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Review on Studies on Brick as a Advance Construction Material using Alternative Materials

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ABSTRACT

The construction industry is using more and more concrete daily. The primary concern is the future growth in demand for concrete, which can be addressed by finding out at no additional cost or at a lower cost and by minimizing the environmental impact caused by the expansion of the cement industry, which is a crucial component of economic development. Given the depletion of natural aggregate sources, it is imperative to discover alternatives to partially replace concrete and cement and make the building material eco-friendly or environment-friendly. One of the most flexible and all-purpose building materials is mud-brick. In today's scenario of the construction industry, lots of different types of materials are used for the construction. Nowadays lots of environment-friendly cements are used but very less innovations are carried out in the brick or ordinary mud brick. As bricks are very important and very useful materials in the construction industry. Fly ash is a very common type of waste which are generated from the burning of coal. Fly ash is mostly used in the production of cement. Bricks are mainly made up of mud or soil. But ordinary bricks need very high temperatures and time to come in the user-friendly material. In this study, ordinary brick is studied and its original content is somehow modified by using different materials like silica fume, fly ash, and other admixtures. So, these modifications may increase the strength parameter as well as it become environment friendly. This study involves the study of the different researchers based on the modifications in the brick. As many researchers are used different materials like fly-ash, baggase, silica fume etc. It is observed that brick with the silica fume gives best compressive strength and better water absorption. Also use of the waste material can also improve the climatic condition of the country and reduce the environmental impact.

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KEYWORDS: *Brick, Silica Fume, Compressive Strength*

INTRODUCTION

There is a greater need for homes in India. The massive rise in building activity throughout the years has made housing a major concern in the modern world. The standard burned clay brick is the most fundamental building material use in the construction of dwelling (Rajkumar et al. 2016).

This research was conducted as a component of a larger project to show the economic, environmental and technological advantages of recycling an industrial by product like fly ash from paper mills (Sarkar et al. 2017).

Fly ash produced in large quantities roughly 90 million tons annually as a result of India’s fast expansion of its thermal power generation capacity. In many places fly ash, lime and gypsum are all readily available nearby (Rajkumar et al. 2016). Assuming this material can be utilized to produce brick with sufficient strength a cost-effective substitute for traditional burnt clay bricks will be accessible (Rajkumar et al. 2016).

One important building material used in the construction of a structure is a brick. Tighter stacks of bricks and mortar create the wall and any kind of structure. Bricks are typically are of 19 cm by 9 cm by 9 cm in size. Bricks have a nominal size of 20 cm by 10 cm by 10 cm. The IS: 2212 (1991) specifies the standard brick size and specifications. Alumina, silica, clay, and other materials are used to make bricks. Typically, clay is used to make bricks (Pujari et al. 2016).

An affordable, sustainable, and widely accessible building material is clay brick. All around the world, it has been widely utilized to construct buildings, especially in extremely hot and arid desert climates. In addition to increasing compressive strength, silica may also keep clay bricks from cracking (Pawar and Garud 2014). After that, the clay brick is formed by hand or in a mold of nearly any size or shape. Before being used, the brick combinations are then spread out to dry in the sun for roughly15 days. One of the essential building materials is brick. This was categorized according to the production material. Additionally, bricks of all kinds can be categorized based on their sizes (Hegazy et al. 2011). In the process of making clay bricks, drying is a crucial step. The act of drying eliminates any free moisture that may be present in brick. The presence of free moisture in the system may result in production faults when the clay bricks are fired at a high temperature. In the process of making clay bricks, drying is crucial Time needed to dry the clay brick is depends on the free moisture content and temperature of the air (Pawar and Garud 2014). Thus, raising the drying temperature can boost the brick production industry's productivity. Clay forming, shaping, and drying are steps in the production of clay bricks (Magdalene 2019).

When compared to other traditional building materials, such as concrete masonry, clay bricks provide a number of advantages. But this concrete masonry bricks have some of the different disadvantages may also likes that sometimes it may generate the cracks in the walls (Hubli et al 2018). These benefits include: a very low manufacturing process; the need for specialized labor is eliminated; clay is obtained from natural resources; it is affordable to create with; and clay constructions may function well in hot weather. Nevertheless, there are a lot of drawbacks to employing clay bricks in construction (Rajamannar and Rama Rao 2016). These include the following: clay brick can dissolve when hit by rain; it can swell when water is absorbed, but it can also shrink and split when water evaporates from it; and it is a relatively brittle material that cannot withstand earthquakes (Sarkar et al. 2017).

The ultimate goal of this study is to ascertain the impact of various clay brick ingredients on strength and absorption through in-depth experimental inquiry. These findings will be utilized in a future study on thermal conductivity attributes (Magdalene and Murugeshwari 2019). In light of this, the study's specific goals are to increase clay brick consolidation by the application of various polymer agents, soluble silicate, ethyl silicate, silanes or siloxanes, isocyanates, and other materials to treat clay brick permeability (Hegazy et al. 2011). Additionally, research is done on the impact of employing metallic fibers to increase the durability of clay bricks. (Sarkar et al. 2017)

This study refers to the recent trends in the construction industry to imparting the material strength as well as improving the quality and characteristics of the material by adding different types of the admixtures, retarders and environmental friendly materials (Hegazy et al. 2011). This may enhance the overall strength and good quality of the construction material.

Materials

Various materials including conventional are mentioned with their respective specifications.

1. RED SOIL

Red soil is a type of soil that develops in a warm, temperate, moist climate under deciduous or mixed forest, having thin organic and organic-mineral layers overlying a yellowish-brown leached layer resting on an alluvial red layer (Nithiya et al. 2016).

2. CLAY

Clay is a finely-grained natural rock or soil material that combines one or more clay minerals with possible traces of quartz, metal oxides and organic matter. Clays are plastic due to particle size and geometry as well as water contentand become hard, brittle and non–plastic upon drying or firing (Rajamannar and Rama Rao 2016).

3. WATER

Water used for making masonry mortar shall be clean and free from injurious quantities of deleterious material. Potable water is generally confided to the requirement of IS 456: 2000 satisfactory for use in masonry mortar (Hegazy et al. 2011).

4. REPLACED MATERIALS

Admixtures that are used apart from the conventional materials are mentioned below with their respective specifications.

5. SILICA

It is a hard, unreactive, colourless compound which occurs as the mineral quartz and a principal constituent of sandstone and other rocks (Shankar Pujari et al. 2016).

6. FLY ASH

Fly ash, also known as "Pulverized" fuel ash" in the U.K. is one of the residues generated by coal combustion. and is composed of the fine particles that are driven out of the boiler with the flue gases(Rajamannar and Rama Rao 2016). Ash that falls in the Bottom of the boiler is called Bottom ash. Generally fly ash collected from 1st & 2nd field of ESP's meet the requirement of Grade 2 of IS: 3812. As per the information collected, the minor variations in quality of dry ash & pond ash does not affect the quality of the brick significantly (Fly ash should preferably be collected from 1st/2nd field of ESP (Magdalene and Murugeshwari 2019).

The following table shows chemical composition of fly ash (Karan et al. 2020).

Component	Bituminous Coal	Sub Bituminous Coal	Lignite Coal
SiO_2 (%)	20-60	40-60	15-45
Al_2O_3 (%)	5-35	20-30	20-25
Fe_2O_3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40

7. BAGASSE

Bagasse is the fibrous matter that remains after sugarcane stalks are crushed to extract their juice. It is currently used as a biofuel and in the manufacture of pulp and paper products and building materials (Magdalene and Murugeshwari 2019). For each 10tonnes of sugarcane crushed, a sugar factory produces nearly 3tonnes of wet bagasse. Since bagasse is a by-product of the cane sugar industry, the quantity of production in each country is in line with the quantity of sugarcane produced. Bagasse is often used as a primary fuel source for sugar mills; when burned in quantity, it produces sufficient heat energy to supply all the needs of a typical sugar mill, with energy to spare (Pawar and Garud 2014). To this end, a secondary use for this waste product is in cogeneration, the use of a fuel source to provide both heat energy used in the mill and electricity, which is typically sold on to the consumer electricity grid. (Rana et al. 2013)

PRODUCTION METHOD

Clay bricks can be produced manually (for small-scale companies), semi-mechanized, or completely automated (for large-scale industries), in accordance with Indian norms. The fundamental manufacturing process is the same regardless of the type of manufacture. These fundamental actions are briefly described below (S.Alaa et al.2013).

SITE SELECTION

The local government's town planning criteria must be followed while choosing a site. Suppliers of raw materials and actual consuming locations must be within the economically feasible transportation radius (Pujari et al. 2016).

CLAY SELECTION

The criteria for choosing the right clay to make the different kinds of bricks are provided by IS 1727: 1967. In alluvial soil, the total amount of lime (CaO) and magnesia (MgO) (according to IS 1727: 1967) should not exceed one percent, while in other situations, it should not be more than fifteen percent (Abano E.E.et al.2011).

The following table indicates the percentage.

COMPOSITION	PERCENTAGE (%)
Silica (SiO_2)	50-60
Alumina (Al_2O_3)	20-30
Lime (CaO)	<5
Iron Oxide (Fe_2O_3)	5-6
Manganese Oxide (MnO)	Small amount

CHOICE OF ADDITIVES

The clay can have several kinds of additives added to it, depending on what is needed and what is available. Fly ash and paddy some examples of this kind of addition are husk and silica (Pujari et al. 2016).

CLAY PREPARATION

The three steps involved in preparing clay are mixing, tempering, and weathering (Pujari et al. 2016).

FORMING

There are two types of hand-made bricks: table-moulded and ground-molded. In the former scenario, a level, stable surface of the ground will be utilized. Indian standards provide typical requirements for table molding accessories (Ganesan et al. 2020).

DRYING

The process of drying involves eliminating any unbound moisture from the bricks. Bricks with free moisture can create a manufacturing flaw when the bricks are being fired. Drying time range from a few weeks (natural drying) to a single day (artificial drying) (Ganesan et al. 2020).

FIRING

The process of removing moisture from bricks at a high temperature. It gives bricks their true strength. For the purpose of firing bricks, a variety of firing kiln types is available. In the brick business today, vertical shaft brick kilns are the most economical and environmentally responsible choice (Siddarth et al.2022).

EXPERIMENTAL METHOD AND PROCEDURES

A. Test For Physical Property of Clay:

1. Grain Size Analysis
2. Liquid Limit Test
3. Plastic Limit Test
4. Swelling Index
5. Shrinkage Limit
6. Specific Gravity
7. Water Absorption

1. Grain Size Analysis

[IS Code:2720-1985(part-4) Reaffirmed 2020 (Cl.No.4), IS 1498-1979 Reaffirmed 2016]

A. Grain Size Analysis by Dry Method

Standard operating procedure for this test is applied for this test which is given below.

1. Dry the sample in oven at 105 to 110˚C
2. Take 200 gm of sample.
3. Assemble sieve in ascending order of sizes i.e. 4.75mm, 2mm, 425 μ, 75 μ and pan. Carefully pour the soil sample into top sieve and place lid on top.
4. Place the sieve stack in the mechanical shaker and shake for 10 minutes or sieving by hand sieving.
5. Remove the stack from the shaker and carefully weigh the soil retained on each sieve in a porcelain dish on the weight balance and repeat the same procedure for remaining sieves also, and weight the soil in the pan as well.
6. Calculate the percentage passing per sieve.
7. Make a grain size distribution curve by plotting sieve size on log scale and percentage finer on ordinary scale.
8. Read off the sizes corresponding to 60%, 30% and 10% finer. Calculate the uniformity coefficient (Cu) and the curvature coefficient (Cc) for the soil.

B. Grain Size Analysis by Wet Method

Standard operating procedure for this test is applied for this test which is given below.

1. Sufficient quantity of soil sample is sieved on 4.75 mm.
2. The sample passing through 4.75 mm IS sieve is dried in oven at 105 to 110˚C
3. Take 200 gm oven dried sample.
4. Take 2 gram of sodium Hexa-metaphosphate or 1 gram of Sodium Carbonate and 1 gram of Sodium Hydroxide and dilute it in 1 liter of water and add it in to the soil sample.
5. The mix should be thoroughly stirred and left for soaking for few minutes.

8. Liquid Limit Test

[IS 2720-1985 (Part5) Reaffirmed 2020(CI. NO. 6&7) IS 1498-1970 Reaffirmed 2016]

Standard operating procedure for this test is applied for this test which is given below.

1. About 120 gm of air-dried soil from thoroughly mixed portion of material passing 425 micron I.S sieve is to be obtained.
2. Distilled water is mixed to the soil thus obtained in a mixing disc to form uniform paste. The paste shall have a consistency that would require 30 to 35 drops of cup to cause closer of standard groove for sufficient length.
3. A portion of the paste is placed in the cup of LIQUID LIMIT device and spread into portion with few strokes of spatula.
4. Trim it to a depth of 1cm at the point of maximum thickness and return excess of soil to the dish.
5. The soil in the cup shall be divided by the firm strokes of the grooving tool along the diameter through the center line of the follower so that clean sharp groove of proper dimension is formed.
6. Lift and drop the cup by turning crank at the rate of two revolutions per second until the two halves of soil cake come in contact with each other for a length of about 1 cm by flow only.
7. The number of blows required to cause the groove close for about 1 cm shall be recorded.
8. A representative portion (15gm) of soil is taken from the cup for water content determination by oven drying.
9. Repeat the test with different moisture contents at least three more times for blows between 10 and 40.

C. Plastic Limit Test

[IS 2720-1985 (Part5) Reaffirmed 2020(CI. NO. 6&7) IS 1498-1970 Reaffirmed 2016]

Standard operating procedure for this test is applied for this test which is given below.

1. Take about 20gm of thoroughly mixed portion of the material passing through 425micron I.S. sieve obtained in accordance with I.S. 2720 (part 1).
2. Mix it thoroughly with distilled water in the evaporating dish till the soil mass becomes plastic enough to be easily molded with fingers.

3. Allow it to season for sufficient time (for 24 hrs) to allow water to permeate throughout the soil mass
4. Take about 10gms of this plastic soil mass and roll it between fingers and glass plate with just sufficient pressure to roll the mass into a threaded of uniform diameter throughout its length. The rate of rolling shall be between 60 and 90 strokes per minute.
5. Continue rolling till you get a threaded of 3 mm diameter.
6. Kneed the soil together to a uniform mass and reroll.
7. Continue the process until the thread crumbles when the diameter is 3 mm.
8. Collect the pieces of the crumbled thread in air tight container for moisture content determination.
9. Repeat the test to at least 3 times and take the average of the results calculated to the nearest whole number.

9. SWELLING INDEX
[IS 2720-1977 (Part 40) Reaffirmed 2021]

Standard operating procedure for this test is applied for this test which is given below.

1. Remove the organic matter like tree roots, pieces of bark, etc.
2. Use heat resistance hand gloves while loading or unloading containers from oven.
3. Take only Class A measuring cylinder.
4. Special care should be taken when using a glass ware.
5. In weight balance set the value "0.00" before using.
6. While using the weight balance for weighing let it stable for a while and after stable observe the weight and unload material and record the reading.
7. Don't load the material directly keeping the tray on weight balance.
8. Equipment's related part(s) and other accessories used for testing should be kept clean.
9. Clean the sieves with the help of a brush.
10. Gently clean the measuring cylinder after completion of test.
11. Wear necessary PPE's at the time, of testing.

10. Shrinkage Limit
[IS 2720-1985 (Part5) Reaffirmed 2020(CI. NO. 6&7) IS 1498-1970 Reaffirmed 2016]

Standard operating procedure for this test is applied for this test which is given below.

1. Place about 30g of the soil fraction passing 425Pm IS sieve in a porcelain dish and thoroughly mix it with distilled water. The water should be added to make the soil slightly flowing.

Note: The amount of required water could be about the liquid limit in low plastic (friable) soils; otherwise, it could be about 1.1 to 1.2 times the liquid limit in medium to high plastic soils.

2. Apply a thin coat of grease to the inside of the shrinkage dish and measure its empty weight.
3. Place the soil aste in the shrinkage dish, simultaneously tapping it so that it fills completely the dish without entrapping any air bubbles. Weigh the dish with soil paste inside.
4. Keep the dish in the oven set at 105˚C to 1100˚C for 24 hours. Take the dry weight of the soil pat.
5. Determine the volume of the dry soil pat by mercury displacement method*
6. Determine the volume of the dish by filling it with mercury.
7. Enter the observation in the record sheet and compute the shrinkage limit.

11. Specific Gravity
(IS 2720(Part 3/ Section 1)-1980)

Standard operating procedure for this test is applied for this test which is given below.

1. Weigh a clean and dry density bottle empty (m1).
2. Take about 15 g of oven dry soil in the bottle. Take the combined weight of soil and bottle (m2).
3. Add distilled water to cover soil (half full) and then boil it on the hot plate for about 30 minutes. Remove the stopper while boiling and avoid spurting.
4. Cool the bottle to room temperature, fill it completely with deaired distilled water and replace the stopper correctly. Wipe the surface of the bottle and weight the bottle (m3).
5. Empty the contents and clean the density bottle thoroughly. Fill the bottle with distilled water and weight (m4).
6. Fill the record sheet given and calculate the specific gravity.
7. If given the time, repeat the above steps 2 to 6 using a dry density bottle.

12. Water Absorption

[IS 3495-2019 (Part 2) (CI. NO. 4&1) IS 13757-1993 Reaffirmed 2016]

Standard operating procedure for this test is applied for this test which is given below.

1. Handling of brick must be done carefully.
2. Transferring of sample must be done carefully.
3. Use heat resistance hand gloves while loading or unloading containers from oven.
4. In weight balance set the value "0.0" before using.
5. While using the weight balance for weighing let it stable for a while and after stable
6. observe the weight and unload material then after record the reading.
7. Don't load the material directly keeping the tray on weight balance. Equipment's related part(s) and other accessories used for testing should be kept clean.
8. Wear necessary PPE's at the time of testing.

CONCLUSION

This study reviews an extensive set of research on bricks. Below are the main conclusions as highlighted. Basically, there are two varieties of innovative bricks exist: substance bricks with an material orientation and a procedure orientation. In this study focuses is mainly on the material orientation. The most popular way of producing bricks is via firing, which has a significant carbon footprint and energy consumption. Additionally, calcium-silicate-hydrate bricks made of cement and lime are not sustainable.There are many different types of materials used in the production of the brick among them Brick with the silica fume and fly-ash gives the better compressive strength compare to the normal bricks. Also, addition of fly-ash and silica fume reduces the environmental friendly nature and improve the sustainability. Brick with the addition of the different materials may improve the characteristics of the normal brick as well as improve the sustainability and take less time to production. So this review may helpful to the new researchers and producers of the Bricks.

REFERENCES

[1] Magdalene, P. S., Arthi, T., & Murugeshwari, G. Strength Stability of Thirumalaipadi Brick Oasis by Admixtures.

[2] Soil, C., & Soil, R. A Study on Manufacturing of Bricks using Black.

[3] Pawar, A. S., & Garud, D. B. (2014). Engineering properties of clay bricks with use of fly ash. International Journal of Research in Engineering and Technology, 3(9), 75-80.

[4] Rajkumar, P. K., Krishnan, K. D., Sudha, C., Ravichandran, P. T., & Vigneshwaran, T. D. (2016). Study on use of industrial waste in preparation of green bricks. Indian Journal of Science and Technology.

[5] Kazmi, M. S., Munir, M. J., Abbas, S., Saleem, M. A., Khitab, A., & Rizwan, M. (2017). Development of lighter and eco-friendly burnt clay

[6] bricks incorporating sugarcane bagasse ash. Pakistan Journal of Engineering and Applied Sciences.

[7] Sarkar, R., Kurar, R., Gupta, A. K., Mudgal, A., & Gupta, V. (2017). Use of paper mill waste for brick making. Cogent Engineering, 4(1), 1405768.

[8] Bhavya Rana, Prof. Jayeshkumar Pitroda, Dr. F.S. Umrigar (2013). Sugarcane Bagasse Ash for eco-friendly fly ash bricks

[9] Mr. Ankush Shankar Pujari, Prof. (Dr.) C. H. Bhosale, Prof. M. M. Wagh, Prof. N. N. Shinde (2016). Effect of Temperature on Drying Rate of Various types of Bricks

[10] B. Rajamannar, Dr. P. Kodanda Rama Rao(2016).An Alternate Solution in Brick Making using Mineral Admixtures

[11] Shakir, A. A., & Mohammed, A. A. (2013). Manufacturing of Bricks in the Past, in the Present and in the Future: A state of the Art Review. International Journal of Advances in Applied Sciences (IJAAS), *2*(3), 145-156

[12] Abano, E. E., Ma, H., & Qu, W. (2011). Influence of air temperature on the drying kinetics and quality of tomato slices. Journal of Food Processing & Technology, 2(5), 2-9.

[13] (ISCode:2720-1985(part-4)Reaffirmed2020(Cl.No.4),IS1498-1979 Reaffirmed 2016)

[14] [IS 2720-1985 (Part5) Reaffirmed 2020(CI. NO. 6&7) IS 1498-1970 Reaffirmed 2016

[15] [IS 2720-1977 (Part 4) Reaffirmed 2021

[16] [IS 3495-2019 (Part 2) (CI. NO. 4&1) IS 13757-1993 Reaffirmed 2016]

[17] (IS 2720(Part 3/ Section 1)-1980)

[18] Siddarth B.H., Dhanush V.M., Hemanth C.N., Jayanth R., Shreyas Yadav S K., Utilization of

Black Cotton Soil in the Manufacturer of Bricks.

[19] Hegazy, B. E. D. E., Fouad, H. A., & Hassanain, A. M. (2011). Reuse of water treatment sludge and silica fume in brick manufacturing. Journal of American Science, 7(7), 569-76.

[20] Ganesan, Y., Sakthivel, K., Murugan, V., & Duraisamy, S. (2020, November). Research analysis of paper sludge and paper ash bricks. In IOP Conference Series: Materials Science and Engineering (Vol. 955, No. 1, p. 012057). IOP Publishing.

[21] Nithiya, R., Chris, A. L., Vinodh, K. R., & Anbalagan, C. (2016). Experimental investigation on bricks by using various waste materials. IJLTET, 6, 395-402.

[22] Mandal, A. K., Verma, H. R., & Sinha, O. P. (2017). Utilization of aluminum plant's waste for production of insulation bricks. Journal of cleaner production, 162, 949-957.

[23] Karan S, Karthick S, Kaviya Sree S,Pavithra A, Arunprakash N (2020),Experimental study on brick manufacturing by using sludge and Pulp production residue