THE HIDDEN RURAL HOUSING CHALLENGES IN ETHIOPIA AND AN ALTERNATIVE MITIGATION MEASURE

Presented to:

ETHIOPIA 2050 – Grand Challenges And Opportunities Conference

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- ***Many nations enshrine housing development in their policy with a strategic plan framework***

- ***In some, such practices do happen rarely***

- ***In which case, a certain segment of the population will be left far behind***

- ***For such states the wake-up call may be felt very late***

- ***By which time, situations might have gone far beyond capacity to reverse***

- **In Ethiopia , the housing situation in the rural was not given a policy coverage (if not mistaken) until the GTP I and GTP II plans**

- **Where it was stated that, rural housing is 3,400,000 and the urban including Addis Ababa is 1,500,000 within the period of 2015/16-2020/21**

※ **Though not sure of the progress made so far, time is speeding up**

※ **To straighten up the ambitious popular plan, specifically, that for the rural domain available alternatives have to be critically evaluated**

※ **One of such alternatives could be amended compressed earth block (ACEB)**

The proposition is:

- **Amending a given natural soil with lime and powdered pozzolans in the presence of optimal amount of water could help in obtaning an improvised building material**

- **The effort pursued achieved a positive result both in compressive strength and durability terms per international earth construction normative**

CONTEXTUAL UNDERSTANDING AND METHOD

- **The local building construction materials are mostly defined by the geographical location and settlement pattern of the Ethiopian people**

- **With the geographic influence comes mode of life and style of built environment**

- **The climatic condition also dictates the endowed natural resources for the construction of houses and their type**

- **In the Ethiopian rural situation everything related to housing is very much dependent on naturally endowed raw materials with little or no improvisation**

- **The lessons from the past enlightens us that, since exercises of this nature were not in place there was little or no improvement in the vernacular housing & life style**

- **This shows that, there are lots to be done to galvanize the practice & bring about a change**

- **We all feel that nothing tangible was done to modernize the ninety million or so of the rural mass habitat**

- **It happened to be left aside to be handled by NGOs; wherever the chance arises**

- **The practice was so fragmented, non-well crafted, short lived, un-sustained in any of its form**

- **It is exacerbated with a zero support of any research effort, to say the least**

- **It is quite unfortunate to see that none of our vernacular construction materials are upheld to navigate through the tide of time**

- **Efforts made to sustain our culture of costumes, food and the like are admirably good; but yet short of basic research and knowledge based innovation**

- **On the other hand, though shelter is one of the prime and fundamental necessities for a continued and meaningful sustained human life**

- **It seems that no attention is yet given to improvise and standardize our own construction materials and their subsequent effective application**

- **Most of the contemporary researches being pursued are focusing on high energy demanding construction materials**

- **Where high energy results in high product cost it truly targets the modernization of mega cities and to some extent those of bigger towns**

- From the perspective of energy consumption and CO_2 emission, most commonly used construction materials locally are: re-bar, cement and hollow concrete blocks (HCBs)

- These are extremely detrimental to the wellbeing of the whole eco-system

- A recent study in Ethiopia reported that, cumulatively, they were responsible for 94% of the embodied energy and 98% of the CO_2 emissions in only the cradle to site phase

- This will further inflate if the whole life-cycle of the buildings is accounted for

- **In which case, with regard to standardizing locally innovated building materials, it seems quite important to learn from others**

- **Who succeeded by encouraging the locals to appreciably use available knowledge to take advantage of the resources at hand**

- **Nepal's code which was implemented in 2001 clearly marked a sign on the bottom-up approach on the success and increasing the code compliance rate**

The four different levels of sophistication of design and construction contents were:

- **International state of the art**
- **Professionally Engineered structures**
- **Buildings of restricted size designed to simple rules of thumb**
- **Mandatory rule of thumb; and**
- **Remote rural buildings where control is impractical**

- **Local building inputs must be supported with product specification and standards**

- **Else, it would be fairly difficult to compete with those industrially produced ones in the market place**

- **In this regard, the main objective of the just concluded research was to shed a limelight on a home grown culture of construction material formulation**

- **Thereby, lay a foundation for their continuous and innovative up keeping**

- **Underpinned with research, technical development and standardization of products and services**

As an output of the research finding:

- **Such type of improvised building block is named as amended compressed earth block (ACEB)**

- **The mortar thereby is labeled as amended earth mortar (AEM)**

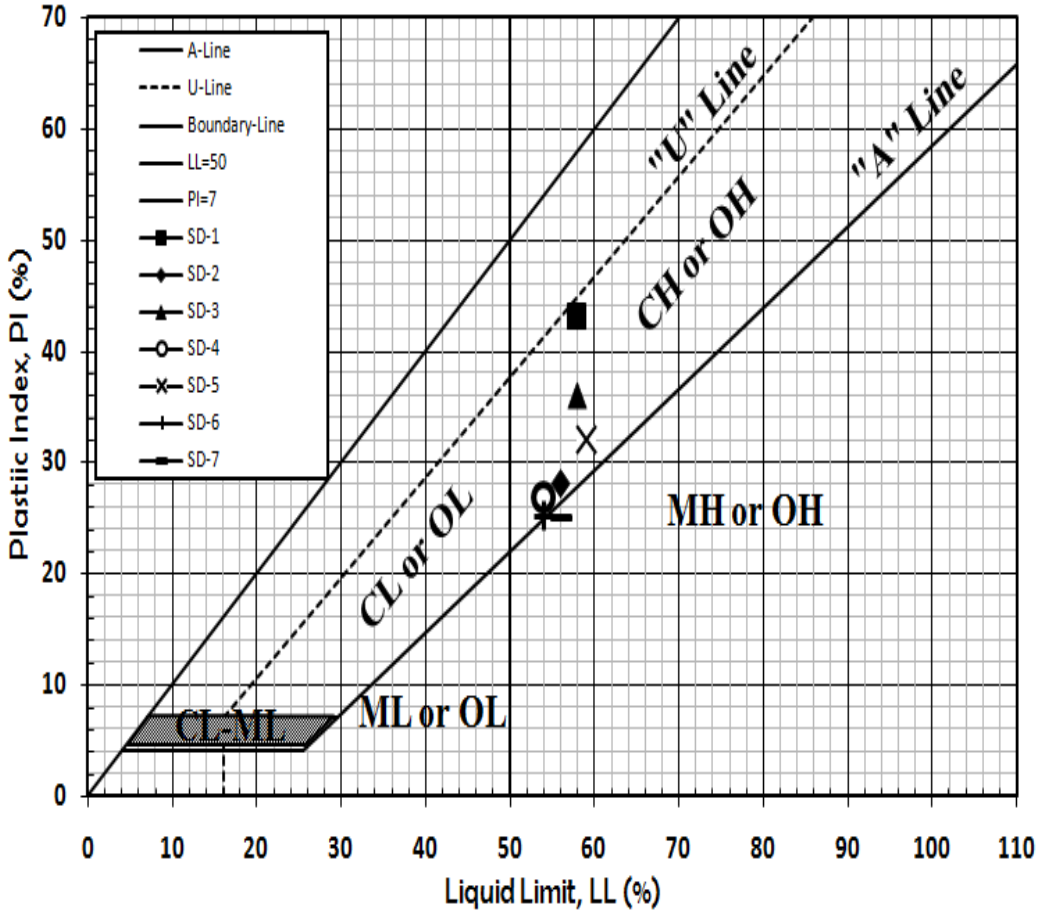
- **For the product, the ingredients were soil, lime and pozzolanic material, separately**

- **Plus the two together leading to six more distinct mixtures to have seven series of specimen blocks as in the table below (SD1-SD7)**

Dry, Post-drip & Post-capillary Test Results

CEB/ACEB		Test Type	Dry Weight (N)	Wet Weight (N)	Comp. Strength (MPa)	Water Effect			Remark
Series	Sample No.					Penetration (mm)	Wt.Gain (N)	% Gain	
SD-1	1.1	Dry	92.7		0.5	----			CEB
	1.2	Drip	05.8		0.9	15			CEB
	1.3	Capillary	14.1	126.0	0.6	----	11.9	10.4	CEB
SD-2	2.1	Dry	91.0		0.6	----			ACEB
	2.2	Drip	03.6		0.9	15			ACEB
	2.3	Capillary	02.7	105.4	0.2	----	26.5	2.6	ACEB
SD-3	3.1	Dry	07.3		1.2	----			ACEB
	3.2	Drip	0.0		1.1	13			ACEB
	3.3	Capillary	01.8	104.2	0.5	----	24.6	2.4	ACEB
SD-4	4.1	Dry	08.0		0.9	-----			ACEB
	4.2	Drip	00.8		1.1	12			ACEB
	4.3	Capillary	03.8	106.0	0.6	-----	21.5	2.1	ACEB
SD-5	5.1	Dry	20.2		1.1	-----			ACEB
	5.2	Drip	25.4		1.2	12			ACEB
	5.3	Capillary	32.3	132.8	0.5	-----	5.5	0.4	ACEB
SD-6	6.1	Dry	14.3		1.3	-----			ACEB
	6.2	Drip	12.4		1.2	10			ACEB
	6.3	Capillary	13.1	113.8	0.8	-----	6.7	0.6	ACEB
SD-7	7.1	Dry	32.4		1.1	-----			ACEB
	7.2	Drip	17.0		1.5	10			ACEB
	7.3	Capillary	16.7	117.5	1.1	----	7.7	0.7	ACEB

Casagrande plasticity chart showing amending effectiveness



The above figure clearly indicates:

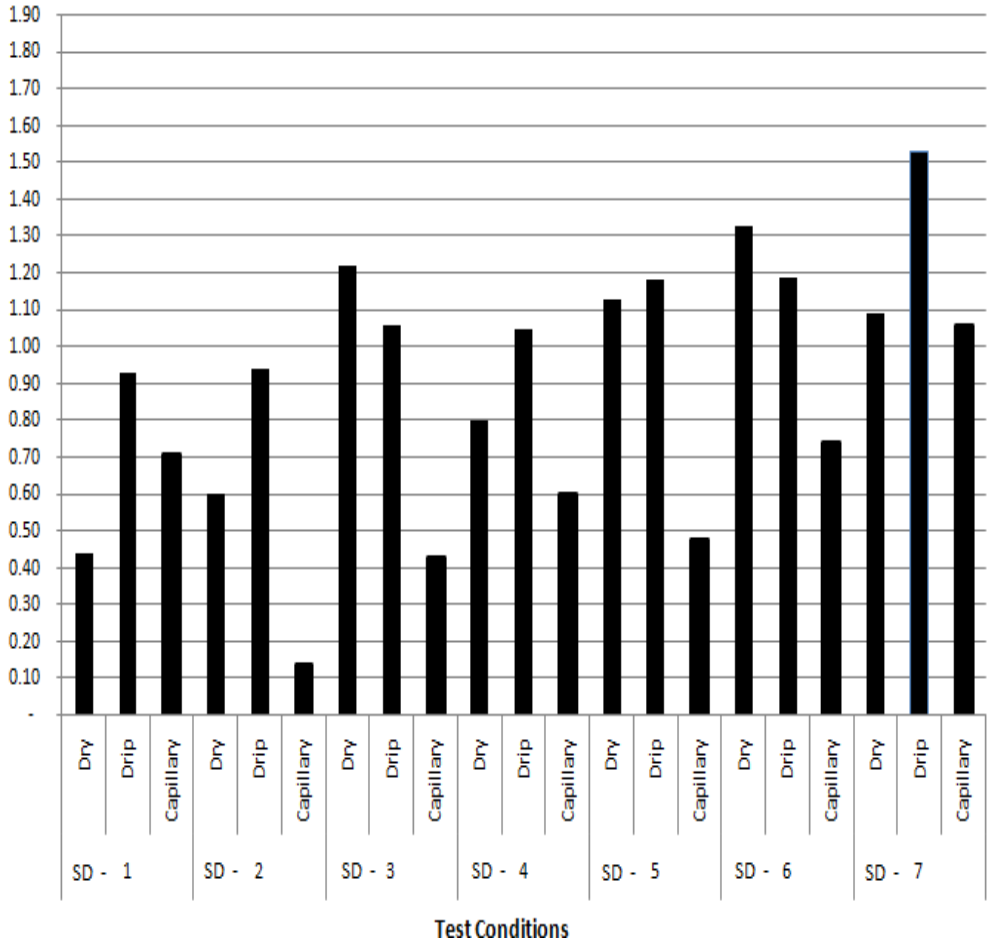
- **The improvement made by changing the highly plastic soil to low plasticity (the PI from 43 to 25)**

- **The soil class from CH or OH (inorganic or organic clays) to MH or OH (inorganic silts or organic clays)**

- **This in turn reduces the characteristics of the given natural soil shrinkage potential from the high to the low range.**

CEB & ACEB compressive strength vs. various testing conditions

- It shows the performance improvement gained by the proposed amending method of natural soils



※ **Referring to international normative of compressed earth blocks, the African Regional Standard Organization (ARSO), has set three mechanical constraints for excessive water absorption limits:**

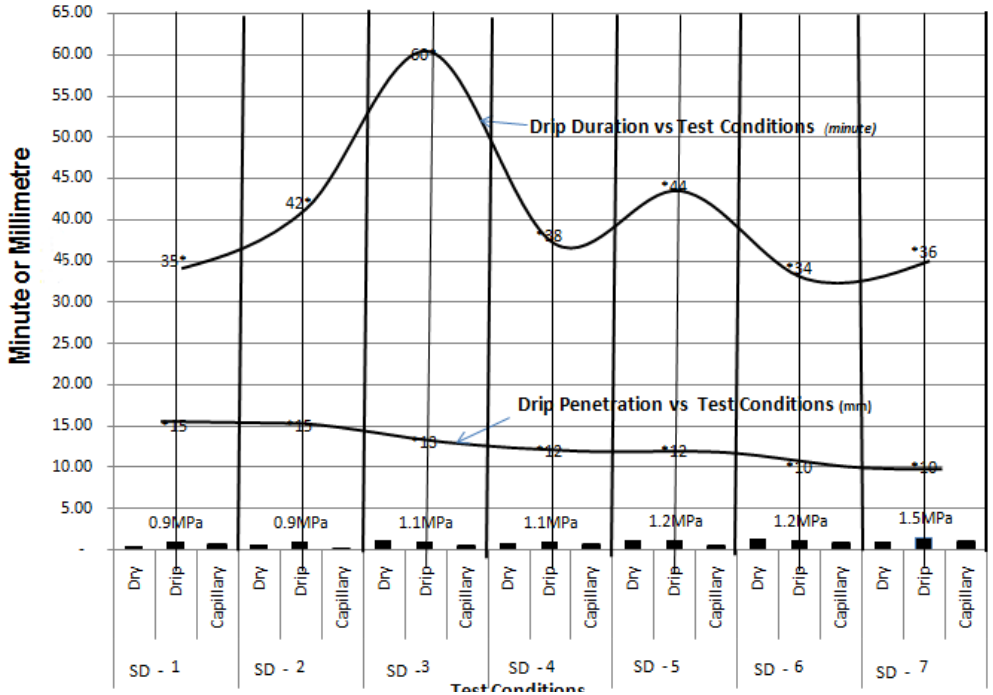
≤ 15% for category one

≤ 10% for category two

≤ 5 for category three

NB:- The results of the current research were found to be in the range of 0.4% - 2.6%

Drip effect on CEB and ACEB units vs. various testing conditions



CONCLUSIONS & RECOMMENDATIONS

1. Conclusions

* The initiated move has proven that, the finding is worth for future application

* The rural housing scheme need to consider this method of construction for its habitat upgrading & affordability

* Further researches must be encouraged to ensure sustainability & durability

2. Recommendations

* Due to susceptibility of earthen structures to various environmental effects study centers need be established at various locations of the country for the purpose of monitoring

* A central monitoring, evaluation and information center has to be established to bear responsibility

* Standards and application guidelines has to be developed to make the product a main stream local construction material

HIGHLIGHT OF THE SO FAR EFFORTS

UTILITY MODEL CERTIFICATE

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Ethiopian Intellectual Property Office

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UTILITY MODEL CERTIFICATE

In accordance with Article 42 of the Proclamation Concerning Inventions, Minor Inventions and Industrial Designs, No. 123/1995 it is here by certified that a Utility Model Certificate Number 836 has been granted to:

D.r KASSAHUN ADIMASU (Where Legal address Addis Ababa, Bole sub city, woreda 03.)

On December 20, 2017 in respect of a minor invention disclosed in:-

Filing Date: 13/01/2017

Application Number: ET/UM/17/2323

Being a Minor Invention Entitled :-

Composition and process for making bricks.

Fikre Tesfaye

A/Director of Patent Protection and Technology Transfer

THE HOUSE

Buee TVET College

Method of Amending Soils for Compressed Block and Mortar in Earthen Construction

Abstract

The paper presents the results of a research conducted aiming at developing a method of producing building block and mortar from locally available natural soils and earth minerals. The main focus of the effort is to establish or advance wall making building blocks and jointing/binding mortars from amended soils with cementitious raw lime/non-factory manufactured and pozzolanic minerals. The targeted beneficiaries of the success are the over eighty million disadvantaged Ethiopians residing in the rural and semi-rural areas of the country. They deserve a decent, sustainable, eco-friendly and a popular technology based habitat.
The long journey towards achieving the noble goal was initiated by investigating the suitability of soils and earth minerals, preparation and testing of informative specimens and the production of mortar cubes and proto-type building blocks in their actual size to simulate field application conditions. The specifics of this particular move is thoroughly focusing on the two prime parameters of compressive strength and durability (water resistance) which are the determinant factors for the viable application of earth based wall making in puts. The attained results of the effort indicated that the designed mix proportioning of the ingredients confirmed that the products are acceptable both in compressive strength and durability terms for the intended purpose. To this effect, the blocks produced using the proposed method, are named as amended compressed earth blocks (ACEBs).

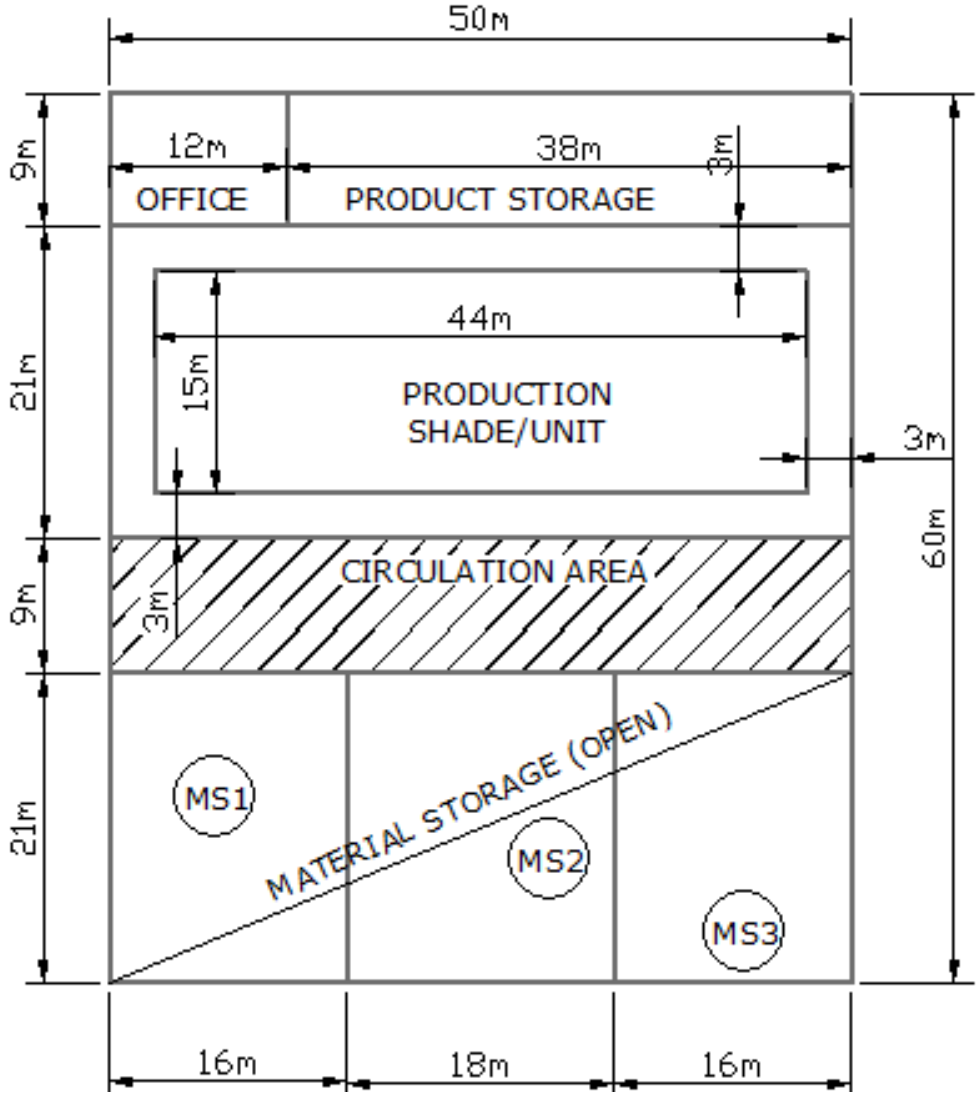
***Keywords**: Natural soils, Earth minerals, Amended compressed earth block (ACEB), Mortar, Earthen construction, Durability*

Zede Journal of Ethiopian Engineers and Architects (2019)

AT ADDIS CHAMBER's EXHIBITION

ACEB's BOOTH AT THE EXHIBITION

Soil Amending Product Processing Unit (Proposal)



THANK YOU!