

Batching, Mixing, and Transporting Concrete





Objectives

- Standards
- Batching
- Mixing
- Transporting

ASTM C94/C94M

Standard Specification for Ready-Mixed Concrete

- Materials specifications
- Ordering information
- Slump tolerances
- Measuring tolerances
- Mixer/Agitator requirements
- Delivery methods
- Testing methods



ASTM C685/C685M

Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing

- Materials specifications
- Ordering information
- Slump tolerances
- Measuring tolerances
- Mixing mechanism
- Delivery methods
- Testing methods





ACI 304R

Guide for Measuring, Mixing, Transporting,
and Placing Concrete

- Control, handling, and storage of materials
- Measurement and batching
- Mixing and transporting
- Placing
- Volumetric batching

Batching

- Process of measuring concrete mixture ingredients by either mass or volume
- Most specifications require batching by mass



Batching by Volume

- ASTM C685
- Yield checks
- Proportioning checks



Tolerances for batching by volume:

- Cement, mass% = 0 - +4
- Fine aggregate, mass% = ± 2
- Coarse aggregate, mass% = ± 2
- Admixtures, mass or volume% = ± 3
- Water, mass or volume% = ± 1

Batching by Mass

- ASTM C94
- Batching plant - precision control discharge operation
- Plant scales - accurate to $\pm 0.15\%$ total capacity or 0.4% net applied load



Batching by Mass

Cementitious materials:

- Measured separately or combined sequentially
- Cement first
- Tolerance at 30% or greater of full scale capacity - $\pm 1\%$ required mass
- Tolerance for loads smaller 30% of scale capacity- 0-+4% required mass



Batching by Mass



Aggregate:

- Can be measured individually or combined
- Tolerances
 - ◆ Individual loads - $\pm 2\%$ of required mass
 - ◆ Cumulative loads
 - ⌘ 30% or more of scale capacity - $\pm 1\%$ of required mass after each successive weighing
 - ⌘ less than 30% of scale capacity - the lesser of $\pm 0.3\%$ of scale capacity or $\pm 3\%$ of required mass

Batching by Mass

Water:

- Tolerance - $\pm 1\%$ by mass or volume
- Ice must be measured by mass
- Wash water remaining in truck mixer drums must be accurately measured
- Total water tolerance - $\pm 3\%$ of the specified total amount



Batching by Mass

Admixtures:

- Powdered admixtures - mass
- Liquid admixtures - mass or volume
- Tolerance - greater of:
 - ◆ $\pm 3\%$ of total amount required
 - ◆ $\pm 100\%$ dosage per 50kg (100lbs) of cement



Inspecting Batch Plants

ACI 311.5

- Project specification compliance
- Storage standards compliance
- Materials testing standards compliance
- Truck operating conditions
- Equipment calibration
- Batch ticket verification



Mixing and Transporting Concrete

- Ordering concrete
- Ready mixed concrete
- Mobile batcher mixed concrete
- Remixing concrete





Ordering Concrete

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Purchaser specifies:

- Sizes of coarse aggregate
- Slump at point of delivery
- Air content at point of delivery
- One of three options for remaining parameters



Ordering Concrete

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Option A—performance based:

Purchaser specifies:

- Compressive strength

Concrete producer selects mix proportions.



Ordering Concrete

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Option B—prescription based:

Purchaser specifies mixture proportions including:

- Cement content
- Water content
- Admixture type and content



Ordering Concrete

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Option C—mixed option:

Purchaser specifies:

- Compressive strength
- Cement content
- Admixture type and content

Concrete producer selects mix proportions.



Prescription to Performance (P2P)

- Move away from prescription specifications
- Move towards performance specifications
- Focus – final product performance



P2P - Advantages

- More efficient process
- Encourages cooperation
- Improved consistency

Ready Mixed Concrete

- Central-mixed concrete
- Shrink-mixed concrete
- Truck-mixed concrete

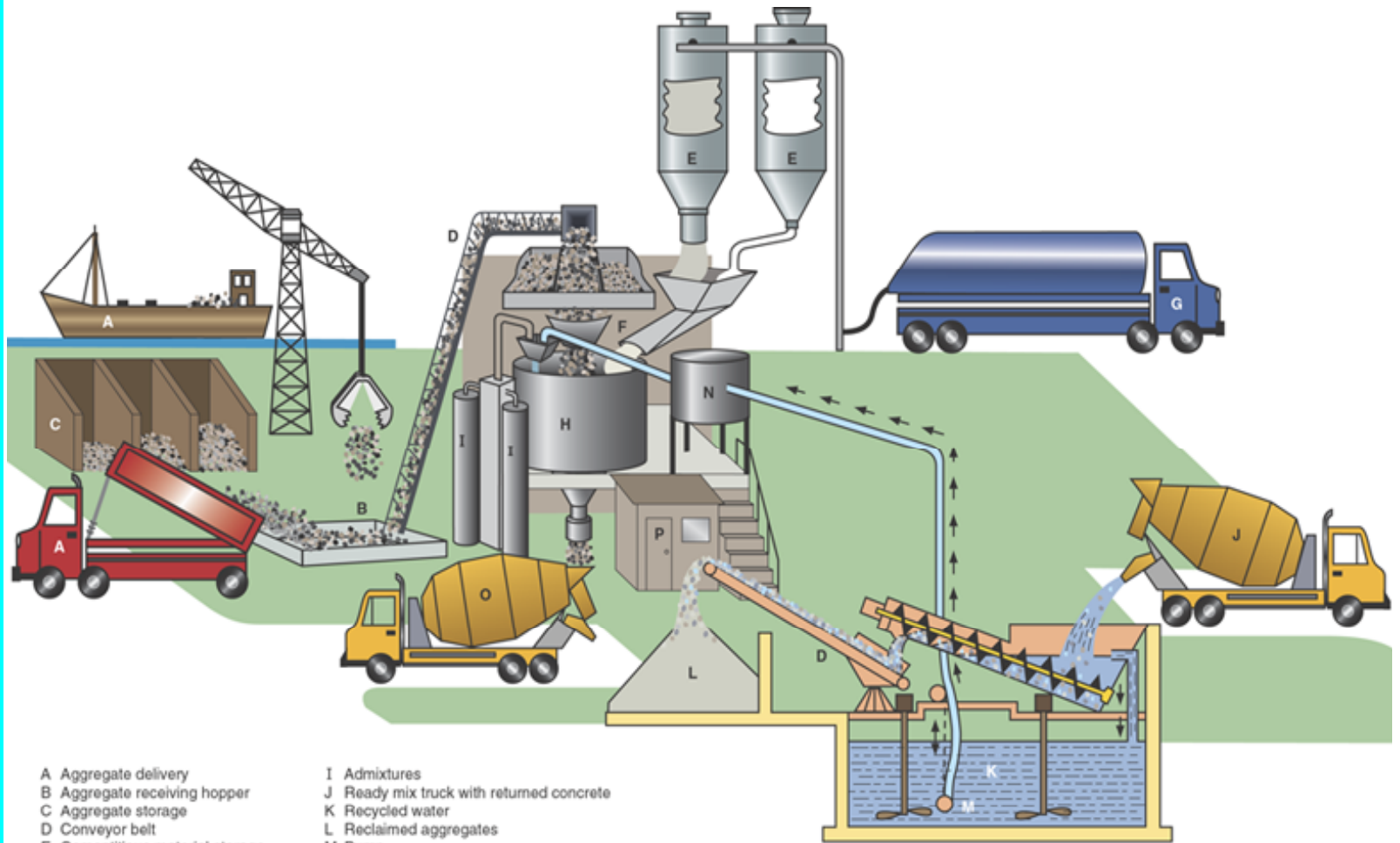


Central-mixed Concrete

- Mixed completely in a stationary mixer
- Delivered in
 - ◆ a truck agitator
 - ◆ a truck mixer operating at agitating speed
 - ◆ a non-agitating truck



Central Mix Plant



- | | |
|---------------------------------|--|
| A Aggregate delivery | I Admixtures |
| B Aggregate receiving hopper | J Ready mix truck with returned concrete |
| C Aggregate storage | K Recycled water |
| D Conveyor belt | L Reclaimed aggregates |
| E Cementitious material storage | M Pump |
| F Weigh hopper | N Water storage |
| G Cement delivery | O Concrete loaded in ready-mix truck |
| H Mixer | P Control room |

Stationary Mixers



- Stationary Mixers
 - ◆ Onsite or central mix ready mixed concrete plant
 - ◆ Used for complete or shrink mixing
- Mixer Types — up to 9 m³
 - ◆ Tilting or non-tilting drum
 - ◆ Open top revolving blade or paddle



Ready Mixed Concrete

Shrink-mixed Concrete

- Partial mixing in stationary mixer and completed in truck mixer
- Stationary mixing time should be minimum
- Performance tests same as central-mixed concrete

Ready Mixed Concrete

Truck-mixed Concrete



- Mixed completely in a truck mixer
- 70 to 100 mixing revolutions, mixing speed = 6-18 rpm
- Agitating speed = 2-6 rpm
- Discharge before 1½ hours or 300 revolutions

Mixer Trucks



Used for: pavements, structures, and buildings – distances must allow discharge of concrete within 1½ hours

Advantages: central mixing plant not needed, discharge is well controlled

Watch for: Timing of deliveries should suit job organization. Concrete crew and equipment must be ready onsite to handle concrete. Control of quality is not as good as with central mixing.

Mixer Trucks



Rear Discharge



Front Discharge

Agitator Trucks



Used for: Transporting concrete for all uses. Haul distances must allow discharge of concrete within 1½ hours.

Advantages: Operate usually from central mixing plants.

Watch for: Timing of deliveries should suit job organization. Concrete crew and equipment must be ready onsite to handle concrete.

Non-agitating Truck



Used for: Transport concrete on short hauls over smooth roadways.

Advantages: Cost of non-agitating equipment is lower than that of truck agitators or mixers.

Watch for: Slump should be limited. Possibility of segregation. Height upon discharge is needed.



Mobile Batcher Mixed Concrete

- Auger-type mixer
- Mixing rate determined by manufacturer
- Slump tolerances $\sim \pm 40\text{mm}$ (1.5 in) depending on specified slump



Mobile Batcher Mixed Concrete Uniformity

Requirements for Within-Batch Uniformity of Concrete

	Range of 2 Samples
Air content, %	1.0
Air free density	16 kg/m ³ (1.0 lb/ft ³)
Slump	
Avg. <100mm (4 in)	25 mm (1 in)
Avg. >100mm (4 in)	40 mm (1.5 in)
Coarse aggregate content, % mass concrete	6.0
7-day strength, % of average	7.5

Mobile Batcher Mixer Truck

Used for: Intermittent production of concrete at jobsite, or small quantities.

Advantages: Combined materials transporter and batching and mixing system. One-man operation.

Watch for: Good preventive maintenance program. Materials must be identical to those in original mix design.



Truck Manufacturers Bureaus





Remixing Concrete

ASTM C94

Water may be added at jobsite provided:

- Spec. w/c-ratio is not exceeded
- Measured slump less than specified
- Mixing time or drum revolutions not exceeded
- Concrete is remixed
 - ◆ min. 30 rev. at mixing speed
 - ◆ until uniformity is within limits

Transporting Concrete

Watch out for:

- **Delays**

- ◆ Labor force management
- ◆ Equipment selection
- ◆ Route planning

- **Early stiffening**

- ◆ Flash/False set
- ◆ Accelerated hydration



Transporting Concrete

Watch out for:

- **Drying out**
 - ◆ Hot and dry weather
 - ◆ Low W/CM
 - ◆ Use of silica fume or admixtures that affect bleed water
- **Segregation**
 - ◆ Cohesive mixture
 - ◆ Placing method and rate



