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Effect of Water Salinity on Concrete Strength

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Abstract: this paper to aim study the effect of mixing concrete with salinity of well water, sea water and fresh water on concrete strength. Forty-five (45) concrete cubes were used for testing. The mixing ratio for all mixtures was 1:1.68:3.33 and the ratio of water to cement was 0.6. The concrete cubes were first immersed in well water (water sample was taken from three different wells), and testing during a period of 7,28 and 60 days, respectively. The dissolved salts concentration for the first well was 2388 mg/L, and the average compressive resistance of concrete recorded was 19.4 N/mm^2, 26 N/mm^2 and 30.1 N/mm^2, respectively. For the second well, the dissolved salts concentration was 3114 mg/L, and the average compressive resistance was 23.9 N/mm^2, 35.5 N/mm^2 and 36.45 N/mm^2, respectively. And, the dissolved salts concentration was 3161 mg/L and the average compressive resistance was 15.95 N/mm^2, 28.4 N/mm^2 and 33.05 N/mm^2 for the third well. The concrete compressive resistance to sea water during the test period was 17.55 N/mm^2, 27.15 N/mm^2 and 28.1 N/mm^2, respectively. For the reference sample, fresh water, the concrete compressive resistance during the same test period was 22.45 N/mm^2, 32.9 N/mm^2 and 36.73 N/mm^2. The results obtained for well water and sea water indicated an increase in concrete strength as the age of the concrete increased.

Keywords: (well water, sea water, fresh water, concrete cubes, concrete resistance)

1- Introduction

Sea water represents about 97% of the total water on earth andonly 3% of usable water [4]. Also, some regions of the world will suffer from a shortage of drinking water, according to the United Nations and the World Meteorological Organization [5].Libyan coast cities suffer from the scarcity of natural water resources because they are located in arid and semi-arid regions [1]. Among these cities is the city of Zliten, which has a highly increase in population where they depend on underground water (well water) to satisfy their water needs. Due to the increase in population and the growth in agricultural, industrial and construction activities, the consumption rate has increased dramatically which led to shortage in well water and rise of dissolved salts [2]. The underground water suffers from pollution due to the interference of sea water [3]. With the lack of fresh water, it is necessary to look for alternative sources of water for use in concrete. Sea water has the characteristic of salinity, whose quantity per kilogram is about (3-5 %) [6] due to the amount of chlorides present in the water, which tends to cause moisture to persist and flourish on concrete [7]. Also, the researchers in field of concrete construction did not seriously study the possibility of using sea water, which can reduce the use of fresh water and help to encounter lack of fresh water in regions to accelerate the development of infrastructure through the use of building materials.

2- MATERIALS AND METHODS

The materials were used to prepare required samples namely; water, cement, coarse aggregate, and fine aggregate. All used material were collected from Zliten area.

2-1 Water

Water is an essential component of concrete. Water occupies 6-8% of the composition of

fresh concrete [8]. Combining water with a cementations material forms a cement paste by the process of hydration. The used water in this study are:

2-1-1 Well Water

Water was collected and prepared for three wells with high salinity, based on a previous study I participated in. Table (1) shows the salinity of well water.

Table 1: The amount of salt in water wells [2].

No. Of well	Name of well	TDS mg/L
W_1	Gwellat	2388
W_2	Ka'am	3114
W_3	Al Shaheed Hamza	6131

2-1-2 Sea water

Earth's surface is covered by water around 71% in that mostly by oceans. The remaining is land consisting of continents, lakes, islands and rivers [4]. The average, sea water in the world's oceans has a salinity of about 3.5% (35 g/L) [9]. Most seawater is fairly uniform in chemical composition, and the primary chemical constituents of sea water are the ions of chloride, sodium, magnesium, calcium and potassium.

2-1-3 Fresh Water

Fresh water was used as a reference sample, and it was prepared from Al Mawred desalination plant.

2-1-4 Water curing

The water used throughout the curing of concrete in this study for all cubes is river water.

2-2 Cement

Cement generally represent 12-14% of concrete weight[8]. The cement was obtained from a local factory (Al-borj for cement – Zliten).

2-3 Coarse aggregate

The aggregate was supplied from Zliten area. Several tests were done on. Figure (1) shows the grading curve of coarse aggregate to ensure that it has good grading according to specifications, ASTM C136 [10]. Also the

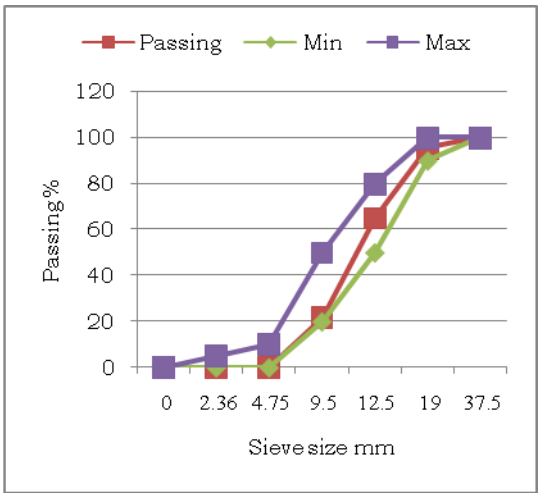

Fig. 1: Grading curve of aggregate(5/10)mm

physical properties of aggregate such as aggregate specific gravity test, water absorption, and Los Angeles abrasion test, were performed at Al-Asmarya University, faculty of engineering laboratory, and shown in table (2), according to ASTM C127, C131 [11], [12].

Table 2: Properties of aggregate observed in laboratory test.

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

2-4 Fine aggregate

Fine aggregate was tested for its physical properties such as specific gravity and water absorption in accordance with ASTM C128[13], as shown in table (3). Figures (2) shows the grading curve of fine aggregate to ensure that it has good grading according to specifications ASTM C136 [10].

Table 3: Physical properties of fine aggregate.

No	Description	Test Result	Range Specification	ASTM
1	specific gravity test	2.63	2.5 – 2.75	C128[13]
2	water absorption %	0.94	Max = 2.5%	C128[13]

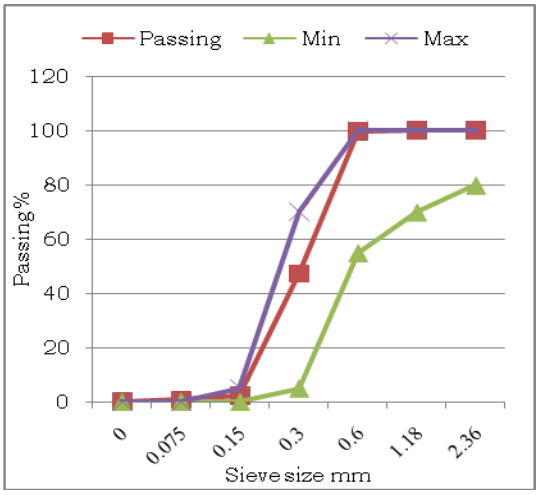

Fig. 2: Grading curve of fine aggregate

3- Mix design

The process of mixing and preparing materials is an important step in concrete mixture. Three types of concrete mixes were prepared. All the concrete mixes were produced by same proportion.

Final mix portions:

C	:	FA	:	CA	:	Water
424	:	712.3	:	1411.9	:	254.4
1	:	1.68	:	3.31	:	0.60

4- Results and Conclusions

4-1 Slump test

The slump test conducted for all the batches shows that the slump is in the range of 120 – 150 mm, according to BS8500 [14], which is suitable for trench-fill foundations where a high flow is required. This is known as a "wet mix".

4-2 Concrete compressive strength

The compressive strength test was performed on the concrete cubes, tested at the curing age of 7, 28 and 60days using the compression testing machine. The cube was placed between the compressive plates parallel to the surface and then compressed until failure occurred. The reported results are the average of five samples. The obtained results are shown in figure (3).

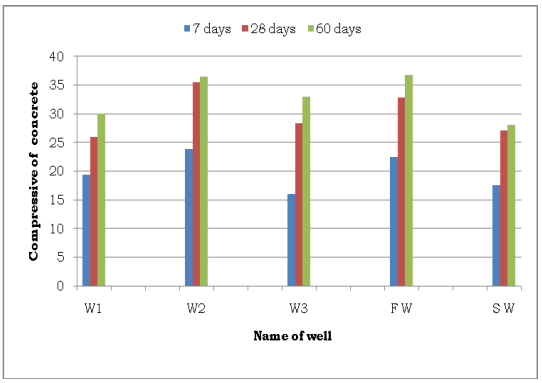

Fig. 3: Comparison of compressive strength for concrete mixes.

(W1,W2 and W3 are three wells salty water respectively and FW, SW are fresh and seawater respectively.)

The following conclusions are conducted from this study:

1- If we use salt water casting, the concrete has no reduction in the strength.

2- The strength of concrete increases with time.

3- Concrete can be made with water from sources other than potable water.

4- According to slump results, the source of water in mixing concrete doesn't affect the workability of concrete.

5- Due to water shortages and limited supplies, it is advised that other sources of water can be used to mix concrete in order to lessen the strain on potable water.

الملخص بالعربي:

تأثير ملوحة المياه علي مقاومة الخرسانة

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الملخص

نتناول في هذه الدراسة، تأثير خلط الخرسانة بملوحة مياه الآبار ومياه البحر والمياه العذبة علي المقاومة الخرسانية. وتم استخدام خمسة وأربعين (45) مكعبًا خرسانيًا لاختبارها. ونسبة الخلط لجميع الخلطات (1:1.68:3.33) ونسبة الماء إلي الاسمنت 0.6 ، وتم غمر هذه المكعبات في المياه العذبة. واختبارها خلال فترة 7 و 28 و 60 يومًا على التوالي .وكانت الأملاح الذائبة في البئر الأول 2388 ملجم / لتر وسجلت متوسط مقاومة الانضغاط للخرسانة 19.4 نيوتن/مم^2 و 26 نيوتن/مم^{2}و 30.1 نيوتن/مم^2 علي التوالي خلال فترة الاختبار. أما في البئر الثاني فكانت الأملاح المذابة 3114 ملجم/لتر ومتوسط مقاومة الضغط للخرسانة لنفس فترة الاختبار هي 23.9 نيوتن/مم^2 و 35.5 نيوتن / مم^2 و 36.45 نيوتن/مم^2 علي التوالي. والأملاح الذائبة في البئر الثالث 6131 ملجم/لتر ومقاومة الضغط 15.95 نيوتن/مم^2 و 28.4 نيوتن/مم^2 و 33.05 مم^2 . وأعطت مقاومة الخرسانة لمياه البحر خلال فترة الاختبار 17.55 نيوتن/مم^2 و 27.15 نيوتن/مم^2 و 28.1 نيوتن/مم^2 علي التوالي. أما العينة المرجعية وهي المياه العذبة فسجلت مقاومة الخرسانة خلال نفس مدة الاختبار 22.45 نيوتن/مم^2 و 32.9 نيوتن/مم^2 و 36.73 نيوتن/مم^2. وأشارت النتائج التي تم الحصول عليها لمياه الآبار ومياه البحر زيادة في مقاومة الخرسانة كلما زاد عمر الخرسانة.

الكلمات المفتاحية: المكعبات الخرسانية، مقاومة الخرسانة، المياه العذبة، مياه الآبار، مياه البحر.

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