"Valuation of Buildings With Greenness Perspective"

Manish **Sakhlecha and** Samir **Bajpai, India**

Key words: Green building materials, LEED, LCC, Greenness assessment model

SUMMARY

India has progressed since independence (15th August 1947), through two important revolutions viz: Green Revolution and White Revolution. The green revolution was meant to grow more food so that everyone would have stomach full food. The white revolution was implemented from 1980 to increase growth of milk and its products so that everyone may get healthy food. Green building materials consumes less energy associated with the excavation, extraction, transport, processing of virgin materials. Therefore "a green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building." Major benefits of Green Buildings include:

- Energy savings to the tune of 40-50 %
- Water savings to the tune of 20-30%
- Intangible benefits which includes: enhanced ventilation, better views and day lighting which significantly improves the productivity of the occupants
- Green corporate image and commitment of environmental protection

A number of green building professional articles and studies emphasize the importance of greenness cost analysis to explain the cost benefits, however, there is little evidence whether it is actually being performed, and to what degree the studies undertaken are influencing project stakeholders.

The objectives of this research paper are:

i) To explore existing greenness criteria and modify them for determination of market value of different buildings.

ii) To identify green building materials and products to conserve natural resources, besides being cost effective, energy efficient etc.

iii) To promote green building practice in the country**.**

The authors have developed a mathematical model on the basis of LEED Ratings laid down by USGBC to determine market value of buildings without ignoring its greenness aspects. In present practice the valuers' do not include greenness factors in their valuation reports meant for Investment, Bank finance or Capital gains purposes etc. The model will be of great help to architects and valuers to account for greenness aspects while determining the market values of buildings.

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1.0 INTRODUCTION

Nomenclature

LEED Leadership in Energy and Environmental Design
GBP - Green Building Policy
USGBC - US Green Building Council
IGBC - Indian Green Building Council
LCC - Life Cycle Costing
PLA - Plinth Area Rate Assessment
HVAC-Heat Ventilation Analysis Code
Environment Influencing Factors: SS- sustainable site, W.E. – water efficiency, E&A- Environment & Atmosphere, M.R.- Materials Resources, I.E.Q. – Indoor Energy Quality, I & D – Innovation and Development, 1/3rd life- 1/3rd life Appreciation, CO_2 - CO_2 Emission and Mkta- Market Appreciation for greenness, I.F.- Impact factor of greenness

The United States Green Building Council (USGBC) was founded in 1993 for the main purpose of driving the change of sustainability in the construction of buildings. Anything that is eco friendly or compatible with the natural environment is termed as green. Green building is one, which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier space for occupants. In 2000, LEED was launched by USGBC to assess credit points of sustainable green building and development practices. Basically LEED is a certification program that has become nationally accepted as a way to prove a building is green. LEED based-rating system comprises 69 points distributed among six categories in the any building Construction program shown in Table (1)

Table (1)-Greenness credit points Tally

Category	Prerequisites	Credits	Sub-credits	Points Available
SS	1	8	6	14
W.E.	0	3	2	5
E & A	3	6	2	17
M.R.	1	7	6	13
I. E.Q.	2	8	7	15
I & D	0	2	3	5
Total	7	34	26	69

1.1 Green Building Movement in India

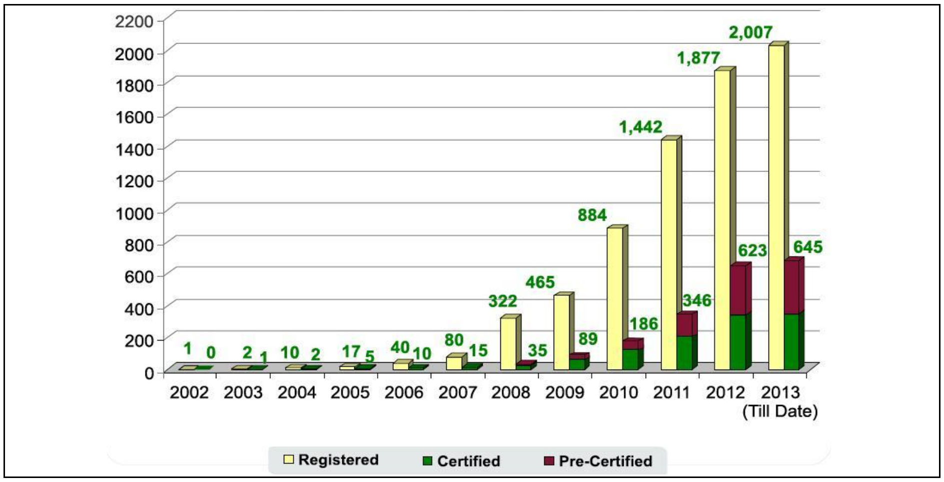


Fig.(1)-Growth of green buildings in India since 2001

Green Building movement in India was triggered off when CII-Sohrabji Godrej Green Business Centre building in Hyderabad was awarded with the first and the prestigious Platinum rated green building rating in India. Since then, Green Building movement in India has gained tremendous impetus over the years. After a modest beginning of green built-up area on 20,000 sq.ft., in the year 2003, now more than 2,000 Green Buildings projects have been registered with a footprint of over 1.40 Billion sq.ft. Out of which 362 Green Building projects are certified and fully functional with Indian Green Building Council (IGBC). This growth has been possible with the participation of all stakeholders in the green building movement Fig.(1). Today all types of buildings are going along Green way codes, e.g. Government buildings, IT Parks, Offices, Residential, Banks, Airports, Convention Centre, Institutions, Hospitals, Hotels, Factories, SEZs, Townships, Schools, etc. Fig.(2). CII - Sohrabji Godrej Green Business Centre is one of the 10 centers of Excellences. It offers advisory services to the industry in the areas of green buildings, energy efficiency, water management, environmental management, renewable energy, green business incubation and climate change activities. The Centre sensitizes key stakeholders to embrace Green practices and facilitates market transformation, paving way for India to become one of the global leaders in Green businesses by 2015. The Centre is housed in a Green Building which received the prestigious LEED (Leadership in Energy and Environmental Design) Platinum Rating in 2003. This was the first Platinum rated Green Building outside of U.S.A and the third in the world. The Centre was inaugurated by Dr A P J Abdul Kalam, the Ex-President of India, on July 14, 2004.

1.2 Green Building Rating Systems by IGBC

Green building rating brings together a host of sustainable practices and solutions to reduce the environmental impacts. Green building design provides an integrated approach considering life cycle impacts of the resources used. An important development in the growth of green building movement is the launch of the following Green Building Rating System:

- IGBC Green Homes
- IGBC Green Townships
- IGBC Green SEZs
- IGBC Green Factory Buildings
- IGBC Green Existing Buildings
- IGBC Green Landscapes
- LEED 2011 for India New Construction
- LEED 2011 for India Core & Shell

All these rating systems are voluntary, consensus based, market-driven building programs. The rating systems are based on the five elements of the nature (Panchabhutas) and are a perfect blend of ancient architectural practices and modern technological innovations. These ratings systems are applicable to all five climatic zones of the country. IGBC rating programs have become "National by Choice and Global in Performance".

2.0 ENVIRONMENTAL BENEFITS OF GREEN BUILDINGS -

One of the biggest reasons why green buildings are now widely accepted by the cross section of the society is the fact that green buildings make good business sense and they are financially very attractive[2].

Environmental Benefit Category	Average Benefits/Million Sq.ft
CO_2 reduction	12,000 Tons
Energy savings	15,000 MWh
Water savings	45,000 KL
Construction waste diverted from landfills	450 Tons

Fig.(2)- Different sectors of growth of green buildings in India

2.1 Building Materials

The construction costs of a green building would be 5-8 % higher for a Platinum building than a conventional building, the incremental cost gets paid back within 3–4 years with substantial reduction in operational costs.

Indian market transformation in the building material sector over the years:

Material	Cost (in INR) @ 2003	Cost (in INR) @ 2011
Waterless Urinals	15,000 per unit	6,000 per unit
CO_2 sensors	50,000 per unit	20,000 per unit
Certified Wood	2,500 per cu.ft.	1,600 per cu.ft.
High Performance Glass	500 per sq.ft.	350 per sq.ft.
High Albedo Materials	90 per sq.ft.	60 per sq.ft.

2.2 Green Buildings Cost Function

The following table illustrates the declining initial incremental cost over years.

Building	**Year**	**Built-in**	**Rating**	**%**	**Payback**

	Awarded	Area(Sqft)	Achieved	increase in cost	(Yrs)
CII-Godrej GBC, Hyderabad	2003	20,000	Platinum	18%	7 years
ITC Green Centre, Gurgaon	2004	1,70,000	Platinum	15%	6 years
Wipro, Gurgaon	2005	1,75,000	Platinum	8%	5 years
Technopolis, Kolkata	2006	7,20,000	Gold	6%	2 years
Spectral Services Consultants Office, Noida	2007	15,000	Platinum	8%	4 years
HITAM, Hyderabad	2007	78,000	Silver	2%	3 years
Kalpataru Square, Mumbai	2008	3,27,000	Platinum	2%	2 years
Suzlon Energy, Pune	2010	8,20,000	Platinum	< 2%	2 years
Kohinoor Hospital, Mumbai	2010	2,30,000	Platinum	< 2%	2 years

2.3 **Performance Monitoring of IGBC Rated Green Buildings -**

To ascertain the performance and sustenance of green buildings, IGBC is in the process of monitoring the overall performance of certified green buildings. Over 40 certified buildings have reported their performance. The following are the benefits achieved from the Commercial Buildings:

Type of Building	Average Energy Savings over Conventional Buildings (%)	Average Water Savings over Conventional Buildings (%)
Corporate Offices	47%	60%
Tech Parks	27%	50%
Hotels	35%	45%
Hospitals	33%	35%
Educational Institutions	39%	40%

Note: The above information is based on the data collected from the 40 IGBC Rated Green Buildings till May, 2013.

3.0 LIFE CYCLE ANALYSIS (LCA) **-**

It is a fundamental process of the greater field in building economics called value engineering. LCA is defined as an economic evaluation process that can assist in deciding between alternative building investments by comparing all of the significant differential costs of ownership over a given time period of life cycle of building in existence Fig.(3).

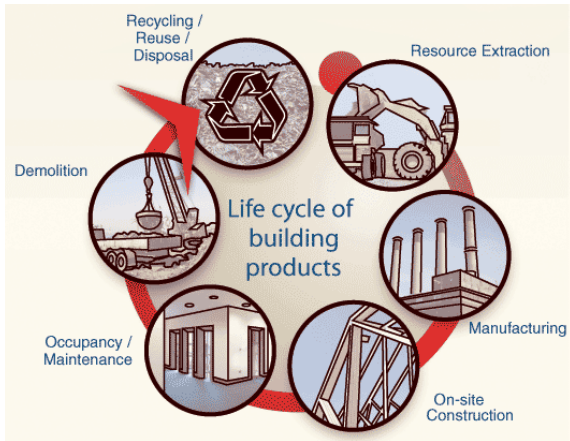


Fig.(3)- Life Cycle of building products

The importance of life cycle analysis in building construction stems from the actual distribution of costs incurred over the life of a project. Buildings are typically long term investments of significant magnitude, and valuation models must account for all costs and benefits throughout the length of ownership. Initial capital cost of a typical building apartment accounts for only 2-10% of costs incurred over the life of the structure, while the remaining 90-98% of costs are realized in operation, maintenance, financing, and staffing.

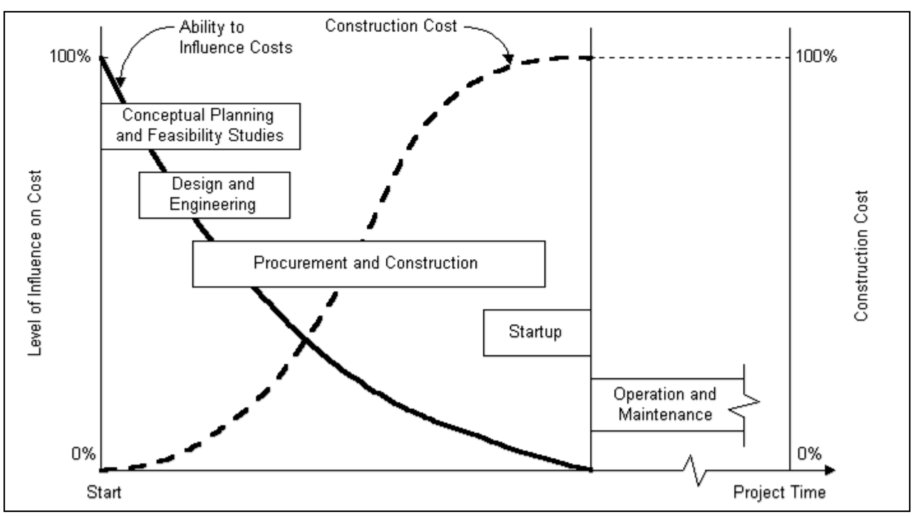


Fig.(4)- Ability to Influence Construction Cost Over Time

The owner holds the key to influence the construction costs of a project because any decision made at the beginning stage of a project life cycle has far greater influence than those made at later stages, as shown schematically in Fig.(4). Moreover, the design and construction decisions will influence the continuing operating costs and, in many cases, the revenues over the facility lifetime. Therefore, an owner should obtain the expertise of professionals to provide adequate planning and feasibility studies.

3.1 LCA– Applied to Plinth Area Rate of Construction -

The materials consumption (per sq.m. plinth area: cement, steel, sand, metal etc.) of a building (no-green) in case of a R.C.C framed structure with ground plus first floor is given in Table (3).

Table (3)- Materials consumption per sq.m.

No.	Material Consumption	Per M^2
1	Steel for reinforcement	4.0 to 5.0 kg.
2	Cement	190 to 210 kg
3	Bricks	100 to 115 Nos.
4	20 mm hard metal	0.25 to 0.30 m^3
5	40 mm hard metal	0.075 to 0.09 m^3
6	Glazed tiles	25 Nos.
7	Sand	0.28 to 0.35 m^3
8	Filling Material	0.30 to 0.35 m^3

Further for miscellaneous items add 20% cost of materials cost and labour is considered as 30 % of total material cost. All above materials can be reused as green building materials after their life cycle (80 years) is completed.

Although green building is increasing in popularity, it is not a standard practice in the construction industry. A number of apparent barriers preventing widespread adoption of green building including legislative/code issues, lack of education and/or training of materials and methods, lack of awareness of building owners to sustainable practice, additional capital costs to build green, and failure to calculate and account for long-term cost benefits associated with sustainable procurement.

A number of technical articles and studies emphasize the importance of life cycle cost analysis to explain the cost benefits of green building. However, there is little evidence whether LCA is actually being performed, and to what degree the studies undertaken are influencing project stakeholders. Additionally, there are a variety of LCA software alternatives, but little documentation is readily available regarding the use of the tools or their reliability. This paper aimed to promote green building practice in the country**.**

4.0 GREENNESS MEASURING SCALE-

The authors made greenness measuring scale on the basis of LEED 69-points criteria by extending the number of credit points to 100 as shown in Table (4).

Total greenness points are 100 and I.F. (Impact Factors) = 9

The survey team during site inspection should assess points scored by a building and enter in Table (4). On basis of above measuring scale the buildings are then classified as (i) 0 to 5 -No green (ii) 6 to 25 points – weak green, (iii) 26 to 45 points -fairly green, (iv) 46 to 70 points -good green and (v) above 71 points-excellent green

Table (4) – greenness measuring scale & Impact Factor

No.	Particulars	Credit Points	I.F.	No.	Particulars	Credit Points	I.F.
1	SS	14	1	5	I.E.Q.	15	1
2	W.E.	5	1	6	I. & D.	5	1
3	E & A	17	1	7	1/3rd life	12	1
4	M.R.	13	1	8	CO_2	13	1
				9	Mkta	6	1
					Sum credit	100	9

4.1 Determination of Greenness Impact Factor (G.I.F.)-

The impact factor to be applied with no green building plinth area rate for greenness aspect is determined by formula given below:

$$\text{G.I.F} = 1 + \frac{\text{mean of greenness ratig points x No.of classified greenness}}{\text{total greenness points x total Number of influencing factor}}$$

For example – If it is weak green building as per LEED rating, then

$$\text{G.I.F} = 1 + \frac{15 \text{ x } 5}{100 \text{ x } 9} = 1.070$$

The greenness multiplying Impact factor from above formula for all types of classified green buildings are given in Table (5).

No.	Type of Greenness	Greenness rating points	G.I.F. multiplier for PLA
1	No green	<6	1
2	Week green	>6 and <26	1.07
3	Fair green	>25 and <46	1.20
4	Good green	>45 and <71	1.32
5	Excellent green	>71	1.48

4.1 Site Survey Questionnaire-

The survey team collects data in following format to prepare an Excel Program sheet to analyze market value of the building. The pro-forma given in Appendix - I is completed at the time of site inspection. Suitable consideration is given to existing details to allocate greenness points in each sub-heads. Old sites and buildings on verge of demolition fetch good scores for there is good scope of reuse of materials. Those sites show good water efficiency, amenities and Environmental Atmosphere. Thus old and ruined buildings sites are better resource for new green building construction.

5.0 MATHEMATICAL MODEL FOR PLINTH AREA-

Compute plinth area rate for building with no-greenness aspect from per m^2 quantity given in Table (3). The model is developed in following steps:
a) The plinth area rate is determined by applying current market rates in table (5).
b) The salvage value of the building at the end of life span (80 years in case of

Normal Building Construction -R.C.C. Framed Structure				
No.	Building works	Materials	Rate	Amount
1	Cement in Kg	200	6.00	1200
2	Bricks in Nos	100	4.00	400
3	Steel in Kg	4.50	50	225
4	20 mm metal in M^3	0.30	900.00	270
5	40 mm metal in M^3	0.08	800.00	64
6	Glazed tiles (Nos)	25.00	30.00	750
7	Sand in M^3	0.30	550.00	165

R.C.C. framed structure) is 10% of its construction cost as per conventional practice. Therefore for no green building the plinth area rate is Rs. 680 per sq. m. But in case of greenness assessed by proposed measuring scale the residual value must be higher.

(c) When the building is demolished, parts of building materials can be reclaimed. The reclaimable rates of various types of materials are found by investigation[3]. The reclaimable rates of several building materials are defined respectively as 90% (metal), 50% (brick), 20% (wood), and 10% (cement). The rate of all other materials is defined as 0%. All the un-reclaimed materials become the solid waste after demolishment.

Table (5)- Plinth Area Rate computation

	Total Material Cost			3074
8	Misc. items 20% of above			615
9	Sanitary & Electricals 50% of Material			1537
	Total		Rs.	5226
10	Labour	30%		1568
	Plinth Area Rate			6793.54
	Plinth Area rate (say)		Rs./Sq.m	6800

Since the demolished waste of the building is reusable as coarse aggregate, filling material etc. and the steel separated from slab, beams and columns can be reused in compression members of new R.C.C. constructions, the plinth area rate computed above must be modified with appropriate factors of greenness.

5.1 **Greenness Valuation Model for plinth area rates-**

Plinth area rate for no green building worked out above is subject to changes for its life span given in Table (6).

Table (6)- Modified Plinth Area Rates for Investment/Market value

No.	Particulars	Life span	Plinth Area Rate
1	Initial investment: PLA- for No-green building (Rs. Per m^2)	0 year	6800
2	Market Value: PLA increase @ 2% per year	First year	6936
4	Market value for 1/3rd life span = (1.02)^25	25years	11156
5	Salvage Value (10% of Rs.6800)	80 years	680

Plinth Area rates of different types of green buildings classified earlier are represented in Table (7) by applying the appropriate greenness impact factors: No green =1, Weak green = 1.07, Fair green = 1.02, Good green = 1.32 and Excellent green = 1.48.

Table (7)- Modified Plinth with impact factors

Greenness	No-green	Weak green	Fair green	Good green	Excellent
0	6800	6895.2	7065.20	7235.2	7446
1	6936	7033.1	7206.504	7379.9	7594.9
25	11156.1	11312.3	11591.21	11870.1	12216
80	680	689.52	706.52	723.52	744.6

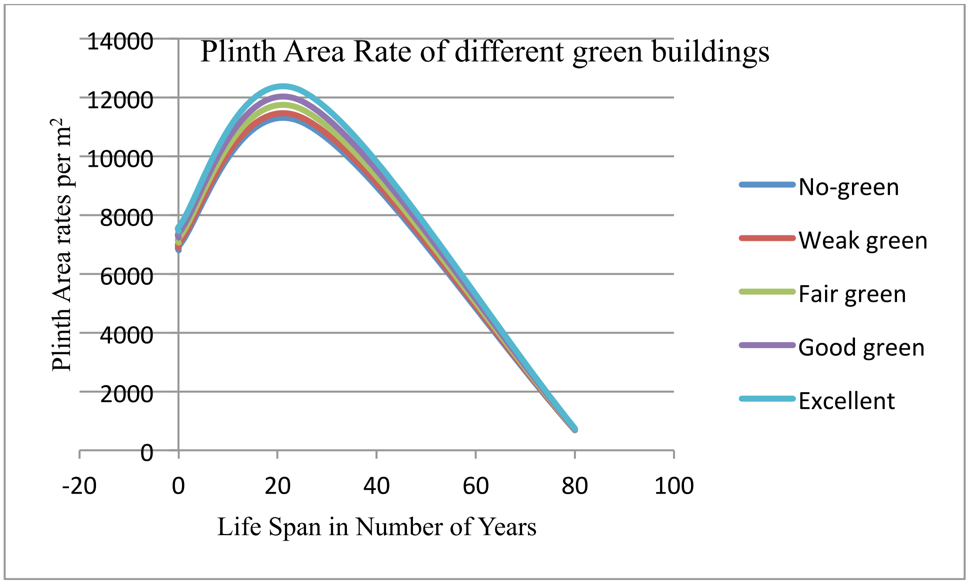


Fig.(5)- Plinth Area Rate Model for different greenness

5.2 Greenness Valuation Model -

The foregoing analysis for no-green building yields the following equation for determining the Plinth area rate:

$$P_{ln} = PLA*(1+m/100)^{n1} - d*PLA*n_1 \qquad \text{------- (1)}$$

Where P_{ln} – Plinth Area rate for market value assessment

PLA - Plinth Area Rate of no-green building computed above = Rs. 6800

M= 2% - increase in building materials cost per year

n - life span (80 years) for R.C.C. frame building

n_1 – present age of building (number of years old)

Therefore d = 0.9/80 (because salvage value = 10% of initial cost

d - Depreciation factor per year = 0.011

Using above equation we have:

P_{linv} = Investment value = Rs. 6800, P_{lmv} market value = 6936, P_{lmv25} market value for 1/3rd life span (25 years) = Rs. 11156 and P_{lsal} salvage value = Rs. 680 from Table (5) gives different values of greenness impact factors to be used with no green PLA to determine the market value of buildings.

5.3 Case Study - The drawing details are shown in Appendix –II, Site Survey data is as under:

No	Particulars	No	Particulars
1	Name of the owner – Mr. X	10	Length of internal walls – 20 m
2	Plot Area – 120 Sq.m.	11	Bearing capacity – 550 Kn per sq.m.
3	Type of building – Residential	12	No. of Floors – 2

4	Plinth Area of ground Floor- 73 sq.m.	13	No. of w.c. and bath units – 2 Nos.
5	Foundation dept - 1.8 m	14	%age of doors & windows opening in external wall – 25%
6	Plinth height – 1m	15	%age of doors & windows opening in internal wall – 12%
7	Floor height – 3 m	16	Slab Area – 85 sq.m.
8	Parapet height – 1 m	17	Land Rate at the time of purchase = Rs. 180/-per sq.m
9	Length of external walls – 32 m	18	Survey team must ensure that reasonable points
19	For room orientation of building out point specified on LEED scale given, for example 90% of the glazing on the south-facing wall should be completely shaded. The roof has a minimum of 50% south-facing area oriented appropriately for solar applications, the east-west axis is within 15-degrees of due east-west and the glazing area on the north-south facing walls are at least 50% greater than the sum of the east-west walls.	20	Ensure that Energy used to heat and cool a home over its lifetime is significant. The average home (no greenness equipment) in India consumes energy worth Rs. 24000 to 30000 per year for space and water heating, cooling, and lights and appliances. Energy efficiency improvements in a green home can reduce above cost by at least 20%. Length of internal walls – 20 m

In order to illustrate the application of greenness model for determining the market value of a building following details have been observed:

5.4 Purpose of Report-

The survey sheet given in Appendix-1, is completed with greenness view point is by the valuer's associates. The building is in Bhilai township in Chhatisgarh. The construction is 55 years old. The owner wants to sell out the property and shift to his home-town, therefore he wants to know fair market value of the building so that the sale deed could be registered. The owner is retired officer of Bhilai Steel Plant. Total greenness Points scored = 29 through the survey report. On greenness measuring scale the building is classified as fairly green structure. Valuation given by no green equation

$$P_{ln} = PLA*((1.02)^{n}{}_{1} -0.011 *n_1)$$

Where n_1 = 55 years and PLA = 6800

Therefore P_{ln} = Rs. 16093 per m^2

Therefore the building value for fairly green = Rs. 1.20*16093*73*2

= Rs 28,19,493

Further Current Land Rate = $180(1.08)^{55}$ = 12404.49 is obtained by capitalizing the purchase rate at 8% interest. Therefore

Land Value = 12404.50 *120 = 14,88,540.00

Fair green building value = 28,19,493.00

Total Market Value Rs. = 43,08,033.00

6.0 CONCLUSION

There are many greenness rating systems available across the world in both private and public sectors. The six elements of LEED credit points tally for Homes are used as the basis of developing a greenness measuring model to determine the market value of any property. In present scenario the valuers' do not include greenness aspect in their valuation reports. Attempt has been made to create an imaginary green model with 100 credit points which can be employed for valuation of a property. Perhaps there are two significant areas in which this model may be tried:

(i) To determine the market value of an existing building, and

(ii) To determine its market value when the structure has enjoyed its entire life span.

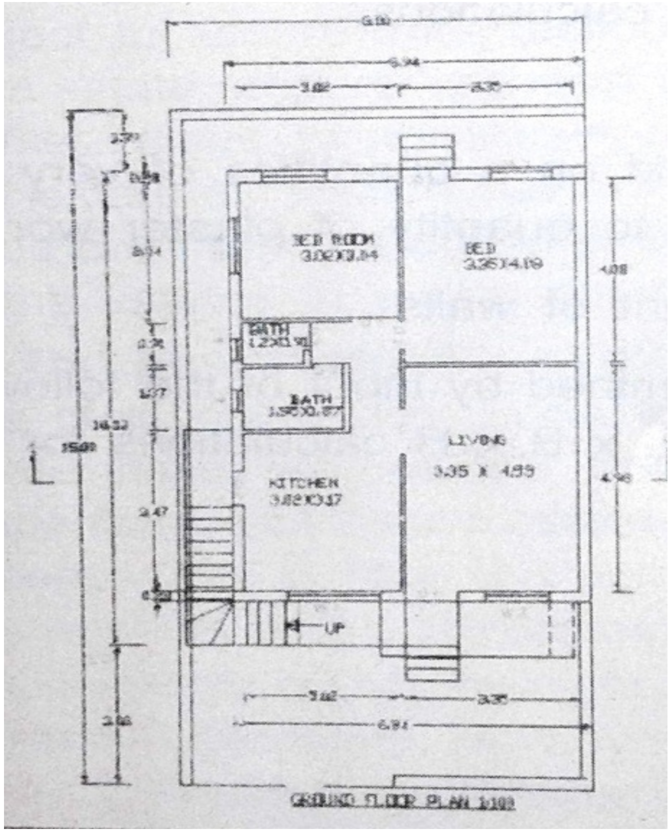
Generally the buildings are salvaged after its life cycle and the salvage value is 10% of its reproduction cost. In greenness measuring model the salvage value would be much higher because most of the materials of green buildings can be recycled and available for reconstruction.

APPEDIX-I: Building Survey pro-forma for greenness assessment

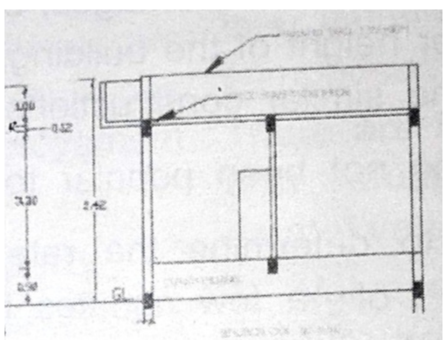
No.	Particulars	Points Available	Points Score
A	Sustainable Sites :		
i)	Site Selection	2	1
ii)	Urban Redevelopment	2	1
iii)	Brown field development	2	
iv)	Alternarive Transportation	2	
v)	Storm water management	2	1
vi)	Heat Island effect	2	
vii)	Light pollution reduction	2	1
	Sub Total	14	
B	Water efficiency		
i)	Water efficient landscaping	2	1
ii)	Innovative waste water technolgy	1	1
iii)	Water use/supply system	2	1
		5	
C	Energy & Atmosphere		
i)	Fundamental building system	3	
ii)	Minimum energy performance	3	1
	(heating, refridgeration, A.C. etc)		
iii)	Heat, Ventilation, A.C. equipment	3	2
iv)	New buildings site	3	2
v)	Old buildings site	5	2

			Sub Total	17	
D	Materials & Resources				
i)	Storage and collection of construction waste			2	2
ii)	Resource use: reuse materials			3	3
iii)	Recycled content:reduction & processing			2	
	new virgin materials				1
iv)	Regional Materials: Use of local			2	2
	extracted or manufactured materials				
v)	Rapidly renewable resources reduce depletion			2	
	finite raw materials				
vi)	Certified wood: forest management			2	
	responsible forest				
			Sub Total	13	
E	Indoor Environmental quality				
i)	Minimum air quality performance inside			7	0
ii)	Environmental tobacco smoke control etc.			8	0
			Sub Total	15	
F	Innovation and design process			5	2
G	1/3rd life span Appreciation of building			6	2
	Material appreciation @ 2%				
H	CO_2 emission & eco-friendly energy systems				
i)	Natural Means to improve inside environment			4	1
ii)	Additional biogas tank as cooking			4	0
ii)	Artificial Means to improve inside environment			7	0
			Sub Total	15	
I	Greenness features of the building				
i)	Room orientation to improve light/venilation			5	1
ii)	Rainwater harvesting, Landscaping, Pavers			5	1
iii)	Additional features of greenness			5	
			Sub Total	15	G.Total= 29

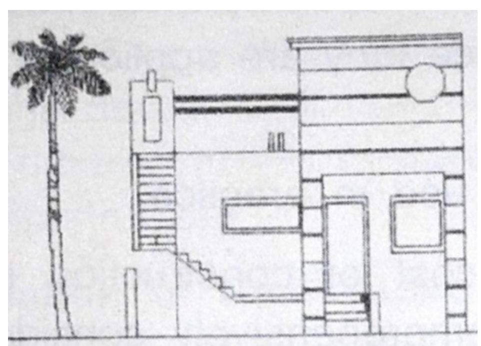
APPEDIX-II: Building Drawing Details



Building Plan



Building Section Details



Building Elevations

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