A REVIEW ON STRENGTHENING OF FLY ASH BRICKS

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Abstract— *Usage of Fly ash in the manufacturing of cement bricks has been emerging into a greater extent. In this paper various improvements that had been done for various parameters is discussed. Importance has been given specially to Compressive strength, Water absorption, and efflorescence. Additives like Ironite have also been added for the improvement of Compressive strength, Reduction of water absorption etc., usual composition includes Fly ash, Lime, Gypsum and Quarry dust.*

Keywords— Fly Ash, Quarry Dust, Lime, Gypsum, Ironite

1. INTRODUCTION

In the field of Construction, emergence of newer materials is at a rapid rate. Introduction of these materials favours the betterment of the strength to the structures. The erection of structures is getting complicated as we emphasis on aesthetic look also. On the go, dead load should be reduced without having an adverse effect on strength. Fly ash being the waste material generated from our thermal power plants is being utilized due to its lesser weight. Also on environmental aspect the wastes are being efficiently handled by adding it to the normal cement bricks. India being 3rd largest producer of fly ash, produces about 112 million tons of fly ash every year. Out of the total amount only 38 % are being reused. These 38 % has its applications in various purposes which include usage in bricks, pozzolana in cement, additive in Distemper, replacement for White Cement etc., Fly ash is finer. Naturally it has some binding property. Bricks made out of fly ash are lighter in weight when compared to normal conventional clay bricks.

2. MATERIALS

A. Fly ash

Fly ash is being obtained from the thermal plants where coal is used as a fuel to heat water. On heating coal, the resultant obtained is fly ash. Fly ash is commonly classified into 2 types by ASTM.

a. Class - C
b. Class – F

a. Class – C

Class C is obtained by burning Sub-bituminous coal or Lignite. It also possesses cementitious properties. It has specific gravity of 2.19. CaO content is above 10 %.

b. Class – F

Class F is a result of burning Bituminous coal or Anthracite. CaO content is less than 5 %. It has only pozzolanic properties only.

B. Lime

Lime is chemically called as Calcium Oxide (CaO) in addition with Magnesium Oxide (MgO). Fly ash reacts with Lime at ordinary temperature and forms a cementitious compound. The High strength of the compound is due to the formation of Calcium Silicate Hydrates formed between Fly ash and Lime.

C. Gypsum

Gypsum is a compound naturally occurring as soft crystalline rock or sand. It is a non-hydraulic binder. It has properties that include fire resistance, incombustibility, sound absorbing capacity, rapid drying, greater surface finish. It also has increased viscosity. Specific gravity is 2.31 g/cm3 and its density is 2.8 – 3 g/cm3

D. Quarry Dust

Granite quarry wastes are often termed as Quarry Dust. Locally available sand, which is found to be our natural resources, is expensive due to its high transportation cost. Due to the depletion of these natural resources, Quarry dust is a best replacement material. Quarry dust is much more economic when compared to river sand. It is also being used as surface finishing material in Highways. Also, it has its place in hollow blocks and in light weight concrete prefabricated elements. Quarry dust used here is of size less than 4.75 mm.

E. Fly ash Bricks

Fly ash bricks have been cast for the following specifications.

Fly ash - 15 to 50 %
Lime - 05 to 30 %
Gypsum - 2 %
Quarry Dust - 45 to 55 %
Brick size (mm) - 230 x 110 x 90
Testing Done (days) - 7, 14, 21

For the above mentioned compositions the bricks were cast and were tested for various parameters which includes compressive strength, Water absorption, Efflorescence.

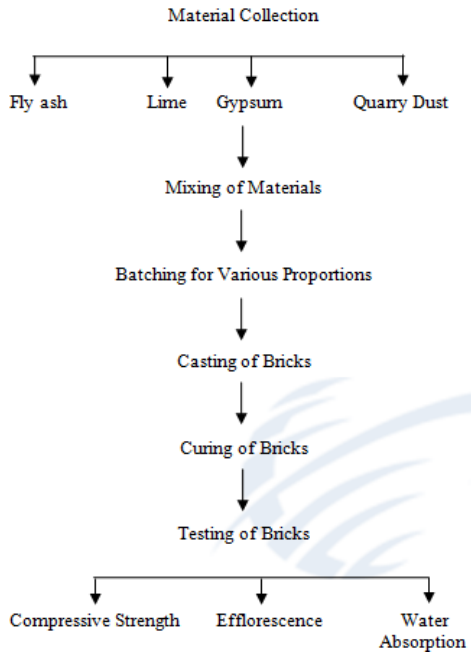

Fig. 1. Flow Chart Of Brick Manufacturing process

F. Mix Design :

Bricks were casted based on the various mix designs. Calculations have been made by trial and error method.

TABLE 1. MIX PROPORTIONS

Mix	Fly ash (g)	Lime (g)	Gypsum (g)	Quarry Dust (g)	W/C ratio (%)
1	525	1050	200	1855	0.45
2	700	875	200	1855	0.43
3	700	1050	200	1855	0.50
4	875	700	200	1855	0.45
5	1000	525	200	1855	0.45
6	1225	350	200	1855	0.45
7	1400	175	200	1855	0.45
8	1400	350	200	1680	0.50
9	1750	875	200	805	0.75

G. Compressive Strength

The compressive strength obtained for the various mix designs are tabulated below. The values taken are mean values of 5 samples at corresponding dates from casting of bricks.

TABLE 2. COMPRESSIE STRENGTH OF BRICKS FOR DIFFERENT MIXES

Mix	Compressive Strength Of Bricks (N/mm^2)		
	7^{th} day	14^{th} day	21^{st} day
1	1.98	3.95	7.91
2	1.68	3.36	6.78
3	1.81	3.43	6.97
4	1.44	3.08	5.98
5	1.22	2.43	5.34
6	1.03	1.97	5.04
7	1.12	2.23	5.14
8	1.21	2.67	5.28
9	1.34	2.62	5.45

H. Water Absorption

The water absorption value for the various mixes are being tabulated below.

TABLE 3. WATER ABSORPTION FOR MIX

Mix	Water absorption (%)
1	10.9
2	12.4
3	12.6
4	13.3
5	15.1
6	15.6
7	15.7
8	16.2
9	16.8

I. Results

Based on the study done by A Sumathi & K. Saravana Raja Mohan on the bricks of size 230x110x90 mm casted for various mixes of the contents Fly ash, Lime, Gypsum, and Quarry dust. Out of all the mixes Fly ash - 15%, Lime - 30%, Gypsum – 2% and Quarry dust - 53% is found to be 7.91 N/mm2.

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A. Fly Ash Bricks

Fly Ash	-	45.3 %
Quarry Dust	-	47.5 %
Lime	-	4.6 %
Gypsum	-	1.5 %
Ironite	-	1 %
Brick Size (mm)	-	225 x 105 x 85

B. Mix Design

The mix designs were obtained by trial and error method.

TABLE 4. MIX DESIGN WITH VARIED COMPONENTS

No of Bricks	Mix	Fly ash	Quarry Dust	Lime	Gypsum	Ironite
50	1	70.21	73.62	7.13	2.32	1.55
45	2	65.68	68.87	6.6	2.17	1.45
40	3	58.21	61.0	5.91	1.93	1.30
35	4	50.96	53.43	5.17	1.69	1.13
30	5	43.71	45.84	4.44	1.45	0.97
25	6	36.24	38	3.68	1.20	0.80
20	7	28.99	30.40	2.94	0.96	0.64
15	8	21.74	22.80	2.21	0.72	0.48
10	9	14.50	15.20	1.47	0.48	0.32

C. Compressive Strength

The compressive strength were taken for 5 bricks and the average was recorded.

TABLE 5. COMPRESSIVE STRENGTH OF VARIED MIX

Mix	Ultimate Load	Compressive Strength
1	240	10.16
2	225	9.52
3	210	8.89
4	170	7.20
5	300	12.70
6	205	8.68
7	240	10.16
8	235	9.95
9	260	11.01

D. Water Absorption test

The water absorption test results were average for 5 bricks and are tabulated.

TABLE 6. WATER ABSORPTION FOR MIX

Mix	Water Absorption %
1	7.6
2	7.3
3	8.4
4	7.3
5	7
6	5
7	6.6
8	7.4
9	6.9

E. Results

Results obtained by the addition of Ironite with the fly ash bricks to the normal composition have found to have additional compressive strength, lesser water absorption. The compressive strength for the brick of size 225 x 105 x 85 mm at 22nd day testing was 12.70 MPa for the mix ratio of

Fly ash – 1.45 kg,
Quarry dust – 1.52 kg,
Lime – 0.147 kg,
Gypsum – 0.048 kg
Ironite – 0.032 kg.

Its water absorption is also found to be 7 %.

F. Conclusion

From the above data it is found that for the proportion

Fly ash – 0.525 kg,
Quarry dust – 1.855 kg,
Lime – 1.050 kg,
Gypsum – 0.200 kg

The compressive strength seems to be a maximum of 7.91 MPa. In other ways by adding an additive named Ironite with the mix proportion

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Gypsum – 0.048 kg
Ironite – 0.032 kg.

has achieved a maximum of 12.70 MPa.

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