BrIM Redefined

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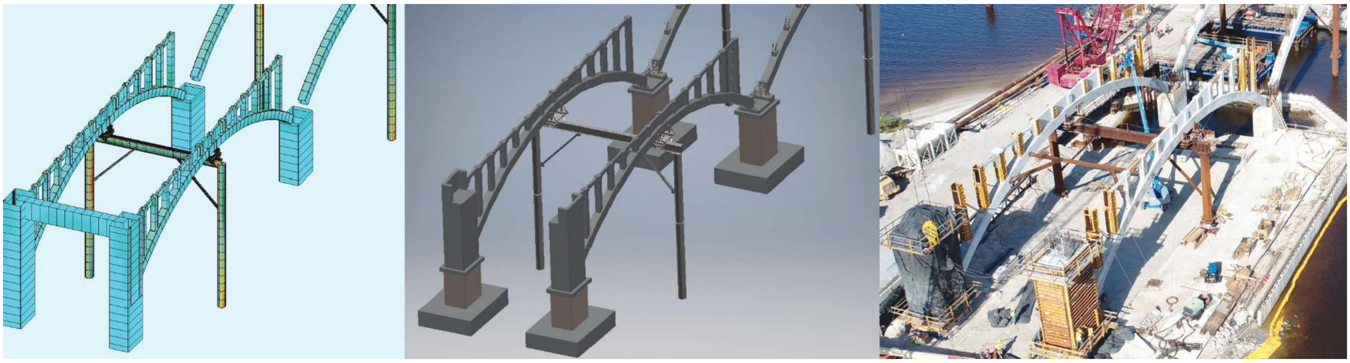


Bridge integration modeling (BrIM) workflow can provide an integrated solution for managing data for design, construction, and asset management from analysis to production to reality. Figures: FINLEY Engineering Group. Photo: Johnson Bros. Corporation.

Bridge information modeling continues to steadily develop as a tool that blends three-dimensional (3-D) visualization capabilities with database storage of information. In the development of complex projects, FINLEY has redefined bridge information modeling as bridge *integration* modeling (BrIM). This approach takes the next logical step in the use of 3-D visualization and advanced engineering software to integrate bridge information databases into the planning, design, construction, maintenance, and inspection processes. BrIM can be used to improve efficiency, consistency, and quality throughout the entire life cycle of a bridge, from the first planning stages to asset management of the completed structure.

In this article, the Veterans Memorial Bridge in Daytona Beach, Fla., and Wekiva Parkway Section 6 in Sorrento, Fla., are provided as examples for FINLEY's application of BrIM on complex bridge projects.

Phases of the BrIM Workflow

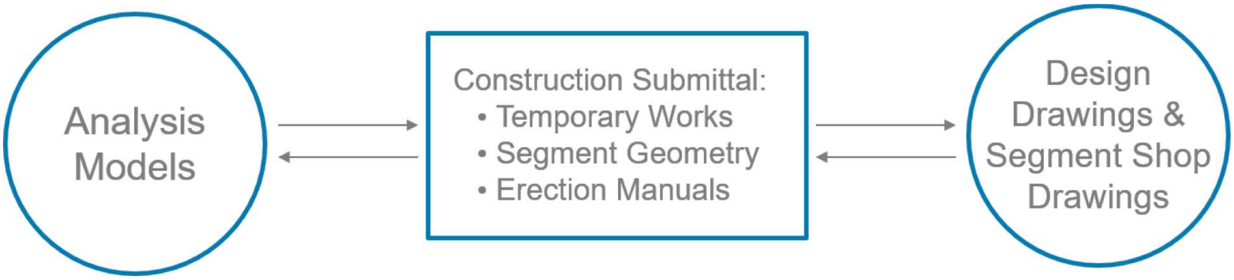
Traditionally, the workflow for a project involves the analysis of the bridge, the design of bridge components and temporary works, and the production of construction drawings. Within those three phases, engineers transfer bridge data, such as roadway geometry, concrete geometry, post-tensioning layouts, and member sizes, into the analysis model, then again into temporary works models, and once again into computer-aided design/drafting (CAD) models.

Before the introduction of modern engineering software to integrate bridge data among separate models, that process of data transfer was time consuming and cumbersome, and there was a risk with each transfer that the data might be input incorrectly or inconsistently. The ideal scenario is to use software to import and export the bridge data among models to minimize repeated efforts by the engineer.

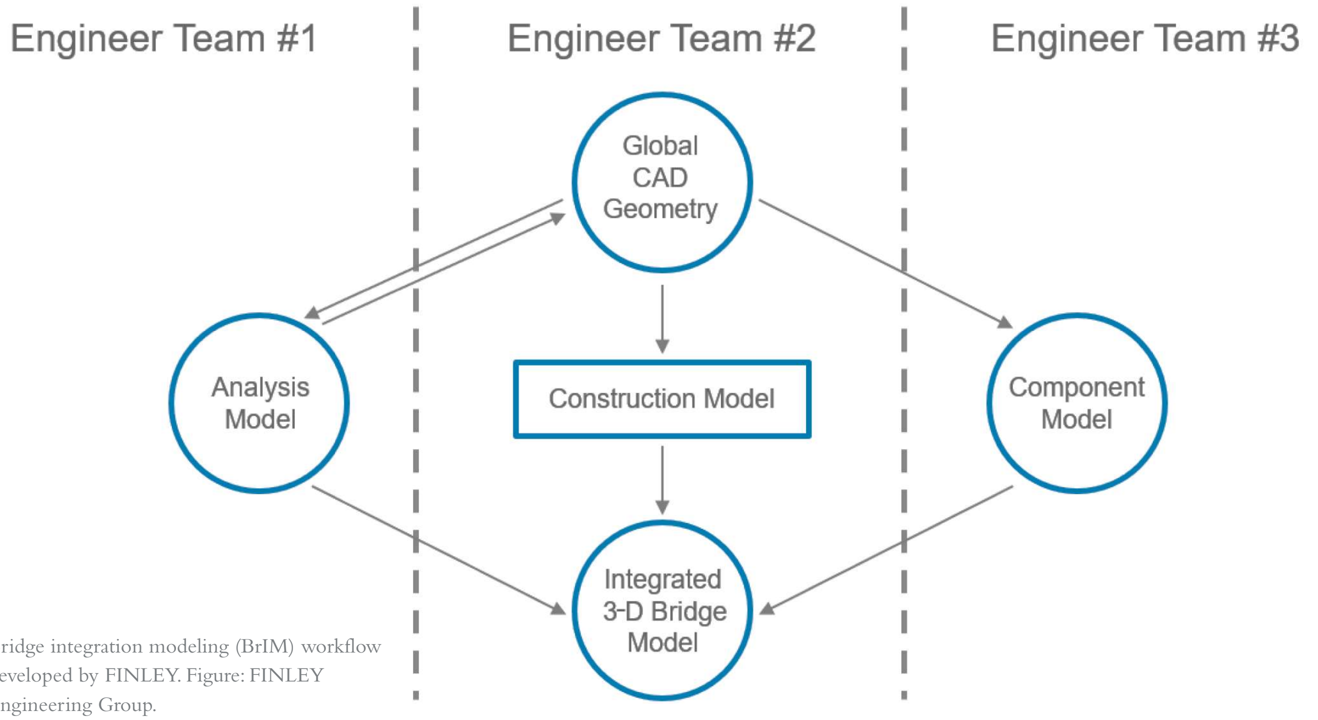
The BrIM workflow is a culmination of FINLEY's efforts to combine its project workflow experience with modern engineering software containing integration capabilities. The following three phases for BrIM workflow have been developed:

1. Input of global CAD geometry;
2. Development of the analysis, construction, and component models; and
3. Generation of the integrated 3-D bridge model.

Phase 1, the foundation of this workflow, is the AutoCAD engine used within the analysis software SOFiSTiK, which FINLEY uses for complex bridge design. The ability to create the geometry of the analysis model through an AutoCAD engine allows the BrIM workflow to begin with a single 3-D geometry model that centralizes the bridge data used by the analysis, visualization, and CAD software. A single centralized and integrated geometry model, or global CAD geometry,



Traditional workflow for bridge design and construction with repetitive effort and risk of errors. Figure: FINLEY Engineering Group.



Bridge integration modeling (BrIM) workflow developed by FINLEY. Figure: FINLEY Engineering Group.

allows for bridge data to be input only once with model referencing; the result is a simplified procedure for any future modifications.

In the second phase of the BrIM workflow, software is used to efficiently output global CAD geometry data from the first phase to generate the analysis, construction, and component models. These three models are needed for the engineering analysis, the design/detailing of temporary work items for construction, and the development of 3-D visualization models for design/shop drawing production, respectively.

In phase 3 of the BrIM workflow, all elements from phases 1 and 2 are assembled within a single integrated 3-D bridge model. For example, the integrated 3-D model might align the existing geometry coordinates of the global CAD geometry from phase 1 with temporary work items and the 3-D component models from phase 2. This third-phase model is used to integrate all bridge visualization, create construction manual drawings, detect conflicts, and identify various construction support items for the bridge project. A significant advantage of the BrIM workflow is that it does not require additional efforts to recreate modeling elements for phase 3.

The Veterans Memorial Bridge

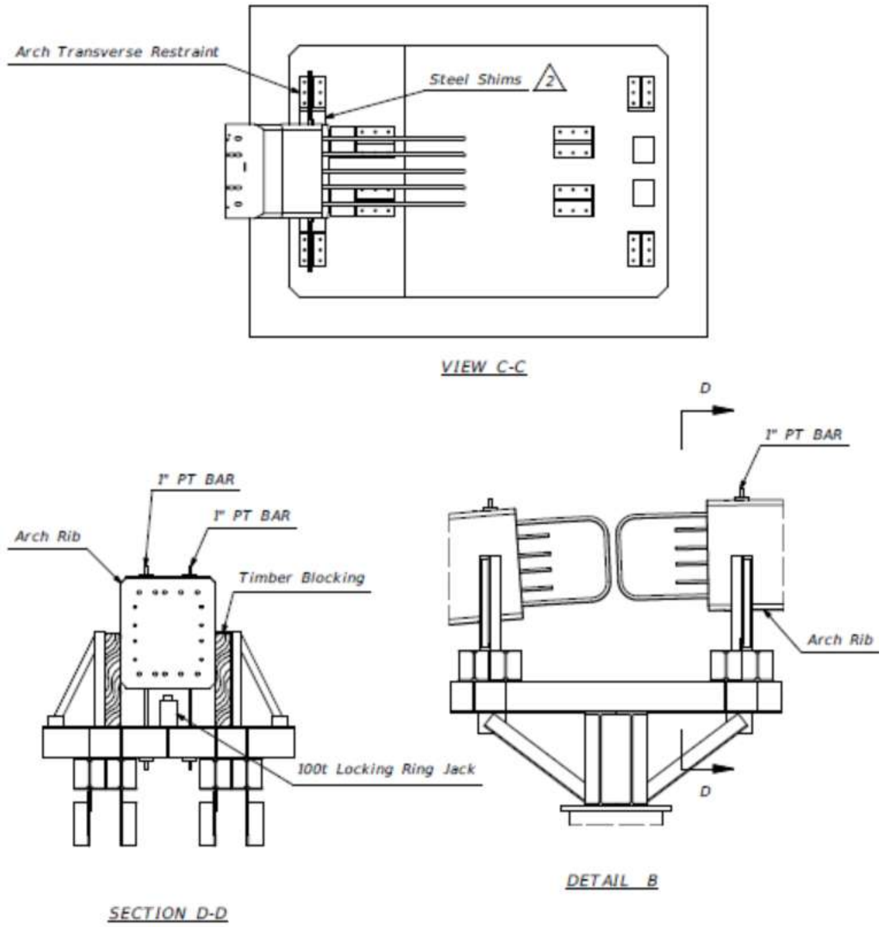
The Veterans Memorial Bridge in Daytona Beach, Fla., is composed of seven spans of a precast concrete arch substructure with spandrel columns and an edge beam that supports transverse precast concrete T-beams beneath a reinforced concrete deck. As part of FINLEY's construction engineering efforts, two types of falsework towers were used at each spandrel arch span. Design and detailing of the falsework towers for the erection of the precast concrete arch ribs benefitted greatly from the BrIM workflow process. The falsework framing geometry was sized and created as required within the analysis model and exported to the construction model, where the framing geometry was used directly to detail the steel member sections for the falsework drawings. As changes were made within the analysis model, the construction model was automatically updated as well.

Integrated three-dimensional bridge model in software with temporary construction supports shown. Figure: FINLEY Engineering Group.

The advantages of the BrIM workflow were also apparent in the integrated 3-D bridge model used for the construction manual. All updates to the falsework towers in the integrated bridge model were also shown in every drawing sheet of the construction manual, significantly reducing errors and CAD-production effort. Using the construction models with the bridge visualization, the fabrication understanding of the temporary falsework towers was simplified with 3-D isometric views; also, the falsework drawings were similar to the physical product produced.

Wekiva Parkway Section 6

Section 6 of the Wekiva Parkway in Sorrento, Fla., consists of a trio of three-span cast-in-place (CIP) segmental bridges built using cantilever construction with form travelers. For each bridge, there are two cantilevers containing 10 pairs of 16-ft-long CIP segments with



Using bridge integration modeling (BrIM) workflow, drawings were produced for the construction manual of the Veterans Memorial Bridge, such as these falsework and connection details for the precast concrete arch segments. Figure: FINLEY Engineering Group.

a twin-column integral pier table. The segmental bridges are post-tensioned using a combination of external draped and internal unbonded tendons.

For the Wekiva Parkway project, shop drawings were required for all CIP segments. FINLEY used the component models created from the BrIM workflow to generate parametric shop drawings that would update with every approved modification required by the contractor. The initial stages for the parametric setup required significant effort, but the payoff was an efficient shop drawing process in which the time required for minor to average shop drawing revisions was reduced from hours to just minutes. The contractor also used these 3-D component models on the project to assist in reinforcement placement for the pier table.

The integrated three-dimensional bridge model (inset) and the actual construction of the precast concrete arch substructure with spandrel columns on the Veterans Memorial Bridge. Figure and Photo: FINLEY Engineering Group.

For the Wekiva Parkway pier table, three-dimensional component models were used to facilitate reinforcement placement. Photo: FINLEY Engineering Group.

Asset Management

Beyond design and construction, BrIM also has applications in asset management. During construction, details of the entire construction history, such as temporary blockouts and lifting holes, can be stored within the BrIM model for future reference. Furthermore, field changes and repairs can also be recorded along with supporting documentation such as photographs, descriptions of repair procedures, and material catalog cuts. Bridge inspections can also be annotated directly within the BrIM model.

Future developments of BrIM could include the incorporation of as-built geometry and load ratings into models. This visualization of design, construction, and inspection creates a powerful tool to help owners proactively address future maintenance issues and assess repair products and repair details.

Conclusion

FINLEY has applied BrIM to multiple projects with great success. Efficiency and quality production are substantial benefits of using the BrIM workflow in place of past methodologies. The ability of engineers to work simultaneously on multiple facets of a project and the increased consistency among models reduces design hours and opportunities for error. Complex projects such as the Veterans Memorial Bridge and Wekiva Parkway clearly demonstrate that BrIM is no longer a future prospect—it is an asset today.

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