INFLUNCE OF INCREASING WATER:CEMENT RATIO ON THE SOME PROPERTIES OF CONCRETE CONTAINS LOW CONTENT OF POLYMER

Dr.Abdulkader Ismail Al-Hadithi
Licturer
College of Engineering
Al-Anbar University

الخلاصة:

تضمن هذا البحث دراسة تأثير تغير نسبة الماء/الاسمنت على بعض خواص الخرسانة المحتوية على نسبة واطئه من بوليمر مطاط الستايرين بيوتادين SBR كمقاومة الانضغاط ، مقاومة الانثناء ، الكثافة وقابلية التشغيل.
استخدمت نسبة الخلط الوزنية (١:٢:٤) واضيف البوليمر كنسبة وزنية من الاسمنت وهي ٢%. استعملت خلطة مرجعية لغرض المقارنة. كانت نسب الماء /الاسمنت ٠.٢، ٠.٣ ، ٠.٤، ٠.٥ و ٠.٦ بينما استخدمت نسبة ٠.٣٥ للخرسانة المرجعية. تراوحت قيم الكثافة ما بين ٢٠٣٠ و ٢٣٦٠ كغم/م٣ . أدت زيادة نسبة الماء/السمنت الى زيادة الهطول. كان لنسبة البوليمر:السمنت الواطئة تأثيراً واضحاً في تحسين مقاومة الانثناء فيما كان تأثيرها أقل وضوحاً في تحسين مقاومة الانضغاط للخرسانة موضوع البحث.

1-Abstract

This research includes the variation effect of (W/C) water: cement ratio on the properties as compressive strength , flxural strength , density and workability of concrete contains low Polymer SBR ratio.

1:2:4 (cement: sand :gravel) by weight mixes were used . The polymer was added as percentages of cement weight and it was 2%. Reference mix was made. Water cement ratio (w/c) were used are 0.2 , 0.3 , 0.4 , 0.5 and 0.6 respectively and 0.35 (w/c) was used for reference mix . The density of concrete varied between 2030 kg/m^3 and 2360 kg/m^3.

Keywords: Polymer; Concrete; SBR;compressive strength ; flxural strength; Properties

2.1. POLYMER PORTLAND CEMENT CONCRETE (PPCC) .

American concrete institute committee 548 [1] defines the PPCC as an ordinary concrete mix with emulsified polymers added during mixing .The result is a uniform polymeric mesh within the hydration products of concrete.

2.2. STYRENE BUTADINE RUBBER (SBR) POLYMER MODIFIED CONCRETE .

SBR Polymer is the most widely used in concrete. High adhesion occurred between the polymer films that forms and cement hydrates. This action gives less strain compared to ordinary concrete and improves the properties of concrete such as flexural and compressive strength and gives also a higher durability (2) .

2.3. .PRINCIPLES OF POLYMER MODIFICATION.

Polymer latex modification of cement mortar and concrete is governed by both cement hydration and polymer film formation. The cement hydration process generally precedes the polymer film formation process by the coalescence of polymer particles in polymer latexes (1 , 2). In due course both cement hydration and polymer film formation processes form a co-matrix phase. The co–matrix phase is generally formed according to the simplified model given by Ohama (1), and also by Schwiete (3,4), shown in fig (1).

Some chemical reactions happens between polymer and cement hydration that leads to improve the bond between cement hydrates and aggregates(1).

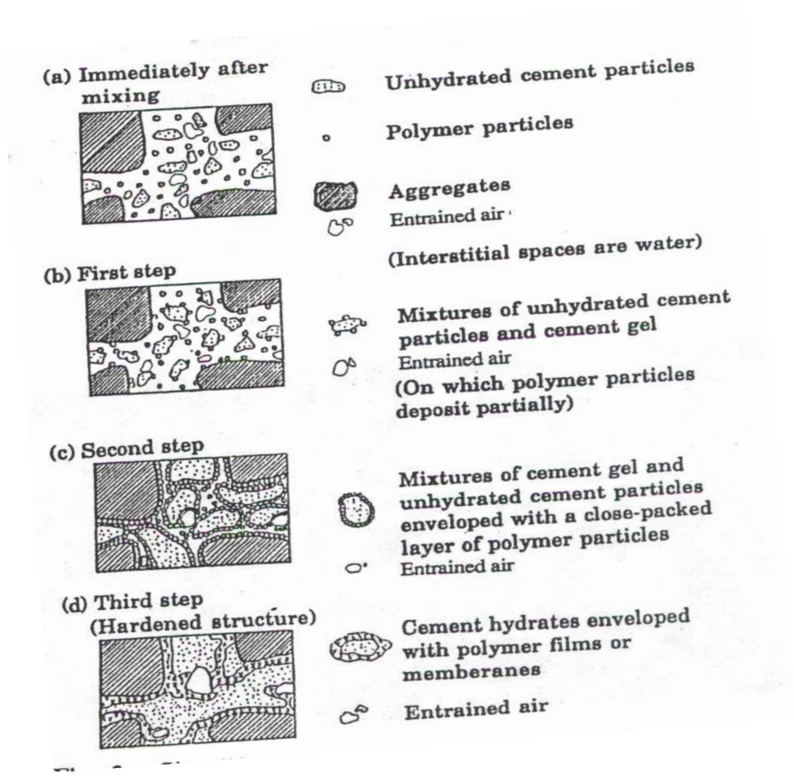


Fig.(1) Simplified model of formation of polymer-cement co-matrix [1]

3- MATERIALS USED IN THE RESEARCH

3.1. Cement

Ordinary Portland Cement (OPC) ASTM Type I from Kubaisa cement factory is used. The cement is complied to Iraqi specification No.5/ 1984.

3.2. Aggregates

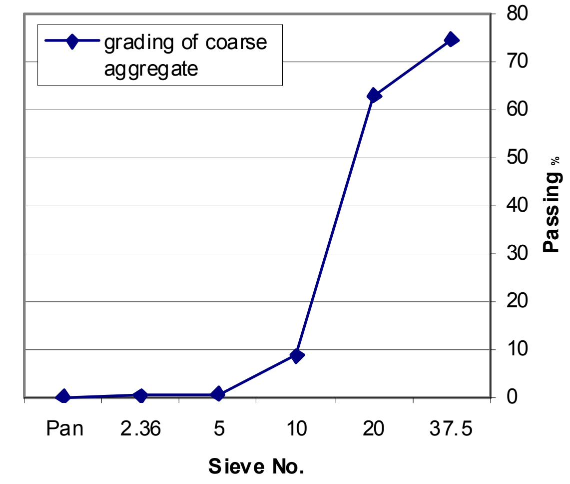
Coarse aggregates from Aljrayeshi area in Al- Anbar Governorate was used . The grading of both coarse and fine aggregate which were found according to to (B.S. 410: 1976)[5] are shown in tables (1) and (2).

Table (1):seive analysis of coarse aggregate.

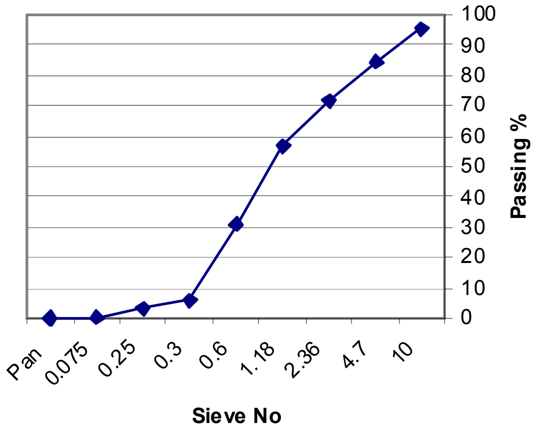
Sieve No.	Retaining%	Passing%
37.5	25.4	74.59
20	11.833	62.76
10	53.94	8.82
5	8.12	0.7
2.36	0.199	0.498
Pan	0.498	0.000124

Table(2): seive analysis of fine aggregate.

Sieve No.	Retaining%	Passing%
10	4.78	95.22
4.7	10.8	84.42
2.36	12.86	71.56
1.18	14.62	56.94
0.6	25.83	31.113
0.3	25.01	6.1
0.25	2.7	3.4
0.075	3.15	0.243
Pan	0.24	0.006



Fig(2):Sieve analysis of coarse aggregate



Fig(3):Sieve analysis for fine aggregate

3.3. Polymer

Styrene butadiene rubber was used in this work. The chemical composition of which is shown in table (3). The polymer (SBR) was used as a ratio by weight of cement of 2%.

Table (3): Chemical composition of Styrene butadiene rubber (SBR)*

Infra-Red (I.R.) test	pH %	Humidity content %	Solid Particles content %
Styrene butadiene rubber with small percentage of admixtures	8.2	42.4	57.42

* The test was done in Ibn-Rushud industrial company.

4- MIXING AND COMPACTION OF CONCRETE

Mixing operations were made in the concrete laboratory in the civil engineering department of Al-Anbar University. A $0.07m^3$ pan mixer was used. Pouring both the coarse aggregates and fine aggregate made mixing and cement in two alternate times and mixing them dry while adding the polymer until a homogenous dry mix is obtained. The water is added then and mixing continued until final mixing mix is obtained.

The concrete mix is poured, in three layers, in the molds. An electrical vibrator made compaction for not more than 10 sec.

5-CURING

The specimens were unmolded after 24hrs.in laboratory. They were submerged in water and in the age of 72 hrs. specimens taken out of water until time of test

6-THE MIXES

The mixes which is used in this rsearch is shown in Table 4.

Table(4): Mixes which are used in the research.

Mixes	Cement:sand:gravel	Water:cement%	Polymer: cement %
Mix 1 (ref.)	1:2:4	0.35	0%
Mix 2	1:2:4	0.2	2%
Mix 3	1:2:4	0.3	2%
Mix 4	1:2:4	0.4	2%
Mix 5	1:2:4	0.5	2%
Mix 6	1:2:4	0.6	2%

7-TESTS

7.1. Density:

The weight of every specimen was recorded air-dry and dimension prior to test.

7.2.Slump Test:

This test were done according to ASTM C 143-90a.[6].

7.3.Compression Strength Test:

The compression strength tests were performed according to B.S.1881:Part 116:1983[7]. A100X100X100mm cube steel moulds were used .The moulds were lightely oiled before filling with concrete.ELE machine with a 1000kN load capacity were used for that test.

7.4.Flexural Strength Test:

Flexular strength tests were carried out according to B.S.1881:Part 118:1983[8]. For this test a 50kN ELE testing machine were used.

8. RESULTS AND DISCUSSION:

8.1 Density – Polymer Content Relationship:

The results of polymer modified concrete revealed that the lowest 28-day density (air-dry) reached 2030 kg/m^3 for mix2 which it had a w/c=0.2 . The highest was 2360 kg/m^3 for mix4 of w/c=0.3 . The density of reference mix (mix1) (without polymer) is 2360 kg/m^3 .

The water:cement ratio effect is clear in increasing density (see Fig(4)). This can be attributed to the effect of water in decreasing friction between the agg. Particals.

8.2. Slump(workability)-water : cement ratio relationship:

As we see in table(4) and Fig:(6) , the effect of (w/c) is more than 0.3 . The effect of low content of polymer SBR was not appear clearly in the mixes of low water : cement ratio .

8.3.Compressive Strength:

8.3.1.Relationship between compressive strength and age:

In all mixes compressive strength increased with age (see Fig(6)). Max compressive strength at age of 180 day was 28.4 Mpa. for mix3 (w/c=0.3) wheras the lowest compressive strength was 13.32 Mpa. For mix6 (w/c=0.6).

Compressive strength at 180 day age of reference mix (mix1 , w/c=0.35) was equal to 24.7 Mpa. That means low content of SBR polymer which equal to 2% developed the compressive strength only when the w/c is low value , so that at very low water : cement ratio and high water cement ratio the effect of low content of SBR polymer was not appear clearly in developing of compressive strength.

8.4.Flexural strength:

8.4.1.flexural strength and time:

Table(5) and Fig(8) refer to increasing in flexural strength with time for all mixes in curent research . Low polymer: cement ratio (2%) developed the flexural strength for mixes which had a water:cement ratio equal to , or greater than 0.3 due to formation of the film which was conect

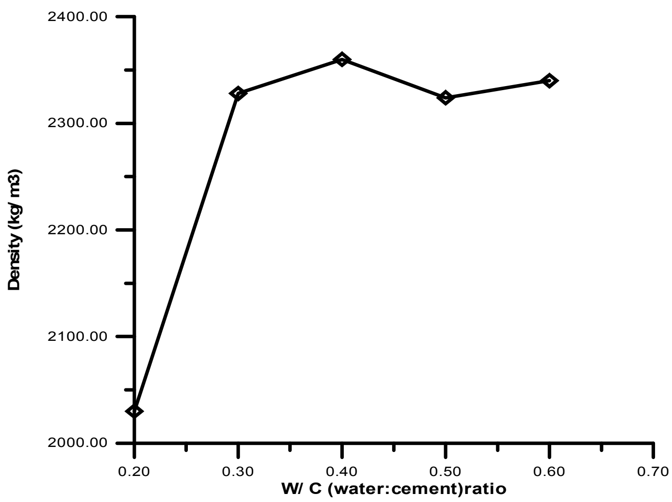


Fig (4):Relationship between density water :

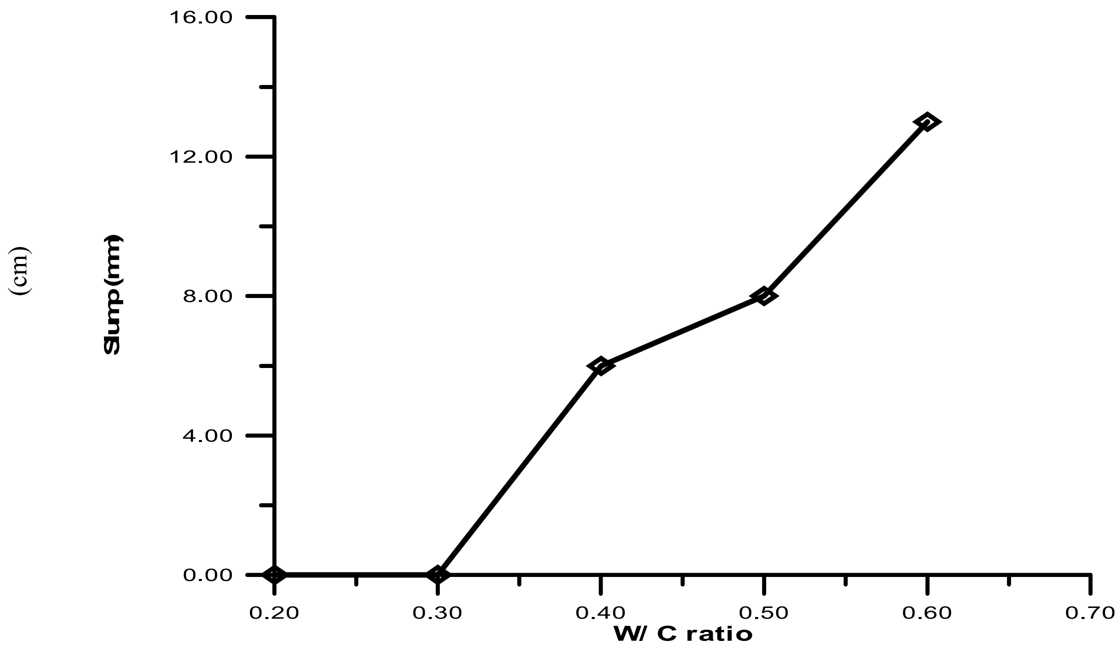


Fig (5):Relationship between slump value and water : cement ratio.

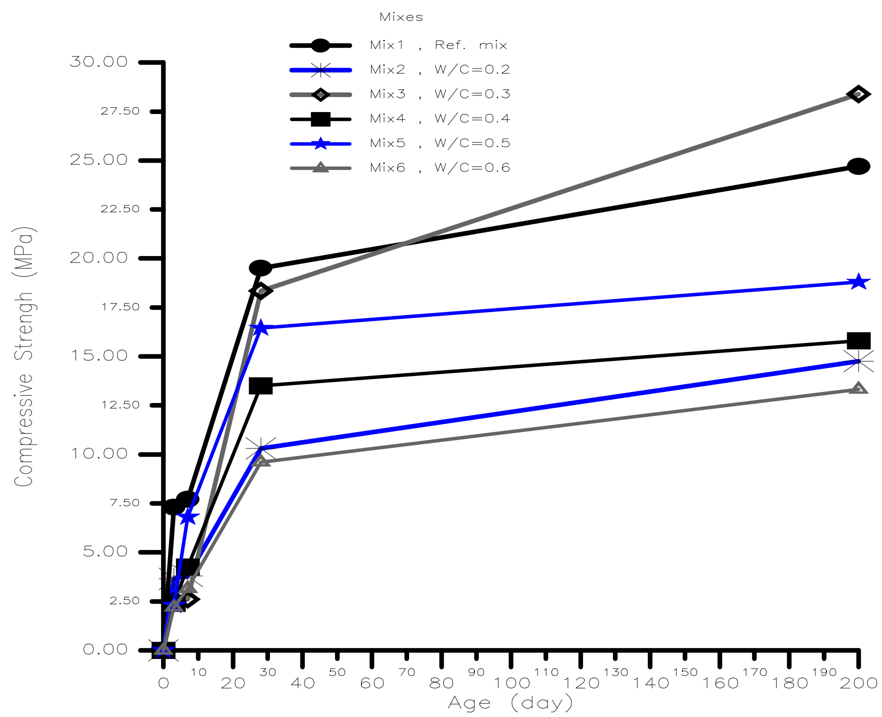


Fig (6):Relationship between compreesive strength and age for all mixes .

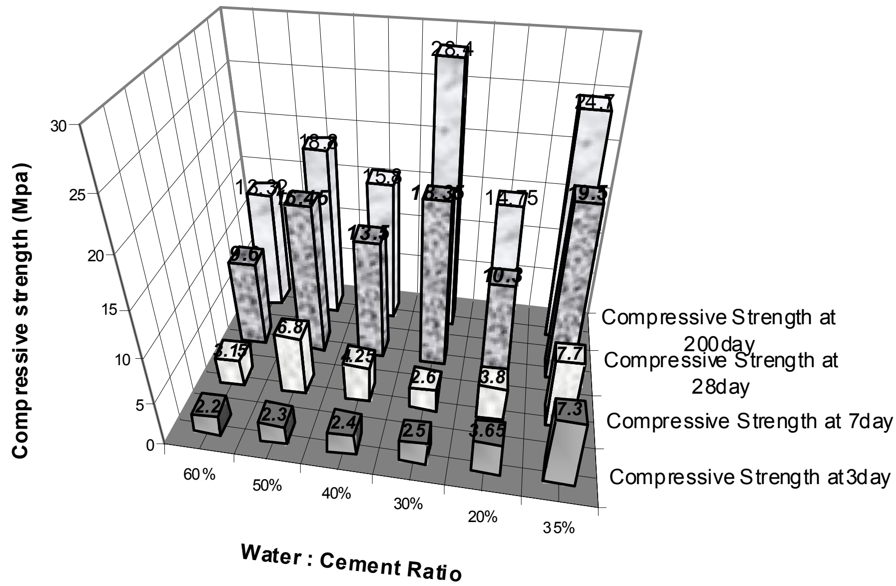


Fig (7):Comparsion of compreesive strengths for all mixes at all ages .

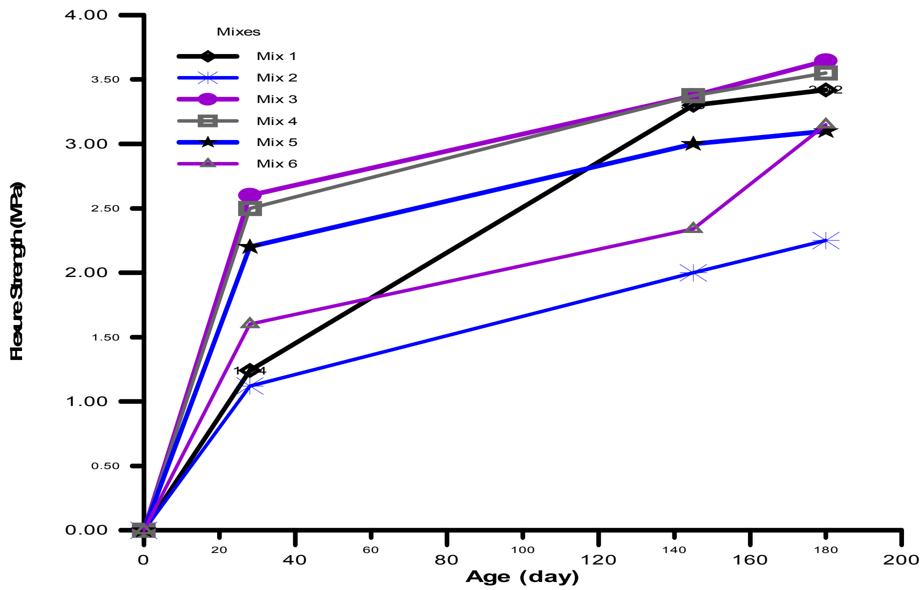


Fig (7):Relationship between flxural strength and age for all mixes .

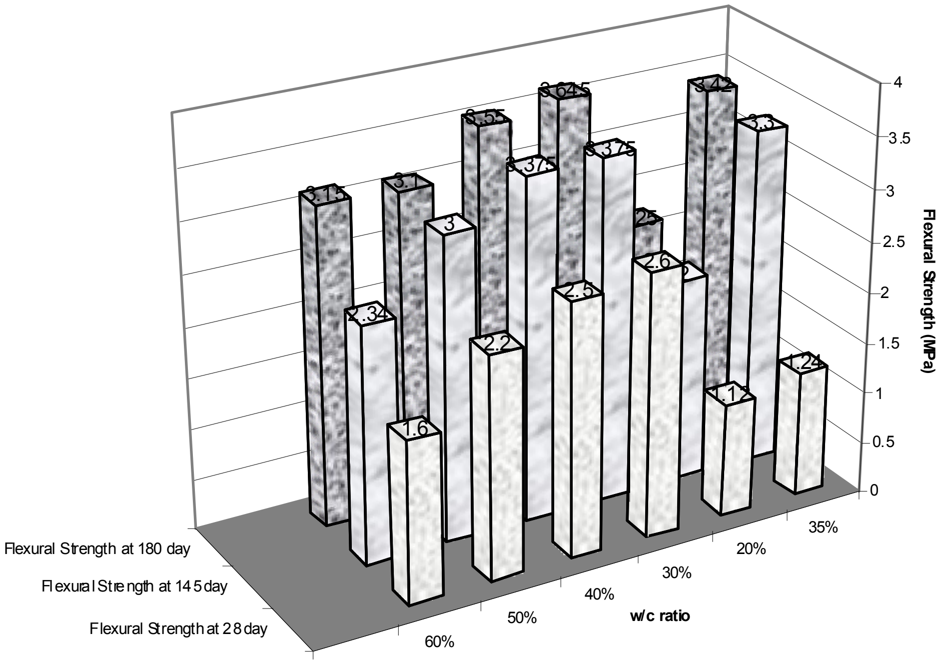


Fig (8):Comparsion of flexural strengths for all mixes at all ages .

REFERENCES

1. ACI committee: 548-1990: Guide for the Ues of Polymer in Concrete: ACI Manual of Concrete Practice-Part 5, Detroit , Michigan, 1990, 86p.
2. Ohama, Y., "Polymer-Based Admixtures." Cement and Concrete Composites J., 1998, 20: 189-212.
3. Wanger, H. B., "Polymer-Modified Cements." Industrial and Engineering Chemistry, Product Research and Development, 1965: 191-196.
4. Ohama, Y., "Study on Properties and Mix Proportioning of Polymer Modified Mortars for Building." Report of the Building Research Institute, No. 65, 1973: 100-104.
5. BS: 812-1975:Test Sieves: Method s for sampling and testing of mineral aggregate sands and filers.London.1975.
6. ASTM Committee, C-143-90a. "Test for Slump of Hydrolic Cement Concrete.

7. BS: 1881-1983:"Method for Determination of Compressive Strength of Concrete Cubes" part 116.British Standars Instituation.

8. BS: 1881-1983:"Method for Determination of Flexural". part 118. British Standars Instituation.

Age (day)	Mix1	Mix2	Mix3	Mix4	Mix5	Mix6
٢٨	١.٢٤	١.١٢	٢.٦	٢.٥	٢.٢	١.٦
١٤٥	٣.٣	٢	٣.٣٧٥	٣.٣٧٥	٣	٢.٣٤
١٨٠	٣.٤٢	٢.٢٥	٣.٦٤٥	٣.٥٥	٣.١	٣.١٥

Age(day)	Mix1	Mix2	Mix3	Mix4	Mix5	Mix6
٣	٧.٣	٣.٦٥	٢.٥	٢.٤	٢.٣	٢.٢
٧	٧.٧	٣.٨	٢.٦	٤.٢٥	٦.٨	٣.١٥
٢٨	١٩.٥	١٠.٣	18.35	١٣.٥	١٦.٤٥	٩.٦
٢٠٠	٢٤.٧	١٤.٧٥	٢٨.٤	١٥.٨	١٨.٨	١٣.٣٢

(W/C)	Density (kg/m^3)	Slump (cm)
٠.٢	٢٠٣٠	٠
٠.٣	٢٣٢٨	٠
٠.٤	٢٣٦٠	٦
٠.٥	٢٣٢٤	٨
٠.٦	٢٣٤٠	١٣