RRB-JE 2024

Railway Recruitment Board

Junior Engineer Examination

Civil Engineering

Building Materials

Well Illustrated **Theory** *with*

Solved Examples and **Practice Questions**

MADE EASY PUBLICATIONS

Building Materials

Contents

CHAPTER 01

Cement

1.1 Introduction

- Cement is an extremely fine material having adhesive and cohesive properties which provides a binding medium for the discrete ingredients.
- Cement is a product obtained by pulverizing clinker formed by calcinating raw-materials primarily consisting of lime (CaO), silicate (SiO_2), Alumina (Al_2O_3), and Iron oxide (Fe_2O_3).
- When cement is mixed with water it forms a paste which hardens and bind aggregates (fine coarse) together to form a hard durable mass called concrete.
- Cements used in construction industry can be classified as hydraulic and non-hydraulic.
- Hydraulic cement set and harden extremely fast in presence of water (Due to the chemical action between cement and water known as hydration) and results in water resistance product which is stable. This allows setting in wet condition or underwater and further protects the hardened material from chemical attack. e.g.: (Portland cement).
- Non-hydraulic cements are derived from calcination of gypsum or limestone because their products of hydration are not resistant to water. However, the addition of pozzolanic materials can render the gypsum and make cement hydraulic. Thus, it will not set in wet condition or underwater, rather it sets as it dries and reacts with carbon-dioxide in the air. It can be attacked by some aggressive chemicals after setting. e.g.: Plaster of Paris.
- The cement experiences the exothermic chemical reactions when comes in contact with water.
- The cement is assumed to have a specific gravity of 3.15.
- Standard density of cement is 1440 kg/m^3 and 1 bag of cement is of 50 kg, thus volume would be 50/1440 = 0.0347 m^3.

  Hence, volume of 1 bag of cement can be approximated as 0.035 m^3 or 35 litres.
- Cement can be manufactured either from natural cement stones or artificially by using calcareous and argillaceous materials.

Argillaceous	Calcareous
• Shale and clay • Blast furnace slag • Slate	• Cement rock • Limestone • Chalk • Marine shells • Marl

1.2 Cement and Lime

Following points of differences may be noted between ordinary cement and lime:

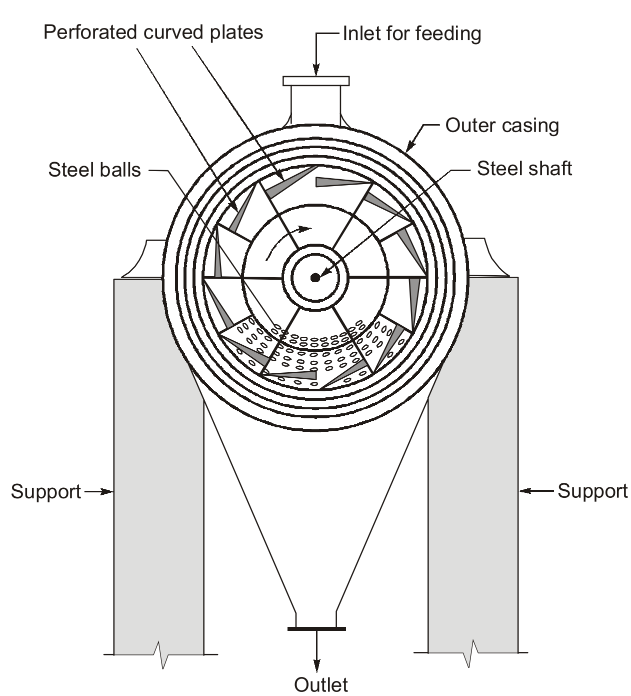
1. The cement is used for the gain of early strength whereas lime gains the strength slowly.
2. The cement and lime color are different.
3. The cement and lime both is a binding material having good ultimate strength but lime experiences less early strength as compare to cement.

1.3 Manufacture of Cement

- The manufacturing of cement was first started in England by the scientist named Joseph Aspdin.
- The first time manufacturing of cement is named as Ordinary Portland Cement (OPC) because when the cement comes in contact with water it becomes a hard mass after a certain period and this hard mass resembles the stone found in portland area of England.
- The India is 2^{nd} largest manufacturing hub after China.
- The cement is manufactured by integrating the calcareous component and argillaceous component in ratio 3 : 1.
- The calcareous components can be limestone chalk, marine shells, marl whereas argillaceous components can be shale clay, blast furnace slag, slate.
- The calcareous component is used to derive the ingredient called lime whereas the argillaceous component composed of silica, alumina, iron oxide, and other impurities.
- Cement can be manufactured either by dry process or wet process.

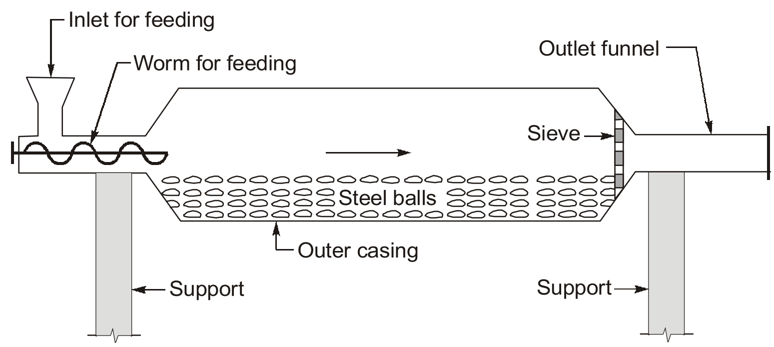
1.3.1 Dry Process

Step (i): The material is gathered from quarry with the help of dumper to manufacturing plant. The material gathered is having content of limestone and clay which is calcareous component and argillaceous component respectively. The material gathered is about more than 80 mm size.



Vertical Section of a Ball Mill

Step (ii): The collected material is fed into heavy crusher where the size of the material get reduced to 60 mm from 80 mm and later this size material is fed into light crusher (Tubemill/Ballmill) where the size reduced to 40-60 mm finally it is stored in the tank.



Longitudinal Section of a Tube Mill

Step (iii): Now, the grinding material called raw mix is fed into preheater (heater before rotary kiln), the temperature is gradually increased upto 500°C due to this increase in temperature the raw mix get fraction into smaller size nearly (25 mm).

Benefits of Preheaters:

(a) It makes the process fast.

(b) Fuel consumption is reduced because the burning time of rotary kiln is get reduced.

Now, this raw mix is fed into rotary kiln where the temperature is 800-1000°C, 1000-1200°C, 1200°-1500°C. In three separate zones respectively. The product obtained is of size 8 to 10 mm from rotary kiln is called clinker.

Rotary Kiln

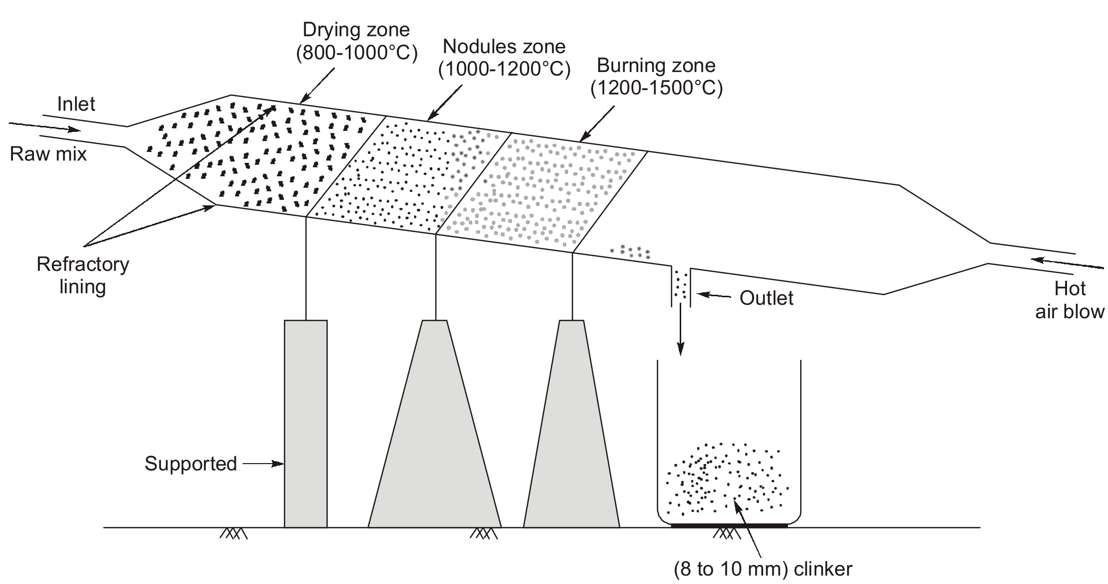
Dimensions:

Diameter = 3 m

Length = 100 m

Revolutions = 3 rounds in 1 minute

Gradient 1 in 25 to 1 in 30.



Zone-1 (Drying zone): In this zone the raw mix, is fractioned into more smaller size. In this zone if there is some water or moisture exist in raw mix then it is also evaporated.

Zone-2 (Nodule zone): In this zone, the major breakdown of raw mix occur. In this zone the calcination of limestone takes place $\underset{\text{(Limestone)}}{CaCO_3} \xrightarrow{\text{Superheat}} \underset{\text{(Lime)}}{CaO} + CO_2 \uparrow$.

Zone-3 (Burning zone): Now, the raw mix which is also called nodules, is sloped down and the major chemical reaction between ingredient of clinker occurs i.e. lime, silica, alumina, iron oxides.

$$\left.\begin{aligned} &2\,CaO + SiO_2 \rightarrow Ca_2SiO_4\,(C_2S) \\ &3\,CaO + SiO_2 \rightarrow Ca_3SiO_5\,(C_3S) \\ &3\,CaO + Al_2O_3 \rightarrow Ca_3Al_2O_6\,(C_3A) \\ &4\,CaO + Al_2O_3 \rightarrow Fe_2O_3\,(C_4AF) \end{aligned}\right\} \text{Bouge's compounds}$$

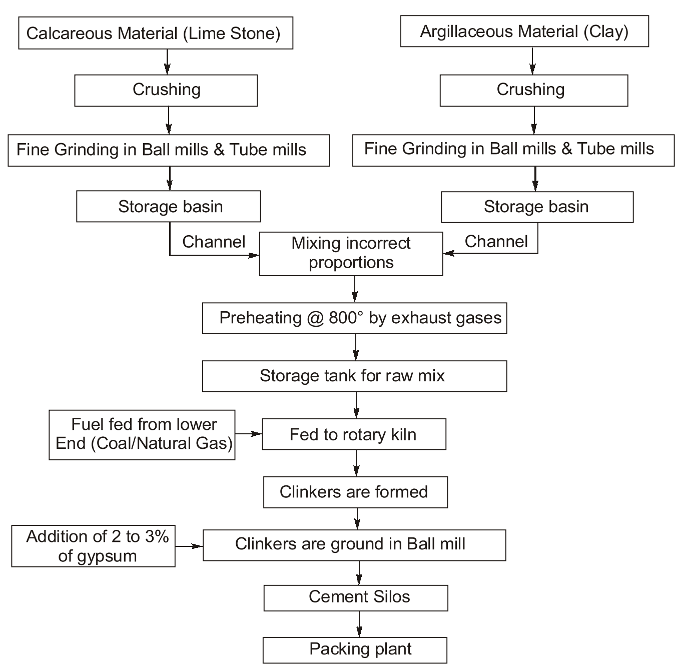
Now, from this rotary kiln the product obtained is called clinker which is composed of major and minor compounds.

NOTE: The clinker obtained has high efficiency to react with water and set immediately (flash set) to prevent this immediately setting of clinker in presence of water is done by adding gypsum in a tubemill.

(v) Now, the clinker is cooled upto temperature of 100°C, after colling it is fed into tubemill where the gypsum is also added to it, the fine grinded powder having gray colour is obtained which is called cement.

(vi) It is packed in 50 kg bag having ±5% volume capacity of 0.035 m^3.

(vii) Now, after packing it is transported to dealers.

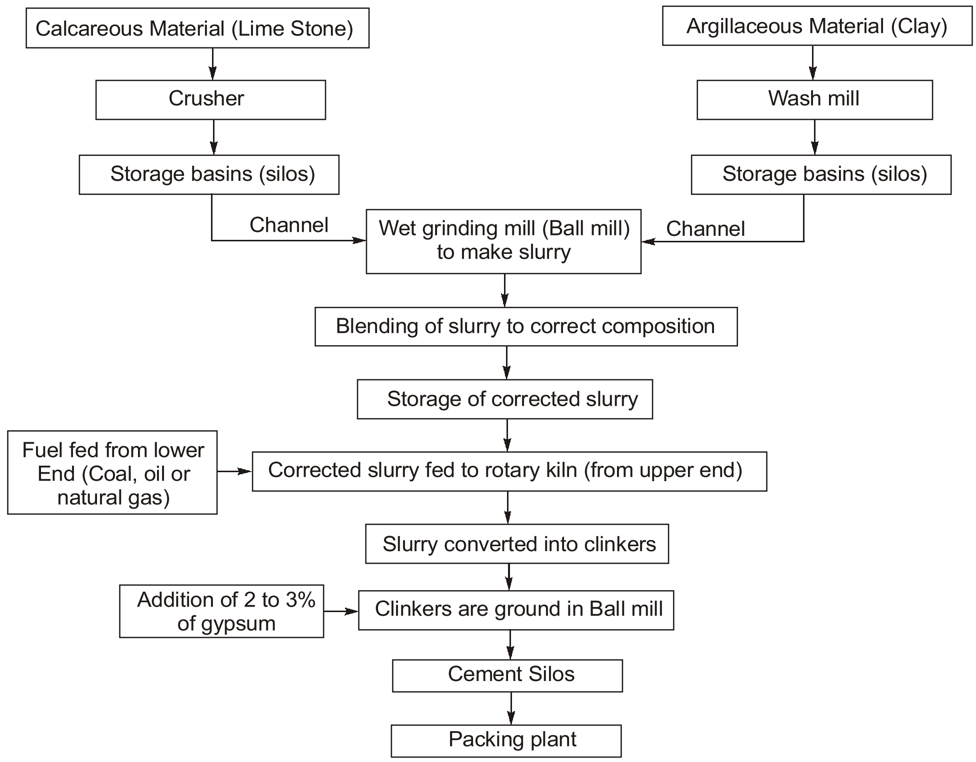


Flow diagram of dry process

1.3.2 Wet Process

In a wet process the heavier crushed material is made wet in storage tank before feeding into tubemill.

In wet process, the preheater is not used, the mix obtained from tubemill is directly fed into rotary kiln.



Flow diagram of wet process

Disadvantages

(i) The process time is long.

(ii) The fuel consumption is more.

1.4 Chemical Composition of Cement

Oxide	Composition (%)	Average
Lime CaO	60 - 65	63
Silica, SiO_2	17 - 25	20
Alumina, Al_2O_3	3 - 8	6
Iron oxide, Fe_2O_3	0.5 - 6	3
Magnesia, MgP	0.5 - 4	2
Soda/or potash ($Na_2O + K_2O$)	0.5 - 1	1
Sulphur tri-oxide	1 - 2	1.5

- The relative proportional of three oxide compositions are responsible for influencing the various properties of cement, like lime, silica and alumina.
- An increase in lime content beyond a certain value makes it difficult to combine completely with other compounds.
- Consequently, free time will exist in the clinker and will result in an unsound cement. An increase in silica content at the expense of alumina and ferric oxide makes the cement difficult to fuse and form clinker.

1. Lime (CaO)

If lime is provided in excess then the cement becomes unsound and if it is in deficiency then the strength is reduced therefore chances of quick setting will be enhanced.

2. Silica (SiO_2)

It imparts strength to the cement due to the formation of di-calcium and tri-calcium silicates. If it is in excess then the strength of the cement would enhanced therefore setting time gets prolonged, hence it prevents quick setting.

3. Alumina (Al_2O_3)

It imparts quick setting property of cement. If it is in excess then the strength of cement is reduced and the chances of rapid hardening would be increased. It acts as a flux and it lower's the clinker temperature.

4. Calcium Sulphate ($CaSO_4$)

It is a retarder (admixture). If it is in excess then it slowdown the quick setting which dominates to increase the strength. It is a gypsum form.

5. Iron Oxide (Fe_2O_3)

It imparts colour, hardness, and strength to the cement. If it is in excess, then it imparts more coloured to the cement (grey).

6. Magnesia (Mgo)

It imparts hardness and colour (yellow) to the cement, if it is in small quantity, and if it is in excess then it imparts unsoundness to the cement.

7. Sulphur (S)

If it is in reference quantity then it imparts strength to the cement and it it is in excess then the unsoundness is increased.

8. Alkalies (Soda and Potash) ($Na_2O + K_2O$)

The most of the alkalies present in raw materials are carried away by the flue gases heating and the cement contents only a small amount of alkalies. If they are in excess in cement then they cause a number of troubles such as alkali-aggregate reaction, efflorescence and staining when used in concrete, brick work or masonary mortar.

1.5 Basic Properties of Bougie Compounds

The principle mineral compounds in portland cement	Formula	Name	Symbol	Percentage
1. Tri-calcium silicate	$3CaOSiO_2$	Alite	C_3S	30 - 50%
2. Di-calcium silicate	$2CaOSiO_2$	Belite	C_2S	20 - 45%
3. Tri-calcium alluminate	$3CaOAl_2O_3$	Celite	C_3A	8 - 12%
4. Tetra-calcium alumino ferrite	$4CaOAl_2O_3$ Fe_2O_3	Felite	C_4AF	6 - 10%

1. Tri-calcium Silicate (C_3S)

It produces faster rate of reaction with greater heat evolution, it imparts early strength to the cement and also contribute good for ultimate strength. If it is in excess then rapid hardening enhances.

2. Di-calcium Silicate (C_2S)

It hydrates slowly and imparts ultimate strength much. The C_2S has less heat of hydration therefore it is resistant against chemical attack.

3. Tri-calcium Aluminate (C_3A)

It imparts fast reaction with water and it produces very high heat therefor it imparts more towards rapid hardening.

If C_3A would be more then immediate setting (flash set) would be enhanced to prevent this flash setting gypsum is added to it during manufacturing.

4. Tetracalcium Alumino Ferite (C_4AF)

It also reacts with water at faster rate and evolves heat by greater extent but it is more stable then C_3A because if produces less heat compared to C_3A.

NOTE

Decreasing order of ultimate: ($C_2S > C_3S > C_3A > C_4AF$)
Decreasing order of quickest reaction with water: ($C_3A > C_4AF > C_3S > C_2S$)

- The rate of hydration is increased by an increase in fineness of cement. However, total heat evolved is the same. The rate of hydration of the principal compounds is shown in figure and will be in the following descending order. $C_4AF > C_3A > C_3S > C_2S$

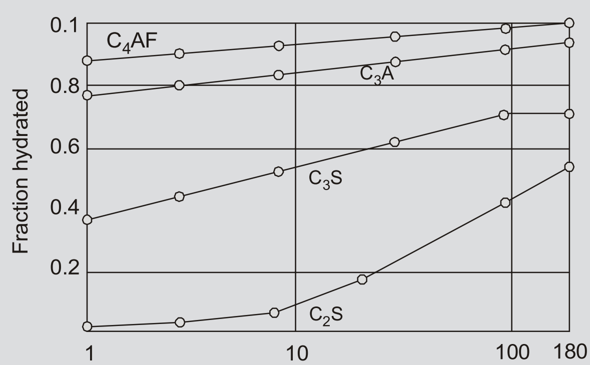


Fig. *Rate of Hydration of Pure Compounds*

- Rate of heat evolution of Bougue compound, if equal amount of each is considered will be in following descending order

  C_3A (865 J/gm) > C_3S (865 J/gm) > C_4AF (420 J/gm) > C_2S (260 J/gm).

Compound	Heat of hydration at the given age (J/g)		
	3 days	90 days	13 years
C_3S	242.44	434.72	509.96
C_2S	50.16	175.56	246.62
C_3A	886.16	1299.98	1354.32
C_4AF	288.42	409.64	426.36

Heat of Hydration

- Development of strength of four Bougue compounds of cement with age.

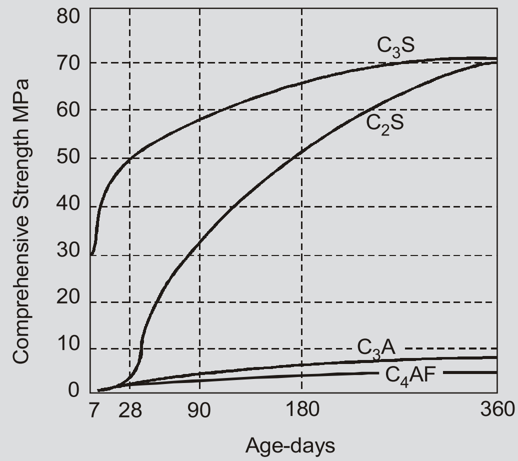


***Fig.** Development of Strength of Pure Compounds*

1.6 Hydration of Cement

- The chemical reaction of cement with water is referred as hydration of cement.
- The reaction of cement and water is exothermic reaction i.e. heat is liberated in a considerable quantity and this liberated heat is called heat of hydration.
- The water added to the cement will leads to evolution of heat, the C_3S and C_2S reacts with water during hydration to form a calcium silicate hydrate along with $Ca(OH)_2$.
- The calcium silicate hydrate is responsible for good properties of cement concrete. The calcium silicate hydrate is having binding property whereas the $Ca(OH)_2$ is not a desirable product in a cement concrete because it is responsible for lack of durability of concrete.
- The $Ca(OH)_2$ also reacts with sulphur present in water or soil to form $CaSO_4$. Which further reacts with C_3A and C_4AF to cause a deterioration of concrete this effect is called sulphate attack.

$$C_3S + \text{Water} \rightarrow \text{C-S-HGel} + Ca(OH)_2$$

$$C_2S + \text{Water} \rightarrow \underbrace{\text{C-S-H Gel}}_{\text{Binding proprty}} + \underbrace{Ca(OH)_2}_{\text{Durability}}$$

$$Ca(OH)_2 + \text{Sulphur} \rightarrow CaSO_4 + C_3A$$

$$\underbrace{CaSO_4 + C_4AF}$$

↓
Product
(Salty nature)
↓
Deterioration
of concrete
↓
Durability
decreases

- To reduce sulphate attack:
  1. Sulphur content in water (↓es)
  2. C_3A and C_4AF (↓es)

NOTE

The total amount of water required for complete chemical reaction between cement and water is 38%. If the gel pores/voids in cement exist where 15% of water is required to fill the voids and gel pores and this percentage is taken by weight.

1.7 Types of Cement

There are different types of cement as classified by the Bureau of Indian Standards (BIS):

(i) Ordinary Portland Cement
- (a) 33 grade – **IS : 269-1989**
- (b) 43 grade – **IS : 8112-1989**
- (c) 53 grade – **IS : 12269-1987**

(ii) Rapid Hardening Cement – **IS : 8041-1990**

(iii) Extra Rapid Hardening Cement

(iv) Low Heat Portland Cement – **IS : 12600-1989**

(v) Portland Slag Cement – **IS : 455-1989**

(vi) Portland Pozzolana Cement – **IS : 1489-1991(Part 1 and 2)**

(vii) Sulphate Resisting Portland Cement – **IS : 12330-1988**

(viii) White Portland Cement – **IS : 8042-1989**

(ix) Coloured Portland Cement – **IS : 8042-1989**

(x) Hydrophobic Cement – **IS : 8043-1991**

(xi) High Alumina Cement – **IS : 6452-1989**

(xii) Super Sulphated Cement – **IS : 6909-1990**

(xiii) Special Cements
- (a) Masonry Cement
- (b) Air Entraining Cement
- (c) Expansive Cement
- (d) Oil Well Cement

1.7.1 Ordinary Portland Cement (OPC)

- It is obtained by Pulverizing argillaceous and calcareous material in correct proportion.
- Portland cement is most common variety of artificial cement and most commonly known as O.P.C. (Ordinary Portland Cement).
- It is available in 3 grades:
  - (a) OPC–33 grade (IS: 269–989)
  - (b) OPC-43 grade (IS : 8112–1989)
  - (c) OPC–53 grade (IS: 12269–1987
- The number 33, 43, 53 corresponds to 28 days characteristic compressive strength of cement as obtained from standard test on cement sand mortar (1 : 3) specimens.
- The OPC 33 is recommended for concrete mix having strength upto 20 N/mm^2 i.e. M20.
- These are most commonly used in general concrete construction, where there is no exposure to sulphates.
- Due to high fineness, the workability of concrete increases for a given water-cement ratio. IS10262 has classified the OPC gradewise from "A to F" based on 28 days compressive strength as follows:
- It is presently available in three different grades viz. OPC 33, OPC 43 and OPC 53. The numbers 33, 43 and 53 correspond to the 28 days (characteristic) compressive strength of cement as obtained from standard tests on cement-sand mortar specimens.
- It is used in general concrete construction where there is no exposure to sulphates in the soil or in ground water.

1.7.2 Rapid Hardening Cement (RHC)

- It is finer than ordinary Portland cement.
- It contains more C_3S and less C_2S than the OPC.
- The 1 day strength of this cement is equal to the 3 days strength of OPC with the same water cement ratio.
- The main advantage of rapid hardening cement is that shuttering may be removed much earlier, thus saving considerable time and expenses.
- Rapid hardening cement is also used for road work where it is imperative to open the road traffic with the minimum delay.
- Cost of Rapid hardening cement is nearly 10–15% more than OPC.
- It can be **safely exposed to frost** as it matures more quickly.

1.7.3 Extra Rapid Hardening Cement (ERHC)

- It is obtained by mixing calcium chloride (not exceeding 2% by weight of the rapid hardening cement) with rapid hardening cement.
- Addition of $CaCl_2$ imparts quick setting properties in extra rapid hardening cement.
- The acceleration of setting, hardening and evolution of heat in the early period of hydration makes this cement **very suitable for concreting in cold weathers**.
- The 1 or 2 day strength of extra rapid hardening cement is 25% more than that of rapid hardening cement.
- The gain of strength disappears with age and 90 days strength of extra rapid hardening cement and rapid hardening cement are nearly the same.
- Use of extra rapid hardening cement is prohibited in prestressed concrete construction.
- Maximum time of using this cement is 20 minute for mixing, transporting, placing and compaction.

1.7.4 Low Heat Cement (LHC)

- It is a Portland cement which is obtained by reducing the more rapidly hydrating compounds, C_3S and C_3A and increasing C_2S.
- As per the Indian Standard specifications, the heat of hydration of low-heat cement shall be as follows:

  7 days – not more than 65 calories per gm

  28 days – not more than 75 calories per gm
- Since the rate of gain of strength of this cement is slow, hence adequate precaution should be taken in its use such as with regard to removal of formwork, etc.
- LHC is used in massive construction works like abutments, retaining walls, dams, etc. where the rate at which the heat can be lost at the surface is lower than at which the heat is initially generated.
- It has low rate of gain of strength, but the ultimate strength is practically the same as that of OPC.

1.7.5 Portland Blast Furnace Slag Cement

- This cement is made by intergrinding Portland cement clinker and granulated blast furnace slag.
- The proportion of the slag being not less than 25% or more than 65% by weight of cement.
- The slag should be granulated blast furnace slag of high lime content, which is produced by rapid quenching of molten slag obtained during the manufacture of pig iron in a blast furnace.

- In general blast furnace slag cement is found to gain strength more slowly than the ordinary Portland cement.
- The heat of hydration of Portland blast furnace slag cement is lower than that of OPC. So this cement can be used for mass concreting but is unsuitable for cold weather.
- It has fairly high sulphate resistance, rendering it suitable for use in environments exposed to sulphates (in the soil or in ground water).
- It is used for all purpose for which ordinary Portland cement is used.
- Because of its low heat evolution, it can be used in mass concrete structure such as dams, foundations and bridge abutments.

1.7.6 Portland Pozzolana Cement (PPC)

- It can be produced either by grinding together Portland cement clinker and pozzolana with the addition of gypsum or by blending uniformly Portland cement and fine pozzolana.
- As per the latest amendment, the proportion of pozzolana may vary from 15 to 35% by weight of cement clinker. Earlier, it was 10 to 25%.
- A pozzolanic material is essentially a siliccious or aluminous material which in itself possess no cementitious properties, which in finely divided form and in the presence of water reacts with calcium hydroxide, liberated in the hydration process at ordinary temperature to produce compounds possessing cementitious properties. This is known as pozzolanic action i.e.

$$Ca(OH)_2 + \text{Pozzolana} + \text{Water} \longrightarrow \text{C–S–H(gel)}$$

- The pozzolanic materials generally used for manufacture of Portland pozzolana cement are calcined clay **(IS : 1489 part 2 of 1991)** or fly ash **(IS: 1489 part 1 of 1991)**.
- Fly ash is a waste material generated in a thermal power station, when powdered coal is used as a fuel.
- PPC produces less heat of hydration and offers great resistance to the attack of impurities in water than OPC.
- PPC is particularly useful in marine and hydraulic constructions, and other mass concrete structures.
- The disadvantage of using PPC is that the reduction in alkalinity reduces the resistance to corrosion of steel reinforcement. But considering the fact that PPC significantly improves the permeability of concrete, thereby increases the resistance to corrosion of reinforcement.
- This cement has higher resistance to chemical agencies and to sea water because of absence of lime.
- It evolves less heat and its initial strength is less but final strength (28 days onward) is equal to OPC.
- It has lower rate of development of strength than OPC.
- The average compressive strength of cement mortar (1 : 3) at
  (i) at 1 day ± 1 hr 16 MPa (Minimum)
  (ii) at 7 day ± 2 hr 22 MPa (Minimum)
  (iii) at 28 day ± 4 hr 33 MPa (Minimum)

- The heat of hydration for low heat Portland cement should not be more than 66 and 75 cal/gm for 7 and 28 days respectively.

1.8.2.9 Specific Gravity Test

- The specific gravity of cement is obtained by using Le Chatelier's flask.
- Long seasoning is the chief cause for low specific gravity in an unadulterated cement.
- The flask is filled either with kerosene free of water or naphtha having a specific gravity not less than 0.7313 to a point on the stem between zero and 1 ml mark.
- The flask is then immersed in a constant temperature water bath and the reading is recorded.
- A weighed quantity of cement is then introduced in small amounts at the same temperature as that of the liquid.
- After introducing all the cement, the stopper is placed in the flask and the flask is rolled in an inclined position, or gently whirled in a horizontal circle so as to free the cement from air until no further air bubbles rise to the surface of liquid.
- The flask is again immersed in water bath and the final reading is recorded.
- The difference between the first and the final reading represents the volume of liquid displaced by the weight of cement used in the test.

$$\text{Specific gravity} = \frac{\text{Weight of cement (in gms)}}{\text{Weight of displaced volume of liquid (in } m\ell)}$$

- The specific gravity of Portland cement is generally about 3.15.
- Specific gravity is not an indication of quality of cement. It is used in calculation of mix proportions.

STUDENT'S ASSIGNMENTS

Q.1 The main constituent of cement which is responsible for initial setting of cement is
(a) Dicalcium silicate
(b) Tricalcium silicate
(c) Tricalcium aluminate
(d) None of above
[APPSC-2016]

Q.2 Cement used for railway sleeper is designated as:
(a) 40 - s (b) 53 - s
(c) 46 - s (d) 48 - s
[APPSC-2016]

Q.3 The apparatus used for determining the soundness of cement is
(a) Slump cone
(b) Le-Chatalier apparatus
(c) Vicat's needle
(d) UTM
[APPSC-2016]

Q.4 Rotary kiln used in manufacturing cement rotates at a speed of
(a) 1 rpm - 3 rpm (b) 10 rpm - 12 rpm
(c) 18 rpm - 22 rpm (d) > 25 rpm
[BPSC-2018]

Q.5 Which of the following is responsible for the initial set and high heat of hydration?
(a) Tricalcium silicate
(b) Dicalcium silicate
(c) Tricalcium aluminate
(d) Tetracalcium alumino ferite
[RPSC-2013]

Q.6 The addition of pozzolona to portland cement may cause
(a) decrease in early strength
(b) increase in early strength
(c) decrease in curing time
(d) increase in permeability
[OPSC-2016]

Q.7 The two main compounds imparting strength for ordinary portland cement are

(a) tricalcium silicate and dicalcium silicate
(b) dicalcium silicates and aluminates
(c) tricalcium aluminates
(d) tricalcium silicate and tricalcium aluminates

[OPSC-2016]

Q.8 Gypsum is added to portland cement during its manufacturing so that it may
(a) accelerate the setting time
(b) retard the setting time
(c) decrease the burning temperature
(d) facilitate grinding

[MPSC-2017]

Q.9 Which is the major constituent of ordinary portland cement?
(a) CaO (b) MgO
(c) SO_3 (d) Fe_2O_3

[MPSC-2017]

Q.10 As per IS specification the heat of hydration of low heat portland cement for 28 days is
(a) not more than 100 calories/gm
(b) not more than 50 calories/gm
(c) not more than 75 calories/gm
(d) not more than 150 calories/gm

[MPSC-2015]

Q.11 The following cement is used in the construction of dam
(a) low heat (b) rapid hardening
(c) quick setting (d) sulphate resisting

[MPSC-2015]

Q.12 The consistency test on cement is to obtain
(a) tensile strength of cement
(b) fineness of cement
(c) percentage of water for consistent paste
(d) compressive strength

Q.13 Match **List-I (Type of cement)** with **List-II (Property/characteristics)** and select the correct answer using the code given below the lists:

List-I
A. High strength portland cement
B. Super sulphated cement
C. High alumina cement
D. Rapid hardening portland cement

List-II
1. should not be used with any admixture
2. is extremely resistant to chemical attack
3. gives a higher rate of heat development
4. has a higher content of tricalcium

Codes:

	A	B	C	D
(a)	3	2	1	4
(b)	3	1	2	4
(c)	4	1	2	3
(d)	4	2	1	3

[HPSC-2016]

Q.14 Consider the following statements:
(a) Tests on cement paste to determine initial setting and final setting times are done at normal consistency.
(b) Low heat cement has a high percentage of tri-calcium aluminate.
(c) High early strength portland cement contains a large percentage of tricalcium silicate and lower percentage of dicalcium silicate.

Which of these statements are correct?
(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

[HPSC-2016]

Q.15 Which one of the following statements regarding the fineness of cement is not correct?
(a) Fine cement is more liable to suffer from shrinkage cracking then a coarse cement.
(b) Fine cement will show faster rate of hardening then coarse cement.
(c) Fine cement shows faster rate of heat evolution and total quantity of heat evolved is much larger than coarse cement.
(d) Fine cement shows the same setting time as coarse cement.

[HPSC-2016]

Q.16 As compared to ordinary portland cement high alumina cement has
(a) higher initial setting time, but lower final setting time.
(b) lower initial setting time but higher final setting time.

(a) lime (b) silica
(c) iron oxide (d) alumina
[SSC-JE-2018]

Q.47 The main purpose of the soundness test of the cement is to determine the ______.
(a) change in volume of cement after setting
(b) strength
(c) fineness
(d) time taken to harden
[SSC-JE-2018]

Q.48 Which of the following shows the correct decreasing order of rate of hydration of portland cement compounds?
(a) $C_3A > C_4AF > C_3S > C_2S$
(b) $C_3A > C_4AF > C_2S > C_3S$
(c) $C_3A > C_3S > C_4AF > C_2S$
(d) $C_4AF > C_3S > C_3A > C_2S$
[SSC-JE-2018]

Q.49 In fineness test rapid hardening portland cement the residue on IS sieve number 9 should not be more than
(a) 0.01 (b) 0.05
(c) 0.1 (d) 0.15
[SSC-JE-2018]

Q.50 For construction of structures in sea water, the cement generally preferred to is
(a) portland pozzolona cement
(b) quick setting cement
(c) low heat portland cement
(d) none of these
[SSC-JE-2018]

ANSWER KEY / STUDENT'S ASSIGNMENTS

1. (c)	**2.** (b)	**3.** (b)	**4.** (a)	**5.** (c)
6. (a)	**7.** (a)	**8.** (b)	**9.** (a)	**10.** (c)
11. (a)	**12.** (c)	**13.** (a)	**14.** (b)	**15.** (c)
16. (a)	**17.** (d)	**18.** (b)	**19.** (c)	**20.** (c)
21. (b)	**22.** (d)	**23.** (b)	**24.** (b)	**25.** (d)
26. (c)	**27.** (c)	**28.** (b)	**29.** (d)	**30.** (a)
31. (c)	**32.** (d)	**33.** (d)	**34.** (b)	**35.** (a)
36. (d)	**37.** (b)	**38.** (c)	**39.** (d)	**40.** (d)
41. (d)	**42.** (a)	**43.** (d)	**44.** (d)	**45.** (a)
46. (a)	**47.** (a)	**48.** (c)	**49.** (b)	**50.** (a)