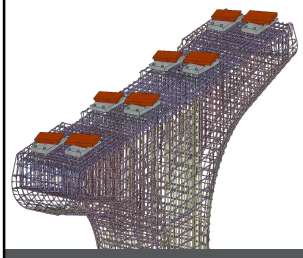
HDR

IOWA DOT | U.S. Department of Transportation Federal Highway Administration | ACEC



2018 ANNUAL CONFERENCE

SIGNED AND SEALED 3D ENGINEERING MODELS

September 12, 2018

Presented By
Will Sharp
HDR Engineering, Inc.

INDUSTRY DRIVERS – BIM

MAJOR TRANSPORTATION AGENCIES

- Early identification of constructability issues
- Improved design accuracy
- Enhanced Design Coordination and Quality Control Reviews
- Reduced Construction Change Orders
- Reduced Construction Costs Due to AMG
  - **Total Project Savings - 4% to 6% of construction costs (Roadway)**

Source: FHWA Techbrief – 3D, 4D, and 5D Engineered Models for Construction March 2013, Photographs courtesy of Iowa DOT

HDR'S COMMITMENT TO ADVANCING BIM

INDUSTRY DRIVERS – BIM
MAJOR TRANSPORTATION AGENCIES

- Enhance quality & our ability to serve our clients better on every project
- Reduce overall Cost of Delivery by 10%
- Provide Life Cycle Management – Planning through Asset Management – of assets through 3D, 4D & 5D applications
- Become information managers for our clients

2014 >> 2017 >> Today

IOWA DOT – ROADWAY DESIGN

IOWA DOT

History

- Began efforts – Automated Machine Guidance – 2003
- First Project – IA 60 Corridor – Let in 2006

Current

- All Capacity Projects require 3D grading TIN file deliverable
- 2015 – Let First Project – **3D Model Files – Signed and Seal Deliverable**
- 2016 – 4 Additional Projects Let – **Signed / Sealed 3D Electronic Modeling Files**
- January 2017 – Iowa DOT / AGC / ACEC Partnering Committee – Fully Electronic Deliverable
- 2018 – New Partnering Committee – Fully Electronic Deliverable

Vision

- 3D Electronic Deliverable as Controlling Document – Plan Sheets Optional
- Utilize BIM throughout lifecycle of asset

2017 IOWA DOT / IOWA AGC / ACEC PARTNERING COMMITTEE KEY FOCUS AREAS

1. Liability Issues – 3D Contractual Deliverables
2. Quality Control
3. 3D model Data Format – Contractual Deliverables
4. 3D Contractual Deliverables – Digital Verification
5. Post Letting Coordination – Engineer of Record and Contractor

NEXT STEPS

1. Continued AGC / Iowa DOT / ACEC Coordination – 3D Contractual Deliverables
2. Pilot Projects (Consultant Engineer of Record)

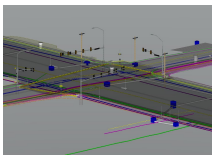
3D MODEL CONTRACTUAL DELIVERABLES FRAMEWORK LEVEL OF DEVELOPMENT

		Design Level of Accuracy			Deliverable	Limitations
Element	LOD	Horiz	Vert	Authorized Uses	Format	
Roadway Design						
Grading Surface Files	300	0.1'	0.1'	Automated Machine Guidance (AMG) grading of typical areas. Excludes areas: ADA Sidewalks Curb Ramps, urban and rural entrances.	Land XML	3d data is intended for AMG Grading only and should not be used for quantity take-offs. Contractor shall verify existing field conditions, and advise Engineer if model adjustments are required.
Paving Surface Files	300	.02'	.02"	Automated Machine Guidance (AMG) paving of typical areas. Excludes areas: ADA Sidewalks, urban and rural entrances.	Land XML	3d data is intended for AMG Paving only and should not be used for quantity take-offs. Contractor shall verify existing field conditions, and advise Engineer if model adjustments are required.
3D line strings for grading and paving surface files.	300	.1'	.1'	Automated Machine Guidance (AMG) grading of typical areas. Excludes areas: ADA Sidewalks, urban and rural entrances.	3d DGN	3d data is intended to support AMG Paving and Grading of typical areas only. Contractor shall verify existing field conditions, and advise Engineer if model adjustments are required. 3d Data should not be used for quantity take-offs.

UTAH DOT – ROADWAY DESIGN

MODEL BASE DESIGN & CONSTRUCTION (MBDC)

UDOT PROJECTS

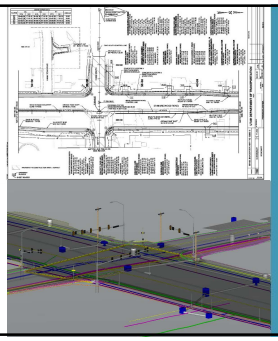


- **12** 3D files as a contractual document
- **100** Majority are 100% paperless
- **5** HDR Involvement
  - SR-68 Redwood Road
  - I-80 at Black Rock
  - I-80 Climbing Lanes
  - SR-201 Widening
  - 90th South Reconstruction

MODEL BASE DESIGN & CONSTRUCTION (MBDC)

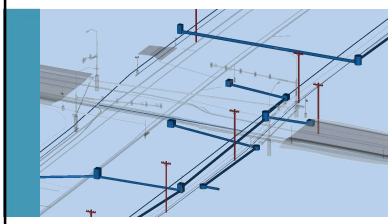
UDOT GOAL

In the near future - eliminate 2D paper plans - 3D files will be the contractual deliverable



- Started design in 2015, $44 Million dollar project
- Widen an existing 2 lane urban highway to 7 lanes with full shoulders and bike lanes.
- Deliver 3D model as a contract document
- Paper plans developed for other disciplines due to overall project risk
- CMGC Process
- Construction will be complete this summer

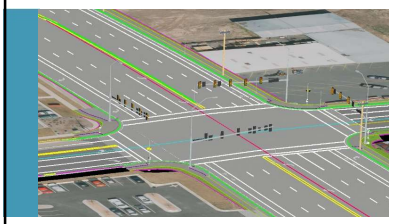
UDOT SR-68 - REDWOOD RD PROJECT



CLASH DETECTION

- Used clash detection feature in Microstation
- Minimized utility conflicts during construction

UDOT SR-68 - REDWOOD RD PROJECT

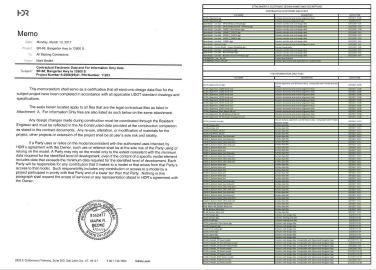


3D DELIVERABLES

- Contractual Documents
  - SS4 Corridor dgn files
  - dgn file of 3D line strings
  - Surfaces, dtm's and xml's of the top and bottom surface
- Information Only Documents
  - ICM File
  - I-Models for every discipline

UDOT SR-68 - REDWOOD RD PROJECT

? How did we Sign & Seal the 3D Files?



Memo

ILLINOIS TOLLWAY

ILLINOIS TOLLWAY CLIENTS IMPLEMENTING BIM

4-STEP IMPLEMENTATION PLAN

1. Require 3-D design model for earthwork & pavement at advertisement
2. Require comprehensive 3-D model of earthwork, pavement, utility and structure envelopes at advertisement and through design milestones
3. Advertise pilot project using a contractual, sealed 3D model and plans without cross sections or drainage profiles
4. Explore removing other elements of the paper plans and standardize contractual 3D models & build a virtual Tollway environment which is updated through construction

ILLINOIS TOLLWAY CLIENTS IMPLEMENTING BIM

4-STEP IMPLEMENTATION PLAN – CURRENT STEP

3. Advertise pilot project using a contractual, sealed 3D model and plans without cross sections or drainage profiles

S.P. 121 ELECTRONIC DATA FILES AVAILABLE

File Name	Description
1234-3-Dmodel.dgn	3-D Model – 3-D DGN file
1234-3-Dmodel.imodel	3-D Model – i-Model File
1234-Zone1.xml	Zone 1 – DTM (LandXML) File
1234-Zone2.xml	Zone 2 – DTM (LandXML) File (if applicable)
1234-eg.xml	Existing Ground – TIN (LandXML) File
1234-sg.xml	Sub-Grade – TIN (LandXML) File
1234-fg.xml	Finish Ground – TIN (LandXML) File

ILLINOIS TOLLWAY CLIENTS IMPLEMENTING BIM

4-STEP IMPLEMENTATION PLAN – CURRENT STEP

3 Pilot Project With 3D Contract Document

- Advertisement in Fall 2018
- Simple interchange reconstruction project with limited structural work
- No 2D cross sections or drainage profiles
- 3D model included as binding legal document
- 3D model for bidding, construction, as-built information, and asset management

I-88 at IL-47 in Sugar Grove, IL

ILLINOIS TOLLWAY CLIENTS IMPLEMENTING BIM

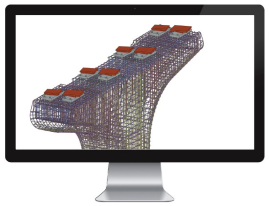
ILLINOIS TOLLWAY & HDR BIM

- 3D MODELING COMMITTEE
  - HDR is helping the Tollway develop their processes and procedures
  - Recent Client Requirements for International Roughness Index (IRI)
- HDR has delivered 8 construction packages to the Tollway that meet HDR BIM requirements
  - Approximately $400 million construction cost
- 6 construction packages in development
  - Approximately $700 million construction cost

IOWA DOT – BRIDGES & STRUCTURES

IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT



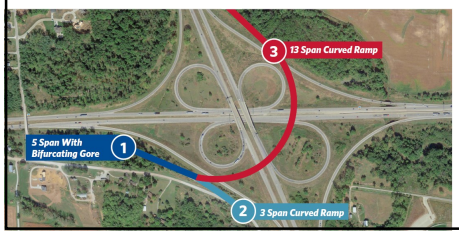
1 DEVELOP BIM MODEL
AS COMPLETE AS POSSIBLE

2 EVALUATE BENTLEY SOFTWARE
- OPENBRIDGE MODELER
- PROSTRUCTURES
- NAVIGATOR CONNECT

3 ENCOURAGE CONTRACTOR USE

IOWA DOT – BRIDGES

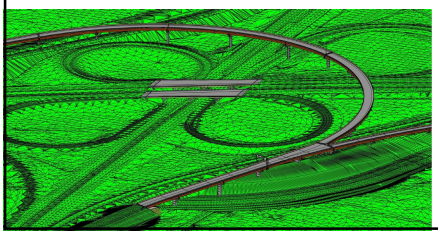
I-80/380 BIM PILOT PROJECT – OVERVIEW



- TOTAL LENGTH = 4200 FT
- BIFURCATING GORE
- DISCONTINUOUS GIRDERS
- COMPLEX SUPERELEVATION AT GORE
- INSPECTION WALKWAYS
- AESTHETIC PIERS & ABUTMENTS

IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – OVERVIEW



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IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – BENTLEY SOFTWARE

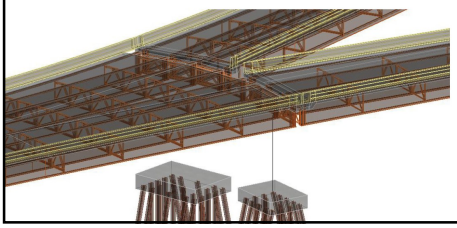
OPEN BRIDGE MODELER
Defines primary bridge elements using horizontal & vertical geometry

PROSTRUCTURES
Used to add elements not created by OBM

NAVIGATOR CONNECTS
For multi-platform viewing with limited element information

IOWA DOT – BRIDGES

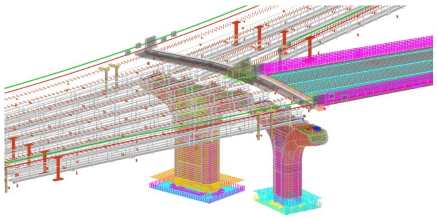
I-80/380 BIM PILOT PROJECT – OPENBRIDGE MODELER ELEMENTS



- BRIDGE DECK, HAUNCH
- BARRIERS
- GIRDERS, PLATES & STIFFENERS
- CROSS-FRAMES
- FOOTINGS & PILES

IOWA DOT – BRIDGES

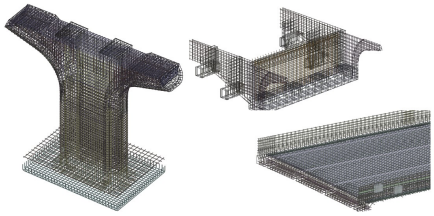
I-80/380 BIM PILOT PROJECT – PROSTRUCTURES ELEMENTS



- REINFORCING STEEL
- BOLTS & BOLT HOLES
- DISC BEARINGS & ANCHORAGE
- FIELD SLICES & MISC. STEEL
- ABUTMENT & PIERS
- SIGN SUPPORT & I.T.S. POLES
- DIAPHRAGMS & ACCESS DOORS
- INSPECTION ACCESS SYSTEM
- MISC. ELEMENTS

IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – PROSTRUCTURES ELEMENTS



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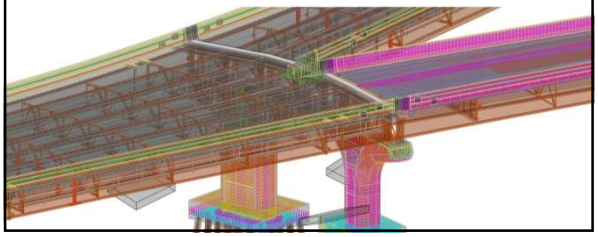
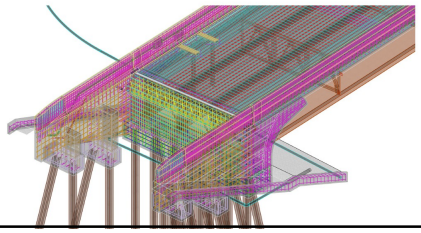
IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – COMBINED OBM & PROSTRUCTURES



IOWA DOT – BRIDGES

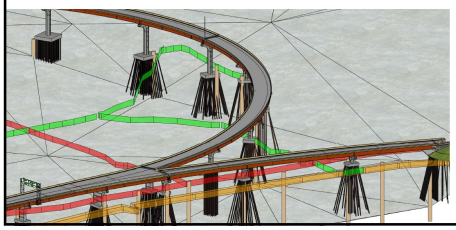
I-80/380 BIM PILOT PROJECT – BIM MODEL DURING DESIGN



- Complex detail visualization
- Bill of bars & quantities
- Parts list
- Clash detection
- Measurements
- Section cuts
- Barrier conduit layout
- 2D plan detail development
- Interdisciplinary coordination

IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – BIM MODEL DURING DESIGN



Interdisciplinary Coordination
- Geotechnical
- Roadway
- Drainage
- Utilities
- Lighting
- Mechanical

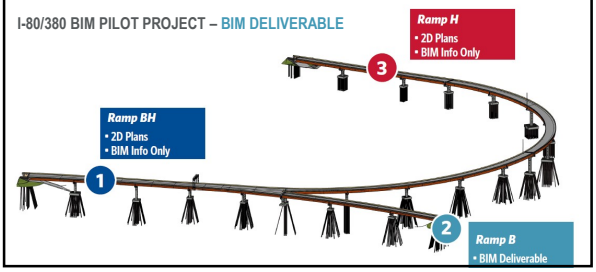
IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – CONSTRUCTION

INITIAL APPROACH	FINAL APPROACH	DESIRED RESULTS
Provide BIM Model for Information	Hybrid Model • Ramp BH & H Bridges - 2D Plan Deliverable *BIM Model for information* • Ramp B Bridge - BIM Model Deliverable *BIM Model deliverable with links augmenting model*	• Reduce Contractor Risk • Promote BIM usage • Gather Information on BIM Usage *(During construction)*

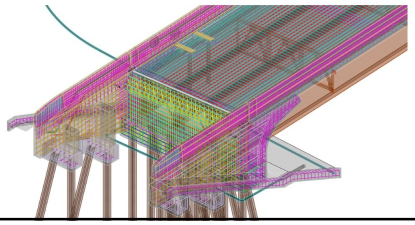
IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – BIM DELIVERABLE



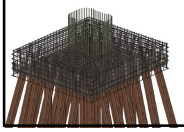
IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – BIM DELIVERABLE RAMP B CHALLENGES



- Contractors and subs unfamiliar with software & process
- Software lacks full functionality
  - Can't summarize complete quantities
  - Some dimensions are not easily accessible in model
  - Not all elements modeled correctly
- Additional information needed

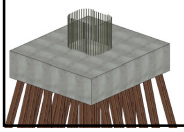
IOWA DOT – BRIDGES



- VISUALIZATION
- SECTION CUTS & MEASUREMENTS
- ELEMENT INFORMATION
- BILL OF BARS & PARTS LIST
- STAGING
- SAFETY...ETC.

I-80/380 BIM PILOT PROJECT
BIM DELIVERABLE CONTRACTOR USE

IOWA DOT – BRIDGES



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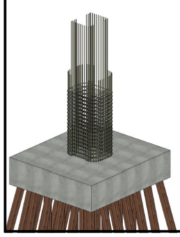

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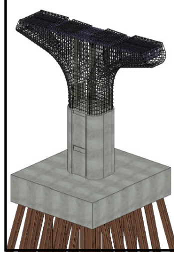

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I-80/380 BIM PILOT PROJECT
BIM DELIVERABLE CONTRACTOR USE

IOWA DOT – BRIDGES

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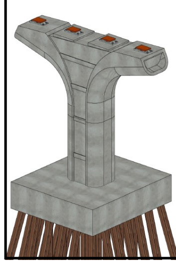

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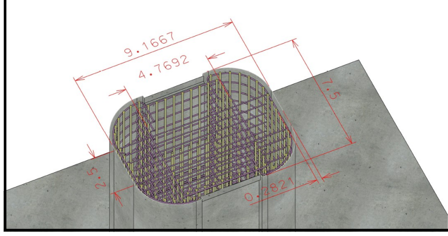
I-80/380 BIM PILOT PROJECT
BIM DELIVERABLE CONTRACTOR USE

IOWA DOT – BRIDGES

I-80/380 BIM PILOT PROJECT – BIM DELIVERABLE DURING CONSTRUCTION



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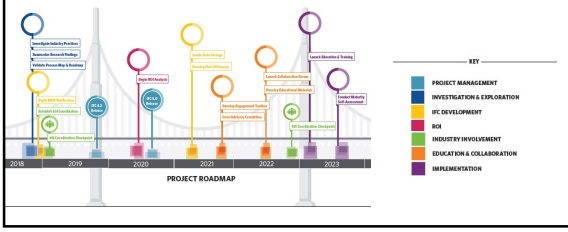
AASHTO BIM FOR BRIDGES & STRUCTURES

AASHTO BIM FOR BRIDGES

BUILDING THE DIGITAL BRIDGE TO A SMARTER TOMORROW

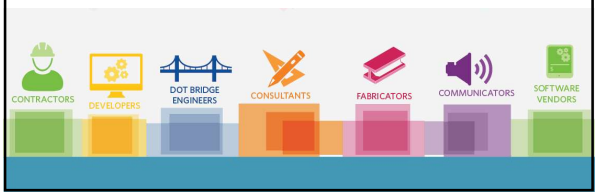


AASHTO BIM FOR BRIDGES

NATIONAL ACCEPTANCE

AASHTO BIM FOR BRIDGES

INDUSTRY INVOLVEMENT



KEY TAKEAWAYS

KEY TAKEWAYS

- 3d Signed and Sealed Deliverables Are Coming
- Key Challenges
  - Standard Open 3d Data Format
  - Liability Issues
  - QC Issues
  - Software Limitations
- Get Engaged and Involved

QUESTIONS