BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE INDIA

BRICK EARTHS OF INDIA

Geologically, the earths of India have been categorised in two major groups : (1) transported soils of the Indo-Gangetic plains and the valleys of South India, and (2) residual soils of penisular India. The transported types do not form any definite group of soils as they are mainly alluviums formed as a result of deposition of the sediments brought by rivers, winds, etc. Generally, the deposits consist of sand, silt and clay, with *kankar* and occasional deposits of gravel. The thickness of the beds vary from place to place.

The residual soils of various types covering a large area in the peninsular region have been formed over a variety of geological formations. These soils can be classified as black soils, red soils, lateritic soils, etc. Vast deposits of black soils occur in the whole of Deccan plateau, Madhya Pradesh, Gujarat, Maharashtra and parts of Andhra Pradesh and Mysore States. Red loam or red yellow soils are found in parts of Assam Manipur, Bihar, Orissa, Andhra Pradesh, Madras and Mysore. Scattered deposits of lateritic soil occur in Kerala, parts of Mysore, Andhra Pradesh, West Bengal, Orissa and Assam.

General Characteristic of Soils

The alluvial soils in the western part of the Indo-Gangitic plain are coarse and their fineness increases as the deltas are approached. The alluvium of the Gangetic valley is light yellow to grey in colour, generally rich in concretions and nodules of impure calcium carbonate ($CaCO_3$) known as *kankar*. The shape and size of such concretions vary from small grains to lumps as large as 20 cm diameter. The alluvium of Punjab popularly known as *khadar* is light coloured and low in calcareous matter. Low lying areas of the Indo-Gangetic valley remain water logged during rainy season and as a result, the accumulated salt in the ground water are drawn up to the surface as efflorescence popularly called *reh* in Uttar Pradesh and *kallar* in Punjab. The alkali laden soils of the alluviums, containing mostly soluble sulphates, chlorides and carbonates of sodium, are known as *usar* and are generally considered unsuitable for cultivation and brick making. In general, the alluvial soils basically consist of illitic clay mineral and are suitable for the manufacture of various types of bricks.

Another example of transported soils is coastal alluvium which has developed as a result of submergence and emergence of coastal areas from the sea. Such alluviums are found at the strips of eastern and western ghats of the country. The bed of these soils contain clay dark in colour mixed with oyster and marine shells and are usually rich in sea water salts.

Regur or black cotton soils belonging to residual lime, magnesia a rather variable but small amount of potash and nitrogen and a fair proportion of organic matter. Such soils are highly plastic, swell enormously when wetted, and dry up with considerable shrinkage developing wide cracks. *Kankar* content in these soils is usually high and clay mineral present is of montmorillonitic group. Black soils present difficulties in manufacturing durable and good quality bricks due to the inherent nature of the clay mineral.

Red soils are found in the region occupying the rocks of a high degree of maturity as granites and gneisses. The red colour of the soil is possibly due to the oxidation and wide diffusion of the iron content into the material. It may not always be red in colour. The composition varies conisderably with the character of original rock. Lateritic soils are porous, pitted clay like rock with red, yellow, brown, grey or mottled colour, depending in some measure on the composition. When such soils are dug up, the fresh material is comparatively soft but on dehydration it becomes hard quickly. This group of soils often contains admixtures of different groups of clay mineral. The red soils of Bihar are rich in kandite group of clay minerals, while the clay mineral associated with Ahmedabad and Hyderabad soils is of montmorillonite group. The soils are often coarse, loamy, calcareous and present difficulties in plastic moulding of bricks. Bricks obtained from such soils are porous, and are generally of poor compressive strength.

Suitability of Soils for Brick Making

The C. B. R. I. has been studying the different soils of India for their suitability for manufacturing building bricks and special bricks. Often it has been found necessary to develop processes for obtaining bricks of satisfactory quality. Detailed information on these processes is available from the Institute.

(A) Alluvial Clays :

These soils are relatively low in soluble salt content which may range up to 0.4 per cent. The calcium carbonate content varies from 0.1 to 6.4 per cent. In certain Terai regions and some localities of Bengal and Bihar, the calcium carbonate content goes up to 25 per cent. As much as 3.4 per cent gypsum has been reported in the soils of Indus valley. The presence of higher proportions of calcium salt above 1 per cent in the alluvial soil decreases the compressive strength and bulk density of fired brick and increases its water absorption. Calcareous constituents also shorten the vitrification range of the soil. Further, nodular lime shows lime bursting in the fired product.

It has been recommended that alluvial soils of the following physical properties are most suitable for brick

Clay	20 — 30 per cent
Clay+silt	40 — 65 per cent
Liquid limit	25 — 38 per cent
Volumetric shrinkage	15 — 25 per cent
Plastic Index	7 — 16 per cent

Soils containing as low as 17 per cent clay may also be used provided the silt content is at least 30 per cent. Calcareous soils containing up to 1 per cent calcium carbonate do not present difficulties in manufacturing good quality bricks.

Bricks from these soils can be fired at a temperature range of 900 to 1060°C. The compressive strength increases with the increase of firing temperature. Higher temperature of firing (1060-1120°C) is recommended for the manufacture of first class bricks from soils containing less than 40 per cent fines.

In general, the bulk density of bricks increases with the increase of firing temperature and may be as high as 2.3 when bricks from alluvial soils are fired at a temperature of 1120°C.

The water absorption of fired bricks decreases with the increase of firing temperature. It also varies with the nature of the soil. First class bricks from alluvial soils usually give a water absorption of 12 to 16 per cent. Soil containing higher proportions of calcium carbonate show high water absorption. In the case of bricks made from calcareous soils, water absorption does not change materially if the firing temperature is between 900 to 1000°C.

The C. B. R I. has developed processes for the manufacture of special bricks such as engineering or heavy duty bricks, acid-resistant bricks, coloured facing bricks, perforated bricks, etc. These can be manufactured by controlling soil composition and firing temperatures Acid resistant bricks can be manufactured from soils containing more than 40 per cent sand, calcium carbonate not exceeding 0.5 per cent and iron content below 6.3 per cent at a firing temperature above 1050°C.

(B) Coastal Alluvium :

The coastal alluviums present difficulties due to the presence of coarse particles, higher percentage of sea salts such as chlorides and sulphates of sodium, calcium and magnesium, and nitrogenous organic matter, humus, etc. Bricks moulded from such soils deform during drying, show heavy efflorescence and may burst in the range of 300-400°C when fired. The lime content in these soils is high, often above 70 per cent. Better bricks can be manufactured by the addition of 15 to 20 per cent of grog (clay calcined at 600-700°C), sand or 3 to 4 per cent powdered coal ash and firing at a temperature of 1000°C. The problem of efflorescence does however occur.

(C) Black Soils :

Black soils often present difficulties for the manufacture of good quality bricks due to the presence of higher proportions of clay fraction of montmorillonitic group of clay minerals, nodular lime and sticky nature of the soil. Bricks made out of these soils exhibit cracks during drying due to the formation of steep moisture gradients and excessive shrinkage. On firing, such bricks fuse at comparatively low temperatures, show short vitrification range and often possess a tendency to bloat at higher temperatures. These bricks show lime bursting also. First quality bricks of 130-145 kg/sq cm compressive strength and water absorption 15-20 per cent can be produced by the process developed at the C. B. R. I. which consists of—

(a) washing of raw clay to remove *kankar* particles and lime nodules ;

(b) addition of 25 to 30 per cent finely ground clay calcined at 600-700°C to the washed clay ;

(c) addition of common salt up to 0.5 per cent to avoid lime bursting, and

(d) firing of bricks in a better controlled kiln (Bull's kiln).

In conventional practice, the bricks are manufactured by the addition of 30-35 per cent coal ash or cinder and are fired in clamps. In this practice, the bricks are generally porous and the compressive strength varies between 40-50 kg/sqcm or even less. It is observed that from soils containing lower proportions of fines, better bricks can be produced by the addition of 0.5 per cent sodium silicate and 3 per cent cinder to the processed clay.

(D) Red Soils :

Red soils do not make good bricks, due to their coarse and sandy nature and low plasticity. The clay mineral in this soil is generally kaolinite or halloysite. The soils of this type containing more than 40 per cent clay and silt can yield good quality bricks provided the firing temperature is maintained above 1000°C.

The red soils of Hyderabad, known as *murrum* soils, contain coarser particles, 50 per cent above 1 mm size. The clay mineral present in the clay fraction is of montmorillonite group. The soil is not plastic, shows lime bursting, possesses short vitrification range and loses strength at higher temperature of firing. Bricks manufactured in these areas have a compressive strength of 25-27 kg/sqcm and water absorption ranging between 12-14 per cent. Due to expansion and contraction characteristics of quartz, granite particles. zirconia, etc., at 573-873°C, the fired bricks turn porous besides being of poor strength. Better bricks of compressive strength 100-105 kg/sqcm can be manufactured by grinding the soil to 1 mm particle size or by removing the coarser fractions by *ghol* process. Plasticity of the soil can be increased by mixing clayey soil available in tank beds, river banks, etc. Firing temperature should be controlled at about 800°C.

In the case of red soils of Ahmedabad region, wet or dry grinding and temperature of firing above 1000°C improves the quality of bricks It is observed that in red soils of montmorillonitic group, the bricks crack during drying. The addition of suitable opening material to reduce the plasticity helps to overcome such problems.

Research on brick earths of India

The above discussion shows the possibility of manufacturing improved quality bricks from the different soils of the country. Investigation of the nature of the soil and problems associated with the manufacture of bricks from it is, however, necessary before taking up the manufacture of bricks. Work of this nature forms a part of the research programme of this Institute.

There is a demand for short notes summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need, this Institute is bringing out a series of Building Digests from time to time and the present one is the 48th in the series. Readers are requested to send to the Institute their experience of adopting the suggestion given in this Digest.

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