
VDOT
Virginia Department of Transportation


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BEYOND HERE THERE BE DRAGONS!

Cautionary tales from beyond the VDOT Bridge Standards and Design Manual

Pretty Lake Bridge,
Norfolk, Virginia

Andrew M. Zickler, PE

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INNOVATION

The process of making changes in something established, especially by introducing new methods, ideas, or products.

VIRGINIA ABUTMENT

VIRGINIA PIER

Lord Delaware Bridge
West Point, Virginia
2- 880 ft Drop-In
Post Tensioned
Bulb Tee Units
220ft Maximum Span

SPAN LENGTHS

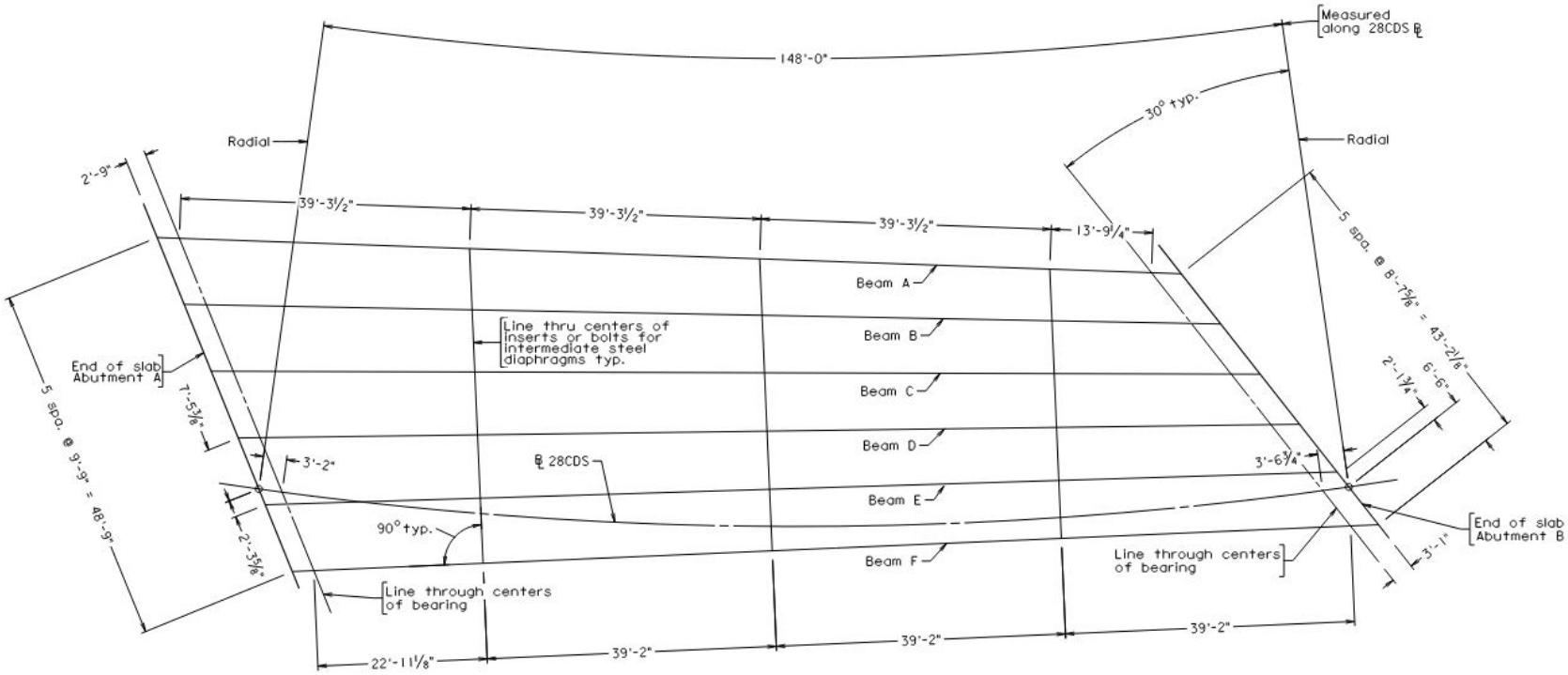
SPAN LENGTHS

- **LONG SPANS (>135')**
  - **STABILITY IMPLICATIONS**
    - FS OVERTURNING
    - FS CRACKING
  - **CONSTRUCTABILITY CONSIDERATIONS (AASHTO REF)**
    - CRANE SIZES REQUIRED (LIFTING WEIGHT)
    - HAULING METHODS/ROUTES AVAILABLE
    - SITE RESTRICTIONS
    - ACCESSIBILITY FOR CONSTRUCTION EQUIPMENT
    - DELIVERY OF GIRDERS TO SITE
    - STABILITY AFTER ERECTION

SPAN LENGTHS

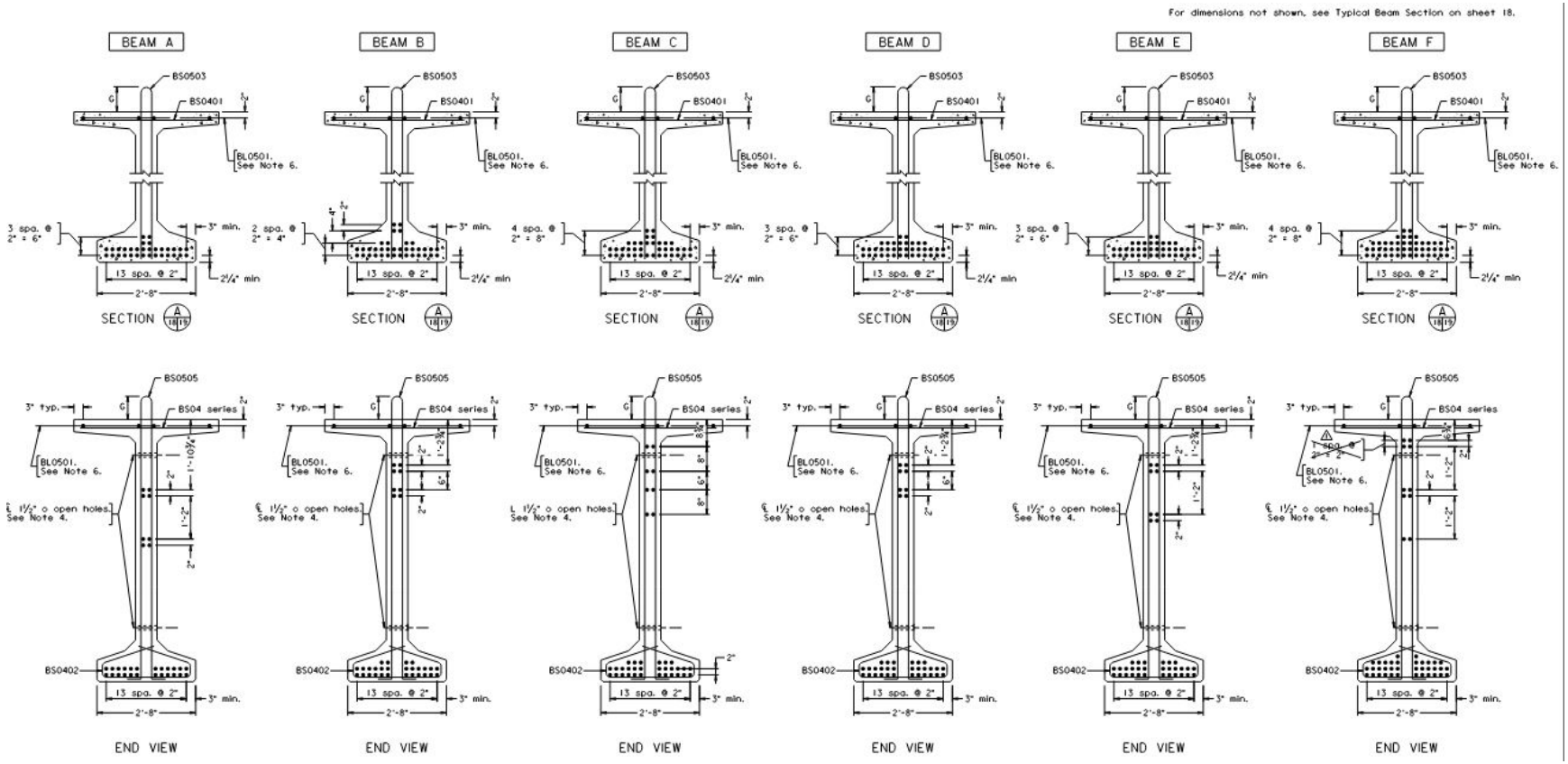
- **VARIABILITY OF GIRDER LENGTHS WITHIN SPAN**
  - **INCREASED COST TO FABRICATOR**
    - LACK OF REPETITION
    - NEED TO SPECIAL DETAILS
    - SHIPPING AND DELIVERY
  - **INCREASED COST TO CONTRACTOR**
    - BIG CRANE FOR ONLY ONE BEAM?
    - LIFTING AND STABILITY
  - **MORE VARIABILITY IN GEOMETRY = MORE ROOM FOR MISTAKES**
    - WHEN DETAILING PLANS
    - IN FABRICATION (LOCATION OF INSERTS NEED TO BE VALIDATED)
    - ADJACENT BEAM CAMBERS?

SPAN LENGTHS



ERECTION DIAGRAM

SPAN LENGTHS



SPAN LENGTHS

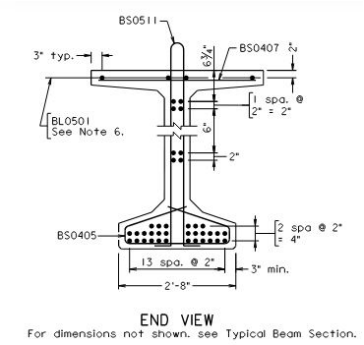
DATA AND DIMENSION TABLE

Span	Beam	Prestr. force at Release lb. per strand	No. and size of strands / beam	Net Camber N in. ⚠	A ft.-in. ⚠	B in ⚠	C ft.-in. ⚠	D ft.-in. ⚠	E ft.-in. ⚠	F ⚠ in	G in. ⚠	J in.	L ft.-in. ⚠
a	A	43,943	32 - 0.6 dia.	~~1.659~~ 1.663	~~1'-3½"~~ 1'-3¾"	3¾"	~~13'-3⁷⁄₁₆"~~ 13'-2"	3'-4⅝"	~~2'-5⁹⁄₁₆"~~ 2'-5⅝"	~~10"~~	~~9⁷⁄₁₆"~~ 10⅜"	5⅝"	~~131~~'-7⁹⁄₁₆" 131'-7½"
	B	43,943	36 - 0.6 dia.	~~1.966~~ 1.977	1'-5⅜	4½"	~~13'-6⁹⁄₁₆"~~ 13'-4"	~~3'-4⅛"~~ 3'-4"	2'-5⅜"	~~10"~~	~~9⁷⁄₁₆"~~ 10¼"	5⅝"	~~133~~'-3⅛" 133'-3⅜"
	C	43,943	38 - 0.6 dia.	~~2.188~~ 2.199	1'-4¾	~~4⁷⁄₁₆"~~ 4½"	~~13'-7¾"~~ 13'-6⅛"	3'-3½"	~~2'-5⅜"~~ 2'-5⅛"	~~10"~~	~~9⁄₁₆"~~ 10"	5⅝"	~~135~~'-0⅛" 135'-0⅝"
	D	43,943	38 - 0.6 dia.	~~2.226~~ 2.237	1'-4¾	4⅛"	~~13'-9⅝"~~ 13'-8⅛"	~~3'-3⅛"~~ 3'-3"	2'-5"	~~10"~~	~~8⅛"~~ 9⅝"	5⅝"	~~136~~'-9⅛" 136'-9¾"
	E	43,944	38 - 0.6 dia.	~~2.255~~ 2.265	~~1'-3⅛"~~ 1'-3⅞	4⅛"	~~14'-0⅜"~~ 13'-10⅜"	3'-2⅝"	~~2'-4⅛"~~ 2'-4¾"	~~10"~~	~~8⅜"~~ 9⅛"	5⅝"	~~138~~'-7⅝" 138'-7¼"
	F	43,943	46 - 0.6 dia.	~~3.026~~ 3.040	~~1'-5⁷⁄₁₆"~~ 1'-5½"	4¾"	~~14'-2⁷⁄₁₆"~~ 14'-0½"	~~3'-2⅜"~~ 3'-2⅛"	2'-4⅝"	~~10"~~	~~7⁹⁄₁₆"~~ 9"	5⅝"	140'-5⅛"

- **VARIABLE SPAN LENGTHS IN ONE SPAN**
  - **131-7 9/16” TO 140-5 1/8” (8% INCREASE IN SPAN)**
  - **32 TO 46 STRANDS (44% INCREASE IN PRESTRESS)**
- **CAMBER ISSUES?**
  - **RELEASE 1 5/8” TO 3” (85% INCREASE) WHAT ABOUT GROWTH?**
  - **ON A CURVE, WHAT ABOUT BOLSTER?**

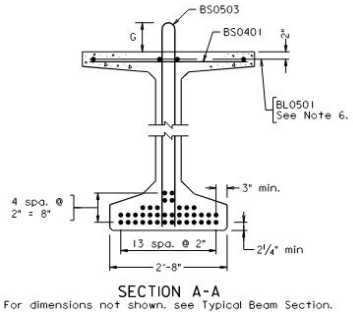
SPAN LENGTHS

- **VARIABLE SPAN LENGTHS AND DESIGNS IN ONE UNIT**
  - **IDEALLY BEAMS AND SPANS EQUAL WITH PS CONCRETE**

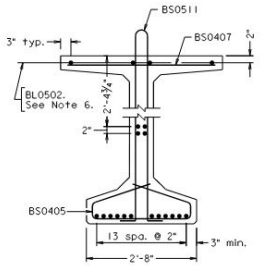


END VIEW
For dimensions not shown, see Typical Beam Section.

SPAN A
38 STRANDS
10 DRAPED!!

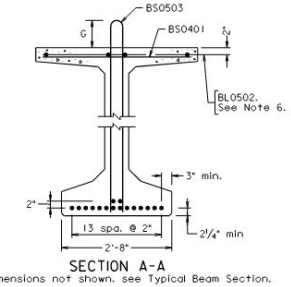


SECTION A-A
For dimensions not shown, see Typical Beam Section.

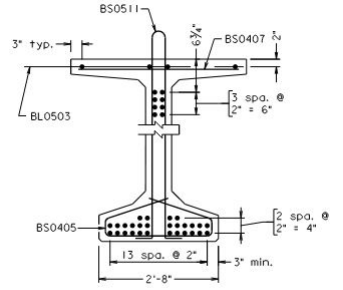


END VIEW
For dimensions not shown, see Typical Beam Section.

SPAN B
16 STRANDS
4 DRAPED!!

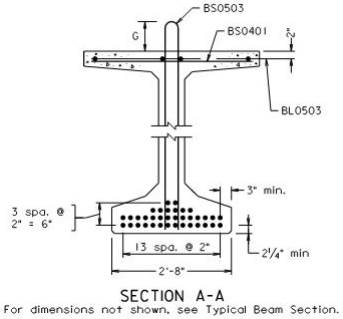


SECTION A-A
For dimensions not shown, see Typical Beam Section.



END VIEW
For dimensions not shown, see Typical Beam Section.

SPAN c
36 STRANDS
8 DRAPED!!



SECTION A-A
For dimensions not shown, see Typical Beam Section.

SPAN LENGTHS

- **IMPLICATIONS OF POOR SPAN RATIOS**
  - **JOINTLESS IS STILL THE GOAL**
    - ADD A VIRGINIA PIER?
  - **MIN. REINFORCEMENT REQUIREMENTS FOR SHORT DEEP SPANS**
    - 6 STRANDS IN AN 85” BEAM
  - **POOR DISTRIBUTION OF MOMENTS**
  - **LACK OF ECONOMICAL DESIGN**
  - **CAMBER ISSUES (AGAIN)**

Stage Construction

- IF THE JOINT BETWEEN STAGES IS OVER THE FLANGE, IS THE DEFLECTION THE SAME IN STAGE II AS IT WAS IN STAGE I
  - IF THIS ANSWER IS NO, NOW WHAT?

DE-BONDED STRANDS

Debonded strands may be used for prestressed Bulb-T beams but are not permitted for other prestressed concrete members. Debonded strands shall be designed in accordance with AASHTO LRFD Specifications.

VDOT BRIDGE DESIGN MANUAL FILE NO. 12.01-1

DE-BONDED STRANDS

- CONVENTIONAL STRANDS
  - AASHTO COVERS BOTTOM STRAND, END DEBONDING
  - FABRICATORS ARE FAMILIAR WITH BOTTOM END DEBONDING
  - FOR CONTRACTORS IT IS “INVISIBLE”
- WHAT ABOUT STAINLESS STRAND?
- WHAT ABOUT CFRP?
  - APPEARS THAT ADDITIONAL CONFINEMENT MAY BE NEEDED
- WHAT ABOUT TOP STRAND DEBONDING?
  - RELEASE CAMBER IS PRETTY SIMPLE
  - WHAT ABOUT AT 90DAYS?
  - WHAT IS CAMBER IF TOP STRANDS ARE CUT?

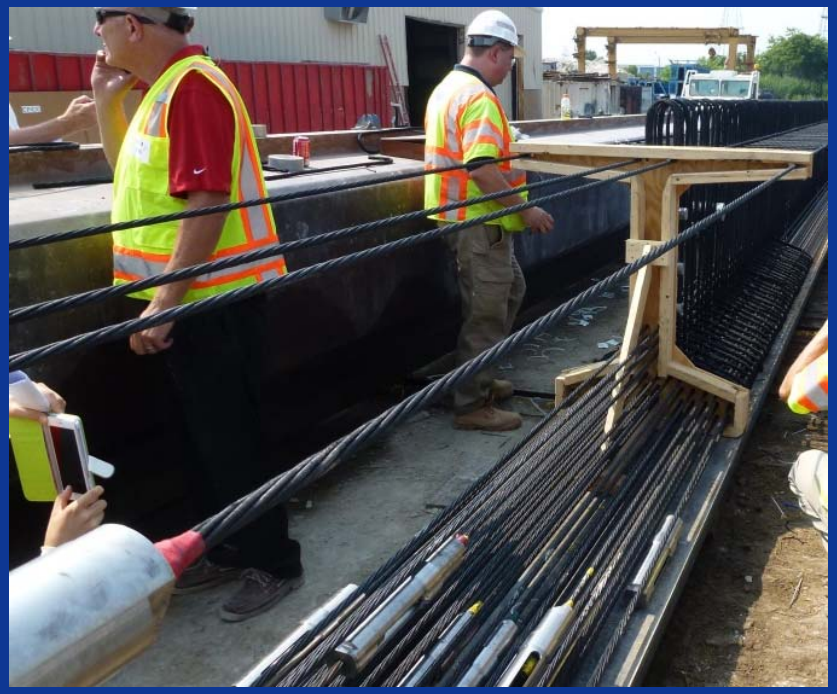
SPAN TO DEPTH RATIO

SPAN TO DEPTH

HOW SHALLOW IS TOO SHALLOW ?

29” BULB TEES LOADED TO PREVENT CAMBER GROWTH ADDING TO HIGH PLANNED CAMBER

AUGER MIXER MOUNTED ON A SKID STEER WAITING TO MIX UHPC FOR TESTING



MATERIALS

RTE 49 OVER AARONS CRK
LYNCHBURG DISTRICT, VIRGINIA
ALL CFRP BEAM BEING CAST

MATERIALS

- **CFRP**
  - **PRESTRESSING STRANDS**
  - **NON PRESTRESSED REINFORCING: STIRRUPS AND SPIRALS**
    - EXPENSIVE
    - POTENTIAL WEAK SPOTS DUE TO BEND GEOMETRY
  - **POST-TENSIONING**
    - PREFABRICATED TO LENGTH WITH STAINLESS ANCHOR ELEMENTS
    - NO GROUT; NOT IN VIRGINIA YET
  - **WRAPS**
    - RESTORATION OF CAPACITY FOR BOTH PRESTRESSED AND DETERIORATED CONVENTIONAL CONCRETE ELEMENTS
- **GFRP REBAR, BRFP REBAR AND STAINLESS STRAND**

MATERIALS

- **FIBERS**
  - **ALWAYS HELP CONTROL CRACKS**
    - REDUCE OR PREVENT WATER PENETRATION
  - **SOMETIMES ADD STRUCTURAL BENEFITS**
    - SHORTEN DEVELOPMENT LENGTHS AND JOINT SIZES WITH UHPC AND VHPC
    - IMPROVE PRECAST HANDLING CHARACTERISTICS BY REDUCING CRACKING
  - **MATERIAL OPTIONS**
    - STEEL
    - POLYPROPYLENE. PVA, GLASS, OTHERS
  - **MIXING CAN BE A CHALLENGE**
    - BAG MIXES ON A SPEL LIST
    - DISTRIBUTION AND ORIENTATION OF FIBERS CRITICAL TO ACHIEVING BENEFITS
    - CLUMPING

MATERIALS

SIZE OF FIBER REINF. CONCRETE JOINT
(6” MIN VS
3FT CONVENTIONAL)

AARON’S CREEK BRIDGE ERECTED

SCC BAG MIX
FAIL AT HRBT MOCKUP

CFRP FIBER WRAP TO RESTORE CAPACITY TO PS BEAM (HRBT)

VDOT'S FIRST 170FT BEAM FAILED BETWEEN CASTING BED AND STORAGE LOCATION

STABILITY

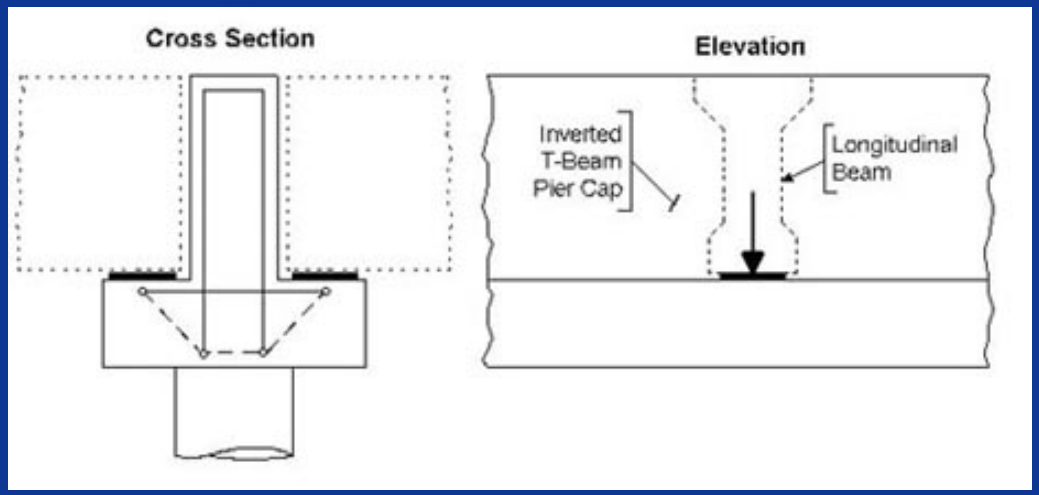
VDOT'S FIRST 170FT BEAM SUCCESSFULLY ERECTED

STABILITY

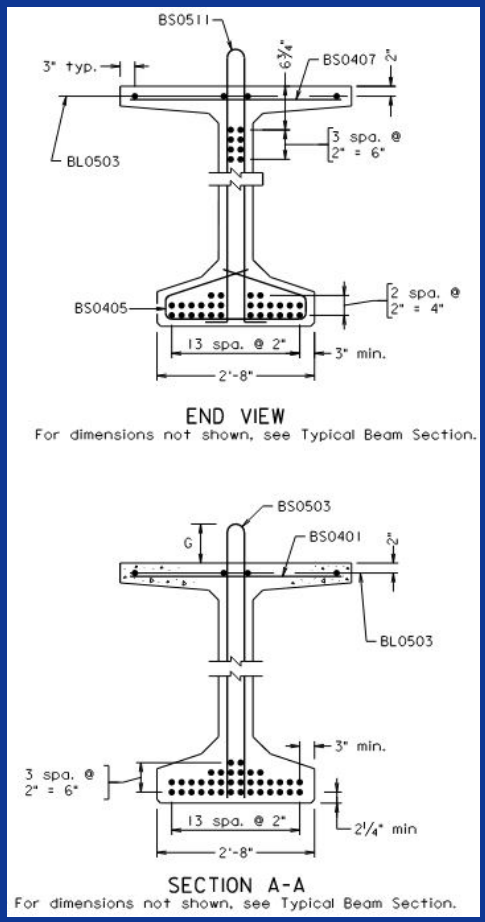
- **WHO IS RESPONSIBLE FOR STABILITY?**
  - **REFERENCES**
    - AASHTO SECTION 2.5.3 ON CONSTRUCTABILITY
    - SECTION 405.05(h) OF R&B SPECIFICATIONS
      - IMPLIED RESPONSIBILITY
        - DESIGNER
        - CONTRACTOR
  - **MEANS TO INCREASE STABILITY**
    - LIFTING DETAILS
      - SPREADER BEAM
      - LIFT NEAR CENTROID OF BEAM
    - TIE-DOWN AND SUPPORT DETAILS FOR TRANSPORTATION AND SHIPPING

STABILITY

- FROM DUD TO STUD
  - LIFTING LOCATIONS CHANGED
  - MORE CARE TO RELATED TO SHIPPING AND HANDLING
- NEW I&IM FORTHCOMING COVERING STABILITY AND ERECTION

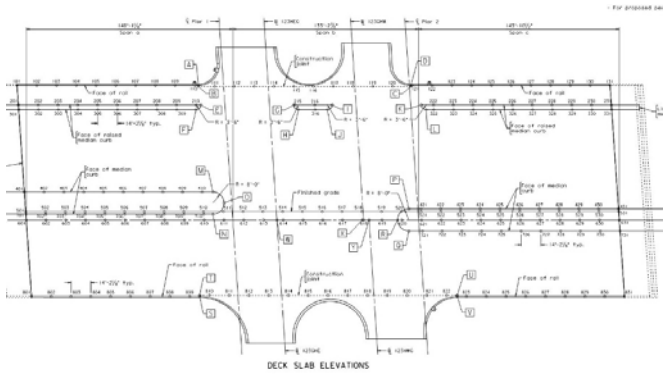

Cross Section
Elevation
Inverted
T-Beam
Pier Cap
Longitudinal
Beam

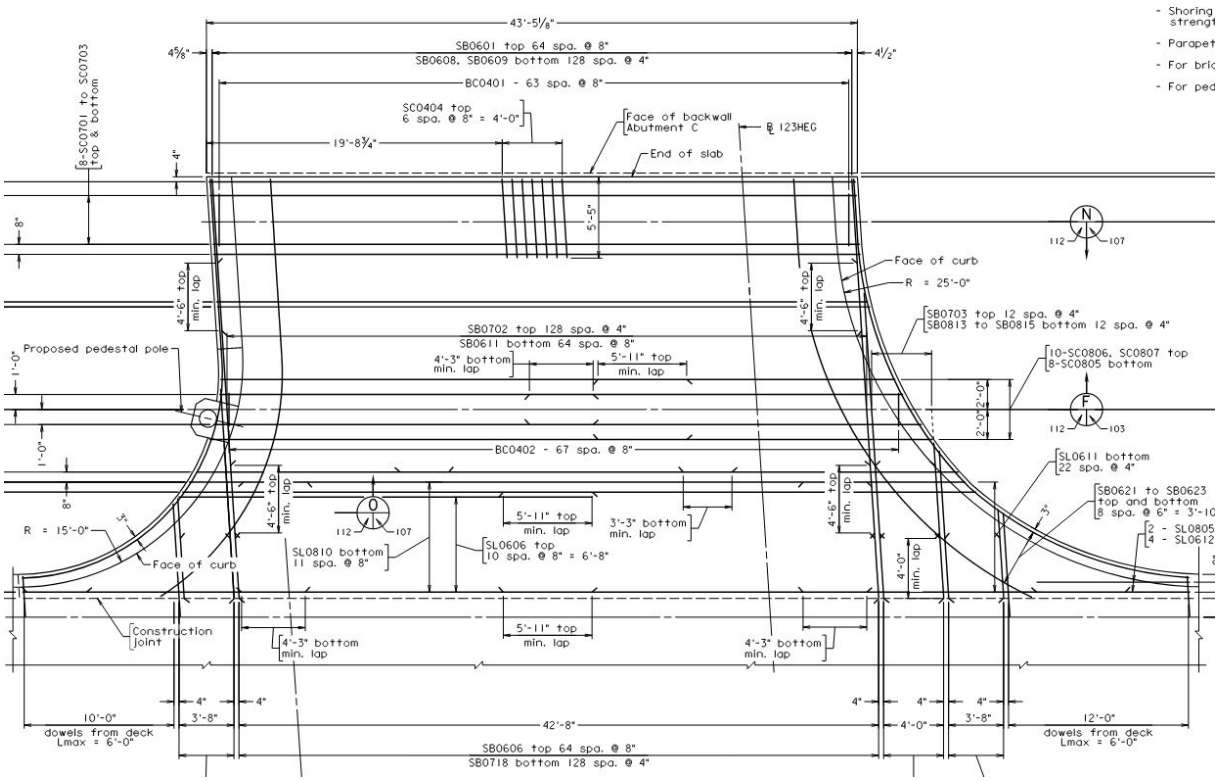
DESIGN


BS0511
3" typ.
6¾"
BS0407
2"
3 spa. @
2" = 6"
BL0503
BS0405
2 spa. @
2" = 4"
13 spa. @ 2"
3" min.
2'-8"
END VIEW
For dimensions not shown, see Typical Beam Section.
BS0503
G
BS0401
2"
BL0503
3" min.
3 spa. @
2" = 6"
13 spa. @ 2"
2¼" min
2'-8"
SECTION A-A
For dimensions not shown, see Typical Beam Section.

DESIGN

EXTREME OVERHANGS OR…
IN THIS CASE, A SLAB
HOW THICK?

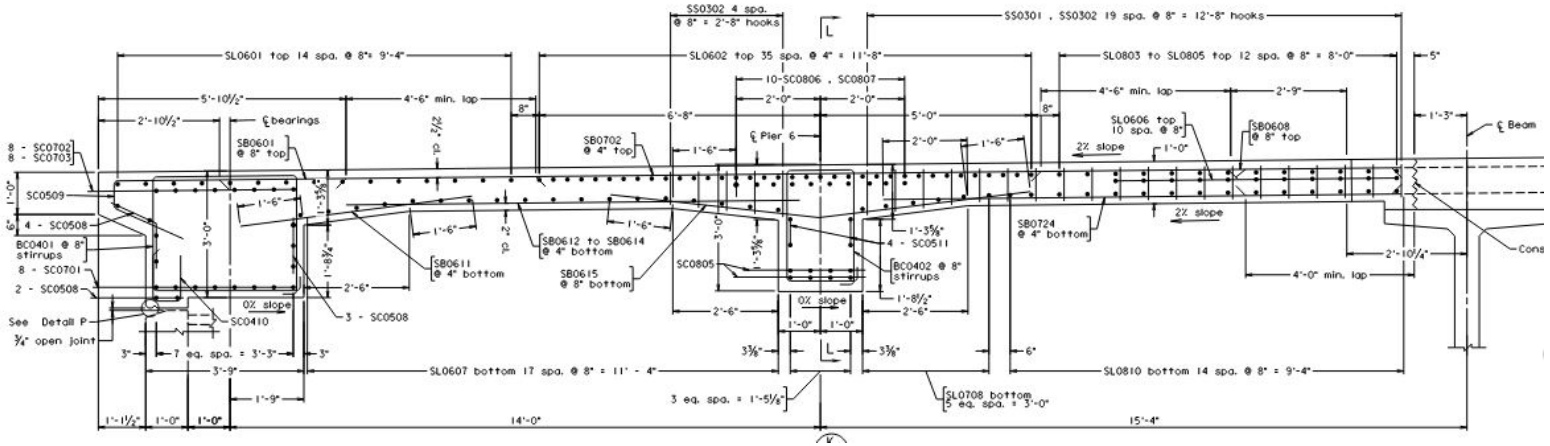




- **8 LAYERS OF REINFORCING REQUIRED**
  - **TRANSVERSE AND LONGITUDINAL (T&B)**
  - **RADIAL AND CIRCUMFERENTIAL (T&B)**

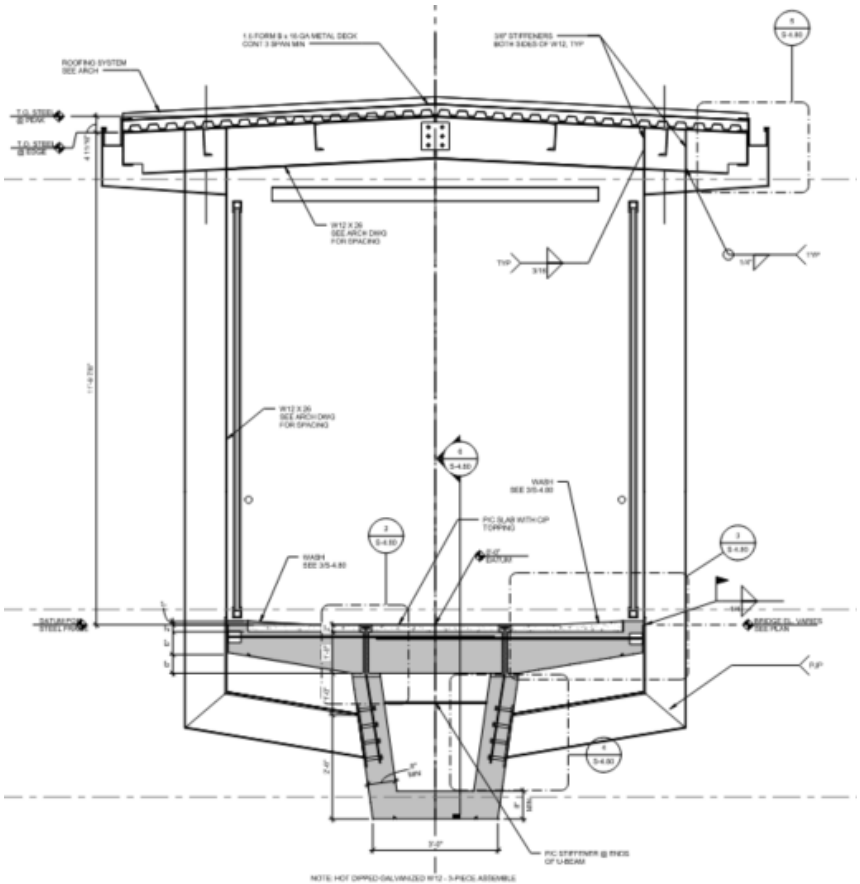
DESIGN

- **STIRRUPS IN SLABS**
  - BAR SHOWN IS THE STIRRUP AS DETAILED
  - THICKER SLAB NOW PLANNED.



DESIGN

- **LAP**
  - **INSPECTABILITY**
  - **MAINTAINABILITY**
  - **CONSTRUCTABILITY**
- **STABILITY?**



1 TYPICAL P/C BRIDGE/W12 FRAME

PRE FABRICATED PIER ELEMENTS?
GENITO ROAD OVER SWIFT CREEK

DETAILING

CONGESTION?

DETAILING

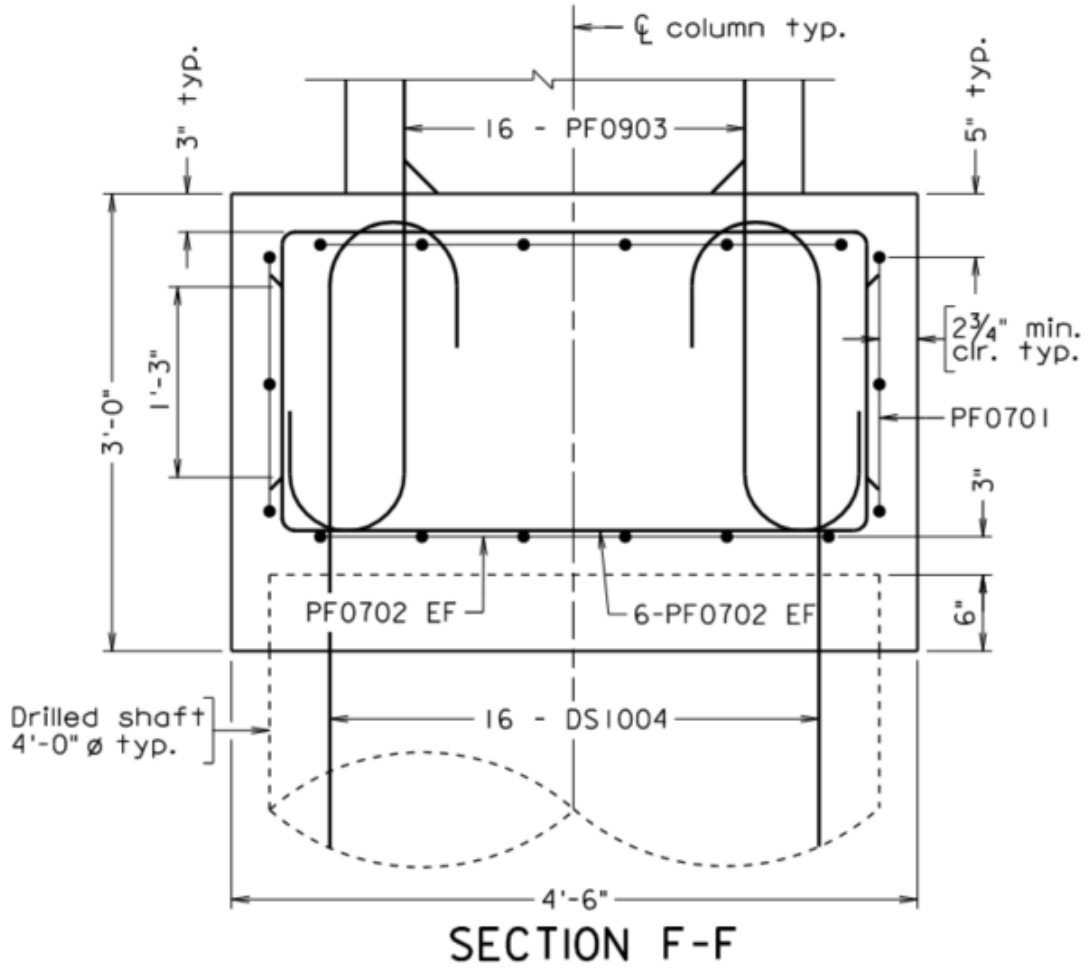
- **BAR LAYOUTS MATTER!**
  - **WHERE DOES THE CONCRETE GO?**
    - WATCH FOR HOW LAPS AND HOOKS WILL PREVENT CONCRETE PLACEMENT
  - **CORNERS AND TEE JOINTS**
    - OPENING AND CLOSING JOINTS ARE DIFFERENT AND CAN BE WEAK POINTS
  - **INTERFACE SHEAR**
    - BARS MUST BE DEVELOPED ON BOTH SIDES OF THE JOINT
  - **ONE LEGGED STIRRUPS**
    - ONE END NEEDS A 135 DEGREE HOOK
  - **SLAB STIRRUPS**
    - JUST SAY NO
  - **BUNDLING BARS**
    - 2X2 MAX, START SIDE BY SIDE, NOT STACKED

DETAILING

- **BAR LAYOUTS MATTER!**
  - **HOW STRONG IS A 1X7 “BUNDLE”?**
  - **HOW COMPLIANT WITH THE SPEC?**

DETAILING

- **BAR LAYOUTS MATTER!**
  - **DO LAPPING TWO HOOKED BARS MEET AASHTO?**



DETAILING

- **BAR LAYOUTS MATTER!**
  - **NEXT TIME, FIBERS**

BEFORE

AFTER

DETAILING

- **BAR LAYOUTS MATTER!**

higher strength details

low strength corner details

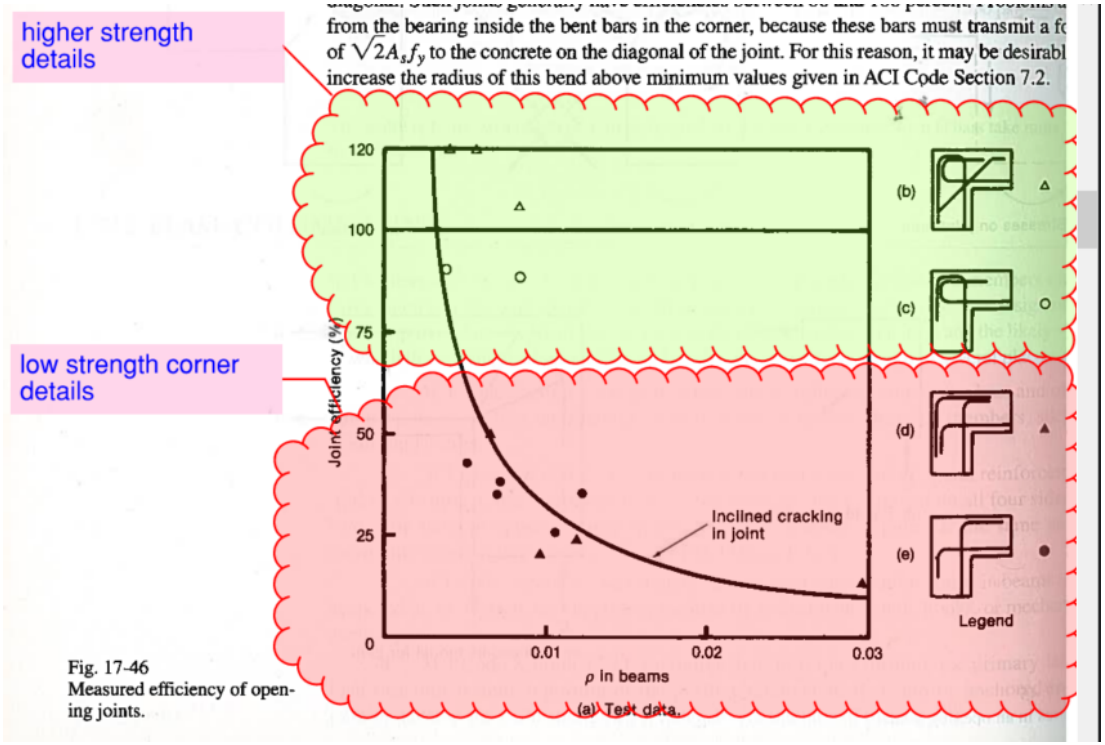
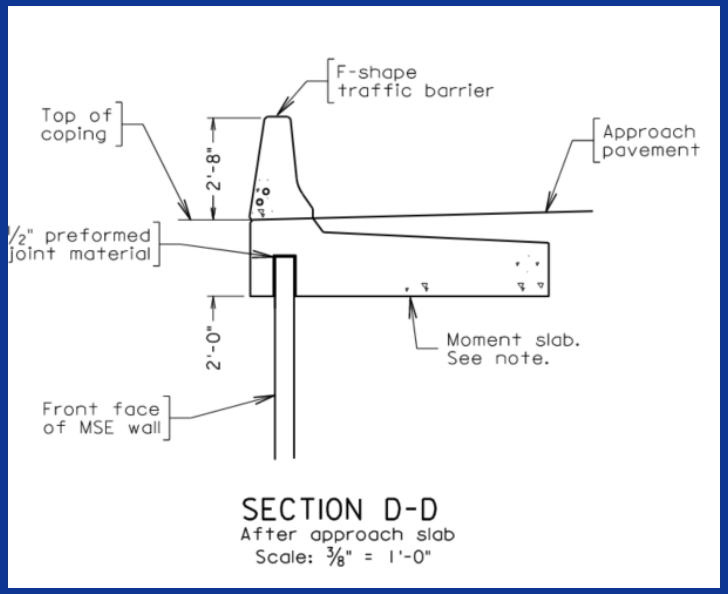
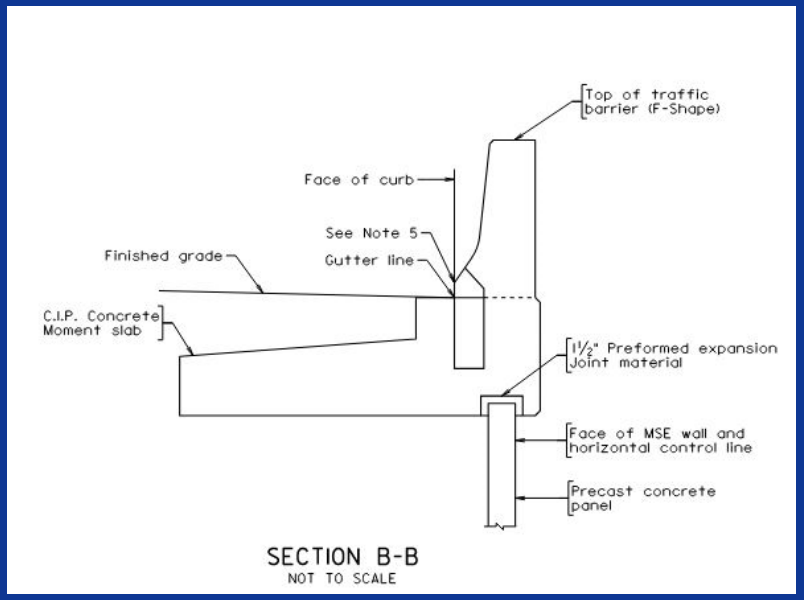


Fig. 17-46
Measured efficiency of opening joints.

MOMENT SLABS

TYPICAL CONCEPT





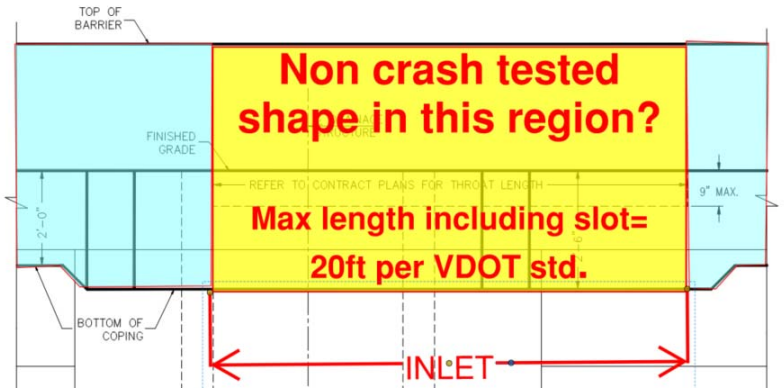
CONCEPT AT DROP INLET

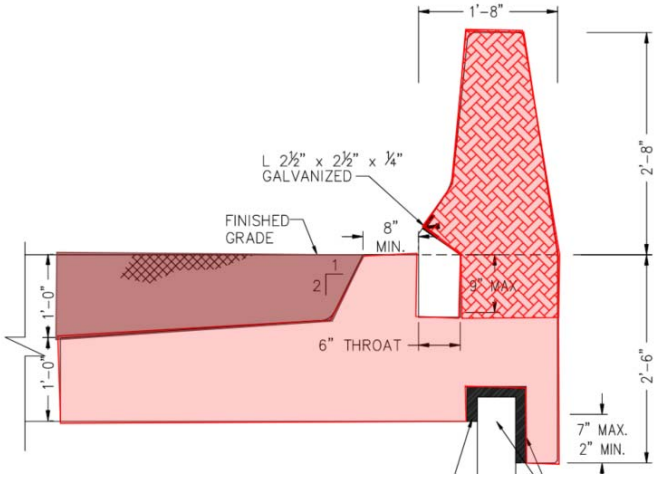
MOMENT SLABS

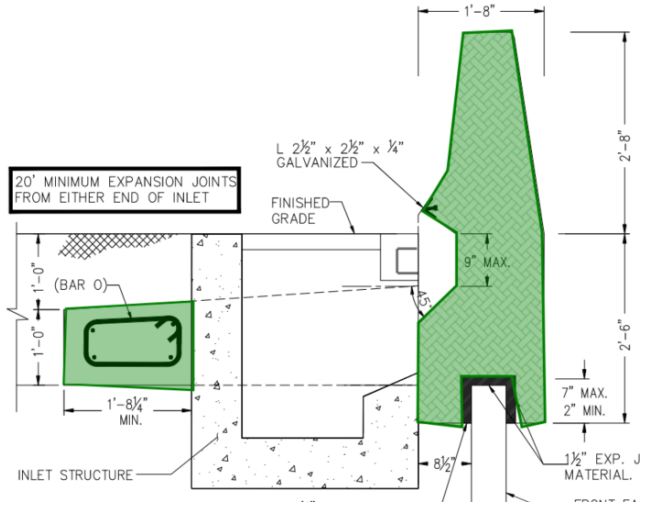
- NCHRP REPORT 663 (AVAILABLE ONLINE)
  - TL-3
- NEW NCHRP RESEARCH, UNPUBLISHED, BUT COMPLETE
  - TL-4, TL-5
  - NON STANDARD HEIGHTS
- DEVIATIONS FROM CRASH TESTED CONFIGURATIONS

MOMENT SLABS

- COMPLEX MOMENT SLABS
- DROP INLETS
  - SHAPE IS CRASH TESTED
  - LOAD PATH CHANGED
  - WHAT IS ·







MOMENT SLABS

- **HOW MUCH PANEL IS TOO MUCH?**

MOMENT SLABS

- **BEDDED? WHERE IS PT OF ROTATION?**

CHAPTER 13 WILL BE REVISED…BUT NOT FOR A FEW YEARS

PILES

CRR TEST PILE TOP

PILES

CURRENT STANDARDS 12”- 24’ SQUARE

- CONVENTIONAL STRANDS AND CRR
  - CFRP AND STAINLESS STRAND
- ONGOING PROJECTS WITH 30”, 36” SQUARE
- ONGOING PROJECTS WITH 54” AND 66” CYLINDER PILES
- USING CFRP AND STAINLESS STRAND PRESTRESSING

- LESSON LEARNED:
- BE VERY CAREFUL IN ASSESSING CAPACITIES OF NON STANDARD PILES

PILES

- CONVENTIONAL STRAND CHIPPED DOWN

CFRP CUT OFF

MINOR CRACKING AND SLIP

- 66” CYLINDER PILE SPALLED DURING DRIVING, SS STRAND

AESTHETICS

AESTHETIC CONCRETE FASCIA PANEL
SOUTHGATE PROJECT AT VIRGINIA TECH

Aesthetics

CONCRETE FASCIA PANELS (MUST BE SELF SUPPORTING)

- MUST BE SELF SUPPORTING IN TWO PLANES
- IS FABRICATED LYING FLAT DUE TO EXTENSIVE DETAIL
- SHIPPED AND ERECTED VERTICALLY

Aesthetics

CONCRETE FASCIA PANELS (MUST CONSIDER SHIPPING)

FABRICATOR ADDED SUPPORTS TO SHIP AS WELL AS THE STRAND

DESIGN EXCEPTIONS AND DESIGN WAIVERS

Exceptions and Waivers

When you are outside of the Standards and the Design Manual you will need one or the other nearly all the time.

FOR DESIGN BUILD AND PPTA, YOUR CONTRACT REQUIRES VDOT APPROVAL FOR ALL NON STANDARD DETAILS.

DON'T GET BURNED BY THE DRAGON AT THE EDGE OF THE BRIDGE MANUAL…

SEEK GUIDANCE.

EVERYONE IS HAPPIER GETTING PAST THE DRAGON THE FIRST TIME RATHER THAN BACKTRACKING AND BURNING SCHEDULE AND BUDGET TWICE

QUESTIONS?

PRESENTED BY:

Andrew M. Zickler, PE
Complex Bridge Design and
ABC Support Program Manager
andy.Zickler@vdot.virginia.gov
804.371.2776

FOOD FOR THOUGHT:

IS THIS HOW YOU ENVISION PARTIAL DECK DEMOLITION?