From Theory to Reality:

How We Actually Delivered the First Contractual IFC Bridge Project in the US

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Joe Brenner, P.E - Director of Bridge Technologies

Hanjin Hu, Ph.D., P.E. - Technical Manager

Cagin Yakar - Chief Executive Officer

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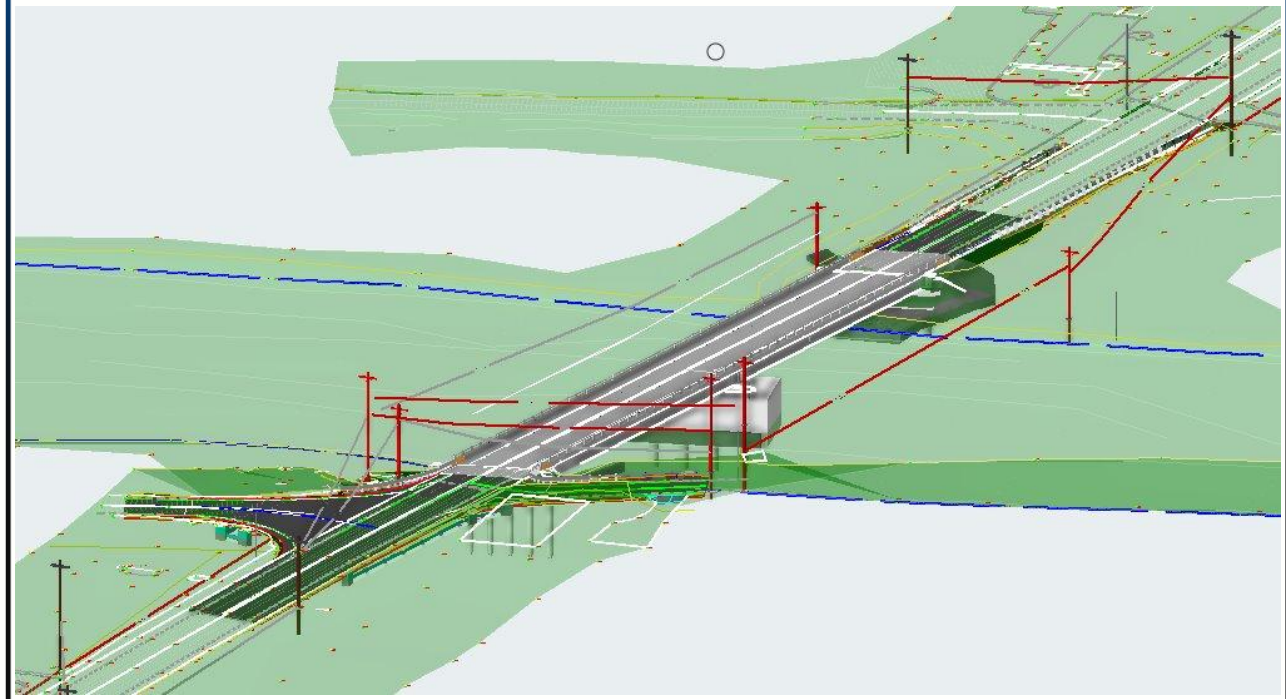
PennDOT ADCMS Pilot Projects

US Route 6 French Creek Parkway

- 2-Span Steel Plate Girders
- Integral Abutments
- Lead Designer: Michael Baker Intl.



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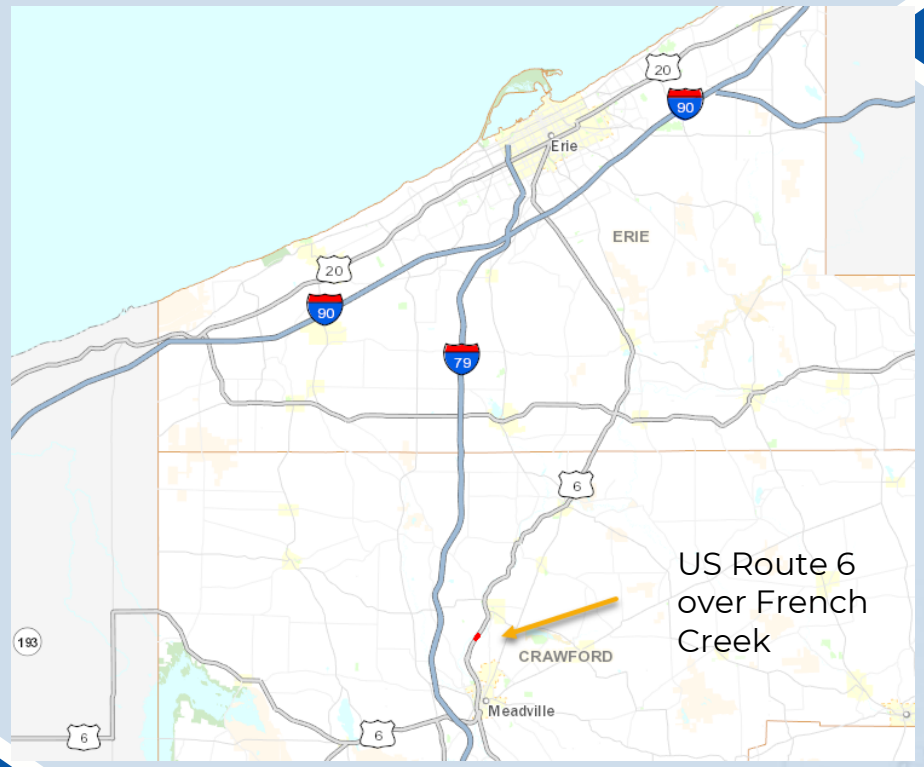
US R6 Over French Creek

Location Map – US Route 6 Bridge Over French Creek in Crawford County, PA



Existing Bridge – Steel Truss Structure Scheduled for Replacement

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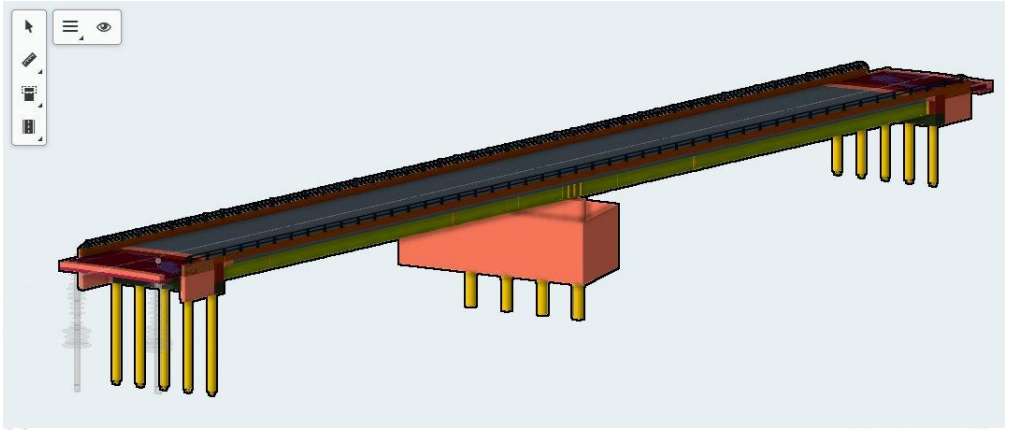
Design Strategy: Deliverables and Tools

Our deliverables include a federated model and supporting 2D plans.

Federated IFC Model

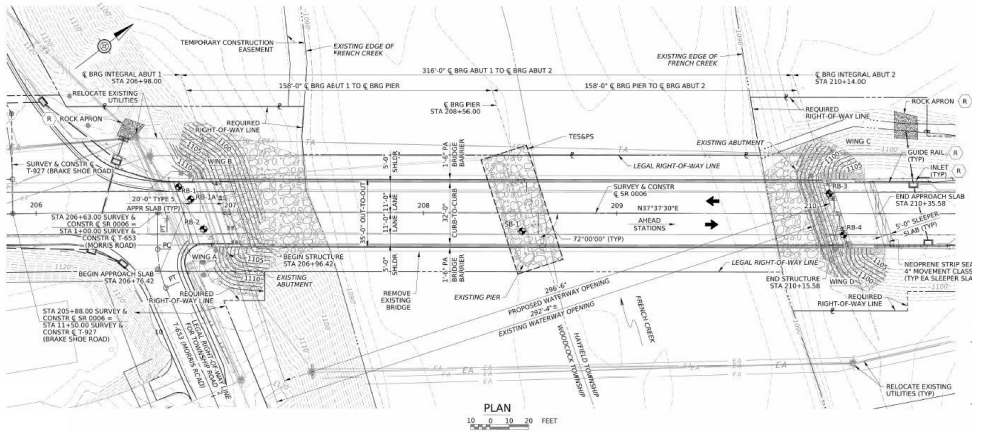
- OpenBrIM: Bridge geometry, materials, and detailed components
- Bentley OBM/Prostructures: Reinforcements



IFC Model

2D Plans

- Bentley OpenBridge Modeler and MicroStation: General notes, camber tables, detailed views, etc.



Supplemental 2D Plans

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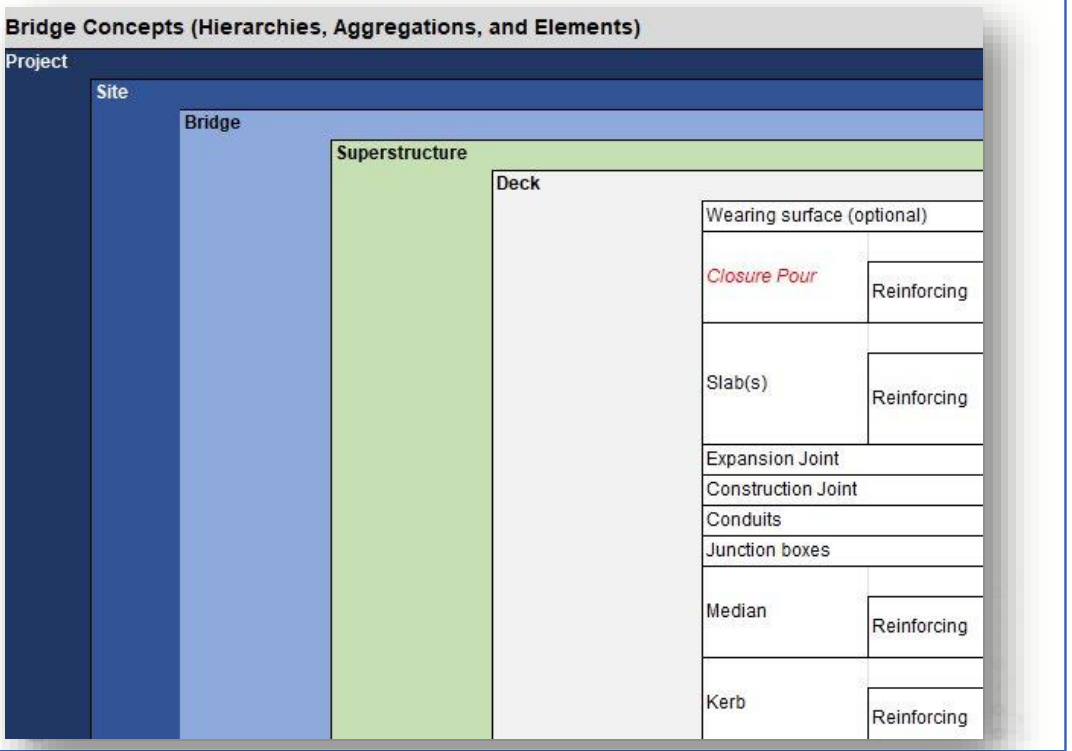
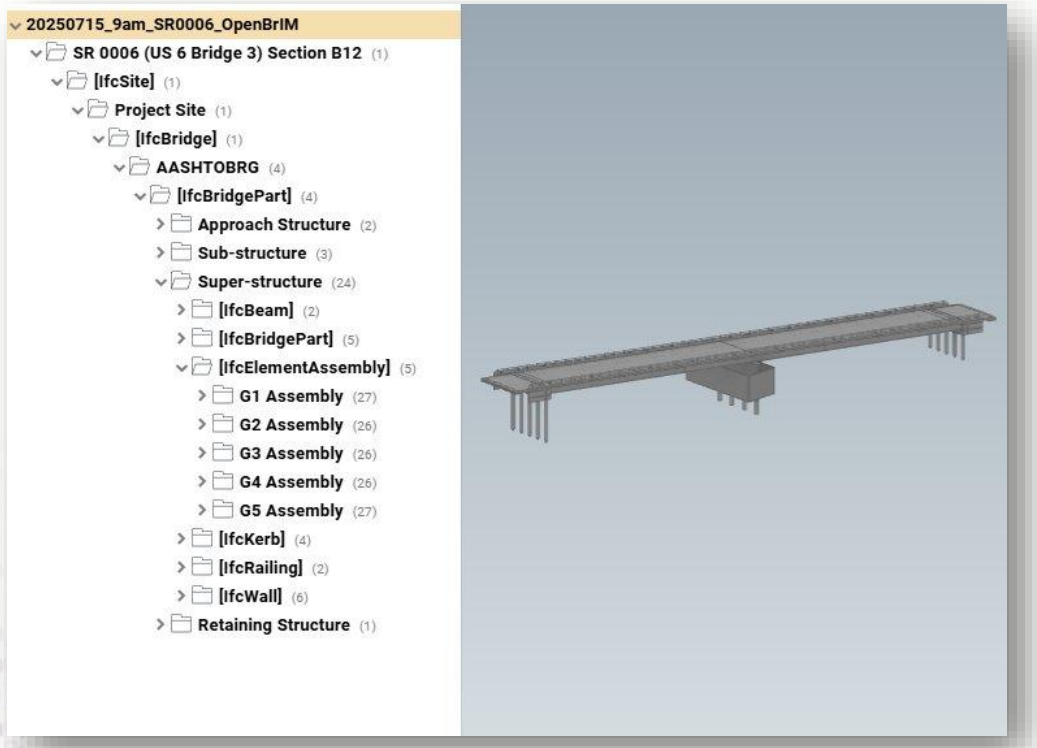
IFC Export: Entity Hierarchy

TPF-5(372), BIM for Bridges



IFC Entity Hierarchy in Viewer



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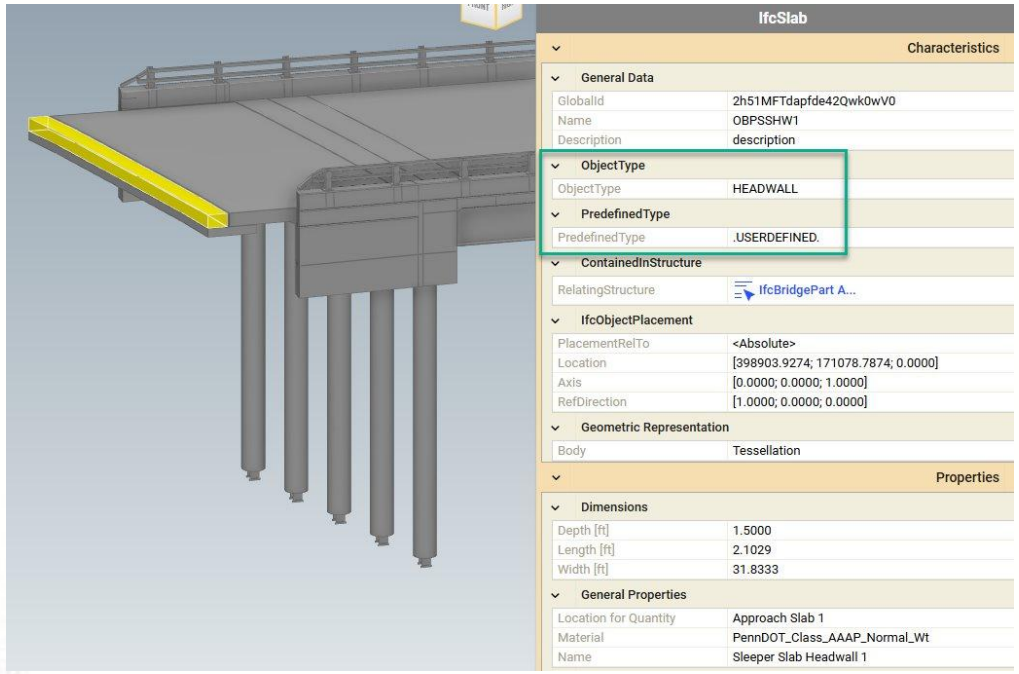
IFC Export: Entity Mapping

IFC Entity Mapping

Bridge Design: OBM + BD/BC Sheets			IFC mapping for bridge concepts (Hierarchy)
	Concrete diaphragm	Reinforcing	IfcReinforcingBar.
			IfcReinforcingMesh
	Drip bar		IfcDiscreteAccessory.USERDEFINED:DRIPBAR
06 Structures			
06.01			IfcBridgePart.USERDEFINED:APPROACH_STRUCT
Approach structure	Approach slab		IfcSlab.APPROACH_SLAB
		Strip seal	IfcDiscreteAccessory.USERDEFINED:STRIPSEAL
		Reinforcing	IfcReinforcingBar.
			IfcReinforcingMesh
	Sleeper headwall		IfcSlab.USERDEFINED:HEADWALL
		Reinforcing	IfcReinforcingBar.
			IfcReinforcingMesh
			IfcReinforcingBar.ANCHORING
	Sleeper slab		IfcFooting.STRIP_FOOTING
		Reinforcing	IfcReinforcingBar.
			IfcReinforcingMesh
		Shear	IfcReinforcingBar.ANCHORING

IFC Entity for Sleeper Headwall



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IFC Export: Defining Properties

We defined IFC Psets and properties in Excel, including metadata, IFC data mapping, source references, and value specifications.

Entity	Property Set	Property	Source	Value	Unit	IFC Entity	IFC Value Type
Bearing	General Properties	Connected by	IDM				
		Connected Elements	IDM				
		Description	IDM				
		Dimension	IDM				
		Identification	IDM				
		Location for Quantity	IDM, PennD	Abutment 1, 2, Pier 1		IfcBearing	IFCLABEL
		Material	IDM	Neoprene rubber 50 durometer		IfcBearing	IFCLABEL
		Quantity	IDM				
		Type	IDM, PennD	Elastomeric		IfcBearing	IFCLABEL
		Name	IDS	ELBRNG1		IfcBearing	IFCLABEL
	Layout	Centerline of Bearing Offset from Horizontal Control Line (HCL) [ft]	IDM	15.5	ft	IfcBearing	IFCREAL
		Distance from Centerline of Bearing to Centerline of Support [ft]	IDM	0	ft	IfcBearing	IFCREAL
	PennDOT_Bearing	Details/Notes	PennDOT	See 2D Details and Notes		IfcBearing	IFCLABEL
		NBI#	PennDOT	310		IfcBearing	IFCLABEL
		Applicable BC Standards	PennDOT	BC-755M		IfcBearing	IFCLABEL
		Element Detail Designation (EDD)	PennDOT	D-2		IfcBearing	IFCLABEL
		Element Information Designation (EID)	PennDOT	I-2		IfcBearing	IFCLABEL
		Fixity	PennDOT	Fixed		IfcBearing	IFCLABEL
	PennDOT_BearingPayItem	Designation	PennDOT	None		IfcBearing	IFCLABEL
		ECMS Pay Item	PennDOT	(Part of LS 8120-0001)		IfcBearing	IFCLABEL
		Description	PennDOT	Laminated neoprene bearing p		IfcBearing	IFCLABEL
		Unit	PennDOT	Each		IfcBearing	IFCLABEL
		Note1	PennDOT	See approximate quantity tabl		IfcBearing	IFCLABEL
		Note2	PennDOT	None		IfcBearing	IFCLABEL

Bridge Modeling: Overview

We used **OpenBrIM** to model and export the bridge to IFC.

- **Key Features**
  - Parametric modeling
  - Built-in IFC export based on IDM and IDS
- **Collaboration** with OpenBrIM developer:
  - Feature enhancements
  - Quick turnaround for IFC export improvements

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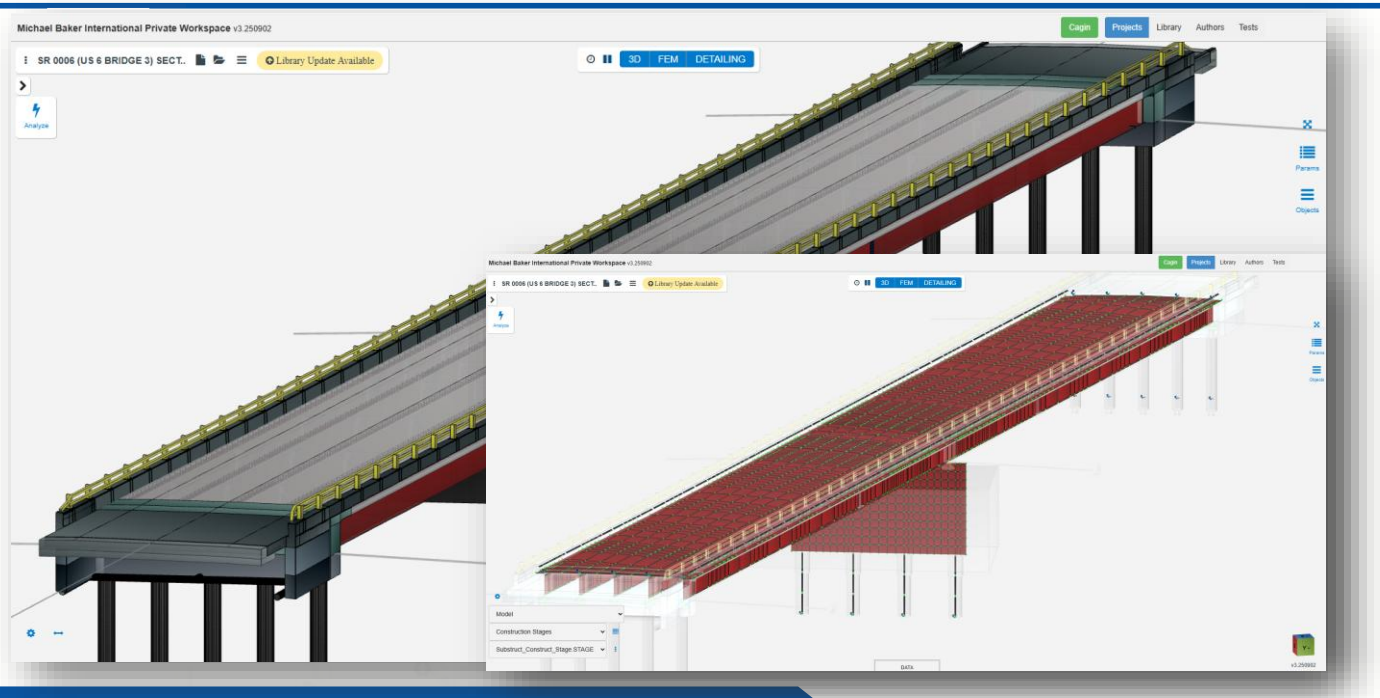
IFC Delivery: OpenBrIM Vision

The software must support four key capabilities:

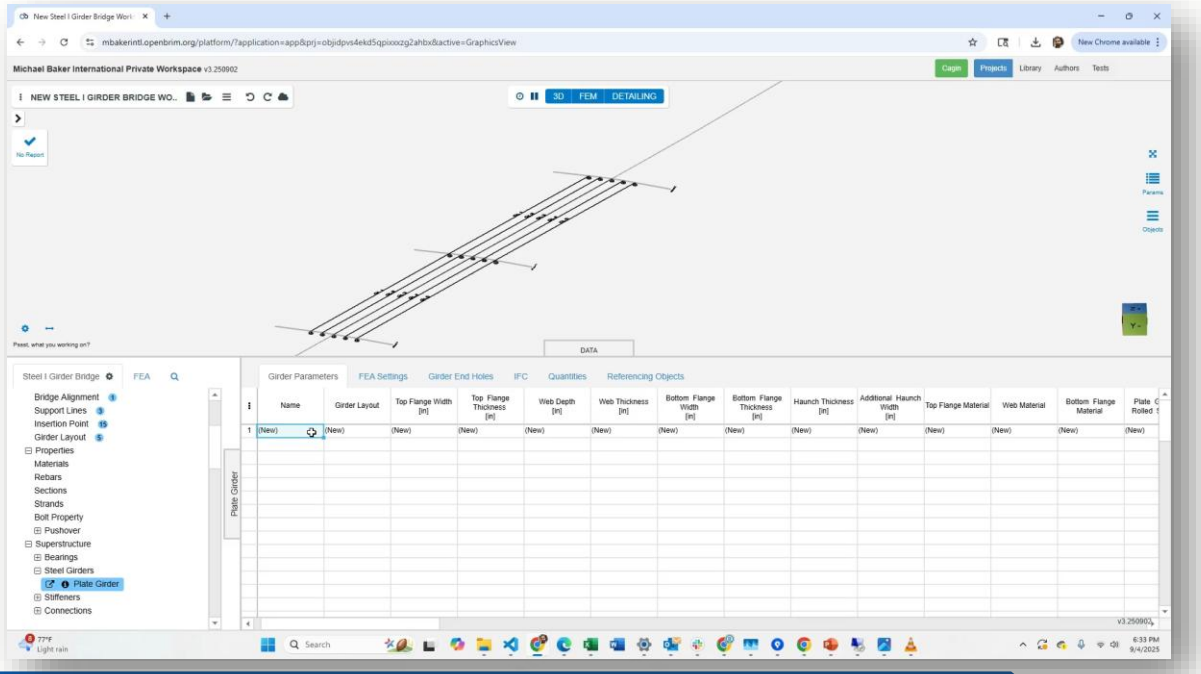
1. **3D Object Creation**
   - Rapid generation of 3D objects
   - Minimal manual effort required
2. **Hierarchy**
   - Structured representation of bridge components
3. **Full Coverage of IFC Entities**
   - Support for all entity types defined in IFC
4. **Properties**
   - Easy entry and management of property sets

OpenBrIM Platform

- Cloud-based, browser-accessible
- Integrated capabilities:
  - 3D modeling
  - Finite Element Analysis
  - Soil-structure interaction
  - AASHTO spec checks
  - Load rating
  - Quantities



Parametric Modeling in Action



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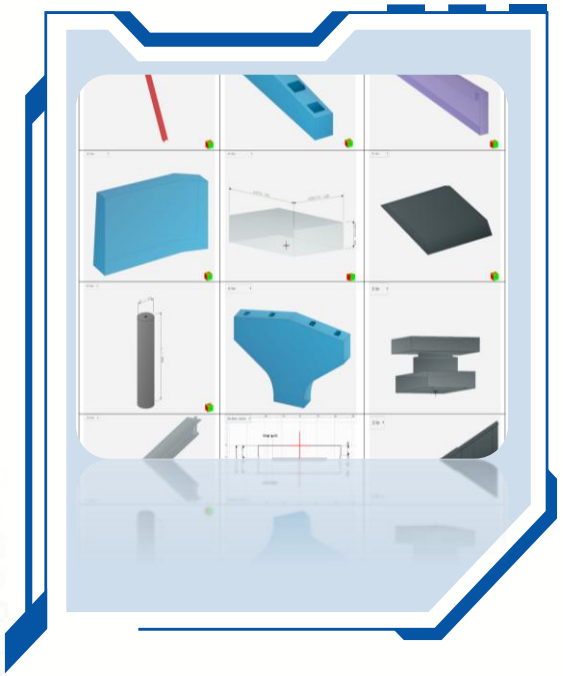
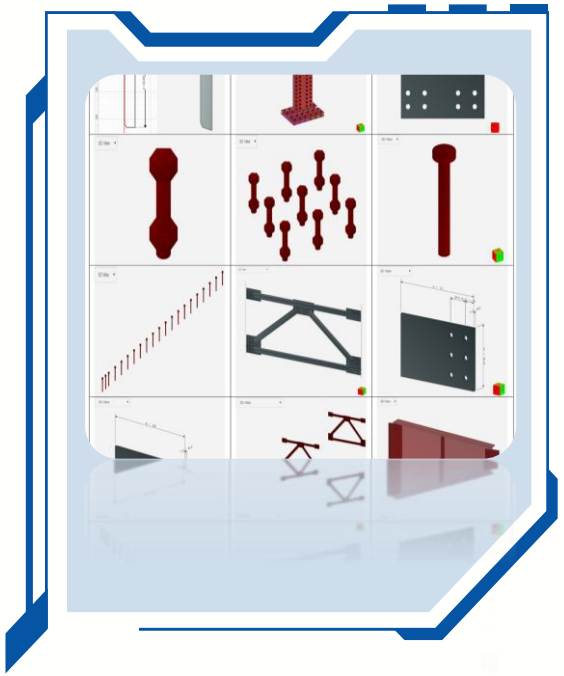
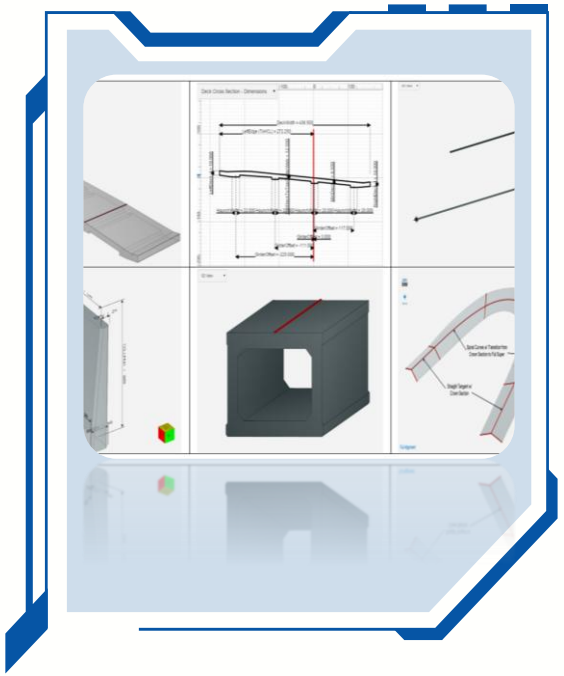
OPENBRIM LIBRARY: BRIDGE ENGINEER'S FUNCTION CONTAINER







Transparent parametric dependencies

Customizable dependencies according to different project and company requirements

Reusable and modular way to define parametric relationships

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OPENBRIM LIBRARY: BRIDGE ENGINEER'S FUNCTION CONTAINER

Parametric Bridge Library

LEGO Structures

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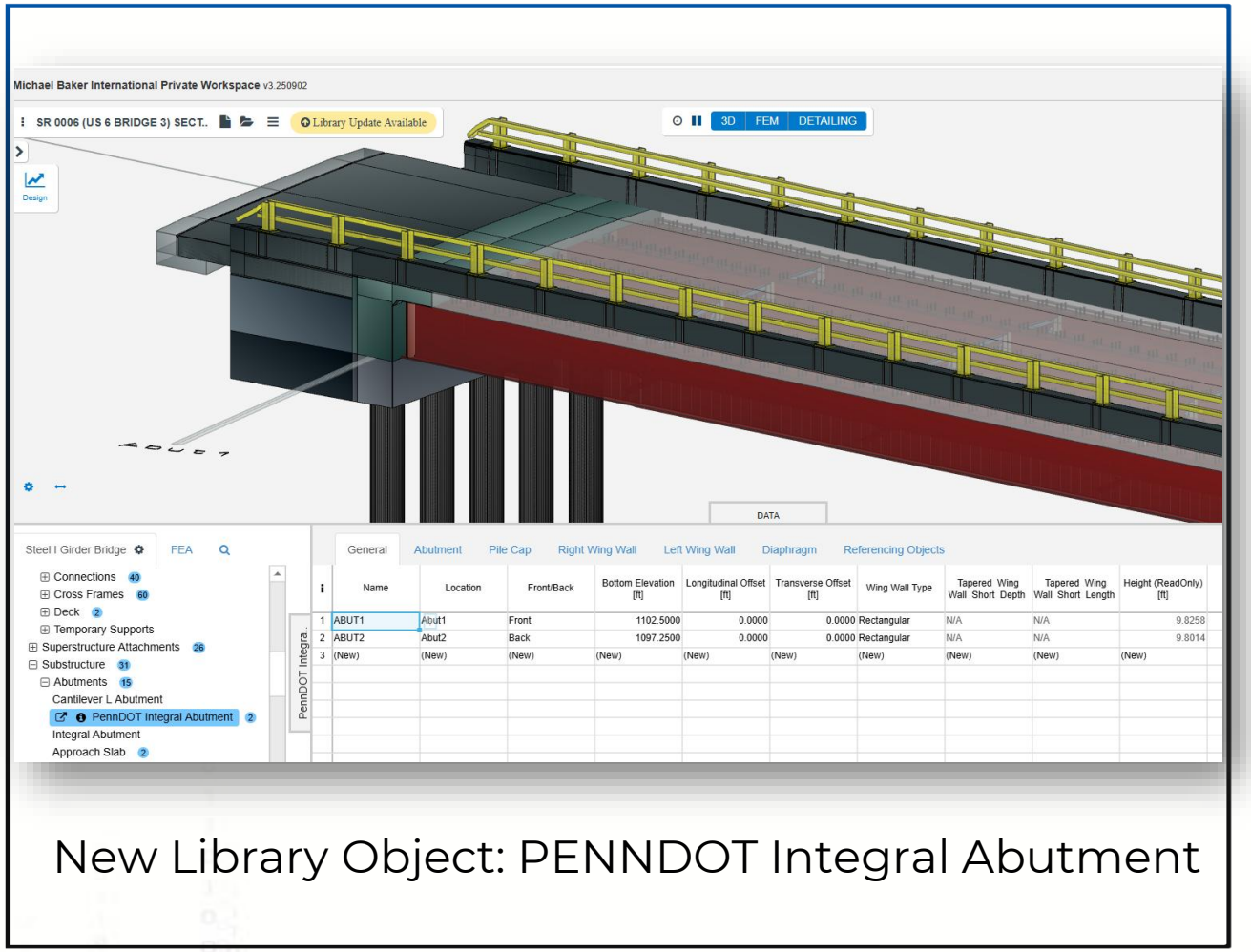
Expanding the Open-Source Library

- Gaps in existing parametric library discovered during project
- New components created for SR6-B12
- Contribution back to open source for future projects

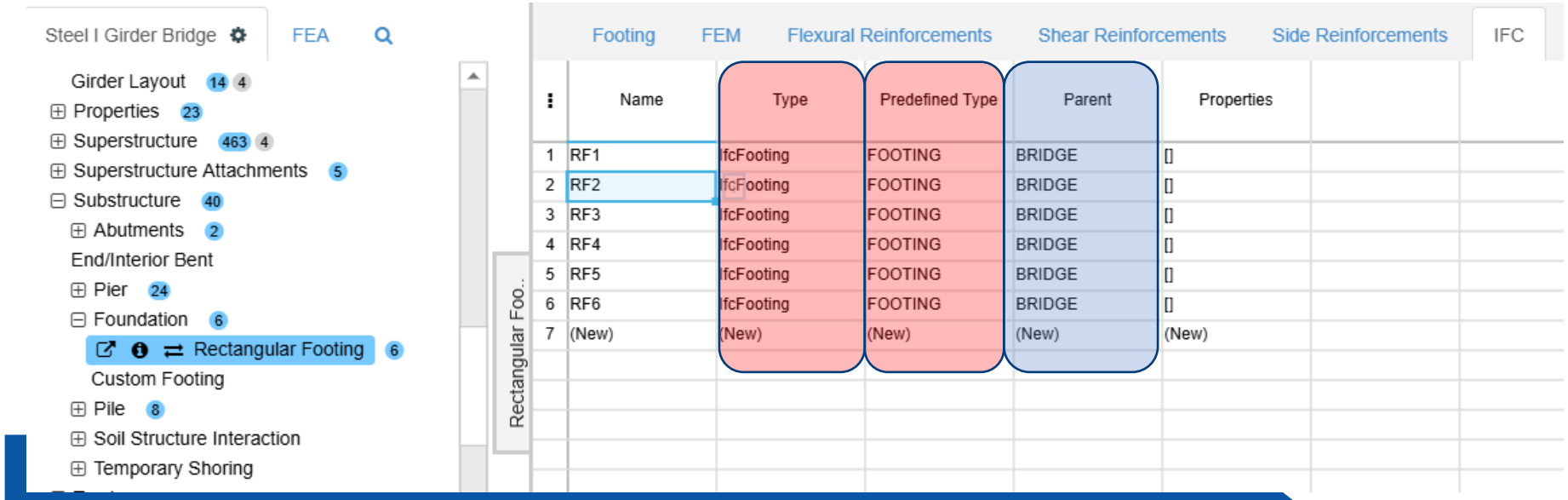


New Library Object: PENNDOT Integral Abutment

IFC Delivery: OpenBrIM Vision

Based on U.S. standards (currently TPF-5(372) BIM for Bridges)

- Predefined **Entities** for each bridge object
- Predefined **Hierarchy** for each bridge object



IFC Delivery: OpenBrIM Vision

Property Standards

Baseline Standard – AASHTO IDM
- Core property definitions for U.S. transportation projects
- Defines common parameters across agencies

State-Specific Parameters
- Each DOT may extend or adjust IDM
- Local standards/specifications drive these properties

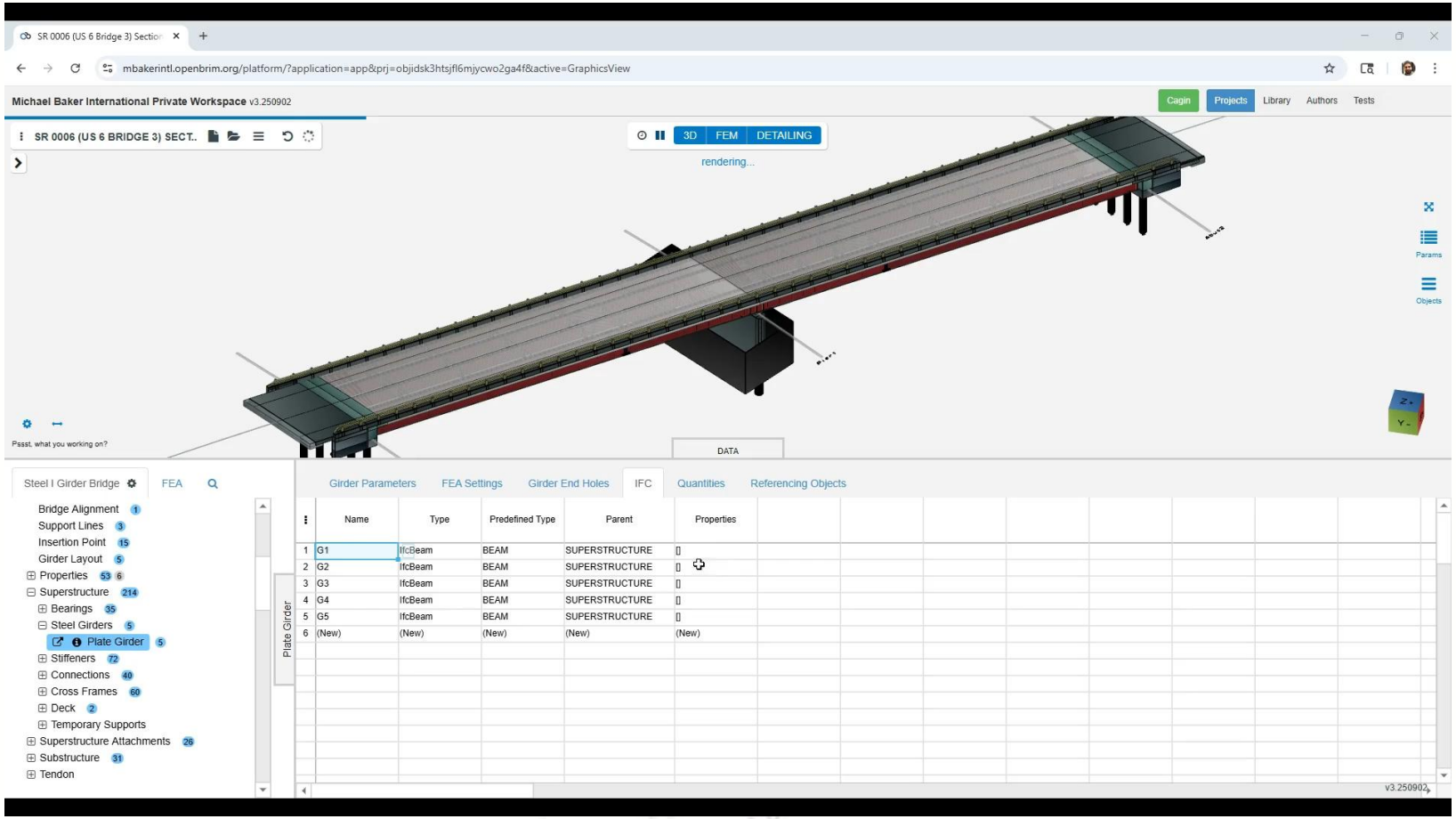
BuildingSMART / IFC Global Parameters
- Ensures compatibility across software platforms

Project-Specific Requirements
- Unique parameters requested by owners, contractors, or fabricators

OpenBrIM Implementation

- Assign parameters easily (Excel-style references)
- Define parametric relationships to support change management
- Customize parameters flexibly
- Import predefined parameters quickly from the library

IFC Delivery: OpenBrIM Vision



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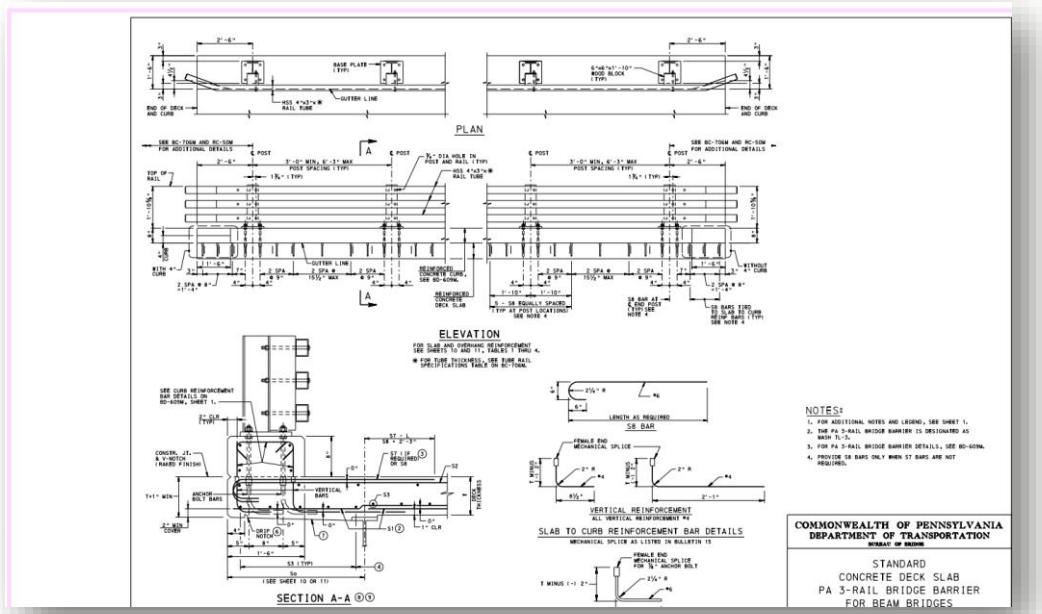
Reimagining Standard Drawings as Parametric 3D IFC Objects

Current Practice (DOT Standard Contracts)



Proposed Future

- Same concept, but in **parametric 3D**
- Each typical drawing → **a parametric 3D object – open source**
- Direct export to **IFC 3D**
- Machine-readable, reusable, contract-compliant
- Collaboration Framework (if agencies provide funding):
  - Consultants (e.g., Michael Baker): Quality Control (QC)
  - Technology Providers (e.g., OpenBrIM): Coding and Implementation

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Finding the Right Software Partner for Digital Delivery

The Reality Today

- Agencies and consultants expect “magic software” to solve all problems.
- Even project engineers may lack clarity on the exact requirements.
- Standards are still evolving and incomplete.
- IFC/IDS specifications are still under development.
- Project deliverables are frequently vague or inconsistently defined.

What to Look For

- Don’t just evaluate software features.
- Choose a **partner**, not just a vendor.
- Seek a team experienced with real bridge projects.
- Work with people who can help navigate unknowns and adapt as standards mature.
- A partner that applies agile development practices.
- A platform designed for rapid iteration and continuous improvement.

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Live Support through Slack

Rapid Continuous Iterations

Contents

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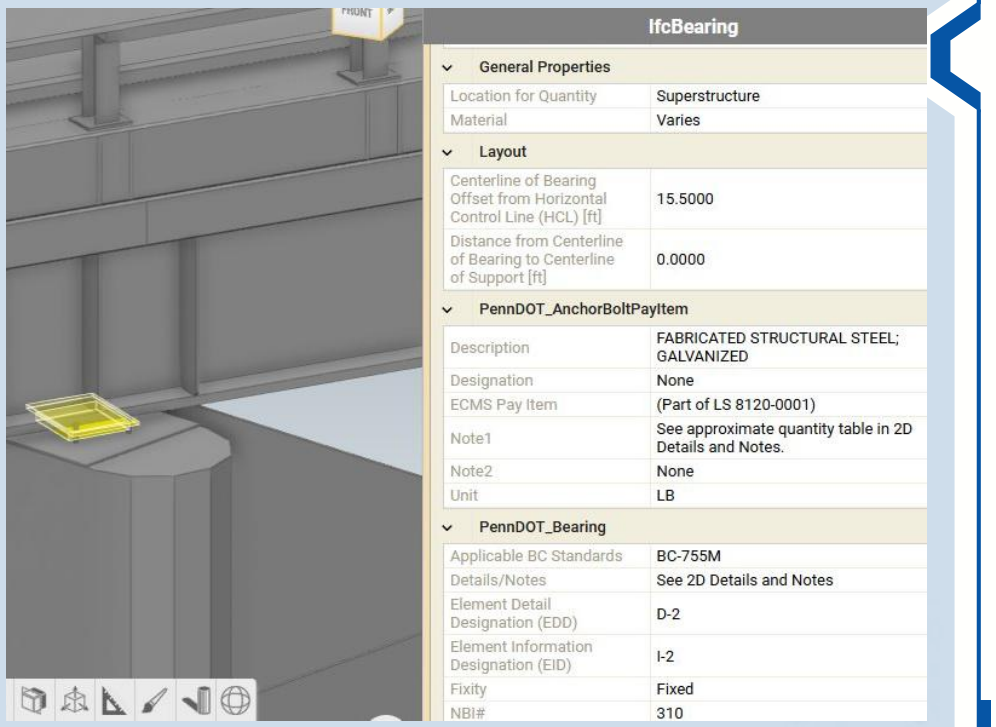
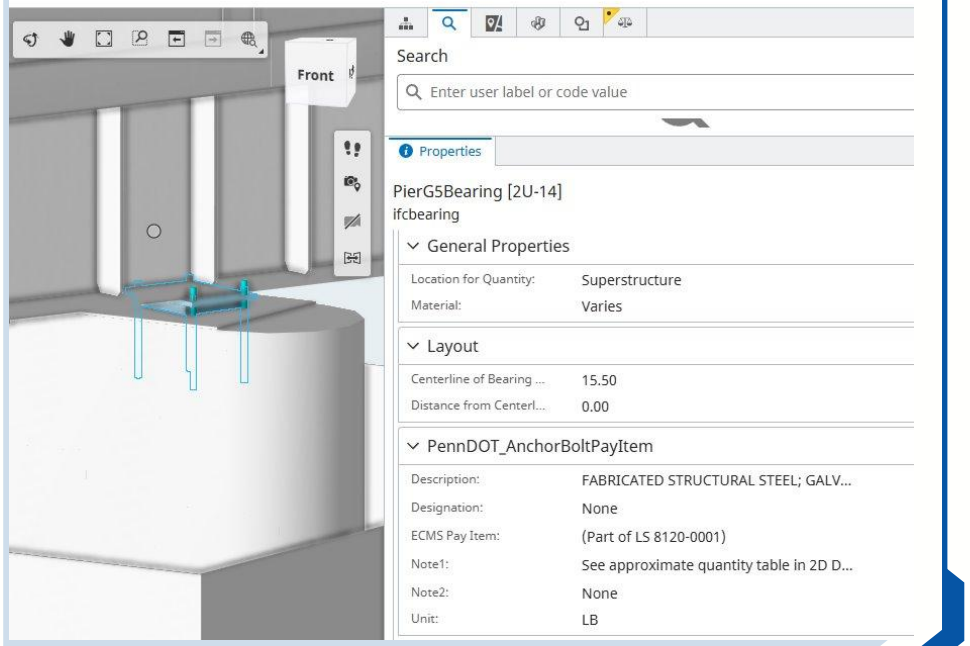
IFC Export: Reviewing Properties

We verified the IFC properties using **IFC viewers** and **Infrastructure Cloud** to ensure accuracy and completeness.



IFC Properties for Bearing (IFC viewers)



IFC Properties for Bearing (Infrastructure Cloud)

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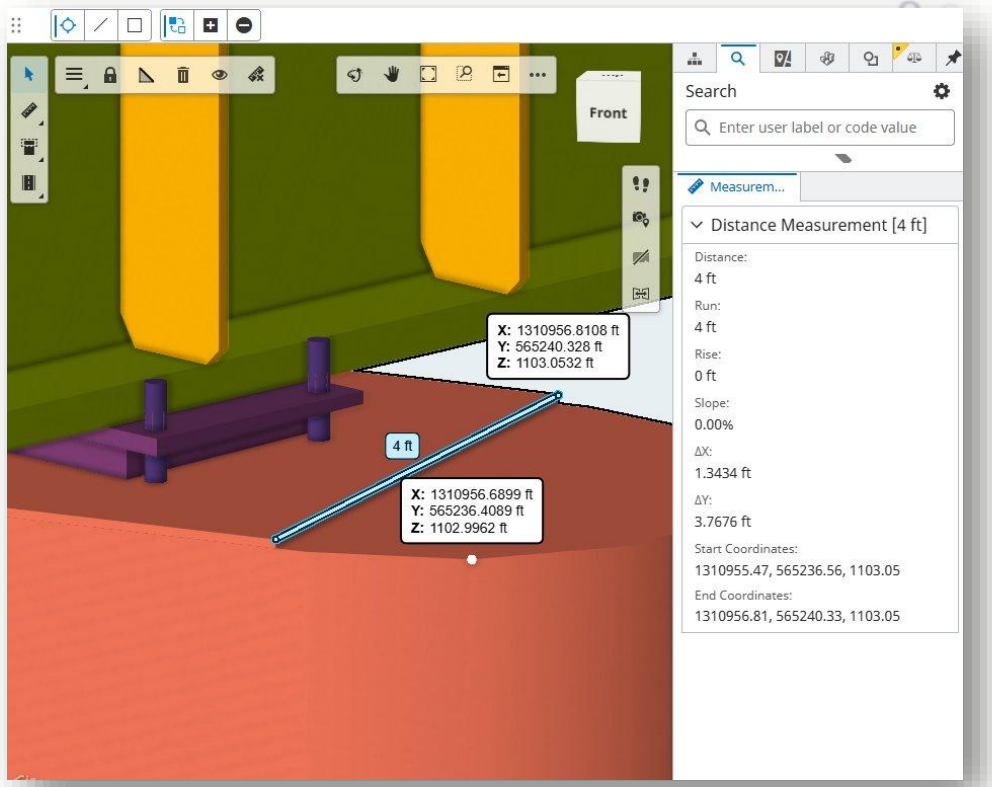
Review: QA/QC Using Infrastructure Cloud

Review Contents

- **Geometry**: Roadway and bridge stationing and elevation
- **Locations**: Placement of bearings, cross frames, and key elements
- **Dimensions**: Girder sizes and section transitions
- **Studs and bolts**: Shear stud and splice bolt counts and spacing
- **Details**: Curb transitions, v-notches, jacking holes
- **IFC properties**: Materials and PennDOT items

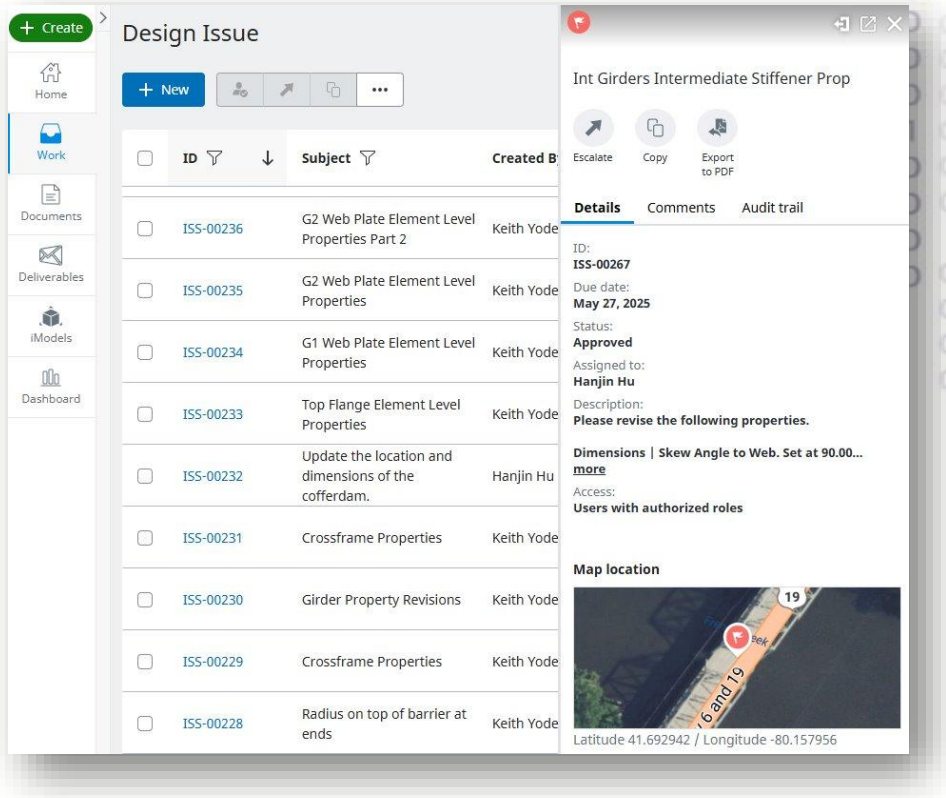


Model Validation with Infrastructure Cloud

Review: Issue Documentation in Infrastructure Cloud

Issue Logging

- Reviewers documented issues directly in the platform.
- Each issue entry included:
  - Descriptive comments
  - Precise location references
  - Annotated screenshots for visual clarity
- Issues were assigned to designers, triggering notifications for action.
- After addressing each issue, designers reassigned it to the original reviewer for backcheck and confirmation.



Issue Documented in Infrastructure Cloud

Review: Issue Summary and Tracking using Excel

Summary and Tracking:

- Documented which components were reviewed and by whom.
- Tracked **issue ownership**: who identified, addressed, and backchecked each item.
- Recorded **timestamps** for each stage of issue resolution.
- Maintained **status updates** and reviewer **comments** for transparency and follow-up.

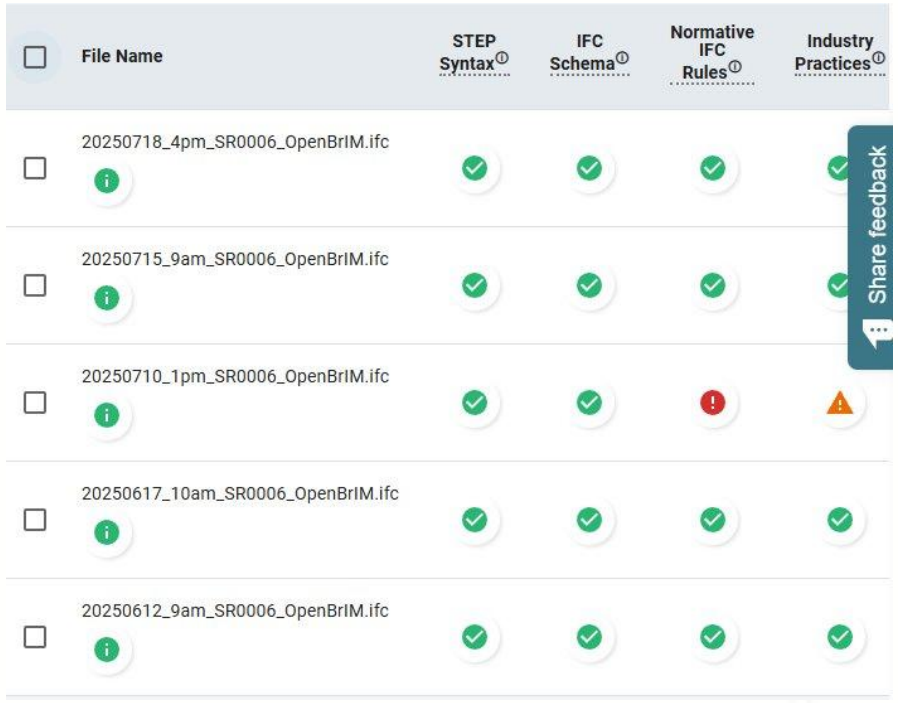
	A	B	C	D	E
1					
2	**Bridge #:**	**US Route 6 French Creek Parkway**			
3					
4					
5	**Element**	**Criteria**	**(Initials and Date**	**Checked By (Initials and Date)**	**Saved View or other locati**
6	**Element Definitions**	Elements on correct Feature Definitions/Element Templates/IFC Classifications per PennDOT Recommended Digital Delivery Guides	HH	KMY - Various Dates	SR6 Model Element Prop.pdf
9	**Stations & Elevations**	Horizontal and vertical alignments in 3D model match the roadway geometry	HH	KMY 3/17/25	Baseline Geom Check.pdf
10		Begin/End of Bridge Stations	HH	KMY 3/14/25	Bridge Stations Check.pdf
11		Abutment - C/L Bearing Stations	HH	KMY 3/14/25	Bridge Stations Check.pdf
12		Pier - C/L Bearing Station	HH	KMY 3/14/25	Bridge Stations Check.pdf
13		Begin/End Approach Slab Stations	HH	KMY 3/14/25	Bridge Stations Check.pdf
14		Begin/End Header Slab Stations	HH	KMY 3/14/25	Bridge Stations Check.pdf
16	**Deck**	Lane widths	HH	RMS 2/19/25	https://mbakerintl-my.sharepoi
17		Shoulder widths	HH	RMS 2/19/25	https://mbakerintl-my.sharepoi
19		Outside barrier widths	HH	RMS 2/19/25	https://mbakerintl-my.sharepoi
20		Increased Thickness of Overhangs	HH	KMY 6-6-25	
21		Width of Bridge (Provide min-max range where variable width is present)	HH	RMS 2/19/25	https://mbakerintl-my.sharepoi

Issue Summary and Tracking with Excel

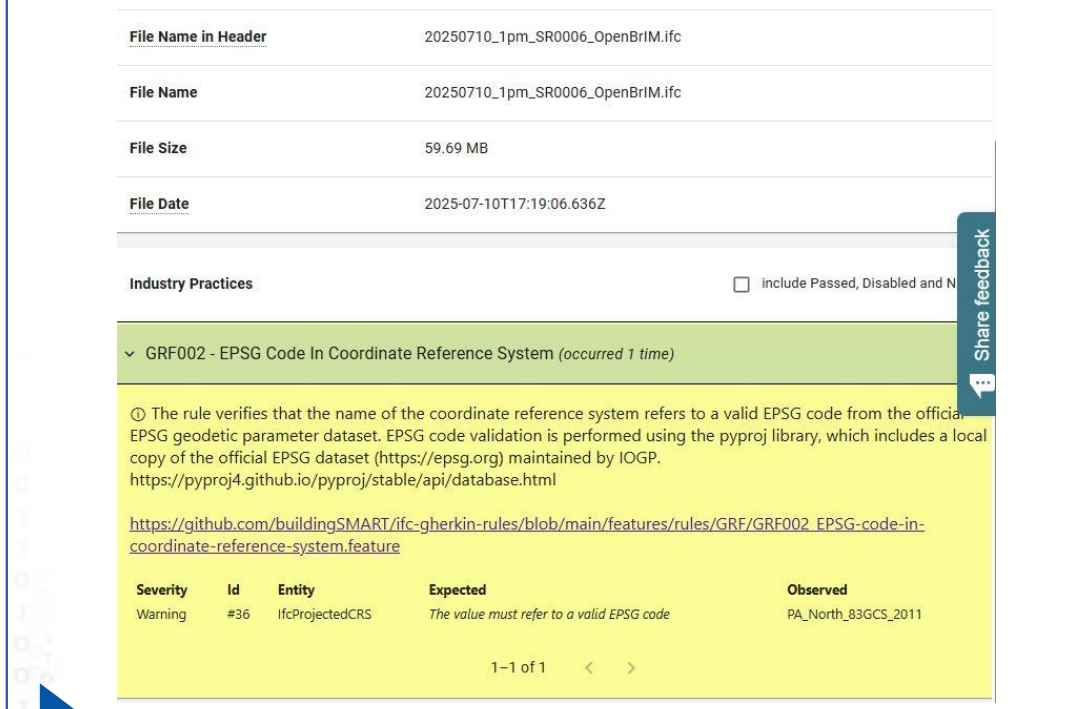
Validation: bSI Validation Service

To verify IFC file quality and compliance, we used the bSI Validation Service to check syntax, schema rules, normative standards, and industry practices.

bSI Validation Service Dashboard



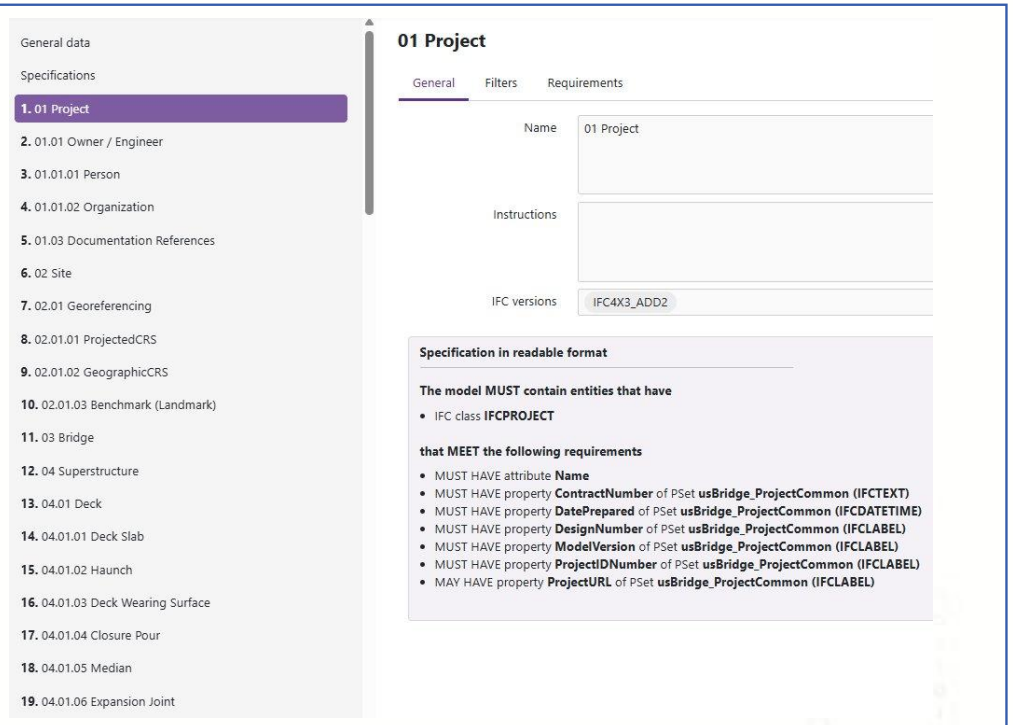
Sample Validation Warning



Validation: bSI Validation Service

To verify the IFC model against specific data requirements for bridge design handover, we used an IDS developed for TPF-5(372), BIM for Bridges.

IDS Snippet



IDS Validation Results

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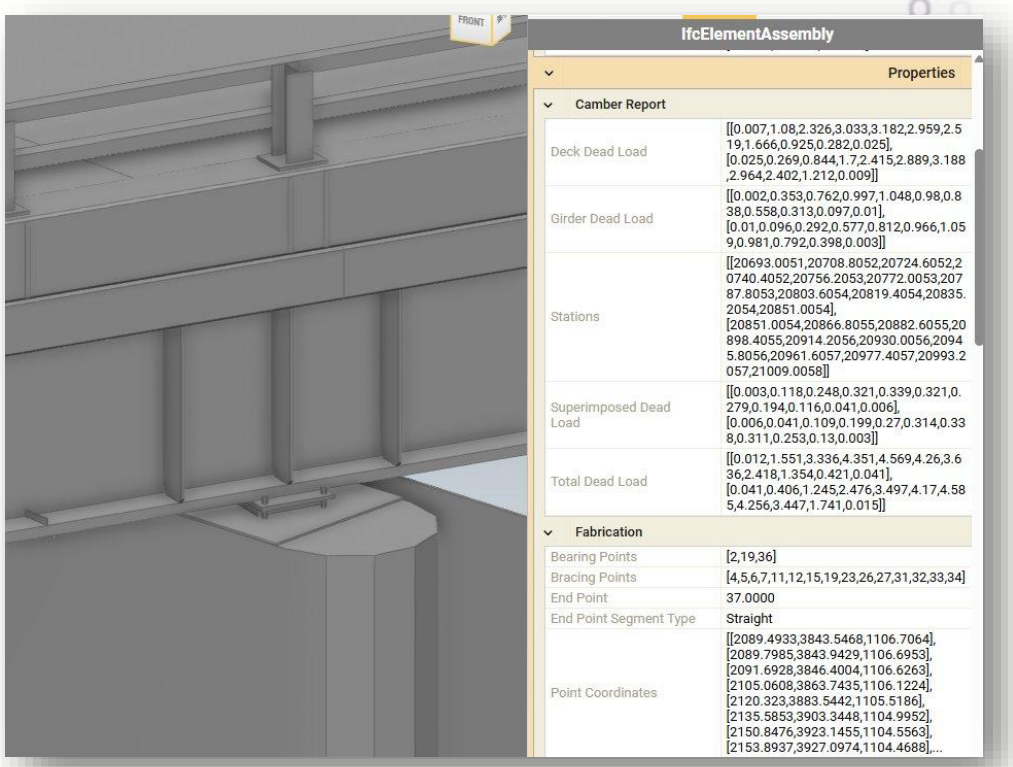
Downstream Use Case: Data for Fabricator

To support fabrication, key data were embedded in the IFC model based on fabricator requirements.

Data Provided

- Control point coordinates
- Camber values
- Girder transitions
- Additional fabrication details



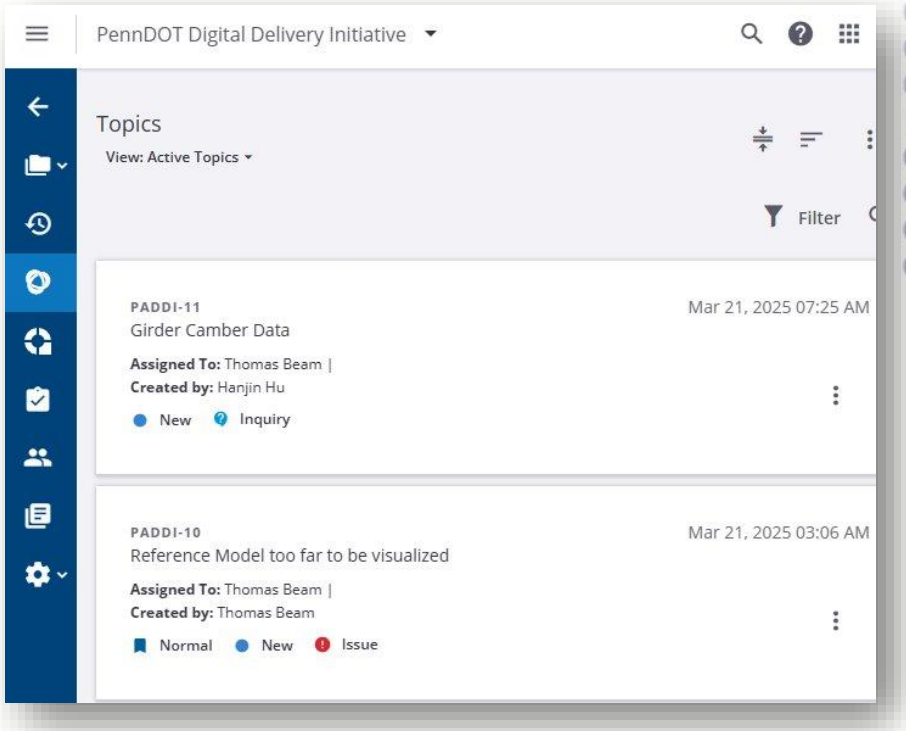
IFC Properties for Fabricators

Downstream Use Case: Communication

Coordination with fabricator was managed through Trimble Connect using BCF for issue tracking and resolution.

Communication

- **Trimble Connect** platform: Enabled real-time collaboration and model-based communication.
- **BCF threads**: Used to raise questions, assign tasks, and share feedback.
- **Issue lifecycle**: Designers responded to fabricator comments and provided updates directly in the shared environment.



Communication with Trimble Connect

Replication Path for Other Agencies

- Steps a DOT can take now
- How this project sets a framework for future digital delivery