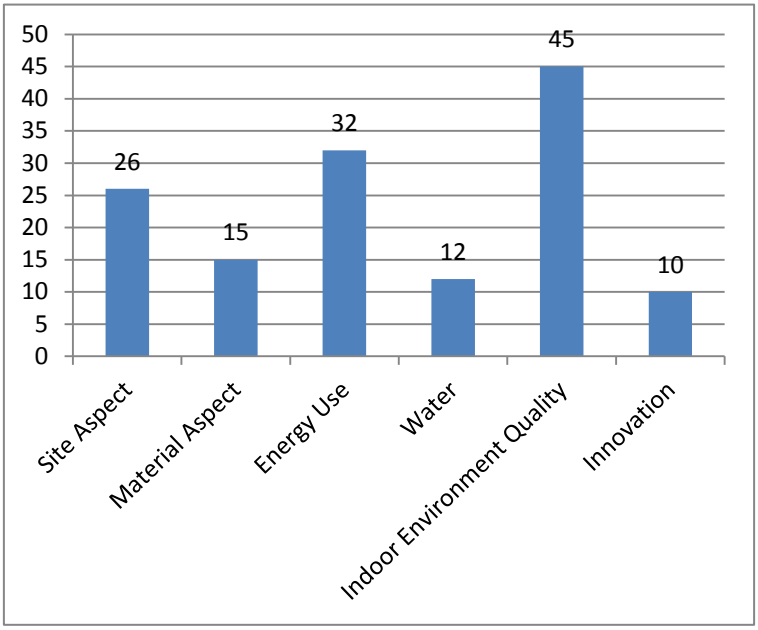
Table No. 04



Graph No. 04

CATEGORY	SCORE
Site Aspect	26
Material Aspect	15
Energy Use	32
Water	12
Indoor Environment Quality	45
Innovation	10
Total	**140**
Bronze	40%
Silver	55%
Gold	65%
Platinum	75%

Table No. 05



Graph No.05

IV. COMPARITIVE ANALYSIS

Comparative analysis which is shown in Table no. 06 gives complete idea of the various assessment criteria i.e. Similarity and dissimilarity of green building rating systems and it also reflects whether respective rating systems have considered or not considered the various criteria while assessment. As it reflects from this analysis that there are many assessment criteria considered which have the same meaning but they are denoted by a different wording in respective rating systems for E.g. (Urban redevelopment or reduced site disturbance or ecological value of site and protection of ecological features or mitigation ecological impact or enhancing site ecology or ecological value of site, it all means that whatever ecological features are their onsite prior to construction should not be disturbed or disrupted.)

From the Graph 01 to Graph 05 of respective green building rating system it is clear that there is no appropriate preference given to various assessment criteria for E.g. (In LEED system energy and atmosphere is given more preference and same in GREEN STAR system Indoor air quality is given more preference.) As this respective rating systems i.e. LEED, BREEAM, GREEN STAR, GREEN MARK, and HK-BEAM are not specific enough on some points while it creates the confusion for builders and developers which rating system shall they refer. In order to overcome this complexity there is a need of one unique, simple and user friendly rating system. Hence based on the comparative study of the green building rating systems criteria a simple and user friendly green building rating system is developed. The new developed rating is more specific for each assessment criteria, as LEED, BREEAM, GREEN STAR, GREEN MARK, and HK-BEAM are not very specific on some assessment criteria which has a very wide window and thus it becomes difficult to arrive at exact rating and inference from that score. The rating system developed from the above comparative study is shown in Table no. 07 & 08 and Graph no. 07.

Table No. 06- Comparative Analysis of Green Rating Systems

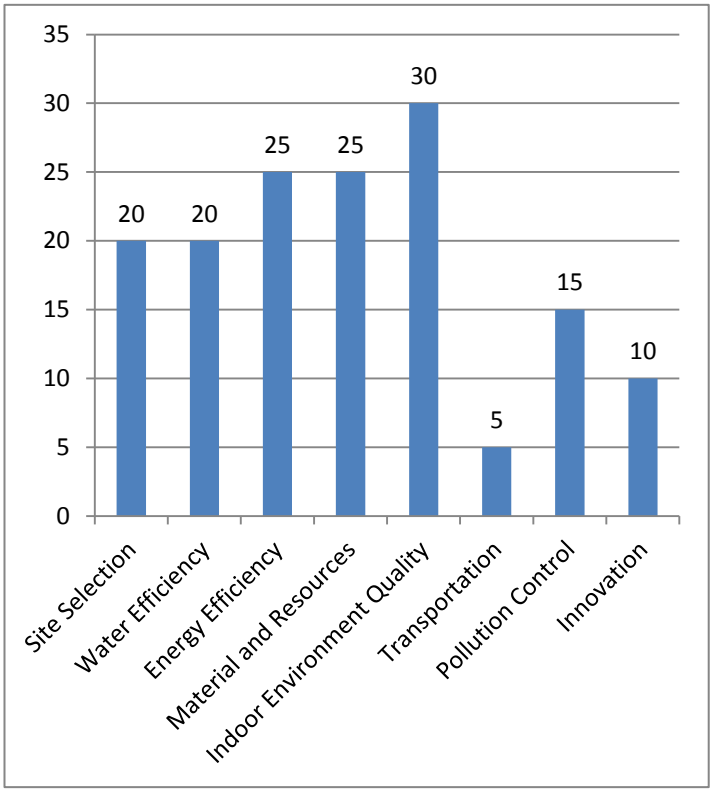
	CATEGORY	LEED	BREEAM	GREEN STAR	GREEN MARK	HK-BEAM
1	**MANAGEMENT/ SUSTAINABLE SITE/ SITE & PROJECT MGMT/ SITE ASPECT**					
a	Site selection/ Brownfield redevelopment/ Reuse of land/ Reclaimed land/ contaminated land/ sustainable construction	●	●	●	●	●
b	Erosion & Sedimentation control/ Topsoil & Fill Removal from site	●	○	●	○	○
c	Urban redevelopment/ Reduced site disturbance/ Ecological value of site & protection of ecological features/ Mitigating ecological impact/ Enhancing site ecology/ Ecological value of site/ Greenery provision/ construction site impact/ Long term impact on biodiversity	●	●	●	●	○
d	Hard Landscaping & Boundary protection/ Environmental mgmt./ Environmental mgmt. practices/ Landscaping& Planters/ Microclimatic around building/ Health, Safety & Environmental mgmt./ Environmental purchasing practices/ User guidance	○	●	●	●	●
e	Responsible construction practices/ Maintainability/ Commissioning clauses/ Commissioning building Tuning/ Environmental mgmt. Practices (CONQUAS)/ Building & Site Operation &Maintenance	○	●	●	●	●
2	**ENERGY/ ENERGY EFFICIENCY/ ENERGY USE**					
a	Fundamental building system commissioning/ Measurement & verification/ Energy monitoring/ Energy conditional requirement/ Electrical sub-metering/ Testing & commissioning / Metering & monitoring	●	●	●	○	●
b	Minimum energy performance/ Optimize energy performance/ Energy efficient cold storage/ Energy eff. Lab system/ Energy eff. Transportation system/ Energy eff. Equipment/ Peak energy demand Reduction/ Eff. External lighting/ Lighting zoning & control/ Centralized energy system/ Thermal performance of building envelope/ Natural ventilated design & A/c system/ Energy eff. Features/ Annual energy use in building/ Ventilation system in mechanically ventilated building/ Lighting system in mechanically ventilated building/ Energy eff. Lighting in public areas/ Energy eff. applications/ Energy mgmt./ A/c units.	●	●	●	●	●
c	Renewable energy/ Green power/ Energy improvement/ renewable energy system	●	○	●	●	●
3	**WATER EFFICIENCY**					
a	Water consumption/ Water monitoring/ Water meter/ Water usage monitoring/ Monitoring & Control	○	●	●	●	●
b	Water use reduction/ Water eff. Landscaping/ Water leak detection & prevention/ Water eff. Equipment/ Occupant amenity potable water efficiency/ Landscaping irrigation water eff./ Heat rejection water consumption/ Fire system water consumption/ Potable water use in lab/ Water eff. fitting/ Irrigation system & landscaping/ Water consumption of cooling tower/ Annual water use/ Water eff. Irrigation	●	●	●	●	●
c	Innovative waste water technologies/ Storm water mgmt./ Water recycling effluent discharge to foul sewers	●	○	○	●	●
4	**MATERIALS**					
a	Building reuse/ Reuse of Façade/ Reuse of structure/ Building Reuse	●	○	●	○	●
b	Storage & collection of recyclables/ construction water mgmt./ Resource reuse/ Recycled content/ Construction waste mgmt./ Recycled aggregates/ Recycled content of concrete/ Recycled content of steel/ Recycled content and Reused products & materials/ Sustainable timber flooring/ Loose furniture/ Deconstruction/ Rapidly renewable materials/ Life cycle impacts/	●	●	●	●	●

	Sustainable procurement/ Recycling waste storage/ Sustainable construction/ Sustainable Products/ Adaptability & Deconstruction/ Sustainable forest products/ Waste Recycling facilities/ Waste mgmt.					
c	Local or Regional Materials	●	○	○	○	○
5	**INDOOR ENVIRONMENTAL QUALITY/ HEALTH AND WELL BEING**					
a	Minimum IAQ performance/ Construction IAQ mgmt. plan / Air change effectiveness/ IAQ in wet areas/ Construction IAQ mgmt./ IAQ in car parking/ IAQ in public transport interchanges	●	●	●	●	●
b	Environment tobacco smokes (ETS) control/ CO2 monitoring/ Low-emitting material/ Indoor chemical & pollutant source control/ CO2 & VOC monitoring & control/ Hazardous materials/ Volatile Organic Compounds/ Formaldehyde minimization/ Mould prevention/ Indoor air pollutants/ Biological contaminations/ Integrated pest mgmt./ Indoor source of air pollution	●	○	●	●	●
c	Reduced heat island effect/ Thermal comfort/ Thermal Insulation/ Thermal performance of building envelope- RETV/ Thermal comfort in centrally A/c premises/ Thermal comfort in A/c or Naturally ventilated premises	●	●	●	●	●
d	Ventilation efficiency/ Ventilation rates/ Naturally ventilated design & A/c system/ Ventilation in A/c premises/ Localised ventilation/ Ventilation in common areas	●	○	●	●	●
e	Day lighting & views/ Visual comfort/ Day lighting/ Day light glare control/ High frequency ballasts/ Electric lighting levels/ External views/ Artificial lighting/ Natural lighting/ Interior lighting in normally occupied areas/ Interior lighting in not occupied areas	●	●	●	●	●
f	Safety and Security/ Fire Safety/ Security	○	●	○	○	●
g	Acoustic Performance/ Internal noise Level/ Noise Level/ Room Acoustics/ Noise Isolation/ Background Noise	○	●	●	●	●
6	**TRANSPORTATION**					
a	Alternative transportation/ Public transport accessibility/ Commuting mass transport/ Green transport/ Local transport/ Vehicular access	●	●	●	●	●
b	Alternative transportation/ Cyclist facilities/ Green transport	●	●	●	●	○
c	Alternative transportation/ Travel plan/ Fuel eff. Transport/ Green transport	●	●	●	●	○
d	Alternative transportation/ Maximum car parking capacity/ Car park minimization	●	●	●	○	○
e	Pedestrian route/ Green transport/ Local transport	○	○	●	●	●
f	Proximity to amenities/ Neighbourhood amenities/ Amenities features	○	●	○	○	●
7	**POLLUTION**					
a	Light pollution reduction/ Reduction of night K=Light pollution/ Light pollution	●	●	●	○	○
b	Ozone protection/ Ozone depletion potential/ Ozone depletion substances/ Impact of refrigerants/ Refrigerant GWP/ Refrigerant leak detection & recovery/ CFC reduction in HVAC & R equipment/ Reduction in CO2 emission/ Low & Zero carbon technology.	●	●	●	○	●
c	No emissions	○	●	○	○	○

NOTE :	
CONSIDERED	●
NOT CONSIDERED	○

CATEGORY	SCORE
Site Selection	20
Water Efficiency	20
Energy Efficiency	25
Material and Resources	25
Indoor Environment Quality	30
Transportation	5
Pollution Control	15
Innovation	10
Total	**150**
Elements marked 'C' not adhered to.	No Certification
Bronze	50
Silver	75
Gold	100
Platinum	125

Table No. 07



Graph No. 07

Table No. 08- UNIQUE RATING SYSTEM

	CATEGORY/REQUIREMENT	SCORE
1	SITE ASPECT	20
a	Site Selection	5
b	Soil Erosion Control	C
c	Retention of Ecology on site	4
d	Heat Island Effect	4
e	Building Regulations	C
f	Basic Amenities	2
g	Design User Friendly Building and its System	2
h	Facilities for construction work force	2
i	Green building guidelines for post occupancy	1
2	WATER EFFICIENCY	20
a	Water Saving	
	i. Water efficient fittings	C
	ii. Efficient landscaping	4
	iii. Efficient Irrigation system	4
b	Rainwater harvesting	C
c	Waste water treatment and reuse	8
d	Water metering	4

3	ENERGY EFFICIENCY	25
a	Energy Saving 3%,6%,9%,12%,15%,18%,21%,24%,27%≤30%	10
b	Use of renewable energy (10%,20%≤30%)	5
c	Solar Water heating system (25%≤50%)	4
d	Energy efficient appliances	4
e	CFC free equipment	C
f	Energy metering	2
4	MATERIAL AND RESOURCES	25
a	Building reuse	3
b	Construction waste management (50%or100%)	5
c	Reuse of salvaged material	5
d	Material with recycle content (10%, 20%)	4
e	Rapidly renewable building material and certified wood (50% or ≤75%)	5
f	Local Material Utility	3
5	INDOOR ENVIRONMENT QUALITY	30
a	Tobacco smoke control	C
b	Separation of House-Hold waste	C
c	Organic Waste Management (50%, 100%)	5
d	Minimum Day Lighting (50%)	5
e	Fresh air ventilation, Cross Ventilation (50%, 75%)	5
f	Exhaust system	3
g	Low VOC material, paints and adhesives	5
h	Building Cleanliness	2
i	Thermal Comfort	3
j	Acceptable outdoor and indoor noise levels	2
6	TRANSPORATION	5
a	Public transport Accessibility	C
b	Green transport, Cyclist facilities, Pedestrian Routes	3
c	Efficient car parking	2
7	POLLUTION CONTROL	15
a	Environmental Impact Assessment & Environmental Management Plan	5
b	Pollution control processes	5
c	Electronic waste control	5
8	INNOVATION	10
	Total	**150**

Note: 'C' in Table No. 08 indicates as Compulsory Requirement and hence the separate score is not to be considered. All 'C' criteria must necessarily be complied with.

The uniqueness of the system further lies in the following aspects

1) Recommendations for compulsory criteria.
2) Motivational aspects like refund of registration fees for innovation aspect and refund of assessment fee if all the green features as recommended are not only provided but maintained for a minimum 10 year period.

V. CONCLUSION

Green building is a building which is environment friendly as it is using certain principles during its design, construction and functioning phase which allow it to get maximum advantages from the environment and cause minimum damage. There are many factors which have to be considered while constructing a green building. It is very necessary to know how effective a particular project is in term of its environment friendliness. The unique system suggested would rate the building on various factors so as to give a fair idea of where it stands in being a green building.

Various rating systems are good enough to be used in certain part of the world but they are not ubiquitous. Also they are quite complex in nature and do not necessarily give a clear idea of the project's effectiveness. Each system has certain strong points and certain weak points. As from above comparative study of green rating system LEED, BREEAM, GREEN STAR, GREEN MARK and HK-BEAM are not specific on some assessment criteria thus a rating system which is simple and effective is suggested. This rating system is an integration of various system such as it carries the advantages of each system where as it overcomes the individual shortcomings.

Unique aspect as regards mandatory compliance and motivational aspect for innovation and maintenance of green features, as suggested would promote more green construction.

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