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Green Building : A Case study of New Paryavaran Bhavan

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Abstract— *The built environment has a vast impact on the natural environment, human health, and the economy. By adopting green building strategies, we can maximize both economic and environmental performance. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if the design and construction team takes an integrated approach from the earliest stages of a building project. 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. In India, there are 2 primary rating systems for green building: GRIHA (Green Rating for Integrated Habitat Assessment) & LEED (Leadership in Energy and Environmental Design). It evaluates the environmental performance of a building over the entire life cycle and hence subsequently awards the points. Now a day the construction industry has been growing at 9-11% year on year, primarily due to the strength of increased domestic and international manufacturing activities and industrial growth. With the growth of construction industry the environment is very much affected so we have to use at least one sustainable building technologies or material to reduce the impact of construction on environment. Here some green building benefits study is done for usefulness to the society.*

Keywords-*green building, benefit, cost, aspect, environment*

I. INTRODUCTION

In year 2011 Shri Narendra Modi, Honourable Chief Minister of Gujarat initiated a drive to make the State Capital Gandhinagar- A Clean, Green and Solar City. with this on 6th April 2012, Hon'ble CM inaugurated first Government Building running on Solar Power, set up by Gujarat Pollution Control Board (GPCB) in Gandhinagar [1].

While initiating the drive to make Gandhinagar a solar city, the government of Gujarat decided to follow their well known ancestral saying "charity begins at home", & thus an entire solar plant was installed in GPCB's New Paryavaran Bhavan which is not only Gujarat government's building but also the first green government building of Gujarat which is a IGBC's LEED India NC Gold rated building, certified by Indian Green Building Council. A very stringent environmental policy has been created & implemented by GPCB in New Paryavaran Bhavan. The building has received awards of appreciation from Bureau of Indian Standards for Environmental Management System (ISO 14001:2004) & Quality Management System (ISO 9001:2008). New Paryavaran Bhavan is located in the sector 10a (under government land use zone) of Gandhinagar.

II. OBJECTIVES

- To study the different green building material.
- To reduce the impact of construction on environment.
- To save the environment from impact of construction.
- To study the different green building technologies.
- To encourage the people to use at least one sustainable material or technologies in their home or work place.
- To study & show the various benefits from green building to the people.
- To minimize the use of products that is not environment friendly.

III. DESIGN ASPECT

3.1. Orientation and Site Design

The longer side (axis) of the building is rightly oriented in east-west direction, which significantly reduces the heat gain of the building as maximum windows face towards north & south side. Adequate overhangs which are shading devices are provided over the window to cut the harsh sun glare & thus to reduce direct heat gain.

3.2. Day Lighting

The building design comprises of two type of windows one which open towards the exterior & receive daylight & have direct line of sight to the day lighting views, whereas second type which open in the courtyards & receive indirect diffused day light. The window to wall ratio (WWR) provided for the window which open towards exterior is restricted to an average of 25% thus adding efficiency to the building envelope.

3.3. Landscaping

More than 20% well designed & maintained landscape area has been provided on the site, which adds aesthetic value to the building & enhances the daylight views from the building. The green views of the landscape creates a positive impact on the health & productivity of the occupants.

3.4. Building Envelope

Energy efficient building envelope is due to proper orientation of the building, efficient glazing, and adequate wall window ratio. High reflective material & shade from solar panel on the roof also help to reduce the heat gain. Thick tree plantation is provided in the periphery of the building thus the building premises remain under shade which significantly reduces heat gain.

IV. HEALTH ASPECT

Following strategies are considered to ensure the building's indoor environmental quality.

- Each unit has adequate aesthetically enhanced day lighting views to the exterior, which has a very positive impact on the occupants.
- Indoor & outdoor plants.
- Cleanliness of the premises is most importantly taken care of in the building, mats are provided at the entrance to prevent dust from entering the building premises, several janitors have been appointed to clean the premises from time to time.
- Eco friendly cleaning agents are used for housekeeping taking care of occupant's health.
- Low voc paints, adhesives & sealants are used to reduce the quantity of indoor air contaminants.
- No added urea-formaldehyde resins are used for interiors of the GPCB building.

Table 1. Indoor air quality test of the building

Sampling Area	Time in (hours)	particulate matter PM_{10} ($\mu g/m^3$)	particulate matter $PM_{2.5}$ ($\mu g/m^3$)	sulphur dioxide (SO_2) ($\mu g/m^3$)	nitrogen dioxide (NO_2) ($\mu g/m^3$)	carbon monoxide (CO) (mg/m^3)
GF Lobby	3	95.7	54.4	75.8	77.2	3.4
FF Office	3	91.8	47.1	71.5	69	2.8
SF Lobby	3	93	51.7	68.4	72.8	3.1
TF Office	3	84.1	42	72.7	75.4	3
TF Lobby	3	90.3	49.2	65.2	64.8	2.1
concentration in air as per national air quality standards	3	100	60	80	80	4

V. WATER EFFICIENCY

In this building they have used efficient water fixtures. Fixtures like ultra-low flow water closet, urinals having flow rate of less than 6 LPF & 4 LPF & low flow taps, low flow showers (water closet & urinals) having flow rate 2 LPM & 6 LPM results in 33.64% of reduction in potable water use. Water meters are provided for monitoring the water consumption [1].

VI. RAINWATER HARVESTING

Entire rainwater runoff from roofs throughout the monsoon is captured & recharged into two percolating wells on ground. This enhances the ground water table. The portable water needs of the building is fulfilled by the bore well located in the site premises [1].

Table 2. Total water recharged

Year	Annual Rainfall of Gandhinagar in (meter)	surface area (m^2)	Total water recharged (KL)
2012	0.69	1600	1104
2013	1.266	1600	2026
2014	0.559	1600	894

Table 3. ground water level at new paryavaran bhavan

year	annual rainfall in (m)	surface area (m^2)	total water recharged in (KL)	water level depth in may(in m)	water level depth in oct (in m)	rise in water table height(in m)
2010	0.913	1600	-	97.3	93.7	3.6
2011	0.819	1600	-	97.3	94.2	3.1
2012	0.69	1600	1104	99.5	93.1	6.4
2013	1.266	1600	2025.6	102.7	90.4	12.3
2014	0.559	1600	894.4	101.4	95.5	5.9

From table 2 we can see that after recharging the rain water in two percolating wells on ground there is a 2 times rise in water table height due to rainwater harvesting. So there is a increase in ground water table level due to rainwater harvesting.

VII. ELECTRONIC APPLIANCES

Energy efficient products & technologies like 5 star rated split air conditioners in some defined areas of the building. Energy efficient lighting like CFL & T5, controlled LPD as per LED norms in specific areas [1].

5.1. BEE star rated split air conditioners

Table 4. Energy and Cost Saving for 1.5 Ton Split Air Conditioner at Different Star Ratings

Star Rating	Minimum Energy Efficiency Ratio (EER)	Maximum Cooling Capacity	Input Power	Units Consumption/ Day	Per Unit Charge (Approx.)	Electricity Cost/Month	Cost Saving Per Month (w.r.t. no star) (Approx.)
		Watts	Watts	kWh	Rs.	Rs.	Rs.
No star	2.2	5200	2364	9.45	9	2552	0
1	2.3	5200	2261	9.04	9	2441	111
2	2.5	5200	2080	8.32	9	2246	305
3	2.7	5200	1926	7.7	9	2079	473
4	2.9	5200	1793	7.17	9	1936	616
5	3.1	5200	1677	6.71	9	1812	740

Assuming eight-hour operation per day and power cost @ Rs.9/kWh Source: Bureau of Energy Efficiency

They have fitted approximately 48 split air conditioners in which 40 AC of 1.5 ton & 8 AC of 4 ton. All AC have minimum 3 star rating & maximum 5 star rating. So from above table if we consider 3 star rating then saving in Electricity Cost/year [2].

= 40*473*12

= RS. 2,27,040/year

5.2. T5 tube light

They have fitted approximately 900 T5 tube of 28 W in this building.

Assumptions of Efficiency [3]:

- T5 = highest efficiency
- T8 = higher efficiency
- T12 = old and inefficient

Table 5. Annual lighting cost comparison of T5, T8 & T12 tube light

	T5	**T8**	**T12**
Watts	28	32	34
Bulbs	1	1	1
Fixtures	900	900	900
Total Watts	25200	28800	30600
Hours/day	8	8	8
Days/week	6	6	6
Weeks	52	52	52
Total hours	2496	2496	2496
Cost/kwh	9	9	9
Annual cost	566093	646963	687398
Saving vs. T12	121306	40435	0

900 T5 tube of 28 W saves Rs.80,870/year in Electricity cost

Saving in Electricity cost =6,46,963-5,66,093 =80,870

VIII. LAPS IN PRESENT DESIGN

- This building is not running completely on solar power.
- All solar panel cleaning is required for optimum performance. They can provide sprinkler system to clean the solar panel automatically at some time interval due to this there is a increase in solar power generation.

Figure 1. Clean & dusty Solar panels on terrace

Calculation of annual solar power generation [4]

- Number of modules – 360

- Number of watt per panel – 230

Table 6. Annual solar power generation at this building

Year	annual solar power generation(in kW)
2013	90850
2014	80063

Table 7. Maximum Power generation capacity per year

Time of Year	Maximum Power generated per day, Fixed mount (in kW) (Solar Panels Used)		Maximum Power generated per year(considering 300 clear days) (in kW)
	1	360	
Winter Worst Peak Sun Hours 3.76	0.86	309.6	92880
Summer Best Peak Sun Hours 4.79	1.1	396	118800
Year round average Peak Sun Hours 4.28	0.98	352.8	105840

Average annual solar power generation =85456 kW

Average annual solar power generation capacity =105840 kW

So it is a 20% less than its maximum capacity.

- For maximum solar power generation from this plant they have to use Dual-Axis Tracking System with Fixed Mount.
- Building management system is not used in this building.
- This building is not equipped with CO2 monitoring sensors.
- Daylight sensors & occupancy sensors are not installed.
- They are using cfl lamp instead of led lamp(479 lamps).
- Rain water from campus in not recharged in recharge well.
  Total plot area =4625 m^2
  Total terrace area =1600 m^2
  So campus area =3025 m^2
- High performance glass is not used in this building.
- There is a minimum use of daylight from windows facing exterior because of when sun light is falling on window there is a heat generation in the office due to normal glass. So that the employees drop down the curtain and there is a need of artificial lighting.

Figure 2. Exterior windows

Figure 3. Exterior windows

- Grey water recycling system is not installed. Most of the grey water is coming from urinals and water from cleaning of building floors so this water is easy to recycle and to reuse for flushing and gardening and other non drinking purpose.

Table 8. Approximate quantity of grey water

year	total water used in (KL)	approximate quantity of grey water in (KL)(40% of total water)
2013	3058	1223
2014	5600	2240

- They have used normal clay brick instead of AAC blocks or fly ash bricks.
- Pavements and roads within the campus are not designed to enable water percolation. they are using normal concrete instead of pervious concrete in campus road.

Figure 4. Pavements and roads within the campus

IX. BENEFITS

Following are the benefits

- 3 star rated split air conditioners saves Rs.2,27,040/year in Electricity cost than normal building
- 900 T5 tube of 28 W saves Rs.80,870/year in Electricity cost than normal building
- Minimum use of artificial lighting
- Increase in ground water table level due to rainwater harvesting
- Better indoor environmental quality
- Positive impact on the health & productivity of the occupants

X. CONCLUSION

The green building construction is initially costly but in the life cycle of the building there is a lots of benefits from various green features. Green building saves environment from various construction material & practices. There are some laps in present design of these building. If they provide some other green features as shown in laps then these building can get platinum rating. There are three types of Benefits of green building like Environmental benefits, Economic benefits, Social benefits. We have to use at least one sustainable building technologies or material to reduce the impact of construction on environment.

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