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Eccentric Problems of Hydraform Building System for Low Cost Mass Housing Construction: Evidence from Some Sites in Northern Nigeria

Baba Shehu Waziri[*1], Bukar Kadai[1], Hassan Sani Biu[2]
[1]Department of Civil and Water Resources Engineering, University of Maiduguri, Nigeria
[2]Department of Civil Engineering, Ramat Polytechnic Maiduguri
*Email of corresponding author shehuwaziri@gmail.com

Abstract

Hydraform building system is gaining recognition and is increasingly used in most developing countries like Nigeria for the provision of low cost housing due to its numerous benefits including environmental friendliness, better thermal insulation, aesthetic value, faster construction and cost efficiency. These benefits embolden the use of hydraform blocks in the provision of mass housing especially in the Northern part of Nigeria to deal with cost and the issues of weather. The study explores through field observation and questionnaire survey the problems associated with the use of Hydraform interlocking blocks for the construction of low cost housing in some selected sites in Borno and Yobe States in Northern Nigeria. The study revealed that the fundamental problems are poor quality of blocks produced on sites, delay in the production process when large volume of work is involved, high rates charged on laying hydraform blocks as compared to conventional sancete blocks and indiscriminate use of unskilled personnel for construction. The study recommends that before embarking on mass housing projects personnel involved on such schemes should be trained and total quality management practice should be adopted to ensure improved performance.
Keywords: Hydraform building system, stabilized blocks, low cost housing, Nigeria.

1.0 Introduction

Adequate housing of the world's population requires sustained investment and continued innovation particularly in appropriate technologies that lower the cost of construction and cost to the environment (UN-HABITAT, 2009). Due to limited means within developing countries, it is necessary to seek ways to reduce construction costs, especially for low-income housing, as well as adopting easy and effective solutions for their repair and maintenance. Such objectives according to Adam and Agib (2001) can be achieved partially through the production and use of cheap yet durable locally available building materials. The initiative to produce bricks and blocks using natural soil to lower the cost of construction is one activity geared toward sustainable low cost housing construction.

Recent studies revealed that it is more economical to build with interlocking soil stabilised blocks such as hydraform than conventional sancrete blocks (Gate, 1995; Oyediran and Alabi, 2005; Adedeji, 2012; Adedeji and Fasakin, 2012 and Olukanyin, 2012). Olukanyin (2012) further observed that the search for more rapid and less workmanship dependent building procedures which could eventually reduce the cost of construction without mitigating the functional requirements has led to the development of dry stackable block masonry units which can be laid without mortar. This type of masonry construction accelerates the rate of construction by eliminating the bedding mortar and makes masonry construction efficient and versatile (Anand and Ramamurthy, 1999).

The use of interlocking blocks as a walling material is gaining recognition and acceptance in most part of the world as a result of their cost effectiveness, aesthetics and environment friendliness as compared with conventional hollow block masonry. The study of Adedeji and Fasakin (2008) revealed that acceptability and popularity of interlocking blocks has increased in recent time due to its reduction in time of construction, labour and cost saving results with less indirect-contributory operation by about 30-50% compared to conventional masonry. Adedeji and Fasakin (2008) further stated that the preference of the use of interlocking blocks is due to its shorter period of setting, higher strength and reduced number of labour involved in its operation and overall reduction in cost of masonry works of about 65%. On the overall it has an acceptance level of 60% which indicates good patronage by both professionals and promoters of building as a better replacement of the conventional sancrete blocks (Adedeji and Fasakin 2008).

2.0 Concept of Interlocking Blocks

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. The concept of these stackable interlocking blocks differs from conventional blocks and bricks because the units are assembled in a geometrical way without the use of mortar (Anand and Ramamurthy, 2000). Interlocking blocks have complex shapes which appear to have been deliberate in design which demands for the need to study the development of blocks with simple geometry. These complexities in block geometry (tongue and grove or undercut and dovetail arrangement) necessitate mechanized production methods and the presence

of continuity of horizontal and vertical joints from inner to outer face. The most popular interlocking block used for masonry construction in most developing countries in recent time is the Hydraform blocks. Hydraform blocks have male and female profile on the face that work as lock and key in four of the six sides of the block which eliminates the use of mortar and makes them self aligning (Hydraform, 2005). Hydraform also fulfil the requirements of Industrialized Building System (IBS) (Ahmad *et al.,* 2011) and have been used even for load bearing masonry structures in many parts of the world (Venkatarama *et al.,* 2005). The concept of interlocking block is based on the following principles:

i. The blocks are shaped with projecting parts which fit exactly into depressions in the blocks placed above such that they are automatically aligned horizontally and vertically, thus laying of block is possible without special masonry skills.
ii. Blocks can be laid dry, no mortar is required and a considerable amount of cement can be saved.

3.0 The Hydraform Building System

The hydraform building system replaces the conventional bricks and mortar by using hydraform blocks with the other components of the conventional system remaining largely unchanged. Hydraform system is essentially a dry stacked masonry system that enables speedier construction of high quality aesthetic and affordable buildings (Hydraform, 2012). The hydraform building system has been in use for over a decade and is the choice of many construction firms, government agencies, NGOs and international agencies worldwide (Hydraform, 2012). The system has been tested extensively for parameters of strength and durability in recognised engineering institutes of South Africa and India. Hydraform bricks are manufactured by hydraulically compressing a soil-cement mixture in a block-making machine (Fig. 1). Hydraform bricks can be manufactured on site and dry-stacked, reducing the embodied transport and curing energy significantly to around 0.635 MJ/kg. The product contains a small percentage of cement which largely accounts for its embodied energy component.

The Hydraform Building system comprises of three primary aspects namely; the hydraform Block, the hydraform machine and the advantage of interlocked stacking offered by the hydraform blocks. Hydraform blocks are three times as efficient as concrete and almost twice as efficient as fired clay bricks in terms of thermal insulation. Hydraform bricks offer attractive face brick finish in a variety of natural colours determined from the soil found at individual.

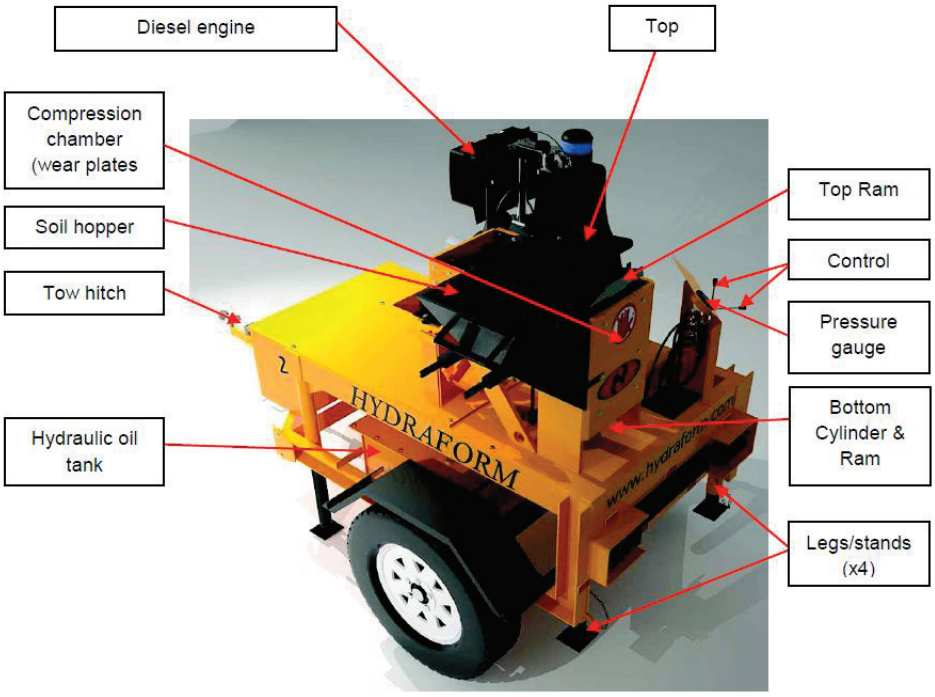

Fig 1. Interlocking Block Production Machine (Hydraform, 2013)

The numerous advantages of hydraform building system are:

i. The materials required for block production and building construction are usually locally available in most regions.
ii. The materials used for the production of blocks are good to most weather conditions.
iii. The materials are recyclable.
iv. The dry assembly of interlocking blocks saves construction time and large amount of mortar which would otherwise be required for horizontal and vertical joints.

v. There is minimal requirement for high wage skilled masons by saving cement and with the speed of construction.
vi. It is maintenance free.
vii. They can be produced on a small scale on the building site for (self-help construction) or on a large scale in centralized production units.
viii. The hydraform building system is suitable for the construction of multi storey buildings in the same way for a standard masonry construction.
ix. It is cost effective and durable which reduces lifecycle cost.
x. It can be produced using both manual and mechanical brick laying machine.

For the system to be effectively used, the following requirements were enumerated by Gate (1995);

i. The technology being relatively new, people may be reluctant to apply it. Hence a well coordinated dissemination strategy to introduce it to potential builders is vital.
ii. 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 (Gate, 1995).
iii. In the production of the blocks, it is essential to determine the correct type of soil, mix proportion, moisture content and size of the blocks for producing uniform sizes.
iv. Even with the greatest care in assembling the walls, the joints are not entirely resistant to wind and rain penetration, therefore plastering the interior surface is usually necessary.

Fig. 2. Hydraform Building under Construction

In spite of the numerous benefits of the hydraform building system in realizing low cost housing, clients and contractors are faced with quite a number of drawbacks making it very difficult to take advantages of the established benefits of the system. The study therefore seeks to investigate through empirical means the significance and the level of these drawbacks.

4.0 Research Methods

The data for analysis were obtained from some selected hydraform building sites in Borno and Yobe States through field observations and oral interviews of professionals to establish problems relating to the use of hydraform building system on such construction sites. Questionnaire survey was also used to corroborate the results obtained through the field observation and interviews. Forty (40) questionnaires were administered to professionals (engineers, builders, architects and quantity surveyors) out of which thirty three (33) were successfully retrieved and analysed representing a success rate of 82.5% which is considered adequate for the study. The respondents were asked to score the factors militating against the successful delivery of housing using the hydraform system based on their severity on a 4 point likert-type scale in which 4 indicates extreme importance and 1 indicating least importance. Simple descriptive statistics and importance indices were employed to analyse the data with the aim of establishing the relative importance of the various factors. The Relative Importance Index (RII) is given by equation (1)

$$RII = \left(\sum_{i=1}^{4} a_i x_i \Big/ 4 \sum_{i=1}^{4} x_i \right) \qquad (1)$$

Where a_i = constant expressing the weight given to i; x_i = variable expressing the frequency of the response for i = 1,2,3,4 and illustrated as follows:
x_1 = frequency of the "slightly important" and corresponding to $a_1=1$; x_2 = frequency of "somewhat important" response and corresponding to $a_2=2$; x_3 = frequency of "averagely important" response and corresponding to $a_3 = 3$; x_4 = frequency of "very important" response and corresponding to $a_4=4$;

5.0 Results and Discussion

5.1 Profile of Respondents

The profile of the respondents for the questionnaire survey revealed that out of the 33 respondents 39.39% (13) are engineers, 27.27% (9) are builders 21.21% (7) are architects and 12.12% (4) quantity surveyors. The result also indicated that majority of the respondents (58.4%) have between 10-15 years of construction experience and more than half (54.6%) have either National Diploma or fist degree as their highest qualification. Therefore the information provided by the respondents can be considered as reliable.

5.2 Problems of Building with Hydraform Blocks

The preference of the hydraform masonry over the conventional system may be attributed to its advantages over the conventional masonry including energy efficiency, environmental friendliness and cost effectiveness among others. The result of the field observation and oral interviews revealed that the use of the hydraform system is usually accompanied by some conundrums related to those bedevilling the production and the construction processes. The survey identified the following problems:

i. Delays in the production of bricks for construction when large volume of work is involve which invariably extends construction schedule.
ii. Absence of quality control on site which often leads to the production of poor quality blocks.
iii. Lack of qualified and trained personnel handling block production on site
iv. Complete absence or few trained masons for interlocking block construction.
v. High cost charged on laying hydraform blocks as compared with conventional blocks.
vi. Slow rate of construction due to unnecessary time spent on cutting blocks into desired sizes, e.t.c.

5.3 Relative importance of identified problems

The result of the relative importance of the factors militating against the successful delivery of hydraform building is presented in Table 1.

Table 1 Relative importance of problems of hydraform building system

S/No	Factor	RII	Rank
1	Delays in the production process when large volume of work is involve which extends construction schedule.	0.824	2
2	Absence of quality control on site which often leads to the production of poor quality blocks.	0.834	1
3.	Lack of skilled machine operators	0.532	7
4.	Lack of qualified and trained personnel handling block production	0.736	3
5.	Complete absence or few trained masons for interlocking block construction due to large volume of work involved.	0.534	6
6.	High cost charged on laying blocks compared with conventional blocks.	0.667	4
7.	Slow rate of construction as compared to conventional system.	0.632	5

5.3.1 Delay in the production process

Delays in the production of the hydraform blocks on sites where large volume of work is involved is a prominent setback and may be attributed to the combination of many factors. The production process is usually faced with a lot of challenges ranging from machine breakdown to time spent on curing the blocks before usage. The process involves preparation of soil, the mixing process, determining the correct moisture content, moulding of blocks and stacking them for curing. Each of these stage has a significant influence on the strength and cost of the blocks (Adedeji, 2012). The investigation revealed that during construction masons are obliged to wait for blocks to be produced and cured which invariably extents construction schedule. From the results of the importance index, this problem is ranked second with a RII of 0.842.

5.3.2 Absence of Quality Control on Site

Lack of quality control is another problem gnawing the successful realisation of desired results using the hydraform building system. The production of blocks under normal circumstance is accompanied by strength evaluation and testing to ascertain quality and standard requirements (Adedeji and Fasakin, 2012). The lack of quality control has often led to the production of poor quality blocks which could not even withstand the rigours of transportation from the production unit to the point of construction on the same site. Moreover huge amount of blocks are wasted in the process which could well be avoided with adequate quality control. The problem is ranked first with a RII of 0.8434

5.3.3 Lack of skilled personnel handling production

The production process also requires the hands of trained personnel for determining correct soil type, moisture content and mix proportion to deliver quality blocks. The study revealed that the production units of the sites more often than not are being handled by untrained and /or unskilled personnel which results in the production of poor quality blocks. This factor is ranked third with RII of 0.736

5.3.4 Lack of trained machine operators

The Nigerian Building and Road Research Institute (NBRRI) developed an interlocking block making machine similar to the one developed by hydraform Ltd for the production of solid interlocking blocks (SIB) type of geometry 225×225×112mm. The frequent breakdown and repair of such machines for the production of blocks is also a major problem. The hydraform machine comes complete with highly value-oriented-knowhow, training and host of services (hydraform, 2013). The machine which is robust instrument powered by a diesel engine requires a trained person for optimum operation. According to Hydraform (2013) it is important that only one person (the trained operator) is in charge and is responsible for the machine and block production. The operating period of machines on sites is usually longer which consequently over works the machines leading to frequent breakdowns. The factor is ranked with seventh with RII of 0.532.

5.3.5 Few trained mason handling Construction

Even though the hydraform building system does not require high skilled masons for wall construction, a reasonable level of training is required for the masons to be able to effectively handle the construction work. The study revealed that the few trained masons on such sites do not usually contain the large volume of work at sites leading to the engagement of untrained masons resulting to slow rate of construction, poor alignment of walls and ultimately poor construction work. The problem is ranked sixth with RII of 0.534.

5.3.6 High cost of Laying Blocks

Prohibitive construction cost has been one major barrier to the realisation of housing efforts by different governments. Under normal circumstance building with interlocking is cheaper than conventional building systems because of component materials, elimination of bedding mortar e.t.c. Comparative cost of laying interlocking blocks with the conventional sancrete blocks indicated that the charges on laying conventional block is usually cheaper at most sites because the cost of laying a unit of sancrete block of dimension 225×225×450 is lower than what is charged for laying 4 units of hydraform blocks of dimension 225×112×225 which make up a unit of conventional sancrete block. From the investigation, the cost of laying 4 units of interlocking blocks is 36.6% higher than the cost of laying a unit of conventional sancrete block. This problem is ranked fourth with RII 0.667.

5.3.7 Slow rate of construction

The ability to construct quickly has been considered as one prime factor for the selection of building materials (Gonzales and Navarro, 2006). Ideally the hydraform building system is faster in operation in comparison to the conventional systems with a potential of saving over 60% of time and cost of masonry work (Adedeji and Fasakin, 2008). The study revealed that due to the varying problems associated with the use of hydraform construction speed is slower as compared with the conventional blocks. This dawdled construction could be attributed to the smaller dimensions of the block compared to the conventional blocks, cutting of blocks to achieve smaller sizes which are not usually produced, insufficient number of trained mason, poor planning among others. The problem is ranked fifth with RII of 0.632.

6.0 CONCLUSION

The use of alternative sustainable materials for building construction is increasingly gaining popularity and acceptance as a result of their tremendous value and plentiful advantages over some of their conventional counterparts. The study explored some peculiar drawbacks associated with the use of hydraform building system as a masonry material in the construction of mass housing in northern Nigeria. The study established seven

prominent issues militating against the successful delivery of housing projects using the hydraform building system including. These problems are those related to production (delays in the production process, absence of quality control, lack of skilled machine operators, lack of trained personnel handling production) and those related to the construction (absence of trained masons for wall construction, high cost of block construction and slow rate of construction).

The study recommends adequate training of personnel before embarking on housing schemes and total quality management practice on sites which are very significant in ensuring successful project delivery. The problems identified are peculiar to the sites investigated which demonstrates the need to expand the scope of the study by capturing problems of as many sites as possible to establish a more universal result.

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