CHAPTER 2
Study of Cost Effective Materials

Prof. M. Vadivel
Nehru Institute of Technology, India

Prof. P. Madhan
Nehru Institute of Technology, India

Ar. S. Sundar
Nehru School of Architecture, India

Ar. S. Stella Mary
Nehru School of Architecture, India

ABSTRACT

The automobile marketing is one of the major problems in creating environmental problems in the earth. One of the most automobile waste is Bakelite i.e., E-plastic waste, which is the phenol formaldehyde resin (thermosetting plastic). It is one of the most toxic materials. The Bakelite waste is filled on the land or incinerated, both causes hazards to the environment and creates health problems to the living organisms. Bakelite waste is prohibited from disposing of direct land filling and open burning, which becomes a waste management problem. The purpose of this research is the use of waste Bakelite aggregate as fine aggregate to replace natural sand material partially. The Waste Bakelite Fine Aggregate (WBFA) was mixed in concrete mixture with various proportion. The sample was tested for compressive strength, split tensile strength and flexural strength shear strength and modulus of elasticity. The objective of this study is a transformation of a waste Bakelite from industrial manufacturing by size reduction with the milling machine. The smaller size of waste Bakelite will be classified into coarse aggregate and fine aggregate by sieve. There are some studies and conclusions by researchers for the properties of plastic waste mixed in the concrete. The compressive strength of premixed concrete blended with recycling plastic (PCBWRP) decreased when a percentage of recycling plastic in the concrete was increased. The tensile strength of plastic mixed concrete lower than traditional mortar and adversely correlated to the rate of recycling plastic mix in the concrete and tensile strength.

In the paper, the studying will focus on the transformation of waste of Bakelite and utilization of waste Bakelite fine aggregate (WBFA) as natural fine aggregate (NFA) replacement in a cement mortar .The milling capacity, the gradation of waste Bakelite fine aggregate grain size was analysed, and illustrated by particle size distribution curve. The utilization study of waste Bakelite concrete (WBC) proceeded by the inspection of the compressive strength of mortar specimens, Furthermore, find the correlation between waste Bakelite fine aggregate (WBFA) content and compressive strength of the mortar. By preparing and testing mortar samples with 0% 20% sand replacement percentage at curing age 28 days, the samples test follow ASTM 109 and the test results compared with the industrial standard allowable compressive strength of plastic cement concrete. The conversion process of waste Bakelite compose of waste Bakelite Bakelite

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

size reduction , waste Bakelite aggregates classification by the sieve , waste Bakelite fine aggregate utilization in cement mortar and sample test.

Keywords: *automobile marketing Bakelite compose,, Bakelite aggregates etc*

INTRODUCTION

The study of cost effective materials is for the materials that are economically and have many advantages over other types of materials . These materials are called cost effective materials modern construction materials .so the materials with more advantages and less cost is called as a cost effective materials

FLY ASH INTRODUCTION

Pulverized fuel ash commonly known as fly ash is a useful by-product from thermal power stations using pulverized coal as fuel and has considerable pozzolonic activity. This national resource has been gainfully utilized for manufacture of pulverized fuel ash-lime bricks as a supplement to common burnt clay buildings bricks leading to conservation of natural resources and improvement in environment quality. Pulverized fuel ash-lime bricks are obtained from materials consisting of pulverized fuel ash in major quantity, lime and an accelerator acting as a catalyst. Pulverized fuel ash-lime bricks are generally manufactured by intergrading blending various raw materials are then moulded into bricks and subjected to curing cycles at different temperatures and pressures. On occasion as and when required, crushed bottom fuel ash or sand is also used in the composition of the raw material. Crushed bottom fuel ash or sand is also used in the composition as a coarser material to control water absorption in the final product. Pulverized fuel ash reacts with lime in presence of moisture from a calcium hydrate which is a binder material. Thus pulverized fuel ash – lime in presence of moisture form a calcium – silicate hydrate which is binder material. Thus pulverized fuel ash – lime brick is a chemically ended bricks. These bricks are suitable for use in masonry construction just like common burnt clay bricks. Production of pulverized fuel ash-lime bricks has already started in the country and it is expected that this standard would encourage production and use on mass scale. This stand lays down the essential requirements of pulverized fuel ash bricks so as to achieve uniformity in the manufacture of such bricks

BASIC AND PPRESUMPTION

The process of manufacture is on the basis of single shift of six hours per day with three hundred working days in a year. ii. To achieve full plant capacity it requires! year after trial production iii. Labor and wages mentioned in profile are as per prevailing local rates. iv. Interest rate at 12.5% considered in the project v. However the rate of interest may be varying while implementing project. vi. The Promoter contribution will be 5% of the total project cost which applicable in the PMEGP scheme. vii. The capacity of the unit 8000 bricks per day on the single sift basis.

RAW MATERIALS

Fly Ash s the inorganic mineral residue obtained after burning of coal/lignite in the boilers. Fly Ash is that portion of ash which is collected from the hoppers of ESP's and pond ash is collected from the ash ponds. Bottom ash is that portion of ash which can be collected fro the bottom portion of the boilers. The characteristics of fly ash depend upon the quality of lignite/coal and the efficiency of boilers. India depends upon primarily on coal for the requirement of power and her power generation is likely to go up from 60,000MW in the year 2010. While generation of power from bituminous sources is on increase. The generation of fly ash is also likely to increase. The fly ash generation in India Thermal Stations is likely to shoot up to 170 million tones in 2010 from the present level of 100 million tones. The disposal of fly ash in the present method will be a big challenge to environment, especially when the quantum increases from the present level. The proposed unite will be using both type of fly ash depends upon the availbality

CHARACTERISTICS OF FLY ASH

The physical and chemical properties of Fly Ash are tabulated below

CHEMICAL PROPERTIES

Silica 35-59 % Alumina 23-33% Calcium Oxide 10-16% Loss on ignition 1-2% Sulphur 0.5- 1.5% Iron 0.5- 2.0 % It may be seen that lignite fly ash is characterized primarily by the presence of silica, alumina, calcium etc. Presence of silica in fine form makes it excellent pozzolanic material. Its abundant availability at practically nil cost gives a very good opportunity for the construction agencies.

MANUFACTURE PROCESS

Fly ash (70%)Lime (10%) Gypsum (5%) and sand(15%) are manually feed into a pan mixer where water is added to the required proportion for homogeneous mixing. The proportion of raw material may vary depending upon quality of raw materials. After mixing, the mixture are allowed to belt conveyor through feed in to automatic brick making machine were the bricks are pressed automatically. Than the bricks are placed on wooden pallets and kept as it is for two days there after transported to open area where they are water cured for 10 -15 days. The bricks are sorted and tested before dispatch.

POLLOUTION CONTROL

The technology adopted for making fly ash bricks is eco-friendly. It does not require steaming or auto-calving as the bricks are cured by water only. Since firing process is avoided. There are no emissions and no effluent is discharged. Facial masks and dust control equipment may be provided to the employees to avoid dust pollution more over all the raw materials are kept under covered by polythene sheet to avoid air pollution.

ENERGY CONSERVATION

General precautions for saving electricity are followed by the unit by providing energy meter. This products are low energy consumption since no need of fire operation in the production unlike conventional bricks. Thus considerable energy could be saved not only in manufacturing activities but also during the construction

HALLOW BRICKS

A concrete block is primarily used as a building material in the construction of walls. It is sometimes called a concrete masonry unit (CMU). A concrete block is one of several precast concrete products used in construction.

The term precast refers to the fact that the blocks are formed and hardened before they are brought to the job site. Most concrete blocks have one or more hollow cavities, and their sides may be cast smooth or with a design. In use, concrete blocks are stacked one at a time and held together with fresh concrete mortar to form the desired length and height of the wall.

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

Concrete mortar was used by the Romans as early as 200 B.C. to bind shaped stones together in the construction of buildings. During the reign of the Roman emperor Caligula, in 37-41 A.D., small blocks of precast concrete were used as a construction material in the region around present-day Naples, Italy. Much of the concrete technology developed by the Romans was lost after the fall of the Roman Empire in the fifth century.

It was not until 1824 that the English stonemason Joseph Aspdin developed portland cement, which became one of the key components of modern concrete. The first hollow concrete block was designed in 1890 by Harmon S. Palmer in the United States. After 10 years of experimenting, Palmer patented the design in 1900. Palmer's blocks were 8 in (20.3 cm) by 10 in (25.4 cm) by 30 in (76.2 cm), and they were so heavy they had to be lifted into place with a small crane. By 1905, an estimated 1,500 companies were manufacturing concrete blocks in the United States.

These early blocks were usually cast by hand, and the average output was about 10 blocks per person per hour. Today, concrete block manufacturing is a highly automated process that can produce up to 2,000 blocks per hour.

RAW MATERIALS

The concrete commonly used to make concrete blocks is a mixture of powdered portland cement, water, sand, and gravel. This produces a light gray block with a fine surface texture and a high compressive strength. A typical concrete block weighs 38- 43 lb (17.2-19.5 kg). In general, the concrete mixture used for blocks has a higher percentage of sand and a lower percentage of gravel and water than the concrete mixtures used for general construction purposes. This produces a very dry, stiff mixture that holds its shape when it is removed from the block mold. If granulated coal or volcanic cinders are used instead of sand and gravel, the resulting block is commonly called a cinder block. This produces a dark gray block with a medium-to-coarse surface texture, good strength, good sound-deadening properties, and a higher thermal insulating value than a concrete block.

A typical cinder block weighs 26- 33 lb (11.8-15.0 kg). Lightweight concrete blocks are made by replacing the sand and gravel with expanded clay, shale, or slate. Expanded clay, shale, and slate are produced by crushing the raw materials and heating them to about 2000°F (1093°C). At this temperature the material bloats, or puffs up, because of the rapid generation of gases caused by the combustion of small quantities of organic material trapped inside.

A typical light-weight block weighs 22-28 lb (10.0-12.7 kg) and is used to build non- loadbearing walls and partitions. Expanded blast furnace slag, as well as natural volcanic materials such as pumice and scoria, are also used to make lightweight blocks. In addition to the basic components, the concrete mixture used to make blocks may also contain various chemicals, called admixtures, to alter curing time, increase compressive strength, or improve workability.

The mixture may have pigments added to give the blocks a uniform color throughout, or the surface of the blocks may be coated with a baked-on glaze to give a decorative effect or to provide protection against chemical attack. The glazes are usually made with a thermosetting resinous binder, silica sand, and color pigments.

MANUFACTURING PROCESS

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

The production of concrete blocks consists of four basic processes: mixing, molding, curing, and cubing. Some manufacturing plants produce only concrete blocks, while others may produce a wide variety of precast concrete products including blocks, flat paver stones, and decorative landscaping pieces such as lawn edging. Some plants are capable of producing 2,000 or more blocks per hour. The following steps are commonly used to manufacture concrete blocks

MIXING

The sand and gravel are stored outside in piles and are transferred into storage bins in the plant by a conveyor belt as they are needed. The portland cement is stored outside in large vertical silos to protect it from moisture.

As a production run starts, the required amounts of sand, gravel, and cement are transferred by gravity or by mechanical means to a weigh batcher which measures the proper amounts of each material. The dry materials then flow into a stationary mixer where they are blended together for several minutes.

There are two types of mixers commonly used. One type, called a planetary or pan mixer, resembles a shallow pan with a lid. Mixing blades are attached to a vertical rotating shaft inside the mixer. The other type is called a horizontal drum mixer. It resembles a coffee can turned on its side and has mixing blades attached to a horizontal rotating shaft inside the mixer. After the dry materials are blended, a small amount of water is added to the mixer.

If the plant is located in a climate subject to temperature extremes, the water may first pass through a heater or chiller to regulate its temperature. Admixture chemicals and coloring pigments may also be added at this time. The concrete is then mixed for six to eight minutes.

MOULDING

Once the load of concrete is thoroughly mixed, it is dumped into an inclined bucket conveyor and transported to an elevated hopper.

The mixing cycle begins again for the next load. From the hopper the concrete is conveyed to another hopper on top of the block machine at a measured flow rate. In the block machine, the concrete is forced downward into molds

. The molds consist of an outer mold box containing several mold liners. The liners determine the outer shape of the block and the inner shape of the block cavities. As many as 15 blocks may be molded at one time. When the molds are full, the concrete is compacted by the weight of the upper mold head coming down on the mold cavities. This compaction may be supplemented by air or hydraulic pressure cylinders acting on the mold head.

Most block machines also use a short burst of mechanical vibration to further aid compaction. The compacted blocks are pushed down and out of the molds onto a flat steel pallet. The pallet and blocks are pushed out of the machine and onto a chain conveyor.

In some operations the blocks then pass under a rotating brush which removes loose material from the top of the blocks.

CURING

ISBN: 978-93-5980-742-3, www.aetsjournal.com ― Handbook of research in Basic and Applied Science

The pallets of blocks are conveyed to an automated stacker or loader which places them in a curing rack. Each rack holds several hundred blocks. When a rack is full, it is rolled onto a set of rails and moved into a curing kiln . 10 The kiln is an enclosed room with the capacity to hold several racks of blocks at a time. There are two basic types of curing kilns. The most common type is a low-pressure steam kiln. In this type, the blocks are held in the kiln for one to three hours at room temperature to allow them to harden slightly. Steam is then gradually introduced to raise the temperature at a controlled rate of not more than 60°F per hour (16°C per hour) . Standard weight blocks are usually cured at a temperature of 150-165°F (66-74°C), while lightweight blocks are cured at 170-185°F (77-85°C). When the curing temperature has been reached, the steam is shut off, and the blocks are allowed to soak in the hot, moist air for 12- 18 hours.

After soaking, the blocks are dried by exhausting the moist air and further raising the temperature in the kiln. The whole curing cycle takes about 24 hours. Another type of kiln is the high-pressure steam kiln, sometimes called an autoclave. In this type, the temperature is raised to 300- 375°F (149-191°C), and the pressure is raised to 80-185 psi (5.5

12.8 bar). The blocks are allowed to soak for five to 10 hours. The pressure is then rapidly vented, which causes the blocks to quickly release their trapped moisture. The autoclave curing process requires more energy and a more expensive kiln, but it can produce blocks in less time

CUBBING

The racks of cured blocks are rolled out of the kiln, and the pallets of blocks are unstacked and placed on a chain conveyor. The blocks are pushed off the steel pallets, and the empty pallets are fed back into the block machine to receive a new set of molded blocks.

If the blocks are to be made into split-face blocks, they are first molded as two blocks joined together. Once these double blocks are cured, they pass through a splitter, which strikes them with a heavy blade along the section between the two halves. This causes the double block to fracture and form a rough, stone-like texture on one face of each piece.

The blocks pass through a cuber which aligns each block and then stacks them into a cube three blocks across by six blocks deep by three or four blocks high. These cubes are carried outside with a forklift and placed in storage.

TYPES OF HOLLOW BRICKS

8 INCH – Rs.31 [25 kg]

6 inch - Rs.27[22kg] 4 inch – Rs.23[14kg]

- The adequate workability necessary for full compaction with the compacting equipment available.

- Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions.

- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

TYPES OF MIX

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

NOMINAL MIXES

In the past the specifications for concrete prescribed the proportions of cement, fine and coarse aggregates. These mixes of fixed cement- aggregate ratio which ensures adequate strength are termed nominal mixes. These offer simplicity and under normal.

INTERLOCKING BRICKS

Fig 1 Interlocking Bricks

Typically, the construction process and masonry can be tedious, time consuming, and expensive. To overcome the hardships and issues encountered during construction, varied methods of construction is being considered and developed. Simultaneously, materials and equipment used for construction are also being fabricated to enhance the quality of construction and furthermore minimize the time and cost. Interlocking bricks is one such advancement in the construction industry.

Interlocking bricks are the enhanced form of conventional clay bricks. Each brick is constructively designed to lock itself to the other bricks around without the use of mortar. The self-locking is achieved using shear-

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

key and lock mechanism. Based on the design, the shape of shear-key will vary and a complimentary lock is provided on the opposite side of brick. Load transfer is achieved by shear transfer and gravity.

Interlocking bricks are compressed and stabilized earth bricks which contributes to strength of the structure. They are usually not subjected to baking. Interlocking bricks come in various sizes and locking systems depending on the supplier. A typical brick size is 230x100x75mm (9x4x3 in). The cost of inter-locking bricks varies from 0.5$ to 2$ (Rs. 30 to Rs. 150).

ADVANTAGES

Earthquake resistant: During earthquakes, there are various stresses acting on the structure. Conventional bricks are not fully equipped to transfer the seismic loads throughout the structure since the only medium of load transfer is the mortar. If the mortar fails then the whole structure fails under seismic forces. Interlocking bricks are an effective and

proven earthquake resistant construction materials. The self locking pattern of the bricks enables the seismic forces to travel across the whole structure equivalently. Plastering can be time consuming and costly in case of conventional wall construction. Plastering of walls can be completely eliminated by using fair faced bricks of your choice available in the market. If required the walls can be given a smooth finish by applying a thin layer of paint. Since these bricks are self-designed that gives a neat finish, the maintenance cost is minimized.

No Plasterwork required (Source: YouTube/Malaysia Interlocking Bricks (MyIB))

Provides cooler interior

High compacted bricks generally result in higher density, which in turn converts itself into high thermal mass. Henceforth, the walls made of high compacted bricks typically furnish warm interiors. Interlocking bricks are less heat intensive. The tests have shown that interlocking bricks provides a much cooler interior (3oC – 5oC). This enables lesser/no use of air conditioners resulting in minimized energy consumption and more cost saving.

Unskilled / Fewer Labours

In case of Conventional brick laying, skilled labour is required for checking water level, spirit level and various other operations. Therefore a layman or an unskilled labour may find it difficult to learn the conventional methods of construction. Whereas interlocking bricks construction enables an unskilled labour to easily follow up on the construction procedure. It also provides various opportunities for an entrepreneur.

Minimizes cost

Since there is no use of mortar in the construction process, the cost of buying cement, sand, mortar and stone dust can be neglected. Also the cost for transportation can also be immensely reduced along with the cost on skilled labour. It does not require plasterwork, minor bar bending work, lesser cement and fewer labourers hence contributing to the overall cost reduction of the construction project.

Time Efficient

It is proved as the most time efficient way of construction. The normal conventional bricks has to be cured for about 21 days whereas the self-locking bricks require only 7 days of curing. In addition to that, time required for setting and curing of the structure can be diminished completely. By eliminating all the time consuming tasks, the project can be completed faster.

Disadvantages of Inter-locking Masonry

There are a few disadvantages as well to this method of construction. Since there is no plasterwork provided, rain water might into the lines making it a hostage for insects and other undesired things.

Due to the action of weather, disintegration of the bricks might also occur (especially in the corners). The colour of the brick changes if the rain water enters through the gaps.

As the interlocking bricks alone are not enough to hold all the forces acting on the structure, it is not advised for building having more than two storeys. 100-120mm slump

g) Exposure condition: Moderate (For Reinforced Concrete)

h) Method of concrete placing: Pumping

j) Degree of supervision: Good

k) Type of aggregate: Crushed Angular Aggregates

m) Maximum cement content: 340 kg/m

BRICKS

Bricks are small rectangular blocks that can be used to form parts of buildings, typically walls. The use of bricks dates back to before 7,000 BC, when the earliest bricks were formed from hand-moulded mud and dried in the sun. During the Industrial Revolution, mass-produced bricks became a common alternative to stone, which could be more expensive, less predictable and more difficult to handle.

Bricks are still in common use today for the construction of walls and paving and for more complex features such as columns, arches, fireplaces and chimneys. They remain popular because they are relatively small and easy to handle, can be extremely strong in compression, are durable and low maintenance, they can be built up into complex shapes and can be visually attractive.

However, more recently, other materials have been developed that can be used as alternatives for building walls or for cladding facades and for some building types, particularly larger buildings, bricks can be seen as time consuming, expensive (although this is disputed by the Brick Development Association), structurally limiting, and requiring too much on-site labour. Some of these difficulties have been overcome by the introduction of reinforcement systems and by the development of pre-fabricated brick panels.

ISBN: 978-93-5980-742-3, www.aetsjournal.com ― Handbook of research in Basic and Applied Science

Fig 2: Bricks

MANUFACTURE

For information on bricklaying, see How to lay bricks.

- With a standard mortar joint of 10 mm, a repeating unit of bricks laid in a stretcher bond will be 225 mm lengthwise and 75 mm in height.

- If bricks are laid cross-wise, two 102.5 mm widths plus two mortar joints gives the same repeating unit as the length of one brick, ie 120 mm.

- If they are laid height wise, three 65 mm heights plus three mortar joints gives the same repeating unit as the length of one brick, ie 120 mm. are most typically made from clay, although they are also commonly made from calcium-silicate and concrete.

- Soft mud or dry-press bricks are formed by pressing the brick mixture into moulds and then firing them in a kiln. Soft-mud bricks are made from a thin mix whereas dry-press bricks are made from a thicker mix that gives crisper definition. Greater strength is achieved by using greater force when pressing the brick and by firing it for longer, but this increases the cost.

- Extruded bricks are formed by pushing the brick mixture through a die to create an extrusion that is then wire cut to produce bricks of the required length.

- Bricks can be solid, or can have holes perforated through them to reduce the amount of material used. Alternatively they may have an indentation on one surface (or two surfaces) commonly called a 'frog'.

ISBN: 978-93-5980-742-3, www.aetsjournal.com ― Handbook of research in Basic and Applied Science

The frog must be filled with mortar when bricks are laid otherwise the structural and acoustic performance of the wall will be affected. For this reason it is best practice to lay bricks with the frog facing upwards so that it is easy to fill. Where there are two frogs, the larger frog should face upwards.

- For information about how bricks are tested, see Testing brick are most typically made from clay, although they are also commonly made from calcium-silicate and concrete.

- Soft mud or dry-press bricks are formed by pressing the brick mixture into moulds and then firing them in a kiln. Soft-mud bricks are made from a thin mix whereas dry-press bricks are made from a thicker mix that gives crisper definition. Greater strength is achieved by using greater force when pressing the brick and by firing it for longer, but this increases the cost.

- Extruded bricks are formed by pushing the brick mixture through a die to create an extrusion that is then wire cut to produce bricks of the required length.

- Bricks can be solid, or can have holes perforated through them to reduce the amount of material used. Alternatively they may have an indentation on one surface (or two surfaces) commonly called a ‘frog’. The frog must be filled with mortar when bricks are laid otherwise the structural and acoustic performance of the wall will be affected. For this reason it is best practice to lay bricks with the frog facing upwards so that it is easy to fill. Where there are two frogs, the larger frog should face upwards.

- For information about how bricks are tested, see Testing brick

FIRST CLASS BRICK

First class bricks are good quality bricks compared to other classes. They are molded by table-molding and burnt in large kilns. So, these bricks contain standard shape, sharp edges and smooth surfaces. They are more durable and having more strength. They can be used for permanent structure

CHARACTERISTICS.

(i) These are sound well burnt bricks of a uniform colour.

(ii) All the faces are uniform and smooth. All the edges are sharp.

(iii) These are free from cracks or flaws.

(iv) A broken surface shows a uniform compact texture.

(v) Scratch with figner nails leaves no mark.

(vi) These do not absorb more than 15% of their weight of water when kept immersed for 24 hours.

(vii) Two first class bricks when struck with each other give a sharp metallic ringing sound.

(viii) These are free from nodules of free lime.

(ix) These may have only slight presence of efflorescence. Uses.

(i) Used for all sound work of a permanent character.

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

(ii) Used in the face work of structure not to be plastered but only pointed.

SECOND CLASS BRICK

These are as hard and well burnt bricks as the first class bricks but may be somewhat irregular in shape or size and may have a slightly rough surface. Other qualities are the same as those of first class bricks.

Uses.

(i) Used in unimportant situations or at places where the masonry is to be plastered.

(ii) Used as brick ballast in R.C.C. work and in Lime Concrete.

THIRD CLASS BRICK

Third Class Bricks are underburnt. They are soft and light-coloured producing a dull sound when struck against each other. Water absorption is about 25 per cent of dry weight.

HARDNESS.

This is a somewhat vague term commonly used in the description of bricks. By general agreement it is recognised that a brick which is to have a moderately good compressive strength, reasonable resistance to saturation by rainwater and sufficient resistance to the disruptive action of frost should be hard burned.

Without some experience in the handling, and of the behaviour, of bricks in general it is very difficult to determine whether or not a particular brick is hard burned.

A method of testing for hardness is to hold the brick in one hand and give it a light tap with a hammer. The sound caused by the blow should be a dull ringing tone and not a dull thud.

Obviously different types of brick will, when tapped, give off different sorts of sound and a brick that gives off a dull sound when struck may possibly be hard burned

COMPRESSIVE STRENGTH

This is a property of bricks which can be determined accurately. The compressive strength of bricks is found by crushing 12 of them individually until they fail or crumble. The pressure required to crush them is noted and the average compressive strength of the brick is stated as newtons per mm of surface area required to ultimately crush the brick. The crushing resistance varies from about 3.5 N/mm2 for soft facing bricks up to 140 N/mm2 for engineering bricks.

The required thickness of an external brick wall is determined primarily by its ability to absorb rainwater to the extent that water does not penetrate to the inside face of the wall. In positions of moderate exposure to wind driven rain a brick wall 215 mm thick may absorb so much water that it penetrates to the inside face.

The bearing strength of a brick wall 215 mm thick is very much greater than the loads a wall will usually carry.

ISBN: 978-93-5980-742-3, www.aetsjournal.com ― Handbook of research in Basic and Applied Science

The current external wall to small buildings such as houses is built as a cavity wall with a 102.5mm external leaf of brick, a cavity and an inner leaf of block. The external leaf is sufficiently thick, with the cavity, to prevent penetration of rain to the inside face and more than thick enough to support the loads it carries.

It is for heavily loaded brick piers and walls that the crushing strength of brick is a prime consideration.

The average compressive strength of some bricks commonly used is:

Absorption.: Scientific work has been done to determine the amount of water absorbed by bricks and the rate of absorption, in an attempt to arrive at some scientific basis for grading bricks according to their resistance to the penetration of rain.

This work has to date been of little use to those concerned with general building work.

A wall built of very hard bricks which absorb little water may well be more readily penetrated by rainwater than one built of bricks which absorb a lot of water. This is because rain will more easily penetrate a small crack in the mortar between bricks if the bricks are dense than if the bricks around the mortar are absorptive. xperimenta1 soaking in water of bricks gives a far from reliable guide to the amount of water they can absorb as air in the pores and minute holes in the brick may prevent total absorption and to find total absorption the bricks have to be boiled in water or heated.

The amount of water a brick will absorb is a guide to its density and therefore its strength in resisting crushing, but is not a reasonable guide to its ability to weather well in a wall. This term ‘weather well’ describes the ability of the bricks in a particular situation to suffer rain, frost and wind without losing strength, without crushing and to keep their colour and texture.

FROST RESISTANCE.

A few failures of brickwork due to the disruptive action of frost have been reported during the last 30 years and scientific work has sought to determine a brick’s resistance to frost failure. Most of the failures reported were in exposed parapet walls or chimney stacks where brickwork suffers most rain saturation and there is a likelihood of damage by frost.

Few failures of ordinary brick walls below roof level have been reported. Providing sensible precautions are taken in the design of parapets and stacks above roof level and brick walls in general are protected from saturation by damaged rainwater gutters or blocked rainwater pipes there seems little likelihood of frost damage in this country.

Parapet walls, chimney stacks and garden walls should be built of sound, hard burned bricks protected with coping, cappings and damp-proof courses.

EFFLORESCENCE.

Clay bricks contain soluble salts that migrate, in solution in water, to the surface of brickwork as water evaporates to outside air. These salts will collect on the face of brickwork as an efflorescence (flowering) of white crystals that appear in irregular, unsightly patches.

This efflorescence of white salts is most pronounced in parapet walls, chimneys and below dpcs where brickwork is most liable to saturation. The concentration of salts depends on the soluble salt content of the bricks and the degree and persistence of saturation of brickwork.

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

The efflorescence of white salts on the surface is generally merely unsightly and causes no damage. In time these salts may be washed from surfaces by rain. Heavy concentration of saks can cause spalling and powdering of the surface of bricks, particularly those with smooth faces, such as Flettons.

This effect is sometimes described as crypto efflorescence. The salts trapped behind the smooth face of bricks expand when wetted by rain and cause the face of the bricks to crumble and disintegrate.

Efflorescence may also be caused by absorption of soluble salts from a cement rich mortar or from the ground, that appear on the face of brickwork that might not otherwise be subject to effiorescence. Some impermeable coating between concrete and brick can prevent this (see Volume 4). There is no way of preventing the absorption of soluble salts from the ground by brickwork below the horizontal dpc level, although the effect can be reduced considerably by the use of dense bricks below the dpc.

Sulphate attack on mortars and renderigs.

When brickwork is persistently wet, as in foundations, retaining walls, parapets and chimneys, suiphates in bricks and mortar may in time crystallise and expand and cause mortar and renderings to disintegrate. To minimise this effect bricks with a low sulphate content should be used.

USES OF BRICK

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.

- Construction of walls of any size
- Construction of floors
- Construction of arches and cornices
- Construction of brick retaining wall
- Making Khoa (Broken bricks of required size) to use as an aggregate in concrete
- Manufacture of surki (powdered bricks) to be used in lime plaster and lime concrete

PROTHERM BRICKS

Porotherm clay bricks are horizontally perforated clay bricks.

These bricks are used for non-load bearing partition walls or infill masonry.

For instance, take a water melon on a summer day and you find the surface is hot. But when you cut into the fruit the flesh inside, it is cool. The outer layer of the water melon acts as an insulator and prevents heat from getting transferred inside.

The Porotherm clay bricks too have the same concept. The perforations of the brick give a unique walling system which facilitates thermal insulation resulting in cooler interiors in summer and warm in winter.

Hence it is also called Porotherm clay Bricks!

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

The walling solutions offered through Porotherm Clay Bricks are environment-friendly, cost- effective, easy to use and feasible to address non-load bearing new age construction methodologies. Under Smart Bricks, Wienerberger offers a range of products including Porotherm HP (Horizontally Perforated Clay Bricks), Porotherm VP (Vertically Perforated) Load Bearing , Porotherm VP Tongue & groove and Porotherm Thermobrick.

Porotherm HP is lauded for being 60 per cent lighter than conventional walling materials, resulting in lower structural cost due to the reduction in the dead load. Given its perforation, the thermal insulation properties are almost 100 per cent more than conventional walling materials. Fired at 1000 degrees in the kilns, the bricks also enjoy a fire rating of F240 for 240 minutes.

The latest addition to the Porotherm Smart brick category is the Porotherm VP Tongue & Grove or VP T&G. This latest format takes masonry construction to a whole new level, being the strongest, non-load bearing walling material in the market which is 100% natural with unquestionable durability.

Along with VP T&G, you get a revolutionary dry mortar system the Dryfix.System, a construction glue which is a remarkable replacement to the convention sand and cement mortar, thereby eliminating curing time and giving you a completed wall within a day!

ADVANTAGES

Strong Bricks: Strong bricks ensure strong walls. It has a high compressive strength of ≥ 7 N/mm2. They have recycled content, as well as energy efficient and are made to last since the bricks are fired at 900 – 9600 C which combined with the non- corrosive nature of terracotta gives the material excellent strength.

Thermal Insulation: It gives a superior thermal insulation that greatly improves the indoor comfort of the building. Unlike walls built with traditional bricks, use of Porotherm Thermo Brick results in interiors being cool in summer and warm in winter, when compared to the external temperatures.

Cost and Energy Savings: It saves a lot of energy as well as cost. In summers generally you will use AC in summer and heaters in winter, but the usage of Porotherm clay bricks eliminates this pre-requisite. Additionally there is no requirement for sand and cement so it brings down the cost of construction to a great extent.

100 % Eco-friendly: The Porotherm is manufactured using natural products. It uses natural clay, coal ash, rice husk, and granite slurry. No chemicals are used so using this will relieve you from allergic problems.

Speed of Construction: Porotherm is much lighter than conventional walling materials. It is easy to handle too. There is no curing required post wall construction. Hence the speed of construction is faster.

Ease of Fitting Pipes and Fixtures: It is easy to cut and chisel for the electrical and plumbing work, when you want to install fixtures.

Maintenance: It has got zero maintenance cost and adding to that these have high fire resistance, as well as longevity.

Clean and dry work site: Porotherm leaves no debris to be transported or disposed of, thereby ensuring a clean and dry work site as working with

Features of the Porotherm clay Bricks

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

The main features of Porotherm clay bricks are: Main Advantages:

- 60% less weight than a solid concrete block
- Compressive strength >3.5 N/mm2
- Density of approx. 694 to 783 kg/m3
- Large size & low weight
- Excellent thermal insulation
- Water absorption ~15% Resulting in:
- Reduction of dead loads
- Saving on structural costs
- Faster construction

DISADVANTAGES

Cannot be used in large structures: - It cannot be used in large structure construction . As it's density is less it cannot be used for foundation and base slab work where water table is high

CONCLUSION

Using modern geotechnical technology which can improve the strength and durability of much of the existing low-cost material should be encouraged. In this study, alternate construction materials were studied and the potential of these materials to be used as al- ternate building materials is brought out. Depending on the availability of the materials in a particular region, these materials can be selected as transportation consists of approximately 30% of total construction budget. In most developing countries, the challenge is to organize and initiate measures that promote these materials as well as train local artisans and masons in the construction techniques involving these materials. There have been several attempts at local levels to make use of bamboo, mud or natural fibers but it still lacks scientific precisions and proper techniques to be used precisely. Also the us age of industrial wastes still needs study on their better usage toxicity. These materials if studied and developed properly hold the key to address the current housing needs.

REFERENCES

[1] http://www.fao.org/docrep/007/ad871e/ad871e10.htm

[2] Building Materials in India: 50 Years, TN Gupta, bmtpc, 253-254.

[3] Building Materials in India: 50 Years, TN Gupta, bmtpc, 270-271.

[4] L. Dinachandran Singh, “Low Cost Housing Using Stabi- lized Mud Blocks,” 2007.

ISBN: 978-93-5980-742-3, www.aetsjournal.com — Handbook of research in Basic and Applied Science

[5] G. Leake, K. Toole, P. Divis and C. Torres, “Sánchez Bamboo as a Solution for Low-Cost Housing and Storage in Pabal (India),” 19 February 2010.

[6] P. Bhattarai, “Straw Bale in Building Construction and Its Future in India,” International Journal for Modern Engi- neering Research, Vol. 2, No. 2, 2012, pp. 422-426.

[7] R. Sarkar, “Post Earthquake Housing Construction Using Low Cost Building Materials,” 4th International Confer- ence on Earthquake Engineering, Taipei, 14-15 October 2006

[8] A. Rai and C. N. Jha, “Natural Fibre Composites and Its Potential as Building Materials,” 2004.

[9] A. L. Moslemi, “Technology and Market Consideration for Fiber Cement Composite,” 11th International Inor- ganic Bonded Fiber Composite Conference, Madrid, 4-7 November 2008.

[10] Science Tech Entrepreneur, “Green Building Materials for Low Cost Housing,” 2009.

[11] Fly Ash Brick. www.wikipedia.com

[12] J. Sunu, “Eco-Friendly Inorganic Bonded Sandwich Pan- els (Aerocon Panels): Production Properties and Applica- tions,” 11th Inorganic Bonded Fiber Composite Confer- ence, Madrid, 4-7 November 2008

[13]http://besharp.archidev.org/IMG/pdf/solidhollow_concrete_blocks.pdf

[14] E. B. Oyetola and M. Abdullah, “The Use of Rice Husk Ash in Low Cost Sandcrete Block,” Leonardo Electronic Journal of Practices and Technologies, Vol. 8, 2006, pp. 58-70.

[15] Adams, O. A; “Perceived Relative Importance of Training in Contractor Development in Nigeria”, The Organization and Management of Construction: Shaping Theory and Practice, Volume Two, Managing the Construction Project and Managing Risk; London; E&FN Spon; pp 640 – 649,1996

ISBN: 978-93-5980-742-3, www.aetsjournal.com ― Handbook of research in Basic and Applied Science