Comparative study of conventional bricks with Padobe

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Abstract. In this study the properties of conventional brick compared with the brick made with Padobe. Padobe is a mixture of clay, paper pulp and water. Here we have added GGBS into this mixture. A composite material of the brick that having moderate physical and mechanical characteristics, which mainly helps the business industry like as construction. The addition of paper pulp and GGBS in clay helps in the reduction of environmental issues and cost of construction. Paper pulp is kept as constant and the other materials like clay and GGBS is done with various proportions such as 70:20:10, 60:30:10, 50:40:10 and 40:50:10. An experimental study has been conducted for optimize the mix of Padobe depending on the compressive strength.

1. Introduction
Due to the huge requirement has been fixed on construction elements business specifically in the recent decade due to the raising community it causes a persistent scarcity on building elements, designer have been confronted to turn the manufacturing wastes to appropriate construction materials. It is huge time we wish to find the best substitute which must be cost effective as well as eco friendly. The maximum waste paper is assembled from various region causes certain environmental issues. This article presents an experimental investigation which analyse the suitable utilize of waste paper and GGBS for providing an energy retaining, cost - effective and less weight blended brick as a construction element. [1] Due to the lesser weight of Padobe, the self weight of the structure is reduced. It do not expand or contract due to the presence of fiber content in the Papercrete [2]. Increment of paper pulp essence in the mix compression strength is gradually reducing. [3] The sun dried Papercrete bricks gives that increase in compression strength whereas water cured bricks infers the reduction in the number of curing days. [4] It is light in weight when compared to conventional brick. Padobe bricks are better sound absorbent. The density of Padobe brick is lesser than the normal brick. By sing this paper pulp waste material in brick decreases the landfill. [5] The water absorption is greater when the essence of GGBS is lesser and the compression strength is low when the GGBS essence is lesser. [6] Papercrete Bricks neither consumes energy nor emits pollutants and hence gives an economical choice to design GREEN Buildings. The water retention of Papercrete brick was found to be greater than 20%, this makes it not worthy for external walls. [7] Paper pulp and clay results in a porous blended material, it infers high crushing and shear strength when compared to other low density material.

1.1. Objectives
- To determine the characteristics of material used.
To compare the compression strength, hardness, soundness, efflorescence, dry density, water absorption value of Padobe brick with normal brick.

To replace normal bricks by an innovative and sustainable material (Papercrete and GGBS).

2. Materials used

2.1. Clay
Clay consists of huge proportion of fine fragments and colloidal material. Clay is used as the binding material for Padobe. The physical properties of clay such as plastic limit, liquid limit and plasticity index are determined and tabulated in table 1. The image of the clay is shown in figure 1. Atterberg limit test was conducted and observed the limit of plastic and liquid.

![Figure 1. Clay.](image1)

2.2. Paper pulp
The waste paper was collected and cannot be utilized directly. The papers were weighed and soaked in a tank for two to three days or till the papers become into a paste. Waste Paper is collected from the industry, which was shown in figure 2.

![Figure 2. Paper pulp.](image2)

2.3. GGBS
Ground granulated blast furnace slag is a by-product procured in the making treatment of iron in blast kiln. This process generates a lustrous and granular material which has pozzolanic characteristics. GGBS in off white colour in appearance which was given in figure 3.

![Figure 3. GGBS.](image3)
2.4. Water
Water is an essential constituent of Padobe as it vigorously takes part in the synthetic response with clay. It shall be free from impurities. pH value of water lies between six and seven.

3. Mix proportion of Padobe
The proportioning of mix used in Padobe is calculated by trail mix. Padobe mix contains clay, paper pulp, GGBS and water. Weigh batching was followed in this study. Therefore the material was measured in kg. GGBS was mixed with clay in a dry condition thoroughly until homogeneous color is obtained. Next the paper pulp is added in drenching condition then water is added to obtain adequate consistency

| Mix Id | Clay (%) | Paper pulp (%) | GGBS (%) | Weight of clay (kg) | Weight of paper pulp (kg) | Weight of GGBS (kg) |
|--------|----------|----------------|----------|--------------------|----------------------------|-------------------|
| P₁     | 70       | 10             | 20       | 2.81               | 0.19                       | 0.30              |
| P₂     | 60       | 10             | 30       | 2.41               | 0.19                       | 0.54              |
| P₃     | 50       | 10             | 40       | 2.01               | 0.19                       | 0.72              |
| P₄     | 40       | 10             | 60       | 1.61               | 0.19                       | 0.90              |

3.1. Mixing and casting
Each and every ingredients of Padobe is mixed together before adding water to the mix as given in figure 4. The clay starts to experience a reaction as soon as paper pulp and water is added to the mixture, which acts as a bonding agent. The operation of specimen casting and drying was mentioned in figure 5. Once the specimen was casted then it is dried and burnt as shown in figure 6.

Figure 4. Mixing of Clay and GGBS.
4. Results and discussion
This stretch generally examines the performance of Padobe brick with normal brick.

4.1. Weight of padobe
The weight of the normal brick is compared with the Padobe brick and tabulated in the table 2. The weight of the Padobe is less when compared to the normal brick.

| Mix Id | Conventional brick (kg) | Padobe brick (kg) |
|--------|--------------------------|-------------------|
| P₁     | 2.13                     |                   |
| P₂     | 1.97                     |                   |
| P₃     | 3.05                     | 1.77              |
| P₄     | 1.63                     |                   |
4.2. Water absorption test
Water Absorption experiment is carried out to determine the water absorbent percentage. The readings were tabulated in table 3.

**Table 3.** Comparison of water absorption of Padobe brick with normal brick.

| Mix Id | Water absorption (%) |
|--------|----------------------|
| P₁     | 25                   |
| P₂     | 23                   |
| P₃     | 20                   |
| P₄     | 18                   |

The Figure 7 shows that the water absorption slight decreases with the increase in the addition of clay, GGBS and constant proportion of paper pulp.

![Water absorption results](image)

4.3. Compression test
Compression test conducted on the Padobe bricks in the compression testing machine and the readings are tabulated in the table 4. The crushing strength of normal brick is 7.06 N/mm². It is coming under the category of second class. While comparing the Padobe crushing vale with normal brick, a steady increment in different mixes P₁, P₂, P₃ and P₄ such as 2.124%, 4.81%, 7.5% and 3.25%. Among these values obtained P₃ achieves maximum crushing strength.

**Table 4.** Compression strength comparison of Padobe brick with normal brick.

| Mix Id | Compression strength (N/mm²) |
|--------|-------------------------------|
| P₁     | 7.21                          |
| P₂     | 7.40                          |
| P₃     | 7.59                          |
| P₄     | 7.29                          |

Figure 8 indicates that the compression strength of the Padobe brick varies with a addition of paper pulp and GGBS. The compression strength increases up to 50% clay, 40% GGBS and 10% paper pulp and then reduces.
4.4. **Testing of Efflorescence**
This experiment is used to determine the presence of soluble salts (Figure 9). It is conducted in a tub filled with water at a depth of 2.5 cm with a temperature range of 68°F to 86°F. Next the normal and Padobe bricks are immersed in the water until the water is absorbed completely and then it is dried in shade. The crushing strength is maximum at P3. So considering P3 for the efflorescence experiment. It is concluded that the normal and Padobe bricks have less than ten percentage of the revealed area of brick is wrapped with a slim deposit.

![Figure 9. Presence of soluble salts.](image)

4.5. **Testing of Soundness**
In this experiment two P3 specimens were taken with same fraction and they were smacked with each other. A clear ringing sound was generated which indicates the bricks obtained quality results. The figure 10 shows the soundness test carried out.
5. Conclusion

From the above experimental studies, following conclusions were made:

- Padobe brick may be a substitute source in the future building and construction industry.
- The utilization of Padobe bricks uses the paper pulp due to this it decreases the landfills and pollution. The crushing strength of Padobe is maximum at p3 is 7.5% when compared to other mixes.
- The compression strength increases up to certain percentage of the mixture of clay, paper pulp and GGBS and then it reduces.
- The weight of the normal brick is more when compared to the Padobe.
- Since the water absorption is high, these bricks cannot be used for water logging and external walls. This range lies between second class brick.

6. References

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Figure 10. Soundness test.