Frequently Asked Questions (FAQ)
MnDOT Transition to Contractor Concrete Mix Designs
3/16/14

The Concrete Engineering Unit and the Concrete Ready-Mix Industry have developed specification language that transfers the responsibility of designing concrete mixes to the Contractor. The Engineer determines final acceptance of the concrete for payment based on satisfactory field placement and performance.

When will it happen?

Starting in 2014, MnDOT will let pilot projects that require the Contractor to design all concrete mixes on the project. This is the next step towards requiring Contractor designed mixes for all concrete placed on MnDOT projects. The MnDOT Concrete Engineering Unit has a goal of 100% implementation by January 1, 2016 if not before.

Special Provision (2461) Contractor Mix Design Pilot Project replaces 2461 from the 2014 spec book in its entirety. The Contract may have specific mix design requirements for bridge or other concrete.

Who will support implementation of the Pilot Projects?

The Concrete Engineering Unit will:

(1) Contact all Concrete Producers near the Pilot Project and make them aware that this project is different from regular MnDOT projects.
(2) Contact all Contract Holders for the Pilot Project at the Districts request and make them aware this is a Pilot Project for Contractor Mix Designs
(3) Provide a Q and A session in the District prior to the project letting at the District's request to discuss how the Pilot Projects will work.
(4) Attend the Pre-letting and/or Pre-construction meeting at the Districts request to discuss with all interested parties how the Pilot Project will work.
(5) Communicate with construction personnel during the Pilot Projects.

Is it required on my project?

The following is a list of projects identified for the Contractor Mix Design Pilot Projects:

District	Project Number	Roadway	Letting Date	Concrete Unit Rep
1	0905-53	TH 33	4/11/14	Gordy Bruhn
2	6004-23	TH 2	5/16/14	Gordy Bruhn
3	0502-103	TH 10	5/16/14	Maria Masten
3	7708-39	TH 71	4/25/14	Wendy Garr
4	7607-29	TH 29	5/16/14	Wendy Garr
6	5580-92	TH 90	2/28/14	Gordy Bruhn
6	7480-113	TH 35	3/28/14	Gordy Bruhn
7	0704-88	TH 22	4/25/14	Maria Masten
8	3403-68	TH 12	4/25/14	Wendy Garr
Metro	2710-42	TH 65	2/28/14	Wendy Garr
Metro	6222-162	TH 61	4/25/14	Ron Mulvaney
Metro	2782-320	TH 35W	5/16/14	Ron Mulvaney

What stays the same?

(1) MnDOT will provide mix design proportions for the following:

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Mix Type	Mix Design Proportions Location
1X62 (Cofferdam Seals)	Table 2461-10
Grout (Riprap)	Table 2461-11
3U17A (Low Slump)	Form 21412, "Weekly Report of Low Slump Concrete"
Lean Mix Backfill	Specification 2520
Bagged Mix Grade 3U18	Specification 3105

(2) Precast/Prestressed Concrete will follow 2014 Standard Spec. 2461.
(3) Plant monitor responsibilities will not change.
(4) MnDOT is responsible for making three (3) control cylinders per structure. Additional control cylinders are the responsibility of the Contractor.

What is changing?

(1) Mix Numbers have a new designation:

Concrete Grade	Intended Use	Old Mix Number	New Mix Number
F	**Flatwork** Sidewalk, curb and gutter, slope paving, median sidewalk, driveway entrances, ADA pedestrian sidewalk, exposed aggregate	3A32 3A36	3F5#
G	**General** Footings, Pile Caps	1A43	1G5#
	General (Non-Bridge) Slope paving, walls, manholes and catch basins, fence posts, signal bases, light pole foundations, erosion control structures, box culverts, culvert headwalls, open flumes, base, formed non-bridge railings	3A34 3A42 3B32 3Y43	3G5#
	General (Bridge) Bridge substructure, abutments, diaphragms, walls	3Y43	3G5#
M	**Slipform** Median barrier, non-bridge railing	3Y12	3M1#
	Slipform Curb and Gutter	3A22	3M3#
P	**Non-Structural Concrete** Pilings	1C62	1P6#
R	**Concrete Pavement Rehabilitation** Full Depth Concrete Repairs	3A32 3A32HE	3R5# 3R5#HE
S	**Bridge Superstructure** Slipform bridge railing	3Y16	3S1#
	Bridge Superstructure Bridge decks	3Y33 3Y33A 3Y36 3Y36A	3S4#
	Miscellaneous Bridge Median barrier, posts, curbs, sidewalks, approach panels, formed bridge railings, end posts	3A42 3Y43 3Y46 3Y46A	3S5#
HE	**High Early Concrete** Designed to achieve the minimum strength to opening at 48 hours	3A22HE 3A32HE 3Y43HE	3F5#HE 3G5#HE 3M5#HE
# Designates the gradation for the 4th digit according to Table 2461-3			

(2) The mix number identifies several details of the concrete mix:

Table 2461-1 Mix Number Identification						
First Digit	**Second Digit**	**Third Digit**	**Fourth Digit**	**Fifth Digit**	**Sixth Digit**	**Additional Digits**
Type Designation	Grade Designation	Maximum Slump	Coarse Aggregate Designation	Class of Coarse Aggregate	Supplementary Cementitious Material Designation	Additional Digits Allowed
1 or 3	F,G,M,P,R,S	As specified	0-9	A, B, C	F, S, M, T	???
Table 2461-2	Table 2461-6	Table 2461-6	Table 2461-3	Table 2461-4	Table 2461-5	

(3) The concrete grade identifies several properties of the concrete mix:

Concrete Grade	Mix Number	Intended Use	Maximum w/c ratio †	Cementitious Content (lbs/cy)	Maximum %SCM (Fly Ash/ Slag/ Ternary)	Slump Range	Minimum Compressive Strength, f'c (28-day)	3137 Spec.
M	3M1#	**Slipform** Median barrier, non-bridge railing	0.42	530 – 750	30/35/0	½ - 1" ‡	4000 psi	2D1
	3M3#	**Slipform** Curb and Gutter	0.42	530 – 750	30/35/0	½ - 3" ‡	4000 psi	2D1

(4) There are minimum 28-day compressive strength requirements for the concrete and may be subject to monetary adjustments for deficient strength. Cylinder strength results are based on an average of three (3) – 28 day strength cylinders fabricated from a single sample of concrete. If there are low cylinder strength results – investigation is required and coring may be required.

Table 2461-17 Acceptance Criteria for Standard 28-day Cylinders Concrete Grades F, G, M, P, and S		
	No strength test less than:	**Moving average of 3 consecutive strength tests***
f'c ≤ 5000 psi	< f'c – 500 psi	≥ f'c
f'c > 5000 psi	< 0.90 * f'c	≥ f'c
*If a project does not establish a moving average of 3 consecutive strength tests, use either the single strength test or the average of 2 strength tests to determine acceptance.		

(5) High-Early (HE) concrete is opened at a minimum of 48 hours of age **and** strength of 3000 psi
  (a) HE concrete requires approval of the Engineer prior to incorporation into the work
  (b) HE concrete requires control cylinders
    i. The Contractor is allowed to store HE control cylinders in an insulated storage compartment, provided the Contractor monitors both the temperature inside the insulated storage compartment and in-place concrete. The temperature inside the storage compartment needs to be the same or less than the corresponding concrete structure.

i. The Contractor will provide the insulated storage compartment and any materials needed to monitor all temperatures.
ii. Insulated storage compartment temperatures higher than in-place concrete temperatures may invalidate the control cylinders.

(6) Contractor Mix Designs will be plant and material specific, not project specific. The Agency will no longer need to request a mix design for specific SP or SAP projects. **Contractor Mix designs are proprietary and not to be shared with other Producers.**
(7) MnDOT will review test results annually and consider the Contractor Mix Designs acceptable indefinitely as long as the aggregates and strength continue to meet requirements and no other placement issues were encountered in the field.

What impact will the change have on the Contractor?

(1) The Contractor has the option of using MnDOT 3137 or ASTM C33 gradation requirements.
(2) Preliminary Test data may be required for mix design submittal based on the proposed mix design parameters.

	Preliminary Testing Required
Level 1 Mixes	None - Old MnDOT Mixes
Level 2 Mixes	Strength Test Data Required, Trial Batching may be required to obtain test data

(3) Contractor mix designs must be submitted to the Concrete Engineering Unit 21 days prior to concrete placement.
(4) The Contractor will identify key Ready-Mix Personnel, at the Pre-construction meeting, responsible for managing issues related to the concrete mix design during placement.
(5) The Contractor will provide moist curing environments of adequate size and number for initial and final curing of concrete cylinders in accordance with ASTM C31 – Note 7 and the MnDOT Concrete Manual. Review MnDOT Guidelines for *Initial Curing* of Concrete Cylinders for 28-day Strength Acceptance at the end of this document.
(6) The Contractor's Certified MnDOT Concrete Field 1 Technician may choose to make additional control cylinders to determine strength at any time other than 28-days.
(7) The Contractor may request the use of concrete maturity to determine opening to traffic.

What impact will the change have on the Agency/Inspector/Engineer?

(1) The Concrete Engineering Unit will provide a copy of the Approved Mix Designs to the District Construction Office Managers, Lab Supervisors and Metro Inspection.
(2) There is an addendum to the Schedule of Materials Control for cylinder testing. The Engineer will make additional cylinders (4 x 8 (Sets of 3) or 6 x 12 (sets of 2)) to establish whether the concrete meets the required 28-day strength and one 7-day cylinder for information only.
   (a) Number the cylinders as follows: 1.1, 1.2, 1.3, 1.4 (next set) 2.1, 2.2, 2.3, 2.4 etc. Break cylinder X.4 at 7-days for information only; break the remaining three cylinders at 28-days.
   (b) ***The Concrete Field Technician will need to take extra precautions when casting, curing, and transporting the standard cure (28-day break) test specimens.***
   (c) Review MnDOT Guidelines for *Initial Curing* of Concrete Cylinders for 28-day Strength Acceptance at the end of this document.
   (d) The Engineer will need to submit field test results as well as the Certificate of Compliance ticket number with the Concrete Cylinder ID card. The Concrete Engineering Unit will provide labels to attach to the back of the ID cards.
   (e) Additional storage room may be necessary for more cylinders.
(3) MnDOT will e-mail concrete aggregate and cylinder test results directly to the Producer.

MnDOT Guidelines for *Initial Curing* of Concrete Cylinders for 28-day Strength Acceptance 2/19/14

The Concrete Engineer defines the ***Initial Curing* period** as the time starting after final finishing of the molded strength specimens up to a maximum of 48 hours after final finishing. During the initial curing period, maintain a moist curing environment with a temperature range from 60°F to 80°F. Because of the new strength requirements, the Agency should exercise great care during the *Initial Curing* period.

ASTM C31 requires creation of a moist environment during the *Initial Curing* of the standard cure (28-day break) test specimens. MnDOT requires the Contractor to provide a moist curing environment for curing cylinders. If the Contractor does not provide a moist curing environment (MnDOT provides cylinder molds) for cylinders, MnDOT will cure the cylinders according to the standard practices they have followed historically.

Moist Cure Recommendations for concrete (ASTM C31 – Note 7):

For temperatures between 60 °F to 80 °F:

One or more of the following procedures can **create** a satisfactory moisture environment during the *Initial Curing* of the specimens:

(1) Immediately immerse molded specimens with plastic lids in water saturated with calcium hydroxide,
(2) Store in properly constructed wooden boxes or structures,
(3) Place in damp sand pits,
(4) Cover with removable plastic lids,
(5) Place inside plastic bags, or
(6) Cover with plastic sheets or nonabsorbent plates if provisions are made to avoid drying and damp burlap is used inside the enclosure, but the burlap is prevented from contacting the concrete surfaces.

For temperatures less than 60 °F or greater than 80 °F:

One or more of the following procedures can **control** a satisfactory temperature environment during the *Initial Curing* of the specimens:

(1) Use of ventilation,
(2) Use of ice,
(3) Use of thermostatically controlled heating or cooling devices, or
(4) Use heating methods such as stoves or light bulbs.
(5) Other suitable methods are allowed provided the requirements limiting specimen storage temperature and moisture loss requirements are met.

After the *Initial Curing* Period, MnDOT will handle 28-day standard strength cylinders in the following manner:

(1) Transport and further cure the test specimens in the Contractor provided curing tanks. Maintain the water in the curing tanks to a water temperature of 60°F to 80°F.
(2) Deliver the test specimens to the laboratory for compressive strength testing. When cured in the laboratory, maintain the cylinders at a temperature of 73.5°F ± 3.5°F.

Additional considerations regarding concrete mixtures with a **specified strength of 6000 psi** (40 MPa) or greater:

(1) Heat generated during the early ages may raise the temperature above the required storage temperature.
(2) Immersion in water saturated with calcium hydroxide may be the easiest method to maintain the required storage temperature. When specimens are to be immersed in water saturated with calcium hydroxide, specimens in cardboard molds or other molds that expand when immersed in water should not be used.
    a. Early-age strength test results may be lower when stored at 60°F (16°C) and higher shown stored at 80°F (27°C).
    b. On the other hand, at later ages, test results may be lower for higher initial storage temperatures.