



BIM for Bridges: OpenBridge Designer

Comprehensive Modeling and Design from Planning to Construction

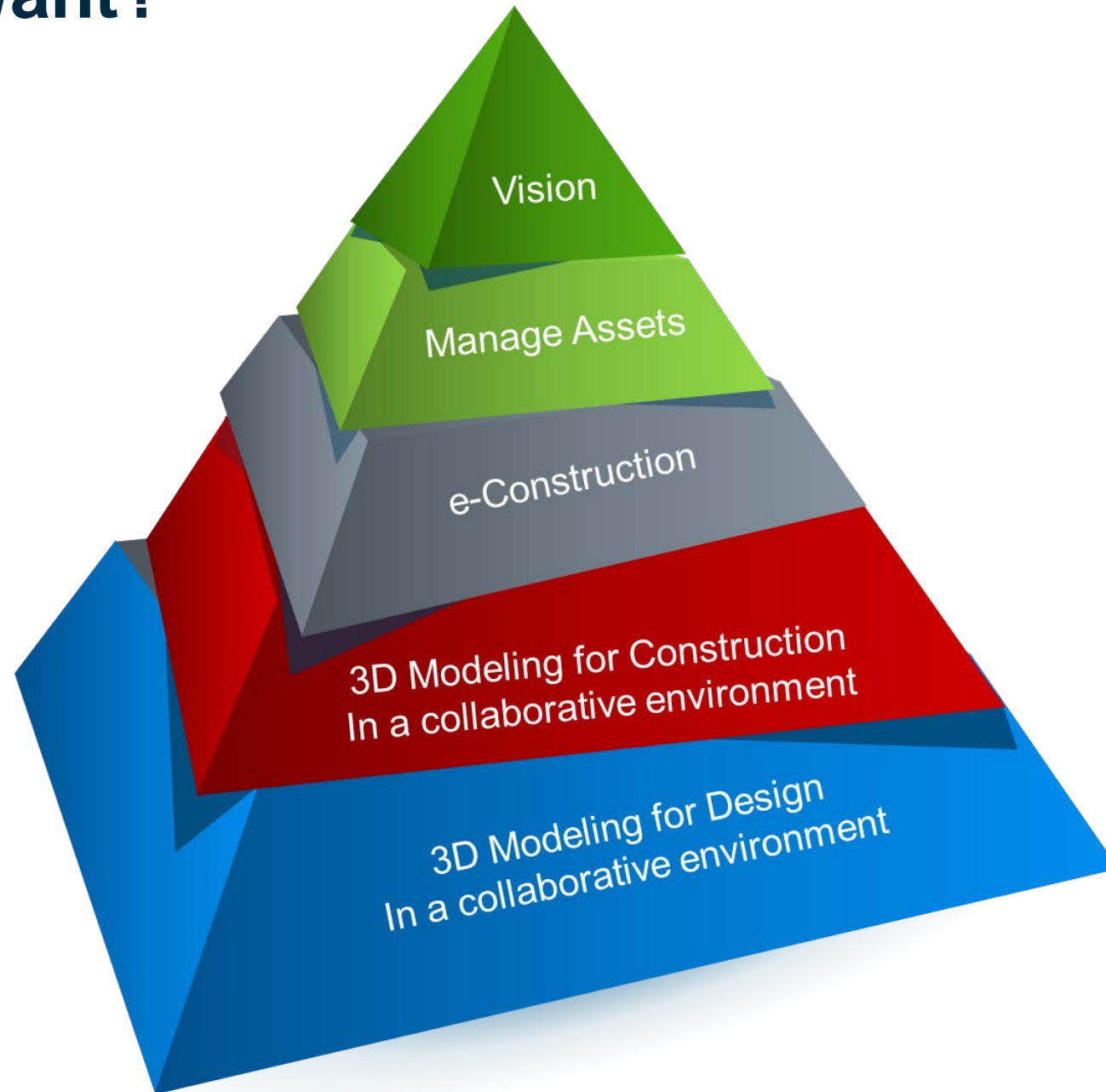
Steve Willoughby
Senior Engineering Consultant

Bentley[®]
Advancing Infrastructure

Everything Is About 3D Digital Project Delivery



What do We Want?

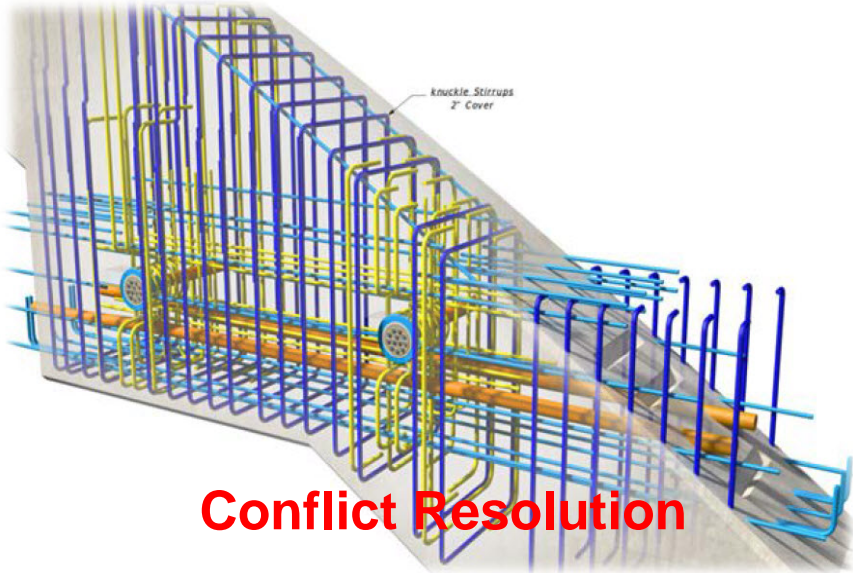


Software: One Piece of the Puzzle

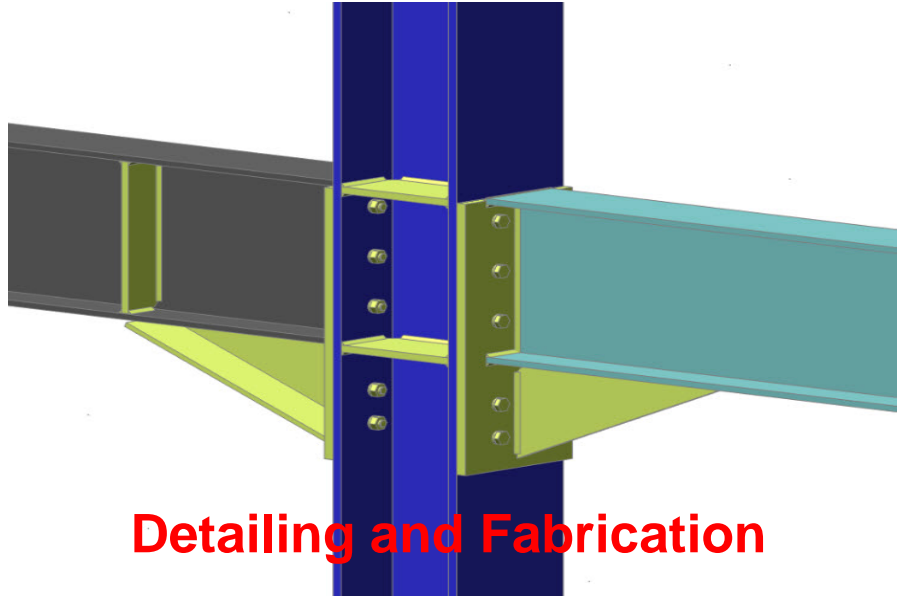


Level of Development of 3D Models

High



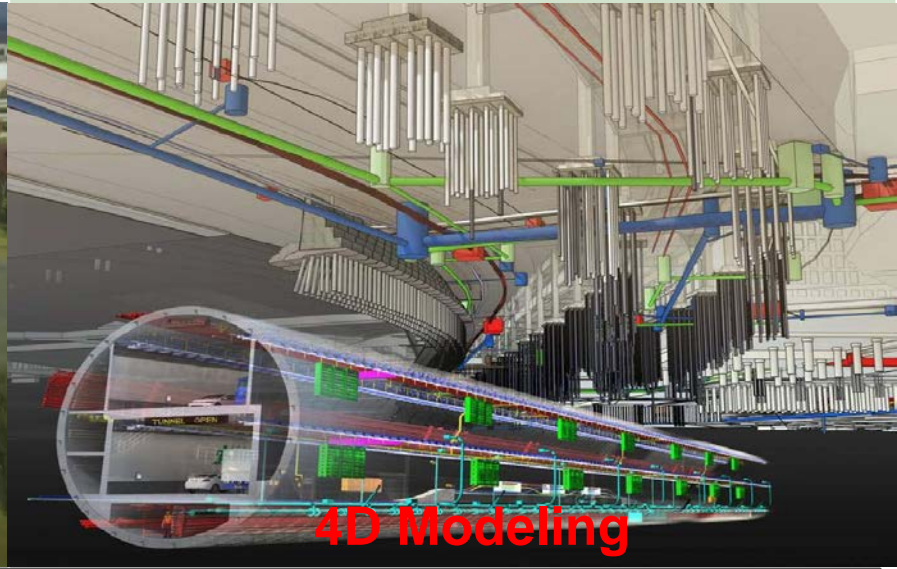
Conflict Resolution



Detailing and Fabrication



Visualization



4D Modeling

Accuracy of 3D Models

Low

3D Elements

High

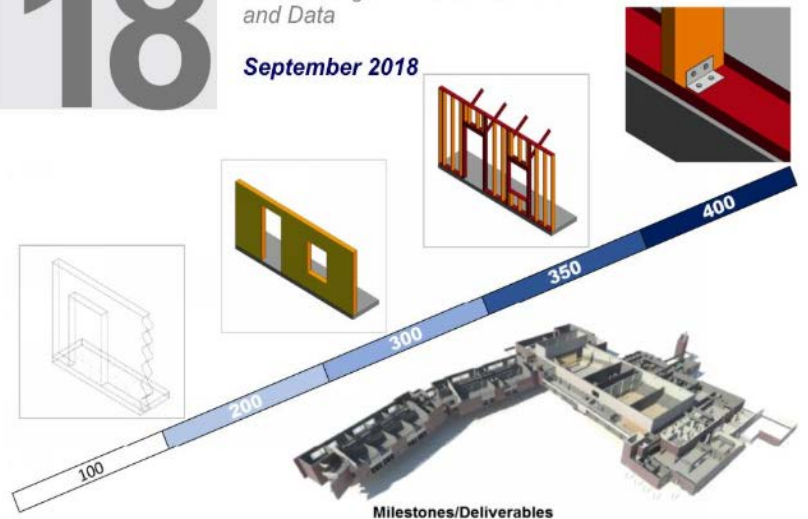
Level of Development of 3D Models

2018

BIMFORUM

LEVEL OF DEVELOPMENT (LOD) SPECIFICATION PART I & COMMENTARY
For Building Information Models and Data

September 2018



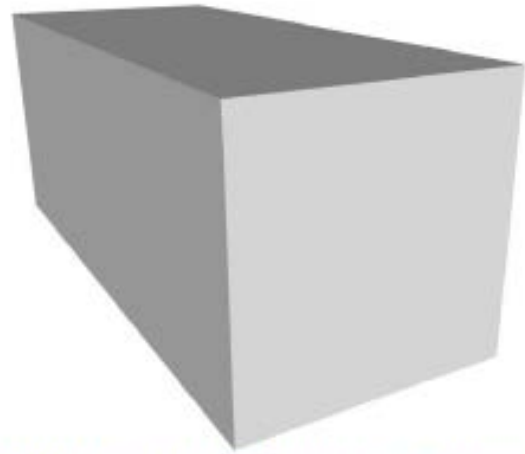
Milestones/Deliverables

Model Elements	SD	DD	CD	Constr. Coord.	Fabrication
Concrete	█	█	█	█	█
Rebar					█
Formwork					█
Other					

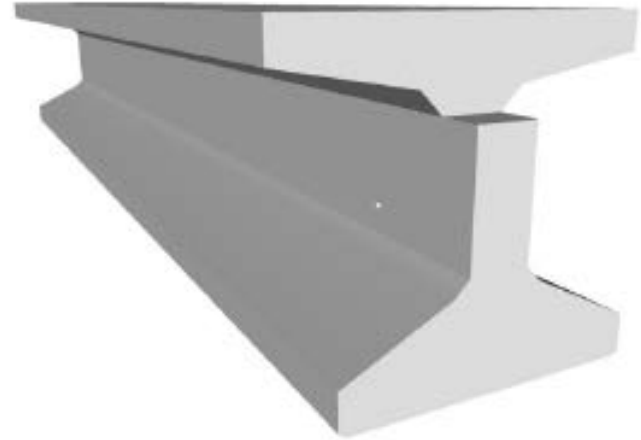
PARTICIPATING ORGANIZATIONS



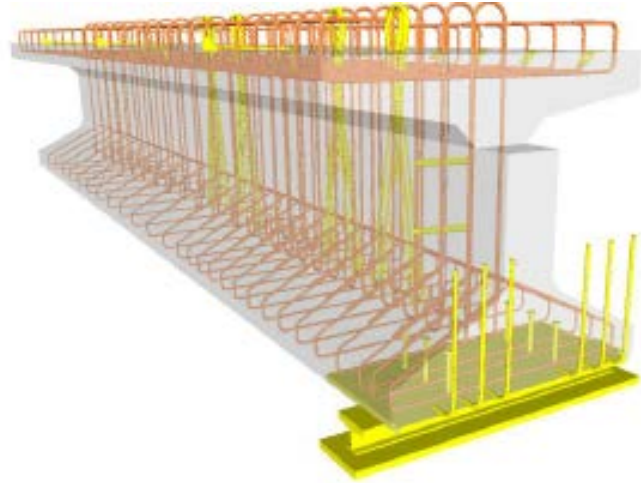
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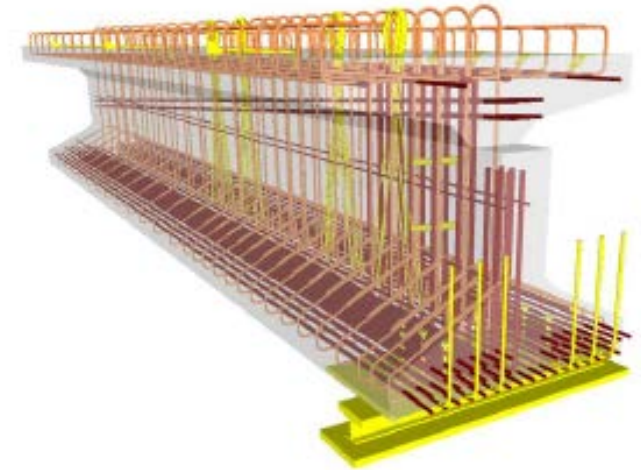
LOD 200 Highway Bridges Precast Structural I Girder (Concrete)



LOD 300 Highway Bridges Precast Structural I Girder (Concrete)

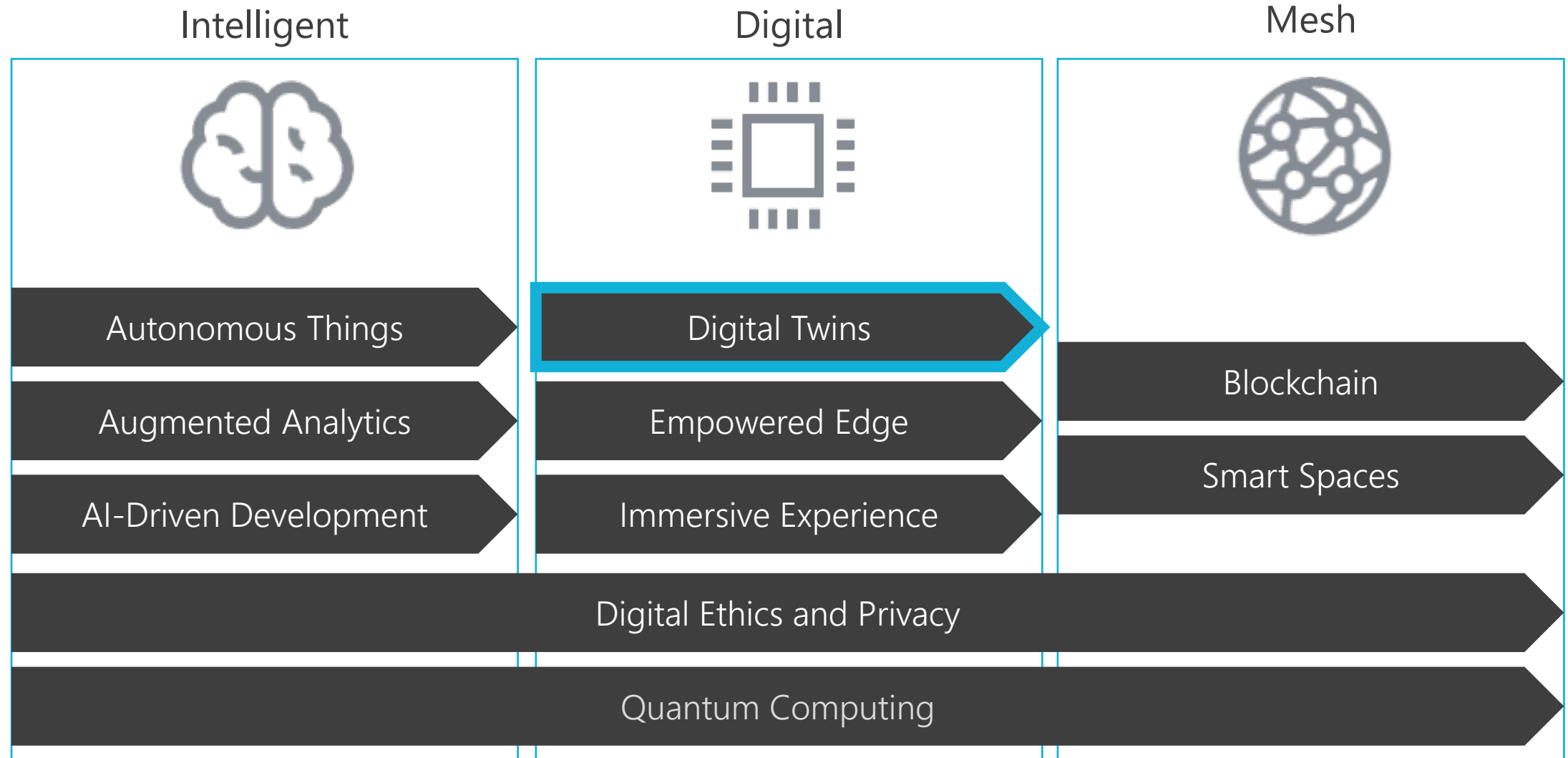


LOD 350 Highway Bridges Precast Structural I Girder (Concrete)



LOD 400 Highway Bridges Precast Structural I Girder (Concrete)

Top 10 Strategic Technology Trends for 2019





A **digital twin** is a **digital representation** of a physical asset, process or system, **as well as the engineering information** that allows us to understand and model its performance.

Typically, a **digital twin** can be **continuously synchronized** from multiple sources, including sensors and continuous surveying, to represent its near real-time status, working condition or position.

A **digital twin** enables users to **visualize** the asset, check status, **perform analysis** and generate insights in order to **predict** and **optimize** asset performance.





Site & Environmental



Geotechnical



Rail & Transit





Modeling & Visualization



Road



Bridge


Connected Data Environment



Modeling & Visualization



Building



Electrical



Plant



Structural



Reality Modeling



Geotechnical



Site & Environmental



Road



Rail & Transit



Bridge

Design Engineering
Infrastructure Solutions

MicroStation



OpenBuilding



Bentley Substation



OpenPlant



STAAD



RAM



ContextCapture



gINT



OpenSite



OpenRoads



OpenRail

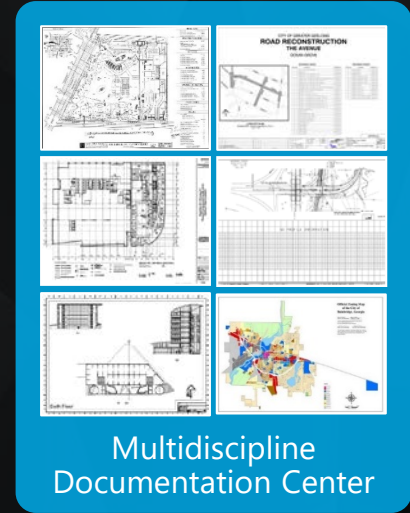
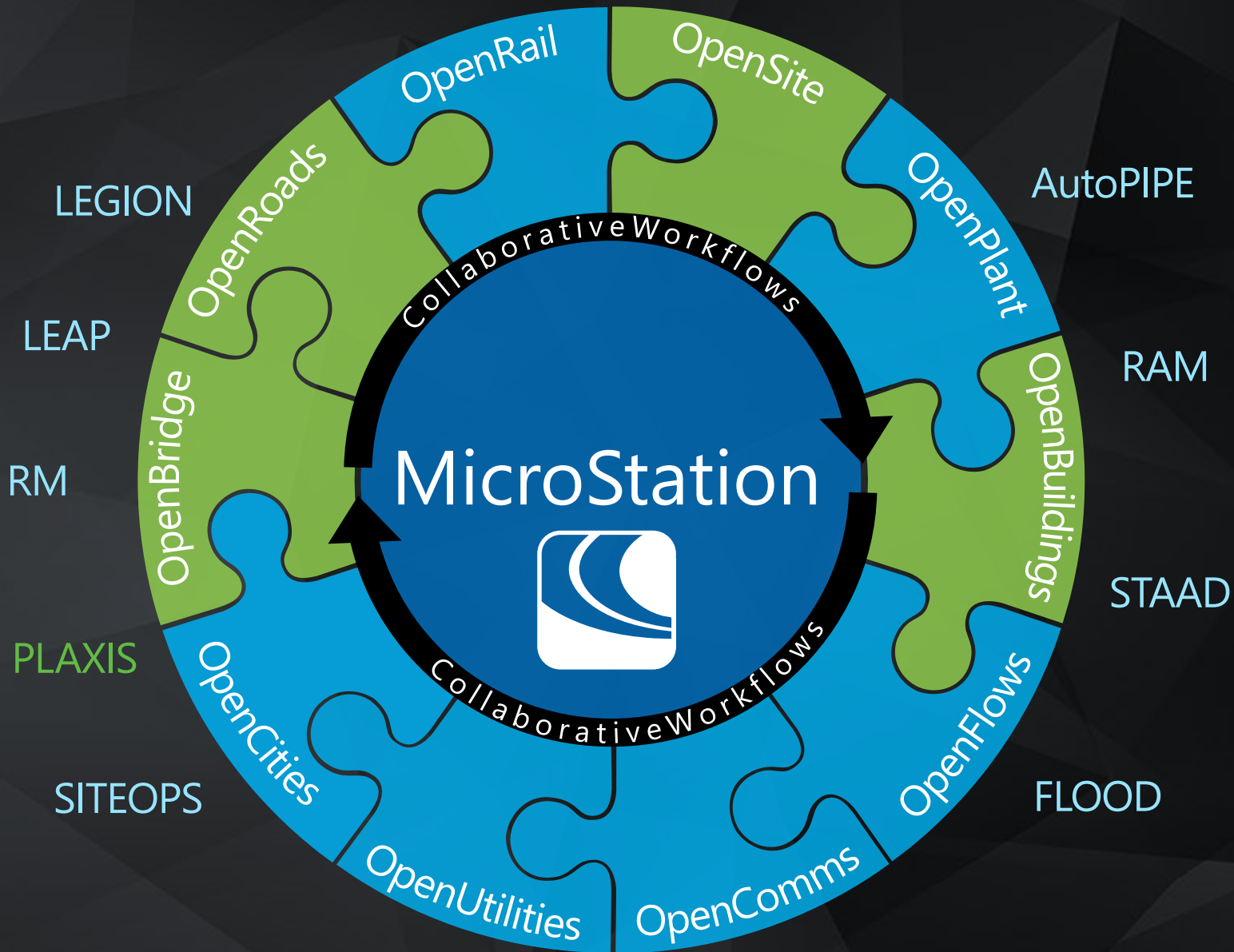
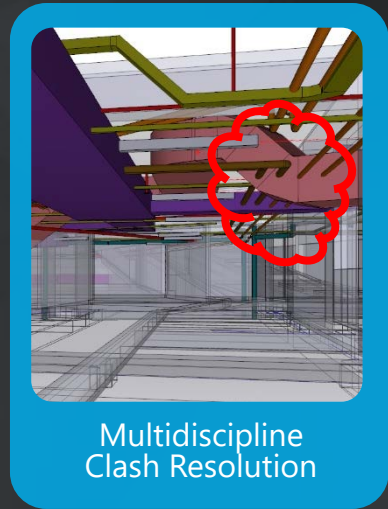


OpenBridge

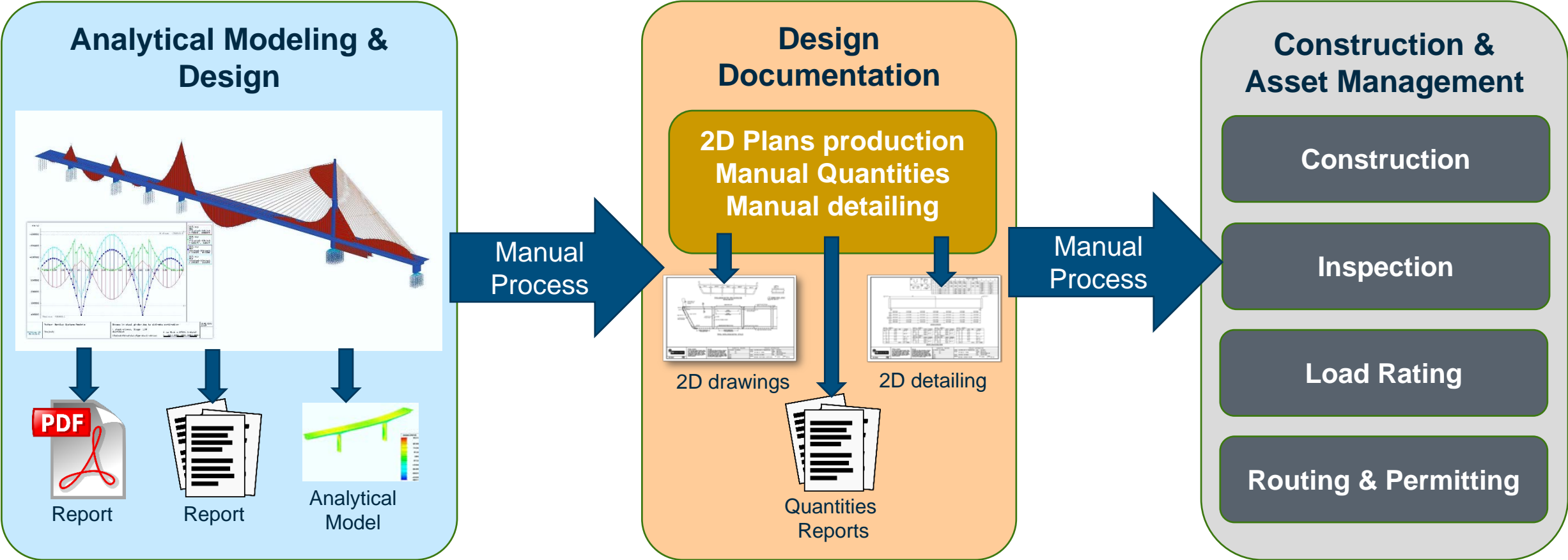


CONNECT Edition

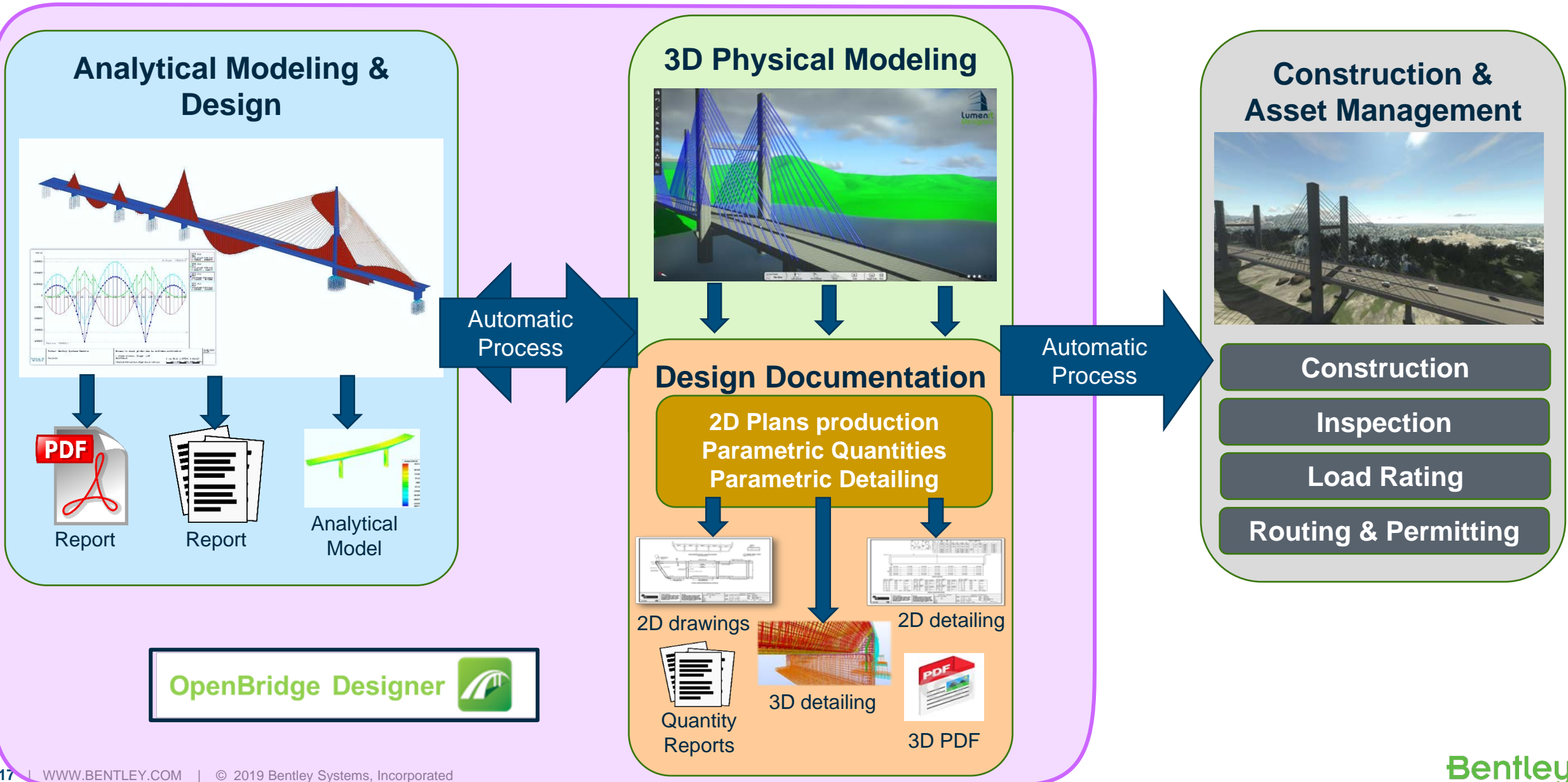
Comprehensive Modeling Environment



Current Disconnected Bridge Workflow



OpenBridge Designer Interoperable Workflow



OpenBridge Designer *Connect Edition*

Perform bridge analysis and design

Interoperate with bridge analytic tools for Concrete and Steel bridges

Develop 2D drawings and design reports

Dynamic views, clash detection, deck elevations, beam seat elevations, input echo report

Prepare quantities and cost estimates

Bid preparation, pay item lists

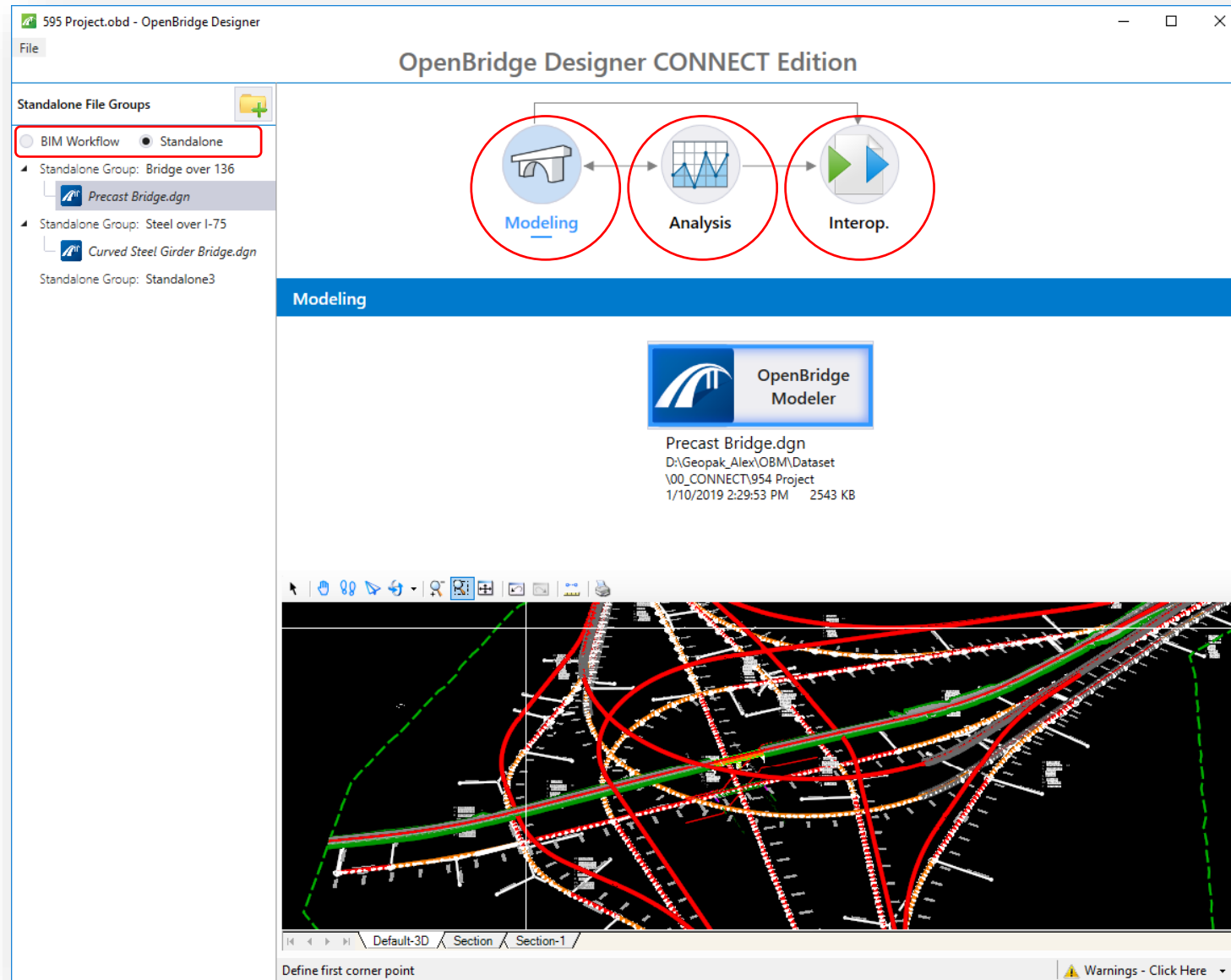
Develop steel and concrete details

Connection details, barmarks, lists, and schedules via ProStructures

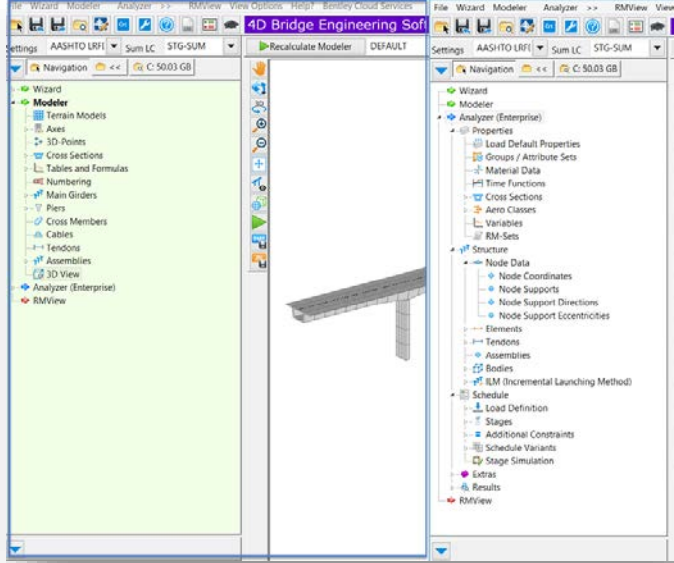
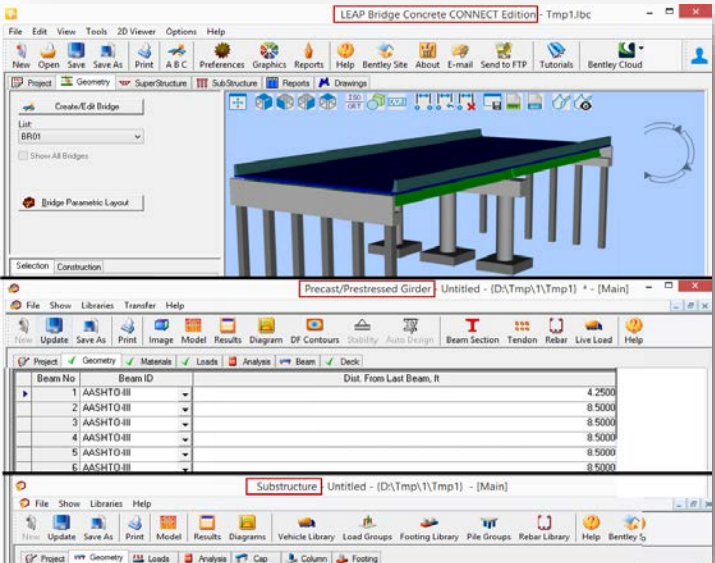
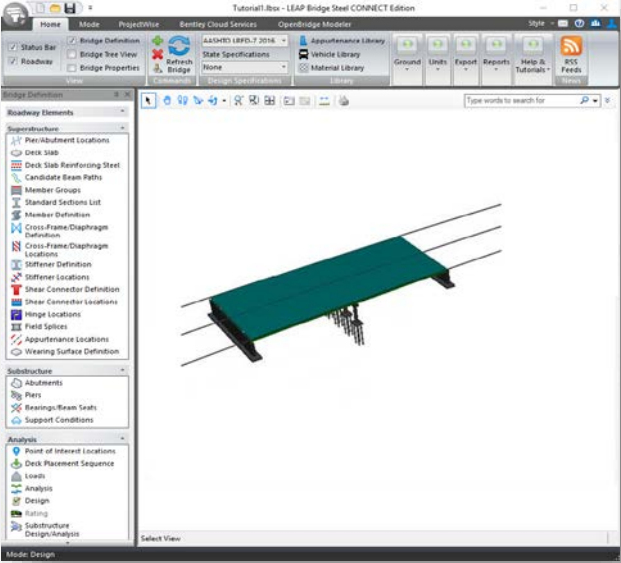
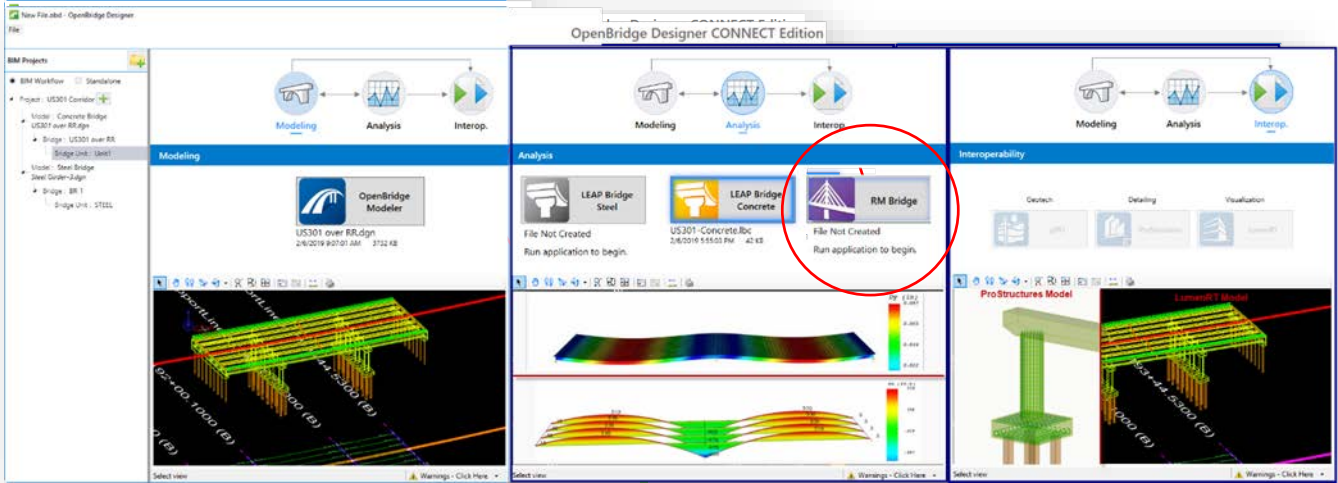
Create intelligent 3D MicroStation-based BIM models

In just
ONE Model
with
**OpenBridge
Designer**

OpenBridge Designer Connect Edition



OpenBridge Designer Connect Edition



OpenBridge Designer *Connect Edition*



The screenshot displays the OpenBridge Designer Connect Edition software interface. The main window shows a 3D model of a bridge structure, viewed from three different perspectives: View 1 (Top, Default), View 2 (Default), and View 3 (Default). The software includes a ribbon menu with various toolsets such as Primary, Selection, Bridge Setup, SupportLine, Superstructure, and Substructure. The Explorer panel on the left shows the project hierarchy, including Bridge (BR 1), Road Alignment, Bridge Alignment, and Units. The Properties panel on the right displays the details for the selected Pier Element (Unit 1 :: PR1), including its Name, Support Name, State Element Number, NBI Element Number, Synchronid, Footing Type, Footing Association, Associated Column ID, Top Elevation, Rotation, Sloped status, Width, Length, Height, Slope Depth, Top Width, and Top Length. The Feature Definition is set to Pier_concrete_piles.

Properties Panel - Pier Element: Unit 1 :: PR1

General	
Name	1
Support Name	PR1
State Element Num	220
NBI Element Num	220
Synclid	e6fe6ac5-386f-4d96-f...
Footing Type	Rectangular Isolated
Footing Associat	Default
Assoc. Column ID	1
Top Elevation	0.8781'
Rotation	0.0000°
Sloped	False
Width	13.5000'
Length	13.5000'
Height	5.5000'
Slope Depth	0.0000'
Top Width	0.0000'
Top Length	0.0000'
Feature	
Feature Definit	Pier_concrete_piles

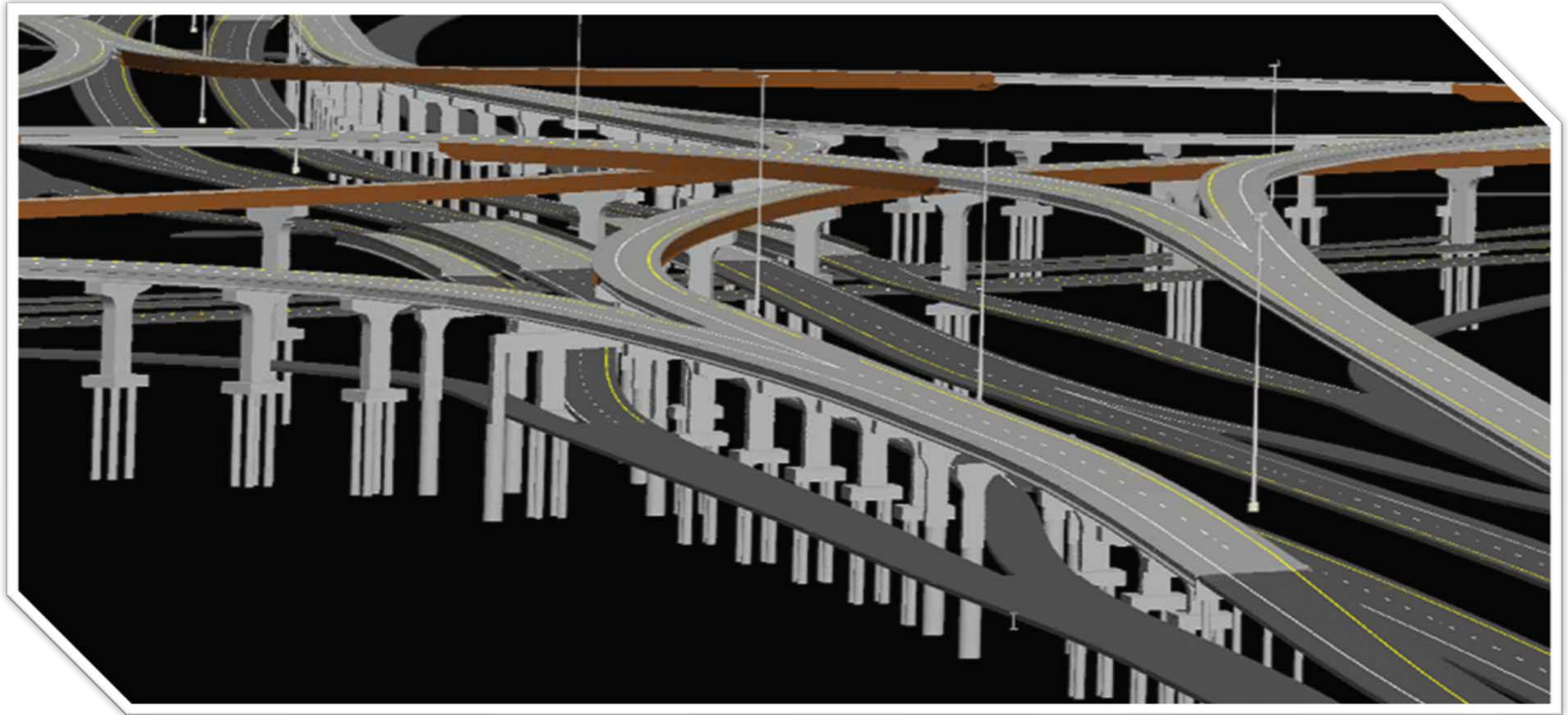


OpenBridge Designer





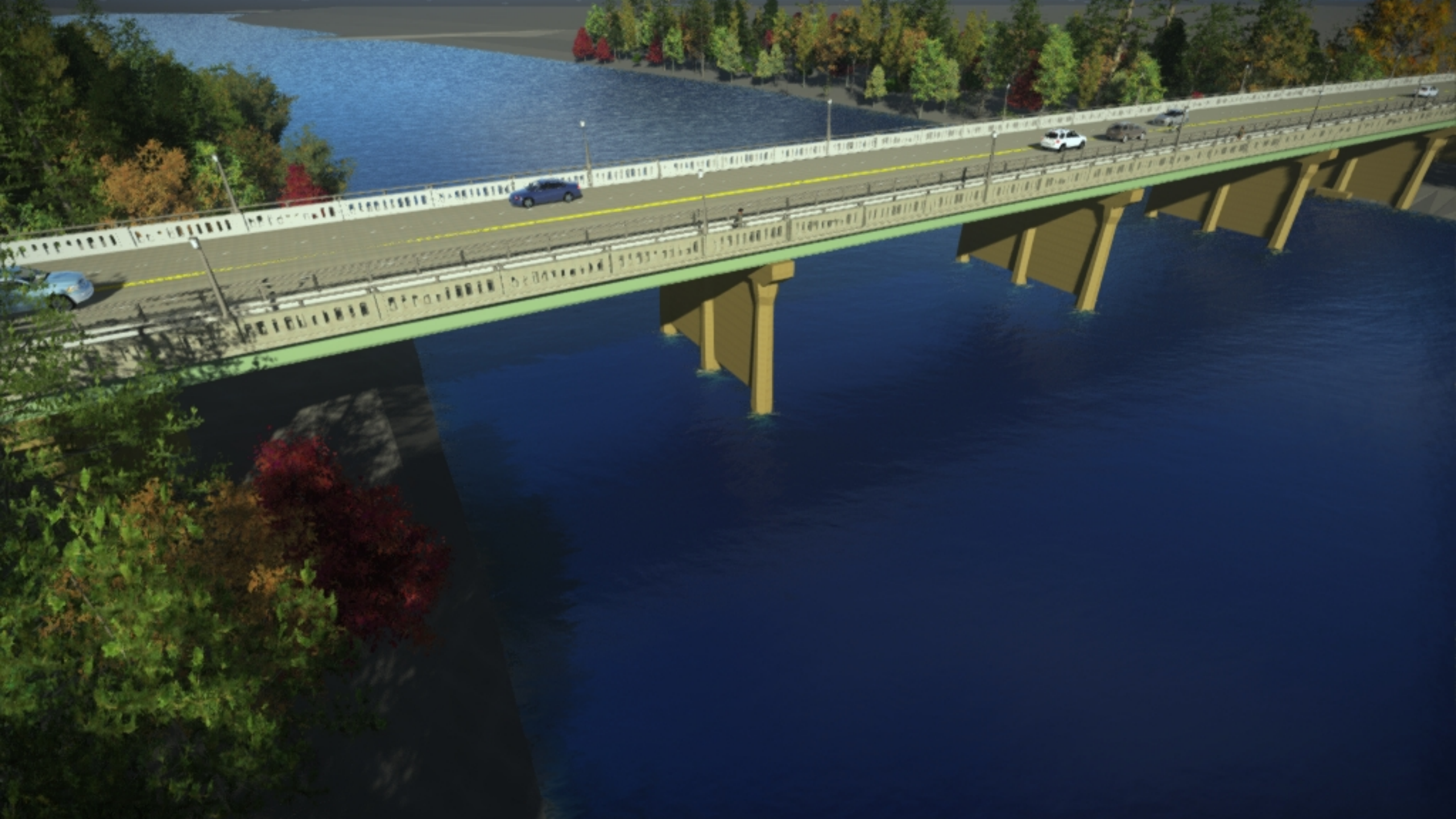
OpenBridge Designer





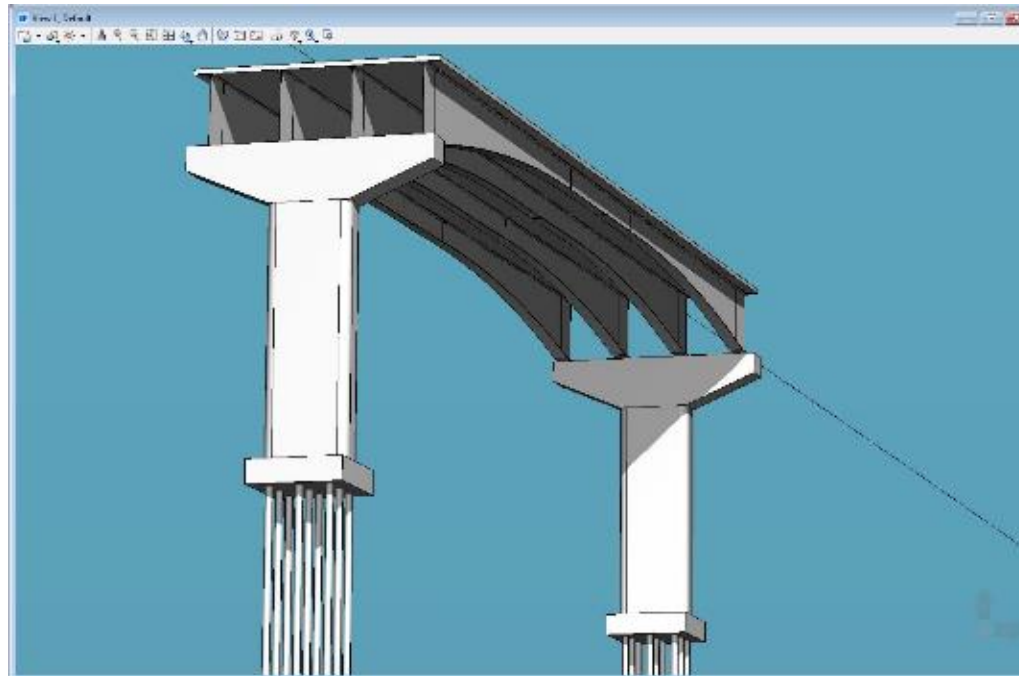
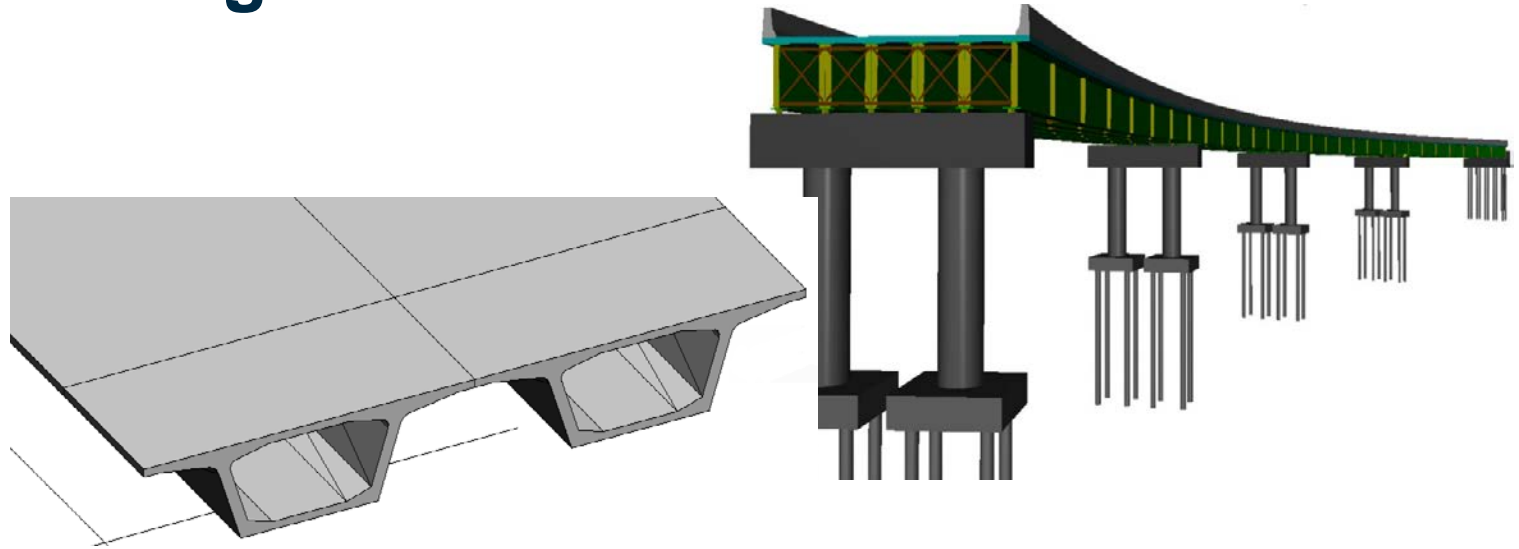
OpenBridge Designer





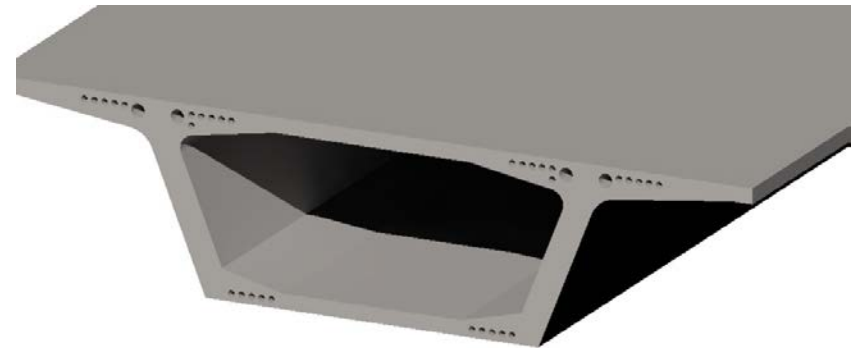
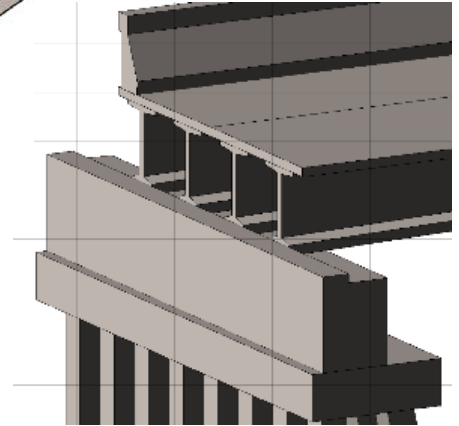
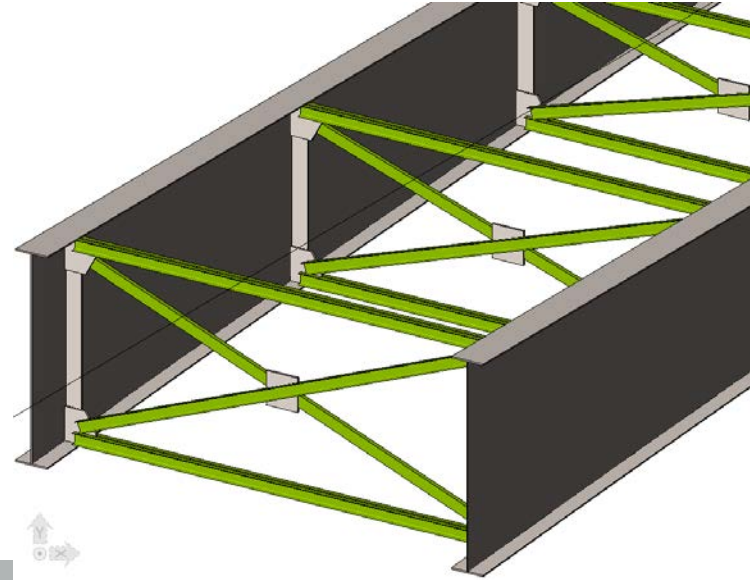
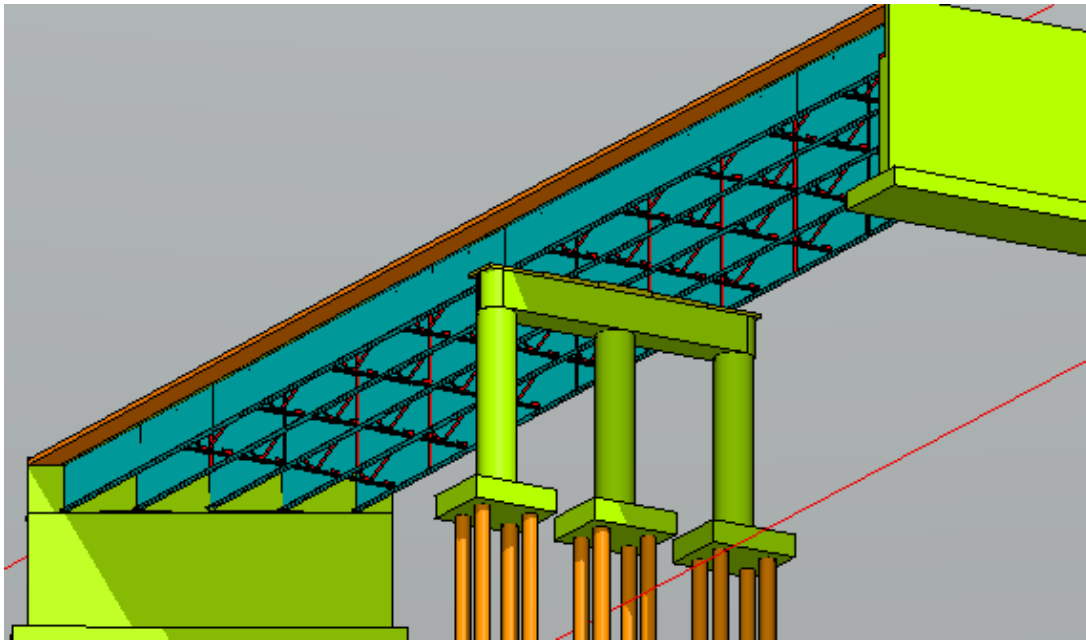
Bridge Types in OpenBridge Designer

- Pre-tensioned Concrete
 - Girder
 - Slab
- Steel girder + concrete slab bridges
 - Rolled Shapes
 - Built-up
- Segmental bridges
 - Span-by-span
 - Balanced cantilever
- Cast-in-Place Concrete Boxes and Slabs



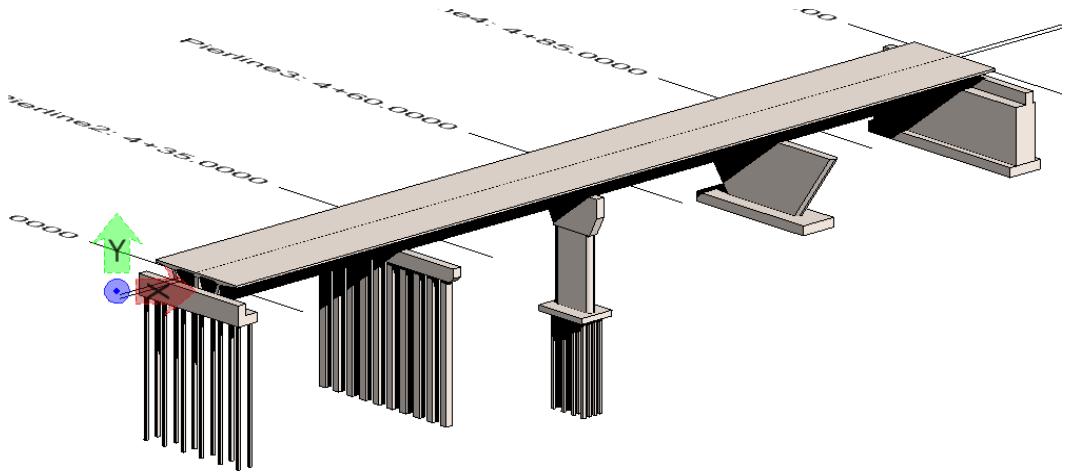
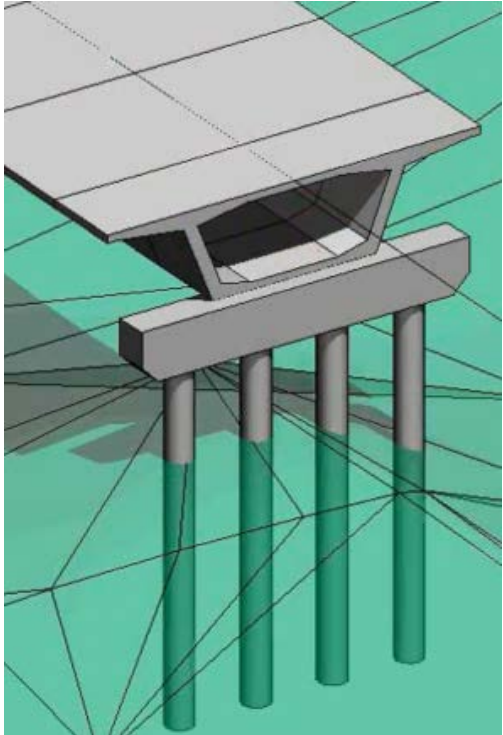
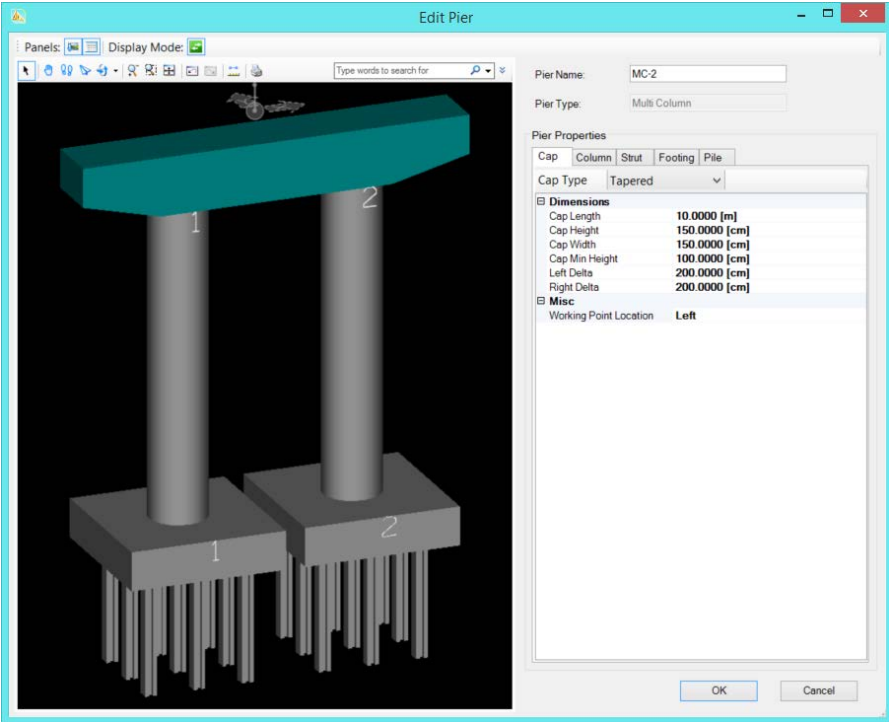
Superstructure Modeling

- 3D parametric bridge modeling
- Super and substructure modeling toolset
- Physical bridge modeling
 - using OBD native geometry tools

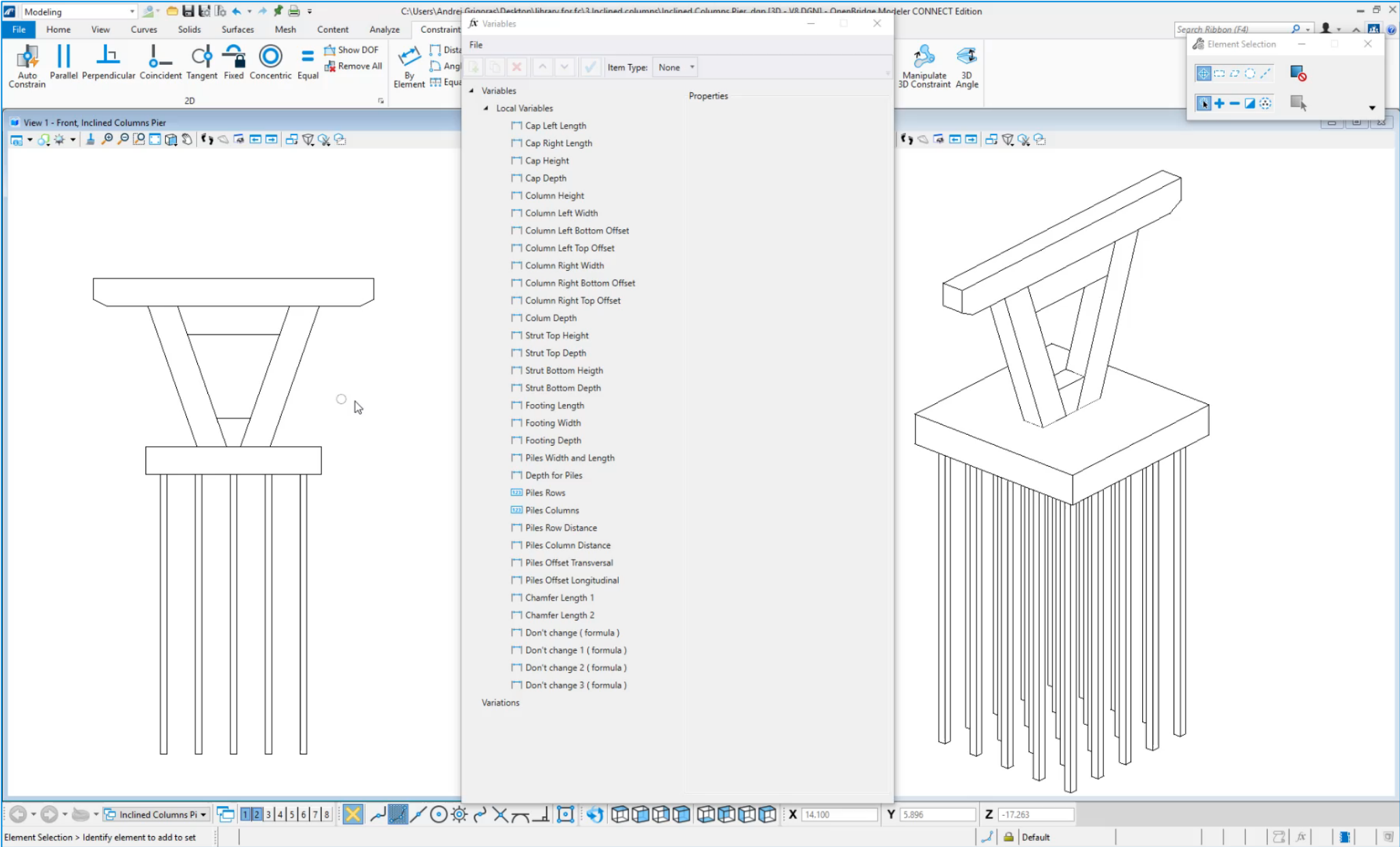


Substructure Modeling

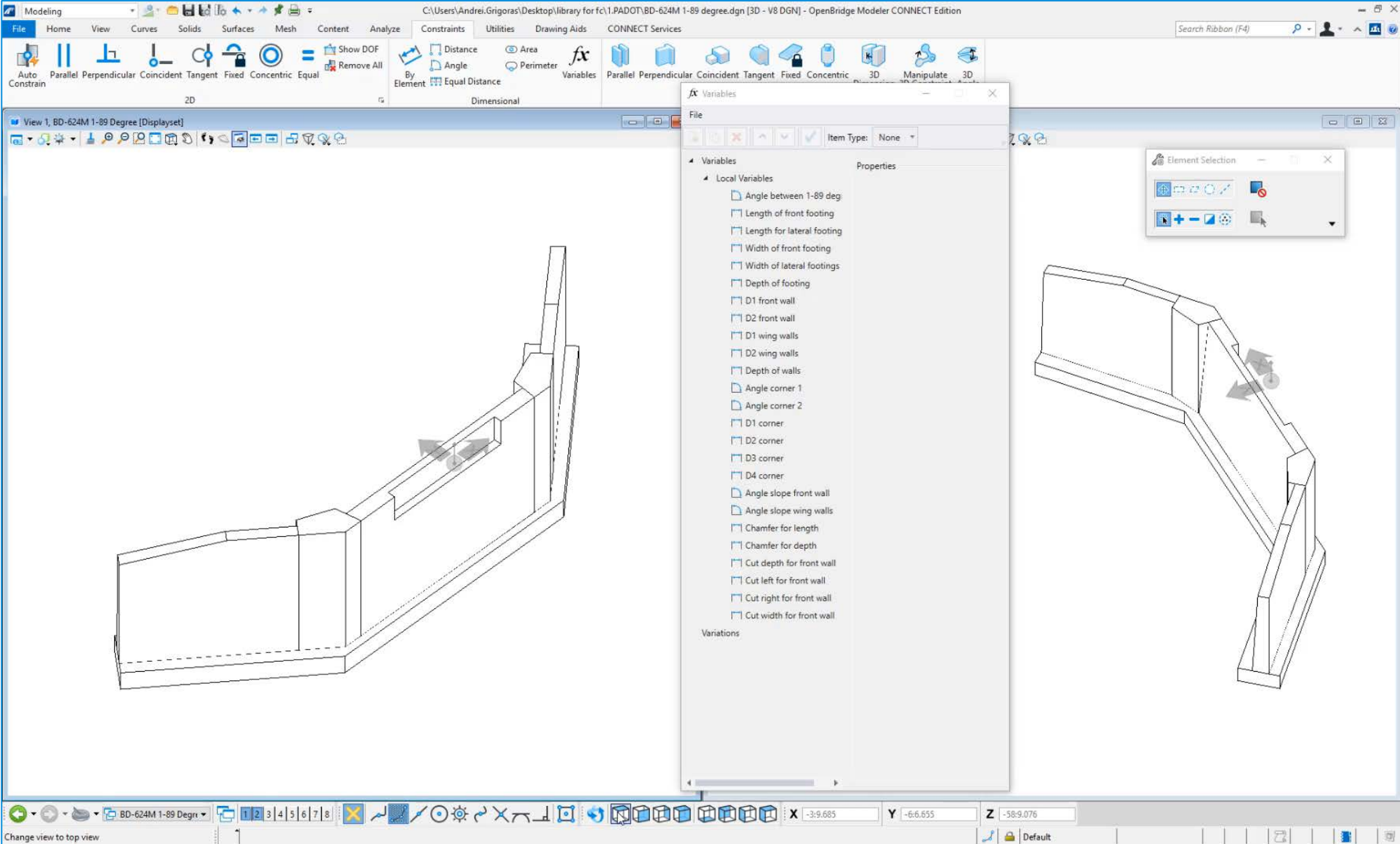
- Abutments
 - Stem wall
 - Pile cap
 - User defined
- Piers
 - Wall piers
 - Multi-column piers
 - Hammer head piers
 - Pile bents
 - User defined



Substructure Modeling

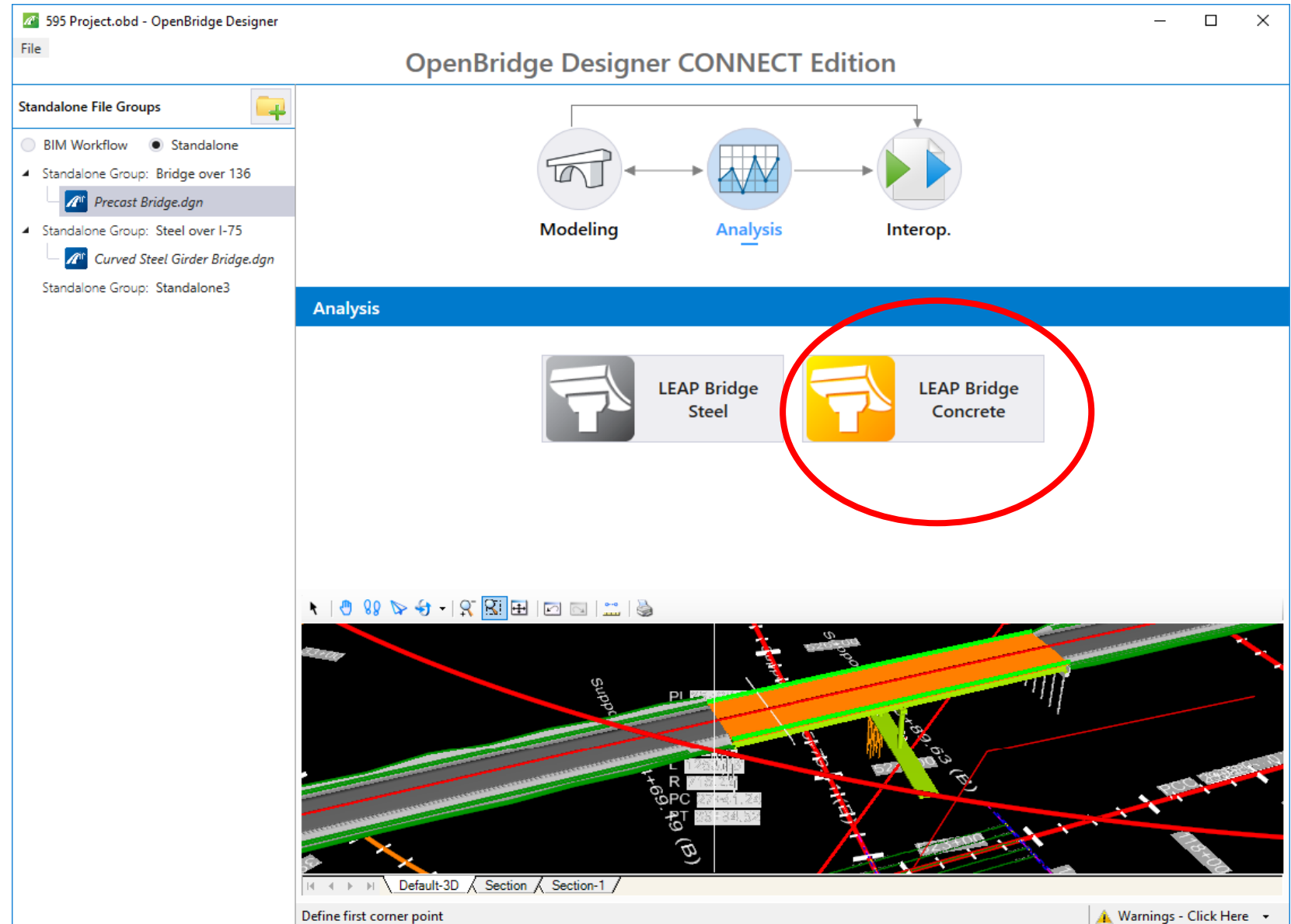


Substructure Modeling

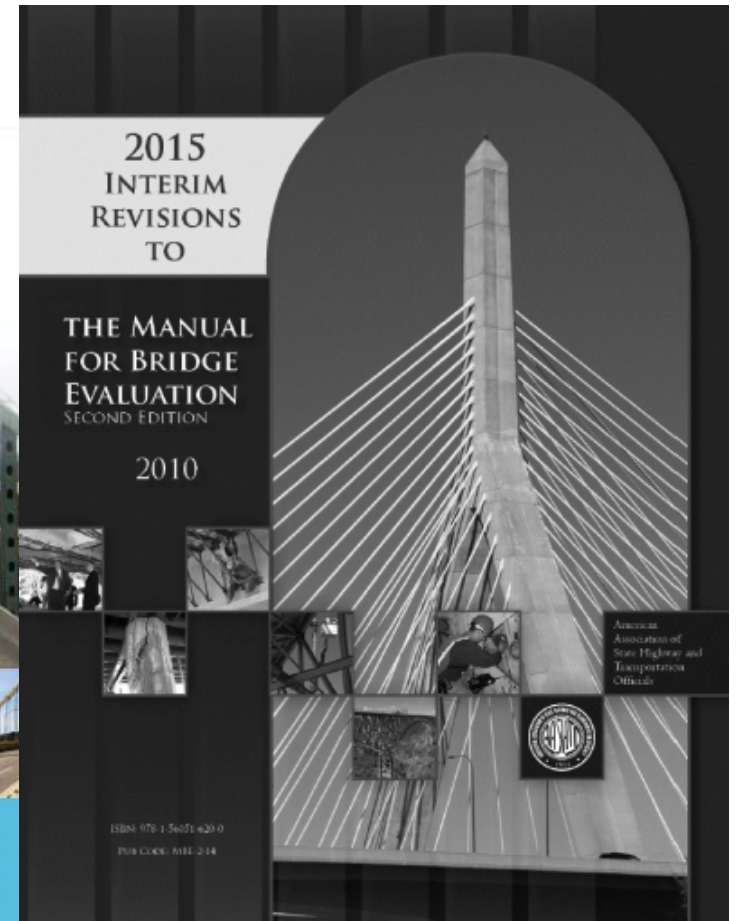
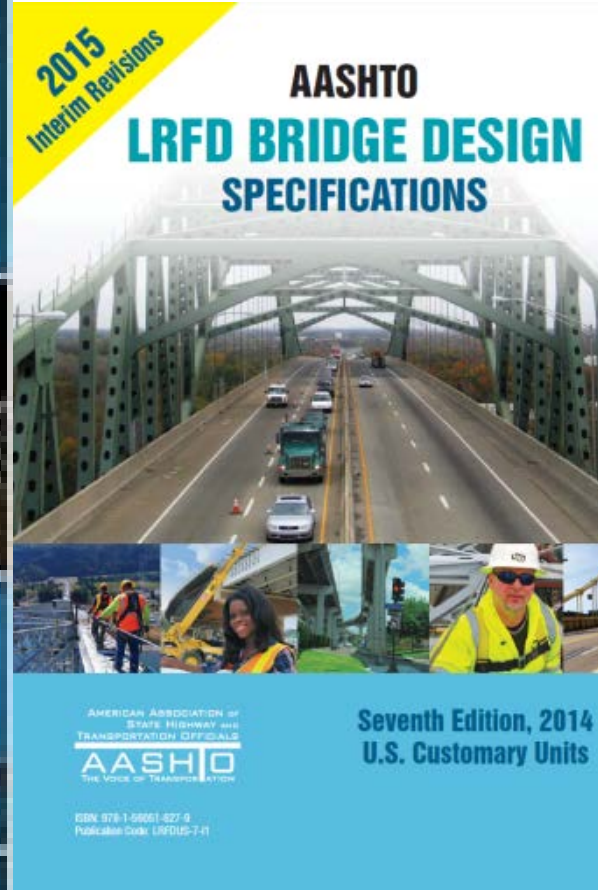
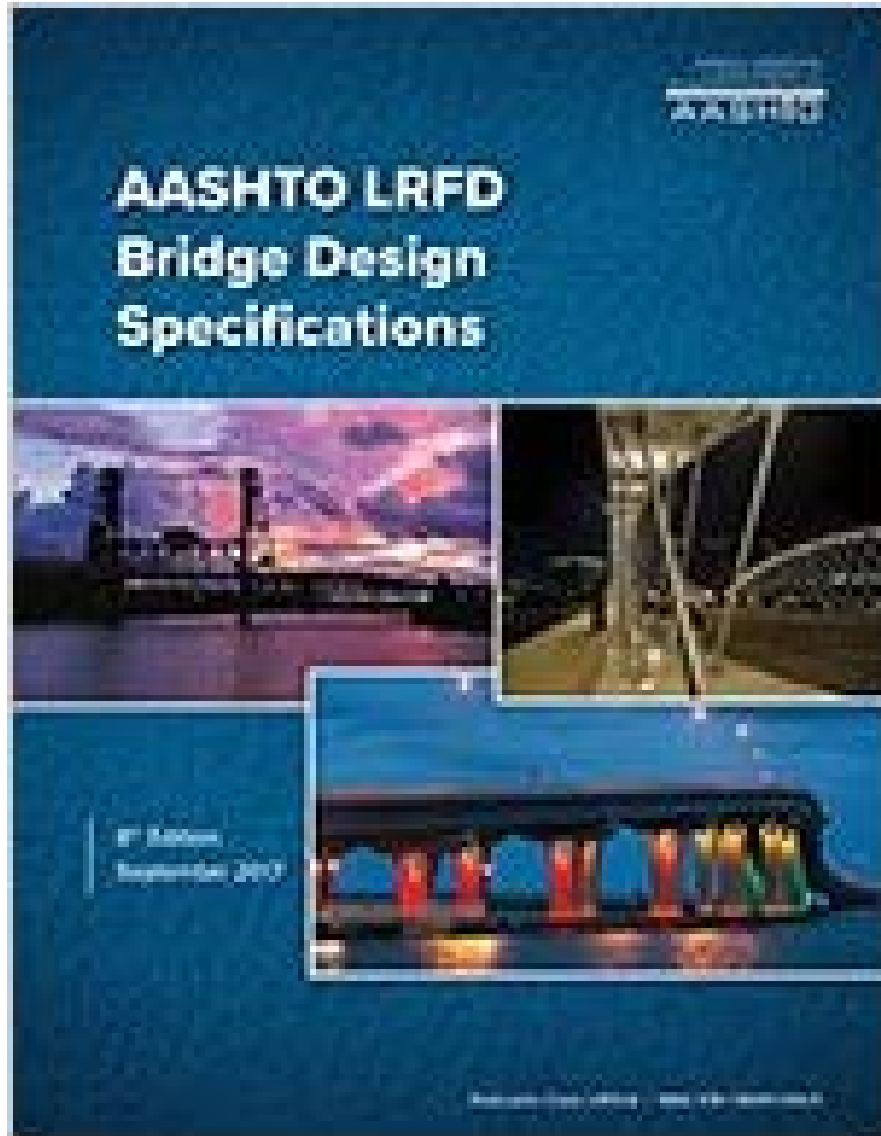


OpenBridge Designer Analytics Connection

- Direct links for Physical to Analytical model
- Bi-directional connectivity



AASHTO LRFD 8th Edition



LEAP Bridge Concrete

Create 3D Bridge Model

Design and analyze concrete bridges

Design and analyze superstructures

Design and analyze substructures

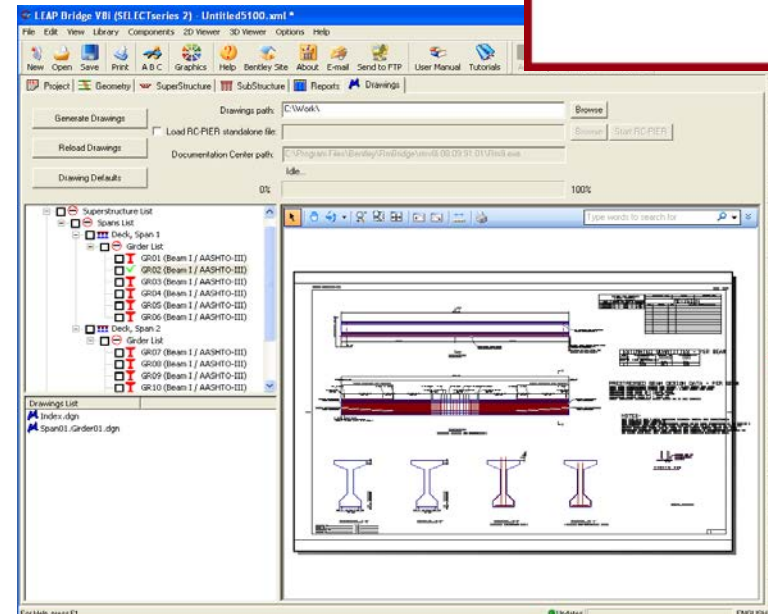
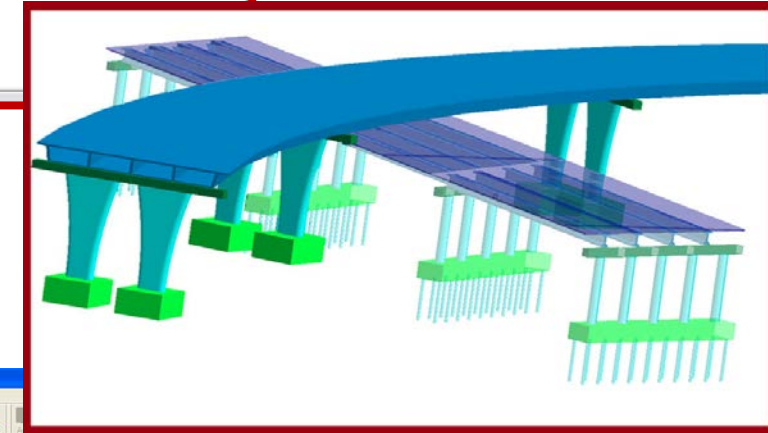
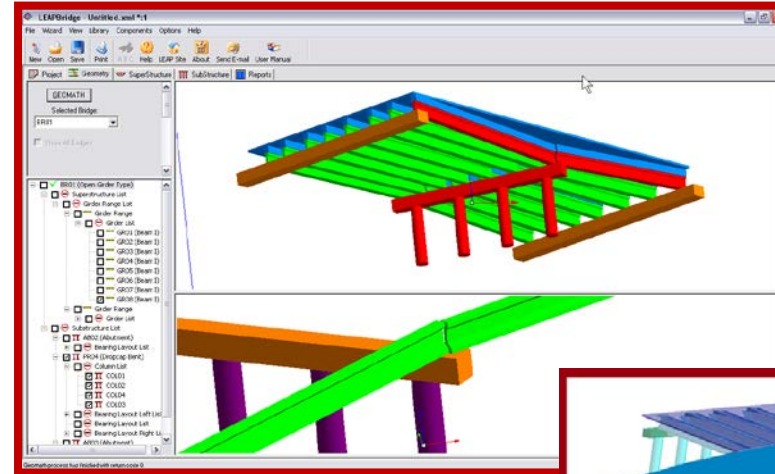
Visualize bridge designs

Analyze and rate traffic loading

Design and analyze spliced girder bridges

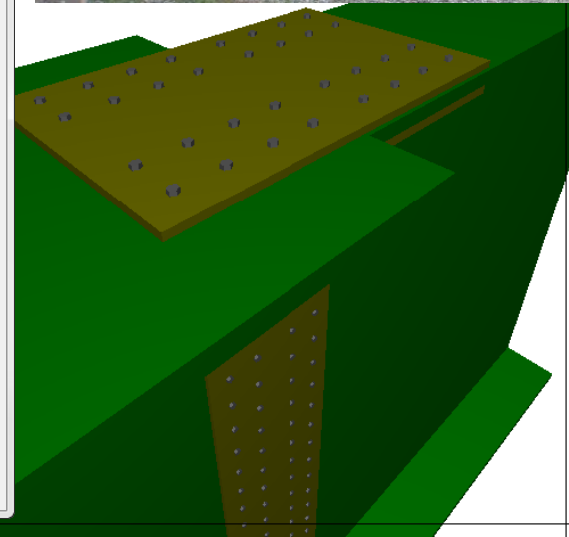
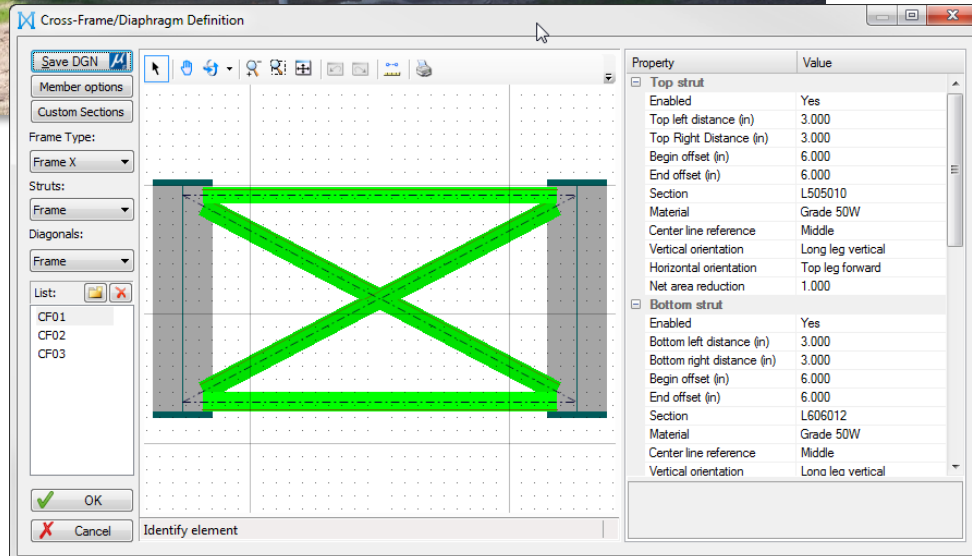
Generate bridge project deliverables

Coordinate multi-discipline bridge teams



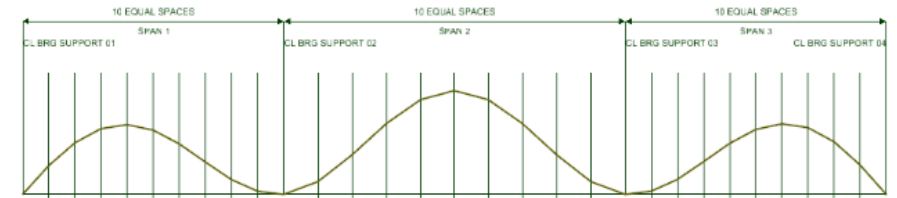
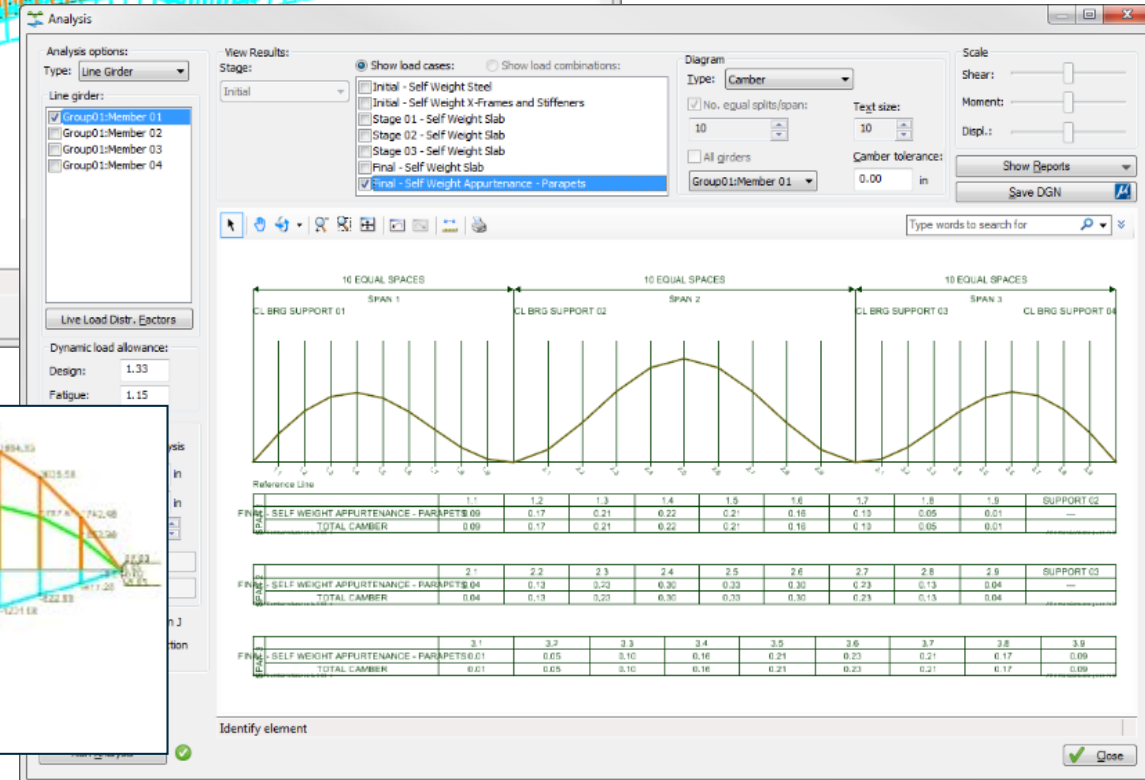
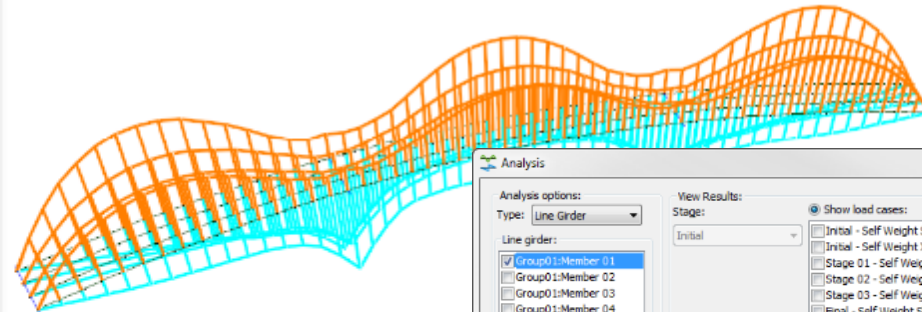
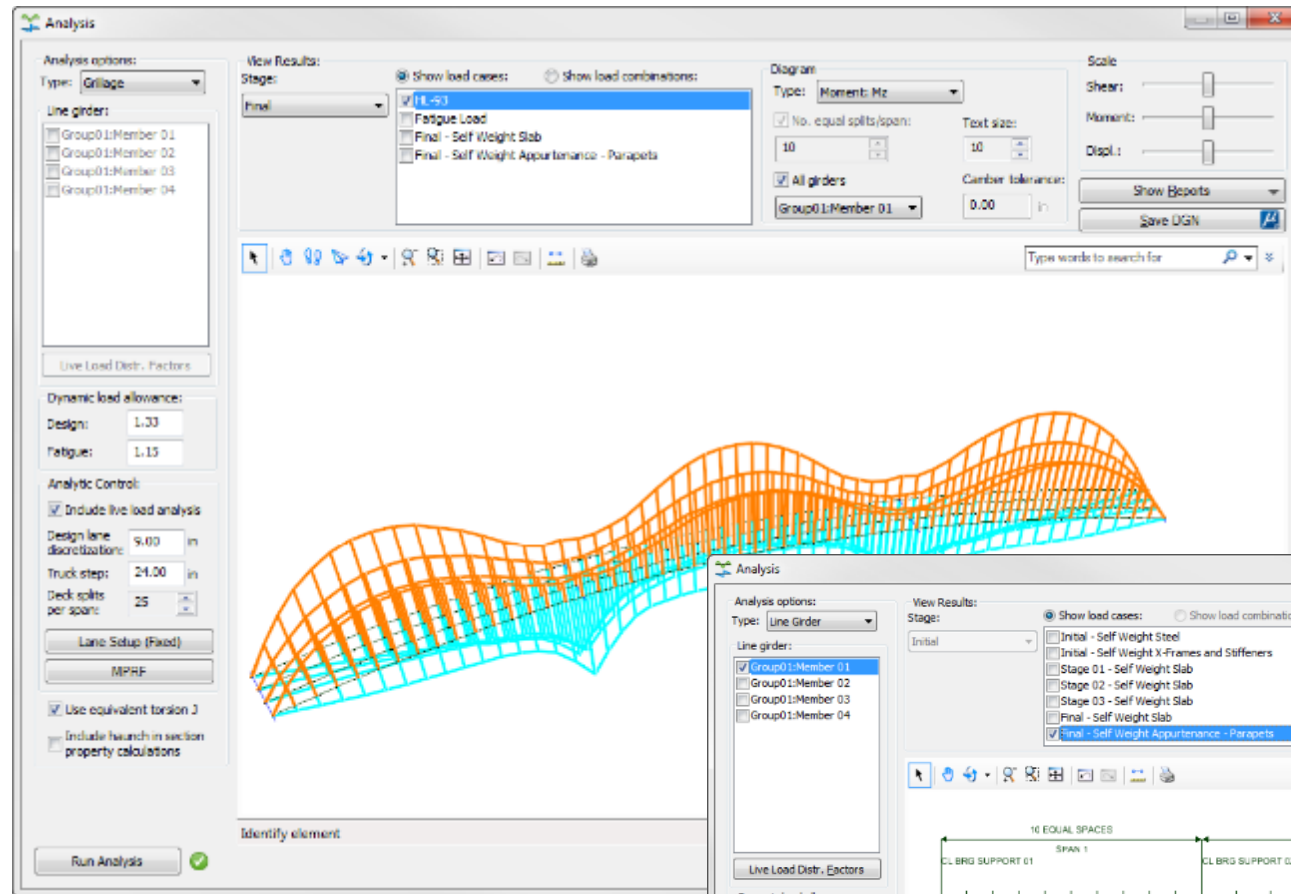
LEAP Bridge Steel

Modeling, design, analysis, and load-rating system for steel bridges

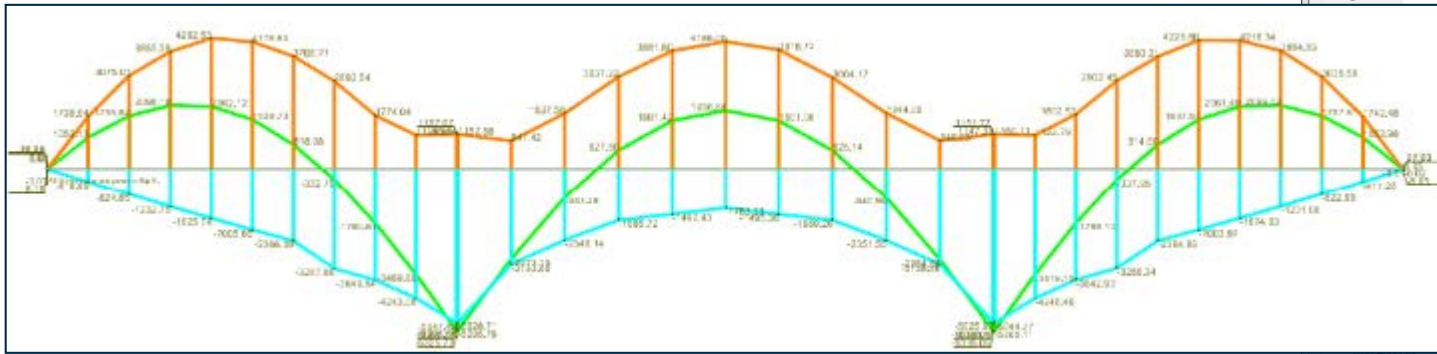


Steel Analysis

- Line girder, grillage and 3D finite element for I-girders
- 3D finite element for tub-girders

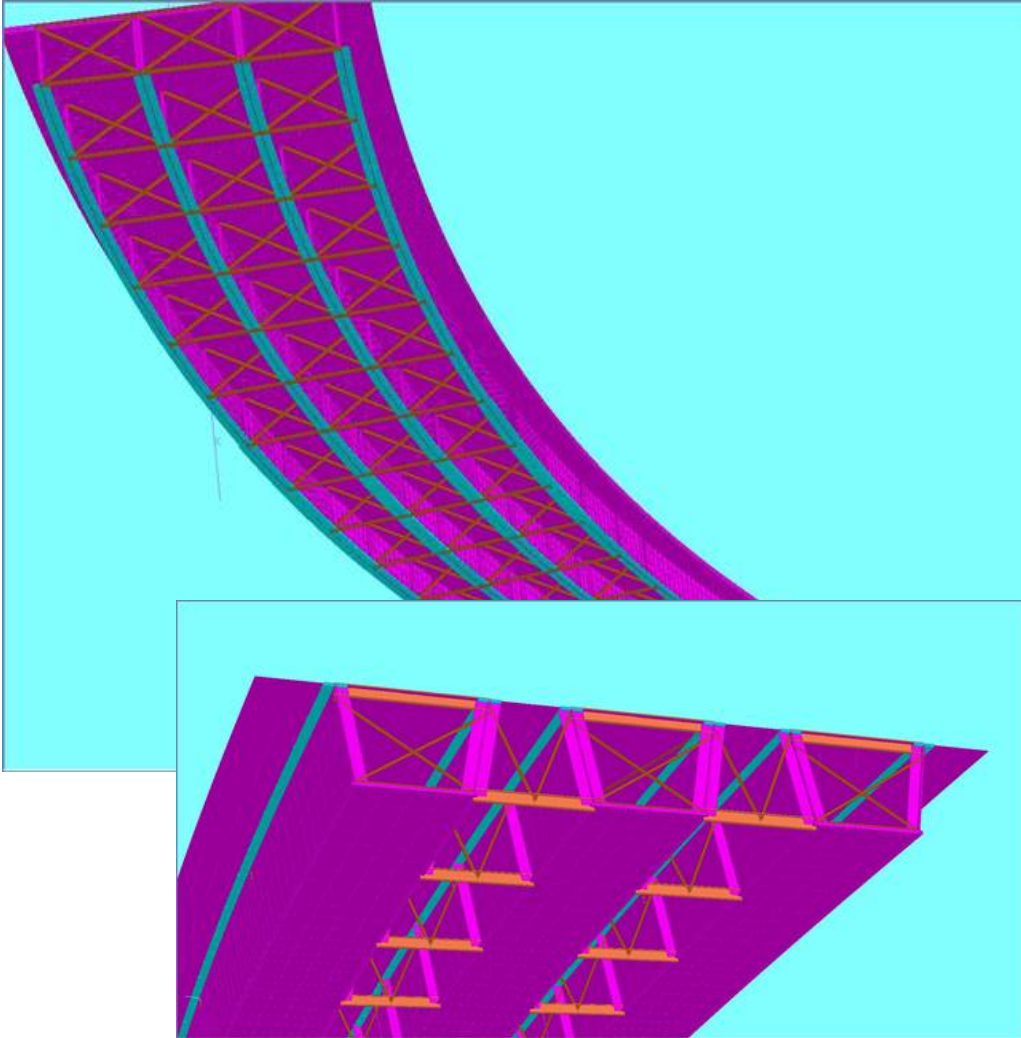


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FN1 - SELF WEIGHT APRTURENCE - PARAPETS 00	0.17	0.21	0.22	0.21	0.18	0.13	0.05	0.01		
TOTAL CAMBER	0.09	0.17	0.21	0.22	0.21	0.18	0.13	0.05	0.01	
FN1 - SELF WEIGHT APRTURENCE - PARAPETS 04	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	SUPPORT 03
TOTAL CAMBER	0.04	0.13	0.23	0.30	0.33	0.30	0.23	0.13	0.04	
FN1 - SELF WEIGHT APRTURENCE - PARAPETS 01	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	
TOTAL CAMBER	0.01	0.05	0.10	0.16	0.21	0.23	0.21	0.17	0.09	

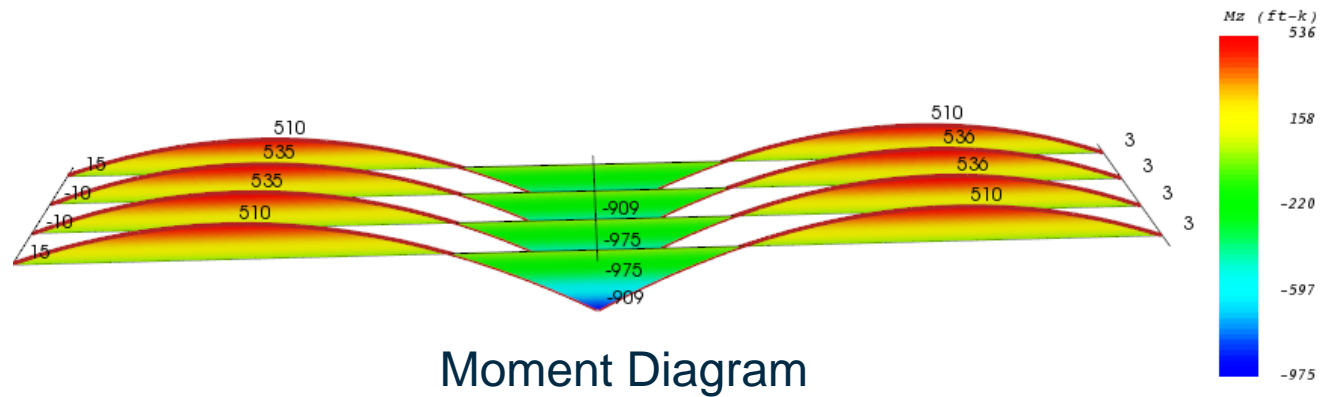
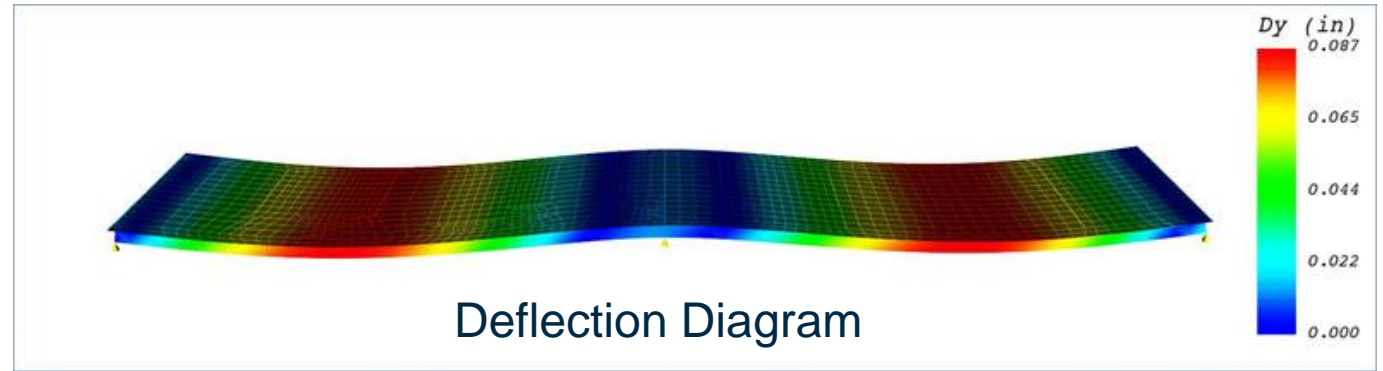


3D Finite Element Analysis

- Analytical Model



- Analysis Results



Camber Diagrams

- Generation of camber diagrams and the ability to export to a DGN file

The screenshot displays the 'Analysis' window in Bentley software, configured for generating camber diagrams for a line girder. The interface is divided into several sections:

- Analysis options:**
 - Type: Line Girder
 - Line girder: Group01:Member 01 (selected)
 - Dynamic load allowance: Design: 1.33, Fatigue: 1.15
 - Analytic Control: Include live load analysis
 - Design lane discretization: 9.00 in
 - Truck step: 24.00 in
 - Deck splits per span: 25
 - Buttons: Lane Setup (Fixed), MPRF
 - Use equivalent torsion J
 - Include haunch in section property calculations
 - Run Analysis button with a green checkmark.
- View Results:**
 - Stage: Initial
 - Show load cases: (Selected)
 - Initial - Self Weight Steel
 - Initial - Self Weight X-Frames and Stiffeners
 - Stage 01 - Self Weight Slab
 - Stage 02 - Self Weight Slab
 - Stage 03 - Self Weight Slab
 - Final - Self Weight Slab
 - Final - Self Weight Appurtenance - Parapets (selected)
- Diagram:**
 - Type: Camber
 - No. equal splits/span: 10
 - Text size: 10
 - All girders
 - Camber tolerance: 0.00 in
 - Group01:Member 01 (selected)
- Scale:**
 - Shear: [Slider]
 - Moment: [Slider]
 - Displ.: [Slider]
 - Show Reports button
 - Save DGN button
- Main Diagram Area:**
 - Graph showing camber curves for three spans (SPAN 1, SPAN 2, SPAN 3) over 10 equal spaces each.
 - Supports: CL BRG SUPPORT 01, CL BRG SUPPORT 02, CL BRG SUPPORT 03, CL BRG SUPPORT 04.
 - Reference Line table below the graph:
- Reference Line Data:**

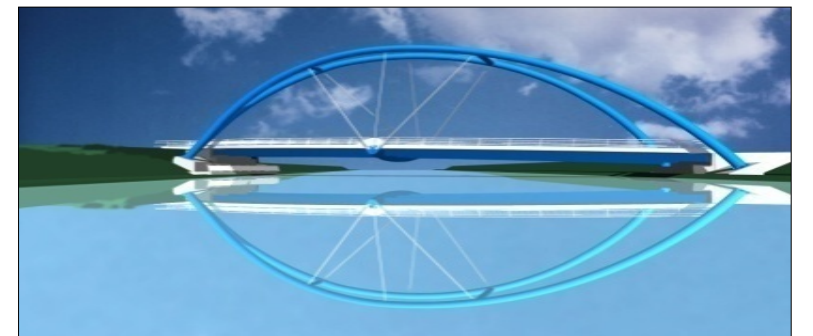
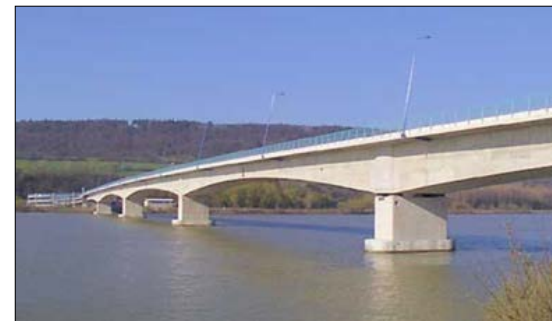
Reference Line	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	SUPPORT 02
FIN - SELF WEIGHT APPURTENANCE - PARAPETS 09	0.09	0.17	0.21	0.22	0.21	0.18	0.13	0.05	0.01	---
TOTAL CAMBER	0.09	0.17	0.21	0.22	0.21	0.18	0.13	0.05	0.01	---

Reference Line	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	SUPPORT 03
FIN - SELF WEIGHT APPURTENANCE - PARAPETS 04	0.04	0.13	0.20	0.30	0.33	0.30	0.23	0.13	0.04	---
TOTAL CAMBER	0.04	0.13	0.20	0.30	0.33	0.30	0.23	0.13	0.04	---

Reference Line	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
FIN - SELF WEIGHT APPURTENANCE - PARAPETS 01	0.01	0.05	0.10	0.16	0.21	0.23	0.21	0.17	0.09
TOTAL CAMBER	0.01	0.05	0.10	0.16	0.21	0.23	0.21	0.17	0.09
- Identify element:** Input field at the bottom.
- Close:** Button with a green checkmark.

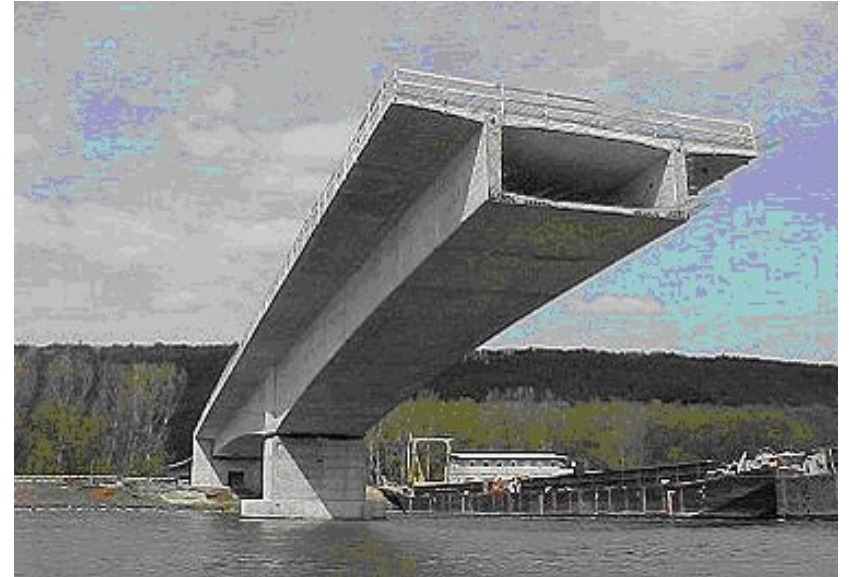
RM Bridge

- **All types of bridges**
 - Reinforced and pre-stressed concrete
 - Steel, concrete and composite
 - Cable-stayed bridges
 - Suspension bridges
 - Arch
 - Truss
- **Any erection method**
 - Span-by-span
 - Advanced shoring
 - Incremental launching
 - Balanced cantilever
 - Pre-cast segmental
- **International codes**



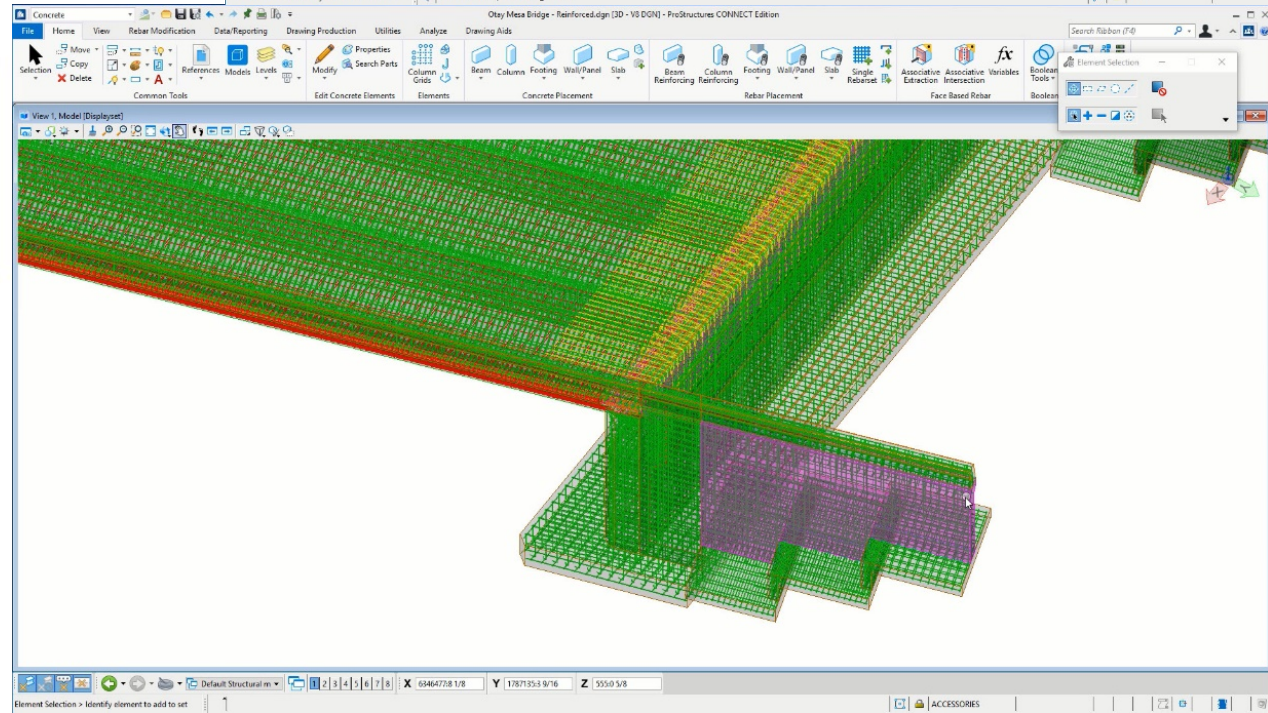
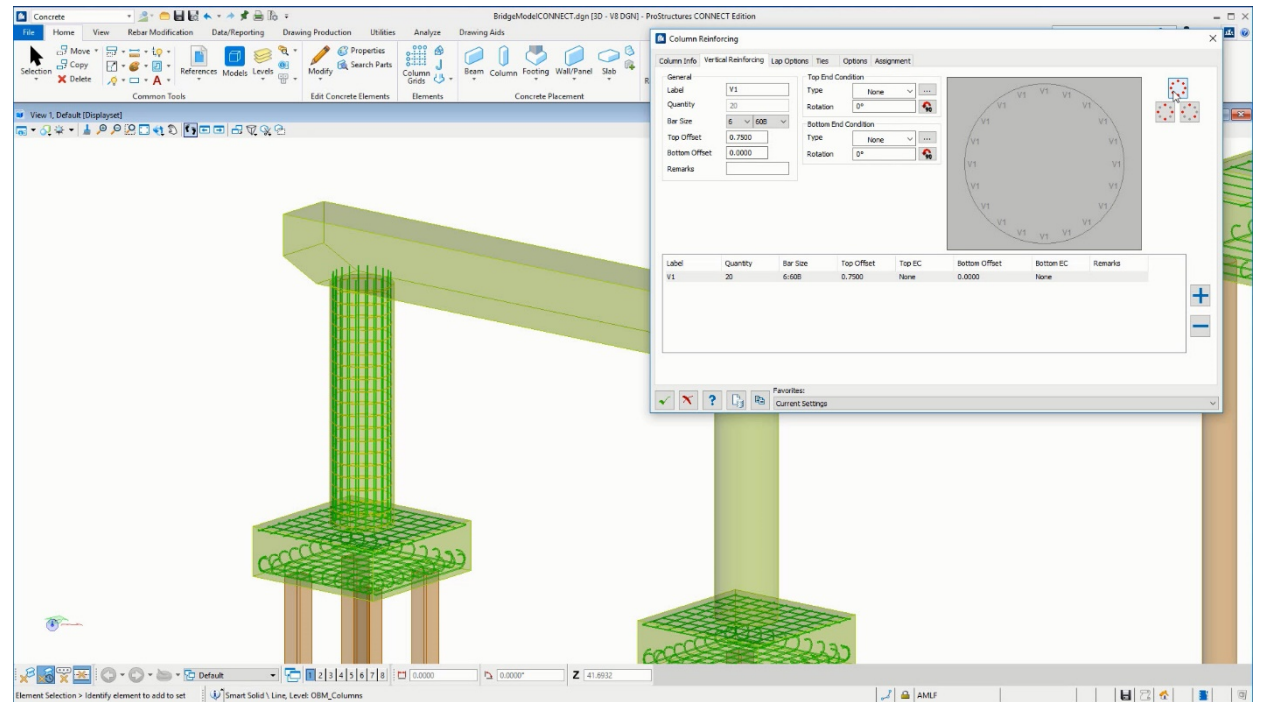
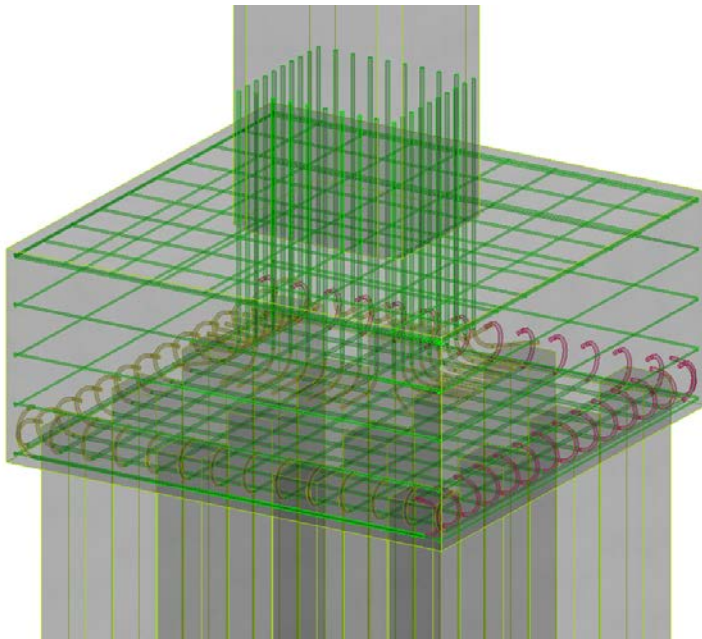
Complex Bridges

- Quickly create/update complex bridges using simple parameters
- Typical, pier, closure segments
- Flexible support for complex section variations
- Report segment weight, volume and surface area
- Full 3D model generated
- Send/Receive to RM Bridge for analysis and design

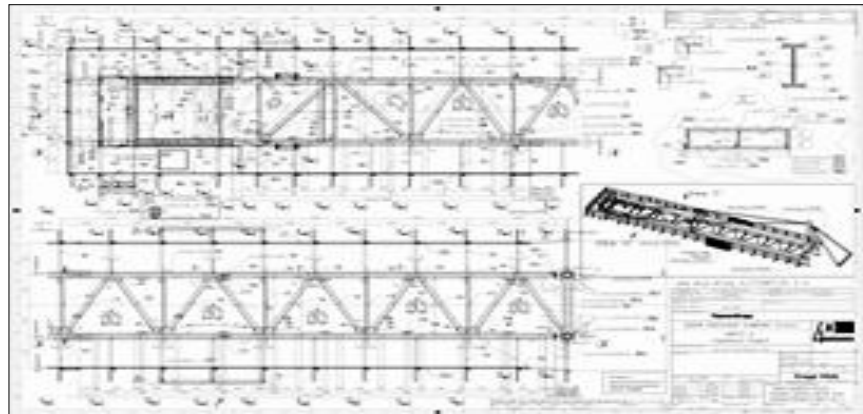
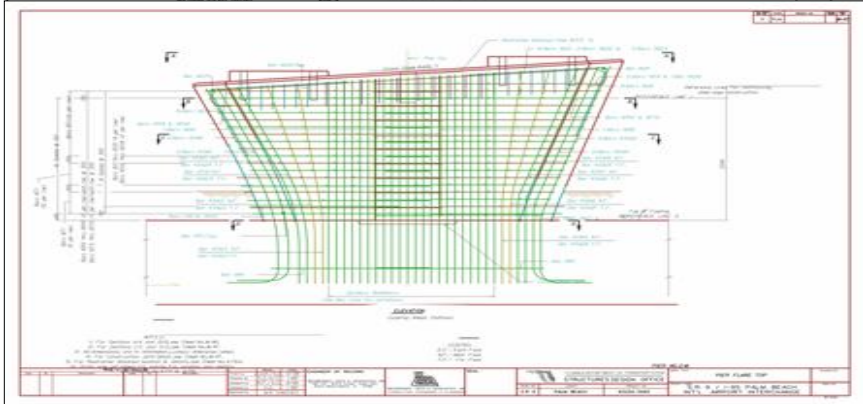
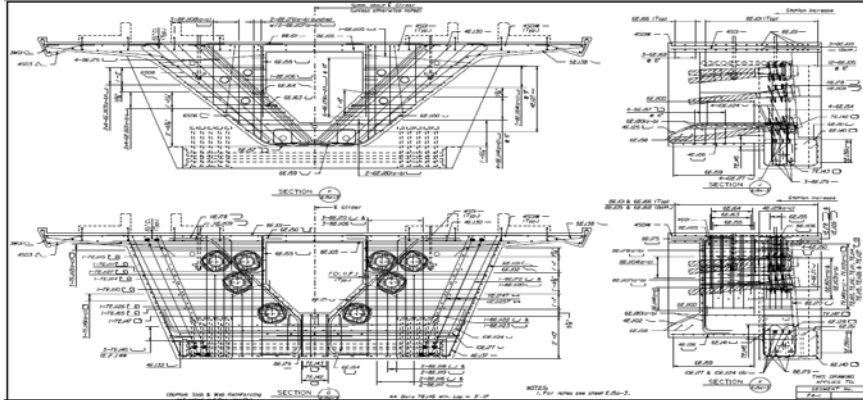
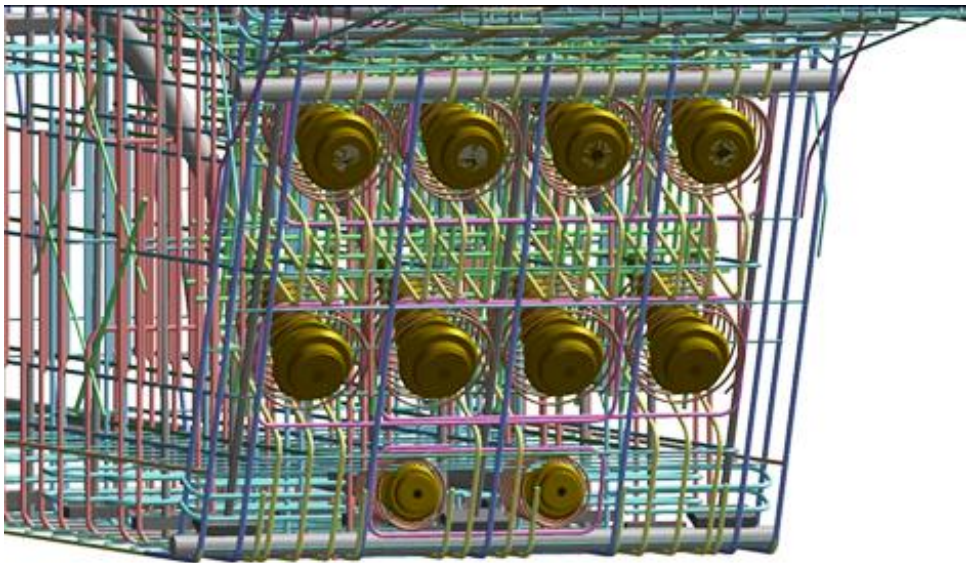
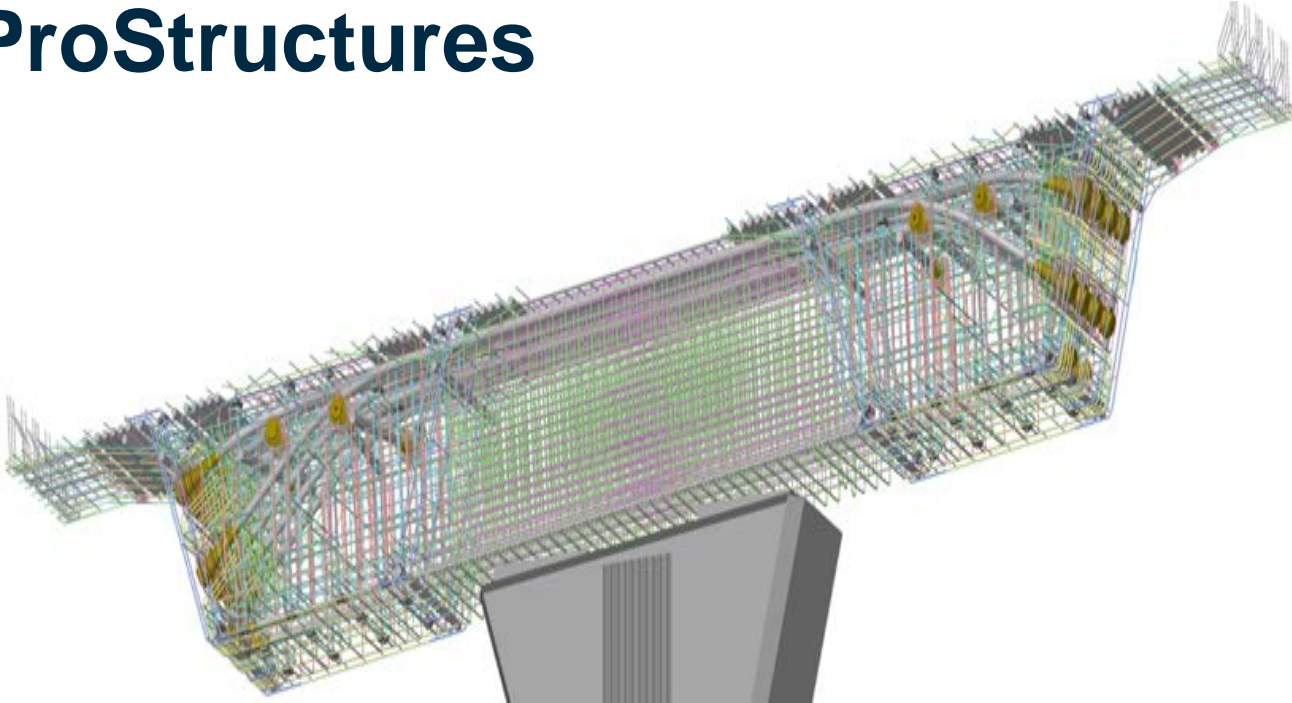


Integration with ProStructures

- Concrete objects are automatically recognized in ProStructures
- Reinforcing using ProConcrete tools and Dynamic Views to Label & Detail



ProStructures



Bar Bending Schedules

- User-defined reports

<u>Order Name:</u> Order		<u>Building Owner:</u> Bentley Systems	
<u>Project Name:</u> ProStructures		<u>Project:</u> Pro 001	<u>Drawing Name:</u>
		<u>Signed by:</u> 	<u>Created at Time:</u> 19.5.2011 8:43 h



Colour Bar Mark Quantity Product E/R Length Bar Style R

	9T4	2	9		20'-11"	
					20'-11"	
					20'-10"	

11-07	Quantity: 25	Size: 5	Grade: 60	Length: 11-11	Mark: 5A8
Job: 06-145 Rel: 1 CC: AAP	Ship: T1 Pin: 0-022 BC: L	2-06	0-05%	0-05%	
Qty: 25 Size: 5 Lgh: 11-11 Mark: 5A8 Grd: 60 BC: L	Session: 000010 Run: 130047 ID: 3	3-00	3-00		
Bndl: 1 of 1 Page: 1 Item: 2 MB: 2J Lbs: 311	1: 135°F 2: 90°F 3: 90°F 4: 90°F 5: 135°F	2-06			
Run: 130047	Applied Systems Associates 1.800.CALLASA				
Session: 000010	Job: 06-145 Dwg: Ref North Point Office Complex A & P STEEL CO. Foundation Steel	Detailer: adm Rel: 1 CC: AAP	Page: 1 Item: 2 Bndl: 1 of 1 Lbs: 311 Ship: Nov 27	List: 2 Tag: 1 Stop: 31 Bin: 2 MB: 2J	
Run Date: 11/14/2008 Ship: Nov 27 Print: 3 Ver: 6.30.227	AAP				

Concrete shapes report

<u>Project Name:</u> Training Project		<u>Project:</u> 2008-001	<u>Drawing Name:</u> Platform	<u>Index:</u> 1
		<u>Signed by:</u> TZ/GJ/JB	<u>Created at Time:</u> 23.6.2011 14:52 h	

ObjectType	PosNum	Grade	Name	Qty	S.Area (SF)	Volume (Yd^3)	Weight (Lbs)	Height	Width	Length
Column	2	5000 psi	Concrete 1'-4"x1'-4"	1	40.9	0.46	1,808	1'-4"	1'-4"	7'
Column	2	5000 psi	Concrete 1'-4"x1'-4"	1	40.9	0.46	1,808	1'-4"	1'-4"	7'
Column	3	5000 psi	Concrete 1'-4"x1'-4"	1	30.2	0.33	1,292	1'-4"	1'-4"	5'
Footing	4	3000 psi	Footing	1	53.0	0.60	2,373	1'	2'	8'-2"
Footing	5	3000 psi	Footing	1	76.7	1.23	4,843	1'-4"	5'	5'
Footing	5	3000 psi	Footing	1	76.7	1.23	4,843	1'-4"	5'	5'
Footing	5	3000 psi	Footing	1	76.7	1.23	4,843	1'-4"	5'	5'
Footing	6	3000 psi	Footing	1	32.0	0.35	1,356	1'	2'	4'-8"
Footing	7	3000 psi	Footing	1	29.3	0.31	1,223	1'	2'	4'-3"
Footing	8	3000 psi	Footing	1	41.2	0.59	2,301	3'	2'	3'-11"
Panel	10	5000 psi	Panel	1	200.0	2.98	11,696	8'	1'	11'-6"
Panel	11	5000 psi	Panel	1	196.0	2.96	11,624	8'	1'	10'
Panel	12	5000 psi	Panel	1	157.8	2.33	9,154	8'	1'	7'-11"
Panel	13	5000 psi	Panel	1	103.0	1.44	5,666	6'	1'	6'-6"
Panel	9	5000 psi	Panel	1	338.0	5.35	21,000	10'	1'	14'-5"

Page totals:										
Quantity	15									
Volume						21.88	Yd^3			
Weight						85,830	Lbs			

DOT Perspective



**Department of
Transportation**



Questions ???





BIM for Bridges: OpenBridge Designer

Comprehensive Modeling and Design from Planning to Construction

Steve Willoughby
Senior Engineering Consultant

Bentley[®]
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