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Determination of Mechanical Properties of Industrial Ash Brick

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ABSTRACT
The normal conventional clay bricks require more area of top soil to manufacture and its manufacturing potential is low. To solve the above problem and to reduce the pollution "Fly Ash and Pond Ash" materials are used. Sand is replaced by quarry dust because of cost consideration. In this study, fly ash wads partially replaced by pond ash and sand are replaced by Quarry dust. The test was conducted for various mix proportion of pond ash and quarry dust. The properties of coal ash brick like compressive strength, water absorption shape and size, efflorescence, weight density of Industrial ash (I-ash) brick was determined.

Keyword: pond ash, fly ash, quarry dust, compressive strength, water absorption, Efflorescence, weight density

I. INTRODUCTION

Fly ash bricks manufacturing units can be set up nearby thermal power stations .Because the main raw materials Pond ash are generated by thermal power stations in big quantity. Pond ash supplied by thermal power stations at free of cost the entrepreneur has to bare only transportations charges from thermal power stations to the fly ash bricks manufacturing unit.

The awareness among the people is required and also at the same time, the government has to give some special incentives for these types of activities. The technologies are ecofriendly, Reduces solid waste and dust in the nature. Compared to hollow brick and clay brick the cost is reasonable. Technology for construction of wall without cement between the brick has been developed by GODWIN industries, Auto Nagar, Guntur. Construction of wall with these bricks is very easy and cost effective. Technology is indigenously available.

At present an enormous amount of pond ash is being produced by thermal power plants throughout the world. Storage of pond ash requires vast land area and disposal of ash becomes problematic and also it creates environmental hazards. This waste material, used practically in this construction industry will effectively reduce the vast land area occupied for its storage. And this will drastically reduce the various environmental hazards created. Fly ash, Pond ash, Quarry dusts are used to manufacture the I-ash brick at low cost.

II. LITERATURE REVIEW

Gaurav & Jayeshkumar (2013) made a comparative assessment of natural sand and pond ash. The specific gravity, fineness modulus and water absorption of pond ash were compared with Indian Standard values. The density of pond ash value was less compared to natural sand but within the IS code. It was concluded that the natural sand could be replaced by pond ash partially or fully in cement concrete. Vidhya et al (2013) investigated the microstructure and mechanical properties of pond ash brick. The researchers found out that the compressive strength of pond ash brick gets increased with increase in lime content. The density of pond ash brick get reduced with increase in percentage of pond ash. The water absorption value of pond ash bricks was less than 10 %. The initial rate of absorption and sorptivity values of pond ash bricks were lower compared to those of conventional clay bricks. Bharathi et al (2011) studied the engineering properties of pond ash for sustainable concrete production. Coal ash material is suitable for road and embankment works and also proves economical by partial replacement of cement and sand. Coal ash material shows better possibilities in geotechnical applications and specifications irrespective of its material properties. Henry et al (2009) studied the environmental values of fly ash bricks and compared the same with that of conventional clay bricks. The greenest fly ash brick mitigates air pollution and global warming problems caused by using fuel in kiln in the manufacturing of conventional clay bricks. Class C fly ash bricks represent excellent structural properties including compressive strength, flexural strength, shear strength, bond strength and freeze-thaw resistance. The study concluded that the long-term strength of fly ash is derived from carbonation caused by CO2 in the atmosphere. Rafat (2003) conducted an experimental study on the effect of fine aggregate replacement with Class F fly ash. Tests were conducted to determine properties of fresh concrete and its strength on five different percentages of fly ash replacing fine aggregate. The results showed that the addition of fly ash improves the strength properties of concrete. The research concluded that the maximum compressive strength and split tensile strength were observed with 50% replacement at all ages and Class F fly ash could be used in structural concrete effectively.

2.1 Qualities of Brick

- The brick should be of standard nominal sizes. Bricks should be free from cracks.
- Brick should be uniform in shape and should be of standard size.
- Bricks should be homogeneous and free from voids and grits.

- Brick should not absorb water more than 20 % by weight when immersed in cold water for 24 hours.
- Brick should have low thermal conductivity. Brick should give clear ringing sound when struck with each other.
- Brick should be sufficiently hard. No impression should be left on brick surface, when it is scratched with finger nail.
- Bricks should not break when dropped flat on hard ground from a height of about one meter.

2.2 Advantages of I - Ash Brick Over Conventional Brick

The I -ash bricks have the following advantages:

Reduction in air pollution

Much fossil fuel is used in heating clay bricks in kilns. Burning such fuel generates air pollution and greenhouse gas (CO_2), contributing to global warming. By manufacturing coal ash bricks (at room temperature) instead of clay bricks (at over 2,000^o F), emission of air pollutants and greenhouse gas is avoided at brick plants, which helps to reduce air pollution and global warming. More on the environmental benefits will be addressed later in this document.

Use less energy

Much energy is consumed in heating clay bricks in kilns. By using a I - ash brick instead of clay bricks, much energy is saved in brick manufacturing. Details on energy saving will be addressed later in this document.

Cost less to produce and save in construction

I - ash bricks are at least 10-15% less than conventional clay bricks. Due to the uniform shape and size of the coal ash brick, it saves labor in laying bricks by about 15%. This translates into an estimated 7 percent reduction in labor cost in laying each brick, which is quite substantial.

Cleans indoor air

Due to the foregoing, the coal ash brick is not only a low-cost, high quality brick; it is also the "Green brick" of the future. Widespread use of the Green brick in the future would contribute not only to lower construction cost for housing but also to a cleaner and healthier environment

III. EXPERIMENTAL INVESTIGATION

3.1 Materials Used

Fly ash and pond ash was produced from Mettur thermal power plant, Tamil Nadu, India. Cement was used is Ordinary Portland Cement with 43 grade. The chemical composition of fly ash, pond ash and cement is given in Table 1.

Table 1 Chemical composition of fly ash, pond ash and cement

S. No	Content	Compositions in Percentage		
		Fly ash	Pond ash	Cement
1	Silica	29.51	29.76	22
2	Iron oxide	-	1.43	3
3	Alumina oxide	36.34	34.29	5
4	Lime	-	-	62
5	Calcium sulphate	-	-	4
6	Magnesia and Sulphur	-	-	2

Locally available Lime and Quarry dust is collected. Lime is an important constituent in brick, having CaO greater than 20 % was used in the preparation of test specimens. Potable water was used for brick manufacturing and curing. The properties of the quarry dust are given in Table 2.

Table 2 Properties of Quarry dust

S. No	Properties of Quarry Dust	Value
1	Specific gravity	2.167
2	Co-efficient of uniformity	26.50
3	Co-efficient of Curvature	0.91

Accelerator:

Accelerating admixture are added to increase the rate of early strength development in concrete to

- The period of curing is reduced.
- The structure can be placed in service in advanced time.
- The removal of formwork is earlier.
- The structure can be placed in service in advance time.
- The acceleration admixture can be used in emergency repair work.

Some of the accelerators produced these days are so powerful that it is possible to make the cement set into stone hard in a matter of five minutes or less.

3.2 Mix Proportion

The specimens are casted after finding the mixing proportions from the standard sample. There is no specific method to find out the mix design using I - ash brick materials. The method adopted for the design of conventional bricks mixes is not applicable to coal ash brick. By trail and error process mix proportions are arrived for various samples. Table 3 shows the mix proportion for casting a I - ash bricks.

Table 3 Details of various mix proportions for I – ash bricks

S. no	Percentage					Accelerator (5% of wt of cement)
	Fly ash	Pond ash	Lime	Quarry dust	Cement	
1.	40	42	12	4	2	0.15
2.	40	40	12	6	2	0.15
3.	40	38	12	8	2	0.15
4.	40	36	12	10	2	0.15

3.3 Casting of test Specimens

3.3.1Pan Mixer

A sturdily machine constructed with heavy rollers to grind and mix material thoroughly. Drive through quality worm reducing gear box. Changeable bottom gear plates with scrappers fitted with TC tips. Easy bottom loading mechanism with rap pinion door arrangement. Pan mixer is used to mix the all ingredients with uniform mixing. Then the mix is homogeneous. Figure 1 shows the pan mixer.

Figure 1 Pan mixer

3.3.2 Conveyor

Frames and intermittent bins are fabricated sturdily. The fly ash mix can be regulated according to the speed of the brick making machine. Nylon with rubber top conveyor belts is fixed between pan mixer and brick moulder. It acts as a friction less idlers. Figure 2 shows the belt conveyor.

Figure 2 Conveyor

3.3.3 Brick Moulder

It is a hydraulically operated, automatic and controlled by electronic circuits. The electronic circuit is self diagnosing. Brick making machine develops 30 T of compressive force over the bricks uniformly to hold pressure for the required time allowing the material to flow and form. The machine structure is designed to take up heavy cyclic loads. The compressive ratio (1:1.6- brick height: filling height) can be varied infinitely within the limits of the moulds. Size of moulds can be fitted with maximum size 230mm x 110mm x 70mm. Monogram on the brick can be embossed. Efficient water cooling system is to ensure the continuous running of the machine. Figure 3 shows the brick moulder. The bricks are handled by pallet truck for easy transportation of coal ash bricks.

Figure 3 Brick Moulder

3.4 Curing of I- ash bricks

I-ash brick should be cured 28days. In this first three days bricks should not kept in direct sunlight. This is done to avoid hair cracks in bricks. Then it is kept in ordinary conditions and cured.

3.5 Testing of Bricks

The following are the various tests conducted on the I-ash bricks.

1. Compression test

2. Water absorption test

3. Shape and size test

4. Efflorescence test

5. Weight density of brick

3.5.1 Compression Test

Compression test is the most common test conducted on brick. The brick is placed with flat face horizontally placed carefully centered between the plates of compression testing machine. Load is applied uniformly. The load is noted when the brick failed or crushed. The compressive strength of the brick is calculated by ultimate load to bed surface area of the brick. The above observations are tabulated and calculated average strength of I-ash bricks. Figure 4 shows the compressive strength test.

Figure 4 Compressive strenght test

3.5.2 Water absorption test

The completely dried bricks are immersed in clean water at a temperature of 27° C for 16 hours. The brick is removed and wiped out of a trace of water with a damp cloth and weighted within 3 minutes. The above procedure is repeated on a fresh brick and all observations are tabulated and average percentage water absorption is worked out. The water absorption was calculated by the ratio of difference in weight of the brick to original weight of the brick.

3.5.3 Shape and size test

In this test, a I-ash brick closely inspected. Its shape is truly rectangular with sharper edges. For this purpose, 20 bricks of selected in random manner and tested the size of the brick. The standard size is checked 230mm x 110mm x 70mm and all bricks are maintained the standard size.

3.5.4 Efflorescence test

After 24 hours I-ash bricks immersed in water, it is taken out and allowed to dry. The absence of grey or white deposits on its surface indicates absence of soluble salts. As the result after immersing bricks in water for 24hours, there is no presence of white deposits over the brick.

3.5.5 Weight density test

The weight density of the I-ash brick is calculated by the ratio of weight of the coal ash brick to volume of the brick. The weight density of the brick is measured by kN/mm^3.

3.6 Result and Discussion

Table 4 shows the test result of compressive strength, water absorption and weight density of the I-ash brick with various mix proportion.

Table 4 properties of I-ash bricks

Sample	Compressive strength N/mm^2	Water absorption In percentage	Weight density kN/m^3
I	5.50	13.00	12.37
II	4.03	12.50	12.88
III	3.79	11.40	12.64
IV	3.50	10.00	13.73

From the result compressive strength of the bricks various from 5.50 N/mm2 to 3.50 N/mm2 and water absorption varies from 13 % to 10 23 % and weight density of the brick is varies from 13.73 kN/m3 to 12.37 kN/mm3. The Quarry dust percentage value is increased in mix proportion the compressive strength decreased. The weight density value in coal ash brick decreased with increasing the pond ash percentage is increased in mix proportion. By using this i-ash bricks, the self weight of the wall element decreased compared to the conventional clay brick.

IV.CONCLUSION

Pond ash is partially replacing by fly ash material. Quarry dust is replacing material of sand. Pond ash and quarry dust is industrial waste material. By increasing the ratio of Quarry dust, the compressive strength of the brick is getting reduced as 5.5 N/mm² to 3.5 N/mm². The weight density value of Mix 1 is reduce 7 % than Mix 4. All mix combinations of I-ash bricks should possesses the compressive strength of brick greater than 3.5 N/mm². So, all types of mix combination are used for load bearing structures. When compared to clay bricks 20 % of cost is reduced using these waste materials. The polluting materials like pond ash and quarry dust are effectively used in manufacturing of I-ash bricks.

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