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Showing 1 to 1 of 1 entries

Previous 1 Next

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VERNACULAR BUILDING MATERIALS AND FUTURE ECO MATERIALS OF EAST INDIA

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ABSTRACT

Vernacular architecture is a term used to categorize methods of construction which use locally available resources and traditions to address local needs and circumstances. Vernacular architecture tends to evolve over time to reflect the environmental, cultural and historical context in which it exists. It has often been dismissed as crude and unrefined, but also has proponents who highlight its importance in current design. With the current market moving rapidly towards globalized building materials and technology are energy intensive with high carbon footprint. Vernacular building materials have the capacity to offset this energy consumption. India has varied climate and each climatic zone has its climate responsive vernacular building materials. It is important that these materials are identified and brought into the main stream industry. The aim of the paper is to study different vernacular building materials in Eastern region of India. The objectives are to study present and earlier used vernacular materials. To study the potential future eco materials that can be used which are context and region specific. To study advantages and limitations of the same. The proposed outcome is to suggest materials which can be derived from the region but have advantages to be applied in the present scenario.

Keywords : locally available, traditions, evolve, globalized, context, region specific.

1. Introduction

Vernacular architecture is the native science of building which is spontaneous, environment-oriented, and community-based and applies to both local styles and local materials.

Characteristics of vernacular architecture are that these are Traditional technologies built to meet specific needs, accommodating the values, economies and way of life of the cultures that produce them. Each community over the years develops a prototype-responds to local needs and carries it forward through generations. Thatch, Straw, timber, Palm tree trunk, Bamboo, Wattle, *Khapraels*, Cement, Compressed earth blocks, Fiber cement tiles are few of the list of vernacular materials used for roof, wall columns in eastern India. Case examples of few materials are elaborated in the paper.

2. Method

The method used is case study analysis. Different materials are studied from regions in East India. The areas studied are Jharkhand, Chattisgarh, West Bengal, Orissa and Assam. The materials are studied for roof and walls majorly. Presently used, and future materials which can be widely used are studied. Application of these in the residential buildings for different building components like walling, roof, columns, screens, beams etc. is explored.

3. Case studies of vernacular materials

Bamboo- Toda hut is a shape-half cylinder made of wooden planks, bamboo, reeds and grass arch-frames are made of long bunches of bamboo splits, lashed together by a spiral of cane or bamboo splits called Thef. Horizontal roofs framed with palm tree's trunk, bamboo,

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trunks of palm tree, hay and earth, supported with bamboo & plastered with clay helpful for heat resistance and storage. Whole & split bamboo exhibits resilience & flexibility in various forms.

Case study-houses in Nagaland- Floor is earth and raised, normally located at the front where the rice plunder is kept; the living quarters are raised and extend to a platform at the rear where tasks such as weaving are performed. *Lhota*, cover the raised floor with woven bamboo slats and mats. Simple layout, barn-like double-pitched roof, plain gable end fortified, stone walls, bamboo spikes, wooden gates, perimeter ditch

Fig 1: Toda Hut

Fig 2: Bangla house

Case study Jharkhand huts- Jharkhand houses have roofing structure of gabled thatched roofs with bamboo mullions & posts. The thick thatch roofs prevents rain from entering the house & provides insulation. Chhatisgarh house called as *jhopri* (hut met) or *haveli* (mansion) is made up of timber, bamboo, clay, straw, cow-dung, special variety of grass. The roof is mainly made of bamboo hay and "*khapraels*", tiles, mud etc. The huts are made of mud walls & thatch roofs. The mud is obtained by souring earth by adding vegetable waste and leaving it to mature. The decaying waste improves the plasticity. This mud is mixed is mixed with cow dung, chopped straw and gravel or stones to make the raw materials for the walls. The walls were formed by applying thick coat of the mixture on both sides of bamboo mesh that wrapped around the posts. Brick-bat coba and lime mortar are the key materials used for constructing high thermal mass walls. Kovar Wall paintings- After a wall is plastered with mud, a coat of black earth or *kalimiti* is applied on it and left to dry. Once dried, it is covered with either white or yellow mud coat. Before the upper coat is dry, it is scrapped. Which reveals a black undercoat, depicting patterns and designs. Cow dung is used to finish walls, floor.

Traditional Assam house-It is a fully wooden structure. Walls are made with timber frame work with panels (*ikara*) cut in size & laid vertically with 3 layers of plaster-mud mortar. Finished coat is of liquid mix of mud and cow dung. Horizontal members are in bamboo. Roof is in corrugated iron sheet fixed in timber purlin by nail. Ceiling is supported by vertical wooden members/steel column. From finished floor level the walls are of half brick thick brick walls up to a ht. 60 cm

***Bunglas* of West Bengal** are traditional Bengali dwelling provided a model for the British bungalow *bangla*.Technology adopted is frame bamboo/ wood posts and beams. The thatched roof generally extended beyond the walls to provide additional shelter from the rains and one side of the roof was often extended four of five feet beyond the wall and supported by a row of bamboo poles to create a small verandah.

4. Present eco -materials

Utilization of waste in material making-Red mud is a waste product from aluminum plants. Stabilized Mud Fly Ash Bricks -Compacted mud fly ash blocks stabilised with lime, cement or other chemicals can be easily made. Stone dust -from granite & sandstone from quarries & processing plants. Coal washery rejects -heavier impurities. Siliceous river sediments -from water treatment plants of Palta Calcutta. Rice husk ash can also be used.

Cellular Light Weight Concrete- Cellular Light Weight Concrete (CLC) can be manufactured by a process involving the mixing of fly ash, cement, coarse sand, fine sand and a forming agent in a mixer to form a thin slurry.

Slurry is poured in moulds and allowed to set. Blocks are removed and cured by spraying water on the stack. Useful in high rise construction reducing the dead weight of the structure. Honeycomb clay block Used both as the inner leaf in cavity walls or as a single skin for external load-bearing construction. The blocks are formed with a cellular structure of vertical perforations that reduces the material quantity as well as weight whilst providing an increased thermal performance. Blocks are assembled through dry vertical interlocking and thin-mortar horizontal jointing.

Advantages are that it has good insulating properties, recyclable, reusable if dismantled carefully, particularly if lime mortar has been used, lower embodied energy than concrete blocks, enables rapid construction when using experienced block layers

Unfired clay block-Uncommon in modern construction despite their excellent environmental credentials. Though limited to non-load-bearing applications, unfired clay blocks are suitable for internal partitions and infill to framed construction. Advantages are that it has very low embodied energy, recyclable, biodegradable (returns to soil), high thermal mass, Can be used to stabilise internal humidity and good sound reduction

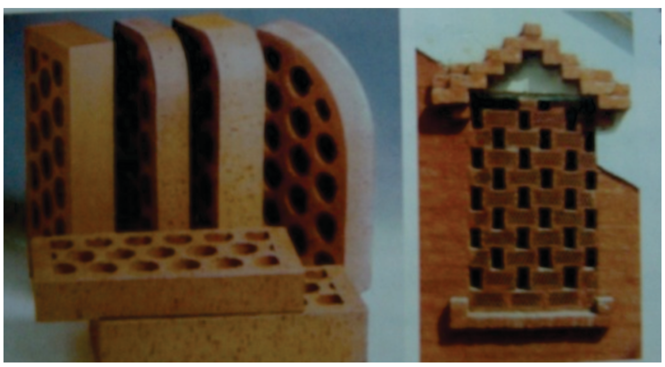

Fig 3: Red mud Stabilized Mud Fly Ash Bricks

Fig 4: Honeycomb clay block

5. Future eco-materials

Ferro-cement-Mixture of Portland cement and sand reinforced with layers of woven steel mesh and closely-spaced small-diameter steel rods. Used in the form of thin curved sheets to make hulls for boats, shell roofs, water tanks, etc. Sculpture and prefabricated building components. Good strength and resistance to impact. Resistance to fire, earthquake, and corrosion than traditional materials, such as wood, adobe and stone masonry.

AAC (autoclaved aerated concrete) blocks- Ideal substitute for traditional clay bricks and hollow concrete blocks used for wall construction made of cement, fly ash, lime, an aeration agent and water. Most suitable for air-conditioned buildings multistoried fire-rated buildings.

Being Light-weight they have high thermal and sound insulation, high fire-resistance

Corrugated bamboo roofing sheets (CBRS)-Excellent alternative to corrugated asbestos, iron, plastic or zinc. Roofing sheets are produced from natural materials and are attractive, durable and resilient to adverse weather conditions and pest attack.

They are environmentally friendly and safe alternative to asbestos, zinc or corrugated iron roofing panels. Quieter in the rain and cooler in the sun than metal roofing panels.

Bagasse boards-Bagasse emerges from sugar factory as a waste and is procured in loose or bale form with 48-50% moisture.

The dried and sized material is mixed with glue binders and is formed in 3 layers, coarse in the middle, fines in top and bottom side and conveyed through caul plates passed through pre-press to consolidate the mat. Then passed on to the hot press and subjected to high pressure with high temperature. These bagasse boards are made at different thicknesses.

The boards are allowed to cure for a day or two and then subjected to sanding to obtain smooth surface and to relieve loose material in the surface and to have uniform thickness of the board.

Water resistant and being hygroscopic material they ensure durability.

Fig 5: Bagasse boards

Fig 6: Agricultural waste

Agricultural waste-Rice husk are solid waste materials with potential for use as building insulation. This board can be formed without use of urea formaldehyde resin or any type of phenol formaldehyde resin which is used in most fiberglass insulation.

Do not use chlorine-base chemicals such as phosgene, propylene chlorohydrins or any ozone -depleting chlorofluorocarbons. Rice husk ash (RHA) and lime can be used as substitute for cement.

Structural components such as the roof, beams, lintels, projection slabs (sunshade), overhead water tank, can also be made with Portland cement, but with 30 % of the required amount replaced by RHA and lime. RHA can be used to produce normal-strength self-consolidating concrete.

with improved hardened properties and durability also. The RHA based sand-cement blocks reduce solar heat transfer.

Coconut husk-The coconut husk is available in large quantities as residue from coconut production. Option for a thermal insulation material. Raw material for making building insulation boards using the hot pressing method of a manufacture process that uses urea formaldehyde resin thus they have a disadvantage in terms of environmental and sustainable issues.

Eco floors made from cow-dung-Cow-dung when sterilized, is entirely odorless and offers some wonderful characteristics for the production of a variety of fiberboard building materials & costs of production are literally dirt-cheap.

The manure essentially replaces the role of sawdust in the production of particle boards, which would cut wood usage as well as posing a creative solution to the huge problem of agricultural waste disposal.

Ecofaebrick- Ecofaebrick, a quality, easily manufactured, low-cost sustainable building material made from cow dung. 20% lighter, but they have a compressive strength 20% stronger than clay bricks and their Production doesn't rely upon devastating quarry mining techniques.

Provide a highly economical solution to a waste problem while helping to curb the destruction of the local environment caused by clay quarries (pictured below). The bricks are made using 75% cow manure and cured in a biogas heating process that reduces the brick factory's co2 emissions significantly over traditional wood fire heat.

Reclaimed bricks-Reusable Durable Negligible embodied energy if sourced locally. No toxic emissions from a manufacturing process Diverts demolition waste from landfill Issues concerning quality assurance

Rammed Earth (RE) and Stabilised Rammed Earth (SRE)-Many of the shortcomings associated with the durability of rammed earth (primarily external surface protection, water resistance, shrinkage and strength) can be averted by the addition of a stabiliser.

Though other forms have been used, the most common stabiliser is cement, which when added typically makes up between 6 or 7% (by volume) of the mix.

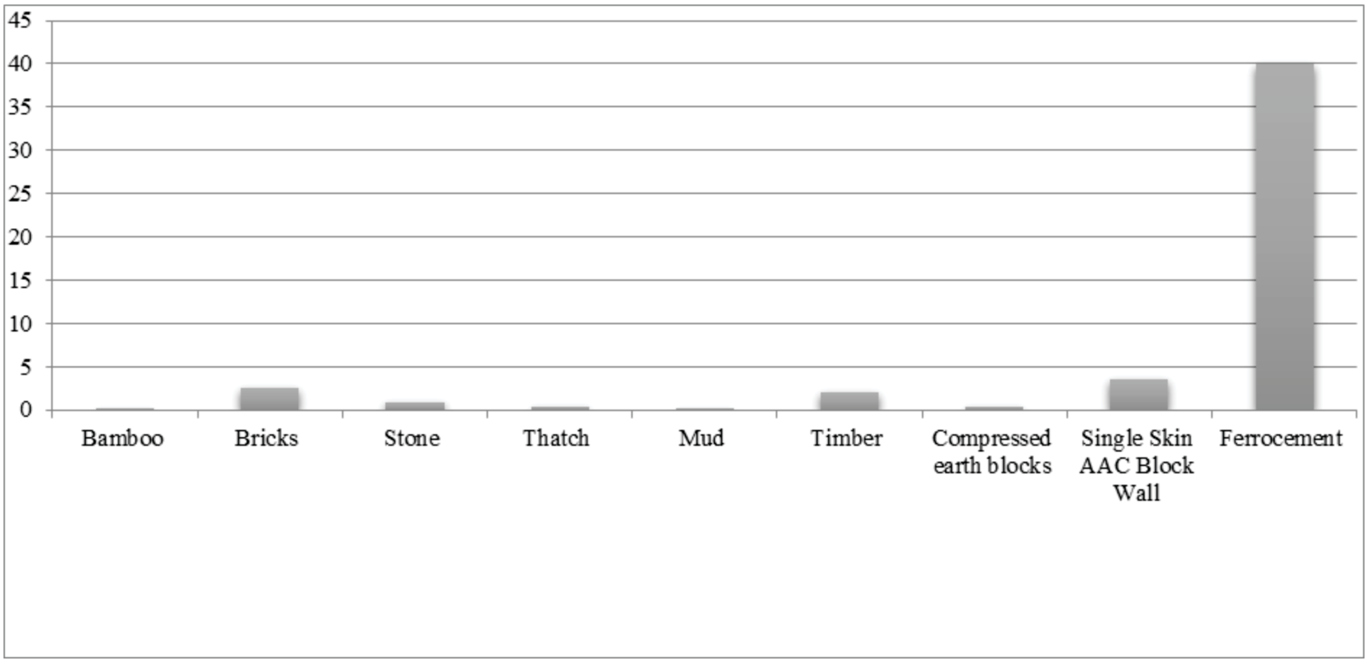

Fig 7: Comparison of embodied energy in MJ/kg

6. Conclusion

Despite being linked to tradition, it could be considered a state-of-art activity, because it offers alternatives to conventional architectural practices that are highly accountable for today's energy crisis. Only 10% of buildings in which we live or work are designed by architects & a huge 90% of world's architecture is vernacular. The analysis provides some recommendations for future design of houses. Vernacular architecture can help in designing an ecofriendly future. Ancient East Indian buildings use the environment, climate responsive design, local & sustainable materials in their design & construction. These building forms embodied an important strategy of environmentally friendly homes: minimal use of energy.

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