International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.7, pp 855-861, 2017

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

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Abstract : This experimental study focuses on the effects of durability of concrete using fly ash and bentonite as partial replacement of ordinary Portland cement (OPC) in mass concrete. Supplanting of OPC with supplementary solidifying materials, for example, fly fiery remains or bentonite is one of the promising approaches to relieve warm breaking because of temperature differentials in mass cement.The replacement percentages are 10%, 15%, 20%, 25% and 30% of bentonite and flyash in equal proportions are replaced for the weight of cement added, comparisons were made control mix. The acidic solution (H_2SO_4)& base solutions (NaOH)of 10 molarity with 2% were used for durability studies.The compressive strength test were performed at age of 28days. The durability tests were performed after 30 days$H_2SO_4$and NaOHattacks followed by 28 days of water curing. Lower compressive strengths were observed in all blended mixes at 28 days of curing, higher compressive strengths was observed after durability attacks as a result of increase in number age of curing.
Keywords : Bentonite, Fly ash, partial replacement, compressive strength, H_2SO_4attack, NaOH attack.

1. Introduction

In the perspective of worldwide Global warming, efforts are going ahead to lessen the emanation of CO_2 to the earth. Concrete Industry is major in supporter in the outflow of CO_2 and in addition spending abnormal state of vitality assets in the creation of concrete. By supplanting Concrete with a material of pozzolanic characteristics, the Construction industry can take care of the developing demand in the development business and additionally help in inciting nature contamination[1].The transfer of modern by-items is turning into an expanding sympathy toward numerous enterprises due to the expanding volume of waste by-item produced. usage of industrial by-products has turned into an alluring contrasting option to transfer. Some of these waste materials could be utilized as a part of constructional materials for the generation of cement. [2]. In India huge measure of flyash is created in Thermal power plants with an Imperative blow on ecological and living organism. The utilization of flyash in cement can lessen the utilization of common assets and furthermore reduces the impact of poison in condition. In late reviews, numerous researchers found that utilization of extra Cementous materials like fly ash in cement is economical and dependable[3]. Bentonite is an earth created every now and again from the modification of volcanic fiery remains, comprising dominatingly of smectite minerals, usually montmorillonite. Bentonite presents solid colloidal properties and its volume builds a few circumstances when coming into contact with water, making a coagulated and gooey liquid[4]. compressive strength are generally watched for comparative aggregate fastener substance. The slower quality pick up is because of relatively gradually happening hydration responses in nearness of fly fiery debris, slag, bentonite or some other pozzolanic material [5].

2. Materials

OPC 43 Grade Cement was Used in this Experiment investigation with a specific gravity (3.15), Consistency (34), Initial time (43 min), Final setting time (125 min) and Compressive strength (43 mpa) these properties are according to the code IS 8112-2013[6-8]. Physical Properties of Bentonite are light yellow in color, size of particles (200µ sieve passing)in nature it is available as pozzolanic material as shown in Figure1., specific gravity (2.38), initial time (68 min), final setting time (190min). Fly ash is the byproduct in the thermal power station it is available as the powder of 200 microns in size and dark grey in color, as shown in Figure 2. It belongs to pozzolanic material. Specific gravity (2.06), Fine aggregates are under the zone-III with a specific gravity of 2.60 & coarse aggregates with specific gravity of 2.64 under revenant code IS2386 (1) – 1963[9].

3. Methodology

3.1 Mix Proportion

The Proportioning of concrete mixture comprises of assurance of the individual fixings important to create concrete having sufficient workability, quality, toughness for the specific quality and for different introduction conditions.FB-10 denotes (fly ash 5% and bentonite 5%), the blend extents for the controlled cement of M30 review was taken from the trial mixtures according to Indian Standard of IS:10262-1982 details and observed to be 1:1.74:2.25.This Mixture was all through the review[10]. The mix proportions were tabulated in Table1.

Figure 1 Bentonite powder

Figure 2 Fly ash powder

Table 1 The mix proportion of various mixes

S.No	Mix name	W/c Ratio	Water (L/m^3)	Cement (kg/m^3)	Bentonite	Flyash	F. A. (kg/m^3)	C. A. (kg/m^3)	Mix Proportion
1	FB-0	0.5	213.5	427	-	-	743.60	960.96	1:1.74:2.25
2	FB-10	0.5	213.5	384.3	8.9	10	740.74	957.26	1:1.73:2.24
3	FB-15	0.5	213.5	362.95	13.4	15.5	736.73	952.08	1:1.72:2.22
4	FB- 20	0.5	213.5	341.6	17.94	20.72	735.59	950.75	1:1.73:2.23
5	FB-25	0.5	213.5	320.5	22.4	25.9	733.18	947.50	1:1.72:2.21
6	FB- 30	0.5	213.5	298.5	27	31.09	730.67	944.25	1:1.71:2.21

3.2 Compressive Strength

To evaluate the effect on compressive strength of specimens were made and cured by IS: 516-1959. Standard estimated block examples of 15 X 15 X 15 cm as per IS: 516:1959 for compressive strength using the compressive testing machine [11] as shown in Figure 3 and 4, failure specimen after testing was shown in Figure5. The compressive strength results were tabulated in Table 2.

Figure 3 Cubes before testing

Figure 4 Cube testing for compressive strength

Figure 5 Cubes after testing

Table 2 Compressive strength

S.NO	Mix type	Compressive strength for 28 days(in MPa)
1	FB-0	38.804
2	FB-10	25.94
3	FB-15	22.235
4	FB- 20	21.4
5	FB-25	17.04
6	FB- 30	13.94

3.3 Durability Studies

To Evaluate the Effect of Durability of Concrete the Standard Cubes of Size 15 x 15 x 15 cm as per IS: 516-1959. After Curing of Cubes in water for 28 days, the cubes will be immersed in acid attack and base attack for 30 days. The comparison between compressive strength and weight loss of cubes before and after immersion of cubes in acids and base are studied. For acid attack$H_2SO_4$is utilized and base attack 10molar of NaOH ,as shown in Figure6 and 7.

Figure 6 Cubes in NaOH solution

Figure 7 Cubes in H_2SO_4 solution

Table 3 Compressive Strength in 2%H_2SO_4 attack

S.NO	Mix type	Compressive strength after 28 days (in MPa)	Compressive strength after 28 days in H_2SO_4 attack(in MPa)
1	FB-0	38.804	20.050
2	FB-10	25.94	20.928
3	FB-15	22.35	25.72
4	FB- 20	21.14	27.00
5	FB-25	17.04	18.53
6	FB- 30	13.94	19.40

Table 4 Weight of the Cubes in 2% H_2SO_4 attack

S.NO	Mix type	Weight of the cubes after 28 days (in Kg)	Weight of the cubes after 28 days in H_2SO_4 attack(in Kg)
1	FB-0	8.035	7.890
2	FB-10	7.775	7.675
3	FB-15	8.375	8.300
4	FB- 20	8.300	8.135
5	FB-25	8.280	8.190
6	FB- 30	8.160	8.090

Table 5 Compressive Strength of the cubes in NaOH attack

S.NO	Mix type	Compressive strength after 28 days (in MPa)	Compressive strength after 28 days in NaOH(in MPa)
1	FB-0	38.804	34.08
2	FB-10	25.94	32.70
3	FB-15	22.35	27.03
4	FB- 20	21.14	23.54
5	FB-25	17.04	24.10
6	FB- 30	13.94	21.30

Table 6 Weight of the cubes in NaOH attack

S.NO	Mix type	Weight of the cubes after 28 days (in kg)	Weight of the cubes after 28 days in NaOH(in Kg)
1	FB-0	8.230	8.105
2	FB-10	7.675	7.625
3	FB-15	8.240	8.240
4	FB- 20	8.285	8.220
5	FB-25	8.290	8.245
6	FB- 30	8.085	8.045

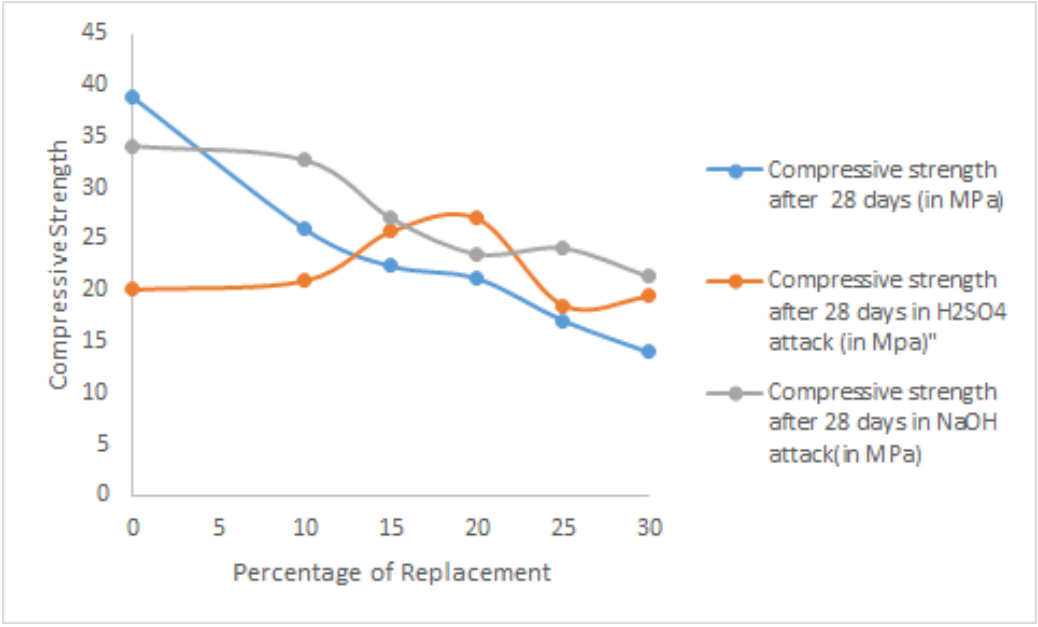

Figure 8Graph showing variations of compressive strength after 28 days of water curing and durability attacks

4. Results & Discussions

The durability of bentonite and concrete mixes tested to failure at the age of 28 days. comparison between weight and compressive strength of cubes before the acid attack i.e curing in water and acid attack for 28 days followed by the 28 days of water curing. The weight loss of FB-10cubes is 1.2% and compressive strength loss of 19.32% in acid attack with comparison of water curing. The weight loss of FB-15 is 0.89% and compressive strength with increase of 15.07% in acid attack with comparison of water curing. The weight loss of FB-20 is 1.98% and compressive strength with increase of 27.71% in acid attack with comparison of water curing. The weight loss of FB-25 is 1.08% and compressive strength with increase of 8.74% in acid attack with comparison of water curing. The weight loss of FB-30 is 0.85% and compressive strength with increase of 39.16% in acid attack with comparison of water curing, were shown in Table 3 and 4.The weight loss of FB-10 cubes is 0.65% and compressive strength increase of 20.67% in Base attack with comparison of water curing. The weight loss of FB-15 is 0% and compressive strength with increase of 17.314% in Base attack with comparison of water curing. The weight loss of FB-20is 0.784% and compressive strength with increase of 10.19% in base attack with comparison of water curing. The weight loss of FB-25 is 0.54% and compressive strength with increase of 29.29% in base attack with comparison of water curing. The weight loss of FB-30 is 0.49% and compressive strength with increase of 34.55% in base attack with comparison of water curing, were shown in TABLE 5 and 6, the graphical representation of all compressive strengths are show in Figure 8.

5. Conclusions

- The maximum compressive strength of 38.804 MPa was observed in FB-0 after 28 days of water curing.
- The highest compressive strength was observed for FB-10 of 27.00 MPa, an increment of 39.16% strength was observed in FB-30, the more weight loss was observed in FB-10 of 1.98% after H_2SO_4 attack.
- The maximum compressive strength was observed for FB-0 sssof 34.08 MPa, compare with all blended mixes. The more weight reduction was seen in FB-20 of 0.784% after NAOH attack.
- The higher compressive strengths was observed in all blended mixes due to more age in both durability attacks.

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