A study on Different Bricks & Identification of Quality of Bricks Based on Existing Data
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Abstract:

The purpose of this study is to investigate the different types of bricks as a construction material. In this study, monitoring different technical specification or characteristics of the bricks. At the end of study, Brick Quality Index (BQI) evaluated. According to BQI, bricks were classified poor to excellent quality.

[Keywords: Bricks, Bricks Types, Technical Specification of Bricks, Building Materials, Brick Quality Index]
1. Introduction:

Bricks is one of the most important construction materials. Bricks may be manufactured from clay, shale or combination of these materials [1]. Other materials such as Silica, Alumina, Lime, Iron oxide, Magnesia may be used for manufacturing good quality brick [2]. Depending on manufacturing process, uses, shape bricks can be classified as different types [4]. In this study some general types of bricks will be investigated with their technical specification including dimension, visual appearance, compressive strength, average water absorption (%), efflorescence characteristics and unit weight. On the basis of manufacturing & preparation burnt clay bricks can be classified as 1\textsuperscript{st} class, 2\textsuperscript{nd} class, 3\textsuperscript{rd} class bricks. Based on constituent materials bricks can be classified as Common Burnt Clay Bricks, Sand Lime Bricks (Calcium Silicate Bricks), Engineering Bricks, Concrete Bricks, Fly ash Clay Bricks etc. [2].

To know the quality of bricks different tests are performed such as Compressive strength test, Water Absorption test, Efflorescence test, Visual appearance test etc. [2,5,9]. Water absorption results represents in percentages and for good quality value is less than 20% [4,11]. Larger compressive strength indicates higher stability, efflorescence test finds out the presence of alkalis which is very essential for building structures [2].

In this study all of these test results for several bricks collected and analyzed for final outcomes. Hope this study will be helpful for knowing some general types of bricks with their technical specification and create a new dimension for further brick quality investigation.

2. Materials and methods:

This study includes data collection, data rearrangement, analysis and final outcomes. The data were collected from several existing study [1, 3-14]. After collection, data were analyzed by MS Excel 2016 software. First general technical specification was identified, after that some plots were generated for comparative study among different bricks type. At the end of the study Bricks Quality Index (BQI) was evaluated to know the quality of several types of bricks.

For brick quality evaluation the steps were followed as bellow:
1. Rating the specification/ characteristics of bricks from 1 to 5. Where 1 for poor quality, 2 for slightly poor, 3 for moderate, 4 for good and 5 stands for excellent quality of bricks.

2. The rating is provided based on some general class. For example, first considering the value of compressive strength (kg/cm²). According to this, bricks are classified as poor (which has 0-30 kg/cm² compressive strength), slightly poor (which has 31-75 kg/cm² compressive strength), moderate (which has 76-100 kg/cm² compressive strength), good (which has 101-140 kg/cm² compressive strength), excellent (which has >141 kg/cm² compressive strength). When bricks are classified as poor then rated it 1, rated 2 for slightly poor, rated 3 for moderate, 4 for good and 5 for excellent class of bricks.

3. Similarly, for water absorption (%), unit weight (kg/m³) and efflorescence the bricks were classified as Table-1.

Table-1: Classification of bricks based on different characteristics.

| Water Absorption | Unit weight (kg/m³) | Efflorescence |
|------------------|--------------------|---------------|
| >25 poor         | 0-670 poor         | Large: poor   |
| 22-25 slightly poor | 671-1340 slightly poor | Little: slightly poor |
| 20-22 moderate | 1341-1680 moderate | Slight: moderate |
| 16-19 good | 1681-2000 good | Nil-slight: good |
| 0-15 excellent | >2000 excellent | Nil: excellent |

4. After that, all of rating value averaged to obtain the Brick Quality Index (BQI).

5. Based on BQI the bricks were identified as poor to excellent quality. Bricks were identified as poor when (0< BQI<2), bricks were specified as slightly poor when (2<BQI<3), moderate when (3<BQI<4), Good when (4< BQI<=4.5), better BQI (4.5< BQI<5), excellent BQI=5.

3. Results & Discussion:

3.1. General characteristics:

The general characteristics of several types of bricks displayed in Table-2. The table includes the visual appearance of bricks, dimension of bricks (Length, weight and height), water absorption rate (%), compressive strength (kg/cm²), Efflorescence and unit weight (kg/m³).
Table-2: General Characteristics of Bricks.

| Types of Bricks                  | Image | Ave. Dimensions (+0.3/-0.3) (in cm) (L*W*H) | Appearance test (visual)                                                                 | compressive strength (kg/cm²) | Ave. water absorption (%) | Efflorescence test (Tendency to efflorescence) | Ave. Dry oven weight (kg) | Ave. Wet weight (kg) | Unit weight (kg/m³) |
|---------------------------------|-------|--------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------|--------------------------|-----------------------------------------------|---------------------------|-------------------|-------------------|
| 1st class bricks                |       | 24 x11.5 x7                                | Sound, hard, well burnt, uniform size, shape and color, homogenous in texture         | 140-170                     | 20% of dry weight        | Nil                                           | 3 - 3.5 kg     | 3.75-4.5 kg       | 2000              |
| Picked jhama bricks             |       | 24 x11.5 x7                                | Over burnt 1st class brick                                                            | 170-210                     | <15%                     | Nil                                           | 3 - 3.5 kg     | 3.51-4.11 kg      | 2000              |
| 1st class machine made bricks   |       | 20 x 10 x 5                                | Rectangular faces with parallel sides and shape                                        | 210                         | 10%                      | Nil                                           | 2.5 - 3 kg     | 3.11 (average)   | 2800              |
| Clinker Bricks                  |       | 20.3 x10.2 x5.1                            | Square, straight, sharply, shiny, dark-colored coating                                | 562                         | 12-15 %                  | Nil                                           | 3.1 kg         | 3.56 kg           | 1601-1794         |
| Material                   | Dimensions                  | Color Description                                      | Strengths                       | Weights               | Classification       |
|----------------------------|-----------------------------|--------------------------------------------------------|---------------------------------|-----------------------|----------------------|
| Chamber clay bricks        | 20x 10 x 5                  | Reddish                                                | 80.86                           | 10.54%                | Nil - slight based on class | 0.563 0.629 562.7    |
| Fly-Ash Bricks             | 10.8 x 10.5 x 5.8           | very attractive color like cement                       | 97.93                           | 13.52%                | Slight               | 1.151 1.133 1805.5    |
| Porothem Blocks            | 39.5 x 20 x 15.2            | Block color is Red                                     | 14.86                           | 14%                   | slight               | 8.906 10.42 741.6     |
| AAC Blocks                 | 10.2 x 6.1 x 6              | Attractive Appearance (white)                          | 33.55                           | 59.68%                | Nil                  | 0.722 1.791 1885.6    |
| CLC Blocks                 | 20.4 x 10.3 x 5.3           | Color like Cement                                      | 25.44                           | 8.72%                 | moderate             | 1.077 1.179 972.2     |
| Concrete Brick             | 21.5 x 10.25 x 6.5          | Attractive Flat, smooth, sharp                         | Around 250                      | 11.23%                | slight               | 2.08 – 3.09 2.34 – 3.47 1450-2150 |
| Common burnt clay bricks   | Standard size: 23*11*7.6 cm | Red copper color, sharp edges and smooth surfaces      | 1st class: 109-350              | <15%                  | Nil                  | 1600 - 1900 Kg/m3     |
|                            | 1st class modular(L*W*H): | 19*9*9 or 19*9*4                                      |                                 |                       |                      | 3.75-4.5 kg           |
|                            | 2nd class Non modular(L*W*H): | Red, Irregular, sharp edges                            | 2nd Class: 75                  | <20%                  | little               |                      |
|                            | 3rd Class:                 | Red,                                                   |                                 | <25%                  | large                | 1100                 |
| Type                        | Class         | Dimensions (mm) | Description                                                                 | Hardness | Moisture Content (%) | Density (kg/m³) |
|-----------------------------|---------------|-----------------|------------------------------------------------------------------------------|----------|----------------------|-----------------|
| Engineering bricks          | 3rd class     | 23*11*7 or 23*11*3 | rough and have unfair edges                                                 | 35-70    | 10%                  | 2.2-2.5         |
| Calcium silicate bricks/Sand lime bricks |               | 24 x 12.1 x 6.98 | Red/ Blue, smooth finish with perforations through the top to the bottom    | Class A: >760 | 14%                  | 102             |
|                             |               |                 | Class B: >1270                                                              |          |                      |                 |
| Perforated Brick            |               | 20 x 10 x 5     | Any regular shape in cross section                                         | 70-210   | 12%                  | 2.8- 3.1 kg     |

- Class A: >760
- Class B: >1270

Note: The density values are approximate and may vary based on specific conditions.
3.2 Comparison of different properties of Bricks

3.2.1 Average compressive strength of bricks type

Figure-1 represents the average compressive strength of several bricks. The outcomes clarify that engineering bricks have larger compressive strength than others. Clinker bricks have also larger compressive strength. In case of different blocks such as porotherm blocks, AAC or CLC blocks compressive strength is lesser. The lower value indicates lower crushing strength that means lower pressure required to break the bricks. It also indicates lower stability of bricks.

![Average compressive strength of bricks type](image)

3.2.2 Average water absorption rate of different bricks type

The water absorption test performed by weighting the bricks at dry condition and weighting these after 24 hours immerged in fresh water. The lower value of water absorption represents good quality. In reverse the higher value of water absorption represents poor quality. It can be noticed that the water absorption rate for 1st class bricks, engineering bricks and 1st class machine made bricks are low which clarify these are good quality bricks. In case of AAC blocks, 2nd class or 3rd class bricks the water absorption rate is comparatively high which indicates the lesser quality. Figure-2 displayed the results.
3.2.3 Average unit weight of different bricks:

Unit weight represents the weight of any materials per unit volume. This weight helps to evaluate the structure’s weight, to specify the load which the structure of such materials can carry, to quantify the amount of material required for specific space, to determine whether the materials will sink or float on water [10]. So, the unit weight of material is more important for any construction purpose. The figure-3 showed the unit weight of different types of bricks. The result clarifies that the unit weight of 1st class machine made bricks and perforated bricks are high on the other hand for chamber clay bricks this value is low.

![Figure-3: Average unit weight of different bricks](image-url)

| Material Type                  | Unit Weight (kg/m³) |
|--------------------------------|---------------------|
| 1st class bricks              |                     |
| Picked jama bricks            |                     |
| 1st class machine made bricks |                     |
| Clinker bricks                |                     |
| Chamber clay bricks           |                     |
| Fly ash bricks                |                     |
| Porotherm blocks              |                     |
| AAC blocks                    |                     |
| CLC blocks                    |                     |
| Concrete bricks               |                     |
| Common burnt clay 1st class bricks |             |
| Common burnt clay 2nd class bricks |             |
| Common burnt clay 3rd class bricks |            |
| Engineering bricks            |                     |
| Calcium silicate/sand lime bricks |           |
| Perforated bricks             |                     |
3.3 Bricks Quality Index Evaluation

The quality of different types of bricks displayed in Table-3. The results indicated that the quality of 1\textsuperscript{st} class machine made bricks and engineering bricks are excellent. Clinker bricks, Picked Jama bricks are of better quality. The quality of 3\textsuperscript{rd} class bricks poor. Slightly poor-quality construction materials are porothem blocks, CLC blocks, 2\textsuperscript{nd} class bricks etc.

Table-3: Quality of different types of bricks.

| Types of Bricks                  | Ave. compressive strength (kg/cm\(^2\)) | unit weight (kg/m\(^3\)) | Ave. water absorption (%) | Efflorescence | Bricks Quality Index (BQI) | Quality     |
|----------------------------------|----------------------------------------|--------------------------|---------------------------|---------------|---------------------------|-------------|
| 1st class bricks                 | 5                                      | 4                        | 4                         | 5             | 4.5                       | Good        |
| Picked Jama bricks               | 5                                      | 5                        | 4                         | 5             | 4.75                      | Better      |
| 1st class machine made bricks    | 5                                      | 5                        | 5                         | 5             | 5                         | Excellent   |
| clinker bricks                   | 5                                      | 5                        | 4                         | 5             | 4.75                      | Better      |
| chamber clay bricks              | 3                                      | 5                        | 1                         | 4             | 3.25                      | Moderate    |
| fly ash bricks                   | 3                                      | 5                        | 4                         | 3             | 3.75                      | Moderate    |
| porothem blocks                  | 1                                      | 5                        | 2                         | 3             | 2.75                      | Slightly poor |
| AAC blocks                       | 2                                      | 1                        | 4                         | 5             | 3                         | moderate    |
| CLC blocks                       | 1                                      | 5                        | 2                         | 3             | 2.75                      | slightly poor |
| concrete bricks                  | 5                                      | 5                        | 4                         | 3             | 4.25                      | good        |
| common burnt clay 1st class bricks | 5                                      | 5                        | 4                         | 5             | 4.75                      | Better      |
| common burnt clay 2st class bricks | 2                                      | 4                        | 3                         | 2             | 2.75                      | slightly poor |
| common burnt clay 3rd class bricks | 2                                      | 2                        | 2                         | 1             | 1.75                      | poor        |
| engineering bricks               | 5                                      | 5                        | 5                         | 5             | 5                         | Excellent   |
| calcium silicate/sand lime bricks | 4                                      | 5                        | 3                         | 5             | 4.25                      | good        |
| perforated bricks                | 4                                      | 5                        | 5                         | 5             | 4.75                      | Better      |
4. Conclusions:

- For compressive strength, it can be seen that engineering bricks and clinker bricks have high compressive strength. On the other hand, different types of blocks such as porotherm blocks, AAC, CLC, and 3rd class bricks also have lower compressive strength.
- The good quality bricks have lower water absorption rate but poor-quality bricks have higher water absorption rate.
- For excellent or good quality bricks efflorescence is nil, compressive strength high, water absorption low and unit weight is also high.
- According to BQI 1st class machine made bricks & engineering bricks classified as excellent quality bricks, Picked Jama bricks, clinker bricks, common burnt 1st class bricks classified as better quality, concrete bricks, calcium silicate/sand lime bricks classified as good quality bricks, 2nd class blocks, porotherm blocks etc. classified as slightly poor and common clay burnt 3rd class bricks classified as poor-quality bricks.

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