openBIM implemented on construction of Beijing-Zhangjiakou high speed railway

Country: China
Category: Construction
Submitting Party: China Academy of Railway Sciences Corporation Limited
Jingzhang Intercity Railway Corporation Limited
1 Project Overview
Project Overview
Qinghuayuan Tunnel
New Badaling Tunnel and Station
Project Overview

Guanting Reservoir Bridge
C1, C2—design teams, such as: bridge team, tunnel team, etc.
C3, C4—construction teams, such as: first/second work area, etc.
C5, C6—supervision teams, such as: first/second group, etc.
Part of the project refers to ISO19650.

1. assessment and need  5. mobilization
2. invitation to tender  6. collaborative production of information
3. tender response     7. information model delivery
4. appointment        8. project close-out
ISO19650 was used

1. Assessment and need
   - appoint the third party
   - establish information requirements
   - establish delivery milestones
   - establish information standards
   - establish CDE

2. Invitation to tender
   - Assemble reference information and shared resources
   - Establish response requirements and evaluation criteria
   - Compile tender information

3. Tender response
   - Establish BIM execution plan
   - Establish capability and capacity
   - Establish mobilization plan
   - Establish risk register
   - Compile tender response

4. Appointment
   - Confirm BIM execution plan
   - Confirm BIM execution plan
   - Confirm BIM execution plan
   - Establish risk register
   - Establish BIM execution plan

5. Mobilization
   - Mobilize resources
   - Mobilize information technology
   - Test production methods and procedures

6. Collaborative production
   - Information model review
   - Review and approve of sharing

7. Information model delivery
   - Review and authorize
   - Submit information
   - Review and accept
   - Archive asset information model

8. Project close-out
   - Compile lessons
Establish CDE

REMPLAT

<table>
<thead>
<tr>
<th>Shared</th>
<th>Initiator Inspection/ approval</th>
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</thead>
<tbody>
<tr>
<td>After the stakeholder approves the sharing, it can be shared with related teams</td>
<td></td>
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<table>
<thead>
<tr>
<th>Published</th>
<th>Inspector / approval</th>
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</thead>
<tbody>
<tr>
<td>After authorization by the stakeholder, all participating teams of the project can view information</td>
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<table>
<thead>
<tr>
<th>Work In Progress</th>
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<tbody>
<tr>
<td>Information initiated by the task team (For Task team use only)</td>
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<table>
<thead>
<tr>
<th>Construction team</th>
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<tbody>
<tr>
<td>Supervision team</td>
</tr>
<tr>
<td>Third party testing team</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Archive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archive historical information, status information and revision information</td>
</tr>
</tbody>
</table>

Internal service network
Server cluster

Security platform

External service network
Server cluster
01 Adopted the concept of openBIM

02 More than 20 software were used

03 Multiple openBIM standards are used

04 Used ISO19650, establish CDE

05 Used openBIM+GIS
06 Implement model review automatically

07 MVD application scenarios

08 Information Exchange Template (COBie)

09 develop Integrated Maintenance System

10 RFID, QR code, etc.
openBIM used
2.1 OpenBIM used in JZHSR (D to C)
Integrated Maintenance System (IMS)

Model Information Exchange Template

Design and delivery

ModelReview Software (MRS)

MicroStation
Revit
Tekla
ProjectWise
iDesktop

SolidWorks + Ansys

UE4
Navisworks

Other MVD
Subgrade MVD
Bridge MVD
Tunnel MVD
Digital Manufacturing
Unity

RFID, QR code

Integrated Maintenance System (IMS)
Use Microstation to create domain models
Modify Railway IFC classes, include their property and derived-relationships

Upgrade xml file version number

Secondary development of ECOobjects in Bentley

Update current model ECSchema by new xml file

Bentley Class Editor

Railway IFC.xml

ECObjects

ECSchema

ECInstance

All ECInstance auto update
Railway IFC application based on Bentley platform
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Process - Create Joint Program Interface
Process - Properties

IFC Class

inherited attribute

unique attribute

buildingSMART International
Using Revit to create station model
Using Tekla to create the steel structure model
Using ProjectWise as a design collaboration platform
Fusion with drone tilt photography data and GIS map data
iDesktop supporting REMPLAT
Using MRS to review the model
2.2 OpenBIM used in JZHSR (construction)
MVD applications in construction

Integrated Maintenance System (IMS)
Using Navisworks for simulation analysis and project optimization
Type one checking calculation:

Type two checking calculation:
UE4 → VR

BIM
- Get the .ifc model
- Lightweight model
- Load into UE4
- BIM and VR integration
  - Hierarchical relationship definition
  - Lighting adjustment
  - Rendering optimization
  - Assign missing material
  - Supplementary identification information
  - Add collision attributes
- Realize VR

VR
-外部设备

BuildingSMART International
Digital Manufacturing of steel structure

3D model design → NC processing module

CNC machining program → Process analysis, tool path simulation

CNC machining equipment → Real parts
Digital Manufacturing of rebar
Digital Manufacturing in Beam Fabrication Field
Digital Manufacturing in Small prefabricated component yard
Build a digital tunnel twin and its digital twin environment.
Tunnel MVD application >> Tunnel model analysis
Bridge MVD application >> Prefabricated bridge
Intelligent monitoring of swivel bridge
Subgrade MVD application >> Continuous compaction
RFID application
Paste QR code for main communication and power supply equipment.
One more >> IFC Rail bSI SPEC, IFD, EBS, WBS (China Railway BIM Alliance)

Simulated construction

Trace quality information

Visualized management of risk sources

Dynamic Analysis
2.3 OpenBIM used in JZHSR (delivery and O&M)
Construction delivery and O&M

- MicroStation
- Revit
- Tekla
- ProjectWise
- iDesktop

- Other MVD
- Subgrade MVD
- Tunnel MVD
- Unity
- SolidWorks+Ansys

- RFID, QR code
- Bridge MVD
- Digital Manufacturing
- UE4
- Navisworks

- Model Information Exchange Template
- Integrated Maintenance System (IMS)

ModelReview Software (MRS)
Establish a total of 423 information exchange templates for railway infrastructure operation and maintenance.
### Information Exchange Template

423 kinds of equipment unit information exchange templates

#### Operation Information

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<thead>
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<th>序号</th>
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#### Geometric Information

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<tr>
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<td>毫米</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>梯子的高度</td>
<td>-</td>
<td>米</td>
<td>-</td>
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</tbody>
</table>
Design and construction process information

IFC model of the construction process

Design information
- Geometric information
- Non-geometric information

Construction information
- Structured data
- Unstructured data

Digital assets

Operation and maintenance management
- Public Works
- Electricity
- Power supply

Jingzhang Integrated Maintenance System Based on BIM
Jingzhang Integrated Maintenance System Based on BIM
After using openBIM...
The use of openBIM promotes project development and information sharing

Realizing custom extensions to railway IFC objects and attributes

Developing tools for automatic verification of design delivery models based on IFC standards

Based on IFC and CityGML standards to realize the integrated application of BIM model and GIS for long-term linear engineering

MVDxml format is used to information exchange of OpenBIM model in multi-domains

The application of the ISO 19650 standard in the construction phase has achieved good results

Establishing a CDE covering the entire delivery phase to promote information sharing among all parties

Establishing operation-oriented information exchange template based on COBie standard
By using the open BIM standard, the construction period was shortened by 144 days; the estimated cost savings is $2.36 million (RMB 15.084 million);

In addition, it also solves the problem of construction data repeated collection in the operation phase, which saves a lot of costs and has a high ROI.

<table>
<thead>
<tr>
<th>Types of</th>
<th>unit price</th>
<th>Quantity</th>
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<tbody>
<tr>
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<td>5,220,000 RMB</td>
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<tr>
<td>Labor costs</td>
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<td>Total price</td>
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<td>$2,366,679</td>
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Benefits from using bSI Standards
The stakeholder’s comment is:

“Through the use of OpenBIM application, we can better understand the site situation, and the status of project progress, quality, safety and other aspects can also be reflected in the BIM model, so that we can make better decisions.”
The comments from the construction parties are: “By using the OpenBIM applications, we can find the problems in the BIM model, strengthen the communication between different construction parties, and also keep in good touch with the owners.”
The comments from the operation and maintenance party is: “The completion model delivery standard and the information exchange template for infrastructure constructed via IFC and COBie standards have realized the efficient transmission of data from the construction period to the operation and maintenance period, and solved the problems of construction data missing, difficult to collect, long collection time and high cost, which will improve the value of construction data and efficiency of operation management.”
Thank you!