

# Designing Affordable Housing for Community Empowerment: Knowledge, Design and Materials

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A thesis submitted for  
Architecture and Construction City

Supervisors

Alberto Bologna, Arch., Ph.D, Assistant Professor of Architecture and Urban Design  
Marianna Nigra, Arch., Adjunct Professor of Economics and Design Organization

Christelle Khoury  
S239023

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# Abstract

This paper aims to address the current housing situation in Tanzania. It kicks off by introducing the country as a whole followed by highlighting the rapid urbanization and population growth which are consequently leading to housing shortages for the people of Tanzania. The housing situation in the country is extremely problematic, where an estimated three million units is said to be required. Due to the lack of capacity for implementing wide-scale capital-intensive projects, government efforts to address the housing needs were in vain. The housing situation in Tanzania is crucially complicated - the need is estimated to be 3 million units - due to high land prices and consequently high cost of housing. To further complicate matters, the current housing schemes available are extremely expensive, which makes poor households unable to afford any ownership.

Shimbwe village was chosen to be the case study that illustrates the current inadequate housing in informal settlement of rural areas. To do so, 392 families participated in a questionnaire which underlined the people's needs regarding an analysis of the current housing situation of the beneficiaries. The principal goal of the questionnaire was to understand how the people of Shimbwe spend their daily lives in order to examine various issues such as the use of space, separation of functions, privacy, health, and comfort. Results were then used to develop a low-cost housing prototype which intends to comprehend all the answers.

An affordable, ecological and sustainable material was chosen as a solution to low-cost housing. A manual of the stated material, Compressed Earth Blocks, was developed from the knowledge gathered during the field practices in Moshi, Tanzania under the supervision of a NGO called C-re Aid. Step by step, the manual guides construction workers through the process of producing Compressed Earth Blocks and building their own houses.

Based on the previously mentioned material, a design proposal was elaborated. Six different phases of solutions were recommended, where the people's needs were always taken into account. Each phase corresponds to a certain budget conforming to each household's means. The prototype is versatile, meaning that it could be upgraded over time by adding particular enhancements, such as a bigger space, reinforcement of the structure, or mechanical features, for the purpose of becoming a self-sufficient house.

Keywords: affordable, housing, tanzania, compressed earth blocks, prototype.

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# PART I - CONTEXT



Picture 01. Oysterbay bordering Msasani suburbs in Dar es Salaam. Source: Unequal scenes.





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## TANZANIA

- EAST AFRICA
- CAPITAL CITY DODOMA
- GMT+3 TIME ZONE
- SWAHILI, ENGLISH
- TROPICAL ON THE COAST, SEMI-TEMPERATE INLAND

### LAND USE

- 885,800 km<sup>2</sup> MAINLAND AREA
- 59,100 km<sup>2</sup> LAKES AREA
- 1,840 km<sup>2</sup> IRRIGATED LANDS
- 42,000 km<sup>2</sup> NATIONAL PARKS
- 17 GAME RESERVES

### DEMOGRAPHICS

- 60,079,712 INHABITANTS
- 50.51% FEMALE 49.49% MALE
- 43.74% 0-14 YEARS
- 19.86% 15-24 YEARS
- 29.88% 25-54 YEARS
- 3.51% 55-64 YEARS
- 3.02% + 65 YEARS

### POPULATION

- 0.79% OF THE WORLD POPULATION
- 69/km<sup>2</sup> POPULATION DENSITY
- 17.4 YEARS MEDIAN AGE
- 28% POVERTY LINE (2012)
- 10.3% UNEMPLOYMENT RATE (2014)

### RELIGION

- 61.4% CHRISTIANS
- 35.2% MUSLIMS
- 1.8% FOLK RELIGION
- 0.2% OTHER
- 120+ TRIBES

### LIVELIHOODS

- 2.75% POPULATION GROWTH RATE
- 35.6 BIRTHS/1,000 BIRTH RATE
- 7.6 DEATHS/1,000 DEATH RATE

### ECONOMY

- 1 US\$ = 2272.73 TSH
- 58 COMMERCIAL BANKS & PRIVATE FINANCIAL INSTITUTIONS
- INFLATION 2016 | INFLATION 2017 | INFLATION 2018
- 5.00 | 5.32 | 4.84

### AFFORDABILITY

- US\$ 5.59 COST OF A 50 KG CEMENT BAG
- US\$ 4.17 COST OF A 25KG LIME BAG
- US\$ 6.88 COST OF A SHEET OF SURROGATED IRON FOR ROOFING
- US\$ 8.60 COST OF A 1 LABOR DAY NORMAL WORKER
- US\$16 705 PRICE OF THE CHEAPEST HOUSE

- Equivalent to 37 966 107 Tsh
- Area of the house 60 m<sup>2</sup>
- Newly built by a formal contractor

### TOURISM

- 3.8% OF GDP TRAVEL & TOURISM
- 1,092,500 CREATED JOBS DUE TO TRAVEL & TOURISM
- 1,957,000 INTERNATIONAL TOURISTS IN 2018
- US\$1.73 BN GENERATED IN VISITOR EXPORTS

### EDUCATION

- 78% OF THE POPULATION ARE LITERATE
- 46% FEMALE 79% MALE
- 21% CHILD LABOR AGES 5-14

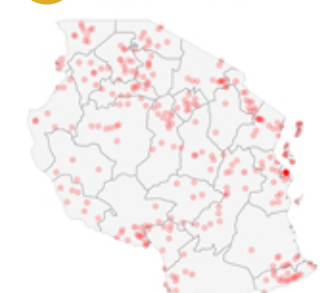
### SERVICES

- 15% OF HOUSEHOLDS HAVE ELECTRICITY
- 55.6% OF HOUSEHOLDS HAVE ACCESS TO CLEAN WATER
- 46% OF RURAL HOUSEHOLDS
- 79% OF URBAN HOUSEHOLDS

### HEALTH

- 38.4% CONTRACEPTIVE PREVALENCE RATE
- 1.4 MILLION PEOPLE LIVING WITH HIV/AIDS
- 33,000 HIV/AIDS DEATHS

### DENSITY





# Introduction

## ORGANIZATION OF THE THESIS

This paper aims to provide a broad picture of the current housing situation in Tanzania. It begins by introducing the continent then the country Tanzania that comprise it. This introductory chapter underscores a brief review of historical housing trends and patterns that have shaped housing policy, then the urbanization and population growth leading to land and housing deficit.

Following this, the paper explores the state of a village in Kilimanjaro region, studying the area by outlining aspects such as housing needs, quality and affordability through a social questionnaire. Based on these needs, ecological, sustainable and affordable materials were studied; leading to a suitable solution which is Compressed Earth Block. Displaying some case studies portraying successful housing project around the world. The thesis ends by proposing a prototype solution and providing some recommendations on how to increase affordable housing.



**HOUSING IS THE BASIS OF STABILITY AND SECURITY FOR AN INDIVIDUAL OR FAMILY. THE CENTER OF OUR SOCIAL, EMOTIONAL AND SOMETIMES ECONOMIC LIVES, A HOME SHOULD BE A SANCTUARY; A PLACE TO LIVE IN PEACE, SECURITY AND DIGNITY."** (UN-HABITAT, 2003)

## OBJECTIVES

The main objectives of this study is to understand the current housing situation in Tanzania.

How is the government dealing with the issue of having affordable housing accessible for anyone? How is the supply of land being treated?

The village of Shimbwe was chosen as a case study to illustrate housing in informal settlement. The research was addressed to the people of Shimbwe and specially people who still live in mud houses, in order to understand their use of space. Hence, a design solution was proposed based on the needs and budgets of the beneficiaries.

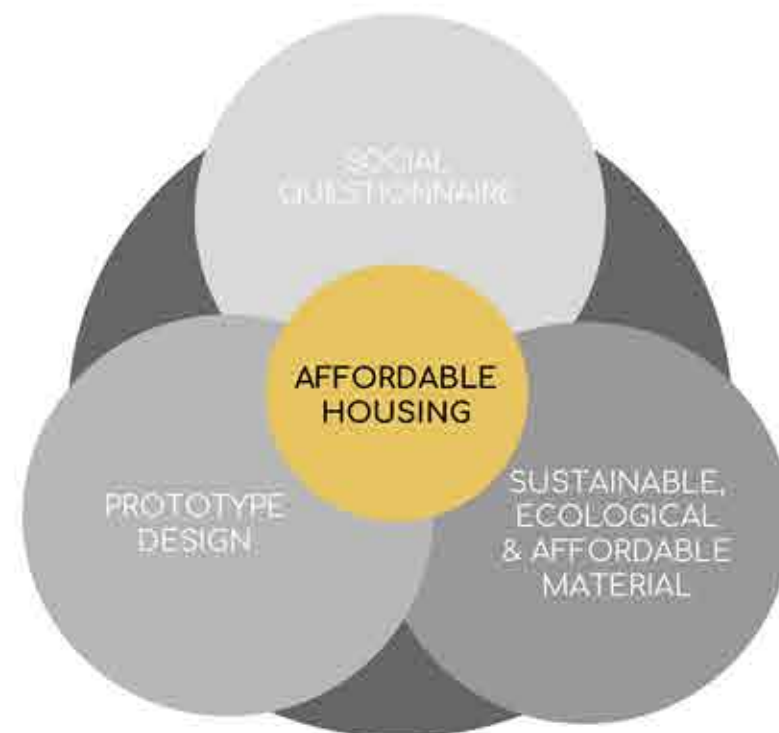


Figure 01. Thesis strategy. Source: diagram by the Author.

## SIGNIFICANCE

This study is considered as a contribution to the research community. The bigger picture is to eradicate all the mud houses still available in Shimbwe, by creating a prototype that could suit all different family sizes, budgets and expectations. Families will be participating in the construction of their own houses, by learning how to use the compressor and then make blocks. Furthermore, enabling rural communities to use local materials from their surroundings for construction. This way they would be saving money and time by using their own labor to build their houses at low cost. This process aims to enable communities to take control over their lives by promoting the participation of the people in a social-action practice. This thesis is an attempt to achieve community empowerment in Shimbwe Uru.

## HOST INSTITUTION

C-re-a.i.d. is a Tanzanian registered nonprofit organization, which conducts research by design on the possibilities of architecture. This is accomplished by the different branches of C-re-aid, including fieldwork, organizing construction, social enterprises, empowering local craftsmen and receiving students of architecture, interior architecture, engineering and product design. Through such work, C-re-aid seeks to understand the possibilities of architecture – as a material and social change of cultural and socially meaningful design, and what it can mean for people who are “vulnerable by material conditions”. Architectural interventions, as conducted by the organization, aim to have an impact through the whole process of a project and change the material environment. With these changes the organization strives to affect not only the physical, built environment but also the social environment, and by that, social health which includes self-esteem and self-respect. By defining the priorities within every project we strive to achieve an optimal impact within our capabilities. As a result, the new situations can lead to “graduation” out of poverty.

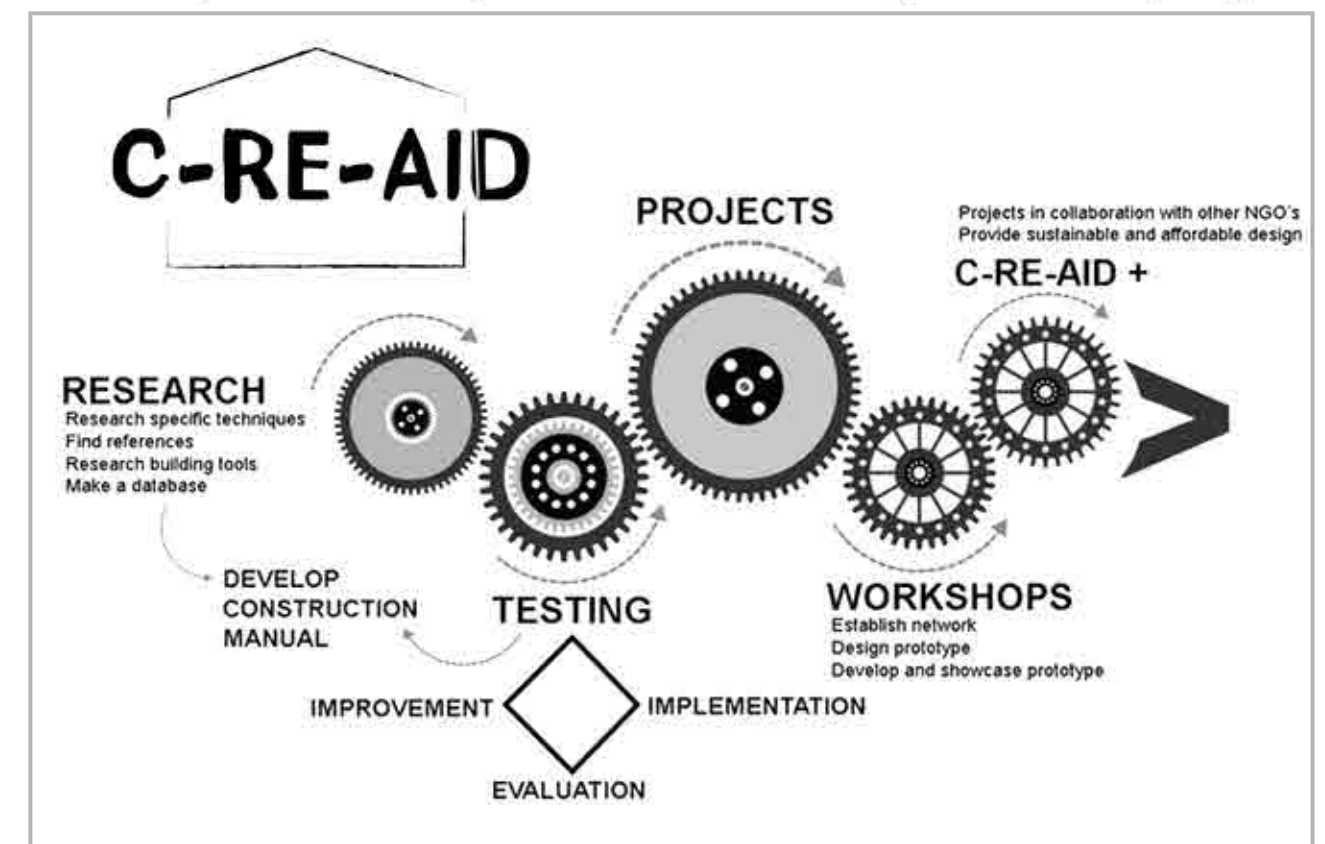
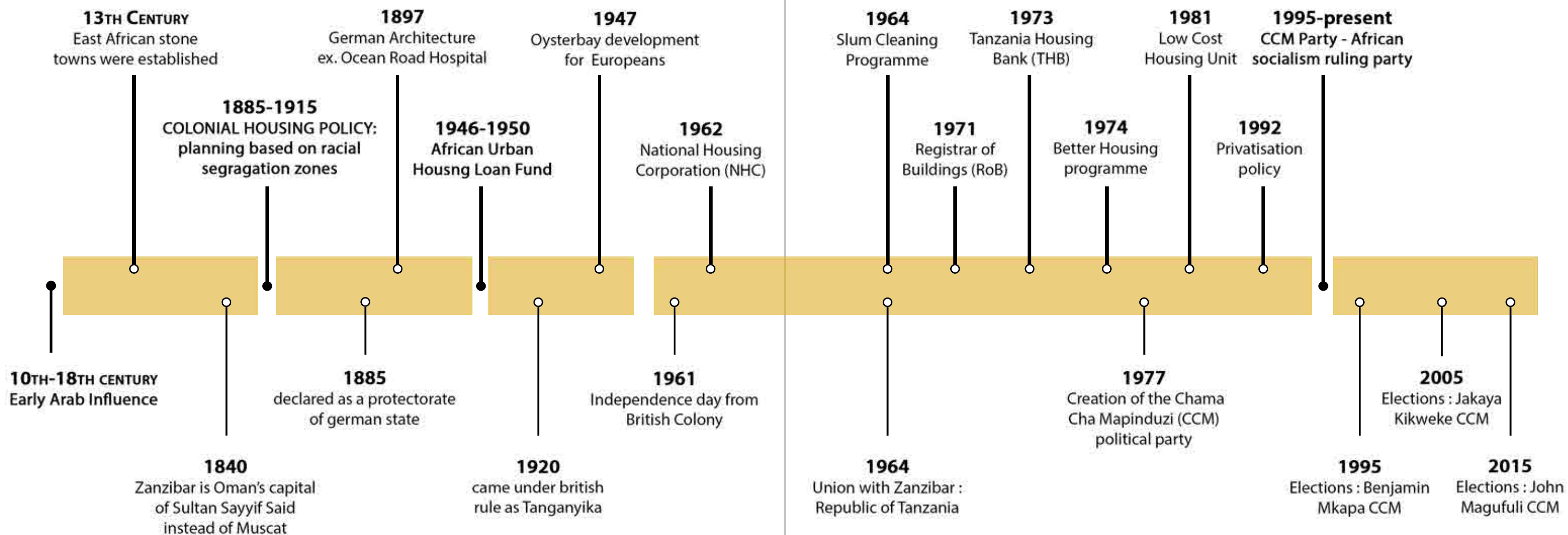


Figure 02. C-re-a.i.d NGO strategy. Source: C-re-a.i.d website



# Timeline

## HOUSING PROGRAMMES



## POLITICAL SITUATION



# Political Background

## COLONIAL HOUSING PROGRAMMES

Tanzania is extremely heterogeneous, its pre-colonial and colonial history of Arabs, British and Germans all left a different cultural imprint. In terms of urban planning to building regulations; as to language and food.

The housing programmes that were implemented following the colonial housing policy were based on ideas of racial segregation. There were separate housing schemes for Europeans, Indians and Africans. The Europeans took the best areas because they thought local people do not deserve to live a comfortable life (The Economics Intelligence Unit, 2007).

Housing schemes for Europeans were located on attractive sites such as Kurasini and Oysterbay while housing for Asians were implemented at Upanga and Chang'ombe.

Housing schemes for Africans were carried at four levels:

- 1- African government housing, for government employees;
- 2- African Urban Housing, for all Africans;
- 3- African Urban Housing Loan Fund, for Africans who wanted to construct permanent houses. They were provided with financial support and long security of tenure;
- 4- Plots were issued to Africans on short-term tenure for self-construction.



Picture 02. Julius Nyerere, independence day 9 December 1961. Source:

## POST-INDEPENDENCE HOUSING PROGRAMMES

It was not until Tanzania got her independence in 1961 that specific housing programmes for the "indigenous people" were carried out. A number of institutions were established:

- National Housing Corporation (NHC) in 1962;
- The slum clearance programme in 1964 - the programme aimed at building permanent houses and demolishing "slums" constructed with traditional materials (mud and pole and thatched roof);
- Registrar of Buildings (RoB) in 1971;
- Tanzania Housing Bank (THB) in 1973;
- Better Housing in 1974, in which workers and farmers were provided with loans to purchase building materials;
- Low Cost Housing Unit scheme In 1981.

All these institutions failed because of insufficient supply of public housing, a lack of coordinated programmes and a lack of resources. These programmes only served middle and upper-income civilians, therefore urban poor had to build their own shelter in informal self-build settlements. Occupation takes place often on vacant, un-serviced land. This type of housing can only be successful when authorities are merging their efforts. While in fact, these houses were self-built without government support.

The government was unsuccessful in addressing the housing needs of low-income households due to the lack of capacity to implement such large-scale capital-intensive projects. However, all of the inputs to housing are far too expensive, or simply not available for low-income households. Public utility agencies have very little influence on the informal settlements; however, they provide basic services such as electricity and water but only upon payment by individuals. To this extent, the government can be considered as an indirect actor in this process; in a sense that all the activities occurring in the informal settlements are not monitored by neither local or national parties.



Picture 03. Oysterbay bordering Msasani suburbs in Dar es Salaam. Source: Unequal scenes.

## TYPES OF HOUSES

- City housing stock is dominated by Swahili house types. These types of houses constituted about 43% of the total housing stock in Dar es Salaam (Hoek-Smit, 1991).
- A compact layout design in the city centre of Dar es Salaam of three to four storey commercial residential houses.
- Multi-storey houses are emerging in Kariakoo area; being a result of ongoing piecemeal redevelopment processes in this part of the Dar es Salaam settlement.
- In Oysterbay and Kurasini areas, colonial residential quarters varying from small detached units, semidetached, row housing units to large bungalow house types built for Europeans.
- Quarters developed by the NHC and scattered in many places within Ilala, Kinondoni and Temeke Municipalities.
- NHC and state organizations developed three to five storey apartment flats.
- Mixed detached single units and large detached type of houses in newly developing areas, both in formal and informal settlements.



# Affordability

Tanzania still follows the colonial planning regulations and building standards. The current available housing schemes are extremely expensive in a sense that poor households cannot afford to own houses in such conditions.

According to the UN, there is no universally agreed measure of what establishes "affordable housing". There are two main variables that determine affordability: housing costs and household income. Widely, housing is considered to be affordable when a household spends less than 30% of their total income on housing expenses. Explicitly, affordability is not just about the price of the house itself; it is about having access to housing finance.

According to the 2015 Formal Sector Employment and Earnings Survey by the NBS, with almost 66 percent of paid employees earning a monthly income of less than TZS 500 000 (US\$220) while the average mortgage size of TZS 114 million (US\$51 454). This indicates that most of these employees are high income earners with most of the households finance sourced from savings or personal loans.

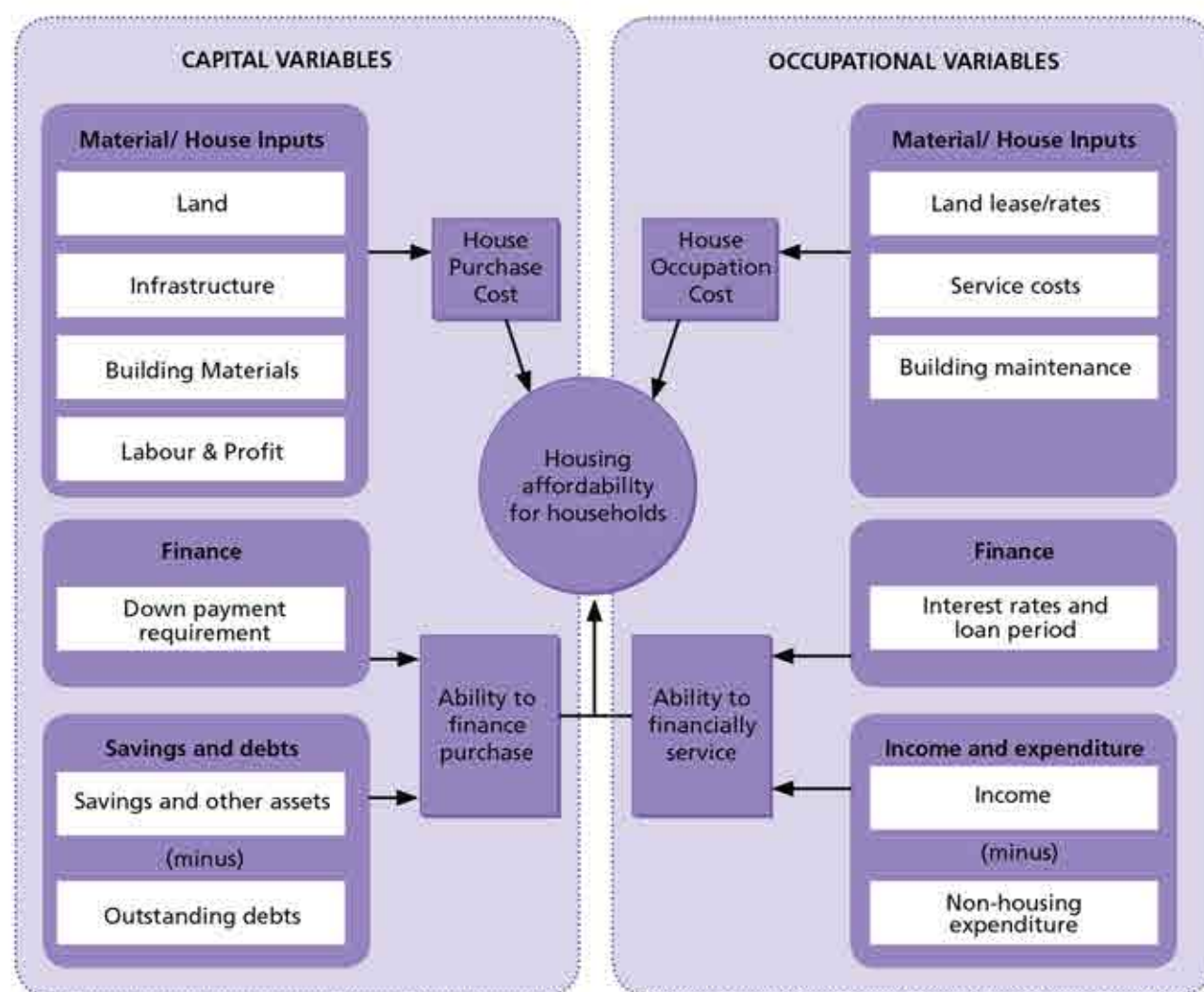


Figure 03. Basic components of housing affordability. Source: UN Habitat - Affordable land and housing



**THE UNAFFORDABILITY AND INACCESSIBILITY OF DECENT, SECURE, AFFORDABLE LAND IS THE MAJOR REASON WHY THERE ARE SO MANY INFORMAL SETTLEMENTS IN AFRICAN CITIES AND IS A CONTRIBUTING FACTOR TO URBAN POVERTY" (UN-HABITAT, 2011)**

This graph below shows that income levels of most households in Tanzania are too low; 90% of the population can afford less than \$45 on housing per month, and 68% can afford less than \$23 per month (Housing Market Study, Tanzania, 2012). In addition, the price of the cheapest, two to three-bedroom house (60-121m<sup>2</sup>), newly built by a formal developer or contractor, ranged between TZS 38 million (US\$16 705) and TZS 109 million (US\$47 960) VAT exclusive. It is a Watumishi Housing Company's countrywide project. On average, only 2.53% of urban households can afford this type of housing. The housing need in Tanzania is estimated to be 3 million units with an annual increase of 200,000 units (Shelter Afrique, 2011), of which 36% are in Dar Es Salaam.

Unfortunately, confirming to the current situation, housing accessibility in Africa does not appear to be improving since African governments have not been proactive in prioritizing planning for urbanization, slums and informal settlements. In the meanwhile, demand for land is higher and higher every day.

The government should be promoting agriculture and farming in order to avoid poverty among people by creating employment opportunities to reduce on mobility of labor. Small scale programs should be empowering vulnerable communities to improve access to food, income and markets by training farmers to increase their production and how they can develop themselves in villages. The authorities should be making land reforms to enable the poor and low income earners get access on land while providing credit facilities in rural areas to enable easy accessibility on finance.

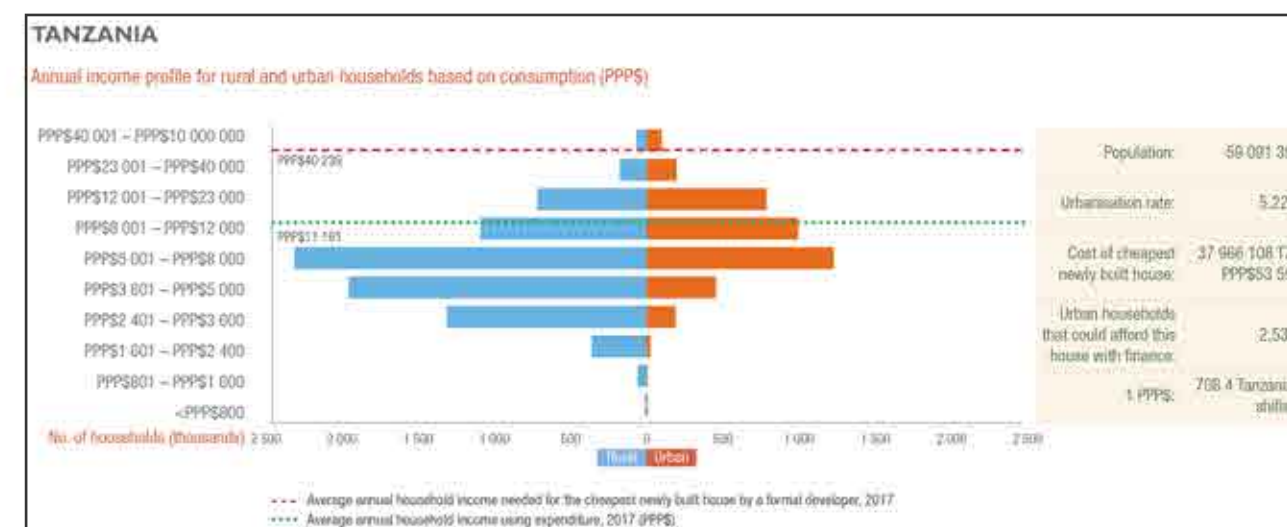


Figure 04. Graph displaying annual income profile for rural and urban households in Tanzania. Source: CGIDD.com



# Rapid Growth

## LAND DEFICIT

With regard to producing shelter, one must start providing land. The housing situation in Tanzania is crucially complicated due to high land prices and consequently high cost of housing. Inadequate land policies result in insufficient and unavailable lands for development. Lands are owned by the state, the government is the primary tool for land delivery (United Nations, 2011). Citizens inherit lands but they do not have title deeds which means they do not have the right to process loans from the banks. Issues related to the Acquisition of Land title:

- 1- The process of getting a land title is long, cumbersome and costly;
- 2- The importance of having a land title, as a tool for mortgage is not understood by all developers.

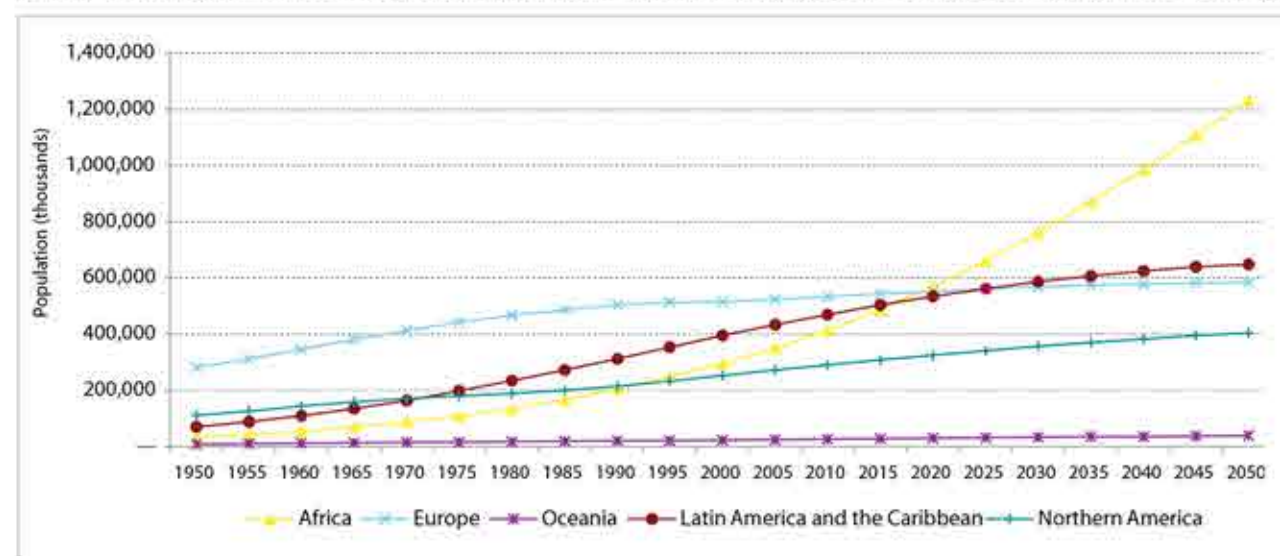


Figure 05. Urban population growth in selected regions 1950-2010 and projections for 2010-2050. Source: United Nations.

## URBANIZATION

According to, urbanization means the share of urban population in the total population of a country. Tanzania is one of the most rapidly urbanizing countries in sub-Saharan Africa. In fact, from less than one million people in the early 1990s, Dar es Salaam's population has grown at an average rate of 5.8 % annually to reach 4.4 million people today, making it one of the fastest growing cities in the world. It is now estimated that the city will be home to over 10 million inhabitants by 2027 (United Nations, 2018). The link between urbanization and economic development in Africa is weaker than elsewhere in the world. In other words, urbanization is not synonymous with economic development. Urban population growth has been outpacing economic development, partly because of the lack of productive employment creation.

This following map shows that already, cities such as Lagos and Kinshasa constitute urban agglomerations of over 10 million residents "megacities", while Dar-es-Salaam, Johannesburg, and Luanda are projected to reach that size by 2030. This explosive city growth creates both opportunities and challenges (World Development indicators, 2014). Access to jobs, public goods, infrastructure, and health care are better in cities. However, if city populations continue to grow without economic transformation, insufficient infrastructure and basic services paralleled with a cycle of high fertility, low wages, and persistent poverty this would lead to a national collapse.

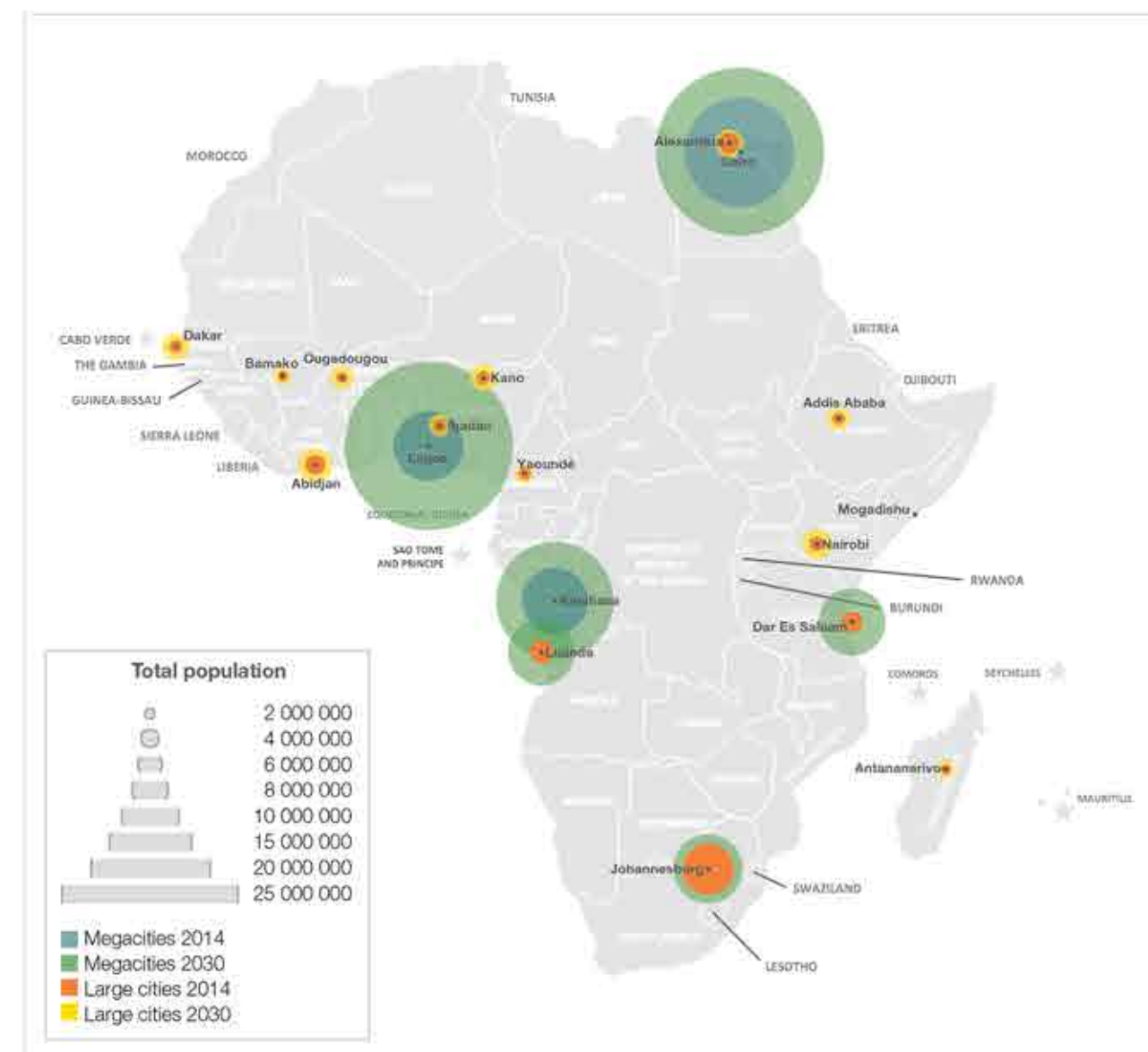


Figure 06. Africa's current and emerging megacities and large cities 2014 vs 2030. Source: UN DESA based on World Development indicators.

## RURAL-URBAN MIGRATION

The rapid urbanization rate has been associated with mainly rural-urban migration and recently in large towns by natural growth. Rural-urban migration accounts for about 30% in Dar es Salaam (International growth center, 2014). Migration from rural to urban areas are leading young people to leave schools to come to the cities. People are migrating to towns in search of employment opportunities, better social services and other facilities not available in rural areas. In the meanwhile, affecting agriculture labor and generating national food deficit. The rising population of young people is rising unemployment and have been widening poverty and hunger. In fact, approximately 70% of the population increase in Dar-es-Salaam between 1978 and 2012 is due to in-migration from other parts of the country.

According to the World bank 2018, statistics show the degree of urbanization in Tanzania from 2007 to 2017. In 2017, 33.05 % of Tanzania's total population lived in urban areas and cities. These urbanization patterns are captured in the actual magnitude of urban expansion, as over 20 million Tanzanians currently live in areas with a population density higher than 150 people per square kilometer.



# Rapid Growth



Picture 04. Kariakoo neighborhood in Dar es Salaam. Source: Unequal scenes.

At first glance, Dar es Salaam looks like a modern city with a panoramic skyline of tall new buildings. But this city is the hub of an unequal scene, where social inequalities are highlighted between congested city slums with poor and inadequate public services paralleled with modern skylines and well thought urban planning.

Economic growth is vital but African economies must also accelerate structural transformation to boost productivity. Connecting rural economies and urban markets is also paramount.

## BIRTH/FERTILITY RATE

The single most important driver of urbanization in Africa is natural urban population growth or the predominance of births over deaths in urban areas.

The birth rate is usually the dominant factor in determining the rate of population growth. It depends on both the level of fertility and the age structure of the population. In 2017, the birth rate in Tanzania reached to 35.6 births/1,000 population; should be noted that Tanzania has one of the highest birth rates in the world (17th highest of any country).

The fertility rate is the average number of children born by one woman while being of child-bearing age. In 2016, the fertility rate in Tanzania amounted to 5.02 children per woman.

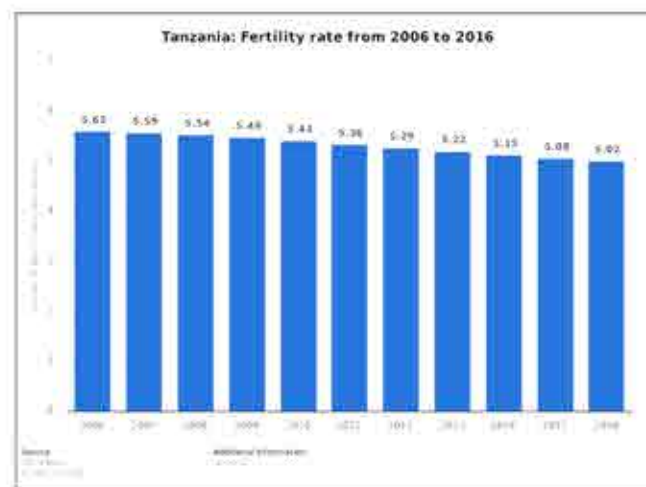


Figure 07. Fertility rate in Tanzania. Source: World Bank 2018.

## DEATH RATE

The death rate, while only a rough indicator of the mortality situation in a country, accurately indicates the current mortality impact on population growth. In 2017, the death rate in Tanzania amounted to 7.6 deaths/1,000 population.

This statistic shows the age structure in Tanzania from 2007 to 2017. In 2017, about 51.67 % of Tanzania's total population were aged 15 to 64 years. More than 20% of the population is aged between 15 and 24 years, which explains the high birth and fertility rate.

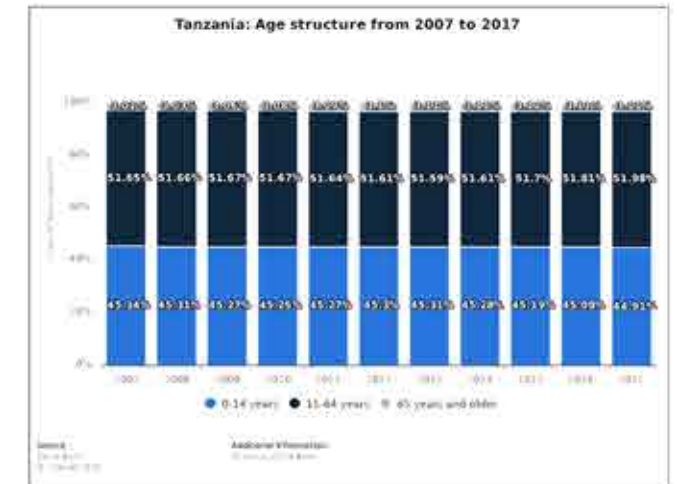


Figure 08. Age Structure in Tanzania. Source: World Bank 2018.



Picture 05. Marina, mother of 5, holding 2 of her grandchildren. Source : Photo by the author.



# Increasing Slums

According to the Oxford dictionary, a slum is defined by "A squalid and overcrowded urban street or district inhabited by very poor people."

As stated in Affordable land and housing in Africa (2011) "At household level, slum is defined by 5 different indicators, known as "shelter deprivation":

- **Durability:** A house is considered 'durable' if it is built on a non-hazardous location and has a structure that is permanent and adequate enough to protect its inhabitants from the extremes of climatic conditions such as rain, heat, cold and humidity.
- **Lack of water:** A household is considered to have access to improved water supply if it has sufficient amount of water for family use, at an affordable price, available to household members without being subject to extreme effort.
- **Overcrowding:** A house is considered to provide a sufficient living area for the household members if not more than three people share the same room.
- **Lack of sanitation:** A household is considered to have access to 'improved' sanitation if it has a private toilet or a public toilet shared by a maximum of two households.
- **Secure tenure:** is the right of all individuals and groups to effective protection by the state against forced evictions."

Housing that is characterized by one or more of the above shelter deprivations is defined by UN-HABITAT as **inadequate**.

Such housing, which is in poor condition or situated in a very high density area, is catered at a cost that low-income households could most probably afford; but such settlements are never healthy or comfortable places to live. The magnitude of households living in slums is expanding at an alarming rate in many African cities and especially Tanzania (UN-Habitat, 2003).



Picture 06. Mikosheni Slum in Dar es Salaam. Source: Unequal scenes.

According to the OECD Glossary of Statistical Terms, informal settlement is defined as follows:

1. Areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally;
2. Unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing).

According to estimates by UN-Habitat, 200 million people in sub-Saharan Africa were living in slums in 2010, or 61.7% of the region's urban population, the highest rate in the world.

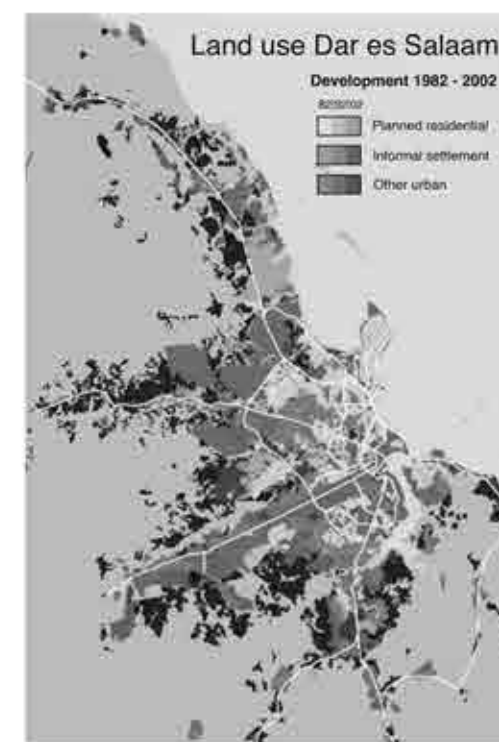


Figure 09. Land use development pattern. Source: Land use data by ITC, data digitised by IRPUD based on aerial imagery.

The majority of people who build houses in informal settlements in Tanzania access land through informal methods and the most common way is through the purchase of a land from local landowners. Other approaches include allocation by local leaders, inheritance and occupation without permit.

During the colonial period, the Germans in the 1889 declared "all land in Tanzania whether occupied or not as crown land vested under the German Emperor". The declaration was executed into a law in 1923 by the British and became the "Land Ordinance" which, with minor modifications and revisions, has guided land administration till today (UN-Habitat, 2010).

All lands in Tanzania are public land vested in the President as trustee for and on behalf of all citizens. In other words, the concept of private ownership of land does not exist. Which means that individuals or groups can have rights to occupy and use land on leaseholds for short terms of 2 years or long terms of 33, 66 or 99 years.

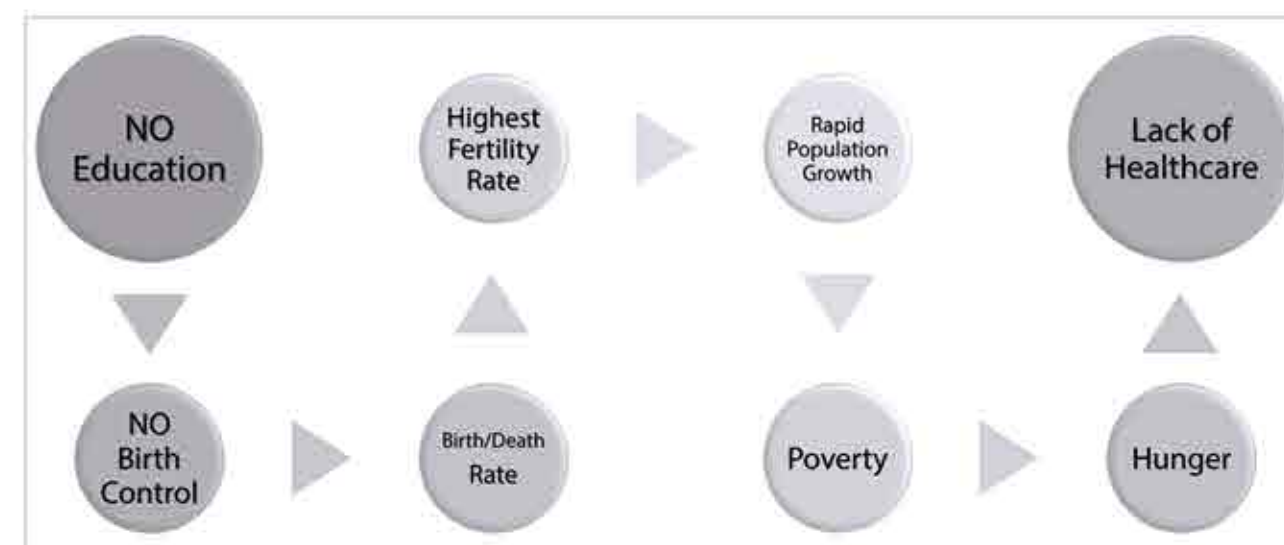


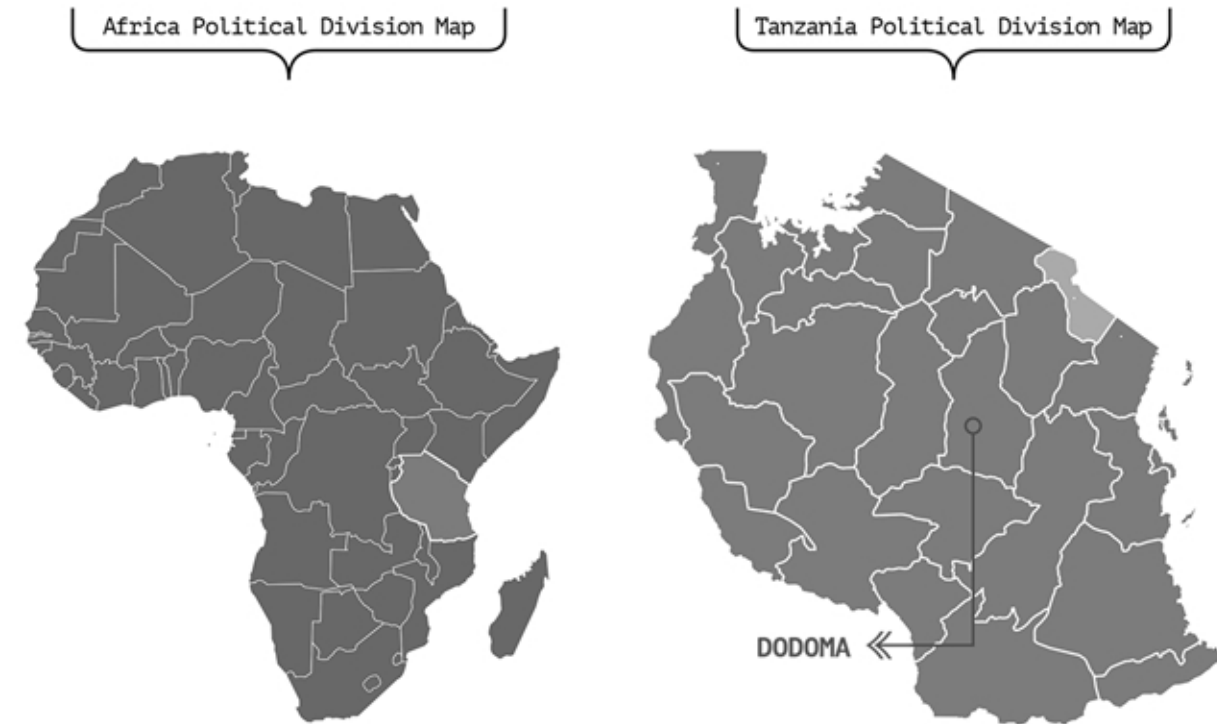
Figure 10. Africa's Demographic Variables. Source: Diagram by the Author.



## PART II - Shimbwe Village



Picture 01. Anna doing her laundry in buckets. Source: Photo by the Author.



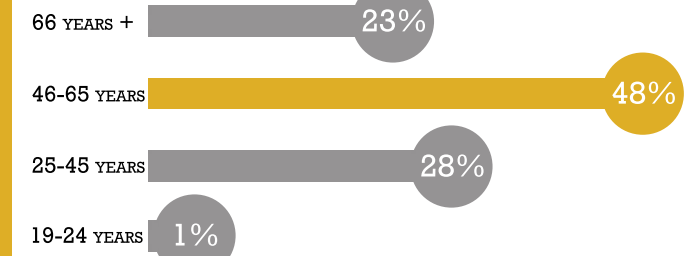
## SHIMBWE URU

- TANZANIA
- 6,186 KM
- GMT+3 TIME ZONE
- SWAHILI, CHAGGA
- SEMI-TEMPERATE INLAND CLIMATE

## INHABITANTS

6,107

## AGE STRUCTURE



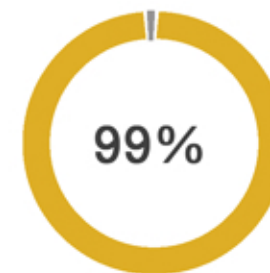
## GENDER



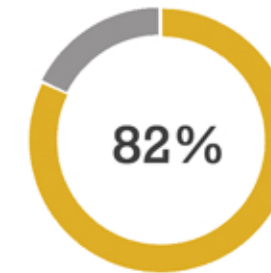
## HOUSEHOLD SIZE



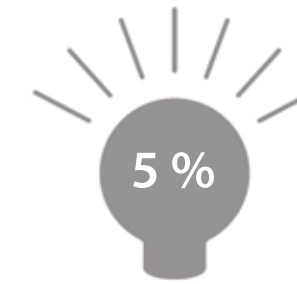
## LAND OWNERSHIP



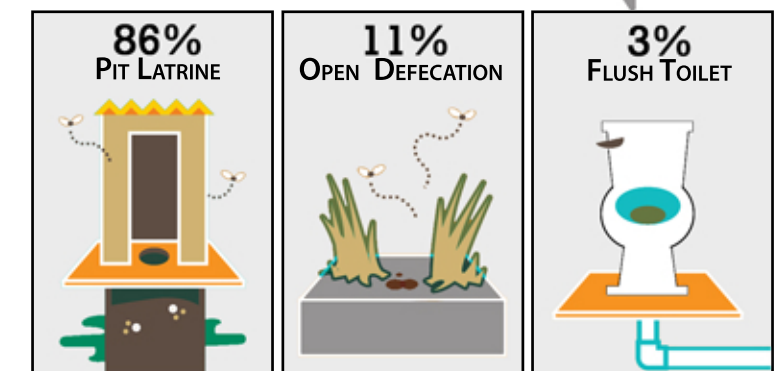
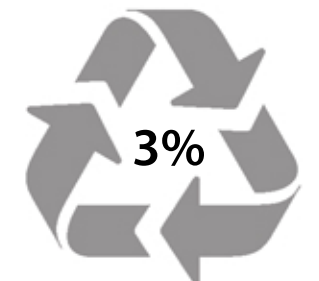
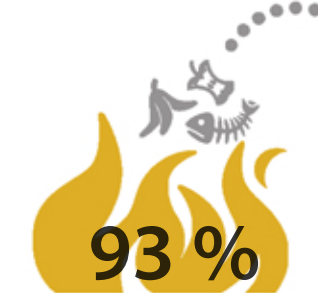
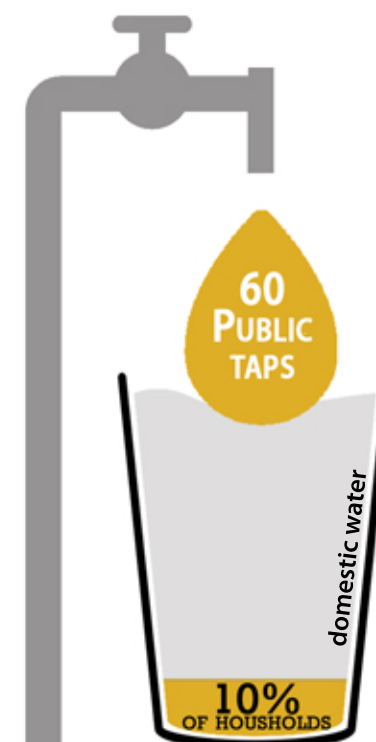
## POULTRY



## ELECTRICITY



## MINIMUM WAGE







Picture 02. View from Shimbwe Village. Source: Photo by the Author.



# Context

## SELECTION OF A CASE: WHY SHIMBWE?

Shimbwe village belongs to the Moshi Rural District into the Kilimanjaro mountainside; bordering the Kilimanjaro National Park and Materuni Waterfalls in the North area of Tanzania. Shimbwe Uru is divided in 7 sub-villages: Shimwe Kati, Tembeni, Sia, Tesheni, Kowere, Kireiyo and Ngaruma. In 2012, total population was of 6107 inhabitants with approximately 1200 houses which 392 of them are mud houses with walls made of wattle (interwoven sticks), mud and thatched roofs or corrugated metal roofs.

Objectives united when the village leader, Bertin Kami, announced that he is working on a new slogan which is to eradicate all the mud houses in Shimbwe. As to C-re-aid, the architectural NGO, is dedicated to promote long-term socio-economic and environmental improvement across Tanzania, and specially Shimbwe where it has already built few homes.



Picture 03. Chagga Tribe. Source: Ona Kwetu.

## CULTURE

The Chagga are Bantu-speaking indigenous Africans and the third largest ethnic group in Tanzania. They traditionally live on the southern and eastern slopes of Mount Kilimanjaro and Mount Meru, and near Moshi. They were one of the first tribes in the area to convert to Christianity. This may have given them an economic advantage over other ethnic groups, as they had better access to education and health care as Christians.

Traditionally, Chagga work has been centered on the farm and is divided by gender. Men's work includes feeding goats, building and maintaining canals, preparing fields, slaughtering animals, and building houses. Women's work includes firewood and water collection, fodder cutting, cooking, and cleaning the homestead and stalls. Women are also in charge of trading in the marketplace. The main language spoken by the Chagga people is Kichagga. It has various dialects spoken by Chagga in different regions. Despite these differences in dialect, the Chagga people can understand each another.

## POLITICS

Before 1900, conflict between chiefdom was resolved either through chiefly diplomas or warfare. In the 1950s, the Chagga ethnic group came under a single political leadership for the first time with the introduction of a Paramount Chief.

This decade marked a period of Chagga nationalism. After independence in 1961, the advantages of the colonial period placed Chagga elites in key roles in the new state. However, as Tanzania moved towards Julius Nyereres ujamaa socialism, the policies of the state began to clash with the more capitalist.

## ECONOMICS

About 95% of the population are farmers. On this mountain side lies the coffee and banana belt from the Kilimanjaro region, making these crops the base of the village economy. Each Chagga family has its own homestead in the middle of a banana grove. This is known as a kihamba (the plural of this word is vihamba).

Their relative wealth comes from the favorable climate of the area and successful agricultural methods, which include extensive irrigation systems, terracing, and continuous organic fertilization methods practiced for thousands of years.

Lack of adequate farm land is forcing Chagga youth to seek work away from the kihamba (family homestead). This has led to a breakdown in social values and an increase in sexual promiscuity. An increasing number of children are born out of wedlock.

## URBAN FACILITIES

Tanzania has undergone a period of economic hardship, limiting the government's ability to provide adequate social services. Public schools and health facilities have run down. As a result, many private schools and health facilities have opened in the Kilimanjaro region.

EDUCATION = Four primary schools, one secondary school.

HEALTH = One Health center (including dispensary)

ADMINISTRATION = One government office (Government employees are 54 out of 98 needed)

## INFRASTRUCTURE

ELECTRICITY = There are some areas provided with electrical installation, some others work with solar panels.

RUNNING WATER = There are a few public taps around the village with drinking water available for everyone.

STREET LIGHTING = There is no public lighting.

SEWER SYSTEM = There is no sewer system in the village, all the toilets work based on a pit latrine.



# Social Questionnaire

## FROM ROUND TO RECTANGULAR

The oldest forms of indigenous shelters were often round in shape. The traditional Chagga house was cone-shaped, with a roof thatched with dried grass. Another type of dwelling, also commonly built, was a house with a roof thatched with banana leaves. Because these houses tended to be large, they were built with the assistance of other villagers.

Swahili houses, initially constructed by chiefs, could be traced way back to the 13th century. By the end of the nineteenth century, rectangular houses were introduced, with walls made of wattle (interwoven sticks) and mud, and thatched roofs. Traditional houses are usually built with local building materials, which are easily collected around the village. In Tanzania, there is a rapidly changing building culture, due to globalization, climate change and environmental policies. Today, these houses are more commonly built with corrugated metal roofs; which was impossible to implement on rounded shaped houses.



Picture 04. Cone shaped Chagga house next to a recent rectangular shaped house . Source: Photo by the Author.

## RESEARCH METHODOLOGY

This chapter presents the research methodology used in the village of Shimbwe. The questionnaire was set to define the needs of the people, regarding an analysis of the current housing situation of the beneficiaries. The principal aim to this study is to understand how do the people of Shimbwe live their daily life? How do they use the space?

Results were used to develop/elaborate a housing prototype based on these answers. This study seeks to analyze issues like space use and spatial qualities, separation of functions, privacy, health and comfort.

## HOW WAS THE RESEARCH CONDUCTED ?

The village leader and its council selected one student from each sub-village to conduct this research in her/his own area.

The questionnaire has 78 questions divided unequally into 11 sections: family structure, modernity, cooking/eating, storage, sleeping arrangements, hygiene, activities, household information, future needs and financial situation.

The questionnaire was written in 3 different types of questions: rating scale 1 to 5 questions, Yes/no questions and multiple-choice questions. This way the students did not need to write down anything which gained time and confusion. Each questionnaire answered represents one mud house. Only one person living in the mud house answered the questionnaire. All the families who still live in mud houses are participating in this research.

Students first went to pre-test the questionnaire with only 4 families each (28 sample questionnaires) and then met again with the researcher in order to identify unclear questions and add missing answers. The questionnaire was then re-improved and translated to Swahili for effortless communication between the students and the families. The research was held over 2 weeks from December 3rd until December 14, 2018. Each student had approximately 60 families to visit.



Picture 05. Students participating in the questionnaire . Source: Photo by the Author.



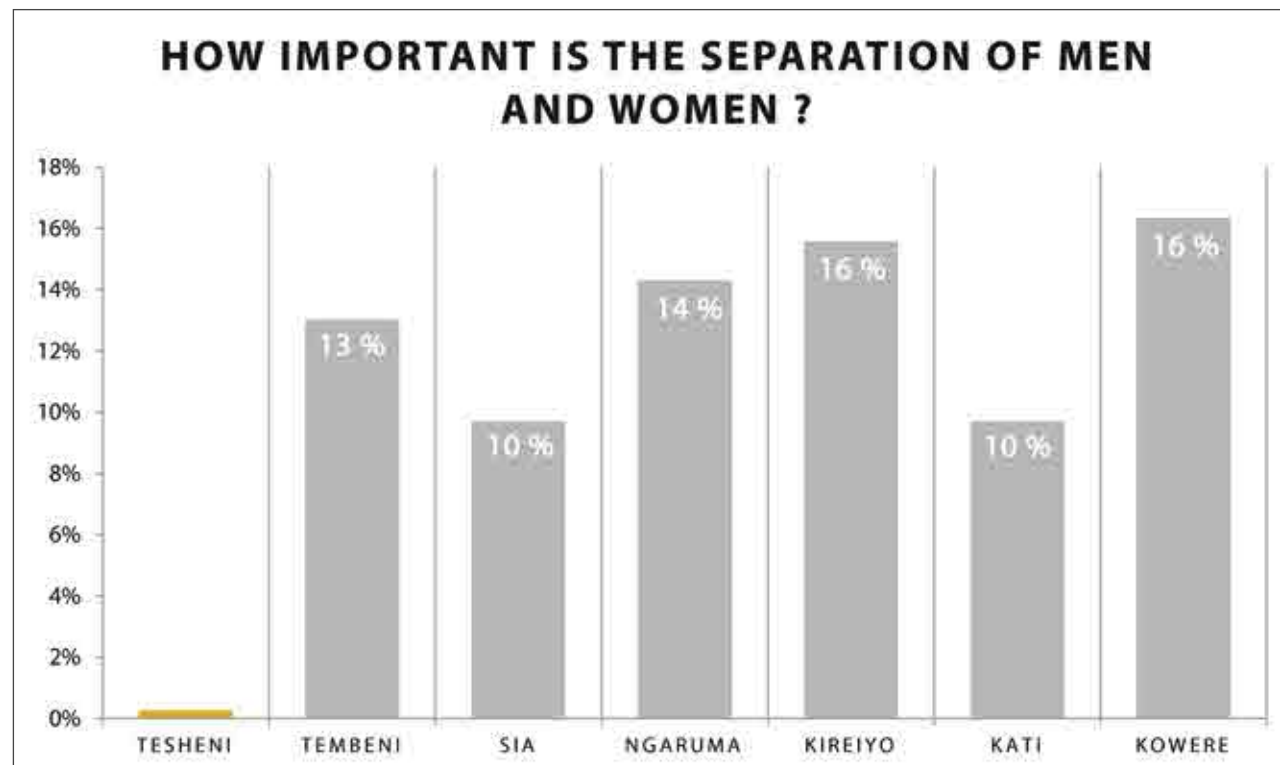
# Results of the Questionnaire

## GENERAL OBSERVATION

The majority of people we interviewed prefer not to live in mud and pole houses. %90 of the families in Shimbwe are not satisfied with their house.

## HOW IMPORTANT IS THE SEPARATION OF MEN AND WOMEN?

6 out of 7 sub-villages (326 out of 392 interviewees) claimed that separation is important between men and women or girls and boy; except Tesheni sub-village (66 out of 66 respondents) entirely disagreed. Separation between sexes is considered an important aspect by the respondents in order to ensure privacy and respect between different sexes and age groups. It is common in Tanzania that when teenagers turn 18 years and above, to stay with their parents until they can afford to stay by themselves by renting a room. Some families requested during meetings to have separate doors for young boys to come and go whenever they please without sharing the sleeping space with sisters or mothers.

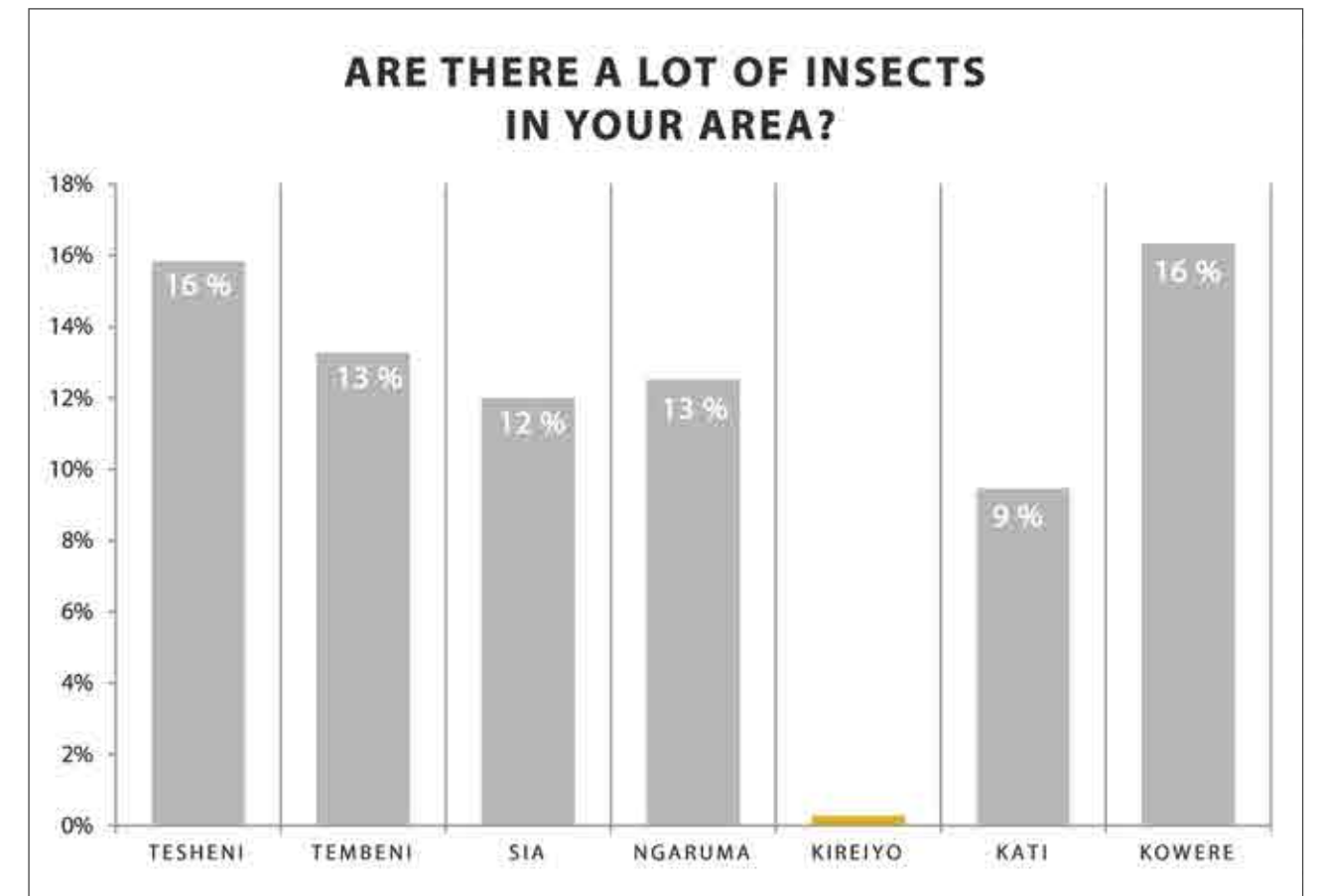


## ARE THERE A LOT OF INSECTS IN YOUR AREA?

The study shows that 81 % of the respondents said that there are lot of insects in the area. People who are complaining about insects most probably are living with animals in the same mud house, this attracts lice, fleas, ticks and bedbugs. It is very common to find a family sleeping nearby cows, goats while the chicken lay eggs under the bed. Indeed, 20% of the population in Shimbwe (78 households), keep their poultry inside their homes.

Since the questionnaires were dealt by sub-villages, it shows that Kireiyo sub-village (64 out of 64 families) is the only one to state that there are no insects nor vermin in the area. While, the 6 other sub-villages complained about that matter.

This means that no extra consideration for termites or vermin needs to be done in the housing design in Kireiyo sub-village. In fact, Kireiyo is modernizing faster than other sub-villages. Besides being the first sub-village to receive water and electricity; it is located near the health center where the villagers have easier access.



**MOST INFORMAL SETTLEMENTS ARE CHARACTERIZED BY THE LACK OF BASIC PUBLIC SERVICES AND FACILITIES. THESE FACILITIES INCLUDE CLEAN WATER, ACCESS ROADS, SANITATION, DRAINAGE AND EFFECTIVE SOLID WASTE COLLECTION AND DISPOSAL SYSTEMS"**

(NGULUMA & LUPALA, 2000)

## Results of the Questionnaire

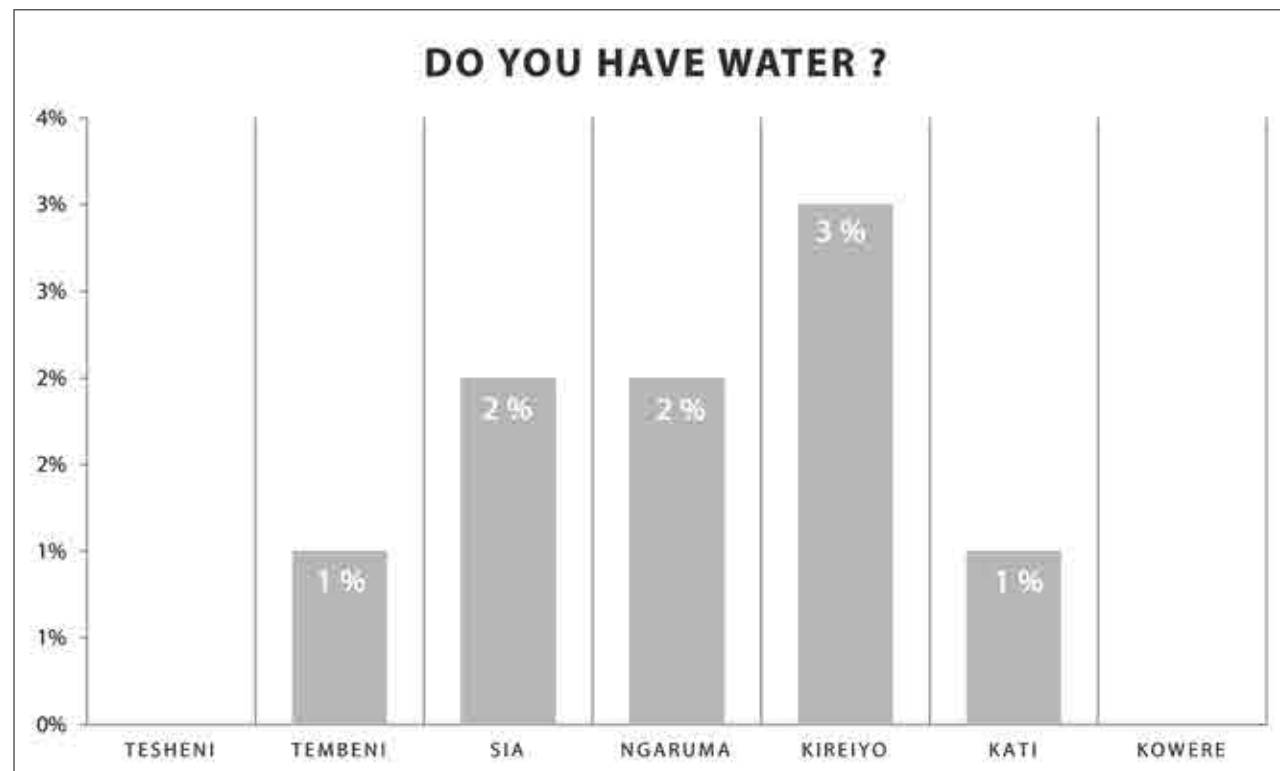


### DO YOU HAVE WATER ?

"All people should have safe and equitable access to water, sufficient for drinking, cooking and personal and domestic hygiene." Water availability is affected by seasonality: more water is usually available in the rainy season and less in the dry season. Adding to it, 10-35% of water is normally lost due to leakages, spillage and waste. (WHO, 2011)

Regarding clean water, only 9% of houses in Shimbwe have a private water connection. This diagram shows that Tesheni and Kowere have no access to water at all. For now, Shimbwe ward has three water intakes coming from the Kilimanjaro National Reserve: Kinyasha, Orawe and Kimboho intake. Many people cannot afford to pay for charges of tapping water to their homes. They are supposed to pay Tsh.150,000 (equivalent to 54 EU) as a charge fee to the Ward Water Committee.

The village leaders have decided to put 60 public water taps on roads to those who cannot afford it. The total area of Shimbwe is 6,185.6 km<sup>2</sup> which means approximately every 100 km<sup>2</sup> has 1 water tap. The UNHCR Emergency Handbook states that, according to long term standards, dwellings should be no further than 200m from water points.



Picture 06. Current houses of 2 out of 392 families participating in the questionnaire. Source: Photo by the Author.



## Results of the Questionnaire

### TOILETS

Answering the question «How do you see the issue of having toilets outside the house?» 91% of the people in Shimbwe (357 out of 392 residents) find the fact of having toilets outside the house satisfactory; only 8% stated that they would prefer the toilet inside.

Further in the survey, it was noted that 85% of all houses have a pit latrine as a form of sanitation and 10% do not have any kind of toilets which open defecation in this case would be using open land or waterways. Unfortunately, this is the only option for millions of people. This is the least sanitary option: waste is tracked by feet, flies and flooding, rapidly spreads disease and strong odor.

Same goes for showering, only 42% have a shower outside the house. 15% use the toilet area same space for showering. Another 11% share the shower with neighbors. Which makes 32% of the population of Shimbwe not having a shower and bathing outside in the nature behind the house.



Picture 07. Open defecation toilet. Source: Photo by the Author.

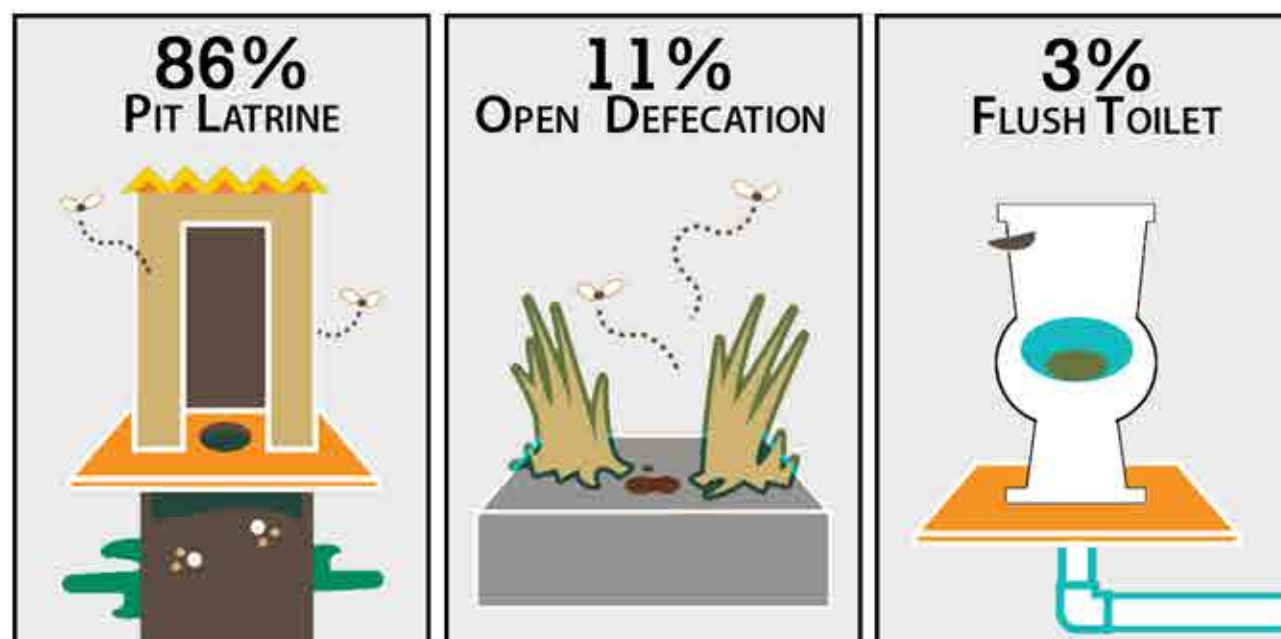


Figure 01. Percentages of three different types of toilets available in Shimbwe Village. Illustrations source toiletday.com



Picture 08. Pit Latrine toilet in Shimbwe Village. Source : Photo by the Author



Picture 09. Pit Latrine toilet in Shimbwe Village. Source : Photo by the Author



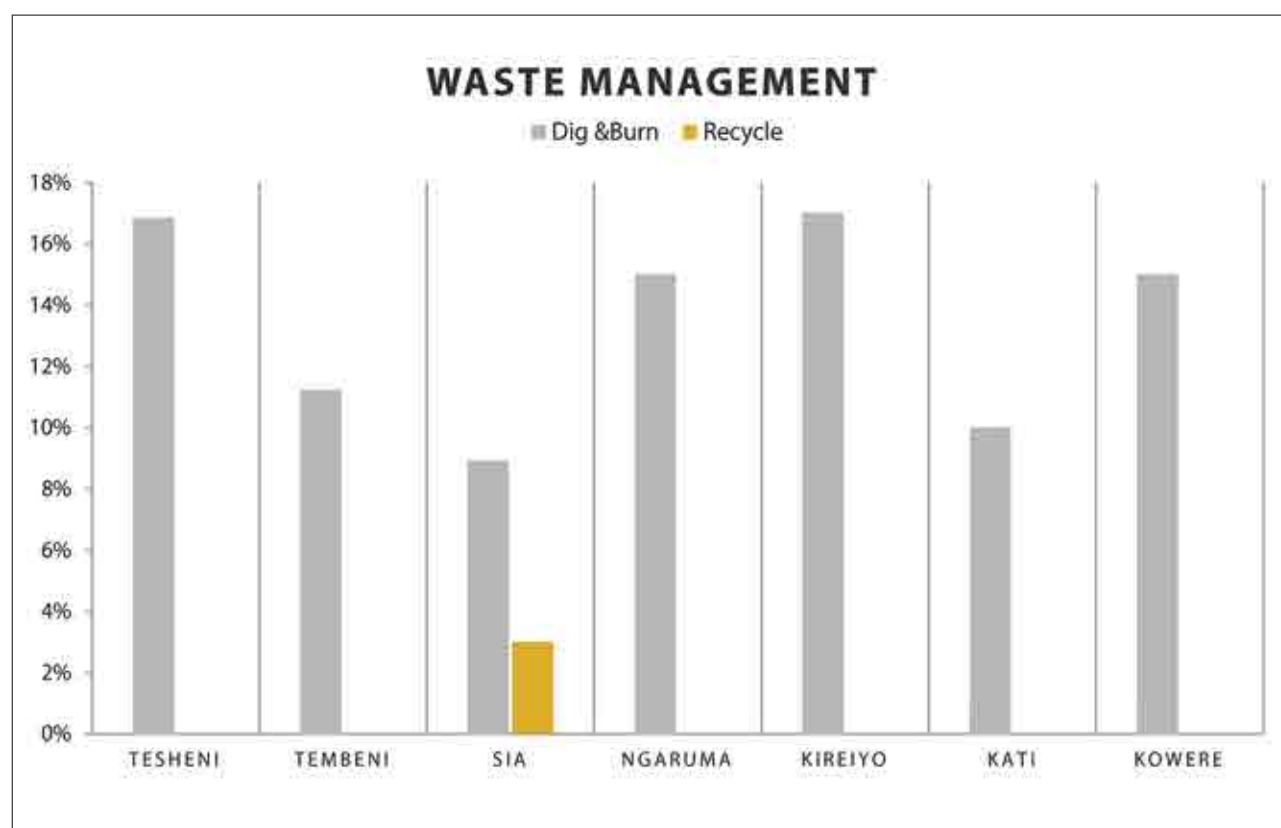
# Results of the Questionnaire

## WASTE

Several methods are used in waste disposal in Shimbwe, 1. open dumping and sanitary landfills disposal, 2. incineration which involves the burning of solid wastes at high temperatures. Only 3% of the families in Shimbwe recycle their waste; all of them are residents of Sia sub-village. Tesheni on the other hand, has the highest percentage, among all the sub-villages: 66 out of 66 families burn their waste.

Overall, 92% of the families in Shimbwe are burning their waste. They dispose through digging a pit and burning paper and plastic. Vegetable wastes are given to animals and toilet refuse disappear in deep pits. In unplanned settlements, solid waste is thrown everywhere because there are no areas designated for waste collection. In fact, no trucks are collecting waste from the settlement and very few households are found using waste bins.

The major reason for the lack of attention to this problem is paying for the service of waste collection. The majority of the households cannot afford the relatively high cost of this service. Lastly, there is no waste management in Shimbwe and no awareness about recycling, reusing or reduction of wastes.



Picture 10. Sandra and her family in front of their current house. Source : Photo by the Author



Picture 11. Anjelika and her family in front of their current house. Source : Photo by the Author



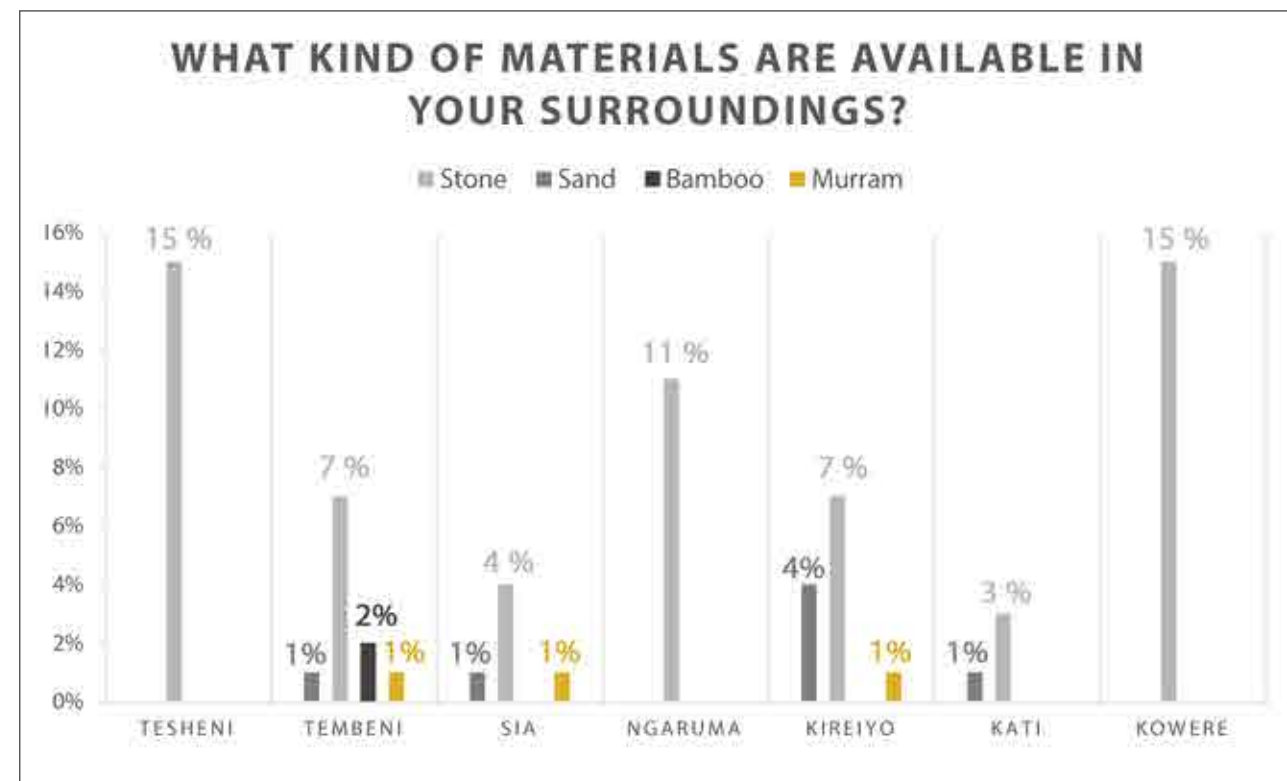
## Results of the Questionnaire

### WHAT KIND OF MATERIALS ARE AVAILABLE IN YOUR SURROUNDINGS?

Due to the diverse nature of the environment in Shimbwe and being in the Kilimanjaro mountain-side; various raw materials were recorded by the sub-villages. Stones, sand, bamboo and murram can be found in the area. 62% of the families have stones in their surrounding areas. Bamboo can only be found in Tembeni sub-village for only 3% of the families. Sand is available in Tembeni, Kireiyo and Kati for 7% of the families.

These numbers portray the fact that they can be used in the housing projects in the respective areas. Which means decreasing the cost of materials and transportation to site thanks to its availability in the area, making the budget even more affordable for the beneficiaries.

Another fact that could decrease the total budget of the project is having to pay less for labor 93% of all the families in Shimbwe confirmed that their family members could participate in the construction process.



### DO YOU KNOW WHAT IS THE PROFESSION OF AN ARCHITECT?

The word architect seems to be unperceived among the people of Shimbwe. Conversely, the town Ngaruma is familiar with this word: 55 out of the 71 positive answers are counted in Ngaruma; opposed to 322 families who haven't heard of this word. After gathering information from the village leader, it turned out that few graduated engineers and architects grew up in Ngaruma.

The confusion between Architect and Engineer is so familiar to many people in Shimbwe, even to middle class elites. The translation of the word architect in Swahili would be «Mbunifu». It has the root «bunifu» which is an adjective meaning imaginative. People in Tanzania are more used to the word «engineer» where it comes on the role of professionals in the design/construction process.

The word engineer in Swahili is «mhandisi» etymologically coming from an Arabic word. The construction activity in Shimbwe is guided by workers, known as «fundi» whose expertise is acquired on the job through learning by doing.

In this research, it was noted that the role of architect is marginalized by the *fundi*. The *fundi* and house owners take care of the design. It was revealed that after living or working in one area for a number of years, a *fundi* becomes known and trusted. Usually fundis are used rather than contractors. A verbal contract is made between the fundi and the owner settling roughly the needs.



Picture 12. Current house of one of the families participating in the questionnaire. Source: Photo by the Author.



# Results of the Questionnaire

## DO YOU OWN A LAND?

Lands are owned by the state; the government is the primary tool for land delivery. Citizens inherit lands, but they do not have title deeds which means they do not have the right to process loans from the banks. As a matter of fact, 388 out of 392 families of the population of Shimbwe own a land and while 4 families would consider taking a loan or a mortgage. When one looks at housing finance the general trend in Tanzania is that people are using their own savings and there is no housing bank.



Picture 13. Current houses of two families participating in the questionnaire. Source: Photo by the Author.

## LAND OWNERSHIP



## MINIMUM WAGE



## INCOME

Many of them depend on subsistence farming of banana trees and vegetables. They grow some maize and beans on their small farms for home use, they do not have any surplus for commercial purposes. They get very little cash from selling banana and coffee which is harvested only once per year. In subsistence agriculture, farm output is targeted to survival and is mostly for local requirements with little or no surplus trade.

Some 82% keep domestic animals such as 1 or 2 cows, few goats and sheep in zero grazing way. They cannot graze or keep large number of animals because, apart from having valleys and slopes, Shimbwe area is a rural land which is densely populated.

Food security is a problem to many families due to lack of reliable sources of income. The minimum wage of a day payment for a laborer is 3,000 Tsh/day (equivalent to 1€). The maximum day payment can get to 5,000 Tsh/day (equivalent to 1.78€). When asked do you have a business at home, 94% of the people in Shimbwe answered NO. This means that 6%, which is only 24 out of 392 families own a business such as a shop, a butchery, selling local brew or vegetable garden. In fact, only 4% of the families in Shimbwe have another form of income or some kind of help or donations.

## KITCHEN OUTSIDE

A lot of domestic activities take place outdoors like cooking, eating, washing dishes and washing clothes. Women cook outside the house in a separate kitchen, wash the dishes and clothes in buckets on the ground and have no space to eat inside.

Most households in low-income countries cook with firewood, which is known to produce fine particles that can get into the eyes and respiratory system. Wood smoke affects the quality of both indoor and outdoor air. The World Health Organization states that "If a woman cooks breakfast, lunch and dinner, it is equivalent to smoking between three and 20 packets of cigarettes a day."

In fact, 73% of the population of Shimbwe cook outside the house and mainly due to the reason that 99% of them use firewood for cooking. That also means that 104 families in Shimbwe are using firewood inside the house. Households can always collect firewood close to their homesteads since it is available all year-round and not prone to heavy seasonal fluctuations. And considering that many households can collect firewood for free, it will remain the cheapest energy source for cooking and heating.



Picture 14. Firewood kitchen. Source: Photo by the Author

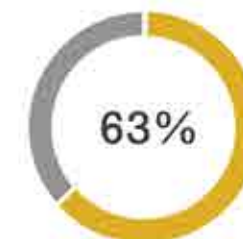
## FIREWOOD COOKING



## COOK OUTSIDE



## EAT OUTSIDE



## DISHES IN BUCKETS





## Cooking and Eating



Picture 15. Anna and her family eating outside on the ground. Source : Photo by the Author



Picture 16. Firewood kitchen. Source : Photo by the Author



Picture 17. Interior of Anna's house. Source : Photo by the Author



Picture 18. Indoor firewood cooking. Source : Photo by the Author



Picture 19. Outdoor firewood cooking. Source : Photo by the Author



## Results of the Questionnaire

### STORAGE

People living in informal settlements spend most of their days outside because of the congested indoor space. There is no space left inside, barely to accommodate beds due to the high number of residents in one space. Indoor space is used for sleeping and storing their belongings. Indeed 27 families do not have any form of bedding and only 172 out of 392 families have sleeping mattresses. Diversely, the other 193 families sleep on "locally made beds" made from tree poles and scrapped timber, using rags and other pieces of old clothes to sleep on. In this context the definition of sleeping space by Larsson (1988:45) is "sleeping space is the total floor area of all rooms used for sleeping (in beds or on the floor). There may be a sofa, a dining table, a stove or a kitchen-cabinet in the room but as long as somebody sleeps in it, I have called it a room for sleeping". As to storing, 76% of the people in Shimbwe are not satisfied of their storage space. 79% of the families in Shimbwe hang their clothes on a line. 95% keep their cooking utensils in plastic containers and store their dry food (rice, beans, sugar, maize flour etc..) in either buckets or plastic containers. Some households do not store food, but would purchase what they consume on a day-to-day basis.



Picture 20. Storage of kitchen tools. Source : Photo by the Author



Picture 21. Interior of Joseph's house. Source : Photo by the Author



## PART III - COMPRESSED EARTH BLOCKS MANUAL

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Picture 01. Bricks laying for curing. Source: Photo by the Author.



# How to read the Manual ?



## WHO IS THE MANUAL FOR ?

The manual has been intended for the Tanzanian population living in mud houses and hoping to build CEB homes with minimal resources.



## WHAT IS THE MANUAL?

The manual is an essential reference about building with Compressed Earth Blocks, shown by easy worksheets and step-by-step instructions to follow. This manual tries to show the advantages of CEB's to these non-ecological building materials.



## WHEN DO I NEED TO USE THE MANUAL ?

The manual can be used when the user has access to a CEB machine, the right materials and 2 other workers.



## WHY SHOULD I FOLLOW THE MANUAL ?

The advice is to follow the manual step by step to safely construct your home from durable earth blocks using an earth block press.



## HOW SHOULD I READ THE MANUAL ?

Before you start, always consider to contact an expert familiar with the content of this manual in order to help you.



Picture 02. Low-cost housing project in Shimbwe Village. Source: Photo by the Author.



# About the Blocks

Blocks of earth produced manually by throwing wet earth into a formwork are called “adobes” or “mud bricks” or “sun-dried earth blocks”. When moist earth is compacted in a manual or powered press, the resulting compressed elements are called “soil blocks”. In their unbaked state, bricks produced by an extruder in a brick plant are called “green bricks.” Larger blocks, compacted in a formwork by ramming, are called “rammed earth blocks or compressed earth blocks (CEB)”. If these blocks are interlocking, they are called “ICEB: interlocking compressed earth blocks”.



Picture 03. Bricks laying for curing. Source: Photo by the Author.

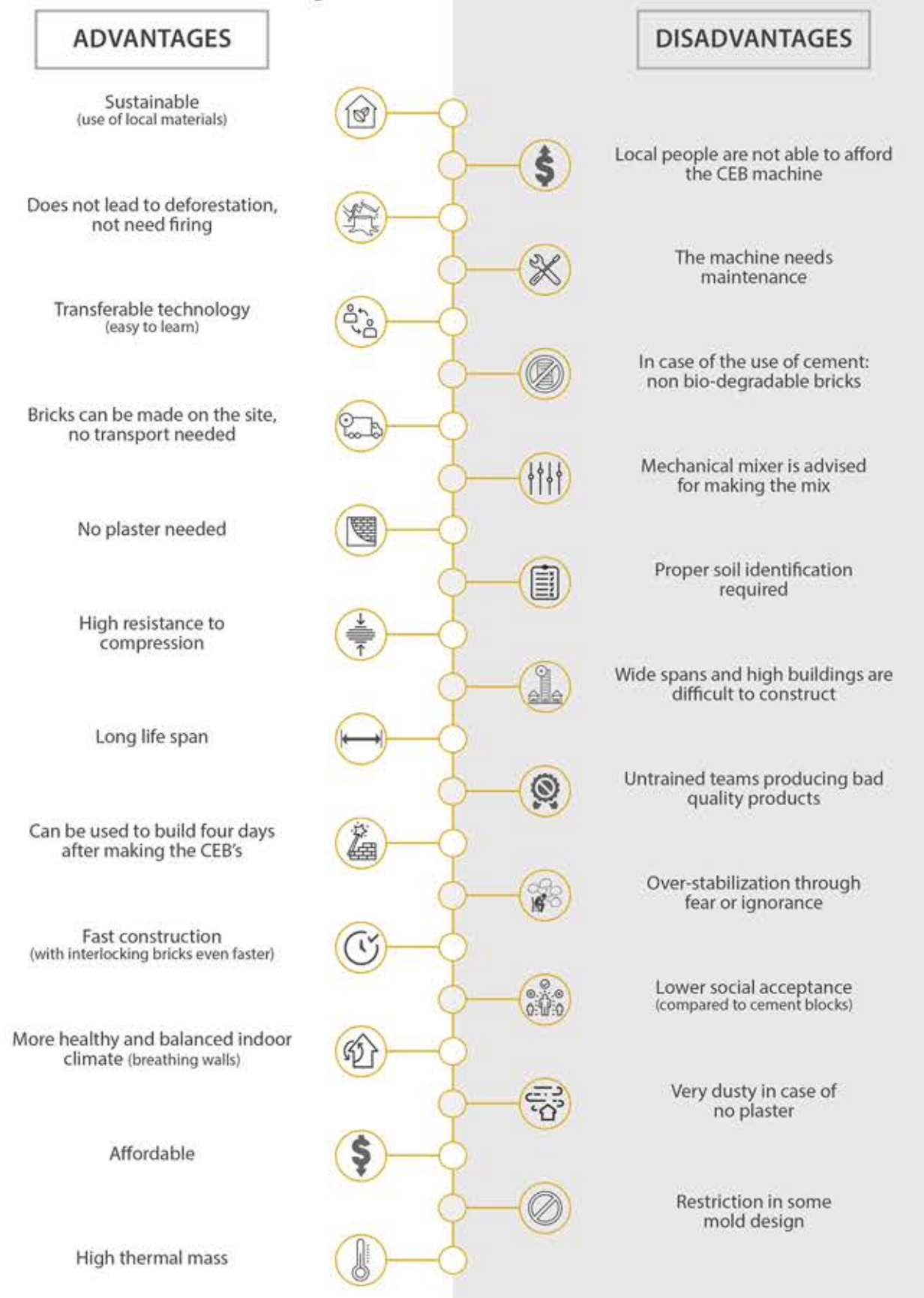
## Social Acceptance

The local population in developing countries are often skeptical towards building with earth. They have a higher regard for modern materials or building techniques like burned bricks, cement blocks, etc. because they are much stronger and more resistant against the impact of water (rain is an important factor for the degradation of the houses).

CEB's represent a considerable improvement over traditional earth building techniques. When guaranteed by quality control, CEB products can very easily bear comparison with other materials such as the sand-cement block or the fired brick. Hence the allegiance it inspires amongst builders and end-users alike.



## Compressed Earth Blocks





## Steps to follow

Choosing a  
Machine



Testing the  
Soil



Getting the  
Right Tools



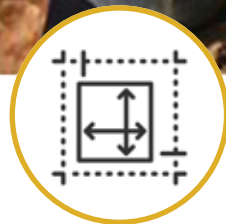
Testing the  
Mixes



Testing the  
Combinations



Getting the  
Site Ready



Building the  
Foundation



Producing  
CEB



Building  
Walls



Building  
Ring-beam  
and Roof



Openings



On-site  
Photographs



# Choosing a Machine

There are machines for making CEB's that works with or without electricity. The manual presses are more suitable for rural areas. It comes in several variations: you can make standard CEB's or ICEB's. These ICEB's also have different variations.

Although the machine is very heavy, it is important to fix the machine extra firmly to the ground, so it doesn't get lifted during the compression. The machine needs to be oiled every time 3-4 bricks are made, to prevent the soil from sticking to the metal. Make sure you don't use black oil, since it will leave visible stains on the bricks. When the work is finished, the machine needs to be cleaned carefully and placed inside.

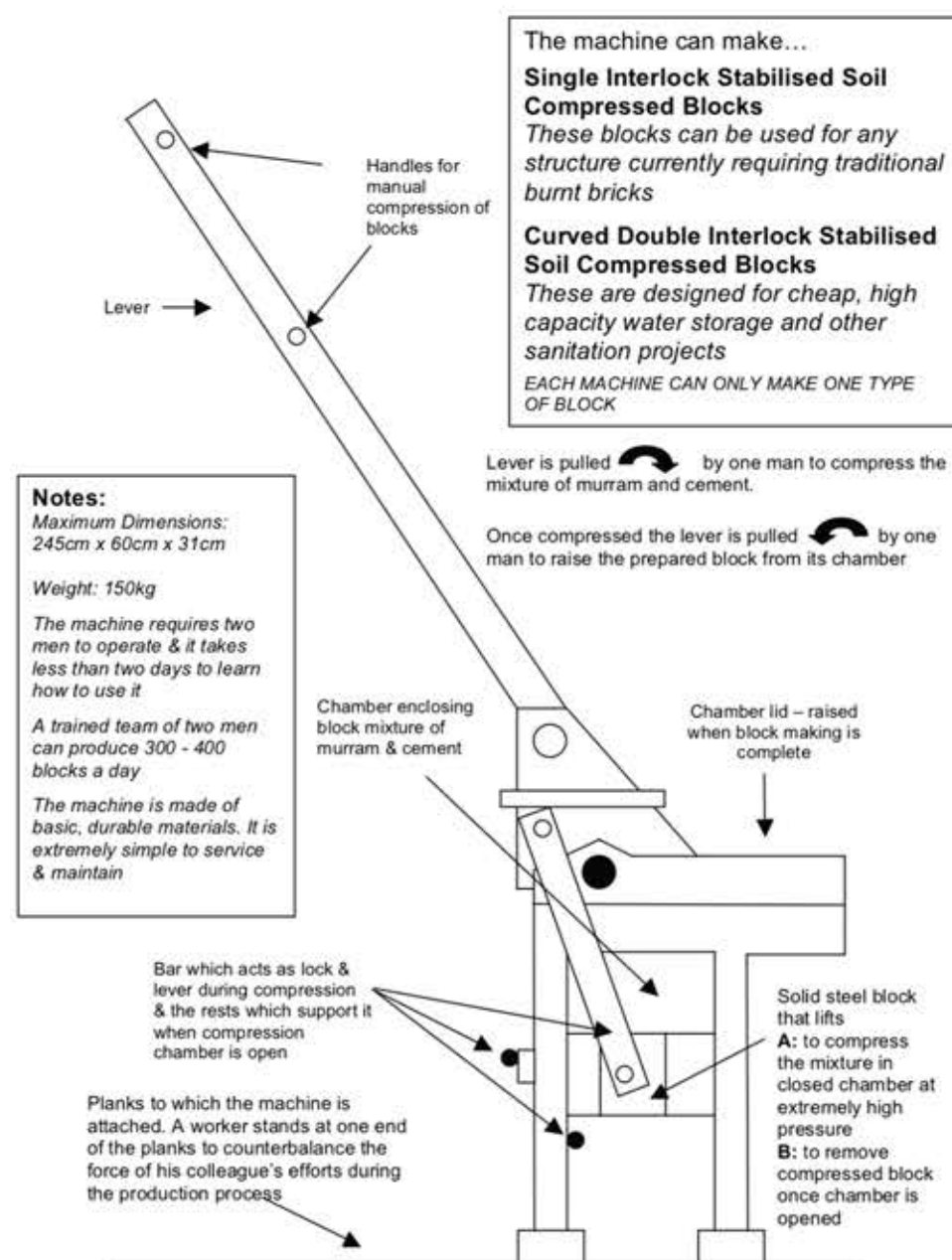


Figure 01. Drawing of the CEB machine used by C-re-aid NGO.



Picture 04. Tanzanian workers compressing earth blocks. Source: Photo by the Author.



# Testing the Soil

Almost all types of earth can be used to build walls. The quality of the earth is determined by the proportion of clay to sand. There are many types of earth in the composition of an earth sample. It is often necessary to combine earth from one area with some from another part of the site, even when the lot is small. A rich earth which has a lot of clay needs to be balanced out with sand, and a poor earth needs to be enriched with clay.

### Smell Test



- Pure loam is odourless; however, if it acquires a musty smell if it contains deteriorating humus or organic matter.

### Bite Test



- Sandy soil produces a disagreeable sensation.
- Silty soil gives a less objectionable sensation.
- Clayey soil gives a sticky, smooth or floury sensation.

### Washing Test



- Sandy soil is indicated when the sample is rubbed between the hands and grains can be distinctly felt.
- Silty soil is indicated when the sample is sticky but the hands can be rubbed clean when dry.
- Clayey soil is indicated when the sample is sticky and water is needed to clean the hands.

### Sedimentation Test




- The mixture is stirred with a lot of water in a glass jar. The largest particles settle at the bottom, the finest on top.
- This stratification allows the proportion of the constituents to be estimated.
- However, it is wrong to assert that the height of each layer corresponds to the proportion of clay, silt, sand and gravel.

Figure 02. Eight different soil tests in order to determine if the soil could be used to produce CEB.


In order to determine whether soil at a specific site can be used and in which specific mix, soil and mix tests should be conducted. Several points on a site need to be excavated to perform these tests. First remove the upper layer of earth that contains organic material and vegetation. Then remove samples of earth from different depths.

### Snowball Test




- The mixture has to be as dry as possible, yet, wet enough to form a 4 cm diameter ball.
- If the ball flattens slightly and shows few or no cracks, then it has a high binding force due to high clay content.
- If the ball breaks in many pieces, then it has an insufficient binding force due to low clay content.

### Consistency Test




- Moist earth is formed into a 2 to 3 cm diameter ball.
- If it is not possible, then sand content is too high and clay content is too low.
- If the ball can be crushed between the thumb and forefinger only with a lot of force, then clay content is high.
- If the ball crumbles easily, then the loam contains little clay.

### Cohesion Test



- The loam sample must be moist enough to be rolled into a 3 mm diameter thread without breaking. From this thread, a 6 mm thick ribbon and 20 mm wide is formed and held. The ribbon is then slid along the border to overhang until it breaks.
- Too much sand, if it breaks before 5cm. Too much clay, if it breaks after 15cm.

### Shrinkage Test



- The soil is placed in a mold of 4cm x 4cm x 40cm. This test will show the clay content.
- The mixture should shrink more than 1/10<sup>th</sup> of the whole length, which means 4cm in this case.
- If the mixture curves (so becomes longer), the soil cannot be used for building.



## GETTING THE RIGHT TOOLS

### MATERIALS



Sieved soil from the site



Lime / Cement / Additives...



Water

### MAKING BLOCKS



**3 to 6** Barrels  
to put the water and lime in



**2** Shovels  
for making the CEB mix



**1** Sieving mesh + wooden stand



**2** Buckets



**1** Watering can



**1** Pickaxe  
to dig soil



**2 to 4** Working gloves



**1** Knife and scissors

### MACHINE



**1** CEB machine



**1** Liter of Oil per **500** bricks  
for oiling the CEB machine



**1** Paint brush  
to apply the oil



**1** Spatula  
to clean the CEB machine



**4** Wooden planks  
to stabilize the CEB machine

### DRYING BLOCKS



Ropes around the CEB's  
to tie the plastic sheets



Plastic foil (size: 150mm x 280mm)  
to put under and on top of the bricks



Plastic sheets (8 sheets of 4m x 5m)  
to cover bricks



Picture 05. Little Tanzania girl, Nicole, helping to mix the soil. Source: Photo by the Author.



# Testing the Mixes

These tests were created to find an ideal mixture of CEB in terms of strength, cost and durability. In order to ensure cost-effectiveness with CEB, soil selection and testing are fundamental. 3 series of tests were conducted using 4 different additives: bagasse, fly ash, hybrid ash and sisal. The 3 series of tests have different binders: dry lime, cement and hydrated lime. These binders were used in different percentages just like sand and soil. Ultimately these tests hope to help refine the strength, economic viability and ecological impact of CEB's.

### BAGASSE

Bagasse fiber is the remaining after the extraction of the sugar-bearing juice from sugarcane



- Burned as fuel in the sugarcane mill or used as a source of cellulose for manufacturing animal feeds.
- The essential ingredient for the production of pressed building board, acoustical tile, and other construction materials and can be made into a number of biodegradable plastics.
- Readily available as a waste product with a high sugar content.

### FLY ASH

Fly ash is a fine powder that is a byproduct of burning pulverized coal in electric generation power plants



- When mixed with lime and water, fly ash forms a compound similar to Portland cement. This makes fly ash suitable as a prime material in blended cement, mosaic tiles, and hollow blocks, among other building materials.
- When used in concrete mixes, fly ash improves the strength and segregation of the concrete and makes it easier to pump.





### SISAL

Sisal is a hard fiber extracted from the leaves of sisal plants which grow best in hot and dry areas.



- An environmentally friendly fiber as it is biodegradable and almost no pesticides or fertilizers are used in its cultivation.
- Has good insulation properties and it is highly resistant to bacterial damage and to deterioration in saltwater.
- Being used in the construction industry as cement reinforcement for low cost housing, as plaster reinforcement and for roofing materials, as well as insulation.





Figure 03. Three different additives used in the mixes.

	 DRY LIME	 SAND	 SOIL	 ADDITIVE
Test 1	5 %	20 %	75 %	-
Test 2	10 %	20 %	70 %	-
Test 3	15 %	20 %	65 %	-
Test 4	10 %	15 %	75 %	Bagasse 5 %
Test 5	10 %	15 %	75 %	Fly Ash 5 %
Test 6	10 %	15 %	75 %	Hybrid Ash 5 %
Test 7	10 %	15 %	75 %	Sisal 5 %







Picture 06. Laying the bricks next to each other for curing phase. Source: Photo by the Author.



	 CEMENT	 SAND	 SOIL	 ADDITIVE
Test 8	5 %	20 %	75 %	-
Test 9	10 %	20 %	70 %	-
Test 10	5 %	15 %	75 %	Bagasse 5 %
Test 11	5 %	15 %	75 %	Fly Ash 5 %
Test 12	5 %	15 %	75 %	Hybrid Ash 5 %
Test 13	5 %	15 %	75 %	Sisal 5 %



Picture 07. C-re-aid NGO intern watering the bricks. Source: Photo by the Author.

	 HYD LIME	 SAND	 SOIL	 ADDITIVE
Test 14	5 %	20 %	75 %	-
Test 15	10 %	15 %	75 %	-
Test 16	5 %	15 %	75 %	Bagasse 5 %
Test 17	5 %	15 %	75 %	Fly Ash 5 %
Test 18	5 %	15 %	75 %	Hybrid Ash 5 %
Test 19	5 %	15 %	75 %	Sisal 5 %

### Strength Tests

Tests on bricks are conducted at construction site since there is no access to laboratories. The bricks should be tested after a little more than three weeks of drying.

**Scratch Test:** A good brick should resist scratches against sharp things. So, for this test a sharp tool is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick.

**Drop test:** A brick should not break when dropped flat on hard ground from a height of about one meter.



Picture 08. Strength tests in order to determine if the blocks are strong enough. Source: Photos by the Author.



# Testing Combinations

The Maji Moto wall tests were designed to test strength, combinations, junctions, corners and efficiency of build specifically for the vertical/horizontal interlocking CEBs used as part of the Dispensary Building in the village of Maji moto. The wall tests were designed and constructed in such a way that they could be later adapted into benches for the local community; as well as canvases for various plastering techniques and tests.

## Testing a vertical orientation of bricks



Bricks seemed secure



Could be used as overhead ventilation mechanism



Requires two courses of bricks which is uneconomical



Requires exact positioning and very precise levelling, time intensive.

## Testing corners and how to avoid cutting bricks



Strong construction but double leaf is uneconomical



Very time intensive



Still requires bricks to be cut



A lot of bricks break when cut



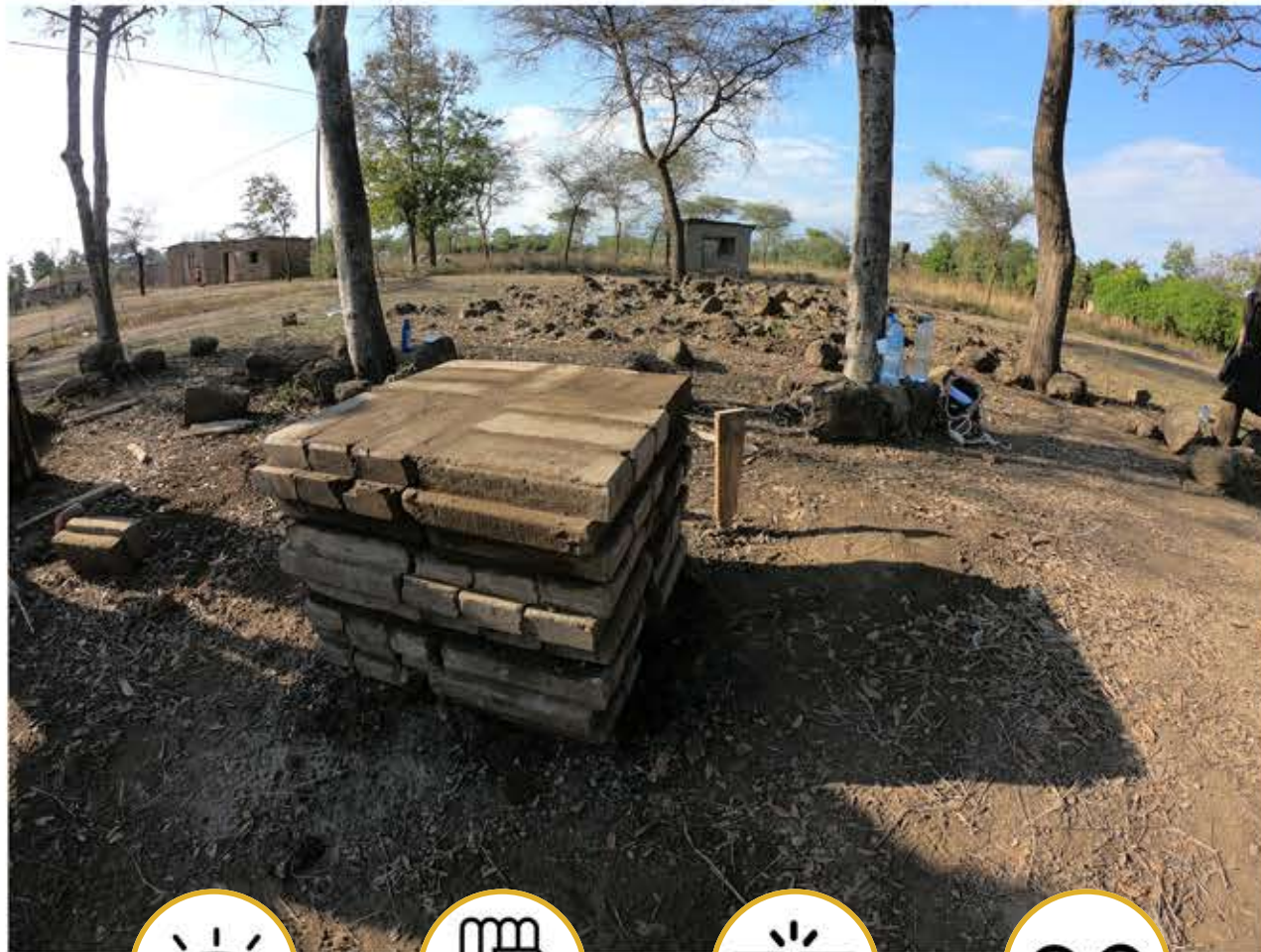
Picture 09. Interlocking bricks at corner. Source: photo by Author.



Picture 10. Interlocking bricks at corner, inside angle . Source: photo by Author.



## Testing a horizontal orientation of the bricks - aiming to construct a column



Visually attractive



Very Strong



Some minor subsidence issues



Requires a lot of bricks



Picture 11. Levelling bricks. Source: Photo by the Author.



Picture 12. Mortar between bricks. Source: Photo by the Author.

## Testing a T junction while looking to avoid cutting bricks



Strong construction but double leaf is uneconomical



Still requires bricks to be cut



A lot of bricks break when cut



The ends are left uneven and require cutting or plaster



Picture 13. Interlocking bricks. Source: Photo by the Author.



Picture 14. Local community using the bench. Source: Photo by Author.



# Getting the Site Ready

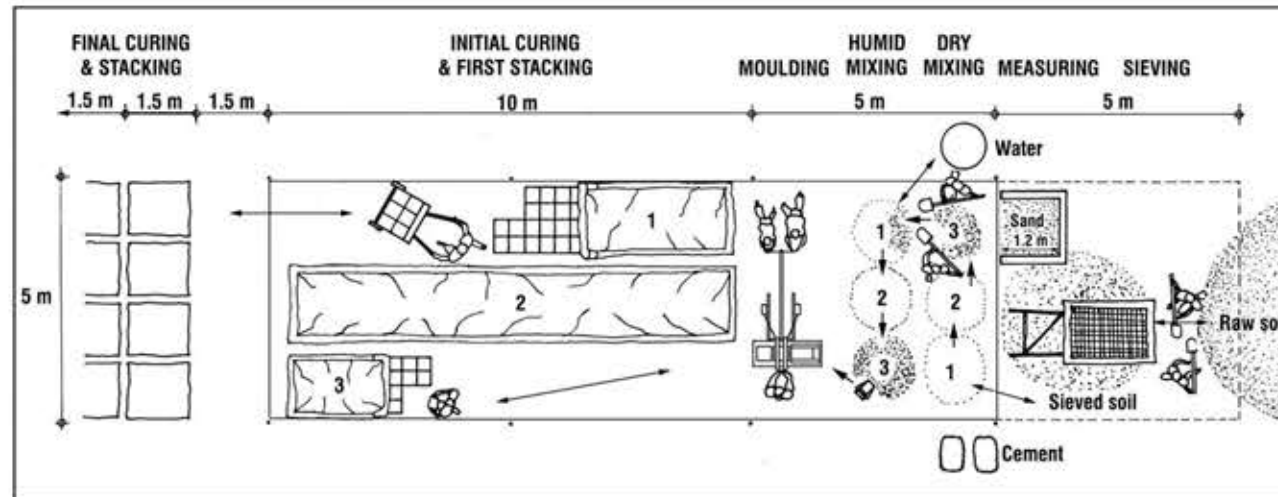


Figure 04. Typical Linear Blockyard Organization. Source: Earth Auroville Institute.



## 1 - REDUCE THE DISTANCE OF TRANSPORTATION

- Try to make minimal distance between the different phases of the blockyard.
- Organize the block-yard as close as possible from the site.
- Organise the storeroom as close as possible from the blockyard.
- Organise the final stacking area as close as possible from the blockyard.



## 2 - BEST EFFICIENCY

Optimise the ratio output / number of workers. The number of persons for digging & sieving will vary with the type of soil. The number of persons for the final curing & stacking will depend of the transportation distance.



## 3 - LINEAR ORGANIZATION

It is preferable to have a linear organization but a circular one can also be suitable.



Picture 15. Getting the site ready. Source: Photo by the Author.



Picture 16. After cleaning the Site. Source: Photo by the Author.



Picture 17. Sieving soil. Source: Photo by the Author.



Picture 18. Organization of the site. Source: Photo by the Author.



# Building the Foundation

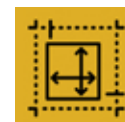


## 5 STEPS TO BUILDING A FOUNDATION



### 1. ECONOMIC

THE USE OF CYCLOPEAN CONCRETE FOR FOUNDATIONS AND FOOTINGS IS AN ATTRACTIVE SOLUTION FROM THE TECHNICAL AND ECONOMIC POINT OF VIEW. THIS TYPE OF STRUCTURE IS PERFECTLY SUITABLE FOR A LOW-COST CONSTRUCTION ON GOOD GROUND, BUT MUST BE WELL DONE.



### 2. CYCLOPEAN FOUNDATION

THE RUBBLE STONES SHOULD NOT TOUCH EACH OTHER, NOR BE LOCATED ONLY AT THE SIDES OF THE FOUNDATIONS

STONES WHICH TAKE UP THE WHOLE WIDTH OF THE FOUNDATION SHOULD BE LAID AT REGULAR INTERVALS. THIS SPACE ENCLOSED BY THE FOOTING IS FILLED WITH A LAYER OF NATURAL STONES AND A LAYER OF REJECT MATERIAL FROM SIFTING AT THE BRICKWORKS. THIS FIRST COARSE LAYER IS THEN COVERED OVER WITH A LAYER OF FINE GRAVEL COMPACTED AND RAISED TO THE LEVEL OF THE TOP OF THE FOOTING.

A CEMENT MORTAR AND GRAVEL SCREED FINALLY PROVIDE THE LEVEL SURFACE ON WHICH THE CEB WALLS WILL DIRECTLY BE BUILT.



### 3. CEMENT USE

FOR CYCLOPEAN CONCRETE FOUNDATIONS, RUBBLE STONES ARE INCORPORATED IN SUCCESSIVE LAYERS OF CEMENT MORTAR WHICH COATS EACH LAYER OF STONE WITH A COVERING AT LEAST 3 CM THICK.

THE OTHER ASPECT TO BE CONSIDERED IS HOW MUCH CEMENT TO USE IN CYCLOPEAN CONCRETE WHICH SHOULD BE DOSED AT  $250\text{KG/M}^3 = 250 \text{ KG OF CEMENT (5 BAGS)}$

+  $0.4 \text{ M}^3 \text{ SAND} + 0.8 \text{ M}^3 \text{ GRAVEL}$



### 4. DIMENSIONS

IN ALL CASES, THE TOTAL WIDTH OF THE FOUNDATIONS SHOULD BE AT LEAST 40 CM, AND AT LEAST 20 CM THICKER THAN THE WALL THICKNESS, DIVIDED BETWEEN BOTH SIDES OF THE WALL FACES STARTING FROM THE LONGITUDINAL AXIS. THE HEIGHT OF THE BODY OF THE FOUNDATIONS SHOULD BE AT LEAST EQUAL TO HALF THE WIDTH.



### 5. MOISTURE BREAK

IF THE FOUNDATIONS REQUIRE AN ANTI-CAPILLARY WATER-PROOF LAYER, THIS CAN BE MADE USING HIGHLY DOSED CEMENT MORTAR ( $500 \text{ KG/M}^3$ ), BITUMEN-BASED PAINT OR A BITUMEN OR PLASTIC FILM IF THESE MATERIALS ARE AVAILABLE. CYCLOPEAN CONCRETE CAN CONTINUE TO BE USED FOR THE FOOTINGS ; ABOVE THE FOUNDATIONS, IN WHICH CASE THE CYCLOPEAN CONCRETE MUST BE SHUTTERED AND THE STONES PLACED RIGHT UP AGAINST THE SHUTTERING.

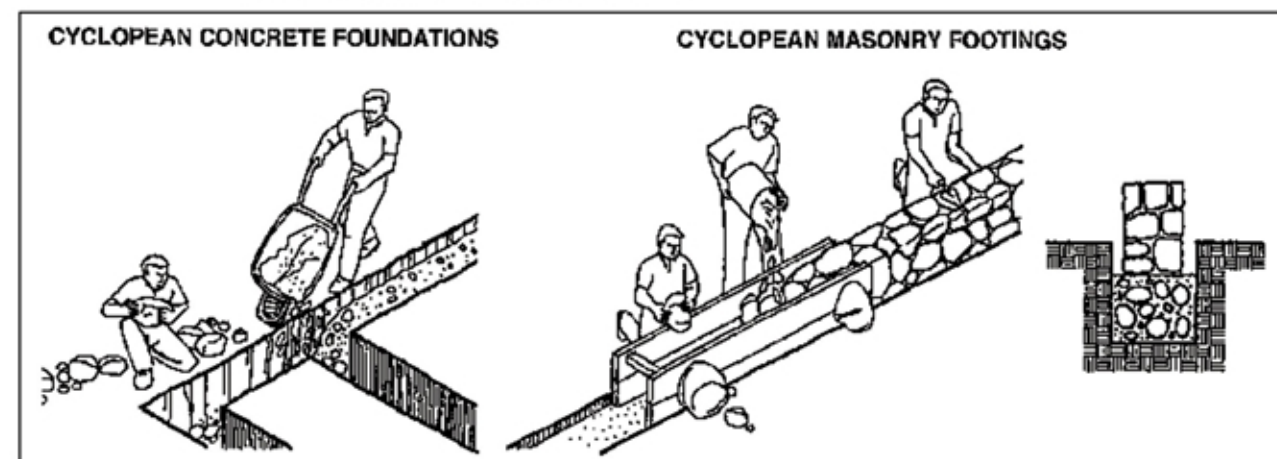


Figure 05. Drawing of cyclopean foundation. Source: COMPRESSED EARTH BLOCKS: MANUAL OF DESIGN AND CONSTRUCTION



# Producing CEB



## 7 STEPS TO MAKING COMPRESSED EARTH BLOCKS

### 1. DIGGING AND SIEVING SOIL

THE MAIN MATERIALS FOR THE CEB'S IS SOIL. THIS SOIL NEEDS TO BE EXCAVATED FROM THE SITE, DRIED AND SIEVED. ROUGHLY, IT CAN TAKE 2 PEOPLE EASILY 1 WEEK OF DIGGING AND 1 WEEK OF SIEVING TO GET ENOUGH SOIL FOR MAKING 5000 CEB'S.

### 2. MIXING

OBTAINING A MIX WITH THE OPTIMUM MOISTURE CONTENT FOR COMPACTION IS CRUCIAL TO THE QUALITY OF THE PRODUCT. THE LIME SHOULD BE PLACED IN WATER FOR 1 DAY BEFORE USING IT, TO BE ACTIVATED. PLACE WATER IN A BARREL AND THEN ADD LIME SLOWLY WHILE STIRRING AND ADDING MORE WATER SLOWLY. AT THE END, A WHITE LIME PASTE SHOULD BE FORMED. THE LIME SHOULD BE DISTRIBUTED EVENLY THROUGHOUT THE MIX.

**N.B. MAKE SURE YOU DO NOT BREATHE IN THE LIME DUST OR LET YOUR SKIN COME IN CONTACT WITH WET LIME.**

### 3. OILING THE MACHINE

OIL THE INSIDE OF THE MACHINE WITH A BRUSH, ESPECIALLY IN THE CORNERS, TO MAKE SURE THE SOIL DOESN'T STICK TO THE SURFACE OF THE MACHINE. PUT NEW OIL EVERY 3 BLOCKS (OR MORE/LESS, DEPENDING ON THE TYPE OF OIL AND THE TYPE OF SOIL).

### 4. STABILIZING THE MACHINE

PLACE A PIECE OF PLASTIC AT THE BOTTOM OF THE MACHINE, THIS WILL HELP THE CEB COME LOOSE MORE EASILY AFTER THE COMPRESSION.

### 5. MAKING THE CEB'S

- USING A SHOVEL, PUT THE MIX IN THE MACHINE UNTIL THE TOP WITHOUT PRESSING THE SOIL.
- PLACE ALSO A PIECE OF PLASTIC ON TOP TO PREVENT THE EARTH FROM STICKING ON TO THE MACHINE.
- CLOSE THE MACHINE AND COMPRESS THE SOIL. YOU HAVE TO CLOSE THE MACHINE COMPLETELY, IF THIS IS NOT POSSIBLE YOU HAVE PUT TOO MUCH SOIL IN THE MACHINE.
- OPEN THE MACHINE COMPLETELY SO THE CEB IS PRESSED OUT OF IT.
- TAKE THE CEB CAREFULLY AND PUT IT IN THE FIRST CURING AREA.

### 6. DRYING THE CEB'S

- THE BRICKS NEED TO BE PUT NEXT TO EACH OTHER TO DRY FOR 17 DAYS.
- FULL CURING TAKES 28 DAYS (THE FIRST 24H SEVERAL TIMES!)
- AFTER THE COMPRESSION, PLACE THE CEB'S ON THE FLOOR.
- COVER THEM WITH BLACK POLYTHENE WHILE THEY DRY.
- KEEP ON WATERING.
- AFTER THIS PERIOD, STACK THE BLOCKS IN LAYERS OF FIVE.
- COVER AGAIN WITH BLACK POLYTHENE AND LEAVE THEM TO DRY.

### 7. QUALITY CHECK

INTRODUCE A FULLY CURED BLOCK INTO A BUCKET OF WATER FOR A DAY TO OBSERVE ITS INTEGRITY AND REACTION. WHEN PULLED FROM THE WATER, IT SHOULD BE IMMEDIATELY SUBJECTED TO A COMPRESSION TEST. TO TEST WITHOUT MACHINES: AN ADOBE BLOCK SHOULD WITHSTAND MORE OR LESS 80 KG'S, SO WE CAN ASSUME THAT THE CEB WILL BE STRONG ENOUGH IF IT CAN WITHSTAND THE SAME PRESSURE.



# Building Walls



## 5 STEPS TO BUILDING WALLS

### 1. COURSING

THE LAYOUT OF THE CEB BUILDING SHOULD BE MADE ACCORDING TO THE SIZE OF THE BLOCKS. **COURSING A PLAN** ASSUMING THE USE OF A PARALLELEPIPED EARTH BLOCK MEASURING 30 x 15 x 15 CM. THE WALL THICKNESS IS EQUIVALENT TO 1/2 A BLOCK.

THE **VERTICAL COURSING** OF THE FACADES, WORKING UP FROM THE PLAN, IS JUST AS IMPORTANT AND INDISPENSABLE AS COURSING THE PLAN. IT PROVIDES THE EXACT NUMBER OF CEB COURSES AND ENABLES CAREFUL CONTROL OF THE VERTICAL DIMENSIONS OF THE OPENINGS, THE POSITION OF THE RING-BEAM AND THE THICKNESS OF THE MORTAR JOINTS.



### 2. MOISTURE BREAK

ALL MASONRY CONSTRUCTION NEEDS A MOISTURE BREAK TO PREVENT THE CAPILLARY ACTION OF THE MASONRY FROM DRINKING WATER UP INTO THE STRUCTURES WALLS. IT IS VITAL TO REMOVE SOURCES OF HUMIDITY, PARTICULARLY AT THE BASE OF WALLS AND AT THE LEVEL OF FOUNDATIONS AND FOOTINGS.

THE MOISTURE BREAK IS ACHIEVED USING **INSULATING PLASTIC SHEETING**.



### 3. MORTAR

THE FIRST COURSE OF CEB NEEDS TO BE PLACED AS LEVEL AS POSSIBLE. USING A REGULAR CEMENT MORTAR ALLOWS THE FIRST COURSE TO BE SET AND REMAIN LEVEL SO THAT COURSES WHICH ARE STACKED ON TOP OF IT ARE ABLE TO BE KEPT LEVEL WITH ONLY A THIN SOIL SLURRY.

THE SECOND COURSE OF STABILIZED COMPRESSED EARTH BLOCKS USES THE SAME PRINCIPLE AS THE FIRST, **LAYING STRETCHERS SHIFTED ALONG** TO AVOID VERTICAL JOINTS ONE ABOVE THE OTHER.



### 4. ATTACHING WINDOW / DOOR FRAMES

FIXING READY-MADE FRAMES OF DOORS AND WINDOWS DIRECTLY INTO COMPRESSED EARTH BLOCK MASONRY MUST BE WELL ANCHORED IN ORDER TO **HOLD THE DOOR-FRAME IN PLACE** AS THE WALLS ARE BUILT UP. THE OPENINGS SHOULD BE LOCATED SUFFICIENTLY FAR ONE FROM THE OTHER AND SUFFICIENTLY FAR FROM THE CORNERS OF THE BUILDING.



### 5. PLASTER

CEB WALLS CAN BE FINISHED IN SEVERAL DIFFERENT WAYS. LIME PLASTERS ON THE EXTERIOR AND EARTH PLASTERS ON THE INTERIOR IS THE BEST COMBINATION. CEMENT PLASTERS ARE NOT IDEAL BUT DO WORK WELL TO FINISH CEB WALLS EASILY.

RENDERS ARE GENERALLY APPLIED IN THREE LAYERS, BUT SOMETIMES TWO LAYERS SUFFICE.

- **THE FIRST LAYER**, KNOWN AS A "ROUGH COAT" IS MADE UP OF A FAIRLY FLUID MORTAR WHICH IS THROWN WITH FORCE ONTO THE SUPPORT USING A TROWEL. BETWEEN 3 AND 5 MM THICK, THE SURFACE OF THIS LAYER IS ROUGH SO THAT THE NEXT LAYER WILL STICK MORE EASILY.

- **THE SECOND LAYER**, KNOWN AS THE "COATING" IS APPLIED A FEW DAYS LATER (MINIMUM 2 DAYS) IN ONE OR TWO PASSES. THIS LAYER IS 8 TO 20 MM THICK AND IS CAREFULLY SMOOTHED USING A RULER; IT SHOULD DISPLAY NO CRACKS.

- **THE THIRD LAYER**, KNOWN AS THE "FINISHING RENDER", COMPLETES THE RENDERING PROCESS AND FILLS ANY SHRINKAGE CRACKS WHICH MIGHT HAVE APPEARED IN THE COATING. IT IS APPLIED WHEN THE COATING HAS COMPLETELY DRIED OUT. IT IS ONLY A FEW MM THICK AND IT CAN BE FINISHED WITH A PLASTERER'S HAWK WITHOUT APPLYING TOO MUCH PRESSURE.





# Building Ring-Beam & Roof



## 7 STEPS TO BUILDING RING-BEAM & ROOF



### 1. RING-BEAM DIMENSIONS

THE REINFORCED CONCRETE UPPER RING BEAM MUST HAVE THE SAME THICKNESS OF THE WALLS (IN THIS CASE IT IS THE THICKNESS OF THE BLOCK CHOSEN)



### 2. REINFORCEMENT

HORIZONTAL REBAR HELPS TO TIE THE WALLS TOGETHER. THESE LAYERS OF REINFORCEMENT PREVENT CRACKING FROM HAPPENING UNDER WINDOW OPENINGS AND GIVE FURTHER STRENGTH TO WALLS FOR GREATER SEISMIC AND WIND RESISTANCE ALLOWING FOR GREATER SAFETY AGAINST NATURAL DISASTERS. THE RING-BEAM ENSURES GOOD TRANSMISSION OF LOADS AND ALLOWS A HIGHLY ORGANIZED MASONRY STRUCTURE TO BE FORMED.



### 3. STEEL FEET

INSTALL STEEL FEET THAT WILL BE JOINING WOOD RAFTERS THROUGH STEEL BOLTS.



### 4. CONCRETE POURING

IT IS POURED INTO A CORRECTLY BONDED LOST FORMWORK MADE FROM CASTING WOOD PLANKS.



### 5. WOODEN RAFTERS AND BEAMS

THE BUILDING SOLUTIONS ADOPTED FOR THE ROOF STRUCTURES OF THE VERY LOW-COST HOUSING ARE SIMPLIFIED, NOTABLY TO AVOID THE USE OF TRUSSES.



### 6. SLOPING ROOF

THE SLOPE MUST BE SUFFICIENTLY GREAT AND THE ROOF OVERHANG MUST BE SUFFICIENTLY WIDE (MINIMUM 30 CM) FOR THE RAINWATER TO BE PROJECTED AWAY FROM THE WALL.



### 7. ROOF COVERING

THE ROOF COVERING IS SIMPLY ACHIEVED, IN A VERY CONVENTIONAL WAY, WITH TIMBER FRAME COVERED WITH CORRUGATED IRON SHEETS ATTACHED BY BOLTS GOING THROUGH THE PURLINS WITH PERIPHERAL OVERHANG.





Picture 19. Front view of window prototype, developed with C-re-aid NGO, made from recycled wine bottles casted in concrete. Source: Photo by the Author.



Picture 20. Back view of window prototype, developed with C-re-aid NGO, made from recycled wine bottles casted in concrete. Source: Photo by the Author.



Picture 21. Front view of window prototype, developed with C-re-aid NGO, made from recycled wine bottles in wood frame. Source: Photo by the Author.



Picture 22. Back view of window prototype, developed with C-re-aid NGO, made from recycled wine bottles in wood frame. Source: Photo by the Author.



Picture 23. Local students helping with transport of materials in Maji Moto village. Source: Photo by the Author.



Picture 24. Local community using the combination tests as benches for community meetings in Maji Moto village. Source: Photo by the Author.





Picture 25. Doctor's house by Studio totale Firenze and C-re-aid NGO portraying roof structure, ring-beam and CEB. Source: Photo by Studio totale.



Picture 26. Tanzanian worker cleaning mortar leveling. Source: Photo by the Author.



Picture 27. Wooden joint in roof. Source: Photo by the Author.



Picture 28. Wooden joints for roof sticks. Source: Photo by the Author.



Picture 29. View from Doctor's house in Maji Moto, using interwoven wooden sticks as a roof shade. Source: Photo by Studio totale Firenze.



Picture 30. Interior of Doctor's house in Maji Moto portraying wooden beam structure for corrugated iron sheets. Source: Photo by Studio totale Firenze.



Picture 31. Tanzanian worker fixing interwoven wood sticks to wooden frame. Source: Photo by the Author.



Picture 32. Interwoven wooden sticks in wood frames. Source: Photo by the Author.



## PART IV - DESIGN PROPOSAL



Picture 01. Structure of walls made from wooden sticks in Shimbwe. Source: Photo by the Author.



## Case Study 'Echale a tu casa'



According to government figures, Mexico has a housing deficit of approximately 9 million homes. The destruction caused by the earthquake of 2017 made an already dire situation worse. 300,000 homes were damaged and 100,000 collapsed after the earthquake of 2017. This means that 400,000 million people became homeless from one night to another.

Francesco Piazzesi, the founder and CEO of "Echale a tu Casa", worked on a solution to help those who are not eligible for any housing credit or support. He came up with a model that makes the community part of the solution.

Eco block is the key to his model. First, It is produced on site. "Echale a tu Casa" brings the equipment to the community, then train the community in order to produce the blocks by themselves; and get paid for the production. The model combines community organization, social inclusion, financial education, technical training and social franchising. The goal is to build around 1,500 new homes and enable 6,000 home improvements per year.



### Social Inclusion

We strengthen the welfare of the community based on its own values, uses and customs; thus the improvement is permanent since the solutions arise from the members themselves.



### Financial Education

We promote financial education in families. The savings culture benefits people, families and communities.



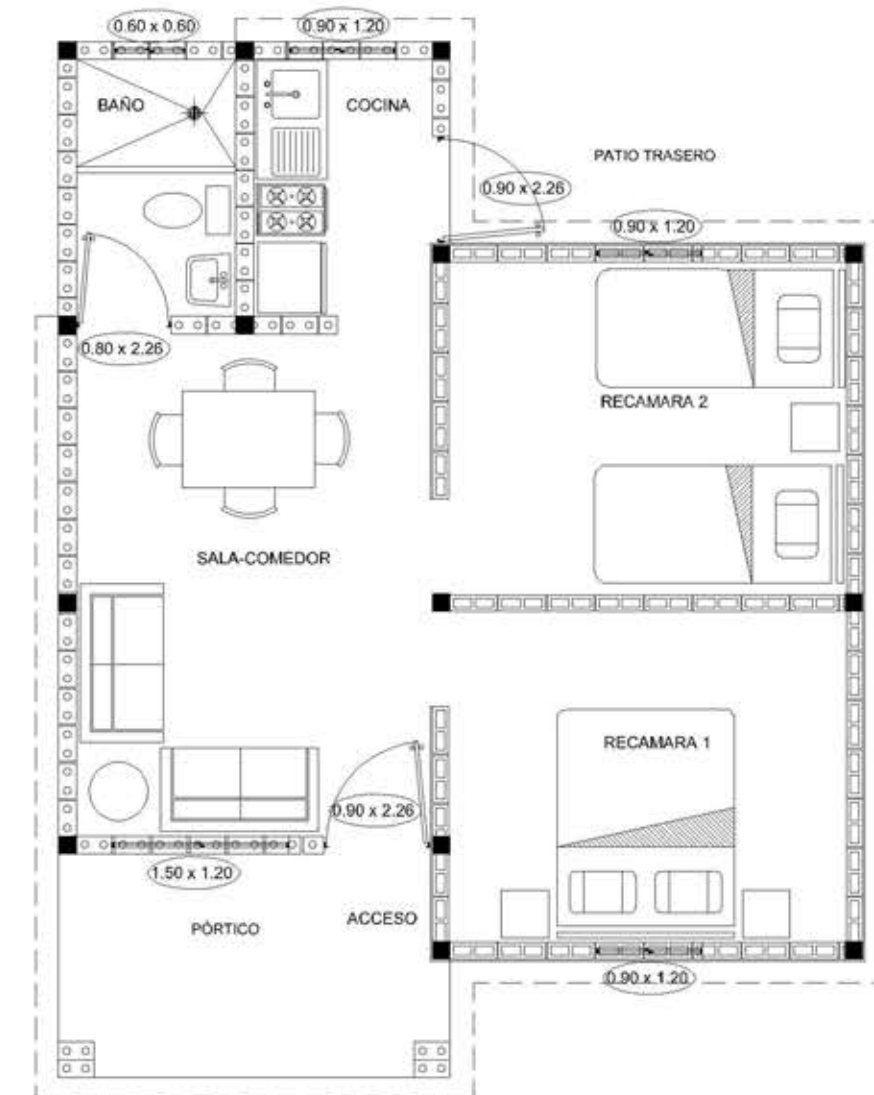
### Technical training

Our technicians provide technical training in the use of this technology. Their learning is easy and safe for women, men and young people.



### Scalability

The model is replicable to promote sustainable development.





# Case Study 'Build up Nepal'



Picture 02. Shanti Majhi working in construction for her own house. Picture 03. Housing project by Build up Nepal. Source: Build up Nepal.

Build up Nepal works as construction partner to INGOs/NGOs and entrepreneurs helping to start building using local materials. We provide machines, training, technical support and project management. For the past three years, we have developed a method for engaging the construction ecosystem including government bodies, NGOs, and private sector construction stakeholders to ensure that families are able to build safe, affordable homes.

Build up Nepal is offering a 3.5 room house for 40 m<sup>2</sup>. (incl. veranda and utility area), for the cost of 7070.15 EU including toilet, kitchen, electricals and painting.

“

MAKING BRICKS AND BUILDING MY OWN HOUSE WAS THE MOST DIFFICULT WORK I EVER DID IN MY LIFE. BUT IT WAS SATISFYING TO FEEL THAT I WAS CAPABLE TO BUILD MY HOUSE BY MYSELF EVEN WITHOUT MY HUSBAND WHO IS ABROAD. So, IT FELT GOOD AT THE END OF THE DAY DESPITE MY BODY ACHED.” (SHANTI MAJHI, 2015)



Construction Enterprises started in  
**135 villages**  
12 123



**2600 Jobs**  
created in rural areas  
770 1830



**1885 Homes**  
22 schools, 5 health posts  
& 14 community buildings  
completed or under construction  
together with our partners and entrepreneurs



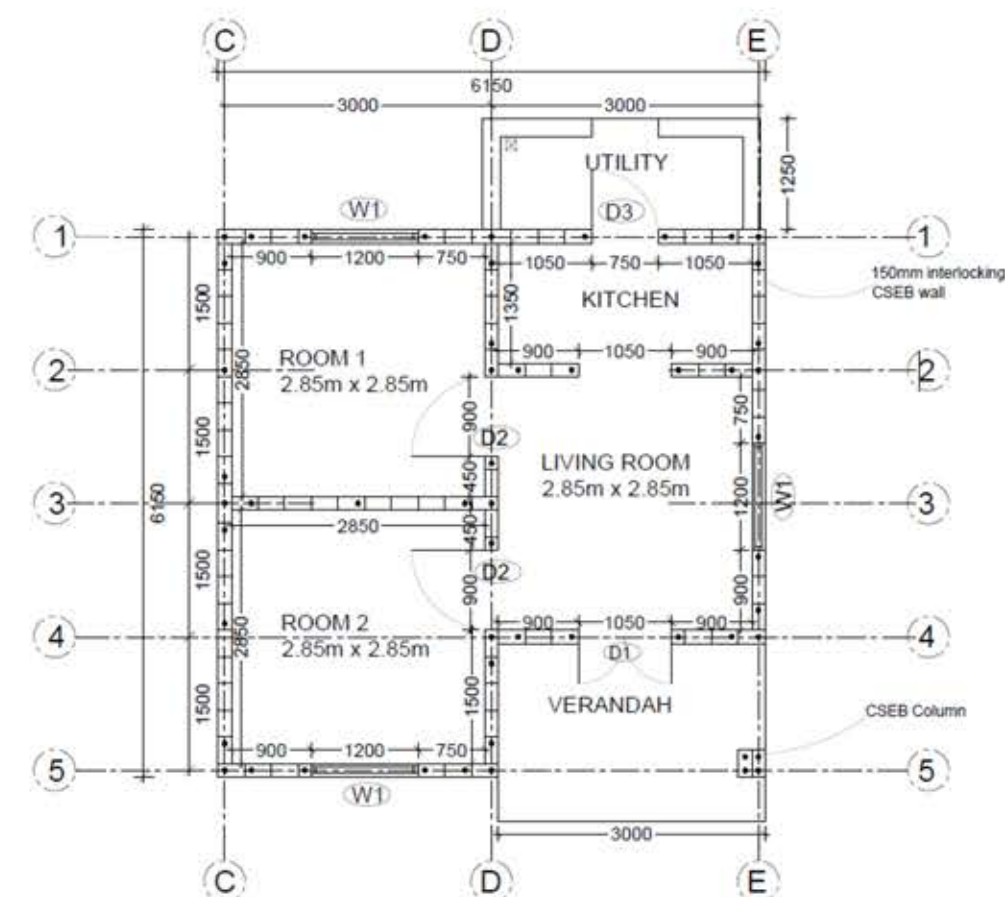
**8105 ton CO<sub>2</sub>**  
saved compared to  
using fired bricks



**2702 flights** (roundtrip)  
London to Kathmandu



Floorplan



**FLOOR PLAN**  
**AREA= 33.3 sq.m**

(inside living area – excl. verandah and utility area)



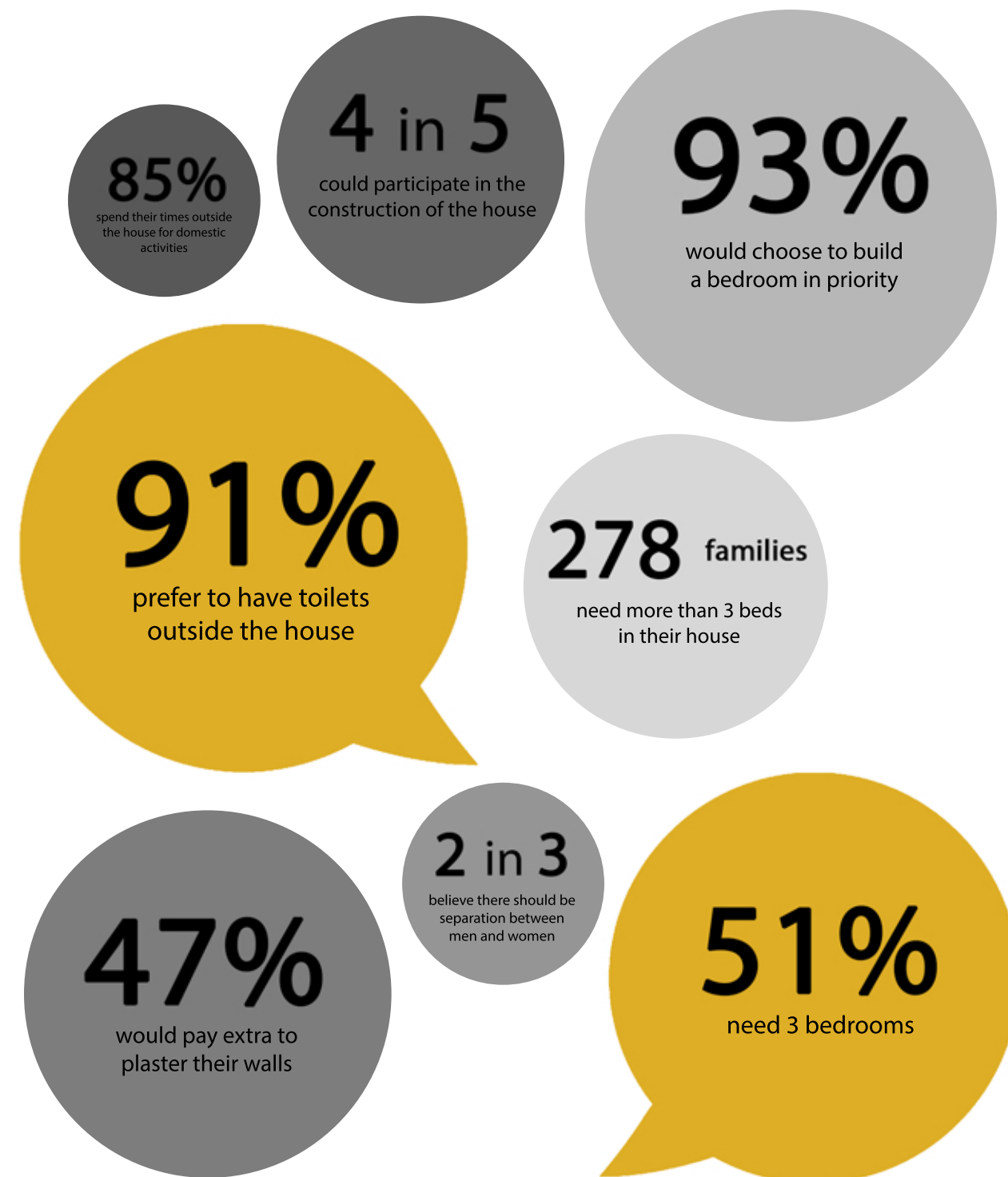
The picture is showing two 3.5 room houses joined together. This way families can save additional cost.

Picture 04. Two adjacent low-cost houses by Build up Nepal. Source: Build up Nepal



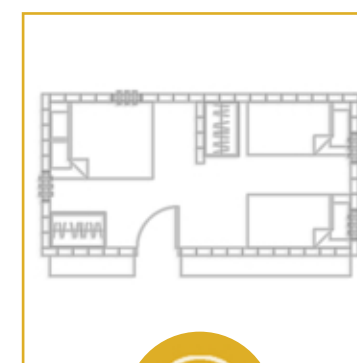
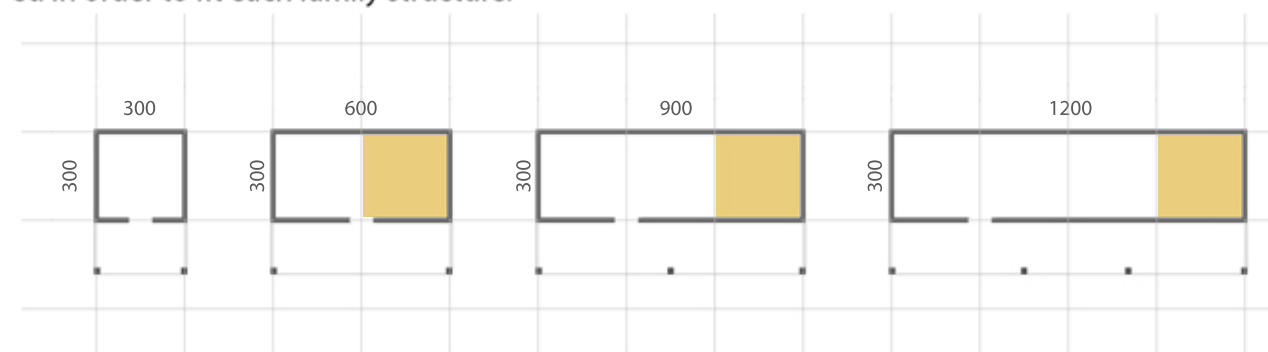
# Basis of Design

392 families participated in the questionnaire in Shimbwe to transmit their needs and expectations in their future hypothetical homes. The most important answers, related to design and space purposes, are portrayed in this diagram. According to their answers, the following prototypes were developed based on findings in the research.

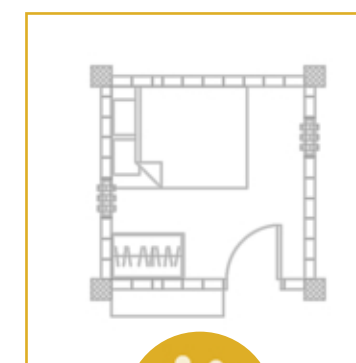


## DESIGN PROPOSAL

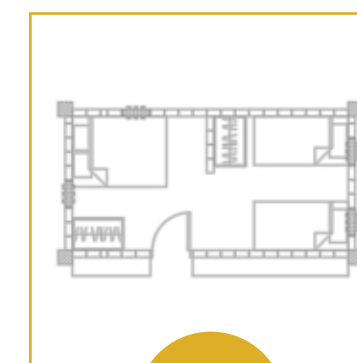
A design proposal is suggested based on the needs of the people of Shimbwe. The questionnaire revealed that these families can afford a house from 1.5 million to 5 million shillings equivalent to 570 € to 1900 €. A design of added modules 3 meters by 3 meters (each module of 9m<sup>2</sup>) is suggested in order to fit each family structure.



**Phase 1**  
Two modules  
Basic prototype  
1240 €



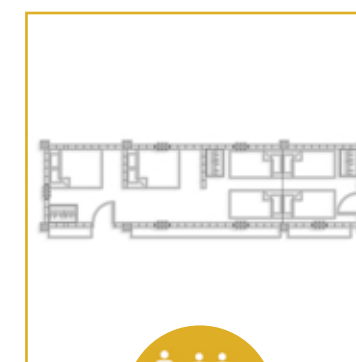
**Phase 2**  
One module  
concrete columns  
1196 €



**Phase 3**  
Two modules  
concrete columns  
1550 €



**Phase 4**  
Three modules  
concrete columns  
2126 €

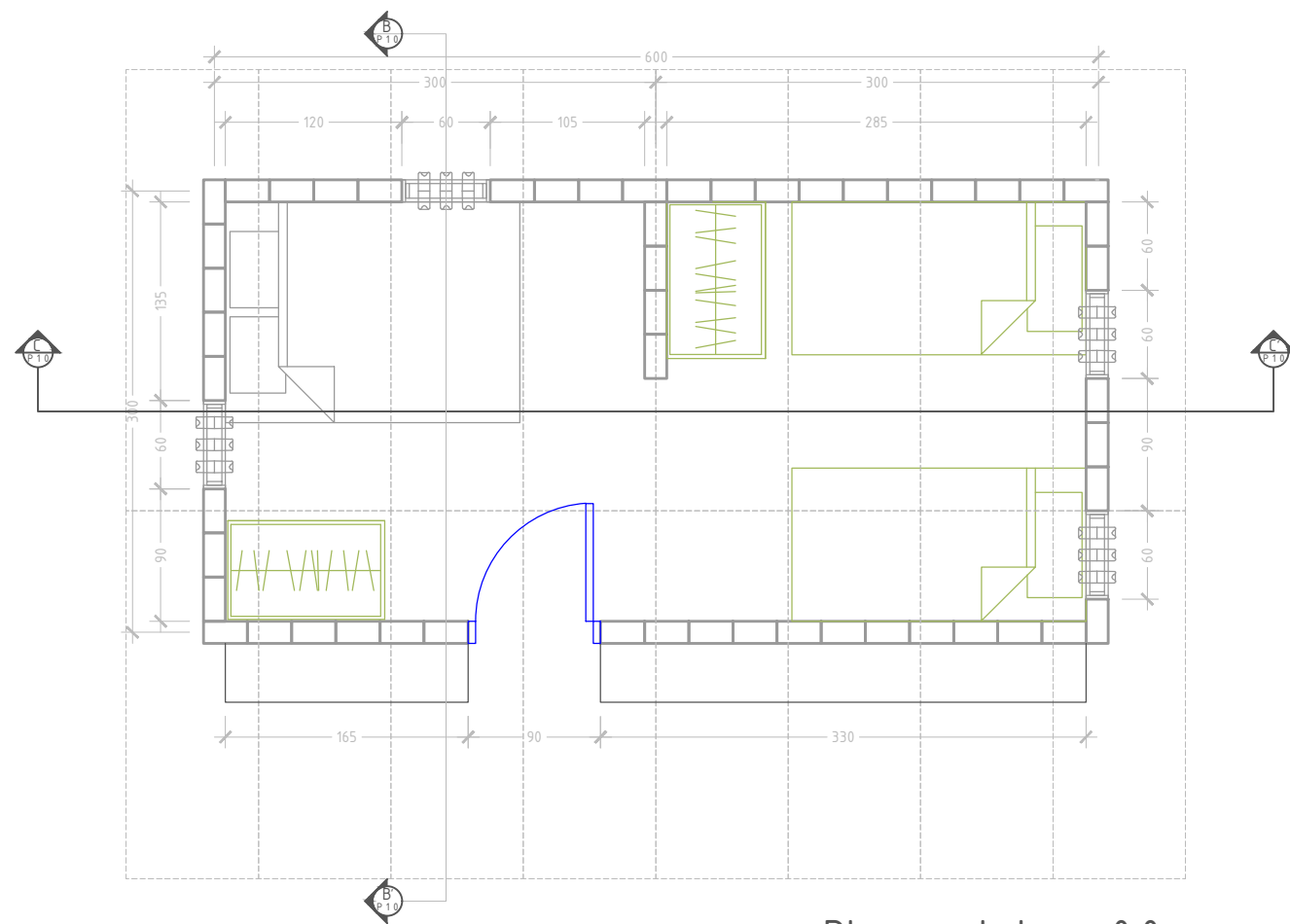


**Phase 5**  
Four modules  
concrete columns  
2584 €

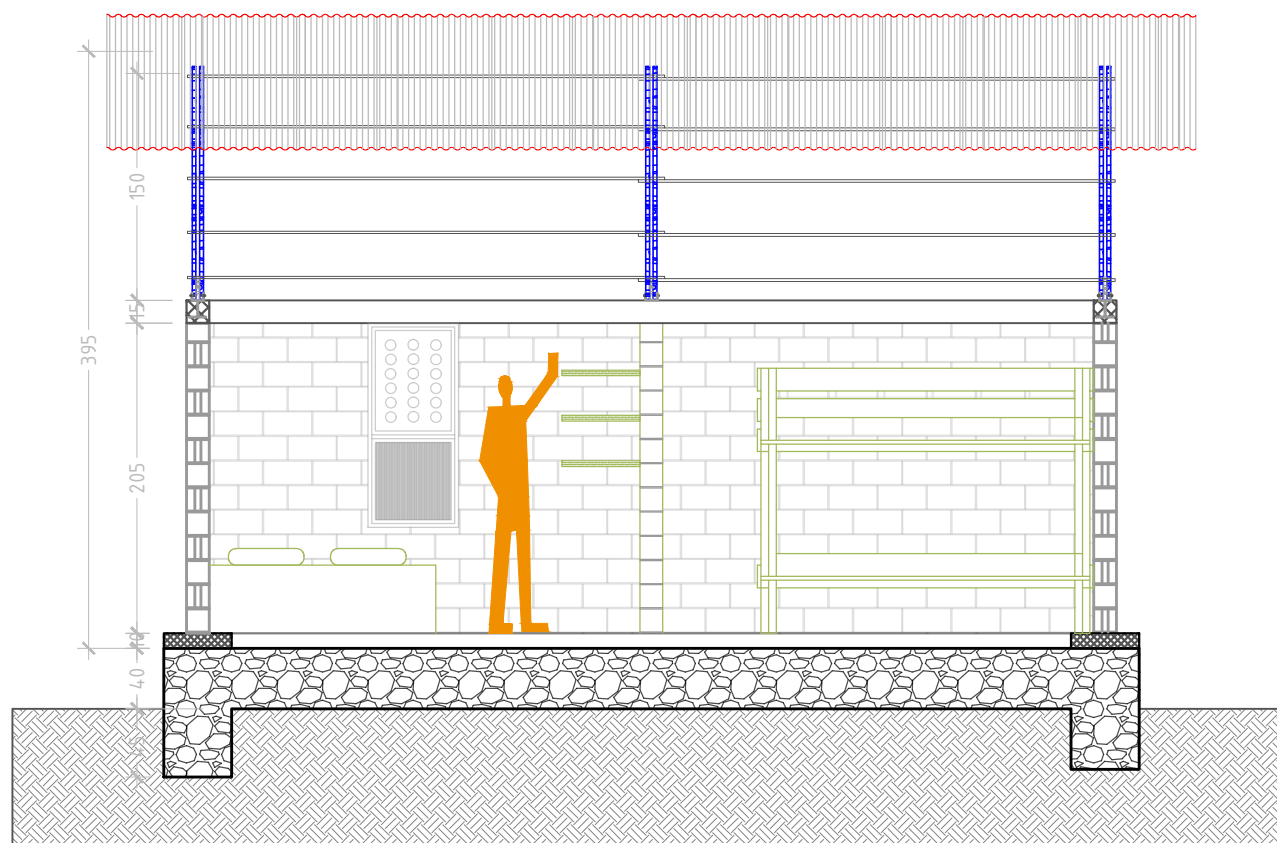


**Phase 6**  
Two modules  
self-sufficient  
2483 €

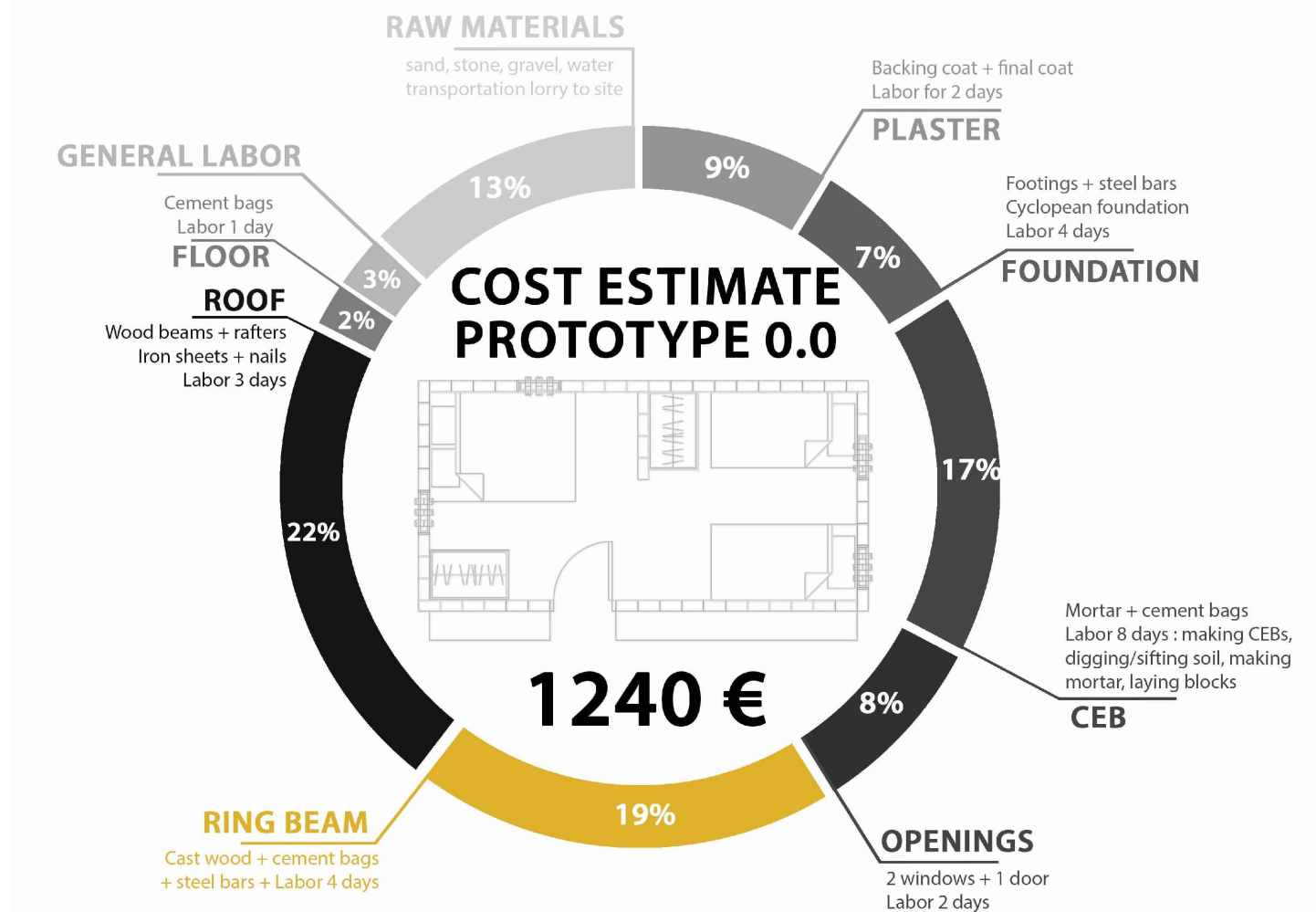




Plan prototype 0.0



Section CC'

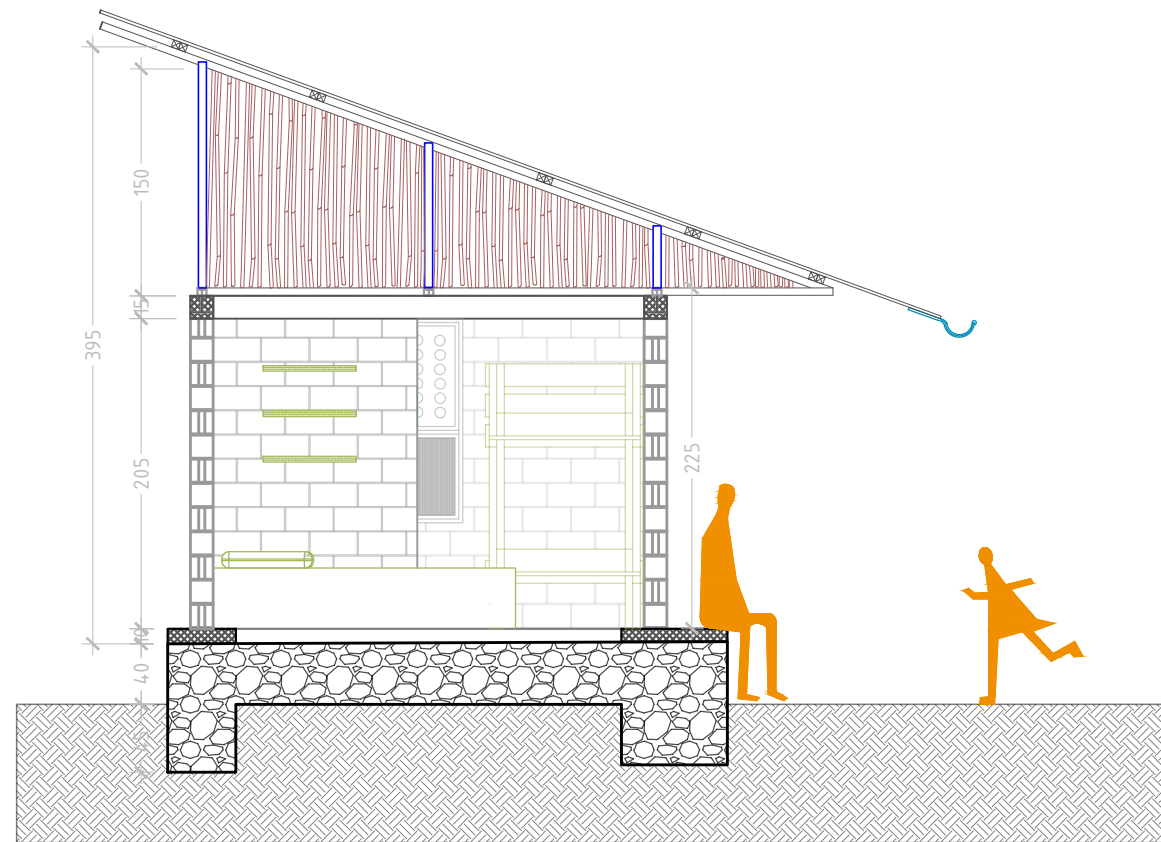


#### Notes

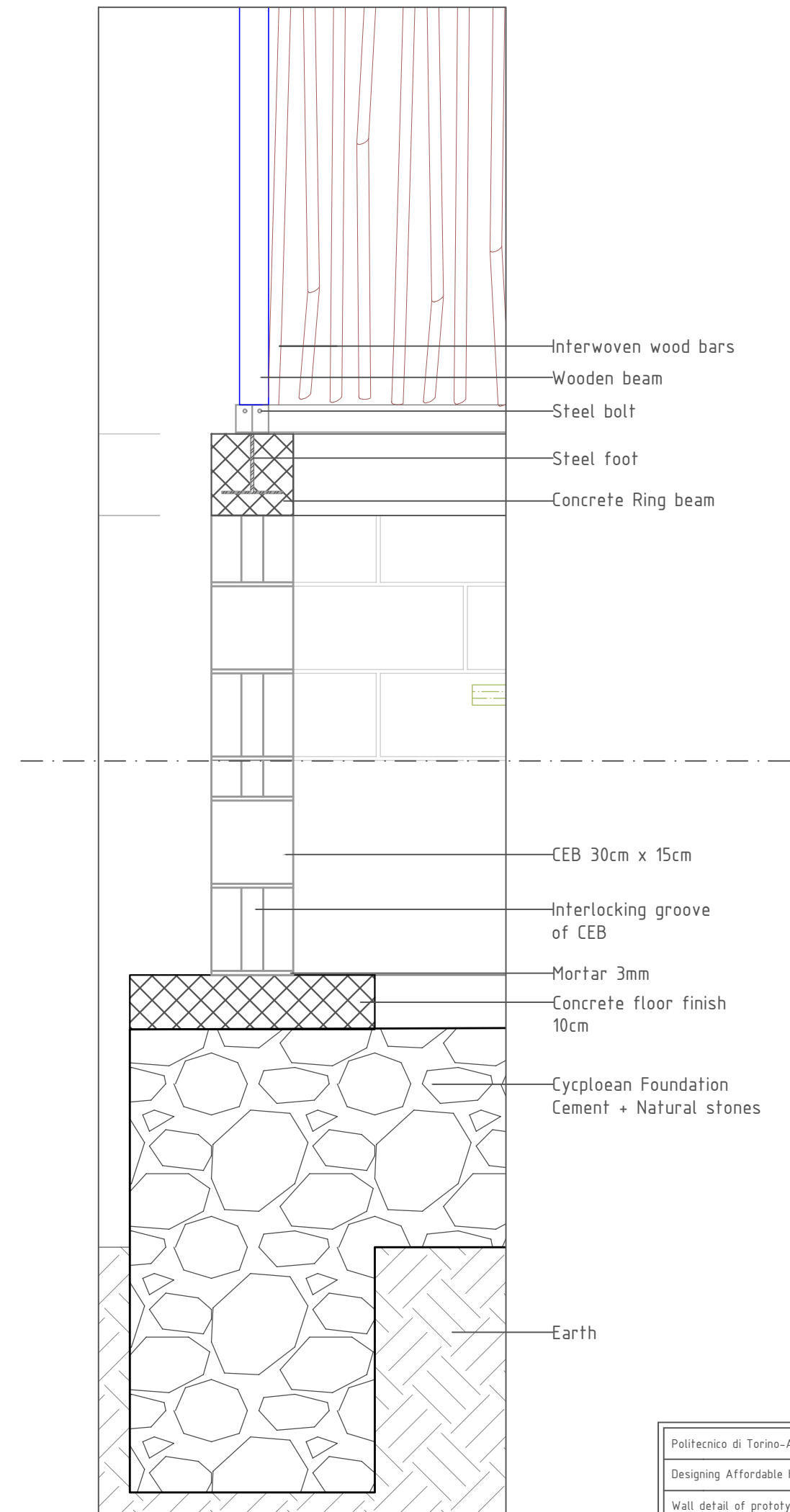
- Prototype 0.0
- Two modules
- Capacity : 2 to 4 people
- Area : 17 m<sup>2</sup>
- Basic Model with CEB

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Plan and section of prototype 0.0	
PHASE #1	Scale 1/50





Section BB

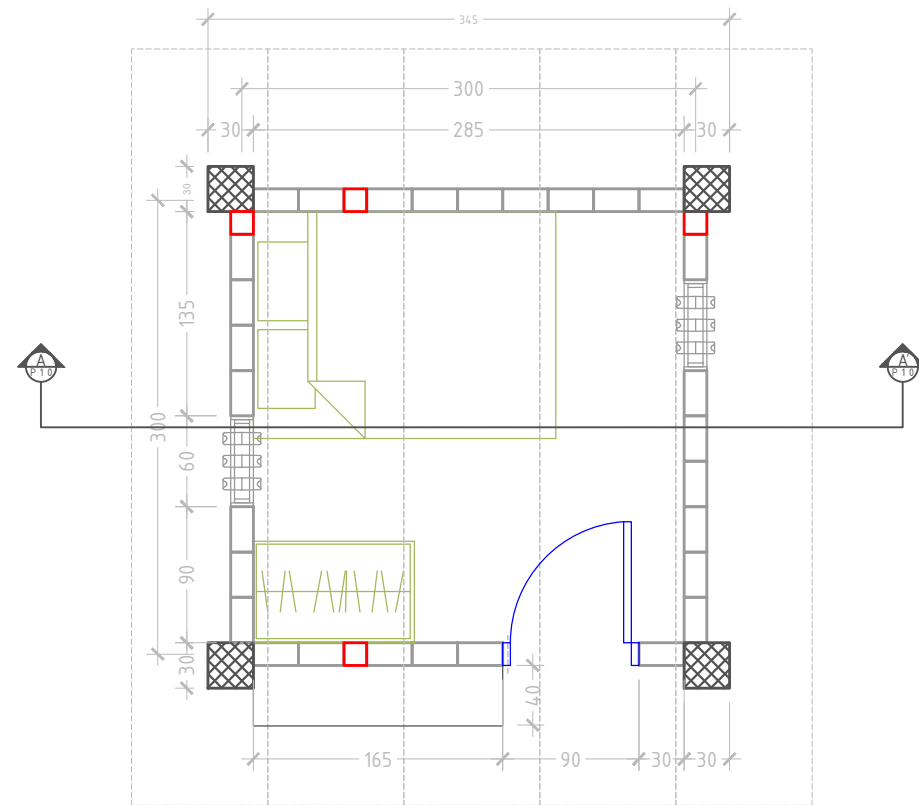


Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Wall detail of prototype 0.0	
PHASE #1	Scale 1/10

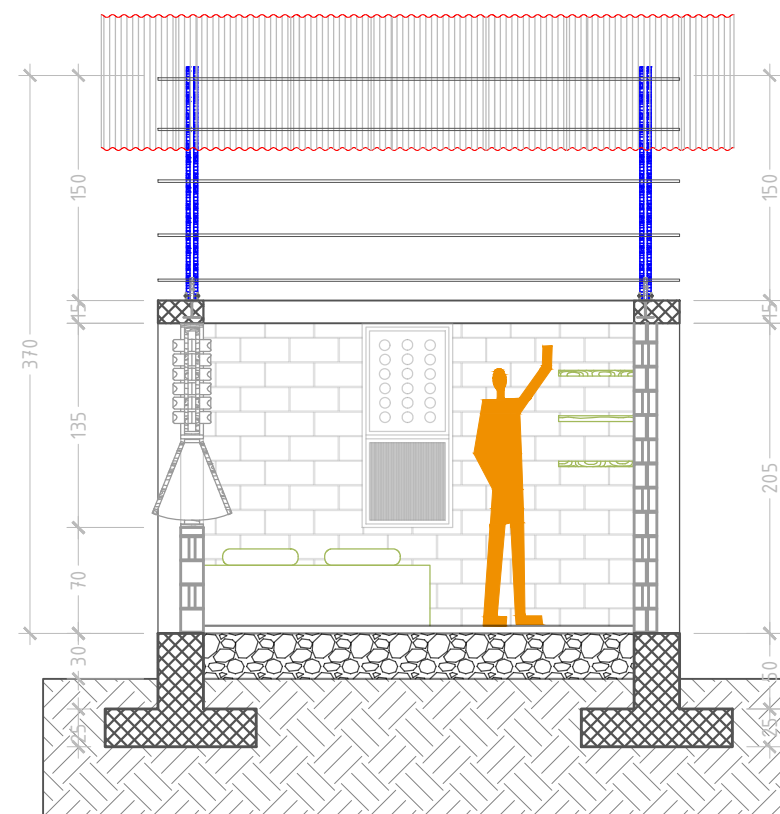
Notes	
- Prototype 0.0	
- Two modules	
- Capacity : 2 to 4 people	
- Area : 17 m <sup>2</sup>	
- Basic Model with CEB	

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Plan and section of prototype 0.0	
PHASE #1	Scale 1/50

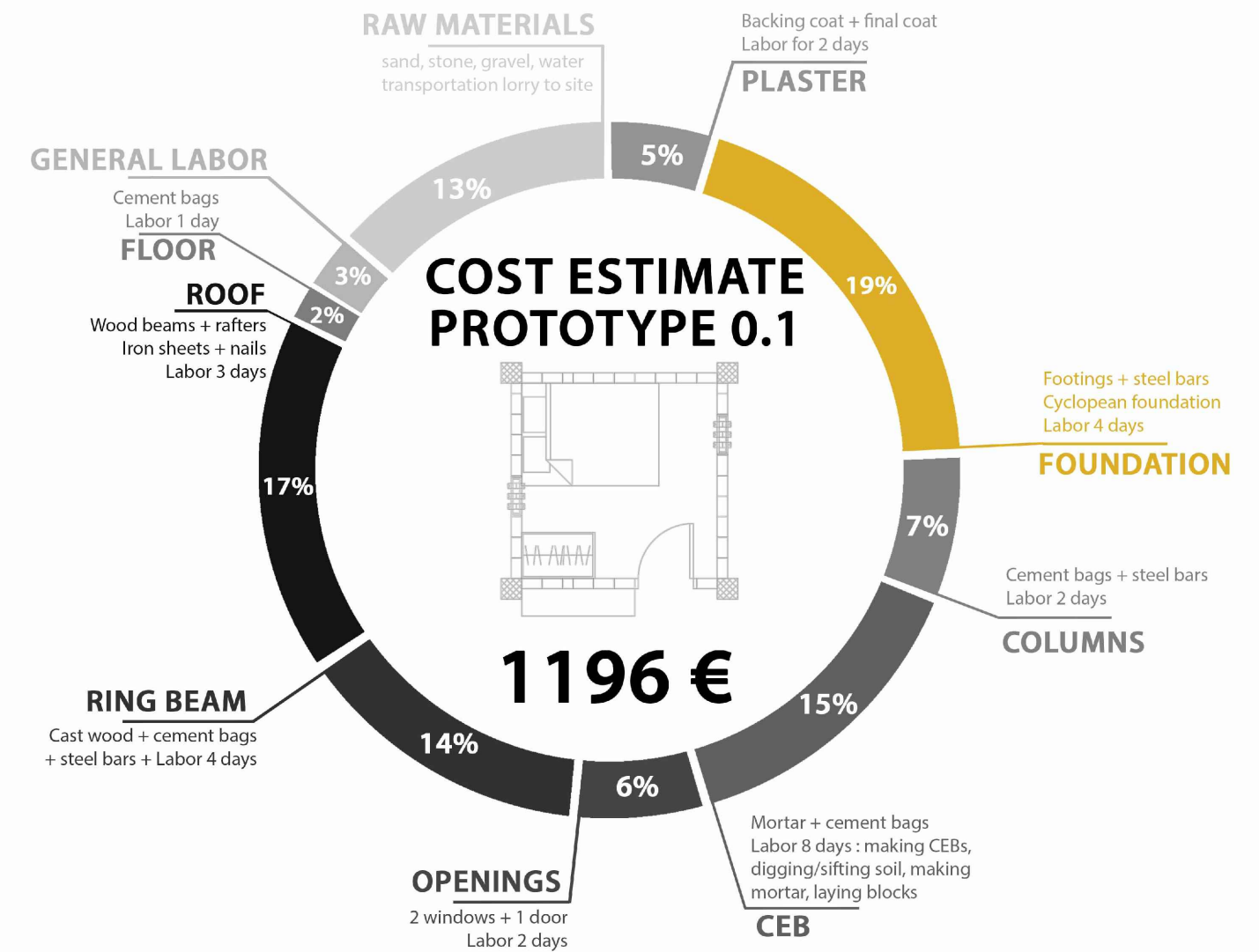




Plan prototype 0.1



Section AA'



Notes

- Prototype 0.1
- One module
- Capacity : 1 to 2 people
- Area : 8 m<sup>2</sup>
- Concrete and CEB Model

Politecnico di Torino-Architecture and Construction City

Designing Affordable Housing for community empowerment

Plan and section of prototype 0.1

PHASE #2

Scale 1/50

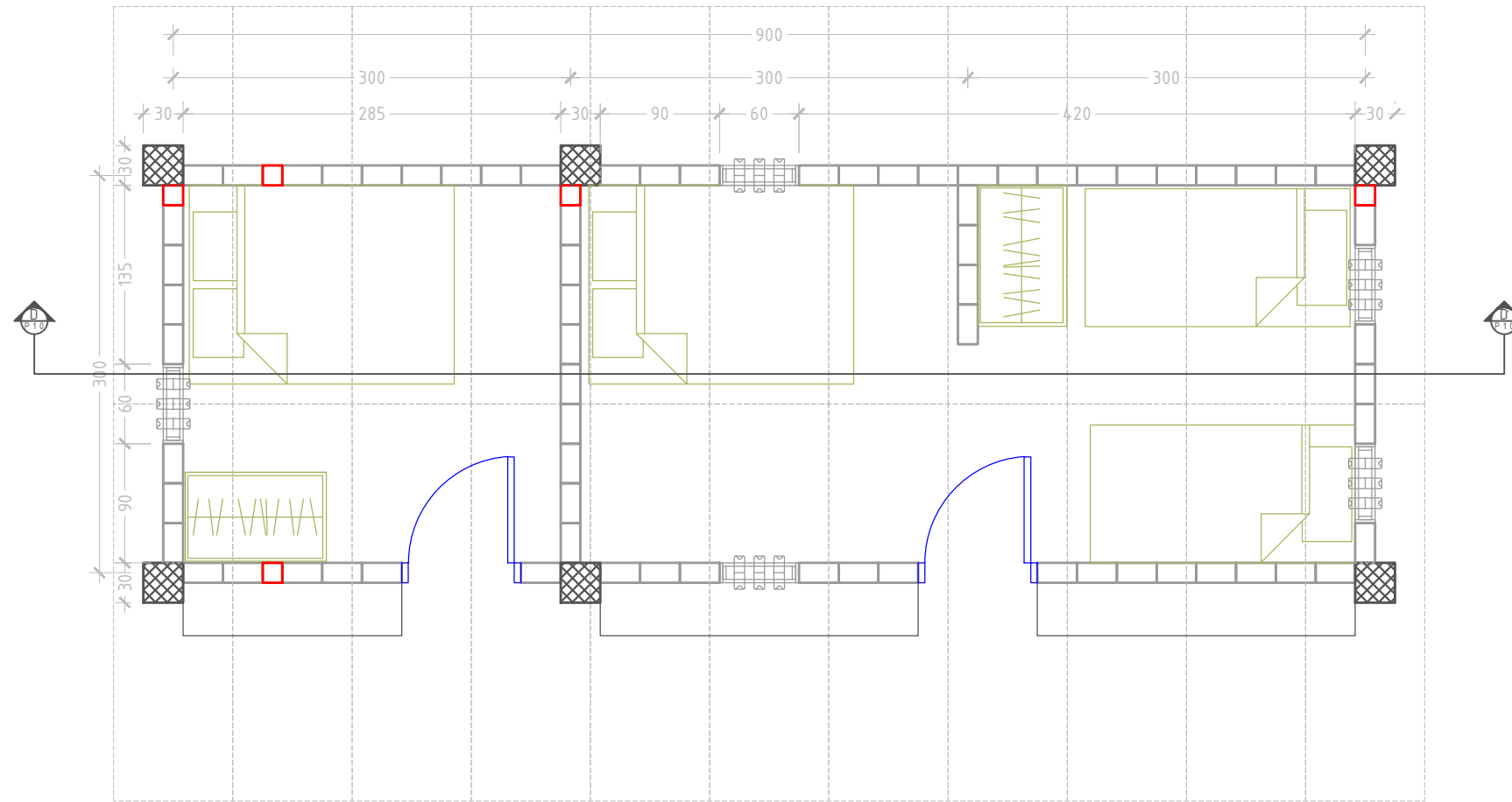




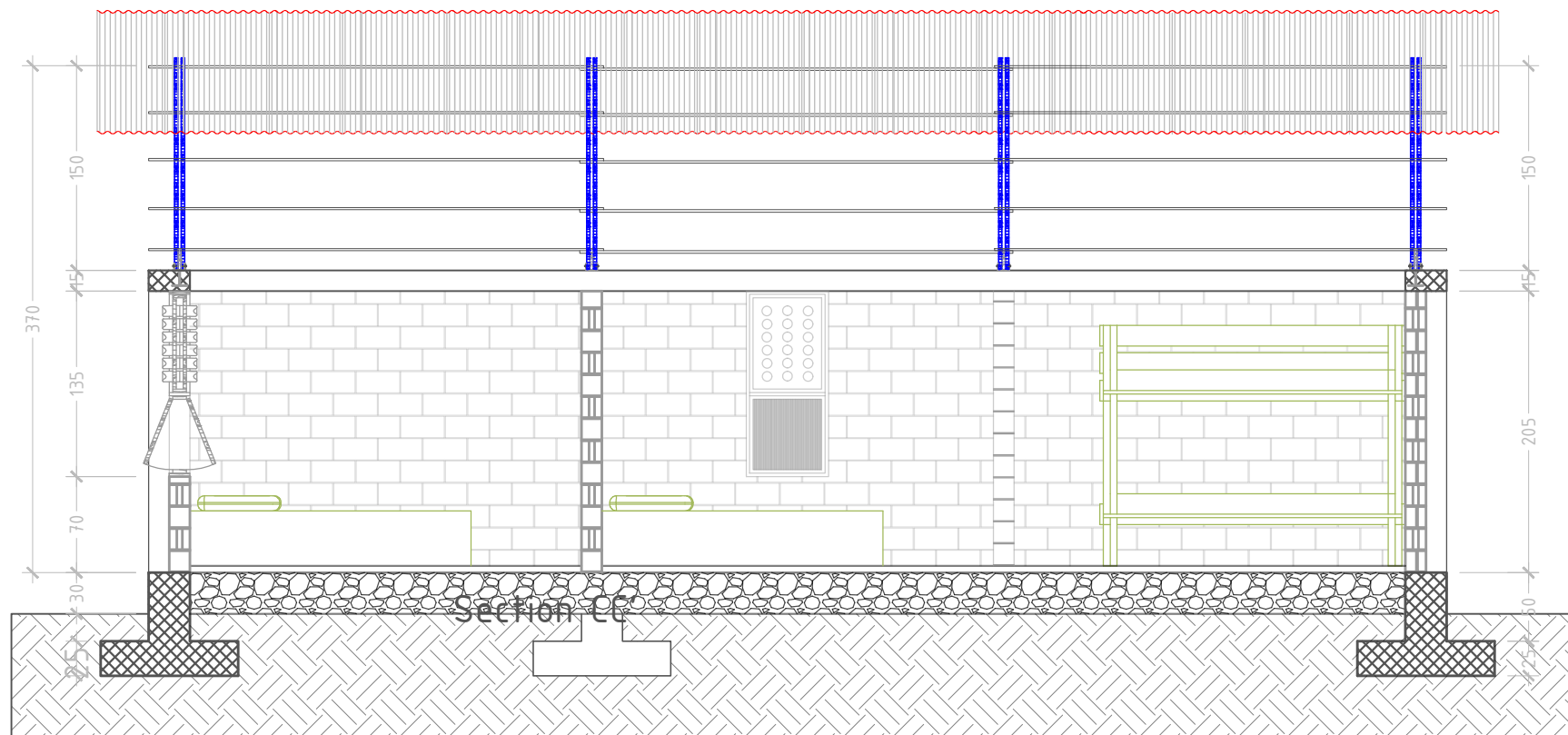
**1550 €**

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Designing Affordable Housing for community empowerment	
Plan and section of prototype 0.2	
PHASE #3	Scale 1/50





Plan prototype 0.3



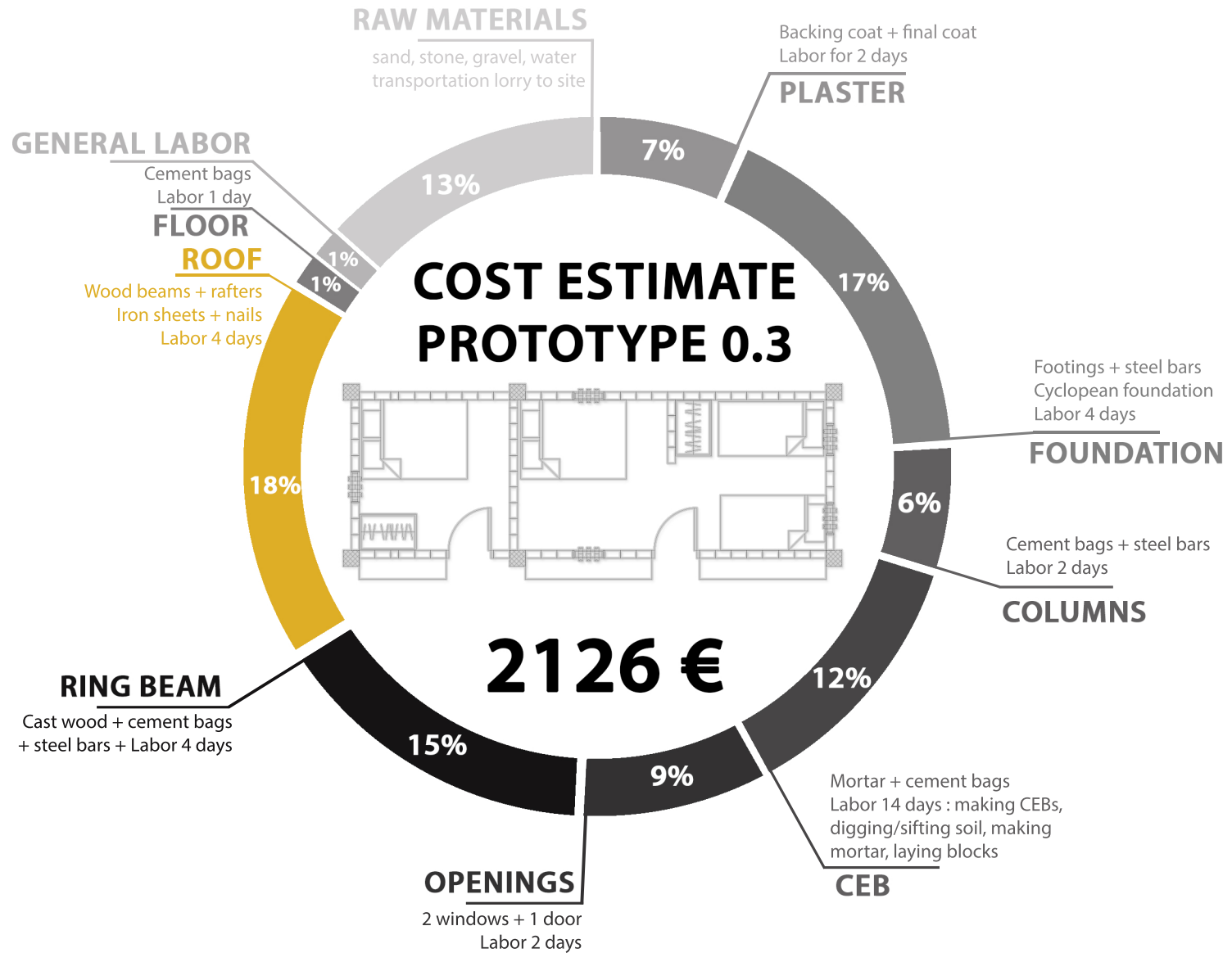
Section DD'

Notes

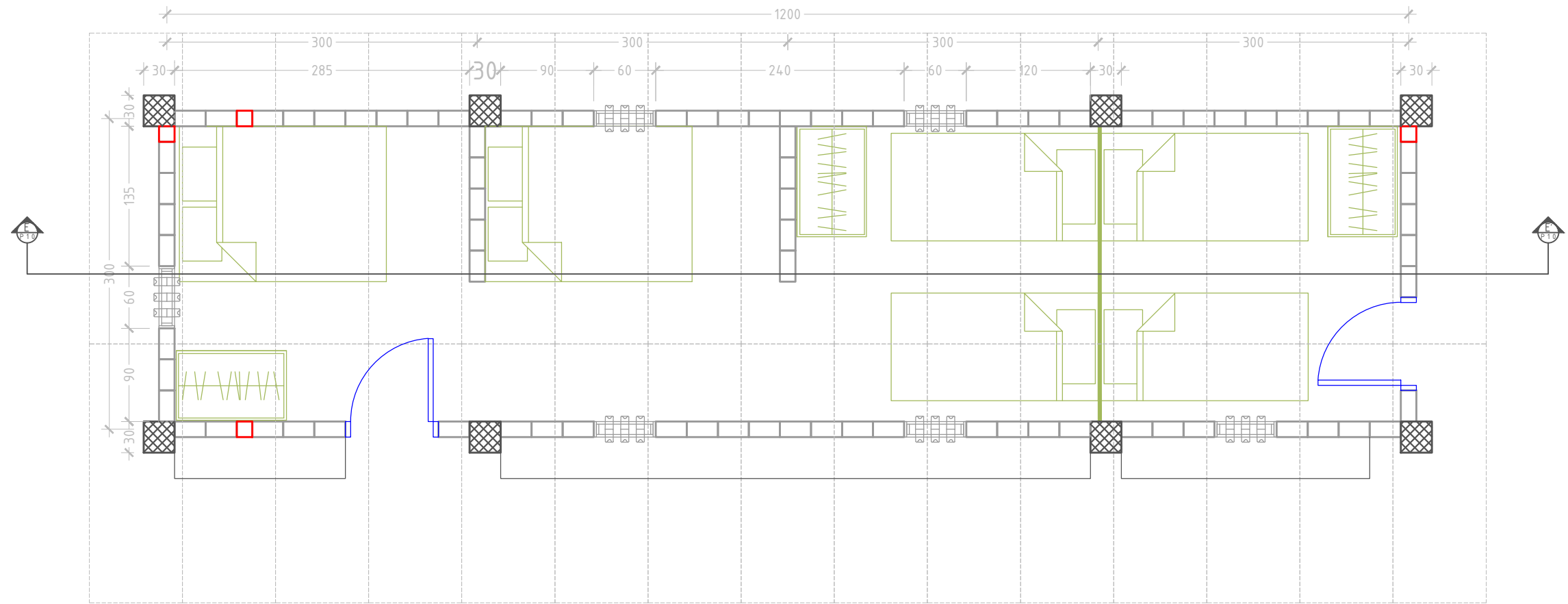
- Prototype 0.3
- Three modules
- Capacity : 6 to 8 people
- Area : 25 m<sup>2</sup>
- Concrete and CEB Model

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Plan and section of prototype 0.3	
PHASE #4	Scale 1/50

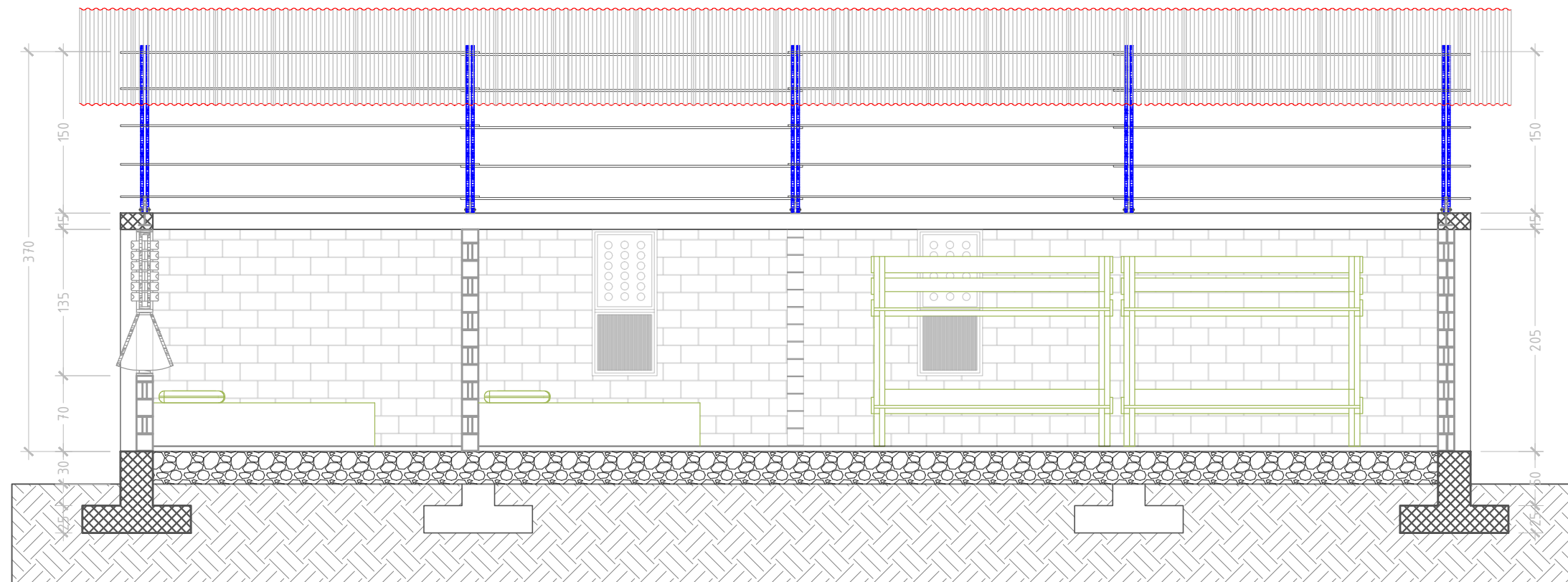








Plan prototype 0.4



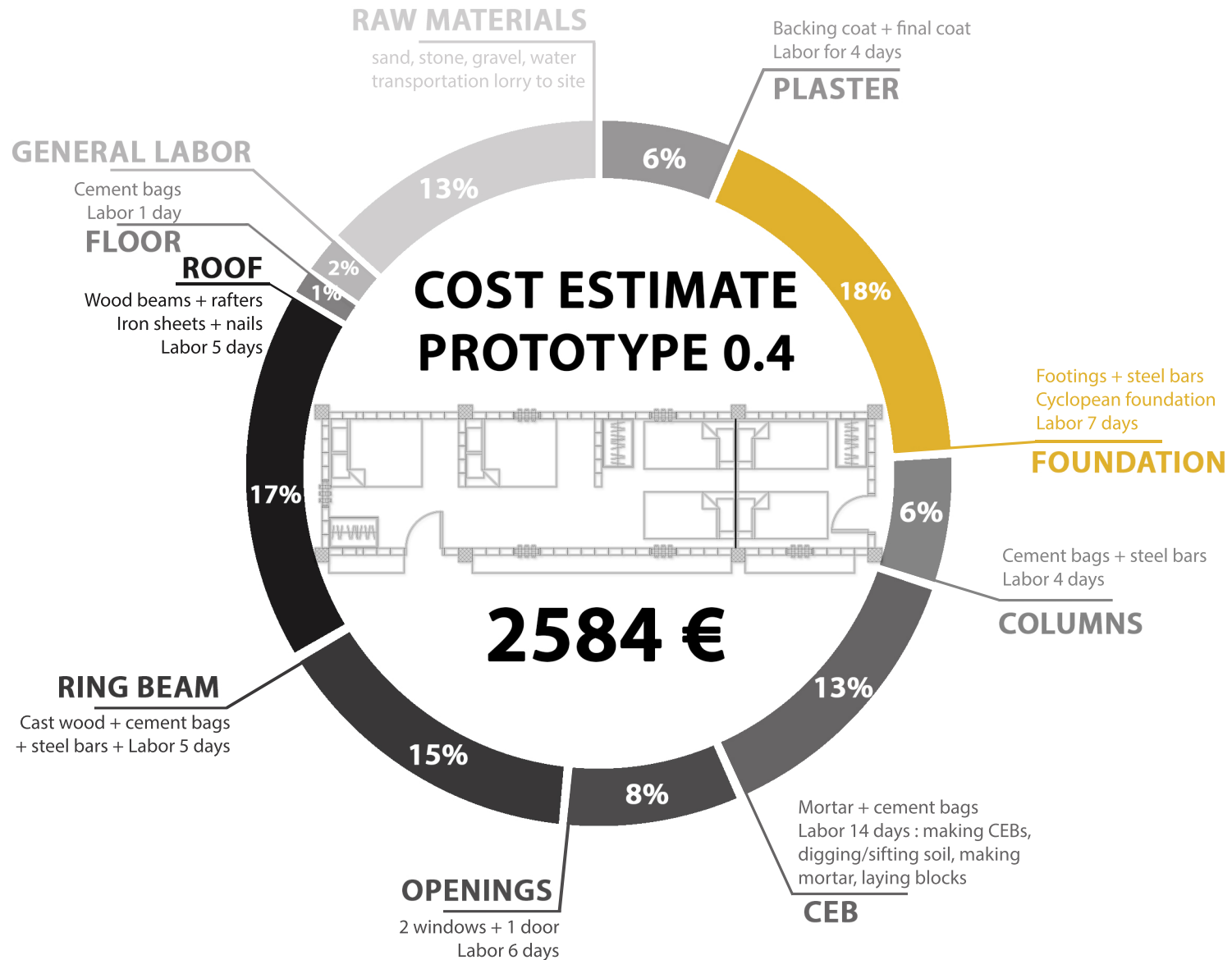
Section EE'

Notes

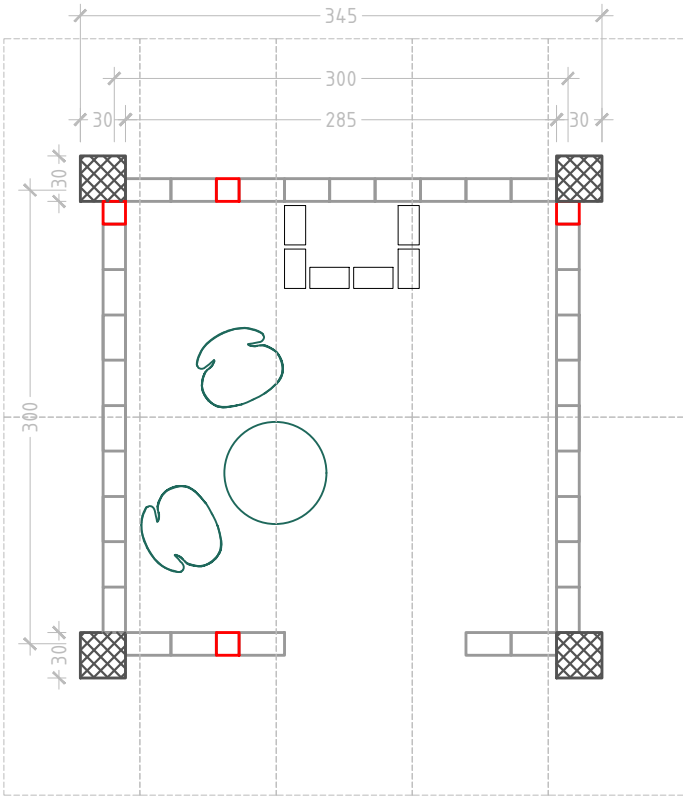
- Prototype 0.4
- Four modules
- Capacity : 8 to 10 people
- Area : 35 m<sup>2</sup>
- Concrete and CEB Model

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Plan and section of prototype 0.4	
PHASE #5	Scale 1/50







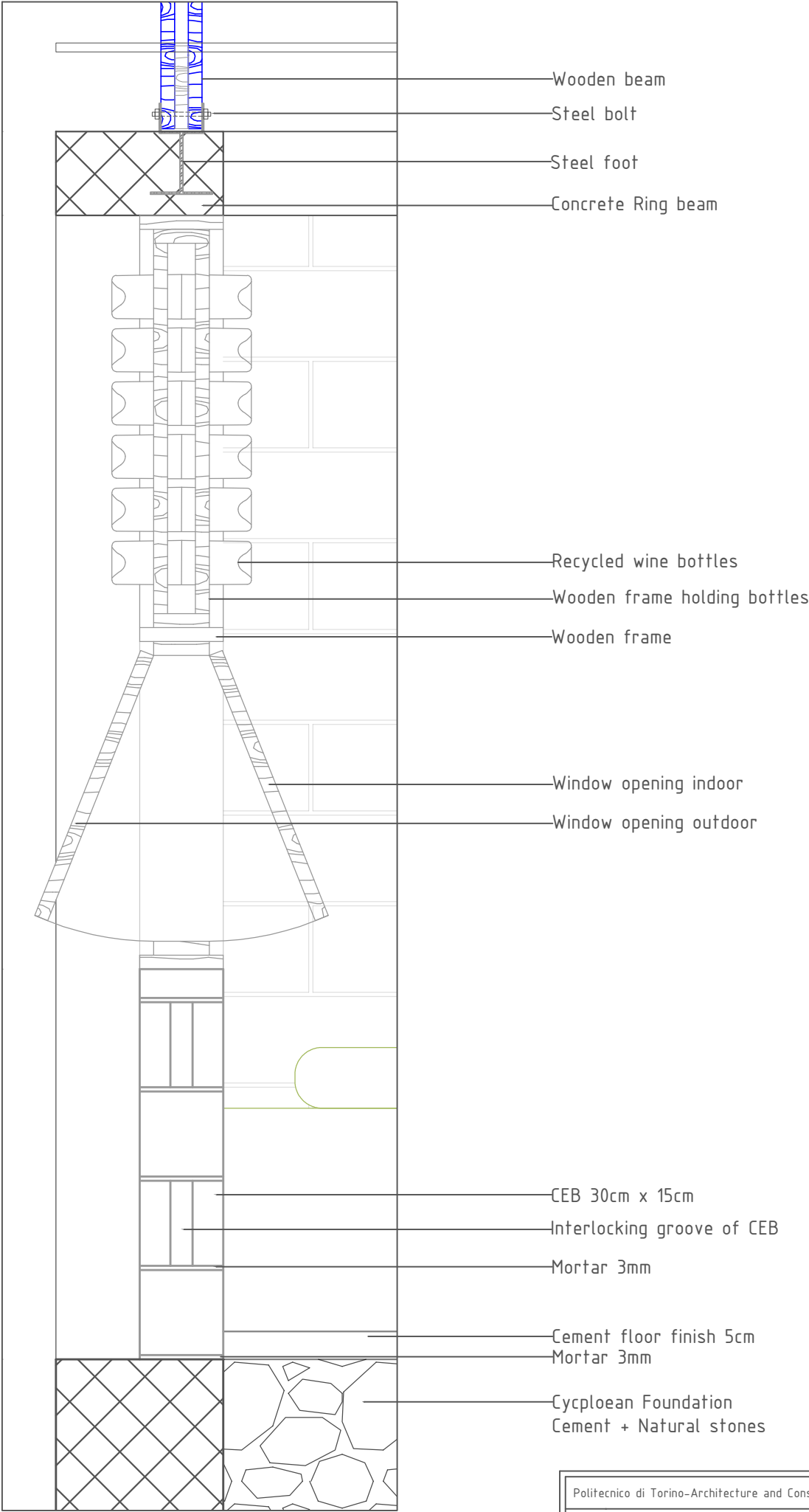


Plan Kitchen

Notes

- Kitchen prototype
- One module
- Area : 8 m<sup>2</sup>
- Model with CEB and concrete columns

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Kitchen Plan	
ALL PHASES	Scale 1/50



- Wooden beam
- Steel bolt
- Steel foot
- Concrete Ring beam

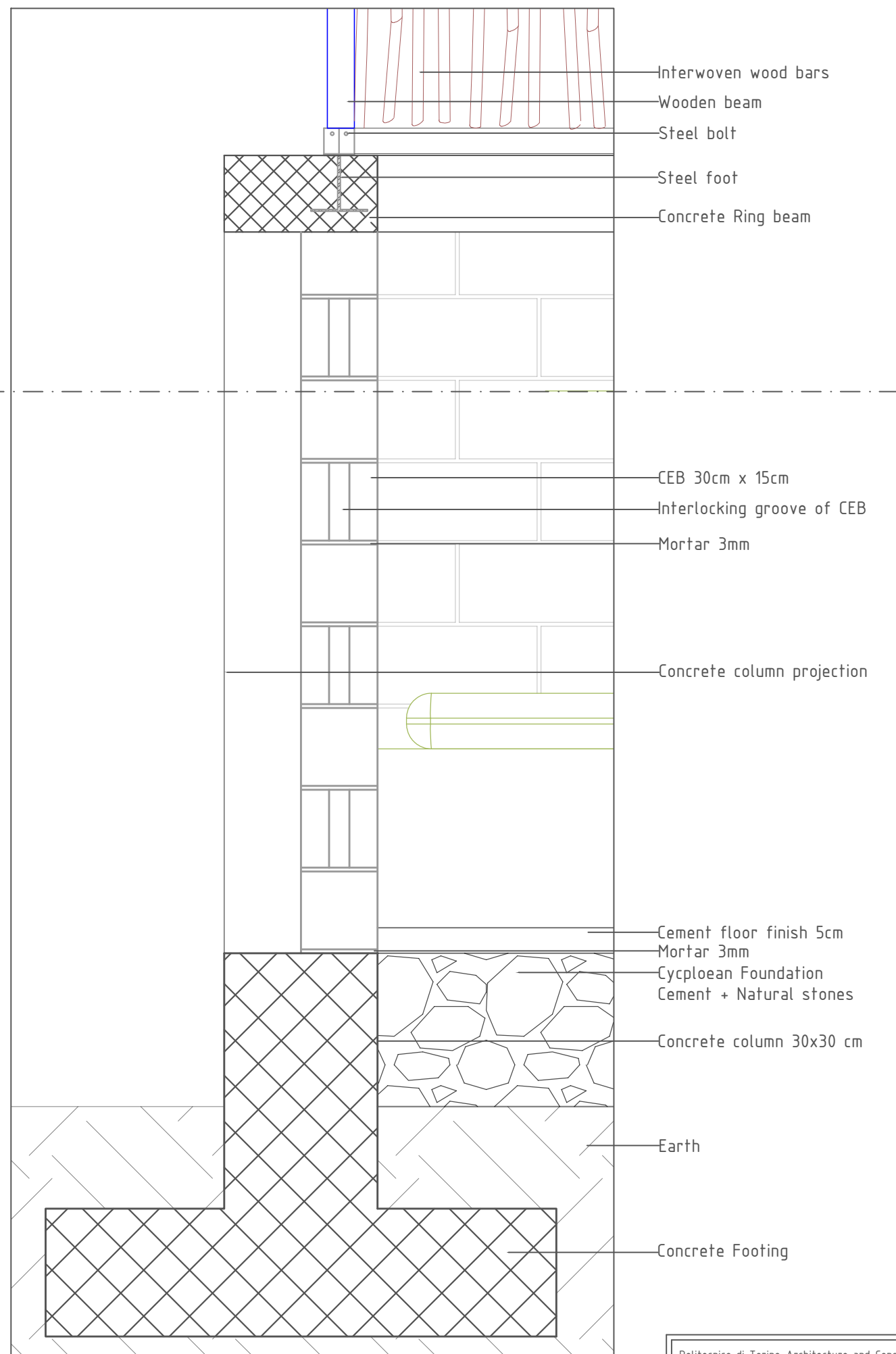
- Recycled wine bottles
- Wooden frame holding bottles
- Wooden frame

- Window opening indoor
- Window opening outdoor

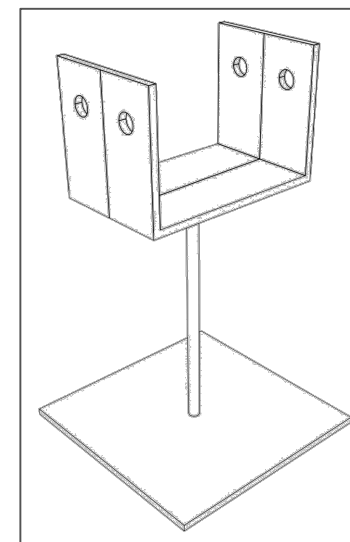
- CEB 30cm x 15cm
- Interlocking groove of CEB
- Mortar 3mm
- Cement floor finish 5cm
- Mortar 3mm
- Cyclopean Foundation
- Cement + Natural stones

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Window Detail	
ALL PHASES	Scale 1/10





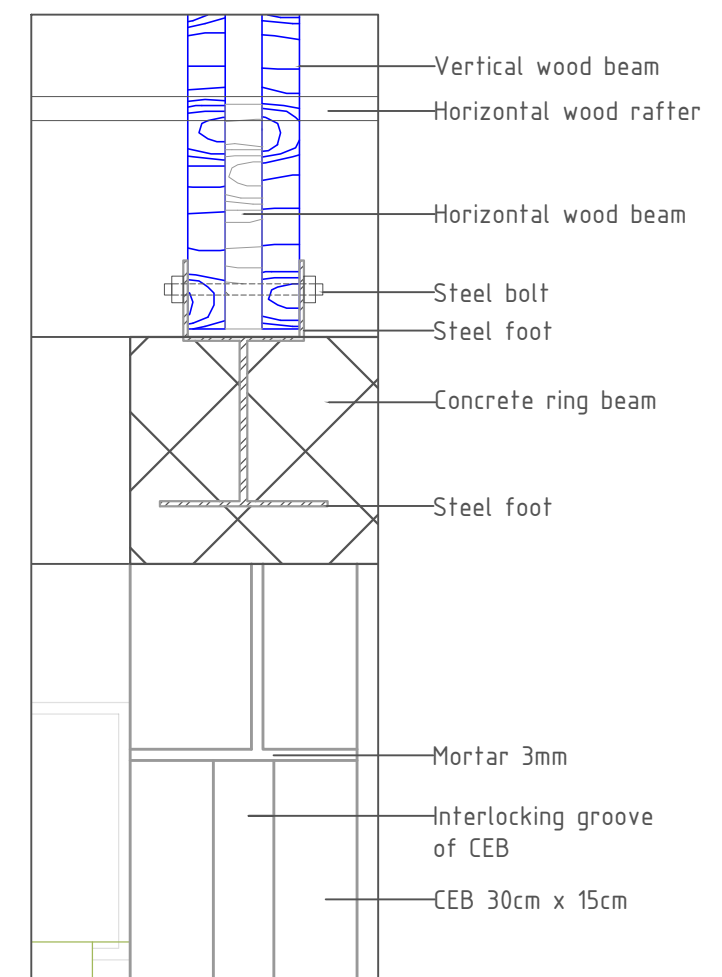
Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Wall detail of prototype 0.2	
PHASE #2,3,4,5,6	Scale 1/10



Steel foot



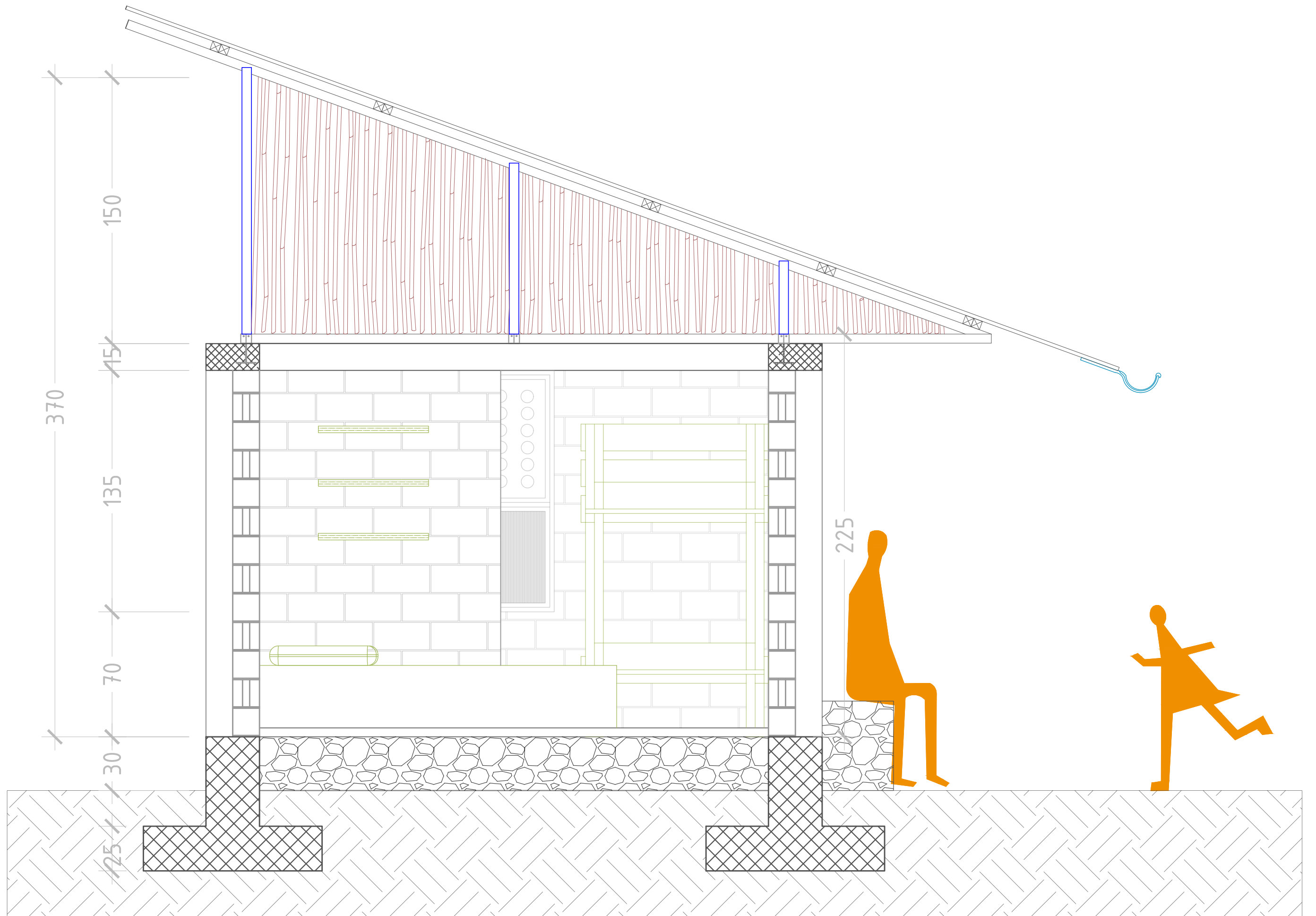
Steel foot installed in the ring beam



Steel foot detail

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Steel foot detail	
ALL PHASES	Scale 1/5

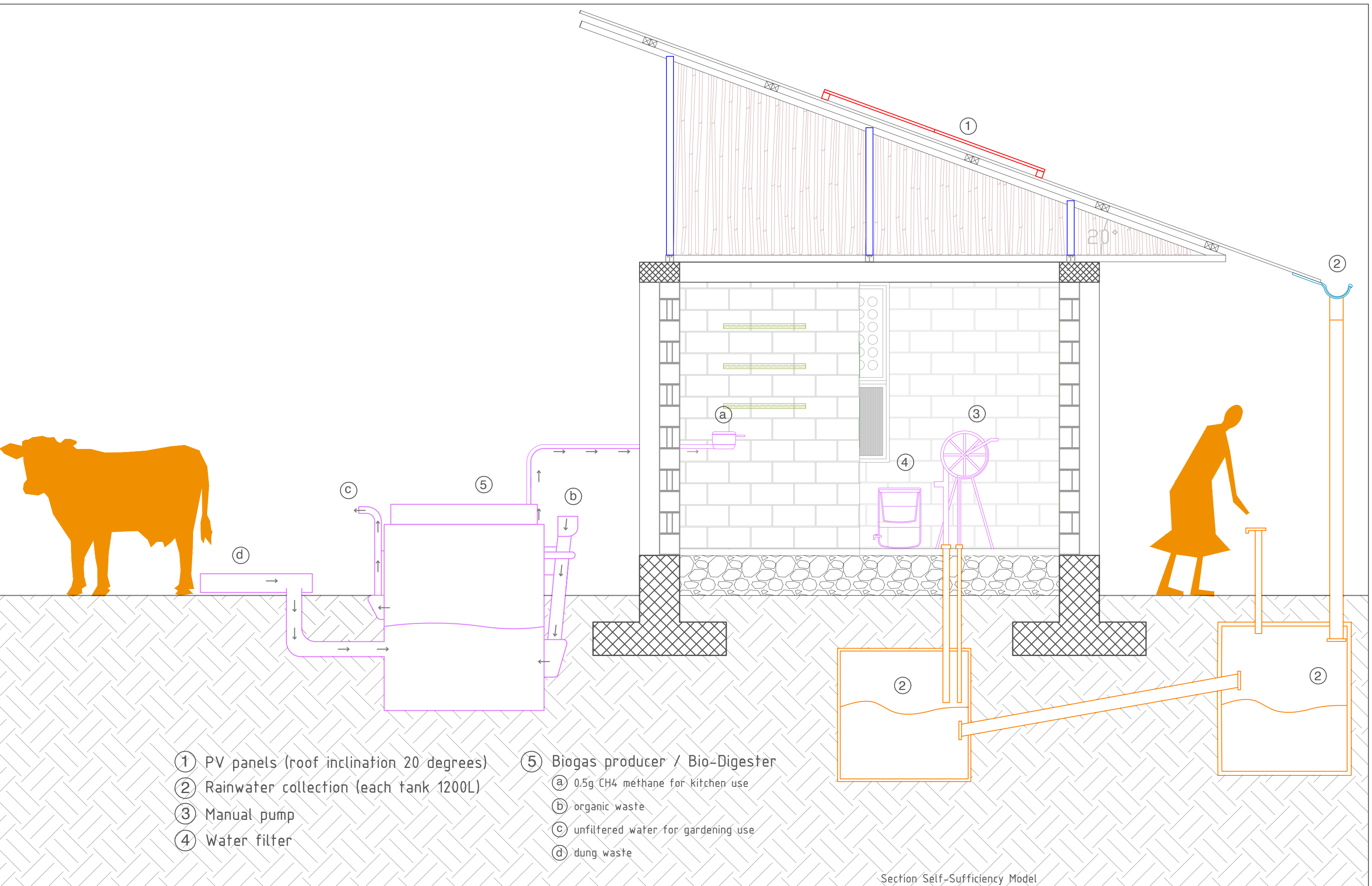




Section BB'

Politecnico di Torino-Architecture and Construction City	
Designing Affordable Housing for community empowerment	
Section BB'	
ALL PHASES	Scale 1/20







## SELF-SUFFICIENCY

Bio-digester tank + rain collection  
pipe + water tank + water filter  
+ manual pump + PV panel  
+ labor 8 days

Backing coat + final coat  
Labor for 4 days

## PLASTER

5%

11%

Footings + steel bars  
Cyclopean foundation  
Labor 7 days

## FOUNDATION

Cement bags + steel bars  
Labor 4 days

3%

## COLUMNS

8%

Mortar + cement bags  
Labor 14 days : making CEBs,  
digging/sifting soil, making  
mortar, laying blocks

## CEB

4%

## OPENINGS

2 windows + 1 door  
Labor 6 days

10%

## RING BEAM

Cast wood + cement bags  
+ steel bars + Labor 5 days

11%

## ROOF

Wood beams + rafters  
Iron sheets + nails  
Labor 5 days

1%

1%

Cement bags  
Labor 1 day

## FLOOR

## GENERAL LABOR

9%

## RAW MATERIALS

sand, stone, gravel, water  
transportation lorry to site

# COST ESTIMATE PROTOTYPE 0.5



# 2483 €



## Conclusion

Four billion people around the world do not have access to decent housing, 150 million of which reside in developed countries and 800 million who live in slums.

In a setting like Africa, in which the population is growing at an alarming rate, housing demand by the poor is one of the major factors that is causing the expansion informal settlements. The government, the private sector, non-governmental organizations and the financing sector set to be the key players in this ever-worsening situation. Furthermore, little or no cooperation amongst these actors, in an effort to meet the housing demands, is therefore contributing to the increase of the informal sector.

Promoting the usage of local building materials, empowering the community and following the sustainability goals were the main objectives of this paper. After testing different combinations of the Compressed Earth Blocks, a design proposal was suggested according to the answers of the questionnaire. A small module was developed for accommodating widows or old couples of Shimbwe. In the need of a further development, a second module could be added to comprise a larger family. For a different phase, this prototype could be enlarged to include up to 4 modules. Finally, mechanical supplies, such as a bio-digester, water tank for rain collection and solar panels can be implemented to harvest a self-sufficient house. As for what concerns the construction costs, it would depend on each design phase accordingly.

The involvement of the people in building their own shelters would empower the community as a whole and strengthen the social bond amongst the inhabitants. International efforts to support the process would further boost the societal mindset that facilitates community growth and prosperity. On a wider perspective, and to initiate the process, architecture students willing to contribute in the development of the aforementioned town could work alongside the beneficiaries in the construction. In this way, both parties will simultaneously benefit, where the ideas of the students fall into place and empowerment of the community commences.



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- <http://www.worldbank.org>



# Annexe 1. Questionnaire

## Family structure

Name *(optional)* \_\_\_\_\_ Gender ☐ F ☐ M

Age ☐ <11 years ☐ 12-18 years ☐ 19-24 years ☐ 25-45 years ☐ 46-65 years ☐ >66 years

Sub-village *(optional)* \_\_\_\_\_ Location \_\_\_\_\_

	none	1	2	3	4	5	6	more
How many are living in the house?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How many are students in the house?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How many are employed in the house?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How many own a business in the house?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
How many are unemployed in the house?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## GENERAL INFORMATION

	(not satisfied) 1	2	3	4	5 (extremely satisfied)
• How satisfied are you with your house?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• How safe do you feel in Shimbwe?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• What is(are) the reason(s)?					
<input type="checkbox"/> I feel safe	<input type="checkbox"/> Theft	<input type="checkbox"/> Drunk people	<input type="checkbox"/> Domestic violence		
• Are there a lot of insects/vermin in your house?	<input type="checkbox"/> Insects	<input type="checkbox"/> Vermin			
• Do you care about nature?	<input type="checkbox"/> Yes	<input type="checkbox"/> No			
• Would you consider using solar energy?	<input type="checkbox"/> Yes	<input type="checkbox"/> No			
• Have you heard about Compressed Earth Blocks?	<input type="checkbox"/> Yes	<input type="checkbox"/> No			
• Have you heard about C-re-aid?	<input type="checkbox"/> Yes	<input type="checkbox"/> No			
• Do you know what is the profession of an architect?	<input type="checkbox"/> Yes	<input type="checkbox"/> No			

## A) MODERNITY

1. How do you see the issue of having toilets outside the house?

☐ Good ☐ I prefer it inside

2. What spaces should be separated?

☐ Kitchen from living room ☐ Toilet from kitchen and living

☐ Bedroom from living room

3. How important is the separation of men and women, children and parents, boys and girls in the house?

☐ There is separation ☐ No need for separation

## B) COOKING AND EATING

1. Are you satisfied with the cooking arrangements? ☐ Yes ☐ No

2. Where do you prepare your meals? ☐ Outside the house ☐ Inside the house

3. What type of cooking equipment are you using?

☐ Charcoal stove ☐ Electric cooker ☐ Kerosene stove ☐ Firewood ☐ Gas cooker

4. Where do you wash dishes?

☐ Washing basin fitted in the kitchen ☐ Concrete platform outside the house ☐ Buckets

5. Where do you and your family eat mostly?

☐ In the veranda ☐ In the sitting room ☐ In a sleeping room ☐ Kitchen ☐ Outside

6. How many times do you cook per day?

☐ 1 time ☐ 2 times ☐ 3 times ☐ More?

7. How do you dispose of your waste?

☐ Burn ☐ Bury ☐ Throw away ☐ Recycle

## C) STORAGE

1. Are you satisfied with storage arrangements? ☐ Yes ☐ No

2. Where do you keep your cooking utensils?

☐ In the utensils cupboard ☐ In the plastic container ☐ Under bed

3. Where do you store food (rice, beans, sugar, maize flour etc...)?



- ☐ Buckets                      ☐ In plastic containers                      ☐ In tin containers
4. Where do you store clothes?
- ☐ In plastic bags                      ☐ Hang on line                      ☐ In suitcases                      ☐ In wardrobe

#### D) SLEEPING ARRANGEMENTS

1. Are you satisfied with sleeping arrangements for your family?
- ☐ Yes                      ☐ No
2. Where do different members of the household sleep?
- ☐ In sleeping rooms                      ☐ In the sitting room                      ☐ Kitchen
3. How many rooms do you currently have?
- ☐ 1                      ☐ 2                      ☐ 3                      ☐ 4
4. How many beds do you currently have?
- ☐ None                      ☐ 1                      ☐ 2                      ☐ 3                      ☐ 4                      ☐ 5                      ☐ More

#### E) HYGIENE

1. Are you satisfied with personal hygiene arrangements?
- ☐ Yes                      ☐ No
2. In which space does the family have a bath?
- ☐ Own outside bathroom                      ☐ Shared outside bathroom                      ☐ Toilet same as bathroom
3. What type of toilet do you use?
- ☐ Water closet -Western type                      ☐ Water closet -Indian type
- ☐ Pit latrine                      ☐ Neighbors facilities                      ☐ No toilet
4. If outside the house, how far is it from the house?
- ☐ 1-5 meters                      ☐ 5-10 meters                      ☐ >10 meters
5. Are you satisfied with the type of toilet and bathing area you have?
- ☐ Yes                      ☐ No

#### F) ACTIVITIES

1. Do you grow vegetables near the house?                      ☐ Yes                      ☐ No
2. Do you have any small business at home (inside the houses or within the plot)?
- ☐ Frying chapatis                      ☐ Shop                      ☐ Coffee/tea shop                      ☐ Vegetable garden
- ☐ Selling local brew                      ☐ Butchery                      ☐ No business at home
3. Do you keep poultry and animals?                      ☐ Yes                      ☐ No
4. If yes, where do you keep them?
- ☐ In the house                      ☐ Pen for animals                      ☐ Separate Farmyard                      ☐ I don't have animals

#### G) HOUSEHOLD INFORMATION

1. How long have you lived at your current residence?
- ☐ 1 to 5 years                      ☐ 5 to 10 years                      ☐ more than 10 years                      ☐ It is my initial home
2. What materials did you use for roofing?
- ☐ Corrugated Iron sheets                      ☐ Mangalore tiles                      ☐ Concrete tiles                      ☐ Thatch
3. What materials did you use for extending walls?
- ☐ Concrete blocks                      ☐ Adobe bricks                      ☐ Mud and pole                      ☐ Mabanzi                      ☐ Mixture
4. How much did you buy your house for?
- ☐ Free/Inherited                      ☐ less than 500 000 tsh                      ☐ 1 million tsh                      ☐ 2 million tsh
- ☐ 3 million tsh                      ☐ 4 million tsh                      ☐ I don't know
5. How much maintenance does it need?
- ☐ every month                      ☐ every 6 months                      ☐ every 12 months                      ☐ every 24 months
6. What does need maintenance?
- ☐ walls                      ☐ plaster                      ☐ roof                      ☐ structure                      ☐ floor
7. How much do you pay for maintenance annually? (plaster, repairs, leaks etc)
- ☐ <10 000 tsh                      ☐ 10 000-50 000 tsh                      ☐ 50 000-200 000 tsh                      ☐ >200 000 tsh
8. Have you had to rebuild it entirely?                      ☐ Yes                      ☐ No



9. If you could renovate only 1 room, which one would you chose?

☐ Sitting room   ☐ Bedroom   ☐ Veranda

10. Do you have electricity? ☐ Yes ☐ No

11. Do you have water? ☐ Yes ☐ No

12. Do you have a TV? ☐ Yes ☐ No

13. Do you have a mobile phone? ☐ Yes ☐ No

14. Do you have a radio? ☐ Yes ☐ No

#### H) FUTURE

1. Is that your permanent house? ☐ Yes ☐ No

2. Would you use your old structure to create a new function? ☐ Yes ☐ No

3. Do you want to build a new home? ☐ Yes ☐ No

4. Do you anticipate any changes to your household in the future?

☐ new children   ☐ to improve the house   ☐ Desire of a modern house

5. How many rooms will you need?

☐ 1   ☐ 2   ☐ 3   ☐ 4

6. How many beds will you need?

☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   ☐ More

7. If you could build only 1 room, which one would you chose?

☐ Living room   ☐ Bedroom   ☐ Kitchen   ☐ Toilet

8. If you could build a second room, which one would you chose?

☐ Living room   ☐ Bedroom   ☐ Kitchen   ☐ Toilet

9. Would you pay extra money to plaster your walls?

☐ Yes   ☐ No

10. Could you or some other member of the family participate in the construction of your house?

☐ Yes   ☐ No

11. Could you or some other member of the family participate in the cooking for the workers?

☐ Yes   ☐ No

12. Do you have any other place to stay while constructing?

☐ Yes   ☐ No

13. What kind of materials are available in your surroundings?

☐ Sand   ☐ Stones   ☐ Bamboo   ☐ Murram   ☐ None

#### I) FINANCIAL SITUATION

1. Do you own a land? ☐ Yes ☐ No

2. Do you own sleeping mattresses? ☐ Yes ☐ No

3. Do you have any other forms of income? Gift? ☐ Yes ☐ No

4. Do you have a bank account / savings? ☐ Yes ☐ No

5. How much can you realistically afford to spend for house construction?

☐ 1-2.5 million tsh   ☐ 2.5-4 million tsh   ☐ 4-6 million tsh   ☐ more than 6 million tsh

6. How would you pay for it?

☐ weekly income   ☐ down payments   ☐ depends on the business   ☐ I don't know

7. Would you consider taking out a loan/mortgage? ☐ Yes ☐ No

8. Are you a member in any registered community group?

9. How much do you contribute in that registered community group annually?

☐ less than 50 000 tsh   ☐ 100 000 tsh   ☐ 200 000 tsh   ☐ 300 000 tsh   ☐ more than 400 000 tsh

#### ANY OTHER SUGGESTION OR COMMENT?



## Annexe 2. Questionnaire Swahili

### MUUNDO WA FAMILIA

Jina (hiari) \_\_\_\_\_ Jinsia ☐ F ☐ M

Umri ☐ chini ya 11 miaka ☐ 12-18 miaka ☐ 19-24 miaka  
☐ 25-45 miaka ☐ 46-65 miaka ☐ Zaidi ya 66 miaka

	hapana	1	2	3	4	5	6	zaidi
Ni watu wangapi wanaoishi ndani ya nyumba?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Jel! Ni wanafunzi wangapi ndani ya nyumba?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ni wangapi wenye ajira nyumbani?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ni wangapi wenye biashara ndani ya nyumba?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ni wangapi wasio kuwa na ajira katika nyumba?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### MAELEZO KIUJUMLA

	(sijaridhika) 1	2	3	4	5 (kuridhika sana)
• Je kwa kiasi gani umeridhika na nyumba yako?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Jel! Unajisikia salama Shimbwe?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Sababu ni nini?					
<input type="checkbox"/> Najisikia salama <input type="checkbox"/> Wizi <input type="checkbox"/> Watu walevi <input type="checkbox"/> Vurugu za ndani					
• Jel! Kuna wadudu wengi ndani ya nyumba?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Hapana			
• Jel! Unajali kuhusu mazingira?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Hapana			
• Ungependa kufikiria kutumia nishati ya jua?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Hapana			
• Jel! Umejisikia kuhusu matofali ya kushindilia?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Hapana			
• Je, umesikia kuhusu msaada wa C-re-aid?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Hapana			
• Jel! Unajua ni nini kuhusu taaluma ya usanifu (architect)?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Hapana			
<b>A) HALI YA KISASA</b>					
1. Unaonaje suala la kuwa na vyoo nje ya nyumba?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Ningependelea ndani			
2. Ni nini cha kutenganisha?					
<input type="checkbox"/> Jiko mbali na sebule <input type="checkbox"/> Choo mbali na sebule <input type="checkbox"/> Chumba cha kulala mbali na sebul					
3. Kuna umuhimu gani kujitenganisha wanaume na wanawake, watoto na wazazi, wavulana na wasichana nyumbani?					
<input type="checkbox"/> Ndiyo <input type="checkbox"/> Hapana					
<b>B) KUPIKA NA KULA</b>					
1. Je umeridhika na mipangilio ya kupika?	<input type="checkbox"/> Ndiyo	<input type="checkbox"/> Hapana			
2. Je, huandaa wapi chakula chako?	<input type="checkbox"/> Jiko la nje	<input type="checkbox"/> Jiko la ndani			

3. Ni aina gani ya vifaa vya kupikia unavyotumia?

☐ Jiko la Mkaa ☐ Jiko la Umeme ☐ Jiko la mafuta ya taa

☐ Kuni ☐ Jiko la gesi

4. Unaoshea wapi vyombo? ☐ sinki la vyombo ☐ Kitalu cha nje ☐ Ndoo

5. Wewe na familia yako ni wapi mnakula kila wakati?

☐ Katika veranda ☐ Katika sebule ☐ Katika chumba cha kulala ☐ Jikoni ☐ Jiko la nje

6. Unapika mara ngapi kwa siku? ☐ Mara 1 ☐ Mara 2 ☐ Mara 3 ☐ zaidi

7. Ni wapi unatupa takataka zako?

☐ Kuchoma ☐ Kufukia chini ☐ Kutupa mbali ☐ Matumizi chanya

**C) UIFADHI**

1. Je, umeridhika na mipangilio ya kuhifadhi? ☐ Ndiyo ☐ Hapana

2. Jel! Unaweka wapi vifaa vya kupikia?

☐ Katika kabati za vyombo ☐ Katika chombo cha plastiki ☐ Chini ya kitanda

3. Unaifadhi wapi vyakula (mchele, maharage, sukari, mahindi unga nk)?

☐ Katika ndoo ☐ Katika vyombo vya plastiki ☐ Katika chombo cha chuma

4. Unaifadhi wapi nguo?

☐ Katika mifuko ya plastiki ☐ Kamba ya kuninginiza nguo ☐ Katika sanduku ☐ Katika kabati ya nguo

**D) MIPANGILIO YA MALAZI**

1. Je, inaridhisha na mipangilio ya malazi kwa familia yako? ☐ Ndiyo ☐ Hapana

2. Wapi wana familia wanalala?

☐ Katika vyumba vya kulala ☐ Sebuleni ☐ Jikoni

3. Kuna vyumba vingapi vya kulala? ☐ 1 ☐ 2 ☐ 3 ☐ 4

4. Kuna vitanda vingapi katika nyumba?

☐ Hakuna ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Zaidi

**E) USAFI**

1. Je hali ya usafi binafsi inaridhisha? ☐ Ndiyo ☐ Hapana

2. Katika sehemu gani familia inaogea? ☐ bafu binafsi ya nje ☐ bafu la kushirikiana la nje ☐ choo ni bafu pia

3. Je, ni aina gani ya choo unachotumia?

☐ Choo cha maji ya kuflashi ☐ Choo cha kuchuchumaa

☐ Choo cha shimo ☐ Choo cha jirani ☐ Hakuna choo

4. Kama choo kipo mbali na nyumba ni umbali gani? ☐ mita 1-5 ☐ mita 5-10 ☐ > mita 10

5. Choo na bafu yako vinaridhisha? ☐ Ndiyo ☐ Hapana



**F) MAKAZI**

1. Una bustani nyumbani ya mboga? ☐ Ndiyo ☐ Hapana
2. Je, una biashara ndogo ndogo nyumbani?
- ☐ Kutengeneza chapati ☐ Duka ☐ Mgahawa wa chai / kahawa ☐ Bustani ya mboga
- ☐ Kuuza mbege ☐ Duka la nyama (bucha) ☐ Hakuna biashara nyumbani
3. Unafuga kuku au wanyama wengine? ☐ Ndiyo ☐ Hapana
4. Kama ndiyo, unawaweka wapi? ☐ Katika nyumba ☐ Banda dogo ☐ Shamba la kufugia ☐ Sina mifugo

**G) HALI YA SASA**

1. Umeishi muda gani katika makazi yako ya sasa?
- ☐ mwaka 1 - 5 ☐ miaka 5 - 10 ☐ zaidi ya miaka 10 ☐ makazi ya kudumu
2. Ni vifaa gani ulivyotumia kwa ajili ya kupaua?
- ☐ Mabati ☐ Vigae ☐ Matofali ya saruji ☐ Makuti
3. Ni vifaa gani ulivyotumia kwa kupanua kuta?
- ☐ Matofali ya zege ☐ Tofali za kuchoma ☐ Matope ☐ Mabanzi ☐ Mchanganyiko
4. Umetumia kiasi gani kujenga nyumba yako?
- ☐ Bure / urithi ☐ Chini ya laki tano ☐ 1 million ☐ 2 million
- ☐ 3 million ☐ 4 million ☐ Sijui
5. Ni kila baadya ya muda gani matengenezo yanahitajika?
- ☐ Kila mwezi ☐ Kila miezi 6 ☐ Kila miezi 12 ☐ Kila miezi 24
6. Nini kinanitajika kwa matengenezo?
- ☐ Kuta ☐ Plasta ☐ Paa ☐ Muundo ☐ Sakafu
7. Ulilipa kiasi gani cha matengenezo kila mwaka kwa plasta au ripu, kuvuja?
- ☐ Elfu kumi tsh ☐ 10 000-50 000 tsh ☐ 50 000-200 000 tsh ☐ Zaidi ya 200 000 tsh
8. Jel Ulibidi uenge upya kabisa? ☐ Ndiyo ☐ Hapana
9. Kama ikibidi kufanya marekebisha ya chumba kimoja ungechagua kipi?
- ☐ Sebuleni ☐ Chumbani ☐ Veranda
10. Una umeme? ☐ Ndiyo ☐ Hapana
11. Jel Una maji? ☐ Ndiyo ☐ Hapana
12. Jel Una TV? ☐ Ndiyo ☐ Hapana
13. Je una simu? ☐ Ndiyo ☐ Hapana
14. Je una radio? ☐ Ndiyo ☐ Hapana

**H) MATARAJIO YA BAADAYE**

1. Je, hii ndiyo nyumba yako ya kudumu? ☐ Ndiyo ☐ Hapana
2. Ungetumia muundo wako wa zamani ili kuunda makazi mapya? ☐ Ndiyo ☐ Hapana
3. Jel Unataka kujenga nyumba mpya? ☐ Ndiyo ☐ Hapana
4. Jel Unatarajia mabadiliko yoyote kwa kaya yako baadaye?
- ☐ Kuongeza watoto ☐ Ili kuboresha nyumba ☐ Matarajio ya nyumba kisasa

5. Kama utajenga nyumba mpya utapenda iwe na vyumba vingapi?
- ☐ 1 ☐ 2 ☐ 3 ☐ 4
6. Je utahitaji vitanda vingapi katika nyumba mpya?
- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ zaidi
7. Ikiwa ungeweza kujenga chumba kimoja tu, ungechagua kipi?
- ☐ Sebuleni ☐ Chumbani ☐ Jikoni ☐ Chooni
8. Ikiwa ungeweza kujenga chumba cha pili, ungependa kuchagua kipi?
- ☐ Sebuleni ☐ Chumbani ☐ Jikoni ☐ Chooni
9. Je ungelipa pesa Zaidi kwa ajili ya kuplasta nyumba yako?
- ☐ Ndiyo ☐ Hapana
10. Je wewe au wana familia wange penda kushiriki katika ujenzi wa nyumba yako?
- ☐ Ndiyo ☐ Hapana
11. Jel Wewe au wanafamilia wangependa kupikia mafundi katika ujenzi wa nyumba yako?
- ☐ Ndiyo ☐ Hapana
12. Je una makazi mengine ya kuishi wakati ujenzi unaendela? ☐ Ndiyo ☐ Hapana
13. Aina gani ya malighafi ya ujenzi yanapatikana katika eneo lako?
- ☐ Mchnaga ☐ Mawe ☐ Mianzi ☐ Moramu ☐ Hapana

**I) HALI YAKIPATO**

1. Unamiliki ardhi? ☐ Ndiyo ☐ Hapana
2. Jel Una godoro? ☐ Ndiyo ☐ Hapana
3. Jel Una aina nyingine ya mapato? Zawadi? ☐ Ndiyo ☐ Hapana
4. Jel Una akaunti ya benki / akiba? ☐ Ndiyo ☐ Hapana
5. Jel Kiasi gani unaweza kumudu kutumia katika ujenzi wa nyumba?
- ☐ 1-2.5 million tsh ☐ 2.5-4 million tsh ☐ 4-6 million tsh ☐ zaidi ya 6 million tsh
6. Ungelipaje?
- ☐ Mapato ya kila wiki ☐ Malipo kabla ☐ Inategemea biashara ☐ Sijui
7. Je ungefikiria kuchukua mkopo wa nyumba? ☐ Ndiyo ☐ Hapana
8. Je wewe ni mwanachama wa kikundi chochote katika jamii? ☐ Ndiyo ☐ Hapana
9. Je ni kiasi gani cha fedha unachangia katika kikundii hicho kwa mwaka?
- ☐ Chini ya 50 000 tsh ☐ 100 000 tsh ☐ 200 000 tsh ☐ 300 000 tsh ☐ zaidi ya 400 000 tsh

**MAPENDEKEZO YOYOTE YA KUONGEZA?**



# Questionnaire table results

	YES	NO	no answer
Are there a lot of insects/vermin in your house?	81%	19%	-
Do you care about nature?	90%	10%	-
Would you consider using solar energy?	93%	7%	-
Have you heard about Compressed Earth Blocks?	65%	35%	-
Have you heard about C-re-aid?	36%	64%	-
Do you know what is the profession of an architect?	18%	82%	-
Are you satisfied with the cooking arrangements?	52%	48%	-
Are you satisfied with storage arrangements?	24%	76%	-
Are you satisfied with sleeping arrangements for your family?	23%	77%	-
Are you satisfied with personal hygiene arrangements?	80%	20%	-
Are you satisfied with the type of toilet and bathing area you have?	9%	91%	-
Do you grow vegetables near the house?	57%	42%	-
Do you keep poultry and animals?	82%	18%	-
Have you had to rebuild it entirely?	18%	81%	1%
Do you have electricity?	5%	95%	-
Do you have water?	10%	90%	-
Do you have a TV?	1%	99%	-
Do you have a mobile phone?	61%	39%	-
Do you have a radio?	31%	69%	-
Is that your permanent house?	93%	6%	1%
Would you use your old structure to create a new function?	23%	76%	1%
Do you want to build a new home?	81%	18%	1%
Would you pay extra money to plaster your walls?	47%	53%	-
Could you or some other member of the family participate in the construction of your house?	93%	7%	-
Could you or some other member of the family participate in the cooking for the workers?	94%	6%	-
Do you have any other place to stay while constructing?	83%	16%	1%
Do you own a land?	99%	1%	-
Do you own sleeping mattresses?	44%	56%	-
Do you have any other forms of income? Gift?	4%	96%	-
Do you have a bank account / savings?	1%	98%	1%
Would you consider taking out a loan/mortgage	2%	98%	-
Are you a member in any registered community group?	24%	76%	-

	None	1	2	3	4	5	6	More
How many are living in the house?	-	10%	14%	18%	18%	17%	9%	14%
How many are students in the house?	35%	22%	23%	12%	6%	1%	1%	-
How many are employed in the house?	99%	1%	-	-	-	-	-	-
How many own a business in the house?	96%	3%	1%	-	-	-	-	-
How many are unemployed in the house?	2%	20%	25%	23%	15%	5%	3%	7%
How satisfied are you with your house?	-	91%	2%	4%	3%	-	-	-
How safe do you feel in Shimbwe?	-	4%	5%	1%	1%	89%	-	-
How many times do you cook per day?	-	65%	34%	1%	-	-	-	-
How many rooms do you currently have?	-	33%	47%	18%	2%	-	-	-
How many beds do you currently have?	7%	29%	45%	17%	2%	-	-	-
How many rooms will you need?	-	1%	17%	51%	31%	-	-	-
How many beds will you need?	-	4%	25%	48%	21%	1%	1%	-

	I feel safe	no answer
What is(are) the reason(s)?	99%	1%

	Throw away	Burn	Bury	Recycle
How do you dispose of your waste?	54%	40%	3%	3%

	Outside the house	Inside the house
Where do you prepare your meals?	72%	28%

	Firewood	no answer
What type of cooking equipment are you using?	99%	1%

	Good	I prefer it inside	no answer
How do you see the issue of having toilets outside the house?	91%	8%	1%

	Kitchen from living room	Toilet from kitchen and living	Bedroom from living room
What spaces should be separated?	20%	78%	2%

	There is separation	No need for separation
How important is the separation of men and women, children and parents, boys and girls in the house?	80%	20%

	Buckets	Concrete platform outside the house
Where do you wash dishes?	96%	4%

	Living	Kitchen	Bedroom	Outside	Veranda	Toilet
Where do you and your family eat mostly?	13%	38%	21%	23%	5%	-
Where do different members of the household sleep?	7%	15%	78%	-	-	-
If you could renovate only 1 room, which one would you chose?	3%	-	97%	-	-	-
If you could build only 1 room, which one would you chose?	4%	-	93%	-	-	3%
If you could build a second room, which one would you chose?	40%	1%	31%	-	-	28%

	Plastic container	Utensils cupboard	Under bed
Where do you keep your cooking utensils?	95%	1%	4%

	Plastic container	Buckets	Tin container
Where do you store food (rice, beans, sugar, maize flour etc...)?	55%	42%	3%

	Hang on line	Suitcases	Plastic bags
Where do you store clothes?	74%	19%	7%

	None	Own outside bathroom	Shared outside bathroom	Toilet same as bathroom
In which space does the family have a bath?	32%	42%	11%	15

	1-5 meters	5-10 meters	more 10 meters	no answer
If outside the house, how far is it from the house?	57%	25%	8%	10%

	Water closet -Western type	Water closet -indian type	Pit latrine	Neighbors facilities	No toilet
What type of toilet do you use?	3%	1%	85%	1%	10%

	Shop	Vegetable garden	Selling local brew	Butchery	No
Do you have any small business at home (inside the houses or within the plot)?	1%	2%	3%	1%	93%

	Pen for animals	House	no answer
If yes, where do you keep the animals?	69%	14%	17%

	1-5 years	5-10 years	More than 10 years	It is my initial house
How long have you lived at your current residence?	2%	6%	17%	75%

	Corrugated iron sheets	Thatch
What materials did you use for roofing?	99%	1%

	Mud and pole	Manbazi	Mixture
What materials did you use for extending walls?	82%	15%	3%

	Every month	Every 6 months	Every 12 months	Every 24 months
How much maintenance does it need?	8%	30%	52%	10%

	Walls	Plaster	Roof	Structure
What does need maintenance?	77%	2%	1%	10%

	Free/Inherited	< 500,000 tsh	1 million tsh	2 million tsh	4 million tsh	I don't know
How much did you buy your house for?	52%	30%	7%	2%	1%	8%

	< 10,000 tsh	10,000-50,000 tsh	50,000-200,000 tsh	> 200,000 tsh	I don't know
How much do you pay for maintenance annually? (plaster, repairs, leaks etc)	34%	36%	1%	1%	28%

	Desire of a modern house	New children	To improve the house
Do you anticipate any changes to your household in the future?	76%	3%	21%

	1.-2.5 million tsh	2.5-4 million tsh	I cannot afford it
How much can you realistically afford to spend for house construction?	66%	7%	27%

	Weekly income	Down payments	Depends on the business	I don't know
How would you pay for it?	10%	17%	2%	10%

	Sand	Stones	Bamboo	Murram	None
What kind of materials are available in your surroundings?	9%	62%	4%	5%	20%



Budget Prototype 0.1											
Work	Section	Material	Comments / Size	Amount	Unit	Unit Price	Value	TOTAL Material (TDS)	TOTAL cost	TOTAL	
Foundation	Base foundation (m²)	Reinforced	2.5 x 0.5 x 0.5 m³	10	m³	100	1000		1000		
	Base foundation (m³)	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Gravel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Soil	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Base foundation	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Gravel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Soil	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Base foundation	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Columns	Base column	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
Base column		Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Gravel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Base column	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
Steel			2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Gravel			2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Soil			2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Base column		Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Walls		Base wall (m²)	Reinforced	2.5 x 0.5 x 0.5 m³	100	m²	100	10000		10000	
		Base wall (m³)	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
	Steel		2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Gravel		2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Base wall (m³)		Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Gravel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Soil	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Base wall (m³)	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Roof	Base roof	Reinforced	2.5 x 0.5 x 0.5 m³	100	m²	100	10000		10000	
		Base roof	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
Steel			2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Gravel			2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Base roof			Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Gravel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Soil	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Base roof		Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
Floor		Base floor	Reinforced	2.5 x 0.5 x 0.5 m³	100	m²	100	10000		10000	
		Base floor	Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
	Steel		2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Gravel		2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000		
	Base floor		Concrete	2.5 x 0.5 x 0.5 m³	100	m³	100	10000		10000	
		Steel	2.5 x 0.5 x 0.5 m³	100	m³	100	1				







TOTAL	€	7.242.600,00
	€	2.595,57

TOTAL	113 7 910 727 14
€	2 503,86