FHWA Task Order - Demonstration of BIM for Bridges

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Joe Brenner (WSP)
The Need

“To advance the standardization of BIM for bridges, the current focus of FHWA is on the execution of a specific data exchange in the bridge life cycle with measurable and well-defined scope.”

- First data exchange to explore is electronic Bridge Design Plans to Bid through Fabrication to Construction
- *IFC Bridge Design to Construction Exchange Requirements* U.S. have already been developed
- Workshop hosted by FHWA for bridge design industry in held in August 2015
- NCHRP workshop was held in May of 2016 to determine next steps with IFC and standardization
- The next phase is implementation of IFC in the bridge community.
  - *Contractual tools*
  - *Familiarity with IFC*
  - *Additional development of standards*
Objective

“The objective of this task order is to implement the use of Building Information Modeling (BIM) for design and fabrication of highway bridge projects using the *IFC Bridge Design to Construction Information Exchange (U.S.*) and to develop recommendations for further refinements and recommendations in the use of the IFC standard for digital delivery of bridge projects in the U.S.”
Current FHWA Task Order

- Task A: Contract Language
- Task B: Data Exchange Utility
- Task C: Case Study
- Task D: Industry Engagement
- Task E: Final Report

U.S. Department of Transportation
Federal Highway Administration
Task A: Develop Guide Contract Language

**BACKGROUND**

— Consultants and contractors are using BIM without owner involvement
— Lack of explicit requirements is holding back transfer of the BIM data
— Owners are paying for BIM, but not benefiting from it
— There is a gap in clear, unambiguous contract language both for design deliverables in BIM and using BIM as supplemental or replacement construction contract documents.
— Contract language is needed for design contracts as well as construction specifications

**APPROACH**

— Collect Documents
— Work with Technical Working Group (TWG) to provide feedback
— Summarize and provide guidance

**DELIVERABLES**

✓ Guide contract language for BIM digital deliverables.
Contract Language

5 sections:
— Introduction
— Professional Services Contracts
— Reference Standards
— Construction Specifications
— Conclusion

Contract Language

Example 1

BIM Requirements

The Department intends to use BIM for design authoring and documentation. The Consultant shall conform to the Department standards for BIM Project Execution Planning and Model Authoring to ensure the end product meets the needs of the Department. While the BIM-related Electronic Engineering Documents may not be construction contract documents, the Department may provide the BIM-related Electronic Engineering Documents as reference information documents for construction. The BIM-related Electronic Engineering Documents shall be developed to comply with the Minimum Modeling Requirements defined in the BIM Manual regardless of whether the construction contract documents are generated from BIM.

Reference Standards for Electronic Engineering Documents

All reference standards refer to the Department’s manual standards in place on the effective date of contract, or new Department’s project manager. It is the Consultant’s responsibility to comply with the Department’s current standards as published on the Department’s project manager’s web page.

Example 2

Definitions

The Terms and Definitions in the National BIM Standard—United States Version 3 (NBIMS-US V3) shall apply. It is the Consultant’s responsibility to obtain a copy of the NBIMS-US V3 as published on the National Institute of Building Science website. The NBIMS-US V3 may be downloaded at https://www.nationalbimstandard.org/. A login is required and is available at no cost. Consultant shall notify the Department within 10 days of Notice to Proceed if Consultant is unable to obtain a copy of the NBIMS-US V3 at no cost.

Reference Standard | Applicable Electronic Engineering Documents
---|---
National CAD Standard Version 6  https://www.nationalcadstandard.org/ncs6/ | All 2D details and plans that are not generated from BIM.
National BIM Standard – United States Version 3  https://www.nationalbimstandard.org/ | Project Execution Plan
Task B: AASHTOWare to IFC

BACKGROUND

— AASHTOWare Bridge Design software allows bridge designers to define parameters

— This project will provide functionality for a user to export bridges as IFC files.

APPROACH

— Capture bridge design detail using standardized representations within IFC

— Documentation will be created for describing how to map each database table to IFC.

— Utility application will be provided to verify and validate IFC exports

— 30 sample bridges and the case study bridges will be tested automatically against the IFC Bridge Exchange Specification U.S. MVD and manually using software supporting IFC 4.1

DELIVERABLE

✓ Simple Windows application for testing and demonstration purposes that allows a user to select from available bridges, export as an IFC file, and open in an IFC viewer application
AASHTOWare to IFC Task

— Exported files tested with Revit, Microstation, Solibri
— Test bridges include AW BrD samples, Wisconsin DOT (shown here)
Task C: Demonstration Project

BACKGROUND

— The demonstration projects provide an opportunity to test IFC, the AASHTOWare BrD data exchange, the guide contract language, and the emerging metadata practices that are important to limiting the risks with digital delivery.

APPROACH

— Partner with Utah DOT
— Provide support to the owner/agency on the application of the developed guide contract language.
— Document the processes during the pilot project and develop a case study report
— Exchange the BIM datasets from AASHTOWare BrD to IFC and then view the IFC files in proprietary BIM formats (e.g. Tekla Structures, ProStructures, and Revit) to evaluate the completeness and reliability of the data exchanges for the Utah models
Blackrock Case Study – Project Workshop

— In-person workshop on June 4-5
— Presentations/discussions focused on pilot project lessons learned and data exchanges
— Document and share data for future initiatives in Utah and other states

Blackrock MBDC & IFC Pilot Quick Answers

Please help the research team capture as much information as possible in the short time available.

**Definitions**

<table>
<thead>
<tr>
<th>Spatial Data</th>
<th>Non-Spatial Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geospatial Data</td>
<td>3D Objects</td>
</tr>
<tr>
<td>Structured Data</td>
<td>Unstructured Data</td>
</tr>
</tbody>
</table>

**Industry Foundation Classes (IFC)**. The IFC data model is an ISO standard for a platform-neutral, open file format to exchange the physical and functional information about a facility. International and local projects are developing the IFC standard for bridges and roadways.

**Model-Based Design and Construction (MBDC)**. An interconnected, fully electronic compilation of project assets.
Blackrock Case Study – Parallel Model Sub-task

— Opportunity emerged from Blackrock Case Study Task
— Apply proposed data standards to pilot bridges
— Create detailed model that can be used in multiple software applications
— Demonstrate what can be done with current software implementation and current IFC data structures
— NOT a validation or check of the production models/process
Three approaches taken to generate “conforming” IFC models:
A) Export IFC from native tools, post-process to parameterize
B) Export other format from native tools, post-process to parameterize
C) Create IFC from design plans

By “conforming”, we mean that data is normalized, correctly typed, and passes validation tests for IFC 4.1 FHWA Bridge Information Exchange.
Post-processing Before and After:

- Tessellated Geometry
- Generic Objects
- Redundancy
- Parametric Geometry
- Typed Objects
- Normalized
Examples of components
Examples of components
Digital exchanges

— Use cases identified
  — Horizontal and vertical geometry
  — Structural Analysis
  — Contract drawing representation
  — Fabrication details
  — Quantity takeoff
  — Visualization
  — Clash detection
  — Shop drawing development and as-built drawings

— Validation process
  — Exporting/importing software
  — Challenging with current lack of adoption of IFC 4
  — “Downgraded” to IFC 2.3 when necessary
Exchanges Tested: Rebar Schedules

Created data by prototyping, imported into Tekla Structures
What works: bar geometry
What doesn’t work: bar grouping, spacing, type definitions
Results and further development

**IFC Data Structure development:**
1. Layout for skew
2. Repetitive components
3. Limitations in “functional” geometry

**Process and data development:**
4. Specifying requirements of data (prescriptive, constrained, provisional, etc.)
5. Multiple camber/deflection states
6. Structural analysis model linking
Task D: Industry Outreach and Consensus

BACKGROUND

Objective: to advance towards bridge data standards through developing a bridge object data template and the guidance for requesting identifying the need for and requesting extensions to the standard, and secondly, building consensus, enthusiasm, and a sense of urgency for the industry to advance the use of digital models based on open standards.

APPROACH

• Engage Technical Working Group formed in Task A to help develop material

• Workshops and presentations
  • 2 Webinars – Tasks A & B
  • 1 Final Webinar
BIM Object Definition Template

- Describe data requirements for objects
- Physical objects needed for project delivery
- Focused on object components and data needed to be exchanged
- Communication between industry and software

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<thead>
<tr>
<th>Domain</th>
<th>Type Name</th>
<th>Field Name</th>
<th>Data Type</th>
<th>Cardinality</th>
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<tr>
<td>Steel Cross Frames</td>
<td>K-Frame Definition</td>
<td>Lower Beam Type</td>
<td>Steel Angle</td>
<td>1:1</td>
<td>Describes cross-frame template with connected members to be adapted for each placement.</td>
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<td>Steel member type used for lower beams.</td>
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<td>Steel plate type used for lower left and lower right plates.</td>
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<td></td>
<td>Upper Plate Type</td>
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<td>K-Frame Instance</td>
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<td>1:1</td>
<td>Cross frame definition defining members and relative positioning.</td>
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<td></td>
<td>Upper Left Axis</td>
<td>Point3D</td>
<td>1:1</td>
<td>Girder line for which cross frame is positioned at the upper left.</td>
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<td>Upper Left Placement</td>
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<td>Placement offset relative to upper left axis, taking girder web and flange into consideration.</td>
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<tr>
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<td>Girder line for which cross frame is positioned at the upper right.</td>
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<td>K-Frame Definition</td>
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<td>Describes a group of cross-frames spanning between two girder lines with repetitive placement.</td>
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<tr>
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Summary

- **Task A**: Contract Language - COMPLETE
- **Task B**: Data Exchange Utility - COMPLETE
- **Task C**: Case Study - FINALIZING
- **Task D**: Industry Engagement - IN-PROGRESS
- **Task E**: Final Report - FINAL WEBINAR