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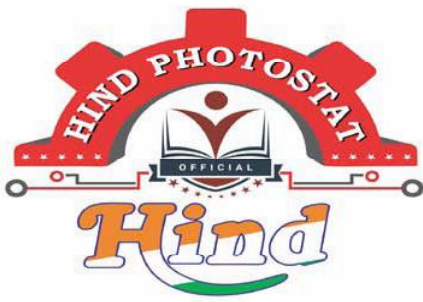
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**MADE EASY
CIVIL ENGINEERING
BUILDING MATERIAL
BY-AKHILESH MATHUR**

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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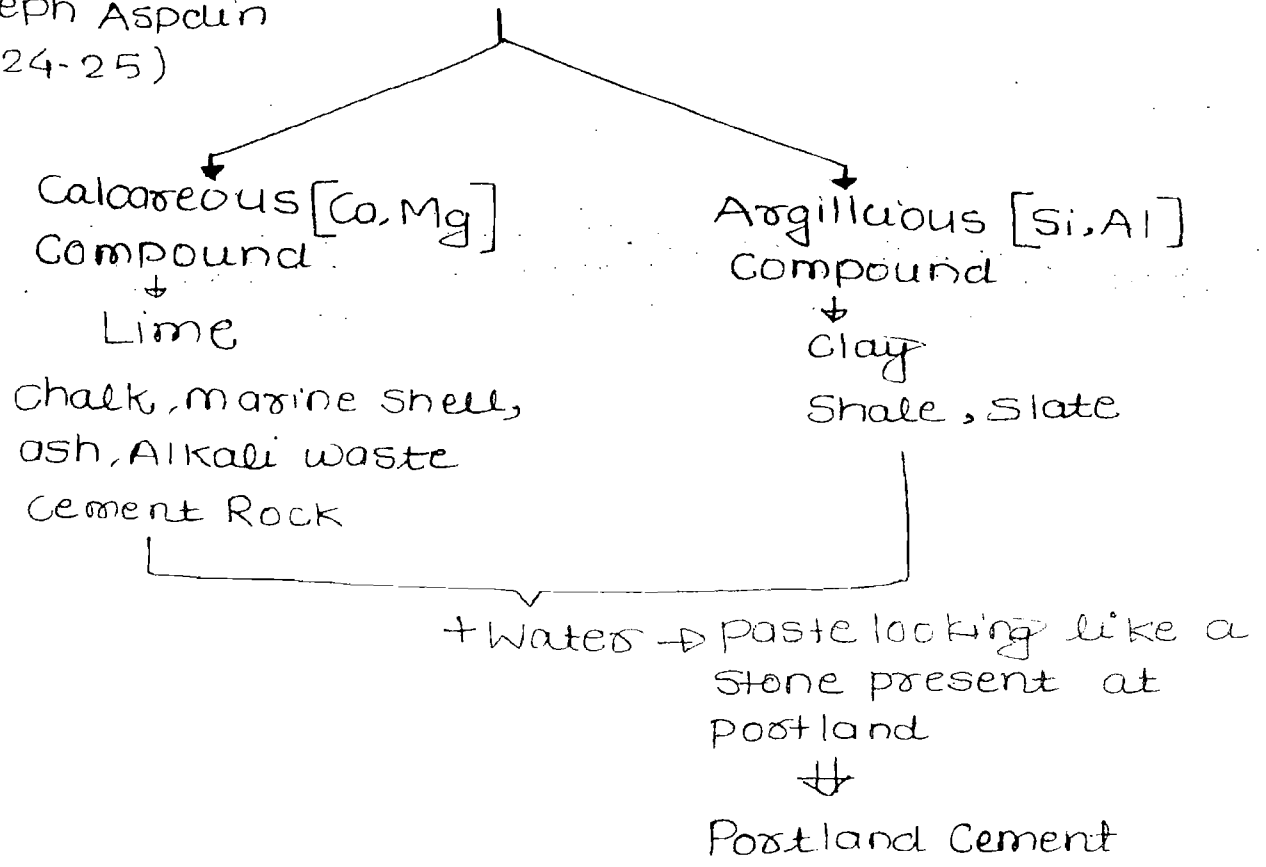
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BUILDING MATERIAL

Chapter-01 Cement

• Cement is artificial building material having binding properties { Cohesion & Adhesion Both }

Joseph Aspcin
(1824-25)

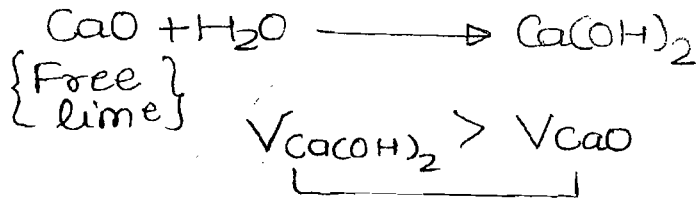


* Constituent of Cement

- Lime (CaO) → 62-67%
- Silica (SiO₂) → 17-25%
- Alumina (Al₂O₃) → 3-8%
- Gypsum (CaSO₄) → 3-4% - (Additive)
- Iron oxide (Fe₂O₃) → 3-4%
- MgO → > 5%
- Sulphur → > 2.5%
- Alkali → > 1%

1] Lime [CaO] 62-67%

- Impart Binding / Strength.
- Excess



Unsoundness \rightarrow Cracks \rightarrow Strength \downarrow

- Deficiency Reduce strength

2] Silica [SiO₂] 17-25%

- Impart Strength / Binding.
- Excess - Increase setting time $\left\{ \begin{array}{l} \text{Silica} \uparrow \\ \text{Clay} \uparrow \\ \text{plasticity} \uparrow \end{array} \right.$
- Deficiency - Reduce strength

3] Alumina 3-8%

- Impart Flash set / Quick set / Initial set
- Rate of Hydration \uparrow

Heat of hydration \uparrow

Water Evaporate

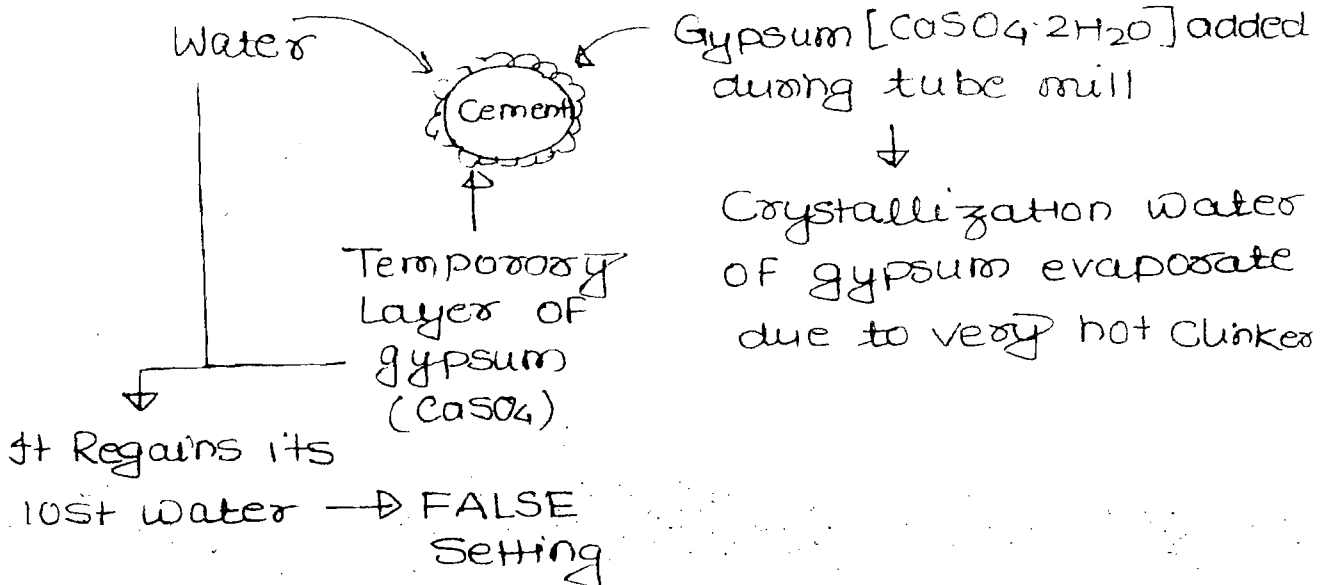
\downarrow
Plastic Shrinkage
Cracks

\downarrow
Strength Gaining
Reduces.

* It works like "FLUX" i.e. it reduces demand of temp to achieve particular degree of fusion hence makes manufacturing economical

4] Gypsum [$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$] 3-4%

- It increase initial setting time / Retard initial set process.



5] Iron Oxide 3-4%

- Impart Strength, Hardness & Reddish Brown Colour

6] Magnesium Oxide [MgO] > 5%

- Impart Strength, Hardness & yellow tinge colour
- Excess of MgO impart unsoundness

Note MgO & Fe_2O_3 helps lime & silica to fuse with each other properly during other burning hence impart strength but indirectly.

7] Sulphur (> 2.5%)

- Impart Unsoundness
- $\text{Ca, Al} + \text{S} \rightarrow$ Calcium Alumeno Sulphate (227% more volume)



⑧ Alkali (7-11%) $\text{Na}_2\text{O} + \text{K}_2\text{O}$

- Its imparts "Efflorescence" (White patches/spots)
- Excess of Alkali may impart Flash Set.
- Alkali enters into pores of Aggregate due to osmosis pressure & result in volume increment of Aggregate

↓
Unsoundness → cracks { Alkali aggregate Reaction }
"Cancer of concrete"

* Unsoundness of cement - Lime
MgO
Sulphur

All the above components of cement fuse with each other during the burning and results in formation of "Bouge's compound"

① C_3A { $3\text{CaO} \cdot \text{Al}_2\text{O}_3$, 4-14%, Tricalcium aluminate }

- Impart Flash Set / Quick Set / initial set.

↓
Rate of hydration ↑ { APPROX 80-90% hydrates with in 24 hours }

↓
Heat of hydration { 865 J/g
310 cal/g (90 days) }

↓
Water Evaporate

↓
Plastic shrinkage crack

↓
Strength ↓

- Resistance against Sulphur attack ↓↓↓
- Harmful Compound

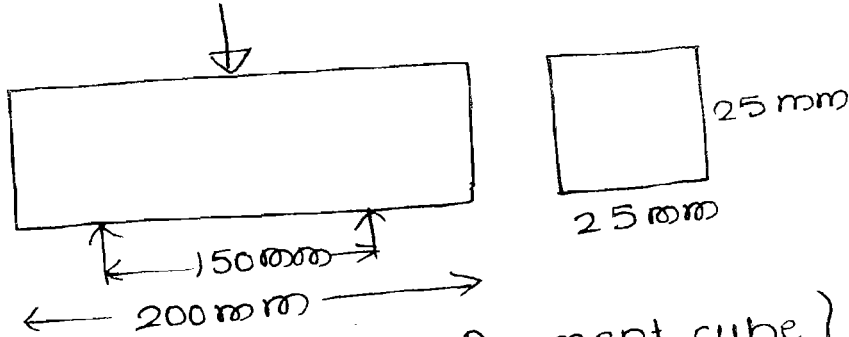
*Testing For Cement

1] Field Test For Cement

- i] Cement should be smooth & have uniform grey colour.
(Finness) (Blending)
- ii] Cement Particles should sink in water (SP gravity)
- iii] Thin paste of cement should feel sticky (Binding)
- iv] Thick paste of (faster) cement should not impart any sign of crack after immersing 24 hr in water [Unsoundness]
- v] There must not be any air lumps and it should feel cool in cement bag { Rehydration or air induced setting }

vi] Strength test

$\approx 340N \times 10$ bricks



{ in given loading condⁿ cement cube should not fail }

2] Lab Test For Cement

i] Specific Gravity Test

→ Le-chatelier Flask

$$G_{cs} = \frac{P_{cs}}{P_w} = \frac{M_{cs}}{V_{cs} P_w}$$