Concrete

Definition

Concrete is a mixture of Portland cement, water, aggregates, and in some cases, admixtures. The cement and water form a paste that hardens and bonds the aggregates together.

Concrete is often looked upon as “man made rock”.

Concrete is a versatile construction material, adaptable to a wide variety of agricultural and residential uses.

Massive Concrete Structures of the world

- Grand Coulee Dam, on Columbia River which used nearly 10 million cubic yards of concrete, making it one of the largest Portland cement concrete projects in history.
- The Erie Canal in Washington. Construction of the canal started in 1817 and it took 8 years to complete it
- Petronas Twin tower in Malaysia. It was built in 1998 and it remained the tallest concrete tower till 2004.

Properties of Concrete

Concrete has strength, durability, versatility, and economy.

It can be placed or molded into virtually any shape and reproduce any surface texture.

Concrete is the most widely used construction material in the world.

In the United States almost twice as much concrete is used as all other construction materials combined.

Demand for concrete with higher strength and better quality, coupled with larger and faster mixer trucks, led to the emergence of the ready-mix concrete industry in the post-World War II period.

With proper materials and techniques, concrete can withstand many acids, silage, milk, manure, fertilizers, water, fire, and abrasion.

Concrete can be finished to produce surfaces ranging from glass-smooth to coarsely textured, and it can be colored with pigments or painted.

Concrete has substantial strength in compression, but is weak in tension.

Most structural uses, such as beams, slats, and manure tank lids, involve reinforced concrete, which depends on concrete's strength in compression and steel's strength in tension.

Since concrete is a structural material, strength is a desirable property.

Compressive strengths of concrete generally range from 2000 to 5000 pounds per square inch (psi), but concrete can be made to withstand over 10,000 psi for special jobs.

Components of Concrete

- **Portland Cement**
- **Aggregate** - sand, gravel, crushed rock
- **Water**
- **Admixtures** - when necessary

Portland Cement

Portland cement was named for the Isle of Portland, a peninsula in the English Channel where it was first produced in the 1800's.

Since that time, a number of developments and improvements have been made in the production process and cement properties.

The production process for portland cement first involves grinding limestone or chalk and alumina and silica from shale or clay.

The raw materials are proportioned, mixed, and then burned in large rotary kilns at approximately 2500°F until partially fused into marble-sized masses known as clinker.

After the clinker cools, gypsum is added, and both materials are ground into a fine powder which is portland cement.

Water

Good water is essential for quality concrete. It should be good enough to drink--free of trash, organic matter and excessive chemicals and/or minerals.

The strength and other properties of concrete are highly dependent on the amount of water and the water-cement ratio.

Aggregates

Aggregates occupy 60 to 80 percent of the volume of concrete.

Sand, gravel and crushed stone are the primary aggregates used.

All aggregates must be essentially free of silt and/or organic matter.

Admixtures

Admixtures are ingredients other than portland cement, water, and aggregates.

Admixtures are added to the concrete mixture immediately before or during mixing.

Air Entraining agents:

They are the most commonly used admixtures for agricultural concrete. It produce microscopic air bubbles throughout the concrete.

Entrained air bubbles:

These bubbles improve the durability of concrete exposed to moisture and freeze/thaw action. They also Improve resistance to scaling from deicers and corrosive agents such as manure or silage.

Retarding admixtures: are used to slow the rate of concrete hardening.

They are useful for concrete that is placed during hot weather.

Accelerating admixtures such as calcium chloride, are used to increase the rate of hardening--usually during cold weather.

Proportions

A properly proportioned concrete mix will provide:

Workability of freshly mixed concrete.

Durability, strength, and uniform appearance of hardened concrete.

Economy

Workability

- Workability is the property that determines the ease with which freshly mixed concrete can be placed and finished without segregation.
- Workability is difficult to measure but redi-mix companies usually have experience in determining the proper mix.
- Therefore, it is important to accurately describe what the concrete is to be used for, and how it will be placed.

Durability

If acceptable materials are used, the properties of concrete, such as durability, freeze/thaw resistance, wear resistance, and strength depend on the cement mixture.

A mixture with a sufficiently low ratio of water to cement plus entrained air, if specified, is the most desirable.

These properties--and thus the desired concrete quality--can only be fully achieved through proper placement and finishing, followed by prompt and effective curing.

Economy

Proportioning should minimize the amount of cement required without sacrificing quality.

Quality depends on the amount of cement and the water-cement ratio.

Hold the water content to a minimum to reduce the cement requirement.

Minimizing water and cement requirements:

Determining Aggregate Size:

Aggregate size depends on the end use. The maximum aggregate size should be no larger than one-third the thickness of the concrete. Aggregate size should also be less than three-fourths the clear space between reinforcing bars where rebar is used.

Water to Cement Ratio

The ratio should be kept as low as possible. 5-6 gallons per sack of cement is acceptable.

Curing

Concrete that has been specified, batched, mixed, placed, and finished "letter-perfect" can still be a failure if improperly or inadequately cured.

Curing is usually the last step in a concrete project and, unfortunately, is often neglected even by professionals.

Curing has a major influence on the properties of hardened concrete such as durability, strength, water-tightness, wear resistance, volume stability, and resistance to freezing and thawing.

Proper concrete curing for agricultural and residential applications involves keeping newly placed concrete moist and avoiding temperature extremes (above 90°F or below 50°F) for at least three days.

A seven-day (or longer) curing time is recommended.

Two general methods of curing can be used:

Keep water on the concrete during the curing period.

These include

ponding or immersion,

spraying or fogging, and

saturated wet coverings.

Such methods provide some cooling through evaporation, which is beneficial in hot weather.

Prevent the loss of the mixing water from concrete by sealing the surface.

Can be done by:

covering the concrete with impervious paper or plastic sheets,

applying membrane-forming curing compounds.

The best curing method depends on:

cost,

application equipment required,

materials available,

Size and shape of the concrete surface.

Begin the curing as soon as the concrete has hardened sufficiently to avoid erosion or other damage to the freshly finished surface.

This is usually within one to two hours after placement and finishing.

Summary

Concrete is a highly versatile construction material, well suited for many agricultural applications.

It is a mixture of portland cement, water, aggregates, and in some cases, admixtures.

Strength, durability, and many other factors depend on the relative amounts and properties of the individual components.

A perfect mix can result in poor quality concrete if correct placement, finishing, and curing techniques under the proper conditions of moisture and temperature are not used.

When specifying and ordering concrete, the customer should be prepared to discuss such things as: