

Quality Characteristics Assessments of Selected Profile Aluminium Sheets Industry in North-Central State, Nigeria

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Abstract: This study assessed quality characteristics of Profile Aluminium Sheets Industry in North-Central States, Nigeria. This helps in ascertain level of quality implementation acceptable standard by Nigeria Industrial Standard, NIS 488: 2010 (NIS, 2010). The industry include Eastchase Aluminium Markudi (A2), Altex Aluminium Lokoja (B1), Shelther Aluminium Ilorin (C2), Andy Aluminium Mararaba (D1), Quesway Aluminum Minna (E1). The quality characteristics test conducted on the profile aluminium sheet include coated characteristics, surface characteristics and chemical constituents of the profile. These include impact resistance, MEK double rub, physical requirement and chemical composition. The test was based on NIS 488: 2010 requirement (NIS, 2010). It was observed only Andy Aluminium Mararaba (D1) and Quesway Aluminum Minna (E1) met major requirement. This indicates majority of profile industries in North-Central State, Nigeria yet to full specification requirement of profiling sheets.

Keywords: Profile Aluminum Sheet Industry, Quality requirement and impact resistance.

I. Introduction

Nigerian industries face stiff competition of aluminium profiles against world manufacturers (Ayeni and Bakare, 2019, Akinwale and Bello 2020). The aluminium profile requires satisfying technological advancement in terms of customer needs (SON, 2015). The customer whose choice and taste remains ever-dynamic needs satisfaction of the produced products such as aluminium profile with notable quality (Nosakhare, 2000, Okeke *et al.*, 2022).

Defects of aluminium sheets can occur when the strip is rolled into a variety of aluminium sheet, and the sheet finishing and packaging and other processes of the production process (Chikhale *et al.*, 2016). Most of these defects are generated due to equipment failure, mishandling, and improper adjustment of process parameters, unskilled operators and various other causes. The quality defects are mainly a large number of pinholes, cracks, poor thickness tolerance and flatness (Xu, 2016, Florese *et al.*, 2015). Defects can also occur during the extrusion and drawing of aluminium. Some of these defects include die lines, scoring, pick up and tearing (Olaru, 2020). Pick up and die lines are particularly common in the 6 xxx series of Aluminium.

There are defects that also occur at the coating stage of aluminium sheet production. Some of the critical painting parameters are current, pressure, and nozzle size which all contribute to painting defects. The common defects are less microns, orange peel, dust particles inclusions, blisters and overlapping (Arif *et al.*, 2015). At the corrugation stage, breaking/creasing can occur along the formed sheet as it is being fed into the rolling system. The creasing occurs due to exerted force along bottom rolls. Misalignment of corrugations also occurs where the curved end width is different from that of the straight section of the sheet. Valley and wavy ripples occur across the curved sheet. Another common problem during corrugation is saw-tooth effects. It occurs when variation is obtained in desired length of sheet. This variation causes the sheet ends not to be lined up or having accurate length of sheet will not be achievable due to saw-tooth effects (Bluescope, 2013, Xu, 2016).

The monitoring of certain product results in determining the relevance of compliance to quality standards (Bhattacharya and Mookherjee, 2020). This leads to the removal of non-compliance products (Lakshmi, 2015, Chikhale *et al.*, 2016, Addy *et al.*, 2024, Agu *et al.*, 2024). However, this paper presents assessment of quality characteristics in North-Central States, Nigeria. This will help in conforming to quality implementation requirement by Nigeria Industrial Standard, NIS 488: 2010 (NIS, 2010). The quality of characteristics of profile aluminium sheet include visual inspection of defection and measurement of thickness, impact resistance test, gloss and chemical constituent requirement.

II. Materials and Methods

The material used for quality test assessment were corrugated sheets measured 930mm to 1000mm in nominal width and a nominal base thickness of 0.4 mm. These were used mainly for the physical measurements. Non-corrugated sheets were also used for the laboratory analysis and part of the physical tests. They had a nominal width and base thickness of 1200mm and 0.4 mm. The composition of the sheets was determined during the analysis as part of the quality analysis. The measuring equipment include measuring tape, digital Vernier calliper (capacity of 0-200mm). Spectrometer was equipment was used for determining the chemical composition of the base metal used in roofing sheets. The model name used in this study is Spectro Max from Germany and this has the capability of determining all known elements that are present as alloy in the roofing sheets. Impact tester: The impact tester was used to test the impact resistance of the profile roofing sheet. The Kamal brand manufactured by Kamal Metal Industry, India was used. The capacity of the tester was in ranges of 0 – 105 J. Gloss Meter: The gloss testing machine was used for determining

the gloss unit of the paint used for coating the aluminium profile sheets. The Gloss Meter was manufactured by PCE Instruments Company, Spain.

Impact Resistance



Gloss Meter Tester



III. Results and Discussion

The results showed quality test indicated coated sheet, surface and chemical constituents of the profile sheet. Table 1 showed coated sheet characteristics.

Table 1: Coated Sheet Characteristics

Company	Impact Resistance	MEK Double Rub	Gloss
Requirements	2J-5J	≥ 50	40-60
A2	2.25	100	26.4
B1	1.5	100	25.1
C2	2.25	30	24.2
D1	2	100	37.9
E1	3	100	46.1

The typed coloured results in Table 1 did not satisfy the required condition of quality requirement of impact resistance, MEK Double Rub and gloss. Table 2 is surface characteristics of aluminium profile.

Table 2: Surface Characteristics

Industry	corrugation number	Corrugation Depth	Pitch	width	thickness	Dry film thickness
Rqt	5 or 6	28m (min)	150 or 200	910 or 1000	0.4mm (min)	$18 \pm 2\mu\text{m}$
A2	5	23.2	200	1000	0.45	5
B1	5	21.5	200	1000	0.39	19.2
C2	5	27.8	200	1000	0.48	16.2
D1	5	28.1	180	900	0.45	17.5
E1	6	35	150	955	0.61	13.7

The typed coloured results in Table 2 did not satisfy the required conditions of physical measurement of aluminium profile. The physical measurement based on the bend test shows that all the companies satisfied the requirement condition in accordance with bending to satisfied the conditions of 0, 1, 2, 3 turns bend test. Table 3 showed the chemical composition of aluminium profile of each industry.

Table 3: Chemical Constituents

Profile Aluminium Sheets Industry						
Element	Rqt	A2	B1	C2	D1	E1
Al	96.1min	99.1	99.2	97.5	99.3	99.1

Cu	0.1	0.032	0.081	0.084	0.085	0.089
Mg	0.6	.0076	.0001	0.0029	0.0001	.0004
Si	0.6	0.086	0.035	0.385	0.044	0.049
Fe	0.7	0.54	0.51	0.52	0.388	0.56
Mn	1.5	0.017	.0005	1.41	0.0005	.0005
Zn	0.2	0.001	.0036	0.017	0.005	.0033
Ni		.0014	0.001	0.001	0.001	0.001
Cr		.0005	.0005	0.053	0.0005	.0007
Pb		.0013	0.002	0.0005	0.0019	.0018
Sn		.0049	.0057	0.0043	0.0054	.0059
Ti		0.025	0.018	0.019	0.015	0.02
Cd		.0009	.0009	0.0009	0.0011	.0013
others	0.2	0.034	.0281	0.0787	0.0249	.0307

where: Rqt is NIS (2010) requirement and Al= Aluminium, Cu=Copper, Mg= Magnesium, Si=Silicon, Fe= Iron, Mn=Manganese, Zn=Zinc, Ni=Nickel, Cr= Chromium, Pb= Lead, Sn= Tin, Ti= Titanium and Cd= Cadmium.

IV. Conclusions

Five industries were considered for quality test. The test results showed that the profile aluminium industry did not fully comply with the established standard. All the industries met requirement of aluminium alloy ≤ 96.1 wt %. Only one out of five industry did not meet the impact resistance requirement and it was Altex Aluminium Lokoja (B1). One industry, Shelther Aluminium Ilorin (C2) did not meet the double rub test. It was observed that only Quesway Aluminum Minna (E1) passed the gloss test. Similarly, Altex Aluminium Lokoja (B1) did not meet the base thickness requirement and Altex Aluminium Lokoja (B1), Shelther Aluminium Ilorin (C2), and Andy Aluminium Mararaba (D1), passed the dry film thickness test. The study has thus established that the profile aluminium produced by these industries do not fully comply with the requirements of NIS 488: 2010. However, this study outcome implies there are profile aluminium sheet industries in Nigeria with acceptable products but the quality process needs to be improved with standardisation approach.

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