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Zanlock Bricks: One-Size-Fits-All Solution to Interlocking Bricks Shape and Form for Wall Construction in Nigeria

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ABSTRACT
This project underscores the interest that the use of interlocking bricks, called mortarless construction, has generated in the last couple of decades in Nigeria in replacement of conventional means of wall construction. Although the focus of all interlocking bricks seems to be on elimination of mortar as a component of wall construction and hence reduction of cost and labour, as well as enhancement of speed of construction, the vastness of the number of shapes and forms in which interlocking bricks seem to be emerging, appears to give the impression of an anxiety to show which of the emerging forms has the most innovative design. Having observed the prospective value and sustainability of the mortarless construction idea, this study has sought to make its own foray into the field by taking the idea a notch higher. From the review of the plethora of forms and shapes of the existing interlocking systems, the study has developed a more unique interlocking brick system named Zanlock Bricks, designed to be a "one-size-fits-all" solution to the cornucopia of the available interlocking brick shapes. It creates a form whose interlocking combinations appear endless and depend only on the creative ingenuity of the builder. Taking advantage of these apparently endless combinations of the Zanlock Bricks, the study has further introduced a new concept called Design for Deconstruction (DfD) which permits disassembly and reconstruction of forms of the mortarless construction as many times as circumstances may demand and in as many different configurations and in as many locations as the ingenuity of the builder permits his creative exploration, in order to allow for flexibility of the houses that may be needed for the poor and the most vulnerable groups in Nigeria.

Keywords: Zanlock Bricks, mortarless construction, interlocking bricks, Design for Deconstruction.

I. INTRODUCTION

Mortarless construction emerged as an attempt to break ranks with conventional means of housing production in developing countries which was becoming more and more difficult due to rising cost of materials and difficulty of procurement of such materials most of which had to be imported. These challenges compelled designers and researchers to come up with designs and other alternatives for faster and more sustainable means of shelter production for the teeming populations of their citizens made even worse by effects of disasters, both natural and hum an, which again resulted to even larger population crises of internally displaced persons (IDPs). It was reckoned that the wall being a major component of the building, a reduction in its cost and time of production would positively achieve overall cost reduction affect the overall cost of the building (Watile, Deshmukh, & Muley, 2014; Jhan,Beigh & Bhowmik, 2017). This was how mortarless construction by means of interlocking bricks began to take root across these developing countries.

The idea of interlocking bricks itself is believed to have emanated from the interplay with children's toys, which was started by the 'LEGO Group' (Kitingu, 2009). The LEGO Group began in the workshop of Ole Kirk Christiansen (1891 – 1958) a carpenter from Billnund Denmark, who began making wooden toys for children in 1932. In

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1934, his company came to be called 'Lego', derived from the Danish phrase 'Leg Godt' meaning 'play well'. Apparently, the progression of the construction of children\s toys progressed from wood to other materials, like tin metal, and clay, developing into creation of complex ensembles in form of cross-word puzzles, and interlocking bricks being witnessed now. The technology of construction advanced quickly to the employment of industrial products, mainly plastics, which essentially paved the way for a more robust study into the use of clay and laterite for the production of interlocking bricks for the construction of buildings for human use.

(a) (b) (c)

Fig.1 LEGO Plastic toys (a) & (b) as a complex ensemble into which children's toys developed as a precursor of interlocking bricks made of clay (c)

From about the 1970s the interlocking mortarless bricks became fairly popular and were now made from sand cement, stabilized soil and burnt/baked soil or fired clay, mainly from Africa, Canada, the Middle East and |India with a variety of forms and shapes of the interlocking bricks, each focusing on the goal and aspirations of the designer. It is from the review of these shapes and forms that this study has leveraged upon to come up with what it considers as the "one-size-fits-all" solution in terms of viability, effectiveness and universality of form in a near endless combinations of interlocking mechanisms which will revolutionize the mortarless building construction industry in Nigeria and beyond.

1. Aim and Objectives

The aim of this proposal is thus to develop an innovative and unique form of interlocking bricks technology for mortarless walling system for a more effective and more sustainable housing delivery to the poor and vulnerable groups in Nigeia, with the view to ensuring that such unique form makes the resultant housing form not only sustainable but also easily de-constructable whenever the need arises therefor. This will be achieved through the following objectives:

(1) Appraise the various available forms of interlocking brick technology in terms of vialbility of the interlocking mechanisms, their shape, form and prospective structural (load bearing) capability, wall alignment, accuracy and aesthetic quality as well as comparative cost benefit as against conventional systems;
(2) Analyse the proposed interlocking brick technology against the same parameters in (1) above using a variety of materials ranging from concrete, laterite, clay, agricultural waste products and appropriate mixes to obtain the most suitable and adaptable and sustainable interlocking system;
(3) identify and adopt or modify the most appropriate extant ones or make an entire new proposal, focusing on the most innovative shape and form for the most creative interlocking mechanisms;
(4) Generate modalities and strategies for implementation and adaptation of the proposed system.

2. Concepts

Interlocking bricks as explained by Kitingu (2009) is produced in a variety of shapes to construct different wall joints and, thus, create variations in the variety of interlocks necessary to perform the same construction operations. Existing interlocking designs have different configurations based on the variations in the locking mechanisms. Kitingu classifies interlocking bricks into two groups based on their locking systems. The first category comprises those that have interlocks that restrict movement both horizontally and transversely to the surface. The second category, on the other hand, comprises those bricks with interlocks which allow horizontal movement, but limit transverse movement during wall assembly. On the other hand, three types of locking (jointing) methods are known: Tongue-and-Grooved (T & G), Protrusions and Depressions (P & D) and Topological non-Planar Locking system. The T & G and the P & D are the most typical interlocking methods over and above the topological type (see Table 1).

Table 1 Categories of Interlock Brick Systems

Category A Both horizontal and transverse movement restricted	Category B Free horizontal and restricted transverse movement
Auram	Alan Block
Bamba	Hydraform
Haener Interlocking System	Solbric
Osteomorphic	
Sparlock System	
Tanzanian	
Thai	

A major advantage of the interlocking wall that appears not to have received much attention is the idea of designing an interlocking wall with a deliberate possibility of deconstruction, should there be a future need to do so, with all, or most components of the wall been retrieved after such disassembly, without losing much. This possibility is what has been refered ro as Design for Deconstruction (DfD).

3. Design for Deconstruction

According to Adebayo and Iweka (2006), Design for Deconstruction can be considered as the design of buildings to accommodate and facilitate future changes and the possibility of eventual dismantling (in part or whole) that will permit the recovery of systems, components and materials and still losing as little (of the components, systems or materials) as possible. To be most effective (such) deconstruction will ensure that recovery of materials and systems after deconstruction) would maximize economic value and humanize environmental impacts through subsequent recovery and reuse (or repair, re-manufacture and recycling, where necessary) of components (see Morgan & Stevenson, 2005; Pulaski, Hewitt & Horman, 2004). To be able to achieve this, such buildings must be designed with some characteristics as a guide as shown in Table 2 below:

Table 2. Characteristics of Buildings Designed for Deconstruction (Source: Adebayo and Iweka, (2009)

Characteristics	**Remarks**
1. Transparency	Building systems that are visible and easy to identify.
2. Simplicity	Building systems and interconnections that are simple to understand, with a limited number of different material types and component sizes.
3. Regularity	Building systems and materials that are similar throughout the building and laid out in regular repetitive patterns.
4. Limited number of components	It is generally easier to dismantle structures that are composed of a smaller number of larger members than a large number of smaller members. Where deconstruction will likely be undertaken using primarily hand (manual) labour rather than large machinery, it may be appropriate to design with smaller lighter members.

5. Easily separable materials	Materials should be easily separable into reusable components, mechanical fasteners are preferable to adhesives. Composite materials are a difficulty unless the composite assembly has reuse value as an assembly

The crux of these characteristics of disassemblable buildings is that

- designed connections must be easily accessible;
- chemical connections to be eliminated or at least minimized, instead -
- bolted or screwed and nailed connections should be the most dominant connections.
- mechanical, electrical and plumbing (MEP) systems should be separatedand also made easily accessible;
- the form of the structure shouldbe as simple as possible.

Possible areas of components that lend themselves more easily to the potentials for disassembly will include wall elements and roof members with connections as specified above. However, in conflicts and crises situations, since the roof is the first target for destruction (the roofs are usually almost totally burnt down or destroyed beyond salvage) our focus on the salvageable parts of the building will be the wall (while not discounting possible areas that may still permit salvage of any roofing elements).

In situations where fighting breaks out following some conflicts, the people are usually the prime targets, before any attention ever shifts to their property (or homes). Thus, where the people are able to effectively repel the attacks, then their properties may suffer little damage. It is only when they cannot effectively defend themselves that they are killed, and then their properties destroyed as an 'icing on the cake'. But by the time the attackers shift their attention to the property of their victims, they are, themselves, in a hurry to move on, as quickly as they are able to, so as not to risk fortune reversals from any unforeseen quarters. Consequently, there is not much time to go for total demolition. The commonest mode of destruction is torching and burning. This generally affects mainly roofs of buildings, with parts of the walls, still suffering serious enough collateral damage. However, though partially destroyed, large portions of walls of buildings in such devastated communities still remain standing, and, if made of deconstructable materials can quickly be dismantled and packed into a truck alongside other belongings and moved elsewhere where they can be reassembled into new homes without losing much.

4. The Most Common Types of Interlocking Bricks

As of now, interlocking bricks are more a common feature of low-cost building construction works in developing countries of Asia and Africa. They are now commonly made from lateritic soil stabilized with a suitable quantity of cement. The most popular of these bricks have been identified by Kitingu (2009) as Thai Interlocking Brick, Solbric, Hydraform and Bamba Systems from South Africa, as well as Auram System from India and Tanzania. These will be reviewed briefly:

1. The Thai Interlock Bricks, according to Kitingu (2009) are of size 300 x 150 x 100mm. The bricks were said to have been developed in the early 1980s by the |Human Settlement Division of the Asian Institute of Technology (HSD-AIT). Bangkok in cooperation with Thai Institute of Scientific and Technical Research (TISTR). The bricks have vertical grooves which (when stacked as a wall) run through the full height of the wall, providing good keys for render. Similarly vertical holes run through the full height of the wall serving to reduce weight and house reinforcement or mortar (to increase wall stability at chosen locations like corners, junctions, openings, etc.) The holes may also be used for electrical and communication conduits. A drawback of the Thai brick is the fact that the locking mechanism is not well secured as the knobs and depressions are (< 5 mm) too small). Thus the strength of the interlocks depend on the surface render or on grut filled into vertical holes with additional reinforcement as and when needed (see illustration.

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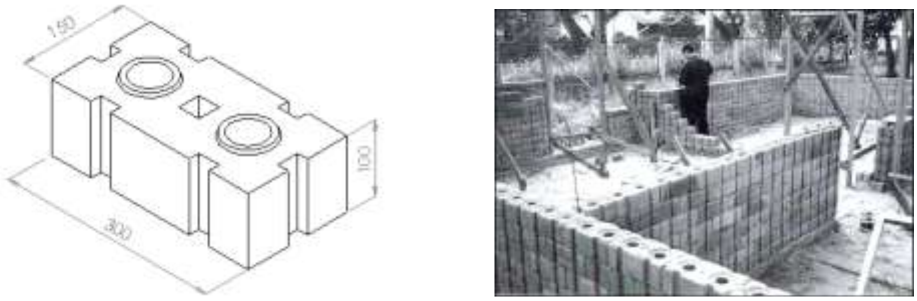

Fig. 2 The Solbric Interlocking Brick system

2. Solbric System from South Africa, according to Kitingu, is a solid interlocking brick of a size 250 x 200 x 100 mm. The system is said to be formed by pressing on their ends so that the compacting stroke moves parallel to the longer size. The brick provides small horizontal cavities between the cervices in which conduits and pipes can k be installed or reinforcements placed to strengthen the wall at certain locations like the all lintel levels. The drawback is that with the composition as it is the brick may not be used in reverse (front to back) as other types of interlocks are,, consequently this brick shape make it impossible to be used elsewhere except for external walls (since there is no means of connecting partitions or making tee or cross walls. Again the smallness of the vertical and horizontal tongues that provide for interlocking are too small (< 15 mm) and too fragile to offer firm interlock because of the brittle nature of the soil (even though stabilized with cement) used for the brick.

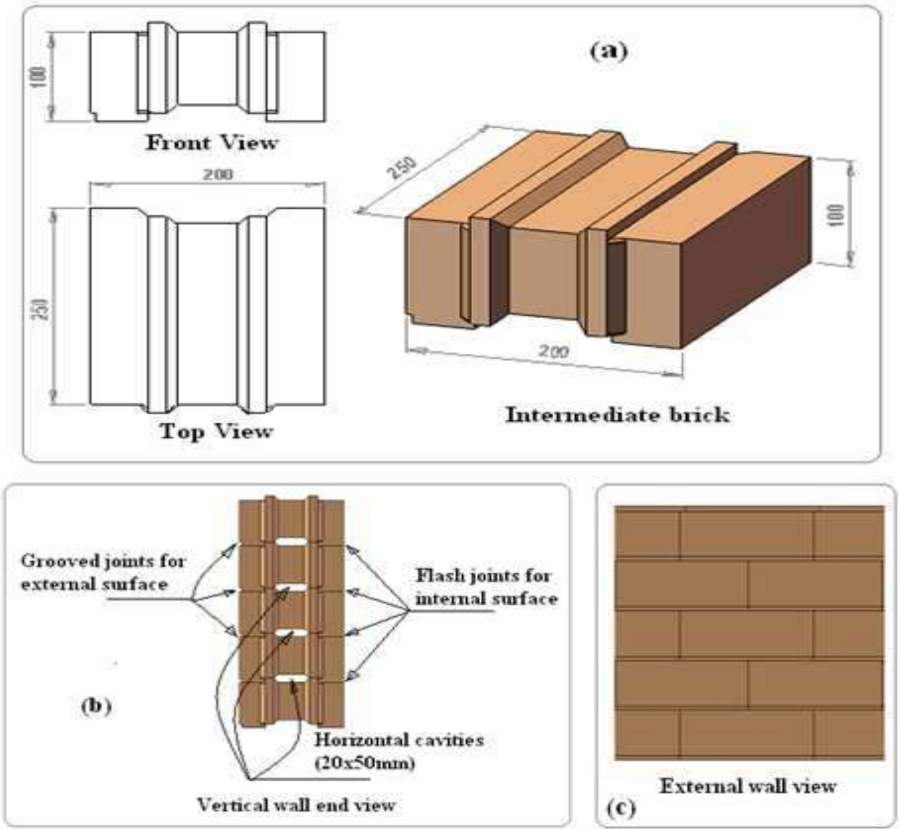

Fig. 3 (a) The Hydraform Interlocking Brick System

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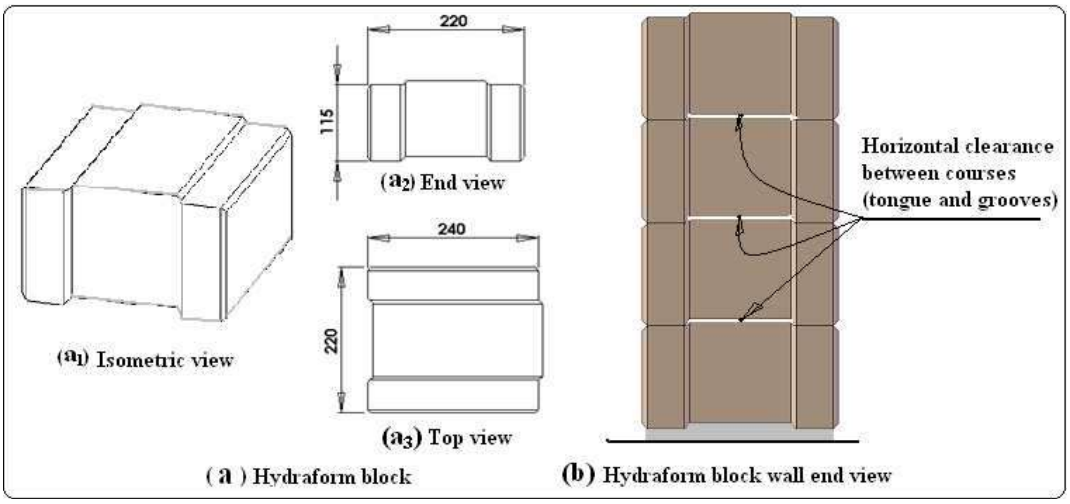
3. Hydraform System which measures 240 x 320 x 115mm from South Africa, according to Kintingu when interlocked it makes a tongue and grooved joint at the sides top and bottom, This makes it possible to slide freely along the horizontal courses with the possibility that it can be pushed along to achieve lighter perpends (vertical joints). However, just like in the Thai system the stability of the butt wall from hydraform blocks is not provided by the locking mechanism but by the with and massiveness of the block. The block requires considerable power to be moulded due to its large volume which has 30% more soil compared to the other types of interlocking bricks. And what is more the design of the brick does not come along with bats or pieces to take care of turnings at corners or other joints and thus requires some shaving and/or chopping of two blocks, have to be laid perpendicular to each other.



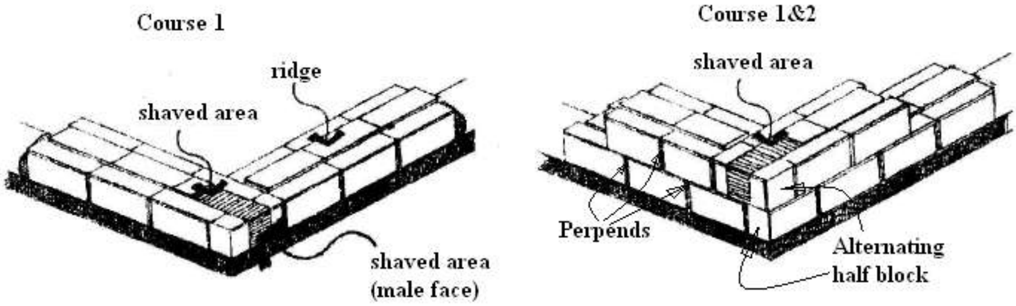


Fig. 3 (b) Building with The Hydraform Interlocking Brick System

4. The Bamba System, also from South Africa, is shown to have perforations, protrusions and depressions. The top and bottom faces of the Bamba brick is designed with 'negative symmetry' meaning a protrusion on one face has a depression on the face directly opposite to such protrusion. This allows the protrusions of one brick to interlock directly with the depressions of the opposite brick. A major highpoint of this system is the fact that 180^{o} rotation of the brick around its Z-axis makes the bottom view to appear as the top view. Actually by its configuration rotating the brick around any axis presents a constant view since any feature on one face translates to an opposite feature on the opposite face. This provides the option of reversing the brick to find a better orientation (or position) during brick laying. Because of this the bricks strength lies in its ability to interlock well, provided high accuracy of shape is maintain. A major drawback is its complicated shape which affects accuracy.

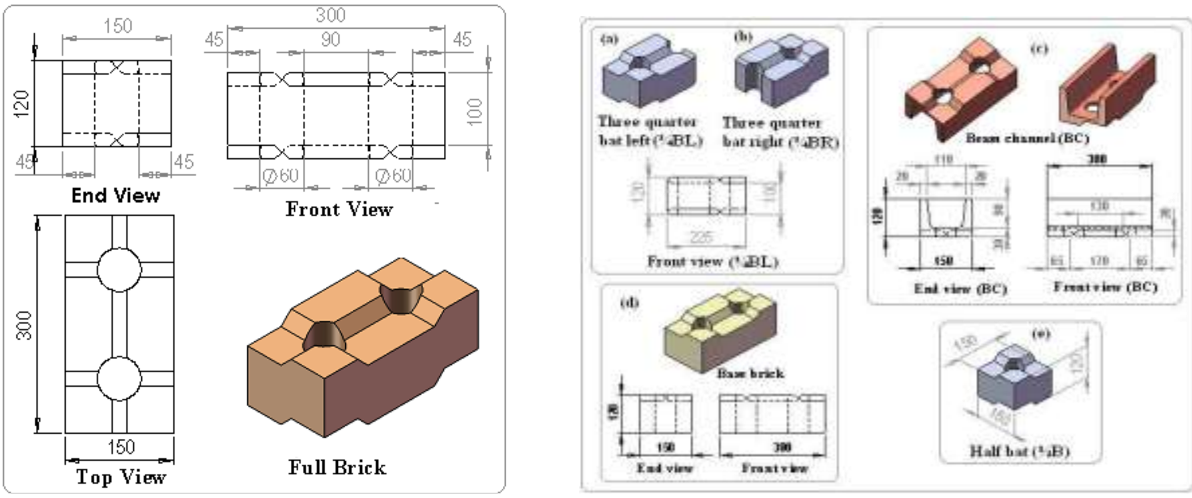


Fig. 4 (a) The Bamba Interlocking Brick System

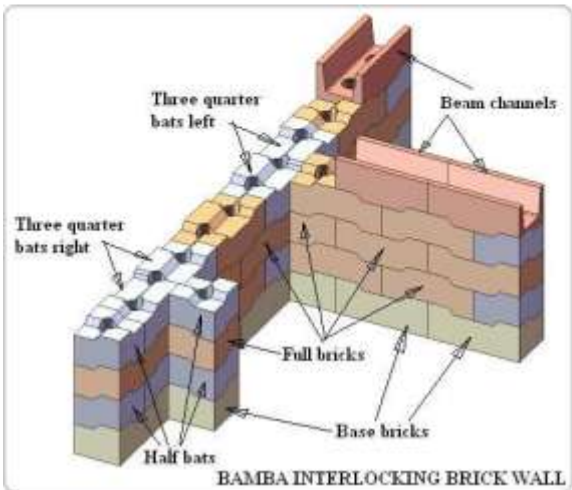


Fig. 4 (b) Building with the Bamba Interlocking Brick System

5. The Auram InterlockingBrick system, from India, is of a size 295 x 145 x 95 mm and is said to provide some similarities with the Bamba and Thai systems. The brick is heavy, weighting in a 9kg and 10kg. This is more than the Thai and Bamba systems which weigh 7 to 8kg. However, the locking mechanism is noted to depend entirely upon the bosses and depressions. Yet, at less than 10mm those bosses (called male) and the depressions (called female) do not appear to give enough room for proper locking and hence may not give enough wall punch through strength from interlocking.

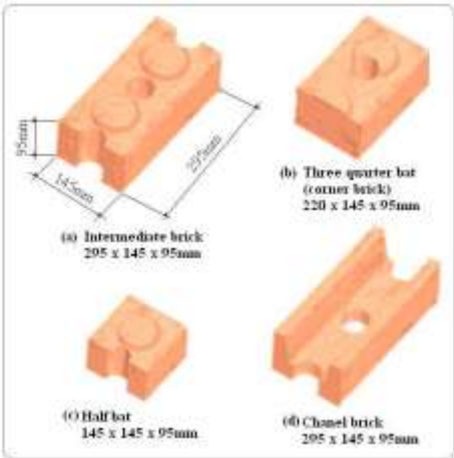


Fig. 5 The Tanzanian Interlock Brick system

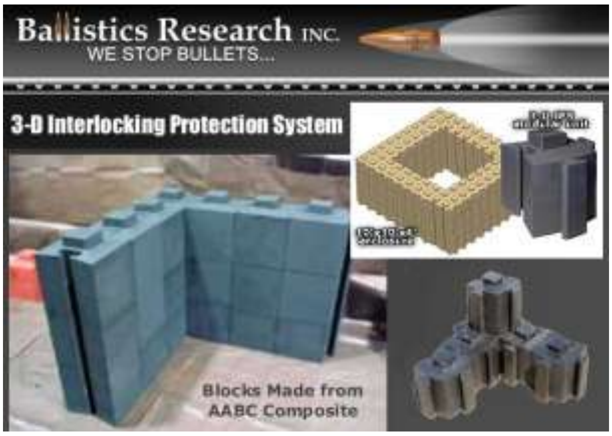


Fig. 6. Pictorial components of interlocking bricks system made from AABC composites (supposedly bullet-proof)

6. The Tanzanian Interlock Brick system of a size 300 x 150 x 100mm was developed by Kitingu (2003) after observing certain drawbacks of the Thai and Bamba systems which he sought to modify. The moulding machine is locally made and manually operated as a modification of the CINA-Ram press. The brick has two locking knobs and depressions shaped in a pyramidal form with holes running through the centre of the knobs to allow for possibility of introducing conduits and/or communication lines where needed.

In various ways and forms, variations of these interlocking bricks have been presented and described elsewhere by the following works: HABITEC Center (2010); Jhan, et al, (2011); Ahmad, et al (2011) and Watile, Deshukh, and Muley (2014). Since these are mere variations of the ones described by Kitingu (2009) these variations are taken as having been covered adequately by Kitingu's presentation.

Fig. 7 Suresh Jangu's Interlocking Bricks (made of clay supposedly meant to withstand earthquakes)

Configuration-wise, the Suresh Jangu bricks are the bricks with which Zanlock Bricks appear to have the closest relationship. These (Suresh Jangu) bricks, it has to be admitted, played a large role in those forms that sired the inspiration of the development of the Zanlock Bricks, with due credit accorded Suresh Jangu. However, the Suresh Jangu bricks have no 'head' and 'bosom' and thus no two of the bricks can interlock along the course of a wall. The interlocking system of the Suresh Jangu bricks is only face-over-back, or, back-over-face. The Zanlock Bricks, on the other hand have 'heads' and 'bosoms', making it possible for the head of one brick to enter the bosom of the next brick permitting any two (or more bricks) along a course to interlock firmly and can be held up to act as one solid unit, making the design of larger units a matter of choice. In addition, the Zanlock Bricks can interlock in almost all directions (face-on-back, back-on-face, back-on-back, and face-on-face) (see S. 10) below for details.

5. Reflections on the Reviewed Existing Interlocking Bricks Forms against the Proposed Zanlock Bricks

It has been shown by several studies (see for e.g., Abdullah & Kandar, 2004; Jahn, Beigh & Bhownik, 2017 and Mohammad, 2012) as reviewed here, that, mortar-less brick construction (especially that which employs interlocking bricks) is gaining popularity round the world whatever flaws to which it may be susceptible. Some of the most common characteristics and advantages of mortar-less construction include:

- increase in construction productivity;
- reduction of duration of construction and labour;
- reduced cost of construction (labour and its continuously escalating cost having been eliminated as mortarless);
- because of its technological simplicity and the fact that the materials are locally sourced.

less waste is produced the brick having been molded in modular components that are fit into all contending nooks, corners and other stretches etc. like in a crossword puzzle ensemble.

- the mortarless brick construction is considered more appropriate to the local communities than the conventional bricks that require the use of mortar.
- in case of some unforeseen disaster (whether natural or man-made) depending on the interlocking style, the bricks may be 'dislocked' (or disassembled) quickly and packed together and moved elsewhere where they may be reassembled just as quickly without losing too many. This way the masons do not have to start remolding bricks from the beginning to rebuild their dwellings.

The various types of interlocking bricks reviewed in the foregone section provide a vast field of possibilities from which a choice could easily have been made to provide the government of Nigeria with the required tool for a faster housing delivery scheme for the homeless. However, in this project, we look beyond the mundane quest for provision of housing for the urban or rural poor, or even for the most vulnerable groups – the IDPs, which a vast amount of policies on the so-called low-cost housing has already been tried severally without much success anyway.

Here, we are more concerned with the emerging variability of types of interlocking bricks system whose adoption could provide the required panacea for more sustainable low cost housing production for those vulnerable groups in Nigeria. In particular we are more focused on the newly developed Zanlock Bricks whose unique form appears to offer a one-size-fits-all solution for building production with interlocking bricks in terms of the numerous interlocking combinations it promises to offer - the spin-off of this unique interlocking brick being mainly the variety of permutations in cost and time reduction, skill development, job creation, and sustainability of the housing production process for the vulnerable groups in Niigeria.

What is more, whereas the choice of any of the existing interlocking bricks might also have benefitted the IDPs in terms of quick access to shelter, reduced cost of dwellings, effectiveness of delivery, etc., our focus on the concept of Design for Deconstruction (DfD) where there will be the prospect, not only of meeting all the mentioned advantages of shelter delivery, but also to provide the additional possibility of deconstruction of the walling materials, retrieval of the disassembled components, without losing much and reassembling them elsewhere should there ever arise an urgent need for them to be forcefully displaced yet again is an icing on the cake of our invention.

6. The Proposed Zanlock Bricks

The new set of interlocking bricks developed by this author, known as Zanlock Bricks have a solid cuboidal configuration measuring 150x150x100mm in its overall outline. Its major features are the protrusions, recesses, depressions and flanges jutting out of, or receding from specifically designated positions of the body, each feature playing a specific role towards perfecting the overall interlocking mechanism (see the 'forms' shown in Blocks 1, 2, 4 and 5 in Fig. 9, showing front face back face and interlocking mechanisms of the brick).

The design permits interlocking in at least four different directions – front-over-back, front-over-front, back-over-back, head-into-recessed bottom and even when placed side by side using a common profile, any pair at the bottom row can be used as a base for inter locking with a top single piece transversely. No other interlocking brick style has these (almost unending) interlocking possibilities, not even 'a game of scrabble'.

The brick is designed as a modular unit providing the possibility of drawing from it fractional parts called three-quarter bats, half-bats and quarter-bats, whose purpose is to form components that will flush at edges, corners and junctions to ensure that no shaving or slicing off of the main bricks or addition of strange elements to complete these areas of the composition are necessary (see the various bats in Block 3 in Fig. 9).

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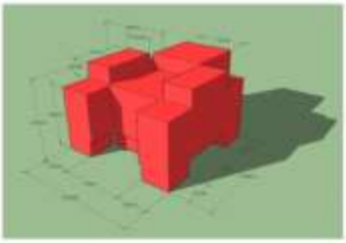
The uniqueness of the design of the bricks comes mainly from the fact that the bricks can be stacked directly, one on top of another, face-over-back interlocking, while still continuing with horizontal interlocking of protrusions into recesses, forming a wall with grooves that appear to the viewer as direct vertical grooves from bottom to the top and yet with the head to recess inner sideways interlocking, the real bonding remains staggered. Alternatively, the bricks can be arranged in a staggered formation where on the first course the bricks are placed facing downwards (it could also just as well be facing upwards and it would not make any difference). On the next course, one brick is made to sit astride and in between the flanges of two bricks below it (this essentially means a face-on-face interlock and on the next course we will have back-on-back interlock - see block 5 in Fig. 9). While this formation is going on, on any given course, there is continuing locking of the head of one brick into the recessed portion of the brick next to it, creating a multiple interlocking system that is completely unique only to Zanlock Bricks and none other type of interlocking brick known to this author (more formations can be seen in the following interlocking combinations).

6.1 Additional Notable Features of the Zanlock Bricks

As will be seen in the illustrations that follow, the Zanlock Bricks also admit of other interesting features worthy of note. These are as follows:

- **Lightweight and handy (overall size of 150X150X100)** – can be carried with one hand, even by a nine-year old child;
- **Two bricks can interlock and hold firmly** with ‘the male head’ (protrusion) and ‘the female bosom’ (recess) in nearly inseparable grip and can be held up to act like one larger unit, thus making the need for larger units unnecessary.
- The brick can be produced using only **compressed earth (laterite) or with a small quantity of cement as little as 4% for stabilization** and produced by a civa ram press; Those produced this way can be used to build even storey buildings of up to two floors.
- Or they can be produced locally using a fabricated machine by local blacksmiths. The machine will then **use clay for production of the bricks which will be fired** in the same way the local burnt bricks are done (but instead of using firewood, which will deplete the environment through deforestation the locals will be trained in the use of agricultural waste like rice husk, corn husk, cobs and stalk, palm kernel shells as well as dry bagasse from sugar cane pulp, etc.).

The Proposed Zanlock Interlocking Bricks (Models of the Bricks together with their Bats)

		
1.Back face showing up	2.Front face showing up	3.Fractional pieces called ‘bats’: quarter, half and three-quarter bats, for corners, jambs and wall edges for smooth ends.

 4. Wall construction with the Zanlock Bricks employing direct stacking (face-on-back interlock)	 5. Wall construction employing staggered stacking (back-on-back and face-on-face interlock)	6.  Formation of columns employing full bricks and the various 'bats' as required
 7. A fully assembled strong metal manual mould	 8. Disassembled mould	 9. Example of a small pilot structure constructed earlier with the Zanlock Bricks made of burnt clay fired in kilns. ote the bridging of openings with only the interlocking bricks without lintels.

Fig. 9. Zanlock Bricks as originally proposed (Note the various components beginning from the paper models to the moulds made of wrought iron and then finally the brick itself made of clay fired in kilns with a pilot structure constructed with the finished product). Although this proposal focuses on the use of plastic waste, it cannot be forgotten that in some rural areas the plastic waste may not be available for use. The mould is universal and can admit of the use of clay fired in kilns afterwards.

Unique form combinations of the Zanlock Brick showing endless possibilities of interlocking mechanisms

	
1. rontal profile (a) of the double wall with Zanlock Bricks	2. Building a wall structure with the Zanlock Brick showing the use of the 'bats' to negotiate at a corner
	
3. Longitudinal profile of a double wall with the Zanlock Bricks	4. Transverse profile of a double wall with the Zanlock Bricks
	
5. Frontal profile of a triple wall structure with the Zanlock Brick	6. Physical form of the Zanlock Brick produced from plastic waste and laterite

Fig. 10. "One-size-fits-all" solution with Zanlock Bricks for all interlocking bricks mechanisms in building construction works in Nigeria.

- In the rural areas where plastic waste may be scarce, the Zanlock Bricks may be produced with clay and fired in kilns as the locals usually produce burnt bricks. But these interlocking bricks will naturally produce, on average, a dwelling house, of, say, three rooms in a time almost three times shorter than the usual known period.
- For interlocking at corners (or to form the beginning of partitions) interlocking pieces as fractional components have been formed out of modules of the main brick – these pieces are either 'quarter', 'halves' or 'three-quarter bats'.

- It is also possible to use polystyrene instead of plastic waste to produce Zanlock Bricks through heating the substance the same way plastic waste is heated without mixing with any other substance and simply moulding the molten polystyrene in the Zanlock moulds. With the DfD concept in mind, the interlocking bricks produced with polystyrene will be useful in partitioning rooms like in bank offices, with the possibility of dismantling and reassembling them at as many locations as the banks may desire.
- A few of them may also carry end-to-end 10mm holes through which 10mm metal rods can be inserted, joining about four bricks to span a door or window space as lintels, etc.
- What is more, most, if not all, of the existing interlocking brick styles presented above, depend on tongue–and-groove (T&G) or protrusions-and-depressions (P&D) locking systems, those depressions and protrusions are less than 10mm and thus cannot depend on the locking mechanism alone to perfect the bonding together of the bricks and often need the mass of the bricks to complement the bonding and provide the needed stability.
- In addition, while being custodians of all the advantages for which interlocking bricks are popular, these extant interlocking bricks actually build homes of near permanence. Their concern appears to be merely in the areas of reduction of cost and speed of construction of the buildings. Thus apart from the bricks being almost as heavy as the conventional sandcrete blocks are, a lot of them also admit of some rendering, plastering and even painting as attested to by the buildings shown by HABITEC Center. Such buildings are therefore meant for permanence and may not be tampered with in terms of deconstruction. But our concept of DfD means how to house the homeless (especially the IDPs) quickly, effectively, decently and sustainably while still ensuring that should there ever be any reason for the inmates to face any further threats of displacement, the interlocking walls should easily be disassembled and as many as possible of the bricks be retrieved and reassembled into new homes at another location without the affected people having to start life afresh as has been the case hitherto. This is the premise upon which our proposed interlocking bricks, called Zanlock Bricks, has been predicated.

The possibilities and unique features of the Zanlock Bricks simply appear endless.

REFERENCES

[1]. Abdullah, C. S. and Kandar, N. (2002). Rain Penetration Performance of Mortar-less Interlocking Blockwwork Walls. School of Information Technology, University of Malaysia, Maju Holdings, Kuala Lumpur, Malaysia, 9DBMC.

[2]. Adebayo, K. A. and Iweka, A. C.O. (2009). Sustainable Design and Construction of Buildings: The Concept of

[3]. Design for Deconstruction. Architects Registration Council of Nigeria (ARCON) Colloquium Proceedings, April 25 – 29.

[4]. Aslam, M. S. (2021). Comressive Behaviour of Interlcoking Plastic Block Structural Elements. A Thesis Submitted in Partial Fulfilment for the Degree of Master of Science, in the Department of Civil Engineering, Faculty of Engineering Capital University of Science and Technology, Islamabad.

[5]. Habitech Center (2010). Interlocking Soil-Cement Brick Technology. A Research and Development Unit for the Housing and Building Components. School of Engineering and Technology, Asian Institute of Technology.

[6]. Jahn, P., Beigh, M. and Bhowmik, S. (2017). Modeling of Interlocking Soil Stabilized Bricks for Improved Wall Construction, Flexibility and Alignment Accuracy. International Research Journal of Engineering and Technology (IRTJE). www.irtjet.net

[7]. Kitingu, S. H. (2009). Design of Interlocking Bricks for Enhanced Wall Construction Flexibility, Alignment

[8]. Accuracy and Load Bearing. An Unpublished Thesis Submitted to the University of Warwick School of Engineering, in Partial Fulfilment of the Requirments for the Degree of Doctor of Philosophy.

[9]. Kognole, R. S., Shipkule, K., Patil, M., Patil, L., Survase, U. (2019). Utilization of Plastic Waste for Making Plastic Bricks. International Journal of Trend in Scientific Research and Development, 3 (4): 878 - 880.

[10]. Sahu, M. K., Singh, L. (2017). Critical Review of Types of Bricks Type 14: Plastic Sand Bricks. International Journal

of Mechanical and Production Engineering. 5 (11): 84 – 88, May.

[11]. Kumi-Larbi Jnr, A., Mohammed, L., Tagbor, T. A., Tulashie, S. K., Cheeseman, C. (2023). Recycling Waste Plastics into Plastic-Bonded Sand Interlocking Blocks for Wall Construction in Developing Countries. Sustainability, 15, 16602.

[12]. Mohammed, A. A. (2012). Assessment of the Mechanical Properties of Soil Cement Interlocking (SCI) Bricks: A Case Study in Malaysia. International Journal of Advances in Applied Sciences (IJAAS) 1 (2), 77-84, June

[13]. Morgan, C., Stevenson, F. (2005). Design for Deconsruction. SEDA Design Guides for Scotland No. 1

[14]. Mwangi, A. N. (2013). Factors Affecting Effective Use of Interlocking Stabilized Soil Blocks (ISSBs) for Reduced Cost of Shelter Improvement: A case study of trained community-based organizations and individuals in Mombasa county. A research project submitted in partial fulfillment of the requirements for the award of the Post-graduate Diploma in Housing Administration

[15]. Pulaski, M., Hewitt, C., Horman, M. and Guy, B. (2004). Design for Deconstruction, in Modern Steel

[16]. Construction. Article based on a Paper titled "Design for Deconstruction: Material Reuse and Constructability" published in the Proceedings of the 2003 Green Building Conference hosted by the U.S. Building Council.

[17]. Watile, R. K., Deshmukh, S. K., Muley, H. C. (2014). Interlocking Bricks for Sustainable Housing Development. Pratibha International Journal of Science, Spirituality, Business and Technology, 2 (2): 58 – 64, May.