The Effect of Water Quality Sources on Concrete Mix Parameters

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ABSTRACT

This research investigated the impact of water from various sources on the mechanical characteristics of concrete. The qualities of concrete made with surface water, well water, and tap water are evaluated in this study. The features of concrete specimens with mix ratios of 1:2:4 created with water from various sources were evaluated using compressive strength and density. Concrete specimens made using tap water had the highest mean compressive strength at 90 days, according to the findings. Although well water had the lowest compressive strength, it was determined that it was not acceptable for concrete work, despite the fact that it is currently being utilized on some locations where tap water is unavailable.

Keywords: Water, Concrete, Compressive strength, Tensile strength, Parameters of water

1. Introduction

Fresh or drinkable water is commonly used in the construction process to create concrete components. Recently, various sources of spent water were tested for use in concrete building. Ocean and alkali waters, canal and stream water, textile evaporation, TreatedWastewater, car wash effluent, industrial wastewater, and so on are examples of these. Water from various quality sources was previously used in the creation of building materials. In comparison to potable water, reclaimed wastewater was used in the concrete [1]. Wastewater from power washing machines was utilized in high-strength concrete and its strength was compared to that of freshwater [2]. Concrete strength was also evaluated using textile effluent in compared to conventional water [3]. For concrete development, general and specific treated wastewater, car wash wastewater, sugary wastewater, saltwater, and treated sewage water were compared to potable and domestic water [4–10]. The impact of water quality on compression strength has been studied [5,6]. As a result, water management, particularly wastewater management, is a concern, and wastewater management systems have been created to address it [7–8]. The construction sector consumes massive amounts of raw materials. Annual concrete manufacturing, for example, necessitates 20 billion tons of aggregate, 1.5 billion tons of cement, and 0.8 billion tons of water globally [6]. According to [9] , the most significant feature of concrete is strength, which affects the quality of the concrete . Engineers and builders utilize the compressive strength of concrete as the most frequent performance metric for testing concrete cubes and cylinders. The failure load divided by the cross-sectional area resisting the load yields the compressive strength of concrete.

The following measures should be followed by ready-mixed concrete production plants in order to adhere to the principles of sustainable building [10-13].

1- decreasing natural resource and energy use,
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2- recovering and reuse products (recycling),
3- have used energy from the environment resources and renewable sources.

2. Materials and Methods

2.1 Cement

Ordinary Portland Cement (OPC) Type 1 produced in Sulaymaniyah; Iraq was utilized in this investigation (Tasluja). This is the most common type of cement used in Iraq's building sector. The cement is packaged in paper and plastic bags in accordance with Iraqi Standard Specifications (No. 5:1984). The most essential cement qualities are shown in Tables 1 and 2.

Table 1: Chemical Composition of Cement

Compound Composition	By weight %	Limits of Iraqi Specification No.5:1984
Lime (CaO)	61.30	-
Silica (SiO2)	19.55	-
Iron oxide (Fe2O3)	3.99	-
Alumina (Al2O3)	4.97	-
Magnesia oxide (MgO)	2.2	<5.0
Sulfate (SO3)	1.13	<2.8
Loss on Ignition	1.39	<4.0
Lime saturation factor	0.87	0.66-1.02
Insoluble residue	0.99	<1,5
	Main Compounds (Bogue׳s equation) %by weight of cemen	
Tricalcium silicate (C3S)	48.33	
Dicalcium silicate (C2S)	32.39	
Tricalcium aluminate (C3A)	4.77	
Tetracalcium aluminoferrite (C4AF)	4.87	

Table 2: Physical Properties of Cement

Physical properties	Test result	Limits of Iraqi specification No. 5:1984
Specific surface area, Fineness Blaine method (m2 /kg)	262.5	>230
Setting time by Vicat׳s method Initial setting(min) Final setting(min)	166 245	>45 <10 hrs
Soundness using Auto clave (%)	0.31	<0.8

2.2 Fine Aggregate

The study employed typical sand from the AL-Ukhaider region in Karbala, Iraq, which complies with Iraqi Standard Specification (No.45: 1984-Zone II). Sand is a readily available, low-cost commodity that helps to reduce the cost of a concrete mix. Table 3 displays the findings of the fine aggregate sieve study. Table 4 shows the chemical and physical characteristics of fine aggregate

Table 3: Sieve analysis of fine aggregate (Zone II)

Sieve size(mm)	% passing by weight	Limits of iraqi specification No . 45:1984 (Z0ne II)
9.5	100	100
4.75	96	90-100
2.36	90.5	75-100
1.18	78.5	55-90
0.6	55.4	35-59
0.3	21.6	8-30
0.15	6.5	0-10
pan	0	-

Table 4: Fine aggregate physical properties

Physical properties	Test result	Limits of iraqi specification No.5:1984
Specific gravity	2.39	-
Sulfate content (%)	0.077	≤ 0.5 %
Absorption(%)	2.85	-
Particles finer than75 mm sieve (%)	2.40	< 5 %
Modulus of Fineness	2.46	-

2.3 Coarse Aggregate

The usage of gravel with a maximum size of 12.5 mm from the AL-Nibaee region (AL Anbar, Iraq). The sieve analysis of natural coarse aggregate according to Iraqi Standard Specification is shown in Table 5. (No.45: 1984). The physical features of this aggregate are shown in Table 6.

Table 5: Sieve analysis of coarse aggregate

Sieve size(mm)	% passing by weight	Limits of iraqi specification 45 : 1984
19	100	100
12.5	96	95-100
9.5	44	30-60
4.75	4.4	0-10

Table 6: Chemical and Physical characteristics of coarse aggregates

Sieve size(mm)	% passing by weight	Limits of iraqi specification No.5:1984
19	100	100

12.5	96	95-100
9.5	44	30-60
4.75	4.4	0-10

2.4 Mixing Water

Three distinct sources of water were used. 250 feet below the land surface, groundwater or tap water was obtained, while surface water was drawn from Baghdad's water canal. Bicarbonates, conductivity, hardness, total dissolved solids (T.D.S), total suspended solids (T.S.S), dissolved oxygen, pH, biochemical oxygen demand, and chemical oxygen demand were all tested in the water.

Table 7. results of the water tests

Parameters	Tap water	Well water	Surface water	Maximum Allowable Limit(WHO)
pH	7.5	7	7.3	6.5-8.5
Temp. C^0	17	17	17	-
T.D.S (mg/l)	420	700	950	1000
T.S.S (mg/l)	12	50	76	155
Bicarbonates(mg/l)		290	185	1000
Cond. (ms/cm)	740	1100	1350	1000
Turbidity (NTU)	0.8	1.5	6	10
Hardness (mg/l)	54.6	270	120	100
DO (mg/l)	5.15	6.1	6.5	4-7
COD (mg/l)	11.2	13	47	150
BOD (mg/l)	2	9	29	80

2.5 Mix Design and Sample Preparation

For the manufacture of concrete based on a cement, sand, and aggregate combination, one mix design proportions were employed. These ratios were (1:2:4). For both design proportions, the water–cementratio was held constant at 0.60. It should be emphasized that just one water sample was utilized at a time when producing the concrete, and no additional water samples were intermixed in any instance or design ratio. According to the American Society for Testing and Materials, the elements were weighted in a separate tray before being blended in a concrete mixer (ASTM C192-98). The whole mixing time was 5–7 minutes, following which the concrete mix was compressed using a vibrating table. The slump test was performed to measure the workability of the concrete and to compare the effect of the water sample on the workability of the concrete. In addition, the compacting factor test was carried out to ensure that the produced concrete was workable. After 24 hours, the specimens were molded, cured in water, and tested at room temperature for the requisite period. In the casting process, 150 mm diameter 300 mm long cylinders were made 36 for each mix design (1:2:4) to assess compressive and tensile strength. In addition, 36 100 mm100 mm500 mm prisms or beams were cast to evaluate the flexural strength (modulus of rupture) for each combination. As a result, 72 samples were created (36 (comp strength-cylinder) + 36 (tensile strength-cylinder). After 7, 28 and 90 days of curing, all of these samples were evaluated. After curing, the following tests were performed on the concrete specimens: A compressive strength test was performed at 7, 28, and 90 days according to ASTM C39, with a loading rate of 2.5 kN/s;•A splitting cylinder tensile test was performed at 7, 28, and 90 days according to ASTM C496-96, with an increasing loading rate of 2 kN/s;•A three-point loaded, flexure strength test of a beam was performed according to ASTMC [10,14].

3 Results Compressive Strength and Splitting Tests

The compressive strength, tensile strength, and lifespan of concrete created with well water, power station water, and fresh water are graphed to help explain the differences in compressive strength and splitting with ages. This is demonstrated in Figure 1 and 2 and Table 8.

Table 8. results of the compressive strength and tensile in concrete

Details Source of water	Concrete Mix	Water percentage	Compressive Strength Mpa			Tensile Strength Mpa		
			7 Days	28 Days	90 Days	7 Days	28 Days	90 Days
Tap water)	1:2:4	0.6	18.5	25	28	1.5	2.7	3
water well	1:2:4	0.6	10	16.5	18.5	0.8	1.35	1.7
Surfacewater	1:2:4	0.6	16.5	20	24	1.3	2.1	2.6

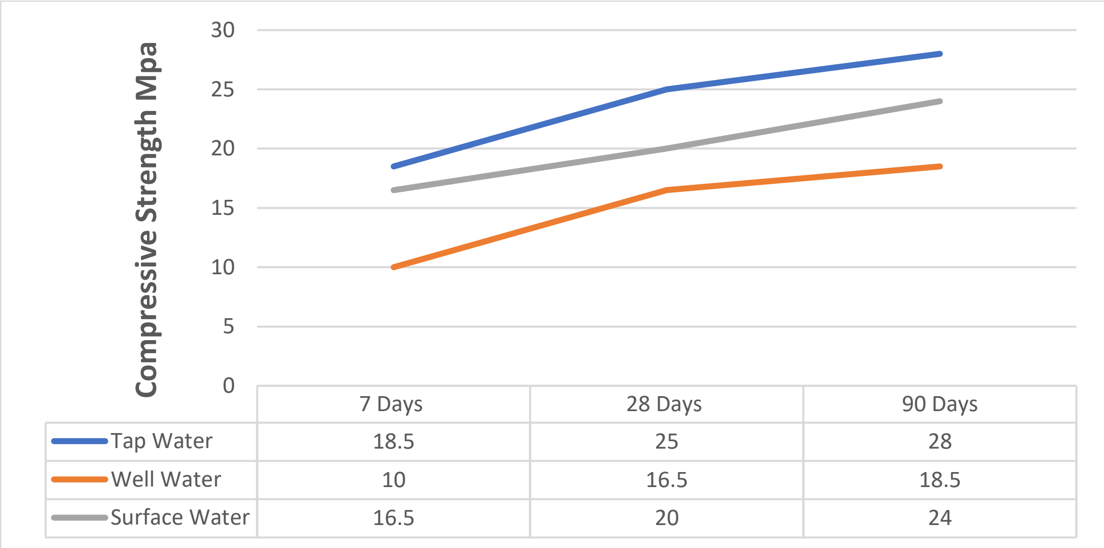

Figure 1. Graph of compressive Strength against Age of Concrete.

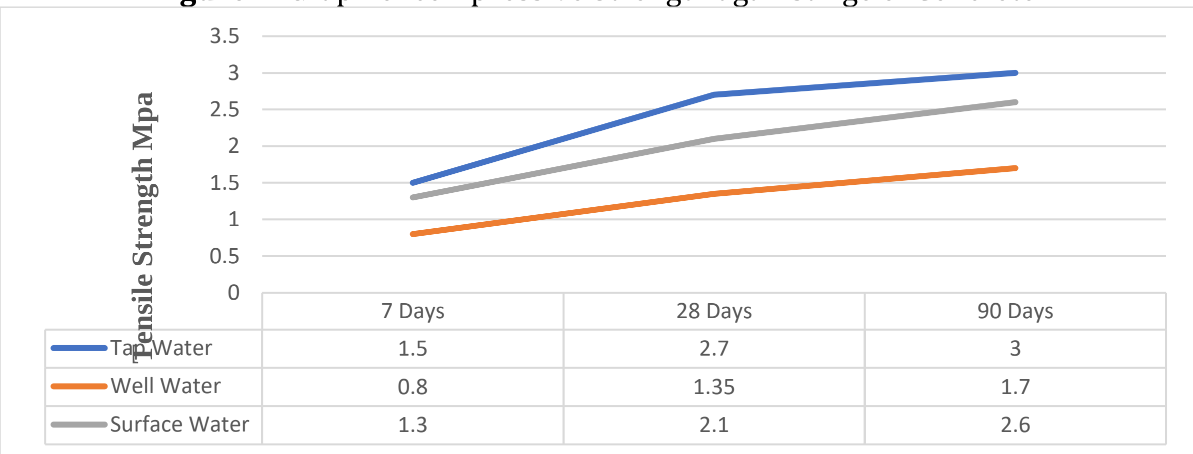

Figure 2. Graph of splitting against Age of Concrete

Table 8 and Figures 1 and 2 demonstrate that the compressive strength and splitting of concrete cubes created using tap water and surface water improved considerably with age, indicating that tap water and surface water are suitable for use in concrete manufacturing. There was a gradual increase in compressive strength and tensile strength from (18.5 and 16.5) and (1.5 and 1.3) N/mm2 to (28 and 24) and (3 and 2.6) N/mm2, and it was discovered from Table 8 and Figure 1 and 2, that the compressive strength and tensile strength of well water-produced concrete cubes tended to increase from 28 days, However, with a 90-day age, it is quite little. The presence of components such as Na, K, Ca, and Cl aided in increasing the rate of hydration, allowing for an early increase in compressive strength but afterwards experiencing a sudden constant due to their decrease quantities.

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