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Research Paper

Corrosion Tests on Some Selected Building Materials Sold Around Sokoto Metropolis

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Abstract
Corrosion is one of the challenges we faced every day in virtually all sectors of the economy more importantly the manufacturing industry and this has resulted to serious economic loss. This research is aimed at providing information regarding the corrosive nature of some selected building material (Zinc Roofing Sheet, Aluminum Roofing Sheet, Iron Nail for Roofing and Binding Wire sold in Sokoto metropolis. Immersion test was adopted in testing the corrosiveness of the selected building materials and 0.1M and 0.2M hydrochloric acid were used as the corrosion test media. It was observed that Zinc Roofing Sheet recorded the highest % corrosion of 38.59% and 79.78% in 0.1M and 0.2M hydrochloric solution acid respectively during the 336 hours contact time while the Aluminum Roofing Sheet reported %corrosion of 19. 55% and 29.97% in 0.1M and 0.2M hydrochloric acid respectively during the 336 hours contact time.

Keywords: *Corrosion, immersion, Building material, Roofing material, Hydrochloric acid.*

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I. Introduction

Corrosion is the gradual deterioration of the useful properties of materials when they interact with their environment. The substances used in construction materials, process equipment including the products manufactured from them, are referred as materials. These materials are usually alloys, metals, ceramic, composite and polymer. Corrosion is also known as "rust". However, "rusting" is more appropriately reserved for corrosion of metals such as iron. As such, the terms "corrosion" and "rusting" are synonyms words. The predominant materials used in the design of various structural components that are affected by corrosion are Iron and its alloys. Corrosion is a spontaneous process as it occurs and progress as long as the corrosion conditions are satisfied. More so, nature designs materials to stay in their lowest possible state of energy (or most stable state) as such almost every metal/alloy has a tendency to convert into its stable oxide state. Therefore, most of the Iron/alloys have a tendency to corrode (when interact with water and air or oxygen) so that they can achieve most stable state. The losses due to corrosion are huge and significantly affecting the economy of many countries around the world. Corrosion can cause catastrophic failure to structural components such as buildings, bridges, pipelines (from gas/petroleum industry), automobiles, drinking water system, home appliances and even loss of lives (Mohebbi and Li 2011; Badara et al., 2014; Carvalho et al., 2014; Rocha et al., 2014; Olawale et al., 2015).

Corrosion tests are techniques employed to evaluate and select suitable material for a particular structural component. Evaluation of corrosion tendency of a material will allow to check the effectiveness of the applied corrosion control measures. These corrosion tests may be performed in laboratory, on site process plant, or in the field such as atmosphere tests. There are several methods in use for the evaluation of corrosion of materials. Laboratory test methods may be classified as an electrochemical and non-electrochemical techniques. The electrochemical technique is based on the measurements of current evolves from electrochemical reactions while the later technique is based on the overall weight lost by the material or surface features as a result of corrosion. There is need to conduct corrosion test for building materials so as to prevent the catastrophic damages to structural components and loss of lives. However, in choosing suitable corrosion test method one needs to be familiar with the type of corrosion against which resistance of materials is being sought (Mohebbi and Li 2011; da Silva et al., 2013; del Grossoac and Lanatab, 2014; Sohail et al., 2015; Olawale et al., 2015).

Many methods are being used to evaluate corrosion of a given material however, this research adopts the immersion test which is a standardized test method used to check corrosion resistance. Immersion testing is an accelerated corrosion test that produces a corrosive attack to the tested samples. The appearance of corrosion products (oxides) is evaluated after a period of time. Test duration depends on the corrosion resistance of the tested material. Salt spray testing is popular because it is well standardized and reasonably repeatable. The correlation between the duration in immersion test and the expected life of a material is not necessary simple to interpret as corrosion is a very complicated process and can be influenced by many external factors. Nevertheless, salt spray test is widely used in the industrial sector for the evaluation of corrosion resistance of finished surfaces (Rajendran et al., 2005; Mohebbi and Li 2011; Olawale et al., 2015 Dhawan et al., 2020).

II. Materials and Methods

Materials

Aluminum roofing sheet (ARS), Binding wire (BW), Iron nail (INFR) and Zinc roofing sheet (ZRS) were purchased from Kara market, Sokoo state. While the wastes from fruits of mango (Mangifera indica L.) were sampled at random from Umaru Ali Shinkafi Polytechnic Sokoto, Nigeria.

Chemicals

Acetone, Ethanol and Hydrochloric Acid are the chemicals used in this research, all of analytical grades from Sigma Aldrich Chemical Company UK.

Sample Preparations

The corrosion media prepared for zinc roofing sheet (ZRS), aluminum roofing sheet (ARS), Iron nail for roofing (INFR) and Binding wire (BW) needed in calculating the weight loss of the material. The samples are 0.1M and 0.2M of HCl prepared using double-distilled water. The experiments were conducted under naturally aerated conditions without stirring.

Preparation of Specimen

Zinc roofing sheet, aluminum roofing sheet, iron nail and bending wire were used in this research. These specimen were cut into specific dimensions and were used for this test. These samples were cleaned with distilled water and ethanol and then further treated using emery paper. Thereafter, the samples were washed using distilled water and degrease with acetone and then the samples (now specimen) were stored in the desiccator.

Weight Loss Measurements

The gravimetric method (weight loss) was used to investigate the weight loss measurements that were conducted under total immersion using 250 ml capacity container containing test solution at 35-40°C maintained in the laboratory (room temperature). The test samples (zinc roofing sheet, aluminum roofing sheet, Iron nail for roofing and binding wire were weighed and suspended in the containers with the help of rod and hook. For the effect of temperature on the inhibition efficiencies, all the tests were carried out in the same temperature ranged (35-40°C).

Procedure

The test samples were immersed in 200 mL of 0.1M and 0.2M HCl separately, various concentrations. The specimens were totally immersed in test solutions and were left for 336 hours during which readings were carried out at intervals of 48 hours. A total of 7 readings were recorded and the results were reported accordingly. The mass of the specimens before and after immersion was recorded after every 48 hours using electronic weighing balance. The corroded specimens were rinse thoroughly with distilled water, dried and then weighed to determine their weights.

$(W-W_1)/W \times 100\%$..3.1

Where W is the mass of sample before the corrosion test and W_2 is the mass of the sample after the corrosion test

III. RESULTS AND DISCUSSION

Weight Loss Method

The corrosion of Zinc Roofing Sheet, Aluminum Roofing Sheet, Iron Nail for Roofing and Binding Wire in different solutions of 0.1M and 0.2M HCl containing at room temperature was studied by weight loss measurements and reported in the Table 3.1.

Table 3.1: Mass loss (%) data of Aluminum Roofing Sheet, Zinc Roofing Sheet, Iron Nail for Roofing and Binding Wire in different HCl concentration

S/N	Sample	Treatment	M_B(g)	M_{AF}(g)	M_{Loss}(g)	%M_{Loss}(g)	SD
1	ARS	Control	1.72800	1.72800	0	0	0.0000
2	ZRS	Control	1.90180	1.90180	0	0	0.0000
3	INFR	Control	2.59440	2.59400	0.00040	0.04	0.0000
4	BW	Control	1.16060	1.16000	0.00060	0.06	0.0010
5	ARS	0.1M HCl	1.52220	1.224522	0.297678	19.55578	0.0020
6	ZRS	0.1M HCl	1.97740	1.214338	0.763062	38.58917	0.0010
7	INFR	0.1M HCl	1.17760	0.916893	0.260707	22.13881	0.0010
8	BW	0.1M HCl	2.56690	2.168979	0.397921	15.50199	0.0000
9	ARS	0.2M HCl	1.51330	1.059732	0.453569	29.97215	0.0010
10	ZRS	0.2M HCl	1.75660	0.355111	1.401489	79.78416	0.0020
11	INFR	0.2M HCl	2.63000	1.815482	0.814518	30.97025	0.0015
12	BW	0.2M HCl	1.27520	0.66536	0.60984	47.82309	0.0010

ARS = Aluminum roofing sheet; ZRS = Zinc roofing sheet; INFR = Iron nail for roofing; BW = Binding wire

From Table 3.1 it is clear that there was no corrosion at all on the control samples (ARS and ZRF). However, the INFR and ZRS recorded %corrosion of 0.04 and 0.06% respectively during the 366 hours corrosion test duration. More so, the ZRS recorded highest %corrosion of more than 38% in 0.1M HCl solution, followed by INFR with 22% while the ARS and BW reported 19.5 and 15.5% respectively. This is an indication that, the so called Zinc roofing sheet is only coated with little concentration of Zinc material which when faded expose the main roofing sheet to the acidic attacks. This is probably one of the reasons why the Zinc roofing sheet used in some of the Nigerian states with many industries turns brown (corrode) within short period of time after used to roof houses due to acid rain. The results also showed the INFR is significantly affected with corrosion of 22% in 336 hours of corrosion test. This is a clear proof that most of the INFR we used are more of made from iron than from steel. Again, the ARS under this test recorded twice better performance compared to ZRS, this is due to the better acid resistance ARS has in comparison to ZRS. Moreover, the lower % corrosion (15.5%) displayed by the BW in comparison to other samples more importantly INFR may likely be connected to the shape and dimensions of the wire. Similar trend were observed when the samples were treated in 0.2M HCl. The ZRS reported the highest % corrosion of more than 79.7%, while ARS recorded the lowest % corrosion (30%) in the same medium. However, INFR reported 31% corrosion which very close to that of ARS.

IV. Conclusion

The Zinc Roofing Sheet (ZRS) reported the highest %corrosion of 38.59% in 0.1M HCl during the 366 hours contact time while the Binding Wire (BW) recorded the lowest %corrosion of 15.5% under the same medium and reaction conditions. However, the Iron Nail for Roofing (INFR) and Aluminum Roofing Sheet (ARS) displayed %corrosion of 19.5% and 22.13% respectively in the same 0.1M HCl and 366 hours contact time. The ZRS corroded by more than 79% in 0.2M HCl during the 366 hours contact time while the ARS corroded by more than 29%. Therefore, based on this immersion test this paper concludes that our roofing materials do not have better protection against acid rain as such there is need to improve their resistance to acid attacks.

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REFERENCES

[1]. Badara, Md. S., Kupwade-Patilb, K., Bernalc, S. A., Provisc, J. L. and Allouchea, E. N. (2014). Corrosion of steel bars induced by accelerated carbonation in low and high calcium fly ash geopolymer concretes, Construction and Building Materials, Volume 61: 79-89.

[2]. Carvalho, A. G. L., Hesko, A. J.,. Gnann, B. A , Bonfim, B. G., Estambasse, E. C., J. P. V., R. A. H. and Ferreira, F. A. (2014). Corrosão associada a fatores mecânicos) Revista de Tecnologia e Ciência do SENAI, 1.

[3]. da Silva, T. J., Ferreira, G. and Dias, J. F. (2013). Influência de variáveis nos resultados de ensaios não destrutivos em estruturas de concreto armado), Ciência & Engenharia, 22(1): 103-113.

[4]. del Grossoac, A. and Lanatab, F. (2014). A long-term static monitoring experiment on R.C. beams: damage identification under environmental effect, Structure and Infrastructure Engineering: Maintenance, Management, Life-Cycle Design and Performance, Volume 10, Issue 7, 911-920.

[5]. Dhawan, S. K., Bhandari, H., Ruhi, G., Mohan, B., Bisht, S. and Sambyal, P. (2020). Corrosion Preventive Materials and Corrosion Testing, CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton

[6]. Mohebbi, H. and Li, C. Q. (2011). Experimental Investigation on Corrosion of Cast Iron Pipes. International Journal of Corrosion 2011(1): DOI:10.1155/2011/506501

[7]. Olawale, O. Bello, J. O. And Akinbami, P. (2015). A Study on Corrosion Inhibitor of Mild-Steel in Hydrochloric Acid Using Cashew Waste. International OPEN ACCESS Journal Of Modern Engineering Research (IJMER), 5(8): 25-30.

[8]. Rajendran, S., Ganga, S.V., Arockiasevi, J. and Amalraj, A.J. (2005). Corrosion Inhibition by Plant Extracts - An overview. Bulletin of Electrochemicals, vol. 21: 367-377.

[9]. Rocha, F., Campos, H., de Andrade, T. S., Roquitski, A. and Medeiros, M. H. (2014). Influência da espessura de cobrimento e da contaminação por cloretos nas leituras de potencial de corrosão de armaduras, REEC - Revista Eletrônica de Engenharia Civil, 8(2): 43-53.

[10]. Sohail, M. G., Laurens, S., Deby, F. and Balayssac, J. P. (2015). Significance of macrocell corrosion of reinforcing steel in partially carbonated concrete: numerical and experimental investigation, Materials and Structures, Volume 48, Issue 1-2: 217-233.