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Experimental Studies on Pond Ash Brick

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Abstract:- Many research studies were carried out for effective utilization of fly ash and pond ash in building industry as it possess suitable pozzolanic properties .They are produced in large quantities during the combustion of coal for energy production and recognized as an environmental pollution. Fly ash and Pond ash utilization in building materials have many advantages like cost effectiveness, environmental friendly, increases in strength and also conservation of natural resources and materials. The Thermal by product such as pond ash and fly ash waste material are effectively utilized in manufacturing of bricks. In this study, various mix proportions were arrived by using materials fly ash, pond ash, lime, gypsum and sand. The microstructure and composition of coal ash brick were studied by using scanning electron microscope (SEM) and X-ray diffraction (XRD) analysis. Experimental investigation was carried out for compressive strength, water absorption, weight density, efflorescence test and IRA.

Keywords:- Fly ash, Pond ash, Water absorption, Compressive strength Weight density, Initial rate of absorption.

I. INTRODUCTION

The combustion of pulverized coal at thermal power plant, the product found is bottom ash or pond ash, fly ash and vapours. This pond ash is the part of residue which is used in particle and collected at the bottom of the furnace. The land disposal of coal ash would required about 1000 km^2 of land to overcome this problem and to encourage the utilization of fly ash and pond ash as an admixture used in construction materials. In this present study, fly ash and pond ash is effectively utilized in manufacturing of bricks. As per Das and Segeran et al [1],in addition to superior conventional properties, fly ash or clay bricks have the advantages of being the usual red color, enhance the acceptance of the product to users. Pond ash is the mixture of bottom ash and fly ash as found in ash disposal ponds at the ash generating units, discussed by sagar et al. Ayoko et al[2], the properties of fly ash products obtained were dependent on quality of ash or coal. As per Masaki et al[3], carried out an experimental investigation to study the feasibility of using fly ash as a fill material for water from retaining structures. As the result of this study, it was found that active earth pressure induced by fly ash mixed with small amount of cement to lower than the conventional sand. Chatterjee et al [4] says fly ash can be effectively used to remove the colour from the textile dying and printing effluents. Tabin rushad et al[5]concluded that compressive strength of brick increased with increase in lime content. Piyush kant pandey and rajkumar agarwal et al [6] concluded that brick manufactured with mixed pond ash of integrated steel plant is cheap, superior structural and aesthetic qualities. In this work, the fly ash and pond ash effectively utilized in making bricks and the experimental studies on strength, weight density, water absorption, efflorescence, scanning electron microscope analysis, X-ray diffraction analysis and initial rate of absorption test were carried out .The test results of coal ash bricks were compared with conventional clay brick and fly ash brick.

II. MATERIALS

The raw materials required for coal ash bricks are pond ash(PA), fly ash(FA), lime(L), gypsum(G)and sand(S).Pond ash is collected from Thermal Power Plant, Mettur (near Salem). The specific gravity of pond ash is 2.25 and the particle size of pond ash ranges between (10-50)µm. Fly ash is obtained from Mettur Thermal Power plant (near Salem).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. Lime is procured from Pollachi. This material activates fly ash and pond ash in mix. As per IS 6932-1973, the minimum 20% CaO content in lime is present for addition in manufacturing of brick. Gypsum is procured from Trichy. It is used to accelerate the hardening process and obtaining the early strength. The local available sand is used to achieve the mix content. As per IS 353:1970, the sand is categorized as Zone

II type. The specific gravity of sand is 2.66. Usage of sand in the manufacturing of brick reduced laminar crack in the mix.

III. METHODOLOGY

The modular brick samples of size 230mm x 110mm x 75mm were casted as per IS 12894-2002 using various mix proportions. The mix proportions are arrived by using fly ash, pond ash, lime, gypsum and sand content. Four mix combinations were arrived by changing the pond ash and lime proportion. The table 1 shows the details of the mix proportions.

Table 1: Details of Mix Proportions

Mixes / Material	I	II	III	IV
Lime	20	18	16	14
Sand	20	20	20	20
Fly ash	35	35	35	35
Pond ash	20	22	24	26
Gypsum	5	5	5	5

CASTING

The required raw materials like fly ash, pond ash, lime, gypsum and sand have to be mixed as per the ratio in pan mixer. These mixed materials are conveyed to the brick mould through the conveyor. After processing, as per required size of bricks were casted and taken in pallet truck for curing purpose. At early stages, bricks were cured by normal water curing and then by sprinkling of water.

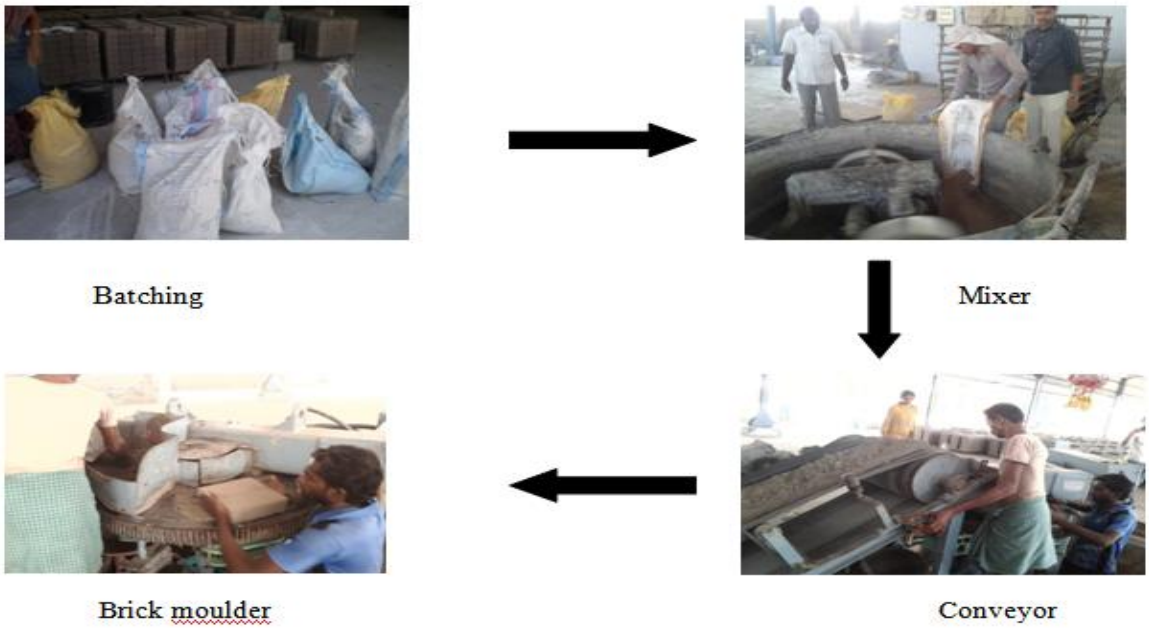

Figure 1: Manufacturing Process of Coal Ash Bricks.

IV. SEM ANALYSIS FOR MATERIALS

A Scanning Electron Microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The figure 2 shows the pictorial view of the texture and porosity of the materials. The microstructure of Fly ash shows the typically well rounded, solid spheres, and the larger particles up to 50 µm. The pond ash image shows the agglomeration texture of Pond ash. The SEM result for Lime shows that there is pores present. The SEM result for Gypsum shows a crystalline structure formation. The micro structure of Coal ash brick powder shows complex formation of molecules indicating no porous formation.

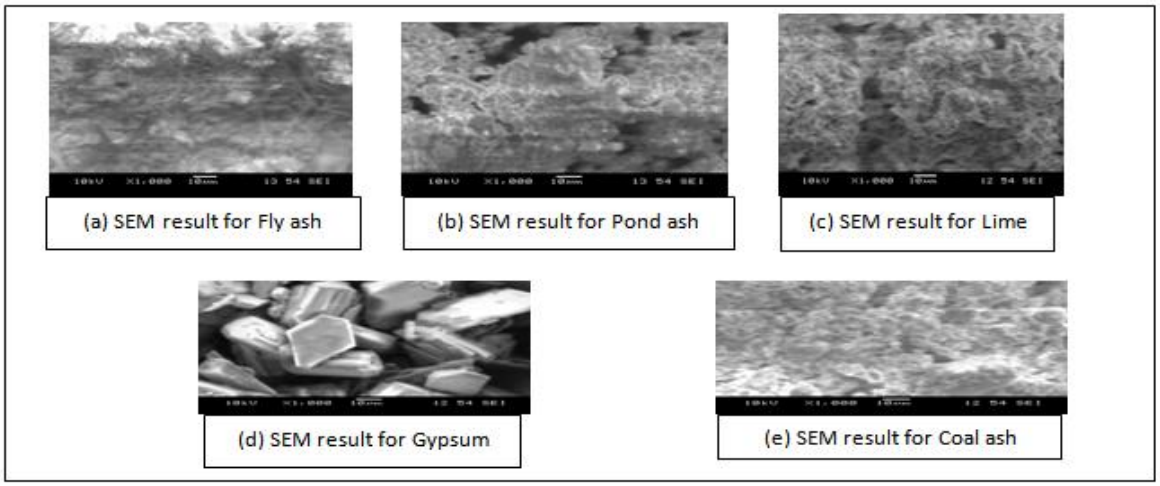

Figure 2: SEM Results of Different Materials.

V. X –RAY DIFFRACTION

X-Ray diffraction analysis is done to obtain the chemical composition of different compounds present in the coal ash brick materials. The setup acquisition parameters consists, Instrument : 6360 (LA); Acc. Voltage : 25.0 kV; Probe current : 1.00000 nA; PHA mode : T4; Real Time : 33.26 sec; Live Time : 26.53 sec; Dead Time : 20%; Counting Rate : 1946 cps; Energy Range : 0 - 26 keV. The figure 2 shows the element mass of the each chemical present in the material. The table 2 shows the chemical compositions of the materials from the obtained X – Ray diffraction analysis result.

Table 2: Test Result for X – Ray Diffraction Analysis.

Materials / Elements	Fly ash	Pond ash	Lime	Gypsum
O	51.09	50.69	34.82	50.03
Al	18.57	18.15	4.69	-
Si	30.84	30.05	7.21	2.61
Fe	-	1.11	-	-
Mg	-	-	4.51	-
Ca	-	-	48.77	21.41
P	-	-	-	1.61
S	-	-	-	24.34
Total	100 %			

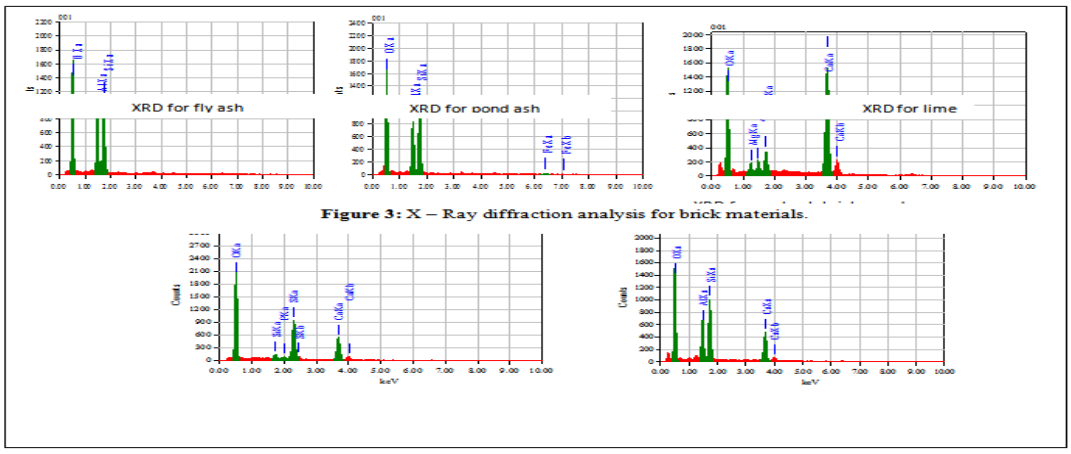

Figure 3: X – Ray diffraction analysis for brick materials.

VI. INITIAL RATE OF ABSORPTION

Sorptivity is a material property that describes the tendency of porous material to absorb and transmit water by capillary suction. This test is an inexpensive, quick and simple one. The test was done by allowing one surface of the specimen to be in contact with 5mm depth of water using a rectangular aluminium support with

two side holes, water of 1-3mm above the whole level allows continuous contact between specimen surfaces. The sides of the specimen are scaled with bitumen to create unidirectional flow through the specimen. The saturation point of each specimen varies. After reaching the saturation point the curves flatten off thus showing an agreement between sorptivity and total water absorption. Sorptivity has an advantage that is shows the total water absorption performance of the masonry brick unit with the mortar. The figure 4 shows the sorptivity result obtained for fly ash, pond ash and clay bricks. The table 3 shows the sorptivity value obtained for fly ash, pond ash and clay bricks.

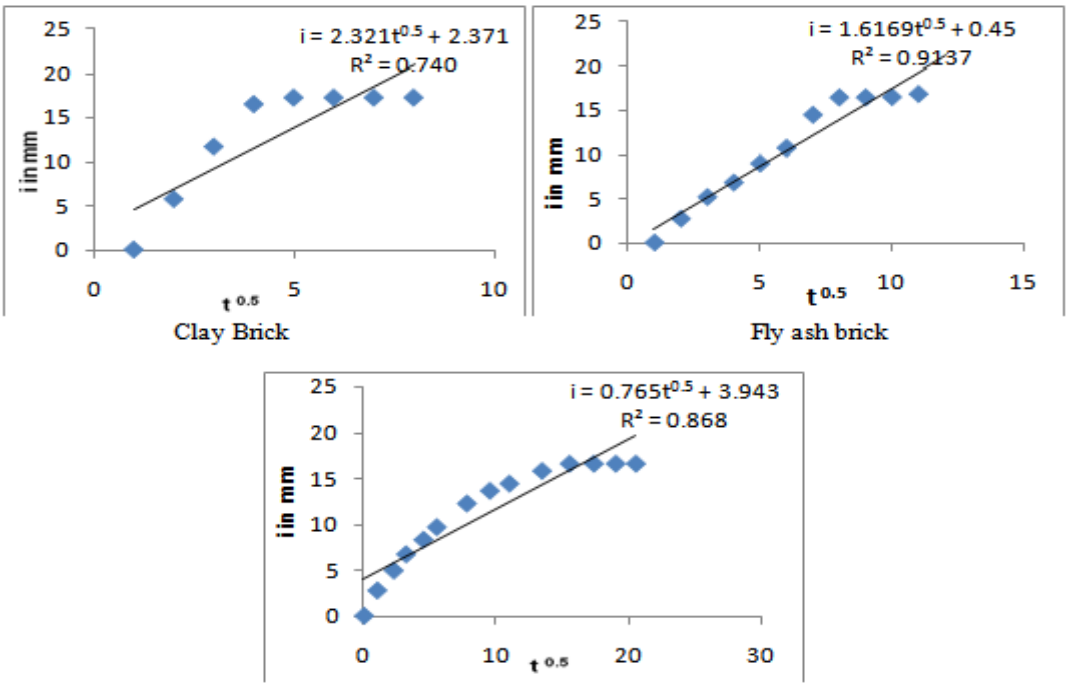

Figure 4: Sorptivity result for Fly ash, Pond ash and Clay bricks**.**

Table 3: Test Result for Sorptivity for Clay Fly Ash and Pond Ash Brick

Brick type	Clay	Fly ash	Pond ash
Time in min	60	300	420
Sorptivity values	2.321	1.616	0.765

The saturation point for clay, fly ash and pond ash is 60, 300 and 420 minutes obtaining sorptivity values of 2.321, 1.616 and 0.765 respectively.

VII. RESULT AND DISCUSSION

The properties of bricks such as compressive strength, water absorption, weight density, efflorescence test were conducted in laboratory. The test results of these properties is calculated and tabulated in table 4. Compressive strength of brick is the ratio between failure loads to cross sectional area of the brick. Load is applied axially at the uniform rate of 14N/mm^2 per minute for the compressive strength calculation. The average compressive strength of brick at 7th, 14th, 28th days is calculated. The Compressive strength value varies from 9.2 to 7.6 N/mm^2 from mix I to IV. All the mixes should satisfy the class designation 7.5. The compressive strength value of mix I is 18% higher than the class designation 7.5. The bricks made of these mixes can be used for framed structures. Weight density of brick is defined as the ratio of weight of the brick to the volume of the brick. Weight density value of mixes varies between 14.53 kN/m^{3}to 15.73 kN/m^3. The mix IV has lower weight density value compared to other mixes. The weight density values are reduced with increasing pond ash content. The self weight of the brick was reduced with increased pond ash content. The water absorption test is carried out by immersing the brick for about 24 hours in portable water and then wiped off with clean cloth for avoiding water dripping then it is weighed to determine the change in the dry weight of the brick. The average water absorption of brick was found to be less than 10%. Water absorption value for mix IV was 10% lower than mix I. This indicates that water absorption value decreases with increase in pond ash content. The soluble salts, if present in bricks, will cause efflorescence on the surface of bricks. For finding out the presence of soluble salts

(Efflorescence test) in a brick, it is immersed in water for 16 hours. It is then taken out and dried in shade. The absence of grey or white deposits on its surface indicates absence of soluble salts for all mixes.

Table 4: Test Result for Properties of Various Mixes

Mixes / Properties	I	II	III	IV
Compressive strength in N/mm^2	9.2	8.7	7.9	7.6
Weight density in kN/m^3	15.72	15.52	15.14	14.53
Water absorption in %	9.16	8.85	8.56	8.34

VIII. CONCLUSION

Based on the experimental investigation the following conclusions are drawn.

1. In future the requirement of this brick will be more because the quantity of pond ash is available enormously at thermal power stations at free of cost.
2. The compressive strength of brick was increased with increase in lime content.
3. Weight density of brick reduced with increase in pond ash percentage.
4. Water absorption value of all mixes has less than 10%. The water absorption value of brick decrease with increase in pond ash content.
5. There is no observation of white patches in all bricks.
6. Sorptivity is used to determine the surface absorption of masonry brick units.
7. The cost is reduced up to 20% than the conventional clay brick manufacturing.
8. Utilization of pond ash and fly ash in brick manufacture can greatly diminish the need for damping the landfills.

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