

Experimental Practice on High Volume Flyash and Stone-Waste Brick-Blocks Alternative to Conventional Bricks / Blocks

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Abstract

Now-a-days conventional masonry work elements like clay brick, cement brick, solid/hollow block and fly ash bricks are used. The same time we are facing many practical difficulties as material source demand, high material cost, and high investment as capital and environmental impact as high amount of heat hydration, while their manufacturing and applications. In which the situation, one proto type practice to produce the fly ash concrete brick or green concrete brick for masonry work. In this experimental practice results from the Compression strength test, water absorption, weight and efflorescence tests on concrete cubes, cylinders (3no's of samples on each mix) and bricks size mould elements containing fly-ash and Stone waste as Quarry dust aggregates with optimum water content. Which material mix proportion binder and filler (or) aggregate ratio is (1.5:1), where the cementing materials as Flyash (Fa) blended with Ordinary Portland Cement (C). The mix of (Fa:C) in various percentages as 67:33, 75:25, 83:17, 92:08, 100:0 of trail mixes are taken for this practice. The present study is used to solve the above mentioned practical difficulties.

Keywords

Conventional brick/blocks, Fly ash bricks, Stone waste, Masonry work, Optimum water content.

I. INTRODUCTION

The discharge of waste of materials causes many problems. The main problems are the place occupied by their storage, importance of costs and the environmental impact. In orderly, Fly ash is a fused residue of clay minerals present in coal. The high temperature generated when coal burns in thermal power plants, transforms the clay minerals in coal powder into a variety of fused fine particles of mainly aluminium silicate composition. Pulverized fuel ash commonly known as fly ash. It is a useful byproduct from thermal power stations using pulverized coal as fuel and has considerable pozzolonic activity. And Stone waste is a widespread by product of industrial processes in INDIA. These wastes pollute and damage the environment due to sawing and polishing processes. To safeguard the environment, efforts are being made for recycling different wastes and utilize them invaluable applications. This national resource has been gainfully utilized for manufacture the fly ash-Stone waste bricks as a supplemented to common burnt clay bricks, leading to the conservation of natural resources and improvement in environment quality. These bricks are suitable for use in masonry construction just like common burnt clay bricks. Production of fly ash-lime bricks has already started in the country and it is expected that this standard would encourage production and use on mass scale. In the same way, this would encourage the entrepreneur development.

II. Scope and Objectives

- To give a little participation as on green product manufacture.
- To initiate the entrepreneurs development on brick manufacturing.
- The aim of this project is to manage some of the practical difficulties, while conventional brick/block manufacturing and application, for masonry wall by Fly-ash and stone waste concrete brick. Such as
 1. Material demand,
 2. High rate of material,
 3. High investment cost.
 4. Environmental impacts.
- To declare the results from the experimental test practices as

compressive strength, weight density and water absorption values on 7 days curing with conventional and Fly ash concrete bricks.

III. Materials

The raw materials required for brick manufacturing are fly-ash (Fa), Quarry dust (Qd), Stone aggregates, Cement (OPC) and Water. Fly ash is obtained from Tutocorin Thermal Power plant. The specific gravity and particle size of fly ash are 2.31 and (10-50) μm respectively. From chemical composition of Fly ash, CaO content is less than 5%, so the fly ash is classified as class F according to the IS code. Ordinary Portland Cement (OPC) 53 grade cement is purchased from virudhunagar. It is used to activate the pozzolonic action in Fly-ash / to accelerate the hardening process and obtaining the early strength. The local available Stone chips (jelly size <12mm) and stone waste as Quarry dust (Qd) is collected from near kallurani in virudhunagar district. The specific gravity of Stone chips and Quarry dust are 2.66 & 1.60 respectively. The density of stone chips and quarry dust is 1465 and 1400 kg/m³ respectively. Usage of Quarry dust in the manufacturing of brick reduced laminar crack in the mix. Above mentioned materials used to make the mix content with water. Water is an important ingredient of brick as it helps to bind all the raw materials for giving proper mix for brick manufacturing. Water used for making brick should be free from impurities. Water must be containing pH value not less than 6. Addition of water reducing agent as SIKAVISCOCRETE 20HE used, while the brick-block manufacturing at factory. Coloring pigments can be added, if brick blocks need various colors.



Fig. 1: Class F Fly-ash

Source: Tutocorin Thermal power plant



Fig. 2: Quarry dust

Source: Local Stone Crusher



Fig. 3: Stone Chips (Coarse aggregate)

Source: Local Stone Crusher



Fig. 4: Course aggregate (size 12mm)

Source: Local Stone Crusher

Table 1: Chemical Compositions of Class F Flyash

Si.No	Chemical Compositions	Class F Fly-ash
1	SiO ₂	54.90
2	Al ₂ O ₂	25.80
3	Fe ₂ O ₅	6.90
4	CaO	8.70
5	MgO	1.80
6	SO ₃	0.60
7	Na ₂ O & K ₂ O	0.60

Source: <http://www.flyash.com>

IV. Mix Proportions

The mix proportions were arrived under consideration factors like the weight of product, method of manufacturing and material demand along with structural suitability.

The design mix proportion is shown in Table 2. Each mix consist 40 percentage water corresponding to weight of binder materials. Total volume of coarse aggregates consisting Stone sizes in 12mm.

Table 2: Mix Proportions for preliminary Lab test

Mixes Materials	Trial mixes in %				
	M _{T1}	M _{T2}	M _{T3}	M _{T4}	M _{T5}
Fly ash	40	45	50	55	60
Cement	20	15	10	5	0
Quarry dust	30	30	30	30	30
Coarse aggregates	10	10	10	10	10

V. System of Approach

In this experimental practice was carried in order of study of material properties, arriving of mix proportions, casting of trail mixes, testing after curing for preliminary lab tests. Then selected mixes (Table no: 3) has been taken for factory manufacturing process to make a final product.

Table 3: Selected Mixes for Factory manufacturing process

Mixes Materials	Factory mixes in %	
	FM ₁	FM ₂
Fly ash	45	45
Cement	17.5	15
Quarry dust	30	30
Stone chips	7.5	10

i. Casting: The evaluation of fly-ash Stone waste brick manufacturing process begins with the casting. Brick contains flyash, stone waste as Quarry dust & Stone aggregates, Cement (OPC) and water. With the control mix, i.e. above mentioned material mix proportions (table no: 2) were prepared for casting. Where the water reducing agent is added while mixing of materials. 15 percentage of water can be reduced by this additive. Five bricks mould samples were cast having size of 200x100x80mm. (But the inadequacy of standard size (230 x 110 x 75mm) brick mould in factory, while we used 200 x 100x 80 mm size of mould). The manufacturing process of bricks broadly consists of three operations viz. mixing the ingredients in pan mixture, placing of mixed materials in moulds, then the mould has get self compaction by vibratory table and finally molded mixture material can transported to drying / to give covered internal curing into the bricks for a stipulated period as 2 days. The data as test results from the fly ash stone waste brick-block is compared with a standard conventional brick (red brick). For manufacturing fly ash stone waste concrete bricks required machineries are pan mixture and table vibrator with brick size moulds (Rubber or PVC in material) above mentioned apparatuses are enough for fly ash stone waste brick-block manufacturing. This process is like paver block manufacturing in wet process. This is an indigenous low cost machine and can be run by ordinary semiskilled worker. Its production capacity is 3000 bricks per shift. The maintenance cost of whole machinery setup is to low, compared with conventional Fly ash brick making machinery setup.

i. Testing: The casted bricks, cubes and cylinders were subjected to laboratory tests as crushing strength, water absorption, weight density and efflorescence.

A Crushing / Compressive strength test

The specimen is placed in compression testing machine (see figure 4) with 6 mm plywood on top and bottom of it to get uniform load on the specimen. Then load is applied axially. The crushing load is noted. Then the crushing strength is the ratio of crushing load to the area of brick loaded. Average of five specimens is taken as the crushing strength.(see Table no: 1) i.e.,

$$\text{Crushing Strength} = \frac{\text{Crushing Load (N)}}{\text{Area of specimen (mm}^2\text{)}}$$



Fig. 4 : Compression strength testing machine

Flow Chart Diagram for Block Manufacturing Process

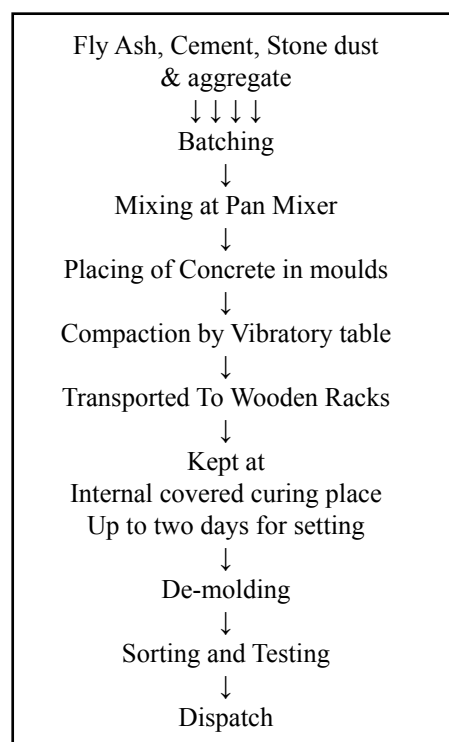
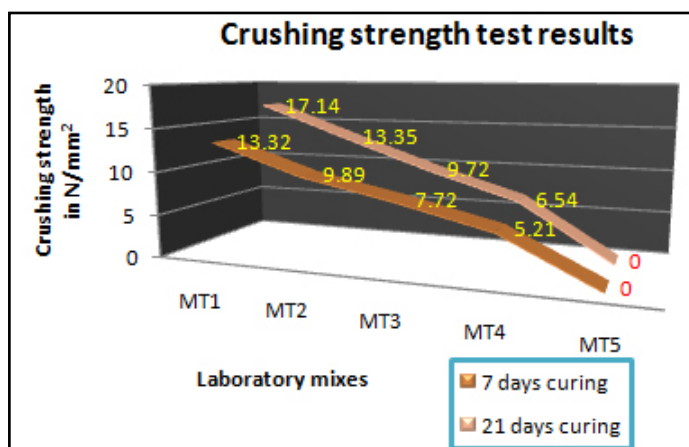


Table 4: Compressive Strength in N / mm² respect to lab mixes & curing days

Lab Mixes	Curing in	
	7 days	21 days
MT1	13.32	17.14
MT2	9.89	13.35
MT3	7.72	9.72
MT4	5.21	6.54
MT5	0	0



Graph 1: Crushing strength (in y-axis) to their (in x-axis) respective laboratory trail mixes on 7 & 21 days curing.

B. Water absorption test

A standard soaking-in-water test can determine the porosity of bricks and blocks, which can then be used as an indication of the potential for the development of problems related to the penetration of salts and other materials into the units, such as salt attack and efflorescence. Water absorption of brick is nothing but the % of water that the brick can absorb when it is placed in water up to 24 hours. Water absorption can be calculated by the formula as

$$\% \text{ of water Absorption} = \frac{[(W2 - W1)/W2] \times 100}{100}$$

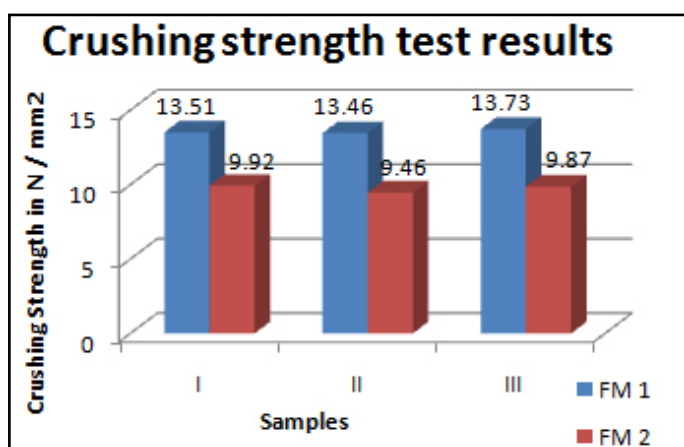
Where, W1 = Dry weight of Sample

W2 = Weight after 24 hrs in water.

Table 5: Crushing Strength* in N / mm² respect to selected mixes

Factory Mixes	Samples			Avg. Strength
	I	II	III	
FM 1	13.51	13.46	13.73	13.57
FM 2	9.92	9.46	9.87	9.75

* - Crushing Strength after Internal covered Curing at Factory



Graph 2: Crushing strength (in y-axis) to Samples in selected mixes (in x-axis)

VI. Economic Feasibility

Table 6: Cost of raw materials for fly-ash and Stone waste brick-block manufacturing

Materials	Cost in rupees per Kg
Fly-ash	1.00
Cement	7.00
Quarry dust	0.30
Stone aggregates	0.40

Table 7: Cost of brick-block by this manufacturing process.

Descriptions	Cost in rupees per Block for	
	FM 1	FM 2
Fly-ash	1.22	1.52
Cement	4.14	3.55
Quarry dust	0.30	0.30
Stone aggregates	0.10	0.14
Chemical additive	0.95	0.91
Machineries setup (pan mixture moulds, Vibratory table and Ex. factory charges)	1.41	1.41
Total Cost per block *	8.42	7.83

* - Total cost per block without loading, unloading and transportation charges.

VII. Result And Discussion

By manufacturing process gives the final product contains more advantages are,

- Both of the selected of factory mixes attained their crushing strengths up to 14 N/mm².
- Both selected mixes results the water absorption limit up to 10 – 20%
- these factory mould blocks are contains their Avg. weight density is 1780 Kg/m³
- Three sides of blocks are in smooth finishing.
- Top surface of the block having good texture design.
- These blocks don't need 6 - 7 days curing after manufacturing.
- The block using masonry wall no need of plastering on both side of wall like Exterior and Internal also.
- Painting is also no need, because coloring pigments can be

- added while manufacturing if need. (see figure: 6)
- Which the manufacturing process helps easily manage the market demand.
 - Low amount of water is to be used while mixing of material.
 - Cost of selected mix Blocks are Rs.7.66 and Rs.6.89/- only.
 - This method of manufacturing process, reduces the investment cost as capital.

And the same time some disadvantages also presents in this block & their manufacturing as followings,

- Handling of these blocks while transportation should carefully. If doesn't care it, the texture surface will be damaged.
- This block made with more cement content, which leads to hydrates more heat from masonry.
- This manufacturing process contains most of the works by man power.
- The blocks will damage or didn't give good finishing, if improper cleanness of moulds & carless demoulding situations.



Fig. 5: Final Product as Block



Fig. 6 : Various colored blocks Some of the Comparison states is shown in table no: 7 for high volume fly-ash & stone waste blocks with Clay bricks (1st class brick).

Table 8: Comparison of fly-ash stone waste bricks with Conventional clay brick

Description	Clay bricks or 1 st class bricks	High volume Fly-ash & Stone waste brick-blocks
Size in mm	215x100x70	200 x 100 x 80
Volume in mm ³	1897500	1600000
No. of Bricks in 1 Cum masonry without mortar joints	505	409
Density in Kg / m ³	1600	1780
Cost in Rupees per 1000 bricks	10000 /-	7660 /-
Compressive strength in Kg / cm ²	70 to 140	100 to 140
Water absorption	20 to 25 %	10 to 20 %
efflorescence	It may be occur depends on soil	Nil
Color	Standard as Red	Any color
Texture	Plain	Various designed textures applicable
Finishing	Smooth	Smooth
Size	Standard	Any size

VIII. Conclusion

Based on this experimental practice on high volume fly-ash and stone waste brick-block is to alternative of conventional brick / blocks consist following observations like,

- In this Proto type experimental practice result as the blocks contain one third volume of (OPC) cement in binder part. This point is notable one, because it is the accelerated material of fly ash's pozzolonic reaction. So, as the cement content must be reduced on further R & D (Research and Development) studies.
- Which the blocks having high volume waste materials as fly-ash & Quarry dust is used, for the purpose of waste material utilization to made new product.
- This method of manufacturing process, initiate the entrepreneurs development as well as reduces the unemployment states..
- The final product contains more structural suitabilities & gives aesthetic appearance also.
- In my point of view, the products cost also acceptable in limit.
- It reduces the density of bricks from 20 (clay bricks) to 13 (Fly-ash & stone waste blocks)

- g) Environmental effects of wastes and disposal problems of waste can be reduced through this practice.
- h) This study helps in converting the nonvaluable waste materials into bricks and makes it valuable.

IX. Acknowledgement

The author thankfully acknowledge to Dr.M.Sivakumar, Principal, Mr.J.Karthick, Head of Department (Civil engg.) in Sree Sowdambika College of Engineering, Chettikurichi-626 134, Virudhunager(Dt), India. Our special credits to Mr.Ramakrishnan (Owner), and Mr.R.Chentil Kumar, Quality Control Manager of Ultra Tech Cobble Paver, Madurai.

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