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March 12, 2022



VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION

ANNUAL RESEARCH JOURNAL

ISSN(ONLINE): 2581-7280

PASSIVE SOLAR HEATING

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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: - *solar building, architecture, energy, environment, software*

I. INTRODUCTION

- In passive solar building design, windows, walls, and floors are made to collect, store, reflect, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. This is called passive solar design because, unlike active solar heating systems, it does not involve the use of mechanical and electrical devices.
- The key to design a passive solar building is to best take advantage of the local climate performing an accurate site analysis. Elements to be considered include window placement and size, and glazing type, thermal insulation, thermal mass, and shading. Passive solar design techniques can be applied most easily to new buildings, but existing buildings can be adapted or "retrofitted".
- The passive technique for different region is differs from climatic zones and their characteristics. 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, Warm and Humid climate covers the coastal part of country. Mumbai region is fall under this 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. Nocturnal radiation

II. METHODOLOGY

1. Site Selection

- We choose Mumbai Because the climate in Mumbai is warm and humid, so it becomes very crucial to design the passive system to control the humidity level. This can be done by adopting passive techniques for reducing the humidity level in the incoming air. Additional benefit of reducing the moisture level is that it can help in controlling the indoor air quality of the indoor space.
- Site should be at favourable location where the building can gain sunlight in winters on the south facing wall without any obstruction.

2. Analysis of Passive design

- A passive solar design involves use of natural processes for heating and cooling to achieve balance interior condition. To prevent heat from entering in to building; this depends upon two conditions; one is availability of heat sink which is at lower temperature than indoor air, and second is promotion of heat transfer towards sink (heat sinks are outdoor air, water, ground, etc.).
- There are various types of solar passive techniques, but the selection of those are depends upon the climatic condition in that region. For Mumbai region, 3 techniques are advisable i.e.,
 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 restricted area, this creating temperature variation 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 is introduced into room through inlet provided at the bottom.
- 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 or space 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. The loop is induced by the movement of hot air in the upward direction.

3. Planning, and Estimation

- Properly oriented windows: - Typically, windows or other devices that collect solar energy should face within 30 degrees of true south and should not be shaded during the heating season by other buildings or trees from 9 a.m. to 3 p.m. each day. During the spring, fall, and cooling season, the windows should be shaded to avoid overheating. Be sure to keep window glass clean.
- Thermal mass: - Thermal mass in a passive solar home commonly concrete, brick, stone, and tile 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 such as water and phase change products are more efficient at storing heat, but masonry has the advantage of doing double duty as a structural and/or 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 objects do 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 conduction, convection, and radiation. In some homes, small fans and blowers help distribute heat. Conduction occurs when heat moves between two objects that are in direct contact with each other, such as when a sun-heated floor warms your bare feet. 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- a sunspace, for example - into the rest of the house. 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 than lighter colours, and are a better choice for thermal mass in passive solar homes.
- Control strategies: - Properly 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/or 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 buildings to consume less artificial energy

Acknowledgements

We are using this opportunity to express our gratitude to everyone who has supported us throughout the completion of this project. We are thankful for their guidance, constructive criticism and friendly advice, during the project work. We express our gratitude to Prof. Monica More for giving us an opportunity to carry out project on PASSIVE SOLAR HEATING. We would also like to thank Prof. Lissy Jose, Head of Civil Department and Dr. Arun Kumar, the Principal for their whole hearted support. Lastly, we express our gratitude towards all those who directly or indirectly helped us in the completion of our studies.

REFERENCES

- [1] Handbook on energy conscious buildings by Nayak and Prajapati, 2006
- [2] Zendejboudi et al, ‘‘A Study on performance of solar desiccant cooling system by TRNSYS in warm and humid climatic zone of IRAN’’.
- [3] Mohamad Arif Kamal, ‘‘An Overview of Passive Cooling Techniques in Building: Design concepts and Architectural Intervention’’.
- [4] H.A. Trethewen, ‘‘Sensitivity of Insulated Wall and Ceiling Cavities to Workmanship’’ Journal of Building Physic, 1991.
- [5] A. Silberstein and H. Hens, ‘‘Effects of Air and Moisture Flows on the Thermal Performance of Insulations in Ventilated Roofs and Walls’’ Journal of Building Physic, 1996.
- [6] I. Budaiwi and A. Abdou, ‘‘Impact of Indoor Air Conditions and Solar Radiation on Moisture Accumulation within Multi-Layer Non-Cavity Walls’’ Journal of Building Physics 1999