

buildingSMART International (2022)

394-PROFESSIONAL Professional Research using openBIM

TPF-5(372) BIM for Bridges and Structures Transportation Pooled Fund



jNdqraZz

Entrant details

Role or Job Title on the Project | Transportation BIM Program Manager

Employer

HDR
USA

Employer Role | Private Sector Owner/Client

Are you or your employer a member
of buildingSMART? | Yes - Chapter Member

Entry details

Entry Details

By checking this box I understand and acknowledge that this awards program is to assess information about openBIM, and that openBIM is not only about the use of solutions. openBIM is about setting up an environment where every party in a team can work in the optimal way ("how they prefer") without putting limitations on others.

It is about freedom to take control over your data and workflows, while keeping that freedom for others as

well. Full use of open standards is not mandatory for this mission.

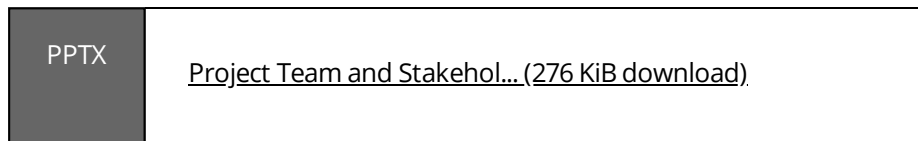
Website

| <https://bimforbridgesus.com/>

Location

This research is being funded by a Transportation Pooled Fund sponsored by 24 state transportation agencies and the United States Department of Transportation (USDOT) under the Federal Highway Administration (FHWA) program. The work is being conducted in the United States through a contract issued by the Iowa Department of Transportation located in Ames, Iowa, USA. The work is being performed by a distributed project team with members located in the USA and Germany. Work is being conducted virtually.

Submitting Party and Stakeholder Logos (compiled into one .ppt/pptx file for upload)



Entry Description

Background

Building information modeling (BIM) has been widely used in the commercial sector and vertical construction to manage projects from conception through design, fabrication, construction and for future maintenance. Although some fabricators who perform work on both vertical construction and transportation structures have begun employing BIM tools in the fabrication of bridge components, its use in transportation infrastructure is severely limited due to the lack of standardization. It became obvious that in order to take advantage of the efficiencies associated with the use of BIM in transportation structures, a comprehensive strategic plan by the American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures (CBS) was needed. Previous national research projects provided a framework for BIM implementation roadmap and provided a list of actionable items to CBS Technical Committee on Technology and Software (T-19). As a result of these recommendations, T-19 identified a path forward for BIM implementation for bridges and structures in the United States of America through a national initiative called BIM for Bridges and Structures to be funded by Federal Highway Administration (FHWA) and a pooled fund study. T-19 agreed to hire HDR as the lead consultant to accomplish the tasks under the TPF-5(372) BIM for Bridges and Structures Initiative.

Project Scope

The TPF-5(372) BIM for Bridges and Structures initiative is a Transportation Pooled Fund that is a collaborative effort of more than 20 state transportation agencies, the Federal Highway Administration, and the American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures. The objective of this project is to develop a standard way of exchanging 3D models and other digital data for conventional workhorse bridges in the United States using the Industry Foundation Classes (IFC) standard. Workhorse bridges in the U.S. are defined as bridges with spans of less than 300 feet, generally constant girder-type structures assembled from standard structural components and systems – are parts of the landscape that go unnoticed until it is time for their replacement.

The scope of the TPF-5(372) BIM for Bridges and Structures project is to develop the standards for exchanging bridge information from design to construction necessary for contractors to prepare a bid (during the tendering or procurement process), construct the bridge, as well as pass this data to the bridge fabricator to initiate their processes. Initiatives led by other disciplines will address elements incidental to bridges and related structures. The work will be based on the buildingSMART International IFC 4x3 schema and the Alignment Based Reference View. Specific activities to achieve the objective of this project include:

- (1) Development of an Information Delivery Manual (IDM)
- (2) Development of a Model View Definition (MVD)
- (3) Development of a U.S. Bridge Data Dictionary
- (4) Engagement activities with software vendors to support development of the Industry Foundation Classes (IFC) 4x3 schema and the MVD being produced under this initiative
- (5) Development of a unit test suite for software developers to test their commercial products functionality to import and

export files using the IFC 4x3 schema

(6) Stakeholder engagement and communication to promote the use of IFC 4x3 to support the exchange of workhorse bridges information from design to construction.

Schedule

2019 - 2024 (Years 1-5) Industry Involvement and Stakeholder Education and Engagement

2019 - 2020 (Year 1) Investigation and Exploration

2020 - 2023 (Years 2 and 3) Development of IDM and MVD

2022 - 2023 (Year 4) Economic Analysis Return on Investment (ROI)

2023 - 2024 (Year 5) Software Certification and Technical Support

What stage of completion is the entry content representing?

Completion of IDM, development of bridge data dictionary, MVD and test suite for software vendors in progress (substantial completion)

Stakeholder Statements

Tim Armbrecht, P.E., S.E.

Engineer of Structural Services

Bureau of Bridges and Structures

Illinois Department of Transportation

"The ability to use a structure's data as input and output among various different structural software has long been desired, but always seemed extremely difficult to accomplish. The BIM for Bridges and Structures pooled fund research has been steadily overcoming the difficulties to make standard data exchange possible. It is also worth noting this research has inspired the rest of the transportation industry to take notice and investigate a national standard for all transportation, not just bridges. This research should lead to transportation professionals being able to share a structure's data across multiple software packages, which will save time and produce more accurate results."

James Hauber, P.E.

Chief Structural Engineer

Bureau of Bridges and Structures

Iowa Department of Transportation

"The vision for BIM for bridges in the US includes the development of an open, ISO-compliant BIM standard utilizing IFC. The BIM for Bridges and Structures project is developing an information delivery manual (IDM) and model view definition (MVD) for the design-to-construction data exchange to support this vision. The US bridge industry will benefit from the continued development of IDMs and MVDs as these efforts continue. With IFC being implemented into software, the national standard will lead to more efficient design, construction, and asset management of bridges."

Brenda Crudele, P.E.

Structures Design Bureau Director

Engineering Division – Office of Structures

New York State Department of Transportation

"Individual transportation agencies in the US do not have the ability to develop their own data standards for bridge design, construction, and asset management. The BIM for Bridges and Structures pooled fund study provided the first step in utilizing a data standard and developing the first model view definition, MVD, for the design to construction data exchange for bridges. This is a tangible deliverable that will be incorporated into software utilized by the bridge industry. It will allow for BIM to be utilized more easily and frequently on bridge projects in the US."

Upload a 2 minute video to show the scope of the entry.

MP4

[Julie Rivera's Personal R... \(2.5 MiB download\)](#)

Problem Statement

Over the last several years, the US has been increasingly leveraging BIM for project delivery with the ultimate goal to use the design intent model as the contractual document. The US bridge community vision is for the design intent model to replace today's 2D contract drawings, which are exchanged as PDF files. The design intent model will be the reliable source transfer the digital information between design and construction as the contractual binding document. The challenge today that is preventing us from executing the vision of using model-based delivery is that US bridge community is locked into proprietary digital data files that make difficult to exchange information between design and construction teams. We need an information delivery standard that will define the requirements for the exchange of model-based information (design intent model) to execute the construction of highway bridges in the US, specifically aid construction teams in preparing bid packages and initiate fabrication.

Previous efforts and limitations

There have been several efforts in the past to look at improving interoperability for bridge lifecycle data management. A pair of 2013 papers, "Bridge Data File Protocols for Interoperability and Life Cycle Management: Information Delivery Manual for Highway Bridge Interoperable Data Protocols" and "Bridge Data File Protocols for Interoperability and Life Cycle Management: Model View Definitions for Highway Bridge Interoperable Data Protocols," identified shortcomings of existing BIM data schemas and workflows specific to bridge projects and mapped a path forward for using BIM for bridges and structures, including extension to the current IFC data schema to support items specific to horizontal design and construction buildingSMART Infra Extension project addressed the gap in the schema, however, even with the schema in place to support bridge projects, the US did not have an information delivery standard that defines the exchange information requirements (per ISO 19650-2). A specific IDM and MVD or Information Delivery Specification (IDS) was still needed to achieve the US Bridge Community's vision to implement model-based delivery as contractual document.

Research method

The team started by researching and evaluating efforts to find comparative implementation efforts of common data standards throughout the infrastructure industry. This approach allowed us to focus on consolidating our findings and removing redundancies to produce a US Bridge Data Dictionary. With a data dictionary in place, we moved to the development of the information delivery manual using the methodology defined in ISO 29481-1: 2020, which began with the process of mapping of data and how it moves between individual players and defining exchange information requirements for the specific use case "design-to-construction data exchange to facilitate preparation of bids and initiation of fabrication". This IDM facilitated the development of the MVD. The exchange requirements are based on the object definitions from the domain. The exchange models are defined so they feature the mappings of object definitions to the IFC schema resulting in a subset of the IFC 4x3 alignment base reference view. Our next steps (2022-2023) will be to finalize a unit test suite that will serve as the instructions for modeling bridge elements and designs to enable software developer/vendor's implementation testing and validation of the IFC-based exchange requirements. Lastly, software vendors will go through the bSI certification program. Then our team will work with US bridge owner representatives to start defining an implementation plan for adopting the IDM as the first "Guide Specification for Design to Construction Data Exchanges for Highway Bridges" in the United States.

Our work will be finalized upon release of the ISO certified IFC 4x3 schema. Currently working with the production standard.

Findings/Validation

The project is still on-going, but as stated in the research methodology, we expect the IDM/MVD to be validated through the unit test suite. We are working collaborative with software vendors that produce authoring tools for 3D modeling of bridges and structures. To-date, the response from the vendors has been very positive. There have been some preliminary demonstrations from software vendors to show their progress of including the IFC 4x3 Candidate Standard and now Production Standard in their products. A total of six software vendors have signed letters of intent to support the BIM for Bridges and Structures IDM/MVD into the software, including: All Plan, Autodesk, Bentley Systems, LUSAS, Midasoft.

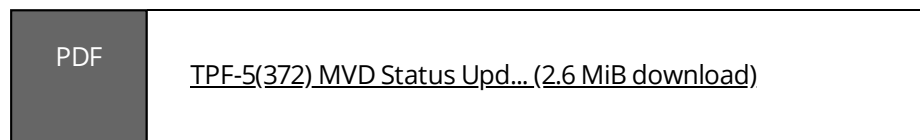
Conclusion/Contributions/Limitations

The IDM has been submitted as a ballot item to the American Association of State Highway and Transportation Officials (AASHTO) Technical Committee Software and Technology (T-19). The Technical Committee T-19 will be voting to adopt and publish this IDM as the AASHTO Information Delivery Manual: Guide Specification for Design to Construction Data Exchange for Highway Bridges. When adopted, this standard will serve as the US National Standard for exchange information requirements to support model-based delivery and for the design intent model to become legal document replacing 2D drawings. The products developed under this project will enable the standardization throughout the US bridge community using several standards, including:

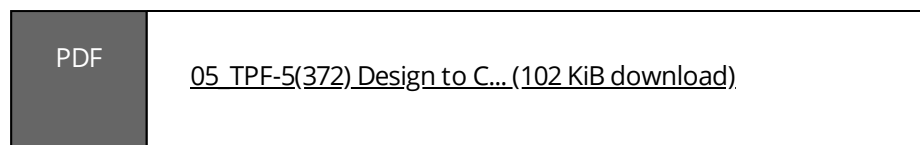
- ISO 16739 (IFC Standard managed and owned by bSI)
- ISO 29481-1 (BIM – Information Delivery Manual – Part 1: Methodology and format)
- ISO 19650-2 (Delivery Phase of the Assets)

openBIM Evidence

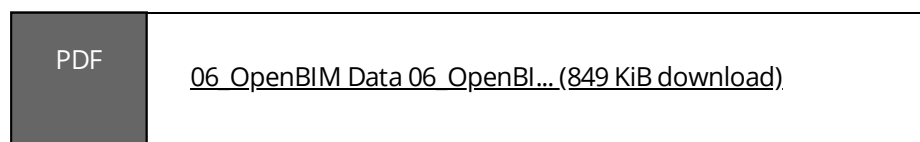
Software Ecosystem Map



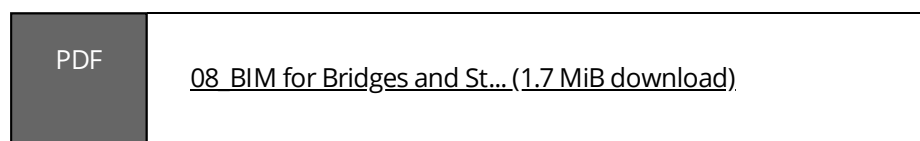
Process Maps



openBIM Data Metrics Summary



Additional openBIM Supporting Evidence



Lessons Learned

The project is on-going, but to-date, our biggest learned lesson is how important is to engage with the software vendor community when developing a standard. Software vendors including Bentley Systems, Autodesk, Trimble and AllPlan are very committed to the project and engage with our team on a regular basis. These major vendors have provided letters of support for the project and participate on regular workshops to demonstrate how they plan to support the AASHTO IDM/MVD being developed for this project.

Also, it would have been helpful to conduct a proof of concept as part of the initial scope. The project team has made suggestions to the project sponsor to consider proof of concepts to demonstrate how to put into practice the resulting product from this project.

"We were able to identify where we need openBIM to develop further."

The design-to-construction data exchange is only one of 19 data exchanges identified for the US Bridge Lifecycle Management. There is much work to do to fully adopt openBIM in the US, the US Bridge Community will need multiple IDMs

to define the exchange requirements to meet specific use cases beyond the one being developed under this research project. In addition, there will be a need for the accompanying data dictionaries, model view definitions and/or an information delivery specification, and validation tools. As each exchange requirement is developed for a use case, the US Bridge owners may be willing to incentivize the software vendors in using these national standards.

Upload .ifc file(s) or other technical files to support validation of the research results.

<https://service.usbim.com/link/62b0909017de4ebb24f88b7b>

Share any instructions for accessing the .ifc or other technical files for review.

Second file: <https://service.usbim.com/link/62b090d817de4ee656f88b7d>

Use Cases

BIM Uses were defined on the project | ✓

BIM Uses formed an integral part to how the project was delivered | ✓

I agree to be contacted for more information about the project BIM uses outside of this awards program. | ✓

Documentation on use case(s) as a single file upload

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