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Experimental investigation on replacement of sand by quarry dust in fly ash bricks

Hari R, Karthick V, Kathiravan S, Lingeshwaran C
Nandha Engineering college, Perundhurai, Erode.
Assistant professor Tharanya S, Dept. of Civil Engg.,Nandha Engineering college, Perundhurai, Erode.

ABSTRACT

Although the use of fly ash has many advantages, its low hydration at early stage causes the strength to be low. In this study, the experimental investigation was carried out to find the optimum mix percentage of fly ash brick. However the brick specimen of size 235mm x 115mm x 65mm were cast for different mix percentage of Fly ash (15 to 50%), Gypsum (2%), Lime (5 to 30%) and Quarry dust (45 to 55%), compressive strength were studied for different mix proportions. The results shows the variation of compressive strength for different mix proportions of materials mentioned earlier at different curing ages. From the results it was inferred that, the maximum optimized compressive strength is obtained for optimal mix percentage of Flyash-25% Lime-20% Gypsum-2% Quarry dust-53%.

Key words : Fly ash, Lime, Gypsum, Quarry dust, Compressive strength and Water absorption.

INTRODUCTION

In the present scenario in the construction industry, use of economic and environmental friendly material is of a great concern. One of the main ingredients used is cement. It is observed from various studies that the heat emitted from cement accounts to a greater percentage in global warming. Cement industries account to a greater emission of CO2 and they also use high levels of energy resources in the production of cement. In order to minimize these effects, replacement of cement with some pozzolanic materials such as fly ash, can have an improving effect against these harmful factors. In this work, identified the optimum mix of fly ash (major ingredients) generated at Barapukuria Thermal Power Plant, sand, hydrated lime and gypsum and also optimized the brick forming pressure. Fly ash-55%, sand- 30% and hydrated lime – 15% with gypsum-14% was found to be the optimum mix. For the optimum mix studied the compressive strength, microstructure, shrinkage property, unit volume weight, Initial rate of absorption, absorption capacity, apparent porosity, open pore and impervious pore of the fly ash–sand–lime-gypsum bricks produced with optimized composition under various brick forming pressures, Efflorescence and radio activity of the bricks formed under optimized conditions were also investigated1. In this paper, experimentally investigated the fly ash brick mix proportions by Taguchi method. Least quantity of cement and fly ash has been used as binding materials and considered the control factor as water binder ratio. Both. So the effects of water/binder ratio, fly ash, coarse sand, and stone dust on the performance characteristics are analyzed using signal-to-noise ratios and mean response data. Furthermore, the estimated optimum values of the process parameters are corresponding to water/binder ratio of 0.4, fly ash of 39%, coarse sand of 24%, and stone dust of 30%2. The addition of fly ash up to 60% at a fixing temperature as 950ºc has no significant harmful effects on the brick quality. It seems that the fly ash added building bricks show reasonably good properties and may become competitive with the conventional building bricks. Use of fly ash as a raw material for the production of building bricks is not only viable alternative to clay but also a solution to difficult and expensive waste disposal problem3. In the present work the attempt has made to find the optimum mix percentage of to obtain maximum compressive strength of fly ash brick admixed with lime, gypsum and quarry dust at various proportions.

PROPERTIES OF MATERIALS

FLY ASH

Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by the flue gases and collected by electrostatic precipitator. ASTM broadly classify fly ash into two classes Class F: Fly ash normally produced by burning anthracite or bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only. Class C: Fly ash normally produced by burning lignite or sub-bituminous coal. Some class C fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class C fly ash also possesses cementious properties. Fly ash used is of type class C with a specific gravity of 2.19**.**

LIME

Lime is an important binding material in building construction. It is basically Calcium oxide (CaO) in natural association with magnesium oxide (MgO).Lime reacts with fly ash at ordinary temperature and forms a compound possessing cementitious properties. After reactions between lime and fly ash, calcium silicate hydrates are produced which are responsible for the high strength of the compound.
Fly ash Bricks.

GYPSUM

Gypsum is a non- hydraulic binder occurring naturally as a soft crystalline rock or

sand. Gypsum have a valuable properties like small bulk density, incombustibility, good sound absorbing capacity, good fire resistance, rapid drying and hardening with negligible shrinkage, superior surface finish, etc. In addition it can strengthen material or increase viscosity. It has a specific gravity of 2.31 grams per cubic centimeter. The density of gypsum powder is 2.8 to 3 grams per cubic centimeter.

QUARRY DUST

It is residue taken from granite quarry. Due to excessive cost of transportation from natural sources locally available river sand is expensive. Also creates environmental problems of large-scale depletion of these sources. Use of river sand in construction becomes less attractive, a substitute or replacement product for concrete industry needs to be found. Whose continued use has started posing serious problems with respect to its availability, cost and environmental impact. In such a case the Quarry rock dust can be an economic alternative to the river sand. Usually, Quarry Rock Dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of

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hollow blocks and lightweight concrete prefabricated Elements. After processing fine particles of size less than 4.75 mm is used in this work.

PROPORTIONS OF INGREDIENTS OF DIFFERENT SAMPLES FOR FLY ASH BRICKS

To make the fly ash brick following mix proportions are arrived by trial and error method. The Table.1shows the various mix proportions.

Table 1 Proportions

Sample	Fly ash	Sand	Quarry dust	lime	Gypsum
Mix-1	70 %	15%	-	10 %	5%
Mix-2	25 %	-	53%	20 %	2%
Mix-3	30 %	-	53%	15 %	2%
Mix-4	35 %	-	45%	17 %	3%
Mix-5	30 %	-	56%	13 %	2%

WATER-BINDER RATIO

Water- binder ratio is calculated based on weight of fly ash and weight of lime to total weight of the brick. It also plays the significant role on the compressive strength of the brick. Considering the water content or water to binder ratio is an indirect approach to sizing the volume, thus ensuring greater durability in the mixture proportions for bricks made. Then water-binder ratio used for various proportions is given in the Table.3

Table 2 Water-Binder ratio (%)

Sample	Water- Binder ratio (%)
Mix-1	0.45
Mix-2	0.43
Mix-3	0.50
Mix-4	0.45
Mix-5	0.45

COMPRESSIVE STRENGTH TEST

The aim of the experimental test is to determine the maximum load carrying capacity of test specimens.

Compressive strength of brick is tested on cube at different percentage of quarry dust content in brick. The strength of brick has been tested on cube at 7,14 & 21 days. Compression testing machine is used for testing the compressive strength test on brick.

$f_c = (P/A)\ N/mm^2$

Where,

P = Load at which the specimens fails in Newton (N)

A = Area over which the load is applied in mm

f_c = Compressive stress in N/mm²

Table 3 : Result of compression strength testat 7,14 & 21 days

SAMPLES	Average compressive strength (N/mm²)		
	7 Days	**14 Days**	**21 days**
A	5.862	7.733	10.390
B	10.294	13.380	17.778
C	7.963	10.233	13.218
D	8.601	11.096	14.526
E	7.480	9.676	12.601

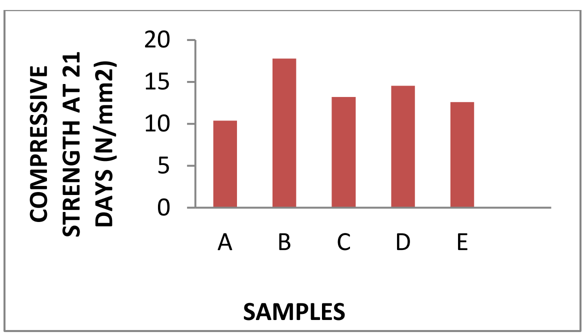

Fig. 1 **: Bar chart for Compressive strength at 21 days**

WATER ABSORPTION TEST

This water absorption of bricks is not related directly to the porosity owing to the nature of pores themselves. Some of pores may be through pores which permit air to escape in absorption test and allow free passage of water in absorption test, but other are completely seated and inaccessible to water under ordinary condition.

% of water absorption = $\{(W_2-W_1) / W_1\} \times 100$

Where,

CONCLUSION

After all the effort and present experiment work the following observation are made by added quarry dust in fly ash bricks with different percentage and conclude that…

Where,

a)Class F ash is utilized in the brick manufacturing work as judicious decision taken by engineers.

b)The study was conducted to find the optimum mix percentage of fly ash brick. However the brick specimen of size 235mm x 115mm x 65mm were cast for different mix percentage of Fly ash.

c)As the compressive strength of the brick increases, the water absorption of the brick decrease. In this experimental work maximum compressive strength after 21 days is 5.845 N/mm² ,where minimum water absorption is 5.52 % after 21 days in quarry dust Fly ash brick.

d) Use of fly ash and quarry dust help in prevention of environmental degradation and use of agriculture land utilized in clay brick production.

W_1 = Dry weight of brick

W_2 = Wet weight of brick

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