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Passive Solar Heating

Aditya Waingankar[1], Sushant Shelke[2], Ashutosh Valvi[3], Sumit Waghmare[4]
[1](Civil, VIVA Institute of Technology/ Mumbai University , India)
[2](Civil, VIVA Institute of Technology/ Mumbai University , India)
[3](Civil, VIVA Institute of Technology/ Mumbai University , India)
[4](Civil, VIVA Institute of Technology/ Mumbai University , India)

Abstract : *Passive solar technologies are means of using sunlight for useful energy without use of active mechanical systems, as contrasted to active solar techniques. The scientific basis for passive solar building design has been developed from a combination of climatology, thermodynamics, particularly heat transfer, and human thermal comfort. Specific attention is directed to the site and location of the dwelling, the prevailing climate, design and construction, solar orientation, placement of glazing-and-shading elements, and incorporation of thermal mass. More than 90% reduction in lighting consumption, and more than 50% saving in overall energy consumption has been achieved in this complex, which thus provides a clean and pollution free work environment. Climate of Mumbai is warm and humid the temperature ranges between 30° to 35° and 25° to 30° in summer and winter respectively and humidity is about 60%. This paper studies the passive techniques that can be adopted for the warm and humid climate of Mumbai.*

Keywords *- Architecture, Energy, Environment, Software, Solar Building*

I. INTRODUCTION

- There are six climatic zones in India. They are as follows;
  1. Hot and dry
  2. Warm and Humid
  3. Moderate
  4. Cold and Cloudy
  5. Cold and Sunny
  6. Composite

  Among these, Mumbai region is fall under Warm and Humid climatic condition.
- The characteristics of each climate differ and accordingly the comfort requirements vary from one climatic zone to another.
- This method is very useful as it fully depends on natural resources. Earth and sunlight are the major elements in working of passive solar heating method.
- There are different types of solar passive techniques and they are as follows; 1. Direct gain 2. trombe wall 3. Water wall 4. Solar chimney 5. Trans wall 6. Roof pond 7. Roof radiation trap 8. Solarium 9. Evaporative cooling 10. Noctumal radiation
- Direct gain is the most basic form of passive solar heating. Sunlight admitted through south facing glazing the space to be heated, and is stored in a thermal mass incorporated into the floor of interior walls.

II. METHODOLOGY

1. Analysis of Passive design

- A passive solar design involves use of Sun's light and natural process for heating and cooling to achieve balance in temperature or interior conditions. There are various types of passive solar techniques, but the selection of those are depends upon the climatic condition in that region.
    1. Induced ventilation
    2. Desiccant cooling
    3. Day lighting
- We are using Induced Ventilation, Passive cooling by Induced ventilation is more effective in Warm and Humid climate. This method involves heating of air into the room and restricted area, this creating temperature variation in the room and causing continuous air movements into the room. The draft causes hot air to rise and exit to the ambient and gets cool air inside, the cooler air having greater density so it I'll enter through the bottom. This cooler air enters into room through inlet provided at the bottom of the room.
- The air circulation is set into an open loop that is connected to the external space through a vent or pipes or mere openings at the top and bottom of rooms to be cooled the exit of hot air through the top vent and entry of external cool air from bottom facilitates the movement of air in that loop. This loop is induced by the movement of hot air in the upward direction.

2. Planning, and Estimation

- Properly oriented windows: -Windows or other devices that collect solar energy should face within 30 degrees of true south and should not be shaded by other buildings or trees from 9 a.m. to 3 p.m. each day during the heating season.
- Thermal mass: - Thermal mass in a passive solar home are commonly concrete, brick, stone, and tile that absorbs heat from sunlight during the heating season and absorbs heat from warm air in the house during the cooling season. Other thermal mass materials are more efficient at storing heat, but masonry has the advantage of doing double duty as a structural and finish material. In well-insulated homes in moderate climates, the thermal mass inherent in home furnishings and drywall may be sufficient, eliminating the need for additional thermal storage materials. Make sure that it does not block sunlight on thermal mass materials.
- Distribution mechanisms: - Solar heat is transferred from where it is collected and stored to different areas of the house by 3 modes of heat transfer 1. conduction, 2. convection, and 3. radiation. Small fans and blowers also help to distribute heat. Conduction occurs when heat moves between two objects that are in direct contact with each other, Convection is heat transfer through a fluid such as air or water, and passive solar homes often use convection to move air from warmer areas and sunspace, Radiation is what you feel when you stand next to a wood stove or a sunny window and feel its warmth on your skin. Darker colours absorb more heat, and are a better choice for thermal mass in passive solar homes.
- Control strategies: - Proper sized roof overhangs can provide shade to vertical south windows during summer months. Other control approaches include electronic sensing devices, such as a differential thermostat that signals a fan to turn on, operable vents and dampers that allow or restrict heat flow, low-emissivity blinds, operable insulating shutters; and awnings.
- Some of the elements we will consider include:
    1. Insulation and air sealing
    2. Window location, glazing type, and window shading
    3. Thermal mass location and type.
    4. Auxiliary heating and cooling systems.
- We will apply these elements using passive solar design techniques that include direct gain, indirect gain, and isolated gain.
- In a direct gain design, sunlight enters the house through south-facing windows and strikes masonry floors and walls, which absorb and store the solar heat. As the room cools during the night, the thermal mass releases heat into the house.
- An indirect-gain passive solar home has its thermal storage between the south-facing windows and the living spaces. The most common indirect-gain approach is a Trombe wall.
- The wall consists of an 8-inch to 16-inch thick masonry wall on the south side of a house. A single or double layer of glass mounted about one inch or less in front of the dark-coloured wall absorbs solar heat, which is stored in the wall's mass. The heat migrates through the wall and radiates into the living space.
- Isolated Gain: -The most common isolated-gain passive solar home design is a sunspace that can be closed off from the house with doors, windows, and other operable openings. Also known as a sunroom, solar room, or solarium, a sunspace can be included in a new home design or added to an existing home.
- Then using software making developed plan, elevation, section, schedule of opening, and staircase design.

- Estimation: - The Cost Estimate Worksheet identifies several design elements and land conditions, independent of the heated square footage size, that increases the cost of the home. Calculating an estimate without taking these less obvious costs into account results in inaccurate numbers. For Example:
    a. A home with a small cover over the entry will cost less than the same home with a wraparound porch, because of the extra labor and materials needed for the porch.
    b. A home with a flat roof will cost less than the same home with a pitched roof because of the additional materials and complexity of a pitched roof.
    c. A home with a five car garage will cost more than a home with a two car garage.

  Our worksheet pinpoints items in our design concepts and building site that cost more and gives a "factor" to those items.
  The final cost of our home depends on the cost of all labour, materials and fees that we pay to get it built. These costs will depend on the location of our home, the time of year we are building. The challenge is to be realistic about our budget from the beginning and then to stay committed to the budget throughout the design process. If we are successful here, our project's budget will stay on track. We take our budgets very seriously and spend extra time in the design process to ensure that there are no budget surprises once the final construction documents are completed.

III. CONCLUSION

The basic natural processes that are used in passive solar energy are the thermal energy flows associated with radiation, conduction, and natural convection.
These basic responses to solar heat lead to design elements, material choices and placements that can provide heating and cooling effects in a building.
They can perform effortlessly and quietly without mechanical or electrical assistance.
Reductions can be made to heating and cooling bills by as much as 40% annually and also improve comfort of living spaces.
The economical solution to a warmer house in the summer is to insulate it well, while understanding the movement of heat is better solution.
Passive techniques can be used for designing the building will result in less maintenance, less energy consumption and comfortable living environment in houses

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OBJECTIVES

- To Design the Passive solar heated house for humid conditions.
- To maximize the benefits to be gained from the radiant heat and light that come to a building from the sun.
- The goal of passive solar heating systems is to capture the sun's heat within the building's elements and to release that heat during periods when the sun is absent, while also maintaining a comfortable room temperature.

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