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Evaluation and Comparison of Utility Consumption for the Sustainable and Normal building.

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ABSTRACT

Sustainable building (Green building) refers the using of processes that are environmentally friendly and resource efficient from design, construction, operation, maintenance, renovation and demolition. The scope of this paper is to protect the environment by minimizing the use of non renewable construction materials and resources through efficient engineering design, planning and construction. This paper explains the need to select for modifying the design of construction and services to suit Leadership in Energy & Environmental Design (LEED) requirements. Green Building Concept was to save maximum energy and protect our environment leads to sustainability. Compare to normal building the utilities (water and power) requirement for sustainable building was more efficient than normal building.
Keywords: Green building, sustainable, normal building, power, water requirement.

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INTRODUCTION

Electricity consumption by the building sectors is nearly 20% in our country. Development has shifted the land usage away from natural, biologically-diverse habitats to landscape that is impervious and devoid of biodiversity [1]. Green building practices can possibly reduce or eliminate negative environmental impacts and improve existing unsustainable design, construction and operational practices [2]. As an added benefit, eco-friendly design reduce the operating costs, improve building marketability, increase worker productivity and reduce potential liability which is caused due to indoor air quality problems [7]. Energy conservation and Environment protection has received attention in India long back. The impact of the energy conservation and sustainability efforts are felt at a very low mark, as the commercial per capita energy consumption is low in the country and efficient end usage devices are costly [5]. The rapid increase in energy demand has caused an increased awareness about the economic advantage of energy usage and conservation mainly in the industrial and service sectors [10]. The economy underwent a structural expansion and it resulted in expansion of the industrial base in the country, and subsequently an increase in demand for energy [12]. Inspite of this there is no much expansion in the electricity generation sector which supported an improved effort on green building concept [3]. Use of resources to meet our needs without exploiting the resources for future generation is known as sustainable development [6]. Green building practices helps to attain sustainable development. Now a day's companies are influenced by globalization and knowledge based economy to set up their industries in India. The downstream operations are critical and mainly aimed at Environment protection [4]. Hence these companies are instructed to adopt Green Building Standards in the stages of office construction and development [5]. Hence the consumers are interested to invest in Green building concept to improve the sustainability. Sustainable building have many benefits compared to the normal building such as efficient water usage, renewable energy and recycled materials usage effective building management systems along with improved indoor air quality for maintaining proper health and comfort [8]. Green design helps to reduce the operating cost and optimize the life cycle of economic performance such as savings in energy consumption and reduces the water consumption [13]. The intangible benefits of Green design include reduction of impact on environment and marked enhancement in the occupant comfort and productivity [10].

Green buildings emphasize greater benefits and the analysis must be broad rather than narrow focus. The emphasis must be given in terms of costs rather than the benefits. The need for more data focuses on the human and organizational factors. If only both the building and organization are treated as an integrated system, the benefits of green building can be realized [5] [2]. it is entirely possible to have a "green" building with "gray " occupants due to lack of systems integration and lack of training . Gray occupants are also more likely to be found in buildings that "green" and "gray" organizations provide opportunities for high-level benefits resulting from resource efficiency and process innovation throughout the organization [5]. This paves way for various advantages such as increased marketing, improved policies and processes to support the financial constraints, providing various training to enhance interest towards green building and seeks support for Green building and LEED Certification. Also it requires the creation of awareness of green building concepts, enhanced effectiveness and development of new ideas on green concepts [2]. The green design strategies are efficient use of community resources, pollution prevention and toxic reduction.

METHODOLOGY

It mainly involves the design and analysis of sustainable materials which make an approach to green building material and resources.

Water requirement

Water is the main resource for any construction projects. Water is used in construction for mixing and curing purposes. Water requirement during construction can be calculated based on water cement ratio of the various mix proportion of concrete and cement mortar.

Power requirement

Thermal transmittance is different in that the heat transfer coefficient is used to solely describe heat transfer in wall while thermal transmittance is used to simplify an equation that has several different forms of thermal resistances.

$$\Phi = A \times U \times (T_1 - T_2)$$

Where, Φ is the heat transfer in watt, U is the thermal transmittance in m^2 K/W, T_1 is the temperature on one side of the structure, T_2 is the temperature on the other side of the structure in K and A is the area in m^2. The difference in temperature between the inside and outside of the building is at least 5°C.

Seasonal energy efficiency ratio SEER = BTU / W- hour

Where, W is the average electrical power in Watts, and (BTU/hour) is the rated cooling power. As per Indian climatic condition regular air conditioner used for residential purpose has a range of 5000 - 14000 BTU/hour. For 6000 BTU/hour air-conditioning unit, with a SEER of 10, would consume 6000/10 = 600 Watts of power on average. The electrical energy consumed per year can be calculated as the average power multiplied by the annual operating time, which is 600 W × 1000 hr = 600 kW-hr. Assuming 1000 hours of operation during a typical cooling season (i.e., 8 hours per day for 125 days per year). Another method that yields the same result is to calculate the total annual cooling output: 6000 BTU/h × 1000 h = 6 x 10^6 BTU. Then, for a SEER of 10, the annual electrical energy usage would be 6 x 10^6 BTU / 10 = 600,000 W h = 600 kWh

RESULTS AND DISCUSSION

Power required in Sustainable Building during operation

In our case outer walls were constructed with fly ash brick work rattrap bond which reduces 20% bricks and 50% mortar compare with normal building **(Table 3.1)**. Inner walls were constructed with GFRG panel which has thermal conductivity is zero. Hence annual electrical energy for cooling is 50 % the actual annual power consumption. 600 x 0.5 = **300 kWh**

Power required in normal building during operation

In normal building wall is constructed using brick work of 230 mm thick with required plastering. Brick has the thermal conductivity of 0.77 W /mK and resist 0.13 Km²/W. There will be loss in cooling energy. Hence the actual annual power consumption **= 600 kWh (Fig. 1)**

Water requirement

The water efficiency for sustainable building was 26 m^3/day **(Table 3.2)** and for normal building was 77 m^3/day **(Table 3.3)**. The power efficiency values during construction for Sustainable and Normal building are 3.375 kWh and 9.75 kWh. The power efficiency values during operation for sustainable and normal building are 300 kWh and 500 kWh. Water efficiency and power efficiency for Sustainable and Normal buildings showed immersive differences. The result of normal building was much greater than that of Sustainable building. Sustainable buildings consume 3 times less water during construction process **(Fig. 2).**

Table 3.1:Thermal conductivity and Resistance value of construction materials

Thickness	Material	Conductivity	Resistance
-	Outside surface	-	0.035 K·m²/W
0.10 m	bricks	0.77 W/m·K	0.128 K·m²/W
0.05 m	Glass wool	0.04 W/m·K	1.27 K·m²/W
0.10 m	light concrete blocks	0.30 W/m·K	0.325 K·m²/W
(bridge,7%)	mortar between concrete blocks	0.88 W/m·K	0.106 K·m²/W
0.01 m	plaster	0.57 W/m·K	0.019 K·m²/W
-	inside surface	-	0.128 K·m²/W
0.124 m	GFRG unfilled panel		0.358 K·m²/W

Table 3.2 Water required during construction for Sustainable building

S.No	Component	Qty	Cement bag required / m3	Cement bag required for total Qty	Liter of water required / Bag	Liter of water required for total Qty
1	CC 1:4:8	14.654	3.3	48.3582	47.5	2300.015
2	Fly ash BW CM1:4	22.7				
	CM 1:4 for BW	8.166	7.9	64.5114	26.5	1729.552
3	RCC 1:2:4	10.677	5.7	60.8589	32	1967.485
4	RCC 1:1:2	0.234	12.2	2.8548	27	79.0796
		Qty	**Bricks / m3**		**Wt. of Fly ash Brick + 12% water absorption**	
5	Fly ash Bricks	22.7	550		0.33	4150.05
						10231.18

Water required for curing & consolidation purpose ≈ 1.5 times the construction = 15346.77L

Total quantity of water required during construction in liter = 25577.77 L

Table 3.2 Water required during construction for a normal building

S.No	Component	Qty	Cement bag required / m3	Cement bag required for total Qty	Liter of water required / Bag	Liter of water required for total Qty
1	CC 1:4:8	23.7	3.3	78.21	47.5	3718.975
2	BW CM1:4	37.64				
	CM 1:4 for BW	13.54	7.9	106.966	26.5	2839.599
3	RCC 1:2:4	70.95	5.7	404.415	32	12945.28
		Qty	**Bricks / m3**		**Wt. of Brick + 20% water absorption**	
4	Brick work	37.64	550		0.55	11390.1
						30890.95

Water required for curing & consolidation purpose ≈ 1.5 times the construction = 46336.43

Total quantity of water required during construction = 77227.38 L

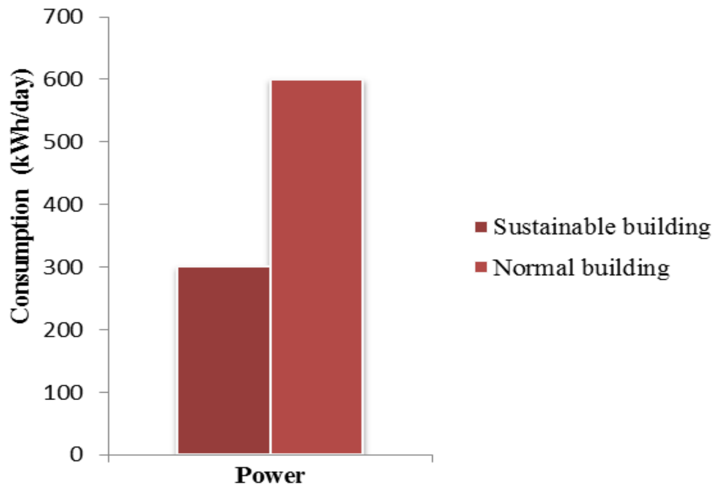

Fig. 1 Power consumption for the Sustainable building and normal building

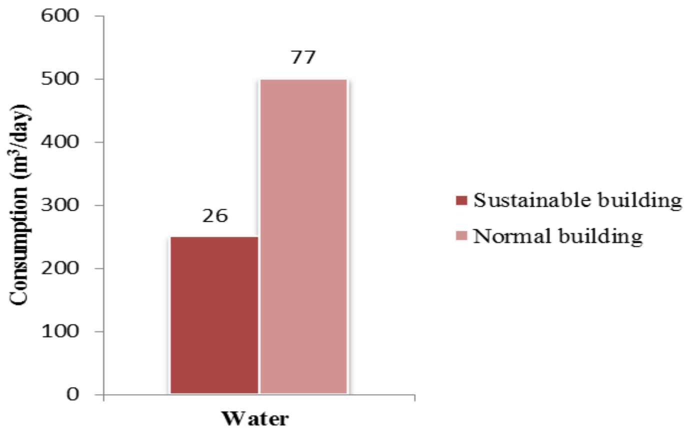

Fig. 2 Water consumption for the Sustainable building and normal building

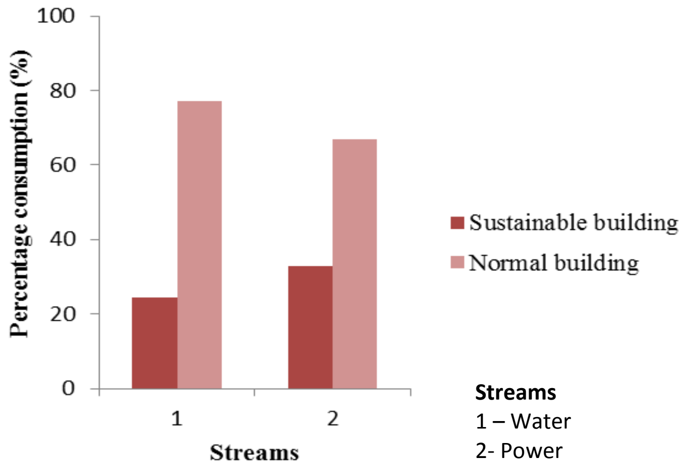

Fig. 3 Percentage consumption of Utilities

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