Adoption of Contemporary Earth Construction in Africa Alleviating Urban Housing Crisis

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1. Introduction

The unprecedented boom in the construction industry since independence resulted in the high demand of building materials that superseded the production capacity of the manufacturing sector in most of the African countries. A house is composed of several materials such as brick, cement, timber, window frames and several other building materials and the use of bricks as a standard building material began in the early 1900s in most of the African countries. Brick, cement, sand and timber are the major construction materials in Africa up to date which is unaffordable nowadays for majority of the population. Therefore, an affordable building material and appropriate construction technique needs to be prescribed and devised to solve the urban housing crisis. For example, 'earth' can be used as an appropriate construction material in Africa. The aim of this paper is to evaluate the up-to-date cases of usage of stabilised earth as a building material alleviating urban housing crisis in Africa.

2. Historical Background of Earth as a Construction Material in Africa

In Africa, the Egyptian civilisation provides abundant evidence of the use of earth in building as found in the early human settlements at the Merimd and Fayum sites in the Nile delta, which dates from the fifth millennia before Christ. The dominance of the Egyptian dynasty promoted buildings of prestigious structures made of brick from the Nile clay, desert sand and straw from the grain fields. These bricks were made by hand and dried in the sun before the development of the mould. The excavation at Saggarah and Bbydos show the use of bricks which were covered by stone. The art of brick vaulting was also developed in the lower Nubia, between Luxor and Aswan.
The Egyptian architect, Hassan Fathy encouraged local materials and saw a more appropriate method of building in the Vernacular Architecture of the Nubians (region of southern Egypt). Nubian craftsmen were masters at constructing domed and vaulted roofs of mud brick which they also used for the walls. While implementing the Nubian building techniques (Figure 1), he aimed to train Egyptian craftsmen to build their houses using mud brick or Adobe, which was ideally suited to the local conditions of Upper Egypt.

In eastern Africa, movements by the Indian Ocean, the migrating Kushites and the influence of the Axum Kingdom (3rd to 8th BC) from Nubia as far back as Kenya have spread the use of sun dried bricks. As a result there was a great change in the architecture of the surroundings with the introduction of mosques. These were mainly built of earth using local expertise. In Zimbabwe, building in earth dates back as far as the 12th century when Great Zimbabwe was built and earth has been used progressively mainly in the rural areas (Mubaiwa, 2002, p10). According to Sidi and Joffroy (2005), Timbuktu was one of the largest academic centers in Africa, playing a role in the spread of science, literature, philosophy and religion. The two main mosques of Timbuktu, Sankore (Figure 2) and Djingarey Bers were built in the 14th and 15th centuries.


Figure 1: Nubian Earth Construction of Goruna Village
(Source: Spatial Agency Website, 2012)


Figure 2: The Great Mosque, Djenné, Mali
(Source: Occasionally Architectural Website, 2012)

The palace of Zinder (Figure 3), a major witness to the history of Damagaram and still inhabited. It was built probably between 1850 and 1852, at the beginning of the reign of Tanimun, the most famous sultan of Damagaram.

It is located in the heart of Birni, the oldest part of the city of Zinder which is the historic capital of Damagaram. The palace was constructed of earth, with a roof of birch or Doum palm supporting the roof terraces. The palace shows the rich cultural heritage of earth construction of east Africa.

The Mousgoum huts (Figure 4) have been famous for its mastery of earth construction technique since the nineteenth century. According to Eloundou (2005), the Mousgoum territory lies in the basin of Lake Chad in the far north of Cameroon, on the riparian territories of the Logone River which separates Cameroon from the Republic of Chad.


Figure 3: Sultan's Palace of Zinder
(Source: Picasa Web Albums, 2012)


Figure 4: Mousgoum Huts
(Source: Foter Website, 2012)

3. Examples of Contemporary Stabilised Earth Construction Projects in Africa

A) Zimbabwe:
One of the first stabilised earth projects was the DfID School block (Figure 5) at the SIRDC centre, Hatcliffe, Harare, Zimbabwe. This project was mainly constructed to demonstrate that Rammed Earth (RE) could successfully support a roof span of 8m whilst at the same time being a test bed for the publication of RE Structures: A Code of Practice. The country has a number of RE projects among some of them were a private house (Figure 6) in Bonda, Manicaland commissioned by pioneering passive solar architect Mick Pearce in 1997, and an office and housing porject (Figure 7) in Chimanda on the North East border with Mozambique. SIRDC also built a RE teacher's house at Rukanda Secondary School in Mutoko. As seen in Figure 8, the house's appearance is impressive.


Figure 5: Rammed earth DfID block at SIRDC, Hatcliffe, Zimbabwe
(Source: Ram Cast CIC website, 2008)


Figure 6: Bonda private house
(Source: Ram Cast CIC website, 2008)


Figure 7: Chimanda office under construction
(Source: Ram Cast CIC website, 2008)


Figure 8: House built by SIRDC at Rukanda School
(Source: House built by SIRDC at Rukanda School)

B) Sudan:
The Al Haj Yousif experimental prototype school (Figure 9), was constructed from compressed stabilised earth blocks, and was found to be very cost effective by Sudanese standards.


Figure 9: El Haj Yousif School Under Construction

C) Burkina Faso & Mozambique:
Gando Primary School (Figure 10) is also a success story of CSEB. This school is the result of one man's (Architect Diébédo Francis Kéré) mission to improve conditions in his village. Not only did he design the school and raise the funds to build it; he also secured government support to train people in building with local materials, and drew on the strong tradition of community solidarity to engage all of the villagers in the construction of this school for their children.

Mumemo is about a training course carried out in Mumemo (Maputo, Mozambique) on earth construction by two Portuguese architects, Miguel Mendes and Teresa Beirao. During the course, a small 50 m2 house was built as shown in Figure 11.


Figure 10: Gando Primary School in Burkina Faso
(Source: Aga Khan Award for Architecture website)


Figure 11: Mumemo RE construction, Maputo, Mozambique
(Source: Mumemo website, 2009)

D) South Africa:
A team carried out a detailed design of structural vaults built from local soil for a new museum at the World Heritage Site of Mapungubwe designed by Peter Rich Architects. Michael Ramage (Cambridge), John Ochsendorf, and Philippe Block designed the unreinforced structural masonry vaults (Figure 12) in collaboration with Henry Fagan in South Africa, Matthew Hodge developed the cement-stabilized tiles in collaboration with Anne Fitchett (Univ. of Witwatersrand). The project was part of masonry research conducted by Massachusetts Institute of Technology (MIT). Figure 13 shows a low cost house constructed out of Hydraform (a form of CSEB) in Angola.

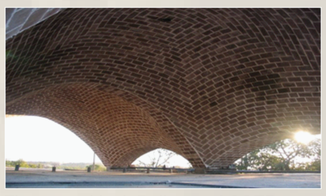
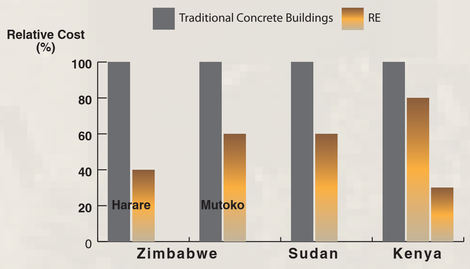


Figure 12: Vault Built out of CSEB, Mapungubwe in South Africa
(Source: Bldg. in South Africa-james-Picasa web albums)


Figure 13: Hydraform house, Angola
(Source: Hydraform website, 2010)

4. Reported Cost Reduction of the Case Studies that Utilized Rammed Earth (RE) Construction



(Source: Data for this figure were compiled by the authors from different sources refered to in the main paper)

5. Conclusions

- Earth is affordable and available and would be appropriate in the case of affordable urban house construction in in many African countries.
- the promotion and implementation of stabilised earth as an alternative building material is worthwhile in the light of successful African cases of earth construction.
- The only challenge that prevents earth becoming the preferred choice of building material amongst the general population is the acceptability of this material by that same population and the lack of knowledge amongst the construction professionals to implement the projects.
- The flexibility and simplicity in technology incorporated in earth building affords adaptability and easy transfer of knowledge between different stakeholders in the building industry. Individuals and community as a whole can easily participate in building their own homes in affordable ways.

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