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Issues and Future Directions

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Introduction

Passive solar design is an interdisciplinary subject involving researchers, construction agencies, material and component development, and finally the architect who translates all the information into a product. The architectural design process involves several steps, from the schematic drawing phase to construction development through detailed design. In this process, the definition of the building evolves from general to specific. Each phase, therefore, requires adequate thermal design tools ranging from rough simple rules of thumb to detailed estimates.

From a detailed survey of literature and information available in the proceedings of workshops in China, India, Nepal, and Pakistan, it seems that the thumb rules do not exist at all, particularly for the climatic region of the Hindu Kush-Himalayas. Even climatic information needed for solar passive design is hardly available. Information about materials, components, and scientific tools is diffused and needs to be made available in an organized and concise manner. There are a number of issues that need to be considered for solar passive buildings.

Climatic analysis

Foremost in considering solar passive designs is the analysis of climatic data, identification of climatic zones, and the need for heating and cooling and duration of need. The management of environmental influences requires adequate evaluation of bioclimatic impacts. Identification of climatic zones and analysis of climatic data

not only establish the severity of the climate but also help to identify possible passive concepts, their potential, and their limitations.

The climatic parameters essential for passive design are temperature, cloudiness, humidity, rainfall, wind direction, and solar radiation. One then needs to plot these parameters to assess the range of variation and the prevailing generalised climatic conditions.

Climatic conditions help to visualise the general features of a place and climatic requirements of building design. For building design level, however, more information is necessary to evaluate how climate is affected by the geography and topography of a certain site and surroundings, and how this could be influenced by building location and landscape features. Heated air and pollution of urban areas produce a haze which leads to lower irradiation levels and poor air quality. Reduced nocturnal heat emission and inversion weather conditions support increasing fog and the frequency of rain through condensation on polluted air.

Though generalised information about climatic parameters in the Hindu Kush-Himalayas is available, organized documentation and its correlation with building design are yet to be made available and useful for architects.

Building Organization

Building design and appropriate selection and sizing and organization of materials can considerably influence the energy requirements of a building. The important points that need to be considered in this respect are building shape, building-sun relationship, building-wind relationship, building vegetation relationship, and building-special organization or thermal zoning. It is also necessary to make an inventory of common building materials and their uses in construction.

Solar access is a requirement for passive solar heating systems. The amount of solar radiation in any location on a site depends on diurnal and seasonal solar availability. Data of monthly mean values and daily and/or hourly values are required for quantitative calculation methods to estimate the efficiency of passive solar systems. For individual design of passive systems, orientation of the sun collecting areas, their construction, and physical properties must be carefully considered.

Orientation of a building with respect to wind direction can influence loss of heat from a building considerably. Building of surfaces exposed to prevailing winds in winter should be minimised, especially with respect to glazed areas. The effect of wind on heat losses can be reduced by landscaping, a phenomenon that needs to be understood in more detail.

Relation of the building location to topography, vegetation, and organization of building space are some of the concepts that need to be studied and documented in detail.

Building System Options

The term building system refers to the structure, exterior envelope, and interior partitions. The manner in which these building elements are configured determines the heat loss or gain characteristics and the type of passive solar system needed. It is essential to make a detailed inventory of the range of options and factors to be considered in the building structure, insulation, glazing, shading, and passive solar system.

The various options that need detailed description are building structure, building components, and strategies that determine thermal storage capacity, structural capacity, durability/reliability, and ultimately the thermal performance of a building. The choice of building materials, orientation, glazing material, and glazing structure along with passive solar strategies such as solar collection, heat storage, heat distribution, natural ventilation, and de-lighting determine the energy performance of a building.

One should distinguish between passive and active solar energy use. Active solar systems require a solar collector outside the living space to be heated, transferring it to a separate storage element by pump or fan. Many times, simple natural means will not be able to create sufficient fluid flow and therefore some knowledge about the type of fan, pump, and power requirements becomes absolutely essential.

Users' Influence

Occupant behaviour and needs directly influence and determine energy demand, consumption, and waste. The way owners operate passive systems in a house will have a major impact on internal climatic conditions. Solar passive design of a house should therefore study occupant behaviour and existing practices and adopt those concepts that match local practices. An example of this aspect is the use of a kitchen's waste heat for space heating either through a hypocaust construction or other design aspects.

Urban Versus Rural

Very often there is a vast difference between rural and urban architecture. Usually rural houses are designed and constructed to match the prevailing climatic conditions. An example of such a house is a farmer's house in Shimla (Figure 8.1)

The house is located on a slope towards the windward side and there is a relatively large verandah to reduce the effect of wind in a climate in which the sun is available only sometimes during the winter. In general, the openings of these houses are small and are well insulated by means of a cavity roof and thick mud walls. The resulting temperatures during typical May and December days are given in Figure 8.2.

A typical urban house (Figure 8.3) on the other hand is made of an RCC frame structure with only 15 cm brick walls resulting in large temperature fluctuations as seen from Figure 8.4.

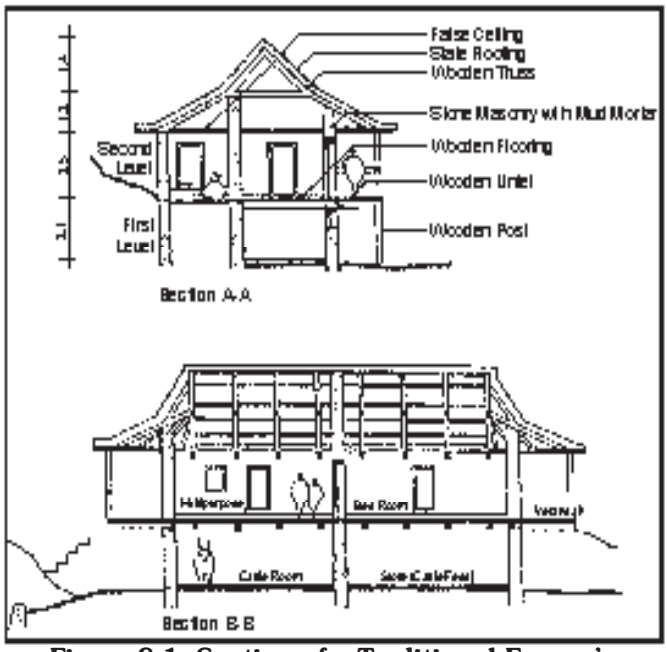

Figure 8.1: Section of a Traditional Farmer's House in Shimla (North India)

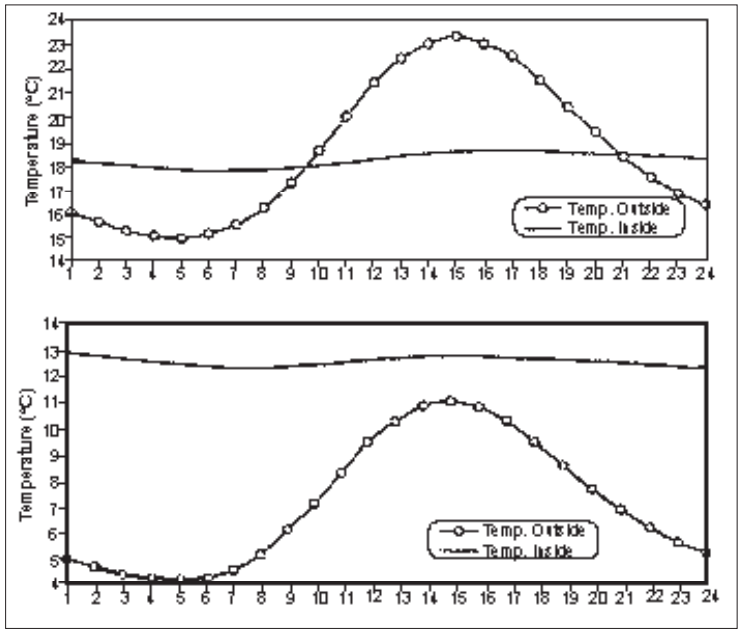

Figure 8.2: Daily Temperature Variations on Typical Summer and Winter Days in the Farmer's House

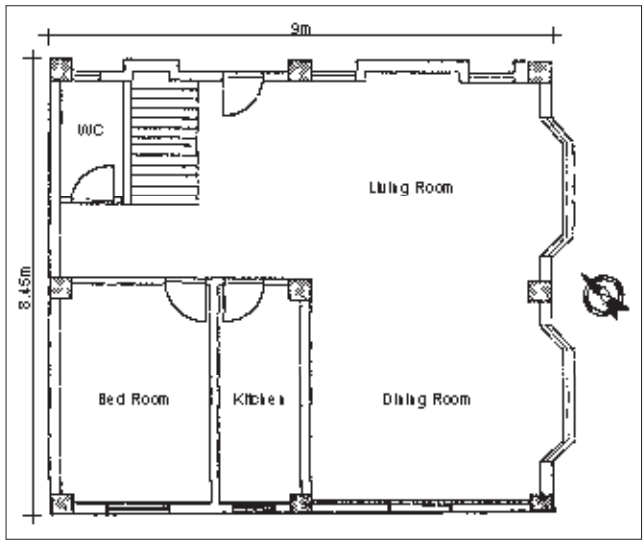

Figure 8.3: A Typical Urban House in Shimla

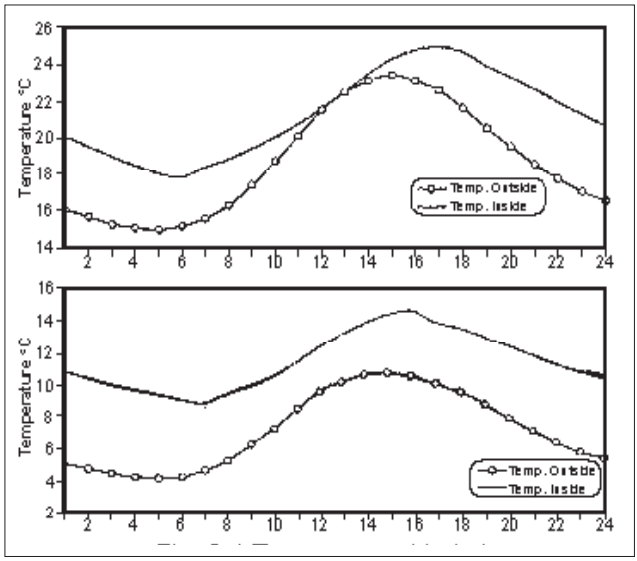

Figure 8.4: Temperature Variation

It is therefore necessary to study vernacular architecture in the Hindu Kush-Himalayas in detail and to try to understand the concepts of solar passive heating /cooling and modify them suitably for urban applications. Solar passive building design in rural areas may require only minor variations in design for improvement in the thermal performance of a building.

The above results clearly show that urban architecture has to be radically modified to use solar passive design concepts. Comprehensive guidelines incorporating available building components are necessary for effective results.

Future Directions

Awareness about solar passive concepts and their utility in achieving either thermal comfort or reducing energy demands in a building is well spread throughout the Hindu Kush-Himalayan region, as evident from the contributions presented in the ICIMOD-sponsored workshops in China, India, Nepal, and Pakistan. There have been concrete programmes for solar passive buildings, especially in China and India. The overall impression from the proceedings is that concrete solutions are needed to introduce solar passive building concepts. The understanding of climatic elements, traditional architecture, construction material, and construction techniques is important for optimum passive building design.

In order to promote the techniques of solar passive design, the following work needs to be undertaken and documented systematically.

1. Analysis and classification of climatic conditions in the Hindu Kush-Himalayan region
2. Study of vernacular architecture and identification of passive building elements
3. Study of urban architecture
4. Selection of an appropriate thermal simulation programme
5. Creation of a data base and thermophysical properties of building materials and traditional building components
6. Quantification of individual design patterns, for example, direct gain, indirect gain, thermal storage, solarium, cavity, insulation, building form, roof shape, and underground structure
7. Preparation of manuals on design guidelines, design context, construction issues, and design tool selection and use

The comprehensive information thus prepared needs to be disseminated to architects, users, and the construction industry. One should be careful in distinguish among users even construction industry. One should differentiate between rural and urban architecture. Design guidelines have not been attempted for the rural context so far anywhere in the world. Any initiative in this direction can i mmensely improve the health, efficiency, and lifestyle of rural people in the Hindu Kush-Himalayan Region.