A Review On Works Done On Rammed Earth, Coir And Bamboo As Alternate Construction Materials

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Abstract- *Concrete being the only building material for its extraordinary properties throughout the world, it leads to destruction and depletion of many natural materials like river sand and aggregates which are the main ingredients of concrete, also limestone and clay which are used in the manufacture of cement. Also as concrete is very brittle it is very week in tension and it requires some reinforcement to take the tensile stresses by means of providing the steel reinforcement. So, in order to come out from this problem lot of research has been carrying out to find the alternate materials for construction. In recent years, study on rammed earth, coconut fibres and bamboo have been increasing in many countries around the world as an alternative materials for building houses due to their valuable characteristics such as affordability, environment friendly, comfort, strength and durability. In the present study, a detailed conclusions and scope of work by using these materials is presented form the recent studies on the rammed earth and coconut fibre.*

Keywords- Rammed earth, Coconut fibers, Bamboo, Durability, Building materials.

I. INTRODUCTION

With the increasing demand for construction of houses with low cost materials , rammed earth is the best way to find the solution, rammed earth is an ancient form of monolithic earth wall construction. Use of rammed earth walls for both load bearing and non- load bearing applications can be seen across the world.

The properties of rammed earth can be improved by physical, chemical and mechanical stabilization. Physical stabilization is achieved by proper mix proportion materials of gravel, sand and clay. Mechanical stabilization is achieved by dynamic compaction using manual hammer (or) pneumatic hammer. Chemical stabilization can be achieved by mixing chemical based agents like cement, lime to improve the properties of soil.

Rammed earth constructions can be classified into two groups: Stabilized rammed earth and un-stabilized rammed earth. In un-stabilized rammed earth, the soil which comprises of mixture of sand, gravel, silt and clay. Whereas, the stabilized rammed earth can be obtained by addition of cement, lime, etc., into the soil. The mixture is wetted to its optimum moisture content before being rammed in between form work.

Great wall of China(fig.1), the construction of which began about 3000 years ago, has extensive sections built on rammed earth and the Horyuji temple(fig.2) in Japan as rammed earth walls built about 1300 years ago are some of the examples which are still in good condition.

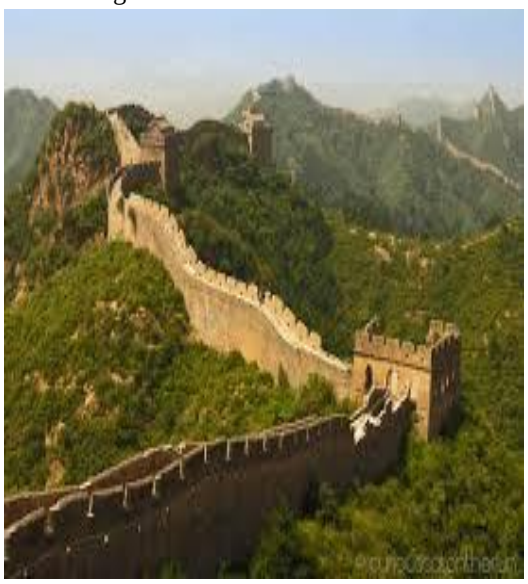

FIGURE 2: GREAT WALL OF CHINA

FIGURE 2: HORYUJI TEMPLE

II. MATERIALS

Rammed earth is prepared by ramming the soil and mixing various materials like cement, lime as stabilizers and coir is mixed to improve its strength.

RED SOIL

Red soil(fig.3) is a type of soil that develops in a warm temperature, (Moist climate under deciduous) red soils are generally derived from crystalline rocks. Red soil denotes the third largest soil group of INDIA covering an area of about 3.5 lakhs Sq.km over the peninsula from the Tamil Nadu in the south to Bundelkhand in the north and Raajmahal hills in the east to Katch in the west.

The texture of the red soil varies from sand to clay the majority being loam. Their other characteristics include porous and triable structure, absence of lime, kankar, and free carbonates, and small quantity of soluble salts. In general, these soils are deficient in lime, magnesia, phosphates, nitrogen, humus and potash. Due to presence of haematite and limonite its colour ranges from red to yellow. These soils are mainly found in Karnataka, Andhra Pradesh, Telangana, Eastern Tamil Nadu, Uttar Pradesh, Madhya Pradesh, Rajasthan.

FIGURE 3: REDSOIL

CEMENT

Cement is a binder, a substance we used for construction that sets, hardens and adheres to the other materials, binding them together. Cement(fig.1) is a seldom used on its own, but rather to bind sand and gravel together. Cement is used with fine aggregate to produce mortar for masonry or with sand and gravel aggregates to produce concrete.

Cement used in construction are usually inorganic often time or calcium silicate based, and can be characterized as being either hydraulic or non-hydraulic depending upon the ability of the cement to set in the presence of water. Cement is made by grinding together with a mixture of Limestone and clay, which is then heated at a temperature of 1450oc, which results a granular substance called clinker, a combination of calcium silicate, Alumina and iron oxide.

FIGURE 4: CEMENT

COIR

Coir or Coconut fibre, is a natural fibre extracted from the husk of coconut and used in products such as floor mats, door mats, brushes, and mattress. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut the individual fibre cells are narrow and hallow, with the thick walls made of cellulose. They are pale when immature, but later become hardened and yellowed as a layer of lignin is deposited on their walls. Each cell is about 1mm (0.04 inch) long and 10 to 20 micrometre in diameter.

The coir fibre is relatively water proof and is one of the few natural fibres resistance to damage by saltwater , fresh water is used to process brown coir, while seawater and fresh water are both used in the production of the white coir.

FIGURE 3: COIR

BAMBOO

Bamboos(fig.4) are giant grasses and not trees as commonly believed. They belong to the family of the Bamboo-soideae. The bamboo culm, in general, is a cylindrical shell, which is divided by transversal diaphragms at the nodes. Bamboo shells are orthotropic materials with high strength in the direction parallel to the fibres and low strength perpendicular to the fibres respectively.

Bamboo is a composite material, consisting of long and parallel cellulose fibres embedded in a ligneous matrix. The density of the fibres in the cross-section of a bamboo shell varies along its thickness. This presents a functionally gradient material, evolved according to the state of stress distribution in its natural environment. Bamboo is one material, which will have a tremendous economic advantage, as it reaches its full growth in just a few months and reaches its maximum mechanical resistance in just few years. Moreover, it exists in abundance in tropical and subtropical regions of the globe.

FIGURE 4: BAMBOO

III. LITERATURE SURVEY

1 LITERATURE REVIEW ON RAMMED EARTH:

B.V.Venkatarama Reddy (2008) conducted a study on durability of rammed earth walls exposed for 20 years to natural weathering. He concludes that a method of stereo photogrammetry used to measure the erosion of rammed earth walls on site may also help to calculate and develop more test to assess the durability of the wall.

B.V.Venkatarama Reddy (2010) Conducted a study on compaction characteristics and physical properties of compacted cement stabilized rammed earth. He conclude that the quality of cement stabilized rammed earth construction are if the cement soil mixture should be rammed into a wall with in an hour after mixing with the water. Time lag results in lower strength and difficulty in achieving higher density.

F. Pacheco-Torgal (2011) Concluded that earth construction is also responsible for an indoor air relative humidity beneficial to the human health, therefore earth construction has clear competitive advantages in the field of sustainability over conventional construction assuring it a promising future in the years to come.

K.K.G.K.D. Kariyawasam (2015) conducted a study on cement stabilized rammed earth as a sustainable construction material. He concluded that the compressive strength of all the wall panels with cement contents above 6% has shown satisfactory results indicating an adequate margin compared to the design strength required for a typical two storey load bearing structure.

2 LITERATURE REVIEW ON COIR:

Anoop Singh Chandel (2016) Conducted a study on a comparative strength study of coir fibre reinforced concrete over plain cement concrete. He concluded that:
1.The compressive strength of coir fibre reinforced in concrete isnearly13%more than plain cement concrete.
2. The tensile strength of CFRC is nearly 40% more than the PCC.
3. The flexural strength of CFRC is 15% more that of PCC.

K.V. Sreenivasa Rao (2016) Conducted a study on mechanical properties of coir fibre reinforced hybrid composites fabricated by cold pressing method. He concluded that:
1. The moisture absorption increases with increase in fibre.
2.40% weight of coir fibres reinforced hybrid composite exhibits more tensile strength than Other hybrid composite.

Shubham Raj (2017) Conducted a study on coconut fibre reinforced cement stabilized rammed earth and he recommended to use 0.8% fibre and 5-10% cement by weight of soil to achieve considerable strength.

3 LITERATURE REVIEW ON BAMBOO:

Khosrow Ghavami (2004) Conducted a study on bamboo as a reinforcement in structural concrete elements. He concluded that bamboo has 90 strengths of its original to that of the steel.

Deb Dulal Tripura (2013) Conducted a study on Bond behaviour of bamboo splints in cement-stabilized rammed earth

blocks. However, it can be concluded from this study that the design development length for 7.5mm diameter (based on embedded area of splint) splint is estimated to be approximately 300–350mm for Melecanna Baccifera and 400–500mm for 9mm diameter Bambusa Balcooa, respectively, under both cured and uncured conditions. Although bond stresses are quite reasonable, end plates are recommended for better anchorage.

All works on rammed earth, coir and bamboo are mentioned clearly in the following table.

S.no	Name of Researcher and year	Title	Material used	Conclusion
1	**B.V.Venkatarama Reddy (2008)**	A study on durability of rammed earth walls exposed for 20 years to natural weathering.	Rammed earth Straw-earth	Method of stereo photogrammetry used to measure the erosion of rammed earth walls on site may also help to calculate and develop more test to assess the durability of the wall.
2	**B.V.Venkatarama Reddy (2010)**	A study on compaction characteristics and physical properties of compacted cement stabilized rammed earth	Soil Silt Clay Ordinary Portland cement	Quality of cement stabilized rammed earth construction are if the cement soil mixture should be rammed into a wall with in an hour after mixing with the water otherwise difficulty in achieving higher density
3	**Anoop Singh Chandel (2016)**	A study on a comparative strength study of coir fibre reinforced concrete over plain cement concrete	Cement Aggregates coir	The compressive strength of coir fibre reinforced in concrete is nearly **13%** more than PPC
4	**Shubham Raj (2017)**	A study on coconut fibre reinforced cement stabilized rammed earth	Coconut fibre Red soil Cement	He recommended to use 0.8% fibre and 5-10% cement by weight of soil to achieve considerable strength
5	**K.V. Sreenivasa Rao (2016)**	A study on mechanical properties of coir fibre reinforced hybrid composites fabricated by cold pressing method.	Coconut fibre	The moisture absorption increases with increase in fibre
6	**Khosrow Ghavami (2004)**	A study on bamboo as a reinforcement in structural concrete elements.	Bamboo Steel Cement Aggregates	Bamboo has 90 strength of its original to that of the steel.
7	**Deb Dulal Tripura (2013)**	A study on Bond behaviour of bamboo splints in cement-stabilised	Bamboos Cement Soil	The design development length for 7.5mm diameter (based on embedded area of splint)

IV. CONCLUSIONS

From the above literature review following the conclusions are as follows.

1. The durability of rammed earth construction is very similar to the conventional materials constructions.
2. Use of coir increases the compressive strength of the cube with some limitation as there is some difficulty in distributing the coir uniformly in the mix.
3. Bamboo is having good tensile strength and it can be used as reinforcement by treating the it using some chemicals.

V. SCOPE OF FUTURE WORK

Based on the literature review the following scopes have been identified in this study.

1. A study on bond strength of bamboo and steel reinforced CSRE blocks.
2. To study the effect of corrosion on bond strength of steel reinforced CSRE blocks.
3. To evaluate the durability analysis of bamboo and steel reinforced CSRE blocks.

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