12/23

unit - 5

Engineering materials.

Cement.

→ Portland cement is a finely grounded product which is obtained by the calcination process at 1500°c from calcarious and argillaceous raw materials

→ These are the inorganic cementing materials which are used as a binding material that joins bricks stones, tiles etc.

→ They have very good adhersive and cohersive property.

They are classified into 2 types:

i Hydrolic cementing materials:

→ These are the materials which undergo setting and hardening in presence of water

ex: portland cement

ii Non-Hydrolic cementing materials.

→ These are the materials which becomes hardend ~~over~~ even in presence of air.

ex: lime stone.

Raw materials of portland cement.

(i) calcareous materials.
ex: calcium oxide (CaO), lime stone chalk.

(ii) Argillaceous materials.
clay containing compounds like silica and alumina

(iii) Gypsum
Hydrated calcium sulphate
($CaSO_4 \cdot 2H_2O$)

Composition of portland cement.
A good sample of portland cement have the following composition.

calcium oxide	CaO	60% - 70%
Silica	SiO_2	20% - 24%
Alumina	Al_2O_3	5% - 7.5%
megnesia	MgO	2% - 3%
Ferric oxide	Fe_2O_3	1% - 2.5%
Sulpher trioxide	SO_3	1% - 1.5%
pottassium oxide	K_2O	1%
Sodium oxide	Na_2O	1%

functions of Raw materials.

1. calcium oxide
→ calcium oxide or lime is the principle constituent of cement.
→ excess lime may reduce the strength of cement due to expansion or disintegration.

2. Silica:
→ Silica imparts strength to cement

3. Alumina
Alumina is used for quick setting of cement.

4. Gypsum
Gypsum retards the setting action of cement.

$\frac{L-U}{L-H} \times 100$

5. Ferric oxide.
Iron oxide Fe_2O_3 imparts colour, strength and hardness to cement.

6. Sulpher trioxide.
SO_3 imparts sound to cement.

setting and hardening of cement

When cement is mixed with water it is made into a plastic mask called as cement paste which slowly loses it plasticity & becomes a rocky mass. This process involves setting and hardening which involves a hydration reaction resulting in the formation of gel & crystalization this process of solidification involves 2 steps

1, setting 2 hardening

→ setting is defined as stiffing the original plastic mass due to initial gel formation.

→ hardening is defined as the development of strength due to crystalization after setting hardening beings. the strength developed by the cement paste at any time depends on the amount of gel formed and the extinct of crystalization

reactions involved in setting and hardening

When cement is mixed with water it forms a cement paste which becomes rigid in a very short time. this is known as initial set or flash set this is due to C_3A which hydrates rapidly.

$$3CaO\,Al_2O_3 + 6H_2O \longrightarrow \underset{\text{(Crystals)}}{3CaO\,Al_2O_3\,6H_2O}$$

The crystals formed prevent the hydration reaction ~~the te~~ ∴ to prevent this flash set a little amount of gypsum is added to cement clinkers. Gypsum refards the dissolution of C_3A by forming insoluable complex of sulpho aluminate

$$3CaO\,Al_2O_3 + x\,H_2O + y\,CaSO_4 \cdot 2H_2O \downarrow$$

$$3CaO\,Al_2O_3 + y\,CaSO_4 \cdot \tfrac{1}{2}H_2O$$

C_4AF reacts with water forming Gel and crystals

$$4CaO\,Al_2O_3\,Fe_2O_3 + 7H_2O \downarrow$$

$$\underset{\text{crystal}}{3CaO\,Al_2O_3\,6H_2O} + \underset{\text{gel}}{CaO\,Fe_2O_3\,H_2O}$$

Thus the initial setting of cement paste is mainly due to hydration of C_3A and gel formation of C_4AF

Final setting of cement is due to the formation of "Tobermorite" gel" and crystals of "calcium hydroxide

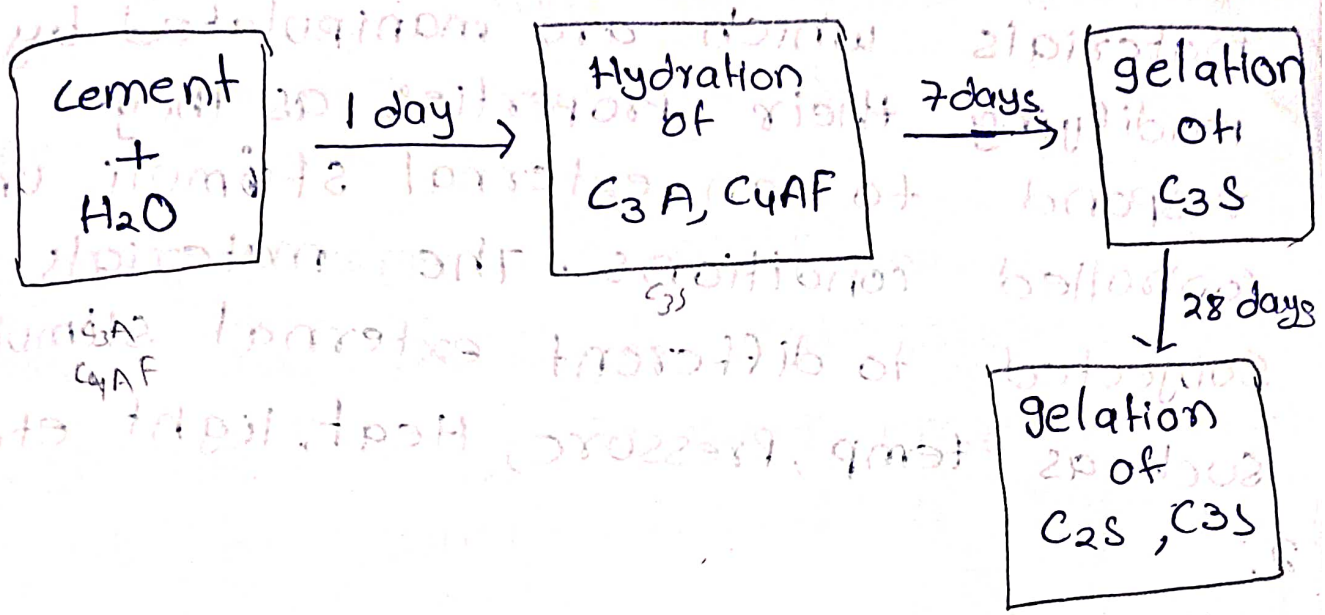
(T gel)

$$2[3CaOSiO_2] + 6H_2O \rightarrow 3CaOSiO_2 3H_2O + Ca(OH)_2$$

(crystal)

Steps → continue.

steps involved in setting and hardening of cement.



1) when cement is mixed with water the first hydration reaction is due to C_3A and C_4AF.

2) the next hydration reaction is due to C_3S which beings within 24 hrs and gets completed in 7 days.

3) The gelation of aluminates and silicates involues hydration reaction which takes place from 7 to 28 days.

for my reference

→ tri calcium silicate $3CaOSiO_2$ C_3S

→ di calcium silicate $2CaOSiO_2$ C_2S

→ tri calcium aluminate $3CaOAl_2O_3$ C_3A

→ tetra calcium alumino ferrite $4CaOAl_2O_3Fe_2O_3$ C_4AF

Smart materials

Smart materials are defined as the materials which are manipulated by modifying their properties as they respond to an external stimuli under controlled conditions. The materials are subjected to different external stimuli such as temp, Pressure, Heat, light etc.

2.

Types of smart materials.

→ Piezo electric materials

these are the smart materials which can convert electrical energy to mechanica energy and vise versa when they respon to an external stimuli like electric field and magnetic stress.

→ Shape memory materials

These are the smart materials whi changes their shape when exposed to hea

→ chromo active materials.

these are the materials which change their colour when subjected to hea light and Pressure.

→ thermo responsive materials

these are the smart materials which undergo change in their property like solubility when exposed to temperatur

→ photo active materials:

These materials include luminescnts, photo luminiscents, electro luminescents under an external stimuli like an electric field.

Applications of smart materials.

1) they are used in soluing engeneering problems with nigh efficiency.
2) they are used in the deuclop ment of innouattue parts and products.
3) they are used in auto mobiles, space systems, air crafts, navel, civil structures mechine tools and medical devices.
4) they are used in technical application which includes composite materials with control

shape and sound control, self repair, artificial organs.

Shape memory meterials.

1. These are the smart materials which changes their shape when subjected to an external stimoli of heat. they are capable of original shape recovary from a significant deformation under an external stimuli. this is called as shape memory effect. these materials possess a unique property of super elastility and super viscosity under certain controlled conditions.

ex; Poly lactic acid.

PLA is obtained from a natural and renewable source like corn, starch, and sugar cane. It is also obtained by the polymerisation of ~~poly~~ lactic acid.