Durability Characteristics of Concrete and Reinforcing Bars Exposed to Harsh Environments

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ABSTRACT

Saline pollution attack is an important factor that leads to the deterioration of the concrete, especially in industrial plants. In spite of research address the sustainability of concrete and particularly steel rebar submeserged in it steel rebar is the most important causal factors the deterioration in the reinforced concrete the main aim of this research is study the effect of additives added to reduce superior degree water and two types of mineral additives that include silica fumes and steel fiber, as well as the combined effect of these additives on the properties of concrete. The experimental work of this measure include concrete specimens have been partially submerged in a solution of chlorides and sulfates in concentrations similar to those found in aggressive conditions. The properties of concrete specimens were evaluated   through the properties investigated included ultrasonic plus velocity, compressive strength electrochemical potential for various types of mixes. Concrete mixed with 10% of silica shown development all properties of concrete, while these properties deceases values of mix reference coated with natural rubber (RFCNR) and steel fiber coated with natural rubber (STFCNR). The result coated specimens has shown resistance to corrosion greater than specimens without coated when immersion in salt solution. Thus group (RFCNR)shown more develops in all properties as compared with all other mixture immersed in salt solution for 180 days at odds with group (SF-SP) which had development in all properties as compared with the reference mixture at 180 days of immersion in salt solution .

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خواص الديمومة للخرسانة وحديد التسليح المعرضة للبيئة القاسية

الخلاصة

يعتبر هجوم المحاليل المالحة من العوامل المهمة التي تؤدي إلى تدهور الخرسانة , وخاصة في المنشآت الصناعية تم في هذا العمل البحثي دراسة تأثير المواد المضافة المقللة للماء بدرجة متفوقة, ونوعين من المضافات المعدنية هما ابخرة السليكا المكثفة والألياف المعدنية , وكذلك التأثير المشترك لهذه المضافات على خصائص الخرسانة. وقد تم غمر النماذج جزئياً في محلول الكلوريدات والكبريتات بتراكيز مماثلة لتلك المتواجدة في ظروف قاسية. ولقد قيمت خصائص الخرسانة من خلال

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دراسة سرعة الموجات فوق الصوتية ,مقاومة الانضغاط و القياسات الكهروكيميائية لأنواع مختلفة من الخلطات الخراسانية كما تضمنت الفحوص الكهروكيميائية مراقبة جهد القطب وتحديد معدلات الصدأ باستعمال مخططات Tafel . أبدت الخرسانة الحاوية 10%من المواد البوزولانية (SF) تطورا ملحوظا في جميع الخصائص مقارنة مع الخلطة المرجعية (RF)   و الخلطة الحاوية على ألياف المعدنية(STF) وكذلك الخلطات المطلية (RFCNR and STFCNR). بالمقارنة مع الخلطة المرجعية . بعد 180 يوم من التعرض للمحلول القاسي.كما اظهرت الخلطة الحاوية على الألياف المعدنية المطلية بالمطاط الطبيعي تدهور ملحوض في كل الخصائص مقارنة مع الخلطة الحاوية على الألياف المعدنية RFCNR بدون طلاء والخلطة المرجعية . وبذلك تكون سلسة RFCNR هي الأكثر تطور في كل الخصائص مقارنة مع باقي الخلطات الى 180 يوم من الغمر بالمحلول الملحي وتليها سلسة SF-SP التي أبدت تطور في كل الخصائص مقارنة مع الخلطة المرجعية .

INTRODUCTION

The durability of concrete mixes is considered one of the most important properties, which is an essential indicator for its future performance. The deterioration of concrete by chemical solutions which consist of concurrent attack of sulfate and chloride salts, is considered one of the largest problems which concern the engineers in situ.There are a lot of works that have been put dealing with the performance of concrete exposed to aggressive solutions. But, no care has been given to evaluate the performance of coating concrete by polymer with regard to the durability against aggressive solutions containing sulfate and chloride ions. Concrete has occupied an important place among construction materials and is widely used in all types of civil engineering structures ranging from small buildings to large projects, as a result the durability of concrete structure has become a key issue for concrete technology recently. The durability of concrete is one of the most important properties of concrete because it's necessary that concrete should withstand the conditions for which it has been designed. Durability is the ability of concrete to resist weathering action, chemical attack, and abrasion while maintaining its desired engineering properties. Different concretes mixtures require different degrees of durability depending on the exposure environment and the properties desired. Concrete ingredients, their proportioning, interactions between them, placing and curing practices, and the service environment determine the ultimate durability and life of the concrete [1].

There are two groups of factors which lead to less durable concrete. These are external factors coming from the environment and internal factors inside the concrete. All of them can be classified into physical, mechanical and chemical factors. Concerning chemical factors, to which our study is related, include the attack by sulfate, sea water chloride. Because this attack happens inside the concrete, its assisting factor must be able to penetrate concrete mass which should be permeable. For concrete in aggressive ground conditions, high quality and low permeability concrete must be used[2].

Permeability is a key factor governing the rate of deterioration of concrete exposed to aggressive chemicals. When permeability is low, the decomposition is limited to the surface; otherwise the process of decomposition spreads into the interior of the concrete [3].

Regardless of exposure condition, steel will only corrode in concrete when it becomes de-passivated. De-passivation can occur through one of the two major routes; loss of alkalinity in the concrete or attack on the steel by aggressive ions, or by a combination of both of these factors. Loss of alkalinity results from reaction of

the hydrated cement matrix with acidic components in the atmosphere, and, to some extent, leaching of hydroxyl ion from the concrete. When the pH of the matrix drops below a value in the range of (9.5 – 10), steel can corrode if adequate supplies of moisture (to provide the electrolytic path) and oxygen are available. Likewise passivity can be destroyed by aggressive ions. Chloride is by far the most aggressive ion in relation to steel corrosion and its presence in sufficient quantities in concrete can readily destroy passivity leading to rapid and often serious corrosion [4].

LITERTUR REVIEW

In 2001, M. Santhanam et al studied effects of sodium and magnesium sulfate solutions on expansion and of different types of Portland cement The results suggest that the expansion of mortars in sodium sulfate solution [5].

In 2002, J.-M. Tulliani et al studied a severe degradation of concrete foundation and results showed large gypsum crystals were mainly located at the interface between the cement paste and aggregates. The degradation effects increased with decreasing the distance of concrete structures from an absorbing well located in the courtyard of the building [6].

In 2004, Adam Neville studied sulfate attack on concrete found and described the consequences of disturbed drainage of the soil adjacent to foundations and of excessive irrigation, coupled with the use of fertilizer. Whether concrete has undergone sulfate attack can be established by determining the change in the compressive strength since the time of placing the concrete [7].

In 2009, B. Chatveera and P. Lertwattanaruk studied the durability of mortars under sulfate attack including expansion and compressive strength loss were investigated. The water-to-binder ratios were 0.55 and 0.65. For the durability of mortar exposed to sulfate attack, 5% sodium sulfate (Na2SO4) and magnesium sulfate (MgSO4) solutions were as result, when increasing the used. Expansion of the mortars exposed to Na2SO4 was more than those exposed to (MgSO4). Results show pozzolanic material to concrete and also improve resistance to sodium sulfate attack, but it can impair resistance to magnesium sulfate attack [8].

In 2011, R. Malheiro etal was studied the influence of mortars used as external rendering on chloride transport in concrete. Prismatic concrete specimens were cast with dimensions of 80 * 80 * 80 mm and water to binder ratio of 0.55. Three different mixtures of mortar were used to cover these specimens .The specimens were subjected to natural diffusion tests for 49 days. This shows that, although mortars have higher porosity than concrete, they can provide an additional protection to concrete structures, delaying chloride penetration into bulk concrete [9].

In 2011, L. Abosrra etal studied corrosion of steel bars embedded in concrete having compressive strengths of 20, 30 and 46 MPa. Reinforced concrete specimens were immersed in a 3% NaCl solution by weight for 1, 7 and 15 days. In order to accelerate the chemical reactions, an external current of 0.4 A was applied using portable power supply. Corrosion rate was measured by retrieving electrochemical information of polarization technique Experimental results showed that corrosion rate of steel bars and bond strength between corroded steel/concrete were dependent on concrete strength and accelerated corrosion period. As concrete strength increased from 20 to 46 MPa, corrosion rate of embedded steel decreased [10].

EXPERIMENTAL WORK AND MEASUREMENT
Materials
Cement: Iraqi ordinary Portland cement manufactured by (Tasloga/ Aljesr) cement factory was used throughout this investigation. It was stored in a dry place (air- tight plastic containers) to reduce the effect of humidity and temperature. The used cement conforms to the Iraqi specification No.5/1984. [11].

Table (1) Chemical composition of the cement used in this investigation˜.

Abbreviation of Oxide	% by weight	Limits of Iraqi Specification No.5/1984
SiO_2	21.95	-
CaO	63.32	-
MgO	1.48	≤5.0
Fe_2O_3	4.66	-
Al_2O_3	3.76	-
SO_3	1.78	≤ 2.8
Loss on Ignition	0.83	≤ 4.0
Insoluble residue	0.77	≤1.5
Lime saturation factor	0.96	0.66-1.02

 *Chemical and physical tests were made by the National Center for
  Construction Laboratories (NCCL).**

Table (2) Main compounds of cement (Bogues's equation)˜ .

Compounds	% by weight	Limits of Iraqi Specification No.5/1984
C_3S	53.9	-
C_2S	22.4	-
C_3A	2.1	<3.5
C_4AF	14.2	-

Fine aggregate
    The fine aggregate was AL- Ekhaider natural sand of 4.75mm maximum size with grading limited zone 2. The grading of the fine aggregate. Results indicate that the fine aggregate grading and the sulfate content were within the requirements of the Iraqi specification (IQS No. 45/1984) [12].
Coarse aggregate
    Crushed gravel of 20 mm maximum size from Al-Nebai quarry was used as a coarse aggregate in all mixes. This aggregate, which conforms to the Iraqi specification (IQS No.45/ 1984)[13].

Water

Ordinary tap water used in this research for mixing and curing all concrete specimens. Almost any natural water that is drinkable and has no pronounced taste or odor can be used as mixing water for making concrete.

Additives material

A. Super plasticizer

Super plasticizer also used in mix 2. It is a high range water–reducing admixture (HRWRA). Structure 520 is differentiated from conventional super plasticizers in that it is based on a unique carboxylic ether polymer with long lateral chains. This greatly improves cement dispersion. At the start of the mixing process, an electrostatic dispersion occurs but the presence of the lateral chains, linked to the polymer backbone, generate satiric hindrance which stabilizes the cement particle's capacity to separate and disperse. This mechanism considerably reduces the water demand in flow able concrete. Structure 520 combines the properties of water reduction and retention. It allows the production of high performance concrete and/or concrete with high workability. Structure 520 is free from chlorides and complies with ASTM C 494 [14].

B. Silica Fume (SF)

It contains extremely fine (0.15 μm) latently reactive silicon dioxide. The presence of this substance gives greatly improved internal cohesion, water retention and increased density when set. The fresh concrete becomes extremely soft and the pumping properties are substantially improved. In the set concrete, the latently reactive silica fume forms a chemical bond with the free lime. The produce is significantly more dense set cement matrix. The average particle size is well below 0.5 micron, meaning that each microsphere is 100 times smaller than the average cement grain. In a typical mix with a 10% inclusion of silica fume, there will be between 50 and 100 silica fume particles per grain of cement. [15].

C. Steel used in this work

C1 Steel fiber reinforcement

Longitudinal deformed steel fibers of 0.385 mm diameter are used in reinforced concrete.Table (3) shows the physical properties of the main steel fiber reinforcement.

Table (3) Physical properties of   steel fiber reinforcement*.

Length	30 mm
Tensile strength	1050 (N/mm^2)
Elongation %	3-4%
Specific gravity	7.48
Elastic modulus	210 (KN/mm^2)
Aspect ratio	50

C2   steel bars

steel bar of 26 mm diameter are used in potential static test . Table (4) shows the physical properties of the steel bar. The steel bars are cleaned by means of   steel brush to remove any rust deposits from their surface.

Table (4) Physical properties of steel bars *.

Diameter	26 mm
Cross sectional area	201 mm^2
Yield stress	426 MPa
Ultimate stress	641 MPa
Elongation %	19%

*Given by manufacturer.

D: Surface coating

There are two types of coating using on the concrete surfaces and steel bars reinforcement

D1: natural rubber

Material used in coating on concrete surface is shown in Tables (5).

Table (5) General properties of natural rubber*.

Physical properties of natural rubber	
Specific Gravity	0.92
Hardness Range (Shore A)	30-100
Elongation	500% to 900%
Mechanical properties of natural rubber	
Abrasion Resistance	Excellent
Impact Resistance	Excellent

Table of (6) properties of coating.

Product Description	Cement-based epoxy-modified two -component anti corrosive coating
Colours	Mix: Green Comp. A: Colourless liquid Comp. b: Dark grey powder
Density	Comp. A 1.05 kg/l Comp. B 1.03 kg/l Comp. A+B+C 2.00 kg/l (density of slurry when mixed)
Mix ratio	Parts by weight : A : B : = 1 : 4 Parts by volume : A : B : = 1.: 4
Shelf life	12 months from date of production if stored properly in unopened original packing

Concrete Mixes

Table (7) Concrete Mixes types.

Mixed type	Mixed component by weight kg/m³									
	Cement kg/m³	Water kg/m³	Coarse Aggregate kg/m³	Fine Aggregate kg/m³	Steel fiber by volume fraction	SP % by wt. of cem.	SF % by wt. of cem	w/c	coated	Slump (mm)
RF	320	160	1280	640	0	0	0	0.5	0	45
SF-SP	288	121.6	1280	640	0	3	10	0.38	0	108
STF	320	144	1280	640	0.5	0	0	0.45	0	55
RFCNR	320	160	1280	640	0	0	0	0.5	coated	45
STFCNR	320	160	1280	640	0.5	0	0	0.45	coated	55

Preparation of Salts Solution

Preparation of salts solution: The combined solution of chloride and sulfate used to attack the concrete specimens in this investigation is similar to that used by more than one investigator [10]. The concentrations of chloride and sulfate ions in this solution lie within the concentration limit present in soil and underground water of the southern parts of Iraq. The salts used in preparing the solution and providing the suitable concentrations of the ions were pure NaCI, $MgSO_4.7H_2O$ and $CaCl_2.2H_2O$. Potable water was used as solution for these salts. Table (8) shows the type and concentrations of salts used in the attacking solution and the actual anions and cations provided by such salts. From this Table, it is obvious that the concentration of (SO_4^{--}) ion of the salts solution of this study can be classified as severe. After the curing period, the specimens were taken out of the water and left inside the laboratory for a period of 3 days, and then submerged in solutions up to half of their depth inside, up to the time of test. The level of the solution was adjusted by adding water to the basin from time to time to compensate for the evaporated water.

Table (8) types and concentrations of salts and ions used in curing solution.

Type of salt	Concentration		Salt content% by wt. of curing solution	$CL^- + SO_4^{--}$ solution			
				Anions		Cations	
	ppm	gm/L		Type	Concentration ppm	Type	Concentration ppm
NaCl	45100.4	45.1	4.51	CL^-	30019.5	Na^+	17750
$CaCl_2.2H_2O$	5512.5	5.5	0.55			Ca^{++}	1500
$MgSO_4.7H_2O$	1796.7	17.96	1.79	SO_4^{--}	7002.7	Mg^{++}	1773

PROCEDURE OF MEASUREMENT
Ultrasonic Pulse Velocity Test

This test provides a good indication of the variation in the density of hardened concrete. This test is carried out according to ASTM C597-83 (reapproved 1991) [15], using the portable ultrasonic non-destructive digital indicating tester (pundit). The transducers are smeared with grease to give good contact, and instrument setting is checked frequently using reference bar supplied with tester. Ultrasonic pulse velocity method consists of measuring the time of travel of an ultrasonic pulse, passing through the concrete to be tested. The time of travel between initial onset and the reception of the pulse is measured electronically. Pulse velocity (V) in Km/sec is calculated, as follows:

$$V = L/T \qquad \qquad \dots (1)$$

Where:

V: ultrasonic pulse velocity, km/sec

L: path length, km

T: transit time, sec

The specimens are tested after removal from curing tanks. Three specimens are tested at specified age, and the average value is obtained. The ultrasonic pulse velocity test is a non-destructive test method, which measures the velocity of an ultrasonic wave passing through the concrete. In this, the path length between transducers is divided by the travel time to determine the average velocity of wave propagation. Ultrasonic pulse transit times are measured (direct method). The average of three cubes (150 mm) was adopted for each test. The test was conducted at age of 28 days after curing with tap water, and at ages (30- 180) days of exposure to salt solution.

Compressive Strength

The compressive strength test was determined according to BS1881: part 116:1989 [16]. This test was measured on 150 mm cubes using an electrical testing machine with a capacity of 2000 KN, at loading rate of 5 MPa per minute. The average of three cubes was adopted for each test.

Potential static test

The test was conducted using potential static type (MIab200/ Bank Elec). The origin is from (Germany), at a speed equal to 3m/sec [17].

Electrochemical corrosion by Tafel method: An electric current is passed in an electrochemical cell which Consists of:

1-A positive electrode representing the specimen (working electrode)(anode) .

2-A negative electrode representing the pole in which the electrons which were released from the anode electrode are gathered. Platinum poles were used in this cell (auxiliary electrode) (cathode).

3- Standard calomel electrode.

4-An electrolyte of salt solution and water.

5-Electric power supply.

A. Preparation of Test Specimen

Many test specimens of steel used according to the standard specification for testing (ASTM) were prepared. The test specimen dimensions are 1.5x1.5x0.2 cm.

B. Tests and Checks: Preparations of specimens for microscopic test inclusive

Grinding the specimen by polishing paper 180-250-400-800-1000 with use of water. Polishing operation by using a special polishing cloth with use of alumina solution (aluminum oxide Al_2O_3. The granules size is 0.3 μm, Developing operation: use of Natal solution (2% nitric acid + 98% ethyl alcohol, imaging microstructure by optical microscope (Computerized optical microscopy)

C. Preparation of corrosion solution: Salt solution& Tap water

Corrosion solution must be conductor is prepared of salt solution consisting of (4.51) gm of NaCl , and $CaCl_2.2H_2O$ and $MgSO_4.7H_2O$ and (0.55) gm of $CaCl_2$.$2H_2O$ and (1.79) of $MgSO_4.7H_2O$ in (1) Liter of tap water with pH of 8.5 measured by a pH meter& One Liter of tap water with pH of 7.3 measured by a pH meter

RESULTS AND DISCUSSION

Ultrasonic Pulse Velocity (UPV)

The influence of curing in tap water and exposure to aggressive solution on the ultrasonic pulse velocity is illustrated in Figure (1). Results indicated that two groups of concrete (RF) and (SF-SP) exhibited continuous increase in ultrasonic pulse velocity cured in water at 180 days as shown in block diagrams except group (STF) exhibited starting decrease in ultrasonic pulse velocity in 150 days in water while in aggressive solution group (STF) begin decreases in ultrasonic pulse velocity at 120 days, compared with group (STF) cured in tap water. The observed trend may be attributed to the fact, that the ultrasonic pulse velocity is related to the density of concrete; this is in agreement with Feldman [18].

However, for a given aggregate and cement content the ultrasonic pulse velocity is affected by changes in the hardened cement paste. Therefore, the ultrasonic pulse velocity will be mainly controlled by the pore size of the cement paste and the density of cement matrix. Since the volume of pores is reduced as hydration proceeds, the ultrasonic pulse velocity is expected to increase with time of exposure. Under the action of the aggressive solution, group (SF-SP) exhibited considerable improvement in ultrasonic pulse velocity. After 180-day of exposure to aggressive solution, the percentage increase in ultrasonic pulse velocity of group (SF-SP) over the reference group (RF) in aggressive solution was (13.88). (UPV) of combined SF and HRWRA in group (SF-SP) were found considerably higher than their reference concretes group(RF) .In group (STF) , with content of steel fiber exhibited increase in ultrasonic pulse velocity in aggressive solution compared with reference concrete group (RF) in water at150 days as compared with reference concrete group(RF) in aggressive solution.
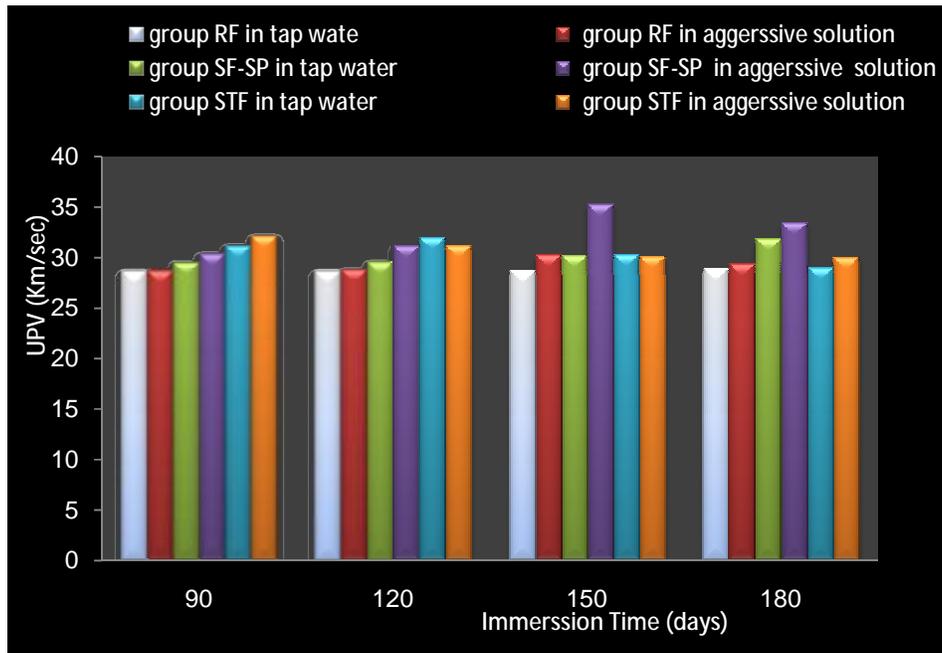
Figure (1) Relationship between (velocity of ultrasonic pulse &age time of immersion in aggressive solution.

Compressive strength

The development of the compressive strength for concrete mixes with and without admixture, cured in water and exposed to aggressive solution is presented in Figure (2). The result was under estimation; at loading rate of 5 MPa per minute .The test results of specimens cured in water show those two groups of concrete (RF and SF-SP) exhibit continuous increase in compressive strength up to age of 180 days. This behavior is attributed to reduced permeability with period of curing in tap water [16].But concrete mix (STF) exhibits increase in compressive strength up to age of 150 days. This behavior is attributed to the lower cover thickness over steel with some minor cracking in concrete structures lead to water entering concrete that may produce hydration products that would fill the pores in concrete and actually lead to an increase in strength .Also these results are in   agreement with results of Tawfiq [17]. The influence of exposure time to aggressive solution on the compressive strength of all mixes concrete is illustrated in Figure (2).
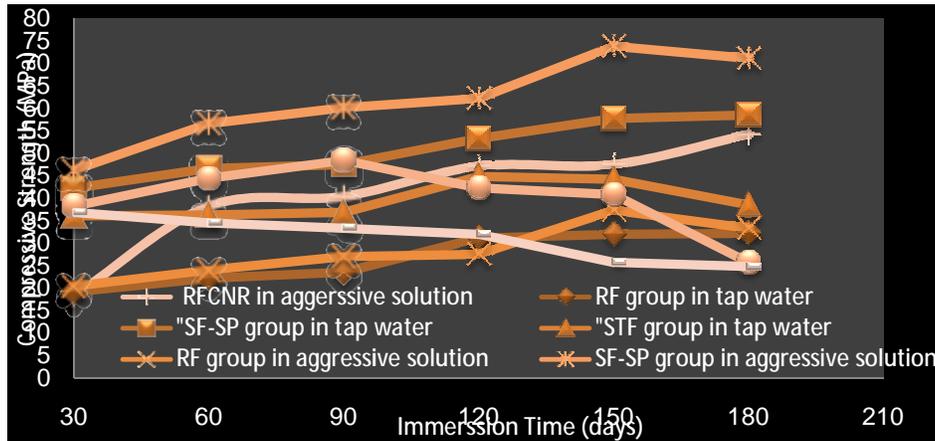
Figure (2a) Compressive Strength for various type of concrete immersed in tap water and aggressive solution.

Results indicated that the group (SF-SP) exhibited continuous strength gain within the tested period more than group (RF) .The retention of strength during the test period is attributed to the reduction in porosity caused by reduction in water content as well as to proper dispersion of cementations material particles in the mixes agreement with K. C. Biswal etal[18]. Confirmed considerable improvement in compressive strength of concrete containing high range water reducing agent and silica fume (SF-SP). This behavior is mainly related to a great water reduction for a given slump caused by incorporation of such admixture in concrete leading to a considerable reduction in capillary porosity that lead to reducing the permeability and porosity leading to an increased strength and high fineness for SF particles, pore size and grain size refinement leading to an increase strength .
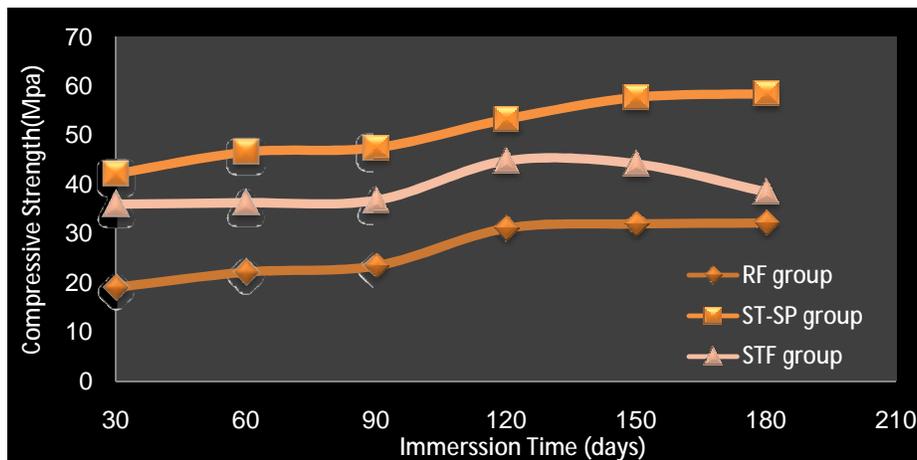

**Figure (2b) Development of compressive strength for various
Types of concrete immersed in tap water.**

Figure(2b) shows the superior performance of group (SF-SP) over that of reference concrete (group RF) as well as over group (STF) in aggressive solution , attributed to the fact that large capillary voids are filled with a micro porous low density calcium silicate hydrates. Group (STF) showed increase in compressive strength at (120) days in aggressive solution compared with the reference concrete group (RF) in tap water , as shown in Figure (2a,c) but after 120-day of exposure to aggressive solution, group (STF) exhibited decrease in compressive strength compared with reference concrete group (RF) ,This behavior is attributed to the oxide layer being broken, because chloride ions in aggressive solution enter the concrete and oxygen will be able to react with the steel, resulting in corrosion in the steel leading to decrease in strength .The percentages of increase in compressive strength after 180 days of exposure to aggressive solution were (3.41%),(21.53%) for (RF) and (SF-SP) compared with group RF and (SF-SP) in Figure (2d) of concrete in tap water respectively .
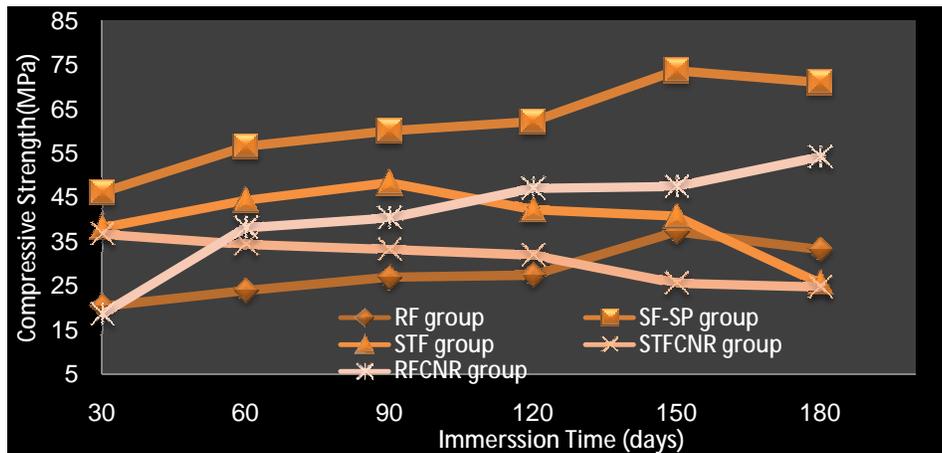

Figure (2c) Development of compressive strength for various types of concrete immersed in aggressive solution.

The ratio of increase in compressive strength for (SF-SP) and (STF) in age (180) days compared with group (RF) in tap water was (81.67%), (19.56%) water respectively.
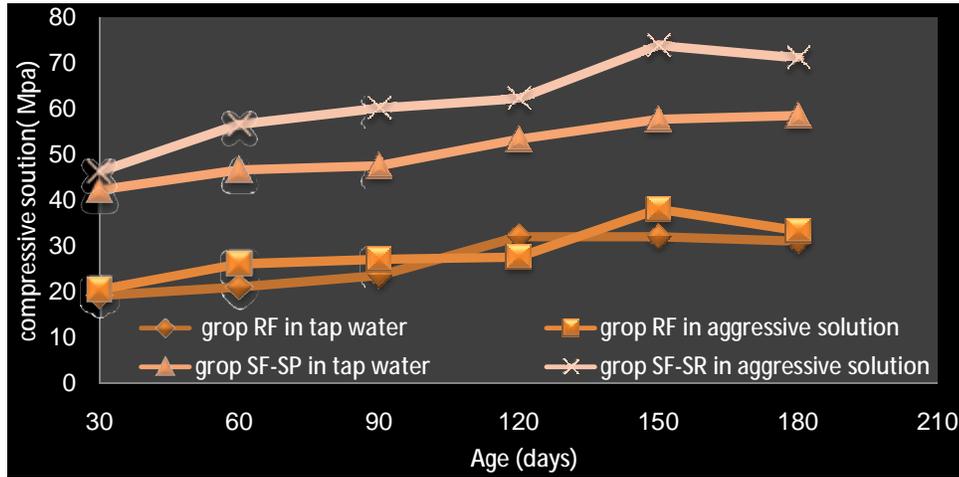
Figure (2d) Effect of exposure to tap water and aggressive solution on Compressive strength for (RF&SF-SP) concrete groups.

In Figure (2e) it is noticed that the group (STFCNR) exhibits continuous decrease in compressive strength for specimens exposed to aggressive solution up to 180 days, compared with group (STF) exposed to aggressive solution up to 180 days. This behavior is mainly related to defect in coating causing pitting corrosion in the surface of concrete leading to permeability increases and the aggressive solution penetrates more easily into the interior, thus accelerating the process of deterioration and lead to decrease in compressive strength.
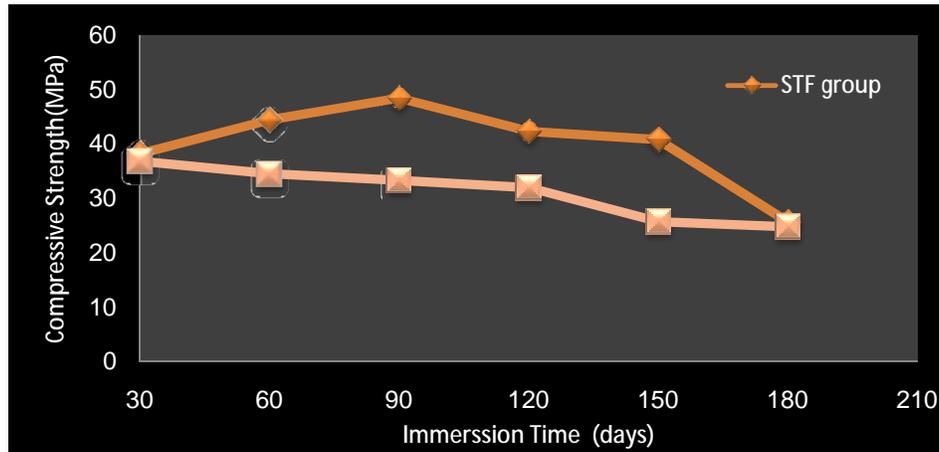

Figure (2e) Effect of exposure to aggressive solution on compressive strength for (STF &STFCNR) concrete groups.

From Figure (2f) it is shown that the use of coating in group (RFCNR) leads to continuous increase in compressive strength in aggressive solution up to 180 days. This behavior is mainly related to coating by natural rubber forming good barrier to aggressive solution. The percentage of increase in compressive strength for group (RFCNR) exposed to aggressive solution up to 180 days compared with (RF) exposed to aggressive solution was 62.76 % , and the percentage of increase in compressive strength for group (STFCNR) exposed to aggressive solution up to 180 days compared with (STF) exposed to aggressive solution was 19.56%.
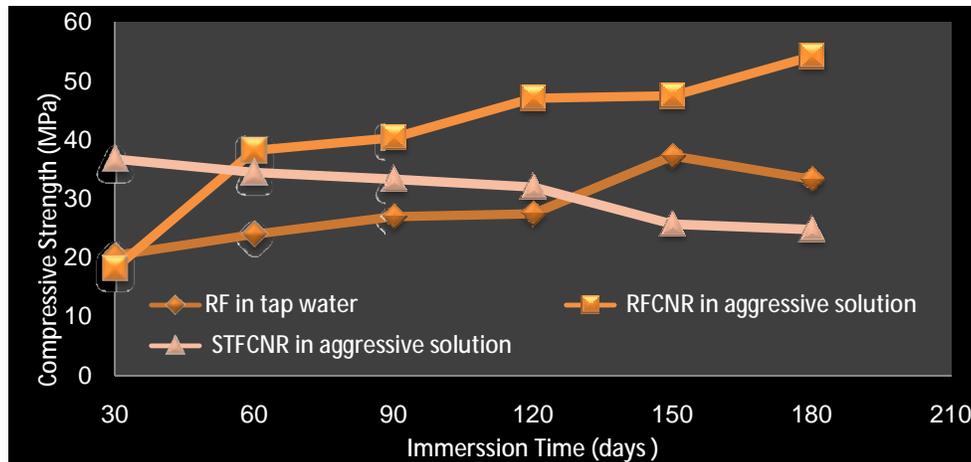

Figure (2f) Effect of exposure to tap water and aggressive solution on compressive strength for (RF -STFCNR and RFCNR) concrete groups.

Potential Static

From the results of the post- electrochemical corrosion conduction, the low-carbon steel is shown in Figure (3) shows that the corrosion rate for uncoated specimen (A) in tap water is greater than that of coated specimen(B) in tap water and that the corrosion rate for uncoated specimen (C) is greater from   coated specimen (D) in salt solution . The corrosion rate for coated specimens (B and D)   in tap water and salt solution is less than that for uncoated specimens (A and C). This is due to existence of alloying elements in the metal of low resistance to corrosion. One method adopted to delimit of metal corrosion is the use of coating that behave as electrodes (anode) with steel as negative electrode (cathode) because both are above steel in the electrochemical series. Salt solution is a medium of good electric conductivity that is electrolyzed to ions of the positive metal which combine with the negative ions of oxygen in the electrolyte forming metal oxides which represent corrosion. Coating process contributes to decreasing the corrosion rate; the correct choice of the coating element is to be according to the location of the element in the electrochemical process rendering it, the element on which corrosion occurs. From the results of the microstructure found that the phase prevailing is ferrite and the barite which has a penchant for union dissolved oxygen in tap water and salt solution generate layer of oxide known as rust, and this is clear in images of corrosion for all samples of the form C the highest rate in the form of sample A where it is noted that the lowest corrosion rate was in the form of samples user coating.

From the results obtained after electrochemical corrosion testing , the relationship between corrosion rate and potential difference shows that this

relationship is a linear relationship at the beginning of the matter indicating that over current when a constant voltage and that any change in this effort gives an indication that the corrosion has occurred and is determine corrosion rate depending on how Tafel by drawing tangents of conduct cathodic and anode curves obtained from the device with computer software as the point of intersection of these tangency will be a corrosion current .protection methods used in this study is working to reduce the soluble iron to reduce corrosion . Form result found that less corrosion rate in coated specimens in tap water and salt solution. Corrosion, the result agreement with Hani Aziz Ameen [19].
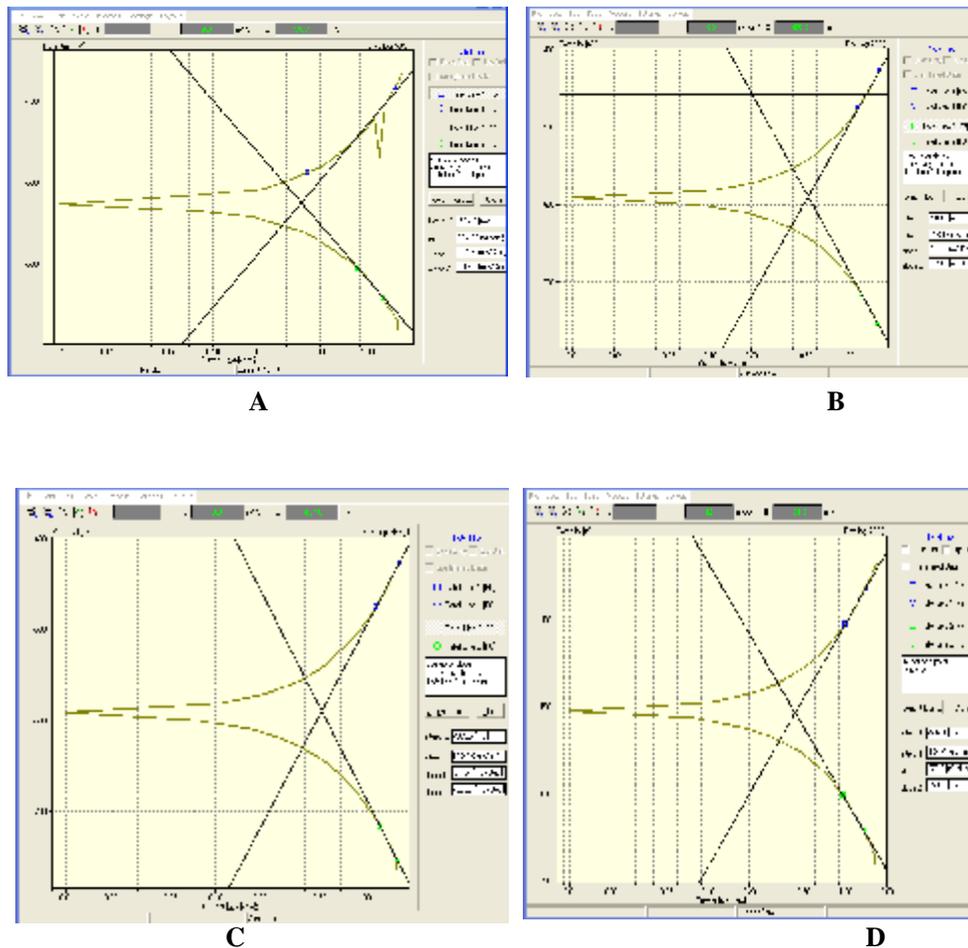

A   B

C   D

Figure (3) Corrosion rate of specimens (A, B, C and D).

CONCLUSIONS
1. The contribution of combined action of SF and HRWRA in group SF-SP exhibits significant improvement in pulse ultrasonic velocity (UPV) and in compressive strength compare with (RF ,STF , DRFCNR, STFCNR) groups in exposed to salt solution.

2. The coated reference concrete by natural rubber group RFCNR with w/c ratio of 0.45   exposed to salt solution   exhibits significant improvement in compressive strength in aggressive solution at all ages relative to group (RF) in salt solution at 180-day was 54.2 MPa compared with 33.3 MPa for group (RF) in salt solution .

3. The corrosion rate for steel bar specimens the corrosion rate for   uncoated specimen(A and B) greater than of coated specimen s (C and D)   in tap water and salt solution   that mean the corrosion inhibitors user in this test reduce the corrosion rate in salt solution

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