Experimental Study on Durability Tests of Standard Concrete

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***Abstract*- concrete is the most necessary and widely used man- made construction material. It is got via mixing cement, aggregate and water. Often, chemical admixtures and mineral admixtures are used as supplementary materials. Concrete can deteriorate for a range of reasons, and concrete damage is frequently as end result of mixture of factors. This causes stresses in the concrete, which can eventually result in cracking, delamination, and spalling."**

"Different concretes require different degrees of durability relying on the exposure of environment and the properties desired. Durable concrete will retain its unique form, quality and serviceability when exposed to its environment. The fundamental characteristics influencing the durability of concrete is its permeability to the ingress of water, oxygen, carbon dioxide, chloride, sulphate and other deleterious substances. It grew to become essential to impart know-how about durability of concrete and factors affecting durability to the society, as the wide use of concrete as a material in the constructions."

"The philosophy of having access to durability involves the understanding that durability will be improved only when unambiguous measurements of appropriate cover concrete properties can be made. In this study use the different Exposure condition for the standard concrete of durability assessment."

***Index Terms*- concrete, exposure condition, water sorptivity, RCPT.**

I. INTRODUCTION

"Durability of concrete is its ability to resist weathering action, chemical attack, abrasion or any different system of deterioration The potential of concrete to face up to the conditions for which it is designed besides deterioration for a lengthy period of years is known as durability."

Durability issues in concrete structures, regularly linked to reinforcement corrosion, have raised focus of the inadequacy of cutting-edge provisions in building specifications. The control of first-rate required in these specifications is traditionally based totally mostly on a measure of compressive strength. In regard to enough safety of the reinforcing steel, durability is, however, no longer at once associated to electricity however established on the great of the concrete cover – its penetrability and thickness."

Table 1.Classification Criteria: Alexander et al., 1999

Acceptance Criteria		OPI (log scale)	Sorptivity (mm/h)
Laboratory concrete		> 1 0	< 6
As-built Structures	Full acceptance	> 9.4	< 9
	Conditional acceptance	9.0 to 9.4	9 to 12
	Remedial measures	8.75 to 9.0	12 to 15
	Rejection	< 8.75	> 15

Charge passed(C)	Chloride ion penetrability
> 4000	High
2000 – 4000	Moderate
1000 – 2000	Low
100 – 1000	Very low
<100	Negligible

Table 2. RCPT test Classification Criteria (ASTM C 1202)

"In this study water sorptivity & rapid chloride penetration test are considered. In this study

moderate exposure condition and severe exposure condition (coastal environment) are considered."

II. EXPERIMENTAL STUDY

A. Durability test Considered for study:
1. Rapid chloride permeability test (ASTM C 1202)
2. Water sorptivity test

B. Material selection:
"As the M30 & M40 grade of concrete is mostly being used in the construction work nowadays, the Concrete with target strength of M40 is considered for the study. In this study also use of the M40+fly ash mix concrete."

C. Proportions:
Table 3. M40 Grade concrete Mix proportion (A1 CODE)

Cement	Water	Super plasticizer	Sand	Coarse aggregate 10mm	20mm
431.05 kg/m^3	172.42 kg/m^3	2.15 kg/m^3	602.12 kg/m^3	356.37 kg/m^3	874.80 kg/m^3
1	0.4	0.0049	1.396	0.826	2.02

Table 4.M40 +30% Fly ash concrete Mix proportion (B1 CODE)

Cement	Water	Super plasticizer	Sand	Coarse aggregate 10mm 20mm	Fly ash
331.90 kg/m3	172.42 kg/m3	2.37 kg/m3	553.54 kg/m3	348.33 kg/m3	855.07 kg/m3
1	0.51	0.007	1.66	1.04	2.57

D. Concrete Cube casting:
"As per the specimen first cast the cubes, Concrete cubes shall be cast according to the relevant specification, and with minimum dimensions of 150mm*150 mm*150mm."

E. Exposure Condition:
"In this study for experiment choose the two different exposure condition for the concrete based on the IS 456-2000 and As per BS 8500-1:2006 (U.K.) code. Considered (As per IS 456-2000 &BS 8500-1:2006 (U.K.))"

1. Moderate Condition /X0 Conditions:-Specimen is fully submerged in portable water for the 90 days period, after this procedure use in the test performed.

2. Severe condition/XS2 conditions:-
Specimen is fully submerged in sea water for the 90 days period, after this procedure use in the test performed. Sea water arrived at Dumas area Surat.

F. Specimens cutting procedure:
"Coring of the cubes must take place at 90 days after casting, unless otherwise required by project specifications. Direction of coring must be perpendicular to the casting direction. Clamp the cube firmly into the holding device and place the core barrel perpendicular to and in the centre of the concrete face to be cored (with a tolerance of 2 mm in any direction).Cut the first 5 mm from the cored face of the core and discard. Cut the required thickness (25) of the test specimen from the core. the cutting & coring procedure used and make the specimens ,the size is 70mm Diameter and 30mm thickness for the OPI test & 100mm diameter50mm thickness for the RCPT and water sorptivity test."

III. EXPERIMENTAL WORK

A. Water sorptivity Test:
"The sorptivity can be determined by the measurement of the capillary rise absorption rate on reasonably homogeneous material. Water was used of the test fluid. The cylinders after casting were immersed in water for 90 days curing. The specimen size 100mm dia x 50 mm thick height after drying in oven at temperature of 100 + 10 °C were drowned as shown in figure6.2.1 with water level not more than 5 mm above the base of specimen and the flow from the peripheral surface is prevented by sealing it properly with non-absorbent coating. The quantity of water absorbed in time period of 30 minutes was measured by weighting the specimen on a top pan balance weighting upto 0.1 g. surface water on the specimen was wiped off with a dampened tissue and each weighting operation was completed within 30 seconds. Figure 1 and figure 2 shows the setup of weight and setup of sorptivity test respectively."
"Sorptivity (S) is a material property which characterizes the tendency of a porous material to absorb and transmit water by capillarity. The cumulative water absorption (per unit area of the inflow surface) increases as the square root of elapsed time (t)."

$I=S.t^{1/2}$

Therefore $S=I/ t^{1/2}$

Where;

S= sorptivity in mm, t= elapsed time in mint. I=Δw/Ad ,Δw= change in weight = W2-W1
W1 = Oven dry weight of cylinder in grams ,W2 = Weight of cylinder after 30 minutes capillary suction of water in grams, A= surface area of the specimen through which water penetrated ,d= density of water

Figure 1: Setup the weights

Figure2: Set up of sorptivity

B. Rapid chloride ion penetration test (ASTM C1202):

"The Rapid Chloride Permeability Test(RCPT) is carried out by monitoring the amount of electrical current that passes via a sample 50 mm thick by means of 100mm in diameter in 6 hours (see figure 4.6). This sample is usually reduced as a slice of a core or cylinder. A voltage of 60V DC is maintained throughout the ends of the sample all through the test. One lead is immersed in a 3.0% salt (NaCl) solution and the different in a 0.3 M sodium hydroxide (NaOH) solution. This test has been done at the Geo designs& Research (P) LTD. Vadodara."

Figure3. RCPT set up

IV. EXPERIMENTAL RESULTS

Table-5 the water Sorptivity test results of % replacement of fly ash in concrete for 90 days curing. The % replacement & exposure condition difference. and Sorptivity results are graphically shown in figure 4 and 5.

Exposure condition	Concrete Mix	% Replacement of Cement by Fly Ash	Dry Wt in grams (W1)	Wet Wt in grams (W2)	Sorptivity value in 10^{-5} mm/min$^{0.5}$
Moderate /X0	A1	0 %	873	973.5	0.58
	A1	0 %	874	875	1.16
	A1	0 %	901	901.5	0.58
	B1	30%	852	853.5	1.74
	B1	30%	870	872.5	2.90
	B1	30%	915	917	2.32
Severe condition/ XS2	A1	0 %	925	927	2.32
	A1	0 %	856	858.5	2.90
	A1	0 %	886	888.5	2.90
	B1	30%	908	911	3.48
	B1	30%	922	925.5	4.07
	B1	30%	890	891.5	4.07

Table 5.water Sorptivity test results

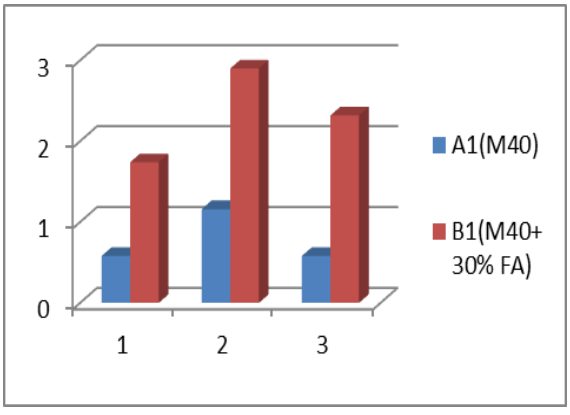

Figure 4.Water sorptivity result in Moderate condition

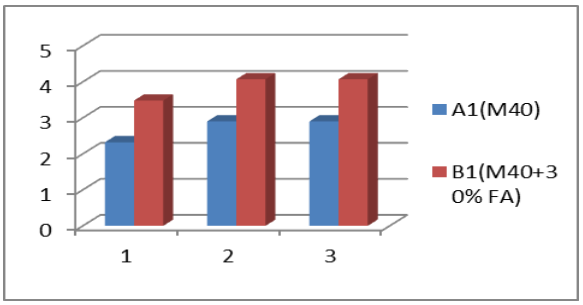

Figure 5. Water sorptivity result in severe condition

Time (min)	Sample-1	Sample-2	Sample-3
	Coulombs(C)	Coulombs(C)	Coulombs(C)
0	0	0	0
30	198	221	235
60	275	330	365
90	365	435	495
120	489	650	625
150	605	780	880
180	810	921	1078
210	1030	1105	1154
240	1155	1337	1320
270	1300	1578	1547
300	1450	1800	1798
330	1685	2150	2015
360	2288	2410	2309

Table6. RCPT concrete M40 controlled result

Time (min)	Sample-1	Sample-2	Sample-3
	Coulombs(C)	Coulombs(C)	Coulombs(C)
0	0	0	0
30	199	230	215
60	305	365	320
90	420	470	465
120	551	615	620
150	694	768	854
180	835	931	1032
210	1040	1085	1241
240	1250	1286	1475
270	1452	1597	1590
300	1704	1897	1610
330	1901	2010	1705
360	1990	2087	1890

Table7.RCPT concrete M40 +30 fly ash result

Time (min)	Sample-1	Sample-2	Sample-3
	Coulombs(C)	Coulombs(C)	Coulombs(C)
0	0	0	0
30	495	431	445
60	705	725	645
90	921	935	800
120	1125	1147	1054
150	1325	1350	1257
180	1547	1598	1482
210	1785	1850	1796
240	2014	2105	1983
270	2245	2350	2379
300	2540	2547	2514
330	2735	2854	2864
	3160	2980	3065

Table8.: RCPT concrete M40+30 fly ash (sea water) result

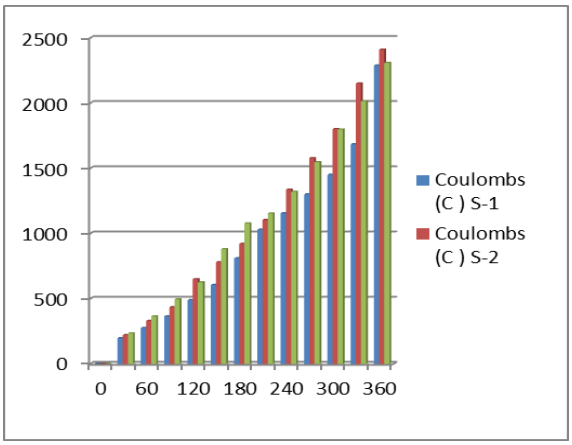

Figure 6. : RCPT concrete M40 controlled result

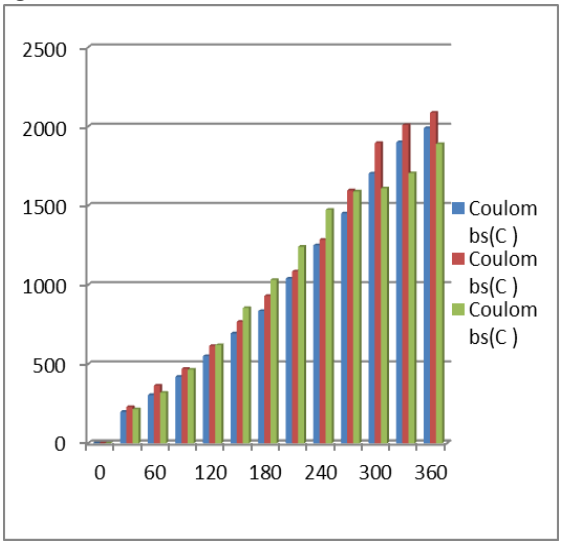

Figure 7. RCPT concrete M40 fly ash result

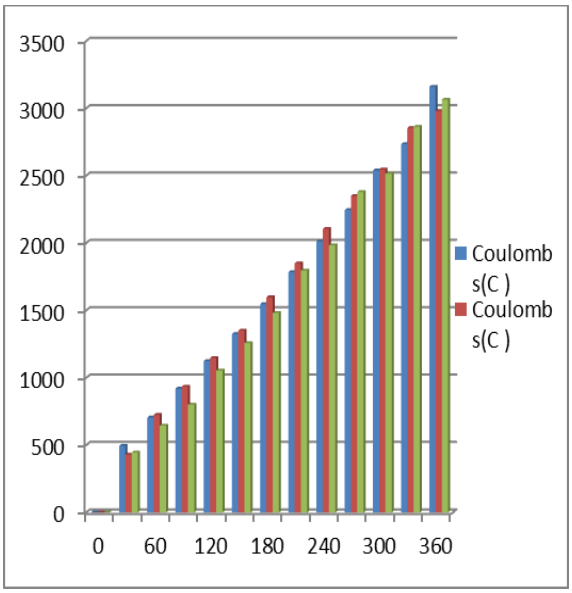

Figure 8. RCPT concrete M40 fly ash (sea water) result

Exposure condition	Concrete Mix	% Replacement of Cement by Fly Ash	Charge passed in coulombs (c)	Chloride permeability
Moderate /X0	A1	0 %	2288	Moderate
	A1	0 %	2410	Moderate
	A1	0 %	2309	Moderate
	B1	30%	1990	Low
	B1	30%	2087	Moderate
	B1	30%	1890	Low
Severe condition /XS2	C1	30%	3160	Moderate
	C1	30%	2980	Moderate
	C1	30%	3065	Moderate

Table 9: RCPT concrete All concrete Mix results

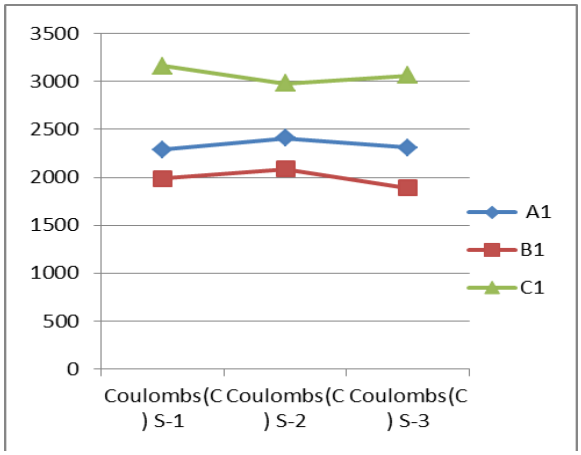

Figure9.RCPT concrete All concrete Mix results

V. CONCLUSION

"Based on limited experimental investigation concerning the RCPT and sorptivity of concrete, the following observations are made regarding the resistance of partially replaced fly ash for M40 grade concrete & different exposure condition":

"-M40 grade concrete & 30% FA mix Concrete in the sorptivity results is shown that the Moderate exposure condition water sorptivity value increase in 30% FA mix concrete .Similarly severe exposure condition the sorptivity value is higher in replacement of 30%FA by cement."

"-The RCPT results the chloride ion permeability is increase in the severe exposure condition respect to the normal moderate condition .and decrease the ions in the 30% Fly ash replacement by cement in concrete."

"-In RCPT results & sorptivity test results, when the replacements of the flyash by cement than the increase the permeability in concrete, and decrease the durability respectively."

-"It has been shown that FA30% has similar resistance to ingress by oxygen, water & Chloride."

"-Better curing and higher amount of binder in concrete improves the durability index values."

"-The 90 days after sea water curing condition (severe condition) concrete's permeability is increase in all test result respect to the normal moderate condition."

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