Properties and Environmental Features of Bricks Made From Textile Waste Sludge

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Abstract: In recent years, there has been a lot of attention paid to the use of textile sludge waste-based products in the building industry to develop ecologically friendly construction materials. An experimental examination of the characteristics of bricks incorporating textile sludge waste and fly ash is presented in this work. In fly ash bricks, fly ash is used to replace textile sludge waste in the following proportions: For the blend percentage of cement, fly ash, and quarry dust, a 230mm x 100mm x 75mm sample size was used. For varying amounts of the components indicated previously, the findings indicate how compressive strength and water absorption fluctuate with curing age. Then we can cast bricks with various mixed proportions of cement, sludge waste, fly ash, and quarry dust using the 230mm x 100mm x 75mm specimen size. After that, the weight, compressive strength, and water absorption of textile sludge with different concentrations of fly ash bricks were compared. This inquiry is primarily concentrated on maximizing the compressive strength of newly produced bricks while limiting weight density and water absorption through extensive laboratory work. The recognition of elements influencing the diverse qualities of bricks is a clear purpose of pursuing this issue as project work.

1. Introduction.
The widespread usage of clay brick in the construction industry has resulted in a significant depletion of natural resources. As a result, various engineers and researchers are now looking for alternate materials for brick manufacturing to safeguard such natural resources. This kind of research/studies had the advantage of securing our natural resources as well as using secondary materials in huge quantities, potentially protecting the environment and making the study sustainable and eco friendly. Fly ash and industrial waste sludge are two types of secondary materials. Textile waste sludge is created during the textile manufacturing process.
For thousands of years, bricks have been widely used as a primary building material all across the world. Cement-based bricks and clay-based bricks are the two most popular types of brick used around the world. Clay-based bricks have the advantage of being less expensive than cement-based bricks, making them more popular. Traditional clay brick manufacture uses a lot of energy and emits a lot of CO2. The ecology and human health will be harmed if sewage sludge is dumped directly into the environment without treatment [1]. As a result, prior to disposal, sewage sludge must be treated to ensure volume reduction, sludge stability, and sludge value. Sludge thickening, conditioning, dehydration, stabilization, and drying are presently the most typical sludge treatment activities, and they're done with a variety of physical, chemical, and biological methods [2].

Sludge is generated during the treatment process due to chemical coagulation (by addition of aluminum/iron/magnesium salts and lime), flocculation, and liquid/solid separation, as a result of a group of industries in this complex establishing Common Effluent Treatment Plants (CETPs) for treating their liquid effluent. As a result of the treatment's completion, a large amount of sludge is produced. The entire sludge is dumped in the sludge yard, resulting in contamination of the soil, surface water, and groundwater. Residents' health is jeopardized by inorganic salts and harmful metals in the sludge[3]. There is a rising need in the construction sector to develop alternate sludge management solutions that can also be used in other ways [4].

Several investigations using this waste material in the making of concrete indicated that increasing the amount of industrial waste resulted in clear increases in workability, compressive strength, abrasion resistance, and chemical resistance [5]. Aside from that, numerous earlier kinds of literature publications revealed in the past few decades that fly ash was a waste material with pozzolanic properties that also presented a promising result in the brick industry [6]. As a result, fly ash is used as a partial substitute material for building bricks in the study. As a result, recycling the above-mentioned wastes as building materials appears to be a viable solution that will not only alleviate environmental difficulties but will also be cost-effective [7]. In light of the foregoing, an attempt has been made in this study to investigate the use of wastes such as fly ash and industry waste sludge in the manufacturing of brick as a natural resource additive[8][9]. In addition, traditional clay bricks were used for comparison purposes, as is customary.

2. Experimental Investigation

2.1 Constituent materials

Portland Pozzolana Cement of 33 grade was utilized, which complied with IS 1489 (Part 1):1991 PPC specification (Fly ash based). Physical parameters such as specific gravity, fineness, consistency, and starting and final setting times are tested under BIS standards and are listed in Table 1. In comparison to regular Portland cement, Portland-Pozzolana cement produces less hydration heat and is more resistant to intense water assault. The fly ash was gathered at the Tuticorin National Thermal Power Plant Corporation. The fly-Ash used was Class F.

| Physical Property         | Cement Properties |
|---------------------------|-------------------|
| Specific gravity          | 3.14              |
| Fineness modulus          | 5%                |
| Consistency               | 28%               |
| Initial setting time      | 60 minutes        |
| Final setting time        | 360 minutes       |
2.2 Quarry Dust
It's a stone quarry's reclaimed sediment. The cost of travel from normal sources is too expensive, hence typical sand is scarce. In addition, the paucity of these resources exacerbates massive natural challenges. River sand is becoming less desirable for buildings; a repurposed or reclaimed product for the solid sector should be developed. For the sake of opportunity, money, and environmental impact, some people have begun organizing tough issues. On interstates with a large scope, quarry rock dust is widely utilized as a surface completing material and for inserting empty squares and weightless cement pre-assembled Elements. After that, small particles having a diameter of less than 4.75 mm were used in this investigation, while large particles and meeting grading zone II as defined by IS 383-1970 were used in the experiments conducted. Table 2 shows the physical attributes determined, such as specific gravity, fineness modulus, aggregate crushing value, and aggregate impact value, as well as test results.

| Physical Property         | Quarry Dust |
|---------------------------|-------------|
| Specific Gravity          | 2.62        |
| Water Absorption          | 0.5%        |
| Fineness Modulus          | 3.324       |
| Surface Texture           | Rough       |
| Particle Shape            | Angular     |
| Grading Zone              | II(IS 2386 (Part I) 1963) |

2.3 Textile Sludge
Textile sludge was acquired from Rajapalayam in the Virudhunagar district of Tamil Nadu, India. Sludge was collected from the drying beds using a random sampling approach in dry conditions. The dried sludge was manually ground at room temperature with the help of the trowel. Using a 150-m sieve to sieve the TS obtained from industry. There was special attention paid to the manufacture of specimens due to their thinness and lack of measurement difficulties. Its preservation in a mound in a dry state akin to cement proved impossible, as it was blown away by a tiny breeze of the discussion. The quality of this sludge appears to be better than cement. It is less dense than cement in terms of specific gravity. It has a larger volume and requires more water to blend. Table 3 shows the physical attributes determined.

| Physical Property             | Quarry Dust |
|-------------------------------|-------------|
| pH value                      | 9.2         |
| Specific gravity              | 2.3         |
| Density                       | 825Kg/m3    |
| TDS                           | 6.251ppt    |

3. Experimental Investigation
Cement, fly ash, and quarry dust in the proper amounts were utilized to make bricks in this investigation. Textile sludge was used to replace 5 percent, 10 percent, 15 percent, 20 percent, 25 percent, and 30 percent of the fly ash. Table 4 shows the various blend proportions that were expected to provide for the essential approach. The blocks are projected using a standard hand form with the required dimensions of 230mm x
100mm x 75mm, as indicated in figure 1. Sludge waste was used to substitute fly ash brick and was tested for compressive strength, dry density, and water absorption.

![Figure 1. (a) Textile Sludge; (b) Brick Manufacturing.](image)

### Table 4. Mix Proportions

| Sample | OPC (%) | Textile sludge (%) | Fly ash (%) | Quarry dust (%) |
|--------|---------|---------------------|-------------|-----------------|
| FB0    | 25      | 0                   | 45          | 30              |
| FB1    | 25      | 05                  | 40          | 30              |
| FB2    | 25      | 10                  | 35          | 30              |
| FB3    | 25      | 15                  | 30          | 30              |
| FB4    | 25      | 20                  | 25          | 30              |
| FB5    | 25      | 25                  | 20          | 30              |
| FB6    | 25      | 30                  | 15          | 30              |

### 4. Results and Discussion

#### 4.1 Water Absorption

Because bricks are porous and dry, they can absorb water. Water absorption is an important component in determining the longevity of bricks and is frequently employed as a measure of open porosity. Raw materials and production procedures have a big impact on the long-term durability of bricks. In general, the lower a brick's water absorption, the higher its durability, or its capacity to resist water damage[10]. The effects of binder content on water absorption of fly ash sludge bricks are shown in figure 2. With the rise in sludge content from 0 to 30%, the water absorption of fly ash sludge bricks rose from 8.54 to 17.26%. The upper water absorption thresholds, according to the BSI, are 20%. The water ingestion of 30% material slime treated with fly debris drew close to the maximum furthest reaches of moderate enduring conditions. The water absorption of fly ash brick was less than 10% when the textile sludge concentration was increased to 15%, which meets the requirement.
4.2. Compressive Strength

The compression test was performed on a 2000kN capacity automated Compression Testing Machine (CTM) with a constant continuing load of 0.6 kN/sec. Compressive strength was measured using the proportion of ultimate failure load to the region of the sample horizontal to the direction of load application (MPa). The compressive strength of the combinations of fly ash sludge bricks was displayed in figure 3. All compressive strength specimens without textile sludge waste and with sludge (0–30 percent) met the minimal strength requirements (5 N/mm²), although the strength declined as the proportion of sludge replacement rose after 20 percent replacement. FB1, FB2, FB3, and FB4 have higher compressive strengths than the control specimen FB0. The addition of textile sludge waste at a concentration of around 20% enhanced the strength.

Figure 3. Various mix to Compressive Strength

4.3. Bulk Density

Figure 4 depicts the density of different proportions of fly ash sludge bricks. The integration of sludge in brick resulted in a drop in density. For a 0% to 30% replacement of fly ash by textile sludge waste, the density of specimens ranges from 2.00 g/cc, 1.87 g/cc, 1.82 g/cc, 1.55 g/cc, 1.42 g/cc, 1.40 g/cc, and 1.35 g/cc. The density reduction is most likely due to the inclusion of finer sludge waste particles. Several studies
found that adding garbage reduced the density of bricks by 35 percent after inserting 30 percent textile waste.

Figure. 4. Represents the Bulk density of the Brick sample.

4.4. Relationship between density and compressive strength

Figure 5 shows the density and compressive strength of fly ash sludge bricks as a function of the percentage of textile waste used. The findings show that the compressive strength of sludge increased by up to 20% as the length of the sludge increased. The bricks are built without air entrainment for this position of the test[11]. The compressive strength was increased by 5MPa even with a 30% match of fly ash sludge bricks, which is close to the BSI basic recommendation for tough weather bricks. It's also possible that the density of the brick decreases as the test area is expanded with textile sludge waste in a precise way.

Figure. 5. Graphical representation of Compressive Strength Vs bulk density.
5. Conclusion

Studies on the sludge produced by textile companies' combined effluent treatment plants have revealed that the sludge could be used in building materials. The use of sludge in cement for diverse uses as structural and nonstructural components in the construction sector may be investigated further. The conversion of textile sludge waste to fly ash bricks results in a significant reduction in brick density, as expected. The brick density, for example, is reduced by 10% when 20% textile sludge is added. This is advantageous in terms of both cost and expertise. Lower block weight reduces transport and labour costs while allowing for greater structural plan adjustability. The cost savings reached a maximum of nearly 20%. The creation of sludge-incorporating bricks could result in large-scale disposal of industrial sludge, resulting in a more environmentally friendly scenario in the future.

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