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METHODS FOR SUSTAINABLE DESIGN IN GREEN BUILDING

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ABSTRACT: Green building also known as sustainable building refers to both a structure and the application of process that an environmentally responsible and resource efficient throughout a building life cycle from planning to design construction, maintenance, and renovation. In this research work cement is replaced by fly ash, because cement releases CO2which is harmful for human and environment. LED lights are used which are more energy efficient. Bamboo used for the construction of boundary wall, partition wall, garden wall and entry gate. For heat insulation purpose green or blue color paints used in the building. Large amount of solar system used to reduce consumption of electricity. Cross ventilation are provided on each room of the building so that outdoor air can reach inside the room very easily. Gardening is done near the building. Rain water harvesting is done on the top of the roof and the stored water is utilized for watering in the garden, washing the floors of the building and in washroom. Fulfilling the needs of today, giving priority to the needs of future. This noble concept of sustainable development is practiced through green buildings. Green buildings are thus tomorrow's needs and not today's luxury

Key Words : Green Building; Renewable; Renovation; Sustainable

INTRODUCTION

The carbon emission by the buildings is more than 40%, it means the 40% carbon is produced by buildings, one of the main culprits implicated in the phenomenon of global warming in which India comes on 144th position (1.4 metric ton) in carbon emission rating in the world. Green building is the practice of manufacturing or modifying structures to be environmentally and economically responsible, sustainable and resource-efficient throughout their life cycle. This includes efficiently using energy, water and other natural resources, protecting Occupant health, improving employee productivity and reducing waste, pollution and environmental degradation. Green buildings are responsible for improving environmental footprint by reducing energy use by 30-5-%, CO2 emissions by 35%, waste output by 70% and water usage by 40%.

LITERETURE REVIEW

Green Building Movement in India concluded that, "With the growing awareness on green buildings, the green building movement is well poised to reach greater heights.

The penetration of green building concepts and the quantum jump in the green building footprints offers many challenges and at the same time presents tremendous opportunities. The stakeholders of the construction industry need to be well equipped to measure up to these opportunities. There is an imminent need for the stakeholders to involve in the green building movement through the IGBC and local chapters. As more green building activities are being initiated to further green the movement, the country is well positioned to emerge as one of the world leaders in green buildings". The evidence presented in the case studies demonstrates that properly designed and sized systems, energy and water efficiency, and reduction in long-term maintenance costs are achievable for no or modest increases in total development costs. These advances are important and should be immediately adopted in all affordable housing developments.

According to a recent research conducted in the US, upgrading an existing building to a green building would increase its capital value by 16% (Eichhlotz et.al, 2009). Hence it can be of great opportunity for the builders to purchase old property at good place and convert them into greener ones.

NEED OF GREEN BUILDING

During the late 20th century, awareness of the impact of technology and the expanding human population on the earth increased. People started to expand their efforts to reduce their environmental impacts and buildings started to be recognized as major contributors to

the world's energy usage, landfill waste and diminishing green space (IFMA Foundation, 2010).Green building practices are not new phenomena. A handful of buildings integrating environmental design aspects were erected as early as the late 19th and early20th centuries(Cassidy, 2003).A unified green design movement did not begin to emerge until the 1970s, when design and building practices first became a focus of environmental advocates(IFMA Foundation, 2010).

ASPECTS OF GREEN BUILDING

The aspects of green building are as follows:

Sustainable Site

The area of construction should be located in the place where the effect of construction on environment is less. The sites have access to basic amenities thereby, reducing pollution caused because of transportation. The landscape design should be such that it preserves all trees and greenery which was present previously and restore natural topography.

Water Efficiency

The main goal here is to increase water efficiency use within the building, thereby reducing the amount of water needed for 26 operations. Following methods can be used for this include efficient landscaping techniques and use of innovative wastewater management technology (Gupta and Shrivatava, 2015).

Energy Efficiency

It involves the installation of various methods of on-site renewable energy production can reduce the overall footprints of the building and other means of using green power. The optimization of building orientation, massing, shape, design and interior colors and finishes is done which maximizes the use of natural day lighting. This reduces the dependence on artificial lighting energy. Window frames, sashes and curtain wall systems should be placed to optimize energy performance.

Material Selection

This aspect mainly concerned with the reusing, reducing and recycling of the waste. Encouraging the use of recycled natural materials, re-usable, renewable, sustainably managed bio-based materials. Ways are identified to use high recycled content materials which range from blended concrete using fly ash, slag, recycled concrete aggregate or other admixtures to structural steel, ceiling and floor tiles, carpeting, carpet padding etc. Bio-based materials and finishes such as various types of garboard made from agricultural waste and by products including straw, wheat, barley, soy, sunflower shells, peanut shells etc.

Indoor Environment Quality

In order to enhance the well-being of the occupants, design of a building is such that materials with low emission are used. Building is designed to maximize the use of natural light for all 27 occupants. Bio degradable and environment friendly cleaning agents are used that do not release VOCs or other harmful agents and residue.

MATERIALS

In this project we are use timber, fly ash brick and green concrete:

Timber

Timber is very cheap building material as compare to concrete content. Cement contains carbon contents which are hazard human health and environment. Timber provides a varied and flexible material for many industries. It's primarily used in construction as structural support, for internal fixtures and external cladding. However, the immense flexibility of this material means it's got a great many other uses.

Figure.1 - Timber House

Fly Ash Brick

This bricks are generally manufacturing by mixing River Sand , Stone aggregates less than 6mm in Size, Cement and Fly Ash (Fly Ash quantity will be 10% to 20% of Cement). Normally the actual quantity of cement required will be replaced with 10% to 20% Fly Ash. Any brick in which the cement is present will increase the heat inside building. Fly Ash Bricks with plastering on both sides will again increase more Heat. When we are manufacturing 1 Metric Ton of Cement equal quantity of C_{O2} (Carbon di Oxide) will also get generated. So we are polluting the environment.

Figure.2 - Fly Ash Brick

Components of Fly Ash Brick

1. Fly Ash :-

Fly ash is a Waste product occupied from burning pulverized coal in electric power generating plants. During the process of combustion in the plants, mineral impurities in the coal (clay, feldspar, quartz, and shale) fuse in suspension and float out of the combustion chamber with the exhaust gases. As the fused product rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters. The fine particle like does resemble Portland cement but it is chemically different. Fly ash chemically reacts with the byproduct calcium hydroxide released by the chemical reaction between cement and water to form additional cementations products that improve many desirable properties of concrete.

2. Lime:-

Lime is the calcium-containing inorganic mineral in which hydroxides and oxides predominate. In the strict sense of the word, lime is Cao or Cah_2. It is also the name of the natural mineral (native lime) Calcium oxide which occurs as a product of coal seam fires and in altered limestone xenoliths in volcanicejecta. The word lime originates with its earliest use as building mortar and has the sense of sticking or adhering.

These materials are still used in heavy amount as building materials and engineering material (including limestone products, cement, concrete, and mortar), as chemical feedstock's, and for sugar refining, among other uses.

The rocks and minerals from which these materials are derived, typically limestone or chalk, are composed primarily of calcium carbonate. They may be cut, crushed, or pulverized and chemically altered. Burning (calcinations) converts them into the highly caustic material quicklime (calcium oxide, CaO) and, through subsequent addition of water, into the less caustic (but still strongly alkaline) slaked lime or hydrated lime (calcium hydroxide, Ca(OH)2), the process of which is called slaking of lime. .

3. Gypsum:-

Gypsum is a mineral which is found in two forms in nature, crystal and the form of masses called gypsum rock. Gypsum is a very soft mineral and sometimes it can be possible to form huge pieces of colored crystal. Massive size rock of gypsum forms within layers of sedimentary rock, typically found in thick beds or layers. Gypsum is naturally forms in the regions of bay where ocean waters high in calcium and sulfate content can slowly evaporate and be regularly replenished with new sources of water.

4. Query Dust:-

As quarry dust which is also called as crushed sand is a byproduct obtained after crushing of stones (rocks) to make aggregates. Results have shown that the concrete made using crushed sand reaches the compressive strength earlier as compared to the concrete made of natural sand. In Practical construction the concrete is prepared crushed sand which is more homogeneous as compared to natural (river) sand,

because crushed sand, aggregate and cement gets easily mixed having similar properties.

Test on the Fly Ash Brick

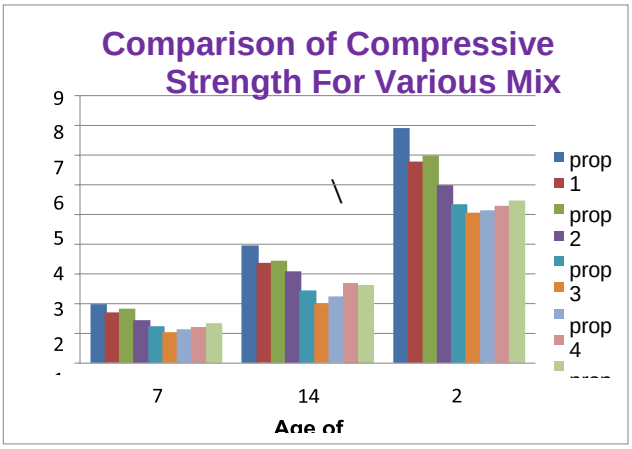
Compressive Strength test
Water Absorption test
Efflorescence

1. Compressive Strength Test

The compressive strength of fly ash brick is three times greater than the normal clay brick. The compressive strength of clay brick is at least 3.5 N/mm^2.So as the fly ash brick has compressive strength of 10-12 N/mm^2. Bricks to be used for different works should not have compressive strength less than 10-12 for fly ash brick and 3.5N/mm ^{2}. The universal testing machine is used for testing the compressive strength of bricks. After the curing period gets over bricks are kept for testing. To test the specimens the bricks are placed in the calibrated Compression testing machine of capacity 3000 kN applied a load uniform at the rate of 2.9 kN/min. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine. In that three numbers of bricks were tested for each mix proportion. Each brick may give different strength. Hence, average of three bricks was taken.

Table – Mean values of compressive strength N/mm^2

Proportions	7 days (N/mm^2)	14days (N/mm^2)	21days (N/mm^2)
I	1.98	3.95	7.91
II	1.68	3.36	6.78
III	1.81	3.43	6.97
IV	1.44	3.08	5.98
V	1.22	2.43	5.34
VI	1.03	1.97	5.04
VII	1.12	2.23	5.14
VIII	1.21	2.67	5.28
IX	1.34	2.62	5.45



Graph.1 - Compressive strength for various mix

Graph.2 - Proportions at 7, 14, 21 days curing

2. Water Absorption

Fly ash Bricks should not absorb water more than twelve percent. The bricks to be tested should be dried in an oven at a temperature of 105 to 115o C till the point of reaching constant weight cool the bricks to room temperature and weight (W1). Dunk completely dried and weighed W1 brick in clean water for 24 hrs at a temperature of 27±20 Degree Celsius. Remove the bricks and wipe out any traces of water and weigh as soon as possible (W2). Water absorption in % by weight = (W2 – W1/W1) x 100 the average of three bricks should be taken. Our bricks absorb approximately 10 % of water only; it has less water absorption property

3. Efflorescence

For this test, brick was placed vertically in water with one end drowned. The depth of immersion in water being 2.5 cm, then this whole arrangement should be kept in a warm-well-ventilated room temperature of 20-30 0 C until all evaporates. When the water in the dish is absorbed by the brick and surplus water evaporates. When the water is completely absorbed and evaporated place similar quantity of water in dish and allows it to absorb and evaporate as before. Examine the brick after the process is done and find out the percentage of white spots to the surface area of brick. If any difference is observed because of presence of any salt deposit then the rating is

Green Concrete

Green concrete is part of a movement to create construction materials that have a reduced impact on the atmosphere and environment. It is made from a combination of an inorganic polymer and industrial waste which is 25 to 100 percent. Green concrete gains strength faster and it poses a fewer rate of shrinkage than concrete made only from Portland cement. As a part of a global effort to reduce emissions of harmful gases, switching over completely to using green concrete for construction will help considerably, and sand are heated to 1500 degrees C using natural gas or coal as a fuel.

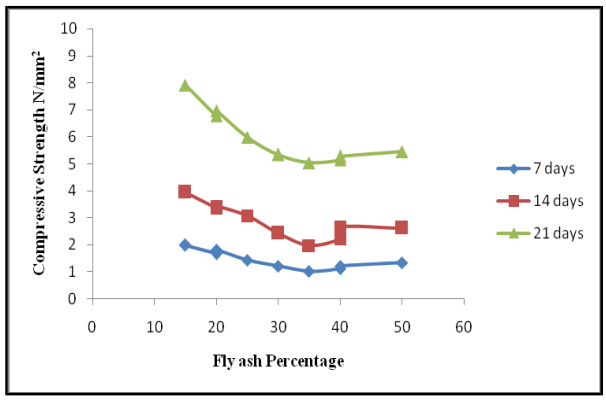


Figure.3 - Green concrete

Suitability of Green Concrete in Structures

Several factors which enhance the suitability of green concrete in structures include:

- Minimize the dead load of the building and minimize the crane age load; allow handling, lifting flexibility with lighter weight.
- Increased concrete industries use of waste products up to 30%.
- Good heat and fire resistance, sound insulation than the traditional concrete.
- Improve damping resistance of the building.
- No environmental pollution and of emission of CO_2 by 30%.
- It increases the development of sustainable concrete,
- It requires less maintenance and repairs.
- Compressive strength behavior of the concrete with water cement ratio is more than that of conventional concrete.
- Flexural strength of both concrete (green concrete and conventional concrete) is almost same

Advantages of Green Concrete

- Mix design is optimized which means better handling, better finishing and better consistency.
- Reduced effect of shrinkage and creep in concrete.
- Green concrete uses local and recycled materials.
- Minimized heat of hydration compare to the traditional concrete.

METHODOLOGY

Following methods are using in this project

- Sustainable construction materials,
- Green architecture with cross ventilation
- Cool roof
- Proper insulation
- Reduce, reuse, recycle
- Installing solar panel
- Rain water harvesting system
- Eco friendly lighting

ADVANTAGES

Several advantages of green building are as follows:-

- The operation and maintenance cost is comparatively lower compare to conventional building.

- Efficiency of energy is very high.
- Less dependent on local resources such as water, electricity.
- Healthy ambience and clean environment.
- Promoting the use of recyclable materials.

DISADVANTAGES

Green building are very good in terms of environmental health, recycling, efficiency and maintenance but some disadvantages are also present which affects the project of green building, and the disadvantage are as follows ;

Location

Large amount of the energy comes from direct sunlight so the building should be located in the region where the exposure of sun is sufficient. It also means that these types of building can't be constructed in Polar Regions and are where sufficient sunlight is not present.

Availability

Green building requires some special kind of raw materials for construction, so sometimes it's very hard to find such types of material especially in urban areas and also the transportation charge can be very high.

Cost

- These are some factors which makes the building uneconomical.
- Cost of special type of raw materials
- Time of the construction

CASE STUDY

Introduction

Indira paryavaran bhavan is the new office of environmental and forest ministry of India which is located in New Delhi. This building sets a great example of green building compare to a normal conventional building design.

The designers of this building put special effort on strategies for suppressing energy demand by providing sufficient natural light, temperature reducing landscape, shading and other energy saving systems. In the rating of green building this building reaches the first position in India.

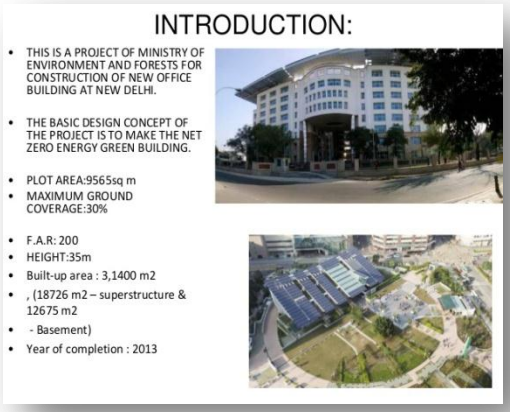


Figure.4 – Project Details of Indira Paryavaran Bhavan

RESULTS

- Sustainable construction materials such as natural paints fly, ash brick, recycled steel bars are generally cheaper than the conventional material but their quality and performance are same as conventional building materials.
- Cross ventilation in any building depends upon the direction of the wind. The windows should be parallel to the air flow and any type of obstruction in the air flow should be avoided.
- Solar panels are a very useful energy saving system but the solar panels requires a sufficient exposure of sun, so they are not suitable for Polar Regions and also the maintenance is difficult.
- Windows and ventilations provides a good amount of natural sunlight if they are proper positioned and for the artificial lighting CFL and LEDs are better than incandescent bulbs
- Cool roofs are very good option for warm regions. The reflective paint or reflective tiles reduces the temperature of the building up to 30-40% but they are not economical in terms of cost.
- The rain water harvesting system reduces the dependency of water supply from municipality but it is not suitable for whole year.

CONCLUSION

Green and sustainable buildings are naturally different from conventional buildings. There are some special requirements for green building such as building practices, special material and also the management commitment to sustainability. Sustainable and green

building requires a client who is sympathetic to this ideal, user who understands and values the concepts and designers and contractors who as a team evolve the design with a sustainable outlook.

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