SONARGAON UNIVERSITY (SU)

Project & Thesis
CE 400

“Laboratory Based Analysis of Bricks for Construction Purpose."

A Project report is submitted to the Department of Civil Engineering of
Sonargaon University in partial fulfillment of the requirements
Degree of Bachelor of Science in Civil Engineering

Submitted By

Md. Imamul Hasan	ID. No: BCE 1602008227
Md. Ashikur Rohman	ID. No: BCE 1602008226
Kashem Mia	ID. No: BCE 1602008204
Md.Golam Mostofa	ID. No: BCE 1602008202
Sultana Parvin	ID. No: BCE 1602008223

Supervisor

Quazi Faisal Bari Purno
Lecturer
Department of Civil Engineering
Sonargaon University (SU)
Dhaka, Bangladesh.

Date of Submission: January 2020

DEDICATION

Dedicated to our beloved parents for their unconditional support and love.

LETTER OF TRANSMITTAL

Fall, 2019

To
Quazi Faisal Bari Purno

Lecturer,

Department of Civil Engineering

Sonargaon University (SU)

Dhaka, Bangladesh.

Subject: Submission of Project Report.

Sir,

With due respect, we are hereby very pleased to submit the project paper on **"Laboratory Based Analysis of Bricks for Construction Purpose"**. This report will give an overview on problems typically faced in constructions as well as their remedial measures. It has been great pleasure for us to work on such a Valuable particular regarding current century. The project work has been done according to the requirement of the Sonargaon University of Bangladesh. in the partial fulfillment of the requirements for the degree of B.Sc. in civil Engineering.

We ensure to be very happy to provide any assistance in interpreting any part of the paper whenever necessary**.**

Thanking you,

Sincerely Yours

Md. Imamul Hasan	ID. No: BCE 1602008227
Md. Ashikur Rohman	ID. No: BCE 1602008226
Kashem Mia	ID. No: BCE 1602008204
Md.Golam Mostofa	ID. No: BCE 1602008202
Sultana Parvin	ID. No: BCE 1602008223

DECLARATION

It is expressed that "**Laboratory Based Analysis of Bricks for Construction Purpose**" has been performed under the supervision of Quazi Faisal Bari Purno, Lecturer, Sonargaon University, (SU) Dhaka. To the best of our insight and conviction, the undertaking report contains no material beforehand distributed or composed by someone else with the exception of where due reference is made in the report itself.

We further undertake to indemnify the university against any loss or damage arising from breach of foregoing obligations.

1. …… Md. Imamul Hasan ID. No: BCE 1602008227	4. …… Md.Golam Mostofa ID. No: BCE 1602008202
2. …… Md. Ashikur Rohman ID. No: BCE 1602008226	5. …… Sultana Parvin ID. No: BCE 1602008223
3. …… Kashem Mia ID. No: BCE 1602008204	

SONARGAON UNIVERSITY (S U)

We will rise up, we will shine

CERTIFICATION

This is to certify that the project report "**Laboratory Based Analysis of Bricks for Construction Purpose**" is the confide record of project work done by Md. Imamul Hasan, Md. Ashikur Rohman, Kashem Mia, Md.Golam Mostofa & Sultana Parvin. The partial fulfillment of the requirements for the degree of B.Sc. in Civil Engineering from the Sonargaon University of Bangladesh (SU).

This project work has been carried out under my guidance and supervision and is a record of successful work.

Supervisor,

Quazi Faisal Bari Purno
Lecturer,
Department of Civil Engineering
Sonargaon University (SU)
Dhaka- Bangladesh.

ABSTRACT

The study was conducted in the Department of “Civil Engineering” at “Sonargaon University” with the objects to prepare a project and thesis with a view to partial fulfillment for the requirements of the degree of B.Sc. in Civil Engineering. The specific objective of the study was to find out which brick is more preferable for construction purposes. The study mainly aimed at the investigate quality of bricks by different laboratory test and it's applied to different purposes. To investigate the brick samples were collected from Savar Hemayetpur and Amin Bazar bricks factory for laboratory tests. We have collected five pieces of bricks samples for each 1st, 2nd and 3rd class from every factory. Then, we did some Laboratory-Based Analyses such as compressive strength of brick, percentage of water absorption & unit weight test of bricks. All data have been collected from different books, engineering websites and some data collected from laboratory tests. As per our Laboratory-Based Analyses, we recommended the bricks as construction purposes the “SAN" is the best for 1st class brick, "TAHA" is the best for 2nd class, " MMSB " is the best for 3rd class, as construction purpose.

ACKNOWLEDGMENT

We would like to express our utmost gratitude to our supervisor Lecturer, "**Quazi Faisal Bari Purno"** for all the help providing us to prepare the project paper. His advice, research proficiency has made working on this project as an invaluable experience. He extended his helping hand by providing constant encouragement, inspiration, suggestions and facilities along with the constructive criticism in the form of valuable suggestion. It has been a pleasure working with him.

We would like to thank our families; friends for their mental support throughout this work.

We would also like to thank our Vice Chancellor Professor M.A Razzaque who has given us the opportunity to study in such a decent environment**.**

Md. Imamul Hasan	ID. No: BCE 1602008227
Md. Ashikur Rohman	ID. No: BCE 1602008226
Kashem Mia	ID. No: BCE 1602008204
Md.Golam Mostofa	ID. No: BCE 1602008202
Sultana Parvin	ID. No: BCE 1602008223

TABLE OF CONTENTS

LIST OF TABLES

TITLE **PAGE NO.**

LIST OF FIGURES

CHAPTER 01

INTRODUCTION

1.1 Background

Brick selection is made according to the specific application in which the brick will be used. Standards for brick cover specific uses of brick and classify the brick by performance characteristics. The performance criteria include strength, durability and aesthetic requirements. The selection of the proper specification and classification within that specification, along with proper design and construction, should result in expected performance.

The bricks are kaleidoscopic units accessible in an assortment of sizes, shapes, surfaces, and hues and are produced from mud, shale, or comparable normally happening gritty substances by terminating. It is one of the most established building materials and is widely utilized at present as the main materials development in view of its sturdiness, quality, dependability, minimal effort, simple accessibility and so forth.

Reasonable outline adjusts ecological, monetary and societal objectives. It is something beyond an accreditation from a rating framework. Block is produced using copious characteristic assets (earth and shale) and is promptly reused for use in the assembling procedure or different employments. Block makers address maintainability by finding plants in nearness to mines; consolidating waste items and reused materials into the block; diminishing vitality utilization, water utilities and environmental outflows; and using landfill gas and different squander for fuel.

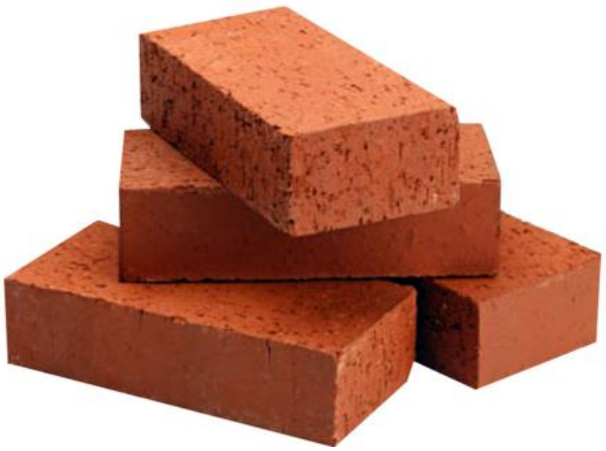


Fig -1.1 Brick

1.2 Objective of The Study

The major objective of this study is to assess the maximum using building bricks quality. Specific objectives are:

1. To determine the compressive strength of bricks.
2. To determine the percentage of the initial rate of water absorption of bricks.
3. To determine the percentage of one day rate of water absorption of bricks.
4. To determine the unit weight of good bricks.
5. To determine the Dimension & Deviation of bricks.

1.3 Structure of The Dissertation

This study report is described and arranged in a chronological and comprehensive way for a better understanding of the topic evaluated from the analysis and findings of the study. This report consists of chapters. Gives a general discretion and objective for brick and brick test. Comprises of comprehensive literature review of the study on bricks classification, properties of bricks, and uses of bricks.

CHAPTER 02
LITERATURE REVIEW

2.1 Characteristics of Good Bricks

The characteristics of a good brick are

1. **Size and Shape:** The bricks should have uniform size and plane, rectangular surfaces with parallel sides and sharp straight edges.
2. **Color:** The brick should have a uniform deep red or cherry color as indicative of uniformity in chemical composition and thoroughness in the burning of the brick.
3. **Texture and Compactness:** The surfaces should not be too smooth to cause slipping of mortar. The brick should have a paracompact and uniform texture. A fractured surface should not show fissures, holes grits or lumps of lime.
4. **Hardness and Soundness:** The brick should be so hard that when scratched by a finger nail no impression is made. When two bricks are struck together, a metallic sound should be produced.
5. **Water Absorption:** Water Absorption should not exceed 20 percent of its dry weight when kept immersed in water for 24 hours.
6. **Crushing Strength:** Crushing strength should not be less than 10 N/mm2.
7. **Brick Earth:** Brick earth should be free from stones, kankars, organic matter, etc.

2.2 Ingredients of Good Brick Earth

For the preparation of bricks, clay or other suitable earth is molded to the desired shape after subjecting it to several processes. After drying, it should not shrink and no crack should develop. Different ingredients present in the good quality brick earth have been shown in the figure below with their percentages.

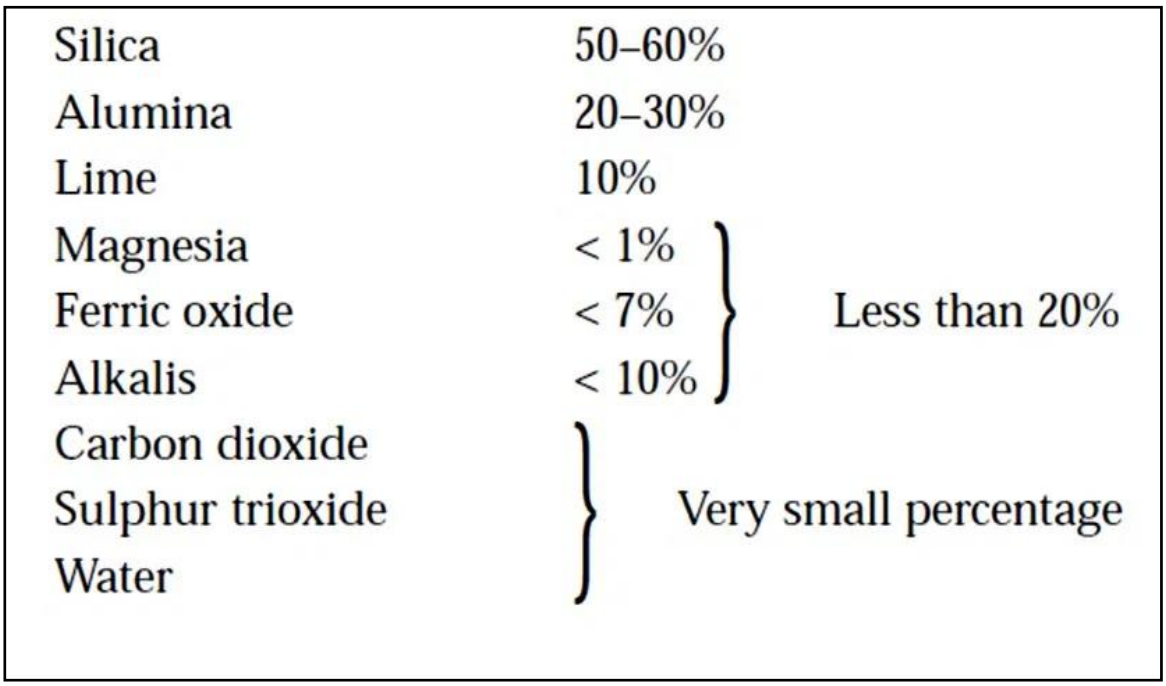


Fig -2.1 Different ingredients present

2.3 Functions of various ingredients

The functions of different substances present in the brick earth have been explained below,

1. **SILICA:** It enables the brick to retain its shape and imparts durability, prevents shrinkage and warping. The excess of silica makes the brick brittle and weak on burning.

2. **ALUMINA:** Alumina absorbs water and renders the clay plastic. If alumina is present in excess of the specified quantity, it produces cracks in brick on drying.

3. **LIME:** Normally lime is added less than 10%. The benefits are,

    - Reduces the shrinkage on drying.
    - It causes silica in the clay to melt on burning and thus helps to bind it.
    - In carbonated form, lime lowers the fusion point.
    - Excess of lime causes the brick to melt and the brick loses its shape.
    - Red bricks are obtained on burning at considerably high temperatures (more than 800°C) and buff-burning bricks are made by increasing the lime content.

4 **MAGNESIA:** Magnesia is rarely exceeding 1 percent, affects the color and makes the brick yellow, in burning; it causes the clay to soften at slower rate than in most case is lime and reduces warping.

5. **IRON:** Iron oxide constituting less than 7 percent of clay, imparts the following properties:

- Gives red color on burning when excess of oxygen is available and dark brown or even black color when oxygen available is insufficient, however, excess of ferric oxide makes the brick dark blue.
- It improves impermeability and durability.
- Tends to lower the fusion point of the clay, especially if present as ferrous oxide.
- It gives strength and hardness.

2.4 Classification of Bricks

The following is the classification of bricks by P.W.D in our country.

1. First class Brick: They should be of uniform size and color, thoroughly and evenly burnt, they should ring clearly when struck. With a hammer or another brick, they should be well shaped with even any Mend. They should not absorb more than one sixth of their weight of water wet in water for 24 hours.
2. Second Class Bricks: These bricks must possess the hardness and color of first-class bricks but are slightly irregular hi shape, size or rough on the surface.
3. Third Class Bricks: These are bricks which are not sufficiently well-burnt sufficiently and of uniform shape and size for use in un-important constructions.

4. First Class Bats: These are broken bricks of the same quality as first- and second-class bricks.
5. Second Class Bats: These are broken bricks of the same quality as first- and third-class bricks.
6. Picked Jhama Bricks: These bricks are uniformly vitrified throughout, but must be of good shape.
7. Jhama Bricks: These are well-burnt bricks but not quite so well shaped as picked Jhama Bricks. They must not be free from cinders and projecting tames and of fairly good shape.
8. Jhama Bats: These are broken bricks of the classes picked Jhama and Jhama bricks.

Bricks are usually made rectangular but they are also made in various special forms to meet the different situation where they are used also to suit to the taste of the uses. Such bricks are called purpose-made bricks and are more costly than ordinary bricks. These are:

1. Perforated Bricks used in building walls.
2. Hollow Bricks used in hollow walls in a building.
3. Checkered Bricks, used in Bricks masonry.
4. Stable Bricks (with grooved pennate).
5. Plinth Bricks.
6. Jam Bricks- Bricks chamfered and rounded to the desired corner, Clinker (paving Brick) for internal flooring. In addition to these, there are other verities of special Bricks. They are mainly used for decorative ornamental purposes.

The Mirpur Ceramic works in Dhaka manufactures various types of special Bricks. A few special Bricks are shown in

2.5 Classification of Bricks

Clay bricks can be classified according to their varieties, qualities, and classes.

2.6 Common Bricks

Common burnt clay bricks, which are accepted for use in general brick work with no special claim for attractive appearances. Walls built with common bricks require rendering or plastering.

Fig -2.2 Common Bricks

2.7 Facing Bricks

Quality burnt clay bricks, which give attractive appearance in their color and texture. It is used without rendering, plastering, or other surface treatments.

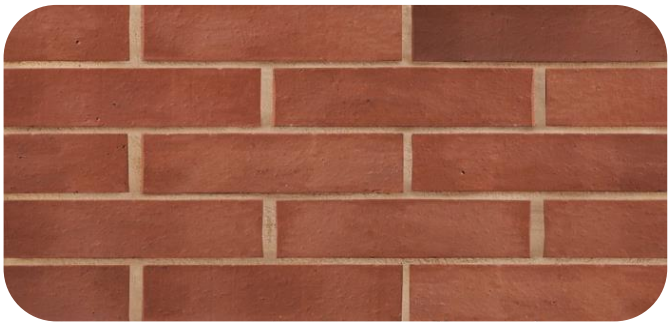


Fig -2.3 Facing Bricks

2.8 Load bearing Bricks

Load bearing bricks, which can be either common or facing bricks, conform to specified average compressive strength limits depending on their classes as given in table below.

Class	Average Compressive Strength	
	N/mm^2	P.S.I.
1	7.0	1,000
2	14.0	2,000
3	20.5	3,000
4	27.5	4,000
5	34.5	5,000
7	48.5	7,000
10	69.0	10,000
15	103.5	15,000
*** Based on British Standard 3921: 1965**		

Table -2.4 Average Compressive Strength

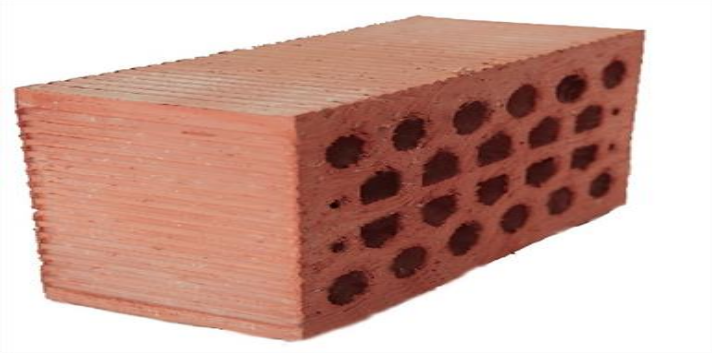


Fig -2.5 Load bearing Bricks

2.9 Engineering Bricks: Engineering bricks are bricks burnt at exceedingly high temperatures. They possess a dense and strong semi-vitreous body and conform to the defined limits for strength and water absorption. They are primarily used in civil engineering works that require high load bearing capacity, good damp-proof., and chemical resisting characteristics.

Engineering	Average Compressive Strength, (No less than) N/mm^2	Average Water Absorption, % (No greater than)
A	69.0 (10,000 psi)	4.5
B	48.5 (7,000 psi)	7.0
*** Based on British Standard 3921: 1965**		

Table -2.6 Engineering Bricks Property

2.10 Types of Bricks

Bricks can be of many types depending on –

1. Quality
2. Building Process
3. Manufacturing Method
4. Raw Material
5. Using Location
6. Weather-resisting Capability
7. Purpose of Using
8. Shape
9. Region

2.11 Classification of Bricks Based on Quality

On the basis of quality, Bricks are of the following kinds:

1. **First Class Brick:** The size is standard. The color of these bricks is uniform yellow or red. It is well burnt, regular texture, uniform shape. The absorption capacity is less than 10%, crushing strength is, 280kg/cm^2 (mean) where it is 245 kg/cm^2 (minimum). It doesn't have efflorescence. It emits a metallic sound when struck by another similar brick or struck by a hammer. It is hard enough to resist any fingernail expression on the brick surface if one tries to do with a thumbnail. It is free from pebbles, gravels or organic matters. It is generally used-

- in a building of long durability, say 100 years
- for building exposes to a corrosive environment;
- for making coarse aggregates of concrete.

Fig -2.7 First Class Brick

2. **Second Class Brick:** The size is standard; color is uniform yellow or red. It is well burnt, slightly over burnt is acceptable. It has a regular shape; efflorescence is not appreciable. The absorption capacity is more than 10% but less than 15%. Crushing strength is 175kg/cm^2 (mean) where the minimum is 154 kg/cm^2. It emits a metallic sound when struck by another similar brick or struck by a hammer. It is hard enough to resist any fingernail

expression on the brick surface if one tries to do with a thumbnail. It is used for the construction of one-storied buildings, temporary shed when intended durability is not more than 15 years.

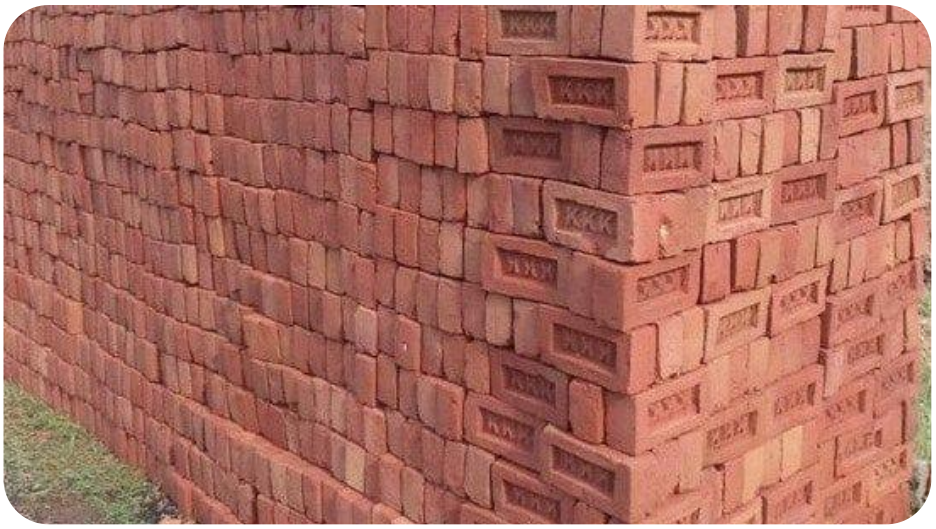


Fig -2.8 Second Class Brick

3. **Third Class Brick:** The shape and size are not regular. The color is soft and light red colored. It is under burnt, slightly over burnt is acceptable. It has extensive efflorescence. The texture is non-uniform. The absorption capacity is more than 15% but less than 20%. The crushing strength is 140kg/cm^2 (mean) where the minimum crushing strength is 105kg/cm^2. It emits a dull or blunt sound when struck by another similar brick or struck by a hammer. It leaves fingernail expression when one tries to do with the thumbnail.

Fig -2.9 Third Class Brick

2.12 Classification of Bricks Based on Building Process

On the basis of the building process Bricks are of following kinds:

1. **Unburnt Bricks:** These are half burnt bricks. The color is yellow. The strength is low. They are used as shurki in lime terracing. They are used as soiling under RCC footing or basement. Such bricks should not be exposed to rainwater.

Fig -2.10 Unburnt Bricks

2. **Burnt Bricks:** Burnt bricks are made by burning them in the kiln. First class, Second Class, Third Class bricks are burnt bricks.

Fig -2.11 Burnt Bricks

3. **Over Burnt or Jhama Brick:** It is often known as the vitrified brick as it is fired at high temperature and for a longer period of time than conventional bricks. As a result, the shape is distorted. The absorption capacity is high. The strength is higher or equivalent to first

class bricks. It is used as lime concrete for the foundation. It is also used as coarse aggregate in the concrete of slab and beam which will not come in contact with water.

Fig -2.12 Over Burnt or Jhama Brick

2.13 Classification of Bricks Based on Manufacturing Method

On the basis of manufacturing method bricks are of the following kinds:

1. **Extruded Brick:** It is created by forcing clay and water into a steel die, with a very regular shape and size, then cutting the resulting column into shorter units with wires before firing. It is used in constructions with limited budgets. It has three or four holes constituting up to 25% volume of the brick.

Fig -2.13 Extruded Brick

2. **Molded Brick:** It is shaped in molds by hand rather being in the machine. Molded bricks between 50-65mm are available instantly. Other size and shapes are available in 6-8 weeks after the order.

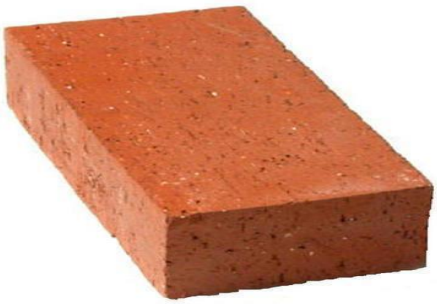


Fig -2.14 Molded Brick

3. **Dry pressed Brick:** It is the traditional types of bricks which are made by compressing clay into molds. It has a deep frog in one bedding surface and shallow frog in another.

Fig -2.15 Dry pressed Brick

2.14 Classification of Bricks Based on Raw Materials

On the basis of raw materials bricks are of the following kinds:

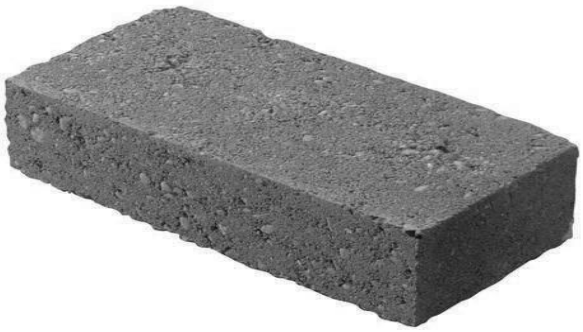
1. **Burnt Clay Brick:** It is obtained by pressing the clay in molds and fried and dried in kilns. It is the most used bricks. It requires plastering when used in construction works.

Fig -2.16 Burnt Clay Brick

2. **Fly ash clay Brick:** It is manufactured when fly ash and clay are molded in 1000 degree Celsius. It contains a high volume of calcium oxide in fly ash. That is why usually described as self-cementing. It usually expands when coming into contact with moisture. It is less porous than clay bricks. It proved a smooth surface so it doesn't need plastering.

Fig -2.17 Fly ash clay Brick

3. **Concrete Brick:** It is made of concrete. It is the least used bricks. It has low compression strength and is of low quality. These bricks are used above and below the damp proof course. These bricks are used can be used for facades, fences and internal brickworks because of their sound reductions and heat resistance qualities. It is also called mortar brick. It can be of different colors if the pigment is added during manufacturing. It should not be used below ground.



4. Fig -2.18 Concrete Brick

4. Sand-lime Brick: Sand, fly ash and lime are mixed and molded under pressure. During wet mixing, a chemical reaction takes place to bond the mixtures. Then they are placed in the molds. The color is greyish as it offers something of an aesthetic view. It offers a smoother finish and uniform appearance than the clay bricks. As a result, it also doesn't require plastering. It is used as a load bearing member as it is immensely strong.

Fig -2.19 Sand-lime Brick

5. **Firebrick:** It is also known as refractory bricks. It is manufactured from a specially designed earth. After burning, it can withstand very high temperature without affecting its shape, size, and strength. It is used for the lining of chimney and furnaces where the usual temperature is expected to be very high.

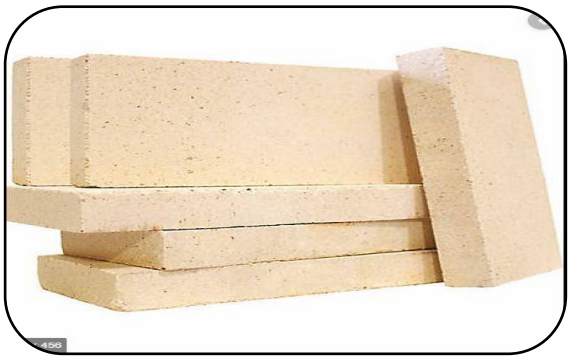


Fig -2.20 Firebrick

2.15 Classification of Bricks Based on Using Location

On the basis of using location bricks are of the following kinds:

1. **Facing Brick:** The façade material of any building is known as facing brick. Facings bricks are standard in size, are stronger than other bricks and also have better durability. The color is red or brown shades to provide a more aesthetic look to the building. There are many types of facing bricks which use different techniques and technology. Facing bricks should be weather resistant as they are most generally used on the exterior wall of buildings.

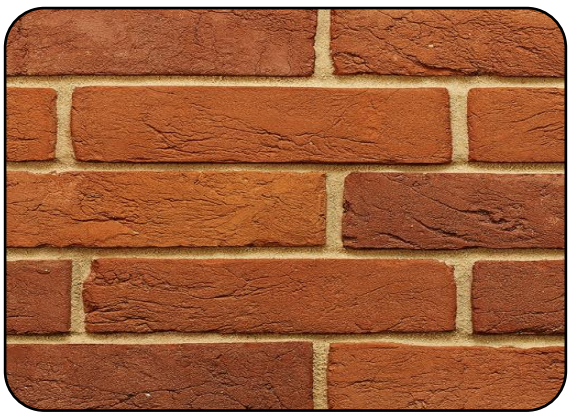


Fig -2.21 Facing Brick

2. **Backing Brick:** These types of brick don't have any special features. They are just used behind the facing bricks to provide support.

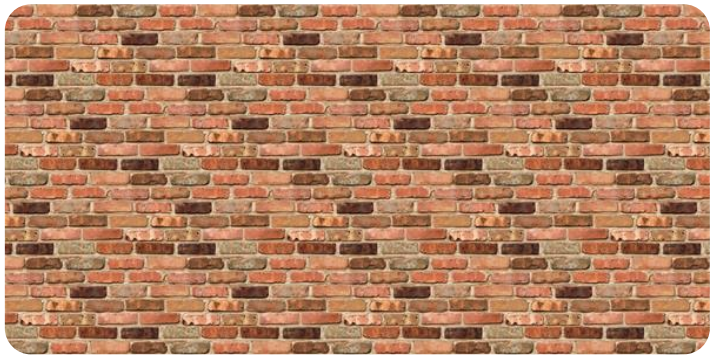


Fig -2.22 Backing Brick

2.16 Classification of Bricks Based on Weather-resisting Capability

On the basis of weather-resisting capability bricks are of following kinds:

1. **Severe Weather Grade:** These types of bricks are used in the countries which are covered in snow most of the time of year. These bricks are resistant to any kind of freeze-thaw actions.

2. **Moderate Weather Grade:** These types of bricks are used in tropical countries. They can withstand any high temperature.

3. **No Weather Grade:** These bricks do not have any weather resisting capabilities and used on the inside walls.

2.17 Classification of Bricks Based on Their Using

There are many uses of bricks. On the basis of the purpose of their using bricks are of the following kinds:

1. **Common Bricks:** These bricks are the most common bricks used. They don't have any special features or requirements. They have low resistance, low quality, low compressive strength. They are usually used on the interior walls.

2. **Engineering Bricks:** These bricks are known for many reasons. They have high compressive strength and low absorption capacity. They are very strong and dense. They have good load bearing capacity, damp proof, and chemical resistance properties. They

have a uniform red color. They are classified as Class A, class B, class C. Class A is the strongest but Class B is most used. They are used for mainly civil engineering works like sewers, manholes, ground works, retaining walls, damp proof courses, etc.

Fig -2.23 Engineering Bricks

2.18 Classification of Bricks Based on Shape

On the basis of shape bricks are of following kinds:

1. **Bullnose Brick:** These bricks are molded into round angles. They are used for rounded quoin.

2. **Airbricks**: These bricks contain holes to circulate air. They are used on suspended floors and cavity walls.

3. **Channel Bricks:** They are molded into the shape of a gutter or channel. They are used in drains.

4. **Coping Bricks:** They can be half round, chamfered, Saddleback, angled varied according to the thickness of the wall.

5. **Cow Nose Bricks:** Bricks having double bullnose known as Cow Nose Bricks.

6. **Capping Bricks:** These bricks are used to cap the tops of parapets or freestanding walls.

7. **Brick Veneers:** These bricks are thin and used for cladding.

8. **Curved Sector Bricks:** These are curved in shape. They are used in arcs, pavements, etc.

9. **Hollow Bricks:** These bricks are around one-third of the weight of the normal bricks. They are also called cellular or cavity bricks. Their thickness is from 20-25mm. These bricks pave the way to quicker construction as they can be laid quickly compared to the normal bricks. They are used in partitioning.

10. **Paving Bricks:** These bricks contain a good amount of iron. Iron vitrifies bricks at low temperature. They are used in garden park floors, pavements. These bricks withstand the abrasive action of traffic thus making the floor less slippery.

11. **Perforated Bricks:** These bricks contain cylindrical holes. They are very light in weight. Their preparation method is also easy. They consume less clay than the other bricks. They can be of different shapes like round, square, rectangular. They are used in the construction of the panels for lightweight, structures, and multistoried frame structures.

12. **Purpose Made Bricks:** For specific purposes, these bricks are made. Splay and can't bricks are made for doors and window jambs. Engineering bricks are made for civil engineering constructions such as sewers, manholes, retaining walls. Fire bricks are made for chimneys and fireworks. Ornamental bricks are made to use for cornices, corbels. Arch bricks are used in arcs.

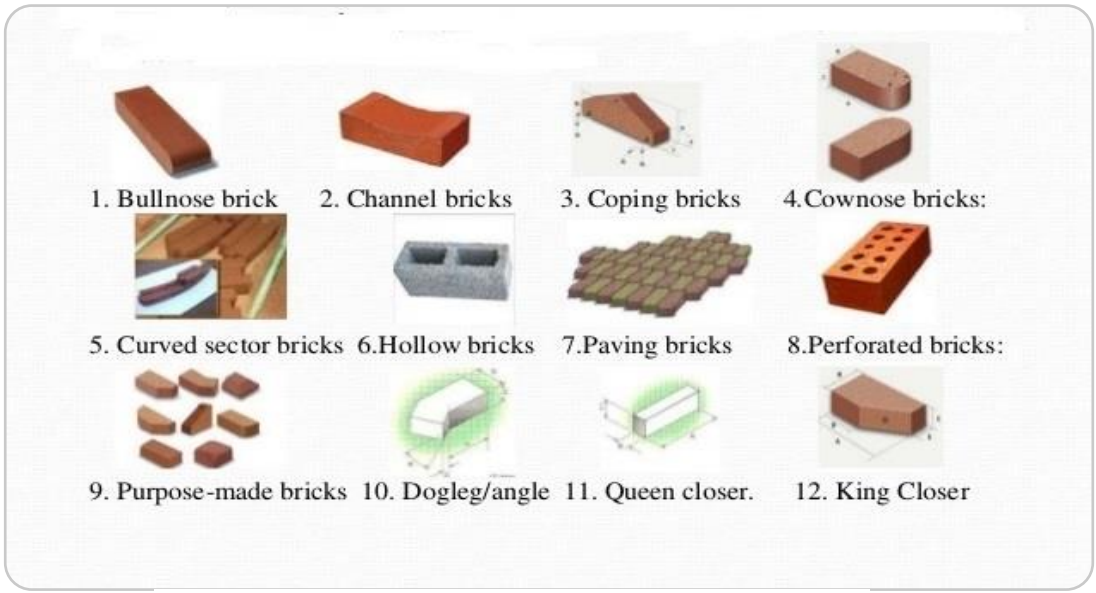


Fig -2.24 Purpose Made Brick

2.19 Classification of Bricks Based on Region

On the basis of the region bricks are of following kinds:

1. **Cream City Bricks:** These bricks are from Milwaukee, Wisconsin.
2. **London Stock:** These bricks are used in London.
3. **Dutch:** These are from the Netherlands.
4. **Nanak Shahi Bricks:** These are from India.
5. **Roman:** These are used in Roman constructions
6. **Staffordshire Blue Brick:** These are from England.

Brick Properties:

2.20 Damp Proof Course

Clay bricks of specified low water absorption used at the base of a wall (minimum two courses) to resist the upward movement of ground water. Their use is recommended for free standing wall where otherwise a sheet of DPC material would create a plane of weakness causing the wall to be vulnerable to lateral forces.

2.21 Properties and Functional Performances of Brick

Bricks are made from clay by burning it at high temperatures. The action of heat gives rise to a sintering process that causes the clay particles to fuse and develops extremely strong ceramic bonds in the burnt clay bodies. Such bonds are highly stable. As a result, bricks can withstand the severe weathering actions and are inert to almost all normal chemical attacks.

2.22 Strength

Bricks are well-known for their high compressive strength. Their compressive strength depends on:

1. the raw materials used,
2. the manufacturing process, and
3. the shape and size.

Bricks made by a de-aerated extruder and fired to sufficiently high temperature can easily withstand a compressive pressure exceeding 28 N/mm^2 (4,000 psi). They are suitable for almost all structural building applications

2.23 Aesthetic appeal

Brick possesses the natural and pleasant colors of burnt clay. Its color formation is achieved through a complicate physical chemical reaction during the firing process. In contrast to color of stained body, brick color is permanent and will not be faded during weathering process. Different clay compositions, firing temperatures or kiln atmosphere can lead to different coolers of the burnt products. By proper control of these factors, bricks can be made to exhibit endless variety of natural and attractive coolers.

Besides its richness in color, bricks can be made to various textures. It is the combination of color and texture that gives brick such distinctive feature which is everlasting and meadows with age. In view of the high cost to maintain the appearance of a building, the unique features of brick become an unparalleled advantage to housing design.

2.24 Porosity

Porosity is an important characteristic of brick. In contrast to other mounded or pre-cast building materials, the porosity of brick is attributed to its fine capillaries. By virtue of the capillary effect, the rate of moisture transport in the brick is ten times faster than in other building materials. Moisture is released during day-time and re-absorbed during night-time. The ability to release and re-absorb moisture (a "breathing" process) by capillary effect is one of the most useful properties of brick that helps to regulate the temperature and humidity of atmosphere in a house. This distinctive property makes brick an admirable building material, particularly suitable for houses in the tropics. On the other hand, all porous materials are susceptible to chemical attacks and liable to contamination from weathering agents like rain, running water and polluted air. Porosity of building material is an important factor to consider in respect its performance and applications.

Experiment results show that bricks with water absorption rate at 8% is 10 times more durable in resisting salt attack than that with water absorption rate at 20%. Well burnt brick has a normal water

absorption rate less than 10% in contrast to that of concrete block and cement mortar exceeding 15%. This explains why brick walls require comparatively minimum maintenance in the course of time.

A rarely known property of brick is its initial rate of absorption (IRA). It is in fact the initial rate of absorption that plays a key role in affecting the strength of bond between bricks and mortar during bricklaying. High value of IRA tends to remove excessive water from the mortar rapidly and thus hampers the proper hydration of cement. Experiments show that and an increase of IRA from 2 kg/m^2/min to 4 kg/m^2/min reduces the strength of brickwork by 50%. Generally, bricks with IRA exceeding 2 kg/m^2/min will gives rise to difficulties in laying using common cement mortars. Modern brick extruder with de-airing action produces denser brick with lower IRA.

2.25 Fire Resistance

Brick is inherent with excellent fire resistance. A 100 mm brickwork with 12.5 mm normal plastering will provide a fire-resistance of 2 hours and a 200 mm non-plastered brickwork will give a maximum rating of 6 hours for non-load bearing purposes. Brick can support considerable load even when heated to 1000°C in contrast to concrete wall at only up to 450°C due to loss of water of hydration. It is a fact that the non-combustibility of brick helps to promote its use in building houses against fire. There have been numerous examples in the past that people chose to use bricks for their houses after a devastating fire that burned down the whole city. Perhaps the most famous instance is the great London Fire in 1666, after which the rebuilding was largely done if not entirely in brick.

2.26 Sound Insulation

Brick wall shows good insulation property due to its dense structure. The sound insulation of brickwork is generally 45 decibels for a 4-1/2 in. thickness and 50 decibels for a 9-in. thickness for the frequency range of 200 to 2,000 Hz.

2.27 Thermal Insulation

Brick generally exhibits better thermal insulation property than other building materials like concrete. Perforation can improve the thermal insulation property of bricks to some extent. Besides, the mass and moisture of bricks help to keep the temperature inside the house relatively constant, hi other words, bricks absorb and release heat slowly and thus keep the house cool during daytime and warm during nighttime. Energy saving of a brick house is remarkable. A study commissioned by the Brick Institute of America had demonstrated that a brick house can save energy up to 30% when compared to that built of wood. A comparison of the thermal conductivities of various materials is given in table below: -

Typical Thermal Conductivities of Various Building Materials		
Material	Btu	W/mK
Sand & gravel aggregate (dry)	9.0	1.30
Cement Mortar	5.0	0.70
Concrete (1:4)	5.28	0.77
Concrete Block (1:5) (four Oval-core)	5.2	0.75
Concrete Block (1:10) (four Oval-core)	6.6	0.95
Solid Brick (density: 1925kg/m^3)	5.0	0.72
Perforated Brick (25% perforation density:1400kg/m^3)	4.0	0.58

Table -2.25 Typical Thermal Conductivities

2.28 Wear resistance

The wear resistance of a substance depends on its particulate bonds. Bricks shows high wear resistance because of its extremely strong ceramic bonds formed by the effect of heat at high temperature.

2.29 Efflorescence

Efflorescence is a phenomenon that soluble slats dissolved in water are carried, deposited and gradually accumulated on brick surfaces to form an unsightly scum. The soluble salts may be originated from the raw material of bricks. But in most cases, efflorescence is caused by salts from the external sources such as ground water, contaminated atmosphere, mortar ingredients and other materials in contacts with the bricks.

2.30 Flexibility in Applications

Brick is used for an extremely wide range of applications in an equally extensive range of building and engineering structures. In particular, it can be used for load bearing structures which greatly simply the construction process so as to save materials, time and labor. Besides, brick can be making into convenient shape and size to facilitate the construction work.

2.31 Durability

Brick is extremely durable and perhaps is the most durable man-made structural building materials so far. There has been numerous ancient brick-building standing for centuries as a testimony of the endurance of burnt-clay brick.

2.32 Uses of Bricks

As a Structural Unit

Since the clay bricks or burnt bricks are strong, hard, durable, resistive to abrasion and fire, therefore, they are used as a structural material in different structures

- Buildings
- Bridges
- Foundations
- Arches
- Pavement (Footpath, Streets)

As an Aesthetic Unit/Surface Finish

Bricks can be used in different colors, sizes and orientations to get different surface designs. As an aesthetic material bricks can be used:

- In Pavements
- As Facing Brick
- For Architectural Purposes

Brick plays very important role in the field of civil engineering construction. Bricks are used as an alternative of stones in construction purpose. Here some main uses of construction brick are given below.

1. Construction of walls of any size.
2. Construction of floors.
3. Construction of arches and cornices.
4. Making khoa (broken Bricks of required size) to use as an aggregate in concrete.

2.33 Advantages of Bricks

1. **Brick is energy efficient:** For energy efficient warmth in winter and cool in summer, brick combines perfectly with passive building design to harness natural sources of energy. The natural density and thermal insulating qualities of clay moderate building temperature and reduce energy consumption rates, to provide year-round comfort and savings.

2. **Brick is low maintenance:** Brick**s** don't need paint or other treatments to maintain aesthetics and durability. Even after 50 years they are still strong, reliable and relatively maintenance free, saving you on the cost and time required to upkeep your home, compared to lighter weight materials.

3. **Brick is weatherproof:** The most endearing quality of a brick home is its ability to withstand the test of time, even under the harshest environmental conditions. Forget about painting, sealing or other high cost finishes; brick is weatherproof and with virtually no maintenance, brick's cost effective, impeccable performance will last a lifetime.

4. **Brick is creative and colorful:** For creative color and design, think brick. From striking rich chocolate to glorious vintage red, creamy almond or golden light sand, even shiny metallic or smooth pastel palettes, the natural earthy tones of brick provide impressive and lasting color contrast, perfect in any setting.

5. **Brick is secure, an investment for life:** As one of the world's most sought after and trustworthy sources of sustainable building materials, brick is renowned for its strength and secure investment potential. The quality construction, quiet calm and ageless appeal of a solid brick home will protect your family for generations to come.

6. **Brick is sustainable:** Made from organic minerals found in shale and local, naturally abundant sources of clay; brick's long-lasting life cycle offers ongoing environmental and health benefits. Durable, re-usable, free from contaminants and naturally resistant to pests or fire, brick is safe to live in, making it the ultimate material in responsible and economical home building design.

7. **Brick is the building material of choice:** Building with brick is cost effective and easy to work with, and without the need for expensive rendering brick is the original building material of choice. Choose from the traditional, classic and enduring natural elegance of heritage, to the sophistication of cutting edge modern symmetrical design.

8. **Style and design:** Bricks add distinct style to any type of home. Their natural coolers and textures enable you to create striking façade contrasts or more traditional neutral cooler tones.

2.34 Disadvantages of Brick Masonry

- Not as strong as other materials such as stone.
- Not as durable compared to stone.
- Brick masonry needs plastering done to finish a project which can raise construction costs.
- Brick absorbs water which will cause dampness and damage overtime.
- Less aesthetic appeal with brick as there is limited sizes and colors.

CHAPTER 03
METHODOLOGY

3.1 Sample Collection:

We went Savar, Hemayetpur and Amin Bazar bricks factory i.e. MMSB, SONY, TURAG, TAHA & SAN for laboratory test we have collected five pieces of bricks samples for each 1st, 2nd and 3rd class from every factory.

3.2 Field Tests of Bricks:

The Following are the lest that are generally

Performed in the field to determine the quality of good bricks

- Take a brick and try to make mark on the surface by nail. If you can make it. it is not, a good brick if not it is very hard and compact.
- Take a brick and strike it with a hammer if it gives clear ringing or metallic sound, it is a good brick if not a bad one.
- Take two bricks and form a tee (T) and drop from a height of 6 ft on a solid surface. If they break, they are not good bricks. If they remain unbroken, they are good bricks.

Laboratory test of bricks:

3.5 Water Absorption:

A brick is taken and it is weighed dry. It is then immersed in water for a period of 16 hours. It is weighed again and the difference in weight indicates the amount of water absorbed by the brick. It should not in exceed 20 per cent of weight of dry brick.

3.6 Compressive/Crushing strength of Bricks:

The crushing strength of a brick is found out by placing it in a compression testing machine. It is pressed till it breaks. As per BIS: 1077-1957, the minimum crushing or compressive strength of bricks is 3.50 N/mm^2. The bricks with crushing strength of 7 to 14 N/mm^2 are graded as A and those having above 14 N/mm^2 are graded, as AA.

3.7 Hardness test on bricks:

In this test, a scratch is made on brick surface with the help of a finger nail. If no impression is left on the surface, the brick is r sufficiently hard.

3.8 Shape and size:

In this test, a brick is closely inspected. It should be of standard size and its shape should be truly rectangular with sharp edges. For this purpose, 20 bricks of standard size (190 mm x 90 mm x 90 mm) are selected at random and they are stacked lengthwise, along the width and along the height

3.9 Initial Rate of Absorption

This test is used to indicate the amount of water a dry brick will soak up upon first coming into contact with water. It is an important test to undertake in order to be able to advise a brick layer what kind of mortar should be used in laying the brick. A brick that has a high Initial Rate of Absorption may absorb water at too fast a rate from the mortar causing the mortar to dry out too fast resulting in a weak bond with the brick. A weak bond between brick and mortar also occurs if the Initial rate of Absorption is too low as the brick may not absorb water fast enough and not enough wet mortar mix will be drawn into the pores on the surface of the brick.

Test procedure:

3.10 Water absorption

The water absorption of brick is the quantity of water absorbed by the brick when submerged under water for 24 hrs. expressed as % of its dry weight. The strength of a brick depends upon its Water Absorption capacity. The Water Absorption of Bricks is due to the presence of voids in the bricks. If the brick has more voids it will absorb more water and reduces the load carrying capacity.

To determine the percentage of water absorption of bricks.

Apparatus

A sensitive balance capable of weighing within 0.1% of the mass of the specimen and Ventilated oven.

Specimen

Twenty-four numbers of solid bricks from samples collected for testing should be taken.

Procedure:

1. Dry the specimen in a ventilated oven at a temperature of 105°C to 115°C till it attains substantially constant mass.
2. Cool the specimen to room temperature and obtain its weight (M_1) specimen too warm to touch shall not be used for this purpose.
3. Immerse completely dried specimen in clean water at a temperature of 27+2°C for 24 hours.
4. Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water (M_2).

Fig -3.1 Fully Immerse Brick in water

Calculations:

Water absorption, % by mass, after 24 hours immersion in cold water in given by the formula,

$$W = \frac{M_2 - M_1}{M_1} X\ 100$$

3.11 Compressive strength of bricks

Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression with the help of compression testing machine. Bricks are generally used for construction of load bearing masonry walls, columns and footings. These load bearing masonry structures experiences mostly the compressive loads. Thus, it is important to know the compressive strength of bricks to check for its suitability for construction.

Classification of Bricks based on Compressive Strength

The common burnt clay shall be classified on the basis of average compressive strength as given in table.

Bricks Class Designation	Average compressive strength of Bricks	
	Not less than (N/mm^2)	Less than (N/mm^2)
350	35	40
300	30	35
250	25	30
200	20	25
175	17.5	20
150	15	17.5
125	12.5	15
100	10	12.5
75	7.5	10
50	5	7.5
35	3.5	5

Table -3.2 Classification of Bricks

Apparatus

Compression testing machine, the compression plate of which shall have ball seating in the form of portion of a sphere center of which coincides with the center of the plate.

Fig -3.3 Compressive Strength Testing Machine

Specimens

Twenty-four numbers of solid bricks from sample collected should be taken. the dimensions should be measured to the nearest 1mm

Sampling

Remove unevenness observed the bed faces to provide two smooth parallel faces by grinding. Immerse in water at room temperature for 24 hours. Remove the specimen and drain out any surplus moisture at room temperature. Fill the frog and all voids in the bed faces flush with cement mortar (1 cement, clean coarse sand of grade 3mm and down). Store it under the damp jute bags for 24 hours filled by immersion in clean water for 3 days. Remove and wipe out any traces of moisture.

Procedure:

1. Place the specimen with flat face s horizontal and mortar filled face facing upwards Between plates of the testing machine.
2. (IT) Apply load axially at a uniform rate of 14 N /mm^2 (140 kg/cm^2) per minute till failure occurs and note maximum load at failure.
3. The load at failure is maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

Calculation:

$$\text{Compressive strength} = \frac{\textit{Maximum load at failure}}{\textit{Average area of bed face}}$$

The average of result shall be reported.

3.12 Initial Rate of water absorption

Initial rate of absorption or IRA is defined as the number of grams of water absorbed in one minute over 30 square inches of brick bed area (ASTM C67). Acceptable values range from 10 to 30 grams. Dry brick, with an IRA above 30, should be wetted before laying. A simplified test for measuring IRA (the one used in this lab) is to place 20 drops of water in a quarter sized area on a brick and time its absorption. If the water is absorbed in under one and a half minutes the brick should be wetted prior to laying. If a brick is too dry, it will absorb too much water out of the applied mortar, weakening the bond.

To determine the percentage of initial rate of water absorption of bricks

Apparatus

A sensitive balance capable of weighing within 0.1% of the mass of the specimen and ventilated oven

Specimen

Twenty-four numbers of solid bricks from samples collected for testing should be taken

Procedure

1. Dry the specimen in a ventilated oven at a temperature of 105°C to 115°C till it attains substantially constant mass.
2. Cool the specimen to room temperature and obtain its weight (M_1) specimen too warm to touch shall not be used for this purpose.
3. Immerse completely dried specimen in clean water at a temperature of 27+2°C for mints hours.
4. Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water (M_2).

Calculations

Water absorption, % by mass, after 24 hours immersion in cold water in given by the formula,

$$W = \frac{M_2 - M_1}{M_1} \times 100 \; W = \frac{M_2 - M_1}{M_1} \times 100$$

3.13 Compressive Strength and Absorption

Both compressive strength and absorption are affected by properties of the clay, method of manufacture and degree of firing. For a given clay and method of manufacture, higher compressive strength values and lower absorption values are associated with higher firing temperatures. Although absorption and compressive strength can be controlled by manufacturing and firing methods, these properties depend largely upon the properties

CHEAPTER 04
RESULTS

4.1.1 Water absorption Test Report

As per IS Specification, the water absorption capacity of the brick shall not be more than 20% by weight for I class, 22% for II class and 25% for III class.

Sample No	Name of Company	Classification	Size of Bricks (mm)	Mass (Kg)	Water absorption (24 Hour)	Absorption Ratio (%)
Sample 01.	**MMSB**	1st Class	235x112x70	2.63	3.16	20.15
		2nd Class	235x110x68	2.95	3.57	21.02
		3rd Class	232x110x68	3.05	3.81	24.92
Sample 02.	**SONY**	1st Class	241x118x68	3.09	3.71	20.06
		2nd Class	240x119x70	2.89	3.53	22.15
		3rd Class	230x112.6x67	2.82	3.53	25.18
Sample 03.	**TURAG**	1st Class	234x115x70	2.9	3.42	17.93
		2nd Class	230x112x70	2.89	3.50	21.11
		3rd Class	235x114x70	2.85	3.56	24.91
Sample 04.	**TAHA**	1st Class	237x114x66	2.85	3.39	18.95
		2nd Class	238x114x66	2.81	3.40	21.00
		3rd Class	243x116x66	2.88	3.54	22.92
Sample 05.	**SAN**	1st Class	234x113x66	2.9	3.51	21.03
		2nd Class	236x114x67	2.89	3.53	22.15
		3rd Class	227x115x67	2.73	3.41	24.91

Table No-4.1: Water absorption Test Calculation

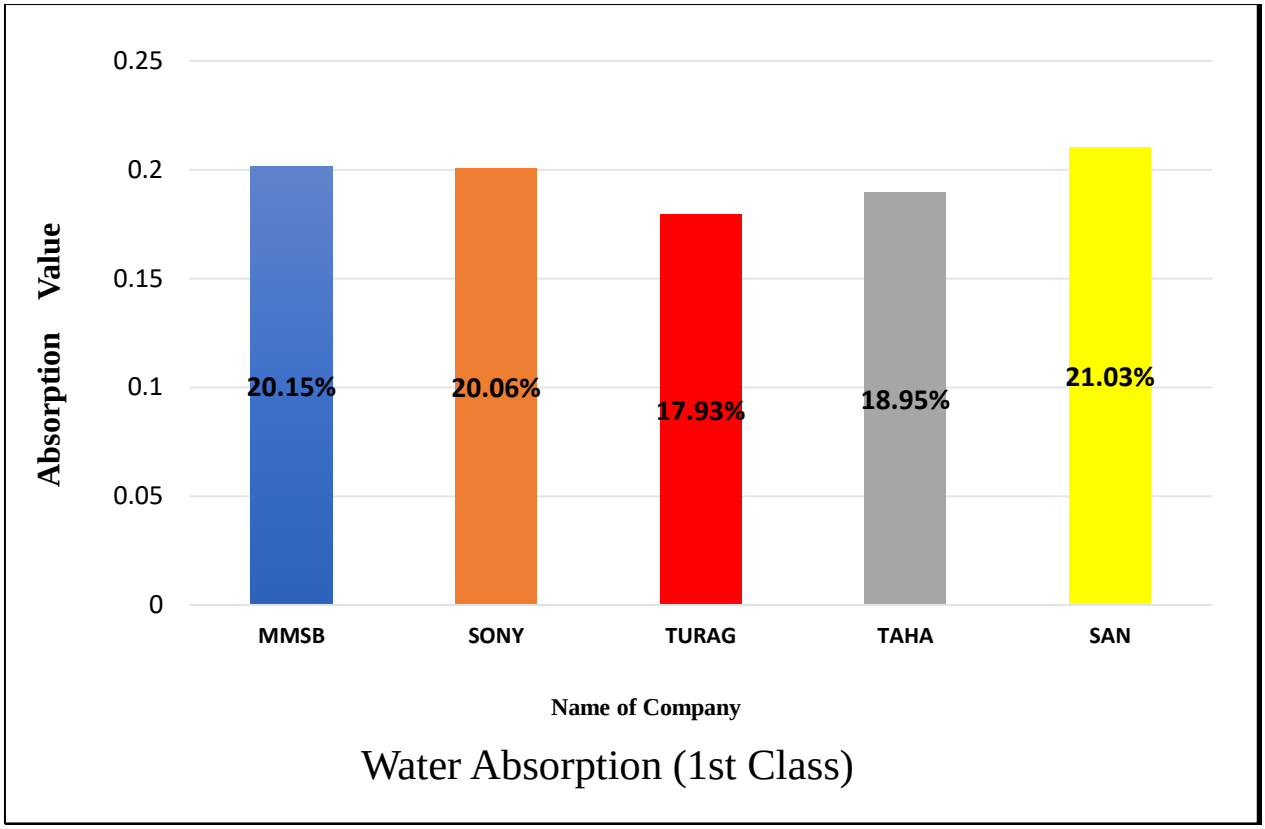


Fig -4.2: "Water absorption" For 1st Class Brick

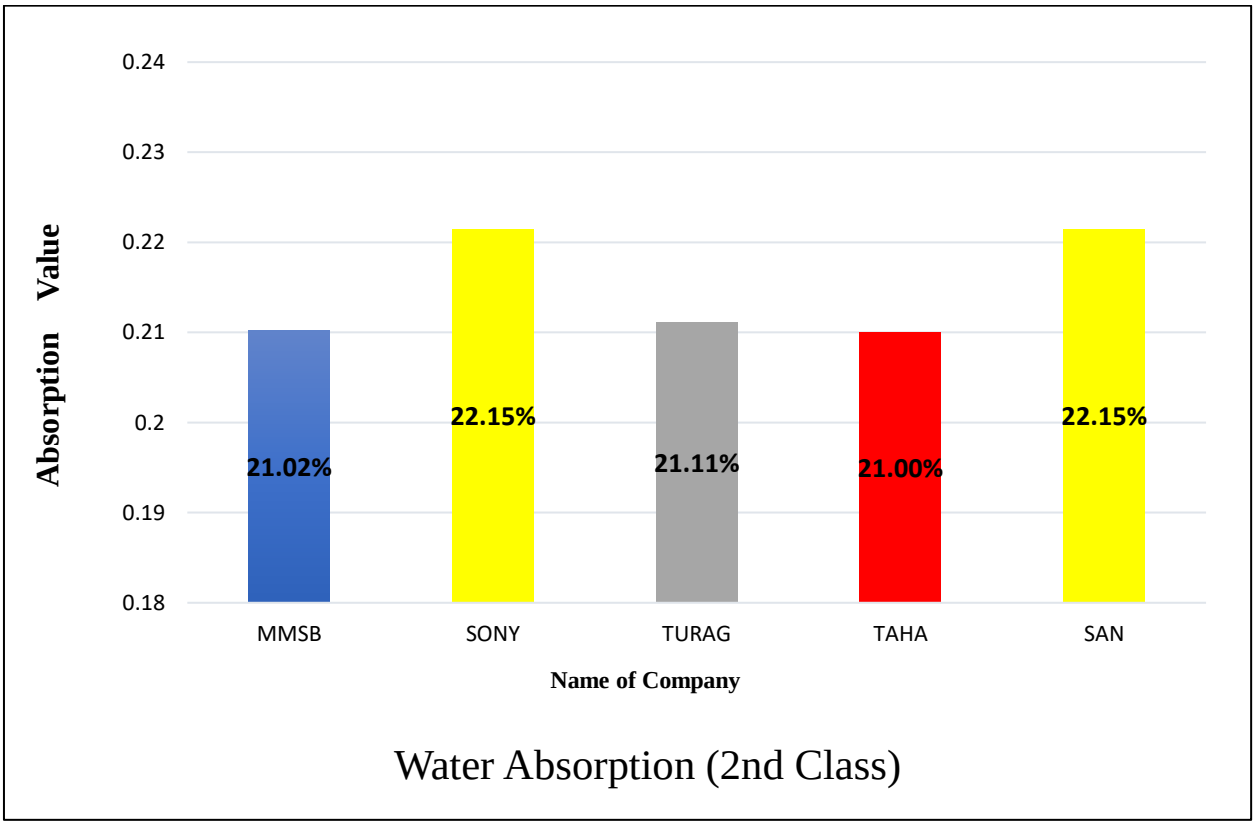


Fig -4.3: "Water absorption" For 2nd Class Brick

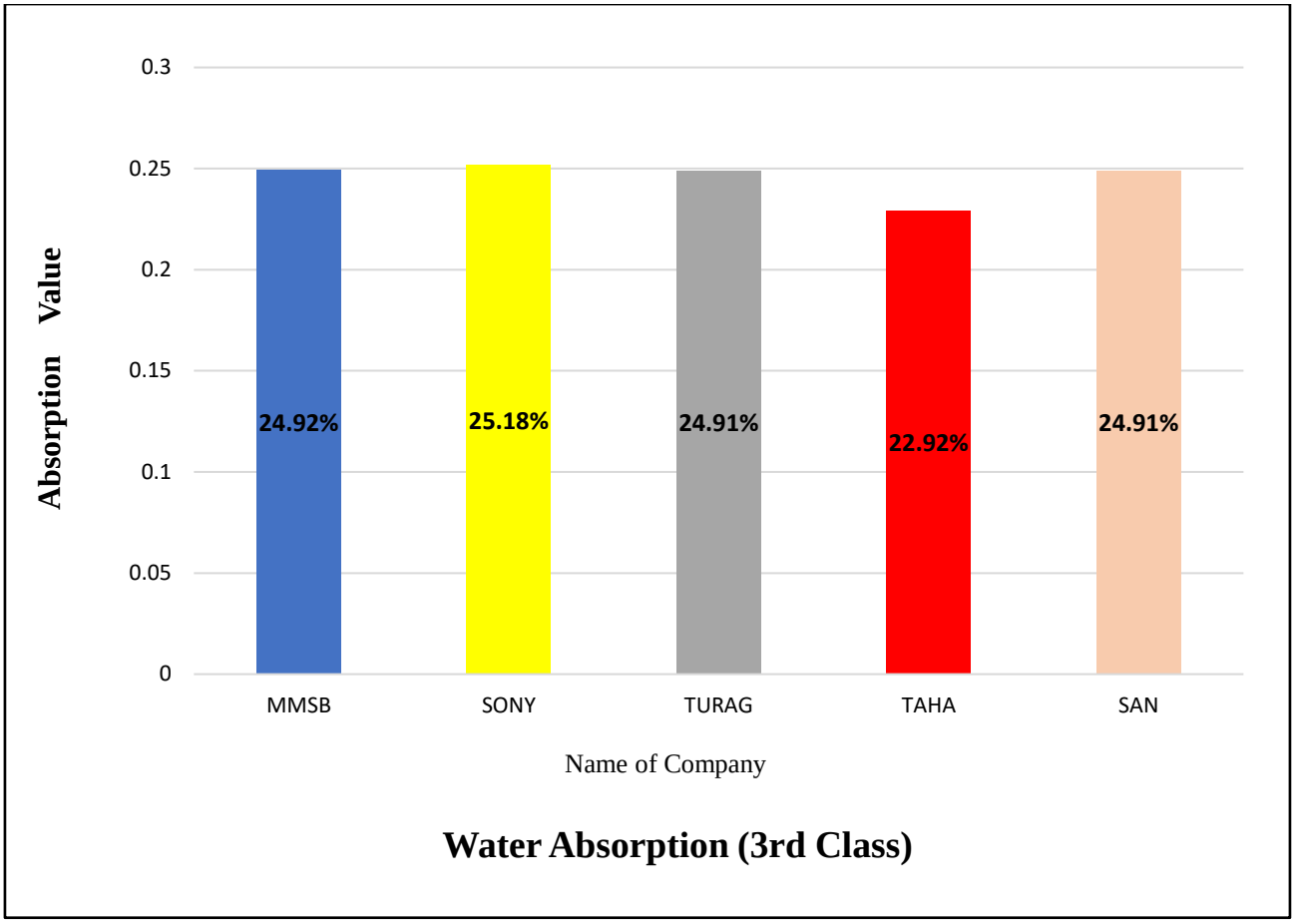


Fig -4.4: “Water absorption” For 3rd Class Brick

4.1.2 Compressive strength Test Report

Sample No	Name of Company	Classification	Size of Bricks (mm)	Compressive Strength (N)	Compressive Strength (N/mm^2)
Sample 01.	MMSB	1st Class	235x112x70	3000	11.4
		2nd Class	235x110x68	2575	9.96
		3rd Class	232x110x68	2742	10.74
Sample 02.	SONY	1st Class	241x118x68	32580	11.43
		2nd Class	240x119x70	3100	10.85
		3rd Class	230x112.6x67	2350	9.12
Sample 03.	TURAG	1st Class	234x115x70	2700	10.03
		2nd Class	230x112x70	3150	12.23
		3rd Class	235x114x70	2100	7.83
Sample 04.	TAHA	1st Class	237x114x66	4026	14.90
		2nd Class	238x114x66	3785	13.95
		3rd Class	243x116x66	2900	10.28
Sample 05.	SAN	1st Class	234x113x66	4000	15.12
		2nd Class	236x114x67	3750	13.93
		3rd Class	227x115x67	3500	13.40

Table No-4.5: Compressive strength of bricks test calculation

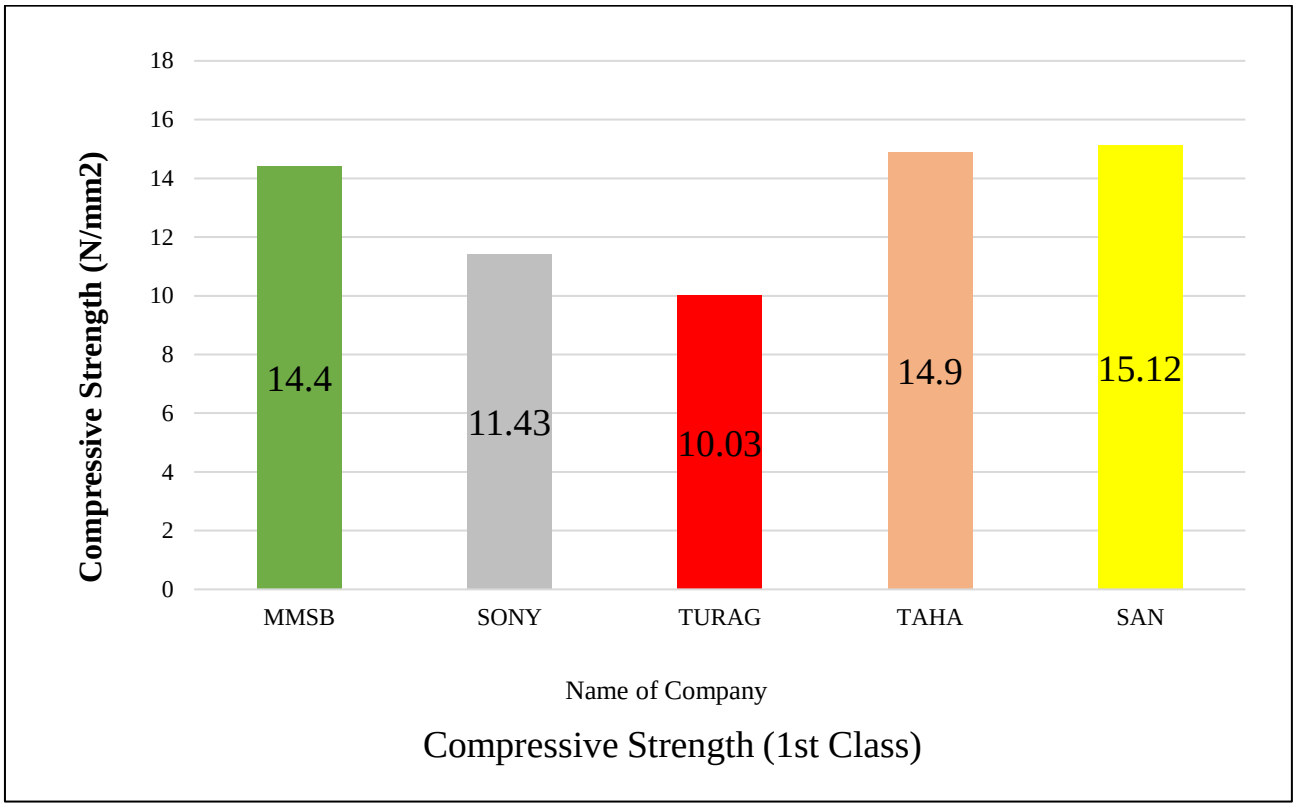


Fig -4.6: “Compressive strength” For 1st Class Brick

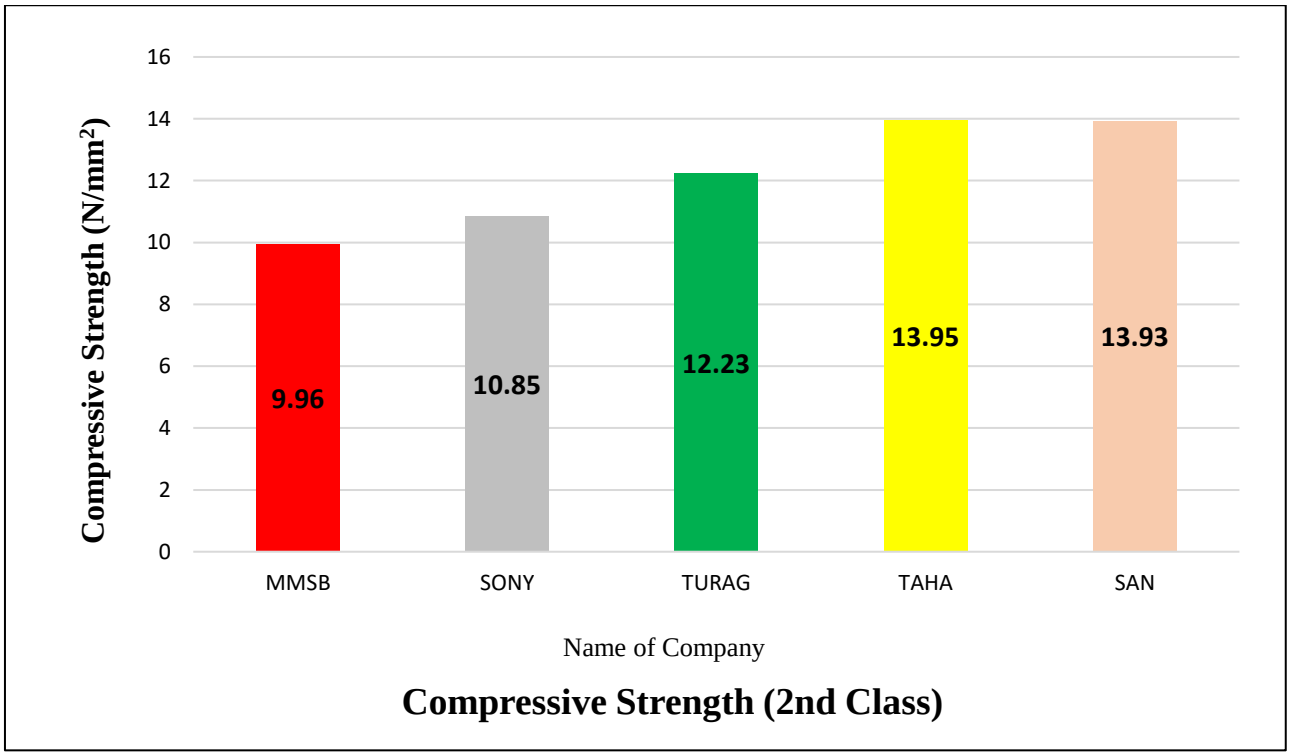


Fig -4.7: “Compressive strength” For 2nd Class Brick

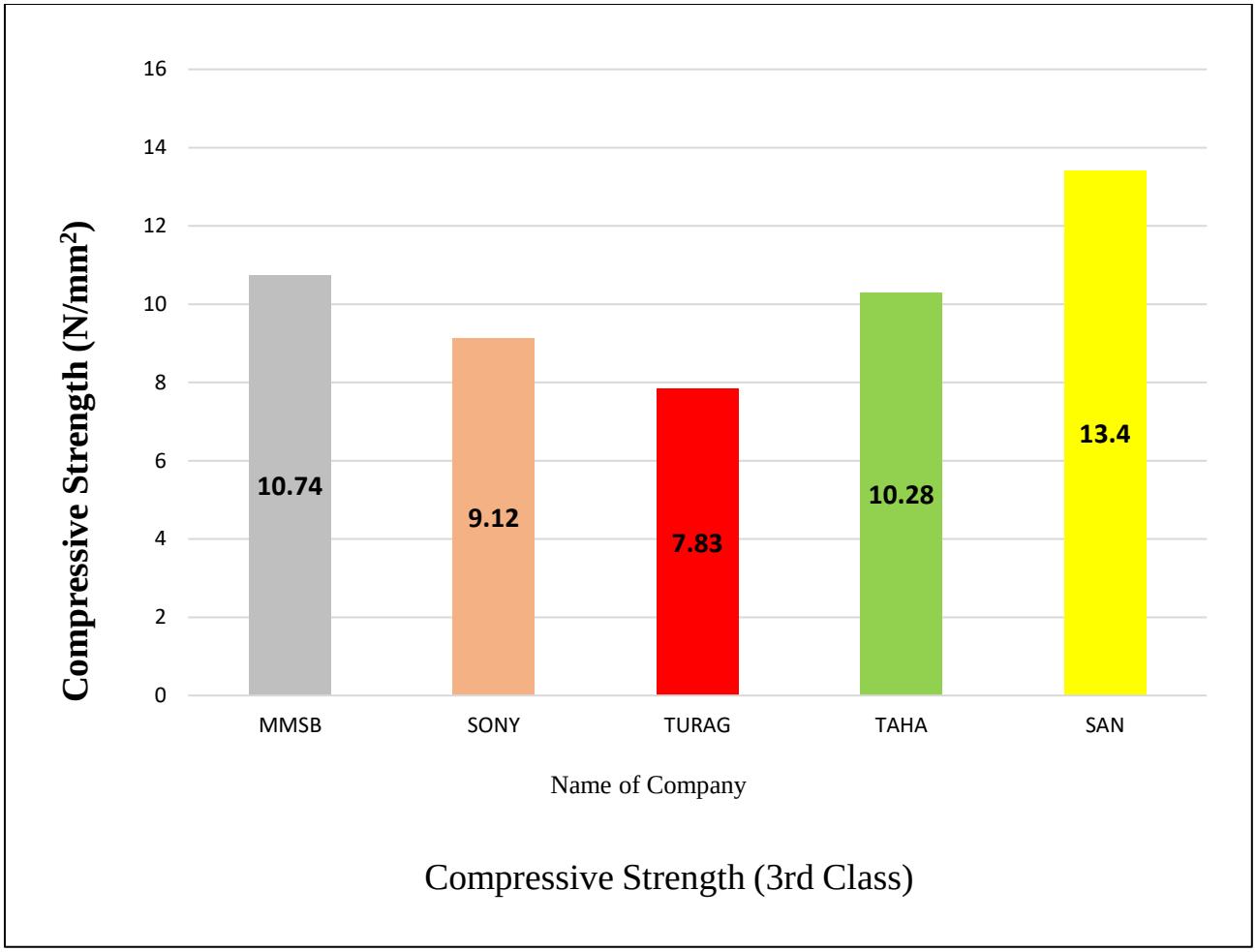


Fig -4.8: “Compressive strength” For 3rd Class Brick

4.1.2 Initial Rate of water absorption Test Report

Sample No	Name of Company	Classification	Size of Bricks (mm)	Mass (Kg)	Water absorption (1 minutes)	Absorption Ratio (%)
Sample 01.	MMSB	1st Class	235x112x70	2.58	2.81	8.91
		2nd Class	235x110x68	2.90	3.25	12.07
		3rd Class	232x110x68	3.00	3.42	14.00
Sample 02.	SONY	1st Class	241x118x68	3.15	3.31	5.08
		2nd Class	240x119x70	2.81	3.18	13.17
		3rd Class	230x112.6x67	2.89	3.16	9.34
Sample 03.	TURAG	1st Class	234x115x70	2.98	3.10	4.03
		2nd Class	230x112x70	2.83	3.18	12.37
		3rd Class	235x114x70	2.87	3.19	11.15
Sample 04.	TAHA	1st Class	237x114x66	2.81	3.05	8.54
		2nd Class	238x114x66	2.73	3.09	13.19
		3rd Class	243x116x66	2.80	3.23	15.36
Sample 05.	SAN	1st Class	234x113x66	2.78	3.10	11.51
		2nd Class	236x114x67	2.93	3.18	8.53
		3rd Class	227x115x67	2.82	3.06	8.51

Table No-4.9: Initial Rate of water absorption test calculation.

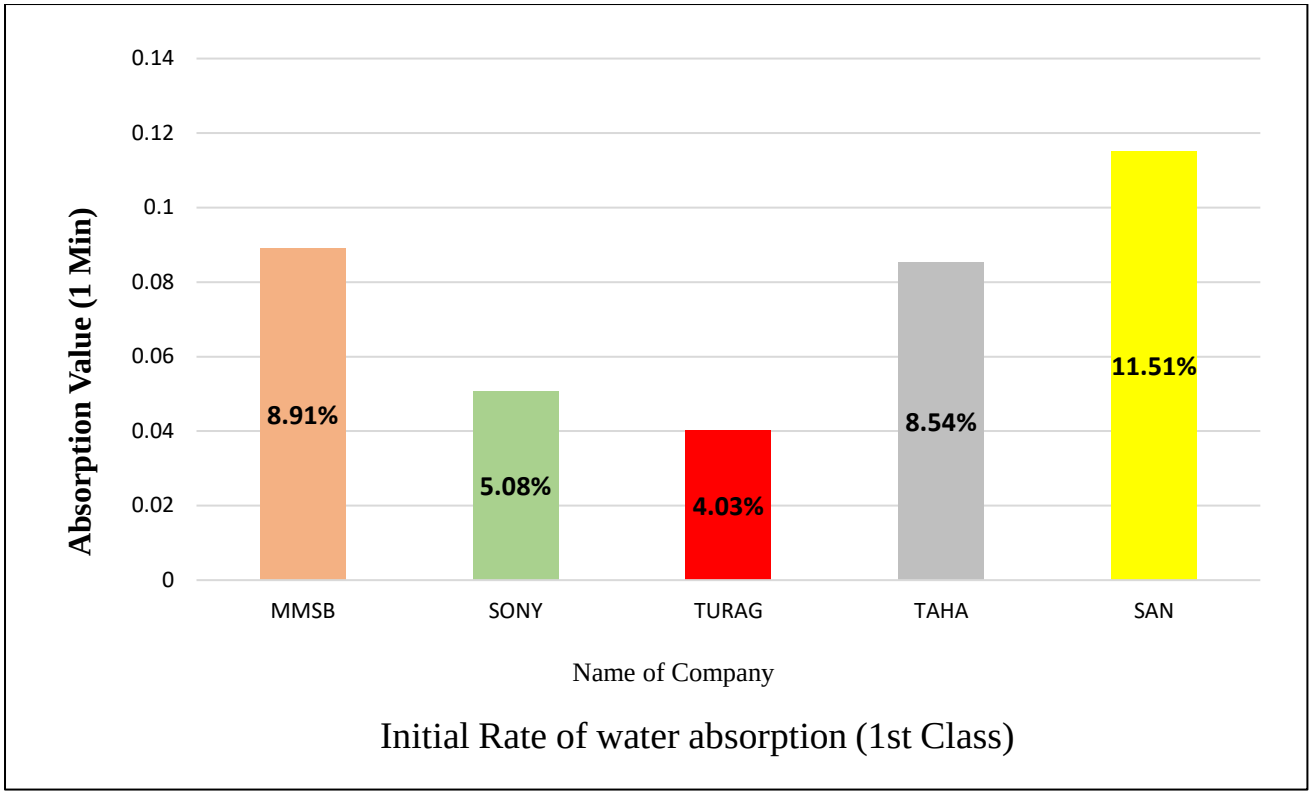


Fig -4.10: "Initial Rate of water absorption (1 Minute)" For 1st Class Brick

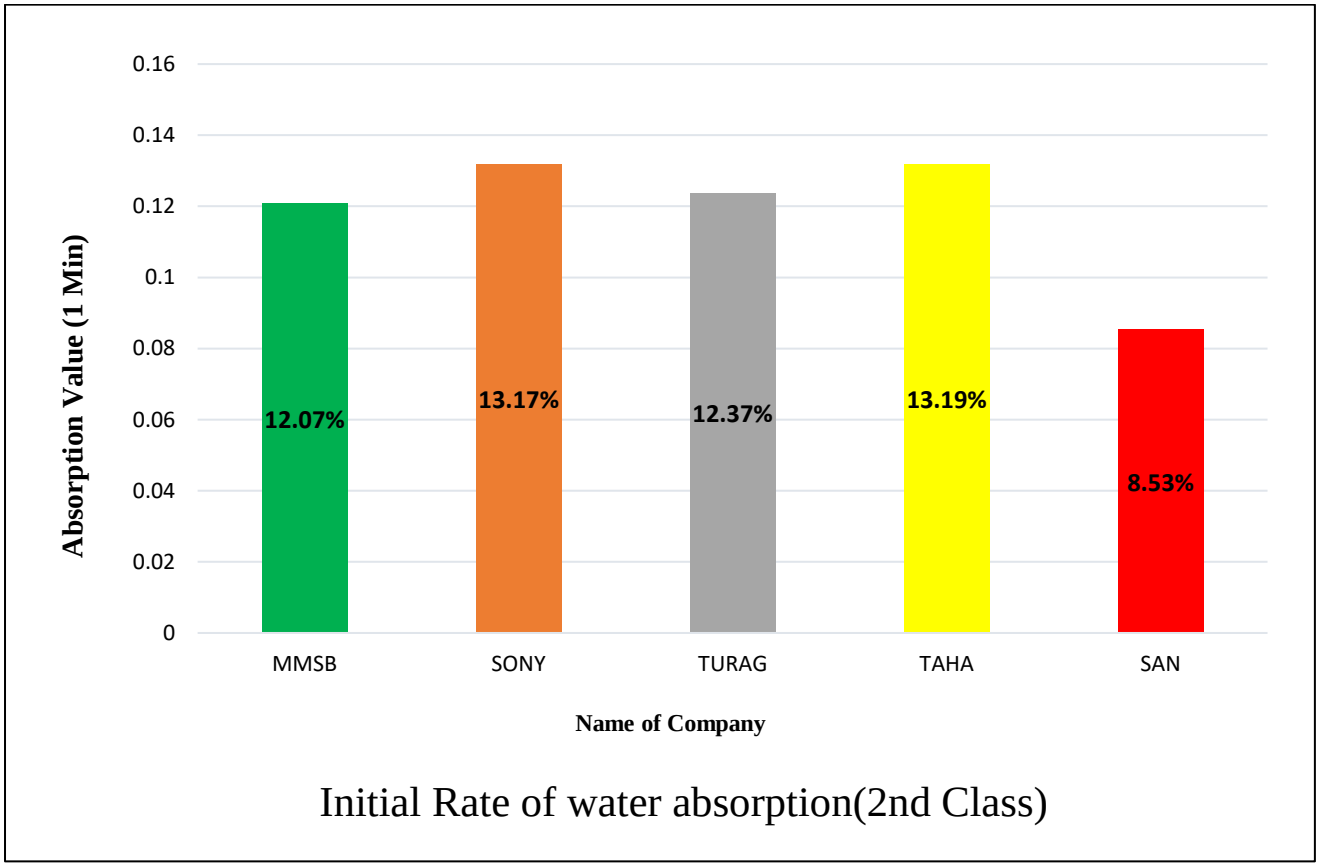


Fig -4.11: "Initial Rate of water absorption (1 Minute)" For 2nd Class Brick

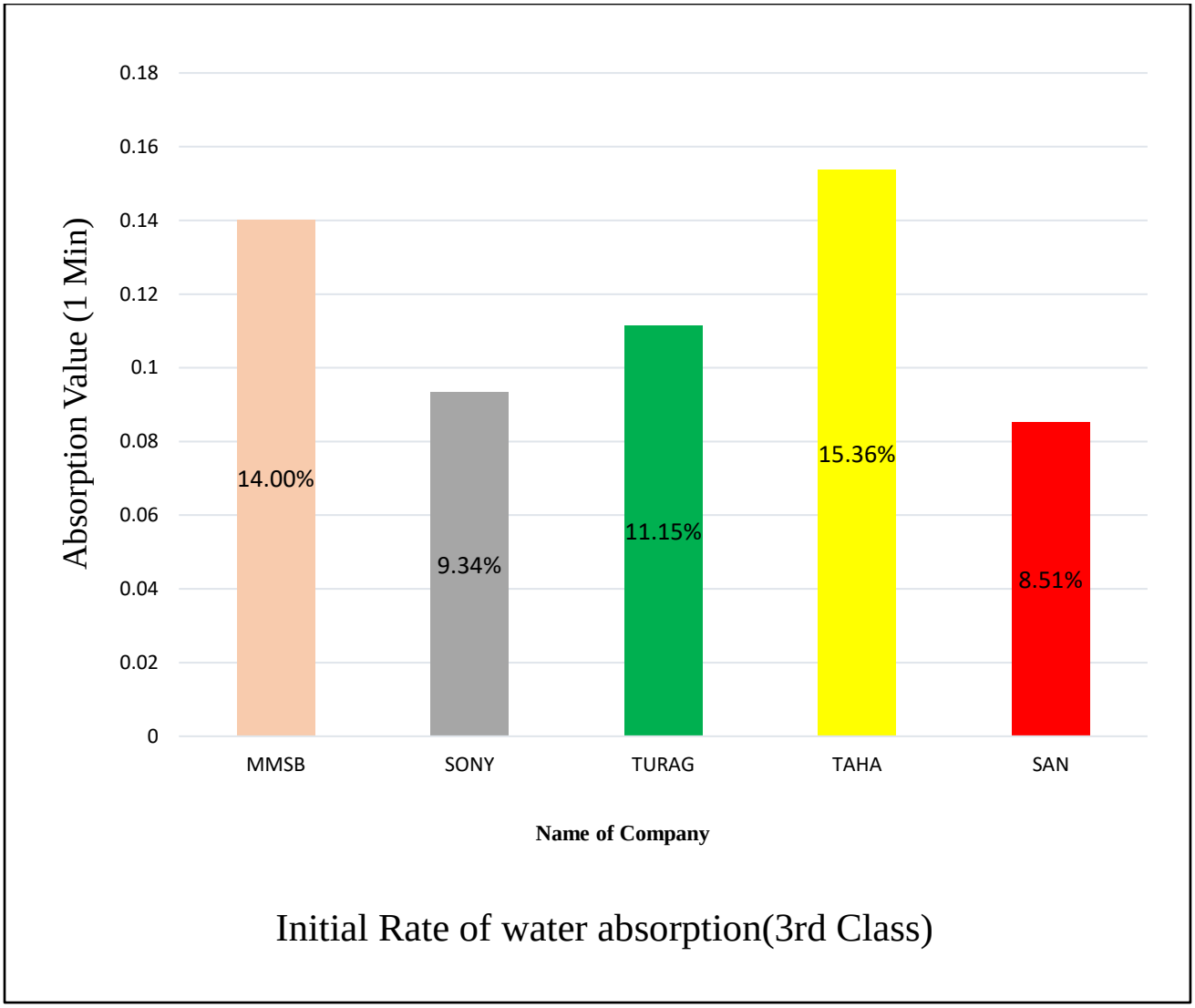


Fig -4.12: “Initial Rate of water absorption (1 Minute)” For 3rd Class Brick

4.1.2 Unit weight test calculation Report

Sample No	Name of Company	Classification	Size of Bricks (mm)	Mass (Kg)	Mass (Ib)	Unit Weight (Pcf)
Sample 01.	MMSB	1st Class	235x112x70	2.63	5.79	88.93
		2nd Class	235x110x68	2.95	6.49	104.55
		3rd Class	232x110x68	3.05	6.71	109.49
Sample 02.	SONY	1st Class	241x118x68	3.09	6.80	99.54
		2nd Class	240x119x70	2.89	6.36	90.05
		3rd Class	230x112.6x67	2.82	6.20	101.24
Sample 03.	TURAG	1st Class	234x115x70	2.9	6.38	95.91
		2nd Class	230x112x70	2.89	6.36	99.84
		3rd Class	235x114x70	2.85	6.27	94.68
Sample 04.	TAHA	1st Class	237x114x66	2.85	6.27	99.57
		2nd Class	238x114x66	2.81	6.18	97.76
		3rd Class	243x116x66	2.88	6.34	96.44
Sample 05.	SAN	1st Class	234x113x66	2.9	6.38	103.52
		2nd Class	236x114x67	2.89	6.36	99.88
		3rd Class	227x115x67	2.73	6.01	97.24

Table No-4.13: Unit weight test calculation

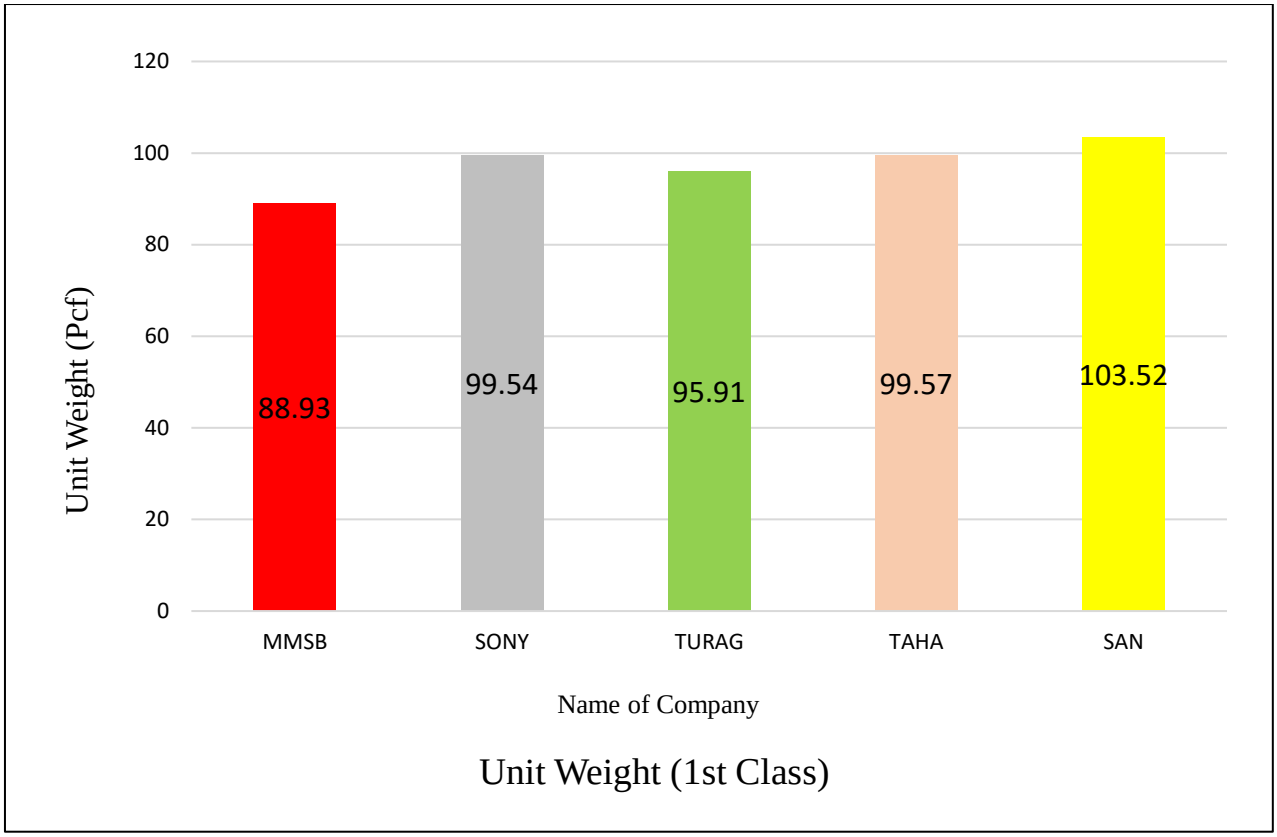


Fig -4.14: "Unit weight test calculation" For 1st Class Brick

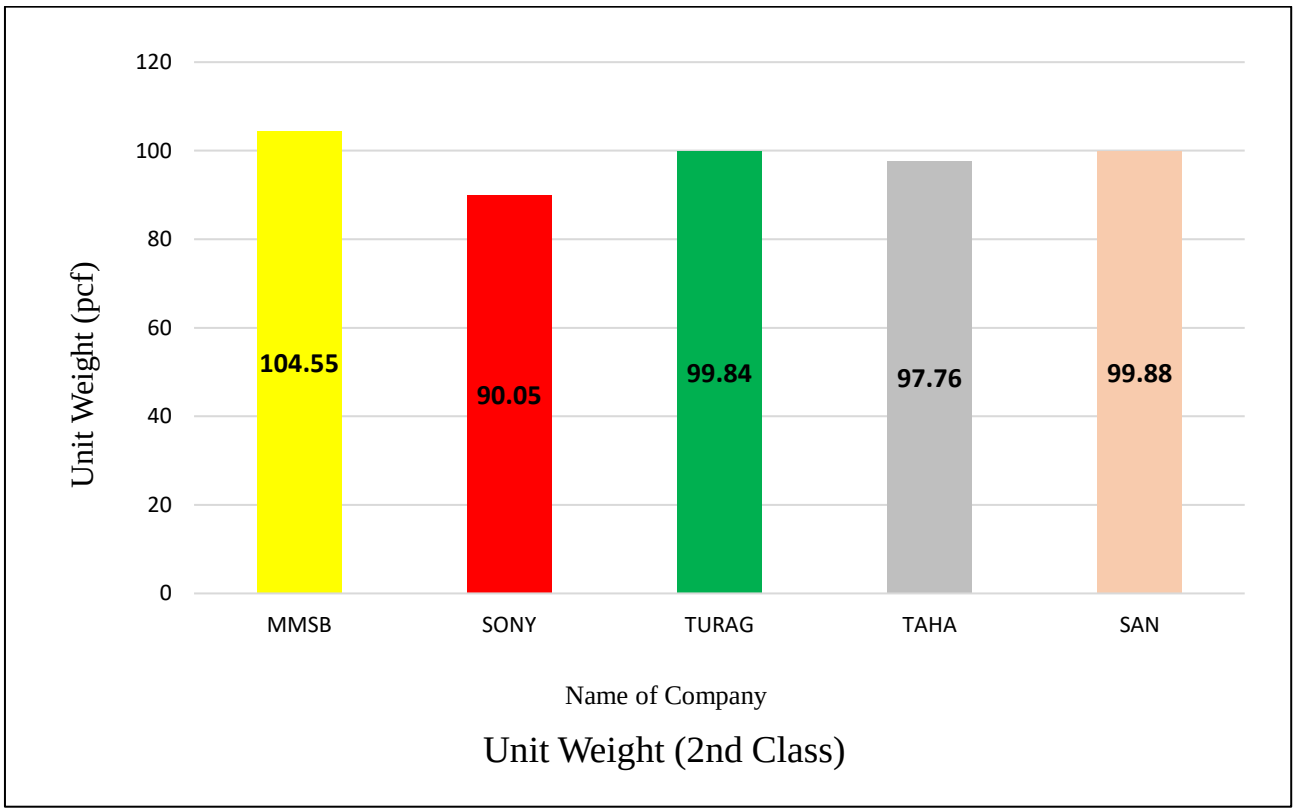


Fig -4.15: "Unit weight test calculation" For 2nd Class Brick

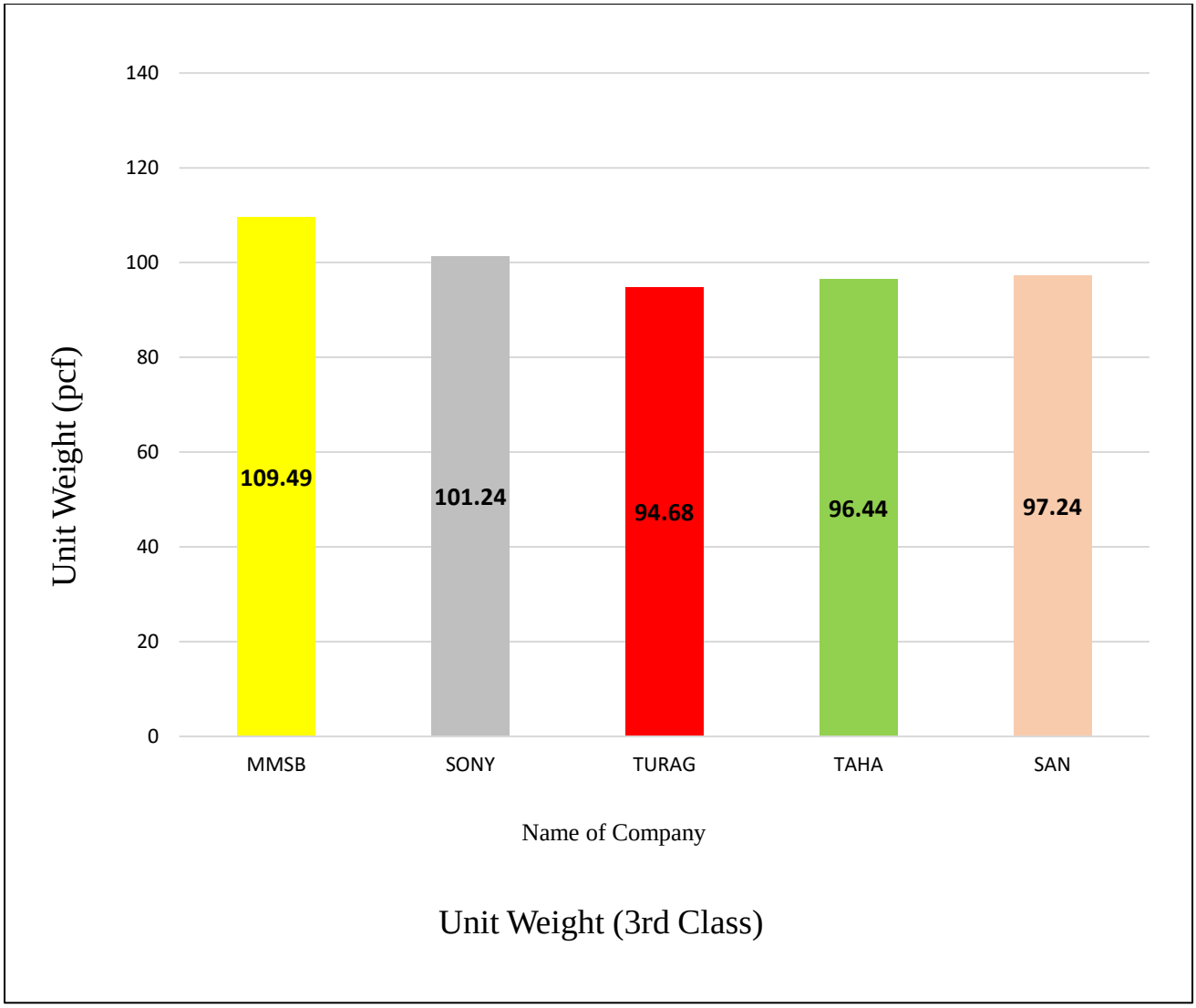


Fig -4.16: “Unit weight test calculation” For 3rd Class Brick

4.1.3 Dimension Deviation test calculation Report

Sample No	Name of Company	Classification	Size of Bricks (mm)	Standard Dimension	Dimension Deviation
Sample 01.	MMSB	1st Class	235x112x70	237.5x112.5x68.75	L=2.5, B=0.5, H=-1.25
		2nd Class	235x110x68	237.5x112.5x68.75	L=2.5, B=2.5, H=0.75
		3rd Class	232x110x68	237.5x112.5x68.75	L=5.5, B=2.5, H=0.75
Sample 02.	SONY	1st Class	241x118x68	237.5x112.5x68.75	L=-3.5, B=-5.5, H=0.75
		2nd Class	240x119x70	237.5x112.5x68.75	L=-2.5, B=-6.5, H=-1.25
		3rd Class	230x114x67	237.5x112.5x68.75	L=7.5, B=-1.5, H=1.75
Sample 03.	TURAG	1st Class	234x115x70	237.5x112.5x68.75	L=3.5, B=-2.5, H=-1.25
		2nd Class	230x112x70	237.5x112.5x68.75	L=7.5, B=0.5, H=-1.25
		3rd Class	235x114x70	237.5x112.5x68.75	L=2.5, B=-1.5, H=-1.25
Sample 04.	TAHA	1st Class	237x114x66	237.5x112.5x68.75	L=0.5, B=-1.5, H=2.75
		2nd Class	238x114x66	237.5x112.5x68.75	L=-0.5, B=-1.5, H=2.75
		3rd Class	243x116x66	237.5x112.5x68.75	L=-5.5, B=-3.5, H=2.75
Sample 05.	SAN	1st Class	234x113x66	237.5x112.5x68.75	L=3.5, B=-0.5, H=2.75
		2nd Class	236x114x67	237.5x112.5x68.75	L=1.5, B=-1.5, H=1.75
		3rd Class	227x115x67	237.5x112.5x68.75	L=10.5, B=-2.5, H=1.75

Table No-4.17: Dimension Deviation Test.

CHAPTER-5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

1. According to our first objective, we determine the compressive strength of bricks with the help of a compression testing machine. We have found that the maximum value of the Compressive strength for 1st, 2nd and 3rd class bricks are SUN, SUN, & TAHA and the minimum value for 1st, 2nd and 3rd class bricks are TURAG, MMSB & TURAG.

2. According to our second objective, we defined as the number of grams of water absorbed in one minute over 30 square inches of brick bed area (ASTM C67). We have found that the maximum value of water absorbed for 1st, 2nd and 3rd class bricks are TURAG, SUN & SUN, and the minimum value for 1st, 2nd and 3rd class bricks are SAN, TAHA, TAHA.

3. According to our third objective, we determine the percentage of water absorption of bricks, when the brick submerged underwater for 24 hrs. We have found that the maximum value of water absorbed for 1st, 2nd and 3rd class bricks are SUN, SONY, SONY and the minimum value for 1st, 2nd and 3rd class bricks are TURAG, TAHA, TAHA.

4. According to our fourth objective, we calculate the brick weight by using the following formula: weight = volume * density. We have found that the maximum weight of bricks for 1st, 2nd and 3rd class bricks are SAN, MMSB & MMSB, and the minimum value for 1st, 2nd and 3rd class bricks are MMSB, SONY & TURAG.

5. According to our fifth objective, we take every dimension of bricks and determine the Dimension & Deviation of bricks. Details results are shown in chapter 4 with tabular data.

5.2 Recommendation

Based on this study, the following recommendations can be made for future research:

1. It is highly recommended that the future researchers should use potable water for all brick tests.
2. To ensure the UTM machine is free from any type of error so that the future researcher can get accurate results in case of Compressive strength test of bricks.
3. To collect brick samples from different brick factories except "MMSB", "SONY", "TURAG", "TAHA" and "SUN" to define the difference between the present and future analysis.
4. Due to a lack of time, it was impossible for us to make cost analysis. So, it is recommended for future researchers to make cost analysis if possible.

REFERENCE

About Civil https://www.aboutcivil.org/bricks-advantages-disadvantages-uses.html

Austral Bricks https://australbricks.com.au/benefits-of-bricks/

Civil Engineerspk https://civilengineerspk.com/characteristics-good-bricks/

DR. M.A. AZIZ, Revised Edition-2012, (Engineering Materials), Hafiz Books, Dhaka, Bangladesh.

Http://gluedideas.com/content-collection/Paving-Brick-and-Paving-Brick-Clays-of-Illinois-1908/Discussion-of-Tests-and_P1.html

Indian Standard Methods of Test for Aggregate for Concrete, IS: 2386 part IV. Indian Standard Institution.

Methods for Sampling and Testing of Mineral Aggregates Sands and Fillers, BS:812, British Standard Institute.

Rangwala (2000), "Engineering Materials", Charotar Publishing House, Opposite Amul Dairy, Court Anand-3888001, India.

The Brick Directory (2010-2011) http://www.brickdirectory.co.uk