Auckland UniServices Limited

RATE OF ABSORPTION OF WATER BY LITECRETE LIGHTWEIGHT CONCRETE AND NORMAL CONCRETE

ACCORDING TO THE ASTM C1585 - 04

AUCKLAND UNISERVICES LIMITED

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THE UNIVERSITY OF AUCKLAND

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Method of Testing:

The test method used was ASTM C1585 – 04: "Measurement of Rate of Absorption of Water by Hydraulic Cement Concrete". This test method determines the rate of absorption (i.e. sorptivity) of water by hydraulic cement concrete by measuring the increase in the mass of a specimen resulting from absorption of water as a function of time when only one surface of the specimen is exposed to water. The exposed surface is immersed in water (the water depth is 1 to 3 mm only) and water ingress of unsaturated concrete dominated by capillary suction during initial contact with water.

Treating and Conditioning the Specimens:

The standard method is to cure the specimens in an oven for three days, at a temperature of 50°C and relative humidity of 80%. The relative humidity is achieved using potassium bromide. As an alternative to the standard test method, potassium bromide was not used.

The specimens - three samples each of normal concrete and lightweight concrete - were cured in the oven for three days at a temperature of 50°C. All of the samples were kept in the same environmental condition in the laboratory during the period of the testing programme. Figure (1) show the schematic of the testing procedure.

Specimens:

Both sets of samples (normal concrete and lightweight concrete) were each aged 28 days and supplied by Litecrete (NZ) Ltd. The properties of each are shown in Table(1). Lightweight concrete samples mix consist of: cement, coarse pumice, fine

pumice, polypropylene fibre, water and admixture. Normal concrete samples mix consist of: cement, sand, coarse aggregate (greywacke) and water.

Type of concrete	Strength, MPa	Density, kg/m3
Lightweight concrete (average for three samples)	13.3	1235
Normal concrete (average)	28.6	2341

Table (1): Properties of both concrete mixes used in the test.

Specimen properties	Lightweight concrete	Normal concrete
Diameter (mm)	101.8	100
Thickness (mm)	51	51
Water temperature °C	18	18
Mass before sealing (grams)	536.6	915.3
Mass after sealing (grams)	544.8	921.6

Table (2): Average sample, dimensions and mass.

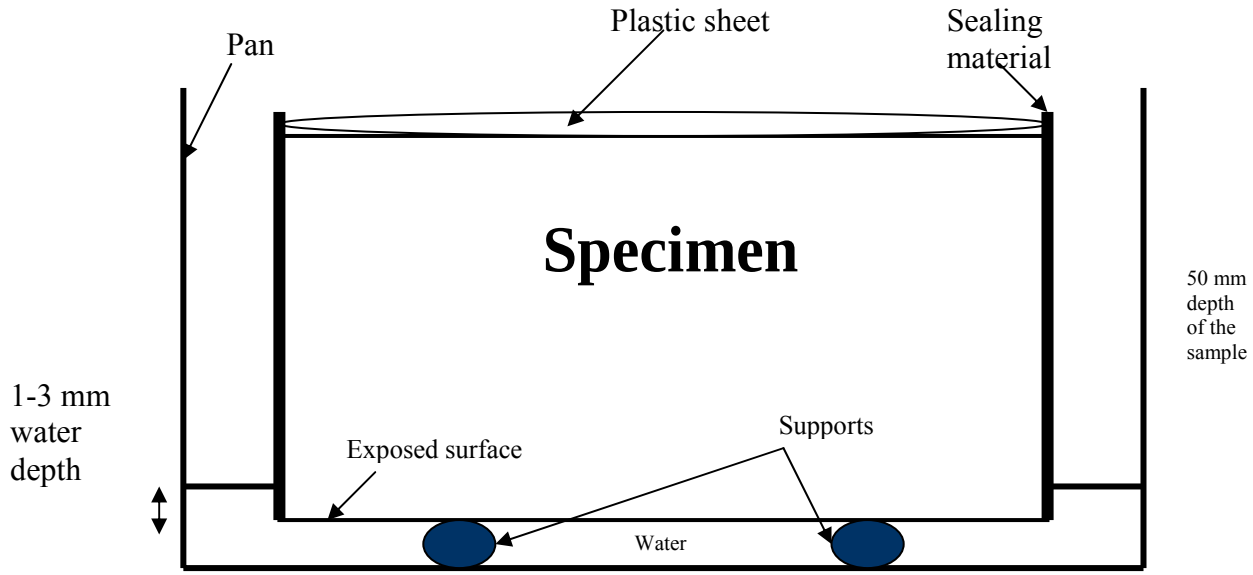

Figure (1) Schematic of the testing procedure.

Test Results and Calculations:

In table (3) the readings of the test and the value of the Absorption (I) is found using the following equation:

$$I = mt / (a^* d)$$ where mt = the change in mass in grams, at different time (t)

a = exposed area of the specimen, mm^2.

d = density of water in g/mm^3.

Figure (2), (3) and (4) below show the Absorption (I) plotted to the square root of the time and from the developed curve the Initial and Secondary Rate of Water Absorption can be determined.

Initial and Secondary Rate of Water Absorption:

- The Initial Rate of Water Absorption is defined as the slope of the line, which is drawn using least squares, linear regression analysis, to fit the curve of Absorption (I) plotted against the square root of time. The points plotted were from one minute to six hours.
- Secondary Rate of Water Absorption is calculated in the same manner, with the points of time plotted from one day to seven days.

Note: To achieve the initial or secondary rate of water absorption using this method there should be a correlation coefficient of more than 0.98. This is calculated using a spreadsheet programme:

- Initial Rate of Water Absorption for lightweight concrete = 107 x 10-4 mm/√sec. R = 0.99.
- Initial Rate of Water Absorption for normal concrete = 215 x 10-4 mm/√sec. R=0.99.
- Secondary Rate of Water Absorption for lightweight concrete = 29 x 10-4 mm/√sec. R=0.98.
- Secondary Rate of Water Absorption for the normal concrete = 4 x 10-4 mm/√sec. R=0.98.

Test Data:

		Lightweight concrete		Normal concrete	
Testing time, (Sec)	√Time, ($Sec^{1/2}$)	m, (gram)	I, (mm)	m (gram)	I, (mm)
60	7.7	1.10	0.14	2.65	0.34
300	17.3	2.33	0.29	5.15	0.66
600	24.5	3.21	0.39	6.73	0.86
1200	34.6	4.30	0.53	8.66	1.10
1800	42.4	5.05	0.62	10.22	1.30
3600	60.0	6.63	0.81	13.35	1.70
7200	84.9	8.70	1.07	17.59	2.24
10800	103.9	10.27	1.26	20.59	2.62
14400	120.0	11.53	1.42	22.98	2.92
18000	134.2	12.57	1.55	24.88	3.16
21600	147.0	13.54	1.67	26.48	3.37
86400	293.9	19.71	2.36	40.12	5.10
172800	415.7	23.82	2.85	40.81	5.19
266400	516.1	26.60	3.18	41.23	5.24
345600	587.9	28.54	3.41	41.49	5.28
604800	777.7	32.13	3.84	41.99	5.34
691200	831.4	33.12	3.96	42.13	5.36

Table (3): Average absorption of normal concrete and lightweight concrete samples.

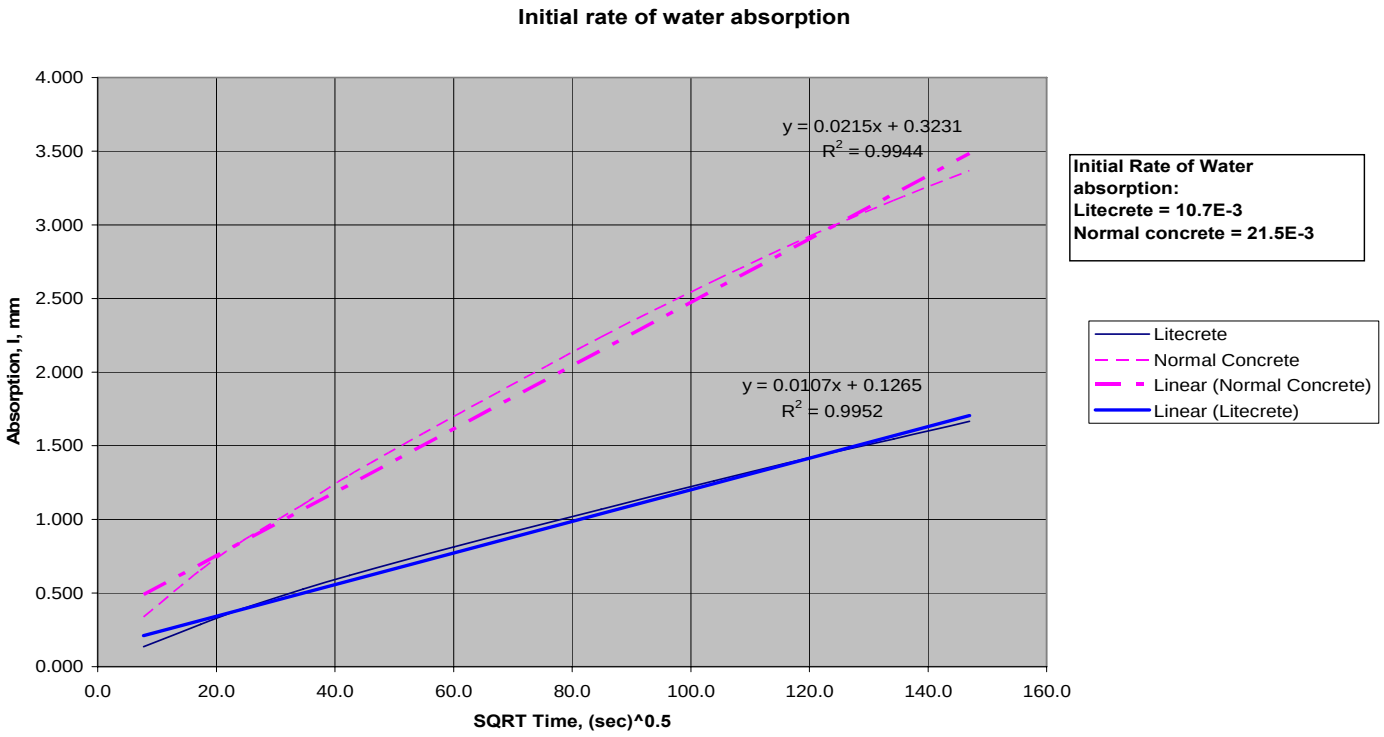

Figure (2): The absorption plotted against square root of time, for both concrete types, plotted from one minute to six hours.

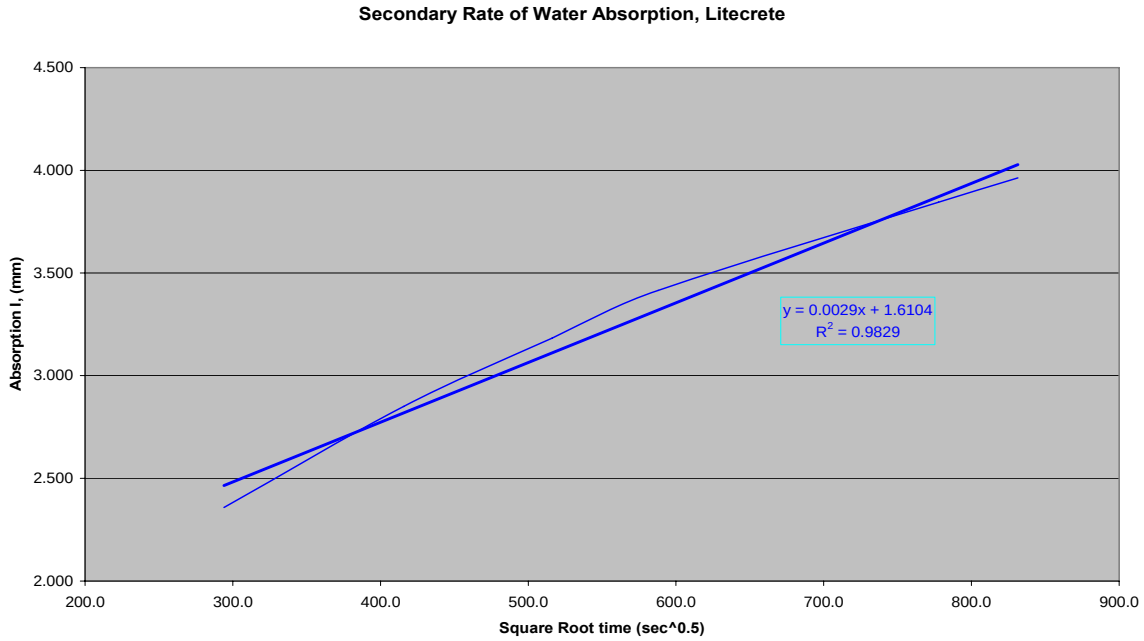

Figure (3): the absorption plotted against square root of time, for lightweight concrete specimens, plotted from one day to eight days.

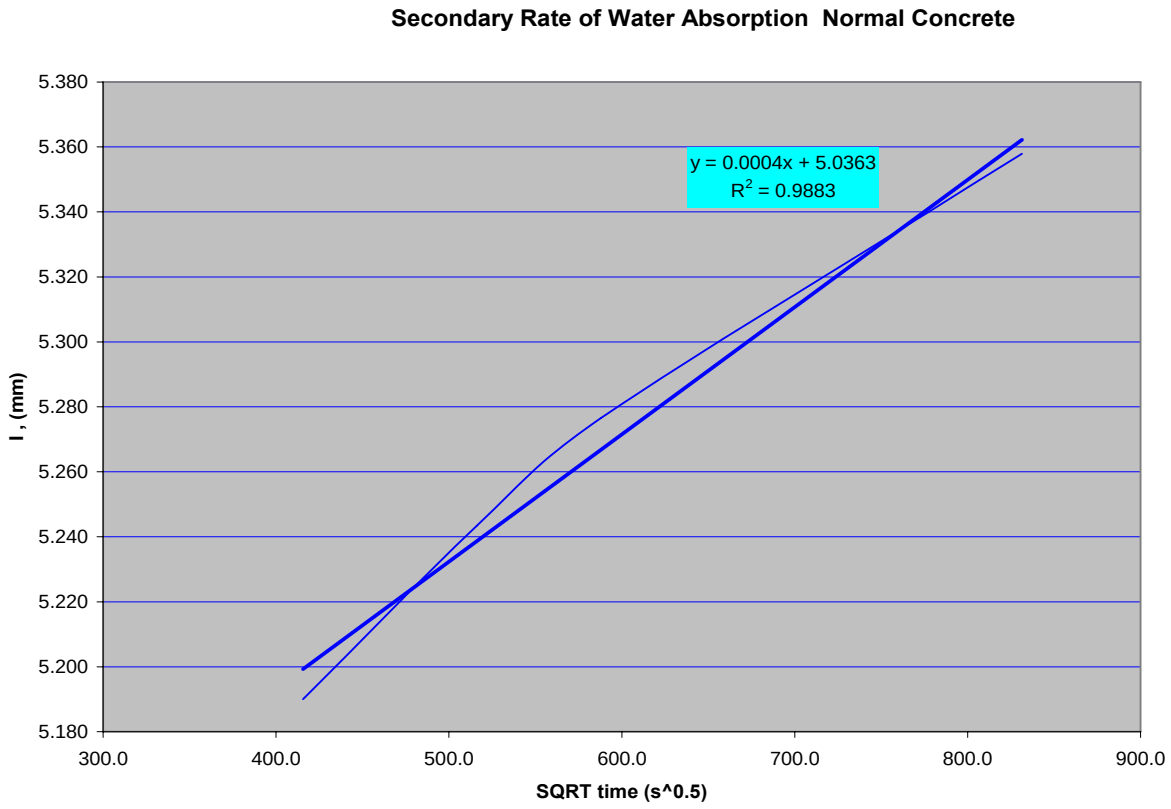

Figure (4): the absorption plotted against square root of time, for normal concrete specimens, plotted from one day to eight days.

Water Ponding

The tests results showed that the water penetrated through the samples, ponding on the top surface at varying volumes for each type of concrete. Water penetration was evident by ponding on the surface of the normal concrete in less than five hours, whereas for the lightweight concrete samples this ponding phenomenon was not evident until after three days. Photos (1) and (2) show the amount of water on top of each sample of normal concrete and photos (3) and (4) show the results for the lightweight concrete.

Photo (1): Normal concrete sample shows traces of water saturating 25% of the surface area after less than five hours from the start of the test.

Photo (2): Normal concrete sample after one day; the top surface area is fully saturated.

Photo (3): Lightweight concrete sample after one day's testing shows no trace of water on the top surface.

Photo (4): Lightweight concrete sample after three days from the start of the test, showing 10% saturation of the top surface area.