479: A quick Design Approach towards the Energy Efficient Buildings in Pakistan

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Abstract

The professionals in building industry of Pakistan, lacks the incorporation of Energy efficient measures in their designs. Vernacular architecture of Pakistan shows that the climate of Lahore - Pakistan, convinces the use of solar passive design strategies to heat and cool the buildings for the energy conservation. To remove the hurdles identified after field survey in implementation of the considerations for an energy efficient future architecture, this paper is an attempt to develop quick passive solar design considerations for the practicing architects and students of architecture to promote the awareness of the subject and presents a quick approach for incorporating the measures into their designs.

Keywords: energy efficient, guidelines

1. Introduction

The careful study of indigenous architecture of composite climate of Lahore, particularly residential buildings, reveals a unique example of the whole city; entire city responds to its climatic effects with its street pattern, thermal mass and mutual shading. Each house plan form enhances thermal comfort through its courtyard planning as a major environmental approach as shown in Figure 1.

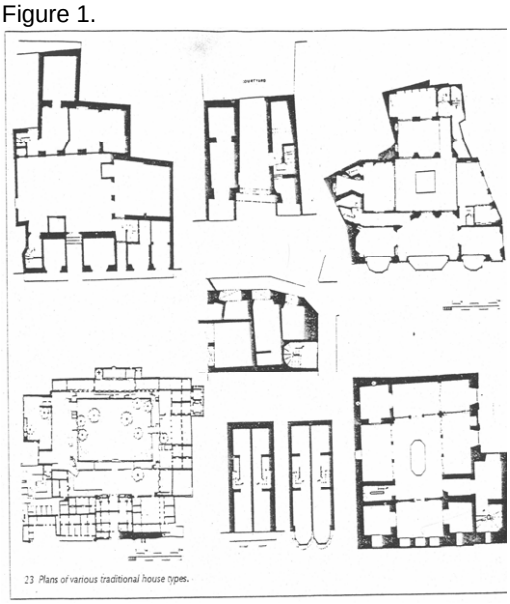


Figure1, Plan forms of traditional house types in walled city of Lahore.

But after the industrial revolution, the modern house forms changed and consumed a huge amount of energy. In recent years, how to build Energy Efficient Buildings (EEB) has been a constant source of discussion all over the world. Almost 40% of the electricity generated is consumed in the building sector in Pakistan and the consumption rate is increasing at 14% per year(1). Government of Pakistan took several measures in the recent past to save energy in the country, as it is under serious energy crises. The electricity load shedding of seven to nine hours is being implemented besides many other measures. The government estimates the supply-demand gap at 4000 MW(2). Moreover, the cost of power is increasing significantly due to oil- fired stations. The question for the option of energy efficient buildings has some urgency as there are serious economic and social costs for letting the energy shortage go unaddressed. The building sector is never given priority for energy conservation by the policy makers in Pakistan.

1.1 Energy consumption in Pakistan

Residential sector represents 52% as compared to Transportation 17%, Industrial 27%, Agriculture 1%, Commercial & public services 2% and Non-energy uses and other consumption 1%(3). Air conditioning loads are expected to grow in the next decades. Energy Conservation centre, Islamabad, in1990, presented an example of the large potential savings due to added insulation; Calculations done for buildings in Kuwait showed that the use of thermal insulation can cut the cooling load in buildings from 11-64% depending on the type of building.

Moreover, greenhouse gas emissions are attributed to the electrical appliances in residential operations (4). Minimizing energy consumption in residential buildings using passive solar strategies demand for the efficient use of building materials combined with solar gain control. Using computerized simulation tools to understand the interactions among all the elements facilitates designing low-energy houses. Finally, the design team must feel confident that these tools are providing realistic results.

In the Pueblo, Colorado climate, other strategies were analyzed to optimize performance after construction. Calibrated computer simulations showed that this house consumes 56% less energy than would a similar theoretical house

constructed to meet the minimum residential energy code requirements (5).

2. Quick Design Guidelines for Energy Efficient Buildings in Lahore

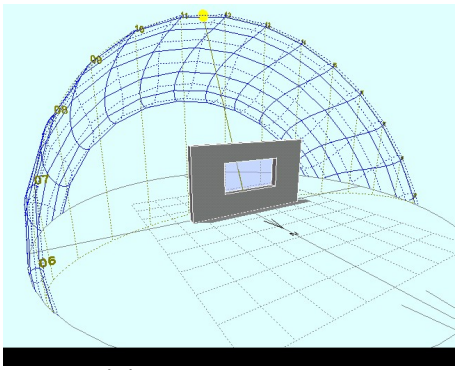
The following guidelines are drawn from the work of many researchers, practical applications and computer simulations for various Solar Passive techniques.

2.1 Building Orientation

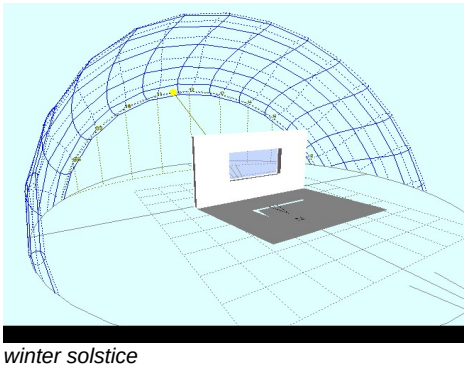
Orienting the building to capture the prevailing wind in summer, keep minimum openings in east and west sides as they receive the highest intensities of solar radiations. The longest wall should face south.

2.2 Internal Room Zoning

The garage, laundry, bathrooms and stores can be placed on west side. Bed rooms are ideally located on the north to avoid summer heating. Living areas on the south with horizontal shading according to the sun path as shown in Figure 2 and 3



Summer solstice



winter solstice

Figure2. Summer and winter sun path guide.

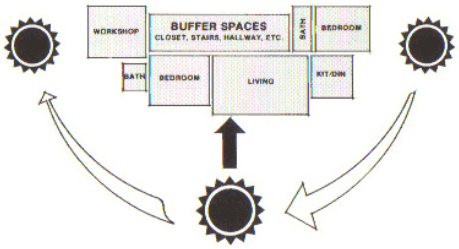


Figure3. Interior space should be arranged so that rooms with high heating and lighting requirements are arrayed along the south wall.

2.3 Shading and Window

Unwanted morning and afternoon solar heat gain can be reduced by minimizing or protecting extent of walls windows facing east or west.

The amount of glass on the south wall may equal to 7% of the building's total area. For example: 2,000 square feet= 140 square feet of glass.

Net glass Area= 0.8x window area.

North and east glass should not be more than 4% of total area. West glass area should not exceed 2% of total area.

High level ventilators can be provided by the modern version of the age- old fanlight and ventilators. Window glass has approximately 80% solar transmittance, tinted 50% and high performance 10% to 40%.

2.3.1 Overhang sizing rule:

. Draw the wall to be shaded to scale.
. Draw the summer sun angle upward from the bottom of the glazing.
. Draw the overhang until it intersects the summer sun angle line.
. Draw the line at the winter sun angle from the bottom edge of the overhang to the wall.
. Use a solid wall above the line where the winter sun hits. The portion of the wall below that line should be glazed

2.4 Landscaping

Semi deciduous trees can be planted to the north, plantation of moderate sized shade trees to the southeast and southwest are recommended as an effective way to help remain comfortable during hot summers in Pakistan. The use of plants and water are a traditional way of tempering the climate in Pakistan, and their use can be adapted to modern designs. Trees, shrubs, trellises and pergolas can shade the walls and windows.

2.5 Thermal Insulation

Thermal insulation is the dominant factor to determine the external heat gain but due to the absence of a materials' specific knowledge and building codes, buildings are made without any insulation. Some buildings use clay with husk (conventional material) with unknown thermal performance. A common practice is to sandwich the polystyrene sheet which may affect the long term insulating quality due to trapping of moisture. However, thermal insulation can reduce 30% of the building cooling loads.

2.6 Ground Surfaces

The temperature on a hard surface such as concrete pathways can be more than 5 degree centigrade greater than on soft surfaces such as organic paving or vegetative areas(6).

2.7 S/V ratio

A compact building gains less heat during daytime and loses less heat at night. The compactness of the building is measured using the ratio of surface area to volume, where,

S= surface area

V= volume

In hot- dry climate as a dominant season in Lahore, the S/V ratio should be the minimum. The same minimum ratio is suitable for cool climate as well to minimize heat loss. For humid climate, the material of construction should be such that it does not store heat.

The increase of Ceiling Height of every 30 cm (1-foot) can reduce 0.3 degree centigrade for single storey buildings. Lower ceiling heights can be compensated for by improving the insulation level of the roof (7).

This guide has been prepared primarily to facilitate the Building designers by providing practical information for applying the principles of low-energy during each phase of a project; An important objective of this paper is to teach energy efficiency for renewable energy and energy-efficient technologies in Pakistan.

5. Conclusion

The Incorporation of simple energy efficient measures in new buildings can reduce a significant amount of energy consumption in Pakistan.

Building bye-laws needs to be reformed in accordance with quick guidelines for energy efficiency in buildings.

There is a need to recast the design courses in learning schools of architecture in Pakistan.

6. Acknowledgements

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