

Materials and Construction Hot Topics

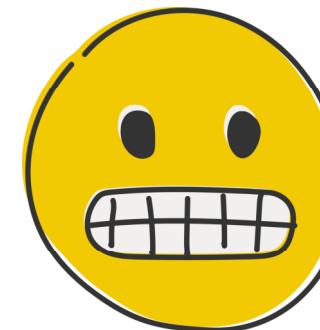
Pete White, PE, INDOT Bridge Design Manager



2025 INDOT Bridge Design Conference

Type 1L Cement

- Production of Portland cement produces significant CO2
- Portland-Limestone Cement
 - Uncooked limestone, lower emissions
 - Currently 5-15% of total cement content
- INDOT has observed issues over past couple years, which coincides with the implementation of Type 1L cement



Type 1L Cement



- **Recent issues with concrete**
 - **Low flexural strength**



609.12 Opening to Traffic

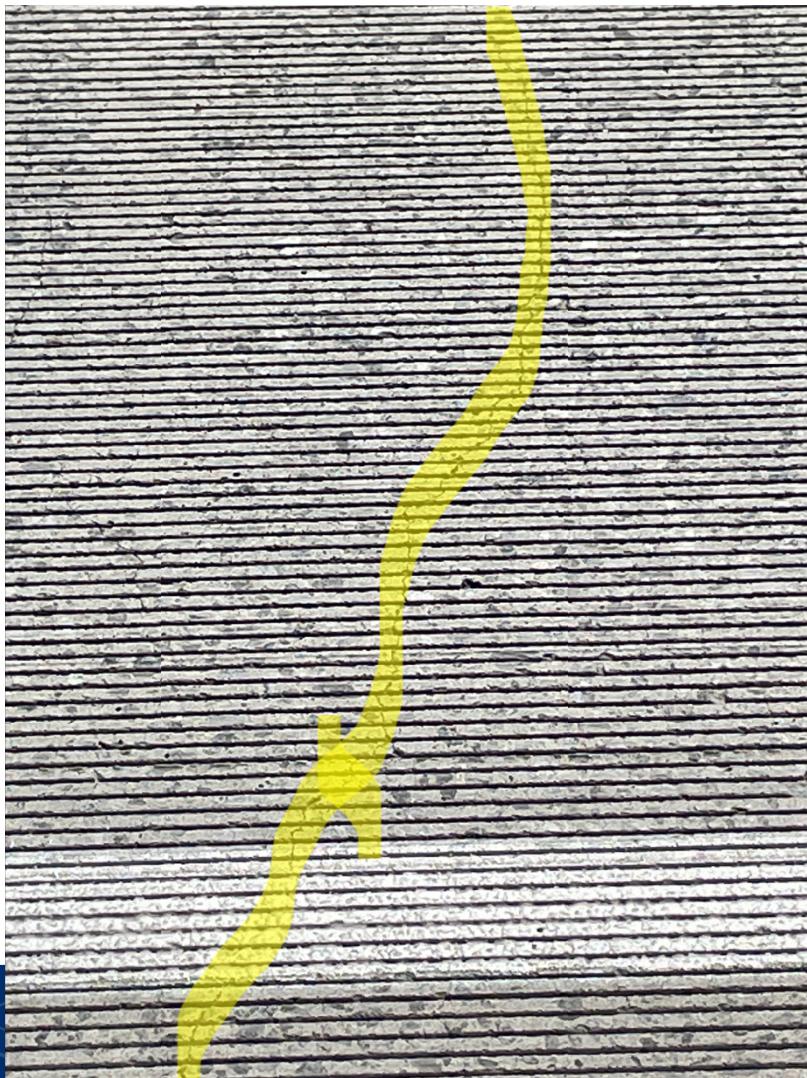
The RCBA may be opened to equipment and traffic when the **flexural strength of the test beams** indicates the concrete has attained a modulus of rupture of 550 psi or greater.



Type 1L Cement



- **Recent issues with concrete**
 - **Increased frequency of cracking**
 - **Scaling and loss of tines**



Type 1L Cement



- **Concerns with recent deck, overlay, and RCBA pours**
 - **Estimating about 15% of placements could exhibit issues**
 - **Long term durability may be compromised**
 - **Construction Memo 24-12 issued Oct. 16, 2024**
 - **INDOT does not want to accept contracts placed in 2024 that exhibit low flexural breaks, cracking, scaling, or loss of tines**
 - **INDOT will perform testing to better evaluate conditions**



[INDOT](#) < [Doing Business with INDOT](#) < [Standards & Specifications](#) < [Construction Memorandums](#)





- **Flexural beam strength (ISS & AASHTO T97)**
 - Used for concrete pavement, RCBA, structural concrete
 - Difficult to correlate flexural strength to compressive
- **Compressive cylinders (ISS & ASTM C94)**
 - Used for pccp patching, prestressed, concrete overlays
 - Limited testing equipment owned by INDOT
- **Resonance Strength Meter (USP & AASHTO T412)**
 - In place concrete strength measurement
 - INDOT currently performing trials





- **Resonance Strength Meter (USP & AASHTO T412)**
 - Sensors embedded in concrete pour
 - Datalogger reads concrete stiffness
 - Concrete stiffness correlated to compressive strength



Bridge Deck Overlays



- **Polymer (Thin) Overlays (RSP 738-B-297)**
 - **Preventive maintenance (keep the chlorides out)**
 - **Typ. installed between 7 and 10 years after construction**
 - **INDOT has caught up, so not installing as many in recent years**
 - **Not intended to correct smoothness or drainage issues**
 - **Max. aggregate is 3/16"**
 - **Min. epoxy is about 1/8"**



Bridge Deck Overlays



- **Rigid Overlays (ISS 722)**
 - Rehabilitation or PM (remove the chlorides)
 - Typically installed about 2" thick, min. thickness is 1 1/2"
 - Thickness over 3" should be avoided (shrinkage cracking risk)
 - Typical No. 11 (1/2") aggregate may be replaced by No. 8 (1") aggregate to reduce paste content (ask INDOT Div. of Materials)
 - How to mitigate the grade raise dilemma?
 - RCBAs have been successfully overlaid with ISS 722 materials
 - Start 720:1 transition at expansion/I-A joint
 - Consider reducing 720:1 transition in lower speed applications



Bridge Deck Overlays



- **Rigid Overlays (ISS 722)**

- **Latex Modified Concrete (LMC)**
 - Batched in volumetric mixer trucks
 - Approx. \$800/CYS
 - 4 day cure time
- **Silica Fume Modified Concrete (SFMC)**
 - Batched in ready-mix trucks
 - Approx. \$450/CYS
 - 7 day cure time

No more alternate Bid!

'Bridge Deck Overlay, Rigid' pay item in 2026 Standard Specs will allow Contractors to choose either material (Only use if either material alright with District)





- **Rigid Overlays ~~(ISS 722)~~ (Construction Memo 24-03)**
 - **Latex Modified Concrete, Very Early Strength (LMC-VE)**
 - **Calcium sulfoaluminate cement (CSA) instead of Portland**
 - **Reaches 2,500 psi min. within 2 hours of placement**
 - **Cures in about 3 hours and can be opened to traffic**
 - **Rapid setting nature limits pour widths to about 20 ft for finishing**
 - **E5 Alternate Mix**
 - **At the discretion of the Contractor and INDOT**
 - **No-cost change order**



What's this E5 stuff?

- **Used at Contractor's discretion (Construction Memo 24-03)**
- **Shouldn't be specified in bid documents**
- **Proprietary product (no “equivalent” products in the market)**
- **Benefits to Contractors (improved workability, lower pump pressures, lower risk of shrinkage cracking)**
- **E5 Internal Cure (E5-IC)**
 - **Colloidal silica holds water (improved hydration of cement)**
- **E5 Liquid Fly Ash (E5-LFA)**
 - **Supplemental cementitious material (SCM) that acts as a pozzolan and decreases permeability**



What's this E5 stuff?

- **Where is this allowed per Construction Memo 24-03?**
 - **Bridge decks and slab superstructures**
 - Mix includes E5-IC & a pozzolan (E5-LFA or silica fume or slag)
 - **Bridge deck overlays**
 - Mix includes E5-IC, E5-LFA, and microfibers
 - **RCBA, bridge rails, median barriers, and substructures**
 - E5-LFA used in lieu of pozzolans listed in 702.05 and 709.05(c)
 - **PCCP / Curbs and sidewalks**
 - E5-LFA and/or E5-IC



Surface Seal and PCC Sealer/Healer



- **What is surface seal?**
 - ***ISS 709 – Portland Cement Concrete Sealers***
 - **Acceptable products listed on qualified products list (QPL)**
 - **100% Silane sealers – penetrate concrete surfaces**
 - **Lines concrete pores to repel water and chlorides**
 - **Still effective after 12+ years (Ley, 2015)**

Qualified Products Lists Qualified Sources Lists

Doing Business with INDOT > Contractors/Construction > Division of Materials and Tests > Qualified Products Lists Qualified Sources Lists

Non-Epoxy Portland Cement Concrete Sealers

709.05(a-b) & 909.10



Surface Seal and PCC Sealer/Healer



- **Where should surface seal be used?**
 - **Standard Spec locations**
 - **602.02(d) – Concrete barrier (not bridge railing)**
 - **702.21 – Pier and bent caps (no mention of joints), f.f. of mudwalls**
 - **707.06 – Top flanges, ext. face & bot. flange fascia beams (unless low permeability requirements of 707.04(c)1 are met)**
 - **IDM locations**
 - **404-2.01 – Concrete bridge railing (must be shown on plans)**
 - **Other locations**
 - **Per INDOT & designer discretion (shoulder piers, MSE wall, etc.)**



Surface Seal and PCC Sealer/Healer



- **What is PCC Sealer/Healer?**
 - ***ISS 901.06 – PCC Sealer/Healers***
 - **Acceptable products listed on qualified products list (QPL)**
 - **Fills cracks and restores tensile capacity**
 - **Various viscosities depending on crack width**
 - All must completely fill 0.031" wide by 6" deep crack, but low viscosity materials can use up to 0.010" or smaller
 - **Qualification testing**
 - Test beams are broken, “glued” back together using PCC Sealer/Healer, and then must rebreak away from repair



Surface Seal and PCC Sealer/Healer



- **Where should PCC Sealer/Healer be used?**
 - **Standard Spec locations**
 - **503.06 – Random crack remediation in PCCP pavement**
 - **707.02 – Prestressed beams (crack repair methods per PCI)**
 - **722.12 – Filling shrinkage cracks in rigid bridge deck overlays**
 - **PCC Sealer/Healer very similar to ISS 727 – Structural Concrete Repair by Epoxy Injection, but material is gravity fed on horizontal surfaces**
 - **Material hardens to a smooth finish, so sand must be applied to traffic surface prior to material curing**



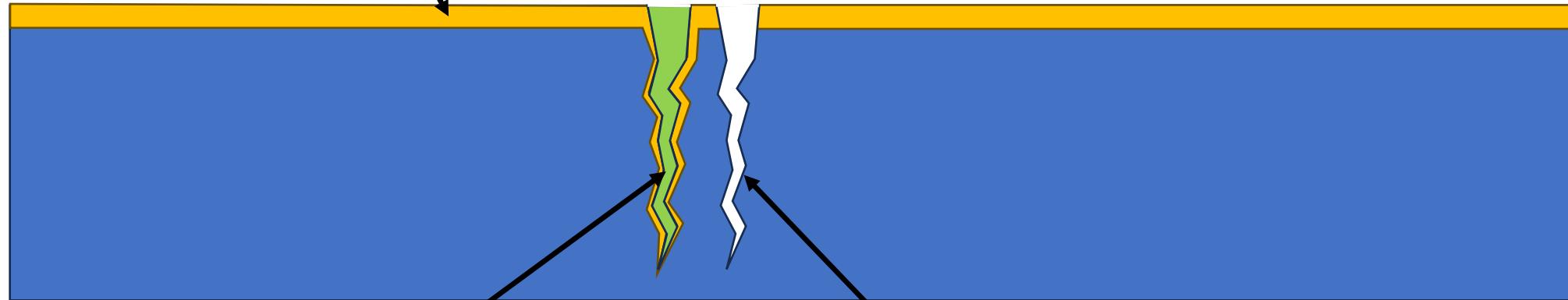
Surface Seal and PCC Sealer/Healer

• Where should Surface Seal or PCC Sealer/Healer be used?

Surface seal penetrates and even coats the inside of many cracks



Surface seal can't be applied until concrete is at least 28 days old and dry



PCC Sealer/Healer completely fills cracks and creates a structural repair for cracks created by "one time" events, such as shrinkage



PCC Sealer/Healer isn't a permanent repair for "working" cracks, such as flexural cracks, as new cracks will form adjacent to the repair



Surface Seal and PCC Sealer/Healer



- **Why isn't surface seal used everywhere?**
 - **28-day concrete cure time could delay opening to traffic**
 - **Pozzolans in concrete decrease permeability**
 - *ISS 709.05(c)* – Alternative to Concrete Sealers allows 3% silica fume or 30% slag in lieu of surface seal
 - Const. Memo 24-03 allows E5-LFA in lieu of 709.05(c)
- **Surface Seal and PCC Sealer/Healer can be use in Rehabs**
 - Surface seal still provides benefit in concrete w/pozzolans
 - **(Sample) USP 507 – RCBA Crack Filling, PCC Sealer Healer**



Concrete Mixes

- Any deviation from Standard Specs should be coordinate with INDOT Bridge Engineering & Division of Materials & Tests
- **Lightweight Concrete**
 - AASHTO LRFD BDS defines lightweight as anything below 135pcf
 - 125pcf obtainable with coarse aggregate substitution
 - 115pcf obtainable with both coarse and fine aggregate substitution
- **RSP 704-B-325 Lightweight Concrete for Floor Slabs**
 - Primarily for restrictive rehab situations, such as historic bridges
- **IDM 406-4.03 Lightweight Concrete for Prestressed Beams**
 - Limited use due to increased costs and production times



Structural Steel

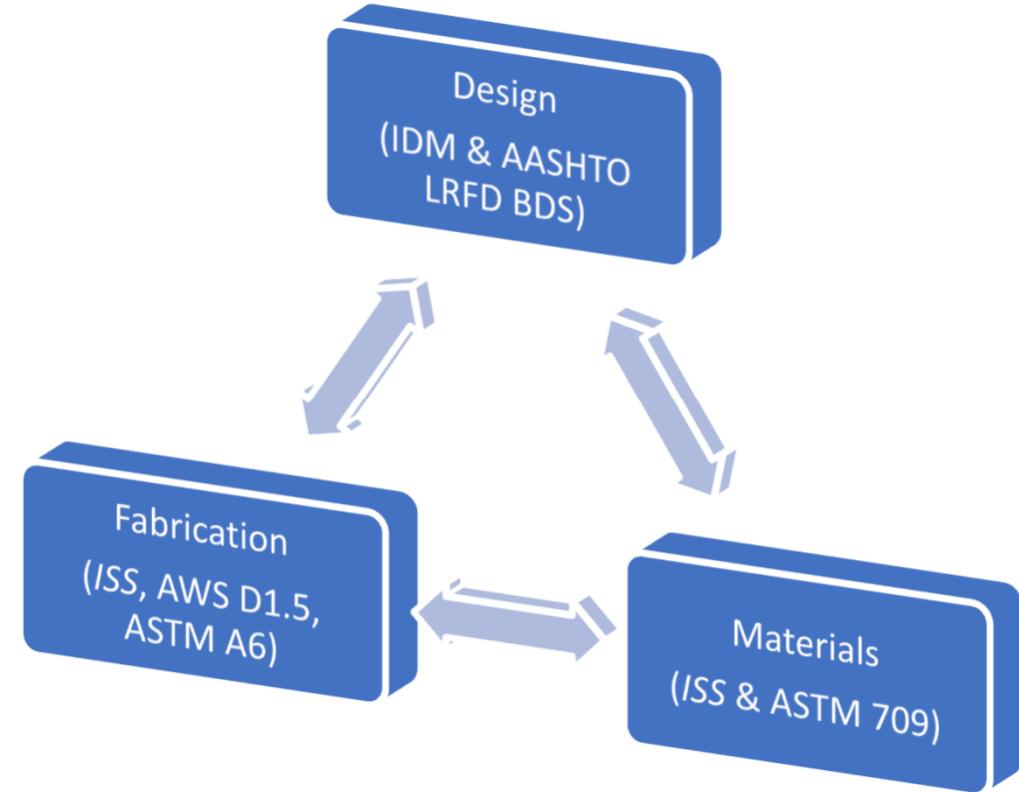


- **There's way more than yield strength**
 - **ISS 711 & 910 covers ASTM A709 gr 36, 50, 50W, HPS 70W, HPS 100W**
 - Requirements for chemical composition, ductility, and toughness
 - Testing and material traceability requirements
 - **AASHTO LRFD BDS is based on the use of ASTM A709 steel**
 - Fatigue and fracture depend on toughness, not yield
 - Only use ASTM A709



Structural Steel

- **Bridge steel required to be fabricated in accordance with AWS D1.5 Bridge Welding Code**
 - **Welding materials, process, qualifications, inspection (including NDT)**
 - **Tolerances for straightness, camber, flatness, distortion, warping, etc., of fabricated members covered by AWS D1.5**
 - **Rolled member tolerances covered by ASTM A6 (listed in ISS 711)**





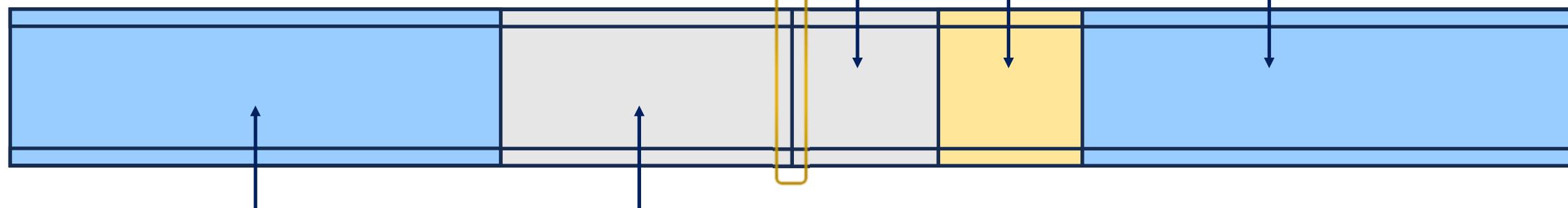
- **INDOT bolt options (2026 Standard Specifications)**
 - ASTM F3125, grades A325, A490, F1825 (round headed twist-off)
 - Type 1 (galvanized or metalized) used with painted steel
 - Type 3 (weathering steel) used with weathering steel
- **Bolt tightening**
 - Only A325 bolts may be retightened, and only if they can be completely threaded without assistance of any tools
 - No reuse of A490 bolts ever
 - We care about bolt tension, not tightening torque



Bridge Painting

Structural Steel Paint System

- Three-part system
- Applied to new steel and fully repainted steel
- Estimated service life approximately 25 years
- Cost to paint new steel included in *ISS 711*



Waterborne or
Polyurethane Finish

Organic Zinc Primer

Inorganic and organic zinc primers
work well together

Inorganic Zinc Primer

Epoxy Intermediate

Polyurethane Finish

Partial Paint System

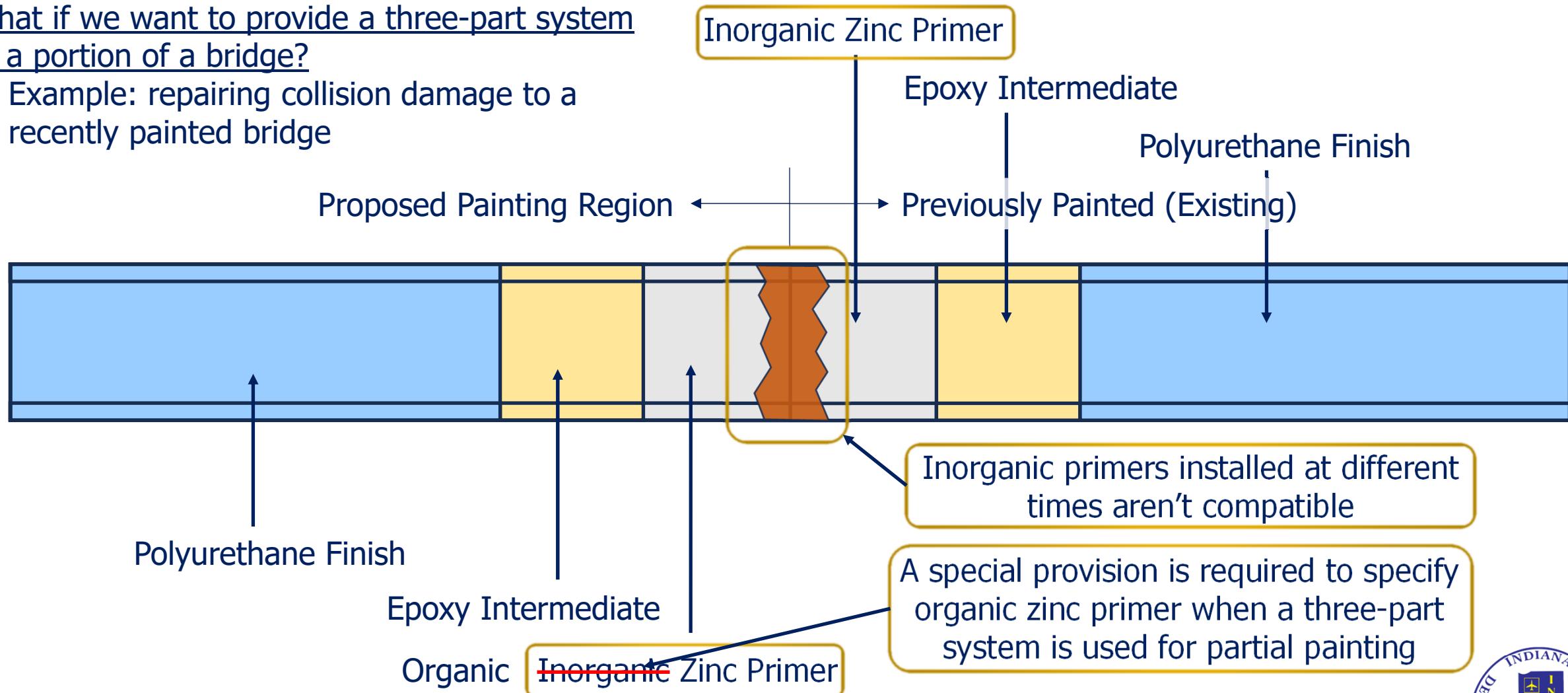
- Two-part system
- Applied to portions of existing steel
- Estimated service life approximately 15 years
- Faster and less expensive than three-part



Bridge Painting

What if we want to provide a three-part system to a portion of a bridge?

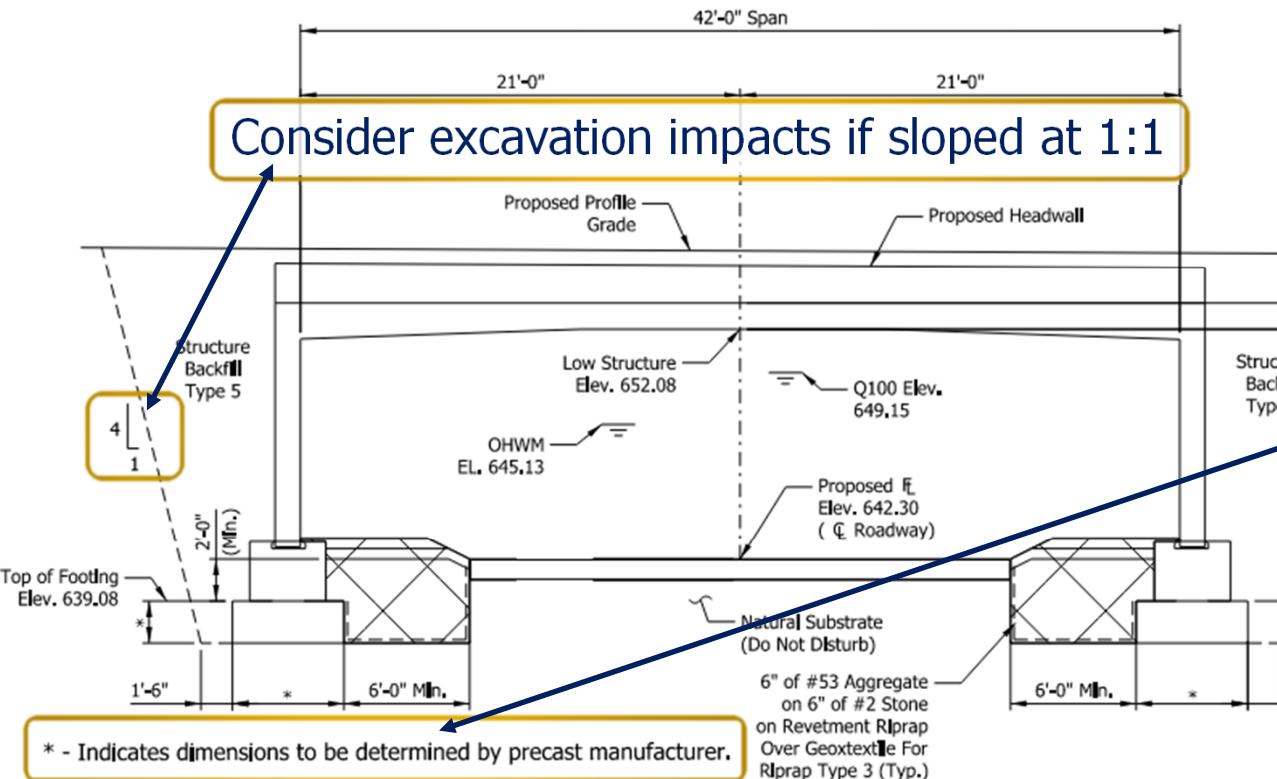
- Example: repairing collision damage to a recently painted bridge



Three-Sided Structures



- **Pre-bid responsibilities of the EOR**
 - **Sizing of the structure based on hydraulics and roadway geometry**
 - **Construction details such as scour countermeasures and backfill**
 - **Feasibility of foundation type (including Foundation Review Form)**



| Support | No. 1 |
|--|-----------------------------|
| Minimum Width of Foundations (ft) | EOR (Preliminary calcs.) |
| Factored Design Load, Q_F (kip) | EOR (Preliminary calcs.) |
| Factored Bearing Resistance, q_R (ksf) | Geotech Report |
| Nominal Bearing Resistance, q_n (ksf) | Geotech Report |
| Permanent Net Axial Force, P_p (kip) | EOR (Preliminary calcs.) |
| Calculated Settlement (inches) | Geotech Report |
| Bottom of Footing Elevation | EOR/Geotech Report |
| Top of Footing Elevation | EOR/Geotech Report |



Three-Sided Structures



• Post-bid responsibilities

Contractor (via Fabricator)

- Designs and details structure including foundation, wingwalls, headwalls, etc.
 - Performs load rating and fills out RPD 700-B-301d

Engineer (INDOT Construction)

- Coordinates review and submittals

EOR (Engineer of Record)

- Submits New Design LR request in LRRA (upload shop drawings, LR calculations, RPD 700-B-301d)
 - Reviews shop drawings and calculations per design and requirements of 723.04(c)
 - Resubmittal in LRRA required if shop drawing comments affect load rating

INDOT Bridge Evaluation

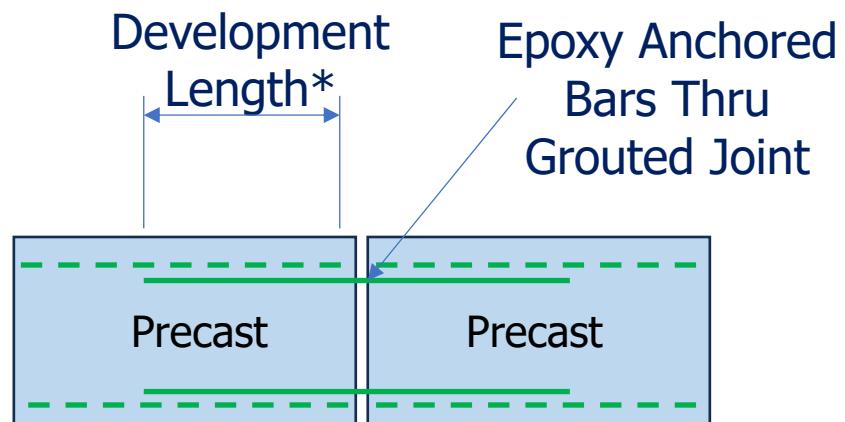
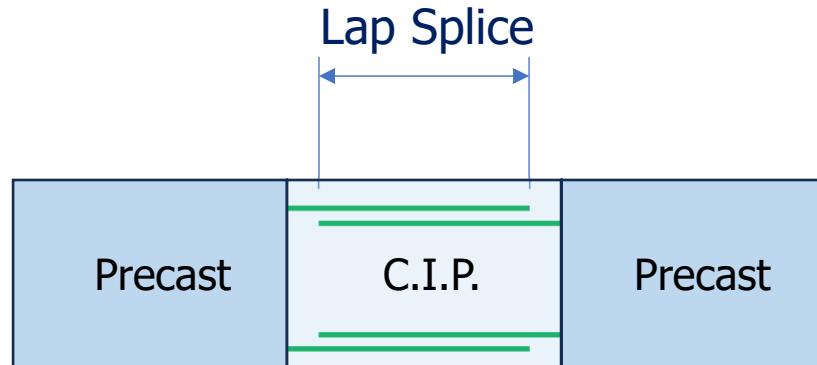
- Enters structure information into BRADIN for load rating and OSOW permitting
 - Notifies EOR via LRRA once load rating review complete
 - Not performing QC on Contractor's design



Three-Sided Structures



- **EOR shop drawing review**
 - Confirm requirements of 723.04(c) are satisfied
 - Design assumptions, design code references, material strengths
 - Details including bar size & spacing, connection devices, lifting device locations, post-installed anchorage locations, etc.
 - If precast footings are proposed, continuity details (723.09)



- * Continuity with rebar in precast controlled by development length of rebar, not epoxy bond strength



Plan Notes – Do's and Don'ts



- **Do's**

- **Limits of work**
- **Concrete class**
- **Material strengths**
- **Rebar coating**
- **Rebar cover**
- **Debonding**
- **Datum shifts**

Surface seal the exposed faces of concrete railings. Estimated quantity is 1,133 sft.

Concrete design strength to be 8,000 psi at 28 days (f'c).

Concrete design strength to be 6,000 psi or more before prestressing force is applied (f'ci at release).

Prestressing steel shall be 0.6"Ø uncoated, low-relaxation seven wire strand (area = 0.217 sq. in.) with an ultimate tensile strength of 270 ksi.

All structural steel to be A709 Grade 50W.

"E" denotes Epoxy Coated Reinforcing Steel.

● INDICATES STRANDS TO BE DEBONDED 50'-0" CENTERED AT MIDSPAN AND CUT AFTER ERECTION. (TYP.)

All stations, dimensions, and Alignment Data are based on existing plans. Elevations are also based on existing plans but adjusted for profile raise and current datum (+36.79') and best fit to provide bridge seat elevations. All information shall be field verified by the Contractor.



Plan Notes – Do's and Don'ts

- **Don'ts**



- **Inadvertently contradict Standard Specifications**
- **Specify payment (should be in USP if not covered by standards)**
- **Specify means and methods**
- **Add unnecessary restrictions**

ISS / IDM

Beams should be designed based on the assumption that they are cast no less than 28 days and no more than 60 days prior to pouring the deck. A note should be placed on the plans indicating the ends of I-beams, U-beams, and bulb-T beams shall extend no more than 1 1/2 in. beyond the supports. The ends of beams or buttons no less than 1 in. wide which are padded with no less than 1/2 in. of rubber. The ends of I-beams, U-beams, and bulb-T beams shall extend no more than the depth of the beam and not more than 3 ft 6 in. beyond the supports. The ends of

Plan Notes

Beams are to be lifted and supported at bearing points during handling, storage and transportation to job site.

Beams shall be cast a minimum of 28 days and no more than 60 days before the floor slab is poured.



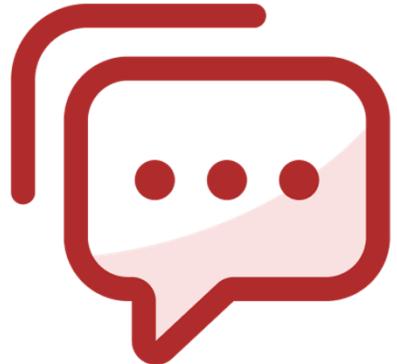


QUESTIONS?

Bridge Design Office

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Audience Q&A

- ① Start presenting to display the audience questions on this slide.