

CEMENT

- A cement is a binding material used in construction industry, that sets, hardens, and adheres to other materials to bind them together.
- Cement is the most widely used binding material in construction industry



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Uses of Cement

1. Used for the preparation of cement mortar, concrete
2. Cement mortar is used for binding of brick & stone masonry
3. Cement mortar is used to cover the masonry surface
4. Cement mortar is used for pointing of brick & stone masonry
5. Cement mortar is used for different type of floors & floor finishes
6. Decorative & Aesthetic works
7. Manufacturing of pipes & posts
8. Manufacturing of RCC roof slab, columns, raft foundations, water tanks, bridges, dams, pile foundations, railway sleepers etc.

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CEMENT

Chemical composition:

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)	0-3%
Sulphur (S)	1-3%
Alkalies	0-1%

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Effects of ingredients

➤ Lime 62-67%

- Makes cement sound and strong
- Excess lime causes expansion & disintegration
- Deficiency causes decrease in strength and early setting

➤ Silica 17-25%

- when mixed with water, Di calcium silicate and Tri calcium silicate are formed, which gives strength
- Excess silica increase the strength but prolongs setting time

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Effects of ingredients

➤Alumina 3-8%

- Impart quick setting property
- Lowers clinkering temperature during manufacture of cement
- Excess alumina weakens cement

➤Calcium sulphate 3-4%

- Added in the form of Gypsum
- Prolongs initial setting time

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Effects of ingredients

➤Iron oxide 3-4%

- Imparts colour, hardness and strength to cement

➤Magnesia 0-3%

- Imparts colour and hardness to cement
- Excess amount makes the cement unsound

➤Sulphur 1-3%

- Very small amount of sulphur makes cement sound
- In excess makes unsound

➤Alkalies 0-1%

- Present in excess causes efflorescence in cement

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Good qualities of cement

1. Provides **strength** to masonry
2. Stiffens **or hardens** early
3. Should have good **plasticity** when mixed with water
4. Easily **workable**
5. Good **moisture-resistance**
6. High resistance to atmospheric and chemical agencies
7. Initial setting time should not be less than **30 minutes** and final setting should be around **10 hrs**
8. Compressive strength should be high
9. Tensile strength should be high

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Field Tests for Cement

1. When a hand is introduced into a **bag of cement**, the cement should be cool to feel.
2. A small sample of cement when **rubbed between fingers** should **feel smooth**.
3. A handful of cement **thrown into a bucket of water** should gradually **sink**.
4. No lumps should be present in the cement. Presence of **lumps** indicate that the cement is already **set**.
5. Cement should have uniform **greenish grey colour**.

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Types of Cement

Ordinary Portland Cement

➤33 grade cement

- Compressive strength of cement mortar cube at the end of 28 days should be more than 33 N/mm²

➤43 grade cement

- Compressive strength of cement mortar cube at the end of 28 days should be more than 43 N/mm²

➤53 grade cement

- Compressive strength of cement mortar cube at the end of 28 days should be more than 53 N/mm²

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Types of Cement

➤Rapid hardening cement

- Develops **strength rapidly**

3 day strength is same as that of 7 day strength of OPC

- Due to higher fineness of grinding Due to **high C3S** and **low C2S**

- Used in pre fabricated construction, road repair work, places where form work has to be removed immediately, for cold weather concrete

➤Low heat Portland cement

- Heat evolution is much lesser as compared to that of OPC
- Used in massive construction like abutments, dams, retaining wall etc.

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Types of Cement

➤Portland Pozzolona cement

- Made by inter grinding Portland cement & pozzolona (10-30%)
- Pozzolona may be volcanic ash or fly ash
- Greater resistance to chemical attack
- Used for marine structures, hydraulic structures etc.

➤ Portland Slag cement

- Made by grinding Portland cement clinker with granulated furnace slag
- Reduces heat of hydration, permeability etc.
- Increases resistance to corrosion, chemical attack etc.
- Suitable in marine environment

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Types of Cement

➤Coloured cement

- Obtained by adding pigment with OPC
- Amount of pigment added varies from 5% to 10%
- ✓ Chromium oxide-Green
- ✓ Iron oxide-Brown, Black, Red, Yellow
- ✓ Carbon pigment-Black

- Used for decorative works

➤Hydrophobic cement/water repellent

- Cement clinker is ground with a water repelling film forming agent
 - Calcium oleates, pentachlorophenol, oleic acid or stearic acid
- Used where water tight conditions are predominant

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Types of Cement

➤ **Expansive cement**

- OPC shrinks during setting & drying
 - Expansive cement when mixed with water, forms a paste that tends to increase in volume
 - This expansion compensates for the shrinkage losses
- Used in machine foundation, concrete repair works

➤ **Acid resisting cement**

- It resist acid attack
- Quartz & sodium silicates are added to OPC
- Used for the construction of acid resisting cement floors in factories

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Types of Cement

➤ **Quick setting cement**

- It sets quickly
 - Setting starts within 5 minutes & hardens within an hour
 - % gypsum is reduced
- For under water construction

➤ **White cement**

- Free from colouring agents like oxides of iron, manganese & chromium

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• Sulphate resisting cement

OPC is easily attacked by sulphates and causes cracks

most severe in case of marine structures

C3A% is made less than 5

Marine structures

Sewage treatment structures

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- High alumina cement
- Air entraining cement
- Oil well cement
- Super sulphate cement
- Low heat Portland cement

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Tests for cement

Compressive Strength

- Cement mortar cubes are prepared and immersed in water for curing
- Samples are taken out and tested in CTM at the end of 3 days and 7 days
- 3 day strength - 11.5 N/mm²
- 7 day strength - 17.5 N/mm²

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Consistency

- to determine the % of water required to prepare cement paste
- Vicat apparatus
- Cement paste is filled in the mould of the apparatus
- Plunger is gently lowered on the paste
- Note the settlement of the plunger
- Penetration of plunger is 5mm-7mm from bottom, water added is correct, otherwise repeat with different % of water till desired penetration is obtained

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Vicat apparatus



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Setting time

- To detect deterioration of cement due to storage
- Vicat apparatus
- Cement paste is filled in the mould of the apparatus
- Note the time when water is added to the cement to prepare the paste
- **Square needle of 1mmx1mm** is quickly released to penetrate the cement paste
- Needle penetrates completely at first
- Repeat till the needle doesn't penetrate completely i.e. about 5mm from bottom
- Initial setting time = time from when water added to prepare the paste till the time when the needle stops penetrating completely
- 30 min

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Final setting time

- Cement paste is filled in the mould of the apparatus
- A needle with annular collar is gently released on top of the paste
- Time at which the needle makes an impression on the test block and the collar fails to do so is noted
- Difference between the above time and the time at which water is added to the cement gives the final setting time
- 10 hrs

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Soundness

- To determine the presence of uncombined lime
- *Le Chatelier* apparatus
- Brass mould of diameter 30mm and ht 30mm is placed on a glass plate and is filled by cement paste
- Cover with another glass plate
- A small wt is placed at top
- Immersed in water for 24 hrs @ 24-35°C

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Le Chatelier apparatus



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Soundness

- Distance between pts of indicator is noted
- Mould is again placed in water and heat is applied such that water boils in 30 min. continue boiling for 1-3 hr
- Mould is removed from water and is allowed to cool
- Distance between pts of indicator is noted
- The difference indicated expansion of cement
- < 10mm

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