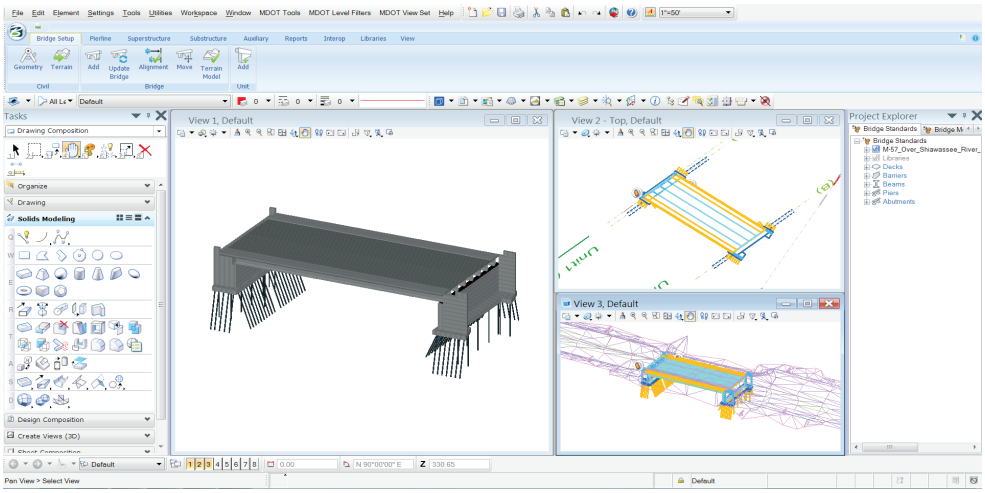
RESEARCH ADMINISTRATION
Bureau of Field Services
Michigan Department of Transportation

Research Spotlight

Implementing 3-D and 4-D modeling software to enhance bridge design

Since 2012, MDOT has been modernizing its highway design processes by using 3-D modeling in road construction. In this study, researchers developed plans for leveraging the benefits of 3-D and 4-D modeling in bridge design projects. This technology will allow designers to visualize bridge designs at all stages, from planning through construction. After reviewing national best practices and gathering input from Michigan bridge stakeholders, researchers developed a roadmap that will guide MDOT in selecting, developing and implementing 3-D and 4-D software to model bridges in the state.



3-D and 4-D modeling software allows designers to visualize bridges from different angles and at various stages of construction.

Project Information

REPORT NAME: Development of 3-D and 4-D Bridge Models and Plans

START DATE: March 2016

REPORT DATE: May 2018

RESEARCH REPORT NUMBER: SPR-1647

TOTAL COST: $272,350

COST SHARING: 20% MDOT, 80% FHWA through the SPR, Part II, Program

MDOT Project Manager

Talia Belill, P.E.
Bridge Engineer
Bridge Design—Consultant Coordinator
Bureau of Bridges and Structures
Michigan Department of Transportation
425 W. Ottawa St.
Lansing, MI 48909
belillt@michigan.gov
517-230-6262

Problem

A national leader in modernizing road design, MDOT has used 3-D modeling to streamline processes for surveying, designing and planning new roads. Bridge design and construction show promise as a new application of this technology. But existing tools have not yet made a compelling case for using 3-D modeling in the design and construction of bridges. The software for modeling these more complex structures lacks functionality for communicating

(continued)

> *"3-D and 4-D modeling is the next logical step for bridge design. This research project allowed us to assess best practices from throughout the country and create a plan to begin implementing this technology in Michigan."*
>
> **Talia Belill, P.E.**
> Project Manager

necessary detail and accuracy. Underdeveloped workflow and modeling tools also complicate decisions for determining when to use bridge modeling.

Research

MDOT worked with researchers from WSP Michigan to review published studies of 3-D modeling in bridge design and identify best practices. Investigators then presented 20 potential uses for 3-D and 4-D bridge modeling with market-ready software to MDOT staff and bridge design consultants in Michigan. Based on feedback from the Michigan bridge community, researchers identified the six highest priority uses for the technology. They narrowed these priority uses to the top three and used them to develop a framework for describing, creating and managing 3-D and 4-D models within MDOT's bridge delivery workflow.

Working with the MDOT Research Advisory Panel, researchers selected four Michigan bridges to model using MDOT data. The team developed software templates for four bridge types and then demonstrated software use and modeling of the four bridges during a web conference with the Michigan bridge stakeholders.

Researchers developed training and outreach materials that were presented at conferences of the Michigan Infrastructure and Transportation Association and the Michigan chapter of the American Council of Engineering Companies to gather additional feedback. Investigators presented the training materials during three sessions with MDOT's bridge design staff.

Results

Researchers developed a process for producing, managing and documenting the production of bridge models with a framework for organizing data in models, defining the development and visual quality of model elements, managing geospatial distortions, and clarifying outputs. Designers can model various bridge structural elements, including abutments, piers, decks, beams and railings. The final report includes a review of MDOT's current geometric bridge modeling software and recommendations for improvements to develop with the software provider to achieve fully automated bridge plan production.

To build awareness about the enhanced bridge modeling software, researchers created materials and instruction for three training sessions: an introductory session, a web-based session for project managers and an in-person session for designers. Guidance for producing 3-D bridge models includes workflows for modeling tasks, video tutorials, standard bridge templates for the MDOT computer-assisted design workspace and external resources. Researchers presented plans with short-term and long-term implementation goals, timelines and future steps to advance modeling.

Value

The new Michigan roadmap for implementing 3-D and 4-D modeling technology positions MDOT as a leader in bridge design. Results from the research will have local and national impact. Locally, MDOT can optimize the value of 3-D modeling software with Michigan bridge stakeholders who better understand the uses and value of 3-D and 4-D modeling to visualize bridges and stage construction efficiently, easing its reception and transferability in the state. Nationally, this research is in line with a $1.2 million pooled fund study created by the American Association of State Highway and Transportation Officials (AASHTO) to examine 3-D modeling for bridges, a study in which MDOT will participate.

Research Administration

Principal Investigator

Alexa Mitchell

Service Area Manager, CIM Consultant
WSP, Inc.
350 W. Washington St., Suite 350
Tempe, AZ 85281
alexa.mitchell@wsp.com
480-449-4924

Contact Us

PHONE: 517-636-4555
E-MAIL: mdot-research@michigan.gov
WEBSITE: www.michigan.gov/mdotresearch

This final report is available online at
https://mdotjboss.state.mi.us/SpecProv/getDocumentById.htm?docGuid=59221021-ad94-41c6-9859-1a29d71d0ec7.

Training materials are available online at
mdotjboss.state.mi.us/SpecProv/trainingmaterials.htm

Research Spotlight produced by CTC & Associates LLC, August 2018.