

# BUILDING MATERIAL

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(EX IES)

## BUILDING MATERIALS

- Cement
- Lime
- Mortar
- Aggregate
- Admixture
- Water
- Concrete
- Bricks
- Rock and stones.
- Timber.

# CEMENT



→ It is an artificial building material which imparts binding property in construction, that is being developed around (1824-25) by "Joseph Aspidin".

→ Cement broadly consists of  
(i) Calcareous compounds  
Compounds having Ca, Mg.

(ii) Argillaceous compounds  
Compounds having Silica, Alumina and oxides.

Examples;

Calcareous compound

- (i) Limes-stones
- (ii) Cemented rock
- (iii) Chalk
- (iv) Marine shell
- (v) Marl
- (vi) Alkali waste

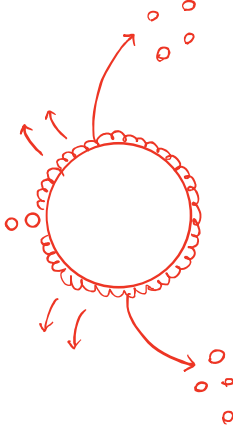
Argillaceous compound

- (i) Clay
- (ii) Shale
- (iii) Slate
- (iv) Ash.

## # Different constituents of OPC



- (i) Lime (CaO) [62-67%] : It imparts strength and soundness to the cement.
  - If it is in excess it makes the cement unsound, Cause it to expand and finally disintegrate.
  - If it is in deficiency, it reduces strength and causes The cement set quickly.



(ii) Silica (SiO<sub>2</sub>) [17-25%] : It also imparts strength to Cement.

- If it is in excess, strength of cement is increased but it also increases the setting time of cement.

(iii) Alumina (Al<sub>2</sub>O<sub>3</sub>) [3-8%] :

- It imparts quick setting property to the cement.
- It act as a flux and helps in reducing clinkering temperature.

[ Soundness : resistance again volume change ]

→ If it is in excess it weakens the cement.



(iv) Calcium Sulphate ( $\text{CaSO}_4$ ) [3-4%]

→ It is generally added in the form of gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ )

→ It helps in increasing the initial setting time of cement.

(v) Iron oxide ( $\text{Fe}_2\text{O}_3$ ) [3-4%]

→ It imparts strength, hardness and colour to cement.

(vi) Magnesia ( $\text{MgO}$ ) [1-3%]

→ It imparts strength, hardness and colour to cement but if it is in excess it makes the cement unsound.

(vii) Sulphur (S) [1-3%]

→ Sulphur in cement is also responsible for volume changes in it there by leads to its unsoundness.



(viii) Alkali ( $\text{Na}_2\text{O}, \text{K}_2\text{O}$ ) [0.2-1%]

Alkalis in cement leads to efflorescence, thereby

causes the development stains over the surface of structure in which it is used for construction.

→ Alkalis undergo expansive reactions with aggregate thereby leads to its disintegration.

→ Alkalis also accelerate the setting of cement paste.



When all the ingredients of cement as mentioned are intergrined and burnt, they fuse with each other and lead to the formation of complex chemical compound terms as "Bogues compound" which in actual are responsible for the properties of cement.

### # BOGUES COMPOUNDS

(i) Tricalcium Aluminate [ $3\text{CaO} \cdot \text{Al}_2\text{O}_3$ ] [ $\text{C}_3\text{A}$ ] (Celite)  
[4-14%]

→ It undergoes hydration within 24 hrs of addition of water into the cement, hence is responsible for flash setting of cement.

→ It produces max heat during its hydration process thereby results in loss of water added in cement for hydration, hence leads to development of cracks over the surface during setting process more over also

reduces the strength by inhibiting complete hydration.

→ It also reduces the resistance of cement against the attack of sulphur.

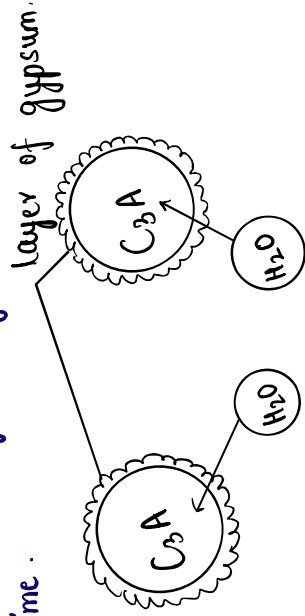
→ It is referred as harmful ingredient of cement.



**NOTE:**

flash setting means immediate or instant setting of the cement which takes place due to the presence of Alumina in cement.

In order to neutralise the instant setting of cement gypsum is added in it which form a layer over  $C_3A$  particle and avoids its interaction with water, but this is temporary and get removed easily, thereby has no effect over final setting time.



→ Water of crystallisation of gypsum vaporises either completely or partially during the manufacturing of cement, hence when water is added in cement, it first reacts with gypsum to fulfill its water deficiency, during which it hardens and gives the impression of "false setting" of the cement which can be identified by adding further more water into the cement.



(ii) Tetra Calcium Aluminoferrite [ $C_4AF$ ] [ $4CaO \cdot Al_2O_3 \cdot f.e_2O_3$ ] (felite) [10-18%]

→ It also undergoes hydration with 24 hr of addition of water into the cement, hence is responsible for flash setting of cement.

[Rate of hydration  $C_4AF > C_3A$ ]

→ It is observed to have worst cementing property amongst all the Bogue's compounds.

→ It also reduces the resistance of cement against the attack of sulphur.

→ It has no engineering use as it does not impart any property to the cement.



[Attack of sulphur on  $C_4AF$  is comparatively less than  $C_3A$  due to the presence of 'fe' in it]

(iii) Tri calcium silicate  $[3CaO \cdot SiO_2]$   $[C_3S]$  [Alite] [45-65%]

→ It undergoes hydration within a week or two after the addition of water in cement hence is responsible for development of early strength.

**NOTE:**

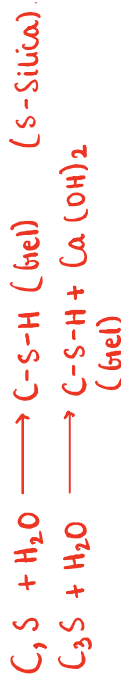
If in any construction early strength is required proportion of  $C_3S$  is increased as in:

- Pavement construction
- Pre fabricated structures.
- Cold weather concreting
- where formwork is to be reused for speedy construction.

→ It is observed to have best cementitious property amongst all bouges compound.

→ It also increases resistance of cement against frost action (freezing and thawing) (melting).

→ In real terms its effects on heat of hydration is more than  $C_3A$ .

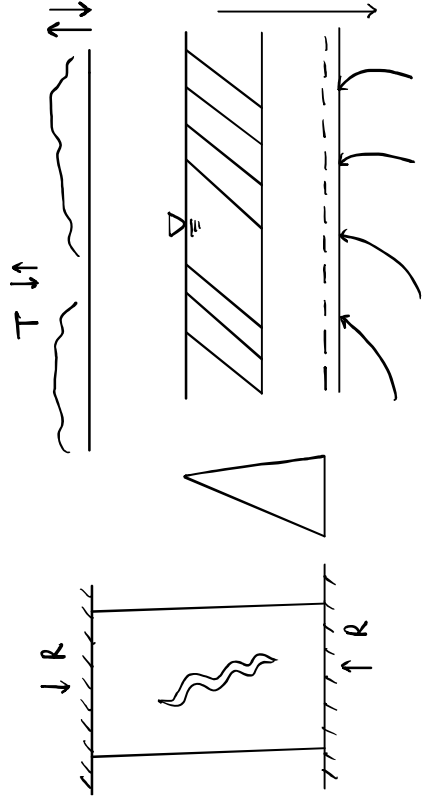


C-S-H Gel: Cementitious compound possessing binding property.

C-S-H Gel: CALCIUM SILICATE HYDRATE GEL also known as Thombohydrite gel.

(Also known as Tobermorite gel).

—  $Ca(OH)_2$  released during hydration reduces the tendency of corrosion in reinforcement.



(iv) Di calcium silicate  $(2CaO \cdot SiO_2)$   $(C_2S)$  (Belite) (15-35%)

→ It undergoes hydration within a year or so after the addition of water into the cement hence is responsible for development of ultimate or progressive strength in cement.