Study on Compressive Strength Characteristics of Brick with Partial Replacement of Cement and Lime by Using Granite Powder

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Abstract **- The main objective of this paper is to provide an alternative to conventional cement and lime for production of fly ash brick. Two widely used fly ash bricks (fly ash cement brick and fly ash lime brick) were selected for this experimental study. However, the brick specimen of size 230x 110x 90mm was cast for diff mix proportions of raw material for testing. The experimental study was performed in two stages. In first stage, cement partially replace by granite powder in fly ash cement brick. And in second stage, lime partially replace by granite powder in fly ash lime brick. In both stages, replacement of cement and lime by granite powder in range of 0 to 15 % with interval of 5% was done. The compressive strength of fly ash bricks at the age of 7, 14 and 21 days was obtained at room temperature. On studying results, it was found that the maximum compressive strength is obtained at 10% replacement of granite powder in both type of fly ash brick and highest compressive strength was found in fly ash cement brick with 10% replacement of granite powder from overall tested brick. It was concluded that a sustainable fly ash brick can be produced by replacing 10% granite powder, after increasing percentage of granite waste more than 10% strength was decreases in both fly ash brick.**

Index Terms **- fly ash brick, granite powder and compressive strength.**

I.INTRODUCTION

Today's demand is to consider the economic and environmental aspect of waste materials for the selection of construction material. Brick is the main material used in construction of buildings and one of the oldest. The worldwide annual production of bricks is currently about 1391 billion units. These bricks are used for construction of any size of wall in building, floors, cornices, arches and retaining wall. The different types of bricks which can be made from different material are used in construction industry. From that the red clay brick are commonly used in large quantity, nearly 180 billion tone of common burnt clay bricks are consumed annually approximately 340 billion tone of clay soil, about 5000 acres of top layer of soil dug out for bricks manufacture. Because of that, quantity of red clay soil decreases from agriculture land area and the alternate solution for red clay brick used in a construction is fly ash brick which is already used for various purposes in construction. There are two type of fly ash brick used most commonly, first fly ash cement brick, in which cement is main raw material. Cement, in general, adhesive substance of all kinds, but, in narrower sense, the binding materials used in building and construction industry and second one fly ash brick is fly ash lime brick. Also, development of fly ash bricks using waste material is necessary. For wide production and application of these bricks not only technical, economic, and environmental sectors but public education related to waste reusing and need for sustainable development should be done. Fly ash is harmful which is already used in fly ash bricks. Power plants in India produce about 6 million tonnes of fly ash per day or 219 million metric tonnes of fly ash per year. Currently in India only 38.67% of fly ash is utilized in the construction sector for various modes like 25.60% in cement, 9.01% in bricks and tiles, 3.40% in roads and flyovers, and 0.66% in concrete. Used of this fly ash with waste material is best solution for environment problem as well as economical for construction sector. Granite powder is one of the waste materials which can be used in brick

manufacturing. Granite is widely used in construction purposes; both interior, exterior and would be required more as the construction industry is expanding constantly. Granite has to be cut to give a desired shape, which would further be installed as per the constructing needs. This cutting of granite generates a lot of powdered waste. According to the research, nearly one lakh cubic meters of granite powder is generated annually in India and has to be disposed of in landfills and top agricultural soil; because it cannot be discarded as the fact is that they pollute the environment. This is not an eco-friendly solution for the problem caused by granite waste. Granite powder is a non-biodegradable waste that can easily affect the health of humans and animals and is also very harmful to the environment. These granite wastes are an efficient alternate option in the construction industry and a worthy solution for the environmental problems. For manufacturing fly ash bricks, the use of fly ash and granite powder is ecologically advantageous as it helps for saving the environment.

1.1MATERIAL USED

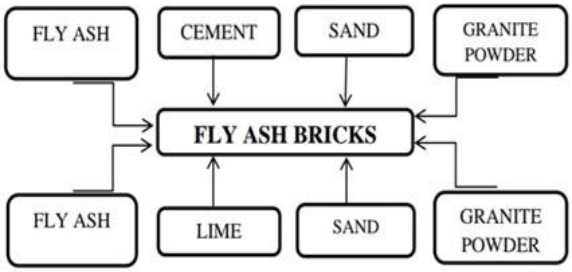


Chart I: flowchart shows the materials used.

The material selection as per IS Codal provision for manufacturing bricks.

Fly Ash- Fly Ash governed by IS 3812 (part I) 2003, The BIS specification for chemical and physical requirement are given in Table 1 &2.

Cement -Physical analysis of ordinary Portland cement as per IS12269 (1987)

1.2 OBJECTIVE

1) To identify the effects of adding waste material on the properties of fly ash bricks mixes such as compressive strength, hardness, and soundness test.

2) To compare the compressive strength of red brick, fly ash cement brick, fly ash lime brick, sample (A) brick (percentage of cements replace by granite powder in fly ash cement brick) and sample (B) brick (percentage of lime replace by granite powder in fly ash lime brick).

3) To investigate the potential use of granite powder in fly ash brick as replacement for cement and lime.

1.3) NEED OF STUDY

The compressive strength, stability and durability of the brick need to be improved by substituting portions of its basic manufacturing materials with other easily available materials, thereby reducing its cost. The high ash content of Indian coals (30% to 40%) is contributing high volumes of fly ash. It is estimated at present nearly 160 million ton of fly ash is produced every year. According to the journal, nearly one lakh cubic meters of granite powder is generated annually in India and has to be disposed of in landfills. Utilization of these wastes in manufacturing bricks is a worthy solution for the environmental problem caused by granite powder.

II. METHODOLOGY

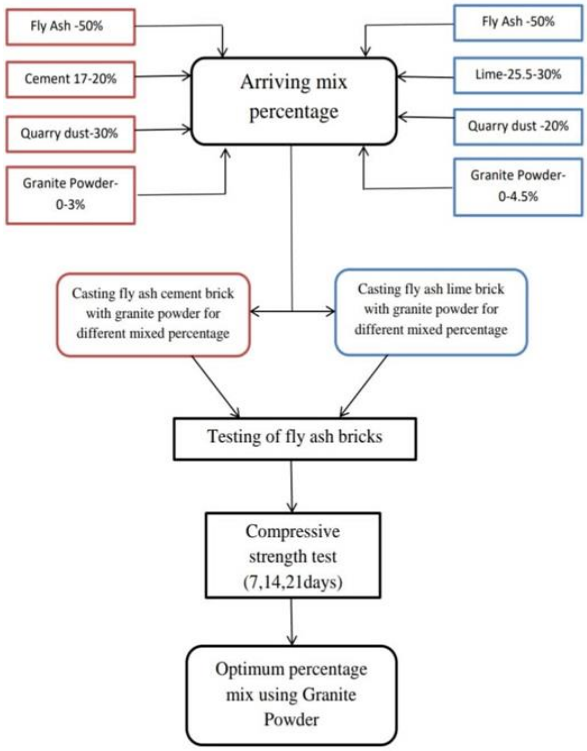


Chart II: Flowchart shows the Methodology

2.1 MIX PROPORTION

Table I: -Various mix proportion of fly ash bricks used

Sample	Fly Ash (%)	Cement (%)	Lime (%)	Quarry dust (%)	Gypsum (%)

Sample-A (GP0)	50	20	-	30	0
Sample-A (GP5%)	50	19	-	30	1
Sample-A (GP10%)	50	18	-	30	2
Sample-A (GP15%)	50	17	-	30	3
Sample-B (GP0)	50	-	30	20	0
Sample-B (GP5%)	50	-	28.5	20	1.5
Sample-B (GP10%)	50	-	27	20	3
Sample-B (GP15%)	50	-	25.5	20	4.5

Table II: - Quantity of Materials used

Sample	Fly Ash (Kg)	Cement (Kg)	Lime (Kg)	Quarry dust (Kg)	Gypsum (Kg)
Sample-A (GP0)	1.815	0.726	-	1.089	0
Sample-A (GP5%)	1.815	0.690	-	1.089	0.036
Sample-A (GP10%)	1.815	0.653	-	1.089	0.073
Sample-A (GP15%)	1.815	0.617	-	1.089	0.109
Sample-B (GP0)	1.815	-	1.089	0.726	0
Sample-B (GP5%)	1.815	-	1.0346	0.726	0.490
Sample-B (GP10%)	1.815	-	0.9801	0.726	0.980
Sample-B (GP15%)	1.815	-	0.926	0.726	1.470

2.2 EXPERIMENTAL PROCEDURE

In order to obtain comparable results, 4 different groups of sample A and sample B were prepared for the tests depending on the amount of waste materials added. The mix proportions were prepared based on the dry weight of the materials. Mixture proportions were mentioned above fly ash brick samples were produced using roller pan mixer (fig I). The raw materials were mechanically mixed for 4-5 min to get a uniform consistency in desired proportion. After dry mixing, water about 8 % weight of total dry mixture weight was added in mixtures for the production wet mixture. Transfer this mix to presses friction screw press 80-120 tons capacity or hydraulic/mechanical press. After presses, bricks are allowed to dry in open air for 24-36 hours (fig II). After that curing is done by spray water on the dried bricks, Bricks are then covered, bricks develop themselves. Test specimens with a dimension 230mm (L) ×110mm (W) ×90mm (H) were produced in a machine.

Figure1 Figure2

2.3 MANUFACTURING PROCESS

Fly ash, lime, cement, sand and granite powder are manually fed into a pan mixer where water is added in the required proportion for intimate mixing. In Sample A brick the proportion of the raw material is in the ratio 50% of fly ash, 30% Quarry Dust and 17-20% cement and 0-3% granite powder and In Sample B brick the proportion of the raw material is in the ratio 50% of fly ash, 20% Quarry Dust, 25.5- 30% lime and 0-4.5% granite powder. The materials are mixed in pan mixture. After mixing, the mixture is conveyed through belt conveyor to the hydraulic/mechanical presses. The homogenized mortar taken out of the roller mixer is put into the mould boxes. Depending on the type of machine, the product is compacted under vibration / hydraulic compression etc. The bricks are dried up under sun from 24 to 48 hours, depending on whether lime route or cement route the dried-up bricks are stacked and subjected for water spray curing once or twice a day, for 7-21 days, depending on ambience. The bricks are tested and sorted before dispatch.

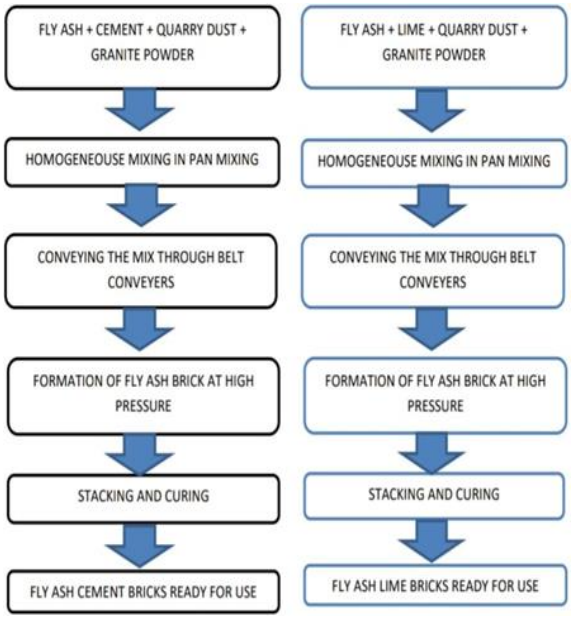


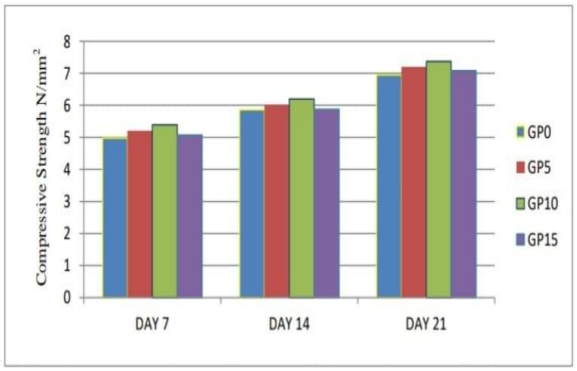
Chart III: Procedure for fly ash bricks

III. RESULT

The compressive strength is the most important index for assuring the engineering quality of a building material because with a higher compressive strength, other properties also improved. The results in table (III) and graph (I) indicated that the variation of average compressive strength of fly ash cement brick using waste granite powder as a partial replacement of cement at 7,14, and 21 days. Similarly, results in table (IV) and graph (II) show fly ash lime brick using granite powder as partially replacement of lime. In table (V) or graph (III) and in table (VI) or graph (IV) show the graph of average compressive strength of day 21 of all bricks sample of both fly ash bricks. This effect is more pronounced for the sampleA3 (GP10) and sampleB3 (GP10) which reaches a peak in compressive strength. The comparison of fly ash bricks, red clay brick and sample fly ash bricks with granite powder show in table (VII) and graph (V). The optimum compressive strength was 7.37N/mm2 which is obtained for the bricks of sampleA3 (GP10).

Table III: -Compressive strength of fly ash cement brick sample at 7, 14, 21 days

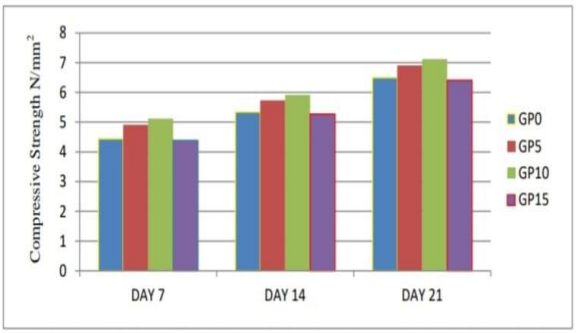
Sample name	Percentage of granite powder in cement	Compressive strength (N/mm2)		
		Day 7	Day 14	Day 21
Sample1(GP0)	0	4.98	5.86	6.95
Sample2(GP5)	5	5.21	6.01	7.20
		5.24	6.04	7.22
		5.18	6.0	7.19
Sample3(GP10)	10	5.39	6.20	7.36
		5.41	6.22	7.38
		5.38	6.19	7.36
Sample4(GP15)	15	5.09	5.90	7.10
		5.06	5.86	7.05
		5.07	5.88	7.08



Graph I: -Compressive Strength for various sample of fly ash cement bricks at 7, 14, 21 days Curing

Table IV: - Compressive strength of fly ash lime brick sample at 7, 14, 21 days

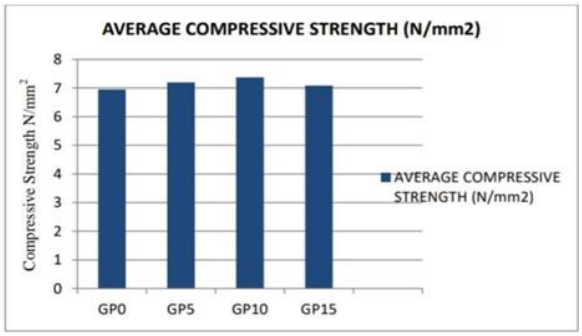
Sample name	Percentage of granite powder in lime	Compressive strength (N/mm2)		
		Day 7	Day 14	Day 21
Sample 1 (GP0)	0	4.44	5.34	6.50
Sample 2(GP5)	5	4.89	5.71	6.90
		4.90	5.73	6.91
		4.93	5.74	6.93
Sample 3(GP10)	10	5.10	5.92	7.10
		5.12	5.93	7.12
		5.14	5.95	7.13
Sample 4(GP15)	15	4.41	5.29	6.45
		4.39	5.27	6.40
		4.37	5.26	6.38



Graph II: -Compressive Strength for various sample of fly ash lime brick at 7, 14, 21 days curing

Table V: Compressive strength of fly ash cement brick increasing percentage of granite powder at 21 days

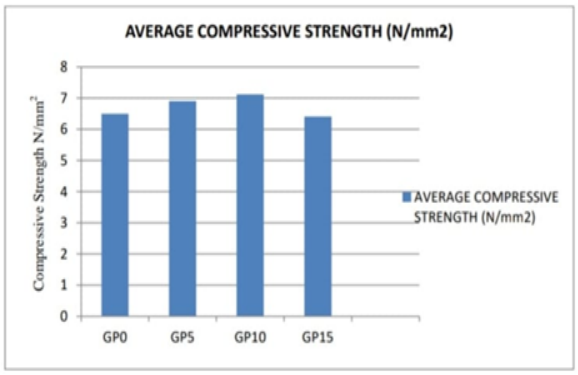
Sample name	Percentage of granite powder in cement	Percentage composition FA:CM:QD:GP	Compressive strength (N/mm2)	Avg. Compressive strength (N/mm2)
Sample 1 (GP0)	0	50:20:30:0	6.95	6.95
Sample 2 (GP5)	5	50:19:30:1	7.20	7.20
			7.22	
			7.19	
Sample 3 (GP10)	10	50:18:30:2	7.36	7.37
			7.38	
			7.36	
Sample 4 (GP15)	15	50:17:30:3	7.10	7.08
			7.05	
			7.08	



Graph III: -Variation in Compressive strength fly ash cement brick with Increase Percentage of granite Powder

Table VI: - Compressive strength at 21 day of fly ash lime brick with increasing percentage of granite powder

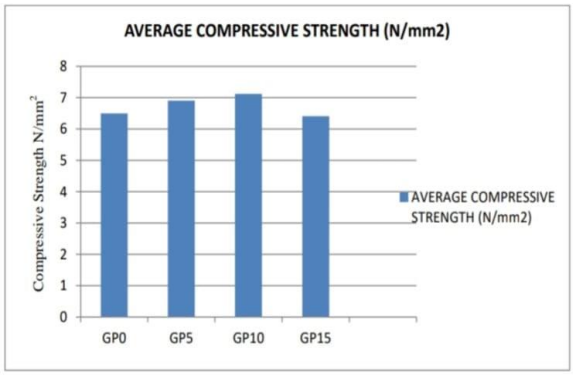
Sample name	Percentage of granite powder in lime	Percentage composition FA:LM:QD:GP	Compressive strength (N/mm2)	Avg. Compressive strength (N/mm2)
Sample 1 (GP0)	0	50:30:20:0	6.50	6.50
Sample 2 (GP5)	5	50:28.5:20:1.5	6.90	6.91
			6.91	
			6.93	
Sample3(GP10)	10	50:27:20:3	7.10	7.12
			7.12	
			7.13	
Sample4(GP15)	15	50:25.5:20:4.5	6.45	6.41
			6.40	
			6.38	



Graph IV: -Variation in Compressive strength fly ash cement brick with Increase Percentage of granite Powder

Table VII: -Comparison of compressive strength of fly ash bricks, red clay brick and samples brick

Sr. no.	Type of bricks	Avg. compressive strength (N/mm2)
1.	Red clay brick	4.56
2.	Fly ash cement brick	6.95
3.	Fly ash lime brick	6.50
4.	Sample A brick	7.37
5.	Sample B brick	7.12



Graph V: Comparison of compressive strength of fly ash bricks, red clay brick and samples brick

IV. CONCLUSION

The following observation concluded from present study:

1. The manufacturing of bricks using fly ash and waste granite powder is environment friendly.
2. The compressive strength test results clearly show that granite powder as a partial replacement of cement and lime has beneficial effects on fly ash bricks.
3. The compressive strength was increase with replacement of granite powder wastes at 10% of cement in fly ash cement brick and this give 6% greater compressive strength comparable to normal strength of fly ash cement brick.
4. Also, compressive strength was increase in fly ash lime brick with replacement of granite powder wastes at 10% of lime and this give 9.5% greater compressive strength comparable to normal strength of fly ash lime brick.
5. Compressive strength of sample A brick (GP10) is maximum from overall tested bricks.
6. Compressive strength is decreases after increasing percentage of granite waste more than 10% in both fly ash bricks samples.
7. Using granite powder in bricks reduces manufacturing cost of brick element.

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