TPF-5(372) BIM for Bridges and Structures

Annual Software Vendor Workshop

20-22 July 2021

Day 2 - Wednesday, 21 July 2021

BIM FOR BRIDGES AND STRUCTURES
TPF-5(372)

Workshop Structure & Schedule

Participants

HDR Project Team

TPF Sponsors

CBS T-19 Committee

Software Vendors

Invited Observers

Mics are muted by default

Vendors, please use “Raise hand” to request unmute

Guests/Observers please enter questions in Chat

Sessions will be recorded for future reference

	Time	Session	Objectives
Tuesday 20 July	9:00am-10:20am	Updates on TPF-5(372)	• Overall Schedule / Scope review • IDM / MVD • Data Dictionary • General Q&A
	10:20am-10:40am	Scheduled Break	
	10:40am-11:20am	Demo w/ Q&A: Allplan & LARSA	Demonstrate early development progress and/or intent to support “BIM for Bridges and Structures”
	11:20am-12:00pm	Demo w/ Q&A: PGSuper	

	Time	Session	Objectives
Wednesday 21 July	9:00am-10:20am	Review of Software Vendor Engagement Plan	• Letter of Intent • Unit Test Suite • Certification • General Q&A
	10:20am-10:40am	Scheduled Break	
	10:40am-11:20am	Demo w/ Q&A: Bentley Systems	Demonstrate early development progress and/or intent to support “BIM for Bridges and Structures”
	11:20am-12:00pm	Demo w/ Q&A: OpenBrIM	

	Time	Session	Objectives
Thursday 22 July	9:00am-10:20am	bSI IFC4.3 Progress	• Candidate Standard status • Feedback from participating Vendors on results • General Q&A
	10:20am-10:40am	Scheduled Break	
	10:40am-11:20am	Demo w/ Q&A: Autodesk	Demonstrate early development progress and/or intent to support “BIM for Bridges and Structures”
	11:20am-12:00pm	Demo w/ Q&A: Trimble – Quadri & Tekla Structures	

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Today's Schedule – Day 2

	Time	Session	Objectives
Wednesday 21 July	**9:00am-10:20am**	Review of Software Vendor Engagement Plan	▪ **Letter of Intent** - Vendor Feedback ▪ **Unit Test Suite** - General Outline - Samples ▪ **Certification** - Cost - Structure ▪ **General Q&A**
	10:20am-10:40am	Scheduled Break	
	10:40am-11:20am	Demo w/ Q&A: **Bentley Systems**	Demonstrate early development progress and/or intent to support "BIM for Bridges and Structures"
	11:20am-12:00pm	Demo w/ Q&A: **OpenBrIM**	

BIM FOR BRIDGES AND STRUCTURES
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Review of Software Vendor Engagement Plan (SVEP)

BIM FOR BRIDGES AND STRUCTURES
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Software Vendor Engagement Plan Overview

Year 1: Outreach ✓

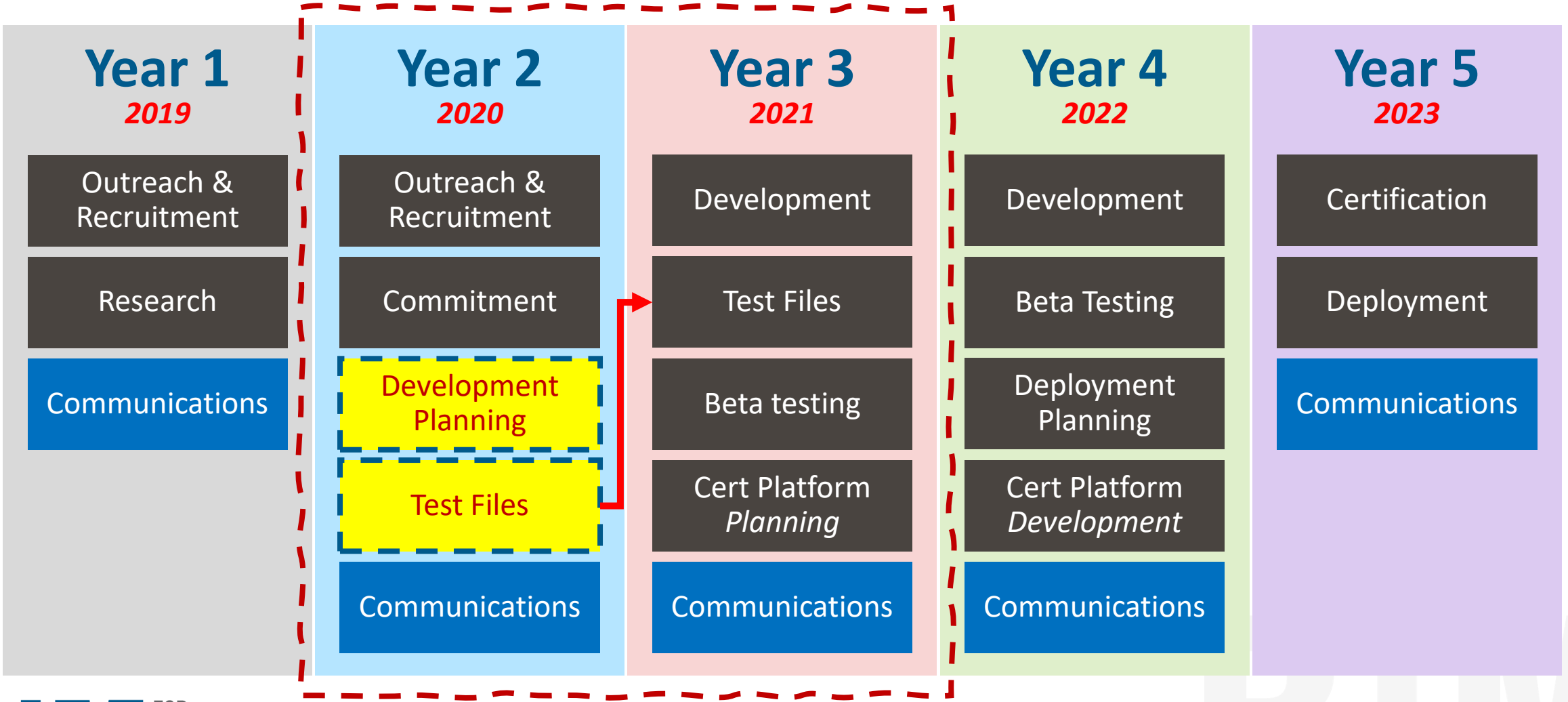
Year 2: Commitment & Planning ✓

Year 3: Development, Implementation & Testing – Phase 1 (current)

Year 4: Development, Implementation & Testing – Phase 2

Year 5: Certification & Deployment

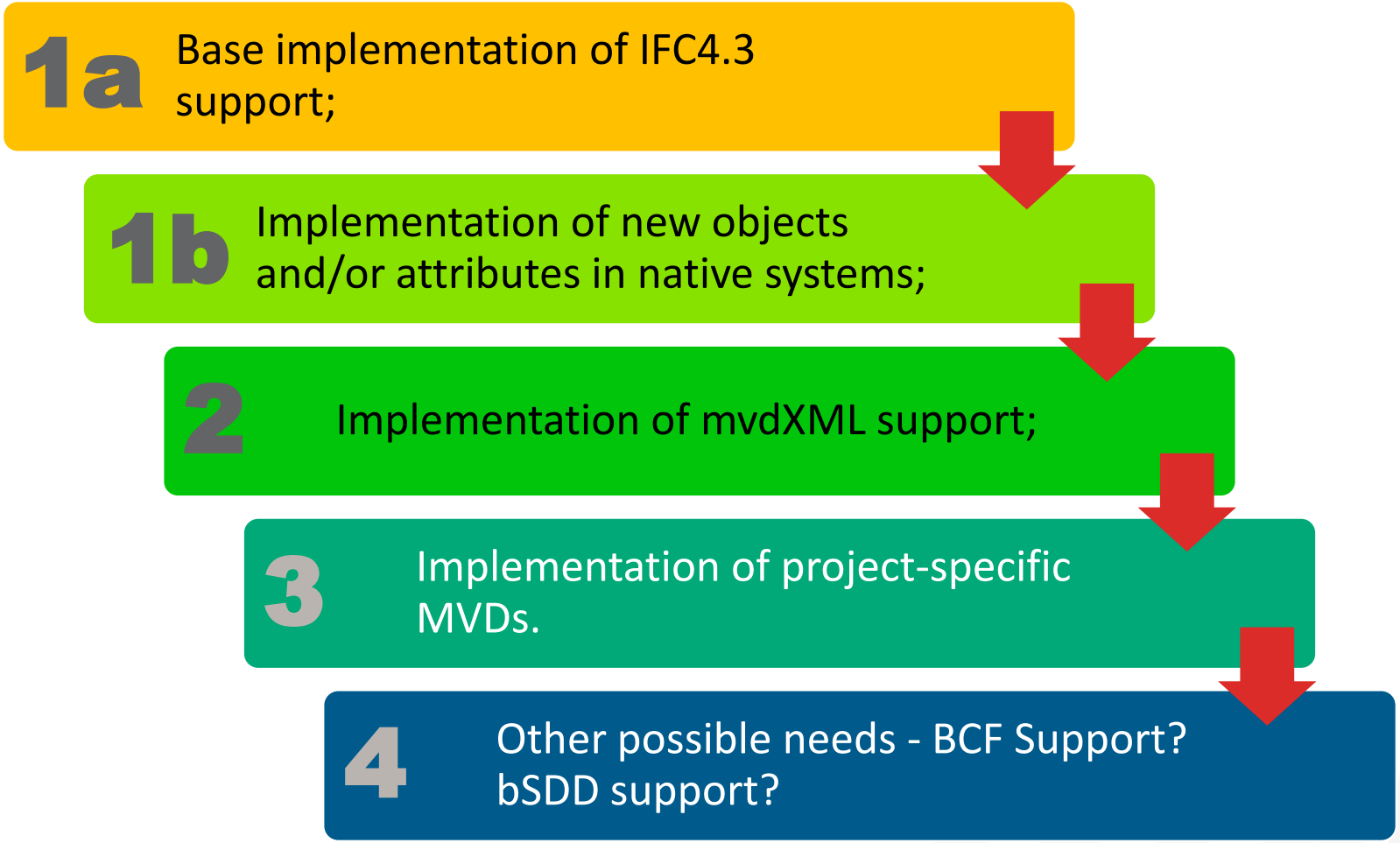
Software Vendor Engagement Plan Overview



Software Vendor Engagement Plan Overview

Meeting Project Requirements

- Phased approach
- Continual progress
- Modular implementation



Letter of Intent

Establish a public, formal, good-faith commitment to supporting the project

Responsibilities of the Software Vendor (Developer) & HDR Project Team (Agent)

Benefits to declaring formal support throughout project

Vendor Feedback!

Positive and constructive concerns

BIM FOR BRIDGES AND STRUCTURES TPF-5(372)

BIM FOR BRIDGES AND STRUCTURES TPF-5(372)

Letter of Intent

Development of Software to support TPF-5(372)

HDR Engineering, Inc.
1917 South 67th Street
Omaha, NE 68106-2973
(402) 399-1000
Julie Rivera
Julie.Rivera@hdrinc.com

Date: September 01, 2021

Developer Company Name
Address
Address
Phone
Contact/Agent Name
Contact email

RE: Intent to Develop Software

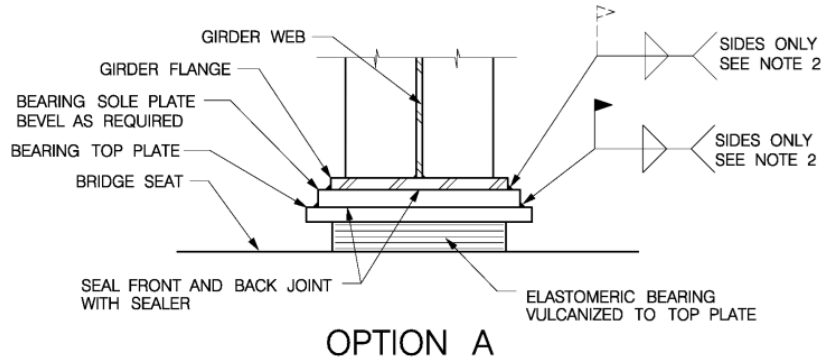
Members of the American Association of State Highway and Transportation Officials (AASHTO) have been learning about the use of building information modeling (BIM) for the design, procurement, construction, and operational management of transportation infrastructure (e.g. roads, bridges, rail, etc.). Several pilot projects have also been executed to explore the technologies, workflows, and resulting benefits of implementation. Just as the vertical construction (buildings) industry has experienced, one of the key factors to getting the most benefit is the use of open data standards to enable the exchange and use of information across a wide variety of technology platforms and processes. As such, AASHTO has resolved[1] to adopt buildingSMART International's (bSI) openBIM®[2] data model standard, Industry Foundation Classes (IFC)[3], as the foundation for the use of BIM-based project delivery and operations workflows and data, for highways and bridges in the United States. The practical application of IFC and related bSI openBIM standards (such as Model View Definitions [MVDs], the buildingSMART Data Dictionary [bSDD], and the BIM Collaboration Format [BCF]) requires that commercial software products used throughout the US transportation industry support these standards. This enables the use of many different types of tools, from many different sources, to address the

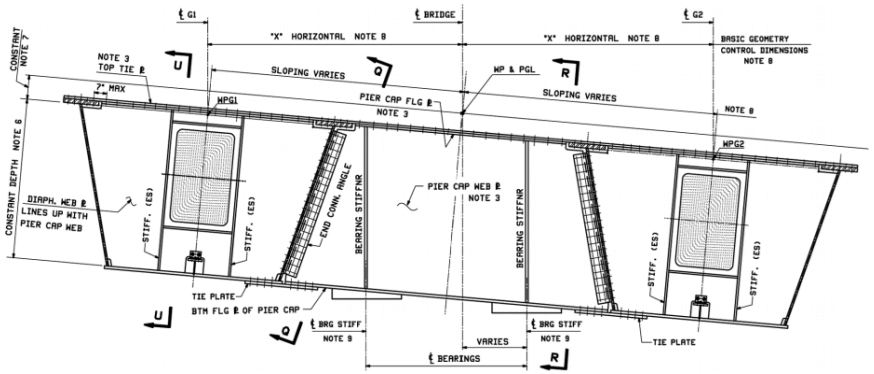
[1] See Administrative Resolution AR-1-19 Adoption of Industry Foundation Classes (IFC) Schema as the Standard Data Schema for the Exchange of Electronic Engineering Data
[2] See https://www.buildingsmart.org/about/openbim/ for the definition of "openBIM"
[3] See https://technical.buildingsmart.org/standards/ifc/ for more information about IFC

Letter of Intent – Development of Software 1

Unit Test Suite

Files used to enable software developer/vendor testing and validation of requirements.





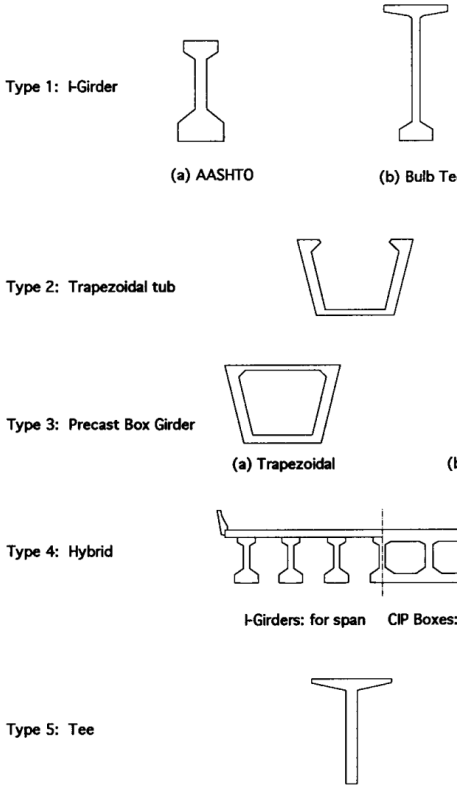
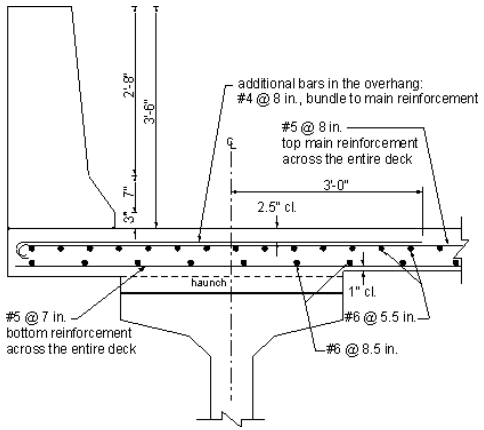


FIGURE 4. Common cross section shapes used in spliced girder bridge applications.

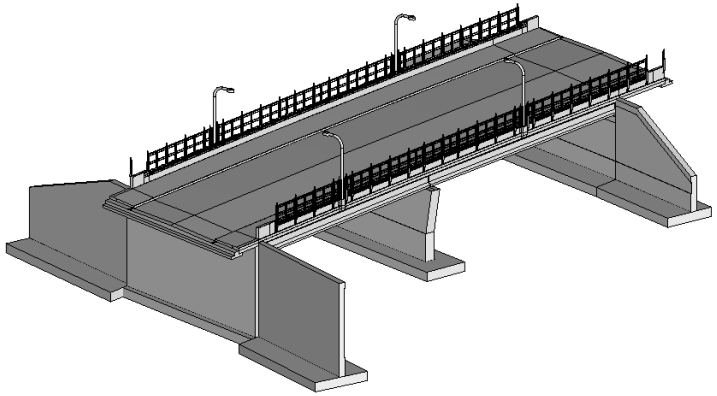


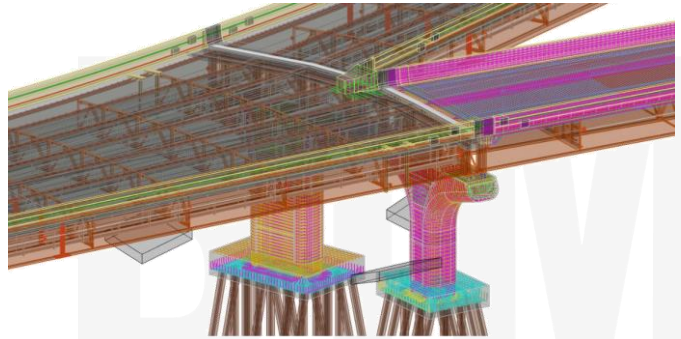
IFC4.3 Schema Properties

Property Set	Property	Value
Information	Name	Pier 01
Information	Type	B
Information	Material	Concrete

Data Dictionary Properties

Property Set	Property	Value
AASHTO Info	Custom Property 01	Value 01
AASHTO Info	Custom Property 02	Value 02
AASHTO Info	Custom Property 03	Value 03





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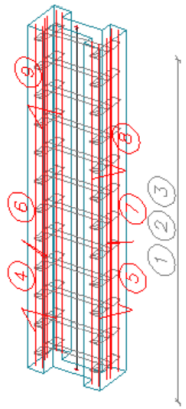
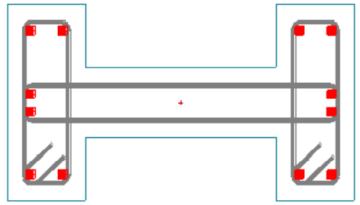
Unit Testing Suite files are descriptions of how objects should be modeled in software and exported as IFC files

Model Element	Concept	Value	IFC4
Building		Name: ReinforcingBar_Building	IfcBuilding [Object User Identity]
	Spatial Composition	Related to Site: LOT-1000	Spatial Composition
Building Storey		Name: Ground Floor	IfcBuildingStorey [Object User Identity]
	Spatial Composition	Related to Building: ReinforcingBar_Building	Spatial Composition
Project		Name: IFC4RV_ReinforcingBar_01S	IfcProject [Object User Identity]
Reinforcing Bar		Name: Properties valid for all reinforcing bars	IfcReinforcingBar
	Body Geometry General	Geometry for objects	Body Geometry General
	Product Local Placement	Has Placement	Product Local Placement
	Spatial Containment	Ground Floor	Spatial Containment
Reinforcing Bar_C-B1-1		Name: C-B1-1	IfcReinforcingBar [Object User Identity]
	Material Single	Material Name. The following substring shall be contained in Material Name: B 400A	Material Single
	Product Geometry Colour	RGB 205-205-205	Product Geometry Colour
	Product Geometry Layer	B1-reinforcing bars	Product Geometry Layer
Reinforcing Bar_C-B1-4		Name: C-B1-4	IfcReinforcingBar [Object User Identity]
	Material Single	Material Name. The following substring shall be contained in Material Name: B 400A	Material Single
	Product Geometry Colour	RGB 255-0-0	Product Geometry Colour
	Product Geometry Layer	B1-reinforcing bars	Product Geometry Layer
Reinforcing Bar_C-B3-1		Name: C-B3-1	IfcReinforcingBar [Object User Identity]
	Product Geometry Layer	B2-reinforcing bars	Product Geometry Layer

Details – Column B1,B2





Position Number	Bar Role	Diameter [mm]	Material	Number of Bars	Stirrup Distances [mm]
1,2	Ligature	8	B 400A	12	300
3	Ligature	8	B 400A	12	300
4,5,6,7,8,9	Main	20	B 400A	2	-

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Unit Test Suite

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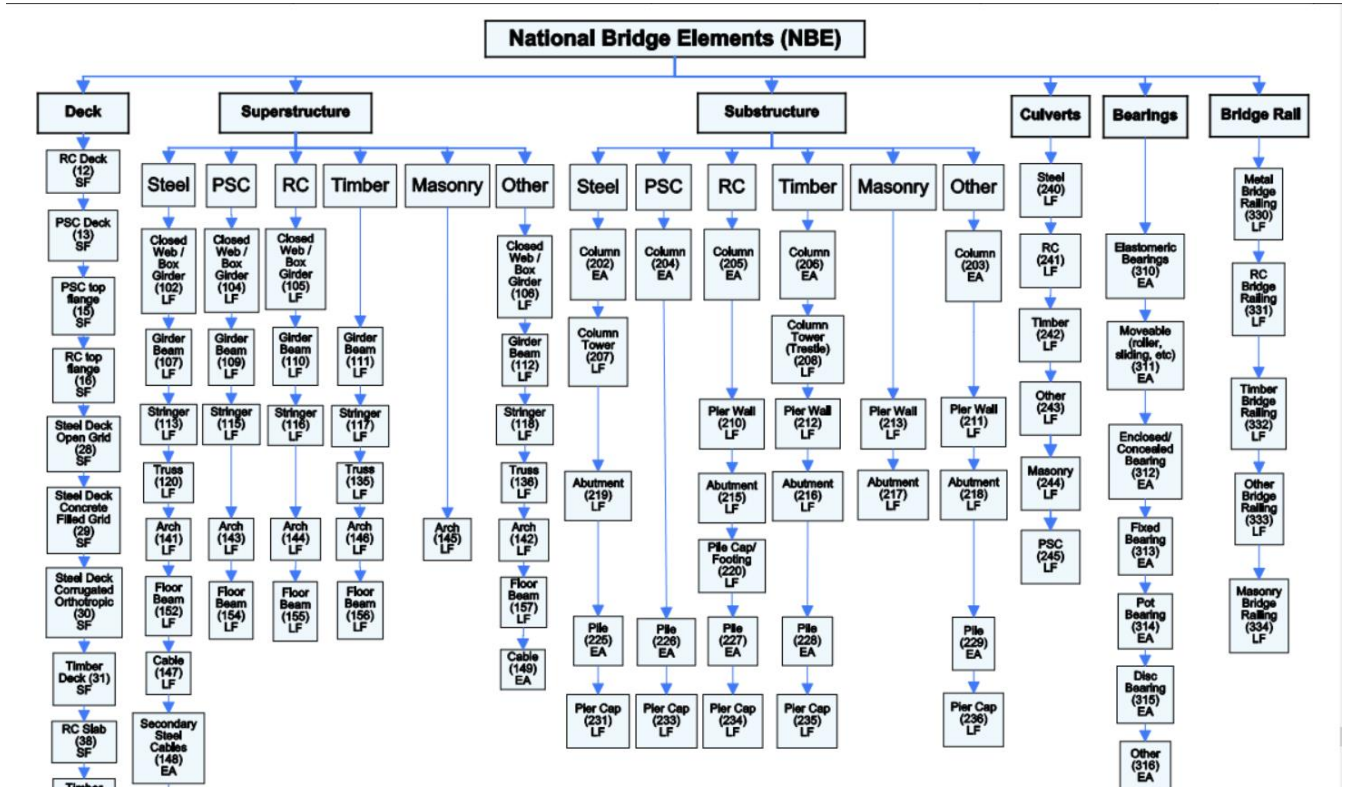
Requirements are based on the IDM and MVD

Scope is initially based on the IDM and the *Manual for Bridge Element Inspection, Second Edition, 2019**

Elements / Systems / Spatial Structure

Material / construction types



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Unit Test Suite

Structure Types

- Slab
- Girder (i.e. I-girder, I-beam, box girder, deck beam)
- Common buried structures (box culverts, three-sided structures, arches)
- Retaining walls associated with or adjacent to a bridge

Material Types

- Reinforced Concrete
- Precast/Prestressed Concrete
- Post-Tensioned Concrete
- Steel

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Unit Test Suite

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Requirements are based on the IDM and MVD

Scope is initially based on the IDM and the *Manual for Bridge Element Inspection, Second Edition, 2019**

Include aspects of FHWA BrIM research, as well as PCI-ACI-NSBA-ASBI-PTI-AASHTO Design Standards & Details

BIM FOR BRIDGES AND STRUCTURES
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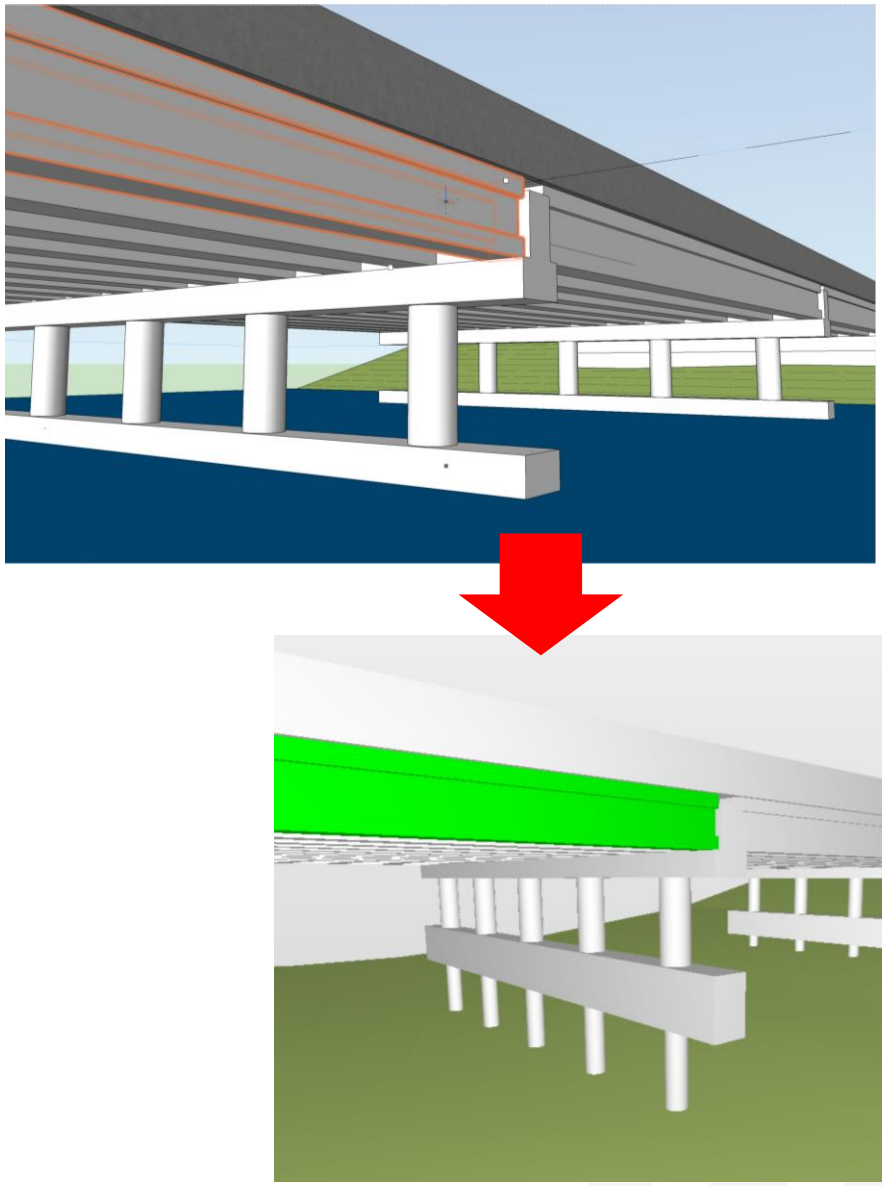
Unit Test Suite

Resulting exports are checked for accuracy

Validated and “correct” exported IFC files can then be used as import validation tests



Unit Test Suite

Resulting exports are checked for accuracy

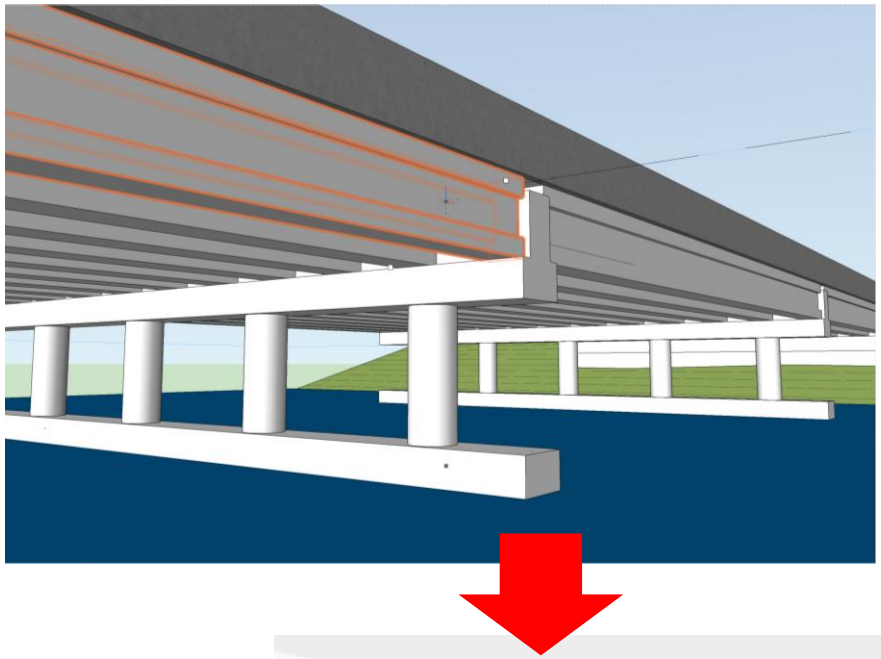
Validated and “correct” exported IFC files can then be used as import validation tests

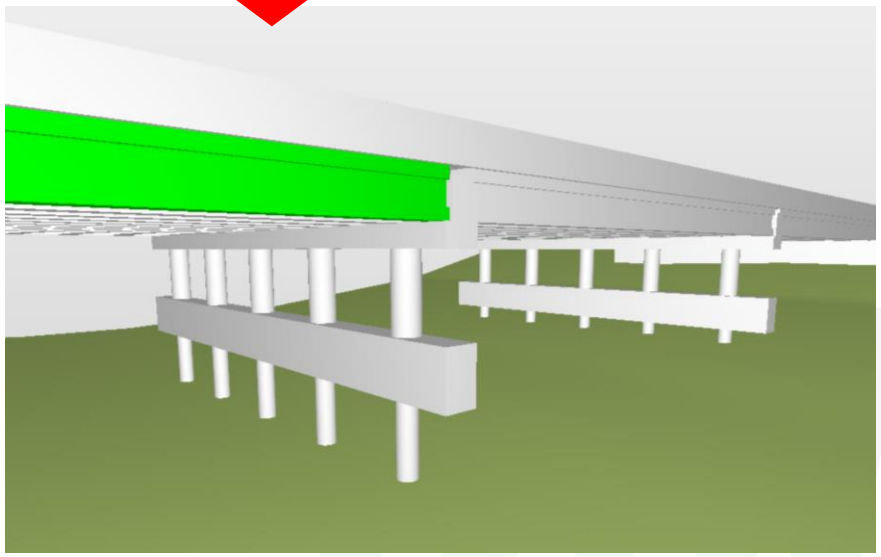
Scope:

- Level 1 – Elements
- Level 2 – Arrays
- Level 3 – Connections / Interfaces
- Level 4 – Aggregations
- Level 5 – Bridges

Size:

- Potentially 200+ tests
- Decrease in number as increase in level





TPF-5(372) IFC4.3 Software Implementation Unit Test Suite

Summary:
The Unit Test Suite is designed to provide software developers/vendors with a series of instructions to create and export models of various elements, systems, and conditions across the breadth of expected supported use cases. It uses the common software development methodology of reducing complex software to the most basic operational "unit" that can be objectively judged as to being correct or not. These unit tests start at simple, single elements and then aggregate in various configurations and growing size and complexity at each level. This enables the developer to quickly test the quality of IFC output and more easily troubleshoot basic issues before moving onto the next level of complexity. Ideally, by the time the developer reaches the level of a complete bridge design, there are few issues to correct and none are explicitly related to prior unit test cases.

The baseline "Level 1 - Elements" list is based on the "National Bridge Elements (NBEs)" and "Bridge Management Elements (BMEs)", as defined in the "*Manual for Bridge Element Inspection, Second Edition, 2019*" by AASHTO, including prestressed concrete-, reinforced concrete-, masonry-, and steel-based material configurations, as well as "Chapter 3 - Scope" of Part One: Industry Use Narrative of the "Information Delivery Manual (IDM): Construction Contract Model, Representing the Handoff from Design to Construction for Highway Bridges". All other lists are logical aggregations of the elements growing in complexity. The "IFC Concepts Tested" for each entry in each list is defined by the exchange requirements of the IDM and resulting Model View Definition (MVD).

Exclusions:
The following elements, elements types, system types, and bridge designs are explicitly excluded from this version of the test suite, but may be added later.
- Timber-based elements and bridges
- Cable-stayed, or suspension, bridges
- "Other" materials, unless explicitly noted
- Agency-Defined NBEs and BMEs
- Independent Agency-Defined Elements

Level	Name	Description	Goals / Tested Concepts
Level 1	Elements	Basic elements of bridge construction in steel and concrete material permutations, as well as all relevant geometric permutations	- Geometry: using standard and custom profiles - Material: Steel & concrete (PRC, RC) - Properties: -
Level 2	Arrays	Simple arrays of similar basic elements, mimicing typical repetitive constructions	- Level 1 + - Object Types - Object Type Properties - Instance overrides of Types and Type Properties - Spatial Hierarchy -
Level 3	Connections_Interfaces	Simple element-element connections and/or interfaces, as well as needed connection, joint, and interface elements	- Levels 1 & 2 + - Connections/Bearings - IfcRelConnects -
Level 4	Aggregations	Aggregation of elements and needed connections into typical substructure and superstructures subsets/bays/spans	- Levels 1, 2 & 3 + - IfcFacilityElement -
Level 5	Bridges	Examples of complete supported bridge designs	- Levels 1, 2, 3, 4, 5 + - IfcAlignment - Geolocation - Project hierarchy including Project, Site, Facility, …. -

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1				IFC concepts tested																
2	**Element**	**Permutation**	**X**	**IfcBuiltElement**	**IfcFacilityPart**	**IfcMaterial**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Ifc...**	**Test Name**	**File Name**	**Notes**
3	Deck	PSC (Prestressed Concrete)		X		X														
4		RC (Reinforced Concrete)																		
5		RC Slab																		
6		PSC Top Flange																		
7		RC Top Flange																		
8		Steel, Open Grid																		
9		Steel, Concrete Filled Grid																		
10		Steel, Corrugated																		
11		Steel, Orthotropic																		
12	Closed Web / Box Girder	Steel																		
13		PSC																		
14		RC																		
15	Girder/Beam	PSC (Prestressed Concrete), Solid																		
16		RC (Reinforced Concrete), Box																		
17		Steel, Rolled																		
18		Steel, Composite																		
19	Stringer	PSC																		
20		RC																		
21		Steel, Rolled																		
22		Steel, Composite																		
23	Truss	Steel																		
24	Arch	PSC																		
25		RC																		
26		Steel, Rolled																		
27		Steel, Composite																		
28		Masonry																		
29	Floor Beam	PSC																		
30		RC																		

Certification

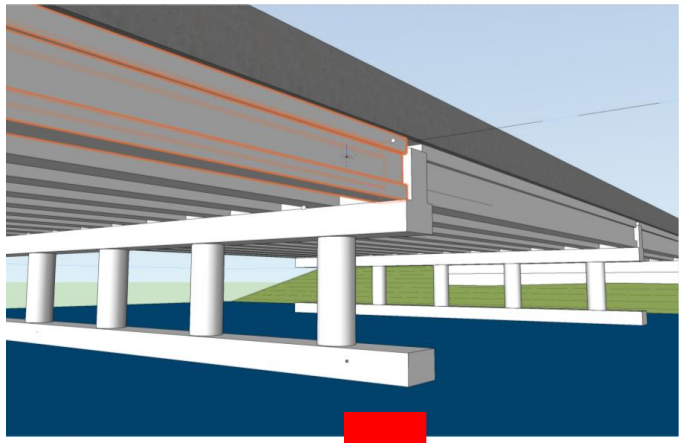
Officially validating software's implementation and support for the exchange standard

ALLPLAN
A NEMETSCHEK COMPANY

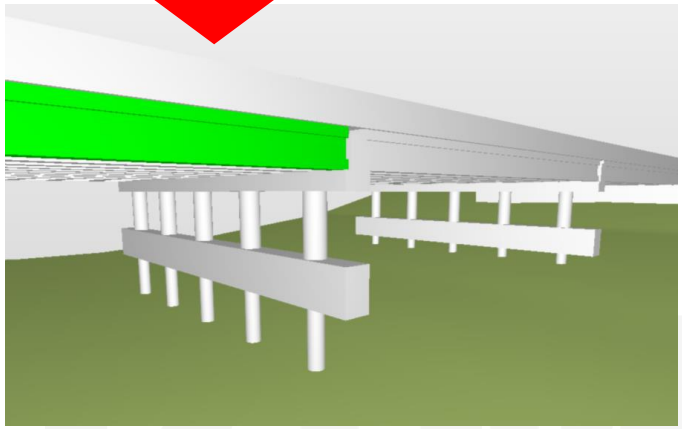
AUTODESK.

Bentley®

Trimble



IFC4.3
(IFC-STP = .ifc)



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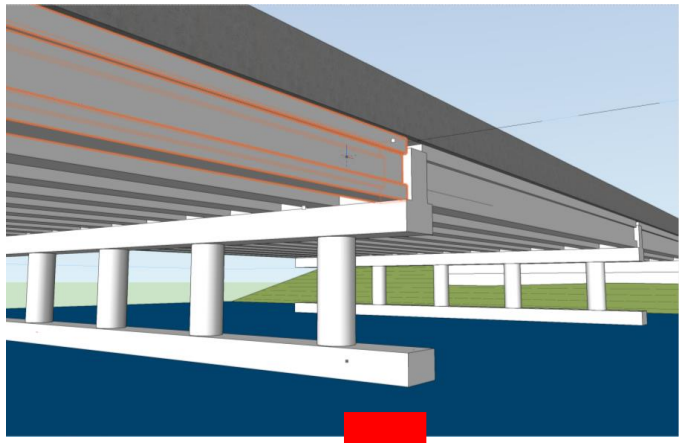


EXPORT → **IMPORT**

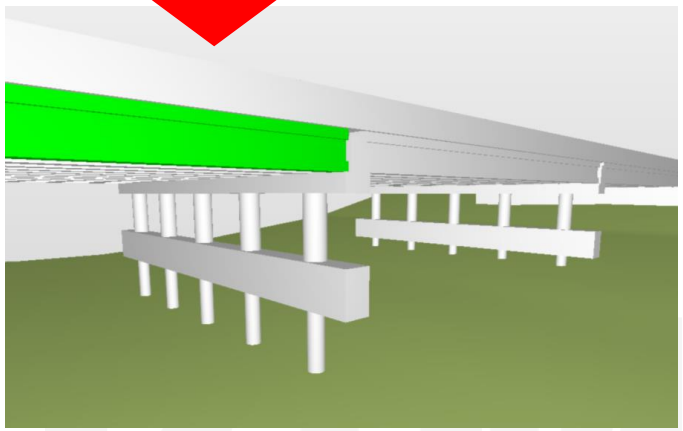
Based on MVD

Assumed design/modeling applications

Initially based on MVD, but should consider broader IFC4.3 support

Dependent on software purpose/functionality

IFC4.3
(IFC-STP = .ifc)



BIM FOR BRIDGES AND STRUCTURES
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Certification

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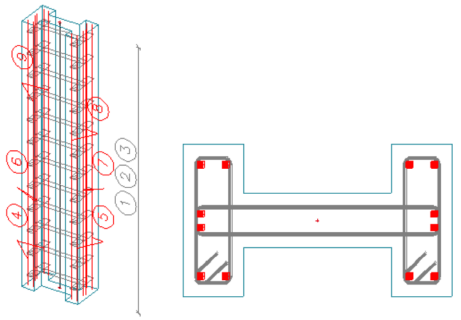
Leveraging:

Unit Test Suite

Details – Column B1,B2



Position Number	Bar Role	Diameter [mm]	Material	Number of Bars	Stirrup Distances [mm]
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TPF-5(372) IFC4.3 Software Implementation Unit Test Suite

Summary:
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Level 4	Aggregations	Aggregation of elements and needed connections into typical substructure and superstructures subsets/bays/spans	- Levels 1, 2 & 3 + - IfcFacilityElement -
Level 5	Bridges	Examples of complete supported bridge designs	- Levels 1, 2, 3, 4, 5 + - IfcAlignment - Geolocation - Project hierarchy including Project, Site, Facility, ... -

Intro | L1-Elements | L2-Arrays | L3-Connections_Interfaces | L4-Aggregations | L5-Bridges

BIM FOR BRIDGES AND STRUCTURES
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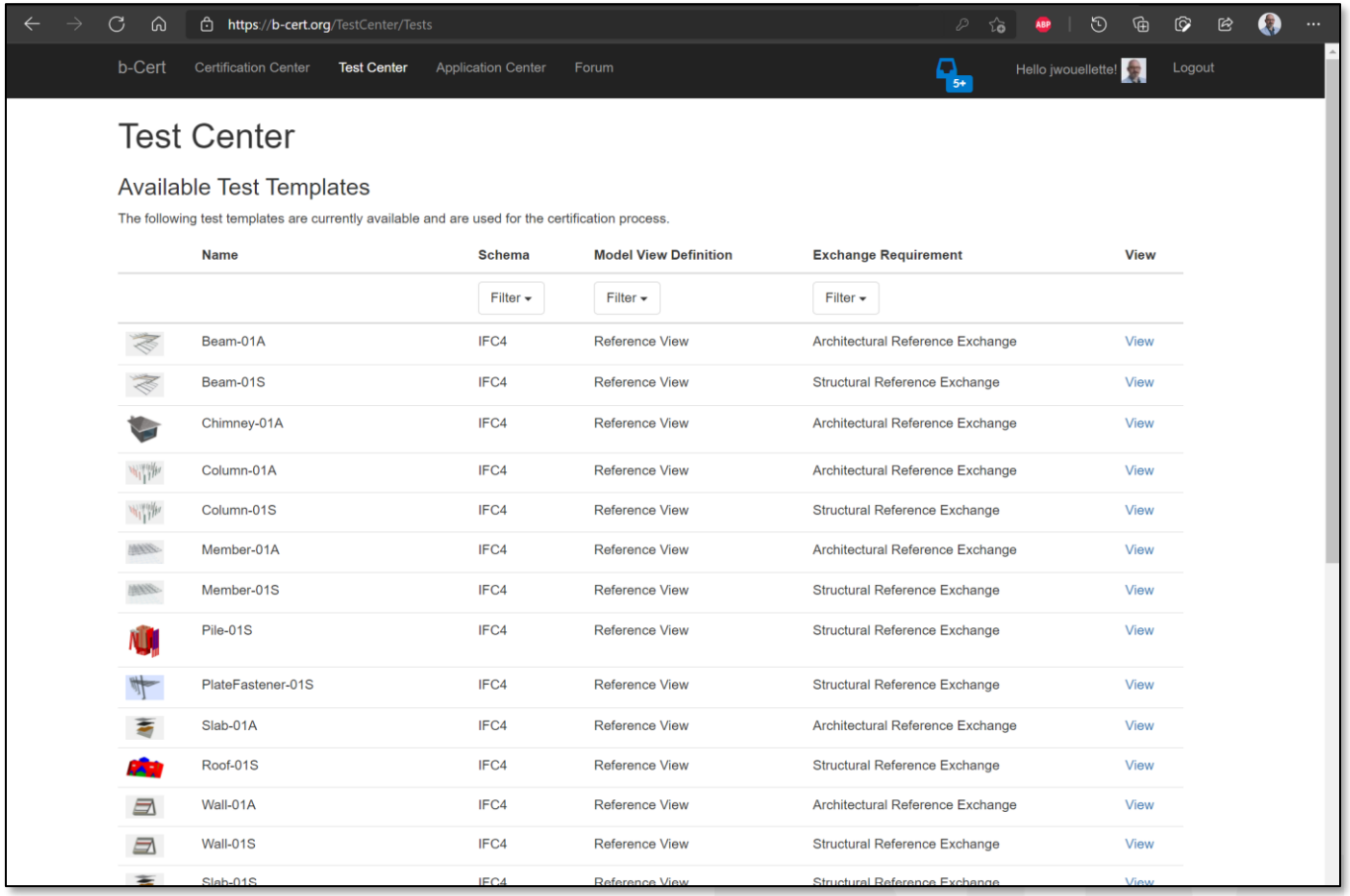
Certification

Officially validating software's implementation and support for the exchange standard

Leveraging:

- Unit Test Suite
- bSI b-cert platform
  - Export 1st, Import 2nd



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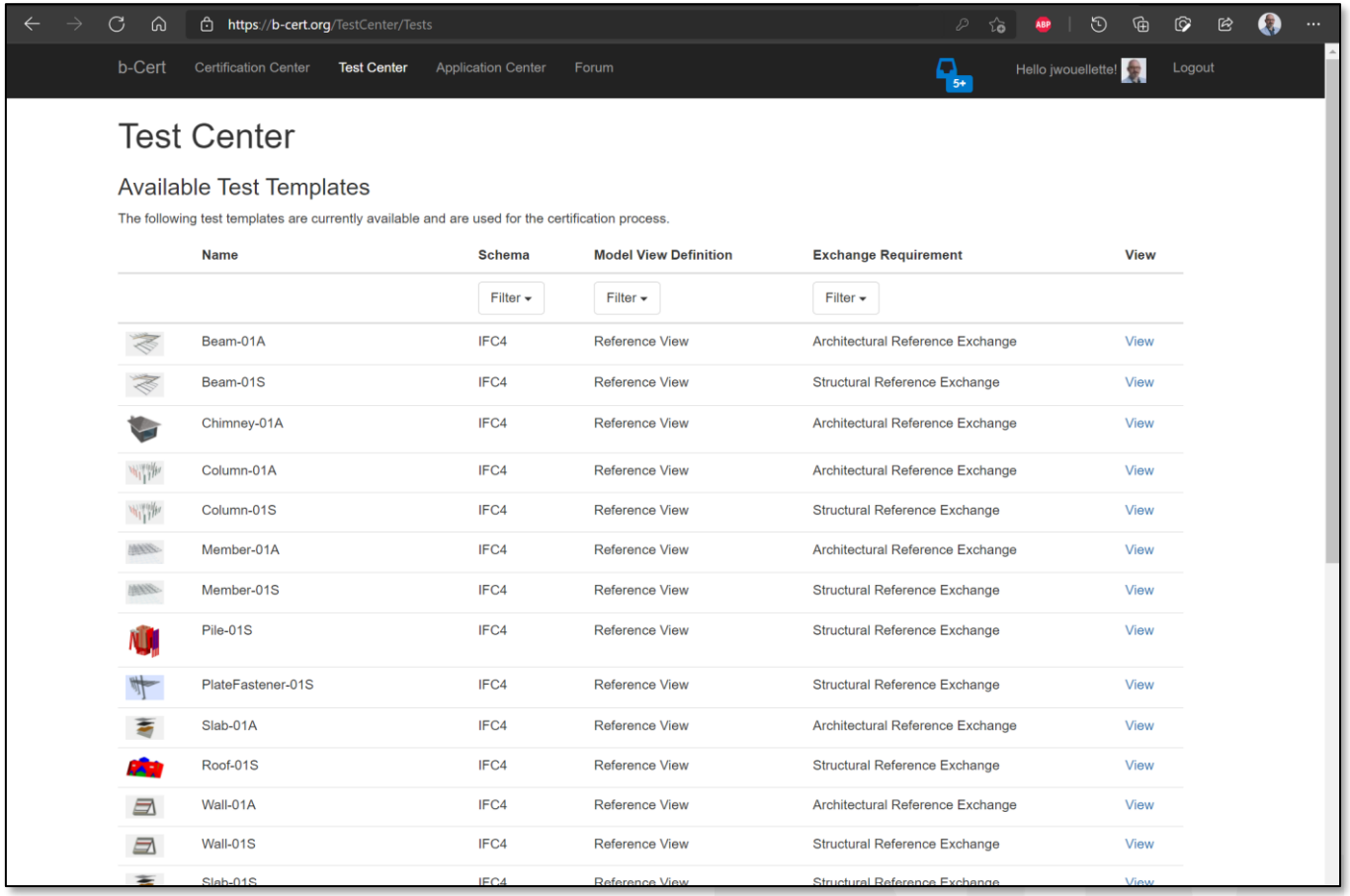
Officially validating software's implementation and support for the exchange standard



Investment, Cost, & LT Support:

Currently investigating with bSI

- AASHTO / Vendor fees
- TPF Project Team resources
- Long-term resources (AASHTO)
- Re-certification requirements

Dependent on scope of tests

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Certification

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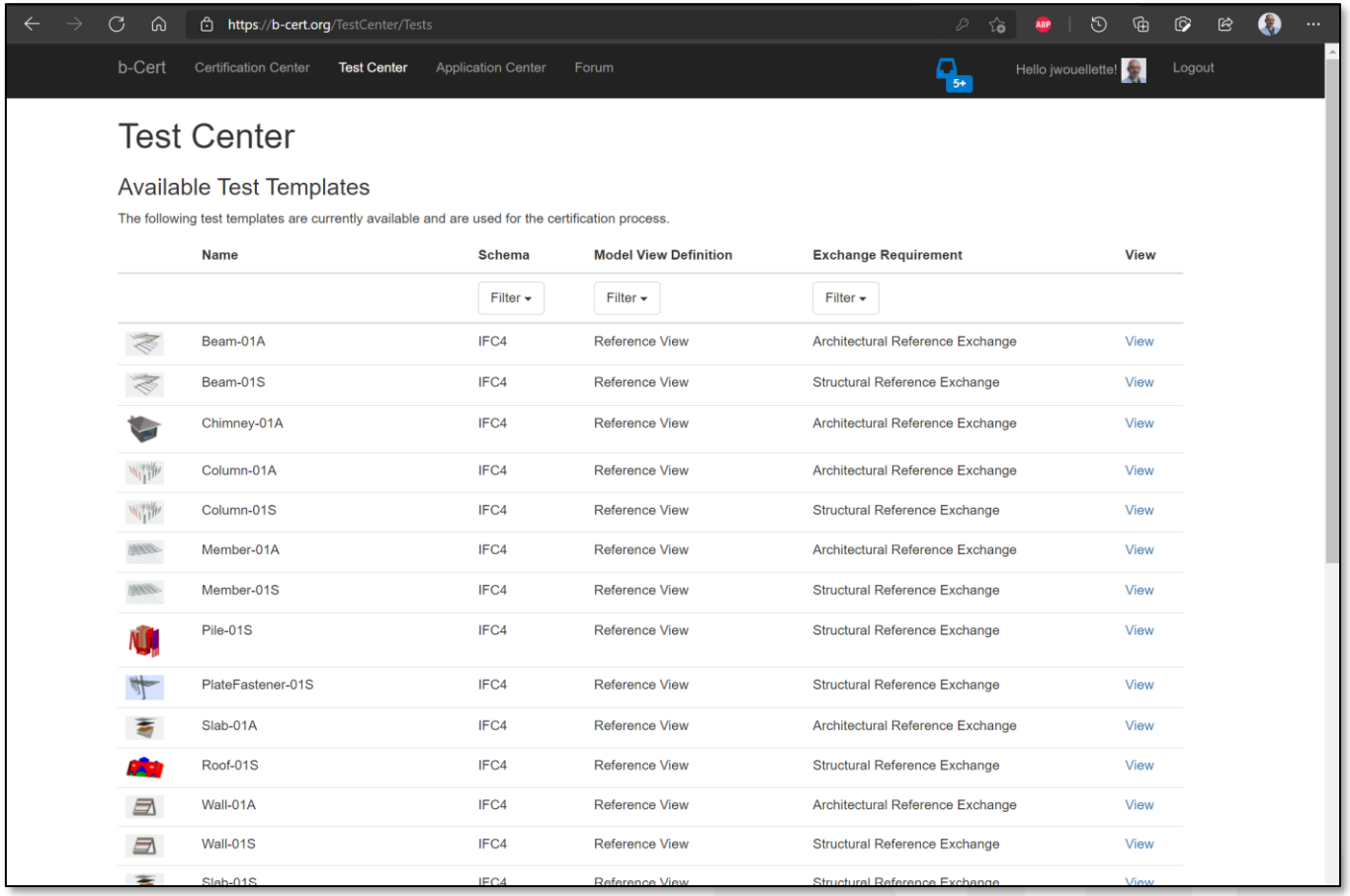
Scope *(Vendor Feedback)* :

Should the certification tests totally overlap the TPF Unit Test Suite OR be a smaller subset?



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General Q & A

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Day 2 Demos

Bentley Systems – 40 mins.

OpenBrIM – 40 mins.

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