

# Introduction to Concrete Technology

## Generalities about concrete

- Ageing/Porous material
- Voids contain 8-15% volume
- Versus time:
  - Strength Increases
  - Porosity Decreases
- High compressive strength
  - 20 to 45 MPa: Ordinary Concrete
  - 45 to 120MPa: High Performance concrete.
- Low Tensile strength (compressive strength/10)
- Density 2.3 Tons/m<sup>3</sup>

Portland Cement type GP	Content (% by weight)
C3S	50-60
C2S	15-25
C3A	12
C4AF	8
Gypsum	5

Cement + Water = Paste or grout

Paste + Sand = mortar or render

Mortar + coarse aggregate = concrete

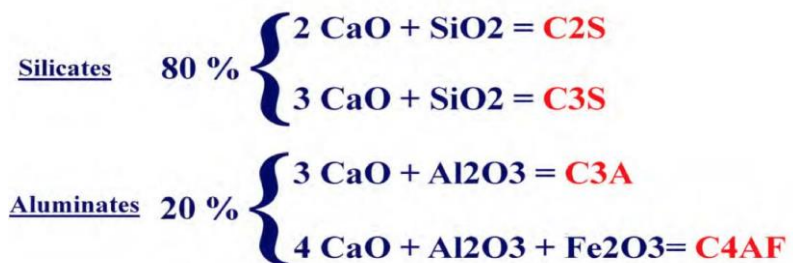
**25%-35% of volume is water and cement.**

## Manufacture of Portland Clinker & Cement

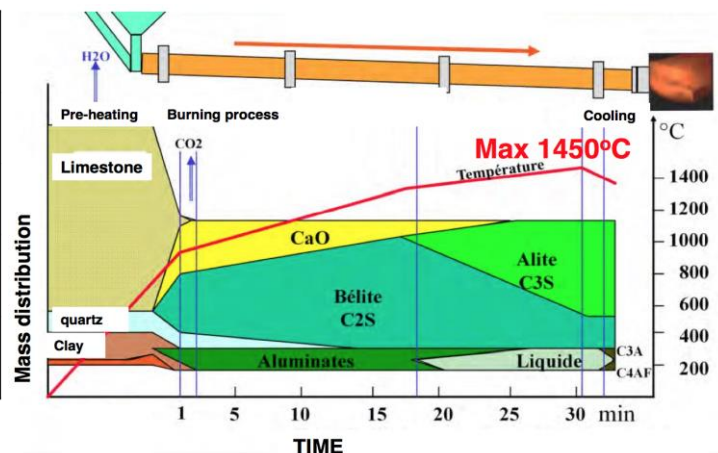
1. Clinker → Produced when limestone and clay burnt together
2. Cement → produced by Grinding clinker and small amount of gypsum

## Raw material for Clinker

LIME (CaO)	- Limestone/Chalk	- C	≈ 91%
SILICA (SiO <sub>2</sub> )	- Clay/Shale/Sand	- S	≈ 4%
ALUMINA (Al <sub>2</sub> O <sub>3</sub> )	- Clay/Shale/Bauxite	- A	≈ 4%
IRON OXIDE (Fe <sub>2</sub> O <sub>3</sub> )	- Clay/Shale/Ironstone	- F	≈ 1%



Compound	Oxide Composition	Abbreviation
Tricalcium Silicate	3CaO.SiO <sub>2</sub>	C <sub>3</sub> S (Alite)
Dicalcium silicate	2CaO.SiO <sub>2</sub>	C <sub>2</sub> S (Belite)
Tricalcium aluminate	3CaO.Al <sub>2</sub> O <sub>3</sub>	C <sub>3</sub> A (Aluminate)
Tetracalcium Aluminoferrite	4CaO.Al <sub>2</sub> O <sub>3</sub> .Fe <sub>2</sub> O <sub>3</sub>	C <sub>4</sub> AF (Ferrite)



- Add gypsum to prevent flash set.

## Portland Cement and Sustainability

- Limestone sampling: landscape deterioration/consumption of natural resources
- Transportation
- Decarbonation of Limestone: High CO<sub>2</sub> release into atmosphere

- Burning process up to 1450°C: require a huge quantity of energy releasing more CO<sub>2</sub> in the atmosphere (fossil fuels). 1 Tonne of Portland Cement = 1 Tonne of CO<sub>2</sub> into atmosphere.

### Green Cements

- SCM's (Supplementary cementitious materials) replace up to 7.5% of the clinker content in cement.
  - Limestone
  - Fly Ash
    - 1 to 100µm in diameter, 75% under 45µm
  - Ground Granulated Blast Furnace Slag
    - By product of iron production in blast furnace.
- Minor Additions of up to 5% are added such as kiln dust (inorganic)

### 7 standard Cements in Australia

<i>General Purpose Cement</i>	<i>Special Purpose Cement</i>
<ul style="list-style-type: none"> <li>• Type GP General Purpose Cement</li> <li>• Type GB Blended Cement</li> <li>• Type GL General Purpose Limestone Cement</li> </ul>	<ul style="list-style-type: none"> <li>• Type HE High Early Strength Cement</li> <li>• Type LH Low Heat Cement</li> <li>• Type SR Sulfate Resisting Cement</li> <li>• Type SL Shrinkage Limited Cement</li> </ul>

### Type GP Cement (General Purpose):

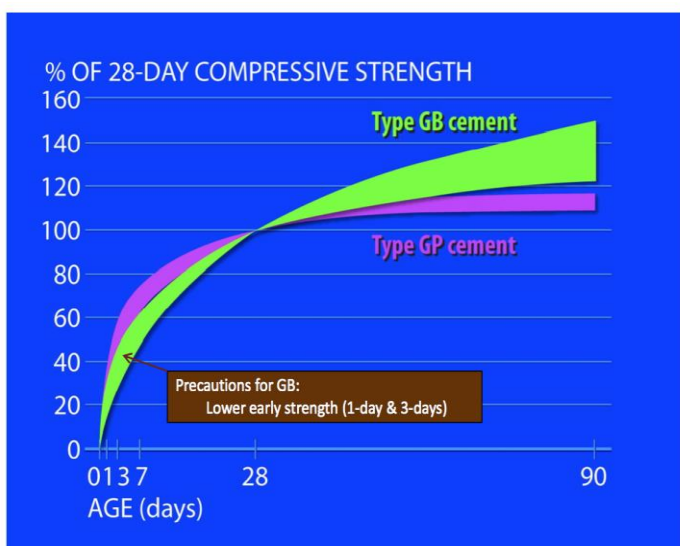
- Clinker
- Mineral additions (<7.5%)
- Minor Additional Constituents (<5%)
- Gypsum

### Type GL Cement (General Limestone):

- Type GP Cement + 8-20% Limestone (reduces carbon footprint)

### Type GB Cement

- Type GP Cement
- Fly Ash and/or Slag
- Amorphous Silica (<10%)
- Higher reduction of carbon footprint. Can improve concrete properties.



## **AS 3972 Requirements**

### *Specified Properties*

- Setting Time (min/max)
- Soundness
- Chloride content (max)
- SO<sub>3</sub> Content (max)
- Compressive Strength (min)
- Peak Temp (LH) (max)
- Expansion (SR) (max)
- Shrinkage (SL) (max)

### *Reportable Properties*

- Loss on ignition
- Fineness
- Nature of materials
- Major oxide composition
- Time of peak Temp Rise (LH)
- Equivalent alkalis