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CONCRETE Basics

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Strides in equipment, materials, and construction methods have changed the face of concrete construction.

Concrete Basics

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Concrete Basics: Portland cement, water, sand, and coarse aggregate are proportioned and mixed to produce concrete suited to the particular job for which it is intended.

History and Manufacture of Portland Cement covers invention of portland cement, origin of industry, and today's manufacturing process.

Aggregate, which accounts for 60% to 75% of a concrete mix, must be clean, strong, and free of other materials

Chemical Admixtures reduce the cost of concrete construction, modify properties of hardened concrete, or ensure quality concrete.

Supplementary Cementing Materials, also called mineral admixtures, contribute to the properties of hardened concrete through hydraulic or pozzolanic activity.

Air-Entrained Concrete is more resistant to freeze/thaw cycles.

Placing and Finishing Concrete: Mixing, transporting, and handling of concrete should be carefully coordinated with placing and finishing operations.

Curing Concrete aids the chemical reaction called hydration by providing optimum moisture and temperature.

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- Concrete Basics
- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

Concrete Basics

In its simplest form, concrete is a mixture of paste and aggregates. The paste, composed of portland cement and water, coats the surface of the fine and coarse aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form the rock-like mass known as concrete. Within this process lies the key to a remarkable trait of concrete: it's plastic and malleable when newly mixed, strong and durable when hardened. These qualities explain why one material, concrete, can build skyscrapers, bridges, sidewalks and superhighways, houses and dams. The key to achieving a strong, durable concrete rests in the careful proportioning and mixing of the ingredients. A concrete mixture that does not have enough paste to fill all the voids between the aggregates will be difficult to place and will produce rough, honeycombed surfaces and porous concrete. A mixture with an excess of cement paste will be easy to place and will produce a smooth surface; however, the resulting concrete is likely to shrink more and be uneconomical. A properly designed concrete mixture will possess the desired workability for the fresh concrete and the required durability and strength for the hardened concrete. Typically, a mix is about 10 to 15 percent cement, 60 to 75 percent aggregate and 15 to 20 percent water. Entrained air in many concrete mixes may also take up another 5 to 8 percent. Portland cement's chemistry comes to life in the presence of water. Cement and water form a paste that coats each particle of stone and sand. Through a chemical reaction called hydration, the cement paste hardens and gains strength. The character of the concrete is determined by quality of the paste. The strength of the paste, in turn, depends on the ratio of water to cement. The water-cement ratio is the weight of the mixing water divided by the weight of the cement. High-quality concrete is produced by lowering the water-cement ratio as much as possible without sacrificing the workability of fresh concrete. Generally, using less water produces a higher quality concrete provided the concrete is properly placed, consolidated, and cured.

Other Ingredients

Although most drinking water is suitable for use in concrete, aggregates are chosen carefully. Aggregates comprise 60 to 75 percent of the total volume of concrete. The type and size of the aggregate mixture depends on the thickness and purpose of the final concrete product. Almost any natural water that is drinkable and has no pronounced taste or odor may be used as mixing water for concrete. However, some waters that are not fit for drinking may be suitable for concrete. Excessive impurities in mixing water not only may affect setting time and concrete strength, but also may cause efflorescence, staining, corrosion of reinforcement, volume instability, and reduced durability. Specifications usually set limits on chlorides, sulfates, alkalis, and solids in mixing water unless tests can be performed to determine the effect the impurity has on various properties. Relatively thin building sections call for small coarse aggregate, though aggregates up to six inches (150 mm) in diameter have been used in large

dams. A continuous gradation of particle sizes is desirable for efficient use of the paste. In addition, aggregates should be clean and free from any matter that might affect the quality of the concrete.

Hydration Begins

Soon after the aggregates, water, and the cement are combined, the mixture starts to harden. All portland cements are hydraulic cements that set and harden through a chemical reaction with water. During this reaction, called hydration, a node forms on the surface of each cement particle. The node grows and expands until it links up with nodes from other cement particles or adheres to adjacent aggregates. The building up process results in progressive stiffening, hardening, and strength development. Once the concrete is thoroughly mixed and workable it should be placed in forms before the mixture becomes too stiff. During placement, the concrete is consolidated to compact it within the forms and to eliminate potential flaws, such as honeycombs and air pockets. For slabs, concrete is left to stand until the surface moisture film disappears. After the film disappears from the surface, a wood or metal handfloat is used to smooth off the concrete. Floating produces a relatively even, but slightly rough, texture that has good slip resistance and is frequently used as a final finish for exterior slabs. If a smooth, hard, dense surface is required, floating is followed by steel troweling. Curing begins after the exposed surfaces of the concrete have hardened sufficiently to resist marring. Curing ensures the continued hydration of the cement and the strength gain of the concrete. Concrete surfaces are cured by sprinkling with water fog, or by using moisture-retaining fabrics such as burlap or cotton mats. Other curing methods prevent evaporation of the water by sealing the surface with plastic or special sprays (curing compounds). Special techniques are used for curing concrete during extremely cold or hot weather to protect the concrete. The longer the concrete is kept moist, the stronger and more durable it will become. The rate of hardening depends upon the composition and fineness of the cement, the mix proportions, and the moisture and temperature conditions. Most of the hydration and strength gain take place within the first month of concrete's life cycle, but hydration continues at a slower rate for many years. Concrete continues to get stronger as it gets older.

The Forms of Concrete

Concrete is produced in four basic forms, each with unique applications and properties. Ready mixed concrete, by far the most common form, accounts for nearly three-fourths of all concrete. It's batched at local plants for delivery in the familiar trucks with revolving drums. Precast concrete products are cast in a factory setting. These products benefit from tight quality control achievable at a production plant. Precast products range from concrete bricks and paving stones to bridge girders, structural components, and panels for cladding. Concrete masonry, another type of manufactured concrete, may be best known for its conventional 8 x 8 x 16-inch block. Today's masonry units can be molded into a wealth of shapes, configurations, colors, and textures to serve an infinite spectrum of building applications and architectural needs. Cement-based materials represent products that defy the label of "concrete," yet share many of its qualities. Conventional materials in this category include mortar, grout, and terrazzo. Soil-cement and roller-compacted concrete-"cousins" of concrete-are used for pavements and dams. Other products in this category include flowable fill and cement-treated bases. A new generation of advanced products incorporates fibers and special aggregate to create roofing tiles, shake shingles, lap siding, and countertops. And an emerging market is the use of cement to treat and stabilize waste.

BACK

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- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

Concrete Basics > History and Manufacture of Portland Cement

An 1824, Joseph Aspdin, a British stone mason, obtained a patent for a cement he produced in his kitchen. The inventor heated a mixture of finely ground limestone and clay in his kitchen stove and ground the mixture into a powder create a hydraulic cement-one that hardens with the addition of water. Aspdin named the product portland cement because it resembled a stone quarried on the Isle of Portland off the British Coast. With this invention, Aspdin laid the foundation for today's portland cement industry.

Manufacturing Process

Portland cement, the fundamental ingredient in concrete, is a calcium silicate cement made with a combination of calcium, silicon, aluminum, and iron. Producing a cement that meets specific chemical and physical specifications requires careful control of the manufacturing process. The first step in the portland cement manufacturing process is obtaining raw materials. Generally, raw materials consisting of combinations of limestone, shells or chalk, and shale, clay, sand, or iron ore are mined from a quarry near the plant. At the quarry, the raw materials are reduced by primary and secondary crushers. Stone is first reduced to 5-inch size (125-mm), then to 3/4-inch(19 mm). Once the raw materials arrive at the cement plant, the materials are proportioned to create a cement with a specific chemical composition. Two different methods, dry and wet, are used to manufacture portland cement. In the dry process, dry raw materials are proportioned, ground to a powder, blended together and fed to the kiln in a dry state. In the wet process, a slurry is formed by adding water to the properly proportioned raw materials. The grinding and blending operations are then completed with the materials in slurry form. After blending, the mixture of raw materials is fed into the upper end of a tilted rotating, cylindrical kiln. The mixture passes through the kiln at a rate controlled by the slope and rotational speed of the kiln. Burning fuel consisting of powdered coal or natural gas is forced into the lower end of the kiln. Inside the kiln, raw materials reach temperatures of 2600ÞF to 3000ÞF (1430ÞC to 1650ÞC). At 2700ÞF (1480ÞC), a series of chemical reactions cause the materials to fuse and create cement clinker-grayish-black pellets, often the size of marbles. Clinker is discharged red-hot from the lower end of the kiln and transferred to various types of coolers to lower the clinker to handling temperatures. Cooled clinker is combined with gypsum and ground into a fine gray powder. The clinker is ground so fine that nearly all of it passes through a No. 200 mesh (75 micron) sieve. This fine gray powder is portland cement.

Types of Portland Cement

Different types of portland cement are manufactured to meet various physical and chemical requirements. The American Society for Testing and Materials (ASTM) Specification C-150 provides for eight types of portland cement.Type I portland cement is a normal, general-purpose cement suitable for all uses. It is used in general construction projects such as buildings, bridges, floors,

pavements, and other precast concrete products. Type IA portland cement is similar to Type I with the addition of air-entraining properties. Type II portland cement generates less heat at a slower rate and has a moderate resistance to sulfate attack. Type IIA portland cement is identical to Type II and produces air-entrained concrete. Type III portland cement is a high-early-strength cement and causes concrete to set and gain strength rapidly. Type III is chemically and physically similar to Type I, except that its particles have been ground finer. Type IIIA is an air-entraining, high-early-strength cement. Type IV portland cement has a low heat of hydration and develops strength at a slower rate than other cement types, making it ideal for use in dams and other massive concrete structures where there is little chance for heat to escape. Type V portland cement is used only in concrete structures that will be exposed to severe sulfate action, principally where concrete is exposed to soil and groundwater with a high sulfate content.

White Portland Cement

In addition to the eight types of portland cement, a number of special purpose hydraulic cements are manufactured. Among these is white portland cement. White portland cement is identical to gray portland cement except in color. During the manufacturing process, manufacturers select raw materials that contain only negligible amounts of iron and magnesium oxides, the substances that give gray cement its color. White cement is used whenever architectural considerations specify white or colored concrete or mortar.

Blended Hydraulic Cements

Blended hydraulic cements are produced by intimately blending two or more types of cementitious material. Primary blending materials are portland cement, ground granulated blast-furnace slag, fly ash, natural pozzolans, and silica fume. These cements are commonly used in the same manner as portland cements. Blended hydraulic cements conform to the requirements of ASTM C595 or C1157. ASTM C595 cements are as follows: Type IS-portland blast-furnace slag cement, Type IP and Type P-portland-pozzolan cement, Type S-slag cement, Type I (PM)-pozzolan modified portland cement, and Type I (SM)-slag modified portland cement. The blast-furnace slag content of Type IS is between 25 percent and 70 percent by mass. The pozzolan content of Types IP and P is between 15 percent and 40 percent by mass of the blended cement. Type I (PM) contains less than 15 percent pozzolan. Type S contains at least 70 percent slag by mass. Type I (SM) contains less than 25 percent slag by mass. The supplementary materials in these cements are explained further on page 28. These blended cements may also be designated as air-entraining, moderate sulfate resistant, or with moderate or low heat of hydration. ASTM C1157 blended hydraulic cements include the following: Type GU-blended hydraulic cement for general construction, Type HE-high-early-strength cement, Type MS-moderate sulfate resistant cement, Type HS-high sulfate resistant cement, Type MH-moderate heat of hydration cement, and Type LH-low heat of hydration cement. These cements can also be designated for low reactivity (option R) with alkali-reactive aggregates. There are no restrictions as to the composition of the C1157 cements. The manufacturer can optimize ingredients, such as pozzolans and slags, to optimize for particular concrete properties. The most common blended cements available are Types IP and IS. The United States uses a relatively small amount of blended cement compared to countries in Europe or Asia. However, this may change with consumer demands for products with specific properties, along with environmental and energy concerns.

Expansive Cements

Expansive cements are hydraulic cements that expand slightly during the early hardening period after setting. They meet the requirements of ASTM C845 in which it is designated as Type E-1. Although three varieties of expansive cement are designated in the standard as K, M, and S, only K is available in the United States. Type E-1 (K) contains portland cement, anhydrous tetracalcium

trialuminosulfate, calcium sulfate, and uncombined calcium oxide (lime). Expansive cement is used to make shrinkage-compensating concrete that is used (1) to compensate for volume decrease due to drying shrinkage, (2) to induce tensile stress in reinforcement, and (3) to stabilize long-term dimensions of post-tensioned concrete structures. One of the major advantages of using expansive cement is in the control and reduction of drying-shrinkage cracks. In recent years, shrinkage-compensating concrete has been of particular interest in bridge deck construction, where crack development must be minimized.

BACK

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Strides in equipment, materials, and construction methods have changed the face of concrete construction.

- Concrete Basics
- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

Concrete Basics > Aggregate

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories-fine and coarse. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch (9.5-mm) sieve. Coarse aggregates are any particles greater than 0.19 inch (4.75 mm), but generally range between 3/8 and 1.5 inches (9.5 mm to 37.5 mm) in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

Natural gravel and sand are usually dug or dredged from a pit, river, lake, or seabed. Crushed aggregate is produced by crushing quarry rock, boulders, cobbles, or large-size gravel. Recycled concrete is a viable source of aggregate and has been satisfactorily used in granular subbases, soil-cement, and in new concrete. Aggregate processing consists of crushing, screening, and washing the aggregate to obtain proper cleanliness and gradation. If necessary, a benefaction process such as jigging or heavy media separation can be used to upgrade the quality. Once processed, the aggregates are handled and stored in a way that minimizes segregation and degradation and prevents contamination. Aggregates strongly influence concrete's freshly mixed and hardened properties, mixture proportions, and economy. Consequently, selection of aggregates is an important process. Although some variation in aggregate properties is expected, characteristics that are considered when selecting aggregate include:

- grading
- durability
- particle shape and surface texture
- abrasion and skid resistance
- unit weights and voids
- absorption and surface moisture

Grading refers to the determination of the particle-size distribution for aggregate. Grading limits and maximum aggregate size are specified because grading and size affect the amount of aggregate used as well as cement and water requirements, workability, pumpability, and durability of concrete. In general, if the water-cement ratio is chosen correctly, a wide range in grading can be used without a major effect on strength. When gap-graded aggregate are specified, certain particle sizes of aggregate are omitted from the size continuum. Gap-graded aggregate are used to obtain uniform textures in

exposed aggregate concrete. Close control of mix proportions is necessary to avoid segregation.

Shape and Size Matter

Particle shape and surface texture influence the properties of freshly mixed concrete more than the properties of hardened concrete. Rough-textured, angular, and elongated particles require more water to produce workable concrete than smooth, rounded compact aggregate. Consequently, the cement content must also be increased to maintain the water-cement ratio. Generally, flat and elongated particles are avoided or are limited to about 15 percent by weight of the total aggregate. Unit-weight measures the volume that graded aggregate and the voids between them will occupy in concrete. The void content between particles affects the amount of cement paste required for the mix. Angular aggregate increase the void content. Larger sizes of well-graded aggregate and improved grading decrease the void content. Absorption and surface moisture of aggregate are measured when selecting aggregate because the internal structure of aggregate is made up of solid material and voids that may or may not contain water. The amount of water in the concrete mixture must be adjusted to include the moisture conditions of the aggregate. Abrasion and skid resistance of an aggregate are essential when the aggregate is to be used in concrete constantly subject to abrasion as in heavy-duty floors or pavements. Different minerals in the aggregate wear and polish at different rates. Harder aggregate can be selected in highly abrasive conditions to minimize wear.

BACK

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- Concrete Basics
- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

Concrete Basics > Chemical Admixtures

Chemical admixtures are the ingredients in concrete other than portland cement, water, and aggregate that are added to the mix immediately before or during mixing. Producers use admixtures primarily to reduce the cost of concrete construction; to modify the properties of hardened concrete; to ensure the quality of concrete during mixing, transporting, placing, and curing; and to overcome certain emergencies during concrete operations. Successful use of admixtures depends on the use of appropriate methods of batching and concreting. Most admixtures are supplied in ready-to-use liquid form and are added to the concrete at the plant or at the jobsite. Certain admixtures, such as pigments, expansive agents, and pumping aids are used only in extremely small amounts and are usually batched by hand from premeasured containers. The effectiveness of an admixture depends on several factors including: type and amount of cement, water content, mixing time, slump, and temperatures of the concrete and air. Sometimes, effects similar to those achieved through the addition of admixtures can be achieved by altering the concrete mixture-reducing the water-cement ratio, adding additional cement, using a different type of cement, or changing the aggregate and aggregate gradation.

Five Functions

Admixtures are classed according to function. There are five distinct classes of chemical admixtures: air-entraining, water-reducing, retarding, accelerating, and plasticizers (superplasticizers). All other varieties of admixtures fall into the specialty category whose functions include corrosion inhibition, shrinkage reduction, alkali-silica reactivity reduction, workability enhancement, bonding, damp proofing, and coloring. Air-entraining admixtures, which are used to purposely place microscopic air bubbles into the concrete, are discussed more fully in "Air-Entrained Concrete." Water-reducing admixtures usually reduce the required water content for a concrete mixture by about 5 to 10 percent. Consequently, concrete containing a water-reducing admixture needs less water to reach a required slump than untreated concrete. The treated concrete can have a lower water-cement ratio. This usually indicates that a higher strength concrete can be produced without increasing the amount of cement. Recent advancements in admixture technology have led to the development of mid-range water reducers. These admixtures reduce water content by at least 8 percent and tend to be more stable over a wider range of temperatures. Mid-range water reducers provide more consistent setting times than standard water reducers.

Retarding admixtures, which slow the setting rate of concrete, are used to counteract the accelerating effect of hot weather on concrete setting. High temperatures often cause an increased rate of hardening which makes placing and finishing difficult. Retarders keep concrete workable during placement and delay the initial set of concrete. Most retarders also function as water reducers and may entrain some air in concrete. Accelerating admixtures increase the rate

of early strength development, reduce the time required for proper curing and protection, and speed up the start of finishing operations. Accelerating admixtures are especially useful for modifying the properties of concrete in cold weather. Superplasticizers, also known as plasticizers or high-range water reducers (HRWR), reduce water content by 12 to 30 percent and can be added to concrete with a low-to-normal slump and water-cement ratio to make high-slump flowing concrete. Flowing concrete is a highly fluid but workable concrete that can be placed with little or no vibration or compaction. The effect of superplasticizers lasts only 30 to 60 minutes, depending on the brand and dosage rate, and is followed by a rapid loss in workability. As a result of the slump loss, superplasticizers are usually added to concrete at the jobsite. Corrosion-inhibiting admixtures fall into the specialty admixture category and are used to slow corrosion of reinforcing steel in concrete. Corrosion inhibitors can be used as a defensive strategy for concrete structures, such as marine facilities, highway bridges, and parking garages, that will be exposed to high concentrations of chloride. Other specialty admixtures include shrinkage-reducing admixtures and alkali-silica reactivity inhibitors. The shrinkage reducers are used to control drying shrinkage and minimize cracking, while ASR inhibitors control durability problems associated with alkali-silica reactivity.

BACK

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Strides in equipment, materials, and construction methods have changed the face of concrete construction.

- Concrete Basics
- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

Concrete Basics > Supplementary cementing materials

Supplementary cementing materials, also called mineral admixtures, contribute to the properties of hardened concrete through hydraulic or pozzolanic activity. Typical examples are natural pozzolans, fly ash, ground granulated blast-furnace slag, and silica fume, which can be used individually with portland or blended cement or in different combinations. These materials react chemically with calcium hydroxide released from the hydration of portland cement to form cement compounds. These materials are often added to concrete to make concrete mixtures more economical, reduce permeability, increase strength, or influence other concrete properties. Fly ash, the most commonly used pozzolan in concrete, is a finely divided residue that results from the combustion of pulverized coal and is carried from the combustion chamber of the furnace by exhaust gases. Commercially available fly ash is a by-product of thermal power generating stations.

Blast-furnace slag, or iron blast-furnace slag, is a nonmetallic product consisting essentially of silicates, aluminosilicates of calcium, and other compounds that are developed in a molten condition simultaneously with the iron in the blast-furnace. Silica fume, also called condensed silica fume and microsilica, is a finely divided residue resulting from the production of elemental silicon or ferro-silicon alloys that is carried from the furnace by the exhaust gases. Silica fume, with or without fly ash or slag, is often used to make high-strength concrete. Below is a summary of the specifications and classes of supplementary cementing materials:

- Ground granulated iron blast-furnace slag-ASTM C989
- Grade 80-Slags with a low activity index
- Grade 100-Slags with a moderate activity index
- Grade 120-Slags with a high activity index
- Fly ash and natural pozzolans — ASTM C618

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Strides in equipment, materials, and construction methods have changed the face of concrete construction.

- Concrete Basics
- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

Concrete Basics > Air-Entrained Concrete

One of the greatest advances in concrete technology was the development of air-entrained concrete in the late 1930s. Today, air entrainment is recommended for nearly all concretes, principally to improve resistance to freezing when exposed to water and deicing chemicals. However, there are other important benefits of entrained air in both freshly mixed and hardened concrete. Air-entrained concrete contains billions of microscopic air cells. These relieve internal pressure on the concrete by providing tiny chambers for the expansion of water when it freezes. Air-entrained concrete is produced through the use of air-entraining portland cement, or by introducing air-entraining admixtures under careful engineering supervision as the concrete is mixed on the job. The amount of entrained air is usually between 5 percent and 8 percent of the volume of the concrete, but may be varied as required by special conditions. The use of air-entraining agents results in concrete that is highly resistant to severe frost action and cycles of wetting and drying or freezing and thawing and has a high degree of workability and durability.

BACK

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- Concrete Basics
- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

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Concrete Basics > Placing and Finishing Concrete

Mixing, transporting, and handling of concrete should be carefully coordinated with placing and finishing operations. Concrete should not be deposited more rapidly than it can be spread, struck off, consolidated, and bullfloated. Concrete should be deposited continuously as near as possible to its final position. In slab construction, placing should be started along the perimeter at one end of the work with each batch placed against previously dispatched concrete. Concrete should not be dumped in separate piles and then leveled and worked together; nor should the concrete be deposited in large piles and moved horizontally into final position.

Consolidation

In some types of construction, the concrete is placed in forms, then consolidated. Consolidation compacts fresh concrete to mold it within the forms and around embedded items and reinforcement and to eliminate stone pockets, honeycomb, and entrapped air. It should not remove significant amounts of intentionally entrained air. Vibration, either internal or external, is the most widely used method for consolidating concrete. When concrete is vibrated, the internal friction between the aggregate particles is temporarily destroyed and the concrete behaves like a liquid; it settles in the forms under the action of gravity and the large entrapped air voids rise more easily to the surface. Internal friction is reestablished as soon as vibration stops.

Finishing

Concrete that will be visible, such as slabs like driveways, highways, or patios, often needs finishing. Concrete slabs can be finished in many ways, depending on the intended service use. Options include various colors and textures, such as exposed aggregate or a patterned-stamped surface. Some surfaces may require only strikeoff and screeding to proper contour and elevation, while for other surfaces a broomed, floated, or troweled finish may be specified. In slab construction, screeding or strikeoff is the process of cutting off excess concrete to bring the top surface of the slab to proper grade. A straight edge is moved across the concrete with a sawing motion and advanced forward a short distance with each movement.

Bullfloating eliminates high and low spots and embeds large aggregate particles immediately after strikeoff. This looks like a long-handled straight edge pulled across the concrete. Jointing is required to eliminate unsightly random cracks. Contraction joints are made with a hand groover or by inserting strips of plastic, wood, metal, or preformed joint material into the unhardened concrete. Sawcut joints can be made after the concrete is sufficiently hard or strong enough to prevent raveling. After the concrete has been jointed, it should be floated with a wood or metal hand float or with a finishing machine using float blades. This embeds aggregate particles just beneath the surface; removes slight

imperfections, humps, and voids; and compacts the mortar at the surface in preparation for additional finishing operations. Where a smooth, hard, dense surface is desired, floating should be followed by steel troweling. Troweling should not be done on a surface that has not been floated; troweling after only bullfloating is not an adequate finish procedure. A slip-resistant surface can be produced by brooming before the concrete has thoroughly hardened, but it should be sufficiently hard to retain the scoring impression.

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Strides in equipment, materials, and construction methods have changed the face of concrete construction.

- Concrete Basics
- History and Manufacture of Portland Cement
- Aggregate
- Chemical Admixtures
- Supplementary Cementing Materials
- Air-Entrained Concrete
- Placing and Finishing Concrete
- Curing Concrete

Concrete Basics > Curing Concrete

After concrete is placed, a satisfactory moisture content and temperature (between 50°F and 75°F) must be maintained, a process called curing. Adequate curing is vital to quality concrete. Curing has a strong influence on the properties of hardened concrete such as durability, strength, watertightness, abrasion resistance, volume stability, and resistance to freezing and thawing and deicer salts. Exposed slab surfaces are especially sensitive to curing. Surface strength development can be reduced significantly when curing is defective. Curing the concrete aids the chemical reaction called hydration. Most freshly mixed concrete contains considerably more water than is required for complete hydration of the cement; however, any appreciable loss of water by evaporation or otherwise will delay or prevent hydration. If temperatures are favorable, hydration is relatively rapid the first few days after concrete is placed; retaining water during this period is important. Good curing means evaporation should be prevented or reduced.

BACK

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