2019 Iowa Transportation Conference

Iowa DOT Bridges and Structures Bureau Update

Michael Nop

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September 11, 2019

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Presentation Outline

- BSB Personnel
- Summary of Work
- AMP
- Bridge Standards
- Design Policy
- Specifications
- Construction Issues
- Research

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Bridges and Structures Bureau Personnel

Consultant Coordination Unit
- Ron Meyer - Unit Leader
- Tim Dunlay
- Steve Maifield
- Christian Yi
- Vacant – <Karen Kontos retired>
- Consultant supplements

Methods Unit
- Jesse Peterson - Methods Engineer/Unit Leader
- Jim Denny - Design Support Engineer
- Kimball Olson - Aesthetic Bridge Specialist
- Brett Kloss - Methods Detailer

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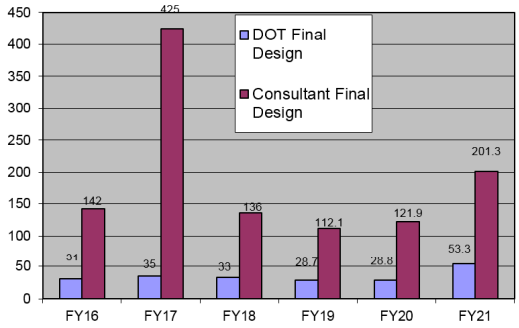
Primary and Interstate
Construction Cost - Bridge & Culvert Bid Items
(Millions)



	% DOT	%Consultant
FY16	18	82
FY17	8	92
FY18	20	80
FY19	20	80
FY20	19	81
FY21	21	79

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Accelerated Migration Program (AMP)

- Bentley's program to assist DOTs to migrate to CONNECT edition applications
- Includes migration to Microstation CONNECT and OpenRoad Designer with implementation of OpenBridge Designer, ProStructures and ConceptStation for Iowa DOT
- Initial workspace development July through December 2019
- Pilot projects start December 2019 to determine any adoption blockers, test the proposed workspace standards and develop new workflows
- December 2019 beta version of workspace to be released to consultants for information only

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Program Highlights

- Microstation CONNECT – new ribbon interface, integrated search and 64 bit platform
- OpenBridge Designer – combines modeling capabilities of OpenBridge Modeler and the analysis and design features of LEAP Bridge Concrete and LEAP Bridge Steel into one comprehensive bridge product
- ProStructures – BIM software comprising of ProSteel and ProConcrete allowing creation of accurate 3D models for structural steel and reinforced concrete structures with integrated tools for design drawings, fabrication details, and schedules

Implementation Dates

- February 2020: All new Survey information to be developed in OpenRoads Designer
- July 1, 2020:
  - All projects where design development has not started will be developed in OpenRoads Designer.
  - Use of OBD and Prostructures workflows will be expected.

Proposal for Active Projects

- Letting date of **January 2021 or earlier** finish in software version design was started with.
- Letting date of **July 2021 and later** will be converted and completed in OpenRoads Designer.

All dates tentative and subject to change.

Bridge Standards Currently Being Updated

- CIP and Precast Box Culvert Standards
- Three Span CCS Bridge Standards
- PPCB Standards

General updates needed:

- All standards need to be updated for lap and development lengths.
- MASH barrier rail update.
- New deck thickness and deck rebar clearances:
  - 8.00" → 8.50" deck thickness
  - 0.50" → 0.75" of uppermost deck portion is non-structural
  - 2.50" → 2.75" top rebar clearance
  - 1.00" → 1.50" bottom rebar clearance
  - 8.75 → 9.00" edge of PPCB deck overhang thickness

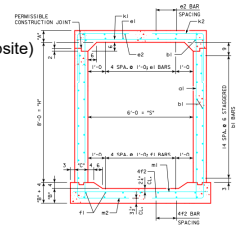
CIP and Precast Box Culvert Standards

- CulvertCalcIA software update (latest version not yet available on website)
- ET Culvert used for precast box culvert updates
- Lap and development length updates for all existing culvert standards

- New CIP and Precast Single Box Culvert Sizes:
  - Span x Height 14' x 4' to 14' x 14' and 16' x 4' to 16' x 14'

- New(ish) Flared Wing Headwalls for CIP Single Box Culverts
- New Parallel Wing Headwalls for CIP Twin and Triple Box Culverts

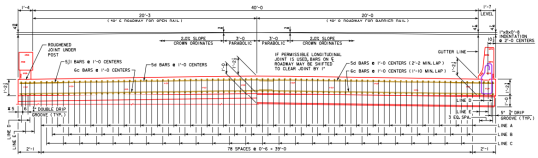
- CIP and Precast Pedestrian Tunnel Standards
  - Span x Height
    - CIP 12' x 11.33' 12' x 12.33' 14' x 12.33' no bottom corner frost troughs
    - Precast 12' x 11' 12' x 12' 14' x 12' no bottom corner haunches
  - CIP flared wing headwalls with concrete texture and safety rails, 0 degree skew
  - Conduit and lighting



6 x 8 BARREL SECTION

Three Span CCS Standards

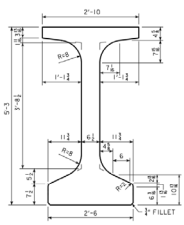
- Mathcad Prime worksheets (to be made available on website)
- Lap and development length updates
- Rail updates required – MASH single slope and open corral rail options
- J24, J30, J40 and J44 standards
  - Base all lap and development lengths on ECR
  - No separate standards for plain, ECR, and stainless steel rebar
  - Standards will accommodate tied and untied approaches in one standard.
- Slab camber diagram may be based on immediate deflection and a portion of long term deflection.



PPCB Standards

- Phase 1 – BTB, BTC, BTD, BTE update
- Preliminary development of a BTF beam
- Excel worksheet for PPCB design (to be made available on website)
- Lap and development length updates in beams based on ECR
- Rail updates required
- Increased deck thickness (i.e. 8.50")
- Eliminate intermediate concrete diaphragms and heavy steel diaphragms
- Camber based on ISU research

Beam Designation	Height in	Area in^2	yb in	Ix in^4	Iy in^4	Perimeter in	Volume/Area in
BTB	36.00	631.24	16.63	99796	35838	166.48	3.79
BTC	45.00	689.74	20.60	178549	36044	184.48	3.74
BTD	54.00	748.24	24.64	284901	36250	202.48	3.70
BTE	63.00	806.74	28.76	421293	36456	220.48	3.66
BTF	72.00	865.24	32.92	590150	36662	238.48	3.63
A	32.00	310.94	14.08	33974	4045	102.68	3.03
B	39.00	381.94	17.08	61841	5119	116.68	3.27
C	45.00	563.94	20.25	116129	10424	134.68	4.19
D	54.00	638.19	24.39	214647	14602	166.49	3.83



BTE BEAM CROSS SECTION

Bridge Barrier Rail

Three Tiered Approach

- MASH Compliant Products
- NCHRP 350 Compliant Products
- Otherwise: Choose the Best Product Available

IOWA DOT Design Bureau

8A-5

Roadside Safety Hardware Assessment

Design Manual Chapter 8 Roadside Safety
Originally Issued: 07-23-19

The Department strives to use roadside safety hardware that meets or exceeds currently adopted testing standards. The Department's approach to hardware is (by priority):

1. Use MASH compliant products.
2. If no MASH compliant products are available or have Department approval for use, use NCHRP Report 350 compliant products. A list of NCHRP Report 350 compliant products is available on FHWA's website.
3. If no products are available that have been tested to MASH or NCHRP Report 350 testing standards, the Department will work with one or both pooled fund groups (currently the Iowa DOT belongs to two pooled funds: Midwest Roadside Safety Facility (MwRSF) and Texas A&M Transportation Institute (TTI)) to either:
   - Choose the best product for the constraints of a project, or
   - Initiate research to develop a compliant product.

The choice of a product to meet the constraints of a project will be based on a combination of:

- In house engineering judgement;
- Research (NCHRP or pooled fund studies) conducted through ISO 17025 accredited crash test facilities showing a device meets AASHTO MASH 2016;
- Review by an ISO 17025 accredited crash test facility (both MwRSF and TTI are ISO 17025 accredited crash test facilities);
- Critical Test Matrix by an IGO 17025 accredited crash test facility and at least one physical crash test (includes final report);
- Crash test results, videos, and test summary sheets that are completed and reported by accredited laboratories according to AASHTO MASH 2016; and/or
- Safety Hardware used by other states. This involves gathering documentation from other states for the systems.

The Methods Section in the Design Bureau will evaluate roadside safety hardware for use on the Interstate and Primary systems.

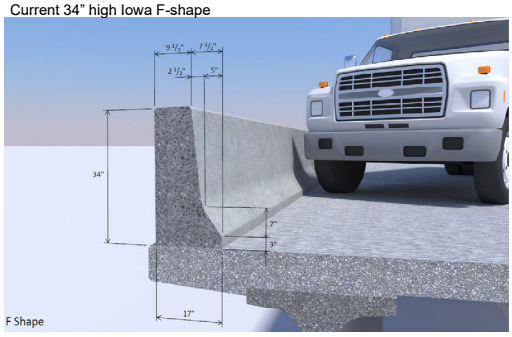
https://iowadot.gov/design/dmanual/08A-05.pdf

DRAFT – Note that primary items and hierarchy are under development.

Primary items to consider in order to comply with our MASH policy:

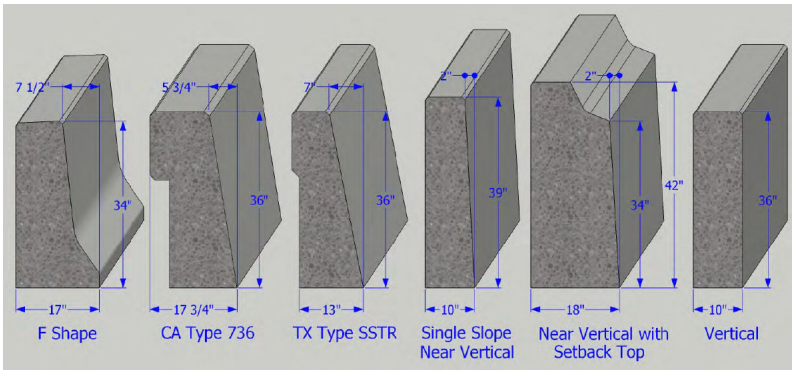
1. FHWA memos and crash tests for rail options.
2. Available in-service records.
3. Adoption by other states and their feedback.
4. Long term rail maintenance.
5. Other safety considerations such as sight distance.
6. Incorporation of rail in bridge and roadway design standards.
7. Affect of rail choice on projects under development.

Current 34" high Iowa F-shape



MASH Policy and TL-4 Concrete Rail Shape Selection:

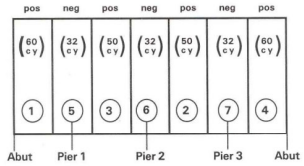
NCHRP 350:	32" height
Iowa F-shape:	34" height
MASH:	36" height
New Iowa Shape:	38"+ height (?)



Deck Pour Sequences (another look)

Construction Manual, Chapter 11.62 Sequence of Pouring, https://iowadot.gov/erl/current/CM/content/CM%2011.60.htm

Continuous Steel Girders
Since the beams of this structure are continuous over the piers, upward deflection can be transmitted to span 2 during concrete placement in span 3. Therefore, it is important for the concrete to remain plastic in the major portion of span 2 until placement is complete throughout the positive moment section of span 3. Experience indicates that stress cracking will not occur if the concrete in the positive moment section of span 2 remains plastic until such time as placement is complete in span 3 positive moment section.



EXAMPLE CONCRETE PLACEMENT DIAGRAM 2
(Continuous)

Place positive moment regions first and then negative moment regions over supports.

However, good practice may also include alternating positive moment regions.

Deck Pour Sequences (another look)

2.12.4 Cast-in-Place Deck Placement Sequence

The cast-in-place deck placement sequence considered by the bridge designer must be provided in the contract plans, and must be taken into account as part of the girder constructibility checks. Common practice when placing the deck in continuous span bridges is to place the cast-in-place deck slab in the positive moment regions first and then place the cast-in-place deck slab in the negative moment regions over the supports. A strategy such as this is typically adopted in order to minimize the potential for cracking at the top of the deck slab in regions that are subjected to negative moment. It should be noted that when concrete is placed in a span adjacent to a span that already has a hardened concrete deck, negative moments in the span with the hardened concrete will often result. These negative moments will cause tensile stresses in the hardened concrete that could result in transverse deck cracking. The concrete deck stresses during deck placement should be checked in accordance with Article 6.10.3.2.4 of the *AASHTO LRFD (7th Edition, 2014)*.

Publication No. FHWA-HIF-16-002-Vol.17 (Dec 2015) https://www.fhwa.dot.gov/bridge/steel/pubs/hif16002/volume17.pdf

AASHTO Article 6.10.3.2.4 allows modulus of rupture to be exceeded if additional longitudinal reinforcement is provided according to Article 6.10.1.7: 1% reinforcement with 2/3 in the top deck layer.

Deck Pour Sequences (another look)

E926: Prestressed concrete beam bridge, deck placement
NOTE: CONCRETE DECK SHALL BE PLACED IN SECTIONS AND SEQUENCES INDICATED. (AN APPROVED ALTERNATE PROCEDURE IS TO PLACE THE CONCRETE DECK IN ONE CONTINUOUS POUR BEGINNING AT ONE END OF THE BRIDGE. << OR >> PLACING THE CONCRETE DECK IN ONE CONTINUOUS POUR IS PROHIBITED AND WILL NOT BE CONSIDERED FOR APPROVAL AS AN ALTERNATE PROCEDURE.)
ALTERNATE PROCEDURES FOR PLACING DECK CONCRETE MAY BE SUBMITTED FOR APPROVAL…

If the total volume of deck concrete is 500 CY or less and the designer has no structural or constructability concerns, then allow the contractor to place the deck in one continuous pour. If the continuous deck pour should start at a specific end of the bridge then modify the note accordingly. If the designer determines a continuous deck pour is not permissible, then explicitly exclude the option in the note.

If the total volume of deck concrete exceeds 500 CY then consider allowing a series of sequential pours sized between 300 to 500 CY from one end of the bridge to another. Consider showing a separate concrete placement diagram for this additional option. The concrete placement diagram shall specify a 2-day waiting period between subsequent pours. See BDM 5.2.4.1.2 for additional information.

Average deck retarders are pre-approved for about 10 hours. Contractors typically pour concrete decks at a rate of 50 CY per hour which results in the volume limit of 500 CY per pour.

Zone Painting for Weathering Steel Bridges

The following criteria is in BDM 5.5.2.4.1.2, but should be detached from tunnel-like conditions.

Zone paint when all of the following present.

When to zone paint (draft):

- Vertical clearance is 20 feet or less~~, because these bridges are more susceptible to "tunnel-like" conditions~~
- Bridges over interstates in urban corridors, since deicer treatment in these areas is typically more concentrated
- ADTT = 10% or more under the bridge, since trucks generate more misting with deicers than cars do
- Posted speed limit is 55 mph or greater, since higher speeds generate more misting with deicers

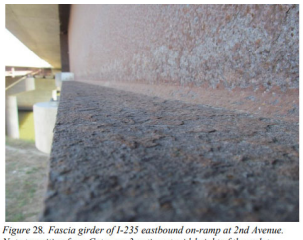


Figure 28. Fascia girder of I-235 eastbound on-ramp at 2nd Avenue. Note transition from Category 3 patina at mid-height of the web to Category 2 at the top of the bottom flange in areas subjected to direct salt spray from the I-235 mainline.

Zone Painting for Weathering Steel Bridges

What to zone paint (draft):

- Paint to a bolted field splice when doing zone painting. [If the field splice is at least 40' from edge of shoulder then you can stop there or else you may need to carry painting over the pier and to the splice in the next span.]
- Paint all diaphragms in the zone.
- When doing zone painting the exterior girders shall be fully painted in the zone, but shall be partially painted for the full length of the bridge according to BDM 5.5.2.4.2. [Painting only a portion of the height may not matter much when doing shop painting, but it may be beneficial for future field painting since you only need to go part way up on a portion of the girder.]
- If painting the entire surface of all girders still use weathering steel, but forgo the 1/16" added thickness requirement.
- If doing zone painting or no painting use weathering steel and include the 1/16" extra thickness for all girders everywhere.

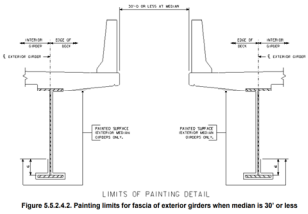


Figure 5.5.2.4.2. Painting limits for fascia of exterior girders when median is 30' or less

Transparent Stay-In-Place Deck Forms (Draft)

Projects with the following criteria may allow transparent stay-in-place forms in the plans:

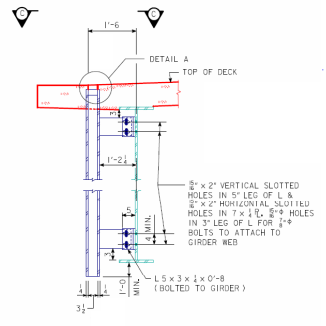
1. Bridge spanning over a railroad.
2. Bridge spanning over non-navigable high water.
3. Tub girder bridges.
4. Bridges requiring top down construction, i.e. utilities or obstructions inhibiting access from below.

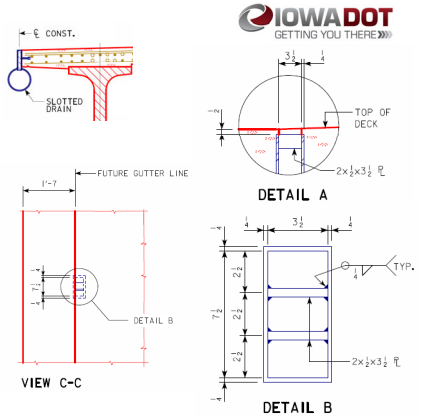
Transparent Stay-In-Place Deck Forms (Draft)

Possible Note:

At the contractors option transparent stay-in-place deck forms may be used for this project. The stay-in-place forms shall have a minimum average transparency of 70%. Shop drawings and calculations shall be submitted for the engineers review. The transparent stay-in-place form material and installation cost shall be included in the pay item for structural concrete for the concrete bridge deck.

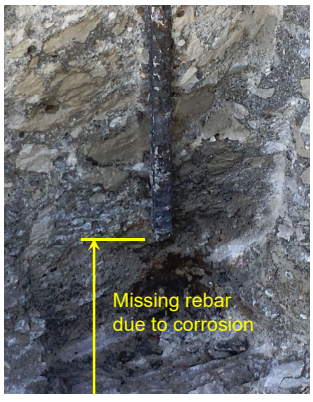
Traffic on 4" x 8" tube deck drains





Curbs for Overlay Projects:

- Cold joint between curb and deck.
- Sound interior curb fascia for hollows.
- Underside of deck overhang and/or exterior fascia of deck or curb has staining and leaching.
- Curb rebar may have up to 100% section loss.



Developmental Specifications in the Works:

New DS for "Mass Concrete – Control of Heat of Hydration"

- Based on current Special Provision (existing DS-15032 is now obsolete)

- Produce a mass concrete placement free of cracks caused or worsened by concrete heat of hydration.
- Accomplish this through appropriate concrete mix design and control of concrete temperatures and temperature differences.
- Use of concrete pre-cooling, concrete post-cooling, application of insulation or external heat, and/or selection of reduced heat of hydration concrete mix may be appropriate for this purpose.

- Mass concrete is defined as any concrete placement with a least dimension greater than 4.5'.
- Tier 1 thermal control plan - mass concrete with a least dimension between 4.5' and 6.5'.
- Tier 2 thermal control plan - mass concrete with a least dimension greater than 6.5'.
  - Requires PE design
  - Thermal modeling

Developmental Specifications in the Works:

New DS for "Girder Erection Plan"

- Based on current Special Provision

- This work shall consist of developing, engineering and submitting a detailed Girder Erection Plan which shall include erection plans and procedures substantiated with appropriate erection engineering calculations.

- Currently required when:
  - Shoring towers and/or strong-backs are used by the contractor.
  - Erection is from floating equipment.
  - The girder system includes lateral bracing.
  - Girder radius of curvature is less than 20 times the span length.
  - The bridge is over or adjacent to a railroad.

Construction Issues

Too much top of concrete deck removal on a CCS bridge with staged construction?

Construction Issues

Too much full depth concrete deck removal on a PPCB bridge with staged construction?

Construction Issues

Too much full depth concrete deck removal on a PPCB bridge with staged construction?

Research

Evaluation of D.S. Brown Steelflex Strip Seal Expansion Joint Systems at Skew

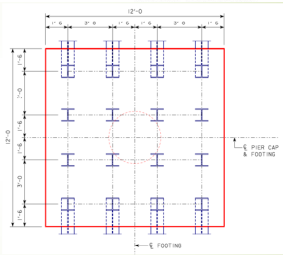
The Iowa DOT LRFD Manual currently specifies that strip seals lose movement capacity and may not be practical for skew values greater than 30-degrees.

This study seeks to test and verify this for the D.S. Brown A2R-400 and A2R-XTRA strip seals installed with D.S. Brown's SSA2 Railing.

“Research”

Pile Footing Optimization

- Optimization Goal
  - Minimum number of piles.
  - If two pile arrangements yield the same number of piles then the secondary goal is minimal footing area.
- Constraints
  - Maximum and minimum pile spacing
  - Maximum and minimum pile load
  - One-way and two-way shear
- DOT and 6 consulting firm examples



$$\sum x_i^2 = 4[2(1.5^2 + 4.5^2)] = 180$$

$$\sum z_i^2 = 4[2(1.5^2 + 4.5^2)] = 180$$

$$P_{ui} = \frac{P_u}{n} + \frac{M_{xx}x_i}{\sum x_i^2} + \frac{M_{yy}z_i}{\sum z_i^2} = \frac{1575}{16} + \frac{1631 \cdot 4.5}{180} + \frac{480 \cdot 4.5}{180} = 151.213$$

$P_{ui} > 145.8$ kips

The End