INDIANA DEPARTMENT OF TRANSPORTATION

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Indianapolis, Indiana 46204

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Eric Holcomb, Governor
Michael Smith, Commissioner

May 15, 2024

CONSTRUCTION MEMORANDUM
24-03
(REVISED)

TO: District Deputy Commissioners
District Construction Directors, Area Engineers, Project Engineers/Supervisors
Division of Materials and Tests
District Project Management Directors
District Technical Services Directors
District Testing Engineers

FROM: Gregory G. Pankow, Chief Engineer of Construction
Division of Construction Management and District Support

SUBJECT: E5 Internal Cure and E5 Liquid Fly Ash in Concrete

SUPERSEDES: 23-01

E5 Internal Cure (E5-IC) and E5 Liquid Fly Ash (E5-LFA) by Specification Products are both colloidal silica-based technology for concrete. E5-IC is an admixture that provides improved water retention. E5-LFA is a liquid supplementary cementitious material (SCM). Both products have been shown to provide significant benefits during the placement of concrete and in the overall quality of the in-place concrete. Some of the benefits include improved workability, pumpability, water retention and higher pozzolanic activity, which can create higher strength and reduced permeability.

If the contractor chooses to use E5-IC and/or E5-LFA, both a request and the proposed concrete mix design (CMD) on the Department provided spreadsheet shall be submitted to the Department's project personnel for approval. The request and CMD shall be submitted a minimum of seven days prior to placement. Project personnel will forward the mix design to the District Testing Engineer for review. Upon approval, a zero-cost change order will be processed to add the appropriate contract pay item(s) with a supplemental description as follows:

For applications 1 & 2:

~~609-06259 Reinforced Concrete Bridge Approach, E5~~
704-51002 Concrete, C, Superstructure, E5
722-12899 Bridge Deck Overlay, E5

For applications 3, 4 & 5:
No revised pay item(s) is required. Include a statement in the general remarks section of the change order stating that "E5 was used" and briefly list the application(s).

These materials may be used on existing and future contracts in applications as follows:

Application #1 -Bridge Decks and Reinforced Concrete Slab Bridges

In lieu of the water curing requirements in 702.22, concrete may be placed and cured as follows. Concrete shall be in accordance with 702 except as follows:

Mix Design & Batching:

Mix Option 1:

1. The concrete mix design shall include E5-IC with a dosage rate of 4 oz/cwt of cementitious.
2. The concrete mix design shall include either 3% silica fume addition or 30% slag cement replacement per 709.05(c). Class C concrete mix designs shall be based on 658 lbs/cu yd of portland cement. The portland cement content shall not be increased.
3. The water-cementitious ratio shall be 0.42 to 0.48.
4. A water-reducing admixture is not required.
5. Ensure that the concrete mixture is fully wetted before adding the E5-IC admixture to the load.

Mix Option 2:

1. The concrete mix design shall include E5-IC with a dosage rate of 4 oz/cwt of cementitious and E5-LFA with a dosage rate of 8 oz/cwt of cementitious.
2. Mix design shall be based on a portland cement content from 550 to 650 lbs/cu yd. The portland cement content shall not be increased above 650 lbs/cu yd. No other SCMs shall be added.
3. Minimum 28-day compressive design strength shall be 4,000 psi.
4. The water-cementitious ratio shall be 0.42 to 0.48.
5. A water-reducing admixture, Type A, may be used.
6. Ensure that the concrete mixture is fully wetted before adding E5-IC or E5-LFA to the load.

During placement:

1. A representative from Specification Products shall be on site during placement.
2. Each truck shall mix the concrete on site for a minimum of 30 seconds at mixing speed before discharging the concrete.
3. No water shall be applied to the plastic concrete surface.
4. Slump (AASHTO T 119): minimum 3 in., maximum 7 in.
5. To avoid damaging the air void system when the slump is greater than or equal to 5 inches (≥ 5 in.) minimal mechanical vibration shall be used. To the extent practical handheld vibrators should only be used as needed to consolidate concrete along copings or in areas that are heavily congested with reinforcing steel.

6. Products marketed as “evaporative retardants” or “evaporation reducers” shall not be used. Some common trade names for these products include Sika Film, MasterKure ER50, and Eucobar.
7. The following products may be used as finishing aids as directed by the manufacturer:
    a. E5 Miracle Aid by Specification Products.
    b. The Juice by M2 Solutions.

After placement:

1. Curing shall be for a minimum period of five days (120 hours) and until flexural test beams indicate a modulus of rupture of 575 psi. Curing shall consist of covering with white plastic sheeting (minimum 4 mil thickness) or clear/translucent plastic sheeting (minimum 6 mil thickness). Sheeting shall be applied as soon as possible.
2. Acceptance beams will be field cured by wrapping the beams in wet burlap and then wrapping in plastic. The beams will be placed near the structure and shaded from direct sunlight. In cooler weather when the ambient curing temperature is below 60 degrees the beams will not be shaded and instead will be placed on an insulating material that is thick enough to prevent heat loss to the ground. Beams shall remain in the form and covered with wet burlap and plastic for a minimum of 48 hours before removing them from the form. It is imperative that the burlap around the beams remain moist during the curing period. The surfaces of the beam will be moist at the time of flexural testing. If any of the surfaces are dried, the beam will be soaked for 24 hours prior to testing.
3. The requirements of 702.24(a) are modified as follows. Equipment or traffic will not be allowed on structures for a minimum of 120 hours and until flexural test beams representing all concrete required to carry live loads indicate a modulus of rupture of 575 psi.
4. The requirements of 702.14(b)1 and 702.14(b)2 are modified as follows. Falsework and/or falsework jacks shall remain in place at least 120 hours after concrete placement and until flexural test beams indicate a modulus of rupture of 480 psi or greater has been achieved.
5. For the purpose of determining cold weather concrete conditions in accordance with section 702.11 the minimum curing period shall be continuous for 168 hours after placement.
6. The Department’s project personnel will provide feedback to the Concrete Engineer at Department’s Division of Materials and Tests, including strength data and visual observations both during the pour and curing periods.
7. Concrete surface sealing is not required.

Application #2 - Bridge Deck Overlays

In lieu of Latex Modified Concrete per SS 722.05(a) or Silica Fume Modified Concrete per SS 722.05(c), concrete shall be in accordance with 722 except as follows:

Mix Design & Batching:

1. The concrete mix design shall include E5-IC with a dosage rate of 4 oz/cwt of cementitious and E5-LFA with a dosage rate of 8 oz/cwt of cementitious.

2. Mix designs shall be based on a portland cement content from 600 to 650 lbs/cu yd. The portland cement content shall not be increased above 650 lbs/cu yd. No other SCMs shall be added.
3. The water-cementitious ratio shall be 0.44 to 0.49.
4. Fibrillated polypropylene fiber (length 0.75") with dosage per manufacturer recommendation (min 1.5 lbs/cu yd) shall be added to the concrete mix.
5. Slump at time of placement (AASHTO T 119): minimum 5 in., maximum 8 in.
6. Compressive strength: 3,200 psi at 7 days, 4,000 psi at 28 days.
7. A water-reducing admixture, Type A, may be used.
8. Ensure that the concrete mixture is fully wetted before adding the E5-IC admixture and E5-LFA SCM to the load.
9. The minimum batch size shall be 4 cu yds. The maximum batch shall be 8 cu yds.
10. An additional 15 seconds of mixing time shall be added during batching of each load.

During placement:

1. A representative from Specification Products shall be on site during placement.
2. No water shall be applied to the plastic concrete surface.
3. Products marketed as "evaporative retardants" or "evaporation reducers" shall not be used. Some common trade names for these products include Sika Film, MasterKure ER50, and Eucobar.
4. The following products may be used as finishing aids as directed by the manufacturer:
    a. E5 Miracle Aid by Specification Products.
    b. The Juice by M2 Solutions.

After placement:

1) Curing shall be for a minimum period of 7 days and consist of 120 hours of wet cure followed by 48 hours of dry cure. Wet curing shall be in accordance with SS 702.22(a) and pre-wetted burlap and soaker hoses shall be used. The deck shall remain completely covered with burlap and plastic (white, clear, or translucent) during the dry cure period except the soaker hoses shall be off. The bridge deck may be accepted and opened to traffic after the dry cure period and when the average compressive strength of cylinders for each sublot is 3,200 psi or greater. For the purposes of this memorandum a sublot is 30 cubic yards.

2) Strength testing will consist of the average of three 4 in. by 8 in. cylinders or two 6 in. by 12 in. cylinders. The cylinders will be cured in accordance with AASHTO R 100 Section 10.1, Standard Cure conditions. The frequency for all plastic concrete testing will be one yield, air content, and slump for every 30 cubic yards and one water-cementitious ratio once per day. The frequency for all hardened concrete testing is defined herein.

3) Cylinders for hardened testing: A minimum of four 6 in. by 12 in. or six 4 in. by 8 in. cylinders will be made for each sublot. Two 6 in. by 12 in. or three 4 in. by 8 in. cylinders will be tested at 7-days and averaged. If the 7-day average does not achieve 3,200 psi, two or three cylinders depending on the size **for all sublots will be held for testing at 28-days.**

4) Cylinders for additional hardened testing: In addition to the cylinders in 3) above, a minimum of four 6 in. by 12 in. or five 4 in. by 8 in. cylinders will be made for each sublot

for the purpose of determining opening-to-traffic when the 7-day cylinders do not achieve 3,200 psi. A single cylinder may be broken to assess the current strength, but the final opening-to-traffic strength will be based on the average of three 4 in. by 8 in. cylinders or two 6 in. by 12 in. cylinders.

Summary of cylinders per sublot for hardened testing:

	4" x 8"	6" x 12"	Comment
Hardened testing	6	4	7- and 28-day testing only
Additional hardened testing	5	4	Opening if 7-day is below 3,200 psi
Total cylinders (minimum)	11	8	Only one size is required

Application #3 - Reinforced Concrete Bridge Approach (RCBA), Bridge Railing, Median Barrier Rail, and Substructure Elements

For concrete used in construction of RCBAs, bridge railings, median barrier railings, and substructure elements (bents, caps, piers, and footings), the following additional options are available.

E5-LFA may be used as an SCM per 702.05 and 709.05(c) with the following exceptions:

1. Specification Products' representatives are permitted to be on site, but not required.
2. The dosage rate shall be a minimum 8 oz/cwt of cementitious.
3. No other SCMs shall be added.
4. Surface sealing (702.21) is not required.
5. For formed concrete the water-cementitious ratio shall be 0.42 to 0.48.
6. For slip-formed concrete the minimum water-cementitious ratio shall be 0.36.
7. Slump (AASHTO T 119) for formed concrete: minimum 3 in., maximum 7 in.
8. A water reducing admixture may be used but is not required for Class A concrete.

E5-IC may be used as the curing method in lieu of the methods in 702.22 with the following exceptions:

1. Specification Products' representatives are permitted to be on site, but not required.
2. The dosage rate shall be a minimum 4 oz/cwt of cementitious.
3. For formed concrete the water-cementitious ratio shall be 0.42 to 0.48.
4. For slip-formed concrete the minimum water-cementitious ratio shall be 0.36.
5. Slump (AASHTO T 119) for formed concrete: minimum 3 in., maximum 7 in.
6. RCBAs shall be covered with clear/translucent sheeting (minimum 6 mil thickness)
7. A water reducing admixture may be used but is not required for Class A concrete.

The following products may be used as finishing aids as directed by the manufacturer:

1. E5 Miracle Aid by Specification Products.
2. The Juice by M2 Solutions.

Application #4 – QC/QA PCCP, Non-QC/QA PCCP, and PCCP Patching

E5-LFA may be used as an SCM in both binary and ternary mixes per 501.05, 502.04, and 506.04 with the following exceptions:

1. A representative from Specification Products shall be on site during the first day of placement and they shall attend trial batches when trial batches are required. They are permitted, but not required to be on site for other pours.
2. In a binary cementitious system E5-LFA shall have a minimum dosage rate of 8 oz/cwt of cementitious.
3. In a ternary system (with two SCMs), the dosage rate of E5-LFA must be determined. The contractor shall submit the request to use a ternary system to Michael Nelson at the Division of Materials and Tests along with the source and mill certification for the SCM to be used in conjunction with E5-LFA.
4. Hand-placed paving operations meeting the requirements of 508.04(c) may utilize concrete having a binary cementitious system with E5-LFA as the only SCM when the ambient temperature is below 50°F during placement or when the ambient temperature will fall below 50°F before the opening to traffic strength is attained.
5. For formed concrete the water-cementitious ratio shall be 0.42 to 0.48.
6. For slip-formed concrete the minimum water-cementitious ratio shall be 0.38.
7. Slump (AASHTO T 119) for formed concrete: minimum 3 in., maximum 7 in.

E5-IC may be used in all mixes per 501.20, 502.15, and 506.11with the following exceptions:

1. Specification Products' representatives are permitted to be on site, but not required.
2. The dosage rate shall be a minimum 4 oz/cwt of cementitious.
3. E5-IC does **not** eliminate or replace the requirement for liquid membrane curing compound.
4. For formed concrete the water-cementitious ratio shall be 0.42 to 0.48.
5. For slip-formed concrete the minimum water-cementitious ratio shall be 0.38.
6. Slump (AASHTO T 119) for formed concrete: minimum 3 in., maximum 7 in.

The following products may be used as finishing aids as directed by the manufacturer:

1. E5 Miracle Aid by Specification Products.
2. The Juice by M2 Solutions.

Application #5 -Curb, Sidewalk, Curb Ramps, Commercial and Private Driveways

For concrete used in the construction of curb, sidewalk, curb ramps, and commercial and private driveways, the following additional options are available.

E5-LFA may be used as an SCM with the following exceptions:

1. Specification Products' representatives are permitted to be on site, but not required.
2. The dosage rate shall be a minimum 8 oz/cwt of cementitious.
3. No other SCMs shall be added.
4. For formed concrete the water-cementitious ratio shall be 0.42 to 0.48.
5. For slip-formed concrete the minimum water-cementitious ratio shall be 0.38.
6. Slump (AASHTO T 119) for formed concrete: minimum 3 in., maximum 7 in.
7. A water reducing admixture may be used but is not required for Class A concrete.

E5-IC may be used as a curing method in lieu of the methods in 502.15, 604.03(h), and 605.04(f) with the following exceptions:

1. Specification Products' representatives are permitted to be on site, but not required.
2. The dosage rate shall be a minimum 4 oz/cwt of cementitious.

3. For formed concrete the water-cementitious ratio shall be 0.42 to 0.48.
4. For slip-formed concrete the minimum water-cementitious ratio shall be 0.38.
5. Slump (AASHTO T 119) for formed concrete: minimum 3 in., maximum 7 in.
6. A water reducing admixture may be used but is not required for Class A concrete.

The following products may be used as finishing aids as directed by the manufacturer:

1. E5 Miracle Aid by Specification Products.
2. The Juice by M2 Solutions.

Any questions should be directed to:
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