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Durability of Concrete with Calcium Bentonite and Robo sand as Admixtures

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Abstract - Use of alternative materials for sustainable development has become need of the day. This work has been aimed at checking use of robo sand and calcium bentonite to produce durable concrete. Acid attack tests with sulphuric acid and hydrochloric acid along with rapid chloride penetration test has been conducted to evaluate the durability of modified concrete. 5% calcium bentonite as replacement of cement at 25% replacement of sand with robo sand had produced concrete which has 13% more compressive strength after acid attack. Durability when tested by rapid chloride permeability test indicated that the modified concrete is low permeable producing a charge of 1800 coulombs.

***Keywords* — Calcium Bentonite, Acid attack, Durability of concrete, RCPT, Robo sand**

I. INTRODUCTION

Robo sand is crushed stone sand confirming to IS 383-2007 [4]. Lack of natural sand is raising demand for use of alternatives; however, sustainability aspects are to be taken care of to counter the negatives of alternative materials. 25% of sand in the mix has been replaced with robo sand.

In this regard an attempt is made to use Calcium bentonite [7] as replacement of cement at various percentages of 5,10 and 15 to check the durability of modified concrete. Calcium bentonite is a kind of clay that has non swelling properties.

II. METHODOLOGY

M40 grade of concrete has been designed confirming IS 20261-2009 [3] as control specimen. 15 cm cubes were cast [8] considering 25% replacement of sand with robo sand at different percentages of calcium bentonite namely 5,10 and 15% as replacement for cement.

Control specimens (conventional concrete) and all the samples with modified specifications were casted at 54 samples for each mix. 9 samples each were used for normal curing, sulphuric acid curing and hydrochloric acid curing for 28 days and 56 days of exposure.

III. EXPERIMENTAL PROGRAM

53 grade cement [1] was considered for the testing. Fine aggregate with fineness modulus of 3.01 and coarse aggregate with fineness modulus of 7.3 is used for testing.

Poly carboxylic ether polymer based high range water reducing agent [5] is used as super plasticizer. M40 mix with the following proportion 1: 1.99:3.54 at a water cement ratio if 0.45 has been found to give the desired result, which is used as control concrete specimen

Durability aspects of concrete [6] were checked at the end of 28 days and 56 days of curing [2]. At the end of 56 days rapid chloride penetration test (RCPT) was conducted. After 28 days of normal curing. Acid tests were done by curing concrete specimens at 5% concentration of 2N sulphuric acid and also with 5% concentration of 2N hydrochloric acid for 28 days and 56 days

Table1 Properties of concrete at 28 days

Mix	Compressive strength (Mpa)			% loss in weight	
	Normal cured	H2SO4 cured	HCL Cured	H2SO4	HCL
Control specimen	49.28	30.31	36.93	0.37	0.12
5% B + 25% RS	51.06	33.95	39.61	0.23	0.015
10% B + 25% RS	50.67	31.2	33.90	0.36	0.039
15% B + 25% RS	40.68	26.30	30.47	0.62	0.078

*B =Bentonite; RS =Robo sand

Table2 Properties of concrete at 56 days

Mix	Compressive strength (Mpa)			% loss in weight	
	Normal cured	H2SO4 cured	HCL Cured	H2SO4	HCL
Control specimen	53.17	25.99	34.06	0.49	0.19
5% B + 25% RS	56.58	29.44	36.25	0.31	0.036

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10% B + 25% RS	52.84	28.65	31.71	0.47	0.078
15% B + 25% RS	41.43	23.09	28.38	0.78	0.095

*B =Bentonite; RS =Robo sand

Table 3. RCPT test results

Mix	RCPT value in Coulombs	Permeability
Control specimen	4000	Moderate
5% B + 25% RS	1800	Low

*B =Bentonite; RS =Robo sand; RCPT= Rapid chloride penetration test

Table 1 depict the compressive strength of control specimens and modified mixes at the end of 28 days of curing for control specimens and 28 days of acid curing after 28 days normal curing. It is observed from the results that the compressive strength of 5% bentonite and 25% robo sand specimens is the highest in case of normal and acid curing, thus can be treated as optimal mix.

Table 2 depict the results at the end of 56 days of curing and the trend shows that 5% bentonite and 25% robo sand mix is the optimal mix.

Table 3 shows the results of Rapid chloride permeability test and clearly shows the optimal mis as obtained is low permeable and hence is durable mix among control and all other mixes.

IV. Conclusion

25% of fine aggregate replaced by robo sand, 5% replacement of cement with calcium bentonite results in higher compressive strength values than control specimens by around 7%.

Acid curing with sulphuric acid is more abrasive than hydrochloric acid, evident by decrease in compressive strength by 25% than the latter and loss in weight is more than 70% when compared to HCl curing.

The compressive strength of concrete affected by acid attack is higher by 13% for 5% bentonite modified mixes than control mix and the trend is same in case of other samples both in case of sulphuric acid and hydrochloric acid.

Durability of concrete in terms of permeability by RCPT teat also proved that 5% bentonite modified mixes resulted in low permeability as compared to control mixes resulting in transfer of 1800 coulombs of charge compared to 4000 coulombs of charge in case of conventional concrete.

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