Halmstad University
School of Business and Engineering

Low-Cost Housing for the Kambaata Region, Ethiopia

- A demonstration project for dwelling-houses

Final Project, Construction Engineering Programme
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-ett demonstrationsprojekt för bostäder

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Abstract

Low-Cost Housing Projects is an essential part in the line of developing sustainable solutions for the provision of shelter for ordinary people in the third world. In poor countries severe problems like population growth, uncontrolled urbanisation processes, deforestation and erosion are present as a result of misuse of all different kinds of resources; this is the fact also in Ethiopia. This degree project is a sub-project integrated in a larger research project at Halmstad University concerning Sustainable Low Cost Housing for the Kambaata Region, Ethiopia. The purpose of this sub-project is to plan and design two dwellings as when erected will serve as a demonstration project in Durame the main urban area of the Kambaata region. The houses will be constructed from the two suitable low cost building materials; Adobe blocks and CSSB (Cement Stabilized Soil Blocks).

Preface

This study has been made at Halmstad University with support from SIDA (Swedish International Development Cooperation Agency) as final project for our BSc degree in Construction Engineering at Halmstad University, spring 2008.

We would like to thank Halmstad University and SIDA for the opportunity and for the provision of sufficient funds to realize this project.

We also want to dedicate special thanks to our supervisor at Halmstad University; Bengt Hjort, our supervisor in field; Workene Hechamo who also together with his wife Hanna-Karin Stark Hechamo has served as our host at the Swedish Lutheran Mission in Addis Abeba. Great thanks also to Simon Schacht and Hermann Kruse at Building Trade School, Hermannsburg Mission in Challia.

We are also very grateful to all other persons who have contributed to our work by answering our questions, showing us around and welcomed us with very warm and hospitable attitudes.

Summary

Ethiopia is one of the poorest countries in the world. As most other developing countries Ethiopia struggles with a lot of severe problems such as a high population growth rate, deforestation with erosion as result and an uncontrolled urbanization process. The traditional way of constructing dwellings widely contributes to the deforestation process in the country hence it is very important to introduce sustainable building materials suitable for low income groups.

In this report two sustainable low cost housing materials have been studied; Adobe blocks and CSSB (Cement Stabilized Soil Blocks). Both techniques are very good and have the potential to replace the traditional way of building once they are accepted among people.

This degree project is part of a larger research programme at Halmstad University which among other things is aiming to erect two demonstration buildings in the Kambaata region in southern Ethiopia. The Kambaata region is a high density population area with a great need for low cost housing techniques. The demonstration houses will hopefully facilitate the implementation process of the unfamiliar building materials to the society by showing people the advantages they involves compared to the traditional way of building.

Our project has resulted in a full set of drawings and a cost calculation for two dwellings intended to function as demonstration buildings in the above mentioned research programme. The drawings and the cost calculation are mainly based on the observations we did during our seven week long field study in Ethiopia. During the field study we travelled around the country and visited a lot of places of interest and gained information both visually and orally.

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Definitions & Acronyms

Definitions

Ordinary people: Low income groups in Ethiopia which represents the majority of the people.

Traditional technique: The traditional way of building houses in Ethiopia

Adobe blocks: Equivalent to mud blocks containing soil, grass and water

CSSB: Cement Stabilized Soil Blocks, containing soil, cement and water

Bottle test: A simple sedimentation test to determine the suitability of the soil for the usage as soil based construction material

Acronyms

CSSB - Cement Stabilized Soil Block

GNP - Gross National Product

UN - United Nations

SIDA - Swedish International Development Cooperation Agency

NGO - Non Governmental Organisation

GIS - Galvanized Iron Sheets

ETB – Ethiopian Birr (currency)

SEK – Swedish Krona (currency)

1. Introduction

1.1 Background

Ethiopia is one of the poorest countries in the world. As most developing countries Ethiopia faces a lot of problems. Generally the main issues can be summarised by the following:

- A high population growth rate
- Deforestation with erosion as result
- Uncontrolled urbanisation

The burn-beating of the land to gain larger areas for cultivation and grazing for the livestock, the demand of firewood and the high timber content in traditional house building techniques in combination with the high population causes deforestation which in the long run leads to erosion of the land. The uncontrolled urbanization puts extremely high pressure on the land surrounding the towns and cities. There is not only one solution to these problems but among others there is a need for the development and implementation of different more sustainable and environmental friendly building techniques, suitable for low-income groups.

There are different techniques available that are suitable for construction of sustainable low-cost houses such as CSSB (Cement Stabilised Soil Blocks) and Adobe Blocks (mud blocks). Since these alternative building materials potentially could contribute to a better standard of living for people and counteract the environmental problems there is reason to continue, broaden and deepen the knowledge about these possibilities. Further research is not only needed as regards the actual building materials and techniques but also to map out people's attitudes towards the methods, the best way of implementation to society as well as regards realistic cost perspectives.

The Kambaata region is located approximately 300km south of Ethiopia's capital Addis Abeba. Kambaata is a high density population area and the pressure on the recourses of the land is constantly increasing but yet the deforestation and erosion problems are not as comprehensively prevailed as in some other parts of the country. It would be suitable to start working with the implementation of alternative sustainable building techniques in this area as soon as possible to prevent the spread of the problems. This study is part of a larger, since several years ongoing, research project at Halmstad University intended to result in the erection of demonstration buildings in Durame, the main urban area of the Kambaata region. [1]

1.2 Aim & Approach

The aim with this project is to plan and design two dwelling houses suitable for low-income groups in the Kambaata region in southern Ethiopia. The project has result in a full set of drawings for the two houses together with a cost calculation for the material needed. Since this degree project is part of a larger research project a further purpose is eventually that the two houses will be built on a site in Durame, the main urban area of

the Kambaata region. The two buildings will function as a demonstration project in the line of implementing alternative building techniques and methods in this region. It is important to keep the project as cheap as possible which means that every little detail has to be considered. Another aim with this report is to; to a lesser extent discuss people's attitudes towards alternative building techniques, why the technology is not yet wider spread and what difficulties lays in the implementation of different and unknown technologies.

Some fundamental issues that have been answered in this report can be summarised as follows:

- What advantages and disadvantages come with the low cost building materials?
- How should a house be designed to be suitable for low income groups in the Kambaata region?
- What details needs to be carefully considered to obtain durable buildings?
- What will a house with our design cost?
- What obstacles and difficulties lay in the implementation of sustainable low cost building materials into society?

1.3 Scope & Limitations

This project has comprised and excluded the following:

- The design and the planning of the houses shall be done in such manner that they are suitable for ordinary people, which means low-income groups in Ethiopia.
- Since previous studies have shown that Adobe blocks and Cement Stabilized Soil Blocks are the most suitable alternatives for low-cost housing, the study will only include these two techniques.
- The study will focus on wall materials and the durability of construction details.
- Research of alternative roofing materials will be excluded.
- No research on seismological issues will be carried out.
- The mapping of people's attitudes towards new building technologies will be limited to a brief introduction and discussion about the subject.

1.4 Methods

This report has primary been based on observations done during the field study in Ethiopia. Interviews with different people have been done during the trip to deepen the knowledge gained from the observations. A limited literature study has been carried out as well as a study of previous research and reports written about the subject. For the actual writing of the report a guideline in technical report writing has been used as an aid to structure the content as well as a Swedish-English dictionary.

1.5 Discussion & evaluation about the choice of methods & sources of information

Our first choice of method to gain information for this project was through our own observations during our field study in Ethiopia. The reason for this choice was that this project mainly aims to result in the design of two buildings intended for an on beforehand defined location and for a particular social stratum. With these preconditions we considered the observations to be the best method to bring about an as suitable and accurate result as possible for this particular region. We also wanted to gain information through interviews with local people in Ethiopia. We chose only to do a limited literature study on the grounds that it is difficult to find literature with narrow and relevant information for the purpose of our project. There is a lot of literature to be found about mud technology and earth construction and there are various reports on similar kind of projects carried out in different parts of the world, but we couldn't find that much written specifically about Ethiopia. The literature we found could from our point of view be used as general information and guidelines about the technologies and about construction in developing countries, but for our project it could not contribute to the detailed planning of the demonstration houses for the Kambaata region to the same extent as actual observations from the area.

It is important to evaluate all sources of information critically [11]. When you do observations you can be pretty sure that what you see is the reality and that it is true, but on the other hand one difficulty that should be mentioned with this choice of method is that it might be more of a subjective source of information than an objective. In all observations you do you bear the stamp of your own culture and frames of references in mind and you more than likely tend to include your own valuations into what you see. The same phenomenon applies not only to yourself but also to people you meet and talk to. It is also important to be aware of cultural issues while doing research in a different country. People might not always answer your questions veraciously; they might give you the answer they think you want to hear just to be polite or answer yes to a question instead of no to avoid being embarrassed. [14]

The main difficulty we met during our field study was the interviews. As the callow interviewers we are doing our degree project as first time research-workers, we discovered pretty soon that it was not as easy to make interviews as we had thought. No matter how well we prepared the interviews never turned out the way we expected. We quickly found that we almost got the same answers from everyone we talked to and that unprepared spontaneous conversations with people, when we appeared without pens, papers, voice recorders and cameras gave us a lot more valuable information than the prepared interviews. This fact made it difficult to exactly document our sources of information. Instead of writing down the conversations literally we made the decision to include most of the information as part of our observations. However we have carried out some proper interviews of which we have chosen to include two in this report, they can be read in Appendix C.

1.6 Structure & Layout of the Report

The structure of this report follows a general layout for a technical report at a Swedish University C level. Comprehensively the report consists of three parts;

- The **Initial Part** with title page, abstract, acknowledgements, summary, list of figures & photographs and list of definitions & acronyms.
- The **Report Part** consisting of an *Introduction* with background, aim & approach, scope & limitations, methods, discussion & evaluation about the sources of information & choice of methods and structure & layout of the report; a *Main Section* with more detailed accounts for theoretical, technical and practical background information, descriptions of the actual study and the planning and design of the demonstration houses; a *Result* with analysis & conclusions; and finally a *Discussion.*
- The **Final Part** with references and appendices.

The sources of information in the report are shown according to the Vancouver-system, where the references are stated as numbers in square brackets after each section of text. A list of references is found in the final part of the report. [11]

2. A brief view of contemporary Ethiopia

2.1 Geography & Climate

Ethiopia is a land-locked sub-Saharan republic situated to the northeast part of Africa, often referred to as the Horn of Africa. As the tenth largest country in Africa, Ethiopia covers an area of 1,133,380km², two and a half times the size of Sweden. Of the surface area, about 7500km² is covered with water. The Ethiopian Highlands is home to beautiful scenery; the geography of the country is dominated by a plateau with far-flung tablelands and deep valleys surrounded by mountains. The average altitude of the central highlands is 2000m with peaks of over 4000m. The country is divided by the 40 to 60km wide Central Rift Valley, which runs from the Red Sea in the north through the country towards southern Ethiopia, to continue through other countries further south. [2, 3]

Ethiopia is located in the tropics but due to the significant differences in altitude there are wide climate variations in different parts of the country. The central highlands have a pleasant climate with an average daytime temperature of 16ºC, the western lowlands gives you a tropical feeling; moist and hot while the eastern lowlands and the far south are very dry and hot. In the north and the central parts of the country the bulk of the rain falls between June and October. Further south the rain starts earlier than in the highlands, while some parts of the country have two rainy seasons. Most parts of the Ethiopian highlands receive a healthy average rainfall figure. Basically the whole plateau gets above 1000mm of rain per year, in the western parts of the country the precipitation figure can be the double; up to 2200mm annually. In the north and the eastern parts the climate is much dryer. The amount of rain can vary a lot from year to year and in times of drought the low-lying eastern parts of the country are extremely vulnerable and famine is likely to occur. [2, 3]

2.2 Population

Year 2005 the population of Ethiopia was estimated to around 70 million people. The population growth rate is very high; the number of people increases with approximately 2.75% annually. With this amount of people Ethiopia holds the second largest population in Africa, beaten only by Nigeria. Ethiopia is a federal republic today consisting of nine states. Officially there are 64 recognized ethnical groups in the country but nobody knows exactly how many there really are. However two thirds of the population belongs to any of the two largest ethnical groups; the Oromo and the Amhara. The majority of the people live in the countryside, mainly in the Highlands where the ground is fertile and the precipitation is good. In the capital Addis Abeba lives today approximately 3 million people. As all other urban areas in the country Addis is rapidly growing due to an uncontrolled urbanization process. More than 50% of the population in Ethiopia is under the age of 16 and the average life expectancy is 45 years of age. This is primarily due to victims of AIDS and Malaria and to an infant mortality rate of 10%. The level of education is low; the adult literacy stands at around 35%, but the situation is getting better since the government puts a lot of effort into the issue. [2, 3]

2.3 The economic situation

Ethiopia is one of the poorest nations in the world and for most people everyday life is a constant struggle to survive. The annual income per capita was in the late 80's estimated to US$120 and the increase over the years up until today is unlikely to be significant. The land is depending on financial assistance and loans from other countries. Corruption is common but is to some extent prevented since financial aids have been diverted from federal to local levels. The current government is aiming to open up the economy to let the free market contribute to a better economic situation. The last years of economic growth have increased the inflation to about 20%.

The mainstay in the Ethiopian economy is the agriculture which stands for almost half of the GNP (Gross National Product) and occupies approximately 80% of the working population. The cultivation is in most cases run as small self-sufficient family farms and every little accessible piece of land is being used. The agriculture is very old-fashioned and extremely sensible to disruptions like drought which easily leads to failure of the crops. For local consumption the main crop grown is teff; a grain used to make injera, a type of sourish pancake eaten in many Ethiopian meals. Coffee beans are the largest export product; it accounts for 55% of the exports. Exports of cut flowers, oil plants and the drug chat are also large. In some parts of the country, especially out east, many of the coffee plantations are being replaced by the growing of the mild legalized drug because it tends to generate more profit than the coffee. Since the methods of farming the land is very primitive the productivity of the agriculture is extremely low. There are great potentials for better earnings but investments that could increase the productivity and the dividend are being restrained as long as the government owns the land. With exception for areas in the east and the northeast parts of the country, the land is criss-crossed by large rivers and is home to several great lakes with enormous untapped potential for irrigation projects. In addition to the introduction of modern machines and irrigation the land would need to be fertilized.

The country has a great amount of undeveloped natural resources like minerals, salt, metals and coal. Oil and natural gas has also been found, but no one knows how large the reserves are. However one of the most important natural resource in Ethiopia is hydroelectric power. This source of energy was earlier not used at all but over the resent years a rapid development has taken place.
The industrial sector in Ethiopia is small and the underemployment is great. The industrialization is slowly under development due to collaboration with foreign investors. The lack of proper infrastructure also holds back the development but large investments are currently being done to make improvements on this matter. [2, 3]

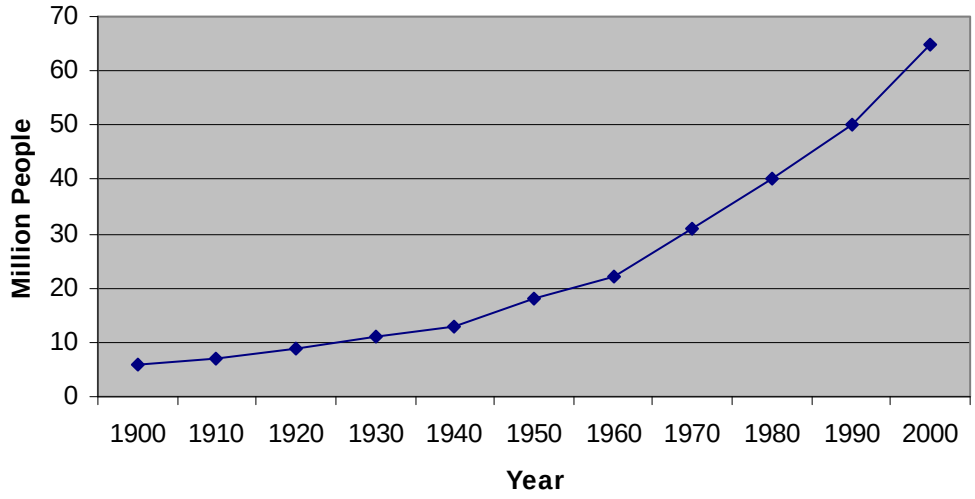
3. Fundamental problems – well known but still growing

3.1 An overview of problems relating to this project

Ethiopia was according to UNDP's annual Human Development Report 2007/2008 rated as the 8th poorest country in the world [13]. The development of Ethiopia is ongoing but the steps forward are slow since the problems in the country are severe, furthermore they are also complexly interlinked and very difficult to solve. A list of problems could be long but the issues that can be directly related to this project can be described as follows:

- *High population growth rate*
  The population in Ethiopia is growing with a trend which is in the closest to exponential. Figure 1 bellow shows an approximate graph of the development of the population growth during the 20th century. Basically every little corner of the country is crowded and the overpopulation is causing heavy degradation of the land. According to a prognosis presented in 2002 the total number of people in 2010 is estimated to be 83.5million and 129million after an additional period of 20 years. This will result in a formidable and intolerable situation. Hand-in-hand with a growing population the demand of firewood and construction timber is increasing. [1]

Figure 1. *Approximate increase in population over the 20th century.* [1]



- *Uncontrolled urbanisation process*
  The ongoing uncontrolled urbanisation process is also a huge problem in Ethiopia. Many people from the countryside move to the cities in the hope of getting a better standard of life. They often have little or no awareness at all of the fact that the odds of succeeding are very small. Such extensive urbanizations more than likely result in deficient housing conditions in the cities and an overall decrease in living standard. [1]

- *Deforestation resulting in erosion*
  The vegetative cover of Ethiopia has dramatically changed over the last hundred years. In the beginning of the 20th century 40% of the total land area was covered by forest, today that figure is down to about 3%. As the population is growing the need for better crops and larger grazing lands for the livestock, the demand of firewood as well as the need for timber as building materials for house structures is increasing. Since the consumption of wood is exceeding the rate of possible re-growth, deforestation is caused. As the result of human intervention in the nature degradation occurs and eventually this leads to erosion of the land. [9, 12]

- *Lack of education and means of communication*
  The lack of education and by that also the difficulty to adopt new ideas and solutions is a big problem. Many children do not have the ability to attend primary and secondary school. Villages in the countryside still do not have supply of electricity or access to means of communication. Because of this the societies are very isolated and the spread of knowledge are slow. Lack of knowledge in combination with an extremely conservative way of thinking creates a heavy barrier in the line of implementing new thoughts and ideas, for example alternative building materials. [5]

- *Termites*
  Even things that at a first thought can seem like a minor issue can turn out to have severe consequences. Termites cause great damage to materials and structures that comes in their way. The ants feed themselves on cellulose and they attack the already vulnerable houses and decrease the lifespan of the timber structures even further. Eucalyptus which nowadays normally is the only available type of tree for house construction has generally a very low resistance to termites. [9]

3.2 The construction impact

As mentioned above the high timber content in the traditional house building technique in combination with the effects of the population growth rate and the termites destroying materials, the present “construction culture” is not sustainable for the future [1]. It is well known from other contexts that concrete with its’ content of energy bulked cement not really is an environmental friendly solution either. Both due to environmental reasons and to the fact that concrete are too expensive for low income groups in Ethiopia, the dependency of products containing cement should be minimized. On the contrary to what we know about concrete; it might be difficult to realize how such an inartificial way of building as the traditional Ethiopian method involves can affect the environment and people’s wellbeing to such a comprehensive extent. With the awareness of these issues other solutions must be found to be able to obtain sustainable housing for ordinary people. [5]

4. Previous research

4.1 Various low-cost housing projects

Low cost housing projects have been carried out in Ethiopia for a long time by different countries and organisations, with greater or lesser success. The oldest project we have been in touch with is a house that was erected, built with the Adobe technique, as early as 1954 by the Swedish Lutheran Mission in eastern Ethiopia; see section 6.1 in this report. The German Hermannsburg Mission has run Adobe technology projects mainly in western Ethiopia for about 20 years where the technique has been adopted by people in rural areas. Various attempts have also been made in parts of the country to introduce CSSB and it seems like this material has been accepted but are mainly used for projects of a more costly character. [1, 5]

4.2 The main research project at Halmstad University

For the Kambaata region no major attempt has yet been made to introduce low-cost housing technologies prior to this one. The main research project was initiated in 2002 by Bengt Hjort, professor at Halmstad University in Sweden together with two of his colleagues. All three project members have close connection to Ethiopia and possess great knowledge and experience from the country. Initially the project was more comprehensive than today consisting of five sub-projects; an initial survey; the development and testing of new house building technologies; the erecting of demonstration projects; mapping out the attitudes towards new house building technologies; and the preparation of guide-lines and recommendations for implementation programmes. This degree project mainly belongs within sub-group three in the main project; the erecting of demonstration houses, but also to some extent deals superficially with sub-group four; Attitudes towards new house building technologies. The progress of the main research project has however been unnecessary slow and the initial plan has not been possible to follow mainly due to lack of sufficient funding. [1]

4.3 Field studies

The field study carried out in connection with this report is the fourth one done within the main sustainable low cost housing project for the Kambaata region. The first and the second one were done in 2002 and 2003 by students at the Construction Engineering programme at Halmstad University as minor field studies executed it connection with their degree projects. The first one was aiming to investigate different building materials as alternative to the traditional technique. The second study comprised the projection of a school building for the Kambaata region. The suitability of the soil in Durame for the production of Adobe blocks was also tested with a positive result. The third field study was done in 2005 by the directors of the main project. That study was aiming to map out the current situation in the context of low cost housing in Ethiopia. Ongoing projects as well as individual initiatives to construct dwellings with sustainable low cost housing methods were studied. The result of all three of these studies has shown proof of the

feasibility of the technology and has strengthened the conviction that the area of research is both relevant and essential. [1]

5. The Kambaata region & the need for low-cost housing

5.1 Current situation in the region

The Kambaata region is situated 300km to the south west of Addis Abeba. The region is a high density population area with around 1million people on an area of approximately 1.200km². [1, 19] The large population put high pressure on the recourses of the land which in the long run leads to severe impacts of both the environment and the health and welfare of the people. The number of inhabitants is constantly growing and the need for jobs and education is huge; in 2002 the rate of unemployment in the region was 85% [9]. Most families live in the countryside where they support their living through cultivation and livestock activities mostly to the extent of a self-subsistent household level. Many people from the countryside migrate to the cities with the hope to find jobs. The main urban area in the region is the town of Durame, today with around 20.000 inhabitants. [1, 5]

In Kambaata the growing population is the fundamental problem, in the same way as in other parts of the country, but the problems with deforestation and erosion have not yet become too extensive. As shown in picture 1 below the landscape, even though it's very dry at this season, still looks healthy with a mixture of groves and tilled land.

Picture 1. *The deforestation is not yet severe in the Kambaata region.* [5]

In contribution to the strain on the land the region also suffers from severe termite problems. [1, 5]

5.2 The importance of low-cost dwelling projects

As earlier mentioned, several low-cost housing projects are run in different parts of the country, but for the Kambaata region no major attempt of implementation has yet been made. Today the people almost entirely build their homes according to the traditional technique. Since the area, despite the high stress from the amount of inhabitants, so far is relatively well preserved it is of great importance to start the work with the introduction of alternative building methods in the region. If the implementation starts immediately a wide number of problems can be reduced or even prevented. The advantages with the alternative building technologies are many and will easily contribute to a better standard of living for people and to a better environmental situation. The idea has been met with positive attitudes from local authorities in Durame; there is no doubt that changes needs to be done. [1, 5, 19]

6. Minor Field Study

6.1 Objects studied & Observations made

To gain information to this project we spent seven weeks in Ethiopia. During these weeks we travelled around the country and got to visit plenty of good sites of interest to our project. Below is a summary of the places we have visit and what we have studied there.

- ***Addis Abeba***
  Our first visit of interest was Selam Technical and Vocational Centre in the outskirt of Addis Abeba. Selam is a centre which pursues child care for orphans, education, vocational training and development of appropriate technology. The technical and vocational centre provides shorter and longer courses within different subjects at college level among them, courses in Building Construction. The training is directly involved in production. For the construction sector the popular building material CSSB is manufactured. It was very interesting to see the production process and to see the blocks which are an excellent result of a fantastic technology. Picture 2 below shows hydraulic manufacturing of the blocks. Tools for manual production are available for purchase at the centre.

Picture 2. *Hydraulic manufacturing of CSSB at Selam Technical and Vocational Centre in Addis Abeba.* [5]

The finished blocks are being sold and it seems like CSSB have become a popular construction material. Several finished buildings and running construction projects using the blocks can be observed in and around the city. One aspect that is good from an enterprising point of view is that the blocks have become rather expensive, but when the material becomes too expensive the technique is no longer available for low-income groups as long as people don't choose to produce their blocks on their own manually.

In Addis we also had a look of another project using CSSB but of less relevance to low cost housing. It was however interesting to see the usage of CSSB and how a great result can be achieved even with cheaper technologies. We visited a project where a company was erecting luxury one family houses, later to be sold to private owners. Both external and internal walls were built from CSSB within a structural framework of reinforced concrete. [5]

- ***Durame***

  Durame is the main urban area in the Kambaata region. It is in this town the result of our project, the two demonstration houses, are intended to be built. In Durame we attended a meeting with the local authorities in order to discuss the possibilities for the project and the attitudes towards the idea. The project has earlier been presented to the authorities and the outcome of this meeting was that they have a positive approach to the idea of implementing alternative construction methods in the area and that there might be a possibility for the government to provide the project with a suitable plot. To apply for permission to go through with the project and for further investigations considering the obtainment of a plot, a detailed description of the project must be submitted. Another requirement to get permission to go through with such project is that a sustainable long-term project management plan is established for the whole lifespan of the buildings. Such project plan should state how the project will be run after completed construction, containing information about for example financial support, responsible organisation, intended use and maintenance duties; the project must have a formal responsible "Project Owner". However, everybody attending the meeting did agree to the fact that low cost housing methods are extremely important for a sustainable development of the Kambaata region. [5, 19]

  While we were in the Durame area we also visited the local primary and secondary school shown in picture 3 below. The buildings, which were built in traditional technique, were only three years old and they were already completely worn out. This was an interesting and evident example of unsuitability and how resources are being wasted due to lack of knowledge.

Surprisingly enough the school buildings had a very well done foundation and there were nothing wrong with the roof construction. With a bit of effort from the community and with the contribution of some “know how” and a small amount of money, proper school buildings made of mud blocks could easily be erected on the excising foundation and with the reuse of the iron sheets and trusses as roofing. [5]

Picture 3. *This school building is only three years old.* [5]

- ***Ambo***

  Ambo is a town located about 100km to the west of Addis Abeba. In Ambo we met with a representative for a company called LEM Ethiopia which is an Environment and Development Society of Ethiopia. The society was established in 1992 and deals with voluntary activities as entering into partnerships with communities, schools, civil societies, national and international NGOs and governmental institutions in projects working on environmental and natural resources conservation and promotion of alternative technologies aiming to involve the noble ideas of sustainable development and livelihood security into everyday action [15].

  During the visit in Ambo we had a look at two different projects. The first one was a demonstration project for dwelling houses where five semi-detached houses had been constructed. Each part of house intended for one family consisted of three rooms. Kitchen and toilet buildings were separately located next to the main residences and shared by two families or more. The houses were built of Adobe blocks on a concrete foundation and with roofs of corrugated iron sheets. The outside of the mud block walls were plastered with cement mortar. [5, 16]

  The second project we visited was an ongoing school building project in a village some kilometres outside of Ambo. Also this building was being constructed with Adobe blocks on a foundation walled up from natural stone and cement mortar and with iron sheets as roofing material. The project was pretty lavishly planned to be a low cost project; the building had a robust concrete

structure, was almost completely plastered with cement mortar both externally and internally and had a nice suspended ceiling. However, it is very important for the durability of a school building to be properly constructed and the result as shown in picture 4 and 5 below looked very good. Even in more costly projects like this, large savings can be made through the replacement of in cast concrete or concrete hollow blocks by Adobe blocks as walling material.
This project was run by LEM Ethiopia, supported by funds from the Japanese government. [5, 16]

To the left: **Picture 4.** *The performance of the building is very accurate.* [5]
Above: **Picture 5.** *Internally the walls are plastered half ways to protect the sensitive surface of the Adobe blocks.* [5]

- ***Building Trade School – Challia***
  Almost two weeks of our stay in Ethiopia we spent at BTS (Building Trade School) located just outside a small village named Challia about 500km west of Addis Abeba. BTS is a school providing education and handicraft training in different fields like wood work, metal work, mud block technology and pottery. The training is provided free of charge for people from the lowest income groups. One month's training is given in all fields but also a longer education lasting for one year is available. The activities on BTS are financially supported partly by the selling of goods produced in the workshops such as furniture, tools and bricks, but partly also by funds from the parent organisation the German Hermannsburg Mission. The school is well established, it has been running for over 40 years and it has provided the local village with among many other things several job opportunities like teachers and managers for the educational activities as well as full time jobs in the workshops. The mud block project at BTS started around 20 years ago and it has resulted in the spread and usage of the technology in the surroundings. The first years the implementation programme for the mud house building project included a payment of 500birr (312 SEK) to the house owner for each finished mud block house. BTS also provided the ones who wanted to build a house with sufficient training and a tool-box with all tools needed for the construction free of charge. This idea was later discontinued since the Mission thought it was morally wrong to pay people to change form traditional house building techniques to mud blocks. However, through the years many mud block houses have been constructed and many projects are currently

running by initiative from the local people themselves, but as an evidence of conservative thinking, sceptic attitudes and lack of ability to adopt unknown things into the society also traditional houses are still after all these years being built in the vicinity. It shows the difficulties it involves to make changes, no matter how needed they are. [5, 17, 18]

Picture 6. *One of the mud block houses at BTS.* [5]

On the compound as well as in the surrounding village a lot of mud block houses could be studied. One example of a very nicely performed mud block house is shown in picture 6 above. The mud block training involves some theoretical studies but is mainly based on practical training which means there is always some project running at BTS or in the surroundings. During our stay at BTS we had plenty of time to study all important details we needed to gain information about to be able to design our demonstration buildings. We also got the opportunity to live in a house made of Adobe blocks which means we ourselves can certify the positive properties the material possess related to indoor climate. [5]

- ***Alemaya***
  450km to the east of Addis the small town of Alemaya is situated. In Alemaya the Swedish Lutheran Mission erected a house built with mud technology as early as 1954. We met up with the headmaster of a closely located school who showed us the old house. The house as can be seen in picture 7 below is built on a proper masonry foundation. All walls, both external and internal, are built from Adobe blocks with no other means of structural support. The roof is made from wooden trusses and corrugated iron sheets. Both externally and internally the walls are fully plastered with cement mortar which is of high importance for the durability of the house. This house is an excellent example of the sustainability of the Adobe technology when preformed in a proper way; the building has been used as a school for over 40 years. Today half of it is used as a private one

family home and in the other half lectures is still being hold in certain subjects as sewing and computer knowledge. [5, 20]

Picture 7. *The 54 year old house in Alemaya, will it stand for another 54 years?* [5]

6.2 Interviews & Spontaneous conversations

The informative observations, interviews and spontaneous conversations we have faced during our time in Ethiopia have widely contributed to the chosen design of the demonstration houses. Our observations in field is the fundamental base for this project and spending time in the environment intended for the project has affected us and inspired us in ways we are both aware and not aware of. The observations have been essential to get a grip of the reality in Ethiopia and with that set out we have then been able to gain deeper knowledge and understanding for the important issues related to our project.

A small selection of the oral sources which has contributed to our project work either through spontaneous conversations or interviews or in some cases both of the two, will be briefly be described below. Two of the interviews are shown word by word in Appendix C.

- *Project coordinator, LEM Ethiopia*
  On our way to Challia we met up with a representative for LEM Ethiopia in Ambo. The man told us that the Adobe technology projects had started in the region by German voluntary service around 1986 and that the spread of the technique has been successful especially in the northern parts of the Showa province. Schools and several demonstration houses have been built where the residents have got training. 10 days courses in mud block construction are held for local people were also women get training. This was the man who later showed us the Adobe block projects in and around Ambo as described above.

- *A German voluntary worker*
  At the Building Trade School in Challia we got to spend a lot of time together with a German military servant who has chosen to do his service as voluntary development worker instead of joining the army. During our stay he showed us around and gave us a lot of useful information about the ongoing projects at BTS. At that time he had been in the service for 9 out of 15 months. It seemed like he had gained a lot of knowledge about the realities of development work without being blind to its defects and he gladly chaired this information with us.

- *Manager at BTS*
  During an interview with the head manager for the mud technology training at BTS we were told about the manufacturing process of the adobe blocks. He told us about the preparation and mixing of the soil, binders and water, about the fermentation process and the importance of maintaining the blocks during the drying. He also told us about how to construct durable foundations out of mud blocks. He explained that they had had mice problems with foundations made of natural stones bound with mud mortar. The conclusion BTS had made from that experience was that the best solution was to use natural stone in combination with cement mortar or else construct the whole foundation from mud blocks. [22]

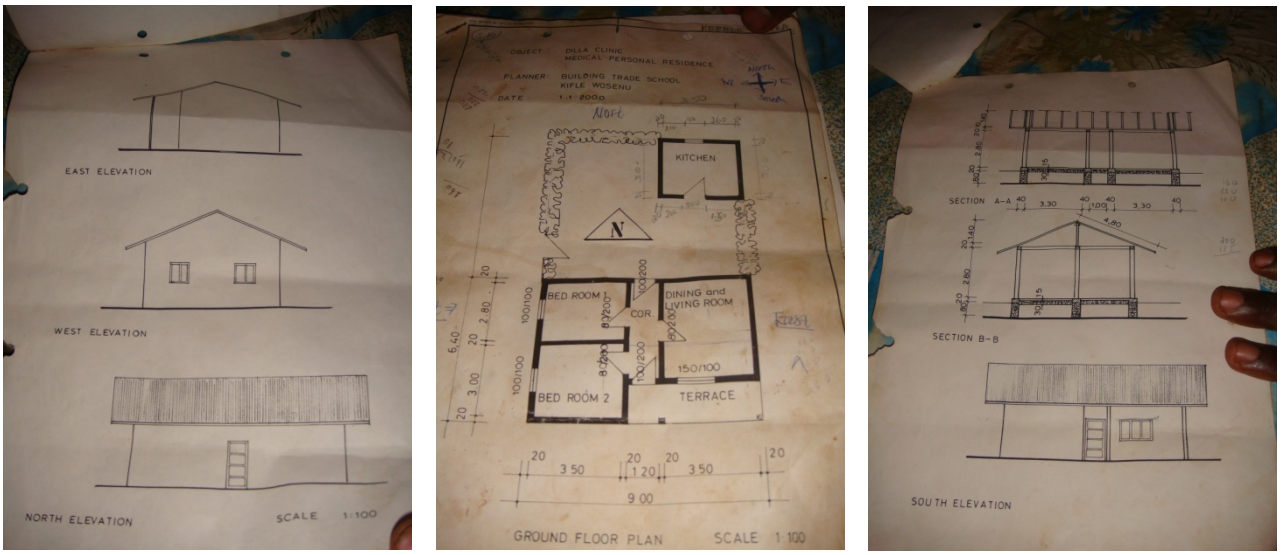
- *Private mud house builder in Challia*
  A very valuable interview was done with a man currently building a private mud house together with his brother and his family. The man was currently studying at Medical Laboratory College but five years ago he graduated from the 1 year vocational course at BTS. After finishing this course he has been involved in several private mud house construction projects in the vicinity. His brother chose to build his house with mud technology because of several reasons among them that it is an easy way of constructing, it is a cheaper alternative than the traditional method and since the materials are to be found naturally on site and by that there is no need for costly and hard transportations. Normally the transportation of water for building projects is a big problem for the people. Usually it is carried out by human labour or by the help of donkeys and is both costly and tiring but in this case the builders are lucky since they have water available on site. The most expensive part of a house is the roof and the price of iron sheets are constantly increasing. Three four years ago the price for one sheet was 45birr (28SEK); today it is between 65 and 70birr (41 – 44SEK). The total cost for a normal sized mud block house approximately lays between 6000 and 10000 birr (3747 – 6245SEK).

  Talking about foundations the house builder clearly states that a foundation made out of natural stone and cement is far too expensive for ordinary people. In this area no stones are available which means that on top of the cost for the actual stones the price of transportation needs to be added and besides ordinary people don’t have any means of transportation for disposal. A foundation of natural stone also needs cement, sand and a skilled person to construct it. The man who talks from his educational knowledge and his experiences says that a

foundation made of mud blocks works good if it is accurately protected from water. This is done by extending the roof to create an overhang of about 1m and to make the ground around the house to sloop so the water is led away from the foundation.

We also showed him the primal sketches and thoughts of our demonstration buildings which he “approved” as good ideas. It was very useful to get to discuss our ideas such as roof construction, wall plastering and floor planning with a person who could represent our intended end users.

After the interview he showed us around on the site were his brother’s new house is under construction and he also invited us to his own house, an older but very well maintained house built with traditional technique, to show us the drawings of the new mud house. The accurate drawings are shown in picture 8, 9 and 10 below.



Picture 8, 9, 10. *Drawings for a mud block house in Challia, made by the house builder himself who is a former student at BTS.* [5]

The main house will contain bedrooms and a living room. Kitchen and toilet will be constructed on the yard outside. The toilet will be constructed according to traditional principles; a 10m deep hole will be dug out and then a house will be built on top.

The attitudes towards mud constructions from local people in his surrounding and in the vicinity of BTS and Challia are according to his opinion very positive. [21]

- *Project Manager at BTS*
  During a conversation with one of the project managers at BTS we got a comparison between living in a traditional house and an Adobe block house. The project manager had as most other people in Ethiopia grown up and lived in a traditional house. Some years ago he built his own mud block house. He

affirmed that it was a great advantage to live in a mud block house than in a traditional one in terms of indoor climate. He explained the mud block function related to the thermal mass theory which explains how the indoor climate is kept cooler in daytime and warmer at night. [23]

- *Head Director at BTS*
  We had a long interview with the Head Director at BTS who told us about the history of the Hermannsburg Mission in western Ethiopia and about BTS and its development over the years.

- *Mud Technology Student*
  A student from Dembidolo, attending the one year long training programme at BTS expressed the situation of attitudes towards mud technology. He said that he himself as well as people in his home district were very sceptic to the idea of building with mud. His view point had however changed since he started his course at BTS. He was hoping to bring his newly gained knowledge back to Dembidolo after finishing his course and hopefully be able to convince people in his surrounding about the advantages of the mud block technology. The student also showed us around in Challia on various ongoing private mud block house building sites. What we saw on some of these projects was unfortunately that enough care wasn't taken in important details such as accurately separating the organic top soil from the construction soil and to cover and protect the drying blocks from sunlight to prevent cracking. This was later explained by the manager at BTS as a result of lack of knowledge among people who haven't done any training in the field or just of negligence to what they have been taught. This will of course affect the result and durability of their houses. [5]

- *Head of primary school in Alemaya*
  At our visit in the old Adobe house in Alemaya we were shown around by the principal for the local primary school. He was very positive to the Adobe technology and was telling us the whole story about the old house. He pointed out details of importance; what had been done in terms of reparations and maintenance and which details of the house for example the windows that today 54 years later still was original and well functioning.

The outcome of and the knowledge gained from the oral sources are used in many sections of this report. Many of these sources with exception from those clearly defined, are included as part of our own observations.

7. Traditional dwellings – Chika houses

7.1 The method of construction

In most parts of Ethiopia a traditional house or hut has a circular shape; a common traditional hut is shown in picture 11 below. The huts are in most cases constructed straight on the ground with walls of timber structure covered with mud. The roof is normally a thatched roof; a wickerwork of grass or straw. Many houses today have a rectangular shape instead of a circular and the roofing material has in most places almost completely changed into the use of corrugated iron sheets but the method of constructing the walls and foundation is still the same.

Picture 11. *Traditional dwellings in the vicinity of Durame.* [5]

Any preparatory ground work or particular foundation work is normally not carried out when a traditional house is being constructed. According to normal practise the house is built straight on the existing ground without any removal of the organic topsoil. The structural timber poles in the external walls are dug into the ground without any protection from subversive processes. Traditional practice is to, after the completion of the house, dig out the soil surrounding the perimeter of the house both internally and externally and fill it up with natural stone. This creates a better and more durable foundation of the house; however this last step of the construction process is more than often being neglected. [1, 5, 9]

7.2 Problems with the Traditional technique

The traditional way of house building in Ethiopia is very poor. Even though the traditional technique have advantages, for example that the initial costs are pretty small which make it affordable for low income groups, the disadvantages are unfortunately exceedingly dominating. The high timber content in the traditional houses is a great problem which has several side effects; one is that it contributes to the deforestation. As

a result of the deforestation due to the dramatically growing population and the increased demand of timber, durable kinds of wood like Tid and Kosso are nowadays almost entirely exterminated from the country. Left as building material is the fast growing low resistant eucalyptus tree. The usage of low resistant wood for construction purpose creates a vicious circle; the consumption of wood increases further which leads to an even faster deforestation process with land erosion as result. In most parts of the country termites is a severe problem. The termites attack the wood in the walls which accelerate the destruction of the houses even further. Another disadvantage worth to mention is the often draughty indoor climate due uncompleted plastering of the walls or to neglected maintenance. Living in draughty houses increases the risk of getting sick. [1, 5, 9]

8. Alternative building materials

8.1 General

There are several alternatives to the traditional way of building private residences in Ethiopia. It would be wrong to still call the alternative methods “new building materials” as many technologies are well known since decades back in time and the knowledge and usage really should have spread more up until today. In this project the focus lays on two environmental friendly alternatives suitable for low-income groups; Adobe blocks and CSSB. The knowledge about the technologies is today adequate enough for full-scale usage. More in-depth descriptions of components, mixture and manufacturing than are being explained in this chapter can be obtained in the previous project “Low cost housing for the Kambaata Region Ethiopia - a demonstration project” by Johan Carlsson and Joakim Gustavsson 2003. [5]

8.2 The Adobe Technique

The first appearance of an Adobe block might not give you a confidence inspiring impression. The technique is very simple and the blocks look pretty much like an amateurish slipshod piece of work, but in fact Adobe blocks are an excellent building material. Naturally, both the manufacturing process and the construction of the buildings need to be carried out with care and accuracy to deliver a satisfying result. Picture 12 shows a pile of Adobe blocks ready to be used in the above mentioned school building project in Ambo. [5]

Picture 12. *Adobe blocks to be used at the school building project in Ambo.* [5]

8.2.1 Components & Mixture

The components of an Adobe block are simply soil, binder and water. However not any type of soil can be used; it has to be a mixture consisting mainly of sand and clay. The ideal building soil is not found straight on the ground surface; organic soil is not suitable and has to be removed from the area. Underneath the organic top layer a strata consisting of different kinds of soil are found. Most soils are likely to be found mixed together rather than completely segregated. It is not necessary to make any complicated or costly soil tests; quite a lot of information about the suitability of the soil can be found out just by simple tests. The result of a bottle test done during the field study carried out in 2003 has shown that there is suitable soil available in Durame, the intended area for this project. Most soils do not function as construction material only by mixing them with water. To remedy this issue a binder has to be added to the mixture. As binders different kinds of grass and straw can be used as well as others like cow dung or material gained form termite-heaps. For this project the most suitable binder would be grass from the local crop Teff since it is known as a good binding material and also available in the area. [4, 5]

8.2.2 Manufacturing Process

The manufacturing process of the Adobe blocks is very simple, though it might be mentioned that the actual work is physically hard. First the organic top soil has to be removed and the construction soil has to be dug out. The soil has to be properly pulverized in order to be mixed accurately with the binding material and to be able to thoroughly soak up the water. If grass is used as binding material this has to be chopped into pieces by some sharp edged tool; the length of the fibres should be between 1 and 30cm. When the fibres are evenly distributed in the dry soil an adequate amount of water should be added. The mud is then pugged, easiest done by people or animals treading the components together with their feet. When the mud is sufficiently mixed it should be left in the pit for a fermentation process to start. The fermentation increases the abilities for the ingredients to bind together and through that the structural properties of the finished block will be higher. After about one week the fermented mud is normally ready to be shaped into blocks. The only necessary tool for this is except for a pair of hands a simple mould made of wood or metal. Picture 13 below shows a wooden mould.

Picture 13. *A mould used to shape the Adobe blocks.* [18]

The stiff mud is squeezed into the mould and then turned out to cure and slowly dry. The drying of the blocks is a very important part. To minimize cracks to arise care has to be taken to dry the blocks slowly and not expose them to direct sunlight. The blocks can easily be protected by plastic sheets or leaves. Normally the drying takes around one month. Picture 14 shows freshly made Adobe blocks which later will be covered up.

Picture 14. *Recently made Adobe blocks at BTS in Challia.* [5]

The blocks can be made to any size but if made too big they will be too heavy to handle. A block made from the mould in picture 13 has the dimensions 14x20x40cm and weighs about 15kg when completely dried. If the blocks are made of good soil and produced and dried with the highest accuracy, the method of construction can be used for two or even three storey houses. [4, 10, 22]

8.2.3 Advantages & Disadvantages - a comparison with the Traditional Technique

The advantages with the Adobe technology are many. The following is a list of advantages and disadvantages as a comparison to the traditional construction technique.

Advantages

- **Low in cost.** First of all Adobe blocks are perfectly suitable as a low-cost building material since it is a very cheap alternative, cheaper than the traditional technique. The soil is free of charge once a plot is obtained, straw as binding material is likely to be found to a reasonable price. The cost for water is variable depending on the supply and distance of transportation.
- **Simple.** Except for the low costs the method is fairly simple. With a small amount of training any healthy person is able to learn how to prepare the blocks and how to put them together into a simple but functional building.
- **Comfortable.** Once the house is built the occupiers can enjoy an indoor climate which is more comfortable than in a traditional house or hut. The Adobe blocks have better thermal properties than the materials in a traditional wall, which

means a better capacity to gain and release heat slowly. During the warm days the Adobe wall gains heat to then slowly release it during the night. In the morning the blocks have became cold and will contribute to a cooler indoor climate during the day.

- **Healthy.** Considering health and well-being, living in an Adobe house is better than living in a traditional house. Since an Adobe wall is more hermetic than a traditional wall the people living in the house will be exposed to draught to a lesser extent which will help to prevent illnesses.
- **Durable.** If the Adobe technique is preformed and maintained in a proper way it is a very durable construction material. It is also resistant to termites.
- **Flexible.** Another advantage to be mentioned is that Adobe is a very flexible material. The blocks can be prepared in different sizes and shapes, depending on the intended use. Two story buildings can be erected.
- **Available.** The soil for making the blocks is normally already available on site which saves a lot of work and transportation costs.
- **Fireproof.** Mud doesn't burn which means it is safer than a traditional house with high timber content.
- **Low energy input.** The production requires very low energy input which makes the material environmental friendly.
- **Strong in compression.** The material is in relation to its content of ingredients strong in compression strength.
- **Sustainable.** Soil based construction materials are sustainable for the future and counteract severe problems like deforestation and poverty.

Disadvantages

- **Poor water resistance.** The main disadvantage with soil based construction materials is its poor ability to resist water. This can however in most cases be overcome by simple solutions and good workmanship.
- **Brittleness.** Another disadvantage is the materials' brittleness as regards seismological issues. This can be overcome with further research in simple preventive solutions and by accuracy in performance.
- **Low in tensile strength.** The tensile strength is poor but it is not a big problem since constructional solutions allow for such materials to be used.
- **Poor resistance to abrasion.** The resistance to abrasion is poor; it requires maintenance and protection from animals. [5, 8]

8.3 CSSB – Cement Stabilized Soil Blocks

CSSB, as shown in picture 15, can be very nice with the impression of a high quality construction material also based on simple methods. The properties and the looks of the material achieve a high standard but it involves a more complicated production process and increased costs. Different types of blocks are available. Some block types are mason together by lime mortar while some types are directly interlocking with no need for mortar in between. CSSB can be suitable for low income groups if manually produced

by the users themselves. The technique requires nevertheless some pre-knowledge about for example soil types, grain size and cement content to attain a successful result.

Picture 15. *The appearance of a CSSB wall. This wall is constructed of interlocking CSSB hence no mortar is needed.* [5]

Most of the advantages and disadvantages listed above are also valid for CSSB. [5, 8]

8.3.1 Components, Mixture & Manufacturing Process

The components in a CSSB are soil, cement and water. The resulting strength of the block is depending on various things like type of soil and its content of certain clay minerals, the distribution of the grain sizes, cement content and density. The preparations for the producing of CSSB require accuracy. After the soil has been dug out it has to be crushed and then screened to separate the different fractions. When the soil is pulverized and mixed into suitable proportions of grain sizes right amount of cement should be evenly spread over the loose soil and dry mixed before water is added. The cement rate is normally recommended within the span of 5% to 10%. The production process then continues by pressing the mixture in a block press. Both hydraulic and manual block presses can be used, however a hydraulic press is expensive and needs propellant hence it is only used for large scale manufacturing. A manual block press also implies a relatively high initial cost but can be suitable if a whole community contributes to a joint purchase. The hydrating and curing process of the shaped blocks takes about one week while the blocks have to be protected from exposure to sunlight and needs to be regularly watered. A proper curing process is essential for the structural qualities and should be carefully looked after. When cured the blocks shall be kept stored for drying in a rain protected storage space for at least four

weeks before use. Picture 16 shows the storage of CSSB ready to be sold at Selam Technical and Vocational Centre. The cost for one CSSB manufactured at Selam is currently 4.14 birr (2.60SEK) which is not much cheaper than the price for a concrete hollow block. [5, 8, 24]

Picture 16. *Storage of CSSB ready for construction at Selam.* [5]

9. Attitudes, Implementation & Spread

9.1 Attitudes

When working with projects in developing countries around the world it is of high importance to gain knowledge and understanding of cultural and social factors of the environment you are active in. Among designers and builders these factors unfortunately often seems to be forgotten or tends to be the last ones considered. Through the years it has become apparent to development workers that local peoples' attitudes and scepticism towards different and for them unknown solutions are a severe obstacle in implementation processes whether it concerns construction, agriculture or other areas. This matter of fact of course also applies to Ethiopia and to the implementation of sustainable low cost housing materials. When it comes to the design of a demonstration building one of the fundamentals is to take influence of and carefully consider local traditions and everyday life of the intended end users; it is decisive to achieve a successful result. [5, 6]

Regarding the implementation of soil based construction materials some difficulties and obstacles relating to attitudes of the people can be stated as follows:

- *Conservative thinking*
  The development in Ethiopia is slow and most people's lives are restricted to the duties that everyday life requires of the individuals to survive. This makes ordinary people pretty isolated and the possibilities to widen their frames of references are very limited. Due to facts like these many people in Ethiopia have an evident conservative way of thinking and a retrospective pattern of behaviour as remarkably counteract attempts to introduce alternative building materials.

- *Lack of knowledge and adoptability*
  The difficulties are not only caused by a conservative way of thinking but as combination of that together with the lack of knowledge and of ability to adopt different unfamiliar things into life people easily condemn a method without even trying it.

- *Stigmatization*
  Pre-convinced ideas and spreading of rumours have resulted in the stigmatization of alternative soil based construction methods as low qualitative building materials.

- *Status*
  Even within very poor society structures a widespread hierarchy exists. Working and building with clay and mud has a low status in Ethiopia and for many people this creates reluctance and affects the choice of house building method. Living in a house almost completely made of mud is closely related with poverty.

- *Security*
  Another prejudged opinion about mud houses among ordinary people is that they should be an easier target for burglary and theft since the mud not has the same

hardiness as wood. People tend to think that just by splashing some water on the house it will fall apart. This is of course not true; it is a matter of how well the building is constructed.

- *Protection*
  People are also afraid that a mud house is less protected in case of an earthquake compared to a traditional one because of the brittleness of the mud material. However it is clearly shown that it is not the material on its own, whether it is mud, concrete, timber or other that is the problem in earthquake situations. The main cause of damage is often the way in which the material has been produced or used in construction; hence it is possible to greatly reduce the risk of disaster by pretty simple means.

With knowledge of factors like such described above we get an understanding of the importance of creating awareness among the target groups and the inclusion of action plans stating how to convince people about different ideas in the initial stage of a development project. [1, 5, 6, 7, 17]

9.2 A small report on the spread up until today

Many projects with different approaches to the house building issue have been carried out through the years with more or less successful results. During our field study in Ethiopia we have seen positive results of soil based construction technology projects but putting it into the perspective of time the spread is unfortunately fairly slow especially when thinking of the rapid growth of the problems connected to the existing house building system. Below is a short statement of our experiences of the spread of the technologies:

- *In Addis Abeba*
  In Addis Abeba we have not seen any spread of the Adobe technology but in the contrary to this we have seen a great spread of the CSSB as material for both smaller and larger buildings as well as fencing material. [5]

- *West of Addis*
  We have seen that in western Ethiopia; in and around Challia, in Ambo with surroundings and in the northern parts of the Showa province where low cost housing projects have been actively present for over 20 years the spread of the technologies are ongoing. We even heard a very positive example of one farmer in a pretty isolated valley outside of Challia who had set up a private enterprise within consulting and construction of Adobe houses for others in the surroundings. It should be mentioned as a great advantage that the spread has already started in these regions, though it in the fare west of Ethiopia still exists large lush forests and the erosion is not yet a big problem. [5, 18]

- *South of Addis*
  Along the Central Rift Valley south from Addis Abeba and as far as down to Lake Langano with surroundings we have seen houses built from Adobe blocks. The reason for the development in this area might be that the deforestation is

almost complete and the inhabitants are simply left without any choice but building with mud. If this is the case it is very unfortunate that people should have to be forced by nature itself before they change their ways. The area has a lot of termites and the material from their nests has a very good function as binder in the mud blocks instead of for example grass. It could be seen that this binding material had been used. [5]

- *East of Addis*
  Travelling eastwards in the country we were very surprised that the usage of natural stone as construction material was not used to a greater extent since there in large areas were a substantial surplus of stones. Around the city of Harar the mud block technology is spreading. Between Alemaya and Harar a place could even be seen where permanent manufacturing of Adobe blocks for selling purpose was running. [5, 20]

A positive thing that we have reflected on from what we have seen of those building mud block houses in the western regions is that the houses built are often much larger and have more rooms than a traditional house. The ability to afford larger houses with this technology might be a positive contribution in the spread of the Adobe method. [5]

10 Planning & Projection the Demonstration Houses

10.1 General

The pre-study together with the field study of this project have except for this report resulted in a full set of drawings for the two dwelling houses with belonging kitchen and toilet building, intended as a demonstration project for the Kambaata region. A cost calculation has also been prepared. The planning and later the projection of the two dwellings have gradually grown and taken shape during the time spent in Ethiopia. In this chapter the thoughts behind the design and the cost calculation is explained as well as important technical details considered. The drawings and the cost calculation are shown as appendix A and B.

10.2 The Design

When working out the design for the demonstration buildings of this project we had certain aims. Primary we were aiming to, with a different construction material, come as close to the traditional design of a dwelling as possible. The price of the houses shall be suitable for low income groups. It should be designed in such manner that it will have high durability which means that certain details have to be considered more than once or twice. One of the most important parts is to design the buildings so that ordinary people can identify themselves with them. It should not be too simple neither too complicated; people has to get convinced that the method could suit them particularly.

10.2.1 The main buildings

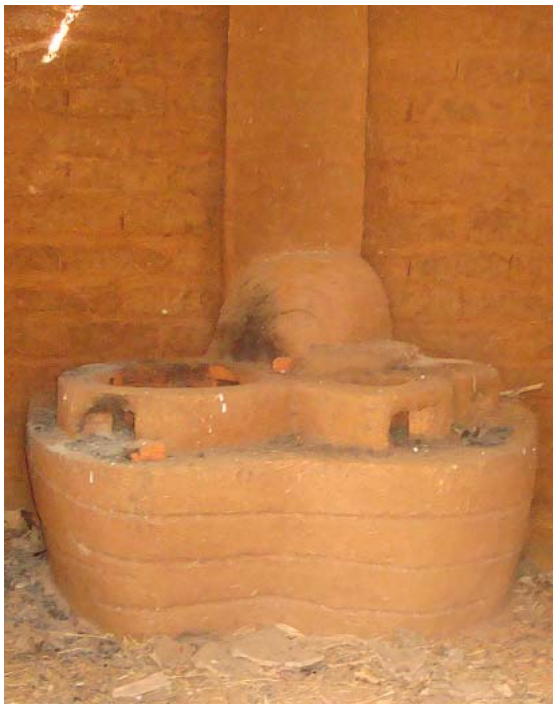
The main building consists of two identical dwellings, one constructed from Adobe blocks and one from CSSB. Both houses will be constructed on a foundation of natural stones and cement mortar. External and internal walls will be constructed in the same way with the same material, Adobe blocks respectively CSSB. The roof trusses will be made of eucalyptus with iron sheets as roofing material. Doors and windows will be of wood, hopefully to be found locally produced.

A traditional circular hut is normally not separated into any rooms but the squared houses we have visited, both traditional and mud block houses have been divided into smaller and larger rooms. Therefore the floor plan of the demonstration houses will be divided into two smaller rooms likely to be used as bedrooms and one larger room for working or fraternizing. The division separating the two smaller rooms from the larger will be along the centreline of the house and the total area will be approximately 26m².

10.2.2 Kitchen building

The kitchen will be placed in a separate simple little house next to the main buildings. It is designed according to demonstration kitchens worked out at BTS in Challia with a stove which can be made out of bricks and mud. As shown in picture 17 below the stove

will facilitate the cooking and at the same time reduce the consumption of firewood as the different hobs are interlinked so that the heat will be utilized more efficiently.



Picture 17. *Stove in a mud block kitchen at BTS made of bricks and mud.* [5]

The kitchen will be built with the Adobe technology with wooden door and window and iron sheets on eucalyptus trusses as roof. The foundation of the kitchen building will be made of mud.

10.2.3 Toilet building

Toilet facilities will also be placed outside the main buildings in a separate house. It will be built according to normal procedures which involves digging a hole around 10 to 15 meters deep and then place a building on top of it. The house will be built in mud block and with the same kind of roof as the other buildings. The foundation wall will be constructed of natural stone and cement but the floor covering the hole will be a wooden construction.

10.3 Important Details

To achieve a high quality performance and to create a durable building it is very important to pay particular attention to details. Different solutions need to be carefully considered without making them complicated. Accuracy must be the guiding-star in all construction! A list of details we have specifically considered in this project is stated below.

- *Foundation and belonging works*
  The foundation for both the CSSB house and the Adobe house will be made of natural stone and cement mortar. This is a durable solution but it makes the whole project considerably more expensive. The floors will have a 50mm thick surface out of cement mortar hence it is important to facilitate the possibilities of cleaning the floor properly as the buildings will serve as official demonstration houses.

  The foundation for the Adobe house has however been discussed back and forth. There is accordingly one optional solution; a simple foundation made of mud blocks. The reason why we would like to construct the foundation of mud blocks is because we would like to show people how it can be done in a correct way and that it actually can be done with good durability if performed right. A natural stone foundation is in most cases to expensive for ordinary people why it according to our opinion should have been better to show a demonstration project which actually is affordable for them. The discussion resulted however in the solution that the kitchen building gets a mud block foundation.

  Whether built of natural stone, Adobe blocks or any other material it is important to lead any water away from the foundation. This will in this case be done by an inclination of at least 1:20 around the houses and possibly also prepare a small ditch around the house depending on what kind of site will be obtained. [7]

- *Details of the roof*
  An important detail is the securing of the roof to the walls. Due to the lifting forces arising by the wind the roof has to be properly fastened. This is, as shown in picture 18, done by tying a thick reinforcement wire through the wall and up around the beams holding the roof trusses. This should be done around the house along all external walls at a distance of 1.5m.

Picture 18. *The roof is being secured to the house with reinforcement wires.* [5]

The roof plays an important role in protecting the sensitive mud block or CSSB walls against the rain. To make this protection sufficient there has to be a certain extension of the roof; an overhang. On a house built with the traditional technique normal practise is to have an overhang of about 0.6m. On a block house with mud foundation an overhang of about 1m is required to achieve sufficient protection. A good example of a well functioning roof is shown in picture 19 bellow.

Picture 19. *The oldest mud block house in Challia. This roof has protected this house for the last 19 years. The inclination and the ditch protecting the foundation from water are also to be noted as well as the fence surrounding the house keeping livestock out of the yard.* [5]

Since iron sheets are expensive and a whole meter of extended roof around the house might support the scepticism among the local people in Kambaata we have chosen a way in between; these demonstration houses will have an overhang of 0.7m. As compensational protection we will plaster the external walls with cement plaster from the ground and up to 1m around the house, this will according to our believes and to other persons we have asked be enough to protect the walls.

- *Fastening of doors and windows*
  To be able to fasten the doors and windows accurately in the walls pieces of wood must not be forgotten to be inserted in the door and window openings at the same time as the walls are erected and the mortar still is soft.

- *Ceiling*
  An internal ceiling helps to keep the indoor climate cool during hot days. Since women in Ethiopia are very skilled in handicrafts made of grass and suchlike our idea was to use some wickerwork of coarse grass or twigs as internal ceiling.

Looser wickerwork of pegs plastered with mud from the top can also be used; only the imagination set the limits!

- *Plaster*
  When a mud house is erected it is important not to neglect the finishing. All mud block walls needs to be completely plastered to get a protecting layer against wind and weather. Mud plaster is fully sufficient but cement plaster is of course more durable. As shown in picture 20 the appearance of a well plastered mud block wall can be very good. All walls need to be accurately plastered even internally.

Picture 20. *Accurately plastered mud block wall.* [18]

The demonstration house built of Adobe blocks will fully be plastered with mud plaster with exception from the lowest external parts which will be plastered with cement mortar to a level of 1m from the ground. The cement plaster serves to protect the walls against rain as we chose not to extend the roof more than 0.7m. To get the cement plaster to stick onto the mud block wall a thin net will be fastened before plastering.

The CSSB house will externally be plastered with cement plaster to the same extent as the Adobe block house. The rest of the external exposed surface will be painted with varnish. Internally the walls need to be plastered with cement mortar from floor to ceiling.

- *Paint*
  To further protect the walls of a mud block or a CSSB house they can be painted. Whether the demonstration houses shall be painted or not is to be determined at a later stage.

- *Fence*
  Since the majority of all livestock in Ethiopia is kept loose it is important to prevent them from rubbing their backs against the houses. The easiest way of protection against wear due to animals is to provide a fence around the house and then make sure no animals are in the yard. The result of having animals around the house is shown in picture 21 below.

Picture 21. *Damage due to animals rubbing against the house.* [5]

By reason of this we prescribe a fence to be erected around the demonstration house.

10.3.1 The importance of maintenance

A house is not, as many people seem to think, a thing you build which will then last forever. A house needs care as most other things do hence the importance of maintenance needs to be harped on the same string over and over again. When it comes to houses built of soil based construction materials especially two practical maintenance advices can be underlined. The first one is to maintain the inclination and the ditch around the house to be sure no water access the foundation. The second one is to continuously mend damage due to wear like scrape offs on corners and such like as shown in picture 22 to the left. [5]

Picture 22. *Damage of the mud plaster due to fair wear and tear.* [5]

10.4 Drawings

A full set of drawings is provided in Appendix A. The drawings are complete with details and explanations.

10.5 Labour

We have chosen to exclude labour costs in the cost calculation. When the demonstration project will be built it will probably involve local unskilled persons from the Kambaata region who will participate in the project to learn the mud block technique. This presumption makes it hard estimate the time needed for the completion of the project and by that also difficult to prepare a cost calculation of the labour costs. Of course some skilled workers need to participate both during the production of the mud blocks and during the actual erecting of the buildings. Whether these skilled persons will be local people or voluntary foreigners are to be determined later. The cost for a skilled construction worker working approximately 10 to 12 hours per day is currently between 35 and 50birr (22 – 31SEK) per day. This is on the grounds of oral sources in Ethiopia presently involved in the construction business. [24]

10.6 Cost Calculation

The cost calculation shown in Appendix B consists of a priced bill of quantities, which is prepared based on the drawings made. The prices in the cost calculation are acquired in Addis Abeba. Travelling around Ethiopia we have clearly found that the prices of some building materials increase the farer away from the capital you come. This is due to the fact that the majority of materials produced in the country are manufactured in Addis Abeba with surroundings and the transportation costs are simply added to the goods. Some materials for this project needs to be obtained in Addis while some can be purchased locally in Durame with surroundings. The cost for the water mainly consists of transportation costs; to minimize this cost the construction should preferably be carried out strait after the rainy season when the access of water is good. Costs for transportation are included as an approximate lump sum. The quantities of the materials in the cost calculation are including wastage with a rate of 10%. The cost for the stove for the kitchen will be excluded since the prescribed stove only is a proposal and needs to be determined by the users of the houses. Internal doors for the main buildings are not either included at this stage because it is not a necessity but the door openings will be facilitated for future instalment. Due to the high inflation rate in Ethiopia the cost calculation needs to be revised prior to the intended construction of the demonstration houses. Subject to this, the cost calculation in this report only serves as a guideline for the future continuation of the project. [5]

A summary of the estimated costs are as follows:

Breakdown:	ETB	SEK
Adobe house	9,739	6,082
CSSB house	20,138	12,576
Kitchen building	3,833	2,394
Toilet building	1,655	1,034
Total sum:	35,365	22,086

11. Concluding Discussion & Recommendations

The main conclusion of our work is that the need for sustainable low cost housing in Ethiopia is very large. The traditional way of building is intolerable and has to be changed. The report also shows that there are suitable low cost housing techniques available to provide ordinary people with shelter in appropriate ways. The advantages that come with low cost building materials presented in this report outweigh the disadvantages by far. A house built of Adobe blocks or CSSB can be performed in exactly the same way as a traditional house and among other things provide a more comfortable and healthy indoor climate.

We think that the erection of demonstration buildings is the best way to implement unfamiliar house building techniques into society and a way to overcome the skepticism among ordinary people.

Furthermore we think that our drawings provide a good basis for the start of a demonstration project in the Kambaata region. However further considerations can be made especially as regards the price. As the cost calculation shows the CSSB house is twice as expensive as the Adobe house which leads us to the conclusion that the Adobe technology is the most suitable alternative for low income groups. It is very important that the price of the houses really is affordable for the intended end users. As one way to save costs we can recommend to substitute the prescribed foundation made of natural stone and cement to a foundation made of Adobe blocks or CSSB.

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[16] Ato Zerinon Torza, LEM Ethiopia, March 2008

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[18] Hermann Kruse, Head Director BTS, March 2008

[19] Ato Gebrechristos Nuriye Dolebo, Durame Authority, March 2008

[20] Ato Esaias Shenkor, Primary school Principal, Alemaya, March 2008

[21] Ato Kedebe Olika, House builder in Challia, March 2008

[22] Ato Fedesa, Manager BTS, March 2008

[23] Ato Elias, Project Manager BTS, March 2008

[24] Ato Workene Hechamo, March 2008

Observations

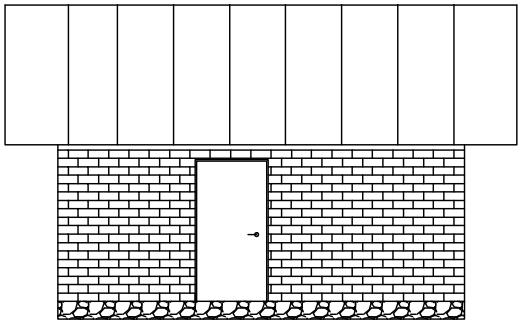
[5] Wartanian & Johansson, Minor Field Study, Observations done in Ethiopia between 21st of February and 9th of April 2008

[14] Minor field study course, Gothenburg University, February 2008

Appendix A

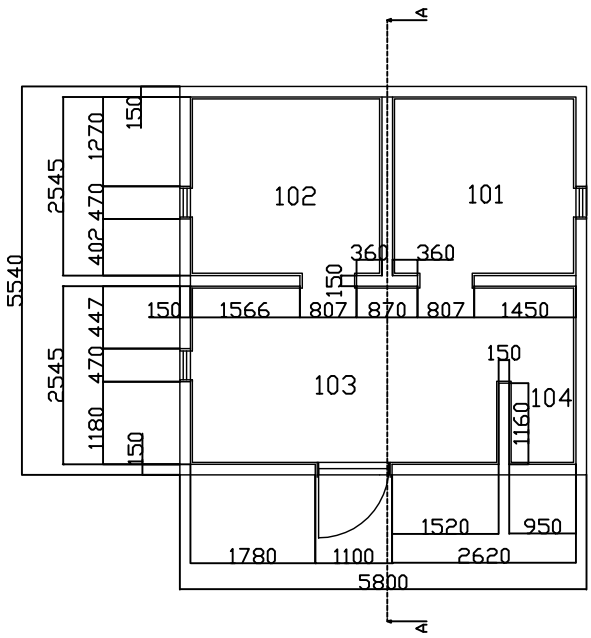
Drawings

Cement stabilized soil block house



Legend

No.	Room Description	Area [m2]
101	Children's chamber	6,7
102	Parent's chamber	7,0
103	Living room	11,2
104	Storage	1,1



Legend of materials

☐ Load bearing walls, cement stabilized soil blocks dim. 290x150x120 mm

Notes:

Indoor walls are covered with cement plaster by a thickness of approximatly 10mm

Chamber rooms have the option for door installement if so needed by the dweller

Demo. project: CSSB and Adobe soil block dwelling house

Facade North side and Typical floor

By: Raffi Wartanian, Ann-Charlotte Johansson

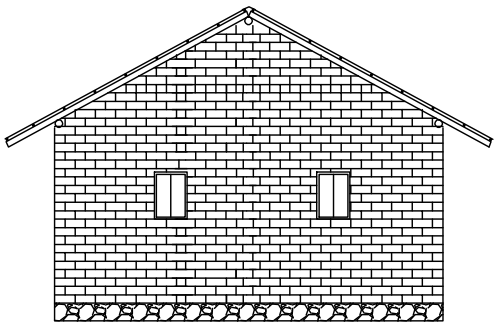
For: Högskolan i Halmstad

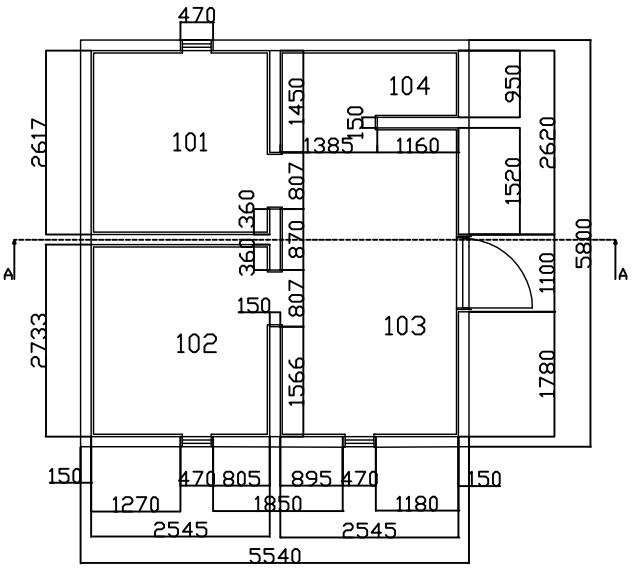
Scale: M1:100

Drawing nr: 001

Year: S 2008

Cement stabilized soil block house





Legend

No.	Room Description	Area [m2]
101	Children's chamber	6,7
102	Parent's chamber	7,0
103	Living room	11,2
104	Storage	1,1

Legend of materials

☐ Load bearing walls, cement stabilized soil blocks dim. 290x150x120 mm

Notes:

Indoor walls are covered with cement plaster by a thickness of approximatly 10mm

Chamber rooms have the option for door installement if so needed by the dweller

Demo. project: CSSB and Adobe soil block dwelling house

Facade West side and Typical floor

By: Raffi Wartanian, Ann-Charlotte Johansson

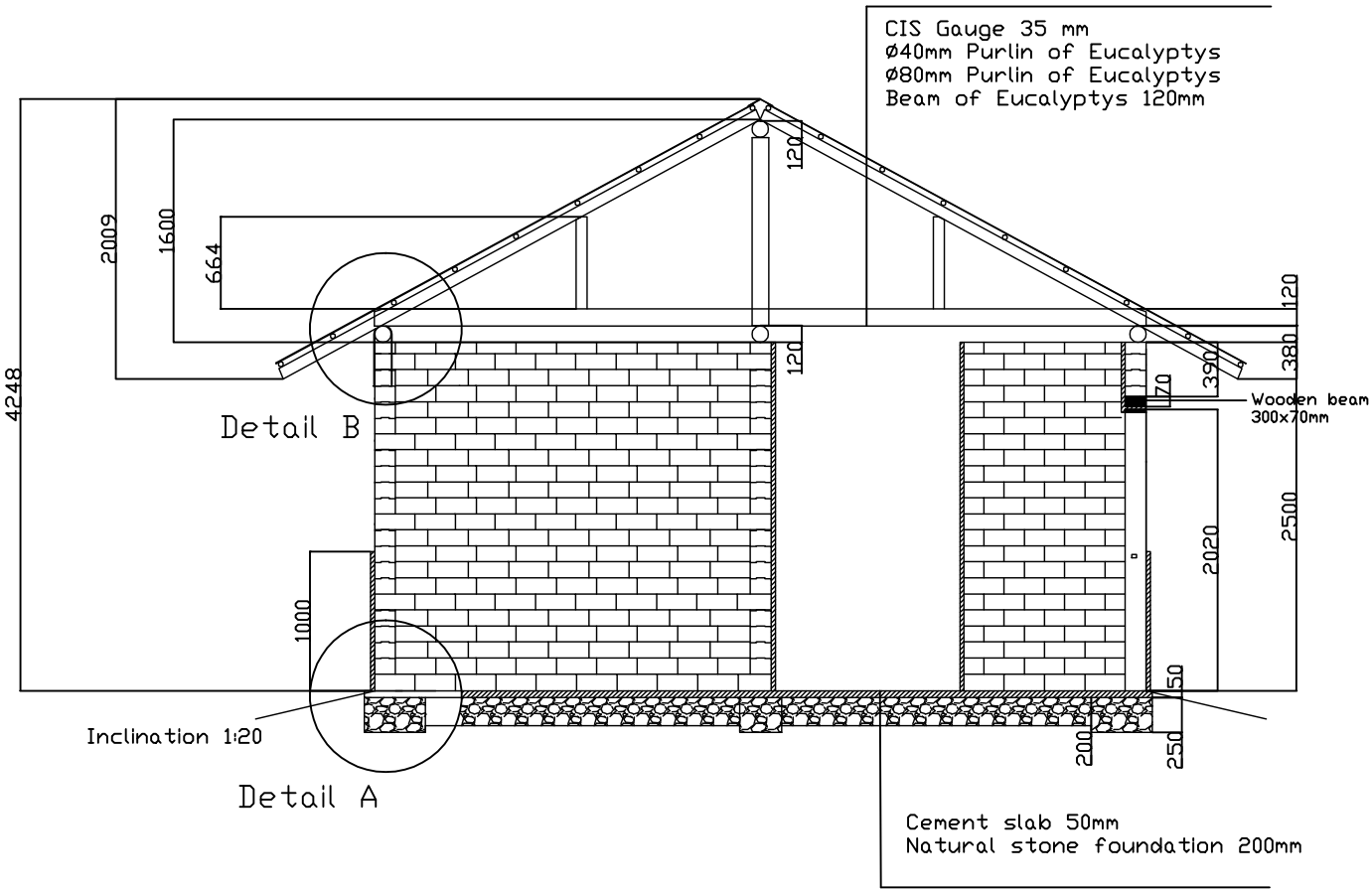
For: Högskolan i Halmstad

Scale: M1:100

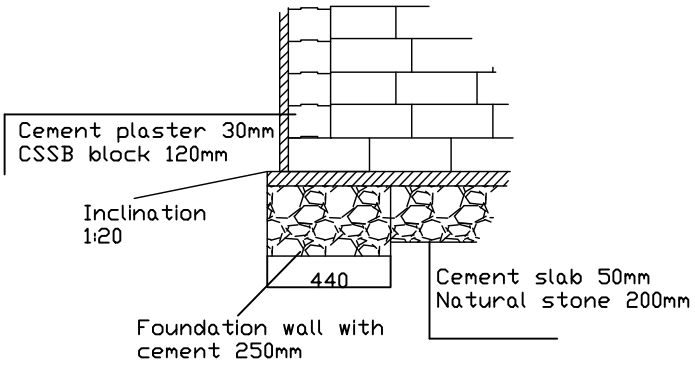
Drawing nr: 002

Year: S 2008

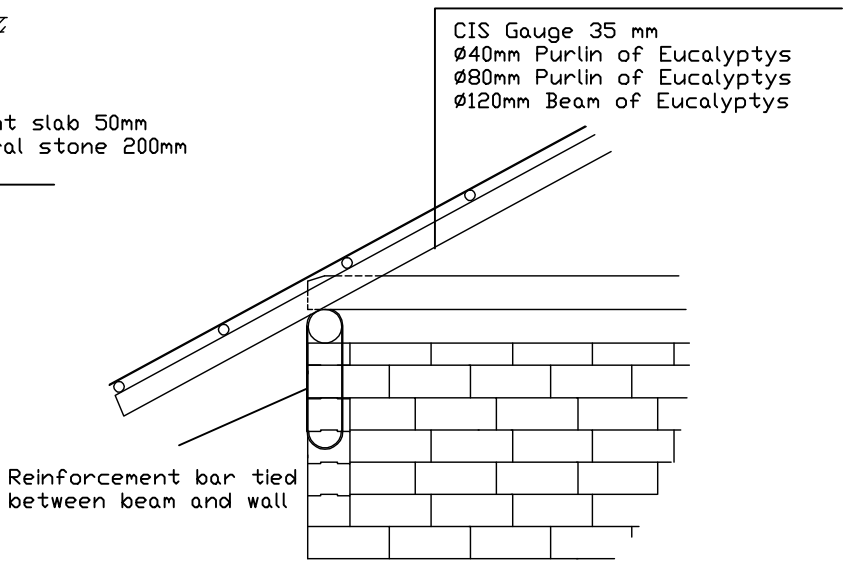
Cement stabilized soil block house



Detail A M1:25



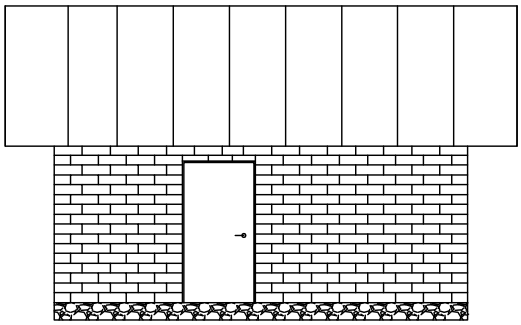
Detail B M1:25

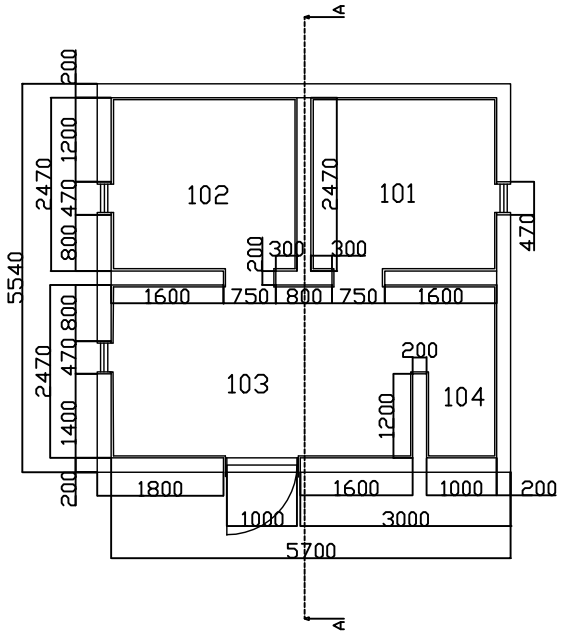


Demo. project: CSSB and Adobe soil block dwelling house

Section A-A Detail A and B	By: Raffi Wartanian Ann-Charlotte Johansson	For: Högskolan i Halmstad	Scale: M1:50
	Drawing nr: 003	Year: S 2008	

Adobe soil block house





Legend

No.	Room Description	Area [m2]
101	Children's chamber	6,5
102	Parent's chamber	6,6
103	Living room	12,0
104	Storage	1,2

Legend of materials

☐ Load bearing walls, adobe blocks dim. 4000x200x140 mm

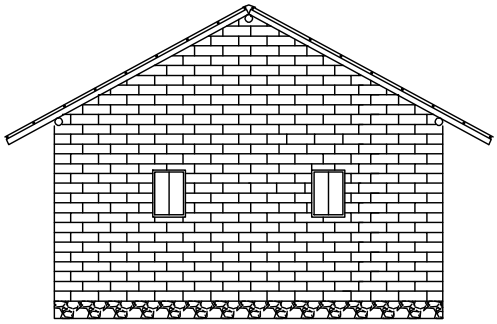
Notes:

Indoor walls are covered with mud plaster by a thickness of approximatly 30mm

Chamber rooms have the option for door installement if so needed by the dweller

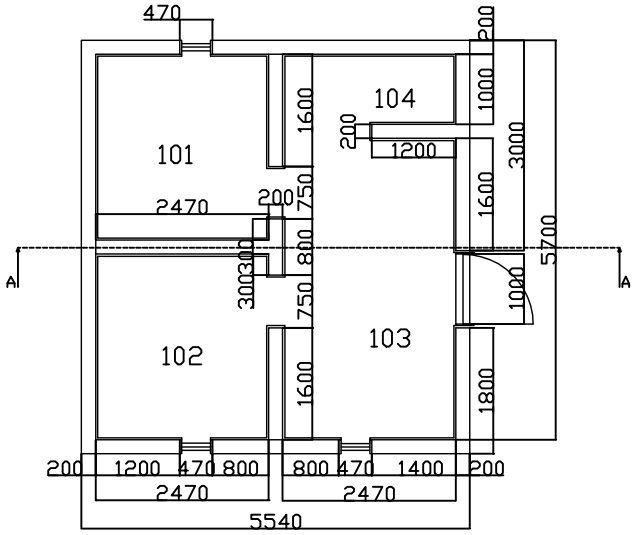
Demo. project: CSSB and Adobe soil block dwelling house			
Facade North side and Typical floor	By: Raffi Wartanian, Ann-Charlotte Johansson	For: Högskolan i Halmstad	Scale: M1:100
	Drawing nr: 004	Year: S 2008	

Adobe soil block house



Legend

No.	Room Description	Area [m2]
101	Children's chamber	6,5
102	Parent's chamber	6,6
103	Living room	12,0
104	Storage	1,2



Legend of materials

Load bearing walls, adobe blocks dim. 400x200x140 mm

Notes:

Indoor walls are covered with mud plaster by a thickness of approximatly 30mm

Chamber rooms have the option for door installement if so needed by the dweller

Demo. project: CSSB and Adobe soil block dwelling house

Facade West side and Typical floor

By: Raffi Wartanian, Ann-Charlotte Johansson

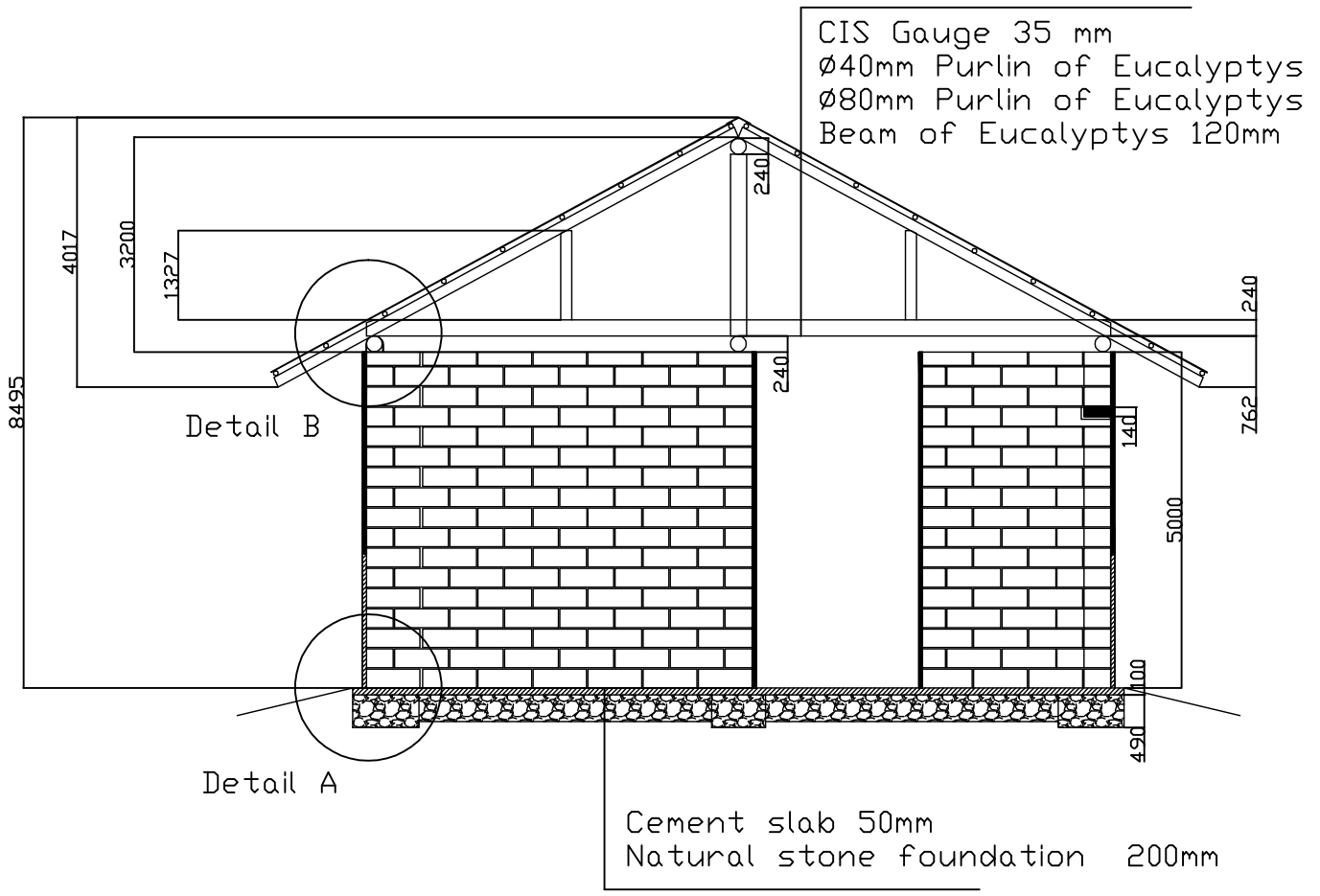
For: Högskolan i Halmstad

Scale: M1:100

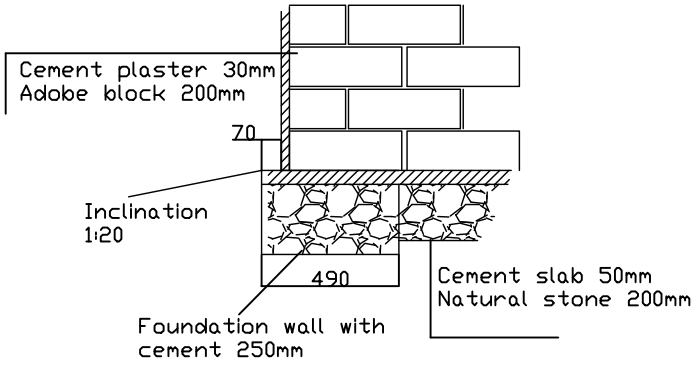
Drawing nr: 005

Year: S 2008

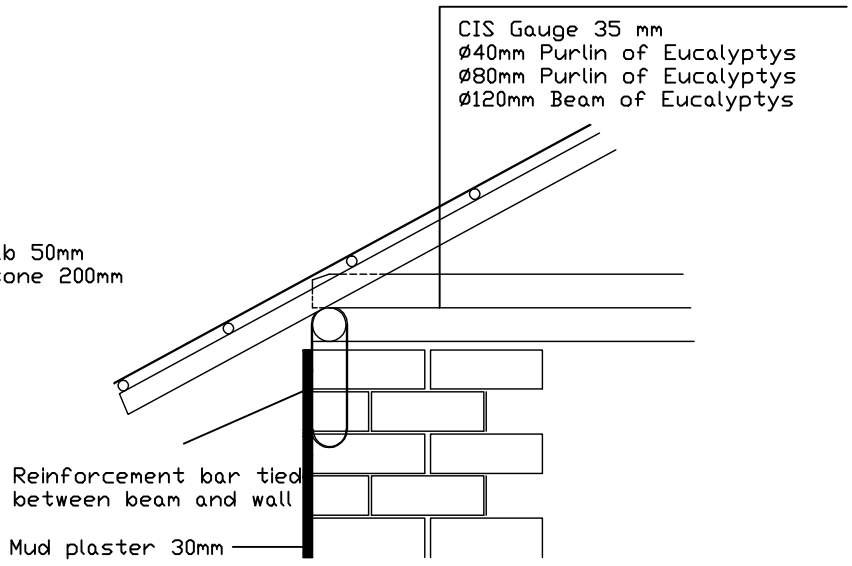
Adobe soil block house



Detail A M1:25

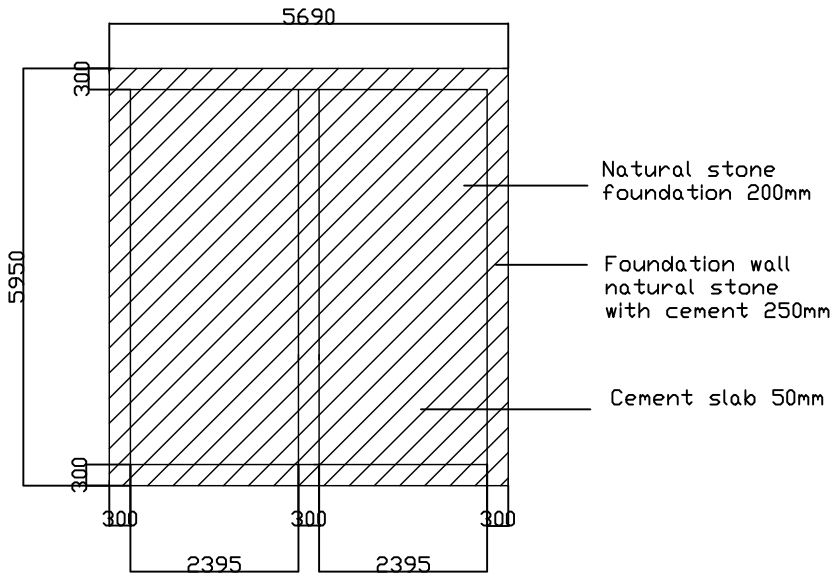


Detail B M1:25

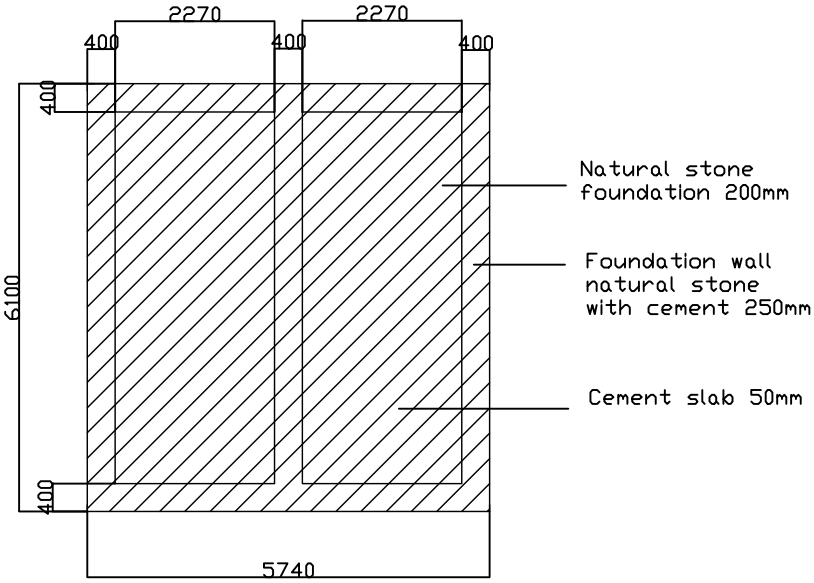


Demo. project: CSSB and Adobe soil block dwelling house			
Section A-A Detail A and B	By: Raffi Wartanian Ann-Charlotte Johansson	For: Högskolan i Halmstad	Scale: M1:50
	Drawing nr: 006	Year: S 2008	

Foundation CSSB

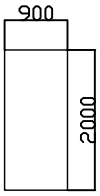


Foundation Adobe

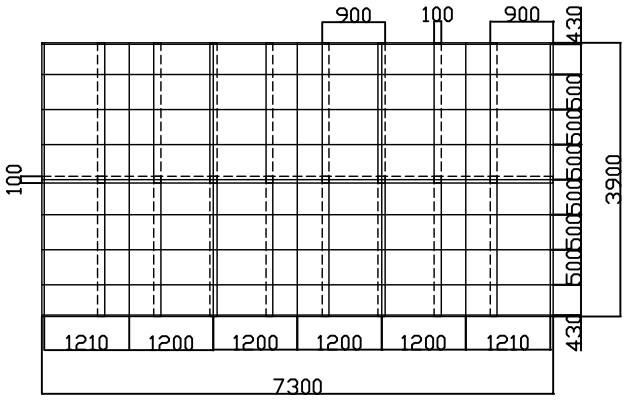


Demo. project: CSSB and Adobe soil block dwelling house			
Foundation plan	By: Raffi Wartanian Ann-Charlotte Johansson	For: Högskolan i Halmstad	Scale: M1:100
	Drawing nr: 007	Year: S 2008	

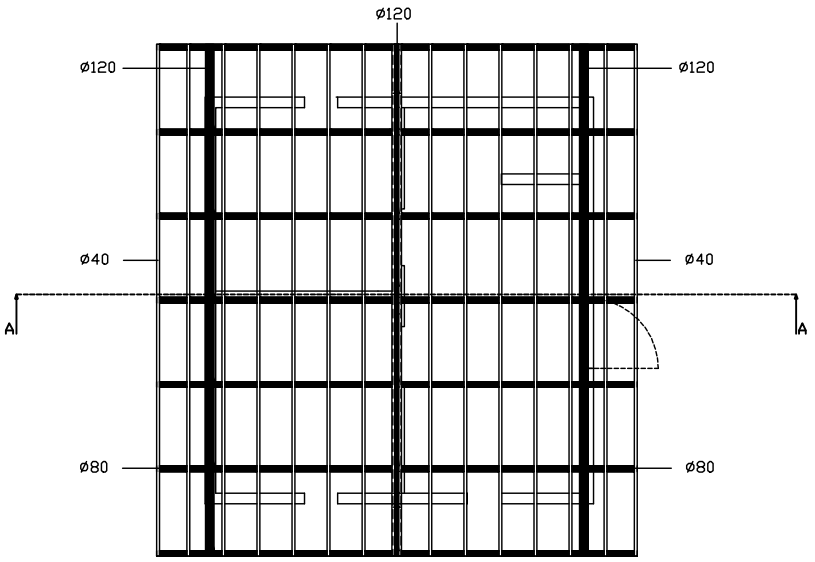
CIS dimension



CIS pattern layout

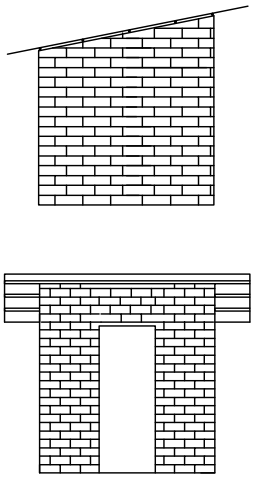


Roof structure plan

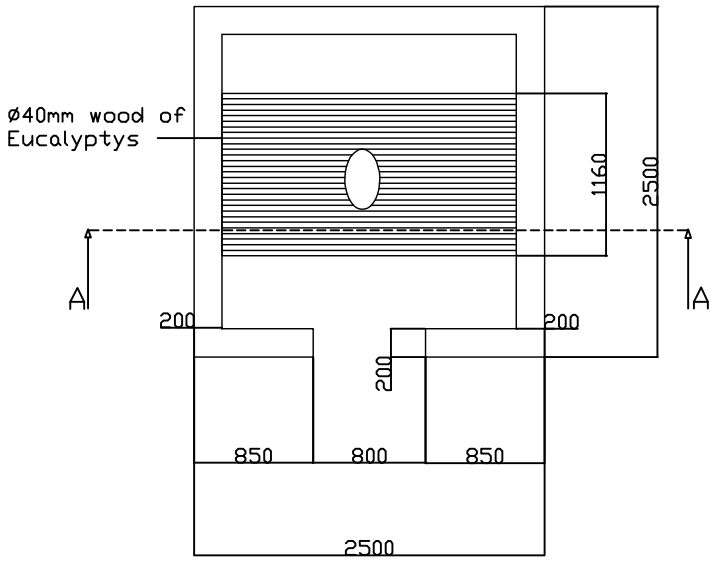


Demo. project: CSSB and Adobe soil block dwelling house			
Roof and CIS structure for CSSB house and Adobe House	By: Raffi Wartanian, Ann-Charlotte Johansson	For: Högskolan i Halmstad	Scale: M1:100
	Drawing nr: 008	Year: S 2008	

Facade M1:100



Floor plan

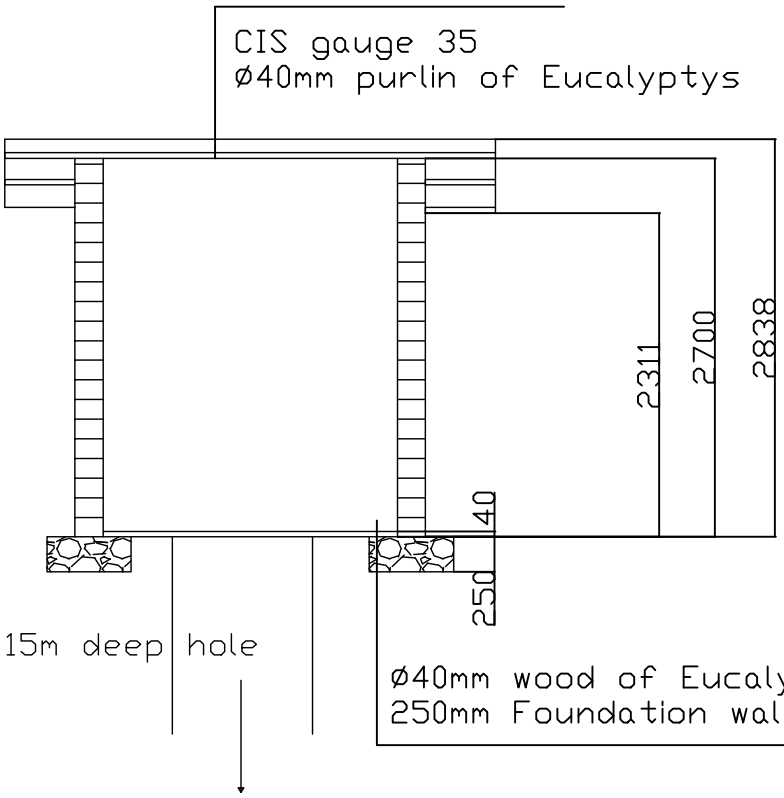


Notes:

This toilet building is designed both for adobe blocks and CSSB. The foundation wall is wide enough to carry either walls made of adobe blocks or CSSB.

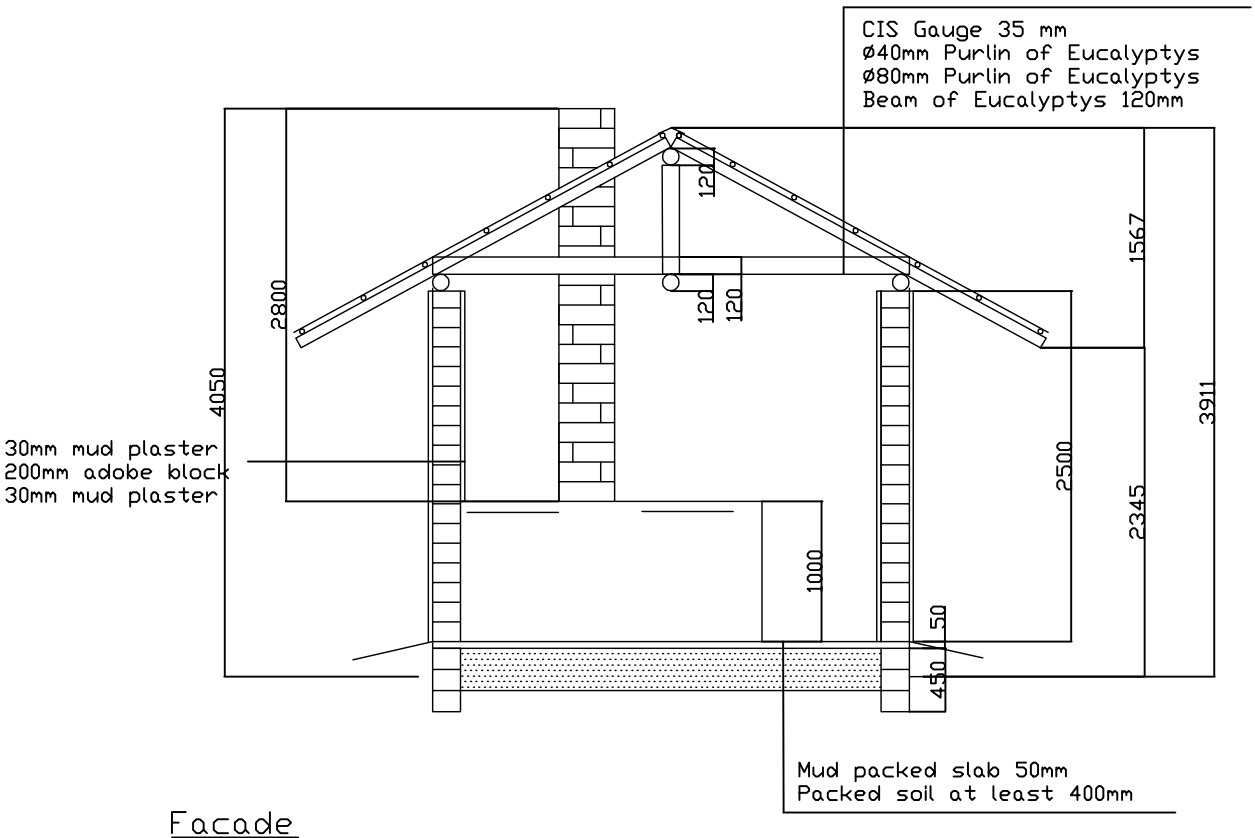
Also the roof structure is a simple design that works well for either kind of material

Section A-A

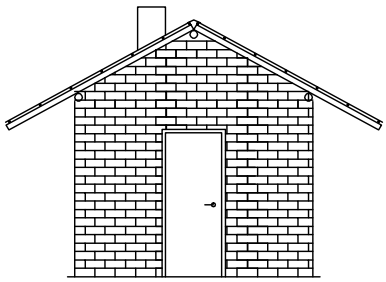


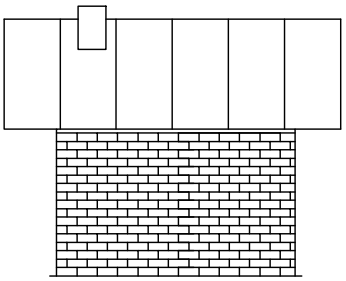
Demo. project: CSSB and Adobe soil block dwelling house			
Toilet building	By: Raffi Wartanian Ann-Charlotte Johansson	For: Högskolan i Halmstad	Scale: M1:50
	Drawing nr: 009	Year: S 2008	

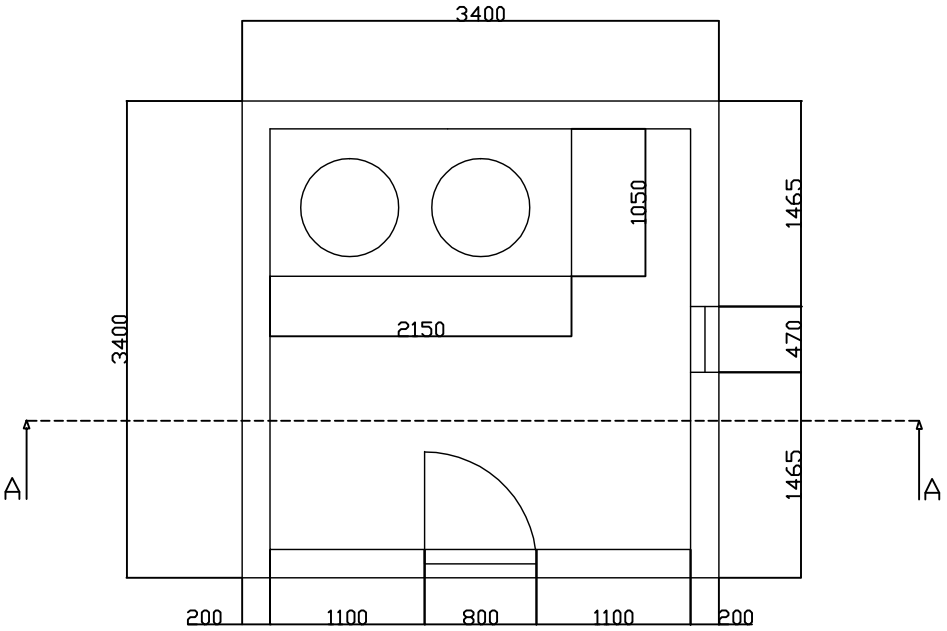
Section A-A



Facade







Demo. project: CSSB and Adobe soil block dwelling house			
Kitchen building	By: Raffi Wartanian, Ann-Charlotte Johansson	For: Högskolan i Halmstad	Scale: M1:50
	Drawing nr: 010	Year: S 2008	

Appendix B

Cost calculation

Low cost housing for the Kambaata region
A demonstration project for dwelling-houses

Cost Calculation: Adobe block dwelling house

Material (incl. wastage)	Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
CIS gauge 35				
House	36	pcs		
Tot. CIS	36	pcs	70	2520
Φ120 Eucalyptus				
House	64,4	m		
Tot. Φ120	64,4	m	5	322
Φ80 Eucalyptus				
House	54,6	m		
Tot. Φ80	54,6	m	4,4	240
Φ40 Eucalyptus				
House	116,8	m		
Tot. Φ40	116,8	m	2	234
Nail	30	kg	17	510
Reinforcement bar	30	m	3,3	99
Cement				
Slab	5	qts (1qts=100kg)		
Plaster	2	qts (1qts=100kg)		
Foundation wall	1	qts (1qts=100kg)		
Tot. Cement	8	qts	230	1840
Poultrynet for plastering	21,9	m2	10	219
Water				
Slab	0,3	m3		
Plaster	0,3	m3		
Soil blocks	7	m3		
Tot. Water	7,6	m3	12,5	95

Material (incl. wastage)		Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
Soil		21	m3	0	0
Fabricationmaterial for Adobe					
	Mould	5	pcs	75	375
	Straw etc	2	m3	80	160
	Tools				300
Natural stone					
	Foundation wall House	2,74	m3		
	Floor House	4,8	m3		
	Tot. Natural stone	7,54	m3	33	249
Sand 0-6mm					
	Plaster	1,8	m3		
	Slab	4	m3		
	Foundation wall	1	m3		
	Tot. Sand	6,8	m3	70	476
Door					
	House 900x2000mm	1	pcs	1200	1200
Windows	House 470x670mm	3	pcs		
	Tot. Window 470x670mm	3	pcs	300	900
SUM. MATERIAL					**9739**

Low cost housing for the Kambaata region
A demonstration project for dwelling-houses

Cost Calculation: Cement stabilized soil block dwelling house

Material (incl. wastage)	Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
CIS gauge 35				
House	36	pcs		
Tot. CIS	36	pcs	70	2520
Φ120 Eucalyptus				
House	64,4	m		
Tot. Φ120	64,4	m	5	322
Φ80 Eucalyptus				
House	54,6	m		
Tot. Φ80	54,6	m	4,4	240
Φ40 Eucalyptus				
House	116,8	m		
Tot. Φ40	116,8	m	2	234
Nail	30	kg	17	510
Reinforcement bar	30	m	3,3	99
Cement				
Slab	5	qts (1qts=100kg)		
Plaster	4	qts (1qts=100kg)		
Foundation wall	1	qts (1qts=100kg)		
Tot. Cement	10	qts	230	2300
Poultrynet for plastering	100	m2	10	1000
Water				
Slab	1,69	m3		
Plaster	1,33	m3		
Tot. Water	3,02	m3	12,5	38

Material (incl. wastage)	Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
CSS Blocks 290x150x120mm	2320	pcs	4,14	9605
Fabricationmaterial for CSSB				
Tools				300
Natural stone				
Foundation wall House	2,5	m3		
Floor House	4,8	m3		
Tot. Natural stone	7,3	m3	33	241
Sand 0-6mm				
Plaster	4	m3		
Slab	4	m3		
Foundation wall	1	m3		
Tot. Sand	9	m3	70	630
Door				
House 900x2000mm	1	pcs	1200	1200
Windows				
House 470x670mm	3	pcs		
Tot. Window 470x670mm	3	pcs	300	900
SUM. MATERIAL				**20138**

Low cost housing for the Kambaata region
A demonstration project for dwelling-houses

Cost Calculation: Adobe block toilet building

Material (incl. wastage)		Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
CIS gauge 35					
	Toilet	6	pcs		
	Tot. CIS	6	pcs	70	420
Φ40 Eucalyptus					
	Toilet	78,4	m		
	Tot. Φ40	78,4	m	2	157
Nail		7	kg	17	119
Reinforcement bar		5	m	3,3	17
Cement					
	Foundation wall	1	qts (1qts=100kg)		
	Tot. Cement	1	qts	230	230
Water					
	Foundation wall	0,3	m3		
	Soil blocks	1,3	m3		
	Tot. Water	1,6	m3	12,5	20
Soil		4	m3	0	0
Fabricationmaterial for Adobe					
	Mould	2	pcs	75	150
	Straw etc	1	m3	80	80
	Tools				300
Natural stone					
	Foundation wall Toilet	0,84	m3		
	Tot. Natural stone	0,84	m3	33	28

Material (incl. wastage)	Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
Sand 0-6mm				
Foundation wall	0,5	m3		
Tot. Sand	0,5	m3	70	35
Door				
Toilet (cover sheet)	1	pcs	100	100
SUM. MATERIAL				**1655**

Low cost housing for the Kambaata region
A demonstration project for dwelling-houses

Cost Calculation: Adobe block kitchen building

Material (incl. wastage)		Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
CIS gauge 35					
	Kitchen	18	pcs		
	Tot. CIS	18	pcs	70	1260
Φ120 Eucalyptus					
	Kitchen	21,2	m		
	Tot. Φ120	21,2	m	5	106
Φ80 Eucalyptus					
	Kitchen	17	m		
	Tot. Φ80	17	m	4,4	75
Φ40 Eucalyptus					
	Kitchen	67,2	m		
	Tot. Φ40	67,2	m	2	134
Nail		15	kg	17	255
Reinforcement bar		10	m	3,3	33
Water					
	Soil blocks	2	m3		
	Tot. Water	2	m3	12,5	25
Soil		6,5	m3	0	0
Fabricationmaterial for Adobe					
	Mould	3	pcs	75	225
	Straw etc	1,5	m3	80	120
	Tools				300

Material (incl. wastage)	Quantity	Unit	Price/Unit (ETB)	Cost (ETB)
Door				
Kitchen 800x2000mm	1	pcs	1000	1000
Windows				
Kitchen 470x670mm	1	pcs		
Tot. Window 470x670mm	1	pcs	300	300
SUM. MATERIAL				**3833**

Appendix C

Interviews

- Kedebe Olika
- Fedesa

Interview with Kebede Olika

Attending persons:
Ann-Charlotte Johansson, AJ
Raffi Wartanian, RW
Kebele Olika, KO

AJ: We were wondering about the mud-block technology. Nobody is using it there.
KO: In the Kambataa?
AJ: Yes. So that's why.
AJ: Would you like to write down your name?
KO: My name? My parents name is Olika, and my first name is Kebede.
RW: What's your occupation?
KO: Right now I'm studying at college. Medical Laboratory College.
RW: That's good!
KO: Before, 5 years ago, I was studying construction, at Building Trading School (BTS).
RW: You where here for 1 year getting an education?
KO: Yes. After that I collected some money and enjoyed medical college now.
RW: Ok! So you started working with construction and collected some money?
KO: Yes after that I enjoyed medical college. (*He started college… own notes)*
RW: So you've been building a lot of houses here?
KO: Yes, before.
RW: In this mud technology?
KO: Yes, mud technology.
RW: Well we have some questions that we thought would be good if you could answer. For example: why did your brother choose this kind of technology?
KO: Because it's easy to construct with, and it's cheaper than wood. Also you can find the mud-blocks here, so no need for transportation.
RW: The only thing you need transportation for is the water?
KO: Yes.
RW: And how do you transport it? Where do you get the water from?
KO: I have water coming from my house.
RW: So you have water coming from your house, ok.
AJ: But when we met you on the site *(his brother's house which is being constructed in this kind of tech… own notes)* you said it's a big problem to transport the water from the river.
KO: Yes for the other people.
AJ: Ok.
RW: And how do they transport the water? Do they walk or they rent a car or?
KO: No no, by human labour.
RW: So they hire some people to bring the water, human labour, or they bring it themselves?
KO: Human labour. We buy 25 litres for 50 cent.
RW: So each person brings 25 litres and gets 50 cent.
KO: Others may bring by donkeys.
RW: And that's even more expensive?
KO: No it's the easiest way because the donkey can bring at 1 time 50 litres. If you go 10 times or 20 times you can get 2 times.
AJ: So you have to pay 25 cents, sorry 50 cent to get the water?
KO: Yes
RW: What's the most expensive part of building this type of a house? Is it the roof or?

KO: Yes the roof, because the iron sheet has become expensive. Before, 3 or 4 years ago, each iron sheet cost 45 birr. Now it's 67 or 70 birr. Between 65 and 70 birr.
RW: The measurement is 2x0.9 metres?
KO: Yes.
RW: Your brother's house is a bit big, but if you would construct a normal size house, how much does it cost all together?
KO: The price?
RW: Yes the total price.
AJ: Maybe for a small house for 1 family.
KO: It depends.
RW: Yes but approximately.
KO: Approximately it costs 6000 birr.
RW: 6000 birr or 60 000 birr?
KO: 6000 birr. For example, the one which we're building will cost approximately 10 000 birr.
RW: That's good, very good answers.
RW: Yes, we were wondering about the foundation for that house. Is the foundations just made of mud-blocks?
KO: Yes.
RW: And it works well that way also?
KO: Yes.
RW: So you don't have to have the rock foundation, sorry stone foundation?
KO: It's expensive, very expensive. No car to transport it with. The stones are far from us. It's expensive.
RW: So that's the main reason?
KO: Yes. It also needs cement and sand for construction. For the foundation. To put the stones together you need mortar. Do you know cement mortar?
AJ: Yes
KO: It's very expensive. Also you need skilled person to put the stone correct.
RW: So you need extra person whom are specialized in that area?
KO: Yes.
RW: But still, this way to make a foundation, it's still good enough?
KO: yes if you protect it from the water, it's good.
RW: How do you protect it from the water?
KO: We will construct the roof, 1 metre of 0.9 metre. I will show you with a drawing.
(He make a drawing and at the same time explains the drawing… own notes) 7.05-8.10 into the recording.
RW: We also thought to put cement plaster on the walls.
KO: Cement plastering? Alright.
RW: It's ok then? *(Showed him our design… own notes)*
KO: It's ok!
RW: And even if you use foundation by mud-block?
KO: It's possible, it's ok.
RW: But if you don't want plaster, then you should extend the roof length to 0.9 metres?
KO: It depends on the money, you can even have 1 metre.
RW: Now the house at your place *(His brother's house is next to his… own notes)* It's pretty down in the ground because you took away the organic material right?
KO: Yes
RW: But are you going to take away the rest of the soil also? Because it's like this now *(Raffi makes a drawing of the current soil levels… own notes)*

KO: Yes *(they will level the surrounding soil as well… own notes)*
KO: Interiors will be mud plastered with the extracted soil.
RW: How thick layer of mud plaster is it? 2 or 3 cm maybe?
KO: It depends, 1-5 cm. It's approximately, not accurate.
RW: Just to have an even surface.
KO: Yes.
RW: Are you constructing the ground closest to the walls with a slope? So that the water will run away from the house.
KO: Yes like that.
RW: We were thinking about the rooms in the house, the partition. We're going to construct it for poor people.
KO: Like that one? *(his brother's house… own notes)*
RW: That one is very nice.
AJ: We're going to make it smaller. As cheap as possible.
RW: We were thinking about something like this. *(Raffi shows them a plan over the designed house and explains the design… own notes) 11.08-11.30 into the recording*
RW: Is it enough like that? Is it good?
KO: Yes!
RW: So 1 room for the parents and 1 room for the children, is it good like that?
KO: Yes it's like that.
RW: The kitchen and the toilette are outside.
KO: Yes outside.
AJ: Are you going to build the kitchen and toilette in your house or outside?
KO: I have the plan, I can give it to you if you want?
RW: Yes it would be very nice.
KO: I did it myself. I can give you. How to build the kitchen, the latrine.
AJ: That would be very nice.
RW: Are you going to make the toilette by digging a big hole or?
KO: In our area, we will dig a hole up to 10 metres or 15 metres, and then we will construct a small house on it. We'll put wood on the floor above the hole. *(makes a drawing for the latrine… own notes) 12.40-13.04 into the recording*
AJ: It's a good idea.
RW: What is the reaction from other people in the neighbourhood? Do they think it's a good way to construct a house by mud-block or they think it's maybe not safe enough?
KO: Many people like it.
AJ: Even the people that haven't got the training and knowledge about it?
KO: Many people did the training.
AJ: But if you talk to a person that didn't do the training, do they still think it's a good way to build also?
KO: Yes.
RW: At first when they see the house maybe they think it's a bad idea to build a house like that…
KO: No no…
RW: They see it and they think wow it's nice?
KO: Yes yes…
AJ: It's good, really good. Ok, maybe we have time to walk down and take some pictures of the house?
RW: Yes and get the plan.
KO: My plan? I have time.
AJ: We'll bring the camera and take some pictures.

Interview with Fedesa

Attending persons:
Ann-Charlotte Johansson, AJ
Raffi Wartanian, RW
Fedesa I, FI

RW: We were just wondering about the foundation with mud-blocks. How you're constructing it. *(Raffi starts to make some drawings about foundation.… own notes) 0.21-0.35 into the recording*
AJ: Or maybe you can draw how it's supposed to be?
FI: First you dig a hole. Then you'll make the first course of the mud-blocks. Then the second course on top of the first course. Then the third course, you will have it finished at the ground level. So up to the ground level you will have 3 course of mud-blocks. *(3 layers.… own notes)*
AJ: Ok.
FI: You got me I think?
RW: Yes
FI: First, second and third course will go round the building.
AJ: In this way, not like this? *(Ann-Charlotte shows how to put the mud-blocks, sideways or straight.… own notes)*
FI: Yes, along the lengths of the block. Mostly the mud-blocks are 40cm (the length) and 20cm (the width).
RW: So if this is the plan for the house you make it like this all around with 3 courses?
FI: Yes.
AJ: And then you make it to the ground level.
FI: Yes. After you reach the ground level the first form, first you will dig a hole, then you will make the first course from the mud-blocks, the first full round, then the second on top of the first, and after the third you will reach the ground level. You will make 3 courses for the sub-structure.
AJ: And do you continue then just putting the blocks on the sub-structure?
FI: The super-structure?
AJ: Yes
FI: Yes, without any problems you will do the same.
AJ: Yes, ok. How do you protect it from water?
FI: Actually that's the problem, you have to care for that, and make a local ditch. You have to dig. The extension for the roof is somewhat a little bit longer, nearly 1 meter, sometimes 1,30 m or 1,40 m.
RW: So it has to be that long?
FI: Yes.
AJ: So you said 1m to 1,40m?
FI: Yes.
RW: And then, this is the area for the roof, the you have to make a ditch around here? *(Raffi makes a drawing example.… own notes)*
FI: Yes
RW: So that the rain won't come down there. Ok, we've constructed (designed) our roof and it 70cm here, and that won't be enough then for the mud foundation. *(Raffi shows another drawing for the roof structure.… own notes)*
FI: Actually no problem, but then you have to make the angle a little bit sharper.
RW: Ok.

AJ: But I thought you put the first blocks like this. I mean in the first one when you dig the hole you put it in on this length, not like that. And then you put the wall on top of it (along the lengths). *(Ann-Charlotte shows a sketch over 2 blocks connected with their long sides together… own notes) 3.35-4.05 into the recording.*
FI: No it's better to put it the same way through the whole structure.
AJ: Ok, the same way.
FI: You are trying to make this one with a straight foundation. No problem, you can make it the same way.
AJ: Ok.
RW: So the only problem with this technique is that you have to construct so that there won't be any water nearby. I think in that region, the Kambataa region, it's a long raining season.
FI: Much more rain than here?
RW: How long is the raining season here?
AJ: 3 months?
FI: No it's around 3 months, more.
RW: Ok, so the rain is more here.
FI: Yes I think, it's here where you get high raining points in Ethiopia. *(one of the locations where it rains the most in Ethiopia… own notes)*
AJ: Ok.
FI: You can dig a little hole here, the depth about 1,5 meters, and you can keep it as a dry store so that the water can gather here. This way it will not disturb you. *(Fedesa draws a little hole near the building… own notes.)*
RW: Yes that's a good idea. Because honestly, this house that we're constructing is for poor people, rural family. Do you think if we design our foundation with rocks and cement and stuff like that, do you think they will construct it that way? If we make it as a demonstration house. Or is it too expensive for that?
FI: Cement is now too expensive in Ethiopia and I think they can't afford it. But rather the problem is the mice. You will get a problem with the mice when you make it with mud mortar. And also you can plaster the foundation with mud. There is one building here which was built last year. I don't know if they have shown you or not.
AJ: No.
RW: Which one is it?
FI: It's 5 min from here, 10 or 5 min. It's a new building. The foundations was made from stone and mud mortar and it was plastered external. The mice can't easily get through it.
RW: So why is it that the mice can't go through mud mortar but cement mortar?
FI: They can't go through cement mortar, they can go through mud mortar.
AJ: But you mean that it's better, more resistant to mice, if you construct the whole foundation with mud blocks?
FI: Not with mud-blocks. They can't go through the mud-blocks but I mean with foundation with stone and mud mortar in between.
AJ: Ok.
FI: It's with mud mortar you get such a problem from mice.
RW: Ok mud mortar.
FI: I think you have to make your foundation with mud-blocks or you have to make it with stone and cement mortar.
RW: Ok now we understand. Well we don't know what to do. We want to make a demonstration house with rocks and cement mortar but it's too expensive and we don't think anybody in the Kambataa region will make it. They have the transportation costs for the rocks also and cement is very expensive so…

AJ: What we also think what the people will react. Normally the length of the roof over here they put 60 cm. *(Ann-Charlotte makes a drawing over a traditional roof structure… own notes)*
FI: For traditional?
AJ: Yes. So if we put it like 1 meter or 1,4 meter then they will…
FI: Normally 1 meter but I don't know the rain situation over there, if it falls directly down or if it rains with an angle.
RW: I don't know actually. We will check.
AJ: Here it rains more…
FI: Vertical.
AJ: It's more forest here than over there. Yes we have to check that up.
RW: But is it good, or enough with mud plaster exterior? If we have cement here and then mud plaster exterior, is it enough for protection against rain? *(Raffi makes a drawing to show Fedesa his thoughts… own notes)*
FI: No, actually you can render with cement, by that's costly. But if you use the paint.
RW: Maybe 1 meter up or something.
FI: Or this height, 75 cm.
AJ: But even if you make the foundation in mud-blocks, maybe you could put cement plaster on the wall 1 meter up, maybe it wouldn't be that much.
FI: Ok, but it's still costly, the price of cement is too high in Ethiopia.
RW: How much is it, do you know?
FI: It's 240-260 birr per 100kg.
AJ: And what is the normal mix for mortar?
FI: 1:2:3
RW: Ok, do you have any more questions?
AJ: No I don't think so.
RW: I think that's it because right now we want to start designing the foundation but we're not sure if we're going to do it in this way or the other way.
FI: Actually it can depend on the soil type for the foundation. If the soil is too fertile you have to go down a little bit more. Is the soil more fertile than here?
RW: No.
FI: I know the name but I have never gone there.
RW: It's not a very fertile soil over there.
AJ: But I don't know if it is or not.
RW: That region, it doesn't look like it. I don't think you can grow anything over there anymore. It's because of the erosion and stuff. The erosion has taken a lot of parts.
FI: So it a erosion area over there. Is the soil over there as red as here? The colour of the soil, is it red?
AJ: No
RW: I can't remember but we know that there where 2 students before us that came and took a piece of soil from that region and they made a soil test and everything was ok.
AJ: It contains a lot of clay.
FI: If you ferment the mortar for the production of the blocks the problem is that it cracks, preventing it from cracking. Did they tell you how many days it should be fermented.
AJ: No.
FI: I'm not sure, but I think it's for 1 week or so.
AJ: What is fermented?
RW: Fermented is when you put it in water?
FI: Yes. You will ad the soil, and the straws and the water and then work the soil like they do it here with their legs (feet) and you have to preserve it so it ferments.

AJ: Ok, so you just have it in the hole, and you mix it every day with more water?
FI: If you make it today, you can leave it for a week. Then after a week you will start making your blocks. They have to work it again with their legs (feet).
AJ: What did you say the word was?
FI: Fermentation.
AJ: Why is that you have to leave it, I didn't know about that.
FI: About fermentation?
AJ: Yes.
FI: What do you call it, do you know when you make beer?
AJ: Yes
FI: Yes it should ferment, I don't know why.
AJ: Is it for the straws to get connected with the mud?
RW: Ska det jäsa eller?
FI: The soil will not easily break down if it's fermented. Like bread for example, it should be fermented to be ok.
RW: We didn't know the English word for it.
AJ: A week.
RW: And then you have to stamp on it again when you want to make the blocks.