Technology Driven Mass Housing Provisions – The Nigeria Concept

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Abstract:

Addressing the housing challenge in Nigeria requires a technology driven approach with focus on harnessing the use of available materials for a more effective use and timely delivery. The subject of mass housing requires speed, good quality control and consideration for issues of land availability and cost of land. This paper x-rays the alternate technology approaches that can be adopted for mass housing provisions with cases of their adoption within the country mentioned and emphasised the need for training and re-training of built environment Profession towards better awareness and adoption of emerging innovative technologies for mass housing provisions in Nigeria. Government policies and actions should be re-directed towards making land and finances more available while constructions and property developers should be encouraged to adopt alternate technologies that fast-track construction process and are more cost effective for increased delivery of housing in our urban environments.

Keywords: Technology, Mass Housing, Delivery Drivers, Modular Construction, 3D Concrete Printing (3DCP).

INTRODUCTION

Shelter is one of the basic needs of Man following only after Food and the provision is grossly inadequate in Nigeria. In the words of Awofeso (2010), "over 90% of Nigerians in low-income bracket cannot afford decent accommodation even if they saved 100% of their income for 10 years". The financial system strategy 2020 International Conference posits that Nigeria, with a housing stock of 10.7 million units has a housing shortfall of between 12 million and 16 million units.

Meeting the housing need especially in developing countries like Nigeria has become a very difficult task. In the face of rapid urbanisation, limited available resources overburdened by recurrent expenditure and mismanagement in developing economy, the housing scarcity becomes inevitable (Jaiyeoba, 2012). The Nigeria's housing situation according to Akeh (2010) as cited in Nyeneime *et al* (2022) shows a monumental deficiency both in quality and quantity. While most urban centres are confronted not only with inadequate supplies resulting in overcrowding and increasing pressures on infrastructure, the rural areas lack qualitative housing and sheer absence of social amenities and infrastructural development (Akeh,2010). Other challenges associated with housing provision for all are high cost of construction technology and materials, limited land availability and high land prices especially in urban areas, limited financial and economic capability.

The concept of mass housing requires delivery of large number of houses with adequate infrastructural facilities with a limited time at an affordable cost. This will surely require practical application of scientific knowledge targeted at solving the problem at hand which is the appropriate definition for technology.

Many attempts at addressing the housing shortfalls such as the 1000 housing units/State by Jakande in the Abacha regime of 1993 – 1998; up till the recent attempt of Federal Government 300,000 prototype housing units across the Nation unveiled in 2020 under the National Social Housing Plan (NSHP) has not been able to fix the housing shortfalls. The schemes always adopted the conventional technology of building with masonry units possibly strengthened with concrete elements adopting designs for bungalow and low-rise structures. This approach does not enjoy speed, required large areas of land and are mostly not cost effective; hence the housing challenge persists especially in urban neighbourhoods.

This calls for adopting approaches at solving the housing challenges through application of low cost, energy efficient, cost effective and timely implementation of housing delivery and use of sustainable technologies. This paper thereby reviews alternate construction technologies for housing which can be easily adopted in the country with a bid to reducing the housing shortage significantly

INNOVATIVE TECHNOLOGIES FOR MASS HOUSING PROVISIONS

The major technologies for housing discussed in this article can be classified as an assemblage or formwork construction technology. These are:

i. Prefab Construction
ii. Precast Technology
iii. 3D Monolithic Precast Construction
iv. Glass Fibre Reinforced Gypsum Panel
v. Structural Stay-In-Place Formwork Technology
vi. 3D Concrete Printing

Prefab Construction Technology

Prefab Construction Technology also technology also known as System Building is a method in which prefabricated components are used to speed up the construction of buildings. This can be adopted as effective technology to satisfy the housing needs in the urban areas. The approach involves off-site fabrication of building components to higher degree of finish and then the components are assembled on site.

Figure 1: Assembly Process of Prefab Element

It is known to involve high quality control practice and produce durable products. Prior to construction, Building Information Modelling (BIM) techniques are used for the construction planning process.

Karmod Construction Technologies Limited also adopts Modular structures of prefab construction technology for most of their construction works. This technology adopts the process of using modules manufactured in a factory environment which are transported to site and connected together to form a complete building.

The prefab construction technology is an innovative technique capable of addressing the issues of mass housing. It reduces wastage involved in the construction process such as cost, waste of materials, time taken for construction and cut down on labour requirement significantly than the traditional method (Shetty & Dash, 2018)

Figure 2:Prefab Building in Nigeria by Karmod accessed online 09/05/2022

Precast Technology

Precast technology adopts the production of concrete in a re-usable mould or form which is then treated in a controlled environment from where it is transported to the site and then assembled on site. The factory is usually developed near the site for economy in storage and transportation. It involves various precast elements (i.e., beams, slabs, columns, walls, staircase and other structural concrete elements).

Precast housing construction involves the designing, planning, lifting, handling and transportation of precast elements. It is extremely suitable for high-rise building construction as the design process can be made to address seismic loads. The building frame is arranged to accommodate maximum repetition of moulds. The approach can be made of precast reinforced concrete or precast prestressed concrete elements respectively. The technology is adjudged to provides good value and the technology offers good quality, fast track sustainable design and

construction with best quality and minimum/no wastage since it is versatile and durable (Indian Building Materials & Technology Promotion Council, BMTPC, 2017a).

The Victoria Garden City (VGC) built by HFP Construction Ltd was said to involve use many prefabricated concrete elements and serve as since hub of who is who on Lekki Express in Ajah, Lagos. The is adjudged to accommodate a 30,000 population in 2015

Figure 3: Buildings in VGC, Lekki, Lagos accessed online 09/05/2022

3D Monolithic Precast Construction

This is an Australian patented innovative technology which involves production of automated and hydraulically driven modules. It is also referred to has modular construction. It involves production of three-dimensional modular units in a controlled factory environment and then the modules are transported to site for assembly. The modules are often customised during its design to have doors, windows, piping, conduits and insulations incorporated in the moulds. Th technology reduces project time and cost significantly. The 3D modules can be fitted and stacked on each other or even side by side. It can be adopted for buildings up to 10 storeys and offers high energy savings over the lifetime of the building. The technology provides long term strength, durability advantages and it is fire, earthquake and termite proof. It is a fast-track construction method, incurs lower cost and provides great flexibility in design. It offers superior finish with controlled manufacturing processes which allows leaving concrete in the natural state without painting or any cover. The working environment for this technology is safer and non-hazardous to the workmen. The 3D monolithic precast construction is environment, energy, acoustic and structurally efficient and is appropriate for construction of affordable housing. Re-use and recycling of leftover materials are also possible with this innovative technique (Hommission, 2017)

Figure 4: Stacking of 3D Monolithic Modules

Figure 5: Nigeria's COVID 19 Modular Hospital

Glass Fibre Reinforced Gypsum (GFRG) Panel Technology

This technology can be adopted for low-cost housing. It involves further calcining gypsum produced as waste from fertilizer industry to give gypsum plaster, which then serve as the raw material for production of gypsum panels serving as the walls, roof sunshade and the boundary walls. The panels are then cut using computerized machinery in the factory and transported to site. High-rise buildings can also be erected using the GFRG panels. The technology is noted to provide structural stability as it is capable of resisting high lateral loads and winds (Charve, 2020). It has advantage of speed of construction and more cost effective than the conventional building materials. The structures are earthquake and water resistant, eco-friendly, energy efficient and durable, hence appropriate for affordable mass housing. It however requires

extreme care in handling the panels and specific machinery necessary for movement of the panels. Goutham (2013) states that the technology is inappropriate for walls with circular curvature. Gypsum panel boards are readily available in the Nigerian building materials and is commonly adopted now for ceiling works. Example of structure in Nigeria built with this technology is the Grand Fishing Hotel in Argungu, Kebbi State.

Figure 6: GFRG Panel Construction in Nigeria

Figure 7: GFRG Panels Construction accessed online on 09/05/2022

Structural Stay-In-Place Formwork Technology

This is also called the Formwork or Coffor Technology which consist of Expanded Polystyrene (EPS) blocks or panel which serve as insulated concrete forms, steel cage filled with concrete or lightweight concrete known as structural forms, Panels, PVC formworks etc. The stay-in-

place formworks act as guide for fast construction of walls and slabs. The technology is cost effective with the components manufactured in the factory and of good quality. The technology as the EPS serving as the outer core, alleviate concrete with EPS beads as infill which makes for thermal and resource efficiency and can be adopted for building up to five storeys. Construction with this technology above five storeys will require additional reinforcement works (BMTPC, 2017b). Cubic Homes, Abuja; CITEC International Estates Ltd. and Alpha Meat Group are some of the Organisations in Nigeria adopting Formwork construction technology for housing development.

(a) (b)

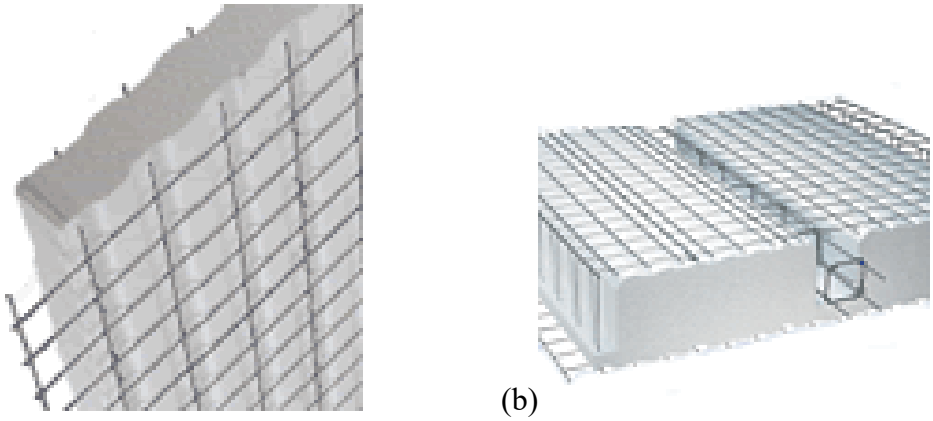

Figure 8: EPS Block Construction for Structural Works. (a). Single Panel; (b) Floor Panel

Figure 9: Block of Flats erected with Formwork Construction in Lagos by Alpha Mead Group

Figure 10:A storey Building Erected with the Stay-in-Place Form Construction by CITEC

3D Concrete Printing

3D concrete printing technology is one of the fastest growing digital technologies in the World which is environmentally friendly, cost effective and fast track construction technique that can be adopted for mass housing delivery and provides flexibility for complex designs. The technology is yet to be adopted in Nigeria housing industry the 3D printing technology when introduced in 2014 was an expensive technology but over the years, the technology is now commonly used in many fields and the cost has also reduced. It can be adopted for mass housing either by printing the building component in prefabricated elements which can then be assembled on site (Hager *et al*) or by the cast-in-place form approach where the 3D printed concrete will be made to serve as the in-fill instead of EPS beads. The printer extrudes mortar printed in the via nozzle layer by layer. The components can be printed in the factory before transporting to site for installation/assemblage.

Figure 11:Concrete Elements Produced via 3D Concrete Printing

Figure 12:3D Concrete Printing Process with the Nozzle Extruding Mortar Layer by Layer

Figure 13: 3D Concrete Printing Arrangement of a Whole Building

Figure 14: 3D Concrete Printed Building

The current challenge with this technology is the development of sustainable durable building materials that can be used for 3D printing. The structural stability, quality and durability of the house constructed will depend on the building materials used in the 3D printing technology. The adoption of 3D Concrete Printing technology in Nigeria can be for low-rise structures and it is believed to present the housing industry with the fastest construction pace possible.

HINDERANCES TO TECHNOLOGY ADOPTION AND THE WAY FORWARD

There are many hinderances to adoption of innovative housing technologies and the focus is how to overcome these hinderances for widespread usage and awareness among the people. The constraints to adoption of new technologies at various stages of development and commercialization can potentially thwart the ability of the technology to succeed. The hinderances range from inadequate knowledge dissemination, restricted technology transfer, inadequate manufacturing facilities, and lack of regulatory environment. Lack of awareness and understanding about the possible technology options by practicing housing professionals and artisans restrict movement of innovative technologies into the mainstream practice. The need thereby arises for training and re-training of built environment Professionals with a target for technology transfer with sufficient aid provided to the housing sector for harnessing the human, physical and materials resources for an improved housing stock provision in Nigeria.

CONCLUSION

Embracing innovative technology is key to realising the drive for housing for all. Continuous education of the various practitioners in the built environment is necessary for better understanding and adoption of emerging innovative technologies for driving mass housing provisions. Government policies should be directed at enhance land availability and reducing the price of land in the urban areas while the private developers should be encouraged towards

investment in the adoption of new technologies for fast track, cost effective and sustainable housing development.

REFERENCES

Jaiyeoba, B.E. (2012). "Housing Quality" To the Low-Income Housing Producers in Ogbere, Ibadan, Nigeria. *Procedia - Social and Behavioural Sciences*, ScienceDirect (Elsevier),35 pp 483 – 494.

Awofeso, P. (2010). One out of two Nigerians now lives in a City: There are many problems but one solution. *World Policy Journal* 27:67.

Akeh, G.I. (2010). Vision20: 2020 and the imperative of housing construction in Nigeria. *First Academic Conference on Vision20: 20202 and the Imperative of Nation Building*. Plateau State Polytechnic, Barkin Ladi, 3rd 6th Aug.

Nyeneime, V.R., Uduak, U & Aniedi, I. (2022). Mass Housing Provision as a Tool for Economic Empowerment and Sustainable *Development in Nigeria. International Journal for Research in Environmental Science and Technology, 8 (1)*, pp. 44 – 48.

Charve, J. (2020). Innovative Housing Technologies for Better Urban Future. *International Journal of Creative Research Thoughts (IJCRT)*, 8 (12), www.ijcrt.org

Hommission, (2017). Manual on 3D Monolithic Precast Construction Technology Solution. Hommission, India.

Building Materials &Technology Promotion Council (BMTPC) (2017a). Annual Report 2016-2017. Ministry of Housing & Urban Poverty Alleviation, Government of India.

BMTPC (2017b). Compedium of Prospective Emerging Technologies for Mass Housing. Ministry of Housing & Urban Poverty Alleviation, Government of India

Goutham, V. (2013). IIT Madras Innovates Eco-Friendly Low-Cost Houses. (Online) Available from: https://www.ecoideaz.com/innovative-green-ideas/iit-madras-innovates-eco-friendly-low-cost-houses [Accessed 9 May, 2023]

Hager, I. Golonka, A. & Putaowics, R. (2016). 3D Printing of Buildings and Building Components as the Future of Sustainable Construction? *Procedia Engineering,* 151, 292-299