UNIT 1 CALCAREOUS CEMENTING MATERIALS

Structure

1.1 INTRODUCTION

One of the principal stages of constructional engineering, whether in building construction, roads, dockyards and airfields, involves binding together of various units of inert materials like stones, stone aggregates, bricks and brick aggregates, etc., with some type of cementing material. The chief purpose of this cementing material is to impart strength, rigidity, solidity, durability and such other structural requirements as desired in a particular type of construction. Except for clay which can be used directly, generally the cementing materials are not found in a ready-to-use form in nature, You will find that, in almost all cases, these materials have to be manufactured from raw materials.

The focus of this unit will be on cementing materials and we will be studying their types, composition, properties, manufacture and fields of application. The carbonaceous cementing materials are bituminous based, and you will find more details about them in Unit **2.**

Objectives

This unit will help you to understand the different types of cementing materials, their composition, properties, manufacture and fields of application. At the end of the unit, you should be able to

* distinguish between different types of cementing materials,
* describe their features which differentiate them from others, and
* describe the specific fields of application for each type of cementing materials.

1.2 CLASSIFICATION OF CEMENTING MATERIALS

The various cementing materials are classified as follows.

a) Argillaceous cementing materials

b) Calcareous cementing materials

c) Carbonaceous cementing materials

Argillaceous Materials

Clays are the most common argillaceous materials. It is the clays were, probably the fust cementing materials to be used in the construction field. Kaolin is the base of all clays. You would notice that clay with the right quantity of water could be worked to form a thin film. This thin film binds the surrounding grains. Some of the common examples where clay acts as a cementing material are

a) as binder in **water, bound macadam in** roads,

b) in dried clay products,

c) for compactness and strength as exhibited by clay coated foundry sand, and

d) for fire clay for binding fue bricks in construction of furnaces.

Let us now move on to **calcareous cementing materials.** Some of these materials are :

i) Lime

ii) Gypsum plaster

iii) Cement

In the subsequent sections, we shall discuss these materials in detail.

1.3 LIMES

Lime and limestones, are the terms generally applied to all calcareous materials found in nature, which contain predominantly calcite {Calcium Carbonate ($CaCO_3$)}. This substance is the starting point in the manufacture of lime, and is the basis, generally, of all calcareous cements, which are so widely used in the Engineering field. The various forms and types of limes will now be discussed to give you an understanding of them.

1.3.1 Quicklime

This type of lime is obtained by the burning or calcination of a limestone containing large proportions of calcium carbonate. During burning, which is done in kilns or clamps, carbon dioxide is driven off, leaving calcium oxide, which is called Quicklime. Quicklime is generally classified into four types with respect to the content of calcium oxide and magnesium oxide present (see Table 1).

Table 1

Type	Calcium Oxide Percent	Magnesium Oxide Percent
1. High Calcium or Fat Lime	**90** or more	–
2. Calcium	85 to 90	
3. Magnesium	–	10 to 25
4. Dolomite	–	25 or more

1.3.2 Hydrated Lime

This lime is a dry powder obtained by treating quicklime with sufficient quantity of water to satisfy its chemical affinity. Pressure hydrated dolomitic lime possesses high plasticity immediately after mixing with water. The better warehousing and handling properties of hydrated lime in comparison with Quicklime have made it more popular. Hydrated lime is the dominant lime product in all limes, which are used in construction. It is used both in masonry and as gauged plaster.

1.3.3 Slaking and Hardening of Lime

When water is added to Quicklime, it forms calcium hydroxide or lime hydrate. **A** large amount of heat is generated, and the mixture swells to about three times its original volume. The hardening of lime paste or mortar is caused by the absorption of carbon dioxide from the air which, in the presence of excess water, unites with calcium hydroxide to form calcium carbonate. Quicklime is slaked to form lime paste or putty, in which condition it is used in the work. It is slaked by placing water in a mortar box and then adding the lime to the water. The quantity of water always being sufficient to cover the lime. If steaming occurs, water should be adcled immediately in sufficient quantity to stop steaming and the mixture should be thoroughly stirred. The linie slaked in a drum with excess of water standing above lime, is made to stand for a couple of days. In this process, the cream of lime, which settles on the top of lime is called lime putty.

Properties

Quicklime putty contributes high plasticity and workability to mortar. Addition of portland cement decreases the time of hardening of the mortar and imparts strength to it.

The high calcium or fat limes are generally more plastic than dolomite Quicklimes, but both impart high plasticity to mortar. When clay is added to limestones in proportions varying from 10 to 30 percent, to produce lime, such limes are called hydraulic limes. Such limes start sefting and hardening on combining with water or under water, hence they are called hydraulic limes. Depending upon the clay content, hydraulic limes can be categorized as Feebly hydraulic, Moderately hydraulic or Semi-hydraulic and eminently hydraulic.

Fields of Application

Lime putty is mixed with sand and cement immediately before use, either by hand or in a mixer, to produce cement lime niortars. The properties of cement lime mortar depend upon the type of application, though generally for masonry niortars it is one part by volume (p.b.v) cement, 2 p.b.v lime putty ancl not more than 9 p.b.v of sand. However, you must follow tlie specifications given in the contract or in the relevant Indian Standard.

- The major portion of quicklime is used to form masonry mortar.
- It is also mixed with gypsum for use as finishing coat of plaster.

However, these days hydrated lime, which is more convenient to use, is more popular.

1.3.4 Classification and Uses : IS:712-1973

Building limes are classified as follows :

Class A - Eminently hydraulic lime used for structural purposes

Class B - Semi-hydraulic limes used for structural purposes

Class C - Fat lime used for finishing coat in plastering, white washing etc., and with addition of pozzolanic material, for masonry mortar

Class D - Magnesium lime used for finishing coat in plastering, white washing etc.

Class E - Kankar lime used for masonry mortars

Some of tlie other I.S. cocles on building limes are listed below for your reference :

- 1625 - 1980 Code of practice for preparation of lime mortar for use in buildings
- 2541 - 1965 Code of practice for use of lime concrete in buildings

You will be able to find a list of other related codes on the last page of IS-712-1973 for your reference.

1.4 GYPSUM PLASTER

Gypsum building plasters are very popular in countries like U.S.A., U.S.S.R., U.K., Canada and Australia for general building operations and for the manufacture of pre-formed gypsum building products. The various sources of gypsum in India have the potential for manufacturing of building materials, gypsum plasters, blocks and tiles. The commercial name GYPBOARD is one of tlie most popular gypsum product. The basic raw material for pure gypsum which when pure consists of hydrous crystalline Calcium Sulphate. Gypsum owes its value as a cementing material to its ability, after partial dehydration by means of heat, to recombine with water to form the original compound. The freshly mixed material may be molded or sliapecl into convenient forms for building purposes. The hardened material is quite firm and strong ancl good fire resisting material.

1.4.1 Gypsum Plaster

Gypsum Plaster can be classified as follows:

a) Plaster of Paris

b) Retarded semi hydrate gypsum plaster

Type I - Under Coat

i) Browning plaster

ii) Metal lathing plaster

Type II - Final Coat Plaster

i) Finish plaster

ii) Board finish plaster

c) Anhydrous gypsum plasters are for finishing only.

d) Keene's plaster is for finishing only.

Browning plaster or brown coat or second coat receives its name from the color resulting from a higher sand content. It is a leveling coat and is finished to a true surface to receive the thin finish coat. Keene's plaster is of anhydrous type. It is characterized by being more easily brought to a smooth and clean finish associated with gradual set.

1.4.2 Pre-mixed Light weight Plaster

It consists of suitable light weight aggregate and retarded semi-hydrate gypsum plasters as per IS:2547 (part 1) 1976. Their classification is :

Type A - Undercoat Plasters

a) Browning plaster

b) Metal lathing plaster

c) Bonding plaster

Type B - Final Coat Plaster - Finish Plaster

Thus we see that gypsum is mainly used in gypsum plaster, in under coat and finish coat in buildings. It is also used as prefabricated gypsum boards for insulation and decoration, We now shift our attention to the cementing material which is most widely used in the world in construction engineering, i.e. Portland cement.

SAQ 1 :

1. What is the classification of cementing materials ?

2. What are calcareous materials ?

3. "Hydrated lime is a dry powder obtained by treating quicklime with sufficient water to satisfy its chemical affinity". True / False ?
4. "Calcium Sulphate is the basic raw material for gypsum". True / False ?

1.5 CEMENTS

In India Portland cement was first manufactured in 1904 near Madras by the South India industrial Ltd. But this venture was not successful. Indian Cement Co., by 1914 was able to manufacture about 1000 tonnes of Portland cement. By 1918 three factories were established. During the First Five year plan (1951-56) cement production in India rose from 2.69 million tonnes to 4.60 million tonnes. During 1977, there were 56 cement factories in India producing a total of 19 million tonnes of cement. This increased to 20.77 million tonnes in 1981. However the decade ending 1990 saw **a** big boost in cement production, with figures reaching 44.88 million tonnes. This is expected to touch 80 million tonnes by 1994-95 and cross 100 million tonnes by the end of the century.

1.5.1 Rudiments of Cement

The name Portland cement has originally come from the resemblancc of the colour and quality of set cement to a limestone which is quarried in a place called Portland in England.

The raw materials for manufacturing of Portland cement are :

i) Calcareous material - limestone or chalk
ii) Argillaceous material - Shale or clay

The process of manufacture of cement consists of -

a) Grinding of raw materials
b) Mixing them intiinatcly in certain proportions, depending on their purity and composition
c) Burning them in a kiln at temperatures of 1330°C to 1500°C, at which the material sinters and partially fuses to form modular shaped clinkers
d) Cooling of clinker and grinding it to fine powder with addition of **2** to **3%** of gypsum.

You may note that there arc two processes of manufacturing of cement

a) Wetprocess
b) Dry process

They are so called depending upon whether mixing and grinding of raw materials is done in wet or dry conditions. In India most of thc cement factories use the wet process, though factories employing dry process have also been commissioned.

Chemical Composition

The raw materials used for the manufacture of cement consist predominantly of lime, silica, alumina and iron oxide. These oxides interact with each other during the process of burning in the kiln to form more complex compounds. Approximate oxide composition of ordinary Portland are given in Table 2.

Table 2

OXIDE	PERCENT CONTENT
CaO	60 - 67
SiO_2	17 - 25
Al_2O_3	3 - 8
Fe_2O_3	0.5 - 6.0
MgO	0.1 - 4.0
Alkalies (K_2O, Na_2O)	0.4 - 1.3
SO_3	1.0 - 3.0

The complex compounds which are formed were largely identified on the basis of R.H. Bogue's work and are called Bogue's compounds. These are given in Table 3.

Table 3

Name Of The Compound	Formula	Abbreviated Formula	Typical Compound Composition Percent
Tricalcium Silicate	3 CaO SiO_2	C3S	54.1
Dicalcium Silicate	2 CaO SiO_2	C2S	16.6
Tricalcium Aluminate	3 CaO Al_2O_3	C3A	10.8
Tetracalcium Aluminoferrite	4 CaO Al_2O_3 Fe_2O_3	C4AF	9.1

You can appreciate from this table that C3S and C2S are the most important compounds, which constitute 70 to 80 percent of cement and are responsible for the strength.

Hydration of Cement

The hydration of cement on mixing with water can be visualized by you in two ways.

a) Through Solution mechanism visualizes that cement compounds dissolve to produce a supersaturated solution from which different hydrated products get precipitated.

b) In the second mechanism, the cement compounds in solid state convert into hydrated products. This hydration starts from the surface and with time proceeds to the interior.

Heat of Hydration

You should also remember that reaction of cement with water is exothermic, resulting in liberation of considerable quantity of heat. This fact is of great importance for you while constructing dams and other mass concreting work. It has been observed that the difference in temperature between interior of mass concrete and that at time of placing of concrete could be as high as 50°C and it persists for a long time.

Hydration Products

You must carefully observe and make a mental note of following points.

a) When the reaction of C3S and C2S takes place with water, calcium silicate hydrate and, calcium hydroxide are formed. Calcium hydroxide is not a desirable product in the concrete. It is soluble in water and gets leached out making the concrete porous.

b) C3S readily reacts with water, produces more heat of hydration and is responsible for early strength of concrete.

c) C2S hydrates slowly, produces less heat of hydration and is responsible for the later strength of concrete. The calcium silicate hydrate formed is dense and in general hydration products of C2S are considered better than those of C3S.

d) The reaction of pure C3A with water is very fast and may lead to flash set. Gypsum is added (as mentioned earlier under 1.5.1 (d)) at the time of grinding to prevent this flash set. The hydrated aluminates do not contribute any thing to the strength of paste, On the other hand their presence is harmful to the durability of cement particularly when the concrete is likely to be attacked by sulphates.

e) The hydrated product of C4AF, does not contribute anything to strength, though they are more resistant to sulphate attacks.

Figure 1.1 shows the development of strength of pure compounds of cement with time. You can observe that C3S is responsible for early strength of cement as stated in (b) above.

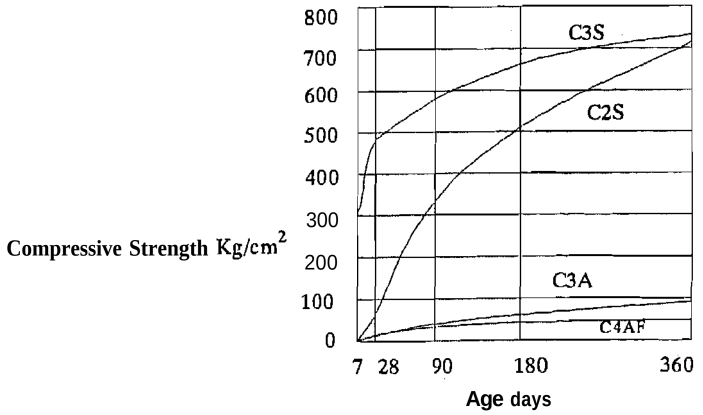

Figure 1.1 : Development of Strength of Pure Compounds

1.5.2 Types of Cements

Continuous efforts have been made over the years to produce different types of cement, suitable for different situations and applications. This has been done by changing oxides content, composition and fineness of grinding. However, this was not sufficient to meet all requirements and therefore recourses were taken to add one or more new additives to the clinker at the time of grinding or by adopting entirely new raw materials in the manufacture of cement. This has made it possible to produce cements to meet specific needs of the construction industry. The prominent lypes of cements are listed below

a)	Ordinary Portland Cement	b)	Rapid hardening Cement
c)	Extra rapid hardening Cement	d)	Sulphate resisting Cement
e)	Blast furnace slag Cement	f)	Quick setting Cement
g)	Super sulphate Cement	h)	Low heat Cement
i)	Portland Pozzolana Cement	j)	Air entraining Cement
k)	Hydrophobic Cement	l)	Masonry Cement
m)	Expansive Cement	n)	Oil well Cement
o)	High strength Cement	p)	Rediset Cement
q)	High Alumina Cement (not used now except in refractories)		

These cements i.e. those at serial numbers (a) to *(f)*, (i), (p) and (q), their properties and uses will be discussed one by one for your benefit. Other cements will be discussed in Unit 1 under Concrete Technology.

1.5.3 . Ordinary Portland Cement (O.P.C)

This is the most commonly used cement and is popularly known and referred as O.P.C. The discussion under 1.5.1 pertains to this cement and, as already stated, primarily consists of C3S, C2S, C3A and C4AF. This cement can be used in all situations except in special cases where special properties are required. The detailed specifications for this cement are given in IS:269-1989, and are listed in Unit 1 of Concrete Technology. The consumption of this cement is 80 to 90 percent of the total production of cement. Its seven day strength is 220 kg/cm^2.

1.5.4 Rapid Hardening Cement (R.H.C.)

This cement is similar to O.P.C., but it develops strength rapidly. Its strength at three days is the same as that of O.P.C. at seven days. The rapid rate of development of strength is attributed to the higher fineness of grinding (specific surface not less than 3,250 sq. cm per gram) and higher C3S and lower C2S content. These two factors also cause quicker hydration and hence greater heat of hydration during the initial stages. Therefore, you should not use this cement in mass cnncrete construction,

Uses

You could use Rapid hardening cement in the following situations :

a) In prefabricated concrete work

b) Where formwork is to be removed early for reuse elsewhere

c) Rigid pavement repair works

d) In cold weather concreting, where the rapid rate of development of strength reduces the vulnerability of concrete to frost damage.

1.5.5 Extra Rapid Hardening Cement

You could appreciate from the name that this cement would harden faster than the rapid hardening cement. This is achieved by inter-grinding calcium chloride upto 2 percent by weight with rapid hardening cement. This accelerates the selling and hardening process. A large quantity of heat is evolved within a short period after placing. It is therefore necessary that concrete made with this cement is transported, placed in position, compacted and finished within about 20 minutes.

Uses

The extra rapid hardening cement is considered very suitable for cold weather concreting, because of accelerated setting, hardening and early heat of hydration.

1.5.6 Sulphate Resisting Cement

Your attention is now again drawn to para 1.5.1 where under **Hydration Products** it was pointed out that during hydration, Calcium hydroxide is formed, together with hydrated aluminates. Now, if this concrete is in an environment where sulphates in solution are present, then these react with calcium hydroxide to form calcium sulphate and with hydrate of calcium aluminate to form calcium sulphoaluminate. The sulphates even attack hydrated silicates. The products formed by these reactions within the hydrated cement paste, result in expansion and disruption of concrete. This phenomenon is known as **Sulphate Attack.** This attack is greatly accelerated if it is accompanied by alternate wetting and drying which is quite common in marine structures in the zone of tidal variations. Since the reactions of sulphates are prominently with hydrates of calcium aluminate, therefore the sulphate attack is countered by use of cement with low C3A (less than 5%) and comparatively low C4AF content. Such a cement is known as **Suiphate resisting Cement.**

Uses

a) It is now mandatory to use Sulphate resisting Cement in all marine structures. It has been used in the slipway in the shipyard at Vishakapatnam

b) You could use it in concreting in foundations and basements where the soil is infested with sulphates

c) In concrete used for casting of pipes which are likely to be buried in marshy regions or sulphate bearing soils, and

d) In concreting work for construction of sewage treatment plants.

1.5.7 Blast Furnace Slag Cement

You are aware of the fact that in blast furnaces, a waste product called blast furnace slag is produced in large quantities. The manufacture of blast furnace slag cement has been developed primarily to utilize this blast furnace slag. Portland blast furnace slag cement is manufactured either by initially inter- grinding a mixture of Portland cement clinker, granulated blast furnace slag with an addition of gypsum or calcium sulphate or by an intimate and uniform blending of Portland cement and finely ground granulated blast furnace slag. The slag constituent is to be between 25 to 65 percent of the cement. Portland blast furnace slag is similar to O.P.C. in respect of fineness, setting time, soundness and strength. However, the rate of hardening is somewhat slower during the first 28 days, compared to O.P.C., but at 12 months the strength becomes close to or even exceeds that of O.P.C. The heat of hydration of this cement is lower than that of O.P.C., hence its use in cold weather can lead to frost damage.

Uses

a) Due to the of low heat of hydration, and relatively better resistance to soils and water containing excessive amounts of sulphates or alkali metals, alumina and iron, as well as, to acidic waters, you could use Portland blast furnace slag cement for marine works.

b) In mass concrete structures, because of lower heat of hydration than O.P.C.

1.5.8 Quick Setting Cement

You may recall that in para 1.5.1 (d), we had stated that gypsum is added at the time of grinding to prevent flash set of cement. In quick setting cement, the early setting is brought about by reducing this gypsum content. This cement, is therefore, required to be mixed, placed and compacted quickly.

Uses

a) Quick setting ceinent is used mostly in underwater construction, where pumping of concrete is involved, resulting in time saving and economy.

b) This cement may also be used to advantage in some typical grouting operations.

1.5.9 Portland Pozzolana Cement

Let us first examine what is a Pozzolana. A Pozzolana is essentially a siliceous material which, while in itself possessing no cementitious properties will, in finely divided form and in the presence of water, react with calcium hydroxide at ordinary temperature to form compounds .possessing cementitious properties. The Pozzolanic materials used in the manufacture of Portland pozzolana cement may include such natural materials as

a) Diatomaceous earth
b) Opaline Cherts and Shales
c) Tuffs
d) Volcanic ashes and pumicites

In addition materials processed by calcination of or fly-ash etc., are also used. Portland pozzolona cement is produced by grinding together portland cement clinker and Pozzolana with addition of gypsum. The pozzolona contenl shall not be less than 10 percent and not more than 25 percent by weight of portland pozzolona cement. The specific surface of pozzolanic cement shall not be less than 3000 cm^2/gm. Tlte compressive strength is specified to be not less than 220 kg/cm^2 at 7days and not less than 310 kg/cm^2 at 28 days. In India there is apprehension in the minds of the user to use this cement in constructional work. But then this fear is not justified as it is not inferior to O.P.C in anyway except for rate of development of strength upto 14 days. It should also be cured under moist conditions for a sufficient period.

Uses

a) Portland pozzolona ceinent can generally be used where ordinary portland cement is usable.

b) Since it reduces the leaching of calcium hydroxide, therefore it is particularly useful in marine and hydraulic structures.

SAQ 2 :

Revise your study of cements and different types of cements through following questions and check answers with the preceding text. You could write your answers in the space given below :

1) What kind of cement would you choose for construction in a sulphate infested soil and why ?

2) What is the role of pozzolanic materials in cement ?

3) In cold weather concreting, which kind of cement would be most suitable out of different types of cements studied by you so far. Support your answer with reasons.

1.5.10 Rediset Cement

Keeping in view the urgent requirements of pre-cast concrete industry and in situations like rapid repairs of concrete pavements, slip forming etc. that is, situations where time and strength relationship is important, a new cement called REDISET was developed by Associated Cement Company of India. Earlier, USA had developed a cement which could yield high strength in a matter of hours, without showing any regression (as happens in case of High Alumina cement, which is now discarded and therefore not included in this unit). Its name is REGSET.

The salient properties are :

(i) This cement allows a handling time of just about 8 to 10 minutes,

(ii) The strength achieved with REDISET in 3 to 6 hrs can be achieved with normal cement only after 7 days,

(iii) REDISET releases a lot of heat which is advantageous for winter concreting but detrimental for mass concrete,

(iv) Rate of shrinkage is fast but total shrinkage is similar to that of O.P.C., and

(v) Sulphate resistance is poor.

Uses

You could use **REDISET** advantageously for

a) Patch repairs and emergency repairs,

b) Quick release of forms in precast concrete product manufacturing,

c) Pelletisation of iron redust,

d) Slip formed concrete construction, and

e) Construction of marine structures between tides.

1.6 CLASSIFICATION OF O.P.C.

Ordinary Portland cement is recently categorised into the following three grades on the basis of their 28 days compressive strength ;

(i) **33** grade O.P.C.

(ii) **43** grade O.P.C.

(iii) **53** grade O.P.C.

33 grade cement means that the compressive strength at 28 days is not less than 33 N/mm^2. The various chemical, physical and mechanical properties of this grade of cement are covered in **IS:269** of 1989.

43 grade cement should have its compressive strength not less than **43** N/mm^2 at **28** days. The various properties of 43 grade cement are covered in **IS:8112** of **1976.**

53 grade cement is a high strength ordinary Portland Cement. It should have a compressive strength of **53** N/mm^2 at **28** days. **The various properties are** covered in **IS:12269** of **1987.**

Activity

Make a list of names of the manufacturers who produce lime and gypsum plaster and their products in the following format :

a) Serial No.

b) Type of Material

c) Brand Name

d) Manufacturer

e) Composition

f) Quantity in which it is sold

g) Cost per kg/bag

1.7 SUMMARY

You have seen that in construction engineering, the execution of different types of works always involves use of some cementing material or other. The cementing materials serve the basic purpose of binding different building materials in order to impart strength, rigidity and durability. However, the cementing materials invariably are to be manufactured from raw materials by different processes, the most common among them being the process of burning in a kiln. You also learnt that cementing materials owe their origin to Argillaceous and Calcareous materials, either singly or in combination. The prominent cementing materials are limes, gypsum and cements. The limes, broadly comprising of Quicklime and hydrated lime, are good cementing materials for mortars and plasters because of high plasticity and workability. The lime is also used with cement and sand for bedding mortar and plasters. Gypsum building plasters can be convenienlty molded into any shape for building purposes and are relatively light in weight. They are used in undercoat and finishing coat in plaster and provide smooth and clean finish. They can also be used with suitable light weight aggregate for plaslers. However the most common and most widely used cementing material in the world is cement. Cement is manufactured by combining both Calcareous and Argillaceous materials. The most popular cement is the ordinary portland cement which is the backbone of the construction industry. However, over the years, it has been modified to meet specific requirements in construction like rapid hardening cement, sulphate resisting cement and portland blast furnace slag cement. These cements find applications in works depending upon their heat of hydration, setting time, rate of development of strength and ultimate strength among other factors. Cement continues to be the most popular cementing material in the world.

1.8 KEY WORDS

Argillaceous Materials	:	Kaolin based clay materials
Calcareous Materials	:	Materials containing calcium carbonate like lime.
Carbonaceous Materials	:	Bituminous based materials like Tar and Asphalt
Hydration	:	The activity which occurs on mixing of cement with waler
C3S		Tri-Calcium Silicate
C2S		Di-Calcium Silicate
C3A		Tri-Calcium Aluminate
Pozzolana		A siliceous material

1.9 FURTHER READINGS

Bateman, John H., Materials **of Construction**, Pitman Publishing Corporation, London.

Neville, A.M. Properties of Concrete, Pitman Publishing, London.

Shetty, M.S., Concrete **Technology**, S. Chand & Conipaiiy Ltd., New Delhi.

IS : 2547 (Part 1) 1967, Specification for Gypsum Building Plasters,

IS : 712-1973, Specification For Building Limes.

1.10 ANSWERS TO SAQs

SAQ 1 :

1. A) Argillaceous cementing material

   B) Calcareous cementing materials

   C) Carbonaceous cementing materials

2. Calcareous materials are materials which contain calcite or calcium carbonate and are limes and limestones.

3. True.

4. True.

SAQ 2 :

1. The sulphates present in the soil prominently react with hydrates of calcium aluminate. Therefore the sulphate attack is countered by use of cement with low

C3A (less than 5%) and comparatively low C4AF Content. Such properties are available in Sulphate Resisting Cement, which is, therefore preferred, for use in sulphate infested soils.

2. The role of pozzolonic materials in cement is to react with calcium hydroxide to form compounds possessing cementetious properties, thus preventing leaching out of calcium hydroxide.

3. In cold weather concreting, cements like Rapid hardening and Extra Rapid hardening cements would be preferred. This is so because of their accelerated setting, hardening, early heat of hydration and rapid rate of development of strength, which reduces the vulnerability of concrete to frost damage.