of sand are of uniform size, owing to the presence of a large proportion of pore spaces. Tests have shown that the shape of the particles is not very important.

Cleanliness of Sand is most essential. Adhesion between the binding material and the sand is only possible if the particles of the latter are clean, and the presence of dirt, especially if finely distributed to such an extent as to surround each small particle, interferes with the setting and reduces the strength of mortars and concretes. The chief impurities are clay, loam and organic compounds such as vegetable matter. The latter, not being inert, is liable to decay, and the organic acids produced may have an ill-effect on the mortar or concrete.

Clean sand when rubbed will not stain the fingers. A simple and effective test consists of half filling a glass vessel with the sand, water is added until it almost reaches the top, and after being agitated, the sand is allowed to settle. If the sand is clean, not more than a thin film of silt will be seen deposited on top of the sand, and the water above it will be clear; if, however, the sample is a dirty one, the bottom layer of the washed sand will be covered by a relatively thick dark layer of dirt, and small particles of suspended matter (generally organic and fine clay) may be seen floating in the water even if several hours have elapsed after agitation and examination.

Sand for general purposes may be considered satisfactory if a test similar to the above (but in a measuring cylinder) shows that it contains not more than 6 per cent. of silt. This is known as a *sedimentation* or *decanting test*.

A test for organic impurities consists of comparing the colour of the water above the sample of sand in a cylinder (to which a definite amount of 3 per cent. sodium hydroxide solution has been added) with that of a standard solution of tannic acid and sodium hydroxide. If, after standing for twenty-four hours following agitation, the colour of the former is darker than the standard colour, it indicates that the sand contains an excessive amount of organic matter which may be injurious and should be treated with suspicion.

If, on the score of economy, a local sand is to be used which is not sufficiently clean, much of the dirt can be eliminated by washing.

The following aggregates are used for mortars: (1) Pit or quarry sand, (2) river sand, (3) sea sand, (4) crushed stone and (5) ashes.

1. *Pit or Quarry Sand.*—The quality varies. Provided it is clean, it is a very good sand for mortar, concrete and plaster. Some pit sands are liable to contain organic matter in the form of coal which may interfere with the setting.

2. *River Sand.*—This is usually clean and is an excellent sand for all purposes. Some river sands may be deficient in *fines* (smaller particles) and thus produce harsh mortars.

3. *Sea Sand.*—Whilst this sand is commonly used locally for concrete, it is not suitable for mortar on account of its salt content which causes efflorescence (p. 13).

4. *Crushed Stone.*—This is now often used, especially for mortar required for ashlar work. The waste stone at the quarries is crushed to the size of sand particles. When this crushed stone is the same as that used for the ashlar work it assists in producing a mortar which closely conforms to the colour of the masonry and thus helps in making the joints inconspicuous.

5. *Ashes or Clinkers* from furnaces are crushed very finely and intimately ground with the lime in a mortar mill to produce a cheap and strong mortar, known as *black mortar*. The ashes should be free from unburnt coal and dust. Old broken bricks, which should be clean and especially free from plaster, are sometimes crushed and mixed with the lime in the mill.

LIME MORTAR.—The slaked lime is mixed with the aggregate and water either by hand or in a mortar mill. Manual mixing should be done on a boarded platform to ensure that dirt will not be shovelled into the mix. The period of slaking, composition and strength of mortar depend upon the class of lime used.

The properties of the mortar should resemble those of the bricks. Thus, whilst a dense, strong impermeable mortar, such as cement mortar, should be used for bedding, jointing and pointing strong bricks of the engineering class, such mortar would be unsuitable for low-strength bricks of medium permeability if used in the construction of external walls. Existing brickwork has been known to develop defects in the bricks subsequent to re-pointing with rich, dense mortar. A possible explanation of the cause of this is that water absorbed by the bricks during wet weather can only be eliminated during dry periods by evaporation on the surface of the bricks and not through the joints, and any salts in the bricks may crystallize near the surface, causing disintegration of their faces.

Non-hydraulic Lime Mortars (from pure and lean limes, see p. 20) must be well slaked before use. This type can be stored in a heap for several days after mixing, provided the surface is smoothed over with a shovel to minimize carbonation by the exclusion of as much air as possible. As such mortars can only harden when exposed to the atmosphere (p. 20), a relatively large proportion of sand must be added to the lime to assist in the penetration of air. For this reason the proportion of sand may be as high as 4 parts by volume of sand to 1 part lime. These mortars are light-coloured. They are not likely to cause efflorescence. These mortars are not suitable for work below ground level, especially if the ground is water-logged. Such mortars are improved if gauged with cement (p. 27).

Hydraulic Lime Mortars (see p. 20) should be used within one hour after being mixed. This especially applies to eminently hydraulic mortar which sets quickly after the addition of the necessary amount of water. Any mortar which has stiffened and cannot be knocked up by means of a trowel to a sufficiently plastic condition should never be used. The proportions of lime to aggregate range from 1 part lime to from 2 to 3½ parts sand, a common mixture being 1 : 3. These are excellent mortars for all purposes and are particularly suited for work below the ground level and in exposed positions.

Eminently hydraulic lime mortars rank next to cement mortars as regards strength. They may be a cause of efflorescence (p. 13) owing to the presence of salts.

Magnesian or Dolomitic Lime Mortars (see p. 21) have a slow-setting action and they should therefore be slaked for several hours before use. Their properties and uses are somewhat similar to those of hydraulic lime mortars.