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Adobe Technology - A Possible Solution to Urban Housing Problems in Ethiopia

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ABSTRACT

The general aim in a country like Ethiopia must be to improve the living conditions for people in general. A very important part of this development must be to provide ordinary people with decent, durable and affordable housing. There are different ways of obtaining this. To build dwelling houses according to the traditional way with walls consisting of a frame of timber covered with mud is one option. However, the increasing difficulty in many areas to obtain timber and a general shortage of durable and termite resisting timber species are serious drags for this option. Another option is to use more advanced building technologies such as concrete hollow blocks for the walls. However, in most cases this option is out of question because of a comparatively high costs and lack of materials. A third option, which is advocated by the authors, is the systematic introduction of adobe technology.

Keywords: Adobe, Low-cost Housing, Urban Environment, Sustainability

This paper describes a building technology, which properly developed and used, could significantly contribute to the well-being of many Ethiopians. The use of this technology can be regarded as construction for development.

1. INTRODUCTION

1.1 BACKGROUND

According to the Human Development Report (2005) Ethiopia is ranking 170 of 177 countries in the world. This low ranking reflects the poverty of and the harsh living conditions for a great majority of the people. It reflects, among other things, the low life expectancy at birth (47.6 years), the extremely low access to adequate sanitation (6 % of the population) and the very low access to clean water (22% of the population).

In order to improve this situation a number of important actions must be taken: improved health-care, improved and greatly enhanced access to clean water, improved and greatly enhanced infrastructure and increased educational efforts just to mention some.

One important part of this is to give Ethiopian people the possibility to obtain better housing conditions and by means of this get a better health situation. This is a need that can be identified all over the country; both in rural regions and in urban centres. This need shall be seen against the big, general problems that the country is facing. Of these problems a high population growth-rate, an increasing deforestation and an uncontrolled urbanization process can be viewed as the most severe, (Bielli et al 2001). These problems cause in their turn, independently or, even worse, in combination other problems and difficulties such as erosion and lack of suitable timber for construction.

1.2 AIM AND APPROACH

The aim of this paper is to present and discuss conditions and possibilities as regards introduction of new sustainable low-cost housing technology, adobe-technology, in an urban context in Ethiopia. This discussion is based on information obtained in the pre-study described below.

1.3 BASIS FOR INFORMATION – PRE-STUDY

This paper is based on the results from a pre-study executed in the years 2002 – 2005. The general aim of this pre-study was to collect information on which the planning of a major research project could be based. A major part of the pre-study was a field-study in Ethiopia. The following four methods have been used:

- Literature survey.
- Structured and spontaneous interviews. These were held mainly in Southern Ethiopia and in Western Ethiopia. With some exceptions

these interviews were held in the native language of the interviewed person. All interviews were recorded.
- Observations made in connection with study-visits to completed and ongoing low-cost housing projects.
- A minor specific study including ocular observations and interviews was made as regards dwelling houses in the town of Durame, the administrative centre of Kambaata. This town has about 20.000 inhabitants.

2. URBANISATION IN CONTEMPORARY ETHIOPIA

Ethiopia is one of the least urbanized countries of Sub-Saharan Africa. However, uncontrolled urbanisation is a highly visible problem of contemporary Ethiopia. According to Mulugeta and McLeod (2004) today about 17 percent of the Ethiopian citizens reside in urban areas, principally in the capital city of Addis Ababa. This city is one of the fastest urbanizing ones which mean that a rapid urban growth is occurring in Ethiopia. Unfortunately Ethiopia is a country with very small resources to meet the basic needs of the population in urban areas, Aseffa (2002). The flow of people from the countryside to the cities is accentuated in Addis Abeba. However, urbanisation is a reality also in minor towns. An uncontrolled flow of people from the countryside into the towns will very often result in deficient housing conditions.

An interesting prognosis is presented in Assefa (2002). According to this prognosis the total population of the country will be about 83.5 million in 2010 and about 129 million in 2030. The population in urban areas is according to the same prognosis expected to increase to about 14 million (about 17% of the total population) in 2010 and to about 30 million (about 23% of the total population) in 2030. These figures can be compared to information given in Mulugeta and McLeod (2004) saying that the population of Ethiopia today is about 71 million and that 17 % of the population today is living in urban areas.

The conclusion is that, if this development is not changed, during the coming 15 years the urban population of Ethiopia will increase with about 18 million individuals! This will be a formidable challenge to the Ethiopian society! As all these individuals have to be provided with housing that meets at least basic human needs!

3. HOUSING CONDITIONS IN URBAN AREAS IN CONTEMPORARY ETHIOPIA

From the information obtained from Aseffa (2002) and Mulugeta and McLeod (2004) and from the results from the detailed survey executed in

Durame and described in Hjort and Sendabo (2006) the following brief description can be given concerning urban housing conditions in Ethiopia:

- The most common roofing material is by far corrugated iron-sheet. A clear majority of the dwellings houses are not provided by a ceiling and the dominating floor material is stamped earth. The by far most common way of building walls are the traditional one, i.e. a core frame-work of timber covered on both sides with mud. Many times, in about 50% of all cases, these walls are not provided with foundations.
- The condition of many houses is very bad. A great part of them are in urgent need of repair if not of demolition.
- The basis for estimating the sizes of urban dwelling houses is very meagre. However, there is some information from Addis Ababa indicating that a majority of the urban dwelling units have areas less than 40 square meters. The result from the survey in Durame gave a somewhat different picture. According to this study more than 50% of the dwelling houses in Durame have a size of 71 m^2 or more.
- The average number of rooms per housing-unit is about 2 in urban areas. About one third of the housing-units have only one room and about three-quarter of the units have three rooms or less.
- The average household size in urban areas is about 4.6. The corresponding figure for Addis Ababa is somewhat higher; 5.2

4. BUILDING TECHNOLOGIES FOR THE FUTURE – ALTERNATIVES

4.1 GENERAL

From what has been said above it is obvious that the Ethiopian society is facing a formidable task in the future: to meet the needs of a dramatically increasing urban population. It must be the aim to provide this population with decent and reasonable living conditions as regards housing, water supply, sewage systems, infrastructure, electricity, waste-handling systems etc. The task is enormous and in this paper the discussion is confined to housing and housing conditions.

The aim must be to provide all strata of the urban population, also the stratum with very low income, with affordable and decent dwelling-houses. In addition to this, the houses must provide a healthy indoor-climate, they must be safe and they must be durable and sustainable.

In the following section different technologies are discussed on how to achieve this goal. The emphasis is put on adobe-technology, as the authors regard this technology as the most promising one for the future.

4.2 TRADITIONAL TECHNOLOGY

The traditional way of erecting a dwelling-house in Ethiopia is to use a framework of timber in the walls. Timber-poles with an appropriate length are put into the soil. The timber-specie mainly used, at least in the highlands, has been and still is fast growing Eucalyptus. However, in order to enhance the durability of the walls, some poles of more durable timber species, Thid (*Juniperus Procera Hochst*) and Kosso (*Hagenia Abyssinica*) have been used in the walls with a spacing of approximately 1000 mm. The framework is provided with a roof structure which most of the times is covered with corrugated iron sheets. This framework is later on covered with mud mixed with straw. One of the last steps in the process is to provide the walls with a "foundation". This is done by arranging a stone masonry around the outer walls. It is clear that this masonry actually is not a real foundation but protection of the lowest part of the walls. The timber core of the walls are in contact with the soil and can thereby be exposed to termite attack and decay caused by high moisture content.

This traditional technology has obviously advantages. The technology is well-known and accepted and the materials can to a certain extent many times be found locally. Dwelling houses that give a good indoor climate and that are reasonably durable can be erected if these houses are provided with a proper foundation, sufficiently long roof overhangs and, at least in the high-lands, gutters.

However, looking into the future, it is very doubtful if this technology should be used on a broader scale. There are two main reasons for this standpoint. Firstly, the traditional technology is very "timber-consuming". With regard to the current de-forestation in Ethiopia and resulting timber-shortage, now and in the future, it seems clear that an alternative technology must be used.

Secondly, the more durable timber species mentioned above, Thid (*Juniperus Procera Hochst*) and Kosso (*Hagenia Abyssinica*), that traditionally have been used in order obtain durable structures have been almost eradicated from Ethiopia; Bekele et al (1997). This has had, and will have, a serious impact on the possibility for ordinary people to erect dwelling houses with framework that could resist termite-attack and decay. The termite problem, which is underlined in Berhane (1984), seems to be a growing problem in Ethiopia

4.3 CONCRETE HOLLOW BLOCKS

One alternative to the traditional technology described above is of course to use ordinary concrete hollow blocks for walls in dwelling houses. Although this technology must be regarded as rather advanced in many parts of Ethiopia it has apparently spread into many towns and can be regarded as well-known, at least in major urban centres.

It is obvious that if this technology is used durable dwelling houses that offer a good indoor climate can be erected. However this is on the

condition that the ground conditions are suitable, that the building is provided with a proper foundation and that the walls are provided with reinforced concrete tie-beams and, in some cases, reinforced concrete columns. If all this is considered it is obvious that such a dwelling house must be regarded as rather advanced.

Even if concrete hollow blocks currently are manufactured locally in many urban centres in Ethiopia, this product cannot be regarded as a local material. As the cement is produced only in a few factories in the country, it has many times to be transported long distances. In addition to this it can be difficult to find sand, with a suitable grading and with a sufficiently low content of organic material, on the spot. Many times sand has to be taken from a river or from a lake rather far away.

The technology to use concrete hollow blocks for walls in houses is already an important technology in Ethiopia. It is reasonable to anticipate that its importance will be even higher in the future. However, it seems unrealistic to anticipate that it will be of a great importance as regards providing ordinary people in urban centres with proper housing. The reason is that it will not, in the foreseeable future, be “the property of everybody”. To erect a dwelling house with this technology will require special knowledge and special equipment and, above all, the cost will be comparatively high. The fact that cement is a key-material will be a major obstacle. The demand on cement at the Ethiopian market will be high for many years to come causing high price-levels for cement.

4.4 CEMENT STABILIZED SOIL-BLOCKS (CSSB)

Cement stabilized soil-blocks (CSSB) can be regarded as an alternative to ordinary concrete hollow blocks. Thus, what is said above about ground conditions, need of a proper foundation and need of reinforced concrete tie-beams and, in some cases, reinforced concrete columns, is applicable also for this technology.

If this technology is properly used durable dwelling houses that offer a good indoor climate can be erected. As regards the durability it can be mentioned that according to Asplund (1997), the first building erected with cement stabilised soil blocks in Ethiopia was a school building in Jinka, about 800 km south of Addis Ababa. This building, which was built in 1968, is still in use, and in good condition, although according to Andersson (2003) the walls were not plastered, either externally or internally. The walls were provided with reinforced tie-beams and the building had a normal overhang.

The CSSB-technology has, during the last years, spread in some urban areas, mainly in Addis Abeba.Selam Technical and Vocational Centre (STVC) was one of the organisations, which continued developing mud based building material. In view of Asplund (1997), this organisation is in the forefront in Ethiopia for cement stabilised soil blocks. STVC has

developed and is marketing both cement stabilised soil blocks and ordinary concrete hollow blocks. The first type contains 5% cement, 15% sand and 80% soil. The second type is made of 20% cement and 80% sand. Special equipment is used when producing both the concrete hollow blocks and the CSSB.

In order to successfully produce CSSB the access to suitable soil is crucial. It means soil with suitable petrographic composition, suitable clay-content, sufficiently low content of organic materials and suitable grading. This type of soil is probably not available all over Ethiopia. As the example above from STVC shows it may be necessary to add sand to the soil available.

The CSSB technology has been introduced on a somewhat broader scale in Ethiopia rather recently. It is reasonable to anticipate that this technology will be further developed in the future and it will be very important. However, it seems unrealistic to anticipate that it will be of a great importance as regards providing ordinary people in urban centres with proper housing. The reasons for this are the same as for ordinary concrete hollow blocks: a technology that will require special knowledge, skilled manpower and special equipment and, above all, a comparatively high cost linked to cement prices on the market.

4.5 ADOBE BLOCKS

The technology to use adobe blocks, i.e. to build walls in dwelling houses with sun-dried blocks made of mud, is not a traditional technology in Ethiopia. However, different attempts have been made and are being made to introduce the technology. An early attempt recorded in the literature is from 1954 when an elementary school building was erected in Alem-Maya in eastern Ethiopia; Nilsson (1954).Hege (1998) briefly mentions an attempt to introduce compressed soil blocks in the vicinity of the city of Nazareth in the beginning of the eighties and Wudenesh (2003) describes a similar attempt made in and around the town of Awasa. As regards ongoing projects a project in Challia in Western Ethiopia can be mentioned. This project is conducted by The German Hermansburg Mission and started about 15 years ago. Apparently the project has been successful as the technology seems to have been accepted by the rural people in the area.

In recent years what can be described as a spontaneous development of low-cost housing based on adobe technology has taken place in some parts of Ethiopia. During a field-study in late 2005 the authors observed the use of Adobe-blocks in Alem-Maya in eastern Ethiopia, in the towns of Nazareth and Dera in central Ethiopia and in and around the towns Meki and Zwai in central south-east Ethiopia. All the towns mentioned, except Alem-Maya, are situated in the Great Rift Valley, where there is a shortage of suitable timber for housing construction. It is

obvious that the technology has been accepted in these areas and that more and more people are using it.

In connection with the field-study mentioned above the composition of adobe-blocks was studied more in detail at some places. The results from these observations are presented in Table 1.1 which shows that the composition varies within a wide range depending on material available, and probably, depending on experience obtained.

Table 1.1. Composition of Adob-blocks. Ocular observation Hjort and Sendabo (2006)

Locality	**Basic material**	**Appr. size of block cm*cm*cm**	**Colour of block**	**Remark**
Challia	Red laterite soil*	20x20x40	Brown	Mixed with straw
Alem-Maya	Red laterite soil*	20x20x40	Red-brown	Without straw
Zwai	Sandy black cotton soil*	20x20x40	Black-brown	Mixed with straw
Langano	Termitary	20x20x40	Grey	Without straw

* Assumption

It is possible to erect durable dwelling houses with adobe blocks. The elementary school building erected in Alem-Maya in 1954 in eastern Ethiopia, see above, is showing this. The walls, which were founded on a stone-masonry wall, were plastered, presumably with lime-cement mortar. This building was used as an elementary school up to 1990, when it was converted into a dwelling house. At a study-visit at the place of this building in December 2005 it was noted that the walls of building was in a fairly good condition despite the fact that the roof overhang is rather short. This deficiency has apparently been compensated by the plaster on the outer surface of the walls. Although this building was repaired and maintained during the years, it clearly shows that such buildings built from adobe blocks can function very well and really be durable, if the walls are provided with a proper foundation and a suitable surface covering.

A dweller of this house stated that the indoor climate was good, Lemma (2005). He mentioned that, at daytime, when it is warm outside it is cooler inside the house. During the night it is warmer in this house compared to other houses erected according to the traditional technology. Corresponding information was obtained at interviews in Challia, Western Ethiopia, Kelbesa and Worknesh (2005). These interviewed persons who live in houses built with adobe-blocks argued that these houses have an indoor climate that is better than what houses built according to the traditional technology can offer. Other persons were expressing a similar view despite of variation in regions visited.

The cases referred to above show that durable houses with a good indoor climate can be built by a proper use of adobe technology. This

technology has many advantages: it is real low-cost, local material can be used to a very great extent and the "timber content" is very low. In addition to this the rather simple with no need of special equipment except some simple forms for block-making. The technology has really the potential to become "the property of everybody".

However, the technology has some disadvantages that must be over-come. These disadvantages are very much linked to the prevailing negative attitudes towards this technology. This issue has earlier been described and discussed by the authors. If the adobe-technology shall be widely accepted such phenomenon as reluctance towards a new building technology, risks of stigmatisation, feelings of insecurity and, finally, status-thinking must be taken into account and eliminated, see Hjort and Sendabo (2005).

When talking about adobe construction, its poor resistance to earthquakes is presented as a critical issue. In areas with high seismic activities such critical views are valid and need to be taken into consideration. In the Rift Valley of Ethiopia where earthquake activities are high, adobe buildings may face problem if not constructed well.

Against what has been discussed above it seems obvious that in the future adobe-technology can be of a great importance as regards providing ordinary people in urban centres with proper housing. The technology should be introduced on a broader scale. How this can be done is discussed below.

5. FUTURE DEVELOPMENT OF THE ADOBE TECHNOLOGY – A PROPOSAL.

5.1 OVERALL AIM - TARGET GROUP

The over-all intention must be to introduce adobe technology as a material for dwelling-houses for poor, ordinary people. Furthermore, the aim should be to introduce the technology in such a way that it can be accepted by ordinary people as their own technology; i.e. the dwellers should be able to construct their houses themselves. The aim should also be to introduce this technology in order to obtain dwelling-houses that are durable and sustainable and that offer a healthy indoor climate.

5.2 BUILDING -TECHNOLOGY

The adobe-technology should be used to erect dwelling houses with a low "timber content" by and large built according to the following:

- Foundation: natural stone with mud as mortar. Alternatively concrete hollow blocks could be used if this is advantageous from an economic point of view.
- Walls: adobe blocks
- Flooring: stamped mud flooring
- Roof structure: round timber
- Roof covering: corrugated iron sheets
- Ceiling: mud and round timber or other local material
- Doors and windows: of timber, locally fabricated

Special attention should be given to important details such as roof overhang, fastening of doors and windows, and roof-truss anchorage with regard to wind action. In zones with recurrent seismic activity precautions for this should be included.

5.3 DEMONSTRATION PROJECTS

To demonstrate the adobe technology for the public demonstration projects should be executed. The suggestion is that three urban centres are selected for this purpose. In order to test and demonstrate the technology in areas with different local climate and different soil conditions, these places could preferable be situated in the lowlands, e.g. in the Rift Valley, in the highlands and in a region with medium altitude.

After mapping-out available soil types at the three places, trial production of adobe-blocks with measurements about 20x20x40 cm should be executed. Based on the results from these test a basis for mix-design as well as production process can be compiled.

The next step should be to erect demonstration buildings. At this stage it is very difficult to specify realistic cost-levels and sizes of the dwelling-houses. However, based on the data in Mulugeta and McLeod (2004) from 1988 concerning Addis Ababa, stating that more than three-quarters of the dwelling-units had areas that were less than 40 square meters while those that had less than 20 square meters comprised about one-fifth of the total, the sizes/no of rooms presented in Table 1.2 could be used as a starting point. The proposal is thus that three dwelling-houses, erected according to the building technology described above and with three different sizes shall be erected at the urban centres.

Table 1.2. Proposed demonstration buildings.

Size (m^2)	**No of rooms**
45	3
60	4
75	5

By this the adobe technology will be tested in full scale which of course will give valuable information and valuable experience. In addition to this these projects will demonstrate the possibilities of the new technology for the public. Finally, the demonstration projects will act as very important references objects in connection with follow-up studies described below.

5.4 FOLLOW - UP STUDIES

The erected demonstration buildings will give opportunities to execute valuable follow-up studies. It is obvious that it will be possible to execute technical follow-up studies. Durability, indoor-climate, surface-coatings and design of important details are examples of important aspects regarding this. However, these demonstration buildings can also act as important reference objects in connection with studies regarding attitudes towards this new technology. By showing these buildings to ordinary people and by executing in-depth interviews with ordinary people, important factors could be analysed, Hjort and Sendabo (2005). The following factors can be mentioned: influence of tradition, cost-levels, security – protection, status and gender perspective.
In our view these follow-up studies, which include studies regarding applied technique and studies about attitudes of the local people, builders and government officials, could give a solid basis as regards a broader introduction in Ethiopia of urban dwelling-houses erected by adobe technology

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