Green Building: Concept and Practice

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Abstract: **Over the years, promotion of Green Building (GB) construction has become inescapable because of unsustainable nature of conventional building technology. Now, all MES buildings to be constructed are required to comply with Green Building norms and meet a minimum GRIHA 03 Star Rating. IDSE officers, being important stake holders, are expected to take lead in promotion and practice of GB. It's planning, being a multifaceted problem, is done by a multidiscipline team to achieve greenness with economy. Here, a brief history of GB has been traced. Subsequently, various stages of planning along with relevant factors for consideration are discussed. Then, a perspective view identifies various aspects of GB planning likely to be adopted in future. It is hoped that GB can be made self sustainable in future by cogeneration, harnessing solar and wind energy and utilizing intelligent control system in near future.**

1. INTRODUCTION

Military Engineer Services (MES), being the largest and oldest Government construction agency in the county, is expected to take lead in adoption and implementation of the Government policy intended to have societal benefits. Ensuring greenness of buildings is a major policy initiative by the Government to meet necessary demand of housing in sustainable manner with minimal depletion of natural resources. But, because of lack of understanding of concept of "Green Building", till date implementation has not been very encouraging. So, as important stake holder it is responsibility of IDSE Officers to take lead in making society in large and construction professionals in particular aware regarding "Green Building". This effort will go a long way in preservation and protection of our natural diversity while ensuring housing for everyone. However, this will require good understanding of concept of green building and utilization of same in our construction practices.

2. BUILDING INDUSTRY AND ENVIRONMENT

Building industry is a major contributor to serious environmental problems because of excessive consumption of energy and other natural resources. Modern building technology is energy intensive. So, to construct a building and meet its energy needs during operation it causes severe depletion of invaluable environmental resources. As an estimate, this industry consumes 40 % of total energy and about one half of the world's major resources. Conventional practices of building technology demonstrate human dominance over nature and inefficient and over use of natural resources. So, the practice of conventional building technology is not sustainable, as sustainability requires restraints over use of natural resources .So, concept of environmental friendly and energy efficient building called "Green Buildings" is a key solution to meet necessary demand of housing in sustainable manner. However, the moot point is whether we are understanding concept of green building and utilizing this understanding in construction and operation of our building's or not?

3. GREEN BUILDING

Green Building is similar to a conventional building in its appearance and functionality. But during its design, conscious steps are taken to ensure that during construction and operation of the building depletion of natural resources is minimal and good health and well being of occupants of the building are ensured. It is sustainable in nature and some of salient features of a green building are that it:

- Causes minimal disturbance to landscapes and site condition.
- Uses Recycled and Environment friendly Building materials.
- Uses New-Toxic and recycled/recyclable materials.
- Uses water and water recycling efficiently.
- Uses energy efficient and ecofriendly equipment.
- Uses renewable energy.

4. LOOKING BACK

Practice of construction of sustainable buildings date to antiquity. The concept of "Vastu" and use of renewable materials/passive solar design concept were well known to ancient Indian and Greeks respectively. However, The contemporary green building movement arose out of the need and desire for energy efficient and environment friendly building practice. Formally, green building field began in 1990. This is mainly as a result of research spurred to improve

energy efficiency because of increase in oil price in 1970s and environment**al** movements after 1960s.In India, Indian Green Building Council (IGBC) promotes concept of "Green Building".

Green Rating for Integrated Habitat Assessment (GRIHA) is an indigenous system developed by "The Energy Research Institute (TERI), New Delhi" for the measurement of greenness of buildings in India. It incorporates Indian Standards and uses 100 point with 01 to 05 Star rating system. Points for greenness to building is awarded depending upon concept, construction practice material and pattern of uses adopted during building construction /construction planning. A building scoring point upto 50 is not considered green. The building scoring 51 to 60 point is rated as single star whereas that with 91 to 100 point is rated as 05 star green building.

4.01 Benefits of Green Buildings:

It has following tangible and intangible benefits over conventional building :

Protection of biodiversity and ecosystem:

- Reduction in operation cost.
- Reduction of strain on local infrastructure.
- Enhanced asset value

Intangible Benefits:

- Improved occupant productivity
- Enhanced occupant comfort and health
- Improve air and water quality
- Higher productivity
- Better health

So, why these building are not being constructed in place of conventional buildings? This is mainly because of lack of awareness on the subject, initial higher cost and because it requires an integrated approach involving all key stake holders in the process of designing, planning and constructing of building. Further, this requires consideration of many factors like site selection, orientation of building, landscaping, energy utilization/ generation/equipments, materials, finishes etc. However, green building planning and construction is a dynamic process which keeps changing with time starting from antiquity and its worthwhile to discuss the same.

5. LOOKING PRESENT

As per current scale, all MES buildings are required to comply with Green Building Norms and meet a minimum GRIHA 03 Star rating as per Government policy. This requirement can easily be met with human resource available with the department as in addition to having multidiscipline planners, defence is having sufficient land available with rich tradition of preservation of natural environment. So, the requisite flexibility to ensure greenness of buildings in terms of site selection, site planning, orientation and layout of buildings etc. is available. Green Building Concept is well known and its long term benefits Over Conventional buildings are well established. Still, it is not so popular mainly because of initial higher cost. So, during planning various alternatives for the complete building should be generated and proper analysis for achieving green and economical building should be done using system design method. The system design approach and other factors involved in planning of Green Building are discussed.

5.01 System Design: Building is treated as a system and system design technique of operation research is applied to obtain an optimum or best system, planning and Sub-optimization for every component is done by synthesizing, analyzing and evaluating various alternatives. This process is repeated continuously to get the optimum sub buildings initially and complete building subsequently. So, adopting this approach initial cost of green building can be optimized.

5.02 Planners: The experts from various fields like architect, landscape Engineer, owner, user, interior designer, electrical, mechanical, plumbing engineers and energy professional need to synergize their effort to apply interdisciplinary approach to plan a Green Building.

5.03 Regulations and directives : Regulations and directives reflect life safety concerns of Society. These are issued to ensure personal safety of the people and to protect the building against damage and defects incorporating human experience. So, planners are required to ensure strict compliance of regulations and directives in vogue. This helps in ensuring health and well being of building occupants.

5.04 Site Selection: Site selected should be such that because of proposed building disruption and disturbance to existing natural systems is kept minimum. Prior to selection of site it should be ascertain whether the site characteristics suit the development concept. Physical features of site, transportation facilities, zoning, distance from population centre and facilities, local soil conditions, anticipated construction problem etc should be considered. The most sustainable and environment sensitive development requiring very minimal site disturbance is selected.

5.05 Location of water bodies: water should be used as a good modifier of microclimate. It works as a sink for large amount of heat and causes significant coaling especially in hot and dry climate.

5.06 Preservation of Soil and trees: The top soil, in most cases, is the most nutrient rich layer that supports vegetative growth. Topsoil removal and preservation should be done. The preserved topsoil should to be re-laid for vegetative growth through a suitable process, after ensuring its nutrient contents as per laid out codes and standards. Suitable measures such as contour trenching, mulching to prevent soil erosion and run-off should also be taken.use of green belts and protected wetland to establish an innate network of native habitats, and to support flexible spaces integrated with the landscape for community gathering or informal activities should be done.

5.07 Use of native species: In the current practice, we develop expansive lawns, which is the largest water consumers in any landscape. Lawns needed as much as 40%-60% more water as compared to native/ indigenous plant species or trees. Native species protect the nutrients in the biomass, promote eco-diversity, and require less maintenance and water as compare to exotic species. Because of their ability to adapt to local conditions, the native communities slow down the depletion of natural resources while maintaining the character of regional landscape. Diverse communities with varying ages and characteristics – such as trees, shrubs, vines and perennials should be planted – and monocultures and invasive species should be avoided. In addition, water requirement for landscaping should be controlled thorough adoption of efficient watering practices e.g. drip irrigation.

5.08 Reduce hard paving: Hard paved parking lots, pathways, plazas and courts should be minimized. Hard paved areas enhance imperviousness of the site and generate a heat island effect, which causes a sharp microclimate temperature rise. By reducing perviousness of the site, hard paving also lowers the localized aquifer recharge potential. Dark colored and constructed surfaces absorb solar energy and radiate it back when the ambience is cooler. So, typically one find a sharp temperature rise in built urban areas than in green areas. Thus, plan strategies should look at a combination of soft and hard landscape, use of pervious paving, use of light colored surfaces with higher solar reflective index, shaded hard paved surfaces. Planting trees and bushes adequately also help to minimize the heat island effect.

5.09 Site lighting: Site lighting is mainly used to illuminate connections between buildings and support facilities such as sidewalks, parking lots, roads, community gathering spaces, landscaped areas and for security purposes. It must be carefully designed to avoid waste and nuisance. It must address a few basic standards such as- it should avoid over luminance; it should be properly shielded to avoid light pollution; the optical control of light is also critical. Waste light does not contribute to increased night time safety, utility or security and needlessly consumes energy. This may be done by:

- Restrict area and time for night time illumination-minimize areas on site that need to be illuminated all night. For security lighting, motion-sensors may serve the purpose, in place of constant lighting.
- Clearly identify the actual purpose of lighting to determine minimum acceptable levels- safety and security lighting is an important part of exterior lighting. Layered lighting provides minimal ambient illumination with accents on hazards, destinations and architectural features.
- Use energy-efficient lamps and ballasts- The most efficient new lamps produce ten times as many lumens per watt of power as a conventional incandescent bulb. Savings on operating-cost and labor, including deferred bulb replacement quickly recover the cost of re-lamping. Technologies to reduce light pollution include full cut-off luminaries, low reflectance surfaces, and low-angle spotlights.
- Use of appropriate control strategies- simple timers of photocells can be used to turn lights on and off at appropriate times.
- Use renewable energy sources for lighting and other outdoor power- Photovoltaic power is low-maintenance and very reliable. Its design must be specific to both the region and the site. It requires storage batteries for night time lighting. Manufacturers also offer solar path lights, steer lights, and security lights. Low voltage lighting with photovoltaic collectors should be considered for energy – efficient alternative.

5.10 Layout of the building: It affects aesthetics, cost, functional and operational utilities, cost of services and even elegance of the building. So, various possible layouts should be considered to selects a system that can economically accommodate the lateral drift, desired bay sizes and help in keeping building green.

5.11 Building Form: Building Farm determines S/V (Surface to Volume) ratio. In hot and dry regions and cold climates, buildings are compact in form with a low S/V ratio to reduce heat gain and losses respectively Building form also determines the air flow pattern around the building directly affecting its ventilation.

5.12 Orientation of the building: In predominantly cold regions, buildings should be oriented to maximize solar gain, the revers is required for hot regions. However, in regions where seasonal changes are very pronounced, both the situation may arise periodically, so a balance in orientation is required. GB is oriented by keeping building in efficient relation to the sun, wind, rain, topography and outlook while ensuring convenient access. Vastu and other religious/ local tradition is also taken into consideration to avoid subsequent alterations on these account. An effective balance between sun and wind orientations is required.

5.13 Building envelope design: The building envelope and its components are key determinants of the amount of heat gain and wind that enters inside the primary elements affecting the performance of a building envelope are :

5.14 Material and construction technique: Material selected should be with low embossed energy. It also helps in attaining the desired comfort conditions conducive to warm and humid climate. This may be done ensuring low level of energy consumed in the construction of the building using natural stone, recyded doors and windows, waste tiles and dominating all forms of plastes.

5.15 Roof : Depending on the climatic needs, proper roof treatment is essential. In a hot region the roof should have enough insulation properties to minimize heat gains.

5.16 Walls: The wall thickness, material and finishes should be chosen based on the heating and cooling needs of the building.

5.17 Fenestration and shading: Fenestration design is primarily governed by requirements of heat gain and loss, ventilation, and day lighting. Fenestration having 15-20% of floor area found adequate in both hot and dry, and hot and humid regions**.** Provisions of IS: 3362-1977 (Code of practices for natural ventilation of residential buildings should be taken into account during planning of design of windows for lighting and ventilation, thus, while planning fenestration, requirement of heat gain and loss, ventilation, and day lighting should be considered.

5.18 Finishes: The external finish of a surface determines the amount of heat absorbed or rejected by it

5.19 Energy Efficiency: Green building is designed such that it should have optimum energy performance and yet should provide the desirable thermal and visual comfort. The fundamental strategies adopted for it are :

5.20 Solar passive techniques: Passive systems provide thermal and visual comfort by using natural energy sources like solar radiation and sinks like vegetation. India has six climatic zones ranging from extreme conditions in the cold regions of Leh and Ladakh to extreme hot & dry conditions in Rajasthan. A building in a cold climate zone needs to adopt measures to maximize its solar heat gains by embracing measures like maximum exposure to the south, windows to capture heat, dark colored surfaces, high thermal mass and insulation, to retain the captured warmth of the sun OR use of design elements such as thrombi wall, sun spaces etc.

On the other hand, a building designed for a hot climate should take measures to reduce solar gain like, smaller window sizes, shaded walls, minimum exposure to the west and east. OR use of design elements like solar chimneys, wind towers, etc to maximize ventilation. Use of building materials like energy efficient glass, e.g. insulated double glass units with solar control coatings can reduce heating / cooling demand by 8-10%.

5.21 Environmental Control System: Environmental Control within HRB is achieved by heating, ventilation and air conditioning (HVAC) along with lighting and sound control. The physical environment within a building is influenced by many variables like temperature, humidity, air movement and air quality. So, proposed environmental control systems are considered in integrity with other building systems such as construction of walls, roofs, shape and orientation of building. Evaluation of alternatives is done by taking into account initial construction costs, life cycle cost, energy conservation and operating costs for HVAC.

5.22 Energy efficient Equipments: Once the passive solar architectural concepts are applied to a design, the load on conventional systems (HVAC and lighting) is greatly reduced. Further, energy conservation is possible by efficient design of the artificial lighting and HVAC system using energy efficient equipments, controls and operation strategies.

5.23 Rain water harvesting: Water harvesting though an age old practice is emerging as a new paradigm in water resource development and management. It is the process to capture and store rainfall to prevent its runoff, evaporation and seepage for its efficient utilization and conservation in a watershed.

- There are two ways of RWH:
- Storing rain water for ready use.
- Recharging into aquifer.

5.24 Use of renewable energy systems: The pressure on the earth's non renewable resources can be eased by effective use of the earth's renewable resources e.g. solar, geothermal, wind and biomass energy.

4.25 Indoor Environmental Quality : Green buildings are required always to be fresh and healthy. So, interior design is done in such a manner that indoor environmental quality is controlled. Interior construction planning is done with proper choice of material, components and details to ensure proper thermal, acoustics benefit, optimal floor ceiling and roof ceiling systems, interior finishes retarding spread of flames from fires in interior spaces along with acceptable light reflectance characteristics .Exterior doors and windows must relate to location of interior partitioning also. Artificial lighting and ventilation should be in co-ordination with utilization of natural light and ventilation.Further, pollution prevention may be done by:

- Avoiding use of carpet
- Use of interior finish materials with low or no volatile organic compounds (VOCs)
- Use of non toxic finishes for wooden floors
- Avoid use of engineered wood products.
- Use of natural alternatives to synthetic cleaning compounds.

5.26 Miscellaneous: Area drainage, internal /external finishes, built environment is kept in resonance with environment.

6. LOOKING AHEAD

Because of technological advancement in the area of information technology, building technology and non conventional energy, there is all probability that in near future the following will be a trend in GB planning:

6.01 Self Sustainable Building: Ideally self sustainable HRB will not require any energy / resources from outside. It will be made self sustainable by cogeneration (i.e. recycling the material generated as waste) and utilizing natural solar energy collected by the huge façade exposed to the sun and stronger and persistent wind on the roof for generation of power. In long term this alternative is likely to prove even economical.

6.02 Intelligent Control system: Direct digital control is utilized as a direct link between substations and the centralized instrumentation system to ensure optimum energy utilization in various operations performed to control internal environment .It will also help in ensuring functional requirement of various mechanical systems. Further, this system will be utilized for safety against natural and manmade disaster management,

6.03 Waste management: Biological waste water treatment with the help of an aerobic process helps even in water requirement reduction as treated water may be used for gardening and flushing requirement.

6.04 Appropriate Building Technology: This technology uses bricks of fly ash, stabilized earth, ferrocement for roof channels, doors and shelves, etc. concrete, glass, steel etc are sparingly used.

7. CONCLUSION

GB planning is a complex, multifaceted and challenging task. It requires synergistic effort of experts from various fields to ensure greenness with economy. Enormous benefits may be gained by creating a green, intelligent and sustainable buildings through proper planning. Further, such planning will not only help in ensuring better productivity and well being of occupants but it will also go a long way in safeguarding our mother earth too.

REFERENCES

[1] **Mili Majumdar (2001)** Energy-efficient buildings in India, TERI, Ministry of Non-conventional Energy sources.

[2] **Merritt F.S. and Ambrose J.(1990)** Building Engineering and Systems Design, VNR New York Publications.

[3] **Yadav R.N. (2004).** Liquefaction Hazard Mitigation. Indian Geotechnical conference: 2004.

[4] **Singh R P and Yadav R.N**. **(1995).**Prediction of subsidence due to coal mining in Raniganj Coalfield, West Bengal, India. Engineering Geology, vol.39, pp: 103 – 111, Elsevier publication.

[5] **Yadav R.N. (2003).**Quality in Indian Construction Industry. 6th National Conference on Construction organized by C.I. D.C., New Delhi.

[6] **Yadav R.N. (2002).**Reforms in Indian construction industry: An overview. 5th National Conference on Construction organized by C.I. D.C., New Delhi.

[7] **Yadav R.N. (2004).** Globalization and Indian Construction Industry. International Conference on Construction organized by C.I. D.C., New Delhi.

[8] **Yadav R.N (2008).** High Risk Building Planning. An overview, 14th Annual convention Seminar on "Recent Trends in High Risk Buildings" organized by Indian Building Congress.

[9] **Yadav R.N (2009),** Seismic Risk Management, National seminar on "Environment Protection In Building Industry" organized by Indian Building Congress.

[10] Yadav R.N. (2009). **Capacity Development: Indian Construction Industry**. **National conclave on construction organized by C.I. D.C., New Delhi.**

[11] **Yadav R.N (2010).** Green Building Planning, 16th Annual convention and Seminar on "Sustainable Development &Environmental Concerns" organized by Indian Building Congress.