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Estimation of Water Sorptivity as Durability Index for Ultra High Strength Reactive Powder Concrete

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Abstract:- Water is generally involved in every form of deterioration, and in porous solid permeability of the material to water usually determines the rate of deterioration. This paper focuses on designing structure the durability characteristics should be evaluated as carefully as the other mechanical properties and the initial cost A South African approach is used to measure the sorptivity index testing and concluded that the method is applicable to actual project also and is sorptivity index is a parameter to evaluate the durability of RPC and cover zone concrete. RPC shows a good resistance to permeability indicating impermeable concrete.

Keywords:- RPC, sorptivity, cover zone concrete, durability index.

I. INTRODUCTION

The water sorptivity test measures the rate of movement of water Front through the concrete under capillary suction. It is particularly sensitive to the micro-structural properties of the near-surface zone of concrete and therefore reflects the nature and effectiveness of curing. The lower the water sorptivity index, the better is the potential durability of the concrete. Sorptivity values vary from approximately 5 mm/√h for well-cured Grade 30-50 concretes to 15 – 20 mm/√h for poorly cured Grade 20 concretes. A diagram of the test is shown in **Figure 1.0**.When the mass of water absorbed is plotted against the square root of time, linear relationships observed, and the slope determines the sorptivity (S).

II. SCOPE OF TEST [06]

The test is suitable for the evaluation of materials and mix proportions for design purposes, and for research and development. The test can also used for quality control of concrete on site. It is not recommended that this test be performed before 28 days after casting. Specimen age may have a significant effect on the test results, depending on the type of concrete and the curing procedure. Care should be taken in interpreting the result of this test when is used on surface treated concrete, or on concrete that has been exposed to environmental influences such as carbonation or marine salts.
The oven drying procedure has been selected to result in the minimum degree of micro-structure alteration of the concrete specimens, while still giving minimal uniform moisture content. Research has shown, however, that significant amount of micro-structural damage may occur for some high quality concrete notably high strength concrete incorporating silica fume. Thus care should be taken in interpreting the results from these concretes.
This test method shall not be used for concrete with a maximum nominal aggregate size exceeding 26.5 mm.

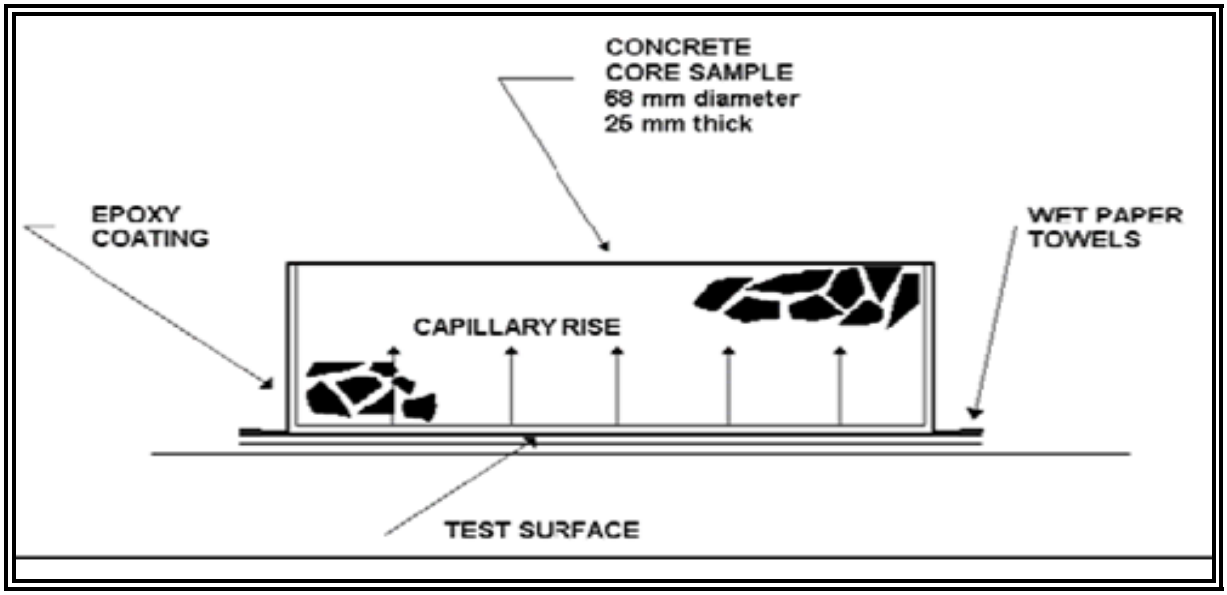

Figure 1.0: Schematic diagram of water sorptivity test

III. TEST SPECIMENS

Four test specimens are required per test. The test specimen shall consist of a 68±2 mm diameter concrete disc with a thickness of 25mm±2mm core and cut in accordance with concrete Durability Index Testing monograph. Alternatively, specimens that they have previously been used in the oxygen permeability test may be used.

IV. TESTING OF SPECIMENS

a) The water sorptivity test shall be conducted in a room in which the temperature is controlled at 23±2 commeasuring the thickness of each specimen with vernier at 4 points equally spaced around the perimeter of the specimens and records the measurements to the nearest 0.02mm on the data sheet. Determine the average of the four readings and record to the nearest 0.02mm.

b) Place 10 layer of paper towel on the tray leaving a gap of at least 10mm between the sides of the tray and the edge of the paper. Pour calcium hydroxide solution in to the tray until the required depth is reached and, if used, the paper trowel is saturated and water is visible on the top surface. All air bubble shall be removed by smoothing the paper pad towards the edges. Whether using paper towel, the final water level should be such that it will be slightly above the bottom edge of the specimens and a maximum 2mm up the side of the specimens shown in **figure-1.0** wet and additional piece of paper towel for use in removing the excess water from the specimens. Weigh the specimen at 3,5,7,9,12,16,20 and 25 minutes, after patting it once on the damp piece of absorbent paper. The specimen should appear saturated surface dry (SSD) on the exposed face at the time the mass is determined,

c) Determine the mass of the specimen to an accuracy of 0.01g and record as the dry mass at time 0. Immediately place the specimen with the test face (outer face or originally exposed face) on the wet paper pad/rollers and start the stop watch.

d) Weigh the specimen at 3,5,7,9,12,16,20 and 25 minutes, after patting it once on the damp piece of absorbent paper. The specimen should appear saturated surface dry (SSD) on the exposed face at the time the mass is determined, i.e. it should look damp, but not have free water on the test face.

e) Record the mass of the specimen to the nearest 0.01g and replace the specimens each time with the test face on the wet paper or rollers/ pins if used. The patting and mass determination procedure must not take longer than 15 seconds per specimen on each occasion that the mass is determined. The stopwatch shall not be stopped during the weighing procedure.

f) Within a maximum of 1 day after weighing of the specimens is completed, place the specimen in the vacuum saturation tank. Seal the lid with petroleum jelly and close it.

g) Evacuate the tank to between -75 and -80 kPa and maintain the specimens under vacuum saturation tank between -75 to -80 kPa for 3 hours±15 min. the pressure must not be allowed to rise above -75 kPa during this period.

h) After 3 hours ±15 min isolate the tank and allow calcium hydroxide saturated water to flow into the chamber until the water level is approximately 40mm above the top of the specimens. Air shall not be allowed to enter the vacuum chamber during this procedure.

i) Reconnect the vacuum pump to the tank and maintain the vacuum for 5 hours ± 15min at between -75 to -80 kPa. At no point during this time period shall the vacuum be permitted to rise above -75 kPa.

j) After 5 hours ± 15min, release the vacuum and allow air to enter. Allow the specimens to soak for a further 18 ± 1 hours.

k) After 18 ± 1 hours soaking, remove the specimens from the solution, dry the surface to a SSD condition with a paper towel, and immediately weigh to an accuracy of 0.01g record this vacuum saturated mass Msv of the specimen.

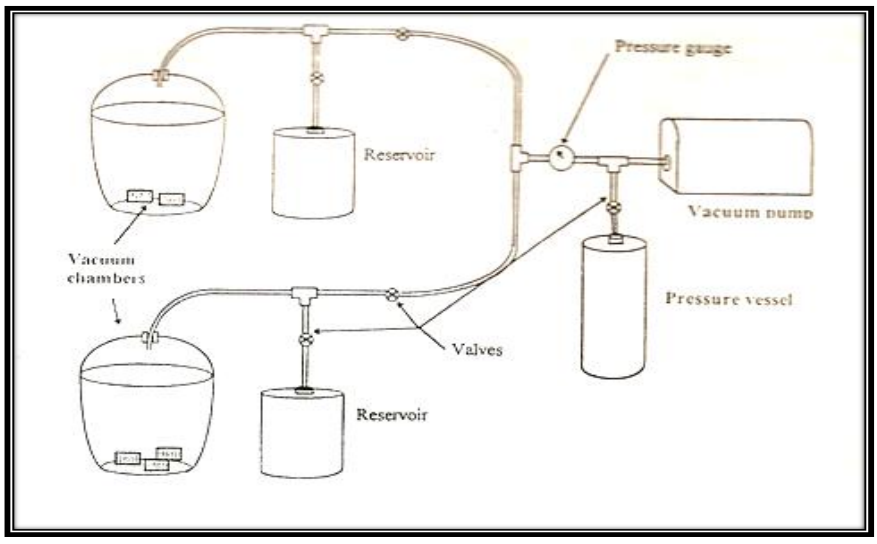

Fig no: 2: test set up for water sorptivity test

V. CALCULATION AND RESULT

1) First determine the effective porosity (n) of each specimen as follows:

$$n= (Msv –Mso)/Ad\rho_w$$

Where

Msv = the vacuum saturated mass of the specimen determine to nearest 0.01g.

Mso = mass of the specimen at t=0 to the nearest 0.01g.

A = cross- sectional area of the specimen to the nearest $0.02mm^2$.

d = average specimen thickness to the nearest 0.02 mm.

ρ_w = density of water $=10^{-3}$ g/mm^3

2) The mass of the water absorbed at each weighing period (Mwt) is Given by:

$$Mwt =Mst –Mso$$

Where:

Mst= mass to the nearest 0.01g of the specimen at time t plot the mass gain versus the square root of time (in hours) determine the slope of the line of best fit by linear regression analysis.

$$Mwt=F\ t^{1/2}$$

Where:

F = the slope of the best fit line obtained by plotting Mwt against $T^{1/2}$ $(g/h^{1/2})$

T = time in hours after a specimen is first exposed to water on its Lower face

3) The water sorptivity of the specimen (S) is given by:

$$S= Fd/(Msv –Mso)$$

4) The water sorptivity is calculated for each of the test specimens.

Specimen calculation for hot curried 1% steel fiber:

Find out effective porosity $n = (Msv –Mso)/Ad\rho_w$

$= (269.27-268.51)/4417.86x25x.001$

$= 0.0069$

Table: 1: Test Result of porosity

Sample	Hot curried	Normal curried
% of steel fiber content	Porosity (%)	Porosity (%)
1.00%	0.0069	0.00914
1.50%	0.0066	0.01005
2.00%	0.0034	0.00715
2.50%	0.0085	0.01077
3.00%	0.0088	0.00951

The sorptivity and porosity differed depending on its composition, that is different results were gained for the Reactive Powder concrete Samples. The sorptivity and porosity were also found depending on the amount of stratification and the materials being used.

From the test result Table 1.0 we can obtain the porosity of reactive powder concrete in (%) which is much less so, microstructure denseness of 2.0% of hot curing water sample is much dense then the other sample.

VI. CONCLUSIONS

Reactive Powder Concrete was found to have highly dense material and can be used for the nuclear waste containment structure. The RPC is classified as a concrete with good to excellent absorption resistance where the structural layer has high porosity due to trapped lightweight material. The lightweight layer was found to have lower sorptivity but higher porosity than the structural layer. The sorptivity and porosity were also depended on the amount of stratification and the materials being used.

RPC is classified as a concrete with the excellent absorption resistance as there is negligible weight gain due to water absorption in sorptivity test because of that it could not became possible to find sorptivity index for RPC.

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