International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.6, pp 898-904, 2017

A Study on Durability of Concrete by Partial Replacement of Cement with Bentonite

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Abstract : The main aim of this study is to search an alternative of cement and to present an experimental study on the durability properties of concrete with the replacement of cement with calcium bentonite. In this paper, six samples of the same grade at desired bentonite percentage of 10, 15, 20, 25 and 30 in comparison with the control mix (CM). The durability properties were studied through sulfate attack (H_2SO_4) and alkali attack (NaOH). The lower compressive strengths were observed for the bentonite mixes, after 28 days cured in water. The weight losses were observed in both sulfate and alkali attacks. The random variation of compressive strengths of the samples was observed, after 28 days of water curing and 30 days cured with H_2SO_4 and NaOH. The increase in strength of bentonite mixes is due to the increase in age and not due to the durability attacks.
Key words: Bentonite, Durability, Sulfate attack, Alkali attack, Compressive strength.

1 Introduction

The world's yearly creation of concrete of 1.6 billion tons discharges 7% of the worldwide stacking of carbon dioxide into the air and it is likewise the most vitality escalated material of development which is in charge of the emanation of extensive measure of greenhouse gasses into the environment [1]. So we are in the requirement for the look of an optional material for cement. Bentonite is exceedingly plastic mud containing around 85% earth minerals and montmorillonite. Two sorts of bentonite uncommonly swelling sort or sodium bentonite and non-swelling sort or calcium bentonite. In our present work, calcium bentonite was utilized which is otherwise called more fuller's earth [2]. Bentonite is accessible bounteously in nature and it obeys pozzolanic properties [3]. The construction industry which utilizes around 12.6 billion tons of crude materials consistently is the largest user of characteristic assets on the planet and it antagonistically impacts the ecology of the planet [4]. Along these lines, the improvement of durability of the concrete structures is essential. The Durability properties were investigated through chemical attacks.

2 Materials

In this experimental work, OPC 43 grade cement was utilized which is having a specific gravity 3.15[5], standard consistency 34[6], initial setting time 43 minutes and final setting time 123 minutes[7].fine aggregate confirming to zone-III[8]and specific gravity 2.60[9]was used. The coarse aggregate of size 20mm and 10mm and specific gravity of 2.64[9] were used. Calcium Bentonite having a specific gravity 2.38, Standard consistency 75, and Initial setting time 68 minutes and Final setting time 190 minutes[12-15].

3. Methodology

3.1. Mix Proportion

Taking after IS: 10262-2009[10], our mix design was gone for ordinary Portland cement concrete having 28 days compressive strength of 30Mpa for control mix. For control mix having a compressive strength of 30Mpa, the mix proportion arranged is organized in Table 1. Other concrete mixes were prepared by replacing cement by weight with a carved measure of Bentonite i.e., 10, 15, 20, 25, 30 %. Different constituents were kept steady.

Table 1 Mix proportion

Mix Type	Bentonite (%)	Cement (kg/m^3)	Bentonite (kg/m^3)	Fine Agg. (kg/m^3)	Coarse Agg. (kg/m^3)	W/C	Proportion (C:FA:CA)
CM	0	427.00	0.00	743.60	960.96	0.5	1:1.74:2.25
B-10	10	384.30	42.70	740.74	957.26	0.5	1:1.73:2.24
B-15	15	362.95	64.05	736.73	952.08	0.5	1:1.72:2.22
B-20	20	341.60	85.40	735.59	950.75	0.5	1:1.73:2.23
B-25	25	320.25	106.75	733.18	947.50	0.5	1:1.71:2.21
B-30	30	298.90	128.10	730.67	944.25	0.5	1:1.711:2.211

3.2. Compressive Strength Test Procedure

To assess the impact on compressive strength cube specimens were made and cured as shown in Fig1. Standard sized cube specimens of 15 X 15 X 15 cm according to IS: 516-1959[11] were tested for compressive strength utilizing the compressive testing machine were shown in Fig2. The results of compressive strength were tabulated in Table 2.

Table 2. Compressive strength results in MPa

S.No	Mix type	Compressive strength in MPa (28 days)
1	CM	38.804
2	B-10	27.032
3	B-15	25.724
4	B-20	25.942
5	B-25	17.004
6	B-30	15.260

Figure 1 Cubes after 28 days of water curing

Figure 2 Cubes testing for compressive strength

3.3. Durability Studies

For acid attack and alkali attack test concrete cubes of size 15X15X15 cm are prepared for various percentages of Bentonite. The specimens are then weighed and immersed in 2% Sulfuric acid[16] (H_2SO_4) shown in Fig4 and 2% Sodium Hydroxide (NaOH) solution of 10 Molar for 30 days shown in Fig3 after 28 days of water curing. After 30 days of immersing in acid and alkali solution, the weights and compressive strength of the cubes were taken and the failure samples were shown in Fig5. The physical properties of the chemicals were tabulated in Table 3. The changes in compressive strength were tabulated in Table 4 and Table 6.

Table 3 Physical Properties of Chemicals Used

S. No	Property	H_2SO_4	NaOH
1	IUPAC ID	Sulfuric acid	Sodium oxidanide, Sodium Hydroxide
2	Molar mass	98.079g/mol	39.997g/mol
3	Density	1.84g/cm^3	2.13g/cm^3
4	Boiling Point	337°C	1388°C
5	Melting Point	10°C	318°C

Table 4 Change in Compressive Strength With 2% H_2SO_4

Mix type	Compressive strength at 28 days (MPa)	Compressive strength after immersion in acid for 30 days(MPa)
CM	38.804	20.050
B-10	27.032	20.710
B-15	25.724	29.860
B-20	25.942	23.106
B-25	17.004	25.280
B-30	15.260	16.347

Table 5 Change in Weight of bentonite mixes With 2% H_2SO_4 attack

Mix type	Weight of specimens before immersion(grams)	Weight of specimens after immersion (grams)
CM	8035	7890
B-10	8120	7815
B-15	8140	8095
B-20	8020	7965
B-25	8015	7955
B-30	8035	8015

Table 6 Change in Compressive Strength with 2% NaOH

Mix type	Compressive strength at 28 days (MPa)	Compressive strength after immersion in alkali for 30 days (MPa)
CM	38.804	34.008
B-10	27.032	30.080
B-15	25.724	34.440
B-20	25.942	22.450
B-25	17.004	18.965
B-30	15.260	18.090

Table 7 Change in Weight With 2% NaOH

Mix type	Weight of specimens before immersion(grams)	Weight of specimens after immersion(grams)
CM	8230	8105
B-10	8180	8105
B-15	8190	8025
B-20	8025	7940
B-25	8035	7860
B-30	8120	7965

4. Results and Discussion

The compressive strength of the mixes is taken for 28 days of water curing. The comparison between the compressive strength of 28 days of water curing and compressive strength of 30 days of sulfate attack and alkali attack after 28 days of water curing. The compressive strength of CM in sulfate attack is 20.050 MPa and in alkali attack is 34.008 MPa, 48.33% and 12.35% are decreased than CM of 28 days of water curing. B-10 shown 20.710 MPa in sulfate attack, 23.38% decrease than B-10 of 28 days of water curing and also it showed 30.080 MPa in alkali attack, 11.27% increase than B-10 of water curing. B- 15 shown 29.860 MPa and 34.440 MPa in sulfate attack and alkali attack, 16.07% and 33.88% increase than B-15 of water curing. B- 20 shown 23.106 MPa and 22.420 MPa in sulfate and alkali attack, 10.93% and 13.46% decrease than B-20 of water curing. B- 25 shown

25.280 MPa and 18.965 MPa in sulfate and alkali attack, 48.67% and 11.53% increase than B-25 of water curing. B- 30 shown 16.347 MPa and 18.090 MPa in sulfate and alkali attack, 7.123% and 18.54% increase than B-30 of water curing. The compressive strengths variations were shown in Fig 6.

The weights are taken after 28 days of water curing and the weights are taken after 30 days of sulfate and alkali attack and the following comparison are done. CM showed 7890 grams and 8105 grams in sulfate attack and alkali attack, 1.8% and 1.5 % decrease than CM of 28 days of water curing. B-10 shown 7815 grams and 8105 grams in sulfate and alkali attack, 3.7% and 0.91% decrease than B-10 of water curing. B- 15 shown 8095 grams and 8025 grams in sulfate attack and alkali attack, 0.55% and 2.01% decrease than B-15 of water curing. B- 20 shown 7695 grams 7940 grams in sulfate and alkali attack, 4.05% and 1.05% decrease than B-20 of water curing. B -25 shown 7955 grams and 7860 grams in sulfate and alkali attack, 0.74% and 2.17% decrease than B-25 of water curing. B- 30 shown 8015 grams and 7965 grams in sulfate and alkali attack, 0.24% and 1.90% decreased than B-30 of water curing. The changes in weights were tabulated in Table 5 and Table 7.

Figure 3 Cubes immersed in alkali solution

Figure 4 Cubes immersed in acid solution

Figure 5 Failure Samples after durability attacks

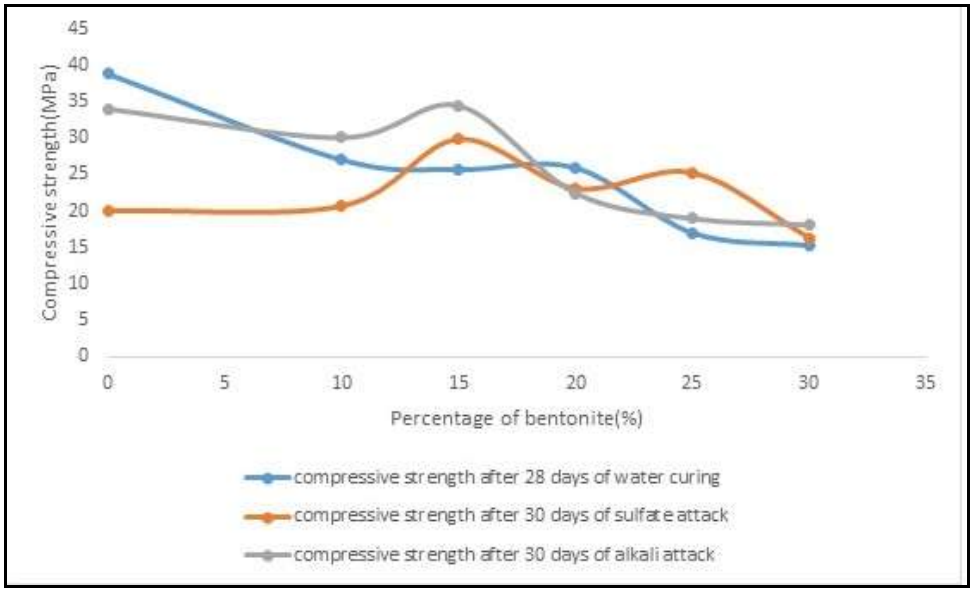

Figure 6 Graph showing variations in compressive strengths after water curing, sulfate attack, alkali attack

5. Conclusion:

The following conclusion are drawn after the finish of the experimental work, the compressive strength of bentonite mixes were reduced at the age of 28 days in comparison to the CM, B-10 shown optimum among all blended mixes. A little bit Weight loss was observed in alkali, high % of weight was observed in acid attack for all mixes, B-20 shown 4.05%. In sulfate attack, the compressive strength is increased in B-15, B-25, and B-30 concrete mixes and decreased in CM, B-10, and B-20 concrete mixes. In alkali attack the compressive strength is increased in B-10, B-15, B-25, B-30 concrete mixes and decreased in CM, B-20 concrete mixes. The control mix does not increase its compressive strength but Bentonite mixes increased their strength due to increase in age. The increase in the compressive strength is because of the increase in age but not due to the sulfate and alkali attacks.

References

1. Mehta, P.K., Reducing the Environmental Impact of Concrete, Concrete International, 23(10), pp. 61-66, Oct. 2001.
2. Indian mineral yearbook. Part-III: mineral reviews, 52ed edition, Bentonite, Government of India, Ministry of mines, Indian bureau of mines, 2013.

3. Lima, G.D., Mello, I., Resende, R. and Silva, R., Use of bentonite and organobentonite as alternatives of partial substitution of cement in concrete manufacturing, International Journal of Concrete Structures and materials, 8(1), pp. 15-26, March 2014.
4. Mehta, P.K. and Monteiro, P.J.M., Concrete: microstructure, properties, and material. Third ed. USA: The McGraw-Hill Companies Inc.; 2006.
5. IS: 8112. Ordinary Portland cement, 43 grade - Specification. Bureau of Indian Standards, New Delhi, 2013.
6. IS: 4031Part (4). Methods of physical tests for hydraulic cement-Determination of consistency of standard cement paste. Bureau of Indian Standards, New Delhi, 1988.
7. IS: 4031Part (5). Methods of physical tests for hydraulic cement-Determination of initial and final setting times. Bureau of Indian Standards, New Delhi, 1988.
8. IS: 383. Specification for coarse and fine aggregates from natural sources for concrete. Bureau of Indian Standards, New Delhi, 1970.
9. IS: 2386(3). Methods of test for aggregates for concrete. Bureau of Indian Standards, New Delhi, 1963.
10. IS: 10262. Concrete mix proportioning - Guidelines. Bureau of Indian Standards, New Delhi, 2009.
11. IS: 516. Methods of tests for strength of concrete. Bureau of Indian Standards, New Delhi, 1959.
12. Reddy, G.V.K., Rangarao, V. and Reddy, M.A.K., Experimental Investigation of Strength Parameters of Cement and Concrete by Partial Replacement of Cement with Indian Calcium Bentonite. International Journal of Civil Engineering and Technology, 8(1), January 2017.
13. Mirza, J., Riaz, M., Naseer, A., Rehman, F., Khan, A.N. and Ali, Q., Pakistani Bentonite in Mortars and Concrete as Low-Cost Construction Material, Applied Clay Science, 45, pp. 220-226, 2009.
14. Hashimi, S.H., and Mirzaei, I.M., Influence of nano-silica and polypropylene fibers on bond strength of reinforcement and structural light weight concrete, IJE Transactions B: Applications, 27(2), pp.261-268, February 2014.
15. Shafabakhsh, G. and Ahmadi S., Evaluation of Coal Waste Ash and Rice Husk Ash on Properties of Pervious Concrete Pavement, IJE Transactions B: Applications, 29(2), pp.192-201, February 2016.
16. https://en.wikipedia.org/wiki/Sulfuric_acid date accessed: 14-02-2017.

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