

Sustainable Construction: Comparative Advantages of Expanded Polystyrene (EPS) Fascia in Housing Delivery in Nigeria

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Abstract

Various environmental challenges posed by the application of non-sustainable construction materials and techniques and higher cost of same in the recent time have made the search for better and cheaper alternatives a crucial task in the provision of housing in Nigeria. As a product of research and technological advancements, modern eco-friendly building materials are currently emerging to satisfy the requirements of sustainable developments and mitigate environmental challenges. One of such materials is the expanded polystyrene or EPS. This paper focuses on sustainable construction with emphasis on the comparative advantages of expanded polystyrene fascia over the conventional concrete fascia in the delivery of housing in Nigeria. The data for the research were obtained through primary sources of data gathering. This involves primary stage of purposeful selection from two cities namely Abuja and Akure, Nigeria, where the material (EPS) was extensively used in housing estates. Analysis of the findings from the two housing estates selected as case studies, reveal that EPS fascia demonstrates faster construction time, flexibility of design, lesser number of labor to be engaged, higher strength, cheaper cost and higher sustainability potentials over the conventional concrete fascia used for similar housing units in same locations. While it was discovered that there is little or no availability of the material in most Nigerian building markets due to lack of awareness among the various stakeholders and practitioners in the building industry, it x-rayed the need for a paradigm shift from the conventional system of building characterized by waste, cradle to grave (demolition) and global warming to a waste-free, recyclable, eco-friendly and cheaper alternative way of building construction.

Keywords: Concrete fascia, Expanded Polystyrene (EPS) fascia, Green architecture, Housing, Sustainable construction,

1. Introduction

The way in which global finite resources are being depleted through human exploitation is alarming and has for a long time become a great concern. The earth is under serious threat of diminishing energy resources which is a threat to the present and future of mankind. To combat this challenge, the concept of sustainable development has been brought to the fore. If one may ask, how did the world come to this threshold of diminishing energy resources and environmental hazard? The answer is not farfetched. The activities of the construction or building industry have been identified as a major contributor of threat to the environment as Prucnal-Ogunsote, Okwoli and Ude (2010) noted that the building industry consumes about 50% of the world energy. In the most developed countries, it has been verified that the traditional and conventional technologies used for construction and maintenance of buildings are inefficient and resource wasteful due to enormous amount of resources consumed (Ogundiran and Adedeji 2012). The building industry, according to Carpenter (2009), must recognize its impacts on global warming and preservation of our valuable and finite energy resources. This environmental threat posed by the building industry has clamored for a better way of carrying out construction activities, which has necessitated a paradigm shift from the conventional system of building construction to best practice, to reduce the negative impacts on the environment.

DBERR (2008) opines that sustainable development lies at the heart of design and construction- an approach, which brings full and lasting environmental, social and economic benefits. It is in agreement with this assertion that Adedeji (2012) noted that the process of housing development should be based on sustainability principles, which could be applied in the conception, construction and use of the buildings to reduce the negative impacts that buildings could have on the environment through choosing better materials and environmental design.

In combating environmental challenges posed by the activities of the building industry, the choice of environmentally friendly materials and techniques is very germane. The construction process must preserve unique ecosystems, biodiversity and local landscapes, whilst ensuring a better quality of life and guaranteeing the health and safety of the building occupants and users (Carpenter, 2009).

Researchers have identified that the major environmental burdens associated with building materials and techniques include embodied energy of building materials and greenhouse gases emissions originated from each stage of their life-cycle (Sodagar, Rai, Murphy, and Altan, 2009; Adedeji, 2012). For sustainable development, materials must ensure low consumption of energy for their production and transportation (embodied energy), and for their operation in use (operational energy) (Ortiz, Castells, Sonnemann, 2009).

Obviously, it is no longer news that the combat against environmental challenges has called for energy efficient materials. In as much as buildings in developed and developing nations account for 40% of the energy demand, over 60% of this being for heating and cooling purposes, appropriate thermal insulation is recognized as one of the most rapid and cost effective ways of reducing energy demand whilst simultaneously reducing greenhouse gas emissions (EUMEPS, 2013). Effective insulation method of walls, roofs and floors is a strategy to improve the efficiency of buildings and ultimately reduce monthly utility bills (Adedeji and Folorunso, 2010). As a product of research and technological advancements, modern eco-friendly building materials are currently emerging to satisfy the requirements of sustainable developments and mitigate environmental challenges. One of such materials is the expanded polystyrene or EPS, a readily available local energy efficient material, which offers 'best' practice of construction, unique modular design, high strength, good thermal and acoustic properties, reduction of labor, cost and time, in addition to the satisfaction of the green building requirements (Ogundiran and Adedeji, 2012). The eco-friendly nature and an outline of the sustainable construction processes using EPS fascia form the focus of this paper. The comparative advantages of EPS fascia over the concrete fascia both in construction and use are the general aspects elaborated by this research.

2. Literature Review

2.1 *The concept of sustainable development and green architecture*

The topical issue of sustainable development which encompasses sustainable design and construction as it relates to architecture is not new and has witnessed considerable growth in literature over the last two decades (Ilesanmi, 2009). Sustainable development has now become a worldwide trend to scale down the negative impact of man's activity on the environment (Bala, 2010). It has been widely asserted by many authors that sustainable development is about "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987; Olotuah, 2002). It is in this regard that (Ilesanmi, 2009) remarked that the concept of sustainability attempts to achieve simultaneously the goals of an improved environment, a better economy, and a more just and participative society, rather than trading off any one of these against the others. In relation to the field of architecture, sustainability or sustainable development has given birth to the concept of sustainable architecture or green architecture. Green architecture is a general term that describes environmentally-conscious design techniques in the field of architecture and it is framed within the larger context of the discussion of sustainability (Prucnal-Ogunsote, Okwoli and Ude, 2010).

Today, interest in sustainable "green" building is growing worldwide and the movement began as a result of the need and desire for more energy efficient and environmental friendly construction practice by taking advantage of renewable resources and energy. Green buildings often include measures to reduce energy use and increase the efficiency of the building envelope. A number of excellent and well proven environmental evaluation schemes such as the Building Research Establishment Environmental Assessment Method (BREEAM) of Building Research Establishment (BRE) of the UK, the Leadership in Energy and Environmental Design (LEED) of the United States Green Building Council (USGBC) of the USA, Haute Qualite Environnementale (HQE) of France and the Green Star of Australia are already in existence. They all set standards for the best practice in sustainable design and have become the modern yardstick for measuring and describing a building's environmental performances. Green buildings therefore often include measures to reduce energy use and increase the efficiency of the building envelope. (Saint-Gobain 2009; Prucnal, Okwoli and Ude, 2010).

2.2 *Expanded polystyrene (EPS) insulation and energy efficiency in buildings*

Expanded polystyrene or EPS, an organic insulation that demonstrates a positive eco-balance, is a rigid cellular plastic which is made from expandable polystyrene containing an expansion agent, pentane. As a building material, EPS has found applications in many aspects of building works including large structures such as roads, bridges, railway lines and public buildings. In addition to its eco-friendly nature, EPS exhibits low thermal conductivity, lightweight, mechanical resistance, moisture and chemical resistance, ease of handling and installation and versatility, which makes it more suitable for building construction than the conventional sandcrete system (Ogundiran and Adedeji, 2012; EPG 2013).

For construction purposes, Whalen (2004) noted that two energy-efficient systems relying on EPS are insulating concrete forms (ICFs) and structural insulated panels (SIPs). Both are recognized as innovative product solutions used to construct building envelopes and are gaining wide acceptance by leaders in sustainable designs. Expanded polystyrene has been found to offer substantial environmental advantages through energy saving and greenhouse gases emission reduction and is therefore ideally suited to the creation of environmentally-friendly new building projects (Saint-Gobain, 2009).

2.3 *The manufacturing process of EPS and the environment*

The five manufacturing stages of expanded polystyrene, which involves pre-expansion, intermediate conditioning and stabilization, molding, shaping and post-production processes as outlined and explained by

Saint-Gobain (2009) and EUMEPS (2013) are environmentally friendly.

During pre-expansion, expandable polystyrene beads are heated in pre-expander using steam from boilers at temperatures between 80 and 100°C. By this process, the expandable beads are expanded by the addition of pentane (an expansion agent) to form larger beads, each consisting of a series of non-interconnected closed cells. As the expanded beads cool, the entrapped pentane condenses within the pearl, which is rapidly filled with air. By this process, the bulk density of the material drops from about 630kg/m³ to values between 10 and 35kg/m³. Intermediate conditioning and stabilization follows pre-expansion. This stage allows the cooling of the drying expanded beads in a fluidized bed drier before conveyance to aerated storage silos for maturing typically over a period of 24 hours. Practically, the recently expanded beads still contain small quantities of both condensed steam and pentane gas. At the silos, the EPS cools and air gradually diffuses into the pores, replacing, in part, the other components until the beads contain up to 98% air. This enables the beads achieve greater mechanical elasticity and regain expansion capacity.

Molding marks the third stage of production of EPS. Here the pre-expanded beads are molded to form boards, blocks or customized products. The mould serves to shape and retain the pre-foam, and steam is again used to promote expansion. During molding, the steam causes fusion of each bead to its neighbors, thus forming a homogeneous product.

Shaping, the fourth stage follows a short cooling period after the molded block has been removed from the block molding machine. The block is cut or shaped as required using hot wire elements or other appropriate techniques.

The last stage is the post-production processing where the finished product is laminated with foils, plastics, roofing felt, fiber-board or other facings such as roof or wall cladding material and wire mesh.

2.4 Description of EPS fascia

The EPS block is the first main product from which many other products are derived. The block itself has found applications in earth construction including soil stabilization, road construction, retaining walling and embankments (Ogundiran and Adedeji, 2012). The block comes in 1200mm x 600mm x 6000mm. The EPS fascia or cornice is one of the derivatives of the EPS block.

The EPS fascia or cornice is an alternative to the conventional concrete fascia and the cast in-situ roof cornices that demands formwork for construction. EPS fascias are in various shapes and sizes, which range from 3000mm x 300mm x 300mm to 3000mm x 600mm x 600mm depending on the designer's tastes, improved flexibility of design and aesthetics. There are two different types of fascias. These are the structural and the non-structural fascias. The former is reinforced with wire mesh and shotcreted on the site whereas the latter is finished with a thin layer of plaster from the factory. The non-structural fascias are usually used for enhanced aesthetics only where no load will be imposed.

The accessories used in the construction of buildings using expanded polystyrene are basically metallic mesh. They are called *splice meshes* used at all joints on the EPS wall panels and EPS fascias. The splice mesh has the same dimension as the cover mesh of the panel and the reinforcement mesh of the fascias. The sole purpose for the use of splice meshes is to create continuous reinforcement to facilitate the box-like nature of the building constructed with expanded polystyrene (with respect to transfer of tensile forces) (Matz, Kuguerl and Peheim, 2007). For this purpose, certain areas – usually panels and fascias' joints – have to be adequately covered with splice mesh as follows.

POINT OF APPLICATION	SPLICE MESH
Straight Panel Joints	Straight Splice Mesh
External Corners	L – Shaped Bent Splice Mesh
Arches, Windows and Doors Reveals and Soffits	U – Shaped Bent Splice Mesh
Corners of All Openings in Walls	*Straight Splice Mesh Cut to Size
Line of Service Conduit	Straight Splice Mesh
Joint of Fascia and Wall	L – Shaped Bent Splice Mesh

Binding wire is also an accessory used in EPS construction. Binding wires are used to tie EPS components (panels to panels, fascias to panels, fascia to fascia) together and to tie the splice meshes to the EPS components.

3. Methodology

Data for the research were obtained through primary sources of data gathering. This involves primary stage of purposeful selection from two cities namely Abuja and Akure, Nigeria, where the material (EPS) was extensively used in housing estates.

The first selected site for case study is Mount Pleasant Estate at Mbora District of Abuja. The estate is a 5000 residential housing units. The estate is currently in four phases (I-IV) of over three thousand (3000) housing units. Phases I and II, constructed from 2003 to 2006 were mixture of prefabricated concrete panels and conventional sandcrete blocks with timber fascias and concrete fascias. Houses in these phases are combination of bungalows, storey and terrace buildings. While phase III, which was built between 2007 and 2008 was constructed with conventional sandcrete blocks and concrete fascias, phase IV constructed with EPS materials for both walls and fascias started in 2009 till date.

30 housing units were selected from phases III and IV respectively, i.e. 30 from phase III, 30 from phase IV and were compared with each other. Housing units selected for study comprises of Bungalows and 2-Storey houses.

Table 1: Housing Types Investigated for Comparison

s/no	Housing Types (Conventional)	Housing Types (EPS)	Frequency	%
1.	Bungalow	Bungalow	36	60
2.	2 Storey House	2 Storey House	24	40

Source: Authors' Field Survey, 2012

The second selected site for case study is Alpha 3D Estate located along Irese road in Akure, Ondo State Nigeria. The estate, which is still under construction, is a 506-housing units estate. Currently 12 housing units where EPS was used for both walls and fascias have been completed. The completed buildings include 2, 3, 4-Bedroom bungalow units and 4-bedroom 2-storey buildings. The cost of the EPS fascia prototype was prepared using bill of quantities and compared with similar houses with conventional concrete fascia at a housing layout along Idanre road in Akure city of Ondo State.

Also, interview schedules were administered to building professionals (architects, builders, structural engineers and quantity surveyors) involved in the supervision of such buildings to elicit their opinion on the comparative advantages of expanded polystyrene over the concrete fascia in housing delivery.

4. Findings and Discussion

4.1 The EPS fascia installation process

The choice of the sizes of fascia is dependent on the taste of the architect or the client. Cost is also a factor always considered in choosing sizes of EPS fascias. In all cases, it is advisable to note that while smaller sizes are aesthetically appealing on bungalows, they are not so on buildings more than one storey. For more appealing elevations, bigger sizes of fascias from 450mm x 450mm to above are preferable.

The installation of expanded polystyrene fascias usually starts from the outer corners of the external walls (Figures 2a & b). The external angles are pre-cut into sizes from the production factory or cut on the site. Starting the installation from the outer angles is crucial in that straight edges and sharp corners add value to the aesthetics of the fascia on a building. Both external EPS fascia angles and the straight fascias are meticulously and strongly tied to the upper edge of the EPS wall panels using binding wires and L - shape bent splice meshes so as to make the fascia an integral component of the entire building (Figures 3 and 4). All the joints between two fascias must be properly covered with chicken meshes (Figure 1). Alignment of the fascias as a horizontal component is important. The fascias must be properly aligned and made paralleled to other horizontal components of the building below them. All edges at the joints must be properly connected to each other. Horizontal lines' continuity must be ensured at these joints without making the joints easily noticed.

Alignment of the fascias

Owing to the lightweight nature of the expanded polystyrene fascias, it is important to be meticulous with the horizontal alignment of the fascias.

The fascias are aligned in conformity with the coordinated levels of the wall panels using levels. In some instances, the level used may give a contrary alignment to that of the wall panels. In such cases, an equilibrium has to be attained by ensuring that the fascia lines are parallel to other horizontal components under it (such as the window lines, archway lines and the floor lines) and without so much deviation from the plumb reading of the spirit or water level. Commonly, fascias give convex appearance at the joints, precaution needs to be taken to ensure that straight lines are achieved and such appearance does not exist. This is done by making sure that the top of the fascias align with each other at the joints. All the alignment beams and props are carefully untied and removed after the first stage concreting of the EPS fascias.

Combining EPS fascias with concrete columns and beams

Expanded polystyrene fascias are connected to concrete columns and beams in a way similar to the way wall

panels are connected to the concrete floor. The construction method for connecting fascia to the ring beam is not different. Dowel bars of same diameter are tied to the reinforcement bars of the beam before the beam is cast. The fascia may as well serve as the formwork for the ring beam on the outer side. In situations where the beam has already been cast, the beam can be drilled in a similar manner the columns are drilled and dowel bars inserted to anchor the fascia (Figure 2a). In all the cases, the dowel bars are inserted at intervals of 500mm centers. The length of the dowel bars is a function of the size of the fascia to be used.

Concreting the fascias

Concreting is a vital stage in the construction of buildings using expanded polystyrene. This stage comes to the fore immediately after successful erection and alignment of the panels and fascias. The mix ratio of the constituents is a function of the grade to be achieved. Concreting is applied in two layers. The first layer usually called 1st stage concreting (or spraying) is about 20mm thick or sufficient to cover the mesh (Figure 5a). The concreting gives the structure the required strength to transfer loads during construction. This first layer is usually kept rough to facilitate an easy application of the 2nd stage concreting which is synonymous to the conventional plastering. During the 1st stage concreting (spraying), the concrete cement content is usually about 300kg/m³. This value ensures both sufficient strength and pumpability of the mortar. The ratio between the water's and cement's quantities does not only influence workability but also strength and rust protection of the reinforcement. If the water content is too high, air voids form in the concrete and influence the quality of the concrete. According to Matz, Kugerl and Peheim (2007), a water / cement ratio of 0.5 to 0.6 is recommended.

Three different methods of concreting have been identified. These are the shotcrete, the hopper gun and the manual methods. For shotcrete methods, there are dry and wet mix methods. In the dry mix shotcrete method, the concrete constituents are shot through the hose by means of compressed air from the compressor and mixes with water at the nozzle only. An advantage which dry-mix method offers is the avoidance of blockings in the hose. In the wet-mix method, the compressor only accelerates the concrete mix at the nozzle and not through the hose. Practical experience has shown that the wet-mix method is the much more favorable variant. In the hopper gun method, the concrete is filled into a hopper from which it is shot with compressed air through the nozzles to the wall or slab. The output however is below the one achieved by the concrete pumps. In the manual processing, the mortar is applied by the masons in a conventional way using broom or trowel. The use of this method makes sense for the application of thin layer (5 – 10mm) only (Matz, Kugerl and Peheim, 2007).

Practically, the ratio of cement to aggregates is 1:4 to produce one cubic meter of concrete. For the aggregates, stone dust with portion of plaster sand is commonly used. The addition of the plaster sand is to increase the plasticity and the gummy nature of the aggregates. The use of plaster sand is however optional. In cases when plaster sand is used, the ratio of plaster sand to stone dust is 1:7. This implies that if 8 headpans of aggregates are required, 1 headpan of plaster sand and 7 headpans of stone dust are used. The overall result from the 1:4 cement/aggregate indicates that for 1 bag of Ordinary Portland Cement, 8 headpans of aggregates comprising 1 headpan of plaster sand and 7 headpans of stone dust.

The second concrete layer as earlier stated is applied as the conventional plastering within gauges and screeded smooth by masons (Figure 5b). To ensure the proper bonding of the second layer to the first layer, the rough surface of the first layer is thoroughly washed. As a result of various gauges necessitated by various levels on the walls, the thicknesses of the plaster may vary from point to point. On the average a thickness of 20mm is commonly achieved.

Concreted fascias are prone to shrinkage immediately after the concreting due to rapid evaporation of water. This has necessitated proper after-treatment of the fascia as curing for concrete. Regular wetting of the plastered fascia is essential in the first week of construction (especially areas exposed to direct sunlight). It has been discovered that insufficient after-treatment always lead to premature dry-out, cracks and dis-alignment of levels in fascias.

4.2 Comparative advantages of EPS fascia over concrete fascia

The Expanded polystyrene (EPS) fascia offers wide range of advantages over the conventional concrete fascia. The observed advantages from sampled cases include flexibility of design. The EPS fascia affords the designer the flexibility of design and improved aesthetics. Uncommon shapes and slanting installations which are difficult to achieve in concrete fascias are easily achieved with EPS fascias. For example, EPS fascia can be installed transversely or in any direction along the gable end of a façade for an improved aesthetics, which ordinarily could be cumbersome if concrete fascia is to be used. Also, smaller grooves as small as 10mm in fascias are easily achieved in EPS fascias. Another advantage of EPS is the absence of formwork for installation. EPS fascia is a precast module which requires no formwork during installation. The construction of formwork inevitable in the construction of concrete fascia is totally avoided during the installation of EPS fascia. Thirdly, fewer numbers of laborers are required for the installation of EPS fascia compared to conventional concrete fascia. The engagement of specialized services such as carpenter and iron benders, which is inevitable in the construction of

concrete fascia, is not required in the EPS fascia installation. Besides, faster construction is achievable as a great deal of time is saved in the construction of fascia using expanded polystyrene. Much time expended in the construction of formwork and iron bending for the construction of concrete fascia is absent. The long duration of time observed before striking off the formwork after the concrete fascia has set is avoided. These merits give EPS fascia short duration advantage over the concrete. Added, firmness and rigidity characterizes the use of EPS. It has been observed that poorly designed and poorly constructed concrete fascias are prone to sagging, falling off the grid or falling off completely. The EPS fascia after proper installation and alignment is firm and rigid. All alignment problems associated with the concrete fascias may not be easily corrected without attracting wastes, demolition, extra cost and extra time. In the case of EPS fascias, there is no risk of fall-off and sagging. Alignments of the slightly off-grid fascias can easily be done without marring the aesthetics at no extra cost and time. Other advantages are deconstruction and material re-use. Despite EPS fascia firmness and rigidity in full installation which is a good structural attribute, the material can easily be disassembled and the materials can be re-used, either on the same project during remodeling or on another project. This is connected with the fact that the production and installation of EPS fascia is in conformity with the principles of adaptability, modularity and componentization. Also, lower cost of installation is achievable with the use of EPS. The cost of EPS fascia's purchase and installation is cheaper than that of the concrete fascia. A cost comparison of the two materials is shown in Tables 2 and 3.

Table 2: Cost of Installation of Expanded Polystyrene (EPS) Fascia

EXPANDED POLYSTYRENE (EPS) FASCIA			
300 x 400mm EPS Fascia	81m	3,400.00	275,400.00
Installation of EPS Fascia	81m	400.00	32,400.00
Materials for Spraying & Plastering (Stone Dust, Sharp Sand, Water, Plaster Sand and Cement)	32m ²	200.00	6,400.00
Labor for Shotcreting (Spraying) EPS Fascia	32m ²	110.00	3,520.00
Labor for Plastering EPS Fascia	81m	675.00	54,675.00
			372,395.00

Source: Authors' Field Survey, 2012

Table 3: Cost of Installation of Concrete Fascia

CONCRETE FASCIA			
Concrete on Fascia	7m ³	26,000.00	182,000.00
12mm Diameter Reinforcement in Fascia	573kg	270.00	154,710.00
8mm Stirrups	185kg	270.00	49,950.00
Sawn formwork to sides and soffit of fascia	81m	4,200.00	340,200.00
Rendering to Concrete Fascia	81m	675.00	54,675.00
			781,535.00

Source: Authors' Field Survey, 2012

Percentage Difference = 52.35

From the Tables 2 and 3, it can be deduced that the cost of installation of expanded polystyrene (EPS) fascia and the cost of installation of concrete fascia of an 81m length of a residential bungalow under the same construction condition. The cost of the installation of EPS fascia, which is three hundred and seventy two thousand, three hundred and ninety five naira (₦372, 395.00) is found to be cheaper than the seven hundred and eighty one thousand, five hundred and thirty five naira (₦781, 535.00) cost of concrete fascia under the same construction condition. The difference of four hundred and nine thousand, one hundred and forty naira (₦409, 140.00) indicates a 52.35 percentage difference in the cost of the two materials.

Another vital advantage of the use of EPS is energy efficiency potential. Energy efficiency in housing as it relates to sustainable construction is achievable through the use of expanded polystyrene insulation. This is sequel to the fact that EPS has good sustainability credentials. Research has shown that EPS is environmental-friendly in its production and building construction application. At any time of its life cycle (during production and application), it does not contain any chlorofluorocarbons (CFCs) or hydro fluorocarbons (HCFCs). EUMEPS (2013) asserted that using oil to manufacture EPS for building insulation applications is an efficient

use of natural resource. About 50% of CO₂ emissions can be avoided using EPS insulation. The implication of this is that expanded polystyrene insulation at both production and application stages does not contribute to the destruction of the ozone layer and as such does not contribute to global warming. Also, researchers have shown that EPS is inert, non-toxic, stable and does not decompose. It neither contributes to the formation of methane or any other chemicals in the atmosphere nor pollutes water supplies. Life cycle analysis has shown that EPS has far less impact on the environment. The use of EPS for fascias, in addition to other advantages, results in low or no waste when properly utilized on the site.

5. Recommendations and Conclusion

This paper has presented expanded polystyrene (EPS) as a sustainable building material for sustainable construction. It outlined the construction processes and methods of building construction using expanded polystyrene fascia. It presented in logical manner the advantages of using EPS fascia over the conventional concrete fascia in housing provisions in Nigeria. While giving comparative advantages of EPS fascia over the concrete fascia, it x-rayed the need for a paradigm shift from the conventional system of building characterized by waste, cradle to grave (demolition) and global warming to a waste-free, recyclable, eco-friendly alternative way of building construction.

Despite the eco-friendliness and other advantages of the EPS insulating material, it has been discovered that there is low level of awareness on the part of the building professionals in Nigeria. The material is not readily available in the market in all the six geo-political zones of the country except at the Federal Capital Territory (Abuja) and the South-West zones (Ikare-Akoko in Ondo state). Against this backdrop, Government agencies, parastatals, developers and all other stakeholders in the building industry should accept the concept of insulation to make buildings energy efficient, satisfy the energy requirements for the actualization of the millennium development goals and save cost of construction considerably. The utilization of expanded polystyrene for public housing projects should be encouraged, not only for saving cost but for generation of employment and sustainable housing delivery in Nigeria. Above all, the paper has provided a technical information brochure on processes and methods of construction using EPS insulation.

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APPENDIX: List of Figures



Figure 1: EPS Fascia reinforced with wire mesh and covered with chicken mesh during production at CIBPL Abuja
Source: Authors’ Survey 2010



Figures 2a & b: Installation of EPS fascias starts at the corner
Housing Units at Alpha 3D Estate, Akure
Source: Authors’ Survey 2013



Figure 3: The bottom of the EPS fascia is connected to the EPS wall panel with binding wire for strength, rigidity and continuous reinforcement. A Bungalow at Mbora Mount Pleasant Estate Abuja
Source: Authors' Survey 2010



Figure 4: The top of the EPS fascia is connected to the EPS wall panel with binding wire and covered with L-shaped splice mesh for strength, rigidity and continuous reinforcement. A Bungalow at Mbora Mount Pleasant Estate Abuja
Source: Authors' Survey 2010



Figures 5a & b: (a) Shotcreting Stage 1 (Spraying with cement, aggregate and water). (b) Shotcreting Stage 2 (Plastering)
A Bungalow at Mbora Mount Pleasant Estate Abuja
Source: Authors' Survey 2010



Figures 6a & b: Plastered EPS fascias (a) 4-Bedroom Duplex (b) 4-Bedroom Bungalow
At Mborra Mount Pleasant Estate Abuja
Source: Authors' Survey 2010

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