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Mass Housing Through Earth Construction Technology in Nigeria

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Abstract: Government efforts at mass housing have been wrought with failure because most of the approaches have considered local cheap building materials indigenous to the local environment. That was why mast of the development plans on housing have not achieved their target goals. This study focuses on the achievement of mass housing through the local unstabilized laterite blocks. It looks at past government efforts at mass housing, the benefit of earth construction, the constraint in the use of laterite blocks and how it can be surmounted and the machineries to be in place to make laterite an acceptable alternative the expensive sandcrete blocks

Key words: Mass housing, laterite block, development plan, earth construction, building materials

INTRODUCTION

Rao[1] noted that earth has been the most essential of the building materials, since the dawn of man. Ever since mankind first congregated in villages almost 10.000 ago. Unbaked earth has been one of the principal building materials, used in every continent. Over a third of the world's population still lives in earth houses today. In ancient times, unbaked earth was widely used in the Mesopotamia and Egypt. While later on, Romans and, Muslims built in earth in Europe, Africa and the Middle East, as did the people of the Indus Valley, Buddhists Monks and the Chinese Emperors. During the Middle Ages, construction in unbaked earth was practiced not only in Europe, but also in North America by the Indians, in Mexico by the Toltecs and the Aztecs and in the Andes by the Machica. The Spanish conquerors of America took with them the European techniques of earth construction and grafted them onto the traditions already established there. In Africa this art was mastered in the cultures as diverse as those of Berbers, the Dogons, the Ashanti, the Bamilikes or the Haoussas, in the kingdom of Ife and Dahomey and in the empires of Ghana and Mali.

Throughout the world, archaeological remains of stunning structures in earth are found. Examples include Ait Benhaddou, Atlas Moutain in Morocco and Hadramaut in Yemen.

It is probably the very ubiquity of earthen buildings, as expressed by Norton[2] that has resulted in the low esteem with which it is held. A cliché of television media reporting proclaims that 'they live in mud huts', the phrase intended to convey poverty, squalor and misery of those in need of aid-including new housing. In much of the world architects engineers and the government or authorities they served have assimilated the message and advocated building in permanent materials, especially unyielding concrete. Like other natural materials such as palm, bamboo or timber, earth building is associated with the disadvantaged and the unprogressive, while concrete, steel frame sheet metal and plate glass are recognized as modern and prestigious even if they are often climatically inappropriate and expensive to produce and use.

The rising cost and limited availability of modern construction materials such as block, cement and concrete make building an expensive proposition. Modern materials in building system were developed because they are strong and longer lasting. The question remains, for whom?

Assessment of past Nigerian government housing policies: Ogunsakin[3] noted that the deplorable urban housing situation has long been a major concern of the Federal and state government. Such responses include the five-yearly economic and development plan periods embanked upon after independent. The first three periods up to 1975 saw varied but very significant attempts by the state in housing provision. Various bodies were formed and certain policies enacted but to little impact. It was the third National Development plan of 1975-1980 that introduced the most comprehensive and active intervention by the government. The plan aimed at specific measures taken were as follows:

- The creation of a specific ministry of housing, urban development and environment.
- The formation of the federal housing authority.
- The establishment of the federal mortgage bank of Nigeria to replace the Nigeria building society.

The government decided to subsidies the housing cost of low-income groups by directly constructing housing units. It also took specific measure to minimize

bottlenecks in the construction industry, such as investment in the domestic production of cement and burnt bricks while also importing other building materials. Housing and urban development issues formed as much as 12% of expected expenditure under the plan period. There was a planned target of 202,000 dwelling units comprising 8,000 units in each of the 19 states and 50,000 in Lagos, the capital. State governments were to launch their own housing programmers each providing 4,000 units with the Federal Housing Authority supplying the infrastructure.

With the establishment of a civilian government in 1979, a new plan on Housing was announced. There was a target of 200,000 dwelling units to be provided annually by both public and private sector effort. The Federal Government itself undertook to build 2,000 dwelling units in each of the 19 states of the country with another 2,000 in the designated new Capital Territory, Abuja. This latest programme was subjected to political abuse and shoddy workmanship in the main. The more serious and somewhat unpardonable error was the repetition of the same house type throughout the whole country in spite of climatic and socio-cultural differences that are bound to prevail. To date over 24 years of the completion of the project, well over 50% are not in use either through lack of basic infrastructure of access roads, water and electricity. Naturally most of such houses have deteriorated or been vandalized. They are sad legacies dotted all over the country.

New approach to mass housing: The desire to own a personal building, Arayela[4], is becoming stronger and stronger in the lives of individuals in the current dispensation. In spite of this desire, cost has been regarded as a major hindrance. Hence, the need for many to consider alterative methods and building materials capable of bringing about reduction in cost. In Nigeria, this is currently being achieved with the use of laterite bricks. Laterite blocks have gained wide acceptability by both the middle and low-income groups in Ile-Ife that it is the toast of anyone who desire to have a roof over his head at the minimal cost. The additional cost input that result from stabilization with cement has not made the stabilized blocks attractive. Most people want to have a roof over their head free from the harassment of landlord. The building will gradually be finished in phases and as their income improved expensive fittings and fixtures will be used. In the way more people have been able to house themselves in affordable and economically descent houses.

Earthen construction: Earth as a building material is available everywhere, existing in many different compositions that can be processed in a myriad of ways. In developing countries, earth construction is economically the most efficient means to house the greatest number of people with the least demand on resources. In developed countries, people are re-discovering the beneficial thermal comfort and healthy aspects of earth walls.

In addition, earth structures are completely recyclable with minimal resource requirements. All over the world, the awareness of the embodied energy of materials and the global impacts of carbon dioxide emissions encourages the use of low-embodied energy materials. It is clear that the use of earth for the built environment will continue to be a strong component in the future of humankind. The most obvious advantage of earth construction is the abundance of the raw material-earth. Other advantages of earthen construction include:

- High thermal insulating properties
- High sound insulation
- Not susceptible to insects or rodents
- No waste generated during construction
- Inert-contains no toxic substances
- Construction is inexpensive and simple
- High workability and flexibility
- Fire resistant

Energy considerations: According to Middendorf (2001) more than 30% of the energy consumed in the United States goes to making and maintaining buildings. This includes both operating energy--the energy required for space heating and cooling, lighting, refrigeration, water heating and other building functions and energy embodied in the physical structure. Earth construction can reduce both categories of energy requirements.

The following are among the more popular types of earthen construction:

- Adobe
- Rammed earth
- Compressed earth blocks

Adobe (laterite block): Adobe is air/sun-dried brick from mud composed of inorganic soil and sand. The soil must have minimum clay content of 10%. Fibers such as straw may also be added to increasing the stability of the block as work well as binders. An adobe brick is typically 250 to 300 mm and weighs between 13 to 22 kg[5]. The bricks are stacked one over the other and bonded using a mud mortar. Additives such as asphalt and flyash help to minimize its susceptibility to moisture while giving it additional strength.

As adobe structures are essentially stacks of mud, they require protection from water, especially rainfall that

can wash the structure away if due precautions are not taken. Some of the steps that can be taken to protect adobe structures are:

- Placing walls on concrete or stone foundations
- Using water inhibiting additives
- Plastering adobe walls with stucco
- Providing substantial overhangs

It is also essential that adobe walls be adequately tied using wood beams at the top and base of the wall. These beams also serve as anchors for the roof trusses. Modern codes require that in areas with high earthquake risk, adobe walls be reinforced with horizontal and vertical steel. New Mexico is an exception to this rule and permits the use of adobe with out reinforcement. Adobe structures have high fire resistance. Adobe is used to build multi-million dollar homes and small hutments. Adobe is slowly but steadily losing its popularity to other technologies but remains a useful solution where an eco-friendly solution is desired.

Rammed earth: Rammed earth involves the compacting of moist soil between rigid forms to create monolithic earth walls with similar properties as that of adobe walls. The soil for rammed earth construction must have about 30% clay and 70% sand and small gravel. Cement is sometimes added as a stabilizer. It is critical to ensure that the moisture content of the wall is just right as if the mixture is too dry then it will lead to a weak and crumbly wall[5]. Too wet a mixture, on the other hand, will result in a mixture that will take long to dry and harden.

Like all earth buildings, rammed earth buildings must also be placed on firm foundations made of concrete or stone. The process of erecting the wall includes raising the form and pouring the earth into the forms and then compacting it either by tampers or pneumatically. The process results in a strong monolithic wall.

Rammed earth structures possess all the qualities and shortcomings of other types of earth construction. They too need surface protection against moisture. The rammed earth walls have a compressive strength of about 1000 psi and are therefore fairly strong. There are several rammed earth structures around the world that have stood the test of time fairly well. The codes are similar to those for adobe structures and the stated of New Mexico, Arizona and California have the most detailed codes for the construction of rammed earth buildings.

Compressed earth blocks: Compressed Earth Blocks (CEBs) are a relatively recent technology and combine the nest characteristics of traditional earthen technology and modern brick making processes. The concept is akin to a miniature rammed earth wall. Earth is poured into moulds and compressed either manually or mechanically. The constituents of the earth mix are the similar to those of adobe: clay, sand and additives or stabilizers such as cement or fly ash. CEBs structures have been found to be a lot stronger and more weather resistant than traditional adobe structures. Several experiments have been carried out to determine the best practices of making the earth mix and the blocks themselves. There are several manually operated and mechanical block-making machines available. The Balram, Cinvaram, TEKram are all examples of manual compressors. Mechanical CEB machines that run of diesel or gasoline engines can churn out up to 1000 units of superior quality per hour[6].

CEBs are better than other earthen construction products as they are more uniform and are therefore easier to work with. Additionally, they help increase the speed of construction, which is otherwise a limiting factor. Also, the use of CEBs ensures a stronger structure that is possesses all the positive characteristics of earthen construction and fewer shortcomings. Codes for CEB technology are similar to those for low strength masonry. New Mexico and California have the most detailed codes thus far and it is possible to construct CEB buildings with the help of these codes in other states as well .

Earthen construction is an eco-friendly and low-cost technology from the past and very relevant to the future. Several expensive homes have been built using these technologies. The emphasis is on low-cost mass housing and earthen construction particularly adobe laterite blocks is an ideal technology to address this global problem.

Constraints: In spite of the well established technology and also of the application areas, Suresh[7], laterite blocks has not really found favour in housing programmes taken up in the country either in the public or in the private sector level. The constraints are mainly due to:

- Acceptabilility of the material in view of bias and stigma attached to the material--otherwise considered to be the material which is and also for use of only the poor man
- The lack of institutional arrangement for market availability of the blocks as normally available for sandcrete blocks through block industries and suppliers.
- The lack of support through codal provisions either in the national codes or through the Public Works Department (PWD) codes.
- The lack of references of material in most of the schedule of rates in the country as an alternative to sandcrete blocks.
- The over-emphasizing use of materials like sandcrete

blocks as of higher strength in comparison to stabilized laterite blocks.
- Tendency to adopt a safer pattern of using established materials.
- Lack of demonstration project that will infuse confidence among the people for using the laterite blocks technology for housing and building.
- Lack of sufficient machinery to be distributed all over the country of proven capabilities and training for entrepreneur and workers for manufacture of stabilized laterite blocks of required quality

Area of support assistance needed: Based on experience, Suresh[7], the following are major areas of support assistance needed to make laterite blocks making technology popular in housing project both at the public sector and private sector levels.

Block making machine: There should be increase access to the block making machines. This should be tied up with the network of Building Centers. Various types of laterite making machine s have also been recently developed. Intra Consolid (India) Ltd has developed a consolid mobile soil brick plant model 'CLU 3000). This is a major development using inorganic chemical stabilizers for block making instead of cement or lime. Bolyn Construction Co Ltd (Nigeria) specializes in the manufacture of laterite making machines.

Training: There should be a crash programme for imparting the training need to the field staff for the appropriate selection and strength required for soil keeping in view the clay content and the nature of the stabilization treatment to be give with sand and stabilizer (concrete or lime) are required etc. For this, the research and development agencies and the technological institution should immediately come forward with solutions to the nature of treatment required for soil available in different parts of the country. More so keeping in view the high clay content or black cotton soil. Possibly, the improvement in strength using lime could also be kept in view.

Codal support: One of the critical bottlenecks in the adoption of laterite and stabilized mud blocks has been the lack of mention in the departmental construction codes and specification of works.

Schedule of rates: The schedule of rates of the PWD should have costing done for manufacture of both stabilized and unstabilized laterite blocks with inputs of cost of soil, cement or lime, labour, etc so that where needed, agencies can proceed with the manufacture of the blocks at site and the prices for the same can be fixed

Public buildings: All efforts should be made to construct public buildings like schools, community halls, primary health centers, banks etc with stabilized and unstabilized laterite blocks as walling materials so that these application would bring in the right level of confidence among the general user so that the technology could be adopted for housing needs of all categories and increased acceptance would be ensured.

Exposure on the subject to student of architecture and engineering: The technical educational system through polytechnics, schools of Architecture and Engineering colleges do not have the subject of stabilized and unstabilized laterte blocks a viable, strong, durable material for the construction of building. There are lots of doubts about the performance from structural and functional aspects of laterite block technology. This myth has to be exploded. The use of laterite in housing should be included in the curriculum of the courses. If possible training should be imparted to architectural and engineering students on laterite-based technologies.

Public awareness: The audio-visual media of the Nigerian Television Authority and the Press in both vernacular and national language should give positive coverage on usage of laterite in housing and building construction. This would alley the fears and misinformation on the use of laterite based technology in housing and building.

The delivery system: A system for generation and transfer and delievery of alternative technology in building construction and human settlement, Bhooshan[8], consist of the following:

- Research Institution/ Technology generators
- Design professionals/Innovators-Architects, Engineers
- Field professionals-site engineers, agency representatives, contractors/contractors reps
- Entrepreneurs/manufacturers/contractors/product suppliers
- Administrators/bureaucrats/decision makers in building agencies, financing agencies.
- Public/Beneficiaries/Clients.

Research personnel-innovators links: We often find an aweful lack of information flow in this channel. The

architects and other design innovators in the design are crucial links in making a development in alternative techniques a success or failure. Many output of research institutions gather dust in the shelves for lack of field applications. Therefore it is essential to develop a strong

link between research institutions and design professionals to take lab finding to the site. This could be done by way of active involvement and seminars and workshop. It is also important that the field experience gets feedback into research.

The technique for making and using laterite blocks has been available for a long time and had been used in some way or the other. Laterite blocks has been demonstrated to be cost effective and also capable of generating noteworthy architecture

Innovators-administrators/agencies-field staff links: This is a very important channel through which much of the technology transfer could take place especially in the field of public housing. But in fact, these are weak links at present. It is necessary to do the following to strengthen the communication and information flow between these;

- Exposure to decision-making personnel on the innovative technologies through literature, conferences, meeting and discussion.
- Encouragement of demonstration projects, and organizing visits to completed projects.
- Training field professionals and site engineers in the proper application of the techniques. These should expose them to the problem associated with them and make them aware of the need for proper quality control.

There is one crucial aspect, which has to be looked into while transferring any new innovation to the site through public agencies. That is to see whether the existing site management and construction system as well as other administrative procedures have enough resilience to adopt a new technology. If not, it is necessary to modify the techniques and introduce built in quality control measures. Also the technical /managerial set up and administrative procedures may have to be suitably changed.

The innovators-general public or private agencies-direct link: Alternative to the diffusion of new technologies through public institution is to develop direct links to the public. The innovators can directly talk to the client/beneficiaries and convince them more easily and work could be implemented even without going through a contractor. Better quality control is also possible because the operation is also limited in scale. Once a technique gets sufficiently accepted in private construction, it can get diffused into the operations of larger private agencies like cooperatives, developers and finally will be adopted by the public agencies also

However, this link, as much as, the public agency channel, presupposes and requires committed actions and orientations of the design innovators /professional and other individuals and field professionals. Craving for novelty and professional recognition (other than economy) could be one incentive for the design professionals to adopt a new technique in private construction. But this alone will not be sufficient enough. Introduction of a comparatively new technique brings additional responsibilities on the profeddionals and architects, which will not get adequately remunerated. New techniques require high profeeional involvement therefore; there must develop voluntary organizations of professional groups or such other institutions to take care of this. These organizations could give a forum for sharing responsibilities.

It is also necessary to organize public awareness camps to disseminate and demonstrate the new techniques and materials that are available .The awareness camp should introduce techniques and materials and also highlight the other issues associated with the techniques. This can, however be done only by professional groups or research and other organizations and not effectively by individuals.

The alternative technology entrepreneurs: No new technology can be transferred to site without entrepreneurs who can produce and supply required alternative materials. In the case of mud products like laterite blocks, we have found that that this had been a major stumbling block, unless entrepreneurs are trained and supported to take up this task and to produce such materials and make them available, no matter whatever design and technology innovations are made, they will not reach the site. Enterprising on new technologies is, always, associated with greater risks. Usually those who come forward will be those with commitments and interest but without enough capital. The problem thus gets confounded. In this situation, organization and voluntary professional groups could be of great help.

The problem is more complex in the rural areas where professional advice seldom reaches .It is here that we require a second line of craftsmen who can do the promotion job. Identifying, organizing and supporting them are major tasks professional groups or agencies like the Nigerian Institute of Architects have to take up.

The construction worker-the vital element: The construction worker-the masons, carpenters and petty contractors, etc are the most vital element in the transfer

of any new methods to the site especially rural areas. If they are not taken seriously into account it cam lead to disasters. It is essential to train them and also introduce incentives so that they will not become restraints and hazards in the dissemination of a technique. The incentives could be of higher wages for such techniques that need not increase the total cost of construction. The additional wage paid is to be understood not as bribes but as the cost for higher skill they have developed to do a new job better.

CONCLUSION

The failure of the government in the provision of adequate houses for the population has made laterite blocks inevitable for the masses. However the low esteem with which the material is regarded can be overcome if some these recommendations given above can be implemented. In this way government will not burden herself with the provision of housing as this will now shift to private developers and the government can concentrate on essential building services.

REFERENCES

1. Rao Gundu, R. 1990. Conservation of the earth architecture of India in Indian National Trust For Arts and Cultural Heritage (INTACH), Manipal Institute of Technology (MIT), Housing and Urban Development Corporation (HUDCO) (1990) National Seminar on Mud in Habitat.Manipal 7-8 December, 1990 pp: 1-8.
2. Norton, J., 1997. Building with Earth; A Handbook 2nd Edn., Intermediate Technology Publications. London pvii.
3. Ogunsakin, L., 1992. The Collapse of official housing policy in Nigeria. Habitat Intl., 1: 41-53.
4. Arayela, O., 2002. Precautionary measures in the preparation of stabilised laterite bricks in the trooics housing today. J. Assoc. Housing Corporations of Nigeria (AHCN) Feb/March 2002, 5: 31.
5. Allen, E. and R. Thallon, 2001. Fundamentals of Residential Construction. New York: John Wiley and Sons in Chandra Varun, Alternative Construction System for Residential Construction http://archnt2.tamu.edu/cgraham/student_project.htm pp: 2-4.
6. AECT CEB Machines, 2003. AECT Compressed earth block machines, retrieved April 24, 2003 from http://webspace4me.net/~fwehman/ in Chandra Varun, Alternative Construction System for Residential http://archnt2.tamu.edu/cgraham/ student_project.htm pp: 2-4.
7. Suresh, V., 1990. Use of stabilized mud blocks in housing and building projects. In: Indian National Trust For Arts and Cultural Heritage (INTACH), Manipal Institute of Technology (MIT), Housing and Urban Development Corporation (HUDCO) (1990) National Seminar on Mud in Habitat.Manipal 7-8 December 1990, pp: 1-24.
8. Bhooshan, B.S., 1990. Delievery system and role of professionals in mud based and other alternative technologies for human settlement in Indian National Trust For Arts and Cultural Heritage (INTACH), Manipal Institute of Technology (MIT), Housing and Urban Development Corporation (HUDCO) (1990) National Seminar on Mud in Habitat.Manipal 7-8 December, 1990, pp: 1-7.