FDOT TRANSPORTATION SYMPOSIUM 2019

I-75 over SR50 – Design and Construction

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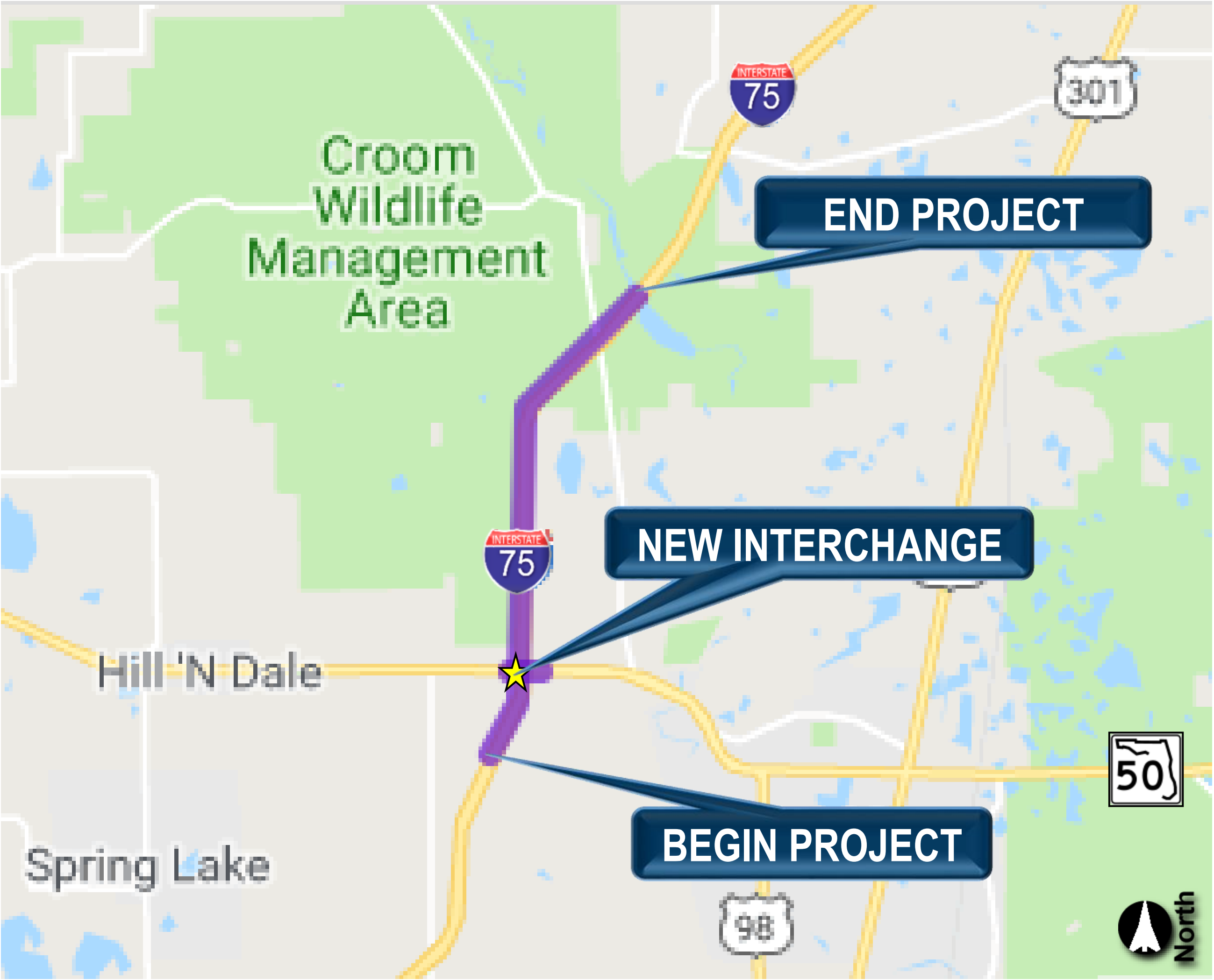
AGENDA

- Introduction
- Project Needs
- Design Challenges
- Design Solutions
- Construction

INTRODUCTION – THE PROJECT

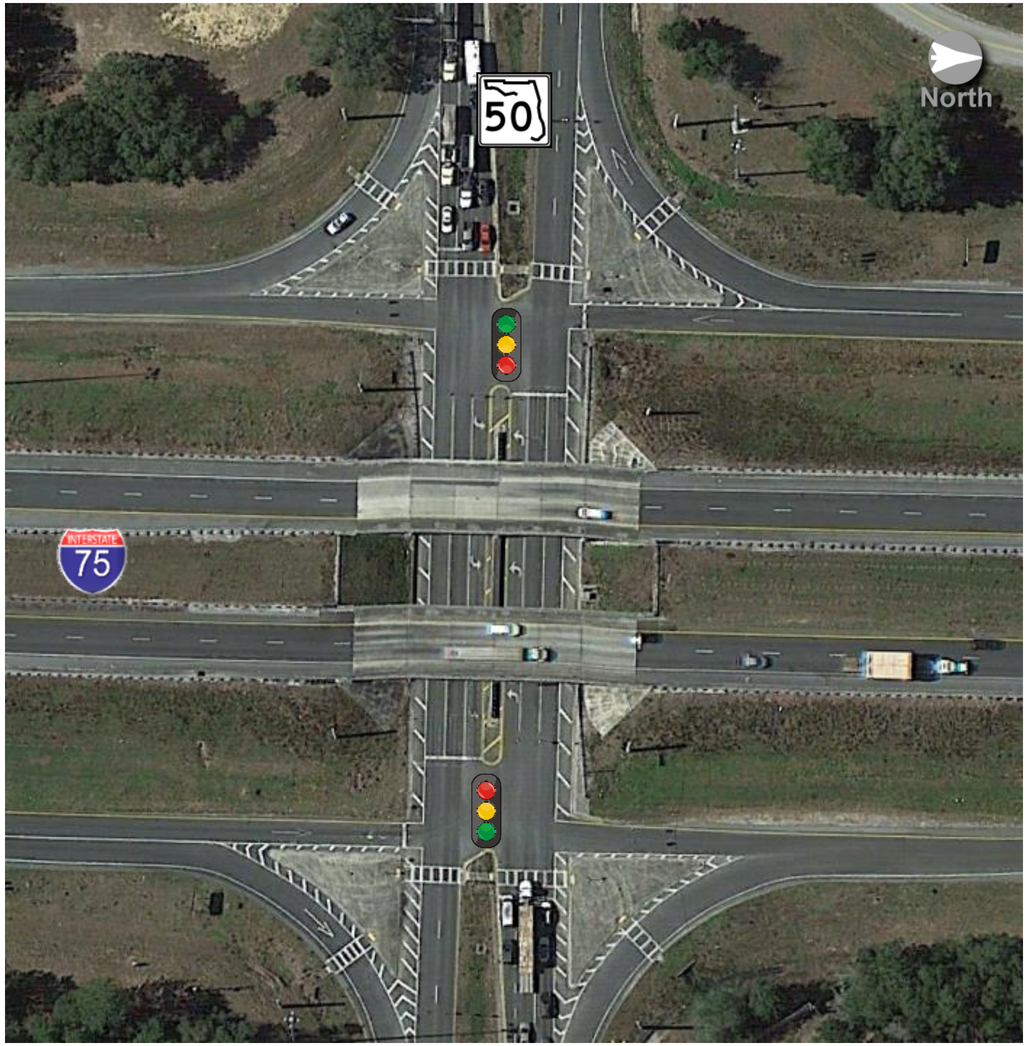
- Location: Brooksville, Florida
- Facility Owner: FDOT District 7
- Scope: 6.25 Miles Widening and Reconstruction
- Construction Bid: $95M
- H&H Roles
  - Interchange Bridge Designers
  - Corridor Temporary Traffic Control
- Partners
  - Wantman Group Inc. (WGI)
  - The Middlesex Corporation



INTRODUCTION - EXISTING INTERCHANGE

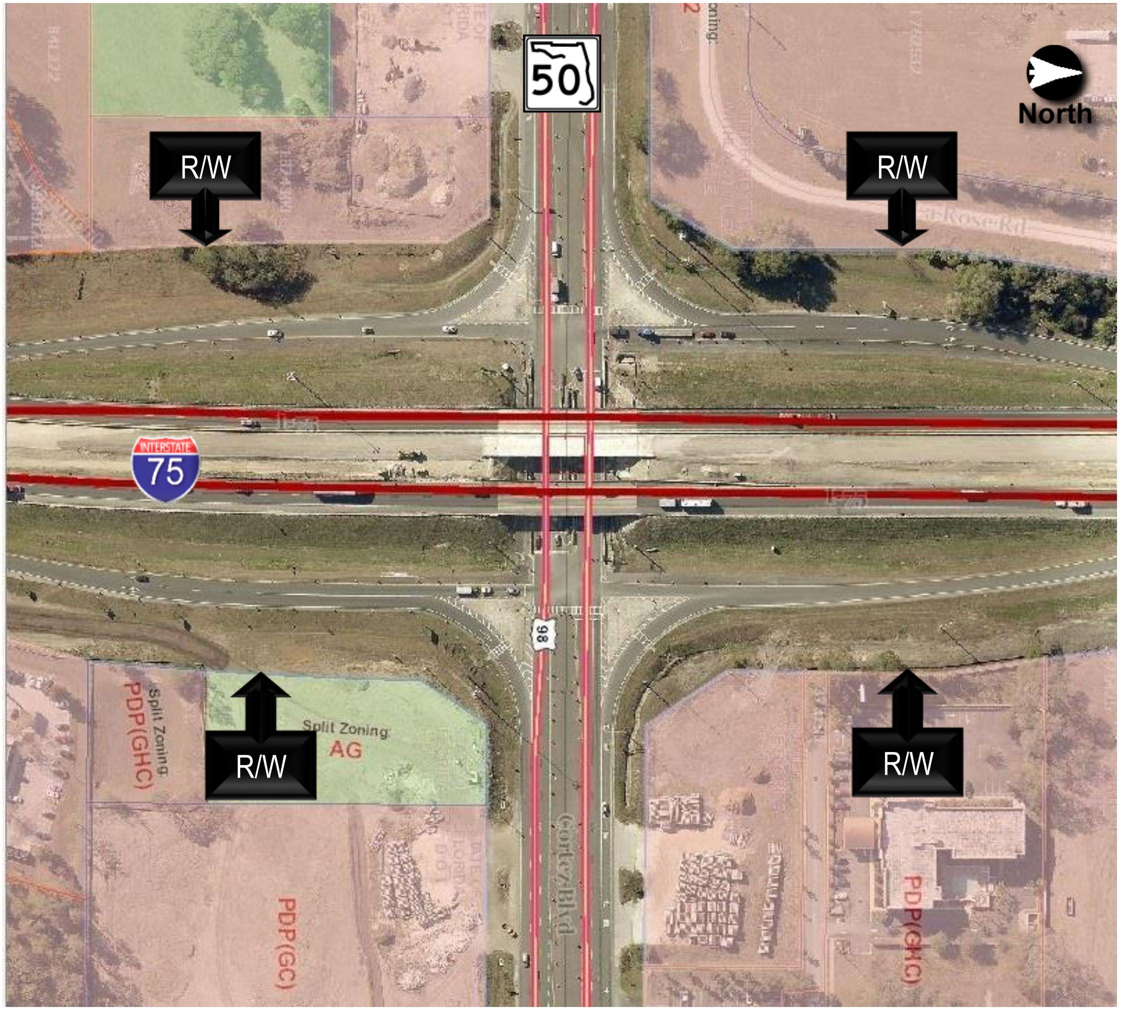
- Built in 1963
- 45 Minutes North of Tampa

	Interstate I-75 (SR 93)	SR 50
Geometry	• Two Lanes Each Direction • Twin Bridges - 174 Feet - Four Spans, Prestressed Beams - 44’ -10’’ Wide Section	• Two Through Lanes Each Direction • One Left Turn Lane Each Direction • No Bicycle Lanes • No Sidewalks
Speed	70 mph	45 mph (Through Interchange)



PROJECT NEEDS – CORRIDOR PLANNING

- I-75 Master Plan - Tampa to Turnpike
  - Add Capacity, Safety and Mobility
  - Prepare for Future Corridor Configuration
- Increasing Population and Urbanization
- Traffic Growth
  - 30 % Truck – I-75
  - 21 % Truck – SR50
- Limited Right-of-Way



PROJECT NEEDS – DEFICIENCIES

- Interchange
  - Stopping Sight Distances (SSD)
  - Limited Truck Turning Radius
  - Wrong Way Driving
  - No Bicycle Lanes and Sidewalks
  - Level of Service No Build = F
- Existing Bridges
  - Insufficient Drainage System
  - Deck Cracks
  - Vertical Clearance = 14’-11½” < 16’-0”
  - History of Trucks Hitting Beams

PROJECT NEEDS – DEFICIENCIES

NB Bridge Beams Damaged By Truck Impact

SB Bridge Beams Damaged By Truck Impact

KEY DESIGN CHALLENGES

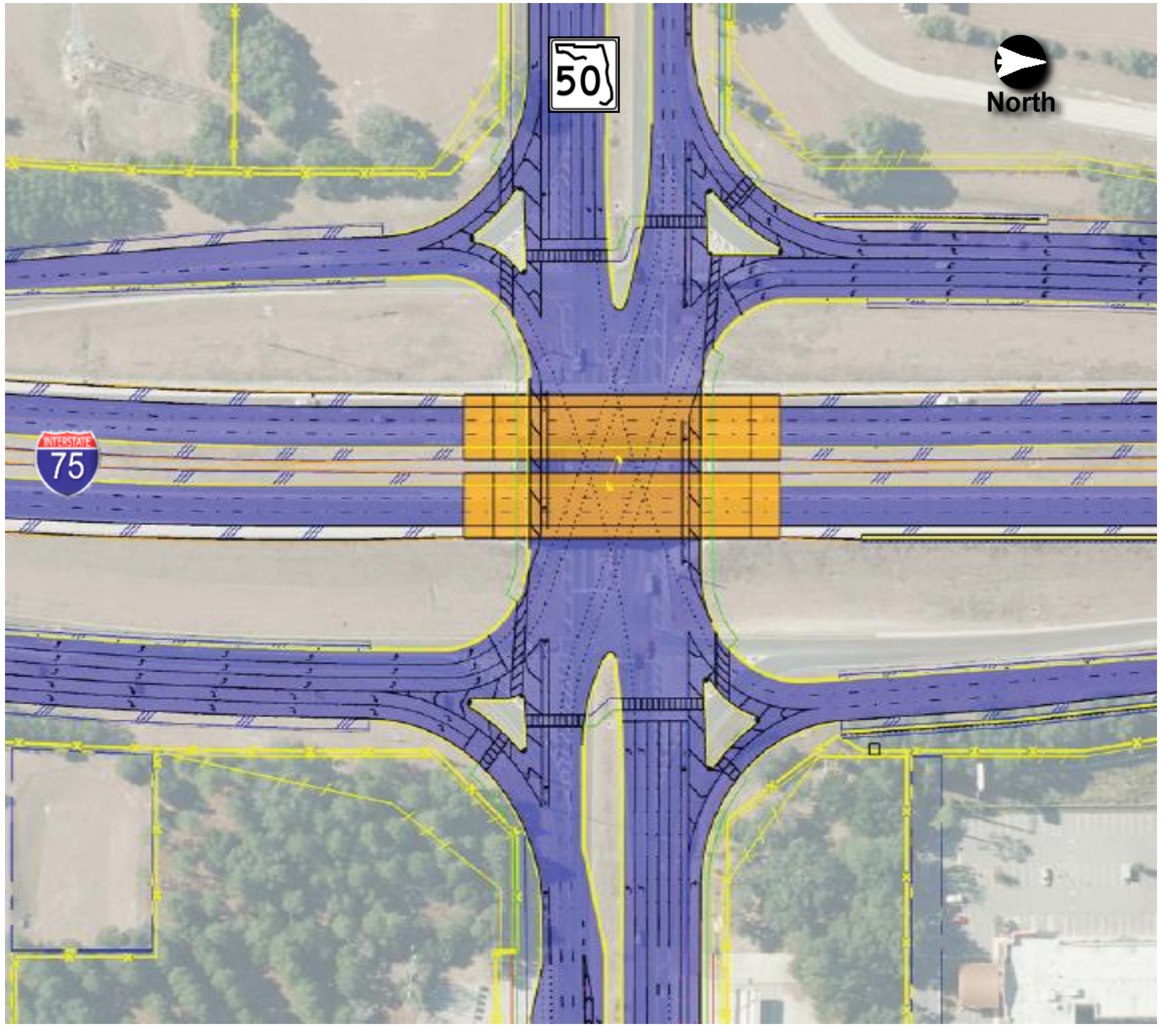
	I-75 (SR 93) / SR 50 INTERCHANGE		
RFP REQUIREMENT	CURRENT & FUTURE ROADWAY CONFIGURATIONS	CLEAR AREA UNDER BRIDGES (NO INTERMEDIATE PIERS)	18’-8” MVC AT ALL CONFIGURATIONS
GEOMETRY & ALTERNATIVES		BUILT ON SAME HORIZONTAL ALIGNMENT	VERTICAL ALIGNMENT RAISED BY 14’
BRIDGE DESIGN FEATURES	TEMPORARY DRAINAGE	3 LANES TODAY AND 4 & 5 LANES FUTURE CONFIGURATION	FUTURE FLYOVER RAMP I-75 NB TO WB SR 50
MOT	I-75 DESIGNATED HURRICANE EVACUATION	INTERSECTION CLOSURE 15-MILE DETOUR	ACCESS TO RAMPS AFTER VERTICAL ALIGNMENT SHIFT

DESIGN SOLUTIONS

- New Interchange Configuration
- Bridge Structural Configuration
  - Bridge Structural Design
  - Superstructure
  - Foundation, Substructure and Walls

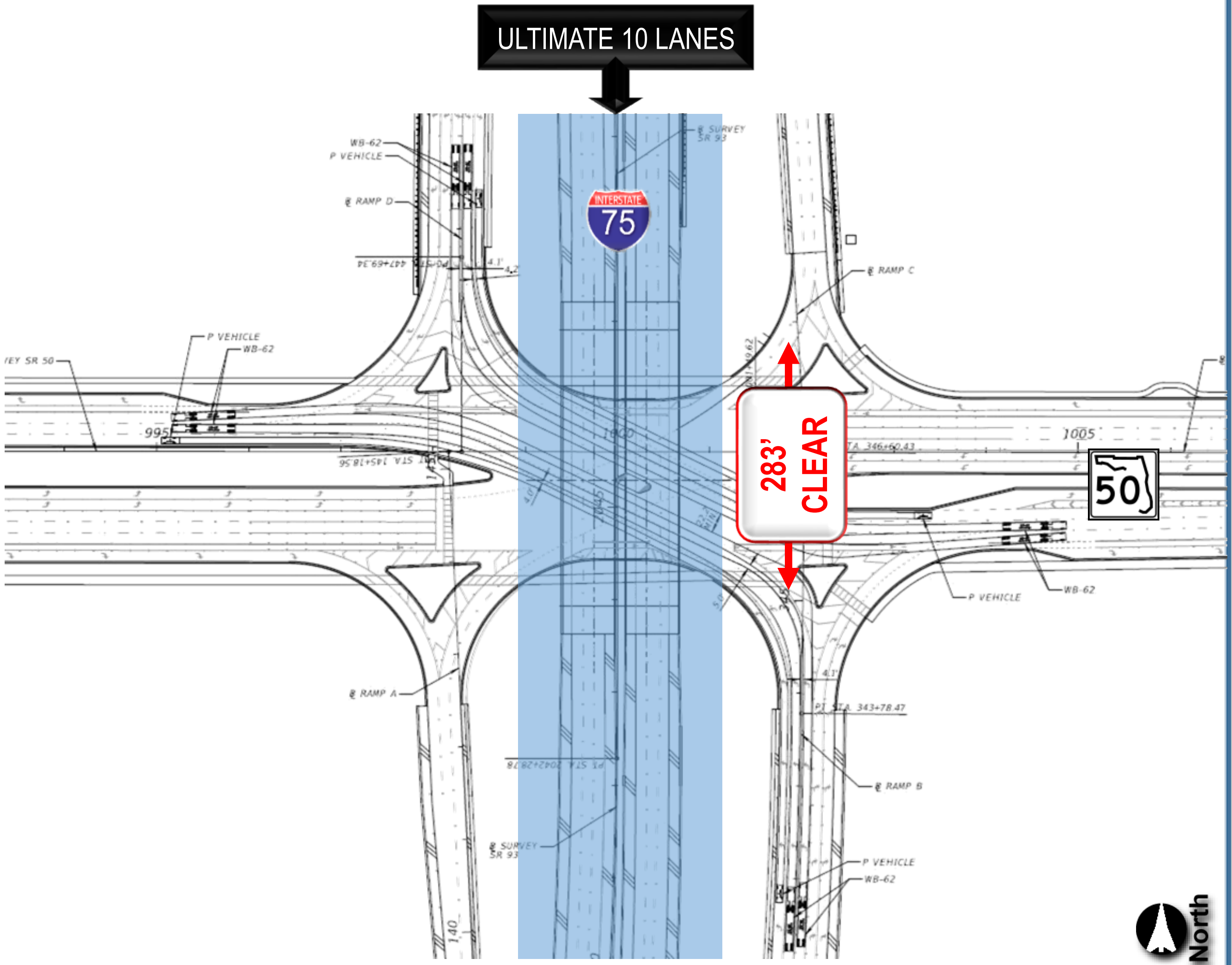
SITE OVERVIEW - NEW INTERCHANGE LAYOUT

- Single-point Urban Interchange (SPUI)
- I-75 (SR 93) Corridor Configuration
  - Three 12’ Lanes and Two 10’ Shoulders Each Direction
- SR 50 (Cortez Blvd.)
  - Three 12’ Through Lanes
  - 66’ Median
  - Two 12’ Shoulders (Striped Out Future Lanes)
  - Two 7’ Buffered Bicycle Lanes
  - Sidewalk and Multi-use Path



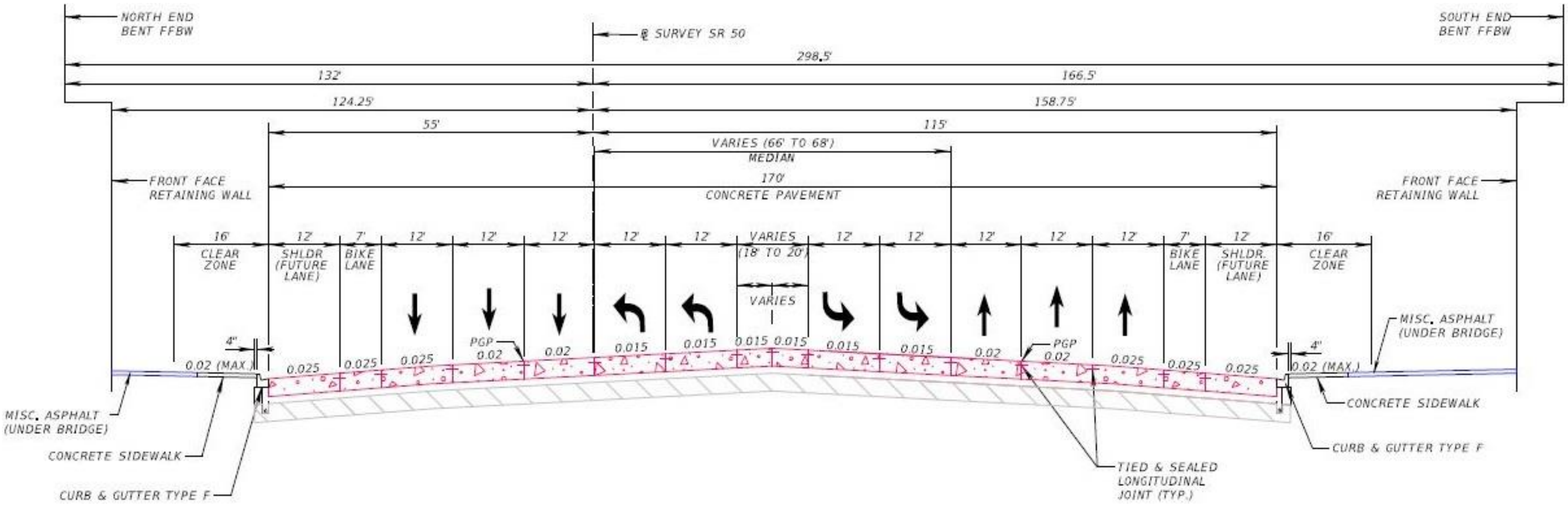
INTERCHANGE GEOMETRY – BRIDGE LENGTH

- Ramp Geometry:
  - Concurrent Design Vehicles
    - Passenger Car (P-vehicle)
    - Two - Florida Interstate Semitrailers (WB-62 FL)
  - Clearance Between Movements
  - Provide 25 mph Operations
- Exit Ramp Radius
- Minimum Lateral Offset
- 283'-0" Clear Area under Bridges!



Left-Turn Movement Details

INTERCHANGE CONFIGURATION – SR 50 UNDER BRIDGES



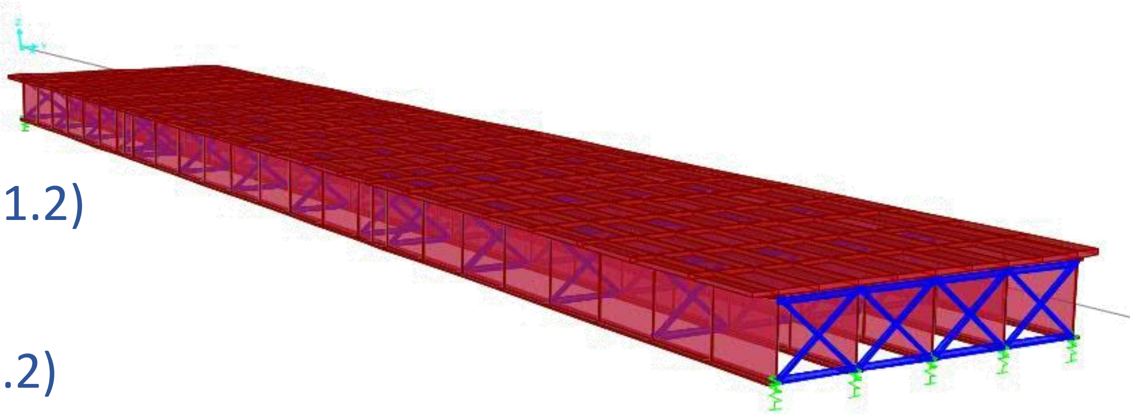
BRIDGE STRUCTURAL CONFIGURATION

- 298’-6” Simple Span Twin Bridges
- 59’-1” Wide Section (3 Lanes)
- Pile Supported End Bents
- Permanent Retaining Walls

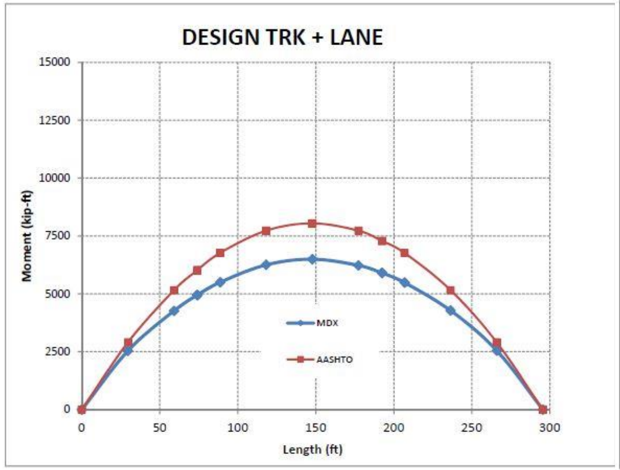
New NB Bridge (Looking West)

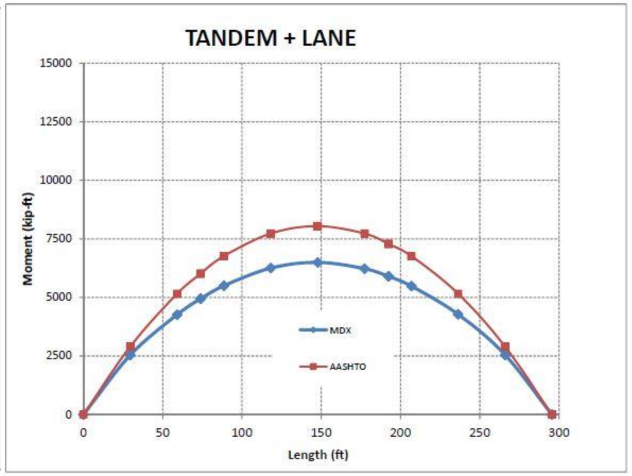
BRIDGE STRUCTURAL CONFIGURATION

- 295’-6” Structural Span Length
- FDOT Structures Design Guidelines (SDG 1.2)
  - Span-to-depth Ratios (LRFD 2.5.2.6.3)
  - LL Deflection Criteria (LRFD 2.5.2.6.2 & 3.6.1.3.2)
- Span Outside of LLDF Applicability
  (LRFD 4.6.2.2) >240’-0”
- Finite Element Model Developed
  - Live Load Distribution
  - Calibration With Design Software
  - Check Bridge Natural Frequency



CSi BRIDGE FEM

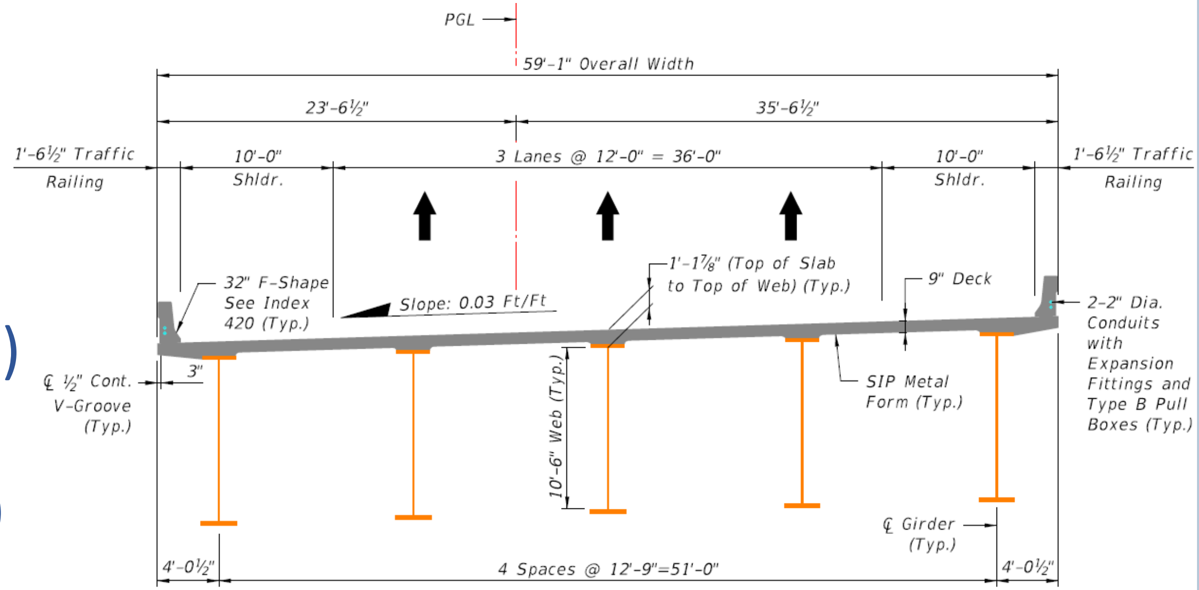




CALIBRATION

BRIDGE SUPERSTRUCTURE

- Weathering Steel (SDG 5.3.1.A)
  - Webs = 10’-6” Deep Grade 50
  - Flanges = 26”/28” Wide Grade 70 (HPS)
- Design Controlled by Constructibility
  Non-composite with LF = 1.4 (LRFD 3.4.2.1)
- 9” Concrete Deck (½” Sacrificial)
- Dead Load Camber = 25”
- Live Load Deflection = 3¼”<4⅜” (L/800)
- Neoprene Bearing Pads
  - Vulcanized Sole Plate (FHWA, CO, ID, NY, WI)
  - Anchor Rods (Prior to SDG 6.5.3)
- Poured Expansion Joint (Index 21110)



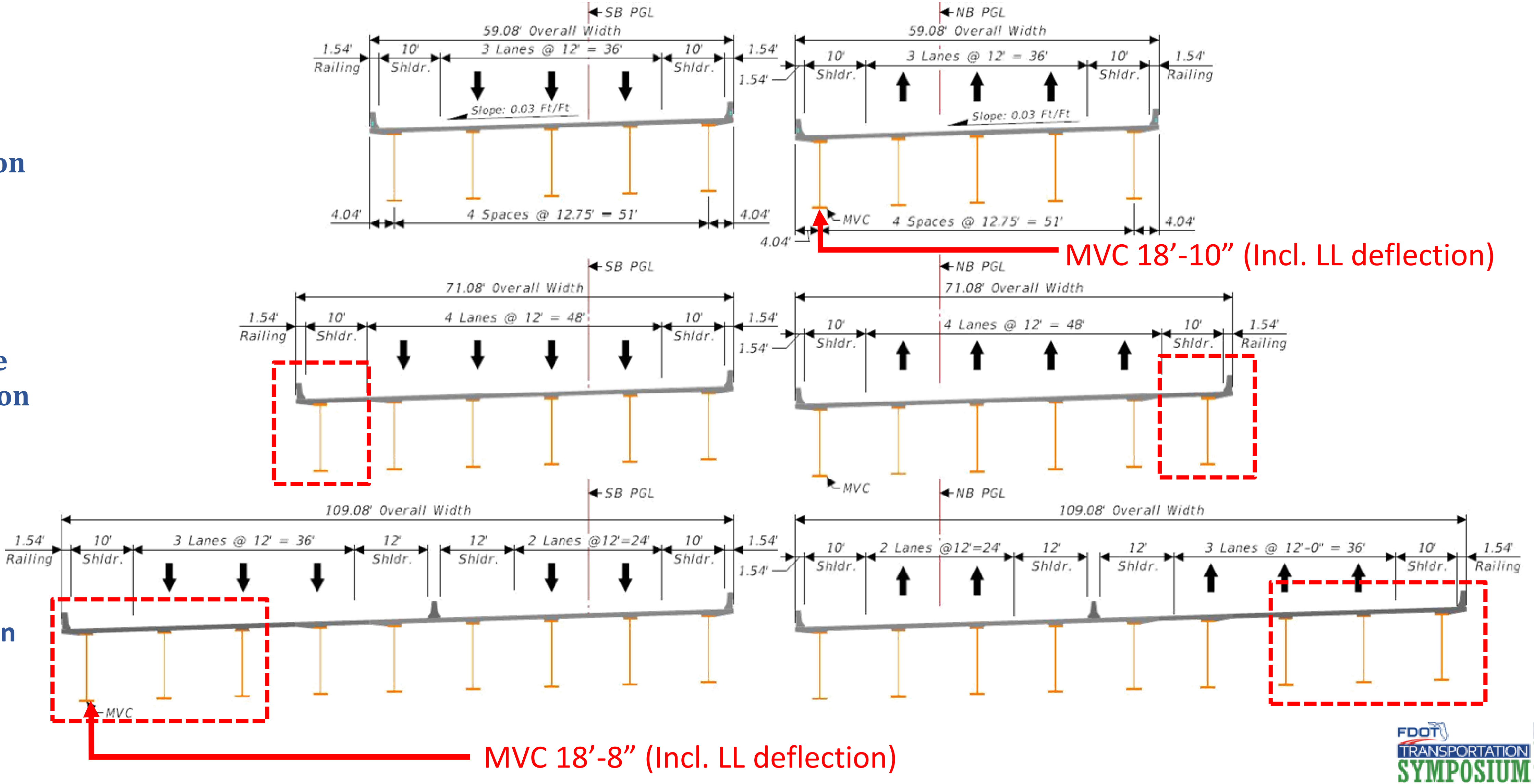
NB Bridge Typical Section (SB Bridge Similar)

BRIDGE STRUCTURAL CONFIGURATION

Six Lane Configuration

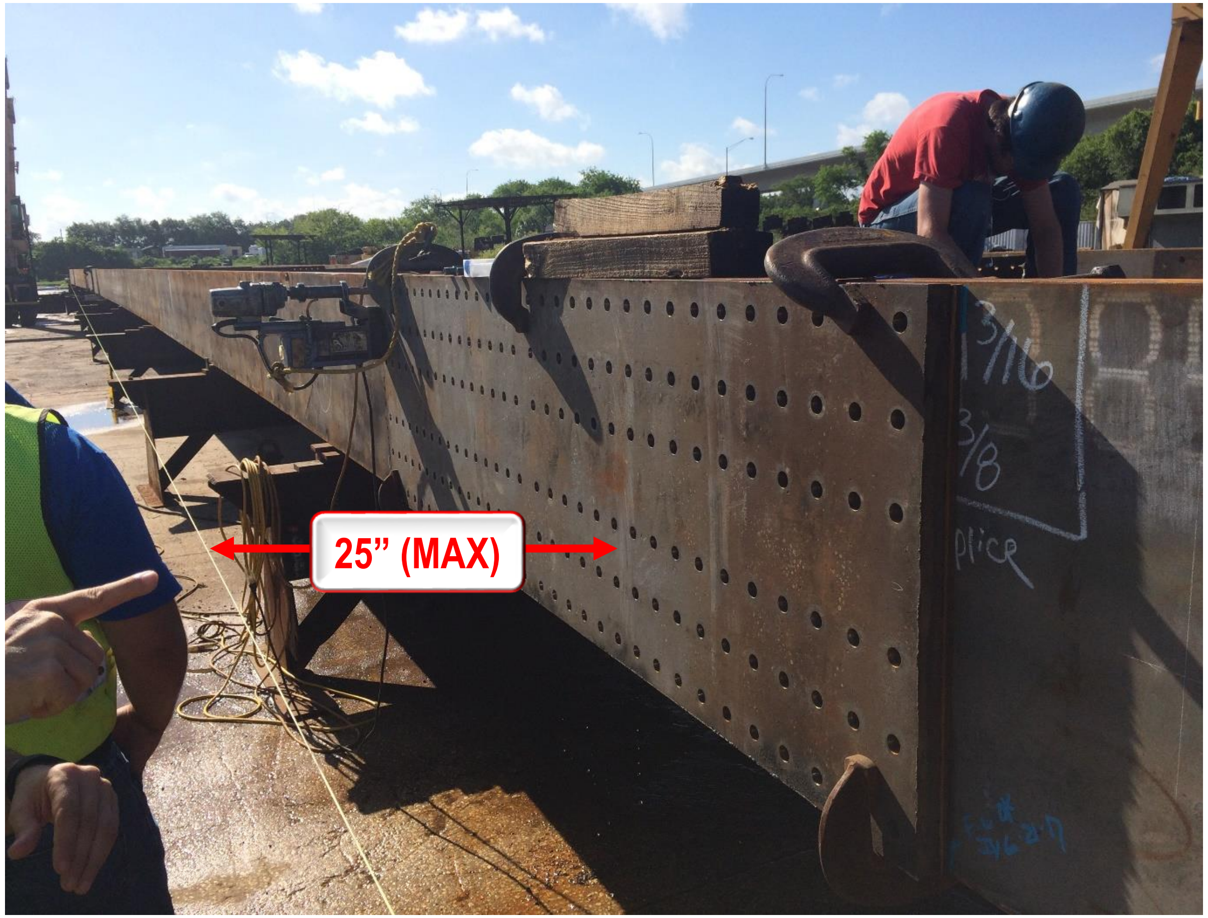
Eight Lane Configuration

Ten Lane Ultimate Configuration



BRIDGE SUPERSTRUCTURE FABRICATION

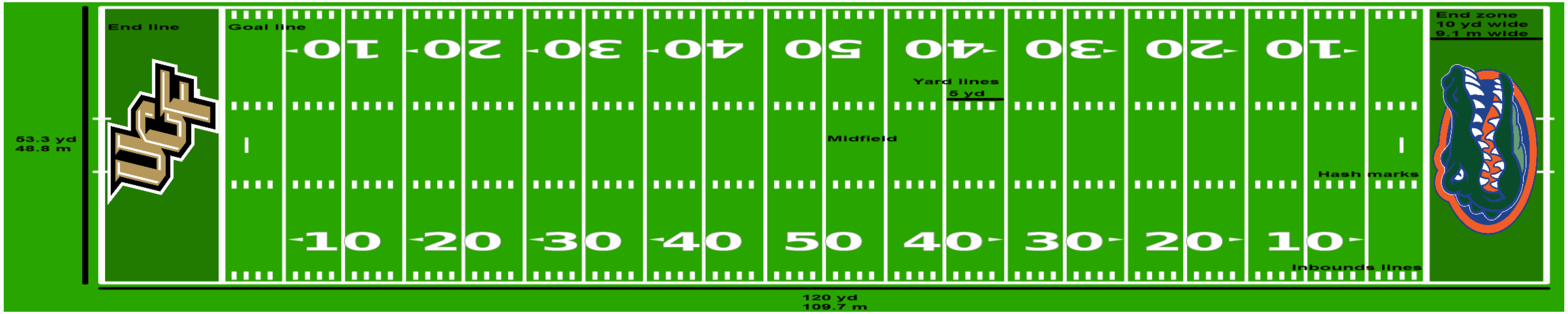
10'-11" Deep Girder



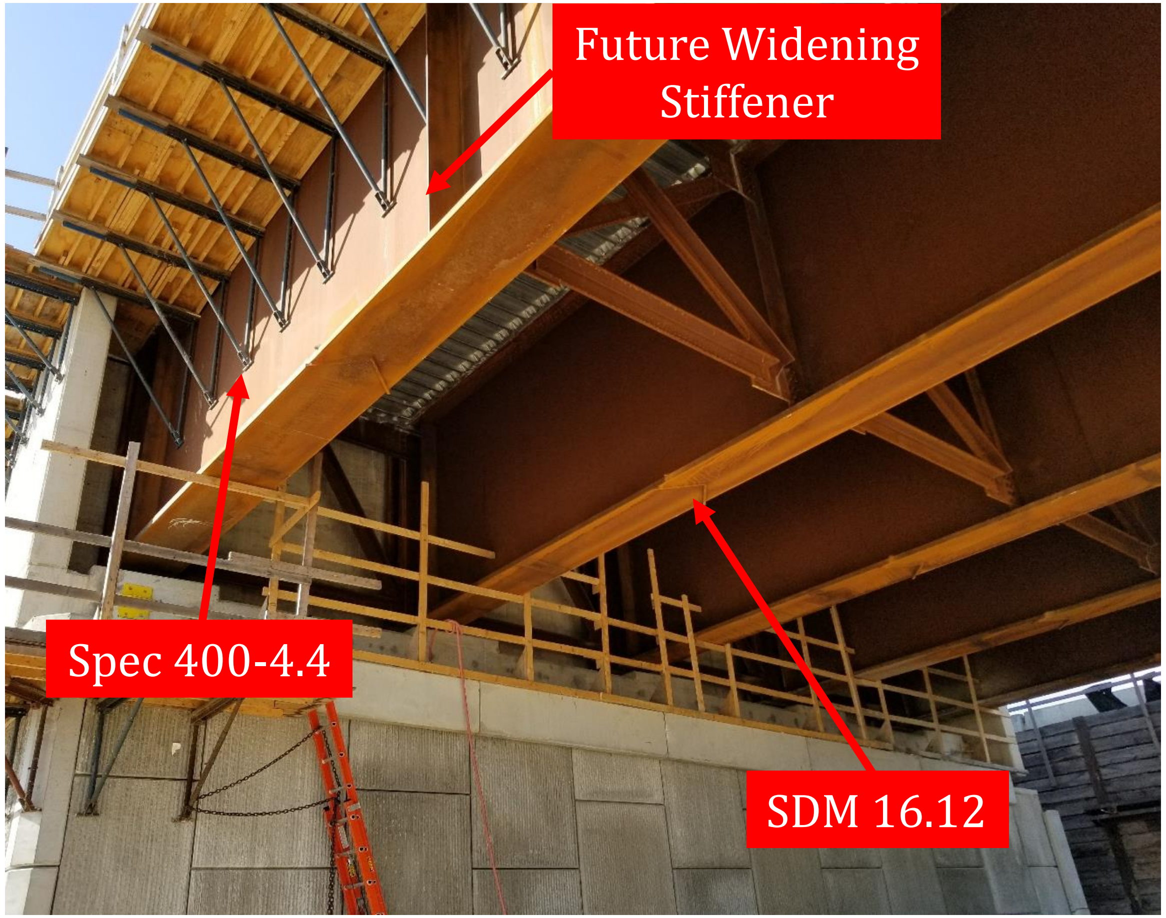
Camber Verification

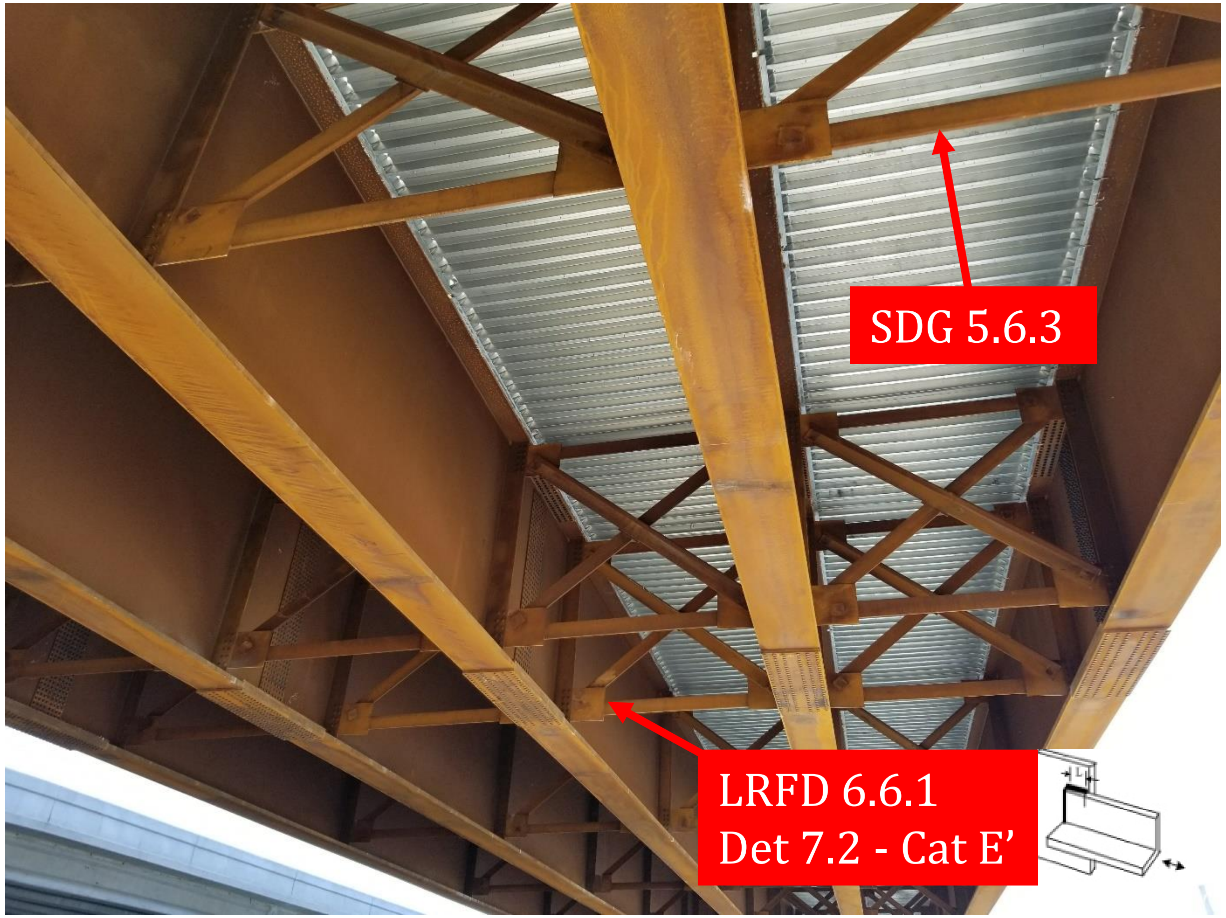
BRIDGE SUPERSTRUCTURE FABRICATION

Girder Lay-Down Ready For Assembly and Camber Verification Almost Length of Football Field!



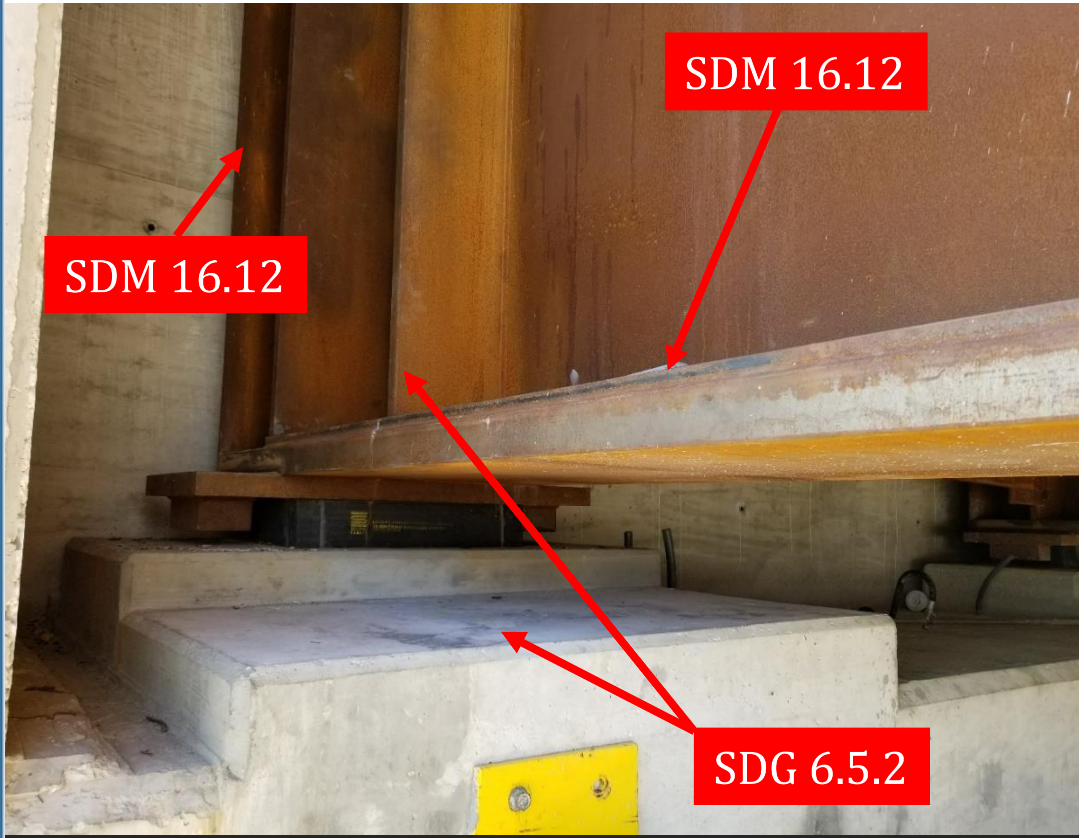
BRIDGE SUPERSTRUCTURE ELEMENTS





Bridge Superstructure, SIP Forms, Field Splices and Weathering Steel Details

BRIDGE SUPERSTRUCTURE ELEMENTS



Bearing Assembly and Future Replacement

Bearing Assembly – Lessons Learned

BRIDGE FOUNDATIONS AND SUBSTRUCTURE

- Foundation
  - 11 - 24" Sq. Prest. Concrete Piles (Index 20624)
  - Pile Lengths = 85' (Max)
  - 343 Tons End Bents 1 and 2 (NBR)
- Substructure
  - 8'-3" Wide x 4'-0" Deep Bent Cap (Mass Concrete)
    - Spec 346-3.3 – Mass Concrete
    - No Instrumentation or temperature measuring
      - Least dimension <= 6'-0"
      - Insulation R > 2.5 for more than 72 hours
      - Slightly Aggressive or Moderately Aggressive
      - Mass concrete mix
        - Cement content <= 750 lb/cy
  - 15" Thick x 10'-0" Deep Backwall
    - Poured After Steel Girder Erection

Prestressed Concrete Piles Installation

BRIDGE PERMANENT RETAINING WALLS

- FDOT Type 2B MSE Walls
  - Steel Strips (ASTM A1011 Grade 65)
  - 10’ Wide Maintenance Berm (PPM 4.2.6.1)
  - 3:1 Slopes (PPM 4.2.6.1)
- Permanent Pressure Relief Wire Walls
  - Type 3 Wire Wall (75 Year Life)
  - Placed Behind End Bent Backwalls (SDG 3.13.2.M.3)
  - Relief From Earth and LL Surcharge
  - 4” EPS Foam for Deflection Control
  - Allow for Girder Placement and Camber Relief

Typical MSE Retaining Walls and Maintenance Berm

BRIDGE SUBSTRUCTURE AND RETAINING WALLS

End Bent With Trough For Water and Weathering Iron Oxide Runoff (Backwall Not Poured)

End Bent Cap, Wrap Around MSE Retaining Wall and Pressure Relief Wall (Backwall Not Poured)

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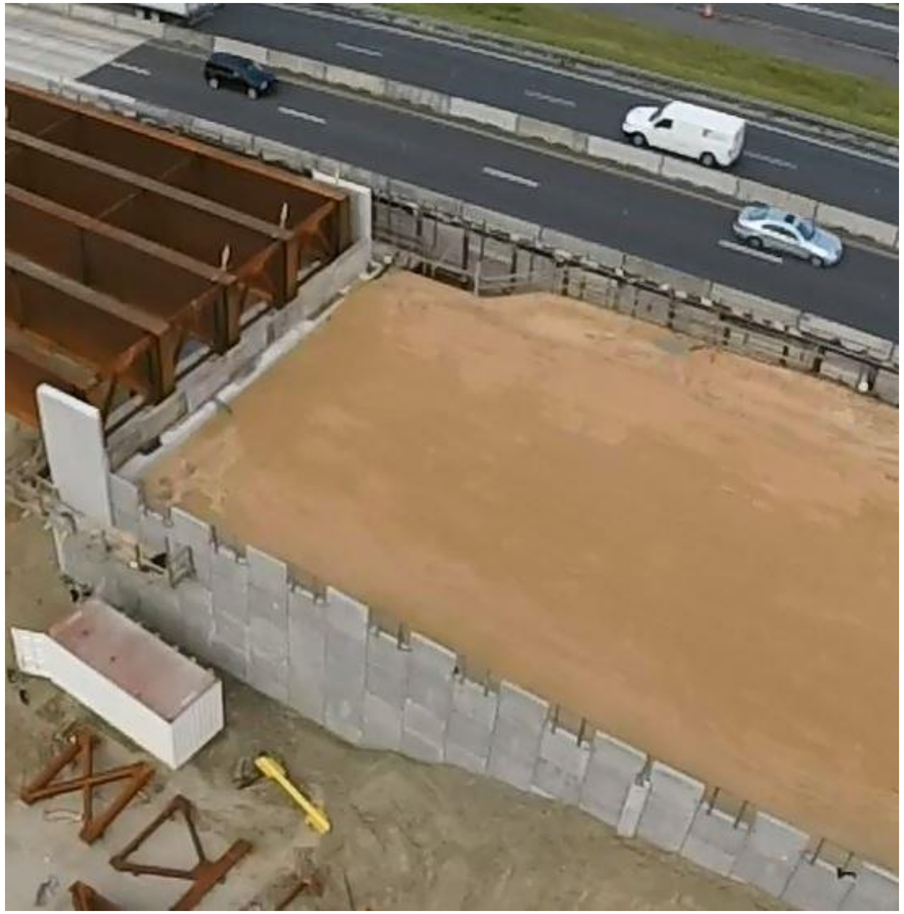
BRIDGE SUBSTRUCTURE AND RETAINING WALLS

South MSE Retaining Wall
(Backwall Not Poured)



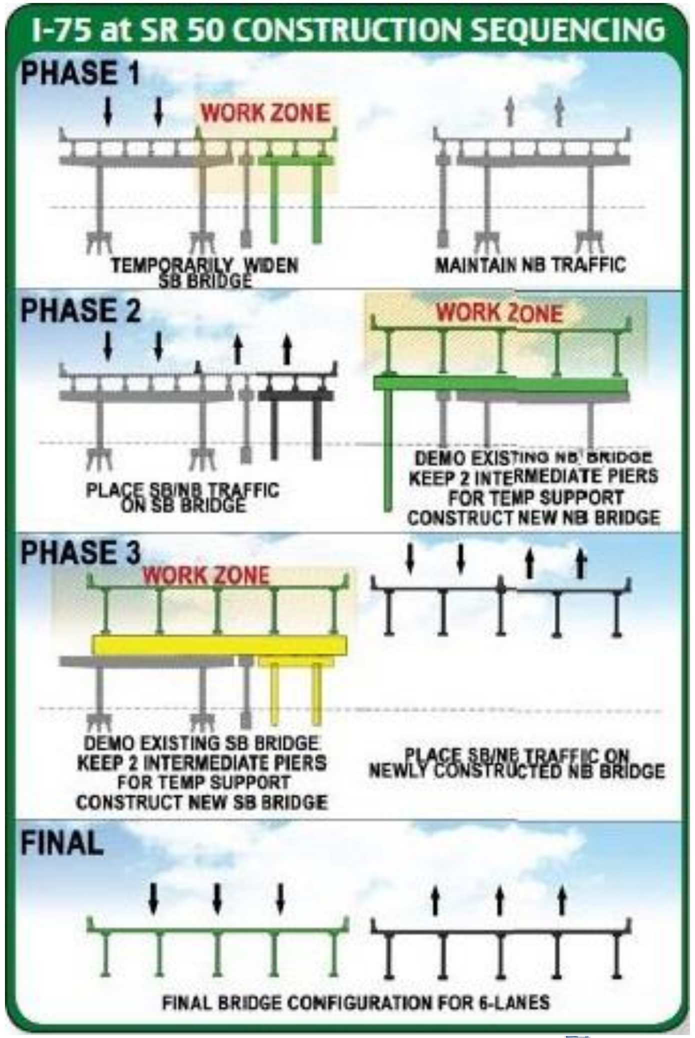
North MSE Retaining Wall
(Backwall Not Poured)

CONSTRUCTABILITY – HOW DO WE BUILD IT?

- Bridge Construction
  - Drainage Requirements
  - Steel Girder Erection Strategies
  - Temporary Critical Walls
  - Camber and Deflection Implications
- Maintenance of Traffic
  - I-75 MOT
    - 60-mph Speed
    - Ramp Access and Minimize TCWs
  - SR 50 MOT
    - Bicycle and Pedestrian Crossings

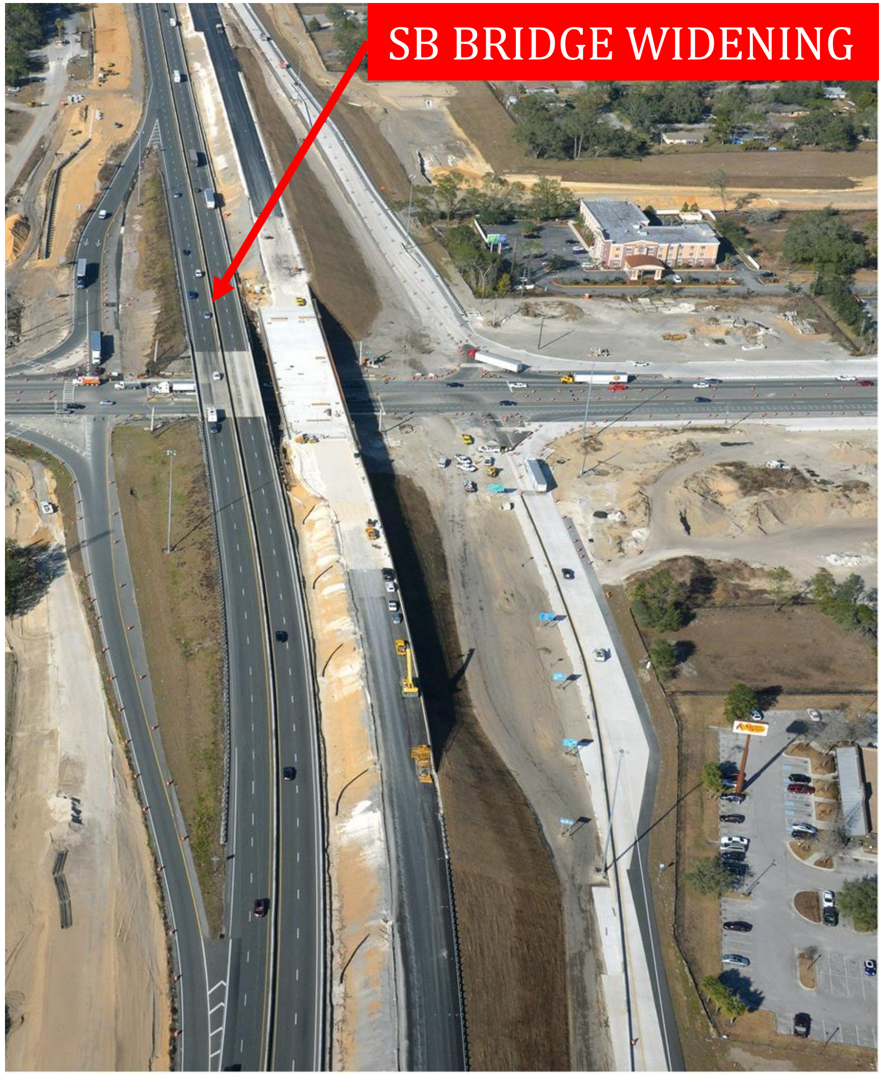
CONSTRUCTABILITY – CONSTRUCTION SEQUENCE

- NB Bridge Construction
  - Widen Existing SB Bridge to carry traffic each way
  - Demolish Existing NB Bridge
  - Build New NB Bridge
  - Shift Traffic to New NB Bridge
- SB Bridge Construction
  - Demolish Existing SB Bridge
  - Build New SB Bridge
  - Shift SB Traffic to New SB Bridge



CONSTRUCTABILITY – TEMPORARY SB BRIDGE WIDENING

- Carry Two Lanes Each Direction
- 18'-4½" Widening (61'-1" Bridge Width)
  - Driven by Drainage Requirements (Spread)
  - 12' and 11' Lanes
  - 3' (Min.) and 2' Shoulders on Low and High Side
- Superstructure
  - AASHTO Type-II Beams (Index 20120)
  - 8" Concrete Deck with Scuppers
- Substructure and Foundation
  - End Bent Widening and New Bent Piles
  - 24" Sq. Prestressed Concrete Piles
- Walls
  - Soldier Pile and Lagging Temporary Critical Walls



CONSTRUCTABILITY – TEMPORARY SB BRIDGE WIDENING

Temporary Beam Bracing and Deck Forming

Widened Segment Of I-75 SB Bridge (View From SR 50)

CONSTRUCTABILITY – TEMPORARY SB BRIDGE WIDENING

Temporary Shared Path and Slope Protection

Temporary Bridge Drainage System

CONSTRUCTABILITY – TEMPORARY SB BRIDGE WIDENING

Phase 1 – Temporary Critical Walls

- Soldier Pile and Lagging Walls
  - Allowable Deflection = 3”
- Prestressed Soil Anchors
  - Maximum Spacing = 8’-0”
  - Factored Load = 12.40 Kip/Ft
  - Min. Comp. Strength = 4,000 psi
- Soldier Pile
  - Maximum Spacing = 8’-0”
  - Yield Strength = 50,000 psi
  - Pile Lengths = 31’ (Max.)

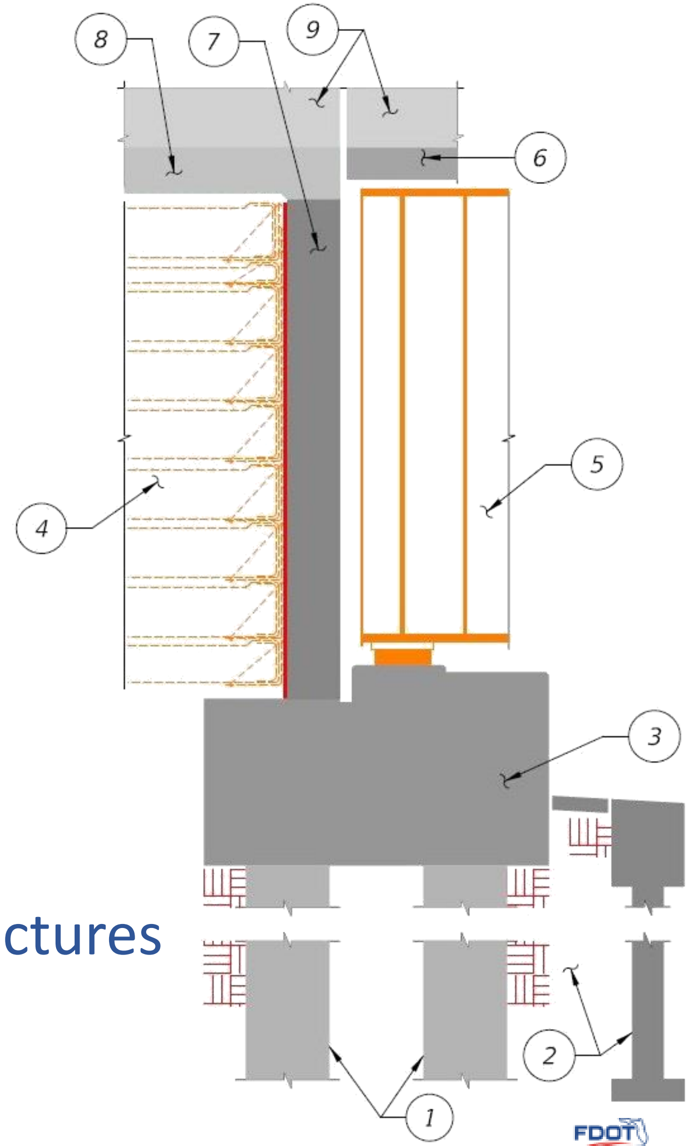
Soldier Pile and Lagging Wall With Prestressed Soil Anchors

CONSTRUCTABILITY – TEMPORARY SB BRIDGE WIDENING

Soldier Pile and Lagging Wall with Prestressed Soil Anchors

CONSTRUCTABILITY – BRIDGE CONSTRUCTION SEQUENCE

- New Bridge Construction Sequence:
  - Construct End Bent Foundations
  - Build Embankment and Permanent Walls to Bottom of End Bent Cap Elevation
  - Construct End Bent Cap and Pedestals
  - Install Permanent Type 3 (Wire Face) Wall
  - Place Steel Girders
  - Construct Bridge Deck
  - Construct End Bent Backwall
  - Construct Approach Slab
  - Construct Traffic Railings and Other Bridge Mounted Structures



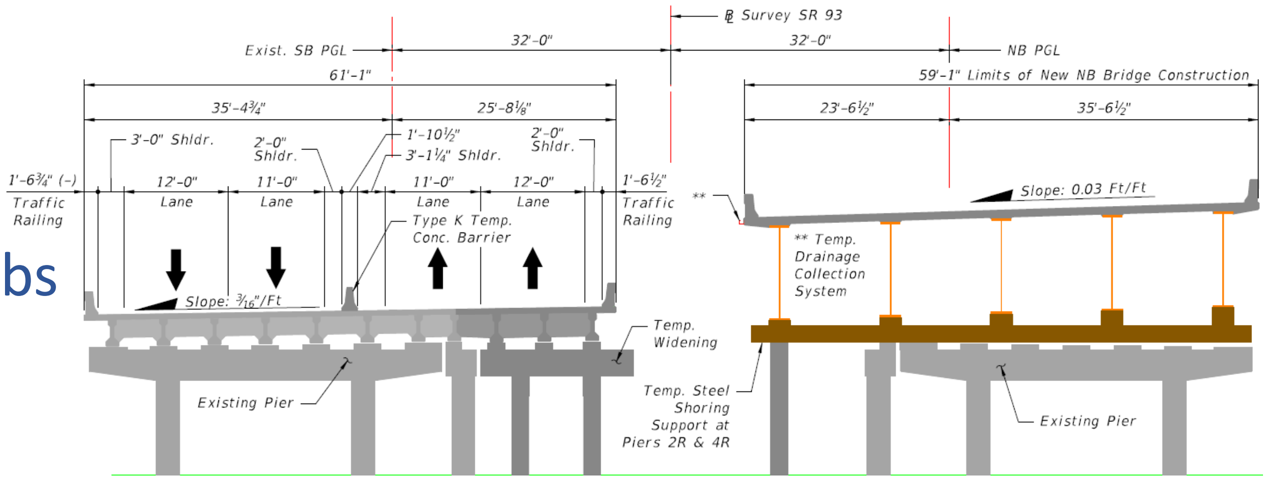
CONSTRUCTABILITY – BRIDGE CONSTRUCTION

Foundations and Wall Construction

Substructure and Walls Construction

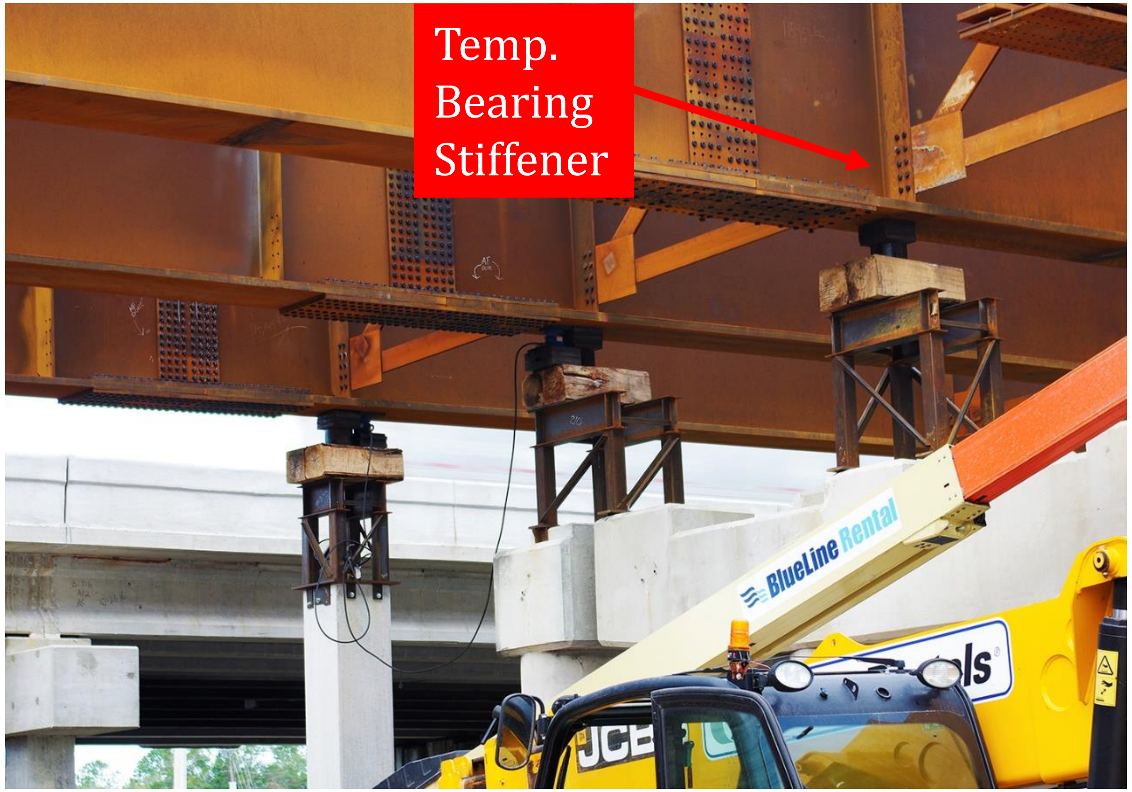
CONSTRUCTABILITY – BRIDGE ERECTION

- Three Girder Segments
  - 75’-0”, 118’-6”, 104’-0” < 130’ Max. (SDG 5.1.2)
  - Max. Weight= 130,000 lbs < 160,000 lbs
  - Strategically Located Field Splices
    - Clear Existing Piers
    - Inter. Stiffener as Bearing Stiffener
- NB Bridge
  - Existing Pier as Temporary Shoring
- SB Bridge
  - Steel Shoring Towers



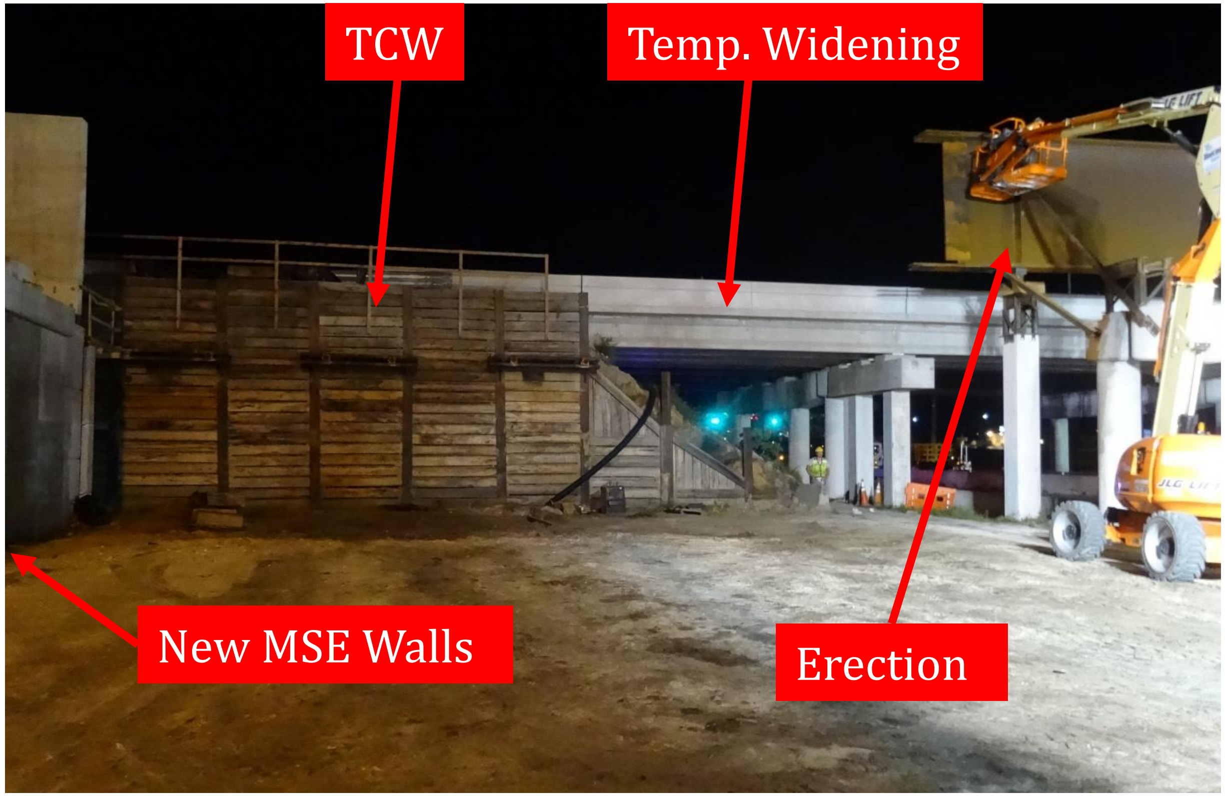
Bridge Widening and Temporary Shoring Support

CONSTRUCTABILITY – BRIDGE ERECTION



Temporary Shoring Support For NB Bridge Steel Girder Erection

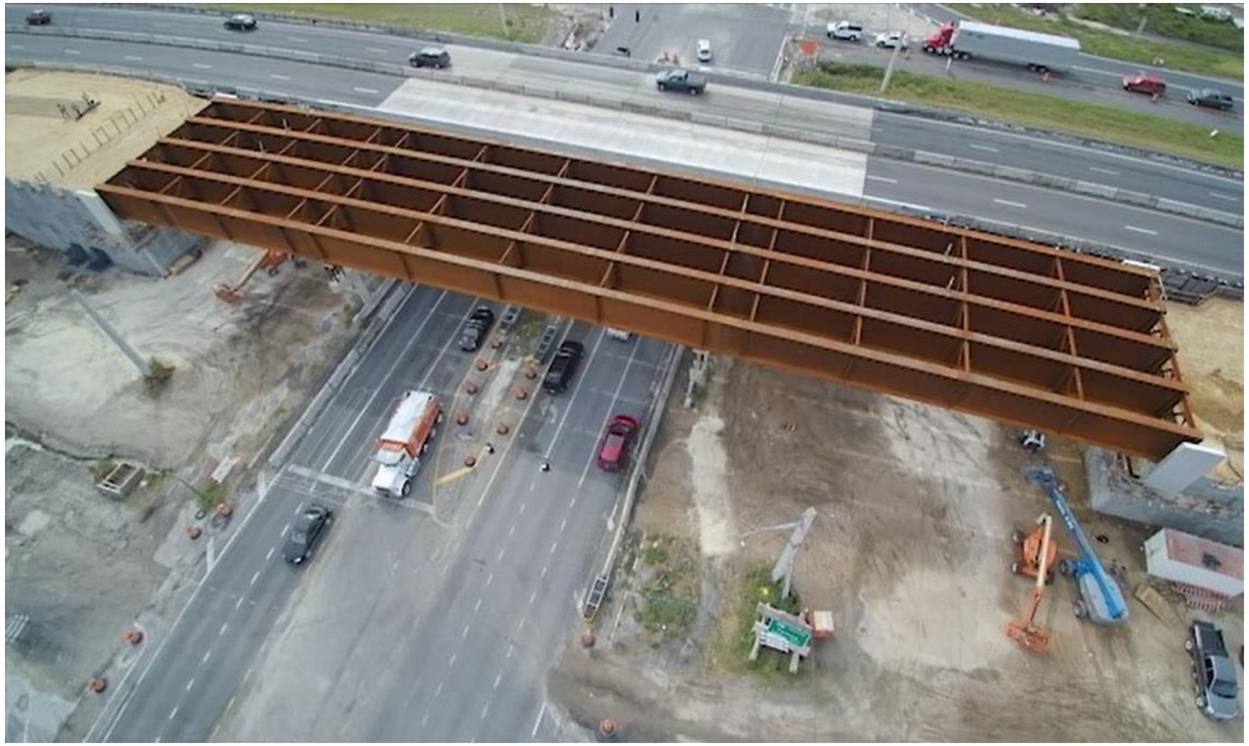
CONSTRUCTABILITY – BRIDGE ERECTION



Holistic Bridge Construction Approach

CONSTRUCTABILITY – BRIDGE ERECTION

NB Bridge Steel Girder Segments 2 and 3 Erection



NB Bridge Steel Girders Fully Assembled

CONSTRUCTABILITY – BRIDGE CONSTRUCTION

Preparing For Deck Pour and Setting Up Terex® Bid-wells

CONSTRUCTABILITY – BRIDGE CONSTRUCTION

NB Bridge Deck Pour In One Single Night Operation With Two Terex® Bid-wells

CONSTRUCTABILITY – BRIDGE CONSTRUCTION

Preparing For Traffic Shift Onto New NB Bridge

Railing Slots For Temporary NB Bridge Drainage System

CONSTRUCTABILITY – BRIDGE CONSTRUCTION

- Shear Deformation On Bearing Pads
  - Dead, Live and Temperature Loads
  - Limit to 50% of Elastomer Thickness (Spec 400-11.3)
  - Minimize Fatigue of Internal Layers
- Allowed Shear Deformation = 1.75”
- Jacking and Bearing Re-set Required
  - Need Plan Notes!!

Bearing Pad Shear Deformation
After Deck Pour and Prior to Re-setting

Shear Deformation	Design	Measured
Dead Load	1.58”	**1.21”**
Expected Temperature Deformation	0.60”	0.60”
Expected LL Deformation	0.31”	0.31”
Total	2.49”	2.02”

CONSTRUCTABILITY – BRIDGE CONSTRUCTION

- Phase 2 – Temporary Critical Walls
  - Ensured New Bridge Embankment Stability
  - Ensured Safety of Traveling Public
  - Temporary FDOT Wall Type 3 (Wire Wall)
    - Short-term Settlement = ¾”
    - Long-term Settlement= 1”

Phase 2 Temporary Critical Walls

CONSTRUCTABILITY – BRIDGE CONSTRUCTION

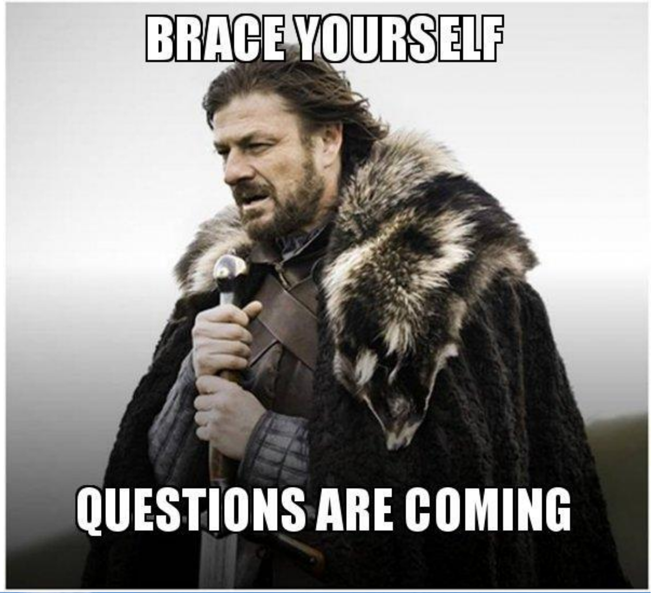
Phase 2 Temporary Critical Walls /
SB Bridge Widening Demolition

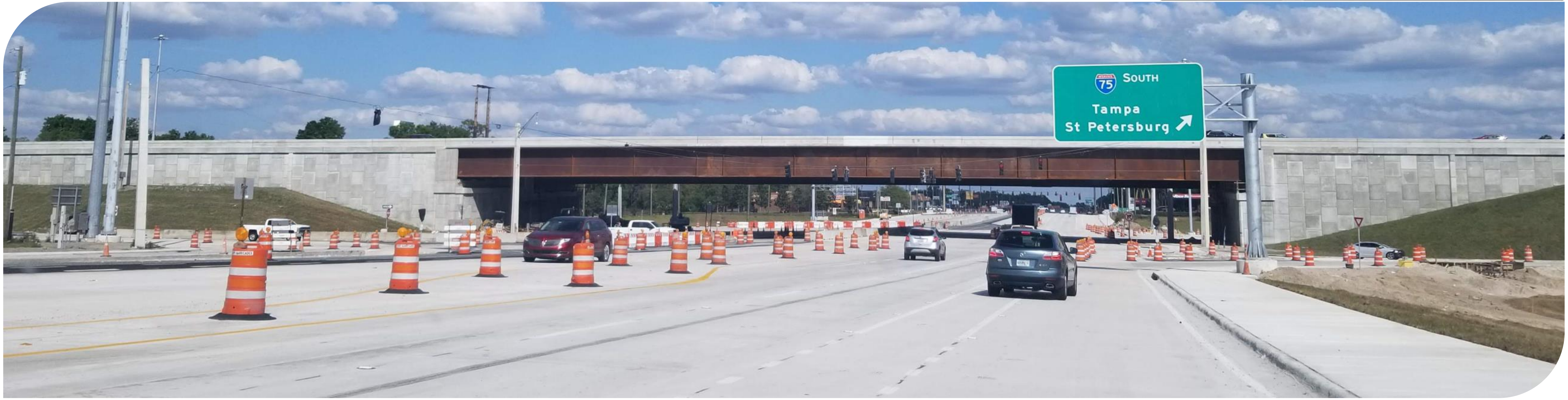
Phase 2 Temporary Critical Walls

CLOSING

- Challenging and Innovative Project
  - Effects of New Interchange Configuration and Bridge Geometry
  - Implementing RFP, FDOT Design Guidelines and Details
    - Design-Build Environment
  - Good Collaboration between Design Team and FDOT
- Conventional <u>PLUS</u> -Longest Simple Span Steel Plate Girder Bridges in FL

QUESTIONS???


BRACE YOURSELF
QUESTIONS ARE COMING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