

What Everyone Receiving Fresh Concrete at the Jobsite Should Know

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Modern construction



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Concrete is “manufacturing”

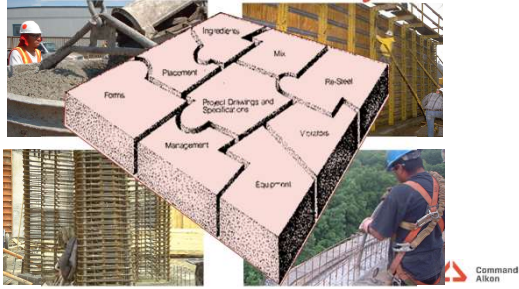
Manufacturing – (industrial production) - in which raw materials are transformed into finished goods - Wikipedia

- Fresh concrete (rock, sand, cement & water)
- Reinforcing steel
- Formwork
- Curing (moisture and thermal)
- (Testing)



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Concrete is Part of a System



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You affect the quality



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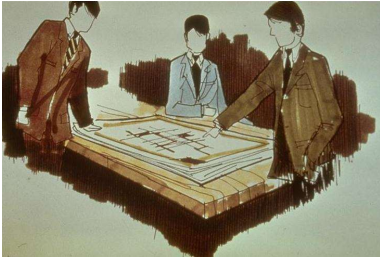
Design of Concrete Mixtures D.A. Abrams, Lewis Inst., Bull. 1, 1918

"... water, is in fact, the most important ingredient, since very small variations in water content produce more important variations in the strength and other properties of concrete with similar changes in other ingredients."



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Before the placement



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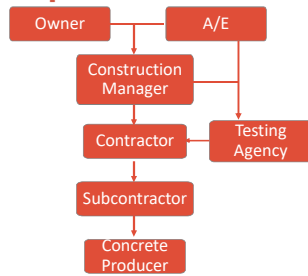
"If you don't know where you're going, you're liable to end up somewhere else."

- Yogi Berra



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Interested parties



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Specifications and Notes

- E. Suspended Slabs: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 30 MPa at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.54.
 3. Minimum Cementitious Materials Content: 320 kg/cu. m for 20 mm nominal maximum aggregate size.
 4. Slump Limit: 125 mm, plus or minus 25 mm.

E. CAST-IN-PLACE CONCRETE

1. CAST-IN-PLACE CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF ACI 301-10, SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDING AND THE ACI MANUAL OF STANDARD PRACTICE.
2. ALL CONCRETE SHALL BE NORMAL WEIGHT.
3. CONCRETE SHALL HAVE THE FOLLOWING MINIMUM COMPRESSIVE STRENGTHS AT 28 DAYS:
 - 25 MPa FOR CHAIRS/WORK AND PERIMETER WALLS
 - 25 MPa FOR FOOTINGS/FOUNDATIONS AND SLABS ON GRADE
 - 30 MPa FOR FOUNDATION WALLS
 - 30 MPa FOR SUSPENDED SLABS, BUILDING WALLS, AND FRAMING MEMBERS
 - 30 MPa FOR CONCRETE TOPPING
 - 30 MPa FOR COLUMNS TOP
 - 42 MPa FOR COLUMNS AT NOB



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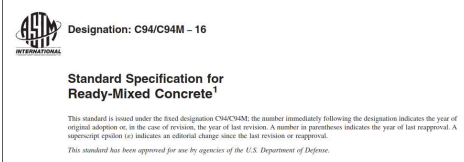
Specifying the Concrete Mix

- Maximum aggregate size
- Slump & tolerance (maximum or nominal)
- Air content and tolerance
- Concrete temperature range
- Concrete unit weight and tolerance (ltwt & hvywt)
- Design strength
- Placement method
- Type of concrete element (i.e. wall, slab, beam)
- How long can the concrete be held at the job?
- ASTM C-94 Option A, B or C



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ASTM C-94, Specification for RM



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ASTM C94 Ordering

- Maximum size of coarse aggregate
- Slump or slump flow at point of delivery
- Air content at point of delivery
- Tolerances for slump, slump flow or air
- Lightweight concrete density
- Heavyweight concrete fresh density
- Optional requirements for water
- Max drum revolutions permitted before discharge
- Use of Option A, B or C
 - A – Purchaser states design requirements, Manufacturer designs mix
 - B – Purchaser assumes responsibility for mix design and Manufacturer batches as designed
 - C – Purchaser states design requirements, including min. cement and/or max w/cm but Manufacturer designs the mix



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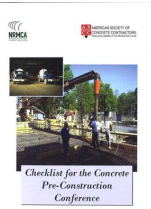
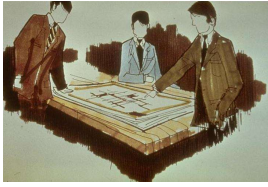
The Concrete Submittal

- Summary of mix design requirements
- Mix target slump, air content, unit weight
- Maximum number of revolutions of drum
- Materials' qualifications
- Mix design material names & quantities
- **Justification of strength**
 - w/cm curve
 - Statistical overdesign



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Preconstruction conference



<http://www.nrmca.org/aboutconcrete/cips/32p.pdf>
<http://www.ascconline.org/>

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The Order

- Mix code/name (alternate mix codes or plants?)
- Time to start placement
- Delivery frequency (i.e. "every 20 minutes")
- Total number of cubic yards/meters
- Placement method
- Placement/delivery location
- Special requirements
 - Materials, clean-up
- NRMCA CIP-31 – "Ordering Ready Mixed Concrete"



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DURING the placement

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Get Ready for Placement

- Placing equipment in place and set up
- Placing crew ready to place concrete
- Finishing crew available
- Truck delivery location accessible
- Truck staging area accessible
- Truck cleanout location accessible
- Testing lab notified and available
- Aware of Mix ID, required slump & air content



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First Truck Arrives

- Notify placing crew
- Prepare delivery equipment



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The Delivery Ticket

[illegible]

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The Delivery Ticket

Truck	Driver	User	Disp	Ticket Num	Ticket ID	Time	Date
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID	
10.00 yd	3000				N	6991	
Material	Design Qty	Required	Batched	% Var % Moisture	Actual	Wet	
CEMENT	817.00 lb	817.00 lb	817.00 lb	0.00%	728 lb		
SAND	10000.00 lb	10000.00 lb	10000.00 lb	0.00%	535.71 lb		
GRAVEL	7000.00 lb	7000.00 lb	7000.00 lb	0.00%	1885.62 lb		
WATER	30.00 gal	30.00 gal	30.00 gal	2.27%	511.86 lb		
HOT							
Summaries	4000.00 lb	Design W/C: 0.585	Water/Cement: 0.587	A	Design 2820.8 lb	Actual 3454.8 lb	To Add: 0.0 lb
Load	3.00 yd	Design W/C: 0.585	Water/Cement: 0.587	A	Design 2820.8 lb	Actual 3454.8 lb	To Add: 0.0 lb
Actual W/C Ratio: 0.587		Actual Water: 3455 lb	Batched Cement: 5870 lb		0.0 g / Load	Form Water: 0.0 g / yd	
Actual W/C Ratio: 0.587		Actual Water: 3455 lb	Batched Cement: 5870 lb		0.0 g / Load	Form Water: 0.0 g / yd	
Load Completed		Load Time: 1:41			---Tares---		
AGG SCALE	8 1 ST	0 lb	ET 43 lb	CEM SCALE	8 1 ST	0 lb	ET 10 lb

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Preliminary Characteristic Test

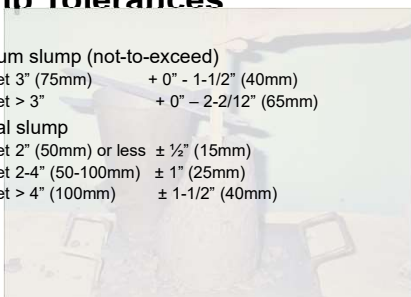
ASTM C94 – “17.6 If preliminary checks of slump, slump flow, or air content are made, a single sample shall be taken after the discharge of not less than ¼ m³ or ¼ yd³. All other requirements of Practice C172/C172M shall be retained. If the preliminary measurement of slump (12.7) or air content (8.3) falls outside the specified limits, address as indicated in section 17.6.1 or 17.6.2 as appropriate.”



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Slump Tolerances

- Maximum slump (not-to-exceed)
 - Target 3" (75mm) + 0" - 1-1/2" (40mm)
 - Target > 3" + 0" - 2-2/12" (65mm)
- Nominal slump
 - Target 2" (50mm) or less ± ½" (15mm)
 - Target 2-4" (50-100mm) ± 1" (25mm)
 - Target > 4" (100mm) ± 1-1/2" (40mm)



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Slump Flow Tolerances

- Target $\leq 22"$ (55mm) $\pm 1\text{-}1/2"$ (40mm)
- Target $> 22"$ (55mm) $\pm 2\text{-}1/2"$ (65mm)



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When Add Water?

- Check the slump after the concrete arrives at the project
- If slump is wrong, mix at mixing speed for 30 revs
- If slump is still wrong, add water to achieve designated slump, but don't exceed allowable w/cm ratio (some limits for air-entrained superplasticized concrete)
- Record added water on delivery ticket



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When NOT to Add Water

- After a 1-time addition of water
- After more than 10% of concrete discharged
- If a superplasticizer has been added
- If there is no water addition allowed based on the batch ticket or specification
- If the design water/cementitious ratio will be exceeded



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Impact of Adding Water

- Adding 1 gallon of water to 1 cyd of concrete
 - Increases slump by about 1 inch
 - Decreases strength by about 5%
- Affects air content, permeability & cracking
- NRMCA CIP-26 – “Jobsite Addition of Water”



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Air Tolerances

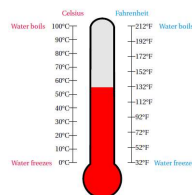
- ASTM C94 8.2: $\pm 1.5\%$ of specified value
- ASTM C94 – “8.3 When a preliminary sample taken within the time limits of 12.7 and prior to discharge for placement shows an air content below the specified level by more than the allowable tolerance in accordance with 8.2, the manufacturer may use additional air entraining admixture to achieve the desired air content level, followed by a minimum of 30 revolutions at mixing speed, so long as the revolution limit of 6.1.9 is not exceeded (see Note 11).”



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Temperature factors

- Hot Weather
 - Concrete initial temperature, accelerated set
 - Proper form or sub-grade preparation
 - Provisions in place for curing
- Cold Weather
 - Concrete initial temperature, delayed set
 - Moisture and thermal curing
 - Insulated forms



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Adding Other Materials

- Superplasticizers
- Pigments
- Fibers
- Powdered admixtures
- Note all additions on the batch ticket and report to the testing agency



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Producer's responsibility

- ASTM C94 – “7.2 Concrete shall be available within the permissible range of slump or slump flow for a period of 30 min starting either on arrival at the job site or after the initial slump adjustment permitted in 12.7, whichever is later.”
- Only 1 addition of water allowed. Consider addition of superplasticizer. (May cause other problems.)



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Contractor's responsibility

- ASTM C94 – “7.2 If the user is unprepared for discharge of the concrete from the vehicle, the producer shall not be responsible for the limitation of minimum slump or slump flow after 30 min have elapsed starting either on arrival of the vehicle at the prescribed destination or at the requested delivery time, whichever is later.”



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Rejecting Concrete

- Person responsible should be established in the pre-construction conference or purchase order
- Consequences of rejection should be known (i.e. cold joint)
- Concrete should not be rejected if it complies with slump, air and temperature requirements without addition of water (other options?)
- Evaluate construction practices if concrete must be rejected or accepted outside of limits



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Reasons for Rejection at Jobsite

Cause	Percent of Respondents
Slump	43%
Air Content	32%
Delivery Time/revs	14%
Other	8%

NRMCA Quality Survey



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Concrete Age When Placing

- What is the objective?
- No real limit if admixtures used appropriately
- ACI 301-10 – After 90 minutes verify slump and air content
- ASTM C-94 – Concrete shall maintain slump range for at least 30 minutes after arrival. Concrete must be placed within 90 minutes of batch time unless it is still workable



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Drum Revolutions

ASTM C94 - Purchaser must state limit on drum revolutions.
If purchaser doesn't state limit, manufacturer must state it.
Limit must appear on batch ticket.



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Other Problems

- Air content, temperature & unit weight – Report to concrete producer
- Segregation – Reduce slump
- Placing & finishing – Report to concrete producer
- Delivery rate – Report to concrete producer



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90% Completion

- Determine quantity of concrete still required
- Who will order additional concrete and when?
- Should placing rate be slowed to maintain even delivery of concrete?



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Receiving Concrete Checklist *(added)*

- Planned start time and spacing factor
- Truck arrival time & truck number
- Qty of water added and time added
- Time start discharge
- Time finish discharge
- Was concrete sampled & tested
- Test results (slump, air, temp., unit weight, # of cylinders)



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Sampling & Testing Concrete



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Curing Boxes



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Concrete Producer & Test Reports

- ACI 318-14, "Building Code Requirements for Structural Concrete" Para 26.12.1.1 (e): "All reports of acceptance tests shall be provided to the licensed design professional, contractor, concrete producer, and, if requested, to the owner and the building official."
- ACI 301-10, "Specifications for Structural Concrete" Section 1.6.3.1.c: "The Owner's testing agency will report test and inspection results of the Work to Owner, Architect/Engineer, Contractor, and concrete supplier within 7 days after tests and inspections are performed."
- ASTM C94, "Standard Specification for Ready-Mixed Concrete" Para. 6.1: "The purchaser shall ensure that the manufacturer is provided copies of all reports of tests performed on concrete samples taken to determine compliance with specification requirements."



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Up and Coming



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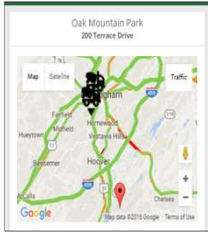
Mobile Apps



- Ordering
- Order status
- Truck tracking
- Electronic ticketing

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Mobile apps



Ticket 115257

Date 05/07/2015

Scheduled 10:12 AM

Ticket Lines

Slump 5.00

Truck Code 9999

Driver Name Unknown

Plant Code 1

Add Delivery Details

Arrival Time At Job 05:35 PM

Revolutions On Arrival

Water Added At Job

Revolutions After Water

Command Alkon

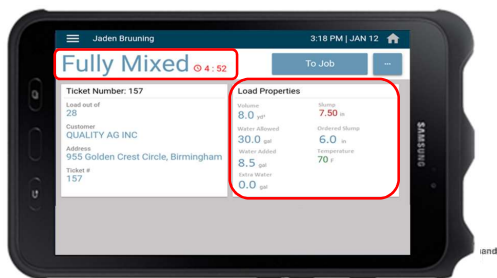
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Probe, IO Box, EDC & External Display

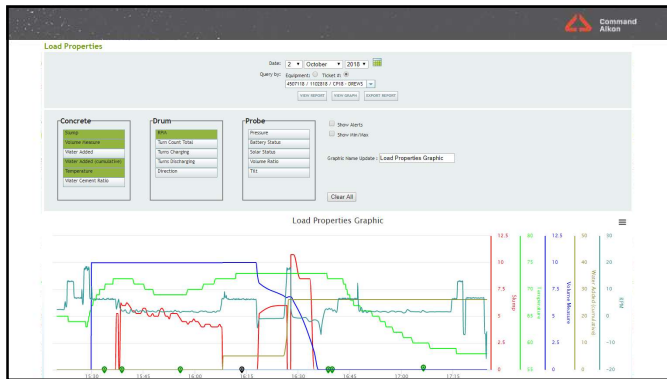


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In-Cab Display



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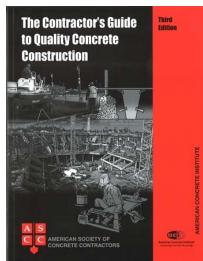
Summary

- Know what to expect
- Plan the delivery
- Manage the delivery
- Follow thru



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ASCC/ACI Contractor's Guide to Quality Concrete Construction



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Thank You!



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