Concrete technology

Civil engineering / third semester

Lecturer: Dr. Wail Asim

Course Objective (Studying cement manufacturing and properties of cement and aggregates and study fresh and hardened concrete and concrete mix design)

Textbook: Concrete technology by dr hana abid yousif

References: Concrete technology by A.M.Neville

Course Assessment	1st	2nd	Lab reports	Quizzes	Final exam
	15 %	15 %	10 %	10 %	50 %

1	Introduction	Concrete definition and composition
2	cement manufacture	Cement raw materials, Methods of cement manufacturing
3	Chem. composition-hydration	Basic chemistry of cement
4	Hydration of cement	
5	Cement prop. And tests	Setting time, soundness, fineness
6	Structure of hydrated cement	hydrated cement paste
7	Types of Cement	
8	Aggregate sieve analysis	
9	Mechanical Properties of Aggregate	Strength, hardness, bond, toughness, Absorption, density, Sieve analysis
10	Fresh concrete tests	Workability
11	Admixtures	Superplasticizer, air entraining, fly ash
12	Strength of concrete	Factors affecting strength

Concrete technology

Introduction:

These days, there are two commonly used structural materials: concrete and steel.

A structural material is a material that carries not only its self-weight, but also the load passing from other members. On the other hand, building materials are any material used in construction.

But it is concrete, and not cement, that is the building material. The concrete has to be satisfactory in its hardened state, and also in its fresh state while being transported from the mixer and placed in the formwork.

Concrete: is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens over time.

Concrete is a manmade building material that looks like stone. The word "concrete" is derived from the Latin *concretus*, meaning "to grow together."

Concrete is the most widely used construction material because it is easy to place and mold, low cost, its ingredients is widely available and it has good compressive strength and durability.

concrete is used for many different structures, such as dams, pavements, building frames, or bridges, much more than any other construction material.

Concrete is a mixture of cement, water, aggregate (fine and coarse) and sometimes admixtures.

Advantages of concrete

1- Economical: The cost of production of concrete is low compared with other engineered construction materials.

2- High compressive strength

3- Ability to be cast: Fresh concrete is flowable like a liquid can be poured into various formworks to form different desired shapes and sizes

4- Excellent resistance to water: Unlike wood (timber) and steel

5- High-temperature resistance

6- Ability to work with reinforcing steel : Concrete has a similar value to steel for the coefficient of thermal

Cement

Cement is used to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete.

The cement that is used in concrete has the property of setting and hardening under water by a chemical reaction, therefore, called hydraulic cement.

In 1824, Joseph Aspdin invented the modern cement which is called "Portland cement" due to the similarity of the color and quality of the hardened cement to Portland stone in Portland Island in England.

Manufacture of Portland cement

Portland cement is made by blending an appropriate mixture of limestone and clay together, and by heating them to 1450◦C in a rotary kiln.

The primary reactions during the calcination process are listed as below:

(a) Clay is mainly providing silicates (SiO_2) together with small amount of Al_2O_3 and Fe_2O_3. The decomposition of clay happens at a temperature around 600◦C:

$$\text{Clay} \rightarrow SiO_2 + Al_2O_3 + Fe_2O_3 + H_2O$$

(b) Limestone ($CaCO_3$) is mainly providing calcium (CaO) and is decomposed at 1000◦C:

$$CaCO_3 \rightarrow CaO + CO_2$$

(c) The final product from the rotary oven is called clinker. grind the clinker into small sizes (<75 μm) with addition of 3–5% gypsum. Gypsum added is to control fast setting caused by $3CaO.\ Al_2O_3$.

There are two methods of cement manufacturing:

1- Wet process
2- Dry process

Wet process – the percentage of the moisture in the raw Minor compounds materials is high.

Dry process used in different cases, such as,

- Raw materials are so hard (solid) that they do not disintegrate.
- Cold countries, because the water might freeze in the mixture.

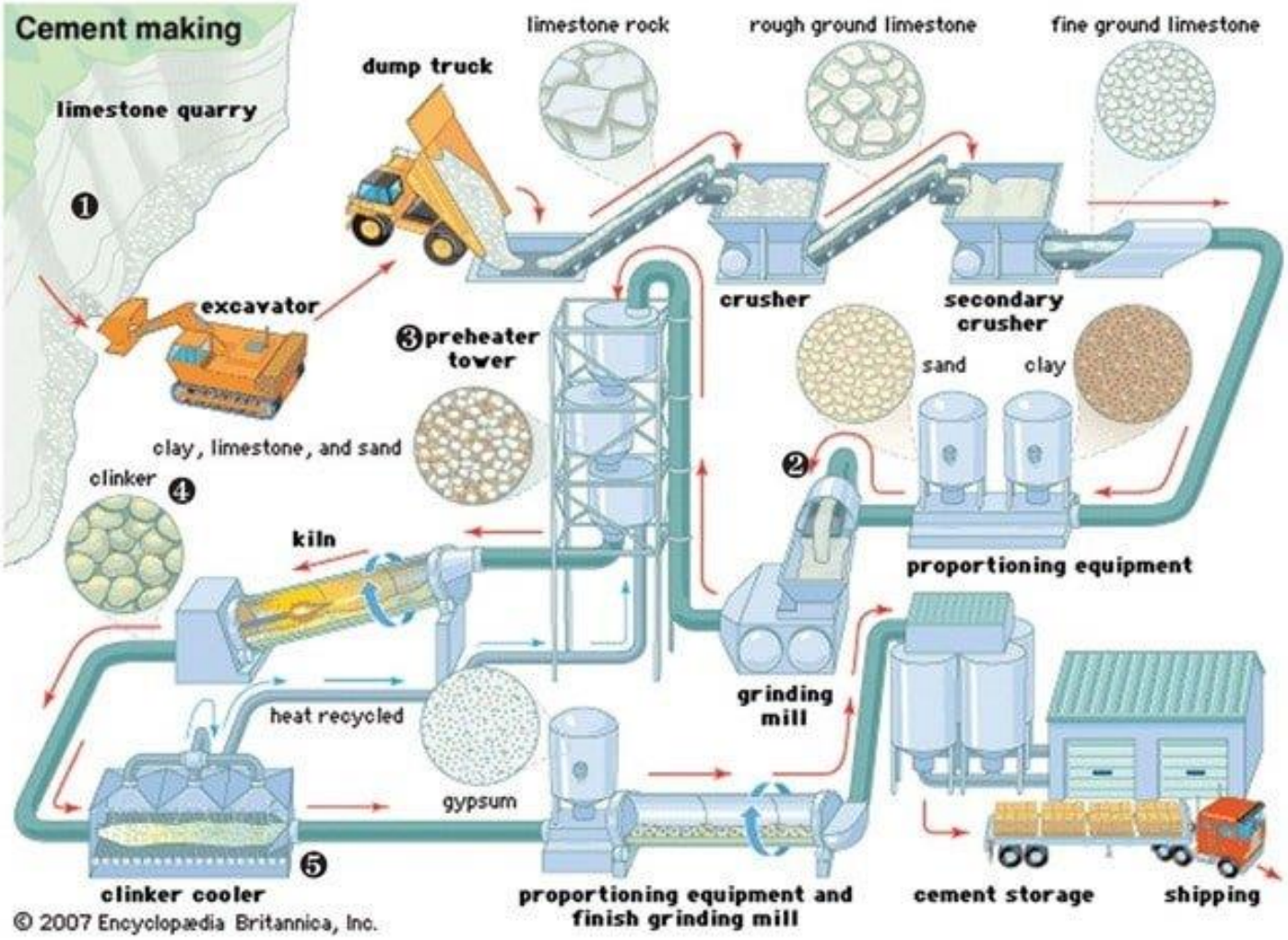
Comparison between wet and dry process

Wet process	
Moisture content of the raw materials are 35-50%	Moisture content of the raw materials is 12%
Size of the oven needed to manufacture the cement is bigger	Size of the oven needed to manufacture the cement is smaller
The amount of heat required is higher so the required fuel amount is higher.	The amount of heat required is lower so the required fuel amount is lower.
Less economically	more economically
better homogeneous material can be obtained	difficult to obtain homogeneous material
do not need much maintenance	need more maintenance

The majority of cement particle sizes are from 2 to 50 μm

Cement

$$\left.\begin{array}{l}\text{Limestone}\\ \text{Clay}\\ \text{Iron ore, bauxite}\end{array}\right\} \xrightarrow[\text{High temperature}]{(1450^{\circ}\text{C})} \left\{\begin{array}{l}3\text{CaO}\cdot\text{SiO}_2\\ 2\text{CaO}\cdot\text{SiO}_2\\ 3\text{CaO}\cdot\text{Al}_2\text{O}_3\\ 4\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot\text{Fe}_2\text{O}_3\end{array}\right.$$



Wet Process

Clay ← Water → Limestone

Clay → Wash mill → Storage basins

Limestone → Crusher → Storage basins

Storage basins → Wet grinding mills to make slurry ← Storage basins

Wet grinding mills to make slurry → Blending of slurry to correct composition → Storage of corrected slurry

Powdered coal, oil or gas → Corrected slurry fed to Rotary klin → Slurry is converted into clinker

Addition of 2 to 3% of gypsum → Clinker is ground in Ball mill → Cement silos → Packing plant

Clinker of Cement

Rotary Kiln for Manufacturing Cement Clinker