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Strength Characteristics of Bricks Using Composite Materials

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Abstract - *An experimental investigation has been carried out to study the feasibility of producing bricks from Sewage Sludge and Industrial Waste materials such as Fly Ash and Bottom Ash. In order to study the various engineering properties of bricks, a total of 15 numbers of brick specimens of 210 x 110 x 80 mm size were prepared in two series by combining Sewage Sludge, Fly Ash and Bottom Ash in different proportions. The brick specimens were then air dried and Each brick series was fired at 900°C, 1000 °C, 1100 °C, and 1200°C., and tested for Compressive Strength in Fly Ash mixed brick are 3.8%, Bottom Ash mixed brick are 3.9%, and Composite brick are 3.9%. Water Absorption test for Fly Ash mixed brick are 15%, Bottom Ash mixed brick are 18.8%, and Composite bricks are 15.9%. Efflorescence and Weight Density as per IS 3495 code procedure. Test results obtained in the present investigation indicate that it is possible to manufacture good quality bricks using locally available Sewage Sludge by suitably adding either Fly Ash and Bottom Ash, bricks can be used in lieu of conventional burnt clay bricks or pressed type water cured cement fly ash bricks presently in use for various construction activities across the country. The further work of phase II work is comparative study on Sewage Sludge brick and other industrial waste.*

Key Words: Fired bricks, Fly ash, Bottom ash, Sludge ash, Waste material

1. INTRODUCTION

Bricks are a widely used construction and building material around the world. They are the chief constituent of masonry construction. Fired Bricks are used for masonry as it can withstand a large amount of load. Bricks chiefly constitutes of clay, alumina, shale and sand. In this thesis, the clay content is partially replaced with various ratios of following composite materials Fly Ash, Sewage Sludge and Bottom Ash. These materials are chiefly waste materials and dumped in a large quantity. The usage of these materials is relatively low compared to their wastage. By more usage of these materials, the waste levels are reduced. And it will be a result in supplementary convention for clay in Bricks.

The Bricks are first made by mixing Fly Ash, Sewage Sludge and Bottom Ash individually with clay. The Bricks are made and are tested for their strength at various ratios. The ratio levels taken are 5%, 10%, 15%, 20% for replacement of clay. After the tests are made on the Bricks, a new set of Bricks are made with a composite mixture of Fly Ash, Sewage Sludge and Bottom Ash with partial replacement of clay in the same above stated ratios and then burned. Then the bricks are tested for their strength.

2. MATERIAL PROPERTIES

2.1 Brick

Fired brick has most numerous types and are laid in courses with various patterns known as bonds and it also known as brickwork, and mortar is used to hold the brick to make the durable structure. Brick are produced in numerous classes, types, materials, and sizes which vary with region and time period, and are produced in bulk quantities.

Table -1: Ingredients of brick

Ingredients	Percentage (by weight)
Silica (sand)	50% to 60%
Alumina (clay)	20% to 30%
Lime	2 to 5%
Iron oxide	≤ 7%
Magnesia	less than 1%

Fire bricks are the most stronger and durable building material and it also known as artificial stone and have been used since circa 5000 BC. Fired bricks are burned in a kiln which makes them durable. The most common and economical method is soft mud method. The raw clay, is mix with 25–30% of sand to reduce shrinkage. The clay is first ground and mixed with water to the desired consistency. The clay is then pressed into steel moulds with a hydraulic press. The shaped clay is fired ("burned") at 900–1000 °C to achieve strength. The standard size of brick in India is set at 228mm × 107mm × 69 mm and 9in × 4¼in × 2¾ in. The size of brick varies for various countries and also for various purposes. Some special sized bricks are made with various shapes. Hence this results in varied brick sizes.

2.2 Clay

Clay was the easily available natural material in the world, to make bricks, the clay must possess some specific properties and characteristics. Such clays must have plasticity which permits them to be shaped or moulded when mixed with water. Clay are must be air dried strength to maintain their shape after forming. The clay particles are combined together when the temperature is increases. The manufacturer

minimizes variations in chemical compositions and physical properties mixing clays from different sources and different locations in the pit. Pits are having variation in chemical composition, and it may compensated with manufacturing process. As a result, brick from the same manufacturer will have slightly different properties in subsequent production runs. Further,

2.3 Fly ash

Fly ash, is produced from the burning of coal and it is also named flue-ash, It is the residue generated in combustion, and comprises the fine particles that rise with the flue gases. Based on the source the fly ash varied considerably but all the fly ash includes some amount of silicon dioxide (SiO_2) and calcium oxide (CaO).

Fig -1: Fly ash

Class F fly ash and Class C fly ash are the two main classes of fly ash as per the ASTM C618 The amount of calcium, silica, alumina, and iron content in the ash is main difference. The chemical properties of the fly ash are based on the chemical content of the coal burned Fly Ash Brick contains up to 50% Class C fly ash. Fly Ash has been chiefly dumped until the research made on Fly Ash revealed the properties to be used in construction works. It was chiefly used as partial or full replacement in concrete. But, now it is used for making Bricks as it has higher strength and more advantages than the conventional bricks. This has resulted in the increase in the usage of Fly Ash in Brick Manufacturing Process. The Fly Ash was collected from Neyveli and is a class C Fly Ash used for the research.

2.4 Sewage sludge

Sewage sludge is a product of wastewater treatment. Wastewater and storm water enter the sewage system and flow into wastewater treatment facilities, where the solid wastes are separated from the liquid wastes through settling. At this point, they are processed and "digested," or decomposed by bacteria. These separated processed solids – sewage sludge – contain numerous known and unknown hazardous materials. This includes everything that is flushed into the sewer system, including: household, medical, chemical, and industrial waste; chemicals and metals that leach from the sewer pipes themselves; and novel materials that are created in the wastewater treatment plant as a result of the combination of chemicals and organic compounds present.

Fig -2: Sewage Sludge

Now a day, sewage disposal is increased in the society. The sewage treatment plants are ng huge problem for handling the dry sludge. In recent years, waste production has increased dramatically in developing nations such as India.

There are two methods to solve the problem such as disposal of solid waste (dry sludge) including land filling and using dry sludge as fertilizers. In these two methods some harmful material remains in the sludge. In the sense grit sludge may be generated in a grit channel or chamber. Grit particles are removed because they may damage pumps and other equipment.

2.5 Bottom ash

Bottom ash are collected from the bottom of the furnaces that burn coal for steam or production of electricity or any other process. It is the by-prodct f these production. It is availale in smaller industries. The type of by-product (i.e., bottom ash or boiler slag) produced depends on the type of furnace used to burn the coal. The clay brick face industry has utilized Bottom Ash as a body additive for many decades in India. Bottom Ash has properties that provide many favorable benefits to making the clay brick.

Fig -3: Bottom Ash

3. MANUFACTURING OF BRICK

Brick is made of clay or shale formed and fired into a durable ceramic product. There are three ways to form the shape and size of a brick: extruded, molded and dry pressed. The majority of the brick are made by the extrusion method. The size of the bricks are varied due to the process of manufacturing. These variations are addressed by the ASTM

standards. Most brick manufacturing facilities are near clay sources to reduce transportation, by recycling of process waste, by reclaiming land where mining has occurred, and by taking measures to reduce plant emissions. Most bricks are used within 500 miles of a brick manufacturing facility. The manufacturing process has six general phases:

1. Mining and storage of raw materials
2. Preparing raw materials
3. Forming the brick
4. Drying
5. Firing and cooling
6. De-hacking and storing finished products

4. TESTING OF CONVENTIONAL BRICK

The normal brick that mainly constitutes Alumina, Lime, Sand, Magnesia and Oxides of Iron etc is known as conventional Brick. It is the commonly used Brick and is used for a long time. The soft mud method is the most common, as it is the most economical. The clay was mixed with 20-30% of sand will reduce the shrinkage. The clay is first ground and mixed with water to the desired consistency. The clay is then pressed into steel moulds with a hydraulic press. The shaped clay is then fired at 900–1000 °C to achieve strength. Then the Brick is left to air dry before it is tested.

4.1 Water absorption test

Weight of Brick in dry condition W1 = 3500g

Weight of Brick after immersed in water W2= 4000g

Water absorbed W = W2-W1/W1 *100 W = 14%

4.2 Compressive strength test

The tests made for the Brick has shown the following results for its compressive strength at the normal size.

Table -2: Compressive Strength of Conventional Brick

SAMPLE	COMPRESSIVE STRENGTH
1	3.1
2	3.3
3	3.2
4	2.9
5	3.0
Average	3.1

5. TESTING OF FLY ASH MIXED BRICK

The Brick is made with addition of Fly Ash at ratios of 5%, 10%, 15% and 20%. The Fly Ash is mixed with the sewage sludge and bricks are made in their respective ratios. The Bricks are then left to be air dried for 3 – 4 days. Then the Bricks are burnt in 800 to 1000°C and dried. After 4 – 5 days of drying they are tested to find their properties. These bricks have a high compressive strength than the normal brick.

5.1 Water absorption test

Weight of Brick in dry condition W1= 3070 g

Weight of Brick after immersed in water W2= 3530 g

Water absorbed W = W2-W1/W1 *100 W = 15%

5.2 Compressive strength test

The compressive strength test is conducted and the result for the fly ash mixed brick is obtained.

Table -3: Compressive Strength of Fly Ash mixed Brick

Sample	Compressive Strength of Fly Ash mixed Brick (N/mm²)				
	0%	5%	10%	15%	20%
1	3.1	3.2	3.6	2.8	2.5
2	3.3	3.4	4.0	3.0	2.7
3	3.2	3.5	4.2	3.2	3.0
4	2.9	3.6	3.7	3.5	2.8
5	3.0	2.8	3.9	3.0	3.2
AVERAGE	3.1	3.3	3.8	3.1	2.8

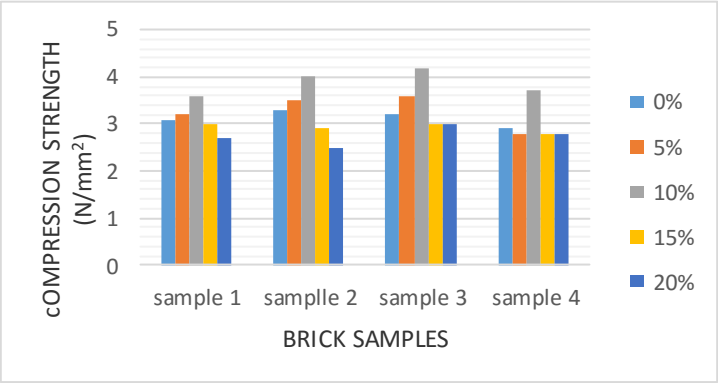

Chart 1 Compressive Strength of Fly Ash Bricks

Comparison of Fly Ash bricks with the 5%, 10%, 15%, 20% are shown in chart 1. Bricks with 10% of replacement gives higher strength than the other mixes. Sample 3 have 7% higher strength than the conventional bricks.

6. TESTING OF BOTTOM ASH MIXED BRICK

The Bottom Ash Bricks are light in weight due to its composition. They are also processed as the others and burned at the same temperature. Then it is left to cool down and then tested for its strength.

6.1 Water absorption test

Weight of Brick in dry condition W1= 2360 g
Weight of Brick after immersed in water W2= 2906 g
Water absorbed W = W2-W1/W1 *100 = 18.8%

6.2 Compressive strength test

Table -4: Compressive Strength of Bottom Ash Brick

Sample	Compressive Strength of Bottom Ash Mixed Brick (N/mm²)				
	0%	5%	10%	15%	20%
1	3.2	3.6	3.0	2.8	2.0
2	3.4	4.0	3.1	2.6	2.1
3	3.4	3.7	2.8	3.0	1.8
4	3.6	4.2	3.3	2.6	2.0
5	3.8	4.0	3.5	2.9	2.6
AVERAGE	3.5	3.9	3.1	2.7	2.1

The comparison of Bottom Ash bricks with the replacement of 5%, 10%, 15%, 20% are shown in in the Fig.5.2, It shows that the 10% replaced bricks gives higher strength than the conventional bricks. Sample 3 shows 6.5% higher strength than the conventional bricks.

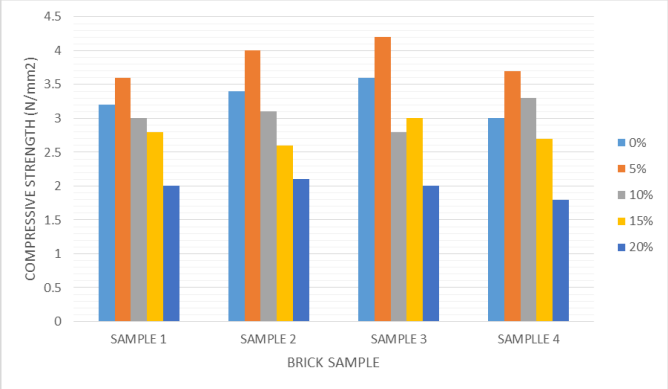

Chart 2 Compressive Strength of Bottom Ash bricks

7 TESTING OF COMPOSITE BRICK

The Composite Brick is the mixed brick of Fly Ash and Bottom Ash in equal ratio with the Sewage Sludge. These Bricks are also light in weight compared to normal brick. But it has a higher compressive strength than the normal brick. This result shows that the composite mixture of Fly ash and Sewage sludge has advantage over the conventional brick.

7.1 Water absorption test

Weight of Brick in dry condition W1=2500 g
Weight of Brick after immersed in water W2= 2975 g
Water absorbed W = W2-W1/W1 *100
W = 15.9%

Table -5: Compressive Strength of Composite Brick

SAMPLE	Compressive Strength of Composite Brick (N/mm²)				
	0%	5%	10%	15%	20%
1	3.3	3.4	4.1	2.9	2.5
2	3.2	3.9	4.3	3.0	2.8
3	3.8	3.8	3.8	3.2	2.7
4	3.5	3.6	3.7	3..5	3.2
5	4.0	4.2	3.6	3.7	2.8
AVERAGE	3.5	3.7	3.9	3.26	2.8

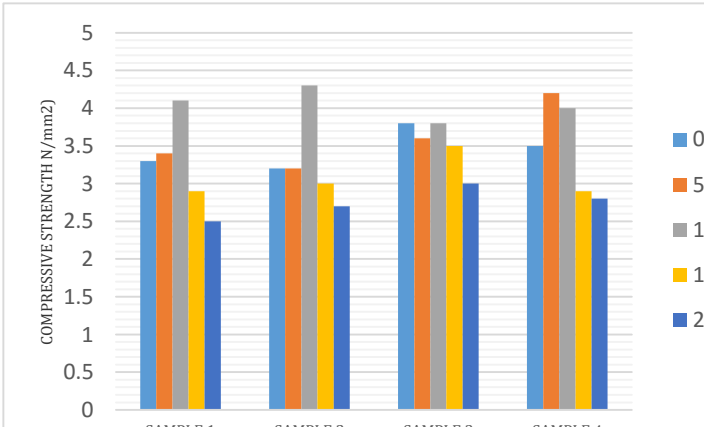

Chart 3 Compressive Strength of composite bricks

The comparison of Compressive Strength of bottom ash bricks with of 5%, 10%, 15%, 20% are shown in in the Fig 5.2, It shows that the 10% replaced bricks gives higher strength than the conventional bricks. Sample 3 shows 6.5% higher strength than the conventional bricks.

8. CONCLUSION

Various test results were discussed and tabulated. Bricks with 10% replacement of Fly Ash gives a higher strength than the conventional bricks. Strength of fly ash bricks increases up to 8% compared with conventional bricks

Bricks with 5% replacement of Bottom Ash gives 6.5% higher strength than the conventional bricks. Composite bricks having fly Ash and bottom ash sludge ash are tested for compressive strength.

Composite bricks gives 8.5 % higher strength than the conventional bricks.Water absorption of a Composite Bricks is 1.5% higher than the Conventional Bricks.

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