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Corrosion of Steel in Reinforced Concrete Using Fresh Water in the Tripoli Area

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ABSTRACT

Concrete cover protects against reinforcement against corrosion. There are many corrosion conditions in structures in the Tripoli area, and we have used fresh or natural water to make the concrete mixture Fresh water and local aggregate were used in the preparation of samples of reinforced concrete with different proportions of water to cement as well as a different concrete cover and the concrete cover was between (25 and 70) mm with a change in the ratio of water to cement by ratios of (0.45 and 0.75) mm using natural water (FW) for the city of Tripoli and it was found that these samples are affected in terms of corrosion rate and electrochemical behavior.

The electrochemical behavior of the samples was monitored for Two year.

The results showed an effect on the corrosion rate of samples containing the ratio of water to cement and concrete cover mixed with conditions of Exposure to fresh water.

The corrosion rate of rebar has been studied for beams and cubes within the climatic environment (Climatic chamber environment) (C.C.E).

Keywords: Concrete cover- corrosion- Fresh water – reinforced concrete- Climatic Chamber Environment.

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تآكل الحديد في الخرسانة المسلحة باستخدام المياه العذبة في منطقة طرابلس

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الملخص

غطاء خرساني يحمي من التعزيز ضد التآكل، هناك العديد من ظروف التآكل في الهياكل في منطقة طرابلس، وقد استخدمنا المياه العذبة أو الطبيعية لصنع خليط الخرسانة.

تم استخدام المياه العذبة والركام المحلي في تحضير عينات من الخرسانة المسلحة بنسب مختلفة من الماء إلى الإسمنت وكذلك غطاء خرساني مختلف وكان الغطاء الخرساني بين (25 و70) ملم مع تغير في نسبة الماء إلى الإسمنت بنسب (0.45 و0.75) ملم باستخدام المياه الطبيعية (FW)لمدينة طرابلس ووجد أن هذه العينات تتأثر من حيث معدل التآكل والسلوك الكهروكيميائي.

تم رصد السلوك الكهروكيميائي للعينات لمدة عامين.

وقد أظهرت النتائج تأثيرا على معدل التآكل للعينات المحتوية على نسبة الماء إلى الأسمنت والغطاء الخرساني الممزوج بظروف التعرض للمياه العذبة.

تمت دراسة معدل تآكل حديد التسليح للعتبات والمكعبات داخل البيئة المناخية (بيئة الغرفة المناخية) (.C.C.E).

الكلمات الدليلة: الغطاء الخرساني– التآكل– الخرسانة المسلحة – مياه االطبيعية –البيئة المناخية

1. Introduction

Reinforced concrete structures are usually very large. Different parts of a structures could be exposed to different environments, so the same steel rebar in a structure may be subjected to different types of corrosion, damage. [1,2].

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Generally, corrosion of concrete in any environment consists of the following basic processes:

1- Depolarization reangent arrives at the surface of concrete through the medium surrounding it.[3,4]
2- Electrochemical (anodic and cathodic) reactions occur at the interface between the concrete and surrounding medium. [5,6]

The object of a corrosion rate measurement in reinforced concrete is to determine the rate of embedded steel turning into rust.[7,8]

2. Experimental program, Material, and Testing

Effect on tap water on the reinforced concrete specimen and bar were studied in two parts. The first part of study involved the effect of mixing water on the reinforcement with different cover exposed to climate chamber environment. The second part of the program was an examination of the corrosion rate electrode potential of embedded bars.

3. Material

3.1 Cement

Normal Portland cement (sooq El-khamees factory) was used in this study table (1) content of chlorides and sulfates cement.

Table (1) chlorides and sulfates contents for cement used

Chlorides%	Sulfates%
0.1964%	2.160%

3.2 Free chloride content

The results in table (2) indicate the total chloride content for the specimen exposed to climatic chamber environment for different water to cement ratio and different concrete cover.

Table (2). Free chloride content for specimen exposed to C.C.E (% age weight of concrete)

Mixing water	W/C ratio	
F.W	0.45	0.75
	0.0011	0.0087

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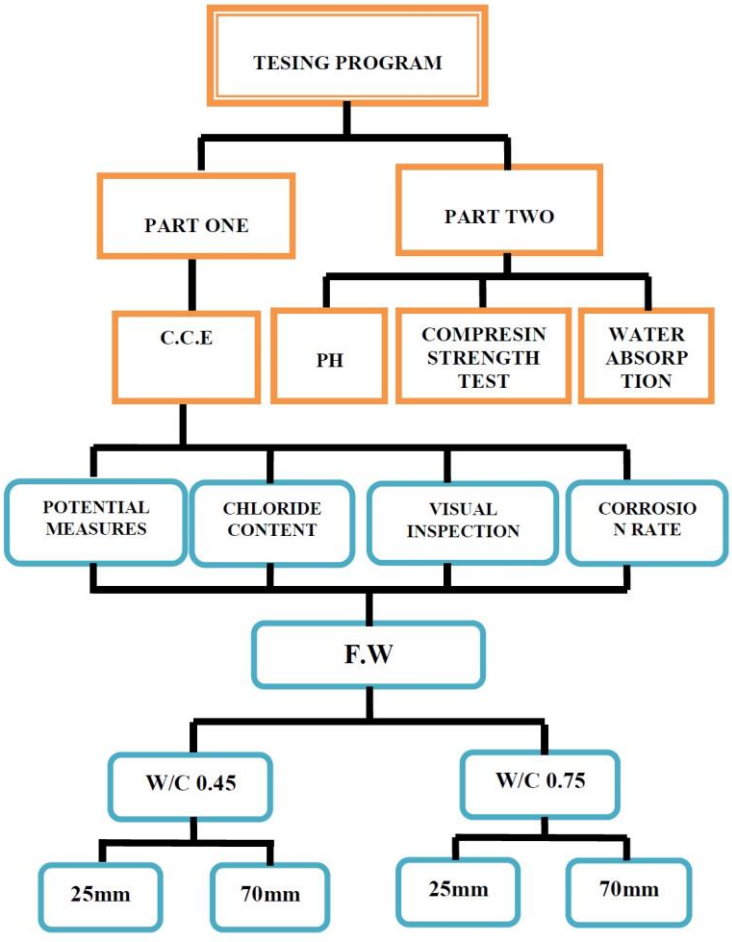

Fig (1). TESTING PROGRAM

3.3 Mixing water

Type of water were used throughout study for mixing fresh water.

3.4 Aggregates

Local aggregates (fine and coarse) were used in this study chlorides and sulfates contents and some properties are listed in table (3).

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Table (3) some chemical and physical properties for aggregate

	chlorides	sulfates	absorption	density	porosity
Fine agg	0.0106%	0.3530%			
Coarse agg	0.0673%	0.0396%	2.6%	2.37	6.57%

Clay and silt content in fine aggregate 0.51%

3.5 Steel

Plain and deformed steel bars with diameter of 12 mm and yield stress 320 Mpa were used from misurata iron and steel factory.

3.6 Compression test of concrete cubes

Result of compression strength results have been obtained for 28 days' specimen for Tripoli tap water and water cement ratios. The results are listed below in table 4.

Table (4) compressive strength results (Kg/sq.cm)

Mixing water	W/C ratio	
F.W	0.45	0.75
	347	255

3.7 PH results

PH of water cement used in concrete mixture, and starting PH of concrete specimen were obtained and listed in table (5).

Table (5) PH results

Mixing water	cement	Starting concrete potential
F.W		F.W
7.8	13.5	12.0

4. Discussion of test results

The starting results of the embedded bars ranged between -495 MV to -397MV, for both specimen mixed with 0.45 and 0.75. involved. w/c ratio fig (3) and fig (4) show the electrochemical behavior of the embedded steel. Whereas the electrochemical potentials of the steel embedded bars in concrete mixed with w/c ratio 0.45 fig (3) reach to greater than -200 MV after 90days for both 25 mm and

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70mm concrete cover. In the other side they gain passivity according to pourbaix diagram fig (2) and located at shaded area(A).

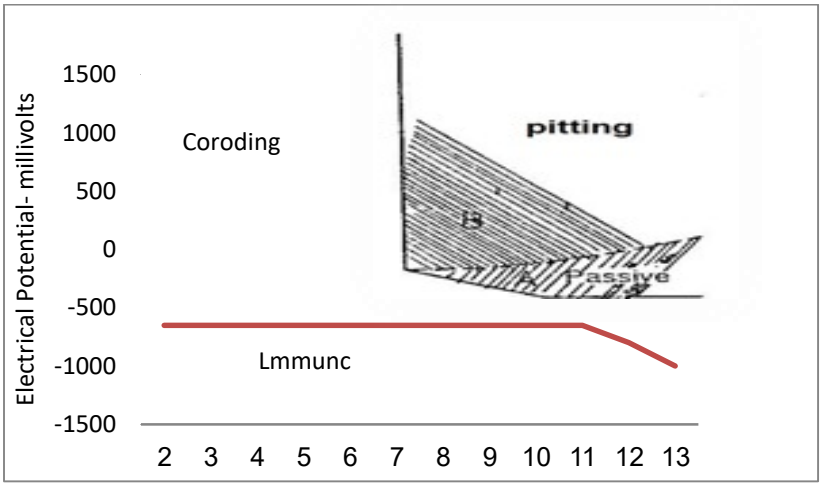

Figure (2) Pourbaix .DIA

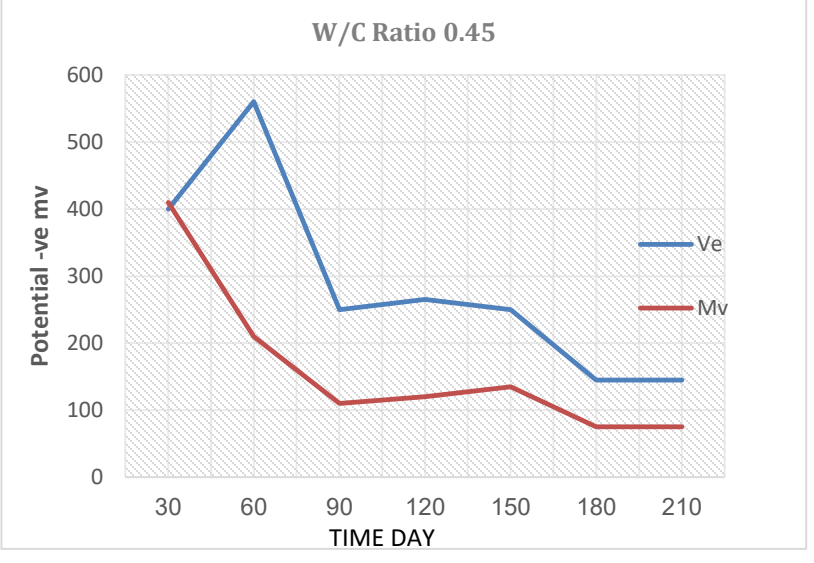

Fig (3) Relation between potential and time for FW specimens exposed to C.C.E to W/C=0.45

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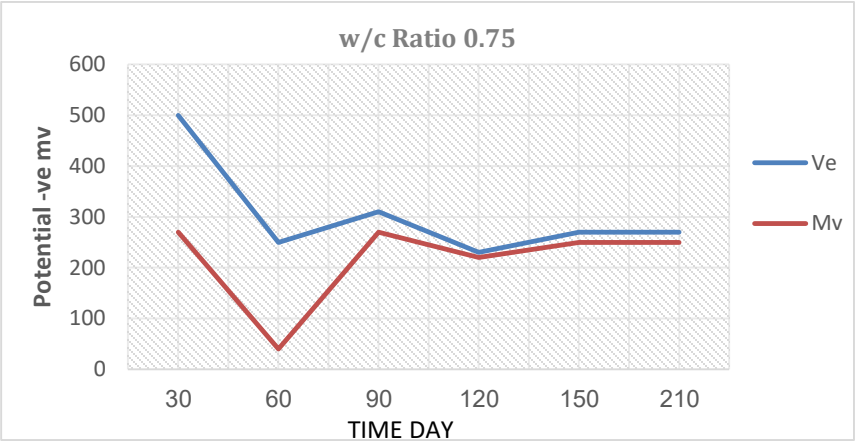

Fig (4) Relation between potential and time for FW specimens exposed to C.C.E to W/C=0.75

Fig (4) represents the relationships between potential of embedded steel bars and time for 0.75 w/c ratio. Potential increases with time and reach to greater than -350 MV, but less than -200 mv for both concrete cover 25mm and 70mm.

In general, water ratio has an important effect on the electrochemical behavior of the embedded steel bars, while no effect of the concrete cover as shown in fig (4).

Concrete cover and water-cement ratio have direct effect on the corrosion rate of the specimen embedded in concrete mixed with fresh water.

Fig (5) shows the corrosion rate of steel bars at 25 mm and 0.75 w/c has more than 1.5 times of the same concrete cover and 0.45 w/c, on the other hand this ratio increased to two times for concrete cover 70 mm.

It could be conclude that corrosion rate decreased more than times from concrete cover 25 mm to 70 mm for both mixing water to cement ratio.

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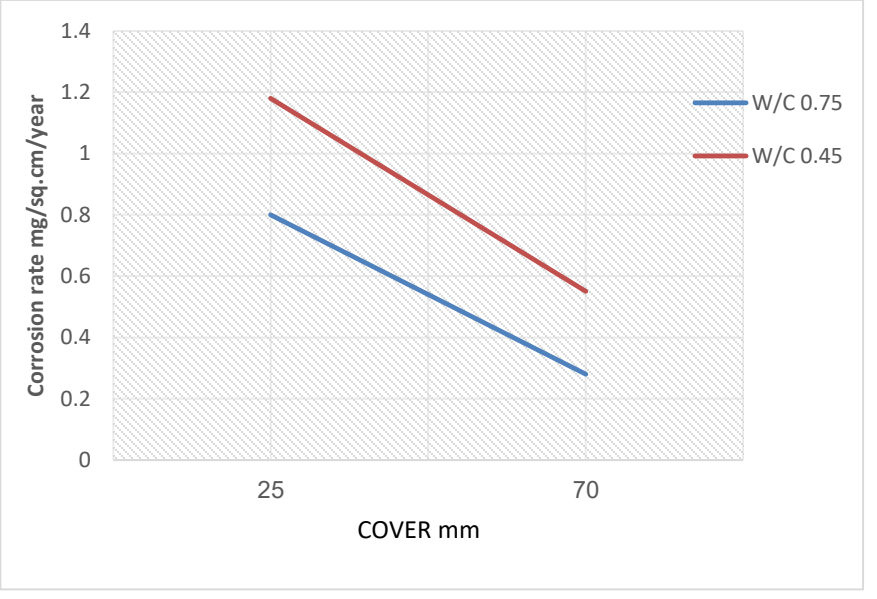

Fig (5) Relation between corrosion rate and cover for FW specimens exposed to C.C.E

5. Conclusion

From the study, discussion of test results it is conclusion the following:

Corrosion rate decreases more than times from concrete cover (25mm to 70 mm) for both mixing water to cement ratio (0.45,0.75), Water ratio has an important effect on the electrochemical behavior of the embedded steel, no effect of the concrete cover, Potential of embedded steel increases white time but less than (-200 mv) for both concrete cover (25mm) and (70mm), Corrosion rate in concrete mixed white (0.75 w/c) ratio and cover (25 mm) has more than 15 times &the same concrete cover, and (0.25w/c) ratio.

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6. References

[1] Climate in the Tripoli area and its Effect on corrosion of R.C International Science and Technology Journal, Volume15, page 195.2020

[2] Corrosion of steel in concrete by JhonP.Broomfield, London, 3rd Edition, 2023.

[3] A.L Geary (stern- Geary Equation), linear polarization Resistance (LPR),2020

[4] Veda;akshmi,R,& thangavel, K.Reliability of electrochemical techiques to predict the corrocion rate of steel in concrete structures, Arabian journal for science and engineering 36(5), 769-783. (2011).

[5] Lv,Niu,D., Liu,X.,& Li y.C corrosion Damage and life predicition of concrete structures in a 41-year- old steel concrete works.Matero=ials, 15(17),5893.(2022).

[6] Understanding and monitoring corrosion in steel Reinforced Concrete By GiAtec scientific, June 20,2023 University of Nebraska-Lincoln College of Engineering.

[7] Corrosion Effects on the Durability of Reinforced concrete structures, By Kathy Riggs Larsen on,2020

[8] Corrosion of steel Rebar in concrete, AKibJabed, Md. ShahiduL islam Shuro,Md Mahamud Hasan Tusher,2023