

## Acceptability Indices of Interlocking Masonry for Housing Construction in Nigeria

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**Abstract:** The study focuses on the acceptability level of interlocking blocks as masonry materials for housing construction in Nigeria. Empirical survey was conducted among selected leading professionals in the building industry namely Architects, Engineers, Quantity Surveyors and Builders through questionnaire, observations and interview methods. Two hundred questionnaires were administered randomly to these professionals in 4 out of the 6 geo-political zones in Nigeria, out of which 120 were good for analysis. Analysis of results reveals that; interlocking blocks have high acceptability index while professionals and clients showed high preference for the use of the material as an alternative for the conventional sandrete blocks.

**Key words:** Acceptability indices, interlocking blocks, building material, Nigeria

### INTRODUCTION

In the recent past, interlocking masonry is expanding in its usage in the Nigerian building industry. Since, it was formally launched in Abuja in 2002 by the Nigerian Building and Road Research Institute (NBRRI) as an alternative masonry material to the conventional types, it has continued to enjoy wider patronage everyday in housing delivery (Adedeji, 2007). In Nigeria, the first documented usage of the interlocking masonry was that of a 60-unit housing experimented in 1991 at the University of Lagos, Lagos (Olusanya, 2001; 2003). In this System housing, a prototype design representing a marriage of architecture design, materials and technology was developed into a commercial level where the product and the process are conceived as an integrated whole. It has evolved into an urban housing prototype as a strategic approach to housing delivery as an engine of growth in a developing Nigerian economy. The objective here is to marry housing production with processes for sustainable industrialisation. This was followed by public patronage in an industrial scale where a 60-unit housing estate for Home Ownership Scheme of Lagos State Government Staff Housing, Board.

Alausa was constructed. This project took the form of terraced houses that provide territorial exclusiveness (private garden and driveway for every housing unit), effective ventilation and functional space usage (Olusanya, 1996; 2003). Besides, the Nigerian Building and Road Research Institute (NBRRI) demonstrated the use of the material in major cities in Nigeria such as Lagos and

Abuja. Examples of such projects are; Good Homes Residential Estate, Isheri; Nigerian Building and Road Research Institute (NBRRI)'s Analytical and Material Laboratory, Ota; Ondo State Housing Corporation Staff Canteen, Akure; Obasanjo Housing Estate, Ado-Ekiti. CITEC Estate Abuja, Kuje Housing Estate Abuja; Brick Estate along Kubwa, Abuja and Residential Housing Estate Kubwa, Abuja.

### OVERVIEW OF DEVELOPMENT OF INTERLOCKING MASONRY

The colossal waste associated with conventional masonry works facilitated the search for more rapid and less workmanship dependent building methods and materials leading to the development of dry stackable block masonry units which can be laid without mortar (Adedeji, 2005). Introduction of interlocking or dry stack mortarless masonry systems in reinforced block masonry construction requires the development of efficient, easy to handle and yet versatile blocks. Two promising interlocking block types were developed at Drexel University (Harris *et al.*, 1992), for application to reinforced masonry construction of earthquake resistant structures using 1/3 scale direct models. These were the modified H-Block and the WHD Block system. Production of the units (facilitated by 1/3 scale reduction) was followed by strength and stiffness evaluation under compressive, bending and, shearing loads. The WHD Block was developed independently at Drexel University and was studied using a 1/3 scale direct modelling

technique of the units. Significant horizontal and vertical bending stiffness is obtained in the staggered joints of the dry stacked system.

The development of interlocking blocks reveals that many have complex shapes, which appear to have been deliberate in design. Such intricacies in blocks' geometry (tongue and groove or undercut and dovetail arrangement) necessitate mechanized production methods and the presence of continuity of horizontal and vertical joints from inner to outer face. On the basis of this, a need for the development of interlocking blocks with simple geometry, a study of their structural behaviour and functional performance is found to be essential.

Akin, the Sparlock Interlocking Building System (SIBS), which is ideal for building interior industrial partitions, was developed in Canada in 1982. The units are quickly and easily assembled without messy mortar and expensive labour. Furthermore, a Sparlock Industrial Partition may be taken apart and relocated, removed or stored outside. Sparlock units are reusable, do not require mortar (saving money for mortar mix and professional labour), will turn right angle corners, accept door and window openings and are quick and easy to install.

Another type of interlocking block masonry system is the Solid Interlocking Block developed at Indian Institute of Technology (IIT) Madras. This variety is simple in shape, locks easily both in horizontal and vertical directions and is economic in production. The system is comprised of units of 3 basic shapes, i.e., stretcher, jamb and corner blocks, with full-course (200 mm) and half-course (100 mm) high units as shown in Fig. 1.

In Nigeria, the Nigerian Building and Road Research Institute (NBRRI) developed an interlocking block making machine meant to produce solid interlocking block types. The blocks have geometric size of 225×225×112.5 mm. This machine produces solid blocks of laterite composition and stabilised with cement material.

Interlocking blocks are manufactured by hydraulically compressing a soil and cement mixture in a block-making machine shown in Fig. 2. The production process includes: preparation of soil, preparation of mix, compression of mix, stacking of blocks and curing of blocks. Each of these stages has a significant influence on the quality and cost of the block produced. The hydraulically compressing machine compresses the soil from top and bottom thus resulting in uniform and high density. With 5% cement stabilization and good lateritic soil strength of about 4-5 N mm<sup>-2</sup> is achieved. Graduated buckets are used to measure the soil and fill the mould of the machine so as to produce approximately equal sizes of blocks. For compression, the machine has to be operated by one person only to avoid damage to it (Fig. 3).

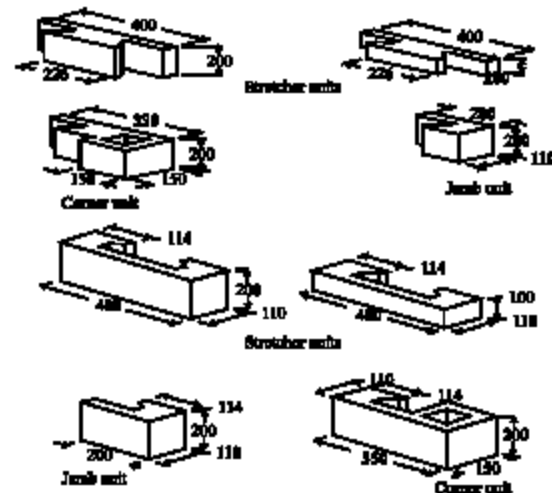


Fig. 1: Dimensional details of sillblocks-1. Source: Anand and Ramamurthy (2000)



Fig. 2: Interlocking machine developed by NBRRI, Ota. Source: Researcher's field survey (2005), Ondo State housing corporation, Akure



Fig. 3: Stacking and curing of interlocking blocks. Source: Field survey (2007), Obasanjo low-cost housing estate, Ado-Ekiti

## MATERIALS AND METHODS

The data for the study were collected with the use of questionnaire administered to selected professionals in

Table 1: Distribution of questionnaires type 'A' within the study area

S/no	Geopolitical zone	Town	No. of questionnaire	No. of responses
1	South West	Lagos	50	40
2	North	Abuja	50	32
3	South South	Port Harcourt	50	28
4	South East	Enugu	50	20
Total			200	120

Source: Field survey (2007)

the building industry. The selected professionals (Architects, Engineers and Quantity Surveyors) distributed over 4 out the 6 geo-political zones in Nigeria expressed their opinion on the acceptability and willingness to use this material as a replacement for the conventional types (Table 1).

The questionnaire collected information on unique projects executed by these professionals using the selected study materials namely: interlocking blocks and the conventional type. One hundred and twenty respondents were randomly selected equally from the 200 administered in the 4 geo-political zones.

Though sample sizes depends on variability of population to be sampled (Kitchin and Tate, 2000), equal number of questionnaire were administered in these zones since all the zones are have large number of building professionals practising in them (Table 1). Nevertheless, the table reveals that more responses were received from Lagos and Abuja. This could be based on the fact that the 2 acts as the economic and administrative seats of the nation, respectively and the level awareness in these societies.

## RESULTS AND DISCUSSION

### Materials price rating in the respondent's locality:

Opinions of respondents were sought in assessing the relationship between the general rating of prices of building materials and housing affordability as expressed in Fig. 4. Common opinions show that the prices of these materials (over 73%) are on the high side.

Figure 4 reveals that interlocking blocks are cheaper than the conventional blocks because interlocking blocks has more local content that can be sourced directly from site than the conventional sandcrete blocks, which is a product of cement and sand and depends largely on the value of the foreign exchange.

**Suitability of interlocking blocks:** Respondents' opinions on the suitability of interlocking blocks for housing were investigated since the material is relatively new in Nigeria. Respondents' responses expressed in Table 2 shows that the material is suitable for construction.

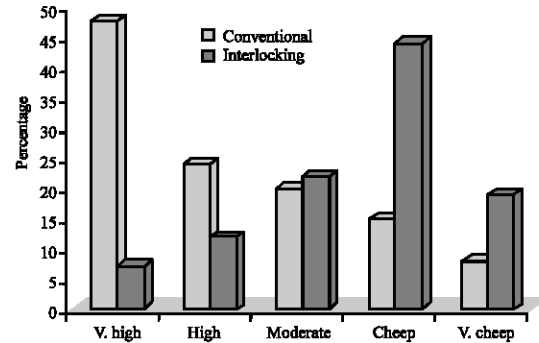


Fig. 4: Materials price rating between conventional and interlocking blocks

Table 2: Suitability of Interlocking Blocks as a current Building Material

S/n	Suitability of interlocking blocks	Frequency	Percentage
1	Not suitable at all	2	1.7
2	Rarely suitable	12	10.0
3	Moderate suitable	20	16.7
4	Suitable	53	44.2
5	Very suitable	33	27.5
Total		120	100.0

Source: Field survey (2007), obtained from the four selected cities

The high suitability level shown in Table 2 could be traced to the quality of the materials (Stabilised laterite) used for solid interlocking block. Stabilised laterite soil have been tested to be bullet proof, of thermal and fire resistant, of very good appearance, can be handled easily by unskilled labour and environmentally friendly. Besides, the aesthetic ratings of the material is also very high as shown in Fig. 5.

### Acceptability of Interlocking blocks as a current building material:

Similarly, respondents' common opinions favours interlocking blocks as an acceptable and current building material for construction of houses as reflected in Fig. 6. The analysis shows that 21.7 and 38.3% favours that it is very acceptable and acceptable, respectively, 16.7% of the respondents responded that it is moderately acceptable while only 20.8 and 2.5% indicated that the material is rarely acceptable and not acceptable at all, respectively for construction. This high pattern of acceptability of the proposed material by building professionals is based on its cost-effectiveness, adaptability to tropical climate, accessibility and suitability.

The acceptability of interlocking blocks for building projects can be further strengthened by the increasing usage of the material both in private and public building projects. Owing to the high level of suitability and acceptability of interlocking blocks for construction; it can expediently replace the conventional blocks in housing delivery. The level of acceptability is bound to

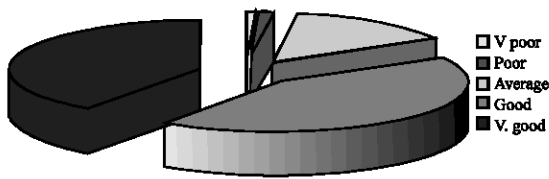


Fig. 5: Aesthetic rating of housing projects with interlocking block

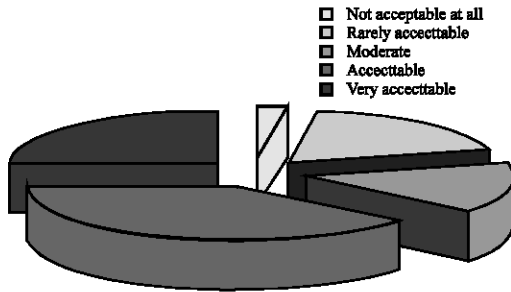


Fig. 6: Aesthetic rating interlocking block (%). Source: Field survey (2007), obtained from the 4 selected cities

increase in Nigeria as the society enjoys more benefits of the material over the conventional types.

Solid-interlocking and hollow-interlocking block systems were developed as part of the efforts towards improving productivity of conventional and interlocking masonry (Anand and Ramamurthy, 2000). It was observed that with a crew of one person, the productivity was  $4.1 \text{ m h}^{-1}$  (Whelan, 1985).

Of recent, interlocking blocks have gained popularity based on the reduction of time, labour and cost saving results observed. With thin-jointed and mortar-bedded cases, the construction speed was observed higher than conventional masonry due to elimination of vertical joints and easier alignment facilitated by the interlocking feature. Compared to conventional masonry, interlocking-block masonry has less indirect-contributory operation by about 30-50%.

The observed higher non-contributory work for interlocking blocks was due to higher idle time attributed to a less indirect contributory work components, which can be rectified by reducing the crew size (like one mason and one helper), thus reducing the idle time and increasing the contributory work components.

#### Respondents' willingness to use interlocking blocks:

The tendency towards the preference for the use of both interlocking-blocks masonry is further studied when testing the opinions of respondents about the willingness to use these materials in Fig. 7. Most of the respondents showed preference for interlocking blocks (83.4%)

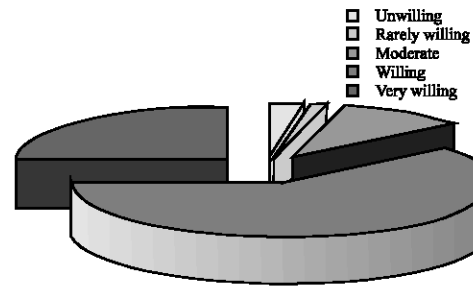


Fig. 7: Willingness to use interlocking block (%). Source: Field survey (2007), obtained from the 4 selected cities

because it is faster in construction of walls, time-saving, uses reduced labour and it is cost-efficient. The degree of preference for the use of the material will increase as more innovations and confident level of users increases. Hence, the material is strongly recommended for use as an alternative to conventional building blocks.

#### CONCLUSION

- It was observed that professionals in the building industry showed high preference for the use of interlocking masonry as compared with the conventional types. This is based on shorter period of setting, higher strength, reduced number of labour involved in its operation and overall reduction in cost of masonry works (65% lesser).
- The level of suitability of interlocking block as an innovative and alternative material to the conventional blocks used for construction is very high i.e. 71.7% as observed in Table 2. Although, the material is not common in the market due to its relative newness, Fig. 6 revealed that it has an acceptable level of 60%. The high acceptability level of interlocking blocks will aid good patronage by both professionals and clients as a better replacement for the sandcrete blocks. Its popularity will continue grow as it becomes available in the market and more houses are built with it.
- The acceptability indices of interlocking-block masonry is also based on the fact that interlocking masonry has much higher output per productive hour, aesthetically pleasing, cost-efficient and environment friendly as compared with conventional-brick/hollow-block masonry.

Although, the study revealed unparalleled advantages of interlocking-block masonry in terms of shorter period of operation, lesser gang of labour and

reduced cost of construction, its usage in construction of houses is very low. This is partly due to low level of awareness on the part of professionals and the public and its non-availability in the market. In view of this, Government agencies and stakeholders in the building industry should accept the use of the material as proposed in this research, to give a wide publicity to them and make the proposed building materials available in the market for users. Interlocking-block masonry should be used in public housing projects to demonstrate government's sincerity and to create awareness within the Nigerian populace.

Accelerated dry masonry system through interlocking masonry is recommended for housing projects as an alternative method that is cheaper than the conventional wet type. It is also faster in operation with a potential of saving over 65% of time and cost of the masonry work. It reduces wastage of materials and gangs of labour required for operation. Interlocking blocks can be produced with the same materials as used in the production of conventional blocks.

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