

BUILDING BLOCK FOR HOT AND DRY CLIMATE OF RAJASTHAN

Priyanka Mehta¹, Dr. Pulkit Gupta²

¹Assistant Professor, Department of Architecture, MBM University, Jodhpur

²Assistant Professor, Department of Architecture, MBM University, Jodhpur

Abstract

The wall materials such as bricks and blocks play an important role in the building design. In the olden days, it has been practiced by the vernacular method of construction for making bricks by using natural building materials which provide a comfortable living environment to mankind. Many such buildings are standing for a long duration and still mounted as examples in front of us. But in the present scenario, the need for rapid infrastructure growth and lack of skilled labor to utilize those vernacular materials in modern construction has diminished. In this age of technology development, the people decided to reduce the energy consumption in their buildings by promoting the concept of construction of low energy buildings using energy-efficient materials especially in wall materials. In this paper, comprehensive review is made on the various walling materials used in the state of Rajasthan such as Jodhpur sandstone, Clay bricks, Adobe Bricks, Fly ash bricks and AAC blocks.

Keywords: Bricks, Blocks, Energy efficient, Rajasthan, Building Blocks

1. INTRODUCTION

A basic unit from which anything is built up is known as a building block, in a building, stone or bricks are extensively used in form of building blocks. Rajasthan lies in hot and dry climatic zone and has extreme climatic conditions. It is extremely important to design buildings in Rajasthan keeping into consideration the climatic conditions. The wall facades act as an important element of the building envelope, protecting the occupant from the extreme external environment. A building block plays a major role in regulating a building thermally, if used wisely the building block can increase the thermal lag, hence functioning efficiently as an envelope. There are several types of walling materials available in Rajasthan. It depends on the designer how wisely he uses the materials to enhance the thermal performance of the buildings and create a comfortable living environment.

2. HOT AND DRY CLIMATE OF RAJASTHAN

The climate of Rajasthan state has varied contrasts and the presence of the Aravalli Range is the greatest influencing factor. The state witnesses great peculiarities in temperature. Winters are very severe and the temperature falls below freezing point at places like Ganganagar; summers are intense and quite severe in regions like the western Rajasthan. May is generally the hottest month and generally, January records the lowest daily maximum and minimum temperature.

For a climatically responsive design of the building, consideration should be given to the sun path (to identify desirable or undesirable radiation), averages, changes and extremes of temperature, the temperature differences between night and day (diurnal range), humidity, sky conditions, rainfall and its distribution and air movements to achieve thermal comfort. It is essential to design an energy efficient building envelope for such an extreme climatic condition for enhancing the thermal comfort in the buildings.

3. BUILDING BLOCKS

Various types of building blocks are used for construction in Rajasthan .The most popular ones areas under:-

- 1) Jodhpur sandstone
- 2) Clay bricks
- 3) Adobe Bricks
- 4) Fly ash bricks
- 5) AAC blocks

3.1 JODHPUR SANDSTONE

Sandstone can be defined as a sandstone made up of small particles of various minerals such as silica, iron, lime, etc. and letters of the same size and are usually smooth and round. It is hard, compact, fine-grained, equigranular and homogenous. Despite sandstone being composed of incredibly common minerals, it doesn't mean that its value or visual appeal decreases in any way. They are often found in areas that have seen a considerable amount of erosion, like desert areas, or even inland seas.The Jodhpur sandstone has a density of 2.24 kg/m^3 . The sandstone element is a hard and durable material and consists of compacted masses of sand infused with moving water or air. Sand grains can be made up of a variety of rocks and minerals, which is why sandstone stones are found in a wide area. It is the most durable and aesthetically appealing sandstone with attractive colours such as brown, red, pink and creamish pink. Being the vernacular material which provides great insulation, is cheap and with almost negligible embodied energy makes it a suitable material for the creation of building blocks.[1]



Figure 1: Jodhpur sand stone

3.2 RED CLAY BRICKS

The process of manufacturing bricks from clay involves the preparation of clay, moulding and then drying and burning of bricks, the raw materials required for the manufacturing of red clay bricks are Clay, Sand, Lime, Iron oxide, Magnesia. The entire manufacturing process emits high CO₂ content. These bricks are Not termite and pest resistant. They provide good sound insulation due to their dense structure, with a dry density of $1600-1920 \text{ kg/m}^3$. Clay bricks are used for buildings & pavement. In metallurgy & glass industries they are used for lining furnaces. Clay bricks do not warp, rust, wear, peel, or fade over time, they do not harbor termites. Water absorption percentage is not be more than 20% of its weight, and the thermal conductivity of burnt clay bricks ranges from 0.4 W/mK to 0.7 W/Mk . It Leaves out Large-scale environmental damage, mainly soil

excavation, therefore, damages the soil and vegetation, and results in soil erosion. The insulating properties of Red Clay Bricks make them suitable for construction in Rajasthan. [2]

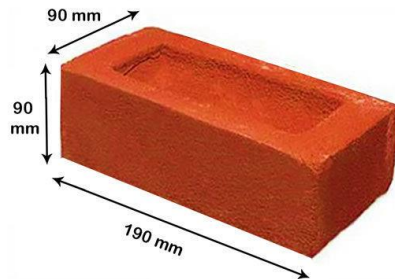


Figure 2: Red clay brick unit and wall

3.3. ADOBE BRICKS

Adobe bricks (mud bricks) are made of earth with fairly high clay content and straw. If produced manually the earth mix is cast in an open mould onto the ground and then left to dry out. Raw materials used in the manufacturing process are Soil(sand+silt+clay), Organic material(straw-dung). These bricks are highly environment friendly with zero CO₂ emission. The product is not termite and pest resistant. These bricks provide the structure with Good sound insulation, with a dry density of 1300 kg/m³. Adobe bricks are used in making houses/buildings etc. Adobe can serve as a significant heat reservoir due to the thermal properties inherent in the massive walls typical in adobe construction. In climates typified by hot days and cool nights, the high thermal mass of adobe mediates the high and low temperatures of the day, moderating the temperature of the living space. Mud and other materials are easily available. Energy-saving during production. Thermal conductivity varies from 0.25 to 0.33 W/ mK. The water absorption level is not be more than 18% of its weight. [3]



Figure 3: Manual method of making Adobe bricks and its application

3.4 FLY ASH BRICKS

Fly ash brick (FAB) is a building material, specifically masonry units, containing class C or class F fly ash and water. Compressed at 28 MPa and cured for 24 hours in a 66 °C steam bath, then toughened with an air-entrainment agent, the bricks can last for more than 100 freeze-thaw cycles.

Owing to the high concentration of calcium oxide in class C fly ash, the brick is described as "self-cementing". Raw materials utilized in the manufacturing of FAB are Cement, sand, Lime, Gypsum, and Fly Ash. A possible material mix for the production of fly ash brick: Fly ash 60%, Sand/ Stone dust 30%, Portland Cement/Lime 10%, these bricks are eco-friendly with low CO₂ emissions. These bricks are termite and pest resistant. WRT other products FAB provides with moderate sound insulation, with a dry density of 1700-1850 kg/m³. Fly ash bricks can be used as an alternative material for burnt clay bricks which is one of the important building materials used for the construction of housing and buildings. They do not absorb heat and give maximum light reflection. They have good fire resistance, it has no problem with vermin attacks. The thermal conductivity of fly ash bricks is 0.90 – 1.05 W/m². Water absorption level is not be more than 15-20% of its weight. Fly Ash Bricks, for the construction of Commercial-scale project, is considered to be a very good option in Rajasthan due to their insulating, light-reflection, and fire resistance properties. [4]

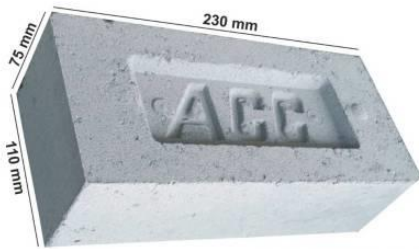


Figure 4: Fly ash brick and its application

3.5 AAC BLOCK-Unlike most other concrete applications, AAC is produced using no aggregate larger than sand. Quartz sand, calcined gypsum, lime (mineral) and/or cement and water are used as binding agents. Raw materials required are cement, lime, gypsum and flyash. The process emits a mediocre amount of CO₂ into the environment. AAC blocks provide resistance to pests and termites. AAC blocks also provide Good sound insulation due to air void, with a dry density of 451-1000 kg/m³. AAC is a highly thermally insulating concrete-based material used for interior and exterior construction. AAC blocks are about 50% lighter and 10 times larger than traditional bricks. This unique property facilitates easy installation and gives the desired flexibility that makes adjustments, cutting, shaping, etc., quite easy. Composed of quartz sand, calcined gypsum, lime, cement, water and aluminum. AAC products are cured under heat and pressure in an autoclave. The thermal conductivity of AAC block varies from 0.1 to 0.7 W/(mK) for density. Water absorption levels should not be more than 10% of its weight. Due to their low density and air voids these blocks have high thermal and sound insulation with resistance to pests and termites. [5]

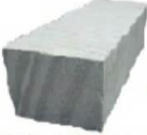

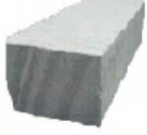






AAC BLOCK SIZE (600 x 200 x 75 - 300)mm		
 <p>3" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 75 mm</p>	 <p>4" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 100 mm</p>	 <p>5" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 125 mm</p>
 <p>6" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 150 mm</p>	 <p>7" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 175 mm</p>	 <p>8" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 200 mm</p>
 <p>9" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 225 mm</p>	 <p>10" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 250 mm</p>	 <p>12" AAC Block (L x H x B) Nominal size</p> <p>600 x 200 x 300 mm</p>

Figure 5: AAC brick blocks



Figure 6: Application of AAC blocks

CONCLUSION

There is a slow rise in the usage of different building blocks which are both economically and ecologically feasible. Current scenarios reduce the need for rapid infrastructure growth and the shortage of skilled workers to use indigenous materials in modern construction. In this era of technological development, people decided to reduce the energy consumption of buildings by promoting the concept of building low energy buildings using energy efficient materials, especially



wall materials.[6]Environmentally friendly building material with zero embodied energy with insulation properties that are better than most should be a viable option for construction in Rajasthan.

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