



Effects of Eco Friendly Housing in Real Estate Sectors of Bangladesh

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Abstract

Natural disasters-flood, cyclonic tidal/storm surge, land slide, river bank erosion, drought and earthquakes are the main hindrance to the sustainable development of Bangladesh. In recent years, these have caused extra burden for the marginal people of the country jeopardizing country's economic growth as a whole. Although it is a small country, its culture, disaster types, availability of building materials are diverse and the housing practices in different regions vary widely too. A large number of rural houses are damaged due to disaster on a regular basis and cause economic losses and sufferings to the people. Repetitive constructions of such houses also impart deterioration of the environment as much of the construction materials are obtained locally from surrounding nature and thus sustainable development is also hampered significantly. To develop the design, at first the local practices and availability of local materials were studied. Besides, it was considered essential to understand and accommodate the need and culture of the community. At the same time it is important to consider environmental issues. Three-stage community level meetings attended by people, leaders and local masons were held to gather their views, demand and experience. Properties of the local construction materials were ascertained from laboratory tests. Respecting local affordability and considering the service and environmental loads, designs were finalized based on FEM analyses. Model houses were constructed at the selected locations to demonstrate them to the local community with an aim that new design or at least some features would be replicated. Different treatment schemes for increasing the durability of materials were employed to study their effectiveness.

Key Words: *Eco Friendly, Eco Friendly, Environment, Bangladesh*

Introduction

The housing sector plays vital roles both in the context of the economy of Bangladesh and serving the fundamental human right of shelter which actually call for the awareness and analysis regarding various pertinent issues involving the sector. These analyses include the size and contribution of the housing sector to the economy, current market structure and trends in this sector, regulatory framework governing this sector, various government policies and associated challenges arising from recent economic crises and policy changes. Without adequate information the players in this sector cannot plan and prepare themselves for the challenges and opportunities. Besides, the government cannot make appropriate policy interventions to make an appropriate balance between the facilitation and regulation for the betterment of both this sector and its contribution to the overall economy. Availability of proper information is also necessary from the perspective of the investors so that they can make efficient investment decisions. This is very vital as the sector grows to its matured phase, investors has to be well aware of the facts and status of the industry. Various linkage industries, particularly those who depend solely or heavily on the housing sector need accurate information, facts and forecasts to safeguard their interests. And last but not the least consumers cannot make the best use of their scarce savings for their accommodation if they do not have proper information of this sector. Thus, availability of more market related information will define, with greater accuracy, the nature of the future development required in this sector. Despite the significant growth of the housing sector in the recent past, good research dealing with the development of this sector is lacking. This is compounded by the fact that there is a lack of adequate statistical information.

Objectives of the Study

1. To justify the efficacy of low cost housing in urban areas in Bangladesh.
2. To identify the measures that can be taken to enhance the efficiency low cost housing
3. To find out issues and challenges for environmental friendly low cost housing in Bangladesh

Methodology of the Study

The study has been conducted on two sets of population, one representing the demand side and the other the supply side of the Real Estate sector. On the demand side, the population consists of all the existing and potential consumers and the supply side consists of all the member companies of REHAB.

Sources of Data

This study has been conducted based on both primary and secondary data. The secondary research was mainly required for the background study on this sector and to define the research problem. For the supply side, secondary sources were brochures and reports from different member companies of REHAB, and the web. Primary sources were the Management and Professionals from REHAB member companies, Government Officials, Experts and Policy Makers, and representatives from different linkage industries. For the demand side, primary sources were from existing and potential clientele. Besides, some secondary sources like small scale research reports conducted during the REHAB fairs have also been used.

Research Design

This study is a combination of both Exploratory and Descriptive research methods. The study was survey and case study type.

Exploratory Research

Initially, exploratory research was done to provide insights and understanding of the problem. Research process in this part was flexible and unstructured; samples were small and non representative; analyses of primary data were qualitative. Methods: Among the different exploratory research methods secondary data analysis and qualitative techniques such as in-depth interview with concerned government officials, experts and policy makers was used. Besides, there was a Focus Group Discussion (FGD) with renowned REHAB member firm owners.

Descriptive Research

A well planned descriptive research followed the exploratory part mentioned above. In this part, research process was formal and structured; sample was large and representative; data analysis was quantitative. Methods: Among the descriptive research methods, questionnaire survey was administered in gathering information. A semi-structured questionnaire with open-ended as well as some closed questions was used to reveal relevant information. Before administering the large scale survey, a pilot survey was conducted to refine the survey instruments and fine tune the study.

Sample Design

As mentioned above, this study was conducted on two sets of population, one representing the demand side and the other the supply side of the Real Estate sector.

Sampling Method: In this survey, non-probabilistic sampling methods were selected because the complete sampling frame for the target population was not available that is necessary to conduct the usual probabilistic sampling techniques. Besides, limited time and budget also guided the researchers to go for non-probabilistic methods. To ensure representativeness, the researcher went to the different zones defined above at different dates to collect data. Within a zone, the researcher randomly approached potential sampling elements and collected responses from those sampling units who have willingly participated in the survey. Moreover, the sample size was large enough, i.e. 676, to ensure representativeness.

Sampling Frame: Several sampling frames based on profession and income level were used.

Basis	Sample frame
Profession (Govt./ Semi-govt./ Private)	Doctor, Engineer, Banker, Teacher, Businessman, Lawyer, Service holder, and Others
Income Level (Tk./ Month)	30,000 or below, 30,000-45,000, 45,000-60,000, 60,000-75,000, 75,000 or above

Sampling Element: Individual households from existing and potential clients

Sampling Unit: Individuals from existing and potential clients sample size: 676, which is sufficiently large for this sort of surveys channel of approach: Both physical survey and online methods

Supply Side:

Target Population: All the member companies of REHAB and different linkage industries.

Channel of Approach: Physical visit.

Data Collection method: Data were collected by face to face interview with the respondents.

Data Analysis: Quantitative analysis was done using statistical and mathematical tools such as Statistical Package for Social Science (SPSS) and MS Excel. Useful and reliable models such as Univariate Analysis, Bivariate Analysis, Multivariate techniques were developed to analyze the data.

Real Estate Business in Bangladesh

Real property such as land, land improvements, and building held for business use in the production of income. It is contrasted with personal property. Real property held for investment purposes. Increased value in real estate has typically exceeded the rate of inflation. But real estate as an inflation hedge varies from locality to locality. Also, leverage exists with real estate since a high percentage of the investment may be made with debt funds. Down payments are often less than 25%. However, a large capital investment is usually required. Real estate provides capital appreciation or depreciation. Certain real estate investments, such as residential and commercial property, generate annual income. Directly managed real estate income property provides tax deductions in the form of depreciation expense, interest expense, and property taxes.

Piece of land and all physical property related to it, including houses, fences, landscaping, and all rights to the air above and earth below the property. Assets not directly associated with the land are considered personal property. Land and attached structures. Interest in real estate can be protected through various insurance policies. In law, land and everything more or less attached to it. Ownership below to the center of the earth and above to the heavens. Distinguished from personal property.

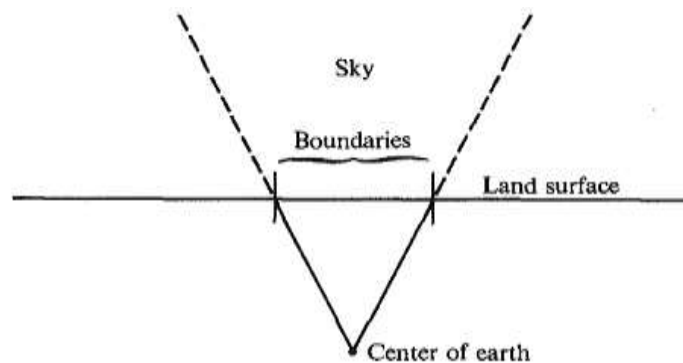


Figure 1: Real Estate

Land

Land, sometimes referred to as dry land, is the solid surface of the Earth that is not covered by water. The division between land and ocean, sea, or other bodies of water, is one of the most fundamental separations on the planet. The vast majority of human activity has historically occurred, and continues to occur, on land. Furthermore, the life forms that exist primarily on land, including terrestrial plants and terrestrial animals, differ from those that exist primarily in large bodies of water. The demarcation between land and water varies. In some places, it is sharply defined by solid rock landforms coming directly to the edge of the water. In other places, land may slowly give way to marshes or swamps, with no clear point at which the land ends and a body of water has begun. In such places, the demarcation can further vary due to tides and weather, with the area where land and sea interact being called the "coastal zone"

Land in Terms of Business

Real estate held for productive use or investment. Land is recorded at the acquisition price plus incidental costs including real estate commissions, attorney's fees, escrow fees, title and recording fees, delinquent taxes paid by the buyer, surveying costs, draining, and grading of the property.

The cost of knocking down an old building to clear the land to construct a new building is charged to the land account. An amount received from selling materials salvaged from the old building reduces the cost of the land.

Land is usually presented under the property, plant, and equipment section of the balance sheet. However, land bought for investment purposes or as a future plant site is classified under investments. If land is held by a real estate business for resale, it is shown as inventory.

Land is *not* subject to depreciation because it is not a wasting asset: Real estate or real property, or any tract that may be conveyed by deed. Estate or interest in real property; often refers not only to the earth itself but also to things of a permanent nature found or affixed there. The surface of the earth; any part of the surface of the earth. (Note: Legal definitions often distinguish land from water.)

Example: Extent of *land* as real property. Air rights may be limited to some defined altitude. Added improvements are distinguished from *land*.

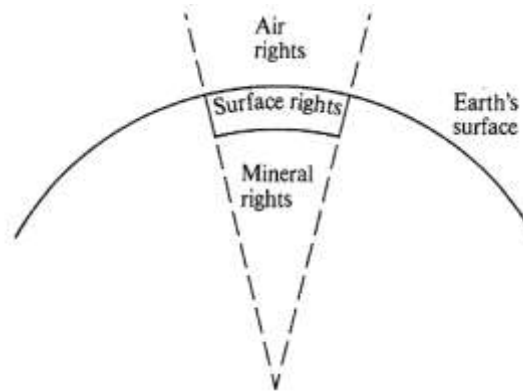


Figure 2: Extent of Land ownership

Conditions of Real Estate Business

Beyond providing physical shelter, housing may have significant impact on the lives of the dwellers in terms of skills enhancement, income generation, increased security, health, self-confidence and human dignity. Nordberg has clearly demonstrated that in most regions, housing has the potential of becoming an engine of economic growth because of its high yield on invested resources, a high multiplier effect, and a host of beneficial forward and backward linkages in the economy. Both the Constitution of the People's Republic of Bangladesh and the UN Declaration on Fundamental Rights recognizes shelter as one of the fundamental human rights. Making shelter available to all is increasingly becoming a significant challenge in Bangladesh. The economic development is far from satisfaction and the GDP per capita in 2010-11 is Tk. 26019 (Monthly Economic Trend, Bangladesh Bank). Moreover, a large portion of the population lives below the poverty line and are deprived of habitable shelter along with other basic services. Bangladesh, like many other developing countries faces an acute shortage of affordable housing both in the urban and rural areas (Md. Maksudur Rahman Sarker, 2011). Moreover, housing affordability is being eroded by poor land administration policies, which have resulted in very high land prices that make urban housing prohibitive for lower-income groups; and in infrastructure that is inadequate for expansion into per urban and rural areas. There is no active secondary market for real estate, mainly because of the high transfer taxes and an uninterrupted long-term increase in land prices (World Bank Document, 2010). With 147.9 million people (Bangladesh Economic Review, 2011), Bangladesh is one of the most densely populated countries in the world. Land prices are high and permanent housing is rare barely 2% in rural areas and 23% in urban centers. Estimates suggest a shortage of about 5 million houses in Bangladesh, with as many as 500,000 houses added annually in urban areas and 3.5 million added in rural regions (World Bank Document, 2010).

Statistics show that Bangladesh will need to construct approximately 4 million new houses annually to meet the future demand of housing in the next twenty years. Estimates for annual requirements for housing in urban areas vary from 0.3 to 0.55 million units. The share of urban population in Asia is 37% at present and is projected to be 45% by 2015. In Bangladesh 25% of the population now live in urban areas; this proportion will be 34% by the year 2015 (Strengthening the Role of Private Sector Housing in Bangladesh Economy: The Policy Challenges, 2003). Dhaka, with a total population of over 10 million, is the 9th largest city in the world and also 28th among the most densely populated cities in the world (Wikipedia, 2012). While comparing the growth of the real estate and housing, and the construction sector with that of GDP, it was found that growths in the two sectors are the period 1992-2002 were 4.8 and 7.5% is much higher than the trend growth in GDP of 4.6% for that period. The shares of the real estate and housing sector and the construction sector in the GDP were quite high in the year 2002 and accounted for 8.3 and 8.0% respectively. However, the incremental contributions of these two sectors in the same year were also considerably high at 6.0 and 12.8% respectively (Strengthening the Role of Private Sector Housing in Bangladesh Economy: The Policy Challenges, 2003). The real estate sector is at present creating employment for about one million people who are directly or indirectly involved in the sector. According to the Labour Force Survey (LFS), in 1999-2000, 2.1% of the labour force was engaged in construction, whereas for 1995-1996 the figure was 1.8% respectively (Strengthening the

Role of Private Sector Housing in Bangladesh Economy: The Policy Challenges, 2003). According to Labour Force Survey (LFS) 2005-2006, conducted by Bangladesh Bureau of Statistics (BBS), projected labour force engaged in construction sector is 4.4 percent. This scenario actually implies a consistent growth in the involvement of the labour force in the construction sector which makes this sector critical from the perspective of employment generation in Bangladesh.

Recent information concerning investment in the housing sector shows steady growth both in absolute terms and as a percentage of total private investment and GDP. Private investment in housing and construction has more than doubled during the Fourth Five Year Plan period, from US\$ 11.66 million in 1989-1990 to US\$ 264.83 million in 1994-1995.

During the first three years of the Fifth Five Year Plan period, the average investment in housing and construction was US\$ 1273.65 million. As a share of total private investment, private investment in housing and construction in the 1997-1998 to 1998-1999 period accounted for 47.3% which far exceeded the target of 16.35% for this period. The proportion of investment in housing and construction in the national GDP increased from 3.4% in FY 1997 to 4.1% in 1999 (Strengthening the Role of Private Sector Housing in Bangladesh Economy: Policy Challenges, 2003). These data portrays the incremental attraction of this sector to the private investors of Bangladesh. This sector is also facilitating the growth of around 300 different linkage industries. Real Estate business, especially apartment projects, took off in the Dhaka City in the late 1970s. From the early 1980s the business started to flourish and showed robust growth. At present, more than 1000 companies are active in the real estate business in the country. The market is highly segmented, primarily based on location, price of the land and size of the apartments. The main reasons for the development of real estate business in Dhaka city are:

1. Scarcity of open spaces in important parts of the city.
2. Hazards of purchasing land.
3. Rapid increase in the population of Dhaka.
4. Increase in remittance flows in recent years which financed the sector.

Experts opine that, Bangladesh will encounter high levels of urbanization by 2015 and by that time Dhaka will need to house about two crores people to become the fifth largest city in the world. So mitigation of this huge demand requires a long-term plan to be formulated so that a collective effort from both the private sector developers and individual developers may adequately provide for the huge demand (Strengthening the Role of Private Sector Housing in Bangladesh Economy: The Policy Challenges, 2003). Real estate business in Bangladesh started in the late 70s. But the business got the main attention in late 90s and in the mean time it experienced a boom too. In the following sections real estate business in Bangladesh and the real estate market in Bangladesh are described. Then after that real estate business in the outskirts of Dhaka city is described followed by the conclusion.

Real estate business in Bangladesh is limited to some designated city areas till now. These cities are the six divisional cities which also got the status of city corporations. They represent the level of urbanization in Bangladesh too. In reality not all the cities have the same level of real estate business activities. Even some cities do not have it at all. So, one might argue that the real estate sector in Bangladesh has a great potential in coming days considering the fact that there is still a large market segment remaining to penetrate. Now question might arise why there are no real estate activities in the rural areas. The answer is that in rural areas people build their houses by own efforts and sometimes with the help of construction workers especially in case of buildings. There are no architects to design houses in rural areas because they are not really needed there. Most of the houses in the rural areas are not buildings. Even when there are buildings they don't employ any architects or construction firms to build the houses. Rather they hire construction workers and discuss their preferences with them and finally reach a decision how to build the house. The same pattern is present in the small towns in different regions of the country.

The major part of the preference of rural people comes from their observation of the houses in neighborhood and in the city areas. When they visit the city areas they get new ideas about housing and try to implement those ideas in their own house building activities. Another question might arise about the differences among the cities based on real estate firming activities-Why there are differences among cities? In fact development of the real estate business activities in a particular area depends on a lots of things and the whole process is much more complex in a country like Bangladesh where

- The level of education is variable across the country
- People have the differing views on the use of their lands
- Affordability and the housing requirements are different
- Government don't yet have a housing policy formally
- Financial sector is less oriented to the real estate business development
- Preferences for housing is different than that in other countries
- Difference in between rich and poor is significant and middle class diminishes

Like all other developing countries, in Bangladesh land is one of the crucial factors for a lot of other products which means that there is always a trade off in case of land use. These tradeoffs sometimes limit the use of lands toward the maximum possible welfare for both the landowners and the country in a macro level. In Bangladesh land can be used in any of the followings:

- As input of agriculture: Bangladesh is an agrarian country and majority of the total population is involved with agriculture either directly or indirectly. In most cases agriculture is almost the sole source of incomes for this large part of the population.
- As factor of production: For business firms especially for the Small and Medium Enterprises (SME), land is one of the most important factors. In fact costs of the lands are sometimes the largest or the second largest costs for these firms.
- As input in Business Model: This is especially relevant for the real estate business firms. Land is the most basic factor on which a real estate firm's business model is developed. So it carries an extra weight when one decides on the business model. As a result, when a farmer decides about the use of his/her lands, he/she has to think a lot because of the potential losses arising from the opportunity costs. But the reality is little bit more difficult in Bangladesh. Here some people have lands as the only source of income. So when they decide upon the use of lands they can't think it much really because this is the only option they have.

Environment Friendly Low Cost Housing Techniques

Proven for Environment Friendly Low Cost Housing are to reduce energy consumption, and thus greenhouse gas emissions, during the useful life of the building and to minimize life cycle emissions associated with building materials and techniques. In order to achieve these goals it is important to implement regionally appropriate energy efficient design utilizing low embodied energy materials, and make use of onsite renewable energy within an energy efficient structure. It is important to understand when designing homes and choosing building methods that it is often the case that a building's total life cycle greenhouse gas profile can be 2/3 to 3/4 in the energy use over its life with the remaining portions in the embodied energy of the materials, although this is not universally the case.

Depending on the construction method, the materials, design and location the embodied energy in the materials can be a much more significant contributor to the overall life cycle climate impact of the dwelling. It is also important to consider the relationship between the housing and the community at large. Within the scope of sustainable urban planning (touched on in section 4.4.3), integrating sustainable planning with sustainable housing design can support numerous synergies which improve economy wide climate change mitigation, as well as adaptation and social benefits. In the following sections, this study will explore some important strategies to address both reduced energy use and reduced embodied energy in building design, as well as address the environment friendly for low cost housing within an integrated design model.

Based on the climatic conditions and the local population that a home is constructed in, it will be important to address energy efficiency and occupant comfort according to the ambient climatic conditions and the thermal comfort expectations of the inhabitants. With future climate change, these regional climate conditions look set to change, adding further complexity. A design which may serve to efficiently reduce energy consumption while providing comfort in one climate zone may not necessarily do so in another climate zone. An issue for many developing nations is that formal "climatic zones" that detail climate characteristics have not yet been identified or established. Most cities in the world, including within developing nations, have historic records of basic geographic, weather and climatic data, including wind speed and direction, humidity, temperature, latitude and other factors. As well the World Meteorological Organization has established climatic data for many regions (Grigoletti et al., 2008).

Climatic data forms the basis for determining general climatic characteristics which can be used to identify climatic zones (Rakoto-Joseph et al., 2009). Establishing climatic zones where they have not been established before is an important step in optimizing energy efficient building design for those areas (Rakoto-Joseph et al., 2009). From this point bio-climatic building design can be achieved with precision (Rakoto-Joseph et al., 2009; UNCHS, 1986). Bio-climatic design can be described as building design which emphasizes energy efficiency through passive heating and cooling systems and which is informed by quantitative climatic data and human comfort data for optimization.

In the case where formal climate zones have not been established, basic weather and climate data as described above can be used to establish a basic data set to inform design. In general, most inhabited areas of the earth can be categorized within a few informal climate zones, such as temperate, cold, hot-humid and hot-arid. There are, of course, important nuances to locations which are disregarded in this basic framework. But for the purposes of scoping the most effective energy efficient design techniques, as they may be applied to low cost sustainable housing to effectively address climate change, this study will generalize the key techniques and their usefulness within general climatic

zones. In the field, it is important to design housing strategies which will be more accurately optimized to local climatic conditions than is presented here.

The descriptions below are only to highlight important strategies to be considered, but should be further optimized in real world applications with advanced energy modeling and LCA tools. For that reason the following design methods are explored in terms of their general appropriateness to climate zones and a discussion follows regarding perceptions of comfort. With regional climate change expected in the lifetime of new homes (20-60 years) it is vital that building techniques that seek to address both climate change mitigation *and* adaptation are used. Of the climate mitigation building techniques outlined below, we also therefore given an indication of their suitability/appropriateness to withstanding gradual changes in climate and climatic extremes (floods, heat waves etc.), in other words, their potential to adapt to climate change.

Passive Solar Heating: Ideally suited to temperate and cold climate zones. Well suited to climate adaptation. Passive solar design for heating is a well-known and established set of methods in use around the world. Much work has been conducted on the establishment of guidelines for passive solar design since the 1970's. There are numerous reference materials available on the web and in the scientific literature. Important resources are listed in the following section. Generally, passive solar design utilizes the natural solar radiation in a given location to warm the interior environment of a home or building. This is accomplished through the proper orientation of the building towards the equator, with adequately sized window glazing to allow winter solar radiation (sunlight) into the home. When properly designed, this passive technique will serve to warm the interior mass of the building materials in colder seasons without overheating in warmer seasons.

Natural Ventilation

Ideally suited to hot-humid and hot-arid climate zones. Well suited to climate adaptation Natural ventilation describes a number of potential techniques which make use of natural convection currents within air flow to direct air into and out of buildings in such a way as to expel heated air from the space and replace it with cooler air or exchange air without losing heat or cool. One example of this would be to design air ducts which allow air to enter low in the building via underground ducts, while simultaneously allowing air to escape high in the building. This technique captures the natural convective currents of rising warm air to draw cooler air into the building, which replaces warm air, providing cooling with no or minimal mechanical parts or energy consumption. The Benazir Housing Technology, used in Pakistan by projects funded by GEF and administered with the help of UNDP and local organizations, uses a design which takes advantage of passive cooling through ventilation in pyramid shaped raised roof structures. **Evaporative Cooling:** Ideally suited to hot-arid climate zones. Poor to moderately suit to climate adaptation. Evaporative cooling describes numerous techniques which utilize water's natural conductive properties to transport heat out of the building via evaporation. Common techniques include maintaining moist surfaces (roofs or walls) that are exposed to the exterior environment and sunlight. The evaporation of water produces a cooling effect (as in human sweat) and can successfully serve to cool building materials which in turn will cool interior ambient temperatures. The effectiveness of this technique was demonstrated in a case study in India, featured in the 1986.

Environment Friendly Infrastructure

There are also, mechanical technologies which use the evaporation of water to produce cool air for circulation in the home. These technologies require electricity to operate, but can be effective. Passive evaporative cooling is a preferred method, but requires caution so as to avoid water infiltration and damage to building materials. Passive evaporative cooling works best in hot-arid conditions where the gradient of humidity is great forcing more evaporation to take place in a shorter period of time. Because of expected increases in water scarcity with climate change, however, this technique does not rate highly in relation to climate change adaptation. **Other Passive Cooling Techniques:** Suited to hot-arid, hot-humid and temperate climate zones.

There are numerous low tech and passive techniques which can serve to reduce the ambient temperature within buildings in during warm seasons. These include solar shading, high albedo wall and roof surfaces, vegetative shading and micro-climate enhancement, vegetative roofs and wall trellises and appropriate spatial design to isolate interior heat loads, especially from cooking. In general, for hot and temperate climates, avoiding overheating is important to comfort and reducing energy inputs associated with air conditioning or mechanical ventilation, especially under conditions of future climate change. Providing adequate shade, as covered porches, patios or courtyards, can serve to provide additional living space and reduce the heat gain associated with direct solar exposure. This can be achieved through the construction of shade structures attached to the home, and through strategic plantings of vegetation and trees.

High Performance Building Envelopes

Appropriate to all Climate Zones As is evidenced by global efforts in developing advanced building energy codes and designs; the building envelope plays a very important role in the energy performance of buildings. There exist

numerous guidelines and standards (as discussed in section 3.2 of this Scoping Paper) which address efficiency in the building envelope. In some regions there are limitations to the availability of high performance insulation or highly efficient windows and doors. This will limit the applicability of some aspects of advanced building design guidelines in relation to a high performance building envelope. Regardless, a well constructed and properly designed home will aim to achieve the most energy efficient building envelope possible with available materials and expertise.

Green Roof Technology

One way of reducing the impact of global warming is by implementing Green Roof Technology where roof consists of vegetation and growing medium sometime referred to as Roof Garden. Many researchers have proved that green roof could give many environmental benefits to the buildings and occupants. A Green Roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It also includes additional layers such as a root barrier and drainage and irrigation systems. The use of green refers to the growing trend of environmentalism and does not refer to roofs which are merely colored green, as with green roof tiles. Also known as living roofs, green roofs serve several purposes for a building, such as absorbing rainwater, providing insulation, and helping to lower urban air temperatures. There are two types of green roofs: Intensive roofs, which are thicker and can support a wider variety of plants but are heavier and require more maintenance, and Extensive roofs, which are lighter than an intensive green. The term "green roof" is generally used to represent an innovative yet established approach to urban design that uses living materials to make the urban environment more livable, efficient, and sustainable. Other common terms used to describe this approach are eco roofs, and vegetated roofs. Green Roof Technology (GRT) is the system that is used to implement green roofs on a building simultaneously dealing with

- a) Strength to bear the added weight.
- b) Seal the roof against penetration of water, water vapour, and roots.
- c) Retain enough moisture for the plants to survive periods of low precipitation, yet are capable of draining excess moisture when required.
- d) Provide soil-like substrata to support the plants.
- e) Maintain a sustainable plant cover, appropriate for the respective climatic region.
- f) Offer a number of hydrologic, atmospheric, thermal and social benefits for the building, people and the environment.
- g) Protect the underlying components against ultraviolet rays and thermal degradation.



Figure 3: A building with roof gardening and solar panels



Figure 4: The Chicago City Hall green roof helps cool the building and minimize water run-off

Inclined Green Roofs

The Extensive green roofs are light-weight with a very thin layer of soil using primarily drought resistant plant species such as sedums and mosses. These roofs survive on natural rainfall and do not need more maintenance than an annual check and a limited feed with nutrients. At the other end of the weight scale is Intensive green roofs with vegetation, roof gardens or even parks which need too much maintenance, watering and weeding just like other gardens. In between these extremes are a wide range of different kinds of roof vegetation with varying soil depths and plant types. Some, like meadows, need occasional maintenance whilst others need more looking after. Green roofs having an inclination of (200 to 300) were used on top of the house. These actually can be found in many different shapes and sizes. Creating a green roof does many favours to the environment and the user as well. These roofs are attractive and can give urban dwellers a positive view and also an improved microclimate. Animals and plants find habitat on the roofs in the midst of all the as-phalt and concrete and these roofs can compensate for lost green space on the ground, to a certain extent. There are also financial benefits to green roofs as the roofing material lasts longer and the cost of heating and cooling the building decreases. Increased green space and more permeable surfaces in the city results in a natural management of much of the rain-water, which leads to decreased costs for drainage and the rainwater does not need to unnecessarily increase the load on the sewage treatment works. Thus these green roofs used had many positive points as said in the previous sentences.



Figure 5: Green roofs have actually been around for centuries in many forms since the Famous Hanging Gardens of Babylon, through Scandinavian sod houses

Researchers from Columbia University Center for Climate Systems Research and NASA Goddard Institute for space studies have discovered that Green roof could potentially reduce energy usage, fossil fuel consumption and green house gas emissions. On an average (5 to 7) °C reduction in indoor air temperatures were measured in building with green roofs during daytime hours and 0.3°C higher at night. Few researches have also confirmed that vegetated surface, green roofs may reduce outdoor air temperature and urban heat island effect through evapo transpiration, and shading also. Thus the objective of this study is to investigate the effect of potted plants on inclined roof to the indoor temperature reduction inside the building in Indian climatic condition.



Figure 6: The Argentinean architect Emilio Ambasz designed the striking green walled Fukuoka conference hall, with one of the largest green walls so far completed. Further it runs down the entire south slopi



Figure 7: Meera House designed by Guz Architects is located in Sentosa Island, Singapore



Figure 8: Green roof system in England



Figure 9: Green Roof structure in Germany

Advantages of Green Roof:

- Roofs represent a large percentage of impervious surfaces; placing vegetation on them can substantially reduce storm water runoff.
- Green roofs can manage much or all of the runoff that would otherwise be generated by a building's roof area.

- c) Green roofs cover normal roofing materials, shielding them from wear and prolonging their life.
- d) Rooftop vegetation adds to the insulation of a building, reducing cooling and heating requirements.
- e) The collective effect of several buildings with green roofs can reduce the —heat island|| effect of urban areas, improve the air quality, and reduce dust and other airborne particles.

Rain Water Harvesting System from Building

Rain water harvesting was also implemented in order to make the project sustainable and eco-friendly. A storage area was made near the house for storage of water. Provision was made to recycle the treated grey water for watering the plants.

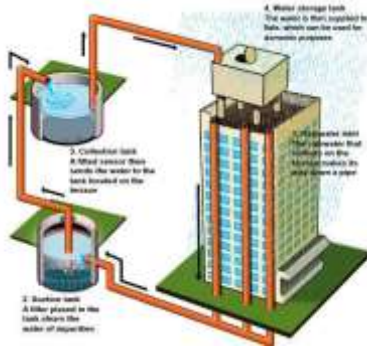


Figure 10: Gulshan Water Pump - Offering Rainwater Harvesting Services, Rainwater Harvesting Service in Malad, Mumbai, Maharashtra



Figure 11: Water harvesting system of a house and connection with water supply channel



Figure 12: Water harvesting system of a house with green field



Figure 13: Flow diagram of rain harvesting system and connection with water supply channel

Conclusion

Residence is one of the basic needs of human beings. The right to live in one's own is a fundamental right of people and it is internationally recognized. The demand of housing in urban areas in developing countries like Bangladesh is dramatically increasing due to natural increase and its fast growth rate. Rural people are migrating not only to find jobs but many wealthy people are moving to urban areas like Dhaka city for the fulfillment of their expectations of better of their future generation, and for enjoying the modern facilities of the city life. This has resulted into a serious crisis all over the country especially in the major cities of Bangladesh. In recent time, the private real estate firms have taken initiatives by ensuring maximum uses of land in a planned way. In this system it is possible to accommodate more people in a comparatively small place. The Organization has an experienced and educated managing Director. The other directors of the Organization are also young and educated. Their innovative idea will help to create new opportunities for the organization but their creative ideas could not be implemented if the attitude of the employees is not changed. The executives, officers and staffs must be trained to change their negative attitude towards new concept of organization.

With a rising population and increasing housing demand, apartment culture has grown up in Dhaka sharply. Apartments were first introduced by the formal private developers in early 80s to the housing history of Dhaka. It first appeared in Dhaka near Central Road and subsequently the city experienced a boom in apartment development in all residential areas including Paribagh, Maghbazar, Siddeshwari, Shantinagar, Dhanmondi, Mirpur, Banani, old DOHS, new DOHS, Gulshan and Baridhara, to name just a few. During the last decade, the total volume of Real Estate, Renting and Business service sector increased every year which implies a positive growth in the sector every year. The growth in this industry also facilitated a fast growth in many linkage industries like glass and glass products industry, brick industry, cement industry, ceramic industry, iron and steel industry etc over the last decade. Such consistent growth in the real estate sector is mainly due to a consistent demand at the consumer end.

Currently, consumers are more interested to buy flats than build their own houses. People who already own a house or flat are still very willing to buy another property which actually adds in the growth in the demand. Buyers from the 40-50 years age group are more willing to build their own houses in upcoming years. Younger segments are willing to purchase flats rather than building their own houses. But in most cases they do not have any immediate plan. For building houses, people mostly prefer Uttara, Mirpur, Purbachal area, Bashundhara area, Mohammadpur, Dhanmondi, and Gulshan areas. For purchasing flats, consumers mostly prefer Dhanmondi, Uttara, Mirpur, Mohammadpur, Gulshan-Banani, Basundhara and Malibagh- Mogbazar areas. Among different occupational groups, Businessmen, Private Bankers, and Doctors (both Govt. service holders and private practitioners) are more willing to build their own houses or purchase flats. Major sources of fund are bank loan, and personal and family savings. One overall perception of the Page 80 of 83 consumers is that the government is yet to play proper roles in meeting the housing needs while the private sector is contributing significantly. The estimated demand for houses in upcoming three years is around 30,000 to 40,000; in upcoming five years demand is around 60,000 to 80,000; and in upcoming 10 years demand are around 95,000 to 130,000. In case of flats, estimated demand in upcoming three years is around 75,000 to 100,000; in upcoming five years demand is around 90,000 to 125,000; and in upcoming 10 years demand are around 70,000 to 95,000. In line with the demand the price of real estate properties are also rising very fast. Price hike of land and construction materials also add to the overall price hike. The price of land is increasing at a very high rate after 1990. After 2000, the rise in land price became steeper.

There is no control of the govt. over the price increase of land within Dhaka city. Increased land price have a direct impact on apartment price. Also, after 2005, price of bricks, granular sand, cement, grade 60 rod etc. had a rapid, almost exponential, increase. Due to such unimaginable increase in land price as well as sharp increase in prices of the construction materials price increase of apartments became an obvious consequence. As an obvious result of such price hike, a good amount of undocumented money has been utilized in acquiring land, apartments, buildings, shops etc. in past few years. Apart from such undocumented money, foreign remittance is a prominent source of fund to purchase any real estate property along with personal and family savings, and bank loan. Apart from meeting the housing needs, the Real Estate sector contributes to the Government exchequer through Registration Fees, VAT, Advance Income Tax (AIT), Stamp Duty, Property Handover Tax etc. Also, the construction industry is a labor-intensive industry, whose capacity of absorbing labor is great. The industry provides many jobs for skilled, semi-skilled and unskilled workers both in the formal and informal sectors. For the migrants from the rural areas the construction industry is often a stepping stone to urban life.

Real Estate sector is a major part of the construction sector. Most of the labour force engaged in the construction sector is basically engaged in the real estate sector. Thus real estate sector is also contributing a lot in the overall economy of Bangladesh. From this study, it is evident that like most other economies of the world, the real estate sector of Bangladesh is playing a vital role in mitigating housing needs as well as contributing to the economy. It is felt by all concerned parties that a long term policy for the facilitation of sustainable growth of this industry is to be formulated very quickly as the industry is said to be entered into its matured state. For such policy formulation, it is very important that proper data is available and accessible to all concerned parties. In spite of being such an important segment of the economy of Bangladesh, there is very minimum data available. For assessing the overall business scenario, taking proper investment decisions and formulating long term strategies REHAB should immediately take some measure to create a central data depository for gathering data. Only this can ensure correct decision making regarding this sector in the future.

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