concrete paving workforce reference no. 1

CONCRETE MATERIALS STORAGE, MIXING, AND DELIVERY

PCC Center
Iowa State University
2901 South Loop Drive, Suite 3100
Ames, IA 50010
www.pcccenter.iastate.edu

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1.1. Inventorying Concrete Materials

Overview

To ensure that high-quality materials are used in concrete mixing, all materials delivered to the site should be inspected to ensure that they meet specification requirements. All materials should be delivered with the proper certifications, invoices, or bill of lading. These records should indicate when the shipment arrived, the amount and identification of material delivered, and the laboratory report certification number, invoice number, and ticket number.

Common Problems

- Non-certified materials
- Materials with outdated shelf life
- Contaminated materials
- Frozen or damaged materials

Aggregates

Description

Aggregates (60%–70% of mix by volume) affect mix workability and concrete strength and durability. Aggregates may consist of crushed stone, gravel, or sand. Well-graded aggregate contains many sizes of aggregate. Gap-graded aggregate contains little or no material retained on certain sieve sizes. Gap-graded aggregates make concrete more difficult to place and require more paste. Ideal aggregate shape is smooth and round like gravels. Crushed limestone is most often used in Iowa pavements because of durability and availability.

Recommended Procedures

- Incorporate certified aggregate into a project if certified truck tickets are provided with delivery.
- Use well-graded aggregate in the mixture when available.
- Use natural gravel or limestone aggregate when available.

Gradations of aggregate

Cementitious Materials

Description

Cementitious materials (9%–15% of mix by volume) control certain characteristics of the mixture and of the finished concrete. Portland cement forms the "glue" that hardens and holds aggregate particles together. Supplementary cementitious materials, including industrial byproducts such as fly ash and ground granulated blast furnace slag, are also used in concrete and can affect concrete properties.

Recommended Procedures

- Incorporate portland cement, fly ash, and slag on the basis of manufacturer certification and as called for in the mix design.

Water

Description

Water (15%–16% of mix by volume) hydrates cement and makes the mixture workable.

Recommended Procedures

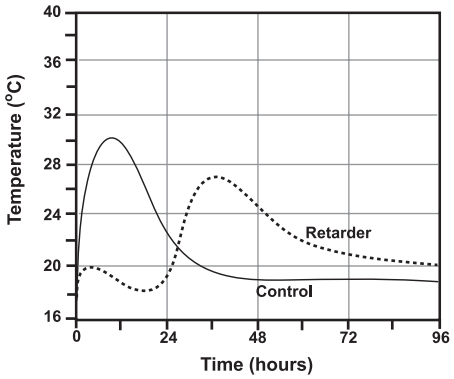
- Use water secured from streams, lakes, and other non-potable sources only after it is tested and approved.
- Water suitable for drinking is suitable for concrete.

Chemical Admixtures

Description

Chemical admixtures fall into the following categories:

- **Air entrainers** are used to stabilize air bubbles that improve freeze-thaw durability. Air entrainers also improve mix workability.
- **Water reducers** maximize the use of the existing water in the mix and decrease the amount of water added.
- **Retarders** slow the hydration process, providing more time for delivery of concrete mixtures that need to be transported long distances or placed during particularly hot weather to delay initial set until placement is completed. When retarders are added, non-agitating dump trucks generally have 60 minutes instead of 30 minutes to deliver the mixture.



Effects of retarders on concrete mixture temperature over time

Recommended Procedures

- Use only chemical admixtures that appear on the approved list.
- Do not use an admixture suspected of being frozen unless it has additional testing and approval.
- Do not use an admixture suspected of being older than 18 months unless it has additional testing and approval.
- Mix admixtures thoroughly once per day prior to proportioning to maintain the solids in suspension.

1.2. Storing Concrete Materials

Overview

Proper storage practices are critical to protect materials from intermingling, contamination, or degradation, and to maintain consistent aggregate gradation throughout a project.

Common Problems

- Segregation of aggregate (example: large aggregate rolls down the side of a tall cone pile)
- Degradation of aggregate (example: endloaders or trucks on pile crush the aggregate)
- Contamination of materials by deleterious substances (example: trucks track clay and mud onto aggregate)
- Inconsistent or undesirable moisture content (example: materials are not wetted or allowed to drain properly)
- Lumps in cementitious materials due to heat or moisture in material
- Frozen lumps of aggregates due to lack of precautions in cold weather

Mudball resulting from stockpile contamination

Recommended Procedures

Cementitious Materials

- Store cementitious materials in separate silos or storage units.
- Clearly identify the contents of storage units.

Chemical Admixtures

- Clearly label storage tanks for chemical admixtures.
- Protect admixtures from freezing.
- Agitate admixtures regularly to prevent settling.

Aggregates

- Store aggregates in separate bunkers when many gradations and types of aggregate are required in small quantities for relatively low-production operations.
- Otherwise, store aggregate in open stockpiles.

Well-built and well-maintained aggregate stockpile

Proper end-loader operation

Stockpiling Aggregate

Locating Stockpiles

- Locate stockpiles where they will not be driven on. Driving on stockpiled aggregate segregates and degrades the aggregate, affecting its performance.
- Separate stockpiles from each other. If there is not enough space between them to keep them separate, use a separating wall.

Preparing Stockpile Base

- Make sure the stockpile base is firm and uniform because it supports the pile and prevents soil from being scooped in with the aggregate.
- Provide adequate base of a differing aggregate type to prevent pumping mud into the bottom of the aggregate pile.

Building Stockpiles

- Determine the equipment to be used and personnel responsible before delivering aggregate to the plant site.
- Do not pile aggregate in a high cone shape because it will segregate.
- Do not make the stockpile higher than the lift of the end-loader's bucket.
- Build the pile outward, not upward.

Maintaining Stockpiles

- Do not drive on stockpiles; this may break down the aggregate and segregate the particle sizes.
- Keep the area clean and discard contaminated materials.
- When removing aggregate from a pile with a front-end loader, attempt to get a portion of each layer in each load.
- Work the aggregate stockpile to maintain uniform moisture and gradation.
- Do not allow stockpile to get so low that the loader digs into soil base.
- Avoid careless dumping of material into the wrong stockpile.

Managing Stockpile Moisture

- Keep the aggregate moisture content at or above the saturated surface dry condition, especially for absorptive aggregates used during hot weather. Drain fine aggregate at least 24 hours before use.
- Note differences in aggregate moisture throughout the stockpile since the moisture condition of aggregate affects the workability of concrete. The moisture content of successive batches should not vary by more than 0.5%.
- If aggregate moisture varies through the day, measure moisture content more frequently.
- Regularly mix aggregate from different areas of the pile for each batch so that the overall aggregate moisture level is consistent from batch to batch.

1.3. Water-Cement Ratio

Overview

The amount of water in the concrete mixture has a direct effect on the quality of the plastic concrete paste that glues the aggregate particles together and, subsequently, on the strength, permeability, and durability of the hardened concrete. The water-cement ratio is the weight of water divided by the weight of cementitious materials in a concrete mix.

Common Problems

- Water-cement ratio too low, resulting in a mix that is difficult to place and finish
- Water-cement ratio too high, resulting in weak, porous paste that has low strength and is less durable

Recommended Procedures

- Use only enough water to make the mix workable and achieve the desired strength.
- Account for the moisture content of the aggregate in determining the amount of free water added to the mix.
- Do not add extra water during mixing, placing, and especially on the surface during finishing.

1.4. Concrete Batching

Overview

Batching is the process of measuring concrete mix ingredients and introducing them into the mixer to produce concrete of a uniform quality. Concrete batch plants need to be well maintained and properly operated to produce a uniform concrete mix from batch to batch.

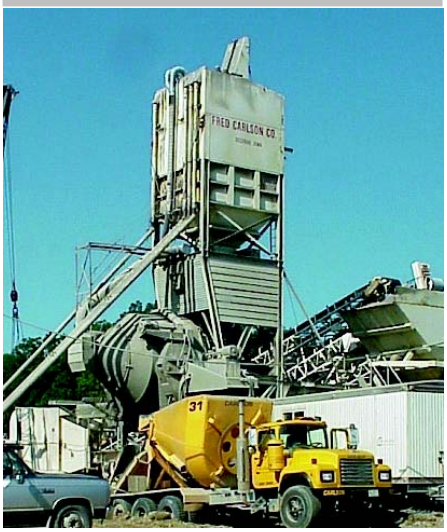
Common Problems

- Aggregate segregation
- Varying moisture content
- Addition of too much water, resulting in reduced concrete strength and increased shrinkage
- Overdose of admixture, resulting in poor workability and retardation

Recommended Procedures

- Use separate aggregate bins for each size of coarse aggregate. Bins should be capable of shutting off material with precision.
- Use controls to monitor aggregate quantities during hopper charging.
- Use standard test weights for checking scale accuracy.
- Maintain mixer blades. Watch for wear and coating.
- Do not load mixer above rated capacity.
- Operate mixer at manufacturer-recommended speed.
- Mix all concrete thoroughly until it is uniform in appearance, with all ingredients evenly distributed.
- Take samples from different portions of a batch to ensure that the whole batch has the same air content, slump, unit weight, and aggregate proportions.

1.5. Stationary Mixing and Delivery



Overview

Stationary mixed concrete is often used where large volumes of concrete need to be placed in a short period of time.

Common Problems

- Short mixing times resulting in non-uniform mixtures, poor distribution of air voids, poor strength gain, and early stiffening problems
- Insufficient monitoring of aggregate moistures
- Lumps or segregation resulting in non-uniform mixture

Mixing

Description

Stationary mixing is the mixing of concrete at a nearby or on-site concrete batch plant.

Recommended Procedures

- Set and lock the mixer timing device to the recommended mixing time if possible.
- Measure the mixing period from the time all cement and aggregates are in the mixer drum.
- Add supplementary cementitious materials after the cement.
- Add all of the water before one-fourth of the mixing time has elapsed.
- When two or more admixtures are used in the same batch of concrete, introduce them separately to avoid any interaction that might compromise the effectiveness of the admixtures.
- Introduce admixtures in the same sequence in the charging cycle.
- Complete the addition of admixtures not later than one minute after adding water to the cement or prior to the start of the last three-fourths of the mixing cycle, whichever occurs first.

Delivery

Description

Standard dump trucks or agitor trucks are used to transport the already-mixed concrete the relatively short distance from the stationary batch plant to the mix placement site. Agitor trucks have an agitator paddle inside the truck box. If the paddle is not rotating, the vehicle is no different from a dump truck.

Recommended Procedures

- Transport mix in well-maintained vehicles.
- Deliver and place concrete mixture at the job site within the specified time period. Retarding admixtures may be used to extend the time limit. The time limit may also be longer with continuous agitation than without continuous agitation.
- Check that delivery vehicles are free from concrete build-up. Check boxes between loads.

Dump truck

Agitor truck

1.6. Ready Mixing and Delivery

Overview

Ready mixed concrete is often used for lower volume paving projects such as urban paving. Ready mixed concrete is proportioned and mixed off the project site and is transported to the construction site in a freshly mixed state in ready mix trucks.

Common Problems

- Mixing at high speeds for long periods of time, resulting in reduced air content and decreased workability
- Excess water added to ready mixed concrete, resulting in decreased long-term pavement durability
- Lumps or segregation, resulting in nonuniform mixture

Recommended Procedures

- Once all materials have been added, apply at least 70 to 100 revolutions of the ready mix drum at the manufacturer-recommended mixing speed (6 to 18 rpm).
- Make sure the ready mix drum is constantly revolving during delivery.
- Deliver and place concrete mixture at the job site within 90 minutes of initial mixing.
- Check each mix truck for worn blades or concrete build-up. Keep blades clean and replace them when they become worn.

1.7. Hot Weather Batching

Overview

Hot weather (air temperatures over 90°F) during concrete batching can reduce mix workability. Many states specify a maximum concrete temperature limit of 90°F.

Common Problems

- Drying of aggregate stockpiles
- Accelerated rate of cement hydration
- High concrete temperatures, resulting in premature setting
- Thermal cracking
- Plastic shrinkage cracking

Recommended Procedures

- Avoid use of fresh or hot cement or fly ash.
- Use slag and/or fly ash as a substitute for some portion of portland cement to lower the peak concrete temperature.
- Do not exceed the maximum allowed water-cement ratio.
- Add chilled water to the concrete mix when necessary.
- Do not exceed the manufacturer's maximum recommended dosage of admixtures.
- If necessary, increase the dosage of air entraining admixture to maintain air content.
- Use retarding admixtures based on trial batch performance.
- Take precautions when concrete temperatures exceed 90°F.

1.8. Cold Weather Batching

Overview

Cold weather (air temperatures under 50°F) during concrete batching can cause plastic shrinkage cracking, especially if the concrete temperature is much warmer than the air or if the wind is blowing. Keeping the concrete mixture at a temperature of at least 50°F helps to maintain mix workability.

Common Problems

- Plastic shrinkage cracking
- Slow strength gain

Recommended Procedures

- Do not use aggregates with frozen lumps.
- Use heated materials.
- Reduce or eliminate slag and fly ash because they slow hydration.
- If necessary, decrease the dosage of air entraining admixture to maintain air content.
- Increase cement content of the mixture to generate more heat.