

Acceptability of Plastic Materials for Structural Applications in Nigerian Buildings

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Abstract—*In lieu of the fact that plastic materials have many unique properties, they are in several new applications. This research studied the application of plastic materials in Nigerian building industry, the extent to which plastic products are being used in Nigeria for structural elements in building construction and factors affecting the choice of plastic materials in the Nigeria building industry. This was done through the distribution of questionnaires and interviews with key persons in the construction sector in order to map their perceptions and personal experience. Companies, research institutes and building sites using various forms of plastic material for building construction were visited. Statistical methods were used to analyse the data. The outcome of this research shows that the level of acceptability of plastic materials in Nigerian construction industry for structural purposes is not very good. Polyvinyl chloride and polystyrene are the most used plastics and they are applied in pipes, finishes, ceiling, wall panels, windows and doors while advanced plastic materials such as fibre reinforced polymers are not widely used.*

Keywords— *Plastic Materials, FRP, Construction Materials, Affordable Houses, Performance Acceptance.*

I. INTRODUCTION

Over the last five decades, there has been a rapid and dramatic rise in world population. Most of this growth is now taking place in the developing nations and the demand for affordable buildings is very pressing. Building means any structure that is used for supporting occupancy or sheltering while building construction involves the use of different materials in the creation of the structures. Building materials have developed due to advancements in knowledge, from huts made of earthen bricks of the Middle East [1] to the development of concrete then followed by the advent of reinforced concrete and also steel, furthermore to the advent of fibre reinforced concrete, self-compacting concrete, high strength concrete, smart concrete, fibre reinforced composites and many other materials that can be applied in civil engineering construction, especially building construction. Building construction is currently one of the largest industries worldwide. In the US, new construction was estimated to cost about 620 billion US dollars, and with renovation, maintenance and repair added together to make the total volume of construction to rise to about 1000 billion US dollars (during 1997-1998), corresponding to 12.3% of the GDP. In the EU, the construction market was about 400 billion pounds in size (in 1997) with an annual growth of about 2-3%. Within building construction, residential construction has the highest share in general (approximately 40%), followed by commercial institutions (30%), public works (20%) and industrial constructions (10%) [2].

In Nigeria, there has been an explosive rate of population growth and subsequently an increase in construction process. This rapid rate of growth has not only progressively complicated and exacerbated inter-related problems of human settlements, environmental degradation and accelerated poverty, but the demand for affordable infrastructure, basic services and housing in growing urban setup have ever been on the increase. Based on these, it will be expedient to discover other materials with advantages over the usual construction material, with the potentials of substituting them or reducing the reliance on them. Such materials must have superior advantages including cost effectiveness, durability, ease of installation, etc. One of the limiting factors in Nigeria however, is the availability of most of the new types of building materials. In building and infrastructure, cement and steel have been the two basic building materials adopted. Cement concrete combined with steel to produce reinforced concrete are used for basic structures such as dams, bridges, buildings etc. In many of these applications conventional plastics do not come near them from the angle of technical and economic considerations. But today, apart from Concrete, timber and steel which are the classic and common materials, there is also a variety of novel materials being used in the same sector, and their use is ever increasing and replacing the conventional ones. Timber and composites of various ligno-cellulosic fibres with plastics are being used in large proportions in construction today. Today, the choice of materials are based on availability of materials, strength, cost of material, ease of erection, aesthetics, sustainability and environmental considerations [3], [4]. The building and construction sector is, of course, fundamentally concerned with long-lasting products and materials that also require less maintenance and that are also environmentally friendly. The choice of materials should not depend only on the purchase and installation cost, but also on the cost of repair, maintenance and replacement of short life-span products. Less durable materials may be cheap to buy but repair or replacement costs are usually high [5]. For example, the service life and usefulness of the building can be shortened due to deterioration of buildings and the corrosion of metallic constructions caused by natural environmental effects and anthropogenic pollution. Some factors that ultimately influence a designer's choice of materials are strength, cost, aesthetics, environmental impact, design suitability, availability, manufacturing process, etc.



Increased pressure to increase strength, reduce sizes, cost, energy use and delivery time is the trend a highly globalized and carbon-sensitive environmentalist world of today. There are lots of applications like residential buildings where time, cost, speed, quality, quantity etc. are beginning to go in favour of plastic materials.

Plastics and polymers are abundant and easily accessible. It is the latest family of materials having many unique properties and is therefore used in several new applications, driving new innovations and path breaking products and solutions while changing the way we live [6], [7]. While concrete may be the icon of the industrial built-environment, it is plastic which is the pre-eminent symbol of modern industrial innovation. As such, plastics are inextricably a major part of the contemporary building industry [8]. More so, the need for new ecological equilibrium in the world has led researchers into the embracing of materials that are more environmentally friendly and this has brought about greater adoption of plastic based materials in the construction industry [9]. Plastics are playing an increasingly high role in the field of infrastructure and building and this sector is the second largest consumer of plastics. The applications range from structural to non-structural uses inside and outside the building, i.e., for pipes, fittings, valves, heavy duty uses and structural members. Depending on the merits of each material, designers, structural engineers and architects now have a wide array of traditional materials, pre-engineered materials, plastic materials or a blend of different materials to choose from.

Plastics are building a reputation for durability, aesthetics, easy of handling, high performance and superior corrosion resistance. These qualities also have combined with plastics' high strength-to-weight ratio to produce materials for bridge construction, including tough reinforcement rods, non-skid surfacing and quickly installed replacement decking and for strengthening and retrofit of deficient structures [10], [11]. Plastic formwork systems are driving innovations for speedy and high quality construction for all income groups of society and cladding or panelling materials are helping to improve aesthetic and increase speed of works. Members of plastics family like polyurethane and expanded polystyrene are helping in energy conservation and are thus indispensable for creation of green built spaces. Even in respect of roofing, plastic coatings and plastic materials are bringing down energy consumption. It is not a common practice to see structures having some of their structural members made of plastic material and yet not recognizable as plastic material. For a country like Nigeria that has a large and rapidly increasing population, provision of sustainable and affordable housing is essential. For that, this research aims to study the extent of application of plastic materials for structural purposes in Nigerian building industry. This study therefore seeks to know the level to which plastic materials are used for structural components of building construction in Nigeria. The extent to which plastic products are being used in Nigeria construction industry will be evaluated via statistical methods while the factors affecting the choice of plastic materials in the Nigerian building construction industry will be rigorously highlighted.

II. METHODOLOGY

This research is on the use of plastic materials in Nigerian construction industry. It considers the areas of application, why it was used, its advantages and benefits over the conventional building materials. The research will develop a set of useful knowledge bases and structured 'selection' systems that will serve as the basis for evaluating the use of plastic building materials in terms of their sustainability and characteristics. The research methodology involves visiting research institutes for information on the use of advanced plastic materials and building sites that might be using any form of plastic material in their building construction and gathering relevant data from the specified sources. The methods of research includes literature investigation regarding plastic building materials, interviews with key persons including researchers, contractors, engineers, architects and builders in order to map their perceptions and personal experiences, and field observations of housing projects. The plastic material for structures will be compared with the use of conventional materials, high-lightening the application in Nigeria, using Abuja and Lagos State as a reference.

The research will utilize both quantitative and qualitative data collection tools. Initially, a survey of the environment where building construction is taking place and areas with large buildings that may involve the use of advanced plastics in their construction will be carried out. A structured observation of the roles the materials play will also be noted. Subsequently, a purposeful sampling of 10 companies and multiple interviews are planned with a number of individuals relevant to building construction to provide more in-depth information collection. Electronic materials and materials from the internet (World Wide Web) will be consulted to compare and validate as much as possible the collected data. The data collection will consist of surveys, observations and interviews/questionnaires with engineers, building technologists, and relevant staff of institutions and companies involved in plastic material technologies. Procedure of the research will be as contained in [12]. (Ndububa, 2013).

III. RESULTS AND DISCUSSIONS

Results of the findings are presented here after visits to different companies, research institute and interviews of professionals in the construction industry. The findings are presented and evaluated in line with the aims and objectives of this study. Seven companies and research institutions were consulted on their products and ideas on plastic materials used in constructions in Nigeria.

They are the International Building Products, Abuja; J & L Energy Plastic Industry Company, Ojodu; Manweb Nigeria Limited, Ikeja; Purechem Manufacturing Limited, Isolo; United Windows and Doors Company, Abuja; Polystyrene Industries Limited, Abuja and the Nigerian Building and Road Research Institute (NBRRI), Ota. Common products produced, handled and known to them are concrete plasticizing admixtures, Polystyrene, PVC panels, pipes, windows and doors. Common areas of application of available products are as plasticizing admixtures, for grouts, anchors, concrete repairs, industrial flooring, protective coating, joint sealants, waterproofing, adhesives and electrochemical applications. Polystyrene products are used for expansion joints, wall panels and general building construction while PVC products are for pipes, doors, windows, wall panels, ceiling panels and fabricated houses. Fibre Reinforced Polymer (FRP) are produced at a very low level. Fifteen building construction professionals were interviewed for this research as shown in figure 1.

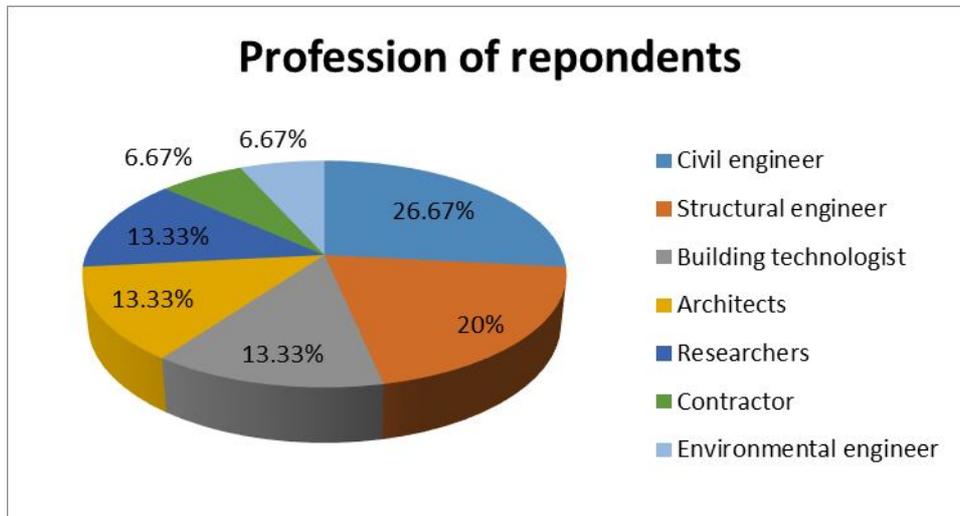


Figure 1: Profession of respondents

They all gave their views on the use of plastic materials in building construction in relation to the knowledge they have from building construction. The use of plastic materials in building construction in Nigeria is outlandish because many other persons had very minimal knowledge on the use of plastic materials in building construction. For a general study with individuals related to building construction, to get effective answers, examples of types of materials had to be mentioned or else the answers from the respondents were that plastics are not used at all in building construction. Most used plastic materials in Nigerian construction industry are shown in figure 2. Figure 3 shows the common applications and the volumes of plastic in Nigerian construction industry.

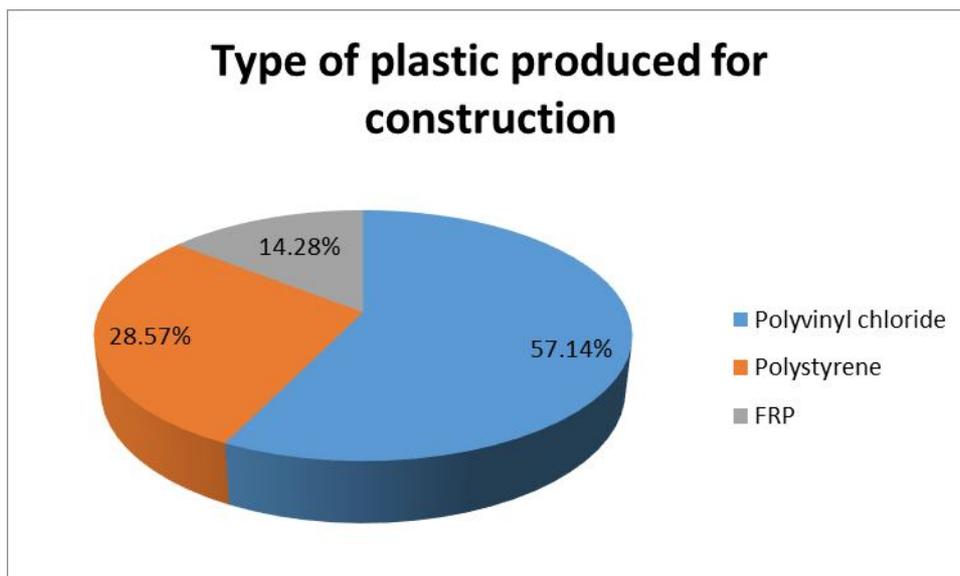


Figure 2: type of plastic produced

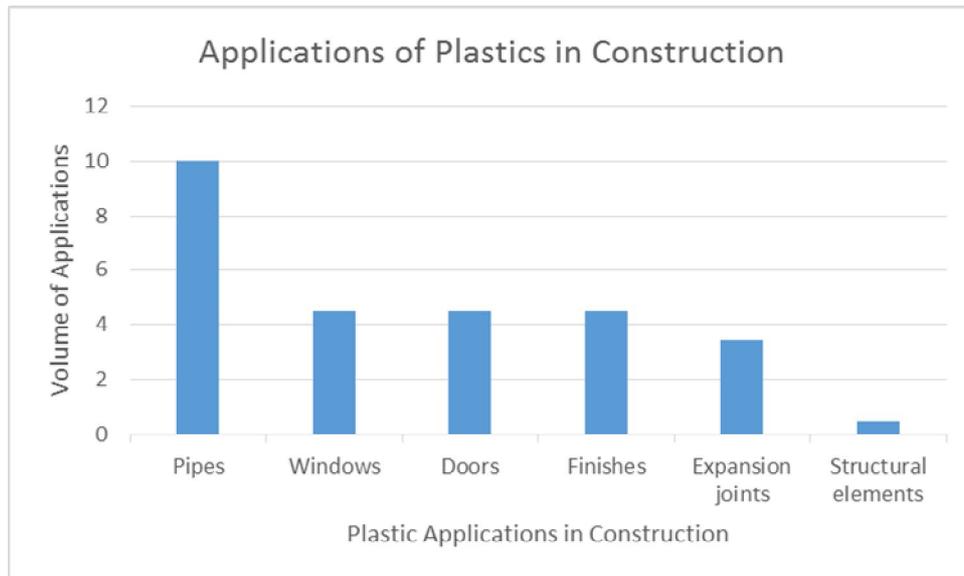


Figure 3: Application of Plastic Materials in Nigerian Constructions

Polystyrene is used for expansion joints and structural elements while PVC is for pipes, windows, doors and most finishes, PVC is applied. PVC is the most produced and used plastic material for building construction in Nigeria today as seen in figure 2. Factors influencing the choice of plastic material in Nigerian construction industry is shown in figure 4.

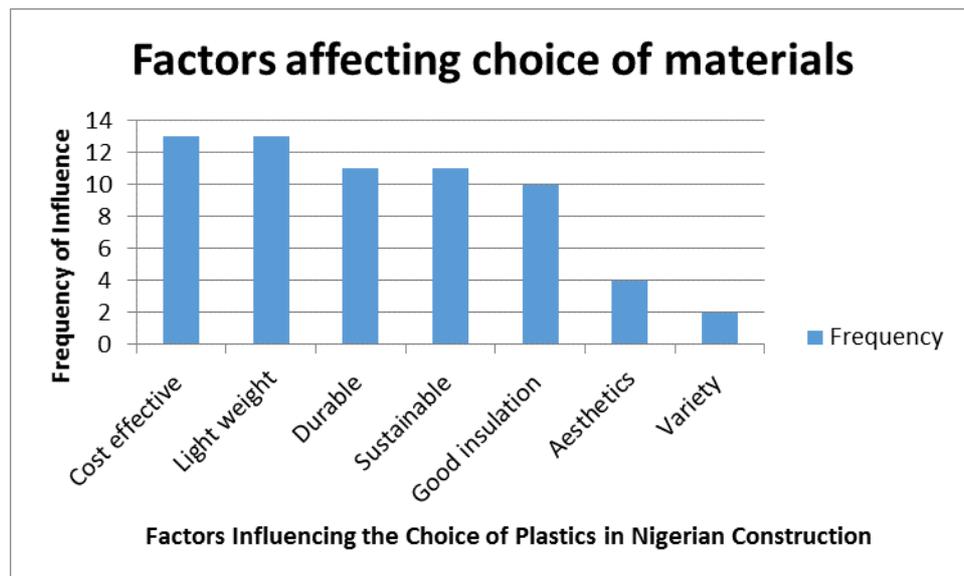


Figure 4 Factors influencing choice of materials

Cost effectiveness and light weight have been the highest driving factor for the acceptance of plastic materials in Nigerian construction industry. This can be attributed to the fact that economy is a major factor being considered in building construction. Light weighted materials are easy to transport and install without affecting the design properties of the structure. The next is durability and sustainability. This is because most designers and owners will want their material to last for a long time and be sustainable or maintain. This factor can also be traced to cost effectiveness because money is saved in minimum maintenance and less frequent replacement of material. The rating of acceptance of plastics in structural applications in Nigerian building construction industry is low, while the rating of satisfaction on the existing applications of plastic materials is averagely good. Therefore, in design and selection of a material for building construction, plastic materials are rarely applied for structural components. The conventional materials (cement, wood and steel) are still dominant in application. This can be a factor affecting the level of advancement of plastic materials for structural applications in Nigeria. Some of the common products and applications are shown in figures 5 to ...



Figure 5: a complete assembled PVC structure used as an office in IBP industry, Idu yard, Abuja.



Figure 6: Polystyrene meshed panels used as wall panels on a building site in Maitama, Abuja



Figure 7: A Finished Building Construction in Abuja where EPS was used

IV. CONCLUSION AND RECOMMENDATION

The research studied the extent of application of plastic materials for structural elements in Nigerian building industry. It was discovered that plastic materials are applied in only minor parts of structural components of building construction in Nigeria compared to many advanced countries such as the United States of America, China and Japan. Polyvinyl chloride and polystyrene are the major plastics used in construction as they are applied in pipes, finishes, windows, doors, expansion joints and structural components. Cost effectiveness and light weight have been the highest driving factor for the acceptance of plastic materials in Nigerian construction industry. The rating of acceptance of plastics in structural applications in Nigerian building construction industry is low, while the rating of satisfaction on the existing applications of plastic materials is averagely good. These research results will form the basis for further research on the use of plastic materials for structural components of building construction in Nigeria.

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