be light coloured (see p. 28). White cement is more expensive than ordinary cement. It is in increasing demand for external rough-casting of walls, pointing of brickwork and masonry, and in the manufacture of reconstructed (artificial) stone and tiles. Well-known brands include "Atlas" and "Snowcrete."

Coloured Cement.—Cement, used for special purposes such as for plastering walls and in the manufacture of reconstructed stone and tiles, is now obtainable in a variety of colours. Pigments, such as black oxide of iron and manganese black (to produce a black colour), red oxide of iron (producing red), brown oxide of iron (producing brown), chromic oxide (producing green), etc., are thoroughly incorporated with the cement in a dry condition by machinery. Coloured cement can be obtained ready for use from the manufacturers, or the cement and pigments can be mixed on the job.

(*a*) (iv) Portland Blast-furnace Cement.—This is a mixture of ordinary Portland cement and blast-furnace slag. The latter is a product of the blast furnace in which iron ore is smelted as a preliminary in the manufacture of cast iron, steel, etc. Normally this slag is an impurity which is run into ladles and conveyed to the slag tip. When, however, it is used in the production of cement, the slag as it issues from the furnace is cooled by a stream of water which reduces it to a honeycombed, granulated condition. The slag is removed, dried and mixed with ordinary cement clinker and passed to a ball mill (see p. 22) for thorough incorporation and fine grinding. Not every slag is suitable for this purpose. The quality of this cement must comply with the British Standard Specification for Portland—Blastfurnace Cement, No. 146—1932. The proportion of slag must not exceed 65 per cent., and that of Portland cement clinker must not be less than 35 per cent. (see p. 28).

(*b*) High Alumina or Aluminous Cement.[1]—There is a considerable difference in both composition and manufacture between this cement and Portland cement. Aluminous cement is made from a mixture of limestone and bauxite (aluminium ore imported principally from Baux, France) which are fired in a furnace in which pulverized coal and a hot air blast are employed. The heat fuses (liquefies) the materials, whereas in the manufacture of Portland cement the heat clinkers the raw materials (see p. 22). The liquid cement is tapped from the base of the furnace and conveyed to mills where it is ground to extreme fineness. The cement is much darker in colour than Portland cement. An approximate analysis is :

	Per Cent.
Lime	39
Silica	7
Alumina	39
Iron oxide	13
Magnesia, etc.	2
	100

This cement is sometimes produced in electric furnaces and known as *electric cement*.

[1] *Various tests are embodied in the British Standard Specification for High Alumina Cement, No.* 915—1940.

Its chief characteristics are : Rapid-hardening, great strength, large amount of heat generated during the setting and hardening process, and its resistance to acids. Concrete composed of this cement develops a compressive strength of at least 5,000-lb. per sq. in. at the age of one day and 7,000-lb. per sq. in. at the age of seven days (see Table II, p. 34). It is unaffected by frost on account of the heat which it generates. Because of these qualities, high alumina cement can be usefully employed when formwork is required to be removed with the minimum delay, for concreting ground floors on certain soils containing sulphates which may attack ordinary Portland cement concrete, for concrete piles (which can be driven after three days' hardening), for road construction (especially in the re-laying of city streets), for general work requiring great strength, and when work must be done during low temperatures. The strength of high alumina cement concrete is affected adversely if the heat rapidly generated during hardening is not got rid of. Thus, formwork encasing concrete should be removed as soon as practicable. Its use is not advocated for mass concrete exceeding 18-in. thick unless it can be deposited in thin layers, preferably 12-in. thick, and the dissipation of the evolved heat permitted. Another disadvantage of high alumina cement is its relatively high cost. It must not be mixed with or brought into contact with Portland cement, as a reduction in the strength of the former will result. Well-known brands are "Ciment Fondu" (fused cement) and "Lightning."

MORTARS

Mortar is composed of an aggregate, such as sand, and a matrix or binding material of lime or cement or both (see p. 2, Vol. I).

Sand in mortar (1) reduces shrinkage and without it cracks would develop, (2) assists in the hardening of pure limes especially (p. 20) by allowing the penetration of air which provides CO_2 for the development of carbonization (p. 20) and (3) reduces its cost, as sand is much cheaper than lime or cement.

To give the best results sand should be well graded and must be clean.

Grading of Sand.—A suitably graded sand consists of particles varying in size from coarse to fine, with the smaller particles packing into the voids between the larger. A *coarse* sand is one the bulk of which is retained on a No. 52 British Standard Sieve ($\frac{1}{84}$-in. square mesh). If most of the particles of a sample pass through this sieve, the sand is classified as a *fine* one. Coarse sand produces what is known as a *harsh* mortar. Sand containing a large proportion of very fine particles, such as dust or silt, is not suitable, as an excessive amount of water is required to make the mortar workable, and this reduces its strength and increases shrinkage. It is therefore recommended that, for mortar, not more than 3 per cent. of sand should pass a No. 100 standard sieve ($\frac{1}{168}$-in. square mesh). To the experienced, the relative coarseness and fineness of a consignment of sand can be gauged approximately by its appearance and by rubbing some of it between the thumb and forefinger.

The strength of mortar (and concrete, see p. 28) is decreased if the particles