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A study for the properties of the Portland cement from different sources available in the Iraqi market

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ABSTRACT

The quality of the cement used is the most important criteria for the implementation of the plain and reinforced concrete mixtures as well as the finishing works. So that the durability of concrete members and other cement applications is a function of the quality of the cement used. In recent years, the Iraqi marketimported many types of cement from another countries, most of them have no typical tests for their chemical and physical properties or not confirm with the Iraqi specifications. In this study a comparisonwas made between random types of cements which are commonly used in Iraq throughout an experimental investigation. All tests werecarried in an accordance with the Iraqi specifications. For this purpose, the cement mix was prepared with cement content of 300 kg/m^3 and W/C ratio of 0.45. Mix proportioning of 1:1.5:3 was used for all of tested mixes. The initial and find setting times and slump tests were performedin order to identify thepropertiesof fresh concrete. On the other hand, tests of compressive strengths were adoptedto evaluatethe properties of hardened concrete. The resultsobtained showed that the locally produced cement (type Al-Muthana) is the most favorable cement compared with the other tested samples (from another countries), because of its high compressive strength and less water requirements to reach the standard consistency.

Keywords: Portland cement, Concrete mixes, Compressive strength, Concrete tests

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1. Research objective

- Indicate the best type of locally available cements which can be used in producing the concrete mixtures for the Iraqi construction projects.
- Explore the constituents of each type of cement and its comply with the Iraqi specification for Portland cement.

2. Experimental program

The preparation of concrete mixes was carried out using a constant cement content of (300 Kg/m^3) and water/cement ratio of 0.45. Both of the fine and coarse aggregate were complied with the Iraqi specification No. 45-1984. The coarse aggregate was within the grading zone of (5-20)mm. For all of the concrete mixtures, the mix design was (1:1.5:3) by weight [6].

2.1. Materials used

2.1.1. Cement

The ordinary Portland cement produced by six different cement plants was used in this study and indicated as follow:

- Ordinary Portland cement type Muthana (locally produced)
- Ordinary Portland cement Kuwaiti type (imported)
- Ordinary Portland cement type Bahbahan (imported)
- Ordinary Portland cement type Bangord (imported)
- Ordinary Portland cement type Falcon (imported)

- Ordinary Portland cement type Taslojah (locally produced)

The chemical compositions of the former cement types were tested in accordance to Iraqi specification No 5-1984 and the results obtained are shown in Table 1.

Table1: The major components and fineness of the tested cement

Source of cement	Fineness of cement Cm2/gm	C4AF%	C3A%	C2S%	C3S%
Muthana	2900	10.6	10.8	27.2	48.8
Kuwaiti	2780	10.8	10.5	25.4	44.5
Bahbahan	2500	10.3	10.1	22.8	41
Bangord	2660	10.5	10.3	23.6	42.3
Falcon	2830	10.8	10.72	27.1	46.5
Taslojah	2710	10.4	10.9	24.4	43.6

Table 2: Chemical composition of the tested cement

Source of cement	So3%	Mgo%	Fe2o3%	Al2o3%	SiO2%	Cao%
Muthana	2.9	3.1	3.8	8.5	23.6	62.4
Kuwaiti	3.2	2.6	3.7	8	21.7	63.4
Bahbahan	3.1	2.7	2.8	7.8	22.5	61.3
Bangord	2.7	2.3	2.9	6.5	21.9	62.4
Falcon	3.3	2.2	1.9	8.1	20.6	63.1
Taslojah	3	3.1	2.8	7.6	23.3	59.6

Tables 1 and 2 show that all types of the cement used in this study complies with the Iraqi Standards.

2.1.2. Aggregate

Natural sand suitable for common purposes was used as fine aggregate in this study. It was satisfying the requirements of Iraqi Standards No. 45-1984 zone 3. Cursed gravel was used as coarse aggregate in this study. It was satisfying the requirements of Iraqi Standards No. 45-1984 grading zone (5-20) mm. Tap water was used in all of the mixing operations. The experimental measurements were carried out for both fresh and hardened status of concrete mixes.

2.2. Tests of fresh concrete mixes

2.2.1. Initial and final setting times

The initial and final setting times were performed for cement pasts. These pasts were with a standard consistency [2]. This test is an indicative for the permitted time for placing the concrete mixes. Vicate apparatus was used in this test according to the BS Standards 12:1971. Table 3 shows the results obtained of initial and final setting times. All of former results were satisfying the requirements of Iraqi specification No.5-1984.

2.2.2. Slump test

This test was carried out in accordance to the B.S 1881 Part-2:1970[17]. Table 3 includes the results of the slump test for all of the concrete mixes.

Table3: The initial and final setting times and slump values for different types of cement

Source of cement	Initial setting time (hr)	Final setting time (hr)	Limits of Iraqi Specifications No.5-1984	Slump (mm)
Muthana	1.35	5.41	Not less than 45 min. for the initial setting time Not more than 10 hr. for the final setting time	22
Kuwaiti	1.43	6.23		29
Bahbahan	2.29	6.7		41
Bangord	2.17	5.51		35
Falcon	2.43	6.45		32
Taslojah	2.48	6.35		26

2.3. Compressive strength

This test was performed in accordance to the B.S 1881 Part-4:1970 using compression tester (TAK AZMA COM 2000) [2]. The loading rate was 15 Mpa /minute and 150mm cube moulds were used in this test [11]. Table 4 shows the results of compressive strength at 7 and 28 days age

Table 4 shows the values of compressive strengths at 7 and 28 days age

Source of cement	Compressive strength at 7 days age	Compressive strength at 28 days age
Muthana	16.869	28.342
Kuwaiti	14.251	27.763
Bahbahan	12.437	27.472
Bangord	16.14	24.524
Falcon	13.351	24.836
Taslojah	13.573	26.632

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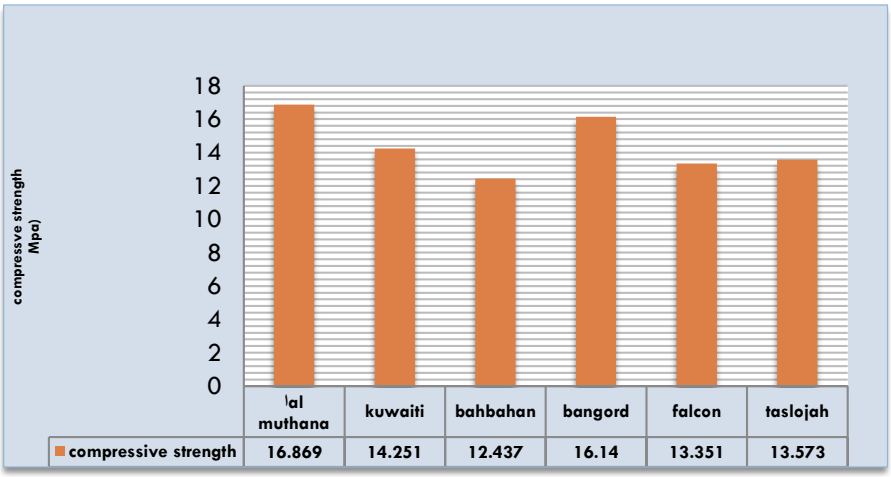

Figure1: The relationship between the source of cement used and the compressive strength at 7 days age

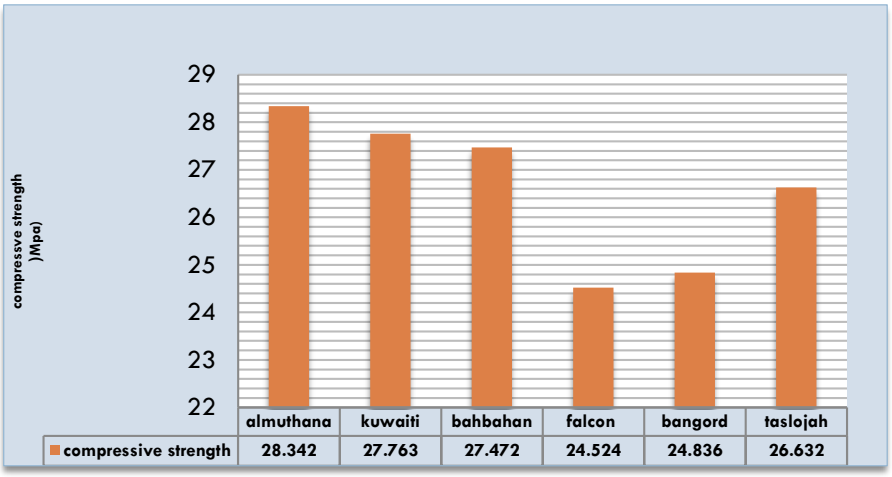

Figure2: The relationship between the source of cement used and the compressive strength at 28 days age

3. Discussion and conclusions

3.1. Discussion

Table 3 shows that cement type Muthana exhibited the shortest initial and final setting times compared with other types of cements adopted in this study. This may be explained by the highest percentages ofC3S, C2S and C3A compositions of this type of cement. The longest initial and final setting times were recorded for the cement type Bahbahan compared with the other tested samples. This may be due to the lowest percentages of the major chemical compositions of this type of cement [9]. It is well known that both the calcium silicate and aluminum silicate hydrates are responsible for the progress of hydration processes. The aforementioned hydrates are the direct results of C3S, C2S and C3A compositions. In addition, the mechanical strength depends upon the gel of calcium silicate hydrate which forms about 75% of the cement weight [5]. If the content of C3A is increased, this needs for more gypsum added with possible of more fineness of cement. Such attitude will increase the surface area available for hydration.

It appears that the C3S content was higher for the cement type Muthana. This led for more early age strength of this kind of cement as per in the results of compressive strength at 7 days [15]. This cannot be said for other types of cement (Table 4). Moreover, the increase of both C2S and fineness of cement were the major cause for the good workability and higher early strength of this kind of cement [12], see Figures 1 and 2. The recorded slump value for the cement type Muthana was lower compared with the other tested samples. This indicative for a dense concrete mix leads to more compressive strength value.

3.2. Conclusions

This study was undertaken in order to evaluate the properties of the ordinary Portland cement available in Iraqi markets produced by six different cement plants based on the fresh and hardened tests of concrete mixes.

The most interested conclusions can be listed below:

- The locally produced cement type Muthana exhibited the highest values of compressive strength at 7 and 28 days age due to its higher fineness particles and C3S content.
- The imported cement type Bahbahan possessed the lowest quality in terms of the values of compressive strength at 7 and 28 days age

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