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Effect of Corrosion for Embedded Steel in Tripoli Area with Tap Water

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ABSTRACT

In this research, we study the rate of corrosion of rebar for beams and cubes within the climatic environment (Climatic chamber Environment) (C.C.E) using a concrete cover ranging from (25 to 65) mm with changing the ratio of water to cement by percentages ranging from (0.45 to 0.75) mm using local water (tap water T.T.W) for the city of Tripoli and show that these samples are affected in terms of the rate of corrosion and electrochemical behavior according to changing the proportions of water to cement
as well as changing the proportions of concrete cover.

The research came as an integral part of what we presented in a previous study [1].

In it, we presented the results obtained after exposing beams and cubes outside the outdoor environment to different conditions using local water.

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

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تأثير تأكل حديد التسليح المعرض في الخرسانة المسلحة لمياه المحلية لمدينة طرابلس

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الملخص

في هذا البحثتم دراسة معدل التأكل لحديد التسليح وذلك لكمرات ومكعبات داخل البيئة المناخية Climatic chamber Environment (C.C.E) وذلك باستخدام غطاء خرساني يتراوح ما بين (25 الى 65) مم مع تغيير نسبة الماء للإسمنت بنسب تتراوح ما بين (0.45 الى 0.75) مم باستخدام المياه المحلية (مياه الصنبور T.T.W) لمدينة طرابلس وتبين ان هذه العينات تتأثر من حيث معدل التأكل والسلوك الكهروكيميائي وفقا لتغيير نسب الماء للإسمنت وكذلك تغيير نسب الغطاء الخرساني.

وهذا البحث جاء كجزء لا يتجزأ مما قدمناه في دراسة سابقة[1].

وقد عرضنا فيها النتائج التي تحصلنا عليها بعد تعريض كمرات ومكعبات خارج البيئة المناخية Outdoor environment لظروف مختلفة وذلك باستخدام المياه المحلية.

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

1.Introduction

Corrosion is deterioration of metals by chemical or electro chemical reaction with its environmental, corrosion changes may be divided into two classes those which produce a solid film and those which don’t[2].

Corrosion is presently restricted to chemical attack of metals[3].

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The engineers apply economical and practical means to avoid damages losses done by corrosion these losses can be divided into direct and indirect losses.

Direct losses that meant the costs of replacing corroded structures or their compounds, the assessment of indirect losses are more difficult than the direct losses. [4,5]

The objective of this paper is to study the effect of concrete cover, local water with different water-cement ratio on the electrochemical behavior and corrosion rate of reinforcement at Climate chamber environment.

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 (a) content of chlorides and sulfates cement.

Table (1) chlorides and sulfates contents for cement used

Chlorides%	Sulfates%
0.1964%	2.160%

3.2 Mixing water

Type of water were used throughout study for mixing Tripoli tap water chemical composition obtained from the laboratory results from industrial Research center tajoura.

Chemical composition Tripoli water is listed in table (2)

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Table (2)chemical composition Tripoli tap water

Ions	Tripoli water
Chlorides mg/lt	2015
Sulfates mg/lt	247.72
Bicarbonate mg/lt	244
Carbonate mg/lt	NIL
Sodium mg/lt	675
Potassium mg/lt	18
Calcium mg/lt	336
Magnesium mg/lt	225.6
pH	7.8
TDS at 105C	3808
Calculated TDS	3761.32

3.3 Aggregates

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

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%

3.4 Steel

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

3.5 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.

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

Mixing water	W/C ratio		
	0.45	0.60	0.75
T.T.W	347	310	255

3.6 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
T.T.W		T.T.W
7.8	13.5	12.1

7. Discussion of test results

These sets of samples were exposed to the climatic chamber environment (RH=90%, temperature 28 c). Every set of samples involved different w/c ratios and different cover Samples Mixed with Tripoli Tap Water

Electrode potential results against time of the specimens transferred to climatic chamber environment shown in figure (1) are for different concrete covers 45mm, and 65mm respectively with different water concrete ratio. The starting results of the climatic chamber specimen, were the final results of the transferred specimens. Whereas, these results were greater than -200mv, which indicate less than 10% probability of corrosion may be occur, and located at shaded area(A) in figure (2). Steel embedded in concrete mixed with 0.45 w/c ratio at the begging loss it's passivity and located in shaded area (B) in pourbiax diagram, after that the steel again starts to gain passivity for concrete cover 45mm and 65mm and potential of embedded steel were greater than -200mv as shown in figure (3), potential of embedded steel well greater than as shown

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in figure (4) -150mv for concrete cover 45mm and 65mm On other hand, the embedded steel potential of the other specimens was less than -200mv except steel embedded in concrete with 0.6 water to cement ratio and concrete cover 45mm the embedded steel were greather -200mv with water cement ratio 0.60 and concrete cover 25 as shown in figure (5).

Figure (6) shows the relationships between corrosion rate and concrete cover of the embedded steel. G1, G2 and G3 are referring to the mixing water to cement ratio 0.45, 0.6 and 0.75 respectively. Corrosion rates of embedded bars in concrete mixed with 0.45 and 0.6 water to cement ratios are decreasing with concrete cover, (see graph G1 and G2), while in concrete mixed with 0.75 water to cement ratio the relationship has concave up shape with inflection point at 45mm concrete cover (see graph G3).

It could be conclude that the water-cement ratio has an important effect on the corrosion rate of the embedded bars, whereas the corrosion rate of the rebar in concrete mixed with water to cement ratio 0.75 have more than 3.5 times of that mixed with 0.45 w/c and more than 1.5 times of specimen mixed with 0.60 water to cement ratio for concrete cover 25mm, in the other hand for concrete cover 65mm corrosion rate of specimen mixed with 0.75
w/c ratio has more than 9.5 times the embedded bars in concrete has w/c ratio 0.60.

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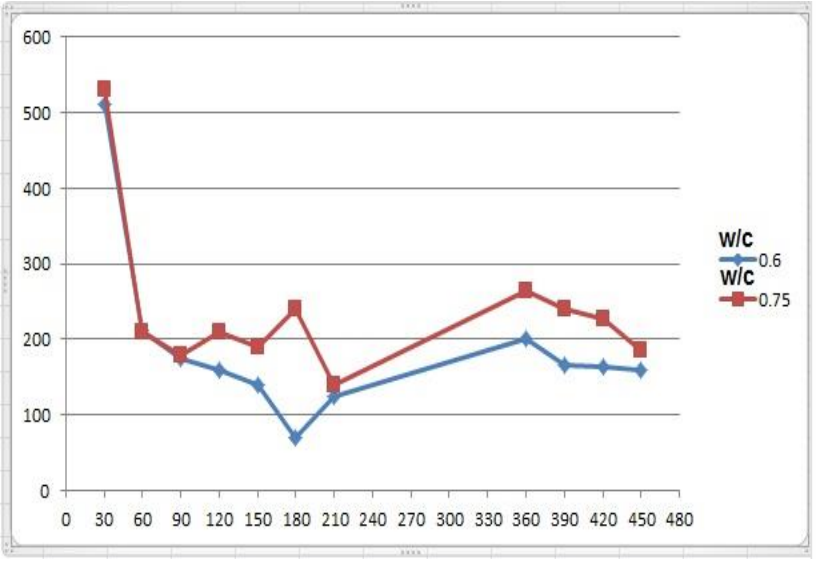
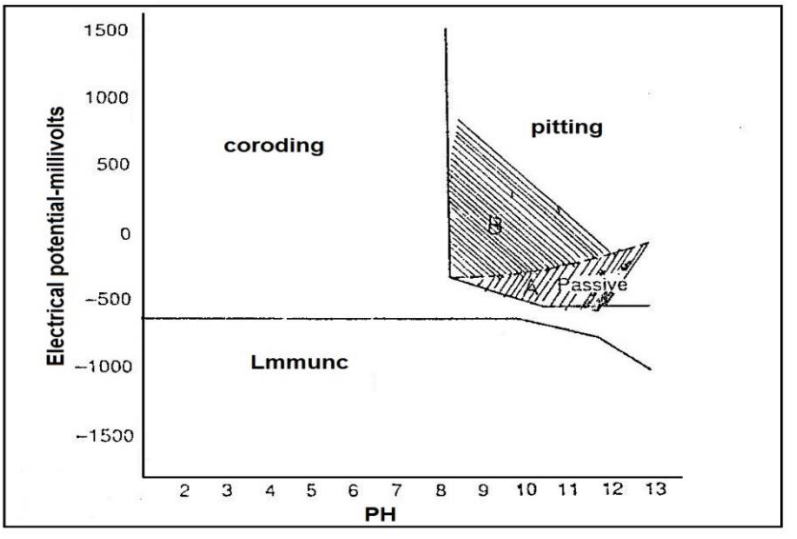


Figure (1) Results of electrode potential of specimen mixed with T.T.W exposed to C.C.E



Figure(2) Pourbaix .DIA

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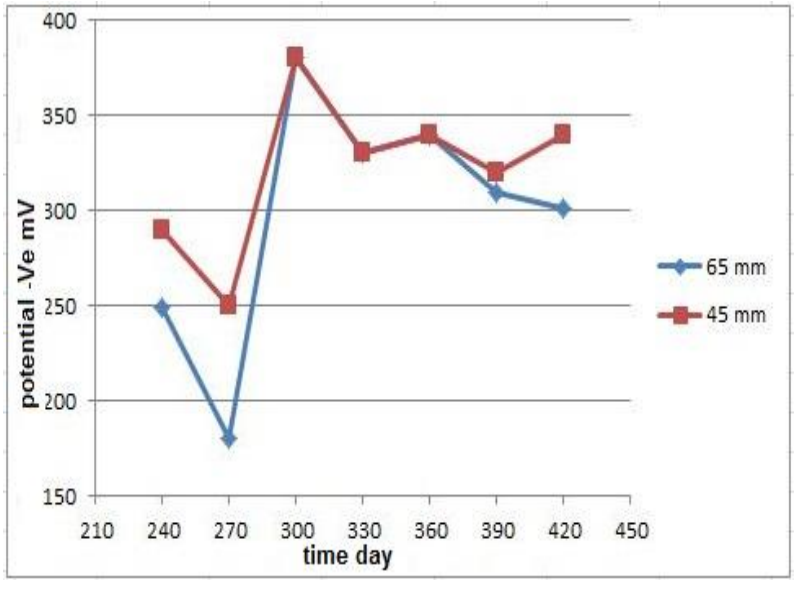

Figure(3) Relation between potential and time for T.T.W exposed to C.C.E

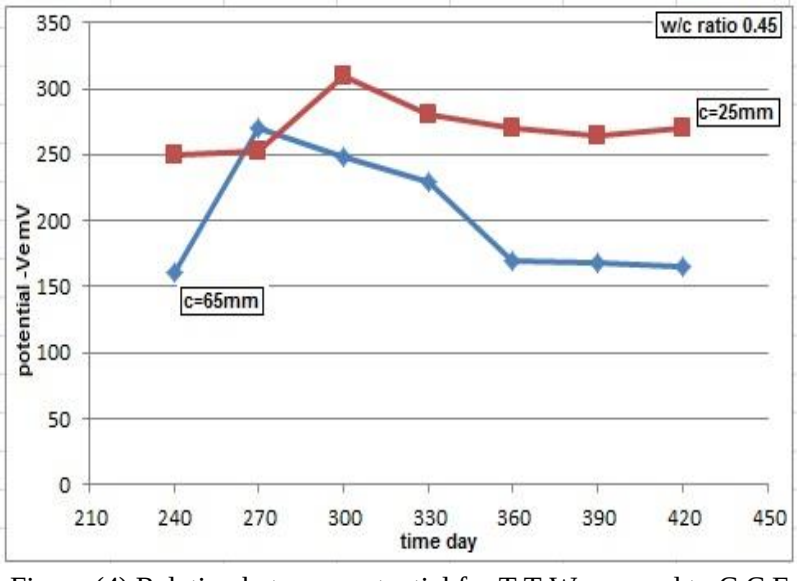

Figure (4) Relation between potential for T.T.W exposed to C.C.E

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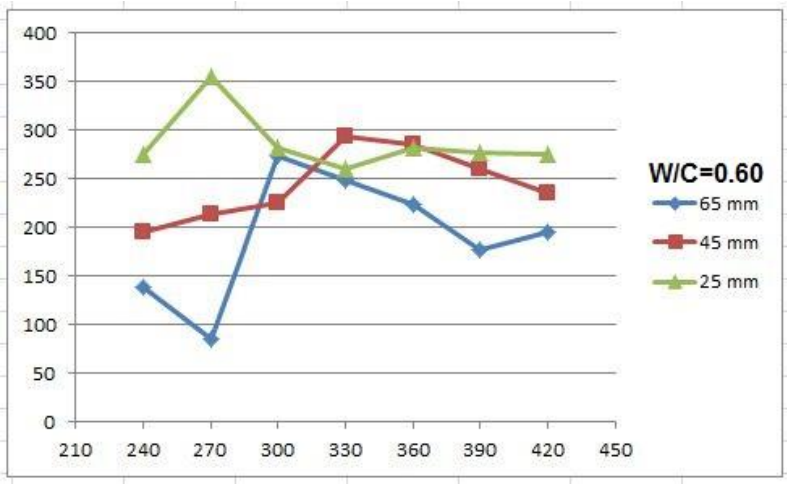
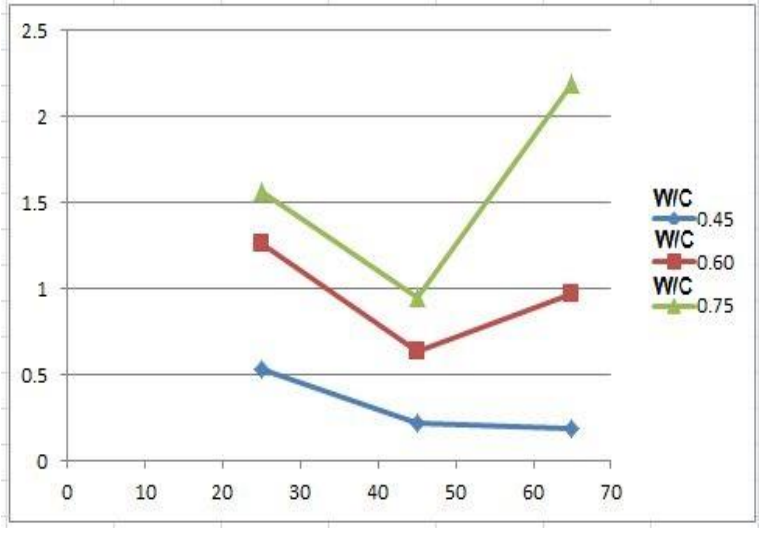


Figure(5) Electrode potential of embedded bars mixed with T.T.W Exposed to C.C.E (w/c 0.60)



Figure(6) Corrosion rate (Cr) results for T.T.W specimen exposed To C.C.E

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8. Conclusion

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

1. Corrosion rate increases with w/c ratio, for specimens mixed with Tripoli tap water and exposed to climatic chamber environment, and their effects was less than 60% for fresh water and sea water.
2. The possibility of corrosion increase with w/c ratio for specimens, exposed to climatic chamber environment and mixed with Tripoli tap water, whereas, plain bars show less than 15% possibility of corrosion for water-cement ratio less than.
3. The potential of embedded steel less than with increase concrete cover with water cement rati (0.60).

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