

Internal Assessment Test Scheme and Solutions – July. 2022

Sub:	Concrete Technology	Sub Code:	18CV44	Branch:	Civil Engg
Date:	09.07.2022	Duration:	90 min's	Max Marks:	50
Sem / Sec:	4 A				OBE

Answer any FIVE FULL Questions

MARKS

CO RBT

1 (a) How cement is manufactured by dry process? Give flow chart.

[10]

CO1 L3

Manufacturing Process:

Main ingredients used in the manufacture of cement are:

Limestone or chalk (Calcareous materials, consists Calcium)

Clay, shale (Argillaceous materials, consists Silica and Alumina)

Marl (a mixture of Calcareous and Argillaceous materials)

Limestone (CaCO_3) and Clay are two main raw materials used for manufacturing Portland cement clinker. Clays have various amount of SiO_2 and Al_2O_3 .

The process of manufacture of cement consists essentially of grinding the raw materials, mixing them intimately in certain proportions and burning in large rotary kiln at a temperature of up to about 1450°C when material sinters and partially fuses into balls known as clinkers. The clinker is cooled and ground to a fine powder, with some gypsum added, the resulting product is the commercial Portland cement so widely used throughout the world.

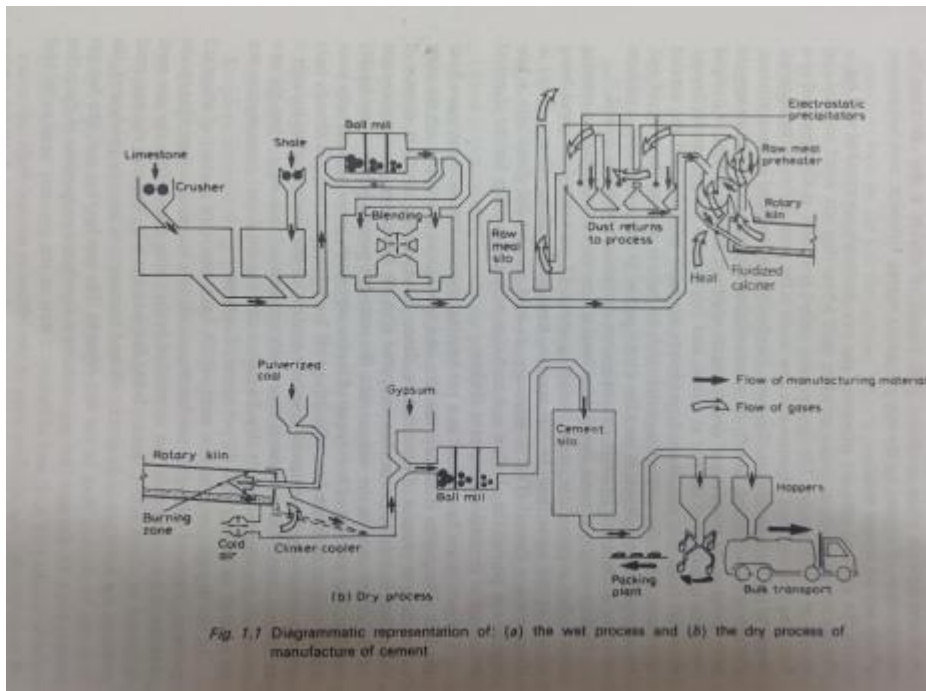


Fig. 1.7 Diagrammatic representation of: (a) the wet process and (b) the dry process of manufacture of cement

2 (a) List the chemical compositions of cement and explain their importance

[10]

CO1 L3

1.8 CHEMICAL COMPOSITION OF CEMENT AND THEIR IMPORTANCE

The raw materials used for the manufacture of ordinary Portland cement contains mainly lime, silica, alumina and iron oxide. These oxides interact with one another in the kiln at high temperature to form more complex compounds

The oxide composition of ordinary Portland cement are given below:

Table 1.3 : Oxide Composition of Cement

Oxide composition	Normal Range	Functions
Lime(CaO)	60-67%	<p>It is a major ingredient of cement and constitutes about two-third of cement.</p> <ul style="list-style-type: none">➤ It makes the cement sound and strong.➤ The lime in excess quantity makes cement unsound and causes the cement to expand and disintegrate.➤ If lime is low in quantity, the mix will be improper which will lead to low strength of cement as this cement will set quickly.
Silica(SiO₂)	17-25%	<ul style="list-style-type: none">➤ It is an important ingredient of cement and imparts strength to the cement due to the formation of dicalcium and tricalcium silicates.➤ Silica in excess provides greater strength to the cement but at the same time prolongs its setting time.
Alumina(Al₂O₃)	3-8%	<ul style="list-style-type: none">➤ It provides quick setting property to the cement.➤ It acts as a flux and lowers the clinkering temperature.➤ Alumina in excess reduces the strength of cement.
Iron oxide(Fe₂O₃)	0.5-6%	<ul style="list-style-type: none">➤ It provides colour, hardness and strength to the cement.➤ It also helps the fusion of raw materials during the manufacture of cement.

Magnesia(MgO)	0.5-4%	<ul style="list-style-type: none"> ➤ It provides hardness and colour to the cement, when present in small quantity. ➤ The magnesium oxide in excess quantity makes the cement unsound.
Sulphur trioxide(SO₃)		<ul style="list-style-type: none"> ➤ It makes the cement sound, when present in very small quantity. ➤ If it is used in excess it produces expansion of cement thus making it unsound and also excess of sulphur trioxide increases the setting time.
Alkalies [Potash(K₂O) and Soda(Na₂O)]	0.3-1.2%	<ul style="list-style-type: none"> ➤ These are used in form of soda and potash. ➤ These should be present in small quantities. ➤ The alkalies in excess quantity will cause efflorescence.
Calcium sulphate(CaSO₄)	3-5%	<ul style="list-style-type: none"> ➤ It is about 3% of the cement and is added in the form of gypsum during the process of grinding of clinker. ➤ It is a retarder since it increases the initial setting time of cement. ➤ If gypsum is not added the cement will set at the moment water is added to it, without giving any time for mixing and placement.

3 (a) List the different laboratory tests conducted on cement and explain any two of them in detail. [10]

(i) Setting time test (ii) Fineness test (iii) Compression strength test (iv) Soundness test (v) Loss on ignition test (vi) Chemical composition test

Setting time

Initial setting time: Is the time elapsed between the moment that the water is added to the cement, to the time that the paste starts to losing its plasticity.

In actual construction practices certain time is required for mixing, transportation, placing, compacting and finishing the Cement mortar or cement concrete, During this time cement paste, mortar or concrete should be in plastic condition.

So the time interval for which the cement product remain in plastic condition is known as the Initial setting time.

As per IS specification (IS 8112 and IS 12269) Initial setting time for an ordinary cement should not be less than 30 minutes.

CO1	L2

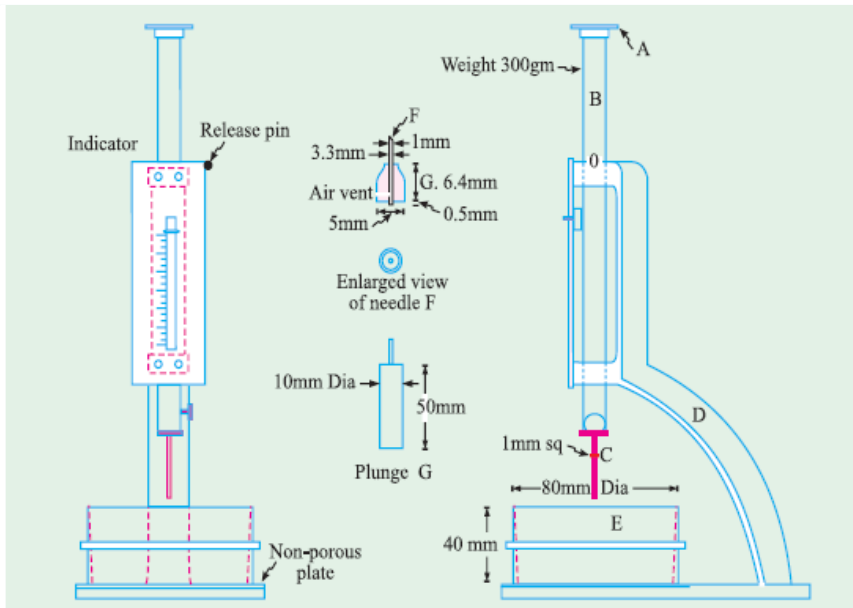


Fig.3.1 Vicat apparatus for determining Normal consistency, Initial and Final setting time

Final setting time: Is the time elapsed between the moment water is added to the cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure.

In actual construction practices once the concrete is placed in the final position, compacted and finished, it should lose its plasticity in the earliest possible time so that least vulnerable to damages from external destructive agencies.

As per IS specification (IS 8112 and IS 12269) Final setting time for an ordinary cement should not be more than 600 minutes.

The Vicat Apparatus shown in Fig 1.8 is used for setting time test also. The following procedure is adopted. Take 500 gm of cement sample and gauge it with 0.85 times the water required to produce cement paste of standard consistency. The paste shall be gauged and filled into the vicat mould in the specified manner within 3 to 5 minutes. Start the stop watch the moment water is added to the cement.

For initial setting time lower the 1.6mm diameter needle gently and bring it in contact with the surface of the test block and quickly release. Allow it to penetrate into the test block. In the beginning, the needle will completely pierce through the test block. But after some time when paste starts losing its plasticity the needle may penetrate to a depth of 5 to 7 mm from bottom. The period elapsing between the time when water is added to the cement and the time at which the needle penetrates the test block to a depth equal to 5 to 7 mm from the bottom taken as initial setting time.

For Final setting time replace the 1.6 mm diameter needle of the Vicat apparatus by a circular attachment shown in the fig. The cement shall be considered as finally set when, upon, lowering the attachment gently cover the surface of the test block, centre needle makes an impression, while the circular cutting edge of the attachment fails to do so. In other words the paste has attained such hardness that the centre needle does not pierce through the paste more than 0.5mm.

- 4 (a) What are fine aggregates? Write a short note on
1. Alternatives to river sand

[10]

CO2 L1

1.26 ALTERNATIVES TO RIVER SAND

Sand is a vital ingredient in making two most used construction materials viz. cement and mortar. Traditionally River sand, which is formed by natural weathering of rocks over years, is preferred as fine aggregate. The economic development fuelling the growth of infrastructure and housing generates huge demand for building materials like sand. The indiscriminate extraction of sand from riverbeds is posing a serious threat to environment such as erosion of river banks, triggering landslides, loss of vegetation on the bank of rivers, lowering the groundwater table etc. Hence, sand mining from riverbeds is being restricted or banned by the government. Controlling extraction along rivers has caused the illegal activities to spread into hillside and creating public hazards such as landslide, deep ponds, and hanging cliffs. This sand extracted from fields (popularly known as filter sand), in addition to depleting the fertile top soil, impairs the strength of concrete / mortar.

The construction sector in India contributes to over 7% of the GDP and it is estimated that more than 70% of India's infrastructure (for 2030) is yet to be built. An increasing urban population will drive the demand for newly built environments, and hence for sand as part of construction in coming years. Low availability of sand is driving the examination of alternate materials, with similar characteristics, for use in construction-related applications. Sand made from sedimentary rocks is perceived as one such alternative. Crushed-stone sand or 'manufactured sand' is produced by crushing rocks to a grade comparable to natural sand. The properties of sand from crushed rock is said to be similar (or often better) to riverbed sand.

Some of the alternatives to river sand are;

- Manufactured Sand
- Fly Ash/ Bottom Ash/Pond Ash
- Copper Slag
- Filtered Sand
- Sea Sand
- Slag Sand
- Crushed Waste Glass
- Recycled Aggregate/Construction and demolition waste aggregate etc.

1.26.1 Manufactured Sand

Manufactured sand is crushed aggregates produced from hard granite stone which is shaped with rounded edges, washed and graded with consistency to be used as a substitute for river sand.

2. Requirements of fine aggregates.

Requirements of Fine aggregates:

1. It should be clean and coarse.

2. It should be free from any organic or vegetable matter, usually silt content should not exceed 5% per cent by weight of sand.
3. It should contain sharp, angular, and rounded grains.
4. It should not contain salts which attract moisture from the atmosphere.
5. **BULKING OF SAND** : The increase in the volume of sand due to the presence of moisture is known as bulking of sand. This is due to the fact that moisture forms a film of water around the sand particles and these results in an increase in the volume of sand. The extent of bulking depends on the grading of sand. The finer the material the more will be the increase in volume for the given moisture content.
6. It should be well graded, i.e., contain particles of various sizes in suitable proportions.
7. It should be strong and durable.
8. It should be chemically inert, should not contain any harmful impurities such as iron, pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shale in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar/concrete.
9. The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand / marble dust shall not exceed the following limits:
 - (a) Clay, fine silt and fine dust when determined in accordance within not more than 5% by mass in IS 2386 (Part-II), natural sand or crushed gravel sand and crushed stone sand.
 - (b) Organic impurities when determined in color of the liquid shall be lighter in lighter in accordance with IS 2386 (Part –II) than that specified in the code

- 5 (a) List the different laboratory tests conducted on coarse aggregates in the laboratory, explain any two of them in detail.
- i) Crushing value ii) Impact value iii) Abrasion value
 iv) Flakiness and elongation index test v) Specific gravity test
 vi) Water absorption test etc....

[10]

CO2	L3

Test for determination of aggregate crushing value

The "aggregate crushing value" gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. With aggregates of 'aggregate crushing value' 30 or higher, the result may be anomalous and in such cases the "ten per cent fines value" should be determined and used instead.

The standard aggregate crushing test is made on aggregate passing a 12.5 mm I.S. Sieve and retained on 10 mm I.S. Sieve. If required, or if the standard size is not available, other sizes upto 25 mm may be tested. But owing to the nonhomogeneity of aggregates the results will not be comparable with those obtained in the standard test.

About 6.5 kg material consisting of aggregates passing 12.5 mm and retained on 10 mm sieve is taken. The aggregate in a surface dry condition is filled into the standard cylindrical measure in three layers approximately of equal depth. Each layer is tamped 25 times with the tamping rod and finally levelled off using the tamping rod as straight edge. The weight of the sample contained in the cylinder measure is taken (A). The same weight of the sample is taken for the subsequent repeat test.

The cylinder of the test apparatus with aggregate filled in a standard manner is put in position on the base-plate and the aggregate is carefully levelled and the plunger inserted horizontally on this surface. The plunger should not jam in the cylinder.

The apparatus, with the test sample and plunger in position, is placed on the compression testing machine and is loaded uniformly upto a total load of 40 tons in 10 minutes time. The load is then released and the whole of the material removed from the cylinder and sieved on a 2.36 mm I.S. Sieve. The fraction passing the sieve is weighed (B).



Aggregate Crushing Value Apparatus.

$$\text{The aggregate crushing value} = \frac{B}{A} \times 100$$

where, B = weight of fraction passing 2.36 mm sieve,
 A = weight of surface-dry sample taken in mould.

The aggregate crushing value should not be more than 45 per cent for aggregate for concrete other than for wearing surfaces, and 30 per cent for concrete used for wearing surfaces such as runways, roads and air field pavements.

Test for determination of 'ten per cent fines value'

The sample of aggregate for this test is the same as that of the sample used for aggregate crushing value test. The test sample is prepared in the same way as described earlier. The cylinder of the test apparatus is placed in position on the base plate and the test sample, in thirds, each third being subjected to 25 strokes by tamping rod. The surface of aggregate is carefully levelled and the plunger inserted so that it rests horizontally on the surface.

The apparatus, with the test sample and plunger in position is placed in the compression testing machine. The load is applied at a uniform rate so as to cause a total penetration of the plunger in 10 minutes of about:

15.00 mm for rounded or partially rounded aggregates (for example uncrushed gravel),
 20.0 mm for normal crushed aggregates, and

24.0 mm for honeycombed aggregates (for example, expanded shales and slags).
 These figures may be varied according to the extent of the rounding or honeycombing.

After reaching the required maximum penetration, the load is released and the volume of the material removed from the cylinder and sieved on a 2.36 mm I.S. Sieve. The weight of the material passing the sieve is weighed and the weight is expressed as a percentage of the weight of the test sample. This percentage would fall within the range 7.5 to 12.5, but if it does not, a further test shall be made at a load adjusted as seems appropriate to bring the percentage of fines within the range of 7.5 to 12.5 per cent. Repeat test is made and the load is found out which gives a percentage of fines within the range of 7.5 to 12.5.

$$\text{Load required for 10 per cent fines} = \frac{14 \times X}{Y + 4}$$

where, X = load in tons, causing 7.5 to 12.5 per cent fines.

Y = mean percentage fines from two tests at X tons load.

Test for determination of aggregate impact value

The aggregate impact value gives relative measure of the resistance of an aggregate to sudden shock or impact. Which in some aggregates differs from its resistance to a slow compressive load.



Aggregate Impact Value Apparatus

The test sample consists of aggregate passing through 12.5 mm and retained on 10 mm I.S. Sieve. The aggregate shall be dried in an oven for a period of four hours at a temperature of 100°C to 110°C and cooled. The aggregate is filled about one-third full and tamped with 25 strokes by the tamping rod. A further similar quantity of aggregate is added and tamped in the standard manner. The measure is filled to overflowing and then struck off level. The net weight of the aggregate in the measure is determined (weight A) and this weight of aggregate shall be used for the duplicate test on the same material.

The whole sample is filled into a cylindrical steel cup firmly fixed on the base of the machine. A hammer weighing about 14 kgs. is raised to a height of 380 mm above the upper surface of the aggregate in the cup and allowed to fall freely on the aggregate. The test sample shall be subjected to a total 15 such blows each being delivered at an interval of not less than one second. The crushed aggregate is removed from the cup and the whole of it is sieved on 2.36 mm I.S. Sieve. The fraction passing the sieve is weighed to an accuracy of 0.1 gm. (weight B). The fraction retained on the sieve is also weighed (weight C). If the total weight (B + C) is less than the initial weight A by more than one gm the result shall be discarded and a fresh test made. Two tests are made.

The ratio of the weight of fines formed to the total sample weight in each test is expressed as percentage.

$$\text{Therefore, Aggregate Impact Value} = \frac{B}{A} \times 100$$

where, B = weight of fraction passing 2.36 mm I.S. Sieve.

A = weight of oven-dried sample.

The aggregate impact value should not be more than 45 per cent by weight for aggregates used for concrete other than wearing surfaces and 30 per cent by weight for concrete to be used as wearing surfaces, such as runways, roads and pavements.

Test for determination of aggregate abrasion value

Indian Standard 2386 (Part IV) of 1963 covers two methods for finding out the abrasion value of coarse aggregates: namely, by the use of Deval abrasion testing machine and by the use of Los Angeles abrasion testing machine. However, the use of Los Angeles abrasion testing machine gives a better realistic picture of the abrasion resistance of the aggregate. This method is only described herein.

Table 3.21 gives the detail of abrasive charge which consists of cast iron spheres or steel spheres approximately 48 mm in diameter and each weighing between 390 to 445 gm.

Table 3.21. Specified Abrasive Charge

Grading	Number of spheres	Weight of charge (gm)
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 20
D	6	2500 ± 15
E	12	5000 ± 25
F	12	5000 ± 25
G	12	5000 ± 25

The test sample consist of clean aggregate which has ben dried in an 110°C and it should conform to one of the gradings shown in Table 3.22

Table 3.22. Gradings of Test Samples

Sieve Size		Weight in gm. of Test Sample Fc				
Passing	Retained on	A	B	C	D	E
mm	mm					
80	63	-	-	-	-	2500
63	50	-	-	-	-	2500
50	40	-	-	-	-	5000
40	25	1250	-	-	-	-
25	20	1250	-	-	-	-
20	12.5	1250	2500	-	-	-
12.5	10	1250	2500	-	-	-
10	6.3	-	-	2500	-	-
6.3	4.75	-	-	2500	-	-
4.75	2.36	-	-	-	5000	-

Test sample and abrasive charge are placed in the Los Angeles Abrasion testing machine and the machine is rotated at a speed of 20 to 33 rev/min. For gradings A, B, C and D, the machine is rotated for 500 revolutions. For gradings E, F and G, it is rotated 1000 revolutions. At the completion of the above number of revolution, the material is discharged from the machine and a preliminary separation of the sample made on a sieve coarser than 1.7 mm IS Sieve. Finer portion is then sieved on a 1.7 mm IS Sieve. The material coarser than 1.7 mm IS Sieved is washed, dried in an oven at 105° to 110°C to a substantially constant weight and accurately weighed to the nearest gram.

The difference between the original weight and the final weight of the test sample is expressed as a percentage of the original weight of the test sample. This value is reported as the percentage of wear. The percentage of wear should not be more than 16 per cent for concrete aggregates.

Typical properties of some of the Indian aggregate sample are shown in table 3.23.



Los Angeles Abrasic

- 6 (a) Write a short note on below mentioned mineral admixtures used in concrete.
i. Fly ash

[10]

CO4	L4
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Fly Ash:

The finely divided residue resulting from the combustion of ground or powdered coal. Fly ash is generally captured from the chimneys of coal-fired power plants; it has POZZOLANIC properties, and is sometimes blended with cement for this reason.

Fly ash includes substantial amounts of silicon dioxide (SiO₂) (both amorphous and crystalline) and calcium oxide (CaO). Toxic constituents include arsenic, beryllium, boron, cadmium, chromium, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium.

Fly ash is the most common artificial pozzolana, the fly ash particles are spherical and have very high fineness : the vast majority of particles have a diameter between less than 1 micrometer to 100 micrometer, and the specific surface of flyash is usually between 250 to 600m²/kg. The high specific surface means the material is readily available for reaction with calcium hydroxide.

Addition of flyash in concrete helps to improve many properties of concrete in fresh and hardened state of concrete. In fresh state of concrete addition of flyash leads to production of a fatty mix which helps in improving workability, reducing segregation and bleeding. Secondary hydration caused by flyash produces more amount of CSH gel and reduces soluble Calcium hydroxide in concrete which will improves strength of the concrete in later ages and reduces permeability of concrete which leads to inhibiting alkali-aggregate reaction, and enhancement of sulfate resistance. In addition use of flyash leads reduced heat evolution during the process of hydration.

Class F Fly Ash:

The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 5% lime (CaO). The glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds.

Class C Fly Ash:

Fly ash produced from the burning of lignite or subbituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 10% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO₄) contents are generally higher in Class C fly ashes.

ii. GGBS

Ground Granulated Blast Furnace Slag (GGBFS)

Ground granulated blast-furnace slag is the **granular material** formed when molten iron blast furnace slag (a by-product of iron and steel making) is rapidly chilled (quenched) by immersion in water. It is a granular product, **highly cementitious** in nature and, ground to cement fineness, hydrates like Portland cement.

(Blast-Furnace Slag: A by-product of steel manufacture which is sometimes used as a substitute for Portland cement. In steel industry when iron ore is molted, then in the molted state all the impurities come at its surface which are removed called slag. It consists mainly of the silicates and aluminosilicates of calcium, which are formed in the blast furnace in molten form simultaneously with the metallic iron. Blast furnace slag is blended with Portland cement clinker to form PORTLAND BLASTFURNACE SLAG CEMENT). GGBFS is used to make durable concrete structures in combination with ordinary Portland cement and/or other pozzolanic materials. GGBFS has been widely used in Europe, and increasingly in the United States and in Asia (particularly in Japan and Singapore) for its superiority in concrete durability, extending the lifespan of buildings from fifty years to a hundred years.

Concrete made with GGBFS cement **sets more slowly** than concrete made with ordinary Portland cement, depending on the amount of GGBFS in the cementitious material, but also continues to gain strength over a longer period in production conditions. This results in **lower heat of hydration** and **lower temperature rises**, and makes avoiding **cold joints** easier, but may also affect construction schedules where quick setting is required.

Use of GGBFS significantly reduces the risk of damages caused by alkali-silica reaction (ASR), provides higher resistance to chloride ingress, reducing the risk of reinforcement corrosion, and provides higher resistance to attacks by sulfate and other chemicals.

Benefits:

1. Durability

1. GGBFS cement is routinely specified in concrete to provide protection against both sulphate attack and chloride attack
2. GGBFS is also routinely used to limit the temperature rise in large concrete pours. The more gradual hydration of GGBFS cement generates both lower peak and less total overall heat than Portland cement.

2. Appearance

1. In contrast to the stony grey of concrete made with Portland cement, the near-white color of GGBFS cement permits architects to achieve

a lighter colour for exposed fair-faced concrete finishes, at no extra cost.

3. Strength

1. Concrete containing GGBFS cement has a higher ultimate strength than concrete made with Portland cement. It has a higher proportion of the strength-enhancing calcium silicate hydrates (CSH) than concrete made with Portland cement only, and a reduced content of free lime, which does not contribute to concrete strength. Concrete made with GGBFS continues to gain strength over time, and has been shown to double its 28 day strength over periods of 10 to 12 years.

7 (a) Write a short note on below mentioned chemical admixtures used in cement concrete. [10]

- i. Plasticizers

Plasticizers :

The organic substances or combinations of organic and inorganic substances, which allow a reduction in water content for the given workability, or give a higher workability at the same water content, are termed as plasticizing admixtures.

These admixtures are used for following purposes:

1. To achieve a higher strength by decreasing the water cement ratio at the same workability as an admixture free mix.
2. To achieve higher workability at same water content as admixture free mix.
3. To achieve the same workability by decreasing the cement content so as to reduce the heat of hydration in mass concrete.
4. To increase the workability so as to ease placing in accessible locations
5. Water reduction more than 5% but less than 15%

The basic products constituting plasticizers are as follows:

- (i) Anionic surfactants such as lignosulphonates and their modifications and derivatives, salts of sulphonates hydrocarbons.
- (ii) Nonionic surfactants, such as polyglycol esters, acid of hydroxylated carboxylic acids and their modifications and derivatives.
- (iii) Other products, such as carbohydrates etc.

Actions involved:

1. Dispersion:

Portland cement, being in fine state of division, will have a tendency to flocculate in wet concrete. These flocculation entraps certain amount of water used in the mix and thereby all the water is not freely available to fluidify the mix.

When plasticizers are used, they get adsorbed on the cement particles. The adsorption of charged polymer on the particles of cement creates particle to particle repulsive forces. Due to this repulsive force cement particles will start to move away from each other as a result cement particles are deflocculated and dispersed. When cement particles are deflocculated, the water trapped inside the flocs gets

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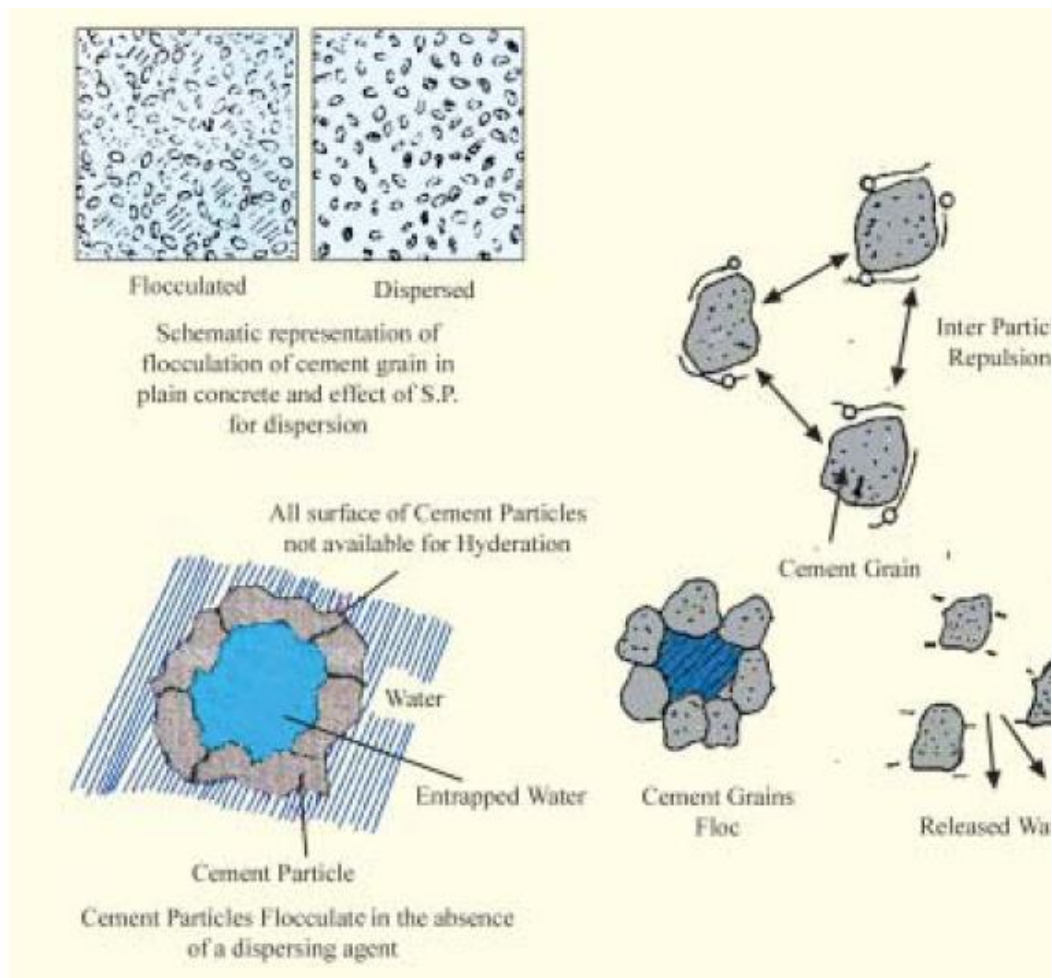
released which will increase workability.

2. Lubrication:

When cement particles get flocculated there will be interparticle friction between particle to particle and floc to floc. But in the dispersed condition there is water in between the cement particle and hence interparticle friction is reduced.

3. Retardation:

A thin layer is formed over the cement particles protecting them from hydration and increasing the setting time. Most normal plasticizers give some retardation, 30–90 minutes.



Effect of surface active agents on deflocculating of cement grains.

ii. Retarders

Retarding Admixtures (Retarders):

The function of retarder is to delay or extend the setting and hardening time of

cement paste in concrete. These are helpful for concrete that has to be transported to long distance, and helpful in placing the concrete at high temperatures.

When water is first added to cement there is a rapid initial hydration reaction, after which there is little formation of further hydrates for typically 2–3 hours. The exact time depends mainly on the cement type and the temperature. This is called the **dormant period** when the concrete is plastic and can be placed. At the end of the dormant period, the hydration rate increases and a lot of calcium silicate hydrate and calcium hydroxide is formed relatively quickly. This corresponds to the setting time of the concrete. Retarding admixtures delay the end of the dormant period and the start of setting and hardening. This is useful when used with plasticizers to give workability retention.

Retarders are useful in concreting in hot weather, when the normal setting time is shortened by the higher temperature, and in preventing the formation of cold joints. In general they prolong the setting and hardening time during which concrete can be transported, placed, and compacted.

They are also used in grouting oil wells. Oil wells are sometimes taken up to a depth of about 6000 meter deep where the temperature may be about 200°C.

Retarders are sometimes used to obtain exposed aggregate look in concrete. The retarder is sprayed to the surface of the formwork, whereas the rest of the concrete gets hardened. On removing the formwork after one day or so, the unhardened matrix can be just washed off by a jet of water which will expose the aggregates.

Perhaps the most commonly known retarder is calcium sulphate (gypsum). It is interground to retard the setting of cement. The appropriate amount of gypsum to be used must be determined carefully for the given job. Use of gypsum for the purpose of retarding setting time is only recommended when adequate inspection and control is available, otherwise, addition of excess amount may cause undesirable expansion and indefinite delay in the setting of concrete.

In addition to gypsum there are number of other materials found to be suitable for this purpose. They are: starches, cellulose products, sugars, acids or salts of acids. These chemicals may have variable action on different types of cement when used in different quantities. Unless experience has been had with a retarder, its use as an admixture should not be attempted without technical advice. Any mistake made in this respect may have disastrous consequences.

Common sugar is one of the most effective retarding agents used as an admixture for delaying the setting time of concrete without detrimental effect on the ultimate strength. Addition of excessive amounts will cause indefinite delay in setting. At normal temperatures addition of sugar 0.05 to 0.10 per cent have little effect on the rate of hydration, but if the quantity is increased to 0.2 per cent, hydration can be retarded to such an extent that final set may not take place for 72 hours or more.