Maximizing Constructability Contractor Panel Discussion

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State Construction Pavement Engineer

Intent of Discussion

- Focus on improving constructability
  - ✓ Review constructability challenges
  - ✓ Discuss possible improvements
  - ✓ Some improvements are Design-related
    - Not all are
- We realize other factors influence & affect the design
  - ✓ Today, we'll focus on constructability challenges

Constructability

- What is Constructability?
  - ✓ Ability to Construct Something
- What's wrong with our Designs?
  - ✓ System-wide they are pretty good
  - ✓ Most designs are constructible
  - ✓ However, there are cases where we can improve or maximize constructability

Why Improve Constructability?

- Typically, as constructability increases…
  - ✓ Construction Time Decreases
  - ✓ Costs Decrease
  - ✓ Quality & Profits Increase
  - ✓ Delays, Claims, & Project frustrations Decrease

Why Improve Constructability?

- Your Designs:
  - ✓ Are easier to construct
  - ✓ Have fewer construction problems
- Your Company:
  - ✓ Increased status among FDOT & Contractors
    - Those who make design team selections

Intent of Discussion

- Improve or Maximize Constructability
- "Make Good Designs Better"

Maximizing Constructability

- Best Design:
  - ✓ Provides an easily constructed project
  - ✓ Meets design intent
  - ✓ Achieves desired Quality
  - ✓ Maximizes use of resources
    - Money
    - Time
    - Equipment

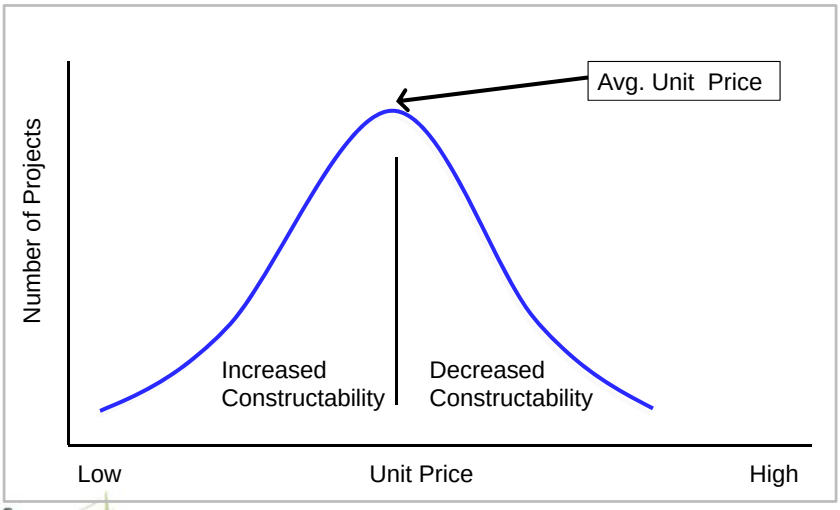
Design/Estimating Challenge

- Sometimes a more constructible design appears more expensive
- Likely it isn't more expensive, if it is easier to construct

Design/Estimating Challenge

- If, Project Cost = Average cost * Quantity
- Then, Lower Quantity = Lower Project Cost
  - ✓ Not always true
- Average cost contains projects with range of constructability
- Projects with Constructability challenges
  - ✓ Cost is typically higher than:
    - Average Cost
    - Cost of a more Constructible Design

Constructability vs. Cost



Constructability

- Keep Constructability in mind during design
- We'll see higher costs if project is less constructible

How do we Improve Constructability?

- Communicate to Design:
  - ✓ Construction Knowledge, Experience, Wisdom
  - ✓ Project Challenges at time they're encountered
    - Involve the Designer ASAP
    - Not always done
    - Sometimes just solved on project
      - Still need to communicate issue & solution to Design
- Designers can factor above info into future designs
  - ✓ But only if construction communicates it

Increasing Constructability Knowledge

- Design Expo Constructability Session
- Milling & Paving Equipment Session (at 2:00 pm)
  - ✓ Equipment on site all day today
    - Stop by to see equipment & ask questions
- Visit Projects
  - ✓ Speak to Contractors about design issues

Increasing Constructability Knowledge

- Training available from asphalt organizations
- Milling & Paving videos online
- Talk to Rich Hewitt about providing training at Company or District Office
- Provide feedback regarding what designers want to know about road and bridge construction

Rules of Order

- Discuss the constructability challenge
- Review Plan details, if applicable
- Discuss possible solutions to improve constructability
- We'd like some input on Design Perspective

Rules of Order

- Constructive Discussion
- Focus on constructability improvement
- Not looking to blame or embarrass anyone
- We've removed FIN #'s, Design Firm, & EOR's from examples

Thanks

- Bob Burleson
  - ✓ Florida Transportation Builders Association
- Jim Warren
  - ✓ Asphalt Contractors Association of Florida

Contractor Panel - Introductions

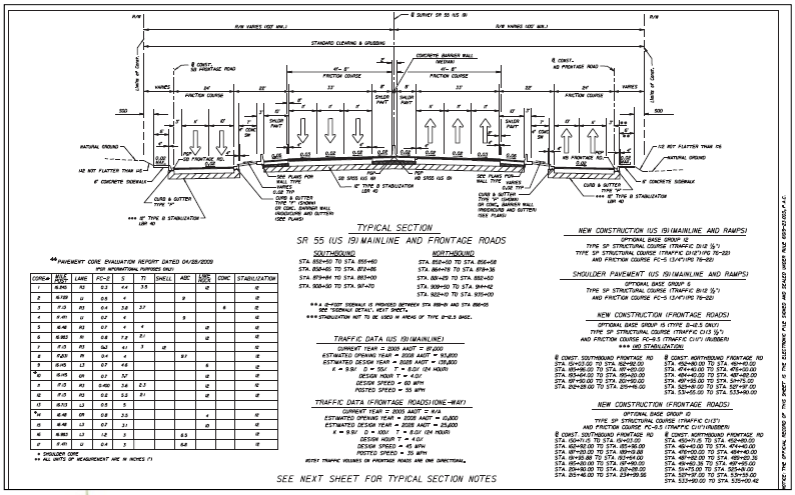
- Bob Bistor - Hubbard Construction
- Kevin Price - D.A.B. Constructors
- Bob Schafer - Ranger Construction
- J.C. Miseroy - Granite Construction
- Brantlee Milner - Superior Construction

Round 1

(#1) Hubbard US 19 - Problem

- Project Phasing
  - ✓ Build Frontage Roads
  - ✓ Put Mainline Traffic on Frontage Roads
  - ✓ Build Mainline Lanes
- Resulted in more than year of mainline traffic on frontage roads
  - ✓ Mainline: Structural Number = 4.2
  - ✓ Frontage Road: Structural Number = 3.3
- Lead to rutting & straightedge issues had to be fixed at contractors expense

(#1) Hubbard US 19



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(#1) Hubbard US 19

NEW CONSTRUCTION (US 19)(MAINLINE AND RAMPS)

OPTIONAL BASE GROUP 12
TYPE SP STRUCTURAL COURSE (TRAFFIC D)(2 ½")
TYPE SP STRUCTURAL COURSE (TRAFFIC D)(2")(PG 76-22)
AND FRICTION COURSE FC-5 (3/4")(PG 76-22)

SHOULDER PAVEMENT (US 19)(MAINLINE AND RAMPS)

OPTIONAL BASE GROUP 6
TYPE SP STRUCTURAL COURSE (TRAFFIC B)(2 ½")
AND FRICTION COURSE FC-5 (3/4")(PG 76-22)

NEW CONSTRUCTION (FRONTAGE ROADS)

OPTIONAL BASE GROUP 15 (TYPE B-12.5 ONLY)
TYPE SP STRUCTURAL COURSE (TRAFFIC C)(3 ½")
AND FRICTION COURSE FC-9.5 (TRAFFIC C)(1") (RUBBER)
*** (NO STABILIZATION)

@ CONST. SOUTHBOUND FRONTAGE RD
STA. 151+03.00 TO STA. 162+92.00
STA. 185+96.00 TO STA. 187+20.00
STA. 193+64.00 TO STA. 195+20.00
STA. 197+90.00 TO STA. 201+90.00
STA. 212+28.00 TO STA. 215+46.00

@ CONST. NORTHBOUND FRONTAGE RD
STA. 452+80.00 TO STA. 461+40.00
STA. 474+40.00 TO STA. 476+00.00
STA. 484+40.00 TO STA. 487+82.00
STA. 497+95.00 TO STA. 511+75.00
STA. 525+81.00 TO STA. 527+97.00
STA. 531+55.00 TO STA. 533+90.00

NEW CONSTRUCTION (FRONTAGE ROADS)

OPTIONAL BASE GROUP 10
TYPE SP STRUCTURAL COURSE (TRAFFIC C)(3")
AND FRICTION COURSE FC-9.5 (TRAFFIC C)(1")(RUBBER)

@ CONST. SOUTHBOUND FRONTAGE RD
STA. 150+71.15 TO STA. 151+03.00
STA. 162+92.00 TO STA. 185+96.00
STA. 187+20.00 TO STA. 189+19.88
STA. 191+95.88 TO STA. 193+64.00
STA. 195+20.00 TO STA. 197+90.00
STA. 201+90.00 TO STA. 212+28.00
STA. 215+46.00 TO STA. 234+99.96

@ CONST. NORTHBOUND FRONTAGE RD
STA. 450+71.15 TO STA. 452+80.00
STA. 461+40.00 TO STA. 474+40.00
STA. 476+00.00 TO STA. 484+40.00
STA. 487+82.00 TO STA. 489+20.36
STA. 491+60.36 TO STA. 497+95.00
STA. 511+75.00 TO STA. 525+81.00
STA. 527+97.00 TO STA. 531+55.00
STA. 533+90.00 TO STA. 535+00.42

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(#1) Hubbard US 19 - Solutions

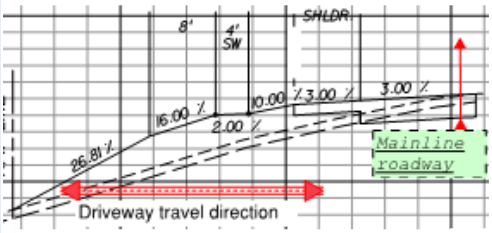
- Options
  - ✓ Increase Structural Number for Frontage Road

    OR
  - ✓ Pay Contractor For Repairs Prior to Friction

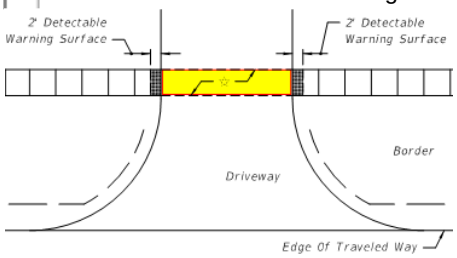
(#2) DAB - Problem

- Side streets & ADA requirements in plans show nice lines
- Reality is constructing the longitudinal profile can't always be done exactly to plan
- Heights & distances of existing driveway, sidewalk, or road define the slope
- Therefore slope is set & desired slope can't be built
  - ✓ Paver cannot achieve this in longitudinal direction

(#2) DAB - Problem
ADA – Sidewalk Crossings & Asphalt Driveways



Equipment cannot control slope Longitudinally. ADA requirements outline that the crossing not be more than 0.02 and in all circumstances these are designed at the maximum leaving no tolerances. No matter how well constructed the riding



2013 Standard Index 310 sheet 2

☆ When driveway is new construction, reconstruction, or altered, cross slope within this area shall not exceed 0.02. Existing driveways that are not being altered may be left as they are.

(#2) DAB - ADA Sidewalk crossings

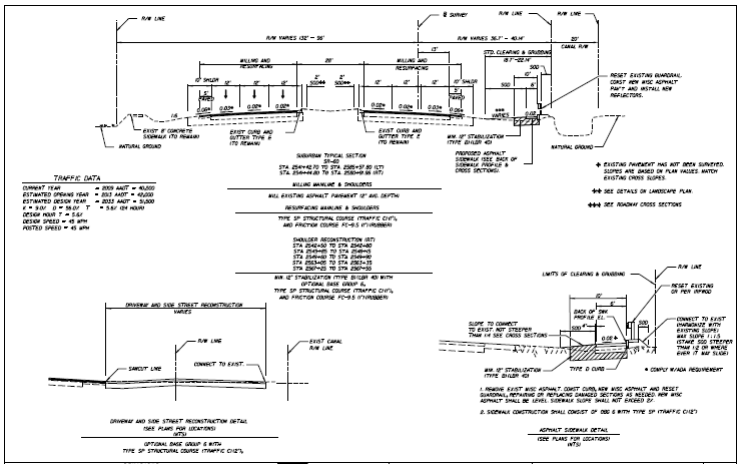
(#2) DAB - Solution Options

- Remember 2% slope is maximum for ADA
- Design for less to provide construction tolerance
  - ✓ Designing at 2% means slight slope increase during construction puts sidewalk or driveway out of Spec for ADA
- Use concrete for ADA crossings
- Locate ADA crossing to minimize number of slope changes
- Consider using curbless concrete turnout with sidewalk crossing

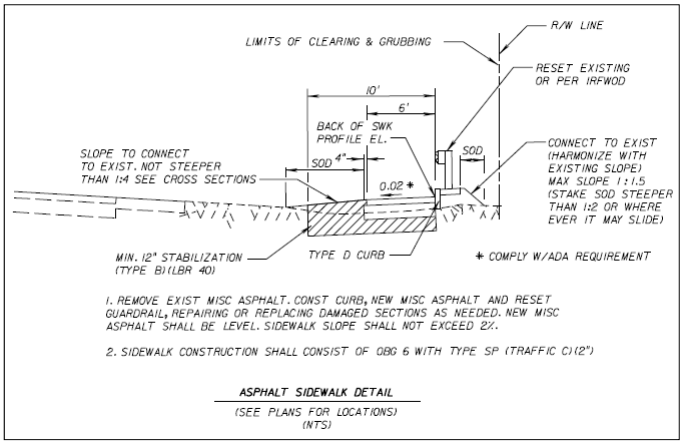
(#3) Ranger - SR 60

- Problem
  - ✓ 6 ft wide paved sidewalk created challenges of not exceeding 2% cross slope, while also meeting rolling straight edge (RSE) requirements
- Solution
  - ✓ A wider path would have permitted a full size paver with electronics
    - Then slope and RSE requirements could be met easily
  - ✓ *Minimum standard paver width is 8ft*

(#3) Ranger - SR 60



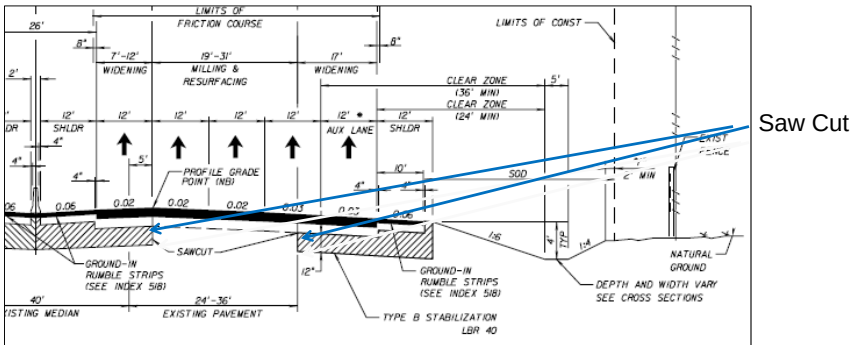
(#3) Ranger - SR 60



(#4) Granite - Turnpike

- Problem
  - ✓ Be careful what direction you give to construction with plan notes.
  - ✓ CEI required saw cut to be made, even though it was not necessary
  - ✓ Milling machine creates a nice joint line during pavement removal – Typically surface course placed on top later
    - Saw cut = $3:00 / lf: 4 cuts = $63,360 / mile

(#4) Granite - Turnpike



Saw Cut

CAL SECTION
ORIDA'S TURNPIKE)

NORTHBOUND LANES
STA 2575+25.00 TO STA 2745+95.0
STA 2830+90.54 TO STA 2877+79.5

RESURFACING ONLY **
7.00 TO STA 2575+25.00

NOTES:

1. HEIGHT OF FILL IS THE VERTICAL DISTANCE FROM THE EDGE OF THE OUTSIDE TRAVEL LANE TO TOE OF FRONT SLOPE.
2. ACTUAL WIDTH OF BASE WIDENING MAY VARY DUE TO ACTUAL EXISTING PAVMENT WIDTH. CONTRACTOR MAY ELECT TO PLACE UNIFORM WIDTH BASE WIDENING STRIP AT NO ADDITIONAL COST TO THE DEPARTMENT.
3. SAW CUT ALL PAVEMENT REMOVAL EDGES.

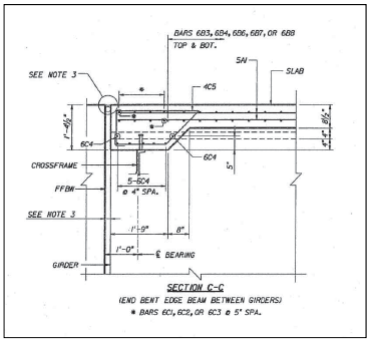
(#4) Granite - Turnpike

- Solution:
  - ✓ Plan Note that states “saw cut may be necessary”
  - ✓ No note required

(#5) Superior - SR 100 - Problem

- Insufficient space between back wall & beams on bridges structure
  - ✓ Tends to be an issue with longer span beams
    - Due to larger camber of longer beam
  - ✓ Large camber makes beam longer on top
    - Longer top length creates placement problems
    - May have to cut beam so it will fit
  - ✓ Beam with tight fit causes other problems
    - Pushes on back wall as it lengthens from heat expansion

(#5) Superior - SR - 100



(#5) Superior - SR - 100

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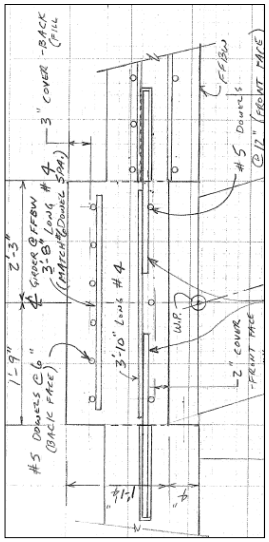


(#5) Superior - SR 100 - Solution

- Provide more clearance between beam & back wall
- Consider Beam Length in Clearance Determination
  - ✓ Longer Beam =
    - Larger Camber → More Clearance Required
    - More Thermal Expansion → More Clearance Required
- Consider Beam Temperature during construction
  - ✓ Beams can get hotter than expected when sitting in sun on site (especially steel beams)

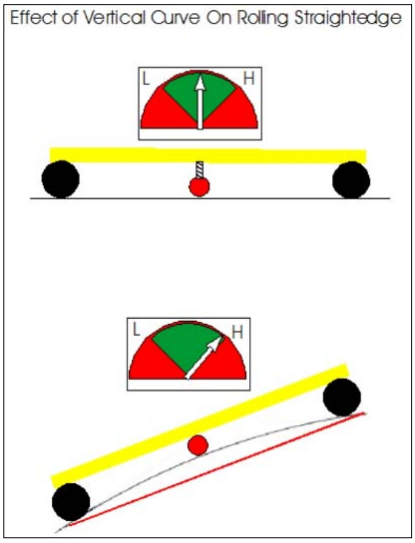
(#5) Superior - SR 100

Round 2

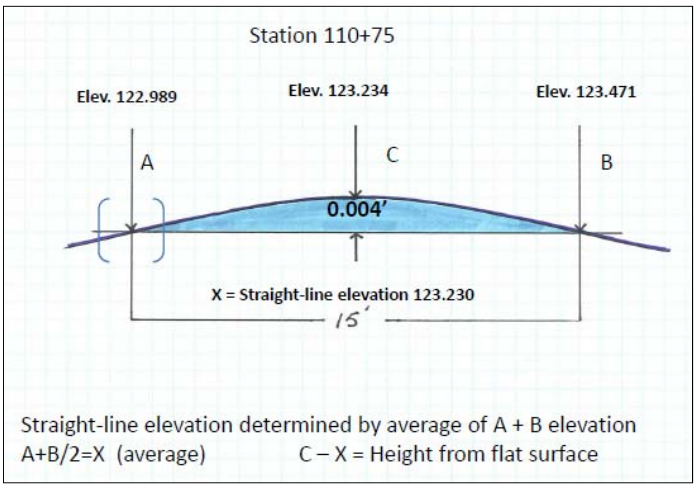
(#6) Hubbard - Problem

- Areas in a vertical curve failed rolling straight edge (RSE) tolerance
  - ✓ Required removal and replacement
- RSE found several areas out of tolerance >3/16”
- However Vertical curve added 1/16” to 2/16”
  - ✓ Curve versus straight line over 15ft Length
- Therefore a 2/16” deviation ends up being out
- Any vertical curve (sag or crest) can cause this

(#6) Hubbard - Problem



(#6) Hubbard - Design Curve Illustration



(#6) Hubbard - Solution

- Consider Affect of Vertical Curve on Rolling Straightedge Reading

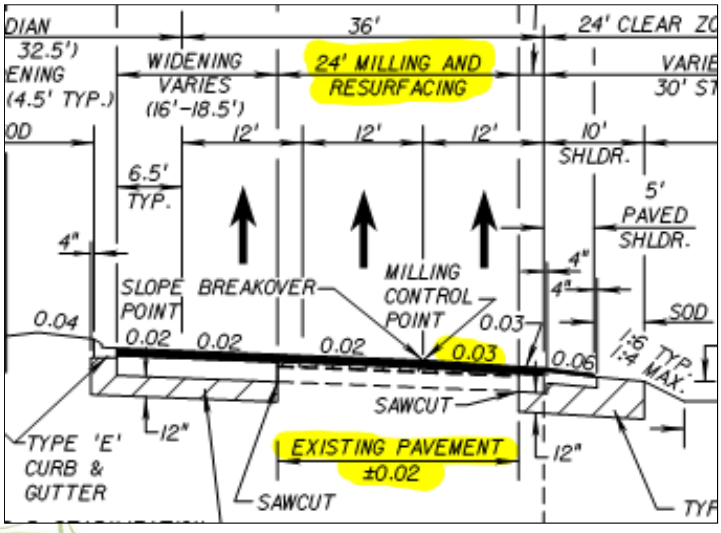
(#6) Hubbard - Solution

- Use design's vertical curve to determine maximum deviation from 15ft straight line
- Modify Rolling Straight Edge (RSE) Tolerance accordingly

(#7) DAB - Problem

- Phasing of work can cause problems
- If Possible, Perform Mill & Resurface with slope corrections before widening
- Why?
  - ✓ Better to pave to actual surface after it has been resurfaced than perform cross slope corrections & hope they match when adjacent lane is milled & paved for slope later

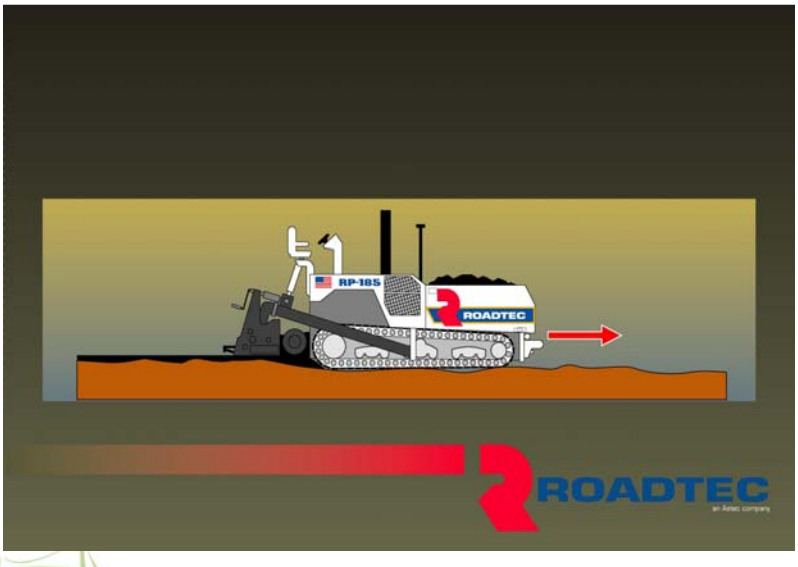
(#7) DAB - widening /slope correction



(#7) DAB - widening /slope correction

- Project's Traffic Phasing Sequence
  - ✓ Build median widening
  - ✓ Outside Widening
  - ✓ Then resurface existing
- Plan shows variable slope milling & paving for the existing

Paver Correcting original road profile



(#7) DAB - widening /slope correction

- Existing profile is irregular and in need of repair
- Milling and paving will change the profile to improve rideability AND slope
- If the adjacent surface is near final configuration before widening is done, widening can be constructed using the actual NEW profile instead of an estimate
- Who wants to survey a control point between 2 live lanes

(#7) DAB widening /slope correction

- Stripe removal on old FC destroys the surface leaving a poor surface & confusing markings
- Easier to relocate Pavement Markings placed on new dense-graded asphalt
  - ✓ Water blasting less likely to remove the asphalt

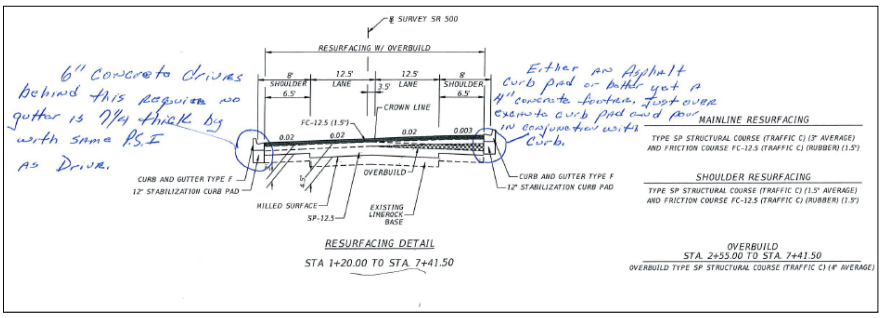
(#7) DAB widening /slope correction

- New construction slopes better accomplished when existing mainline is profiled & in final location
- While not always possible, preferable when changing profile of existing travel way

(#8) Ranger – SR 5

- **SR-5**: Use of 12" stabilization under curb & gutter sections
- Problems:
  - ✓ Behind the curb & gutter sections to be constructed are 6" concrete driveway with no stabilized subgrade
    - Why stabilize under the gutter sections, but not under the driveways, widening areas, or new roadway sections?
  - ✓ Difficult to construct 2' wide stabilized area
    - Can't fit a standard mixer in most locations
    - Bringing in pre-mixed material is expensive and time consuming

(#8) Ranger - SR 5



(#8) Ranger - SR 5

- Solution:
  - ✓ Sometimes PA will allow contractor to over excavate (4" under the C&G) & install asphalt curb pad or pour curb thicker
  - ✓ Saves an incredible amount of time and money
  - ✓ In areas where this constructability problem exists, delineate from Sta to Sta where this would be acceptable

(#9) Granite - Veterans

- Problem
  - ✓ Plan Note inconsistent with Standard Specifications for payment of reinforcing steel
  - ✓ Bidder who misses this note will not have dollars for steel in estimate

(#9) Granite - Veterans

110-1-1	INCLUDES THE COST OF SAWCUT. INCLUDES COST TO REMOVE EXISTING WALL 'A.' INCLUDES THE COST TO DISPOSE OF EXISTING FDOT UTILITIES IN ACCORDANCE WITH THE UTILITY ADJUSTMENT GENERAL NOTES. TREE PROTECTION BARRIERS ARE INCIDENTAL TO CLEARING AND GRUBBING. REFER TO EROSION CONTROL PLANS FOR TREE PROTECTION INFORMATION.
337-7-22	INCLUDES 186 TN OF FRICTION COURSE FOR TRANSITION WITH PROJECT FPID 406151-1-52-01 AND 340 TN OF FRICTION COURSE FOR TRANSITION WITH PROJECT FPID 431275-1-52-01.
400-2-11	CLASS II CONCRETE WILL INCLUDE THE COST OF REINF. STEEL FOR SPECIAL WALLS "A" AND "B".
425- / 430-	TEMPORARY SHORING, GROUND WATER REMOVAL AND SURFACE WATER CONTROL MAY BE NECESSARY DURING CONSTRUCTION OF THE DRAINAGE SYSTEM. ALL ASSOCIATED COSTS SHALL BE INCIDENTAL TO THE COST OF THE RELATED ITEMS AND NO SEPARATE PAYMENT SHALL BE MADE. THE TRENCH EXCAVATION SAFETY SYSTEM AND SHORING MAY REQUIRE THE USE OF TEMPORARY STEEL SHEET PILE WALLS FOR DRAINAGE CONSTRUCTION. SOME OF THESE TEMPORARY WALLS ARE SHOWN IN THE STRUCTURE PLANS. WHERE NOT DETAILED IN THE PLANS, TEMPORARY WALLS SHALL BE DESIGNED BY THE CONTRACTOR. THE COST OF FURNISHING, INSTALLING AND REMOVING THESE TEMPORARY WALLS SHALL BE INCIDENTAL TO THE COST OF THE RELATED ITEMS AND NO SEPARATE PAYMENT SHALL BE MADE.

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(#9) Granite - Veterans

- Solution
  - ✓ Avoid using plan notes that deviate from standard pay item practice

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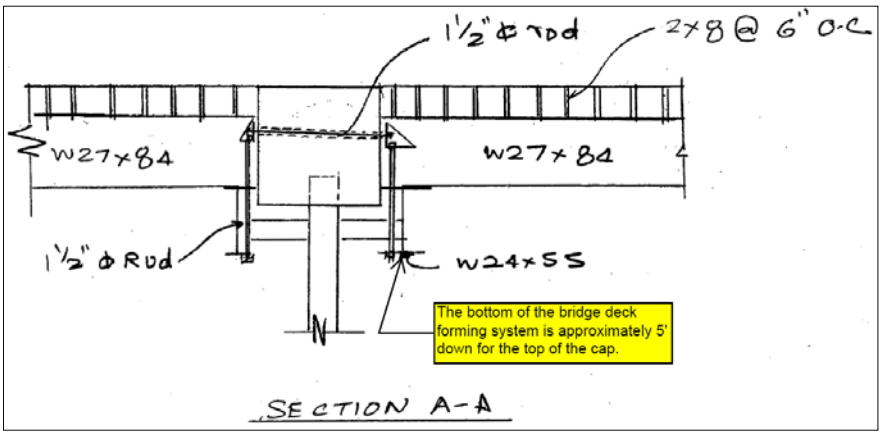
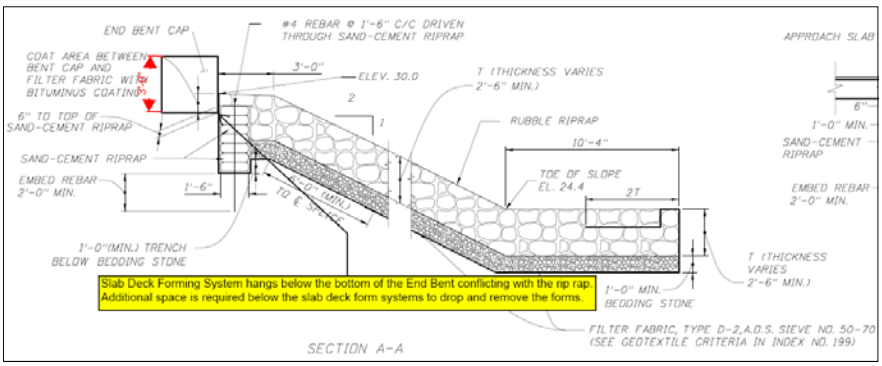
(#10) Superior - Structure Problem

- Slab Deck Bridges & Rip Rap underneath it
- Scour protection & Rip Rap at End Bent present constructability issues
  - ✓ Due to elevation of required for forms & Construction Sequencing
- Rip Rap's Final Elevation Conflicts with Formwork

(#10) Superior - Structure Problem



(#10) Superior - Structure Problem



Slab Deck Forming System hangs below the bottom of the End Bent conflicting with the rip rap. Additional space is required below the slab deck form systems to drop and remove the forms.

(#10) Superior - Solution

- Lower Rip Rap Final Elevation to allow for removal of bridge deck form work

  OR

- Consider additional scour protection methods for slab deck bridges

- Only a problem on slab deck bridges

Round 3

(#11) Hubbard - Constructability Improvement

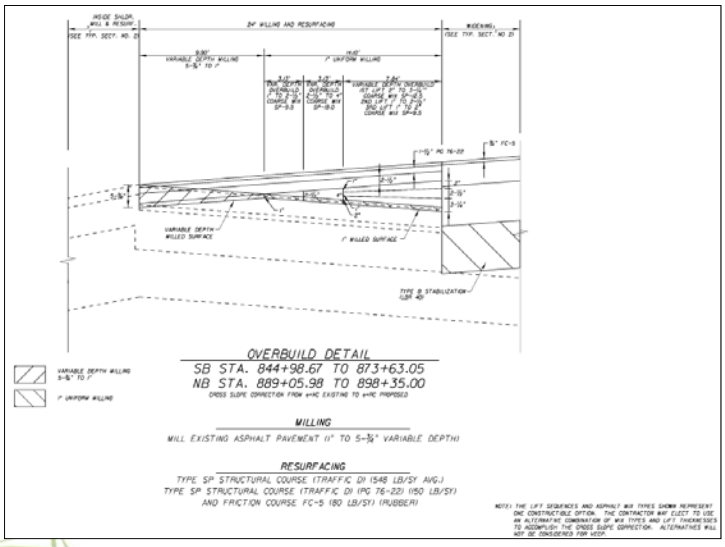
- Bid/Build Projects
  - ✓ Supply Comp Book with bid docs for informational purposes
  - ✓ Good tool for quick budget & schedule checks
  - ✓ Allows for quantity comparisons
  - ✓ Currently have to request Comp Book after bid documents come out
    - By the time its received, its too late to be useful

(#12) Old stripe removal

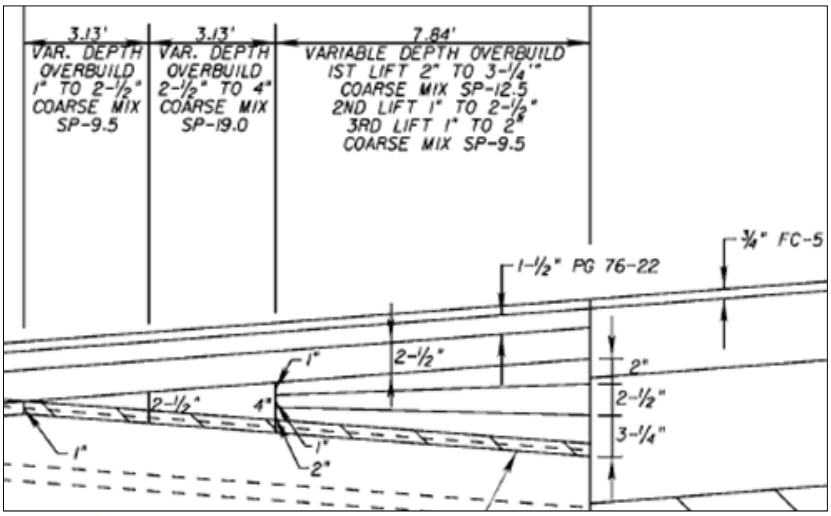
(#13) Ranger - SR 91

- Problem
  - ✓ Overbuild had too many mixes, (9.5, 12.5, & 19mm)
  - ✓ This is not constructible
  - ✓ Especially challenging at night, under traffic on a high-speed roadway like the Turnpike
  - ✓ Although CEI modified on site, it is better handled in Design

(#13) Ranger - SR 91



(#13) Ranger - SR 91



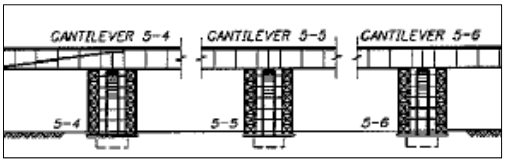
(#13) Ranger - SR 91 - Solution

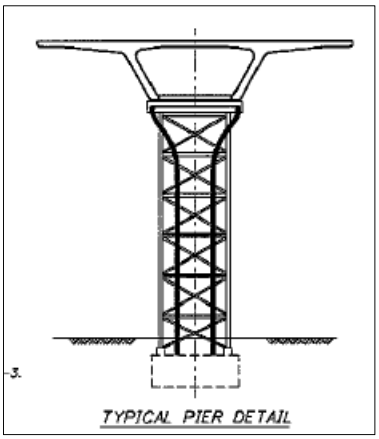
- Solution
  - ✓ Design to minimize number of mixes, lifts, & widths of pulls (number of pulls) required
  - ✓ On this example's project, contractor used one mix (SP-12.5 fine)
  - ✓ Engineer was OK with this change

(#14) Granite - Selmon Connector

- Problem
  - ✓ Plans clearly anticipate use of heavy shoring for segment erection
  - ✓ Shoring is typically large diameter pipe or 10' x 10' frames
  - ✓ Footer not large enough to support shoring
  - ✓ Shoring on footer / supplemental supports could lead to differential settlement of shoring during construction, leading to construction problems

(#14) Granite - Selmon Connector





(#14) Granite - Selmon Connector

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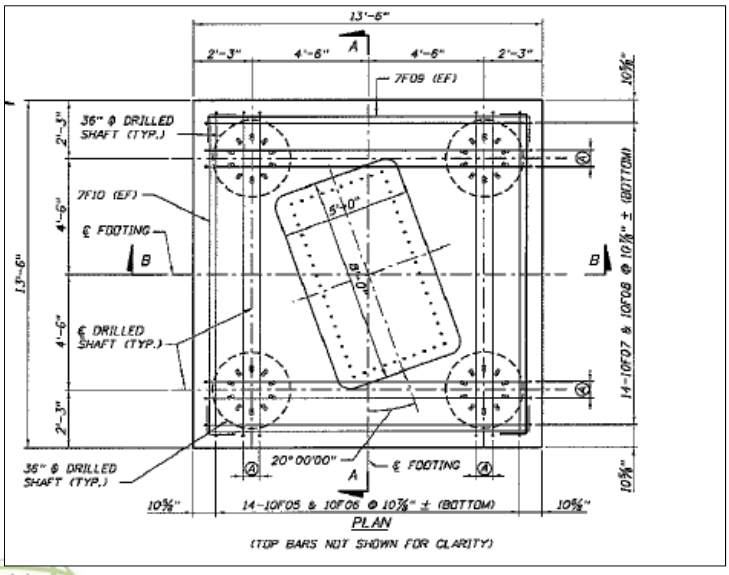


(#14) Granite - Selmon Connector

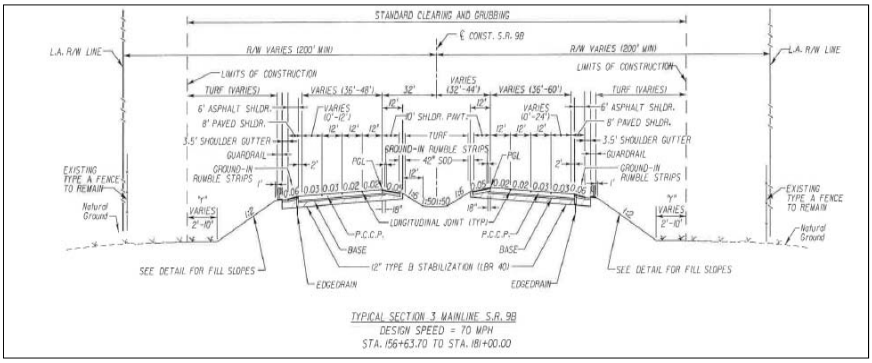
- Solution:
  - ✓ Consider shoring size during design
  - ✓ Make footers large enough to support shoring

(#15) Superior - Problem

- Standards for concrete paving with asphalt working surface beneath it
- Affects concrete paving thickness
- 4” paved layer on stabilized subgrade
- Since concrete ½” under plan thickness is likely removed, contractor lowers subgrade to ensure 4” of asphalt is placed AND full concrete pavement thickness

(#15) Superior - Solution

- Consider asphalt’s structural value before removing concrete that is only ½” under thickness



Round 4

(#16) Hubbard - Constructability Improvement

- Provide design files in formats easily readable by machine control programs
- Design Files should include alignments & TIN files
- TIN Files:
  - ✓ Provide smoother, more accurate surfaces when machine guided control is used, especially for asphalt
  - ✓ Data can be easily split up so the entire project doesn't have to be loaded at one time

(#16) Hubbard - Constructability Improvement

- TIN Files should be easily editable by contractor or surveyor
- Why?
  - ✓ Contractors probably won't agree on line work they want visible in model
  - ✓ Unlikely design firms will provide machine-related file revisions as quickly as contractors want them

(#16) Hubbard - Constructability Improvement

- Only 3 major suppliers of GPS machine controls
  - ✓ Should be easy to provide properly formatted generic files
  - ✓ Machine control software can deal with those files
- Contractors have received .xml, .dgn, and .dwg files from designers containing embedded DTMS or TIN surfaces
  - ✓ However they must edit with other CAD software before machine control software will accept
- Need design professionals & machine control programmers to develop formatting for exporting from design software used on FDOT projects & import into machine control software

(#17) DAB - Problem

- Shoulder pavements 1” lift Limits how the mainline is constructed
- Adjacent mainline to be constructed with additional passes
- 1” lift requires 9.5mm mix
  - ✓ May require a crew to pave an additional pass throughout the project
- 2013 Specification 334-1.4.3 requires shoulders to be paved at the same time as the mainline structure

> 2. When construction includes the paving of adjacent shoulders (less than or equal to 5 feet wide), the layer thickness for the upper pavement layer and shoulder must be the same and paved in a single pass, unless called for differently in the Contract Documents.

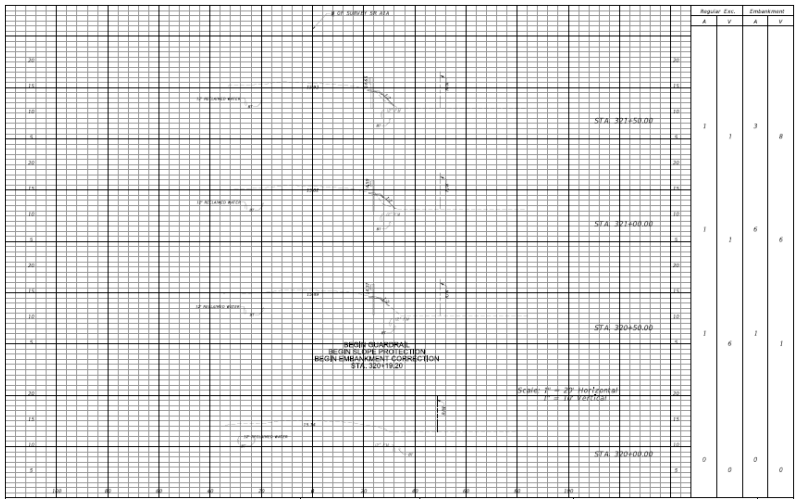
(#17) DAB - Solution

- Consider a thicker shoulder when possible
  - ✓ Reducing the amount of times an area has to be paved reduces cost
- Thinner lifts increase risk due to the inconsistency of density – which increases the price
- 2 – 1.5” inch lifts are typically a smoother product than a 2” lift followed by a 1” lift

(#18) Ranger - A1A

- Problem
  - ✓ Elevations given for misc. asphalt pad in the cross sections created a slope steeper than 1:10 between the edge of paved shoulder and misc. asphalt
- Solution
  - ✓ If elevations were not part of the plan, misc. asphalt could have been constructed per Index 400 with a slope less than 1:10

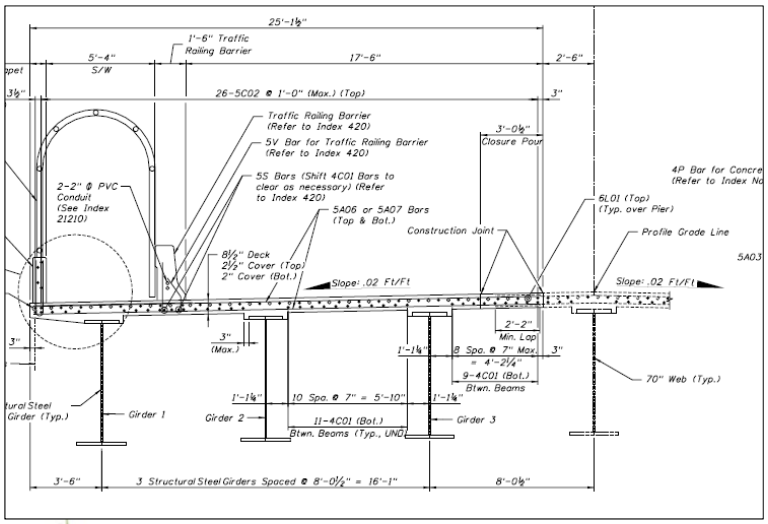
(#18) Ranger - A1A



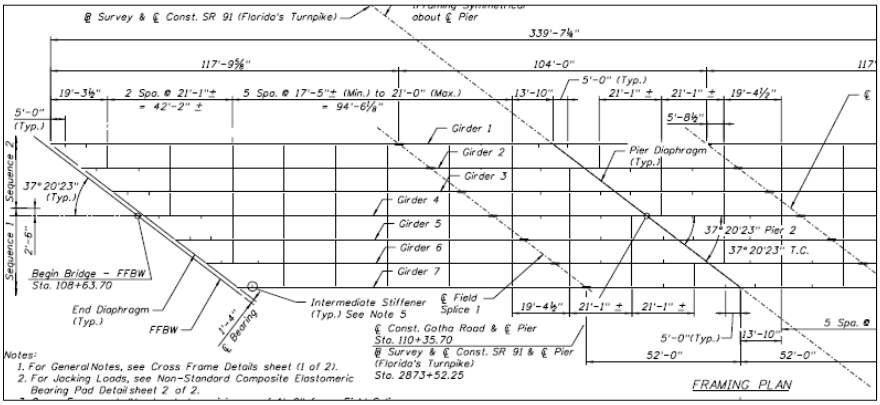
(#19) Granite - Phased Steel Bridge

- Problem
  - ✓ Often significant grade differential across phases of bridge deck
  - ✓ Creates a problem with X-frame installation

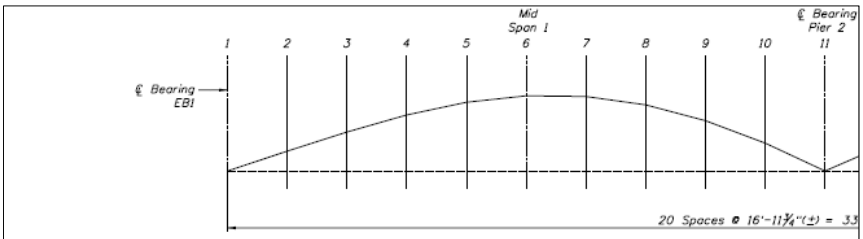
(#19) Granite - Phased Steel Bridge



(#19) Granite - Phased Steel Bridge

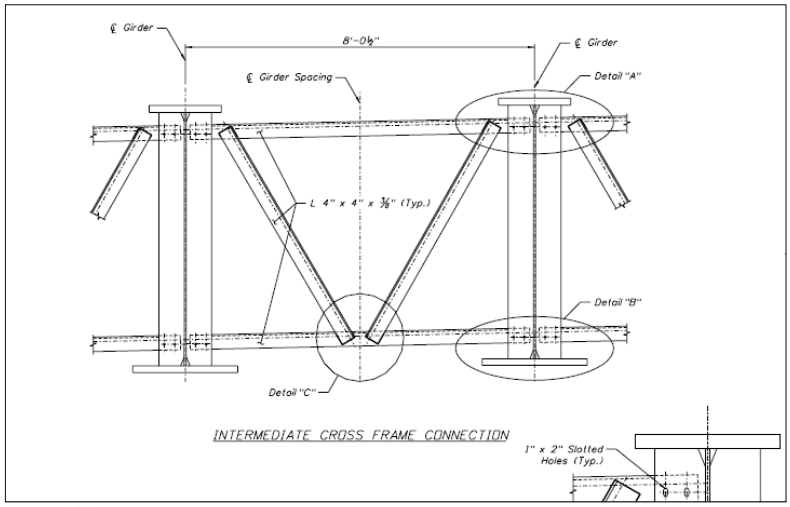


(#19) Granite - Phased Steel Bridge



Girder	Item	℄ Bridge EB1					Mid Span 1				
		1	2	3	4	5	6	7	8	9	10
7	Steel DL	0.000	0.364	0.653	0.833	0.888	0.820	0.652	0.422	0.186	0.018
	Slab DL	0.000	1.204	2.148	2.720	2.882	2.650	2.095	1.345	0.584	0.050
	Superimposed DL	0.000	0.135	0.243	0.310	0.332	0.308	0.247	0.161	0.073	0.009
	Geometric Camber	0.000	2.739	4.870	6.392	7.305	7.609	7.305	6.392	4.870	2.739
	Total Camber	0.000	4.442	7.914	10.255	11.406	11.388	10.299	8.320	5.713	2.815

(#19) Granite - Phased Steel Bridge



(#19) Granite - Phased Steel Bridge

GENERAL NOTES:

1. Fabricator may shift Cross Frame up to 1' if needed for fit-up.
2. Intermediate Stiffeners are not shown on Girder Elevation.
3. Dimensions shown are not adjusted for Camber or Vertical Curve.
4. Plates marked (Tension) shall meet minimum Charpy V-Notch requirements. Refer to General Notes and Specifications.
5. Place Bolt Heads on the outside of Exterior Girders and at the bottom of Flanges.
6. Bolt Holes for Cross Frames and Diaphragms may be oversize in both Plies. All other Holes shall be Standard Size unless noted otherwise.
7. All Welds and Weld Types shall be shown on the Shop Drawings.
8. All Shop Welded Splices shall be Prequalified AWS Full Penetration Weld Joints.
9. Cross Frame Connection Stiffener Plates are not shown on Framing Plan (See this Sheet).
10. Bolts for all cross frames in the individual phased construction shall be tightened prior to the deck pour, with the exception of cross frames between girders 3 & 4, which shall be tightened after placing the deck closure pour.

(#19) Granite - Phased Steel Bridge

- Solutions:
  - ✓ Can X-frames be installed after closure pour has been made?
  - ✓ Use of oversize holes for X-frame in closure pour bay to allow movement from closure pour.
  - ✓ X-frame details that facilitate connection when grades are different.

Questions & Comments