CE6002 Concrete Technology

Unit I - Constituent Materials.
Cement:

Cement is finely pulverized material which by itself is not a binder, but develops the binding property as a result of hydration.

Different types of cement:

The following types of cements like Portland cement, Portland Pozzolana cement can be subdivided into:

1) Ordinary Portland cement (OPC),
2) Rapid hardening cement (RHC)
3) Eaba rapid hardening cement,
4) Portland blast furnace cement,
5) Low heat Portland cement,
6) Sulphate resistant Portland cement.
D) White portland cement,
E) Coloured cement,
F) Natural cement,
G) Super sulphate cement,
H) Special cement like
   a) Masonry cement,
   b) Trench cement,
   c) Expansive cement,
   d) Oil well cement,
   e) Hydrophobic cement,
   f) Waterproof cement,
   g) High alumina cement,
   h) Sinker cement.

Ordinary portland cement (OPC)

This is most suitable for use in general concrete construction when there is no exposure to sulphates in the soil or in groundwater.

The OPC was classified into 3 grades, namely 33, 43, 53 grades.
depending upon the strength of the cement at 28 days when tested as per IS 4031: 1988.

If the 28 days strength is not less than 33 N/mm², it is called 33 grade cement. If the strength is not less than 43 N/mm², it is called 43 grade cement and if the strength is not less than 53 N/mm² it is called 53 grade cement.

Rapid hardening cement:—

As the name implies, it develops strength rapidly, and therefore can be called as high early strength cement.

The strength of this cement at the age of 2 days is equal to the 7 days strength of ordinary Portland cement with the same W/C ratio.
This is useful for winter
concreting, urgent repairs work, wall
sealing, etc.

Extra Rapid hardening cement:–

This cement is obtained by
inter grinding calcium chloride with
rapid hardening cement. The quantity
of calcium chloride should not exceed
2%.

The strength is about 25% higher than rapid hardening cement
at 1 or 2 days, and 10 to 20% higher
at 7 days.

Portland Blast Furnace cement:–

This type of cement is made
by inter grinding Portland cement clinker
and granulated blast furnace slag (a
Waste products in the manufacture of pig iron and which is a mixture of lime, silica, and alumina, the proportion of slag being limited to 65% of the weight of mixture.

Low heat Portland cement

The rise in temperature in the interior of a large concrete mass due to the heat of hydration can lead to serious cracking.

As per IS specifications, the heat of hydration should not exceed 65 cal/gm. & 75 cal/gm at the end 7 and 28 days respectively.

Sulphate resisting cement:

The sulphate resisting cement is theoretically ideal cement but because of the special requirements...
for the composition of raw material
used in its manufacture, it cannot be
cheaply and easily made:

White Portland cement:

The greyish colour of Portland
cement is due to the presence of
Iron oxide.

The process of manufacturing
white cement is the same but
amount of Iron oxide is reduced to
less than 1%.

Coloured Portland cement:

The different forms of
cement have their own characteristic
colours, but most coloured cements
are basically Portland cements to which
pigments have been added.

Natural cements:

These are manufactured
from naturally occurring cement rocks which have compositions similar to the artificial mix from which Portland cement is manufactured.

Super sulphate cement:

This cement is made from well granulated slag (80 to 85%) and calcium sulphate (10 to 15%) together with 1 to 2% of Portland cement.

Properties of cement:

A good cement possesses the following general properties,

1) Provides strength to masonry,
2) Sets and hardens early,
3) Possesses good plasticity,
4) An excellent building material,
5) Easily workable,
6) Good moisture resistant.
Chemical Composition:

The chief chemical constituents of Portland cement are:

- **Lime** (CaO) - 60 to 67%
- **Silica** - 17 to 25%
- **Alumina** (Al₂O₃) - 8%
- **Iron oxide** (Fe₂O₃) - 0.5 to 6%
- Little amount of magnesia, sulphur trioxide, and soda.

**Test on Cements:**

- **Test for Consistency** of Standard cement paste.

**Apparatus and Materials:**

1. The Vicat's apparatus,
2. Ordinary Portland cement
3. Balance,
Procedure:

1) A cement sample weighing 350g is taken on a non-porous surface.
2) About 25% by weight of water is mixed with it thoroughly.
3) The paste is filled in the mould of the Vicat apparatus, taking care that the time of gauging is between 3 to 5 minutes.
4) The time of gauging is the time elapsing from the moment
After adding the water to the dry cement until commencing to fill the mould.

5) After adding filling the mould completely, the surface is smoothed off, making it level with top of the mould.

6) The mould is slightly shaken to expel the air is placed under the rod bearing the plunger.

7) The plunger is lowered gently to touch the surface of the test block, and released quickly, allowing it to penetrate into the paste.

8) The standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger to penetrate to a point 5 to 7mm from the bottom of
the Vicat mould.

9. The process is repeated with another
y. of water till the end of the
standard consistency is obtained.

Test for determining the setting time
of cement:

Apparatus and Materials:
1. The Vicat's apparatus,
2. Ordinary Portland cement
3. Balance
4. Cylinder mould
5. Stop watch

Procedure:
1) A sample of cement weighing
350g is taken.

2) The cement paste is prepared
by mixing the cement with 0.85 times
the water required to give a paste of
Standard Consistency

3) A stop watch is started at the instant when water is added to the cement.

4) The test block is placed under the rod bearing the needle.

5) The needle is lowered gently in contact with the surface of the test block and quickly released, allowing it to penetrate into test block.

6. In the beginning, the needle pierces the test block completely.

7. The procedure is repeated until the needle fails to pierce the test block by 5mm from the bottom of the mould.

8. The initial setting time of the cement paste defined as the period
elapsing between the time when water is added to cement and the time at which the needle fails to pierce the test block by about 5 mm from the bottom.

9. The needle is then replaced by another needle (final setting time needle) with an annular attachment.

10. The cement is considered as finally set when upon applying the needle gently to the surface of the test block, the needle makes an impression there on.

Aggregates:

- Water, cement and crushed rock or gravel and sand are the chief ingredients of concrete.
About 75% of volume of concrete is composed of aggregates and hence properties of aggregate greatly affect the properties of concrete.

General classification of aggregate

1. While producing good quality concrete, the aggregate is used at least from two size groups.

1) Fine aggregate, often called sand-size, not larger than 3/16".

2) Coarse aggregate, which comprises material at least 3/16" in size.

Is 383: 1963 define fine aggregate as the aggregate most of which will pass 4.75 mm IS sieve and the coarse aggregate as one most of which is retained on 4.75 mm IS sieve.
Mechanical properties of aggregates

- Toughness
- Hardness
- Specific gravity
- Bulk density
- Porosity and absorption of aggregate
- Moisture content of aggregate

Test on Aggregates:
The standard tests as specified by I.S. specifications mentioned are discussed below.

Test for determination of Flakiness Index and Elongation Index:

Apparatus Required:
1. A balance
2. A standard metal gauge
3. I. S sieves of sizes show in table.

Procedure:
A sufficient quantity of aggregate is taken such that the minimum number of 200 pieces of any fraction can be used.

The material is then washed and sieved so as to remove material finer than 75 micron Is sieve.

Each fraction is then gauged in tin for thickness on the standard metal gauge or in bulk on sieves having elongated slots.

The total amount passing the gauge is weighted to an accuracy of at least 0.1% of the weight of the test sample.

Then the flakiness index is calculated which the total weight of the material is passing the various
thickness gauge or sieves, expressed as a percentage of the total weight of sample gauged.

* The best procedure for determination of Elongation Index is very similar except that the material is gauged for length on a standard metal length gauge.

* The gauge length is given in the table for the appropriate size of the material.

* Then the elongation index is the total weight of the material retained on various length gauges and expressed as a percentage of the total weight of the sample gauged.

The following table shows dimensions...
Test for the determination of the percentage of Building & Fine aggregates:

Apparatus required: —

* 250 ml measuring cylinder.

Procedure: —

The damp sand, consolidated by shaking, is poured in a 250 ml measuring cylinder until it reaches the 200 ml mark. (16)
Then it is filled with water and the sand is stirred well.

* In this operation the sand should be in submerged condition.

* The level of the surface of sand is noted, say mark y ml.

* Then the percentage of the bulking of the sand due to moisture is calculated as

\[
\text{percentage of bulking} = \left( \frac{200}{y} - 1 \right) \times 100
\]

Water:

* Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement.

* Since it helps to form the strength giving cement gel, the quality
The quantity of water is required to be looked into very carefully.

Qualities of water:

1. If water is fit for drinking, it is fit for making concrete.

2. But this does not appear to be a true statement for all conditions, because some drinking water contains a small amount of

   organ.

   Some specification also accept water for making concrete if the pH value of water lies between 6 and 8 and the water is free from organic matter.