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Study on Stabilized Compressed Earth Bricks in Building Construction for Sustainable Development

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Abstract – Building materials, technologies and building practices have evolved through ages. Housing and building sector reflect the living standards of society. Stones, mud, thatch, leaves and timber represent the building materials used for the construction of dwellings. Any energy is spent in manufacturing and use of these natural materials for construction. Burnt bricks, lime, cement, steel, metal products, paints and PVC are the manufactured materials (using external energy) commonly used for construction industry. Extensive use of these materials can drain the energy resources and adversely affect the environment. It is difficult to meet the ever-growing demand for buildings by adopting only energy efficient materials and construction methods. The raw materials to produce simple, energy efficient , eco-friendly and sustainable building materials and techniques to satisfy the increasing demand for buildings and decrease the consumption of energy in buildings .

Key words: Energy, Sustainable materials, alternative technologies

1. Introduction :

India's terrific ecological problems are taking place in construction industry due to rapid urbanization. Increase in demand of inhabited dwelling units which results in consuming more energy, resources, raw materials are identified as responsible for the rise in the carbon footprint. All urban areas are already facing environmental issues such as change in weather pattern, destruction of ecology.

The only solution seems to be use of sustainable development by employing sustainable materials & technologies. Sustainable growth is the one which meets the needs of present without compromising the ability of future generations to meet their own needs.

This development is attainable through use of locally available materials for construction which meet nature upon the intended use. The concept recognizes that human development is an integral part of natural it needs to be preserved at any cost.

Sustainable development envisages this idea through carefully planned designs that epitomize the principals of conservation & supports the application of those premises that prompt healthy growth. Sustainable development provides alternative approaches to the conventional practices.

The new approach must focus on impacts of every requisite material & technology on local culture and weather conditions. The quest of sustainable growth brings the built surroundings and construction activity into major relief.

It has registered increase of up to 15 per cent every year, primarily due to cost of basic construction materials such as steel, cement, bricks, timber and other inputs as well as cost of labor. As a result, the cost of construction using traditional building materials and construction is becoming beyond the affordable limits particularly for low-income groups of population as well as a large cross section of the middle - income groups.

Therefore, there is a requirement to espouse energy saving, cost-effective building materials and methods either by improving the traditional knowledge using local resources (or) adopting modern construction materials and methodologies with efficient inputs leading to cost-effective solutions (Jain and Paliwal, 2012).

Sustainable construction assumed major focus in terms of policy, research and innovation, internationally. Green building initiatives in India include establishment of institutions by formation of IGBC, TERI launch of LEED and TERI-GRIHA . The sustained growth uses locally available construction materials which are energy efficient and resilient.

It provides a chance to living residents to live with good ambience, comfortable conditions throughout the life cycle of the structure. The life cycle comprises of material manufacturing, construction, scheduling, preparation of blueprint, execution, operation and maintenance processes.

The objective of sustainability is to achieve efficient use of wherewithal, namely appropriate technologies, energy use and building materials with minimum impact on the built environment. Nonetheless, because of the intricacy of sustainability and the division of the construction industry, the scale of implementation of sustainable construction practices is still low.

Cost-effective building tools can bring down the embodied energy level connected with production of construction materials by bringing down use of energy-intense materials. This embodied energy is a decisive factor for sustainable construction applications and useful lessening of the same would aid in extenuating global warming. The gainful construction technologies would lead to the most acceptable case of sustainable practices in India both in terms of cost and environment.

2.0. Role of Construction Industry in Climate Change

The building industry is one of the key sources of greenhouse gasses. Construction-related practices account for quite a large portion of CO_2 emissions. Involvement of the building industry to global warming can no longer be ignored. Modern constructions consume energy in a multiple ways. Energy utilization in buildings occurs in different phases.

The first phase relates to the production of building materials and parts thereof, which is named as embodied energy. The second and third phases constitute to the energy used to transport materials from production places to the construction site and the energy used in the actual construction of the building, which are respectively referred to as grey energy and induced energy.

Fourthly, energy is needed at the operational phase, which corresponds to the maintenance of the building when it is used. Finally, energy is consumed in the flattening process of buildings as well as in the recycling of the materials, as is frequently observed due to changes circumstances and requirements.

The cost-effective and alternate construction technologies, are being explored, as a measure to reducing the cost of construction by reduction of quantity of building materials through improved and novel techniques or use of other energy efficient materials, which promotes a wider role in reduction of CO_2 emission and thus help in providing healthy environment (Nilanjan Sengupta , 2008).

3.0. Sustainable Building Materials and Construction

Quality construction materials are to be used in important housing projects as also in cost effective housing. As use of these materials improve the ambience and can reduce the cost of maintenance apart from providing endurance.

A well planned and executed house shall have to provide comfort against local climatic conditions and provide much needed warmth and ambience for a pleasant stay. Further, the house must provided inhabitants required safety and privacy, and it should be safe over design period.

Sustainable construction should also:

- Enhance living, working and leisure environments for individuals and communities.
- Consume minimum energy over its life cycle
- Generate minimum waste over its life cycle
- Integrate with the natural environment
- Use renewable resources where possible

4.0. Durability and Sustainability

Apart from robustness aspects of housing, sustainable house building also comes from other drives, namely protecting the environment, the climate and the natural resources. Often, the objective of the concerned agencies is that housing would not contribute adversely to climate change or result in emission of greenhouse gases in particular.

If the use of high energy consuming building materials and the associated high transport costs is avoided, the benefits are instantaneous. If the use of fossil fuels is avoided, both in the identification of raw-materials and in the manufacture and transport of materials, environmental benefits are increased.

For example, in the production of bricks and roofing materials and tiles, clay is often collected locally and burnt using in kilns using wood leads to pollution and which does not come under the ambit of sustainability even though they may be long-lasting or durable.

In general, utilizing of concrete is not sustainable because a lot of energy is consumed in the manufacturing of cement and the shipment of cement, gravel and sand to the construction site. Therefore, use of cement and concrete is to be minimized in every aspect of building construction. The conditions in the region determine the construction techniques that are needed regarding strength and resilience. In earthquake zones the houses must be earthquake resistant (Bredenoord , 2017).

5.0. Promising Building Materials for Cost Effective Housing Construction

Therefore, construction activity calls for careful planning, design and execution keeping in view the environmental impact, design, choice of building materials and appropriate technologies for execution. All the aspects must be given due emphasis for long reaping lasting benefits.

Though numerous research works focused on their utilization in various aspects of infrastructure development, the use of locally available materials and use of clayey soils in making stabilized compressed earth bricks.

The alternative materials which are drawn from local areas would be compatible with the environment and would result in saving considerable energy. These building materials are traditionally used in these areas and are slowly becoming obsolete as the stakeholders are turning their preferences to energy consuming techniques owing to popularity and facility of construction.

If these materials are used coupled with latest techniques of building construction would help in mitigating the grim situation of overall environmental destruction.

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6.0. Stabilized Compressed Earth Bricks – Alternative to Brick For Wall Construction:

Stabilized Compressed Earth Bricks

Earth is a local material and the soil should preferably extract from the site itself or not transported too far away. Earth construction is a labour-intensive technology and it is an easily adaptable and transferable technology.

- It is a cost and energy effective material.
- It is much less energy consuming than country fired bricks (about 4 times less).
- It is much less polluting than country fired bricks (about 4 times less).

Making of Stabilized Compressed Earth Bricks:

- Soil digging and Preparation
- Mixing stabilizer and water
- Bricks pressing
- Stocking of bricks and curing (Venkatarama Reddy B.V., 2004).

Conventional building materials using locally available soils comprising of clayey soils , loamy soils, and sand can be used in combination or otherwise in the preparation of uniform, rectangular compressed earth bricks or stabilized soil bricks. .

A proper mix design, for use in different engineering applications is necessary. Due to their inherent characteristics, walls made from compressed earth bricks have good thermal features, reducing heating and cooling costs. If executed properly, buildings made with compressed earth bricks are sustainable and durable. This implies that technological improvements can be used in small-scale and at the local level, potentially contributing to local economic development.

The stabilized soil bricks production consists of mixing at least 5 to 10 per cent cement in addition 2 to 5 percent lime or FaLG (Flyash, lime Zypsum) stabilizer with soil and 8 to 10 percent of water. The are compressed using either steel hand press machines or mechanical presses machines to produce good quality bricks. As compared to burnt bricks, the benefits of this technology lead to greater energy efficiency and savings on money and on firewood. The other features of using the compressed earth bricks include:

- Use of locally available soils
- Local employment
- Stability and adequate strength
- Minimal environmental impact

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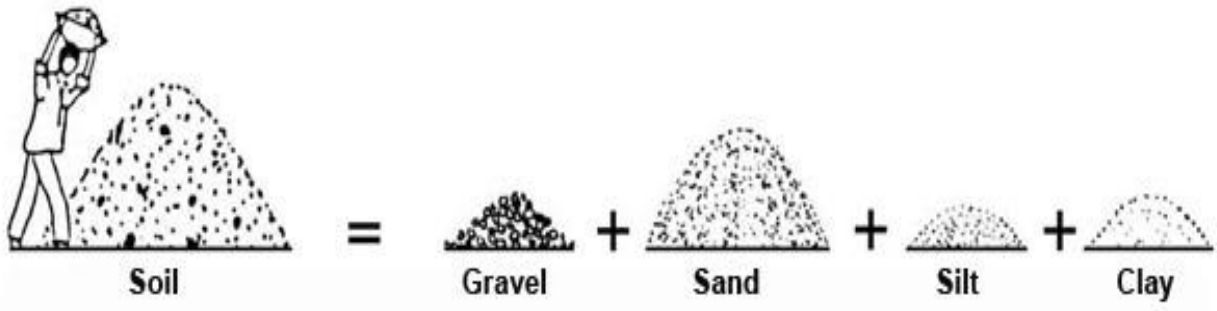
Stabilization based on available soils:



Cement stabilization: It is more sandy than clayey.	**Gravel**	**Sand**	**Silt**	**Clay**
	15%	50%	15%	20%
Lime stabilization: It is more clayey than sandy.	Gravel	Sand	Silt	Clay
	15%	30%	20%	35%

(Auroville Earth Institute, (2015)

7.0. Technological development of compressed earth blocks

Technological development of (CEBs) can be accomplished by using compression machines (Astra, Aurum-300) to make the bricks or blocks. This makes sure that the bricks are consistently sized and highly pressure resistant. Another advantage is that these bricks can be produced in larger volumes. The machine used for manufacturing of blocks is comparatively less costly and demands the use of fossil fuel to a limited extent as compared to fired bricks. Homes made with compressed earth blocks have better moisture regulation and are more comfortable than homes made with hollow concrete blocks.

8.0. Embodied Energy:

A useful indicator of the environmental impact of construction materials is embodied energy. Embodied energy is the sum of all the energy required throughout the lifecycle of a material (Vijaya Bhaskar S et.al 2015),
That is energy in:

- Acquisition of the raw material
- Manufacture of the finished product
- Transportation of the product to site
- Construction of a building
- Maintenance through the life of a building
- Demolition of a building

9.0. Initial embodied energy and Pollution emission per m^3 of wall :

Embodied energy (MJ) per m^3 of wall

Compressed Stabilized Earth Brick = 631 MJ / m3
Kiln Fired Brick (KFB) = 2,356 MJ / m3
Country Fired Brick (CFB) = 6,358 MJ / m3

Pollution emission (Kg of CO2) per m^3 of wall

Compressed Stabilized Earth Brick = 56.79 Kg / m3
Kiln Fired Brick (KFB) = 230.06 Kg / m3
Country Fired Brick (CFB) = 547.30 Kg / m3

To reduce the embodied energy it is important to use a good design not only in the structure but also in the management and utilisation of materials (Auroville Earth Institute, 2015).

10. Cost Comparison of wall :

A finished 1.0 m^3 of CSEB wall cost is 15 % -20 % cheaper than country fired bricks cost comparison of walls (Bricks produced on site).

11. Conclusion:

• Considerable savings can be made by using alternate materials apart from savings in the energy.
• Sustainable development is possible by using alternative materials are adopted.
• Environmental effects using the conventional materials can be mitigated by employing the alternate materials and methodologies are used.

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