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CASE STUDY

RODDA CONSTRUCTION: A STUDY OF EARTH HOUSE AT RAJENDRAPUR, GAZIPUR

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ABSTRACT

Mud house is a typical indigenous style and is considered as an affordable means of construction to create shelter for poor. Bangladesh, due to its socio-economic condition, can harness the traditional and indigenous practice of building construction, partly due to the easily available craftsmen and lower cost of providing affordable construction materials in rural areas.

Examining a distinct quality of earth construction in the northern part of Gazipur reveals a most innovative yet economical and environmental friendly earth construction method, termed as Rodda construction.

This paper presents an empirical investigation into the process of making Rodda construction.

Conclusion is drawn with the objective of presenting a suitable building process. Rodda, although originates in a unique physical setting, can be alternative building construction method for affordable housing in Bangladesh, providing a technical input is given by architects.

Keywords: Rodda, affordable housing, sustainable construction, indigenous material.

I. INTRODUCTION

Unlike many techniques available for mud house construction, Rodda construction is exclusively an example of northern Dhaka where special cohesive soil is one of the reasons for its popularity. Case study shows a systematic approach to such mud housing construction which needs further assistance to enhance its usability for a wider region in Bangladesh. Rodda construction is not a popular techniques recognized by the majority of architects in Bangladesh. This can perhaps partly be due to the fact that most of the urban dwellers prefer to have a permanent materials for the building construction, and due to the believe that mud-built housing has less life cycle. But investigation shows that mud house, if managed regularly, can last for more than 100 years which is environmental friendly and comfortable in terms of the indoor air quality. Moreover the thick mud walls work as good thermal insulators, thus reducing the thermal conductivity and keeping indoor air quality cooler than outside hot and humid air. Only drawback of mud housing seems to be the limitation of its vertical construction although two storied is a popular building.

II. GLOBAL CONTEXT

Mud or earth construction has been regarded by many architects and builders as a potential building material that can help produce durable houses for many growing urban as well as rural population regardless of their income. Architect Laurie Baker spent most of his career exploring and perfecting the skills required to build mud houses that can last for a longer life cycle. His predecessors are traditional craftsmen and masons who still build mud houses in many parts of India. His philosophy and techniques which is an unbroken tradition of architecture that stretches over 4,000 years has successfully been implemented in many mud housing design and construction in India. Most of these houses have been built by the user themselves, with some assistance from skilled craftsmen. And this is also the situation in countries

like Australia, Iran, and Africa; many of these houses are 50-100 years old.

In contrast to other construction materials, including cement and steel, mud does not demand imported commercial machines and energies and is therefore a favored material for those desirous of living sustainably. But modern materials are environmentally destructive as these materials contain embodied energy harmful for the environment and costly to recycle. It is also common problem that firing mud brick requires the felling of trees. He has therefore insisted that architects develop their conscience about using expensive and imported materials that use up a lot of natural resources in their manufacture: this applies not only to cement and steel, but also to brick and timber, glass, asbestos, galvanized iron sheets and so on.

Contrary to popular perception, mud houses are affordable to all classes and can be designed to suit different affordable ranges. They are environmentally virtuous and can be as durable and hard as concrete.

Laurie Baker's pioneering efforts in using mud in durable house construction have inspired much new generation of younger architects to use mud in their designed houses and liberated from the older fixations and prejudices on conventional fired bricks and concrete. The beneficiary of this changes has been the public, not only those who are inclined to mud because it is inexpensive and copiously available, but also those who consider themselves at the vanguard of society's new yearnings.

One more beneficiary is the building tradition of old, and the indigenous construction techniques using mud, which have received a fresh lease of life from the attention and research now being focused on them.

Bangladesh Context

As Laura Baker, many local architects in Bangladesh have strived on their own initiatives to promote the use of mud. Academics often engage their students to incorporate mud as their design strategies. Most of the researches done in the architectural schools remain in the cocoons of bind research thesis without getting these off to a real project application. Independent architects like Jalal Ahmad has tried in his own capacity to train rural people and erect mud houses with innovations that never became a popular approach for mass rural people. [1]

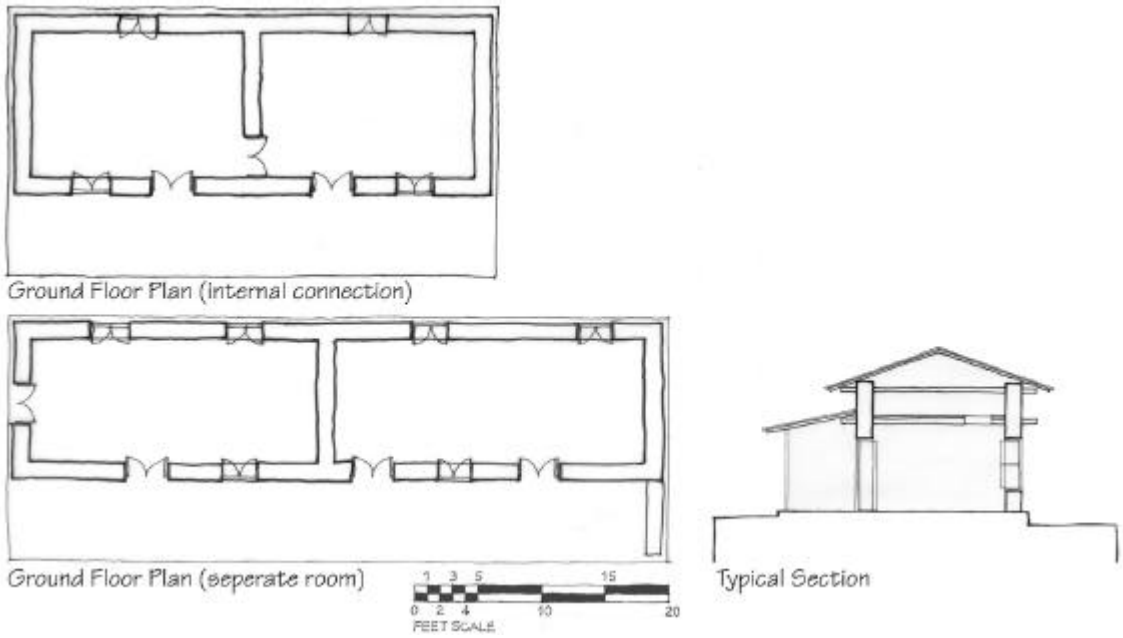


Figure 1: One storey Rodda house: Plan and Section

A case in Gazipur can sheds some light on a technique locally called Rodda wall construction. Thick earth wall construction with churned mud without any reinforcement is popular in Gazipur, Modhupur, Kapasia, Kaliganj and Mymensing areas. These thick walls are constructed in layers. It is suitable for flood free high land zones and having adhesive clayey earth, locally termed as 'Etel mati' (Cohesive hard soil).

III. EMPIRICAL INVESTIGATION: RODDA

Construction period

This method of earth house construction takes place only in winter. It takes approximately 6 months to complete an earth house. This gradual process is required in order to allow the soft soil to consolidate and dry fully.

Workers

Earth construction workers are locally called *'Mali'*. They are rural craftsmen living within the vicinity of the construction sites as Rodda requires special adhesive soil only to be available in Kapasia. These workers have long generations of skills and have been used only during winter and spring seasons. They are not too well paid as the urban builders and craftsmen but having very congenial and lead happy way of life and enjoying every pace of construction process collectively.

Plinth preparation

The site of the house is usually selected in a plain land since the flat base can minimize foundation work and allow maximum stability to the upper Rodda layers. After the base is being prepared, plinth is constructed by digging up earth with a spade. Earth then churned with water and mud is prepared by stepping. It is then kept for 7days for being compact.

Earth preparation for Rodda walling

Local earth is collected by digging in a nearby area with the help of spade and gathered in a in an earth pit (Fig: 2a). The earths then churned with water by 10 to 15 workers for making mud by stepping, which is locally termed as doing 'Chana' (Fig: 2b). Then churned earth is kept for 7 to 15 days for drying and allows the composition to get compact and later allow it to settle down by putting polythene over the pit (Fig: 2c).

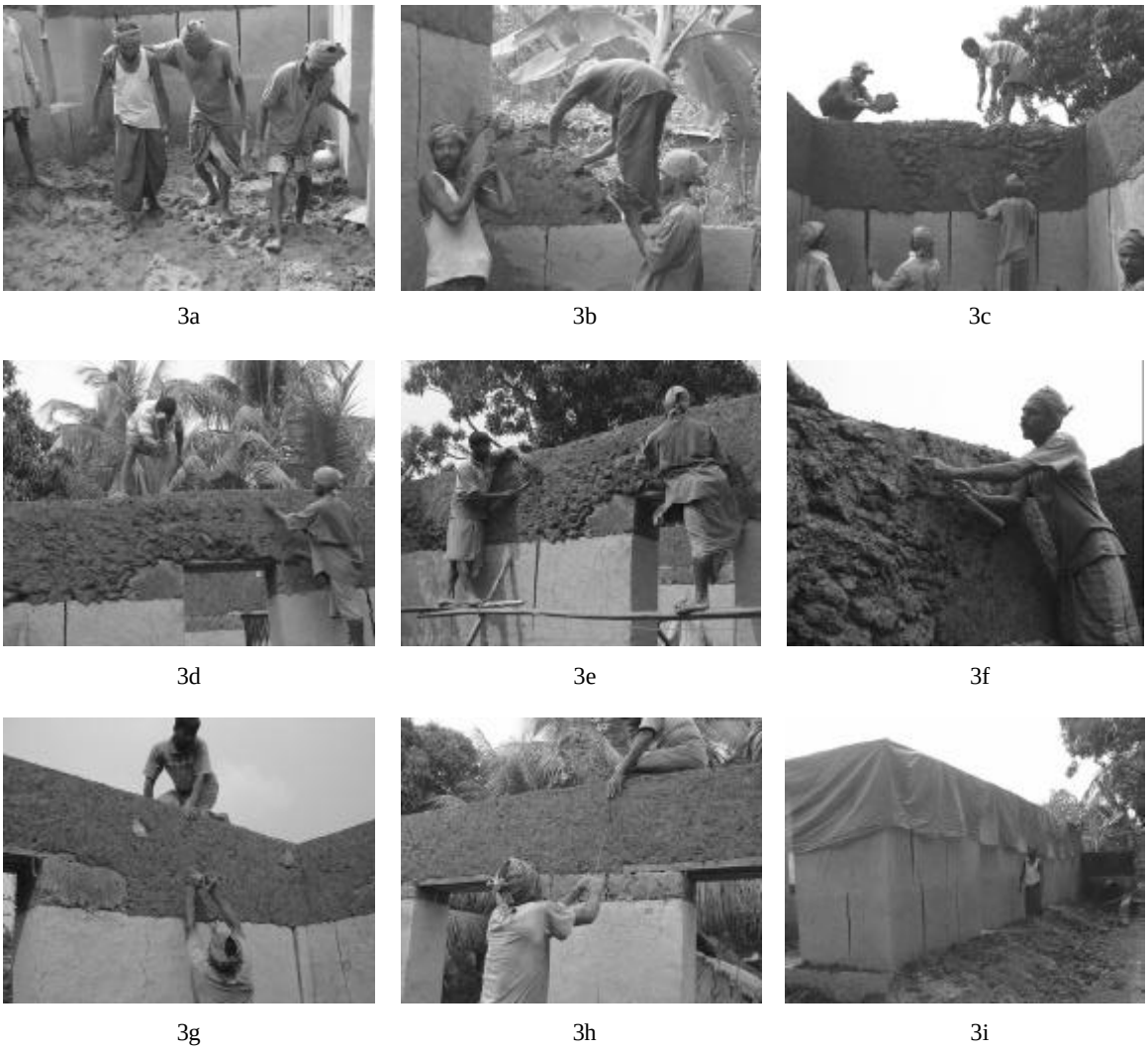
2a 2b 2c

Figure 2: Earth preparing pit

Rodda wall construction

Prepared earth (Chana) is taken from earth pit and staged on plinth. Then again the earth is churned by applying pressure with the help of continuous stepping by 4 to 6 workers (Fig: 3a). Churned earth then dug with spade and piled up along the designated wall line (Fig: 3b). Wall is constructed in layers with an average height of 30 inches which is locally termed as 'Rodda' (Fig: 3c). Piled earth is simultaneously made compact by hitting with wooden mallet (Fig: 3d). Earth mound is chiseled with a scythe locally termed as 'Kachi' to get vertical and smooth wall section during this piling (Fig: 3e, 3f). The Rodda wall then divided into vertical segments of 2' feet to 3' feet by cutting with steel wire to allow the Rodda to shrink evenly and prevent irregular cracks on the wall (Fig: 3g, 3h).

The Rodda layers then left for drying for 15 to 20 days by covering with polythene sheet at the top (Fig: 3i). During this time it becomes compact and gets the strength to carry further layers and loads on its top. Then another Rodda layer is prepared on top of the previous layer. The slit cut/gaps are not done aligned on the same line for conjugative Roddas; they are made in staggered way along so that these gaps allow partial failure in case the whole wall collapses. It also looks like a pattern of running bond.



3a 3b 3c

3d 3e 3f

3g 3h 3i

Figure 3: Rodda Wall Construction

Wall Thickness

The wall thickness is inversely proportional with the height of the structure. General, as a thumb rule, the wall is kept as 16 to 18 inch at plinth level for 20 hands by 10 hand room space of 12 feet height. Most of the mud houses have a wall thickness of 16 to 18 inch at plinth level. This thickness reduces on the upper level of Rodda and remains 12 to 14 inch in average. Partition walls are treated as load bearing walls and are constructed as the same thickness as periphery walls.

Support for openings

Strong wooden plank is used to make lintel for the openings (Fig: 4a, 4b, 4c). If the wood is not strong enough, it tends to bend downwards due to heavy earth mass on the top. Window and door frames are added later after the walls are fully dry.

4a 4b 4c

Figure 4: Wood planks are used to support load over openings

Wooden beam and upper storage

Banana trunk is added as a composite material together with the rodda layer (Fig: 5a). After proper drying of rodda layer as well as the trunk gets rotten, the trunk is taken out to make space for wooden beams. This creates a room for wooden beams as earth gets dry. Palm trunk is cut longitudinally to prepare beams, locally termed as 'Chatir' (Fig: 5b). Black colored palm wood ('Shar') is preferred for beams as it does not get infected with termites or wood-worm. Wooden platform, locally termed as 'Pataton' is made up with any kind of wood on the beams for upper storage. A staggering pattern is done with the beam to create a platform for crop storage (Fig: 5c).

A layer of mud is usually added on top of the wooden platform to keep crop dry and to stop any fungus to grow during rainy season that usually happens as moisture penetrates the crop from wooden platform. A wooden shutter is provided to close the opening for the storage space thus created. Depending on the height of the staggering, 40kg to 400kg crop can easily be stored on the upper storage without any sag effect.

5a 5b 5c

Figure 5: Wood beams made of Palm trunk and upper storage

Upper floor

In case of any provision for upper floor, a wooden stair case is provided for vertical circulation (Fig: 7e). Periphery walls and partition walls are constructed according to same layout. In some case, Rodda partition walls are seen to be replaced with C I sheet to get more space at upper floor as there will be no further load from roof on it (Fig: 6, First Floor Plan). Wooden floor is prepared with wood of Kathal or Koroi tree (Fig: 7f). Mud layer is provided on wooden floor to ensure privacy and reduce noise for ground floor. Dwellers prefer to keep food grains in lower floor and live in upper floor for security at night.

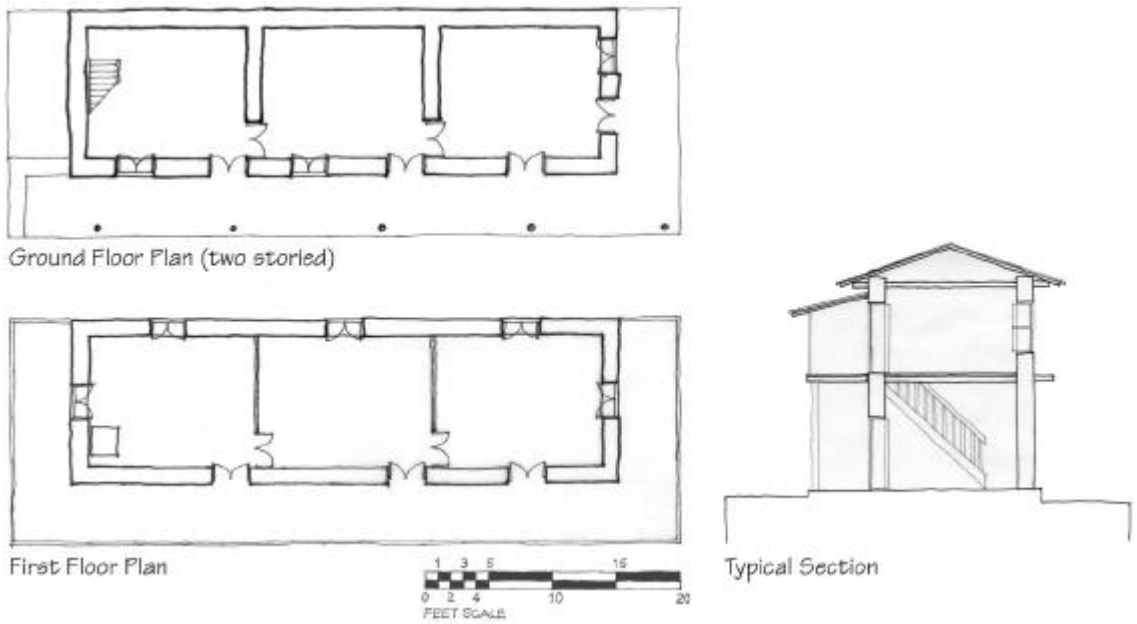
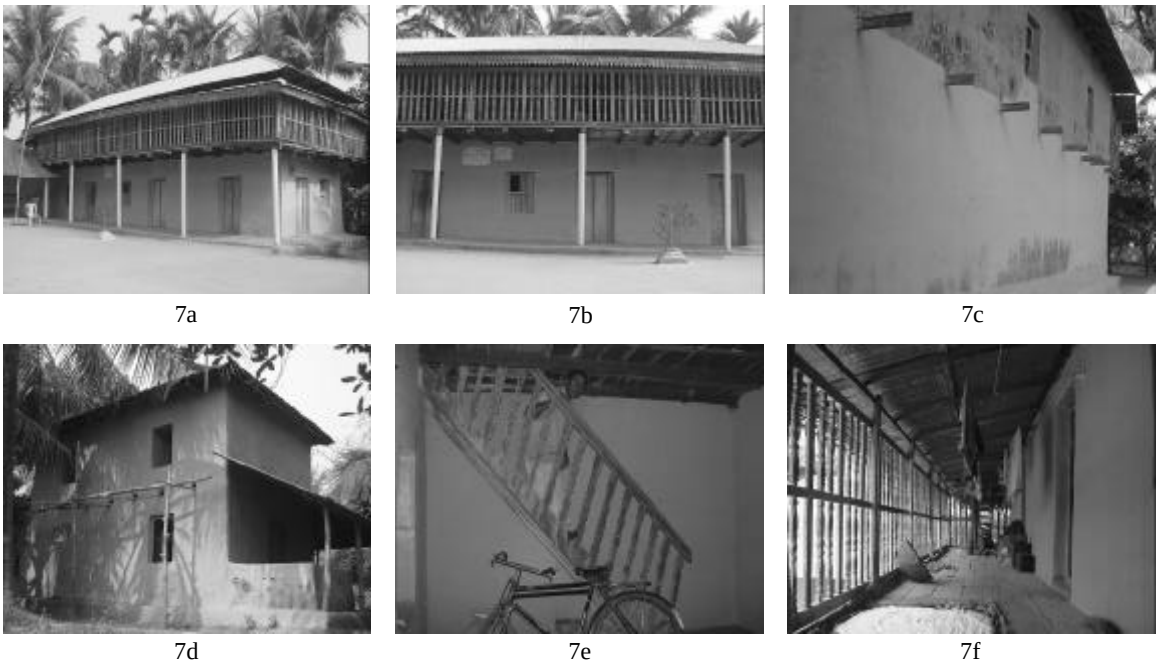


Figure 6: Two storied Rodda house: Plan and Section



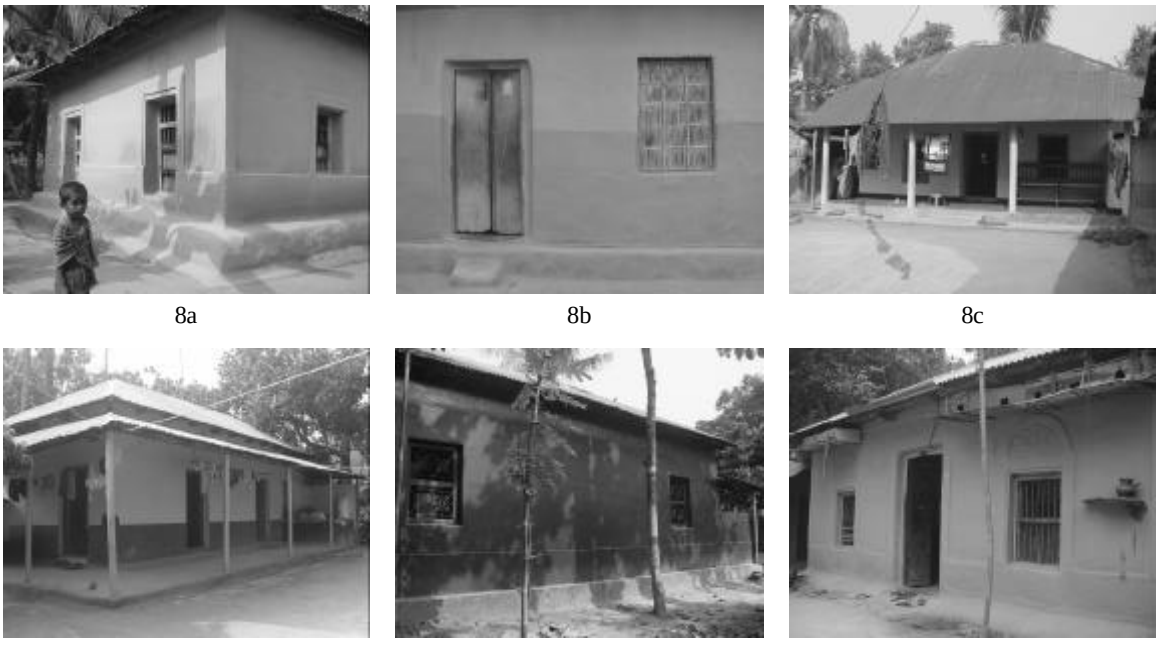
7a 7b 7c

7d 7e 7f

Figure 7: Two storied earth house with Rodda construction

Surface Finish

After construction of earth house in six months dwellers start living in the house without any surface finish. After the earth walls get enough drying for a period of one year, the vertical slit gaps thus created during this period are filled with earth. Several coat of mud slurry is provided all over the wall on both outside and inside surface of the wall. Husk of grains are incorporated with the mud slurry to protect the wall from further cracks along the first layer of the slurry coating. This layer would prevent the earth wall from rain water yet gives a finished look. Apparently, as a new visitor, the surface looks like concrete wall because of its strength as well as of its surface finishing (Fig: 8a 8f).



8a 8b 8c

8d 8e 8f

Figure 8: Different colour of surface finish

Maintenance

Mud slurry coats need to be applied on earth walls, especially on the outdoor sides in every six months in order make the wall surface water proof.

Durability

Earth walls are as durable as brick walls. Durability is inversely proportional to the height of each wall layers or Rodda. Generally, an earth house does not show any defect for a continuous period of 20 years or more. In case the owner wants to dismantle the house, shovel is found to be useless due to the hardness of the wall, and axe, therefore, is required to break the wall.

Art works

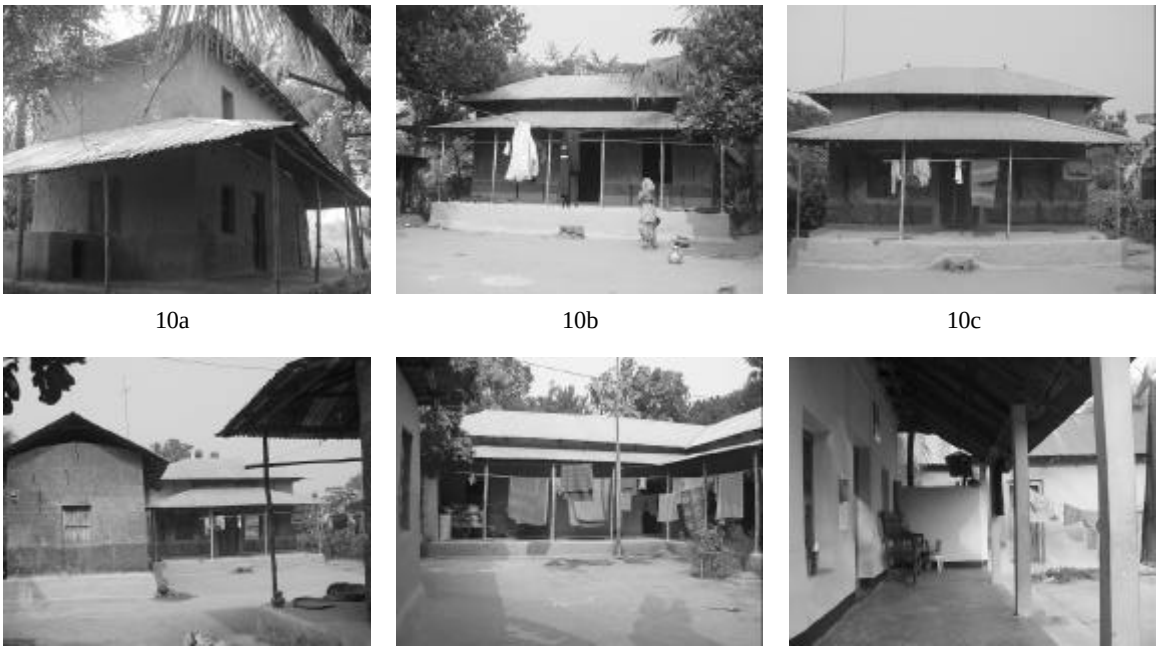
Different decorative motifs are curved on earth walls to give a relief effect. Patterns are drawn on walls with different color tones of mud slurry, which are locally termed as 'Alpana'. Additional color of mud coating can also be applied on earth walls for more aesthetic purpose (Fig: 9a 9c).

9a 9b 9c

Figure 9: Artistic motifs and patterns on surface

Precautions

According to the constructors of mud house, mud slurry coat has to be applied after the earth wall is properly dried. If this coat is applied on earth wall before proper drying, the layer could easily fall off like skin. Long projection of C I sheet roof and C I sheet verandahs are useful to protect earth walls from rain. This, moreover, creates an additional space for semi-outdoor living space that allows visitors to sit for social, agricultural and business discussions (Fig: 10a - 10f).



10a 10b 10c

10d 10e 10f

Figure 10: Long projection to protect the wall surface from rain

Costing

Rodda wall construction is very cost effective. It is 60 percent cheaper than any equivalent size semi-permanent (Pacca) construction. Generally, the total earth construction is done through a contract done between an owner and a Mali Wala (contractors). Average rate is 2000 taka (US$34) for a 24 hand by 2 hand Rodda wall construction.

Merits

The environment inside an earth house is very comfortable for human living. Earth wall protects the indoor environment from outdoor hit penetration during hot summer and, thus, keeps indoor air much cooler than a comparable urban house. If the provision of cross ventilation is kept in the design, it appears to have a much comfortable air conditioned room. On the other hand, during winter seasons, thermal mass of the earth wall keeps inside air warm enough to live comfortably without any heater.

Demerits

Although it is a common incident in rural habitat, burglars commit burglary by making holes on the earth walls. Generally an earth wall house is safe from termite for 10 to 12 years. After this period if termite attacks on earth wall, then dwellers generally put fire on the wall surface for several days to resist termite to grow further, but it is likely to be ineffective. Some rich house owner applies pest control chemical, called 'Hepta Chloro', which is very effective against termite breading. But during recent times, this chemical is banned and substitute chemicals, which are available in the market are less worthy compared with the price. Rats also live inside earth walls which comfortably consume stored grains.

IV. CONCLUSION

Besides being unpopular as a common building material, Rodda construction is far advantageous than many a methods currently available for mud house construction. A closer look at the construction process and the advantage this can provide us will shed some hope for architects and builders in Bangladesh. Although, the soil is typical of Rajendrapur, it is possible for material suppliers to establish a market for the growing house construction in urban and suburban areas. There are ample opportunities for researchers to study on the property, use and complexities Rodda may give us, but Government should promote builders to become more sustainable and sensitive towards indigenous material as our country is running behind many other neighboring countries as far as the sustainable and green architecture means to us.

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REFERENCE

[1] Ahmad, J., Mallick F., and A. Q. M. Abdullah, *"Local Resources and Participation in Design: 2 Projects in Bangladesh"*, Open House International, special issue on "The Architecture of Development" Volume 28, No.3, September 2003.

[2] Ahmed, K I, *"Up to the Waist in Mud"*, University Press Limited, 1994.

[3] Anil Agarwal, *"Research: Mud as a Traditional Building Material"*, The Changing Rural Habitat: Volume I: Case Studies, The Aga Khan Award for Architecture, 1982

[4] Salma Samar Damluji, *"The Valley of Mud Brick Architecture: Shibam and Tarim in Wadi Hadramut"*, Garnet Publishing Limited, UK, 1992.

[5] Center for Maximum Potential Building Systems, *"Earth Block Manufacturing and Construction Techniques"*, University of Arizona & Arizona Solar Energy Commission, Tuscon, 1982

[6] Jolyon Leslie, *"Building with Earth in South Arabia"*, In Minar 38; Architecture in development, Concept Media Ltd., London, 1991

[7] Kamel O. Mahadin, *"Regionalist Architecture in Jordan A critical view"*, Open House International, Vol. 19 No. 3, 1994

[8] Pierre Maas, *"Djenne: Living Tradition"*, Aramco World Magazine, Robert Arndt (ed), Houston, 1990

[9] Seven Nilson, *"Environment and Design: Notes on the Vernacular Architecture of the Asir"*, Environmental Design: Journal of the Islamic Environmental Design Research Centre, 1985

[10] Bee, Becky. The Cob Builders Handbook: You Can Hand-Sculpt Your Own Home. Murphy, OR: Groundworks, 1997

[11] Chiras, Daniel D. The Natural House: A Complete Guide to Healthy, Energy-Efficient, Environmental Homes. White River Junction, VT: Chelsea Green Publishing Company, 2000

[12] Denzer, Kiko. Build Your Own Earth Oven. Blodgett, OR: Kiko Denzer, 1998

[13] Easton, David. The Rammed Earth House. White River Junction, VT: Chelsea Green Publishing Company, 1994

[14] Fathy, Hassan. Architecture for the Poor. Chicago, IL: The University of Chicago Press, 1973

[15] Golany, Gideon S. Chinise Earth-Sheltered Dwellings. Honolulu: University of Hawaii

[16] Khalili, Nader. Ceramic Houses & Earth Architecture. Hesperia, CA: Cal-Earth Press, 1986

[17] King, Bruce. Building of Earth and Straw: Structural Design for Rammed Earth and Straw-Bale Architecture. White River Junction, VT: Chelsea Green Publishing Company, 1996

[18] McHenry, Paul Graham. Adobe and Rammed Earth Buildings: Design and Construction. Tucson, AZ: The University of Arizona Press, 1984

[19] Pearson, David. The New Natural House Book: Creating a Healthy, Harmonious, and Ecologically Sound Home. New York, NY: Simon and Schuster, 1989

[20] Smith, Michael. The Cobber's Companion: How to Build your Own Earthen Home. Cottage Grover, OR: The Cob Cottage Company, 1998

[21] Steen, Athena Swentzell; Bill Steen. Earthen Floors. Elgin, AZ: The Canelo Project, 1994