

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

Ahmed Taresh<sup>1</sup>, Majid Abd<sup>1</sup>, Walaa Mohammed Hamza<sup>1</sup>

<sup>1</sup> Civil Engineering Department – University of Al-Qadisiyah-Iraq

### 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 market imported 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 comparison was made between random types of cements which are commonly used in Iraq throughout an experimental investigation. All tests were carried in an accordance with the Iraqi specifications. For this purpose, the cement mix was prepared with cement content of 300 kg/m<sup>3</sup> and W/C ratio of 0.45. Mix proportioning of 1:1.5:3 was used for all of tested mixes. The initial and final setting times and slump tests were performed in order to identify the properties of fresh concrete. On the other hand, tests of compressive strengths were adopted to evaluate the properties of hardened concrete. The results obtained 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

### *Corresponding Author:*

Ahmed Taresh,  
Civil Engineering Department  
University of Al-Qadisiyah-Iraq  
Email: [Ahmed.ejel@qu.edu.iq](mailto:Ahmed.ejel@qu.edu.iq)

### 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<sup>3</sup>) 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<br>Cm2/gm | C4AF% | C3A%  | C2S% | C3S% |
|------------------|------------------------------|-------|-------|------|------|
| <b>Muthana</b>   | 2900                         | 10.6  | 10.8  | 27.2 | 48.8 |
| <b>Kuwaiti</b>   | 2780                         | 10.8  | 10.5  | 25.4 | 44.5 |
| <b>Bahbahan</b>  | 2500                         | 10.3  | 10.1  | 22.8 | 41   |
| <b>Bangord</b>   | 2660                         | 10.5  | 10.3  | 23.6 | 42.3 |
| <b>Falcon</b>    | 2830                         | 10.8  | 10.72 | 27.1 | 46.5 |
| <b>Taslojah</b>  | 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% |
|------------------|------|------|--------|--------|-------|------|
| <b>Muthana</b>   | 2.9  | 3.1  | 3.8    | 8.5    | 23.6  | 62.4 |
| <b>Kuwaiti</b>   | 3.2  | 2.6  | 3.7    | 8      | 21.7  | 63.4 |
| <b>Bahbahan</b>  | 3.1  | 2.7  | 2.8    | 7.8    | 22.5  | 61.3 |
| <b>Bangord</b>   | 2.7  | 2.3  | 2.9    | 6.5    | 21.9  | 62.4 |
| <b>Falcon</b>    | 3.3  | 2.2  | 1.9    | 8.1    | 20.6  | 63.1 |
| <b>Taslojah</b>  | 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 | 22         |
| Kuwaiti          | 1.43                      | 6.23                    |                                                    | 29         |
| Bahbahan         | 2.29                      | 6.7                     |                                                    | 41         |
| Bangord          | 2.17                      | 5.51                    | Not more than 10 hr. for the final setting time    | 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                              |

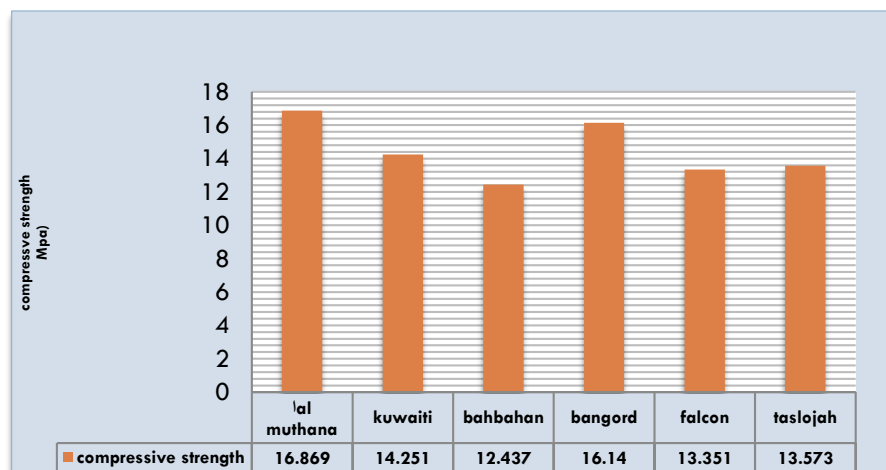


Figure1: The relationship between the source of cement used and the compressive strength at 7 days age

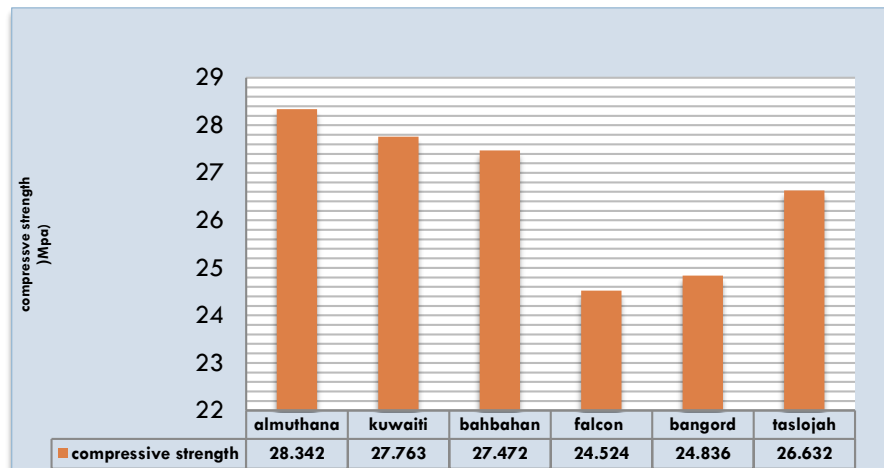


Figure2: The relationship between the source of cement used and the compressive strength at 28 days age

### 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 of C3S, 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

#### .References

- [1] Adalberth K. Energy demand during the life cycle of a building. CIB Symposium Energy Mass and Flow in the life Cycle of building, Vienna, 1996.

- 
- [2] Steiger P. Hochbaukonstruktionen nach Uokologishen Gesichtspunkten. SociTetTesuisse desing Tenieurset des architectes SIA.
  - [3] Dokumentation D 0123, Zurich, 1995. [3] Walker P. SpeciHcation for stabilised pressed earth blocks. MasonryInternational 1996;10(1):1–6.
  - [4] Houben H, Guillaud H. Earth building comprehensive guide. CRAToNe-EAG, Greenbelt, 1994.
  - [5] Harris DJ. A quantitative approach to assessment of theenvironmental impact of building materials. Building andEnvironment 1999;34:751–8.
  - [6] VenuMadhavaRao K, Venkatarama Reddy BV, Jagadish KS.Strength characteristics of stone masonry. Materials and Structures1997;30:233–7.
  - [7] Kreijger PC. Ecological properties of buildings materials. Materialsand Structures 1987;20:248–54.
  - [8] John Wiler (ed.) In Environmental Resource Guide. Buildingmaterials, a quarterly publication of The American Institute ofArchitect, 1997.
  - [9] Wadel G. Sustainability in industrialized architecture: Modular lightweight construction applied to housing (La sostenibilidad en la construcción industrializada. La construcción modular ligera aplicada a la vivienda).Doctoral Thesis. Polytechnic University of Catalonia-Department of Architectural Constructions; 2009. Available online at: <http://www.tdx.cat/TDX-0122110-180946>.
  - [10] Zabalza I, Aranda A, Scarpellini S. Life cycle assessment in buildings: State-of-the-art and simplified LCA methodology as a complement for building certification.Building and Environment 2009;44:2510e20.
  - [11] Janssen GMT, HendriksChF. Sustainable use of recycled materials in building construction. Advances in Building Technology; 2002:1399e406.
  - [12] Kotaji S, Edwards S, Schuurmans A. Life cycle assessment in building and construction. A state-of-the-art report. Florida: SETAC press; 2003.
  - [13] Kellenberger D, Althaus H- J. Relevance of simplifications in LCA of building components. Building and Environment 2009;44:818e25.
  - [14] Nicoletti GM, Notarnicola B, Tassielli G. Comparative Life Cycle Assessment of flooring materials: ceramic versus marble tiles. Journal of Cleaner Production 2002;10(3):283e96.
  - [15] Shukla A, Tiwari GN, Sodha MS. Embodied energy analysis of adobe house.Renewable Energy 2009;34(3):755e61.
  - [16] Asif M, Muneer T, Kelley R. Life cycle assessment: a case study of a dwelling home in Scotland. Building and Environment 2007;42(3):1391e4.
  - [17] Buchanan A, Levine B. Wood-based building materials and atmospheric
  - [18] Alaa J, Al-Yousefi, H, Mohammed, A, Murtadha, H. “Optimization of water-cement ratio in concrete contains recycled polypropylene (PP) plastic waste, ” periodicals engineering and nature science, Vol 4, No 7 (2019).