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Research paper

Dispersion degree data and chemical properties of Nigerian steel bars used as structural element

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Abstract

The study was aimed at assessing degree of uncertainty, effect of water and other chemicals on both locally made and imported reinforcement used for structural elements via Optical Emission Spectrometry technique. Reinforcement from various locations in Lagos state, Nigeria was soaked with chemicals (NaOH, Na2SO4, H2SO4, HCl and H2O) to detect chemicals impact. The results indicated that Carbon, phosphorus and sulphur of Pulkit reinforcement was within ASTM limit. The severity of aqueous solutions on steel rebars was in the order H2SO4 > HCl > Na2SO4 > H2O for both local and imported local bars, while steel rebars were not affected by NaOH solution. Degree of dispersion (COV) of local steel was the highest. This was in terms of elongation of 23.69%, H2SO4 of 0.39% and 1.24% for one and six weeks respectively.

Keywords: *Structural Elements; Steel Bars; Chemical; Dispersion.*

1. Introduction

Reinforcement bars both local and imported have been used in various parts of the world as a methods of strengthening concrete works and frame structure stability. The application of chemicals on steel rebar isn't merely a brand innovative and trendy approach, but it reveals severe mass loss and the severity of aqueous solutions on rebars in construction works. The use of various chemicals on steel bars from south-west Nigeria is worth investigating upon since local producers used waste (scraps) as their major raw materials. Nigerian reinforcement and chemicals had been used in previous studies for several construction purposes [1–3].

2. Methods

Steel bars sampled from various locations (Yaba, Obalende, Sura, Agege and Ogba) in Lagos State, Nigeria were obtained from major distributors. Reinforcement were immersed inside containers with distilled water, and 5% solution of H_2SO_4, $Na2SO_4$, HCl, NaOH, that are in soluble water over a total period of six weeks. The five location samples obtained were analyzed for chemical
Constituents using Optical Emission Spectrometry technique as well as compared with ASTM A706/A706M [4]. The deterioration as a result of corrosion expressed as a function of mass loss increased curvilinearly with exposure period. Change in colour of each chemical reaction with steel bars was observed at 1st and 6th weeks, while degree of uncertainty (dispersion) for both local and imported steel bars was calculated with 16.0 SPSS software.

3. Results and conclusions

Chemical analyses of steel rebars with international limit are itemized in Table 1, also graphically represented with cluster dendogram and Predator in Figure 1 - 3. Cluster diagrams shows two clusters (A and B), Cluster A for all local reinforcement and Cluster B for imported steel. Predator diagram shows foreign reinforcement Ukraine as the target and all locally made reinforcement as the predictors.
Statistical parameters showing degree of dispersion (COV) of imported and local steel rebars (Table 2). Corrosion effect for all the Lagos steel bars at week 1 and 6 (Table 3).From the results, the severity of aqueous solutions on rebars was in the order H_2SO_4 > HCl > Na_2SO_4 > H_2O, whereas COV of local steel was the highest. This was in terms of elongation of 23.69%, H2SO4 of 0.39% and 1.24% for one and six weeks respectively.

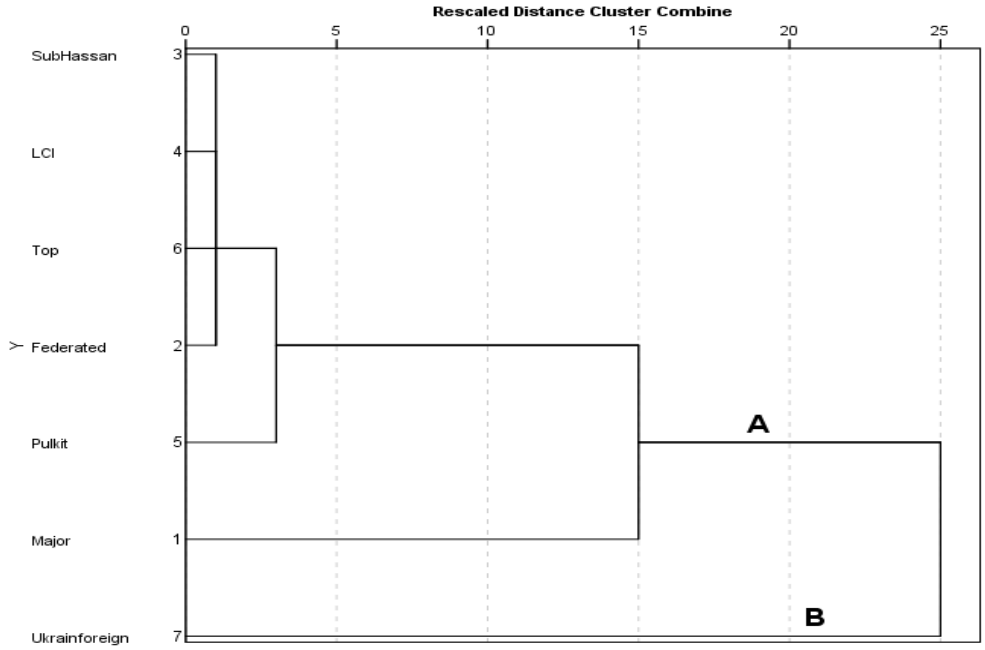

Fig. 1: Dendrogram Showing Two Group of Cluster for both Local and Foreign Reinforcement.

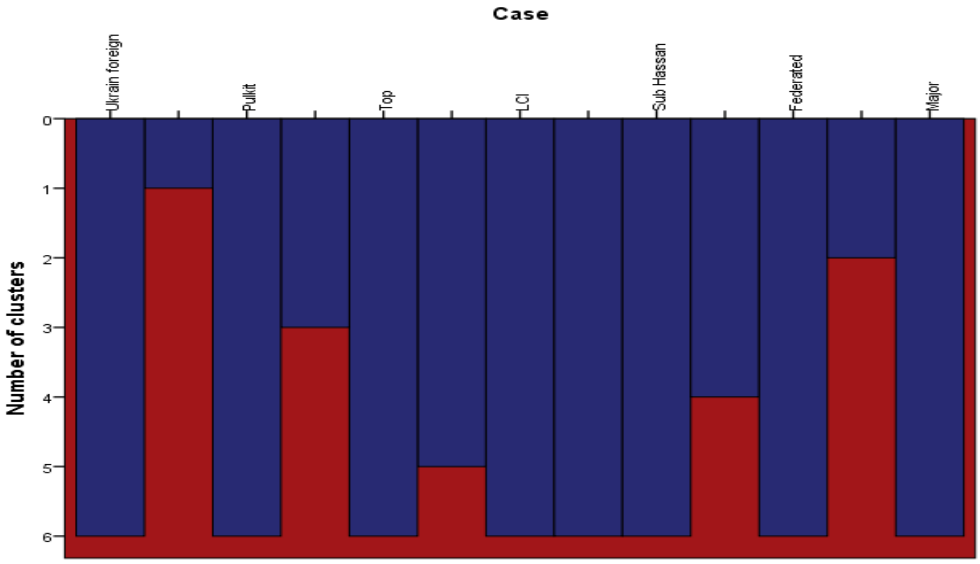

Fig. 2: Cluster Graph Showing Two Group of Cluster for both Local and Foreign Reinforcement.

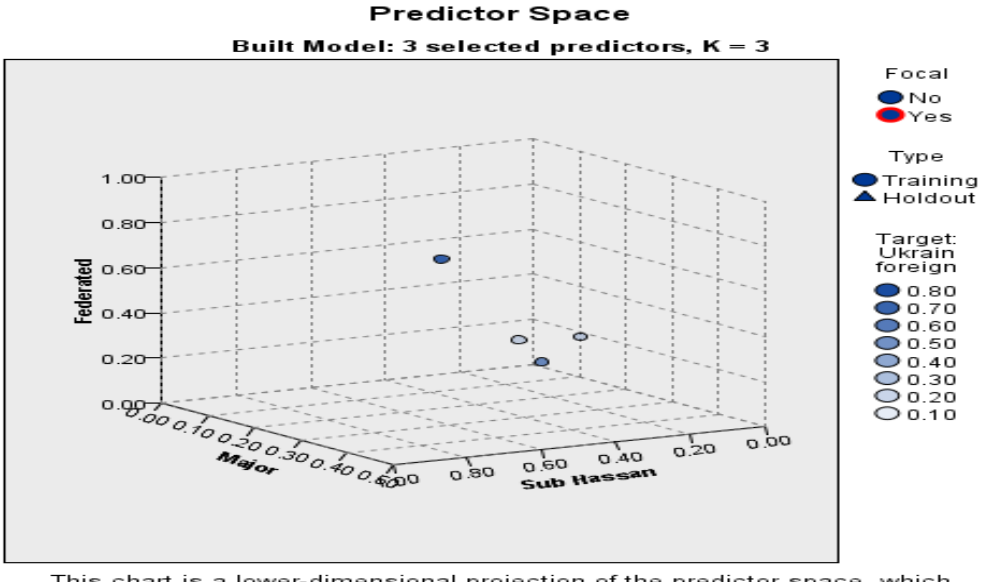

Fig. 3: Predictor for Target and Focal Showing Two Group of Cluster for both Local and Foreign Reinforcement.

Table 1: Chemical Analysis of Reinforcing Bars with International Standard

Chemical Content	Local reinforcement sources in Nigeria Major	Imported Federated	Sub Hassan	LCI	ASTM Pulkit	Top	Ukraine	Limit
Carbon	0.282	0.317	0.248	0.259	0.368	0.238	0.204	0.30
Silicon	0.174	0.247	0.256	0.272	0.293	0.251	0.182	0.50
Manganese	0.486	0.882	0.852	0.862	0.752	0.812	0.710	1.50
Phosphorus	0.059	0.053	0.052	0.043	0.061	0.061	0.505	0.06
Sulphur	0.055	0.053	0.055	0.053	0.052	0.054	0.042	0.05

Table 2: Corrosion Effect on Lagos Steel Bar

Solutions	Steel samples (all)	Result in changes					
		Week 1			Week 6		
		IM (g)	FM (g)	ML (%)	IM (g)	FM (g)	ML (%)
H2SO4		442.30	443.60	0.39	447.73	442.43	1.24
Initial colour	pale green						
Final colour	brownish						
Na2SO4		430.35	429.85	0.12	448.52	445.72	0.74
Initial colour	deep brown						
Final colour	brownish						
HCl		498.32	497.62	0.15	448.20	442.40	1.07
Initial colour	brownish						
Final colour	reddish brown						
NaOH		430.24	430.24	0.00	424.64	424.64	0.00
Initial colour	NR						
Final colour	slippery						
Water		442.85	442.75	0.02	420.94	419.40	0.38
Initial colour	slippery						
Final colour	brownish						

Note: NR denotes no reaction, IM means initial mass, FM and ML denote final mass and mass loss respectively.

Table 3: Statistical Parameters of Imported and Local Steel Rebars

Steel Bar Sizes (mm)	Coefficient of Variation (COV) imported bars Yield Strength (N/mm^2)	Ultimate Strength (N/mm^2)	Elongation (%)	Coefficient of Variation (COV) local bars Yield Strength (N/mm^2)	Ultimate Strength (N/mm^2)	Elongation (%)
10	3.18	5.52	14.10	13.77	14.16	21.75
12	2.54	4.16	9.27	9.55	9.42	13.21
16	6.61	8.37	9.65	10.57	8.83	10.43
20	2.76	16.66	10.59	10.20	13.57	19.65
25	7.18	8.25	21.83	16.02	18.74	23.69

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