



‘BRICK’ AS A HISTORIC BUILDING MATERIAL

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INTRODUCTION

Historical buildings and heritage are our cultural properties. They have priceless value and should be preserved. And for preserving, it is important to know about all its characters, properties, materials etc.

What is a brick?

A brick is that construction material without which construction is incomplete. It is used as a filler material in framework structures and as a main material in masonry structures. Its first tracing has been dated back to Indus Valley Civilization [9]. It is a block made up of clay. Over the time, bricks have appeared, gained importance, lost importance and then come back again with various styles of architecture. Burnt bricks were used in ancient Indian, Babylonian, Egyptian and Roman civilizations [2]. The process of making a brick has not changed much over the centuries or through various types of topographies. Because of its simplicity, it is in use.

Evolution of Bricks:

At early Stone Age or Paleolithic Age, people were nomads. They took shelters in cave, rock shelters and temporary structures (huts) of plants and animal materials such as wooden poles, grasses, leaves and animals skin. These temporary structures were round. By the end of the Paleolithic age, construction was of mud. In the Mesolithic age, structures found were a bit more durable, made of clay and stones but in a wild and natural state. In Neolithic age, people started settling down and so came the need for their settlement. Because of this people started farming and producing various other things for their living. They started exchanging things for their living. And because of this, came the need for permanent settlement which brought in the use of mud in larger extent. So the bricks came into existence. Their early and popular mode of construction was mud, mud bricks and stone. In Indus/Harappan civilization, both kiln and sun-baked bricks were used for construction. Most of the villages or towns of Indus civilization are



built from stones and mud bricks. Mud bricks have been used since 7000B.C.[10] at Mehrgarh whereas baked bricks at Jalilpur from around 2800B.C.[10] which was a mature Harappan phase. The prominent role was of baked bricks between early and beginning of late Harappan phase. Clay brick masonry continued to be in use during medieval and modern times.

During the Neolithic era, sun-dried bricks were used in India for construction. It is believed that nearly 5000 years ago, a group of people came and settled in the north-west of India, which is considered as the beginning of Indus Valley Civilization. Indus basin was rich in timber and soil. So the standard building material was baked or kiln-fired mud bricks. Mud bricks have been used since 7000B.C. at Mehrgarh whereas baked bricks at Jalilpur from around 2800B.C. which was a mature Harappan phase. The prominent role of baked bricks was between early and beginning of late Harappan phase. Mauryan Dynasty constructions were earlier being done by wood. But because of its less durability, bricks were used. But when Ashoka came and adopted Buddhism, baked bricks were used earlier for Stupas and later were made of stones and rock cut architecture. After the death of Ashoka, Sunga Dynasty took over and replaced the brickwork of Ashokan period by stones, though the unimportant structures like residences etc. were still constructed either by sundried bricks or baked bricks.

Kushan Dynasty – bake and unbaked

Satvahana Dynasty – baked

In south India, Dravidian Architecture was in its full freedom to develop as it was less affected by outside invasions. It mainly consisted of five major dynasties which changed its architectural style. They are:

- PallavaDyanasty – baked bricks
- Chola Dynasty – baked bricks
- Pandya Dynasty – baked bricks
- Vijayanagar Dynasty – baked bricks
- Madura Dyansty – baked bricks



Classification of bricks:

Bricks in modern times are made in the same way as they were made in earlier times but because of various technologies available today, they can be classified in different types. But in earlier times, bricks were made simply and according to their needs were used. They were not classified separately under some heads as they are done today. So, they can be classified according to quality, usage, colour, sizes, materials, mineral content and also the shapes.

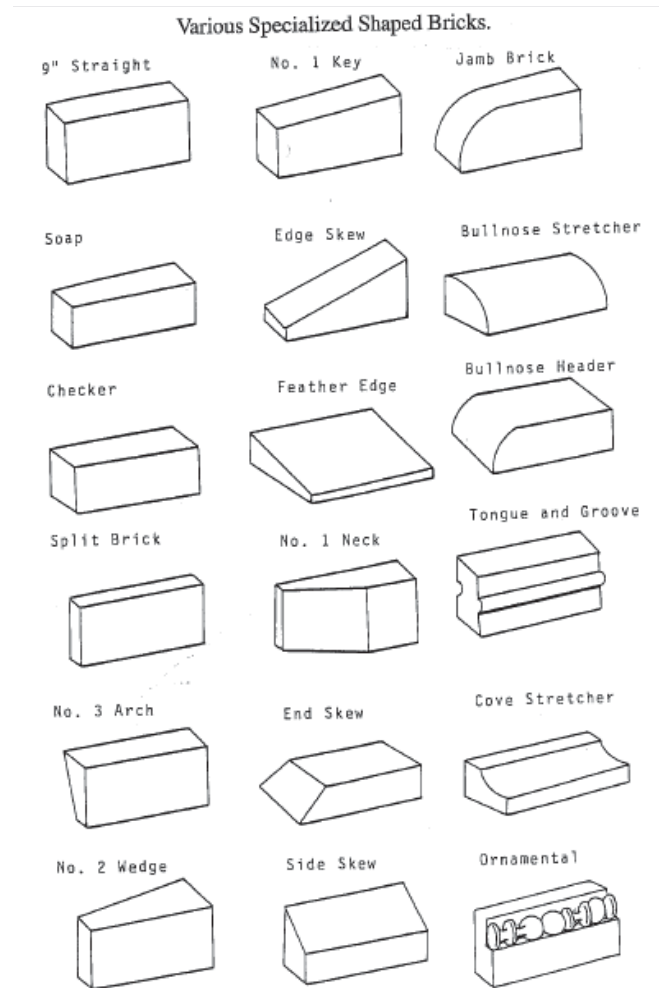
1. Classification according to quality – Burnt bricks are divided into three classes namely, (a) first (best quality bricks); (b) second (some imperfection due to shape or colour or both); (c) third, remaining bricks in the kiln (suitable for interior work).

2. Classification according to usage – Division according to the suitability for their usage like (a) interior purpose (common bricks are used for this); (b) exterior purpose (requirement is durability and freedom from defects and in case of exposed work, colour and texture); (c) pressure-resisting purpose (strength is the chief requirement to resist large stresses) and (d) fire-resisting purpose (suitable to resist high temperatures).

3. Classification according to colour – Colour is influenced by (a) chemical composition of clay, (b) temperature during burning, (c) atmospheric condition of kiln (depends on the smoke in kiln), (d) sand-moulding (includes the bricks which are hand moulded and sand sprinkled on it defines its colour) and (e) staining (done with sprinkling various metallic oxides before burning).

4. Classification according to materials – Bricks made of different material other than clay and sand are – (a) cement and concrete bricks, (b) concrete bricks, (c) glass bricks, (d) calcium silicate bricks (sand and lime), (e) adobe bricks and (f) stone bricks.

5. Classification according to shapes – Bricks was moulded as per the shape required for the structure which is practiced till now. (a) arch bricks (voussoirs); (b) bullnose bricks; (c) rectangular bricks; (d) splayed bricks (champhered edges); (e) circular or semi-circular bricks



Specialized size bricks (Source: [12] p.12)

Sizes of the Bricks:

The size of bricks varies significantly depending on type and date of manufacture. Size and visual appearance can help in dating bricks, particularly those made in the period before bricks were machine-made. Handmade bricks vary in dimension from one place to the other and even locally. The different dimensions of the bricks used for construction in the heritage structures of various parts of the world are:

- In Indus valley civilization as well as the Harappan civilization, ratio was 4:2:1 [9] whereas the Kalibangan city has the ratio of bricks as 3:2:1 [9].
- During Egyptian civilization, the ratio used was 2:1:3/4 or 4:2:1 [4].

- Bricks used in the Scottish architecture were called Scottish brick measuring 8-9x3x21/2 (inches)[16] whereas in Irish architecture, they were called Irish brick measuring 81/2-93/4 x 4-45/8 x 13/4-25/8 inches during 17th century [6].
- In the 17th century, the heritage structures of Cheshire, U.K. had the brick size of 93/4x45/8x2 inches.
- In the Roman architecture, bricks had the size ratio of 8:4:1 and in some of the structures length and width were same and the height varied [5].
- American brick sizes

Table 1. Comparison of Royal Size Standards to Colonial Brick Sizes (in inches)

Brick	Length	Width	Thickness
English Royal Standards (Lloyd 1925)			
1571, Elizabeth I	9	4 1/4	2 1/4
1625, Charles I	9	4 3/8	2 1/4
1725, George I (Place Bricks)	9	4 1/4	2 1/2
(Stock Bricks)	9	4 1/4	2 5/8
1729, George II (within 15 miles of London)	8 3/4	4 1/8	2 1/2
1769, George III	8 1/2	4	2 1/2
(Sizes same as George I beyond 15 miles)			
1776, George III (all of England)	8 1/2	4	2 1/2
English/American Colonial Bricks			
Typical 18th C Colonial Brick (Nöel Hume 1969)	8 3/4	4	2 5/8
Nöel Hume "English" Brick (small cherry red),mid 18thC	7 1/2	3 1/2	2
Brunswick Brick (small) 1725-1775 (South 1964)	7 1/2	3 1/2	1 1/2
Brunswick Brick (large) 1725-1775 (South 1964)	9	4 1/8	2 5/8
Williamsburg Brick, 1719 (South 1964)	9	4 1/4	2 1/4
Jamestown Brick (small) (South 1964), 1650	8 1/2	4 1/8	1 7/8
Jamestown Brick (large) (South 1964), 1650	9	4 3/8	2 1/2
Fort George Brick, Pensacola (Lazarus 1965), 1765-75	9 1/4	4 1/4	2 1/2

Different Brick sizes (Source: [12] p.14)

Raw Materials:

Raw materials used for the construction of bricks vary with the types of bricks. Raw materials commonly required for brick making are –clay, water, sand fuel. Clay is the naturally occurring raw material which is used to make bricks. Clay has variations in its appearance, its physical properties and minerals with the site variations. Minerals content is the key common in all clay



type which are formed from the erosion and weathering of primary igneous rocks. The different types of clay are surface clays, shales and fire clays. All these three types of clay are composed of silica and alumina with some metallic oxides (which influence the color of the bricks). Clays occur in three principal forms, all of which have similar chemical compositions but different physical characteristics.

In earlier times, the clay used for making bricks were taken from the river bed or lakes in monsoon season and left for weathering for one complete year during which the mud used to gain and lose all the components required like various minerals etc. It uses to get wet and break the large mud lumps into smaller ones.

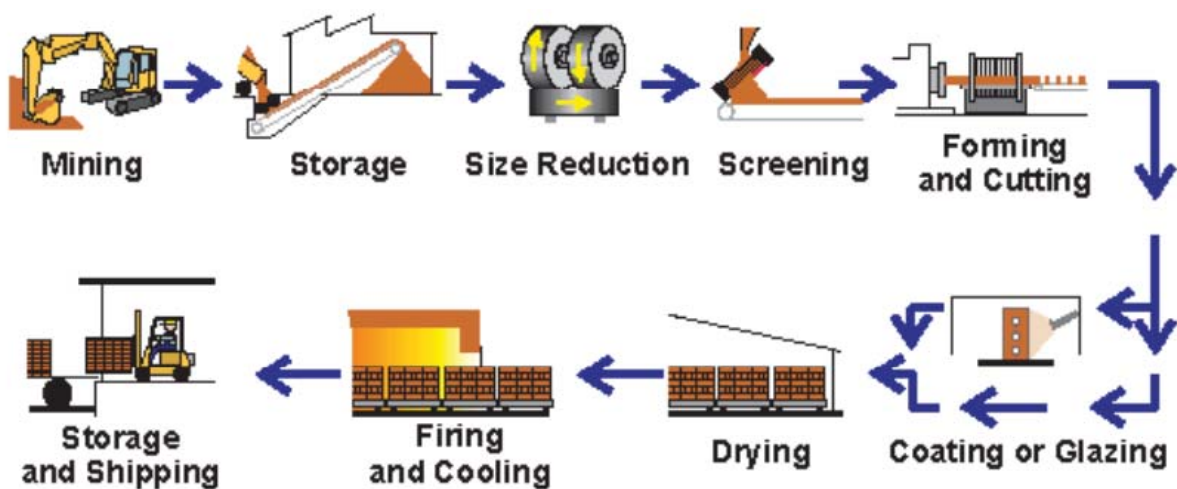
Brick Manufacturing Process:

Now if we see the traditional process of brick making, the process is like this – the traditional manufacturing of fired clay bricks can be divided into four stages. Firstly the extraction of the clay for making bricks (which in today's term is known as mining) is done and is kept at one place in open. Selection for clay depended on the availability of construction location. The mixing of clay was done by hands or feet by adding water to it in very earlier times. Later, when they learned how to tame animals, mixing was done by heavy wheels in a pit tied to the animals like – Ox, Horse or Donkey etc. amount of water to be used was directly depended on the type of element. For eg. – as small and thin the particles of clay will be, the more water will be required to mix it.

After this, the prepared mix is put into the mould which was usually of wooden material with no base. Before keeping the brick on ground, sand is placed below the brick so that it doesn't stick to ground. The excess clay was removed with the help of wooden stick or rope etc. The still rough clay elements were removed from the mould and dried in a covered space, which was generally a shelter made of scraps of wood and with a straw thatched roof: these shelters were known as hovels [3]. Sun dried bricks were made like this and were left for longer durations to get hardened. But for fired baked bricks, they were kept for 1 week or so for drying and then were fired with the natural fuel like wood straw, etc. Bricks were sorted and which were not fit for external use, were used internally.

But in today's time, bricks are prepared in kilns and from selection of plant setup area to raw material, various factors are to be considered [7]. Clay rocks are extracted from the quarries and are further grinded into dust and then with crusher.

The crushed raw material is stored in an open area. After this, the materials which are to be used to form a brick are mixed together and grinded further. This mix is screened for proper unit size and stored at a place from where it is put into a machine for brick making where water is added in it. Now quantity of water added to the mix is according to the process adopted for making bricks. Air is removed from the mixture before it is sent for extrusion. Next, the texture and coatings are applied before it is cut into the size of an individual bricks. In case of small production, hand moulded bricks are produced. After this bricks are sent to dryer for evaporation of water and then fired in kilns. After the temperature has risen to its maximum to prepare bricks, cooling process begins. Cold air is drawn into the kilns to cool the bricks slowly which has direct effect on the colour of bricks. Then the bricks are unloaded from kiln and are sorted.



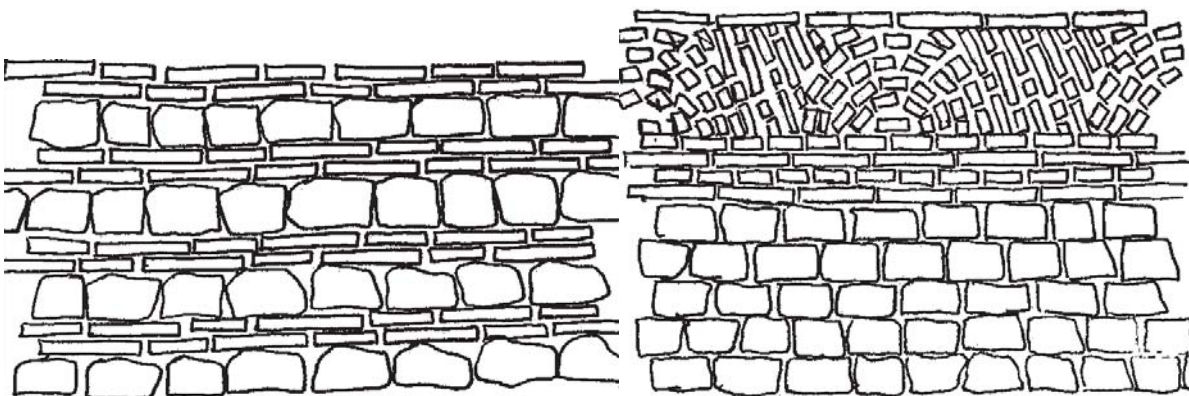
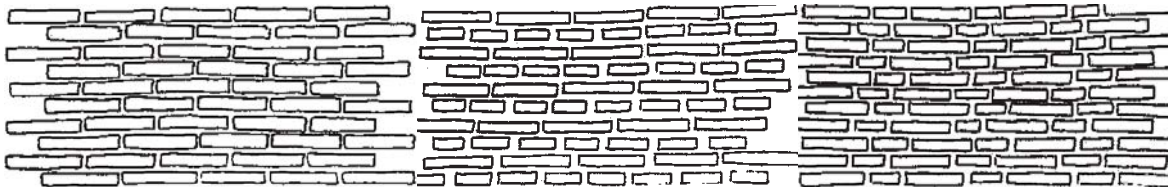
Diagrammatic Representation of Manufacturing Process (Source: Internet)

Techniques of Construction:

Bonding is the technique used for constructing a brick wall by laying them over each other either just below or above immediately. It has various courses to tie the units together. They have been practiced since olden times. The only difference is, that they were not given names as they are

defined today. The main aim for bonding is to provide strength. Various bonds used for construction in olden times (that can be easily seen in Bhopal) are as follows:

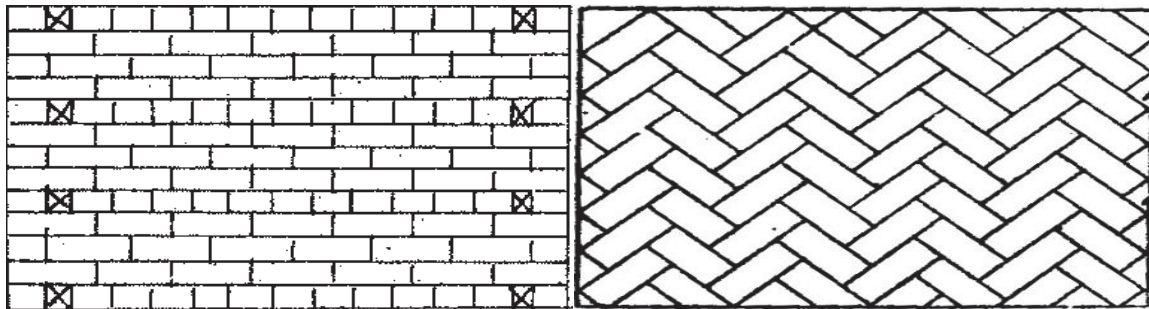
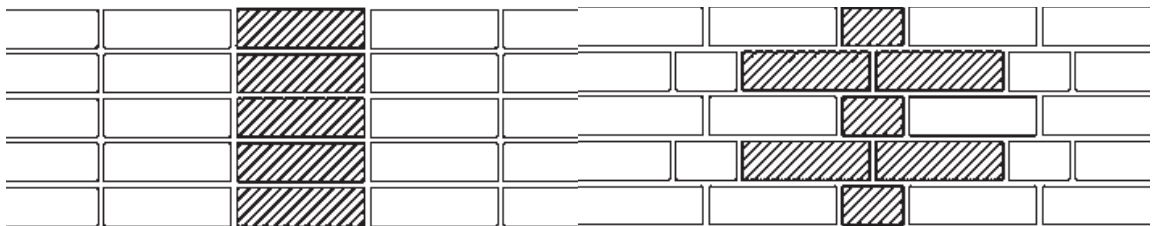
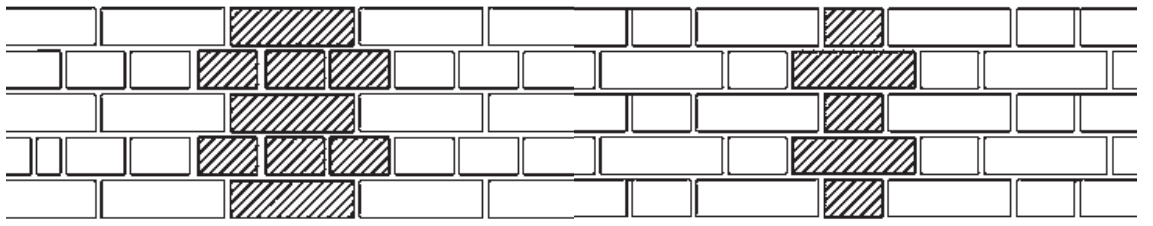
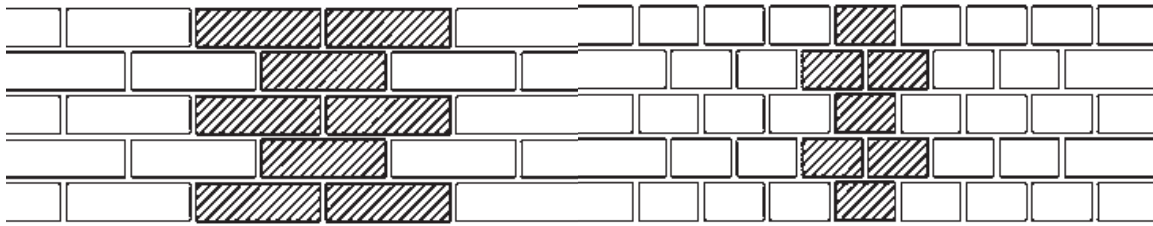
1)Traditional Techniques



2)Modern Techniques

Additional bonds which are used for construction today other than the common ones mentioned above are:

English cross bond; Brick on edge bond; Facing bond; Dutch bond; Raking bond; Zig zag bond; Garden wall bonds; Bonds at connections – Tee junctions, Intersection or Cross junction, Squint junction, Quoins; bonding in Piers etc.



Use of Bricks:

•**Traditional use** – Traditionally, bricks have been used for construction in many ways. They have been prepared in several shapes including simple rectangular one for different purposes like walls, footings, sills (Bullnose brick), copings, piers, treads, arches (Voussoirs), radials (curved surface brick), lintels, roofs, floors, parapets, brick carving (examples can be seen in Tanjore), dome, buttresses, corbelling, in walkways, minars, stairs etc.



•**Modern use** – The common structures constructed in brick work in today's time are: walls, piers, footings, buttresses, window sills, corbels, copings, jambs, chimneys arches, lintels etc.

Laurie Baker has used the bricks in new form and shape and given a new meaning to it in today's time with countless creations. He has built arches, jaalis, frameless doors and windows with bricks, which are not a new discovery as an element but are the new techniques from the old material i.e. brick. He tried to use the minimum possible quantity of materials. His objective was to generate the possible use with the common brick in building line to create beauty, cost efficiency and environmental harmony to which he succeeded.

The Architecture of Bhopal Region from the Mughal patrons sought shelter under various chiefs and hence the process of raising Islamic monuments continued in different states of India. The monuments bear the stamp of decayed Mughal styles and are deeply influenced by the local art traditions. The monuments raised under the patronage of the Nawabs of Bhopal which also were in line with the above movement may be discussed under the following major heads where bricks had been the major element for their construction:

1. Religious architecture—Idgah, Tombs and Mosques.
2. Civil architecture—Palaces, Baghs, Pavilion, Summer Resorts, Baradaris and Baolies.
3. Forts

Conclusion:

The common burnt brick is one of man's greatest discoveries. Thousands of years ago, bricks were made in several different shapes and sizes but, one by one, the less suitable ones were rejected. Now all over the world, with few exceptions, almost all bricks are roughly of the same shape and size i.e. 9 x 4.5 x 3 inches which is neither by chance nor fluke, but the result of thousands years research and change. But today also according to the need and the requirement, shapes and sizes of the bricks are designed and modified. Although the art of making bricks by hand has been left behind but still is being practiced in some of the areas and is a part or a step in the process of making bricks.

•Identification of Issues



The most common problems likely to be encountered in the brick buildings (based on various case studies of Bhopal) are the decay of the joints in the brickwork and/or the decay of individual bricks in specific areas and in varying amounts. The causes of such decay will vary. They may be related to particular structural problems or failures, or may be simply the normal effects of weathering from rain and frost. Water in its different forms is the main agent of decay and brickwork, like all other building materials, needs to be correctly detailed to minimise the impact of driving rain and to cut down the potential for water saturation. Maintenance of rainwater goods, flashings and drainage are also essential to prevent damage. Issues may be classified into two broad categories –

1. Natural or inherent problems based on the characteristics of the material and the conditions of the exposure –

- i. Cracking
- ii. Efflorescence
- iii. Erosion
- iv. Flaking
- v. Peeling
- vi. Rising Damp
- vii. Spalling
- viii. Weathering
- ix. Vegetation Growth and surface staining from it
- x. Rusting

2. Vandalism and human induced problems –

- i. Chipping
- ii. Prolonged saturation with water caused failures in the roof or flashing above or by leaks in pipes and gutters, open joints or ground moisture
- iii. Incompatible material used for repointing.
- iv. Application of paint or water-repellent coating to masonry surface
- v. Repointing Failure and failure due to no repoint

• Impacts on the structures that leads to Issues

1. Neglect
2. Weathering
3. Improper material used for restoration
4. Unplanned growth nearby
5. Human Vandalism

In the heritage structures, bricks that have been damaged and had been through various natural and manmade calamities need the repair of either as a whole or as a part which can be done in the ways like-



- 1)By replacing Bricks
- 2)By reversing Bricks
- 3)By brick Slips
- 4)By mortar Repair

In today's world, the shift has been made from brick to concrete. But if ones work can be done with brick which is a cost effective material – cheaper than concrete, its dead load is lighter than concrete, it is easy for construction, it has flexibility and it has its scrap value as well. Then why the bricks are being replaced by non-friendly material.

When the bricks can be left exposed then why there is need in today's world to hide it with plaster? Laurie Baker said that it is very foolish practice to build a brick wall and then plaster it with cement and then paint it all over to make it look "beautiful". In his words - "I just think it is plain stupidity to build a brick wall, plaster it all over and then paint lines on it to make it look like a brick wall. I think it is equally untruthful to cover it all over with tiles shaped to look like bricks. Or another variation of untruthfulness is to plaster it and then paint it to look like marble!" (3).

Even the writers, whose books are being studied by the students for construction and material purposes, have clearly defined that how the bricks are made, what are the uses of them, how they bond with each other for strength, etc. Uncommon uses of bricks, like in making slabs and in concrete as aggregate, are lost now as they are not mentioned by the writers in the books. So only the people those who are working with the traditional methods and techniques, are aware of it.

The things which were originated thousands years ago, are still being used but in a modified manner. Bricks were used with lime mortar to give strength to the structure but today it is used with cement mortar which sets quickly as compared to lime. Bricks are made more or less in the same manner as they were prepared when there were no mechanical means.

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