A STUDY ON OXYGEN PERMEABILITY OF CONCRETE CONTAINING DIFFERENT WATER PROOFING ADMIXTURES AND CEMENTATIONS MATERIALS

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ABSTRACT

Hydraulic and water retaining structures are made with a huge quantity of concrete. Design life of such hydraulic structure should be large compared to normal concrete structure. Durability of concrete is an important factor affecting the strength of concrete as well as design life of hydraulic structure. Permeability of concrete affects the durability of concrete. The permeability of concrete is mainly affected by pore structure system of concrete. Different company’s water proofing admixtures and pozzolana materials are used to reduce the oxygen permeability of plain concrete. In present experimental work, seven different water proofing chemicals, silica fume and fly ash were used in concrete to evaluate its performance and effect on concrete oxygen permeability. Oxygen permeability test was performed after 56 days of casting and their oxygen permeability were compared.

KEYWORDS: concrete, water proofing chemicals, oxygen permeability.

1 INTRODUCTION:

Hydraulic and water retaining structures are made with a huge quantity of concrete as they are mostly cast by mass concreting. Design life of such hydraulic structure is large compared to normal concrete structure. In these structures, concrete is directly exposed to water or humid environment. Hence, permeability of concrete becomes major concern for the durability of such structures. Permeability of concrete is generally determined by the flow of gas or liquid through pore structure of concrete. Several attempts have been made to reduce the oxygen permeability by either adding chemicals or pozzolanic material. Water proofing admixtures and pozzolana materials can be use to improve the pore structure of concrete and hence to reduce the oxygen permeability of concrete.

B.K. Marsh, R.L. Day and D.G. Bonner [1] studied pore structure characteristics affecting the permeability of cement paste containing fly ash. Specimens tested were cured over a temperature range from 20 to 65°C for periods from seven days to one year. The results show that a dramatic reduction in permeability occurs due to the pozzolanic reaction of the fly ash.

R.F. Feldmen [2] discussed permeability measurements made by fluids, water and oxygen, on both normal and blended hydrated Portland cements. Sample preparation and experimental procedure were vital considerations. Results were showed that more simple techniques gave valid result.

M. M. Al-Zahrani, S. U. Al-Dulaijan, M. Ibrahim, H. Saricimen and F.M. Sharif [4] carried out a study to evaluate steel reinforcement corrosion and some physical properties of concrete specimens coated with two polymer-based, a cement-based polymer-modified, and a cement-based waterproofing coatings. The accelerated corrosion test results showed that the specimens coated with the polyurethane elastomeric-based waterproofing material performed better than concrete specimens coated with other waterproofing materials.

J.P.Charron, E.Denarie and E. Brahwiler [5] carried out tensile test and liquid permeability test on ultra high performance fiber reinforced concrete. The results show that the equivalent water permeability coefficient of the ultra high performance fiber reinforced concretes increases, with increase in the rate of loading.

Nowadays, a number of waterproofing products are available in market which works on reduction of permeability of concrete. Few of them are required to be added while mixing the concrete ingredients whereas few other are applied on the concrete surface. Methodology and dosage of these compounds vary significantly and are usually prescribed by the manufacturer.

2 NEED OF STUDY

There is not any type of detail research work or research paper available on the effect of different water proofing admixtures product and application methods on the permeability of concrete. The water proofing admixtures can mix in concrete during casting or apply on the surface of concrete in two or three layers. Which method is best for reduces the permeability was also need to study. Therefore, in present work, an attempt is made to study the change in oxygen permeability of concrete by using few such water proofing compounds. An attempt is therefore made in present work to study the change in oxygen permeability of concrete by using water proofing compound.

3 SCOPE OF STUDY

In present work, there are five national and one local firm of water proofing admixtures was used. The water proofing admixtures was added during concreting as well as applied on surface. The details of products accounted in present study are given in Table.1. Concrete with 10% fly-ash and another with 10% silica fume was also casted and tested.
Table 1

<table>
<thead>
<tr>
<th>Concrete Mix</th>
<th>Company Name</th>
<th>Product Name</th>
<th>Application Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plain Concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Dr. Fixit</td>
<td>101 Pidi Proof WL Mixing</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fairmate</td>
<td>Faircrete RMW Mixing</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fosroc</td>
<td>Comiplast WL Mixing</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Perma</td>
<td>Plastic-Ex Mixing</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cico</td>
<td>Tapecrete Surface</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sica</td>
<td>Raintite Surface</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Concrete containing 10 % Fly Ash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Concrete containing 10% Silica Fame</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. EXPERIMENTAL WORK

During experimental work, plain concrete, concrete with water proofing admixtures and concrete containing pozzolanic materials were casted as per the description given in Table 1. Compaction factor test was carried out on fresh concrete. Compression test, split tensile test, pull off strength and oxygen permeability tests were carried out after 56 days of casting.

4.1 CONCRETE MIX

In present work, concrete mix proportion 1:0.5: 2.13: 2.76 was used.

Table 2

<table>
<thead>
<tr>
<th>C kg/m3</th>
<th>W kg/m3</th>
<th>F.A. kg/m3</th>
<th>C.A. kg/m3</th>
<th>W/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>383.16</td>
<td>201.03</td>
<td>818.37</td>
<td>1058.54</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Water proofing admixtures were added in to concrete mix as per manufactures instruction. Surface application with water proofing admixture was also done as per manufactures instruction in two layers.

4.2 TESTING OF FRESH CONCRETE

While concreting, compaction factor test was performed on fresh concrete to know the effect of adding water proofing admixtures and pozzolanic materials on workability of concrete.

4.3 TESTING OF HARDENED CONCRETE

After casting, for 28 days the cube specimens used for compressive strength are stored in water storage tank specimens and then specimens are stored in storage room for 28 days for dry in environment. The specimens used for split tensile test and oxygen permeability test are kept in sealed plastic bags for 28 days and then kept in dry environment for next 28 days to make them completely dry. Concrete was then tested for compressive strength, split tensile strength and oxygen permeability.

4.3.1 OXYGEN PERMEABILITY TEST:

The permeability of concrete is determined either by measuring gas/air flow or water flow through concrete. The water permeability test are considered to be less reliable than air/gas flow tests, as water causes change in pore structure hence does not give correct picture of permeability of concrete. Oxygen being inert towards the concrete, its flow through pores does not alter the structure hence is considered to be more reliable. Oxygen permeability test apparatus consist Aluminum permeability cell, Rubber tube, Air chamber, 3 bubble type flow meters, digital pressure gauge meter, flow control valve, distribution panel with valves to activate the flow meters, various connectors and tubes, stop-watch, foot air pump and oxygen cylinder.

Record the weight of concrete cylinder disk. Fill the three rubber aspirators with slightly soapy water. Place the disk in to the rubber sleeve. Insert the rubber tube in to the cell so that the valve exits through the hole in the side of the cell. Place the cover on the cell so that the holes correspond with the threaded holes of the cell body. Fix the cover in position using the six hand screws. Fill up the rubber tube using foot air pump. Connect the oxygen supply to the pressure control valve. Switch on the digital pressure gauge. First open the valve of oxygen cylinder and control flow of air throw control valve. Then control the inlet air pressure with flow control valve at digital pressure gauge meter. Introduce the gas in the permeability cell at the first pressure value 1.5 x 10^5 Pa. One by one open the valves start the soapy water bubble by squeezing for a moment the rubber aspirator of the flow meter in use. Select the flow meter and measure the distance of travelling of bubble in meter and time of bubble travel in second. Repeat the operations for the gas input pressures: 2; 2.5; 3 and 3.5 x 10^5 Pa.

\[ v = s \times l, Q = v/t \]

\[ K \text{(oxygen)} = \frac{4.14 \times 10^{-4} \times q \times P_a}{(P_a^2 - P_e^2)} \]

Where, v= volume in meter^3, s= net cross section area of flow meter in meter^2, l= bubble travel length in meter, t= travel time of bubble in second, q= gas flow in meter^3/s, p= input pressure in pascal, pa= atmosphere pressure in Pascal.

5 TEST RESULTS AND DISCUSSION

Test results of compaction factor test, cube compressive strength, split tensile strength and oxygen permeability are shown in chart 1 to chart 6.
Compaction factor test results shown that concrete with different water proofing admixtures improve the workability of fresh concrete. Pozzolanic materials reduce the workability of fresh concrete. Workability of plain concrete is higher compared to concrete with pozzolanic materials. Concrete with FOSROC CONPLAST water proofing admixture gave higher workability among the entire the concrete mixes. No significant change was observed in 56 days compressive strength of concrete by addition of various water proofing compound and 10% fly ash in plain concrete. The 56 days compressive strength of concrete containing FAIRCRETE, CONPLAST and 10% fly ash was slightly less compare to plain concrete. The 56 days compressive strength of concrete containing 10% silica fume was slightly higher compare to plain concrete. 56 days compressive strength of concrete with silica fume is increased by about 10%.

56 days split tensile strength of concrete with different admixtures increases by 10% to 45%. 56 days split tensile strength of concrete with silica fume and fly ash increases by 20% to 30%.

Concrete with different water proofing admixture reduce the oxygen permeability of concrete compared to plain concrete. Concrete with silica fume and fly ash also reduce the oxygen permeability of concrete compared to plain concrete. Surface application of SICA RAINTITE water proofing admixture reduces more oxygen permeability among all the concrete. The oxygen permeability of plain concrete casted disc was about 1.10 to 3.05 times higher compare to concrete casted disc containing water proofing compound, which were adding in concrete during casting. The oxygen permeability of plain concrete casted disc was about 2.50 to 5.80 times higher compare to concrete casted disc containing water proofing compound, which were apply on concrete surface in two layers. The oxygen permeability of plain concrete casted disc was about 1.20 to 2.50 times higher compare to concrete casted disc containing pozzolanic materials.

The oxygen permeability of plain concrete cored disc was higher compare to concrete cored disc containing water proofing compound and pozzolanic materials except in case of PLAST EX water proofing compound. The oxygen permeability of plain concrete cored disc was about 2.50 to 3.30 times higher compare to concrete cored disc containing water proofing compound, which were adding in concrete during casting except in case of PLAST EX water proofing compound. The oxygen permeability of plain concrete cored disc was about 1.84 to 4.60 times higher compare to concrete cored disc containing water proofing compound, which were apply on concrete surface in two layers. No significant change was observed in oxygen permeability of concrete cored disc by addition of pozzolanic materials in plain concrete.
6 CONCLUSIONS:

- Concrete with FOSROC CONPLAST admixture gave higher workability among all the concrete mixes.
- Silica fume and fly ash reduce the workability of concrete.
- Silica fume concrete mix gives higher 56 days compressive strength compared to other mixes.
- Concrete with fair mate FAIRCRETE RMW gives higher 56 days split tension strength compare to other mixes.
- SICA RAINITITE water proofing admixture surface application on concrete casted disc as well as cored disc reduces oxygen permeability more compared to other mixes.
- 10 % replacement of cement by fly ash or silica fume reduces oxygen permeability of concrete compared to plain concrete.

REFERENCES

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