BUILT SUSTAINABLE ENVIRONMENT

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ABSTRACT. The building sector is going at a rapid speed in India. The construction materials concrete is being used extensively for all infrastructure projects in this country. This paper brings out the advantages of green building practice and measures required for saving energy by using green materials and measures for saving energy for reduce impact of the built environment. This could be achieved by efficiently used of energy, water and other resources. In this paper it's highlighted that by using green materials and taking advantages of renewable resource, construction and efficient energy use we can build sustainable environment.

Keywords: Sustainable, Environment, Carbon dioxide emission, fossil fuels, renewable energy, building envelope, green building

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INTRODUCTION

God created this beautiful earth for us but we human beings have ravaged the mother earth for our short-term gains. We have tried to squeeze out maximum short-term gains, depleting its resources. Sustainability, as a new paradigm in the past few decades, shows through some scientific evidence that flora and fauna, species, water, air, forests, deserts and other ecosystems have begun to be destroyed and natural resources are being depleted. Since sustainability is a multidimensional issue (local, regional and international dimensioned), it has to be developed at a level that people live work and interact with each other and with nature, minimize the problems resulting from degradation of the environment. More than half the world's population now lives in urban areas. Most critical infrastructure is built to last for several decades or longer. Globally buildings are responsible for huge share of energy, electricity, and water and materials consumption. Building green gas emissions account for 18% of global emissions, equivalent of 9 billion tonnes of CO_2 annually.

- Ruthless unplanned growth is showing its disastrous consequences in the form of tsunamis, floods, glacier melting and so on. In India we have the Mumbai's flood in 2005, Leh cloud burst in 2010, Kedarnath floods in 2013 and lately the Jammu & Kashmir floods.
- Construction of buildings, artificial flattening of natural and slope terrain, illegal constructions on river banks and flood prone areas are the bane of Indian cities.
- Deforestation, river bank encroachments, degradation of lakes, siltation through river flow and obstruction in river by human activities and utter mismanagement of natural drainage are the main reasons for Uttarakhand and Jammu & Kashmir tragedies.
- The importance of infrastructure design increases with climate change. There is increasing risk of floods and landslides. Discouraging property development in such high-risk areas, by imposing restriction on planning in areas near the sea, detrimental heights from sea levels for buildings in each location have to be determined.

Global population and consumption are increasing very fast Production waste are also increasing in spite of increased efficiencies.

1. Ascending to "the living planet report" human population (humanity) is consuming 20% more the than resources the earth can produce.
2. We need to know how much land and water a human population uses to provide all it takes from nature. This includes the areas for producing the resource it consumes the space for accommodating its buildings and roads and the ecosystems for absorbing its waste emissions such as carbon dioxide.
3. Human population has been an ecological overshoot with annual demand on resources exceeding what earth can regenerate each year.
4. Earth system science involves:
    a) Exploring interactions among the major components of the earth's system e.g. the biosphere, atmosphere energy system etc.
    b) Studying the human induced cause of change in nature.
    c) Understanding and predicting the consequences of change.
5. The main flows of nature are carbon and oxygen flows. Oxygen is necessary for breathing and carbon is most important part of molecules leading to photosynthesis carbon flow is known as "Carbon Cycle".
6. Carbon is a major carrier of energy. Animal consumes food produced by photosynthesis; thus, releasing the stored-up energy and Carbon dioxide.

7. These days, the carbon cycle is out of balance and as concentration of CO_2 increases, the earth is undergoing "global warming and climate change".

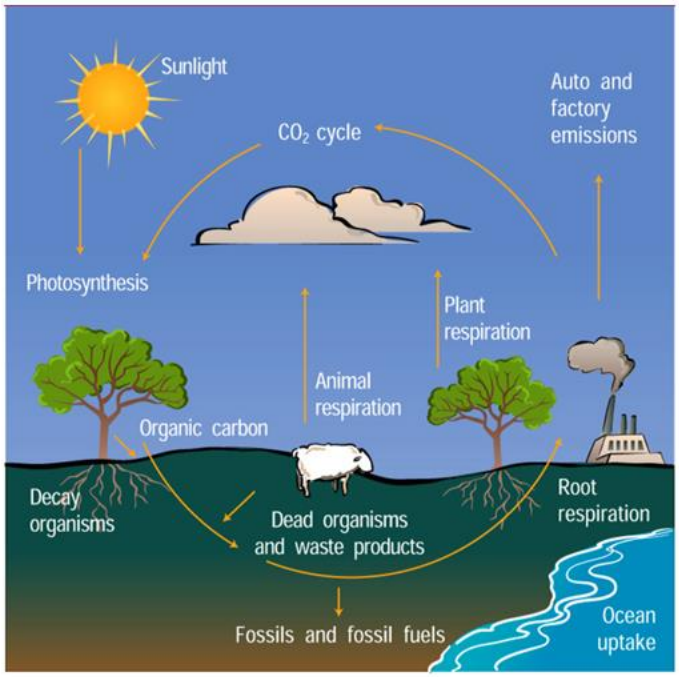

Figure 1 Carbon Cycle

CO_2 emission (USA)

- Fossil fuel use 57%
- Deforestation decay of biomass etc 17%
- Methane 14%
- Nitrous Oxide 8%
- F-Gases 1%
- Others 3%

Energy Supply 26% (USA)

- Transport 13%
- Residential commercial building 8%
- Industry 19%
- Agriculture 14%
- Forestry 17%
- Waste Water 3%

Large quantity of carbon emissions is released by burning fossil fuels. This increase is affecting adversely to our rain patterns, temperature change, water management, and food and energy production.

The impact can be; first we use resources Second, we dump waste. By the techno process we take everything from earth that we can take often that we use it, consume it, process it and dump it as a waste in the liquid, solid or gas form. Both the things harm environment. 80% of

the natural resource taken from earth goes into waste which is very harmful for our environment. Its Impacts:

1. Shortage of clean and accessible fresh water.
2. Degradation of terrestrial and aquatic ecosystem
3. Increase In soil erosion, loss of biodiversity.
4. Change in the chemistry of atmosphere

Our only concern was shortage of resources for the future but now the main problem is what is happening around us in the environment. Global warming is the biggest problem and its major contribution comes from the burning of fossil fuels, cement, steel manufacture etc. Both processes involve major emission of CO_2.

Process of change:

1. Reducing, Reusing, Recycling and Recoveries.
2. Re-engineering the materials we use
3. Changing the molecule flows using non-fossil fuel energies
4. Realizing that sustainability is Good Business scene

By the processes of change, we can reduce the environment impact of technology. By re-engineering materials, we can reduce the volume of take and waste. Through cultural change we can create awareness for the demand of sustainable outcomes and by evolving and changing techno processes, achieve cost effective sustainable solutions.

Sustainability is the capacity to endure or support sustainable materials use of resources such as energy, material and water with increased efficiencies for its production and induction. While reducing impact on human health and environment during the life cycle, up to demolition and disposed or recycle, shall meet the current needs and requirements without compromising with the ability of future generations to meet their own needs.

To minimize Embodied energy and CO_2 emission

SUSTAINABLE DEVELOPMENT

Living within the means of planet, reduction of impact of our activities on the earth system.

Role of materials

Use of locally available natural material is sustainable and shall have low embodied energies. India being the 2^{nd} largest producer of cement after china, there is significant scope of improvement by reduction of wasteful misuse. Cement can be sustainable by use of recycled aggregate and use of other cementious materials such as flyash, ggbfs, pozzolonic rather than OPC alone and also lowering cement consumption through mechanization and admixtures. {By variations in properties of materials, variation in properties e.g. w/c, variation due to mixing process, variation of compaction quality}. Efficient and effective use of admixture is possible in engineered concrete. Mechanical admixtures used for improvement of long term strength and durability performance and chemical admixture used for specific property/performance enhancement using above admixtures together, significant reduction in cement consumptions is possible.

By substituting use of puzzolonic materials, we can replace the part of ordinaryportland cement and also lower cement consumption through mechanization and addmixtures.

1. Materials play a major role in buildings. The green materials are sustainable and will have low embodied energy,
2. Durability and speed of construction,
3. There is significant scope for improvement in India by reduction of wasteful misuse. In making use of recycled aggregate, other cementitious materials rather than OPC alone (Pozzolanic, ggbgs, flyash, silicafume etc)
4. It will lead to less consumption of embodied energy and less carbon dioxide emissions.

Concrete and green construction

Through mechanization we can reduce the consumption of cement by
1. Variation in properties of materials.
2. Variation in proportion, e.g. w/c ratio,
3. Variation due to mixing process,
4. Variation in compaction quality,
5. Use of admixtures
6. Efficient and effective use of admixture is possible in engineered concrete

Role of Building envelope

Design/Decision Variables
1. Envelope
2. Orientation and shape of the building with respect to sun and wind direction.
3. Appropriate WWR (20-30%) that would increase day light to reduce the need for day time lighting.
4. Fenestration and Glass
5. Good ventilation and good indoor air quality
6. Shading devices and land scaping to allow the desirable sun and cut off the non-desirable sun as well as divert the wind direction wherever required.
7. Use of balconies, Verandah, court yard, sky light for conservation and light ventilation

Thermal Properties

Mechanics are conduction through solid:
Thermal properties are given below

(Max U factor and minimum R Value) Insulation materials in building envelope walls Roofs
A. Energy conservation as per energy's Building Code 2007.
- Automatic light shut off occupancy sensors and other lighting controls
- Efficient transforms electric check metering and monitoring

B. Mandatory Requirement
- Natural ventilation as per National Building Code 2016
- Maximum equipment efficiencies
- Automatic controls for cooling and heating system

Energy Efficiency: - Use of LED, improved insulation, energy efficient appliances house energy and (By Technological improvement 40-60% consumption could be reduced)
Energy Conservation: - Turn off lights and gadgets when not required, unplug such appliances, conserve water (Behavior change) less use of fossil fuel energy will bring down pollution and global warming and will bring down expenses. Energy efficiency, water

efficiency, materials efficiency, indoor environment quality enhancement, reduction of waste pollution, environment degradation, and maintenance optimization would reduce impact on built environment.

The whole Building as a System:

Basic requirements – Building, Lighting, HV AC, Electrical Lifts and Escalator service, water heating, envelope.

- Heat gained from roof
- Heat gained from well
- Heat gained from glass/ day light from glass
- Heat gained from infiltration,
- Heat gain from equipment/lighting/people
- Max thermal value permissible into the Building through (Outdoor-indoor temperature difference Thermal comfort, ventilation, Daylight)

GREEN BUILDING

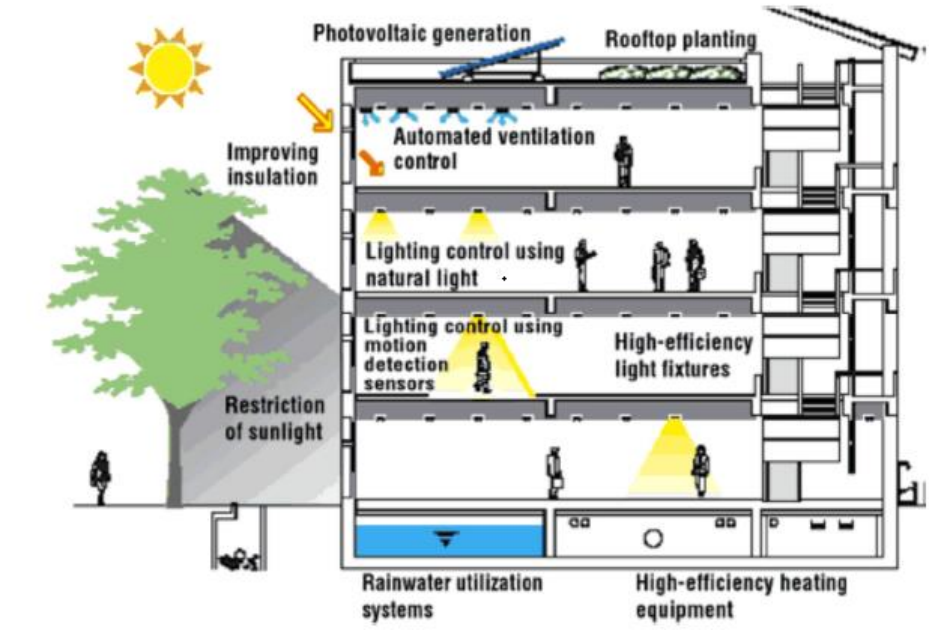

Figure 2 Sample of Green Building

- Site assessment/development- protect and restore habitat, maximize open space
- Energy efficiency
- Material efficiency; use of recycled non-toxic building materials
- Water efficiency; efficient use of water
- Air quality
- Building operation and management
- Solid waste management
- Use of eco-friendly equipments
- Use of renewable energy
- Effective controls

Green Building Strategies

- Reduce human exposure to hazardous materials
- Maximize use of renewable energy
- Consume non-renewable energy and scarce materials
- Green Construction or sustainable building refer to both a structure and the application of processes that are environmentally responsible and resource efficient throughout a building's life cycle; from planning to design, construction, operation, maintenance, renovation and demolition. This requires team work (close co-operation of the contractor, the architects, the engineers and the client at all project stages.)
- Use of H2O efficiency
- Use energy as effectively as possible
- Protect and restore local air, water, soils, flora and fauna
- Minimize materials impact by employing green products
- Present environment degradation
- Create built environment that are livable, comfortable and safe
- Minimize materials impact by employing green products
- Reduce human exposure to hazardous material,
- Use integrated design process
- Protect and restore habitat
- Mineral Admixture: - used for improvement of long-term strength and durability performance.
- Chemical Admixture: - used for specific property/performance enhancement

Using above admixtures together, cement consumption can be reduced.

Factors affecting concrete sustainability

- Life cycle energies implication
- Life cycle green house gas contribution
- Contribution to natural resource depletion
- Fly ash, Light concrete, aerated blocks, Recycled aggregates, etc.

Energy Consumption

- To provide energy efficient design and construction of buildings,
- Building envelope,
- Mechanic system and equipment for heating ventilating and conditioning
- Interior and exterior lighting,
- Electrical power and motors safety, environment should take precedence,
- Less transformer loss, motor efficiency, electric check metering and monitoring system,

Effective utilization of resources, reduce pollution, water conservation energy conservation brings people closer to nature, conservation of the not environment for a better tomorrow development not at the cost of health. On the World Environment (5^{th}June) a few initiatives should be taken. Save energy, go digital, go paperless, green practice through plantation drives, eco-friendly products for pollution check; discourage the use of plastic on daily use and awareness campaign.

Sustainable features; Good orientation, sufficient indoor thermal mass, good ventilation, use of renewable solar energy with photovoltaic panels, smart building with efficient energy system.

CONCLUSION

We need to learn from the Scandinavian countries who have developed lighter form of construction for their mountainous and river side terrains and there are countries where construction is forbidden in geologically unstable territories.

New buildings and infrastructure must reduce the use of fossil fuel. Need to increase the use of renewable energy (solar energy, wind etc.). New buildings will have to incorporate a range of new technologies to reduce their energy use, and to cut the energy needed to build them, including the embodied energy in the materials they contain. Policy makers and urban planners need to prepare a road map to deal with the unprecedented threads of climate change posed to our infrastructure.

A few important measures are immediately required.

- Mitigation of climate change by reducing green house emissions
- Identify infrastructure vulnerable to climate risks and implement adaption strategies to maintain transportation systems and services and ensure public safety.
- New development away from areas at risk for sea level rise, flooding, landslides or wildfires.
- Strengthen contingency plan to prepare for and respond to more frequent and severe weather.
- Step up energy and water efficiencies and conservation efforts and promote new methods to boost reliability and energy and water supply security.

Taking timely action to reduce risks can help to ensure that our infrastructure investments and operations are safe and prudent under future climate conditions. We must clearly understand that in the modern world the environment hosts the city rather than the other way around. Less consumption of resources will result in sustainable environment and better tomorrow.

REFERENCES

1. PROF. B. BHATTACHARJEE, Advanced Concrete Technology, Lecture notes, IIT Delhi