

**AN INVESTIGATION INTO THE ISSUES INFLUENCING THE USE OF  
INTERLOCKING STABILISED SOIL BLOCKS IN KENYA, A CASE STUDY OF  
SIAYA COUNTY.**

**BY**

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## **DECLARATION**

This research project report is my original work and has not been presented for academic purposes in the University of Nairobi or any other University.

Sign.....Date.....

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This project report has been submitted with my approval as university supervisor

Signed.....Date.....

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## **DEDICATION**

This research project is dedicated to my dear wife, Judy N. Muinde, for her motivation, my son Ryan and daughter Riya, for letting me to be away to attend classes, Although they may not understand why I have been away for long, may this piece of work be a testimony of their hardworking father and encourage them to work even harder in the future. To my parents, Mr. and Mrs. Walter M., for your prayers and support.

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## **ABBREVIATIONS.**

<b>ISSB</b>	Interlocking Stabilized Soil Block
<b>NHP</b>	National Housing Policy
<b>MoH</b>	Ministry of Housing
<b>KNBS</b>	Kenya National Bureau of Statistics
<b>ABMT</b>	Appropriate Building and Materials Technology
<b>KOD</b>	Kenya Open Data
<b>UNDP</b>	United Nations Development Programme

## **ABSTRACT**

This research report presents a survey study done to investigate issues contributing to the uptake of ISSB technology in Kenya, and in particular Siaya county.

The literature review revealed that, a number of factors contributed to low uptake of the technology. Key among the factors was the fact that people were found to be a bit conservative and as such, rigid to technological developments, especially in construction where many believe the conventional methods are still the best.

The study was carried out in Siaya County. Stratified sample was used where the researcher, identified three strata, namely masons, housing officers and inadequate house owners. All the respondents in each stratum were selected randomly from all the six sub counties in equal measure. The study involved certified masons from all the sub counties as per the department of housing records, all sub county housing department heads, and inadequate house home owners sample size was determined using Cochran (1963) approach. To achieve the objectives of the study, 24 masons, 6 housing heads and 196 home owners responded to the questionnaires. The questionnaire had both open and close ended questions. Tables, graphs and statements were used to analyze and discuss the data. From the findings, it was evident that the continued low use of ISSB technology in siaya is as a result of the kind of attitude that people have towards new technologies, Many respondents seemed not to be aware of the cost per unit block, yet believed that it was very expensive to put a house using ISSB. It was also confirmed that the ministry had done enough sensitization on ISSB, and created adequate awareness, and the question of lack of information did not arise for the low use of the technology and generally people were just resistant to change and remained adamant on the continued use of conventional methods of building.

Recommendations to improve and increase the uptake of ISSB were, a need for, more sensitization workshops, More demonstration units. The government should embrace the technology in its Projects, Clear cost guidelines should be availed to the expected recipients of new technologies and an increase in the number of interlocking mechanized Machines.

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1 Background Information**

Housing despite its importance, has become a serious problem to mankind in recent times.

One aspect that constitutes a grim problem is its delivery and affordability in developing countries like Kenya. Housing being one of the basic human needs, is usually ranked third after food and clothing (Simion, 2009). In most developing countries housing is inadequate and the housing backlog has been increasing rapidly. Statistics has it that Kenya has not been able to meet the ever rising housing demand with a short fall currently standing at over 150,000 units annually (KNBS, 2009). One key reason for housing inadequacy is the increase in population and the relatively high cost of permanent building materials (Racodi, 1997). The poorest sector of the community is most affected by this housing shortage as it is least able to afford construction materials classified as permanent under prevailing Kenyan building regulations. Though the rate of inflation has gone down to about 3.5 as at January of this year, the cost of construction materials have continued to rise and it is time to 'think outside the box'. Utilizing available technologies such as the interlocking stabilized soil blocks and efficient house designs can therefore shield one from feeling the cost pressure during construction. A recent study carried out on the comparative cost of selected walling material types revealed that it will be cheaper to build with interlocking blocks or stabilized blocks than non-interlocking types (Oyediran and Alabi, 2005). The ministry of housing estimates this walling cost to fall by 50%.

The traditional methods of constructing houses that are relatively cheap like bricks contribute to the deforestation process and it is of significant importance to introduce

sustainable building materials and building methods that are sustainable. Development of appropriate technologies for the production of low-cost building materials of good quality will not only speed up the provision of affordable adequate housing thus easing the demand pressure but will also preserve our environment as they are eco-friendly. Appropriate technologies refer to materials, methods and/or practices which help protect the natural environment, take inspiration from the cultural values and practices in the area, make use of local resources, and contribute to local economic development (Living,2009)).

One such technology is the use of stabilised-soil blocks as an alternative walling material. This research focuses on appropriate building materials and in particular on cement-interlocking stabilized soil blocks (ISSB) use in Siaya County.

Siaya county, located in northern Nyanza of Kenya, has a population of 842,304, 199,034 households and a poverty rate of 35% (KNBS,2009) is a good example of an area where a greater percentage at 80%,(KOD,2008), of its inhabitants have continued to live in inadequate houses and thus, a need to develop/improve on the same, and as a result the government through the ministry of housing Kisumu, took the initiative to introduce ISSB technology to this region as an alternative walling method to ensure that the community has access to affordable housing.

ISSB technology, involves the use of stabilized soils to make blocks, Soil stabilization may be defined as any process aimed at improving the performance of a soil as a construction material. Bell (1993), referred to soil stabilization as the process of mixing additives with soil to improve its volume stability, strength, permeability and durability.

This can be done through a number of stabilizers namely, bitumen, lime, ash, cement among others.

The concept of interlocking blocks differs from conventional blocks and bricks because the units are assembled without the use of mortar thus this reduces the overall cost. Hydraform,( 2002) defines interlocking blocks as block that have male and female profile on face that work as lock and key in four of the six sides of the block. Hines (1992) describes it as a technology that eliminates the use of mortar for wall construction and is self-aligning and reduces construction cost. Because of its technological simplicity and local resource dependence, mortarless-block construction is more appropriate to many local communities than conventional mortared-block techniques like quarry stones.

## **1.2 Problem Statement.**

The Universal Declaration of Human Rights of 1948 recognizes the right to adequate housing as an important component of the right to adequate standard of living.

Improvement of housing for the Kenyan population is a major concern to the Government. This concern has been influenced by the fact that the improvement in housing stock is a strategically important social and economic investment. In addition, well-planned housing and infrastructure of acceptable standards and affordable cost when combined with essential services affords dignity, security and privacy to the individual, the family and the community as a whole. (NHP, 2004). There is a need to promote awareness of appropriate construction technologies in civil society and the private sector in a bid to achieve adequate housing.

Using alternative technologies can be challenging in the Kenyan market, but if done correctly it has the potential to be an essential piece of bringing down the cost, as a result

the Kenyan government through the Ministry of housing introduced ISSB technology as an alternative cheaper walling technology in Siaya in a bid to improve the housing situation in this region.

Despite the above, to date the housing situation has not improved in Siaya County, and majority of its inhabitants have continued to live in poor shelter. Kenyans, Siaya community being no exception, have been slow to adopt alternative building technologies and especially ISSB, and have a strong bias towards traditional materials and techniques, specifically bricks; various challenges have been poised as the major obstacles to the use of interlocking stabilized soil blocks as an appropriate building technology. This research will seek to understand the challenges faced and issues surrounding the use of these blocks

### **1.3 Objectives**

#### **1.3.1 General Objective**

This study aims at establishing issues that affect the use of interlocking stabilized soil blocks as an alternative walling method.

#### **1.3.2 Specific Objective**

The study seeks to achieve the following specific objectives:

- a) To establish how suitable the technology is in Siaya
- b) Establish the level of awareness on the use of ISSB technology.
- c) Determine how skilled masons are in the use of interlocking blocks.



#### **1.4 Research Questions**

The study will seek to answer the following research questions in an effort to ascertain the sustainability of interlocking stabilised soil blocks as an appropriate building technology in Siaya county,

- a) How acceptable and suitable is ISSB technology in Siaya?
- b) How well informed are the people of Siaya about ISSB?
- c) How skilled are the masons in Siaya county in the use of ISSB, technology.

#### **1.5 Justification**

The country wide housing shortage has stimulated a search for appropriate, easy, fast and cost-effective new ways of wall construction. Among many technologies found to have promise is mortar less technology using dry-stack interlocking blocks, simply known as interlocking stabilized soil blocks.

The best approach in the development of technologies is to increase the utilization of locally available building materials. Appropriate solution for affordable housing will vary from one location to another. Some general rules, however, apply, for instance, affordability and availability of course are the basic requirements for the low-cost housing industry (Harlae and Marten, 1990). So do these general rules apply for the case of Siaya county?

However, researchers worldwide have made significant efforts to find sustainable and affordable technologies, most of these technologies have never quite picked up with ISSB, being no exception, one major challenge that has faced many new technologies is the issue of sustainability, as (Gilkinson and Sexton ,2007), defined the process of housing development should be based on sustainability principles.

Sustainable housing technologies require proper definition of housing needs and the participation of the end users to ensure their satisfaction. However, more than often, the end users and the basic requirements underlying a sustainable housing are never put into consideration and as a result, people tend to stick to the conventional methods of building houses and these technologies barely pick and this has been the case with siaya county where people are still using mud, even after the introduction of ISSB.

As Harlae and marten(1990), put it, a number of factors play a role in determining how suitable a given technology is, for a given region. The low uptake of ISSB in siaya is a point of concern, justifying the need for this study to establish what issues would be causing people not to embrace the technology.

## **1.6 Significance**

### **1.6.1 Ministry of Housing.**

The Ministry having had procured 82 hydraform machines by March 2010 (MoH, 2010), and rolled out training workshops throughout the country to transfer skills and empower community groups to construct affordable houses, social facilities and other utilities. This research will help in giving an overall picture to the ministry on why, some of these resources have not been utilized in ensuring that Kenyans have access into affordable adequate housing

The outcome of this research will highlight key areas where the ministry requires to reform, and change in their ISSB program.

### **1.6.2 Private Developers and Stake Holders**

Affordable housing through the use of interlocking stabilized blocks is one key area for social enterprises. Roberts (1997), defines social enterprise as, a revenue generating

venture founded to create economic opportunities for very low income individuals, while simultaneously operating with reference to the financial bottom-line. This research will highlight key areas of opportunities in siaya in regards to interlocking stabilized soil blocks as a key input to housing development process. The research will also highlight potential challenges to new social entrepreneurs venturing into this market allowing them early opportunities to overcome these obstacles in order to succeed in the low income housing market.

### **1.6.3 Community**

The research will look into the issues and challenges that the community has had in using interlocking stabilized soil blocks and have this passed to the concerned parties for a workable solutions.

### **1.6.4 Future Research.**

The study will give rise to key areas of weakness as far as walling through the use of ISSBs is concerned, and as such there will be significant opportunity for further research in an effort to encourage people to use ISSBs or enhance investments in making of interlocking stabilized soil blocks in provision of low income housing.

## **1.7 Limitations of the Study**

Due to the size of the area under survey, the research took longer than anticipated, although this did not affect the outcome or use of the survey.

Transport was also a major challenge especially in the interiors.

### **1.8 Assumptions of the Study**

The study assumed that the selected sample was a good representative of the population under study.

The questionnaires used gave precise data and that the element of biasness never set in during the data collection and analysis. The respondents were also expected to cooperate with the researchers in order to make the study both valid and reliable.

### **1.9 Scope**

The study was carried out in Siaya County, in the six sub counties namely, Alego, Rarieda, Ugenya, Mbondo, Gem and Ugunja . It involved participation from inadequate houses owners', which forms 80% of all house owners in siaya county (KOD,2008), masons/technicians Were drawn from all the 6 sub counties, and only those certified, no matter the grade, were interviewed, those who were not professionally trained were not interviewed, so as to achieve the desired results. All 6 sub county heads of housing drawn from the ministry of lands, housing and urban development also participated

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This section provides a review of various previous studies which have focused on the low income housing market and specifically those done with interlocking stabilized soil blocks as an alternative walling material. It aims at comparing and contrasting the different authors' views on ISSBs, highlighting any gaps, summarizing and concluding on the same.

#### **2.2 History of Interlocking Blocks**

Earth has been used as a building material for years. From ancient times to the present day, it's been used to build everything from modest shelters to elaborate temples using a wide variety of techniques. Earthen construction has witnessed a renaissance in recent years due largely to economic & environmental concerns. Availability, low cost & eco-friendly nature of soil as a building material makes it an attractive alternative to conventional building methods. (Makiga,2008).

The first attempts for compressed earth blocks were tried in the early days of the 19th century in Europe. The architect François Cointeraux precast small blocks of rammed earth and he used hand rammers to compress the humid soil into a small wooden mould held with the feet.(The first steel manual press which has been produced in the world in the 1950's was the Cinvaram. It was the result of a research programme for a social housing in Colombia to improve the hand moulded & sun dried brick (adobe). This press could get regular blocks in shape and size, denser, stronger and more water resistant than the common adobe. Since then many more types of machines were designed and many

laboratories got specialised and skilled to identify the soils for buildings. Many countries in Africa as well as South America, India and South Asia have been using this technique a lot.

Bankole (2008), noted that research activities that ultimately led to the development of the interlocking block technique, which is gaining popularity in Thailand, as well as Malaysia and the Philippines, to have dated back to the 1960s. In these countries, houses in the rural areas were traditionally built of timber, which was readily available in the extensive forest areas. However, the alarming rate of deforestation in Thailand - from 70% forest cover in 1936 to about 55% in 1961 (now it is less than 30%) - led the government to initiate research into alternative materials for building construction in the rural areas.

The idea of making blocks by compacting earth or mixing it with stabilizing supplements is an old concept dating back thousands of years. Previously, and still customary in certain parts of the world, wooden molds are used for making sun-dried or burned earth blocks. A key step in the evolution of this technology was the creation of the CINVA-RAM press in the 1950s by the Chilean engineer Raul Ramirez for the Inter-American Housing Center in Bogota, Colombia. Since then, the methods of producing earth blocks has progressed resulting in diverse types of motor-driven and manual presses, and mobile and industrial scale production units. Even though the CINVA-Ram and other machines of this sort provided a more cost effective and environmentally-friendly solution for block-making, some disadvantages remained. There was still a need for masonry skills to lay the blocks, as well as significant amounts of cement for mortar. The Human Settlements Division of the Asian Institute of Technology (HSD-AIT) along with the Thailand Institute of Scientific and Technological Research (TISTR) combined efforts for the creation of the

first interlocking soil blocks by modifying the CINVARAM machine in the early 1980s (Nils,2009). This new wall construction technique reduced the use of cement drastically; hence reducing final building cost considerably, and enhanced the structural stability of the wall.

### **2.2.1 Interlocking Blocks Initiative in Kenya.**

The Kenyan Ministry of housing established the ABMT Programme in 2006 to address the high building costs by facilitating the provision of improved and affordable housing in both urban and rural areas. ABMT addresses poverty through enhanced living/housing conditions and promotion of related income generating activities.

In its web site, Ministry of housing defines, Appropriate Building Materials and Technologies (ABMT) to be, building processes, materials and tools that are cost-effective, safe, innovative, green/environmentally friendly as well as acceptable to the climate, socio-economic conditions, and natural resources of an area. ABMT have to be complemented with efficiency in layout design, unit designs, appropriate construction specifications, optimization in infrastructure design and minimum project administrative overheads.

Ministry of Housing in collaboration with the Housing and Building Research Institute(HABRI) of the University of Nairobi, development partners and other stakeholders were involved in the research, development and dissemination of ABMT particularly Stabilized Soil Blocks (SSBs) and Micro-Concrete Roofing (MCR) Tiles and Pozzolana/Rice Husks Cement. The process culminated in the partial revision of the Building Code that allows the use of ABMT in designated areas within the local

authorities that have adopted the Code. Centers have been established country wide to provide services such as, Collaborative research

Evaluation and certification, Documentation, Training and skills development, Dissemination and demonstration, Hiring ABMT equipment/services to Wananchi Technical assistance and consultancy, Facilitating affordable housing and related social facilities, Technology transfer Testing, quality control and maintenance of standards.

The Ministry has spearheaded the revision of the current Building Code which would facilitate the use of new and viable ABMT. Currently under use in the Country are Hydraform machine Interlocking stabilized soil blocks for walling, from South Africa (SA) and Manual Interlocking stabilized soil blocks press from Kenya. (MoH, 2010)

Makiga Engineering Services Ltd is also another private company committed to offering low cost, eco-friendly and durable construction using appropriate building technologies. The heart of its operation rests on unique manual machine presses for making interlocking stabilised soil blocks (ISSB) for building. They not only have successfully adapted this technology but also expanded products & services to include special community re-development projects, incorporating environmental management with effective social & community sustainable modelling.( Makiga,2008 )

Gichui (2012), affirms that the use of Interlocking Stabilized Soil Blocks technology is slowly increasing in Kenya. More and more Kenyans are becoming aware of the eco-friendly, pocket-friendly method of construction and choosing it over the usual masonry stone or iron sheet walling. He is especially fascinated by the fact that in this technology, soil stabilized with some cement forms a solid hard rock seconds after compression and the soil block after curing when submerged into a bucket of water overnight together with



a masonry stone and then lifted shoulder high and left to fall freely, will still not break. However, strange enough, the masonry stone will break into two if subject to the same fall. He further writes that the recently completed Thika road is also based on stabilized soil block technology. This is based on the American Standard as opposed to the usual British Standard of roads we are used to in Kenya where the base is made of several layers of compacted hardcore. On Thika road, the base is made of stabilized soil as opposed to hardcore. This is the method that the world is working towards since it's better and more cost-effective.

Jeckonia (2011), in one of his articles writes that, home builders in Western Kenya are leading in the use of the brick technology. It has been said to be cheaper and less of a hustle, with the bricks being made on site, however, the move towards appropriate building technologies and materials has caught steam. From stabilised soil blocks to prefabricated building panels and even interlocking blocks such as hydraform, 'innovative' is the way to go. It is often cheaper, the materials are locally available, and the construction can be done using unskilled labour or by labourers trained on the job. To use or not to use bricks, is the big question. But the general feeling is that, it's lack of sensitization by the concerned parties that the technology is not being used widely despite its huge benefits.

In laikipia west for instance a number of institutions have been put up using ISSB technology. To name but just a few, Gatero Day, Kiriti Day, Ndurumo Day, Kagaa Primary, Kio Day, Lariak Day, Tandare Day, Thigio Day, Naigera Day, Muthengera Day, Marmanet Police Post, Mung'etho Day, Rumuruti Polytechnic, Rumuruti Day, Narok Primary, Raya Primary, Thama Primary, Karangi Primary, Huho-ini Primary, 91

Municipality Primary, and now Rugongo Primary school which is under construction. The blocks produced through hydraform machines are advantageous since they are eco – friendly and cost – saving. Their building system has been tested for structural strength and durability as well as fire, rain and sound resistance.

Many factors have been put forth for the wide use in laikipia, transport for building stones, sand and cement are high. Hydraform machines are labour intensive thereby creating employment and allows for skills transfer. The machines are relatively easy to use and people normally learn quite quickly. In the case of Laikipia West Constituency, parents and communities around each project receive free training of production of the blocks during the production period. (laikipia west, 2011). This benefits experienced in laikipia can also be replicated to other regions like siaya, what's key is the approach and attitude.

### **2.3 Types of Interlocking Blocks**

A variety of interlocking blocks have been developed during the past years, differing in material composition, shape and size, depending on the required strengths and uses. Its important before the analysis of attitude, as a factor affecting the use of ISSB, is looked into, people get to understand the various types, since a particular type might possibly be the cause of the slow uptake of the technology.

The classification of interlocking block types are based on the, Material used in production and Shapes and sizes of blocks (Ludamm, 2006).

#### **2.3.1 Fly Ash Interlocking Blocks**

Fly ash blocks / bricks is an established technology with established standards in large parts of world. Fly Ash is an industrial waste and is residual of burnt coal. It is typically available in plenty where coal is fired in power generation process. Use of Fly Ash in

construction is increasingly being promoted in the areas where it is available in abundance. For instance in India where its being promoted by the government.

Like soil, fly ash is available in various grades and quality depending on quality of coal, coal firing technology, ash handling, etc. Thus it is recommended to check the Ash quality to get best quality blocks. The manufacturing process of Fly ash blocks requires fly ash, coarse sand / stone dust, cement, gypsum and lime (both optional) to be added in a suitable proportion and mixed in a good quality pan mixer like Hydraform. Optimum Water is added. The mix once homogeneous is fed in Hydraform machine and hydraulically pressed and water cured for 7- 14 days to let the block reach full strength over 28 days. (Hydraformasia, 2010)

### **2.3.2 Soil-cement blocks**

Hydraform (2008), gives the guidelines for the soil and cement qualities, the cement-to-soil ratio, usually lies between 1: 6 and 1: 10, by volume i.e, one bag of cement to 6/10, 10 litre wheel barrows of soil. Laboratory tests are essential to determine what ratios will be used not to compromise on the quality. This type of block is the most common in Kenya and what has been introduced to siaya, most soils in siaya are very good allowing for a mix of 1:8,(HD, 2013) and as such cost per block is cheaper, then most areas.

### **2.3.3 Rice husk ash (RHA) cement blocks.**

4D journal of technology and science, defines rice husk ash blocks to be those that have been made from,cement-to-RHA ratio which is generally 1: 4, by volume. Two types of blocks can be produced:

**white blocks**, with a compressive strength of 4 N/mm<sup>2</sup>, using ash (amorphous silica) from field kilns, burnt below 900°C;

**black blocks**, with a compressive strength of 1.4 N/mm<sup>2</sup>, using boiler ash (crystalline silica), burnt up to 1200°C;

#### **2.3.4 HF 220**

HF220 is the standard hydraform block and is suitable for external 9" thick walls. The block shape is interlocking with beveled edges. Interlocking blocks can be used in dry masonry or with mortar slurry. First course (above DPC), lintel and top courses are mortar layered. For standard 170 full length blocks will comprise 1 cu. m of wall masonry, whereas 37 full length blocks will comprise 1 sq. m of 9" wall. Block dimensions (in mm) are: Length: +- 120 – 240 mm Width: 220 mm Height: 115 mm

#### **2.3.5 HF 220 conduit**

Hydraform Conduit Block is similar in dimension and application as HF 220 block above with additional provision for conduit and horizontal reinforcement applications in Earthquake resistant construction applications. Block dimensions (in mm) are: Length: +- 120 – 240 mm Width: 220 mm Height: 115 mm

#### **2.3.4 HF150**

HF150 is the standard hydraform block is suitable for external / partition 6" thick walls. The block shape is interlocking with beveled / champhered edges. These blocks can be used with mortar slurry. First course (above DPC), lintel and top courses are full mortar layered. for suitable application, 250 full length blocks will comprise 1 cu. m of wall masonry, whereas 37 full length blocks will comprise 1 sq. m of 6" wall. Block dimensions (in mm) are: Length: +- 120 – 240 mm, Width: 150 mm, Height: 115 mm.

Hydraform can also provide tailor made special block sizes to suit ones construction requirements, (hydraform), this is the most common block in Kenya, with the only mould available being of the length, 240 mm, and as such there is a need for a tailor made moulds to meet clients needs in terms of dimension.

#### **2.3.6 Full or half block**

Blocks can also be classified as,

Full blocks (240x 220x 115 mm) for all standard walls (single or double brick thick) or

Half blocks (120 x 110 x 115 mm), which can be moulded to size or made by cutting freshly, moulded full blocks in half.

#### **2.3.7 Interlocking hollow-blocks**

Interlocking hollow-blocks are made from sand-cement that can compete with conventional

technologies in terms of quality, strength and cost (Simion, 2009). There are a number of interlocking hollow blocks depending on size as classified by Hydraform in their internet site, (Hydraform, 2008), 4" Hollow block (390 × 190 × 90 mm), 6" Hollow block (390 x 190 x 140mm), and 8" Hollow block (390 × 190 × 190mm), though these blocks are not very common in Kenya.

#### **2.3.8 Curved/straight blocks**

Depending on the use, the block can either be curved or straight. Curved blocks, which also come in various dimensions, are mainly used for water tanks, septic tanks among others.

Commonly used blocks in Kenya, are the manual machine blocks, commonly referred to as the Makiga blocks, and the the HF 220, made using hydraform machine as shown in the figures shown,

**Fig 2.1: Manual interlocking machine**



**Fig 2.2 Hydraform Machine.and block.**



**Fig. 2.3: HF 220 blocks, common in Kenya, laid in a curing yard.**



## **2.4 How to Make Interlocking Blocks**

Perez (2009), noted that, ISSB technology had not been appealing to many potential clients, as a result of the poor quality blocks made, which would wear out with the setting of rains, this was no exception of most areas in Kenya and as such a need to follow on the guidelines set out by Hydraform (2008) Makiga (2010). Summarized as,

### **2.4.1 Soil Selection**

ISSB block is produced from a soil and cement mixture. The soil type is classified as a sandy – loam. The soil should contain more sand than clay and silt (fines). If the clay content is too high, sand will need to be blended in with the soil. The clay keeps the block together so it is easy to carry the block during block making. The sandy portion is what binds with the cement to give the block its ultimate strength. Too little clay will make block handling difficult, too much clay will make the block shrink and crack during curing. Hydraform blocks are made from sub soil 1 metre below ground level, never top soil, which contains organic material.

### **2.4.2 Sieving**

Sometime the soil may have bigger particles than required or even foreign bodies, thus there's a need to do sieving using an 8-10mm strong mesh to achieve the desired texture.

### **2.4.3 Mix design & Selection**

This basically involves coming up with various mixes as per block requirement of the structure being put up, for instance a 4MPa and a 7MPa block, will require, 1 bag of cement and 10 wheelbarrows of soil and 1 bag of cement and 5 wheelbarrows of soil respectively. It's worth noting that a 50kg bag of cement should not exceed 80 blocks in number and that block strength is affected by cement content, curing duration (7 days minimum) and soil type.



#### **2.4.4 Soil Mixing**

Mixing can be done through, pan mixer (comes with some hydraform machines) or manually through use of spades. It involves dry mixing where soil is first mixed with cement as per the agreed mix design without any water addition, then there's wet mixing where water is introduced to the dry mix slowly while still mixing. After mixing a drop test is done to check whether the right moisture has been attained. A dry mix will produce a poor quality block. The mix should be close to the optimum water content of the soil. The water content will vary block length. When the soil – cement mix is too dry the block length will be longer than when the water content is correct.

#### **2.4.5 Stacking and curing.**

Blocks should be Stacked 5 high and 7 wide. They should be covered as they are stacked and should never be left in the sun or wind uncovered, even in shades the blocks must be covered. Curing should be done twice a day – once in the morning & once in the evening, and covered again immediately. The blocks are cured for 7-14 days. The longer the curing, the stronger the block. Quality checks should also be done on the blocks so as to get the desired results.

#### **2.5. Advantages of interlocking blocks.**

Interlocking stabilized soil blocks have a number of advantages which can be sensitized to the community in a bid to increase on its uptake.

The advantages can be classified into, health, economical, aesthetic, environmental, ease of use, structural and educational (Gooding et al, 1995).

### **2.5.1 Health:**

The curved ISSBs are ideal for meeting water and sanitation needs. The curved ISSB can make water tanks, lining for pit latrines, and septic tanks. There are samples of above ground water tanks of up to 30,000 liters and below-ground of up to 200,000 lts. The final cylindrical shape of the structure and the block interlocking mechanism resists well against water pressure.

### **2.5.2 Environmental:**

ISSB technology provides an alternative to the commonly used fired brick, which currently is the cause of grave environmental degradation due to deforestation, and destruction of wetlands.

### **2.5.3 Economical:**

ISSB technology is an affordable way of construction. The bricks are weather proof hence, there is no need to plaster the building exterior. Also, due to its interlocking mechanism, little cement is needed between block joints and wall construction goes up quickly allowing for labor savings. The machine can also be towed to site of construction, thereby cutting down on cost of transporting blocks.

### **2.5.4 Aesthetic:**

ISSB technology is growing in popularity due to its aesthetic qualities, and has been successfully embraced by many communities. Also, in view that it is an earth technology,

as most of the common and traditional methods used; it is not foreign to local communities

#### **2.5.5 Structural:**

ISSB technology has proven to be strong and durable when compared with traditional method of construction. It is suitable for multi-story building, has a good compressive strength.

#### **2.5.6 Easy To Use:**

The ISSB machine is easy to use and to maintain and does not require specialized training. Due to the interlocking mechanism of the blocks, wall construction is much easier and quicker

Adding to the same, Hines (1992), and Olusanya ( 2005) identified the various advantages of interlocking blocks and bricks as, It eliminates the problems associated with mortar joint, such as inadequate bond and mortar cracking that give rise to water penetrations, The material used is very good in various weather changes; it makes the house cool during hot and cold weather, that is laterite has a feature of regulating temperature, It makes it possible to eliminate the use of mortar for laying the blocks. It does not require the need of a high-waged skilled labour. It reduces the time of construction because of the mortar elimination, The materials required for production and construction are locally available excavating your well, septic tank and underground water tank can give you the material. The material is recyclable; most of the materials are recoverable and reusable in cases of

demolition or alteration of structure. There is structural stability and durability no need for wetting for the mortar to cure, therefore, speeding construction.

Further, they wrote that,

ISSB is suitable for the construction of multi-storey building as the strength is higher than that of conventional sand Crete blocks, the precise alignment of blocks produces an attractive finish that requires no plastering or painting, a plain white wash can give perfect and simple wall finish. It is maintenance free. It is cost effective and durable, which reduces the life cycle cost, and it can be produced locally with both manual and mechanical brick making machine.

## **2.6 Disadvantages**

Bankole (2008), identified a number of disadvantages, that if addressed would improve on the promotion of ISSB, technology. The factors were,

The technology being relatively new, people may be reluctant to apply it. Hence, a well co-ordinated dissemination strategy to introduce it to potential builders is vital; this is a key area of action in Kenya. Although skilled masons are not needed for constructing walls, a certain amount of training is required to ensure that the walls are properly aligned and no gaps are left; also in the production of the blocks training is needed not only in determining the correct type of soil, correct mix proportion and moisture content, but also in producing uniform sized blocks (that is, avoiding under or over-filling the block moulds before compaction).

Even with the greatest care in assembling the walls, the joints are not entirely resistant to wind and rain penetration, therefore, plastering the interior wall surfaces is usually necessary.

Compressed stabilized earth blocks have a poor bending strength but this is not so critical because the block itself will not bend but the masonry will do. ISSB have very poor shear strength, which is critical in the case of earthquakes. Interlocking blocks will not have a stronger shear strength compared to ordinary ISSB. But the key effect will increase the shear strength of the masonry if the cohesiveness of the material is high enough to keep the link between the key and the body of the block. (Especially shocks and vibrations of an earthquake).

In a nutshell, this are some of the factors hindering the use of ISSB Kenya, siaya and a need to work them out for return in value of the already invested resources.

## **2.7 Cost of Interlocking Blocks**

To serve as a guide line to potential investors, and clear the air on wether ISSB is expensive or not, Gichui (2012) was of the opinion that the cost of building with stabilized soil blocks is way lower than using iron sheets (mabati) for walling or cut stones. For instance, Gauge 30 iron sheets cost around Sh400 per square meter, timber to support the structure costs an extra Sh300 per square meter. Masonry stone walling takes 13 stones per square meter and each stone cost Sh50, adding up to Sh650. when mortar is added at Sh200 per square meter, this brings the cost to Sh850.

The contractors who build with the stabilized soil blocks construct at an average of Sh500 per square meter. Assuming you opt to hire the block-making machine and the land

already has the right soils, costs may fall significantly to between Sh250 to Sh400 per square metre. Besides cost, this technology is eco-friendly and saves the environment from degradation compared to the manufacture of iron sheets and stone cutting. (Gichui, 2012)

A multi-disciplinary architectural firm, a4architect, analysed the cost of building a 1 meter square of interlocking blocks and masonry stone wall as follows,

#### **2.7.1 Interlocking Blocks Cost Break Down.**

Assuming an average price of KES 750 for a 50kg bag of cement, and kshs 350 to 400 for unskilled labour per day, the cost of producing 1 meter squared is as below:

Cost of cement per block will approximately be KES 7, labour to manufacture brick-KES4 per brick, labour to make wall-assuming 1 fundi and 1 assistant at a total of KES 1,100 per day with a minimum of 500 bricks per day.-KES0.4 per brick. Then the total will be KES 11.4 per brick. 1 M<sup>2</sup> of walling will have an average of 33 bricks. The total amount for 1 m<sup>2</sup> of Stabilized soil walling will be KES 378 per m<sup>2</sup>. This is an estimate assumes that the soil is freely available at the site. If the soil is bought, assuming at KES 500 per ton then this translates to an extra KES 10 per square meter.

#### **2.7.2 Masonry Stone Cost Breakdown**

Machine-cut stone delivered around Nairobi costs between KES 60 to KES 70 per block. In 1 m<sup>2</sup> of wall, there are 13 stones. This totals to KES 780 per m<sup>2</sup>. The stones require cement mortar for joining. Each m<sup>2</sup> requires approximately 1m<sup>2</sup> of cement mortar at a cost of KES 200 per m<sup>2</sup>. This adds the amount to KES 980M<sup>2</sup>. Masonry walling requires plaster on the interior surface and key finishing on the exterior surface. This costs a

further KES 200 per M<sup>2</sup>, adding the cost to KES 1,180 per m<sup>2</sup>. After plastering, masonry walling will need paint since the dull grey color of cement cannot be left bare compared to the reddish stabilized soil block color. Paint costs a further KES 200 per m<sup>2</sup>, totaling the amount of masonry walling to KES 1,380 per m<sup>2</sup>. Thus in Comparison, Masonry walling costs 256% more than Interlocking Stabilized soil block walling.

Based on a number of factors the ministry of housing puts the cost of doing walling with ISSB at 50% less, than if the walls are put up with some of the conventional materials. It's worth noting that to achieve maximum results in terms of cost savings in construction, a holistic approach whereby all elements of construction are taken into consideration, from foundation to walling, roofing, windows, external works and finishes

## **2.8 Interlocking Blocks, A Successful Venture.**

Hydraform (South Africa), the main supplier of hydraform machines to Kenya, was founded in 1988 by Jochen Kofahl and Robert Plattner Hydraform with the objective of producing a cost effective building system for the Developing World. The Company has sold machines in more than more than 50 countries on six continents, today it operates from offices in Johannesburg, South Africa, With regional offices throughout Southern Africa, East Africa, West Africa and Asia.( hydraform,2008). This is a clear indication that ISSB technology is rapidly picking up in many regions and as such building up on the housing stock.

Right here in Kenya, ISSB has been successful in a number of regions, especially in laikipia west, where Economists from Ministry of Planning, National Development and Vision 2030, staff from Ministry of housing have done a case study on the adoption of the

new house building technology using interlocking soil blocks and findings have shown that Laikipia West Constituency is leading in the whole country.

The new technology was introduced in the Constituency by Hon. Ndiritu MP. Peter Ngugi, projects coordinator CDF, was trained to train beneficiaries of the CDF funded projects. More than 500 persons have been trained and have provided labor in more than 27 projects done using the technology (Ujuzi na Biashara, 2011).

In TaitaTaveta When Elizabeth Mutheu, a trained medic, ventured into the business of making interlocking bricks, she had no expertise, let alone knowledge of the market trends and demand for the bricks. All she knew was that there was a need to have access to better housing and affordable material to improve living conditions for people in her community. Barely four months after she had began, her business is booming and she is trying to meet the demand for the interlocking bricks in a rapidly growing town of Voi, which is situated 150 Kilometers from the coastal town of Mombasa in Kenya, with more than a thousand blocks being made every day. (UNDP, 2012).

As demonstrated by the various cases, the potential for growth of ISSB technology is evident and this should serve as best practices for areas like siaya, where the technology is taking long to pick.

## **2.9 Conclusion.**

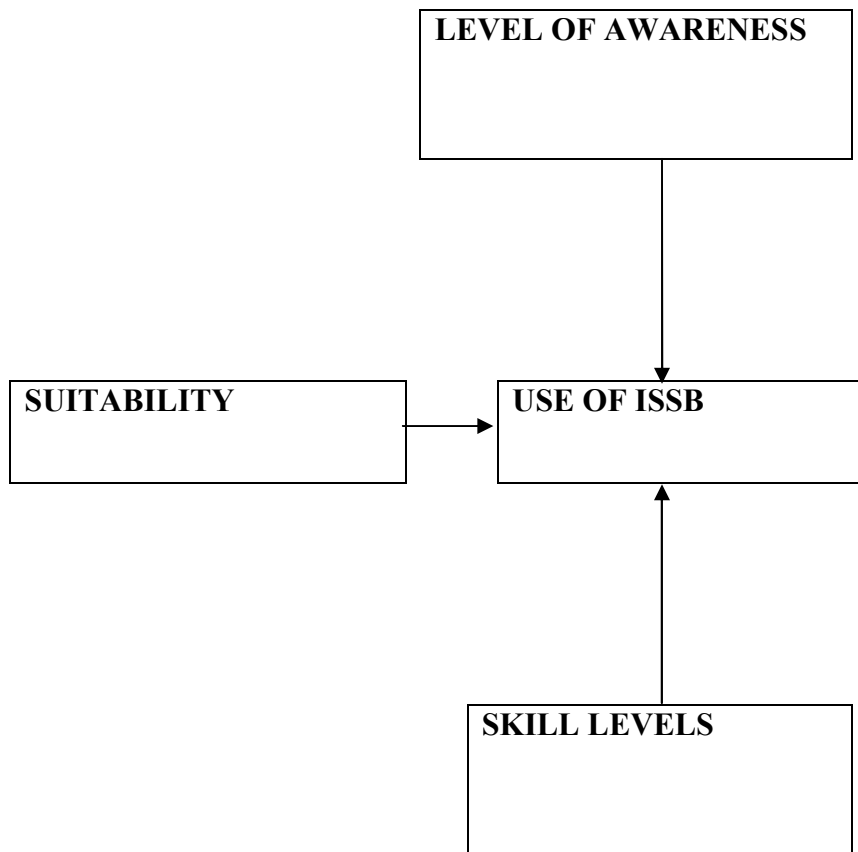
The literature survey has revealed a number of things, users of ISSB technology seem to be facing the challenge to achieve the right compressive force/strength and as such poor quality blocks which are not appealing are made, and this discourages more use, cost guidelines are not clear to make a well informed choice. The technology being new,



proper dissemination is missing and issue of unskilled masons has also been raised. Basically of importance and what most of the writers seem to agree on is the fact that, the strength of ISSB is dependent on the type of soil and amount of stabilizer added to the mix. The materials required for block production and building construction are usually locally available in most regions and of key and as such a need to survey on the suitability aspect, before introducing the technology to new areas.

In spite of the various challenges that have been raised, ISSB technology has been a big success in Nigeria, South Africa and some regions right here in Kenya and Uganda.

## 2.9 Conceptual Framework



**Figure 2.4 Conceptual Framework**

The use of interlock blocks is influenced by a number of factors among them, suitability of the technology in a given area, skill levels of the users/technological knowhow, as well as how the community or recipients of the said technology are well sensitized in a bid to create awareness.

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

This chapter outlines how the research study was conducted. It includes the research design that was adopted, the target population, data collection and how data was analyzed.

#### **3.2 Research Design**

Kothari (2004), defined research design as the conceptual structure within which research is conducted. It consists of the blueprint for the collection, measurement and analysis of data. As such the design includes an outline of the framework of study, availability of various data, and observations.

Bell (1999) stated that, a case study approach is particularly appropriate for individual researchers because it gives an opportunity for one aspect of a problem to be studied in some depth within a limited time scale, as such this case used descriptive research design. The main aim of descriptive research was to provide an accurate and valid representation of the factors or variables that are relevant to the research questions.

As there are two categories of descriptive designs: surveys and observational studies. This research was done by survey through administering structured open ended and closed questionnaires distributed among respondents. The design was adopted because it allows collection of large amounts of data from the target population as compared to other methods.

### **3.3 Target Population**

The target population for this research study was, Masons/technicians drawn from all sub counties, Siaya home owners, occupying inadequate houses and government housing officers in Siaya. This group of respondents held key information which would assist the researcher in determining whether attitude was a key contributor in the low uptake in ISSB technology.

Skill levels would be determined through surveying masons, while awareness levels would be determined through home owners, suitability of ISSB in Siaya, would be tested through housing officers

### **3.4 Sample size and Sampling procedure**

A sample is a finite part of a statistical population whose properties are studied to gain information about the whole (Webster, 1985).

There are three criteria used in determining the appropriate sample size, the level of precision, the level of confidence at risk and the degree of variability in the attributes being measured (Miaoulis and Michener, 1976). As there are various ways of determining a sample size, the research adopted Cochran's (1963) approach in determining home owners sample size through the shown formula.

This sampling procedure was chosen because, our population and especially home owners was big.

$$n = \frac{z^2 * pq}{d^2}$$

Where :

z = standard normal deviation usually set at 1.96

n = desired sample size in an infinite population

p = proportion of the characteristic that we are interested in (80%)

(80 % of residents in Siaya live in inadequate housing. (KOD, 2008)

q = (1 – p) = 1 – 0.8 = 0.2

d = the degree of accuracy set at 5%.

Therefore the minimum estimated sample size is

$$= \frac{1.96 \times 1.96 \times 0.8 \times 0.2}{0.05 \times 0.05} = 210.13 = 210$$

80%, gives a proportion of the group of interest, which is those owning in inadequate housing

This gives the minimum number of respondents to be sampled in the study, and as such, home owners respondents would not be less than 210, all sub county heads were requested to provide data on certified masons who had registered with them, and only 30 masons were professionally certified as per the report. Stratified random sampling was used to obtain Siaya home owners sample. A total number of thirty five residents were chosen from each constituency. Gender balance was ensured, the only 6 sub county heads in Siaya county office were all interviewed.

**Table 3.1 Respondents and questionnaires issued**

<b>Respondents</b>	<b>questionnaires issued</b>
Housing officers	6
Technicians and masons	30
Residents	210
<b>Total</b>	<b>246</b>

### **3.5 Data Collection**

The survey instrument for collecting primary data in this study was structured questionnaires. Questions were both open and close ended. Questionnaires were distributed and respondents given ample time of two weeks to fill them up. Ultimate control was exercised to ensure all questionnaires issued to the respondents were received and to achieve this, a register of questionnaires sent and received was maintained.

### **3.6 Data Analysis**

The data collected was edited for accuracy, consistency and completeness. Descriptive statistics was used; Quantitative data collected was analyzed with the help of MS - excel and presented using tables and graphs.

## **CHAPTER FOUR**

### **DATA PRESENTATION, ANALYSIS AND INTERPRETATION**

#### **4.1 Introduction**

This chapter presents the research findings obtained from Siaya County where the study was conducted. The findings of this study generated enough information which can effectively answer the research questions.

#### **4.2 Response rate**

This study was conducted in 6 sub counties in Siaya County and questionnaires were administered to 6 housing officers in charge of the sub county offices, 30 technicians and 210 home owners from siaya. Out of these questionnaires, those successfully collected were from 6 housing officers, 24 technicians and 196 home owners, indicating an overall 91.86% return success.

**Table 4.1 Survey Return Rate**

<b>Respondents</b>	<b>Number of questionnaires issued</b>	<b>Returned</b>
Housing officers	6	6
Technicians/masons	30	24
Home owners	210	196
Total	246	231

### 4.3 Descriptive Characteristics of the Respondents

Male population was higher among the respondents at 66.7% among housing officers, 91.7% among technicians and 52% home owners. Most of the technicians at 92% have more than 6 years experience with ISSB, technology.

**Table 4.2: Characteristics of the Respondents**

Variable	Frequency	%
<b>Gender of housing officers</b>		
Female	2	33.3
Male	4	66.7
<b>Gender of masons</b>		
Female	2	8.3
Male	22	91.7
<b>Gender of home owners</b>		
Female	94	48
Male	102	52
<b>Experience of technicians</b>		
0-5	2	92
6 and above	22	8



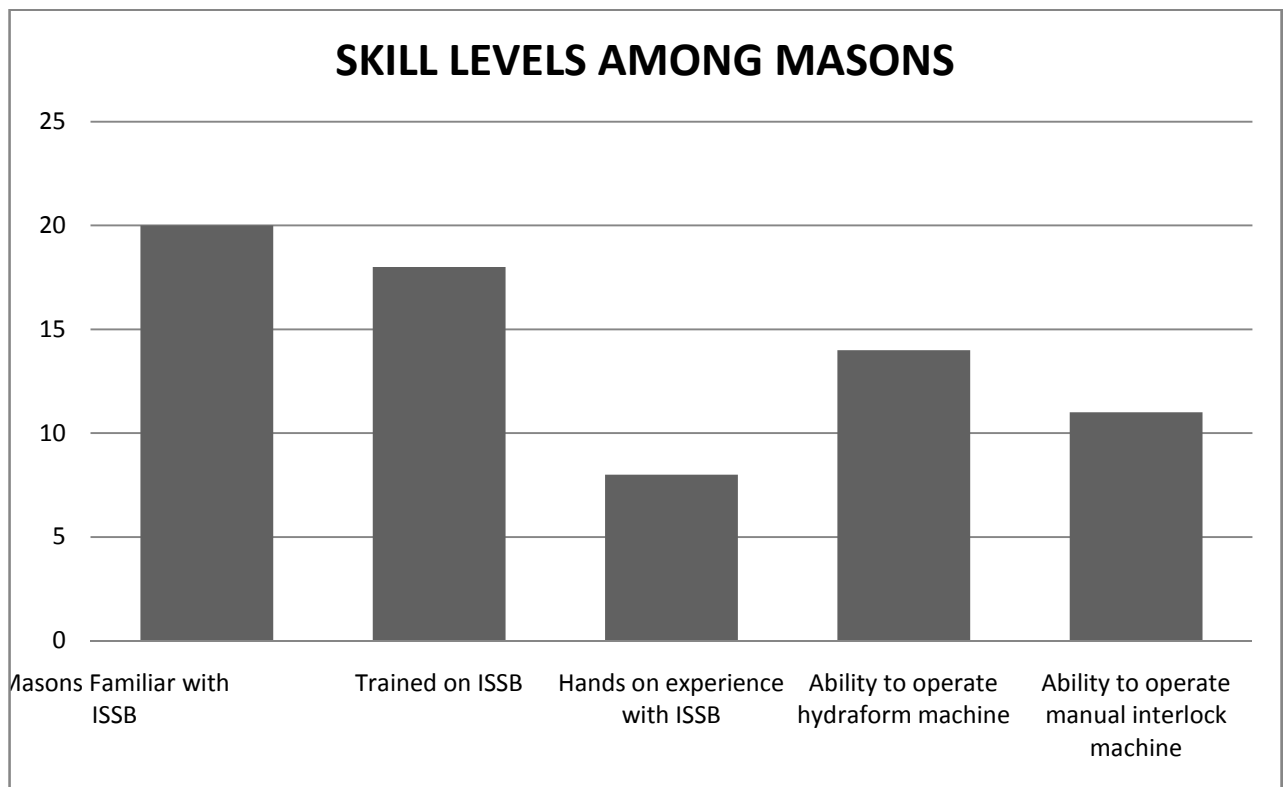
#### 4.4 Skill levels among Masons in Siaya

A total of 24 masons responded to the interview out of a sample of 30, 83% were familiar with the technology, 75% had also been trained through the Ministry of housing. 58% were able to operate mechanised hydraform machines unlike 46% who were only familiar with the manual machines, commonly referred to as Makiga, this gave a Clear indication that the county, in terms of skills had the capacity to support the technology. In terms of real hands on experience, only 33% had carried out projects using ISSB, and one major reason given was that people were not so confident about the technology.

**Table 4.3: Training and Skill levels among the Technicians/Masons**

Variable	Frequency	%
Masons Familiar with ISSB	20	83
Trained on ISSB	18	75
Hands on experience with ISSB	8	33
Ability to operate hydraform machine	14	58
Ability to operate manual interlock machine	11	46

**Figure 4.1: Skill levels among Masons**



#### **4.5 Level of Awareness Among Residents**

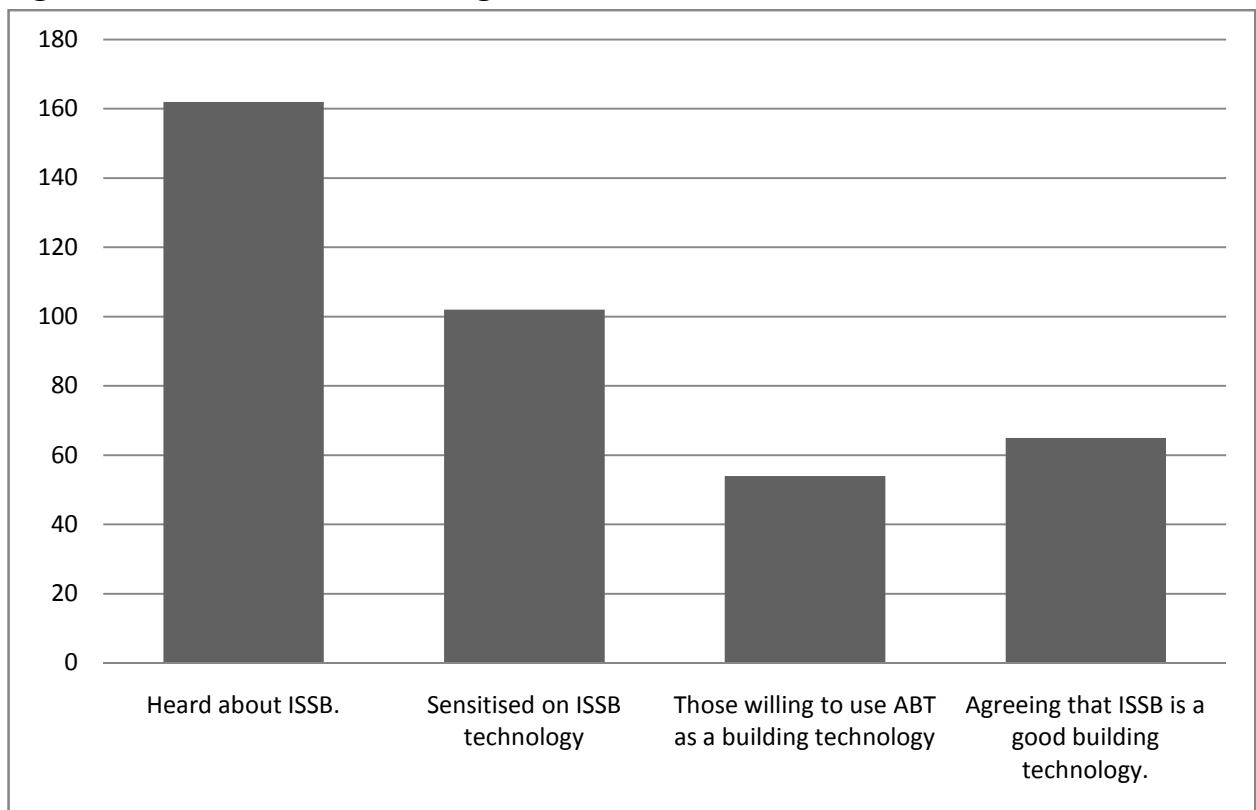
The researcher sought to find out too whether home owners were aware of the technology, since lack of awareness would definitely jeopardize government's effort to promote the technology. 83% had heard about the technology, either from friends, internet, Non governmental organizations and government workshops, while 12% seemed not to have ever heard about the technology, while 5% were not quite sure whether they knew about the technology or not. To understand whether the ministry was actively on the ground, sensitizing people, it came out clear that 52% of home owners had been sensitized, through workshops, market days and schools open days and this was strong indication that the ministry was really active getting people to know more about the technology. but the

bone of contention was, after all the sensitization, only a few home owners at 28% were willing to use the technology to put up their houses, majority at 55% were not sure whether they would use it to build, and the reasons given for the same was uncertainty over the blocks strength, no mortar used and many thought that the wall would collapse, though this is a low cost technology many believed it was still very expensive. Only 33% were of the opinion that ISSB technology was a good building technology, with 48% not sure and 19% of a contrary opinion

**Table 4.4: Awareness levels among Home Owners in Siaya.**

Variable	frequency	%
Heard about ISSB.	162	83
Sensitized on ISSB technology	102	52
Those willing to use ABT as a building technology	54	28
Agreeing that ISSB is a good building technology.	65	33

**Figure 4.2: Awareness levels among Home Owners**



#### **4.6 Suitability of ISSB Technology in Siaya.**

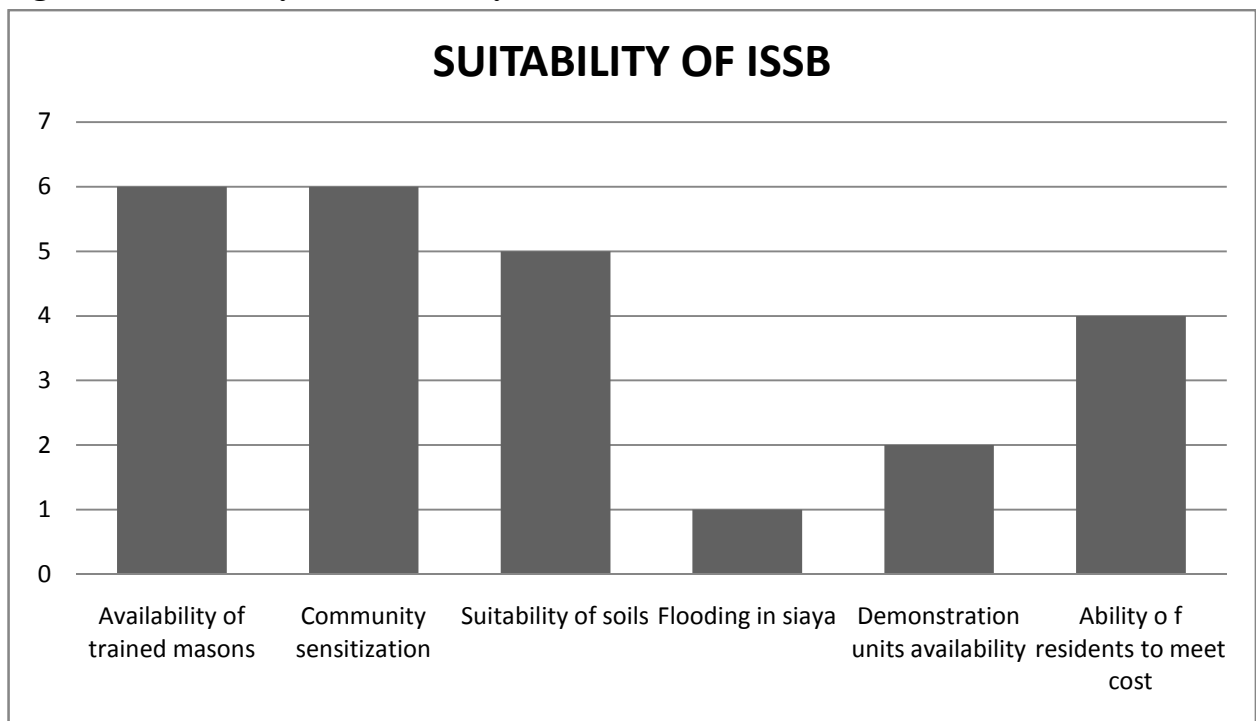
To get to understand whether this type of technology is suitable for use in siaya all housing sub county heads were interviewed on areas touching on soil types, flooding, cost, demonstration units, trained masons and community sensitization among others. All the heads at 100% were in agreement that, they had enough stock of trained masons and the community had been sensitized well enough on ISSB. Only one region, Rarieda didn't have good soil for blocks as most of this region had black cotton soil, majority areas had red clay soil which is very much okay when blended with sand, though this could be sourced from the nearby, Mbondo sub county. a great part of siaya at 83% doesn't flood, only parts of ungenya flood and as making the technology suitable for the greater

majority. It was however noted that the government had not done much to build to put up demonstration centers and there only 2 (33%) at Mbondo and Alego. To get to understand and know how suitable this technology is , there is more need for more demonstration units, since this are the Centers where soil samples are tested and trainings done.

**Table 4.5: Suitability of ISSB in Siaya**

<b>Variable</b>	<b>frequency</b>	<b>%</b>
Availability of trained masons	6	100
Community sensitization	6	100
Suitability of soils	5	83
Flooding in siaya	1	17
Demonstration units availability	2	33
Ability o f residents to meet cost	4	67

**Figure 4.3: Suitability of ISSB in Siaya**



#### **4.7 Hindrances to the use of ISSB as a Walling Technology.**

The most commonly mentioned hindrance to the use of ISSB was the inadequate number of hydraform machines that cannot sufficiently match the high number of demand and people get discouraged and opt for the conventional methods. Manual machines were available but Members complained about their block quality.

Lack of cost information per unit block was also another concern. Home owners complained that it was not clear how much a block costs so as to enable them make an informed choice. In addition masons complained that standard clear guide lines on the use of blocks were not available and quacks who had not been trained were also involved in building using ISSB blocks

Housing officers were also in agreement that some of their staff, had not been trained and those who had been trained also required refresher courses to boost the uptake of the ISSB. Lack of funding by the government to service the machines and other technical support was also raised by the heads.

#### **4.8 Factors/Strategies Promoting the use of ISSB.**

There was a general feeling that, more sensitization was required so as to make most of the residents aware of the technology since some seemed not to know about it, this would be done through barazas, during market days, agricultural shows and other festivities where majority would assemble.

Providing ISSB training to local communities, there is a need to do intensive training to communities so as to let them understand all the aspects of ISSB, especially the youth as this will also create jobs.

Respondents also agreed that the government should be in the fore front in Promoting the technology through project implementation, using this type of technology so as to create confidence among those who might want to use it, Dissemination of information on ISSB to relevant stakeholders so that areas of weakness can be pointed out and worked on. Cost comparison schedules to be prepared to assist communities make informed choices.

## CHAPTER FIVE

### SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

#### 5.1 Introduction

The findings from the research indicate that the use of ISSB in Siaya County is still down, hydraform machines are still inadequate and people are still to embrace the technology.

**Table 5.1: Summary of Research Findings.**

The summary table below presents the research findings in brief,

Objectives	Research findings
<b>1. Level of awareness</b>	<ul style="list-style-type: none"><li>- 162 out of 196 had heard about the technology, 10 were not quite sure of the technology while 24 had never heard about the technology.</li><li>- 102 agreed that they had been sensitized while 92 had not been sensitized at all.</li><li>- 54 home owners were willing to use the technology to build houses, while 108 were not sure whether they would use ISSB, because of the obvious uncertainties. 34 were not willing to use the technology at all.</li><li>- 65 home owners agreed that the technology was good for walling, as 94 of them were not sure whether it was good or not while 37, did not see ISSB as a good walling technology.</li></ul> <p>This clearly shows that enough awareness on the use of ISSB had been created and as such increased use of the blocks was expected which was not the case.</p>



<b>2. Skill levels among Masons</b>	<ul style="list-style-type: none"> <li>- Out of the sampled masons , those familiar with ISSB Were 20 out of a possible 24, a clear indication that masons were well informed</li> <li>- Those who had received training on ISSB, were 18 a clear indication that the department of housing was doing a good job in ensuring that masons were equipped with the right skills.</li> <li>- Out of the sampled masons, only 8 had had hands on experience in various ISSB projects, but out of the 8, 2 had hands on experience without ever been trained, clearly showing that quacks were also involved in the technology.</li> <li>- Masons who would operate an hydraform machine (mechanized) were 14, meaning 4 of those who had been trained had lost skills, the reason given for this was the fact that, mechanized machines were few and rare to get for continued practice.</li> <li>- Those able to operate manual machines were 20, an indication that manual machines were easy to operate, since 2 more masons out of the 18 trained had acquired skills without being trained.</li> </ul>
<b>3. Suitability of ISSB</b>	<ul style="list-style-type: none"> <li>- On suitability of ISSB, all the 6 sub county heads of housing ,were interviewed on a number of suitability measures that they were familiar with as a result of their line of duty, 6 heads agreed that they had adequately trained masons, 6 also agreed that they had done community sensitization, out of the 6 sub county regions only one region did not have suitable soils, as it had black cotton soil that was</li> </ul>

not fit for block making.

- Only one region was prone to flooding, making the other five suitable for ISSB.
- To confirm whether the technology was suitable for siaya, the researcher sought to know whether there were demonstration units for community support, but the confirmation was that they were only 2, in Mbondo and Alego Usoga, and this was an area that the government clearly needed to work on as more demonstration units would build up more confidence and increase its uptake.

## **5.2 Conclusion**

From the findings it was evident that the continued low use of ISSB technology in siaya is as a result of perception that people have towards new technologies, since people seem to be conservative and rigid to change. Many respondents seemed not to be aware of the cost per unit block, yet believed that it was very expensive to put a house using ISSB.

The number of machines especially the mechanized ones were minimal, members seemed not to be aware of the total number in the county and just assumed that they could not get access to the machines and make ISSBs, of which was not the case since manual machines were available and adequate enough in each county with an average of 25 manual machines per sub county and this could make good quality blocks which met the required Ministry standards in terms of Durability and strength.

It was also confirmed that the Ministry had done enough sensitization on ISSB, and created adequate awareness, and the question of lack of information did not arise for the low use of the technology and generally people were just rigid to change and remained adamant on the continued use of conventional methods of building,

The researcher went further to note that, the soils in Siaya and weather conditions were very suitable for ISSB, technology and the fact members assumed that the soil were not suitable was misguided, though some places in Ugenya sub county do flood at times, a greater part in Siaya doesn't flood and is appropriate for the technology. The common believe that the technology was not suitable for Siaya was just but a belief with no factual evidence as confirmed from the sub county housing heads. In a nut shell the low uptake of ISSB technology was all but an issue of attitude towards its use.

From the success stories noted, it's evident that, ISSB technology is a good cost effective alternative walling technology and regions that have not embraced this technology need to learn from these successful ventures.

### **5.3 Recommendations**

After discussing the findings of the research, certain recommendations are put forward for future consideration.

#### **5.3.1 More Sensitization Workshops.**

The low uptake of ISSB in Siaya is as a result of lack of the right information, though sensitization workshops have been carried out as confirmed from the department of housing, more workshops need to be held where residents need to be taken through the need to use ISSB as an appropriate technology. Housing staff should also visit barazas oftenly for the sole purposes of encouraging the community to use the technology other

than waiting for workshops that at times take due to government bureaucracy and red tapes.

#### **5.3.2 More Demonstration Units.**

People can only get to understand the technology better if they got support from demonstration centers and as such the department of housing needs to move with speed and put up more centers and this would definitely change the communities' attitude towards the technology.

#### **5.3.3 Government to Embrace the Technology in Its Projects**

To win the confidence of Kenyans and possibly change their attitude, the government should play a central role in the use of the same technology in its housing projects, especially projects by the national housing corporation (NHC), schools, hospitals among others.

#### **5.3.4 Clear Cost Guidelines.**

One of the major outcomes of the research was that, respondents were not sure whether the technology was cheaper than the conventional methods of doing a house and as such there was a need for the concerned parties to provide clear cost guidelines.

#### **5.3.5 Increase the Number of Hydraform/Mechanized Machines.**

During the survey, it was clear that, mechanized machines were limited to three for a whole county, and there was a need for the government to build up on the stock so as to promote the uptake of the technology.

#### **5.4 Suggestions for Further Studies**

A thorough study should be carried out on cost implications of doing houses with ISSB technology, putting all factors such as, those excavating raw materials such as soil and sand from their sites, unlike those sourcing them from outside, this will enable clients make more informed choices. More studies should also be done to determine why people tend to prefer conventional methods of building and remain rigid to new appropriate technologies.

## BIBLIOGRAPHY.

Adedeji, Y.M.D, Fasakin, J.O(2009) *Investigation of Acceptability Indices of Interlocking Masonry for Low-Income Housing in Nigeria*, Akure, Federal University of Technology.

Adedeji, Y.M.D. (2011) *Sustainable housing provision: preference for the use of interlocking masonry in housing delivery in Nigeria*, Federal University of Technology, Akure

Adrian p. (2009) *Interlocking stabilized soil blocks, appropriate earth technologies in Uganda*, Nairobi, UN-HABITAT,

Akinsany O. (2004) *lifecycle assessment of interlocking blocks and bricks, Nigeria*, Yaba College of Technology.

Bankole O. (2008) *The use of interlocking blocks in achieving aesthetics and stability in Public housing*, Nigeria, Awolowo university.

Bell, J. (1999). *Doing your research project*. Buckingham: Oxford University Press.

Brian (2010) *Research design and methods Part I*, University of Western Cape

Cochran w. (1963) *sample size and sampling procedure*, Oxford, Oxford University Press..

Francis G. (2012) “Cost Of Interlocking Blocks” *4D Journal of Technology and Science* Vol.1, Issue1,

Gooding D. E., Thomas T. H. (1995) *The Potential of Cement-Stabilised Building Blocks as an Urban Building Material in Developing Countries*, Oxford University Press.

Hines, T (1992). *The use of mortarless, dry-stack, concrete masonry as a Contributor to affordable construction*. Proceedings of the 4th International Seminar on Structural Masonry for Developing Countries, Madras, 176–186.

Hydraform (2004). *Hydraform Training Manual*. Johannesburg, Libradene boksburt.

Hydraform (2008). *Hydraform Asia Interlocking blocks*. Retrieved online on February, <http://www.hydraformasia.com/products/blocks/>.

Kepner, R. A., R. Bainer and E. L. Barger, (1972). *Principles of Farm Machinery*, AVI Publishing Co., Inc.

KNBS (2009) *Kenya Intergrated Building and Housing Survey Data*. Retrieved on January 22, 2013 <https://opendata.go.ke/Poverty/Vol-II-Tables-5-6-7-Housing-Characteristics-2009/9pvb-bt58>

Kothari, C.R (2004), *Research Methodology Methods and Techniques*, second edition, Oxford press.

Ludamm O.( 2006). *Techniques of Producing and Dry Stacking Interlocking Blocks*. Nigerian Building and Road Research Institute Workshop on Local Building Materials: Ota, Ogun State, Nigeria.

Makiga (2008) *Interlocking blocks for building*. Retrieved on January 22, 2013  
[http://www.makiga-engineering.com/downloads/docs/makiga\\_brochure.pdf](http://www.makiga-engineering.com/downloads/docs/makiga_brochure.pdf)

Ministry of housing (2010) *Appropriate Materials and Building Technology Program*. Retrieved online on February, 8,2013 from <http://www.housing.go.ke/?cat=7>

Nils, G. (2009) *Understanding stabilised earth blocks construction using Cinva-Ram*, University Of Kansas.

Olukanyin, A.K. (2012) *The lifecycle assessment of interlocking blocks and bricks*, Abuja, Nigeria.

Oyediran, O.S. and Alabi, O.F. (2005). *Non-Economic Factors associated with the adoption and utilization of alternative masonry materials*, Obafemi Awolowo University, Nigeria.



Raheem,A. A.,Bello, O. A., Makinde O.A.(2010) “a comparative study of cement and lime stabilized interlocking blocks” *pacific journal of science and technology* 11(2): 27-34

Simion Hosea (2009) *Design of interlocking blocks for enhanced wall construction*, Nigeria university.

Ujuzi na kazi (2011), *Interlocking blocks success story*, Retrieved online on November, 6,2013 from <http://www.ujuzinabiashara.org>

UN. (1992) *Earth Construction Technology*, United Nations Centre for Human Settlements, Nairobi.

## **APPENDICES**

### **APPENDIX I:**

#### **LETTER OF TRANSMITTAL**

Dear respondent,

#### **RE: RESEARCH DATA COLLECTION**

I am a post graduate student, in housing administration at the University of Nairobi. I am carrying out this research as a requirement for my study, as well as availing pertinent information for improving the use of ISSB technology, as an appropriate walling technology in Kenya.

The questionnaire has been designed to gather information from respondents, which will be treated as confidential and no names will be mentioned in the research. The report will make recommendations on the improvement of ISSB uptake in order to improve the quality of housing in the country.

Your assistance in facilitating a successful study will be highly appreciated. A copy of research report, upon completion will be availed at your request.

Thanks in advance.

Yours sincerely,

.....

Samson M. Mutune.

## **APPENDIX II:**

### **QUESTIONNAIRE**

**A Questionnaire to establish whether attitude is a key factor, in determining the uptake of ISSB in Siaya County.**

Individual responses will be kept strictly confidential to the researcher and his team of research assistants. However, the results of statistical and other analyses of data may be published.

The survey is in three parts. Please complete the relevant sections.

- 1.     Schedule A:** Masons
- 2.     Schedule B:** Housing officers
- 3.     Schedule C:** Residents/Home owners.

### APPENDIX III

#### SCHEDULE A: MASONS' QUESTIONNAIRE

Gender .....

Sub county .....

No. of years in practice,

☐ 0-2 years      ☐ 3-5 years      ☐ 6 and above

Gender

☐ Female      ☐ Male

Are you familiar or ever heard about ISSB technology?

☐ Yes      ☐ No

If yes from what source.....

Have you ever received any training specifically on ISSB technology?

☐ Yes      ☐ No

If yes, who were the facilitators? .....

Have you ever carried out any construction project, using ISSB technology in Siaya County?

☐ Yes      ☐ No

Are you able to use manual interlock machine, commonly referred to as "Makiga"?

☐ Yes      ☐ No

Are you skilled enough to operate, mechanized machines such as hydraform or hydrateuc?

☐

Yes

☐

No

What four factors do you think hinder the use of ISSB in your area of practice?

.....

.....

.....

.....

What four factors can promote the use of ISSB technology?

.....

.....

.....

.....

## APPENDIX IV

### SCHEDULE II: HOUSING OFFICERS

Station.....

Gender.....

What numbers of interlock machines are in your area of administration,

Manual.....

Mechanized.....

Does the department of housing train masons on ISSB technology in your area of administration?

☐

Yes

☐

No

If yes how often.....

If no, reasons.....

.....

.....

Do you hold sensitization workshops for the community?

☐

Yes

☐

No

If yes how often?.....

What is the common type of soil in your region of administration?

.....

.....

From the available guidelines on making and the use of interlocking blocks, is the soil in your area of administration suitable for making blocks?

☐

Yes

☐

No

Is your area prone to flooding during rainy season?

☐

Yes

☐

No

Are there any ISSB demonstration units in your area of administration?

☐

Yes

☐

No

If no what's the reason attributed to this?

.....

From your analysis and the available data on income levels as well as the total cost of doing 1square meter of walling available, can the residents in your region be able to meet the cost?

☐

Yes

☐

No

If yes, what is the likely reason for the slow uptake of the technology?

.....

What four strategies can the government undertake to promote the use of the technology?

.....

.....

.....

.....



## **APPENDIX V**

### **SCHEDULE III: HOME OWNERS**

Gender.....

Sub county.....

Have you ever heard or come across ISSB technology?

☐ Yes      ☐ Not sure      ☐ No

If yes from what source?

.....

Have you ever attended any workshop on ISSB, technology?

☐ Yes      ☐ Not sure      ☐ No

If yes who were the facilitators?

.....

Given an opportunity would you use ISSB, to build your house?

☐ Yes      ☐ Not sure      ☐ No

Give any two reasons for any of your choices above.

.....

.....

.....

In your opinion, do you think ISSB, is a good building technology?

☐ Yes      ☐ Not sure      ☐ No

What two reasons for any of your choice above?

.....

.....

.....

What 4 factors do you think hinder the use of, ISSB technology?

.....

.....

.....

.....

What four factors do you think can promote the use of ISSB, technology?

.....

.....

.....

.....

## APPENDIX VI

### TABLES

**Table 4.3: Training and Skill levels among the Technicians/Masons**

Variable	yes	No
Familiarity with ISSB	20	4
Trained on ISSB	18	6
Hands on experience with ISSB	8	16
Ability to operate hydraform machine	14	10
Ability to operate manual interlock machine	11	13

**Table 4.5: Suitability of ISSB in Siaya**

Variable	Yes	No
Availability of trained masons	6	0
Community sensitization	6	0
Suitability of soils	5	1
Flooding in siaya	1	6
Demonstration units availability	2	4
Ability o f residents to meet cost	4	2

**Table 4.4: Awareness levels among Home owners in Siaya.**

<b>Variable</b>	<b>Agree</b>	<b>Not sure</b>	<b>Disagree</b>
Heard about ISSB.	162	10	24
Sensitised on ISSB technology	102	2	92
Those willing to use ABT as a building technology	54	108	34
Agreeing that ISSB as a good building technology.	65	94	37