



Fig. 1 Rendering of Veterans Memorial Bridge [3]

BrIM has arrived! ... and it's better than we thought!

Ivan Liu, P.E. | Finley Engineering Group

Summary:

The true Bridge Information Modeling approach to bridge projects integrates bridge information databases into the planning, design, and construction process using advanced engineering software. General aspects of Bridge Information Modelling and advancing software are used by FINLEY Engineering Group to develop its project workflow, designated as Bridge Integration Modelling (BrIM), to integrate SOFiSTiK analysis models with CAD drawing production models.

Through integration, the design team becomes more efficient, requiring fewer engineers due to the ability to work simultaneously on multiple facets of the project by each engineer. This increases consistency between models, reduces manhours for "repeated efforts", and significantly increases the overall quality of the final product resulting from the project workflow. FINLEY used Bridge Integration Modelling (BrIM) for the Veterans Memorial Bridge

Project in Daytona Beach, FL. Through BrIM, one centralized CAD model was created and used to generate and integrate the SOFiSTiK analysis model, the bridge construction manual, shop drawings, bridge temporary works design/drawings, geometry control for precasting, and the visualization for the Veterans Memorial Bridge.

1 | The Veterans Memorial Bridge

The Veterans Memorial Bridge is composed of seven spans of a precast concrete arch substructure with spandrel columns with an edge beam that supports transverse precast T-beams underneath a reinforced concrete deck. In addition, there are eight spans of precast concrete Florida I-Beams underneath a reinforced concrete deck leading up to the arch spans. The 220ft main span of the bridge has a similar T-beam deck superstructure but is supported by an above-deck arch through

post-tensioned hanger columns. Johnson-Bros Inc. selected FINLEY as the Contractor's Engineer with a scope of work for the spandrel arch spans consisting of the construction analysis, geometry control services, precast arch rib shop drawings, construction manuals, and design of temporary works. With the complexity of the bridge elements and the large scope of work covering all phases of bridge construction, utilizing BrIM for the Veterans Memorial Bridge allowed FINLEY to simplify this complex project through 3D visualization.

2 | The BrIM Workflow

Traditionally, the workflow for the project begins with the analysis of the bridge, the design of bridge components and temporary works, and lastly the drawing production (Figure 2). Within those three phases, the transfer of bridge data is done repeatedly by the engineer and not seamlessly by the engineering software used. Bridge data such as roadway geometry, concrete geometry, post-tensioning layouts, steel member sizes, etc., can be long and cumbersome to input into the analysis model, then again into temporary works models, and once again into CAD models without a loss of quality and a lot of time spent. That was required before the advancing capabilities of modern engineering software to integrate bridge data among separate models. The ideal scenario is to use the software capabilities to import and export the initial bridge data input and minimize the repeated efforts of the engineer. FINLEY developed the BrIM workflow (Figure 3) to integrate the analysis model from SOFiSTiK to CAD production models.

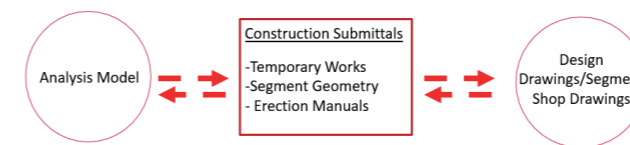


Fig. 2 Traditional Project Workflow

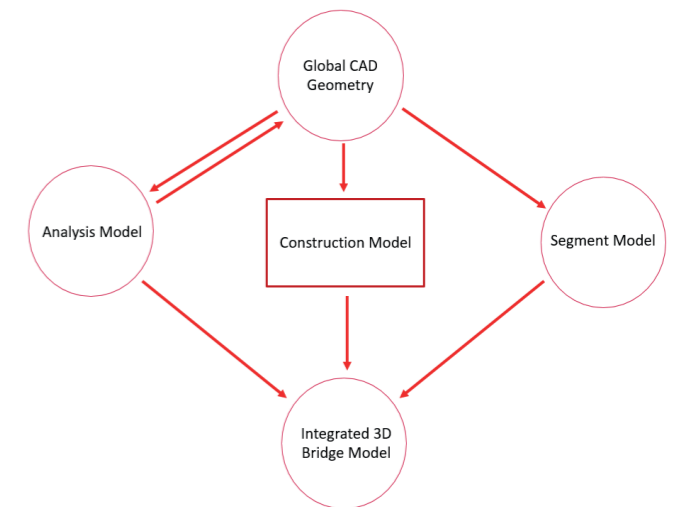


Fig. 3 FINLEY BrIM Workflow

The three phases of the BrIM workflow are:

- 1 Input of Global CAD Geometry
- 2 Development of the Analysis, Construction and Segment Models
- 3 Generating the Integrated 3D Bridge Model

The foundation of the BrIM workflow is SOFiPLUS, which is a preprocessing software containing an AutoCAD-based engine used by SOFiSTiK. The ability to create the analysis model through a CAD engine allows the BrIM workflow to begin with a single 3D CAD model (Figure 4) that centralizes the bridge data used by the analysis, visualization, and CAD software. A single centralized and integ-

atedly by the engineer and not seamlessly by the engineering software used. Bridge data such as roadway geometry, concrete geometry, post-tensioning layouts, steel member sizes, etc., can be long and cumbersome to input into the analysis model, then again into temporary works models, and once again into CAD models without a loss of quality and a lot of time spent. That was required before the advancing capabilities of modern engineering software to integrate bridge data among separate models. The ideal scenario is to use the software capabilities to import and export the initial bridge data input and minimize the repeated efforts of the engineer. FINLEY developed the BrIM workflow (Figure 3) to integrate the analysis model from SOFiSTiK to CAD production models.

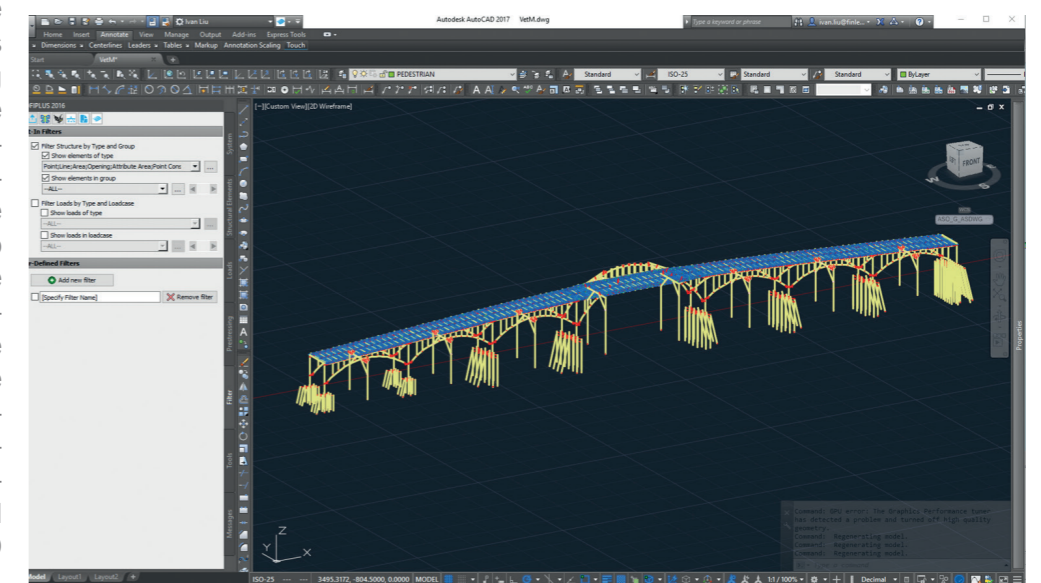


Fig. 4 Global CAD Geometry in SOFiPLUS

rated CAD model, or Global CAD Geometry, allows for one instance of bridge data input with model referencing resulting in a simplified procedure for any future modifications. This is Phase 1 of the BrIM workflow and was performed within AutoCAD for the Veterans project.

The Global CAD Geometry of Phase 1 outputs data to the three models generated within Phase 2 of the BrIM workflow. The three models: Analysis, Construction, and Segment are standard models for every bridge project that are required for the bridge analysis, design/detailing of temporary work items for construction, and development of 3D precast models for design/shop drawing production, respectively. FINLEY uses SOFiSTiK (Figure 5) and Autodesk Products (Figure 6 & Figure 7) with their software capabilities to integrate the CAD data of Phase 1 to efficiently generate the necessary models of Phase 2 for analysis and drawing production. All elements from Phase 1 and Phase 2 are assembled within a single Integrated 3D Bridge Model (Figure 8 & Figure 9) in Phase 3 that is used to produce all bridge visualization, create construction manual drawings, and clash detection for the construction site on the Veterans project. FINLEY directly used the global geometry coordinates from the Global CAD Geometry to align the temporary work items and 3D precast models from Phase 2 into the bridge model. This was a significant advantage for FINLEY

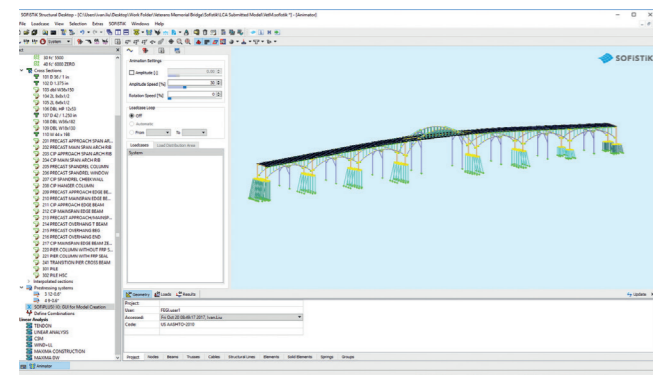


Fig. 5 Analysis Model in SOFiSTiK

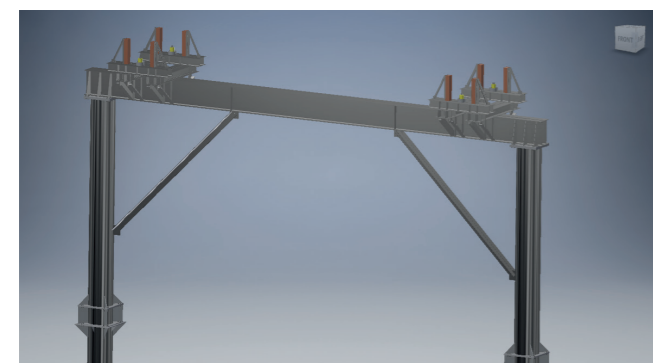


Fig. 6 Construction Model in Autodesk

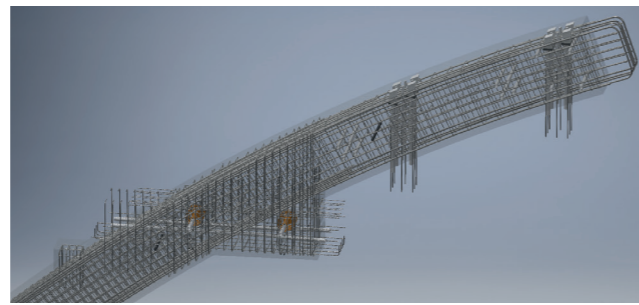


Fig. 7 Segment Model in Autodesk



Fig. 8 Integrated 3D Bridge Model in Autodesk



Fig. 9 Integrated 3D Bridge Model in Autodesk

as it did not require additional work to recreate model elements for the production.

3 | Precast Models for Production

For the Veterans project, shop drawings were required for all precast elements. There are two types of precast arch ribs in each approach span and three types in the mainspan. FINLEY used the 3D precast models to generate parametric shop drawings that would update with every necessary modification required by the contractor. An increased effort was made in the initial stages for the parametric setup but resulted in an efficient shop drawing product which only required minutes of additional time versus hours spent for minor to average revisions. These 3D precast models were used for the initial phases of construction for the Veterans project for

clash detection of the exposed reinforcement between the foot of the precast arch rib and the external splice reinforcement extending from the construction joint of the Pier (Figure 10).

4 | Development Temporary Works

For construction of the Veterans bridge, two types of falsework towers were used at each spandrel arch span. In the approach spans, the falsework tower supports 4 precast arch ribs prior to closure (Figure 11). In the main-span, a pair of falsework towers support all 3 pairs of precast arch ribs in addition to the precast T-beams.

Design and detailing of the falsework towers for the erection of the precast 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 revised as well. This is also apparent in the integrated 3D bridge model used for the construction manual (Figure 12), as the falsework towers in the integrated bridge model would update and follow through within every drawing sheet of the construction manual, significantly reducing errors and CAD production effort. Using the Autodesk construction

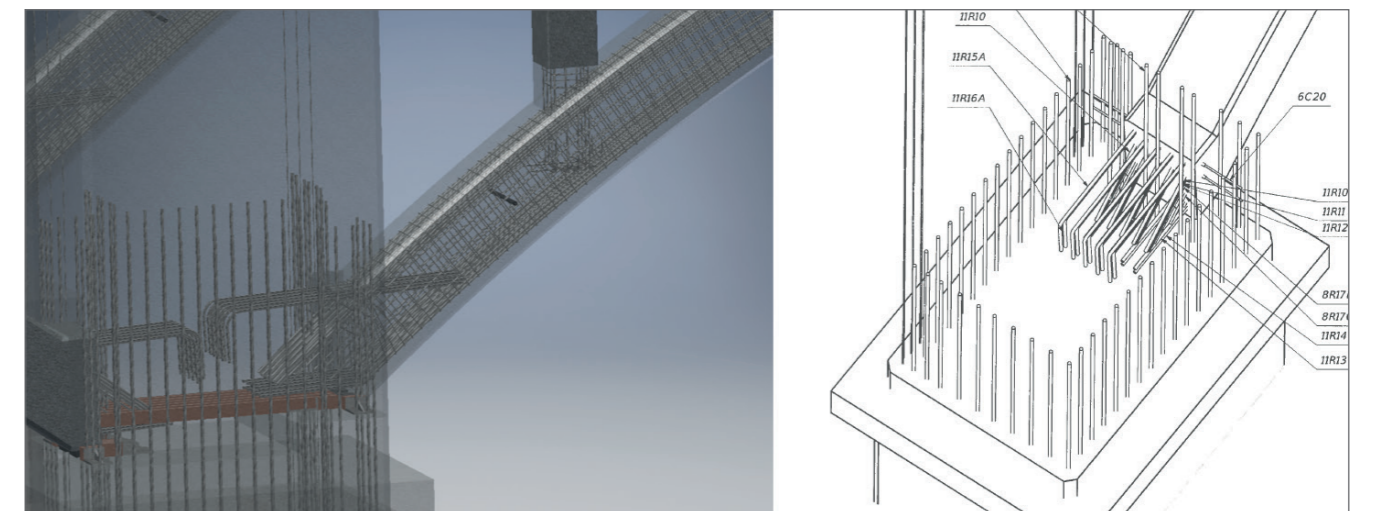


Fig. 10 Clash Detection of Precast Rebar



Fig. 11 Approach Span Precast Arch Ribs on Falsework Towers [1] with Integrated 3D Bridge Model Rendering (Top Right)

models with the bridge visualization, the fabrication of the temporary falsework towers was simplified with 3D isometric view and falsework drawings were very similar to the physical product produced (Figures 13 & Figure 14).

scope of work and complex elements in the bridge structure, the Veterans Memorial Bridge became a great showcase project for what FINLEY has achieved with BrIM and SOFiSTiK.

5 | Conclusions

FINLEY has utilized the Bridge Integration Modeling (BrIM) Workflow for the Veterans Memorial Bridge project with great success. Efficiency and quality production were a great result of using the BrIM workflow and could not have been replicated using past methodologies and software. With the large

Sources

- [1] Site Photos provided by Johnson-Bros Inc. & Southland Holdings, LLC.
- [2] SOFiSTiK Model Photos provided by FINLEY International
- [3] Veterans Memorial Bridge and Proposed Future Memorial Plaza | URL: <https://www.volusia.org/veteransmemorialbridge/>

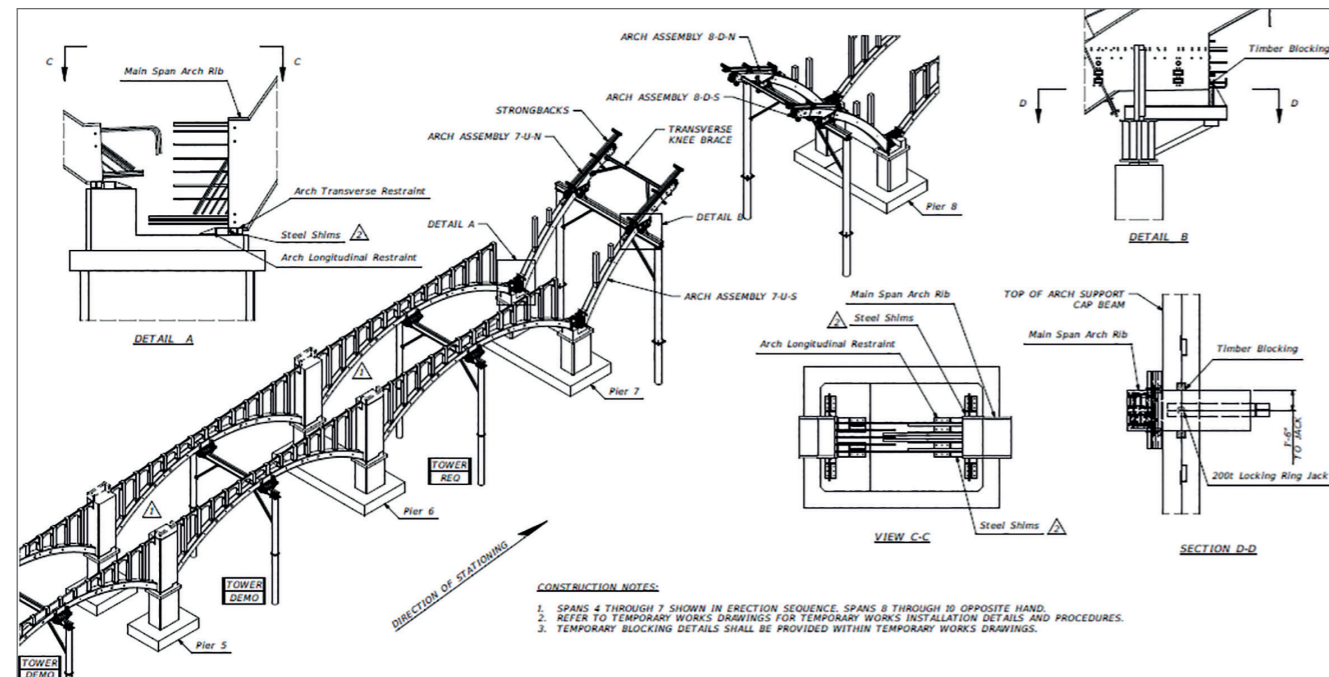


Fig. 12 Veterans Memorial Construction Manual

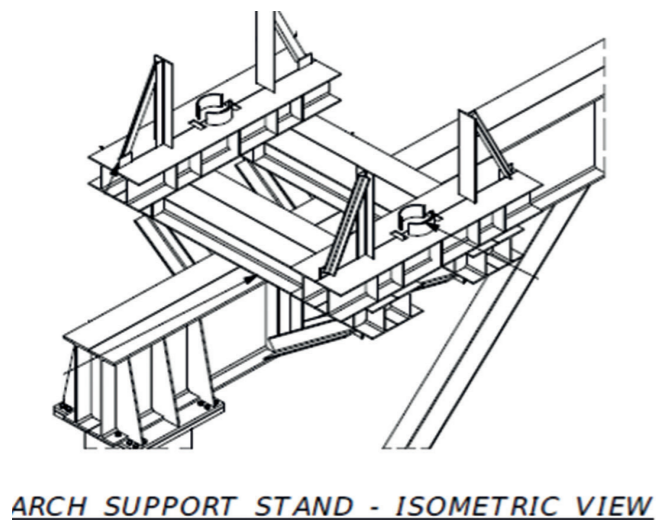


Fig. 13 Comparison of Falsework to Fabrication



Fig. 14 Approach Span Falsework Tower



Fig. 15 Construction Site Photo of the Erection of First Precast Arch Rib [1]