Ecological Construction of Low Cost Building in Public and Government Sectors

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Ecological Construction of Low Cost Building in public and Government Sectors

(A feasible solution to contaminated environment of Bangladesh)

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Abstract :

Climatological issue has always been a foremost apprehension for any country especially in housing technologies. Bangladesh is among the most populous countries in the world with average 1115.62 people packed into every square kilometer. More than two million people in Dhaka either live in slums or are without any proper shelter. People always try to migrate to Dhaka for various reasons. Urban migration is mainly due to better employment opportunities - especially in the ready-made garments sector - and educational opportunities. More than $1/4^{th}$ people leave for the cities because of natural disasters, river erosion and recurrent flooding. In a developing country like Bangladesh –housing inadequacies and backlog have been increasing mainly due to the increase in population. Families who pay more than 30 percent of their income for housing may have difficulty affording necessities such as food, clothing, transportation and medical care. So, it is important to make low cost dwelling place for them. Low cost housing means housing at low cost but suitable to the environment for all sections of the population. Model houses were constructed at the selected locations to demonstrate disaster resilient structure 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. The prime objective is to reduce cost and make housing an eco-friendly one. As natural calamities like flood and cyclone are common phenomena. This low cost housing should be durable and should have good living conditions for the dwellers.

Keywords : Climatological, disaster resilient, eco-friendly, durability;

INTRODUCTION

Housing is a basic need for civilized dwelling. In a developing country like Bangladesh- housing inadequacies have been increasing mainly due to the galloping increase in population; fast pace of urbanization and other social and economic factors, which include breaking up of the joint family system, and steep rise in the price of land, building materials and labor. Since 75% of the households are still living in simple huts or houses made of mud, the consequences of these scourges are all the more disastrous. Many house destructions are noted every year in rural areas due to low quality housing, poor materials and wrong building practices. Habitable shelter is one of the basic needs of human being. The housing pattern of a community largely depends on its socio-economic conditions, availability of raw materials and environmental factors. The low-income profile of a population is naturally forced to choose a low cost option to raise their dwellings. However, these houses need to be structurally stable and durable to provide a cost-effective return. A minimum level of provision for safe water supply, sanitation, fuel and lighting facilities are also associated with these dwellings. The focus should not only be on rural areas but also on slum areas in big cities like Dhaka and Chittagong. Low cost housing should not mean low quality housing, although the cost and quality go together. Low cost houses like mud bamboo houses has lot of advantages than brick, cement house and also one can easily beautify their houses in architectural view.

Eco-friendly structure

Eco-friendly, or ecological, construction is building a structure that is beneficial or non-harmful to the environment, and resource efficient. Otherwise known as green building, this type of construction is efficient in its use of local and renewable materials, and in the energy required to build it, and the energy generated while being within it. Eco-friendly construction has developed in response to the knowledge that buildings have an often negative impact upon our environment and our natural resources. This includes transporting materials hundreds or thousands of miles, which has a negative impact in the energy required to transport them, and also in emissions of hazardous chemicals from a poorly designed building that creates, and traps them. Other features of an ecological building might include :

- Different use of solar panels for domestic hot water heating
- Water conservation, possibly including biological waste water treatment and the simple collection and recycling of rainwater for garden use
- Low energy solar bulbs, which can last up to 150 times longer than regular bulbs
- Cellulose insulation
- Lead-free paints and wood preservatives
- Locally-grown and harvested timber from sustainably managed forests

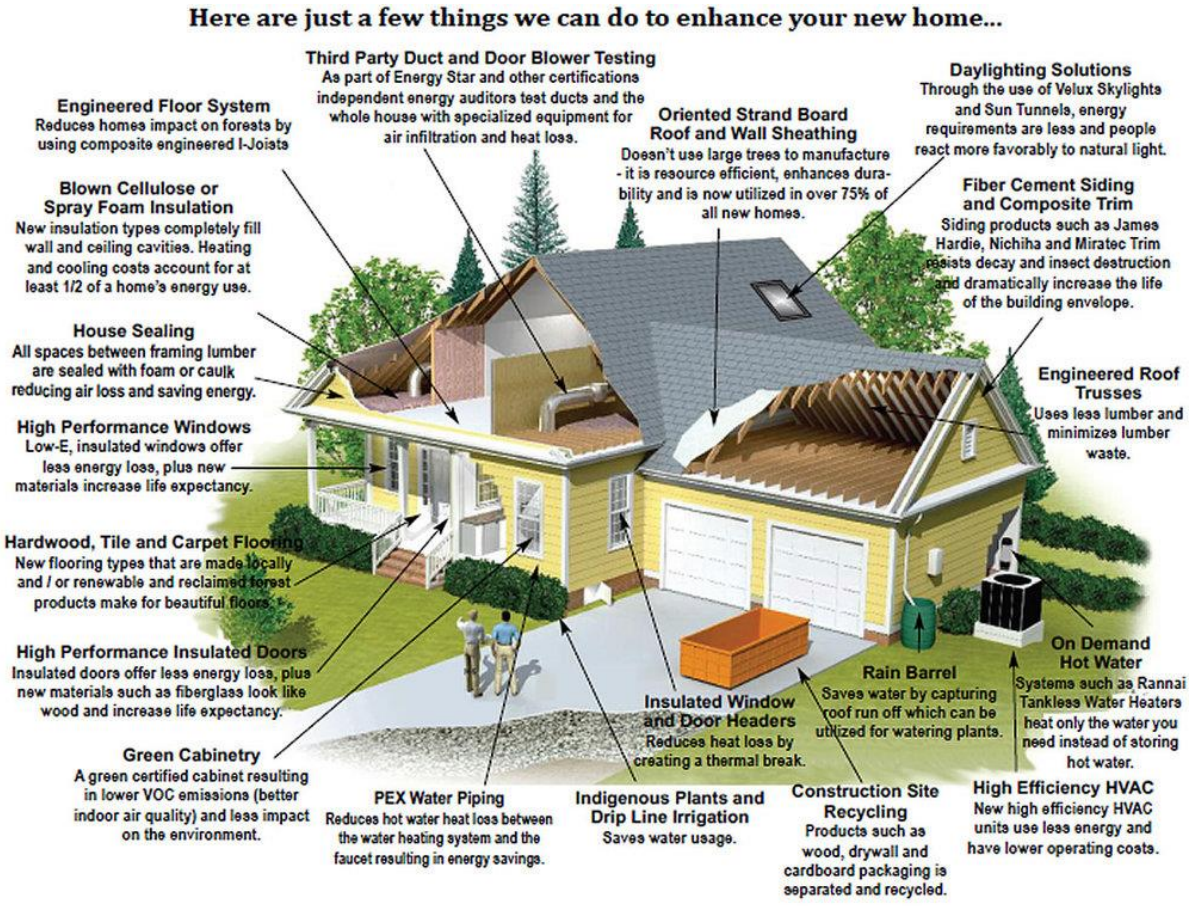

Figure: Eco-friendly building features

10 Ecological low cost materials

- **Recycled Steel-** Producing and smelting steel takes a lot of energy. Just think of forges and smelters, with sparks flying up to the sky. That's one of the reasons recycled steel has become an enormously popular green building material.
- **Bamboo-** Bamboo is increasing in popularity as a building material. It has a great deal of tensile strength and can be used in walls and flooring. It is an ideal building material because it can be used behind the scenes , underneath another type of flooring, for example wall screens and mats. Bamboo is very sustainable since it grows quickly. While trees such as pine and cedar can be reforested, growing them can take years. Bamboo can be reforested much more promptly and grows throughout the world.
- **Straw Bales-** Straw bales also have fantastic insulating properties. Straw bales are placed in walls, attics and ceilings to contribute to cooler temperatures in the summer and warmer temperatures in the winter. Straw can be harvested and re-planted easily with minimal environmental impact. The making of straw into bales also has a very low influence.
- **Polyurethane Rigid Foam-** Rigid foam is often used as insulation material in building. Think of what surfboards are made of — but that material is not environmentally friendly. Enter plant-based polyurethane rigid foam. Yes, it's quite a mouthful. It's made from kelp, hemp and bamboo. Because it is rigid — and relatively immovable — it can be used in insulation. It offers protection against mold and pests, as well as sound insulation and heat resistance.
- **Grasscrete-** As its name might indicate, grasscrete is a method of laying concrete flooring, walkways, sidewalks, and driveways in such a manner that there are open patterns allowing grass or other flora to grow. While this provides the benefit of reducing concrete usage overall, there's also another important perk — improved stormwater absorption and drainage.
- **Rammed earth-** walls that have a similar feel to concrete can actually be created with nothing more than dirt tamped down very tightly in wooden forms. Rammed earth is a technology that has been used by human civilization for thousands of years, and can last a very long time. Modern rammed earth buildings can be made safer by use of rebar or bamboo, and mechanical tampers reduce the amount of labor required to create sturdy walls.
- **Hempcrete-** It is just what it sounds like – a concrete like material created from the woody inner fibres of the hemp plant. The hemp fibres are bound with lime to create concrete-like shapes that are strong and light. Hemp Crete blocks are super-lightweight, which can also drastically reduce the energy used to transport the blocks, and hemp itself is a fast-growing, renewable resource.
- **Wood-** Plain old wood still retains many advantages over more industrial building materials like concrete or steel. Not only do trees absorb CO_2 as they grow, they require much less energy-intensive methods to process into construction products. Properly managed forests are also renewable and can ensure a bio-diverse habitat.
- **Mycelium-** Mycelium is a crazy futuristic building material that's actually totally natural – it comprises the root structure of fungi and mushrooms. Mycelium can be encouraged to grow around a composite of other natural materials, like ground up straw, in molds or forms, then air-dried to create lightweight and strong bricks or other shapes.
- **Ferrock-** Ferrock is a new material being researched that uses recycled materials including steel dust from the steel industry to create a concrete-like building material that is even stronger than concrete. What's more, this unique material actually absorbs and traps carbon dioxide as part of its drying and hardening process – making it not only less CO2 intensive than traditional concrete, but actually carbon neutral.

Figure: Ferrock and Mycelium

Figure: Hempcrete

The Range of Ecologically Built Structures

Many options are now available to those wishing to design and build an eco-friendly dwelling. Architects, engineers and builders worldwide are now using construction techniques that have been developed throughout human history, in response to local environmental concerns and the physical resource opportunities available. These ranges from rammed earth construction, which involves clay-based material mixed with water and then rammed into brick or solid wall form, suitable in hot and dry climates, to straw bale houses, literally using bales of straw as the core structure. Straw is a great insulator, is a breathable material that filters the air passing through it, and contrary to expectation, is fire-resistant when compressed and it is low cost.

Structural condition of Bangladesh

Recently, huge number of construction projects are developing in the major cities of Bangladesh. Unfortunately, deterioration of some concrete structures is found after several years of construction. Many things have been monitored during the construction. They are-

- Causes of deterioration of concrete structures in Bangladesh
- Problems at construction sites that causes early deterioration of concrete structures in Bangladesh
- Quality of cement brands commonly used in Bangladesh
- Properties of concrete made with various aggregates commonly used in Bangladesh
- Recycling of demolished concrete as coarse aggregate for new construction
- Recycling of demolished concrete as fine aggregate for new construction
- Development of pervious concrete for limited application

For solving the entire problem, the following concluding remarks are made during the initial phase:
1. To avoid early deterioration of concrete structures, the durability design of the structures to be taken into account
2. More research works on the durability of concrete structures are to be carried out to understand deterioration process in our hot and humid country
3. Quality of the cement brands is to be controlled for the sustainable development of concrete construction works
4. With similar abrasion value, brick aggregate concrete gives higher strength compared to the same with stone aggregate concrete
5. Concrete strength from 3,000 ~ 3,700 psi can be obtained using recycled coarse aggregate
6. In undergraduate program, more courses on concrete technology are to be included
7. Skilled workers are to be produced through professional organizations

Steps of constructing ecological building in Bangladesh

Eco-friendly construction begins with intelligent design. By thinking strategically and adopting the right materials and technology early, you can help save the environment while saving you money. The steps are-

- **Planning smartly-** Smaller buildings are generally more environmentally friendly and cheaper to run. Intelligent design means making the best use of space possible. It forces developers to start thinking creatively about space, and the future of infrastructure.
- **Consider the placement of windows-** Something as simple as the placement of windows can make a great deal of difference to the atmosphere of a room. Innovative technology for builders assist in identifying the most strategic window positions to take advantage of sunlight and natural breezes.
- **Proper Insulation-** Insulation is another thing to consider when building an eco-friendly property. Investing in proper insulation keeps the area cool in the hotter months, and warm during the winter, minimising the need to run heating and cooling units regularly.
- **Cooling the roof-** In particularly tropical areas like Australia, a building's exposure to the sun can result in heat being trapped inside the roof, gradually warming up the interior of the building. Green roofs are an innovative solution to this problem. Heat-reducing methods such as using reflective roof paint, roof covering, tiles, or planting grass will result in a cooler building, and save the energy and money it would otherwise take to cool it.
- **Assess durability-** Life expectancy in architecture and construction is growing in importance. Durable materials such as brick, stone, and concrete have a longer lifetime and are more eco-friendly during the demolition and disposal phase. Extensions, renovations, and refurbishments stretch the life of a building, especially when structures are built using durable materials.
- **Sustainable, Biodegradable and Recycled materials-** Reusing old materials where possible is an easy way to save money and reduce environmental impacts of your construction. Products like recycled lumber, plastic, and glass are less damaging than buying new. Biodegradable materials are also being produced with reduced energy costs and pollution.
- **Water Saving Fixtures-** Reducing water wastage is easily achieved by installing water fixtures to reduce the flow of toilets, showerheads and taps. Encourage clients to purchase eco-friendly products by calculating their future water savings.
- **Geothermal Heating Control-** A geothermal system harnesses temperatures below ground to warm residential homes or businesses. Pipes under the ground are led to a heat pump to either warm or cool the building. The relatively new technology only needs a small amount of electricity to run, saving owners money and energy.
- **Initiation of Solar System-** Solar power converts the sun’s radiation into energy. Installing solar panels may be expensive, but in the long run saves a lot of money and energy consumption. However, to take advantage of solar power, location must be considered, as well as the positioning of solar panels. Estimating software assists in determining how much power can be collected and saved.

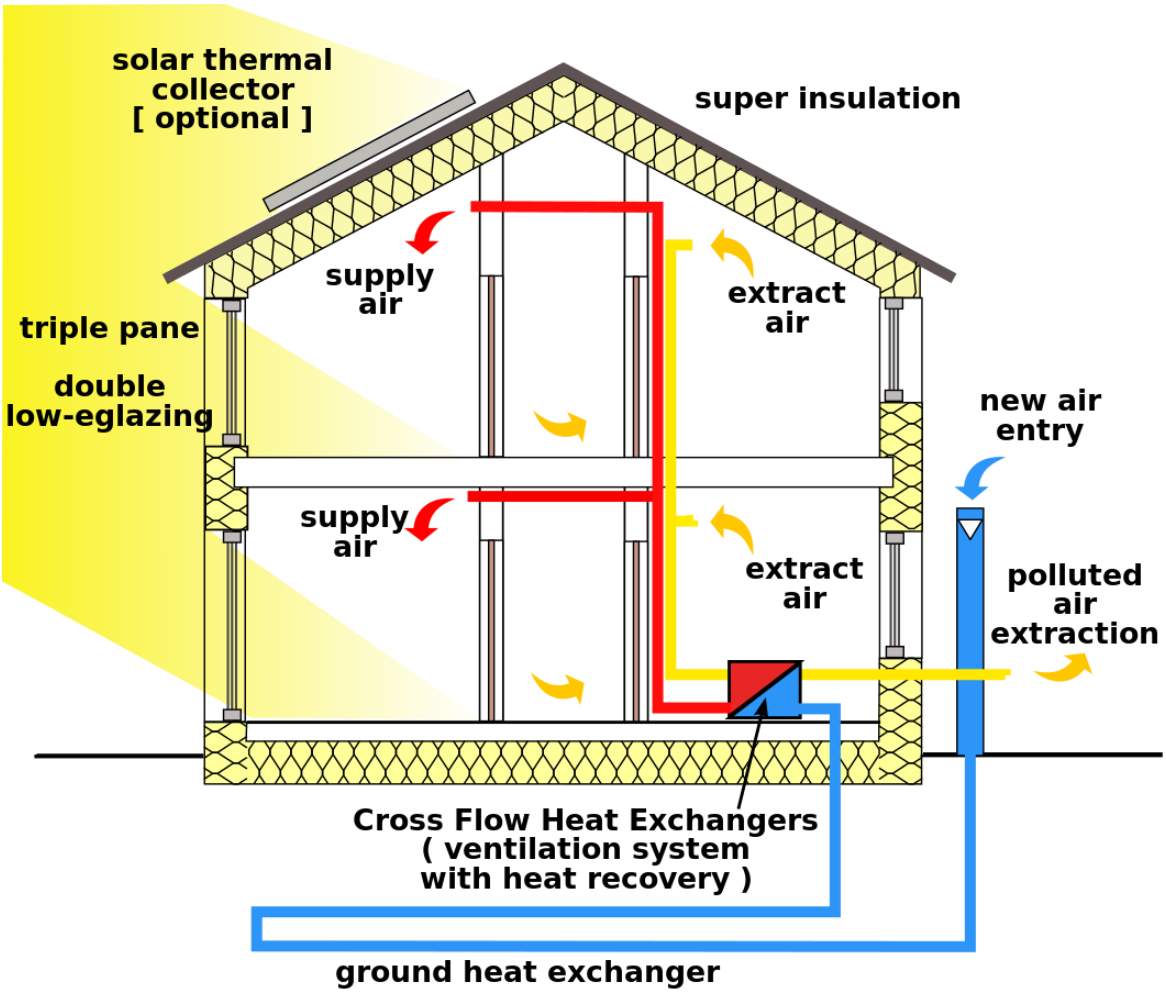

Figure: Solar system setup

“Heat consuming Brick” -A key concept

Brick is the main building material for the construction industry, which has been growing at about 5.6 percent annually between 1995 and 2005, leading to an estimated growth rate of 2–3 percent for the brick sector. Annually about 17.2 billion burnt clay bricks are produced allover Bangladesh whose output value is about Tk. 83 billion (BUET 2007). With about 5,000 operating kilns, brick-making is a significant sector in Bangladesh, (The World Bank, ESMAP-2011) contributing about 1 percent to the country‘s gross domestic product (GDP) and generating employment for about 1 million people (BUET 2007). These vast amounts of clay bricks consume 45 million tons of clay, 3.5 million tons of coal and 2 million tons of fire wood. The Fixed Chimney Kiln (FCK) dominates the brick sector in Bangladesh, despite its highly polluting and energy-intensive features. Most operating kilns consume about 18–22 tons of coal to produce 100,000 bricks (BUET 2007). Coal burning by kilns releases pollutants into the atmosphere, leading to harmful effects on health (e.g., from PM) and agricultural yields and contributing to global warming and climate change (e.g., from CO2). Annually 9.8 million tons of CO2 is emitted due to burning of bricks in Bangladesh (BUET 2007).

Figure: Heat Consuming Brick

Also, the clay is being collected from agricultural land. Research indicates that about 42000 acres of agricultural land is being diminished annually due to unplanned brick field and collection of clay from agricultural top soil. If these processes continue our food security will be in danger very soon.
Considering above facts Housing and Building Research Institute (HBRI) has taken a number of research programs regarding alternative to burnt clay bricks. Thermal block is one of them.
The thermal block is a type of concrete block where expanded polystyrene is used to increase the thermal resistant properties of the block and to lighten the gross block weight. Cement mortar is casted over EPS and cured for specified period. As no burning is required so this block will be environment friendly, sustainable, and cost effective. The wall made of this block will provide comfortable indoor environment both in summer and winter. Due to its lightweight characteristics this will save structural cost and uses of this block in multi storied buildings will be suitable in earth quake point of view.
EPS under confining compression Sun (1997) reported that with in-crease in confining stress the strength and initial tangent modulus decrease. Sun concluded these results based on axial deviator stress strain curves, which are important for submerged EPS.

Making of Thermal Block
Full size (4'X8') EPS panel collected from factory is first cut to size to make thermal blocks. After proper sizing and grooving the EPS pieces are placed into the steel mold. The molds are rectangular steel box open in one side. Cement mortar is then placed in the gap between the mold wall and EPS. These are de-molded after 24 hours and then blocks are kept for curing. The blocks can be used after 28 days of proper curing with water. The complete process of making thermal blocks can be best described by the following pictorial presentation. Some tests are performed for gaining different parameters of this block:

1. **Compressive strength test:** Compressive strength of thermal block was tested in accordance with appendix B of BS 6073: Part 2 of five samples. Average result based on the gross area of thermal block of each test was considered for the particular proportion. Compressive strength of 7 days, 14 days, and 28 days was measured for each set of sample.

2. **Water Absorption Test:** Water absorption test of thermal block was done after 28 days of water curing and 14 days of air curing following the water curing period. The test was performed in accordance with ASTM C20-00 Standard. The percentage of water absorption by thermal blocks of different proportion was calculated for the gross weight of the blocks. Besides water absorption test of burnt clay bricks randomly collected from local market was done to compare the water absorption characteristics of two types of block/bricks. The test result is presented in later sections.

Solutions and Benefits of ecological construction

- Thermal performance improved by 20%
- Construction waste reduced by 40%
- Construction cost reduced by 35-40%
- Funding related costs reduced by 10-15%

Country Benefits

- The aim of Government is, day by day each village will become into a city.
- As a result, the traffic jam of the city will be reduced.
- The people density on Dhaka city will be reduced.
- The beauty of Dhaka city will be increased.
- Improving Worker and Employer Attraction.

Benefits for Village People

- Economic development will happen drastically.
- The work facility of women in the village will be increased and well organized.
- It will be not necessary to go to capital city for higher education/internship.
- The people of the village will be in a good environment, where they get all kinds of benefits.
- Possible to organize House, school, college, hospital, playground, pond, market, park, office in an inaccessible place or high places in the rural area.
- Women's job facilities will be increased by hand made products or any other ways.
- The people of the village will be able to know the land surrounding. They will harvest different crops, vegetables, cultivate and so on.

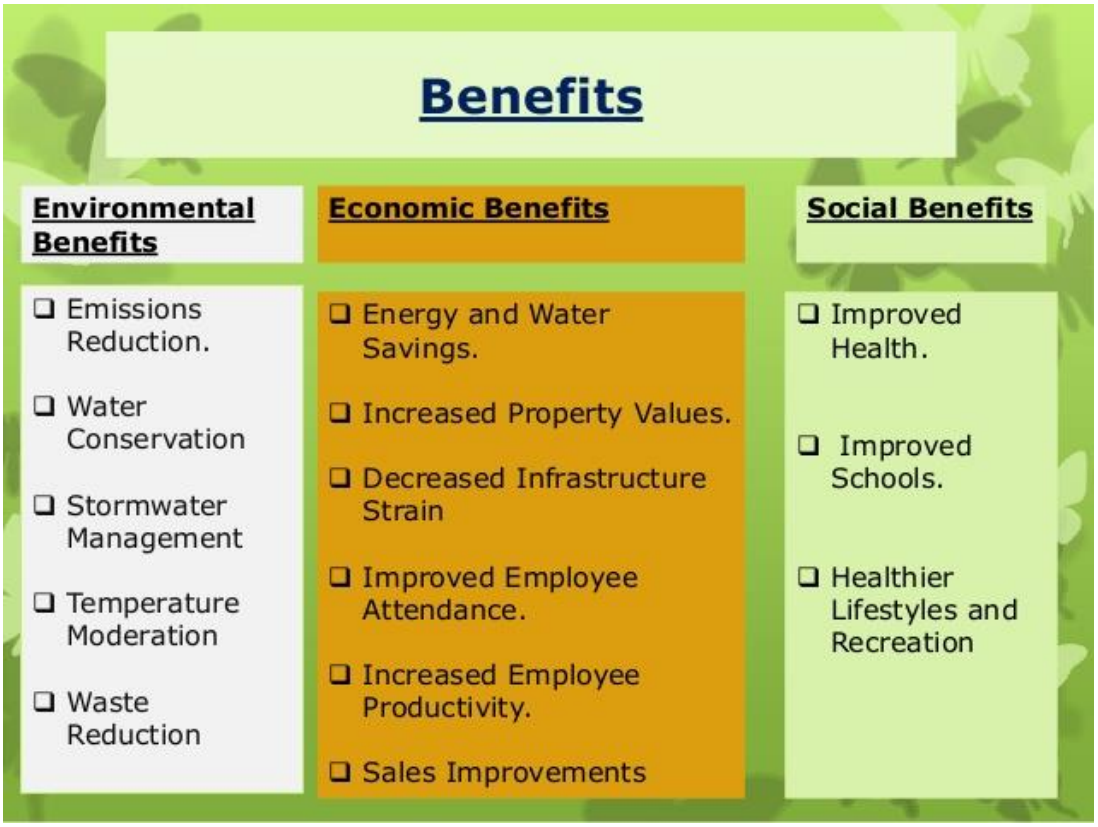

Figure: Overall benefits of ecological building

Summary

There is no denying of the fact that housing and other facilities are not merely provision of physical refuge but more importantly successful housing and living standard has to ensure psycho-socio-economic shelter against all sorts of internal and external restraints. The paradigm of “participatory development” could have bearing in this regard, at least to begin gaining actual understanding of the situation on the ground and by that means to formulate policy and practice guidelines. A much more widespread and concerted effort is required from all sectors of society to address these constraints, which are structural in nature. Moreover with a backdrop of intricate, fragile ecosystem of the country, provision of ideal housing and living quality is more than that of ensuring basic human rights. To be true, it will be a fundamental impetus for sustainable development. Recognition of the problem and thereby identifying and developing understanding of the constraints could perhaps serve as an initial step towards informing policy and practice. The ecological building construction can be a savior from the future up-gradation of environmental issues in a developing resource restrained country like Bangladesh.

Recommendations

- ✓ We can use the above 10 materials for construction that can ensure low-cost, low thermal heat and low waste production facilities.
- ✓ Green building can be enlarged to the people and for government sectors as a ecological use of building construction.
- ✓ Green Brick or Heat consuming brick can have a severe impact in low-heat production and keep the residence cooler in summer seasons.
- ✓ Village can be turned into cities by making such dwelling all over as it is easy to make it in rural.

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