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IDEAL BUILDING DESIGN BY CREATING MICRO CLIMATE

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ABSTRACT

The Vernacular Architecture in India means variety of aspects of climate, materials, local craftsmen and utmost comfort. In true sense these designs are energy efficient. But in Modern Architecture majority of time buildings are designed based on passive, mechanical systems to consume more energy. But in comparative analysis they prove how they are energy efficient. But if these buildings are designed by understanding proper sun-path, climate and wind directions; these buildings can be more energy efficient than the former one. This paper is showcasing the different possibilities for building zonings, orientations, and fragmentation of the building foot-print to get more responsive design with respect to climate, sun-path and wind flows along with proper landscape to divert wind flows. If at schematic levels buildings are designed with these strategies energy consumption after building completion is reduced.

Designers need to use the tools and techniques to have a multifaceted approach in building design involving-climate responsive architecture, materials with low embodied energy, reduction of ecological footprint, efficient structural design, recycling and harnessing renewable energy to meet the energy needs of the building etc.

This paper deals with the relation between building form and envelope and its energy consumption in hot dry climatic zone of the country. The purpose of this paper is to provide the guidelines for creating micro climate in any building design focusing mainly on building form and envelope; without using passive techniques for heating and cooling. This design research paper refers to the various primers and manuals that exist for energy efficient buildings in India to arrive at an appropriate building form and then compares it with a base condition. Both considerations for comfort and energy efficiency are accounted for in the building.

KEYWORDS: *Sun-Path, Wind-Flow, Building Orientation*

INTRODUCTION

The global environment in future is in danger. So just copying the planning strategies of developed world is unfair. The Indian architects should think of the strategies suiting to Indian climate, economy and society. At the planning stage only, they should think of surrounding, local micro climate, wind flows, sun path, available resources and minimalism. India is preoccupied with its own problems, will hopefully make some serious efforts to put their own house in order to follow reduction in possible energy consumption.

2. FACTORS EFFECTING BUILDING DESIGN AND ENERGY USE TO CREATE MICRO CLIMATE

2.1 Form

The radiation hitting a building can increase energy requirements for cooling up to 25%. Studies identify the hemispherical shape as the most suitable shape for the building. Other studies have also revealed that H form and L form shapes of the plan as good in terms of energy efficiency. In addition, the presence or absence of a courtyard also helps in lowering the ambient temperature thereby reducing the heat energy inside a building.

Courtyard as the best type of external space in this type of climate as the pool of cool night air can be retained in the inner space as it is cooler and so heavier than the surrounding warm air. If the courtyard is small, where the width is not greater than the height, even breezes will leave such pools of cool air undisturbed. Hence the courtyard is considered as an excellent thermal regulator.

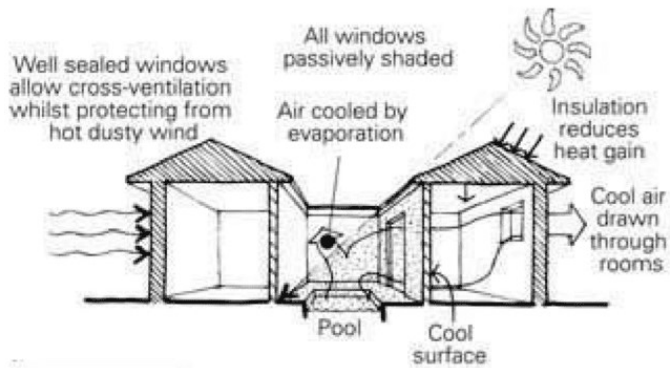

Figure 1.

2.2 Orientation

From radiation purpose of read, the most effective orientation is that that receives most radiation throughout winter and receives minimum radiation throughout summer season. The South façade has advantage of receiving additional radiation throughout winter than that of receiving throughout summer. Even for openings on south facade, little overhang like curtains will bring to a halt direct star penetration throughout summer and permits it throughout winter. Obviously, this can be most useful side, not accessible on the other façade. to attenuate star heat gain in south a parcel of land should be developed. Orientation of the building is that the approach the building is placed on the location in alignment to the sun and wind movement (so on enable or avoid sun/wind). In buildings while not insulation and with totally different shapes, a heating energy saving rate of 1-8% was obtained betting on the orientation of the building. Solar access' is that the term wont to describe the quantity of helpful sunshine placing glass the living areas of a home. the specified quantity of star access varies with climate. Variations in orientation towards east and west will have blessings in some climates and for a few activities. as an example, in cold climates, orientations west of north increase star gains within the afternoon after they area unit most fascinating for evening comfort, however east of north will heat the house additional within the mornings, up daytime comfort for people who area unit reception then. In hotter climates, orientations east of north will enable higher capture of cooling breezes. Poor orientation and lack of applicable shading will exclude winter sun and cause warming in summer by permitting low angle east or west sun to strike glass surfaces at additional direct angles, reducing reflection and increasing star gains. Good orientation, combined with different energy potency options, will scale back or perhaps eliminate the necessity for auxiliary heating and cooling, leading to lower energy bills, reduced gas emissions and improved comfort. It takes account of summer and winter variations within the sun's path in addition because the direction and sort of winds, like cooling breezes. Good orientation will facilitate scale back or perhaps eliminate the necessity for auxiliary heating and cooling, leading to lower energy bills, reduced gas emissions and improved comfort. Ideally, opt for a website or home with smart orientation for your environmental condition and regional conditions and build or renovate to maximize the site's potential for passive heating and passive cooling, adjusting the main focus on every to suit the climate. For those sites that aren't ideally oriented, there area unit methods for overcoming a number of the challenges. In hot wet climates and hot dry climates with no winter heating needs, aim to exclude direct sun by victimization trees and conterminous buildings to shade each façade year spherical whereas capturing and funneling cooling breezes.

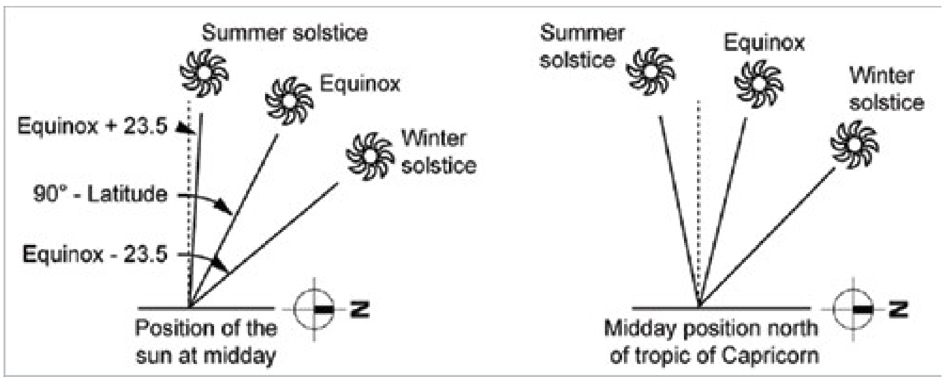

Figure 1, 2.

Left: How to calculate sun angles. (See Shading for a table of latitudes from which to calculate sun angles for Australian cities.) Right: Midday sun position north of the tropic of Capricorn.

North orientation is generally desirable in climates requiring winter heating, because the position of the sun in the sky allows you to easily shade northern façades and the ground near them in summertime with simple horizontal devices such as eaves, while allowing full sun penetration in winter.

North-facing walls and windows receive more solar radiation in winter than in summer. As shown in the diagram, the opposite is true for other directions and why, in mixed or heating climates, it is beneficial to have the longer walls of a house facing north to minimise exposure to the sun in summer and maximise it in winter

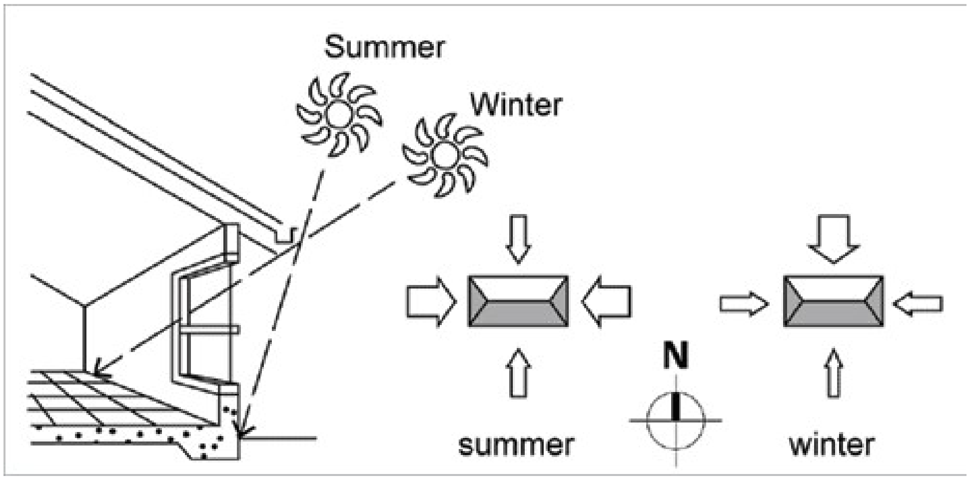

Figure 4.

However, on narrow blocks, careful design is required to ensure sufficient north-facing glass is included for adequate passive solar heating.

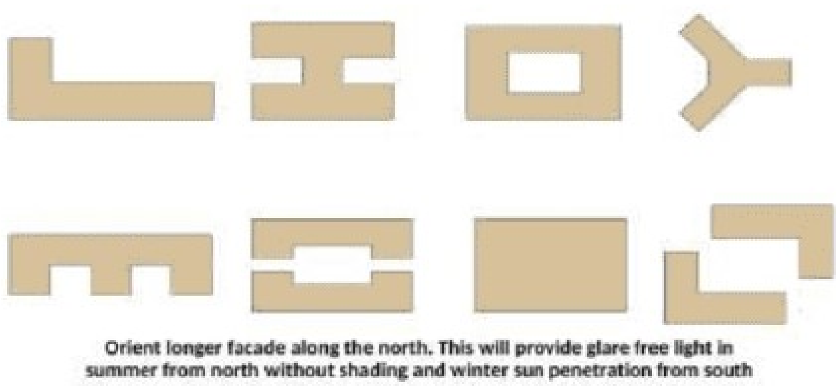

Fig 5: Orientation of longer facades towards north
(Source: http://www.nzeb.in/knowledge-centre/passive-design/form-orientation/)

Figure 5.

2.2 Ventilation

Ventilation, whether or not mechanical or natural, is also used for:

- Air Quality Control: to regulate building air quality, by diluting internally-generated air contaminants with cleaner outside air.
- Direct Adjective Cooling: to directly cool building interiors by commutation or diluting heat indoor air with cooler outside air once conditions are favorable.
- Direct Personal Cooling: to directly cool building occupants by leading cool outside air over building occupants at comfortable rate to boost convective transport of warmth and wetness from the occupants, and

- Indirect Night Cooling: to indirectly cool building interiors by pre-cooling thermally huge parts of the building cloth or a thermal storage system with cool nighttime outside air.

2.3 DAYLIGHTING

Smaller openings that are expeditiously shaded. Building with compact internal coming up with having curtilage, with dense grouping so the east and west walls are reciprocally shaded. High-level windows (with a sill higher than the attention level) or lightweight shelves, which might admit mirrored lightweight to the inside. Low-level windows are acceptable if they open towards a shaded and planted curtilage. Vertical strip windows at the corner of the area to avoid excessive brightness and supply a lightweight ‘wash’ on the walls. Not solely does one need the house to be visually appealing within and out, however it should even be designed to stay cool and conserve the facility. the majority can board this climate year-around, therefore with no escape to greener pastures, you’ve ought to discern a way to create it snug beneath these but ideal conditions. For warm climates taking advantage of star PV systems may be a great way to conserve energy and use the sun’s energy. For best results, you need to begin from the bottom up. Meaning however the walls are created.

Smaller openings that is efficiently shaded. Building with compact internal planning having courtyard, with dense grouping so that the east and west walls are mutually shaded. High-level windows (with a sill above the eye level) or light shelves, which would admit reflected light to the interior. Low-level windows are acceptable if they open towards a shaded and planted courtyard. Vertical strip windows at the corner of the room to avoid excessive brightness and provide a light ‘wash’ on the walls.

2.4 Building Envelope Design

Another important criterion is the “Wind Direction.” Generally, wind direction for any plot is changing in a day many times. By considering the possible wind directions for the particular plot there are different remedies to follow. In general, when obstacles are coming in the way of wind direction, they cause wind shaded areas on the opposite side of the obstacle. If buildings are becoming the obstacle for wind flow, then they are creating wind shadow regions at the opposite side of the building, causing problems. In this shadow area if dwarfed buildings are placed with proper openings, such dwarfed buildings get surprisingly good cross ventilation as illustrated below in the figure 6.

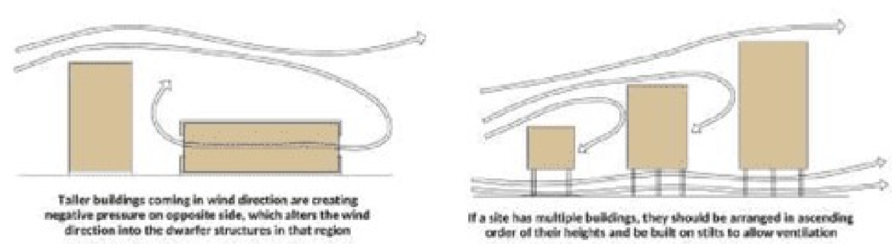

Fig 6: Tall buildings and wind (Source: http://www.nzeb.in/knowledge centre/passive-design/form-orientation)

Fig 7: Variable height buildings and wind flow (Source:http://www.nzeb.in/knowledge-centre/passive-design/form-orientation)

Figure 6,7.

Figure 6: Tall buildings and wind (Source: http://www.nzeb.in/knowledge centre/passive-design/form-orientation)

Figure 7: Variable height buildings and wind flow (Source:http://www.nzeb.in/knowledge- centre/passive-design/form-orientation)

While designing the buildings in big layout we designed variable height buildings. The placement and zoning of the buildings can be decided by understanding wind flow. The building can be stilted and placed in ascending order of heights along the win direction to achieve maximum cross ventilation in all buildings. This is illustrated in figure 7. When the buildings are zoned perpendicular to the wind flow, wind shadow effect occurs at the opposite side of buildings creating uncomfortable conditions. To overcome these buildings can be placed in angular way i.e. to an angle of 30 or 45 degree to get ample wind flow and cross ventilation (figure 8).

Even the buildings can be staggered to divert the wind flow within the buildings (figure 9)

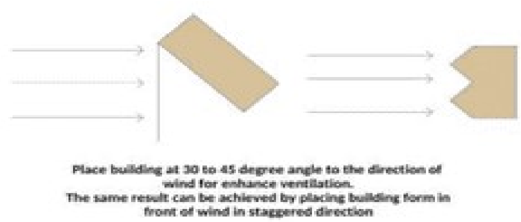

Fig 8: Angular placement of buildings and wind flow (Source: http://www.nzeb.in/knowledge-centre/passive-design/form-orientation/)

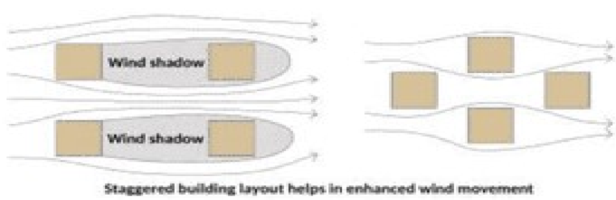

Fig 9: wind flow and staggered buildings (Source: http://www.nzeb.in/knowledge-centre/passive-design/form-orientation/)

Figure 8,9.

Figure 9: wind flow and staggered buildings (Source: http://www.nzeb.in/knowledge-centre/passivedesign/form-orientation/) Many times as per the microclimate site gets good wind flow. But if it is not captured well it just blows around the building but cannot flow inside the building if it is not managed well in design. The following example illustrates how wind can be forced to flow inside the building with proper openings and plantation of trees. The fragmentation of building or staggering the rooms give ample cross ventilation and even enhance the aesthetics of the building. This is achieved by providing tree plantation at require places. Due to desirable cross ventilation the comfort level of the building is as well enhance and additional sources for mechanical ventilation can be omitted. (Figuer. 10)

Figure 10: wind flow and Design (Source: http://www.yourhome.gov.au/passive-design/orientation)

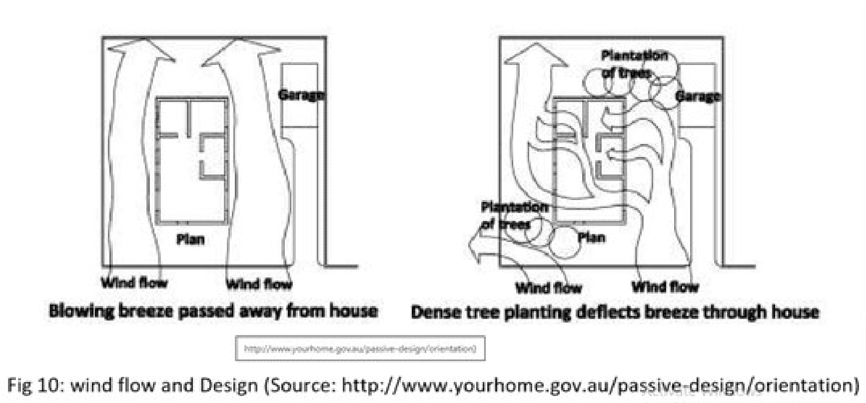

Figure 10.

2.5 Shading

The following design recommendations generally shall be followed:

Study of the sun angles is vital for coming up with the shading devices. Associate in Nursing understanding of sun angles is vital to varied aspects of style together with determinant basic building orientation and choosing shading devices. Fixed shading devices, mistreatment properly sized overhangs or porches, or style the building to be “selfshading” ought to be put in. mounted shading dev ices, that square measure designed I o a building, can shade windows throughout the star cycle. Permanent sunglasses could also be designed into the building type. they're only on the south-facing windows. Awnings which will be extended or removed may also be thought-about for shading the windows. The depth and position of mounted shading devices should be rigorously designed to permit the sun to penetrate solely throughout preset times of the year. within the winter, overhangs permit the low winter sun to enter south facing windows. within the summer, the overhangs block the upper sun. · Limit east/west glass. Glass on these exposures is tougher to shade from the jap morning sun or western evening sun. Vertical or egg-crate mounted shading works well if the shading projections square measure fairly deep or shut together; but, these might limit views. the employment of landscaping may also be thought-about to shade east and west exposures. North-facing glass receives very little direct star gain, however will offer diffuse daylight. · In hot and dry climates, the movable blinds facilitate to scale back the convective heat gain caused by the new close air. In heat and wet climates wherever the air flow is fascinating, they impede ventilation. In composite climates, the sunshine colored/reflective blinds block the radiation effectively.

3.0. RECOMMENDATIONS

- Shading Reduction in solar radiation by shading windows can reduce the heat gain and consequently increase the comfort. An increase of 12.6% in the number of comfortable hours can be achieved, if windows are shaded by 50% throughout the year.
- Roof type Insulating the roof using polyurethane foam insulation (PUF) increases performance by 2.2% as compared to a roof with brick -bat-coba waterproofing. However, an uninsulated roof i.e. plain RCC roof having a higher U-value decreases the n umber of comfortable hours by about 16.8%

- Color of the external surface White and cream colors are desirable compared to puff shade (base case) or dark grey. The percentage increases in comfortable hours compared to the base case are 4 .8 and 3.0 respectively.

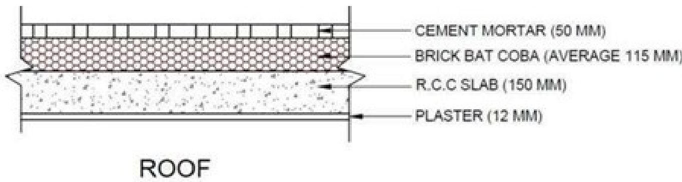

Figure 11.

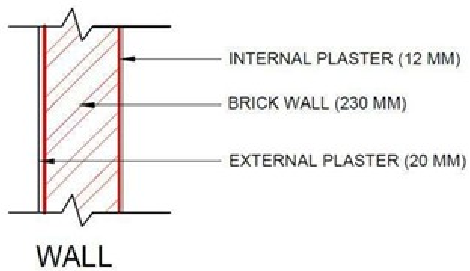

Figure 12

4.0 CONCLUSIONS

In developing country like India, the architectural designs can be made very sensible at planning stage only by understanding sun path, micro climate of the site, wind directions, locally available material and vernacular aspects like culture, social and economic impacts of the society, to conserve energy for every development. How much energy is being saved in such cases? Further research can be done to calculate amount of energy saved with comparative analysis of various methods adopted for mechanical ventilation. However, having a courtyard arrangement of living spaces also brings down the internal gain considerably. The roofs are the most important building element that helps the building gain less heat and lose more in such climates. Hence the material selection of the roofs and the shading property has to be given utmost priority. Selective shading during day time and its removal during night time also helps in lower heat absorption and faster heat radiation. Moveable shades that are operated during summer and rolled back in winters also help in permitting the sun rays which are desirable in the winter.

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