NORTH CAROLINA
Department of Transportation

Research & Innovation Summit - 2020

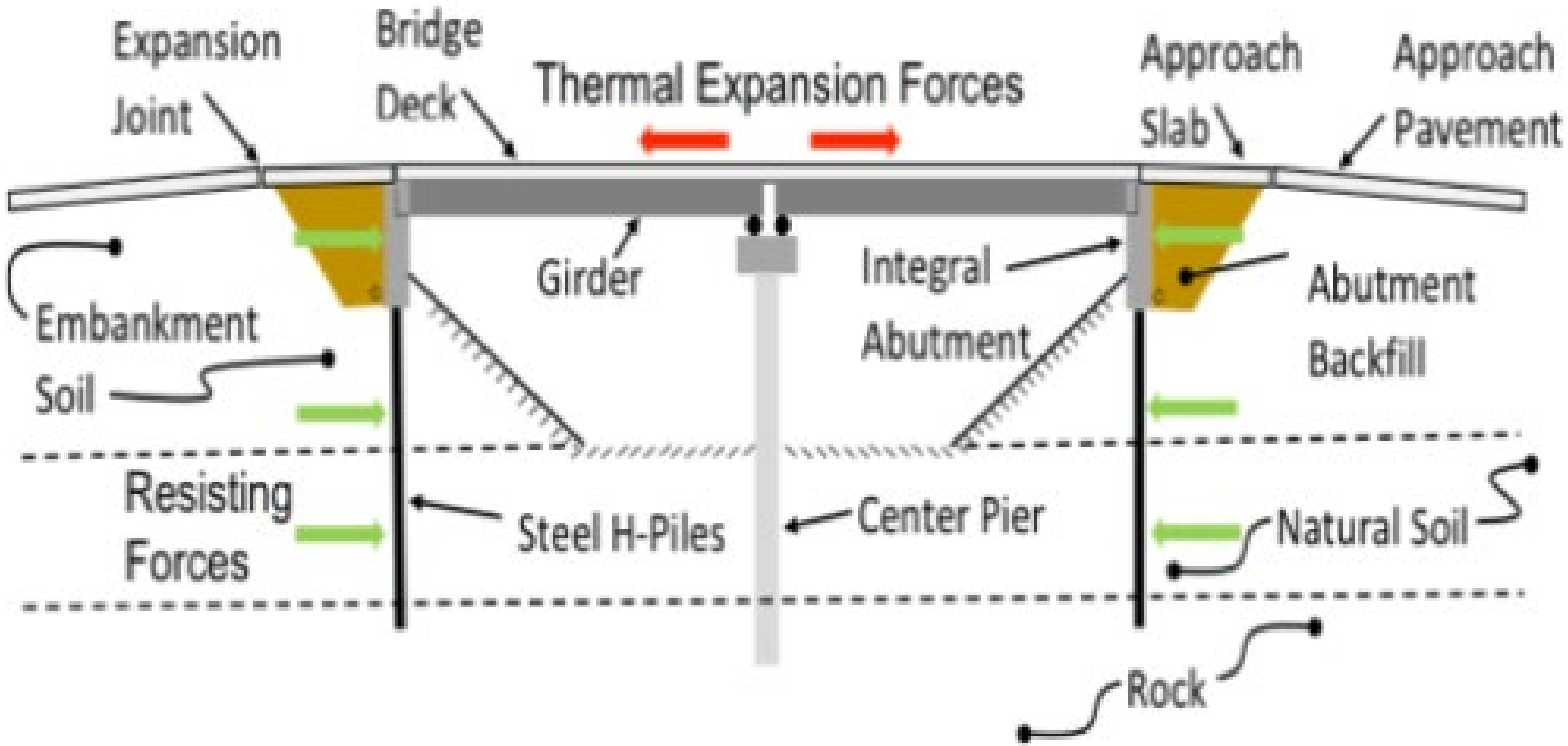
Performance Evaluation of Integral Abutment Bridges

Rajprabhu Thangappa

10/13/2020

Constructed Facilities Laboratory
NC STATE UNIVERSITY

What are Integral abutment bridges



Advantages of IA bridges

- Lower construction and maintenance cost
- No expansion bearings-less maintenance
- Increased redundancy and better stability

Disadvantages/Research need

- Soil-structure interaction problems
- Non-uniform design guidelines
- Scope for improvements in geometric criteria limitations
- Impact of seasonal demands not documented

Research objectives and plan

- To revise the design guidelines and geometric criteria for Integral abutment bridges

Tasks involved

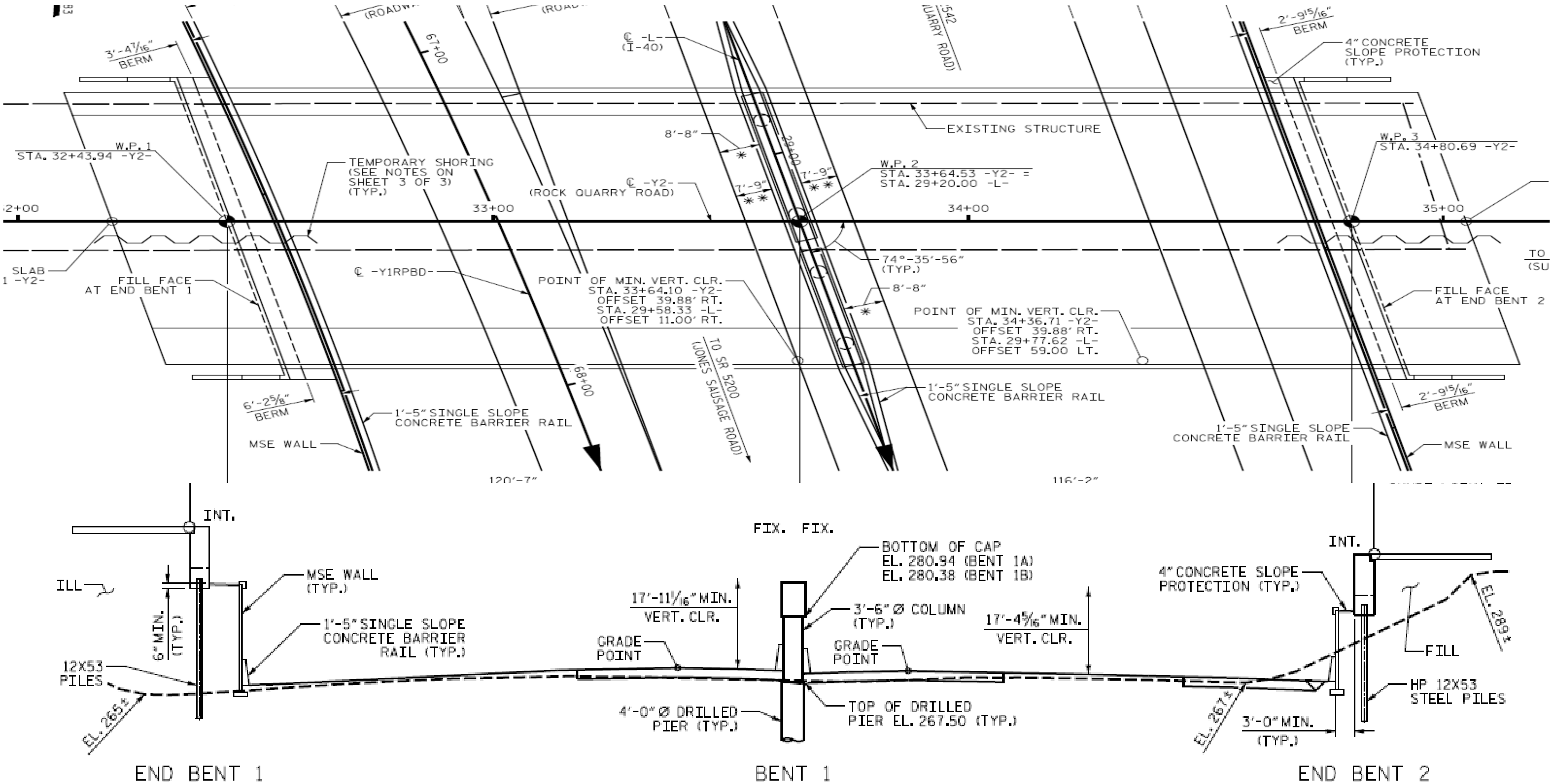
1. Visual inspection
2. Field monitoring
3. Analytical modelling
4. Parametric investigations

Field monitoring and inspection

- Bridges chosen for visual inspection based on severity of damages and extent of maintenance performed (Task 1).

- Long term field monitoring of bridges under construction through a robust instrumentation plan(Task 2).

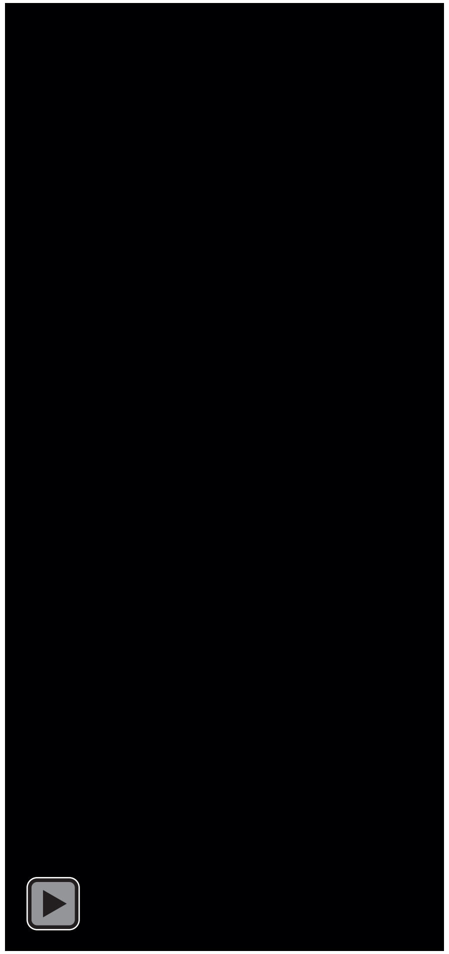
Bridge plan and elevation-Site 4 for I-440 design build project



Instrumentation plan-site 4 (Highlights)

	Required No.
Pile strain gages	20
Pressure transducers	6
Crackmeters	6
Tiltmeters	8
Girder strain gages	18
Embedded gages	6

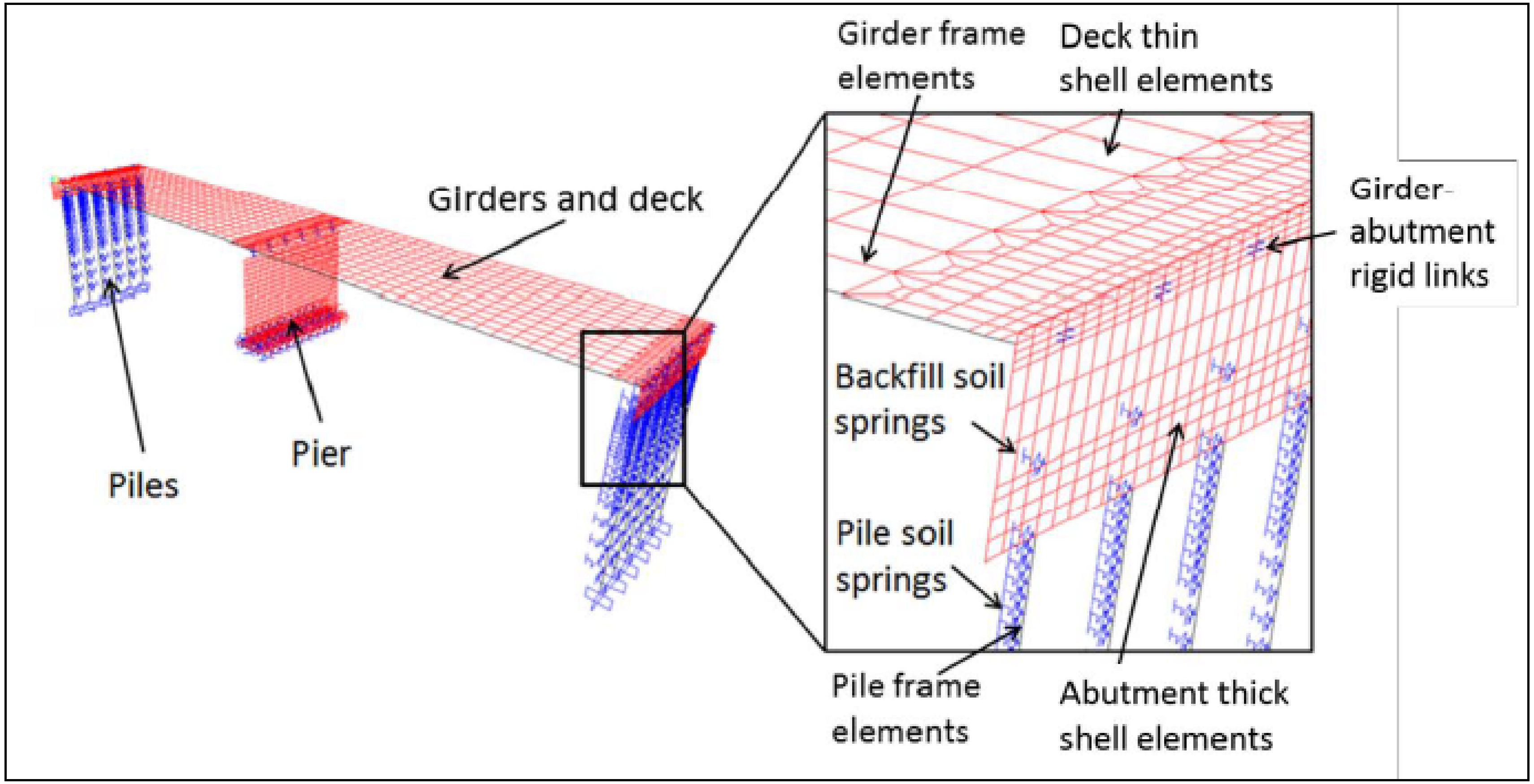
Strain gauge installation -Pile



This is a live clip compiled from different Videos to explain the installation of strain gages in the piles

Analytical modelling (Task 3)

- Typical FE model in SAP 2000 [LaFave et al. 2017]



Parametric study (Task 4)

- Analytical models to be calibrated using field data
- Parametric studies to be performed for different bridge length, skew, and abutment height

Design guidelines and geometric criteria-revised

- The interdisciplinary tasks are performed in order to revise the existing design guidelines and geometric criteria limitations for integral abutment bridges

Acknowledgement

- The research team from NCSU and ECU thank Trey Carroll and Aaron Earwood from NCDOT for providing us their support whenever needed.

- We would also like to thank Joey Knoll of S.T.Wooten in coordinating the instrumentation plan at Site-4.

Thank you!!

&&&

Questions??

NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY

EVALUATING EXISTING SOFTWARE FOR BRIDGE VIRTUAL DESIGN AND CONSTRUCTION

Mohammed Mawlana, Ph.D.

10-13-2020

AGGIES DO

Outline

- Introduction
- Bridge Information Modeling
- Objectives
- OpenBridge Modeler
- Modeling Workflow
- Conclusions

Introduction

- Traditionally, the exchange of information during the life cycle of a bridge is fragmented.
- Repeated manual data transition from the design phase to other phases of the bridge life cycle:
  - time-consuming
  - lead to data entry errors

Bridge Information Modeling

- 3D model that includes all the data related to all stages of a bridge life-cycle.
- Benefits:
  - Better design
  - Increased efficiency and productivity
- Shorter time needed to evaluate more alternatives, execute design changes, and produce construction documentation.

Objectives

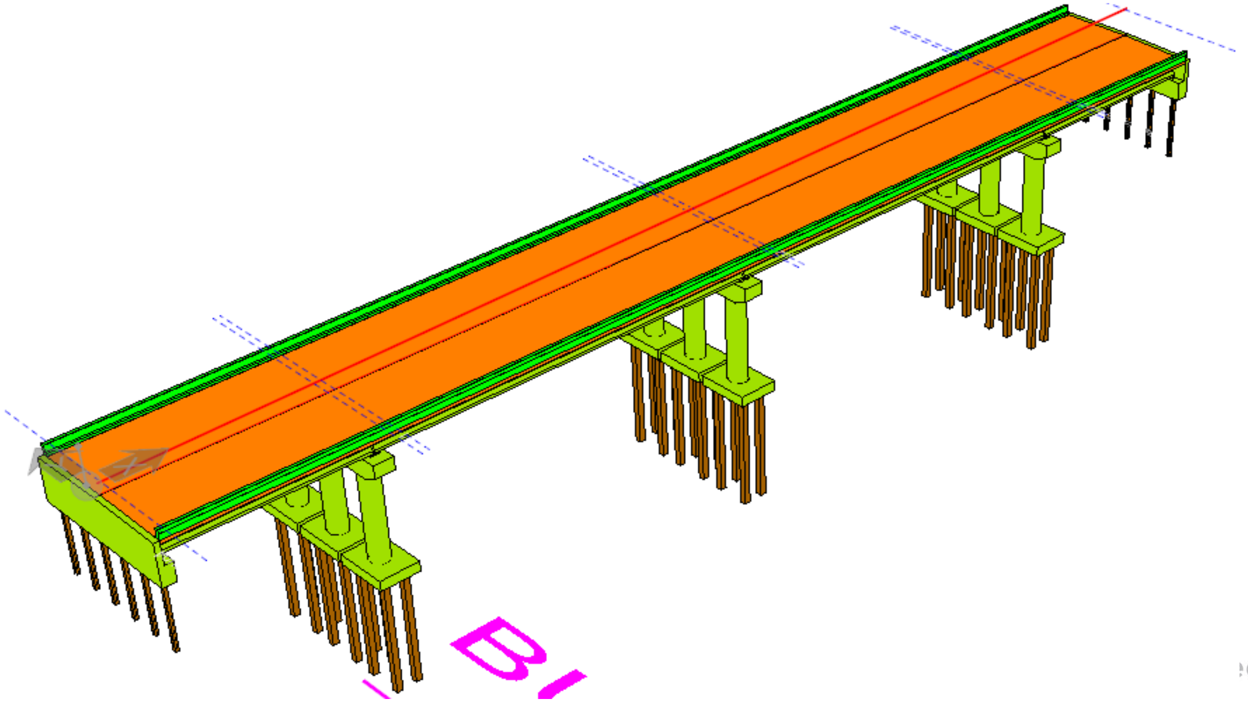
- Determine the feasibility of using existing software for bridge virtual design and construction.
- Study and analyze Bentley's software that is used for virtual design and construction of bridges.

Bentley Software for Bridge Design and Construction

- OpenBridge Modeler
- LEAP Bridge
- RM Bridge
- ProStructures
- LumenRT
- Synchro

OpenBridge Modeler

- 3D parametric bridge modeling software that is capable of creating intelligent objects.
  - compressive strength
  - structural steel grade
  - standard beam designations
  - etc.



Benefits

- Visualization
- Rendering
- Clash detection
- Reports
- Integration with civil data
- Interoperability

Visualization

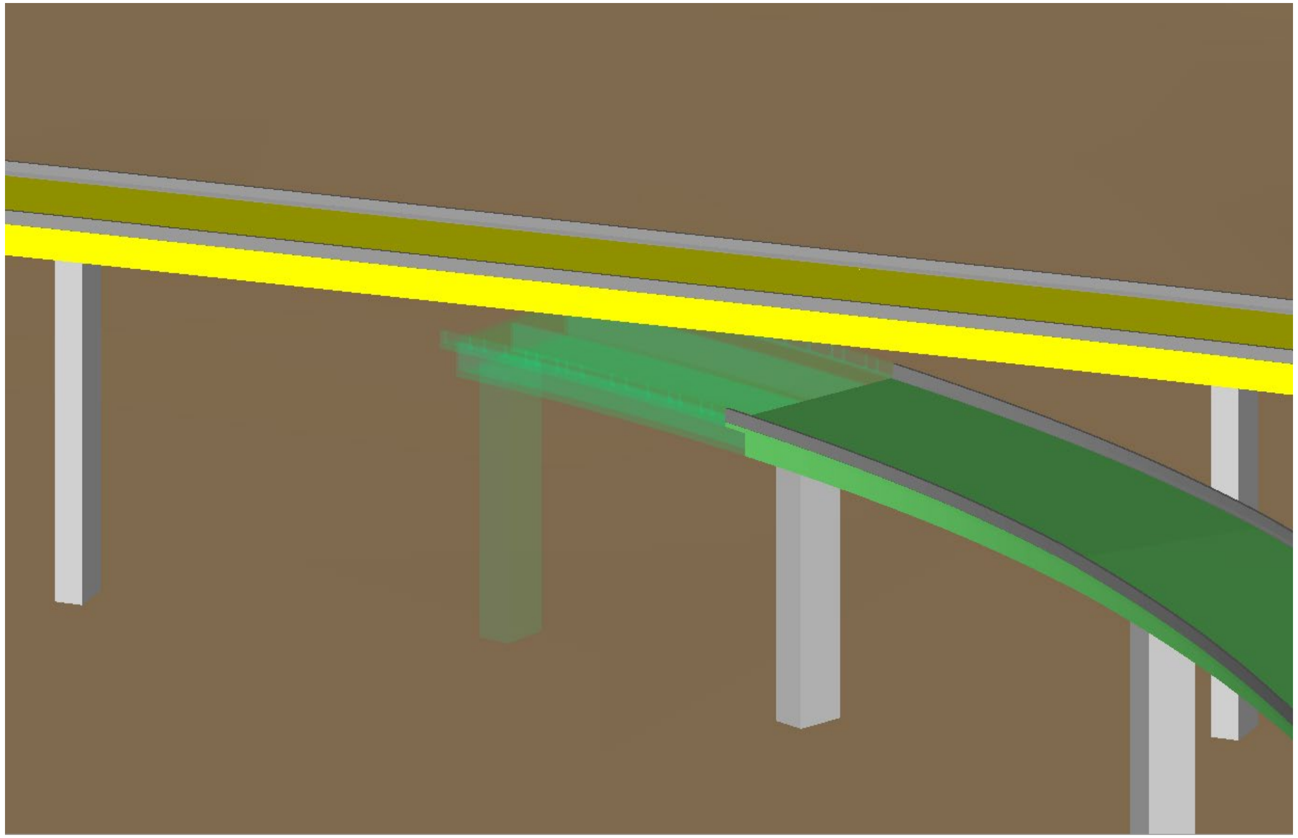
- 3D environment provides rapid verification of the bridge geometry before analysis and design starts.

Rendering

- Create an animated model of the structure complete with materials, vehicles, people and trees.

Clash Detection

- Detect clashes with other structures, objects, and underground utilities.
- Measure vertical and horizontal clearances



Reports

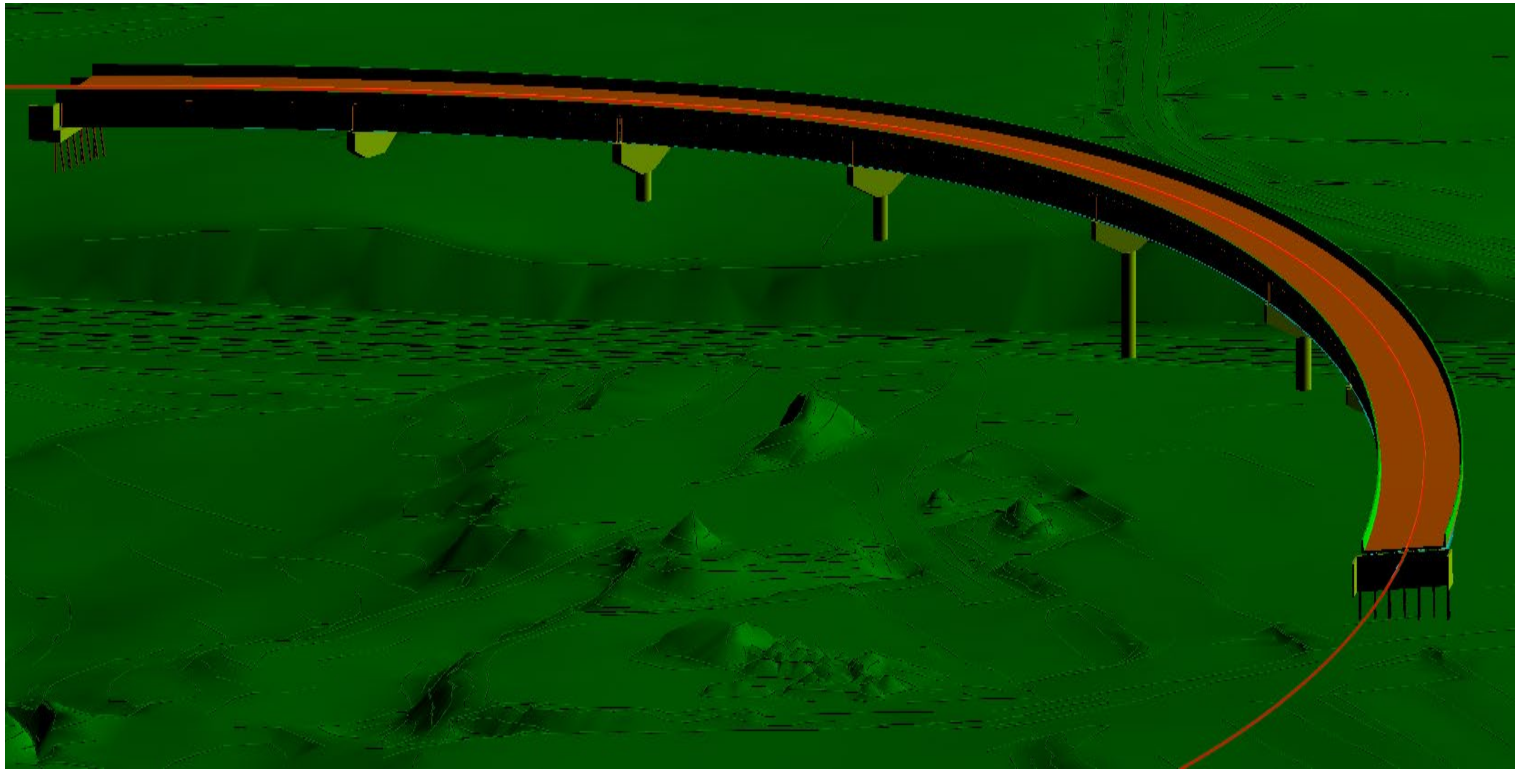
- Deck elevations
- Bearing seat elevations and heights
- Quantities and cost estimates
- Beam elevations, haunch thickness and elevations
- Automated drawings

Superstructure Quantities

Component Name	Component Type	Material Name	Material Type	Pay Unit	Unit Price	Quantity	Cost
Deck	Deck (Slab w/ constraints)	Deck Concrete	Concrete	Cubic Yard	850.00	294.647	250449.97
	Haunch	Deck Concrete	Concrete	Cubic Yard	850.00	30.771	26155.65
BeamSegment1	Beam (PCBT-61)	AASHTO-II, CL.A	Concrete	LF	165.00	1097.190	181036.31
						Total	457641.94

Integration with Civil Data

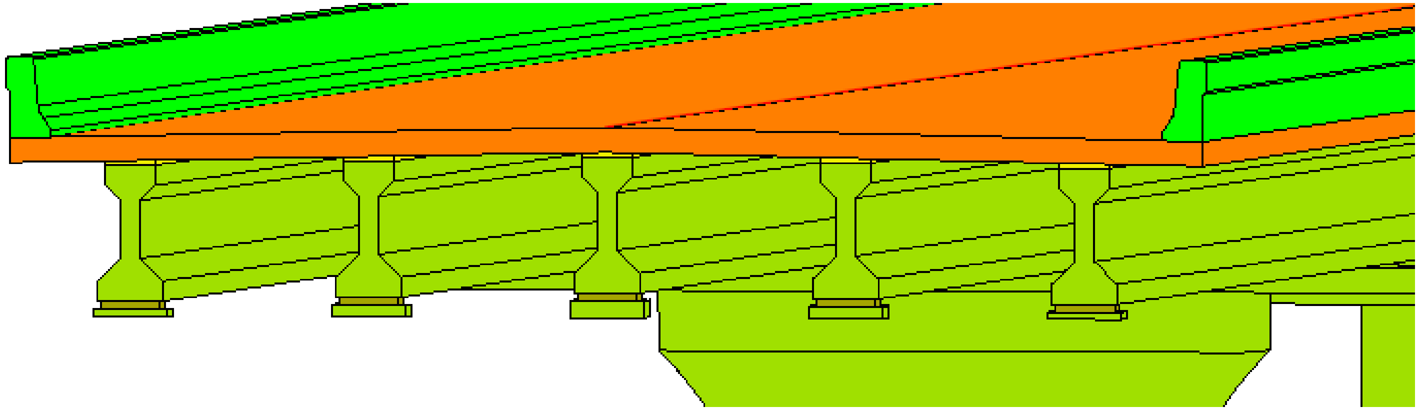
- Horizontal alignment, vertical profile, ground contours, and terrain model.
- DEM and point cloud.
- Google Earth



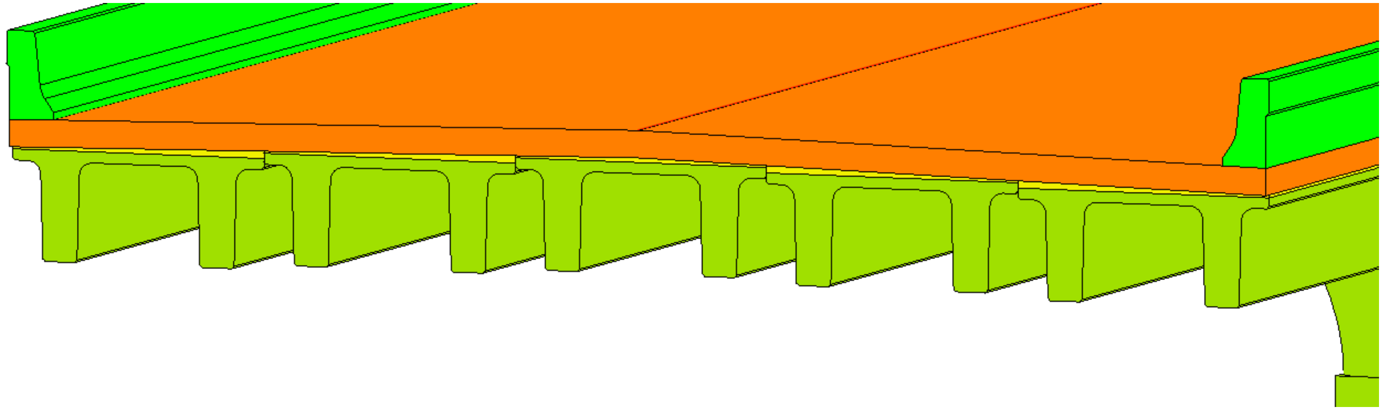
Interoperability

- Analytics:
  - » LEAP Bridge, RM Bridge
- Operations and Maintenance
  - » InspecTech
- Detailing and Documentation:
  - » ProStructures, MicroStation
- Rendering and Animation:
  - » LumenRT

Types of Bridges

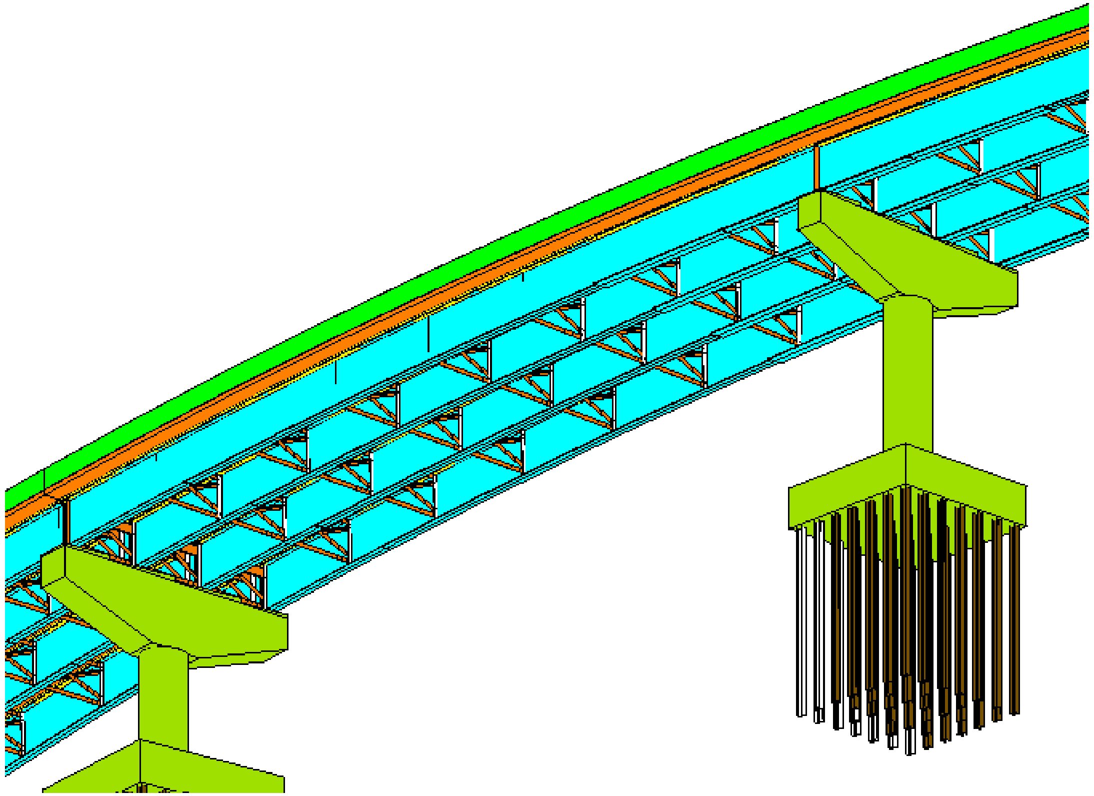


- Concrete Girder
  - Prestressed girder
  - Double Tee
  - Bulb Tee
  - RC concrete girder



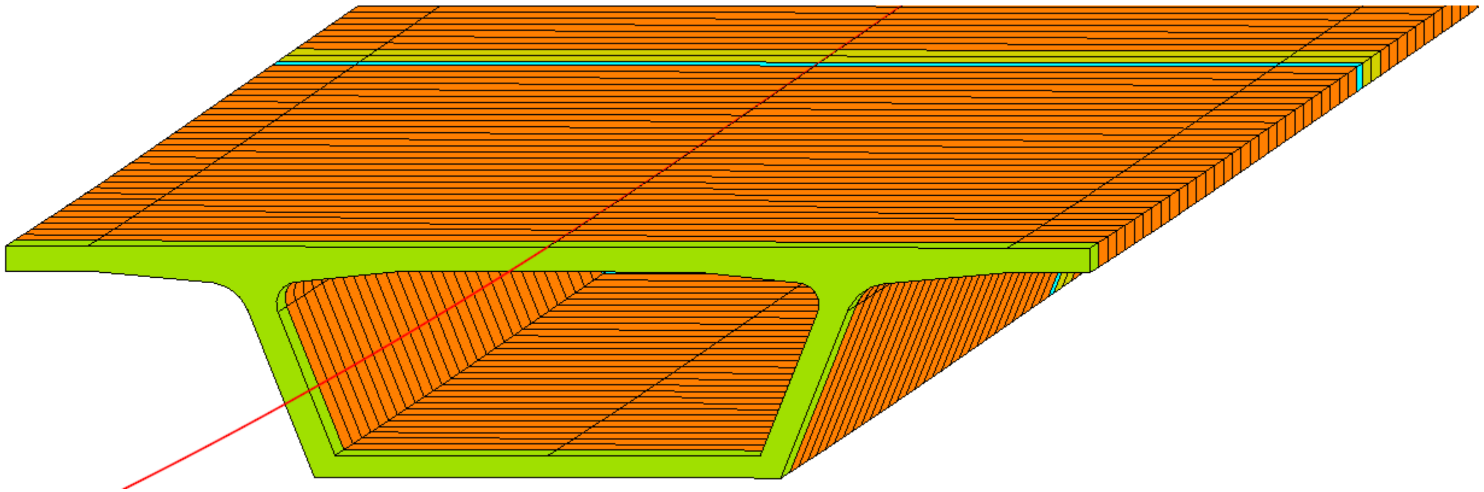
Types of Bridges

- Steel Girder
  - Rolled Shapes
  - Built-up



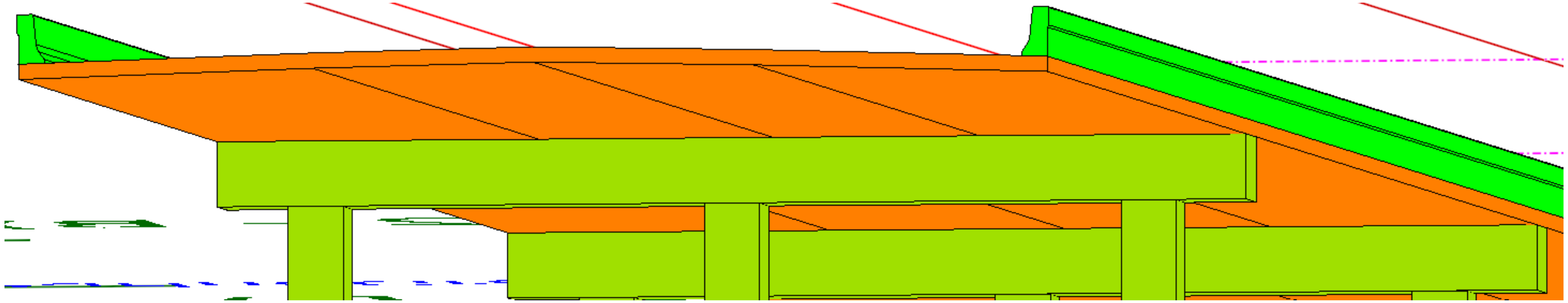
Types of Bridges

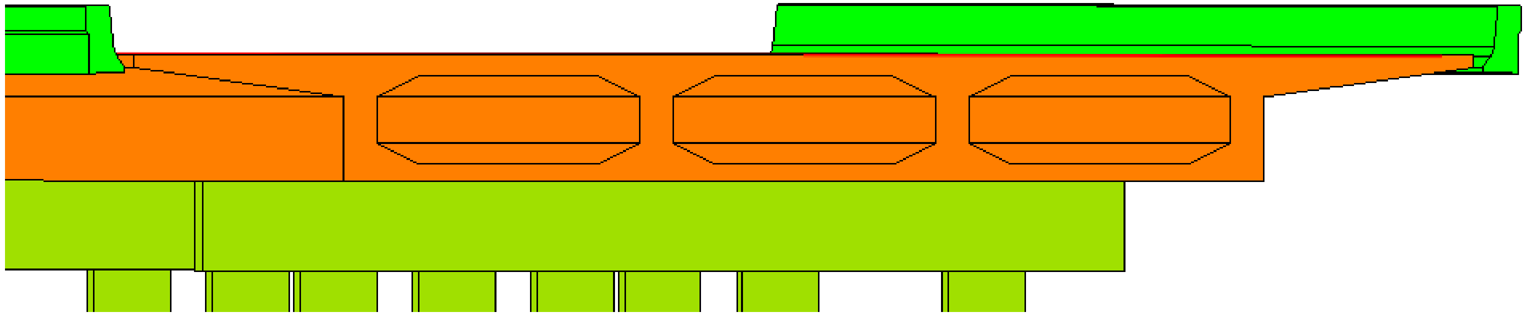
- Segmental box girder
  - Span-by-span
  - Cantilever



Types of Bridges

- Others:
  - Slab bridges
  - CIP concrete boxes



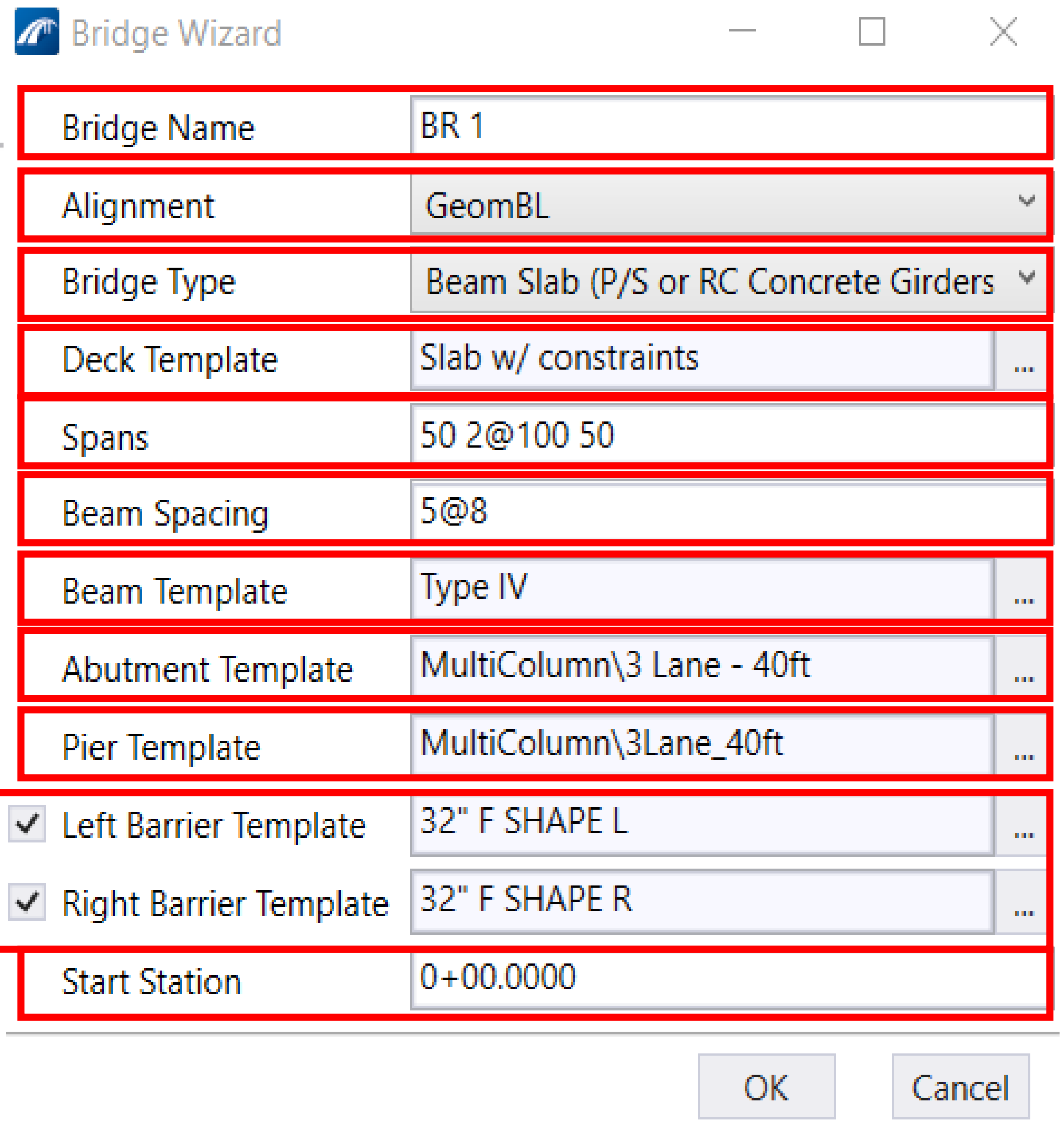


Modeling Workflow

- Two methods:
  - Bridge wizard
  - Top-down approach

Bridge Wizard

- Create a model quickly using saved templates.



Top-down Approach

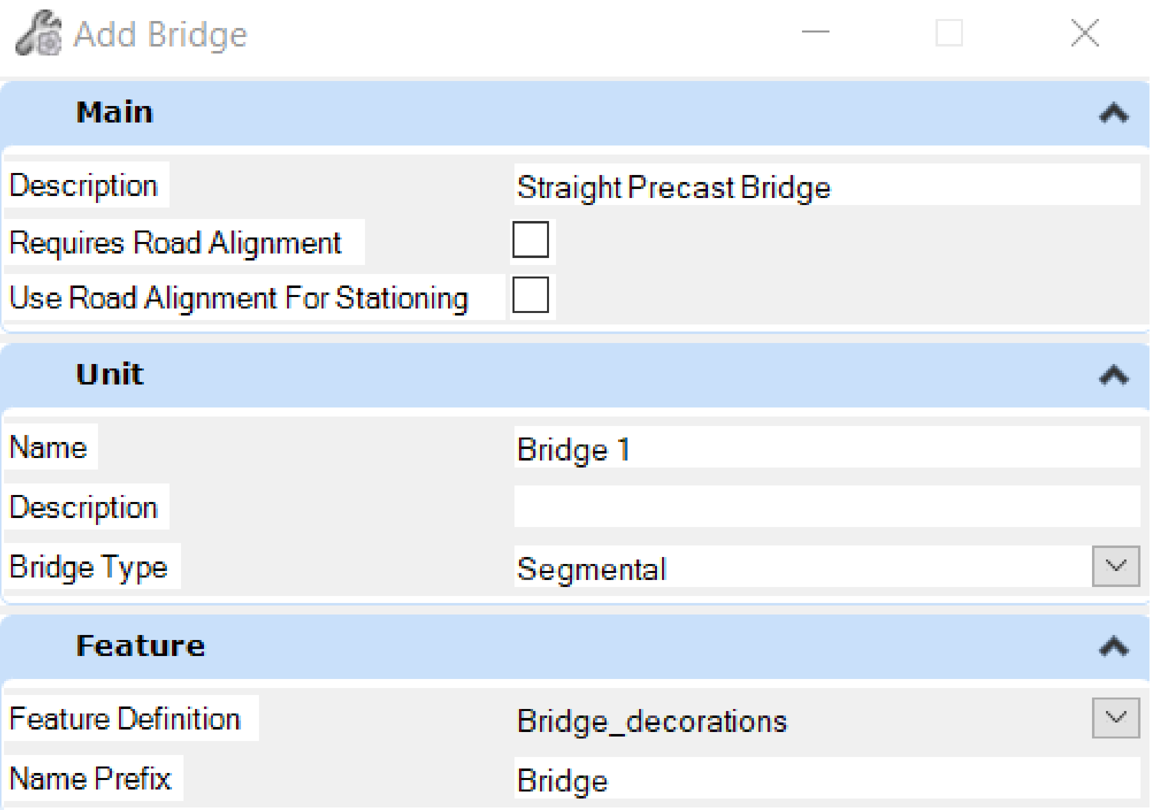
- Modeling starts from the deck and all the way down to the piers and abutments.
- In each step of this workflow, the bridge elements are customized.

Top-down Approach

- Import the geometry of the alignment.
  - OpenRoads
  - InRoads
  - GEOPAK
- Alignment can be also be created in OBM

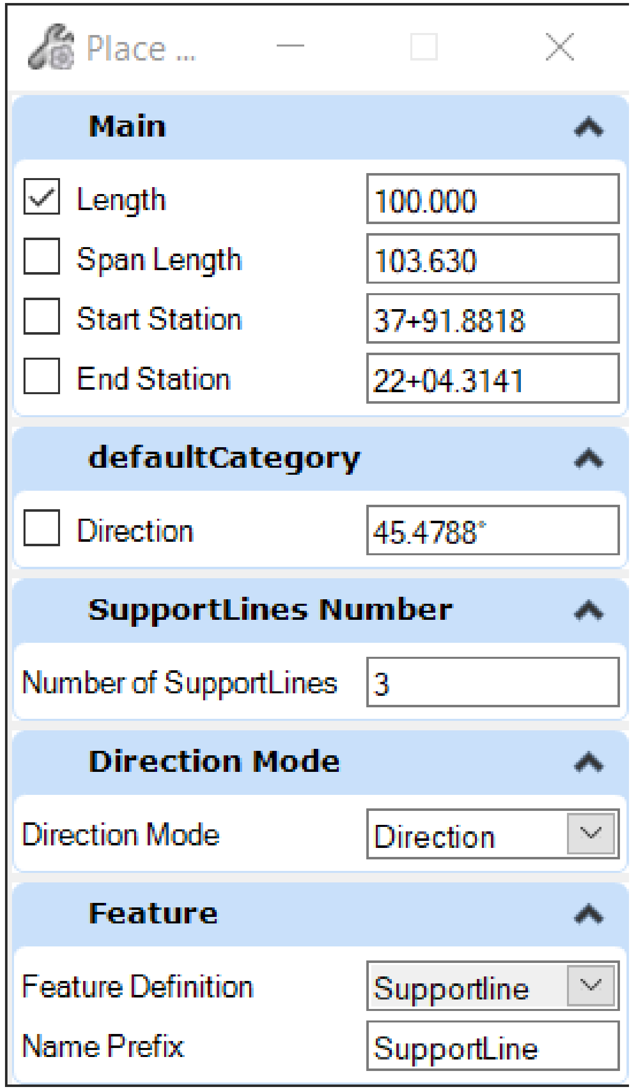
Top-down Approach

- Add a bridge to the alignment.
  - single bridge
  - multi-unit bridge



Top-down Approach

- Add support lines:
  - placed where the supports of the bridge are located
  - skew
  - length of the spans



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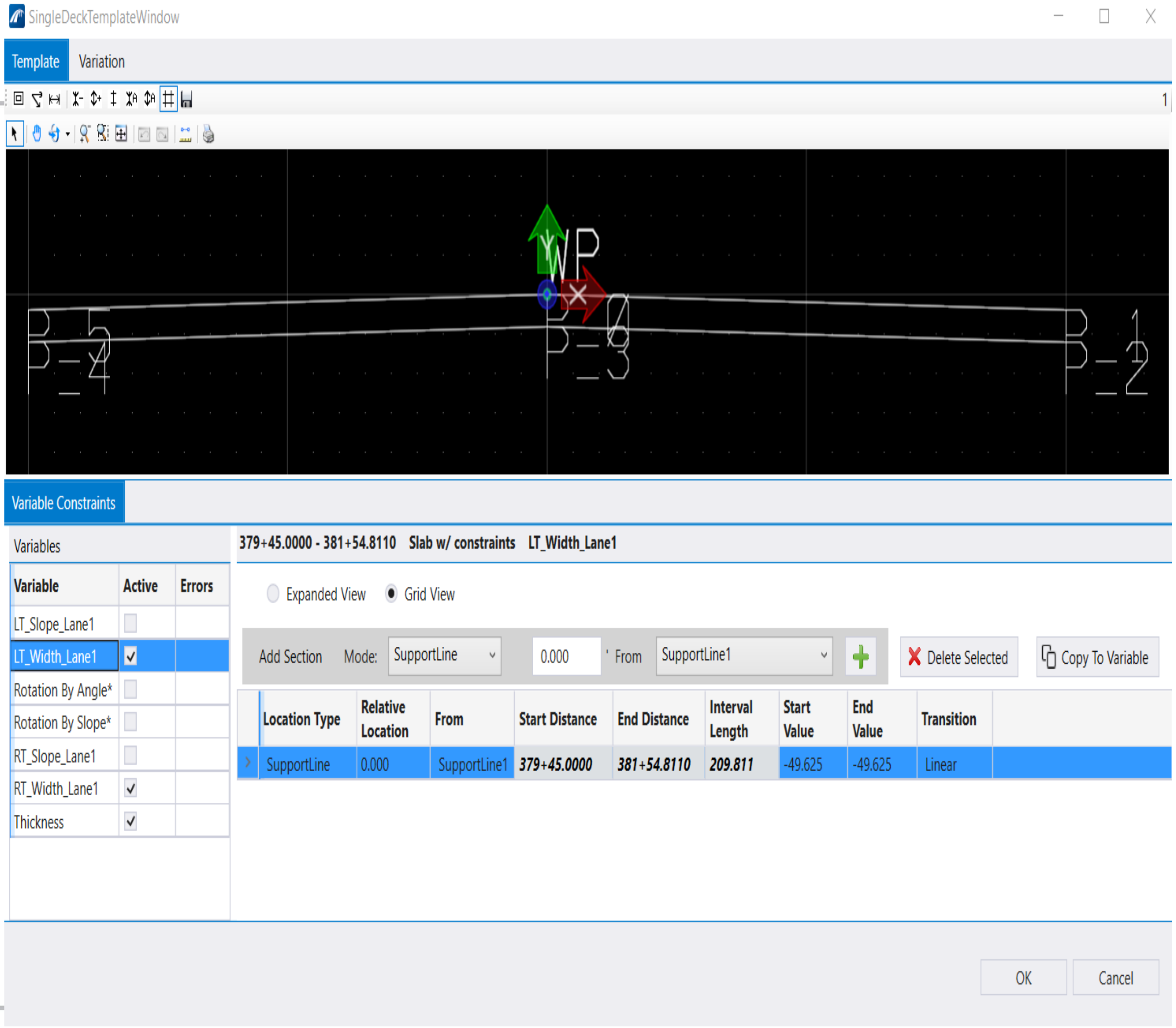
Top-down Approach

- Model the bridge deck:
  - width
  - thickness
  - slope



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Top-down Approach

- Define the beam layout:
  - » centerlines
  - » number of beams
  - » spacing between beams
  - » offsets

Aux Alignments | Add | Delete

Details

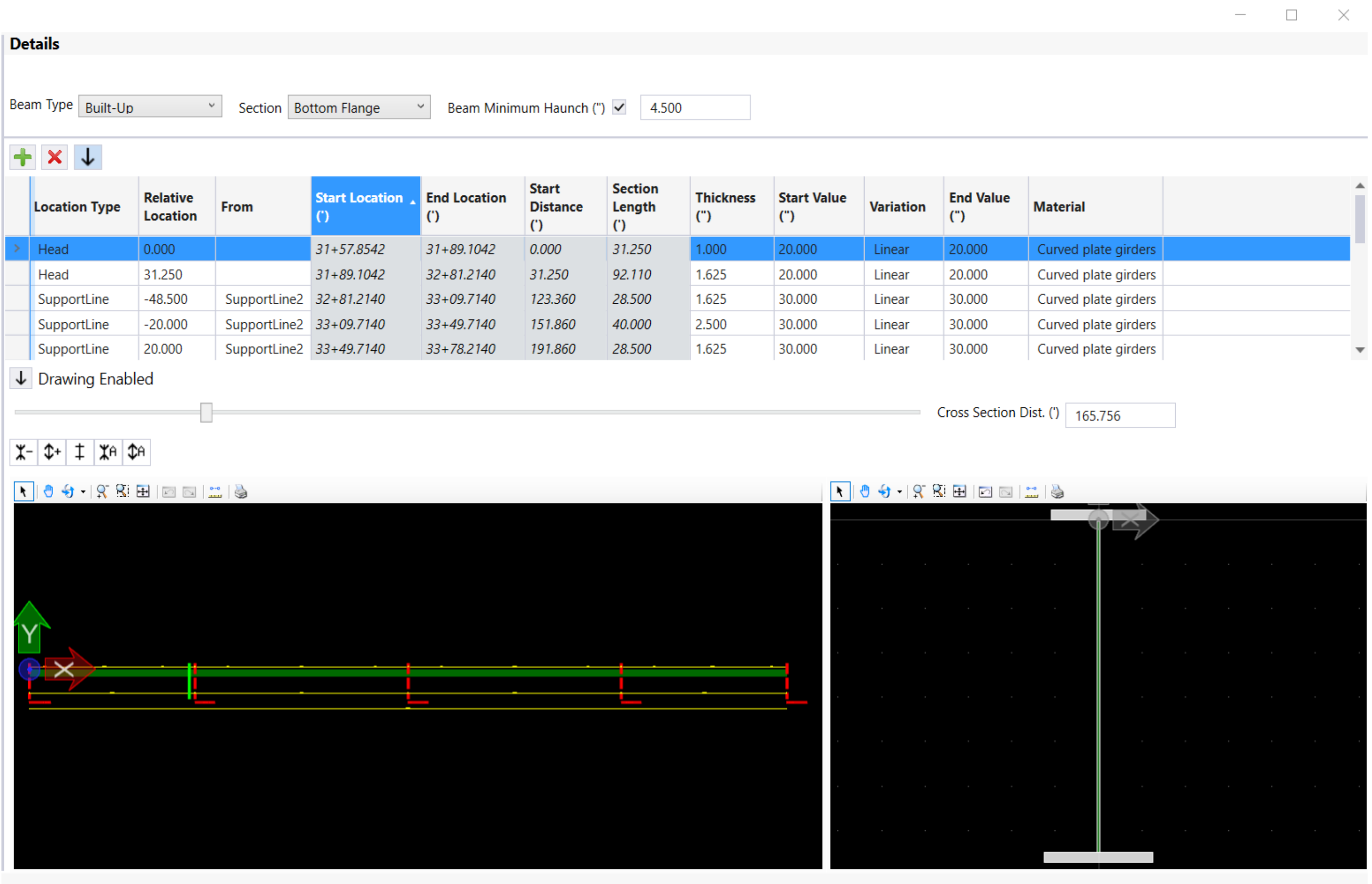
Number Of Beams 4 | Edge Distance (') 0.000

Apply | ☑ Equal Edge Distance | ☐ Advanced Bearing Definition

		BEAM START				BEAM END			
Beam #	Name	Spacing (')	Method	SL Offset (") 0.000	Skew Ends	Spacing (')	Method	SL Offset (") 0.000	Skew Ends
1	Beam-L	3.625	Normal	3.000	☐	3.625	Normal	-3.000	☐
2	Beam-2	12.000	Normal	3.000	☐	12.000	Normal	-3.000	☐
3	Beam-3	12.000	Normal	3.000	☐	12.000	Normal	-3.000	☐
4	Beam-R	-3.625	Normal	3.000	☐	-3.625	Normal	-3.000	☐

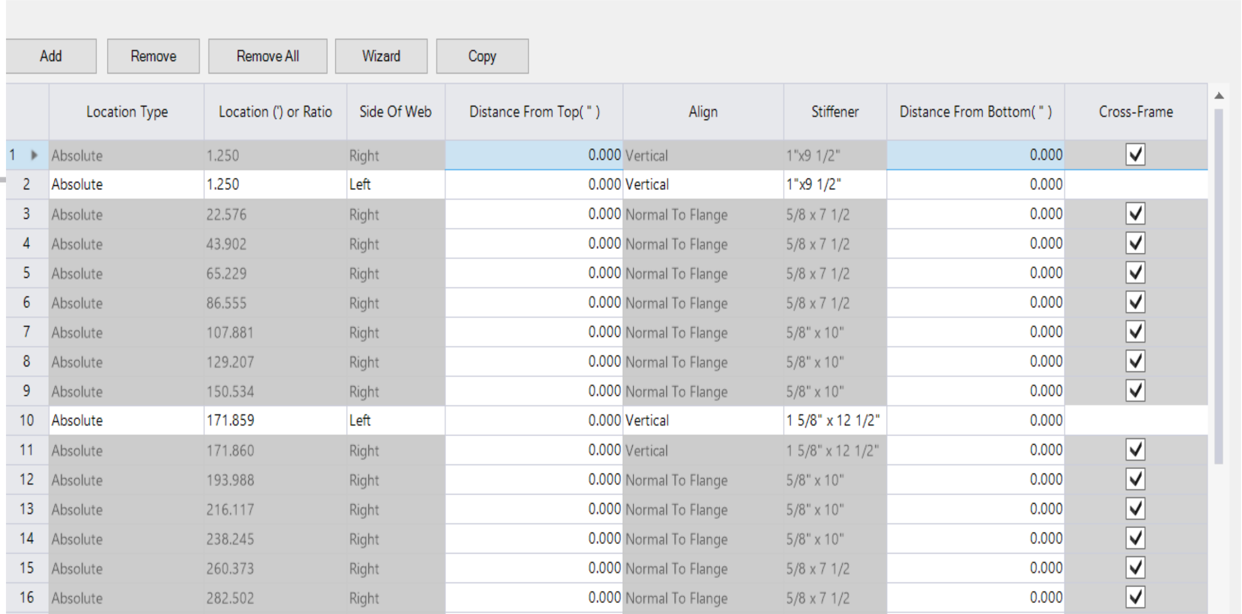
Top-down Approach

- Place the beams using the defined layout:
  - type of beam
  - dimensions

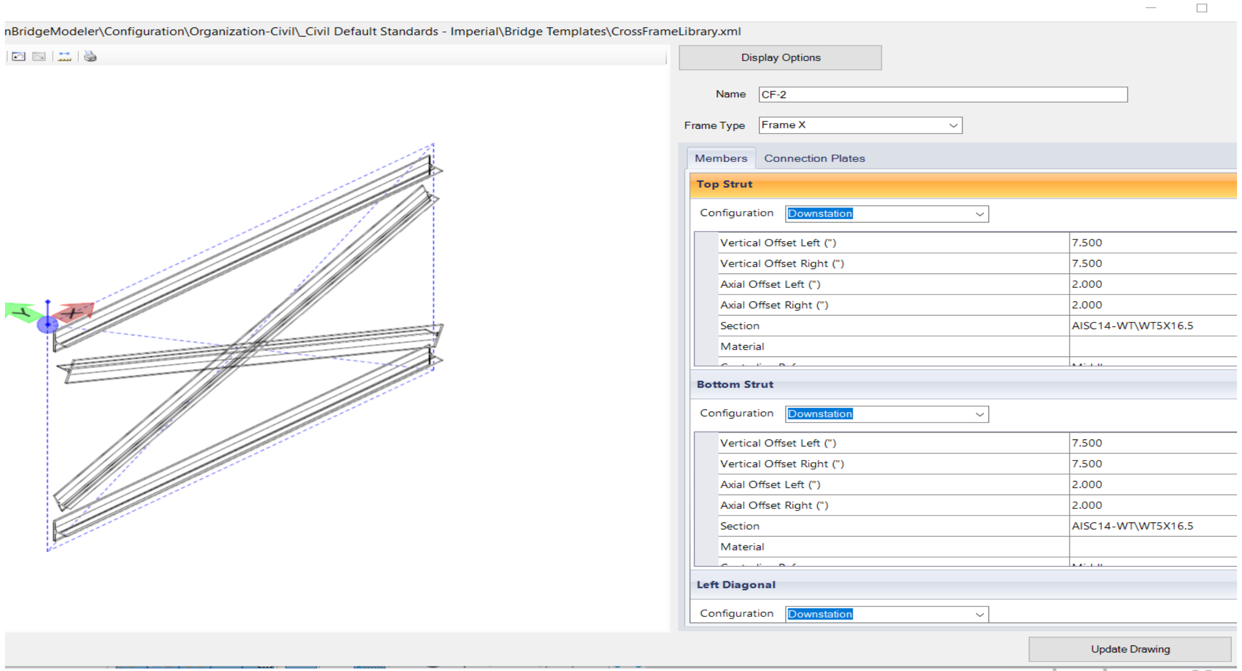


Top-down Approach

- Model stiffeners, cross frames, and diaphragms.



	Location Type	Location (') or Ratio	Side Of Web	Distance From Top(")	Align	Stiffener	Distance From Bottom(")	Cross-Frame
1	Absolute	1.250	Right	0.000	Vertical	1"x9 1/2"	0.000	✓
2	Absolute	1.250	Left	0.000	Vertical	1"x9 1/2"	0.000	
3	Absolute	22.576	Right	0.000	Normal To Flange	5/8 x 7 1/2	0.000	✓
4	Absolute	43.902	Right	0.000	Normal To Flange	5/8 x 7 1/2	0.000	✓
5	Absolute	65.229	Right	0.000	Normal To Flange	5/8 x 7 1/2	0.000	✓
6	Absolute	86.555	Right	0.000	Normal To Flange	5/8 x 7 1/2	0.000	✓
7	Absolute	107.881	Right	0.000	Normal To Flange	5/8" x 10"	0.000	✓
8	Absolute	129.207	Right	0.000	Normal To Flange	5/8" x 10"	0.000	✓
9	Absolute	150.534	Right	0.000	Normal To Flange	5/8" x 10"	0.000	✓
10	Absolute	171.859	Left	0.000	Vertical	1 5/8" x 12 1/2"	0.000	
11	Absolute	171.860	Right	0.000	Vertical	1 5/8" x 12 1/2"	0.000	✓
12	Absolute	193.988	Right	0.000	Normal To Flange	5/8" x 10"	0.000	✓
13	Absolute	216.117	Right	0.000	Normal To Flange	5/8" x 10"	0.000	✓
14	Absolute	238.245	Right	0.000	Normal To Flange	5/8" x 10"	0.000	✓
15	Absolute	260.373	Right	0.000	Normal To Flange	5/8 x 7 1/2	0.000	✓
16	Absolute	282.502	Right	0.000	Normal To Flange	5/8 x 7 1/2	0.000	✓



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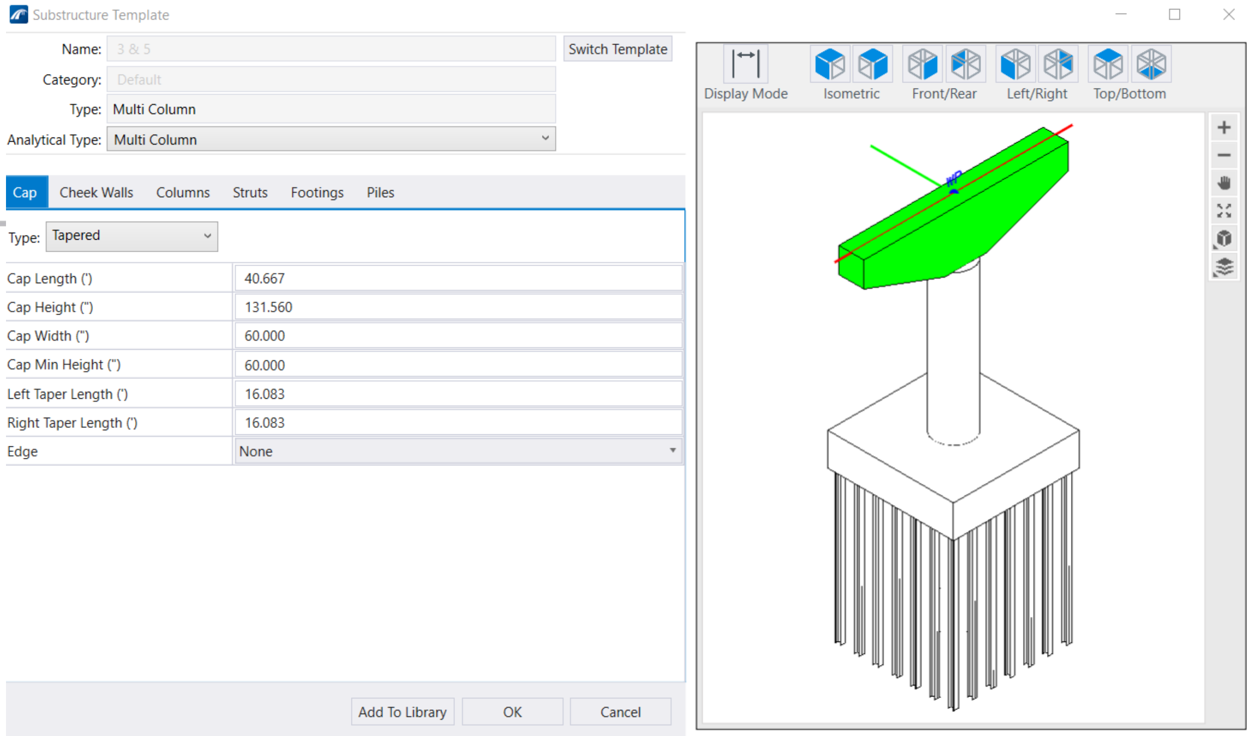
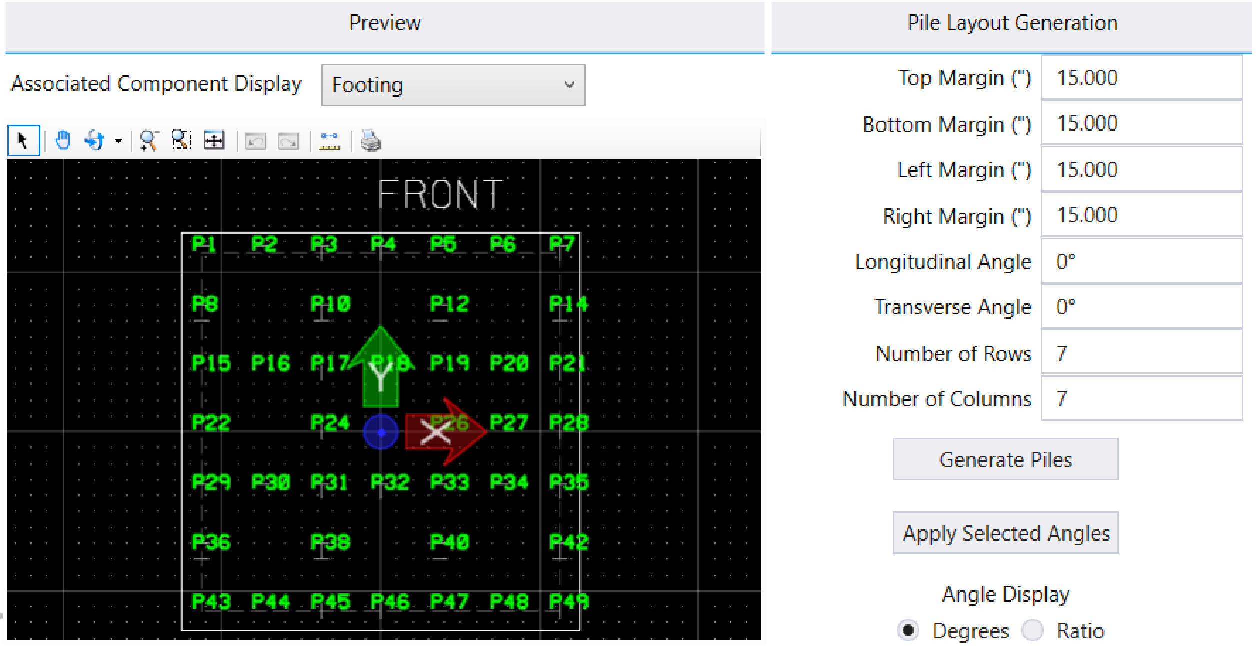
Top-down Approach

- Model the piers and abutments:
  - cap
  - columns
  - footing
  - piles





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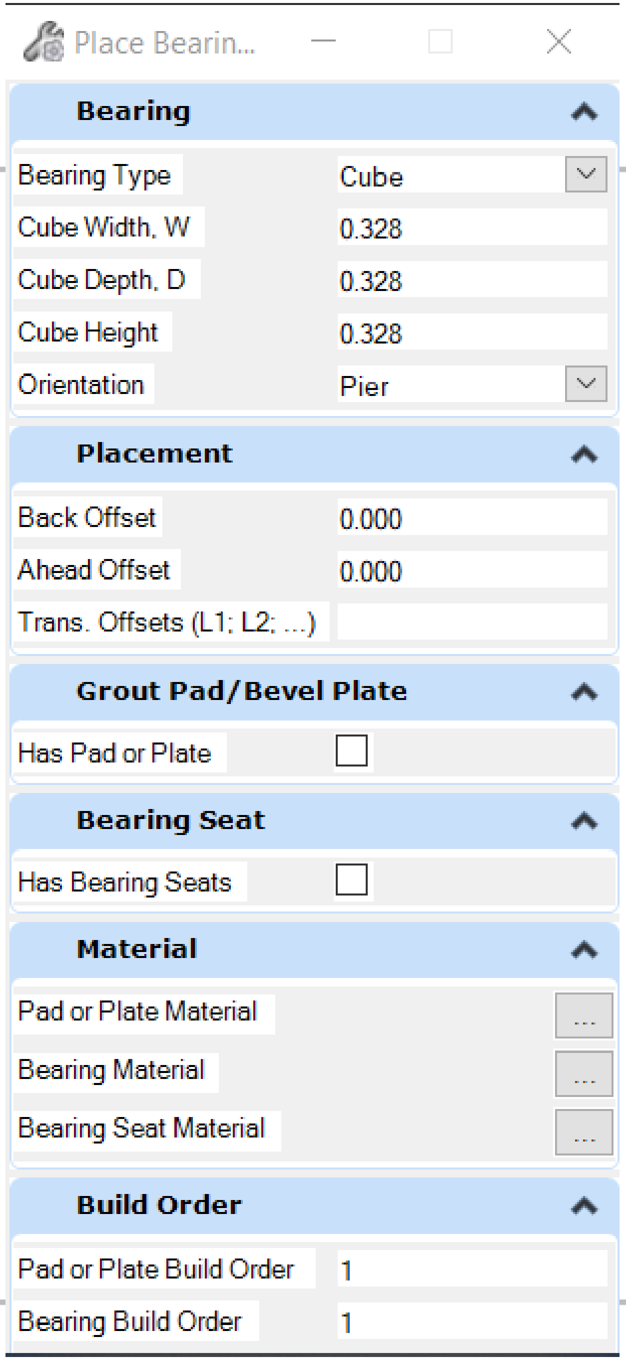
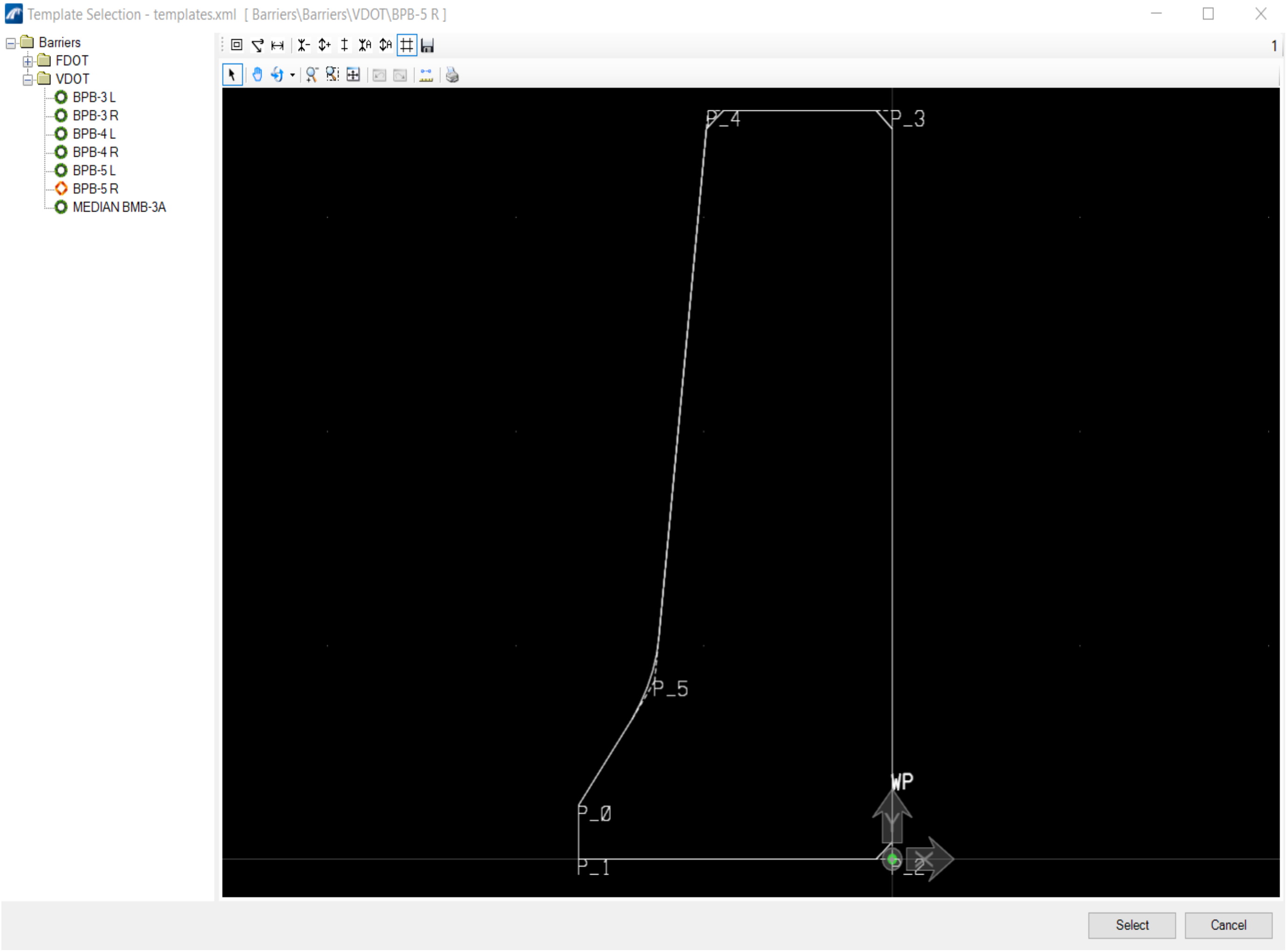
Top-down Approach

- Place the bearings and stepped cap:
  - type of bearings
  - Dimensions
  - Offsets
  - stepped cap
  - plates
  - pads



Top-down Approach

- Model auxiliary elements:
  - » barriers
  - » light poles



Bridge Design

- Transfer the model to LBC, LBS, or RM Bridge.
- LEAP bridge can be used for conventional bridges such as prestressed girder and steel I-girder bridges.
- RM Bridge can be used for complex bridges such as segmental box-girder and cable-stayed bridges.
- ProStructures is used for detailing of various elements such as reinforcement, and connections.

Bridge Design

- Assumptions and limitations when transferring the physical model between OBM and LBC/LBS.
- These assumptions and limitations can change when software updates are released.

Conclusion

- Benefits of adopting BrIM framework.
- LBC and LBS can be used for the bridge 3D modeling, analysis and design.
- OBM can be used for visualization, clash detection, and detailing.
- Modeling the bridge provides the interoperability advantage.

Questions?

Proposed Specifications for Performance Engineered Concrete

Tara L. Cavalline, Brett Q. Tempest, R. Blake Biggers,
Memoree S. McEntyre, Austin J. Lukavsky, Ross A. Newsome

NCDOT Research & Innovation Summit

October 13, 2020

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Background

- NCDOT specifications for concrete have changed little over the past 85 years
  - Prescriptive specification
  - Little room for innovation
  - Mixtures are often over-designed for strength, high cementitious/paste contents
- Resource reductions drive the need to reduce maintenance cost, increase service life
- NCDOT desires fly ash in most mixtures because of the benefits
  - Encounter fly ash shortage throughout the years
  - Need to find equivalent performance of mixtures without fly ash
    (in case of "what if" scenario)
- 2018 increased allowable fly ash substitution rate from 20% to 30%
  - Needed data to support/encourage use of higher substitution rate, account for slower early age strength gain
- Need data to support decision to allow use of portland limestone cement
  - PLC has lower carbon footprint (up to 15% reductions in GHG)

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AASHTO PP 84 (2017, 2018, 2019, 2020...)
Performance Engineered Concrete Pavement Mixtures

"A group of senior experts representing agencies, industry and academia met at two FHWA sponsored events and agreed that the following parameters that should be addressed in a materials specification."

- *Sufficient strength*
- *Low risk of cracking and warping due to drying shrinkage*
- *Durable (freeze-thaw resistance)*
- *Durable (resistance to chemical deicers)*
- *Durable (low absorption, diffusion, and other transport related properties)*
- *Durable (aggregate stability)*
- *Workable*

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What is Performance Engineered Concrete?

- Concrete that does what you want it to do:
  - during construction (workable and constructable)
  - over the service life (adequate strength and good durability performance)
- Meets other needs
  - construction challenges
    - pumpable
    - highly flowable
    - high early strength
    - many other kinds of project-specific needs
  - sustainability goals
    - lower emissions/carbon footprint
    - use of recycled materials
    - use of local materials

Moving specifications away from slump, strength, and air content...

and towards materials and tests that support long term performance.

What does Performance-Engineered Concrete need?

Appropriate material selection/proportioning

- Appropriate cement contents
- Lower paste contents
- Use of SCMs
  - fly ash
  - portland limestone cement
  - slag
- Stable (non-reactive) aggregates
- Optimized aggregate gradation
- Materials/mixtures that provide:
  - workability/strength
  - reduced permeability
  - reduced cracking/curling
  - freeze-thaw durability

Tests for enhanced acceptance criteria

Overall Objectives

1. Establish preliminary specification recommendations, targets for selected PEM technologies and some prescriptive provisions
   - surface resistivity
   - w/cm, cementitious content (prescriptive provisions)
   - shrinkage
   - SAM
   - potentially other tests

2. Explore ways to reduce paste/cement contents
   - optimized aggregate gradation
   - reduced cementitious contents

3. Support pilot project implementation
   - pavement projects
   - bridge projects
   - bridge deck overlay projects

4. Support technology transfer to NCDOT division/regional personnel as well as industry stakeholders

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RP 2018-14
Project Objectives

1) Use existing data on concrete materials, mixtures, and field performance, to identify trends and link to unacceptable, acceptable, and excellent performance.

2) Perform laboratory testing of a broad matrix of conventional highway concrete mixtures, to establish performance-related criteria for selected tests + evaluate some existing prescriptive provisions:
    1) - Range of w/cm, range of cementitious materials contents
    2) - Representative materials for Piedmont region
    3) - Consistency in materials from previous studies to leverage data already obtained

3) Produce additional performance data on concrete containing PLC and fly ash
    - support a better understanding the potential enhanced durability and economy
    - provide additional justification for use.

4) Develop specification provisions for:
    - surface resistivity
    - shrinkage
    - early age strength for opening of pavements and bridge component

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Mixture Matrix

Mixture ID **W-XXX-YYY,** where **W** is *w/cm* ratio, **XXX** is cement content, **YYY** is fly ash content	Mixture Characteristics			Mixture Proportions, pcy					
	Mixture type	Cement type	*w/cm*	Fly ash replacement (%)	Cement	Fly ash	Coarse aggregate	Fine aggregate	Water
H-700-0	AA (high and medium cm content)	OPC	0.47	0	700	0	1659	1072	329.0
H-560-140				20	560	140	1659	1022	329.0
H-650-0				0	650	0	1659	1175	305.5
H-520-130				20	520	130	1659	1129	305.5
H-600-0				0	600	0	1659	1277	282.0
H-480-120				20	480	120	1659	1235	282.0
H-420-180				30	420	180	1659	1214	282.0
M-700-0			0.42	0	700	0	1659	1163	294.0
M-560-140				20	560	140	1659	1114	294.0
M-650-0				0	650	0	1659	1259	273.0
M-520-130				20	520	130	1659	1214	273.0
M-600-0				0	600	0	1659	1356	252.0
M-480-120				20	480	120	1659	1313	252.0
M-420-180				30	420	180	1659	1292	252.0
M-600P-0		PLC		0	600	0	1659	1356	252.0
M-480P-120				20	480	120	1659	1313	252.0
M-420P-180				30	420	180	1659	1292	252.0
L-700-0	AA (low cm content) and Pavement	OPC	0.37	0	700	0	1659	1254	259.0
L-560-140				20	560	140	1659	1205	259.0
L-650-0				0	650	0	1659	1344	240.0
L-520-130				20	520	130	1659	1298	240.0
L-600-0				0	600	0	1659	1434	222.0
L-480-120				20	480	120	1659	1392	222.0
L-420-180				30	420	180	1659	1370	222.0

Testing Program

	Test name	Standard	Testing age(s) in days	Replicates
Fresh	Air content	ASTM C231	Fresh	1
	SAM number	AASHTO TP 118	Fresh	2
	Slump	ASTM C143	Fresh	1
	Fresh density (unit weight)	ASTM C138	Fresh	1
	Temperature	AASHTO T 309	Fresh	1
Hardened	Compressive strength	ASTM C39	3, 7, 28, 56, 90	3 each age
	Modulus of rupture (MOR, or flexural strength)	ASTM C78	28	2
	Modulus of elasticity (MOE) and Poisson's ratio	ASTM C469	28	2
	Resistivity	AASHTO T 358	3, 7, 28, 56, 90	3 each age
	Formation factor (via Bucket Test)	Protocol by J. Weiss, Oregon State University (Weiss 2018)	35	2
	Shrinkage	ASTM C157	Per standard	3
	Rapid chloride permeability	ASTM C1202	28, 90	2

RP 2018-14 Outcomes

This project provided:

- Insight into "what concrete mixtures are being used, how they are doing"
  - Statistical analysis identifying mixture parameters that are linked to performance
- Data to support increased use of fly ash at higher rates, PLC
- Data to support identification of performance targets for:
  - surface resistivity
  - early age strength for opening to traffic
  - shrinkage
- Recommended specification provisions for:
  - surface resistivity
  - early age strength for opening to traffic
  - shrinkage
- Additional data to support SAM specification recommendations

Ready for use as shadow specifications in upcoming pilot projects

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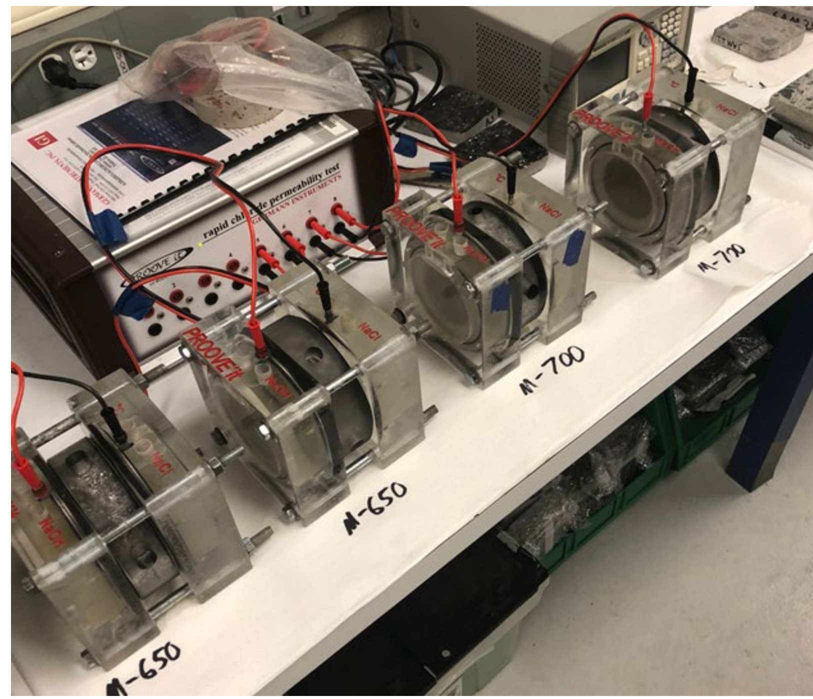
Development of a Surface Resistivity Specification



- Surface resistivity (left) highly correlated to Rapid Chloride Permeability Test (right), a more time/labor intensive test historically been linked to field performance

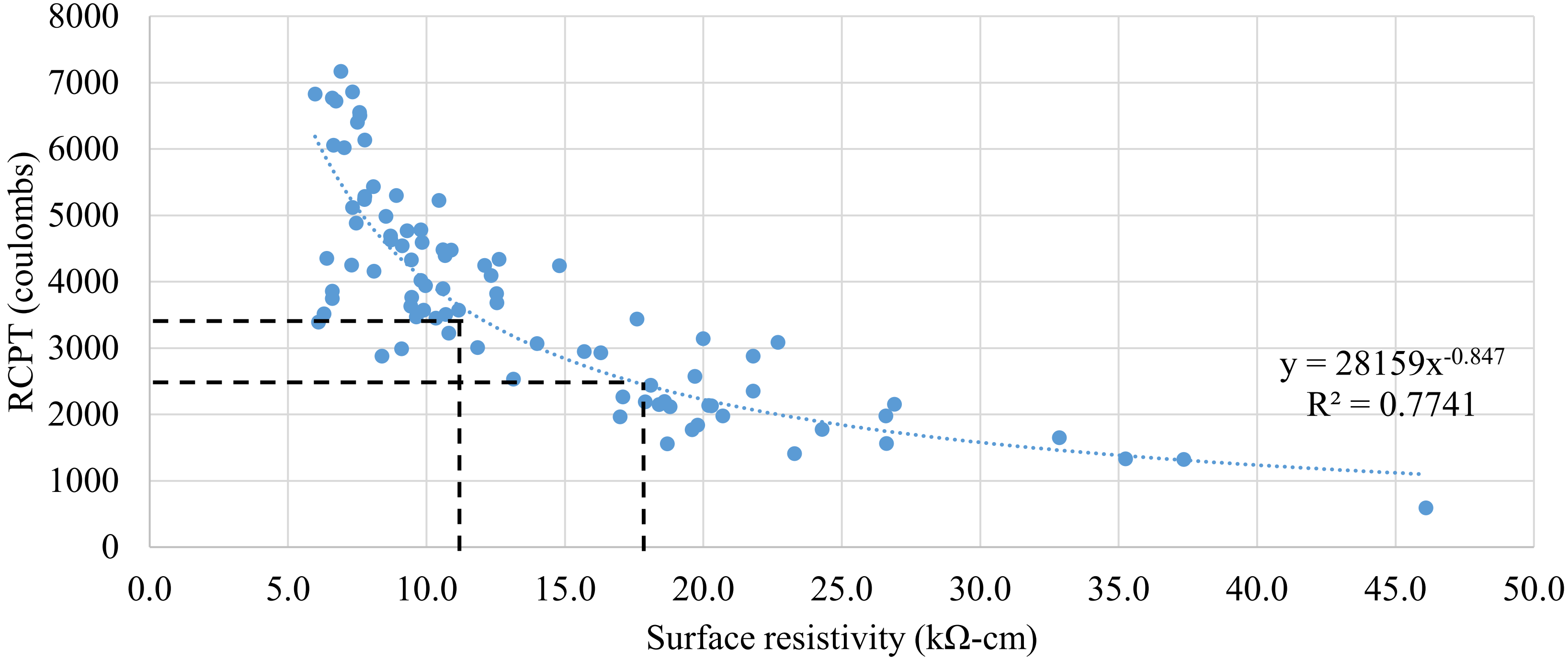
Review of Existing State Specifications

- Virginia, Florida, Louisiana, New Hampshire, Kansas, New Jersey, New York, Rhode Island, Texas, Utah, West Virginia, and Montana have specification provisions on resistivity

- A variety of approaches, with targets generally linked to the type(s) of mixtures and importance/exposure of element
- Many states have 28-day targets. Some states have 56-day targets.
  - Trade off between ease of use at earlier age (28-days) vs. capturing value of fly ash on permeability reduction (56-days)

- Virginia DOT provides RCPT targets for pavements (3,500 coulomb) and bridges (2,500 coulomb)
  - Field performance of these targets verified in similar climate/traffic conditions
  - Use 28-day values, but use of same targets at 56-days could also show promise

Surface Resistivity



- Pavement target of 3,500 coulombs RCPT corresponds to ~ 10.5 kΩ-cm resistivity
- Bridge target of 2,500 coulombs RCPT corresponds to ~ 18.8 kΩ-cm resistivity

- VDOT uses these targets at 28 days which would preclude many NC mixtures with lower w/cm, fly ash, good performance
- Use of targets at 56 days is recommended (NJDOT and NHDOT use 56-day targets)
- Alternatively, could identify 28-day target that correlates to 56-day value (mixture specific)

Suggested Specification for Resistivity

- Suggested revision to Section 1000-4C "Portland Cement Concrete for Structures and Incidental Construction"

(C) Strength and Surface Resistivity of Concrete

The compressive strength *and surface resistivity* of the concrete will be considered the average test results of two 6 inch x 12 inch cylinders, or two 4 inch x 8 inch cylinders if the aggregate size is not larger than size 57 or 57M. Make cylinders in accordance with AASHTO T 23 from the concrete delivered to the work. Make cylinders at such frequencies as the Engineer may determine and cure them in accordance with AASHTO T 23 as modified by the Department. Copies of these modified test procedures are available upon request from the Materials and Tests Unit. Testing for compressive strength should be performed in accordance with AASHTO T 22. *Testing for surface resistivity should be performed in accordance with AASHTO T 358.* When the average compressive strength or surface resistivity of the concrete test cylinders is less than the minimum targets specified in Table 1000-1 and the Engineer determines it is within reasonably close conformity with design requirements, these properties will be considered acceptable. *When the Engineer determines average cylinder strength or surface resistivity is below the specification, the in-place concrete will be tested.* Based on these test results, the concrete will either be accepted with no reduction in payment or accepted at a reduced unit price or rejected as set forth in Article 105-3.

Suggested addition to Table 1000-1

Class of Concrete	Minimum surface resistivity at 56 days (kΩ-cm)
AA	15.0*
Pavement	11.0

*A 56 day minimum of 16.0 kΩ-cm can be required at the engineer's discretion for applications where risk of chloride ion penetration is high.

Development of a Specification for Early Age Opening to Traffic

Photo: concreteconstruction.net

Review of Existing State Specifications

- Florida, Illinois, Iowa, Louisiana, Minnesota, New York, Virginia, West Virginia specifications summarized.
- A variety of approaches, with targets generally linked to the type(s) of mixtures (conventional bridge or pavement, repair, VHES)
- Many states have 7-day or 14-day targets for conventional mixtures.

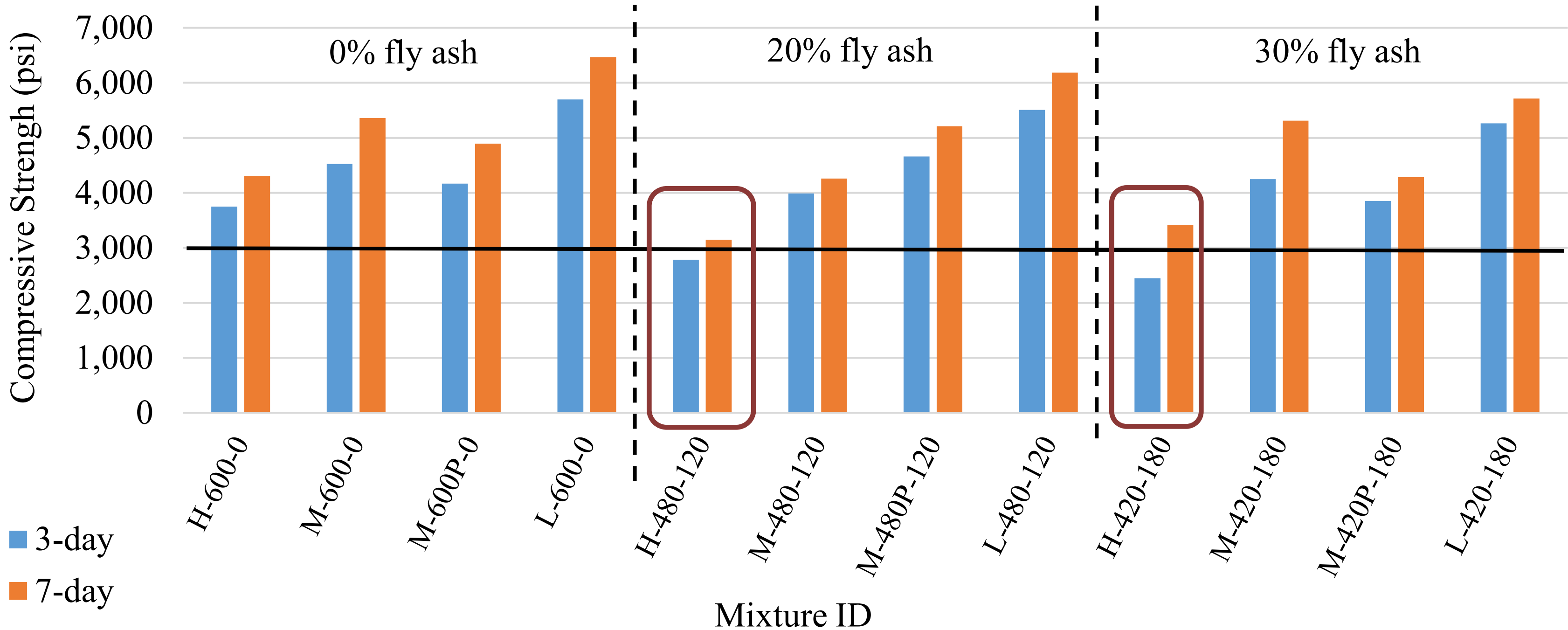
Current NCDOT Specifications:

- Pavements
  - 3,000 psi for opening to traffic
  - 4,500 psi compressive (650 psi flex) for acceptance

- Bridge substructures
  - 2,400 psi prior to placement of beams/girders

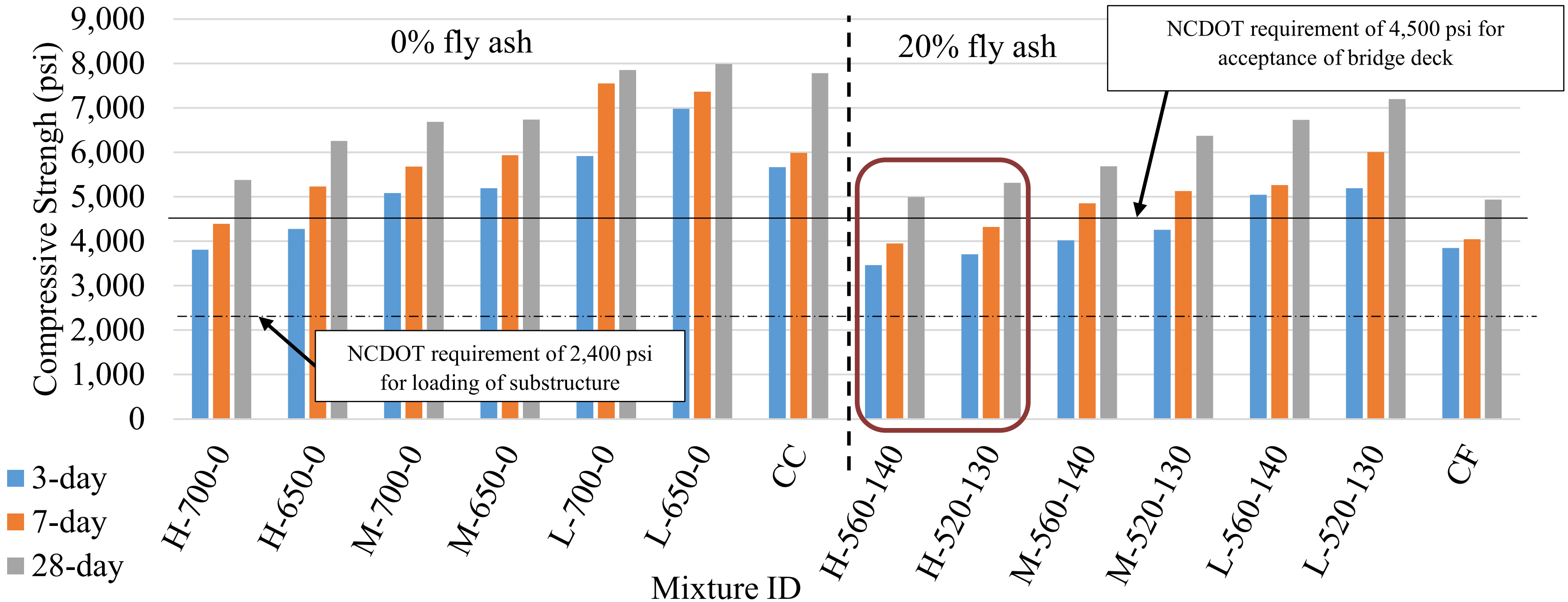
- Bridge Decks
  - 4,500 psi to open to vehicles of construction traffic

Pavement Mixtures



- Current target appears appropriate for most mixtures, provided a reasonable w/cm ratio is utilized.
- Use of fly ash will provide durability benefits, but delay in strength gain may impact time required to meet 3,000 psi target.

Structural Mixtures



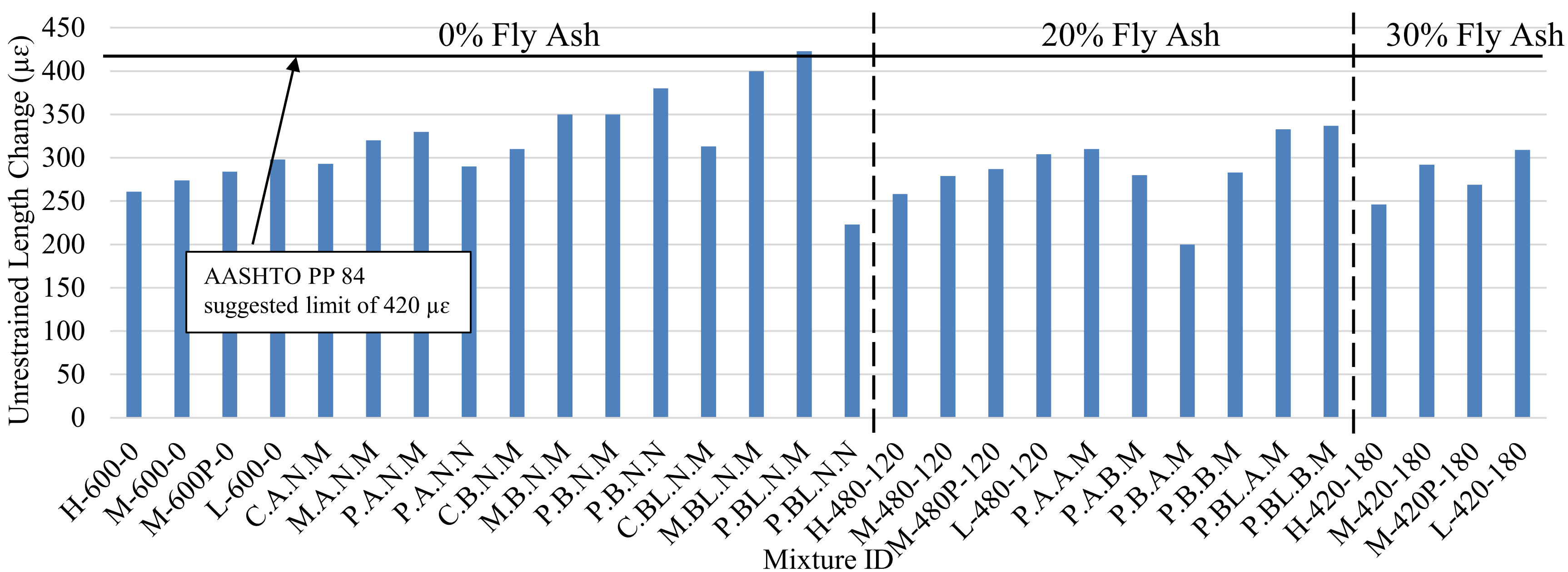
- Current targets appear appropriate for most mixtures, provided a reasonable w/cm ratio is utilized.
- Use of fly ash will provide durability benefits, but delay in strength gain may impact time required to meet 2,400/4,500 psi targets.
- Some states open bridge decks to traffic at 4,000 psi. NCDOT could investigate use of this target if desired. Lowering the target to 4,000 psi could promote additional use of SCMs.

Development of a Volumetric Shrinkage Specification

Photo: Humboldt

Review of Existing State Specifications

- Louisiana, Minnesota, New York, Florida, Virginia, and West Virginia have specification provisions on volumetric shrinkage
- Many shrinkage specifications are for repair materials, some for bridge decks, superstructure elements.
- AASHTO PP 84 suggests 420 με at 28 days
- Mokarem et al. (2003) suggest 400 με at 28 days for crack-resistant concrete
- Only 1 mixture from RP 2015-03 (w/cm 0.48) didn't meet target.
- 350 με at 28 days was reasonable for almost all mixtures (even w/cm 0.47)



Suggested Specification for Shrinkage

- Suggested revision to Section 1000-4A Portland Cement Concrete for Structures and Incidental Construction”

(A) Composition and Design

Table of laboratory tests to be submitted with Form 312U for mixture approval

Property	Test Method
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump	AASHTO T 119
Compressive Strength	AASHTO T 22 and T23
Shrinkage	AASHTO T 160

Additional information could be provided in a new Section (E) Shrinkage requirements or added to Project Special Provisions for use at acceptance.

(E) Shrinkage Requirements

Concrete should be tested for unrestrained length change at 28 days using AASHTO T 160. For typical concrete pavement and bridge applications, the length change is limited to 420 με. For concrete applications where enhanced provisions against cracking are desired, length change can be limited to 350 με at the engineer’s discretion.

Table below should be added or incorporated into Table 1000-1 with the following note:

Class of Concrete	Shrinkage Limit (με) at 28 days
AA	420*
Pavement	420*
*For concrete where a reduction in cracking due to shrinkage is desirable, 350με could be used.	

Recommendations

- NCDOT should promote use of fly ash, particularly at higher replacement rates.
- NCDOT should promote use of PLC

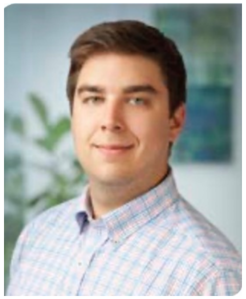
- Promote use of resistivity as a readily implementable tool to promote construction of durable infrastructure
- Consider implementing shrinkage targets for applications were reduced cracking is desirable.

- Engage contractors in PEM initiatives through pilot projects, technology transfer, other avenues.
- Remain engaged with FHWA activities related to PEM.
  - Findings of other states Implementation Studies
  - Use of PEM tools in QC (QC Guidance)

Thank you!

We greatly appreciate the support of:

- NCDOT and the StIC
- Brian Hunter, Materials and Tests Unit
- FHWA
- Mobile Concrete Technology Center
- CP Tech Center
- ACPA and Carolinas Concrete Paving Association
- Lane Construction
- PEM pooled fund research team
- Cecil Jones
- Material suppliers
- Research assistants at UNC Charlotte:
  - Blake Biggers, Austin Lukavsky, Memoree McEntyre, Ross Newsome, Joe OCampo, Alex Dillworth, Peter Theilgard



Questions or comments?
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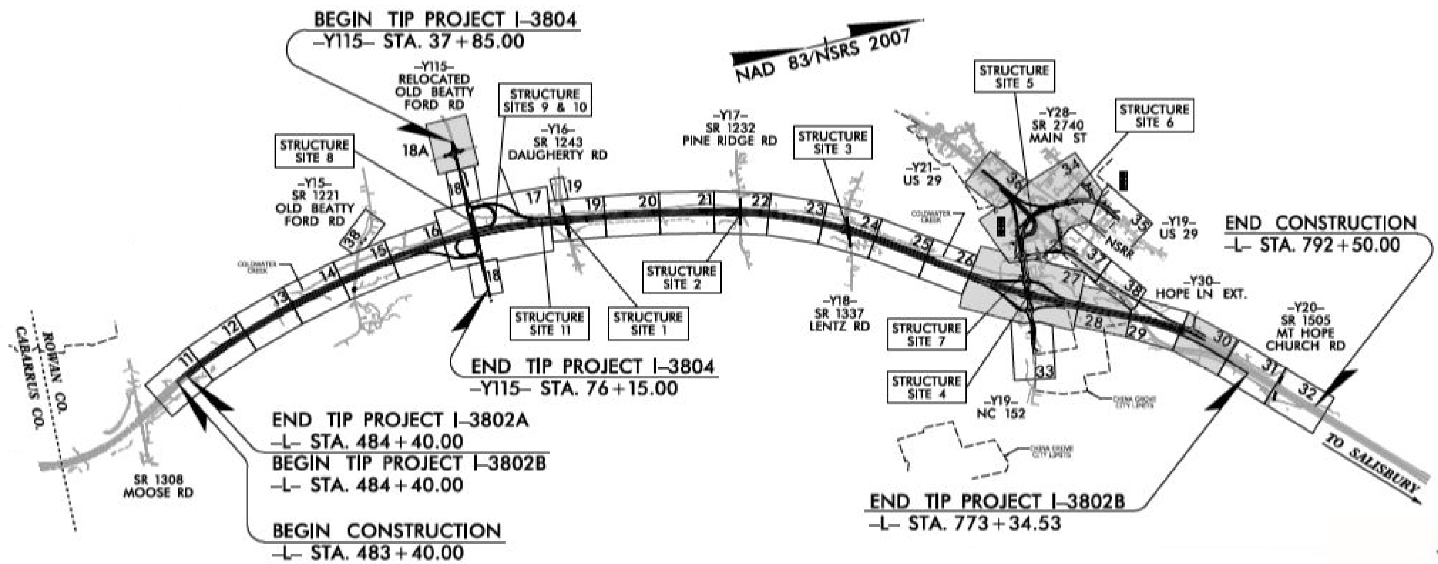
UNC CHARLOTTE

FHWA Implementation Project

- I-85 widening project north of Charlotte, NC
  - 5.3 miles long
  - Existing 4-lane interstate widened to provide 4 additional travel lanes (2 lanes in each direction)
  - 500,000 SY of concrete pavement construction (12” thick JPCP)
  - Two phases:
    - April 2018 to September 2018
    - April 2019 to October 2019



FHWA Implementation Project Outcomes

This project resulted in:

- Engagement of a contractor to implement PEM tests for QC on a pavement project:
  - Box Test
  - SAM
  - surface resistivity
- Technology transfer to regional/divisional NCDOT personnel
- Data collection during FHWA Mobile Concrete Technology Center visit (April/May 2019)
- Technology transfer to NC stakeholders during Open House hosted at the Implementation Site

★ Support of a contractor and commitment to use of PEM tools on their next project ★





LANE

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