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Application of Green Technology in Infrastructure

Isha Verma	Assistant Professor, Civil Engineering Department, ITM University, sector 23 A, Gurgaon-122017, Haryana
Prachi Sohoni	Assistant Professor, Civil Engineering Department, ITM University, Gurgaon
Nipun Verma	Assistant Professor, Civil Engineering Department, ITM University, Gurgaon

ABSTRACT

A green building, which is also known as a sustainable building is designed to meet some objectives such as occupant health; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment. It is an opportunity to use the resources efficiently while creating healthier buildings that improve human health, build a better environment, and provide cost savings. All the development projects lead to over-consumption of natural resources. This leads to serious environmental problems. Green building concept deals with the optimum use of natural resources for the development of infrastructure. The low cost eco-friendly house is the modern construction method which uses locally available material and unskilled labor and also reduces the construction time. Similarly, use of recycled plastic, recycled aggregates and municipal wastes for the construction of pavement has considerable effect on the environment of earth. Another advanced method is the construction of low carbon building which uses sustainable materials like blended cement, compacted fly ash blocks, low energy intensity floor and roofing system, rammed earth walls and stabilized mud blocks etc. This ultimately results in reduction of green house gases which will help to reduce green house effect. This paper presents an overview of application of modern green infrastructure construction technology which makes a significant impact on conservation/proper utilization of resources like land, water, energy, air, material etc thereby reducing the overall cost of construction as well as adverse impacts of climate change.

Introduction

In today's world of climate change and high energy prices, it is critical that buildings use as few fossil fuels (including coal generated electricity) as possible to "future proof" the home against unpredictable and rapidly rising prices.

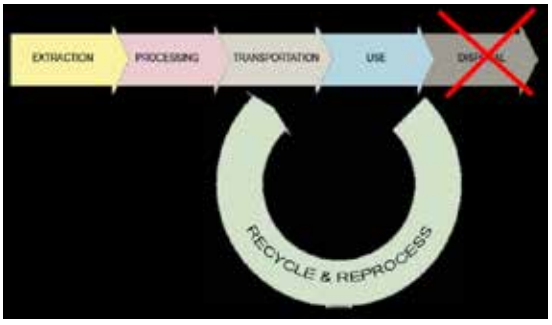

Figure1. Lifecycle of material

Fossil fuels currently provide 95 percent of the world's commercial energy supply, whereas renewable energy sources supply less than three percent. If we are going to approach our future with foresight, it would be wise to reduce our consumption of fossil fuels and invest in renewable energy at home as soon as possible. The green technologies adopted in infrastructural facilities emphasize on the "three R's" of environmental conservation viz., reduce, recycle and reuse.

The term "green" refers to environmental friendly practices from building design to the landscaping choices. It also encompasses energy use, water use, and storm water and wastewater reuse. Its cost may be more up front but, in the long run, will save money through lower operating costs over the life of the building. The green building approach applies a project lifecycle cost analysis in determining the appropriate up-front expenditure. The key to creating sustainable habitats is to minimize usage of energy and resources, thereby reducing waste generation and pollution, as byproducts of construction. So to conserve the natural resources, by keeping the effects of global warming in mind, we can go for the green revolution technology for the infrastructure. These modern green movement and the green rating systems are a consequence of the oil crisis of 1970's that inspired engineers, architects, environmentalists and ecologists to devise ways of reducing energy use and consequently the adverse impact on the environment.

There are some principals which guide the green infrastructure.

- Green infrastructure should be grounded in sound science and land-use planning theory and practice.
- Green infrastructure should be planned and protected before development.
- Green infrastructure is a critical public investment that should be funded up front.
- Green infrastructure affords benefits to nature and people.
- Green infrastructure respects the needs and desires of landowners and stake holders.
- Green infrastructure requires long-term commitment.

By preferring Green Building over a conventional building we help this planet earth and the people to retain nature to a maximum extent possible in three ways with reference to the location of the buildings.

√ Retain the external environment at the location of the building.
√ Improve internal environment for the occupants.
√ Preserve the environment at places far away from the building.

A green building is one that makes the greatest possible use of natural light & air, least possible utilization of energy & water. It emphasizes on recycling of waste water, harvesting rain water, least use of air conditioning, less production of carbon dioxide and tries to safeguard environment in every possible way. An integrated approach to building design means minimizing negative impacts of buildings on our fragile environment. Building should be designed as integrated system that interacts with their surrounding environmental conditions by efficiently using valuable recourses and enhancing user's comfort and productivity.

Figure2. Energy optimization of building

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Applications of Green Technology

1. Green technology for Low cost housing

The recent phenomenal rise of price of building materials and construction costs have stood in the way of providing low cost houses for millions of people using conventional building materials. The appropriate way of developing low cost dwelling units is to make best use of locally available material. Low cost housing techniques can be achieved by replacing the conventional methods of planning and execution of building operations. No single approach and solution is available which will be acceptable in the whole country. The technique has to select on the basis of local climatic condition and on the availability of local natural building materials/resources. There is an urgent need to develop new building materials and technologies for low cost housing in rural areas.

This necessitates the use of appropriate and cost effective building materials and technologies in the construction of dwelling units. The use of bamboo as a reinforcing material after suitable treatment with cheaply available material like asphalt is one of the solution for low cost housing. The main problem with using bamboo as reinforcement in place of steel is that it absorbs water and swells and later on when it dries it reduces to its normal size and henceforth reducing the strength of the bond between bamboo and concrete. Treatment of bamboo with some waterproof coating makes bamboo less susceptible to moisture. Thus negligible swelling and shrinkage of bamboo occurs during the curing period of concrete.

Figure 3. Low cost housing

2. Green technology for Road Construction

Road construction technology needs changes to minimize damage to the environment of the earth. Aggregates are heated to temperatures between 1500C and 1800C for drying, proper coating and mixing with bitumen. Mixing temperature of bituminous mixes can be lowered by using foamed bitumen, bitumen emulsion and some chemicals which reduce the viscosity of bitumen so that less fuel is used with consequent reduction of green house gases. Use of recycled plastic, recycled aggregates and municipal wastes will slow down the degradation of the earth. Pavement can be designed to help charging of ground water.

Municipal wastes consist of considerable amount of waste materials such as plaster, bricks bats, demolished concrete. They can easily be used as materials for widening of roads as well as new road construction. Some of the waste product from coal mining is highly variable and sometimes may get ignited due to presence of pyrites. If they are used deep in embankment, there is little risk of combustion due to too low air content to allow combustion.

All footpaths, parking yards, roads of residential area and other low volume roads can be made permeable so that rain water enters into the pavements and then slowly drips into the ground water. This will also eliminate splash of water when a car moves during light rains. Most appropriate type of pavement is precast concrete pavement. For low volume roads, the sub base and base layers must be open graded granular layer which have good permeability. Treatment with cement or bitumen can enhance the strength of the granular layers for heavy traffic.

3. Low carbon building

Discovery of natural inorganic binders like pozzolanic materials resulted in lime-pozzolana (LP) cement and this paved the way for the invention of Portland cement in 1824. Portland cement and steel brought revolutionary changes in the construction practices since early part of twentieth century. Later on plastics and plastic products entered the construction industry. As we moved away from zero energy materials to more modern materials for the construction activities, it became imminent to spend more energy and natural resources. These modern materials are energy intensive and are hauled over long distances before being used for construction. In the context of carbon emission reduction and the issue of global warming, there is a need to pay attention to use of modern building materials with reference to (i) energy intensity of materials, (ii) natural resources and raw materials consumed, (iii) recycling and safe disposal and (iv) impact on environment. Indiscriminate use of natural resources and energy-intensive process for the building materials will not lead to sustainable options. Brief detail of some low carbon building material and techniques are discussed below:

BLENDED CEMENT- These are cements containing a high volume of one or more complementary cementing materials (CCM), such as coal fly ash , granulated slag, silica fume and reactive rice-husk ash. A large volume of CO2 is directly emitted during the cement manufacturing process (0.9 tonnes/tonne of clinker). Reduction in the quantity of clinker by substituting with CCM results in lesser CO2 emissions.

STABILIZED MUD BLOCK FOR MASONARY- Stabilized mud blocks (SMB) are energy efficient eco-friendly alternatives to burnt clay bricks. These are solid blocks manufactured by compacting a mixture of soil, sand, stabilizer (cement/lime) and water. After 28 days curing, these blocks are used for wall construction. Compressive strength of the block greatly depends upon the soil composition, density of the block and percentage of stabilizer (cement/lime). Major advantages of SMB are: (a) energy efficient, do not require burning, 60–70% energy saving when compared with burnt clay bricks, (b) decentralized production, production on site is possible, (c) utilization of other industrial solid wastes like stone quarry dust, fly ash etc. and (d) easy to adjust the block strength by adjusting stabilizer content.

COMPACTED FLY ASH BLOCKS- A mixture of lime, fly ash and stone crusher dust can be compacted into a high-density block. Lime reacts with fly ash minerals forming water insoluble bonds imparting strength to the block. Some advantages of the technology are: (a) decentralized production in tiny scale industries, (b) utilization of industrial waste products and (c) energy efficient and environment friendly.

Figure 4. Fly ash Blocks

RAMMED EARTH WALLS- Rammed earth is a technique of forming solid walls by compacting processed soil in progressive layers in a temporary formwork. There are two types of rammed earth constructions: stabilized rammed earth and unstabilized rammed earth. Unstabilized rammed earth is made from mainly soil, sand and gravel. Whereas stabilized rammed earth contains additives like cement or lime in addition to soil, sand and gravel. Some of the advantages of rammed earth construction include: (a) low energy intensity, (b) materials used are recyclable and bulk of the materials are locally available, (c) rammed earth offers wide variety of textures and finishes,

(d) Flexibility in plan forms for the buildings and (e) strength and wall thickness can easily be adjusted in case of stabilized rammed earth walls.

4.Green technology for Eco- friendly house

Buildings are one of the major consumers of energy and are the third largest consumers of energy, after industry and agriculture. Buildings annually consume more than 20% of electricity used in India. The awareness about the impact of depletion of fossil fuels and global warming phenomena has led to renewed interest in the green technologies.

Figure 5. Eco- friendly house

Eco-friendly house uses the naturally available resources. The house can be built in such a way that it can use the naturally available light and ventilation. The openings can be provided in south-west side which will provide better ventilation. Windows can be placed considering cross ventilation concept. Wind breakers can be provided for west side windows which will guide more air in the house. Higher ceiling height can be provided than the conventional one which will give relatively cool air at the leaving area. If the built up area is less then more space will be available around the building for air circulation.

Solar panels can be installed which will reduce the burden on the electricity consumption. Solar system can be used for the cooking of food as well as water heating. This will reduce the consumption of electricity or LPG. Implementation of rain water harvesting system can be beneficial in many ways. Few of them are i) Independent and ample supply of water in the dwelling. ii) Water received is free of costs. Use of this water significantly reduces water bills for purchased water from municipal supply.

iii) Costs incurred for purifying the water for potable use are nominal.
iv) For users located in the rural areas, an independent supply of water avoids the cost of installing a public water supply system.
v) Rainwater harvesting lessens local soil erosion and flooding caused by rapid runoff of water from impervious cover such as pavements and roofs.

Conclusion

Based on the study made above, the following conclusions are drawn:

- Green buildings are feasible & economically viable. India can reach and is capable of setting new environmental landmarks, by virtue of it being a spiritual, ecological and scientific powerhouse from times immemorial.
- The use of locally available bamboo as a reinforcing material for construction of beam/column/wall/slab is more economical and at the same time environmental sustainable.
- It is difficult to sustain the building activity to meet the future demand for buildings using the currently available energy-intensive materials and building techniques/technologies. Some examples of alternative low-energy materials were discussed which shows that embodied energy of buildings using the low-energy materials and techniques results in 50% savings in total embodied energy.

At the end of this paper, to deliver maximum benefits a holistic assessment should be considered for the green infrastructure approach. So that it is necessary to develop and use interdisciplinary approaches that integrate biological, social and other sources to provide a better understanding of the challenges of land use planning and management. Rigorous methodological approaches in order to advance land use planning and management are necessary. There is a clear need to evaluate the potential economic implications of green infrastructure linked to heath effects and health service budgets, facilitating interdisciplinary research for urban planning. Research is also needed to examine the relationship between the benefits of green revolution technology contributed individually and the sum of benefits in interaction with each other.

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