Study on Preparation of Brick Blocks by Using Construction Waste and Sludge

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Research Article

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Abstract

Sewage waste is a crucial factor in the disposal and also harmful to the environment. The growing demand for waste utilization is construction and demolition waste. This study aims in preparing a brick using construction and demolition waste and sludge waste. The materials such as fly-ash, cement, construction, and demolition waste, and sludge waste are used. The sludge content was added at constant percentage of 30%, 40% and 50% with different proportions such of fly-ash, cement and demolition waste of 3:2:2, 1:3:2, 2:1:2, 2:3:2, 2:3:1, 2:2:1, 2:2:3, 3:2:1, and 1.5:1.5:2 respectively. The physical characteristics such as compressive strength, bulk density, and chemical characterization such as water absorption, pH, and detection of heavy metals were carried out. The test results infer that increase in the content of sludge, the strength decreased. Maximum compressive strength of 14.5 Mpa was achieved for the ratio of 2:3:2 at 30% of sludge. The maximum bulk density was achieved at 30% of sludge. This was attributed due to the presence of organic properties in the brick. Moreover, the water absorption increases with an increase in the percentage of sludge.

Introduction

Manufacturing bricks is inevitable. Generally, bricks are made using shale and clay over decades. The removal of clay and topsoil affects natural sources. The industrial waste products from the combustion plant also made an impact on the environment (Feuerborn 2005). Many types of research have been made on industrial waste such as rice husk, fly-ash, and bottom ash. (Shakir et al. 2013) reported that large quantities of such waste are utilized in the manufacturing of bricks. Globally, nearly 1500 billion blocks are produced everywhere. The hardened properties of the brick such as modulus of rupture, water absorption, and compressive strength were become promising and qualified them to use in the civil engineering field (Liaw et al. 1998; Pimraksa et al. 2000; Lin et al. 2006; Chiang et al. 2009; Hegazy et al. 2012). The manufacturing of brick blocks generally adopts the traditional method of drying and firing of blocks which have not been changed yet. Recent research has been made on shortcomings of manufacturing of brick blocks like greenhouse emission, energy consumption, and also to reduce the impact on the environment (Toledo et al. 2004; Koroneos and Dompros 2007; Alam and Starr 2009; González et al. 2011). Fly-ash has been used in many applications in a recycled form such as masonry mortar, cement, bricks, and concrete (Hsu et al. 2003; Li and Wu 2005; Cultrone and Sebastián 2009). Pozzolans are aluminous or siliceous materials that themselves have next to zero cementitious esteem. Pozzolans respond with calcium hydroxide at surrounding temperature to shape the compounds with the cementitious property as per ASTM (Caldarone 2009). Construction and demolition waste generally consists of 50% of raw materials of which 33% of waste is generated each year (Econometrics and Bio 2014; Bravo et al. 2015). Construction and demolition waste generally includes concrete from the structures, ceramics, floor tiles, bricks, wood, glass, etc., Such waste is directly disposed of in the environment or land area resulting in an impact on the environment (Pacheco-Torgal 2014). Creating sustainable reusing alternatives will prompt reducing the biosolid over a long time. Storing biosolids can cause the emanation of ozone-depleting substances and may bring about the deficiency of nutrients.

Biosolids have been generated significantly due to the enhanced development of wastewater (Rulkens 2008; Mohajerani et al. 2018). The broad utilization of blocks in the construction field joined with the underlying synthesis of the block, offers a remarkable chance for recycling (Rouf 2003; Abdul Kadir and Mohajerani 2011). Many types of research have been made with the various recycling waste materials in the manufacturing of brick blocks such as petroleum waste, steel slag, saw dust, recycled paper etc., (VEYSEH and Yousefi 2003; Velasco et al. 2014). The balanced out waste can be utilized as a constructional material given that the material has the fundamental engineering properties and drains the harmful contaminants to an adequate degree (Rouf 2003; Hassan et al. 2014). Tanny sludge is effectively used in the construction field as ceramic tiles, concrete, and in engineering properties (Basegio et al. 2002; Montañés et al. 2014). The forthcoming advantage of utilizing sludge waste in a brick block destroys the presence of microorganisms during the firing stage (Alleman and Berman 1984; Okuno and Takahashi 1997). This study reports the investigation made on the manufacturing of bricks using sludge waste and construction and demolition waste. The materials are mixed at different ratios and made to be flowable. The materials used in this study result in sustainable development.

Materials And Experimental Methods

Materials

Fly-ash

Fly-ash is obtained from the thermal power plant. It is a coal ignition product that is made out of particulates that is fine particles of consumed fuel that are driven out of coal terminated boilers along with the pipe gases.

Construction and demolition waste

Construction and demolition waste are typically found at any point of development or destruction happen like extensions, flyovers, streets, and so on. It includes generally idle and non-biodegradable materials like concrete, glass, sand, plastic, gravel, etc.,

Sludge waste

The sludge sample was dried in an oven at 105● C for 1 day. The basic physicochemical characteristics including particle size, pH, basic chemical elements, particle density, organic matter were analyzed. The sludge was incinerated to remove the organic substance.

Results And Discussion

Compressive strength

Compressive strength conforming to the code BS 3921-74 was used. This test is used to analyze the engineering properties of the building material. The standard size of brick blocks is made with different percentages of sludge such as 30%, 40%, and 50% respectively. Fly-ash, cement, and demolition waste were added in different ratios consisting of 3 samples with different percentages of sludge. The various proportion of the mix are 3:2:2, 1:3:2, 2:1:2, 2:3:2, 2:3:1, 2:2:1, 2:2:3, 3:2:1, and 1.5:1.5:2 respectively. From the test results discussed in Table 1, it is observed that increase in the percentage of sludge waste, the compressive strength gradually decreases. This is because the strength of the brick highly depends on the sludge content and temperature applied. The compressive strength of various mixes ranges from 11 Mpa to 15 Mpa. The maximum strength was attained at a ratio of 2:3:2 with 30% of sludge.

Table 1
Compressive strength of concrete

Percentage of sludge	Sample 1	strength (Mpa)	Sample 2	Strength (Mpa)	Sample 3	Strength (Mpa)
30	03:02:02	14.1	02:03:02	14.5	02:02:03	13.9
40	01:03:02	13.8	02:03:01	14	03:02:01	12.5
50	02:01:02	11.7	02:02:01	13.6	1.5:1.5:2	11.6

Bulk density

Bulk density was carried out under the water boiling method. Generally, the brick blocks made with earth typically have a bulk density of 1.4–2.1 g/cm^3. As appeared, the molecule thickness of the brick blocks is inversely corresponding to the amount of sludge. These findings are firmly identified with the amount of water assimilated. From the test results as discussed in Table 2, it is observed that bulk density is a declining slope. The bulk density of the brick block gradually decreased due to the sludge content. The bulk density expanded with the expanding measure of cement as its binding material. At this point, when the combination assimilates more water, the block displays a bigger pore size, coming about in lighter thickness. The terminating temperature can likewise influence the molecule thickness of the block. The results infer that expanding the sludge content outcomes in the reduction of molecule thickness.

Table 2
Bulk density

Percentage of sludge	Sample 1	Sample 2	Sample 3
30	2.72	2.68	2.54
40	2.32	2.27	2.18
50	1.92	1.85	1.8

pH

The synthetic alkalinity or acidity of the blocks was tried with the assistance of the pH meter. The dried sludge has a pH esteems from 6.05–6.40 with a normal of 6.25. the normal pH esteems for muck debris is 8 with a range of 7.8-9. From Table 3, it is seen that increase in the level of sludge content, the alkalinity of the sample also increased. This is primarily because of the presence of different non-metallic and metallic components.

Table 3
pH of the sample

Percentage of sludge	Sample 1	pH	Sample 2	pH	Sample 3	pH
30	03:02:02	7.9	02:03:02	7.5	02:02:03	7.12
40	01:03:02	12.23	02:03:01	15.42	03:02:01	13.9
50	02:01:02	10.12	02:02:01	7.74	1.5:1.5:2	8.12

Water absorption

Water assimilation is a key factor influencing the durability of a block. The less water penetrates the block, results in greater the durability. The interior design of the block escalated enough to resist the water intrusion. From Table 4, increment in the percentage of sludge, the water ingestion was also increased. When the mixture contains a high amount of sludge, the adhesiveness present in the blend diminishes, however the increase in the inner size of the pore. This results in decreasing the workability of the block.

Table 4
Water absorption of brick block

Percentage of sludge	Sample 1	Sample 2	Sample 3
30	0.15	0.21	0.25
40	0.26	0.27	0.31
50	0.3	0.35	0.29

Presence of heavy metals

The detection of heavy metals is carried out under an atomic absorption spectrometer. Table 5 illustrates the presence of heavy metal in sludge.

Table 5
Detection of heavy metals in mg/l

Material	Zn	Cu	Fe	Pb
sludge	2.92	2.36	22.6	2.72

Conclusions

The following conclusions are made from the experimental results

- The brick blocks are made using sludge waste in different percentages such as 30%, 40%, and 50%.

- The various mix proportions were adopted. Out of which, the ratio of 2:3:2 consisting of fly-ash, cement, and demolition waste at 30% of sludge showed a better ratio for manufacturing of brick block.
- The properties of the brick were tested. The better compressive strength was attained at a ratio of 2:3:2 with 14.5 Mpa.
- It is recommended to use 30% of sludge for the preparation of brick blocks.

Declarations

Ethics approval and consent to participate – Not Applicable

Consent for publication – Not applicable

Data Availability – Not applicable

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Author’s contribution – Conceptualization and methodology by Raguraman. Data curation, testing of materials by Deepasree. Arul kumar analysed the properties of brick blocks. All authors participated in writing the manuscript, read, and approved the final manuscript.

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Figures

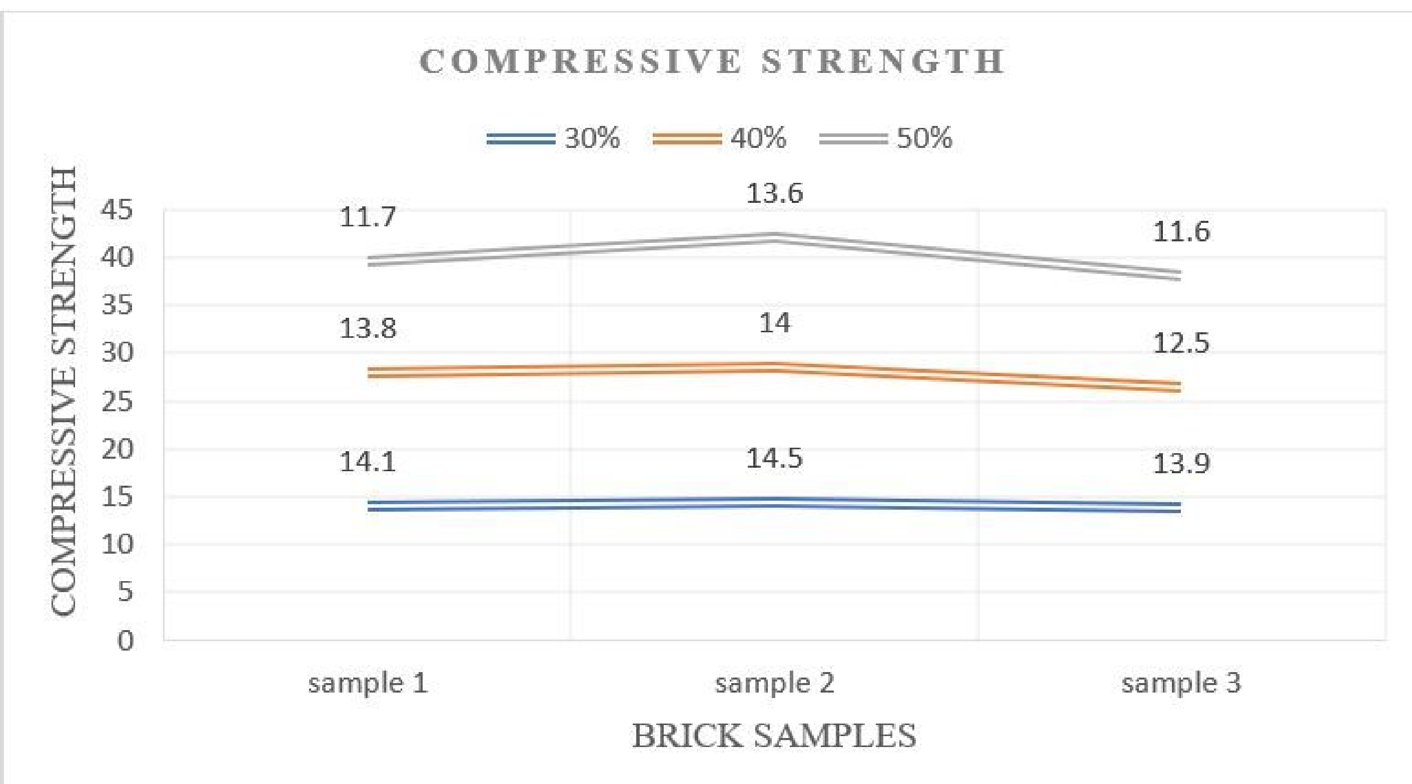

Figure 1

Compressive strength of brick

Figure 2

Brick samples

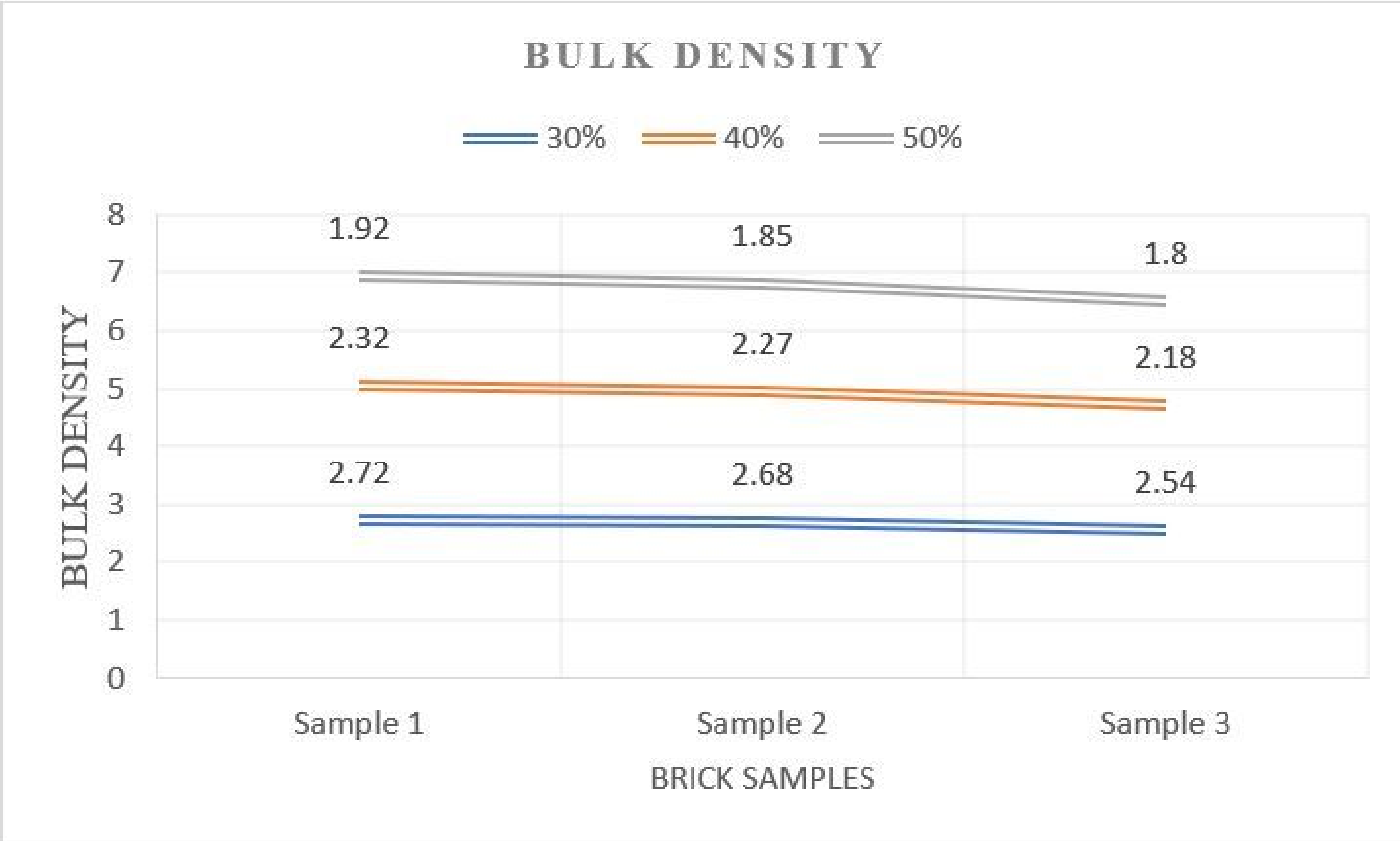

Figure 3

Bulk density of a brick