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Effect of two component acrylic coating on initial water absorption of concrete surfaces

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Abstract: This paper reports the results of a study conducted to evaluate the effectiveness of an acrylic coatings in limiting the initial surface absorption in concrete. Certain mechanical properties of the coated concrete were also determined. The acrylic coating used was of two compounds, hardened (cement based) and resin (acrylic based).The mixing ratios of resin to hardened were 1:1, 1:1.5, 1:2. The 1:2 mixing ratio was able to achieve waterproofing of 100% for the concrete specimens. The acrylic coating resulted in an increase in flexural strength of 25-48%, and an increase in the splitting strength of 15-63%.

Keywords: Acrylic coatings, initial surface absorption, waterproofing.

1. INTRODUCTION

Dampness and water leakage in different kinds of buildings has many economic, health, and aesthetic adverse effects .Therefore, waterproofing is increasingly being an integral item of civil engineering projects such as buildings, underground metro and railway tunnels, port structures, water and wastewater treatment units, most of the structures that are in contact with water. Initial surface absorption is the rate of flow of water, at constant head and temperature, into concrete per unit area within a specific time interval [1]. Several approaches are available to make concrete water tight. Among these approaches are : a)reduction of water cement ratio ,b) addition of fine materials, and c) Application of surface coatings. Water cement ratio (w/c) has a significant impact on permeability. Generally, permeability increases with increased w/c ratio, conforming to the general perception. Permeability increases more rapidly with water/cement ratio approaching or exceeding 0.6. On the other hand, it was found that higher cement content at a constant w/c ratio appears to reduce permeability [2, 3, 4]. Silica fume is used in cement-based composites to enhance the durability through the extremely fine spherical particles [5]. The highly amorphous silica content in the silica fume increases the density of the microstructure and improves strength, initial surface absorption, and other properties of concrete [6].

Al-Zahrani et al [7] Carried out a study to evaluate reinforcing steel corrosion and some physical properties of concrete coated with polymer-based materials, a cement-based polymer-modified, and a cement based water proof coatings. The results showed that concrete coated with polyurethane elastomeric based material performed better than the concrete coated with the other waterproof material in terms of accelerated corrosion.This paper focuses on the effectiveness of two component acrylic coating with different ratios of hardened to resin on water absorption of concrete surface. The effects of the acrylic coating on the flexural and splitting strength were also investigated.

2.0 METHODOLOGY

2.1 Fabrication of the initial surface absorption test apparatus:

The first step in the experimental work was the fabrication of an apparatus for initial surface absorption test The apparatus was fabricated by the authors according to British Standard BS 1881: Parts 5:1970 [1].Figure 1 shows the apparatus .

Figure 1: Initial surface absorption test apparatus

2.2 Materials:

2.2 The concrete mix ingredients:

2.2.1 Natural coarse aggregate (NA)

The natural coarse aggregate used was river bed gravel obtained from River Dijla (Mosul/Iraq). The maximum aggregate size used was (19.5) mm.

2.2.2 Fine aggregate (sand):

Sand used in this study was natural sand supplied from Kanhash site (Mosul). This type of sand is known for its good grading according to the BS 882 limits [8]. Figure 2 shows the sieve analysis of this sand.

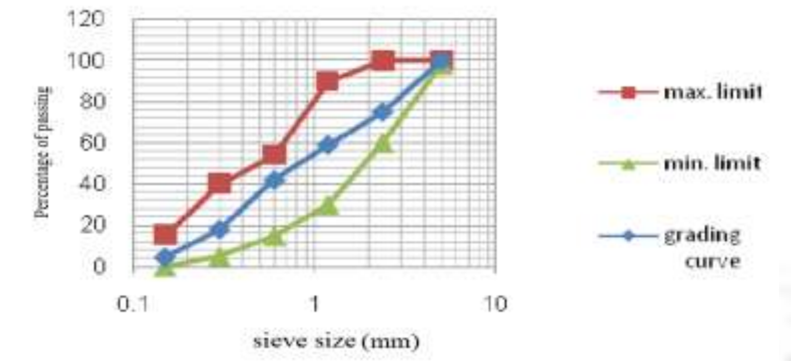

Figure 2: Grading Curve of the Sand

2.2.3 Cement:

The binding material used was ordinary Portland cement produced by Badoosh Factory (Mosul), Table 1 shows the Chemical composition of the cement.

Table 1: Chemical composition of the Portland cement used in this study [9]

Main Oxide	Cao	Sio2	Fe2o3	Al2o3	So3	Mgo
%	62.2	21.31	2.67	5.89	2.6	3.62

2.2.4 Water:

Tap water was used for concrete mixtures as a medium for cement hydration.

2.3 Coating materials:

2.3.1 The primer (FADOBOND AC):
The Primer used has a commercial name of FADOBOND AC. It is a powerful agent used to improve the property of adhesion of the top layer of cement concrete surface. It is usually applied on the surface by normal brush, roller brush or by sprayer. The concrete surface is to be free from oil, grease, dust, and any foreign materials before applying the primer in order to avoid separation of the coating. Figure 3 shows the primer used in this study.

Figure 3: The Primer

2.3.2 Two component acrylic coatings:

2.3.2.1 Hardened ;(cement based)
2.3.2.2 Resin; (acrylic based)

The percentages of resin to harden used were (1:1, 1:1.5, 1:2). Figure 4 shows the two component acrylic coatings.

The hardened **The resin**

Figure 4: Two component acrylic coatings

2.4 Methods:

2.4.1 Mix Proportion, Casting and Curing:

A predetermined compressive strength of 35 MPa was decided for the resulting concrete at age of 28 days. Accordingly, the mix proportions obtained through British mix design method were (1: 1.92: 2.95) with water cement ratio (w/c) of 0.47 .The cement content of the mix was 380kg/m^3 .Fresh concrete was casted in iron molds immediately after mixing. Mixing was accomplished by batch mixer for 3 minutes followed by 3 minutes rest, then another 2 minutes mixing. Samples were then cured with water at temperature of 23 ± 2 C° according to ASTM (C511-98) [10].

2.4.2 Aggregate tests:

The tests applied to the aggregate were guided by ASTM Standards. The testes with the corresponding ASTM Standards are: Specific gravity and absorption (C 128-01) [11] of fine aggregate, and (C 127-93) [12]. of coarse aggregate. Voids ratio and bulk density (C 29) [13] and clay content (C 117-95) [14].

2.4.3 Preparation of concrete surface:
The surfaces of concrete specimens were thoroughly cleaned. Ridges were also removed before applying the primer.

2.4.4 Application of acrylic coatings:

The components in the different ratios of resin to harden were mixed using a high speed mixer until the mixture became homogenous. Application of the coating was made by a roller brush. A time period of 3 hours was allowed for the coat to set. Table 2 shows the coating specifications of the concrete samples.

Table 2: Coating specifications of the concrete samples

Sample	**Description**
A	Samples of concrete without coating
B	Samples of concrete coated with two component acrylic in which the ratio of resin to hardened is 1:1
C	Samples of concrete coated with two component acrylic in which the ratio of resin to hardened is 1:1.5
D	Samples of concrete coated with two component acrylic in which the ratio of resin to hardened is 1:2

2.4.5. Concrete Tests:

The tests applied on the fresh and hardened concrete samples are those given in Table 3 below.

Table 3: The tests performed on the concrete samples

Test	Standards	Shape and dimension of specimens
Slump test	ASTM (C143-98)	__________
Initial surface absorption test (ISAT)	BS 1881: Parts 5:1970	Cube: 100mm x100mm x 100mm.
Compressive strength	BS 1881: Parts 116	Cube: 100mm x 100mm x100mm.
Flexural strength	ASTM (C 78-94)	Beam: 100mmx 100mm x400mm.
Splitting tensile strength	ASTM (C 469-96)	Cylinder: diameter 100mm , height 200mm.

3.0 RESULTS AND DISCUSSIONS.

3.1 Slump test:

The predetermined slump value for the concrete was 70 mm. Figure 5 shows the slump test performed.

Figure 5: Slump Test

3.2 Initial surface absorption test (ISAT):

The results of the ISAT for the reference concrete sample A and the coated concrete samples B, C and D are shown Figure 6,7,8 and 9, respectively.

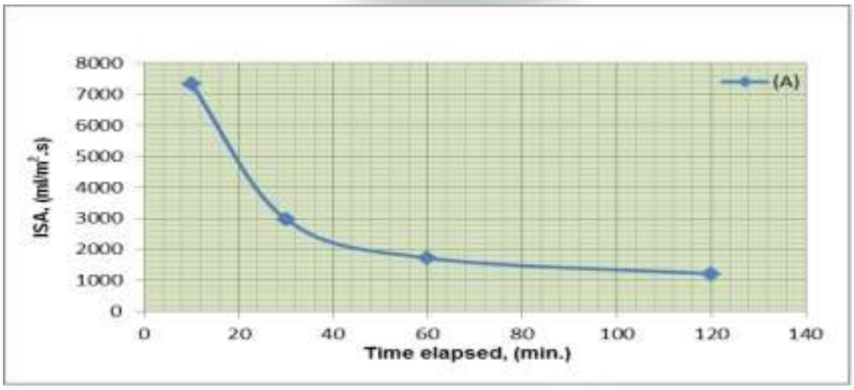

Figure 6: ISA vs. time for sample A

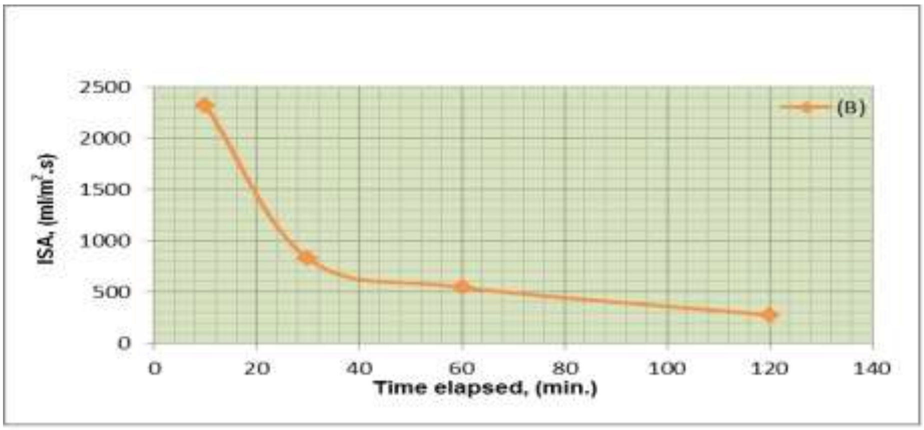

Figure 7: ISA vs. time for sample B

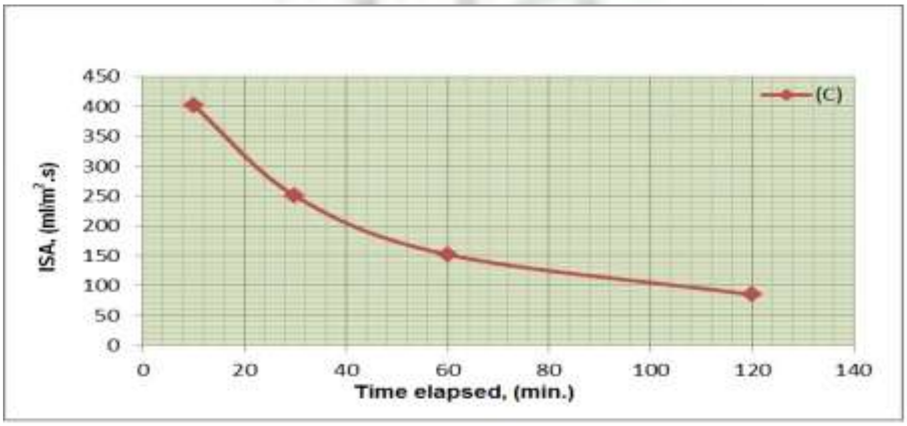

Figure 8: ISA vs. time for sample C

Generally Figure 6,7and8 suggests that ISA value decreases with exposure time. Specifically, the coated specimens had less ISA values as expected but in varying degrees. As the hardened content increased in the mixture the initial surface absorption decreased as a result of increasing the fine materials and, consequently, the reduction in voids ratio in the acrylic coatings itself.
At the hardened to resin ratio of 1:2 (sample D) there was an abrupt charge in the ISA values. As they fall down to zero as shown in Figure 9 below:

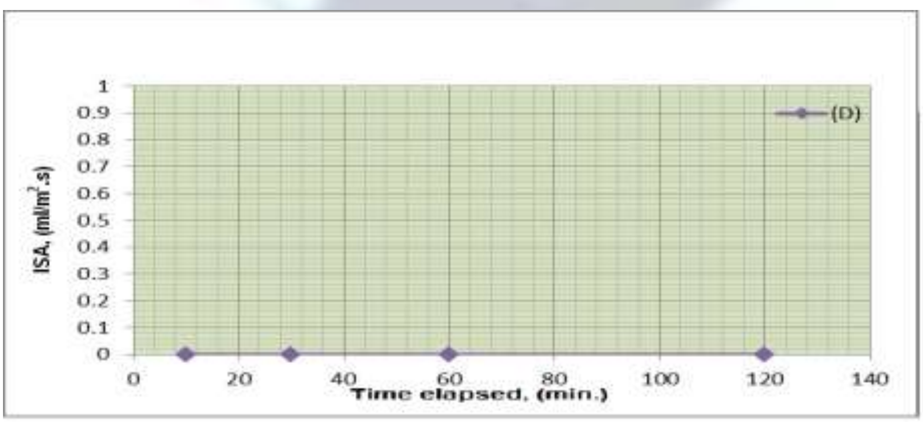

Figure 9: ISA vs. time for sample D

Figures 10, 11, 12, and 13 present the ISA values for the four samples at the specified exposure time.

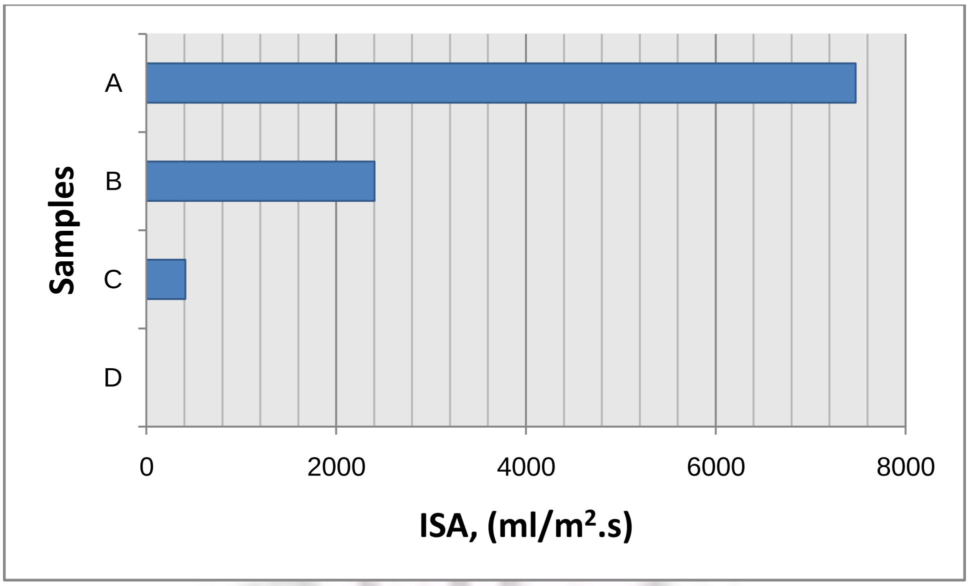

Figure 10: ISA for different hardened to resin mixing ratio at time 10 min.

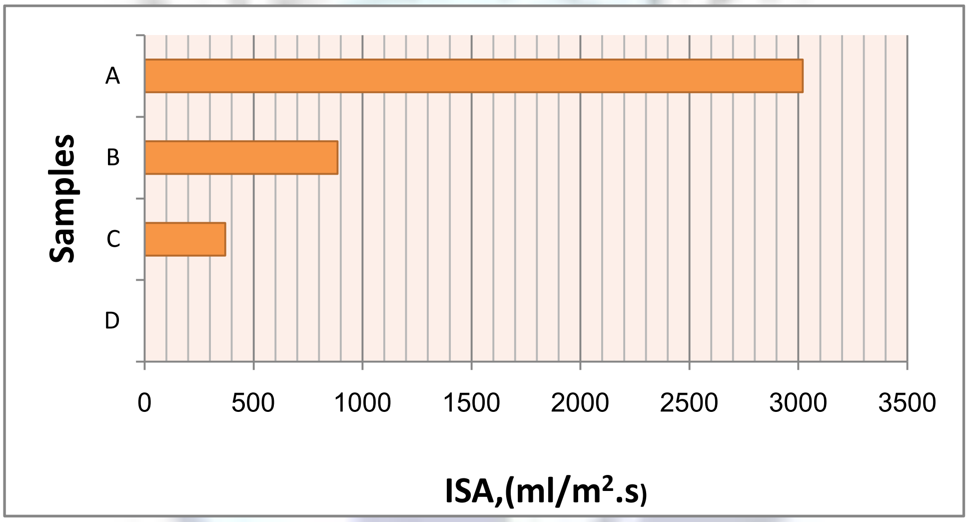

Figure 11: ISA for different hardened to resin mixing ratio at time 30 min.

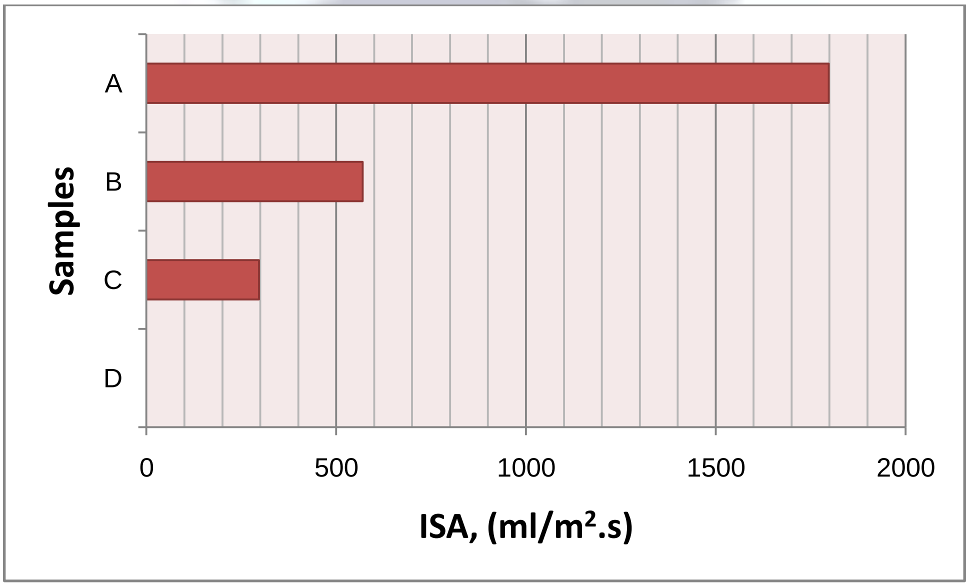

Figure 12: ISA for different hardened to resin mixing ratio at time 60 min

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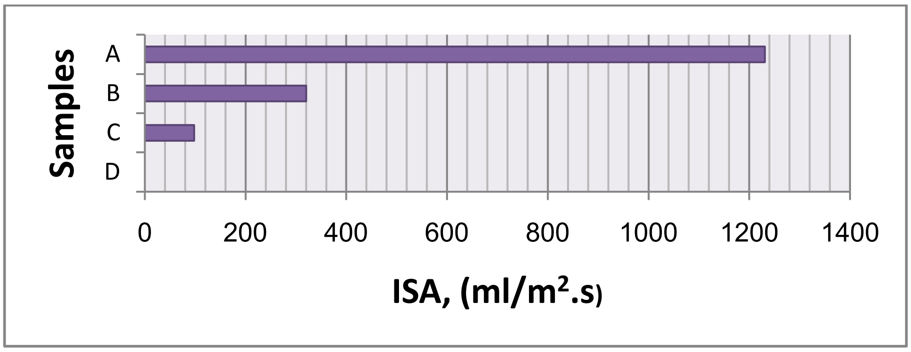

Figure 13: ISA for different hardened to resin mixing ratio at time 120 min.

3.3 Compressive strength

British standard BS 1881: Parts 116 [15] was used as a guide for testing the compressive strength of the hardened concrete. The average compressive strength at 28 days was 39 .4 MPa .The effect of the acrylic coating on the compressive strength was negligible.

3.4 Flexural strength:

Flexural strength values of concrete samples are represented in Figure 14. The results show the variation between the samples in this respect. The flexural strength obtained for the uncoated sample A was less than those of the coated samples B, C and D. The increase in flexural values with respect to sample A were about 25,39,and 48 % for samples B,C, and D, respectively.

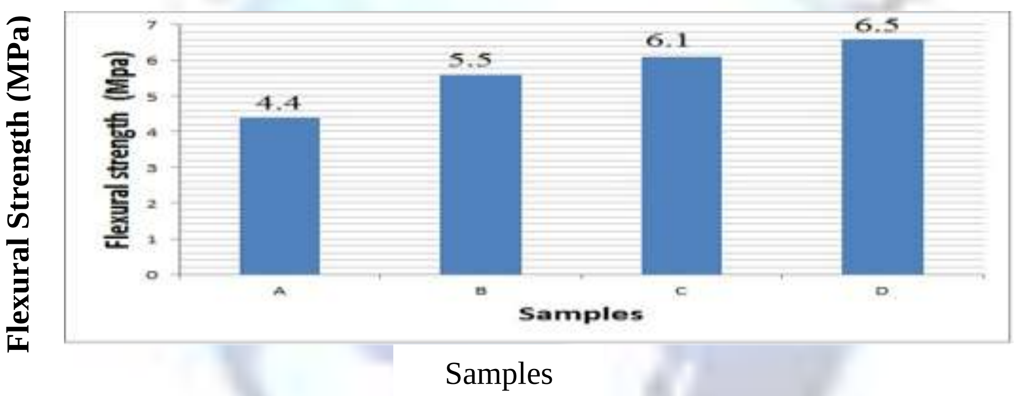

Figure 14: Flexural strength values at age of 28 days

3.5 Splitting tensile strength:

The splitting strength of each of the coated samples B, C and D was more than of the uncoated sample A by about 15%, 37% and 63%, respectively. Figure 15 shows the values of splitting strength for the coated and uncoated concrete specimens.

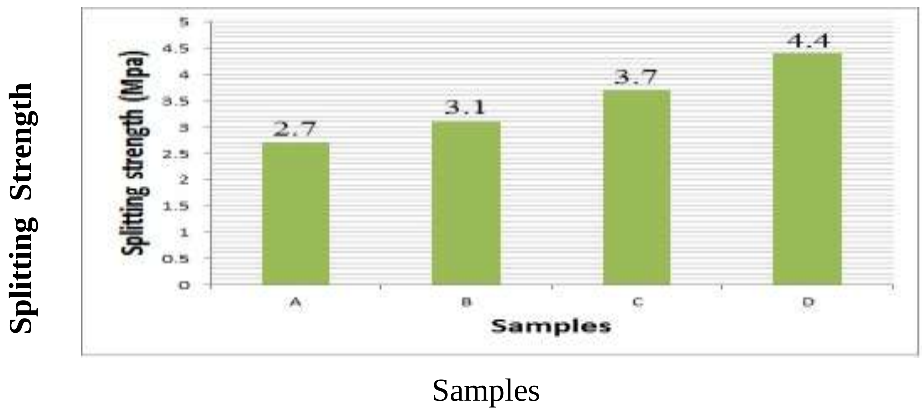

Figure 15: Splitting tensile strength values at age of 28 days

4. CONCLUSIONS

The following conclusions were reached through the results obtained in the experimental work of this study:

1. Coating the concrete surface with acrylic is effective in limiting the water absorbed by the cover concrete

2. Acrylic coatings with mix ratio of resin to hardened 1:2 was able to a cheive100% water proofing for the concrete samples .The 1:1, 1:1.5, mix ratios also considerably reduce the water absorption compared to the uncoated concrete.

3. Acrylic coatings have a positive effect on the flexural and splitting tensile strengths due to the excellent tensile strength and high ductility of the acrylic coatings.

References

[1]. British Standards.BS 1881: Part 5: 1970, Standards test method for determining the initial surface absorption of concrete.
[2]. Shamsad Ahmad, Abul Kalam Azad and Kevin F.Loughlin."A study of permeability and tortuosity of concrete ", 30th conference on our World IN CONCRETE & STRUCTURES: 23 -24 August 2005, Singapore.
[3]. Seishi, Goto and Della .M.Roy, 1981, "The effect of water cement ratio and curing temperature on the permeability of hardened cement paste ",Cement and Concrete Research , vol.11,pp(575-579).
[4]. Neville A. M., Brooks J. J., (2010) “Concrete Technology”, 2nd edition, London: Pearson.
[5]. Abolfazl Shamsai, Saber Peroti, Kamal Rahmani and Loghaman Rahemi, 2012,"Effect of Water-Cement Ratio on Abrasive Strength, Porosity and Permeability of Nano-Silica Concrete", World Applied Sciences Journal 17(8):929-933.
[6]. Wei-Ting Lin, Ran Huang, Jiang-Jhy Chang, and Chin-Lai Lee, 2009,"Effect of Silica Fumes on the Permeability of Fiber Cement Composites ,Journal of the Chinese Institute of Engineers ,vol. 32,No. 4, pp.531-541.
[7]. Al-Zahrani, Al-Dulaijan, Saricimen, and Sharif" Effect of waterproofing coatings on steel reinforcement corrosion and physical properties of concrete ",Cement & concrete composites 24(1) (2002) 127-137.
[8]. British Standards.BS 822: 1983, Standards test method for aggregates from natural sources for concrete.
[9]. Cement Badoosh factory, Personal communication.
[10]. American Society for Testing and Materials. ASTM C 511-98, Standard test method for moist cabinets, moist rooms, and water storage. Standards 2004.
[11]. American Society for Testing and Materials. ASTM C 128-01, Standard test method for specific gravity and absorption of fine aggregate. ASTM Standards 2004.
[12]. American Society for Testing and Materials. ASTM C 127-93, Standard test method for specific gravity and absorption of coarse aggregate. ASTM Standards 2004
[13]. American Society for Testing and Materials. ASTM C 29, Standard test method for bulk density and Voids in aggregate. ASTM Standards 2004.
[14]. American Society for Testing and Materials. ASTM C 117-95, Standard test method for materials finer than 75-µm (No. 200) sieve in mineral aggregates by washing. Standards 2004.
[15]. British Standards. BS 1881:parts116:1983, Standards test method of determination of compressive strength of concrete cubes .
[16]. American Society for Testing and Materials. ASTM C 192-98, Standard test method for making and curing concrete test specimens in the laboratory. ASTM Standards 2004.
[17]. American Society for Testing and Materials. ASTM C 136, Standard test method for sieve analysis of fine and coarse aggregates. ASTM Standards 2004.
[18]. American Society for Testing and Materials. ASTM C 143-98, Standard test method for slump of hydraulic-cement concrete. Standards 2004.
[19]. American Society for Testing and Materials. ASTM C 78-94, Standard test method for flexural strength of concrete (using simple beam with third-Point loading).Standards 2004.
[20]. American Society for Testing and Materials. ASTM C 496-96, Standard test method for splitting tensile strength of cylindrical concrete specimens. Standards 2004.