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UTILIZATION OF WASTE FOUNDRY SAND IN FLY ASH BRICKS

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***Abstract*—** The fast and continuous technological development has led to enormous amount of waste, the accumulation of waste which is an environmental concern. The demand for natural sand in the construction industry has increased a lot, resulting in the reduction of availability of natural sand resources. Natural sand deposits are being depleted and causing serious threat to environment as well as the society. In this situation research began for inexpensive and easily available alternative material to natural sand, a sincere attempt has been made in choosing waste foundry sand as an alternative & as a partial and full replacement of conventional sand in the Fly ash bricks as well as This paper presents Fly Ash brick properties and comparative study between fly ash brick & clay brick, manufacturing process material required for preparing the fly ash bricks as per Indian standard code provisions, inspection and quality control. The textures of the bricks with Fly Ash were very similar to that of clay bricks; the sample with the additive could have practical Implications as a means of recycling and for achieving cost savings in brick production. The absorption coefficient, shape and size, density, weight, porosity, thermal conductivity and compressive strength of Fly Ash bricks Compare with normal clay bricks that delivered good results. From the present study, it can be concluded that Fly Ash bricks used as an alternative to clay bricks. The strength property are assessed and is compared with the clay bricks and Fly ash bricks. When compared with clay bricks 28 days Compressive strength of fly ash Bricks is 5% more. Water absorption capacity of fly ash brick is less by 0.8% and, Efflorescence for fly ash Bricks is Nil.

Keywords: Waste Foundry Sand (WFS), fly ash bricks, compressive strength.

Introduction –

A.Foundry sand- Foundry sand is high quality silica sand that is a by-product from the production of both ferrous and nonferrous metal castings. Foundry sand used for the centuries as a moulding casting material because it's high thermal conductivity. When sand can no longer be reused in the foundry, it is removed from the foundry and is termed "waste Foundry Sand". Foundry sand production is nearly 6 to 10 million tons annually. The raw sand is normally of a higher quality than the typical bank run or natural sands used in fill construction sites. The sands form the outer shape of the mould cavity. These sands normally rely upon a small amount of betonies clay to act as the binder material. There are two basic types of foundry sand available, green sand (often referred to as molding sand) that uses clay as the binder material, and chemically bonded sand that uses polymers to bind the sand grains together. Green sand consists of 85-95% silica, 0-12% clay, 2-10% carbonaceous additives, such as sea coal, and 2-5% water. Green sand is the most commonly used molding media by foundries. Green sands also contain trace chemicals such as MgO, K2O, and TiO2. Chemically bonded sand consists of 93-99% silica and 1-3% chemical binder. Silica sand is thoroughly mixed with the chemicals; a catalyst initiates the reaction that cures and hardens the mass. There is various chemical binder systems used in the foundry industry. The most common chemical binder systems used are phenol-urethanes, epoxy-resins, fury alcohol, and sodium silicates.

Figure.1 Waste foundry sand

B. Fly Ash -Fly ash is the finely divided mineral residue resulting from the combustion of powdered coal in thermal power generating plants. The products formed during the combustion of coal are bottom ash, fly ash and vapor. Fly ash which tries to escapes with the combustion gas from the boiler is collected by either mechanical or electro static precipitator. Fly Ash is an excellent resource material for construction industry. Bureau of Indian standard BIS-1489 suggested that fly ash up to 35% by mass of cement conforming to BIS-3812 can be used in the manufacture of Portland pozzolanic cement (PPC). Also, IS 456-2000 suggested that up to 35% by mass of cement can be replaced with fly ash in RCC works. The Central Public Works Department, in its circular dated 13.05.2004, permitted to use fly ash in Ready Mixed Concrete (RMC). Fly ash is currently utilized in variety of applications such as Cement manufacture, concrete mixes, fly ash bricks/blocks, light weight aggregates, cellular light weight concrete blocks, autoclaved aerated concrete blocks, roads/embankments etc.

Figure.2 Fly ash

C. Fly Ash Brick- Fly Ash Bricks are machine made bricks manufactured by hydraulic or vibratory press. Raw materials required for manufacturing Fly Ash Brick are Fly Ash (by-product of thermal power station), hydrated lime, Gypsum, locally available sand/stone dust and water. Ordinary Portland cement can also be used in place of hydrated lime and gypsum. Raw materials in the required proportion are mixed in the pan mixer to have a semi dry uniform mix. Semi dry mix is placed in the moulds of hydraulic/vibro-press. Molded bricks are air dries for one or two days in a shed depending upon the weather conditions and then water cured for 28 days. The brick thus produced are sound compact and uniform in shape. These are produced with or without fog and are uniform in shape and size and therefore requires less mortar in brick work. These bricks are environmental friendly also. The quality of Fly Ash bricks depends on following factors

- Quality of Raw materials
- Proportioning of Raw materials
- Handling and mixing of Raw materials
- Handling and Pressing of mix
- Curing Period
- Proportioning of Raw materials is an important aspect for making desired quality of Fly Ash brick.

Figure.3 Fly ash bricks

D. Objectives

1) The main objective is to compensate the scarcity of natural sand.
2) Used foundry sand as an alternative for conventional sand?
3) To economies the cost of construction works.
4) Strength comparison of clay bricks and fly ash Bricks.
5) Deciding suitable percentage of waste Foundry sand as an alternate for conventional sand

II. METHODOLOGY

Following sequence showing Methodology for the study is shown below

1. Raw Materials Procurement (Cement, Sand, Fly ash, Waste Foundry sand)
2. Physical, Chemical tests on Raw Materials
3. Preparation of Trail Mix
4. Fixing W/c Ratio for Desired Mix
5. Casting of fly ash Bricks
6. Curing of fly ash Bricks
7. Testing of fly ash Bricks
8. Results and Comparison with clay brick
9. Conclusion

Tests on Conventional and Waste Foundry Sand Tests conducted on the Conventional and waste foundry sand are as follows:-

1. Silica Content
2. Fineness Modulus
3. Specific gravity
4. Bulking
5. Bulk Density

A. Silica estimation in Conventional and waste Foundry Sand

Weigh accurately 0.5 g of the finely ground test sample in a crucible. Add 3 to 4 g of anhydrous fusion mixture and mix thoroughly. Heat the crucible gently at first and finally at 950° C to 1000°C for at least half an hour with occasional swirling of the melt with platinum tipped tongs the lid into a platinum dish containing 75 to 100 ml of dilute hydrochloric acid (1: 2) and 2 drops of dilute sulphuric acid (1: 1). Cover the dish with the watch glass. When the reaction ceases, wash the crucible and the lid thoroughly with water. Evaporate the solution over a steam bath until the smell of hydrochloric acid is no longer detected. Finally cover the dish with the watch glass and bake the mass for an hour in an air oven at 105 to 110°C. Cool and digest the contents of

platinum dish with about 50 ml of dilute hydrochloric acid (1:2). Filter through fine textured filter paper. Transfer quantitatively all the residue by hot water to the filter paper. Wash the residue five times with hot dilute hydrochloric acid and then with hot water until free from chloride. Preserve the filtrate and washings in a 500 ml beaker for the subsequent determination to get a clear melt. Cool and observe that a transparent mass is obtained. Place the crucible and residual silica. Ignite the paper with the residue in a weighed platinum crucible raising the temperature gradually and finally at 950" to 1000°C for 30 minutes. Cool in desiccators and weigh. Moisten the residue with a few ml of water; add 1 drop of dilute sulphuric acid and 10 ml of hydrofluoric acid. Keep the crucible covered at room temperature for 10 minutes. Then remove the lid and place the crucible on a sand bath for evaporation and continue up to copious fuming. Cool the crucible, add further 5 ml of hydrofluoric acid and repeat the process. Lastly, drive out all the acid to obtain a dry residue. Finally, ignite the residue at 1000°C for 30 minutes. Repeat heating, cooling and weighing until constant mass is obtained.

B. Fineness modulus

Fineness modulus is an empirical factor obtained by adding the cumulative percentage of aggregate retained on each of the standard sieves ranging from 4.75 mm to 150 micron and dividing this sum by 100. The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which we call gradation. The fine aggregates generally used normally ranges from size of 4.75 mm to 150 micron and the fraction of particle between those sizes is usually termed as Fine Aggregate. The size 4.75 mm is a common fraction appearing both in coarse aggregate and fine aggregate.

C. Bulking

The volume increase of fine aggregate due to presence of moisture content is known as bulking. Fine sand bulks more as compared to coarse sand. Extremely fine sand particularly the manufactured fine aggregate bulks as much as about 40%. Fine aggregate do not show any bulking when it is absolutely dry or completely saturated. The moisture present in aggregate forms a film around each particle. These films of moisture exert a force, known as surface tension, on each particle. Due to this surface tension each particles gets away from each other. Because of this no direct contact is possible among individual particles and this causes bulking of the volume. Bulking of aggregate is dependent upon two factors they are Percentage of moisture content and Particle size of fine aggregate. Bulking increases with increase in moisture content up to a certain limit and beyond that the further increase in moisture content results in decrease in volume. When the fine aggregate is completely saturated it does not show any bulking. Fine sand bulks more as compared to coarse sand, i.e. percentage of bulking in indirectly proportional to the size of particle. Due to bulking, fine aggregate shows completely unrealistic volume. Therefore, it is absolutely necessary that consideration must be given to the effect of bulking in proportioning the concrete by volume. The apparatus required for the Bulking experiment are 250 ml measuring cylinder, weighing balance etc.Fill a sample of moist fine aggregate (sand) into a measuring cylinder in the normal manner. Note down the level, say h1.Pour water into a measuring cylinder and completely cover the sand with water and shake it. Since the volume of the saturated sand is the same as that of the dry sand, the saturated sand completely offsets the bulking effect. Note down the level of sand, say h2.Subtract the initial level h1 from final level h2 (i.e. h2-h1), which shows the bulking of sand under test.

A. Manufacturing of fly Bricks Wooden Mould used for the preparation of Fly Ash Brick and is of Non-Modular size 230×110×75(mm) and Considered weight of one Fly Ash Brick is 3.5Kg.

B. Composition of Fly Ash Brick

1. Composition of Fly Ash Brick (1:4:5) is kept as shown:-
2. Cement (53 grade) -10%
3. Sand (Conventional) waste Foundry sand (Non conventional)- 40% Fly ash- 50%

C. Preparation of mix for casting of fly ash Bricks

1. After adopting suitable water binder ratio, casting of fly ash Bricks are started
2. First Fly Ash and sand is mixed in pan-mixture and then cement is added into pan-mixture to have uniform dry mixture.
3. After getting the uniform dry mixture, then water is added to dry mix as per w/c ratio and it is mixed uniformly.
4. The mixing method adopted is of Hand mixing.

D. Casting of fly ash Bricks:

1. The prepared mix is then transferred into the wooden Moulds and the mix is subjected to tamping with the help of rod.
2. Once the bricks are taken out of the mould, they are air dried for about 1-2 days.

E. Curing of fly ash Bricks:

1. After casting, the fly ash Bricks are dried for 1-2 days.
2. Then the bricks are kept for curing for about 3,7 and 28 days.

F. Frequency of Sampling:

- Total of 25 fly ash bricks were casted

V. TESTSON FLYASH BRICKS

Three tests are conducted on the prepared Conventional and Non-Conventional Fly Ash Bricks. They are:-

- Compressive strength test The dimensions of specimen shall be measured to the nearest 1 mm. The number of specimens for the test shall be selected according to IS 5454 : 1976.Apparatus required for the test are compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which coincides with the centre of the plate, shall be used. Place the specimen with flat faces horizontal and between the two plywood sheets of same length and breadth and carefully centered between plates of testing machine. Apply load axially at a uniform rate of 140 kg/cm2/min till the failure occurs and note the maximum load at failure. The load at failure shall be maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine. In place of plywood sheets plaster of Paris may be used to ensure a uniform surface for application of load.

- Water Absorption Test Water absorption test is done to determine the water absorbing capacity of Conventional and Non-Conventional Fly Ash Brick. To determine the percentage of water absorption of bricks. Apparatus used for this test are sensitive balance, oven. Dry the specimen in a ventilated oven at a temperature of 105 to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (M1). Specimen warm to touch shall not be used for the purpose. Immerse completely dried specimen in clean water at a temperature of 27 f 2°C for 24 hours. Remove the specimen and wipe out any traces of water with a damp cloth and weigh the specimen. Complete the weighing 3 minutes after the specimen has been removed from water (M2). Water absorption, percent by mass, after 24-hour immersion in cold water is given by the following formula:

- Efflorescence test Efflorescence is the usual terms for deposit of soluble salts, formed in or near the surface of a porous material, as a result of evaporation of water in which they have been dissolved. Usually sulphate of magnesium, calcium, sulphate and carbonate (and sometimes chloride and nitrates) of sodium and potassium are found in efflorescence. Apparatus required for the efflorescence test is a jar containing distilled water to completely saturate the specimen in water. Place the end of the bricks in the dish, the depth of immersion in water being 25 mm.. Place the whole arrangement in a warm well ventilated room until all the water in the dish is absorbed by the specimens and the surplus water evaporates. Cover the dish containing the brick with suitable glass cylinder so that excessive evaporation from the dish may not occur. When the water has been absorbed and bricks appear to be dry, place a similar quantity of water in the dish and allow it to evaporate as before. Examine the bricks for efflorescence after the second evaporation and report the results as:
  1. When there is no perceptible deposit of efflorescence it is reported as Nil.
  2. Not more than 10% area of the brick it is reported as Slight.
  3. Covering up to 50% area of the brick, it is reported as Moderate.
  4. Covering 50% or more but unaccompanied by powdering or flaking of the brick surface, then it is reported as Heavy.
  5. When, there is a heavy deposit of salts accompanied by powdering and/or flaking of the exposed surfaces, and then it is reported as Serious.

VII. CONCLUSIONS

A. When compared with clay Bricks it is observed that :-

1. 28 days Compressive strength of fly ash brick Bricks is 7% more.
2. Water absorption capacity of fly ash brick is less by 0.6%.
3. Efflorescence for fly ash Bricks is Nil.

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