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Understanding Sustainable Approach on Eco-Design in Cold Climate – A Case Study

Abhimanyu Sharma

Assistant Professor, Department of Architecture & Landscape Design ,
Shri Mata Vaishno Devi University, Katra, Jammu & Kashmir, India

(Corresponding author: Abhimanyu Sharma)
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ABSTRACT: In today's era, urbanization, globalization and modernization have become the necessity of the humanity. Pertinent to that, the building sector is the world's largest contributor of global greenhouse gas emissions. More than 33% of energy produced use is consumed in offices, homes, and other buildings. This figure is expected to double by 2030. It is authoritative that new construction projects and renovations to existing construction should be focused on eco-friendly design, which provides a low-cost means to battling climate change, thus, reducing energy bills, and diminishing our reliance on fossil fuels. Consideration of climate must also figure prominently into eco-planning, emphasizing the most appropriate forms of renewable energy for the region. Many factors need to be considered while creating an eco-sensitive built environment, including: making the finest technical use of local resources to avoid the cost (financially and ecologically); determining the most optimum balance between harnessing natural sunlight and insulating the inside of a structure from its accompanying heat; and creating natural ventilation and air filtering through design rather than focusing on energy draining air conditioning systems. These aspects significantly affect quality of life and should not be forsaken. Their ecological adaptation is necessary for public to adopt more sustainable lifestyles. The focus of this study is to balance our communities' future needs with the sustainment of home comforts and quality of life, urban development with renewable energies and finally the balance of ecological building design with high life-cycle materials with people and nature.
My aim of this research is to highlight the basic principles of eco-friendly architecture in cold climate and to apprise the community about environmentally conscious design process to achieve sustainable results. More thrust will be given on creating awareness of proposing eco-friendly design by taking advantage of climatic conditions and vernacular architecture by highlighting the resource efficient building practices.

Keywords: Eco-design, energy efficiency, solar passive heating, timber roofs

I. INTRODUCTION

The ecosystem is defined as the way that plants, animals, and people affect their environment and how the environment can be kept healthy. Ecology is defined as the study of the interactions of organisms and their physical and biological environment.

In architecture field the eco-design is how to exploit the existing energy improving, the integration between environment and human being needs and how they should tie together to achieve the ideal performance for building, environment and human welfare.

An eco-design is modelled on the energy and material flows of natural ecosystems, and thus enhances rather than corrupts the environment. It conserves resources (energy, water, food and materials). It also produces resources or gathers and stores more of them than it uses.

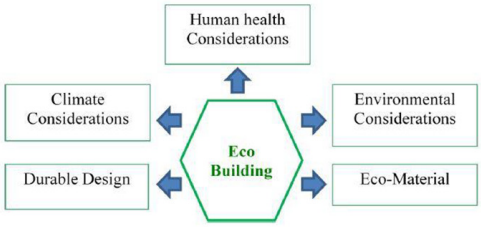

Fig 1. Ecological design criteria

There is no waste because the resource flow is circular. It is a part of complex interaction between people, building themselves, the climate and environment. Environmentally-helps reduce pollution, conserve natural resources and prevent environmental degradation.

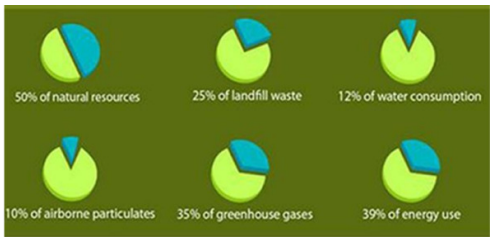

Fig. 2. Impact and Usage of Building.

II. NEED OF STUDY

Buildings and construction sector takes up greater share of resources for land use and material extraction -many of which are non-renewable resources and are responsible for 36% of all waste generated worldwide. Pertinent to that, the building sector is the world's largest contributor of global greenhouse gas emissions. The basic principles of eco-friendly architecture in cold climate are require to be follow and implement for the improvement of the humanity.

III. PRINCIPLES OF ECO-DESIGN

A. *Eco Materials*
B. *Structural Design efficiency*
C. *Energy Efficiency*
D. *Water management*
E. *Waste and toxic reduction*
F. *Indoor environment quality control*
G. *Operation and maintenance*
H. *Maintaining the Integrity of the Specifications.*

IV. CASE STUDY - 1 - AAMOD RESORT,SHOGHI (SHIMLA), H.P.

Fig. 3. Resort Hut.

A. *Introduction to the site*

The Site of Aamod Resort, Shoghi is set in forest near to Shimla town on land provided by Forest Department under its new eco-tourism policy. The resort is developed in an area of 3 acres with all the administration, recreational and residential facilities with beautiful landscaped pockets. The city lies in Cold and Cloudy Climate zone having fairly long winters (October to March) during which temperature reach about zero degrees. Site has hill slope and thick cover of oak and pine trees.

The pedestal and vehicular movement is segregated within the site in such a manner that the main parking is provided at a distance of 0.5 km from site and only the service van is allowed to enter the site and to reach the areas for basic amenities. As far as materials are concerned, use of local slate tiles for paths inside the site in implemented to balance the natural ambience of the site. The resort is developed on a contour site with the level difference of 30 meters from highest to lowest point. Minimum alteration in site landform is done without disturbing the natural levels of the contours. Efficient planning of structures Placement of structures is in a way to minimize movement in the site to avoid pollution.

Fig. 4. Pathways.

B. Structure design efficiency
Construction type- Prefabricated timber construction
Foundation- random rubble masonry
Materials- Wood, thatch, tinplate

The pre-cut system is the oldest system of prefabrication. Pieces of timber are processed, cut to the required lengths, notched or drilled at the factory. The pieces are then marked and transported to the site for assembly.

Fig. 5. Prefabricated cottage.

Compared to the conventional method of cutting timber in falling lengths at the site, this system is more accurate in its measurement and material wastage is minimized and minimum damage to landscape and wildlife is done. The production and processing of wood uses much less energy than most other building materials.

- ✓ *Construction type*- Prefabricated fibreboard walls with thatch roof
- ✓ *Foundation*- random rubble masonry
- ✓ *Materials*-Fibre board, Thermocol, Plywood panel ,
- ✓ C.G.I sheet, thatch ,tinplate, Bamboo mat
- ✓ Pre-Fab system –Dry construction
- ✓ Factory made components are transported and assembled on site to form the structure.-So no pollution on site
- ✓ No wastage of materials
- ✓ Less maintenance
- ✓ Minimum damage to landscape and wildlife

C. Energy Efficiency Implemented

Cottages are located on the south slope of the hill for better access to solar radiation. Exposure to cold wind is minimized by locating the building on leeward side compact planning in order to reduce heat loss. Sufficient sloping roofs are implemented to enable quick drainage. As far as the walls and floors are concerned, wood is the main material used for the construction as it is a natural insulator due to air pockets within its cellular structure. Tin is light weight and thatch being naturally waterproof protects tin from rusting and also acts as an insulator. (It helps in keeping heat sealed in).

Fig. 6. View of a Single Cottage.

- ✓ Fibreboard panel with thermocol sheet for insulation
- ✓ Tinplate roof- Locally available
- ✓ Easy installation with less pollution
- ✓ Thatch-Renewable building material (made of water reed)
- ✓ Very less maintenance

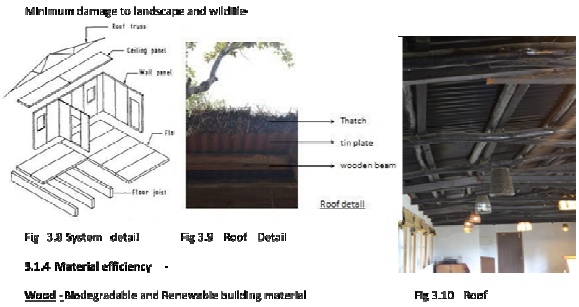

Fig. 7. Roof Details.

V. MERITS AND DEMERITS

MERITS

- ✓ Use of low embodied energy materials.
- ✓ Minimum waste and pollution generated during construction
- ✓ Preservation and protection of landscape during construction
- ✓ Utilities planned efficiently to achieve onsite circulation efficiency
- ✓ Efficient building design to reduce energy demands
- ✓ Reduced volume, weight and time of construction by adopting prefabricated system of construction
- ✓ Efficient waste segregation
- ✓ Parking is planned outside the site to ensure minimum pollution in site

Fig. 8. Interior view of Dining Area.

DEMERITS

- ✓ Some of the construction techniques require high maintenance and protection from rain like adobe brick construction
- ✓ Non-renewable sources of energy used
- ✓ No use of rainwater harvesting. No water recycling or reuse techniques adopted.
- ✓ Nonrenewable energy based hot water system.

VI. CONSIDERATION FOR ECO DESIGN

1) Site-

- ✓ Isolated location should be avoided as they usually make operation both difficult and expensive.
- ✓ Site should be chosen with low operating cost and low environmental impact.
- ✓ Any unnecessary changes to the landform should be avoided.
- ✓ Traffic flow within the site should be planned using the shortest available route.
- ✓ Landscaping should become an extension of the existing ecosystem, mimicking it and preventing further fragmentation.
- ✓ Native vegetation should be allowed to grow on site, such vegetation can be employed to create shelter belts used for redirecting winds and breezes, visual screen and acoustic barrier.

2) Energy:-

- ✓ Use renewable sources of energy. (The pressure on earth's non-renewable resources can be reduced by judicious use of earth's renewable resources)
- ✓ Design building layout in order to reduce energy needs
- ✓ Building schematic design relating to building size and form have major impacts on energy performance, climate responsive design should be adopted.

3) Materials:-

- ✓ Select materials, construction and demolition technologies to limit the amount of waste, emission,pollution, contamination at all stages of development and operation.
- ✓ Select technologies either vernacular or prefabricated.
- ✓ Use low embodied energy material.
- ✓ Use nontoxic building material.
- ✓ Select reusable and recyclable material
- ✓ Select materials that helps in improving performance and reducing operating energy use

4) Water Management:-

- ✓ Carefully select services that require water
- ✓ Retain on site as much water as you can
- ✓ Find resort uses for water you are harvesting including grey water
- ✓ Adopt techniques for grey water treatment.

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