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IES MASTER

Civil Engineering

Toppers Handwritten Notes
Building Materials

- Theory
- Explanation
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BUILDING MATERIALS

Topic

(40 ± 5 marks)

- Cement ✓ (Definite ques)
- Lime
- Mortar
- Concrete ✓ (Definite ques)
- Timber ✓ (Definite ques)
- Bricks

1. Cement

Composition of Cement

- Cement is found to consist of 2 basic ingredients

(i) Calcareous Compound (Lime)

(ii) Argillaceous Compound (Clay)

All ingredients included are present in their oxide form

			(%)	Objective
Major	Lime	(CaO)	-	62-67
	Silica	(SiO ₂)	-	17-25
	Alumina	(Al ₂ O ₃)	-	3-8
	Calcium sulphate	(CaSO ₄)	-	3-4
	Iron oxide	(Fe ₂ O ₃)	-	3-4
	Magnesia	(MgO)	-	1-3
	Sulphur	(S)	-	1-3
	Alkalies	(K ₂ O, N ₂ O)	-	0.2-1

Functions of different ingredients of the cement

1. Lime

- It imparts strength & soundness to the cement. If it is in excess it makes the cement unsound, causes it to expand & disintegrate. If it is in deficiency, strength of the cement is reduced and it sets quickly.

2. Silica

It also imparts strength to the cement. If it is in excess, strength of the cement is increased along with the setting time.

3. Alumina

It imparts quick setting property to the cement. It acts as a flux ^(aid) & helps in lowering the clinkering temperature. If it is in excess it also weakens the cement.

4. Calcium sulphate

It is generally present in the form of gypsum. It helps in increasing the initial setting time of the cement.

5. Iron Oxide

It imparts colour, strength & hardness to the cement.

6. Magnesium Oxide → characteristic colour → Yellow

It also imparts colour & hardness to the cement.

If it is in excess it makes the cement unsound.

7. Sulphur

It also imparts unsoundness to the cement

8. Alkalies

It causes efflorescence and staining of the structure in which it is used for construction. ^{→ ability to react with water vapour}

MgO \neq 5%, K₂O \neq 2%.

Bogues Compounds

When water is added into the cement. It reacts with the ingredients chemically & leads to the formation of complex ~~so~~ chemical compounds which are not being formed simultaneously. These are referred as Bogues Compounds

(i) Tri Calcium Aluminate ($3CaO \cdot Al_2O_3$) (C₃A) (4-14%)
by wt.

It is formed within 24 hrs of the addition of water into the cement & is responsible for

Evolution of maximum heat of hydration
↓
during chemical rxn, heat is

(ii) Tetra Calcium Aluminoferrate ($4CaO \cdot Al_2O_3 \cdot Fe_2O_3$)
(C_4AF) (10-18%) by wt.

It is also formed within 24 hrs of addition of water into the cement & is responsible for high heat of hydration in the initial stages.

(iii) Tri Calcium silicate ($3CaO \cdot SiO_2$) (C_3S) (45-65%) by wt.

It is formed within a week or so after the addition of water into the cement and is responsible for early development of the strength in the cement.

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

It is formed within an year or so after the addition of water into the cement & is responsible for progressive strength of the cement.

Heat of Hydration associated with these Bauges

Compounds are as follows:-

Compound	Heat of Hydration (Cal/gm)	
	<u>3 days</u>	<u>90 days</u>
C_3A	210	310
C_4AF	70	100
C_3S	60	105

Heat of hydration of cement =

$$(H) = aA + bB + cC + dD$$

Heat of Hydration of
% of respective respective compounds
compounds.

Note:- Depending upon the Engg. construction, proportion of C_3S & C_2S can be altered to attain the desired property in the ~~constr~~ construction.

If strength is reqd. in initial stages, like in ^{cold weather concreting,} Pavement construction, Road repair work, Grouting, where formwork is to be reused, pre fabricated structures, proportion of C_3S is increased, and if strength is reqd. in later stages like in hydraulic structures, bridges etc. proportion of C_2S is increased.

- About 24% weight of water is required by C_3S for complete hydration.
- About 21% wt. of water is required by C_2S for complete hydration.
- In general 23% wt. of water is reqd. by the cement for complete hydration.
- Approx. 15% of the water is Embedded in the Gel pores of the cement which is not available