Earth Construction in Botswana: Reviving and Improving the Tradition

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ABSTRACT

The purpose of this paper is to explore the opportunities for earth construction in Botswana. In the past two decades, there has been a decline in the use of traditional local building materials, techniques and styles. There are several possible causes that led to this decline including: socio-economic and cultural transformation / growth, invasion of industrial / modern building materials and changing value systems (modern replacing traditional values).

Building with modern / industrial materials is hindered by several factors such as the high cost of producing these materials, and excessive transportation costs to deliver them from the production to the building sites. The use of modern industrial building materials in Botswana is therefore not sustainable. There is need to seek for alternative non industrial materials which can be affordable to the majority of people especially those in rural areas. At independence in 1966, Botswana was one of the poorest countries in the world. However, since diamonds were discovered, the country’s fortunes have made it one of the most rapidly developing countries in the world averaging an annual growth of about 10% p.a. between 1980 and 2010. The country has invested heavily in infrastructure especially water supply, transport and social services (health and education). With a population of only 2 million in an area of about 600,000km² (same size as France), the population is quite scattered (about 3.5 per km²) as shown on Figure 2, and therefore providing services can be very expensive.

In the past ten years, there have been discussions about the rising cost of building schools and hospitals. Most building materials are imported from neighbouring countries. The few that are produced in the country are concentrated in a strip along the east of the country. Thus, the delivery of some of these building materials like bricks, cement, steel etc. involve 1000-1500 km by road to the various construction sites as can be seen on Figure 1. As a result, projects are very expensive. All these projects are erected in either clay face bricks or sand cement bricks made far from the construction sites. At the same time, not only does the country have a long tradition of building in earth, it has the ideal climate for building using earth. Countries with similar climate in West Africa (Mali, Niger and Burkina Faso) have made great progress in promoting earth construction. In Botswana, earth buildings are limited to residential building in rural areas. Despite all the developments in earth construction technologies (UNCHS 1989), there is no initiative or programme to support / encourage its use. This paper attempts to document the strength of earth construction by looking at the various options and recommending some possible techniques that can be adopted in Botswana. It concludes by recommending the establishment of a building materials research centre as well as introducing the subject to construction colleges and brigades.

Key words: Traditional, Local, Building materials, Adobe, Soil blocks, Rammed earth, Construction, Technology
1.0. Introduction

For several decades now, numerous urban and rural settlements of developing countries have experienced considerable population growth and are unable to meet their shelter needs. This is mainly because of a combination of two main reasons: scarcity of traditional building materials and techniques accompanied by lack of alternative affordable building materials. Amongst the various building materials available, earth is an attractive option because it is abundant, accessible, and inexpensive and also requires simple techniques (ideal for self-help / do-it-yourself). But why is it that half the world’s population lives in dwellings made from earth and aspires only to get away from them? Earth construction which once flourished has undergone a significant decline due to industrialisation of construction techniques and the progressive spread of western / modern models of architecture. Many people continue to build and live in earthen dwellings, but without having acquired a vast store of knowledge. Skills were handed down from one generation of artisans to the next without the interference of modern technicians. The economic and energy crises of the 1970s have cast doubt on the sustainability of building with industrial materials. At present, priority is given to construction materials which require low energy input for their production and utilisation and which offer natural insulation properties.

Earth, a material used for construction since time immemorial has been the subject of a revival in interest since the 1980s. What has aroused this sudden interest in a material which has been around for a long time and which has been abandoned by architects and civil engineers over the last half century in favour of new cement based materials? Interest in improving earth’s usefulness has been attracting considerable attention throughout the world, and the number of earth-construction projects, both in developing and industrialized countries is increasing. But according to Agarwal, Anil (1981), “In most of the cities of Africa, Asia and Latin America, at least a quarter of the population has to live in ramshackle, makeshift shelters in slums and shanty towns……. Mud is the most widely used building material in the world, yet it is almost invariably ignored by governments, development banks and aid agencies.” “One would like to avoid using the word ‘mud’ but in the absence of another expression in common usage (adobe, daga and pise are too limited) readers are asked to strip it of its pejorative overtones.” Denyer S (1978).

This prejudice is also noted in the book, “Decorated Homes in Botswana” by Sandy and Elinah Grant, who observed that the ‘Mud Hut’ Stereotype is the first barrier to acknowledging earth as a normal building material. They contend that, “If a house were indeed made of mud, which by definition is wet (and fluid), it would undoubtedly collapse….. But even the affluent in Africa associate poverty with a ‘traditional mud building’ and blind themselves to the inherent qualities of earth as a building material”. On the other hand, vernacular architecture in both Africa and Europe is characterized by its use of locally available building materials and skills honed over long periods of time. Buildings in Europe which are erected of chalk, lime, clay, pebbles and flint as well as wood, straw and reeds are not described as ‘mud huts’ or even ‘mud houses’. (Grant 1995)

“Worldwide each year, the making of concrete consumes 1.6 billion tons of Portland cement, 10 billion tons of sand and aggregates, and 1.0 billion tons of water; making the concrete industry the largest user of natural resources in the world.” (Allen E. and Iano J. 2008) And according to Lafarge, the largest Portland cement producer in South Africa, “To produce 1.0 ton of cement requires 1.5 tons of limestone with 0.5 ton released as carbon dioxide into the environment!” No wonder the global warming effect is worsening. This trend does not lead to sustainable development; something has to change.
2.0 Earth Construction Situation in Botswana

2.1 Traditional Tswana Houses
On the basis of design and construction materials, houses in Botswana can be divided into two major categories: traditional and modern houses. Modern houses are built with manufactured or processed materials such as sawn timber, concrete blocks / bricks, tiles and metal sheets based on western architecture. The traditional houses are those units built using vernacular architecture and locally available materials.

Traditional Tswana houses are commonly found in the eastern hardveld among Tswana speakers. A typical traditional Tswana house consists of a cone roof over a cylindrical wall. The roof structure is made of timber rafters covered by grass. The materials are obtained from the respective village and its surroundings. The walls are built of hand-moulded mud bricks of various sizes and shapes which are placed in vertical layers and immediately plastered with a rough coating of mud. One or two more coatings are added later to fill the cracks. The final coating is a thin layer of a mixture of cow-dung, soil and water. Cow dung is generally put in the mixture as it acts as binder. Finally, the wall is coloured and decorated using different types of soil or lime. The layer of colour is smeared on to the wall with the hand. The soils used for decorations vary from one village to the other. The construction of walls and floors, and thatching of roofs is the responsibility of women while men are responsible for the construction of the roof structure. The materials used in shelter provision are based predominantly on their availability, known traditional construction techniques and the need to shield from the sun. Each homestead consists of several house units each serving a specific activity such as sleeping, cooking or storage. The several houses are usually connected or surrounded by a short wall built of earth bricks (adobe). The space enclosed by the wall in front of the houses, locally known as lolwapa, is used for family gatherings and receiving special guests (DSM 2001). The layouts and details of some traditional houses can be seen in the Appendix 1.

Traditional house construction in Botswana is a family affair. For the household itself, in the self-subsistence economy, the traditional building methods are of great importance. The necessary building materials can be collected without costs around the village on communal land of the tribe. The household itself builds the houses. The skills are known by everyone and a few simple tools are used. This is typical for many traditional constructions as documented by writers like Rapoport (1969), Oliver Paul (1969, 1971).

According to Rapoport (1969) the major attributes of a tradition include:
- Indigenous – free from undue external and non-local influences
- Informal – not being regulated by anyone individual or group of individuals
- Homogenous / anonymous – overwhelming similarities that are not attributable to anyone person
• Working by example – not a result of prescribed knowledge of formal education
• Reflection of accumulated wisdom and experiences – that is, a result of many experiments whereby the good workable elements are retained and poor ones dropped to adapt to socio-geopolitical and climatic conditions.

Much as this tradition has worked well in the past, it is not stagnant: it is changing, and therefore it has to adapt otherwise it will die. Thus the building materials and processes have to take the positive aspects while discarding the non-functional / undesired ones. Much of the vegetable / plant materials (thatch, grass, poles) are becoming scarce, the same cannot be said about earth.

2.2 Decline in the use of Earth in House Building
According to the 1991 Census, almost 45.8% of all houses in Botswana had walls built in earth or its various combinations compared to about 50% of walls which were in sand cement
The two figures changed a lot ten years later. In the 2001 Census, earth based walls had dropped to only 24% while sand cement shot to 70% (Table 1)

Table 1: Building Materials used in houses in 1991 and 2001 (DSM 2001, CSO 2003)

<table>
<thead>
<tr>
<th>PART OF HOUSE</th>
<th>MATERIALS</th>
<th>NATIONAL %</th>
<th>TOWNS % *</th>
<th>MAJOR VILLAGES % *</th>
<th>OTHER VILLAGES % *</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROOF</td>
<td>Metal Sheets</td>
<td>68.9</td>
<td>49.6</td>
<td>80.8</td>
<td>57.9</td>
</tr>
<tr>
<td></td>
<td>Tiles / Asbestos</td>
<td>7.4</td>
<td>6.8</td>
<td>15.5</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>Thatch</td>
<td>22.1</td>
<td>41.2</td>
<td>2.2</td>
<td>34.7</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>1.6</td>
<td>2.4</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>WALL</td>
<td>Stone /Sand cement</td>
<td>70.4</td>
<td>49.3</td>
<td>84.5</td>
<td>62.8</td>
</tr>
<tr>
<td></td>
<td>Earth</td>
<td>15.0</td>
<td>32.2</td>
<td>10.4</td>
<td>27.0</td>
</tr>
<tr>
<td></td>
<td>Mud &amp; Wattle</td>
<td>7.5</td>
<td>10.4</td>
<td>1.1</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>Poles / Reeds / Thatch</td>
<td>1.6</td>
<td>2.8</td>
<td>0.1</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>5.5</td>
<td>5.3</td>
<td>3.9</td>
<td>3.2</td>
</tr>
<tr>
<td>FLOOR</td>
<td>Stone /Sand cement/Tiles</td>
<td>57.7</td>
<td>89.6</td>
<td>72.7</td>
<td>34.2</td>
</tr>
<tr>
<td></td>
<td>Earth</td>
<td>35.9</td>
<td>5.7</td>
<td>23.6</td>
<td>57.3</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>6.4</td>
<td>4.7</td>
<td>3.7</td>
<td>8.5</td>
</tr>
</tbody>
</table>

* See definitions of towns, major and minor villages in Appendix 2

In the capital city (Gaborone), in 1991, 2% of walling material consisted of earth; this was more or less the same ten years later (1.7%) as shown on Table 2. From the same table, in Mogoditshane, which is only ten kilometres from Gaborone the change in between the two census periods went from 12.3 to 3.9. The situation in Southern District is similar to that in Mogoditshane: in 1991, 50% of walls were built with earth; this had dropped to 28.7% by 2001. In Kanye village, the percentage went down from 20 to 8 (60% change) over the same period.


<table>
<thead>
<tr>
<th>PART OF HOUSE</th>
<th>MATERIALS</th>
<th>GABORONE %</th>
<th>MOGODITSHANE %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROOF</td>
<td>Metal Sheets</td>
<td>83.5</td>
<td>80.4</td>
</tr>
<tr>
<td></td>
<td>Tiles / Asbestos</td>
<td>14.6</td>
<td>19.1</td>
</tr>
<tr>
<td></td>
<td>Thatch</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>1.7</td>
<td>0.2</td>
</tr>
<tr>
<td>WALL</td>
<td>Stone /Sand cement</td>
<td>93.1</td>
<td>96.5</td>
</tr>
<tr>
<td></td>
<td>Earth</td>
<td>2.1</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Mud &amp; Wattle</td>
<td>4.8</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>4.8</td>
<td>1.8</td>
</tr>
<tr>
<td>FLOOR</td>
<td>Stone /Sand cement/Tiles</td>
<td>93.3</td>
<td>97.6</td>
</tr>
<tr>
<td></td>
<td>Earth</td>
<td>1.1</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>5.6</td>
<td>1.9</td>
</tr>
</tbody>
</table>

There are several misinformed allegations that traditional earth houses are temporary and last for very short periods. According to Anita and Viera Larson (1984) “The life span of traditionally built house may very well be over 20 years. Fifty years is not an impossibility. Rain and termites are the main threat. The earth wall is strong enough to carry the weight of the whole roof. Regular maintenance is a crucial factor for a long house life.” Access to cash and the fact that many members of a rural household are absent for considerable periods of the year (tending to cattle, or seeking paid jobs in urban areas), have led to some changes in the way traditional buildings are erected. Some materials may be purchased and a skilled artisan hired to do the work.
3.0 Options for Botswana

3.1 Botswana Soils
In Botswana, the silt content of most soils is low and this means they are mixtures in varying proportions of sand and clay. Whereas this is a disadvantage for agriculture, it is an advantage for building. The clay makes the soils sticky while the sand gives them the strength. The various soils in Botswana are according to DSM (2001):

a. About two thirds of Botswana falls under the sandveld, or the Kgalagadi (Kalahari). These are the red and grey desert soils. The thickness of the sand stratum varies but can reach 500m in some places. Fine sand is the dominant size (50-75%), with clay and silt at 5-10%. The organic matter content is low (less than 2%) and as a result the bulk density (which is about 1.5-16 gm/cc) does not vary much between the surface and the sub-surface.

b. The eastern part of Botswana falls under the less sandy hardveld region with hills and sand bed rivers. These are rocky areas where basement complex rock outcrops are associated with shallow stony soils. They have dark red loams.

c. Vertisols which are sometimes referred to as Black Cotton Soils are found in depressions in the eastern part of Botswana and in the north around Pandamatenga. The texture is about 80% clay and is deep and poorly drained. They are characterized by shrinking and swelling with deep v-shaped cracks when dry. When dry they are extremely hard and when wet extremely sticky.

3.2 Earth as a Building Material
Currently, scientific knowledge of earth, its technical performance and different production and construction techniques are well known and documented, but unfortunately, by too few scientists and researchers. Even if the skills involved have been perfected, there are still many obstacles to the use of earth on a socio-cultural level. One should not present an over-idealised picture of earth as a building material without mentioning its drawbacks / limitations. The use of earth as a construction material comes up against political, industrial and psychological opposition. This material is often associated in people’s minds with low-standard and primitive housing. It is not easy to overcome this perception. Earth has a very poor image both in the eyes of the people and in those of the leaders of developing countries. It is regarded as a weak material, non-durable and uncomfortable, associated in people’s minds with disasters and underdevelopment; only the poorest of the poor live in such dwelling.

3.3 Building with hand-made sun-dried bricks: Adobe in Botswana
From the soil profiles of Botswana, it is obvious that earth construction offers a viable construction for most residential as well as social and community buildings – houses, primary and secondary schools, clinics, and rural administration centres. Traditionally, most earth constructions in Botswana have revolved around adobe (handmade sun dried bricks) and stacked earth. For adobe, the main ingredients earth, straw and water are mixed and shaped into a brick which is then baked in the sun until dry. Adobe is ubiquitous because the soils required to make it are as varied as the cultures, periods, and locations that employ it. The soil composition required to create a high quality brick must have large particle sizes of aggregate and sand which help to create a stronger brick, and silt and clay to bind the various components together. When dry a mud brick with more clay is less strong but more water resistant. More aggregates means greater strength but the resulting brick is more susceptible to erosion. The ideal mixture to make an optimum brick is (Rael: 2009) Clay 14-15%; Silt 22-32%; Sand 61-62%; Gravel 2-7%.

In Botswana, according to Larson (1984),

*Two types of bricks are used for walls: wet or dried ones. Wet bricks are also called the traditional bricks. They are moulded by hand……. The wet blocks are put on top of each other in a few layers. The wall while still wet is plastered and then allowed to dry. The raising of the wall continues after the previous layers have dried, when a couple of new courses of wet blocks are added and then plastered.*
The dried bricks are made in a simple mould of wood which gives the brick proper shape. The bricks are dried in the sun and then laid with mortar of the same mixture as the bricks. There is very little difference in the strengths of the walls built by the wet and sun dried bricks. An advantage of moulded bricks is that they can be used again from old house. Another advantage is that the time to build with dried bricks can be shortened because a large amount of sun-dried bricks can be made in advance.”

The surface of earth wall is easily eroded and therefore regular maintenance is required, at least once a year. A more lasting maintenance free wall can be obtained by plastering with a cement mixture. However, this is not done by the women builders; a skilled artisan is employed and paid for it.

There is no reason why building with adobe is not given the due encouragement and the improvement in line with current research in earth construction. Given the semi-arid climate of Botswana and the long tradition of earth construction, the government should put measures in place to assist and encourage the use of adobe especially in rural housing.

3.4 Rammed Earth in Botswana

The rammed earth process begins with soil selection. Soil used to make rammed earth must have an appropriate ratio of sand, gravel, and clay to give cohesion, stability, and strength to the wall. Commonly, soil used in the construction of rammed earth building is taken directly from the site, moistened, and compacted with little thought as to its precise composition. Traditional builders also found many ways to adapt their material to local conditions by inserting branches (to act as reinforcement), water, blood, or lime to prevent cracking / reduce shrinkage or to increase cohesion and durability.

However, Botswana does not have a tradition of rammed earth construction, but it could be one of the best methods to erect institutional buildings: schools clinics village offices. Because rammed earth is now used in places where the tradition has been lost, or even in areas where the tradition never existed, or where it must comply with building codes that demand specific performance values, experts have determined the appropriate amounts of gravel, sand, silt, clay, moisture and stabilizing agent necessary to build structures compatible with the demands of today’s rigorous standards. The ideal mixture for rammed earth is (Rael: 2009) Clay 15-18%; Silt 32%; Sand 30%; and Aggregates 23%. There are different opinions regarding the best formula for making rammed earth structures. The ideal conditions of high quality earth and the right moisture content do not always coincide. Appropriate moisture content cause particles to become increasingly dense as the soil is compressed, and moisture levels are good if there is no dust being emitted by the pounding of the earth. If the soil is too wet, it will stick to the formwork or the tamping device.

The formwork used in the construction of rammed earth structures is designed to resist the outward forces created by the compaction of the soil. It also defines the structure’s shape and allows for the creation of openings or impressions in the earth structure. While traditional formwork may vary slightly around the world, it is generally constructed of wood, it is portable, and is typically light enough to be managed by one or two people. Portable formwork allows a builder to construct only small sections of the wall at a time, moving the form along the length of the wall and lifting it as the wall grows taller. In contemporary modern construction practices, the formwork used in rammed earth has become very advanced, through the use of steel-lined slip forms used in building concrete structures.

3.4 Compressed Earth Block

The modern compressed earth block (CEB) originates from the French architect François Cointeraux from Lyon. He saw building with earth as inexpensive and readily available. In 1803 he developed a mechanical press based on the traditional wine press to create a building module that he felt held the future for decent construction in villages. CEB had the versatility of a brick but the social, economic, and environmental potential of rammed earth. One of the most important moments of the compressed block machine in 1952 is the development of a manually operated machine by the Colombian engineer Raul Ramirez who was working for Centro Interamericano de Vivienda (CINVA), now popularly known as Cinva-
The popularity of CEB comes from their perceived superiority. In semi-arid countries of West Africa like Mali, Niger and Burkina Faso, CEB are employed for various institutional projects: schools and clinics. The capital required to procure the machine is expensive for individual household builders but is nothing compared to the investment required to produce sand cement bricks. To produce CEB requires very little moisture (water) which is rare in a dry country like Botswana. The precision of shaping earth in a steel mould results in a standardized product, and its sharp edges and smooth surfaces allow a CEB to be left exposed as a finish material. CEB does not need to be cured; it can be used immediately out of the machine. Some of the machines, such as those with a hydraulic press, require very little manual labour compared to that necessary to produce mud bricks or rammed earth. The ideal soil for CEB consists of (Rael: 2009) Clay 10-30%; Silt 15-25%; Fine Sand 15-35%; Coarse Sand 15-35%; Fine Gravel 10-70%. It is always recommended to include a stabilizer because the blocks are compressed only once in the press and the soil mixture does not bind completely, so the blocks must include a stabilizer to reach a higher compressive strength than adobe. The use of compressed earth blocks is ideal for institutional buildings. It requires some investment to acquire the machines, but these can be moved from one site to another.

Figure 6: A Primary School in Guinea, built with CEB

Figure 7: A Primary School in Burkina Faso built with CEB

Figure 8: An Institute in Burkina Faso built with CEB
4.0 Conclusions

Who can spearhead the promotion of earth construction?

To respond to this question, one needs to look at who is currently building using earth. There are three categories of groups involved in Earth Construction in the world:

a. Occasional Group which chooses earth for its qualities – either for ecological reasons or as a renewed tradition or even for commercial / exotic (tourism) reasons. These are people who are well informed of the properties of earth construction and although they can afford any building material, they choose earth for its qualities or want to be different from others and these are very few. In Botswana, there is the case of a businessman in Maun who had to struggle for almost six months before he could get the permission to build with earth! Earth is not one of the materials allowed in urban areas.

b. Government: Official Government Policy to promote local building materials for employment creation, or local research. This requires a robust and political leadership to put the message across. Ordinary people will follow if this is preached by the powers that be and social and community buildings (schools, clinics, offices etc.) are erected using earth. As indicated earlier, some governments in the Sahel (West Africa) are following this path.

c. Obliged Group which has no other choice due to financial constraints (no cost material) or as temporary structures (informal). This constitutes the majority of earth construction builders. This is the group that requires support and assistance from government to improve on the material (earth) as well as the techniques employed.

The image that its users have of earth construction and the way this image develops is a key factor in determining the way an entire population will use this material. As mentioned earlier, earth as a building material is all too often associated with the image of poverty and backwardness. Many of these perceptions prevent people from seeing the real potential of this material and put a brake on its utilisation at certain levels. The promotion of earth as a building material depends on political decisions regarding the savings to be made on energy and transport of industrial building materials. Governments and its cooperating institutions have an important role to play in the promotion of this material as they have the power to organise adequate ways and means of doing so – taking the necessary initiatives in terms of information, training, practical demonstration and research. In particular, the role of public authorities to facilitate the path to utilisation of earth through a range of measures including the introduction of appropriate guidelines and standards which do not hinder, but actually encourage its utilisation and to insist that financial institutions regard earth construction as durable and therefore give mortgages on buildings made from it.

But governments and official institutions cannot be left to make this effort alone; universities, building research centres, professional associations and all other non-governmental development organisations should contribute to this effort. A crucial step is to bridge the gap between the experimental use of earth in construction and its complete integration in the construction sector. The success of this material can be measured by the extent to which it is accepted by the construction industry. According to BADC (1985: 5), “In Indonesia, the stabilised block is sold like any other construction material and obeys the rules of the market. In Brazil, one can order earth block over the phone……. In New Mexico, it was estimated that in 1984, 15% of new housing used adobe stabilised with cement.”

During the HABITAT-United Nations Conference on Human Settlements in Vancouver (1976), much emphasis was put on the necessity to develop and promote building materials and techniques that are suitable for local conditions. Subsequently, the Commission on Human Settlements, at its annual sessions called attention to various issues relating to appropriate building technologies. In one of its resolutions, the Commission recommended inter alia, that governments stimulate research and disseminate findings on efficient methods of construction, low cost design and technology for infrastructure, and indigenous building materials. Earth Construction Technologies Appropriate to Developing Countries’ is one of the projects sponsored by HABITAT to promote earth construction. The project consisted of contributions made to the topic by independent groups either by research, or through publications, exhibitions or colloquia. It was the aim of the project to first define the potential for and constraints to earth as a building material, and secondly, to promote the use of earth in construction where desirable (UNCHS-HABITAT 1984).

5. Recommendations

In order to promote earth construction in Botswana, it is recommended to:

1. Establish a building research centre where various building materials (earth included) and techniques will be developed and tested before being propagated.
2. Include earth construction technologies in the curriculum of technical training colleges (brigades and technical colleges, etc.)

3. Amend the Building Regulations to allow some standards in earth construction to be used in urban areas. Currently, the Southern African Development Community (SADC) is working on joint Earth Construction Standard to be applied by all countries.

4. Use earth construction (rammed or compressed blocks) in institutional buildings especially in rural areas to create local employment as well as promote the material and technology.

APPENDIX 1: TRADITIONAL TSWANA HOUSING
(All Drawings: Larsson, 1988, 1996)
APPENDIX 2: CLASSIFICATION OF SETTLEMENTS IN BOTSWANA

(Based on the 1998 National Settlement Policy by Department of Town and regional Planning, Ministry of Local Government, Lands and Housing)

1. **Town** – An urban settlement which has been declared as a township by the Minister responsible. Botswana has 9 townships namely Gaborone, Francistown, Lobatse, Selebi-Phikwe, Orapa, Jwaneng, Sowa, Ghanzi and Kasane.

2. **Urban Village / Settlement [Major Village]** – A settlement with a population of at least 5000 people, with at least 75% of its economically active population engaged in non-agricultural activities. There are 26 urban centres of which 17 are declared planning areas. The 17 are: Palapye, Tlokweng, Lethakane, Serowe, Mahalapye, Maun, Molepolole, Kanye, Mochudi, Ramotswa, Moshupa, Tonota, Thamaga, Gabane, Mogoditshane, Bobonong, and Tutume.

3. **Villages** – A permanent settlement which has a population of at least 500 people but less than 5000, and is at least 15km away from another village, and has a gazetted tribal authority, sustainable water source, and is capable of supporting a commercial or industrial business.

4. **Cattle post / lands area / tourist settlement** – a settlement with less than 500 people.

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