Mixing, Placing and Curing Concrete

Concrete Start to Finish

When you order a truck-load of concrete, it has to be batched (i.e., the aggregate, cement, and water must be acquired and properly proportioned), mixed (at the batch plant or in transit), transported (in dump trucks or ready-mix trucks), placed in the formwork, consolidated (to remove as much trapped air as you can), finished (to achieve a smooth, level surface), and cured (so the cement properly hydrates).

Concrete Start to Finish

1. Batch
2. Mix
3. Transport
4. Place
5. Consolidate
6. Finish
7. Cure

Concrete Start to Finish

Ready-mix concrete arrives at the job site having already been batched, mixed, and transported. This is typically done in a “ready-mix truck” (what many mistakenly call a cement mixer) that can, depending on the type of concrete plant, both mix and transport the concrete before discharging it into the formwork.

Concrete Start to Finish

Ready Mixed

1. Batch
2. Mix
3. Transport
4. Place
5. Consolidate
6. Finish
7. Cure

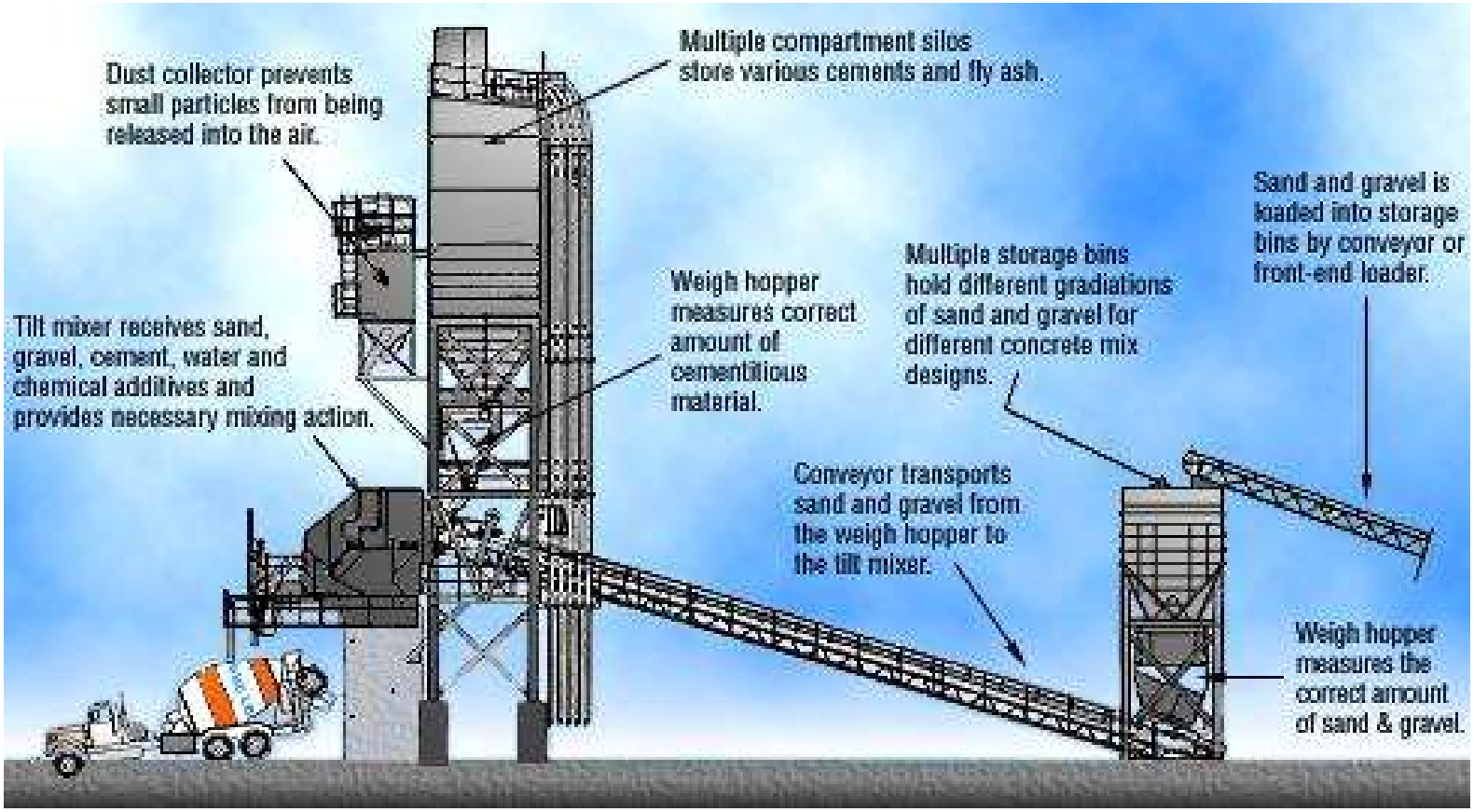
Ready-Mixed Concrete

There are three types of ready-mix concrete. They are distinguished by how and where the materials are batched and mixed. In a central-mix plant, everything is batched and mixed at the plant. In a shrink-mix plant, the ingredients are batched and partially mixed at the plant, then the rest of the mixing is done in the transit truck. In a transit-mix plant, the ingredients are batched at the plant, then the mixing is done in the transit truck on the way to or at the job site.

Central Mixing

- Approximately 20% of all plants in US
- Concrete is completely mixed using a stationary mixer (drum, paddle, pan)
- High production volumes (4000 yd^3/day)
- Rapid mixing (30 to 120 seconds)
- Improved quality control
- Can use ordinary dump trucks for transit

Central Mix Plant



Central Mixing

The mixing can be done using a drum mixer (similar to what you used in Dr. Camp's class but many times larger), a paddle mixer, a pan mixer, or a plentary mixer. These differ only in the way the ingredients are blended together.

Drum Mixer

Paddle Mixer

Source: www.answers.com/topic/concrete-mixer-1

Pan Mixer

Planetary Mixer

Source: www.sicoma.biz/code/planetary.htm

Concrete Paving

If the concrete is completely mixed at the batch plant and the travel time to the job site is short, ordinary dump trucks can be used to transport the concrete to the job site because the concrete doesn't need to be continuously agitated to keep it from setting up. This is often done in concrete paving where the batch plant is set up onsite. The concrete is dumped on the ground in front of a slip-form paver that then distributes and consolidates the concrete into a finished pavement.

Concrete Paving

Concrete Slipform Paving

https://www.gomaco.com/Resources/gp2400.html

Concrete Slipform Paving

https://www.gomaco.com/Resources/gp2400.html

Concrete Slipform Paving

Source: http://www.starkcompanies.com/

Concrete Slipform Paving

Source: http://www.starkccompanies.com/

Shrink Mixing

- Concrete is partially mixed using a stationary plant mixer to reduce volume
- 1 yd^3 of fully mixed concrete requires 1½ yd^3 of ingredients
- Concrete finishes mixing in a transit mix truck on the way to the job site

Transit Mix Truck

Transit Mix Truck

https://concretetruckmixer.net/volumetric-concrete-mixer-truck/

Transit Mix Trucks

- 9-12 yd^3 mixing drums are typical
- Low speed rotation (2 rpm) agitates
- High speed rotation (12-15 rpm) mixes
- Drum rotates one direction to mix
- Drum rotates the other to discharge

Transit Mixing

- Concrete is batched dry at a central plant and placed in a transit mix truck
- Water is either added at the plant or from a tank on the truck itself
- Concrete is mixed entirely in the truck
- Very useful for long transit times since water isn't added until it's needed

Dry Batch Concrete Plant

https://www.cmi-roadbuilding.com/concrete

Dry Batch Concrete Plant

https://www.ceienterprises.com/literature/52-products/concrete-equipment/

Transit Mixing Options

1. Mixing at the batch plant
    a) Mix for 50 revs at 12-15 rpm at batch plant
    b) Agitate at 2 rpm while in transit
2. Mixing in transit
    a) Mix for 70 revs at 8 rpm while in transit
    b) Agitate at 2 rpm until ready to discharge
3. Mixing at the job site
    a) Agitate at 2 rpm while in transit
    b) Mix 50-100 revs at 12-15 rpm at job site

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Concrete Placement

Once the concrete arrives at the job site, it has to be conveyed from the truck to the formwork. For smaller jobs, this can be done with a simple wheelbarrow. If the concrete doesn't have to travel far from the truck, it can be placed with a chute extending from the back of the truck. For longer distances, a conveyor belt can be used to move the concrete.

Concrete Placement

If the concrete has to be moved even farther, or is to be placed at a great height, you can use a crane with a bucket or, with proper mix design, the concrete can be pumped from the truck to point of deposition.

If you're casting concrete beams or panels at a precast concrete plant, you can use a Tuckerbilt, which has a hopper to transport the concrete to the forming beds and an auger to discharge the concrete into the forms.

Chute Delivery

Conveyor Belt Delivery

Conveyor Belt Delivery

Bucket Delivery

Concrete Pumping

Concrete Pumping

Tuckerbilt

Concrete Start to Finish

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Consolidation

Once the concrete has been placed in the formwork, it must be consolidated. Consolidation is the process of reducing the volume of voids, air pockets, and entrapped air in the fresh concrete, usually through the input of mechanical energy (e.g., vibrating, tamping, or rodding).

Consolidation

Consolidation is needed because the freshly placed concrete is usually honeycombed with entrapped air voids that are larger than the intentionally entrained air voids.

Without consolidation, the concrete will be weak, porous, and poorly bonded to the reinforcement (and unsightly).

Poor Vibration

Poor Vibration

https://www.construct-ed.com/concrete-vibration/

Consolidation

On small jobs involving flatwork such as sidewalks, consolidation can be accomplished using manual or mechanical tampers. For thicker slabs, vibrators are needed to get all of the trapped air out. For vertical concreting (things like beams and columns) either internal or external vibrators can be used. The latter clamp onto the outside of the formwork and vibrate the entire form to release the trapped air.

Tamping

https://www.concretenetwork.com/concrete/concrete_tools/tampers.htm

Internal Vibrators

https://civilsnapshot.com/concrete-vibrators-and-its-type/

External Vibrators

https://www.mooser.net/en/construction-references/industry-construction/bv-augustin-riederau-e.html

External Vibrators

https://djcoregon.com/files/2014/05/0523_Zoo_Wall_Pour_08_WEB.jpg

Concrete Start to Finish

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Finishing

Once the concrete has been consolidated, you might only need to level it off. For flatwork such as floors, though, several more steps might be involved.

Flatwork is any poured concrete whose surface is horizontal. This includes floors, patios, sidewalks, driveways, and pavements.

Finishing

In ***tilt-up construction***, walls are poured flat on the ground then tilted up into place, so that is also a form of flatwork.

The goal is to ensure the surface is flat; level; sealed to produce a hard, durable, and non-porous surface; and perhaps textured to provide a non-slip surface or stamped to imprint a pattern on the surface.

Flatwork Finishing Methods

Screeding

bringing concrete to correct height

Floating

pushing coarse aggregate below surface

Troweling

bringing bleed water to surface and sealing

Texturing

providing nonskid texture

Screeding

Screeding removes any excess concrete and brings the surface to the proper grade. Screeding takes place immediately after the concrete is placed and must be completed before excess ***bleed water*** appears on the surface. Bleed water is water that rises to the surface of the concrete. Excessive bleeding is a bad thing, but some bleeding is both natural and necessary to produce a proper finished surface.

Screeding

Screeding can be done with a simple straightedge pulled across the concrete surface. For larger jobs, a power screed can be used. Power screeds vibrate the straightedge side-to-side to aid in moving the concrete around.

Screeding

Manual Screed

Power Screed

Floating

Floating fills in voids left by screeding and pushes the coarse aggregate particles slightly below the surface, leaving a thin layer of mortar at the surface to aid in finishing.

Floating can be done with something as simple as a wood, magnesium, or aluminum board or as elaborate as a power float with rotating magnesium blades.

Floating

Power Floating

Manual Floating

Troweling

Troweling brings a small amount of bleed water to the surface to produce a hard, dense finish. The bleed water contains cement, so you're actually producing a thin layer of cement paste to seal the surface.

Troweling

Power Troweling

Manual Troweling

Texturing

Brooming and dragging impart a rough texture to the surface of sidewalk and pavement slabs to provide good traction in wet weather. As the name implies, brooming is done with a broom whose bristles impart thin grooves to the surface. Dragging is done with a burlap sheet. By dragging it across the surface of the concrete, the rough material imparts a texture on the surface.

Brooming

Burlap Dragging

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Curing

The final step in the process is to cure the concrete. Curing is essential to developing proper strength and durability by:

1. Maintaining adequate moisture in the concrete to hydrate the cement, and
2. Maintaining a minimum temperature inside the concrete so hydration proceeds at an adequate rate.

Poor Curing

Concrete Curing

There are two main ways to ensure adequate moisture: keep the water in or replace the water that leaves.

Barrier methods include simple plastic sheeting, waxy spray-on coatings, and insulating blankets that retain both heat and moisture.

Replacement methods keep the concrete surface wet so water doesn't want to escape or is replenished as it does escape.

Concrete Curing

Replacement Methods	Barrier Methods
ponding	plastic sheets
fogging	curing compounds
wet burlap	insulating blankets
wet straw	
wet sawdust	

Ponding

Ponding

Fogging

Fogging

http://www.concretebridgeviews.com/i80/Article3.php

Wet Burlap / Straw

Wet Burlap and Plastic Sheeting

Plastic Sheeting

Insulating Blankets

Curing Compounds

Curing Compounds