



Design Considerations for Bridge Widening

TxDOT Winter Bridge Webinar

February 7, 2020

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Purpose of Bridge Widening



- Add Horizontal Width to Accommodate:
 - Widened Shoulders
 - Additional Lanes
 - Pedestrian Sidewalks





- Condition State of Existing Structure
- Load Rating of Existing Structure
- Condition Survey
- Geometrics
 - Vertical clearance existing and in widened condition
 - Relative clearances to lower roadways or reconfigured roadways
 - Maintenance of skew (if possible)
 - Stream geometry relative to widened bridge
 - Make sure all notes read “Field verify existing dimensions and elevations prior to ordering materials and beginning work”



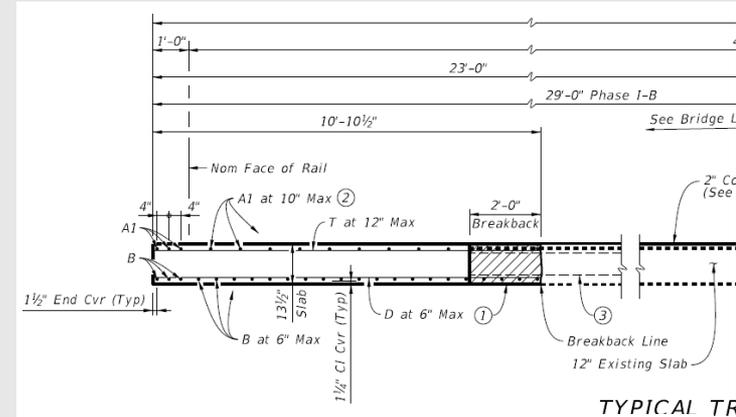
- Current: Chapter 5 Section 1 of the TxDOT Bridge Design Guide
 - Lists recommended superstructure types when widening historical previous types
 - Little or no information on substructure
- Previous:
 - Chapter 9 Section 1 of the 2001 TxDOT Bridge Design Manual
 - Section 7.1.1 of the 1990 TxDOT Bridge Design Manual



Superstructure Considerations: Cast-in-Place Slab Spans

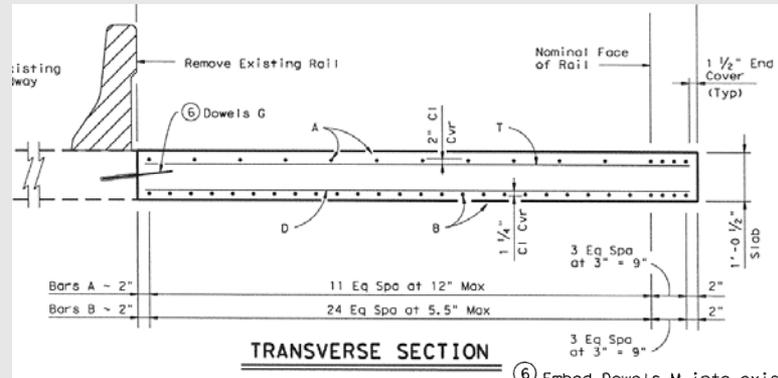


- Typically Match Existing Depth
- Two Connection Methods
 - Breakback and clean/extend existing reinf (preferred)
 - Dowel connection without breakback



TYPICAL TR

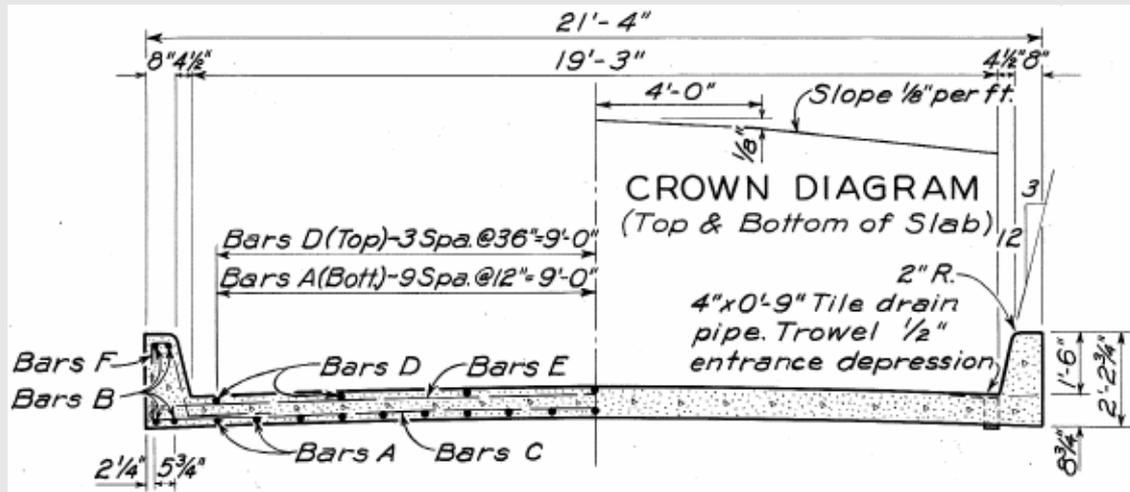
- ① Hatched area indicates portion of line existing slab to be broken back. Saw cut a vertical line to the depth of one inch for the full length of the slab. Do not cut existing reinforcing steel. Clean, straighten, and extend existing reinforcing a minimum of 1'-9" into new construction.
- ② A2 Bars not shown. Place Bars A2 between Bars A1 over bent (See Plan for placement).
- ③ Existing reinforcing steel to remain, clean, straighten and extend into new construction.



TRANSVERSE SECTION

- ⑥ Embed Dowels M into existing construction as shown, using an approved adhesive anchorage system. Depth of holes and installation shall be in accordance with manufacturers recommendations. The maximum hole depth shall not exceed 9".

CIP FS Slab Bridges – DO NOT WIDEN Unless BRG Approves



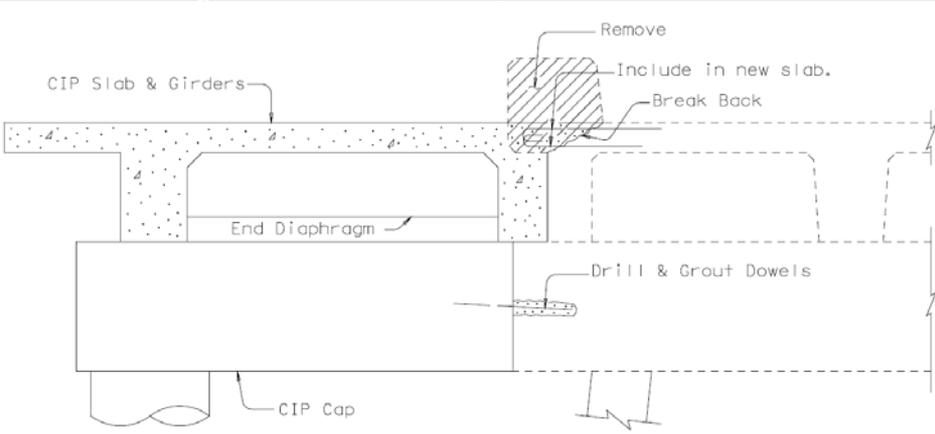
GENERAL NOTES:

Design: 2 Lanes H-10 Loading. A.A.S.H.O. (1941) Specifications, except moment distributed in accordance with the provisions of University of Illinois Experiment Station Bulletin No. 346.

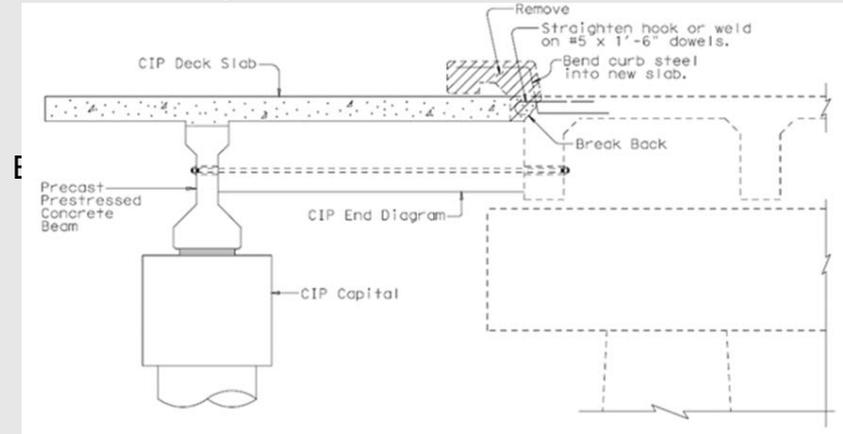


■ Concrete Girder Spans

- Early generation reinforced concrete superstructure 1920's to 1930's; use faded in 1940's
- Span lengths ranging from 16 to 40 ft (most 26 ft)
- Original widths were restrictive enough that most have already been widened once
- Age and short span nature of existing structure may warrant replacement



Example Widened with Concrete Girder Span

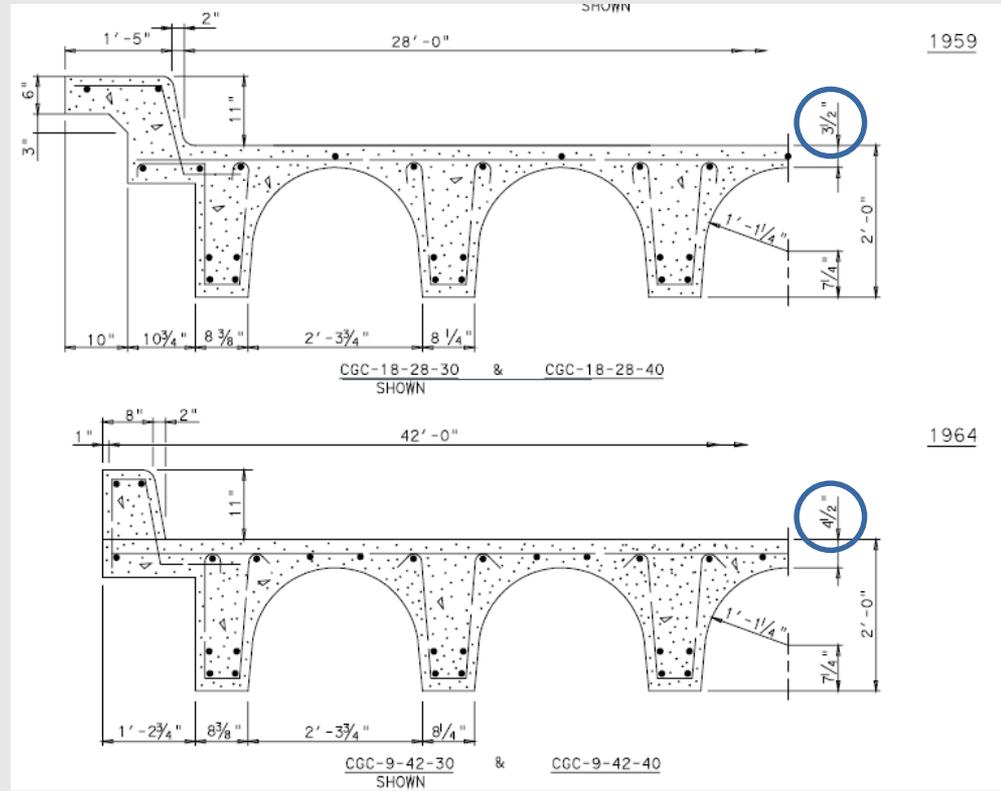


Example Widened with Prestressed Beam

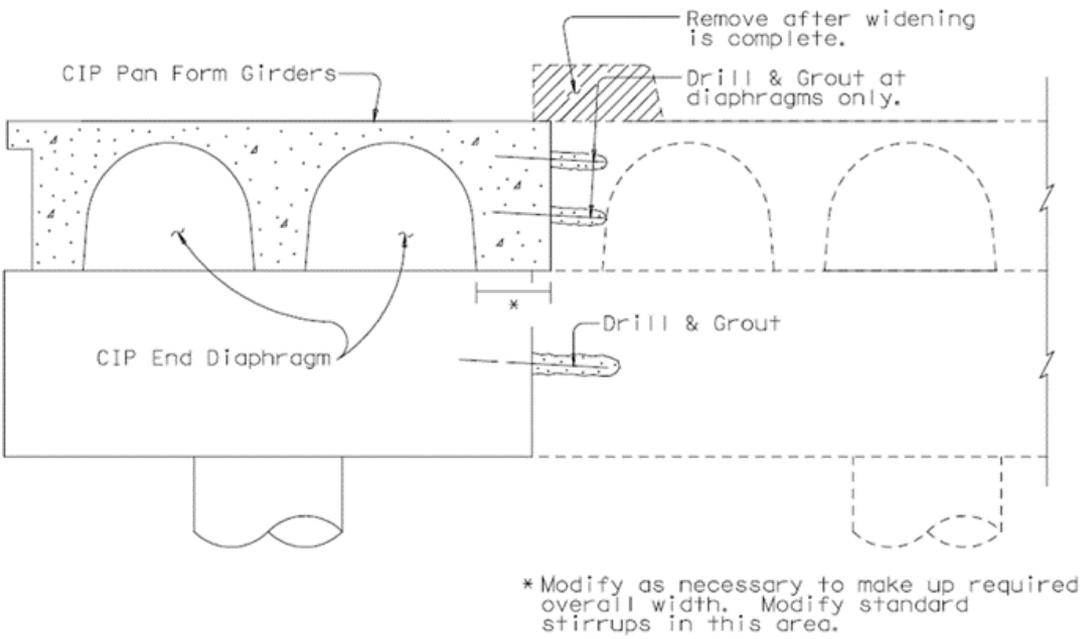
Superstructure Considerations: Cast-in-Place Concrete (Pan) Girders



- CIP Concrete Pan Girders
 - Reinforced concrete superstructure late 1940's to present; use has faded over last 20 years
 - Span lengths 30.33 ft and 40 ft
 - Very common stream crossing structure
 - Age and short span nature of existing structure may warrant replacement

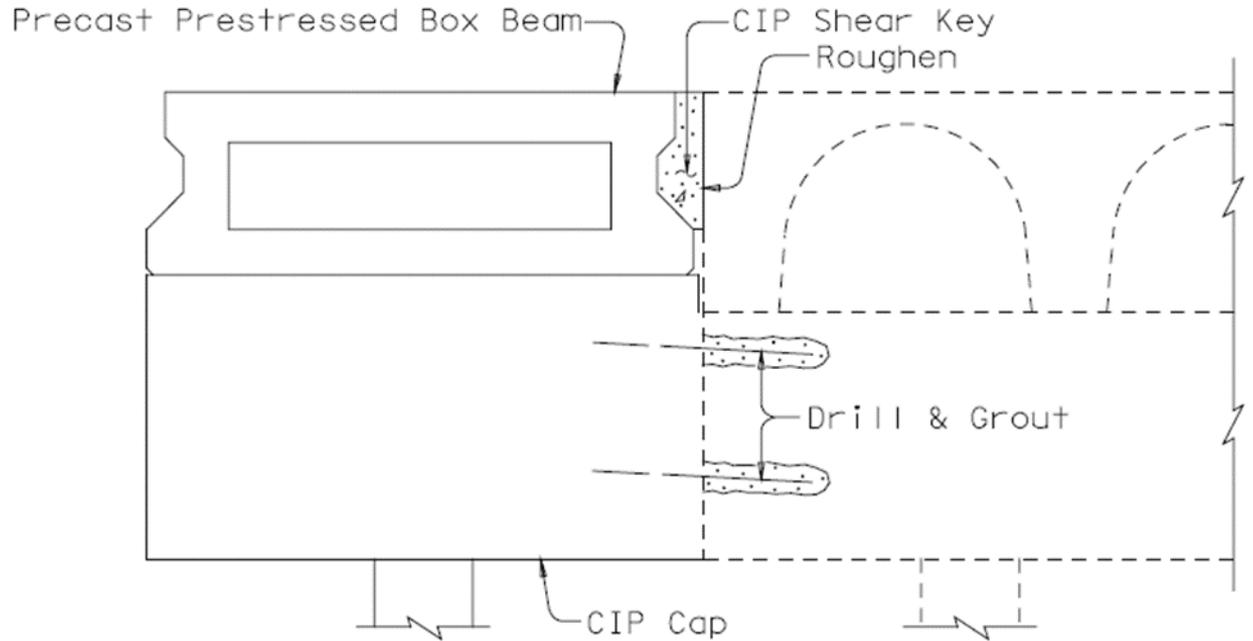


Superstructure Considerations: Cast-in-Place Concrete (Pan) Girders



Example Widened with CIP Pan Girder Span

Superstructure Considerations: Cast-in-Place Concrete (Pan) Girders



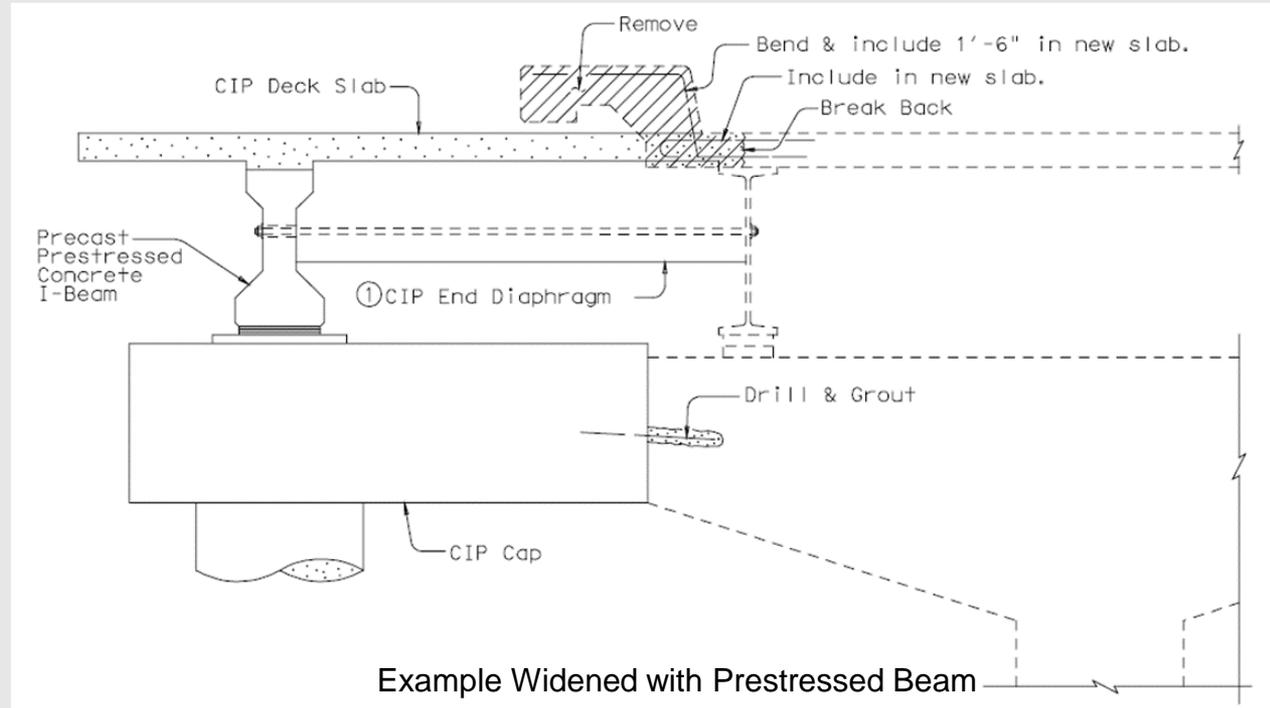
Widening of Pan Form Girder Spans with Prestressed Concrete Box Beams

Example Widened with Box Beam



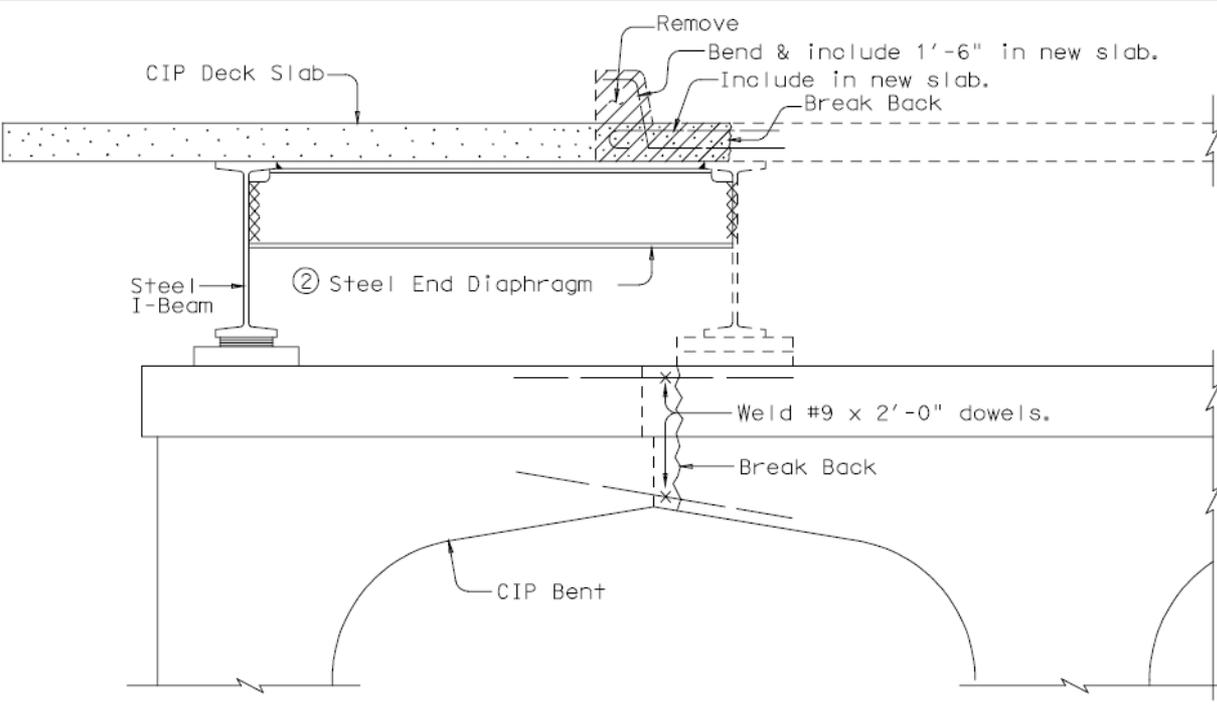
■ Steel I-Beams

- Steel Beam superstructure with concrete deck
- Very common until 1960's
- Earlier designs were non-composite and had thin decks



① End diaphragms required at joints. Interior diaphragms between steel and prestressed beams are not required.

Superstructure Considerations: Steel I-Beams/Girders



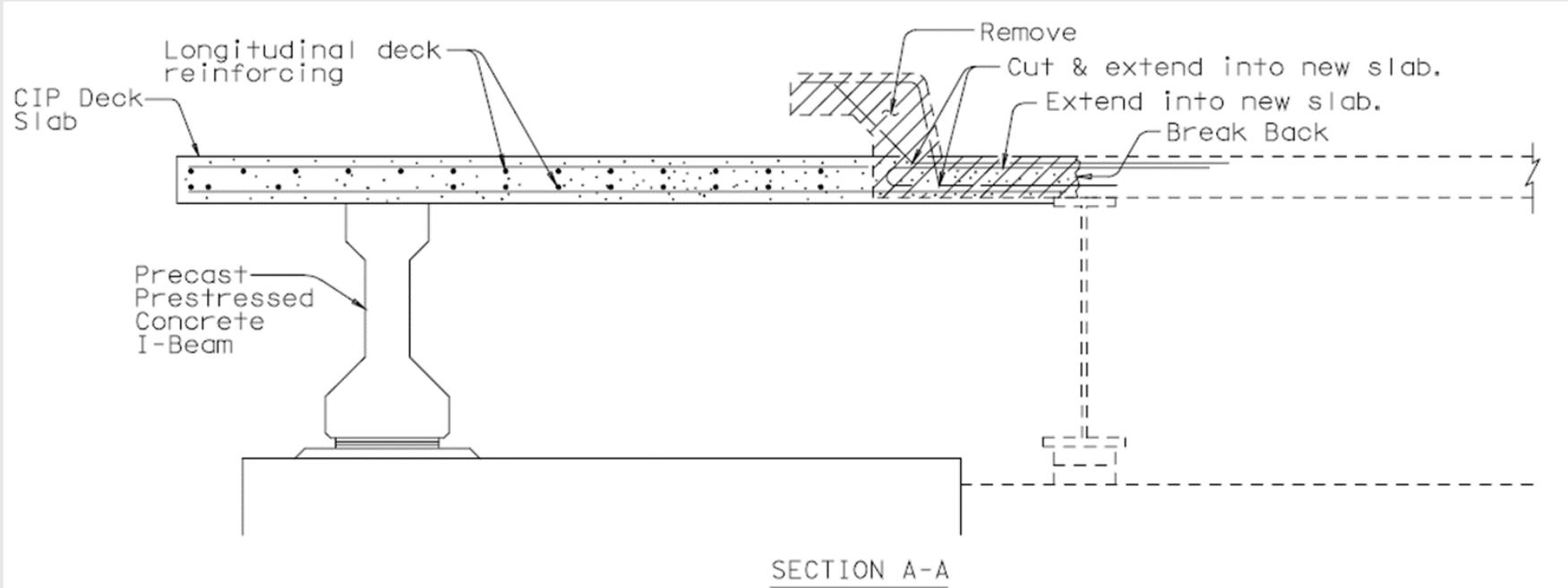
Example Widened with Steel Beam



Example Post-Installed Shear Connectors to Strengthen Existing

② End diaphragms required at joints. Interior diaphragms are required for spans over 25 ft.

Superstructure Considerations: Continuous Steel I-Beam/Girder



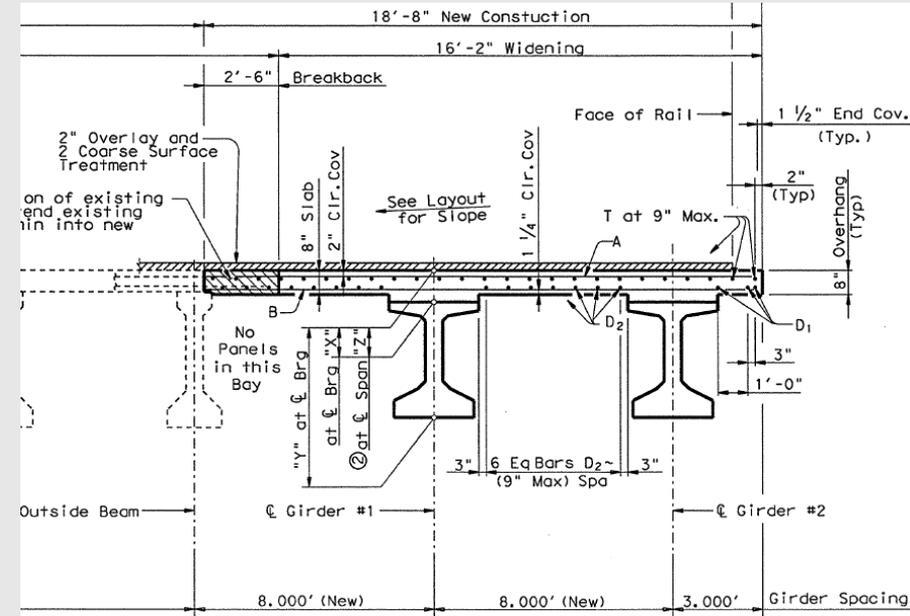
Note: Longitudinal deck reinforcing continuous across interior supports.
Interior diaphragms not required.
End diaphragms required at ends of units only.

Superstructure Considerations: Continuous Steel I-Beam/Girder



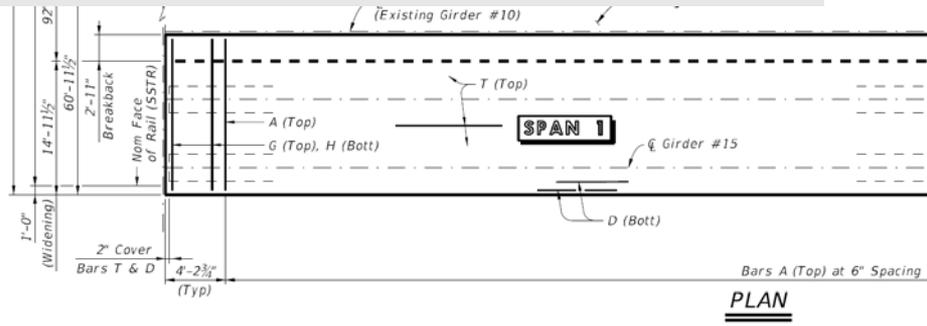
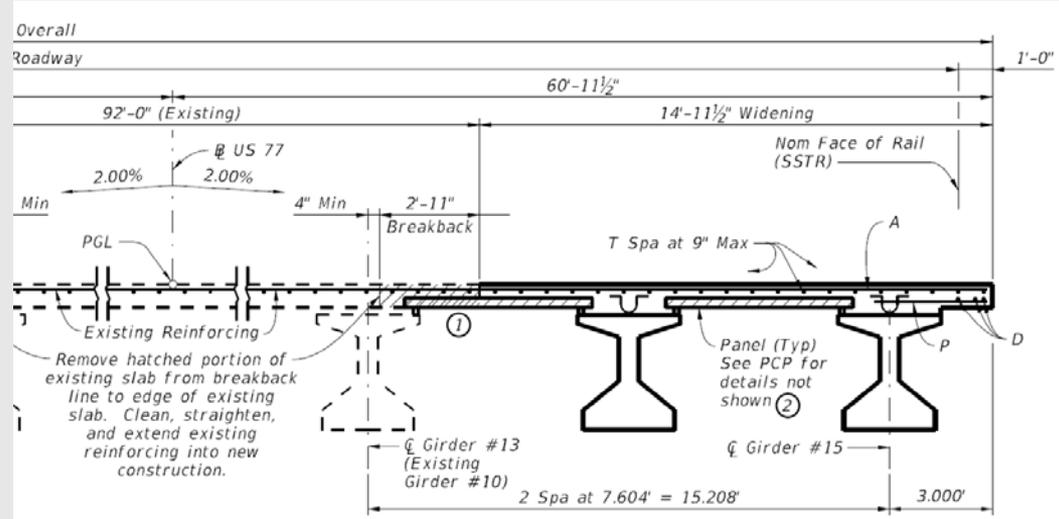
Superstructure Considerations: Prestressed Concrete Beams and Girders

- Existing Prestressed Beam
 - Older AASHTO shapes (A/B/C/IV)
 - TxGirder shapes
- Widened Beams = TxGirder shapes
- Deck Considerations
 - Bedding requirements of panels on existing exterior girders may preclude panels in the first deck bay
 - Reinforcing steel arrangement of existing versus modern “empirical” deck size/spacing/pattern
 - New deck should adopt 8 1/2” thickness (existing will not be)
 - Does it make sense to use epoxy coated steel or HPC when existing bridge did not? Unlikely



Superstructure Considerations: Prestressed Concrete Beams and Girders

- Consider existing deck steel arrangement
- Case of original TxGirder with earlier generation non-empirical deck (Bars A #5 at 6" and Bars A on top of longitudinal Bars T)



- ① Field bend existing bottom mat reinforcing to lay flat above panel and below top mat reinforcing.
- ② At the contractor's option, the PCP panels may extend to end of unit per PCP standard "Option 2" in lieu of thickened end slab shown.



- Nearly 40% of On-System Bridge Structures are Bridge Class Culverts
- Topic of It's Own
 - Reference previous webinar: <https://ftp.dot.state.tx.us/pub/txdot-info/brg/webinars/2014-0716/hyzak.pdf>



Bridge Railing Considerations



- Provide a MASH-compliant bridge rail on widened side
- Provide a MASH-compliant rail retrofit on non-widened side
 - September 2019 Bridge Railing Manual update
 - 3R Projects: If work is scheduled or performed which widens to either side any span, all traffic railing on the structure must comply with MASH
 - Design exceptions allowed if sent to BRG
 - Previous editions grandfathered 350 compliant rails





- Foundation Selection
 - Existing structures with drilled shafts likely suggest drilled shafts for widening
 - Existing structures with piling could be either drilled shafts or piles depending on soil conditions
- Proximity of New Foundation
 - Prefer 3 ft clear to existing structure as room for pile driving leads or drilled shaft equipment
 - Prefer 2 foundation diameters clear and 3 foundation diameters on center relative to existing foundations



Interior Bent Considerations



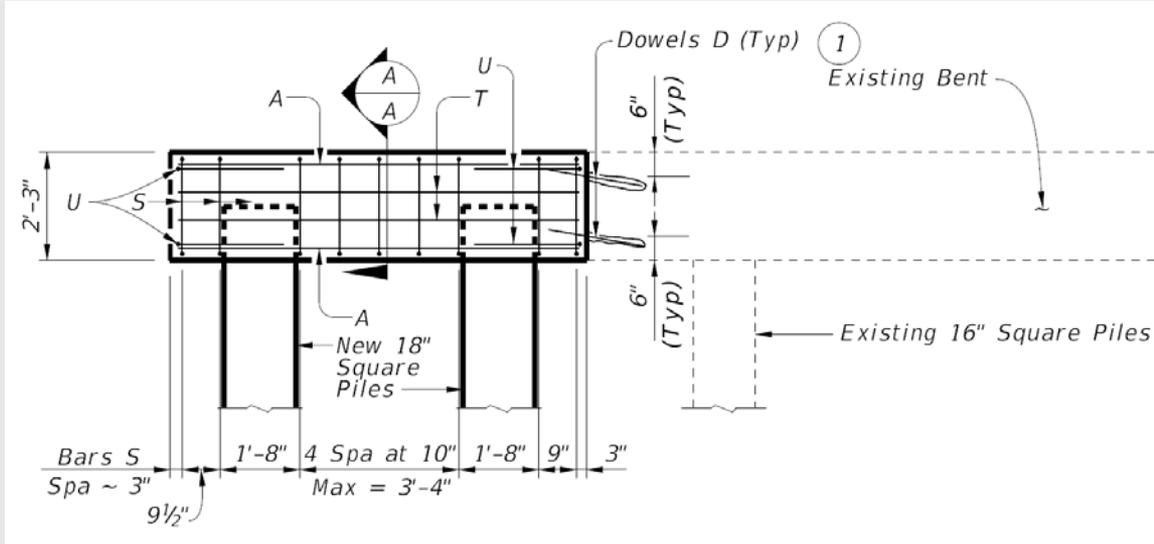
- Depending on widening width:
 - Separate isolated caps
 - Single column caps with shear connection
 - Single column caps without shear connection



Interior Bent Considerations: Shear Connection



- Dowel Connections
 - 4 ~ #6 or #9 bars typically (not smooth)
 - Extend 1'-0" to 1'-6" into existing and proposed
 - Sloped installation with cementitious grout
 - Straight or sloped installation with Class III Epoxy per DMS-6100



1 Drill and grout Dowels D 1'-6" into existing bent.



- TxDOT LRFD Bridge Design Manual:
 - Chapter 2, Section 2 “Loads – Vehicular Collision Force”
 - Redirect or Resist
 - Do not investigate if AASHTO Eqn C3.6.5.1-1 $AF_{HPB} < 0.001$
 - Otherwise resist 600 kip equivalent static load in LRFD 3.6.5
 - Chapter 4, Section 6 “Columns for Multi-Column Bents – Column Collision” and Section 7 “Columns for Single Column Bents or Piers – Column Collision”
 - Evaluate for shear only, but do not consider transfer to other elements
 - One or two shear plans depending on number of columns
 - 40 SF area criteria for no analysis required
 - Vehicular Deflection Walls often a solution for retrofit of existing bents

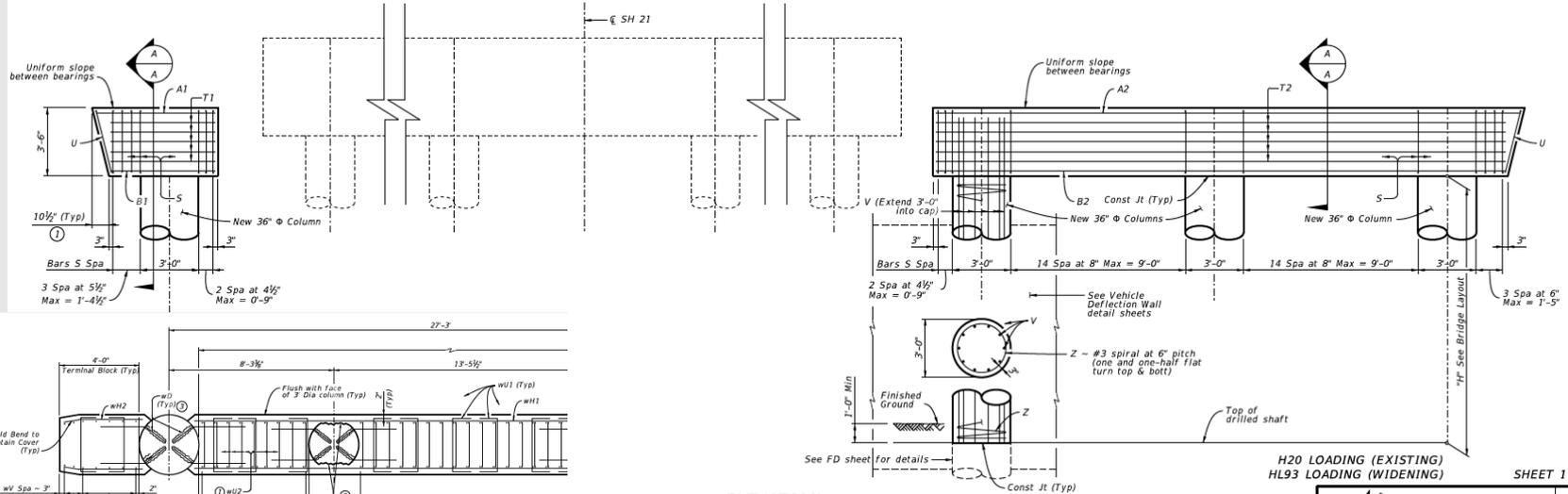




- For Widening, Pier Protection Method:
 - Depends on existing structure design
 - May require a deflection wall
 - Depends on widening width and how many columns
 - Depends on method of connection
- Lower Roadway Functions May Influence
 - Site distances at intersections
 - Ponding width if immediately adjacent to roadway
- Case-by-case evaluation

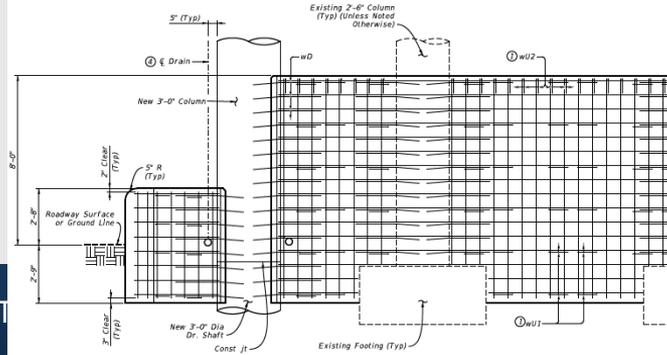


Interior Bent Considerations: Pier Protection for Vehicular Collision



ELEVATION

H20 LOADING (EXISTING)
HL93 LOADING (WIDENING) SHEET 1 C





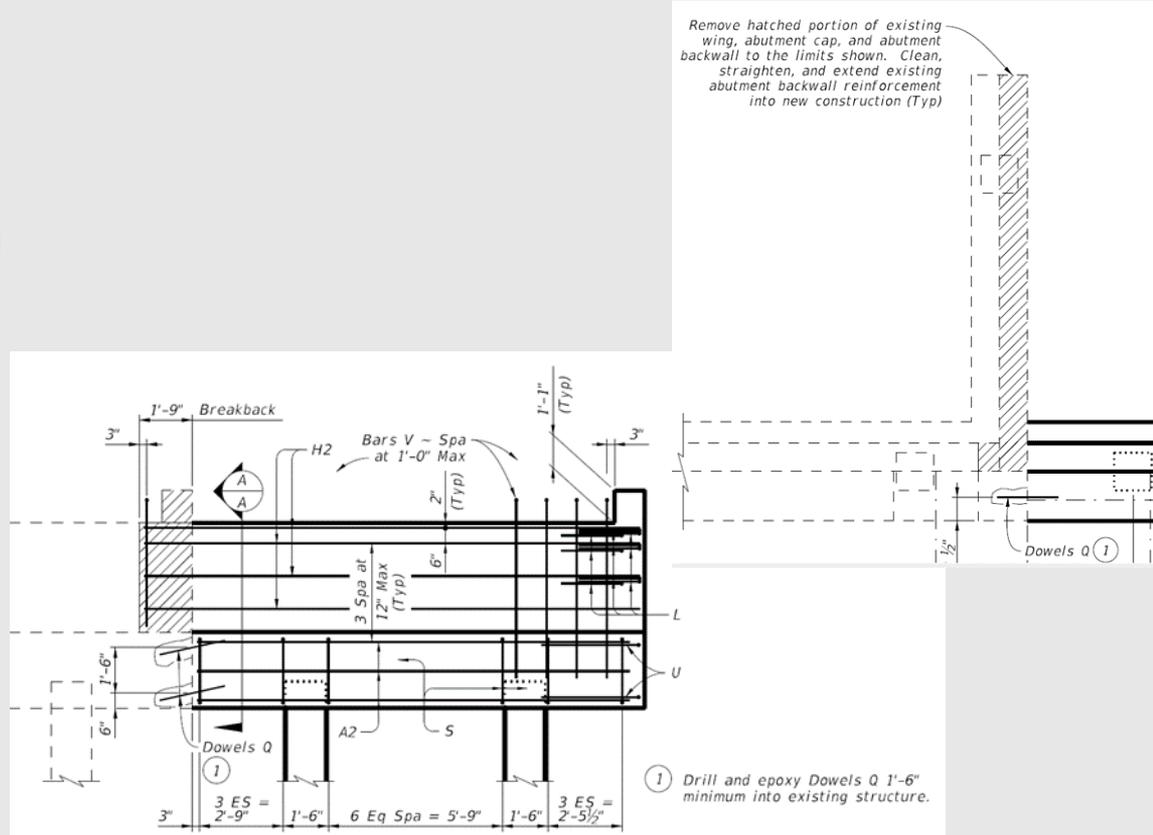
- Same Foundation Clearance Considerations as Bents
 - Full height spread footing abutments a special case though
- Match Face of Existing Backwall
 - if there is a backwall and if bearing area is sufficient for new superstructure
- Match Cap Width or Make Wider
 - to accommodate new foundations



Abutment Considerations



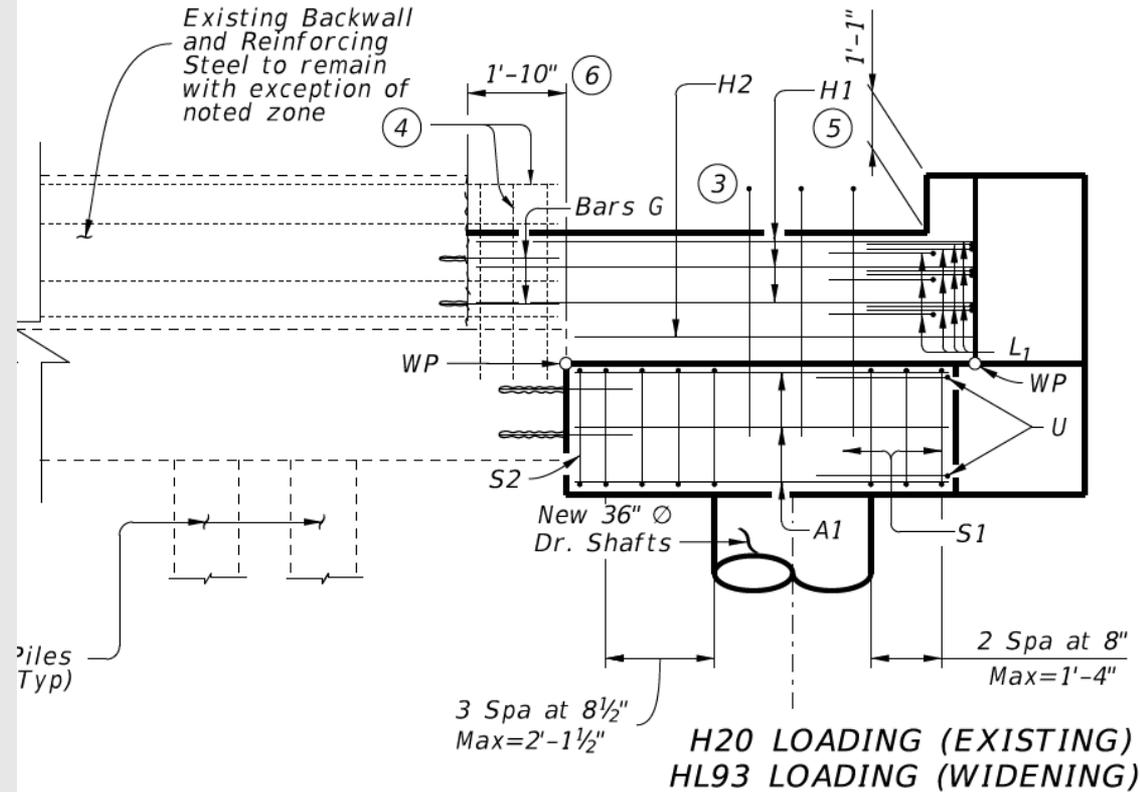
- Existing to New Cap Connection
 - Usually do not breakback and couple/lap reinforcing
 - Usually use a shear connection
 - Limits the offset of new foundations
- Existing to New Backwall Connection
 - Breakback to allow a lap splice with cleaned and extended existing reinforcing
 - Remove the upper portion of the existing wingwall



Abutment Considerations



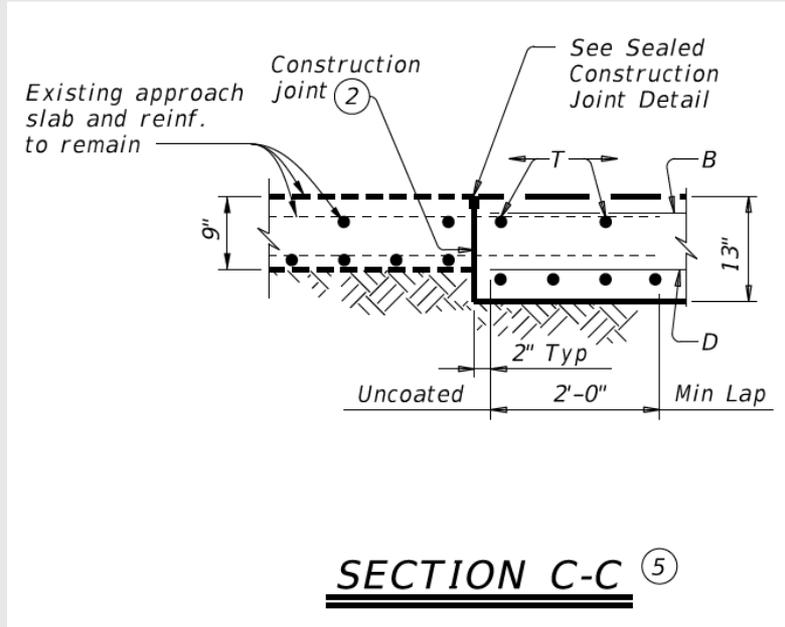
- Existing structure depth and bearing differences may require a “step” (same holds true for connected bents)

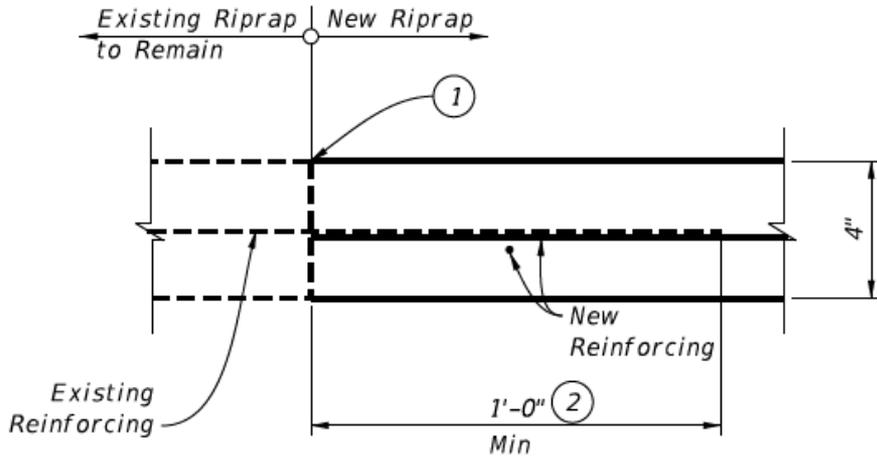




- Consider existing conditions and details with respect to fixed/expansion conditions
- Widening could be allowed to “float” and rely on restraints of existing
- Verify condition of existing expansion joints

Approach Considerations: Approach Slabs

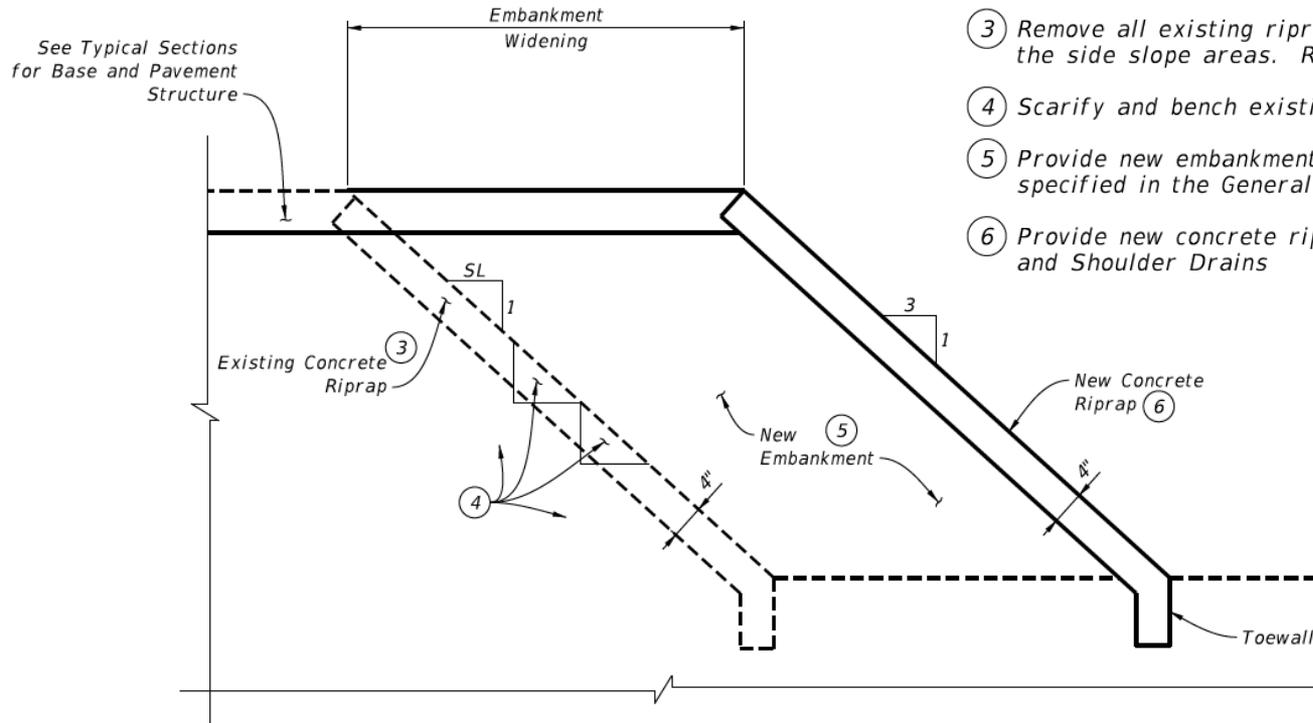




SECTION AT RIPRAP WIDENING

- ① Breakback existing riprap to a location approved by the Engineer. Saw the top surface of the riprap concrete along a linear "break" line to a depth of $\frac{1}{2}$ " before breaking back. Do not cut the reinforcement at the "break" line. Do not damage the remaining reinforcement for a distance of 1'-0" from the "break" line
- ② Clean and extend existing steel into new concrete riprap. Replace any steel spaced further than 1'-6" due to damage or lack of existing reinforcing using dowel bars. Where needed, provide #4 dowel bars x 1'-6" clean and drill/epoxy 6" into existing riprap. Provide a Type III Class C, D, E, or F epoxy meeting the requirements of DMS-6100, "Epoxies and Adhesives". Install per anchor adhesive manufacturer's instructions, including provisions for drill diameter, depth, and hole preparation.

Approach Considerations: Embankment

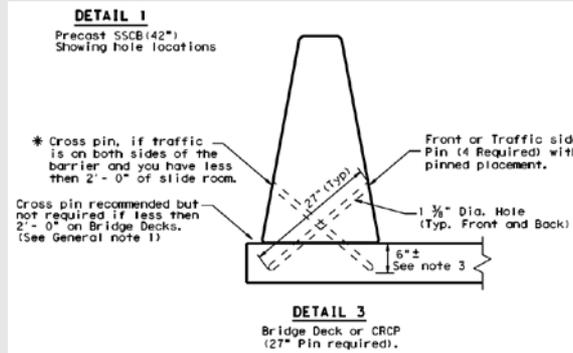
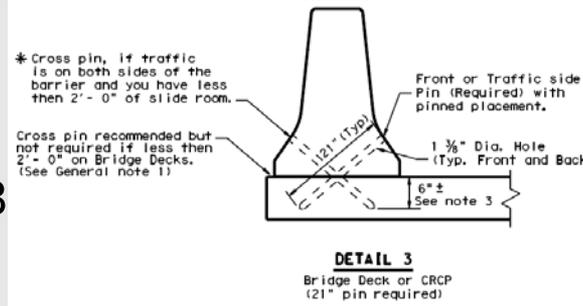


- ③ Remove all existing riprap from the breakback location and throughout the side slope areas. Riprap removal is subsidiary to Item 432.
- ④ Scarify and bench existing side slopes in accordance with Item 132.3.
- ⑤ Provide new embankment in accordance with Item 132 and of a type specified in the General Notes to Item 132.
- ⑥ Provide new concrete riprap per standard sheet CRR, Concrete Riprap and Shoulder Drains

SECTION AT EMBANKMENT WIDENING



- Current Barrier Types Used
 - CSB
 - SSCB
 - Older stocks of existing CSB
- Working Room
 - Ideally provide 2 ft or more of room to avoid pinning and provide worker access and room for screeds
 - Tighter situations can pin (TL-3 level detail)
 - TL-4 barrier with better connections with only 1” beyond toe in development



Construction Access and Traffic Control





- Differential dead load deflection between new beam and existing
- Diaphragms between new and existing beams
- Flexible columns with no tie to existing cap have allowed uncomfortable lateral connection before deck connection is made
- Span length variation in existing bridge versus designed bridge misfit
- Breakback of existing concrete can cause damage to remaining structure, especially underside of deck slabs not broken back over a beam line



- Maintenance problems are rare
- Deck problems have not been reported
- Some cases of differential movement in old versus new foundations



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