SUSTAINABLE BUILDING DESIGN STRATEGIES FOR PAKISTAN

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Summary

The OEDC has recently estimated that buildings today account for over 40% of energy consumption in the world, and are responsible for about 45% of all carbon emissions, 40% of all freshwater consumption, 70% of all timber consumption, 50% of world's material consumption and are responsible for 40% of all human-produced waste (OECD1999).

However, this quantity of energy consumed can be greater in more industrialized countries due to their energy needs, while the proportion of energy usage by buildings in developing countries is comparatively higher due to inefficiency of systems and is more significant than the developed countries due to prevailing extreme shortage of energy. The building sector consumes more than 43% of total energy produced within Pakistan while 10% is used for manufacturing and transportation of building components & materials (World Resources Institute. 2007).

It is a matter of common experience that a large majority of new buildings constructed in Pakistan are not designed in accordance with local climatic conditions. Excessive use of concrete and glass, high levels of illumination and heavy reliance on space conditioning are common feature of our buildings. This means that owners and occupants consume extra energy to make them comfortable for living. ENERCON has estimated that improved building design can reduce building energy bills by 20% and this figure can be raised to 50% by use of efficient appliances (ENERCON2008).

Energy Efficient Sustainable Buildings where at one hand can reduce the energy burden, on other can avoid global warming, improve local air quality, retard global climate change and save consumers money. The choices we make in designing and constructing new buildings (and renovating old ones) will impact the global climate directly..

Keywords: Energy Efficiency in Buildings, Green Architecture, Sustainable Buildings, Sustainable Building Materials

1 Introduction

Sustainable Building Design (Green Architecture) is a general term that describes environmentally-conscious design techniques in the field of architecture. Sustainable architecture is framed by the larger discussion of sustainability and the pressing economic and political issues of our world. In the broad context, sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. Most simply, the idea of sustainability, or ecological design, is to ensure that our actions and decisions today do not inhibit the opportunities of future generations (Doerr Architecture, 2003). This term

can be used to describe an energy and ecologically conscious approach to the design of the built environment (Dublin Institute of Technology, 2001).

Today energy efficiency over the entire life cycle of a building is the most important single goal of sustainable architecture. Architects use many different techniques to reduce the energy needs of buildings and increase their ability to capture or generate their own energy.

2 Our Buildings Today

The OEDC has recently estimated that buildings today account for over 40% of energy consumption in the world **(Fig. 1)** and are responsible for about 45% of all carbon emissions, 40% of all freshwater consumption, 70% of all timber consumption, 50% of world's material consumption and are responsible for 40% of all human-produced waste (OECD, 1999).

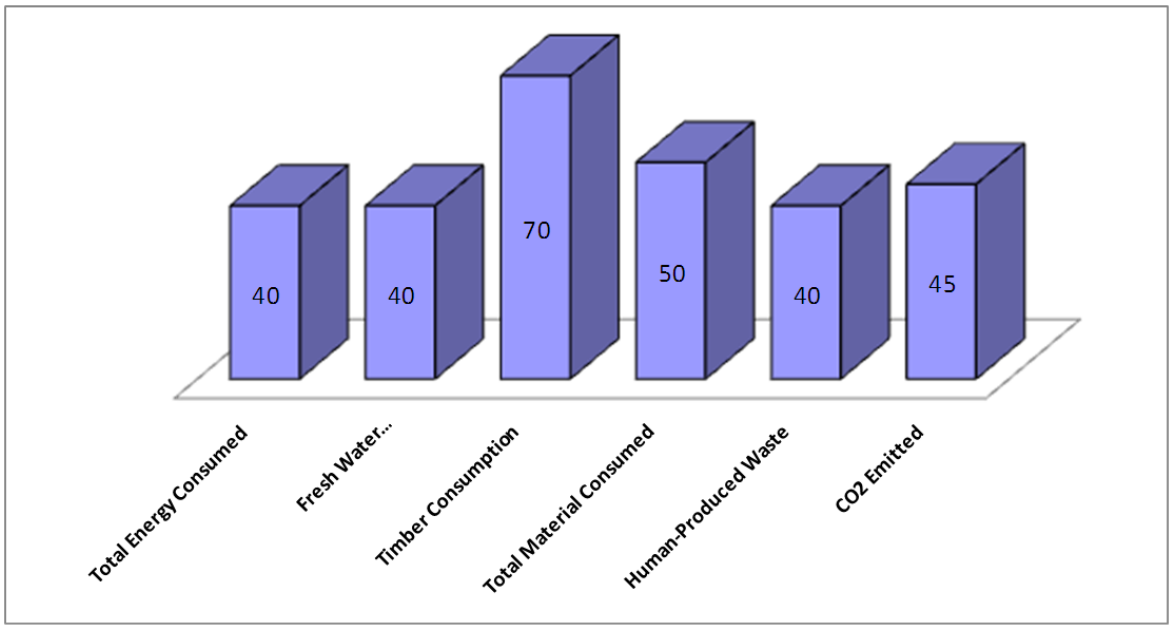

Fig. 1 Our Buildings Today World Over

However, this quantity of energy consumed can be greater in more industrialized countries, for example in UK 56% of all energy produced is used to operate buildings and 10% of all the energy produced is used to manufacture building materials. Therefore over two third of all UK energy use, stems from or is associated with building construction and use. While buildings in the United States consume 39% of America's energy and 68% of its electricity, while 15% is used in manufacturing and transporting building materials, furthermore, buildings in USA generate 38% of the carbon dioxide, 49% of the sulphur dioxide, and 25% of the nitrogen oxides found in the air. Europe is lagging behind by consuming 42% of its energy to operate buildings and 13% associated with building materials (OECD 2006).

The proportion of energy usage by buildings in developing countries is comparatively higher due to inefficiency of the systems and is more significant than the developed countries due to prevailing extreme shortage of energy **(Fig. 2)**. The building

sector consumes more than 43% of the total energy produced within Pakistan while 10% is used for manufacturing and transportation of building components & materials (World Resources Institute, 2007).

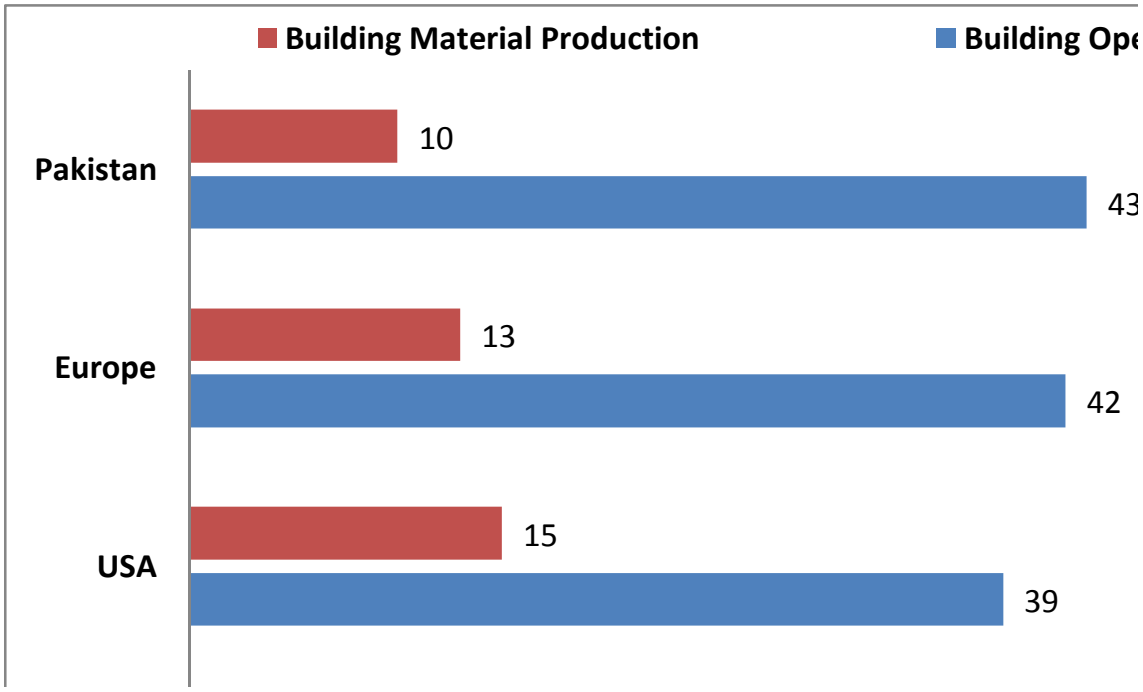

Fig. 2 Energy Consumption in Buildings

It is a matter of common experience that a large majority of new buildings being constructed in Pakistan are not being designed in accordance with our local climatic conditions. Excessive use of concrete and glass, high levels of illumination and heavy reliance on space conditioning are a common feature of our buildings. This means that owners and occupants consume extra energy to make them comfortable for living. ENERCON has estimated that improved building design can reduce building energy bills by 20% and this figure can be raised to 50 % by the use of efficient appliances (ENERCON Annual Report, 2008).

Energy Efficient Sustainable Buildings where at one hand can reduce the energy burden, on the other can avoid global warming, reduce demand on the power grid and stress on natural gas supplies, improve local air quality, and save consumers money. The choices we make in designing and constructing new buildings (and renovating old ones) will affect energy use for many decades to come. Building design and construction provide by far the best and most cost-effective opportunity to build in energy-efficient features that will last for the lifetime of the building. Thus it is critical to make energy efficiency a fundamental part of sustainable building design and construction.

3 Pakistan's Construction Industry

Pakistan's construction industry is considerably a large industry in terms of economic expenditure, volume of raw materials/natural resources consumed, volume of materials and products manufactured, employment generated, environmental impacts, etc. Large variety

of materials are manufactured and consumed in the construction industry. It has been estimated that 18% of green house gas (GHG) emissions is contributed by the construction sector in Pakistan (ENERCON Annual Report, 2008). There is an ever-increasing demand for building materials. For example demand for houses has almost doubled in last two decades. Demand for the building materials like bricks, steel and cement has also been doubled.

Usage of raw material for building components is consuming earth resources at a very high rate (**Fig. 3**) for example in case of brick-making activity, at present precious topsoil is being consumed rapidly. We have arable land comprising alluvial soils, black soil, red soil, laterite soil and desert soil. Alluvial, laterite and red soils are suitable for brick making. Area under the soils suitable for brick making may not exceed 50% of the arable land. Brick-making activity to meet the present and future demand can result in consuming the fertile topsoil of arable land in about a century (Lunt, M. G., 1980, PP 184.). Similarly the pressure on raw materials like limestone to manufacture cement and energy requirements to produce these materials has to be addressed.

Production of building materials has slowly and steadily moved from highly decentralized and labour-intensive methods and processes to centralized, machine-dependent industry mode. Centralized mode of production necessitates hauling of raw materials and distribution of finished materials over great distances. These activities again require expenditure of fossil fuels for transportation. Transportation of raw and finished building materials is another key issue that can contribute to cost of materials, increased energy requirements and environmental issues.

Material	**Period**
Mud, stones, wood/thatch	Prior 8000 BC
Sun dried bricks	6000 BC
Pottery products	4000–8000 BC
Burnt bricks	4000 BC
Lime	3000 BC
Glass	1300 BC
Iron products	1350 BC
Lime-pozzolana cement	300 BC–476 AD
Aluminum	1808 AD
Portland cement	1824 AD
Plastics	1862

Fig. 3 Historical Development in Building Materials (Walker et al, 2000, pp. 27–35)

Sustainability of the present mode of production, consumption and distribution of building materials and currently adopted construction practices is questionable.

4 Sustainable Alternatives

Steel, cement, glass, aluminium, plastics, bricks, etc. are energy-intensive materials, commonly used for building construction. Generally these materials are transported over great distances. Extensive use of these materials can drain the energy resources and adversely affect the environment.

On the other hand, it is difficult to meet the ever-growing demand for buildings by adopting only energy efficient traditional materials (like mud, thatch, timber, etc.) and construction methods. Hence, there is a need for optimum utilization of available energy resources and raw materials to produce simple, energy efficient, environment friendly and sustainable building alternatives and techniques to satisfy the increasing demand for buildings.

Some of the guiding principles in developing the sustainable alternative building technologies can be summarized as follows:

- Energy conservation;
- Minimize the use of high energy materials;
- Concern for environment,
- Environment-friendly technologies;
- Minimize transportation and maximize the use of local materials and resources;
- Decentralized production and maximum use of local skills;
- Utilization of industrial and mine wastes for the production of building materials;
- Recycling of building wastes,
- Use of renewable energy sources.

Building technologies manufactured by meeting these principles could become sustainable and facilitate sharing the resources especially energy resources more efficiently, causing minimum damage to the environment.

5 Our Traditional/ Indigenous Sustainable Buildings

Our traditional planning and building methods were often good examples of green architecture in their time, and represented good uses of local resources matched with local skills. Combined they produced a built environment which met people's needs. There are many lessons to be learnt that can contribute to meeting contemporary and future building and planning needs *(Ed. Paul Oliver, 1997)*. Our traditional/ historic buildings were designed to consume minimal of energy but were enabled to provide environmental comfort to its fullest.

"In our traditional Buildings Environmental comfort against harsh weather condition is achieved by passive means through intelligent and innovative designs of forms, fabrics, and fenestrations - making the best use of local materials and construction techniques (Qureshi. S, 2008)"

Traditional buildings, therefore, offer treasure of traditional wisdom to design energy-efficient buildings for today. Although solutions that we find in traditional buildings may not be suitable to the present socio-economic and technical context, yet the principles on which those solutions were based are still relevant. There is a need to appropriate traditional wisdom in order to develop sustainable building designs for today.

The best existing example of our traditional buildings is Lahore Fort (**Fig. 4**) which provided Mughals with the best environmental comfort without consuming considerable energy, many Mughal and Sikh Havelis continued the tradition and Choona Mandi Haveli Complex (**Fig. 5**) is a very good living example of it.

Fig. 4 Lahore Fort

Fig. 5 Choona Mandi Haveli Complex

Colonial Buildings further improved on the techniques when foreign technology was successfully amalgamated with local traditional wisdom of environmentally comfortable Sustainable Building Design. National College of Arts, Lahore (NCA) **(Fig. 6)**, Punjab University, Lahore Museum and Aitcheson College **(Fig. 7)** are very good working examples of this success.

Fig. 6 National College of Arts, Lahore

Fig. 7 Aitcheson College

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. But after the industrial revolution, the modern built forms changed and consumed a huge amount of energy.

But factors such as demographic growth, shifts from rural to urban areas, natural and human-made resource depletion, and significant changes in expectations and life styles, all combine in their various ways to erode the viability of traditional approaches to building design.

This means that whilst there are aspects of traditional approaches that still work well, some aspects may have become inefficient or unworkable, or in general, unsustainable i.e. the local resources may no longer be available; the sheer concentration of people may require a different sort of building or simply more buildings more quickly, or the source of finance may have changed or may be insufficient.

Taken together, all these changes mean that a building method that worked well in the past in its given context may have now become difficult to afford, build and maintain, and it may no longer meet the desired requirements of the family or community. Gradually it becomes clear that an alternative has to be found. It is very clear today that architects cannot build Hava Khana (air rooms) as of Haveli Nau Nihal Singh **(Fig. 8)** in a 5-10-20 Marla i.e. (1125-2250-4500 sq feet) house. Architects cannot have 20-30 feet high ceiling of Punjab University **(Fig. 9)** as They have to accommodate many floors in this height and also have height restrictions. Architects do not afford the skylights of NCA galleries **(Fig. 10)** as they have to go multistory, they cannot create thermal mass of Lahore Fort as simply there is not enough space for it and architects even cannot have the chamfered windows of the basement of Sethi Haveli as they do not have finances for it.

This scenario tells that Architects have now got the limited resources and many approaches to shelter provision developed over the time require equipment, skills or capital that is inaccessible to the majority in Pakistan.

Fig. 8 Haveli Naunihal Singh

Fig. 9 Punjab University

Fig. 10 NCA Skylights

6 Conclusion

Blind usage of modern day technology and materials without understanding its potentials for being sustainable took away the embedded environmental comfort of our buildings and we became dependent on more and more energy consumption for our environmental comfort which in turn is polluting our environment and is causing global warming on one hand while on the other is depleting our precious non-renewable energy resources.

We as architects need to relearn the old tried and tested methods of designing environmentally

comfortable, energy efficient, sustainable buildings, learning the sustainable principles from our traditional/ indigenous buildings and applying them through modern day "state of the art" sustainable building materials.

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

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