

PERFORMANCE RELATED SPECIAL PROVISION FOR TERNARY CONCRETE MIX DESIGNS FOR COMPOSITE PAVEMENTS (Tollway)

Effective: January 30, 2012

Revised: April 5, 2013

DESCRIPTION

This work consists of designing and furnishing ternary portland cement concrete for special applications to composite pavements. The objective of this performance related special provision is to provide the Illinois Tollway with a methodology to assure high quality concrete, while simultaneously allowing the Contractor the maximum freedom in deciding how to develop the mix design and place the concrete.

Ternary concrete refers to concrete that incorporates hydraulic portland cement, ground granulated blast furnace slag, fly ash and other supplementary cementitious materials (SCM) as cementitious constituent materials. A Type IT blended cement in accordance with AASHTO M 240 shall be acceptable. A Type IP or IS blended cement in accordance with AASHTO M 240 may be used when an SCM is combined as a constituent material to produce a ternary mix. Slag, fly ash, and any other SCM's combined as constituent materials in a mix or as part of a blended cement may consist of no less than 35% and no more than 50% of the total cementitious material in any mix design.

Composite pavement refers to a pavement that consists of multiple flexible and rigid layers or multiple rigid layers bonded together without separation. This special provision applies to the lower lift of a concrete composite pavement of multiple rigid layers.

REFERENCE STANDARDS

Except where modified by the Illinois Department of Transportation or the Tollway, the following Standards shall apply:

Illinois Department of Transportation (IDOT)

- Standard Specifications for Road and Bridge Construction, Adopted January 1, 2012.
- Supplemental Specifications and Recurring Special Provisions, Current Edition.
- Tollway Supplemental Specifications to the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, Current Edition.
- Test Procedures referenced herein, as described in the current edition of the Manual of Test Procedures for Materials, as well these test procedures:
 - AASHTO T 105 Chemical Analysis of Hydraulic Cement
 - AASHTO T 196 Air Content of Freshly Mixed Concrete by the Volumetric Method

- ASTM C 457 Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
- ASTM C 856 Petrographic Examination of Hardened Concrete
- ASTM C 1293 Determination of Length Change of Concrete Due to Alkali-Silica Reaction
- AASHTO T 161 Procedure A Modified Resistance of Concrete to Rapid Freezing and Thawing

REQUIREMENTS

Contractor shall provide a concrete mix design according to the following performance requirements. The testing shall be performed by an AASHTO-accredited laboratory.

Laboratory trials shall initially be performed by the Contractor to determine the basic strength, slump and air content properties of a mix. Once mixture proportions are determined through laboratory trials, a plant trial batch of the proposed mix design shall be required, and the trial mix shall be sampled and tested to confirm that the required properties listed below are obtained. The Contractor is required to contact the Engineer a minimum of 2 days prior to any plant trial batch mixing so that a Tollway representative can observe the process. The same 2-day notification is required prior to any physical testing on hardened concrete samples.

Compressive Strength

Interim compressive strength for opening to construction traffic shall be a minimum of 2,850 psi as tested in accordance with AASHTO T22 for both lifts of concrete at no less than 5 days of age.

Interim compressive strength of the bottom lift concrete for opening to public traffic shall be 3,200 psi at no less than 14 days age after the top lift concrete has obtained an interim compressive strength of 3,500 psi.

Ultimate compressive strength shall not be less than 3500 psi at 28 days. Test cylinders shall be made and cured in accordance with AASHTO T 23. Test results will also be presented at 7 and 14 days.

Flexural Strength

Interim flexural strength for opening to construction traffic shall be a minimum of 450 psi as tested in accordance with AASHTO T97 for both lifts of concrete at no less than 5 days of age.

Interim flexural strength for opening to public traffic shall be 575 psi at no less than 14 days age after the top lift concrete has obtained an interim flexural strength of 650 psi.

Ultimate flexural strength using AASHTO T97 for third point loading shall be 650 psi at 28 days, with test results also presented at 5, 7, and 14 days.

Plastic Air Content

Plastic Air Content determined using AASHTO T 152 test method shall be from 5.0 to 8.0 percent.

Hardened Air Content

Air-void system having the following characteristics as determined by ASTM C 457:

- Spacing factor not exceeding 0.008-in.
- Specific surface not less than 630 in²/in³
- Total air content not less than 4.0 percent

Slump

For slipform concrete pavement placement, place the concrete with a slump value that optimizes placement, except ensure the concrete does not slough or slump and is adequately consolidated and meets all other requirements. Maintain the concrete at a uniform consistency.

Slump range for formed or manual placement shall be 2 to 4 inch.

Alkali – Silica Reaction

Concrete shall be proportioned such that the maximum total alkali content contributed by Portland cement (as determined in accordance with AASHTO T 105) shall not exceed 5 lb/yd³.

MATERIALS

Portland cement, mixing water, fine and coarse aggregates, supplementary cementitious materials, and concrete admixtures shall conform to the requirements of Section 1000 of Illinois Department of Transportation *Standard Specifications for Road and Bridge Construction*, Current Edition. Specific references are as follows:

Material	Section
Portland Cement	1001
Mixing Water	1002
Fine Aggregates (See Note 1)	1003
Coarse Aggregates (See Notes 1 & 2)	1004
Supplementary Cementitious Materials(See Note 3)	1010
Concrete Admixtures	1021
Other Materials	see Note 4

Note 1: Fine and coarse aggregate requirements shall be per the intended pavement application.

Note 2: Fractionated Reclaimed Asphalt Pavement (FRAP) or Recycled Concrete Aggregate (RCA) used as an aggregate source as allowed for the intended pavement application shall be in accordance with the Tollway special provisions for Coarse Aggregate for Composite Concrete Pavement.

Note 3: Blended cement shall be according to AASHTO M 240 with no additional restrictions. Blended cements with a percentage of supplementary cementitious materials differing by more than 5% shall be considered different cementitious materials. If a blended cement is used in a mix, a certification of compliance shall be provided and include a statement signed by the blended cement supplier that indicates the actual percentage by weight of supplementary cementitious materials in the blend. No more than 15% by weight of a cement shall consist of any processing addition. No more than 15% by weight of a cement shall consist of ground limestone.

Note 4: Fibrous reinforcement shall be permitted provided the material is used in accordance with the product manufacturer's recommendations and it is demonstrated that the concrete complies with the herein established performance requirements.

MIX GRADATION

The mixture for the bottom layer of a composite pavement shall contain coarse aggregate with no less than 15 percent of the coarse aggregate being an approved FRAP source in accordance with the contract special provision for Coarse Aggregate for Composite Portland Cement Concrete Pavement. The maximum amount of recycled coarse aggregate from an approved FRAP source allowed in a mixture may be 50 percent of the total coarse aggregate. The maximum amount of recycled coarse aggregate from an approved recycled concrete source allowed in a mixture may be 100 percent of the total coarse aggregate, or the percentage needed to make up for the

remaining amount of coarse aggregate needed in any mix containing 50% or less coarse FRAP aggregate. Fine virgin aggregate sources used in the mix shall be in accordance with Article 1003.02, and shall be FM-01 or FM-02 gradation. Coarse virgin aggregate sources used in the mix shall be in accordance with Article 1004.02, and shall be a combination of any gradation specified in Article 1004.1(c) of the Standard Specifications needed to obtain the desired blended aggregate gradation. The virgin and recycled aggregates used in the recycled mixture shall be blended to produce a combined aggregate gradation that complies with the following:

AGGREGATE BLEND FOR THE RECYCLED MIX
Percent by weight passing

Sieve Size	% Passing
1 in.	100
¾ in.	88 - 98
⅝ in.	78 - 90
½ in.	66 - 86
⅜ in.	50 - 75
# 4	40 - 52
# 8	33 - 43
# 16	25 - 35
# 30	15 - 25
# 50	5 - 15
#100	1 - 8
#200	1.0 - 6.0

This gradation specification may be used with virgin only aggregate sources to develop a special ternary concrete mix design for the upper lift of a multi-lift rigid pavement.

MIX SUBMITTAL

Submittal shall include:

1. Mix design, showing:
 - a. Quantities, description, sources and mill certifications of all mix ingredients
 - b. Design water-cementitious materials ratio (w/cm)
 - c. Design Slump
 - d. Design Air content
 - e. Gradation and absorption of all aggregates
 - f. Bulk specific gravity (SSD) of all cementitious materials and aggregates
 - g. Theoretical mass and fresh density
 - h. Admixture dosage
2. A trial batch report demonstrating that the concrete complies with the performance requirements herein specified.

MATERIAL TOLERANCES

Portland Cement

No re-submittal shall be required under the condition that the Portland cement (AASHTO M 85 and M 240) source complies with the following tolerances:

Acceptable tolerance for alkali content ($\text{Na}_2\text{O}_{\text{eq}}$): ± 0.10 percent.

Acceptable tolerance for tri-calcium aluminate content: - 2.0 percent, + 1.0 percent.

Acceptable tolerance for supplementary cementitious materials in a blended cement: $\pm 2\%$.

Fine Aggregate

Substitution of fine aggregates from different sources shall not be permitted without re-submittal.

Acceptable tolerance for fineness modulus: ± 0.20 .

Coarse Aggregate

Substitution of coarse aggregate from different sources or different size classification shall not be permitted without re-submittal.

Supplementary Cementitious Materials

No change in type or classification shall be permitted without resubmittal.

Concrete Admixtures

Contractor may change between Type A and Type D admixtures as seasonal conditions warrant. With cold weather placements, the use of an accelerating admixture conforming to ASTM C 494, Type C or E will be allowed without the need for a re-submittal.

Other Materials

No change in brand or type shall be permitted without re-submittal.

TEMPERATURE CONTROL FOR PLACEMENT

The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive ternary concrete shall not be less than 40°F. The temperature of the concrete when placed shall not be less than 60°F for ternary mixtures of any concrete with more than 20% fly ash or 35% slag replacement of Portland cement. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature with cold weather placements. Materials entering the mixer shall be free from ice, snow, or frozen lumps. The use of accelerating admixtures conforming to ASTM C 494, Type C or E is allowed.

QUALITY MANAGEMENT PLAN

At least 14 days prior to the first concrete placement, the Contractor shall submit a Quality Management Plan (QMP), for materials and construction in accordance with the Illinois Tollway recurring Special Provision for Contractor's Quality Program.

Production Facility and Transportation Equipment

The production facility and transportation equipment shall conform to the certification requirements of the Illinois Department of Transportation. For concrete composite pavements, the concrete for each lift of pavement shall be delivered from different production facilities or from separate mixers at any facility location.

FIELD ACCEPTANCE

Acceptance to this specification shall be based on the following key characteristics:

- Strength
 - Interim
 - Ultimate
- Plastic air content – 5.0 to 8.0 percent
- Slump (Formed Placement) – Design \pm 1.5 inches
- Slump (Slipform Placement) - Maintain the concrete at a uniform consistency. The Engineer will not allow an edge slump greater than ½ inch where no additional concrete work is to be constructed immediately adjacent to the pavement being placed. The Engineer will not allow an edge slump greater than ¼ inch where additional concrete work is to be constructed immediately adjacent to the pavement being placed.
- Water / cementitious materials ratio – Design -0.03, +0.00

