Critical Analysis of Different Building Rating Systems

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***Abstract*- Sustainable construction movement has been deeply transforming the traditional construction sector. An important part of the sustainable construction delivery system, being sustainable/green building rating systems. This plays an essential role in implementing the sustainable principles into the construction industry and assessing the building's rating. Most of the countries of the world have developed their own rating systems. All the rating systems are not the same as they all provide different weightages to the assessment tools different assessment tools are adopted according to their available resources and regional locations. Each rating system has its own method of calculating weightages. For evaluation of buildings in India the various rating systems can be used, but it may not give assessments, since the regional resources may be different. This Project aims to focus on the study of LEED, IGBC and GRIHA rating system, compare these three with regards to their assessment methods; scopes, performance criteria and energy rating scales are presented. Through this study, an attempt is made to make clear understanding of LEED, IGBC and GRIHA rating system assessment criteria that need to be considered during comparison. From this critical analysis it is possible to choose a rating is more applicable for India. In this study one case studies are chosen for analysis of rating system.**

Index Terms- Building Rating Systems, LEED, IGBC and GRIHA

I. INTRODUCTION

Members of the society live in a modern, consumerist and largely urban world consuming more energy and resources than it is possible to replenish .Historically, man's need for technological and economic advancement has resulted in environmental degradation. Today, increasing global population, urbanization, rising income level and resultant increase in consumption are adding a lot of pressure on precious natural resources. The concept of sustainable development was first defined by the United Nations in the 1987 Brundtland Commission Report as "developments that meet the needs of the present without compromising the ability of the future generations to meet their own needs". Sustainability and sustainable development focus on balancing the fine line between our competing needs, our need to move forward technologically and economically, and the need to protect the environment in which we live

A. The Concept of Green Buildings

Starting in the 1930s, new building technologies began to transform the urban landscape. The advent of air-conditioning, elevators, low wattage fluorescent lighting, structural steel and reflective glass made possible enclosed glass and steel structures that could be heated and cooled with massive HVAC systems due to the availability of cheap fossil fuels in the developed economies. Soon this design, known as International Style "Glass Box" became the design icon of most American cities, which was later emulated by cities around the world. It is broadly estimated that buildings worldwide consume about 40% of the planet's material resources and 30% of its energy. The construction of buildings is reported to consume 3 billion tons of raw materials per year and generates between 10 and 40 per cent of the solid waste streams in most countries. The manufacture of many of the materials used in buildings require the consumption of large amounts of energy derived from the fossil fuels and the displacement of mega-tones of earth during the course of mining4. The Indian Economy has grown at an average of 6.6% over the last 5 years, and is expected to grow at an average rate of 7.5% over the next 5 years. India is already facing an overall energy shortage of 9.8% and a peak shortage of 16.6%, making it imperative for developers and space occupiers to consider constructing and occupy "Green Buildings". In Figure 1.1 sustainability is used to describe technologically, materially, ecologically, and environmentally stable building design mainly from the economical point of view. On

the other hand green is viewed as an abstract concept that includes sustainability ecology and performance these are the pillars of green technology or sustainable concept Ecology in this case is concerned with the relation and balance of the building with the nature interaction among these three pillars is the sustainable concept or green technology

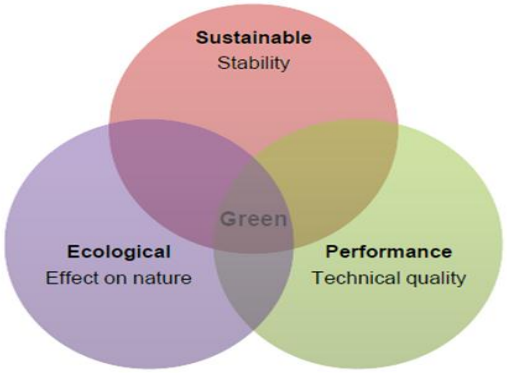

Figure 1.1 – Inter relationship between green, sustainability, ecology, and performance.

Different rating systems

Table 1.1 - Rating system source(s)

Sr. no	Sustainable Building Rating Systems	Development Basis
1	BREEAM (Building Research Establishment's Environmental Assessment Method)	Original
2	BREEAM Canada	BREEAM
3	BREEAM Green Leaf	BREEAM, Green Leaf™
4	Calabasas LEED	LEED®
5	CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)	Original
6	CEPAS (Comprehensive Environmental Performance Assessment Scheme)	LEED®, BREEAM, HK-BEAM, IBI
7	Earth Advantage Commercial Buildings (Oregon)	Undisclosed
8	EkoProfile (Norway)	Undisclosed
9	ESCALE	Undisclosed
10	GBTool	Original
11	GEM (Global Environmental Method) For Existing Buildings (Green Globes) – UK	Green Globes Canada
12	GOBAS (Green Olympic Building Assessment System)	CASBEE, LEED®
13	Green Building Rating System – Korea	BREEAM, LEED®, BEPAC
14	Green Globes Canada	BREEAM Green Leaf
15	Green Globes™ US	Green Globes Canada
16	Green Leaf Eco-Rating Program	Original
17	Green Star Australia	BREEAM, LEED®
18	HK BEAM (Hong Kong Building Environmental Assessment Method)	BREEAM
19	HQE (High Environmental Quality)	Undisclosed
20	iDP (Integrated Design Process)	Original
21	Labs21	Original
22	LEED (Leadership in Energy and Environmental Design)	Original
23	LEED Canada	LEED
24	LEED India (IGBC)	LEED
25	LEED Mexico	LEED
26	MSBG (The State of Minnesota Sustainable Building Guidelines)	LEED, Green Building Challenge'98, and BREEAM
27	NABERS (National Australian Built Environment Rating System)	Undisclosed
28	Promis E	Undisclosed
29	Protocol ITACA	GBTool
30	SBAT (Sustainable Buildings Assessment Tool)	Original
31	Scottsdale's Green Building Program	Undisclosed
32	SPiRiT (Sustainable Project Rating Tool)	LEED
33	TERI Green Rating for Integrated Habitat Assessment (GRIHA)	Original
34	TQ Building Assessment System (Total Quality Building Assessment System)	Original

II. REVIEW OF LITERATURE

General

There are many factors which have to be considered while constructing a green building. It is very necessary to know how effective an infrastructure project is in term of its environment friendliness. This brief comparison would check the building on various points so as to give an idea of where it stands being a green building. The rating systems are good enough to be used in certain part of the country but they are not unique in nature. Since these systems are based on different parameters, there is a possibility of these rating systems rate the same buildings differently. Also they are quite complex in nature and do not necessarily give a clear idea of the projects effectiveness. Each system has certain strong points and certain weak points and they are not specific on some assessment criteria. Due to this these systems are currently confusing the Indian developers, builders over the certification of their projects and buildings.

III. MATERIALS & METHODS

CASE STUDY 1: BUILDING RATING FOR LOW-RISE HOME.

Project Details:

Name of Project: Low-rise Multifamily home.

Location: Lat: 12* 57’ 36.61” N; long: 77*30’ 35.63”E, Nagarbhavi, Bengaluru, (fig.3.1)

Project Type: Low-rise

Building stage: Planning and design

Property area: 222.93m2.

Project area: 111.41m2.

G+3 building with multifamily 5 houses

Owner requirement: Concerned about economical aspect and also concerned towards environment so rating is carried and also owner requires tenant occupied building for income.

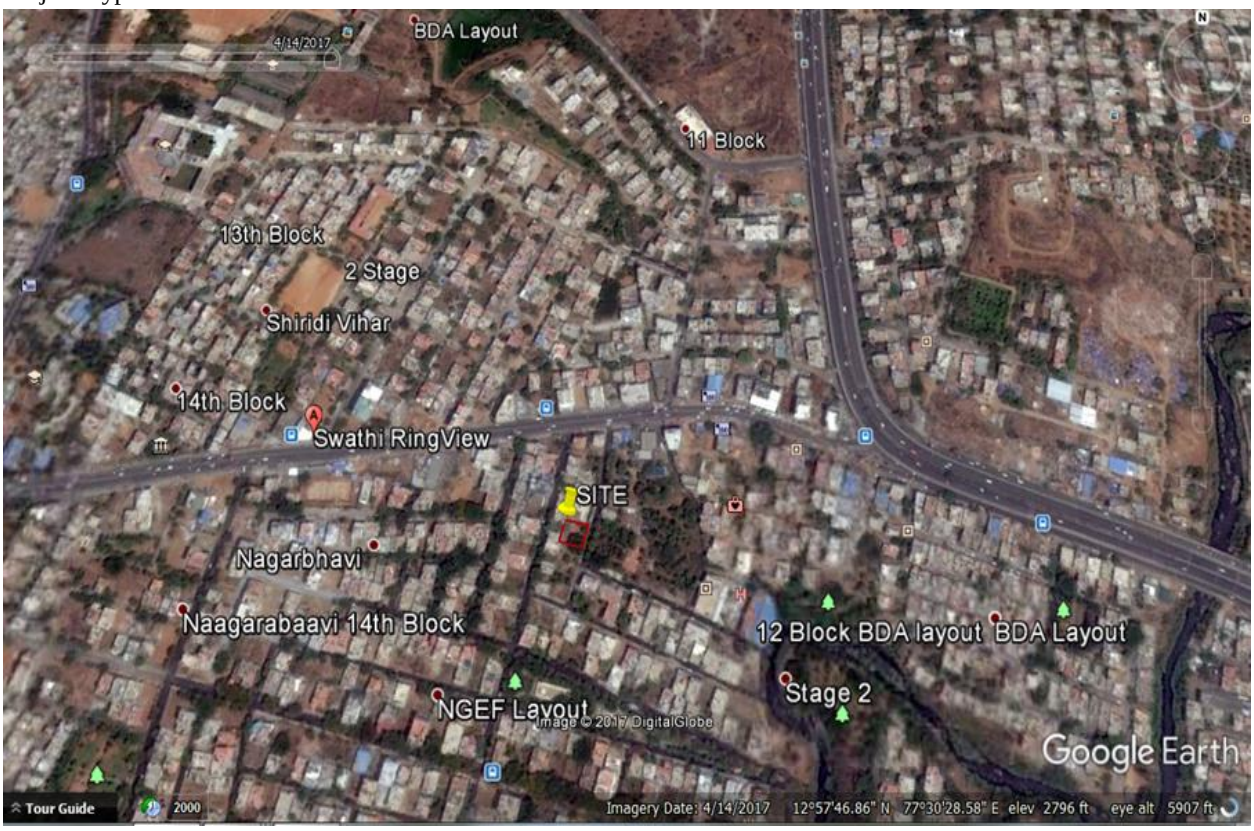

Fig 3.1Site location on Google earth

Salient features of the building

a) LOCATION

Nagarbhavi is a residential area of Bangalore, Karnataka, India. Located in West Bangalore, Nagarbhavi is located between Mysore road and Magadi road. It is surrounded by Vijaynagar on the north, Bangalore University and Chandra Layout on the east, Magadi road on the west and Sir.M.V.Layout on the south. Nagarbhavi is broadly divided into two areas, called Nagarbhavi 1st stage and Nagarbhavi 2nd stage.

b) CLIMATE

Bangalore has a tropical savanna climate with distinct wet and dry seasons. Due to its high elevation, Bangalore usually enjoys a more moderate climate throughout the year, although occasional heat waves can make summer somewhat uncomfortable. The coolest month is January with an average low temperature of 15.1 °C and the hottest month is April with an average high temperature of 35 °C .The highest temperature ever recorded in Bangalore is 39.2 °C (recorded on 24 April 2016). Bangalore receives rainfall from both the northeast and the southwest monsoons and the wettest months are September, October and August, in that order.

2) Building proposed plan:

The building is planned for G+3 with 5 dwelling units each plan is showed in below fig 3.2, fig 3.3, fig 3.4, and fig 3.5.

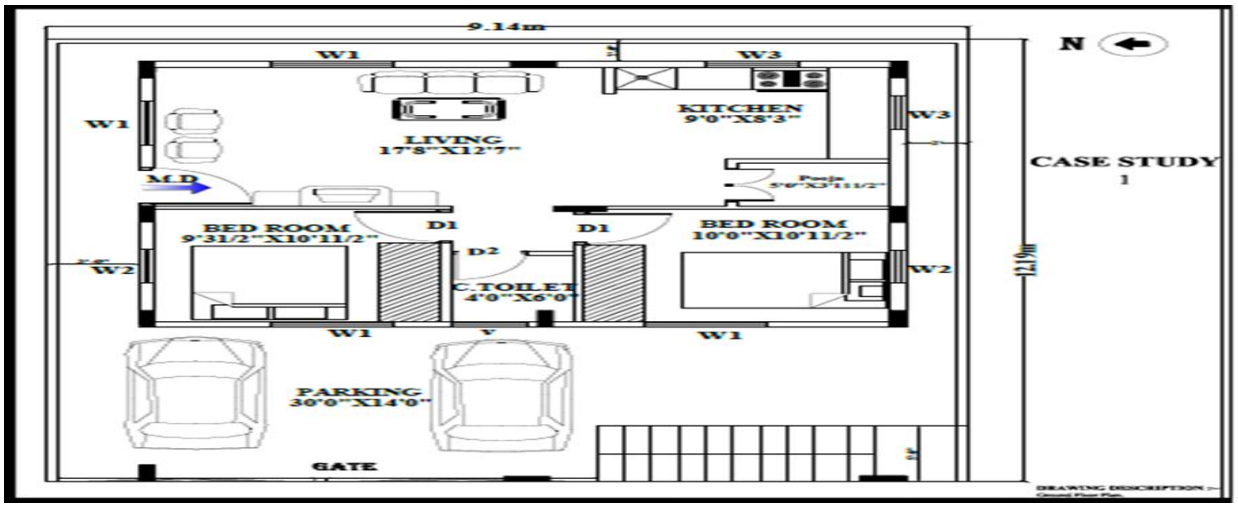

Fig 3.2 - Ground Floor plan

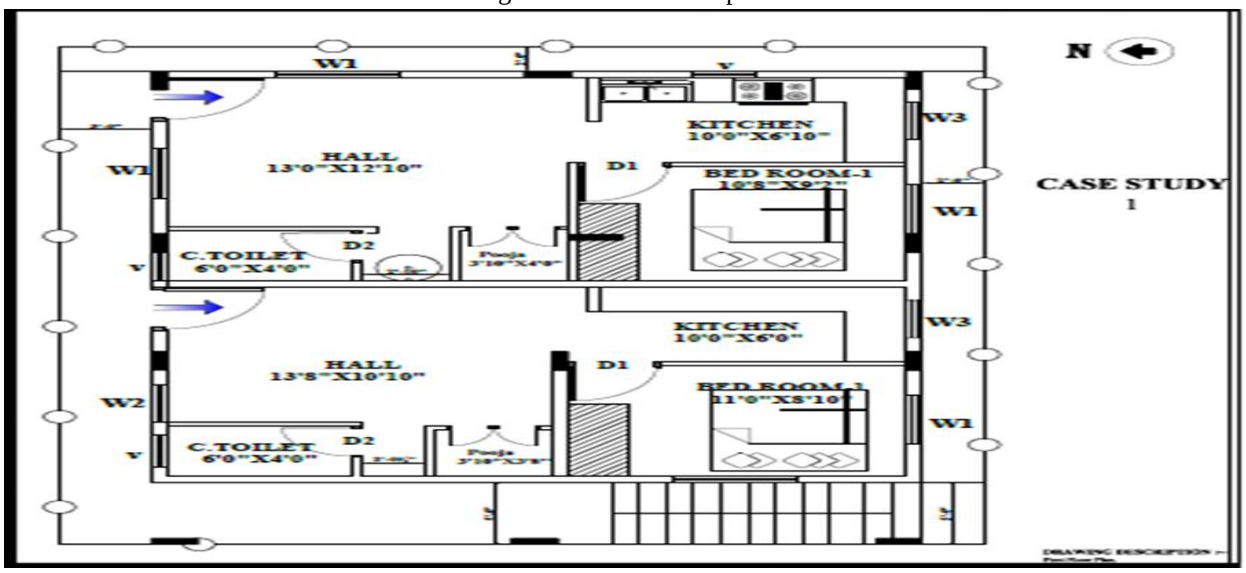

Fig 3.3 1st Floor plan

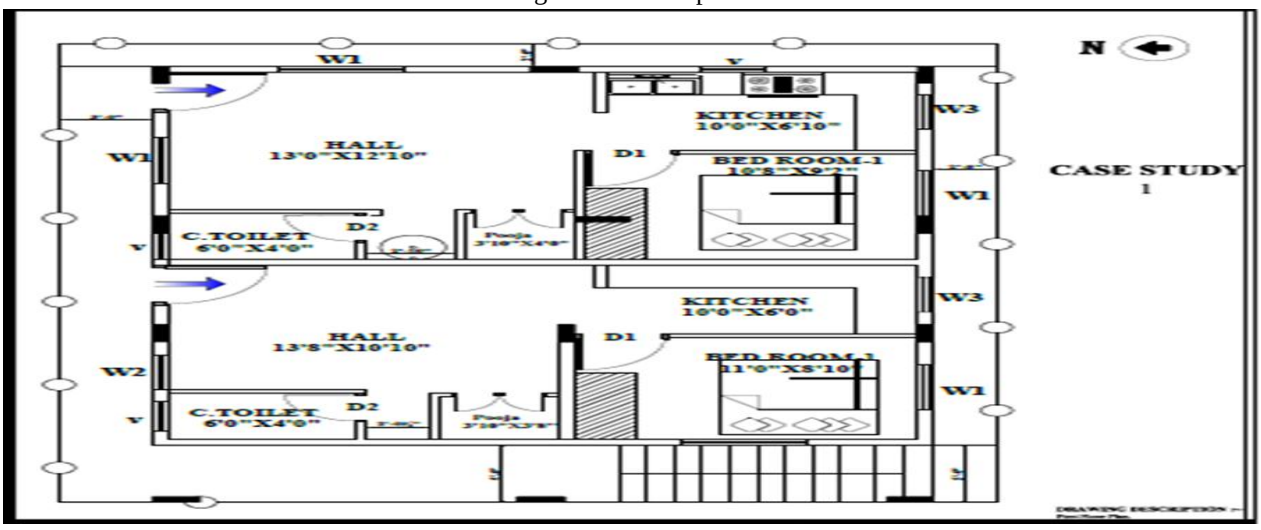

Fig 3.4 2nd floor plan

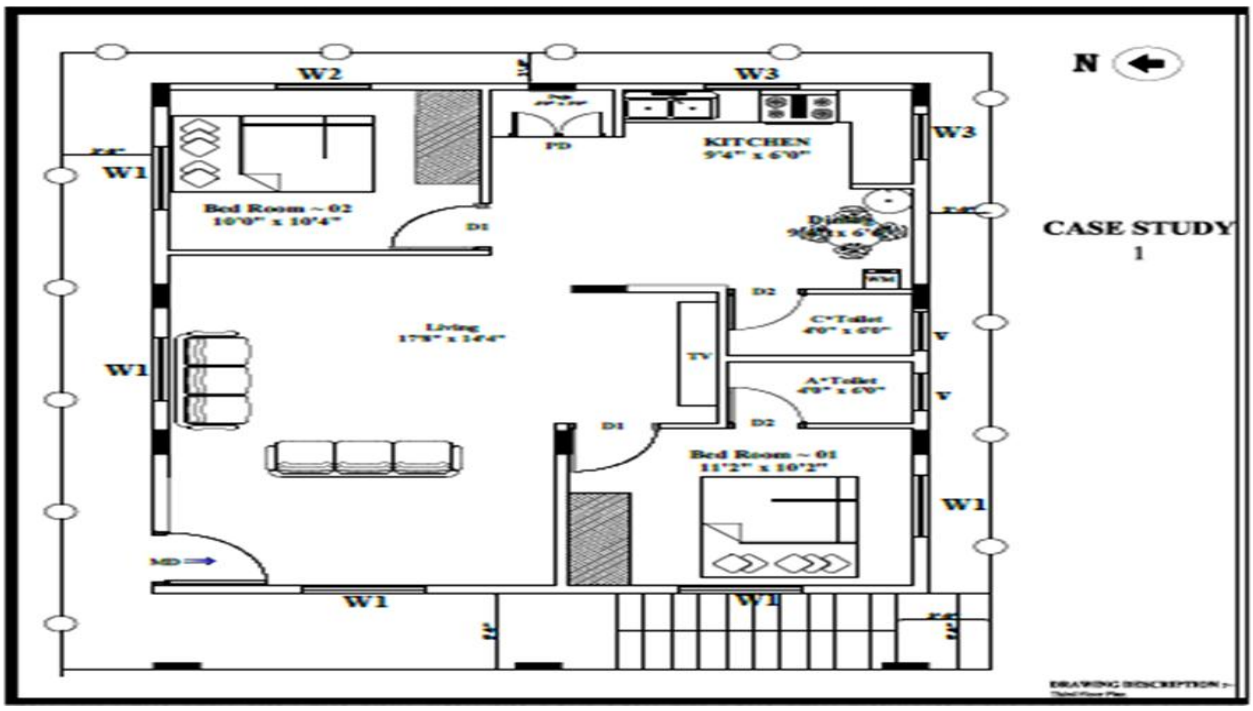

Fig 3.5 3rd Floor plan

B. LEED rating: Home Low-rise

C.The various aspects as per checklist are to be evaluated

SR.NO	ACHIEVED			MAXIMUM
1	2	Credit	Integrative Process	2
2	14.5	**Location and Transportation (LT)**		15
	MANDATORY	Prereq	Floodplain Avoidance	Required
	8	Credit	Site Selection	8
	3	Credit	Compact Development	3
	2	Credit	Community Resources	2
	1.5	Credit	Access to Transit	2
3	6	**Sustainable Sites**		7
	MANDATORY	Prereq	Construction Activity Pollution Prevention	Required
	MANDATORY	Prereq	No Invasive Plants	Required
	2	Credit	Heat Island Reduction	2
	2	Credit	Rainwater Management	3
	2	Credit	Non-Toxic Pest Control	2
4	10	**Water Efficiency**		12
	MANDATORY	Prereq	Water Metering	Required
			PERFORMANCE PATH	
	0	credit	Total water use	12
			PRESCRIPTIVE PATH	
	6	Credit	Indoor Water Use	6
	4	Credit	Outdoor Water Use	4

5	11	**Energy and Atmosphere**		38
	MANDATORY	Prereq	Minimum Energy Performance	Required
	MANDATORY	Prereq	Energy Metering	Required
	MANDATORY	Prereq	Home Size	Required
	MANDATORY	Prereq	Education of the Homeowner, Tenant or Building Manager	Required
	0	Credit	Efficient Hot Water Distribution System	5
	0	Credit	Advanced Utility Tracking	2
	1	Credit	Active Solar Ready Design	1
	0	Credit	HVAC Start-Up Credentialing	2
	0	Credit	Building Orientation for Passive Solar	3
	0	Credit	Air Infiltration	2
	0	Credit	Envelope Insulation	2
	1	Credit	Windows	3
	0	Credit	Space Heating & Cooling Equipment	4
	0	Credit	Heating & Cooling Distribution Systems	3
	2	Credit	Efficient Domestic Hot Water Equipment	3
	1	Credit	Lighting	2
	2	Credit	High Efficiency Appliances	2
	4	Credit	Renewable Energy	4
6	5	**Materials and Resources**		10
	MANDATORY	Prereq	Certified Tropical Wood	Required
	MANDATORY	Prereq	Durability Management	Required
	1	Credit	Durability Management Verification	1
	4	Credit	Environmentally Preferable Products	4
	0	Credit	Construction Waste Management	3
	0	Credit	Material Efficient Framing	2
7	9.5	**Indoor Environmental Quality**		16
	MANDATORY	Prereq	Ventilation	Required
	MANDATORY	Prereq	Combustion Venting	Required
	MANDATORY	Prereq	Garage Pollutant Protection	Required
	MANDATORY	Prereq	Radon-Resistant Construction	Required
	MANDATORY	Prereq	Air Filtering	Required
	MANDATORY	Prereq	Environmental Tobacco Smoke	Required
	MANDATORY	Prereq	Compartmentalization	Required
	1	Credit	Enhanced Ventilation	3
	2	Credit	Contaminant Control	2
	0	Credit	Balancing of Heating and Cooling Distribution Systems	3
	0	Credit	Enhanced Compartmentalization	1
	2	Credit	Enhanced Combustion Venting	2
	2	Credit	Enhanced Garage Pollutant Protection	2
	2.5	Credit	Low Emitting Products	3
8	2	**Innovation**		6
	MANDATORY	Prereq	Preliminary Rating	Required
	1	Credit	Innovation	5
	1	Credit	LEED AP Homes	1
9	4	**Regional Priority**		4
	1	Credit	Regional Priority: Specific Credit	1
	1	Credit	Regional Priority: Specific Credit	1
	1	Credit	Regional Priority: Specific Credit	1
	1	Credit	Regional Priority: Specific Credit	1
	64	**TOTALS**	Possible Points:	**110**
	Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110			

D. Credit detail for each category

INTEGRATIVE PROCESS

Intent: To maximize opportunities for cost-effective adoption of integrative green design and construction strategies.

Appraisal: Integrative Project Team (1 point) Assemble and involve a project team to meet the three criteria below:

a) Include team members, in addition to the builder and verification team, whose capabilities include at least three of the following skill sets: Architecture or residential building design; Mechanical or energy engineering; Building science or performance testing; Green building or sustainable design; and Civil engineering, landscape architecture, habitat restoration, or land-use planning.

b) Involve all team members referenced above in at least three of the following phases of the home design and construction process: Conceptual or schematic design; LEED planning; Preliminary design; Energy and envelope systems analysis or design; Design development; Final design, working drawings or specifications; and Construction.

c) Conduct meetings with the project team at least monthly to review project status, introduce new team members to project goals, discuss problems, formulate solutions, review responsibilities, and identify next steps.

Design Charrette (1 point)

No later than the design development phase and preferably during schematic design, conduct at least one full-day workshop (or two half-day workshops) with the project team, as defined in Option 1. Use the workshop to integrate green strategies across all aspects of the building design, drawing on the expertise of all participants.

Compliance: Both options are possible to follow.

a) CERTIFIED TROPICAL WOOD

Intent: To encourage environmentally responsible forest management.

Appraisal: All wood in the building must be non tropical, reused or reclaimed, or certified by the Forest Sustainability Council, or USGBC-approved equivalent.

Compliance: FSC certified wood is used.

DURABILITY MANAGEMENT

Intent: To promote durability and performance of the building enclosure and its components and systems through appropriate design, materials selection, and construction practices.

Appraisal: Meet the requirements of the ENERGY STAR for Homes, version 3, water management system builder checklist (with the exceptions for existing homes listed in EA Prerequisite ENERGY STAR for Homes Performance). Midrise projects are exempt from this requirement.

Compliance: The ENERGY STAR for Homes can be used.

DURABILITY MANAGEMENT VERIFICATION

Intent: To promote enhanced durability and high performance of the building enclosure and its components and systems through appropriate design, materials selection, and construction practices.

Compliance: Highly durable materials can be used.

ENVIRONMENTALLY PREFERABLE PRODUCTS

Intent: To increase demand for products or building components that minimize material consumption through recycled and recyclable content, reclamation, or overall reduced life-cycle impacts.

Appraisal: Use building component materials that meet one or more of the criteria below. A material must make up 90% of the component by weight or volume, except as noted. A single component that meets Option 1 and Option 2 can earn points for each point per item). Local Production Use products that were extracted, processed, and manufactured locally for the following components. Meet the thresholds in Table 1: framing (0.5 point); aggregate for concrete and foundation (0.5 point); drywall or interior sheathing (0.5 point). Environmentally Preferable Products

Compliance: To minimize the material consumption the above methods can be easily followed

CONSTRUCTION WASTE MANAGEMENT

Intent: To reduce construction waste generation and to reuse and recycle debris.

Requirements Reduce total construction waste or divert from landfills and incinerators a large proportion of the waste generated from new construction.

Compliance: Waste generation can be reduced by using recycling methods.

MATERIAL-EFFICIENT FRAMING
Intent: To conserve resources by reducing the use of unnecessary framing materials.
Appraisal: Implement any of the following advanced framing techniques for at least 90% of each component. Implement one of the following optimum value engineering measures in exterior walls and common walls (1 point):
Compliance: Modular, panelized, or other prefabricated wall or structural systems must comply with the requirements.

INDOOR ENVIRONMENTAL QUALITY (EQ)
VENTILATION
Intent :To reduce moisture problems and occupants' exposure to indoor pollutants from kitchens, bathrooms and other sources by exhausting pollutants to outside and ventilating with outdoor air.
Appraisal: Naturally ventilated spaces must comply with ASHRAE Standard 62.1–2010
Compliance: Can follow the standards

COMBUSTION VENTING
Intent: To limit the leakage of combustion gases into the occupied space of the home.
Compliance: Modular, panelized, or other prefabricated wall or structural systems must comply with the requirements.
INDOOR ENVIRONMENTAL QUALITY (EQ)
VENTILATION
Intent :To reduce moisture problems and occupants' exposure to indoor pollutants from kitchens, bathrooms and other sources by exhausting pollutants to outside and ventilating with outdoor air.
Appraisal: Naturally ventilated spaces must comply with ASHRAE Standard 62.1–2010
Compliance: Can follow the standards

COMBUSTION VENTING
Intent: To limit the leakage of combustion gases into the occupied space of the home.
Appraisal: Place all air-handling equipment and ductwork outside the fire-rated envelope of the garage. Tightly seal shared surfaces between the garage and conditioned spaces, including all of the following: In conditioned spaces above the garage, seal all penetrations and all connecting floor and ceiling joist bays. In conditioned spaces next to the garage, weather-strip all doors, install carbon monoxide detectors in rooms that share a door with the garage, seal all penetrations, and seal all cracks.

IV. RESULT & DISCUSION

All the rating systems have been developed on the basis of their regional factors including available resources, materials and regional trends, hence one rating system which has been developed for a specific region shall not be used for any other region or else it shall produce wrong results. Currently there is IGBC and GRIHA rating system in use which has been developed for these areas hence there is an advantage of the rating system which must be based on the regional current situation and factors. It must also be considered that renewable energy resources, water and recyclable material must also be given more concern for the development of such rating system. Compared to the three rating system IGBC is a good option.

V. CONCLUSION

Rating system is very important to identify the green features of the building and also in guiding the building to be sustainable, as there are many rating systems available all over the world but which rating system is preferable for India is taken in study, compared to LEED IGBC and GRIHA in all aspects IGBC has a upper hand among all and is more focused on India when compared to LEED

A. Comparative analysis

Sr. no	Type of building	Rating system points		
		GRIHA	IGBC	LEED
1	CASE STUDY-1 New Building	(31/50) ★★	(54/75) gold	(64/110) Gold

VII. ACKNOWLEDGEMENT

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