Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2011
(ICMERE2011) 22- 24 December 2011, Chittagong, Bangladesh

ICMERE2011-PI-056

STRUCTURAL AND AESTHETICAL ASPECTS OF GREEN TECHNOLOGY IN PERSPECTIVE OF BANGLADESH

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Abstract- *Bangladesh as a fast growing nation is more exposed to environmental damage due to unplanned urbanization, rapid population growth, and massive boom in construction sector, improper management and planning. So, it is the time that emphasis should be given to develop sustainable design and construction techniques for Bangladesh by analyzing worldwide practice and following accredited code. Green construction practice expands and complements the classical building design concerns of economy, utility, durability and comfort. This paper reviews the aspects of green design and construction techniques, available building materials and their use, and also renewable energy. The practice and technology of green construction may vary from region to region. The aim of the paper is to review green technology from structural and aesthetical point of view and also proposing sustainable design and construction techniques for Bangladesh.*

Keywords: Green construction, green material, structural aspect, aesthetical aspect**.**

1. INTRODUCTION

Green building is also known as sustainable building or high performance building. In ICC White Paper 2007 it was defined in simple words as "structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner." Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Increasing the efficiency with which buildings and their sites use and harvest energy, water, and materials.
- Reducing building impacts on human health and the environment, through better site planning, design, construction, operation, maintenance, and removal — the complete building life cycle.
- Protecting occupant health and improving employee productivity.

Green building can reduce energy use 24-50%, CO_2 emission 33-39%, water use 40% and solid waste 70% [1]. But buildings have huge impact on the environment and a current statistics [2] estimated that, by the year 2050, residential, commercial and institutional buildings will consume 38% of global energy and release 3800 mega tones of carbon in the atmosphere. All these will have huge impact in increasing global temperature. Bangladesh is one of the countries which will have highest catastrophe by green house effect. This paper will give a review on green construction techniques adopted by various countries and give structural and architectural suggestions of green technology for Bangladesh**.**

2. GREEN PRACTICE WORLDWIDE

Green building practice has been embraced worldwide with great enthusiasm. Figure 1 shows the scenario of appreciation of green technology in Australia, Southeast Asia and China.

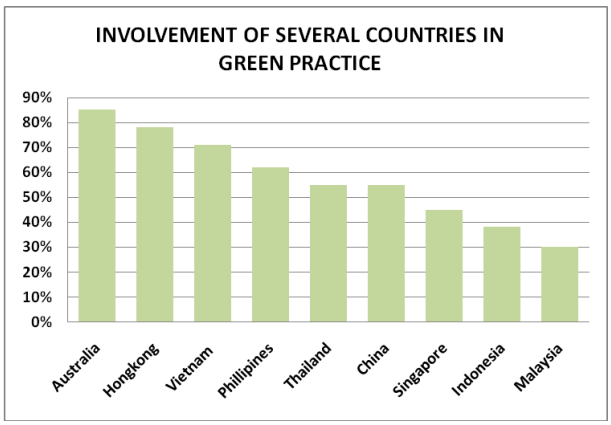

Fig.1: Percentage involvement of several countries in green practice [3]

For example, PWD (Public works department) of Delhi government has taken the initiative [4] to adopt green practice. PWD will adopt optimum energy

efficiency in air conditioning, lighting, water saving systems and fixtures, use of solar energy for water heating and lighting, rainwater harvesting system and Effluent Treatment Plants (ETPs) etc. PWD is also working towards climatic control in its buildings to conserve energy. It is experimenting with trenchless technology and pollution free Hot Mix Plant. Delhi Government is implementing the MOEF (The Union Ministry of Environment and Forest) notification regarding mandatory use of fly-ash bricks or blocks or tiles by all construction agencies in Delhi.

Reviewing worldwide practice green design and construction techniques are discussed in the next section.

3. GREEN DESIGN TECHNIQUES

Green design may be determined in co ordination between owner, designer and contractor before and during construction. Architectural considerations are very important part of green building design. During design LEED (Leadership in Energy and Environmental Design) or other accredited code must be followed. In design stage proper care should be taken to provide and protect natural habitats and emphasis should be given to increase the use of on and off site reclaimed material. It will decrease the emission of transport energy.

3.1 Designs for Local Environment

The main design considerations for local conditions are earthquake, wind patterns, rainfall humidity, high & low temperatures, pests (termites) etc. Considering these for countries with hot and humid climatic conditions, green building should be designed to protect the building from direct sun during the hot season because it will increase the use of cooling appliances.

For structural safety, Bangladesh National Building Code (BNBC) must be followed. In terms of energy consumption, much of the existing commercial building stock in Bangladesh is made up of multi-storey, highly-glazed, thermally-lightweight developments that are totally dependent on non-renewable energy for heating, cooling and lighting. In terms of materials, most commercial buildings tend to make extensive use of brick, steel, glass and concrete, all of which can be energy-intensive to produce, via processes with the potential to have adverse environmental impacts and using resources that are in shortening supply. Indoor environment quality can be improved by setting the architectural plan to have sufficient day light and solar access and views. As Bangladesh is a fast growing nation and construction sector had seen a massive boom, the commercial aspect had been a more important factor than making a healthy home; in most of the cases buildings are so closely held that most of the flats or office spaces do not have ample air and light. By adopting simple architectural consultation it is possible to improve the local environment without affecting economic prospect of the houses.

For example, Passive solar design method [5] can be followed. Following this the building layout can be oriented so that rising heat wave on the south side of the building naturally heats up the roof terrace work areas and south facing sleeping rooms during winter.

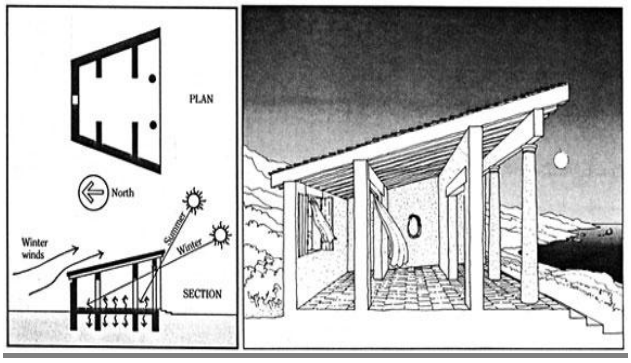

Fig.2: Passive solar design method.

High angle sun light in summer is shielded from interior rooms by insulative roof structures. North side storage rooms are ventilated and are cooler in all seasons as shown in figure 2. South side loftier can be built to get the winter sun and the north side should be lowered to keep out the winter winds.

3.2 Positioning of Building Components for Proper Indoor Environment

To save energy interior of the building need to be designed with energy efficient appliances and equipments. Windows should be designed not using so much of glass to lower heat gain. But there should be plenty of light. Ample space for tree plantation, native planting with non toxic gardening technique can improve indoor air quality as it is said one large shade tree can provide cooling equal to four ton air-cooler and not only that it also increase aesthetical view .

Liberty tower in Tokyo which is a 26 story building with university classrooms and offices is an example of passive ventilation driven by stack effect [6]. Openings are controlled by small electrical motors and also provided with pressure and temperature sensors.

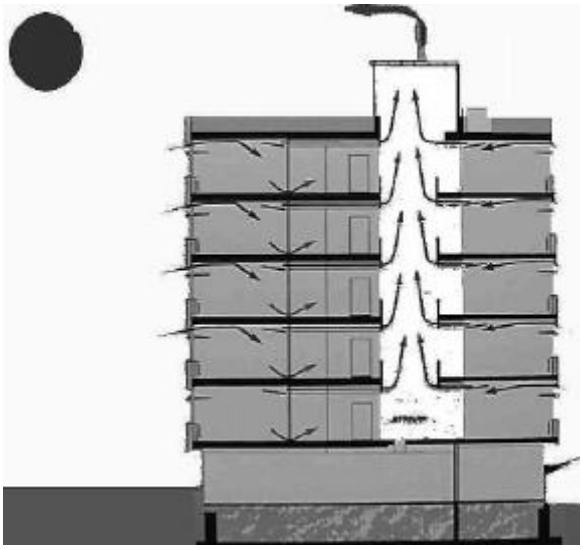

Fig.3: Stack ventilation technique used in Liberty tower in Tokyo.

Figure 3 shows a section of the whole building indicating

the ventilation pattern. Here air enters the rooms through vents in the facade, flows via the atrium and exits through the rooftop opening.

3.3 Provision of Waste Water Collection and Treatment Plant.

Green buildings should be designed in such a way to have waste water collection and treatment system but it must conserve natural resources. Waste water treatment alternative should emphasis on the methods that minimize the need of chemical treatment and energy consumption.

Although, new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment.

In Bangladesh, WASA (Water and Sanitation Authority) is the government body responsible for supplying water to 6 city corporations and municipalities. The major sources of water whether for drinking, industrial or agricultural use are surface water (30%) and ground water (69%) [7]. Very little recycling or reuse of water is taking place. Waste water in Bangladesh is mainly recycled to use in irrigation. Till date this practice is mainly confined in rural areas of Bangladesh for cultivation other than in domestic use in urban areas in private sector or individual initiative taken by residents of the house.

4. CONSTRUCTION TECHNIQUES

4.1 Selection and Use of Green Materials

Green construction materials are selected not only considering their performance but also their end of life, i.e. how the materials can be recycled, reclaimed, recovered and disposed. For example wood can be a very efficient alternative for concrete and aluminium because they have very high carbon footprint during their production process. Movement of materials from distant location to job site should also need to be reduced.

4.2 Use of Recycled and Reclaimed Materials

Best practice need to be adopted to decrease the use of concrete and increase the use of recycled and reclaimed materials to the mix offsetting the intensive energy requirements from cement production process. Recycled aggregate and incorporated fly ash can be used in concrete replacing 15-50% cement.

As Green products are more durable than conventional product, CCA treated wood, vinyl, ozone depleting HCFC, PVCs should be completely avoided.

4.3 Construction

In design phase rooms can be designed so that sawn lumber and other products (drywall, plywood, carpet and tile) require minimal cutting and produced minimal waste. Tile, brick, concrete should be evenly distributed throughout a house. The more mass in direct contact of sunlight is the better. For structural frame, structural insulated panels (SIPs) for floors, wall or roof can be used. Recycled gypsum wall are used in Singapore as common practice [8]. Rigid foam forming system can be used to hold concrete in place during curing and provide long term thermal insulation for concrete walls. Through the control of the sun exposure and natural lightening optimum performances can be obtained by means of both mechanical and architectural systems, for example by using wooden sun breakers. The aspect of the thermal-acoustic isolation is absolutely relevant.

Fig. 4: Use of solar tubes to bring in additional daylight into underlying soils [10].

The performance of the exterior envelope can be increased by the thermal inertia of the non-structural elements. This effect can be obtained by using a greater thickness of the opaque surfaces and, for the transparent surfaces, by using high performing glass systems and sun radiation control systems. Photovoltaic system can be used for hot water heating as shown in figure 4[9] and solar tubes can be used to bring additional daylight as shown in figure 5[9].

Fig. 5: Photovoltaic electricity generation and integrated passive solar hot water heating.

Depending on climatic conditions various unconventional construction techniques [11] are adopted in many countries. Straw Bale construction, Rammed Earth construction, Dirt Bag construction, Log and cordwood construction, papercrete construction are some of these techniques. The advantages are lower materials costs, requires less skilled labor, most techniques are suitable for building off the grid and more suitable to some climates and locations. Techniques have been

around for 1000s of years, some of the oldest buildings on earth are rammed earth structures. Rammed Earth construction had been practiced greatly in the rural areas of Bangladesh and can be a suitable green alternative of concrete structures of low rise building.

Fig. 6: Permeable pavement.

Also, onsite infiltration practice can be developed for storm water control. Pervious paver block systems, pervious concrete mixes and pervious asphalt mixes allows storm water to pass to the sub-base and infiltrate.

5. CONCLUDING REMARKS

Bangladesh now needs to incorporate the green technology to meet the challenge of global warming. The techniques discussed in the previous sections can be adopted in construction of new buildings. These techniques should be discussed in planning stage and considering the financial ability of the owner can be incorporated.

As Bangladesh is a hot country solar panels can be installed into building. Again, during monsoon rainwater harvesting can be a great solution not only meeting the demand of scarce water but also it can be an initiative to be conservative about our resources. It can be incorporated in the roof of the building only through some structural modification.

Due to rapid and unplanned urbanization in Bangladesh especially in Dhaka city, storm water drainage is a major problem. During monsoon water logging has become unavoidable. Use of pervious pavement can be a solution for this. If we construct our premises with pervious block or pervious concrete it would be a step forward to green practice.

New conceptual approaches to the building design deriving from the use of innovative systems allowing an improved passive protection against extreme attacks like earthquakes should be proposed.

As Bangladesh lies in the active earthquake zone a regular plan grid should be tried to adopt as far as possible. The designers, by means of the operated choices of sustainable architecture and engineering, have tried to combine the structural and architectural aspects and better solutions are coming day by day. All these initiatives will help to make green practice popular in Bangladesh with safer, environmentally friendly and aesthetically beautiful structures.

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7. NOMENCLATURE

Symbol	Meaning
CCA	Chromated copper arsenate
HCFC	Hydrochloroflurocarbon
PVC	Poly vinyl chloride