STUDY OF SUSTAINABLE PRACTICES IN BRICK MANUFACTURING PROCESSES

Dr. S. V. Agarkar
Professor,
Applied Chemistry Department
Anuradha Engineering College Chikhli,
Dist-Buldana, Maharashtra, India

Mandar. M. Joshi
Asst.Professor,
Applied Mechanics Department
Anuradha Engineering College Chikhli,
Dist-Buldana, Maharashtra, India
mandarjoshi_1608@yahoo.com
Contact No- 09420563898

1. ABSTRACT:
The construction sector is an important part of the Indian economy. Clay fired bricks are the backbone of this sector. The Indian brick industry is the second largest producer of bricks in the world after China. India is estimated to produce more than 14000 crores of bricks annually, mainly by adopting age-old manual traditional processes. The brick sector consumes more than 24 million tonnes of coals annually along with huge quantity of biomass fuels. The per annum CO₂ emissions from Indian brick industry are estimated to be 42 million tonnes. Due to large scale construction activities in major towns and cities, a number of brick plants have been set up on the outskirts of these cities. These clusters are the source of local air pollution affecting local population, agriculture and vegetation. For the production of clay bricks, top soil to the extent of 350 million tonnes is used every year, which is a reason for concern.

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. Various test are taken on different types of bricks available in market. Flyash bricks can replace the conventional burnt clay bricks. The results obtained are very encouraging.

2. INTRODUCTION:

2.1 What is sustainability?
Sustainability is defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”. Sustainable buildings are designed in a way that uses available resources efficiently and in a responsible manner, balancing environmental, societal and economic impacts to meet the design intents of today while considering future effects. Sustainably designed buildings are energy-efficient, water-efficient and resource-efficient. They address the well-being of the occupants by considering thermal comfort, acoustics, indoor air quality and visual comfort in the design. They also consider the impact of a building’s construction, operation and maintenance on the environment, and the environmental impact of the building’s constituent materials. A sustainably designed building considers all of these aspects through the entire life cycle of the building, including its operation and maintenance.

2.2 Efficient Use of Materials
How a building material is used also should be considered when examining the sustainability of a material. Brick masonry walls are able to perform multiple functions that often require several components in other wall systems. By designing walls that serve multiple functions, materials are used efficiently. This translates into reduced environmental impacts for the building. A single brick can do all of the following:

• Serve as a load-bearing structural element.
• Provide an interior or exterior finish without the need for paints or coatings.
• Provide acoustic comfort with a sound transmission class (STC) rating of 45 or greater.
• Regulate indoor temperatures as a result of thermal mass.
• Provide fire resistance (a nominal 4-in. (100 mm) brick wall has a one-hour fire rating).
• Provide impact resistance from wind-borne debris or projectiles.
• Improve indoor air quality by eliminating the need for paint and coatings.
• Provide a non-combustible material which does not emit toxic fumes in fires.
• Provide an inorganic wall that is not a food source for mold.
• Serve as a heat-storing element in a passive solar design.
• Last for generations.

In addition, other innovations in brick masonry design can further decrease the raw materials used. The use of prestressed brick walls capitalizes on the inherent compressive strength of brickwork, resulting in typically thinner, taller walls.

2.3 Sustainable design with brick

Every sustainable building is unique, designed specifically for its site and the programming requirements of the user. However, all high-performance, sustainable buildings should consider the following components of design. The versatility and durability of brick facilitate its use as part of many elements of sustainable design.

• Environmentally responsive site planning
• Energy-efficient building shell
• Thermal comfort
• Energy analysis
• Renewable energy
• Water efficiency
• Safety and security
• Daylighting
• Commissioning
• Environmentally preferable materials and products
• Durability
• Efficient use of materials
• High-performance HVAC
• High-performance electric lighting
• Life cycle cost analysis
• Acoustic comfort
• Superior indoor air quality
• Visual comfort

2.4 Flyash bricks

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 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.

3. BRICK MANUFACTURING AND SUSTAINABILITY

In order to understand how brick can contribute to sustainable building design, it is important to consider how brick is made, as well as how it is used. Brick manufacturing is a highly efficient process incorporating many sustainable practices as described below.

Fly Ash is 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 from 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. The generation of fly ash is also likely to increase. 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.

4. MATERIALS AND METHODS

4.1 Flyash

The physical and chemical properties of Fly Ash used are as shown below.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>2.54 to 2.65 gm/cc</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>1.12 gm/cc</td>
</tr>
<tr>
<td>Fineness</td>
<td>350 to 450 M2/Kg</td>
</tr>
</tbody>
</table>
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.

### 4.2 Sand or stone dust.
Stone dust about 40 to 50% is used.

### 4.3 Water
Drinkable water is used for the test.

### 5. MANUFACTURING PROCESS:
Fly ash (50%) and stone dust (50%) 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 where the bricks are pressed automatically. Then 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.

### 6. COMPRESSION TEST
Conventional burnt clay brick and flyash bricks are tested in laboratory for compression on Universal testing machine.

### 7. RESULTS AND DISCUSSION
#### 7.1 INSPECTION AND QUALITY

**CONTROL:**

The Bureau of Indian Standards has formulated and published the specifications for maintaining quality of product and testing purpose. IS: 12894:2002. Compressive strength achievable: 60-250 Kg/Cm.Sq. Water absorption: 5 – 12 %; Density: 1.5 gm/cc Co-efficient of softening (depending upon water consistency factor) Unlike conventional clay bricks fly ash bricks have high affinity to cement mortar though it has smooth surface, due to the crystal growth between brick and the cement mortar the joint will become stronger and in due course of time it will become monolithic and the strength will be consistent.

#### 7.2 ENERGY CONSERVATION:
These 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.

#### 7.3. COMpressive strength:
The compression test was carried out in accordance with IS 456-2000; on different samples of flyash bricks & conventional burnt clay bricks. The average compressive strength of flyash brick is 66 kg/cm² while that for conventional burnt clay brick is 44 kg/cm².

### 8. CONCLUSIONS

1. The results are indicative of the satisfactory performance of flyash bricks as load bearing elements. This type of bricks uses 100 % flyash without mixing with clay and shale. It, therefore provides a large disposal of flyash in a very efficient, useful and profitable way.
2. The mechanical properties of flyash bricks have exceeded those of the standard load bearing clay bricks. Notable among these properties are the compressive strength. Compressive strength is 20 % better than good quality clay bricks.
3. There is evidence that the micro structural feature of the surface of flyash bricks is characterised by a rougher texture then that of clay bricks. The characteristics is belived to be responsible for the increased bond strength with mortar.
4. The density of flyash bricks is 28% less than that of standard clay bricks. This reduction in the weight of bricks results in a greater deal of saving amount which are saving in the raw material and transportation cost and saving to consumer, that result from increased number of units and reduction in the structural elements.
5. The process of manufacture of flyash bricks indicate clearly that there is much saving to be done during the making of the bricks. These savings arise mainly from the uniformity of the
raw material as well as from doing away with whole process of mining, transporting, mixing and grinding that are necessary in the case of the clay bricks.

REFERENCES


