CEMENT

VARIETIES OF CEMENT

In addition to ordinary cement, the following are the other important varieties of cement:

(1) Acid-resistant cement
(2) Blast furnace cement
(3) Coloured cement
(4) Expanding cement
(5) High alumina cement
(6) Hydrophobic cement
(7) Low heat cement
(8) Pozzuolana cement
(9) Quick setting cement
(10) Rapid hardening cement
(11) Extra rapid hardening cement
(12) Sulphate resisting cement
(13) White cement.

Each of the above variety of cement will now be discussed in brief.

(1) Acid-resistant cement: An acid-resistant cement is composed of the following

(i) acid-resistant aggregates such as quartz, quartzites, etc.,
(ii) additive such as sodium fluosilicate $Na_2 SiF_6$; and
(iii) aqueous solution of sodium silicate or soluble glass.

- The addition of additive sodium fluosilicate accelerates the hardening process of soluble glass and it also increases the resistance of cement to acid and water.
- The binding material of acid-resistant cement is soluble glass which is a water solution of sodium silicate, $Na_2O.nSiO_2$ or potassium silicate, $K_2O.nSiO_2$, where n is the glass modulus.
- The term glass modulus is used to indicate the ratio of the number of silica molecules to that of alkali oxide molecules and its value in soluble glass varies from 2.50 to 3.50.
- The acid-resistant cement is used for acid-resistant and heat-resistant coatings of installations of chemical industry. It is not water resistant and it fails when attacked by water or weak acids. By adding 0.50 per cent of linseed oil or 2 per cent of ceresit, its resistance to the water is increased and it is then known as the acid and water resistant cement.

(2) Blast furnace cement:

- For this cement, the slag as obtained from blast furnace is used. The slag is a waste product in the manufacturing process of pig iron and it contains the basic elements of

cement, namely, alumina, lime and silica. The clinkers of cement are ground with about 60 to 65 per cent of slag.

- The properties of this cement are more or less the same as those of ordinary cement. Its strength in early days is less and hence it requires longer curing period. It proves to be economical as slag, which is a waste product, is used in its manufacture. This cement is durable, but not suitable for use in dry arid zones.

(3) Coloured cement:

- The cement of desired colour may be obtained by intimately mixing mineral pigments with ordinary cement. The amount of colouring material may vary 5 to 10 per cent. If this percentage exceeds 10 per cent, the strength of cement is affected.
- The chromium oxide gives green colour. The cobalt imparts blue colour. The iron oxide in different proportions gives brown, red or yellow colour. The manganese dioxide is used to produce black or brown coloured cement.
- The coloured cements are widely used for finishing of floors, external surfaces, artificial marble, window sill slabs, textured panel faces, stair treads, etc.

(4) Expanding cement:

- This type of cement is produced by adding an expanding medium like sulpho-aluminate and a stabilising agent to the ordinary cement. Hence this cement expands whereas other cements shrink.
- The expanding cement is used for the construction of water retaining structures and also for repairing the damaged concrete surfaces.

(5) High alumina cement: This cement is produced by grinding clinker formed by calcining bauxite and lime. The bauxite is an aluminium ore. It is specified that total alumina content should not be less than 32 per cent and the ratio by weight of alumina to the lime should be between 0.85 and 1.30. This cement is known by the trade names of Cement Fondu in England and Lumnite in America

Following are the advantages of this cement:

(i) The initial setting time of this cement is more than 3 hours. The final setting time is about 5 hours. It therefore allows more time for mixing and placing operations.
(ii) It can stand high temperatures.
(iii) It evolves great heat during setting. It is therefore not affected by frost.
(iv) It resists the action of acids in a better way.
(v) It sets quickly and attains higher ultimate strength in a short period. Its strength after 1 day is about 40 N/mm^2 and that after 3 days is about 50 N/mm^2
(vi) Its setting action mainly depends on the chemical reactions and hence it is not necessary to grind it to fine powder.

Following are the disadvantages of this cement:

(i) The extreme care is to be taken to see that it does not come in contact with even traces of lime or ordinary cement.
(ii) It cannot be used in mass construction as it evolves great heat and as it sets soon.

(iii) It is costly.

(6) Hydrophobic cement:

- This type of cement contains admixtures which decrease the wetting ability of cement grains. The usual hydrophobic admixtures are acidol, naphthenesoap, oxidized petrolatum, etc. These substances form a thin film around cement grains.
- When water is added to hydrophobic cement, the absorption films are torn off the surface and they do not in any way, prevent the normal hardening of cement. However, in initial stage, the gain in strength is less as hydrophobic films on cement grains prevent the interaction with water. However its strength after 28 days is equal to that of ordinary Portland cement.
- When hydrophobic cement is used, the fine pores in concrete are uniformly distributed and thus the frost resistance and the water resistance of such concrete are considerably increased.

(7) Low heat cement:

- The considerable heat is produced during the setting action of cement. In order to reduce the amount of heat, this type of cement is used. It contains lower percentage of tricalcium aluminate C_3A of about 5% and higher percentage of dicalcium silicate C_2S of about 46%
- This cement possesses less compressive strength. The initial setting time is about one hour and final setting time is about 10 hours. It is mainly used for mass concrete work

(8) Pozzuolana cement: The pozzuolana is a volcanic powder. It is found in Italy near Vesuvius. It resembles surkhi which is prepared by burning bricks made from ordinary soils. It can also be processed from shales and certain types of clays. The percentage of pozzuolana material should be between 10 to 30.

Following are the advantages of this cement:

(i) It attains compressive strength with age.
(ii) It can resist action of sulphates.
(iii) It evolves less heat during setting.
(iv) It imparts higher degree of water tightness.
(v) It imparts plasticity and workability to the mortar and concrete prepared from it.
(vi) It is cheap.
(vii) It offers great resistance to the expansion.
(viii) It possesses higher tensile strength.

Following are the disadvantages of this cement:

(i) Its compressive strength in early days is less.
(ii) It possesses less resistance to the erosion and weathering action.

This cement is used to prepare mass concrete of lean mix and for marine structures. It is also used in sewage works and for laying concrete under water.

(9) Quick setting cement:

- This cement is produced by adding a small percentage of aluminium sulphate and by finely grinding the cement. The percentage of gypsum or retarder for setting action is also greatly reduced. The addition of aluminium sulphate and fineness of grinding are responsible for accelerating the setting action of cement. The setting action of cement starts within five minutes after addition of water and it becomes hard like stone in less than 30 minutes or so.
- The extreme care is to be taken when this cement is used as mixing and placing of concrete are to be completed in a very short period. This cement is used to lay concrete under static water or running water.

(10) Rapid hardening cement: The initial and final setting times of this cement are the same as those of ordinary cement. But it attains high strength in early days. It contains high percentage of tricalcium silicate C_3S to the extent of about 56%. This is due to the following facts:

(i) Burning at high temperatures.
(ii) Increased lime content in cement composition.
(iii) Very fine grinding.

This cement is slightly costlier than ordinary cement, but is offers the following advantages.

(i) As it sets rapidly, the construction work may be carried out speedily.
(ii) The formwork of concrete can be removed earlier and it can therefore be used frequently.
(iii) It obtains strength in a short period. The compressive strength at the end of one day is about 11.50 N/mm^2 and that at the end of 3 days is about 21 N/mm^2. Similarly the tensile strength at the end of one day is about 2 N/mm^2 and that at the end of 3 days is about 3 N/mm^2.
(iv) It is light in weight.
(v) It is not damaged easily.
(vi) The structural members constructed with this cement may be loaded earlier.
(vii) This cement requires short period of curing.
(viii) The use of this cement allows higher permissible stresses in the design It therefore results in economic design.

(11) Extra rapid hardening cement: This type of cement accelerates the setting and hardening process. It imparts strength of about 25% higher than that of rapid hardening cement at one or two days about 10% to 20% higher at 7 days The gain of strength disappears with the age and at 90 days, the strength of extra rapid Hardening cement is not merely same as that of ordinary Portland cement. Extra rapid hardening cement is obtained by inter-grinding calcium chloride with rapid hardening Portland cement. The normal addition of calcium chloride should not exceed 2% by the weight of rapid hardening cement. Its specific varies between 5000 to 6000 cm^2 per gram and the size of the particles is less than 3 microns This type of cement should be transported, placed, compacted and finished within 20 minutes after mixing.

(12) Sulphate resisting cement (IS: 2330-1988):

- Ordinary Portland cement is susceptible to the attack of sulphate. Free calcium hydroxide and hydrate of calcium aluminium present in the set cement react with sulphate and form calcium sulphate and calcium aluminate respectively. The product formed by reaction within the framework of hydrated cement paste results in expansion and subsequently disruption of the set concrete occurs.
- The remedy of sulphate attack is sulphate resisting cement. It is a cement with low C_3A content and comparatively lower C_4AF content. The percentage of C_3A (tricalcium aluminate) is kept below 5 percent and it results in the increase in resisting power against sulphate attack.

Sulphate resisting cement is used the following conditions:

(i) For the structures which are likely to be damaged by severe alkaline conditions such as canal linings, culverts, siphons, etc.
(ii) In construction of sewage treatment worker.
(iii) In foundations and basements where soil contains sulphate.
(iv) In marine construction.
(v) In pile fabrications which are likely to be buried in marshy region or sulphate bearing soils.

(13) White cement (IS: 8042-1989):

- The first white cement factory was set up in Kottayam, Kerala by Travancore Cement Limited (TCL) in 1956 and the cement was sold under the brand name Vembanad Cement. Few more plants have now been put up for the manufacture of white cement in our country.
- This is just a variety of ordinary cement and it is prepared from such raw materials which are practically free from colouring oxides of iron, manganese or white in colour and it is used for floor finish, plaster work, ornamental work, etc. It should not set earlier than 30 minutes. It should be carefully transported and stored in closed containers only. It is more costly than ordinary cement because of specific requirements imposed upon the raw materials and the manufacturing process.
- The white cement is the wonder material of the century and it has quickly established itself as absolutely indispensable for the housing and construction industry. It is quick drying, possesses high strength and has superior aesthetic values. The miscellaneous applications of white cement are in swimming pools where it replaces the use of glazed tiles with coloured shades usable under water, for moulding sculptures and statues, for painting garden furniture, etc. It is also used for ready mixed concrete and precast concrete blocks and also for fixing marble and glazed tiles.