International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 05 | May - 2023 SJIF 2023: 8.176 ISSN: 2582-3930

THE CRITICAL ANALYSIS OF MUD AS A COMPOSITE MATERIAL

Ar. K. CHITHRA, RAAM MURALE.S, SOWMIYAA.S AND SNEHA S

ABSTRACT: Man has always erected with natural accoutrements, erecting with slush/ earth; the most natural of all structure accoutrements poses a special challenge. Architecture moment is discerned by cold hard, machine made structure accoutrements. Conceptually the material can be used to combine traditional rudiments in contemporary contest. A lesser understanding of the possibilities of the material and the great strides it has made with respect to operation and use will enable a formative reconsidering of its felicity for different types of construction. Construction with slush is the answer to numerous of our waxing casing problems and presents an instigative and down to earth volition to the perpetuation of the concrete jungle.

1. INTRODUCTION

Mud is generally used in constructing erected forms from the ancient times. Least energy consumption by minimum archconservative energy and recyclability are the reasons for using slush as construction material. It's available in cornucopia in utmost corridor of pastoral India. Hence the technology can be transferred easily to other areas. A huge insufficiency of containing demand in communal and pastoral areas can be minimized by operation of slush as structure material. But vulnerability of this material to exposure to rain etc may lead to the imagination of hooch's with thatched roof, dark innards, and damp walls that give rise to unhealthy and aseptic living conditions. Nature is an illustration and always inspires mortal beings. The cone- suchlike termite mounds are unfit of being tampered with, and the fact that they're also truly porous is astounding.

1.1. MUD CONSTRUCTION TECHNIQUES

1.1.1. COB:

It's a traditional structure fashion using hand formed lumps if earth mixed with sand and straw. Cob is easy to learn and affordable to make. It dries to hardness analogous to spare concrete.

1.1.2. ADOBE BRICK:

Adobe bricks (slush bricks) are made of earth with a fairly high complexion content and straw. If produced manually the earth blend is cast in open moulds onto the ground and also left to dry out. Adobe bricks are only sun- dried, not kiln- fired. When used for construction they're laid up into a wall using an earth mortar.

1.1.3. RAMMED EARTH:

Rammed earth is a technique for building walls that places gravel and other raw materials like earth, chalk and lime in between flat panels known as formwork. Due to a rise in the popularity of natural building techniques and more sustainable building materials, this age-old construction technique has recently come back into favor.

1.1.4. WATTLE AND DAUB:

In the construction process known as "wattle and daub," a woven lattice of wooden strips called "wattle" is covered with a sticky substance typically comprised of a mixture of moist soil, clay, sand, animal dung, and straw.

FIG.1.1. Rammed earth

TABLE – 1.1. – Classification of mud construction techniques

Liquid state	Earth poured into formwork. (Monolithic wall)	Poured earth in shuttering
	Earth poured into a mould (Bricks)	
Plastic state	Moulded earth (Bricks)	Adobe
	Shaped earth (Bricks)	Adobe
	Earth shaped in position (Monolithic wall)	Direct moulding
	Earth built up in position (Monolithic wall)	cob
Dry state	Earth compacted within formwork (Monolithic wall)	Rammed earth
	Compressed earth(Bricks)	Compressed bricks

2. SOIL USABILITY AND ANALYSIS

TABLE – 2.1 – HANDS ON – Mud techniques

Technique	Location	Soil type	ratio	stabilizer	
Adobe brick	Sacred grooves, Auroville.	Red soil, M.sand.	3:1	Coconut fibre, human hair	
Cob	Sacred grooves, Auroville.	Red soil, M.sand.	3:1	Fibres and straws	
Earthcrete	Sacred grooves, Auroville.	Mud, M.sand, cement	6:4:1	Aggregates from rubble	
Adobe brick	Earth matters, Tanjore.	Deep brown soil, dirty white soil	1:2	straws	

2.1 Adobe brick – Hands on:

- Location: Vilar, Tanjore.
- Soil type- 1. Deep brown soil.
  2. Dull brown or dirty white soil.
- The soil is collected and tested for proportion by ball drop and cigar test.

- The deep brown soil has further complexion whereas the other soil had summations. One part of brown soil and two part of white soil is suitable for construction. The soil should have both total and complexion as well. The soil is also cast in a mould without air gaps with fritters and dried for 4 days.
- The summations in the soil binds the complexion as the structural members binds the cement in the conventional structures.
- Proportion 1: 2.

FIG. 2.1. Straw as stabilizer

2.2 Soil selection:

1. **Too much clay:** cracks appears due to the volumetric insecurity of complexion when exposed to water makes them vulnerable to corrosion.
2. **Too much sand:** are too multitudinous to all cleave together sufficiently, there will be cohesion and the bricks will deteriorate
3. **Too much organic matter:** As this decomposes it causes the characteristics of the material to change over time, makes it pervious and of poor continuity when exposed to water. These proportions can be established in a lab or assesses on point by simple tests.

2.3 Soil identification:

2.3.1. Collecting samples:

Good earth is to be set up in upper layers of loose earth low in organic matter. Top soil, which is infelicitous because of the organic matter it contains, must thus be removed. Samples of each soil set up should be collected in sufficient amounts

2.3.2. Laboratory test:

A. Particle size analysis

Particle size analysis allows one to determine the separate amounts making up the soil.

B. Sedimentation analysis

Sedimentation analysis After raising, the patches which have passed through 0.1 mm mesh sieve are collected. As it would be extremely laborious, if not insolvable, to try to sieve them through finer sieves,

their size is measured thanks to sedimentation analysis. This system exploits the difference in speed at which different soil patches suspended in water settle. The largest will settle first and the lowest last.

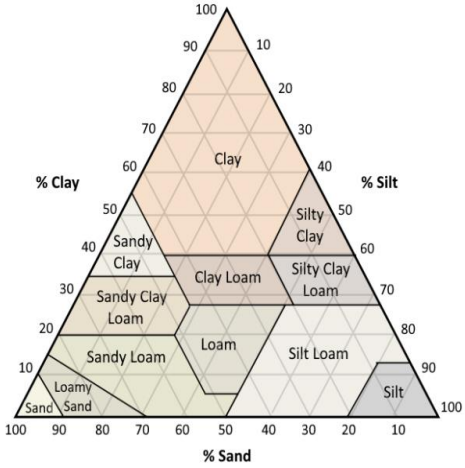


FIG.2.2. Triangular representation of textures.

2.4. Field test:

➢ **Color test**

Procedure

- Observe the color of soil.
- Interpretation
- Deep yellow, orange and red, ranging to deep browns indicate iron content which is good as erecting slush.
- Greyish or dull brown, ranging to dirty white indicates further complexion. Dull brown with slightly greenish color indicates organic soil.

➢ **Touch & smell**

Procedure

- Rub small volume of dry soil on win to feel its texture. Moisten the soil and rub again.
- Interpretation
- Soil that feels course when dry but sticky when wet contains lumps of complexion.
- Soil that feels course when dry but gritty when wet contains sand.
- Soil that feels course when dry but little gritty when wet contains silt.
- If the wet soil gives off musty smell also it contains organic matter.

➢ **Ball drop test**

Procedure

- Making the soil into a ball after moisturizing. Dropping the soil to the ground from a certain height.
- Interpretation

- Still, the soil contains further summations, if soil breaks into pieces. If soil doesn't crack after dropping also it has a good proportion of sand and clay.

➢ **Cigar test**

Procedure

- Make a smooth paste from the soil removing all gravels. Roll it on win to make a cigar. Slowly push it outside your palm. Measure the length at where it breaks.
- Interpretation
- Length below 5 cm- too much sand.
- Length above 15 cm- too much clay.
- Length between 5 cm to 15 cm-good mixture of sand and clay

TABLE – 2.2 – Jar test

Sedimentation test – jar test			
	Location	Soil type	Inference
	Vilar, Tanjore	Deep red soil	Coarse gravel – high level – settled at the bottom. Sand silt on the top at very low level.

2.5 General characteristics of earth as a building material

- Compressive : 2 kg / sq. cm
- Tensile : 0
- Shearing : 0.3 kg/ sq. cm

Wet compressive strength:

- Roughly half the dry compressive strength.

Tensile strength:

- 1/5 of the compressive strength.

Young's modulus:

- 70000 kg/sq.cm

Thermal expansion:

- 0.012 mm /m per deg. Celsius

Acoustics characteristics: 40 cm wall:

- Attenuation for a frequency of 500 Hz – 56 dB

Thermal characteristics:

- Measure of conductivity: 0.44 to 0.57 Kcal/h m °C

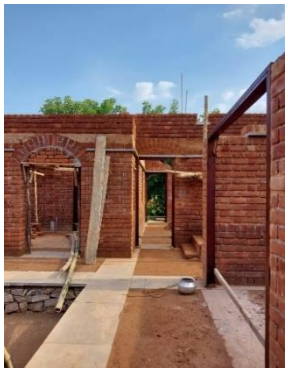
3. NET CASE STUDY:

Case studies	Design features	Material/techniques used
1. St. George Orthodox Church,Mattanchery,Cochin,Kerala -Ar.Vinu Daniel	Early Marthoma cross symbols are where the idea of domes, vaults, and arches came from. A "cross of light" made of organic earth bricks graced the altar.	Wall- compressed, stabilized mud blocks. Rammed earth foundation Using ancient Nubian technology of bow and vault Roof- CSEB laid for centenary vault.
2. Weaving walls, cottage, Thannal Hand Sculpted Homes. -Ar.Biju Bhaskar	Pleasantly contained yet still being connected to the surroundings' openness. Free-flowing areas with flooring made of broken tiles and built-in furnishings. glass bottles with blue tints were inserted into the west side wall. The blue colour of the home is reflected in the glass bottle by the setting light.	Wall- wattle and daub construction The cobbed portion of the wall not only acts as the base of the structure but also flows into innards to take form of seating, shelves and niches. Roof-Double sub caste roof, with Mangalore pipe above that allows the heat to escape from the top. Green roof by having a sub caste of slush on top is one of the trials. Flooring- broken penstocks
3. Vikas Community, Apartment, Auroville. -Ar.Satprem Maini	Utilisation of a four-story building using on-site soil that is self-sufficient. This soil extraction made it possible for the excavations to be seamlessly integrated with the surrounding structures and environment.	Foundations- Stabilized rammed earth Walls-CSEB Roof-CSEB (flat ,vaults and domes) These vaults and domes were built with, by using the “Freespanning” technique Floorings- CSEB tiles

Fig.3.1.2. St. George Orthodox Church, Bangalore.

Fig.3.1.3. Weaving walls, cottage, Mattanchery.

3.2. EXPLORING MUD HOUSES IN TANJORE:

<table>
<tr><td colspan="2">MUD HOUSE – 1
30 years old</td></tr>
<tr><td>  </td><td>1.Owner: Padhmavathy
2.Location: vilar, Tanjore
3.Age of house: 30 years old
4. Type of construction: cob without plastering.
5. Stabilizer: broken tiles inserted on to the cob walls to increase stability.
6. Roof: pitched roof.
7. Materials on roof: roof tiles, locally available wood as rafters.</td></tr>
<tr><td colspan="2">MUD HOUSE – 2
Not in use</td></tr>
<tr><td>  </td><td>1.Condition of structure: not in use
2. Type of construction: cob walls, lime washed with couple of layers.
3. Damages: complete destruction of lime wash.
Brick work is done later to protect the cob wall from moisturizing.</td></tr>
<tr><td colspan="2">MUD HOUSE – 3
On construction</td></tr>
<tr><td>  </td><td>1. Location: vilar, Tanjore.
2. Type of construction: brick wall and mud as composite material.
3. Condition: on construction.
4. Mud technique: rammed / poured earth.
5. Structure: load bearing.
6. Beams: bamboo.
7. Roof: stone slabs with wooden rafters, lime.
8. Walls: exposed brick.
9. Plinth raised by random rubble stones.</td></tr>
</table>

4. Function and usage of mud through 5R concepts (Reduce, Reuse, Recycle, Refuse, and Respect)

Reducing use of concrete is good for environmental protection, reduction of pollution and energy consumption associated with the manufacture of accoutrements , and it's also associated with profitable and social benefits. Exercise of earth in erected form by applying applicable ways, integrates the natural lighting and ventilation with the presence of jaalis, bamboo openings and skylights and comfort position seems to give air- conditioning effect. The structure remains cool in summer and comfortably warm in downtime. The specific of Recycled soil for construction remains the same. Refusing to use gratuitous precious effects by simply saying ' No ' just because it's forced down and allured us by way of announcements in ultramodern world. Rather use of cow soil flooring subject to its original vacuity, andnon-toxic effect of smoothened plastered slush walls creates an authentic air. esteeming our art and culture, our ancestor 's traditional wisdom and sensibility by conforming a sustainable life style, flashing back traditional ways of life that start with simplicity, and satisfaction with the available accoutrements , we may embellish the walls with wall declensions made of terracotta and placing different art accoutrements of terracotta at applicable places.

5. CONCLUSION

There's compass for a detailed scientific study on slush as a construction material. Raw slush has to be duly stabilised with traditional(cow soil), conventional(cement or lime) or artificial stabilisers(bitumen) which when corroborated with either natural or artificial fibres conduct better strength and continuity to the structure. The walls of the houses should be suitable to breathe. Stabilisation with 5 cement is enough to make the slush walls strong and resistant to termite attack and water penetration. Other styles of diving termite attack are through NEM cataplasm, roasted fenugreek seeds and crushed neem seeds. NEM cataplasm can also check corrosion of slush walls. Lime publishing provides better finish and good appearance. The added advantage of slush constructions is that trouncing is voluntary. utmost of the guests prefer to leave the wallsun-plastered in order to expose the beauty of laterite blocks or monuments. By doing so, frugality in trouncing can also beachieved.However, the Ifrequired.walls can be plastered with slush itself. It's possible to give different tones of colours to the slush walls by mixing different textures of slush collected from colorful points. The unique character of slush is its malleability, reusability and transformability. Experimental slush construction systems and ways display the durability of traditional character and expression connecting the history, present and the future. Indeed in numerous areas in India due to rapid-fire urbanization and changing life style, the possibility of slush getting an integral part of construction material seems to be grueling . This also gives the satisfaction of affordable healthy living for the rest of the life. " It's concluded that the eventuality of slush as a sustainable structure material is undoubtful and immense handed that it should be promoted and rehearsed with high significance given to the generalities of sustainable development. "

REFRENCES

R Gopalan Nair, 2011, "Back to earth homes", Deccan Herald.
David C. Easton, 1996), "The Rammed Earth House"
http://www.earth-auroville.com/
http://thannal.com/

https://www.thehindu.com/life-and-style/homes-and-gardens/the-making-of-modern mud-walls/article20103701.ece
EBAA-"Earth Building Book", Earth building Association of Australia
Hassan Fathy, 1973, "Architecture for the Poor" The University of Chicago Press
Sruthy, G.S 'Mud architecture', Proceedings on International Conference on Energy and Environment, IJIRSET, 12–14 December 2013, Vol. 2, No. 1, Kottayam, Kerala, India.
Q.B. Bui , J.C. Morel , B.V. Venkatarama Reddy ,W. Ghayad 'Durability of rammed earth walls exposed for 20 years to natural weathering' Building and Environment 44 (2009) 912–919.