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Passiven Solar Residential Building Design: Analytical Study for Warm and Humid Climatic Condition in India

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Abstract : Structures are significant buyers of energy to the extent that their development, activity, and upkeep are concerned. However this isn't very much evaluated in India, there is adequate extension for energy reserve funds. Indoor conditions are turning out to be progressively significant for human solace and according to a wellbeing perspective. It is assessed that practically half of the worldwide energy request is because of structures. Accordingly, energy-cognizant design has advanced to resolve the issues. It includes the utilization of eco-accommodating and low energy-concentrated building materials, fuse of detached sun oriented standards in building plan and activity including daylighting highlights, combination of sustainable power advancements, preservation of water, wastewater reusing, precipitation gathering, and utilization of energy-proficient machines in structures.

Regardless of admittance to a huge data base on different elements and methods, and spearheading work in this field by engineers the world over and in India, the energy-cognizant plan approach isn't exceptionally far and wide. The mastery created at different Indian foundations has not permeated to engineers at large, especially in a structure that can straightforwardly be executed in their plans. This exploration is a work to situate the reasoning towards the significance and advantages of energy-cognizant plan. The exploration gives data on essential standards, climatic states of India, detached sun oriented approaches, general suggestions, explicit rules, and mix of sustainable advancements in structures.

IndexTerms **- Passive Solar building, Energy conservation, Climatic zones, Energy-conscious architecture.**

I. INTRODUCTION

Sun controlled energy, amazing light, and power from the sun have been taken care of by people since past times utilizing a degree of truly making improvements. Sun arranged radiation, nearby optional sun based stimulated assets, for example, wind and wave power, hydroelectricity, and biomass, address the majority of the open innocuous to the environment power on the planet. One piece of the open, sun based energy is being utilized. Light based advancements are extensively portrayed as either isolated sun controlled or dynamic sun-powered, contingent on how they catch, convert, and spread sun based energy. Dynamic sun based frameworks coordinate the utilization of photovoltaic sheets and sun arranged warm experts to saddle the energy. Isolated sun based systems incorporate organizing a development toward the sun, picking materials with ideal warm mass or light dispersing properties, and organizing spaces that routinely course air. Light, in the most stretched out sense, is the immovable rehashing extent of electromagnetic radiation released by the sun on the planet. The light is secluded by the World's ongoing conditions, and sun based radiation is quite obvious when the Sun is into the great beyond. Precisely when the quick sun arranged radiation isn't hindered by the hazes, it is capable as light, a blend of great light and breathtaking power. Precisely when it is closed by the hazes or weaves off of different articles, diffusing light is capable. Fig 1.1 shows around 50% of the approaching sun based energy which arrives at the World's surface.

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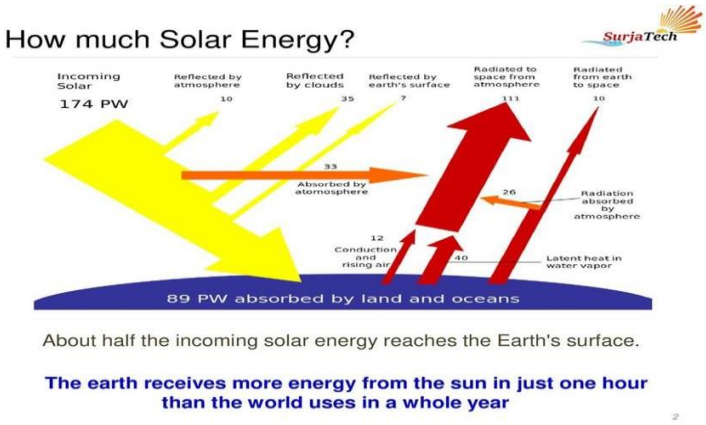

Fig. 1: Half the incoming solar energy reaches the Earth's surface

(Source: https://slideplayer.com/slide/16681313/)

There are six essential aloof sun-oriented energy arrangements:

1. Direct sunlight-based gain
2. Aberrant sun-based gain
3. Separated sun-based gain
4. Heat capacity
5. Protection and coating
6. Arranging and gardens

At the point when the sun isn't exactly apparent, for example, around evening time, latent sun based warming frameworks discharge the intensity that has been aggregated in the structure's constituents. The plan should have south the plan should have south-bound glass and warm mass to successfully assimilate, store, and move heat.

'Warm mass' portrays a material's ability to ingest, store and delivery heat. A typical similarity is warm mass as a sort of warm battery. Water and cement have a high ability to store heat and are alluded to as 'high warm mass' materials. Protection froth, conversely, has next to no intensity stockpiling limit.

In warm or sweltering environments, heat is retained during the day and then delivered at night when the abundance can be either "flushed out" through normal ventilation or it very well may be utilized to warm the space as the external temperature decreases. On the other hand, by putting away and delivering heat, a high, warm mass "smooths out" the limits in daytime temperatures.

Summer Cooling:

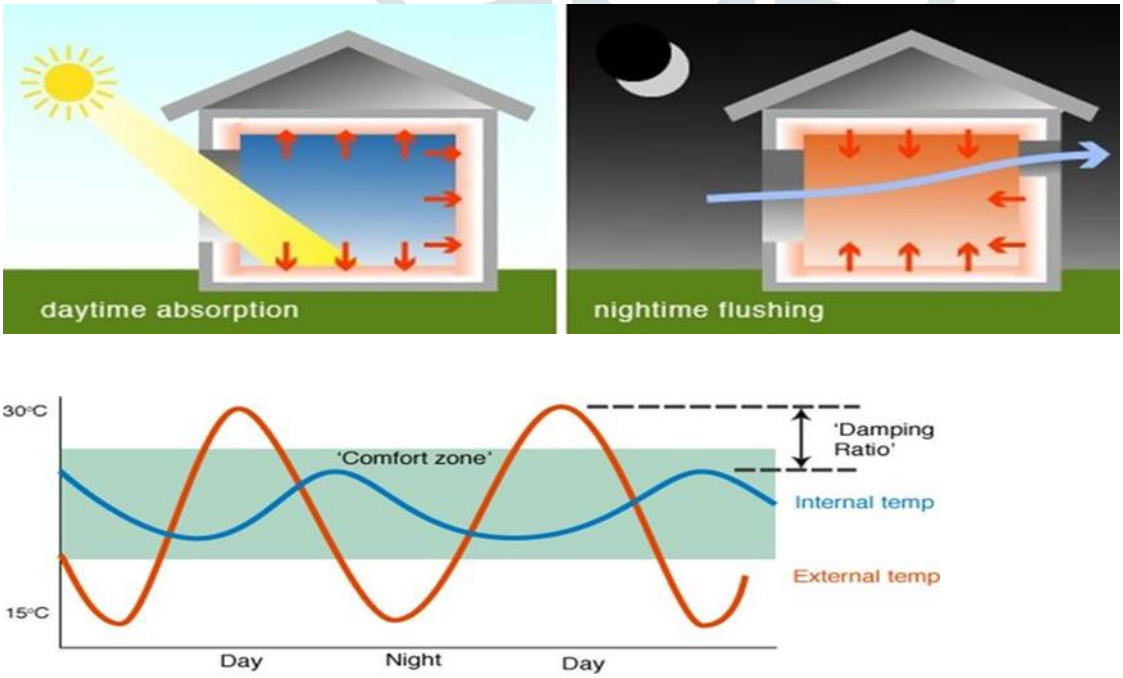

Fig.2 Summer cooling

Winter Cooling:

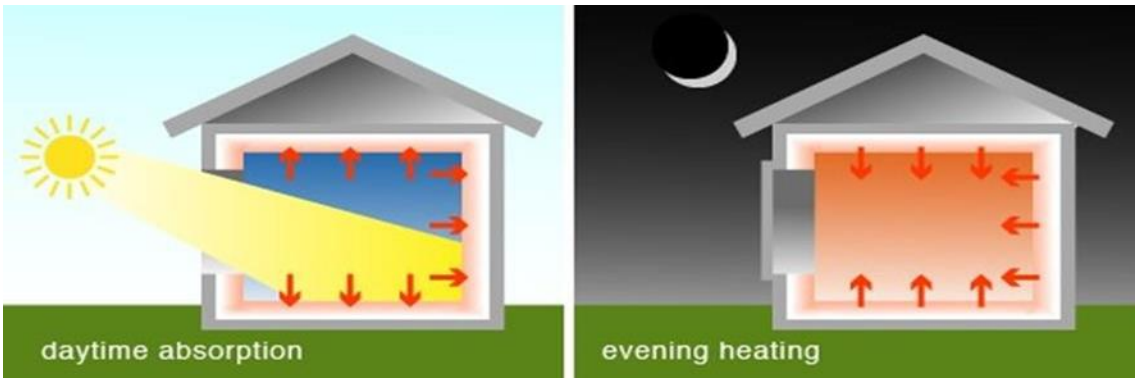

Fig. 3 Winter heating

(source: https://www.greenspec.co.uk/building-design/thermal-mass/)

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II. Literature Review

The PJ Trade Center (2016) acts as an effective passive design, with shading devices, orientations, vegetation, natural ventilation, concrete ventilation blocks, and materials playing a key role in achieving thermal comfort. The trees and buildings planted around Garden Square act like a heat-relieving filter. Using concrete ventilation blocks on parts of the building will improve the quality of the room and improve ventilation for user comfort. The concrete ventilation block also acts as a shading device, allowing air to flow into the building and allow it to ventilate naturally. The natural ventilation and stack effect system used at the PJ Trade Center also facilitates ventilation and helps reduce the amount of time the air in the building is ventilated. Building orientation supports the design of concrete ventilation blocks as a natural cooling strategy. The brick material of the building also contributes to heat absorption and thermal comfort at average ambient temperatures.

Singh et.al (2016) examine the height-to-width ratio of the constructed mass to each other and the height-to-width ratio to other physical features such as trees and roads. Not only can it contribute to the desired indoor heat conditions, but it can also reduce the use of valuable land for other purposes.

Andreas Athienitis et al (2008) predicts that installing a heat pump in home design will result in a very cost-effective way to design a home with low energy consumption and a net budget of almost zero within about five years increase. The basic system is used for heating and the heat is recovered by the PV system for efficient use at home.

III. Methodology

Actual properties of the materials like concrete,

The presentation investigations of the structures were done. The climate information for the computations have been taken from handbooks. The technique took on depended on two suppositions, to be specific,

1. The building is conditioned and
2. The building is not conditioned.

The private structure has been researched under the two circumstances. For the adapted cabin, nonetheless, they were loose to 20°C for warming and 25°C for cooling. The month to month as well as yearly cooling and warming burdens for each building type and for every one of the six urban communities referenced before, are introduced graphically. The portion of burdens through different structure parts is likewise given.

The parts are:

- Surfaces: heat move from all surfaces to the room air,
- Air trades: the intensity move brought about via air trades, and
- Inside gain: the convective intensity gains because of metabolic intensity delivered by tenants and that delivered by hardware and lights.

The rate wise intensity gains and misfortunes because of the parts consistently are introduced graphically for simpler translation. It very well might be noticed that the rate values depend on outright numbers.

IV. PROPOSED RESEARCH WORK

On account of non-molded structures, the room temperatures have been determined. From these, the yearly least, greatest and normal temperatures of each room are utilized for correlation. Furthermore, two other execution markers have been utilized for correlation. One of them is the level of hours in a year that each room is inside the agreeable temperature range. This reach depends on the month to month versatile solace temperature (Demonstration) of a spot, which is characterized as:

ACT = 16.2 + 0.41 Tm …(4.1)
where,
Tm is the month to month mean surrounding dry bulb temperature.

For yearly rate, the lower furthest reaches of the reach is ACT-2.2oC for the coldest month of the spot, and as far as possible is ACT+2.2oC for the most smoking month of the spot.

The other boundary utilized for correlation of non-molded structures is the solace portion for example CF, which is characterized as:
CF = 1 - Distress Degree Hours/105.6 … (4.2) where,

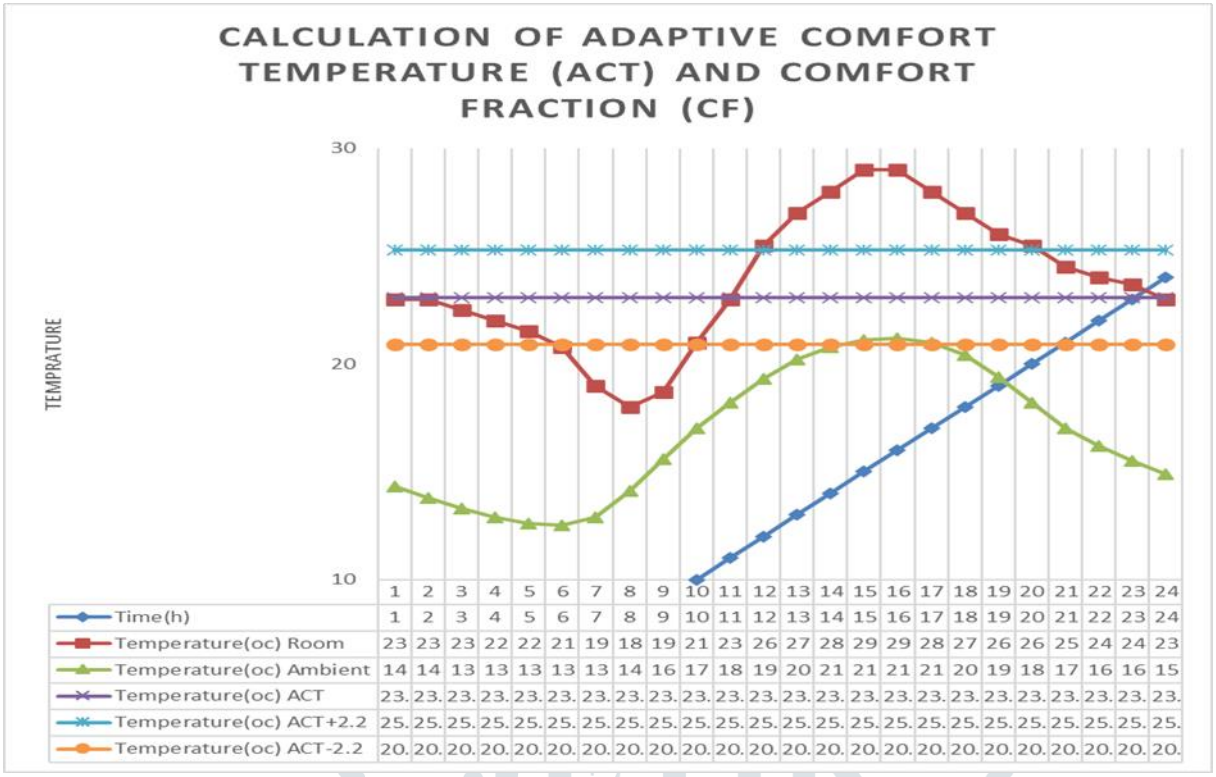
Inconvenience Degree Hours (DDH) is the amount of the hourly room air temperatures outside the safe place characterized by ACT ± 2.2 °C.

The strategy for computation of the solace part is made sense of as follows:

1. Work out month to month ACT from Eq. 5.1 and plot ACT ± 2.2 °C against the hour of the day. The zone characterized by ACT ± 2.2 °C is called as safe place.
2. Figure out the hourly room air temperature for the typical day of the month and plot it in a similar figure.
3. Figure out the deviations (outright upsides) of room air temperatures from the safe place. (Values are organized at the edge of the plot in Fig. for the model case).
4. The amount of these qualities are the uneasiness degree hours.
5. Ascertain the solace part utilizing Eq. 4.2.

Table 1 Calculation of Adaptive Comfort Temperature (ACT) and Comfort Fraction (CF)

Time(h)	**Temperature(oc)**					**DDH**
	Room	**Ambient**	**ACT**	**ACT+2.2**	**ACT-2.2**	
1	23	14.3	23.1	25.3	20.9	0
2	23	13.8	23.1	25.3	20.9	0
3	22.5	13.3	23.1	25.3	20.9	0
4	22	12.9	23.1	25.3	20.9	0
5	21.5	12.6	23.1	25.3	20.9	0
6	20.8	12.5	23.1	25.3	20.9	0.1
7	19	12.9	23.1	25.3	20.9	1.9
8	18	14.1	23.1	25.3	20.9	2.9
9	18.7	15.6	23.1	25.3	20.9	2.2
10	21	17	23.1	25.3	20.9	0
11	23	18.2	23.1	25.3	20.9	0
12	25.5	19.3	23.1	25.3	20.9	0.2
13	27	20.2	23.1	25.3	20.9	1.7
14	28	20.8	23.1	25.3	20.9	2.7
15	29	21.1	23.1	25.3	20.9	3.7
16	29	21.2	23.1	25.3	20.9	3.7
17	28	21	23.1	25.3	20.9	2.7
18	27	20.4	23.1	25.3	20.9	1.8
19	26	19.4	23.1	25.3	20.9	0.7
20	25.5	18.2	23.1	25.3	20.9	0.2
21	24.5	17	23.1	25.3	20.9	0
22	24	16.2	23.1	25.3	20.9	0
23	23.7	15.5	23.1	25.3	20.9	0
24	23	14.9	23.1	25.3	20.9	0
					Sum	**24.5**



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Time(h)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Temperature(oc) Room	23	23	23	22	22	21	19	18	19	21	23	26	27	28	29	29	28	27	26	26	25	24	24	23
Temperature(oc) Ambient	14	14	13	13	13	13	13	14	16	17	18	19	20	21	21	21	21	20	19	18	17	16	16	15
Temperature(oc) ACT	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.	23.
Temperature(oc) ACT+2.2	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.
Temperature(oc) ACT-2.2	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.

Fig. 4 Calculation of ACT and CF

IV. RESULTS AND DISCUSSION

(1) Site:

(a) Landform:

The thought of landform is insignificant for a level site. Nonetheless, on the off chance that there are slants and miseries, the structure ought to be situated on the windward side or peak to make the most of cool winds.

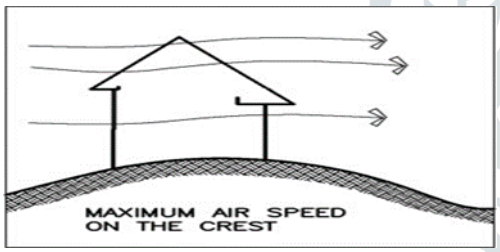


Fig. 5 Proposed Recommendation for Warm and Humid Climate for Landform
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

(b) Waterbodies:

Since humidity is high in these regions, water bodies are not essential.

(c) Open spaces and built form:

Structures ought to be fanned out with enormous open spaces for unlimited air development. In urban communities, structures on braces can advance ventilation and cause cooling at the ground level.

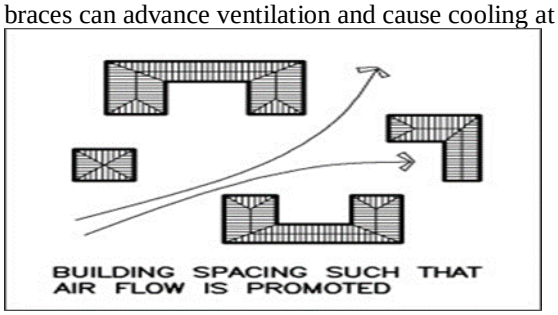


Fig. 6 Proposed Recommendation for Warm and Humid Climate for Open spaces and Buildform
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

(d) Street width and orientation:

Significant roads ought to be situated lined up with or inside 30º of the common breeze course during mid year months to support ventilation in warm and muggy areas. A north-south bearing is ideal according to the perspective of impeding sun powered radiation. The width of the roads ought to be with the end goal that the extraordinary sun powered radiation during late morning and early evening is kept away from in summer.

(2) Orientation and planform:

Since the temperatures are not unnecessary, free plans can be advanced the length of the house is under defensive shade. An unhampered air way through the insides is significant. The structures could be long and restricted to permit cross-ventilation. For instance, an independently stacked passageway plan (for example rooms on one side just) can be embraced rather than a doubly stacked one.

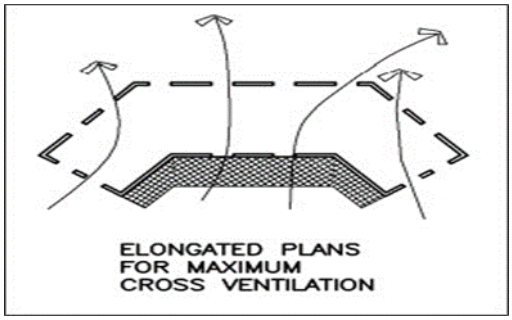


Fig. 7 Proposed Recommendation for Warm and Humid Climate for Orientation and Planform
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

Heat and moisture producing areas must be ventilated and separated from the rest of the structure.

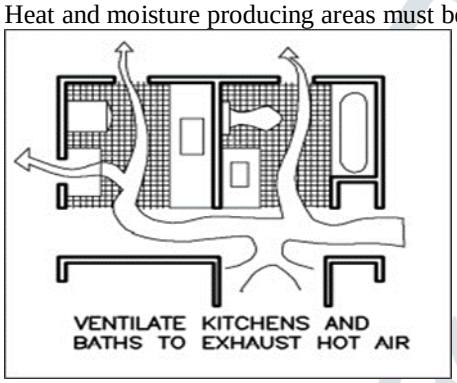


Fig. 8 Proposed Recommendation for Warm and Humid Climate for Heat Moisture Areas
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

Since temperatures in the shade are not exceptionally high, semi open spaces like galleries, verandahs and yards can be utilized profitably for daytime exercises. Such spaces additionally give assurance from precipitation. In multistoried structures a focal patio can be given vents at more elevated levels to draw away the rising hot air.

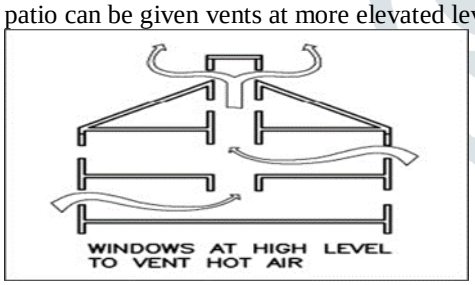


Fig. 9 Proposed Recommendation for Warm and Humid Climate for windows at high levels
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

(3) Building envelope

(a) Roof:

In addition to providing shelter from rain and heat, the form of the roof should be planned to promote air flow. Vents at the roof top effectively induce ventilation and draw hot air out.

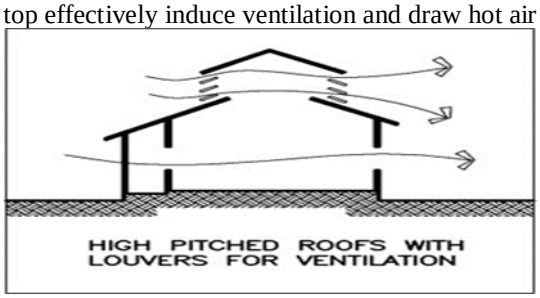


Fig. 10 Proposed Recommendation for Warm and Humid Climate for Roof
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

As diurnal temperature variety is low, protection gives no extra advantage to a typical supported concrete cement (RCC) rooftop in a non-molded building. Notwithstanding, exceptionally slender rooftops having low warm mass, for example, asbestos concrete

(AC) sheet material, do require protection as they will quite often quickly emanate heat into the insides during daytime. A twofold rooftop with a ventilated in the middle between can likewise be utilized to advance wind current.

(a) Walls:

As with roofs, the walls must also be designed to promote air flow. Baffle walls, both inside and outside the building can help to divert the flow of wind inside.

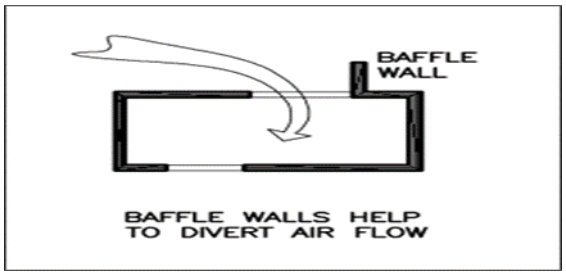


Fig. 11 Proposed Recommendation for Warm and Humid Climate for Walls
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

They ought to be shielded from the weighty precipitation predominant in such regions. Assuming sufficiently shielded, uncovered block facades and mud put walls function admirably by engrossing the moistness and assisting the structure with relaxing. Once more, concerning rooftops, protection doesn't fundamentally work on the presentation of a non-molded building.

(b) Fenestration:

Cross-ventilation is significant in the warm and muggy districts. All entryways and windows are ideally saved open for greatest ventilation for the majority of the year. These should be furnished with venetian blinds or louvers to protect the rooms from the sun and downpour, as well concerning the control of air development. Openings of a similarly more modest size can be put on the windward side, while the comparing openings on the leeward side might be greater for working with a crest impact for regular ventilation.

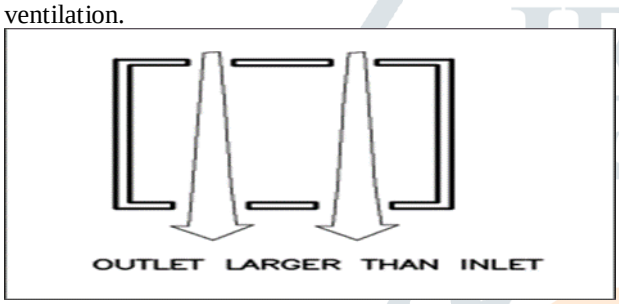


Fig. 12 Proposed Recommendation for Warm and Humid Climate for Fenestration
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

The openings should be shaded by external overhangs. Outlets at higher levels serve to vent hot air.

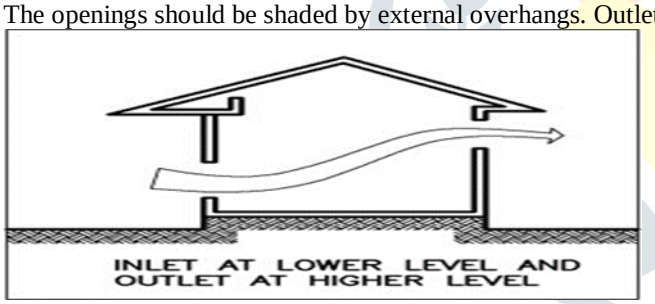
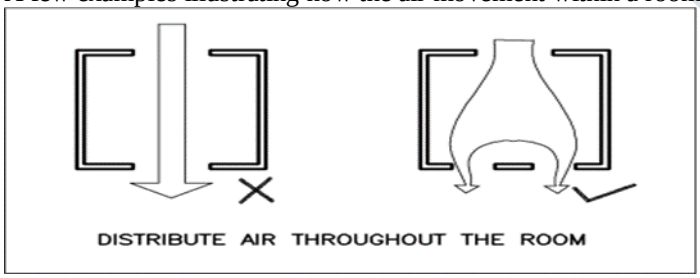


Fig. 13 Proposed Recommendation for Warm and Humid Climate for Outlet at overhang
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

A few examples illustrating how the air movement within a room can be better distributed, are shown in fig. 6.10



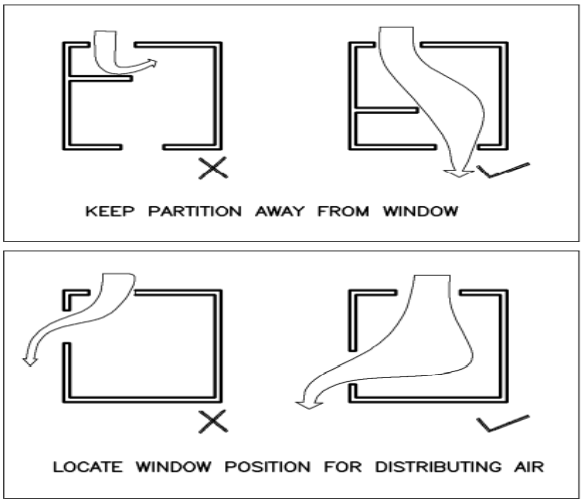


Fig. 14 Air Movement
(Source: https://issuu.com/suuplimentrytechtv2035/docs/)

(c) Colour and texture:

The walls ought to be painted with light pastel shades or whitewashed, while the outer layer of the rooftop can be of broken coated tile (china mosaic deck). The two strategies help to mirror the daylight back to the encompassing, and subsequently decrease heat gain of the structure. The utilization of proper varieties and surface completions is a modest and extremely powerful method to bring down indoor temperatures. It is worth focusing on that the surface completion ought to be shielded from/impervious with the impacts of dampness, as this can in any case prompt development of form and result in the rot of building components.

Table 2 Annual savings due to building design and operational parameters for the conditioned bungalow - Mumbai (warm and humid climate)

Parameter	**Annual load (MJ)**			**Energy saving**	
	Cooling	**Cooling**	**Total**	**(MJ)**	**(%)**
Base case	221617	0	221617	--	--
Orientation (longer axis)					
North-south	219606	0	219606	2011	0.9
Glazing type					
Double clear	218761	0	218761	2856	1.3
Single reflective coated	194390	0	194390	27227	12.3
Double reflective coated	193129	0	193129	28488	12.9
Double low-E	202750	0	202750	18867	8.5
Shading					
10%	214403	0	214403	7214	3.3
20%	207234	0	207234	14383	6.5
50%	185830	0	185830	35787	16.1
Wall type					
Thermocol (EPS) insulated brick wall	200848	0	200848	20769	9.4
Concrete block wall	232880	0	232880	-11263	-5.1
Autoclaved cellular concrete block	205102	0	205102	16515	7.5
Roof type					
Uninsulated RCC roof	229563	0	229563	-7946	-3.6

Uninsulated RCC roof	203093	0	203093	18524	8.4
Colour of external surface					
White	207068	0	207068	14549	6.6
Cream	211869	0	211869	9748	4.4
Dark grey	236069	0	236069	-14452	-6.5
Air exchanges					
0.5 ach	220817	0	220817	800	0.4
1.5 ach	222415	0	222415	-798	-0.4
Internal gain					

Table 3 Improvement in the performance of non-conditioned bungalow due to building design and operational parameters - Mumbai (warm and humid climate)

Objectives	**Physical Manifestation**
1)Resist heat gain	
a)Decrease exposed surface area	Orientation and shape of building
b)Increase thermal resistance	Roof insulation and wall insulation. Reflective surface of roof
c)Increase buffer spaces	Balconies and verandahs
d)Increase shading	Walls, glass surfaces protected by overhangs, fins and trees
e)Increase surface reflectivity	Pale colour, glazed china mosaic tiles, etc.
2)Promote heat loss	
a)Ventilation of appliances	Provide windows/ exhausts
b)Increase air exchange rate (Ventilation throughout the day)	Ventilated roof construction. Courtyards, wind towers and arrangement of openings
c)Decrease humidity levels	Dehumidifiers/ desiccant cooling

V CONCLUSION

For speedy and simple reference, the data has been summed up in a bunch of tables and introduced in this segment. Table sums up the solace prerequisites for each climatic zone in view of the attributes of the environment. The comparing actual appearances are additionally given close by the solace prerequisites. Table presents the uninvolved strategies that can be utilized in various environments. The particular rules and proposals for every one of the three structure types that were explained are summed up in the Tables.

Uninvolved sun powered perspectives ought to turn into a vital piece of the general course of engineering plan. Figure explains such mix interaction of configuration bit by bit. The upper layer shows the typical grouping that a modeler follows, while the lower layer shows extra contemplations for integrating the detached sun based viewpoints. While the course of configuration is basically iterative, the given chart is demonstrated to be straight for effortlessness.

The significance of assessing the warm presentation of the structure being planned utilizing recreation methods, to comprehend the adequacy of the plan in accomplishing energy effectiveness, can't be overemphasized. A definitive advantages of consolidating detached standards far offset any worries that a draftsman might have of the extra work included.

REFERENCES

[1] A. N. Tombasiz and S. A. Preuss, 'Design of passive solar buıldıngs in urbanareas,'SolarEnergy, 70, (2001), 311-318..

[2] Andrejko,Dennis A. And Wright,David,1982.Passive Solar Architecture:Logic and Beauty – 35 Outstanding Houses Across the United States, VanNostrandReinhold Company.

[3] Butti, Ken and Perlin, John, 1980, A Golden Thread: 2500 Years of SolarArchitecture and Technology, Cheshire Books ; New York : Van NostrandReinhold.

[4] Climatic data for design of buildings - Bombay Region, National Buildings Organisation, New Delhi, 1958

[5] Doğrusoy,İ.T.,'DoğalAydınlatmanınİşlevselveEstetikBoyutları,'Yapı,235,(2001),pp.76- 77

[6] Gluch, P., & Baumann H. (2004), The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. Building and environment, 39(5), 571-580

[7] https://www.slideshare.net/SowmyaRangu/passive-solar-buildings

[8]https://www.nationalgeographic.org/encyclopedia/solar-energy/#:~:text=by%20the%20sun,Solar%20energy%20is%20created%20by%20nuclear%20fusion%20that%20takes%20place,an%20enormous%20amount%20of%20energy.