

Acceptability of Corbel Construction for Housing Development in Ogbomoso, Southwest, Nigeria

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Abstract: This study assesses the knowledge and attitude of people on the use of corbel arch for lintel construction to reduce concreting in housing construction. Ogbomoso was the case study and Ikose community was purposively selected being a fringe area receiving an influx of people from the city. Google earth and ground-truthing were used in capturing one hundred and eighty-nine inhabited houses and questionnaire was the instrument for data collection and was administered to collect information on the socio-economic background of respondents, knowledge of material and willingness to utilise. Descriptive statistics were employed in the presentation of findings; chi-square was used to test the relationship between characteristics of residents and willingness to adopt the material. Analysis showed that 32.5% were 51-60 years; 60.4% were male; while 62.1% of the respondents were married. Also, 38.2% had modern/secondary/technical/teacher's grade II certificate, while 38.1% were traders. Only 12.1% of respondents knew the material, 68.5% were willing to utilise based on availability within the environment and ability to mitigate the effect of climate change, while 57.1% will recommend its usage. Gender, educational background, income and access to information are significantly related to willingness to utilise the material ($P = 0.000$). Suggestions were made towards factoring the material into housing policies in Nigeria.

Keywords: Knowledge and Attitude of People, Corbel arch, Lintel construction, Reducing concrete, housing development.

I. Introduction

Literature is replete with discussions on issues pertaining to housing in Nigeria [1-10]. [11] succinctly states that adequate housing must be affordable, more than having a roof over one's head, provide adequate privacy, adequate space, physical accessibility, adequate security, adequate lighting, heating, and ventilation as well as adequate infrastructure such as electricity and water supply and yet, housing problems continue unabated. There is no gainsaying that housing is symbolic in nature and that the value attached to it cannot be easily measured. Socially, housing is central to all human activities. In it, man lives, grows,

procreates and declines [12]. Also, human behaviour depends on symbols, and housing is one of the most important aspects of human activities. The multifaceted importance of housing encapsulates life's basic necessities: shelter, physical, mental, health, economic and social wellbeing [13]. In furtherance to this, housing provides avenues for security, privacy, neighbourhood and social relations, status, community facilities and services, access to jobs, and control over the environment [5]. It can therefore be concluded that housing is a very important requirement for good health and in fact, one of the greatly cherished material properties in the traditional African setting which provides dignity [14].

Globally, it is alarming to note that in the urban areas, about 1.1 billion people live in inadequate housing conditions, while about 100 million people are homeless globally [15]. In developing countries, 600 million urban dwellers live in overcrowded and poor quality

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houses [16]. This precarious condition is exacerbated by the high rate of urbanisation being experienced and has invariably led to urban poverty and housing poverty [15]. Adequate housing has become a mirage and unaffordable to the people, especially in the developing world. The reason is traceable to the high cost of conventional building materials, recession and unemployment [3,8,10,17, 18,19,20]. In Nigeria, the government embarked on various housing development paradigms and shelter delivery systems which have not solved the problem. This is because the focus has always been on conventional building materials which will always lead to a high cost of housing and make housing unaffordable to the people. Thus, there is the need to look into another alternative, one of which is the corbel construction. It is against this background that the paper assesses the Knowledge and Attitude of People (KAP) on the use of corbel arch for lintel as a means of reducing concreting in housing development in Nigeria. In the end, the paper proffers a solution towards utilisation of the material.

Housing the teeming population and the required services became a formidable task for successive governments and the supply of adequate and affordable housing has not kept pace with increasing need. Rapid urbanisation in Nigeria has increased the need for urban housing [21]. The adequate supply of housing has remained a mirage in Nigeria despite its significance. The situation is worsened as the population continues to grow at an exponential rate. Rapid urbanisation is the order of the day and there is a difference between housing need and housing supply which is high [1,22].

Thus, it has been asserted that housing problems in Nigeria are more precarious in the urban centres, where a high proportion of the houses are qualitatively deficient, lacking in essential amenities, crowded, dirty and in need

of major repair [1,3,4,8,23]. Various researchers have seen housing in urban Nigeria as qualitatively and quantitatively substandard with a significant proportion of the dwellers living in unsecured and unhealthy conditions. Rapid deterioration of urban housing and living conditions are often, the most visible and obvious consequences of urbanisation in developing countries [8, 15]. This is traceable to the fact that, urbanisation leads to an explosive population growth, occasioned by phenomenal leap in the quantitative housing needs of the populace. These housing needs are not matched by effective demand, since majority of the populace do not have the wherewithal for adequate housing.

Housing should be seen as highly significant in the socioeconomic and physical development of any country. Lack of access to housing leads to the suffering of people, especially the poor ones and the reason is due to un-affordability. There is no doubt that the colonisation of the country has subjected it to neo-colonisation. Nigeria has been opened up towards the importation of different types of expensive building materials and construction technologies that are capital intensive. Thus, efforts should be directed towards evolving local building materials that are cheap and easy to develop for sustainable housing construction in Nigeria

The need for spanning over wall openings came about with the utilisation of masonry for construction [24]. Masonry construction is the use of stone or brick in the construction of buildings [25]. This method of construction has been in practice since ancient times and was favoured because of the masonry elements, that is cut-stone or rubble, cohere through sheer gravity or the use of cementitious mortar. The two main methods of spanning that had been used originally were the post-and-lintel construction and the arch construction [26]

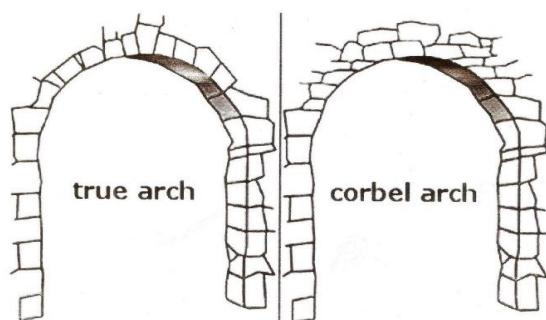


Figure 1: True arch and corbel arch

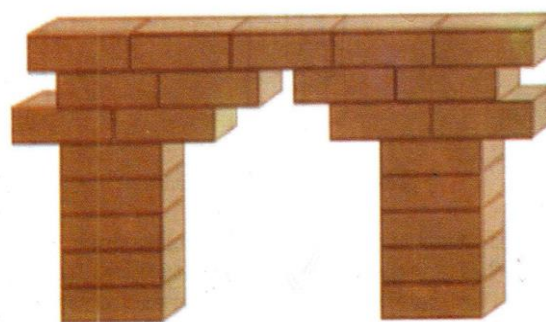


Figure 2: Corbel arch using brick

Source: Golesh (2014)



Figure 3: Map of Ogbomoso

The arch construction allowed for spanning wide distances because vaulting permits spanning without subjecting the spanning element to bending stresses. Among improvements to the spanning elements are the corbel or masonry arch or the true arch. The true arch is formed with a continuous line of wedge-shaped stones, while a corbel arch is formed by a series of overlapping stones in which each stone juts out further than the one below. The corbel arch can be traced back to 1500 B.C when corbelled brick arches were used in the middle-east to support the walls above doorways as shown in Figure 1.

An actual application of corbelled arch using stone can be seen at the tomb of Nasirud din Mahmud, Ghorī in New Delhi. The corbelled arch has also been used by the Sumerians to take an aqueduct across a 20-metre wide valley and it can be used for door and window openings, bridges and for regulating masonry work for sub-structural works such as manhole construction. The process of corbel arch involves the neat stacking of blocks or bricks such that a bit of the block above extends over the preceding block beneath it. An advantage of corbelling over the conventional lintel and post-construction in buildings is its cost-effectiveness. The components and construction processes of the lintel include cement, fine and coarse aggregate, water, reinforcement rods and shuttering for placement of the concrete. These materials have cost units attached to them, while corbelling does not require any material besides the brick or binding mortar as the case may be.

II. Materials and Methods

A. The Study Area

Ogbomoso is the study area and one of the newly urbanised communities in Ogbomoso North was used as shown in Figure 3. Ogbomoso is a pre-colonial urban centre and the second-largest city, both in terms of

population and spatial extent in Oyo State, Nigeria [27,28]. The city is located approximately 100 KM north of Ibadan, the Oyo State capital and roughly 80 KM from both Ilorin and Osogbo respectively, the Kwara and Osun state capitals.

Ogbomoso is approximately $8^{\circ} 7'$ north of the equator and $4^{\circ} 15'$ east of the Greenwich meridian. It lies in the transitional zone forest of Ibadan geographical region and the northern savannah region. As a result of this, it is regarded to be derived savannah vegetation. The mean annual temperature is about 26.20 degrees centigrade and the lowest temperature is experienced in August with a mean temperature of 24.30°C

The highest temperature is in March with a mean temperature of 28.70°C . The mean annual rainfall is about 120mm. Rainfall peak occurs twice a year between April and October and the city is affected by both the northeast trade wind and the southwest trade wind. The northeast trade wind blows between November and February bringing cold, dry and harsh weather conditions. The southwest trade wind which blows over the Atlantic Ocean between March and October brings copious rainfall/moisture.

The larger part of the plateau in Ogbomoso is about 300-600 metres above sea level. The relief is moderate with low-forested hills and at times, steep-sided ridges arise abruptly from the surrounding. The rivers in the town include Alalubosa, Adunhin, Ogunbado, Kuye and Laka. There is also the Oba river which flows southward and runs 5 KM west of Ogbomoso. The city comprises five local government areas which are Ogbomoso North and Ogbomoso South.

B. Research Methods

The urban fringe of Ogbomoso was used for the study because it is rapidly developing and

becoming part of the urban centre and hence, the study adopts a multistage sampling technique. The pattern of urbanisation developed by [27] was adopted and according to them, urbanisation takes place in four local government areas out of the five local government areas that make up the city. These are Ogbomoso North, Ogbomoso South, Surulere and Oriire local government Areas. Thus, the first stage involved the selection of a local government area to be used for the study in which Ogbomoso North was purposively selected because Ladoke Akintola University of Technology is domiciled in it and the local government, therefore, has a large concentration of both staff and students of the school.

The next stage involves the selection of the community that was used for the study. Ikose community was purposively selected as it has a high rate of housing development (Table 1). Google earth and Ground-truthing were used in capturing one hundred and eighty-nine inhabited houses. The instrument used for data collection was the questionnaire which was administered to the household head or his representative and was harvested on the spot.

Table 1: Urbanisation of Ogbomoso

S/ N	Local Governme nt Area (LGA)	Settlements/Communities/ Local areas
1.	Ogbomoso North	Oke Adunhin, Ile Ewe, Igbo sai, Oke Paku, Ikose, Eyeba
2.	Ogbomoso south	Ayedade, Sunsun, Saanu Aje, Safejo, Arinkinkin, Owolaake
3.	Surulere	Ladokun, Aroje, Abaa
4.	Oriire	Iluju

Source: [26]

Most of the questions took close-ended form, while some were open-ended. The questionnaire was divided into two sections; Section A was on background information, while Section B sought information on the knowledge and attitude or willingness of

people to utilise the material for housing construction. The statistical method used in analysing the results includes descriptive statistics such as frequency counts, percentages and chi-square. Chi-square was used to test the relationship between variables of respondents (such as level of education, age, marital status, income and access to information) and willingness to adopt the material. However, out of 189 questionnaires sent out, a total of 187 were duly filled and returned which shows 98.9% response and which was valid for the assessment of the situation under study

III. Results and Discussion

A. Socioeconomic Background of Respondents

Analysis shows that 32.5% of the respondents were between 51 and 60 years of age. This was followed by: those that were 41 – 50 years (27.9%) and 31 – 40 years (19.6%). Respondents that were 61 years and above constitute 14.3%, while 21- 30 years was 5.7%. This implies that the modal age is 51 – 60 years. Therefore, majority (74.7%) of the respondents are adults and should know the implication of the cost of construction of a building in terms of concrete utilisation. Three-fifths (60.4%) of the house owners were male, while 39.6% were female. This is because men are usually the head of the family in any Nigerian community. Married respondents constitute the bulk of the respondents (62.1%), followed by the widow/widower (23.4%). Separated constitutes 10.1%, followed by the divorced (2.9%) and single (1.5%). The result confirms the submission of [8,26,29,30,31] that, the bulk of a set of the population is married.

More than three-quarters (74.3%) of the respondents were male-headed households, while 25.7% were female-headed households. The fact that most household heads are male is typical of most Nigerian communities, where most households have been found to be male-

headed households [26]. The educational background of respondents reveals that most (38.2%) of the respondents had modern/secondary/technical/teacher's grade II certificate. This was followed by respondents who have certificates above O' level (47.6%). House owners with primary education were 12.3%, while people with no formal education constitute 1.9%. The implication, therefore, is that majority of the inhabitants of the area are low-income workers as evident in their educational background.

Expectedly, trading (38.1%) was the most prominent job in the area, followed by civil service (19.0%). Farmers rank next with 18.4% and was followed by Private sector workers (11.8%). Artisans constitute 8.5% with unemployed being 2.2%, while retirees were 2.0%. Most (27.3%) of the respondents earned between ₦21, 000 and ₦40, 000. This was followed by those who earned ₦81,000 - ₦100,000 (22.9%) and ₦61,000 - ₦80,000 (19.2%). Only 12.7% of the respondents earned ₦100,000 and above, ₦41, 000 - ₦60, 000 was 16.3%, while 0.6% of the respondents collect below ₦20, 000 per month.

B. Knowledge and Attitude of People

A total of 12.1% respondents had knowledge of the material, while 87.9% were not aware of the material and its existence. This implies that the bulk of the respondents sampled do not have knowledge of the material probably because the two materials that are in vogue these days are conventional building materials such as concrete and steel which people are conversant with. Observation also shows that none of the houses in the study area was constructed using corbel arch which implies that there is a lack of awareness of the material. The implication of this is that people are not aware of any other building material, except conventional building materials that are in vogue these days.

Analysis shows that 68.5% of respondents are ready to utilise the material for housing construction, while 31.5% will not use the material. This implies that the bulk of the respondents sampled are ready to use corbel arch to replace conventional lintel in houses and the reasons adduced to this include ability of corbel arch to reduce concreting in residential construction; which therefore reduces the rate of cement consumption and consequently reduce carbon emissions into the environment. It is also environmentally friendly in terms of being able to mitigate the effect of climate change. The reason for the non-willingness of the material for house construction is because the material is yet to be fully accepted and adopted. Acceptability measures the ease at which Nigerians accept houses constructed with a building material irrespective of status. The psychological feeling is that a building constructed with the material is a “poor man’s building” whereas, in Brazil, cities wear a red look because of the predominance of brick used in construction. Only 57.1% will recommend the material, while 42.9% are not ready to recommend to people to use it. The import is that though, the bulk of the respondents are not aware of the material, it is gaining ground as more than half of them are willing to utilise it.

When the relationship between Respondents’ characteristics and attitude to utilise corbel arch was subjected to chi-square test as shown in Table 2, the result shows that gender, educational background, access to information and income are all significantly related to the willingness of people to use the material for construction; whereas, marital status and employment status do not have any bearing on the attitude of people to use the material for house construction. This implies that the determinant factors for the utilisation of corbel arch for housing construction in the area are

gender, educational background, access to information and income.

Table 2: Chi-square Test of Relationship between Respondents’ Characteristics and Attitude to Utilise Corbel Arch

S/ N	Variables	X ² calculate d	X ² Tabl e	d ^o f	Remar k
1.	Gender	5.97	5.01	1	S*
2.	Educational background	6.33	4.78	4	S*
3.	Marital status	4.19	7.62	4	NS*
4.	Access to Informatio n	4.51	3.88	1	S*
5.	Income	3.60	3.02	5	S*
6.	Employme nt status	5.07	6.98	6	NS*

Note: S*- Significant at $P \leq 0.05$

NS – Not Significant at ≤ 0.05 dof- Degree of Freedom

Source: Authors Field Survey (2020)

IV. Conclusion

It has been observed that the use of corbel arch for lintel construction in housing has not gained popularity. Thus, there is the need to create awareness in the country pertaining to the cost-effectiveness of the material and integrate it into house construction. People are ready to use the material and there is the need for re-evaluation now that economic considerations have begun to dictate the choice of materials. Thus, in order to increase housing stock and make housing affordable for the poor, it is recommended that the material be integrated into housing policies for its cost-effectiveness.

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