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# The Effect of Construction Wastes in Concrete Bricks for Load Bearing Wall

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## ABSTRACT

Natural disasters, demolition projects, and construction projects generate massive waste. Materials from demolition, roadwork, and excavation were included in the "construction wastes" category, and more complicated wastes, including cardboard, plastic, metal, and ceramic. The objective of this study focused on the possibility of utilizing construction wastes such as plastic wastes such as reinforcing steel bars, tiles, tie wires, and nails in making effective concrete bricks for the load-bearing wall. Construction wastes such as 10%, 15%, and 20% were used to replace aggregates in concrete. Laboratory tests, such as compressive strength and water absorption tests, were carried out to evaluate replacements on the properties of ordinary Portland cement mixes. Results showed that as the amount of construction waste increases, the compressive strength of brick significantly increases. Also, as the percentage of construction wastes increases, with decreasing sand percentage, the water absorption decreases. Thus, this study on creating sand bricks from construction wastes as a replacement for aggregate is an excellent possibility for utilizing as building and construction material and a workable solution in combating the waste problem.

## INTRODUCTION

Natural disasters, demolition projects, and construction projects generate massive waste. Despite increased efforts to recycle and reuse construction and demolition waste, approximately 35% of the amount produced globally is estimated to be sent to landfills without further treatment (Menegaki & Damigos, 2018). Materials from demolition, roadwork, and excavation are included in the "construction wastes" category, as well as more complicated wastes, including cardboard, plastic, metal, and ceramic. Moreover, the cost of housing structural components is a contributing factor that leads to homelessness and a lack of suitable housing. According to national reports, a minimum of 150 million individuals, or around 2% of the world's population, are thought to be homeless. However, about 1.6 billion, more than 20% of the world's population, lack adequate housing (Chamie, 2017).

The built environment consumes more natural resources than necessary, generating a large amount of waste (Osmani, 2011). Various studies proved that construction wastes are effective replacement for aggregates. According to Rao, Jha, & Misra (2007), using recycled aggregates in concrete provides a promising solution to the problem of construction and demolition waste management problem. Batayneh, Marie, & Asi, 2007 studied the selected waste materials in concrete mixes and proved that demolished concrete, glass, and plastic could be reused successfully as partial substitutes for sand or coarse aggregates in concrete mixtures. The addition of agricultural waste or construction waste in concrete indicates positive and satisfactory strength when compared to normal concrete (Tambichik, Mohamad, Samad, Bosro, & Iman, 2018). In the study of Silva, Delgado, Azevedo, Lima, & Vieira (2021) stated that the mechanical strengths of recycled aggregate concrete produced with recycled fine aggregate were equal or higher than those from the reference concrete. On the other hand, decreases in concrete mechanical strengths were observed, especially in compressive strength, with values around 35% lower when compared to the reference concrete. Tensile mechanical tests results confirmed the excellent behavior of all recycled aggregate concrete made with the replacement of usual fine aggregates by recycled. Still, the most effective way to reduce the waste problem in construction is agreed to implement reuse, recycling and reduction the construction materials in construction activities (Tam & Tam, 2006).

This study aims to ascertain how construction wastes such as steel bars, ceramic tiles, nails, and tie wires affect the production of high-quality concrete bricks for load-bearing walls. Specifically, this study aims to address the problem of decreasing building wastes and successfully using them as parts of reusable structural elements that will replace expensive construction materials. The researcher performed a compression test and a water absorption test.

### Objectives

This study aims to determine the efficacy of using construction wastes such as steel bars, crushed tiles, nails, and tie wires as a partial replacement for aggregates to make concrete bricks meeting the minimum standards of the American Society for Testing and Materials (ASTM) for load-bearing walls. This study specifically sought

American Society for Testing and Materials (ASTM) for load-bearing walls. This study specifically sought to answer the following questions:

1. To calculate the compressive strength of concrete bricks made from construction waste for a load-bearing

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wall; and

2. To determine the water absorption rate of concrete brick for the load-bearing wall using construction waste.

## MATERIALS AND METHODS

This section presents the methodology for making concrete bricks for load-bearing walls from construction wastes. Steel bars, crushed tiles, nails, and tie wires will be collected as construction waste. Similarly, ten (10) kg of river sand were sieved using a mesh size of 4.75 mm to 0.075 mm. Potable water was used to wash the sand to get rid of contaminants. Construction waste is washed separately as well.

The materials were then sun-dried to remove water content and improve efficacy. Steel bars - 10 mm in diameter were cut to lengths ranging from 5 cm to 1 inch. Porcelain tiles were crushed. Tie wires were cut to lengths ranging from 1 to 3 inches. The nails used in this study ranged from 1 to 3 inches. The digital weighing scale was used to weigh the materials.

### Mixing Proportion by Weight

**Table 1:** Materials' Mixing Proportion by Weight and Percentage

| Brick Code | A | | B | | C | |
|---|---|---|---|---|---|---|
| | Kg | % | Kg | % | kg | % |
| Cement | 1.0 | 33.33 | 1.0 | 33.33 | 1.0 | 33.33 |
| Sand | 1.7 | 56.67 | 1.55 | 51.67 | 1.4 | 46.67 |
| Wastes | 0.3 | 10.00 | 0.45 | 15.00 | 0.6 | 20.00 |
| Total | 3.0 | 100.00 | 3.0 | 100.00 | 3.0 | 100.00 |
| Breakdown of Wastes | at 10 % Wastes | | at 15 % Wastes | | at 20 % Wastes | |
| | Mass, g | Mass, % | Mass, g | Mass, % | Mass, g | Mass, % |
| Steel Bars | 150.00 | 50.00 | 225.00 | 50.00 | 300.00 | 50.00 |
| Crushed Tiles | 75.00 | 25.00 | 112.50 | 25.00 | 150.00 | 25.00 |
| Nails | 37.50 | 12.50 | 56.25 | 12.50 | 75.00 | 12.50 |
| Tie Wires | 37.50 | 12.50 | 56.25 | 12.50 | 75.00 | 12.50 |

(a) Nails (b) River sand (c) 10 mm Steel bars

(d) Galvanized iron wires (e) Portland cement (f) Porcelain tiles

**Figure 1:** Materials in Making Concrete Bricks

**Sand Brick Testing**

Compression and water absorption testing are the two types of testing required for this investigation.

The compressive strength of the concrete bricks was measured using the universal testing machine. For each brick mixture of concrete brick, three (3) samples have typically been evaluated as per the American Society for Testing and Materials, ASTM C90. Finally, each sample's compressive strength was recorded, along with any unusual characteristics like the failure of the sand bricks.

Sand bricks, conversely, can absorb or release moisture due to their dryness and porosity. If the brick is dry, it will absorb water, weakening the mortar and lowering the overall structural strength. The IS 3495 (Part 2) 1992 water absorption test was carried out with this. Before obtaining the individual dry mass (M1) using the digital weighing scale, specimens must be air-dried and cooled at room temperature. The dried samples were then submerged for twenty-four (24) hours in clean, fresh water at a temperature of 27°C ± 2°C. After spending twenty-four (24) hours submerged, the specimens were taken out, and any water residue was cleaned using a damp cloth. Three (3) minutes after being taken out of the water, the digital weighing scale measured each specimen's wet mass (M2). A good quality brick does not absorb more than 20% of the water it comes in contact with. Lastly, the following formula was used to calculate the percentage of water absorption:

$[(M_2 - M_1)/M_1] \times 100$. ----------------- (1)

## RESULTS AND DISCUSSION

This section discusses the findings of various tests conducted on concrete brick, including testing for compressive strength, and water absorption. The minimum specifications for bricks are also covered in this section to compare their effectiveness and quality. This explores the potential for producing concrete bricks that meet the quality requirements established by the American Society for Testing and Materials (ASTM) for a load-bearing wall utilizing construction wastes such as steel bars, tiles, tie wires, and nails.

### The Effect of Varied Concrete Brick Mixture on Compression Test

The table provides the information on the maximum load and compressive strength of the varied brick mixture.

**Table : 2** Compressive Strength Test Results

| Brick Code | No. of Samples | Average Compressive Strength in psi | Remarks |
|---|---|---|---|
| A | 3 | 2,105.05 | Passed |
| B | 3 | 2,445.93 | Passed |
| C | 3 | 3,014.51 | Passed |

Also, the data on mass and density was provided for the different concrete brick specimens.

Table 2 displays the results of the compression test. Likewise, the minimum criteria for net area compressive strength set by the ASTM C90 - Standard Specification for Load-Bearing Masonry Units is 1,900 psi (13.10 MPa). Based on the findings, an average of three bricks from each brick sample exceeded the 1,900 psi standard for load-bearing masonry units. Brick C, which has an average strength of 3,014.51 psi, has the maximum compressive strength after 28 days of curing. However, the results show that the compressive strength of brick dramatically increases with an increase in building waste. On the other hand, Mixtures A and B, 2,105.05 and 2,445.93 psi, respectively, meet the ASTM C90 criterion.

**Figure 2:** Specimens subjected to the Universal Testing Machine (UTM)

**The Effect of Varied Concrete Brick Mixture on Water Absorption**

Table 3 contains data on water absorption, including the dry mass, wet mass, and absorption percentage. Because of their dryness and porosity, concrete bricks can absorb or discharge moisture content. If the brick is dry, it will absorb water, making the mortar frail and poor, reducing its overall strength.

**Table : 3** Water Absorption Test Result

| Brick Code | Dry Mass, M1 | Wet Mass, M2 | Percentage, % | Remarks |
|---|---|---|---|---|
| A | 1,515.50 | 1,591.50 | 5.15 | Passed |
| B | 1,546.50 | 1,623.50 | 4.98 | Passed |
| C | 1,567.00 | 1,615.50 | 3.10 | Passed |

Following the water absorption test, table 3 revealed excellent performance on the various concrete brick specimens. The results showed that as the percentage of construction wastes increased, water absorption decreased with decreasing sand percentage. It implies that the lower the water absorption rate, the higher the quality of the concrete brick. Hence, Brick A, with 10% construction waste and 56.67% sand, has a water absorption percentage of 5.15%. Brick B, which contained 15% construction waste with 51.67% sand, had a water absorption of 4.98%. The result indicated that the absorption rate increased by 0.17%. Brick C contained 20% construction waste and 46.67% sand, with the lowest water absorption percentage of 3.10%. The result showed an increase in the absorption rate by 1.88%. All brick specimens met or exceeded the requirement set by the IS 3495 (Part 2) 1992. The acceptance criteria for the water absorption test on bricks must not exceed 20%. As a result, construction waste improves the performance of concrete bricks.

## CONCLUSION

The study's findings are based on the conducted test, which utilizes construction wastes such as steel bars, crushed tiles, nails, and tie wires to make concrete brick a construction material for load–bearing walls. This study aims to produce high-quality, reliable, and effective concrete bricks as a load-bearing construction material. The results from the different tests conducted show numerous findings. First, it was found that construction wastes for concrete brick significantly alleviate the effects of solid waste. Second, data from the conducted compressive strength test shows that all the brick specimens have surpassed the 1,900 psi (13.10 MPa) minimum requirement prescribed by the ASTM C90 - Standard Specification for Load Bearing Masonry. On the other hand, the optimum combination is the data signifying the use of 20% construction waste in proportion to the total weight of the mixture. Third, by conducting the IS 3495 (Part 2) 1992 water absorption test, the specimens obtained less than 20% absorption on various concrete brick specimens, signifying an excellent standard. It also means that water absorption decreases as the percentage of household waste increases. Due to these results, creating concrete bricks from construction wastes as an alternative building and construction material for the load-bearing wall is highly probable and considerable, as it is an effective solution to reduce the effect of construction waste.

Based on the findings and the conclusions, the following are recommended: steel bars must be increased to 1.5 cm to 2 inches as the standard specification of ASTM mold, and it can be tested to see if there is a substantial difference in compressive strength and water absorption between bigger and smaller steels. Thorough cleaning of tarnished steel must be observed to avoid contamination of concrete bricks. Tiles must be pulverized to avoid lumps and obtain the maximum density, water absorption, and compressive strength. Steel mold dimensions must follow the specifications of the ASTM standards. Future researchers should focus more on the effectiveness and quality of concrete bricks in terms of flexural, and efflorescence.

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