

# Concrete Basics 101

In its simplest form, concrete is a mixture of paste and aggregates (sand & rock). The paste, composed of cement and water, coats the surface of the fine (sand) and coarse aggregates (rocks) and binds them together into a rock-like mass known as concrete. A remarkable trait to this process is that concrete is plastic, and can be molded or formed into any shape when newly mixed, becoming strong and durable when hardened. This versatility explains why concrete can build skyscrapers, dams, bridges, sidewalks, superhighways, and homes.

The key to achieving a strong, durable concrete rests on careful proportioning and mixing of the ingredients. A concrete mixture without enough paste to fill all the voids between the aggregates will be difficult to place and will produce a honeycombed surface, rough 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 will be more likely to crack and be uneconomical.

A properly proportioned concrete mixture will possess the desired workability for the fresh concrete and the required durability and strength for the hardened concrete. Typically, a mixture is by volume about 10 to 15 percent cement, 60 to 75 percent aggregates and 15 to 20 percent water. Entrained air bubbles in many concrete mixtures 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 surrounds & binds each particle of sand and stone. Through a chemical reaction of cement and water called hydration, the paste hardens and gains strength. The character of concrete is determined by the quality of the paste. The strength of the paste, depends on the ratio of water to cement. Water-cement ratio is the weight of the 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 & cured.

Besides portland cement, concrete may contain other cementitious materials that include fly ash, a waste byproduct from coal burning electric power plants; ground slag, a byproduct of iron and steel manufacturing; and silica fume, a waste byproduct from the manufacture of silicon or ferro-silicon metal. Some of these cementitious materials are similar to the volcanic ashes the Romans mixed with lime to obtain their cement binder. Some of these structures still exist today!

The concrete industry uses these materials, (normally disposed in land-fills), to the advantage of concrete. The materials participate in the hydration reaction and significantly improve the strength, permeability and durability of concrete.

*Transit mixed (or "truck mixed") concrete. (The barrel trucks you see on the road.)*

In transit-mixed concrete, also called truck mixed or dry-batched, the raw ingredients are charged directly in the truck mixer. The water is usually batched at the plant. The mixer drum is turned at charging (fast) speed during loading of materials. The 3 options for truck mixed concrete are:

- Concrete mixed at the job site. While travelling to the job site the drum is turned at agitating speed (slow speed). After arriving at the job site, the concrete is completely mixed. The drum is turned for 70 to 100 revolutions, or about five minutes, at mixing speed.

- Concrete mixed in the yard. The drum is turned at high speed (12-15 rpm for 50 revolutions.) This allows a quick check of the batch. Concrete is then agitated slowly while driving to the job site.
- Concrete mixed in transit. The drum is turned at medium speed or about 8 rpm for 70 revolutions while driving to the job site. The drum is then slowed to agitating speed.

*"Mix Mobiles" - Mobile Volumetric Proportioning Plants*

"Mix Mobile" are truck-mounted, volumetric batching and continuous mixing units. These "plants-on-wheels" often supply small-volume or specialty pours and offer the convenience of freshly mixed concrete in fairly precise quantities. The unit consists of a truck with bins of sand, coarse aggregate, cement, water, and admixtures. The aggregate bins have longitudinal belts at the bottom of the sand, and as well as coarse aggregate bins that drag the aggregate to separate adjustable gates at the rear of the bin. The speed of the belts is connected to a feeder in a cement bin, and all three materials drop down into a mixer. Flow meters control the introduction of water and admixtures.