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Experimental Investigations on Flowable Fly ash Bricks

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***Abstract*— This paper presents an experimental study on flowable fly ash bricks. In this study, an attempt has been made to examine the feasibility of adopting flowable slurry concept in bricks production. The flowable fly ash bricks produced from fly ash, cement and crushed sand. The essential properties such as compressive strength, water absorption, density and efflorescence of flowable fly ash bricks were determined. Further, compressive strength and flexural bond of flowable fly ash brick masonry prism are evaluated. The test results reveal that flowable fly ash brick fulfilled the requirements of bricks.**

Key words: Flowable, fly ash bricks, crusher sand, efflorescence.

I. INTRODUCTION

There is a continuous demand in construction activities and so also the demand for construction materials. Typically, the use of brick is inevitable in the construction. The traditional bricks depend on good quality clay. Huge amount of clay are extracted and used in the production of red bricks. However, the availability of raw material for red bricks is not sufficient to meet the present construction activities. Thereby, fly ash bricks as an alternative to red brick are emerged in the construction industry especially in India. Fly ash brick made from fly ash, lime and gypsum is introduced in the year 1991. The manufacturing process of fly ash bricks does not require the thermal treatment and also the combustion of any fuel. The technologies are eco friendly, reduces solid waste and dust in the nature. The cost of fly ash brick is comparable with red brick. India consume about 200 billion tones bricks, exhausting approximately 340 billion tones of clay every year and about 5000 acres of top soil land is made unfertile for a long period. The Government is seriously concerned over soil erosion for production of massive quantities of bricks, in the background of enormous housing needs. The excellent engineering property and durability of fly ash brick enlarges its scope for application in building construction and development of infrastructure, construction of pavements, dams, tanks, under water works, canal lining and irrigation work etc. Enormous quantities of fly ash are available in and around thermal power stations in all the states. The demand of bricks could be met by establishing small units near thermal power stations and to meet the local demand with less transportation costs. Therefore laboratory investigation and field applications are attempted using different industrial by-products in the global scenario. Further Duggal & Srivastava (1994) attempted to develop Fly ash-Lime-Soil bricks with a mix proportion of 60% to 80% of fly ash, 15% to 40% of lime and 5% to 20% of soil. Ritwik Sarkar et al (2007) developed bricks using washed clay with pond ash and fly ash. Fly ash up to 80% can replace clay in brick with properties superior to conventional red clay brick. Pond ash, up to 40% replacement can also be made without compromising the quality of brick. Sengupta (1993) developed Fly ash-Lime bricks with major quantity of fly ash, lime and an accelerator and a catalyst. Sunil kumar (2002) suggested that FaL-G brick could be used as filler media for walls. In other aspect, self-compacting concrete (SCC) is being popularized due to its numerous inherited benefits. SCC technology is considered as an energy conservation technique in construction industry as it eliminates electricity requirement for compaction of concrete. Similar to self-compacting concrete, if self compacting brick is manufactured without adopting hydraulic/mechanical presses over fly ash bricks for compaction, it could save electricity power. In this viewpoint the proposed work aimed to develop flowable fly ash bricks using fly ash, cement and crushed sand and to assess the feasibility of flowable slurry concept in brick production.

II. MATERIALS

Class F Fly ash, ordinary Portland cement (OPC), crushed sand and water was used in the present study. The fly ash is obtained from Mettur thermal power plant. The fly ash is in conformity with the general requirements of pozzolana. Ordinary Portland cement (OPC) 53 grade satisfied IS: 8112 – 1989. Crushed sand with a fineness modulus of 2.49 and specific gravity 2.74 is used as filler material.

III. EXPERIMENTAL WORK

The flowable fly ash bricks were made from Fly Ash (FA), OPC and crushed sand (CA). Trial mixes were made with different cement content varied from 10% to 30%. Crusher sand was used from 0% to 30% in all cement content mixes. The water content was selected based on the flowabilty of the mix. The

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flowabilty of mix was measured with 75 mm x 150 mm open-ended cylinder as per ASTM D 6103 method. The spread of flow was selected as 200 ± 50 mm in diameter for all mixes. Brick specimens were made in standard size of 190 x 90 x 90 mm. Specimens were demoulded after 24 hours and were cured by means of humid curing.

Compressive strength was determined at the age of 7 and 28 days for all mixes.The properties such as water absorption, density, compressive strength and efflorescence were determined only for the flowable fly ash slurry mix with minimum cement content satisfying minimum requirement of brick as per Indian Codal Provisions for bricks. Trial bricks were made to attain the approximate strength of 3.5 MPa by flowable slurry concept. Also the properties of compressive strength and flexural bond strength of the masonry prism were investigated with minimum cement content satisfying minimum requirement of brick as per ASTM provisions for bricks.

IV. RESULTS & DISCUSSIONS

A.Compressive Strength of Flowable Fly Ash Bricks

The compressive strength of various mixes of flowable fly ash brick is presented in Table I. The variation of 28 days compressive strength of mixes of flowable fly ash brick with crushed sand content is shown in Fig 4.1.

The test results indicate that mix D30 containing 20% cement and 30% crushed sand, cement with 25% and 30% mixes in all crushed sand content satisfied the requirements for bricks. The compressive strength of flowable fly ash brick made with 50% fly ash, 20% cement and 30% crushed sand achieved 3.86 MPa at 28 days. Addition of cement increased the rate of strength gain for flowable fly ash brick mixtures and maximum compressive strength is achieved for 30% cement contents which gives highest compressive strength of 5.38 MPa. Addition of crushed sand also increased the compressive strength of flowable fly ash bricks. It is suggested that flowable slurry concept could be used in the manufacturing of bricks. The mixes with cement content 10% and 15% does not satisfying minimum requirement of brick as per Indian Codal Provisions for bricks. In case of 20% cement content except 30% crusher sand all the crusher sand content does not meet the requirements.

B.Density of Flowable Fly Ash Bricks

The density of mixes which fulfilled IS requirements based on compressive strength are considered and the results are presented in Table II. Density of flowable fly ash bricks were found to increase with crusher sand content in all cement content mixes. It is also observed that addition of cement increased the density of flowable fly ash bricks for the same crusher sand content.

C.Water Absorption of Flowable Fly Ash Bricks

The water absorption of mixes which satisfied IS requirements based on compressive strength of flowable fly ash bricks are given in Table III. Test results indicate that water absorption of flowable fly ash bricks were in the range of 2.09 % to 5.76%. It is very well below the requirement of brick (< 20%) as per Indian Codal Provisions for bricks

D. Efflorescence

The efflorescence of the various achieved mixes of flowable fly ash bricks was observed. No mixes showed any perceptible deposit.

Table I. Compressive Strength of Flowable Fly ash Bricks

Brick Identification	Cement Content	Compressive Strength (MPa)	
		7 days	28 days
B_0	10%	0.29	0.7
B_{10}		0.41	0.89
B_{20}		0.87	1.29
B_{30}		1.11	1.57
C_0	15%	0.64	1.52
C_{10}		0.70	1.59
C_{20}		1.16	1.63
C_{30}		1.40	1.87
D_0	20%	1.11	2.45
D_{10}		1.17	2.57
D_{20}		1.46	2.77
D_{30}		1.69	3.86
E_0	25%	1.58	4.44
E_{10}		1.64	4.69
E_{20}		1.75	3.98
E_{30}		2.05	3.68
F_0	30%	1.98	4.56
F_{10}		2.16	4.68
F_{20}		2.34	4.73
F_{30}		2.40	5.38

Note: The suffix in the identification indicates the crusher sand content and the alphabets indicate the cement content in the mix.

.Table II. Density of Flowable Fly ash Bricks

Brick Identification	Density (kg/m^3)
D_{30}	2106
E_0	1884
E_{10}	1969

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E_{20}	2043
E_{30}	2093
F_0	1903
F_{10}	1977
F_{20}	2040
F_{30}	2123

Table III. Water Absorption of Flowable Fly ash Bricks

Brick Identification	Initial Weight M_1 (kg)	Weight after 24 hours in water M_2 (kg)	Water Absorption (%)
D_{30}	2.600	2.750	2.09
E_0	2.300	2.890	3.67
E_{10}	2.450	2.900	2.40
E_{20}	2.500	2.990	2.80
E_{30}	2.626	2.694	2.59
F_0	2.351	2.437	3.66
F_{10}	2.523	2.583	2.38
F_{20}	2.562	2.634	2.81
F_{30}	2.575	2.629	5.76

E. Comparison of Bricks

The properties of flowable fly ash bricks were compared with fly ash bricks and red bricks and are displayed in Table IV. All the properties of flowable fly ash brick are higher than other two types of bricks. Compressive strength of flowable fly ash brick is more than other two types of bricks. Density of flowable fly ash brick was lesser than other two types of bricks. Water absorption of flowable fly ash brick is much better than other two types of bricks. Efflorescence of all the three types showed nil perceptible deposit.

Table IV. Comparison of Flowable Fly Ash Brick with Red Brick and Fly Ash Brick

Type of Brick	Compressive Strength (MPa)	Density (kg/m^3)	Water Absorption (%)	Efflorescence
Flowable Fly Ash Brick (D_{30})	3.86	2106	2.09	Nil
Fly Ash Brick	3.47	2456	6.83	Nil
Red Brick	3.75	2650	14	Nil

V. CONCLUSION

The experimental study on flowable fly ash bricks has the following conclusions.

a. The mix containing 20% OPC with 30% crusher sand and cement content 25% and 30% mixes in all crusher sand content are also satisfied all the requirements for bricks.
b. Flowable fly ash bricks eliminate completely hydraulic/mechanical presses over fly ash bricks for compaction.
c. This advantage could save electricity power used in the production of commercially available fly ash bricks.
d. Hence it is concluded that the new method of flowable fly ash brick is a viable alternate to conventional burnt clay brick and fly ash brick.

REFERENCES

[1] ACI Committee 229R (1994), 'Controlled Low Strength Materials (CLSM)', ACI Concrete International, July 16(7), pp.55-64.

[2] S.K.Duggal, and R.K. Srivastava, "Assessment of Fly ash-Lime-Soil Mixtures for Utilization in Manufacture of Bricks and Construction Material", New Build Mat, CE & CR, pp.35-40. 1994

[3] Indian Standard IS 1077: 1992, 'Common Burnt Clay Building Bricks –Specification', August 1996.

[4] Indian Standard IS 3495 (Parts 1 to 4): 1992, 'Methods of Tests of Burnt Clay Building Bricks',October 1998.

[5] Ritwik Sarkar, Narsingh, Swapan kumar Das (), 'Effect of Addition of Pond ash and Fly ash on Properties of Ash-Clay Burnt Bricks', Waste Mgt & Res, vol.2, no.4, pp.566-571, 2007.

[6] J. Sengupta, "Fly ash-Lime-Bricks as an Alternative Walling Material", New Building Materials, CE & CR, pp.12-15.1993.

[7] Sunil kumar (2002), 'A Perspective Study on Fly ash-Lime-Gypsum Bricks and Hollow Blocks for Low Cost Housing Development', Construction and Building Materials, vol.16, no.4, pp.519-525, 2002.