ISSN 2349-0292
Impact Factor 2.675

GLOBAL JOURNAL OF ADVANCED ENGINEERING TECHNOLOGIES AND SCIENCES

RAMMED EARTH WALL - GREEN CONSTRUCTION

Ahmad Soiur*, Mrs.Shruti S.Wadalkar

* P.G. Student M.E (Construction Management), Dr. D.Y. Patil institute of Technology, Pune-India

ABSTRACT

As the building industry quickly changes and demand is shifting towards energy efficient, healthy building that consumes less precious resources. Buildings are a major energy consuming sector in the economy. About 35 to 40% of total energy is consumed by buildings during construction. The major consumption of energy in buildings is during construction and later on for lightening, heating/cooling or air-conditioning systems, This consumption must be minimized. The paper attempts to discuss about the highlights of the green building- a focus on rammed earth wall can be built from local material. Rammed Earth wall is used as insulation on the face of exterior wall for heating/ cooling purpose of the buildings it may release the temperature slowly. Rammed Earth wall is a method of insulating of building in hot and cold climate regions, in this paper applicability of rammed earth wall is studied in colder climate region like Afghanistan – Bamyan province, there is very cold in the winter almost -20C. Rammed earth wall is made of local material can be used as an insulation to conserve Energy (consumed for heating purpose of the building) or indoor building temperature. At this stage attempt to achieve comparison of cost/time between rammed earth wall and conventional materials. Water ratio analysis need to be carried out to finding out proper water ratio and proper moisture of earth before placing in the framework to be compacted well. Once rammed earth wall build it should be used for 4-5 decades and the main objective of compressive testing to find the ultimate crushing strength of rammed earth wall, which is carried out in Afghanistan.

KEYWORDS: Local material, Low energy consumption, good insulation.

INTRODUCTION

Industrialization and fast increasing of population natural resources are consuming, so during the planning building there is need to take attention minimum energy and water consumption. Buildings are major energy consumer during the construction and later on for lightening, heating and cooling or air conditioning. Building materials for insulation with an increasing consumer demand for environmentally friendly building products and materials. Sustainability is becoming a paramount concern to key stakeholders in the construction industry. Insulation materials used in homes and commercial buildings play a primary role in their overall energy efficiency studied by (Manoosingh, 2016). Rammed earth wall is a local material as the name shows , the main material used in rammed earth wall is the soil so it is local material and available in Everywhere . Rammed earth wall is solid or panels made by processed soil laid in the framework by adding a little water and compacted layer by layer , it is used as an insulation around the exterior walls of the building to release the temperature slowly it can be built in hot and colder regions .

A green building consumes less natural resources such as energy , water also create less wastes and greenhouse gasses , it should be healthy and confortable for occupants or the people use the building , it is refers for entire life cycle of the building from design , choosing local material , construction and maintenance ,so it is required to close coordination and cooperation between design team , engineer , architect and clients , as we know due to global climate change ,

LITERATURE REVIEW

The importance of energy efficient buildings and sustainability has assumed great urgency in light of fast evacuating energy resources, energy scarcity and increasing environmental pollution. Innovative ways to reduce energy consumptions are necessary. The construction industry is one of the largest energy consuming sectors. In modern buildings significant amount of energy is consumed to keep the building environment comfortable described by (Chaturvedi, 2008). In cold region countries like Afghanistan large quantities of electricity, coal and wood consuming for heating the buildings and for developing countries due to rising population, increasing standards of living and rapid urbanization result in an increase in building construction activities, To achieve the collective objectives of energy security and environmental protection, Eco sensitive buildings that utilize their resources judiciously, minimize their emissions and have efficient waste management systems, should be considered and designed. The available options in architectural intervention, building materials and design methodologies need to be carefully evaluated to minimize energy usage, minimize the

ecological degradation that may be caused by the construction of the building and provide cost effective solutions. The aim is to achieve the desired comfort with the least input of conventional energy. Depending on above environmental concerns, rammed earth wall is a natural building material and system, can be built with non-industrial materials such as soil, sand, bamboo. Some examples of natural building materials with structural uses are straw bale, bamboo. Rammed earth wall construction can be dividing into two categories, described by (Reddy and Kumar, 2011).

- Not Stabilized rammed earth wall (soil , sand , gravel)
- Stabilized rammed earth wall (cement/ lime , soil , sand , gravel)

Cement stabilized rammed earth wall (CSRE) can be seen 4-5 decades , CSRE can be as a load bearing and not load bearing type it is depend on content of cement , used as an insulation to conserve Energy and maintain temperature of the building , noise control, strength and durability, low maintenance, fire proofing, load bearing ,no painting required once built , as well as its beauty and the pleasure of building with a natural/local and environmentally sound material. Advantages of Rammed earth wall including high aesthetic appeal and low embodied energy and passive hygroscopic humidity regulation of internal space. Rammed earth can be built by local material (earth , sand , small quantity of Portland cement and water) and used local equipment during the construction , main materials is earth it is available everywhere . As we know huge quantity of energy Consumed for Heating and cooling purpose of building so this can be a good insulation on the face of exterior walls.

TECHNIQUES AND INVISTIGATION OF CSRE

With a panel of recycled Styrofoam. Rammed earth wall also assist for interior humidity of the building, where walls containing clay are exposed to an internal space, the ideal range for asthma sufferers and for the storage of sensitive items the process is time consuming and repetitious, but rewarding. And now with power tampers, the job is a bit less demanding. A newly tamped section of wall is so solid that, if desired the forms can be removed immediately. If wire-brushing is needed after the forms are removed, to even out the framework edge imprints or to add texture, it should be done in the first hour after the form is removed, and Rammed earth wall will not be fully dried throughout for months. Exposed walls may need to be sealed to prevent water damage if the walls will be exposed to heavy rain. Worldwide, more than forty percent of the population lives in earth built structures, yet earth building disappeared in western countries after World War II, when suburbs sprung up and speed reigned. The skill was lost. Although never given up in developing Countries, the west now is relearning this ancient art and begging building authorities. Building regulation permits this building method to take its proper place of advantages. We need to step back and learn from the past, but with pneumatic tamper in hand and openness of mind. Rammed earth is essentially manmade sedimentary rock. The compaction can be done manually with a hammer made by timber or metal or pneumatically with an air – driven Tamping which connected to air compressor tool. Dynamic compaction using manual or power tampers not only compresses the soil but it also vibrates the individual particles of earth , converting them into the most tightly Panels arrangement possible. When finished, rammed earth wall is about as strong as concrete. Rammed earth wall houses have several benefits then wood-frame construction. The walls are fireproof and sound proof, the solid/panel, 18-24 inch thick walls sound soundproof. Rammed earth wall assist to keep a comfortable temperature inside the house. Temperature swings that normally occur on hot summer days or cold winter night's .When designed and oriented properly to get the best advantage of solar energy, a rammed earth house may be 80% less energy consumption than a wooden house. But rammed earth wall construction is about 5% more expensive than wooden construction because it needs of more labor.

RAMMED EARTH CONSTRUCTION PROCEDURE

(a) Raw Materials

Experimental Study of Effect of Fly Ash on Self-Compacting Rammed Earth Construction Stabilized with Cement-Based Composites, in recent years growing energy costs and climate change both have become the key concerns for future development (Chen and Bing, 2016).

As the name implies the main material used in rammed earth construction is the earth itself. Proper types of soil (gravel, sand, silt, clay). The previous rammed earth walls were made of soil that was 70% sand and 30% clay. The soil from a new building site during the excavation is tested to determine its suitability. Soil must free from Organic and other strange material such as roots, weeds, and coal. If necessary a different type of soil can be collect in and mixed with the existing soil to create a mixing design that will work. Cement may be added to the soil to excess rammed earth stability or strength and its resistance to moisture usually at about one-fourth the ratio that would be used to make concrete. Steel reinforcing bars are placed in the foundations and sometimes in the walls vertically and horizontally, if the rammed earth wall carried out on the external face of Concrete structure with CMU or brick surrounded wall, the steel anchorage will be used normally with already placed anchor also.

ISSN 2349-0292
Impact Factor 2.675

Used steel for rammed walls must be applied anti rust. Plywood is used to make the removable forms for standard rammed earth construction. Sheets of (1.6cm to1.9 cm) plywood are thick enough. Plastic coating should be used on one side because they release more easily from the wall after construction, plastic coating not only leaves a nice finish on the just-completed wall, but it helps to remove the form boards easily and in a good condition to be used on future projects. For better stability of form works the back timber should be used (20 cm x 10cm) or we can fabricate form work from steel boxes to use several times, and plywood boards can be replaced if it was damaged.

(b) Preparing the site

Two inches (5 cm) of topsoil is removed from the building site and stored so it can be replaced around the completed structure. Organic matter such as weeds and roots are removed and may be composted for use in post-construction landscaping. After the site is cleared, the outline of the house is staked out. The soil is excavated to a depth that guarantees a level surface the excavation includes the floor area of the building as well as one meter surrounding buffer zone. A trench may be excavated so that the walls will be anchored into the ground to a depth below the winter freezing line.

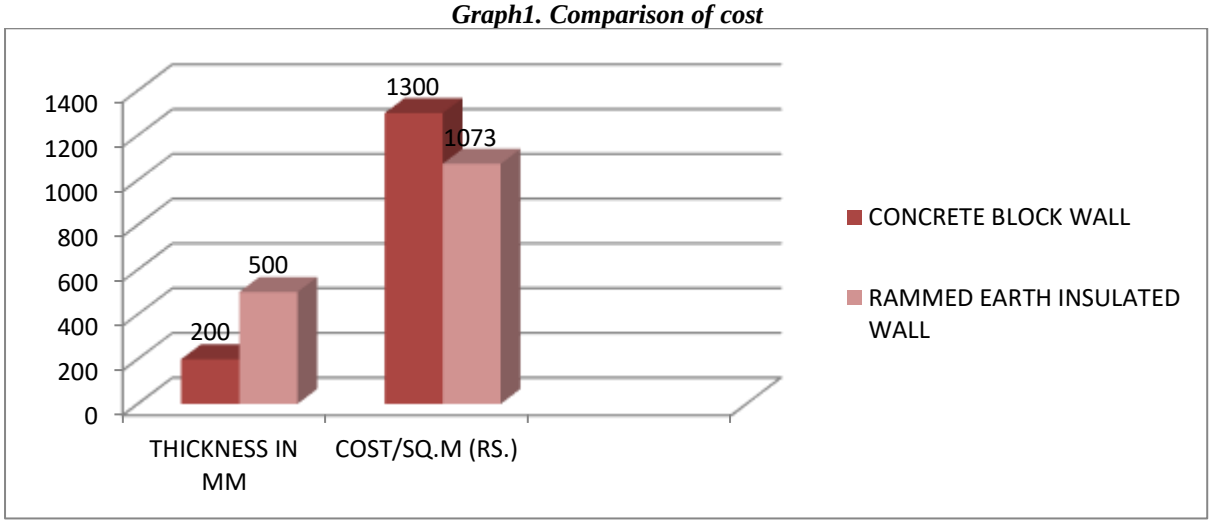
(c). Cost comparison of Rammed earth wall and Conventional material

Cost comparison of rammed earth wall and conventional material (CMU) carried out following.

CMU block.

CMU block size : 0.2 x 0.4 = 0.08 m2
1 m2 CMU block = 1/0.0m2 = 12.5 = 13 blocks
1 block = 50 Rs
1 m2 blocks : 50x 13 = 600 Rs
Labor cost: including curing and scaffolding for 1m2 CMU work is = 250 Rs
Mortar cost :1:6 mortar for 1m2 CMU work is = 150 Rs
Plaster cost : 1:4 two coats of plaster (20mm) including labor , curing = 300 Rs
Total cost of 1 m2 CMU work including plaster , scaffolding , curing and material (complete work) is :
(600 + 250 +150+ 300) = 1300 Rs
Dry density of 5% white cement content rammed earth wall is-1500 kg/m3 (5% = 75 kg/m3)
Wall thickness is assumed here 30 cm = 0.3x1x1 = 0.3 m3 = 22.5 kg/ m2 = 22.5x 12= 270 Rs
Sand/gravel : 2-12mm gravel = 0.23x0.3x12 = 83 Rs
Labor cost: including carpenter and scaffolding = 640Rs
Frame work : frame work and curing = 80 Rs
Total cost for 0.3x1x1 = 1073 Rs

Graph1. Comparison of cost



(d). rammed earth wall compressive strength testing

Rammed earth wall strength and structural behavior of story-high cement-stabilized rammed-earth (CSRE) walls, reviews literature on the strength of CSRE, and discusses results of the compressive strength of CSRE prisms, wallets and story-high walls described by (Reddy and Kumar ,2011).

The primary objective of testing rammed earth wall is assess its ultimate crushing strength ,Compressive strength of rammed earth carried out in Afghanistan by 6 specimens in three stages which Has Been tested between 14- 28 days , tests examined by cylinder specimens 200mm height and 100 mm diameter, after completion of curing period kept in open condition to dry , first two specimens tested on 14 days results came 1.6 Mpa , second specimens tested on 21 days result came 2.46 Mpa and the third Specimens tested after 28 days results came 3.4 Mpa .

Mixed materials –

- 23% of sand which content small size of river aggregate (2–12)mm
- 72 % of cleaned soil which is free from organic materiel or free from other strange materiel.
- White cement 5 %

Table1. Compressive strength test results

No of tests	No of specimen	weeks	Result In Mpa
T1	2	2	1.6
T2	2	3	2.46
T3	2	4	3.4

(e).water requirement

Water should be add till the mix get a little moisture, addition of the water should be under the acceptable circumstance, using pressure hose with limitation of the time period. Prepare a ball with 100mm diameter then drop down from one meter height if it is disintegrated in three portions that is the best moisture. Water requirement also depending on gravel , soil and sand moisture content , during the mixing needs to consider the materials moisture as well , hence preparation of the ball is good and easy method .

CONCLUSION

Rammed Earth wall is made of local material or new procedure. It can be used as an insulation to conserve Energy, release temperature slowly or indoor temperature of the building, noise control, strength and durability, low maintenance, fire proofing, load bearing no painting required once built as well as its beauty and the pleasure of building with a natural/local and environmentally sound material. Benefits of Rammed earth including high aesthetic appeal and low contained energy and passive hygroscopic humidity regulation of internal space. Rammed earth can be built by local material (earth , sand , small quantity of Portland cement and water) and used local equipment during the construction , main materials is earth it is available everywhere . As we know huge quantity of energy Consumed for Heating and cooling purpose of building so this can be a good insulation on the face of exterior walls. Rammed earth insulated wall humidity measured 40 % so block wall humidity is 55 %. So it can be used for hot and cold climate regions rammed earth wall can be strengthen by vertical and horizontal 12mm rebar against horizontal loads. From cost comparison with conventional method, it is observed that Rammed earth wall is economical with less costing for 300 mm thickness. From compressive strength test results the maximum strength of 3.4 Mpa is achieved at 28 days, which proves that Rammed earth is suitable as a construction material for wall.

ACKNOWLEDGEMENTS

I hereby take this opportunity to express my profound thanks and deep sense of gratitude towards my guide Mrs.Shruti S. Wadalkar. She gave me a precious time from his busy schedule & his valuable guidance has been a constant encouragement and also Dr.D.Y.PATIL Institute of Engineering and Technology, pimpri , Pune -411018 for carrying out this work and the approval for publish the paper .

REFERENCESS

[1] Chen, Y., Fazio, P., Athienitis, A., and Rao, J. (2012) “Sustainable Building Design in Cold Regions:High Performance Envelope and Façade-Integrated Photovoltaic /Solar Thermal Systems at High Latitudes. Cold Regions” “Engineering 2012: pp. 199-209. Doi
[2] Dhillon, C. and Aschheim, M. (2010) “ Natural Building Materials and Systems Sustainability Guidelines for the Structural Engineer” :pp.225242. doi:10.1061/9780784411193.ch
[3] Manoosingh, C. (2016) “Improving the Thermal Efficiency and Environmental Sustainability of Building Insulation”. Construction Research Congress 2016: pp. 1163-170.doi; 10.1061/9780784

479827.117
[4] Zhou, H., Li, W., Chen, Y., Lai, D., Sun, H., and Chen, Q. (2015). "Case Study of Industrial Building Energy Performance in a Cold Climate Region in a Developing Country"
[5] Chaturvedi,S. (2008) "Energy Efficiency and Sustainability in Buildings." AEI 2008: pp. 1-8. doi: 10.1061/41002(328)59
[6] Vasilios Maniatidis and Peter Walker (2008) . "Studied Structural Capacity of Rammed Earth in Compression". 10.1061/ ASCE 0899-1561-2008-20:3-230
[7] B. V. Venkatarama Reddy1 and P. Prasanna Kumar2. "Structural Behavior of Story-High Cement-Stabilized Rammed-Earth Walls under Compression". DOI: 10.1061/(ASCE)MT.1943- 5533 .0000155. © 2011 American Society of Civil Engineers.
[8] Cong Ma1; Longzhu Chen2; and Bing Chen, Ph.D. "Experimental Study of Effect of Fly Ash on Self-Compacting Rammed Earth Construction Stabilized with Cement-Based Composites" appropriate to study the fly ash effects. DOI: 10.1061/(ASCE)MT.1943-5533.0001518. © 2016 ASCE
[9] Surjya K. Maiti1 and Jnanendra N. Mandal2 ." Rammed Earth house construction " J. Geotech. Engrg., 1985,