Review On : Passive Solar Building

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ABSTRACT

Houses generally refer to a shelter or building that is meant as a dwelling or place for habitation by human beings. "Houses" include many kinds of dwelling ranging from rudimentary huts or nomadic tribes to high-rise apartment buildings. A major constraint in meeting this demand is the spiraling cost of energy and other changes in climate. Passive solar buildings aim to maintain interior thermal comfort throughout the sun's daily and annual cycles whilst reducing the requirement for active heating and cooling system Passive solar building design is one part of green building design, The scientific basis for passive solar building design has been developed from a combination of climatology, thermodynamics (particularly heat transfer), and human thermal comfort (for buildings to be inhabited by humans). 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. While these considerations may be directed to any building, achieving an ideal solution requires careful integration of these principles

***Keywords**: Houses, type, buildings, rim bearing, thermal, design, heating etc.*

I. Introduction

In passive solar building design, windows, walls, and floors are made to collect, store, 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 or climatic ,design because, unlike active solar heating systems, it doesn't involve the use of mechanical and electrical devices. The key to designing a passive solar building is to best take advantage of the local climate. Elements to be considered include window placement 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". New construction offers the greatest opportunity for incorporating passive solar design, Passive solar system make use of natural energy flows as the primary means of harvesting solar energy, Passive solar system can provide space heating, cooling load avoidance, natural ventilation and day lighting.

Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces. In this approach, the building itself or some element of it takes advantage of natural energy characteristics in materials and air created by exposure to the sun. Passive systems are simple, have few moving parts, and require minimal maintenance and require no mechanical systems Sun light can provide ample heat, light, and shade and induce summertime ventilation into the well designed home. Passive solar design can reduce heating and cooling energy bills, increase spatial vitality, and improve comfort.

Solar energy is a radiant heat source that causes natural processes upon which all life depends. Some of the natural processes can be managed through building design in a manner that helps heat and cool the building. The basic natural processes that are used in passive solar energy are the thermal energy flows associated with radiation, conduction, and natural convection. When sunlight strikes a building, the building materials can reflect, transmit, or absorb the solar radiation. Additionally, the heat produced by the sun causes air movement that can be predictable in designed spaces. These basic responses to solar heat lead to design elements, material choices and placements that can provide heating and cooling effects in a home. Passive solar energy means that mechanical means are not employed to utilize solar energy.

To get the most from your home - think sun. That's right, the sun can heat and cool your home and reduce its energy use. More importantly, the energy from the sun can make your home comfortable year round. There are two types of solar design systems -passive and active. Homes constructed as passive solar design use the natural movement of heat and air to maintain comfortable temperatures, operating with little or no mechanical assistance. It's called passive solar because the design of the home maximizes the benefits it receives from the sun with standard construction features. Passive solar takes advantage of local breezes and landscape features such as shade trees and windbreaks, and uses a simple system to collect and store solar energy with no switches or controls. On the other hand, active solar systems use mechanical devices such as pumps and fans to move heat from collectors to storage or from storage to use. Photovoltaic panels that collect solar energy, turning it into electricity, are also considered an active solar system.

II. Literature Review

- **Serkanet.al (2003)** concluded that the energy-efficiency design strategies by passive solar components having the additional cost of about 9% of the total building cost, it is possible to save the total annual energy used in this specific residential building by 18%. It will save three types of energy need for the space conditioning and visual comfort (i. e., heating, cooling and lighting), 61% energy use reduction in heating is the maximum energy saving, lighting energy use is also decreased by 40%. However, in cooling energy need, there is an increase of 34%.
- **Andreas Athienitiset. al (2008)** stated that Based on the design of the houses, it is expected that homes with low and near net-zero energy use can be designed in a cost effective manner within a period of about 5 years, provided a heat pump-based system is used for heating and heat is recovered from the PV system and efficiently utilized in the house.
- **Tanbiruj et.al (2010)** finalized that the solar energy that receive naturally by a building can be used to heat the building without special devices to capture or collect sunlight in direct gain passive solar system. Passive solar heating can be apply by using of large sun-facing windows (south-facing in the Northern Hemisphere) and building materials. A well-insulated building with such construction element can absorb the sun's energy and reduce heating bills around 50 percent.
- **Anil kumar (2013)** concluded that concept of appliance of solar energy distribution through the use of a sun path diagram and the multiple ways in which this can be used for energy efficient buildings and also for evolving passive solutions possible in buildings and also provides an overview of the sun based passive solutions and design approaches possible in the case of buildings especially with reference to tropical countries.
- **AbdolvahidKahoorzadeh et.al (2014)** shows passive solar elements like shading devices. Additional elements would keep the interior space at a more comfortable and stable temperature. Similarly, the indoor humidity can be controlled. Open the building up at night to ventilate and cool interior thermal mass. Close the buildings up during the daytime to keep the heat out. Therefore, with a standard passive solar system, dwellers feel more comfortable in terms of any conditions either cold weather or hot weather. It also has financial benefits. In fact, buildings require relatively small cooling or heating systems.

III. Components

- **Collection:** Passive heating concepts use heat from the sun to offset winter heating needs. The collection subsystem may include windows, skylights, or some other type of solar aperture. The purpose of the collection subsystem is to allow sunlight into the building to heat the space and, if appropriate, to heat the storage mass. The storage subsystem usually includes parts of the floor or interior walls of the building.
- **Storage:** The purpose of the storage subsystem is to store the collected solar heat until it is needed by the occupants in the building. In most cases, heat is collected during the daytime and used at night. Stored energy is released from the storage mass and distributed throughout the building to offset heating energy use.
- **Distribution:** Distribution is accomplished by arranging the functional spaces of the building such that those that need heat are closest to the storage subsystem. The size and shape of the solar apertures (collection subsystem) affects the quantity of heating energy available to offset auxiliary heating energy needs. The size of the storage subsystem affects the quantity of heat stored and the time delay between initial collection and final use of energy. The size, shape, and location of rooms in the building impact the optimum distribution of the heat throughout the building. Heat distribution is accomplished by a combination of radiation and convection. Heat is radiated from the storage subsystem into the rooms being heated after the collected solar energy has passed through the storage system. Heat is convected through the air, warming it, and thereby warming the people in the room.

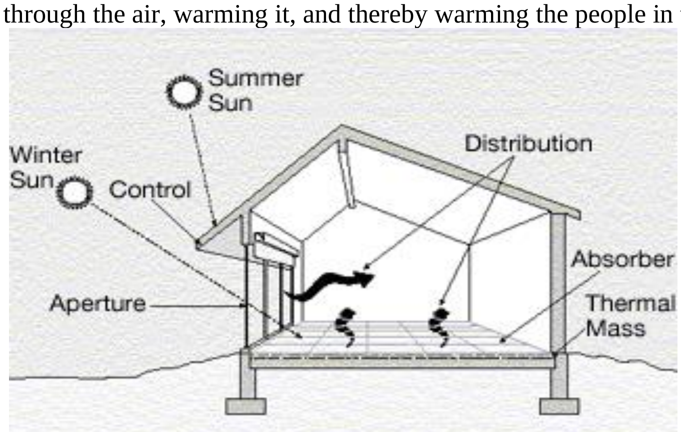

Fig. 1 Components

- **Control:** Control of the passive heating system might be quite different from control of an HV or HVAC system. In many passive buildings, control is achieved through the use of shading devices, or some other means to regulate the sunlight entering the building. More complex passive buildings may also have thermostats to control fans and motors that regulate the air flow control vents. In many passive buildings, the control mechanisms are manual; that is, people control the building. A balance between the size, shape, and location of each subsystem must be achieved to ensure optimal system performance and Efficiency. If the collection subsystem is too large or too small, then either too much energy is collected and the building is overheated or not enough energy is collected to be effective. Similarly, if the storage subsystem is improperly sized, then it either holds the energy in storage too long (oversized) or not long enough (undersized) to provide heat to the building when it is needed. Finally, if the spaces of the building are not correctly organized, the heat cannot be distributed in a manner that ensures optimal auxiliary heating energy savings and comfort. In developing this handbook, extensive analysis was done to determine the - optimal size of different subsystems for various climate zones and building types.

IV. Passive Solar Building Design Principle

- **Orientation**

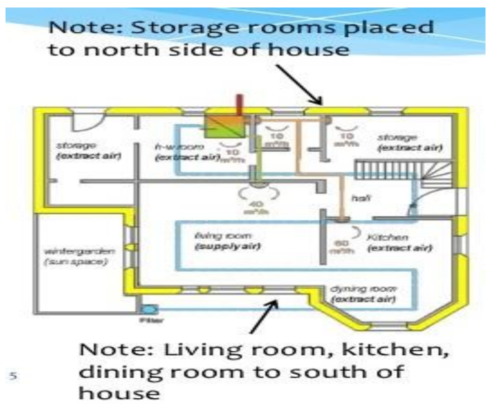

Fig.2 : Orientation

Here's a news flash...the sun rises in the east and sets in the west. Here's another the sun is higher in the summer sky and lower in the winter sky. So what does that have to do with a passive-design house? Everything. This simple lesson of nature literally sets the foundation for a well-designed solar home.When settlers constructed haciendas and missions in early California, they used a simple and inexpensive design technique that today's builders all-too-often overlook: placing a building in its natural surroundings to make it more comfortable for its inhabitants. Early Spanish designs were usually long rectangular buildings, situated so their longer walls faced toward the south to absorb the heat from the low winter sun. In the summer, when the sun was higher in the sky, long porches helped to shade the buildings and keep them cooler.

- **Overhangs And Shading**

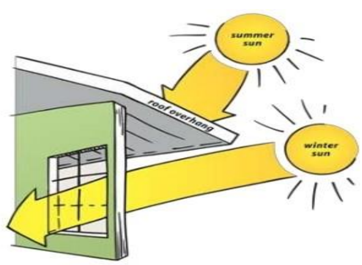

Fig. 3. Overhangs and shading

Keep the sun off the glass in the summer. Let the sun fall on the glass in the winter. How can you do both? Shade, of course. Overhangs are one of the best (and least costly) shade design elements to include in your home. In the summer, when the sun is high in the sky, the overhangs should shade the room completely. In the winter, when the sun is low, the overhangs should allow the full sun to enter, warming the air, as well as the floor, wall and other features. It's important that overhangs are properly sized. If they are too short and in the summer, your south-facing glass can act as a solar cooker for your living spaces. If they are too long, your living areas will stay dark and cool not only in the summer, but in the winter as well. The best scheme to keeping your home cool is not to let it get hot in the first place, so use shade when possible. Besides overhangs, shading can be provided by several other means: cover panels over skylights, insulated drapes or shutters, exterior shades, awnings and landscaping.

- **Windows :-** Keep the sun off the glass in the summer. Let the sun fall on the glass in the winter. How can you do both? Shade, of course. Overhangs are one of the best (and least costly) shade design elements to include in your home. In the summer, when the sun is high in the sky, the overhangs should shade the room completely. In the winter, when the sun is low, the overhangs should allow the full sun to enter, warming the air, as well as the floor, wall and other features. It's important that overhangs are properly sized. If they are too short and in the summer, your south-facing glass can act as a solar cooker for your living spaces. If they are too long, your living areas will stay dark and cool not only in the summer, but in the winter as well. The best scheme to keeping your home cool is not to let it get hot in the first place, so use shade when possible. Besides overhangs, shading can be provided by several other means: cover panels over skylights, insulated drapes or shutters, exterior shades, awnings and landscaping.
- **Thermal mass**

Fig. 4 Thermal mass

Thermal mass is simply a solid or liquid material that will absorb and store warmth and coolness until it is needed. Thermal mass in the form of concrete, masonry or water has a much better storage capacity for heating and cooling than does the surrounding air. That's why thermal mass acts to prevent large changes of indoor temperature as the outdoor temperatures rise or fall. In fact, a well designed solar home can hold an interior temperature between 68 and 70 degrees, balancing the square footage of glass (solar collectors) and the right amount of effective thermal storage mass.

V. Passive Solar Building Design Concepts

- **Direct Gain:-** Direct gain is the simplest approach and usually the most economical to build. With this system, sunlight enters the house through large areas of south-facing glass. It heats the floor and walls directly. Energy from the mass in floors and walls is released to the living space when the inside air temperature is lower than that of the mass. Clerestory windows and skylights are sometimes used to increase the amount of sunlight hitting the back area of walls or floors. They can help improve the performance of the direct gain system. Skylights, however, tend to create overheating problems in the summer and may leak if improperly installed.

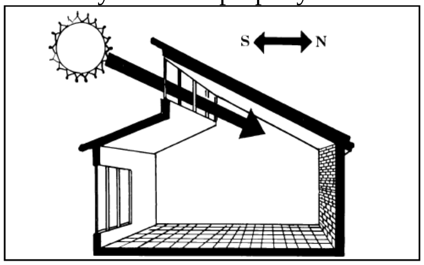

Fig. 4 Direct Gain

- **Indirect Gain**

In this passive solar system, the storage mass is between the south glass and the living space. Indirect gain systems use a thermal wall to store collected heat. Usual choices are a masonry Trombe wall or a water wall of tubes or barrels placed several inches behind the window. The concrete block or brick Trombe wall is usually 8 to 12 inches thick. In comparison, direct gain mass is usually just 4 to 6 inches thick but is spread out over a larger area. During the day, sunlight passes through the south-facing glass and is absorbed by the mass. The mass heats up slowly and then releases heat to the living spaces 6 to 8 hours later. The time lag as the mass warms and then gives off heat keeps temperatures in the living space fairly uniform. It also means that the heating of the living area occurs in the late afternoon and evening, when it is most needed. The Trombe wall can be vented or unvented. The vented wall allows heated air to circulate directly to the living space. Stored heat in the thermal mass is also radiated later to the living space. A vented Trombe wall requires nighttime closing of wall vents. Otherwise, heated air would cycle back to the front of the Trombe wall from the living space and be lost to the cooler temperatures outside.

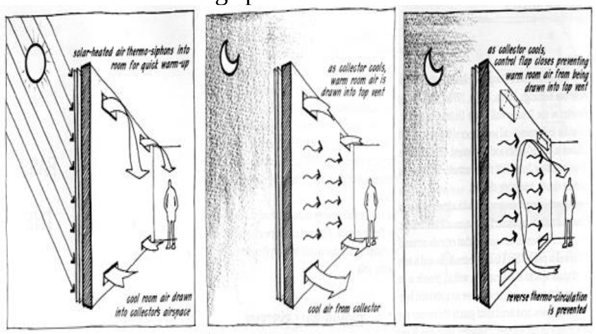

Fig.4: Indirect gain

- **Isolated Gain:** An isolated gain system has its integral parts separate from the main living area of a house. Examples are a sunroom and a convective loop through an air collector to a storage system in the house. The ability to isolate the system from the primary living areas is the point of distinction for this type of system. The isolated gain system will utilize 15 - 30% of the sunlight striking the glazing toward heating the adjoining living areas. Solar energy is also retained in the sunroom itself. Sunrooms (or solar greenhouses) employ a combination of direct gain and indirect gain system features. Sunlight entering the sunroom is retained in the thermal mass and air of the room. Sunlight is brought into the house by means of conduction through a shared mass wall in the rear of the sunroom, or by vents that permit the air between the sunroom and living space to be exchanged by convection. The use of a south facing air collector to naturally convict air into a storage area is a variation on the active solar system air collector. These are passive collectors.

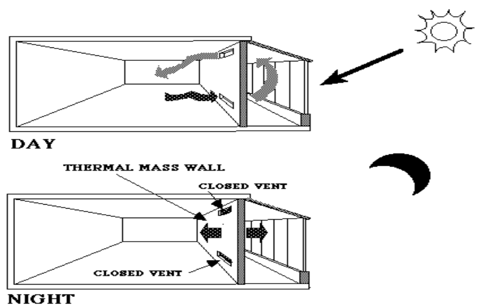

Fig. 5 Isolated Gain System

- **Passive Solar Cooling:**
  - **Ventilation & Operable Windows:-** A primary strategy for cooling buildings without mechanical assistance (passive cooling) in hot humid climates is to employ natural ventilation. (The Fan and Landscape sections also address ventilation strategies.) In the Austin area, prevailing summer breezes are from the south and southeast. This matches nicely with the increased glazing on the south side needed for passive heating, making it possible to achieve helpful solar gain and ventilation with the following strategies:
  - **Wing Walls:-** Wing walls are vertical solid panels placed alongside of windows perpendicular to the wall on the windward side of the house. Wing walls will accelerate the natural wind speed due to pressure differences created by the wing wall

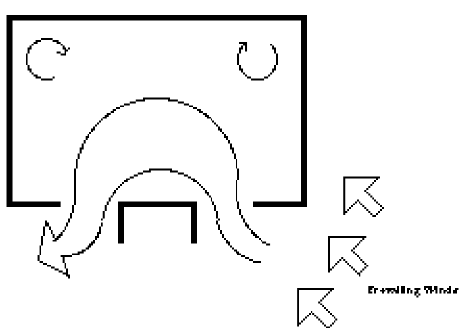

Fig. 6 Top View of Wing Walls Airflow Pattern

- **Thermal Chimney:-** A thermal chimney employs convective currents to draw air out of a building. By creating a warm or hot zone with an exterior exhaust outlet, air can be drawn into the house ventilating the structure. Sunrooms can be designed to perform this function. The excessive heat generated in a south facing sunroom during the summer can be vented at the top. With the connecting lower vents to the living space open along with windows on the north side, air is drawn through the living space to be exhausted through the sunroom upper vents. (The upper vents from the sunroom to the living space and any side operable windows must be closed and the thermal mass wall in the sunroom must be shaded.)

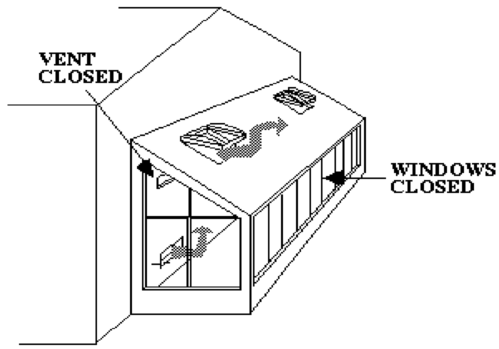

Fig.7 Summer Venting Sunroom

- **Passive solar lighting:** "Passive solar" is a term used to describe the sun's natural lighting and heating abilities. One of the most effective ways to utilize passive solar lighting in your home is through the installation of a skylight Skylights (SKY), as illustrated in Figure, are horizontal apertures cut through the roof of a building. Skylights bring light into a room year-round, and are perfect ideally placed above rooms that are located at the center of a building. To achieve the most benefits from your skylight, the unit should be installed with a south facing orientation. This will provide light to rooms on the northern side of your home, even if they do not have an east or west exterior wall.

VI. Conslusion

Passive solar building design is a part of green building design by the providing this type of design; we can able to use solar energy, which offers no cost & our non-renewable resources can be saved to a larger extent. Passive solar building design provides thermal comfort during various seasons, like summer, winter & it is very use full design to provide natural ventilation in the building, passive solar provides natural light by installation of photovoltaic, which didn't require any other source of energy, proper orientation of building can be done by this type of design. As we are seeing the day by day the earths weather condition is changing improperly due to the pollution which we are making on the earth, & global temperature is also raising day by day, This year in India we are observing a Highest temperature of 47^{o} C, in north, so there is a lot of scope for this type of construction which provide us a complete comfort during all seasons and all weathering condition. In western countries this type of construction is common scenario, and they have codal provisions for Passive solar design, but unfortunately in India we are still lacking behind, this is a very vast study area to deal with, So i expect this report may help us to know something about the need for this subject.

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