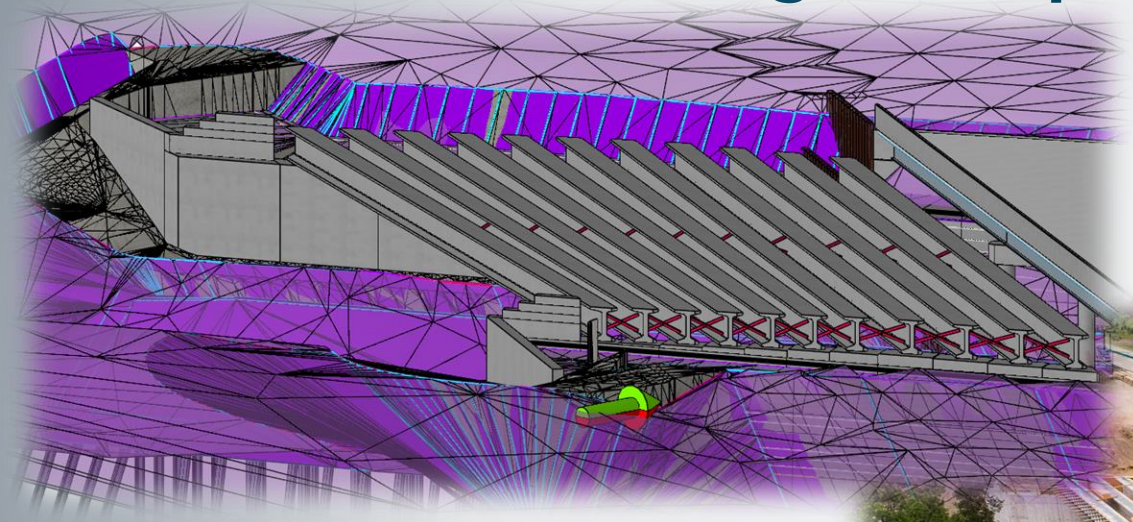
Bridge Model as a Legal Document (MALD)

Michigan's Experience



Brad Wagner – Michigan DOT

Brian Travis – Michigan DOT

Jake Hall – C.A. Hull Co., Inc.

C.A. HULL

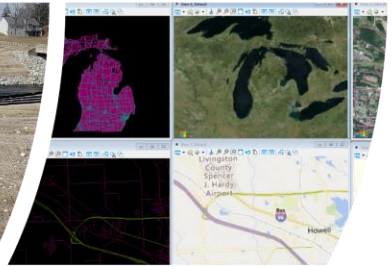
Michael Baker INTERNATIONAL

MDOT Michigan Department of Transportation

BACKGROUND

Key Milestones

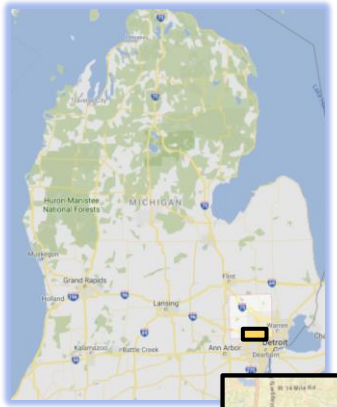
Year	Milestone
2003	Statewide Document Management System
2005	eProposal
2008	ArcGIS Enterprise geospatial database
2014	eConstruction
2015	3D Design Models Required
2016	Automated Machine Guidance
2017	Digital Delivery Pilots
2020	Ancillary Asset Management System
2023	Model As a Legal Document (MALD) Pilot



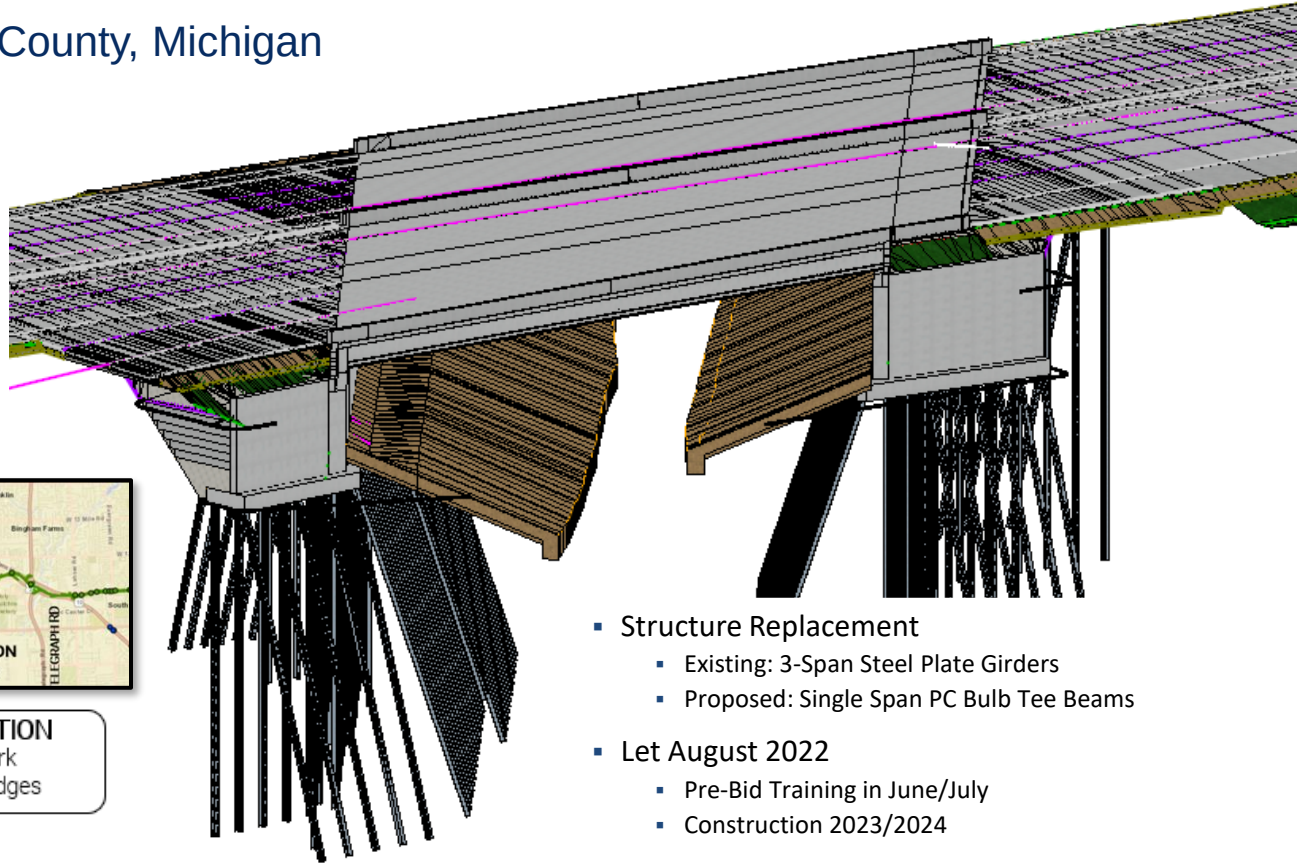
"It's in there..."

I-696 EB & WB OVER ROUGE RIVER

City of Southfield, Oakland County, Michigan

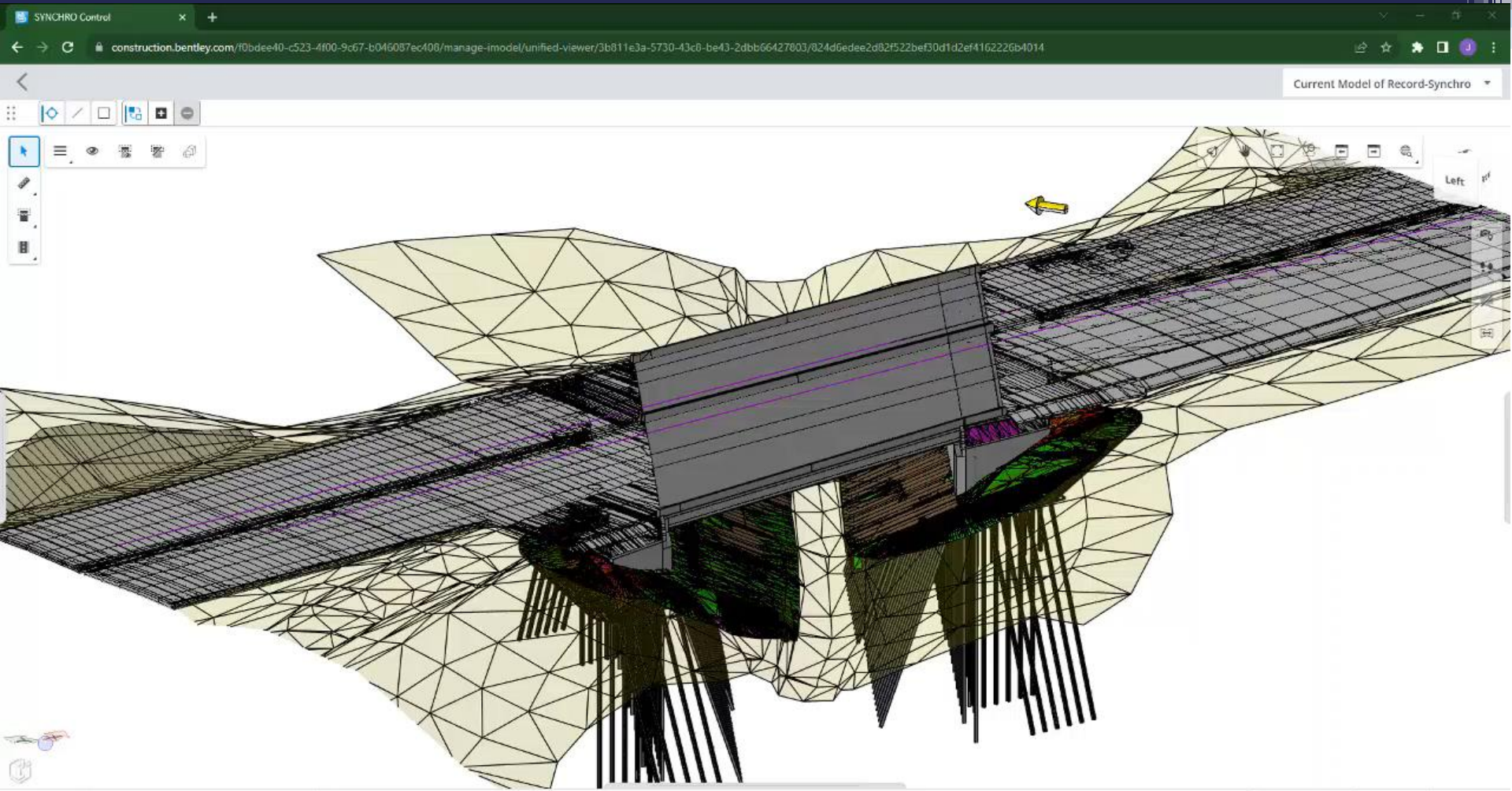


I-696 RECONSTRUCTION
8.5 miles of road work
Rehabilitation of 10 bridges



- Structure Replacement
  - Existing: 3-Span Steel Plate Girders
  - Proposed: Single Span PC Bulb Tee Beams
- Let August 2022
  - Pre-Bid Training in June/July
  - Construction 2023/2024

MODEL OVERVIEW


SYNCHRO Control
construction.bentley.com/f0bdee40-c523-4f00-9c67-b046087ec408/manage-imodel/unified-viewer/3b811e3a-5730-43c0-be43-2dbb66427803/824d6edee2d82f522bef30d1d2ef4162226b4014
Current Model of Record-Synchro
Left
Messages
Identify element
Views
Presentation
Snap Mode
Scope:
Element
0
Settings

MODEL STRUCTURE & FORMAT

Model & Software Structure

Bridge Model Files

ProConcrete
Steel Reinforcement
Design & Quantities

OpenBridge Modeler
3D Structure Models
(Existing and Proposed)

Others

Other Discipline Files

OpenRoads Designer
3D Road Models
Survey and Earthwork Models
gINT Geotechnical Data

Excel
Tables (deck elevations, beam details, etc.

PDF
Reports (SP, etc.)

MicroStation
2D details

"Container" File

DGN (OpenRoads Designer or Bentley View)

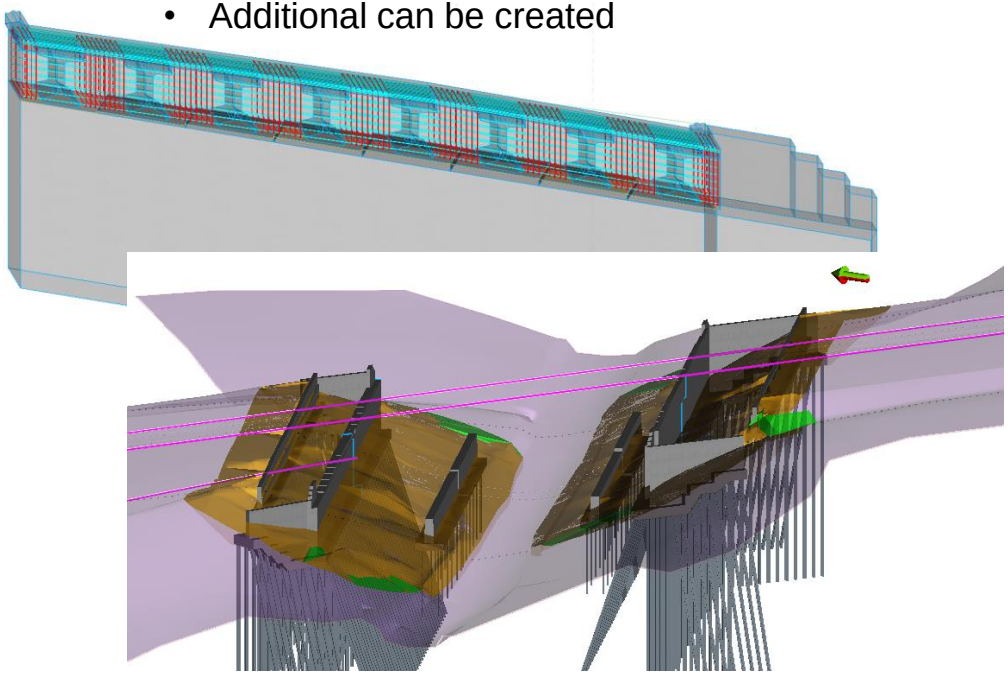
Construction Software

SYNCHRO
Trimble
Leica Geosystems

Others

Saved Views

- Allows user to quickly access oriented information
- Additional can be created

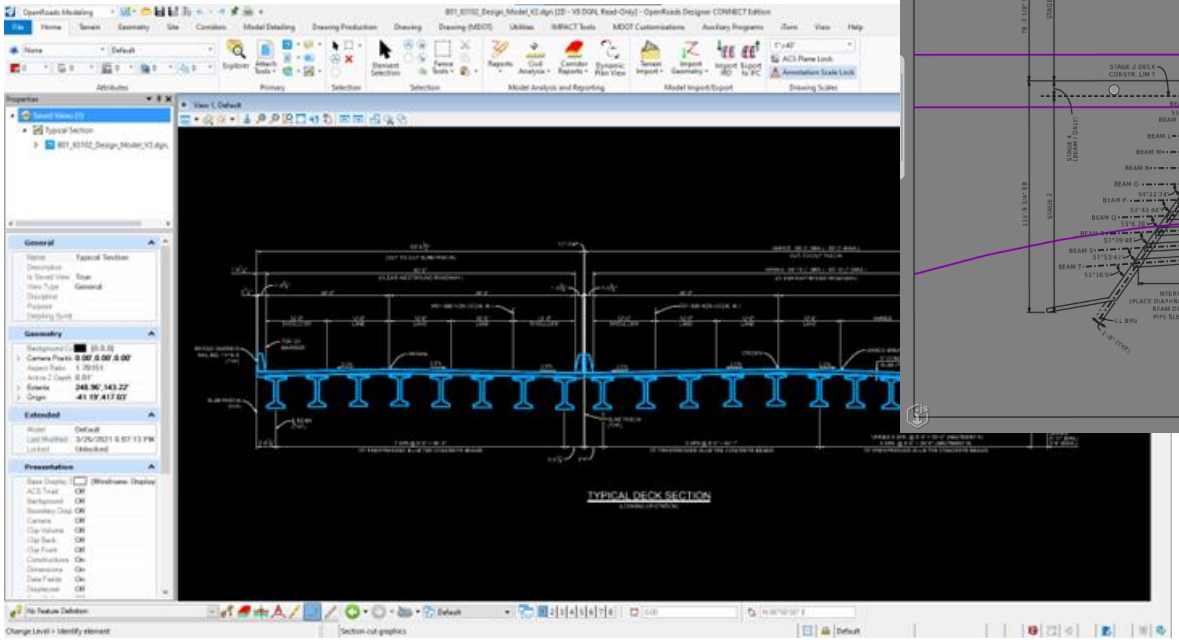


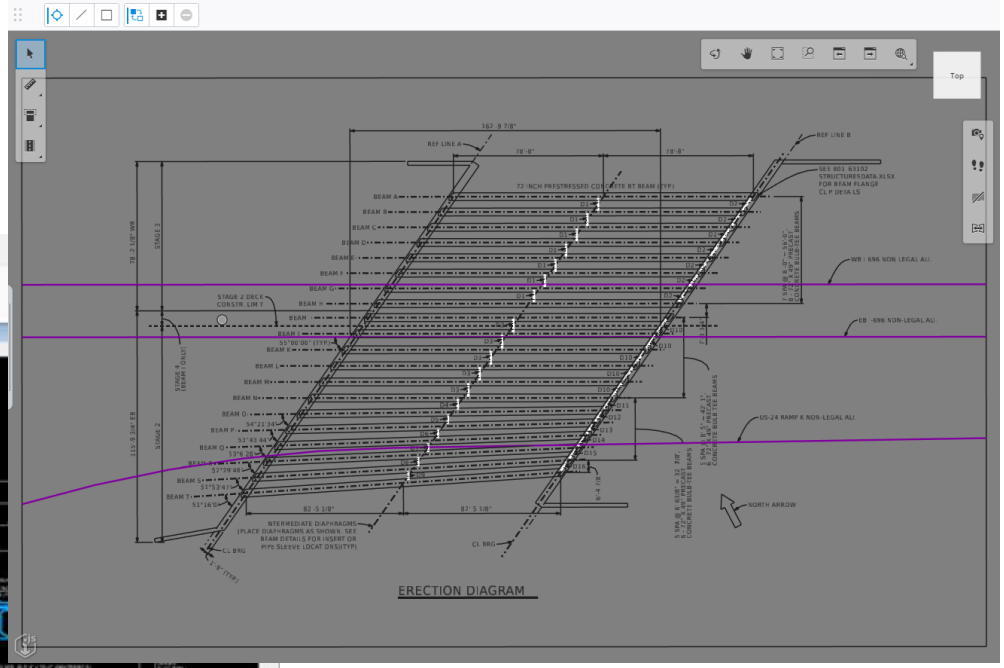
Saved Views - View 1

Name	Description
1.00 Plan Overview	Overall general plan of structure and approaches
1.04 Structure 3D View	Isometric view of the structures
1.05 Earthwork	Excavation and fill limits in 3D with only pertinent surfaces and subst
1.07 Pile Layout	Plan view of pile layout including location of test piles (red circles arc
1.08 Utilities Existing	Plan view of existing utilities near the structure
0.04 General Notes	General notes for overall bridge construction
0.05 Riprap Header Details	2D details and notes of the riprap header placement and limits at abu
0.06 Construction Joints - Superstructure	2D details of longitudinal construction joints for superstructure inclu
0.07 Joints - Substructure	2D details of construction and expansion joints (including expansion
0.09 Superstructure Coating Detail	2D detail and notes for barrier & deck fascia coating limits
0.13 Abutment pour diagram	Proposed pour locations and designations in 2D elevation views
0.10 Deck pour diagram	Proposed deck pour locations and designations in 2D plan view
0.11 EPS Block Lightweight Fill Details	2D details and notes for placement of EPS block lightweight fill
0.12 Slopewall Details	2D details and notes for placement of slopewall adjacent to abutmen
0.08 East Approach Section	2D details including at abutment, approach/sleeper slabs, and underc
1.03 Typical Section_a	Annotated superstructure typical section
1.01 Elevation_a	Annotated general elevation views along the alignment and normal t
1.02 Erection Plan_a	Annotated erection plan with dimensions for setting beams along sk
WB_2.01 Abutment A Footing View	Combine traditional views into an isometric of the abutment footing
WB_2.01 Abutment B Footing View	Combine traditional views into an isometric of the abutment footing
WB_2.02 Abutment A View	Combine traditional plan and elevation views into an isometric of the
WB_2.02 Abutment B View	Combine traditional plan and elevation views into an isometric of the
WB_2.03 Abutment A Section	Traditional abutment section view with reinforcement (perpendicular
0.14 Project Title	View with Project Location and other information traditionally shown
0.00 Model Elements Included as Links	Extents of Model Elements Included as Links section (overview)
0.01 Contractual Model File Links	Links to project contractual model file links
0.02 Special Provision and NTB Links	Links to project Special Provisions and Notice to Bidders
0.03 RID File and Report Links	Link to the RID review checklist and index and other RID files and rep
1.09 Utilities Proposed	Plan view of proposed utilities near the structure
WB_3.02 Deck Plan	Traditional deck plan view with reinforcement
WB_3.02_1 Deck Plan_Top	Traditional deck plan view with reinforcement with only top mat of re
WB_3.02_2 Deck Plan_Bottom	Traditional deck plan view with reinforcement with only bottom mat
WB_3.04 Deck and Barrier View	Isometric view of deck and barriers with reinforcement
WB_3.03 Deck Section	Traditional deck section view with reinforcement (perpendicular to al
WB_3.05 Dependent Backwall View	Isometric view with only the backwall concrete and reinforcement sh
WB_4.01 Approach Slab View	Isometric view of approach slab with reinforcement
1.11 Phasing View-1	Phase 1 isometric view with shape element showing extents of EB str
1.10 Phasing Section-1	Phase 1 Section with shape element showing extents of EB structure
1.12 3D Boring Logs	3D soil boring logs with representative data from gINT export

Annotated Views

- Saved views with dimensions, tags, and notes
- To scale and model attributes are available





Model Properties/Attributes

- Added directly to model “solids”
- Includes customized Item Types
  - Design information and pay items/specs
- List per bridge element
- Pay Items

Element	*NBI#*	*Attribute 1*	*Attribute 2*	*Attribute 3*	*Attribute 4*	*Attribute 5*
Abutment Stem		Concrete Grade	f'c (psi)	Pour #	Fixity	
example data:	219	3500HP	3500	B	Exp	
Concrete Deck		Concrete Grade	f'c (psi)	Bevel dim. (in.)	Barrier Key/Water Stop	Drip Edge
example data:	12	4000HP	4000	0.75	6" x 4" Trap. Key (see model for detail)	3/4" triangle molding
Concrete Haunch		Concrete Grade	f'c (psi)	Slope		
example data:	13	4000HP	4000	Slope as required for form removal		
Concrete Parapet		Concrete Grade	f'c (psi)	Bevel dim. (in.)	Barrier Key/Water Stop	
example data:	331	4000HP	4000	0.75	6" x 4" Trap. Key (see model for detail)	
PS Concrete Beams		Type	f'c (psi)	f'ci (psi)		
example data:	109	72" Bulb Tee	8000	6500		

Links to Supplemental Documents

CONTRACTUAL ITEMS

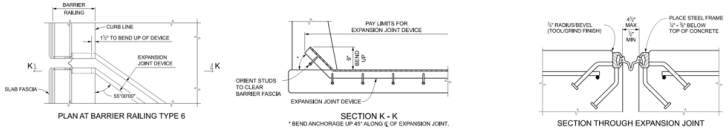
CONTRACTUAL MODEL FILES	FILE TYPE	DESCRIPTION
B01_63102_StructuresData.xlsx	EXCEL	SPREADSHEET W
B01_63102_ReinforcementDetails.xlsx	EXCEL	SPREADSHEET W
B01_63102_Quantities.xlsx	EXCEL	SPREADSHEET W
B01_63102_Project Signature Sheet.xlsm	EXCEL	FILE LIST WITH DI

- Files linked to model space
- Can be any type of .pdf, excel or word file

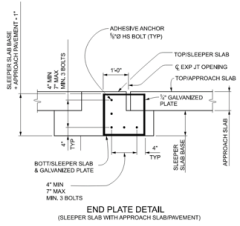
EB BOTTOM OF DECK ELEVATIONS

Beam		CL Brng, Abut A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	CL Brng, Abut. B
Dist. From CL Brng, Abutment A (ft) *		0.00	10.49	20.98	31.47	41.95	52.44	62.93	73.42	83.91	94.40	104.89	115.38	125.86	136.35	146.84	157.33
I	Fascia	679.09	679.35	679.58	679.80	680.00	680.17	680.33	680.47	680.58	680.68	680.75	680.81	680.84	680.86	680.85	680.83
I	Right	679.64	679.89	680.13	680.35	680.54	680.72	680.88	681.01	681.13	681.22	681.30	681.35	681.39	681.40	681.40	681.37
J	Left	679.69	679.95	680.18	680.40	680.60	680.77	680.93	681.06	681.18	681.28	681.35	681.41	681.44	681.46	681.45	681.43
J	Right	679.74	680.00	680.23	680.45	680.65	680.82	680.98	681.11	681.23	681.33	681.40	681.46	681.49	681.51	681.50	681.48
K	Left	679.79	680.05	680.29	680.50	680.70	680.88	681.03	681.17	681.28	681.38	681.45	681.51	681.54	681.56	681.55	681.53
K	Right	679.84	680.10	680.34	680.55	680.75	680.93	681.08	681.22	681.33	681.43	681.50	681.56	681.59	681.61	681.60	681.58
L	Left	679.90	680.15	680.39	680.61	680.80	680.98	681.13	681.27	681.39	681.48	681.56	681.61	681.65	681.66	681.66	681.63
L	Right	679.95	680.20	680.44	680.66	680.85	681.03	681.18	681.32	681.44	681.53	681.61	681.66	681.70	681.71	681.71	681.68
M	Left	680.00	680.26	680.49	680.71	680.91	681.08	681.24	681.37	681.49	681.59	681.66	681.72	681.75	681.77	681.76	681.74
M	Right	679.99	680.25	680.48	680.70	680.89	681.07	681.23	681.36	681.48	681.57	681.65	681.70	681.74	681.76	681.75	681.72
N	Left	679.87	680.12	680.35	680.56	680.76	680.93	681.09	681.22	681.34	681.43	681.51	681.57	681.61	681.63	681.63	681.60
N	Right	679.76	680.01	680.24	680.45	680.65	680.82	680.97	681.11	681.23	681.32	681.40	681.46	681.49	681.51	681.51	681.49
O	Left	679.64	679.89	680.13	680.34	680.54	680.72	680.88	681.01	681.13	681.23	681.31	681.38	681.42	681.44	681.44	681.42
O	Right	679.44	679.70	679.93	680.15	680.35	680.53	680.69	680.83	680.95	681.06	681.14	681.20	681.25	681.27	681.27	681.26
P	Left	679.24	679.51	679.75	679.98	680.19	680.38	680.54	680.69	680.82	680.92	681.01	681.08	681.12	681.15	681.16	681.15
P	Right	679.04	679.31	679.56	679.78	679.99	680.18	680.34	680.49	680.62	680.73	680.81	680.88	680.93	680.95	680.96	680.95
Q	Left	678.84	679.12	679.38	679.62	679.83	680.03	680.20	680.35	680.49	680.60	680.69	680.76	680.81	680.84	680.85	680.84
Q	Right	678.64	678.92	679.18	679.42	679.63	679.83	680.00	680.16	680.29	680.40	680.49	680.56	680.61	680.64	680.65	680.64
R	Left	678.45	678.74	679.01	679.25	679.48	679.68	679.86	680.02	680.16	680.28	680.37	680.45	680.50	680.53	680.54	680.52
R	Right	678.25	678.54	678.80	679.05	679.28	679.48	679.66	679.82	679.96	680.08	680.17	680.24	680.30	680.33	680.34	680.32

EXPANSION JOINT DETAILS



END PLATE DETAILS



EXPANSION JOINT TABLE

Structure Number	Angle of Crossing	Location of Joint	Min. Tot. Travel Along Centerline of Bridge	Required Length of Expansion Joint Device
B01-3 of 63102	55	E Sleeper Slab	1"	104'- 7 1/2"
B01-4 of 63102	55	E Sleeper Slab	1"	74'- 3 1/2"

Structure Number	Size
B01-3 of 63102	1'-8" X 1'-9"
B01-4 of 63102	1'-8" X 1'-9"

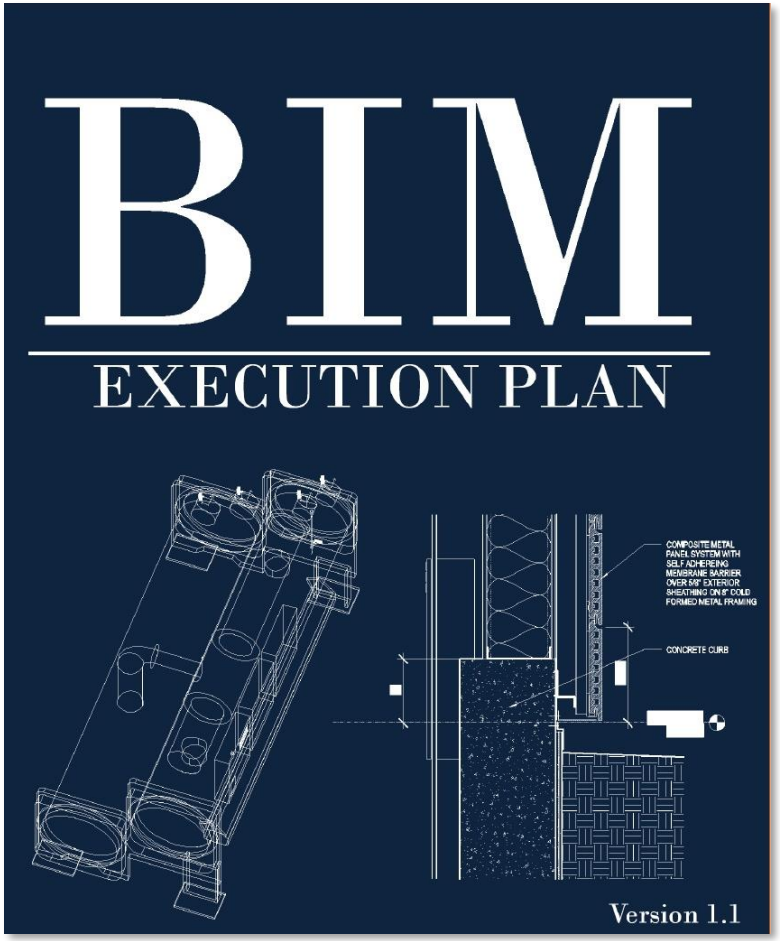
Model Element Breakdown (MEB)

Model Element/Entity	Project? Y/N	LOD	2D/	requirements to be further informed by the IDM being developed for TPF(5)-372	Required Reports	Engineer of Record	Applicable References	Authorized BIM Uses	Limitations	Includes reinforcement or other connection details:	Required File Deliverables	Contractual or FIO?	Comments
Category: Decks and Slabs				Type (e.g. open grid), material (e.g. reinforced concrete, steel deck), location (e.g. station and offsets), geometry (e.g. spacing, skew angles, length, width, thickness, area, volumes), other information (e.g. pay item number, NBI number, specification, etc.)		**Structural Engineer Name**							
Deck	Yes	400	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Construction joints and pour locations provided as 2D details.	Yes	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn; B01_63102_StructuresData.xlsx; B01_63102_Structures_Additional_Info.dgn	Contractual	Elevations and notes in B01_63102_StructuresData.xlsx; construction joint information provided in 2D details and notes
Haunches	Yes	200	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Slope as required, not shown in model	N/A	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn; B01_63102_StructuresData.xlsx	Contractual	Elevations and notes in B01_63102_StructuresData.xlsx; construction joint information provided in 2D details and notes
Precast Deck Panel													
Approach Slabs/Sleeper Slabs	Yes	400	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Construction joints and pour locations provided as 2D details.	Yes	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn; B01_63102_StructuresData.xlsx; B01_63102_Structures_Additional_Info.dgn	Contractual	Elevations and notes in B01_63102_StructuresData.xlsx
Deck Joints	Yes	200	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Element set at 2.6" width for width at 70 degrees F	No	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn; B01_63102_StructuresData.xlsx; B01_63102_Structures_Additional_Info.dgn	Contractual	Details, tables, and notes in B01_63102_StructuresData.xlsx
Sidewalk													
Bridge Barrier/Railing	Yes	400	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Transitions to curb not shown in model	Yes	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn	Contractual	
Wearing Surfaces and Protective System													
Category: Superstructure						**Structural Engineer Name**							
Steel Girder													
Prestressed Beam	Yes	200	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			models is approximate; work with B01_63102_ItemTypesList.xlsx	No	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn; B01_63102_StructuresData.xlsx	Contractual	Details, tables, reinforcement, and notes in B01_63102_StructuresData.xlsx
Closed Web/Box Girder													
Stringer													
Truss													
Arch													
Floor Beam													
Cable-Primary													
Cable-Secondary													
Gusset Plate													
Pin, Pin and Hanger Assembly, or Both													
Steel Shear Studs													
Steel Stiffeners/Connection Plates													
Steel Field Splice													
Steel Cross Frame and Diaphragm	Yes	100	2D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Not shown in 3D in model; 2D details and information provided	No	B01_63102_StructuresData.xlsx; B01_63102_ElevationPlan.dgn; B01_63102_StructuresData.xlsx	Contractual	Details, tables, reinforcement, and notes in B01_63102_StructuresData.xlsx
Concrete Diaphragm (End and Intermediate)													
Beam Seats/Pedestals	Yes	400	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Construction joints, pour locations, and details provided as 2D details.	Yes	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn; B01_63102_Structures_Additional_Info.dgn	Contractual	
Bearing Assembly	Yes	100	3D	See B01_63102_ItemTypesList.xlsx for additional information requirements as Item Types included as attributes in the model		Parker Thompson, PE, SE			Details and notes provided as 2D details	No	B01_63102_EB_OBM.dgn; B01_63102_VB_OBM.dgn; B01_63102_StructuresData.xlsx	Contractual	

Unique Special Provisions

Spec Book Modifications

- Add definition of Model
- Expand the definition of Plans
- Incorporate “Model” language
- Order of precedence for model elements



Model Coordination & Training Special Provision

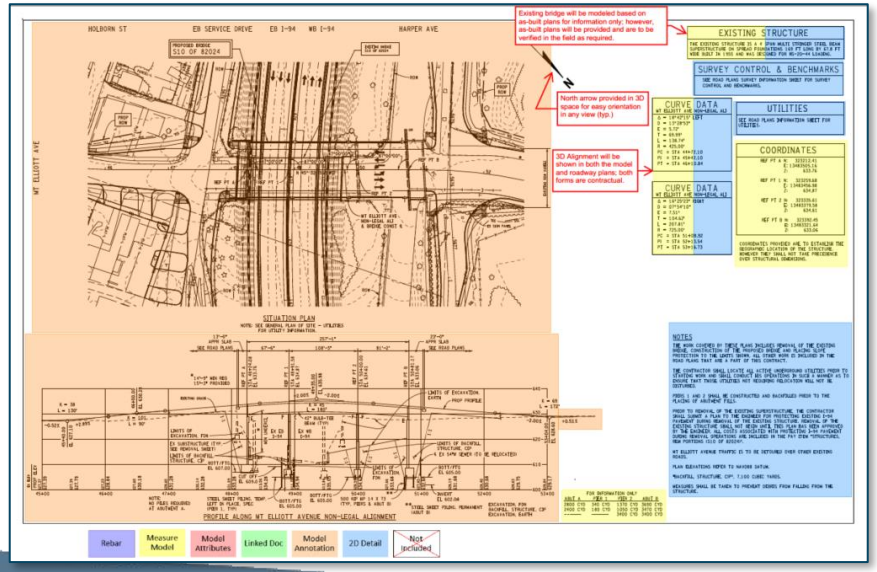
- Create Model Coordinator role
- Training after award
- Model coordination meetings
- Contractor Develop BIM Execution Plan
- Lessons Learned

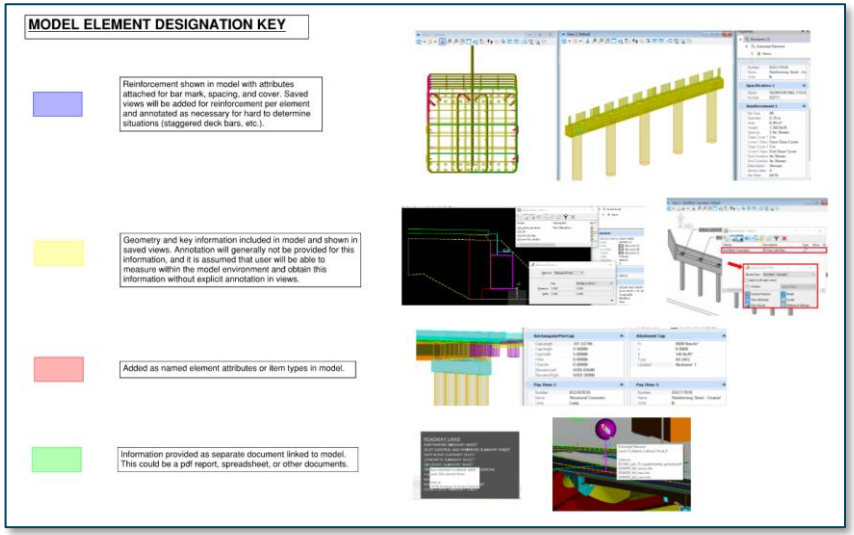
INDUSTRY ENGAGEMENT

Design Deliverable Working Group (DDWG)

Industry Engagement – Cross Walk

- Where to find the information in model files
- Sample 2D plan set





BUILDING A BRIDGE USING BIM

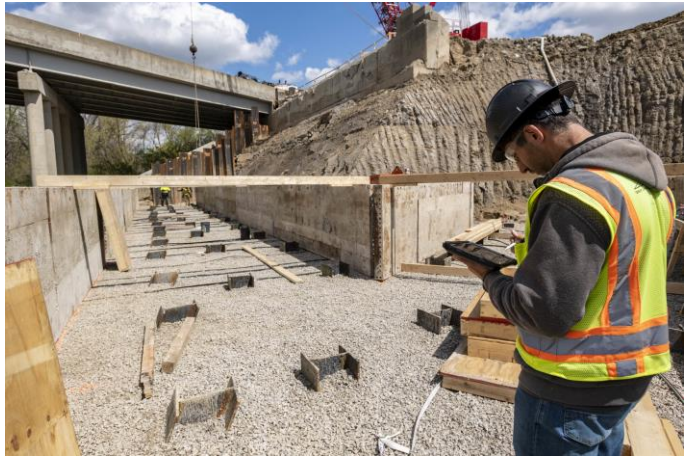
Construction Oversight

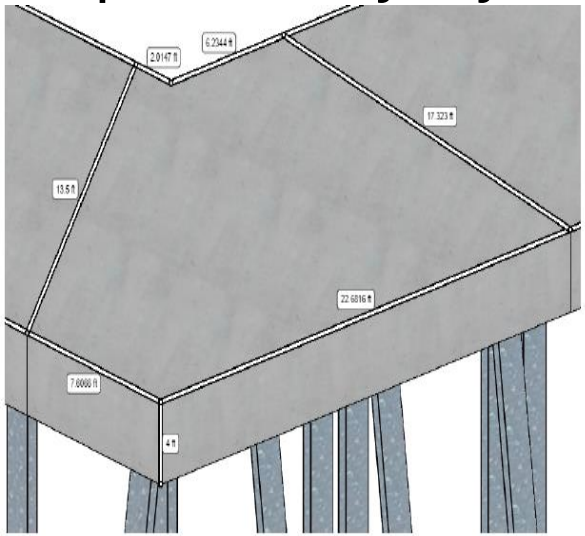
Construction Oversight

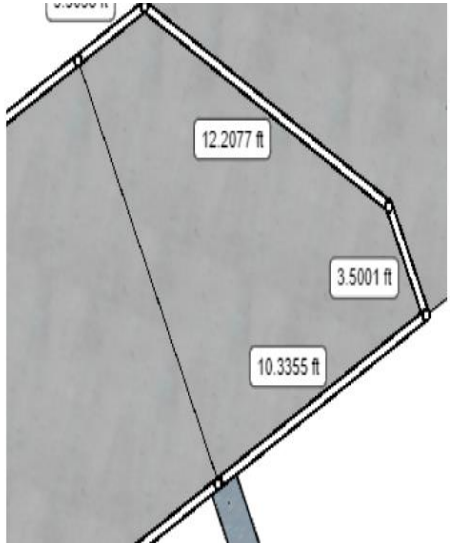
- Existing three span steel to single span concrete
- GLEG + QA survey CA Hull + QC Survey
- Weekly Model Coordination Meetings

Construction Oversight

- Utilize Synchro field with I-pad for model viewing
- Created Marked up “2-D plan sheets” for field and IDR use
- Lean on QA/QC survey for preliminary layout

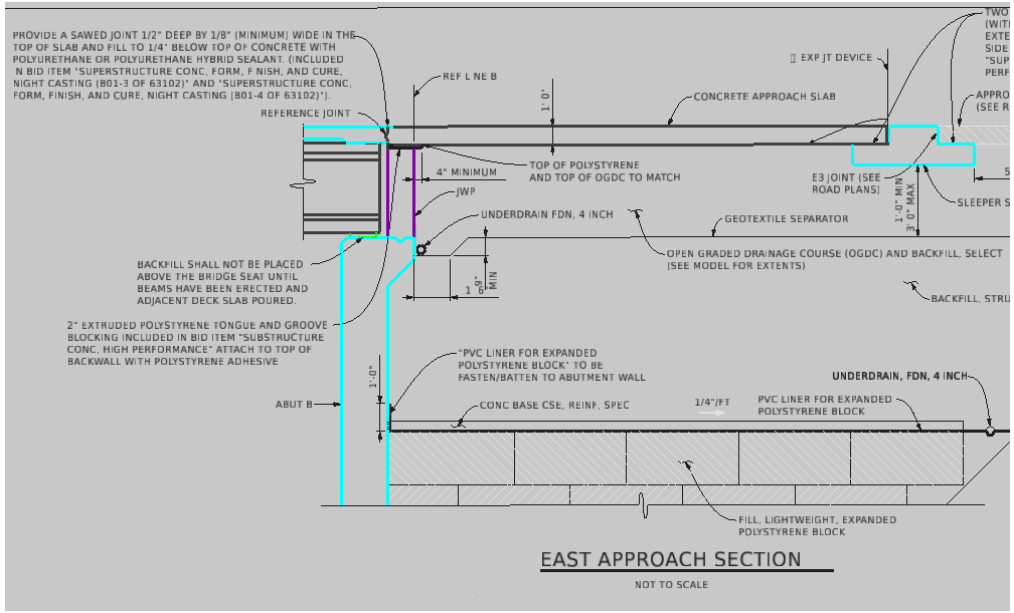


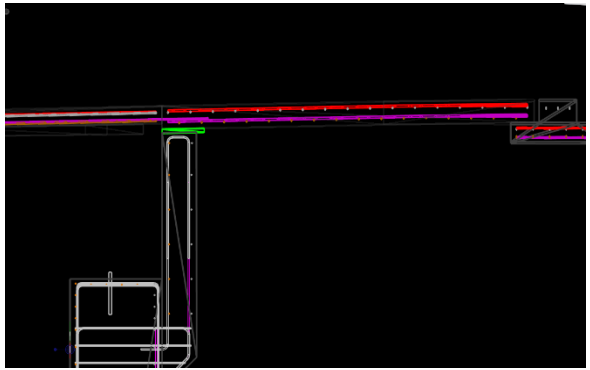


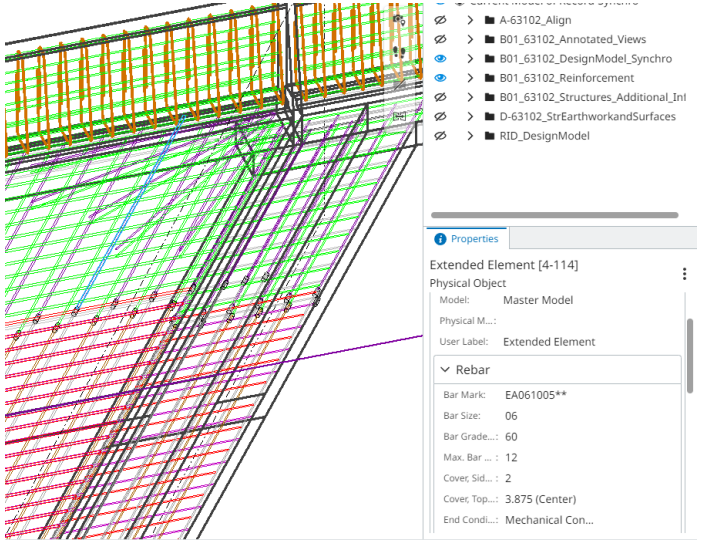


Model to Construction

- Multiple methods to attain information

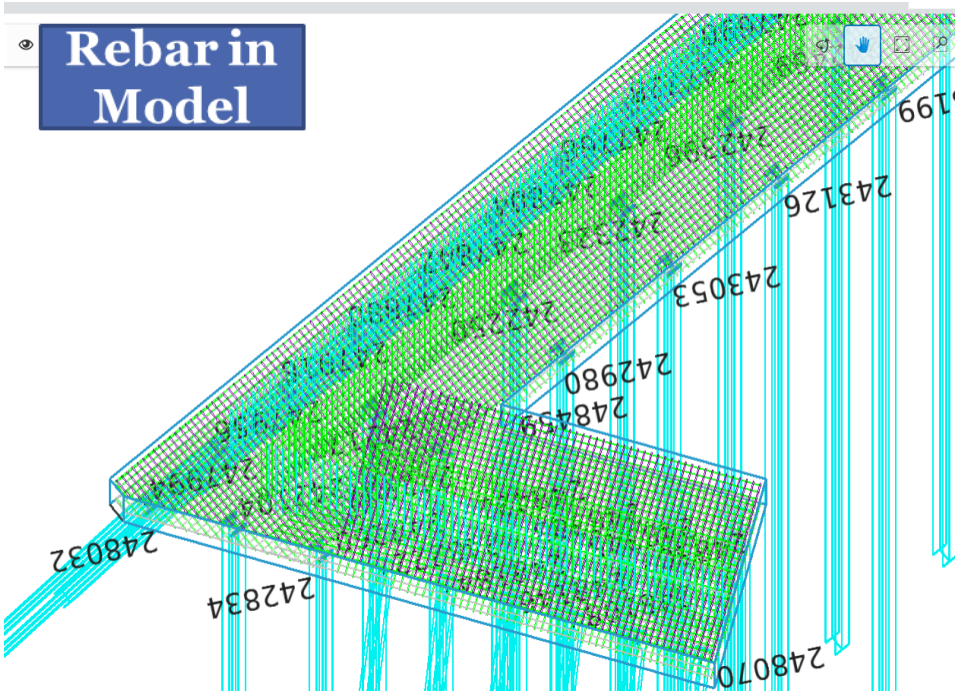






Model to Construction

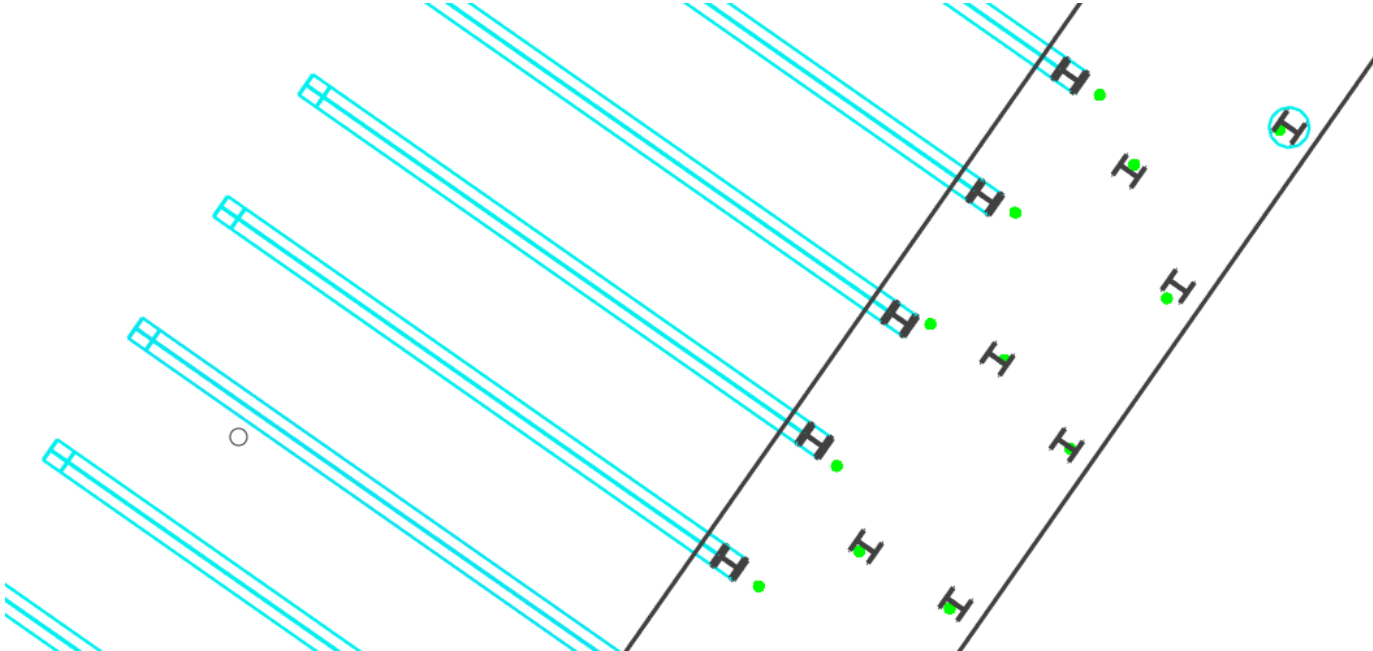
Rebar in Model


248070
242834
248032
247994
248459
242980
243053
243126
242730
242730
242730

LESSONS LEARNED

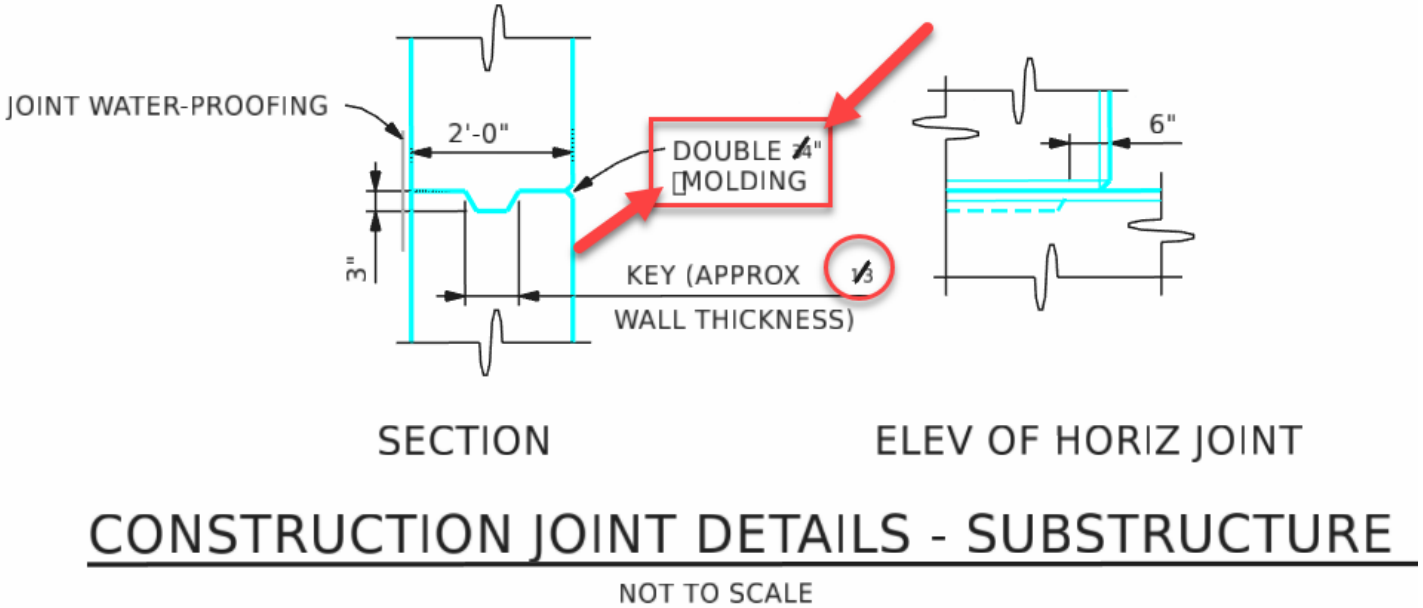
Designer – What went well?

- Partnership attitude and approach
- Model revisions and as-builts



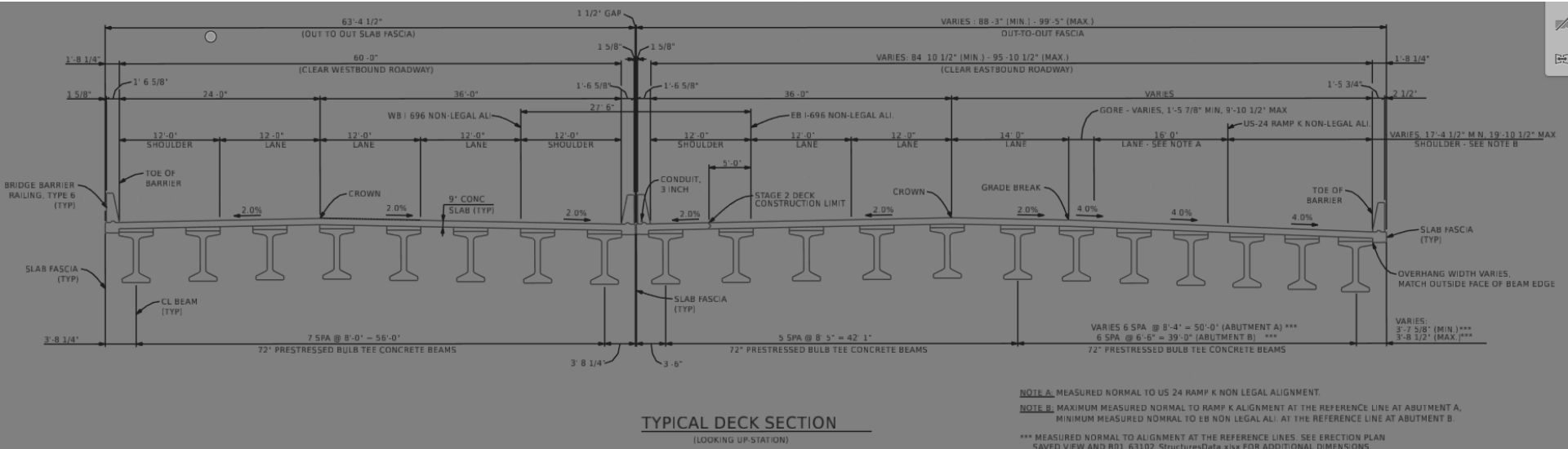
Designer – What was challenging?

- Communicating model changes
- Design to construction software data sharing



Designer – What would you change?

- Add more annotated and section views
- Include staging in contractual model

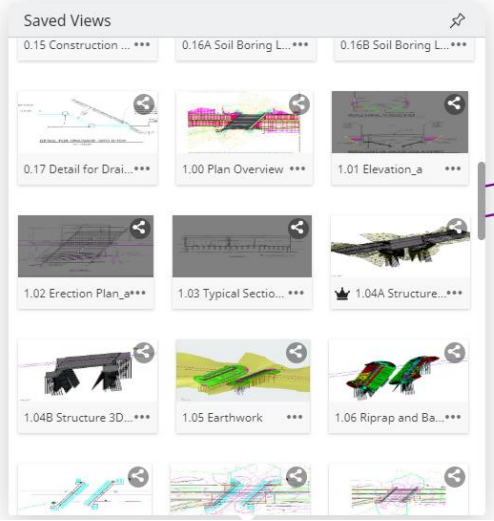


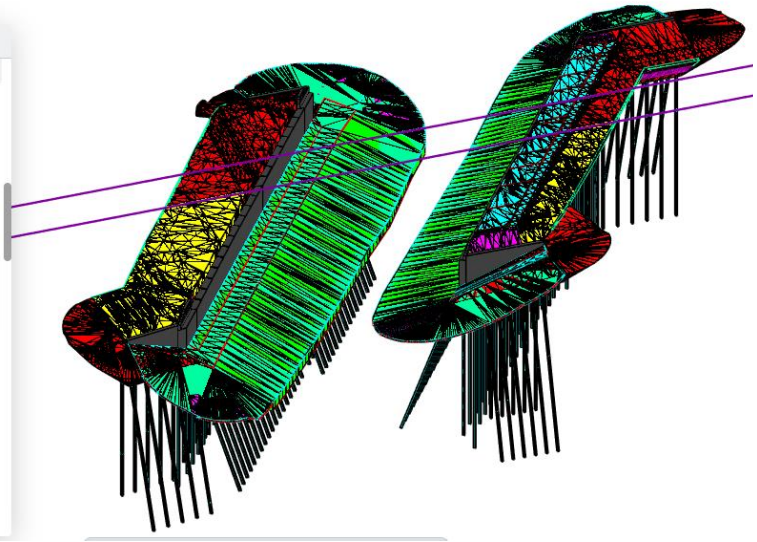
Owner – What went well?

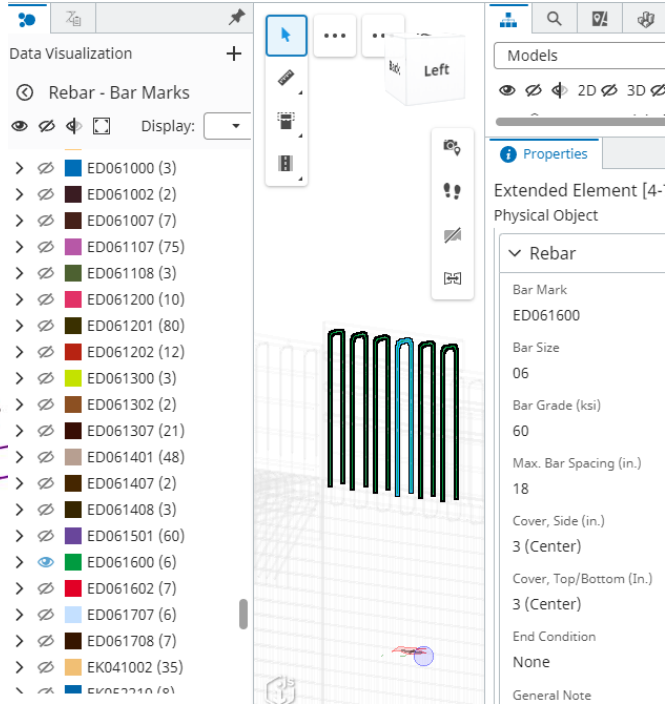
- Consistent collaboration between owner/contractor/design team

Owner – What went well?

- Saved views & data visualization

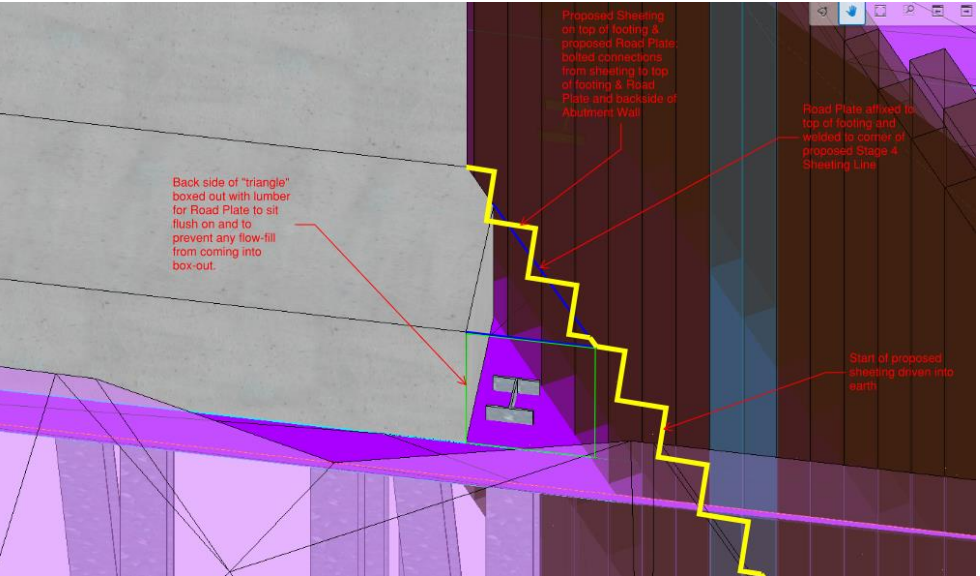


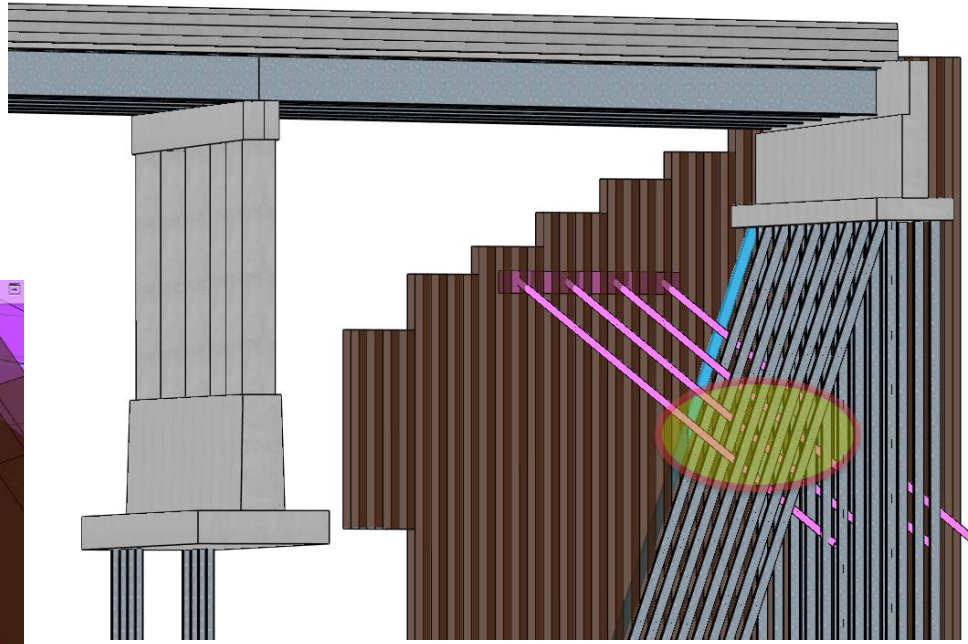




Owner – What went well?

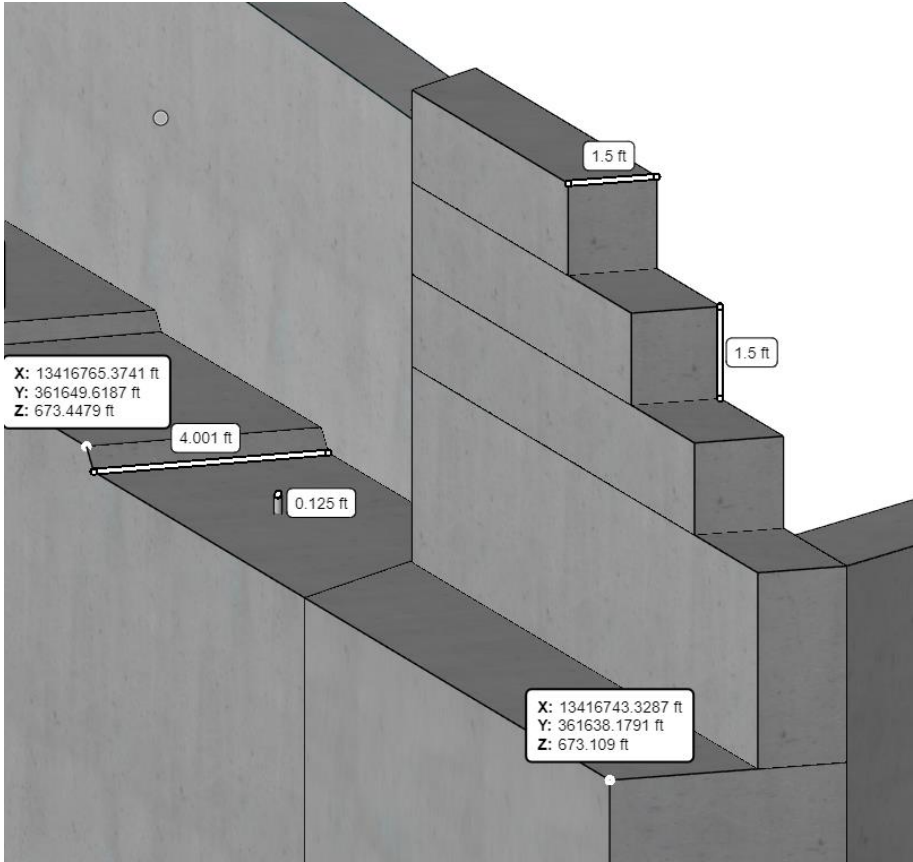
- Visualization of risk areas
- Sharing content between design and field





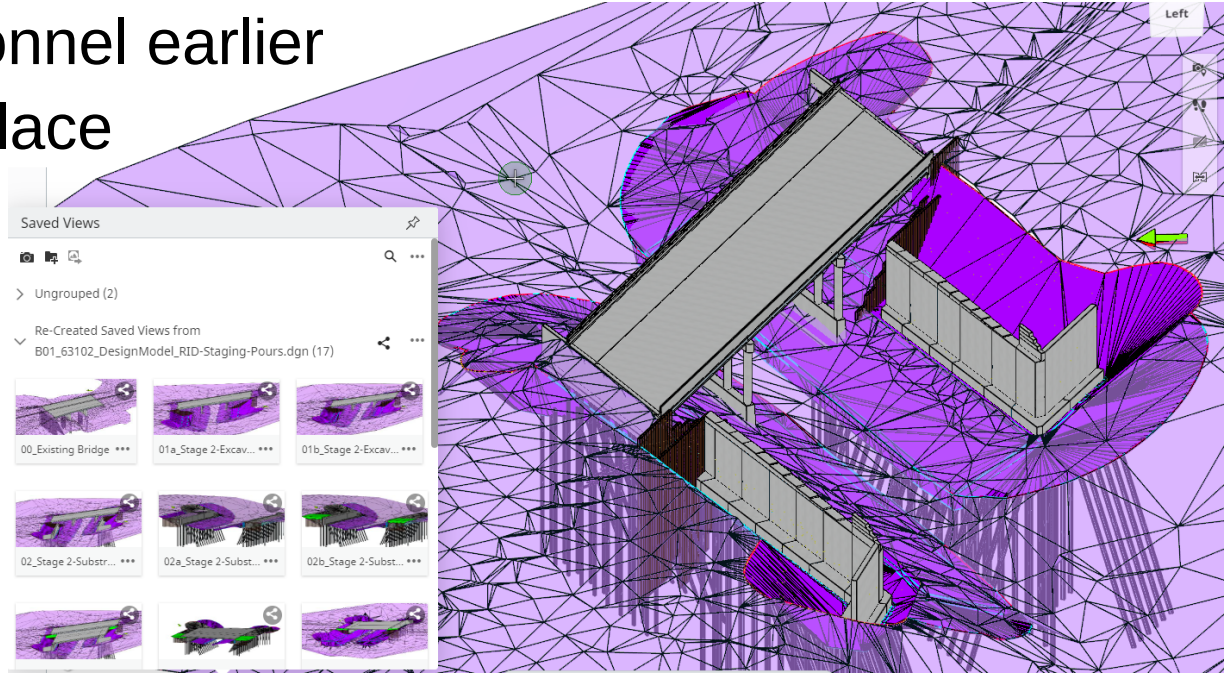
Owner – What was challenging?

- Learning curve
- Field model use with tablets
- Staging info
- Identifying conflicting info
- Model changes
- Equipping staff



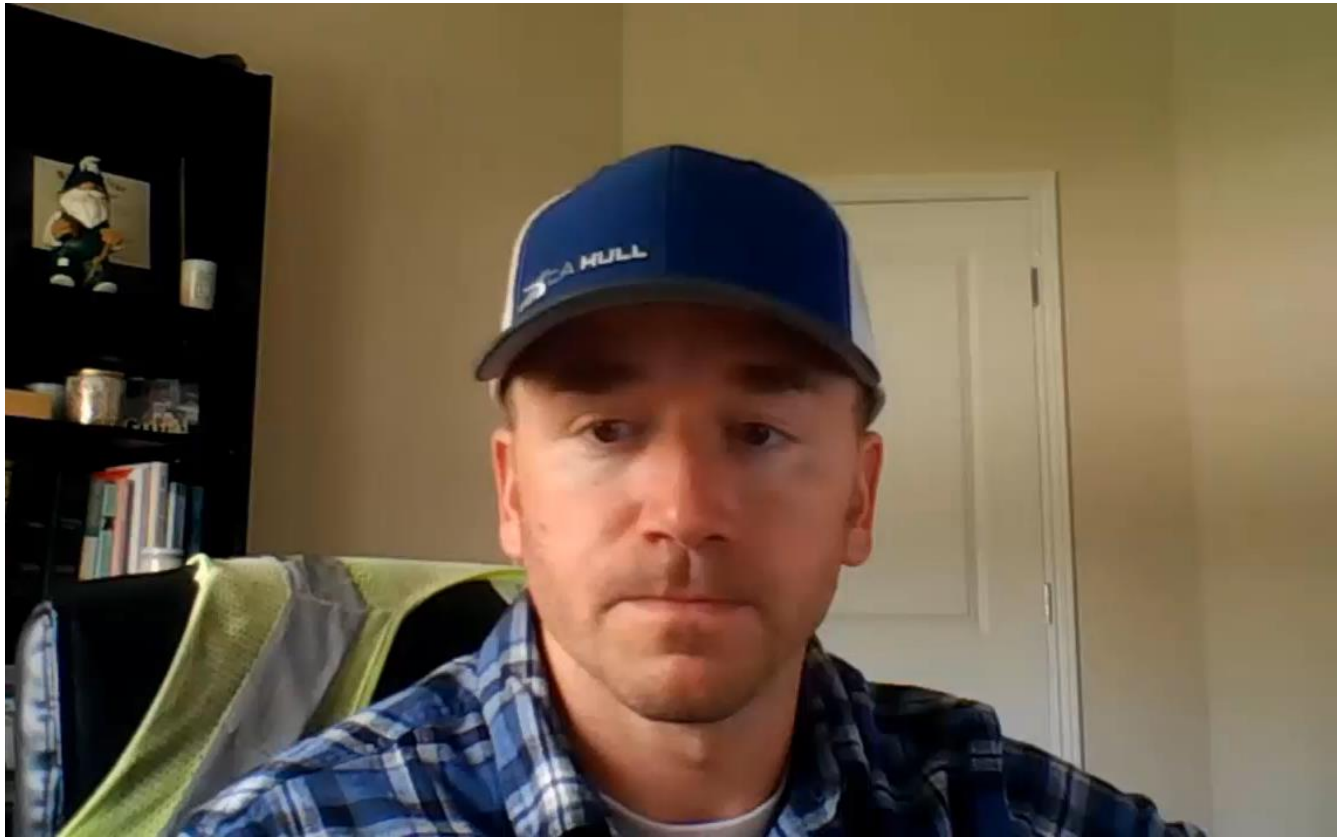
Owner – What would you change?

- Add more saved views from the start
- Staging info better defined
- Train internal personnel earlier
- Keep data in one place

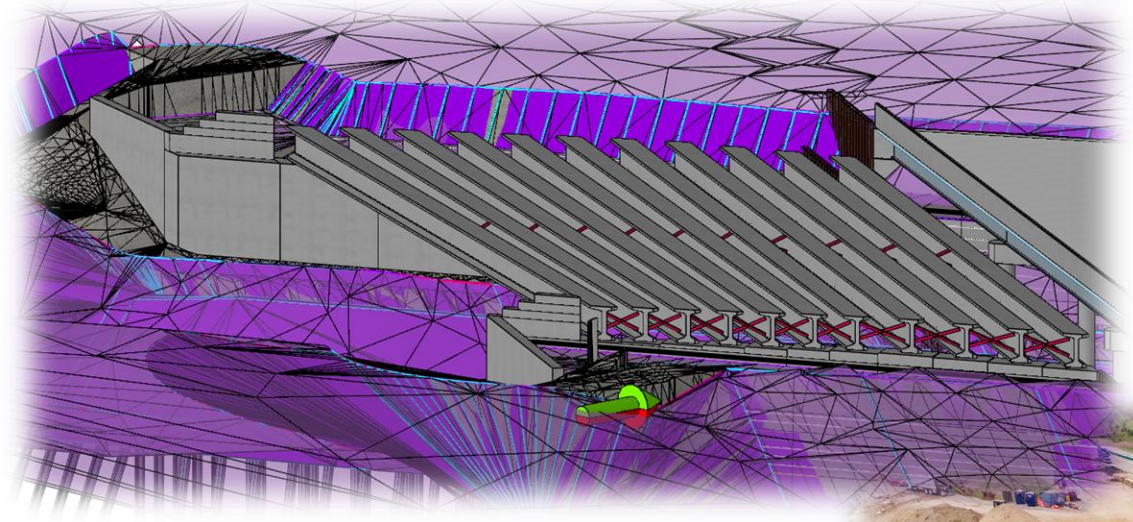


Contractor – What went well?

Contractor – What was challenging?



Contractor – What would you change?



Thank you!

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Michigan Department of Transportation