INVESTIGATION INTO THE PROPERTIES OF LONG-SPAN ALUMINIUM ROOFING MATERIALS USED IN CONSTRUCTION INDUSTRIES IN NIGERIA

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ABSTRACT

The paper presents the results of experimental investigation on the properties of Aluminum long-span roofing sheets used in building construction in Nigeria. The determination of the properties was done in accordance with ASTM E-466(2000) and NIS 488(2004) using specimens manufactured by three most common aluminum roof material producers in Nigeria. The three most common gauges: 0.45, 0.55 and 0.70 were chosen for the investigation. The results of the tests revealed that the tensile strength, flexural strength and the impact resistance properties increase as the thickness of the aluminum sheet materials increases. The specific gravity of the specimens, also, increases with the thickness of the materials. These results are in consistency with the ASTM standard. It is also evident from the results that the specimen gauge of 0.45 failed to meet the ASTM E-466 and NIS 488 standards for all the variants of the roofing sheets. It is therefore recommended that 0.55 gauge should be the minimum thickness for structural aluminum roofing sheets in the Nigerian building industry.

1.0 INTRODUCTION

Long-span Aluminum roofing products have been discovered lately to be largely replacing other roof covering materials such as asbestos, clay tiles, concrete, asphalt shingles, etc. in construction industry in Nigeria. This particular trend in building industry has led to importation of different variants of this material. Aluminum roofs come in a great variety of beautiful colours designed to accent the style and add grace to our homes. Earlier report in Roofing Directory (2008) reveals that aluminum roofing material is one of the most common metal roofing materials widely used in roof industry across the world. This wide acceptance may not be unconnected with its properties that were reported by Baker (1984) and Smith (2008) which include strength, lightweight, rust resistance and attractive posture. Its numerous benefits include durability, easy installation, easy to work with and lightweight, energy efficiency and rust resistance among others.

Premature structural roof collapses have been recorded in building industry as a result of the use of less than adequate roofing materials for the environment to which the roof is exposed. For instance, asphalt shingle roof is reported to start losing its protective properties once it becomes exposed to the action of sun, wind, snow, rain and ice. Also Aluminum roofing materials have been preferred to steel galvanized roof materials in coastal areas where heightened concentration of salt in the environment can make the steel materials susceptible to corrosion over the time (Smith, 2008). In choosing an appropriate roof material, it is necessary to consider economy, quality, aesthetics, as well as application and service life. Most materials used today in Nigeria roof industry are factory finished sheets referred to as prefabricated roofing sheets (Queensway Aluminum, 2007). Some appear of much higher quality while some are easily punctured, cut-burnt or deteriorated by common contaminants. The performance behaviour of many variants of the long span aluminum roof materials used in roof industry in Nigeria has elicited the investigation into the properties of the materials

2.0 MATERIALS AND METHODS

2.1 Materials: There are various types of long-span Aluminum roofing products used in Nigerian construction industry. These products can be analysed based on their profiles, Gauges (thickness), colours, flashings and other fixtures. Samples of Aluminum material used for the tests were obtained from three Longspan Aluminum manufacturing companies namely; Queensway Aluminum company Ltd, Kaduna; First Aluminum Ltd, Port-Harcourt and Qualitec Aluminum Ltd, Abuja. The materials were obtained in three common thickness variants of 0.45mm, 0.55mm and 0.70mm gauges.

2.2 Methods: Tensile strength, flexural strength, specific gravity, impact resistance and weather resistance tests were carried out in accordance with the relevant standards on at least three samples of each variant thickness for each identified manufacturer.

2.2.1 Tensile strength test. The tensile strength test was carried out in accordance with ASTM E-466: 2000. A 50mm x 150mm sized specimen was loaded destructively using Makewa universal testing machine of 98.07kN capacity. Load was applied at rate of 7.84N/mm per second until the specimen failed in tension. The test was repeated for all the selected samples and average values taken. The result is as presented in Table 1.

Table 1: Tensile Strength of Longspan Aluminum Roofing Sheets Tested.

Manufacturer	Profile Thickness (mm)	Load (kN)	Average Tensile Strength (N/mm^2)
First Aluminum	0.45	0.63	28.00
	0.55	1.30	47.00
	0.70	2.52	72.00
Qualitec Aluminum	0.45	0.60	27.00
	0.55	1.10	40.00
	0.70	2.35	67.00
QueensWay Aluminum	0.45	0.65	29.00
	0.55	1.35	49.00
	0.70	2.70	77.00

2.2.2 Flexural Strength Test. The compressive strength test was also carried out in accordance with ASTM E- 34: 2000 and NIS 488:2004. The same sized specimen was tested using simple compression equipment with magnifiers as the free end was bent to angle of 90^o in a smooth and uniform manner. The operation continued until the bent end completes a 180^o bend. The bent specimen was then examined for possible cracks using lens or low power microscope. The results on the three thickness variant of the manufacturing company as test are shown in Table 2.

Table 2: Specific Gravity of Longspan Aluminum Roofing Sheets Tested

	Profile Thickness (mm)	Specific Gravity	Observations
First Aluminum	0.45	1.32	Minor Cracks
	0.55	1.34	No Cracks
	0.70	1.41	No Cracks
Qualitec Aluminum	0.45	1.26	Visible Cracks
	0.55	1.39	Minor Cracks
	0.70	1.42	No Cracks
QueensWay Aluminum	0.45	1.44	Minor Cracks
	0.55	1.45	No Cracks
	0.70	1.51	No Cracks

2.2.3 Specific Gravity Test. The test was conducted in accordance with the Archimedes principles using the pyconmeter bottle. The result is as shown in Table 2.

2.2.4 Impact and Weather Resistance Test. Impact and Weather Resistance tests were conducted in accordance with NIS 487:2004 using rapid deformation, ultra –violet ray light, oxygen and water. The specimen used was 100mm x 200mm in size for both tests. The test results are as shown in Tables 3.

Table 3: Impact and Weather Resistance of Long span Aluminum Roofing Sheets Tested

Specimen	Profile Thickness (mm)	Impact Resistance on 14mm punch size	Weather Resistance	
			Corrosion	Fungi growth
First Aluminum	0.45	Slight crack(4.6mmØ)	Free	No Attack
	0.55	No Crack		
	0.70	No Crack		
Qualitec Aluminum	0.45	Visible Crack(10mmØ)	Free	No Attack
	0.55	Slight Crack(5mm Ø)		
	0.70	No Crack		
QueensWay Aluminum	0.45	Slight crack (3mm Ø)	Free	No Attack
	0.55	No Crack		
	0.70	No Crack		

3.0 ANALYSIS AND DISCUSSION

3.1 Tensile Strength: The result of the tensile strength shown in Table 1 showed that the tensile strength increases as the thickness of the various long-span Aluminum increases. When compared to provision of the ASTM standard which provided for 49N/mm^2 as the minimum tensile strength, it is evident that the thickness range of 0.45mm is unsatisfactory for all the variants of the long-span Aluminum tested. Also the 0.55mm thick products of First Aluminum and Qualitec Aluminum barely satisfied the minimum standard leaving only the 0.55mm of QueensWay Aluminum and 0.70mm thick products of all the Aluminum samples as satisfactory. According to NIS 488: 2004, the minimum prescribed standard thickness is 0.55mm. Any thickness less than this specified are easily susceptible to leakages and discolouration due to corrosion and tear. The variations in tensile strength may be as a result of production variants in the material properties. This is also depicted as in Figure 1.

3.2 Flexural Strength: According to NIS 488:2004 the Flexural strength of the aluminum materials is its ability to resist cracks or deformation when subjected to 180^o bend test. A comparison of compressive strength results of the three products tested in Table 2 shows that visible to minor cracks were observed in the 0.45mm thickness variant for all the products. Whereas Qualitect Aluminum brand of 0.55mm thickness still displayed evidence of failure in bending with minor crack, the 0.55mm thickness brands for First Aluminum and Qweensway proved satisfactory in bending. All the brands with 0.70mm thickness satisfied the bending stress test.

3.3 Specific Gravity: The results shown in Table 2 reveal that Specific Gravity increases as the thickness increases. All the values obtained in the tests are within the recommended values in the code.

3.4 Impact and Weather Resistance: The Impact and Weather resistance test results presented in Table 3 showed that the Aluminum brands displayed these same results as in bending stress test. Whereas the 0.45mm thickness failed impact tests for all brands, the 0.70mm thickness was satisfactory. Qualitec brand was adjudged weakest as its 0.55mm thick brand still failed the impact test. The results also indicate that all the Aluminum brands satisfied the weather resistance test in respective of the thickness variants. It shows that all the brands contain Aluminum Oxide's coating which provide resistant to attack by the environment. This simply implies that all the Aluminum brands are basically sound in terms of colours coated on them as they will stay many years without discolouring.

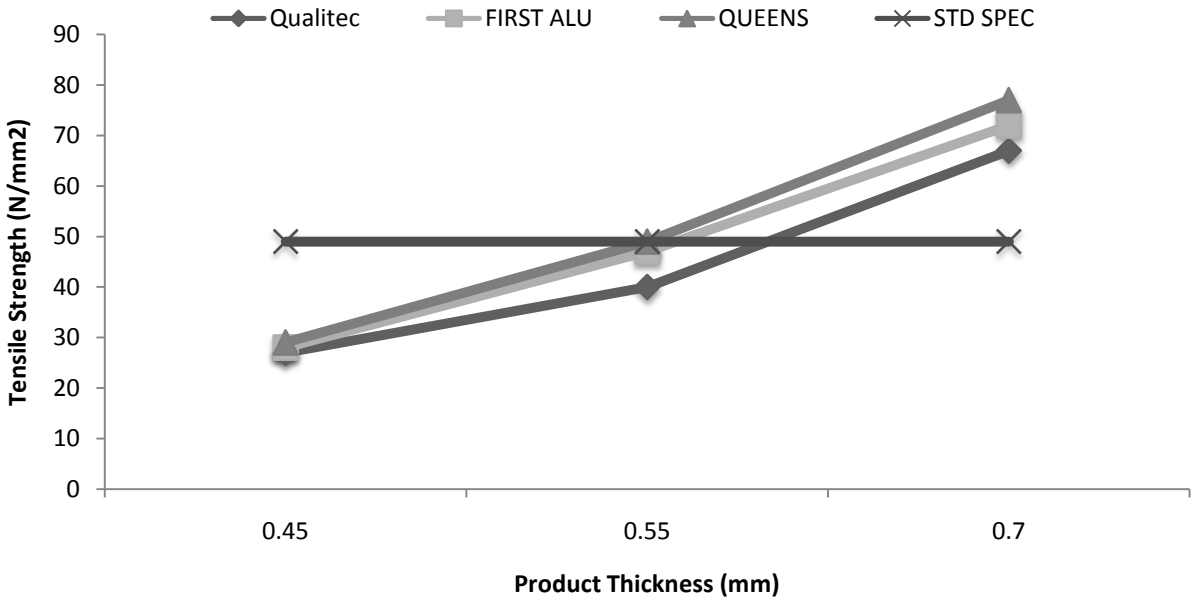

Figure 1: Tensile Strength of Long-span Aluminum Roofing sheets used in Construction Works in Nigeria

4.0 CONCLUSION

The results of the investigation into the properties of some long-span Aluminum roofing materials used in construction industry in Nigeria has been presented. The following conclusions are hereby made.

1. The strength of Aluminum roofing material increases with increase in thickness of the variants, which conforms with facts established in the literature.
2. The tests on the common thickness variants of 0.45mm, 0.55mm and 0.70mm showed that long-span roof materials of 0.45mm thickness failed all standard specifications of tensile, bending stresses and impact resistance test.
3. All the long span roof materials tested passed the specifications on weather resistance as there were no corrosion or fungi attack on the materials.
4. The quality grade of the three sample variants showed that Queenways Aluminum rates highest. This is followed

by First Aluminum and then Qualitec Aluminum.

5. It is recommended that 0.45mm thick of any long-span Aluminum products employed in roof work in Nigerian construction industry should be discontinued.

5.0 REFERENCES

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