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The Effect of Replacing Fresh water with Salt water and Sea water in Concrete

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Abstract: this study aim to verify the possibility of using salt water and sea water instead of fresh water for concrete in mixing and treatment. Comparing its results with the pressure resistance test of a previous study, where this study relied on two previous studies, the first one, which I was involved in, depended on determining the place underground water wells and the highest salinity water. But in second study, which I have conducted, the water of the highest salinity wells was used in the first study in addition to the use of fresh water and sea water. Concrete cubes for all this water were prepared and immersed in fresh water. This study is the same as the second one mentioned above, however, the difference between them is the use of sea water in immersion of concrete cubes.
The results showed that the used underground water had a resistance in 7 days between (22.66-26.66)Mpa, while the result in 28 days were between (28.06- 34.13)Mpa. For fresh water submerged in sea water in 7 days were 25.06 Mpa, and in 28 days were 31.16 Mpa, while sea water in 7 days were 22.1 Mpa and in 28 days 28.93 Mpa.
Keywords: (treatment, sea water, fresh water, underground, resistance test)

1- Introduction

Libya is located on the northern coast of Africa. It is considered among the poorest Arab countries in water resources, due to its location within arid and semi-arid areas [1,2]. The main and important resource in Libya is underground water, and it represent 95% of human consumption for various purposes [3]. About 85% of underground water available is consumed in agriculture and 11.5% for urban purposes while the industrial consumption represents 3.5% [4]. The Libya coast on the Mediterranean Sea is about 1980 km [4].

The increase in population led to an increase in demand for water in all fields, and the lack of infrastructure encourages the citizens to dig wells and break the restrictions on drilling wells [5]. All of which caused the deterioration of underground water, especially in coastal areas [6,7]. Water resources are one of the most important elements of development that control the continuity of sustainable development. It is impossible to plan for continuous development without managing and planning the most important resources for its establishment and preservation for future generations.

Mr. A. C. Govalkar and Mr. D. S. Lalal is study showed good and satisfactory results of use of sea water in mixing and treatment of concrete [8]. Also, another study by Mr. Rita Irmawaty showed that sea water can be used in mixing and treatment [9].

1-1 Objective

Libya is considered one of the poorest countries for fresh water resources and it depends on groundwater as the main resource. Because of its geographical site along the seashore, the idea of this study rose by providing an alternative to preserve fresh water and groundwater. The main objective is to use sea water, groundwater and fresh water in mixing concrete and curing it with sea water. The impact of each of them on compressive resistance of concrete during 7 and 28 days and comparing the obtained results with a previous study results of freshwater treatment.

1-2 Background of study

In this study, the compressive resistance of concrete was determined by carrying out compression tests in 7 and 28days. The concrete cubes were prepared using a prescribed concrete mix ratio of 1:3.31:1.68 and the water cement ratio was taken as 0.6. The concrete was produced using salt water, fresh water and sea water.

A total of 60 numbers of 150 x150x150mm concrete cubes were cast. The mixing of concrete was carried out manually by hand. After twenty-four hours the cubes were cast, the hardened concrete cubes were de-molded, and the cubes were submerged carefully in the curing tank filled with water sea. At each specified period of days, the cubes were crushed to determine the compressive resistance of the concretes.

1-3 Literature Review

Studies carried out by researchers related to this area are highlighted and the gaps required to be filled by this project work our pointed out.

1- Similarly, Akinkurolere O.O et al (2007), in their paper titled "The Influence of salt water on the compressive strength of concrete" presented the result and findings of an experimental research on the influence of salt water from Lagos Lagoon, in Nigeria on the compressive strength of concrete. In the research, 132 concrete cubes of mould size 150x150x150mm were casted with fresh water (66 cubes) and salt water (66 cubes) in the ratio of 1:2:4 by weight of concrete and water-cement ratio of 0.6. They were cured in fresh water and seawater respectively. The concrete cubes were tested for compressive strength for 7, 14, 21 and 28 days respectively. The compressive strength of concrete is shown to increased by the presence of salt or ocean salt in the mixing and curing water. The rate of strength gain is also affected when the concrete is cast with fresh water and cured with salt water.

2- Felah M Wegian (2010) observed that the compressive strength and consequently the other related strengths of concrete were shown to increase for specimens mixed and cured in sea water at early ages up to 14 days, while a definite decrease in the respective strengths was observed for ages more than 28 days and up to 90 days. The reduction in strength increases with an increase in exposure time, which may be due to salt crystallization formation affecting the strength gain.

3- M.I Retno Susilorini et al (2005) conducted experimental and analytical method. Through experimental method they investigated the compressive strength of concrete cylinders, with 7 days and 14 days with seawater curing and plain water curing. After 7 days and 14 days of curing, the concrete cylinders were tested by compressive testing machine. This research concludes that both experimentally and analytically, the compressive strength of 7 days and 14 days old concrete specimens cured by seawater are higher than those cured by plain water.

4- E.M. Mbadike et al (2011) investigated the effect of sea water in the concrete production and reported that the strength reduction is about 8%.

5- Md. Moinul Islam, Md. Saiful Islam(2012) reported that, when the concrete specimens made with sea water and cured with sea water compared to concrete made with plain water and cured with plain water the loss of compressive strength of concrete is 10%.

2- MATERIALS USED AND METHODS

All the materials used in this study are from Zliten.

2-1 Cement

The used cement is from Al-Burj Contracting Company.

2-2 Coarse aggregate and fine aggregate

They were prepared in quantities sufficient to conduct the previous study [10] and the current study. The tests were conducted in the Faculty of Engineering laboratories at the Alasmarya University. It included the tests of granular gradient of coarse and fine aggregates and the results that are shown in figures (1) and (2) respectively satisfy the American specifications [11]. Los Angeles test, the percentage of absorption and specific weight of coarse aggregate results are shown in table (1). The specific test of sand is shown in table (2). All the states tests are within the mentioned specifications.

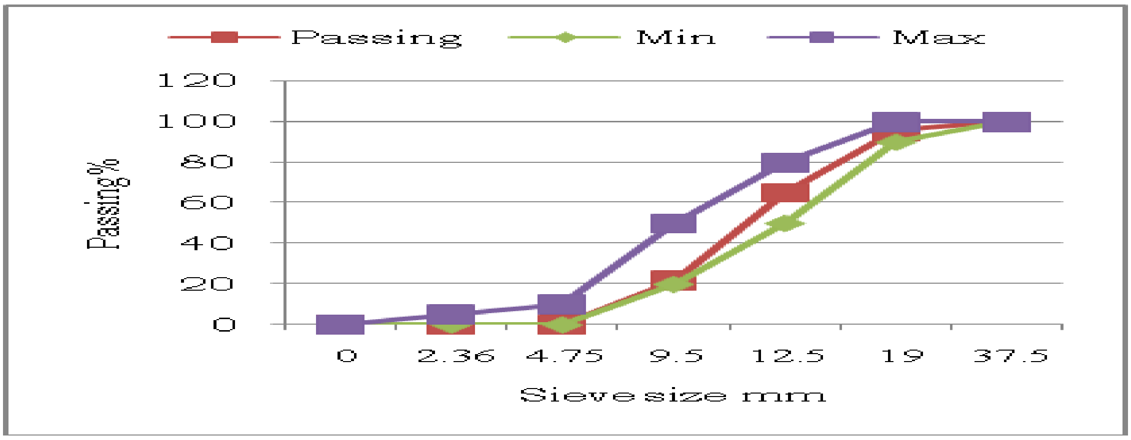

Fig. 1: The granular gradient of coarse aggregate [10]

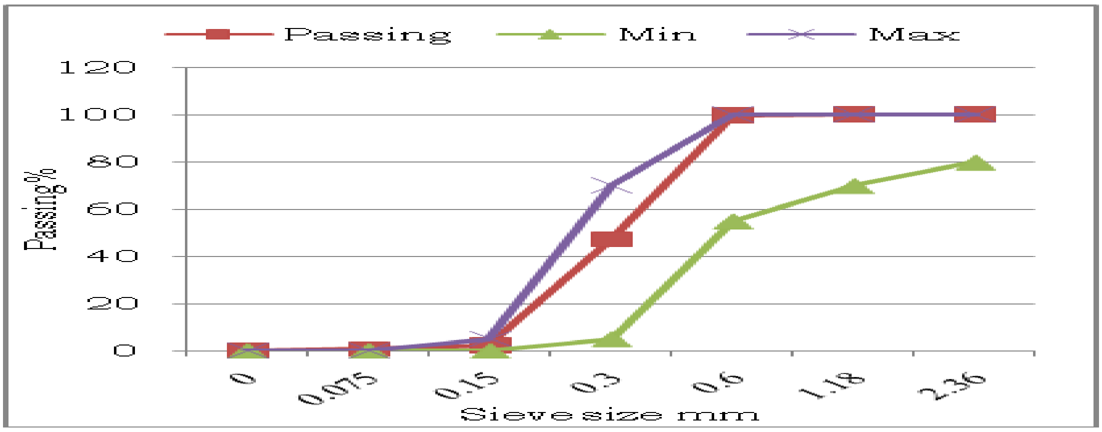

Fig. 2: The granular gradient of sand [10]

Table 1: Properties of aggregate observed in laboratory test [10].

No	Description	Test Result	Range Specification	ASTM
1	specific gravity test	2.667	2.5 – 2.75	C127[11]
2	water absorption %	2.15	Max = 2.5%	C127[11]
3	Los Angeles Abrasion test %	26.9	Max = 40%	C131[12]

Table 2: Physical properties of fine aggregate.

Description	Test Result	Range Specification	ASTM
specific gravity test	2.63	2.5 – 2.75	C128[13]
water absorption %	0.94	Max = 2.5%	C128[13]

2-3 Water used in mixing

2-3-1 Concrete mixing

The high salinity underground water from three wells taken from previous study which I involved – was used to mix the concrete. Table (3) shows the results of wells water tests [7]. Also, sulfate test and fresh water test were carried on the results are shown in table (4). All these tests were conducted in the Environmental Sanitary Office laboratory in Zliten. Sea water was used to flood the concrete cubes.

Table 3: The amount of salt and chloride in wells water [7].

No. Of well	Name of well	TDS mg/L	CL mg/L	PH	SO_4 mg/L
W_1	Gwellat	2388	1503	7.4	1414
W_2	Ka'am	3114	890	7.4	1860
W_3	Al Shaheed Hamza	6131	2475	7.1	870

Table 4: Fresh water test

No. Of well	Name of well	TDS mg/L	CL mg/L	PH	SO_4 mg/L
W_4	Fresh Water	62	40	7.53	22

2-3-2 Immersion water

After completion of the preparation of thirty concrete cubes for underground water for the three wells, as well as fresh water and sea water, they were immersed in sea water.

2-3-3 Mixing process

In Higher Institute of Engineering Technology. The components of concrete had been mixed manually because there were some problems in mechanical mixing. Figure (3) shows the components of the mixture and the mixing process. The mixing ratio of the components was (1:3.31:1.68:0.6), which expresses cement, coarse aggregate, sand, water respectively [10].

Fig. 3: The components of the mixture

4- Results and discussion

4-1 Concrete compressive strength

After mixing the concrete components manually, preparing the cubes and immersing them in sea water, and conducting a cracking test for concrete cubes after 7 and 28 days in Faculty of Engineering laboratory, the obtained results were recorded in tables (5, 6). Also, the results were compared with the results of the previous study [10] which are shown in figure (4).

Table 5: Results of weights and compressive resistance of concrete cubes in 7 days.

SSample Well	Sample symbol	Sample No.	Weight (g)	Concrete Resistance (Mpa)	AV
Gwellat Well	W1	1	8007	26	26.6
		2	8271	26	
		3	7993	28	
Ka'am Well	W2	1	8302	21.3	25.2
		2	8024	29.8	
		3	8013	24.5	
Al Shaheed Hamza Well	W3	1	7879	25.3	22.66
		2	7983	22.3	
		3	8401	20.4	
Fresh water		1	8246	25	25.06
	W4	2	7892	28	
		3	7979	22.2	
Sea water	W5	1	8435	17	22.1
		2	8015	232.3	
		3	8178	26	

Table 6: Results of weights and compressive resistance of concrete cubes in 28 days.

Sample Well	Sample symbol	Sample No.	Weight (g)	Concrete Resistance (Mpa)	AV
Gwellat Well	W1	1	7960	28	28.06
		2	8269	29.9	
		3	8337	26.3	
Ka'am Well	W2	1	8119	29.1	28.9
		2	8218	30.1	
		3	8107	27.5	
Al Shaheed Hamza Well	W3	1	7839	28.8	34.13
		2	8118	33.1	
		3	8189	40.5	
Fresh water		1	8044	34	31.16
	W4	2	7977	29.2	
		3	7989	30.3	
Sea water	W5	1	8130	26.5	28.93
		2	8326	34.8	
		3	8025	25.8	

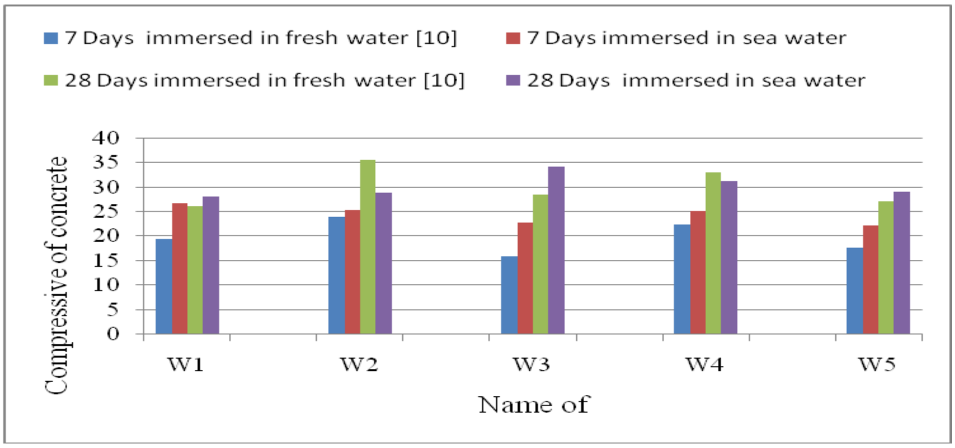

Fig. 4: A comparison of the compression resistance results of concrete cubes immersed in sea water and fresh water. (w_1, w_2, w_3 are three salty wells water respectively and w_4, w_5 are fresh and sea water respectively).

Figure (4) shows the results of the concrete compression resistance for cubes immersed in fresh water [10] and for cubes immersed in sea water. From the results It can be concluded that sea water can be used in mixing and curing of concrete, as it gave satisfactory results up to 28 days. The results also showed that the average compression resistance of concrete immersed in sea water exceeded 25 Mpa. From the results, it can be concluded that:

4-2 Salt:

From figure (4), it can be noticed that the higher the concentration of dissolved salts in wells water, the higher the compressive resistance of concrete after 28 days, and it gave the greatest resistance to the highest salinity at W_3, in concrete to 7 days, which gave the maximum resistance to the lowest salinity at W_1, and figure (5) explains the relationship between the soluble salt of the water used in the study and the compressive resistance of concrete.

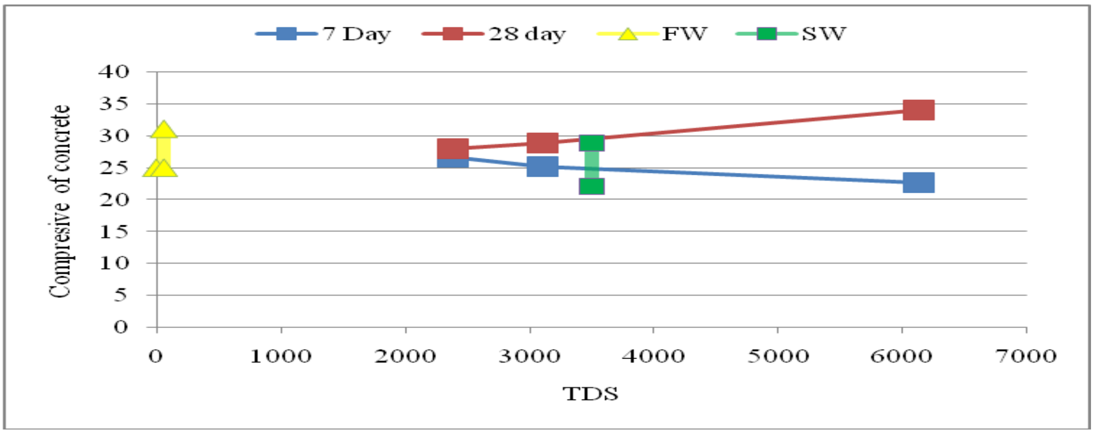

Fig. 5: The relationship of total dissolved salts to the compressive resistance of concrete

4-3 Chlorides:

The results indicated a fluctuation in the compressive resistance of the concrete in 7, 28 days. Figure (6) shows the relationship between the compressive resistance of concrete and the chlorides present in the water. Where it has been noticed from the figure that the compressive resistance of both fresh water and sea water ranges between higher and lower concrete resistance to underground water.

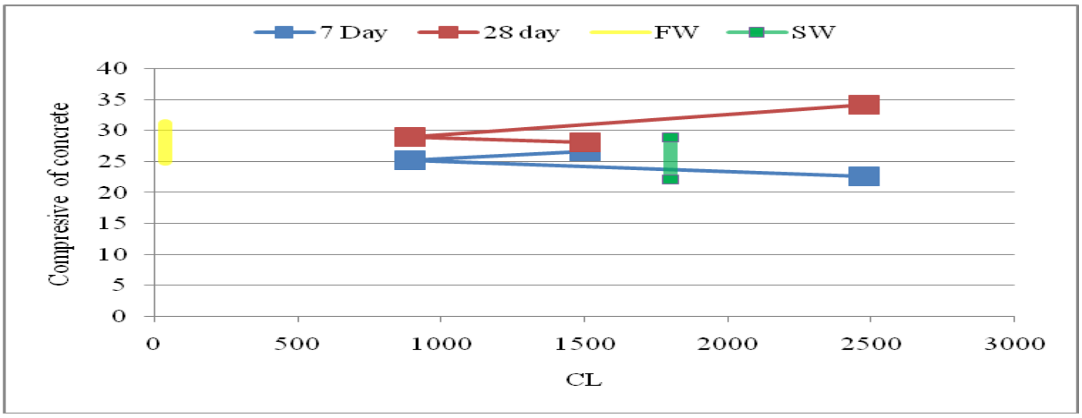

Fig. 6: The relationship of chlorides to the compressive resistance of concrete

4-4 PH:

The results of wells water in 7 days indicate that the relationship between PH and compressive resistance of concrete is a direct relationship, unlike in 28 days, the relationship is considered inverse. Figure (7) shows the relationship between compressive resistance of concrete and the PH of water used in concrete.

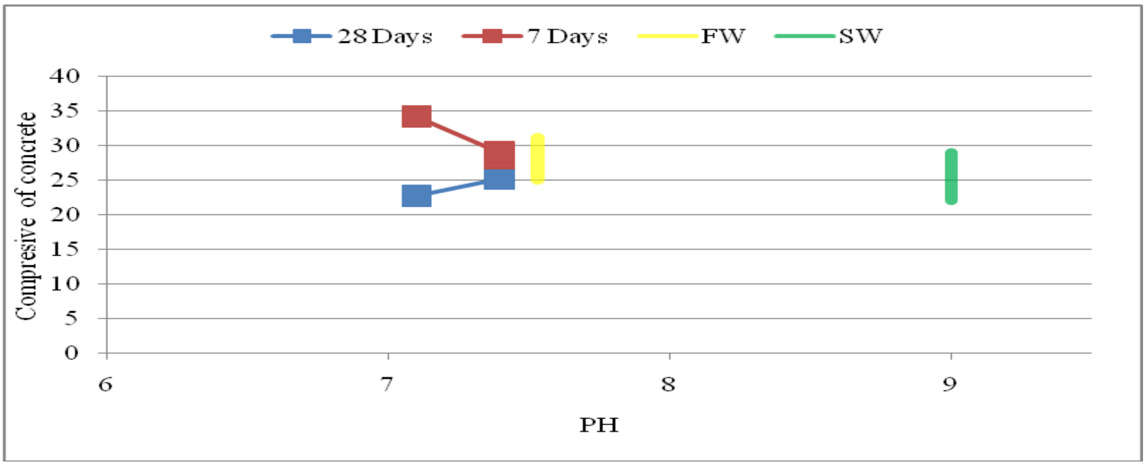

Fig. 7 The relationship between the PH of the used water and the compressive resistance of concrete

4-5 Sulfates:

The results showed a fluctuation in the compressive resistance of concrete between rise and fall in 7, 28 days, where it can be noted that in 28 days the maximum strength of concrete is the lowest concentration of sulfate, while fresh water and sea water pressure resistance varies between the results of concrete strength for wells water. Figure (8) indicates the relationship between the compressive resistance of concrete and the concentration of sulfate in water.

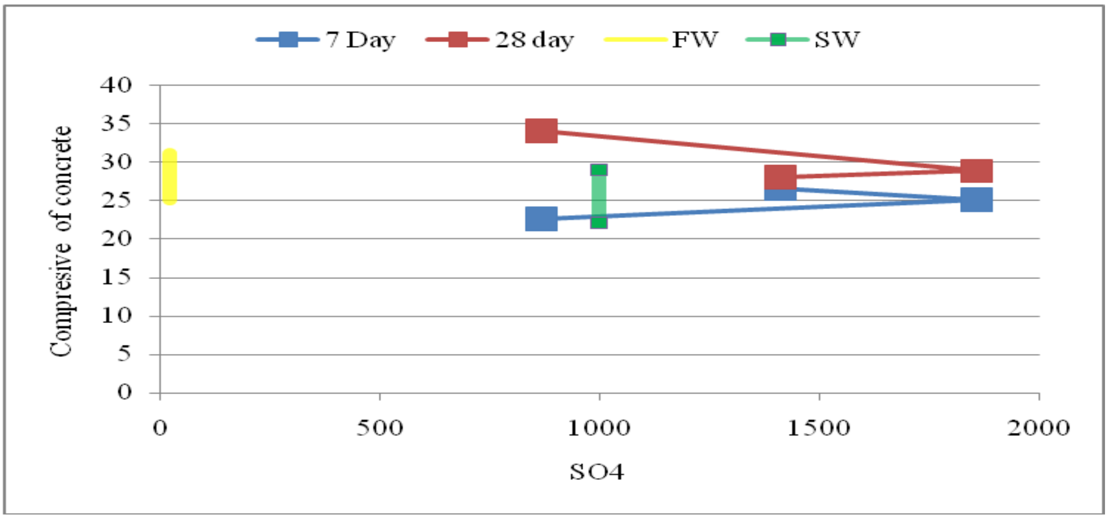

Fig. 8: The relationship between sulfates and the compressive resistance of concrete

5- Recommendations:

According to the results and the fact of limited underground water in Libya, the following recommendations can be considered:

1- Conducting tests on concrete: tensile, bending and corrosion tests in the short and long term.

2- Benefiting from sea water and using it instead of the man-made –river water or underground water.

3- The use of recycled or treated water from sewage in the fields of industry and conducting the necessary tests, while preserving human health and the environment.

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