Cement & Concrete Basics

Frequently Asked Questions

What is the difference between cement and concrete?

Although the terms cement and concrete often are used interchangeably, cement is actually an ingredient of concrete. Concrete is basically a mixture of aggregates and paste. The aggregates are sand and gravel or crushed stone; the paste is water and portland cement. Concrete gets stronger as it gets older. Portland cement is not a brand name, but the generic term for the type of cement used in virtually all concrete, just as stainless is a type of steel and sterling a type of silver. Cement comprises from 10 to 15 percent of the concrete mix, by volume. Through a process called hydration, the cement and water harden and bind the aggregates into a rocklike mass. This hardening process continues for years meaning that concrete gets stronger as it gets older.

So, there is no such thing as a cement sidewalk, or a cement mixer; the proper terms are concrete sidewalk and concrete mixer.

How is portland cement made?

Materials that contain appropriate amounts of calcium compounds, silica, alumina and iron oxide are crushed and screened and placed in a rotating cement kiln. Ingredients used in this process are typically materials such as limestone, marl, shale, iron ore, clay, and fly ash.

The kiln resembles a large horizontal pipe with a diameter of 10 to 15 feet (3 to 4.1 meters) and a length of 300 feet (90 meters) or more. One end is raised slightly. The raw mix is placed in the high end and as the kiln rotates the materials move slowly toward the lower end. Flame jets are at the lower end and all the materials in the kiln are heated to high temperatures that range between 2700 and 3000 Fahrenheit (1480 and 1650 Celsius). This high heat drives off, or calcines, the chemically combined water and carbon dioxide from the raw materials and forms new compounds (tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetracalcium aluminoferrite). For each ton of material that goes into the feed end of the kiln, two thirds of a ton the comes out the discharge end, called clinker. This clinker is in the form of marble sized pellets. The clinker is very finely ground to produce portland cement. A small amount of gypsum is added during the grinding process to control the cement's set or rate of hardening.

What does it mean to "cure" concrete?

Curing is one of the most important steps in concrete construction, because proper curing greatly increases concrete strength and durability. Concrete hardens as a result of hydration: the chemical reaction between cement and water. However, hydration occurs only if water is available and if the concrete's temperature stays within a suitable range. During the curing period-from five to seven days after placement for conventional concrete-the concrete surface needs to be kept moist to permit the hydration process. new concrete can be wet with soaking hoses, sprinklers or covered with wet burlap, or can be coated with commercially available curing compounds, which seal in moisture.

Can it be too hot or too cold to place new concrete?

Temperature extremes make it difficult to properly cure concrete. On hot days, too much water is lost by evaporation from newly placed concrete. If the temperature drops too close to freezing, hydration slows to nearly a standstill. Under these conditions, concrete ceases to gain strength and other desirable properties. In general, the temperature of new concrete should not be allowed to fall below 50 Fahrenheit (10 Celsius) during the curing period.

What is air-entrained concrete?

Air-entrained concrete contains billions of microscopic air cells per cubic foot. These air pockets relieve internal pressure on the concrete by providing tiny chambers for water to expand into when it freezes. Air-entrained concrete is produced through the use of air-entraining portland cement, or by the introduction of air-entraining agents, under careful engineering supervision as the concrete is mixed on the job. The amount of entrained air is usually between 4 percent and 7 percent of the volume of the

concrete, but may be varied as required by special conditions.

What are recommended mix proportions for good concrete?

Good concrete can be obtained by using a wide variety of mix proportions if proper mix design procedures are used. A good general rule to use is the rule of 6's:

- A minimum cement content of 6 bags per cubic yard of concrete,
- A maximum water content of 6 gallons per bag of cement,
- A curing period (keeping concrete moist) a minimum of 6 days, and
- An air content of 6 percent (if concrete will be subject to freezing and thawing).

Why does concrete crack?

Concrete, like all other materials, will slightly change in volume when it dries out. In typical concrete this change amounts to about 500 millionths. Translated into dimensions-this is about 1/16 of an inch in 10 feet (.4 cm in 3 meters). The reason that contractors put joints in concrete pavements and floors is to allow the concrete to crack in a neat, straight line at the joint when the volume of the concrete changes due to shrinkage.

Why test concrete?

Concrete is tested to ensure that the material that was specified and bought is the same material delivered to the job site. There are a dozen different test methods for freshly mixed concrete and at least another dozen tests for hardened concrete, not including test methods unique to organizations like the Army Corps of Engineers, the Federal Highway Administration, and state departments of transportation.

What are the most common tests for fresh concrete?

Slump, air content, unit weight and compressive strength tests are the most common tests.

- Slump is a measure of consistency, or relative ability of the concrete to flow. If the concrete can't flow because the consistency or slump is too low, there are potential problems with proper consolidation. If the concrete won't stop flowing because the slump is too high, there are potential problems with mortar loss through the formwork, excessive formwork pressures, finishing delays and segregation.
- Air content measures the total air content in a sample of fresh concrete, but does not indicate what the final in-place air content will be, because a certain amount of air is lost in transportation, consolidating, placement and finishing. Three field tests are widely specified: the pressure meter and volumetric method are ASTM standards and the Chace Indicator is an AASHTO procedure.
- Unit weight measures the weight of a known volume of fresh concrete.
- Compressive strength is tested by pouring cylinders of fresh concrete and measuring the force needed to break the concrete cylinders at proscribed intervals as they harden. According to Building Code Requirements for Reinforced Concrete (ACI 318), as long as no single test is more than 500 psi below the design strength and the average of three consecutive tests equals or exceed the design strength then the concrete is acceptable. If the strength tests don't meet these criteria, steps must be taken to raise the average.

How can you tell if you're getting the amount of concrete you're paying for?

The real indicator is the yield, or the actual volume produced based on the actual batch quantities of cement, water and aggregates. The unit weight test can be used to determine the yield of a sample of the ready mixed concrete as delivered. It's a simple calculation that requires the unit weight of all materials batched. The total weight information may be shown on the delivery ticket or it can be provided by the producer. Many concrete producers actually over yield by about 1/2 percent to make sure they aren't short-changing their customers. But other producers may not even realize that a mix designed for one cubic yard might only produce 26.5 cubic feet or 98 percent of what they designed.

Why do concrete surfaces flake and spall?

Concrete surfaces can flake or spall for one or more of the following reasons:

- In areas of the country that are subjected to freezing and thawing the concrete should be air-entrained to resist flaking and scaling of the surface. If air-entrained concrete is not used, there will be subsequent damage to the surface.

- The water/cement ratio should be as low as possible to improve durability of the surface. Too much water in the mix will produce a weaker, less durable concrete that will contribute to early flaking and spalling of the surface.

- The finishing operations should not begin until the water sheen on the surface is gone and excess bleed water on the surface has had a chance to evaporate. If this excess water is worked into the concrete because the finishing operations are begun too soon, the concrete on the surface will have too high a water content and will be weaker and less durable.

Will concrete harden under water?

Portland cement is a hydraulic cement which means that it sets and hardens due to a chemical reaction with water. Consequently, it will harden under water.

What does 28 -day strength mean?

Concrete hardens and gains strength as it hydrates. The hydration process continues over a long period of time. It happens rapidly at first and slows down as time goes by. To measure the ultimate strength of concrete would require a wait of several years. This would be impractical, so a time period of 28 days was selected by specification writing authorities as the age that all concrete should be tested. At this age, a substantial percentage of the hydration has taken place.

What is 3,000 pound concrete?

It is concrete that is strong enough to carry a compressive stress of 3,000 psi (20.7 MPa) at 28 days. Concrete may be specified at other strengths as well. Conventional concrete has strengths of 7,000 psi or less; concrete with strengths between 7,000 and 14,500 psi is considered high-strength concrete.

How do you control the strength of concrete?

The easiest way to add strength is to add cement. The factor that most predominantly influences concrete strength is the ratio of water to cement in the cement paste that binds the aggregates together. The higher this ratio is, the weaker the concrete will be and vice versa. Every desirable physical property that you can measure will be adversely effected by adding more water.

How do you remove stains from concrete?

Stains can be removed from concrete with dry or mechanical methods, or by wet methods using chemical or water.

Common dry methods include sandblasting, flame cleaning and shotblasting, grinding, scabbing, planing and scouring. Steel-wire brushes should be used with care because they can leave metal particles on the surface that later may rust and stain the concrete.

Wet methods involve the application of water or specific chemicals according to the nature of the stain. The chemical treatment either dissolves the staining substance so it can be blotted up from the surface of the concrete or bleaches the staining substance so it will not show.

To remove blood stains, for example, wet the stains with water and cover them with a layer of sodium peroxide powder; let stand for a few minutes, rinse with water and scrub vigorously. Follow with the application of a 5 percent solution of vinegar to neutralize any remaining sodium peroxide.

What are the decorative finishes that can be applied to concrete surfaces?

Color may be added to concrete by adding pigments-before or after concrete is place-and using white cement rather than conventional gray cement, by using chemical stains, or by exposing colorful aggregates at the surface. Textured finishes can vary from a smooth polish to the roughness of gravel. Geometric patterns can be scored, stamped, rolled, or inlaid into the concrete to resemble stone, brick or tile paving. Other interesting patterns are obtained by using divider strips (commonly

redwood) to form panels of various sizes and shapes rectangular, square, circular or diamond. Special techniques are available to make concrete slip-resistant and sparkling.

How do you protect a concrete surface from aggressive materials like acids?

Many materials have no effect on concrete. However, there are some aggressive materials, such as most acids, that can have a deteriorating effect on concrete. The first line of defense against chemical attack is to use quality concrete with maximum chemical resistance, followed by the application of protective treatments to keep corrosive substances from contacting the concrete. Principles and practices that improve the chemical resistance of concrete include using a low water-cement ratio, selecting a suitable cement type (such as sulfate-resistant cement to prevent sulfate attack), using suitable aggregates, water and air entrainment. A large number of chemical formulations are available as sealers and coatings to protect concrete from a variety of environments; detailed recommendations should be requested from manufacturers, formulators or material suppliers.

Is there a universal international specification for portland cement?

Each country has its own standard for portland cement, so there is no universal international standard. The United States uses the specification prepared by the American Society for Testing and Materials-ASTM C-150 Standard Specification for Portland Cement. There are a few other countries that also have adopted this as their standard, however, there are countless other specifications. Unfortunately, they do not use the same criteria for measuring properties and defining physical characteristics so they are virtually "non-translatable." The European Cement Association located in Brussels, Belgium, publishes a book titled "Cement Standards of the World."

What is alkali-silica reactivity (ASR)?

Alkali-silica reactivity is an expansive reaction between reactive forms of silica in aggregates and potassium and sodium alkalis, mostly from cement, but also from aggregates, pozzolans, admixtures and mixing water. External sources of alkali from soil, deicers and industrial processes can also contribute to reactivity. The reaction forms an alkali-silica gel that swells as it draws water from the surrounding cement paste, thereby inducing pressure, expansion and cracking of the aggregate and surrounding paste. This often results in map-pattern cracks, sometimes referred to as alligator pattern cracking. ASR can be avoided through 1) proper aggregate selection, 2) use of blended cements, 3) use of proper pozzolanic materials and 4) contaminant-free mixing water.

Are there different types of portland cement?

Though all portland cement is basically the same, eight types of cement are manufactured to meet different physical and chemical requirements for specific applications:

- Type I is a general purpose portland cement suitable for most uses.
- Type II is used for structures in water or soil containing moderate amounts of sulfate, or when heat build-up is a concern.
- Type III cement provides high strength at an early state, usually in a week or less.
- Type IV moderates heat generated by hydration that is used for massive concrete structures such as dams.
- Type V cement resists chemical attack by soil and water high in sulfates.
- Types IA, IIA and IIIA are cements used to make air-entrained concrete. They have the same properties as types I, II, and III, except that they have small quantities of air-entrained materials combined with them.

White portland cement is made from raw materials containing little or no iron or manganese, the substances that give conventional cement its gray color.

If you have a question that was not answered in this section, please email us and we will be happy to answer it!