

LADOTD Concrete Specifications A Glimpse into the Near Future

Zach Collier, E.I.
Concrete Research Engineer



Outline

- What this presentation is
 - ▣ An overview of new specifications
 - ▣ Major step forward
- What it is not
 - ▣ Fully inclusive
 - ▣ Have too see published result soon



Background

- Process has taken over 4 years
- 901 has been completed for over 2 years
 - Few minor editorial changes since original acceptance
- Publication date is '*Spring 2016*'



Major 901 Changes

- All structural concrete shall require permeability testing by surface resistivity in accordance with TR 233
- ACI Concrete Field Testing Technician Grade I qualify as an Authorized Concrete Field Tester
- Trial mixes to show performance
 - Strength
 - Permeability



Major 901 Changes

- ASTM C494 Type S admixtures
 - Show performance to Lab Engineer or Fabrication Engineer as required
- Allow IL cement
 - Do not treat as a blended cement

<u>Use</u>	<u>Allowable Cement Types</u>
General Construction (Structural Class Concrete and Minor Structure Class Concrete)	Type I and/or II portland cement; Blended Hydraulic Cement Type IL portland lime cement
Concrete Pavement	Type I and/or II portland cement; Blended Hydraulic Cement Type IL portland lime cement Type III portland cement for high early strength (HES) applications only
Prestressed or Precast Concrete	Type I and/or II, or III portland cement; Blended Hydraulic Cement Type IL portland lime cement



Major 901 Changes

□ Substitutions

Structural Class ¹	Substitute
A1	No Substitutions
A2	No Substitutions
A3	No Substitutions
P1	P2, P3
P2	P3,
P3	No Substitutions
S	No Substitutions
MASS(A1)	No Substitutions
MASS(A2)	No Substitutions
MASS(A3)	No Substitutions
Minor Structure Class ¹	
M	A1, B, D
R	A1, B, D
Pavement Type ^{1,2}	
B	D
D	B
E	No Substitutions

¹The substituting mixture shall meet the requirements of Table 901-3 for its class or type. The substituting mix shall meet the strength requirements of the original mix. .

²If approved by the engineer, small irregular areas of paving projects using Types B or D concrete may be substituted with Class A1 concrete.



Major 901 Changes

- Substitutions – Binary (I, II, III, or IL)
 - Pound for pound
 - 30% max fly ash
 - 50% max GGBFS



Major 901 Changes - Structural

- Substitutions – Ternary w/ Type I, II, III, or IL
 - Pound for pound basis
 - 70% maximum replacement
- Substitutions – Ternary w/ Type IP or IS
 - Pound for pound basis
 - 40% maximum replacement
- C & F fly ash combinations are allowable provided they are introduced at an equal rate
- Use no more fly ash than GGBFS



Major 901 Changes - Pavement

- Substitutions – Type B or D
 - Ternary maximum substitution rate is 50%
 - Binary remains the same

- Use of Type III outside of precast, prestress and specified HES requires approval



Major 901 Changes

- AEA use is required
- Portable volumetric mixers are allowed
- 90 minutes or 300 revolutions
- 45 minutes with non-agitator truck
- Time may be reduced if showing problems
- Time may be *modified* based on trial batch results for special applications





Major 901 Changes

- Weather Limitations
 - Precast/prestress elements may be exempt at determination of Fabrication Engineer
 - Temperature of concrete must be greater than 45° F
- Cold Weather
 - PC Mixtures
 - 35° F or forecast to be less than 32° F within 24 hour period after placement
 - Resume after reaches 32° F providing it remains above 32° F for minimum 24 hours

Major 901 Changes



□ Cold Weather

■ Binary Mixtures

- 40° F or forecast to be less than 35° F within 36-hour period after placement
- Resume after reaches 40° F providing it is forecasted above 45° F for 36 hours

■ Ternary Mixtures

- 45° F or forecast to be less than 40° F within 48 hour period after placement
- Resume after reaches 45° F providing it is forecasted above 50° F and remains above 45° F for 48 hours

Major 901 Changes



- Hot Weather Limitations
 - Become effective when internal concrete temperature exceeds 85° F
 - Maintain internal temperature less than 90° F
 - Reject any concrete attaining a temperature in excess of 99° F during production and placement.
 - Can still place in hot weather
 - Trial batch criteria

Major 901 *Proposed* Changes

- Hot Weather Limitations – Trial Batch Criteria
 1. Maintain the minimum of 94°F throughout the trial batching process
 2. After initial mixing, hold the trial mix in the mixer for 90 minutes. During this extended mixing period, turn the drum intermittently for 30 seconds every five minutes. At the end of the 90-minute mixing period, remix the trial batch a minimum of one minute before testing for slump and air content
 3. Ensure slump and air content are in desired range
 4. May add water to maximum w/cm

Major 901 Changes

- Mass concrete
 - 48" or greater in the least dimension or as specified on the plans
 - Class S is exempt
 - Required to have an analysis with projected thermal developments
 - Cementitious combination heat of hydration of not more than 70 calories/gram (290 kJ/kg) at 7 days as determined by ASTM C186



Major 901 Changes

- Mass concrete
 - PC replacement of 20 – 50% fly ash
 - PC replacement of 50 – 70% GGBFS
 - Ternary is ok as well
 - B or D gradation is required
 - Concrete temperature differential nears 35° F take corrective measures
 - Maximum temperature of 160° F



Major 901 Changes

- Mass concrete
 - Abbreviated submittal is allowable when previously approved mixtures are submitted
 - Monitoring devices are required
 - Geometric center
 - Surface at shortest line from geometric center
 - Measure at maximum interval of one hour



Major 901 Changes

**Table 901-3
Master Proportion Table for Portland Cement Concrete**

	Average Compressive Strength, psi (MPa) at 28 days	Grade of Coarse Aggregate	Min. Cement, lb/yd ³ (kg/m ³) of Concrete ^{9,14}	Maximum Water/Cement ratio, lb/lb (kg/kg) ^{1,9}	Air Content (Percent by volume) ⁴	Slump Range ¹⁰ , inches (mm)		
						Non-Vibrated	Vibrated	Slip Form Paving ²
Structural Class¹¹								
AA(M)	4400 (30.4)	A, P	560 (332)	0.44	7 max ¹⁵	2-5 (50-125)	2-4 (50-100)	N.A.
AA	4200 (29.0)	A, P	560 (332)	0.44	7 max ¹⁵	2-5 (50-125)	2-4 (50-100)	N.A.
A(M)	4400 (30.4)	A, P	510 (302)	0.53	7 max	2-5 (50-125)	2-4 (50-100)	N.A.
A	3800 (26.2)	A, F ⁸ , P	510 (302)	0.53	7 max	2-5 (50-125)	2-4 (50-100)	1-2.5 (25-65)
D	3300 (22.8)	A, B, D, P	420 (249)	0.58	7 max	2-5 (50-125)	1-3 (25-75)	N.A.
F	3400 (23.5) ⁵	A, P	460 (273)	0.44	7 max ¹⁵	2-5 (50-125)	2-4 (50-100)	N.A.
P(X)	7500 (51.7) ⁵	A, F ⁸ , P	700 (415)	0.40	7 max	N.A.	2-10 (50-250) ⁷	N.A.
P(M)	6000 (41.4) ⁵	A, F ⁸ , P	600 (356)	0.44	7 max	N.A.	2-6 (50-150) ⁷	N.A.
P	5000 (34.5) ⁵	A, F ⁸ , P	560 (332)	0.44	7 max	N.A.	2-6 (50-150) ⁷	N.A.
S	3800 (26.2)	A, P	650 (385)	0.53	7 max	6-8 (150-200)	N.A.	N.A.
Minor Structure Class¹¹								
M	3000 (20.7)	A, B, P	470 (279)	0.56	7 max	2-5 (50-125)	2-4 (50-100)	1-2.5 (25-65)
R	1800 (12.4)	A, B, D, P	370 (219)	0.70	7 max	2-5 (50-125)	2-4 (50-100)	N.A.
Y	3000 (20.7)	Y	560 (332)	- ³	6-9	N.A.	1-3 (25-75)	N.A.
Pavement Type¹¹								
B	4000 (27.6) ⁶	N/A ¹³	475 (282)	0.53	7 max ¹⁶	N.A.	2-4 (50-100)	1-2.5 (25-65)
D	4000 (27.6) ⁶	N/A ¹³	450 (267)	0.53	7 max ¹⁶	N.A.	2-4 (50-100)	1-2.5 (25-65)
E	4000 (27.6) ⁶	A, F ¹² , P	600 (356)	0.40	7 max	N.A.	2-4 (50-100)	1-2.5 (25-65)

N.A. – Not Applicable

¹ Except for Class AA, AA(M), or F concrete, the maximum volume of water; gal. (L), shall be reduced 5 percent when a water-reducing admixture is used, and 10 percent when an air-entraining admixture, or air-entraining and water-reducing admixtures, is used. When the coarse aggregate portion of the mix is 100 percent crushed aggregate, the water may be increased by 5 percent provided the maximum water listed in Table 901-3 is not exceeded.

² Also slump range for other concrete placed by extrusion methods.

³ Refer to Subsection 901.08(c).

⁴ Maximum allowed air content when air-entrainment is allowed or specified. See Subsection 901.08(b).

⁵ Values shown represent the minimum compressive strengths allowed.

⁶ Average compressive strengths for Pavement Type concrete shall be 3600 psi (25.0 MPa) when air-entrainment is used.

⁷ No more than a 2 inch (50 mm) slump differential for any design pour.

⁸ Grade F coarse aggregate shall be used only when specified or permitted. The minimum cement content shall be increased when this aggregate is used.

⁹ For mixes including partial replacement of cement with fly ash or ground granulated blast furnace slag, the minimum cement and maximum water contents shown apply to the total cement and fly ash or ground granulated blast furnace slag content of the mix. Additional cement may be required to achieve minimum compressive strength.

¹⁰ When a slump range is specified in other sections, that range shall govern.

¹¹ See Subsection 901.08(a) for allowable types of cement.

¹² For use in partial depth patching.

¹³ Aggregate grading shall comply with the requirements of Subsection 1003.02(b).

¹⁴ The minimum cement factors may be waived in writing by the District Laboratory Engineer in accordance with Subsection 901.06(a).

¹⁵ Test first loads for air content. Subsequent loads shall maintain a minimum 2% air content to avoid rejection.

¹⁶ If slip formed, test first loads for air content. Subsequent loads shall maintain a minimum 2% air content to avoid rejection.



Major 901 Changes

Table 901-3¹²
Master Proportion Table for Portland Cement Concrete

	Average Compressive Strength, psi at 28 days	Grade of Coarse Aggregate ¹	Surface Resistivity ² (kΩ-cm)	Maximum Water/Cementitious Ratio, lb/lb	Air Content (Percent by volume) ³	Slump Range ⁵ , inches		
						Non-Vibrated ⁴	Vibrated	Slip Form Paving ⁶
Structural Class⁷								
A1	4,500	57M, 67, 89M ⁹ , B,D	22	0.45	2 - 7			
A2	6,500 ¹¹	57M, 67, 89M ⁹ , B,D	22 ¹¹	0.45	2 - 7	2-5	2-4 ⁴	N/A
A3	9,000 ¹¹	57M, 67, 89M ⁹ , B,D	22 ¹¹	0.36	2 - 7	2-5	2-4 ⁴	N/A
P1	6,000 ⁸	57M, 67, 89M ⁹ , B,D	22	0.44	2 - 7	N/A	2-6 ¹⁰	N/A
P2	8,500 ⁸	57M, 67, 89M ⁹ , B,D	22	0.40	2 - 7	N/A	2-6 ¹⁰	N/A
P3	10,000 ⁸	57M, 67, 89M ⁹ , B,D	22	0.40	2 - 7	N/A	2-6 ¹⁰	N/A
S	4,500	B, D	22	0.53	2 - 7	6-8	N/A	N/A
MASS(A1)	4,500	B, D	22	0.53	2 - 7	N/A	2-4 ⁴	N/A
MASS(A2)	6,500 ¹¹	B, D	22 ¹¹	0.46	2 - 7	N/A	2-4 ⁴	N/A
MASS(A3)	9,000 ¹¹	B, D	22 ¹¹	0.36	2 - 7	N/A	2-4 ⁴	N/A
Minor Structure Class⁷								
M	3,000	57M, 67, 89M ⁹ , B,D	N/A	0.56	2 - 7	2-5	2-4 ⁴	1-2.5
R	1,800	57M, 67, B, D	N/A	0.70	2 - 7	2-5	2-4 ⁴	N/A
Pavement Type⁷								
B	4,000	B, D	N/A	0.53	2 - 7	N/A	2-4	1-2.5
D	4,000	B, D	N/A	0.53	2 - 7	N/A	2-4	1-2.5
E	4,000	57M, 67, 89M ⁹ , B,D	N/A	0.40	2 - 7	N/A	2-4	1-2.5

N/A – Not Applicable

N/A – Not Applicable

¹ Combined aggregate gradation shall comply with the requirements of 1003.08.2.

² Value based on a 4 inch X 8 inch cylinder tested at 28 days of age.

³ See 901.08.3.

⁴ Allow an 8-inch maximum slump if water reducers are used.

⁵ Additional allowance in slump range to be approved by the Chief Construction Engineer.

⁶ Also slump range for other concrete placed by extrusion methods.

⁷ See 901.08.1 for allowable types of cement.

⁸ Values shown represent the minimum compressive strengths allowed for all test cylinders.

⁹ Grade 89M coarse aggregate shall be used only when specified or permitted.

¹⁰ No more than 2 inch slump differential for any design placement. Allow 8-inch maximum slump if water reducers are used.

¹¹ Average Compressive Strength, psi and Resistivity (kΩ-cm) at 56 days.

¹² Dry-cast concrete for concrete pipe is exempt from Table 901-3. See Section 1016 specifications.



Major 901 Changes

Average Compressive Strength per Lot, psi (28 to 31 days: A1 Mixes) (56 to 59 days: A2 & A3 Mixes)	
	Percent of Contract Unit Price ¹
Class A1, S & MASS (A1)	
4500 & above	100
4301-4499	98
4000-4300	90
below 4000	50 or remove and replace ²
Class A2 & MASS (A2)	
6500 & above	
6301 -6499	100
6000 – 6300	98
Below 6000	90
	50 or remove and replace ²
Class A3 & MASS (A3)	
9000 & above	100
8801 – 8999	98
8500 - 8800	90
Below 8500	50 or remove and replace ²



Major 901 Changes

Surface Resistivity per Lot, k Ω -cm (28 to 31 days: A1 Mixes) (56 to 59 days: A2 & A3 Mixes))	
Class A1, A2, A3, S, P1, P2, P3, S & MASS(A1,A2,A3)	Percent of Contract Price
22.0 & above	100
20.0 - 21.9	98
18.0 - 19.9	90
below 18.0	50 or remove and replace ¹



Questions

