EXPANDED POLYSTYRENE (EPS) AS SUBSTITUTE FOR TRADITIONAL FASCIA MATERIALS.

Hassan, 1. O[1], Sani, D. O[1], Umar, A[2], Usman, B.W[2].

[1]Department of Building, School of Environmental Technology, Federal University of Technology Minna
[2]Department of Architecture, Faculty of Environmental Technology, A.T.B.U Bauchi

Timber and reinforced concrete have been used for the construction of fascia for buildings over the years. However, these conventional materials have their shortcomings hence, the need for better materials. One of such materials is expanded polystyrene (EPS). This research therefore focused on the evaluation of the properties of expanded polystyrene with the view of using it as a substitute for the traditional materials as fascia. Company standards of expanded polystyrene was obtained and compared with those of timber and concrete. Also laboratory tests were carried out to ascertain the effects of moisture on weight, cost benefit analysis and construction requirements were evaluated for the three materials. The susceptibility of the materials to fire was evaluated. It was found that, the cost of constructing reinforced concrete fascia is 46% higher than EPS fascia of comparable size. Also, timber gains 16.67% increase in weight when exposed to moisture while EPS gained only 7.69%. In terms of fire resistance, timber has the least tolerance with a temperature range of 140-180°C followed by EPS with 180-210°C while concrete ranges between 300-650°C. However EPS is normally installed with a concrete cover on the inner phase thereby utilizing the fire resistance of concrete on that face. Thus, expanded polystyrene is an excellent replacement for timber and concrete (conventional materials) in fascia construction.

Keywords: *Expanded Polystyrene; Fascia*; *Reinforced Concrete; Timber;*

i.hassan@futminna.edu.ng

1.1 Introduction

With the evolving technology around the world, there is an invariably commensurate upgrade in the building materials in use in our contemporary society. This change however is fought constantly by the individual professionals in the construction industry. One of such materials that have suffered from this dismal trend to stick to the status co is the expanded polystyrene (EPS) which though, is an innovative and reliable material with alternative uses, have not been truly put to consistent use in the Nigerian construction industry. EPS has a variety of uses which includes walls, ground stabilization, ceiling, cornices, and fillers for light weight floors and in more recent time fascia for roofs.

Fascia is any material usually nailed to or attached to the free end of the rafters or the outer face of the cornice which can be a flat board, band, or moldings of composite or simple material that is designed to sometimes include the gutter and finished in such a way as to enhance the aesthetic outlook of the building.

The word fascia derives from Latin "fascia" meaning "band, bandage, ribbon, and swathe". The term is also used, although less commonly, for other such band-like surfaces like a wide, flat trim strip around a doorway, different and unattached to the wall surface.

EPS is a lightweight material that has been utilized in engineering applications since at least the 1950s. Its density is about a hundredth of that of soil. It has good thermal insulation properties with stiffness and compression strength comparable to that of medium clay (EPG 2013).

EPS is an organic insulation that displays a positive eco-balance. It 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 displays low thermal conductivity, lightweight, mechanical resistance, moisture and chemical resistance, ease of handling and installation and versatility, making it more suitable for building construction than the conventional sandcrete system (Ogundiran and Adedeji, 2012; EPG 2013).

The EPS fascia is an alternative to the conventional concrete fascia and the cast in-situ roof cornices that require formwork for construction. There are two different categories of fascias which are the structural and the nonstructural fascias. The structural is reinforced with wire mesh and shotcreted on the site whereas the non-structural is finished with a thin layer of plaster from the factory. The non-structural fascias are usually used for improved aesthetics only where no load will be imposed.

EPS is a multipurpose plastic material made accessible for a collection of uses. EPS has encountered extensive variety of utilizations attributable to its lightweight, inflexibility, warm and acoustic protecting properties. Initially, EPS was chiefly utilized for protection form for shut hole dividers, rooftops and floor protection. In any case, the application has expanded tremendously in the building and development industry such that EPS is currently utilized as a part of street development, extensions, floatation and wastes. EPS utilized for building development are of changed sorts and sizes with the most widely recognized ones being for divider boards and for section. These boards are built with steel networks. The steel lattice serves as support. The EPS 3D fortified divider framework more often than not exchanges shear and compressive strengths along the divider plane. The divider framework is finished by applying solid layers of worthy thickness on both sides to perform the double elements of securing the fortifications against erosion and for exchanging the compressive powers (Ede and Ogundiran, 2014).

The EPS piece is the first primary item from which every single other item are determined. The piece itself has discovered applications in earth development including soil adjustment, street development, retaining walling and decks (Ogundiran and Adedeji, 2012). The square comes in 1200mm x 600mm x 6000mm. The EPS belt or cornice is one of the subordinates of the EPS piece.

The EPS sash or cornice is a distinct option for the customary solid belt and the cast in-situ rooftop belts that requires formwork for development. EPS sashes are in different shapes and sizes, ranging from 3000mm x 300mm x 300mm to 3000mm x 600mm x 600mm. There are two distinct sorts of EPS belts. These are the auxiliary and the non-structural sashes. The basic belt is fortified with wire network and shotcreted on the site while the non-basic is done with a meagre layer of mortar from the manufacturing plant. The non-basic sashes are generally utilized for upgraded style just where no heap will be forced.

(a) (b)

Fig. 1 (a) Structural polystyrene fascia reinforced with wire mesh and shotcreted (b) Non-structural fascia finished with a thin layer of plaster

2.1 Methodology

The research design for this study is mainly quantitative in nature with the data been sourced from both primary and secondary sources. The primary data were basically obtained from the test carried out to determine the effect of moisture and heat on the various fascia materials under consideration. The weights of the respective materials were compared before and after absorption by using standard 500mm sample sizes. Furthermore, the effect of heat was also carried out on standard 500mm sample sizes. The secondary data were obtained from documented records of tests and experiments conducted and carried out on the product by the company for the purpose of standardization. These data were made available to the public through brochures and catalogue and published articles in scholarly journals.

Comparative cost analysis of the respective fascia materials was carried with respect to the unit cost and cost of installation.

3.1 Results and discussions

3.2 Comparative assessment of the weight and water absorption of fascia materials

The results of the assessment of the weight of respective fascia materials as presented in Table 1 shows that there is a relatively large amount of load on the structure coming from the reinforced concrete fascia of 500mm length. The weight of 450mm reinforced concrete facia is 12 times greater than that of timber and 33 times greater than that of polystyrene. If this load is not properly handled and transmitted to the foundation, it can cause serious defects to the building in the form of cracks and even in extreme cases, total collapse of the structure. The water absorption of the respective facia materials as presented in Table 1 revealed that timber has higher water absorption which is 11.7% and 9% higher than that of reinforced concrete and polystyrene respectively. This difference in the total absorption can be attributed to the fact that the wood fibers have higher affinity for water absorption when compared to equal section of reinforced concrete. In addition, the thin layer of mortar finishing provided on face of the polystyrene coupled with the fiber mesh are responsible for the 7.7% water absorption. Though the expanded polystyrene has a relatively higher response to water absorption than reinforced concrete, the implication has higher magnitude in reinforced concrete over a long period of exposure due reinforcement corrosion.

Table 1. Summary of the weights

S/N	Particulars	Timber	Reinforced concrete		Polystyrene	
			300mm	450mm	300mm	450mm
1	Weight of 500mm	4.0kg	25.4kg	40.5kg	1.3kg	1.5kg
2	Weight of 1m	8.0kg	50.8kg	80.1kg	2.6kg	3.0kg
3	Total weight on structure	465.92kg	4665.02kg	5958.59kg	151.42kg	174.72kg
4	Water Absorption	16.67%	4.94%	5.91%	7.69%	7.69%

3.3 Comparative costing

The results presented in Table 2 shows that the lowest cost of construction for fascia is that of timber. However, timber has been known to be associated with a lot of maintenance issues within the life span of the building as presented in Table 3. Review of life cycle costing revealed that timber has the highest cost because of its high maintenance cost, followed by concrete which has high initial cost as shown in Table 2. Expanded polystyrene happens to be a fair balance of the two materials cost.

Table 2. showing the cost for the various types of materials

S/N	Type of material	Sample Size	
		300mm	450mm
1	Expanded polystyrene	₦ 176696	₦ 333944
2	Reinforced concrete	₦ 393800	₦ 472560
3	timber	₦ 81850	Nil

Table 3. Summary of cost and benefits incurred in each construction process

s/n	Particulars	Timber	Reinforced concrete		Polystyrene	
			300mm	450mm	300mm	450mm
1	Monetary cost	₦ 81850	₦ 393800	₦ 472560	₦ 176696	₦ 333944
2	Weight on the structure	465.92kg	4665.02kg	5958.59kg	151.42kg	174.72kg
3	Time involved	2days	5days	5days	2days	2days
4	Reaction to moisture	16.67%	4.94%	5.91%	7.69%	7.69%
5	Susceptibility to insect attack	attacked	Not attacked		Not attacked	
7	Possibility of delay in process	Not likely	Very likely		Not likely	
9	maintenance	Replacement	Repainting		Repainting	

3.4 Susceptibility to Fire

Table 3 shows the temperature range at which the various materials under consideration are affected by fire. The information has been put into ranges because it is difficult in practice to ascertain exactly the temperatures at which these various materials are affected due to the variation in the materials properties.

From the data presented, concrete has the highest temperature allowance followed closely by polystyrene and lastly timber. However in practice, the internal face of the installed polystyrene is covered with concrete thereby allowing the installed fascia to exhibit a combined resistance of both the factory installed fire retardant coating and that of cast in place concrete provided in the site.

Table 4. Temperature at which different materials are affected by fire

S/N	Material	Upper Limit (˚C)	Lower Limit (˚C)
1	Timber	140	180
2	Concrete	300	650
3	Polystyrene	180	210

3.5 Other Considerations

From the considerations presented in Table 5 it is clear that the conventional fascia materials have a lot of processes and their associated cost. These processes if not well coordinated and properly handled could lead to disastrous consequences. It can also be noted that there is a lot of supervision required for the installation of formwork, reinforcement and other wood work involved in the installation of the traditional fascia materials. On the other hand; the installation of expanded polystyrene fascia is more of a specialist process that requires very little supervision.

Table 5. Other considerations

s/n	Particulars	Reinforced concrete	polystyrene	timber
1	**Scaffolding**	**Required**	**Required**	**Required**
2	**Formwork**	**Required**	**Not required**	**Not required**
3	**Reinforcement**	**Required**	**Not required**	**Not required**
4	**Bracing**	**Required**	**Required**	**Not required**
5	**Concrete gang/ mixer**	**Required**	**Not required**	**Not required**
6	**Casting of concrete**	**Required**	**Not required**	**Not required**
7	**Curing/ curing time**	**Required**	**Not required**	**Not required**
8	**Striking of formwork**	**Required**	**Not required**	**Not required**
9	**Supervision**	**required**	**required**	**required**

Conclusion

From the array of data available and the preceding discussions, the following conclusions can be drawn

i. The weight of 450mm reinforced concrete facia is 12 times greater than that of timber and 33 times greater than that of polystyrene.

ii. The water absorption of the respective facia materials as presented in the study revealed that timber has higher water absorption which is 11.7% and 9% higher than that of reinforced concrete and polystyrene respectively.

iii. Reinforced concrete facia generally has higher initial cost of installation which is 55% and 116% greater than that of polystyrene and timber respectively. On other hand, timber has higher maintenance cost in comparison to concrete and polystyrene which is as a result of issues relating to insect attack, susceptibility to moisture penetration, repainting and replacement.

iv. Concrete has the highest temperature allowance followed closely by polystyrene and lastly timber. However in practice, the internal face of polystyrene is covered with concrete while the external face is coated with fire retardant mortar thus enabling it to exhibit the fire resistant characteristics of both materials.

Generally, conventional fascia materials have a lot of processes and their associated cost while installation of expanded polystyrene fascia is more of a specialist process that requires very little supervision.

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