USER'S GUIDE FOR

MODEL-CENTRIC WORKFLOW USING BENTLEY'S OPENBRIDGE DESIGNER

pennsylvania
DEPARTMENT OF TRANSPORTATION

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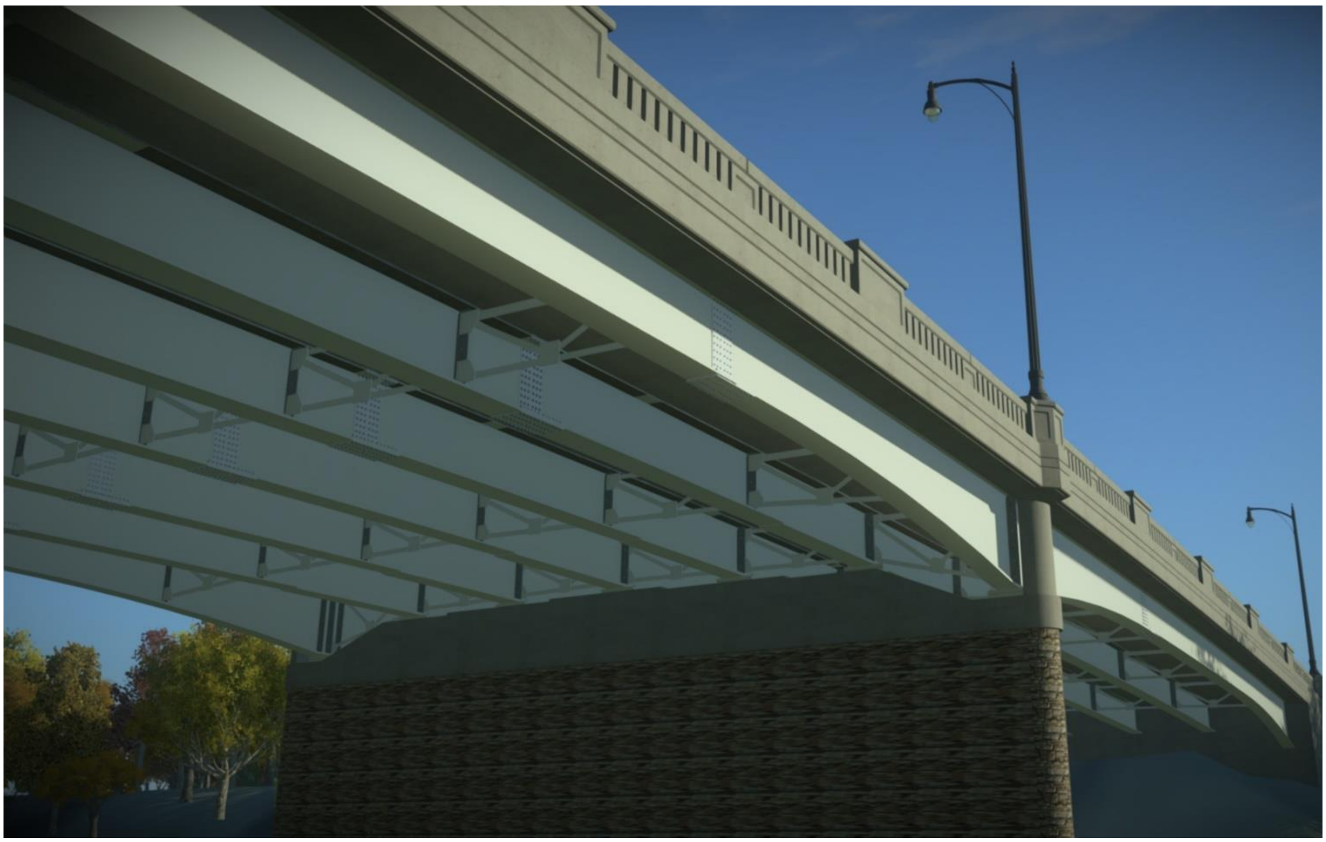
USER'S GUIDE FOR
MODEL-CENTRIC WORKFLOW
USING BENTLEY'S OPENBRIDGE DESIGNER (OBD) SOFTWARE
VERSION 1.0



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Pennsylvania Department of Transportation

March 2023

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GENERAL DESCRIPTION

1.1 PURPOSE OF THIS GUIDE

The purpose of this guidance manual is to instruct users on the process and timing used to develop a bridge model for Digital Delivery in accordance with the PennDOT Digital Delivery guidance documents using Bentley software. This method is referred to as a “model-centric workflow” throughout the document, which describes the use of a 3D model as the central repository of digital data that grows with the progression throughout project phases and is used as the basis for required content and deliverables. This manual walks the user through the typical phases and needs of the bridge model from preliminary to the final design. Though there are limitations in this current workflow noted throughout this guidance document, workarounds and alternative processes are provided to give users the tools to create and modify bridge models to comply with the modeling standards. It is important to note that these limitations and processes will continue to change rapidly for the foreseeable future due to software development, updates, and improvements. Also, it is not possible to cover every situation encountered in a typical PennDOT bridge project in this manual; therefore, the user will have to apply and extend the processes and workarounds included herein to complete the bridge models to the project-specific requirements. There will be additional components including 2D details, attached documents, and other items needed to supplement the 3D bridge models which are described in other modeling standard documents. This manual’s scope is limited to the actual 3D bridge model components, serving as the basis for the Digital Delivery of PennDOT bridges.

The software programs specified herein, like all software, are tools. This manual aims to provide the user with guidance and the methodology in which these tools can be best applied for common PennDOT bridge projects. It is the engineers’ and technicians’ responsibility to accurately convey design intent while meeting the Department’s requirements for the project.

1.2 PROFILE OF INTENDED USERS

The intended users of this manual include bridge engineers and technicians, both internal within PennDOT and external consultants. Though it is recommended that the users first take an introductory Bentley OpenBridge Modeler (OBM) or OpenBridge Designer (OBD) training or go through the tutorials in the OBM Help materials, it is not required for use of this guidance document. It is also not limited to new or novice users. The workflows and processes shown provide progressive modeling techniques to create advanced models with a high Level of Detail and information.

It is assumed that users have a general knowledge of common MicroStation commands/topics including drawing, referencing, dimensioning, etc., especially for some of the advanced topics and techniques in the workflow.

1.3 ORGANIZATION OF MANUAL

This guidance document generally follows the PennDOT Bridge LRFD program manual organization. This is done for several reasons. First, users who have worked on PennDOT projects are likely to have used these manuals, so there is a level of familiarity and comfort with this format. Second, the outline provides a logical format to walk through the use of software with beginning users, as well as to convey advanced information to more experienced users.

Below are general descriptions of the chapters.

- Chapters 1 and 2 provide general information and background of the software utilized and the workflows addressed
- Chapter 3 details the specific workflow elements and procedures
- Chapter 4 gives practical instructions on starting a new project, essentially serving as a “quick start” guide
- Chapter 5 is the bulk of the manual providing detailed information on all the necessary inputs

- Chapter 6 provides advanced techniques or processes for more detailed modeling, categorized by inputs described in Chapter 5
- Chapter 7 describes several different outputs and how they can be generated from the model-centric workflow
- Chapter 8 includes examples of bridge models and selected model components used in training material to provide the user with samples highlighting this workflow (electronic files also delivered with this manual)
- Chapter 9 provides guidance and direction on submitting software modification requests, as well as requests for changes or enhancements to this document
- Appendix content includes exhibits of the workspace delivered templates, template variable values for typical situations, and additional resources for help, support, and more

Users are encouraged to use the bookmarks with the Chapter and Section topics, as well as the search functions, to search for key terms or phrases.

1.4 ADDITIONAL RESOURCES

The structure and content of this manual seeks to provide the information required for users to follow the workflow for PennDOT bridge models with Bentley software. This guidance document does not intend to recreate content relevant to this workflow that is conveyed adequately in other resources and readily available to all users. The list of material in this category is sizable and continues to grow rapidly. The following information is provided to give users examples of helpful resources to supplement this manual. Though links are provided, this content is often moved and website names can change, so it is important to verify the links and the content in these locations.

This workflow utilizes software that is developed and maintained commercially by Bentley Systems and multiple resources are provided by Bentley:

- OBD Help: https://docs.bentley.com/livecontent/web/openbridge%20designer-v3/en/GUID-3339A995-3E8E-4CDE-8D02-0958A7EC80D4.html
- OBM Help: https://docs.bentley.com/LiveContent/web/OpenBridge%20Modeler%20Help-v15/en/GUID-E9849062-68DE-4BA8-B734-CD5664469596.html
- Link to OBM Tutorials (on Bentley Learn Server): https://docs.bentley.com/LiveContent/web/OpenBridge%20Modeler%20Help-v15/en/GUID-E9849062-68DE-4BA8-B734-CD5664469596.html
- OpenBridge YouTube Channel: https://www.youtube.com/c/BentleyBridgeAnalysis

Additional State Highway Administration content:

- Florida DOT – FDOTConnect Bridge Design and Modeling: https://www.fdot.gov/cadd/downloads/documentation/fdotconnecttraining/fdotobm/fdotconnect-bridge-design-modeling
- Connecticut State DOT: https://portal.ct.gov/DOT/Engineering-Applications/CTDOT-CONNECT-DDE-eBook-Volume-011---OpenBridge-Modeler
- Utah DOT – Structures Design Digital Delivery: https://digitaldelivery.udot.utah.gov/pages/structures-design

Additional resources, including instructional videos, can be found on free open-source sites or paid training sites.

1.5 DOCUMENT STYLE

Style conventions are included in the table below. The standard format for the PennDOT bridge software manuals is followed when applicable for consistency.

Input	Description	Example
Menu names and commands	Bold (Names separated with > symbol)	• General form is **Workspace** (when applicable) **> Tab > Panel > Command** • **File > Open** • **File > Settings > User > Preferences** • **OpenBridge Modeler** (workspace) **> Analysis and Reporting > Bridge Reporting > Quantities Report**
Dialog box actions	Bold	• Click the **Apply** button • In the *Direction Mode* list, select **Skew**
Dialog box field names	Italic	• Key in **Warwick Road** in the *Alignment Name* field • In the *Direction Mode* list, select **Skew**.
Key-ins	Bold	Key in **Warwick Road** in the *Alignment Name* field
File names	Italic	Use the seed file: *PennDOT_Bridge_NAD83_S_SF.dgn*
File paths	Underline	The seed files can be accessed at the following location: … Organization-Civil \ Bridge Design \ OpenBridge Modeler \ Seed folder
New terms or emphasis	Italic or Bold	• The Decks Library contains *templates* that represent typical deck sections for proposed bridges • ***The user is not to utilize this tool***
Notes	Symbol and underlined	Note: It is important for users to consider the size of the bridge and how many bridges/units/files to break…
Tips and Tricks	Symbol and underlined	**Tips and Tricks:** The Feature Definitions for the substructure (abutments and piers) and…
Workarounds	Symbol and underlined	**Workaround:** *After information is exported to LBC or LBS, users can work in these .obdx files separately…*

1.6 ABBREVIATIONS

This section provides definitions of abbreviations that are commonly used throughout this document.

2D	-	Two-dimensional content, typically drawings
3D	-	Three-dimensional content, typically models
AASHTO	-	American Association of State Highway and Transportation Officials
Bentley	-	Bentley Systems, Incorporated
BIM	-	Building Information Model
DD	-	Digital Delivery

DM-4	-	Pennsylvania Department of Transportation Design Manual Part 4: Structures, December 2019 Edition. This publication can be ordered from: PennDOT Sales Store P.O. Box 2028 Harrisburg, PA 17105-2028 This publication can also be downloaded free of charge from PennDOT's website
GUI	-	Graphical User Interface
LBC	-	Bentley's LEAP Bridge Concrete software
LBS	-	Bentley's LEAP Bridge Steel software
LRFD Specifications	-	AASHTO LRFD Bridge Design Specifications, 8th Edition, 2017, published by: American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, D.C. 20001
OBD	-	Bentley's OpenBridge Designer software
OBM	-	Bentley's OpenBridge Modeler software
ORD	-	Bentley's OpenRoads Designer software
PennDOT	-	Pennsylvania Department of Transportation
PS	-	Bentley's ProStructures software
WP	-	Work Point

1.7 GLOSSARY OF TERMS

A full list of terms that form the foundation for PennDOT's Digital Delivery is provided in the Digital Delivery Guidelines. (https://www.penndot.gov/ProjectAndPrograms/3D2025/Pages/default.aspx) Several terms that directly relate to this manual are included below for convenience.

1.7.1 Digital Delivery and Building Information Modeling Terms

The following terminology is standardized language that is used throughout the construction industry, both vertical and horizontal, related to Building Information Modeling.

Building Information Modeling (BIM) Use of 3D Models to coordinate different disciplines (e.g., structural and utilities) and to identify/resolve possible clashes between virtual elements prior to actual construction or fabrication.

Clash Detection Use of 3D Models to coordinate different disciplines (e.g., structural and utilities) and to identify/resolve possible physical conflicts between virtual elements prior to actual construction or fabrication.

Common Data Environment (CDE) A service that collects, stores, manages, and shares information through a managed process.

Digital Delivery A modernized approach to project delivery processes and contract media that incorporates digital data. Simply stated, construction projects have the ability to be bid using 3D technology and no longer only be delivered in a traditional construction plan format.

Digital Delivery Execution Plan (DDEP) A project management tool that documents the overall approach for developing, updating, reviewing, sharing, and using the digital design models.

Discipline Model See also: Federated Model. A model or linked models related to a single discipline. *The superstructure model, substructure model, and detailing models are linked together into a federated Structural Discipline Model.*

Federated Model See also: Discipline Model. A model that is compiled by integrating different discipline models together into one model through either linking, referencing, and/or importing.

Industry Foundation Classes (IFC) See also: Open Data**.** A non-proprietary data schema and format to describe, exchange, and share the physical and functional information for the assets within a facility. IFC is the International Organization for Standardization standard for BIM and is being extended to roadway and bridge asset classes.

Level of Detail See also: Level of Development. Often confused with Level of Development, Level of Detail describes only the amount of geometric detail in a model element, not the amount of engineering intent. Highly detailed model elements may be placed in a model as placeholders with no engineering intent. Though detail often increases in parallel with development, observing the detail of a model element is not an effective way to determine its development or appropriate uses.

Level of Development (LOD) See also: Level of Information, Level of Visualization, Model Progression Specification. A qualitative designation that communicates the degree of engineering intent behind a 3D model element (or group of model elements) and defines the authorized uses for which the model element is sufficiently developed. Normally the LOD will increase through the design development process, as defined in the MPS.

Level of Information (LOI) See also: Level of Development. A description of the completeness and quality of the non-graphical information attached to the model elements.

Level of Visualization (LOV) See also: Level of Development. A qualitative designation that communicates the degree of visual enhancement given to the 3D model elements, to suit the needs of different target audiences. Generally, non-technical audiences need color-realistic geometry or even photo-realistic materials to be able to understand bridge models.

Model Element See also: Level of Development, Level of Information, Model Element Author, Model Progression Specification. An entity within a model that represents a physical object or an abstract concept (e.g., alignment, north arrow).

Model Element Author (MEA) See also Model Element. The individual, normally identified in a BIM Execution Plan and/or MPS, responsible for creating a specific model element or group of model elements. The MEA may work under the direct supervision of an EOR who assumes professional responsibility for the design represented in the model.

Model Breakdown Structure (MBS) See also: Model Progression Specification. A list of model elements adhering to a set classification. A MBS is the basis for a Model Progression Specification.

Model Progression Specification (MPS) See also: Model Breakdown Structure**.** A specification that defines how the LOD for individual model elements increases over the project milestones. The MPS will assign a specific, minimum LOD to each model element for each milestone. The LOD typically increases from milestone to milestone.

1.7.2 Data-related Terms

The following terminology is standardized language that is specific to the data contained in a digital model.

Attribute Non-graphical data that is associated with a model element definition.

Component A physical item or feature within a model.

Constraint See also: Parametric. A relationship between two or more elements in a model, which should be maintained in any modifications made to the base element. *The slab geometry is a constraint for the rebar layout.*

Digital Twin Initially conceived for smart manufacturing, a digital twin is a digital representation of a physical asset that contains a 3D digital model of the physical asset, as well as non-graphical information about the asset, such as its properties, functions, evaluative properties, and other analytical attributes.

Feature See also: Model Element. Anything that can be seen or located and is a physical part of the project.

Graphical Data See also: Non-graphical Data, Spatial Data. Data conveyed using shape and arrangement and/or location in space.

Layer See also: Level. A container within software for model elements or features. Some CADD, GIS, and PDF software products use the term "Layer" to describe the container, while other software products use the term "Level." Common software features include styling elements and controlling the visibility of elements using layer settings.

Level See also: Layer. A container within software for model elements or features. Some CADD, GIS, and PDF software products use the term "Layer" to describe the container while other software products use the term "Level." Common software features include styling elements and controlling the visibility of elements using level settings.

Links Hyperlinks that can be applied to geometry to allow a user to connect to and access a wide range of external files and formats. These links can be used to link to web addresses, networked folder locations, files and/or folders located in a CDE, or bookmarks within the file.

Metadata See also: Model Progression Specification. Data used for the description and management of documents and other containers of information. Metadata is usually structured data embedded within the file. However, it could include an external document that describes pertinent information to others on the assumptions and basis for the 3D models, such as the geospatial metadata (grid/ground coordinate system definitions), intended uses of the 3D models, approximations and simplifications (e.g., removing minor curvature from analysis models). A MPS is important metadata that accompanies a Federated Model.

Model A representation of a system that allows for investigation of the properties of the system. (EN ISO 29481-1:2016). *The roadway and bridge models were delivered in CADD files.*

Naming Convention A set of rules for naming components and features within a model. A naming convention may provide instructions for choosing the character sequence to be identifiers that denote variables, types, functions and other entities in source code and documentation.

Non-graphical Data See also: Attribute, Feature. Anything that can be seen or located and is a physical part of your project.

Parametric See also: Component, Constraint. Representing digital information for a model component by parameters. This is usually referring to geometric data, which can be linked to related components through internal logic.

Property See also: Attribute. Non-graphical information that describes a model element. *The Modulus of Elasticity is a property of a girder.*

Schema See also: Industry Foundation Classes. A formalized model for structuring information.

Spatial Data See also: Geodatabase, Feature, Model Element. Anything that can be seen or located and is a physical part of your project.

1.7.3 Data Management Terms

The following terminology is standardized language that is specific to the management of data and data exchanges within a digital model, between digital models, and between the digital model and associated systems and applications.

Data Exchange See also: Information Exchange. The process of taking data structured under a source schema to transform and restructure into a target schema, so the target data are an accurate representation of the source data within specified requirements and minimal loss of content.

Information Exchange See also: Data Exchange, Information Requirements. Packages of information passed from one party to another in a BIM process, or the act of passing such information, possibly as a contractual deliverable. Parties involved agree upon and understand what information content and format will be exchanged.

Information Requirements See also: Information Exchange. A specification for what, when, how, and for whom information is to be produced. Information requirements could be documented in a PennDOT Publication, in a project Scope of Work, or in a BIM Execution Plan.

Open Data See also: Open Specification. Data that is publicly available and free to use or reuse without restrictions. *PennDOT's Open Data Portal provides access to all published GIS data that members of the public can map, style, chart, download, or share.*

Open Specification See also: Industry Foundation Classes, Proprietary Specification. A specification for data that is structured according to an open schema that is freely available and not controlled by any one particular vendor. Open specifications are intended to facilitate data exchange.

Proprietary Specification See also: Open Specification. A specification for data that is structured according to a proprietary schema. Proprietary data can usually only be read and written by one vendor's software products.

1.7.4 Use Cases

The following entries define the industry standardized Use Cases, or potential situations in which a digital model may be used.

3D Coordination The process in which information models are used to determine field conflicts via Clash Detection software or visual inspection. 3D coordination is accomplished by comparing proposed 3D geometry from discipline models aggregated into a federated model. 3D elements for all objects are required to perform 3D coordination.

Analytical Design The process of capturing the existing and proposed alternatives in analytical models to design the proposed facility.

Construction Documentation The process whereby a construction inspector documents the construction process. This includes, but is not limited to, daily diary records, materials testing results, pile driving reports, monthly payments, routine erosion prevention, and sediment control inspections, NEPA compliance, and the process of seeking remedies to work that was not in conformance with plans, quantities, and/or specification.

Design Authoring The process in which 3D design software is used to develop information models based on specific roadway and structural criteria to convey design intent for construction. The core functions of design authoring include development and analysis of the design elements.

Design Review The process in which an information model is used to review and provide feedback related to multiple design aspects. These aspects include evaluation of design alternatives and environmental constraints, review and validation of geometric design criteria, and completeness or quality of overall design.

Quantity Take-off Preparing the estimated construction quantities as determined by the Designer. Designers use QTO to determine Contract Item (Pay Item) quantities and multiply those quantities by reasonable rates (usually from historical bids) to produce an aggregate cost estimate.

Existing Conditions Modeling See also: Design Authoring. The process to create a 3D model of existing conditions for a roadway and/or bridge project, including an existing ground surface and the demarcation of features, such as above and underground and utilities, structures, fences, and trees. It may also include the modeling of existing pavement structures.

Reference Information Supplemental information provided to the contractor that is not contractually-binding and is used at the contractor's risk. *The soils report was Reference Information provided with the bid package.*

Scoping Capture digital information about the asset inventory, condition, and other performance information (e.g., traffic, safety) and evaluate alternatives to determine the scope and estimated cost of the project. For bridge projects, conducting a "type, size, and location" (TS&L) study that includes preliminary structural design.

Stakeholder Engagement See also: Visualization. A process that uses digital information to communicate the project to technical and non-technical stakeholders and document their input throughout project delivery.

Visualization See also: Stakeholder Engagement. The process of creating visual representations of the project to communicate with technical and non-technical stakeholders throughout the project lifecycle.

1.7.5 References

The following entries provide references used to compile PennDOT's Glossary of Terms.

Brenner, J. et al., 2018. *Development of 3D and 4D Bridge Models and Plans,* Lansing: Michigan Department of Transportation.

Commonwealth of Pennsylvania Department of Transportation Publication 408/2020 Specifications

International Organization for Standardization, 2018. *ISO 19650-1:2018.* [Online]
Available at: https://www.iso.org/standard/68078.html
[Accessed 14 August 2019].

ISO 29481-2, Building information models — Information delivery manual — Part 1: Methodology and Format. Switzerland: ISO 2016.

National Institute of Building Sciences, 2015. *United States National Building Information Modeling Standard Version 3,* Washington, DC: National Institute of Building Sciences.

Utah Department of Transportation, 2020. *Glossary of Terms.* [Online]
Available at: https://digitaldelivery.udot.utah.gov/pages/terms
[Accessed 9 December 2020].

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WORKFLOW DESCRIPTION

2.1 GENERAL

The current bridge modeling workflow provided in this manual utilizes several Bentley software programs, as well as other discipline data files created by other software. The required data is created, stored, read, modified, updated, and then transferred from one software to another in order to utilize the most up-to-date information and the best suited tools for the stated purpose. The workflow is created to follow a typical bridge project submission timeline from preliminary engineering to final design, utilizing models and data generated in previous phases to update and enhance the same model. Every effort is made to minimize data loss and re-work required through utilization of the parametric capabilities of the software to adapt to updates and changes quickly and efficiently as the design progresses. Though this is not always possible with the current limitations in the software, the framework is structured so updates in the software can be incorporated as they become available.

Topics covered in this manual include:

- Reference and import other discipline data for bridge design and modeling
- Develop a “Base” bridge model with typical elements including deck, girder/beam, barrier, sidewalk, bearings, diaphragms/cross frames, abutment, wingwall, and pier
- Update the model for a “Refined” bridge model with increased Level of Development for the bridge elements
- Add reinforcement to concrete components in the bridge model
- Generate output from the model including saved views, 2D drawing views, reports, and transfer to LEAP software for structural analysis

These items are NOT covered in this manual:

- Development of auxiliary components for bridge models not included above
- Sheet development for a typical 2D plan set
- ProStructures specific outputs including reinforcement schedules and other ProStructures exclusive tools
- Development of models for high-level visualization in LumenRT or other software

2.2 SOFTWARE DESCRIPTION

There are several software programs covered in this manual. The primary software is OpenBridge Modeler as accessed through OpenBridge Designer.

Program Title:	OpenBridge Designer
Version:	10.11.00.40 at time of manual creation
Function:	A unique application that combines modeling, analysis, and design into one comprehensive bridge product. The application utilizes the modeling capabilities of OpenBridge Modeler and the analysis and design features of LEAP Bridge Concrete, LEAP Bridge Steel, and RM Bridge to meet the design and construction needs of all types of bridges. (Bentley Systems, Inc., 2022)
Authors:	Bentley Systems, Inc.

Program Title:	OpenBridge Modeler
Version:	10.11.00.310
Function:	Comprehensive bridge information modeling application built on OpenRoads technology, addressing the geometric layout, connection to analysis and design,

	visualization, and documentation for any type and scale of bridge project (Bentley Systems, Inc., 2022)
Authors:	Bentley Systems, Inc.

2.3 FUNCTIONS – OBD VS. OBM

OpenBridge Modeler (OBM) is Bentley's software for creating intelligent 3D Bridge Models (Bentley, 2021). This is the primary software used and referred to in this manual for creating a 3D bridge model. The OBM software can be accessed currently as a separate software or, as the workflow outlined in this manual follows, through Bentley's OpenBridge Designer software (OBD). OBD consolidates multiple Bentley software programs including OpenBridge Modeler and Bentley structural analysis software, such as LEAP Bridge Concrete (LBC) and LEAP Bridge Steel (LBS), as well as software for other functions. The LBC and LBS analysis input and use are covered in a separate guidance document; however, the process for preparing and transferring OBM models is included, as it is a key function in the workflow.

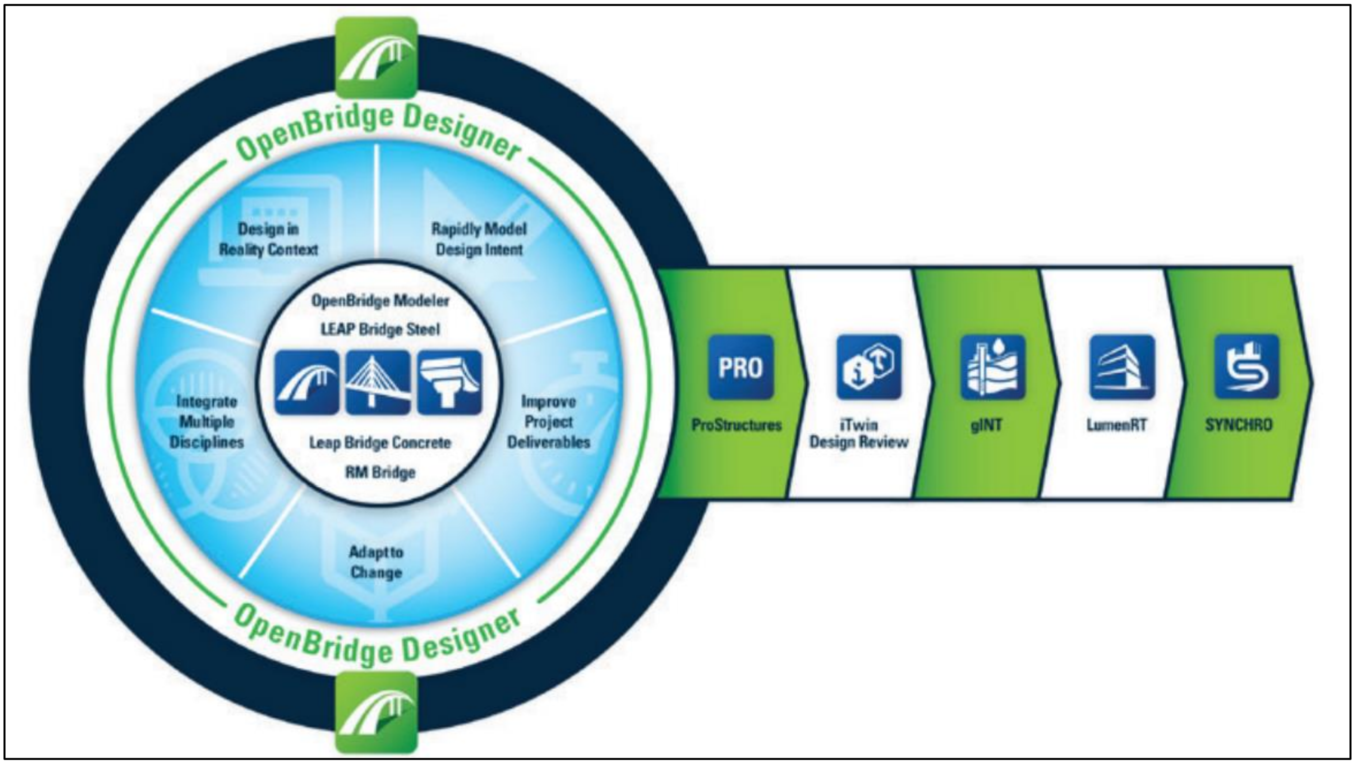

Figure 2.3-1 OBD Software and Available Add-on Software (Bentley Systems, Inc., 2022)

Essentially, OBD is the glue that connects the applicable Bentley programs. Though there are limitations in the current workflow, as described in the manual, presumably, there will be enhanced functionality and software options in future releases.

2.3.1 Workflow Options

The user can utilize the full OBD workflow, which requires creating an OBD file before creating or incorporating OBM files within the OBD file. This allows the user some benefits with integrating other Bentley software programs such as LBS and LBC for analysis, as well as LumenRT for visualization, ProStructures for structure detailing, and others. See Sections 4.1 and 4.2 for more details.

If users have access to an OBM version, which is unconnected to OBD, they can also choose to use OBM separately without starting OBD first. If the user wants to utilize LBC or LBS with this approach, the data will need to be exported and a separate OBD file created before the data is imported. This option can be used to allow more concurrent users on a bridge model (one working in OBM and one working in OBD for the analysis). It could also potentially limit software licensing requirements for OBD. License requirements are different for every organization, are not controlled by PennDOT, and are subject to change.

Either option, OBM with OBD or OBM separately, can be used currently. Users can also start with OBM separately, and later incorporate it into OBD. However, it is not possible to start from the OBM with OBD and then open the files with the separate version of OBM. It is recommended that users consider these options before starting a bridge model and choose one that best fits the project needs.

Also, since the release of the 2021 R2 version of OBM, a ProStructures (PS) license can be accessed inside of OBM without physically opening the PS software separately. This brings up a new workflow within OBM in which the user has access to all the PS tools. The user must physically close this license when not using the PS-specific workflow in order to avoid incurring charges for use of the separate PS license.

Note: These workflows are being updated frequently with new releases, so there may be updated functionality and/or constraints with these options not covered in this manual. The user should verify/test workflows at the beginning of the project to validate their use and functionality.

2.3.2 Standalone vs. BIM Workflow

The OBD workflow has two additional workflow options when creating files: the **Standalone** or the **BIM** workflows for creating projects and file groups in OBD. The OpenBridge Designer Help documentation provides a lengthy description of each, as well as the functionality and limitations of both. At this time, it is recommended to remain in the **Standalone** workflow for the PennDOT projects. However, a file/project can be moved back and forth between these options at any time.

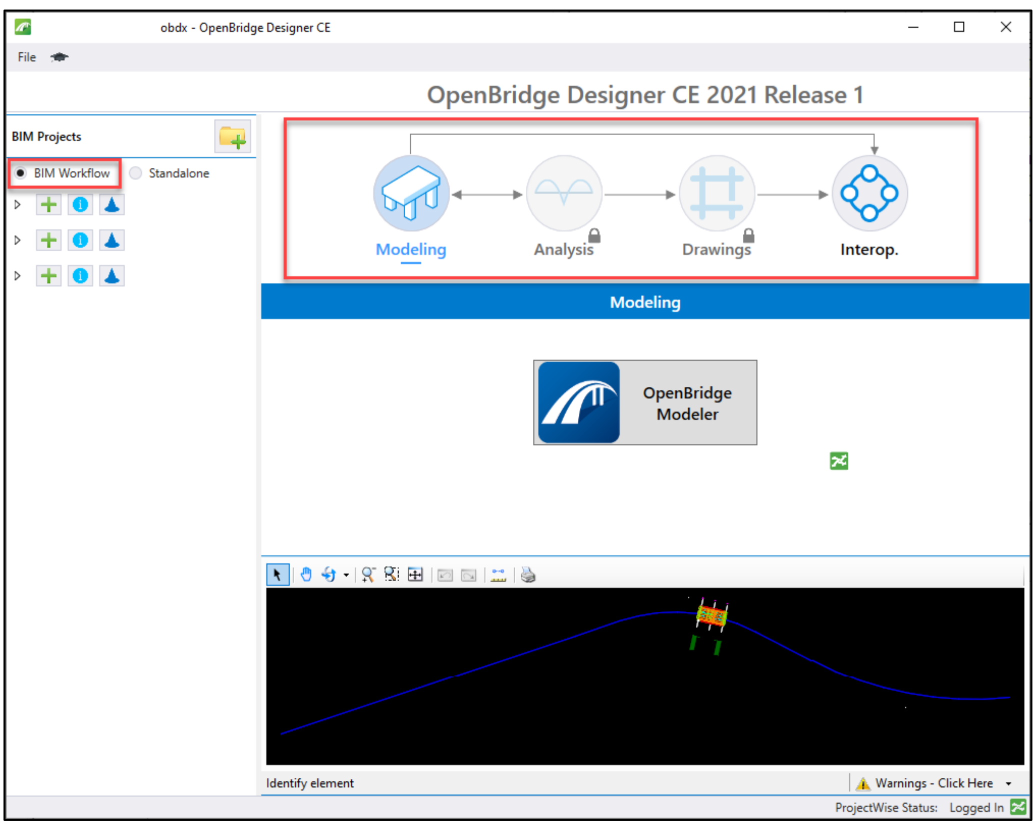

Figure 2.3-2 OpenBridge Designer – BIM Workflow

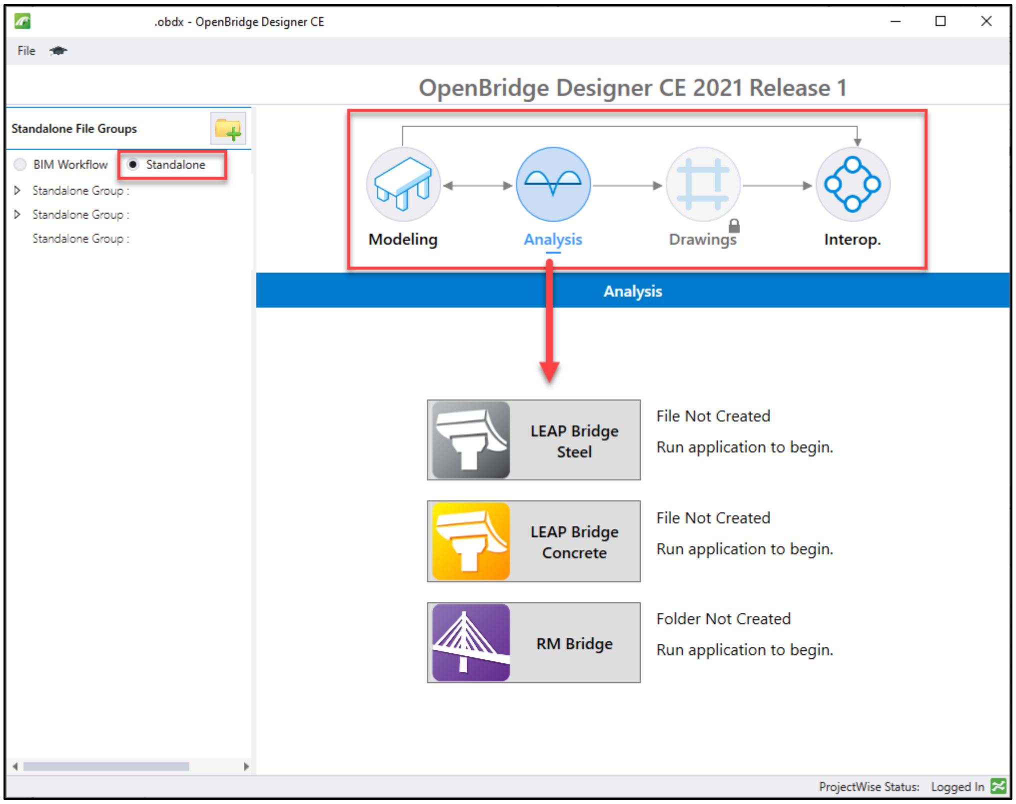

Figure 2.3-3 OpenBridge Designer – Standalone Workflow

2.4 BRIDGE TYPES COVERED (AND NOT COVERED)

The bridge superstructure types covered in this manual include typical prestressed concrete and steel girder superstructure types.

Prestressed girder sections can consist of:

- I-beam
- Bulb-tee beam
- Type F or Type D NEXT beam
- Adjacent plank beam
- Spread or adjacent box beam with rectangular voids

Steel girder sections can consist of:

- Rolled sections
- Welded plate I-girders

The substructure types covered in this manual include cantilever and pile cap abutment types (integral), and multiple typical pier types, such as multi-column, hammerhead, and wall piers. The foundation types include piles, drilled shafts, and spread footings.

Note: The OBM software can handle additional bridge/superstructure types including segmental concrete, welded steel box girders, and others; however, the specific content in this manual is limited to the above listed types.

2.5 ASSUMPTIONS AND LIMITATIONS

2.5.1 OBM Tools

There are limitations with the OBM tools for creating bridge elements with a high Level of Detail and Level of Information, especially with the substructure tools. The specific limitations for each are highlighted in Chapter 5 Input Description, and 6 Advanced Input Description; workarounds are provided wherever possible. The user should not expect the OBM tools to provide final design detail and must realize that other techniques such as Solids Modeling and supplemental model attachments (2D details, etc.) will likely be required. However, the software is improving constantly, and updates are being added to enhance functionality and usability of these tools.

2.5.2 Interoperability with Structural Analysis

Currently, the interoperability and bi-directional flow of information from the OBM model to the analysis software is limited. Updating an OBM model directly from LBC and LBS is not practical at this time and is not recommended as a viable workflow. However, there is value in transferring geometric, material, and other properties from OBM to LBS and LBC as a starting point for the analysis. It is important to understand the assumptions and limitations associated with this export. The Transfer Report that is provided each time this transfer occurs is detailed and helps determine key information critical to updating the LBC and LBS run for an effective structural analysis. This list is constantly evolving as the software is updated and improved. The user is responsible for reading and understanding the list of assumptions and limitations.

Assumptions and Limitations When Exporting to LEAP Bridge Concrete

Assumptions and Limitations When Exporting to LEAP Bridge Steel

More details and information on this transfer process are included in Section 7.3 Exporting to LEAP Structural Analysis Software.

2.5.3 Assumptions and Limitations Guide

Below is a table of situations that are commonly encountered in a typical PennDOT bridge design workflow which expose limitations and require specific assumptions. The second column provides where these specific items are covered in this manual.

Table 1 Common Assumptions and Limitations Guide

Assumptions and Limitations of Common Situations encountered in PennDOT Bridge Design	
Organization and Separation of Files	Section: 3.2 Organization and Separation of Files
Base and Refined Model	Section: 3.3 Base and Refined versions of model elements
Starting a New Project	Section: 4.2 Starting a New Project
Place Concrete Diaphragms	Section: 5.12 Place Concrete Diaphragms
Custom Abutments	Section: 5.17 Place Custom Abutment
Place Approach Slabs	Section: 5.23 Place Approach Slabs
Options to Modify Deck Templates	Section: 6.6.1 Options to modify deck templates
Beam Daps	Section: 6.10.1 Modifying for Beam Daps

	Section: 6.21.1 Modifying pad depth to account for beam daps
Data Transfer from OBM To LEAP	Section: 7.3.1 Data Transfer
Bi-directional Data Transfer	Section: 7.3.3 7.3.3Bi-directional Data Transfer

2.6 REFERENCES

The following entries provide references used in Chapter 2.

Bentley Systems, Inc., 2022. *OpenBridge Designer Help.* [Online]
Available at: https://docs.bentley.com/LiveContent/web/OpenBridge%20Designer%20Help-v3/en/GUID-EAE9E80F-5D05-4E6F-9165-C8FFF4F4FABE.html
[Accessed 22 August 2022].

Bentley Systems, Inc., 2022. *OpenBridge Modeler Help.* [Online]
Available at: https://docs.bentley.com/LiveContent/web/OpenBridge%20Modeler%20Help-v16/en/GUID-16CA7978-0B20-4517-AD50-9F46CCB5F469.html
[Accessed 22 August 2022].

Bentley Systems, Inc., 2022. *OpenBridge Designer Connect Edition Product Data Sheet.* [Online]
Available at: https://cdn2.webdamdb.com/md_IFTZphEdmq50.jpg.pdf
[Accessed 20 January 2022].

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WORKFLOW METHODOLOGY

3.1 WORKSPACE ELEMENTS AND FEATURES

The OBM workspace has several specific components added to enhance and customize the software for PennDOT bridge modeling. All of these resources are included in the PennDOT Connect Edition Workspace download and are available when the PennDOT workspace is activated within the software. The following describes the workspace elements.

3.1.1 Bridge Templates and Material Library

Custom templates are provided for typical PennDOT bridge components and situations. These templates follow the PennDOT BD and BC Standard Drawings wherever possible. Below is a list of templates included in the workspace. The templates provided cover a wide range of typical PennDOT projects, although there will likely be project-specific situations that are outside of the capabilities of the provided template libraries. See Chapters 5, 6, and Appendix 9.1 for more details on typical variable information on how these can be modified to allow the templates to adapt to project-specific constraints.

The PennDOT-specific Bridge Templates and Material Library files are in the PennDOT Connect Edition Workspace under the …Organization-Civil / Bridge Design / OpenBridge Modeler / Bridge Templates folder. The barrier, deck, and beam templates are included in the *_PennDOT_templates.xml* file; the standard piers are included in the *_PennDOT_PierLib.xml* file; the cross frames are included in the *_PennDOT_CrossFrameLibrary.xml* file; and the materials are included in the *_PennDOT_MaterialLibrary.xml* file.

3.1.1.1 Barrier Templates

Barrier templates include 45", 42", 32" F-Shape Concrete Barriers, 32" and 50" median barrier, 50" split concrete median barrier (the 32" split concrete median barrier is the same as the 32” F-shape), concrete mountable divisor, and split concrete mountable divisor per BD-601M. Also, 32" and 42" vertical barriers are included per BD-618M. These barriers have variables and constraints included to accommodate light pole blisters, structure mounted sound barriers, and sidewalk placement per BD601M, BD-610M, BD-617M, and BD-618M. Raised sidewalks per BD 601M have also been added as barrier templates in a "Sidewalks" folder within the "_PennDOT" category.

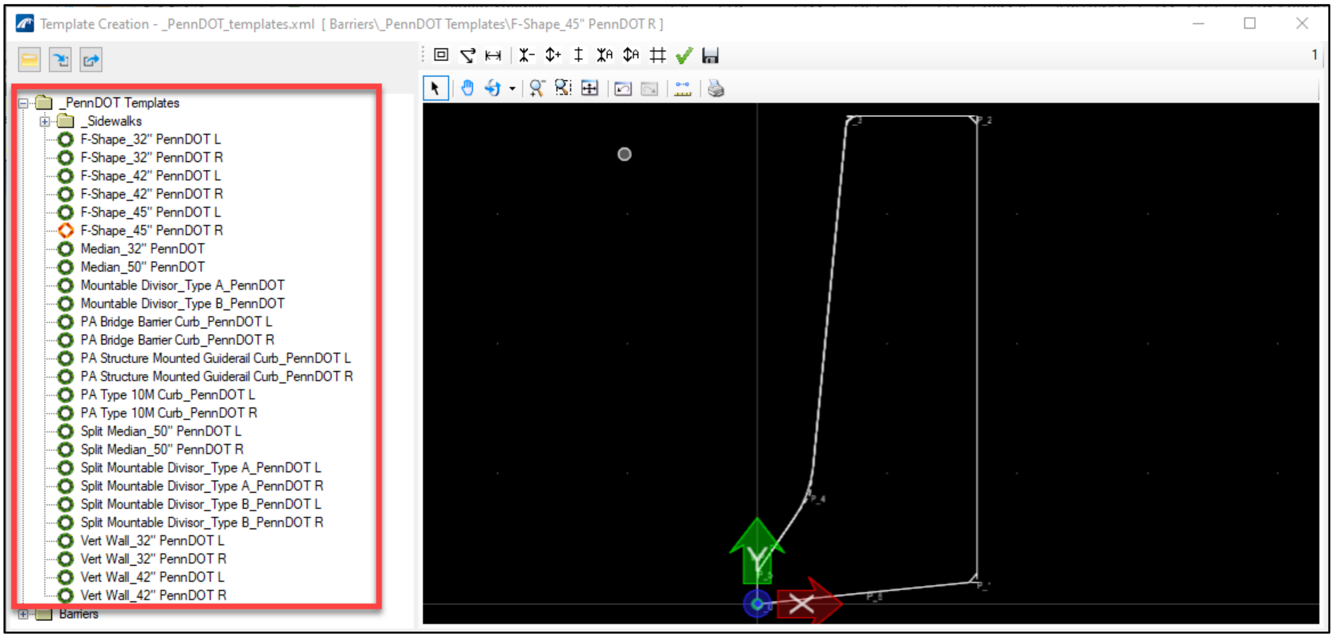

Figure 3.1-1 PennDOT Barrier Template Library

3.1.1.2 Deck and Approach Slab Templates

Deck templates include typical bridge deck cross sections per BD-601M with 2/4 lane with shoulders configurations, 2/4 lane with shoulders and sidewalks on both sides, and 2/4 lane with shoulders and sidewalks on right or left sides. These deck templates have variables and constraints included to accommodate varying lane and shoulder widths and configurations, normal crown and superelevated cross sections (and transitions), the PennDOT barrier templates added in the workspace, light pole blisters, and sidewalk placement per BD-601M, BD-610M, BD-617M, and BD-618M. Approach slab versions of these templates have also been added in an "Approach Slabs" folder within the "_PennDOT" category. Recent updates to the workflow include a separate tool for adding the approach slabs and sleeper slabs (sleeper slab templates included in the substructure template file).

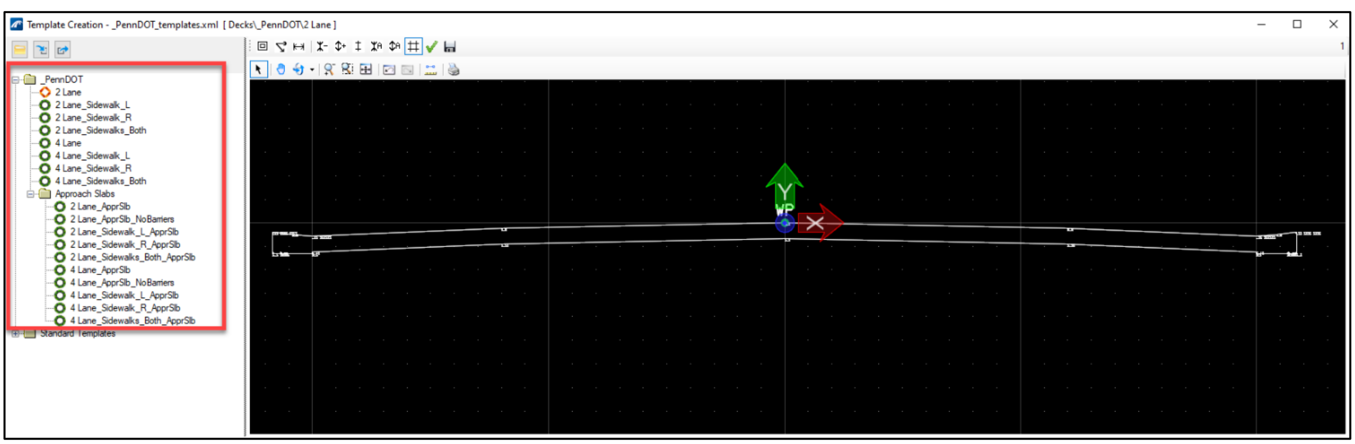

Figure 3.1-2 PennDOT Deck Template Library

3.1.1.3 Prestressed Beam Templates

Beam templates include sections per BD-652M, including Adjacent and Spread Box Beams (36" and 48" width), Plank Beams, PA I-Beams, AASHTO Type I-Beams, and PA Bulb-Tee Beams. There is a “PADOT” folder in the templates delivered in the out of the box workspace; however, these do not contain all the PennDOT sections, and those that are included, are missing some required details. Therefore, it is recommended to only use the templates listed under the "_PennDOT" folder.

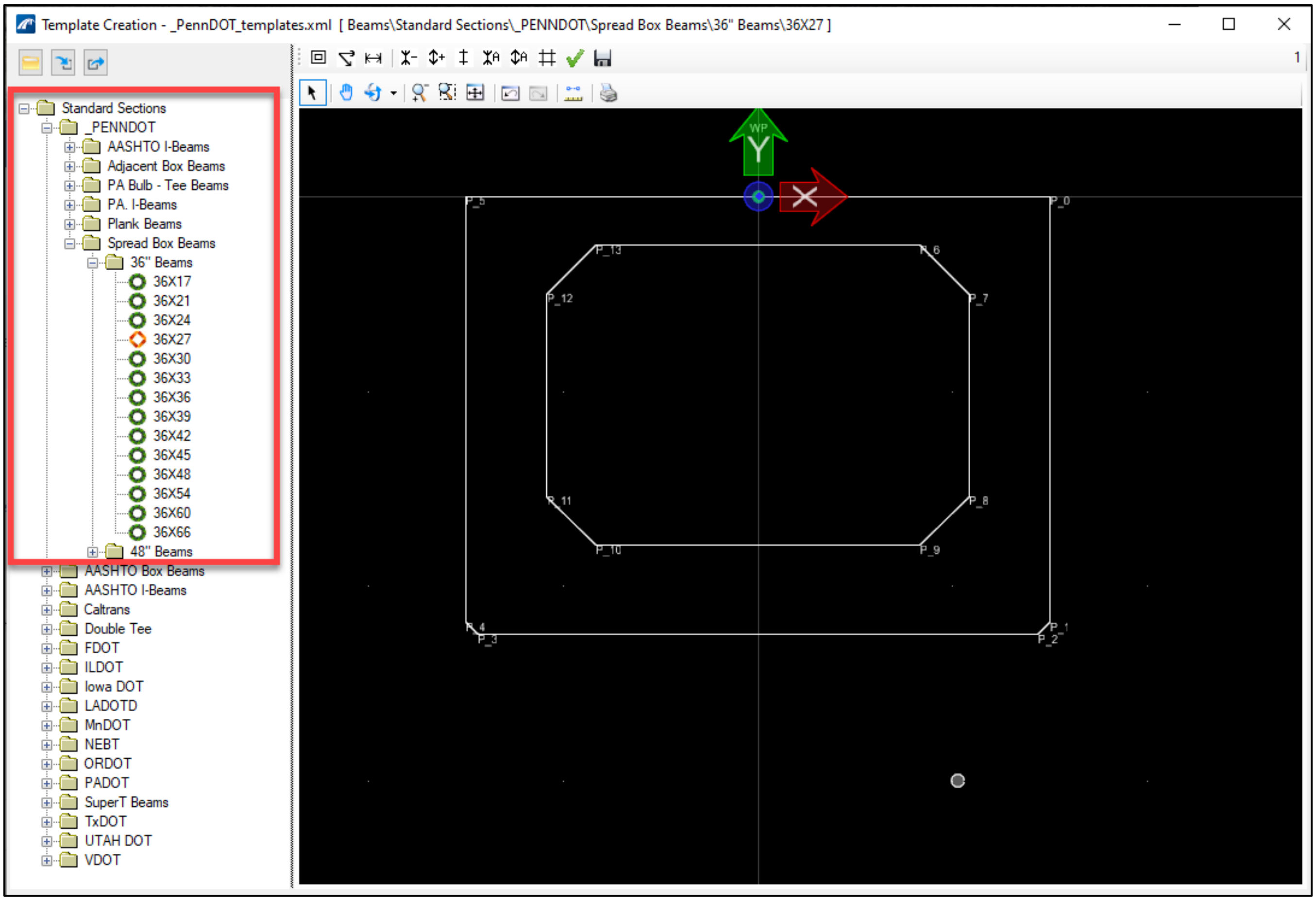

Figure 3.1-3 PennDOT Beam Template Library

3.1.1.4 Pier Templates

Pier templates include typical pier sections per BD-629M. The piers consist of hammerhead, multi-column, single column, and wall piers. These templates use H-piles as default but can be converted to drilled shafts or spread footings as needed.

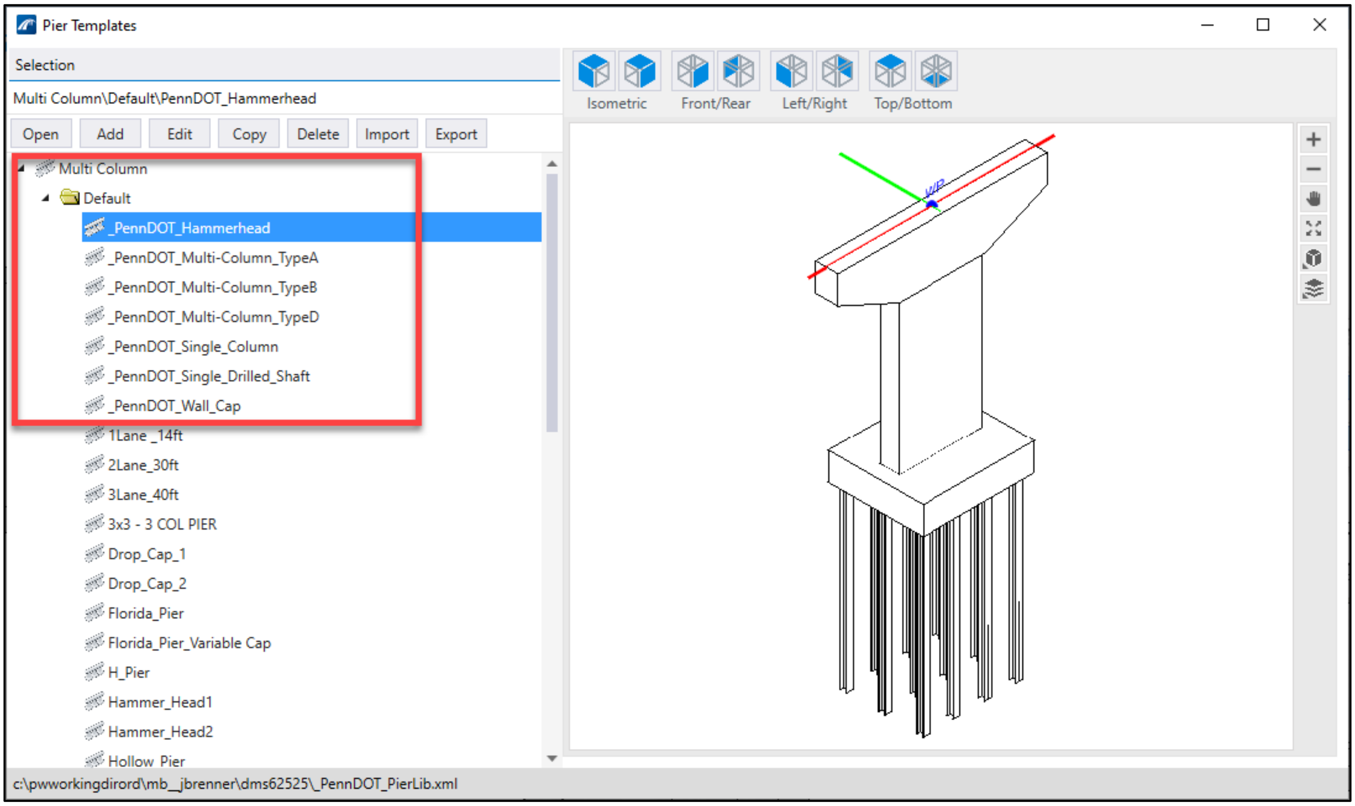

Figure 3.1-4 PennDOT Pier Template Library

3.1.1.5 Abutment and Wingwall Templates

Abutment templates include an integral abutment section per BD-667M. The “backwall” component is being used for the end diaphragm. See Section 6.16.1 for modifications of this template for final design details.

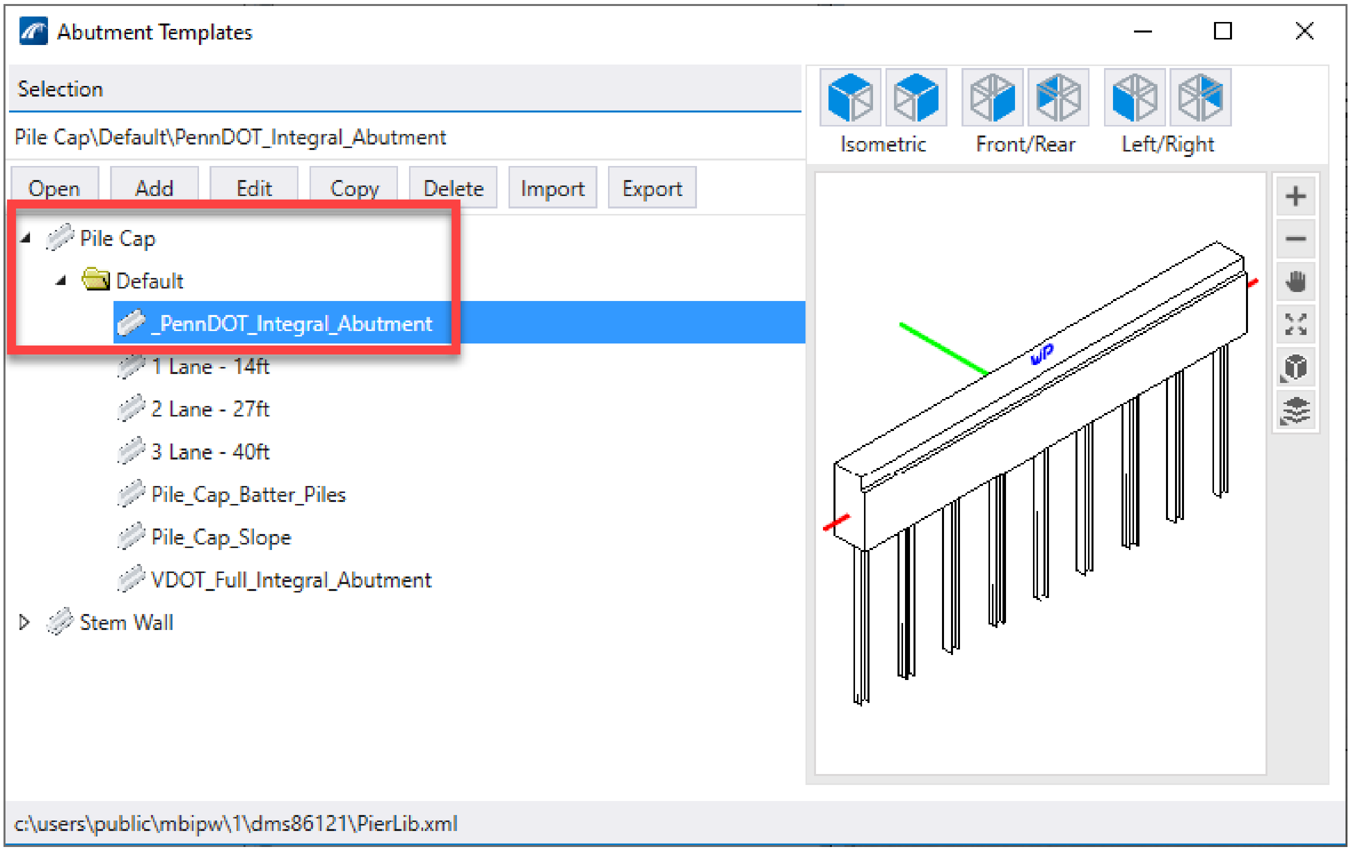

Figure 3.1-5 PennDOT Abutment Template Library

Wingwall templates for integral abutments are provided per BD-667M. The template options include rectangular, tapered, and detached wingwalls.

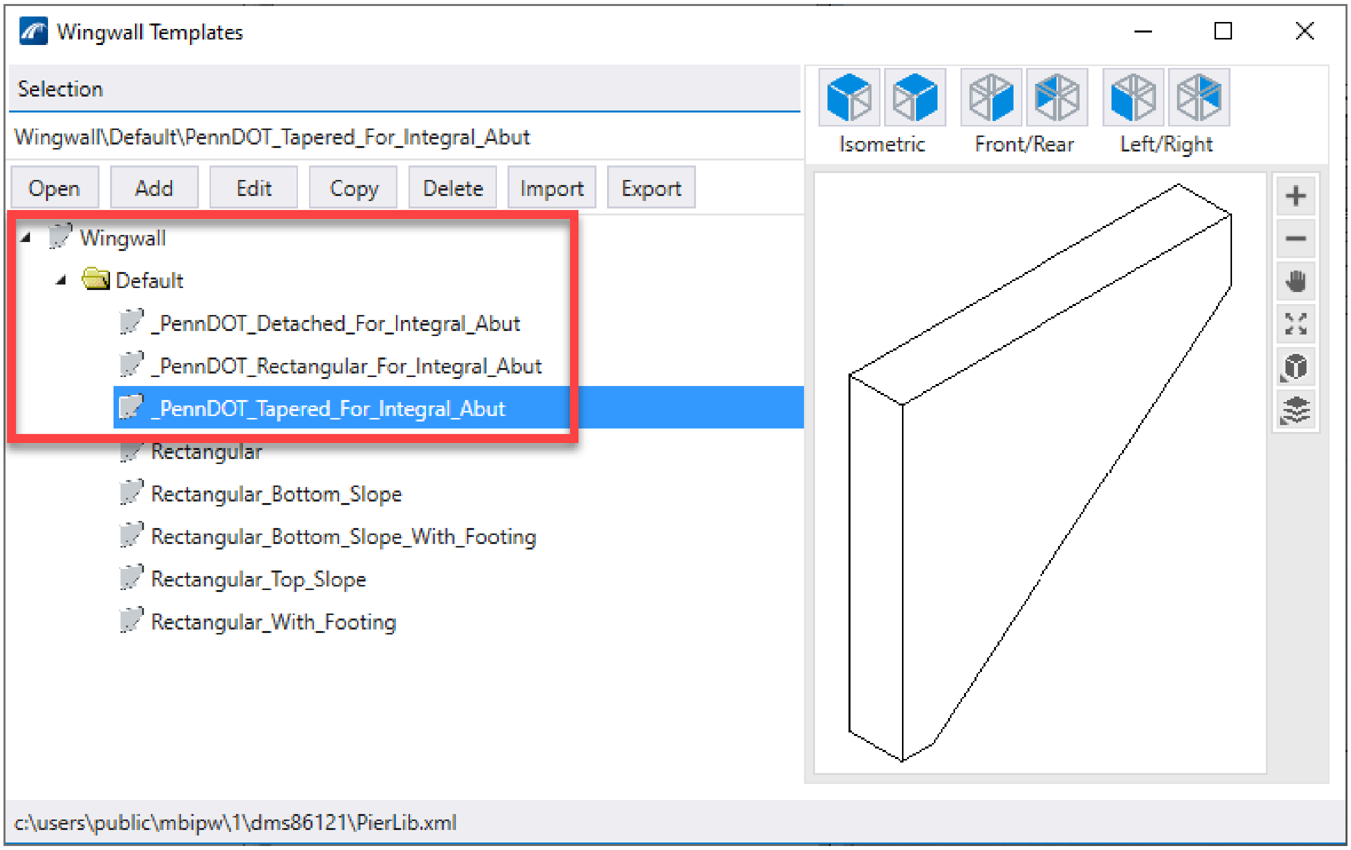

Figure 3.1-6 PennDOT Wingwall Template Library (Integral Abutments)

[This section is under development. Content will be completed after BD-621M abutment workflow is finalized through development and Digital Delivery Directive 2025 Pilot Project feedback.]

3.1.1.6 Cross Frame Templates

Cross frame templates include typical cross frame configurations per BD-619M. The specific types consist of Type X, Type K, Type K Inverted, and Solid Plate Diaphragms. The connection plates associated with these cross frames will likely need to be modified for project-specific conditions, so these templates can be used as the starting point (correct member size/orientation, plate shape, etc.).

[Templates for the Steel Mid-Span Diaphragms for Prestress Concrete I-beam and Bulb-Tee beams are under development. Content will be completed after software update requests are provided.]

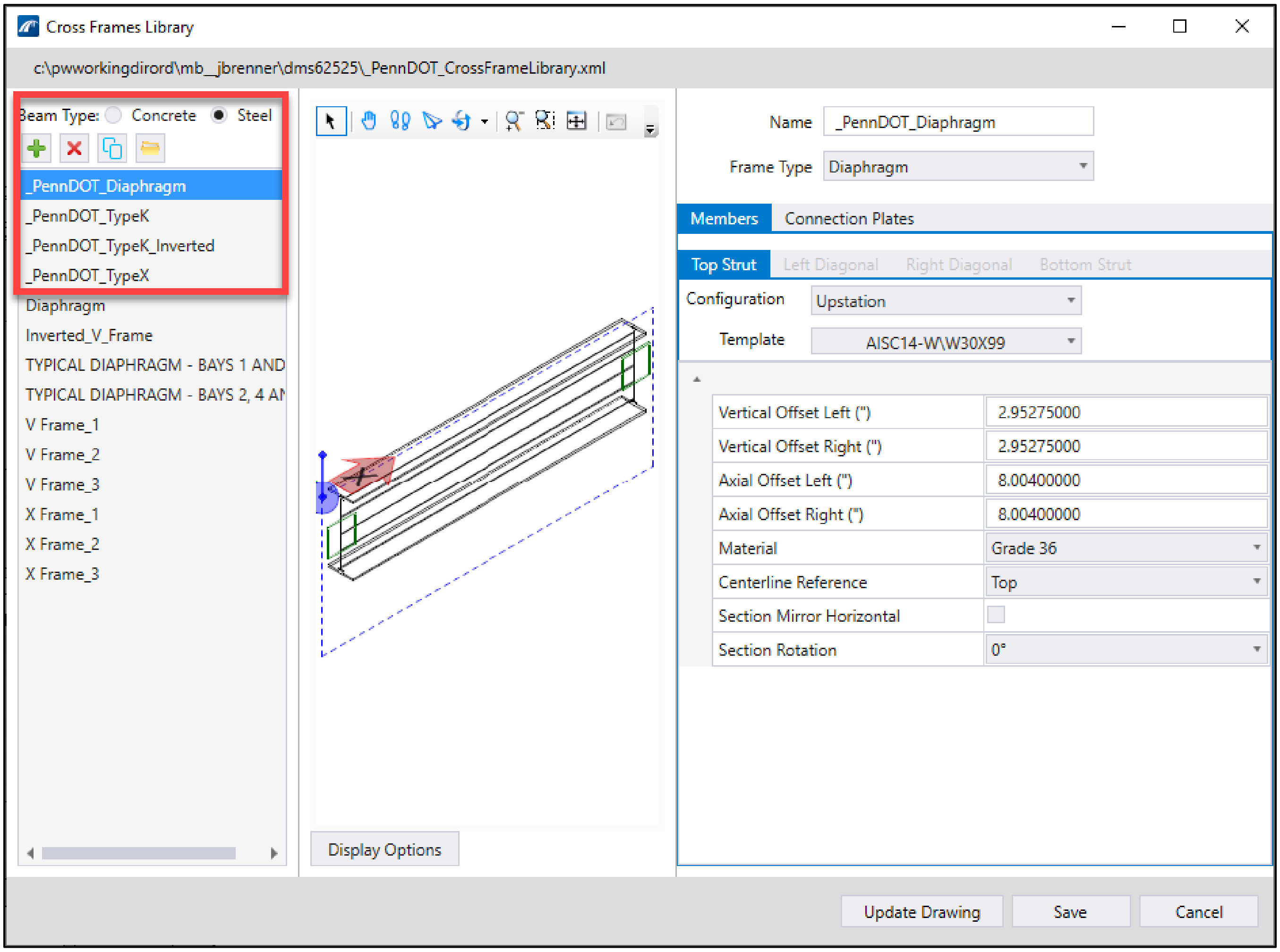

Figure 3.1-7 PennDOT Cross Frames Library

3.1.1.7 Material Library

PennDOT Bridge materials for typical Concrete and Steel designations have been provided in the OBM Materials database. The use of these materials is currently limited in the software and, because of this, is not used significantly in the workflow. This is due to the lack of reporting capabilities of the materials when bridge elements are modified (see Section 3.3). The included materials will be investigated further for value as updates in the software are available. Additional materials and supplemental data, such as unit cost information, may be added in the future.

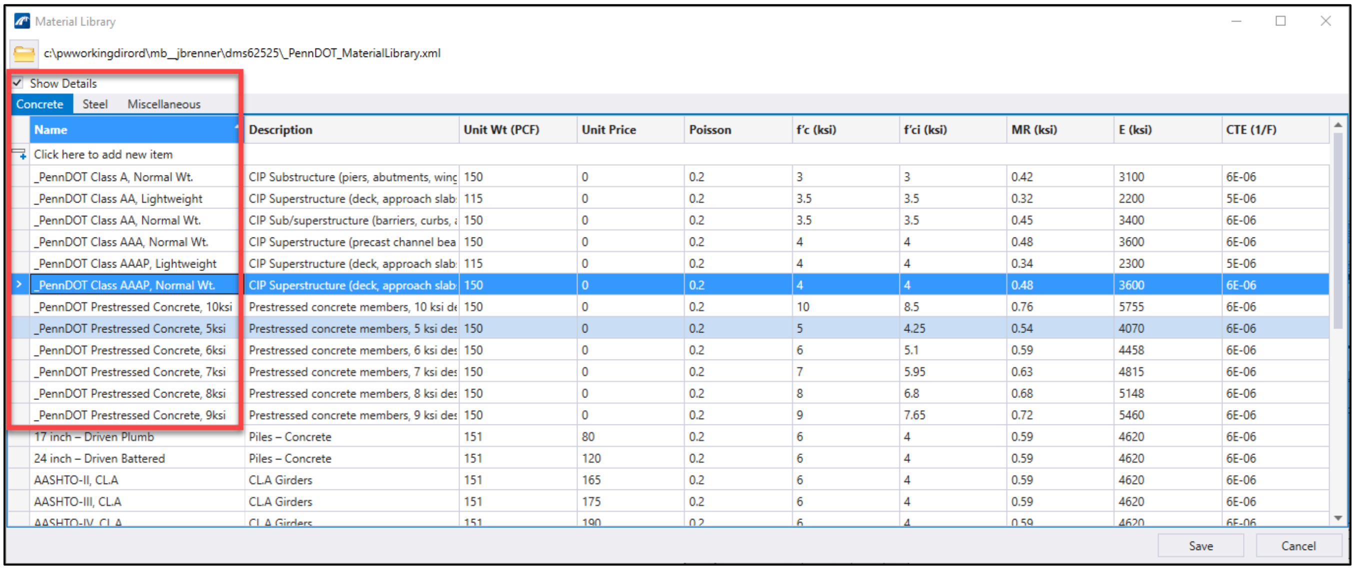

Figure 3.1-8 Material Library

3.1.1.1 Bridge 3D Cells

[This section is under development and will provide barrier transitions and other bridge-specific 3D cells. Content will be completed after testing feedback for the Digital Delivery Directive Pilot Projects is incorporated.]

3.1.1.2 Bridge Feature Definitions

OBM is structured similarly to ORD in that the content created is categorized by Features. This is an extension of the "levels" in MicroStation used in traditional CADD drawings. Features are used to define content in the OBM files and organize information in an intelligent structure.

Defining Features requires the integration of three separate categories: Element Templates, Feature Symbologies, and Feature Definitions. These three elements are controlled by a hierarchy, meaning that Feature Definitions are created from Feature Symbologies, and Feature Symbologies are created from Element Templates. Below are brief descriptions of each in terms of how they are used in the OBM workspace.

Element Templates define the properties of certain elements and are controlled at the "Level" classification. Many categories can be controlled, including Material appearances, Text Styles, and Item Types.

Feature Symbologies provide settings to define model content types, such as lines and solids and applies the Element Templates for specific bridge sub-components, such as pier caps, columns, footings, and piles.

Feature Definitions are broken down into the bridge components (deck, pier, etc.) and define the specific Feature Symbologies of the feature sub-components.

Note: Element Templates are flexible, and the user can name/categorize them as desired. However, the Feature Symbology and Feature Definition categories are predetermined within OBM and cannot be removed, edited, or added.

PennDOT-specific Element Templates, Feature Symbologies, and Feature Definitions have been added for typical proposed bridge elements in the *PennDOT_Bridge_Features.dgnlib* file which is located in the PennDOT Connect Edition Workspace under the …Organization-Civil / Bridge Design / OpenBridge Modeler / Dgnlib / Feature Definitions folder. Take note that these Feature Definitions developed for PennDOT all start with "_PennDOT_..." to differentiate from the Bentley-delivered features. Currently, these Feature Definitions control the OBM element levels and appearance settings (visually shown as concrete, steel, patterns, etc.) and do not include separate features for existing or temporary conditions/elements. In the future, additional Feature Definitions will be added to the workspace, and Item Types for attributes, such as Pay Items, will be added to the Feature Definitions and attached to the elements.

Tips and Tricks: *The Feature Definitions for the substructure (abutments and piers) and the beams/girders include a "wrap" level. This level encompasses all of the element components and does not allow for selection of individual sub-components, such as piles, footings, columns and caps for piers, and beam flanges/webs and haunches for steel girders. This allows for modifications to the overall templates; however, it can be turned off for selection of those sub-components for individual properties and attributes.*

3.1.1.3 Customizing Feature Definitions

Users should apply the Feature Definitions provided in the PennDOT Connect Edition Workspace whenever possible. However, there will likely be instances in which the provided Feature Definitions do not cover project-specific needs. In these cases, users can create their own Feature Definition Libraries. These libraries are created in a separate DGNLIB file containing customized Element Templates, Feature Symbologies, and Feature Definition structure. New libraries can be placed in the appropriate directory for the software to recognize automatically. Also, new and existing level libraries can be attached, detached, imported, and exported using the Level Manager dialog.

3.1.2 Bridge Seed Files

Specific bridge seed files are available for use in OBM. Seed files are used by Bentley products as the starting point for settings within DGN files that can then be used for project files. The seeds control the file's coordinate system, working units, etc. to be consistent with the overall PennDOT Digital Delivery standards. For OBM, the seed files are 3D DGN's, which is different from the ORD workflow using 2D files.

The bridge seed files included with the PennDOT workspace contain separate files for the north and south regions of the Pennsylvania State Planes Coordinate System:

- North (PA-83-NF): PennDOT_Bridge_NAD83_N_SF.dgn
- South (PA-83-SF): PennDOT_Bridge_NAD83_S_SF.dgn

The seed files are located in the **Organization-Civil / Bridge Design / OpenBridge Modeler / Seed** folder. More details on how to navigate to and use these seed files are provided in Section 4.2, as well as more information on how to modify the file settings in Section 4.4.

3.2 ORGANIZATION AND SEPARATION OF FILES

One aspect of the workflow that is important to consider when starting a project is how to organize and potentially divide the model into sections. Only one user can be actively working in a single DGN file at a time. Therefore, it is not recommended to have multiple bridges in the same OBM file. Furthermore, it may be prudent to split large/long bridges into multiple files so several users can work in OBM on the same structure.

Also, any drawing views or sections that are developed from the bridge model should be created in a separate file. This allows for one user to work in the OBM file and another to work in the file on annotation or further detailing, which could be completed in the MicroStation Connect software without using OBM since it is only referencing the bridge model. Similarly, separate files should be created for modeling reinforcement and references utilized to access and view the OBM bridge models. With this approach, multiple users can access and work with individual files to allow for advancement of the bridge model and project. Early in design, this will likely not be critical, but as the design progresses, it is important to keep these considerations in mind as the file structure is developed.

Workaround: After the information is exported to LBC or LBS, users can work in these .obdx files separately. However, if the users are utilizing the full OpenBridge Designer workflow, separate OBD files should be created for use in the analysis software to facilitate multiple users' ability to access the files at the same time. This is due to the limitation that OBD files are restricted to one user access at a time. This may change in the future, but currently a separate OBD file will be needed for concurrent work in OBM and LBC or LBS.

3.3 BASE AND REFINED VERSIONS OF MODEL ELEMENTS

It is important to realize that to develop a PennDOT final design level model for digital delivery, there will be manual efforts needed. The OBM tools for bridge elements will not be sufficient for the users to simply type parameters into the software and generate a bridge model that follows all the PennDOT standard details and requirements. However, it is beneficial for the user to leverage the OBM tools and templates whenever possible.

Using the OBM tools for as much and as long as possible is advantageous for several reasons. First, these tools allow for parametric updates when elements are updated or changed as a result of a design or other modification. For example, if the bearing pad height is changed due to design requirements, the top of the abutment/bearing seat area will automatically adjust accordingly to this change in the model. Second, there is an inherent advantage to automating and enhancing aspects of this process so users can take advantage of software logic tied to specific bridge components. The software can add attributes to specific bridge components, which supplement key pieces of information, both geometric and non-geometric, to be easily and consistently viewed and mined. For example, a bridge abutment stem can be attributed to the NBI number, concrete material specifications, fixity condition, overall length, skew, and more. Though these capabilities are limited in the current version of the software, these tools are updated frequently with new releases of the software, creating increased exposure of this information and opportunities to benefit from the attributes. This manual refers to the model elements which maintain their OBM-developed status and properties as "Base" elements.

Currently, there are some situations which require elements created by the OBM bridge tools to be modified in a manner that loses their recognition as a bridge element within OBM. These elements then become Smart Solids in the model and will retain level information and general properties, but any OBM specific properties tied to the element will be lost. Additionally, the element will no longer be able to be updated by the OBM tools. When a change is required after an element has lost its OBM bridge element status, the user must decide whether it is more effective to modify further with the Solids Modeling tools, or to delete the element and re-start the modeling process. This will depend on the size and impact of the required change. This manual refers to the model elements which have been modified and have lost their OBM-developed status and properties as "Refined" elements. The next page provides a diagram of the workflow for creating a bridge model that illustrates this concept and shows outputs that are extracted from the model.

Note: In addition, there are situations in which elements must be developed completely outside of the OBM bridge tools (culverts, retaining walls, etc.). These elements will be Smart Solids or Parametric Solids within the program and follow the Refined model element status for the purposes of this manual.

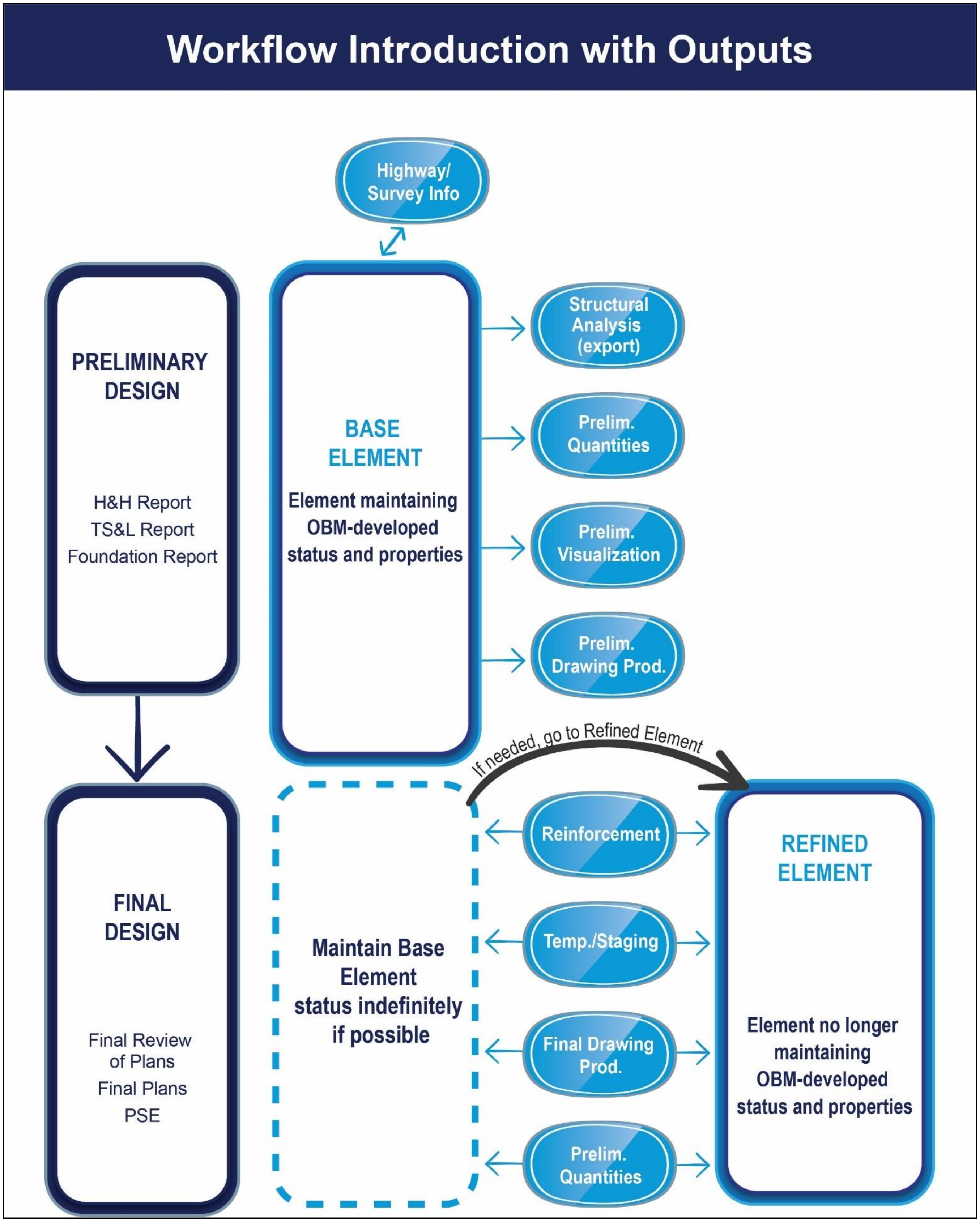

Figure 3.3-1 Base and Refined Model with Outputs

Though this can be frustrating at times and there certainly needs to be further development with the tools, it is also advantageous to have the designers, both engineers and technicians, directly interacting with the model. This workflow requires users to inspect and modify elements and to ensure the design intent is met. Working in 3D provides an advantage to facilitate enhanced processes, allowing better decision making earlier on in a design, especially using this workflow early in preliminary design.

The following sections and Chapters 5 and 6 outline how the OBM tools for bridge elements can be used to their fullest extent and the types of situations that may require a more manual approach to reach the desired Element Detail Designation and Element Information Designation.

3.3.1 Base Model Element Description

As noted above, it is advantageous for elements to remain in the Base status for as long as possible throughout the design process, and the workspace provided aims to take full advantage of the current software capabilities. The tools are limited but, in certain situations, can be leveraged to produce model elements that can remain intact as Base elements through the design process.

An example of this is the deck templates. The templates provided can essentially handle most variations and project situations in the cross section by adjusting the variable inputs for constant and varying dimensions and cross slopes along the length of the deck.

Below is an example model showing Base model elements for a typical PennDOT prestressed beam bridge. The indicators in the image and the descriptions below highlight some of the limitations with the Base elements.

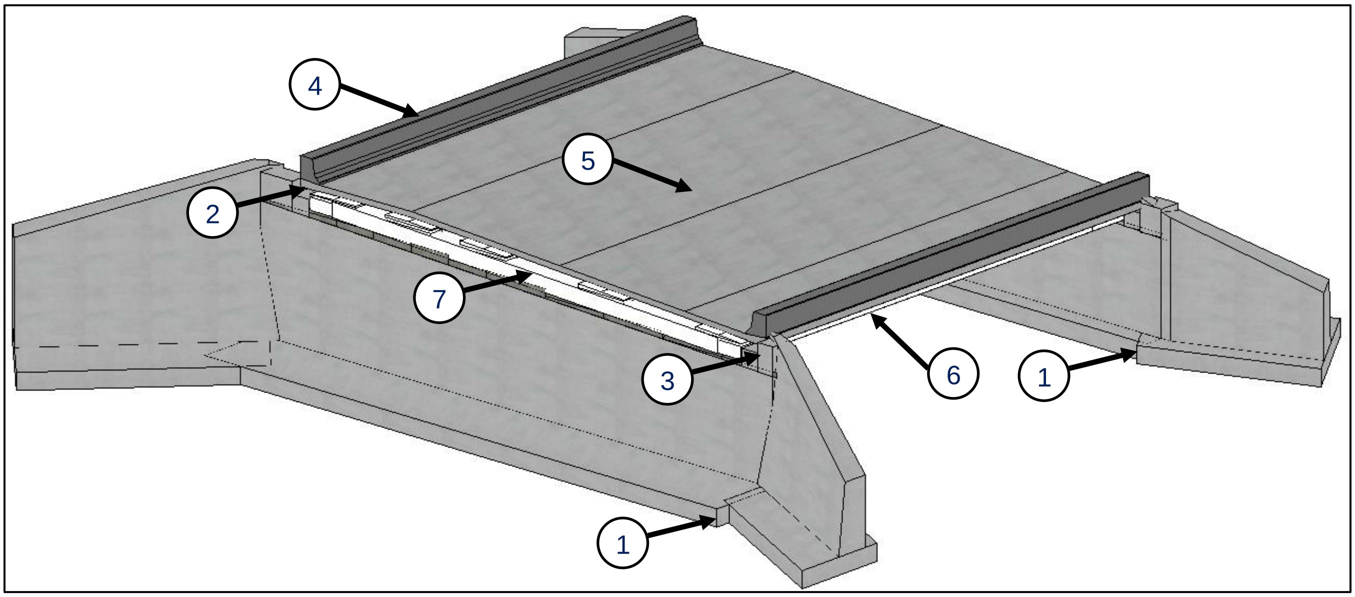

Figure 3.3-2 Example Base Model

1. Footings not combined. Bottom of footing at the correct elevation
2. Deck ends not squared off
3. Safety wings missing and corner blocks do not meet PennDOT standards
4. Barrier deflection joints missing
5. Correct deck elevations and cross slopes
6. Correct beam sizes modeled
7. Basic diaphragm modeled, does not meet PennDOT standards.

3.3.2 Refined Model Element Description

A model component should only be made a Refined element when the Level of Detail or Level of Information needed for the general design process, or a specific submission exceeds that which can be provided as a Base element. This tipping point is different for every component and every project. The user must follow this manual, the PennDOT Digital Delivery standards documents, and leverage personal experience and judgement to determine if this should occur for each element in the model.

Using the deck example from above, the OBM tools cannot currently “square-off” the end of the deck for significantly skewed structures. Therefore, to show this Level of Detail, the deck must be modified with Solids Editing tools, which will create a Refined deck model element.

Below is the same example: a typical PennDOT prestressed beam bridge from the above section with all of the bridge components updated as Refined model elements. The indicators in the image and the descriptions below highlight some of the enhancements made to create the Refined elements.

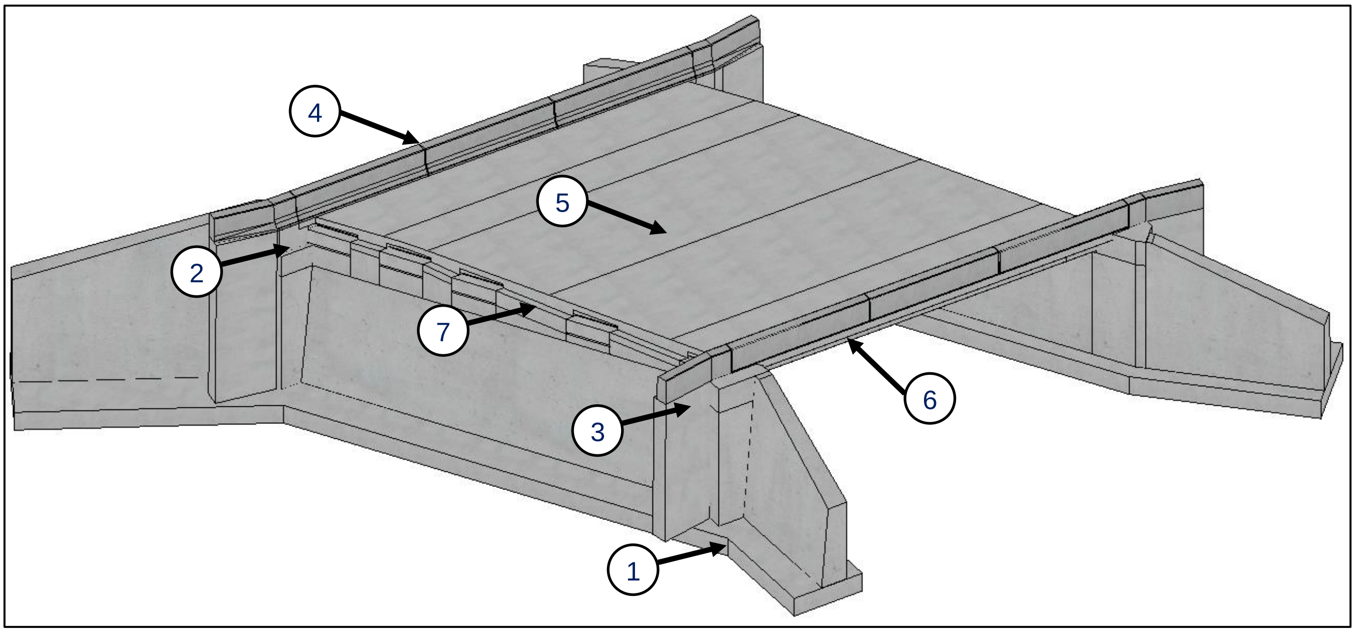

Figure 3.3-3 Example Refined Model

1. Footings combined. Bottom of footing at correct elevation
2. Deck ends squared off
3. Safety wings missing and corner blocks meet PennDOT standards
4. Barrier deflection joints added
5. Correct deck elevations and cross slopes
6. Correct beam sizes modeled, and beam notches added
7. Diaphragm modified for approach slab and dimensions modified to meet PennDOT standards

3.4 WORKFLOW TO UPDATE BASE MODEL ELEMENTS TO REFINED MODEL ELEMENTS

When the Base model elements are developed to the fullest extent possible using only OBM templates and methods, the user can begin creating separate models in the same file or a different .dgn file for the bridge elements. This is completed before any elements are transitioned to Refined bridge elements. The specific model/file breakdown of elements can vary based on the specific project elements and size, but typically it is recommended to add a model for each major bridge element (deck, beams, abutments, piers, etc.). Adjacent or related elements can be combined such as including both the deck and barriers in one model or the entire superstructure if a smaller bridge. A detailed description and example of the process is provided in the sections below.

Tips and Tricks: As the project/bridge grows in size and complexity, the more helpful it can be to create the separate bridge element models in another .dgn file. When this approach is utilized, multiple users can work on different tasks within the project simultaneously.

There are several reasons for using this approach. First, it preserves and essentially archives the Base model elements as OBM-recognized components that can still be modified with the OBM tools. This is especially helpful if major changes occur in the design after Refined model elements are created. Also, this eliminates the potential for extraneous copies of model elements during the transition to Refined elements. This is a common problem if model elements are modified with Solids Modeling tools directly without creating separate models/files. Another important reason is that reinforcement can be defined and applied in the individual element models, which helps keep the model size down for smooth functioning, and it maintains an organized file with all the components contained within. This approach also offers advantages on drawing view development. For example, it allows the ability to contain only pertinent drawing composition elements, such as section, detail, and other view callouts within each model. This prevents confusion later on during detailing stages when there would normally be an extensive number of these section callouts across the entire bridge model. It also allows more flexibility in turning on/off specific components in Saved Views.

Note: More general views or sections that utilize multiple bridge components (i.e., general plan and elevation, etc.) can be added in the Default model. Alternatively, other models can be referenced within the component models to include several bridge elements in a section or view (i.e., referencing the deck model into the integral abutment model for the end diaphragm sections.

The separate models of bridge elements are then be referenced together into a federated model or “container.” Again, this can be created as a separate model in a single .dgn file, or it can be a separate .dgn file. This container provides convenient viewing of all the components together for visual inspection and for coordination with other disciplines.

[This section, 3.4, is under development. Content will be completed after workflow is finalized through development and Digital Delivery Directive 2025 Pilot Project feedback.]

3.4.1 Workflow Steps

The first step in this process is to create a separate 3D design model for each bridge element in the model (Abutment 1, Deck, Framing, Pier 1, Wing A, etc.). The user will need to reference the Default 3D design model into the new element 3D design model and merge the reference into the new design model. The user can decide to adjust the level display before merging in order to merge only the desired components, or the user can delete the unwanted solids after merging the entire model. After merging the reference into the component design model, the user will notice the OBM components have become Parametric Solids and will have lost their OBM status and specific Item Type parameters assigned when creating the component in OBM. These solids are what we will be modifying to create the refined components, applying custom Item Types, and referencing back into a Container file which will “contain” all of the referenced elements needed for the complete bridge model. Refer to Section 10.3 for Solids Modeling Tools and Techniques.

Note: If any of the elements do not need additional adjustments (i.e., the elements can remain in Base element status), the same process should be followed. The only difference from the Refined model elements is that there is no need for the additional steps of Solids Modeling.

At this stage, the user must ensure that all attributes (attached as Item Types) for each component are applied and accurate within the component models. Item Types can be applied at the element template level (as they are with most components), or they can be applied individually with the **Apply Item Type** tool.

After the Item Types have been properly defined and confirmed, they can be referenced into a new container design model and maintained in the model as individual references. The user must understand that the Base model components should always be retained in the user’s version of the OBM model or in a separate archived file in case critical parameters and/or base components need adjusting in the project's later stages. However, the new container file will hold the final version of all bridge elements to avoid any potential confusion between base and refined components. See the Digital Delivery standard documents for more information on 3D deliverables.

3.4.2 Workflow Example – Integral Abutment

The above workflow procedure will be discussed in detail in the integral abutment example below.

3.4.2.1 Create a New 3D Model for Integral Abutment

With the base OBM solids placed in the Default model in the correct position, first select the **Home > Primary > Models** dialog or flyout and select  **Create a New Model**. When prompted with the **New Model** dialog, select **Design From Seed** and ensure the project 3D seed file is indicated. Next, input the name of the component model and any other settings the user wishes to include and click OK.

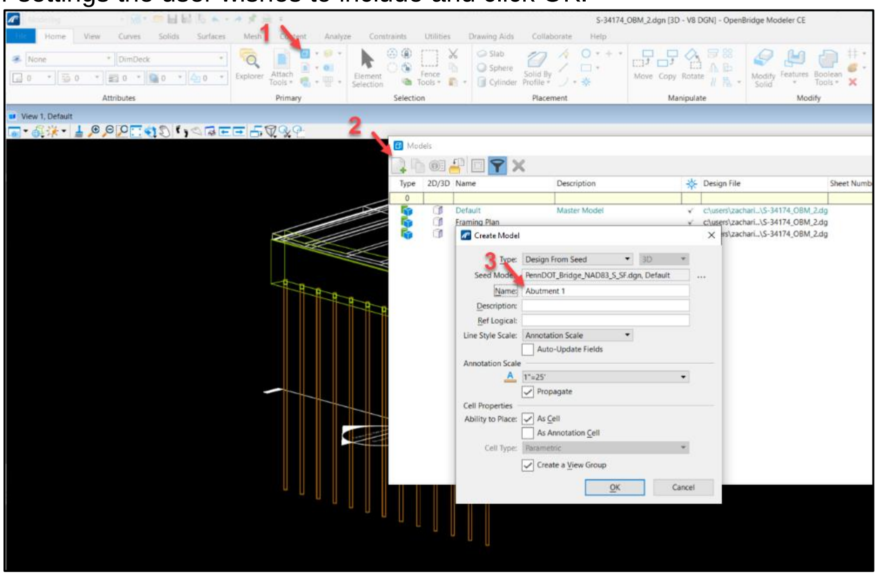

Figure 3.4-1 Create New Model dialog

3.4.2.2 Reference Default Model into Component Model

After navigating to the new component model, the user can open the **Home > Primary > Reference Manager** and attach the Default 3D model in the active file. To keep the component global coordinates aligned in true-space, set the attachment orientation to Coincident - World. Do not Live Nest any attachments, as the only components we want to bring in are those OBM elements placed in the Default model. To avoid merging in more components than the user needs in this element model, all levels except those associated with the desired components can be shut off in the Default model.

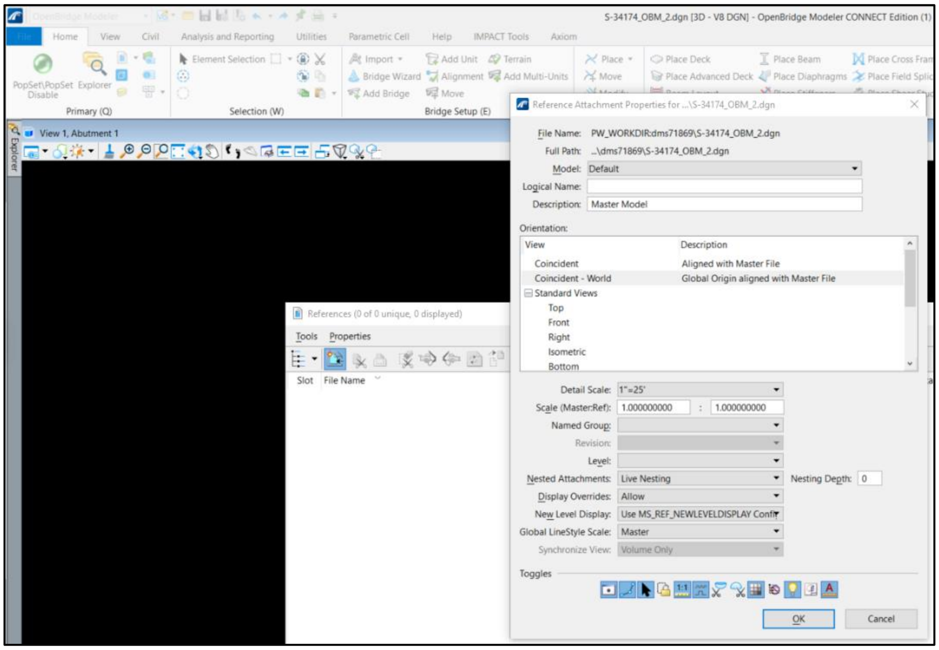

Figure 3.4-2 Attach Default model Coincident – World

3.4.2.3 Merge Default Model reference into Element Model

In the **Home > Primary > Reference Manager**, right-click the Default model reference and select **Merge into Master**. The components displayed in the reference will be merged into the active element model as parametric solids to be modified.

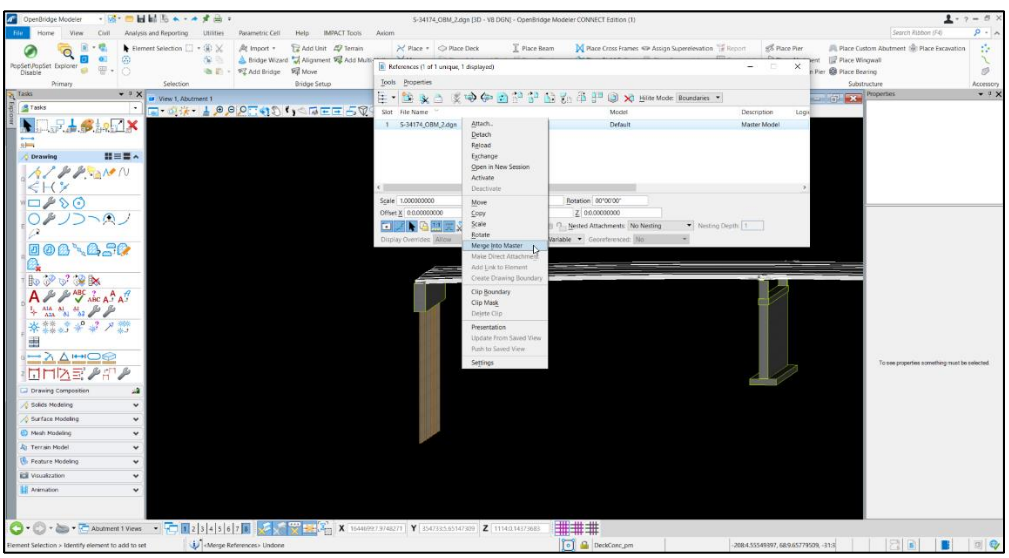

Figure 3.4-3 Merge Default Model into Component Model

3.4.2.4 Delete Unrelated Solids and Refine Elements

There may be some components merged into element models that are not associated and need to be removed. Simply select these components and delete them. There may also be some components that need to be modeled, such as the wingwalls, or component refinements can be made to increase the level of detail. These refinements are project-specific, but in this example, refinements such as adding concrete chamfers to the abutment-wing intersection and the abutment-deck intersection were modeled.

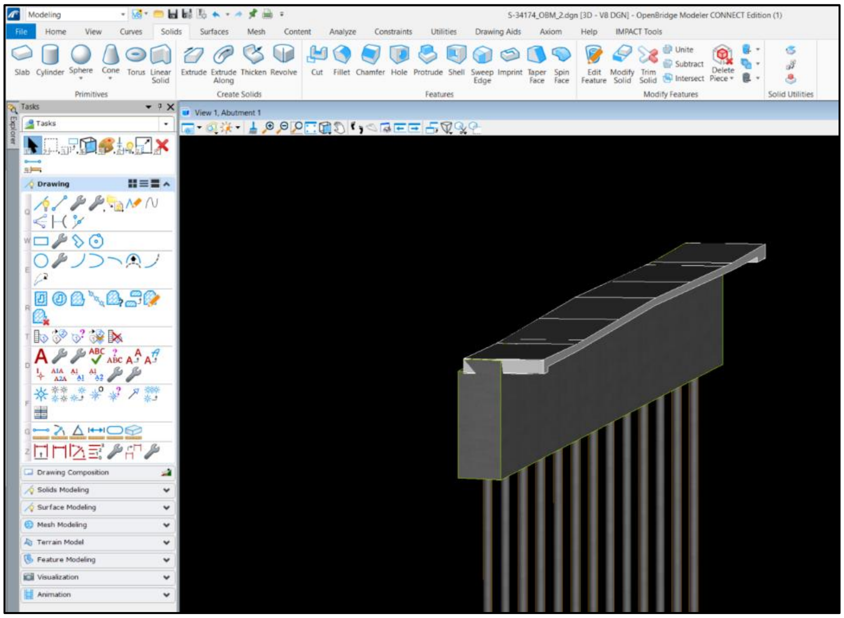

Figure 3.4-4 Merged Solids Stripped Down to Associated Components Before Refinement

3.4.2.5 Assigning Item Types

In order for these Parametric Solids to be identified with the correct bridge element properties, each requires an Item Type attached to it to define it and attribute information that is to be associated with it. As the top half of the abutment includes the concrete end diaphragms, wingwalls, barriers, and closure pour, all Item Types for these components need to be selected. The bottom half of the abutment includes the bearing seats, pile cap and piles and needs the appropriate Item Types associated with it. Simply check the properties you want associated with the components and select the component.

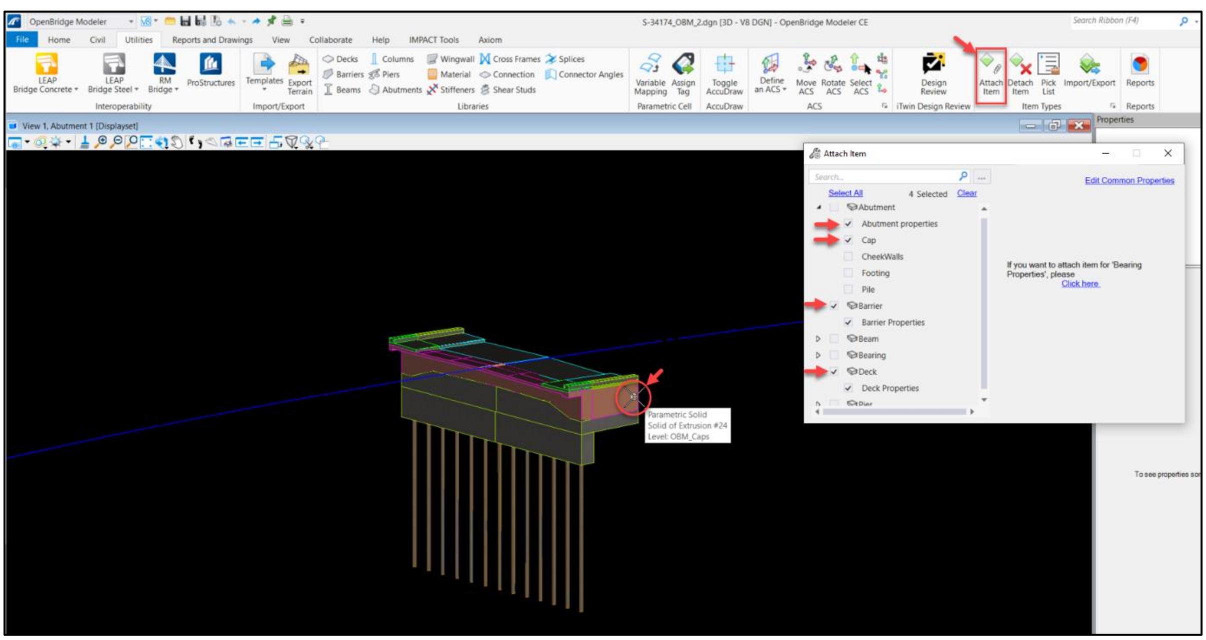

Figure 3.4-5 Attaching Item Types to the Top of the Abutment

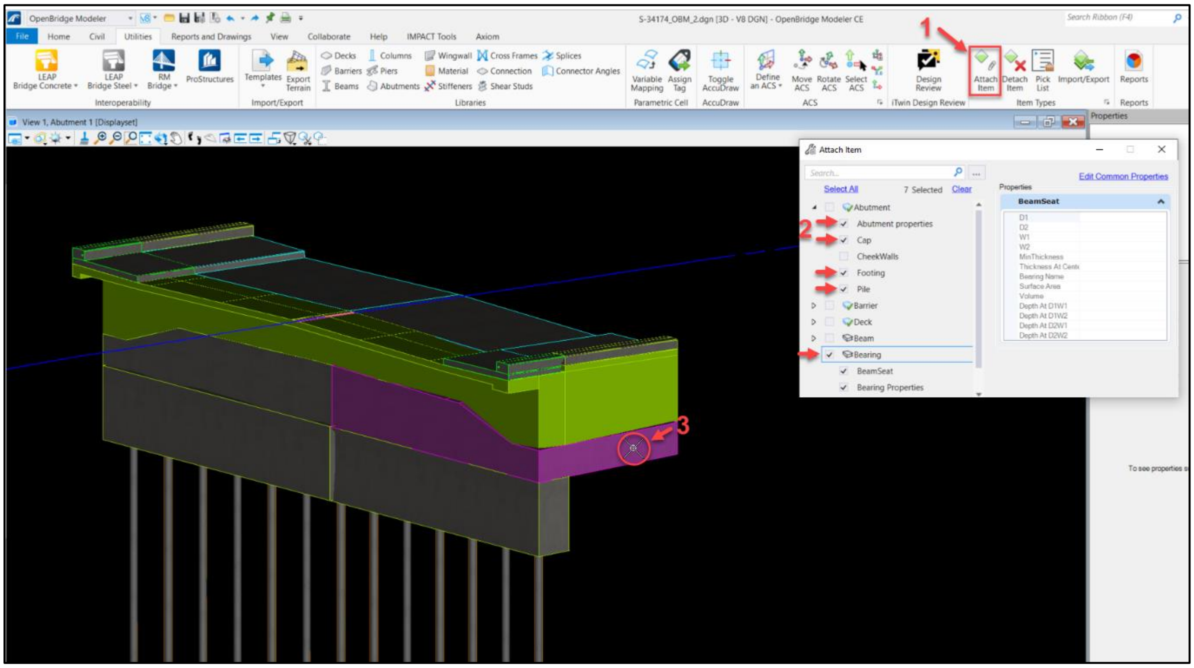

Figure 3.4-6 Attaching Item Types to the Bottom of the Abutment

Item Types for Pay Items are also added through the same process. This is why it is important to develop the models with separation at construction joints in situations such as this integral abutment example.

See Section 5.255.25 & 6.25 for more information on adding Item Types as attributes.

[This section and the specific Item Type list is under development. Content will be completed after the workflow is finalized through development and Digital Delivery Directive 2025 Pilot Project feedback.]

3.5 PROGRESSION OF MODEL THROUGH BRIDGE SUBMISSIONS

The Level of Development of the physical bridge model will coincide with the required project submissions. The Level of Detail and Level of Information minimum requirements are provided in the PennDOT Digital Delivery Interim Guidelines. This manual provides the context and instructions to create bridge models to meet those standards. Below is a summary and overview of the general workflow and progression of the bridge model through the design process.

In accordance with PennDOT Design Manual 4, Part A, Chapter 1.9, the anticipated sequence of bridge-related submissions is the following:

- Hydraulics and Hydrologic Report (H&H Report) – DM-4 PP 1.1.1
- Type, Size, and Location Report (TS&L Report) – DM-4 PP 1.1.2
- Foundation Submission – DM-4 PP 1.1.3
- Final Review of Plans – DM-4 PP 1.1.4
- Final Plans – DM-4 PP 1.1.5
- Plans, Specifications, and Estimate – DM-4 PP 1.1.6
- Additional Project Submissions – DM-4 PP 1.1.7

Developing the Level of Detail and Level of Information associated with the model in conjunction with each subsequent bridge-related submission is a logical approach as each submission is deeper into the overall project design schedule. As more pertinent details related to the structure are determined, they become relevant additions to the model.

Beginning with the Hydraulics and Hydrologic Report submission and the Type, Size and Location Report submission, maintaining the parametric nature of model elements as much as possible is recommended throughout the physical model development as updates and changes are to be expected through the design process. Therefore, elements should maintain their Base status regardless of the limitations and lack of detail/information that can be provided.

Certain geometric and design parameters may require manual editing and manipulation of elements causing them to lose parametric properties. This approach should be avoided throughout model development when possible. As the structural design progresses and more detail is added to the physical model, it may be necessary to make these edits, and for model elements to move to a Refined status in later submissions, including the Final Structure Submissions. The goal is to reduce and eliminate the need for this approach as the software progresses and is updated, allowing more elements and customization to be modeled within the OBM tools.

3.5.1 Hydraulics and Hydrologic Report (H&H Report)

The H&H Report details the hydraulic performance of the proposed structure. The analysis is conducted in other software outside of the OpenBridge Modeler software, but the proposed structure layout, span lengths, and vertical clearances are needed for the analysis. Though most information is approximate at this stage in design, it is important to provide key pieces of information such as the hydraulic opening, both in terms of substructure locations and low-chord elevations for the hydraulic analysis. The initial creation of the Base Model will need to occur, and the following model elements are required:

- Bridge
- SupportLine Locations
- Deck
- Beam Layout
- Beams
- Abutments
- Piers (as necessary)
- All necessary custom attributes for modeled bridge elements required for the hydraulic analysis per PennDOT Digital Delivery Standards
- Any additional and supplemental model elements required in order to address DM-4 Part A: Policies and Procedures, Section 1.9.2

At this stage in the model development, it is advised that all the elements added to the model are created with the custom PennDOT templates delivered with the workspace without specific modifications, which may affect the parametric functionality for future model updates (keep “Base” model elements). Annotated 2D drawing models, saved views, and/or custom attributes may be required at this stage to convey the key information.

3.5.2 Type, Size and Location Report (TS&L Report)

The TS&L Report is the first bridge structure specific submission in the design process. A sufficiently thorough analysis of structure types is required to determine the proposed structure concept. In accordance with DM-4 Chapter 1.9.3, preliminary cost comparisons are to be generated to further support the selected structure type.

The list of required Model Elements for the TS&L submission is the same as the H&H Report (Section 3.3.1) with the following additions:

- Superelevation (as necessary)
- Barriers
- Diaphragms
- Stiffener and cross-frames (for a steel superstructure)
- Excavation
- Approach slabs
- All necessary custom attributes for modeled bridge elements required for the TS&L per PennDOT Digital

Delivery Standards
- Any additional and supplemental model elements required in order to address DM-4 Part A: Policies and Procedures, Section 1.9.3

Unlike the H&H report, project-specific modifications to templates and objects that are required for superstructure elements should be made at this time. However, model elements should remain “Base” wherever possible for future changes and updates.

Quantity reports are to be generated from the bridge model as part of the preliminary cost comparison. Because the TS&L cost comparison typically compares two or more structure concepts, all considered structure concepts must have a physical bridge model generated in OBM. In this way, comparable quantity reports can be generated and compared.

Plan requirements for the TS&L submission can be found in DM-4 Chapter 1.9.3.3. Annotated 2D drawing models, saved views, and/or custom attributes should be generated in the bridge model file for the proposed structure type.

3.5.3 Foundation Submission

The Foundation Submission requires a more detailed Level of Design of the bridge structure, specifically of the substructure units (footing dimensions, pile layouts, stepped footing locations, etc.). At this stage in the model development, custom templates for abutments and piers should be present in the physical model, as required. Model Elements should be revised to reflect the final footing elevations, pile tip elevations, drilled shaft length, and length of socket into bedrock, as applicable per the project requirements. Select annotated 2D drawing models, saved views, and/or custom attributes should be generated in the bridge model file to convey the required information for the foundation design and documentation.

3.5.4 Final Review of Plans

The Final Review of Plans submission will require the complete Refined Model which has been built upon all previous model elements from past submissions. The following additional Model Elements are required for the Final Review of Plans:

- Bearings
- Reinforcement
- All necessary custom attributes for the modeled bridge elements per PennDOT Digital Delivery Standards
- All necessary 2D details not explicitly modeled in the physical 3D model
- Any additional and supplemental model elements required in order to address DM-4 Part A: Policies and Procedures, Section 1.9.5

Saved views will be required for ease in model viewing, including referenced information from other disciplines (roadway, drainage, etc.). In addition to the saved views for the Refined Model, 2D drawing models shall be generated, which includes 2D details for bridge items not explicitly modeled in the physical 3D model. The 2D drawing models shall also include annotated sections of the relevant portions of the bridge structure, which are required for contractor use during bridge construction.

3.5.5 Final Plans

After receiving any comments from the Final Review of Plans submission, the model shall be updated and/or corrected accordingly. All comments must be addressed before the Final Plans will be approved. Ownership of the Final Bridge Model will be assigned at this time. The exact format for Responsibility, as defined in DM-4 Chapter 1.9.6, is currently To Be Determined. This section will be updated accordingly to correspond with DM-4.

3.5.6 Plans, Specifications & Estimate (PS&E)

The PS&E submission is the final model submission during the design phase. The bridge model will be included with the 3D roadway model and information, and other discipline files required for the project, as deliverables for the project's advertisement.

3.5.7 Additional Project Submissions

Throughout the life of the bridge design project, there are several other submissions that require varying levels of structural detail. Those submissions include, but are not limited to, Line & Grade, Erosion and Sediment Pollution Control, Safety Review, and Design Field View submissions.

Line & Grade – Line & Grade plans are typically an early submission in a project's life cycle, as such, the required detail level of the bridge model will be at a minimum. Those model elements include the following:

- Bridge
- SupportLine Locations
- Deck

Erosion & Sediment Pollution Control – E&S details typically require an accurate determination of the location of bridge elements, most notably, substructure units. For E&S submissions, the Base Model will provide the necessary amount of information for project impact limits and the number and type of BMPs required. However, a completed Base Model is not required, as long as the following Model Elements are provided:

- Bridge
- SupportLine Locations
- Deck
- Abutments
- Piers
- Excavation limits (temporary and permanent)
- Approach Slabs
- Temporary roads and causeways

Safety Review – The Safety Review is a major review point during a project's life cycle. Identifying hazards and potential safety issues caused by the project requires an appropriate Level of Detail and confidence in the structures detailing. The TS&L model should provide sufficient development for this review and allow for any issues or concerns to be identified by the Safety Review Committee.

Design Field View – The DFV submission is typically the final project submission during the Preliminary Design Phase of a bridge design project (although TS&L submission may occur after DFV depending on the project schedule). It is important to coordinate structure issues with the rest of the project submissions to generate a complete design concept. A more accurate cost estimate is needed at this stage, and if Refined Model substructure element details are required to provide this, they should be included in the model at this time.

3.6 INCORPORATING CIVIL AND OTHER DISCIPLINE DATA

When developing the physical 3D bridge model, resources from other models and disciplines will be required. The two most important resources are the 3D roadway geometry and the Existing/Proposed Terrain Models. In the OpenBridge Modeler workspace, each of these resources should be provided as DGN files that can be referenced into the bridge model.

The Existing Terrain Model can be generated from standalone traditional topographic survey and/or LIDAR survey data. The terrain model will be crucial for determining the proposed vertical profile during the roadway alignment development, and it will be required later during the structure model's development to determine excavation quantities and limits.

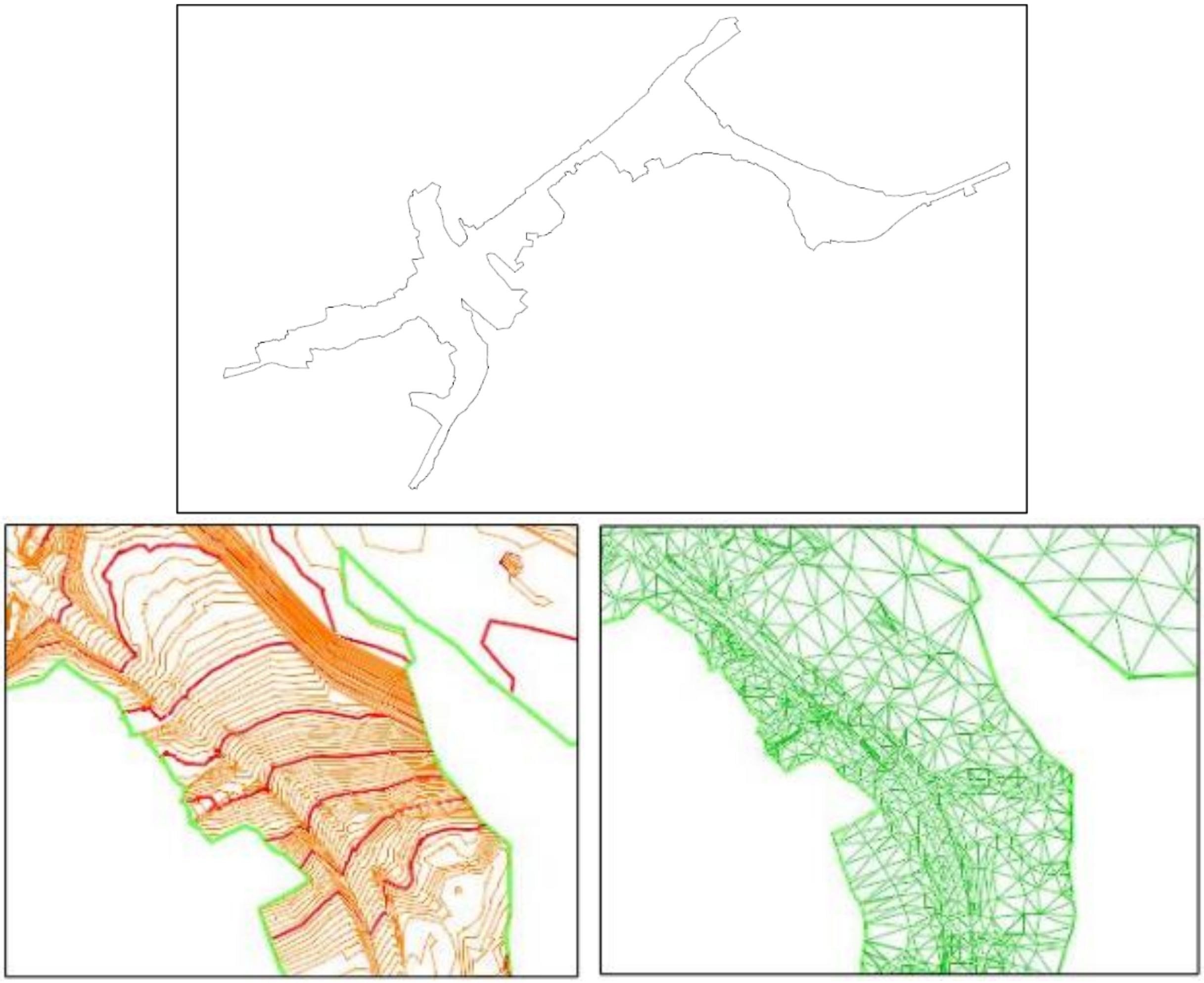

Figure 3.6-1 Example Terrain Model Data

The 3D roadway geometry file will need to include a horizontal alignment and a vertical profile. This is important since the Bridge Element will be associated with this alignment and the deck PG will coincide with the vertical profile.

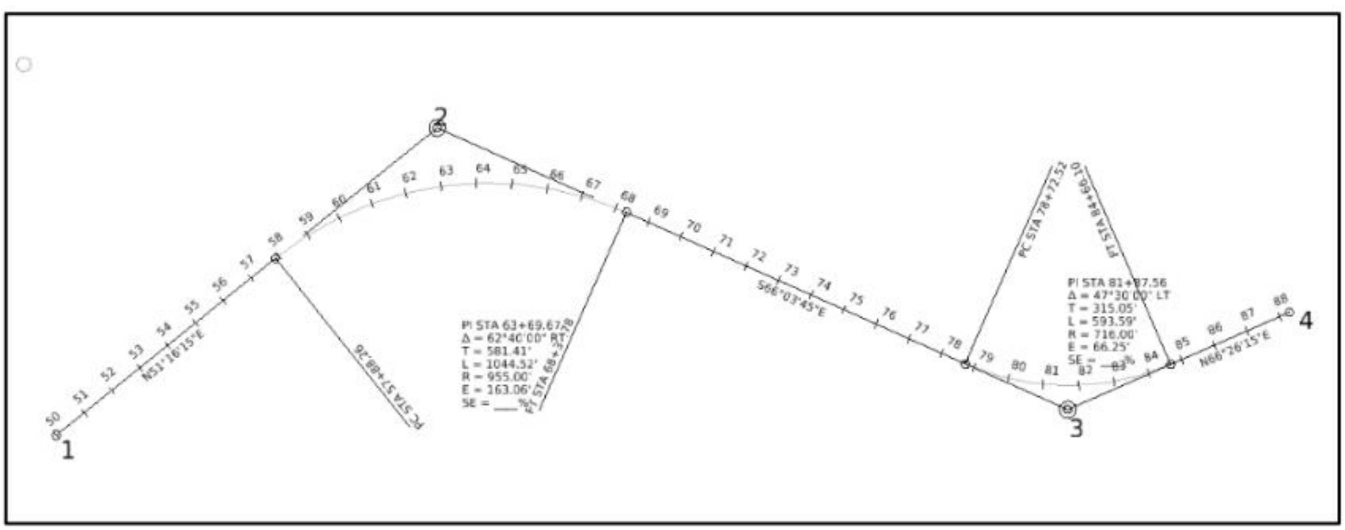

Figure 3.6-2 Example Horizontal Geometry Data

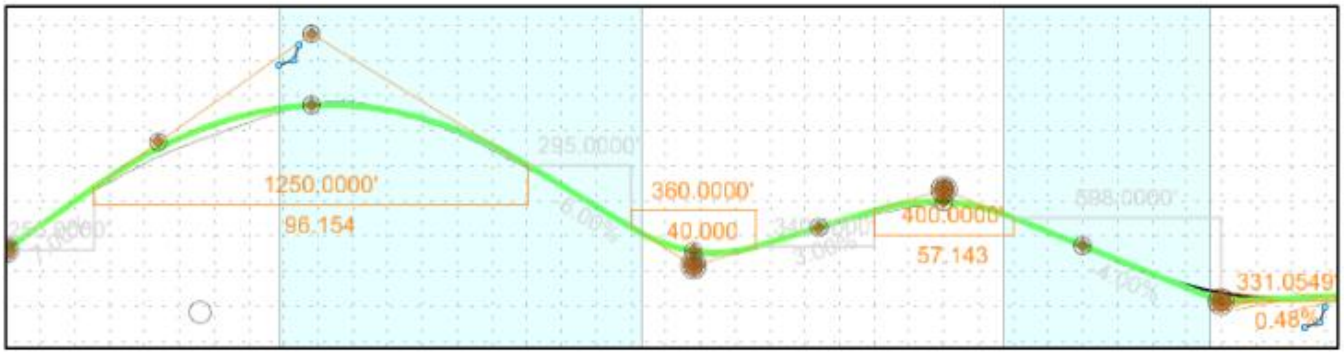

Figure 3.6-3 Example Vertical Profile Data

Roadway corridor models, as separate DGN files, may also be referenced into the bridge model. The corridor model can help determine the required deck and lane widths as well superelevation details (if a superelevation is present). The corridor model will also provide proposed roadway embankment limits, which are critical for determining wing location, length, and height.

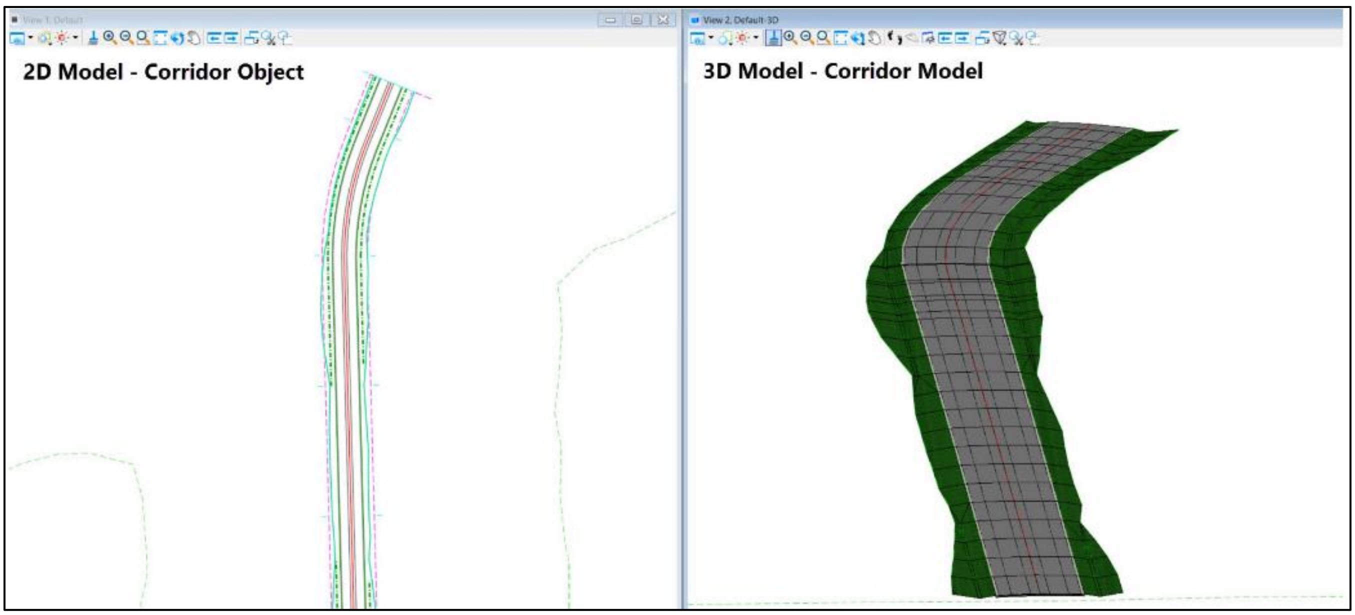

Figure 3.6-4 Example Corridor Model Data

Future civil data that may be incorporated into the bridge model to aid in design includes, but is not limited to, drainage models and details, ITS, and utility models.

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GETTING STARTED

4.1 SOFTWARE AND WORKSPACE INSTALLATION

Obtain and install the Bentley software per the organization’s IT department and per the developer’s instructions.

The PennDOT OBM workspace is delivered in the same installation as the ORD workspace. Users can find the PennDOT Connect Edition Workspace content along with instructions on the PennDOT CADD Resources Website:

https://www.penndot.gov/ProjectAndPrograms/RoadDesignEnvironment/RoadDesign/Pages/CADD-Resources.aspx.

This includes workspace instructions for local installation and a network configuration. ProjectWise specific installation instructions will be available in the future.

4.2 STARTING A NEW PROJECT

As mentioned previously, there are several options for how to start a model-centric process. This manual will focus on the OBD workflow in which an .obdx file must be created before creating an OBM file for modeling. However, the user can create a standalone OBM file without first accessing the OBD. These files will still have all the functionality within OBM but will not have some of the interoperability options such as the BIM workflow with the LEAP products, visualization with LumenRT, and others. If the desired workflow is to use only the OBM software and not use the LEAP analysis products, users can skip to Step # 5 below.

Below are the steps to starting a Model-centric workflow project in a ProjectWise environment. If not using ProjectWise, the steps are very similar, and differences are indicated in the descriptions below.

1. Open OBD and select the “ProjectWise” command button. Select your desired Datasource and login. Typically, the Single Sign-on option is used, but the alternative User Name and Password option is included in the screenshots below as well.

Figure 4.2-1 Selecting ProjectWise Command Button

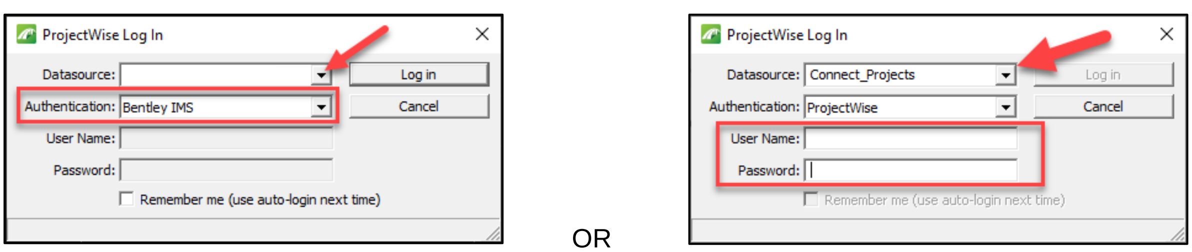

Figure 4.2-2 Login Using the Windows Single Sign-on or User Name and Password

2. Left click on the “New File” and navigate to the desired location to save the file and add the specific file name and description. Then left click on “Save” to save the file.

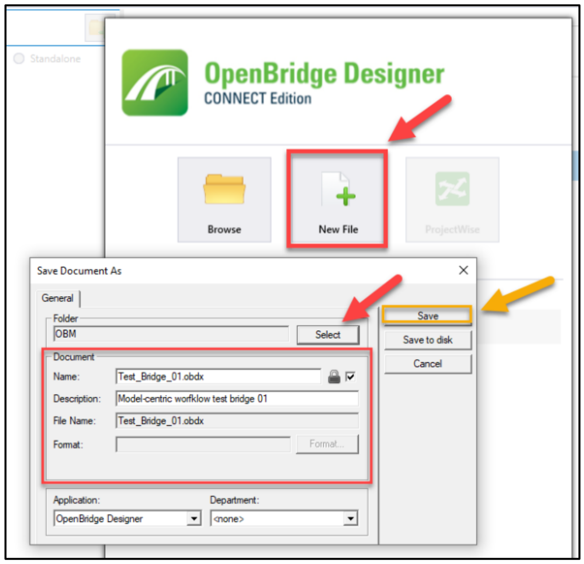

Figure 4.2-3 Saving New File

3. Select the “Standalone” File Groups option and left click on the **Add Standalone Group** command. Add your group name and select “OK.”

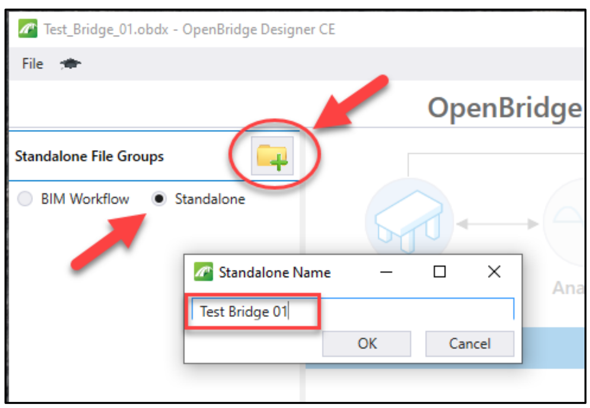

Figure 4.2-4 Creating Standalone Group

4. Selecting the newly added group, left click on the OpenBridge Modeler icon to open OBM.

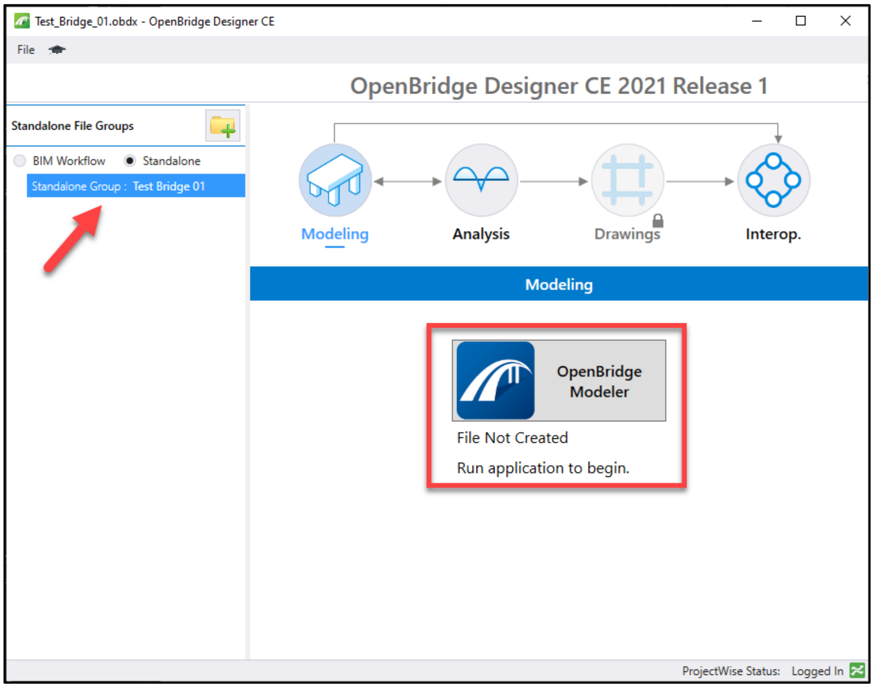

Figure 4.2-5 Selecting and Launching the OBM Application

5. Sign into the ProjectWise Datasource again (if prompted) and left click on New File command on the OBM home screen.

6. In the “New” dialog box, select the correct folder to save the OBM file in (typically the same folder as the OBD file), add the document information (file name, description), and Then access the “Source File” by left clicking on “Seed…” and navigate to the PennDOT workspace configuration setup location (either in PW, local, or on a network drive) under …Organization Civil / Bridge Design / OpenBridge Modeler / Seed and select the appropriate seed file based on whether your project is using the North or South State Plane Coordinates. Make sure the “Application” selected is “OpenBridge Modeler.” Then left click on “Open.” If the seed file is not visible within the dialog box, change the “Application” to “All Applications” and check for the correct seed file.

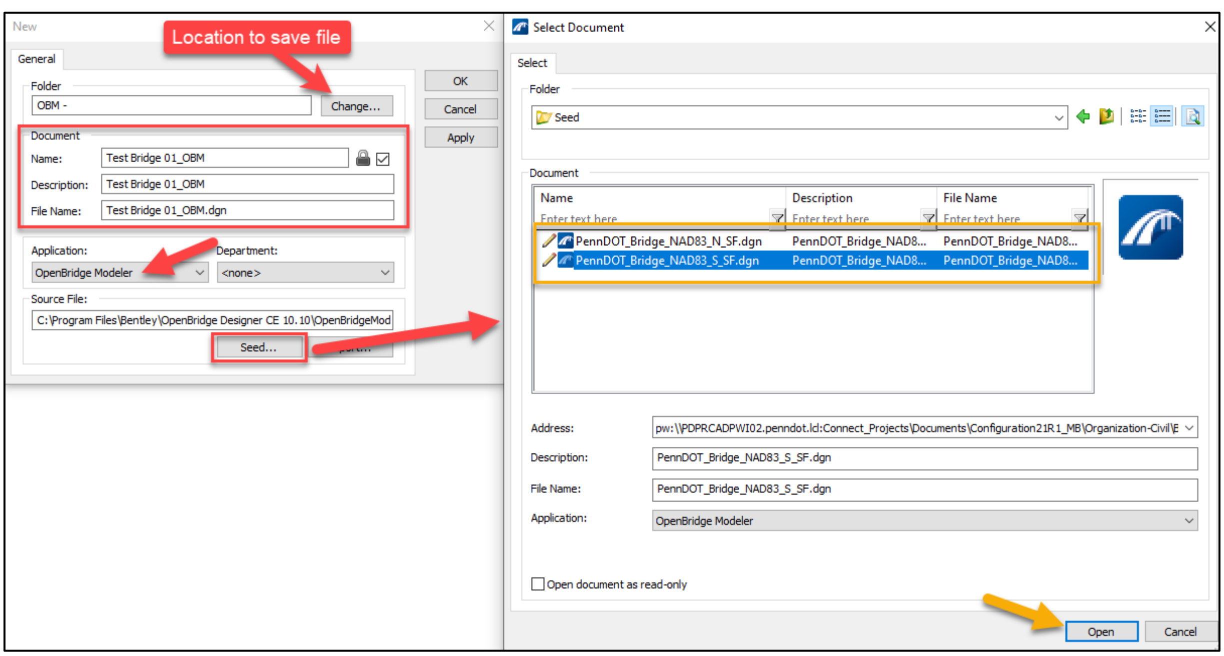

Figure 4.2-6 Setting Up New Design File

7. The user can then select "OK" in the "New" Dialogue box to launch the new OBM file, which is ready to use. The user may get a prompt that the software needs to be restarted for the new configuration. If so, click "OK." The OBD file now shows the name and a preview of the OBM file. It may require checking the file back in ProjectWise to see this preview for the first time.

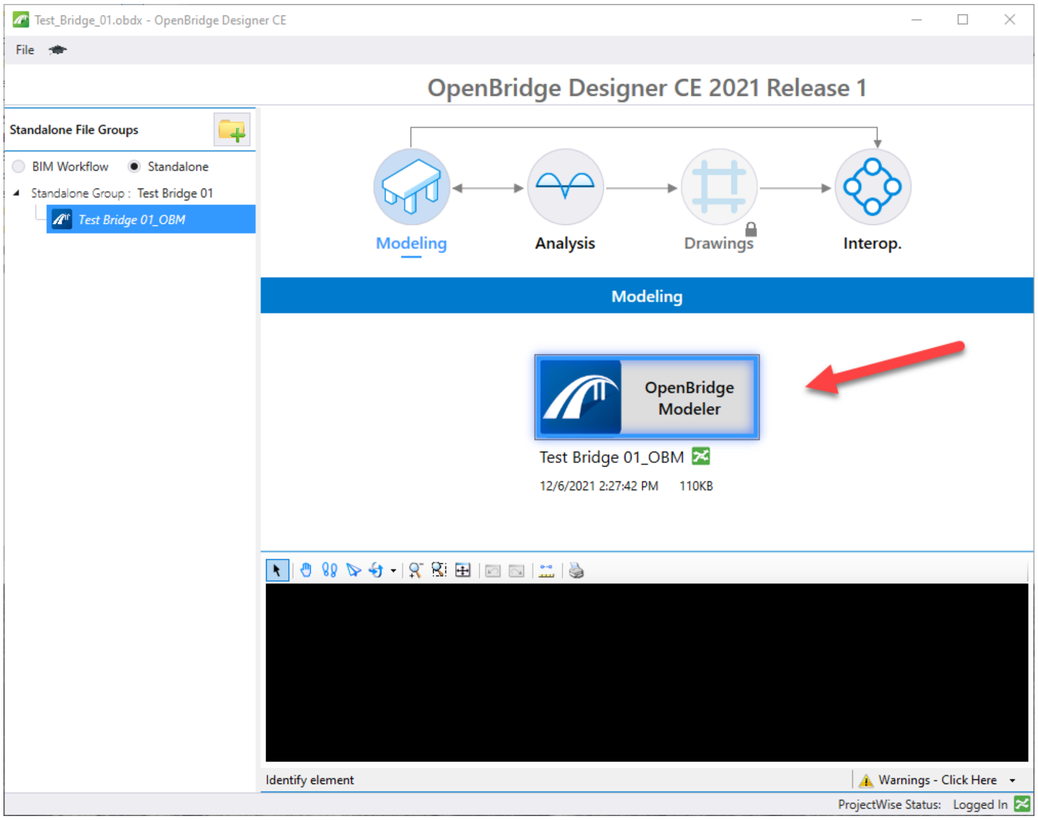

Figure 4.2-7 Preview of OBM File in OBD

The following sections provide additional helpful tools and techniques for viewing and using this software. It is recommended the user walk through these sections before using the software for the first time. If the user is experienced, proceed to Chapter 5 but note these sections for future reference.

4.3 TOOLS FOR INPUT

Tools used to input and generate a new bridge model are located under the **OpenBridge Modeler** workflow. Select the **OpenBridge Modeler** workflow from the **Workflow** drop down menu located in the upper left-hand corner of the screen. Through this workflow, all the tools needed to generate a Base bridge model can be found in the panels within the tabs.

Below are screenshots of the general ribbon terminology with markups, as well as the **Workflow** dropdown menu and the **Home** tab.

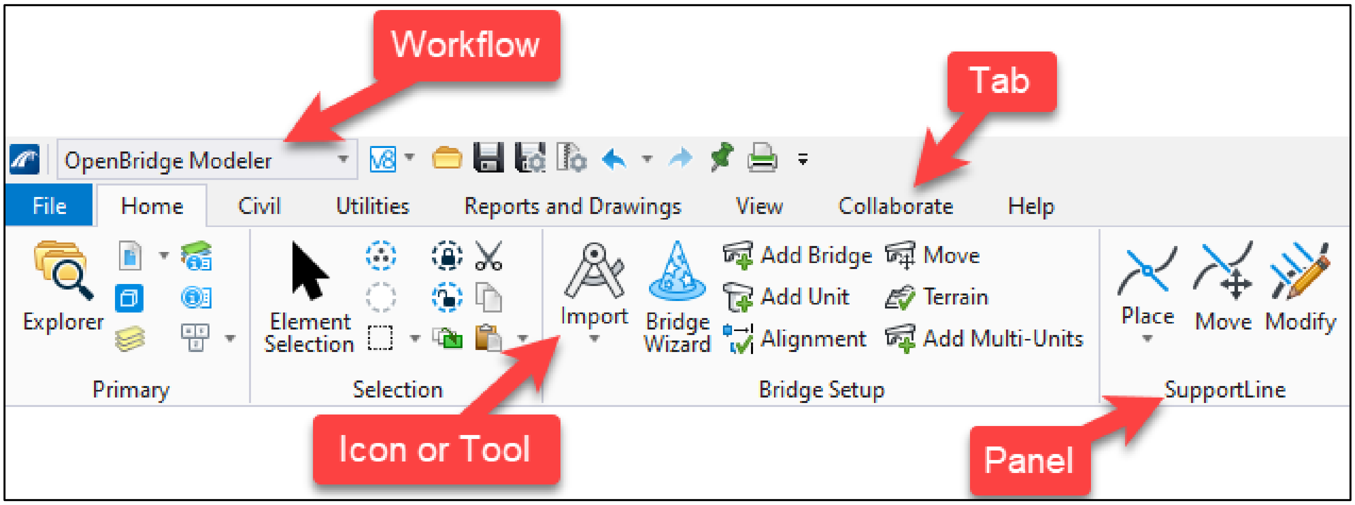

Figure 4.3-1 OBM Ribbon Toolbar Terminology

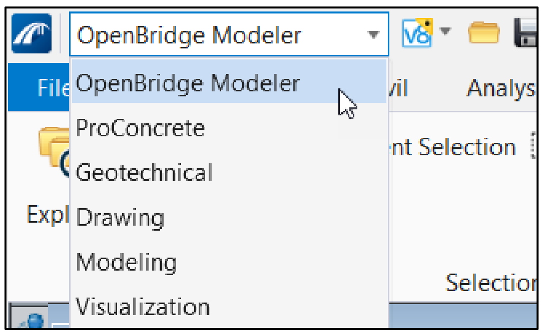

Figure 4.3-2 Workflow Dropdown Menu

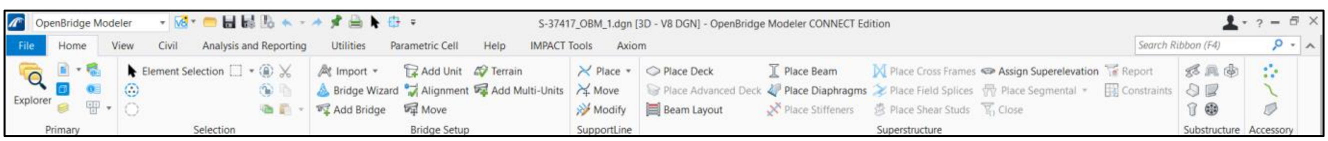

Figure 4.3-3 OpenBridge Modeler Workflow – Home Ribbon

4.4 FILE SETTINGS

File Settings are set and replicated through the seed files and other workspace elements. Typically, the users will not need to modify these as part of the set-up process, and the default settings in the seed file will be sufficient. However, there are certain aspects of the Settings that the user may want to change in certain circumstances. Following are several sections explaining some of these situations.

First, in order to access the File Settings, the user can navigate to the **File > Settings > File > Design File Settings**.

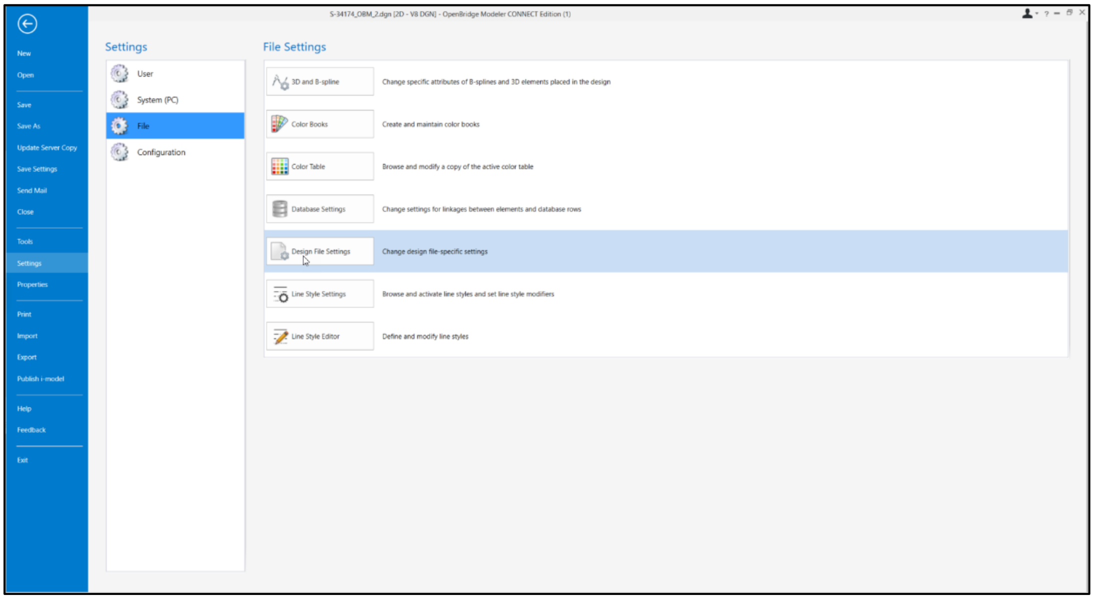

Figure 4.4-1 Design File Settings Location

4.4.1 Working Units

In OpenBridge Modeler, it is essential to set the **Working Units** at the start of the project, and the default (and recommended) Accuracy is set to 8 decimal places. This does not mean the user has to input 8 decimal places or presume that the accuracy of the input values will ever reach that level. However, it was determined that the software will report some erroneous values in trailing decimal places if this accuracy is not specified when placing the model elements.

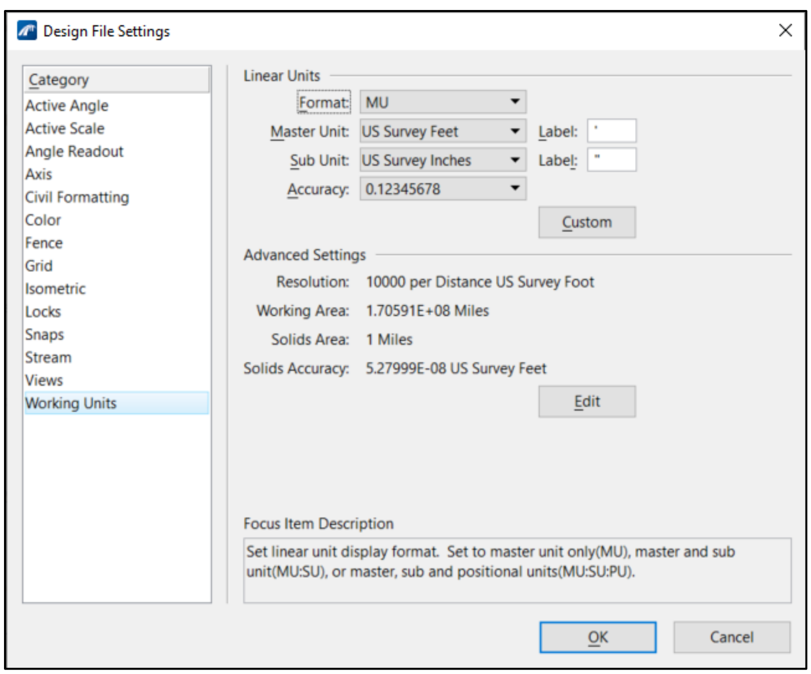

Figure 4.4-2 Working Units - Design File Settings Dialog

Working Units Format can be adjusted from **Major Units (MU)** to **Major Units: Sub Units (MU:SU)** and back again, at any time, affecting only the units when using the Measure tool. Sometimes it is necessary to switch between feet and inches and decimal feet to assist in certain tasks while using OBM. While **Dimension Styles** are set up for feet and inches, Working Units are a different entity and can be set up as only decimal feet without changing dimensions.

4.4.2 Position Mapping

To set up Task shortcuts similar to MicroStation v8i, the user must set up **Position Mapping**. Navigate to the Preferences Dialog box by first selecting **File > Settings > User > Preferences.**

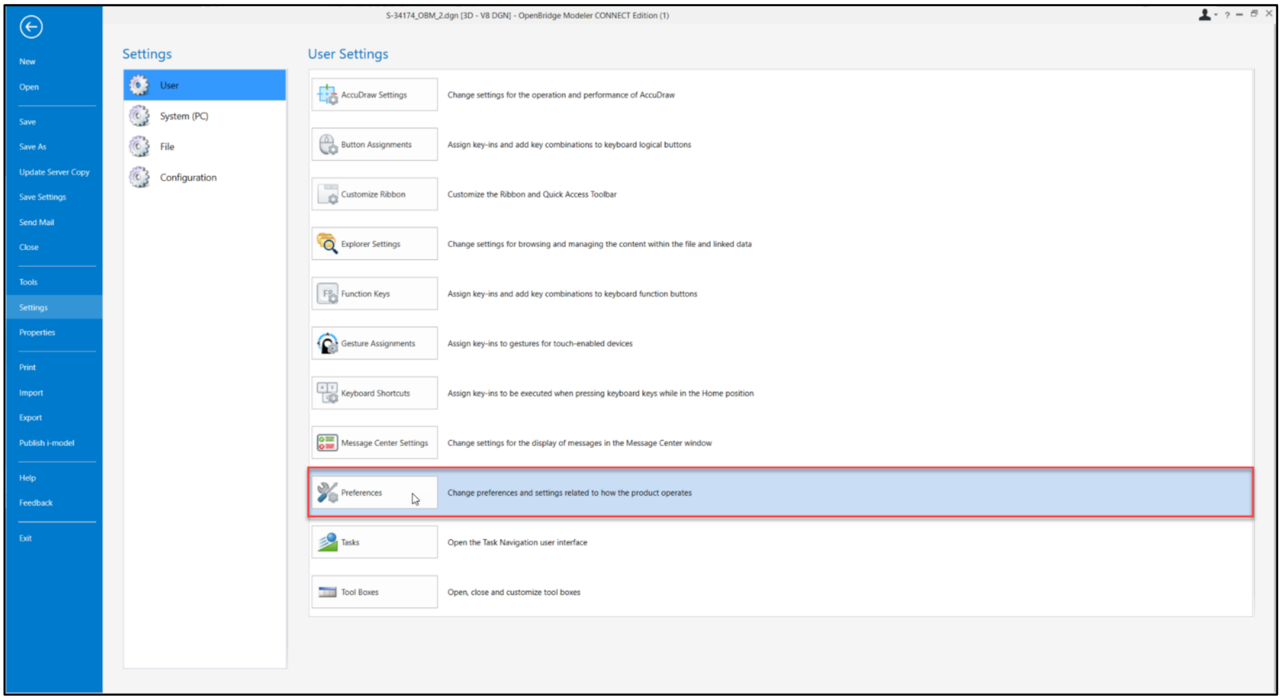

Figure 4.4-3 Settings > User > Preferences

After selecting Preferences, select Position Mapping in the left Category Panel. Enable Position Mapping by checking the box next to Use Position Mapping. Populate the settings in the dialog box as seen below:

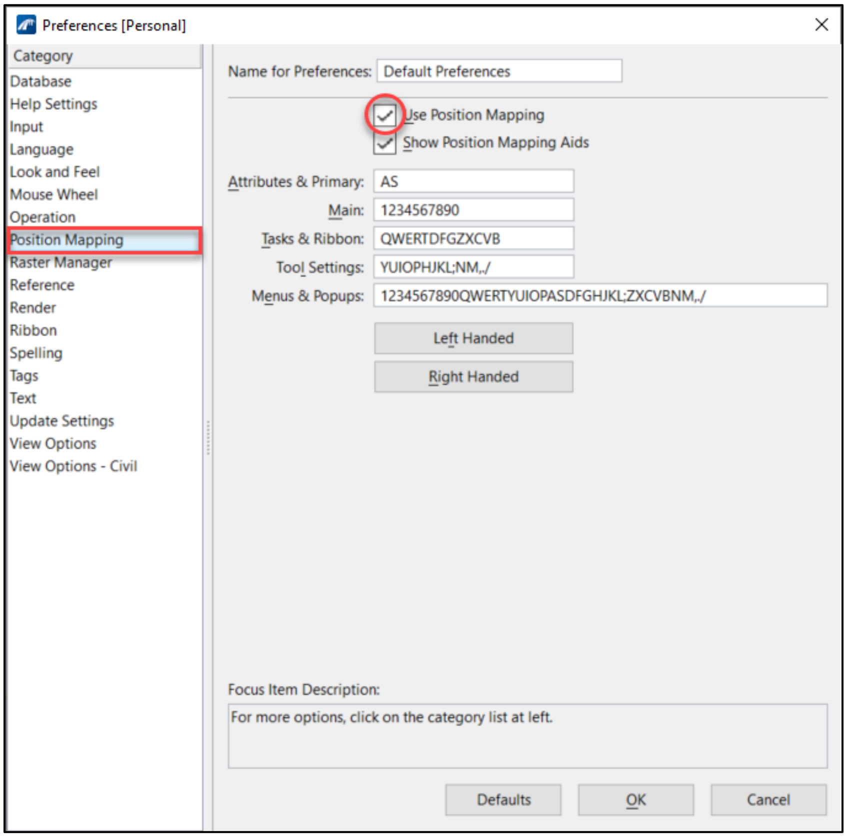

Figure 4.4-4 Working Units - Design File Settings Dialog

The Task Navigation user interface needs to be activated in order for the Position Mapping to work. Enable the Task Navigation user interface by selecting it from the **File > Settings > User > Preference** menu.

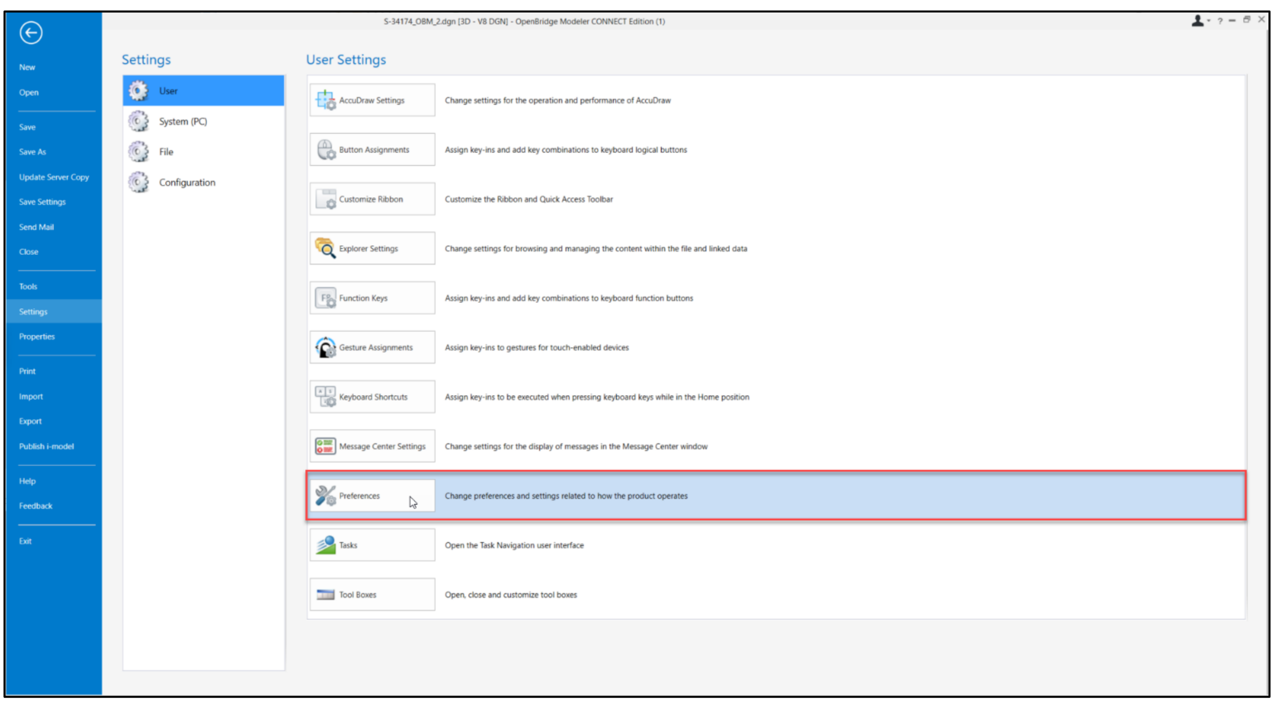

Figure 4.4-5 Settings > User > Preferences

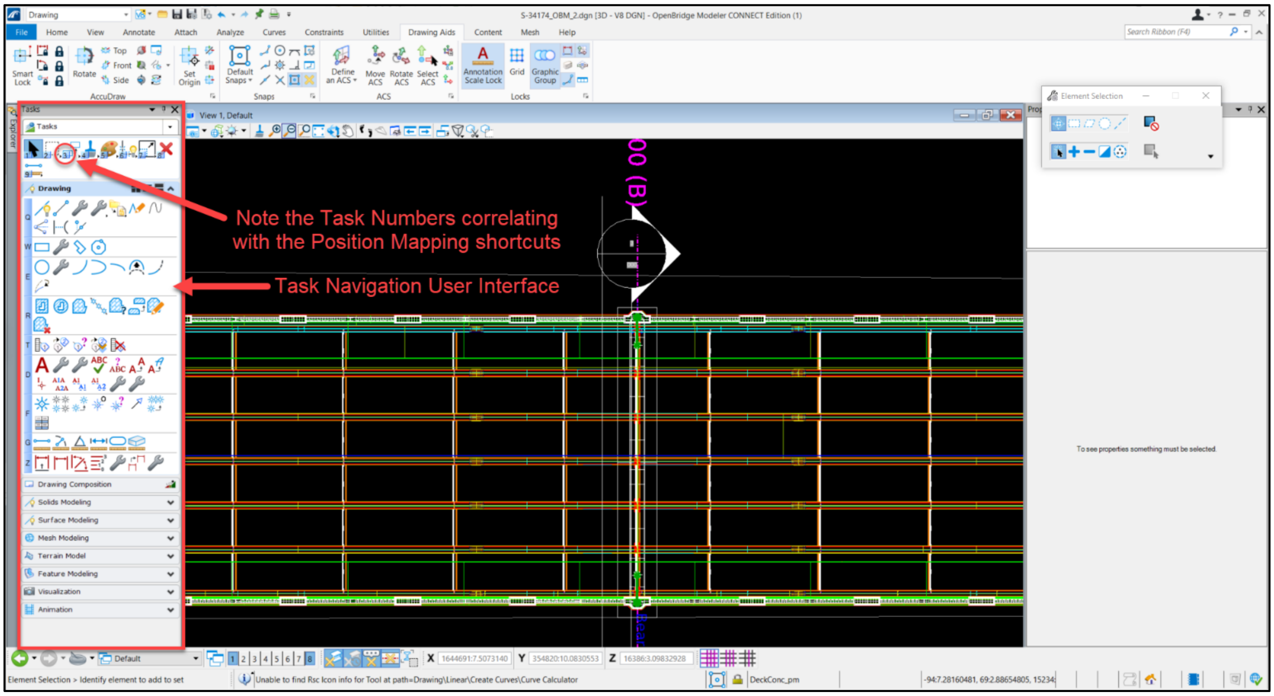

Figure 4.4-6 Task Navigation Bar

4.5 VIEW CONTROLS

4.5.1 Optional View Windows

The user can customize the view windows in the modeling workspace to aid in the modeling of the structure. Additional view windows can be especially helpful when solids modeling and allow the user to view multiple perspectives (**3D Rotate View**) of the structure at one time. Up to 8 view windows can be open at one time with different views and display styles. and perspective in perspectives. The current perspective of each window can be seen in the upper left-hand corner of the view window. Placing view windows in a separate application window will be covered in Section 4.5.2.1: Open Multiple OpenBridge Modeler Application Windows.

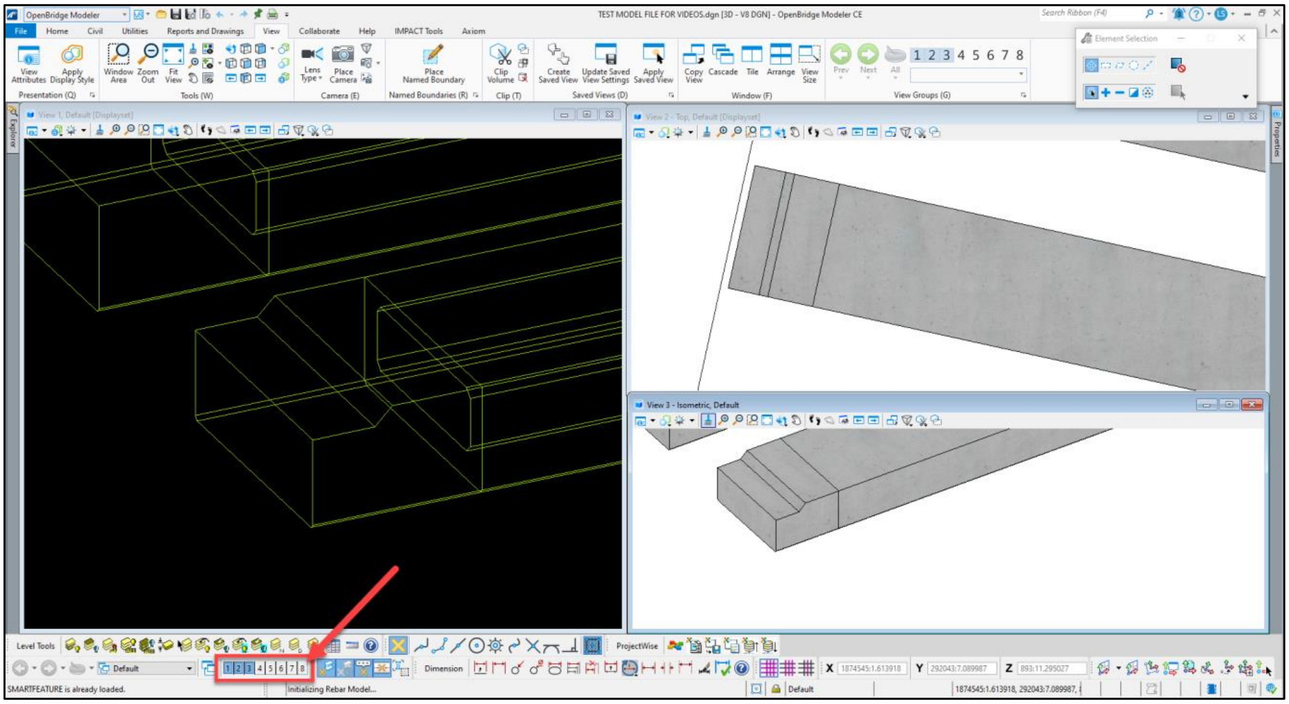

Figure 4.5-1 View Windows in OBM

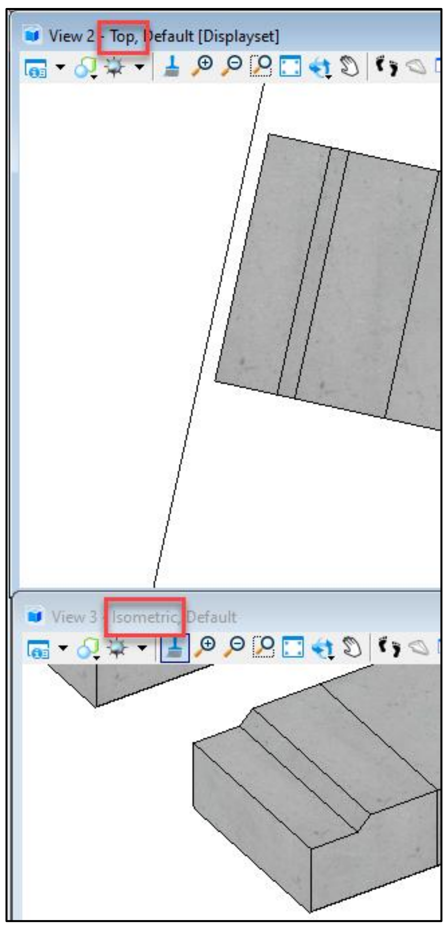

Figure 4.5-2 Current View Perspective

4.5.2 Application View Settings

The Application View Settings consist of how tabs, panels, and the overall window configuration are displayed. Most of these view settings can be adjusted in the View tab.

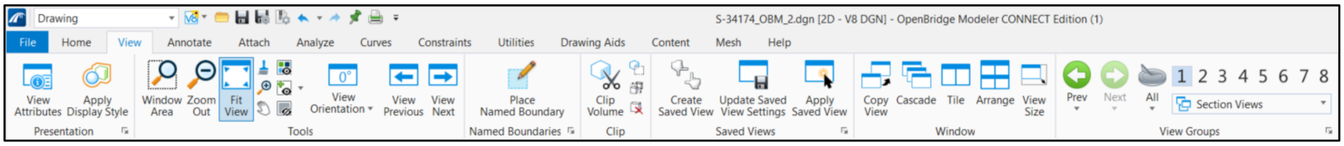

Figure 4.5-3 Application View Settings

4.5.2.1 Open Multiple OpenBridge Modeler Application Windows

The user can open multiple application windows simultaneously, if desired. This should only be done if the user has at least 2 monitors, as the overlapping of the active window makes the secondary window useless. Having a window on separate monitors in a 3D program like OBM is extremely beneficial since the default design model can be created and modified in one window with the illustrated 3D model open on another screen, so the user can see the updates in real-time. Another benefit of having 2 windows open on separate monitors is modifying text and dimensions in a drawing model while observing the changes being made in the sheet model. This helps avoid placing text or dimensions outside of the sheet border.

To enable the **Open Multiple Application Windows** option, the user must navigate to the Preferences Dialog box by first selecting **File > Settings > User > Preferences.**

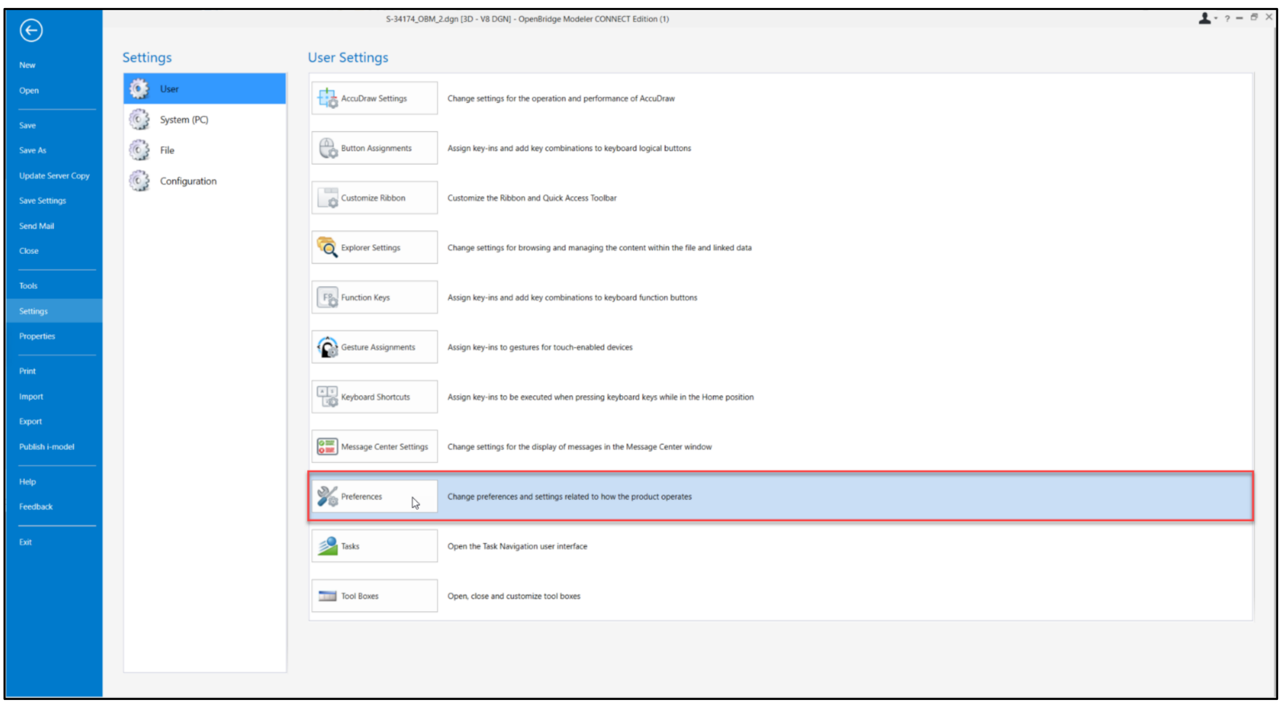

Figure 4.5-4 Settings > User > Preferences

When the dialog opens, the user will see a Category list on the left side of the menu. The **Open Multiple Application Windows** option is located under the **Operation** Category. The user can now check the box next to the option and select the number of windows to open simultaneously. After making this change, the application needs to be restarted for the changes to take effect.

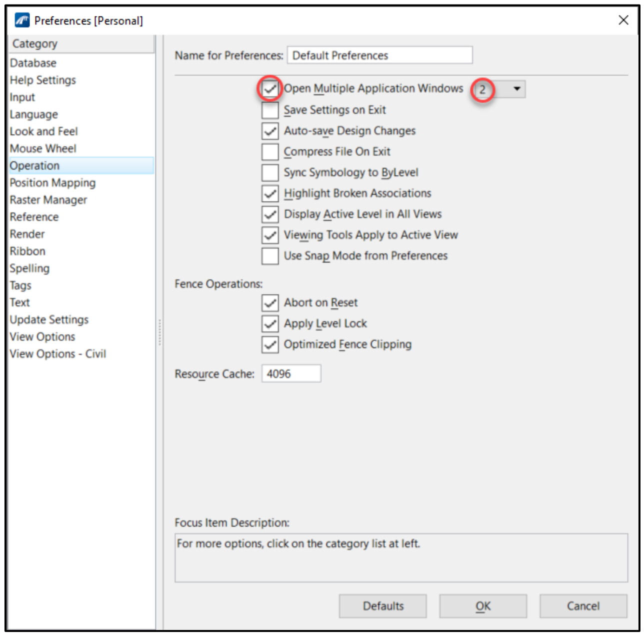

Figure 4.5-5 User Preferences Dialog

When multiple application windows are open, you cannot drag and drop Views to other windows. You must **left click** the **top left corner** of the **View Window** and select **Change Screen**.

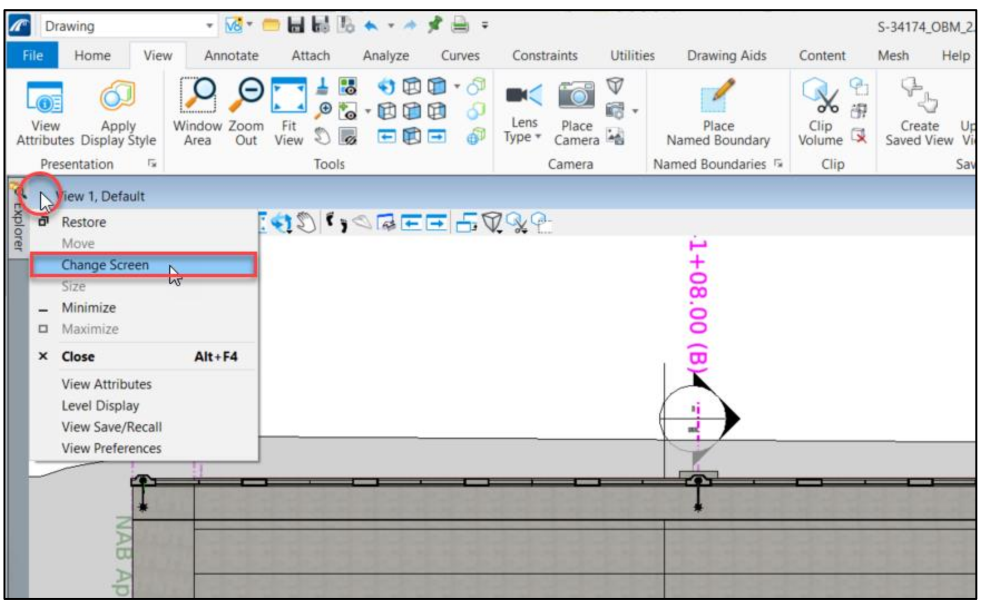

Figure 4.5-6 Change Screen

Note: Generally, the number of windows should not exceed the number of monitors the user has available for the program.

4.5.2.2 Minimize/Expand Ribbon

The user can customize the Tabs and Panels and how they function. If the user wishes to minimize the ribbon, a simple **double-click** on the **Tab name**, or selecting the **Minimize Ribbon** tool, will collapse it. Positioning the cursor over the Tab name will expand it to temporarily reveal the Tab. If the user wishes to permanently expand the Tab, **double-clicking** the **Tab name**, or selecting the **Expand Ribbon** tool, will permanently expand it until the previous methods are used to minimize it again.

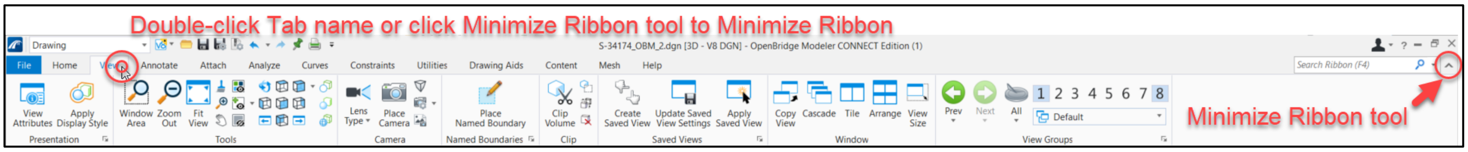

Figure 4.5-7 Minimize Ribbon Tool

Figure 4.5-8 Expand Ribbon Tool

4.5.2.3 Customize Ribbon

The Ribbon can be customized at the user's discretion to add or remove panels and/or tools. This can be done in any tab and in any workflow. Simply right click the ribbon in a blank area and select **Customize Ribbon**.

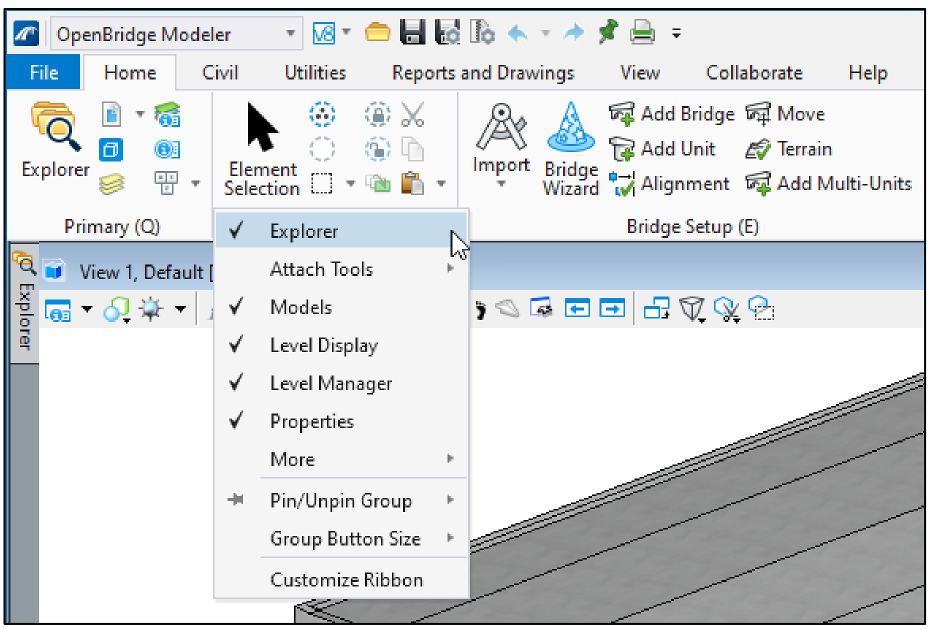

Figure 4.5-9 Customize Ribbon

The user can add or remove tools or make any adjustments to the current tool arrangement as desired. Simply select a tool and the preferred destination and click Add or Remove.

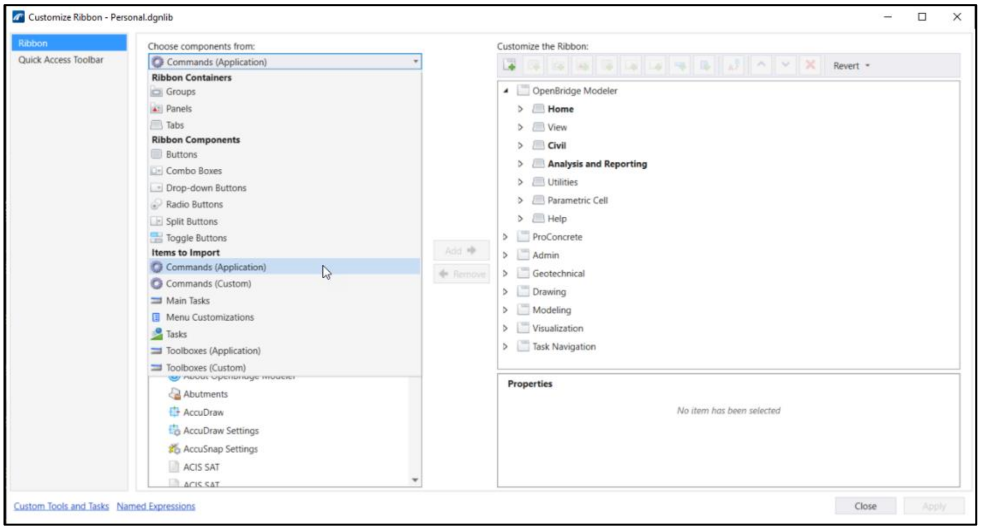

Figure 4.5-10   Customize Ribbon Dialog

4.5.3   View Settings

The available options in the View Settings change slightly when switching between 2D and 3D models, but the settings discussed in this section are available in both 2D and 3D model views. Any differences between 2D and 3D tool settings are identified below.

Figure 4.5-11   Window View Settings

1. **View Attributes** – Toggle display settings in the current View, such as Dimensions, Grid, or Level Overrides.

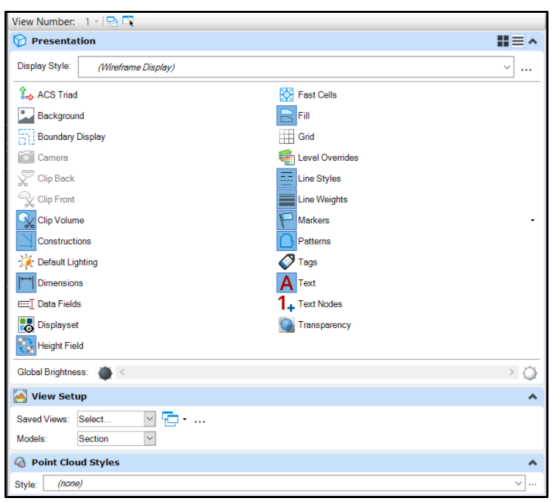

Figure 4.5-12   View Attributes Dialog

2. **Display Style List** – Adjust display styles of the model, such as Wireframe, Illustrative, or Transparent. The user will have to left click inside the desired window when changing the Display Style. Display styles can be modified to display specific features, such as Render Mode, Overrides, and Edge Settings.

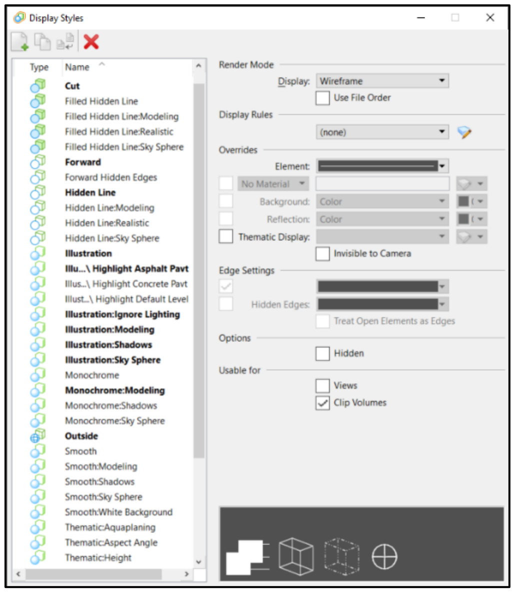

Figure 4.5-13 Display Styles Dialog

3. **2D Rotate View** (if in 2D file) – View can be oriented by using any of three methods

Dynamic: Manual view rotation along X-Y plane
2 Points: View set by selecting 2 consecutive points along the desired X plane
Unrotated: Sets view in True North perspective

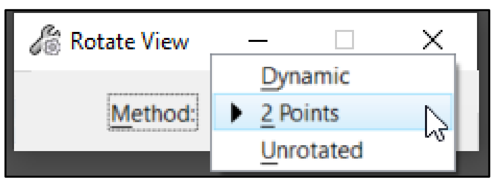

Figure 4.5-14 2D Rotate Settings

4. **3D Rotate View** (if in 3D file) – Choose from preset view perspectives such as Top, Front, or Isometric, or Rotate the view manually. Focus origin can be dragged and dropped to a specific point, or snapped to an object, and the view will maintain focus on the origin while rotating.

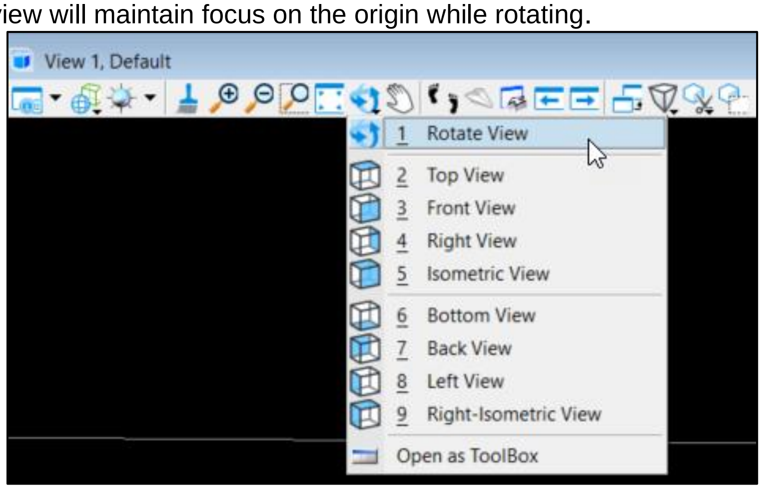

Figure 4.5-15 3D Rotate Settings

5. **View Previous** – Returns view to previous setting or perspective
6. **View Next** – Returns view to next setting or perspective, if the View Previous tool was selected
7. **Copy View** – Copies view settings from active view to apply to another view

4.5.4 Displaysets

Displaysets allow the user to isolate model elements based on active selections. A Displayset may be quickly modified or reset as needed and they can be created from the **Tools Palette** of the **View Tab.**

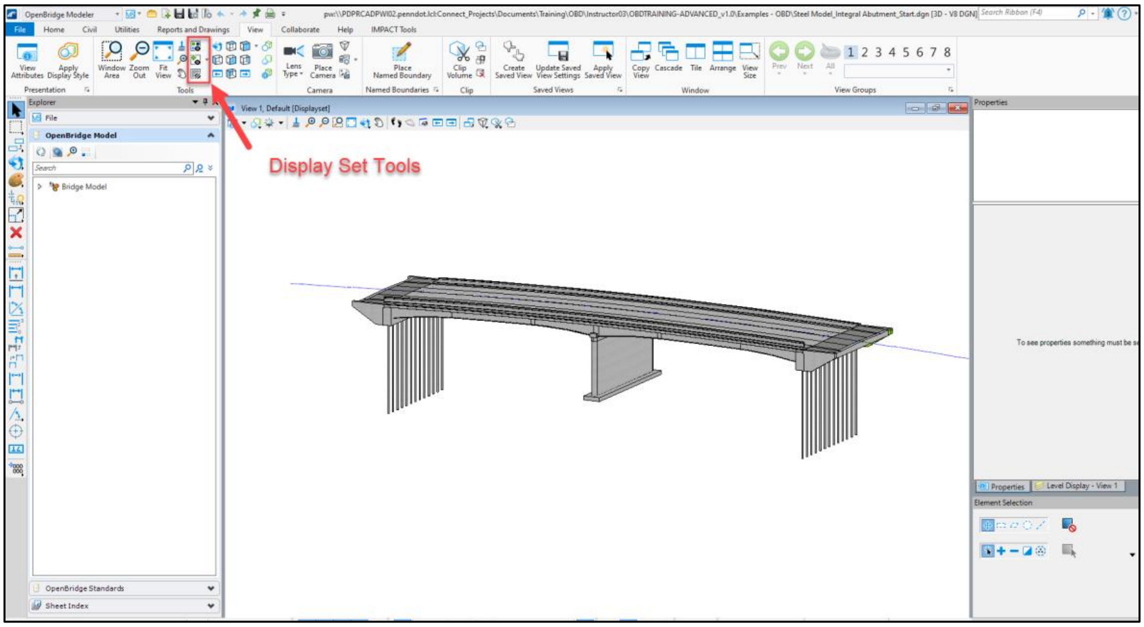

Figure 4.5-16 Displayset Controls

The User can select model elements and isolate them using the **Displayset Set** command. The **Displayset Set** tool can also be found by right-clicking in the model window and selecting the command from the context sensitive menu.

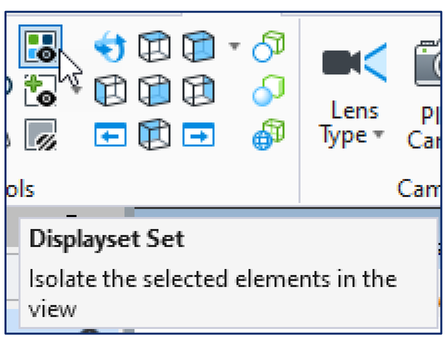

Figure 4.5-17 Displayset Set Tool

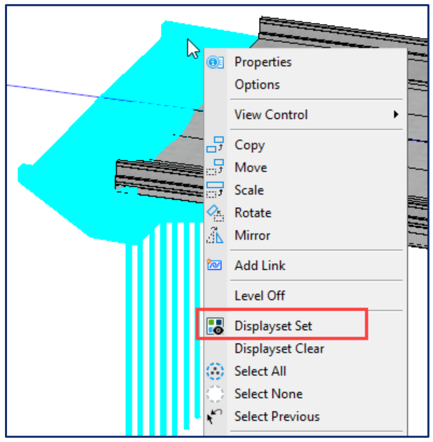

Figure 4.5-18   Displayset Set Tool (right-click menu)

Model elements may be removed from a Displayset using the **Displayset Remove** tool. Start by selecting the desired element to be removed, and then select the **Displayset Remove** tool from the toolbar.

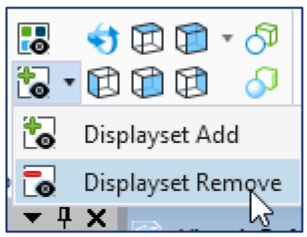

Figure 4.5-19   Displayset Remove Tool

The **Displayset Clear** tool can be used to remove the active displayset and display all model elements again. Select the tool from the tool bar or the right-click context sensitive menu as before.

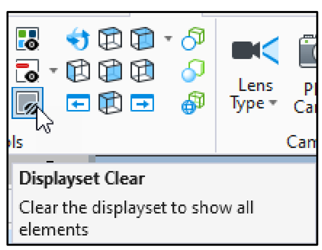

Figure 4.5-20   Displayset Clear Tool

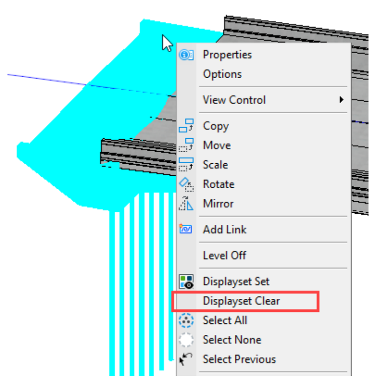

Figure 4.5-21   Displayset Clear Tool (right-click menu)

4.5.4.1 View Attributes

Displaysets can be enabled/disabled in the View Attributes dropdown menu of any active View window.

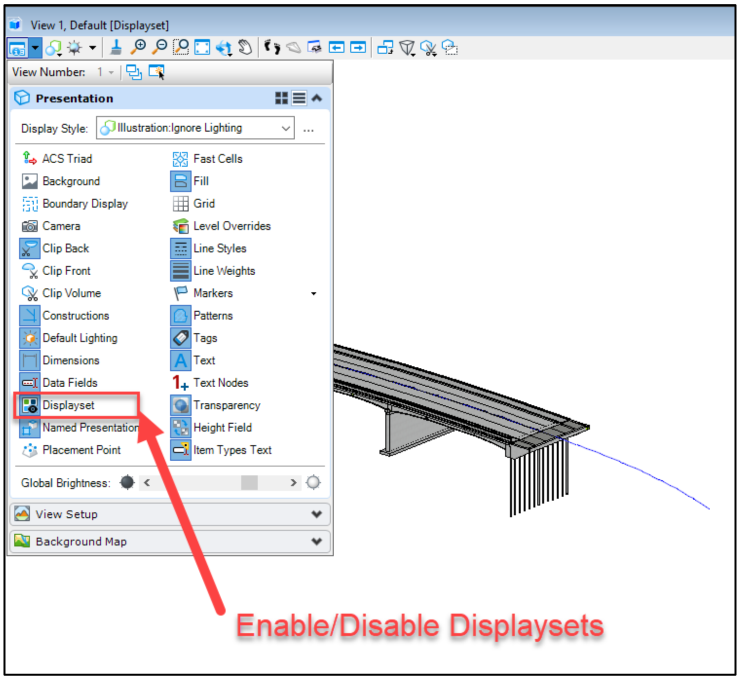

Figure 4.5-22 Reference View Settings

Note: Any View window that has Displaysets enabled will show **[Displayset]** in the window header as can be seen in figure above.

4.5.5 Reference View Settings

Reference View **Settings** can be controlled per individual reference and per view. If the same model is open in multiple view windows, the individual reference view settings in each view window can be controlled separately through the **Reference Manager** in the active view window. Settings such as **Level Display** are controlled through the **Level Display** tool in the active view window.

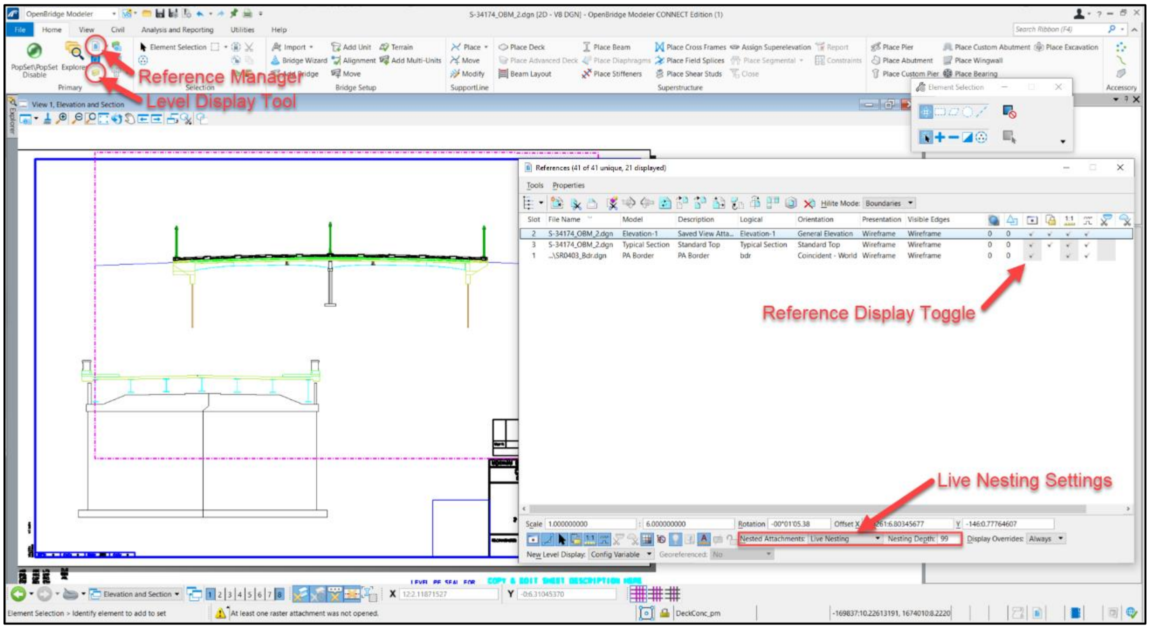

Figure 4.5-23 Reference View Settings

4.5.5.1 Live Nesting

Live Nesting controls the display of references within references. Live nesting settings are found within the reference manager. A nesting depth is selected per reference to control the depth of references within references, visible in the current view. If **Live Nesting** is turned off, only the elements drawn in the active view of the model referenced are visible.

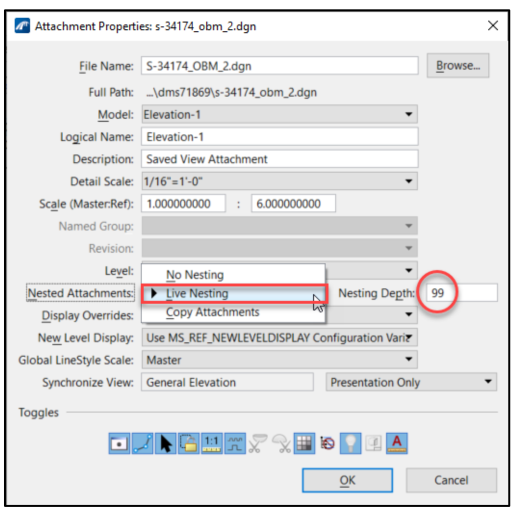

Figure 4.5-24 Attach Reference Dialog

Example: A Professional Engineer seal is referenced into a border file for a project. The border file itself includes all the border linework and text for the project. If that border file is referenced into an OBM file with the Nested Attachments setting set to No Nesting or set to Live Nesting but Nesting Depth set to 0, only the elements created in the border file will display. The PE seal will not be visible with the current settings. The border reference Nested Attachments setting must be set to Live Nesting with a minimum Nesting Depth of 1.

4.5.5.2 Update Sequence

The **Update Sequence** setting is a tool to organize references in a specific order in a 2D model to display on top of other references. Update Sequence settings are found within the reference manager. A common use of this tool is to adjust the order of references to display behind the text or objects in the active design file.

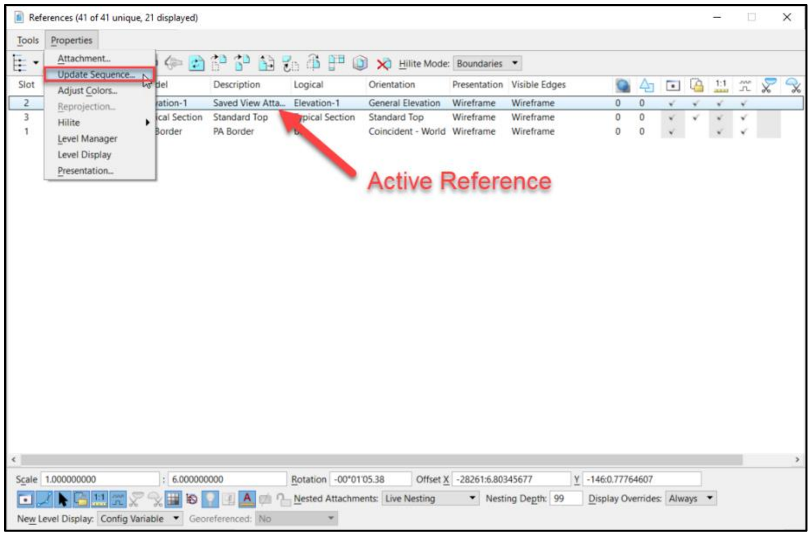

Figure 4.5-25 Update Sequence Location

The **Update Sequence** list is arranged from back to front, with the reference located behind all other references at the top of the list. As described above, if the text and elements in the Active Design File are to be at the front or on top of all other references, the model denoted Active Design File should be at the bottom of the list.

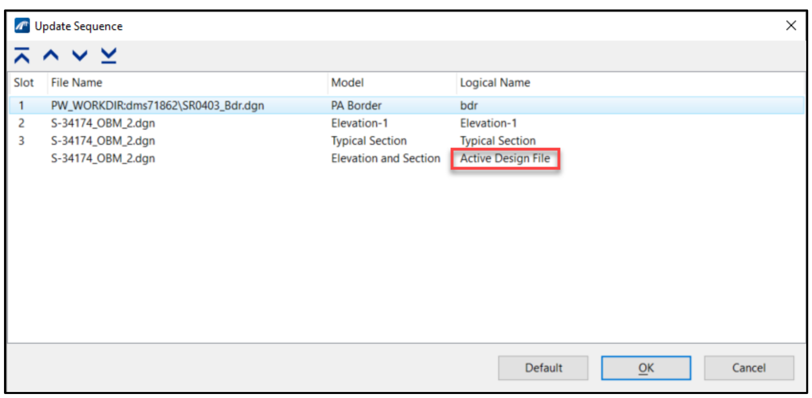

Figure 4.5-26 Update Sequence Dialog

4.5.5.3 Global/View Level Display

Level Display is used to toggle on or off specific levels in the active view or globally (throughout the file). Levels can be controlled in the active model, or the references and nested attachments can be referenced in the active model.

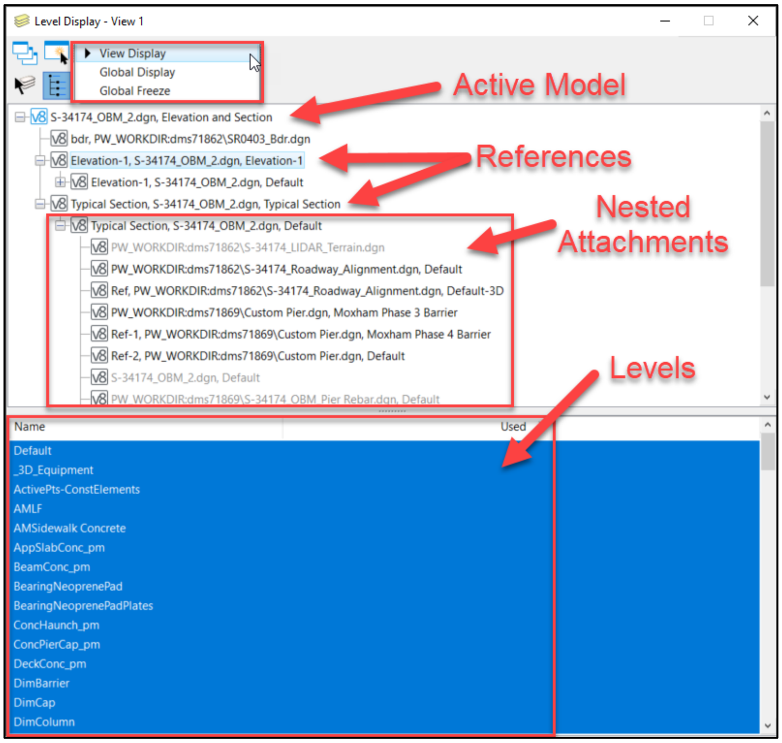

Figure 4.5-27 Level Display Dialog

View Display: All levels in the active model, references, and all nested attachments can be toggled on or off in each view. Reference display can also be achieved here by right clicking the reference or nested attachment and checking or unchecking Display in the menu. References that are greyed out in the list are currently not displayed in the view.

Global Display: All levels in the active model and references can be toggled on or off globally. Nested attachment levels cannot be toggled on or off globally if the nested attachments are from files other than the active OBM file.

4.5.5.4 Presentation

The Reference Presentation tool is a powerful tool when individual reference display settings need to be adjusted. The Presentation tool is a combination of the standard View Attributes tool and the Display Styles tool, with options that vary depending on model type and the active reference selected in the Reference Manager.

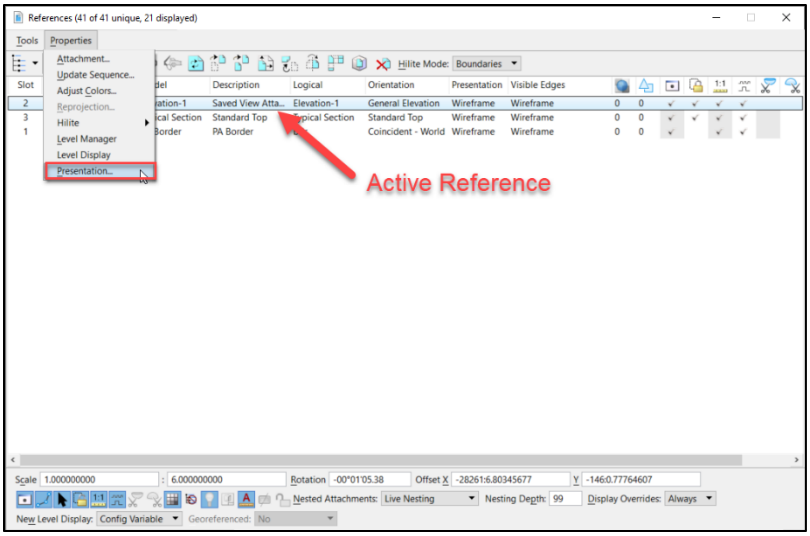

Figure 4.5-28 Update Sequence Location

In a 2D Drawing Model Reference, the Presentation options are very similar to the options available in the 2D View Attributes and Display Styles. Settings can be updated from a Saved View or pushed to a Saved View. If the View Attributes options are greyed out, ensure the Use View Flags box is checked. The Reference Display Style includes a Display Style exclusive to the Reference called **From Parent.** This Display style adopts whatever display style is active in the model being referenced, but the view attributes are still editable if the Use View Flags box is checked.

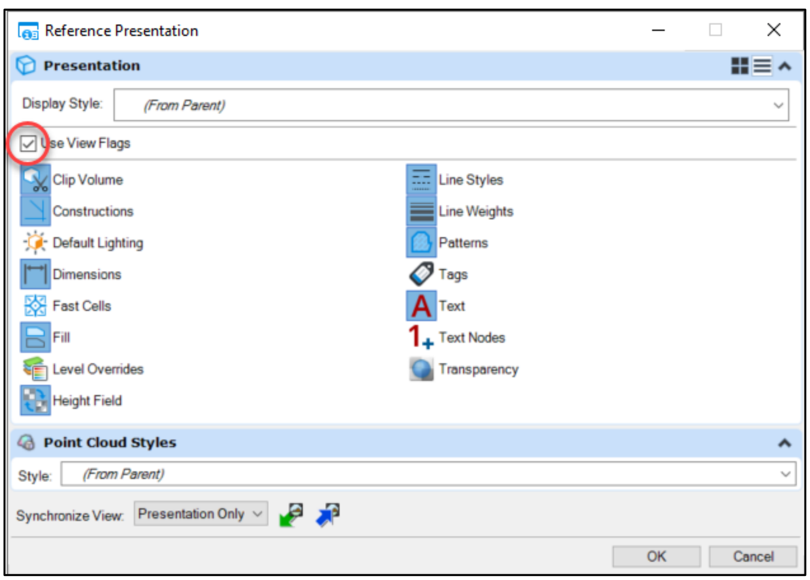

Figure 4.5-29 2D Drawing Model Reference Presentation Dialog

When a Plan Callout, Elevation Callout, or Section Callout creates a view that is referenced into a drawing model, more options become available within the Reference Presentation dialog in the drawing model to adjust the display settings of these views. The user will notice an additional section for the **Clip Volume Settings**, including view settings for **Forward, Back, Cut, and Outside**. Each of these settings has a correlating Display Style that can be toggled on or off and is fully adjustable.

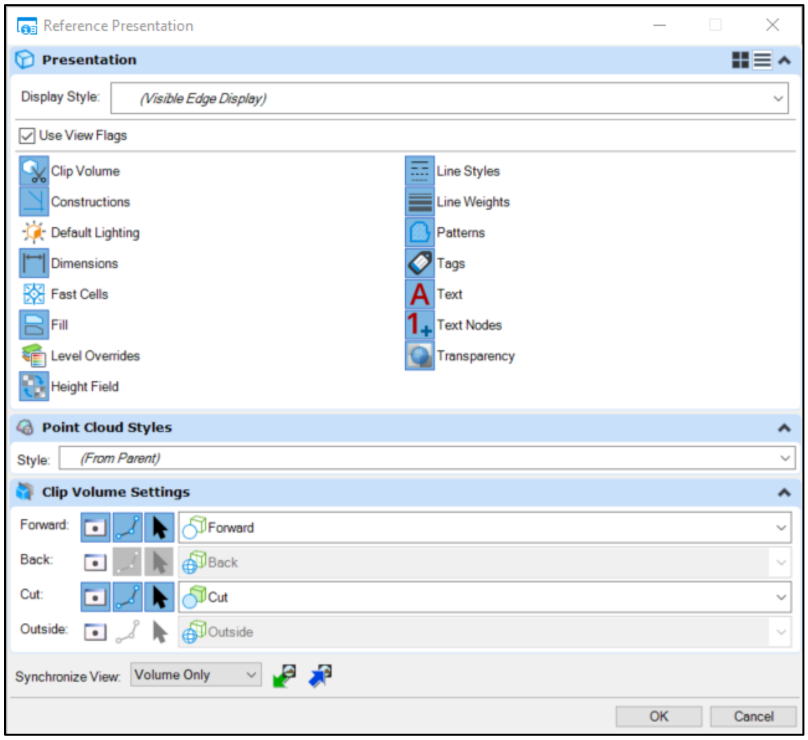

Figure 4.5-30 Plan/Elevation/Section Reference Presentation Dialog

Clip Volume Settings:

- Forward: Displays any objects in the model, in front of the cut plane, up to the depth of the designated clip volume
- Back: Displays any objects in the model, behind the cut plane, up to the depth of the designated clip volume
- **Cut**: Displays any objects in the model, passing through the cut plane, directly at the cut plane with no depth
- Outside: Displays all objects, Forward and Back, that are not within the Clip Volume

4.5.6 Auxiliary Coordinate System

OBM has a primary **Geographic Coordinate System,** which is on the global level for the file, but OBM also has a local coordinate system that can be set up for specific views and objects. This local coordinate system is called the **Auxiliary Coordinate System (ACS),** and the tools for the ACS can be found in the **Drawing Aids Tab** in the **Drawing** and **Modeling** workflows.

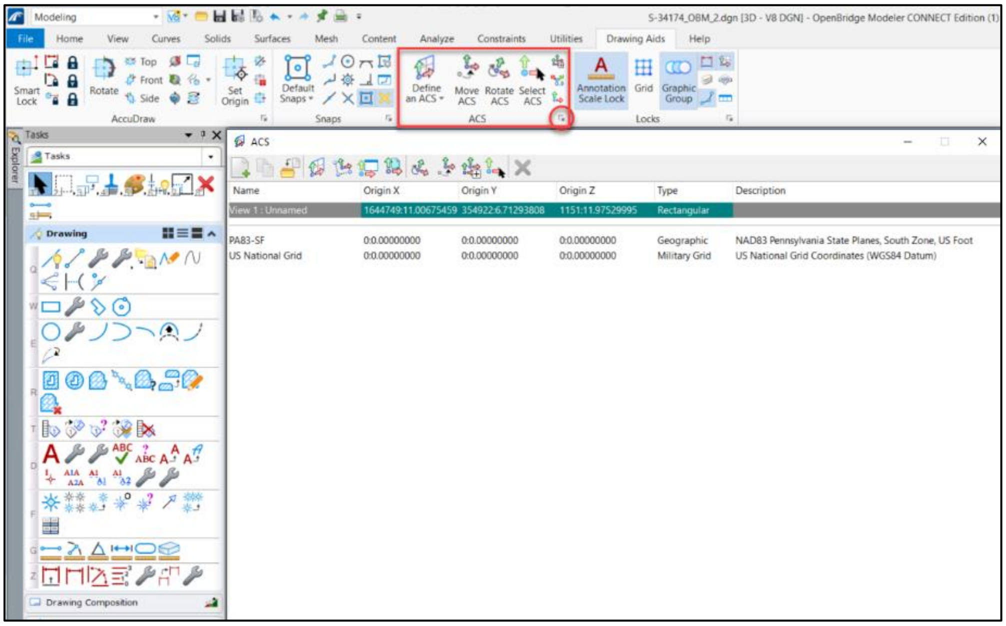

Figure 4.5-31 ACS Dialog

Multiple **Auxiliary Coordinate Systems** can be set up in the same file, and any of them can be activated and applied to a view at any time. To create an ACS, the user can define an ACS Aligned with Element, by Points, by View, by Reference, and by Plane. The ACS origin can be moved or rotated, at any time, by using the Move ACS or Rotate ACS commands, respectively. An existing ACS can be applied to any view using the **Apply ACS to Selected View**. Select **Toggle ACS Triad,** if the ACS symbol is not visible in the current view.

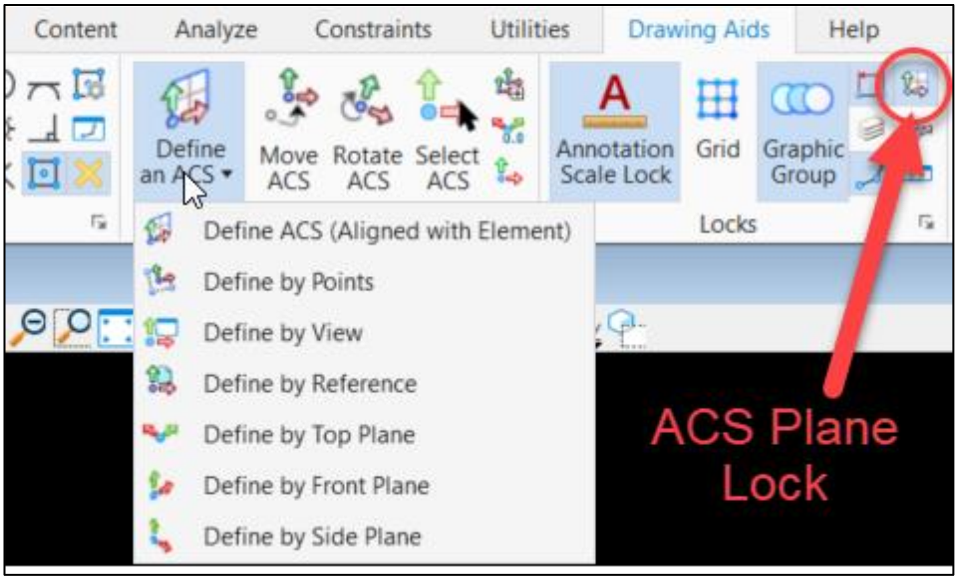

Figure 4.5-32 ACS Panel and Lock Panel

If the ACS is defined by anything other than View, but the view will not rotate to align with the ACS axis after it is defined, be sure the ACS Plane Lock in the Locks Panel is toggled on. Once toggled on, try changing View Rotate to the desired preset view perspective.

This ACS setup is especially useful to orient the user with the bridge before setting up any views, as most views need set up using the AccuDraw assistance to align view callouts parallel or perpendicular to the alignment.

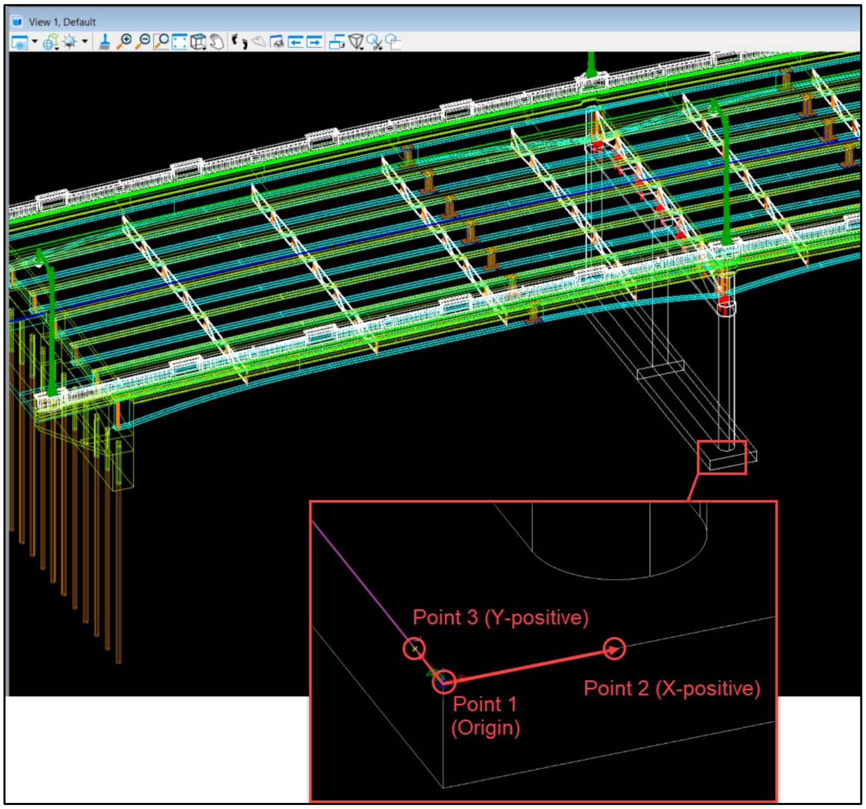

Figure 4.5-33 ACS Setup Example

Example: Instead of using the baseline to set up the ACS, as it is likely there is some type of vertical geometry that could throw off the vertical axis, set up the ACS with a 90-degree corner on a level plane, such as a Substructure Footing. Rotate the view to an isometric perspective to see the corner and the top edges. If placing the ACS by points, first select the rear right Footing corner point (looking ahead stations) to set the ACS origin then travel along the X-positive edge and click point 2 to set the X axis. Finally, travel along the top rear edge of the footing in the Y-positive direction and click point 3 to set the Y axis. Since the face of the footing is level, and the footing edges were selected for the X and Y axes, the Z axis will be truly vertical. A true vertical Z axis is required to obtain true Top, Front, and Side views in the rotate view presets. Toggle the ACS Plane Lock on and select Top from the View Rotate tool.

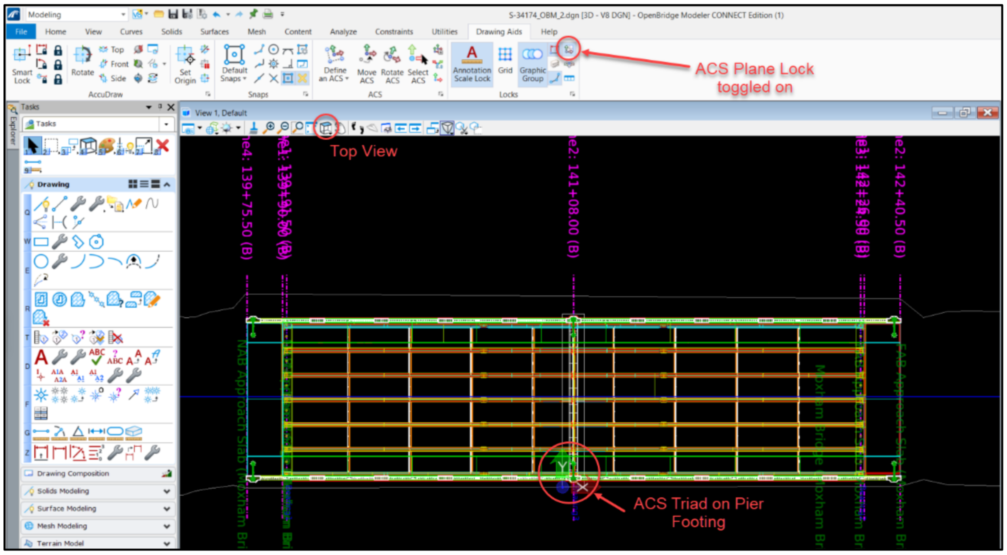

Figure 4.5-34 ACS Setup Example Complete

4.6 RECOGNIZING COMMAND PROMPTS AND INPUT

OBM follows a stepwise approach and uses “Command Prompts” to communicate to the user what the software requires next in order to execute the selected command. These prompts usually appear following the cursor in the active View, as well as in the bottom left corner of the OBM Window in the Status Bar. Also, many OBM tools use a Tool Setting dialog box that will appear after the tool is selected.

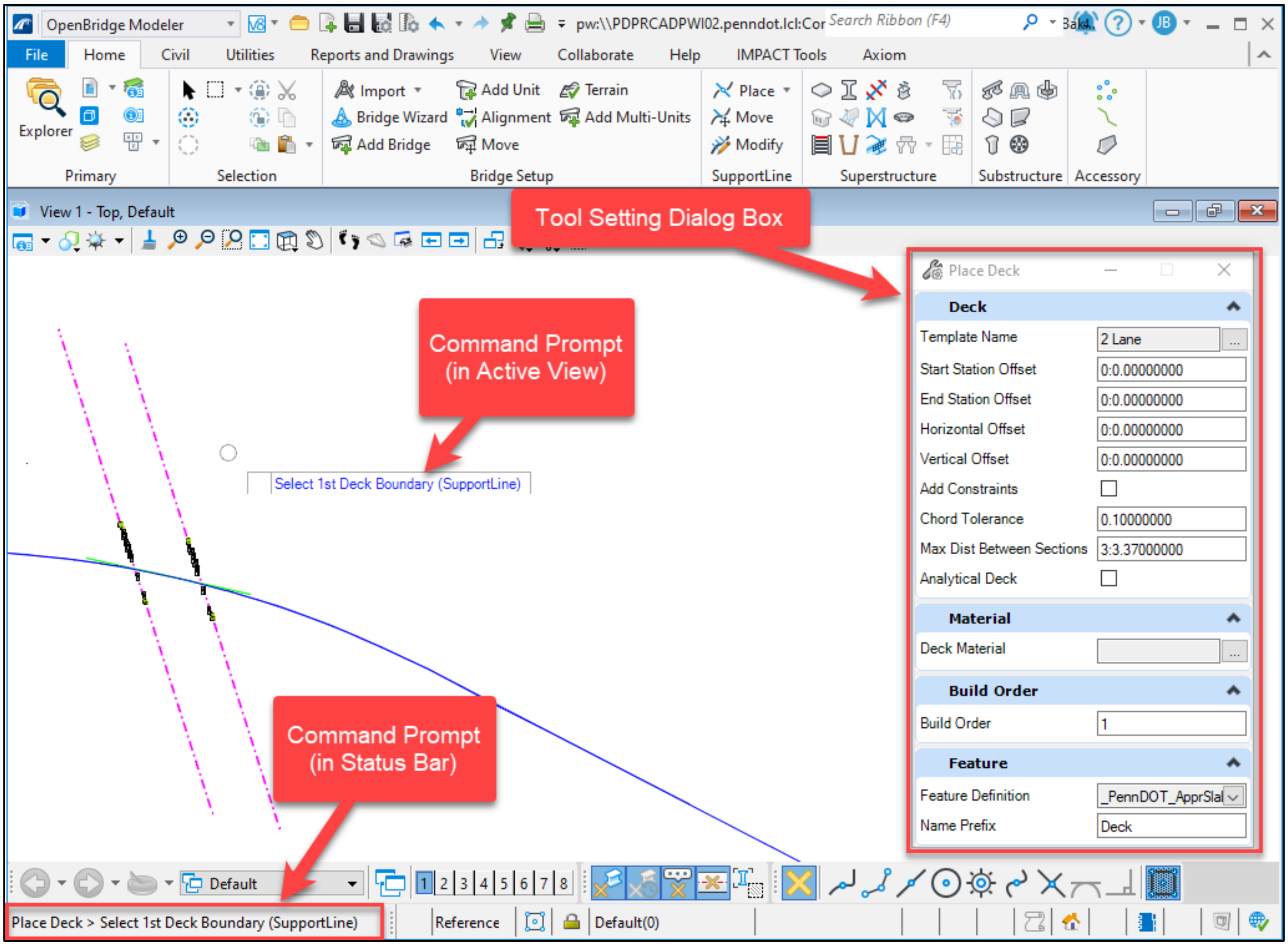

Figure 4.6-1 Command Prompts

Several of the prompts are not clear, and new users need to understand their meaning to successfully navigate this workflow:

- **Select**: Left click on an applicable model element
- **Data Point**: Left click anywhere in the active View
- **Reset**: Right click anywhere in the active View

On the next several pages, a list of the commands in the recommended sequence of use is provided for both prestressed superstructure and steel superstructure model development. Chapter 5 provides detailed input descriptions and guidance for these commands and tools.

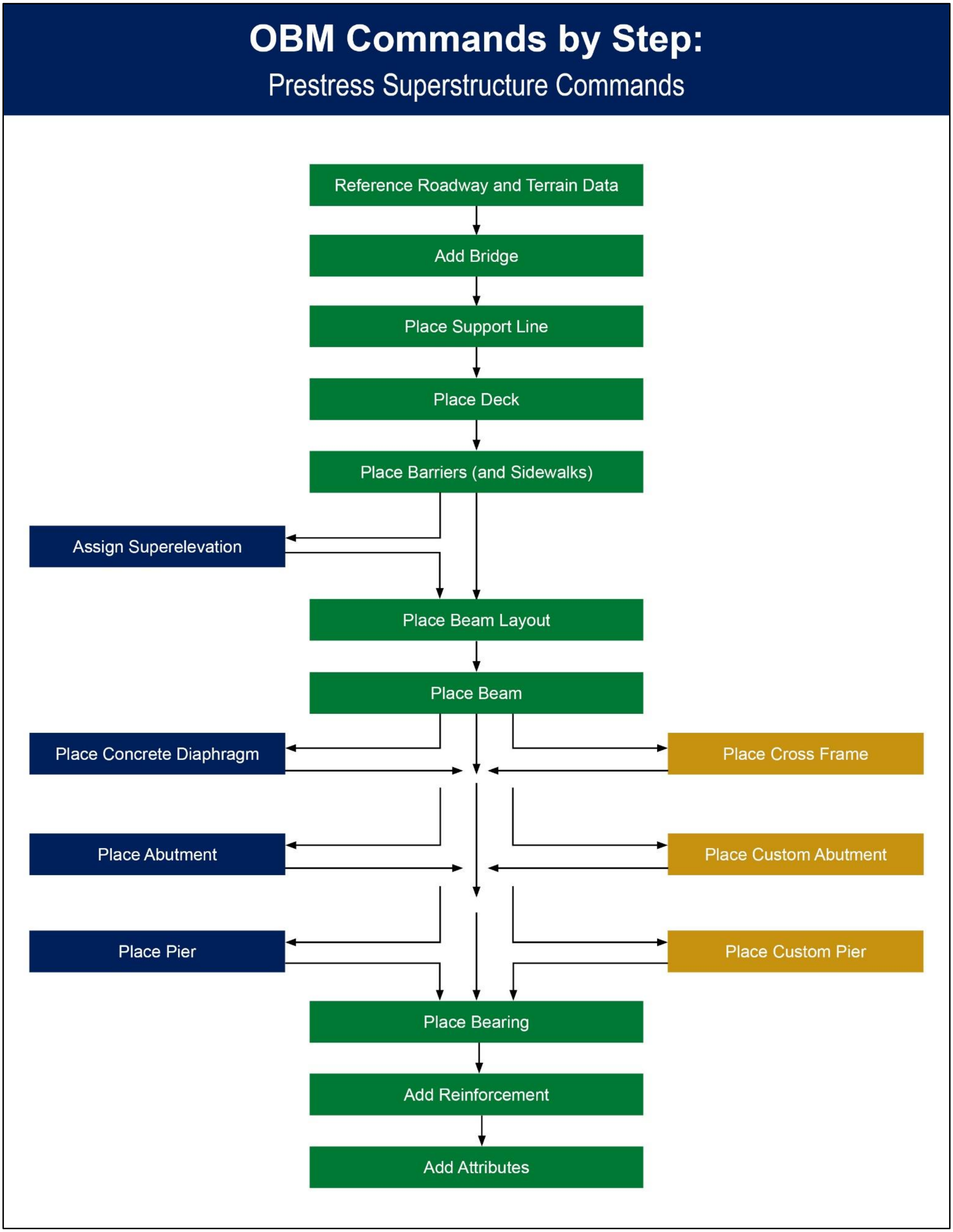

Figure 4.6-2 OBM Commands by Step: Prestress Superstructure Commands - Flowchart

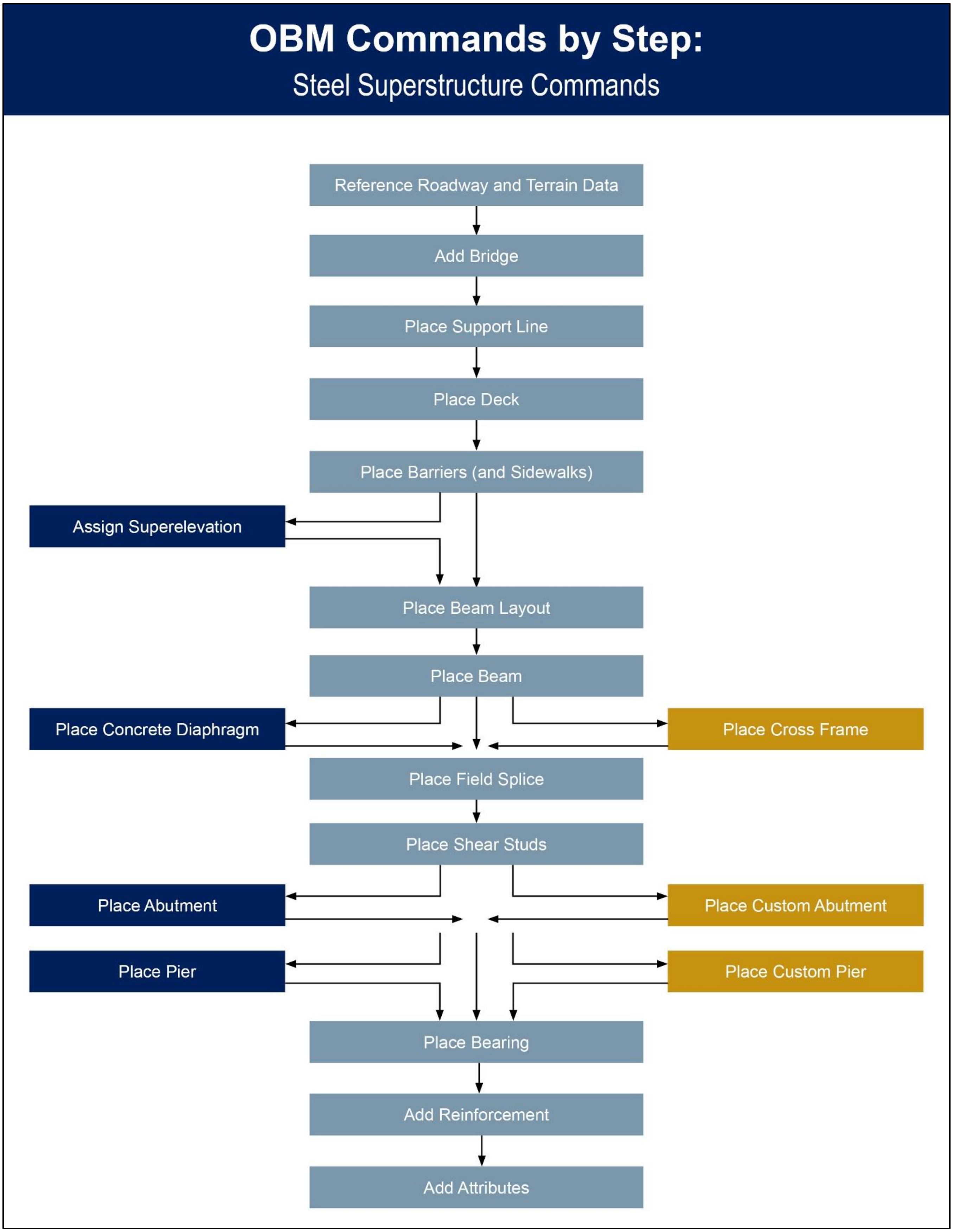

Figure 4.6-3 OBM Commands by Step: Steel Superstructure Commands - Flowchart

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INPUT DESCRIPTION

5.1 BRIDGE WIZARD

OBM has an option to use the **Bridge Wizard** to generate a bridge model. This tool can be used to create a low Level of Detail model quickly. However, not all commands/options are available through this wizard; the user must go back into most, if not all, bridge model components to edit these inputs for project-specific inputs. It is also easier to go through each command prompt from the start rather than attempt to go back and determine what needs to be modified. Therefore, it is recommended that users *not* use the **Bridge Wizard** at the current time. Users can follow this chapter to step through the applicable OBM commands without using the Bridge Wizard.

5.2 ORDER OF COMMANDS

When generating a new bridge model, some bridge elements are required to be entered in a specific order. In general, the bridge model is created with a “top-down” approach, and the elements use the information from previous commands as the basis for development, continuing in a stepwise fashion to create the bridge model in the 3D space. For example, a user cannot create a beam without first creating a beam layout. This chapter will outline the tools and order in which the elements and commands are recommended to be entered to create a bridge model using the OBM software.

5.3 ADDING ROADWAY GEOMETRY AND TERRAIN

The suggested workflow for adding roadway geometry and terrain data is to reference these files as DGNs into OBM so the user can automatically see updates and changes to alignment and other files without having to re-import files. The referenced information can be read and used by OBM with the same functionality as the roadway alignment/profile.

5.3.1 File Referencing

To reference the data into OBM, select the **OpenBridge Modeling** Workflow.

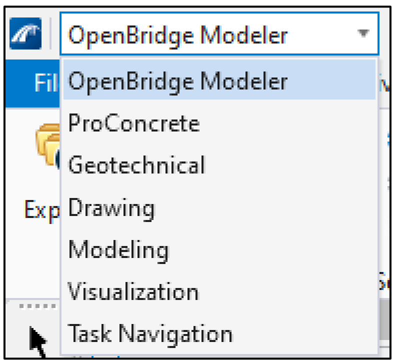


Figure 5.3-1 Workflow Dropdown

Navigate to **Home > Primary > References** to launch the References Dialog Box.

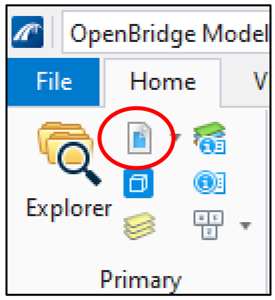


Figure 5.3-2 Open References Dialog Box

In the References Dialog Box select **Tools > Attach** or select the **Attach Reference** icon from the tool bar.

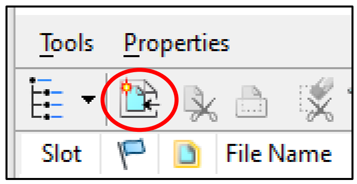


Figure 5.3-3 Attach Reference Icon

Browse to the file location where the roadway geometry and/or terrain model DGN files are stored. Select the file(s) to be attached.

Tips and Tricks: Multiple files may be referenced at the same time by using Ctrl + Left Mouse Click to select files.

The Reference Attachment Properties dialog box will appear for each reference file being attached. In the **Model** selection drop down bar, a 3D model must be selected for the reference file to display correctly in the active bridge model. This is mostly an issue for roadway geometry models, as the terrain models should only contain 3D model data. **Logical Name** and **Description** may be filled out to help organize and catalog various references beyond the file names alone. Ensure the Orientation is set to **Coincident – World** prior to selecting **OK**.

Workaround: In most cases, both the 2D or "Default" model and the 3D or "3D-Default" models must be referenced separately. The user can follow the same procedure twice for the same file and select the different models needed, as shown in the image below.

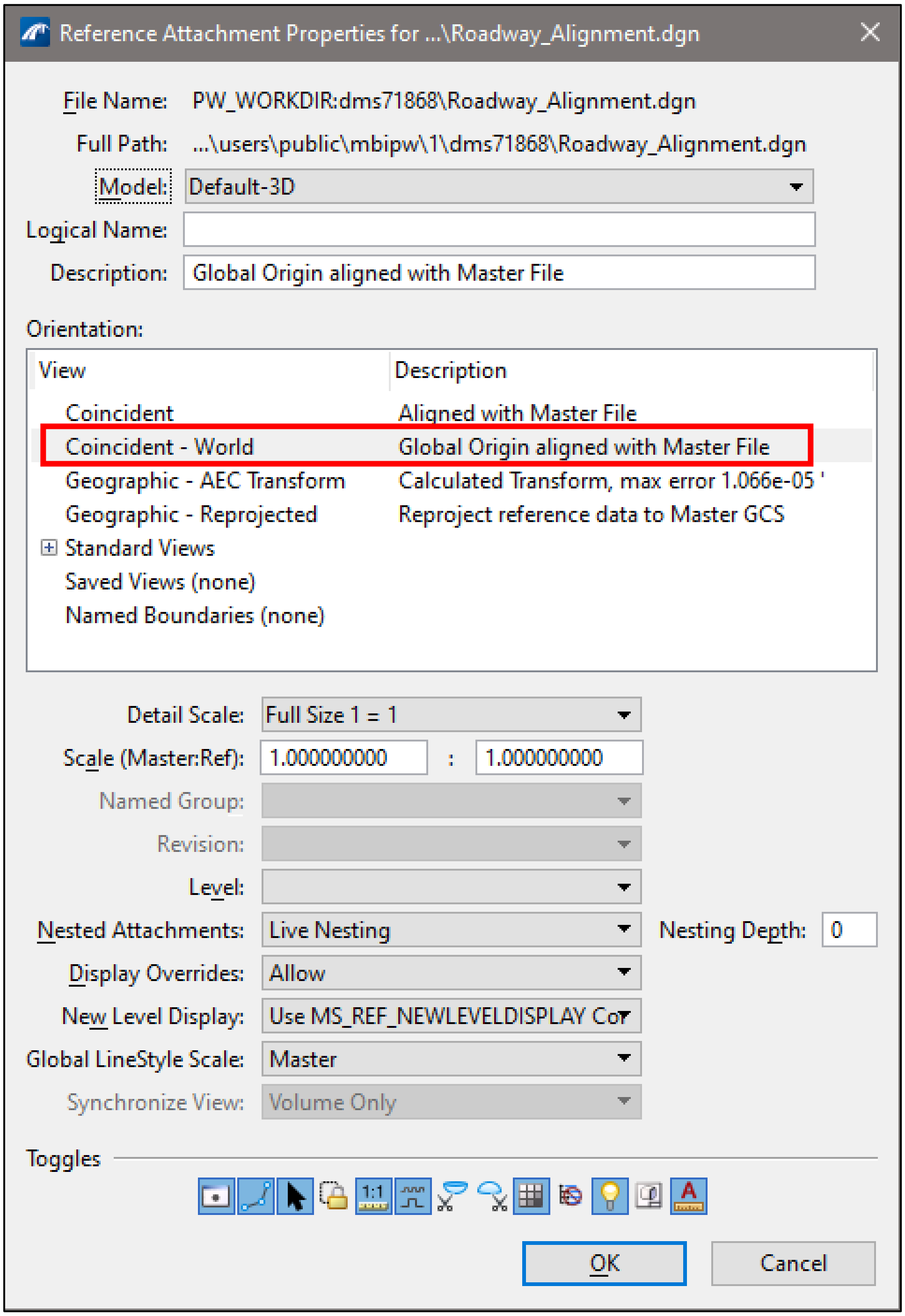


Figure 5.3-4 Reference Attachment Properties Window

In the active View Window, select **Fit View** to verify the file(s) were referenced correctly.

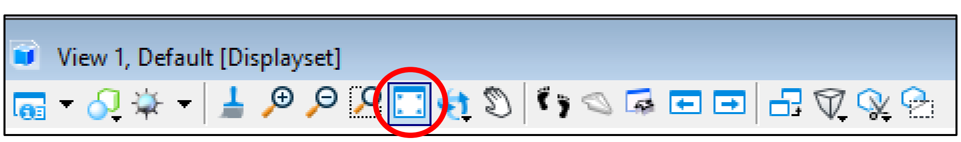


Figure 5.3-5 View Navigation Toolbar

Note: The roadway alignment can be imported into OBM with the **Home > Bridge Setup > Import Tool**. This workflow makes the geometry an active element of the Bridge Model file instead of a separate reference. It should be noted that if subsequent revisions are made to the working geometry file, it will not be automatically updated to the imported data and must be re-imported. Therefore, this is not the recommended workflow.

5.3.2 Terrain Model

Terrain Models referenced into the bridge model will display features that are currently active in the source file. Typically, this may be limited to only the terrain model boundary.

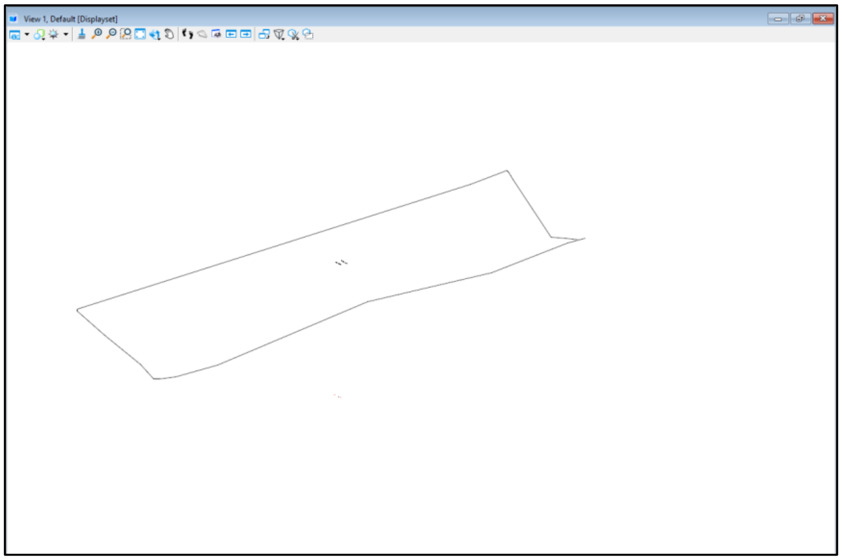


Figure 5.3-6 Terrain Model Displayed after Importing

To display additional features, such as contours or triangles, select the terrain model. In the **OpenBridge Modeler** workflow, select **Home > Primary > Properties** to launch the **Properties Dialog Box**. Navigate to **Reference > Override Symbology** and select **Yes** from the dropdown menu. All Calculated and Source Features present in the model can now be displayed in the OpenBridge Model.

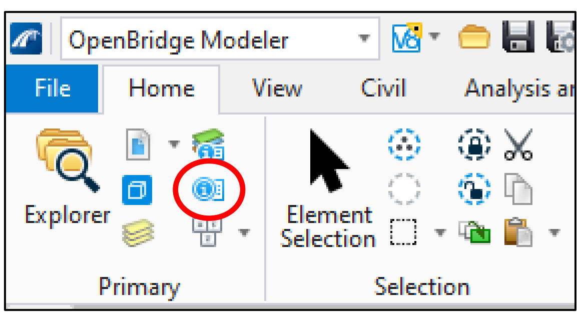


Figure 5.3-7 Open Properties Dialog Box

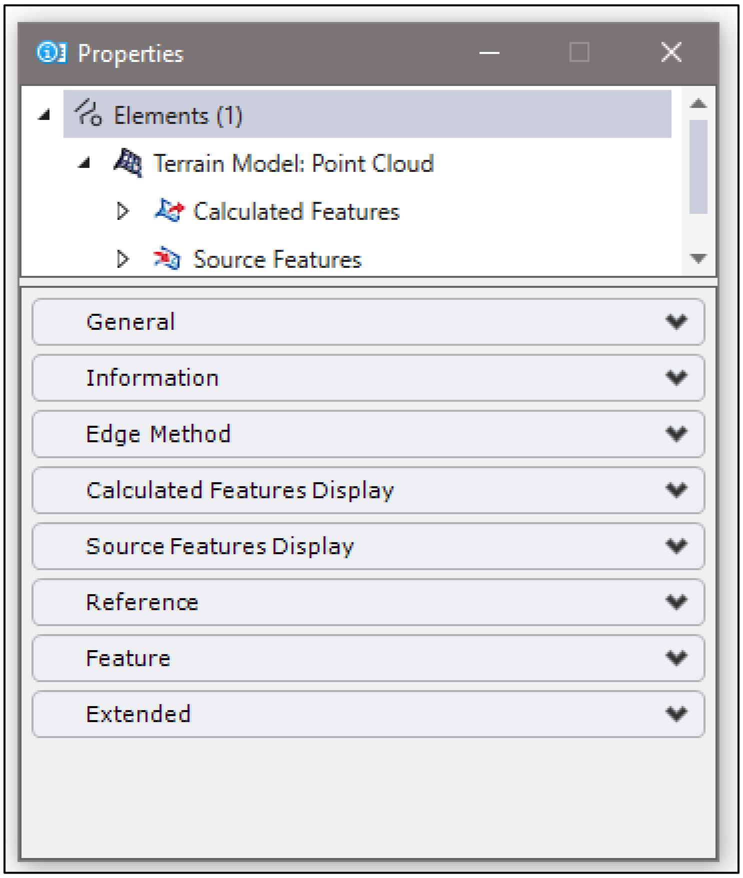


Figure 5.3-8 Properties Dialog Box (Terrain Model selected)

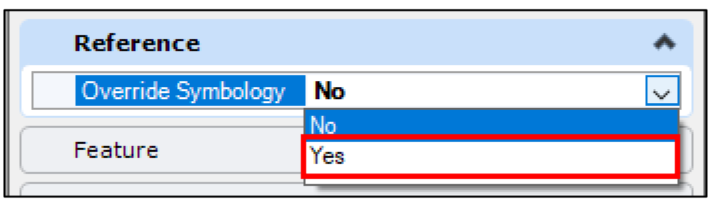


Figure 5.3-9 Override Reference Symbology

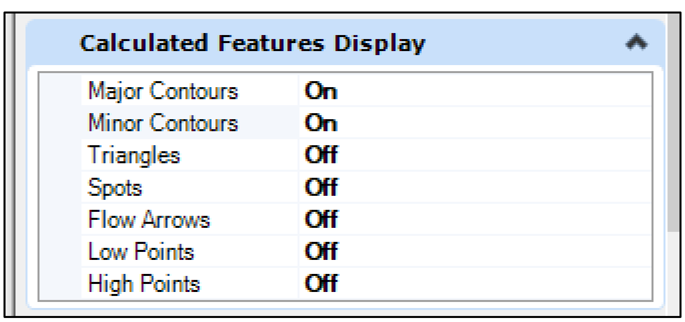


Figure 5.3-10 Calculated Features Display Options

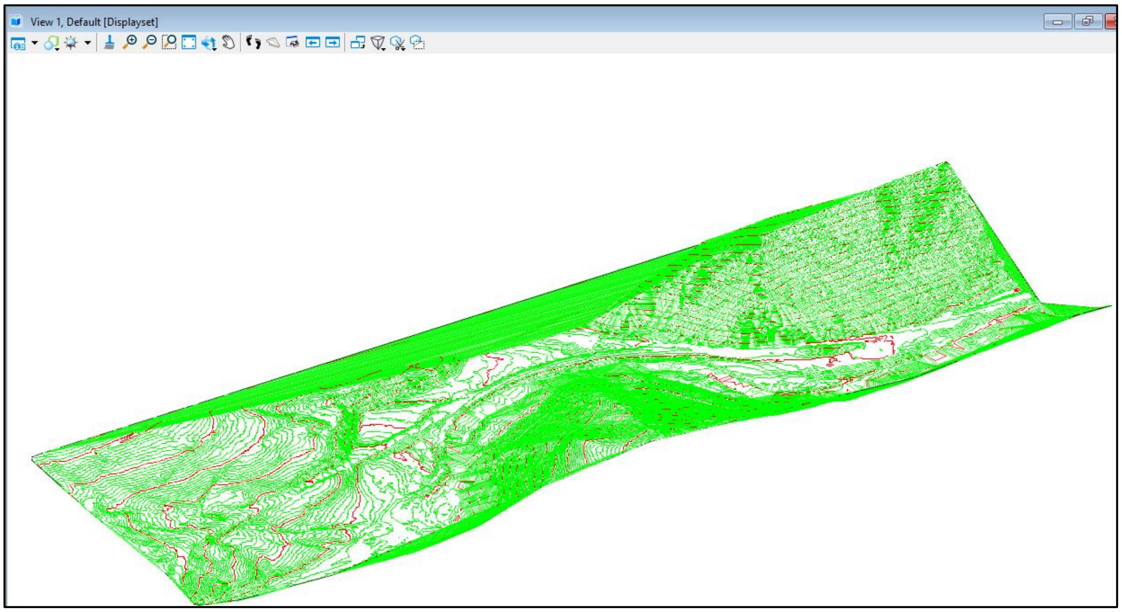


Figure 5.3-11 Referenced Terrain Model with overrides enabled

Additional information regarding importing and manipulating Terrain Models can be found in the PennDOT ORD training materials. Terrain models can be used to define initial footing elevations for substructure units during preliminary design. Footings can be set to a specific depth below the terrain model at the location of the substructure unit. This application will be discussed further in Chapter 6.

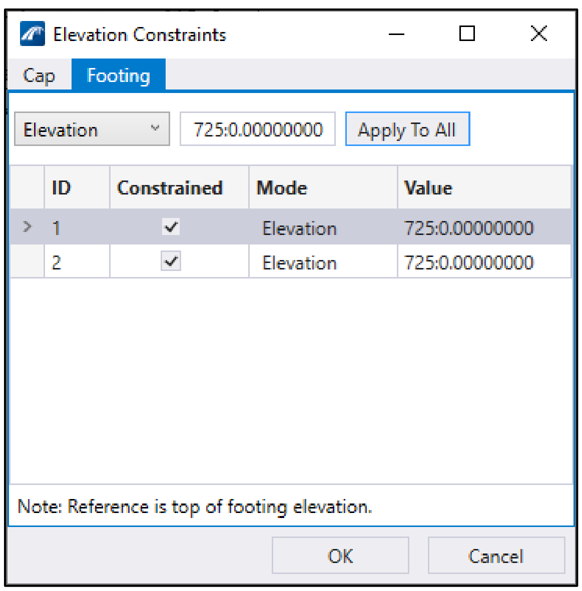


Figure 5.3-12 Elevation Constraints Window – Footings Tab

5.4 ADD BRIDGE

The first step in creating the actual 3D bridge model is to use the **Add Bridge** tool. The tool is located on the home tab: **Home > Bridge Setup > Add Bridge.** Basic bridge information and characteristics are entered in this window, and the bridge superstructure type is selected at this time. Once the superstructure type is selected; it cannot be modified later. To change superstructure types, a new bridge model must be created with the desired superstructure type.

An additional method for adding approach slabs, approach spans, and breaking up longer structures, is to use the **Add Unit** tool. This will place an additional bridge "unit" in the active bridge. However, all units in a bridge must use the same alignment/profile to use this tool. This tool helps the users organize and break the structure into defined segments. Using this tool, a different superstructure type can be modeled along the same alignment under the same bridge (P/S or RC Concrete Girders, Steel Girders, etc.).

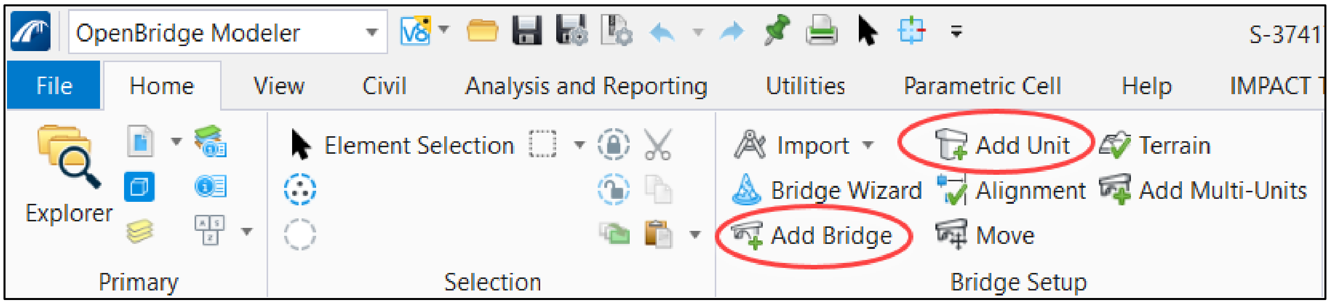


Figure 5.4-1 Add Bridge & Add Unit Buttons

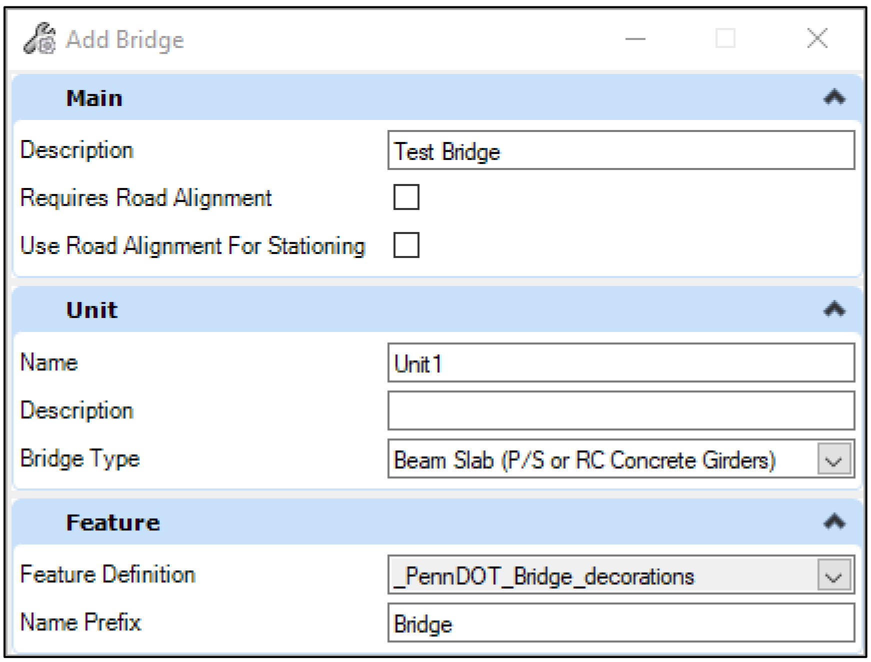


Figure 5.4-2 Add Bridge Input Window

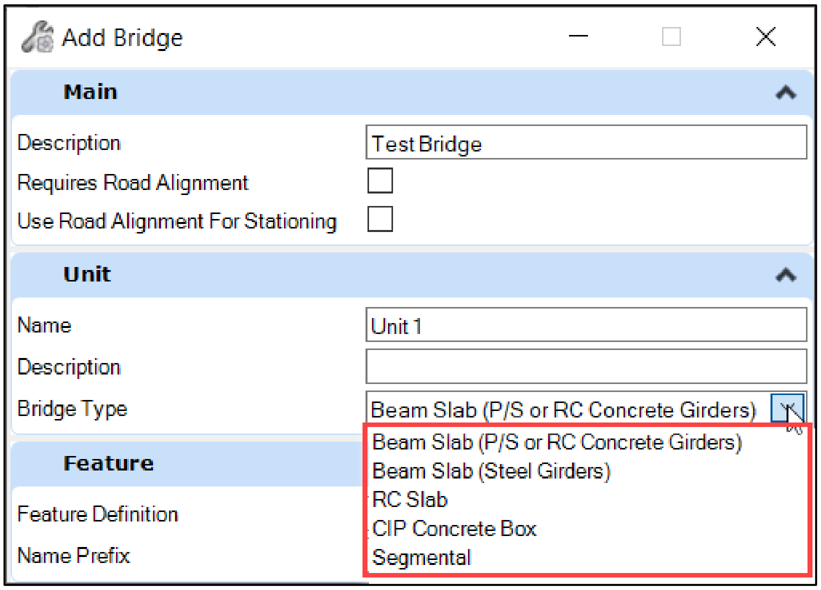


Figure 5.4-3 Bridge Superstructure Types Available in OBM

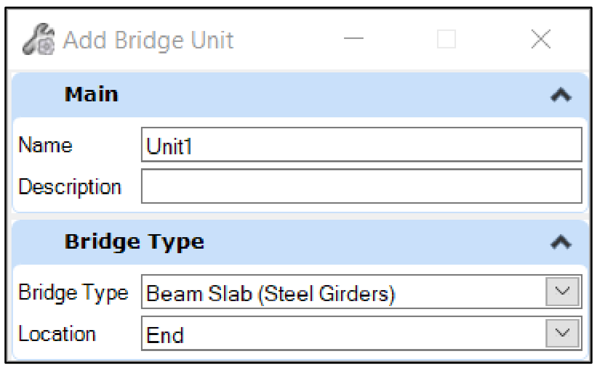


Figure 5.4-4 Add Bridge Unit Input Window

Note: It is important for users to consider the size of the bridge and how many bridges/units/files to break the bridge into since only one user can work in a file at a time. References can be used for larger bridge models to bring sections together that are completed in other files.

The prompts will require the user to select the alignment to use for the new bridge. It is important to select the "2D" alignment on the Z=0 plane and not the 3D alignment shown at the correct elevation. This requires both the 2D alignment or "default" model and the 3D alignment model to be separately referenced into the OBM .dgn file.

After the **Add Bridge** or **Add Bridge Unit** prompts are completed, the newly created bridge will appear under the **Explorer > OpenBridge Model** window. The Explorer window can be turned on and off through the **Home > Primary > Explorer Tool** and pinned in the view window based on user preference.

5.5 PLACE SUPPORTLINE

SupportLines are used to lay out the spans of a bridge and the location of substructure units. In general, add SupportLines for each CL bearing location of the substructure (this includes continuous, continuous for live load, and simply supported multi-span structure).

The **Place SupportLine** tools are located under the **Home > SupportLine** panel**.** There are three ways to place SupportLines; **Middle Point**, **Parallel**, and **Multi**.

Tips and Tricks: The Multi SupportLine tool offers the most flexibility and advantages when changes to the model occur and should be used whenever possible in model development.

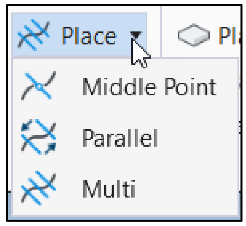


Figure 5.5-1 Place SupportLine Tools

5.5.1 Middle Point

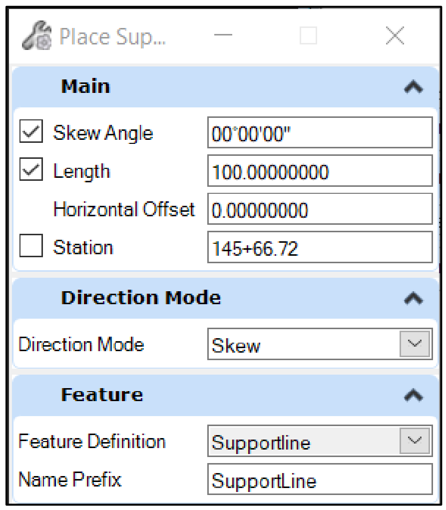
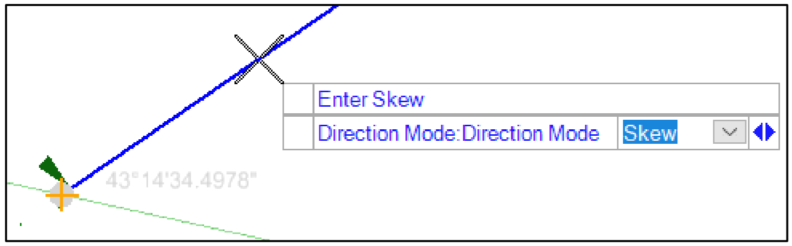
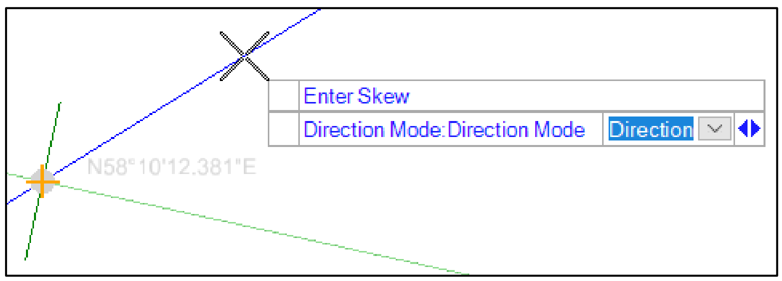


Figure 5.5-2 Place SupportLine By Middle Point

Table 2 Place SupportLine By Middle Point

Input	Description
Skew Angle	*AASHTO* skew angle for SupportLines normal to the alignment (no skew = 0 degrees). **Note:** OBM uses the AASHTO definition of skew angle, not PennDOT's.
Length	Length of SupportLine element generated in the model space. **Note:** The length must be longer than the width of the bridge to avoid modeling errors when placing the deck. If length is not specified, the distance away from the alignment where the data point is selected will be taken as half the SupportLine length; The additional half being generated on the opposite side of the alignment.
Horizontal Offset	Horizontal Offset of the SupportLine element from the alignment. Positive values shift the SupportLine to the right looking stations ahead, negative values to the left looking stations ahead.

Input	Description
Station	Station to place SupportLine. If stations are not specified, then the point on the alignment where the data point was selected will be used for the station.
Direction Mode	Select input: **Skew -** AASHTO skew angle will be displayed next to the alignment to aid in the placement of the SupportLine.  **Direction** - A direction angle will be displaced to aid in the placement of the SupportLine. 
Feature Definition	Select the feature definition to assign to the SupportLine.
Name Prefix	Insert/create a name for the SupportLine.

5.5.2 Parallel to SupportLine

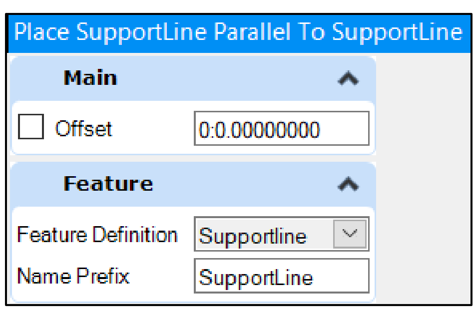


Figure 5.5-3 Place SupportLine Parallel to SupportLine

Table 3 Place SupportLine Parallel to SupportLine

Input	Description
Offset	Distance between parallel supports along the alignment.

Input	Description
	Tips and Tricks: This method places SupportLines at a distance normal to other SupportLines, not along the alignment. No station is associated with the Offset SupportLine, so editing placement can only occur by that normal distance input.
Feature Definition	Select the feature definition to assign to the SupportLine.
Name Prefix	Insert/create a name for the SupportLine.

5.5.3 Multi SupportLines

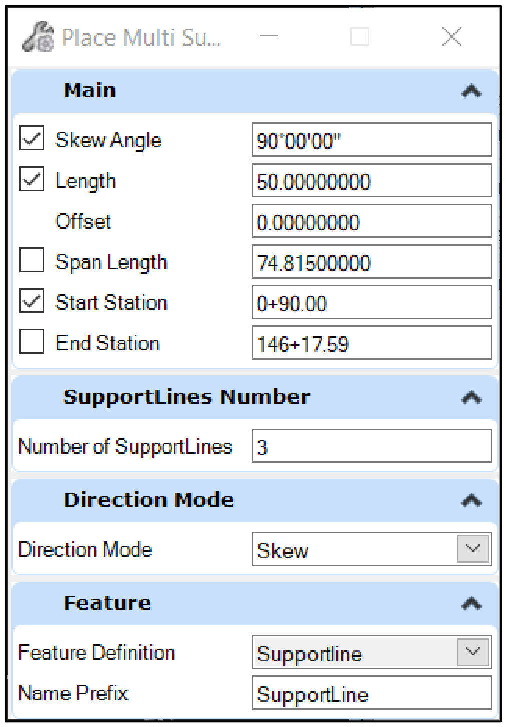
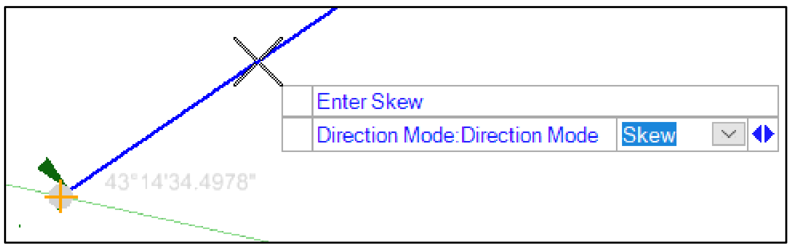
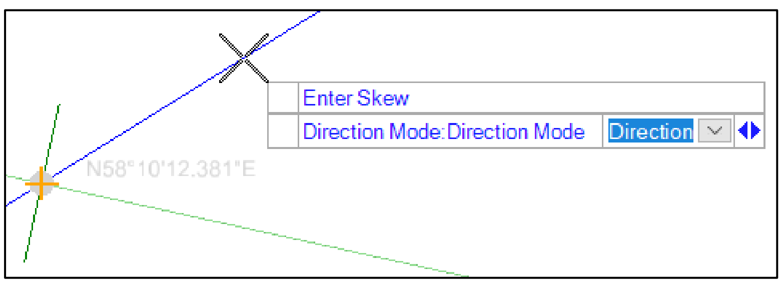


Figure 5.5-4 Place Multi SupportLines

Table 4 Place Multi SupportLines

Input	Description
Skew Angle	AASHTO Skew angle for SupportLine normal to the alignment (no skew = 0 degrees). **Note:** OBM uses the AASHTO definition of skew angle, not PennDOT's.
Length	Length of SupportLine element generated in the model space. **Note:** The length must be longer than the width of the bridge to avoid modeling errors when placing the deck. If length is not specified, the distance away from the alignment where the data point is selected will be taken as half the SupportLine length; The additional half being generated on the opposite side of the alignment.

Input	Description
Horizontal Offset	Horizontal Offset of the SupportLine element from the alignment. Positive values shift the SupportLine to the right looking stations ahead, negative values to the left looking stations ahead.
Start Station	Specify the station of the first SupportLine in the group.
End Station	Specify the station of the last SupportLine in the group.
Number of SupportLines	Enter the number of SupportLines to generate.
Direction Mode	Select input: **Skew -** AASHTO skew angle will be displayed next to the alignment to aid in the placement of the SupportLine.  **Direction** - A direction angle will be displayed to aid in the placement of the SupportLine. 
Feature Definition	Select the feature definition to assign to the SupportLine.
Name Prefix	Insert/create a name for the SupportLine.

Once the commands have been completed to place the SupportLines, the SupportLines can be modified using either the **Move** or **Modify** commands. The **Modify** command can only be used on SupportLines that have been created originally using the **Multi SupportLine** command.

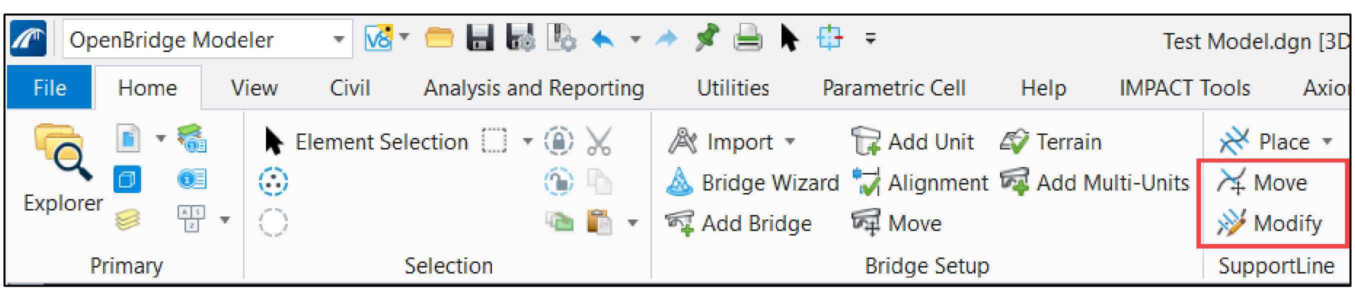


Figure 5.5-5 Tools to Modify SupportLines

5.6 PLACE DECK

5.6.1 Place Deck

SupportLines are required to be modeled before a deck(s) can be defined. **Decks** are placed from **SupportLine to SupportLine**. Users can model the same deck template across multiple spans by selecting the **Start SupportLine** of the first span and **End SupportLine** of the final span to be included in the set.

The Place Deck tools is located here: **Home > Superstructure > Place Deck**.

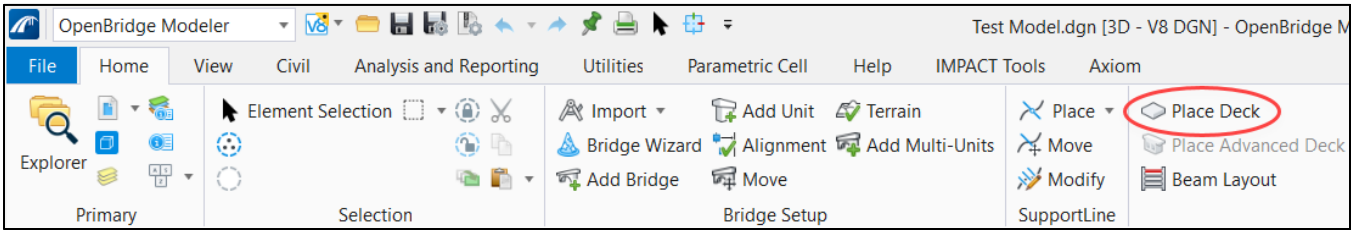


Figure 5.6-1 Place Deck Command

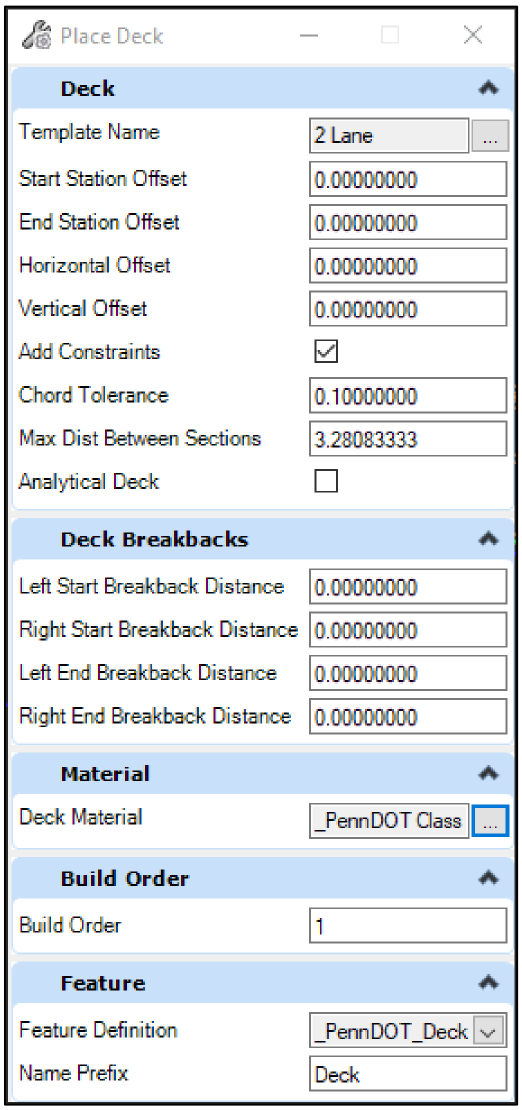


Figure 5.6-2 Place Deck Input Window

Table 5 Place Deck

Input	Description
Template Name	Selecting the ellipses or three dots next to the **Template Name** will open the **Template Selection** dialog. Select the template to place in the model. There are several templates available under the “PennDOT” folder included with the workspace. There are also the deck templates that are delivered in the standard workspace that can be used, especially for preliminary models. **Note:** Deck templates can be accessed at ***Utilities > Libraries > Decks,*** and more information is provided below and in Chapter 6.
Start Station Offset	Enter offset distance from the starting SupportLine along the alignment.
End Station Offset	Enter offset distance from the end SupportLine along the alignment.
Horizontal Offset	Enter horizontal offset distance from Work Point (WP) to alignment of the deck template.
Vertical Offset	Enter vertical offset distance from WP to alignment of the deck template.
Add Constraints	Assign variable constraints immediately after deck is placed. **Tips and Tricks:** Variable constraints can be adjusted after the deck has been placed by **Element Section (Deck in Model) > Properties > Rule Property > Variable Constraint**.
Chord Tolerance	To build more accurate/refined models and allows for further refinement when alignments have curvature present. **Tips and Tricks:** Small tolerance creates more accuracy but also produces a larger file size and will slow model regeneration.
Max Dist Between Sections	The distance along alignment between templates. OBM will then interpolate between these sections, so the distance between affects the accuracy of the modeled deck in horizontal/vertical curvature or variable conditions. **Tips and Tricks:** A small distance increases the accuracy of the model but will slow model regeneration. Use small distance (i.e., 1 ft.) for curved or skewed structures where more accuracy is needed and/or when having issues with deck breakbacks not functioning properly.
Analytical Deck	Designate the deck to have analytical properties or not. This is used only when data is transferred to LBC and LBS.
Deck Breakbacks	Allows for “squaring off” of deck ends at skewed supports per PennDOT BD standards. **Note:** See Section 5.6.3 and 6.6.3 for more details and information on this tool and its applicability and functionality.
Left Start Breakback Distance	Distance normal to the alignment (i.e. width of the barrier) for the deck “square-off” point for skewed decks on the left side of the deck start location (looking stations ahead).
Right Start Breakback Distance	Distance normal to the alignment (i.e. width of the barrier) for the deck “square-off” point for skewed decks on the right side of the deck start location (looking stations ahead).

Input	Description
Left End Breakback Distance	Distance normal to the alignment (i.e. width of the barrier) for the deck “square-off” point for skewed decks on the left side of the deck end location (looking stations ahead).
Right End Breakback Distance	Distance normal to the alignment (i.e. width of the barrier) for the deck “square-off” point for skewed decks on the right side of the deck end location (looking stations ahead).
Deck Material	Select the deck material from the **Material Library**. Several PennDOT specific materials are included in the workspace. Users can create material libraries as needed.
Build Order	Define build order for the construction of elements.
Feature Definition	Select the feature definition to assign to the deck. (see Section 3.1 for more details)
Name Prefix	Insert/create a name for the Deck.

5.6.2 Variable Constraints

Variables can be added to the deck templates to vary the deck properties along the length of the deck. Some examples are variable deck thickness, variable cross slopes for shoulders and lanes, variable lane widths, flared deck, etc. The Variable Constraints dialog box can be accessed, as noted above, when placing the deck or through the Properties menu. A full list of variables for each deck template supplied in the PennDOT workspace is included in Section 10.1: Deck Template Exhibits.

Modifying the constraint variables of a standard deck template is one approach to defining the deck for project-specific parameters. Another approach is to copy the standard deck template in the **Utilities > Libraries > Deck** library and modify it before placing it. Refer to Section 6.6.1, Options to modify deck templates, for more information.

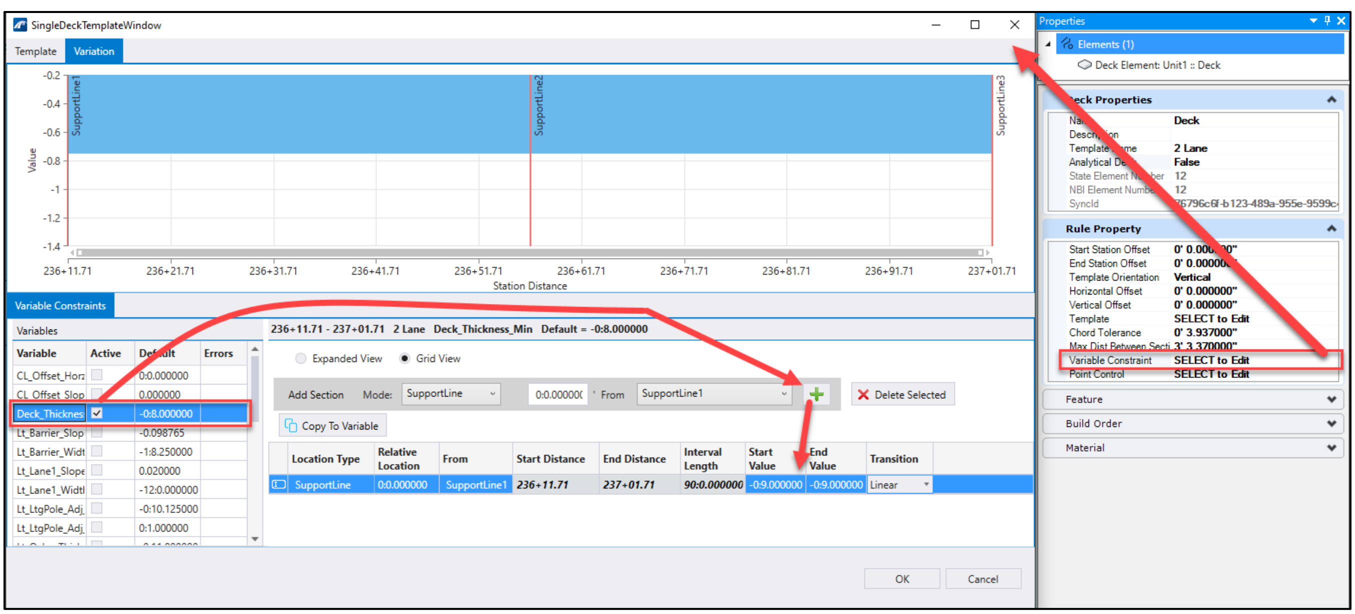


Figure 5.6-3 Deck Properties – Variable Constraint [FDOT, 2022]

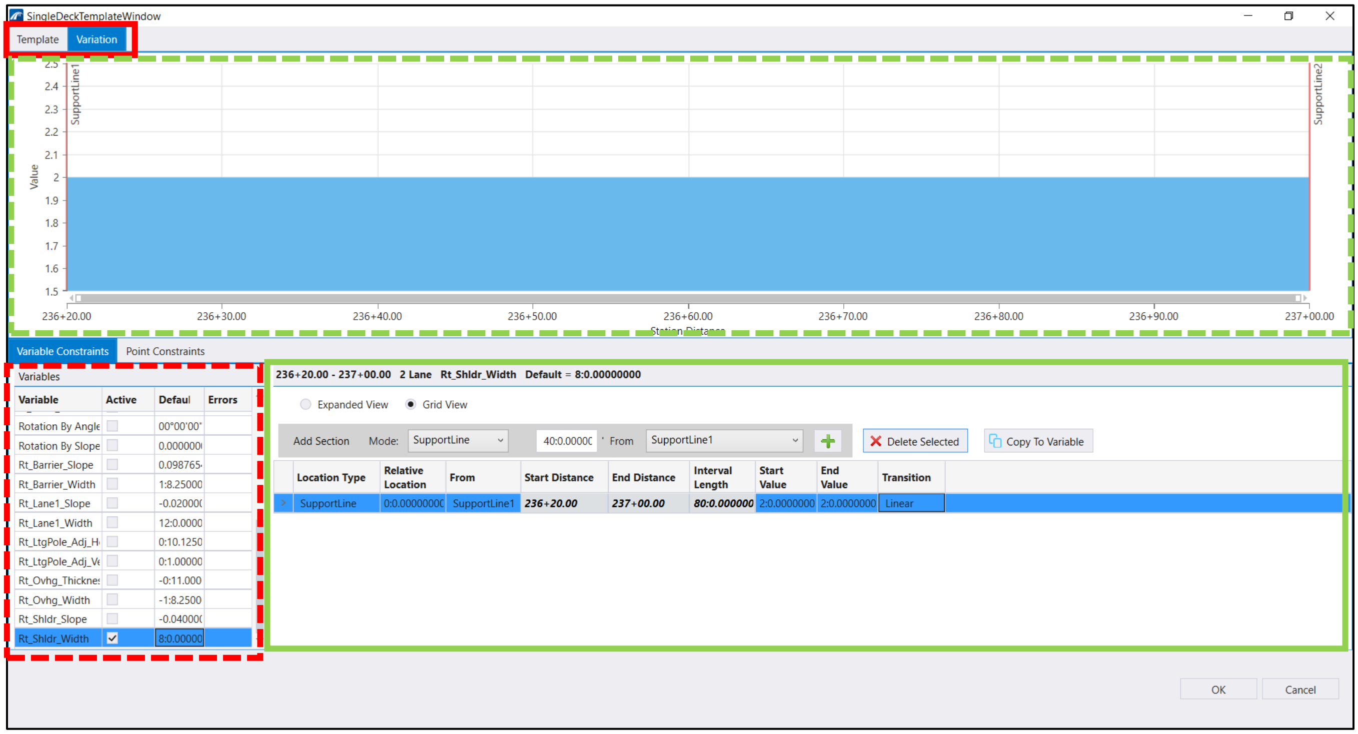


Figure 5.6-4 Single Deck Template Window (or Variable Constraints dialog) [FDOT, 2022]

Solid Red Box – Selection between viewing windows. The “Variation” Window is shown in the screenshot, displaying the details of the selected variable. The “Template” Window shows the cross section of the selected template.

Dashed Red Box – This **Variable** table has 4 columns. The **Variable** column lists the variable names as defined by the selected template. The **Active** column contains check boxes for each variable, that can be checked if desired inputs for that variable are different than the values brought in by the template. The **Default** column shows the values given by the template and will be used if the check box is unchecked.

Solid Green Box – This window shows the change in the selected variable over the length of the active bridge. Changes can be made only if the checkbox for the selected variable is checked. The screenshot above shows the details for the **RT_Shldr_Width** variable, which has changed the width of the right shoulder from the default value of 8’, to 2’ over the entire length of the deck.

Dashed Green Box – This window shows a graphical representation of the information put in the Solid Green Box. The y-axis represents the values for that variable, and the x-axis follows the stationing of the selected deck. [FDOT, 2022]

5.6.3 Deck Breakbacks

The Deck Breakback inputs allows for “squaring off” of deck ends at skewed supports per PennDOT BD standards. The distances entered by the user specifies the width of deck being affected. Therefore, the distances typically entered are the barrier widths at each corner of the structure with skewed supports. Use this functionality in conjunction with the Barrier “End Cut Orientation” and station offsets for modeling these components for skewed structures.

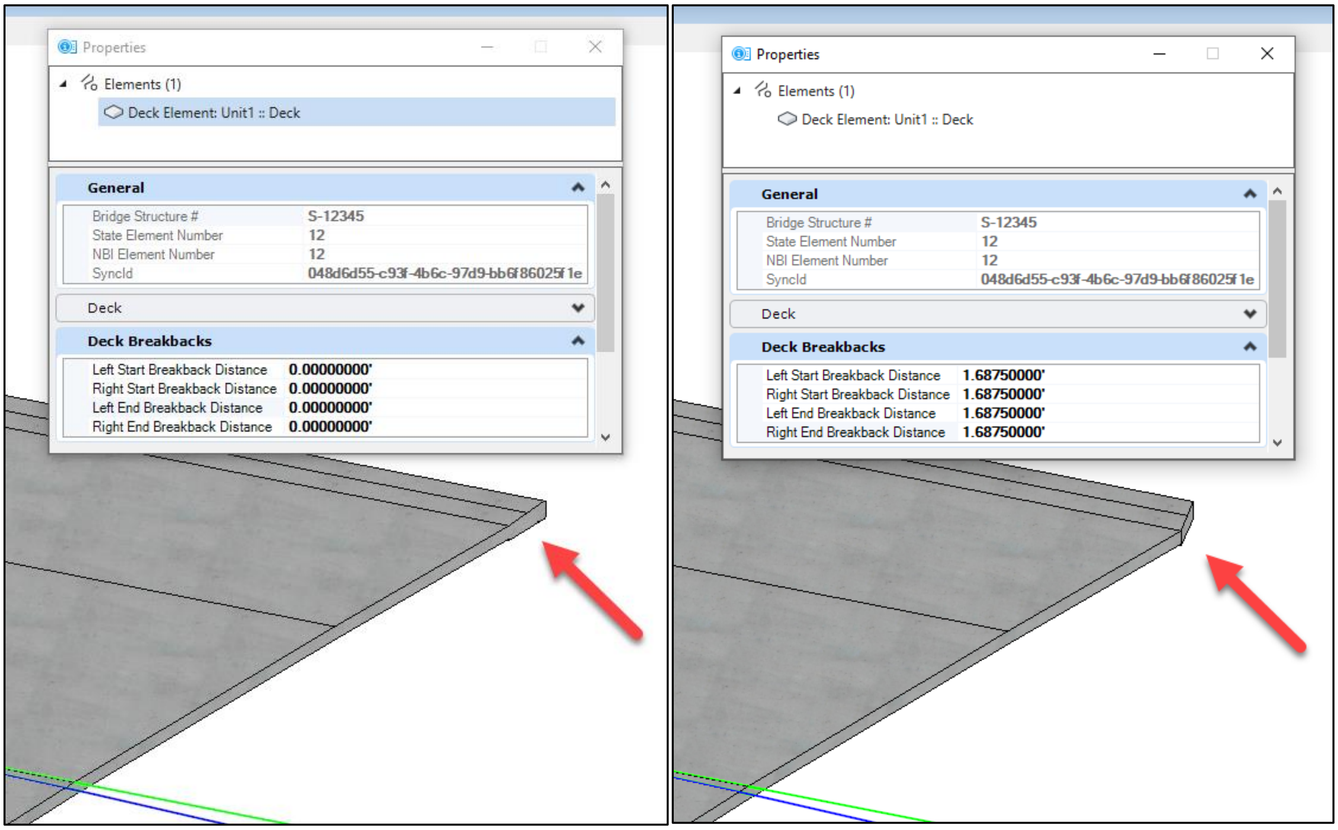


Figure 5.6-5 No Deck Breakback Distance VS. Breakback Distance Equal to Barrier Width

Tips and Tricks: If the model is not responding to the Deck Breakback Distance input value, try choosing a smaller distance for the "Max Dist Between Sections" input (i.e., 1 ft.) in the **Place Deck** input or the Deck Properties (after placement).

5.7 PLACE BARRIERS AND SIDEWALKS

Barriers and sidewalks (**Home > Accessory > Place Barrier**) are placed into a model by selecting an active deck. Barrier and sidewalks are placed into the model using the **Work Point (WP)** location designated in the barrier or sidewalk template. The procedure for placing barriers and sidewalks is the same, but the location at which they are placed may differ.

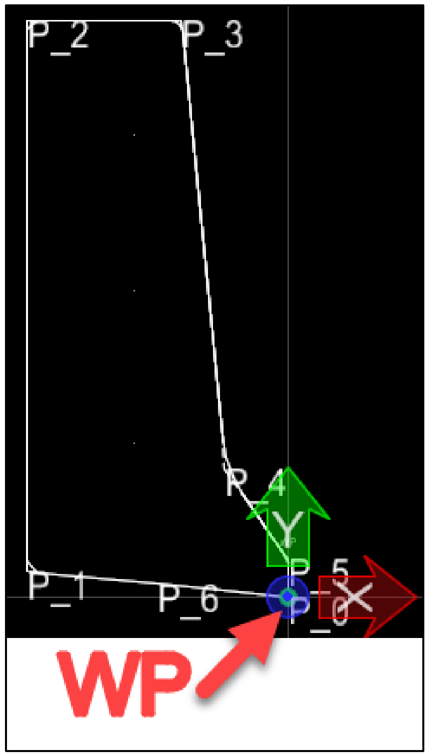


Figure 5.7-1 Barrier Template and Work Point

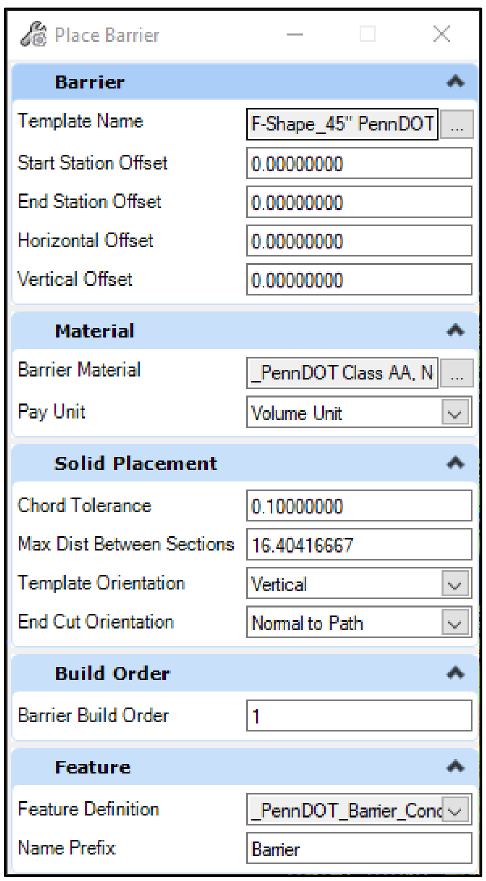


Figure 5.7-2 Place Barrier

Table 6 Place Barrier

Input	Description
Template Name	Selecting the ellipses or three dots next to the **Template Name** will open the **Template Selection** dialog. Select the template to place in the model. Note: Deck templates are created or modified under ***Utilities > Libraries > Barriers***. More information is provided in Chapter 6.
Start Station Offset	Enter offset distance from the starting SupportLine along the alignment.
End Station Offset	Enter offset distance from the end SupportLine along the alignment.
Horizontal Offset	Enter horizontal offset distance from the WP of the template to the path that has been selected for the barrier.
Vertical Offset	Enter vertical offset distance from the WP of the template to the path that has been selected for the barrier.
Barrier Material	Select the deck material from the **Material Library**. There have been several PennDOT specific materials added to the workspace and users can create libraries as needed.
Chord Tolerance	Used to build more accurate/refined models and allows for further refinement when alignments have curvature present. **Tips and Tricks:** Small tolerance creates more accuracy but also a larger file size and will slow model regeneration.
Max Dist Between Sections	Distance between sections increase or decrease the accuracy of the modeled barrier. **Tips and Tricks:** A small distance increases the accuracy of the model but will slow model regeneration.
Template Orientation	Details the orientation of the solid faces of the barrier along the alignment.
End Cut Orientation	Details the end condition of the barrier. Specifically, if the barrier end condition (see Figure 5.7-4 Barrier Normal to Path VS. Follow Skew): • Follows the skew • Normal to the barrier path Note: This typically should be set to "Normal to the barrier path," and, along with Station Offsets, can orient the barrier correctly at skewed supports.
Build Order	Defines build order for construction of elements.
Feature Definition	Select the feature definition to assign to the deck.
Name Prefix	Insert/create a name for the Deck.

Using the **WP** designated in the barrier template, the barrier template is placed along an alignment or placed along a deck template point that is selected from a guideline list. When the **Select Guideline from List** is chosen, the deck template in which the barrier is to be placed is shown, and the user must select the correct deck template point in which to align with the WP on the barrier template.

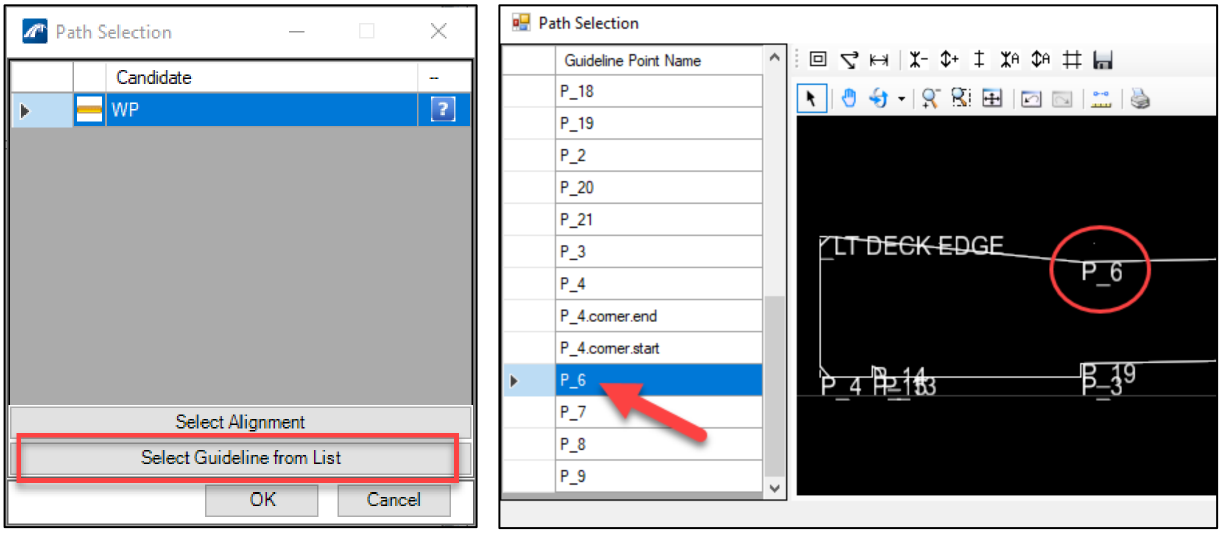


Figure 5.7-3 Path Selection and Guideline Point Names Example for Left Barrier Placement

Tips and Tricks: The text size in the template view window can be adjusted with the [tool icons] tools at the top of the window as the text is often overlapping in the default setting.

Note: The Work Point for the outside barrier templates is the curb line, and it is the center for median barrier templates.

The barrier template end condition can be specified to **Follow Skew** or **Normal to Path**, before or after the barrier is placed. Typically, “Normal to Path” should be specified per PennDOT standards.

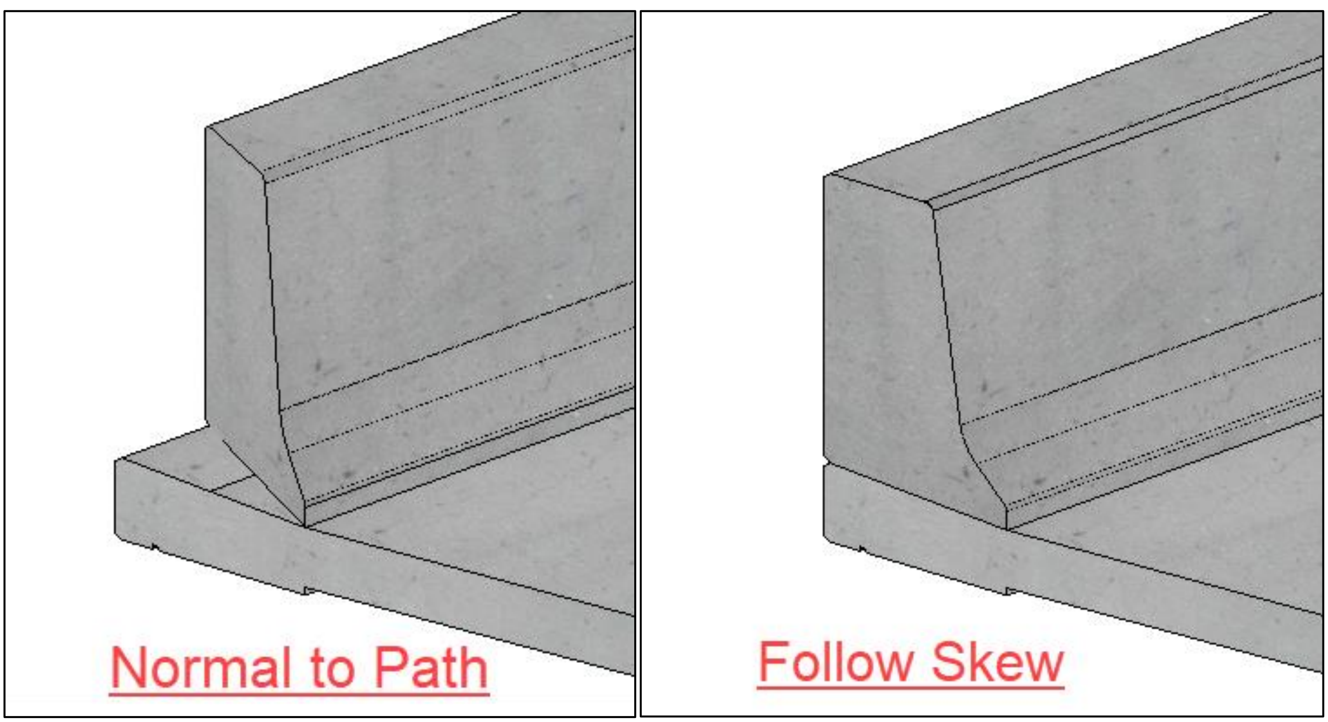


Figure 5.7-4 Barrier Normal to Path VS. Follow Skew

Sidewalks are created within the barrier templates dialog (**Utilities > Libraries > Barriers**) and placed in the same manner as the barriers. More information is provided in Section 6.7.1 for template creation and modification.

Figure 5.7-5 Sidewalk Template and Work Point

When barriers are placed on top of sidewalks, such as the alternative sidewalk detail from BD-601M Sheet 4 of 12 shown below, the barriers use the deck or barrier guidelines/points for placement. To place a barrier, select the deck or barrier to place the additional barrier on top of. The user will then select the template point from a guideline list of the selected element.

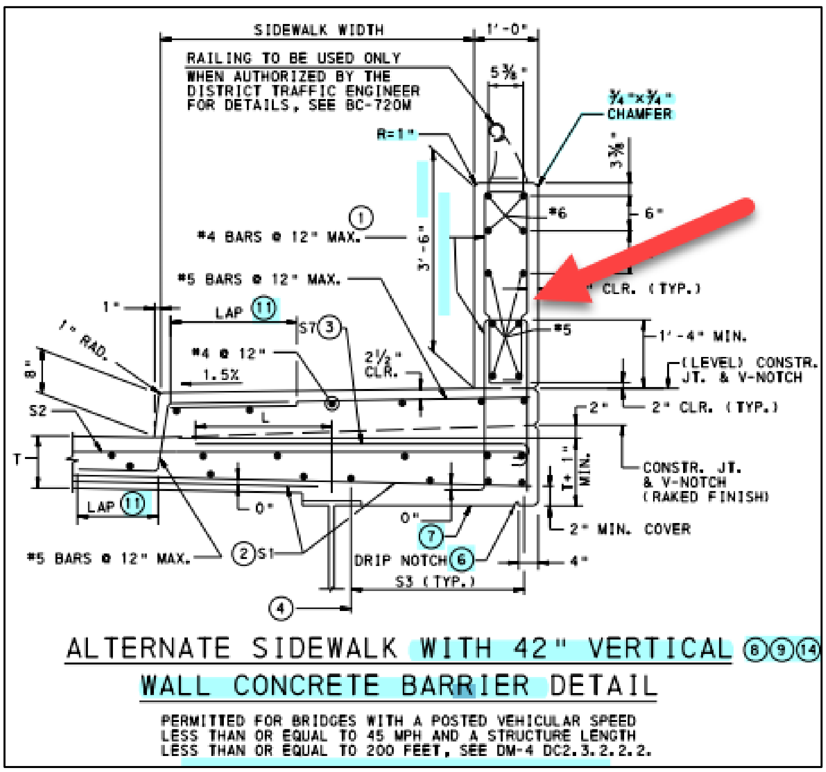


Figure 5.7-6 Alternate Sidewalk Detail from BD-601M Sheet 4 of 12 with Barrier Cast on Sidewalk

5.8 ASSIGN SUPERELEVATION

Superelevation can be assigned to the bridge deck in the active model. There are two methods to assign superelevation to a bridge deck: 1) Manually modifying the deck geometry variables to the desired superelevation values or 2) Using the **Assign Superelevation** tool located here: **Home > Superstructure > Assign Superelevation**.

Users can also assign Superelevation using the Variable Constraints dialog box by accessing the properties of a modeled deck component. In this window you can select the Variables for deck slope and define the start/end stations and slope values for the Superelevation transition. This is the same process used for modifying any of the deck template variables outlined in Section 5.6.2.

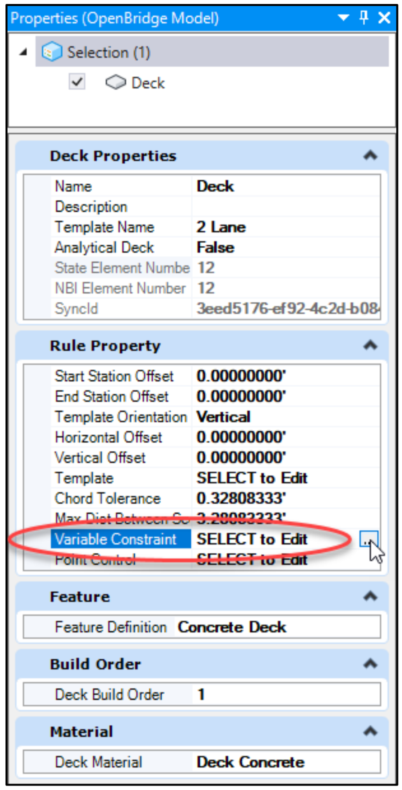
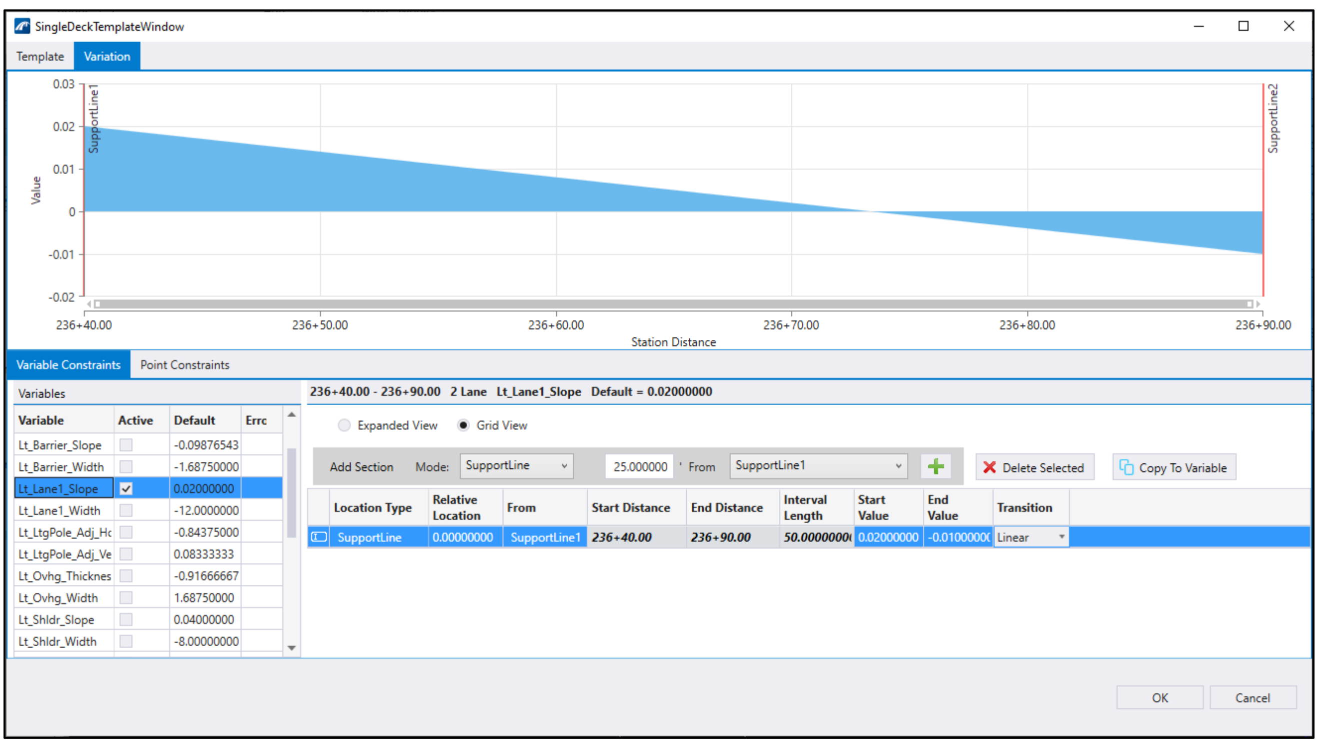


Figure 5.8-1 Adjusting Variable Deck Constraints



Variable	Active	Default	Erro
Lt_Barrier_Slope		-0.09876543	
Lt_Barrier_Width		-1.68750000	
Lt_Lane1_Slope	✓	0.02000000	
Lt_Lane1_Width		-12.0000000	
Lt_LtgPole_Adj_Hc		-0.84375000	
Lt_LtgPole_Adj_Ve		0.08333333	
Lt_Ovhg_Thicknes		-0.91666667	
Lt_Ovhg_Width		1.68750000	
Lt_Shldr_Slope		0.04000000	
Lt_Shldr_Width		-8.00000000	

Figure 5.8-2 Assigning Superelevation Using Manual Inputs

The **Assign Superelevation** tool utilizes a references roadway dgn file with the Superelevation information already included. To use this approach, the correct highway file with the superelevation information included must be attached and the reference turned on. The **Assign Superelevation** tool uses points designated with **Superelevation Flag** within the deck template to apply the superelevation along the length of the deck.

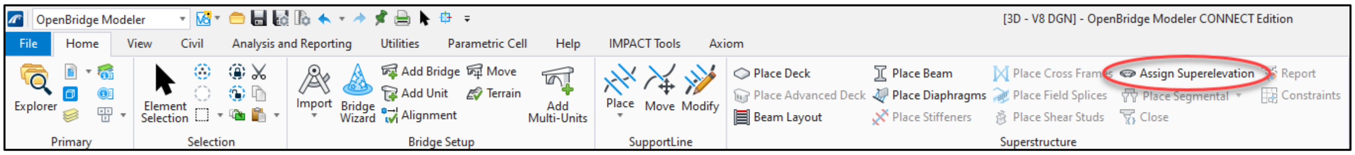


Figure 5.8-3 Location of Assign Superelevation Tool

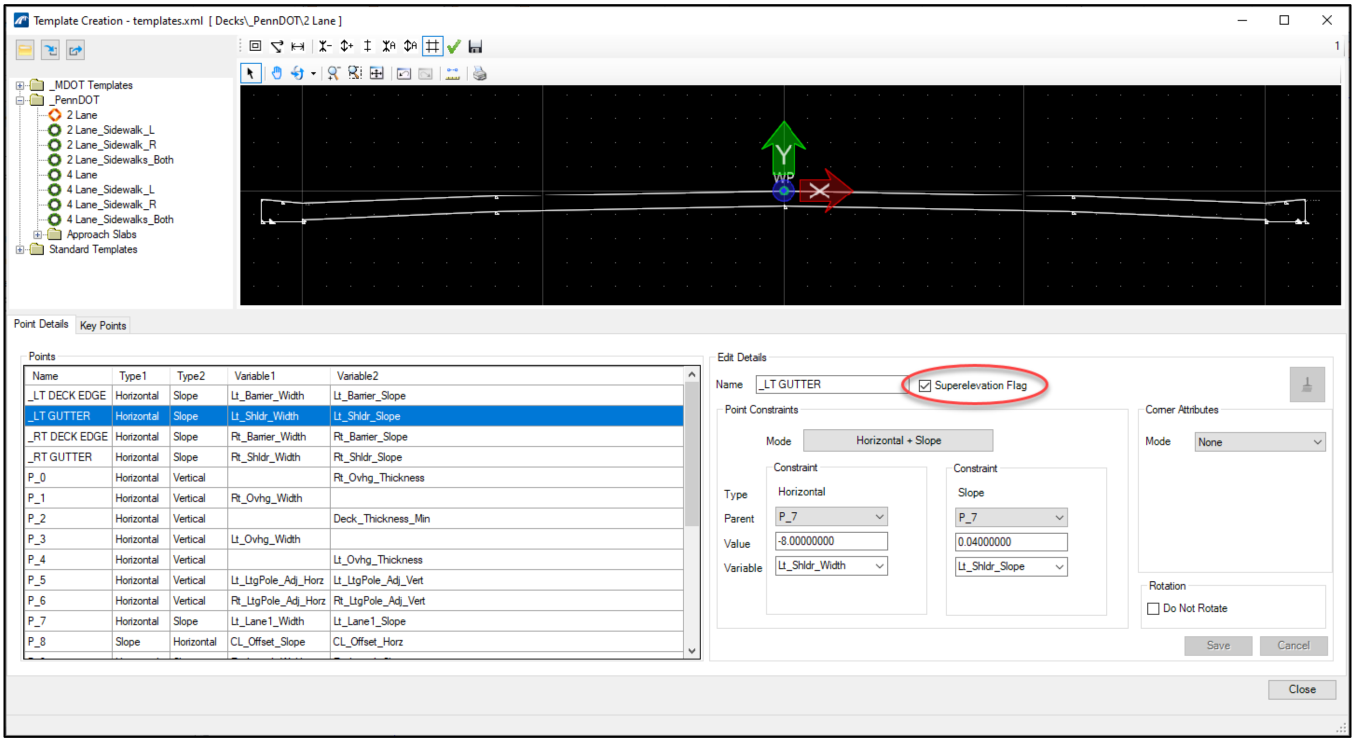


Figure 5.8-4 Location of Superelevation Flag within the Deck Templates

After the prompts are followed and the Superelevation section and deck element are selected, the Superelevation Assignment dialog box is available.

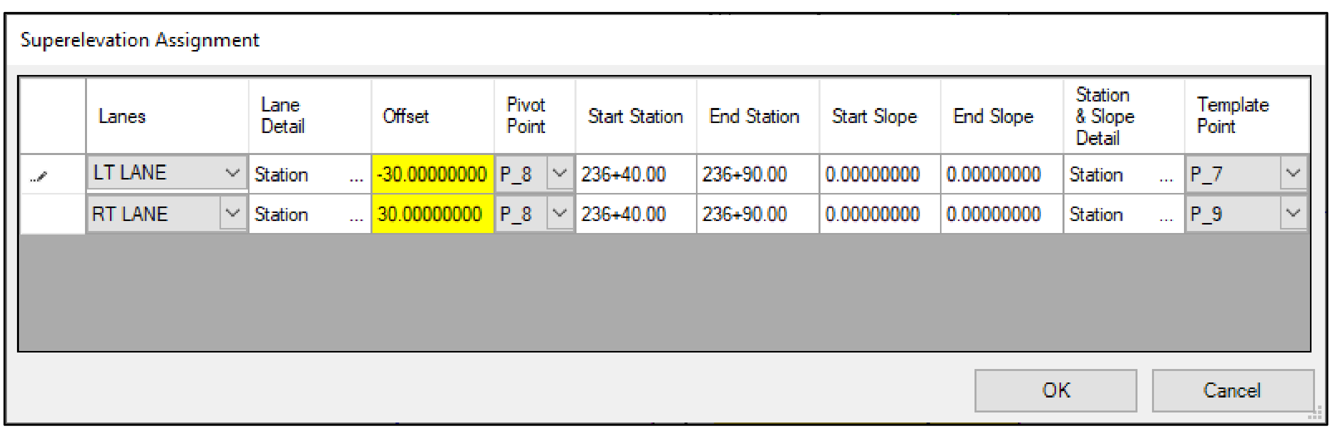


Figure 5.8-5 Superelevation Assignment Window

The current version of OBM makes the Superelevation Point selection process slightly cumbersome. The **Pivot Point** and the **Template Point** cannot be the same value in the same row. For example, if the **Pivot Point** for the *LT LANE* row is desired to be P_8., and the Superelevation Assignment dialog box automatically brings in P_8 for the **Template Point** field, the user should:

1. Change the **Template Point** to a value different than the desired **Pivot Point**, chosen from the dropdown arrow.
2. The dropdown window for the **Pivot Point** should now display P_8 as an option.
3. Go back to the **Template Point** dropdown window and select the desired value.

Note: A positive slope in a Superelevation file from ORD, is from the alignment line moving outward. Slanting upward while looking down station is considered a positive slope, while slanting downward is a negative slope. Alternatively, OBM has positive and negative slope designations consistent with the slope of a line in a cartesian coordinate system. Also, in OBM, Superelevation grade and signs are referencing the Superelevation pivot point, not as assigned in the Superelevation definitions in ORD. Superelevation in OBM will not allow pivoting points outside the deck template. (FDOT, 2022)

5.9 PLACE BEAM LAYOUT

Before beams can be added to the model, a **Beam Layout** is required to create a path for the beam elements to follow. The **Beam Layout** tool serves as the guidelines that are generated in 2D line work that is visible in plan view (at z = 0 elevation) for the beam members that will be placed into the model. This step generates information that is typically found on a framing plan such as the number of beams, beams spacing, overhang spacing, SupportLine offset. The Beam Layout tool is located here: **Home > Superstructure > Beam Layout.**

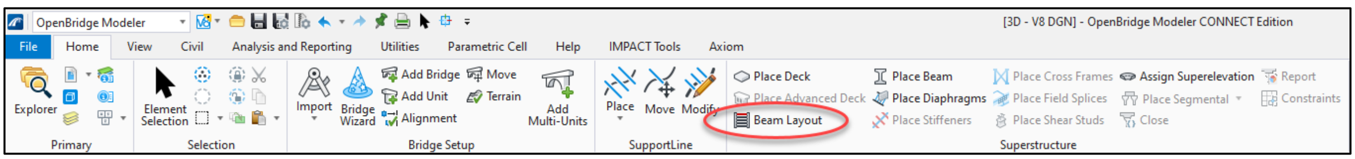


Figure 5.9-1 Beam Layout Tool

Once the start and end SupportLine limits have been selected, the **Beam Layout** window will open allowing the user to specify the details of the beam group. After the user has entered all the information to define the beam layout, select the **Validate** button to verify that the beam layout has been defined properly. Then click **Save** if no validation errors are found. If the beam ends are to be skewed, the user must select the **Skew Ends** checkbox column in the dialogue box, shown in the figure above, to ensure the beam ends will be skewed when placing the beams, as detailed in the next step.

Tips and Tricks: The user should verify that the correct placement method is selected before proceeding with the input. Changing this from simple to continuous after defining layout parameters will remove all the existing parameter input.

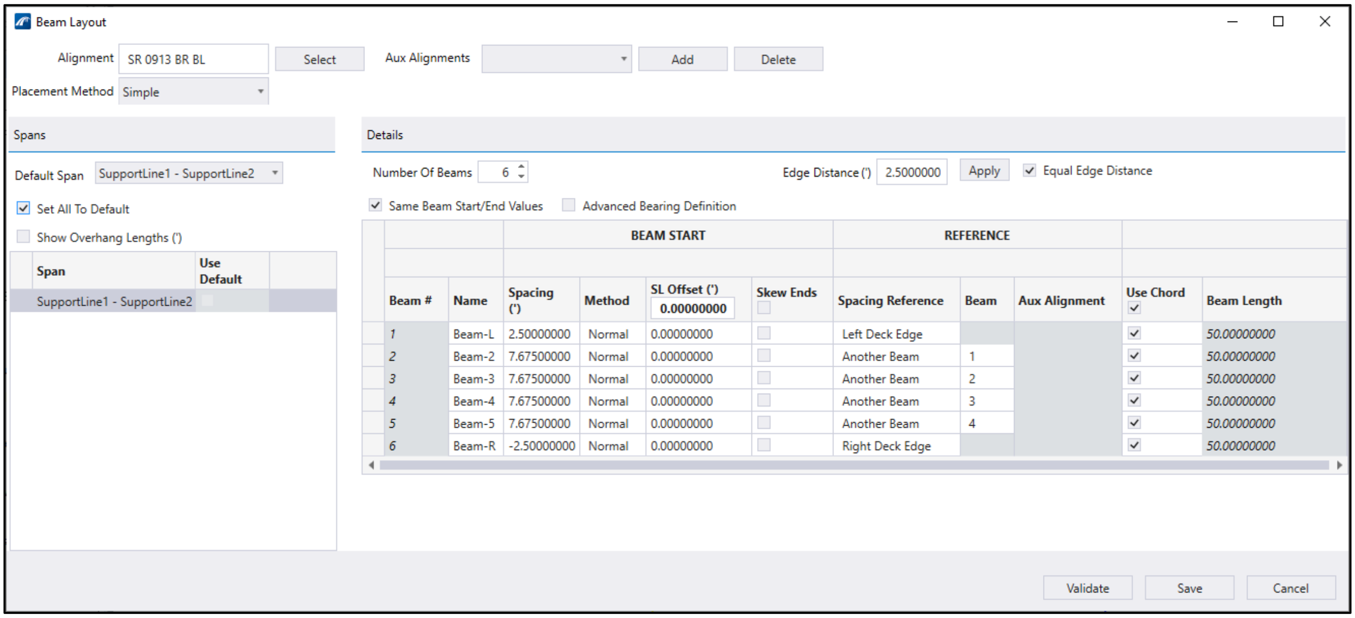


Figure 5.9-2 Beam Layout Window

Note: For box beam superstructures with 2 bearing pads, the "Advanced Bearing Definition" checkbox must be selected, and the additional inputs entered (number of bearings, spacing, and offsets). See Section 6.21.3 for more details.

5.10 PLACE BEAM – CONCRETE

Once a **Beam Layout** has been defined, concrete beams can be applied to the beam layout. The **Place Beam** tool will generate a window with different options depending on which bridge type has been defined when the **Add Bridge** tool was used (P/S or RC Concrete Girders versus Steel Girders).

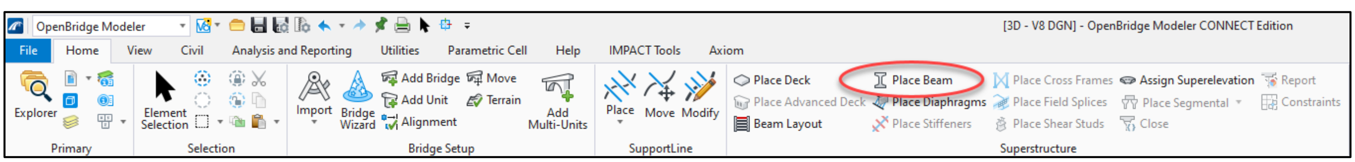


Figure 5.10-1 Place Beam Tool

After selecting the beam layout to add the concrete beams, a window will open that allows the user to select the project-specific beam template and haunch or camber values. Selecting the **Apply to All Beams** check box will allow the user to define one beam for the entire group instead of defining each beam individually.

To use the PennDOT workspace Beam Templates, the user must select "Custom" for the **Beam Type** and then navigate to the proper section.

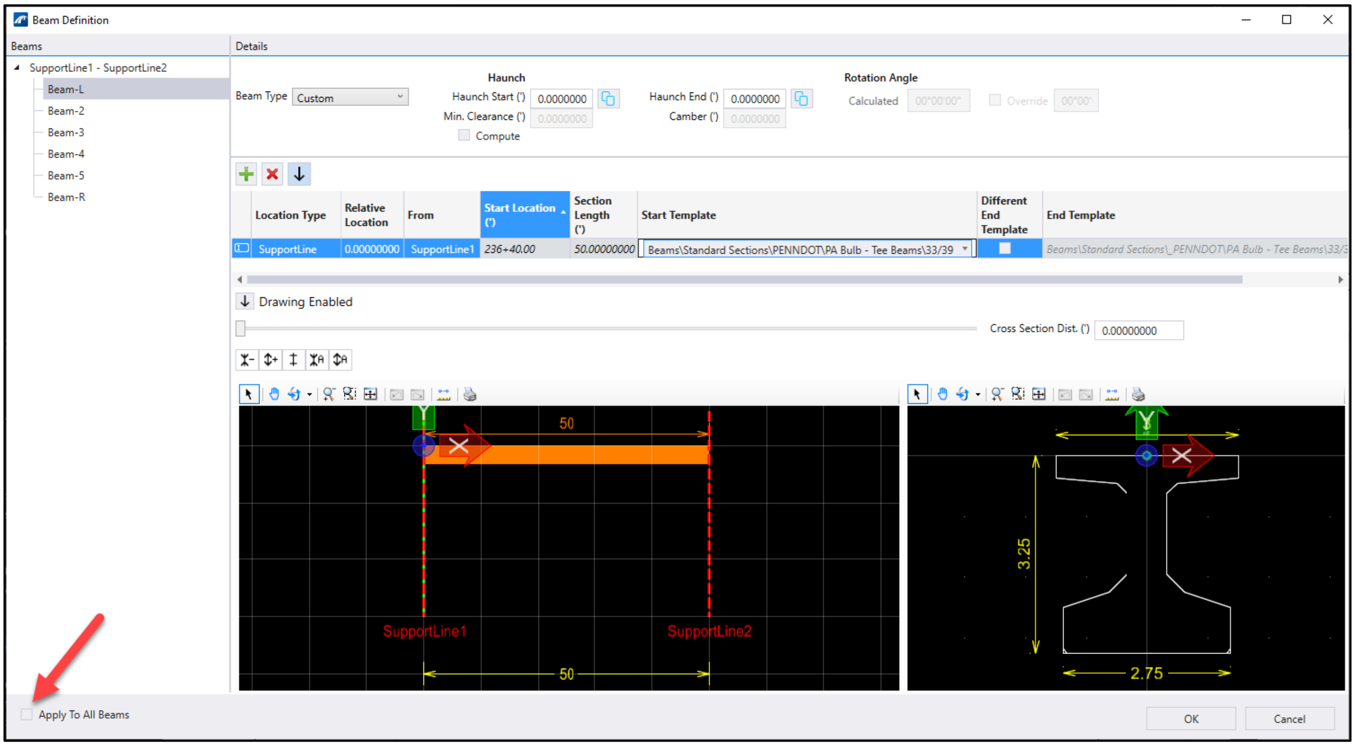


Figure 5.10-2 Beam Definition Window

Changes can be made to the beam group after it has been created by selecting one of the beams in the group and then, in the property window, clicking on the ellipses (three dots) next to **Beam Definition SELECT to Edit**. The same window will appear that was used to generate the beam group. Adjustments can then be made, such as changing the beam size, haunch values, etc.

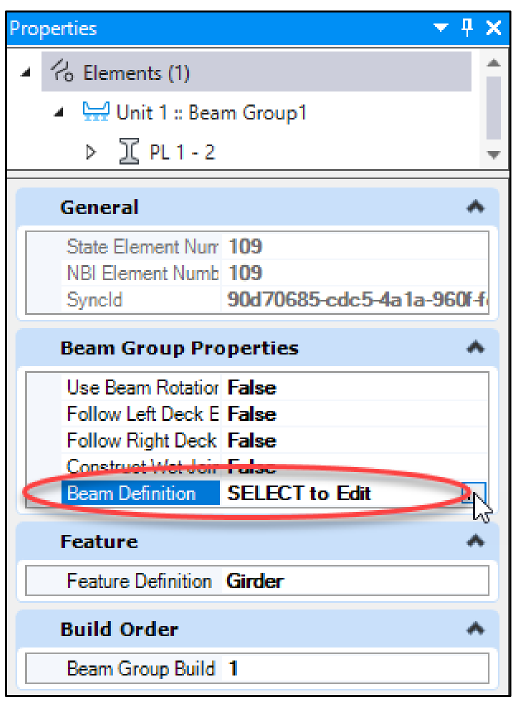


Figure 5.10-3 Editing Beam Definition

The default setting in OBM is to place beams vertically without rotation. The user can specify beams that are rotated, so the top flange of the beam will be parallel to the top surface of the deck. This change will affect the bearing seat elevations and details. The change can be made within the properties window.

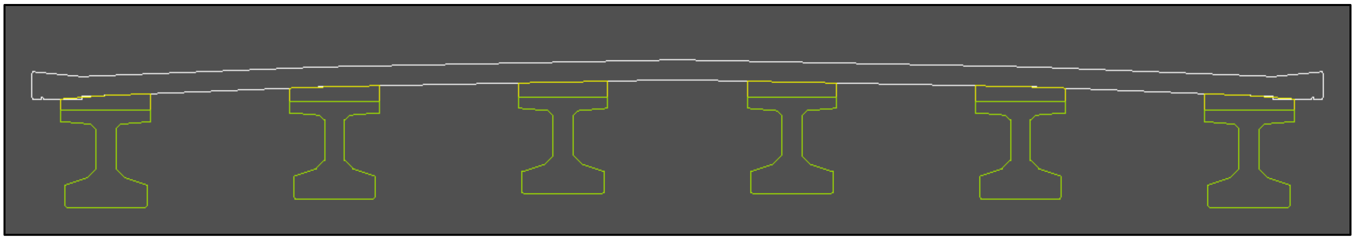


Figure 5.10-4 Beams Placed Without Rotation

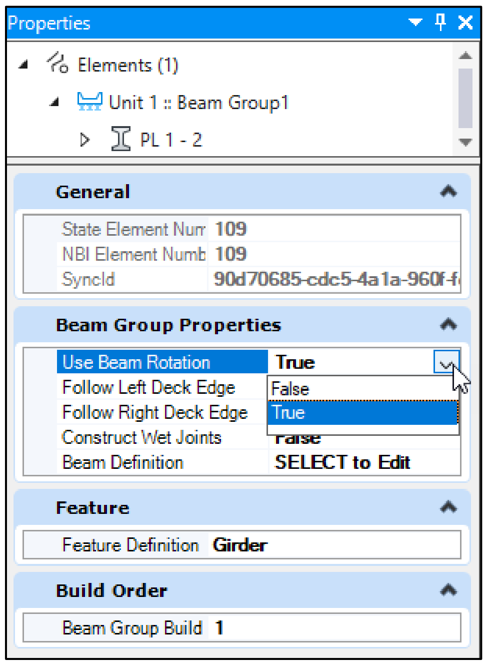


Figure 5.10-5 Changing Beam Rotation

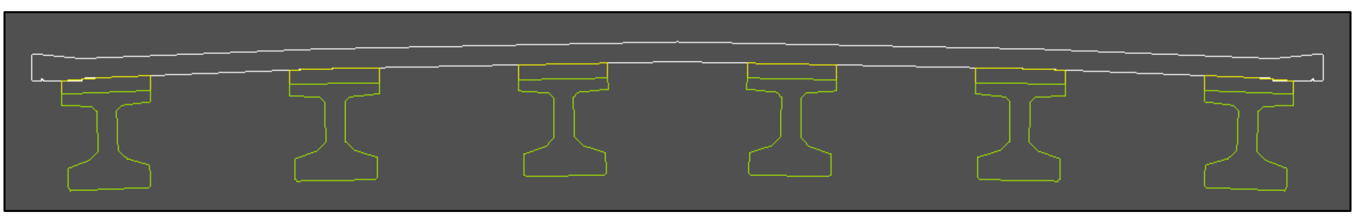


Figure 5.10-6 Beams Placed With Rotation

5.10.1 Haunch Manual Input

Minimum haunch thicknesses for a beam group are computed automatically in OBM. However, they can also be manually defined in the **Beam Definition** dialog window. The minimum thicknesses are defined at the bearing lines and are referred to as the **Haunch Start** location and the **Haunch End** location.

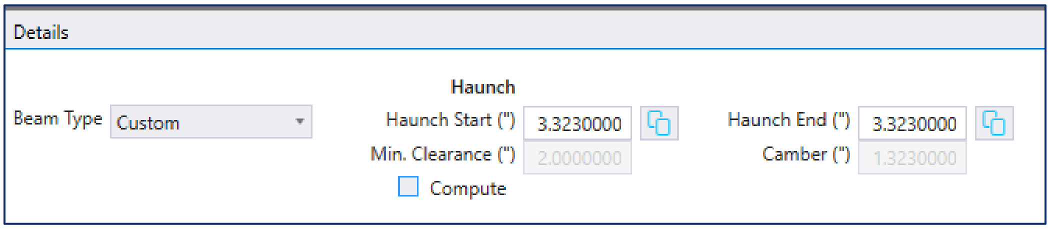


Figure 5.10-7 Manual Haunch Inputs

The user must first **uncheck** the **Compute** check box to enable the manual input fields for the **Haunch Start** and **Haunch End**. The actual value of the haunch should be set to the haunch thickness over the girder at its centerline, which may not be the minimum haunch thickness if the girders are set level.

For **Base Models**, allowing OBM to compute the haunch thickness is acceptable, but these values should be verified independently and modified manually as required.

Note: Camber at mid-span can be input in certain haunch option; however, the prestressed beams cannot currently be modeled with parabolic camber. The beams are modeled with a straight line from top of beam at start to top of beam at end.

Note: Additional information about manually defining haunches may be found on the Bentley website at https://docs.bentley.com/LiveContent/web/OpenBridge%20Modeler%20Help-v16/en/obm_Beam_Definition.html

5.11 PLACE BEAM – STEEL

Steel beams can be applied to the beam layout similarly to concrete beams. The **Place Beam** tool will generate a window with different steel specific beam options when the steel bridge type has been defined previously in the **Add Bridge** command.

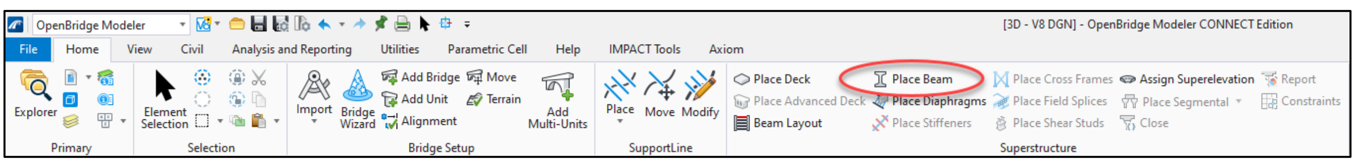


Figure 5.11-1 Place Beam Tool

After selecting the beam layout to add the steel beams, a window will open that allows the user to select the project-specific beam template and haunch or camber values. Selecting the **Apply to All Beams** check box will allow the user to define one beam for the entire beam group instead of defining each beam individually. If the beams are not identical, each beam's parameters can be defined individually, while beam parameters can be copied to identical beams to prevent defining the same properties multiple times. In cases where variable depth beams are required, adjust the **Relative Location** field to the necessary values and specify the desired transition type using the **Variation** option.

Additional input locations may be required to adequately define the needed beam shape. To do so, select the **Add** button, denoted with the green plus symbol, and a new input line will be placed above the currently highlighted row. All of the information from the highlighted row will be copied to the new row.

Dimensional properties for flanges, webs, and cover plates may all be varied by selecting the **Section drop-down menu** and adding new rows under the specific section.
Also

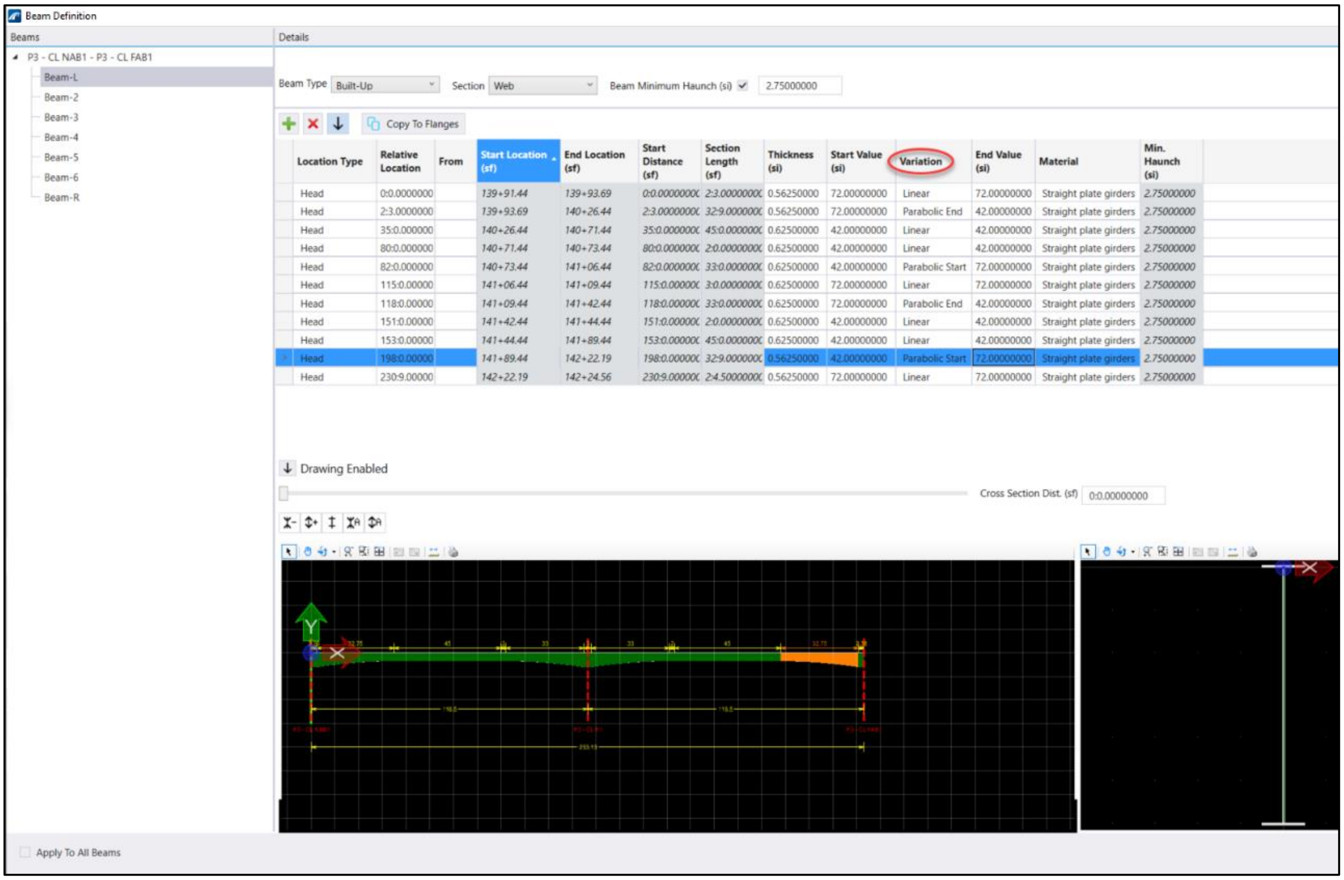


Figure 5.11-2 Beam Definition Window

Just like the concrete beams, changes can be made to the beam group after it has been created by selecting one of the beams in the group and then clicking on the ellipses or three dots next to **Beam Definition SELECT to Edit** in the properties window. The same window will appear that was used to generate the beam group. Adjustments can then be made, such as changing the beam properties, haunch values, etc.

Note: In OBM, the haunch is measured from the top of web for steel girders and the girder will be modeled following the profile of the deck (final position).

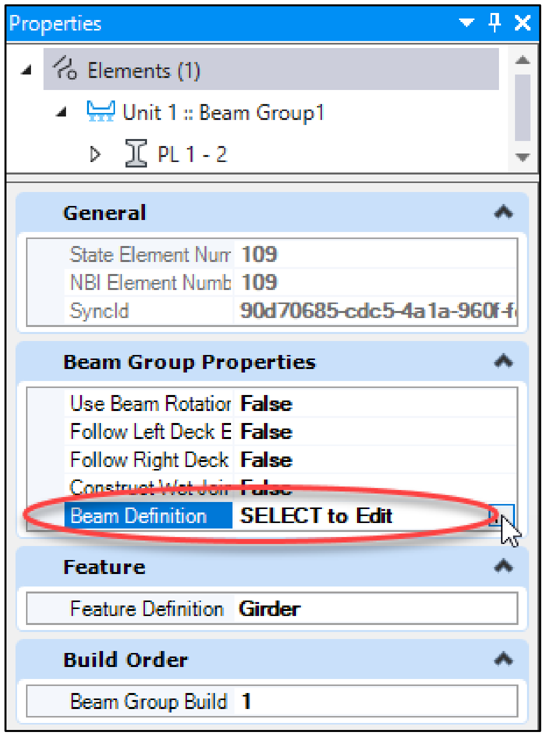


Figure 5.11-3 Editing Beam Definition

5.12 PLACE CONCRETE DIAPHRAGMS

OBM at the current time can only generate very basic concrete diaphragms with little detail. Also, they can currently only be used with prestressed concrete beams, not steel girders. Concrete diaphragms can only be placed after a beam group has been created. To place concrete diaphragms, select the **Place Diaphragms** button and select the beam group to apply the diaphragms. This will then launch and open the **Place Diaphragms** dialog window.

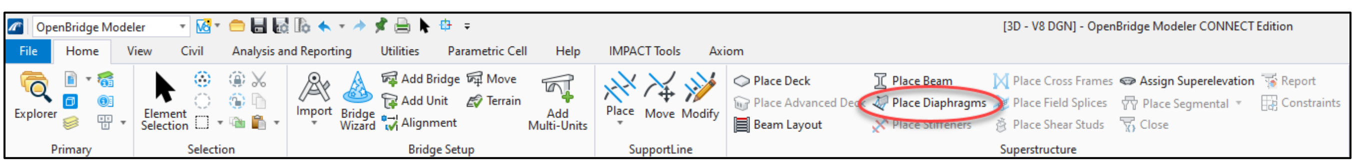


Figure 5.12-1 Place Diaphragms Tool

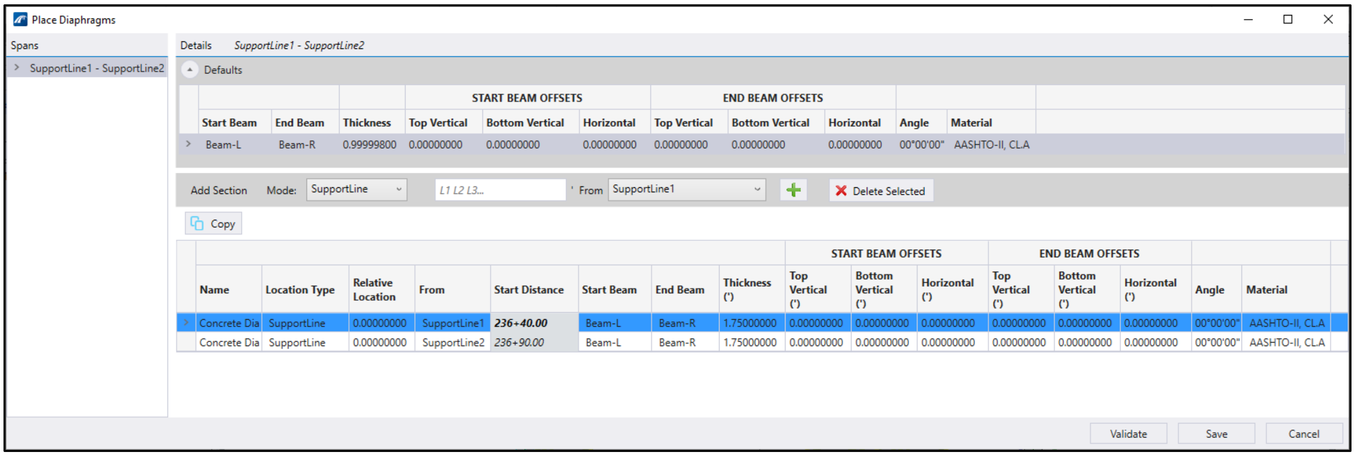


Figure 5.12-2 Place Diaphragms Window

The **Place Diaphragms** dialog window has a variety of inputs that the user can use to create project-specific diaphragm details. For example, the skew input may need to be updated to match the bridge. The diaphragm thickness will be centered on the location entered by the user. For example:

- A diaphragm placed from SupportLine 1
- Relative Location = 0.00000’
- Thickness = 1.75000’

Will result in the diaphragm being placed 0.875’ before and after the SupportLine 1.

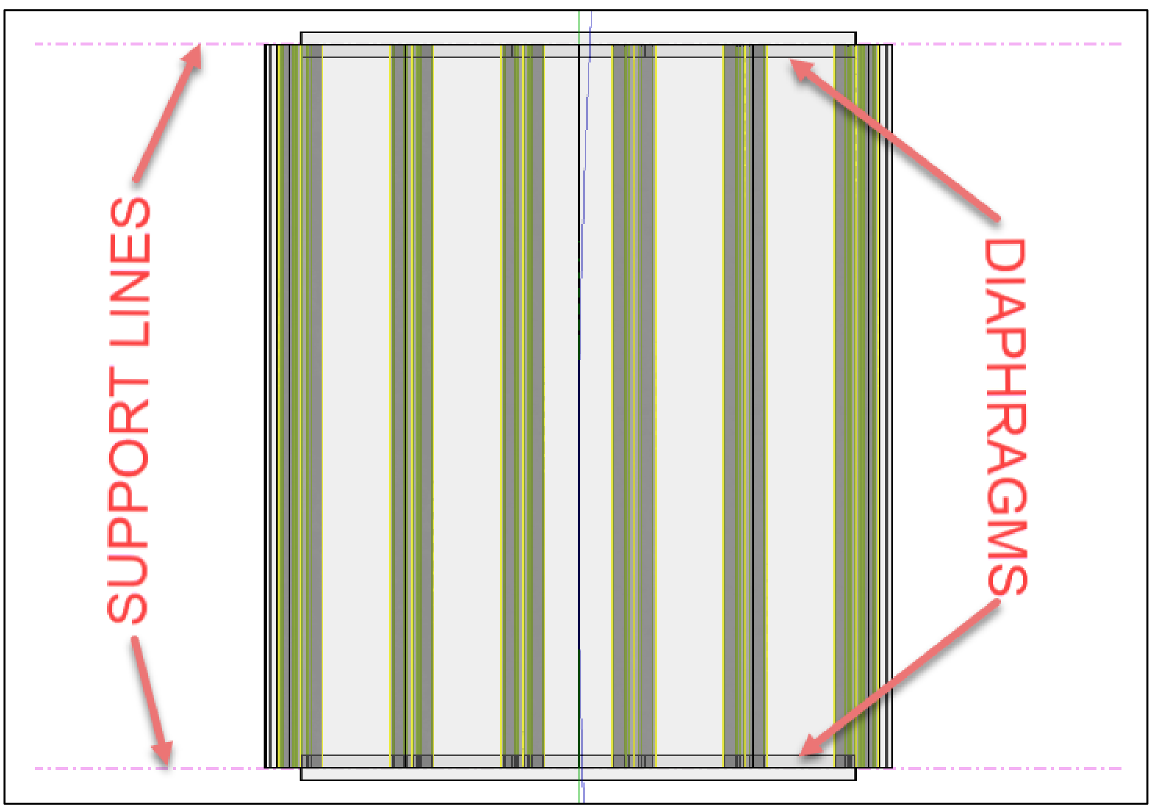


Figure 5.12-3 Plan View - Diaphragm Thickness Centered on SupportLines

Changes can be made to the concrete diaphragms after they have been created by selecting one of the diaphragms then clicking on the ellipses or three dots next to **Concrete Diaphragm SELECT to Edit** in the properties window. The same window will appear that was used to generate the diaphragms.

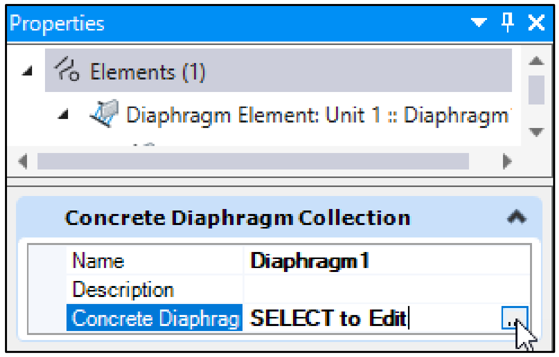


Figure 5.12-4 Accessing Diaphragms for Editing through Properties

Note: The Concrete Diaphragm tool currently has limitations, including not accounting for beam solid volumes when modeling (i.e., will not conform to Bulb-Tee beam shape) and not allowing for sloping or other modifications needed in typical projects. See Section 6.11 for more detailed description and modifying these elements for a Refined model element.

5.13 PLACE STEEL DIAPHRAGMS/CROSS FRAMES AND STIFFENERS

5.13.1 Place Cross Frames

Cross frames and their associated stiffeners/connection plates can be selected and placed with the cross frames using the **Place Cross Frames** tool. Structural angles cannot be used as stiffeners; only stiffener plates from the stiffener template library, **Utilities > Libraries > Connection**, may be defined.

Figure 5.13-1 Place Cross Frames Tool

Note: Recent updates of the software now allow for additional option for orienting the connector plates along the diagonals of the members and also using the member center of gravity for alignment of member placement.

Cross frames can be placed individually or by using the included Wizard. The wizard places cross frames by number of locations at equal spaces or by the desired spacing. If placed by desired spacing, OBM will fit as many cross frames within the given limits as possible. When using the wizard to place cross frames, it is also possible to add cross frames individually. **Therefore, the recommended workflow is to use the Wizard as a starting point and adjust/add manually from the results.**

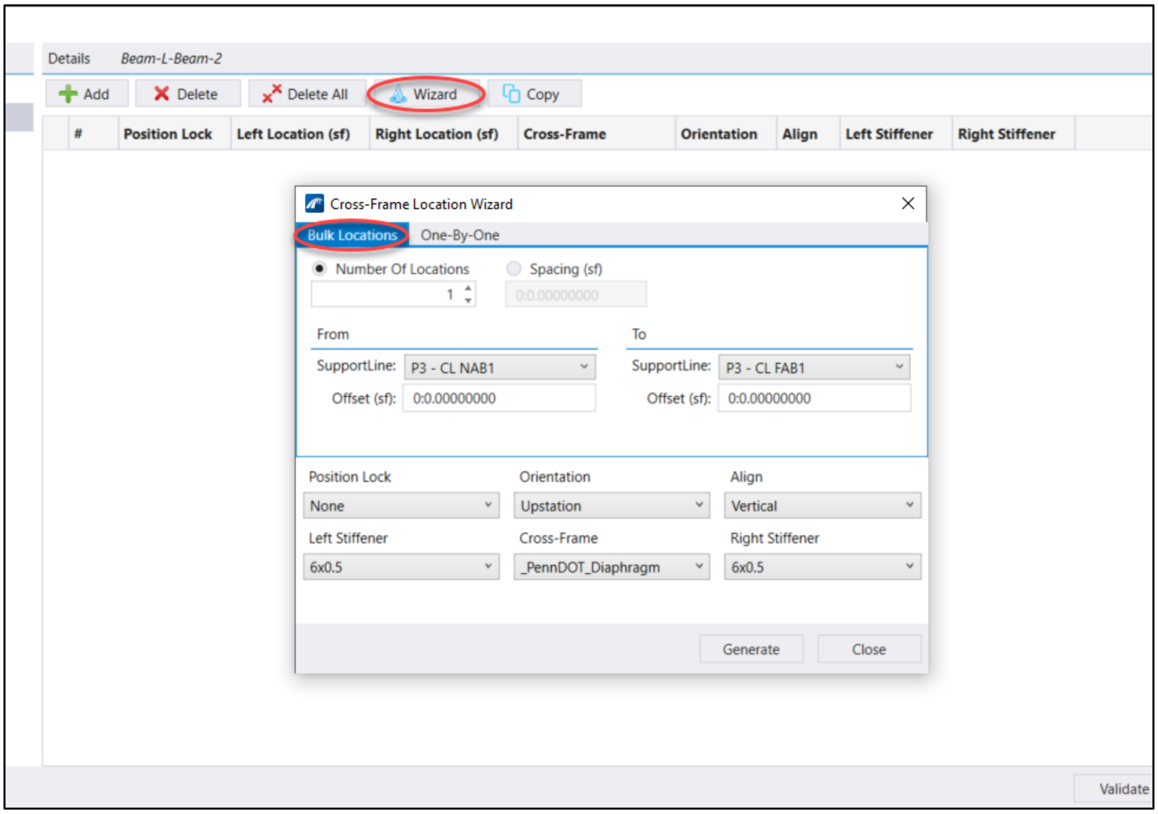


Figure 5.13-2 Beam Definition Window

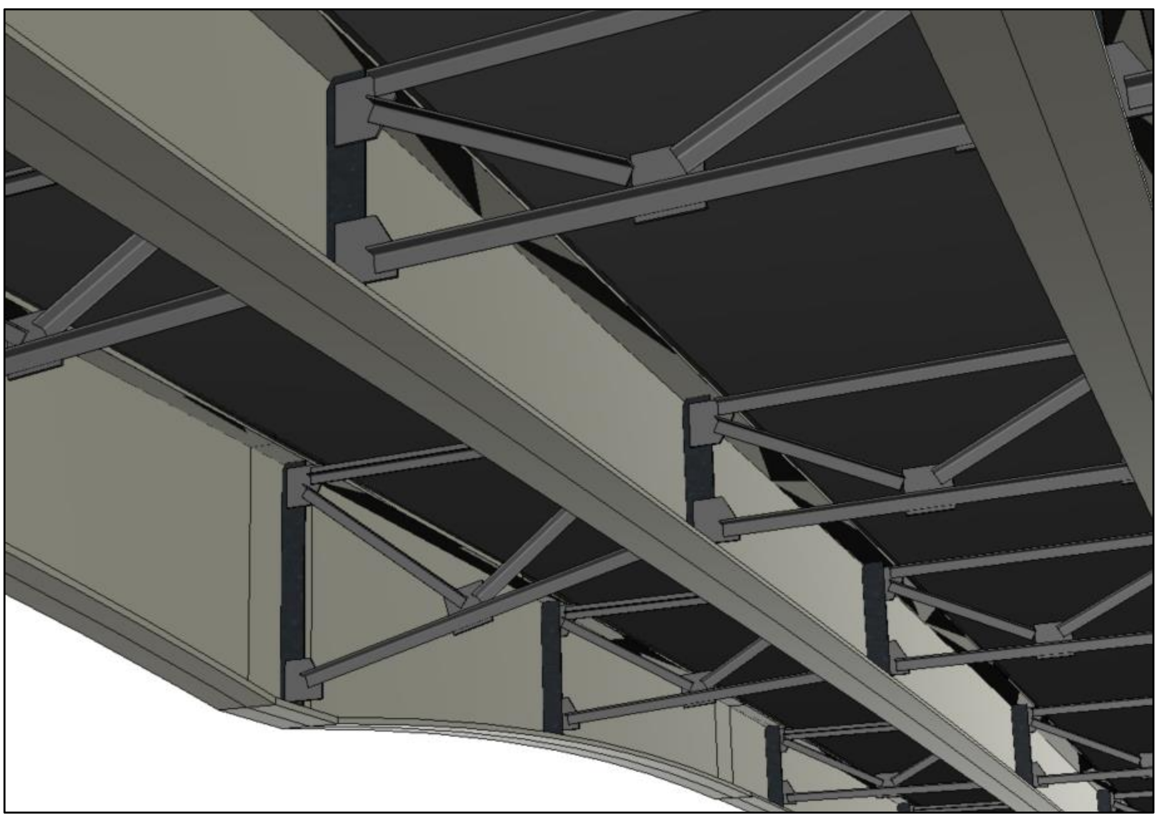


Figure 5.13-3 View of Stiffeners and Cross Frames

5.13.2 Place Stiffeners

The stiffeners and connection plates associated with the cross frames and diaphragms should be placed with the Place Steel Diaphragm/Cross Frame tool and associated Wizard. Additional stiffeners, whether bearing, jacking, or other transverse stiffeners, can be placed along the beams using the **Place Stiffeners** tool in the Superstructure ribbon. Structural angles cannot be used as stiffeners for steel superstructure bridges; only stiffener plates can be defined.

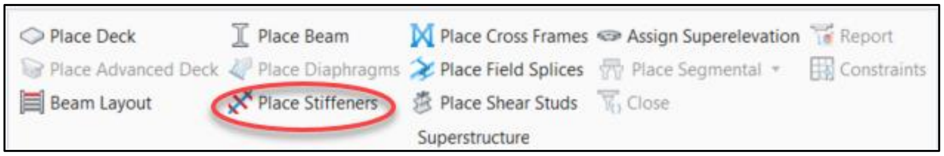


Figure 5.13-4 Place Stiffeners Tool

Note: Longitudinal stiffeners cannot currently be placed with this tool. Users will need to manually place longitudinal stiffeners with Solids Modeling tools and techniques, if they are required to be modeled.

The stiffener dimensions can be modified, and new stiffener options are created in the **Utilities > Libraries > Stiffeners**.

Stiffeners can be placed along the beams independently or by using the included Wizard. Stiffener spacing is specified from end of beam or from a previous stiffener and can be placed individually or with a specified number of stiffeners at equal spacing.

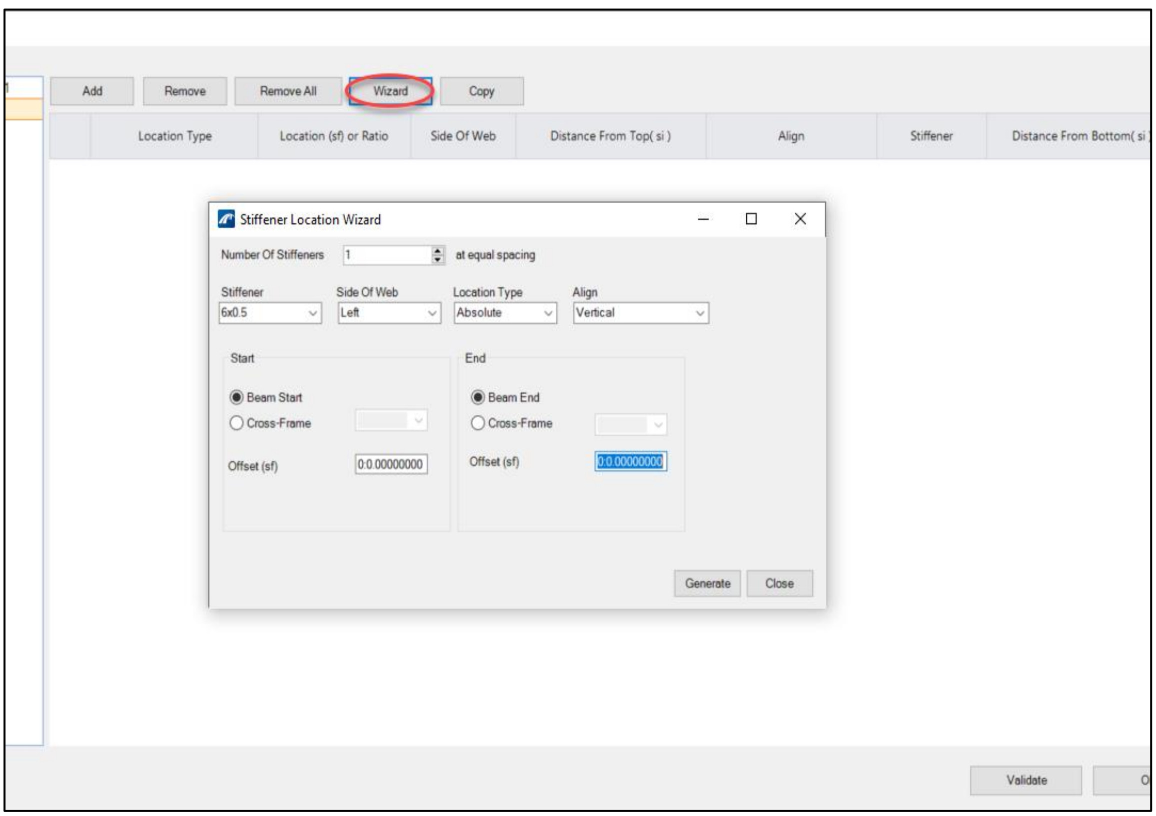


Figure 5.13-5 Place Stiffener and Wizard Dialog

5.14 PLACE FIELD SPLICES

Field Splices can be defined and placed by using the **Place Field Splice** tool in the Superstructure ribbon.

Figure 5.14-1 Place Field Splice Tool

After defining the field splice parameters in the Splices template library found here: **Utilities > Libraries > Splices**, the template can be selected in the **Field Splice Pattern** drop down in the dialog and placed on the framing in the desired location(s). Placement is based on a desired length from a SupportLine, or a ratio of span length between multiple SupportLines. Field Splice parameters can be copied to multiple beams after being defined to prevent needing to repeat definitions.

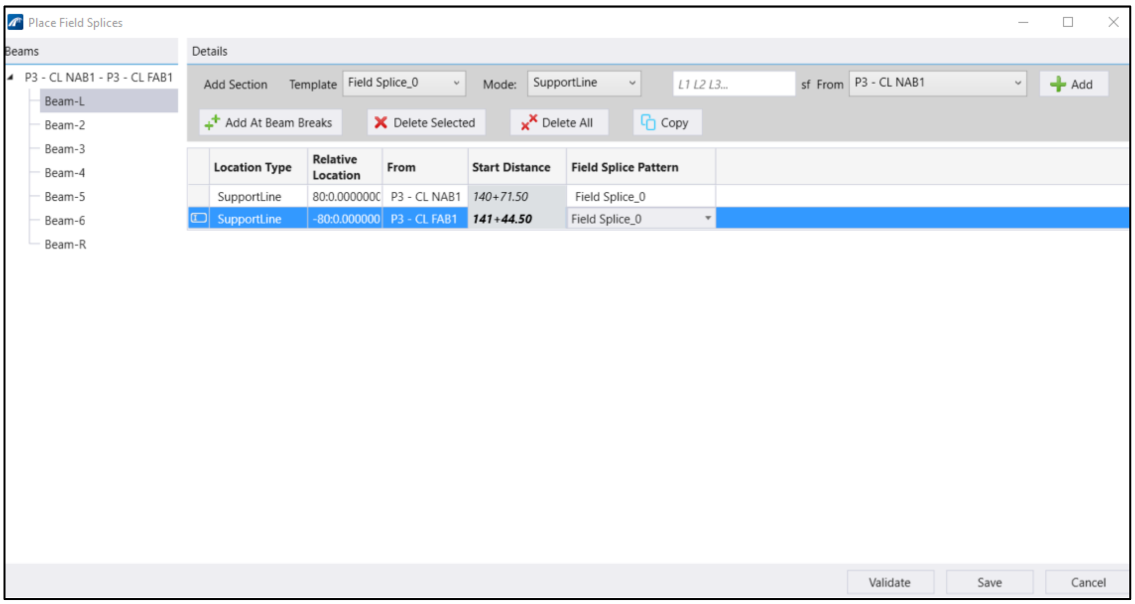


Figure 5.14-2 Place Field Splice

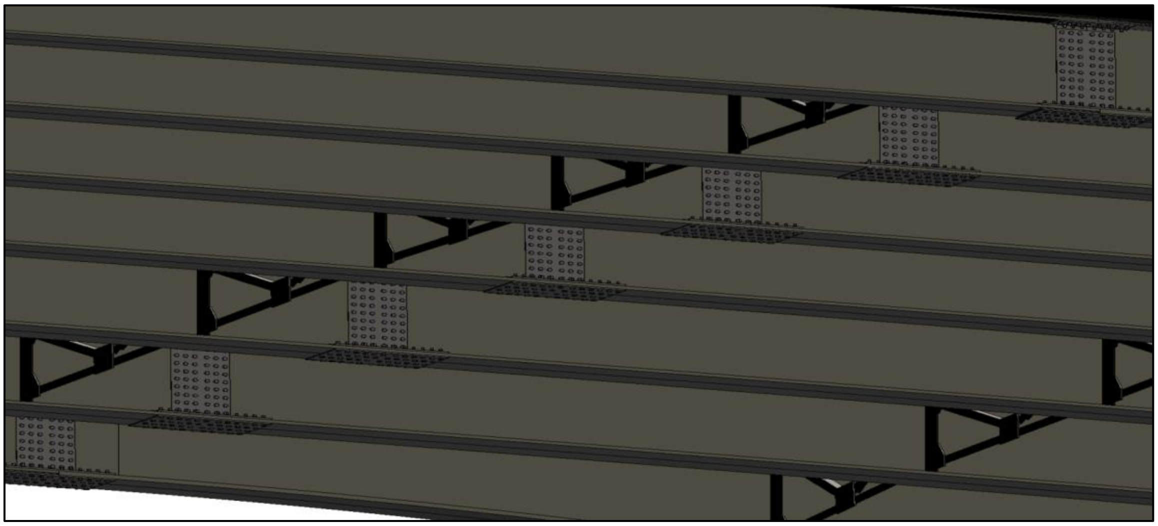


Figure 5.14-3 View of Stiffeners and Cross Frames and Field Splices

5.15 PLACE SHEAR STUDS

Shear studs can be defined and placed by using the **Place Shear Studs** tool.

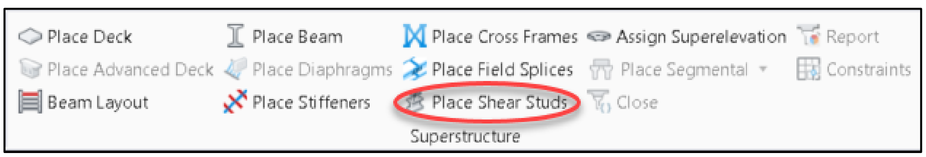


Figure 5.15-1 Place Shear Studs Tool

Shear studs are placed by first selecting the beam group then clicking **Add.** Multiple groups of shear studs can be placed along the beam by defining start and end locations or span ratios and defining shear stud spacing. Shear studs can be selected from a predefined library of shear studs within the program or after parameters are defined in the shear stud template library, and number of studs per row can be set in the dialog with the desired transverse spacing. The template library can be found here: **Utilities > Libraries > Shear Studs.**

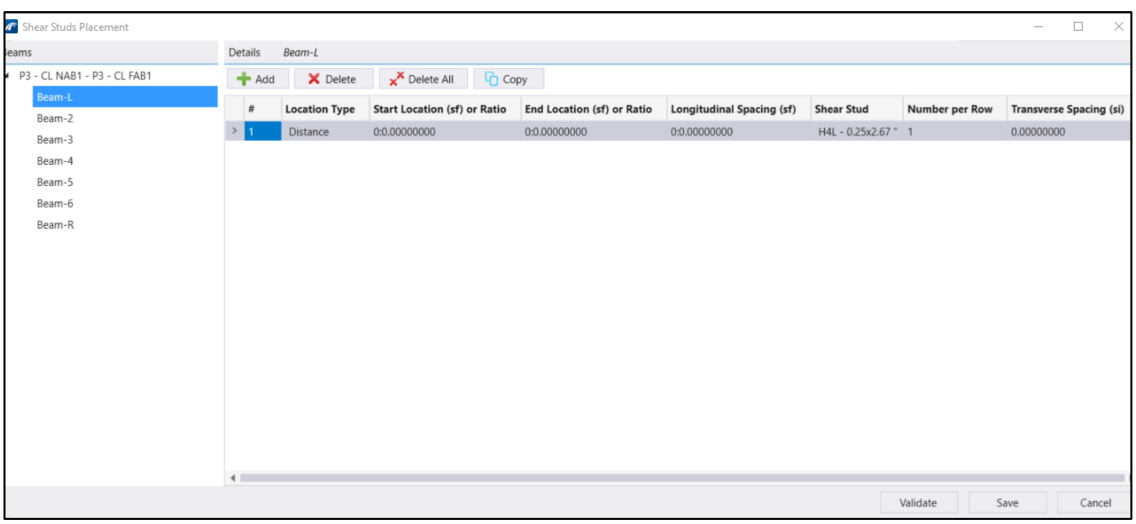


Figure 5.15-2 Shear Stud Dialog

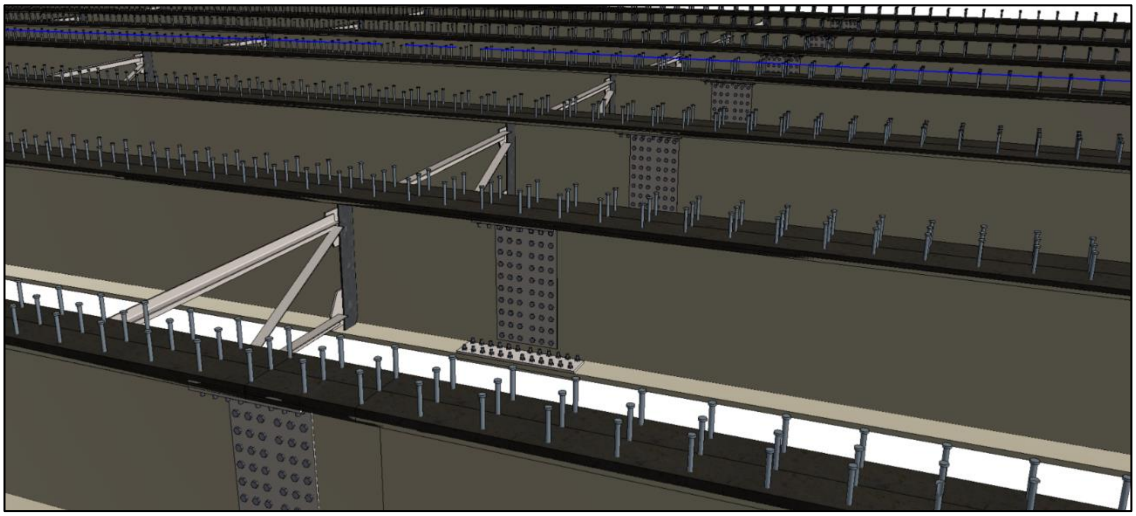


Figure 5.15-3 Shear Stud View

5.16 PLACE ABUTMENT

Abutments are placed on a **SupportLine** location within the OBM model. The **Place Abutment** tool places abutments from the **Utilities > Libraries > Abutments** template library.

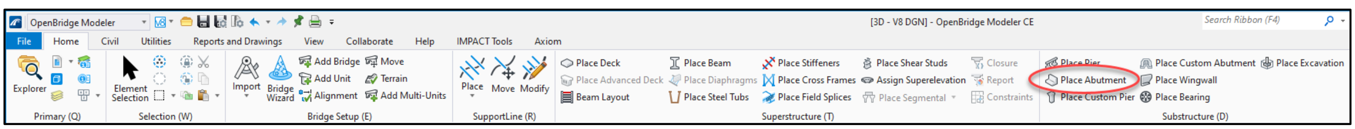


Figure 5.16-1 Place Abutment

Note: Currently, **this tool is only recommended for use with stub or pile cap type abutments such as integral or MSE abutments**. The BD-621M, BD-622M, and BD-624M standard abutments will need to follow Section 5.17 and Section 6.17.

After selecting the **Place Abutment** button, the user will be promoted to define basic abutment properties and select the **SupportLine(s)** to place the abutment. When defining the abutment properties, it is recommended that the user leaves the “Integral” box unchecked as this can have unintended effects on the placement and is not used for analysis or other purposes.

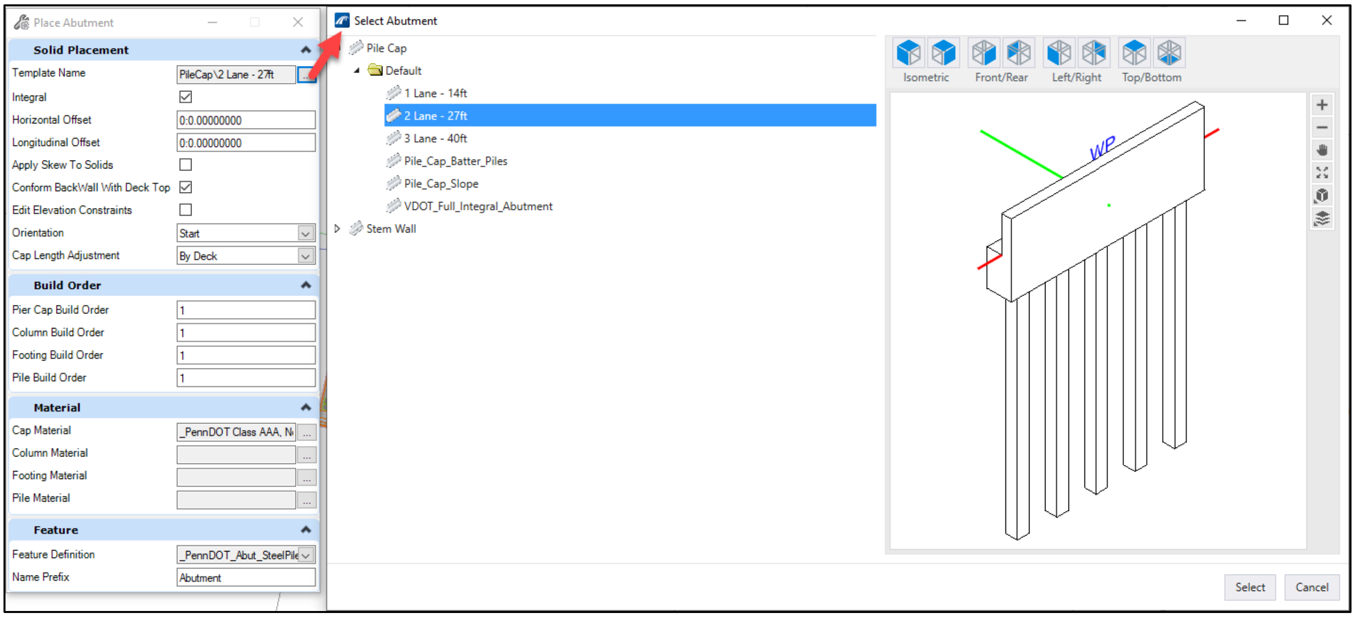


Figure 5.16-2 Defining Abutment Properties and Selecting Abutment Template

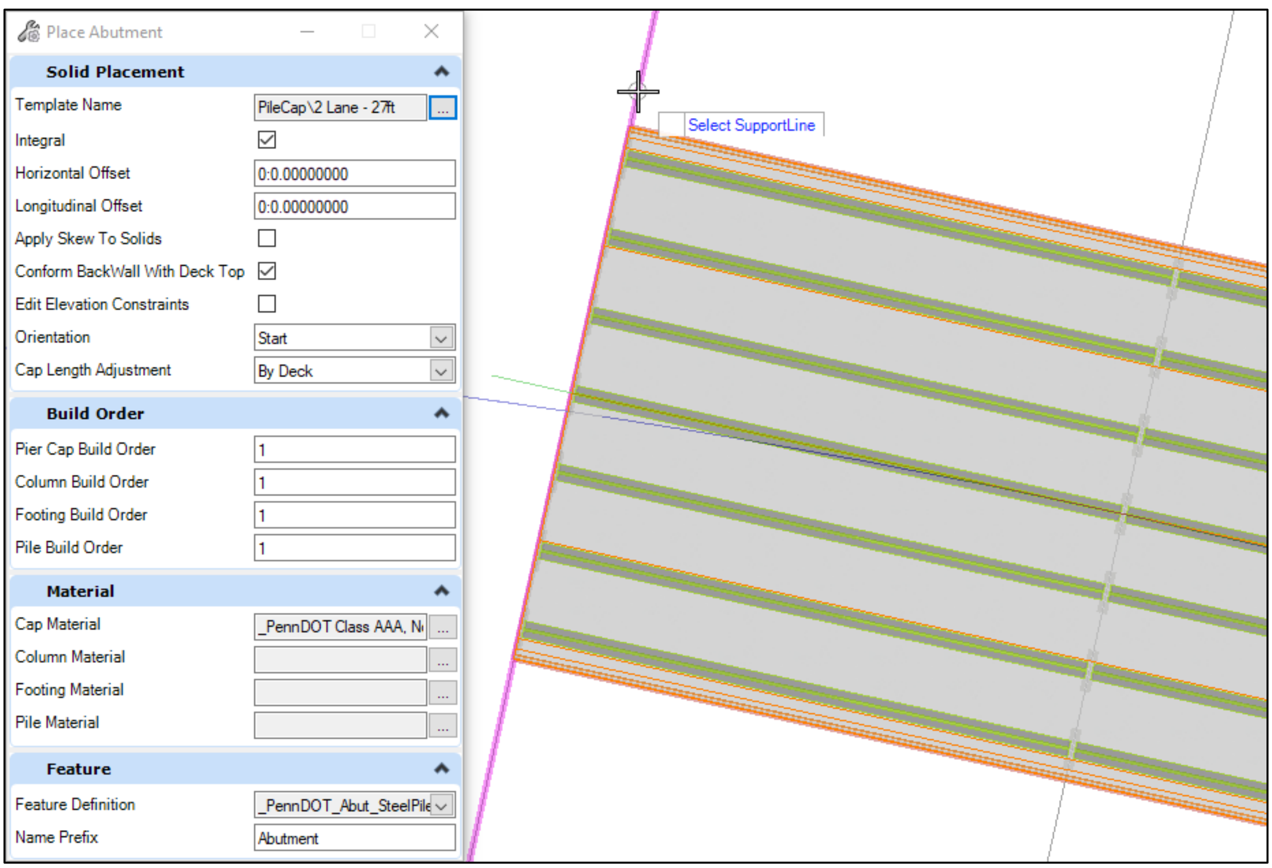


Figure 5.16-3 Selecting SupportLine for Abutment Placement

After the abutment has been placed, the user can click on the abutment to activate the properties and click on the ellipses or three dots of **SELECT to Edit** to the right of the **Substructure Template** to adjust the abutment dimensions. In this window the user can adjust the cap, cheek walls, footings, and piles.

[**Workaround:**]() For integral abutments, it is recommended that the user add the end diaphragm as an oversized backwall per the provided workspace template. This provides the most visually correct and functional component until solids modeling is needed to create a diaphragm Refined element.

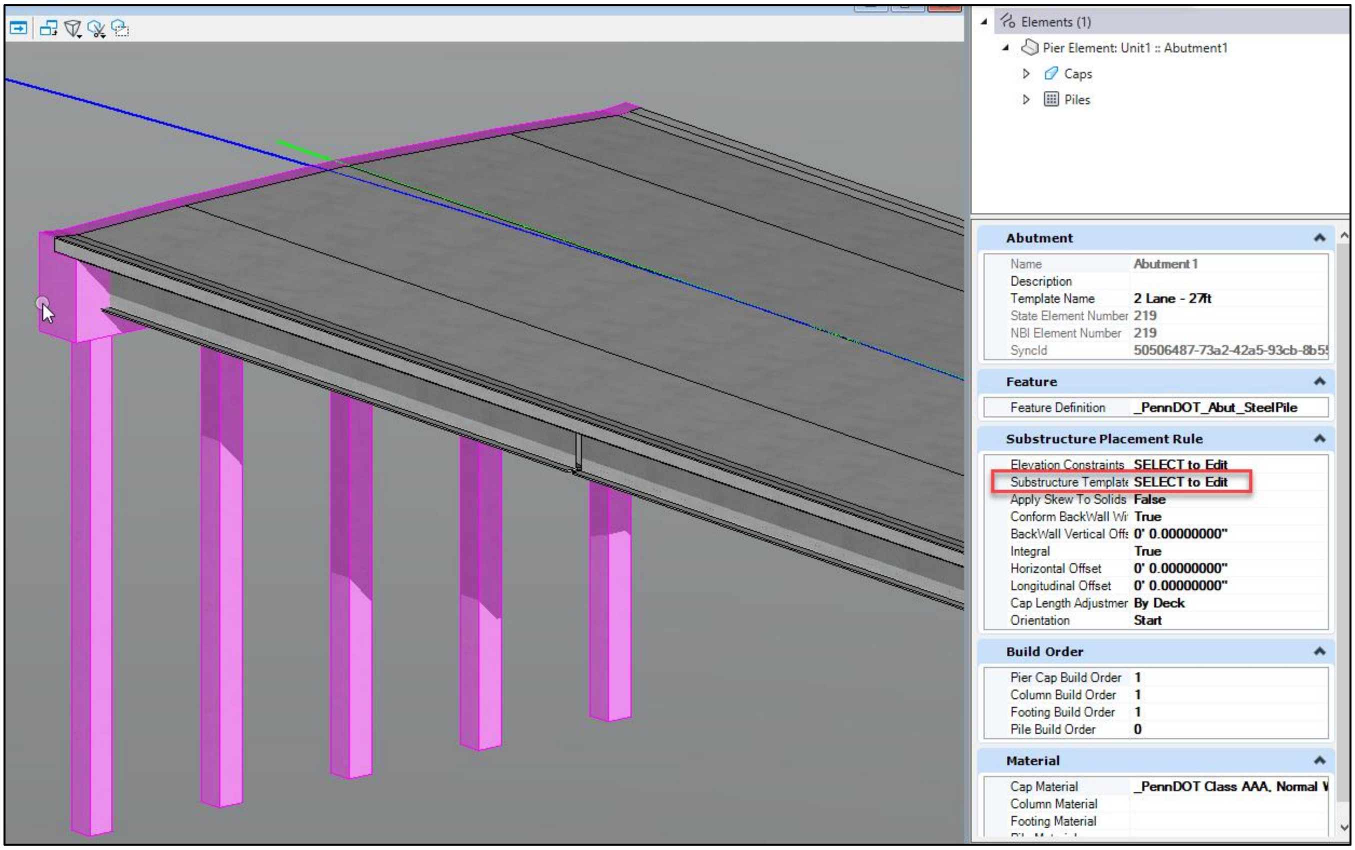


Figure 5.16-4 Editing Abutment Properties

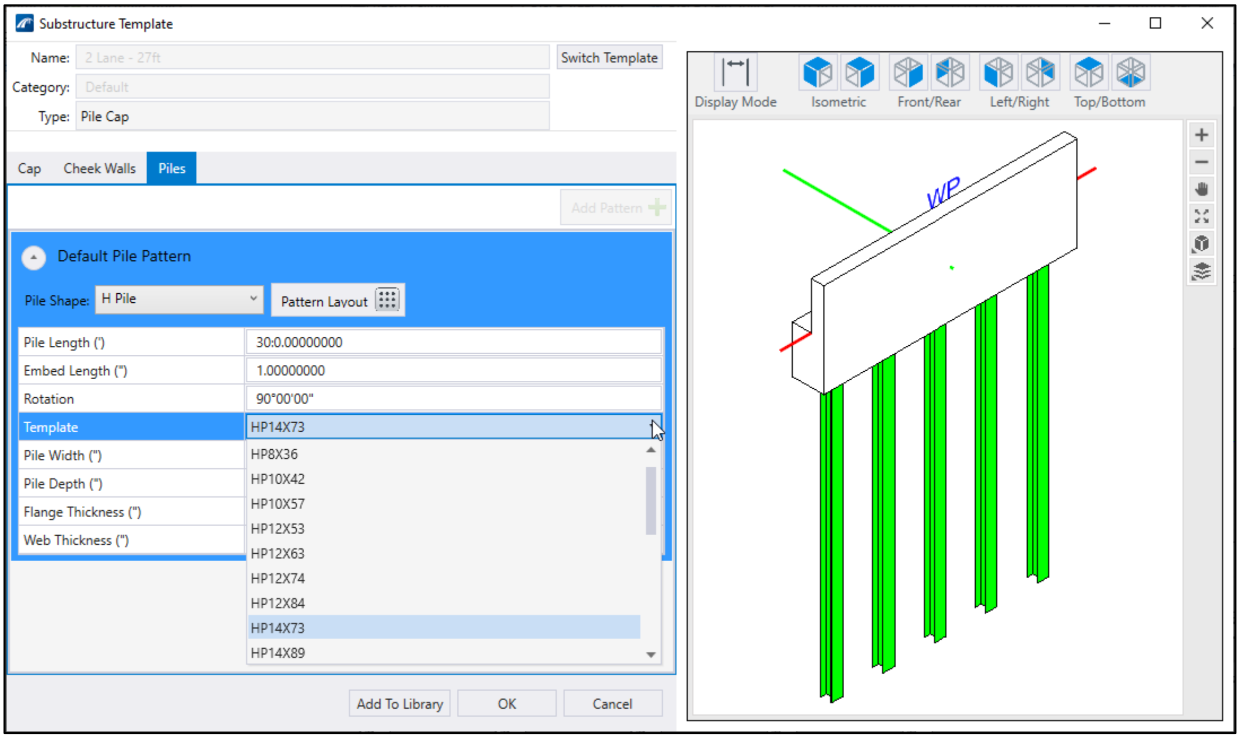


Figure 5.16-5 Adjusting Abutment Properties

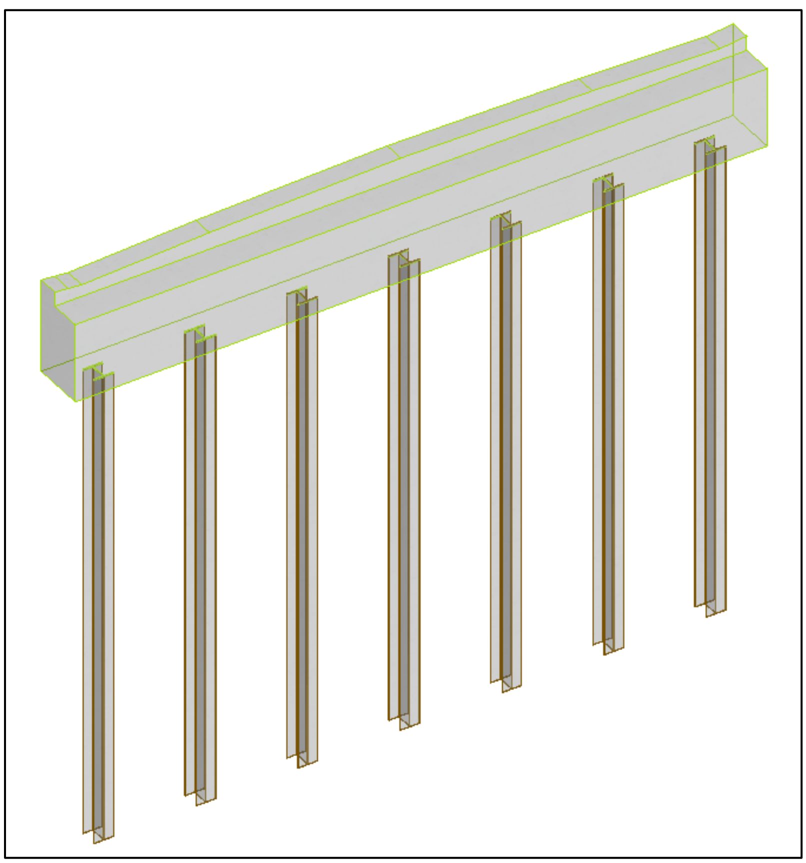


Figure 5.16-6 Abutment After Properties Modification

A stepped abutment cap or pedestals are modeled with bearing elements. See section 5.21 (Place Bearing) for more information.

Also, additional information for customizing and reaching the necessary final design development and detail is included in Section 6.16.

5.17 PLACE CUSTOM ABUTMENT

Abutment designs that do not conform to the standard abutment templates provided in the **Place Abutment** tool, will have to be placed using the **Place Custom Abutment** tool. These components are currently being developed for PennDOT standard BD-621M, BD-622M, and BD-624M abutments, and more information will be included in subsequent releases of this manual.

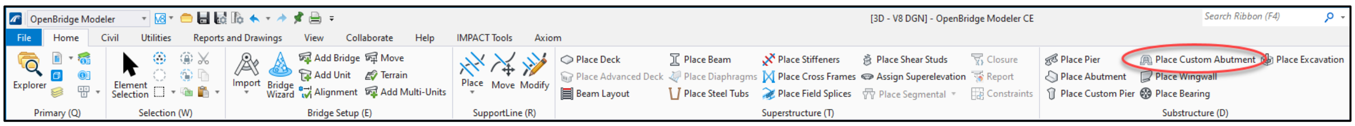


Figure 5.17-1   Place Custom Abutment Tool

After selecting the **Place Custom Abutment** button, the user will be prompted to define basic abutment properties. Select the **SupportLine(s)** to place the abutment.

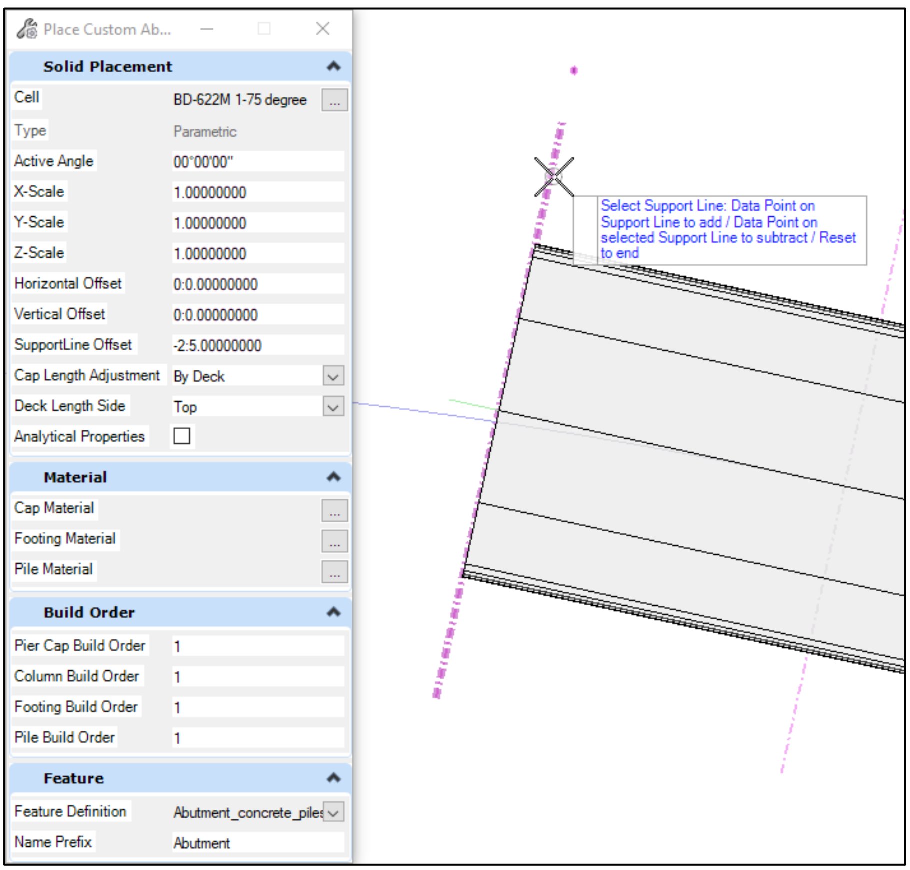


Figure 5.17-2   Selecting SupportLine for Custom Abutment

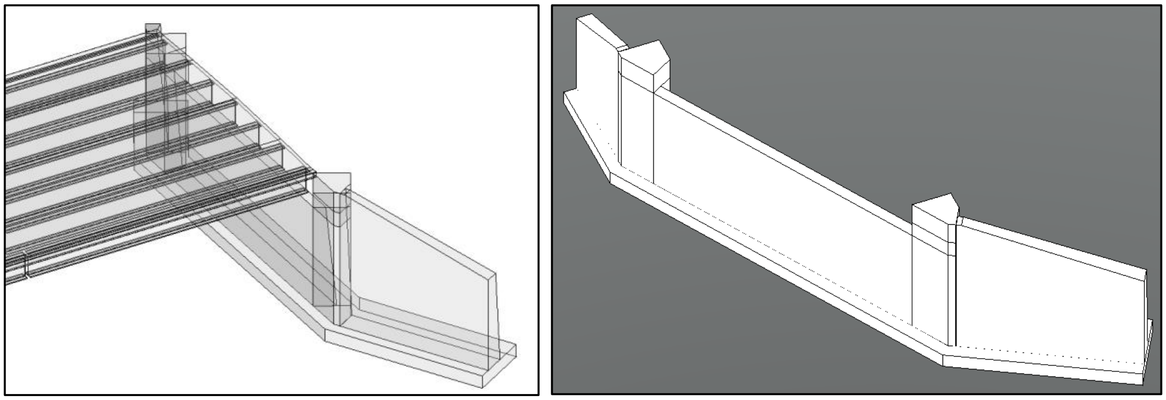


Figure 5.17-3 Abutment After Placement

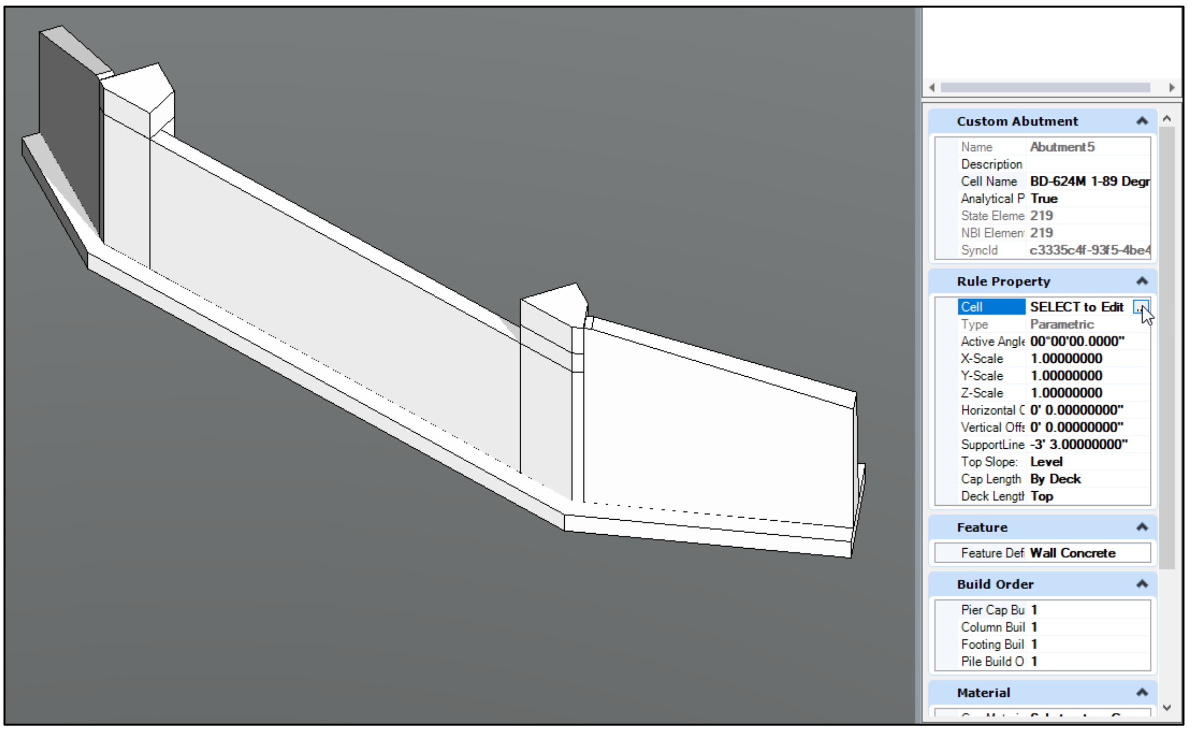


Figure 5.17-4 Changing or Updating Abutment Cell

5.18 PLACE WINGWALL

Wingwalls can only be placed after an abutment has been modeled in OBM. Wingwalls can only be added to an abutment that was created using the **Place Abutment** tools and cannot be added to an abutment that was placed using the **Place Custom Abutment** tools. The **Place Wingwall** tool places abutments from the **Utilities > Libraries > Wingwall**.

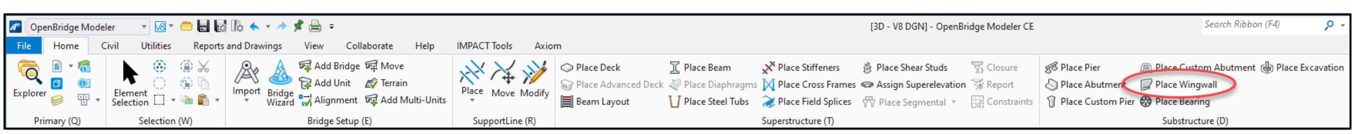


Figure 5.18-1 Place Wingwall

After selecting the **Place Wingwall** button, the user will be prompted to define basic wingwall properties and select the **Abutment** to place the wingwalls. When defining the wingwall properties, the user can define the left wingwall, right wingwall, or both wingwalls at the same time. Different properties and templates can be defined for each individual wingwall.

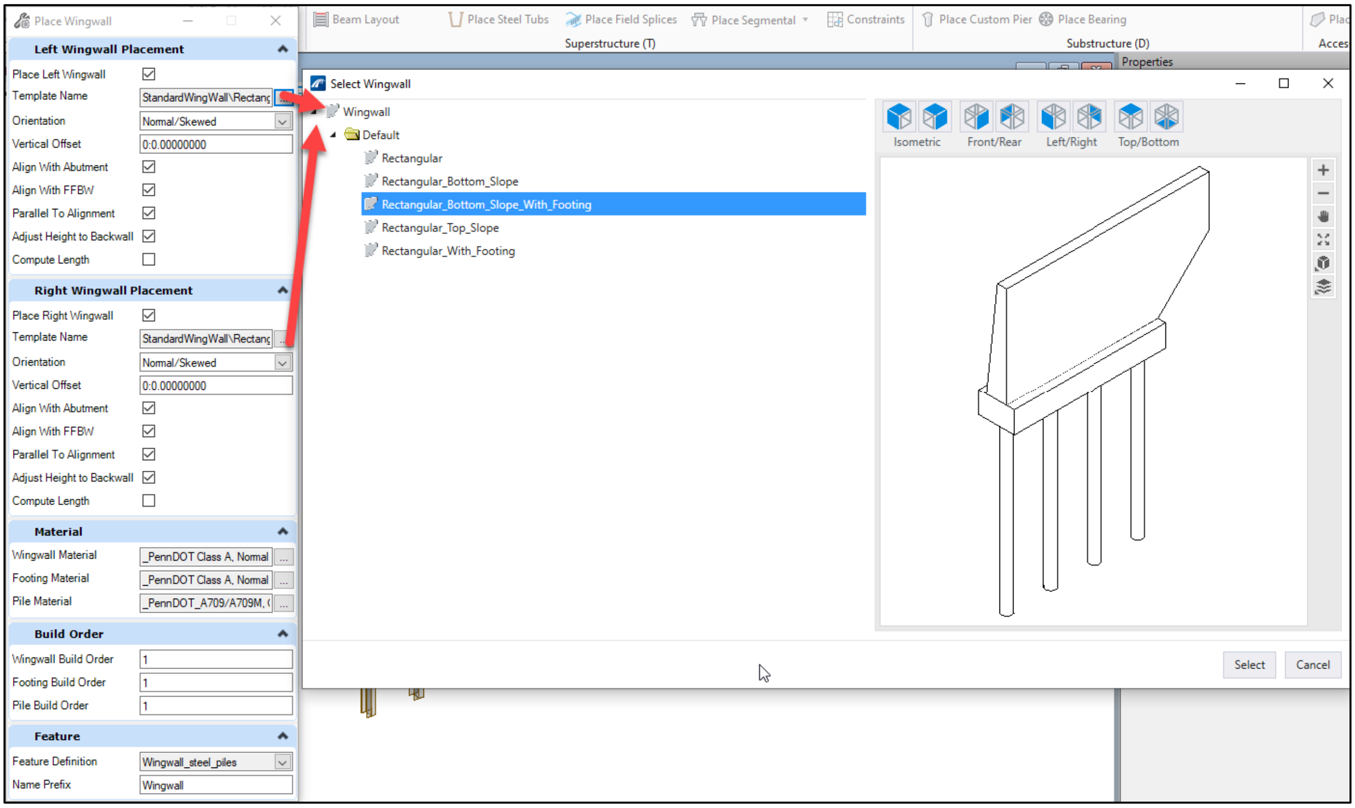


Figure 5.18-2 Defining Wingwall Properties and Selecting Wingwall Template

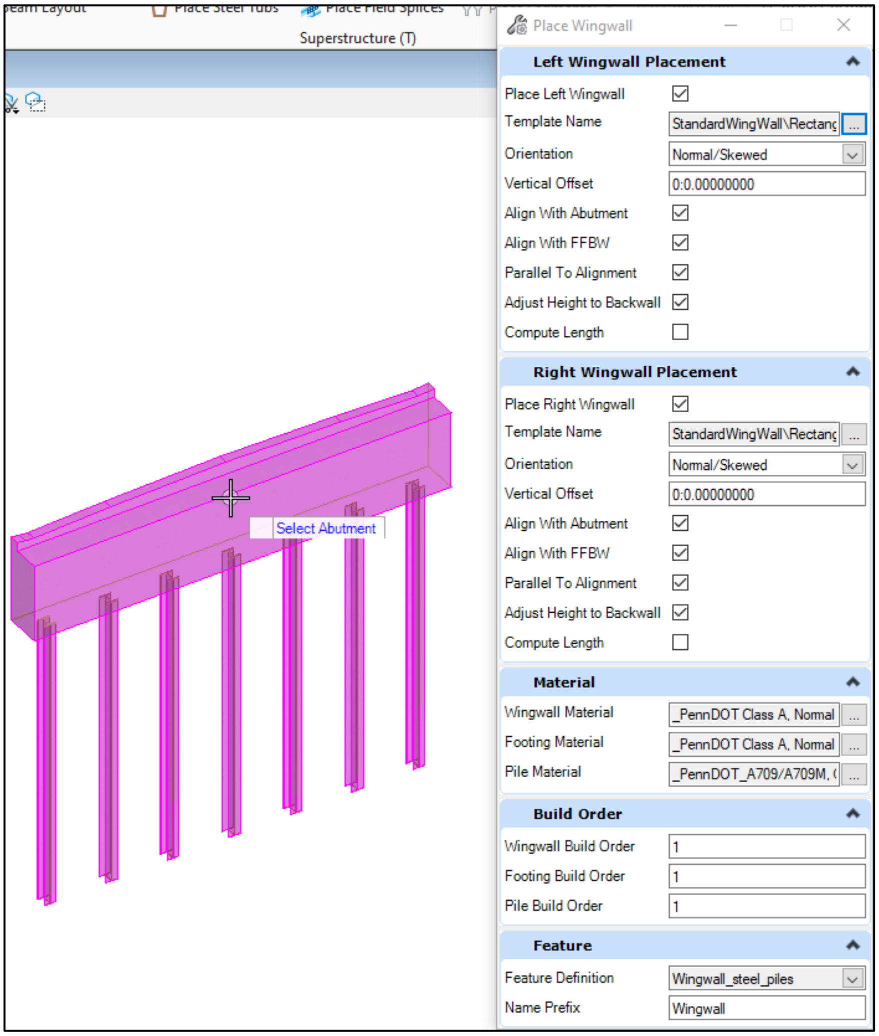


Figure 5.18-3 Selecting Abutment for Wingwall Placement

When placing wingwalls, the user may select the orientation of the wingwall relative to the abutment, and then apply in necessary skew angle. Two **Orientation** options are available. The first orientation is the **Normal/Skew** option. This option places the longitudinal reference axis of the wingwall **normal** to the back face of the abutment. The reference axis is located through the longitudinal center of the wingwall and as such the wing may need to be adjusted to line up correctly with the left or right face of the abutment respectively. A skew angle may then be provided to rotate the wingwall relative to the reference axis.

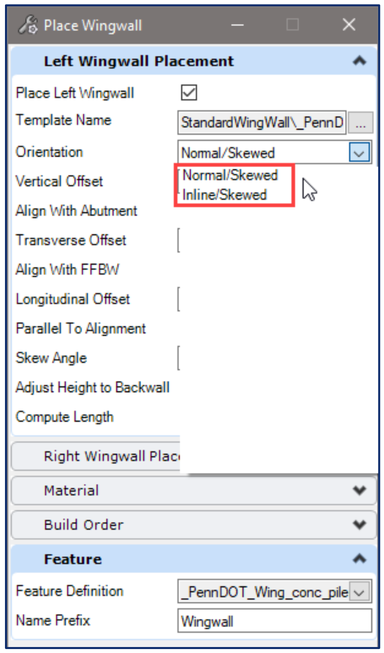


Figure 5.18-4 Wingwall orientation options

Similarly, the second orientation option is the **Inline/Skew** option. This option places the wingwall **inline** with the abutment it is being attached to. The reference axis, and thus the longitudinal length of the wingwall, is place along the same line as the abutment centerline. Adjustments to the wingwall's location/alignment may also be required at this time, and the wingwall itself may be skewed about the reference axis as well.

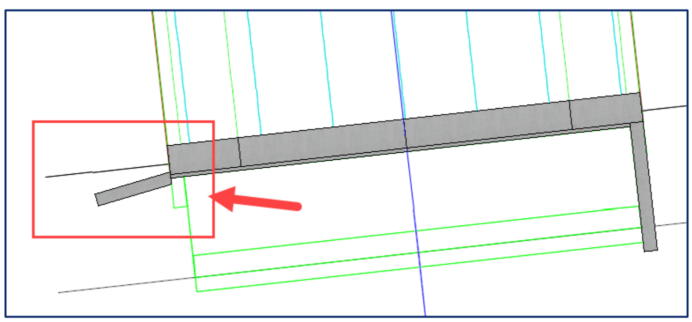


Figure 5.18-5 Inline wingwall with a -10° 00' 00" skew

After the wingwall has been placed, the user can click on the wingwall to activate the properties and click on the ellipses of **SELECT to Edit** to the right of the **Wingwall Template** to adjust the wingwall dimensions. A pair of wingwalls can be placed together, but the properties must be edited individually after they have been placed. In this window the user can adjust the cap, footings, and piles.

The OBM supplied substructure tools can be difficult to work with to obtain a cohesive design, especially when trying to incorporate PennDOT specific design details for substructure units and combined footings with abutments. OBM provides a wide variety of properties that allow the user to adjust and fine tune the wingwall design, but the user may encounter situations such as combined abutment and wingwall footings not lining up, wingwall front face not aligning with abutment front face, and the wingwall top not following the roadway or curb profile such as for U-wing abutments. When these situations are encountered, it may be helpful for the user to use a custom abutment, as described in Sections 5.17 and 6.17.

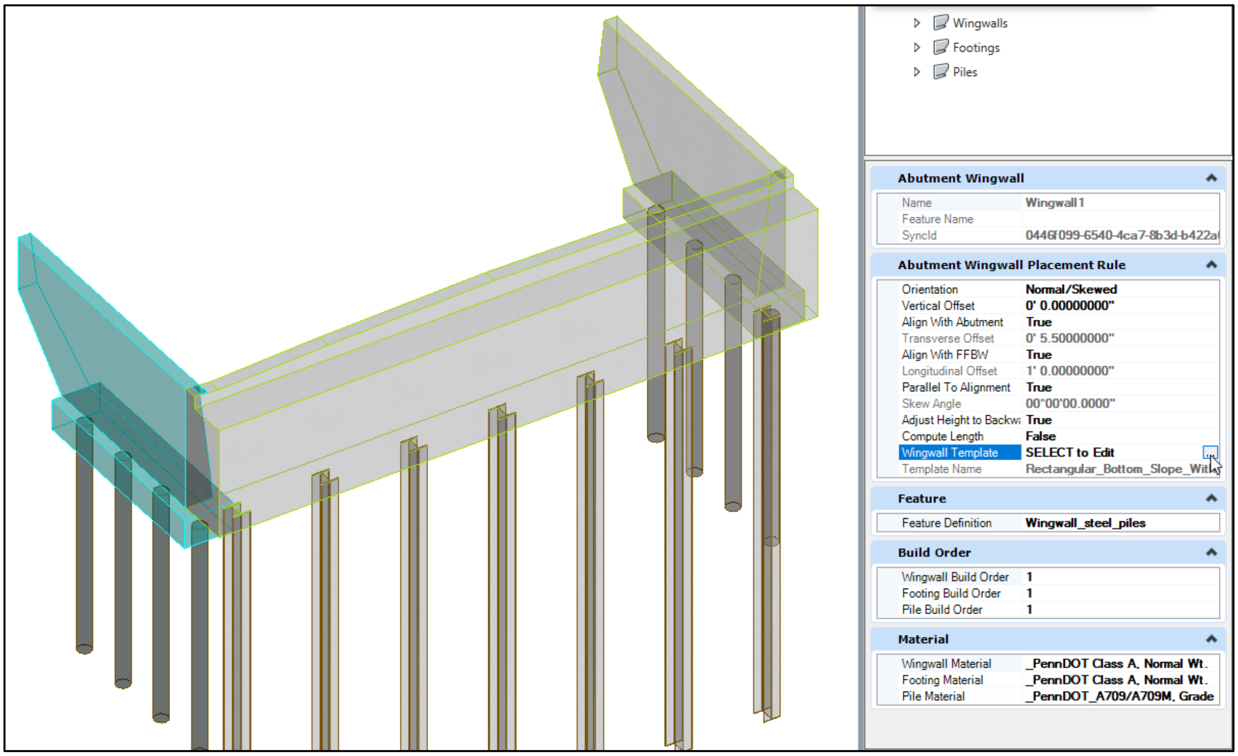


Figure 5.18-6 Editing Wingwall Properties

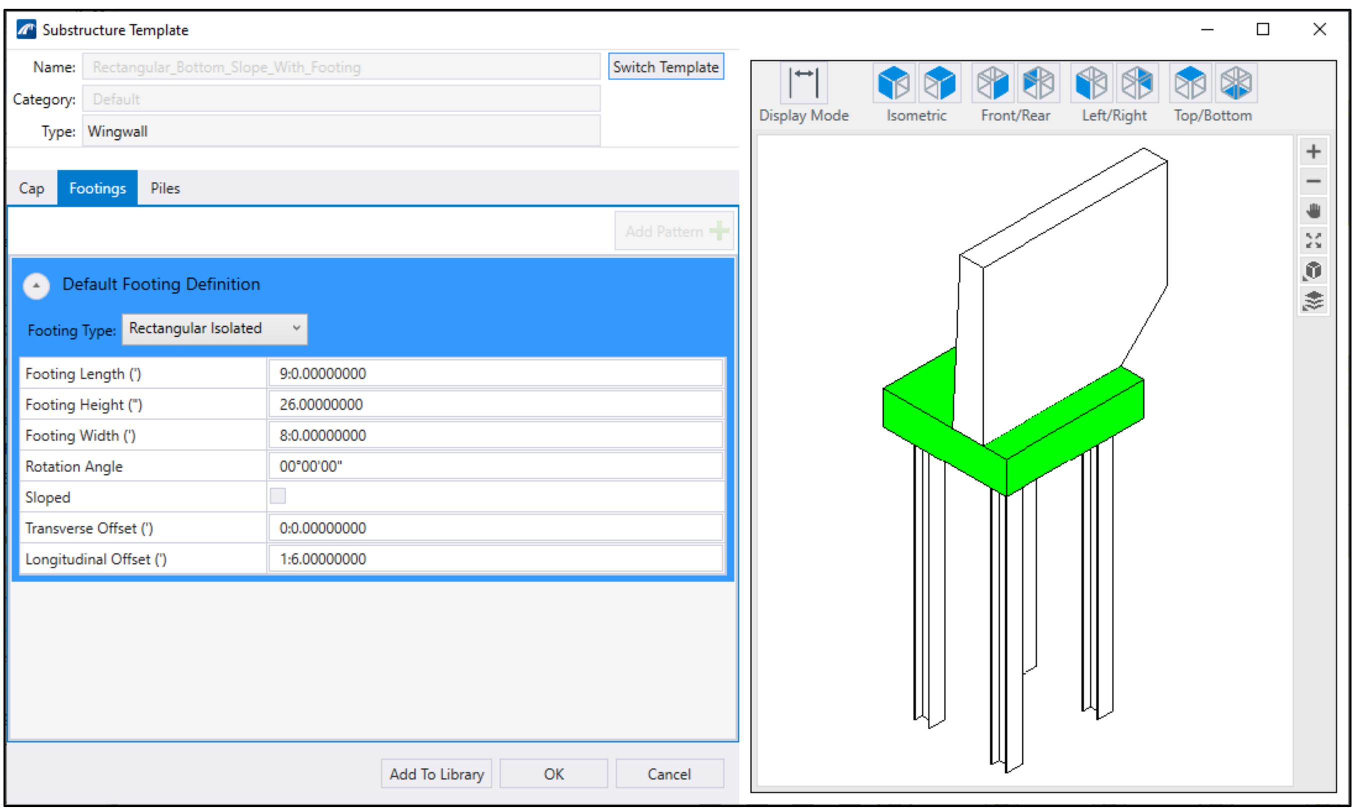


Figure 5.18-7 Adjusting Wingwall Properties

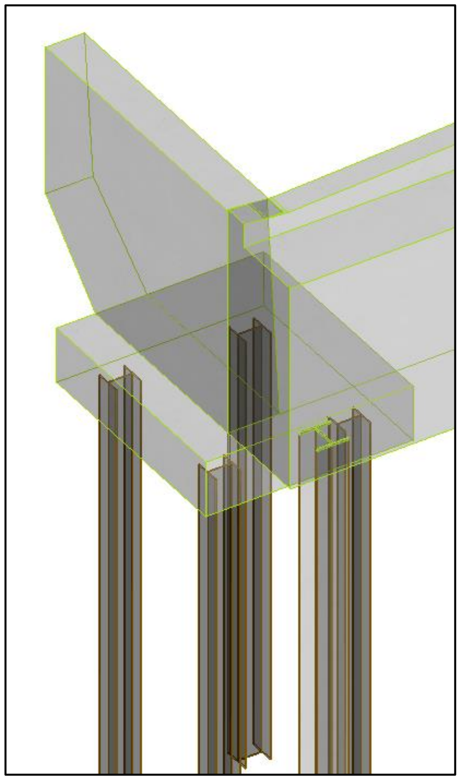


Figure 5.18-8 Wingwall After Properties Modification

5.19 PLACE PIER

Piers are placed in OBM models similarly to abutments. Piers must be placed on a **SupportLine** location within the model. The **Place Pier** tool places abutments from the **Utilities > Libraries > Piers**.

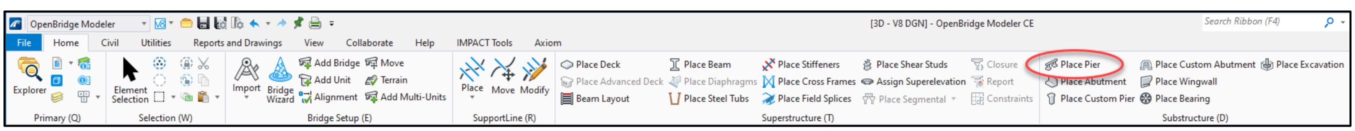


Figure 5.19-1 Place Pier

After selecting the **Place Pier** button, the user will be prompted to define basic pier properties and select the **SupportLine(s)** to place the pier.

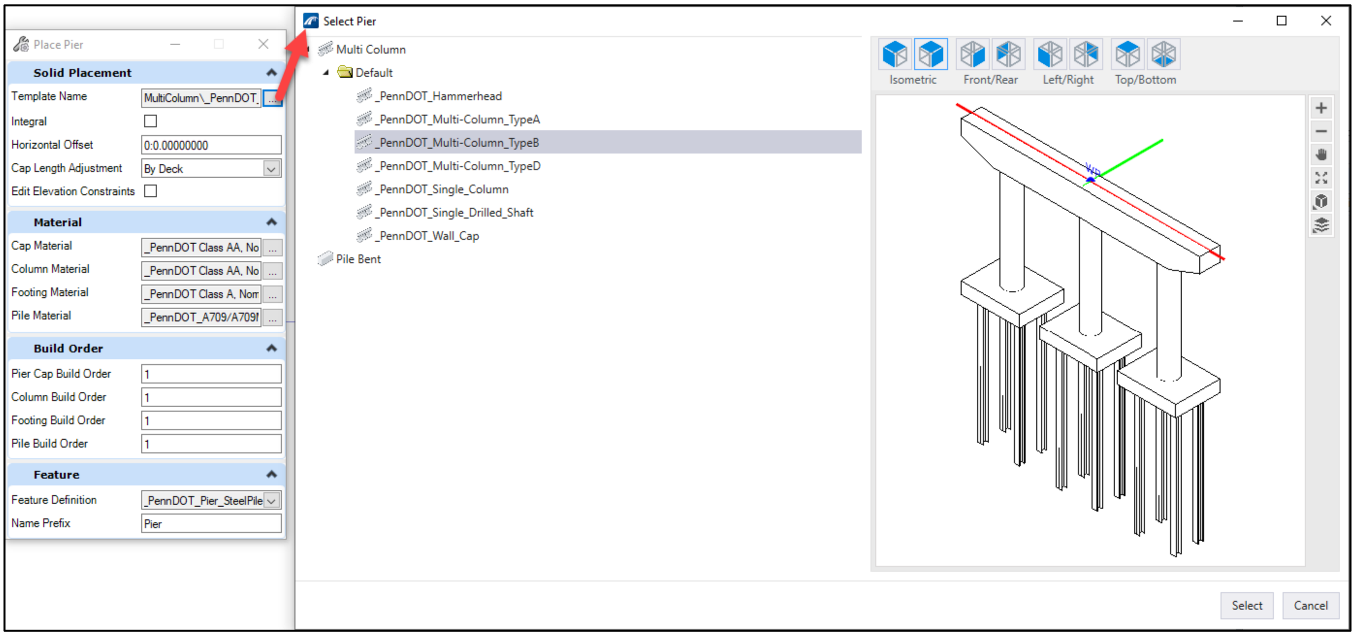


Figure 5.19-2 Defining Pier Properties and Selecting Pier Template

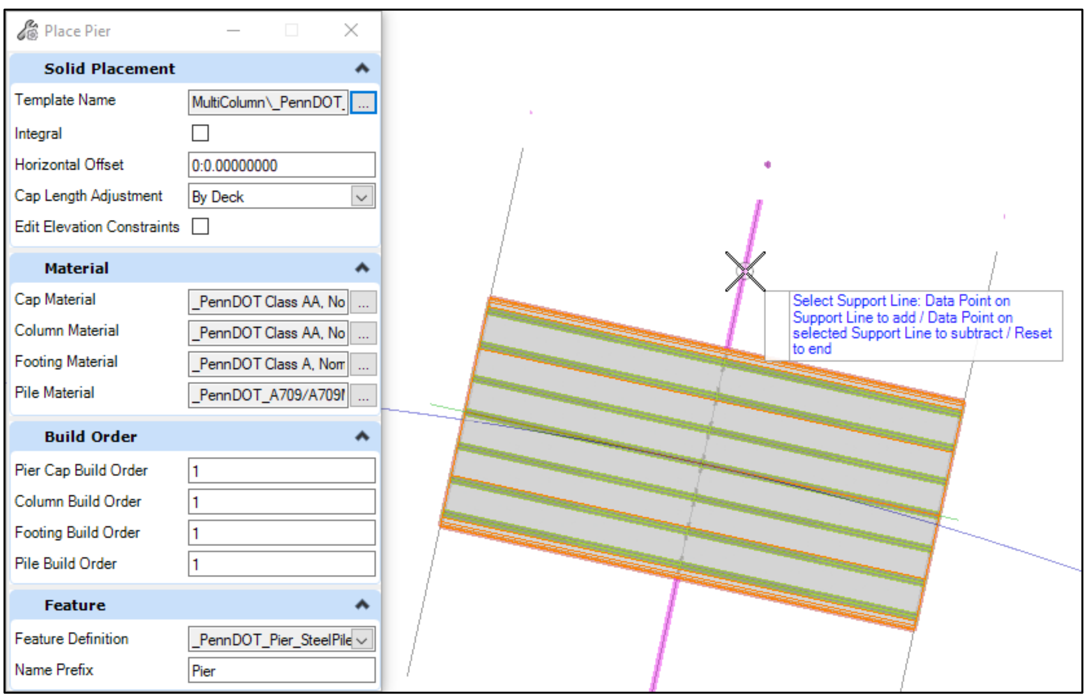


Figure 5.19-3 Selecting SupportLine for Pier Placement

After the pier has been placed, the user can click on the pier to activate the properties and click on the ellipses (the three dots) of **SELECT to Edit** to the right of the **Substructure Template** to adjust the pier dimensions. In this window the user can adjust the cap, cheek walls, columns (size and number), struts, footings, and piles.

Note: The stem of a wall type pier is adjusted in the column tab of the Place Pier dialogue box.

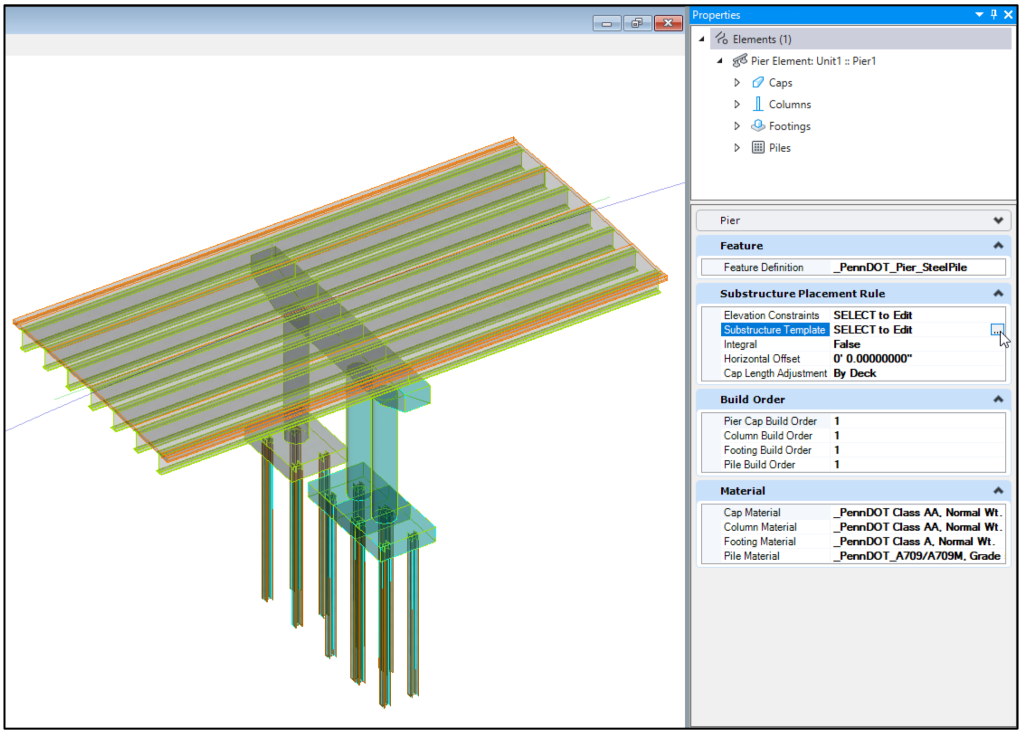


Figure 5.19-4 Editing Pier Properties

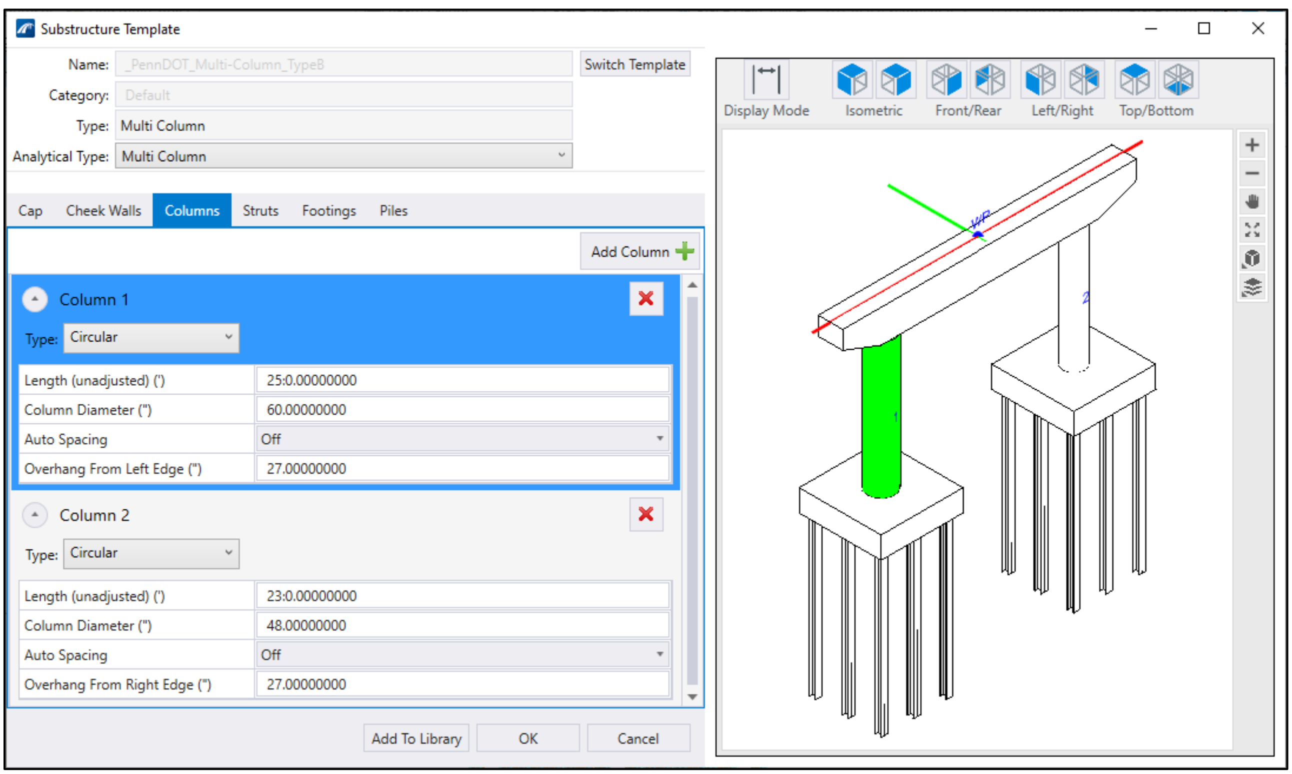


Figure 5.19-5 Adjusting Pier Properties

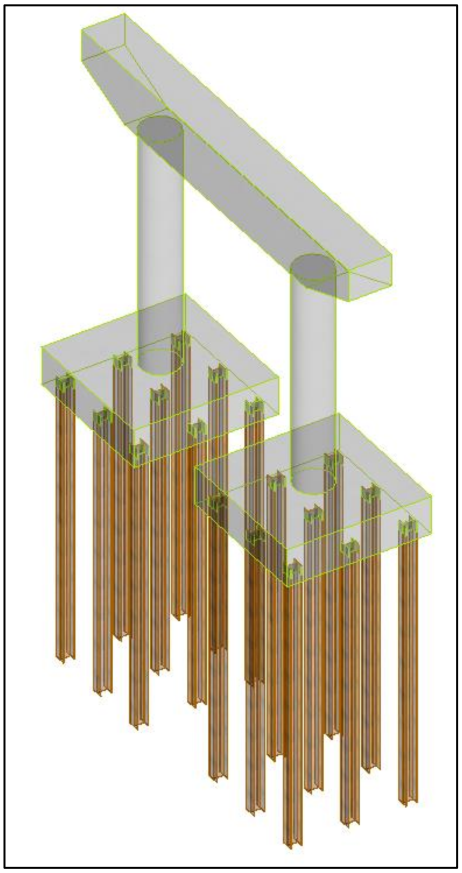


Figure 5.19-6 Pier After Properties Modification

A stepped pier cap or pedestals are modeled with bearing elements. See Section 5.21, Place Bearing, for more information.

5.20 PLACE CUSTOM PIER

Pier designs that do not conform to the standard templates provided in the PennDOT workspace and cannot be created as a template using the OBM tools, must be created outside of OBM (MicroStation) and imported using the **Place Custom Pier** tool. An example is a signature pier design with architectural details of aesthetic purposes.

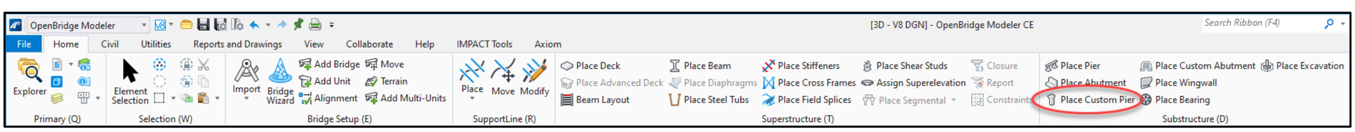


Figure 5.20-1 Place Custom Pier Tool

After selecting the **Place Custom Pier** button, the user will be prompted to define basic pier properties and select the **SupportLine(s)** to place the pier.

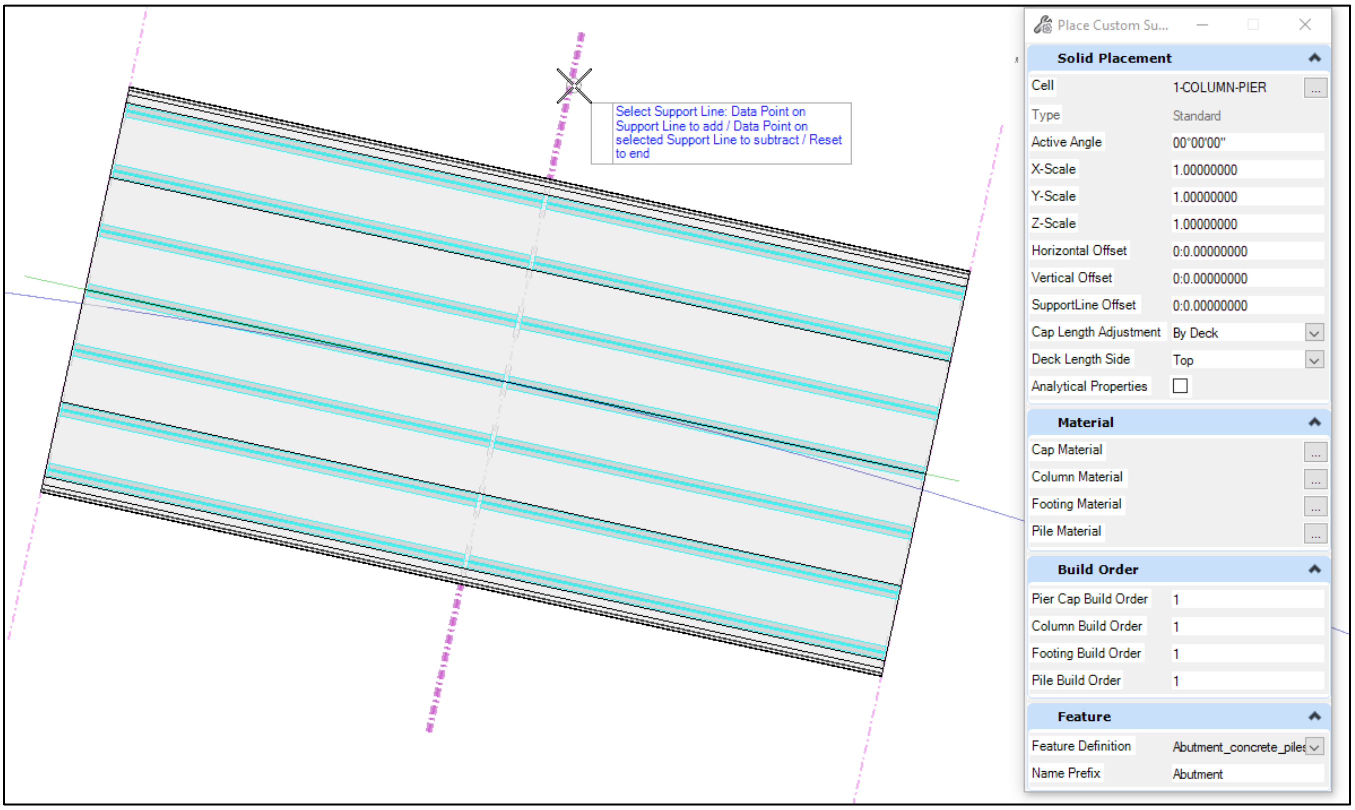


Figure 5.20-2 Selecting SupportLine for Custom Pier

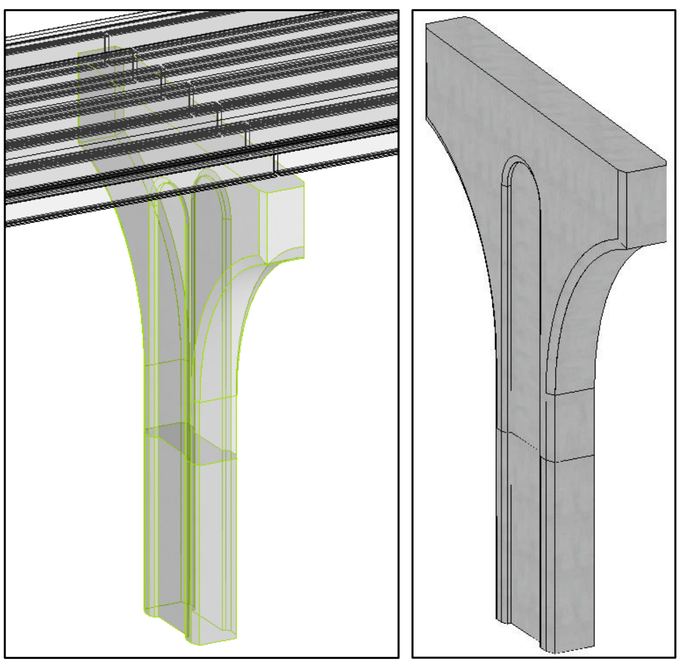


Figure 5.20-3 Pier After Placement

After the pier has been placed, the user can click on the pier to activate the properties and click on the ellipses (the three dots) of **SELECT to Edit** to the right of the **Cell** to change the pier or import an updated pier cell.

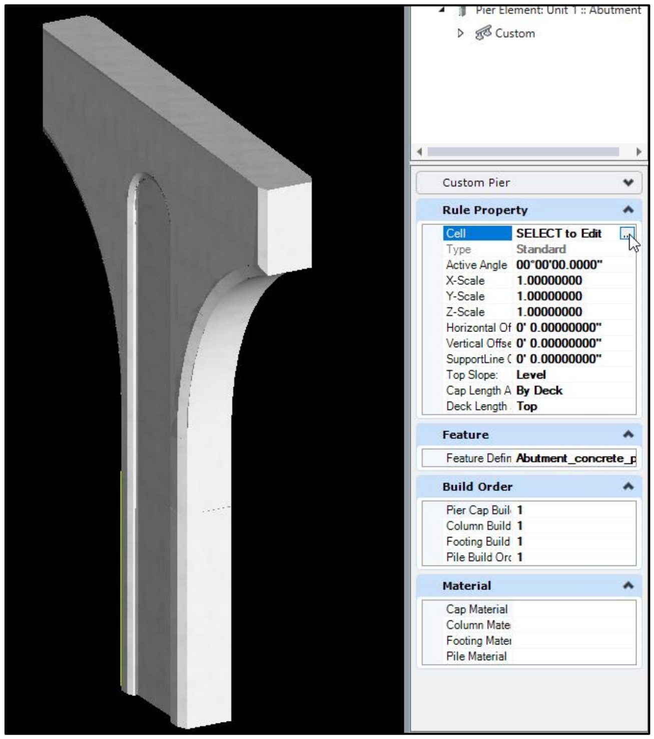


Figure 5.20-4   Changing or Updating Pier Cell

5.21   PLACE BEARING

Bearings are placed in the OBM model along **SupportLines**. Bearings can be placed as a single set along a SupportLine (abutment locations, continuous pier), or placed in groups ahead and back stations (pier locations with non-continuous spans). Bearings, like piers, can be placed along multiple SupportLines at one time.

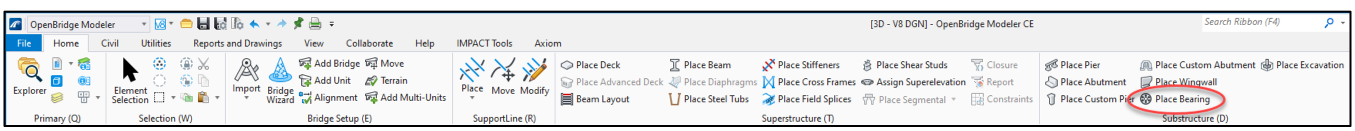


Figure 5.21-1   Place Bearing Tool

After selecting the **Place Bearing** tool found in the **Home > Substructure > Place Bearings**, the user will be prompted to define basic bearing properties by selecting the **SupportLine(s)** to place the bearings.

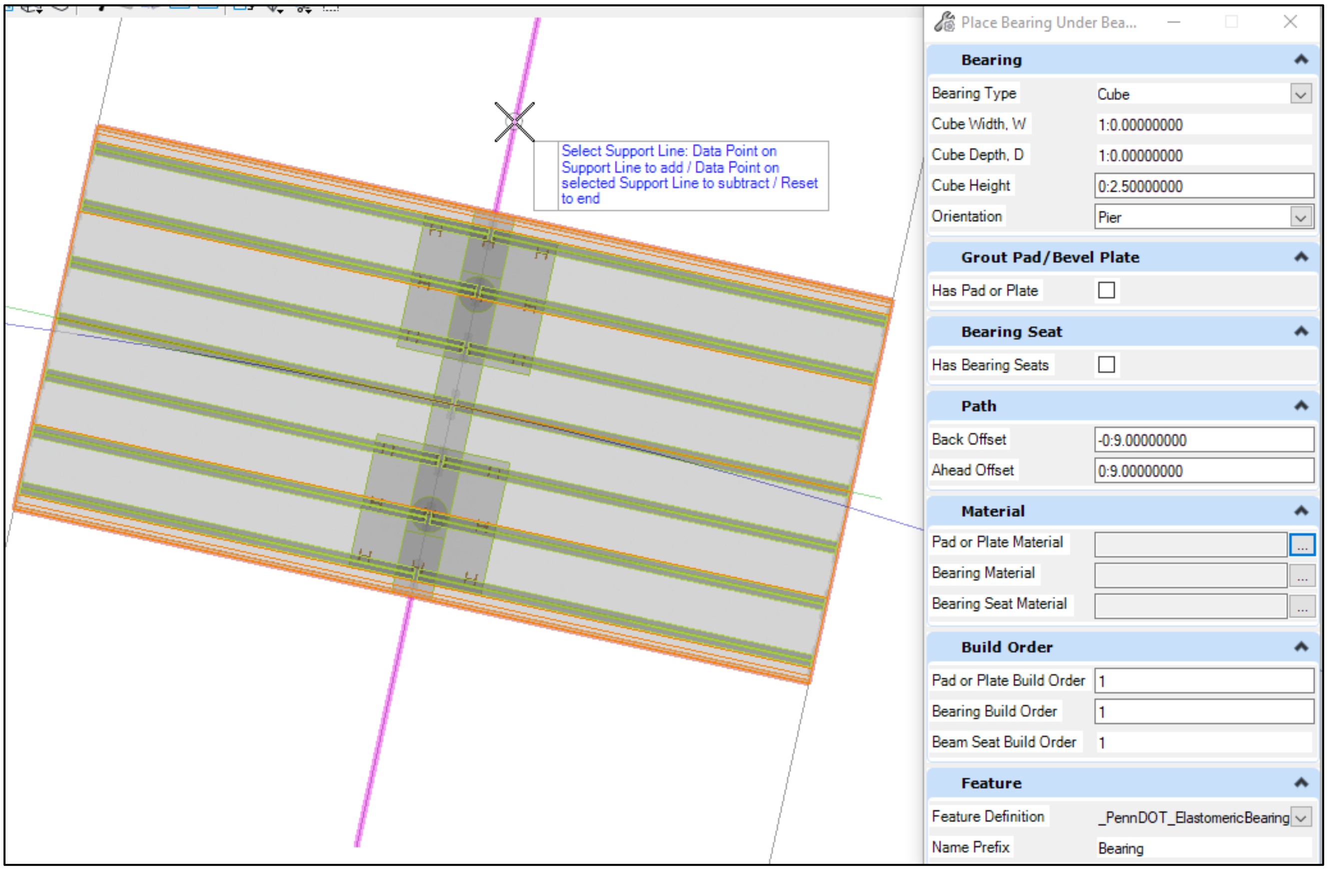


Figure 5.21-2 Selecting SupportLine for Pier

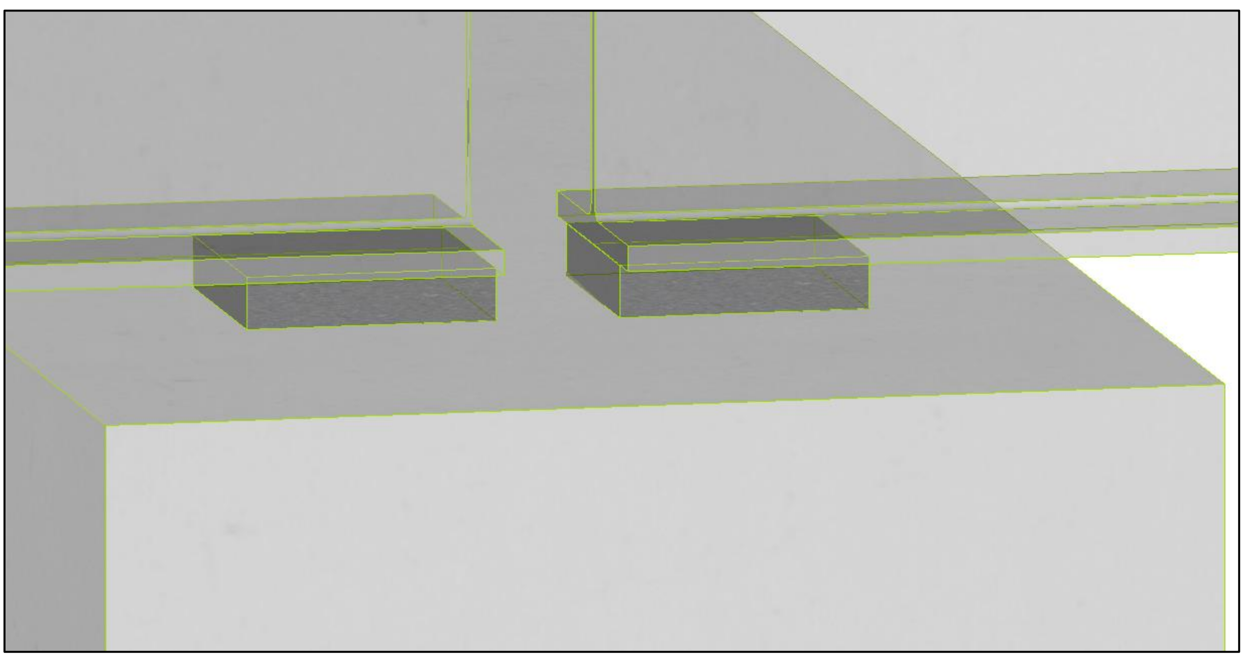


Figure 5.21-3 Bearings After Placement

The user can create a stepped pier cap or pedestals at the bearing seat locations. These changes can be made or adjusted under the bearing properties window.

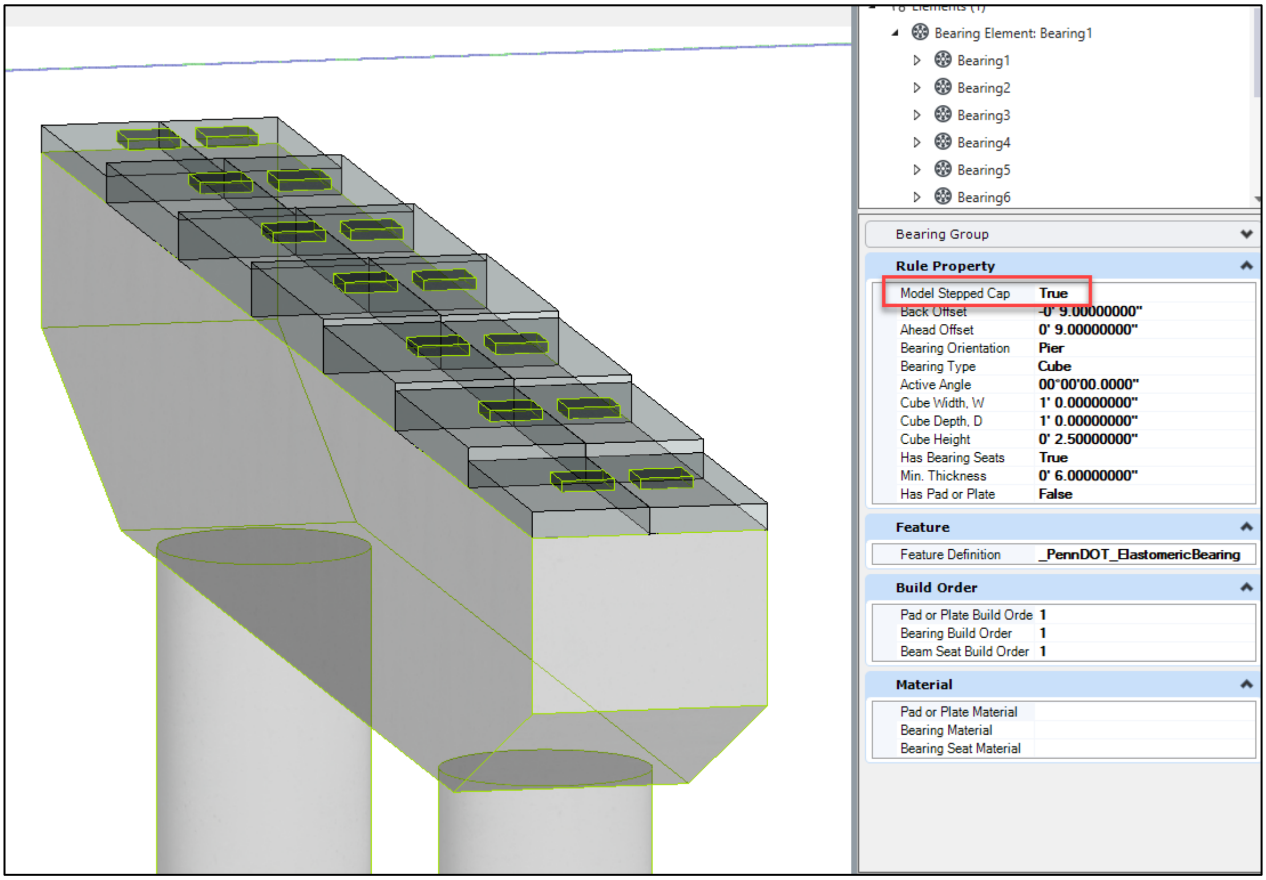


Figure 5.21-4 Stepped Pier Cap

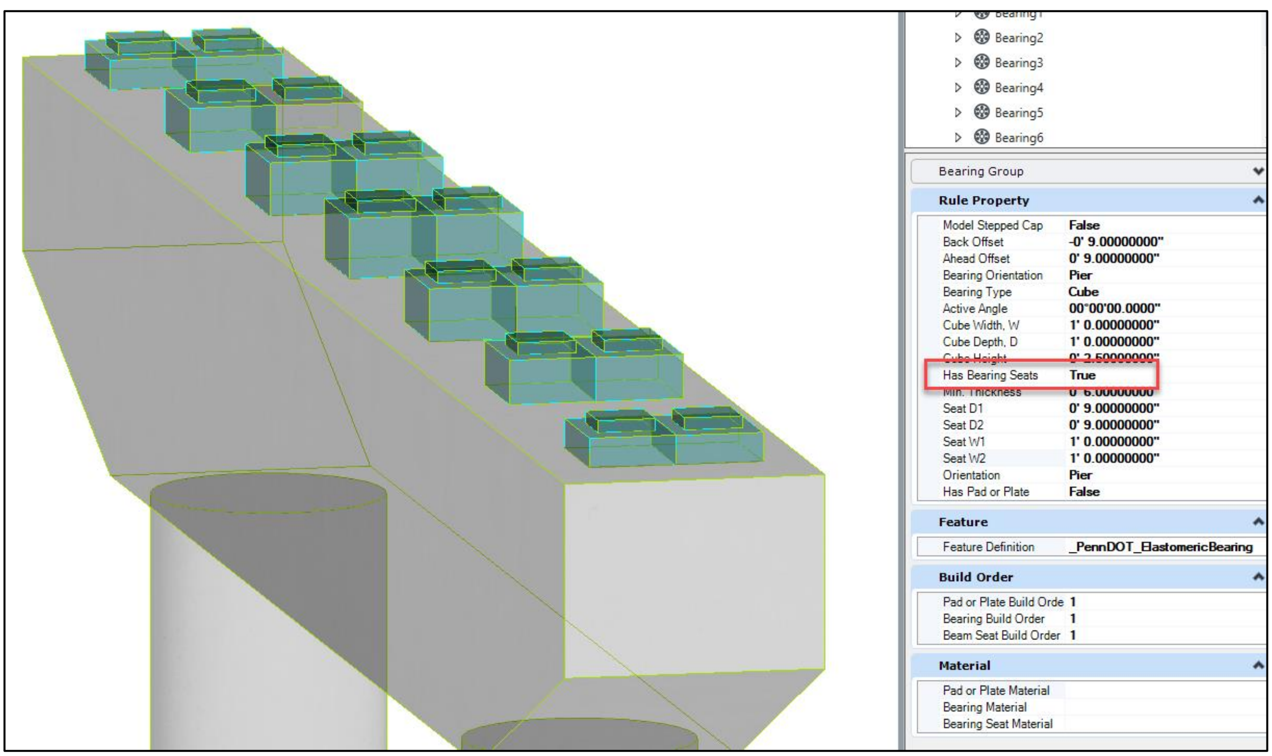


Figure 5.21-5 Bearing Pedestals

Currently, the basic OBM bearing modeling tools can only model cube, cylinders, and cells created outside of OBM template tools. Bearings requiring a higher Level of Detail should be modeled outside of OBM (MicroStation) and imported as a cell, such as pot bearings, disk bearings, rollers, etc.

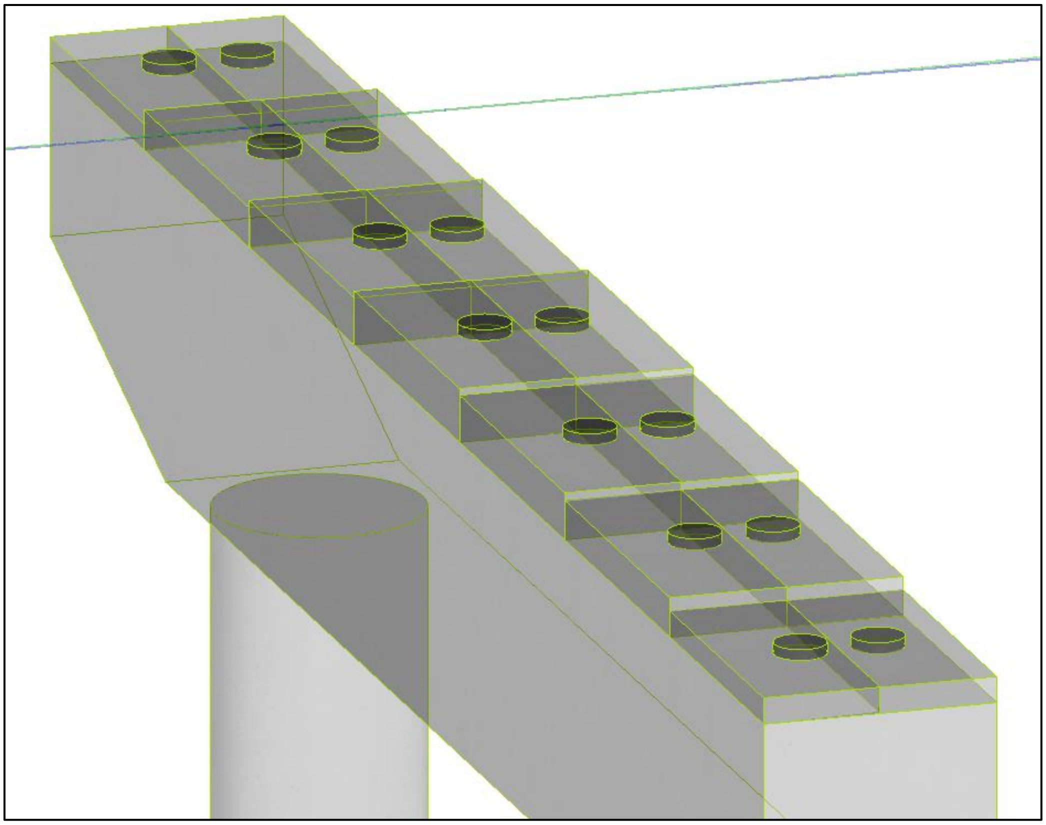


Figure 5.21-6 Cylinder Bearing Type

5.22 PLACE EXCAVATION

There is a **Place Excavation** tool within in OBM that can be used with basic rectangular footings with constant slopes; however, the recommended workflow is to use OpenRoads Designer tools as outlined in the PennDOT OpenRoads Class III Excavation Modeling Training and Class Guide.

5.23 PLACE APPROACH SLABS

Approach slabs are placed in the OBM model using the **Approach Slab** tools. The **Approach Slab** tools consist of Place **Approach Ref Line**, **Place Approach Slab**, and **Place Sleeper Slab**.

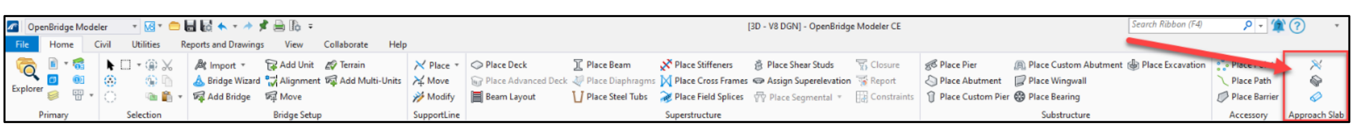


Figure 5.23-1 Place Approach Slab Tools

5.23.1 Approach Ref Line

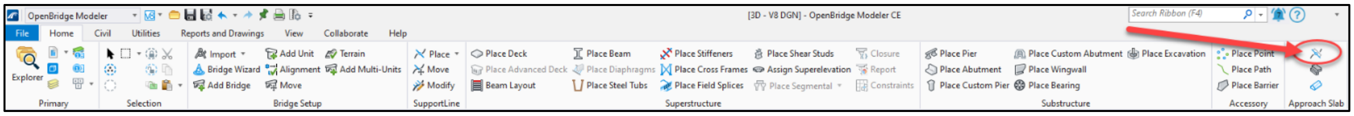


Figure 5.23-2 Place Approach Ref Line Tool

After selecting the **Place Approach Ref Line** tool found in the **Home > Approach Slab > Place Approach Ref Line**, the user will be prompted to define basic properties to define the location of the reference line. Toggle between **Start** and **End** location and enter an Offset From SupportLine distance to position the Approach Ref. Line in the correct location and orientation.

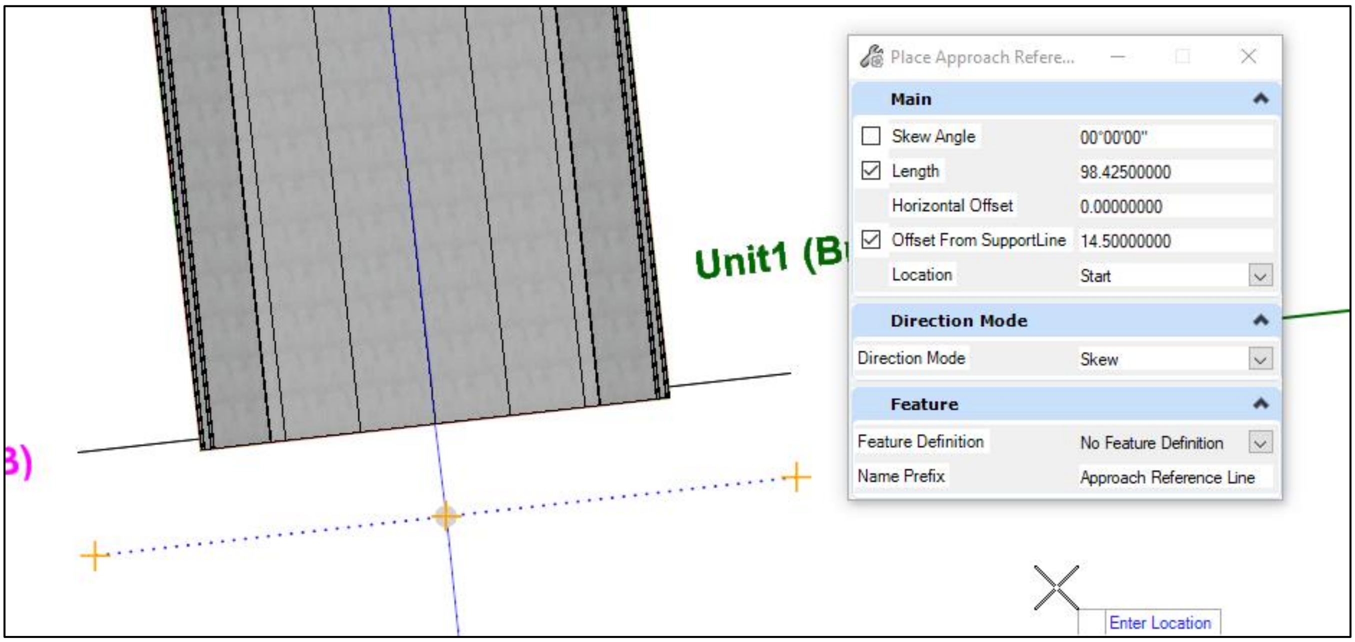


Figure 5.23-3 Placing Approach Ref Line

After placing the **Approach Slab Ref Line**, a new unit will be added for the approach slab in the bridge explorer.

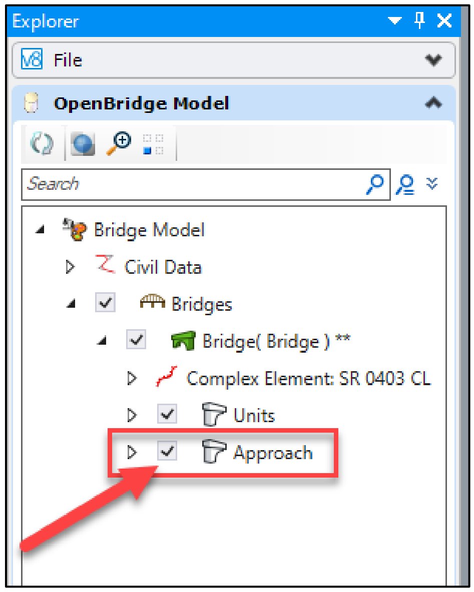


Figure 5.23-4 New Unit for Approach Slab

5.23.2 Place Approach Slab

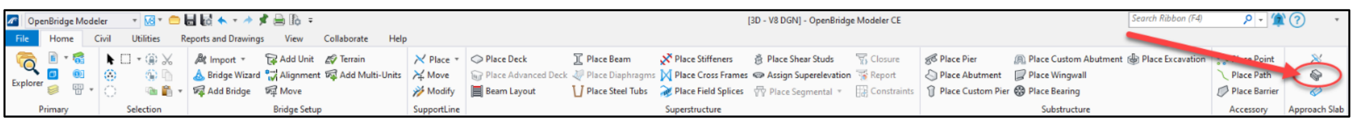


Figure 5.23-5 Place Approach Slab Tool

After selecting the **Place Approach Slab** tool, found in the **Home > Approach Slab > Place Approach Slab**, the user will be prompted to define basic parameters to define the approach slab. The user can choose to sync the approach slab with the deck or choose to define a separate template for the approach slab. Templates for the approach slab are defined in the deck library (**Utilities > Libraries > Decks**). The approach slab is similar to the deck and variable constraints can be edited to meet design requirements to adjust slope, lane widths, shoulder width, thicknesses, etc.

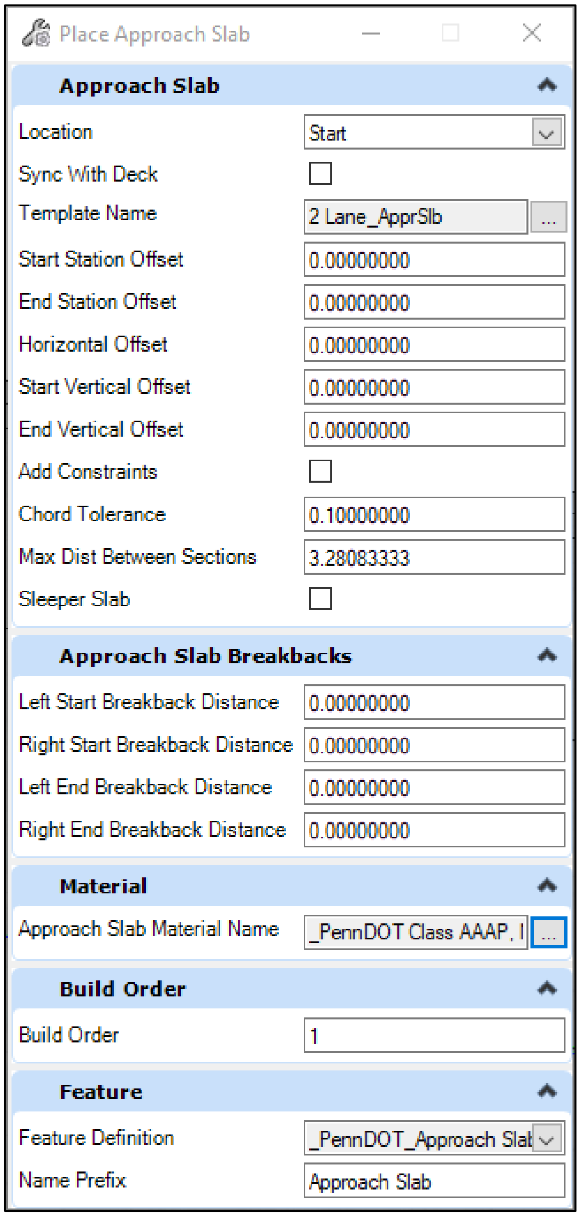


Figure 5.23-6 Placing Approach Slab

Note: The Approach Slab Breakbacks are to be used for skewed supports. See Section 5.6.3 for more information.

5.23.3 Place Sleeper Slab

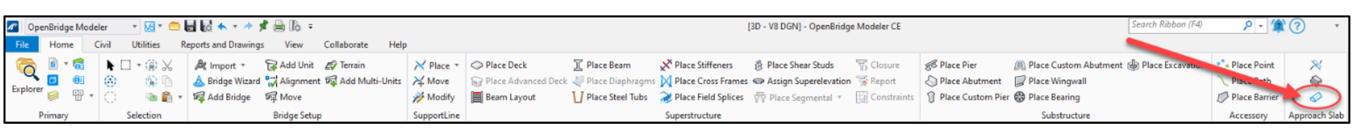


Figure 5.23-7 Place Sleeper Slab Tool

After selecting the **Place Sleeper Slab** tool, found in the **Home > Approach Slab > Place Sleeper Slab**, the user will be prompted to select the template and the approach slab reference line to place the sleeper slab. Templates for the sleeper slab are defined in the sleeper slab library (**Utilities > Libraries > Sleeper Slab**). The user can define the sleeper slab to conform backwall with approach top, conform with approach bottom, and adjust the length of the sleeper slab to the width of the approach slab.

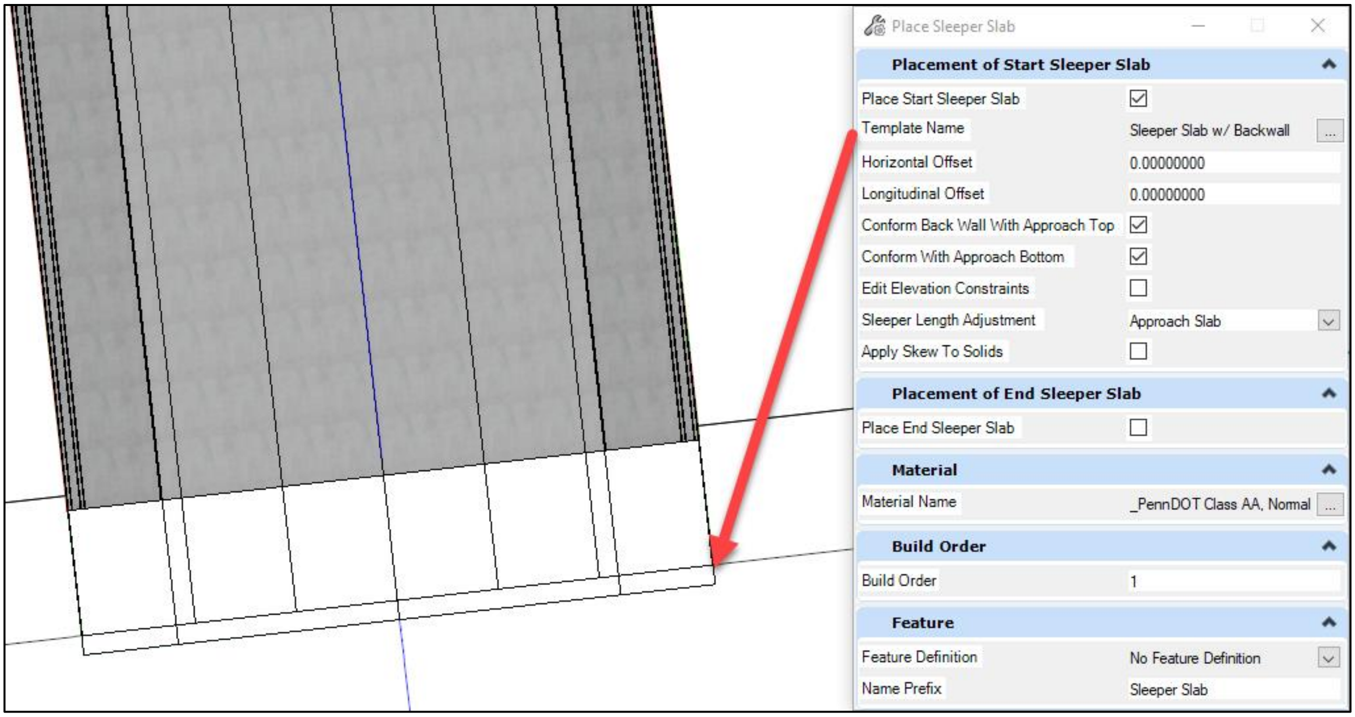


Figure 5.23-8 Placing Sleeper Slab

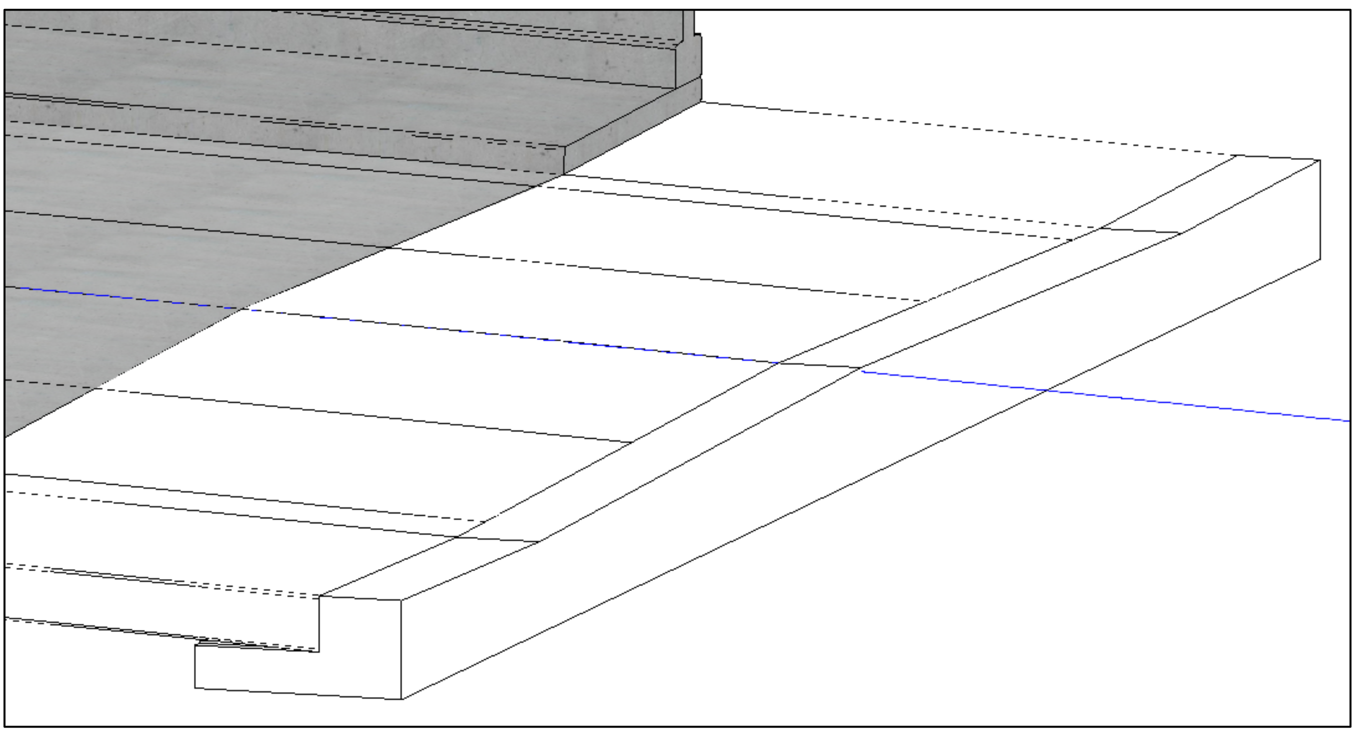


Figure 5.23-9 Sleeper Slab

5.24 ADDING REINFORCEMENT

Reinforcement can be added in OBM to concrete elements within the bridge model. The reinforcement tools can be accessed in the **ProConcrete** workflow.

Rebar can be detailed using OBM, but rebar schedules cannot be generated using OBM alone. A ProStructures' license is required to generate rebar schedules. After the rebar has been detailed in OBM, the files can be opened with ProStructures to generate a rebar schedule.

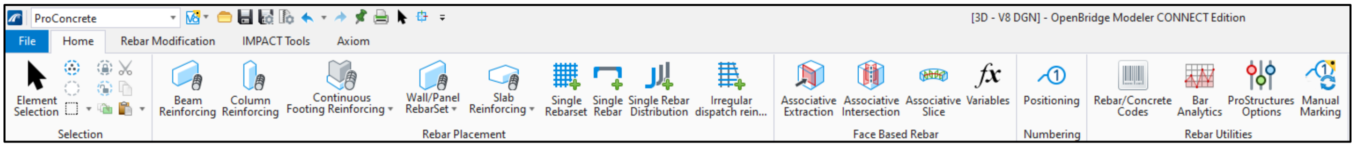


Figure 5.24-1 ProConcrete Workflow

The ProConcrete workflow has a variety of tools that can be used to place rebar within a concrete element. There are specific tools for **beams, columns, footings, walls, and slab reinforcement**. For detailing that might be outside these elements, the user can use the additional rebar tools, such as **Single Rebarset, Single Rebar, Single Rebar Distribution, Irregular Dispatch**. The user should examine the tools and their capabilities to determine which tool is right for the element they wish to detail. As is common with many other modeling tools in OBM, there is more than one tool to achieve the intended goal. These basic tools are similar in their function. Below is an example of reinforcing a concrete footing.

Under the ProConcrete workflow, select **Continuous Footing Reinforcement** and the window will open on the screen. The first step is to Select Active Concrete using the  icon. Select the icon then select the concrete footing.

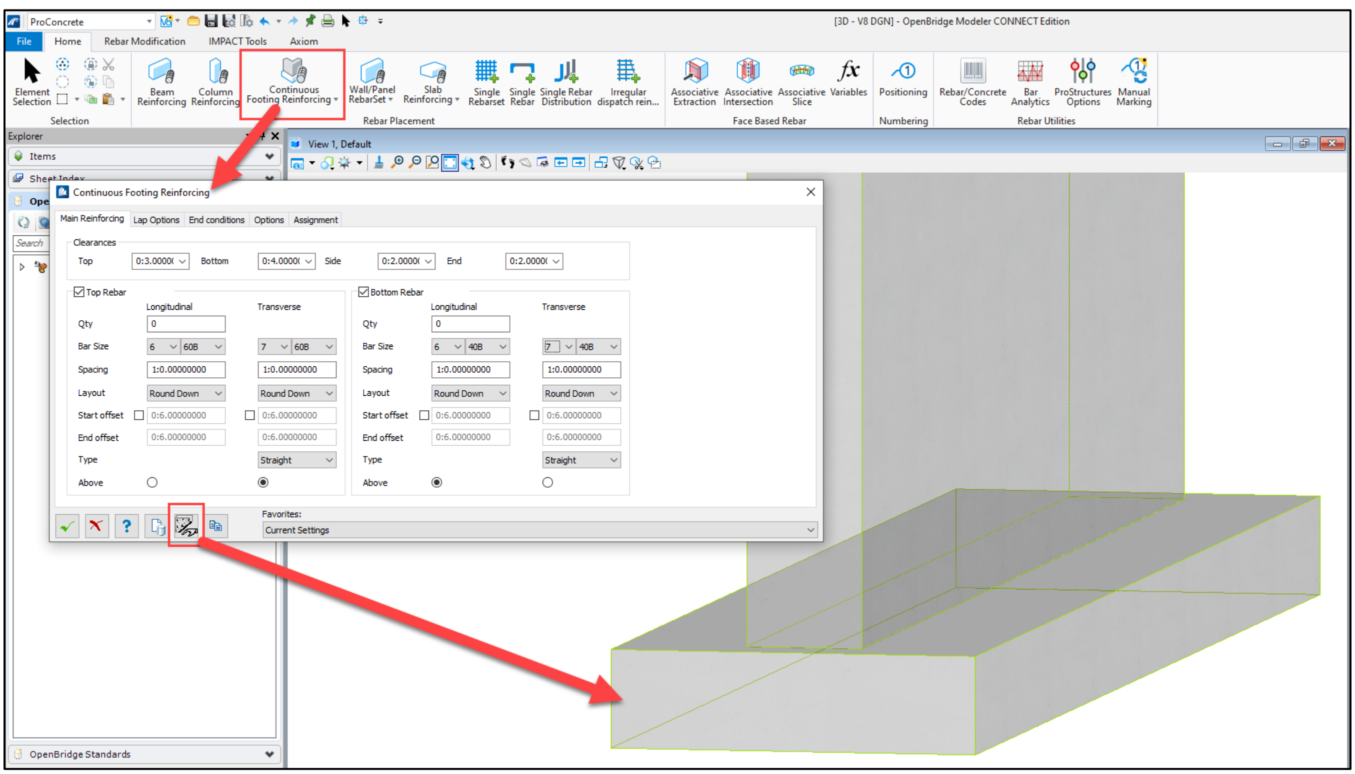


Figure 5.24-2 Continuous Footing Reinforcing Tool

After the concrete is selected, the user will see the rebar in the model view. The user should then use the input dialogs to define the footing reinforcement. The user can define the number of bars or define the space and allow OBM to generate the bars based on the spacing.

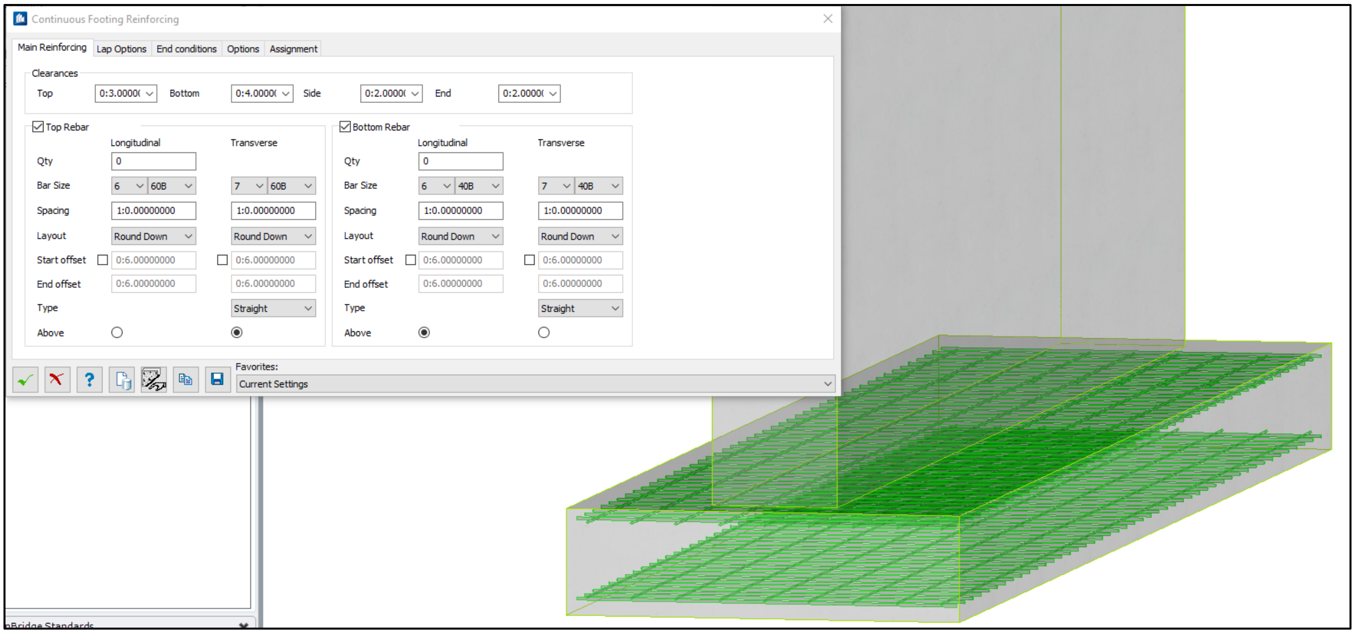


Figure 5.24-3 Footing with Reinforcement Defined

There are also tools that allow the user to add **Laps** to the reinforcement bars. These commands are all user controlled and can be manipulated for project-specific needs and to follow design requirements.

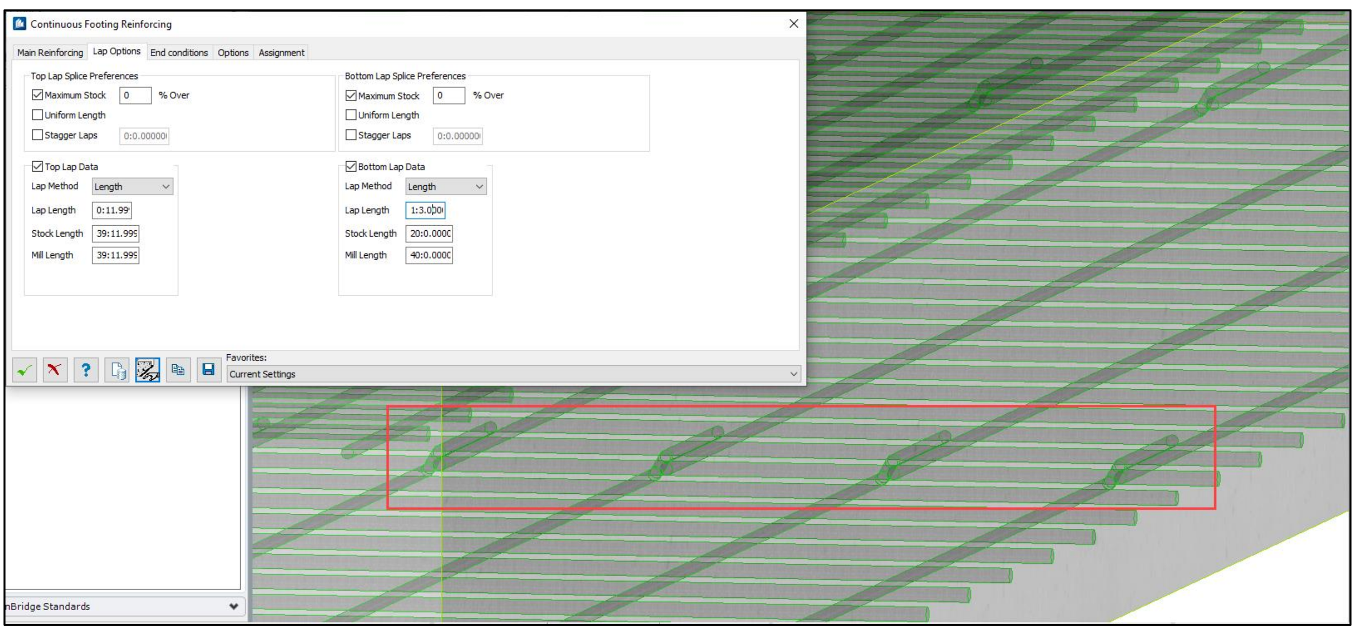


Figure 5.24-4 Footing Reinforcement Detailed with Laps

Another option available to users is the add **End Conditions** to the reinforcement bars. For example, if hooked bars are required for design, the user can define hooks and the bend angle to meet design requirements.

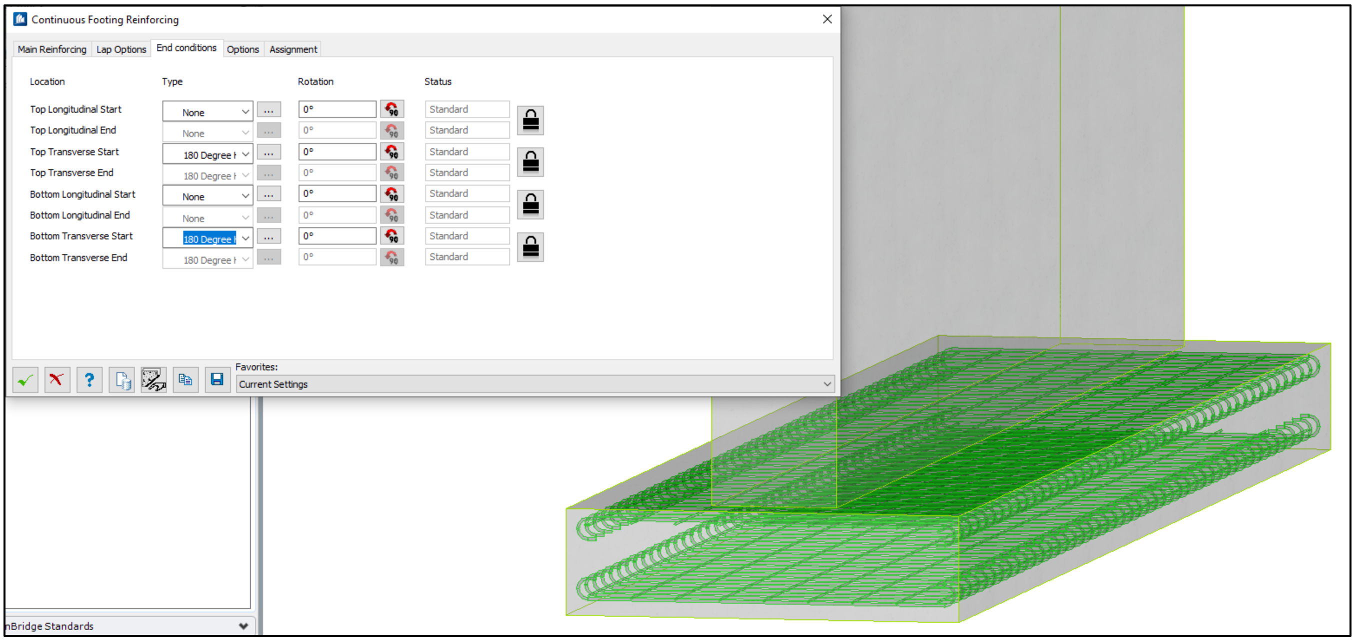


Figure 5.24-5 Footing Reinforcement Detailed with 180 Degree Hooks

After the rebar is placed, the user can edit the rebar adjusting rebar size, spacing, clearances, end conditions etc., by double clicking one of the rebar members in the set. The window used to place the rebar members will open and adjustments can be made.

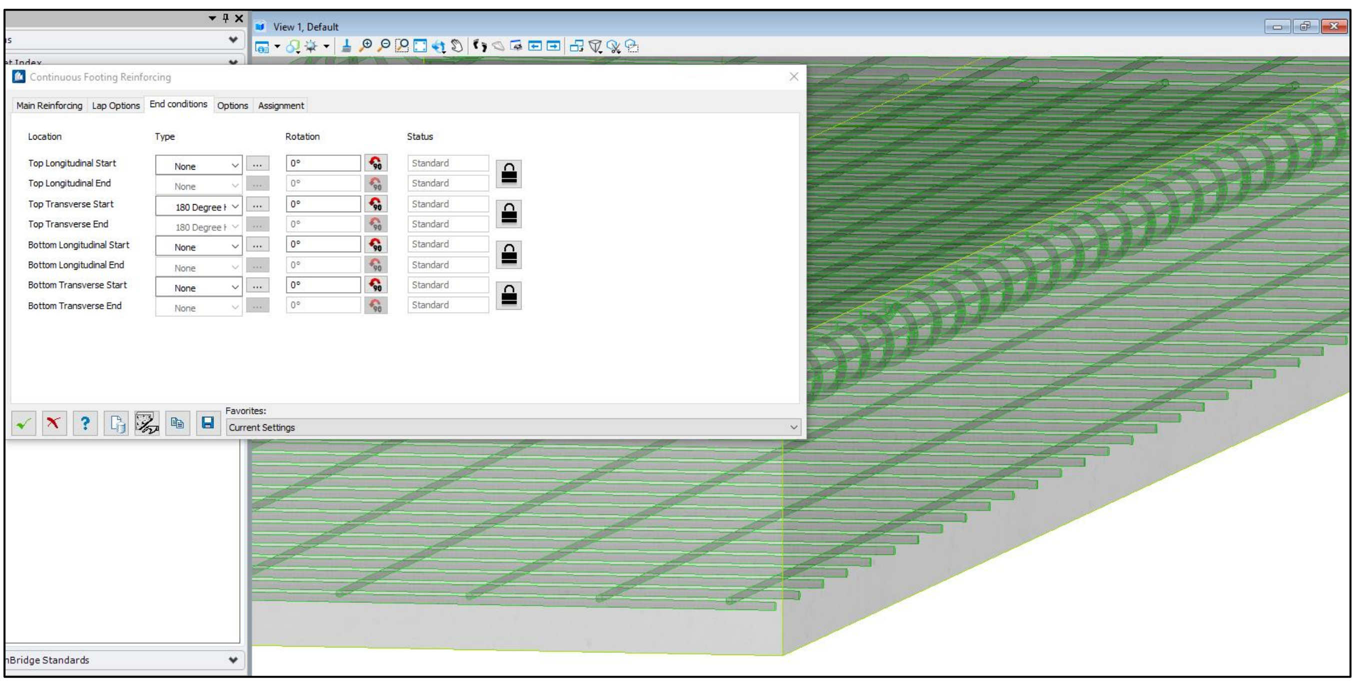


Figure 5.24-6 Footing Reinforcement Modification

There are some basic tools provided in OBM that apply to most concrete elements generated in the OBM model. Footings with nonorthogonal angles or footings with piles that require the rebar to be spaced around them are likely outside of the capability of these tools, and advanced rebar detailing is required.

Note: Once the rebar is placed and accepted with the green check mark you can always double click a single or set of rebar to reopen the placement dialog window to make further changes.

For additional and more advanced reinforcement tools for use in other bridge elements, see Section 6.24.

5.25 ADDING ATTRIBUTES

[This section is under development. Content will be added after PennDOT Item Type list development is complete and Digital Delivery Directive 2025 Pilot Project feedback is incorporated.]

5.26 REFERENCES

State of Florida Department of Transportation, 2022. *FDOTConnect for OpenBridge Modeler: Bridge Design and Modeling Course Guide.* [Online]
Available at: https://www.fdot.gov/cadd/downloads/documentation/fdotconnecttraining/fdotobm/fdotconnect-bridge-design-modeling
[Accessed 26 August 2022].

ADVANCED INPUT DESCRIPTION

6.6 PLACE DECK

6.6.1 Options to modify deck templates

The primary method for using and updating deck templates is to use the PennDOT-specific deck templates provided in the workspace and modify the **Variable Constraints** as described in Chapter 5, Section 5.6.2. Doing so will result in a consistent deck model cross section that is fully parametric, follows BD-601M, and follows the Digital Delivery Guidelines for final design detail and information requirements. These templates will also allow for linking superelevation when using roadway templates.

However, there will likely still be situations where the supplied templates cannot be modified sufficiently to match the model and project needs. In these cases, there is an alternative method for modifying the deck templates or creating your own.

If the user accesses the deck templates through **Utilities > Libraries > Decks**, the user can right-click and select **Copy** to duplicate the selected template within that same folder.

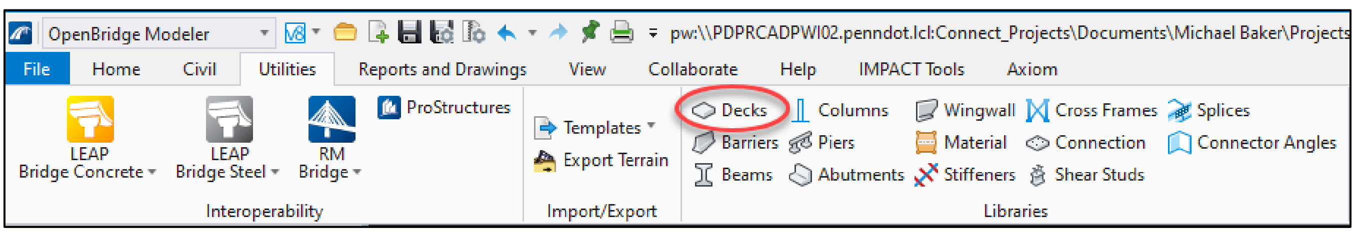


Figure 6.6-1 Location of Deck Template Library

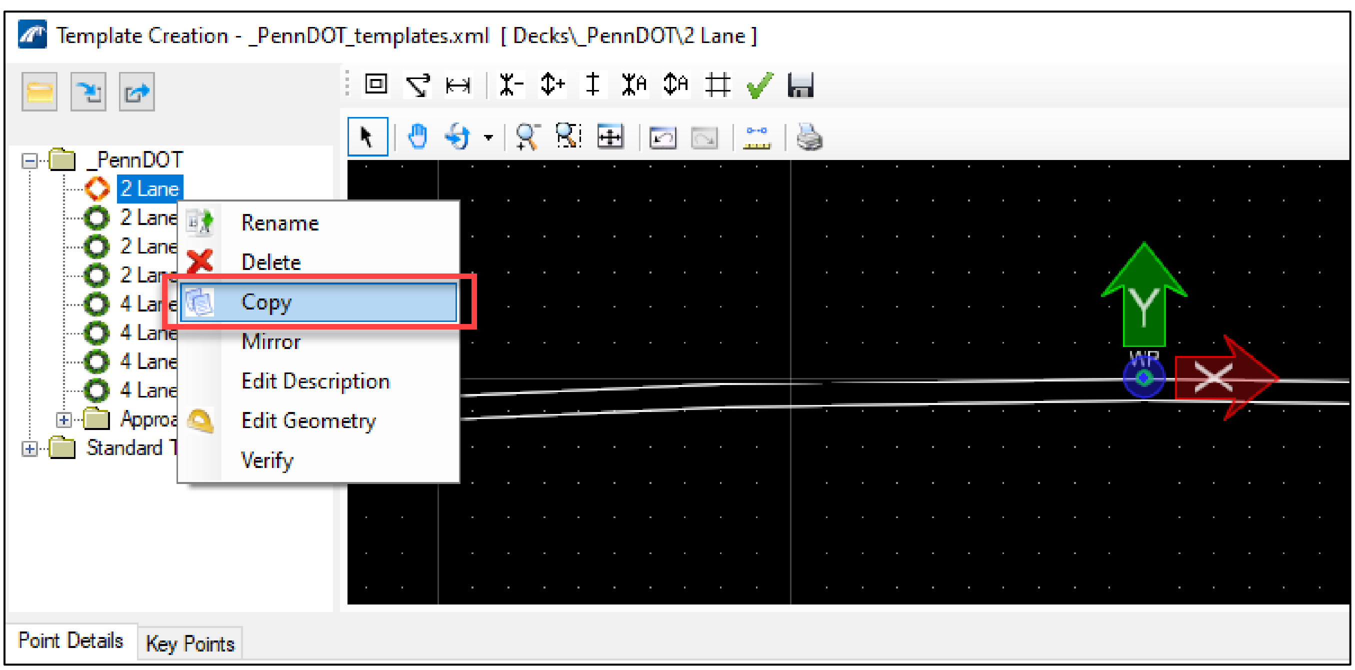


Figure 6.6-2 Copying Deck Templates for Modification

The copied template can then be renamed if desired by right-clicking again and selecting **Rename**. Then the copied template can be modified by selecting "**Edit Geometry**" in the drop-down menu.

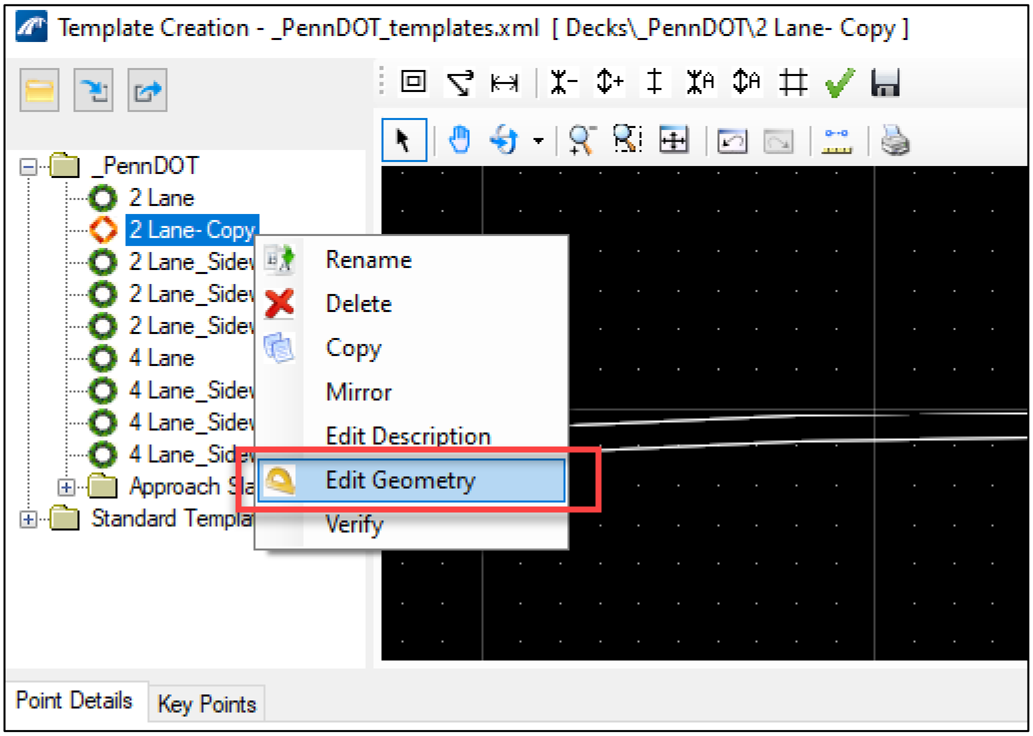


Figure 6.6-3 Edit the Copied Templates

After **Edit Geometry** is selected, the Template Creation window will minimize, and the user must left click in an open OBM window to open the template for editing and modification. The template geometry will open in the selected window as shown in the image below.

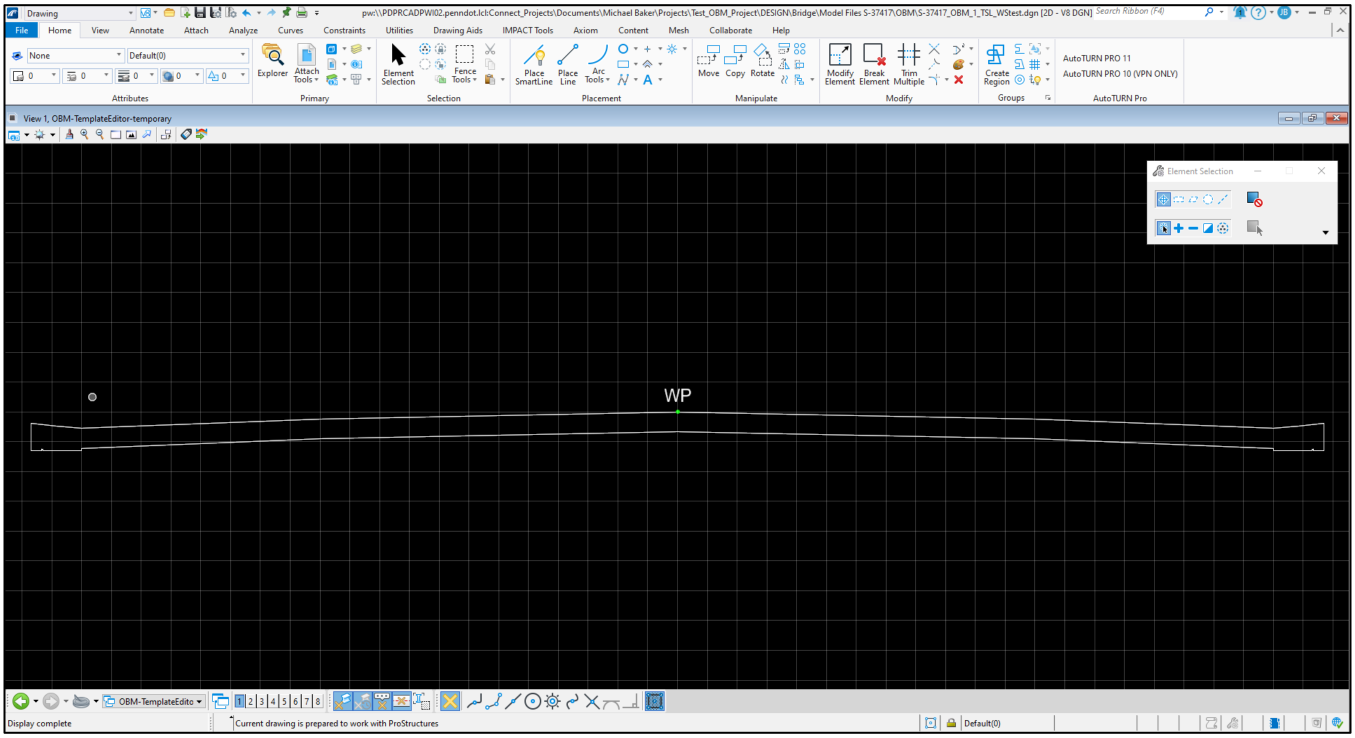


Figure 6.6-4 Modifying the Template

After the template geometry opens, the common Drawing workflow tools, similar to MicroStation, including **Place Line, Move, Modify Element**, etc., are accessible to update the sketch of the deck template for the project-specific conditions. Previously drawn cross sections can also be copied and imported into this workflow.

After modifications are made, the new geometry can be imported back as the new template geometry. It is important to realize that the completed deck template must be a single closed loop, meaning that there can be no gaps or openings in the linework and there cannot be two separate closed loops (i.e., cannot have a single deck template for separate EB and WB structures). If the loop is not closed, OBM will warn the user of the error and the user will have to modify the template or risk losing changes.

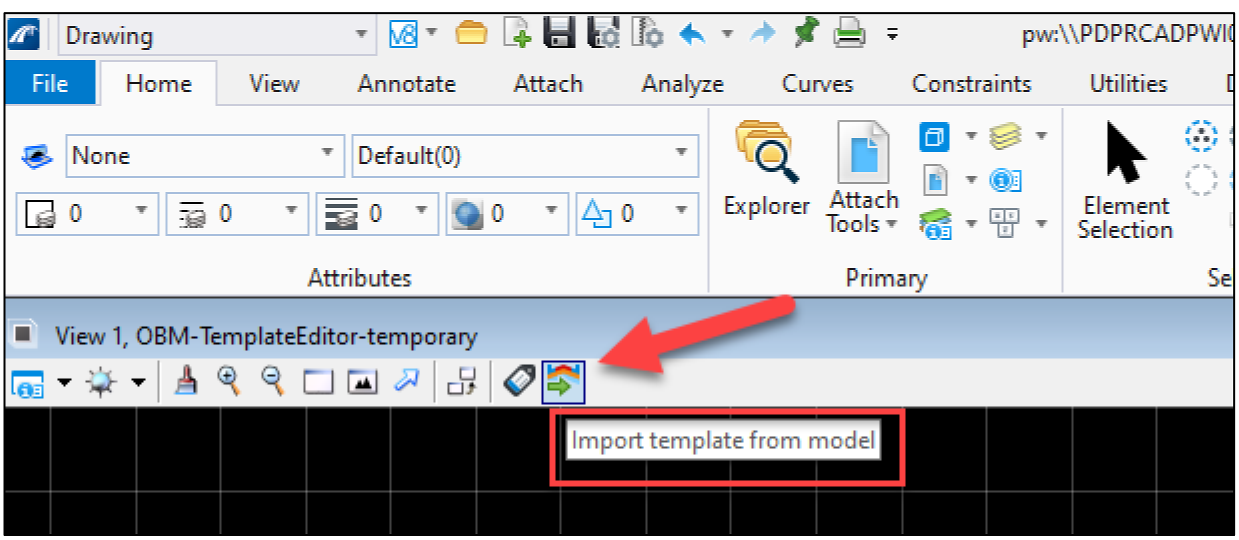


Figure 6.6-5 Icon to Import Revised Geometry

Workaround: If the original template geometry was modified and not fully deleted, the new template geometry may overwrite some of the previous variables and constraints and cause issues with the template. If that is the case, the constraints/variables can be deleted/updated or the user can "Edit Geometry" to delete and re-draw any problem linework.

6.6.2 Adding an overlay

An overlay is a typical detail for rehabilitations and new decks. To model an overlay, the user should add the main deck with appropriate template at the proper thickness and add a **Vertical Offset** to the thickness of the overlay. The overlay can then be added by using one of the provided templates and modifying the thickness, or by creating a new template for this purpose. The overlay template can then be added as a new deck over the previously added main deck.

The user should be aware that the barrier templates may also have to be modified and raised to account for the overlay thickness. See Section 6.7.1 for more details on modifying the barrier templates.

6.6.3 Modifying for final design

Even though the provided templates will cover the vast majority of typical PennDOT bridge projects, several common situations require the user to further refine the model to provide a model consistent with the Digital Delivery standards for the Final Plans submission For example, the recent addition of the "Deck Breakback" functionality allows for the "squaring off" the deck at the barrier locations in skewed bridges. However, the situation shown below in Figure 6.6-6 Refined Deck Element for a Skewed End cannot be replicated with this breakback functionality due to the extension of the breakback area. This requires additional editing the deck solids which can result in the element losing its status as an OBM deck element and instead being viewed by the program as a "Smart Solid." These new solids retain their level settings and any attached Item Types but lose any OBM deck attributes and the ability to parametrically modify the deck through the template variable constraints.

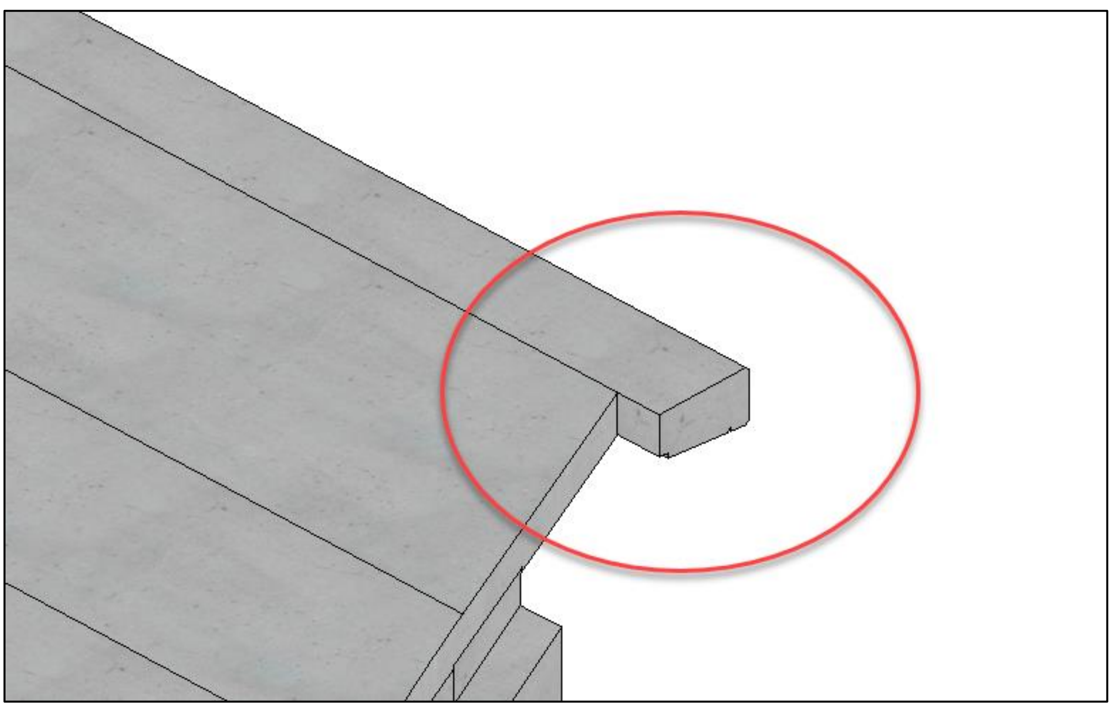


Figure 6.6-6 Refined Deck Element for a Skewed End

See Appendix 10.3 for more instructions and details on using the Solids Modeling tools for modifying the deck solids for a Refined model element including:

- Extract Faces/Edges
- Extrude Along
- Difference/Subtract (Boolean Feature)
- Union/Unite (Boolean Feature)

6.7 BARRIER/SIDEWALKS

6.7.1 Options to modify barrier templates

Similar to the deck templates, the PennDOT specific barrier and sidewalk templates have variables that are the primary method for modifying these templates. There should be limited cases in which these barrier and sidewalk templates are required to be modified. Typically, the user should be able to place them with the default values. Some instances in which the barrier variables may need to be modified are:

- Light pole blister width change
- Change in height due to overlay thickness
- Nonstandard barrier guide rail transitions (currently only possible for vertical wall barriers and curbs)
- Sidewalk width and height change

The appendix provides typical variable adjustments for reference in the situations noted above.

6.7.1.1 Model Barriers, Sidewalks, and Decks Separately

It is recommended for users to model barriers and sidewalks separately from each other and from the deck using the supplied PennDOT workspace templates. This follows BD-601M details as a construction joint is shown between the elements and allows for specific properties to be maintained between the elements (concrete mix, etc.). This is also helpful when exporting the geometry data to LBS and LBC for analysis. The elements can be combined during final design, if required, using Solids Modeling tools.

6.7.2 Modifying for Final Design

Similar to the deck design, the barriers will also need to be modified for “squared off” interactions at the beginning/end of the structures for skewed bridges. Starting in the 2021 R2 release, OBM now has a “**End Cut Orientation**” option in the Place Barrier tool. This allows the user to select if the barrier should be cut with the skew or normal to the path or alignment. See Section 5.7 for more information on this functionality.

This option, along with the start and end station offsets, should accommodate most end cut situations for the barrier. However, there may still be instances where a process similar to that which is outlined in Section 6.6.3 must be used.

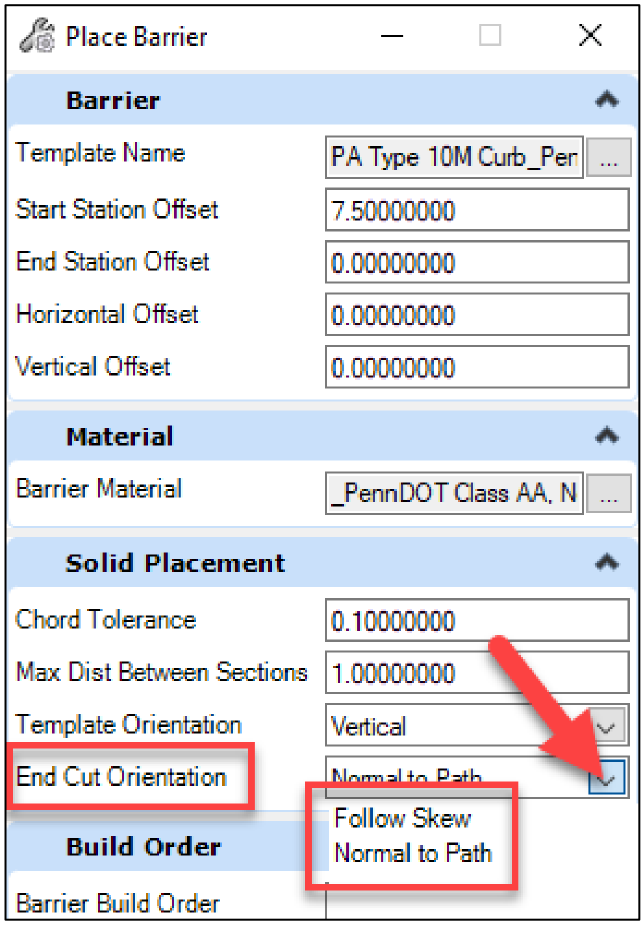


Figure 6.7-1 Barrier End Cut Orientation Option

Barriers also have additional common details that cannot be modeled with the OBM Workflow tools alone. These are detailed in the following sections.

See Appendix 10.3 for more instructions and details on using the Solids Modeling tools for modifying the barrier solids for a Refined model element including:

- Extract Faces/Edges
- Extrude Along
- Difference/Subtract (Boolean Feature)
- Union/Unite (Boolean Feature)

6.7.2.1 Modified Deflection Joints

Modified Deflection Joints can be added by creating lines at the joint location in plain view and splitting the barriers at those joints. This will create separate Smart Solids objects that no longer hold the properties of an OBM Barrier object, so users need to check each solid created and make sure any Item Types or other attached properties are still present in all solids. After the deflection joints are created, the edges can be chamfered to create the V-notch per BC-752M.

6.7.2.2 Guide Rail Transitions

Guide rail transitions for F-shaped barriers cannot be modeled with OBM Workflow tools alone. A number of standard and typical transitions are provided in the workspace for placement. See Section 3.1.1.1 for list of available cells.

[This section is under development and will provide a workflow for placing barrier transitions as 3D cells. Content will be completed after testing feedback for the Digital Delivery Directive Pilot Projects is incorporated.]

Below is an image of both the Modified Deflection Joints in the span and the F-Shape Barrier Transition at an abutment.

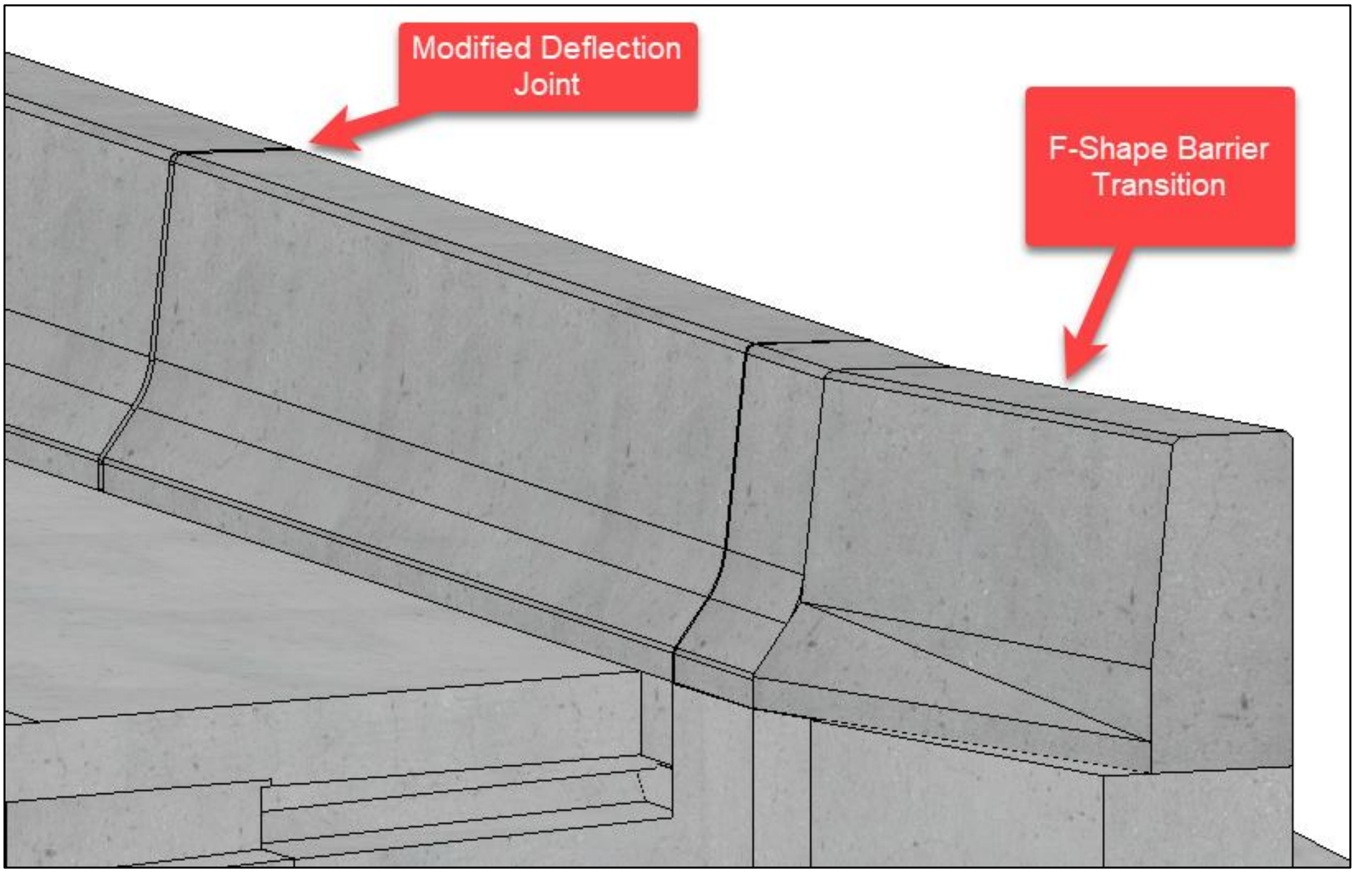


Figure 6.7-2 Modified Deflection Joint and F-Shape Barrier Transition Example

6.7.2.3 Railings and Connections

There may be cases that metal barrier railing and connections of railings, posts, etc. are not efficient to model and are more easily conveyed in a 2D detail. However, there are situations for visualization, clash detection, and others in which the metal railing and associated components should be modeled. A number of standard and typical railing and post elements are provided in the workspace for placement. See Section 3.1.1.1 for list of available cells.

Users can create additional cells under the **OpenBridge Modeler > Home > Accessory > Place Path** tool to model the railing shapes. Plates, bolts, and other connection details can be added with the Modeling Workflow tools using copy whenever feasible.

An alternative method is to use custom 3D linestyles, but they are difficult to control when post spacings and details are not constant along the entire path.

6.10 PLACE BEAM – CONCRETE

6.10.1 Modifying for Beam Daps

OBM does not have a straightforward approach to modeling beam daps. At this time, beam daps are not typically required in the 3D model. If beam daps are required for a project, two approaches can be taken. 1) Complex 3D solids modeling to beam ends outside of the OBM workflow. 2) Adjust the height of the bearings to account for the dap depth at the center line of the girder, at the center line of bearings.

The recommended approach is to adjust the bearing height to account for the dap, and to add notes and/or details in the contract documents to properly convey the beam dap and bearing details to the contractor and fabricator. This is critical for all parties to be aware of since the bearing height in the model is not the actual bearing height required for design.

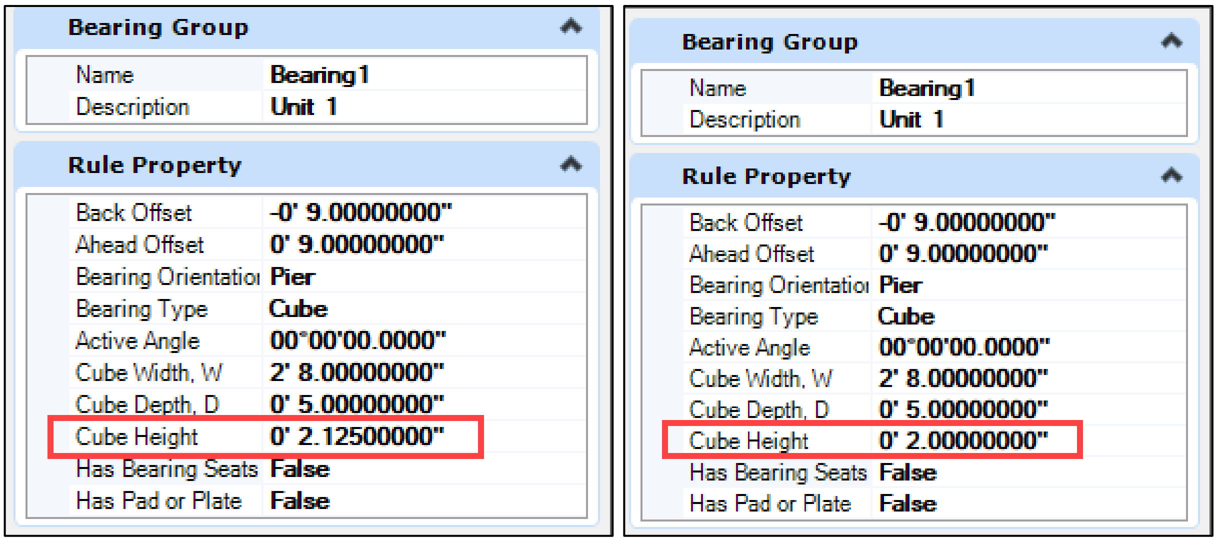


Figure 6.10-1 Example of Changing Bearing Height to Account for 1/8" Beam DAP

6.10.2 Modifying for Beam Notches

A typical detail of prestressed beams in Pennsylvania is the addition of a beam notch or paving notch as shown in the Standards for Bridge Design (BDs). A regular 90° notch that might be shown on a bulb tee will be easier to model than a notch at a 45° angle that would be detailed on a spread or adjacent box beam.

6.11 PLACE CONCRETE DIAPHRAGMS

As previously stated in Section 5.12 Place Concrete Diaphragms, OBM can only generate very basic concrete diaphragms with little detail. Advanced diaphragm detailing will require solids modeling. It is recommended that the user utilize the OBM workflow tools to their fullest extent before using solids modeling tools. Use the OBM workflow tools to place diaphragms with the correct size and location in the framing plan before advancing to solids modeling tools.

The OBM workflow can model the common diaphragms that cover many situations. For example, in the image below, OBM workflow tools were used to create a diaphragm in the size and location required for design. The user needs to be aware that it is recommended to generate all the diaphragms individually and not create one diaphragm across the entire bridge width. If a higher Level of Detail is required than what can be obtained from using the OBM workflow, the user should use solids modeling tools.

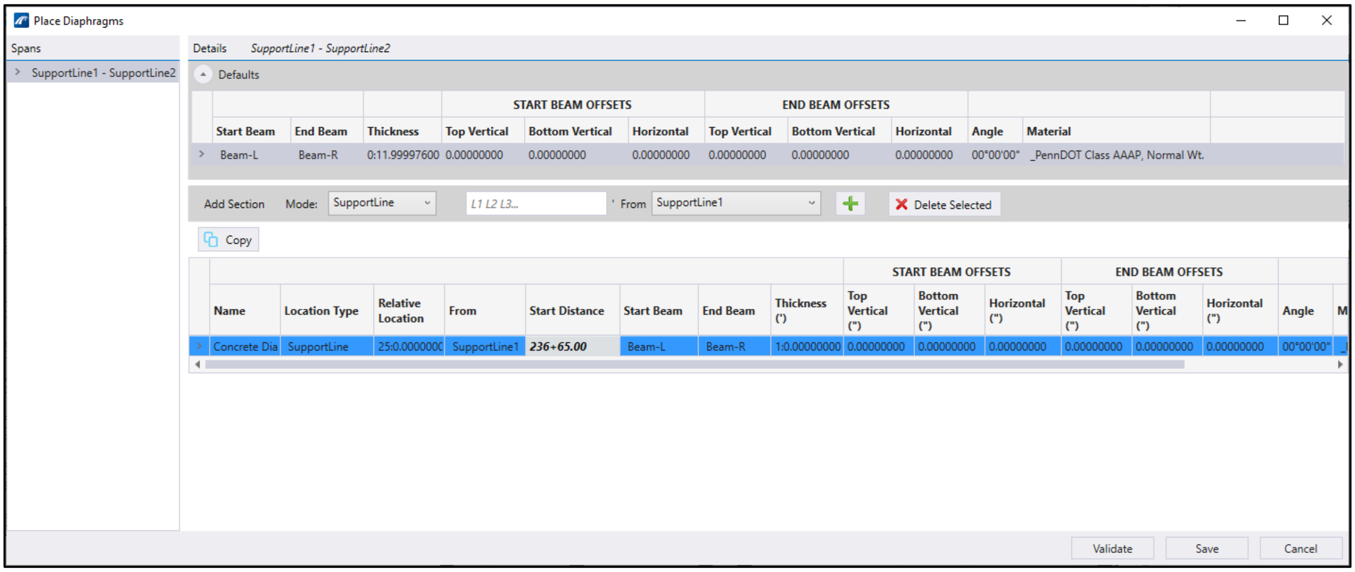


Figure 6.11-1 Input For Diaphragms Modeled Across the Entire Width (Beam-L to Beam-R)

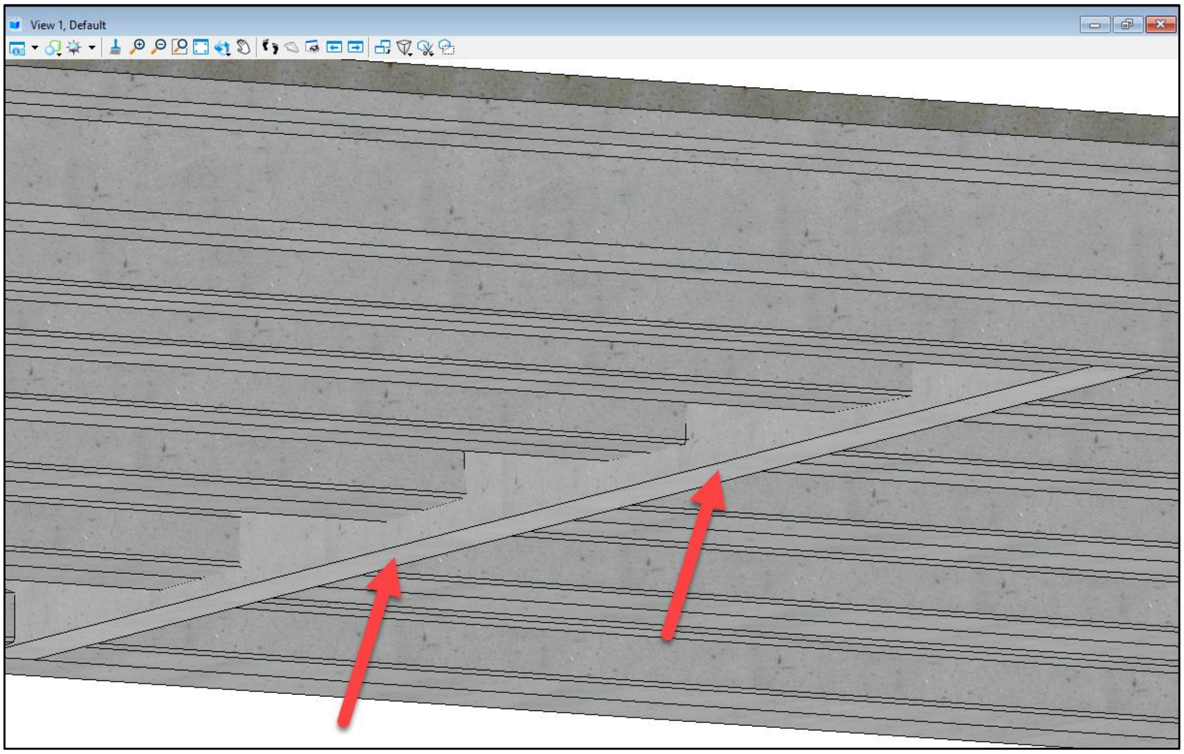


Figure 6.11-2 Diaphragm Modeled Across the Entire Width

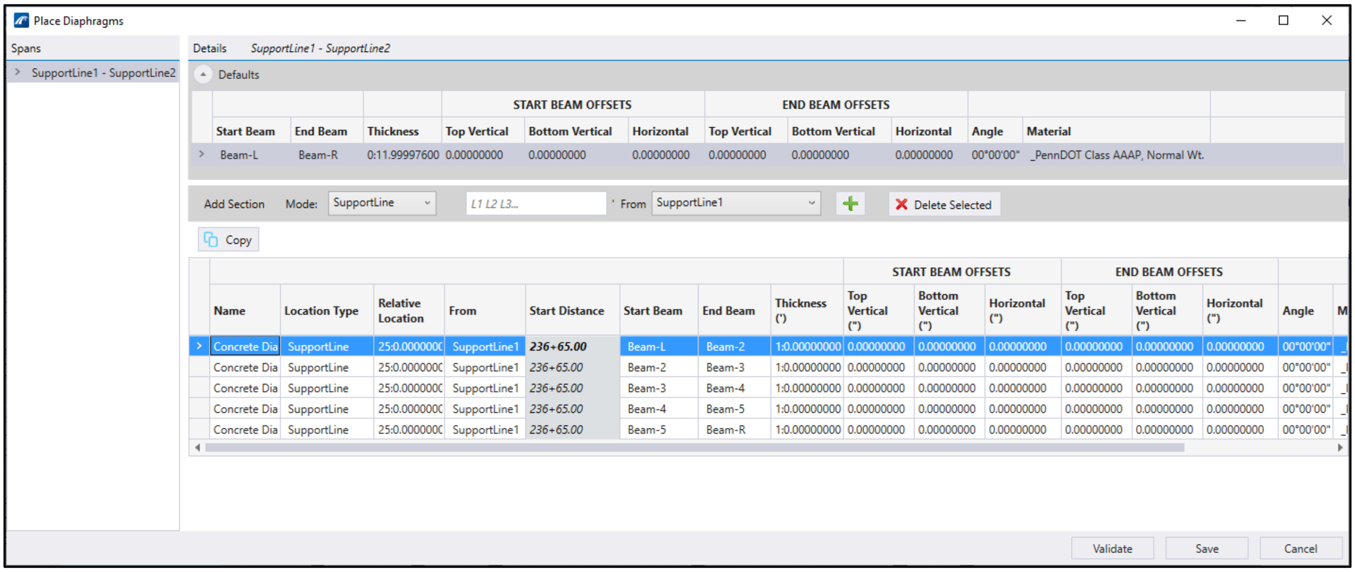


Figure 6.11-3 Input For Diaphragms Modeled Individually

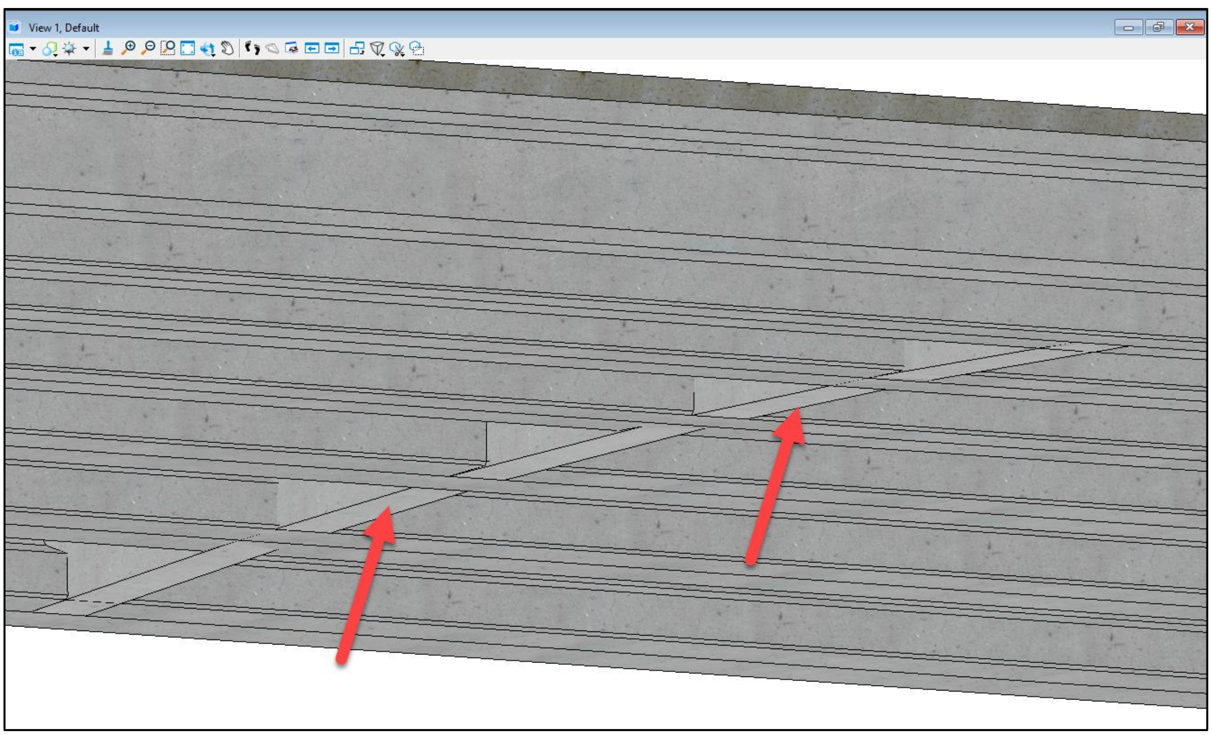


Figure 6.11-4 Diaphragm Modeled Individually

6.16 PLACE ABUTMENT

6.16.1 Integral Abutment Modifications

The **Place Abutment Tool** provides a template for integral abutments that can be used for most of the required detail as shown in BD-667M. The pile placement tool can add a single row of piles, the Pile Cap template type works for the simple geometry of the cap beam, the backwall feature can be used to generate an end diaphragm, and the wingwall geometry can also mostly be accommodated.

However, several additional modifications are needed for Final Design Element Detail Designation that will require solids modeling to create a Refined element. Below are the typical steps for creating a Refined integral abutment element.

6.16.1.1 Chamfers at Attached Wing Connections

The BD-667M details require a chamfer in the end diaphragm and cap beam in plan view for attached rectangular and attached tapered wingwalls.

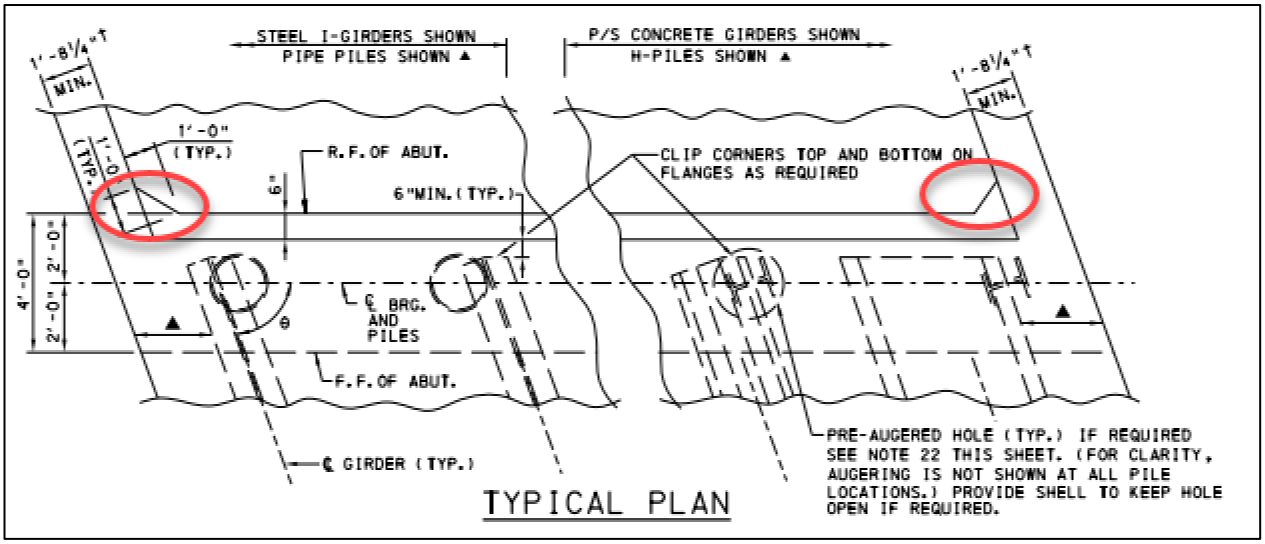


Figure 6.16-1 Plan View of Integral Abutment with Chamfers at Attached Wings from BD-667M

Then the user can create the necessary linework for the chamfer and create an extrusion to the desired height (see Section 10.3.3 for more details and guidance).

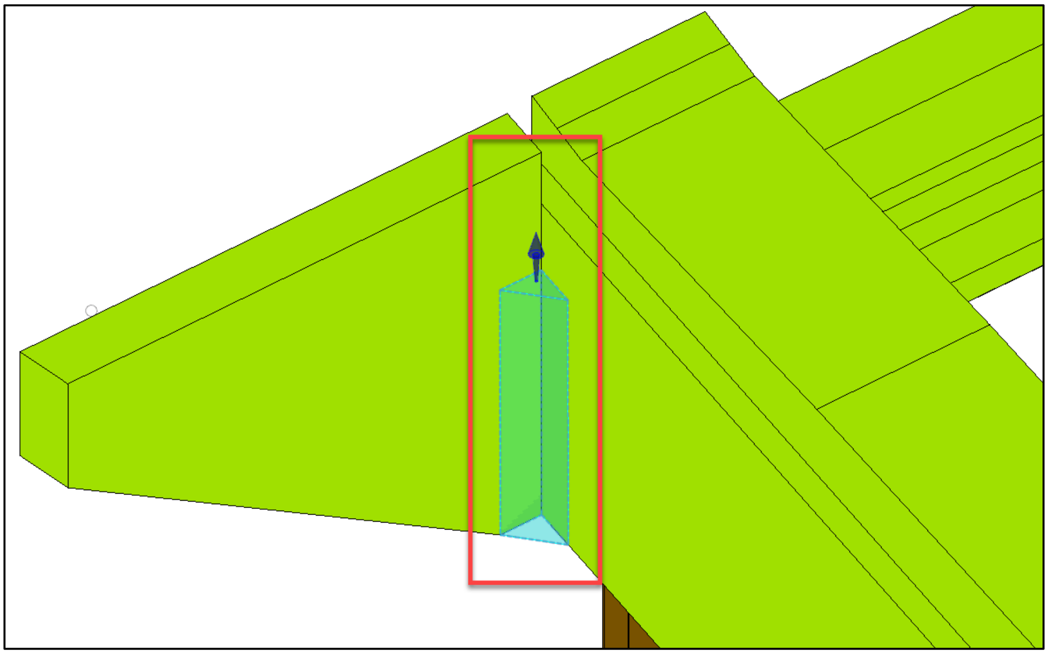


Figure 6.16-2 Integral Abutment Chamfer Extruded for an Attached Wingwall

After the chamfers are created, the items can be combined with the Union tool (see Section 10.3.8 for more details and guidance).

The “lug” at the detached wing configuration can be created using a similar process.

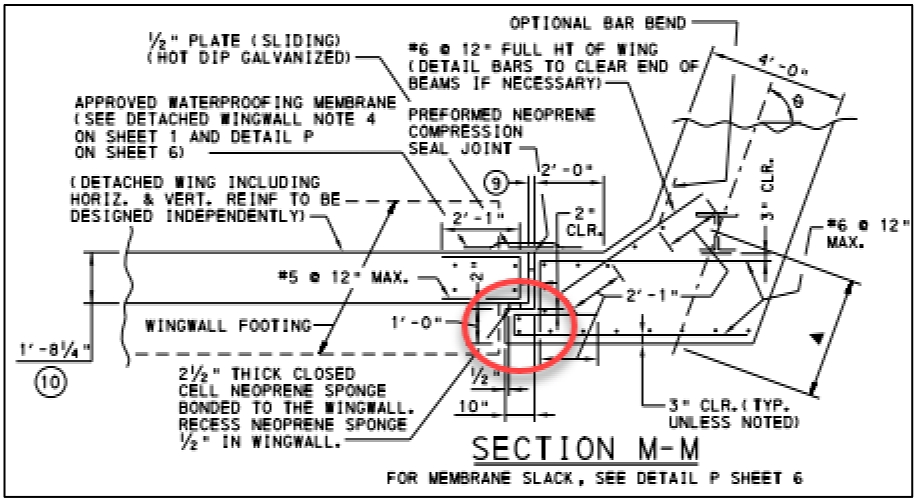


Figure 6.16-3 Plan View of Integral Abutment Detached Wing “Lug” from BD-667M

6.16.1.2 Construction Joints Between Beam Cap and End Diaphragm

The construction joint is required in between the beam cap and the end diaphragm to separate these elements and apply the different concrete materials needed. The user can essentially draw or imprint directly on the solids in order to split the solids as required to create the Refined elements. This process should be continued through the attached wings as well per BD-667M. More details and guidance for using these tools are in Sections 10.3.2, 10.3.9, and 10.3.11.

Figure 6.16-4 Adding the Construction Joint Linework Between the Beam Cap and Diaphragm

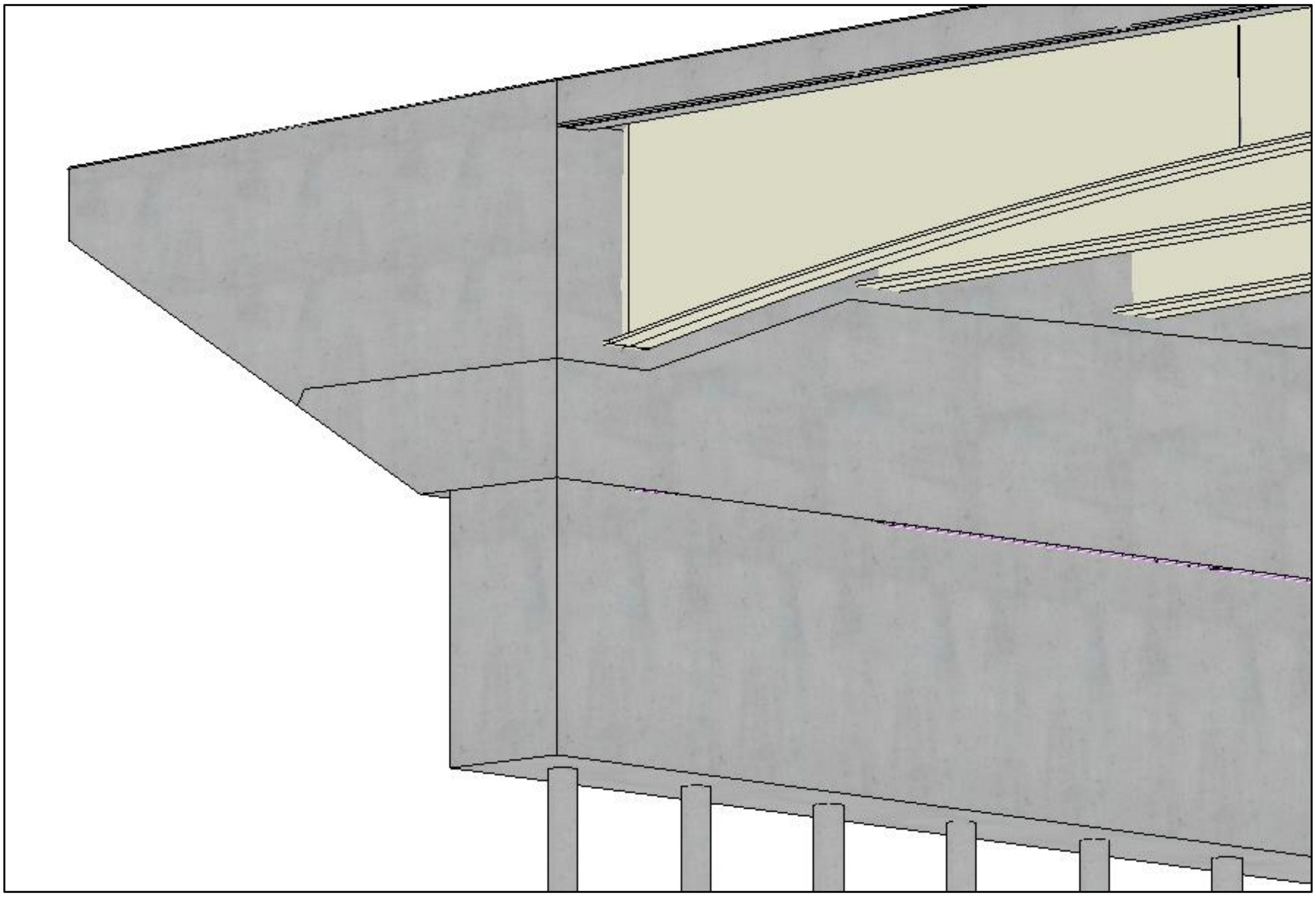


Figure 6.16-5 Example of Completed Construction Joint of Integral Abutment (with Cap Extension)

6.17 PLACE CUSTOM ABUTMENT

[This section is under development. Content will be completed after BD-621M abutment workflow is finalized through development and Digital Delivery Directive 2025 Pilot Project feedback.]

6.18 PLACE CUSTOM WINGWALL

6.18.1 Wingwall Construction Joints

Wingwalls with **construction joints** can be detailed in OBM using the 3D modeling tools. To begin, the wingwall, with or without the abutment, should be referenced into a new model and **merged into master** as detailed in Section 3.4.2. Using 3D modeling techniques as outlined in Chapter 10, a cutting element should be created at the location of the construction joint.

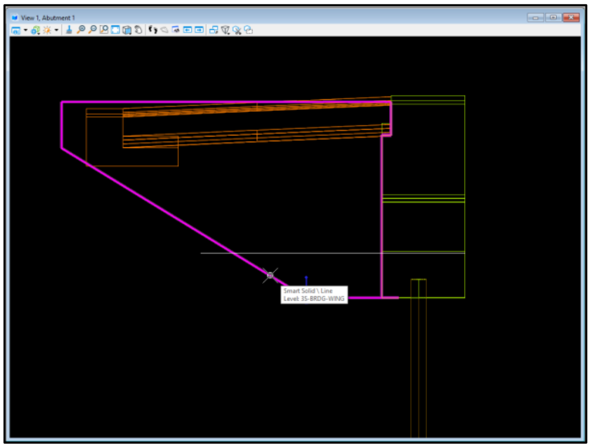


Figure 6.18-1 Cut Solids tool – Cutting profile selected

Finally, the **Cut Tool** should be used as shown in Section 10.3.11 to split the wingwall into separate pieces.

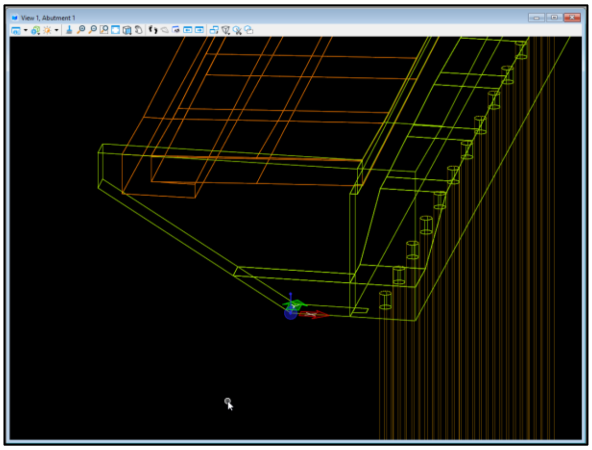


Figure 6.18-2 Wingwall after splitting operation

6.20 PLACE CUSTOM PIER

[This section is under development. Content will be completed after the custom substructure workflow is finalized through development and Digital Delivery Directive 2025 Pilot Project feedback.]

6.21 PLACE BEARING

6.21.1 Modifying pad depth to account for beam daps

In lieu of modifying the bottom of beam ends for a DAP, the user can adjust the bearing pad height to model the correct bearing seat elevations in the model. Refer to Section 6.10.1 for more details and information.

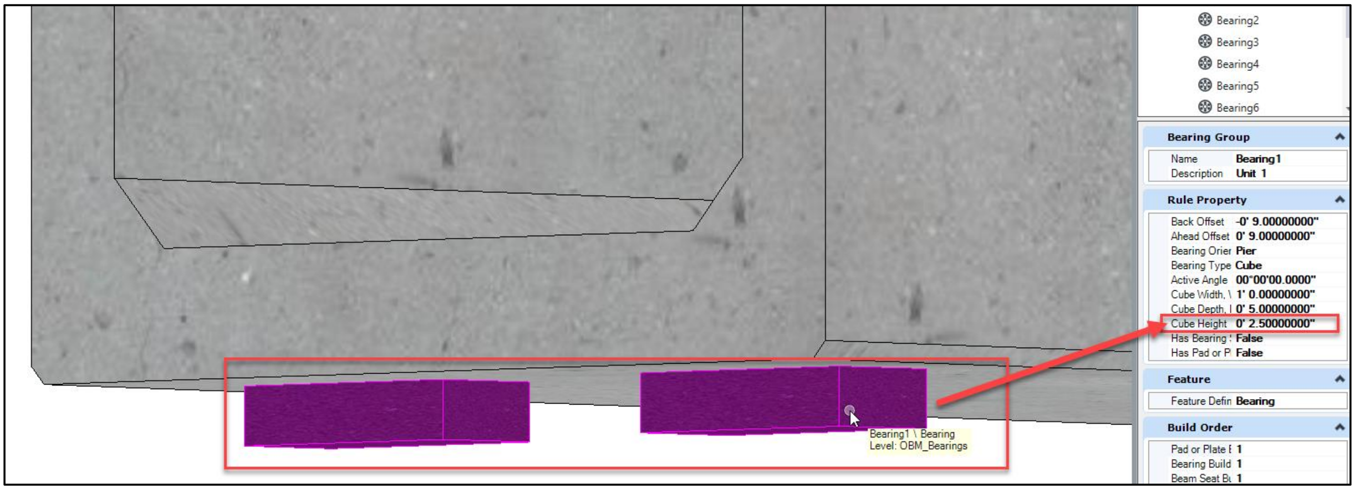


Figure 6.21-1   Modifying Bearing Pad Height

6.21.2   Adding anchor bolts and other bearing features as a cell

Bearings that are not elastomeric bearing pads, such as Multirotational, Pot, Sliding, and Disc, can be placed in OBM. These bearings are created in MicroStation and placed in OBM as a cell. There are a few bearing cells included with OBM by default.

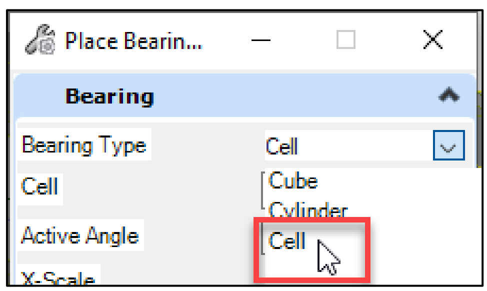


Figure 6.21-2   Selecting Bearing Type

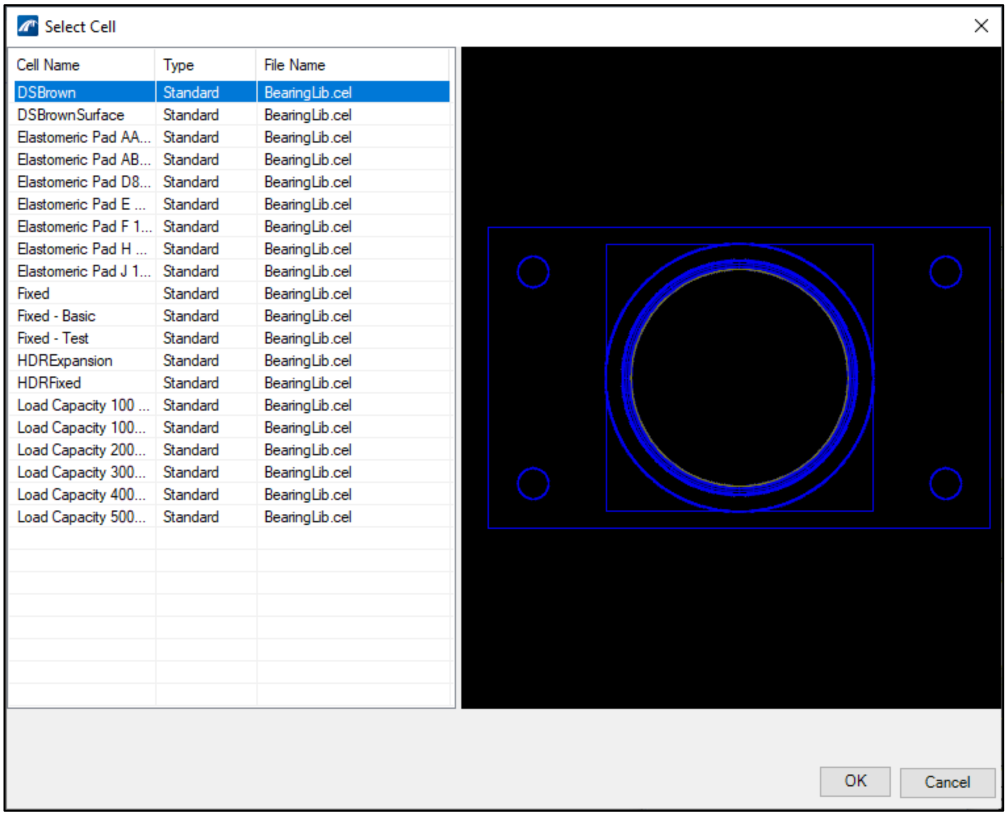


Figure 6.21-3   Selecting Bearing Cell

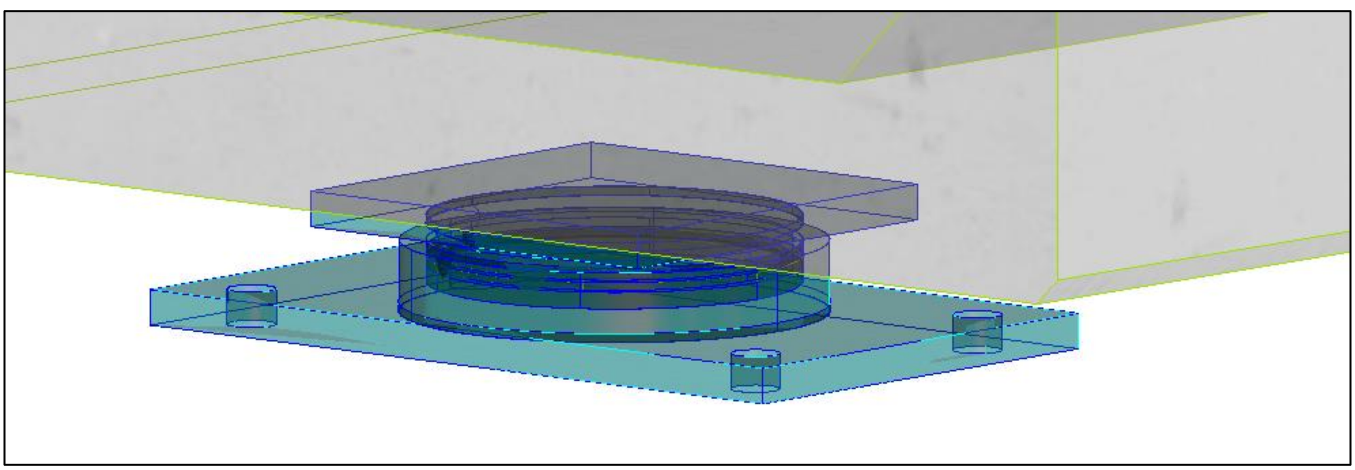
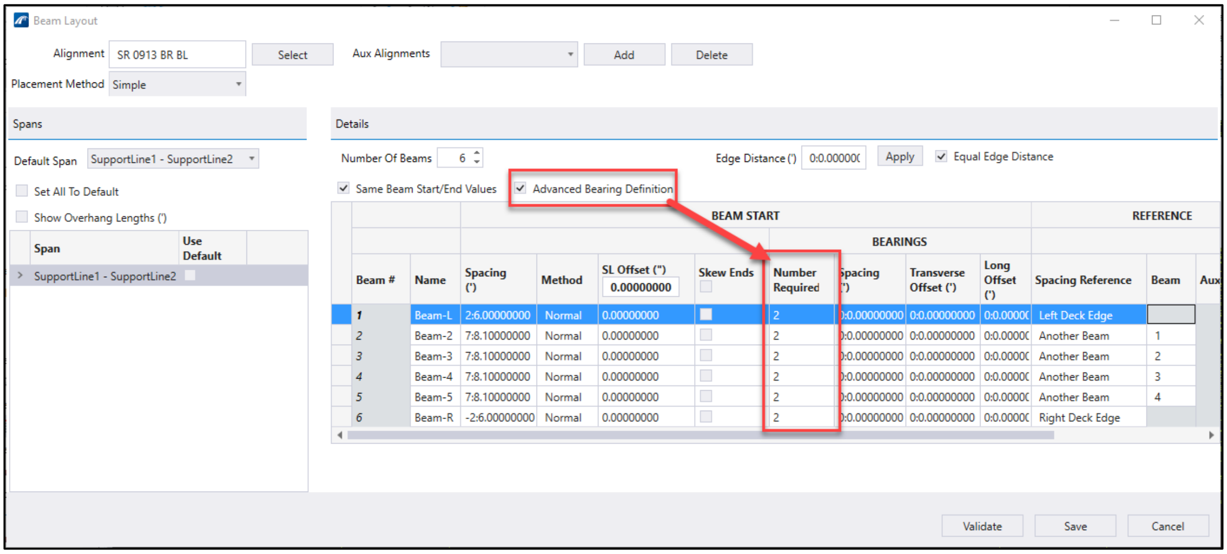


Figure 6.21-4   Multirotational Bearing Underneath Beam

6.21.3   Placing Multiple Bearing Pads

OBM can be used to define more than one bearing at a beam end. To define more than one bearing (which is default) navigate to the **Beam Layout** window and check the **Advanced Bearing Definition** box. Bearings are placed in the same fashion as a single bearing. OBM will place two of the defined bearings under each beam end.



Beam #	Name	Spacing (')	Method	SL Offset (")	Skew Ends	Number Required	Spacing (')	Transverse Offset (')	Long Offset (')	Spacing Reference	Beam
1	Beam-L	2:6.00000000	Normal	0.00000000		2	0:0.00000000	0:0.00000000	0:0.0000(	Left Deck Edge	
2	Beam-2	7:8.10000000	Normal	0.00000000		2	0:0.00000000	0:0.00000000	0:0.0000(	Another Beam	1
3	Beam-3	7:8.10000000	Normal	0.00000000		2	0:0.00000000	0:0.00000000	0:0.0000(	Another Beam	2
4	Beam-4	7:8.10000000	Normal	0.00000000		2	0:0.00000000	0:0.00000000	0:0.0000(	Another Beam	3
5	Beam-5	7:8.10000000	Normal	0.00000000		2	0:0.00000000	0:0.00000000	0:0.0000(	Another Beam	4
6	Beam-R	-2:6.00000000	Normal	0.00000000		2	0:0.00000000	0:0.00000000	0:0.0000(	Right Deck Edge	

Figure 6.21-5 Advanced Bearing Definition

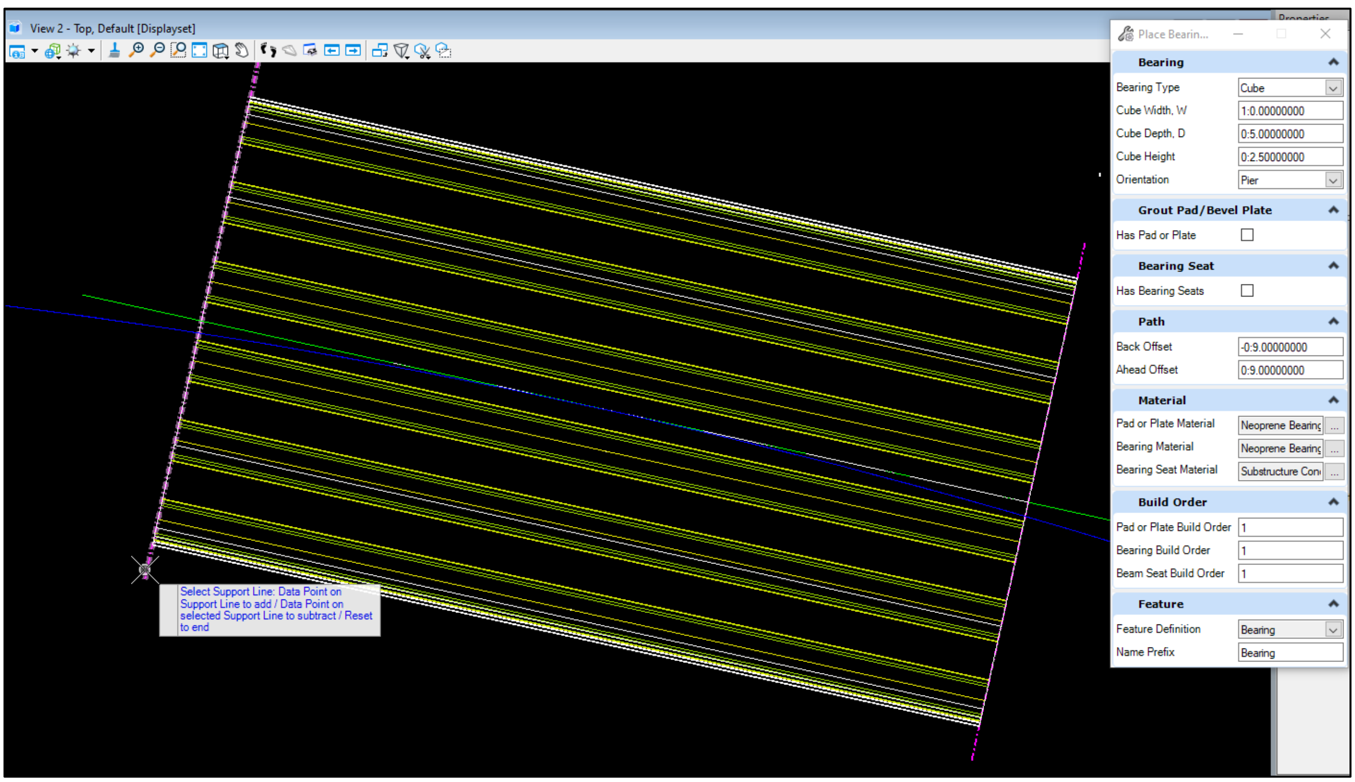


Figure 6.21-6 Placing Bearings

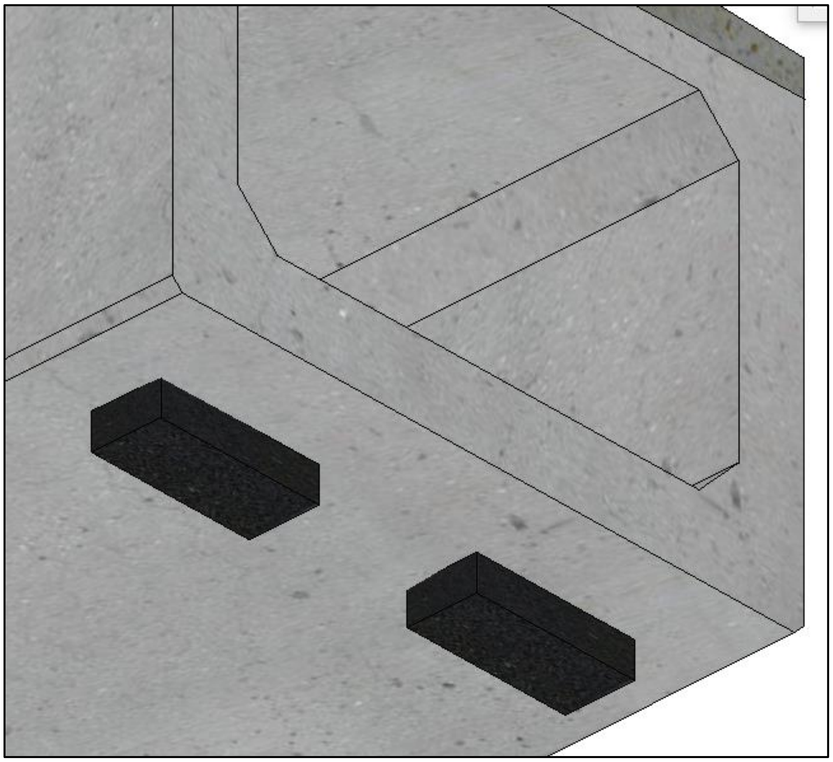


Figure 6.21-7 Two Neoprene Bearing Pads Under Spread Box Beam (not showing end block)

6.24 ADDING REINFORCEMENT

Basic tools are provided in OBM that apply to most concrete elements generated in the OBM model. However, there may be some elements of the model that are outside of the capability of these tools and require advanced rebar detailing.

Below is an example of one way to model barrier reinforcement using some of the advanced OBM tools. As previously stated, there is more than one way to come to the same conclusion, and this is an example of one user approach.

6.24.1 Barrier Rebar Modeling Using the Associative Extraction Tools

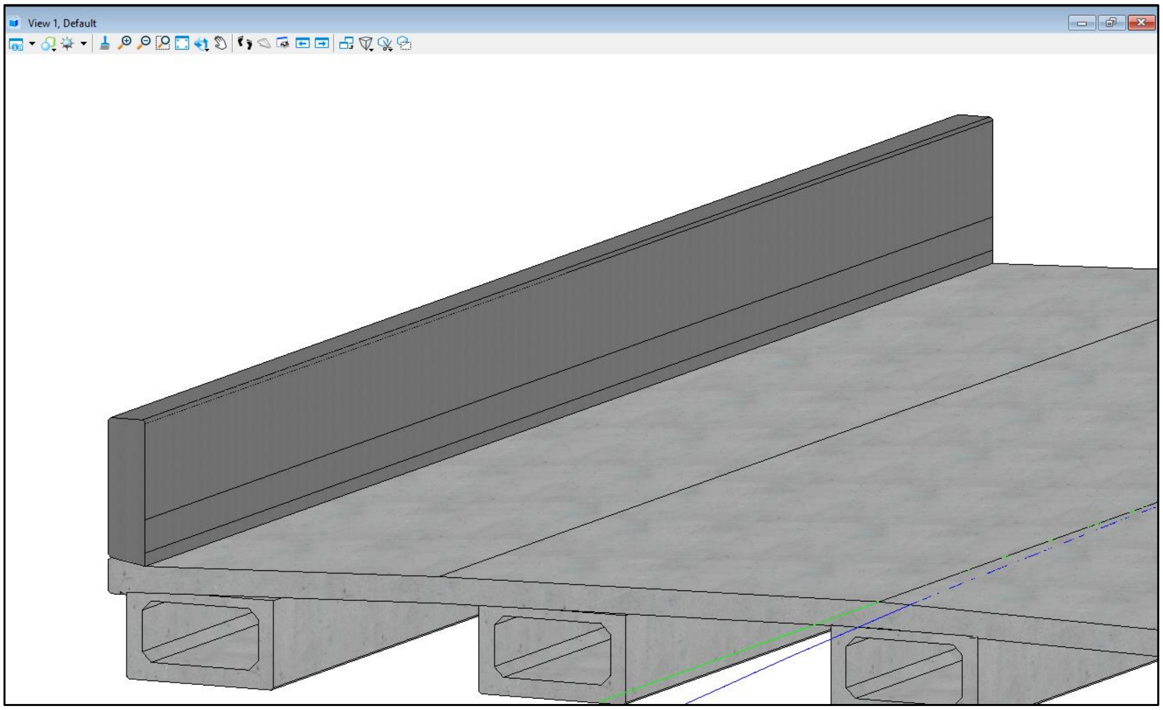


Figure 6.24-1 42" Vertical Wall Concrete Barrier

The user can start by using the **Associative Extraction** tool to create planes that represent the clearances required for rebar detailing. This gives the user framework to start creating the rebar modeling.

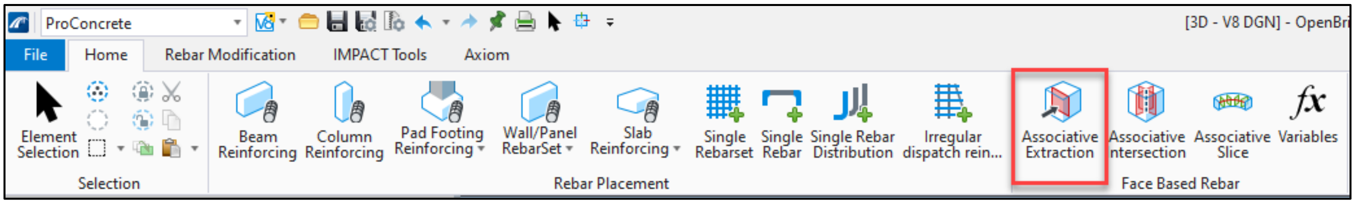


Figure 6.24-2 Associative Extraction Tool

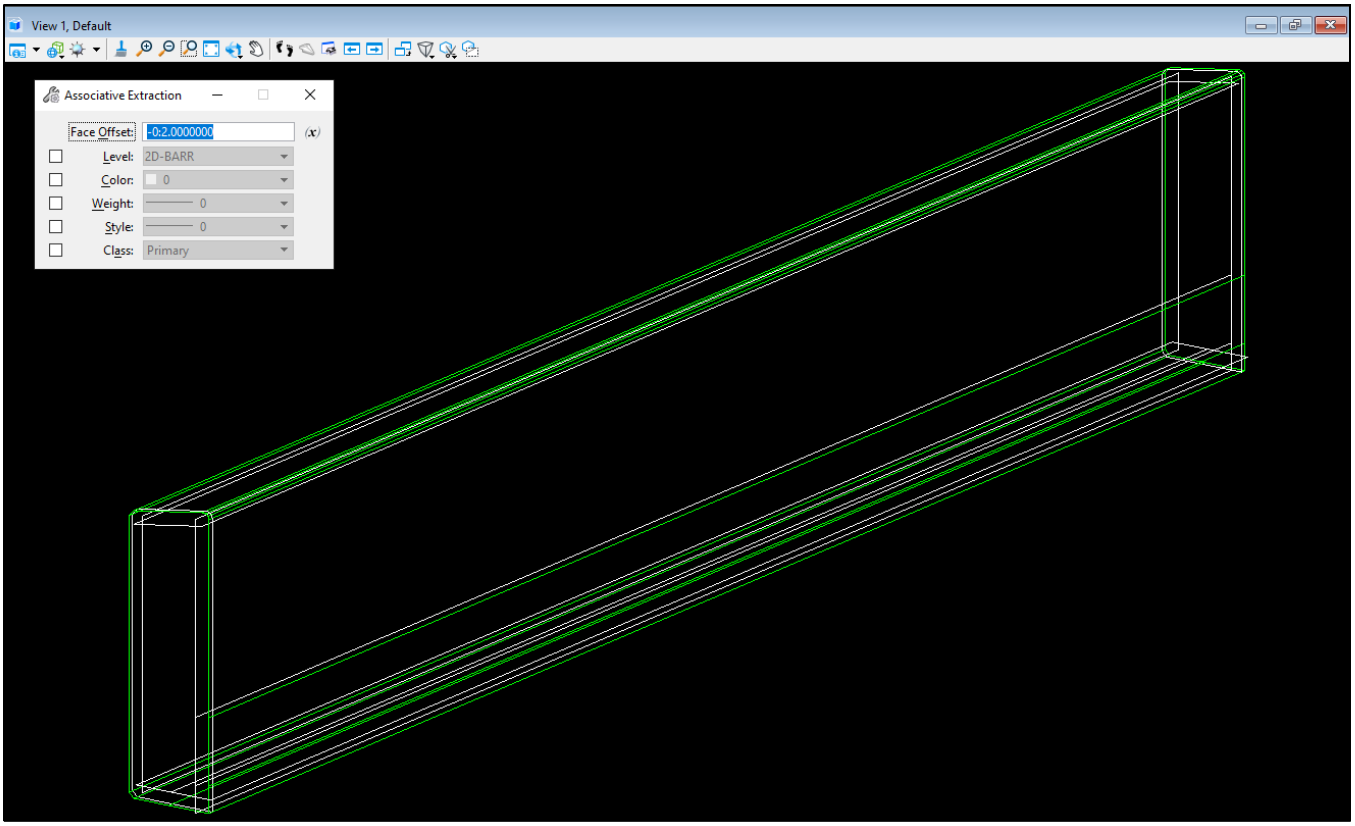


Figure 6.24-3 Barrier Faces Extracted 2” To Create Clearance

After the faces have been extracted, the **Associative Intersection** tool can be used to create an intersecting edge between two associative faces.

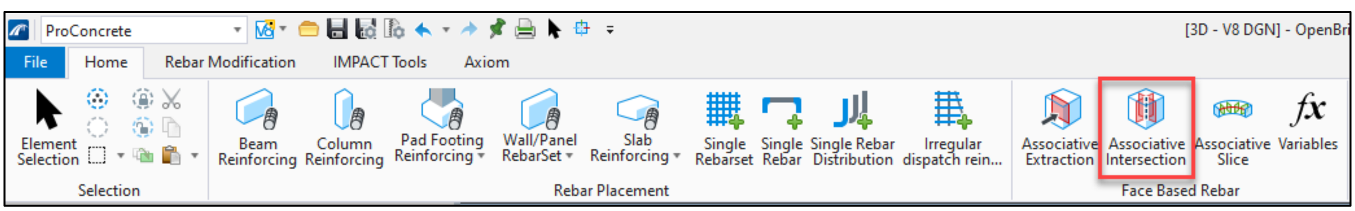


Figure 6.24-4 Associative Intersection Tool

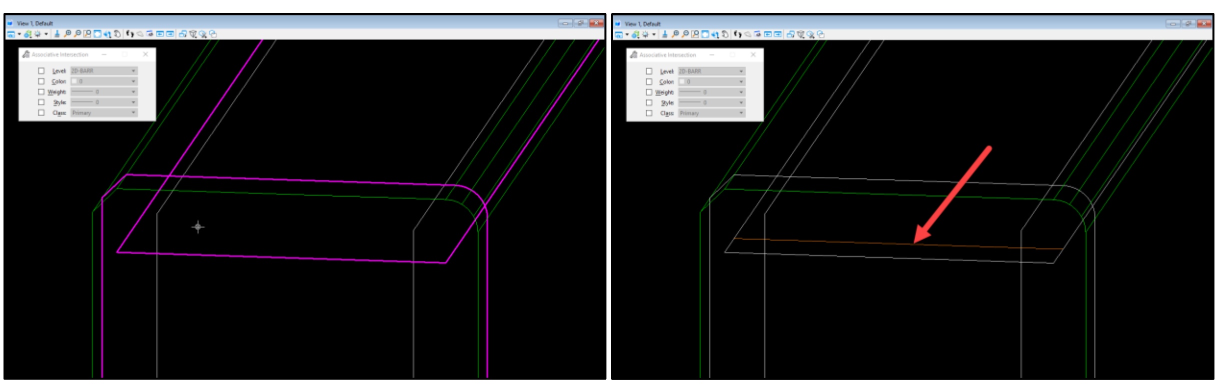


Figure 6.24-5 Associative Intersection Tool Creating Edge for Rebar Detailing

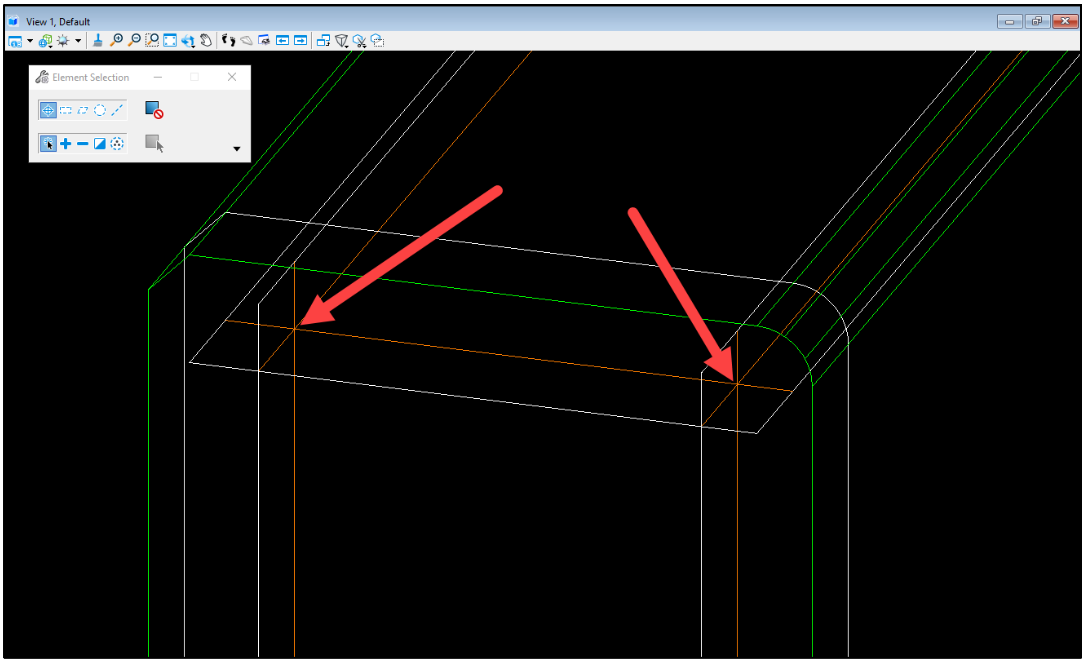


Figure 6.24-6 Intersection of Clearances – Intersecting Point Is 2” Clear From All Faces

One tool that can be used to place rebar is the **Single Rebar Distribution** tool. This tool uses two elements created by the user in 2D linework to generate the rebar set. The first element created by the user is the **Bar Properties**. For our example, this will be the complex chain that defines the shape of the barrier rebar. The second element is the **Distribution Line** which defines the path that the rebar will follow. First, the user must **Select Concrete** member that contains the rebar members then define the **Bar Properties** and **Distribution Line** and any additional design and project-specific constraints.

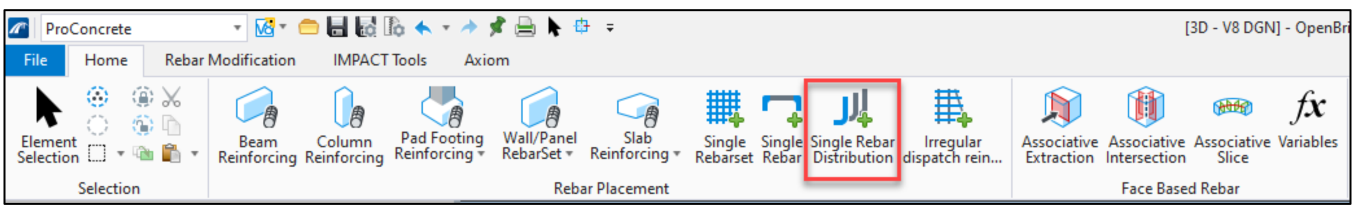


Figure 6.24-7 Single Rebar Distribution Tool

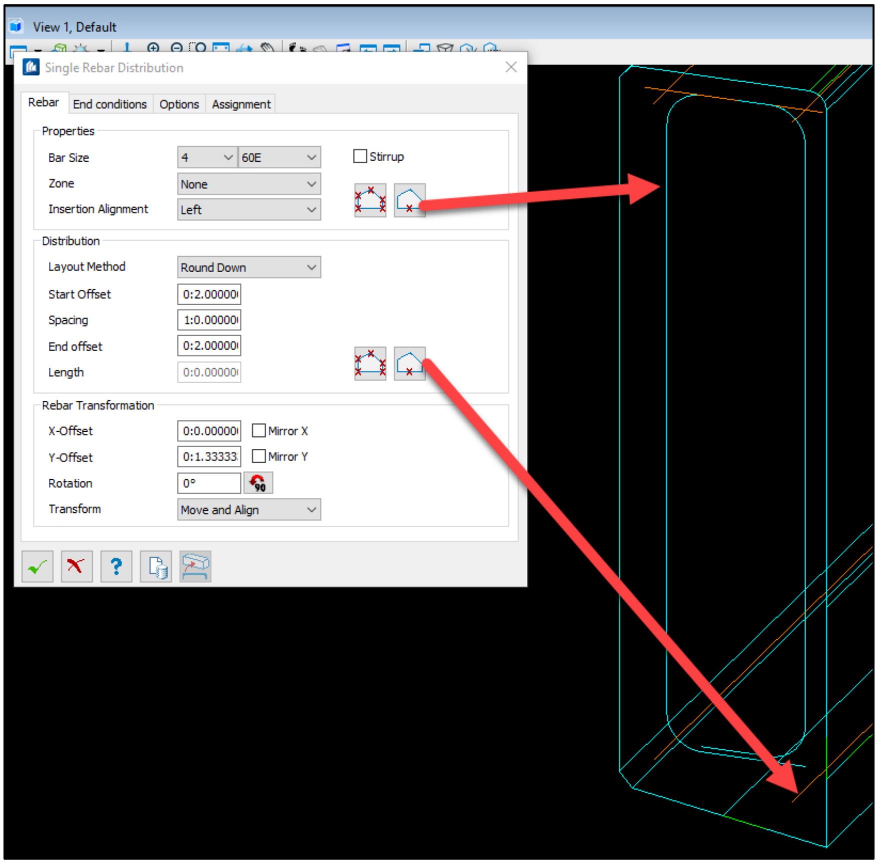


Figure 6.24-8   Single Rebar Distribution Inputs

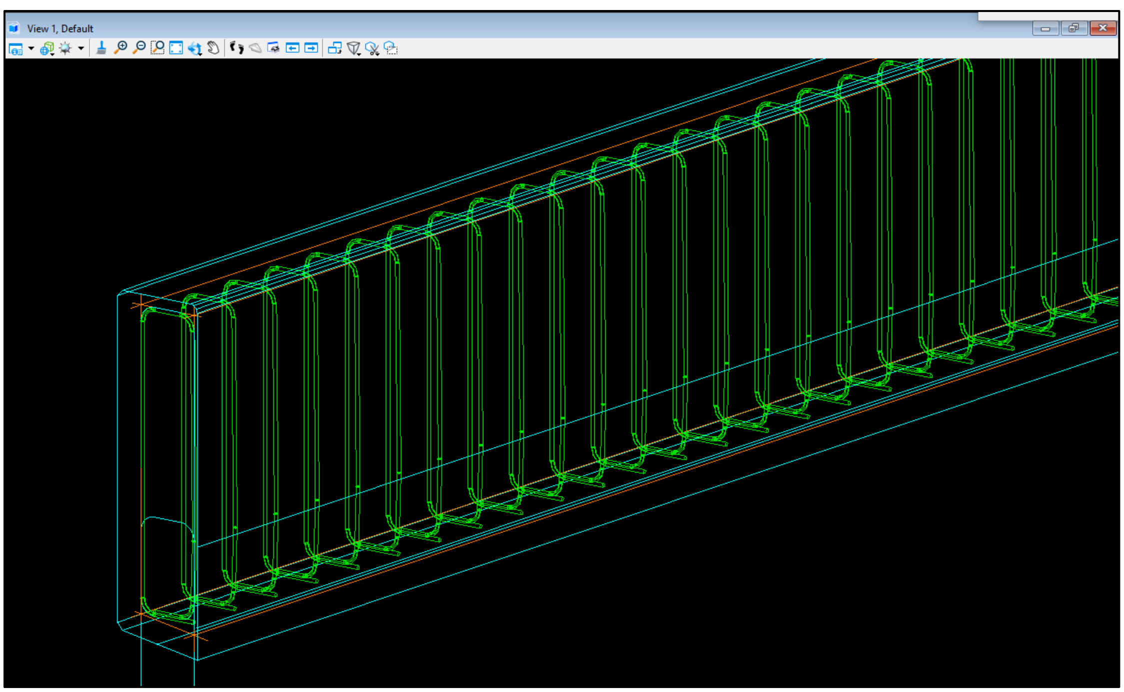


Figure 6.24-9   42” Vertical Wall Barrier Reinforcement

This process can be repeated for additional reinforcement until all reinforcement is detailed.

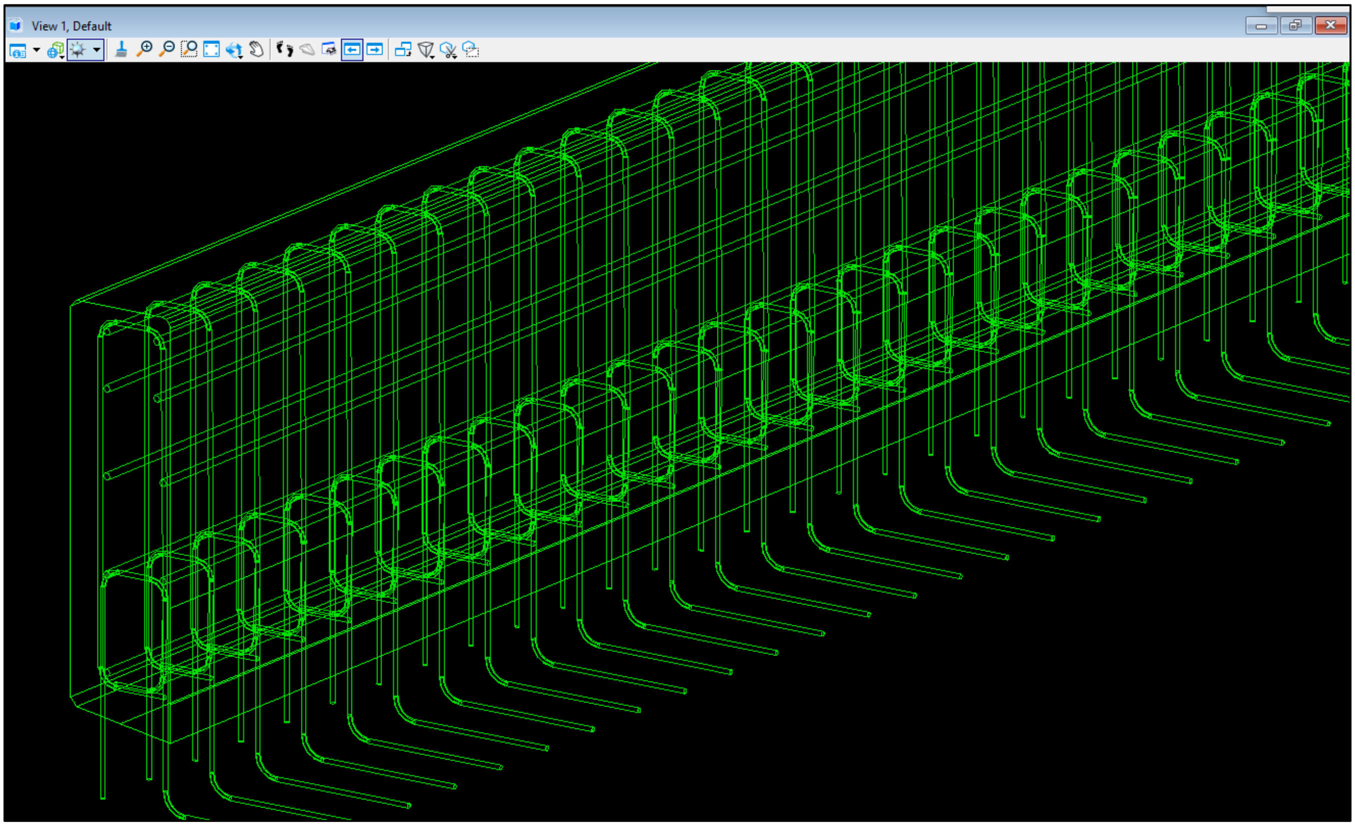


Figure 6.24-10 Fully Detailed 42" Vertical Wall Barrier Reinforcement

The Slab Reinforcing tool does not currently have the ability to deal with the cross slope of the deck. Therefore, most decks need to be modeled using some of the advanced ProStructures reinforcement tools. As previously stated, there is more than one way to come to the same conclusion, and this is an example of one user approach.

The rebar should be modeled in its own .dgn. This allows for easier level display management later when the entire model is fully populated with rebar.It also allows for advantages when adding bar marks and scheduling. See Section 6.24.8 for more information.

6.24.2 Deck Rebar Modeling Using the Single Rebar Distribution Tool Using Guidelines

As a starting point, copy the bridge model .dgn. Delete everything in the model except the geometry for the deck. This is done to ensure when modeling rebar no changes are accidently made to the geometry of the original deck element. If changes are needed to the geometry of the deck element, the user will have to adjust the geometry in the file the deck was created. Keeping the deck and rebar in separate files also helps with level control. Next create a large box that runs orthogonal to the alignment and envelopes the entire cross section of the deck geometry. Then use the **Difference Feature** tool in the Booleans Tools drop down to subtract the larger cut box from the deck geometry. After this step the rest of the bridge model can be deleted from the Explorer window. Then reference in the original bridge model that was previously copied. It will be used when populating rebar later in the process. The reference can be turned off until needed later.

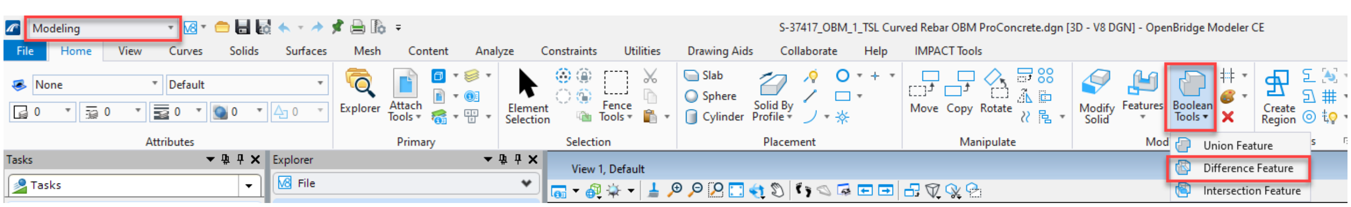


Figure 6.24-11 Boolean Tools > Difference Feature Tool

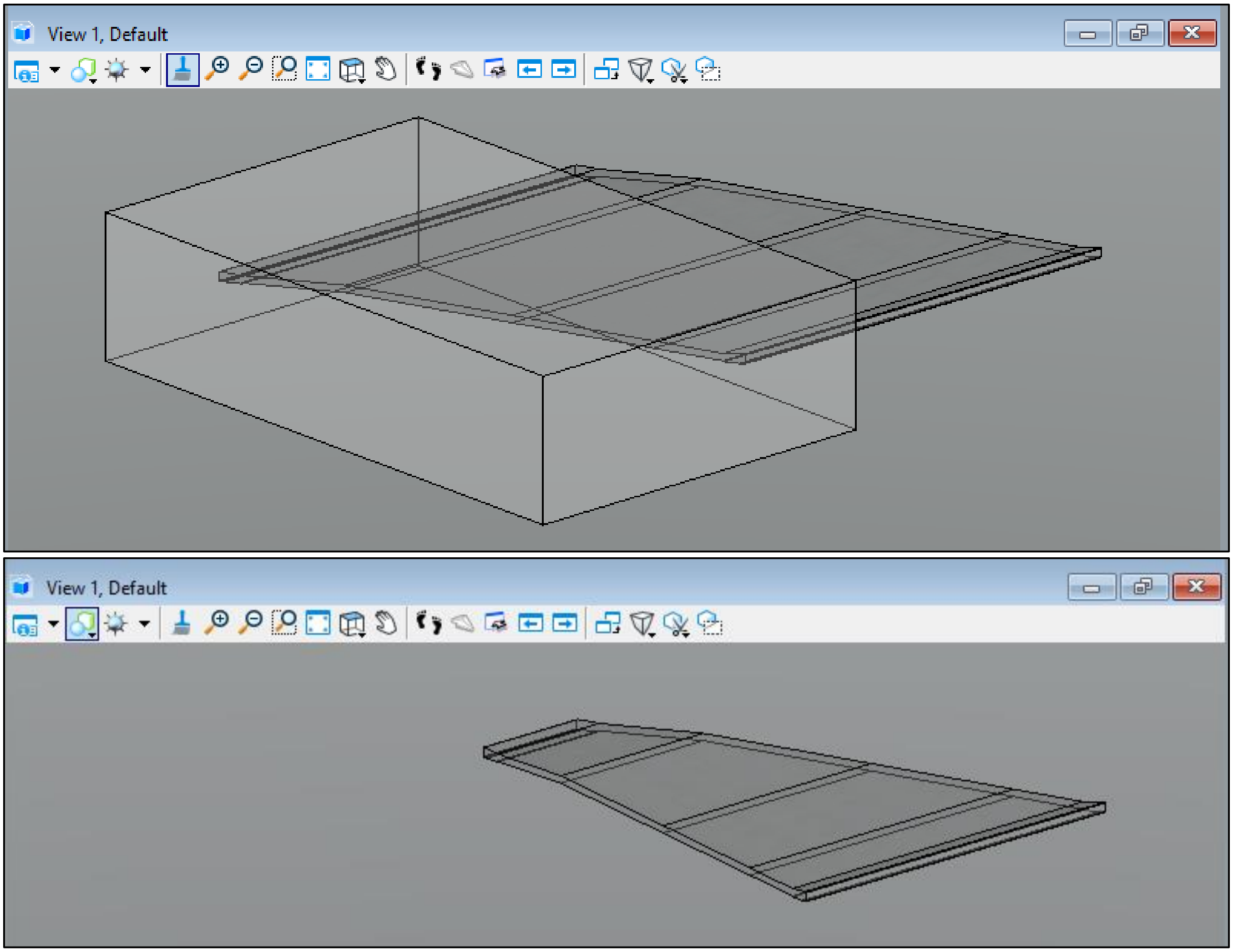


Figure 6.24-12 Before and After Boolean Operation

What's left is an accurate cross section of the deck normal to the alignment. This will be used as a template to draw the control lines that place the deck rebar. The reinforcement in the deck is aligned according to the bridge skew angle per BD-660M. This this case the transverse rebar runs parallel to the top of the deck and perpendicular to the alignment, so the first step is to trace the top of the deck with the Shape Guideline using the **Smart Line** tool.

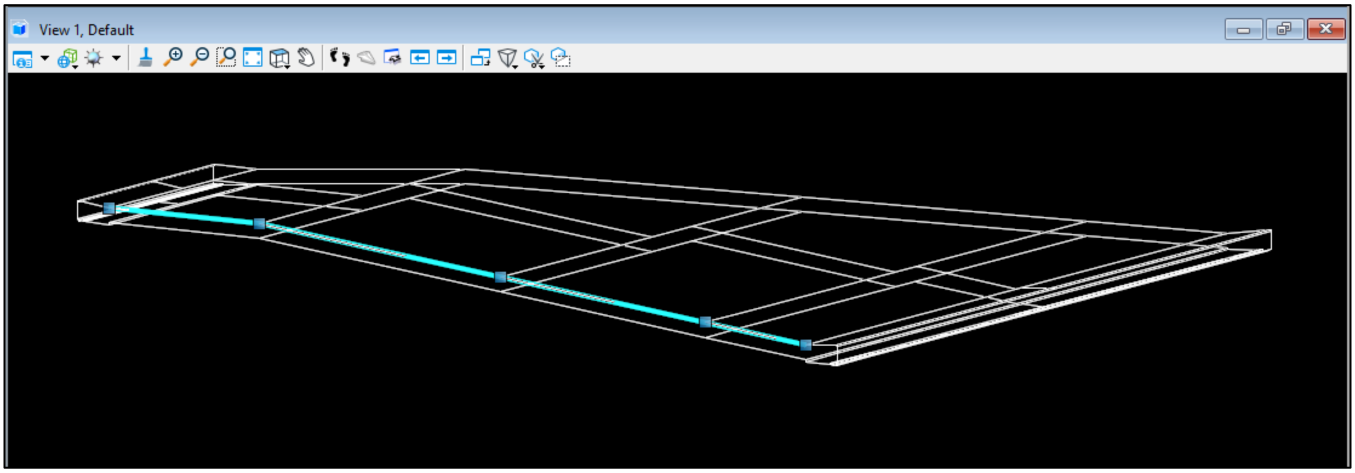


Figure 6.24-13 Shape Guideline Created with Smart Line Tool

The next step considers the clear cover on the sides of the deck. This is taken into account by extending/trimming the ends of the Shape Guideline closest to the edge of deck. In plan view Trim Lines are drawn. Trim Lines are sacrificial lines that will be deleted after using them to trim Guidelines. The lines are placed along the outside edge of each side of the deck.

These Trim Lines are then moved with the **Move/Copy Parallel** tool from the top view to place them at the correct clear cover distance away from the edge of the deck. These lines are then used to trim/extend the top deck transverse rebar Shape Guideline to the appropriate stopping point using the **Trim Multiple** tool while in the top view. Once this is done, the Shape Guideline accurately represents a single transverse rebar at the correct vertical and horizontal location with respect to the cross section.

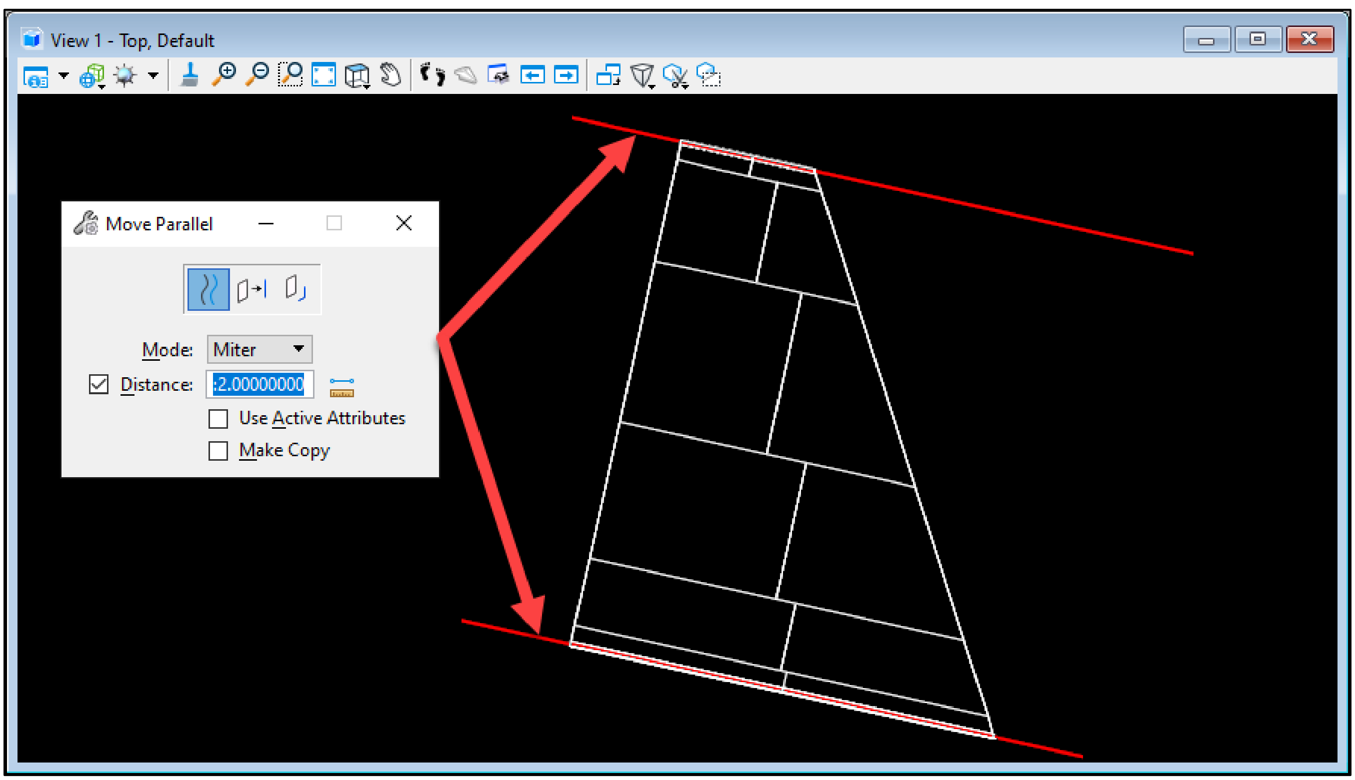


Figure 6.24-14 Move Parallel Tool Used from the Top View for Side Cover

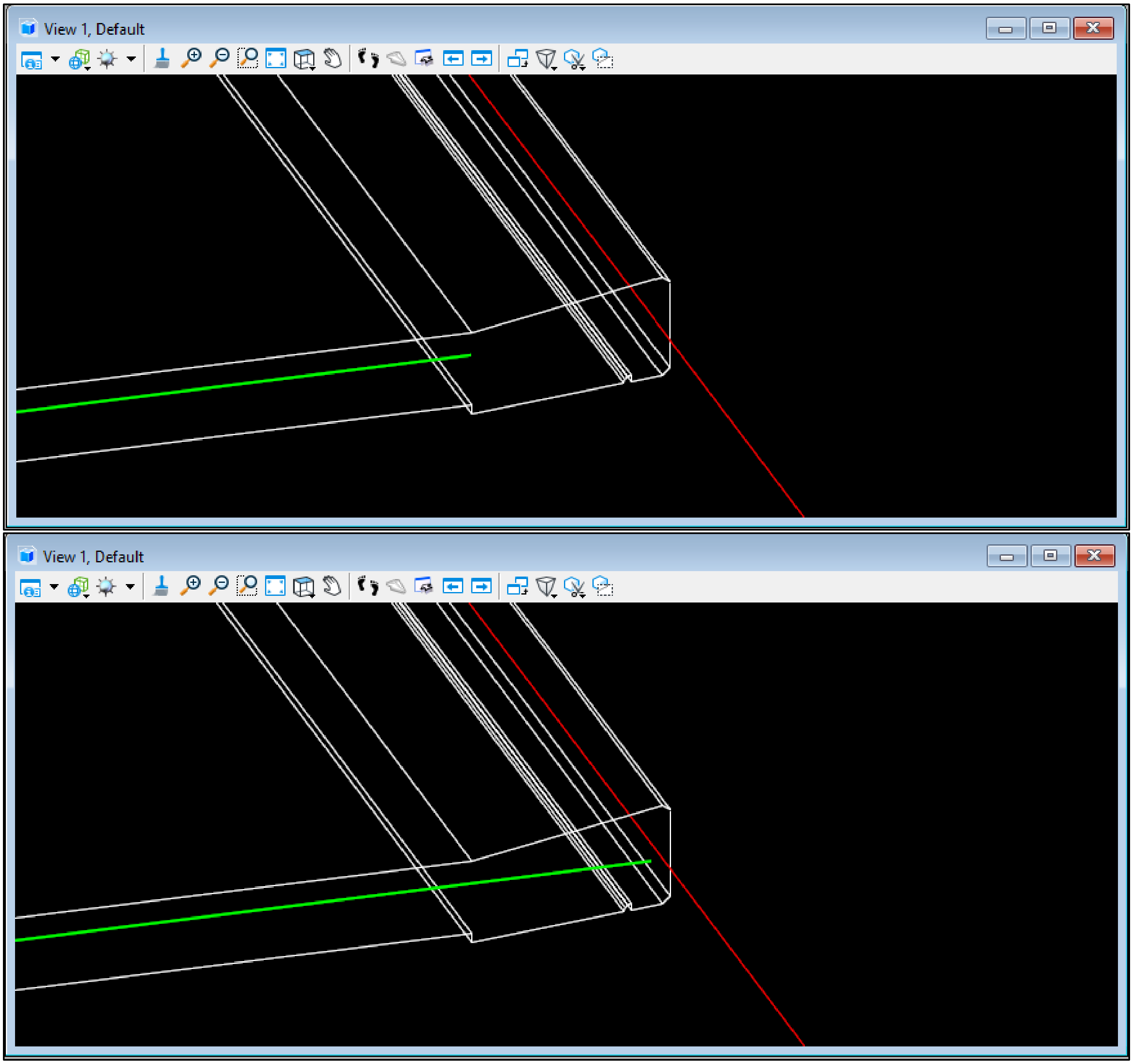


Figure 6.24-15   Before/After Extending the Shape Guideline to Side Cover Trim Line

Next step is drawing the Distribution Guideline that sets the path for the spacing and overall length of the rebar set. First a line can be drawn along the crown of the deck and extended beyond the limits of the referenced full deck geometry using the **Extend Line** tool. Then this line needs to be moved to connect with the end of the Shape Guideline that was previously created. Next the Distribution Guideline needs to be trimmed to represent the portion of the deck it will cover. In this example the deck is skewed. The full width transverse rebar will run a portion of the deck before reaching the skewed end of the bridge. This length also needs to consider the begin/end of deck clear cover. This is determined by drawing a line perpendicular to the alignment of the bridge at the point where the side clear cover cut line and the begin/end of bridge clear cover cut line intersect. Each corner needs a perpendicular line that extends beyond the opposite side of the deck.

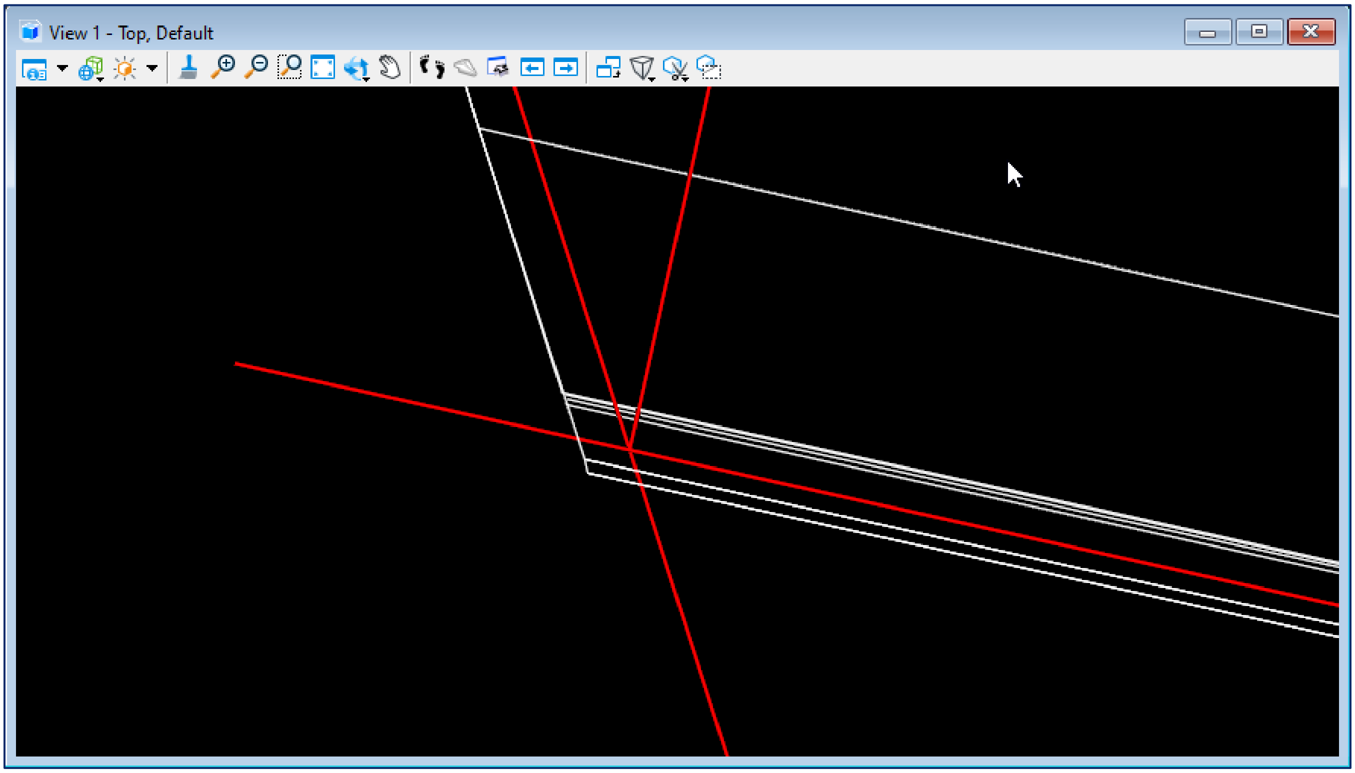


Figure 6.24-16 Side & Begin/End Cover Line with Alignment Cut Line

Then two perpendicular cut lines are used to trim the Distribution Guideline that is attached to the end of the Shape Guideline.

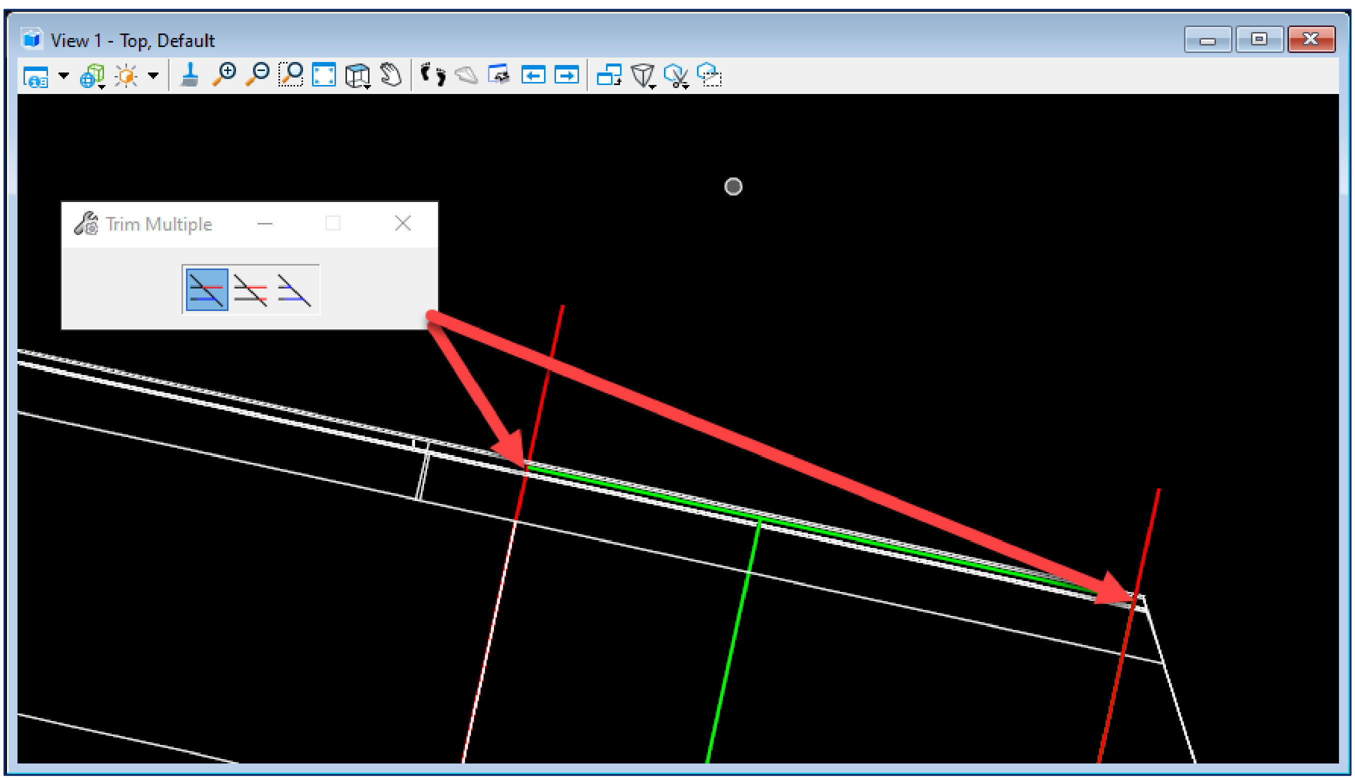


Figure 6.24-17 Trim Multiple Tool from Top View with Red Cut Lines & Green –Guidelines

Next the Shape Guideline is moved to the end of the distribution control line. Mainly this is done to keep the file organized in case changes need to be made further along in the rebar modeling process.

Finally, the rebar is modeled using the **Single Rebar Distribution** tool. Once the tool dialog is open there are three steps to creating the rebar:

1. The deck from the referenced OBM bridge model is input into Select Concrete button.
2. The Shape Guideline is input into the Create bar by object button in the Properties dialog
3. The Distribution Guideline is input into Select path by object button in the Distribution dialog. The inputs into the rebar can be modified by double clicking the rebar, making changes, and clicking the green checkmark to accept the changes.

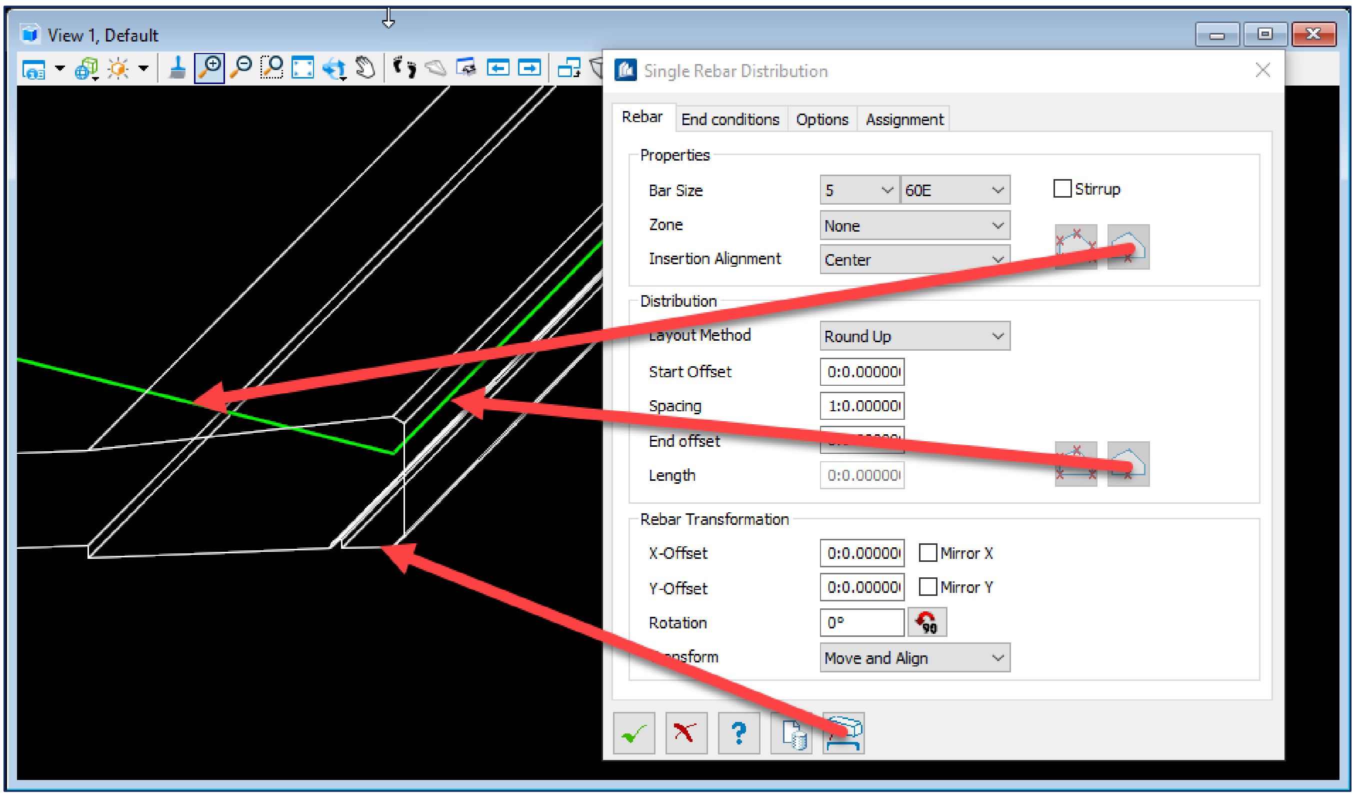


Figure 6.24-18 White – Referenced Deck Geometry, Green - Shape & Distribution Guidelines

The **End conditions** tab allows the setting of the end condition of the rebar. This example will be using **Hook** as the end condition, but other end conditions such as 90° and 135° bends are also available. A rotation and extension of the hook can be implemented here if required. The assignment tab allows for the selection of the level the rebar will be placed. Click the green check mark to accept the rebar placement. Note that the lines themselves control the shape of the rebar even after placement. Care needs to be taken to not move, delete or alter the lines as the rebar will follow the Guidelines.

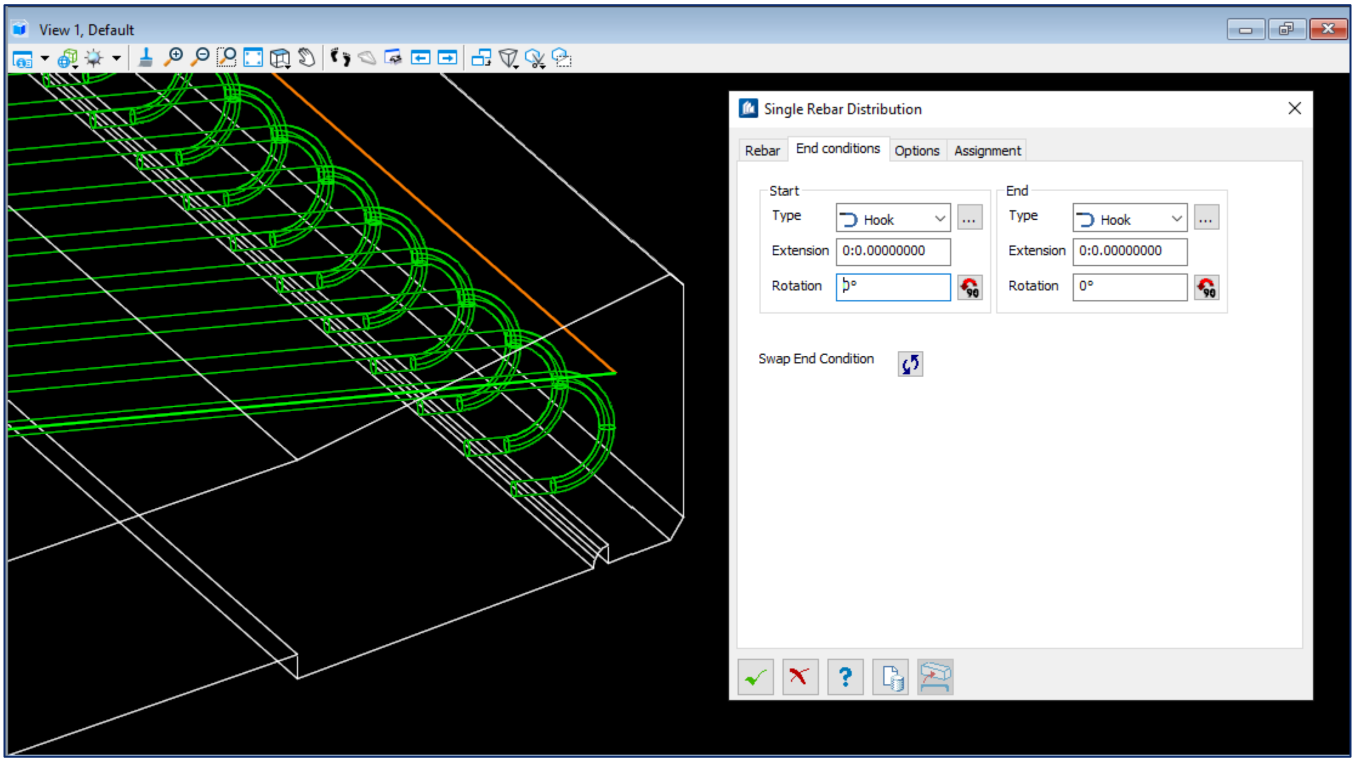


Figure 6.24-19 Hook End Condition in the Single Rebar Distribution tool

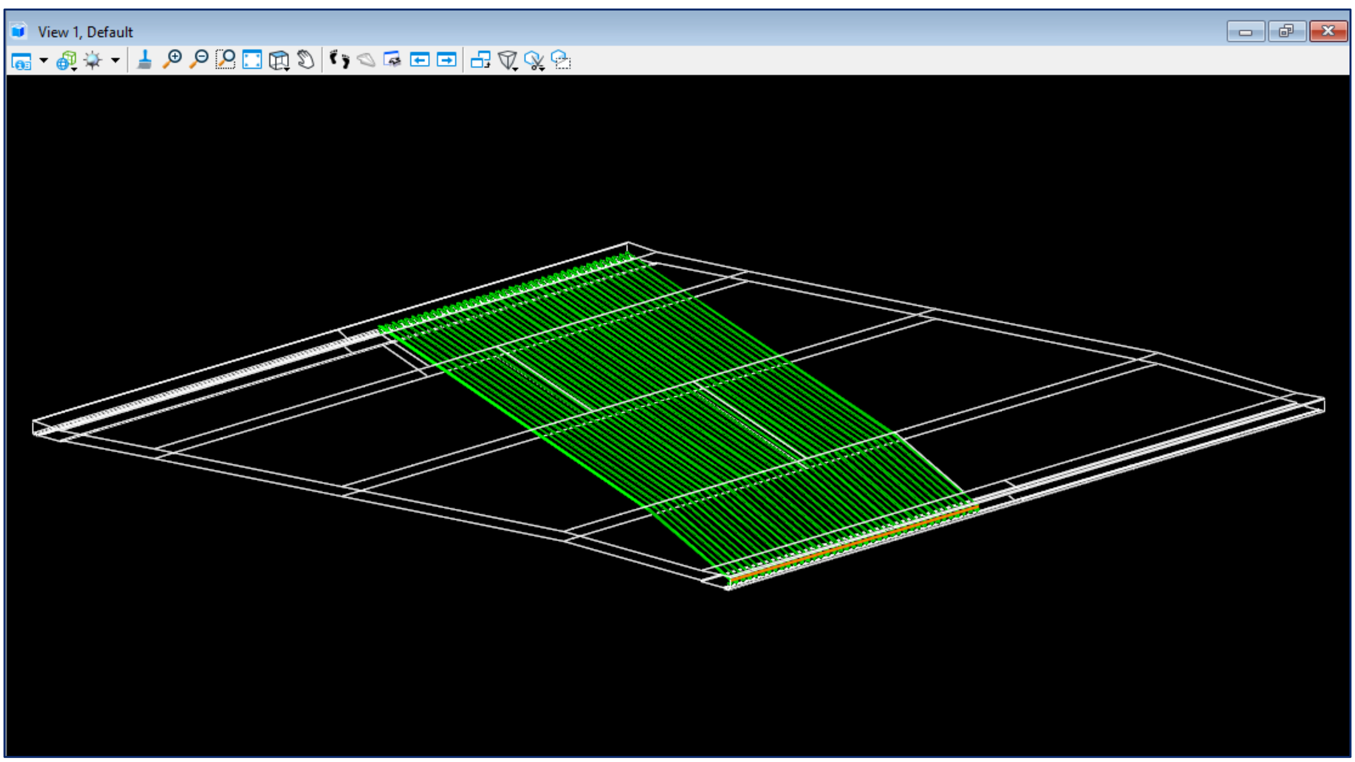


Figure 6.24-20 Transverse Rebar Modeled

6.24.3 Vertex Method of the Irregular Dispatch Reinforcing Tool

The next steps will be using the same tools for longitudinal reinforcement and then modeling the bottom transverse and longitudinal rebar in a similar fashion. For skewed bridges the next step will be adding rebar with variable lengths to the skewed end of the bridge. This will be done using the vertex method of the **Irregular Dispatch Reinforcing** tool.

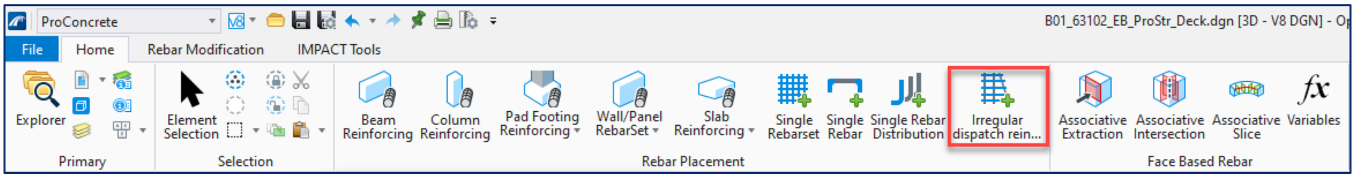


Figure 6.24-21 Irregular Dispatch Reinforcing Tool

First the Shape Guideline and Distribution Guideline from the first set of rebar (created in 6.24.2 Deck Rebar Modeling Using the Single Rebar Distribution Tool Using Guidelines) needs to be copied to the skewed portion. Then both lines need to be moved one rebar spacing further towards the start of the bridge along the Distribution Control line (which runs parallel to the alignment). In this example the rebar spacing is 5 1/2”.

Next the Shape Guideline needs to be copied multiple times along the Distribution Guideline at the required design spacing until the end of the deck. Then a cut line is drawn along the end of the deck. Next use the **Move/Copy Parallel** tool from the top view to account for the clear cover on the end of the bridge. Then use the **Trim Multiple** tool from the top view to shorten the Shape Guidelines along the end/start of the deck.

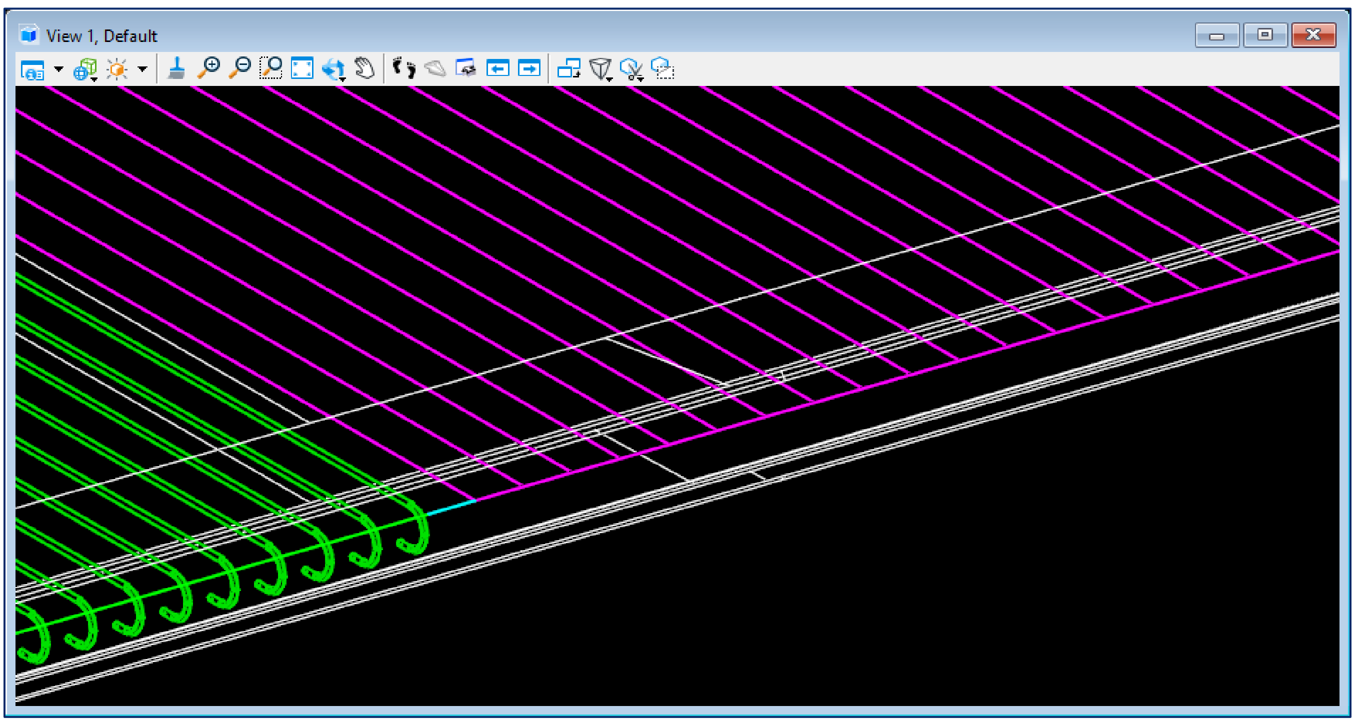


Figure 6.24-22 Various Guidelines Needed When Adding Skewed End Bars

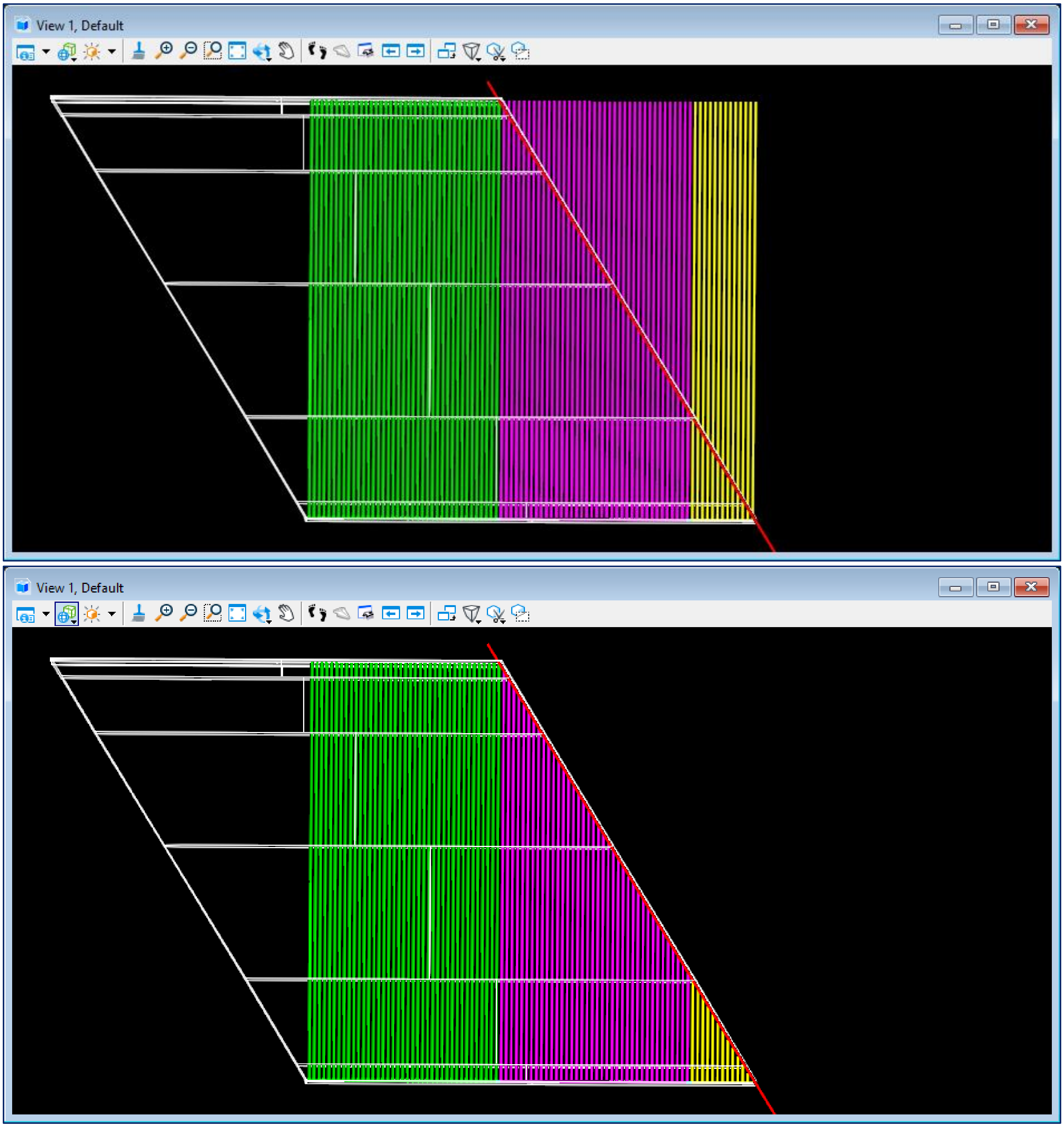


Figure 6.24-23 Before/After Skewed Shape Guidelines Trimmed using the Trim Multiple Tool

There will be two types of Shape Guidelines after this cut is made. One type will include a vertex at the crown for a total of 3 points and the other will be passed the point of the crown and only have 2.

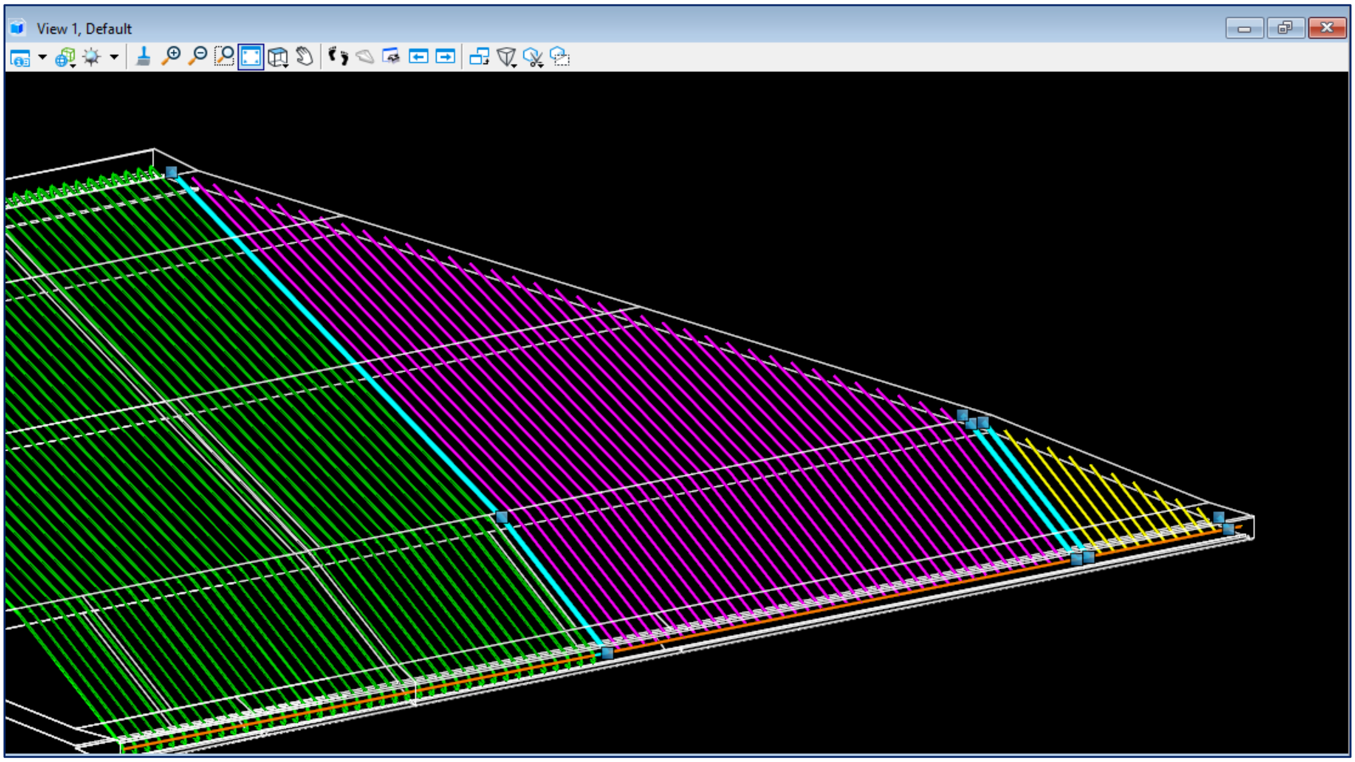


Figure 6.24-24 Green – Placed Rebar, Magenta – Three Vertex Lines, Yellow – Two Vertex Lines

The vertex method of the **Irregular Dispatch Reinforcing** tool requires that all Vertex Guidelines have the same number of points. Therefore, two different sets of rebar will need to be created for this portion of the deck.

The process for creating the Vertex Control lines is by drawing a smart line along each vertex of the Shape Control Line rebar running parallel to the alignment. The result will be three Smart Lines with the same number of vertexes.

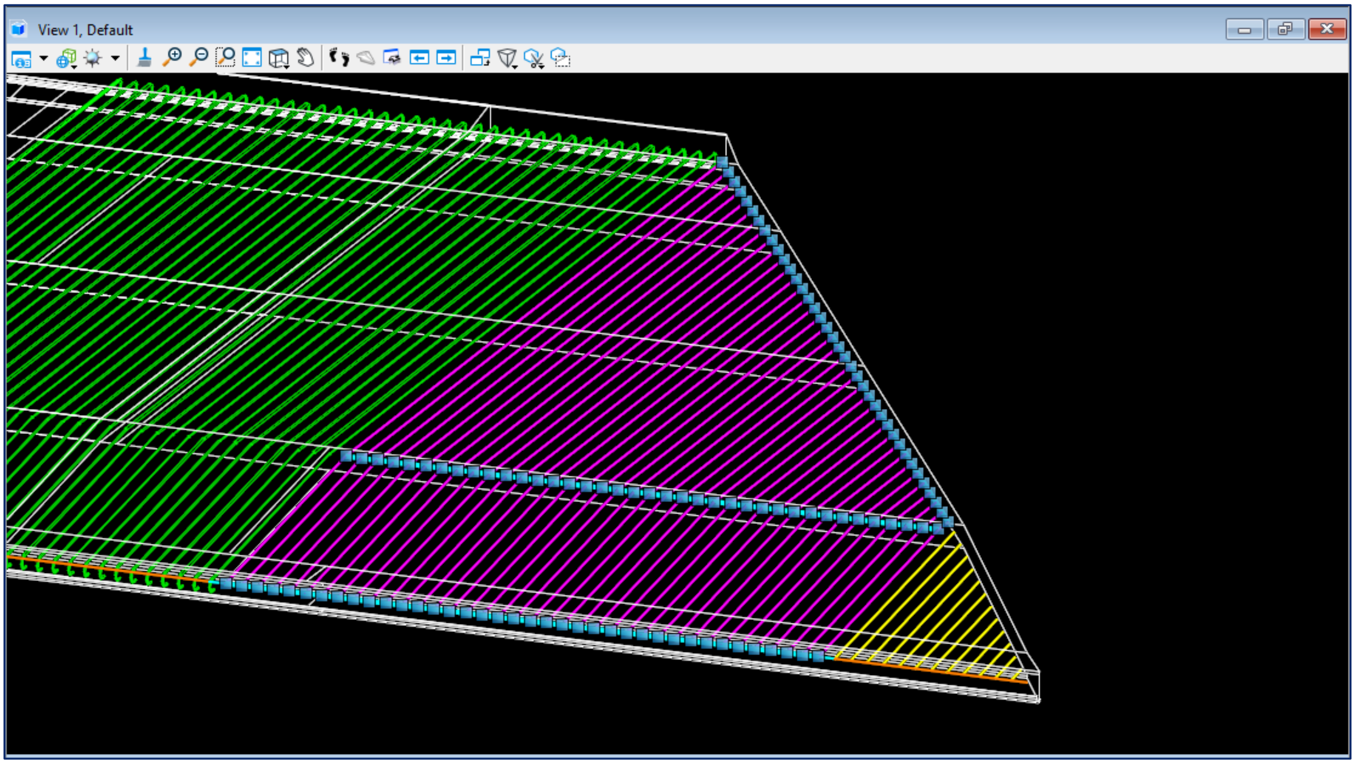


Figure 6.24-25 Blue – 3 Selected Smart Lines with Same Number of Points

Next the **Irregular Dispatch Reinforcing** tool is used to create the rebar. Choose the designed bar size, strength and select Vertex for the Dispatch Method in the Irregular Dispatch Reinforcing window. Next select the referenced deck geometry for the **Select Concrete** button and then select the three Vertex Guidelines for the **Select Guidelines** button. An end condition can also be added in the **End conditions** tab.

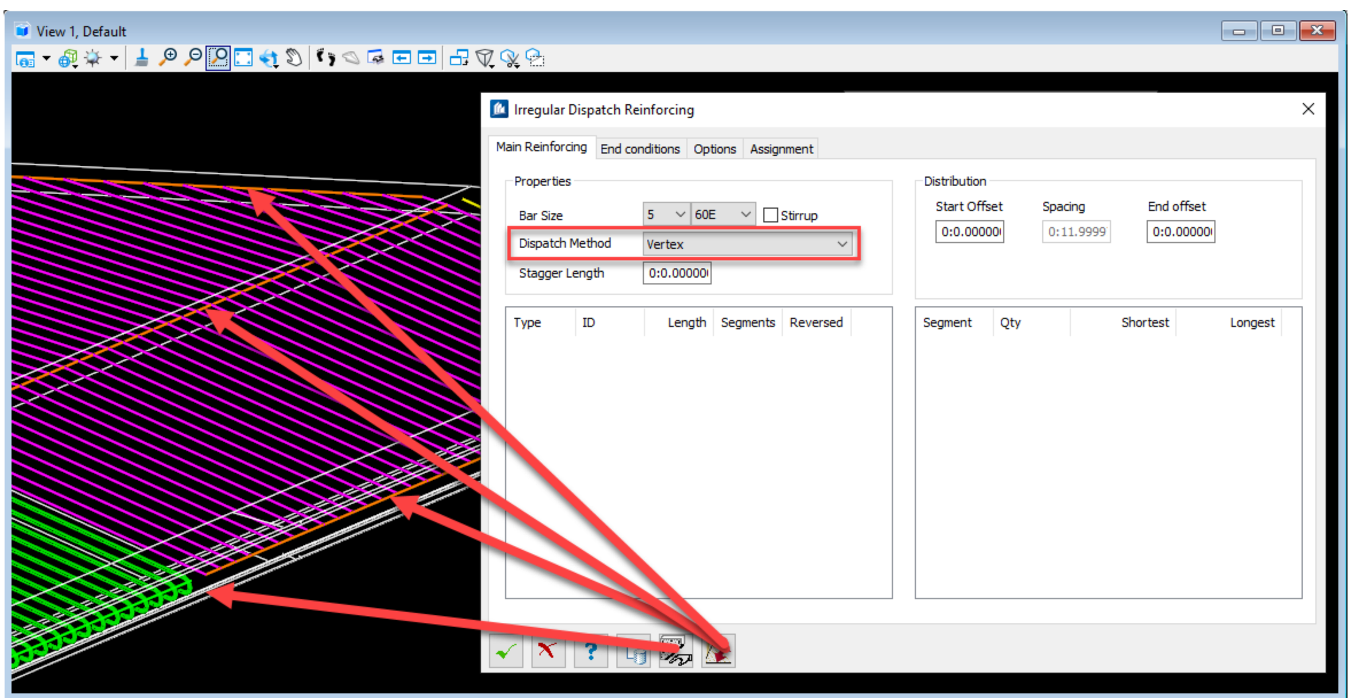


Figure 6.24-26 Irregular Dispatch Reinforcing Tool Dialog Box

The result will be a set of rebar that are controlled by the vertexes of the lines. This process can be repeated for the last section of top transverse rebar but only using two Vertex Guidelines instead of three.

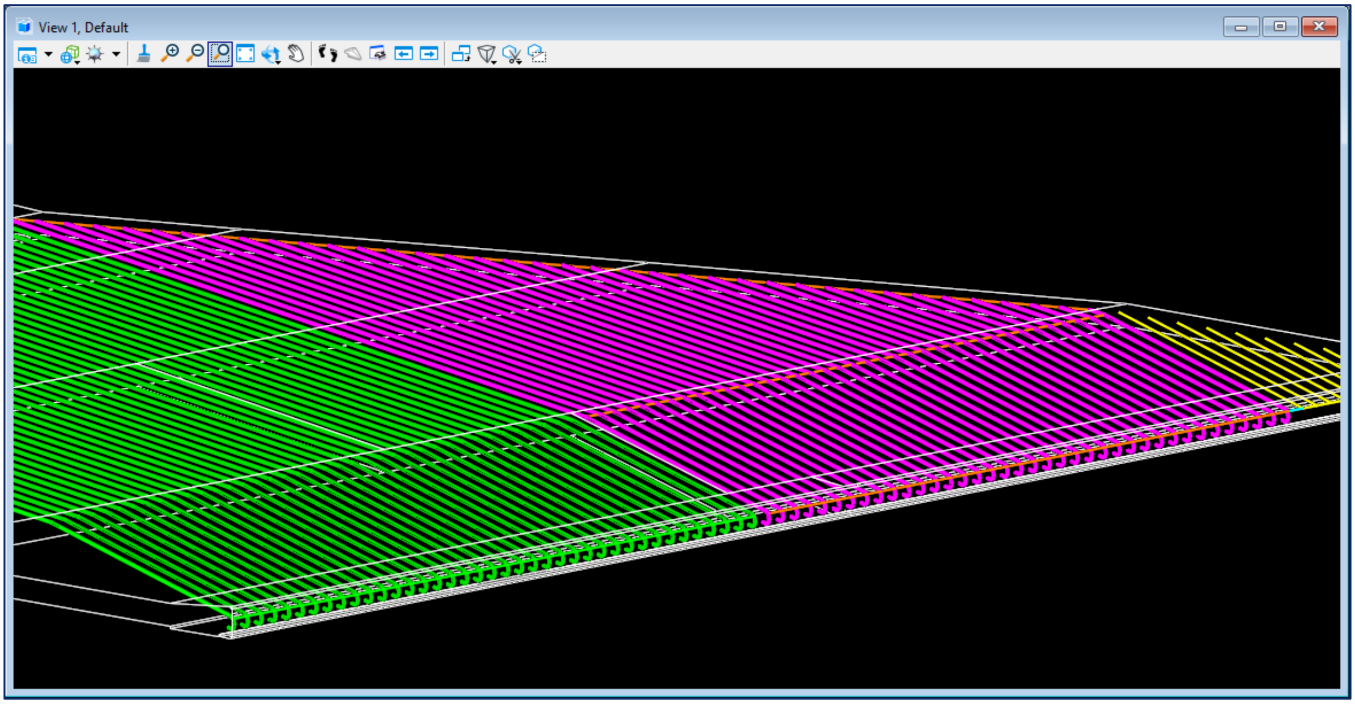


Figure 6.24-27   Skewed End of Bridge Reinforcement

This same vertex method can be utilized for the longitudinal reinforcement. The Shape Guideline will run along the alignment. The Vertex Guideline will run along the skewed top of deck. Then the lines will need to be moved down vertically to avoid the top clear cover and the transverse reinforcement. Subsequently the lines will need to be trimmed/extended with the clear cover cut lines at the start/end of the bridge and each side. Then the Vertex Guideline will be copied to the end of the Shape Guideline at the other end of the bridge.

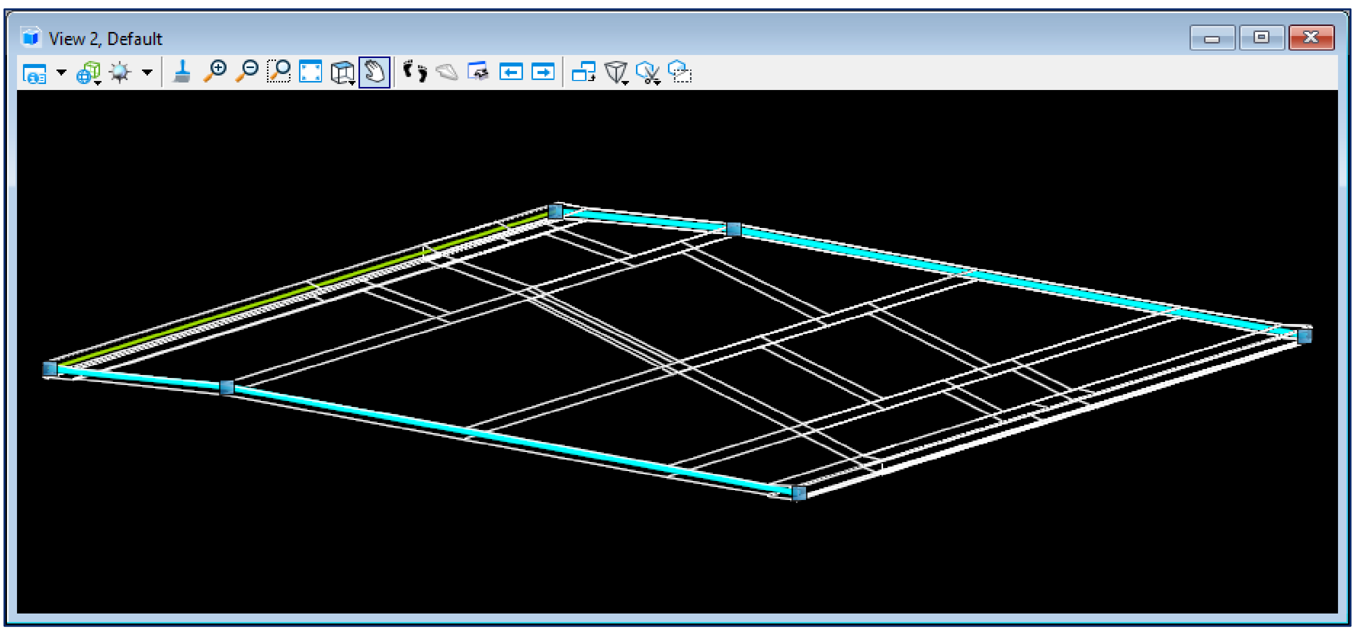


Figure 6.24-28   Blue – Selected Vertex Guidelines

Then these Vertex Guidelines with 3 points on them will be used for the vertex method of the **Irregular Dispatch Tool**.

Note: Since the spacing of the rebar is based a skewed line, the spacing for the longitudinal reinforcement will need to be adjusted in accordance with the skew of the project. In most situations the spacing of the deck rebar is measured perpendicular to the alignment and not along the skew.

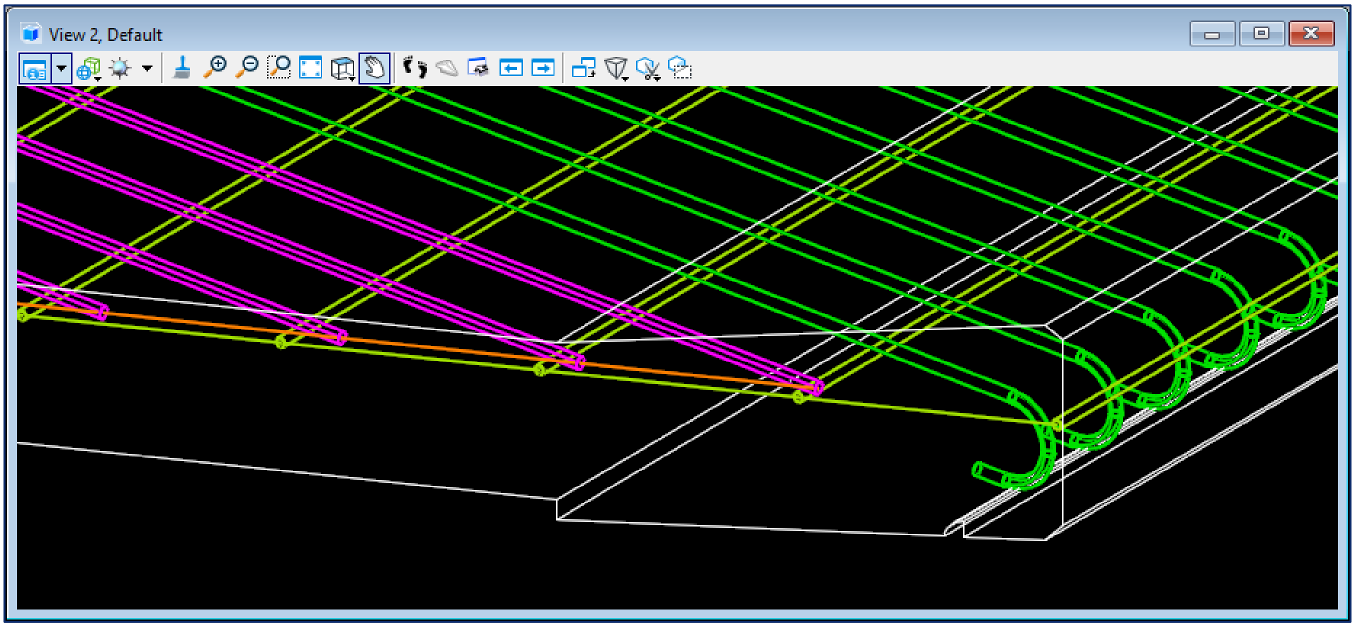


Figure 6.24-29   Corner of Deck Showing Modeled Top Rebar

6.24.4   Substructure Reinforcement Modeling

The built-in footing reinforcement tool does not currently have the ability to deal with non-orthogonal footings. It also does not have the ability to deal with the variable spacing needed to deal with modeling footing rebar around embedded piles of any shape.

Similar to the deck reinforcement the substructure can be reinforced with the **Single Rebar Distribution** tool and the **Irregular Dispatch Reinforcing** tool. The process works the same way. Make a Boolean difference cut in the geometry that is normal to the cross section of the concrete to be reinforced. Draw out Shape Guidelines considering clear cover to the edges of the concrete and the thickness of the rebar. Then draw out Distribution Guidelines to control the spacing of the rebar into and out of the cross section. Then these Guidelines are used in the **Irregular Dispatch Reinforcing** tool to create the rebar.

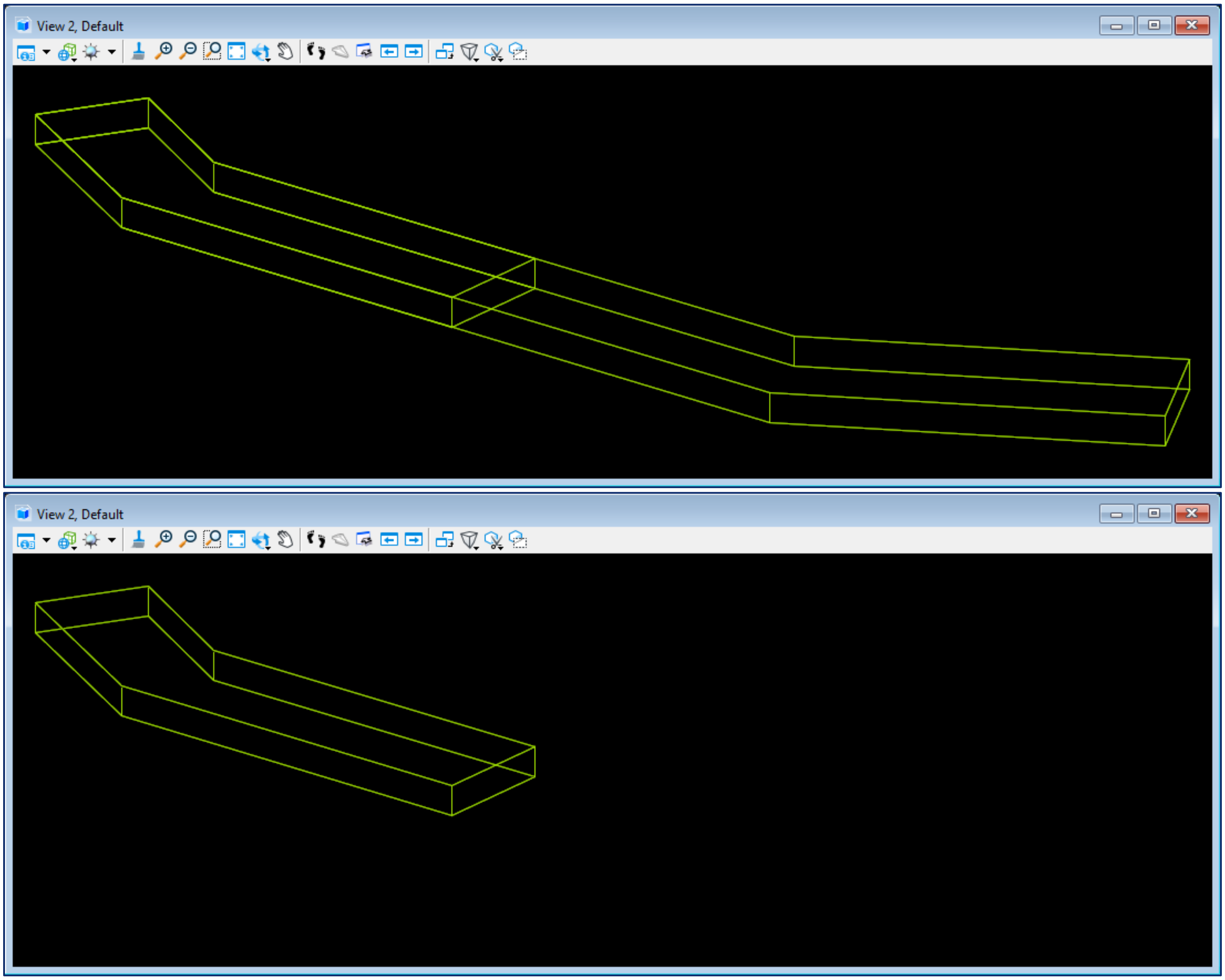


Figure 6.24-30 Substructure Boolean Difference

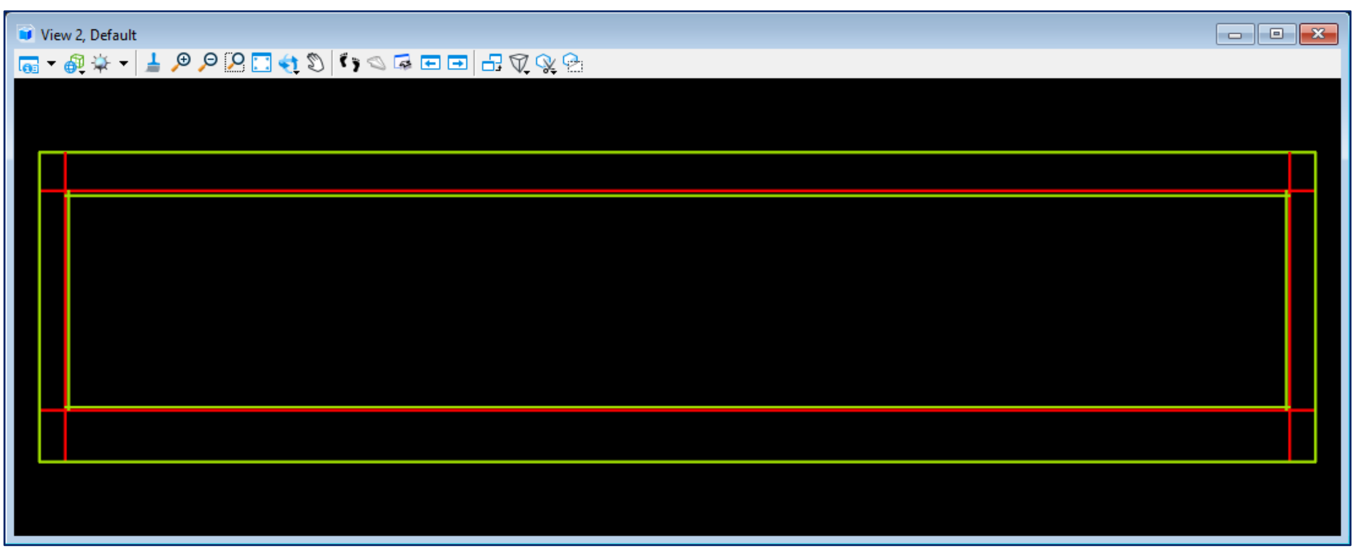


Figure 6.24-31 Substructure Cross Section, Red – Clear Cover Lines, Yellow – Shape Guidelines

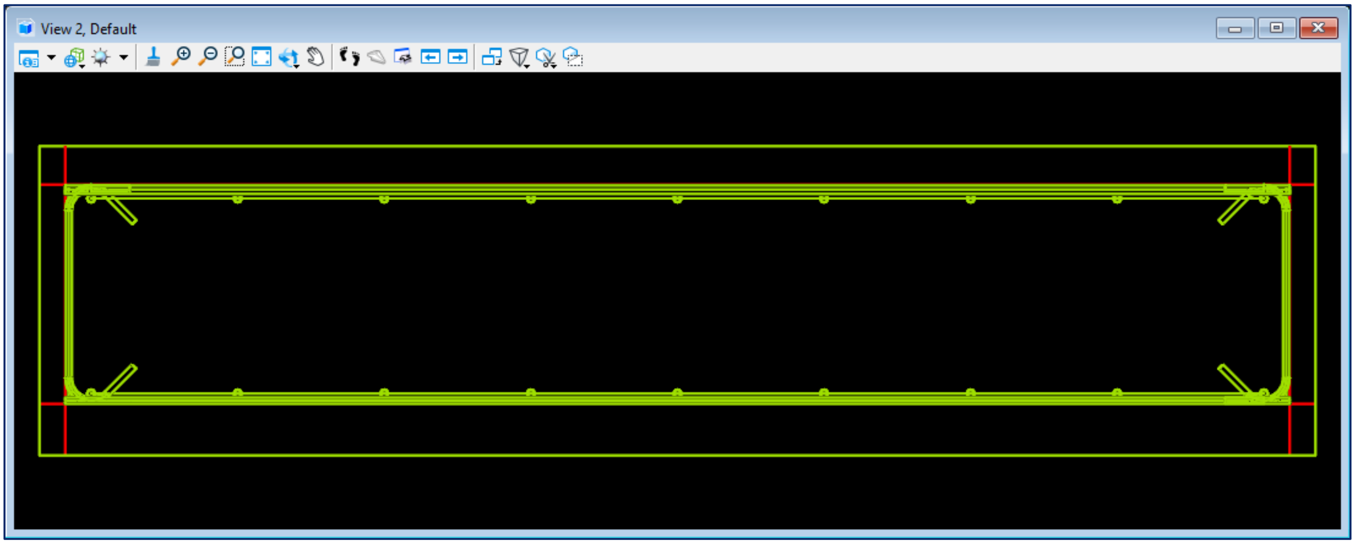


Figure 6.24-32 Substructure Cross Section with Placed Reinforcement Inside Cover Lines

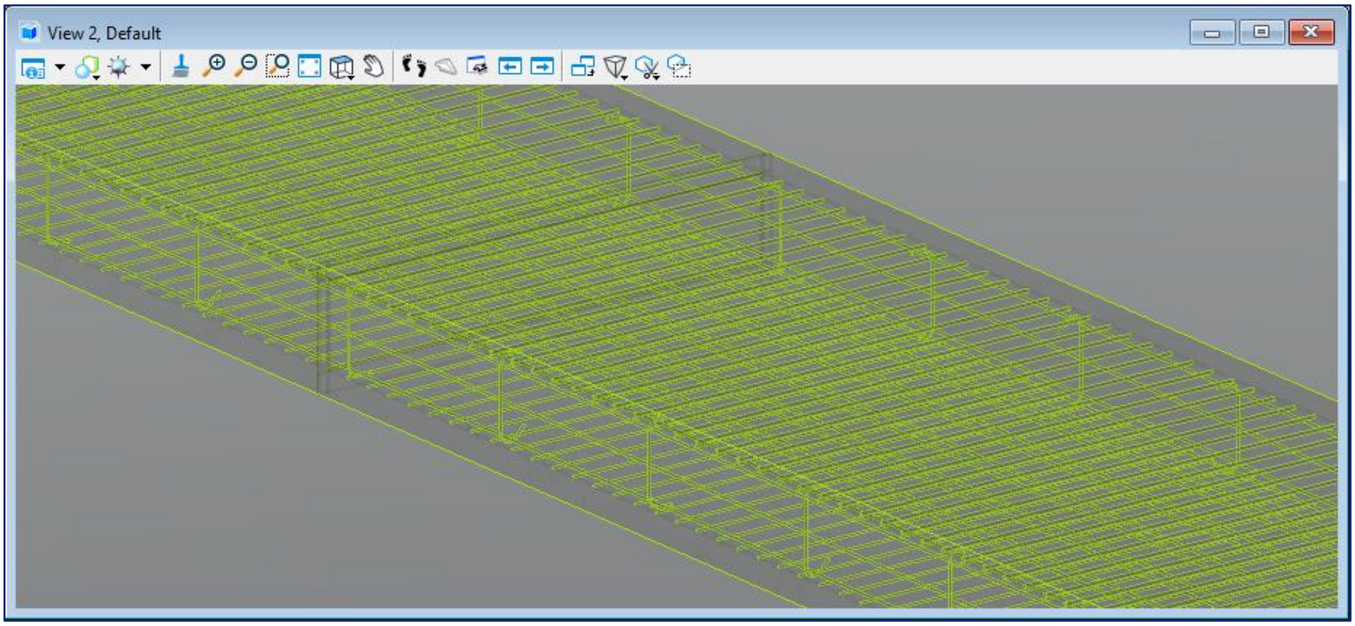


Figure 6.24-33 Reinforced Substructure Concrete

6.24.5 Modeling Splices and Phase Lines

If a structural element is wider or longer than the acceptable rebar length, then splices will need to be added to the reinforcement.

One method for splice creation is modeling another set of reinforcement. Follow the steps for the creation of the Guidelines in the Single Rebar Distribution section. Then a copy of the Shape Guideline would be made and then moved one rebar thickness along the Distribution Control Line (which is parallel to the alignment). This is so the Shape Guidelines for the modeled rebar will not overlap. Then a line would be drawn parallel to the alignment at the point where the splice would be centered. Then this line would be offset using the **Move/Copy Parallel** tool (with the copy toggle turned on) a distance half of the required spliced in each direction.

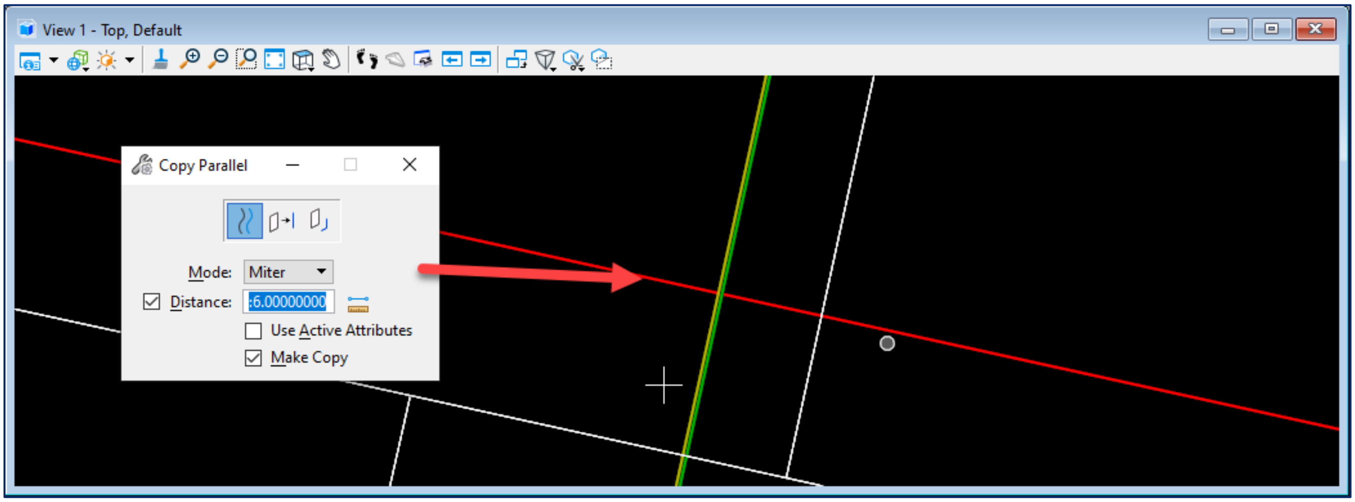


Figure 6.24-34 Splice Guideline Along Alignment with Move/Copy Parallel Tool Used in Top View

Then each of the Shape Guidelines would be trimmed using the **Trim Multiple** tool leaving a shortened Guideline for each side of the spliced rebar. The next step would be creating rebar from the trimmed lines using the **Single Rebar Distribution** tool.

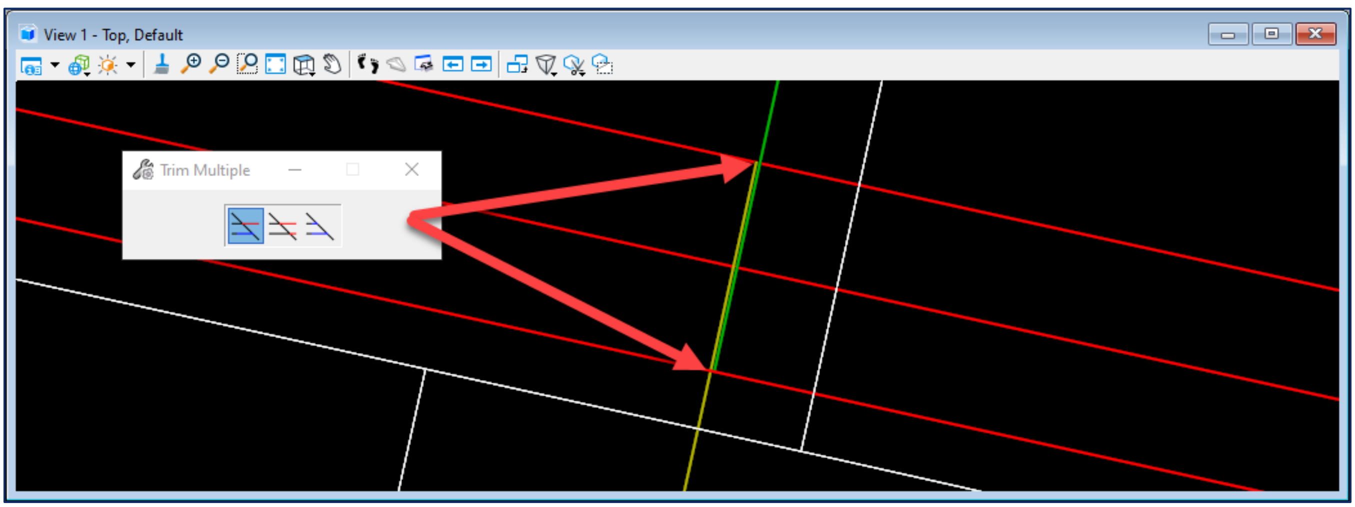


Figure 6.24-35 Trim Multiple Tool to Shorten Shape Guidelines

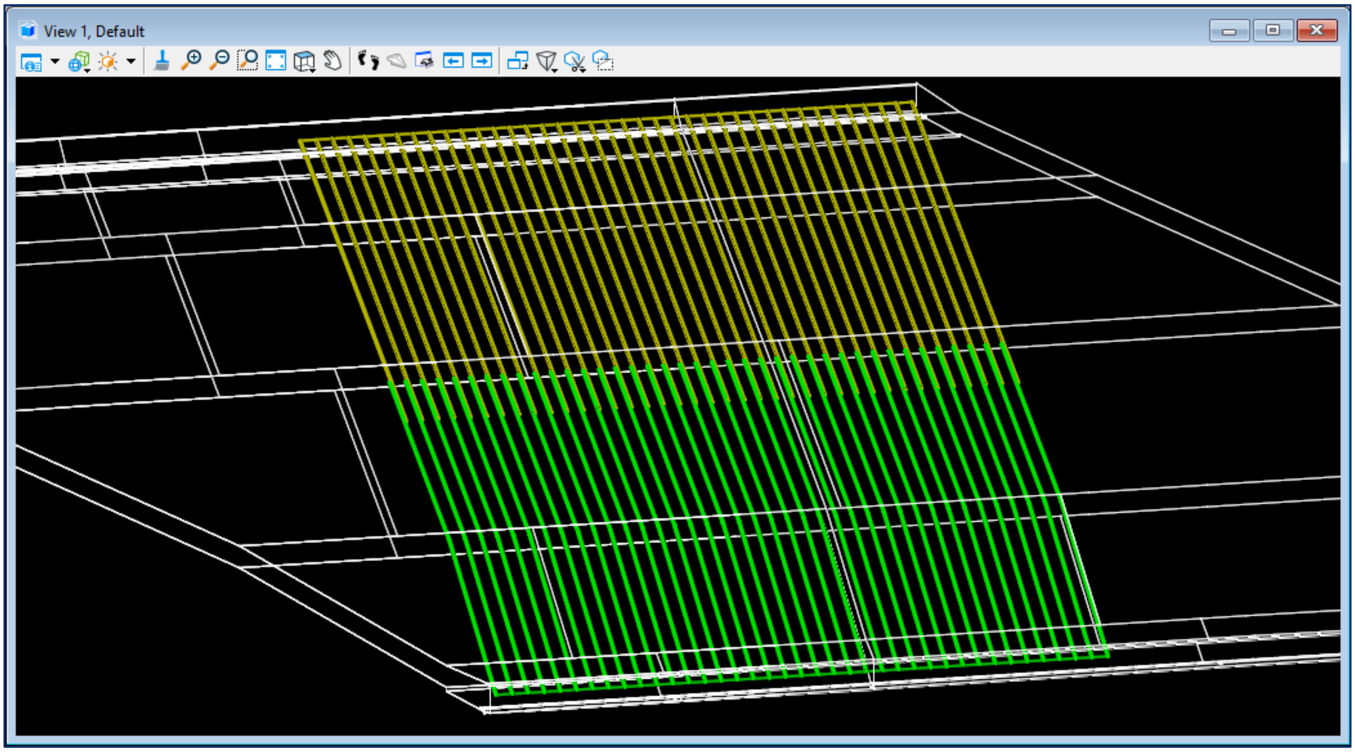


Figure 6.24-36   Transverse Deck Reinforcement Spliced in the Center

If there are phases on the bridge, then the Shape Guidelines will need to be further divided along the phase lines and more sets of rebar will need to be modeled. There is also an end condition that allows for the end of the rebar to be modeled as a mechanical coupler along the phase line if required by the project. The process for this will be similar to the splicing.

6.24.6   Tapered Deck Reinforcement Modeling

Tapered decks require a further level of refinement from decks with a constant width. In a tapered deck situation, the transverse reinforcement will need to modeled using the Irregular Dispatch tool.

6.24.7   Curved Deck Reinforcement Modeling

Curvature in either the horizontal or vertical direction will need some more specialized tools and methods for rebar modeling.

Modeling the transverse reinforcement in a curved deck will start by making a SmartSolid copy of the deck geometry into the rebar OBM file.. The next step will be using the **Extract Faces/Edges** tool to make copies of the surfaces that represent the outside edge of deck and the top of deck underneath the barrier. This tool is located in the **Modeling > Solids** > **Solid Utilities**.

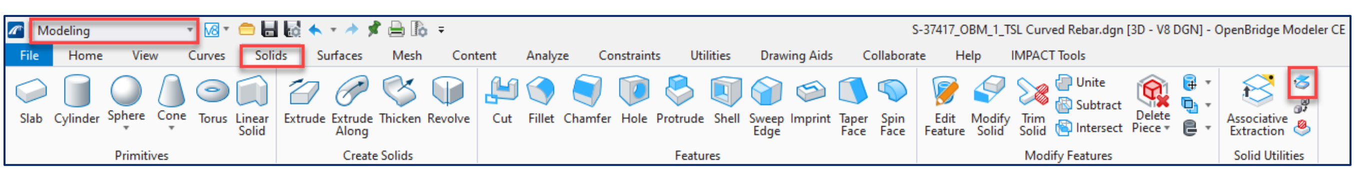


Figure 6.24-37   Extract Faces/Edges Tool

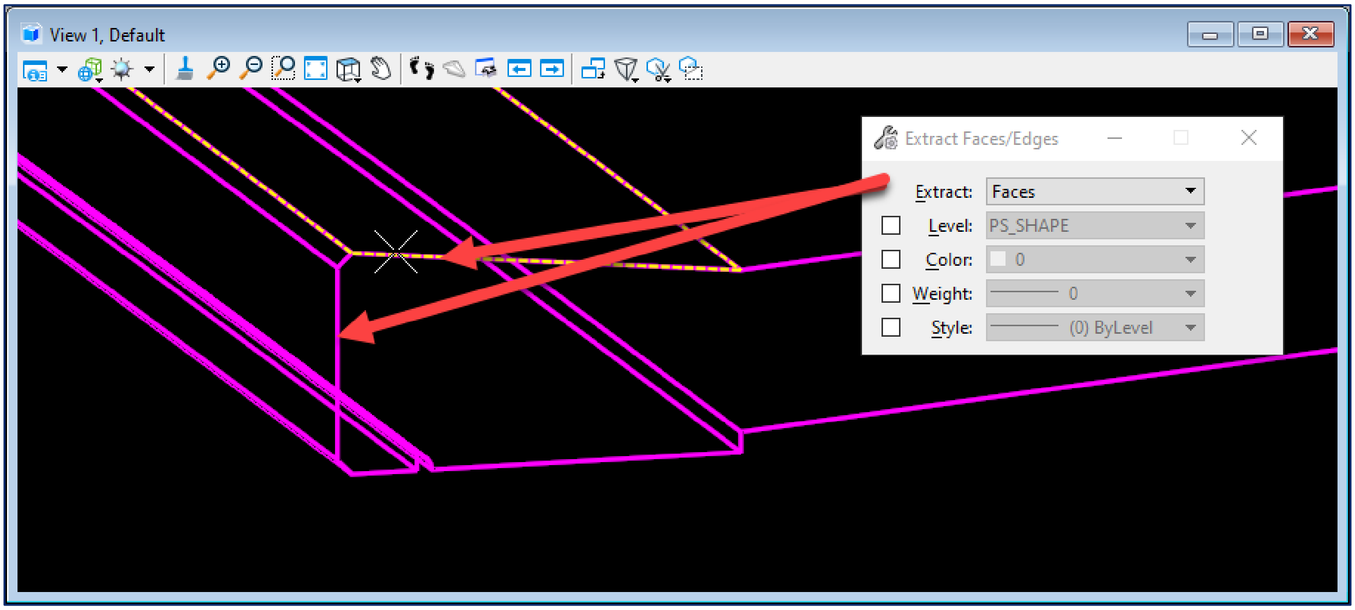


Figure 6.24-38 Using the Extract Faces/Edges Tool on Deck Geometry SmartSolid

Next the **Offset Surface** tool is used to move the faces inward to properly account for the clear cover and half the thickness of the bar for each surface as the Guideline runs down the center of the rebar. **Modeling > Surfaces > Offset Surface**

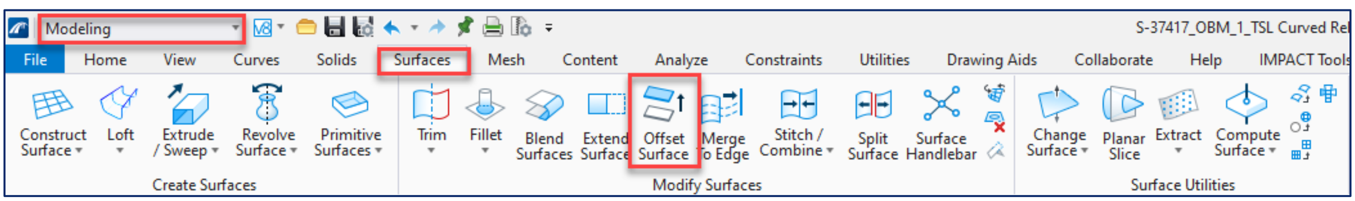


Figure 6.24-39 Offset Surface Tool

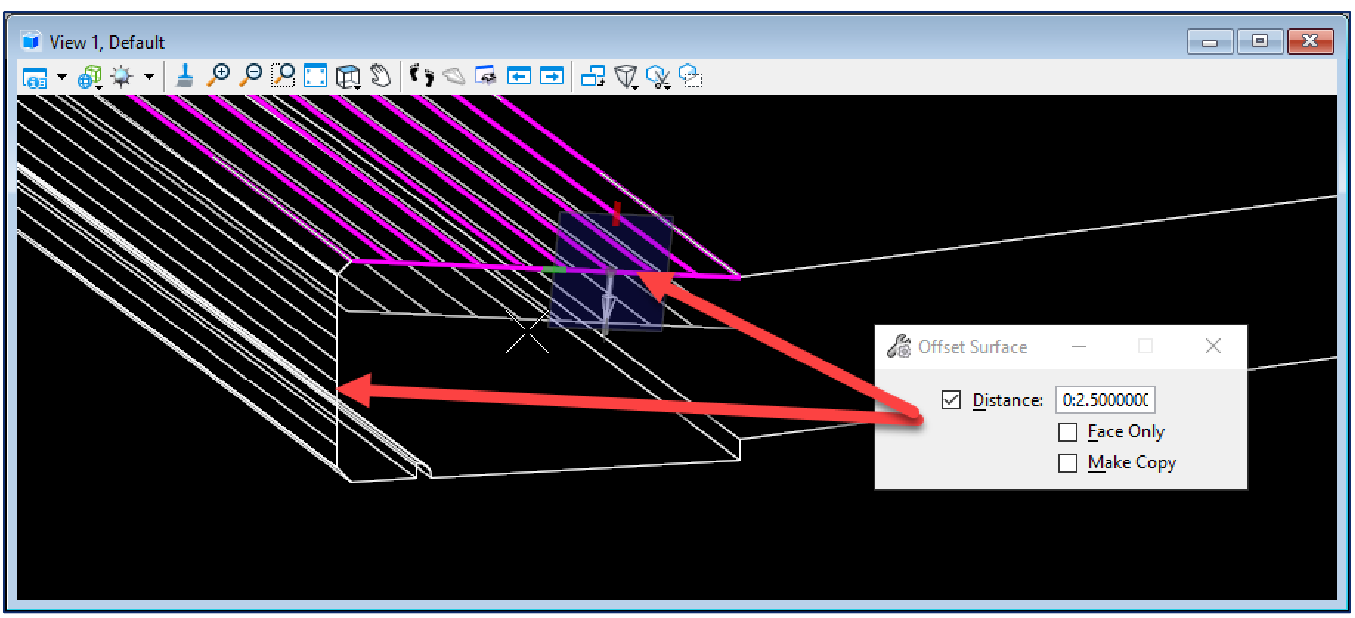


Figure 6.24-40 Offset Surface Tool on Extracted Deck Faces for Cover and Rebar Thickness

Next the **Compute Intersections** tool is used to create a **Spline** that represent the intersection of these two planes. This spline will be used as one of the **Irregular Dispatch Distribution** Guidelines for the transverse rebar. **Modeling > Surfaces > Compute Surface > Intersections**

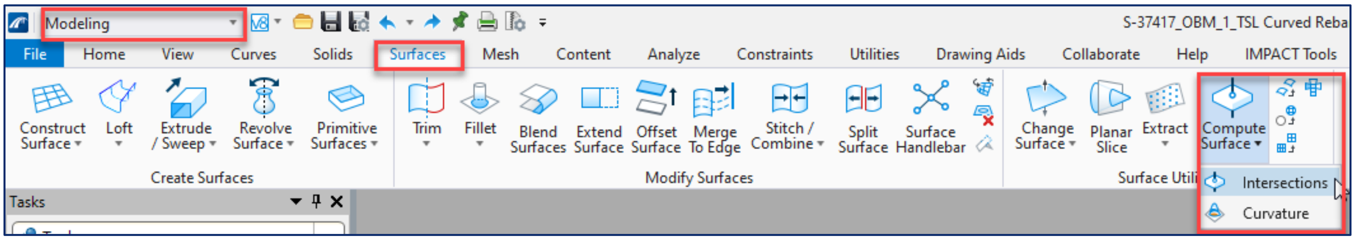


Figure 6.24-41   Compute Intersections Tool

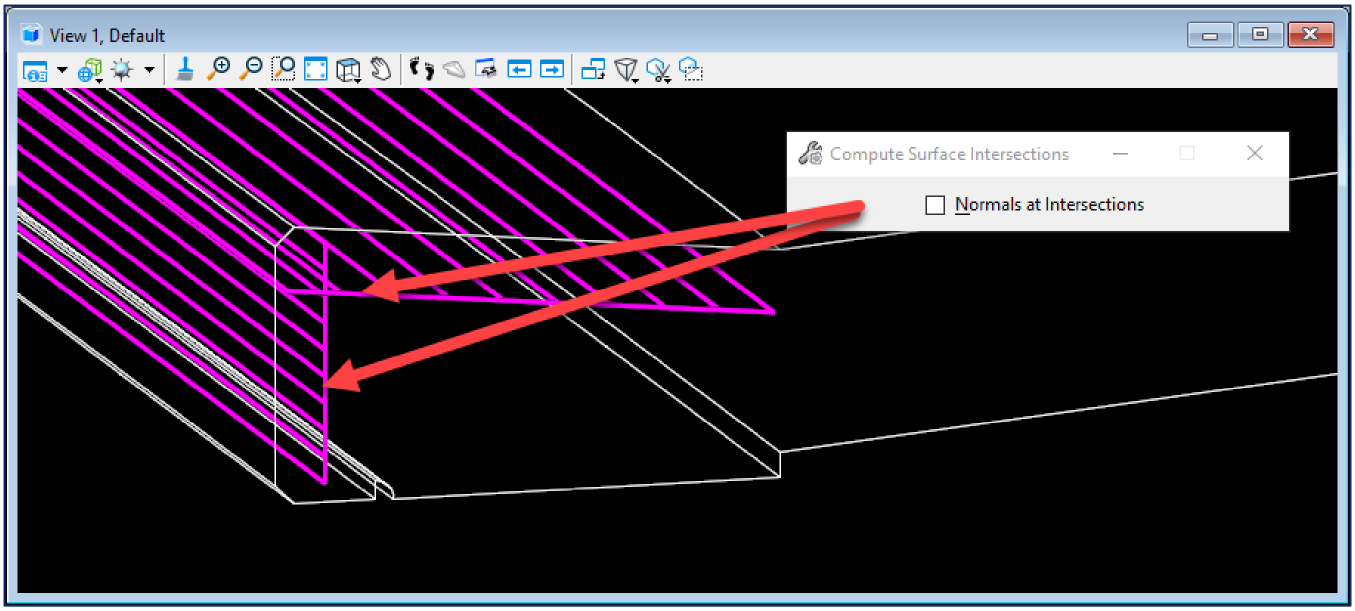


Figure 6.24-42   Compute Intersections Tool to Create Spline for Distribution Guideline

This process will be replicated on the other side curved deck underneath the opposite barrier. The next step will be creating the Distribution Guidelines at the gutter lines and at the crown. This will be done using the Extract Faces/Edges tool at the each of the gutter lines and at the crown. Then these lines will need to be moved vertically to account for the clear cover on the top of the deck and the thickness of the rebar.

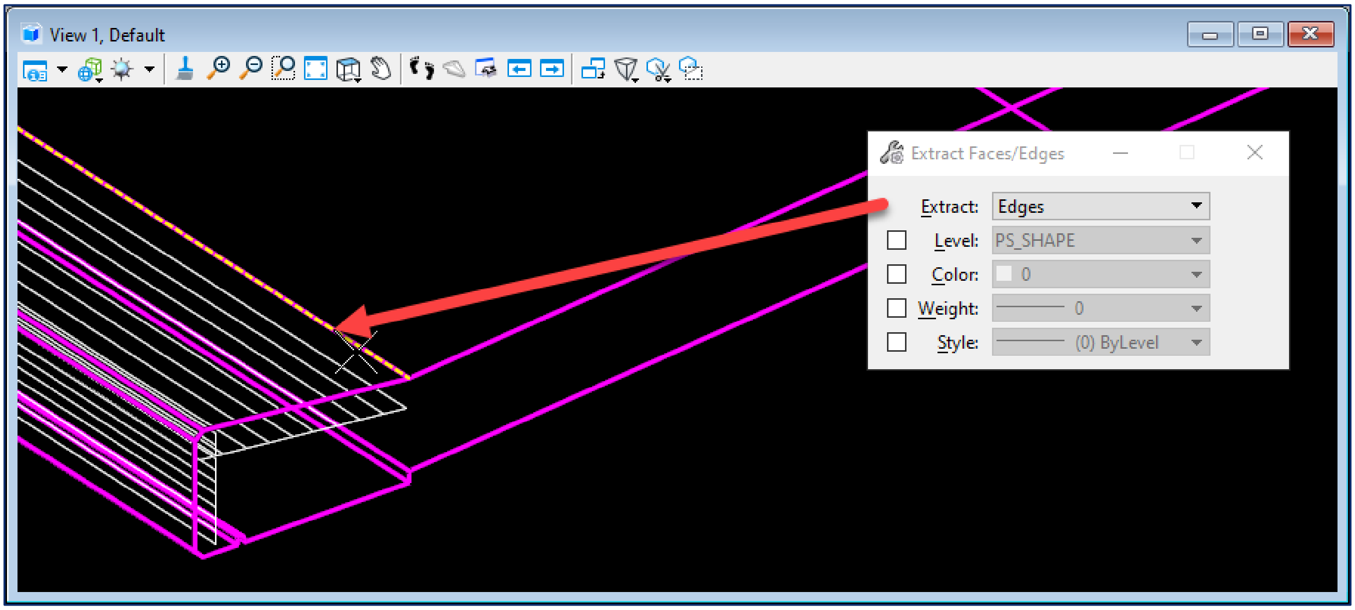


Figure 6.24-43 Extract Faces/Edges Tool to Create Spline for Distribution Guideline

The example curved bridge has a standard cross slope in each direction from the crown. If there are more cross slope transitions in a bridge deck, more Distribution Guidelines will need to be extracted.

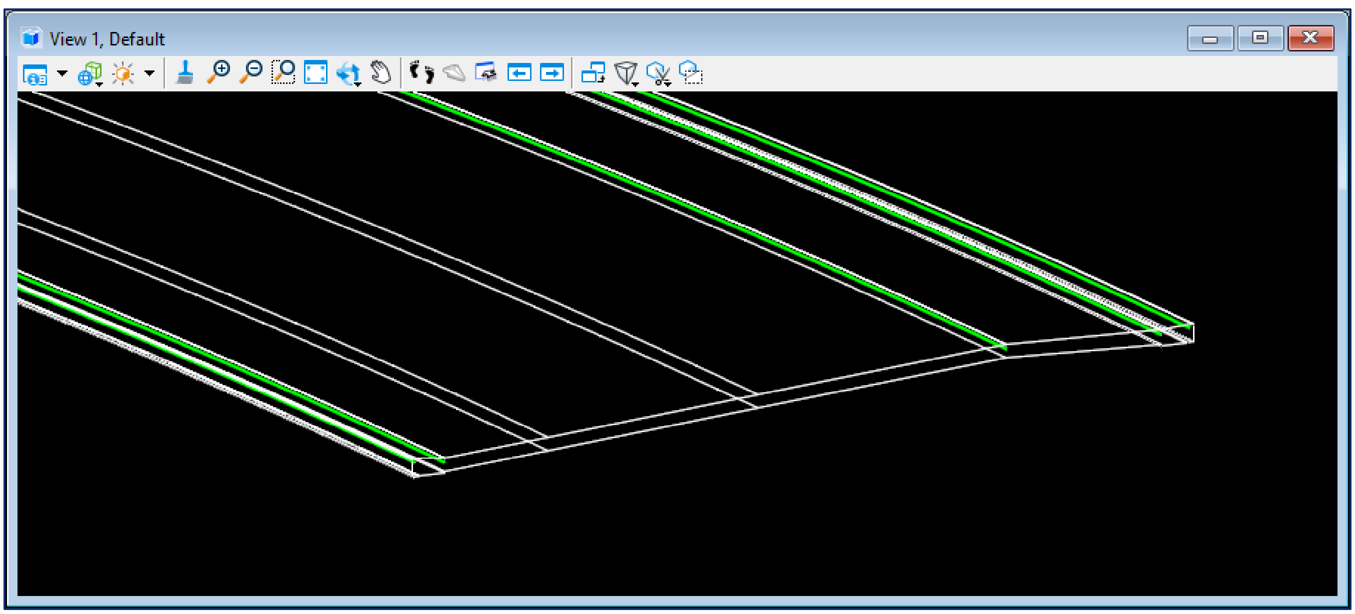


Figure 6.24-44 White – Bridge Deck Geometry, Green – 5 Distribution Guidelines

Next the **Irregular Dispatch Reinforcing** tool will be used to create the transverse reinforcement. This time the **Dispatch Method** will be **Spacing**. The referenced concrete deck geometry from the OBM model will be selected for the **Select Concrete** button. The 5 Distribution Control Lines will be selected for the Select Guideline(s) button. The Distribution Guidelines need to be selected from one end of the deck to the other for the tool to work correctly. Bends at the end of the bar can be set in the End Condition tab. The level can be set in the Assignment tab.

Note: In this example instead of trimming the start and end of the Distribution Guidelines to account for the start/end of deck clear cover the Start/End Offset was used to accomplish this offset. This is an effort to illustrate that there are many ways to accomplish the same thing in OpenBridge Modeler.

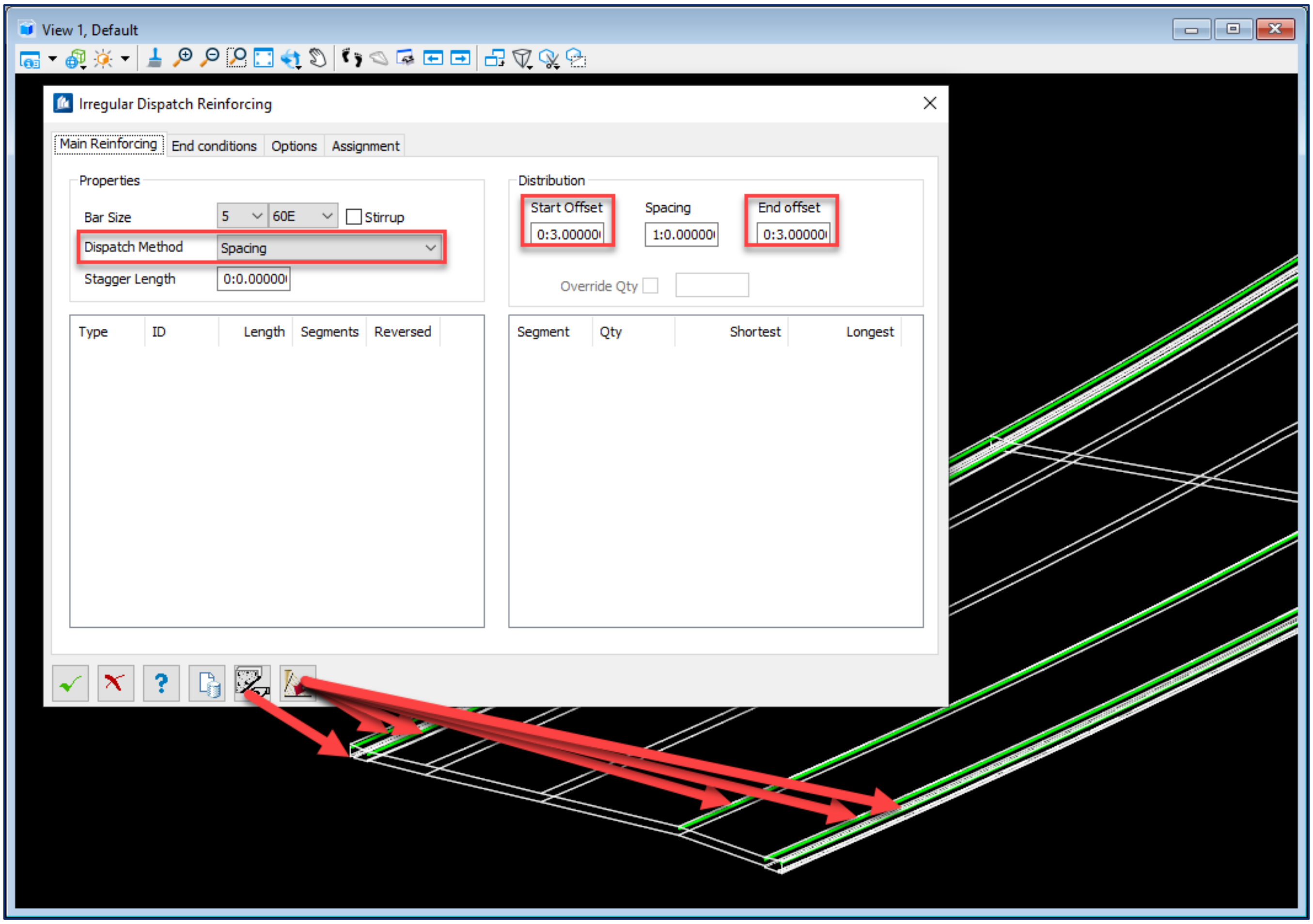


Figure 6.24-45 Irregular Dispatch Reinforcing Tool Using Dispatch Method of Spacing

Next the longitudinal reinforcement will be modeled. A copied SmartSolid will be used as a starting point to pull reference information from. First the **Extract Faces/Edges** tool will be used to create a spline element along the crown of the roadway. Next this spline will be used to subdivide the deck geometry SmartSolid using the **Associative Slice** tool. This tool is located in the ProStructures workflow and the Home tab. The deck geometry will be selected as the Select solid to be sliced prompt and the **ProConcrete > Home > Face Based Rebar > Associative Slice** is then selected.

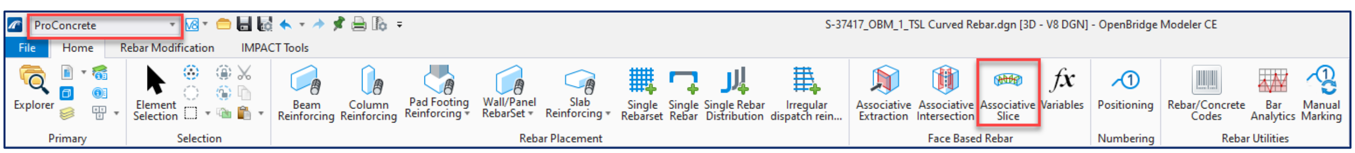


Figure 6.24-46 Associative Slice Tool

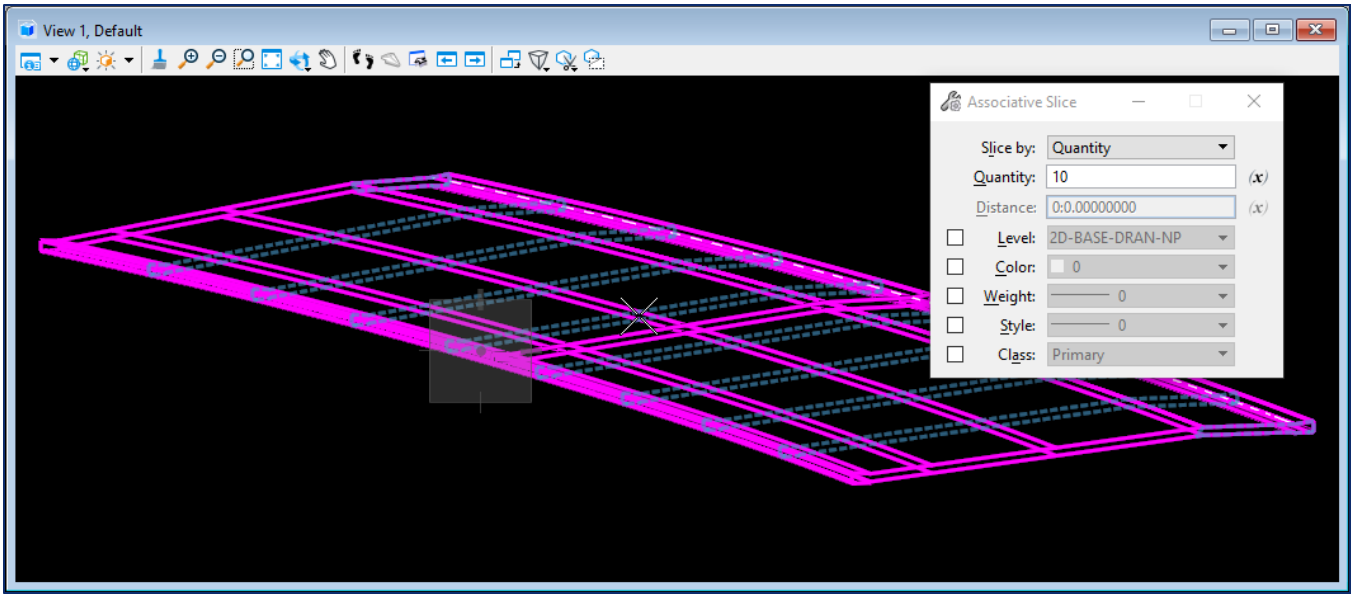


Figure 6.24-47 Deck Subdivision with Associative Slice Tool

Note: In this example the deck was divided into 10 parts. This number will need to vary depending on the complexity of the vertical/horizontal curvature and/or an increased length of the bridge deck being reinforced.

Next smart lines will be drawn along the top of each of these subdivisions. There will be vertices at the edge of the top of deck before the chamfer, the gutter line, and along the crown for a total of 5 in this example. These SmartLines will be the Distribution Guidelines for the **Irregular Dispatch** tool. Then these Distribution Guidelines will be moved vertically to avoid conflicts with the top of deck clear cover and the transverse reinforcement.

Now these Distribution Guidelines will be used in the Irregular Dispatch tool. The referenced bridge deck geometry will be selected for the **Select Concrete** button. The Distribution Guidelines will be selected for the **Select Guideline(s)** button. The Distribution Guidelines need to be selected from one end of the deck to the other to work properly. Next each of the lines except the start and end Distribution Guidelines needs to be right clicked and set to **Make Arc Intermediate Point**. This modification changes the rebar from being straight sections of rebar along the Guidelines to being curved rebar that more accurately follow the curvatures of the deck. Again this example utilizes the start and end offset to account for the side clear cover instead of trimming the Guidelines.

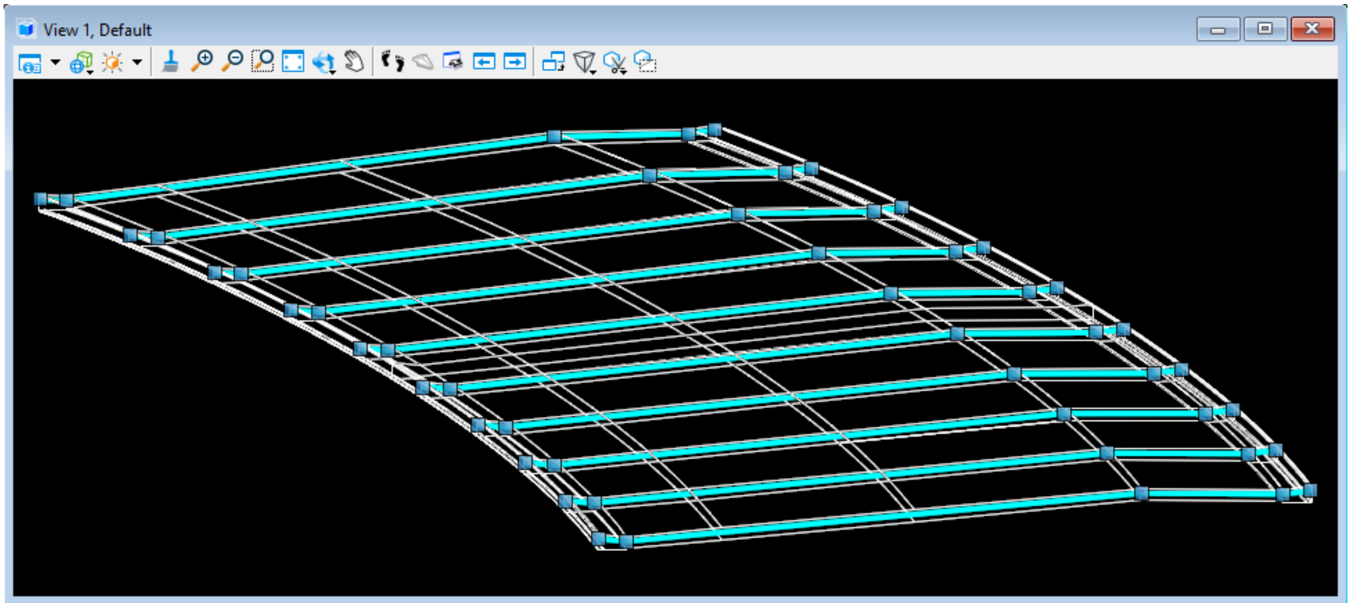


Figure 6.24-48 10 Selected Vertex Guidelines Each with 5 Vertices

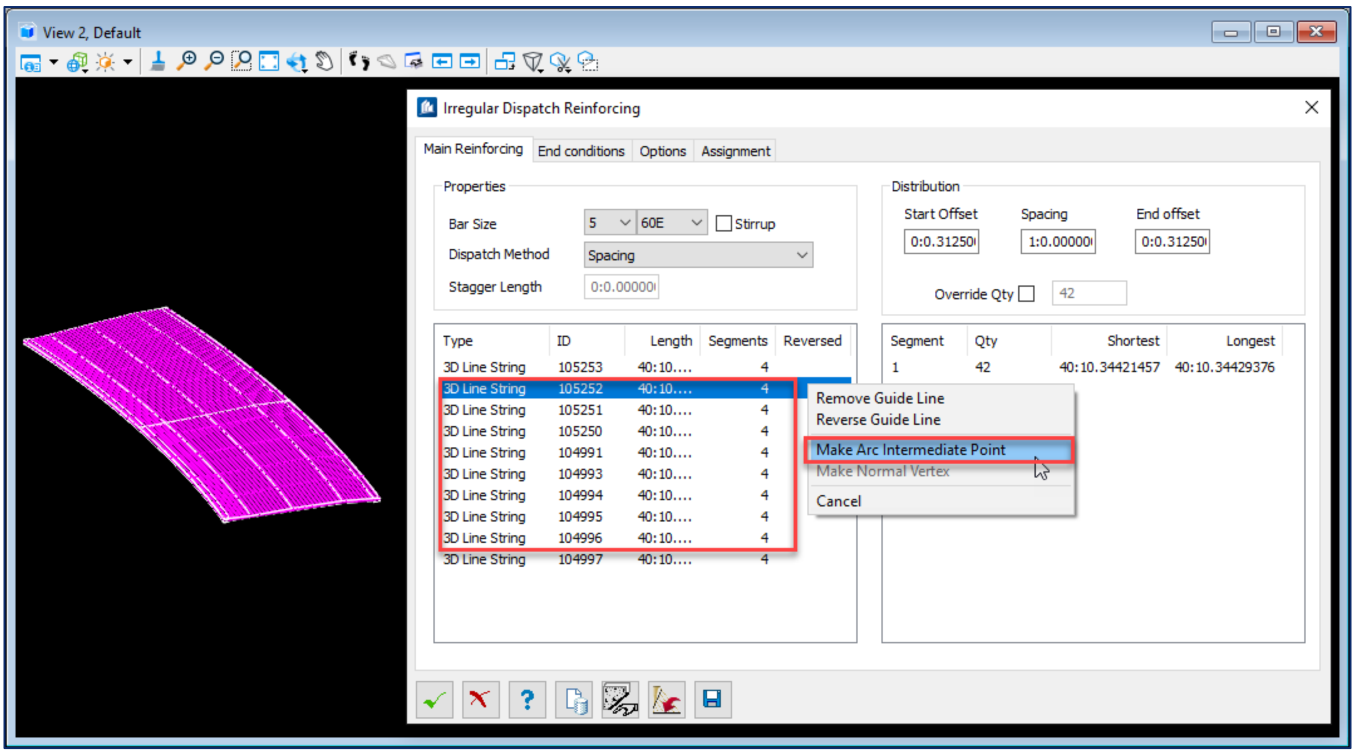


Figure 6.24-49 Changing 3D Line Strings in Irregular Dispatch Reinforcing Tool

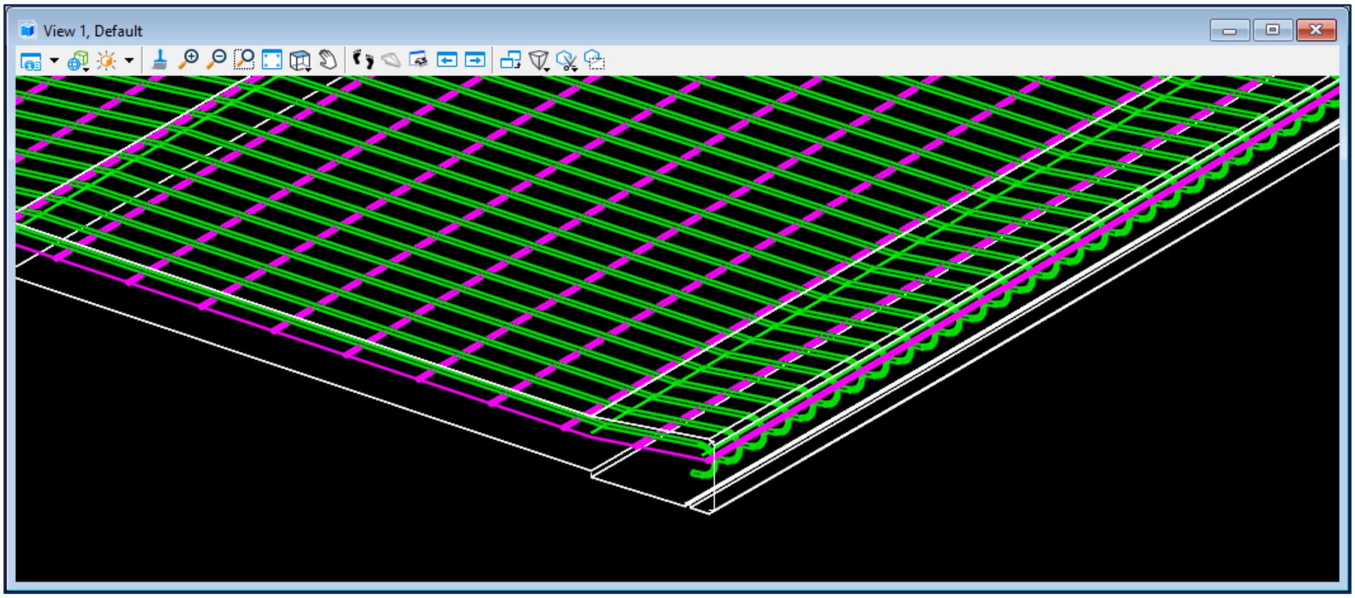


Figure 6.24-50 Transverse and Longitudinal Reinforcement in a Curved Deck

6.24.8 Adding Bar Marks and Scheduling Rebar

[This section is under development. Content will be added after necessary updates in the software and Digital Delivery Directive 2025 Pilot Project feedback is incorporated.]

6.25 ADDING ATTRIBUTES

[This section is under development. Content will be added after PennDOT Item Type list development is complete and Digital Delivery Directive 2025 Pilot Project feedback is incorporated.]

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OUTPUT DESCRIPTION

7.1 REPORTS

There are several built-in reporting options in OBM. The more common and useful are listed below. In addition to the reports highlighted, there may be uses for the additional reports, especially for QA/QC processes, and the user should investigate the tools and the Bentley Help Content for more information.

The reports can be exported to many common formats including xlsx, csv, txt, and pdf. and can be integrated and combined with other design information as part of additions to drawings, calculation packages, and digital deliverables.

Note: These reporting tools are based only from OBM recognized elements (OBM decks, OBM abutments, etc.). As soon as these elements are modified and no longer retain their OBM-element status, the results from these reports may not be available or they may report erroneous information. All information and data generated from these tools are to be verified by the user.

7.1.1 Updating Design File Settings for Reports

The reporting tools will automatically use the Design File Settings which are typically consistent with the seed file settings. However, the user can change the Design File Settings to generate the desired formats for certain reports. For example, the accuracy can be changed to two decimal places for elevation reports.

The Design File Settings are accessed from **File > Settings > File > Design File Settings**.

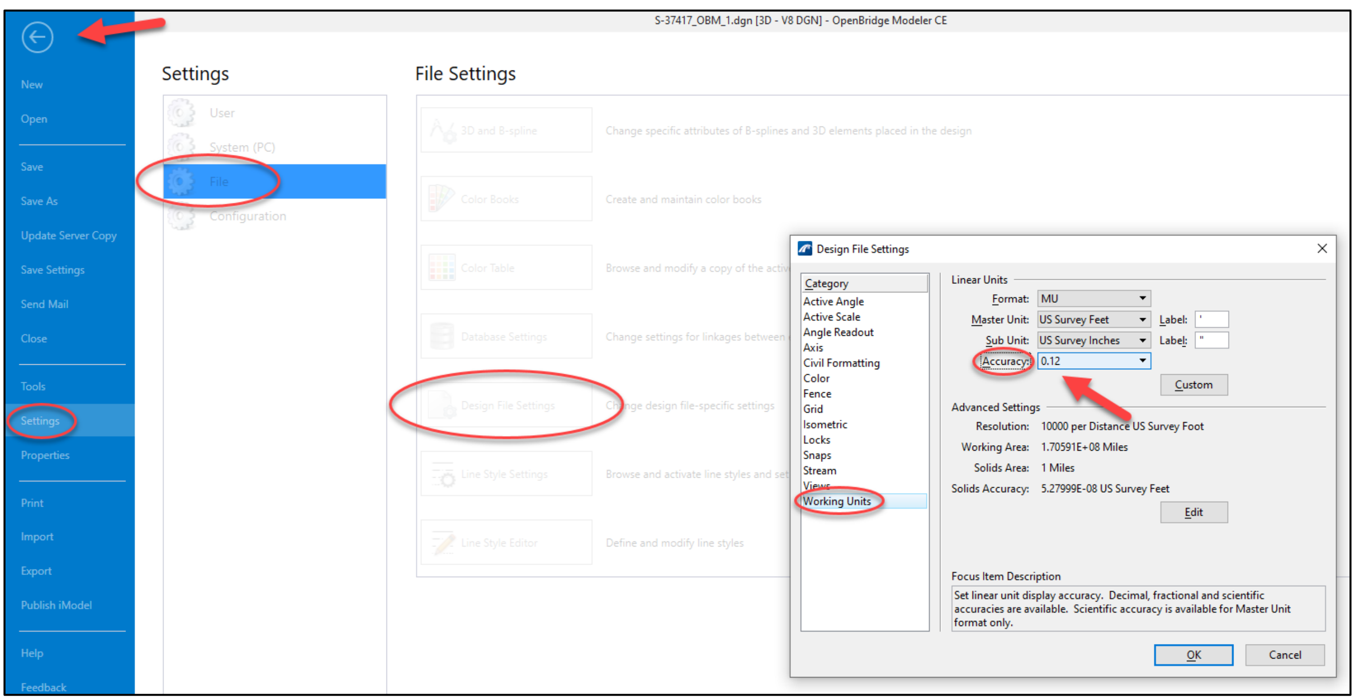


Figure 7.1-1 Changing Design File Settings for Reports

7.1.2 Deck Elevations

Several elevation reports can be generated with OBM. The first is the Deck Elevations Report located in the **Reports and Drawings > Bridge Reporting**. This is a helpful report that will generate the top of deck elevations based on parameters input by the user. The first prompt after selecting this report is to select the start and end SupportLines for the deck elevations. The reporting tool can only use the active bridge unit, so if there are multiple units or bridges in the same file, separate reports will be needed. After the SupportLines are selected, the **Deck Elevation Report** dialog box becomes visible.

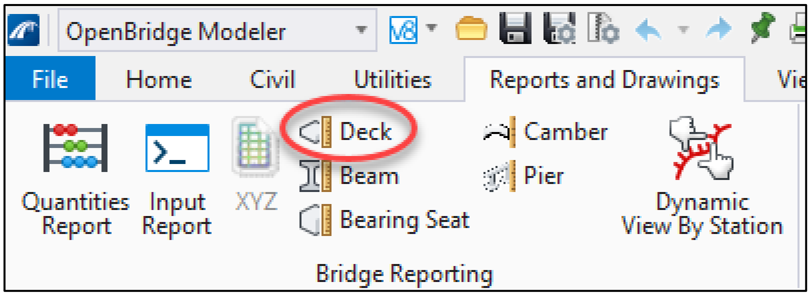


Figure 7.1-2 Deck Elevation Report Tool Location

Below are the inputs and parameters the user can modify and a detailed description of each.

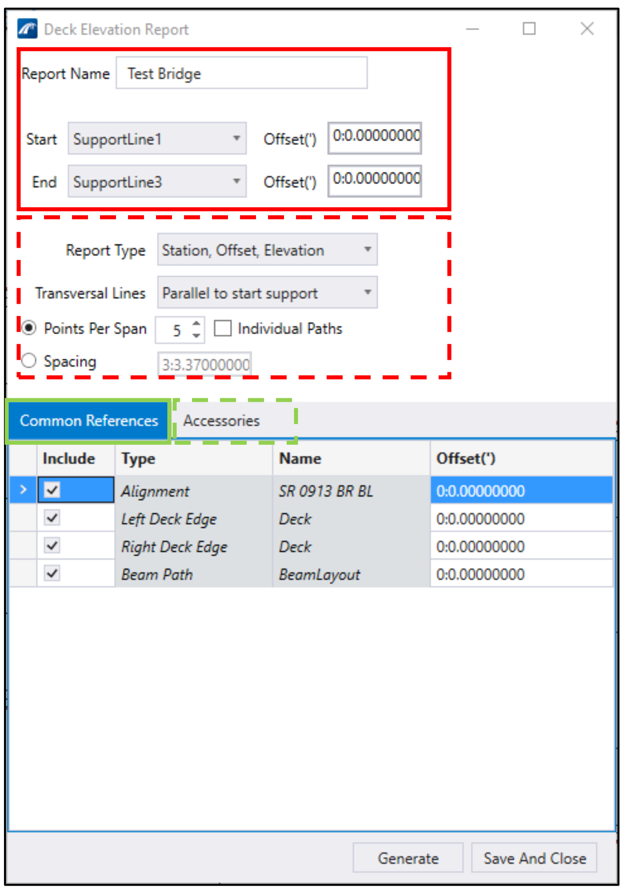


Figure 7.1-3 Deck Elevation Report Dialog Box

Solid Red Box – This section includes inputs for the Report Name and Start & End SupportLines and Offsets. This can be used to modify the SupportLines selections and to choose a starting point different from the

SupportLines. SupportLines are typically at the centerline of bearings and start and end of approach slabs, and the “Offsets” input can be used to start before or after these points (positive or negative inputs).

Dashed Red Box – These inputs provide additional reporting variables and formatting. The *Transversal Lines* input allows for points reported normal to the alignment or along the SupportLine skew. The number of elevations generated can be entered as points per span or an equal spacing between the start and end points. Additionally, the Report Type offers several formats and reporting options including the typical station, offset, and elevations; x,y,z coordinates; and a consolidated report option. The *Individual Paths* checkbox is only to be used for flared decks or splayed beam framing plans. For PennDOT projects, both the points per span and the spacing (10 ft intervals) are utilized per DM-4 PP 1.6.4.11(e), and the Report Type is set to Consolidated.

Solid Green Box – This selection input for **Common References** allows the user to select specific template points to report the deck elevations. The inputs include the alignments, deck edges, barriers (curb), and beam centerlines. Offsets can be added to any of these points to capture additional points such as beam flange edges as commonly done for PennDOT projects. Select the checkboxes for the desired points to include them in the report. For PennDOT projects, at least two reports are required to capture all desired points for the 10’ intervals and the 10^{th} points of girders. If additional offsets are needed (i.e., left and right beam flange tips), additional reports are required.

Tips and Tricks: To have elevations reported at exact round stations, at 10ft intervals, offsets from the start and end SupportLines are likely required.

Dashed Green Box – The *Accessories* input allows the user to select additional elements in the model to include in the deck elevation report. This input is not commonly used for typical bridges. (FDOT, 2022)

The resulting report is generated in the Print Preview window. The window used to select the SupportLines will also show the preview of the elevation points with orange circles.

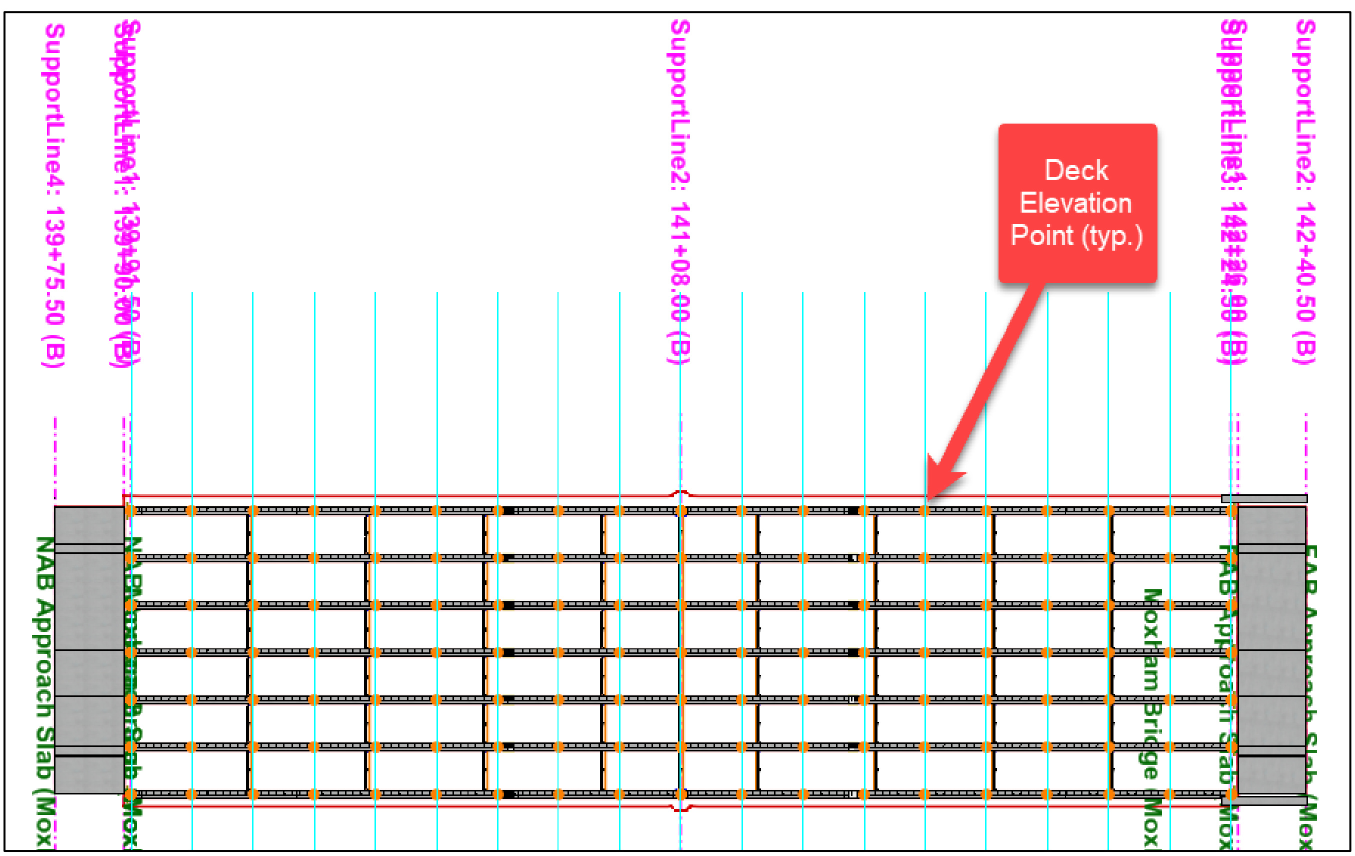


Figure 7.1-4 Preview of deck elevations along girder 10^{th} points; locations indicated with orange circles.

The Print Preview window contains several formatting options including scaling the report document size, margin size and the page orientation.

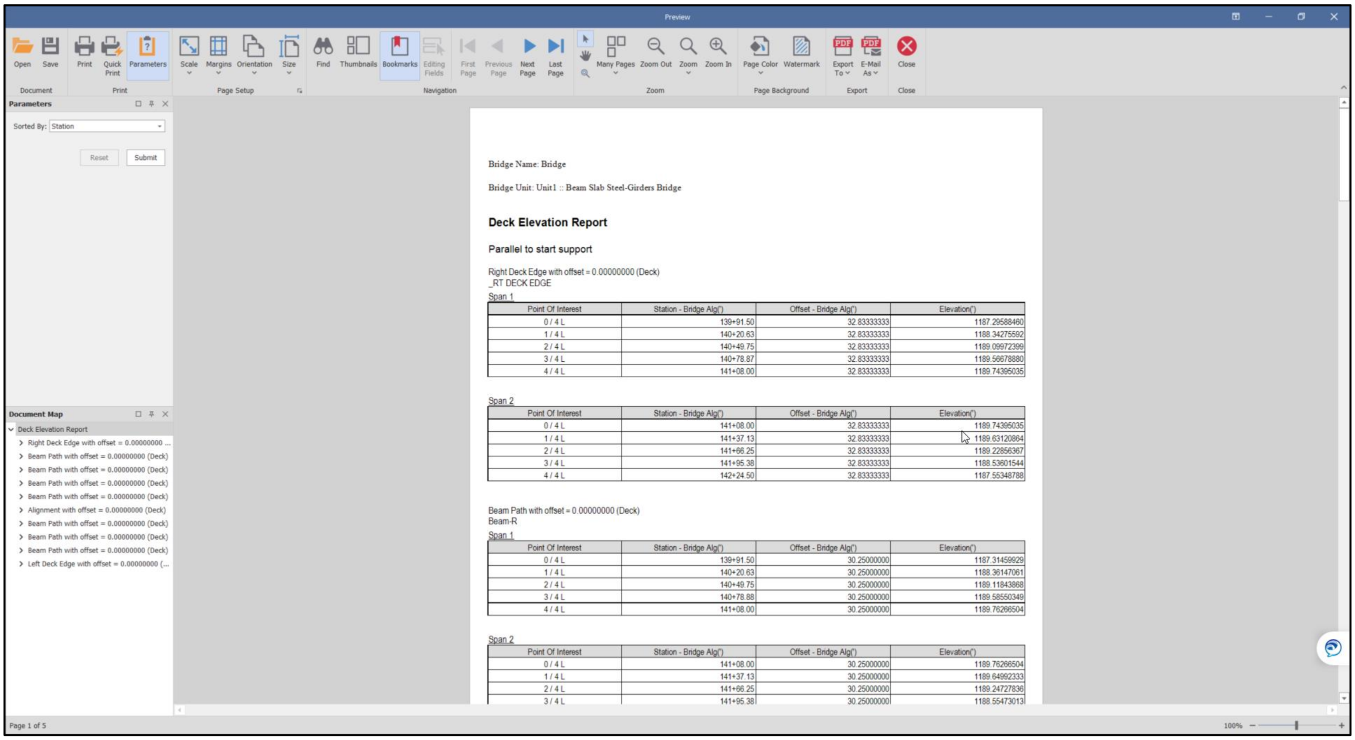


Figure 7.1-5 Report Preview Window

The reports can then be exported to a PDF, Excel, text, or another file format for further consolidation and modifications for adding to the bridge plans or for digital delivery per the Modeling Standard documents.

Figure 7.1-6 Export Report File Format options

Note: Initially, when a report is exported from the Preview Window, it must be saved on to a local drive. Afterwards, the file may be uploaded to ProjectWise or another document management system as required. As of the writing of this manual, exported files cannot be directly saved to a ProjectWise directory.

7.1.3 Bearing Seat Elevations

Another useful reporting tool is the Bearing Seat Elevation Report.

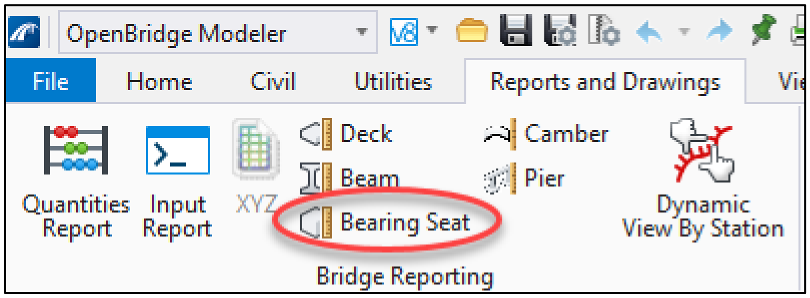


Figure 7.1-7 Bearing Seat Report Tool Location

The bearing seat elevation for each beam at each bearing line, as well as information for beveled plates, can be obtained via the ‘Bearing Seats and Grout Pads or Bevel Plates Report’.

For a project where prestressed concrete beams will utilize a beam end dap to accommodate differential slope between the bottom of the beam and the bearing seat, the user needs to check and confirm the reported bearing seat elevations. As discussed previously in Section 6.10.1, OBM does not currently have the functionality to directly model beam end daps. The user must manually manipulate the bearing height to account for the dap thickness. See Section 6.21.1 for more details.

Bridge Name: Moxham Bridge

Bridge Unit: Moxham Bridge :: Beam Slab Steel-Girders Bridge

Bearing Seats and Grout Pads or Bevel Plates Report

Moxham Bridge

Bearing Seats

Elevation

Support Line Name	Bearing Line	Girder1(')	Girder2(')	Girder3(')	Girder4(')	Girder5(')	Girder6(')	Girder7(')
Abutment1	None	Beam-L	Beam-2	Beam-3	Beam-4	Beam-5	Beam-6	Beam-R
		1180.15	1182.76	1182.96	1183.14	1182.94	1182.74	1180.14
Abutment2	None	Beam-L	Beam-2	Beam-3	Beam-4	Beam-5	Beam-6	Beam-R
		1180.47	1183.01	1183.21	1183.39	1183.19	1182.99	1180.46

Figure 7.1-8 Example of Bearing Seat Report Output

This report is beneficial but only provides the elevation at the intersection of the centerline of beam and the centerline of bearing. If the bearing seat is level, then this elevation will apply to the entire bearing seat surface. However, the software currently does not have the capability of reporting out the corner elevations of a sloped bearing seat. The Bearing Seat Report output could be exported into a separate software package, such as Microsoft Excel, to use as a starting point for computing corner elevations of a sloped bearing seat.

7.1.4 Quantities

The Quantities Report tool divides the quantities for superstructure, substructure, and miscellaneous categories. Unit costs can also be input into the **Material Library** to provide preliminary cost estimates for the bridge elements.

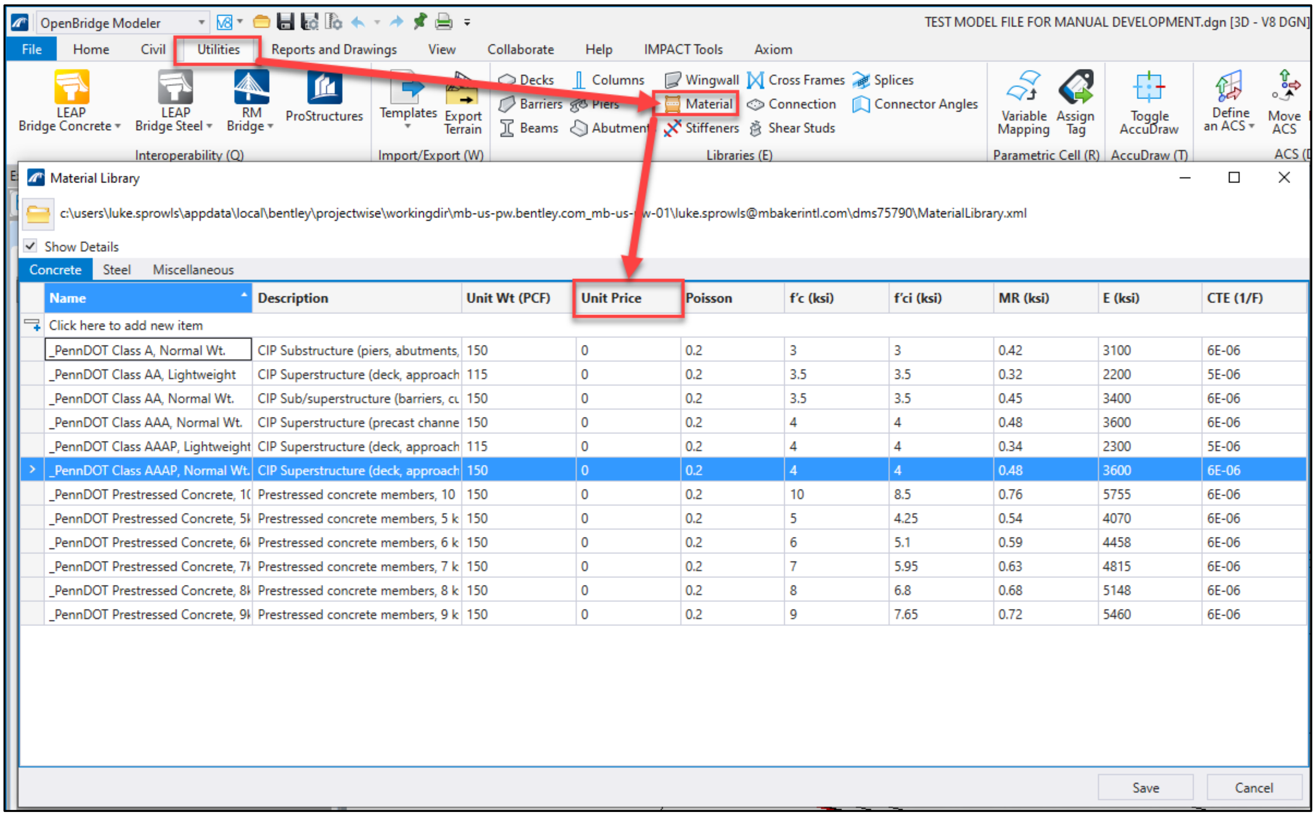


Figure 7.1-9 Editing Material Unit Prices

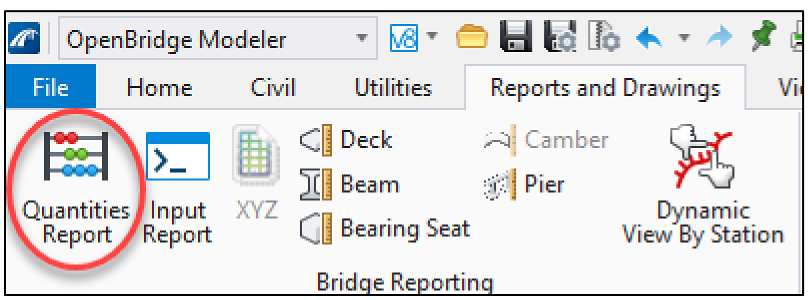
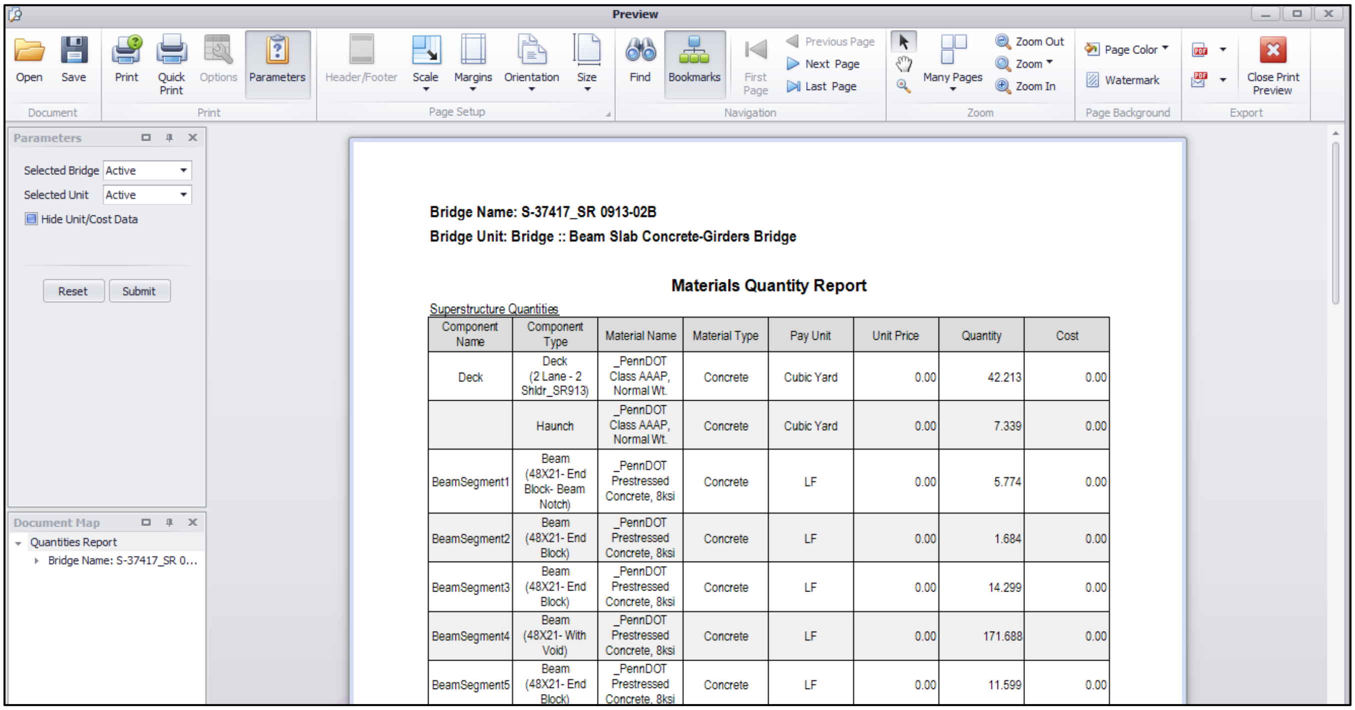


Figure 7.1-10 Quantities Report Tool Location



Component Name	Component Type	Material Name	Material Type	Pay Unit	Unit Price	Quantity	Cost
Deck	Deck (2 Lane - 2 Shldr_SR913)	_PennDOT Class AAAP, Normal Wt.	Concrete	Cubic Yard	0.00	42.213	0.00
	Haunch	_PennDOT Class AAAP, Normal Wt.	Concrete	Cubic Yard	0.00	7.339	0.00
BeamSegment1	Beam (48X21- End Block- Beam Notch)	_PennDOT Prestressed Concrete, 8ksi	Concrete	LF	0.00	5.774	0.00
BeamSegment2	Beam (48X21- End Block)	_PennDOT Prestressed Concrete, 8ksi	Concrete	LF	0.00	1.684	0.00
BeamSegment3	Beam (48X21- End Block)	_PennDOT Prestressed Concrete, 8ksi	Concrete	LF	0.00	14.299	0.00
BeamSegment4	Beam (48X21- With Void)	_PennDOT Prestressed Concrete, 8ksi	Concrete	LF	0.00	171.688	0.00
BeamSegment5	Beam (48X21- End Block)	_PennDOT Prestressed Concrete, 8ksi	Concrete	LF	0.00	11.599	0.00

Figure 7.1-11 Example of Quantities Report for a Prestressed Superstructure (no unit costs provided)

After the “Submit” button is clicked, the results are visible. Values from this report only reflect the OBM recognized solids. Any changes to elements that have been made outside of the OBM specific tools (i.e., beyond the Base model), will not be reflected in these reports. Therefore, the reports will likely have the most use in preliminary design, and the user should verify all output.

7.1.4.1.1 Quantities by Element Property

An alternate method for obtaining quantities from the model is selecting specific element properties. This is a more robust and flexible method as any solid or surface element can be selected, and the volume and surface area will be visible as a property. When selecting an OBM element, ensure that the individual components are selected (footings, walls, etc.), and the volume will be reported under the **Solid** category.

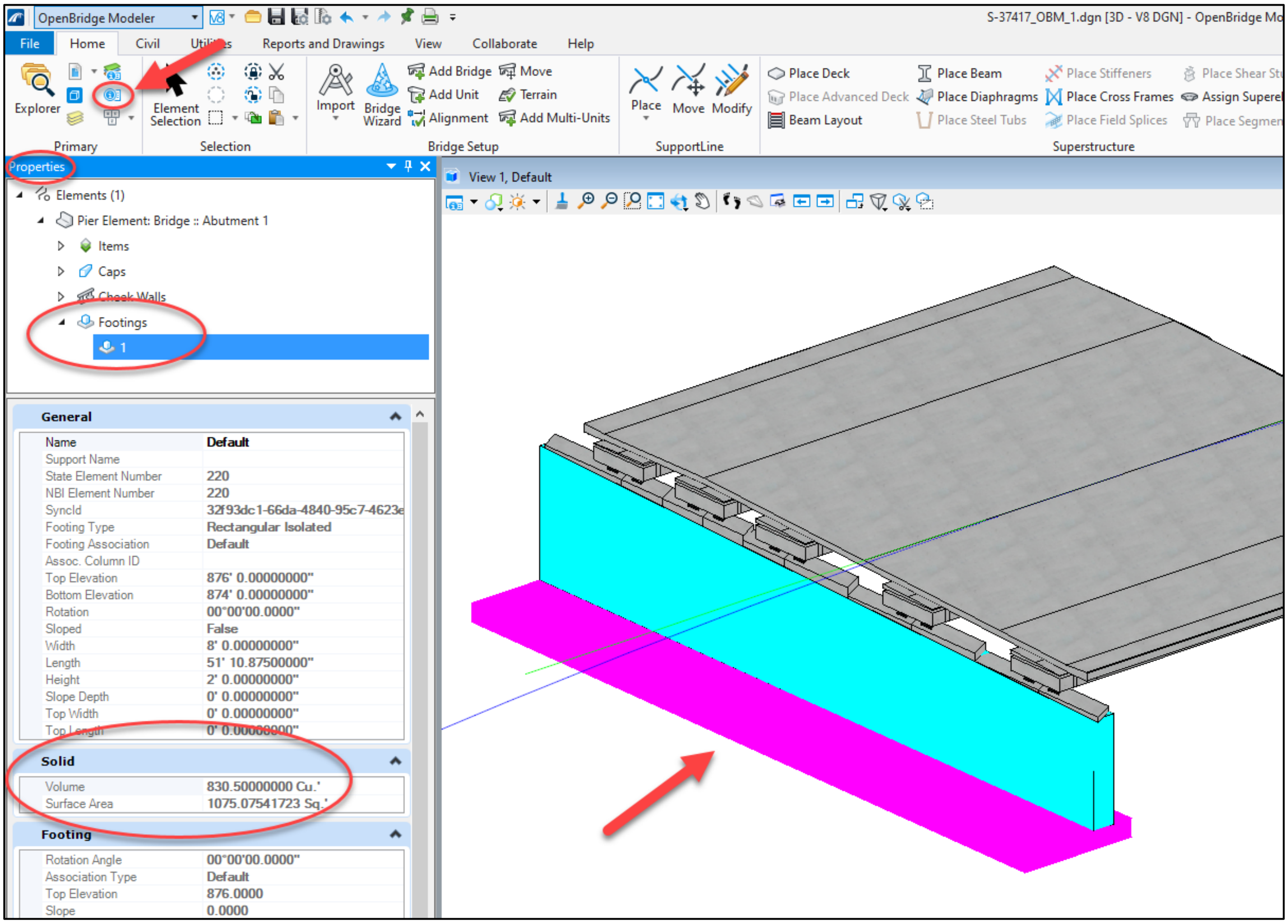


Figure 7.1-12 Example of Volume Quantities from Element Properties

This method will provide volumes and surface areas for any solid or surface, including elements that have been modified in the Refined model condition.

7.2 DRAWINGS

When setting up views, annotating, and creating drawings, the user should switch to the **Drawing Workflow**, unless noted otherwise. There are multiple ways to create views for drawings. In all cases, a 2D drawing is created from the model where an annotation scale is selected, and annotations are applied. The 2D model can then be referenced into a 2D sheet model where the titleblock and border can be attached. The user can decide which method of creating views is appropriate for their specific situation and can adjust annotation scale dynamically.

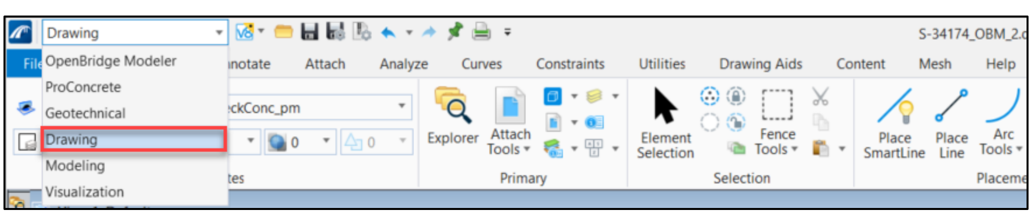


Figure 7.2-1 Selecting Drawing Workflow

7.2.1 Plan Views

Plan views can be created using several methods. The recommended method is to utilize **the Place Named Boundary** tool. The other method for setting up plan views is the **Place Plan Callout.**

7.2.1.1 Place Named Boundary

The **Place Named Boundary** tool can be found in the Named Boundaries Panel of the View Tab (**View Named Boundaries > Place Named Boundary**).

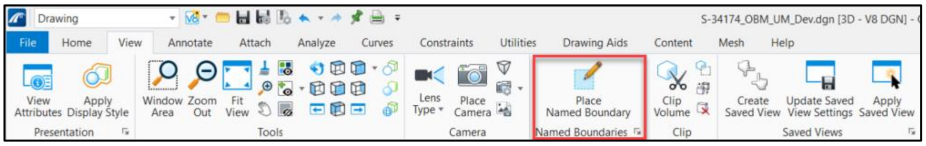


Figure 7.2-2 Place Named Boundary Tool

After selecting **Place Named Boundary**, the user may create the named boundary by several methods including Civil Plan, Civil Plan by Element, By Element, 2-points, Polygon or Length.

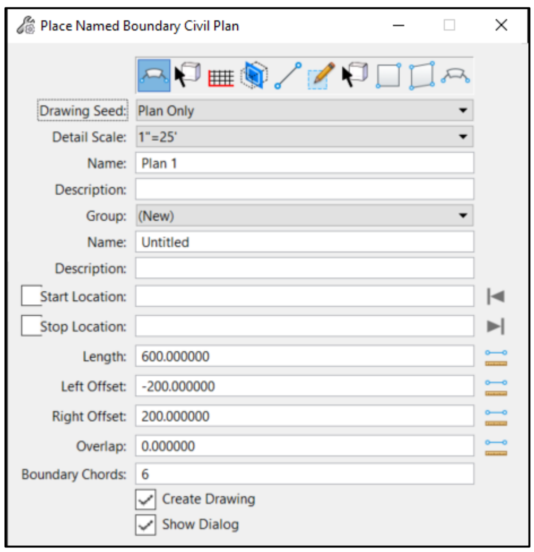


Figure 7.2-3 Place Named Boundary Dialog

Any of the included options within the **Place Named Boundary** tool can be used to create named boundaries, each offering different levels of control over the view extents and how they are modified. The most controlled named boundary for a standard plan view is the **Civil Plan**. This method allows the named boundary to be controlled by a **Start Locations** and a **Stop Location** and/or a **Length** after an alignment is selected. If the **Start** and **Stop Locations** are defined for the view, but the length is too long to see clearly on a single sheet or a different scale is desired, the user can define a **Length** and an **Overlap** value to place multiple named boundaries along the alignment to split the plan views up onto separate sheets.

7.2.1.2 Place Plan View Callout

The **Place Plan Callout** tool can be found in the Detailing panel under the Annotate tab (**Drawing Workflow > Annotate > Detailing > Place Plan Callout**). This tool is similar to the **Place Section Callout** tool, except can only be placed in a front, back, or side view with the section pointing down (towards Z=0) to create a plan view.

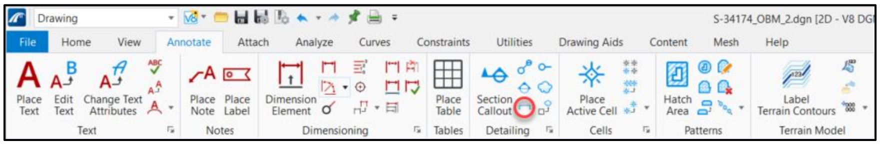


Figure 7.2-4 Place Plan Callout Tool

When the **Place Plan Callout** is activated, the user must be in a front, back, or side view and pick Point 1 at the beginning of the plan view limits, pick Point 2 at the end of the plan view limits, and move the cursor down to the desired depth of the clip volume then click Point 3.

Note: if the ACS is not set up with the X plane parallel to the alignment, the Y plane perpendicular to the alignment and the Z plane truly vertical, as discussed in Section 4, the plan view will be skewed and will not display correctly.

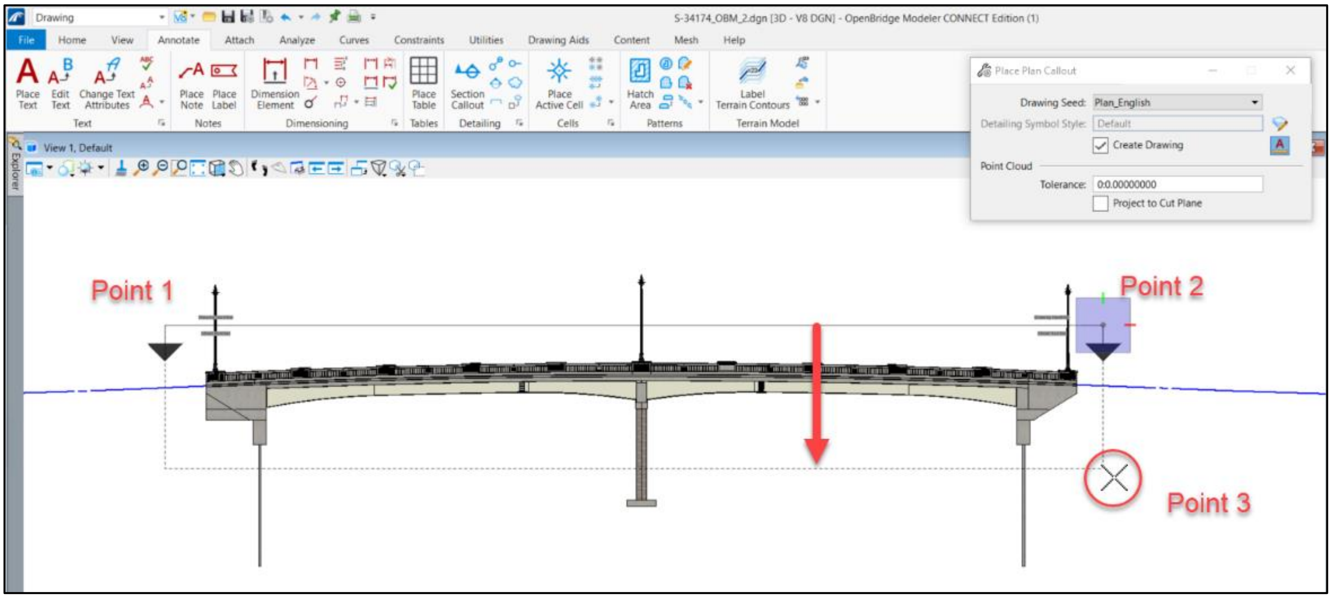


Figure 7.2-5 Placing Plan Callout

After placing the **Plan Callout**, a dialog appears to set up the drawing and the sheet. First, the user will name the plan view drawing and select the **Drawing Seed** file. Then the user will ensure the **Create Drawing Model** box is checked and set a desired annotation scale. This annotation scale can be modified in the drawing model after it is created using the **Annotation Scale** dropdown in the **Utilities Tab** (**Utilities > Drawing Scale > Annotation Scale**). The user can select whether the visible edges are dynamic or cached, which determines if the references are updated automatically (dynamic) or updated manually (cached). It is at the user's discretion to set up a sheet at this time or a sheet can be created later, and the drawings/views referenced into it.

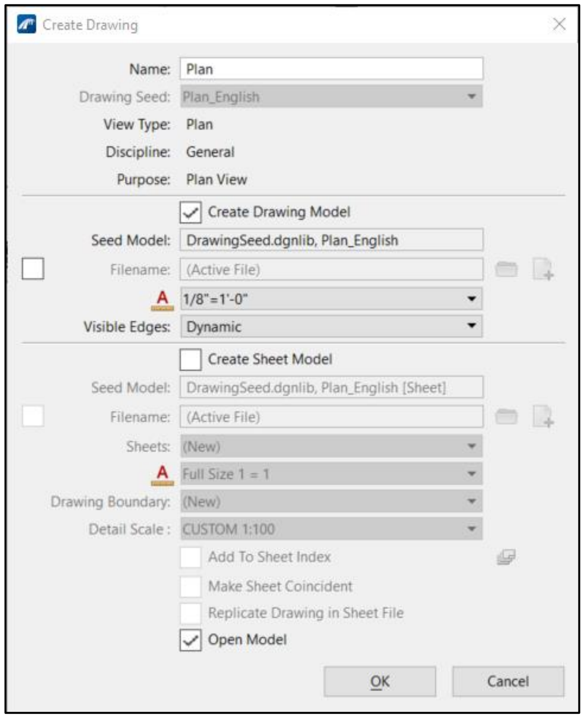


Figure 7.2-6 Place Plan Callout Dialog

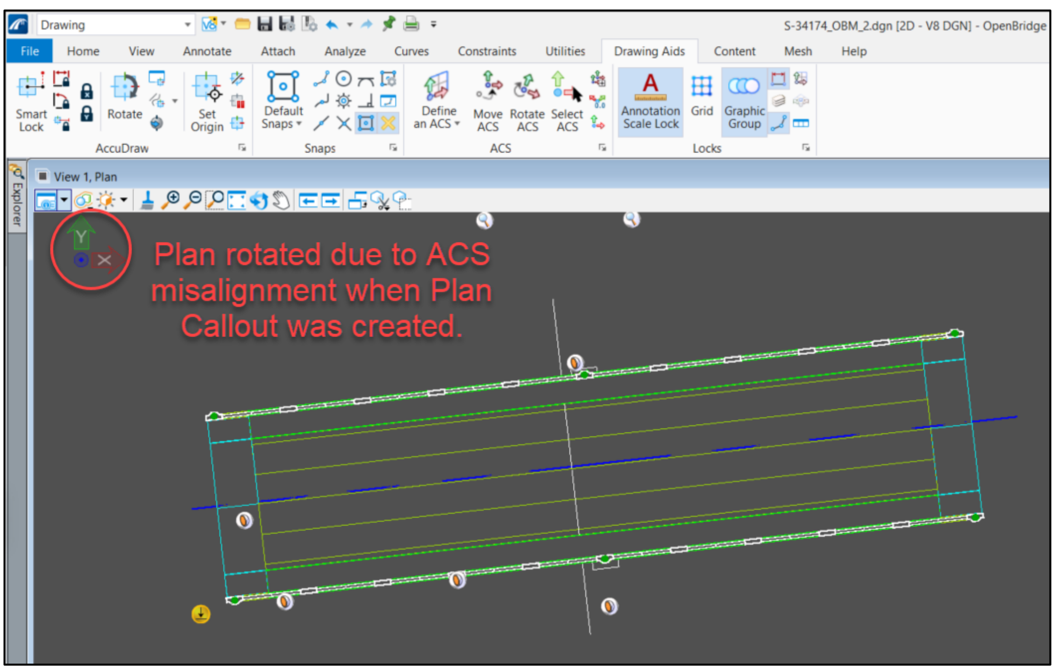


Figure 7.2-7 Plan Drawing displaying ACS Misalignment

7.2.2 Elevation Views

Elevation views can be developed with ease using OBM's **Elevation Callout** tool.

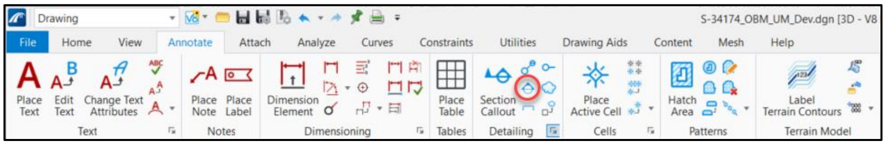


Figure 7.2-8 Elevation Callout Tool Location

When the **Elevation Callout** tool is activated, an elevation parameter dialog box will prompt the user to select the **Drawing Seed** and the **Height**. The user must be in a top view and will pick Point 1 to place where the elevation view is located. The user will notice the elevation callout is placed and rotating freely with the position of the cursor. The user will then pick Point 2 to set the direction of the elevation view.

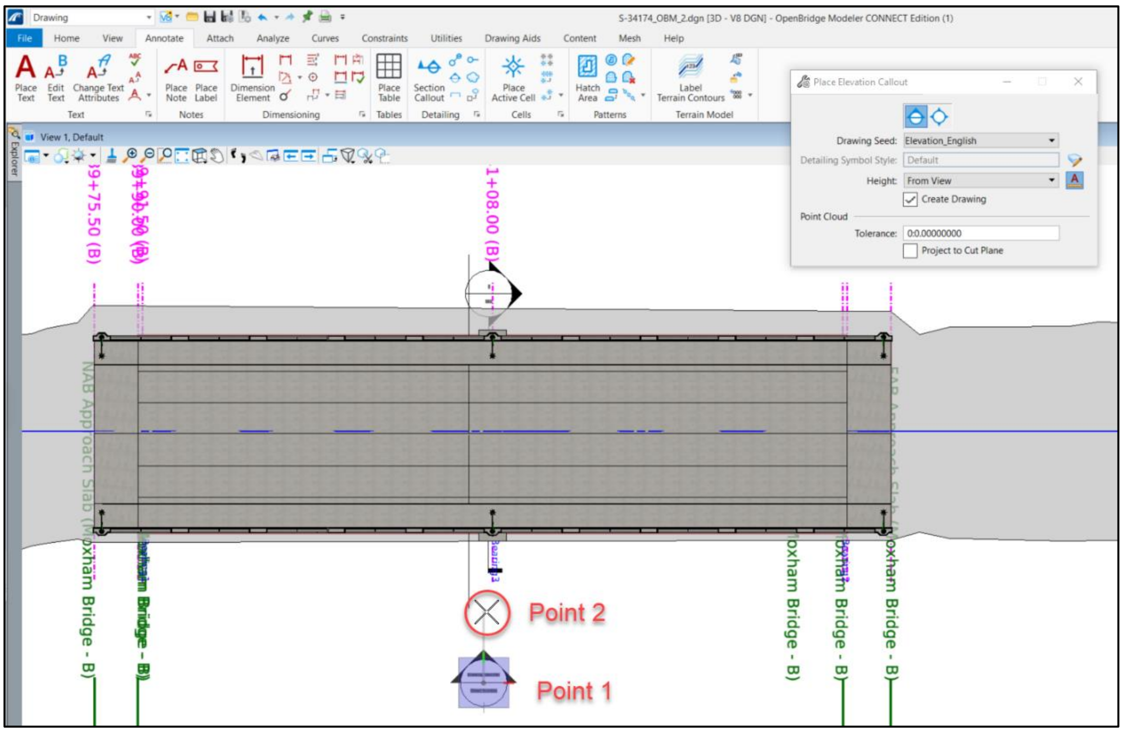


Figure 7.2-9 Placing Elevation Callout

Just like the **Plan Callout** tool, after placing the **Elevation Callout**, a dialog appears to set up the drawing and the sheet. First, the user will name the plan view drawing and select the Drawing Seed file. Then the user will ensure the **Create Drawing Model** box is checked and set a desired annotation scale. This annotation scale can be modified in the drawing model after it is created. The user can select whether the visible edges are dynamic or cached. It is at the user’s discretion to set up a sheet at this time or a sheet can be created later, and the drawings/views referenced into it.

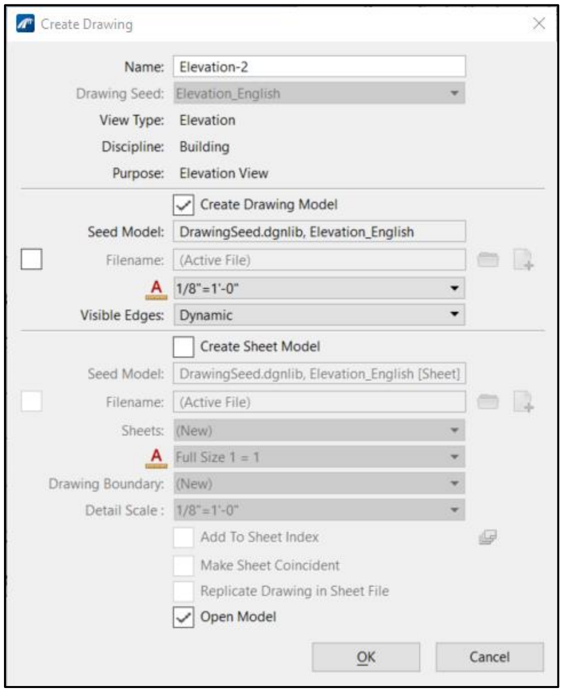


Figure 7.2-10 Place Elevation Callout Dialog

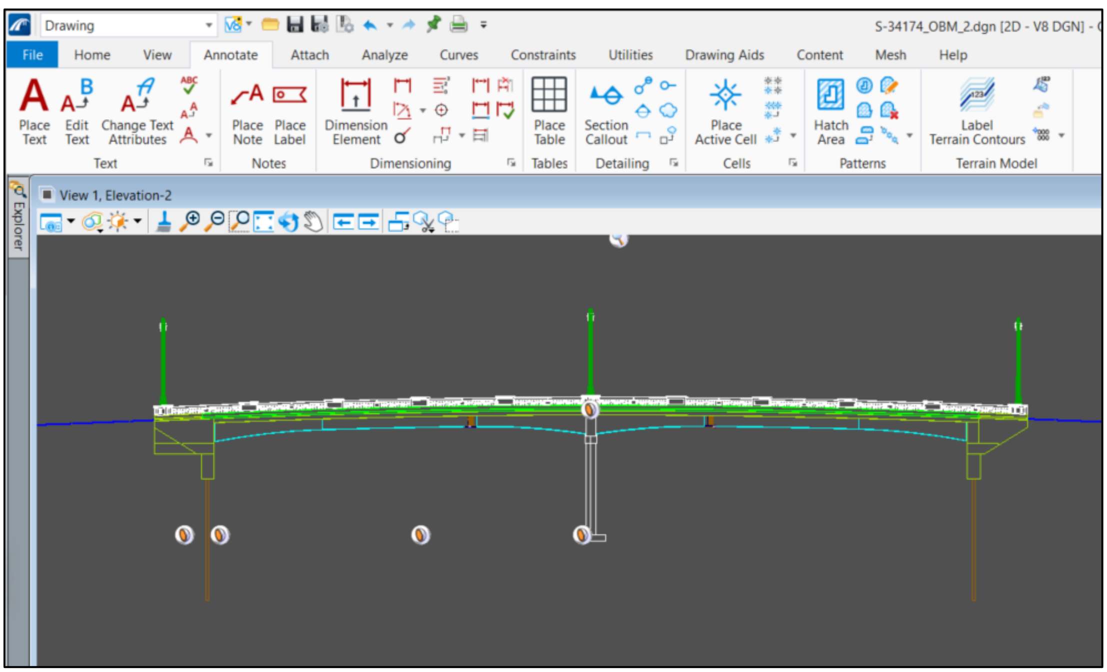


Figure 7.2-11 Elevation Drawing Model

7.2.3 Section Views

Section Views can be created in a couple of ways, depending on what the user wishes to achieve from the section. If the user is interested in developing a typical section of the bridge superstructure, the user can navigate to **Analysis and Reporting > Drawings > Create Superstructure Cross-section Drawing** tool in the OpenBridge Modeler Workflow. If the goal is to show a section at a specific location for a detail, such as a barrier section, wingwall section, cross frame view, etc., the **Place Section Callout** tool is recommended.

7.2.3.1 Create Superstructure Cross-section Drawing

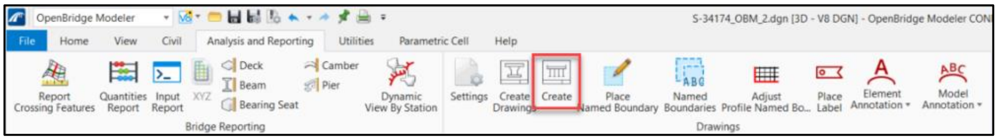


Figure 7.2-12 Create Superstructure Cross-section Drawing Tool

When executed, the user selects the alignment, sets a station, and moves the cursor to define the width of the section. When the cursor is moved to the left of the alignment, looking stations ahead, the direction of the section is looking stations back. When the cursor is moved to the right of the alignment, looking stations ahead, the section is cut looking stations ahead, as indicated by the blue arrow.

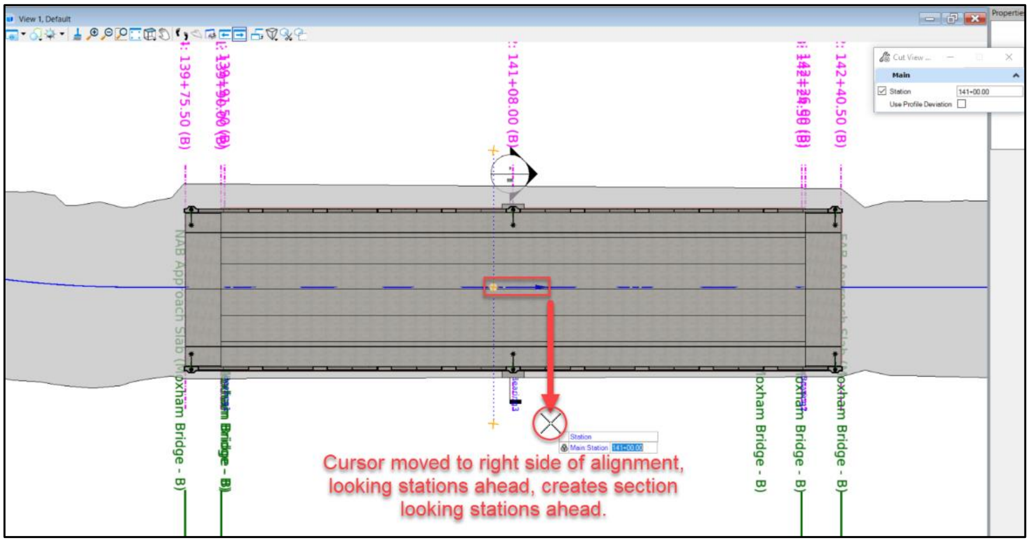


Figure 7.2-13 Creating Superstructure Cross-section Drawing

Just like the **Plan** and **Elevation Callout** tools, after placing the Superstructure Cross-section, a dialog appears to set up the drawing and the sheet. First, the user will name the cross section drawing and select the **Drawing Seed** file. Then the user will ensure the **Create Drawing Model** box is checked and set a desired annotation scale. This annotation scale can be modified in the drawing model after it is created. The user can then select whether the visible edges are dynamic or cached. It is at the user's discretion to set up a sheet at this time or a sheet can be created later, and the drawings/views referenced into it.

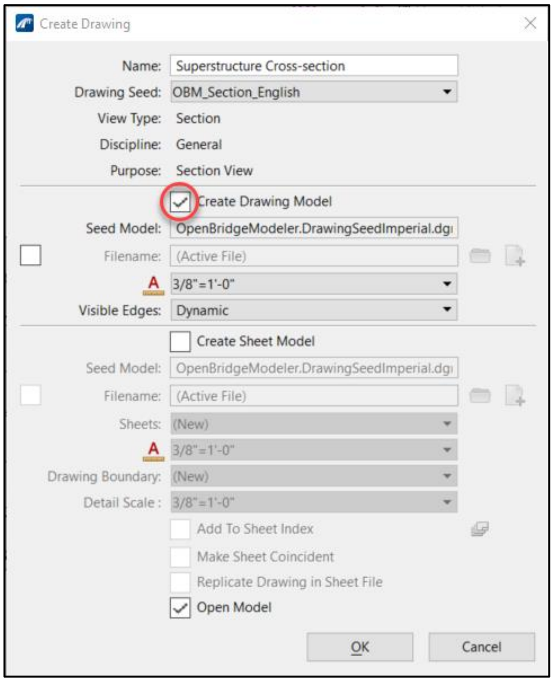


Figure 7.2-14 Create Superstructure Cross-section Dialog

7.2.3.2 Place Section Callout

The **Place Section Callout** is in the **Drawing Workflow > Annotate > Detailing Panel**. Sections can be created from any view perspective and the limits of the section adjusted at any time.

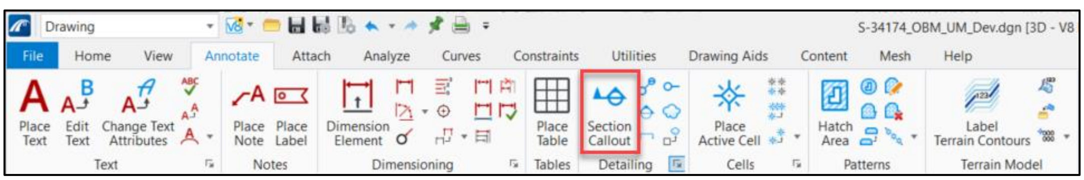


Figure 7.2-15 Place Section Callout Tool

After selecting the **Place Section Callout** tool, the user is prompted with a dialog box to select the *Drawing Seed* and the section *Height*. When Section parameters are set, the user can click the first point where the section is to be cut, the second point to create the cutting plane, and lastly move the cursor in the direction in which the section is to be facing and click at the desired depth of the section.

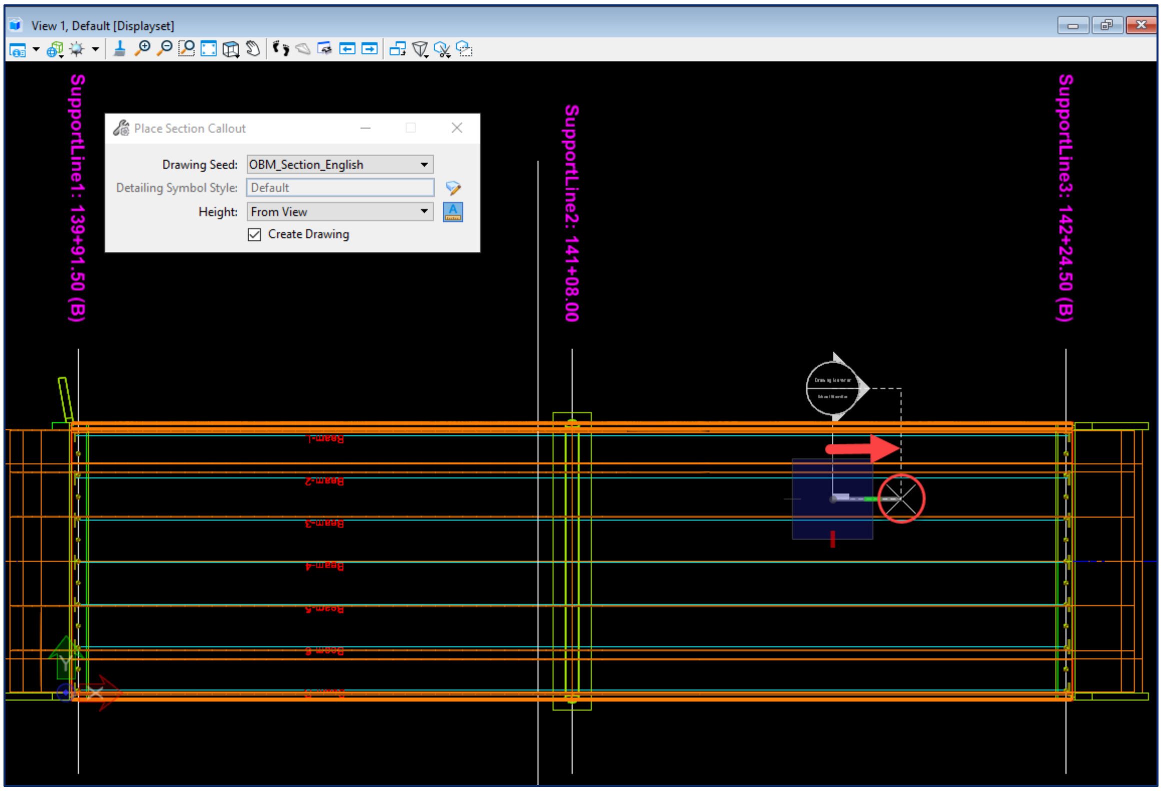


Figure 7.2-16 Place Section Callout

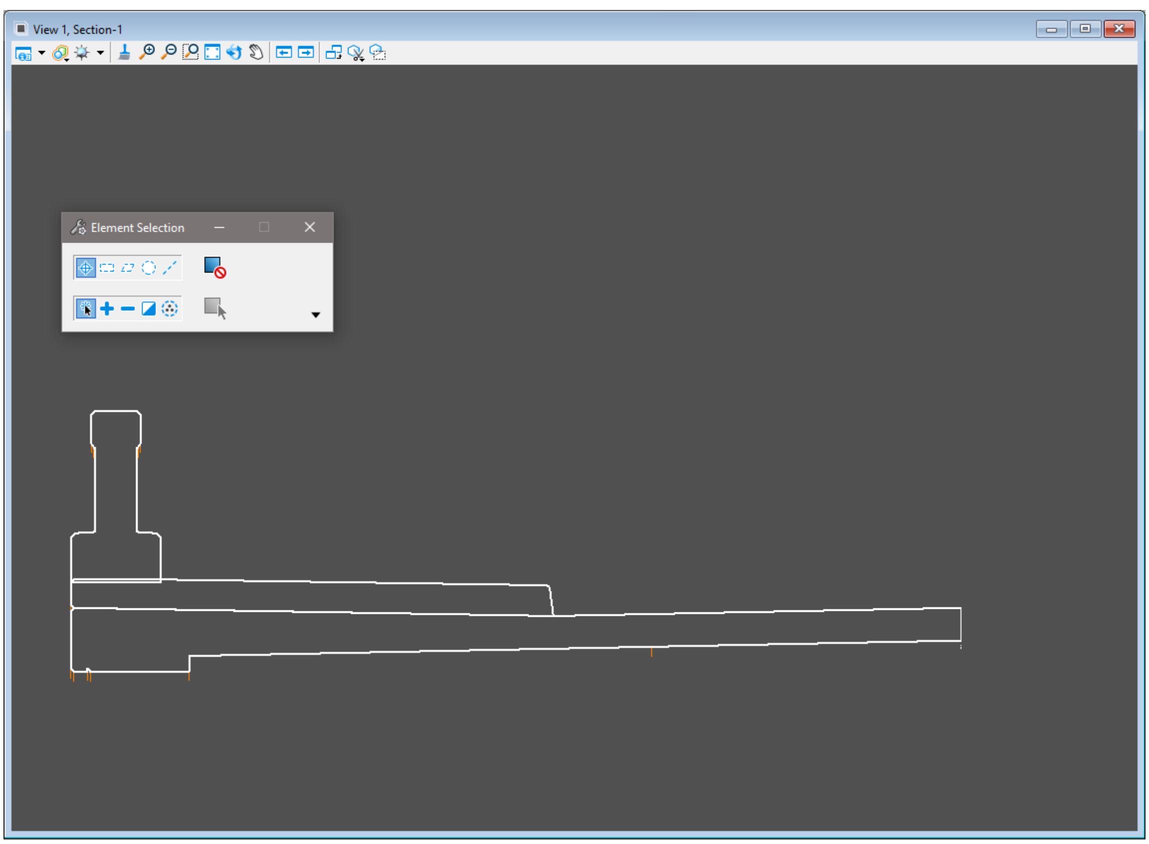


Figure 7.2-17 Section View

7.2.4 3D/Isometric Views

The user can save a specific view of the 3D model from any perspective using the **Rotate View** tool, or the user can select one of the preset views available in the **View Rotation** tool in OpenBridge Modeler. For more information regarding view setup, refer to Chapter 4.

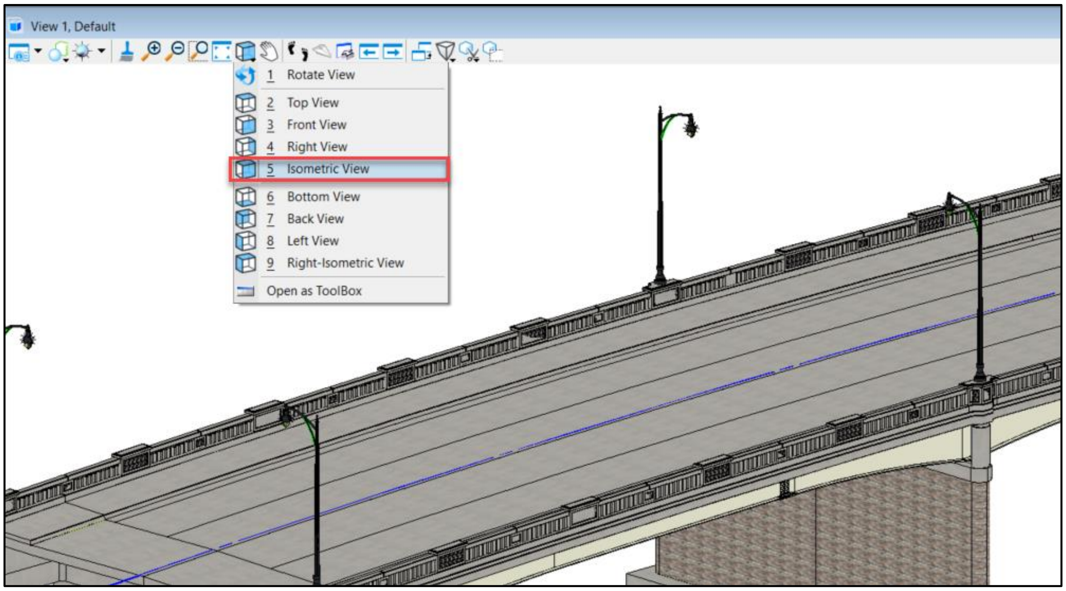


Figure 7.2-18 Isometric View

To create a view of the model that retains the settings and perspective in which it was created, the user will find the **Create Saved View** tool in the Saved Views pane in the View ribbon.

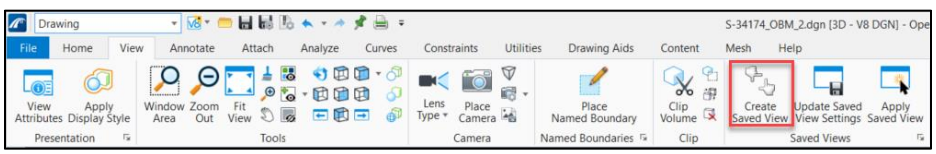


Figure 7.2-19 Create Saved View Tool

A **Saved View** is essentially a screenshot of a region in a model view and includes the level display for both the active model and references, the clip volume, and other view attributes like display styles. **Saved Views** can be created in 2D or 3D views and view settings can be modified after the saved view is created. A saved view can be created by the method of 2 Points (placing rectangle by clicking opposite corners) or by view (the extents of the view window). After selecting the method, view type, name and description, you can choose whether a drawing is to be created where it can be annotated, and if the limits of the saved view are associative.

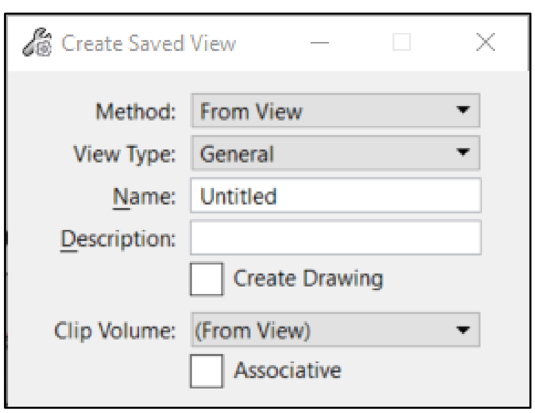


Figure 7.2-20   Create Saved View Dialog

7.3   EXPORTING TO LEAP STRUCTURAL ANALYSIS SOFTWARE

The process for exporting to LBC and LBS Models generated in OBM can be transferred to LBC or LBS software's for analysis. Navigate to **Utilities > LEAP Bridge Concrete** or **LEAP Bridge Steel > Send To** to send for analysis. Though this process is limited at this time, it is still the recommended workflow if LBC or LBS will be used for the superstructure analysis of the bridge.

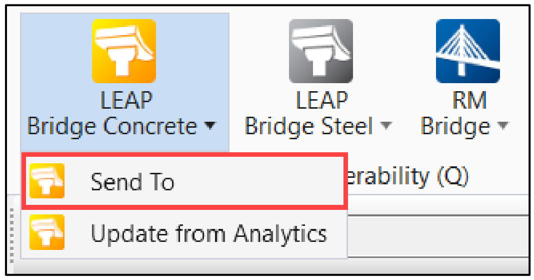


Figure 7.3-1   Send To LBC Tool (LBS Similar)

7.3.1   Data Transfer

After sending data from OBM to the LEAP software programs (LBC and LBS) for analysis, a data transfer message will be displayed informing the user of the successful transfer and outlining the limitations of the data transfer. The user can select the "Model Transfer Report" box to see the full report. Once **OK** is selected in this menu, the selected LEAP analysis software will be automatically opened, and another data transfer message will appear in LEAP. From this point the analysis procedure can continue entirely in LEAP. For help with the analysis procedure, refer to the PennDOT User's Guide for LEAP Bridge Concrete and LEAP Bridge Steel. The user is responsible for checking all the transferred data for accuracy and each step of the analysis process will still need to be completed to verify the bridge geometry.

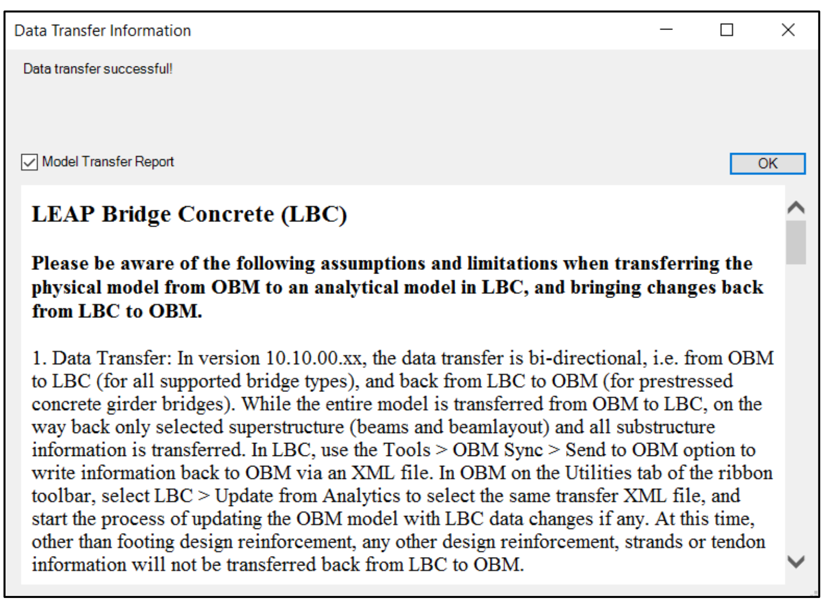


Figure 7.3-2   Data Transfer Information in OBM

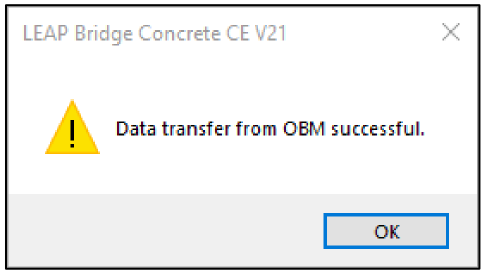


Figure 7.3-3 Data Transfer Message Window in LBC (LBS Similar)

If using LBC, after transferring data from OBM a message may prompt the user to define a custom beam section and the user should select the appropriate beam type and section properties before proceeding. The recommended workflow in LBC at this point would be to select the equivalent beam section from the LBC standard beam library. This is done from **Superstructure > Precast/Prestressed Girder** and then once in that window, the user can update the **Beam ID** in the **Geometry** tab. If this step is not taken, the user will need to manually define available strand locations for analysis.

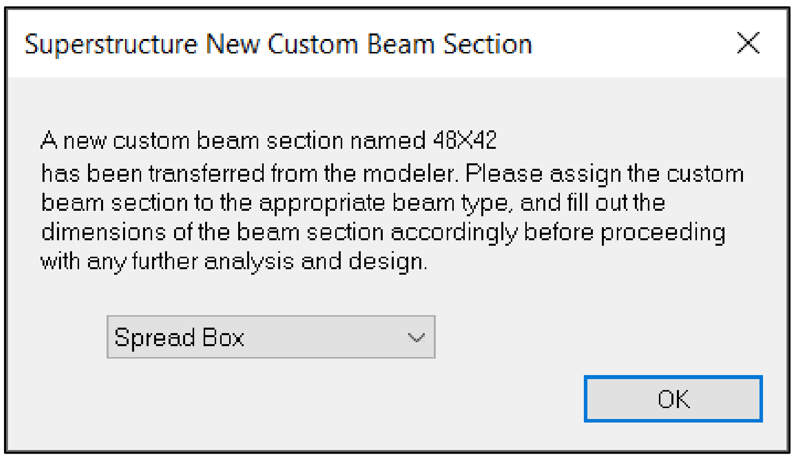


Figure 7.3-4 Custom Beam Type

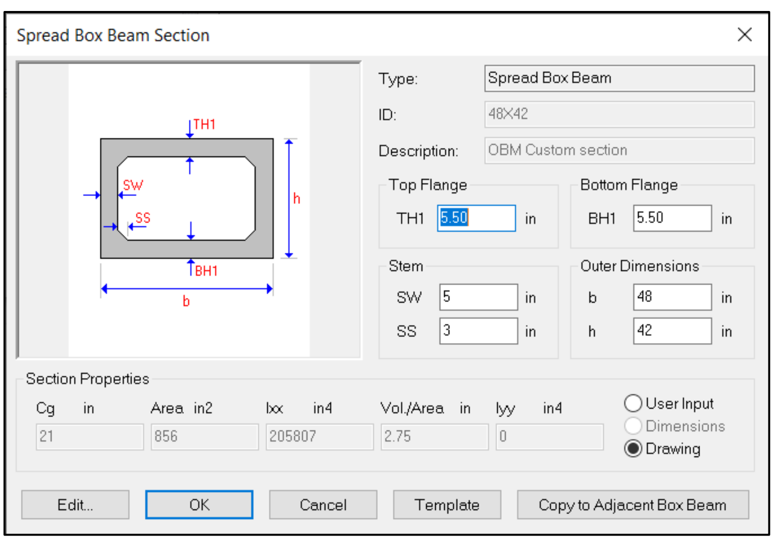


Figure 7.3-5 Custom Beam Section Properties

	Beam No	Beam ID
▸	1	PA42-48
	2	48X42
	3	48X42
	4	48X42

Figure 7.3-6 Selecting an Equivalent Standard PA Beam Section

Also, if a bridge is modeled with a beam notch detail (defining more than one template along the length of the member) or similar details, these details are not supported by the LEAP software. The user will be prompted to select one template to be defined along the entire length of the member.

> 5. Beam Layout: LBC only supports prestressed beams spanning between supports. End blocks modeled in OBM with different sections will not be transferred to LBC. Beam Layout (including spacing of beams) changes in LBC can be transferred back to OBM. User will have an opportunity to view and accept or reject changes before coming back to OBM.

Figure 7.3-7 LBC Assumption and Limitation Message

Much of the information generated in an OBM model can be transferred to LEAP. For example, OBM elements that can be transferred to LEAP are decks, beams, and girders with one defined template along the entire span length, abutments, diaphragms, and cross frames.

Examples of items that cannot be transferred into LEAP include wingwalls, beams and girders with multiple defined templates along the length of the member, and barriers depending on the template.

The user should carefully review the limitations in Section 2.5.2, as well as the entire structure after transferring to LEAP. It is common for items to be slightly different (stations slightly off, diaphragms not in the correct location, etc.) than what was generated in OBM. Some modifications to the structure after transfer to LEAP may be required.

Likely not all the geometric features of the bridge will appear the same in LEAP as they were modeled in OBM. The user should ensure that an acceptable **Level of Development** is present in LEAP such that the correct engineering intent is being utilized for analysis, but it is not critical for the details of the visual model in OBM and LEAP to align perfectly. Common errors in the display of elements in LEAP include misplaced or missing barriers, removed skew from the ends of beams, and incorrect details.

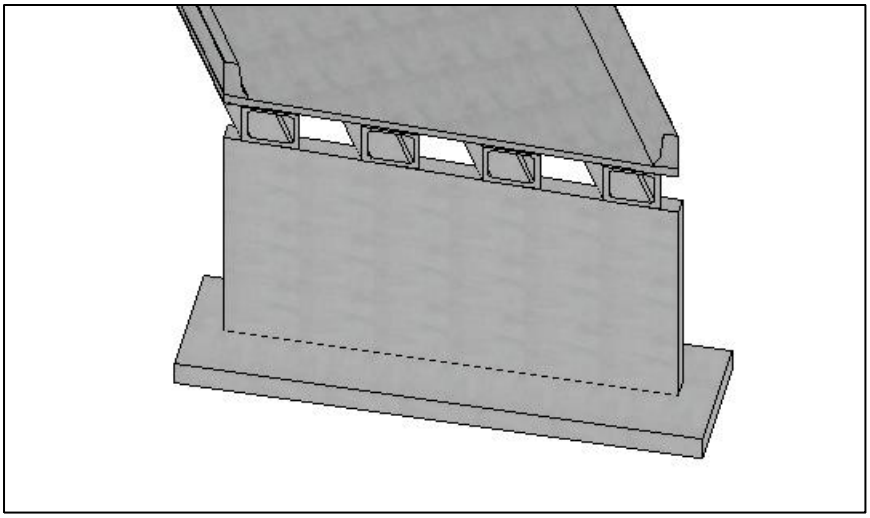


Figure 7.3-8 Skewed Beam Ends in OBM

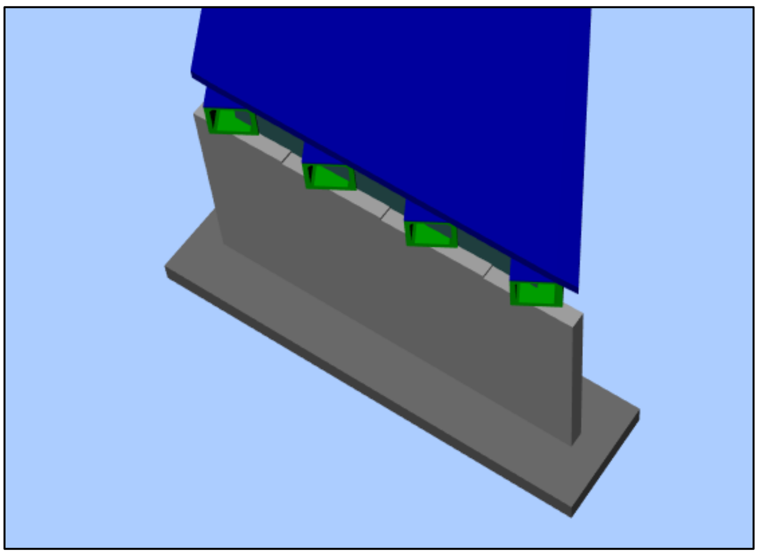


Figure 7.3-9 Removed Skew from Beams Ends after Export to LBC

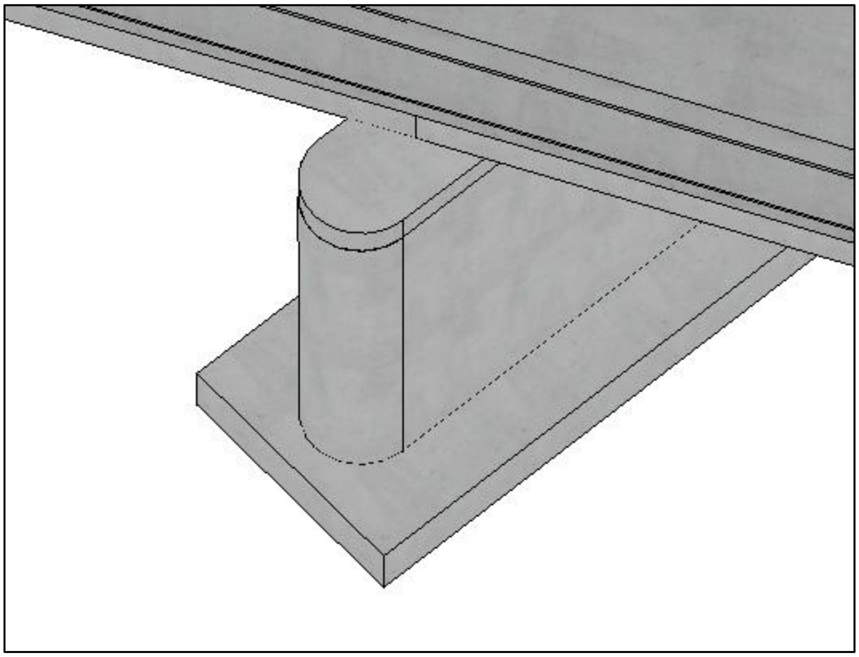


Figure 7.3-10 Pier Cap in OBM

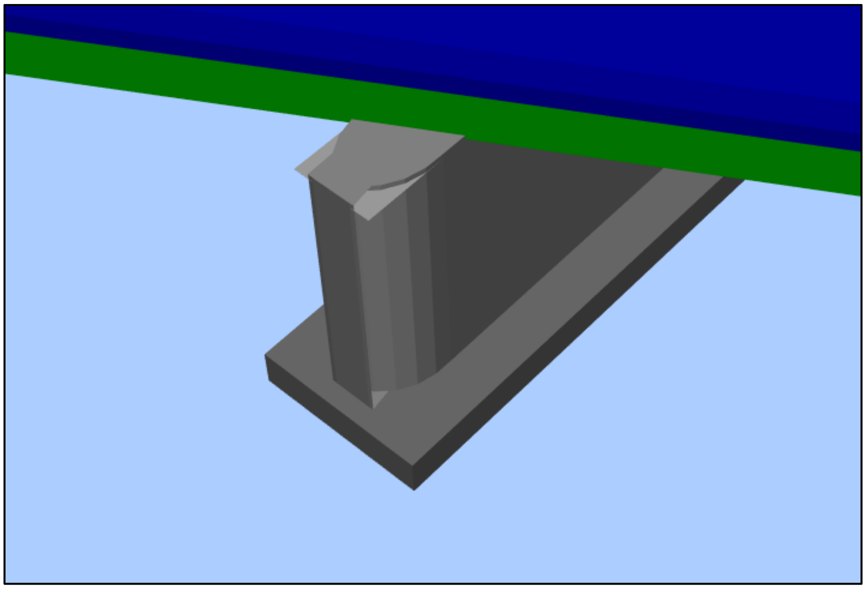


Figure 7.3-11 Pier Cap after Export to LBC

The user should be aware that certain elements in OBM will create errors when attempting to transfer to LEAP. In the example below, the user created barrier templates that could not be transferred to the LEAP software. After the barriers were deleted, the structure was able to be transferred to LEAP software. Also, note that the barriers are transferred as rectangular and will not retain the F-shape solid.

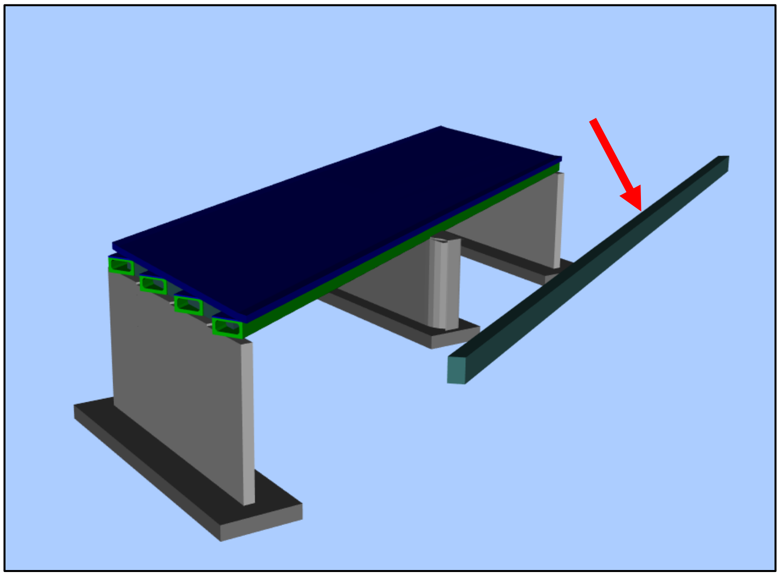


Figure 7.3-12 Barriers Not Attached to the Deck or Missing after Export to LEAP

Below is another example of an error encountered during the transfer from OBM to LEAP. The issue was isolated to the barriers and was reported as a bug fix request to Bentley. The current workaround offered by Bentley if this issue is encountered, is to delete the barriers and re-model them before transferring to LEAP.

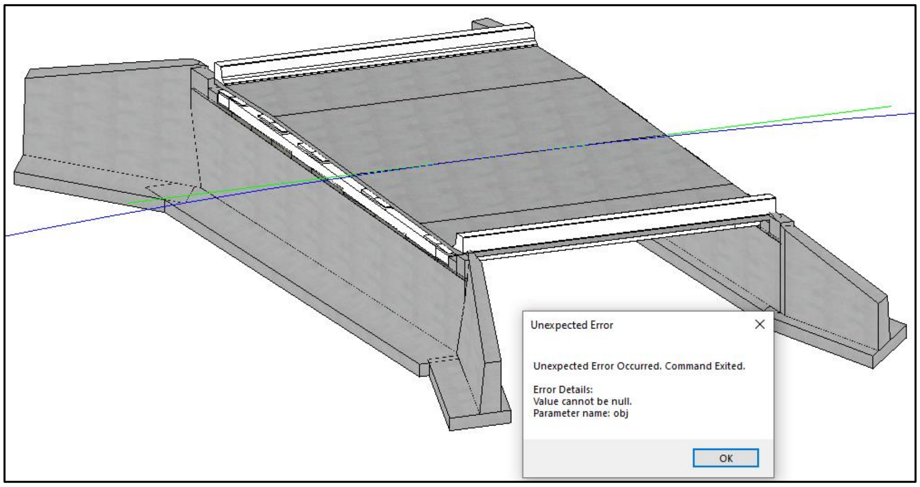


Figure 7.3-13 Error Message Attempting to Transfer Data to LEAP

The user is responsible for reading and understanding LEAPs Assumption and Limitation Messages when attempting to transfer data.

7.3.2 Best Practices for Timing of Transfer

It is recommended that the user transfer data to LEAP when the model is in a lower Level of Development state, and all are still in Base element status and fully editable as OBM objects. The material type, beam spacing, and general beam sizing (estimate) should be set, but the less complexity or detail of the model, the higher the chance of the model transferring to LEAP without issue. If the model is transferred after Refined elements have been created, there may be issues with transferring older versions of those elements and should be avoided whenever possible.

In typical bridge replacement projects, the recommended time to transfer data from OBM to LBC or LBS is during the TS&L development. OBM can be used to develop several superstructure alternates to assist in preparing quantities and cost estimates, then either the preferred alternative or several alternate options can be transferred for analysis to prepare more refined cost estimates and other considerations for alternate selection.

7.3.3 Bi-directional Data Transfer

OBM currently has some limited functionality to import design modifications from LEAP to update the model in OBM. The update does not happen automatically and requires the user to go through a process to update the model. When updating the model, the user can select which changes made in LEAP to import back into OBM. This currently is not a recommended workflow as there are many limitations in the current process. Simple changes, such as a change in beam section may transfer properly, but more complicated changes such as additional beams or changes to cross sectional geometry will need to be updated manually in OBM, if necessary. Any minimal value gained from this process is outweighed by potential issues and lack of automation currently provided. If there are additional functionality and usability improvements in future releases, this option will be reevaluated for viability. However, the current recommendation is for a one-time transfer from OBM to LEAP to translate geometry and material properties for analysis, and the user is then to maintain the OBM model and LEAP analysis files separately.

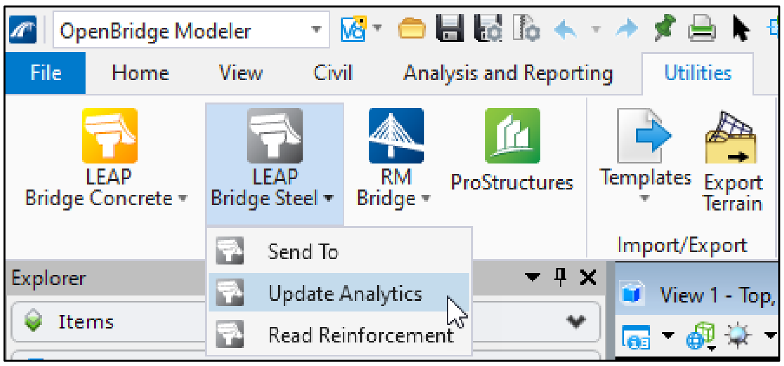


Figure 7.3-14 Update OBM File from LEAP

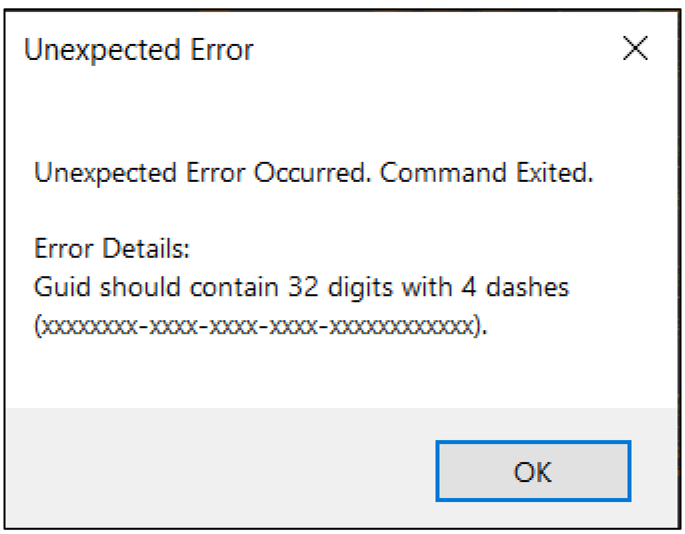


Figure 7.3-15 Error Message When Attempting to Import LEAP Analysis to OBM

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EXAMPLE PROBLEMS

[This section is under development. Content will be added after training course material is released and feedback from initial course offerings and Digital Delivery Directive 2025 Pilot Project feedback is incorporated.]

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TECHNICAL QUESTIONS AND REVISION REQUEST

This chapter contains several forms to make it easier for users to convey their questions, problems or comments to the proper unit within the Department. General procedures for using this form are given. Users should keep the form in the manual as a master copy, which can be reproduced as needed.

Technical questions related to the guidance provided in the manual or the PennDOT workspace elements Feature definitions, bridge element templates, etc.), why certain recommendations are made, applicability and limitations of this guidance document, and other questions not related to the operation of the Bentley software program can be directed to the appropriate person in PennDOT using the form or the information provided on the form. Suggestions might include typographical error correction, clarification of confusing sections, expansion of certain sections, changes in format, and the inclusion of additional information, diagrams, or examples. Please review the information provided in this User's Guide and the references given in Chapter 1 before submitting the Model-centric User Guide Technical Questions / Revision Request form for processing or calling for assistance.

Alternatively, any Bentley software suspected program malfunctions or bug fix requests, enhancement requests, or other questions regarding the internal functioning of the actual software programs should be logged in the Bentley Software Technical Questions / Revision Request form. Unexpected or incorrect output, rejection of input data, endless program cycling, and program abortion are examples of program malfunctions. Users are requested to review their input data and the User’s Guide before submitting the form for processing.

The completed forms should be sent to the Engineering Software Section via fax or e-mail.

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MODEL-CENTRIC USER GUIDE

TECHNICAL QUESTION / REVISION REQUEST

This form is to be used to request revisions to this user manual documentation. Users are requested to review their input data and the Bentley documentation before submitting this form.

CONTACT PERSON: ____ DATE: ____________________
ORGANIZATION: _______________________________________ PHONE: ____________________
E-MAIL ADDRESS: _______________________________________ FAX: ____________________
PROGRAM VERSION: _________

Define your problem and attach samples and/or documentation you feel would help correct the problem. If the input data is more than 4 or 5 lines, please provide the input data file as an e-mail attachment. If you require more space, use additional 8½ x 11 sheets of plain paper.

FORWARD COMPLETED FORM TO: Pennsylvania Office of Administration
Infrastructure and Economic Development
Bureau of Solutions Management
Highway Applications Division
E-MAIL: PenndotBisEngineer@pa.gov
PHONE: (717) 783-8822 FAX: (717) 705-5529

FOR DEPARTMENT USE ONLY

RECEIVED BY: ________________ ASSIGNED TO: ___________________ DATE: __________

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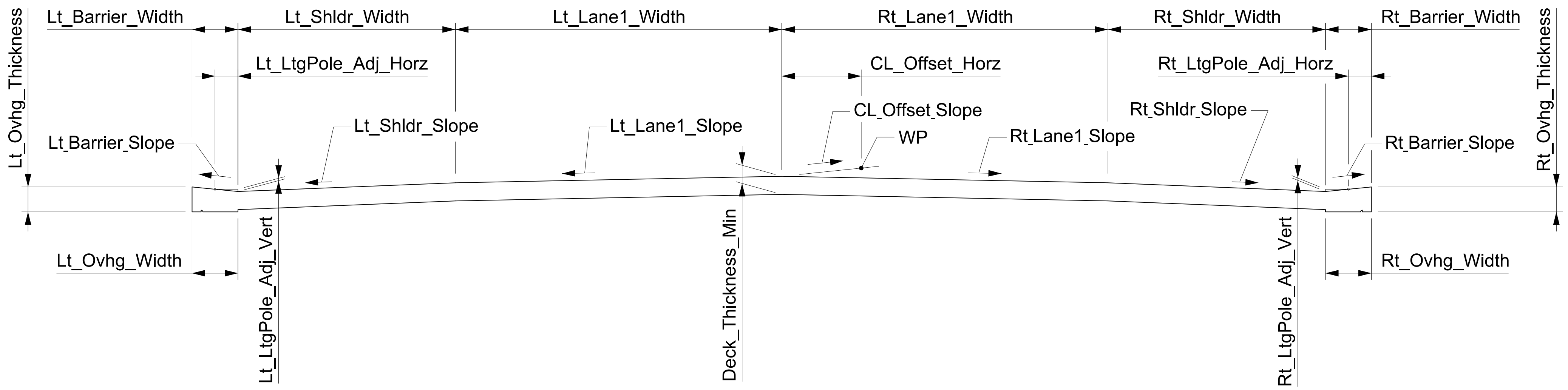
APPENDICES

10.1 DECK TEMPLATE EXHIBITS

Below are sketches of the variables included in the deck templates supplied in the PennDOT OBM workspace. These templates can be located under the …Organization-Civil / Bridge Design / OpenBridge Modeler / Bridge Templates folder. Also included is a description, default value and orientation of the variables.

Note: All PennDOT deck templates can be modified for normal crown or superelevated cross sections by entering positive or negative slope values.

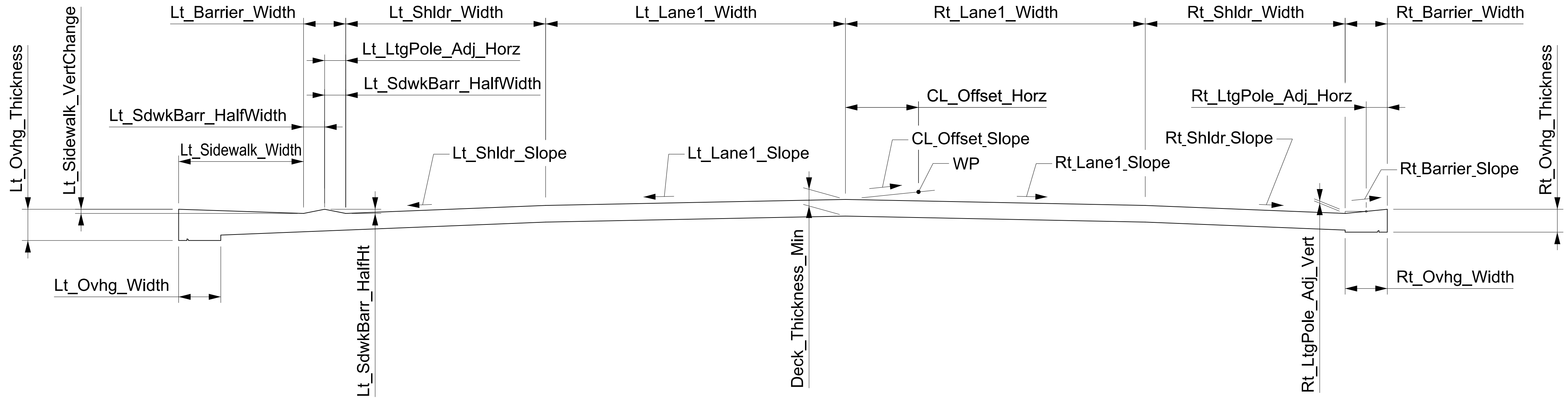


2 LANE

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

DECK TEMPLATE SECTION

2 LANE

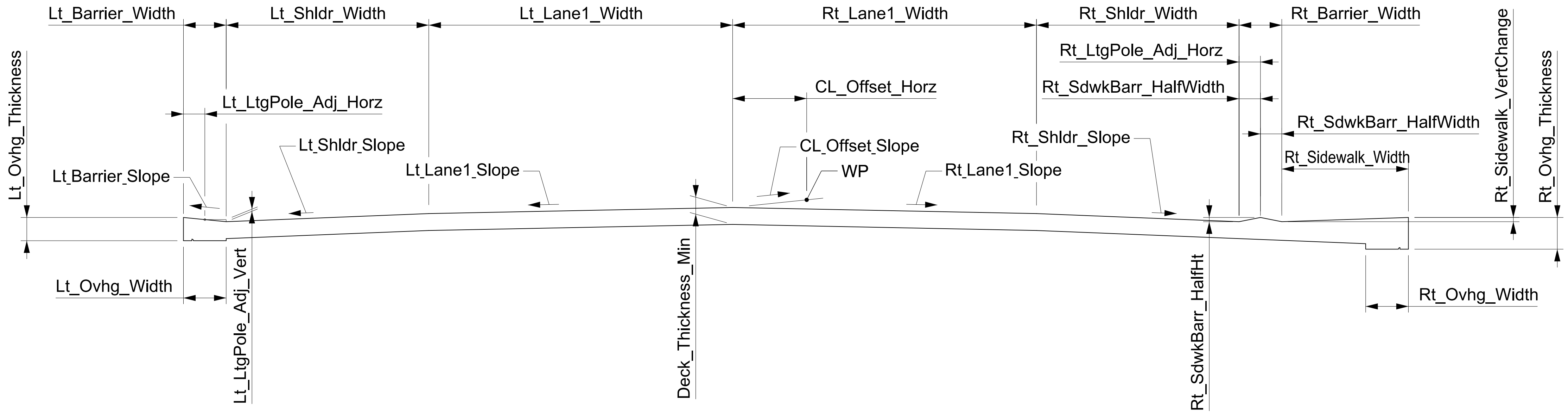


2 LANE_SIDEWALK_L

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

DECK TEMPLATE SECTION

2 LANE_SIDEWALK_L

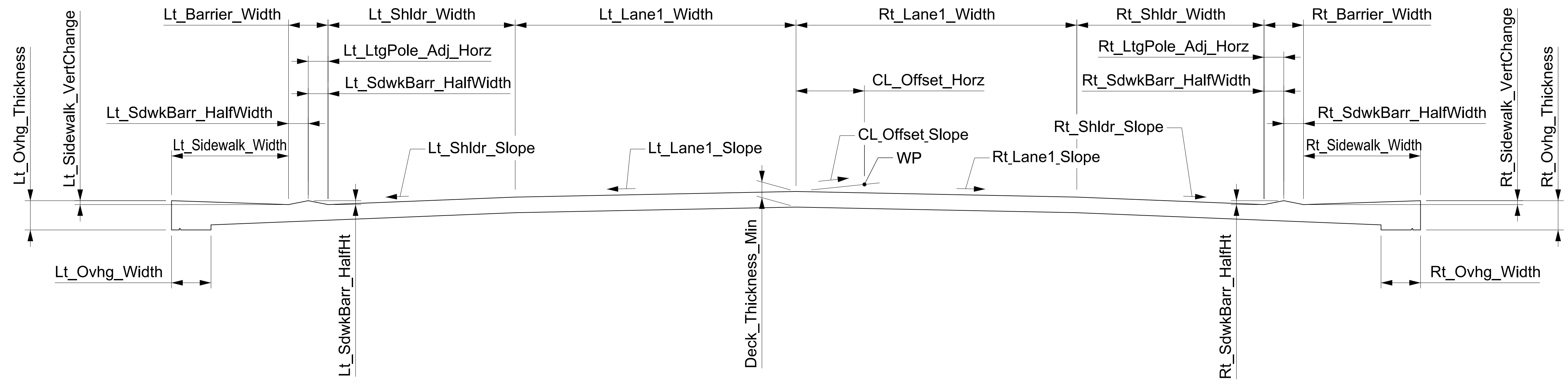


2 LANE_SIDEWALK_R

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

DECK TEMPLATE SECTION

2 LANE_SIDEWALK_R

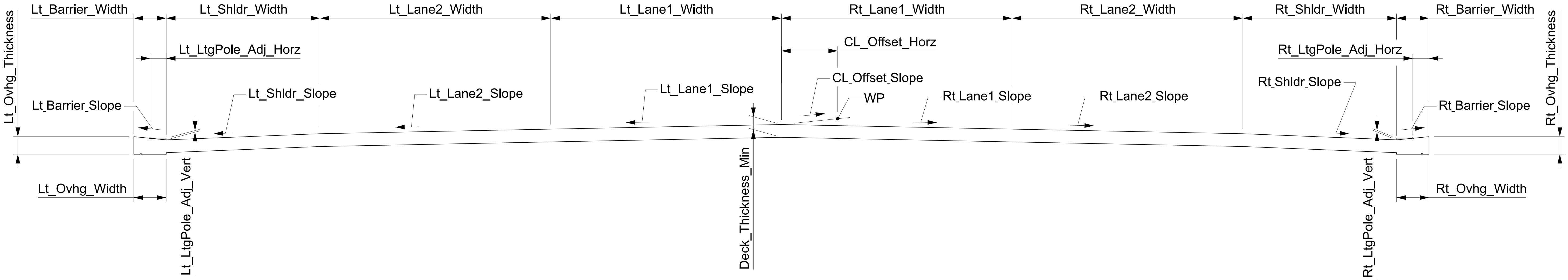


2 LANE_SIDEWALK_BOTH

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

DECK TEMPLATE SECTION

2 LANE_SIDEWALK_BOTH

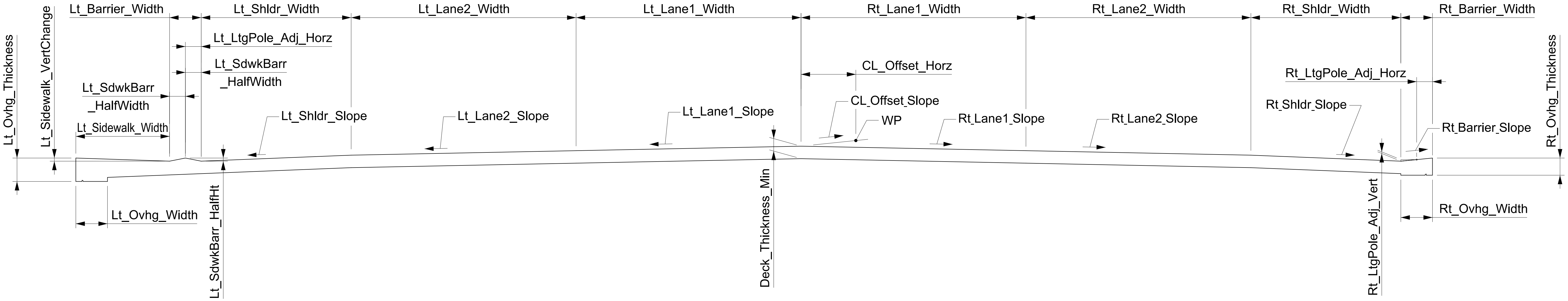


4 LANE

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

DECK TEMPLATE SECTION

4 LANE

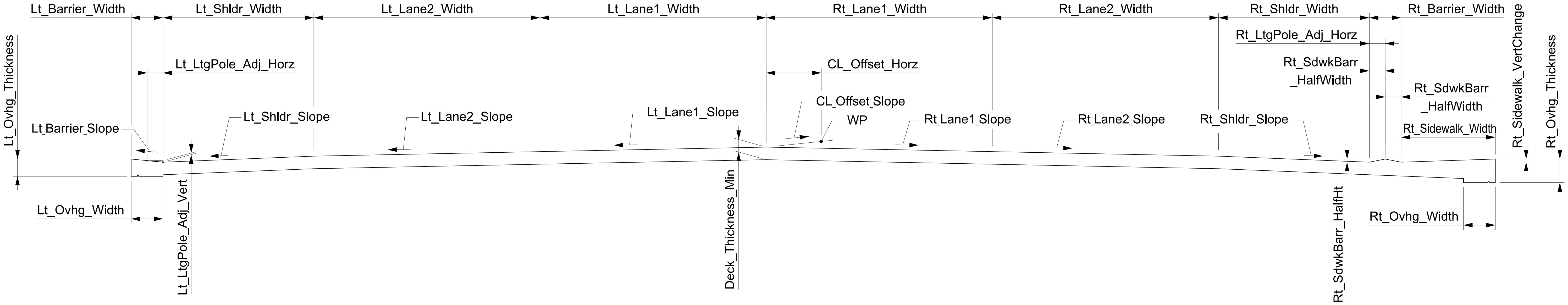


4 LANE_SIDEWALK_L

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

DECK TEMPLATE SECTION

4 LANE_SIDEWALK_L

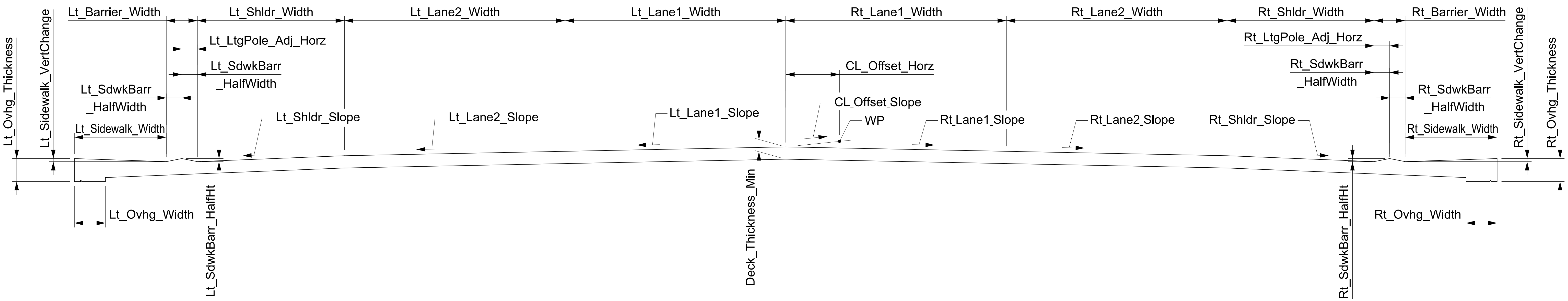


4 LANE_SIDEWALK_R

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

DECK TEMPLATE SECTION

4 LANE_SIDEWALK_R



4 LANE_SIDEWALK_BOTH

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

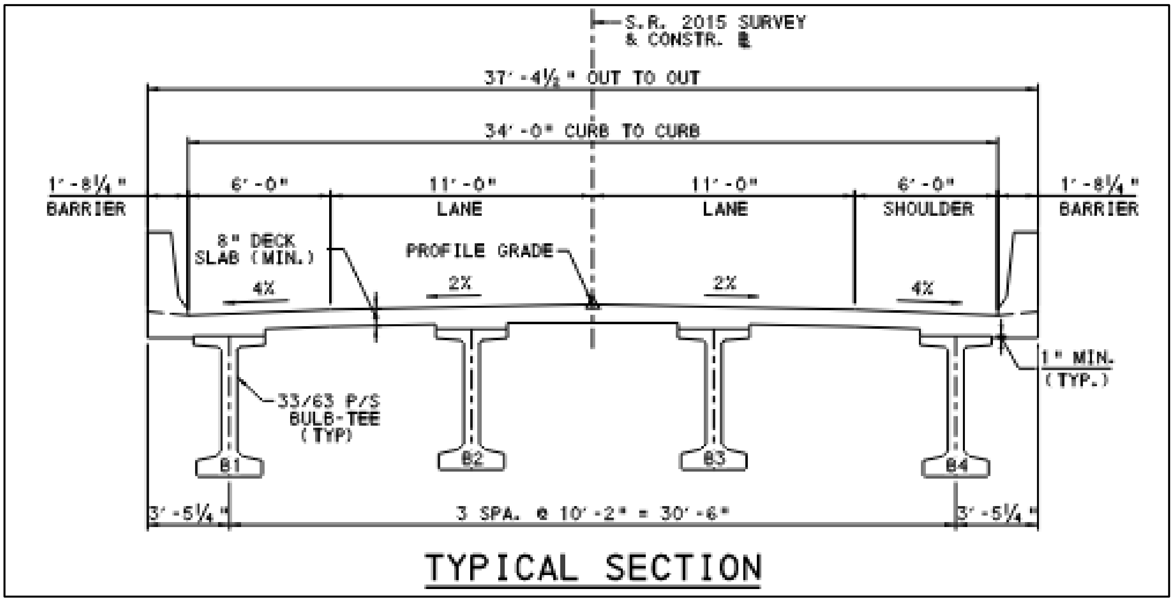
DECK TEMPLATE SECTION

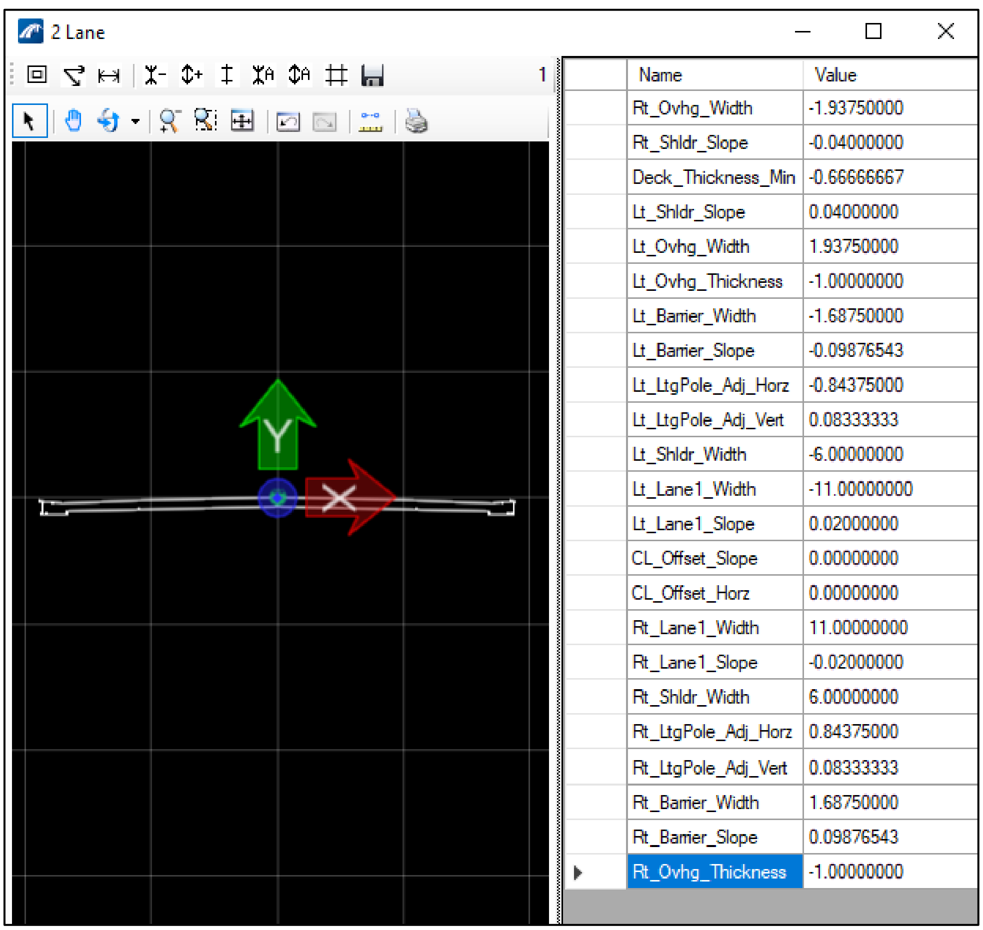
4 LANE_SIDEWALK_BOTH

10.2 EXAMPLE TEMPLATE VALUES AND VARIABLE CONSTRAINTS

10.2.1 Deck Templates

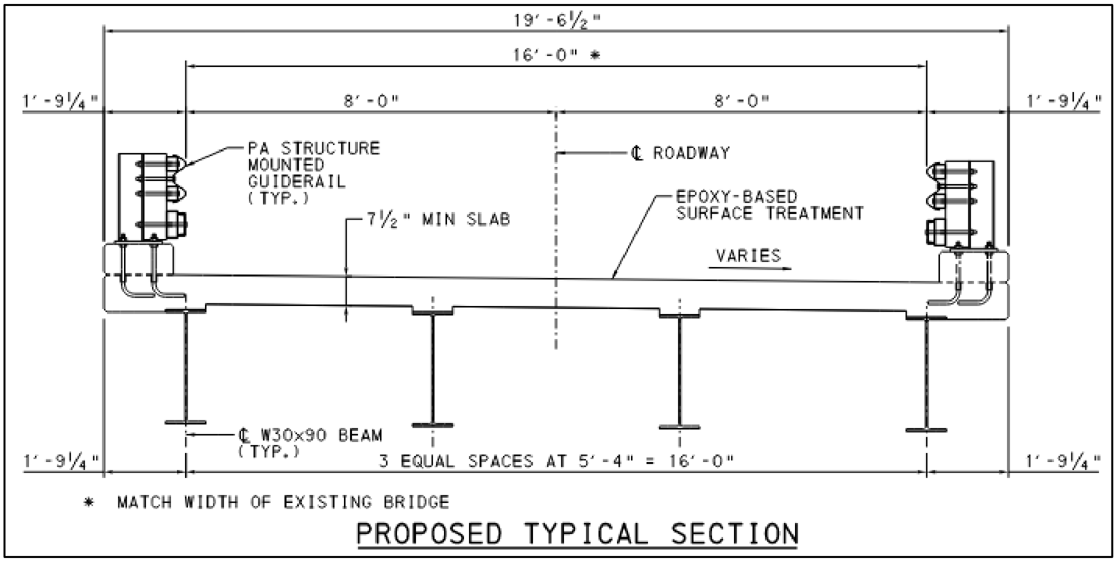
10.2.1.1 2 Lane Template – Typical

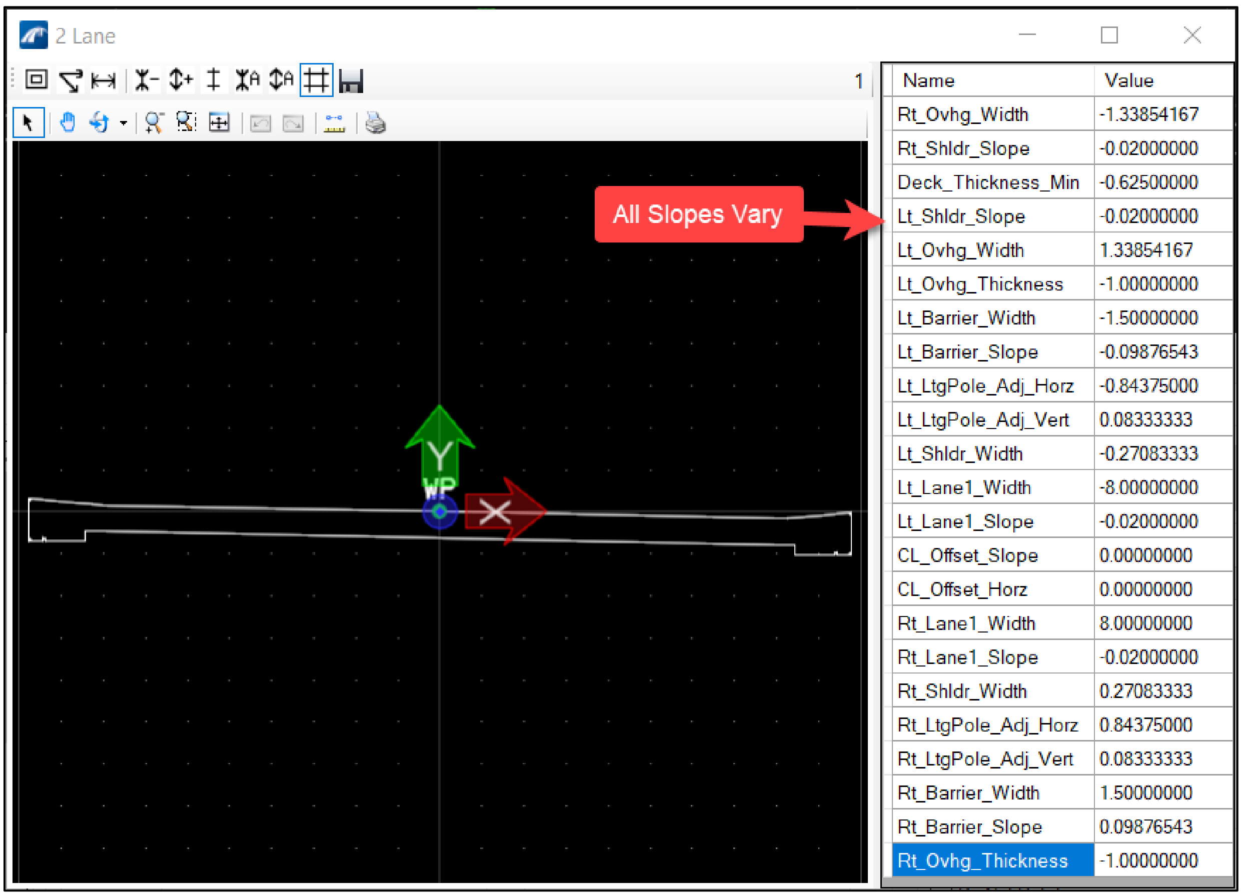




Name	Value
Rt_Ovhg_Width	-1.93750000
Rt_Shldr_Slope	-0.04000000
Deck_Thickness_Min	-0.66666667
Lt_Shldr_Slope	0.04000000
Lt_Ovhg_Width	1.93750000
Lt_Ovhg_Thickness	-1.00000000
Lt_Barrier_Width	-1.68750000
Lt_Barrier_Slope	-0.09876543
Lt_LtgPole_Adj_Horz	-0.84375000
Lt_LtgPole_Adj_Vert	0.08333333
Lt_Shldr_Width	-6.00000000
Lt_Lane1_Width	-11.00000000
Lt_Lane1_Slope	0.02000000
CL_Offset_Slope	0.00000000
CL_Offset_Horz	0.00000000
Rt_Lane1_Width	11.00000000
Rt_Lane1_Slope	-0.02000000
Rt_Shldr_Width	6.00000000
Rt_LtgPole_Adj_Horz	0.84375000
Rt_LtgPole_Adj_Vert	0.08333333
Rt_Barrier_Width	1.68750000
Rt_Barrier_Slope	0.09876543
Rt_Ovhg_Thickness	-1.00000000

10.2.1.2 2 Lane Template – No Shoulders





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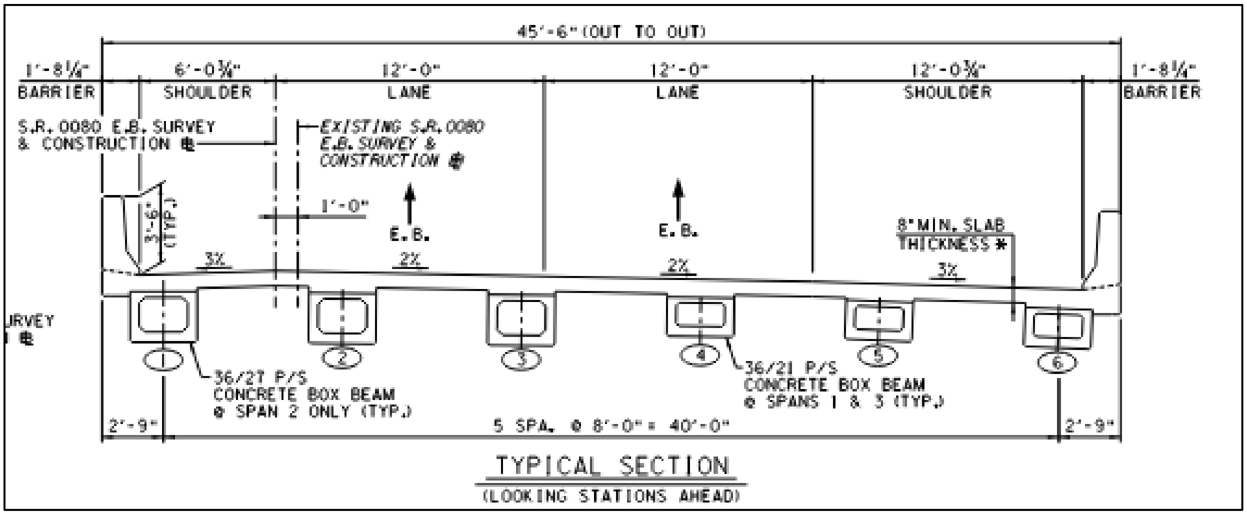
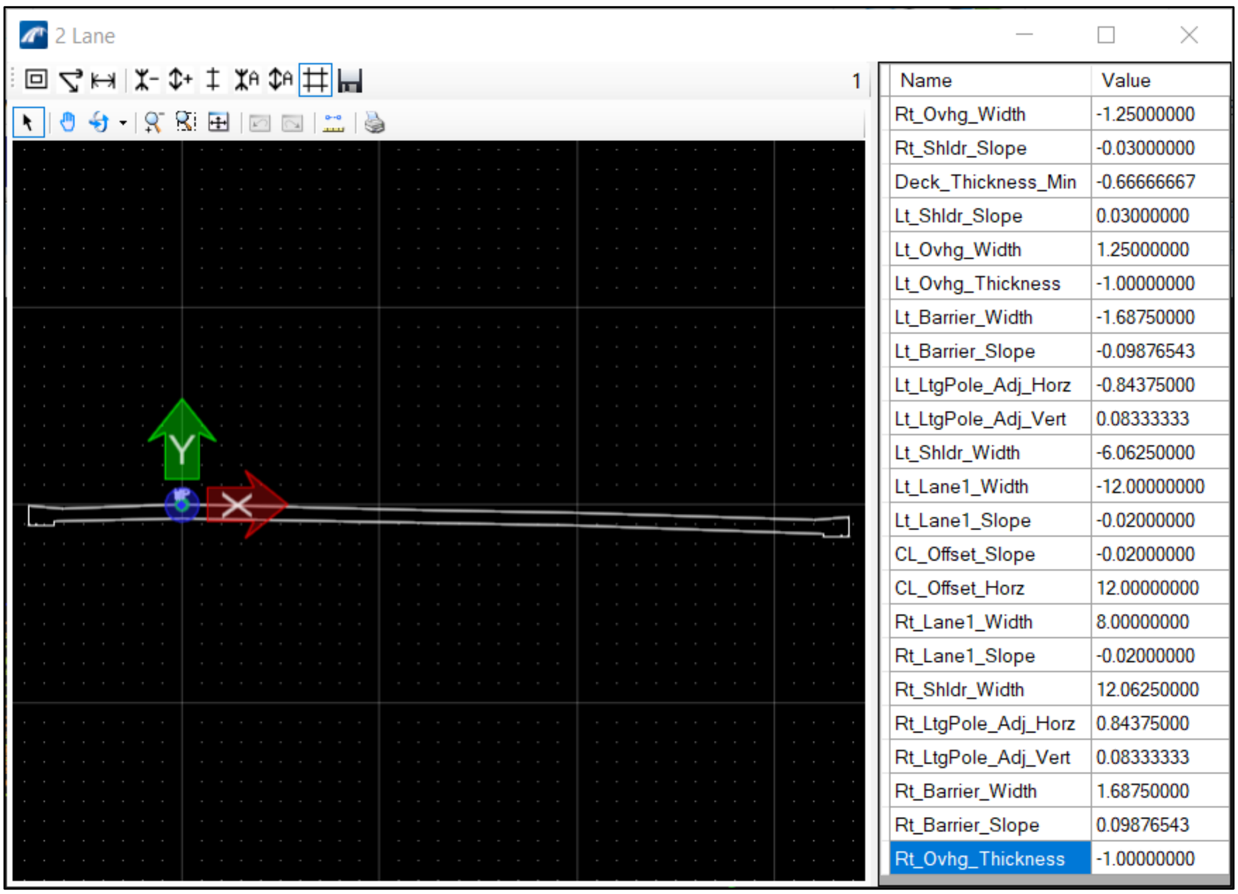
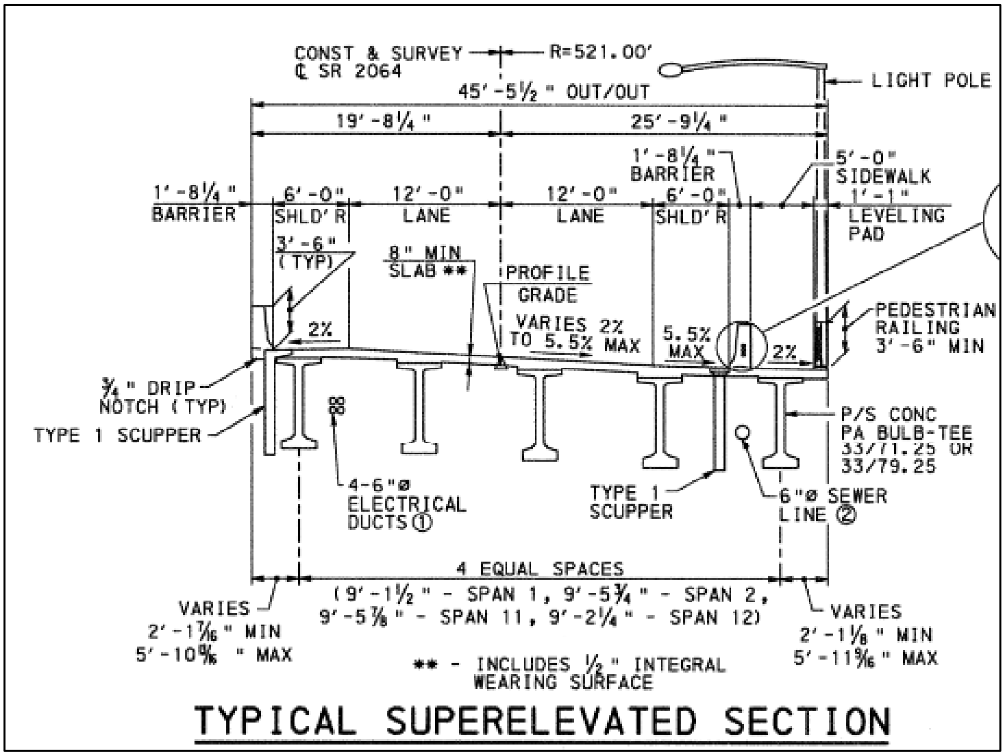
Deck_Thickness_Min	-0.62500000
Lt_Shldr_Slope	-0.02000000
Lt_Ovhg_Width	1.33854167
Lt_Ovhg_Thickness	-1.00000000
Lt_Barrier_Width	-1.50000000
Lt_Barrier_Slope	-0.09876543
Lt_LtgPole_Adj_Horz	-0.84375000
Lt_LtgPole_Adj_Vert	0.08333333
Lt_Shldr_Width	-0.27083333
Lt_Lane1_Width	-8.00000000
Lt_Lane1_Slope	-0.02000000
CL_Offset_Slope	0.00000000
CL_Offset_Horz	0.00000000
Rt_Lane1_Width	8.00000000
Rt_Lane1_Slope	-0.02000000
Rt_Shldr_Width	0.27083333
Rt_LtgPole_Adj_Horz	0.84375000
Rt_LtgPole_Adj_Vert	0.08333333
Rt_Barrier_Width	1.50000000
Rt_Barrier_Slope	0.09876543
Rt_Ovhg_Thickness	-1.00000000

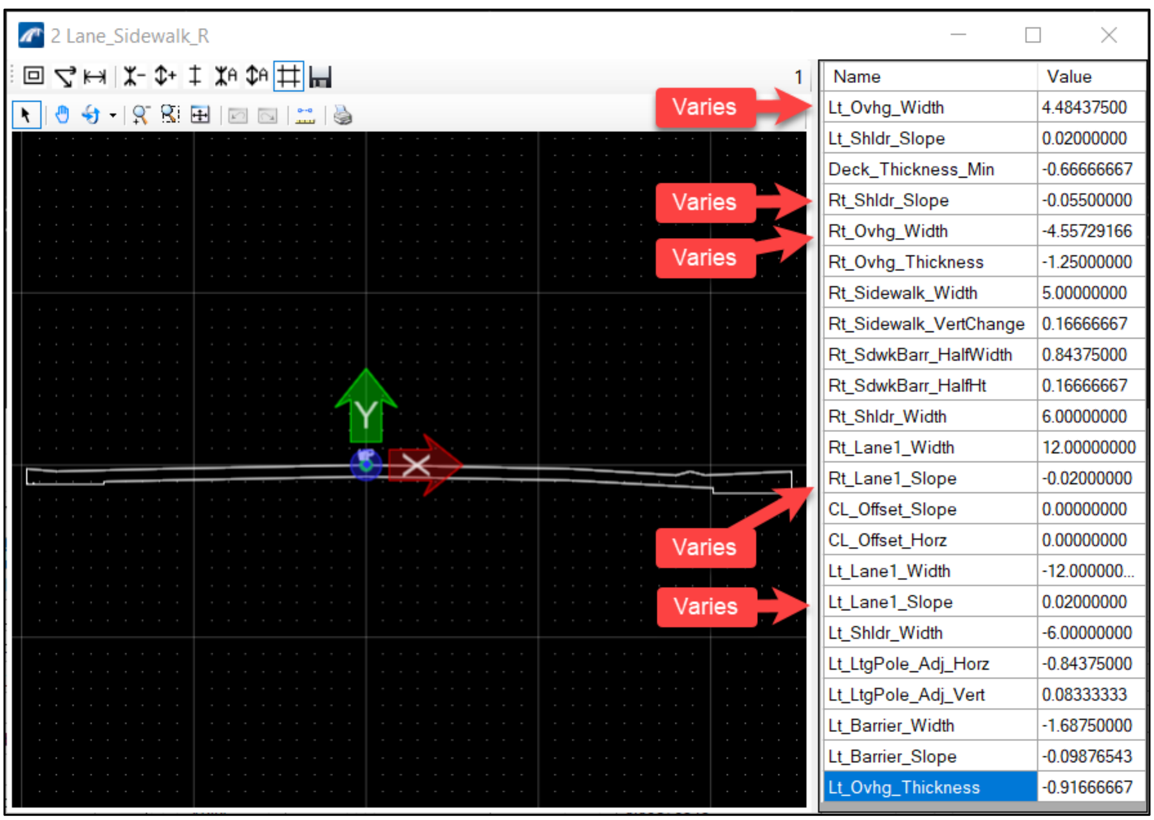
10.2.1.3 2 Lane Template – Offset Baseline



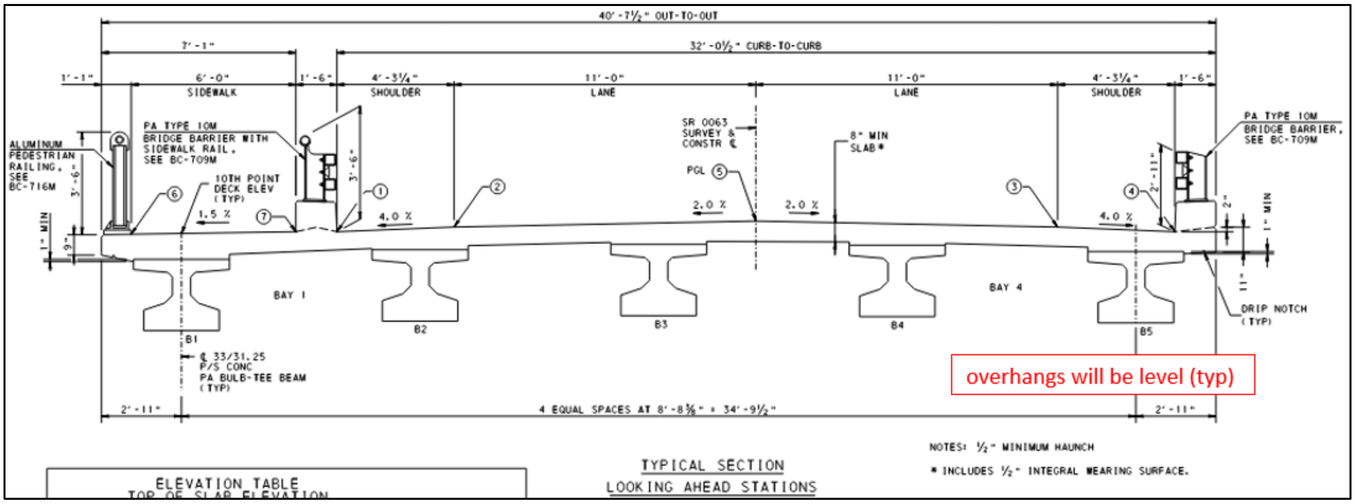


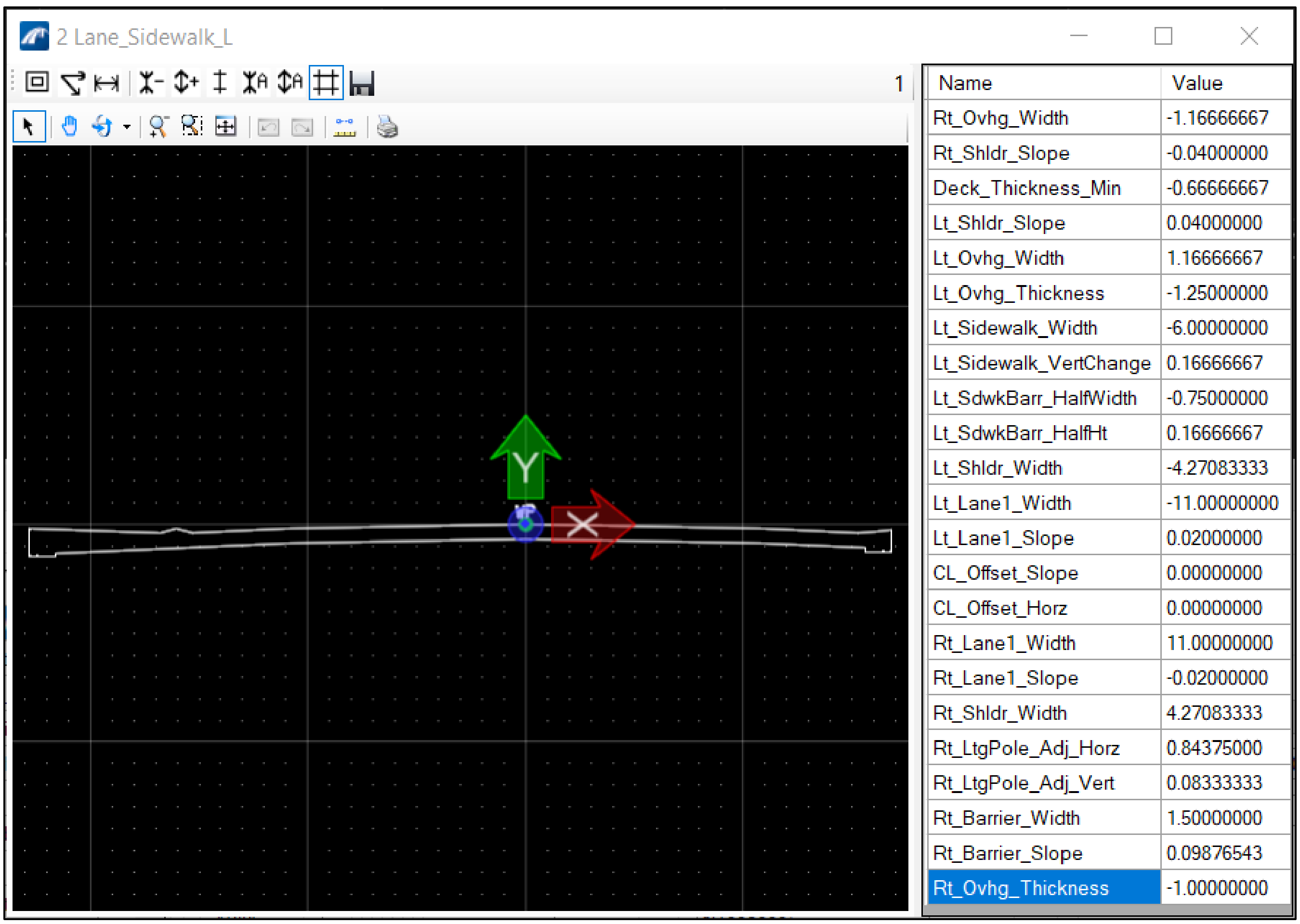
10.2.1.4 2 Lane_Sidewalk_R Template – Typical Sidewalk Detail



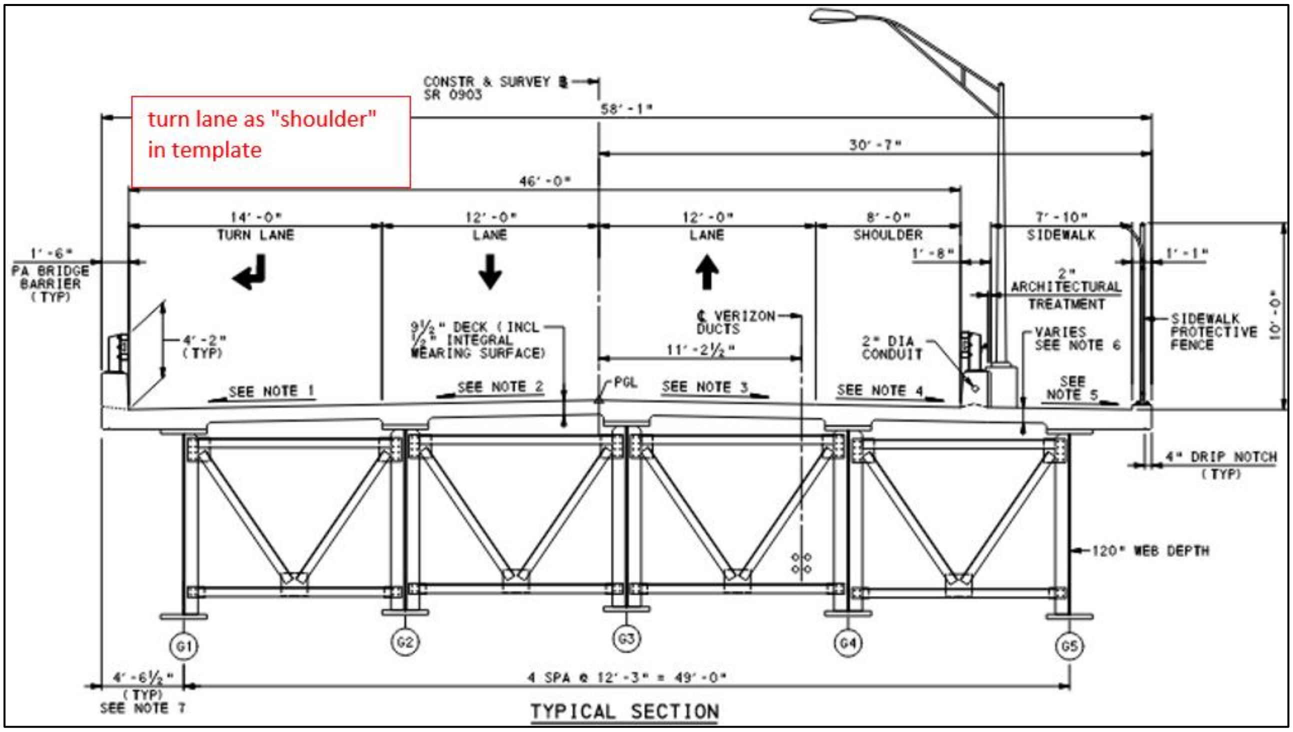


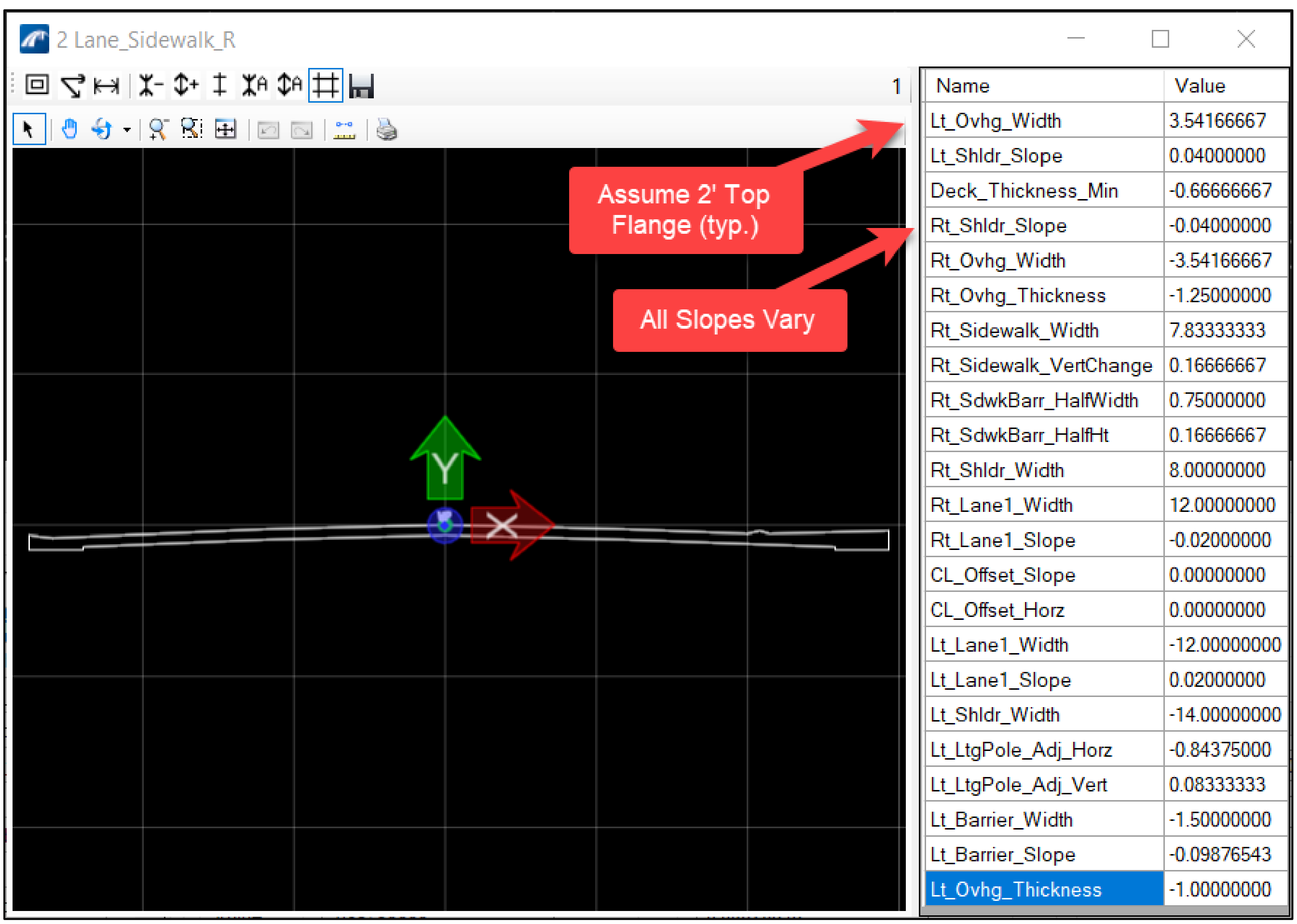
10.2.1.5 2 Lane_Sidewalk_L Template – Typical Sidewalk Detail





10.2.1.6 2 Lane_Sidewalk_R Template – Turn Lane as “Shoulder” and Typical Sidewalk Detail





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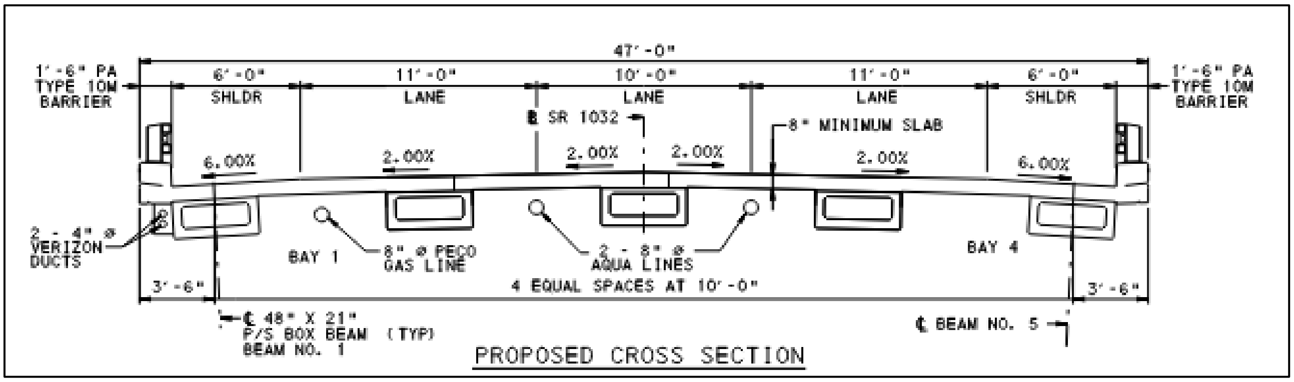
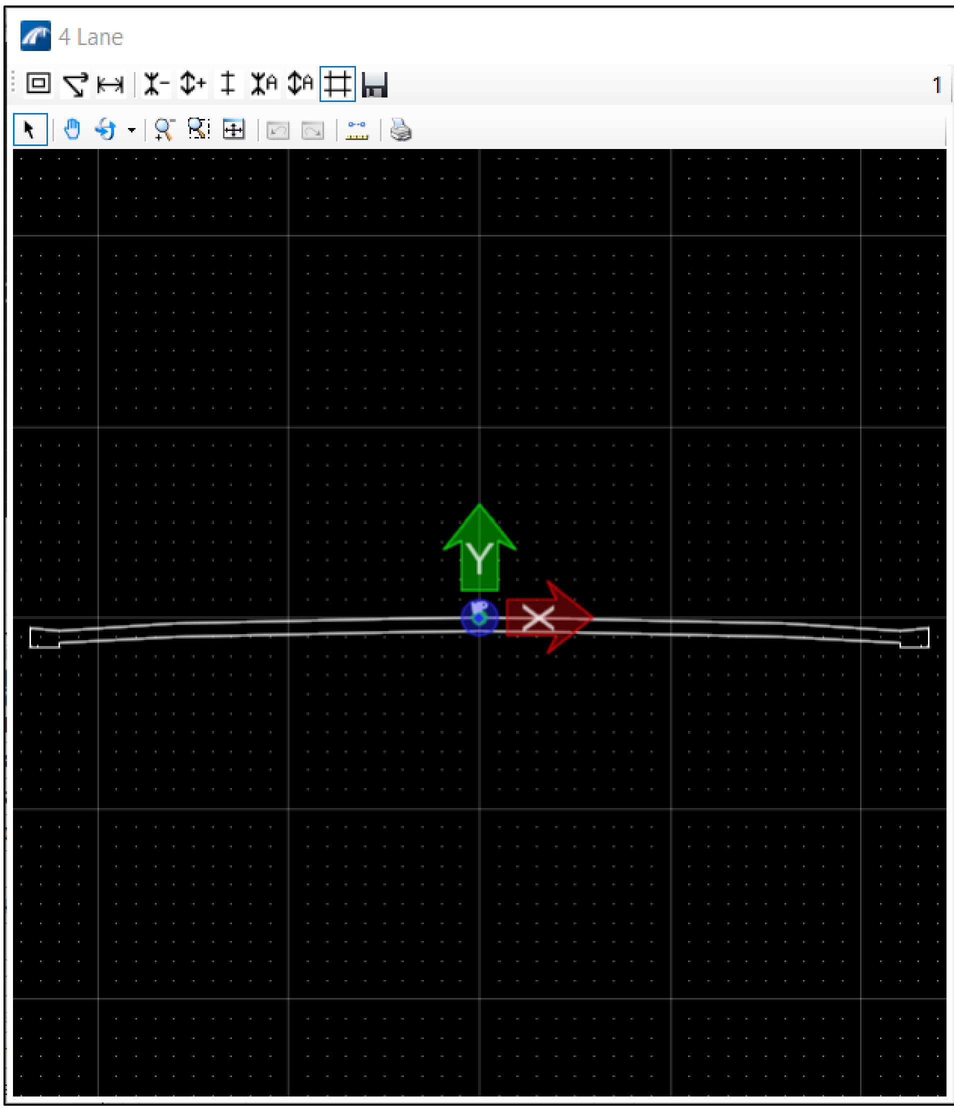
Deck_Thickness_Min	-0.66666667
Rt_Shldr_Slope	-0.04000000
Rt_Ovhg_Width	-3.54166667
Rt_Ovhg_Thickness	-1.25000000
Rt_Sidewalk_Width	7.83333333
Rt_Sidewalk_VertChange	0.16666667
Rt_SdwkBarr_HalfWidth	0.75000000
Rt_SdwkBarr_HalfHt	0.16666667
Rt_Shldr_Width	8.00000000
Rt_Lane1_Width	12.00000000
Rt_Lane1_Slope	-0.02000000
CL_Offset_Slope	0.00000000
CL_Offset_Horz	0.00000000
Lt_Lane1_Width	-12.00000000
Lt_Lane1_Slope	0.02000000
Lt_Shldr_Width	-14.00000000
Lt_LtgPole_Adj_Horz	-0.84375000
Lt_LtgPole_Adj_Vert	0.08333333
Lt_Barrier_Width	-1.50000000
Lt_Barrier_Slope	-0.09876543
Lt_Ovhg_Thickness	-1.00000000

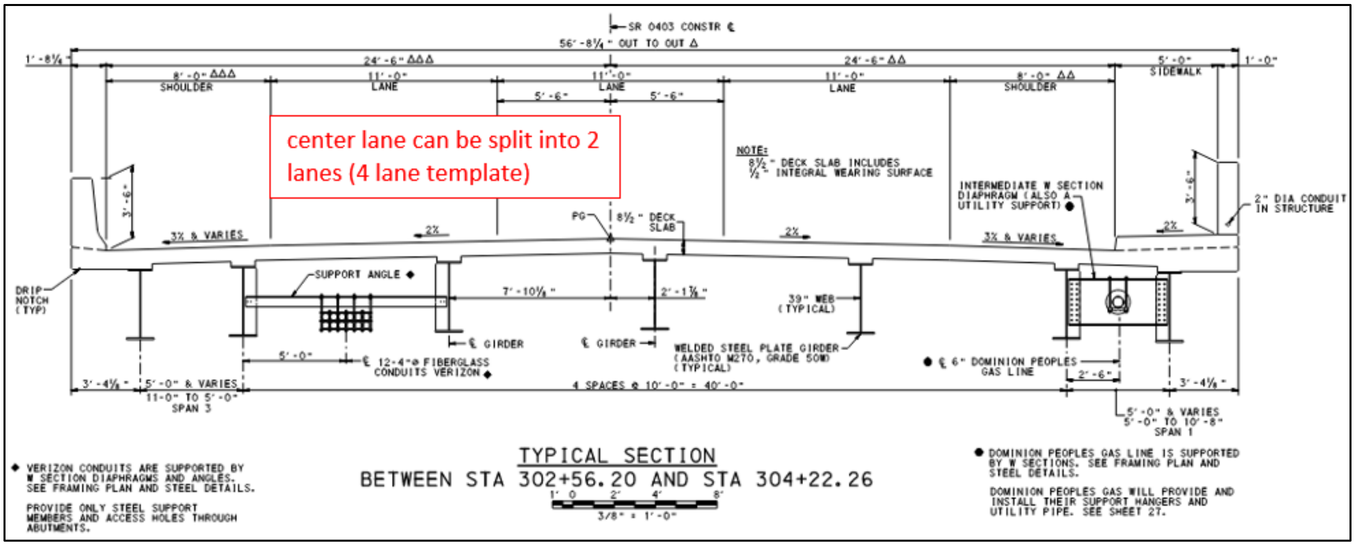
10.2.1.7 4 Lane – Center Lane Split

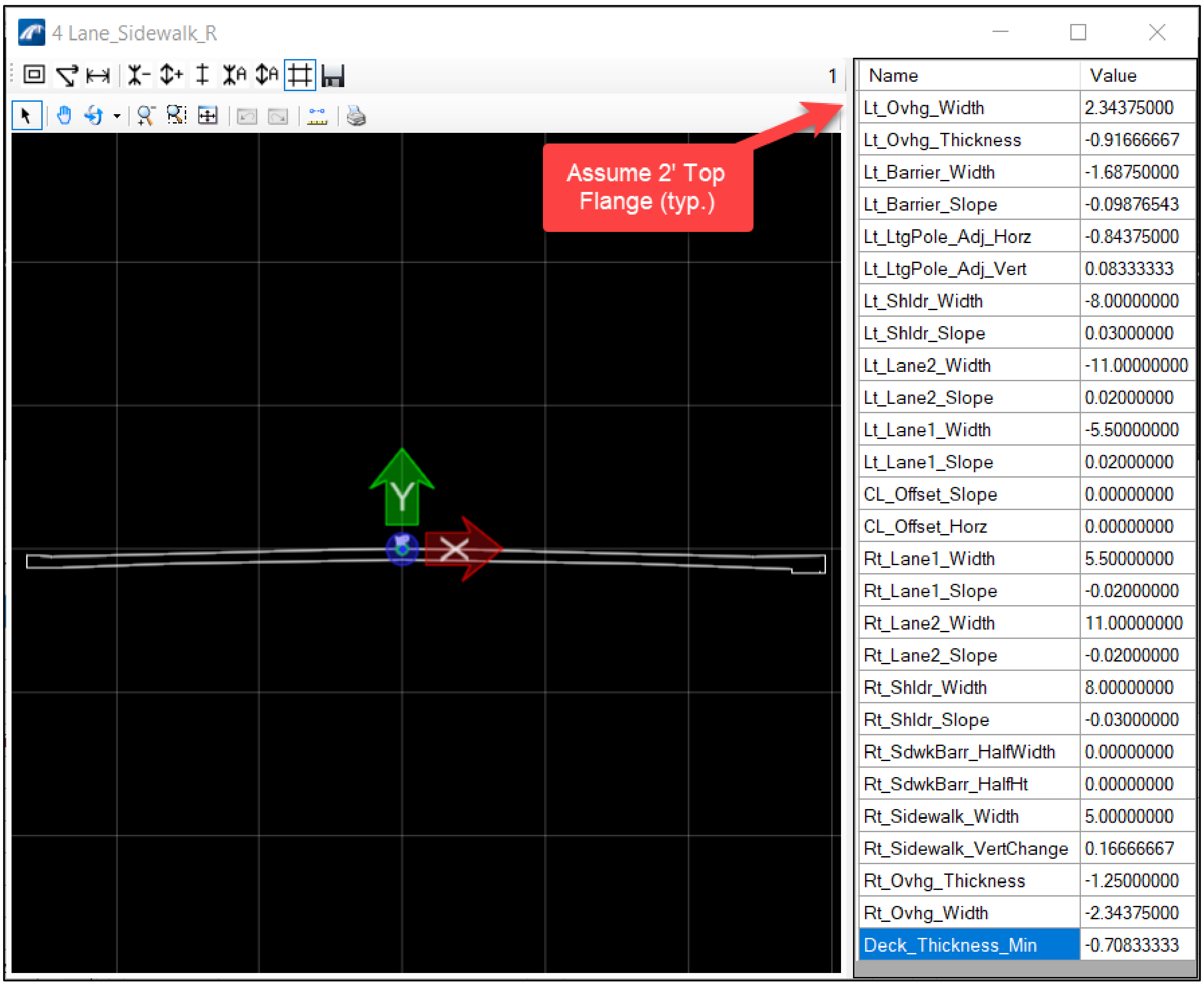




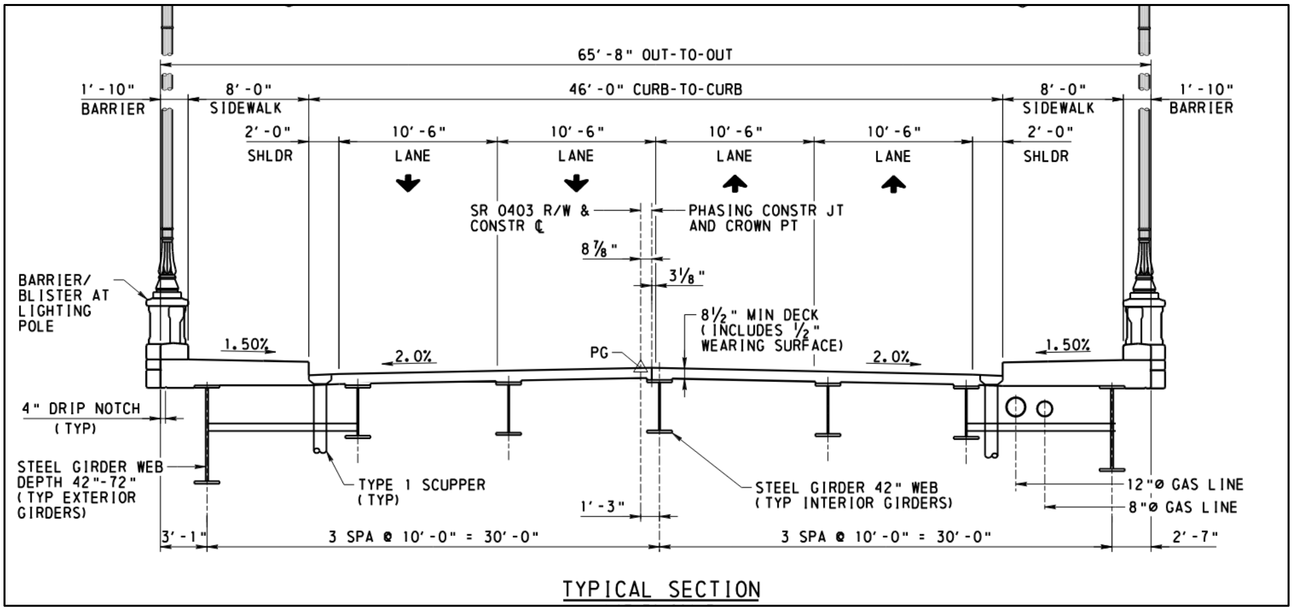
Name	Value
Rt_Ovhg_Width	-1.50000000
Rt_Shldr_Slope	-0.06000000
Deck_Thickness_Min	-0.66666667
Lt_Shldr_Slope	0.06000000
Lt_Ovhg_Width	1.50000000
Lt_Ovhg_Thickness	-1.00000000
Lt_Barrier_Width	-1.50000000
Lt_Barrier_Slope	-0.09876543
Lt_LtgPole_Adj_Horz	-0.84375000
Lt_LtgPole_Adj_Vert	0.08333333
Lt_Shldr_Width	-6.00000000
Lt_Lane2_Width	-11.00000000
Lt_Lane2_Slope	0.02000000
Lt_Lane1_Width	-5.00000000
Lt_Lane1_Slope	0.02000000
CL_Offset_Slope	0.00000000
CL_Offset_Horz	0.00000000
Rt_Lane1_Width	5.00000000
Rt_Lane1_Slope	-0.02000000
Rt_Lane2_Width	11.00000000
Rt_Lane2_Slope	-0.02000000
Rt_Shldr_Width	6.00000000
Rt_LtgPole_Adj_Horz	0.84375000
Rt_LtgPole_Adj_Vert	0.08333333
Rt_Barrier_Width	1.50000000
Rt_Barrier_Slope	0.09876543
Rt_Ovhg_Thickness	-1.00000000

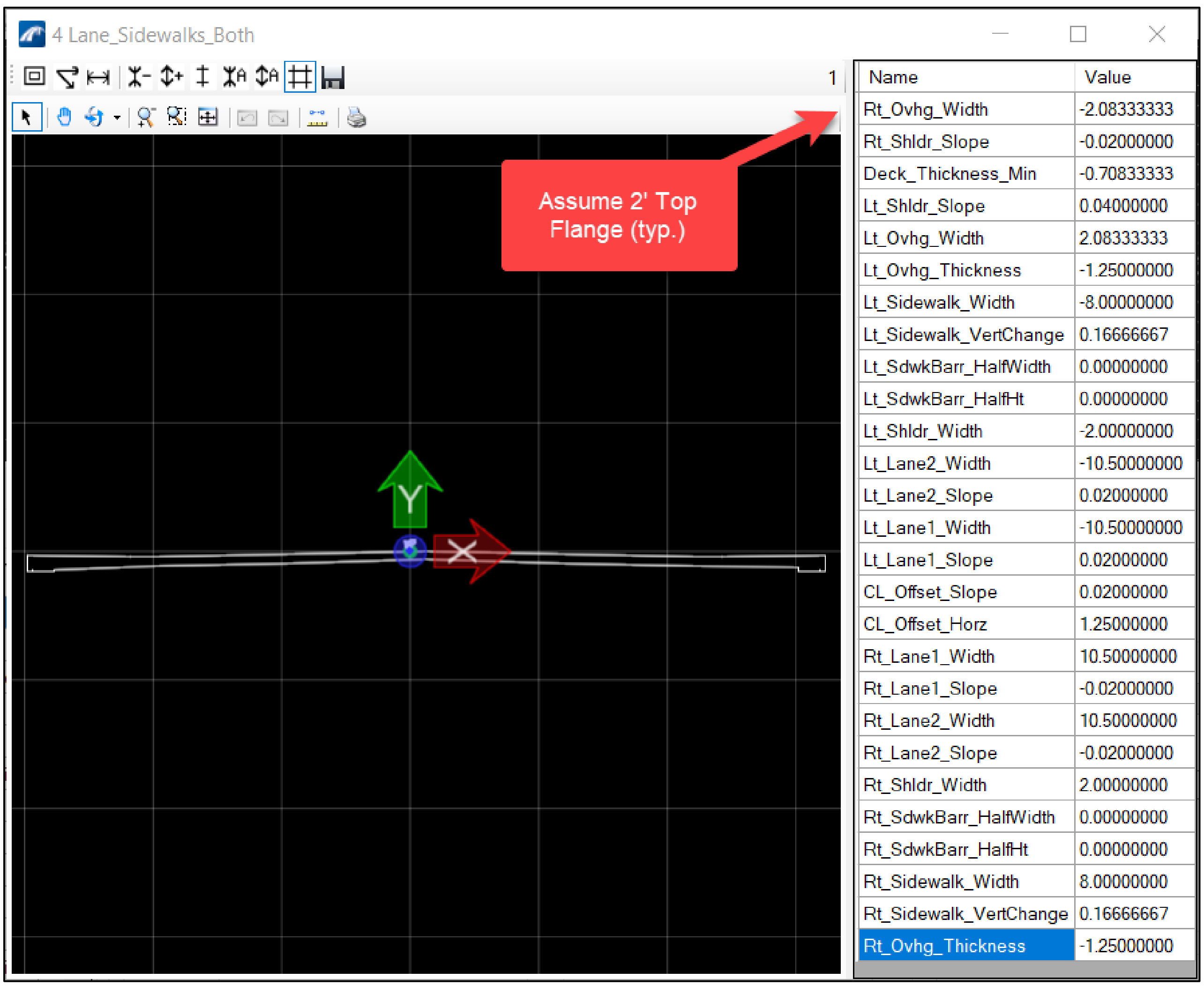
10.2.1.8 4 Lane_Sidewalk_R – Alternate Sidewalk Detail and Center Lane Split





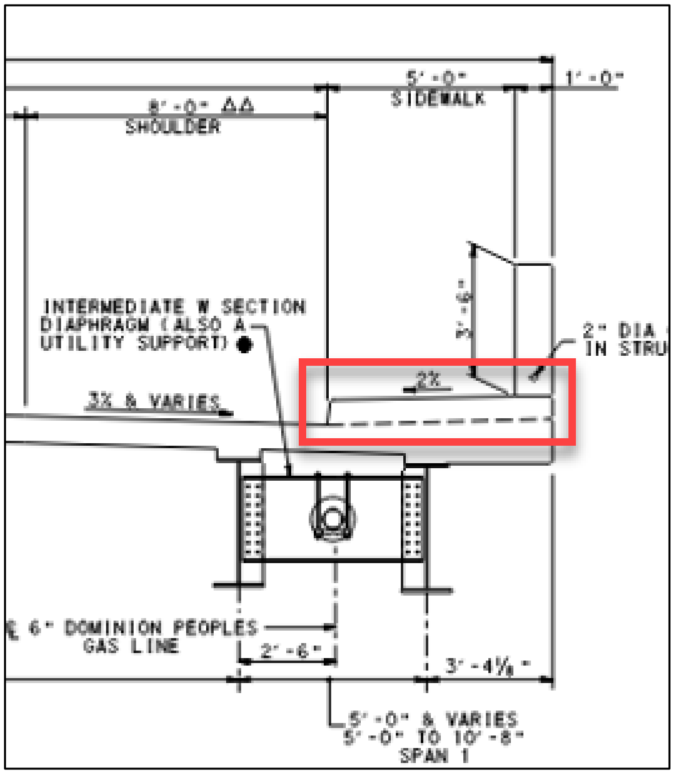
10.2.1.9 4 Lane_Sidewalk_Both – Alternate Sidewalk Details and Offset Baseline

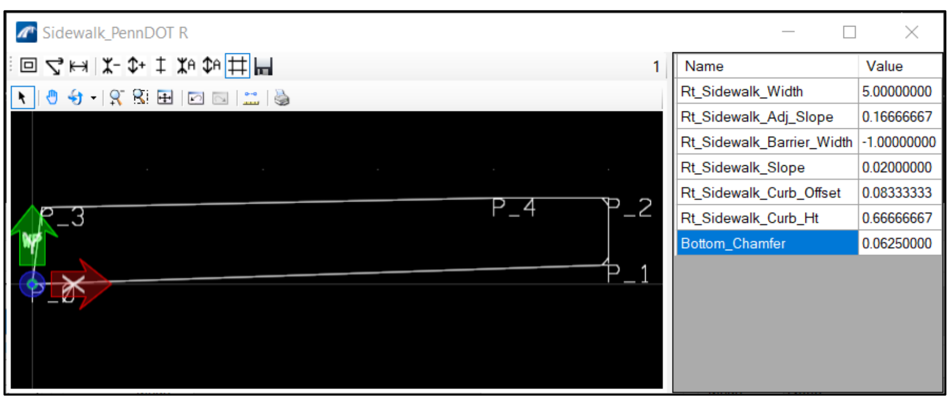




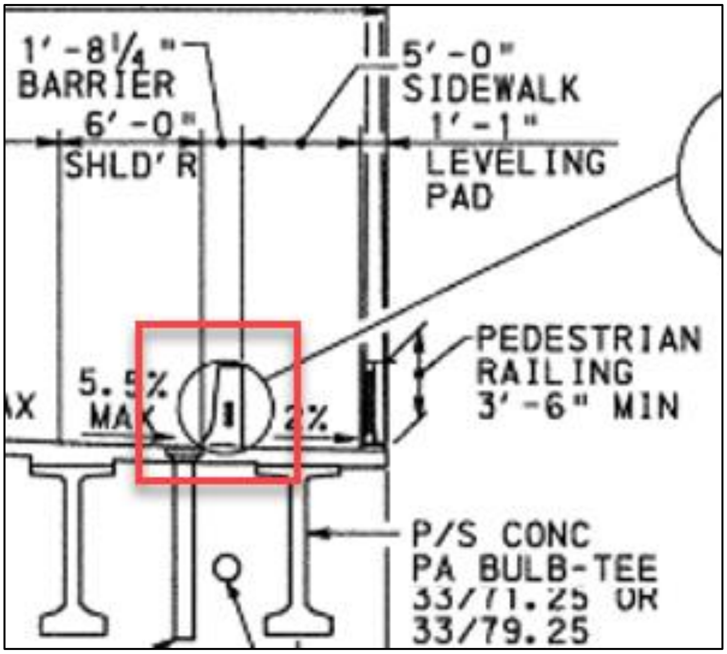
10.2.2 Barrier/Sidewalk Templates

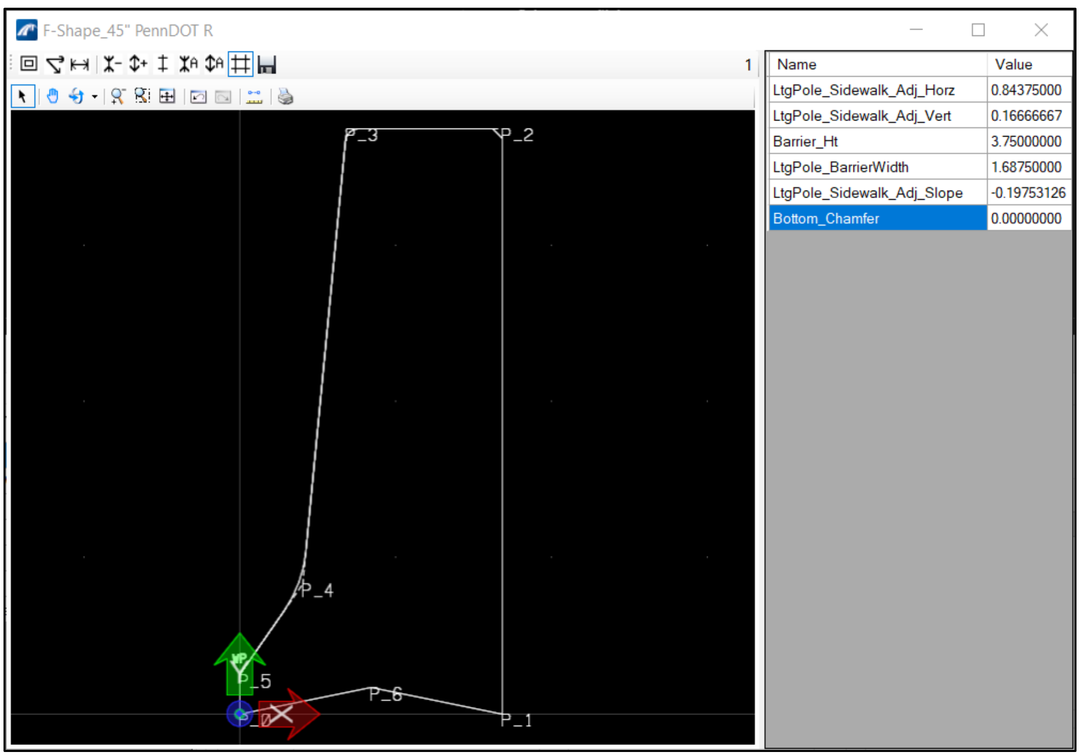
10.2.2.1 PennDOT_Sidewalk R – Typical





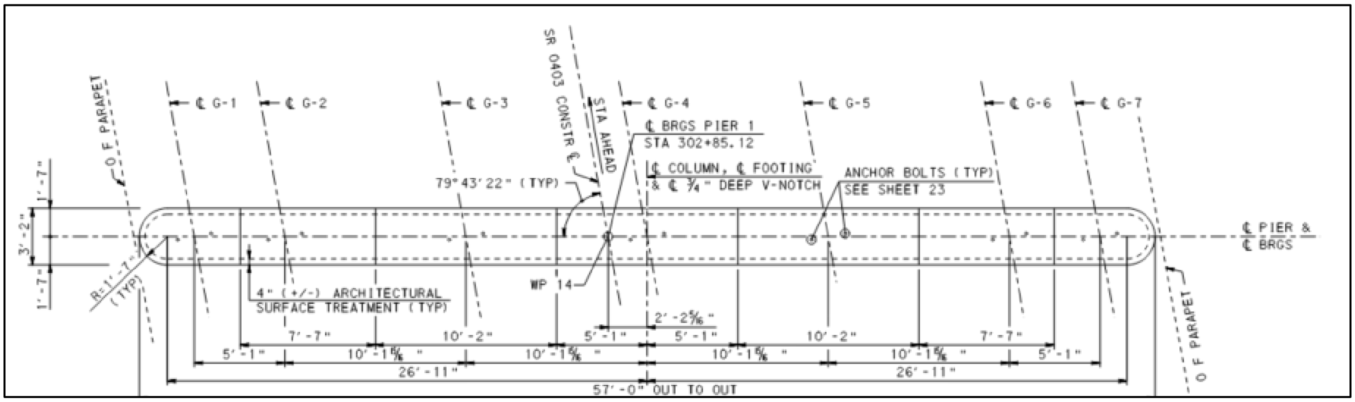
10.2.2.2 F-Shape_45" PennDOT R – Barrier with Sidewalk

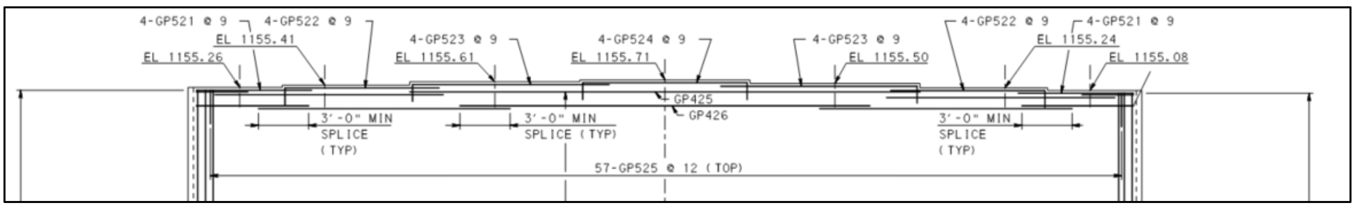


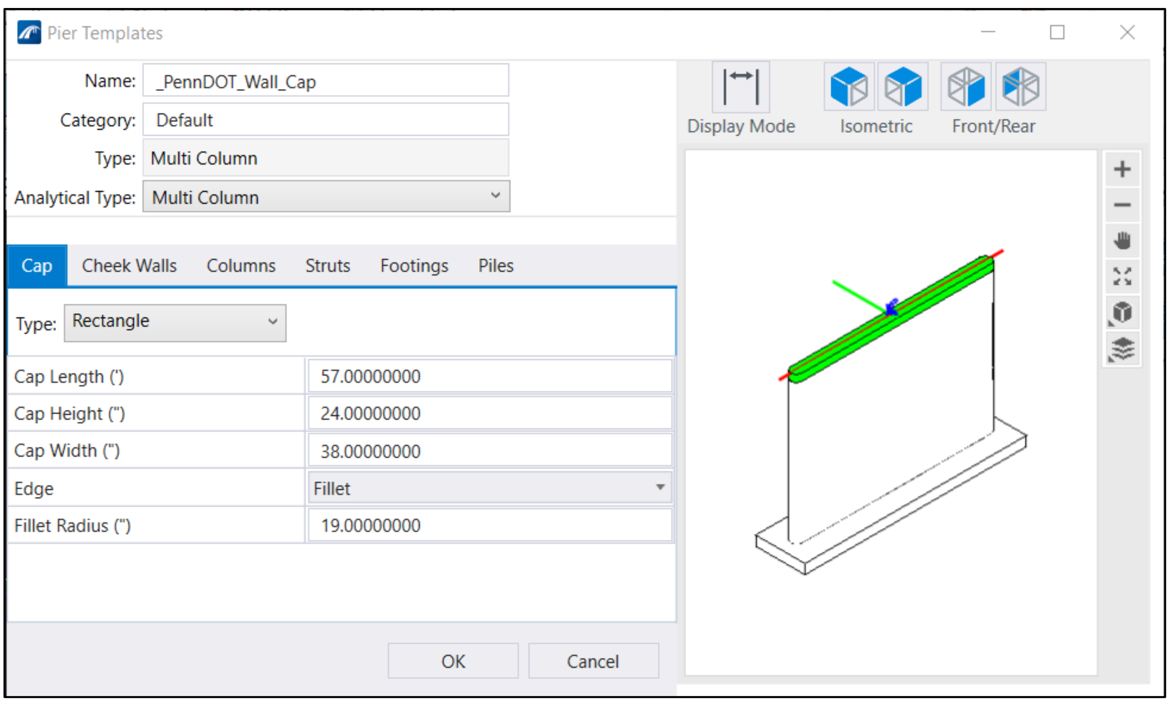


10.2.3 Wall Pier Template

10.2.3.1 Cap Tab

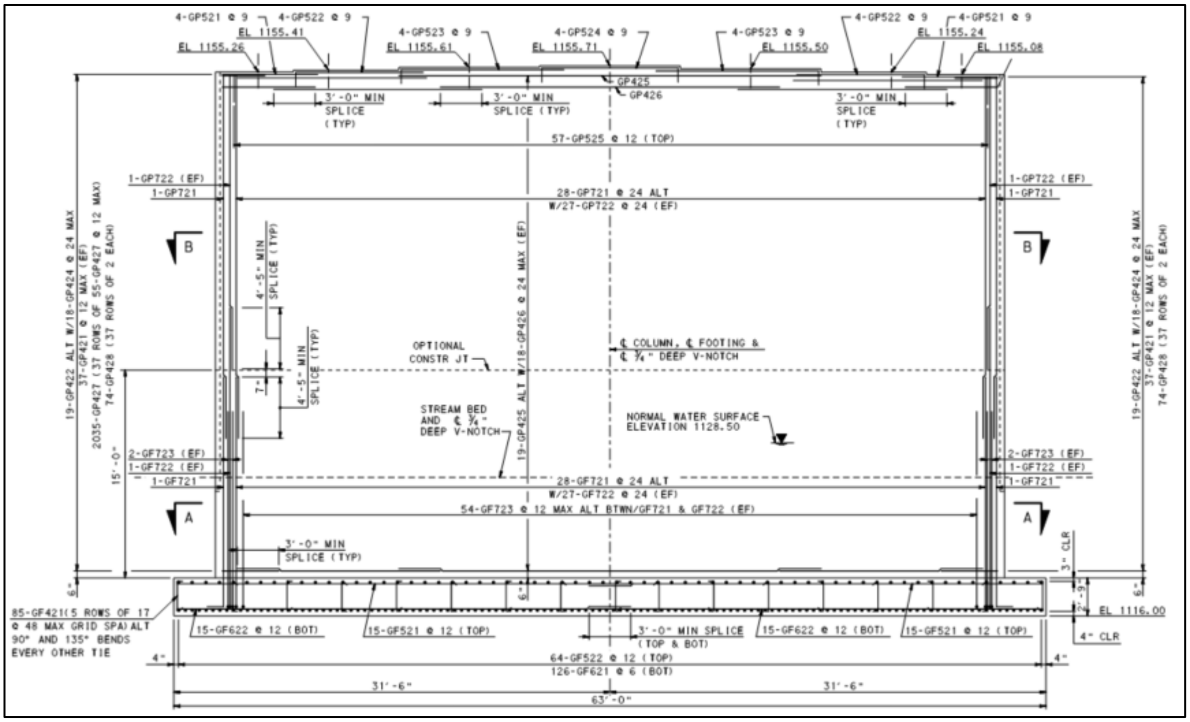


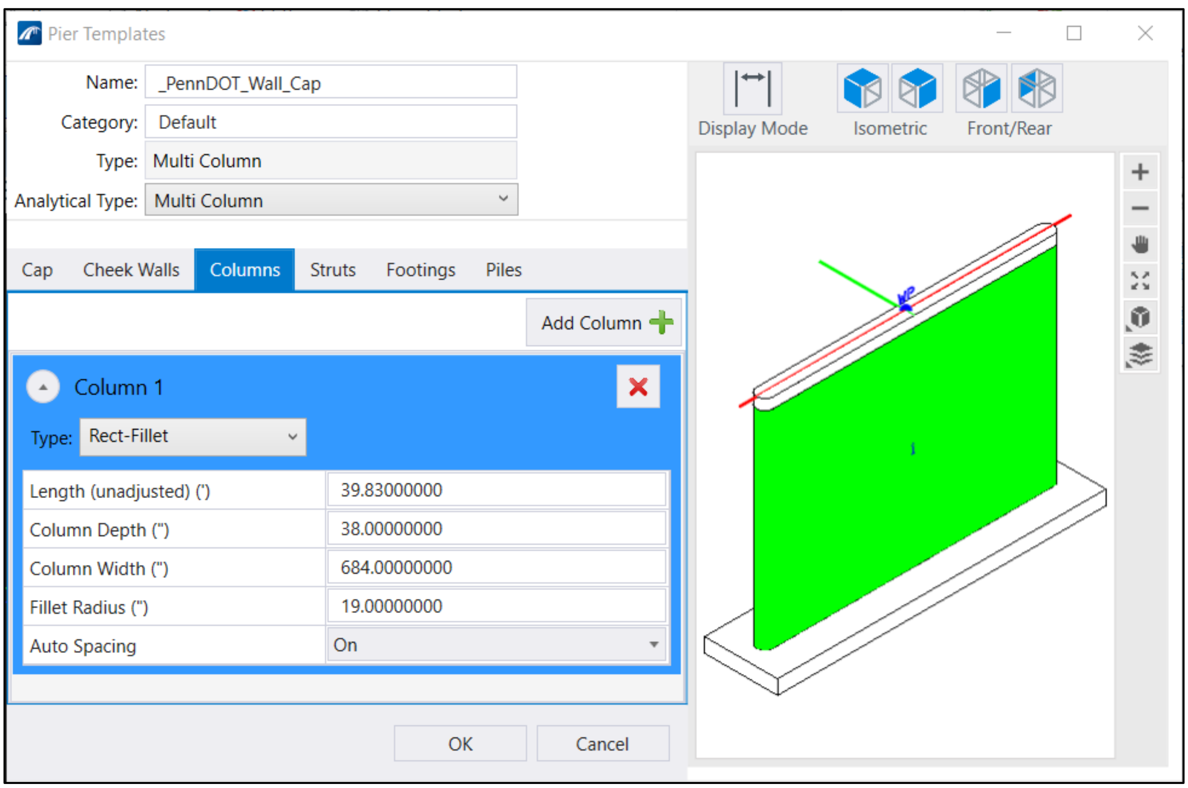




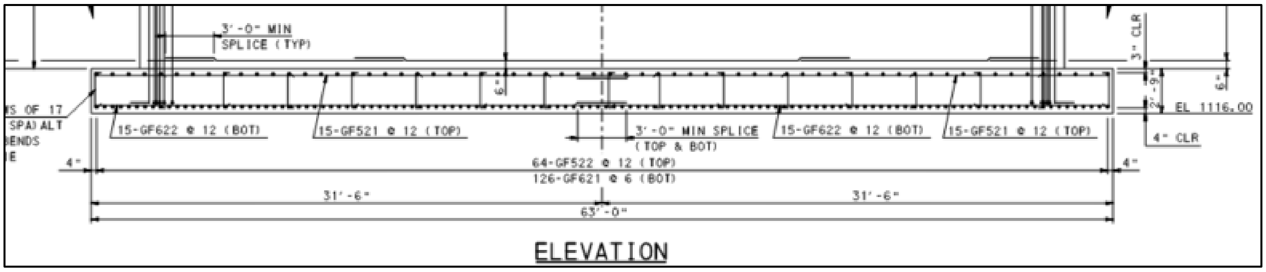
Note: A stepped pier cap or pedestals are modeled with bearing elements. See Section 5.21 Place Bearing for more information.

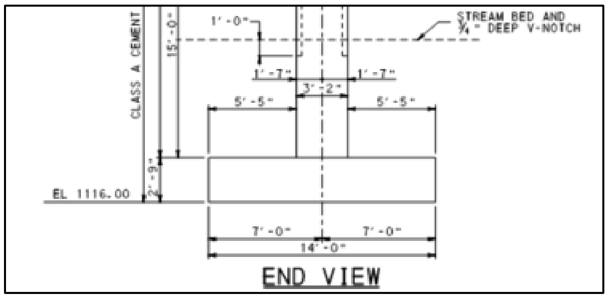
10.2.3.2 Columns Tab

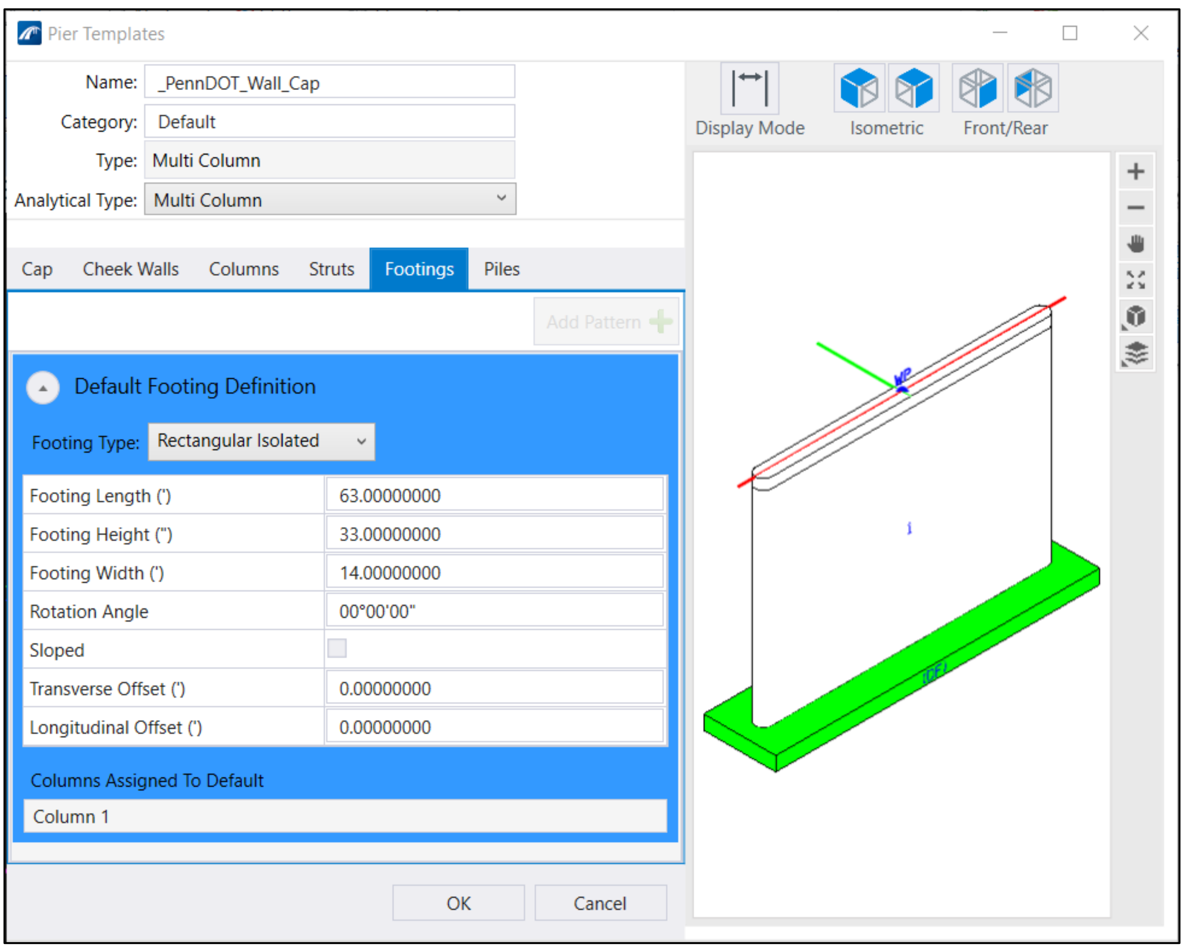




10.2.3.3 Footings Tab

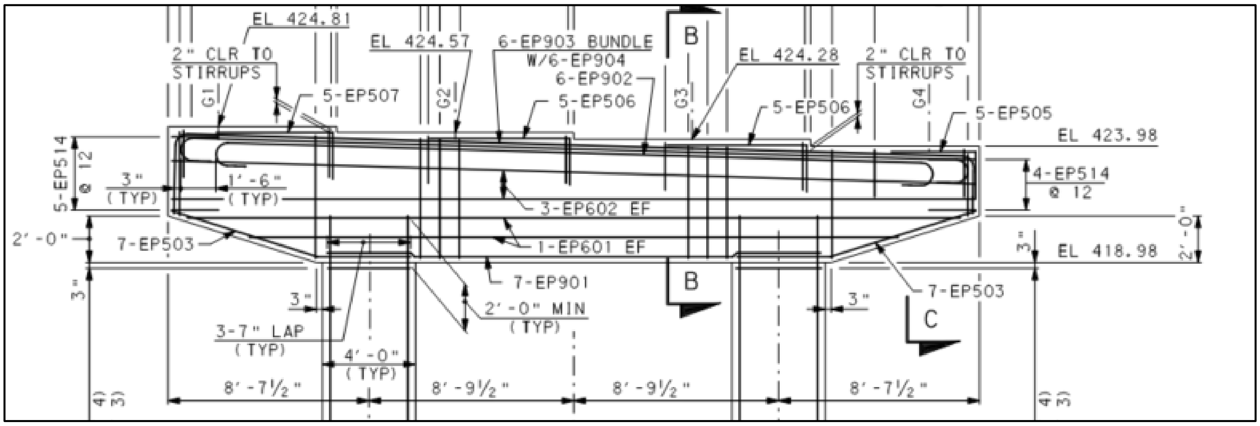


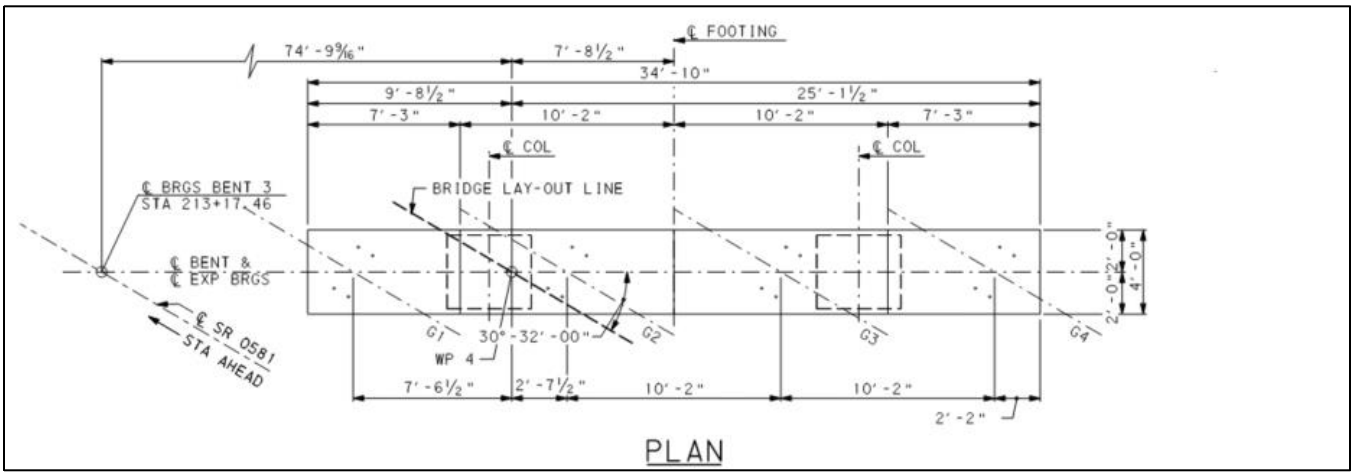


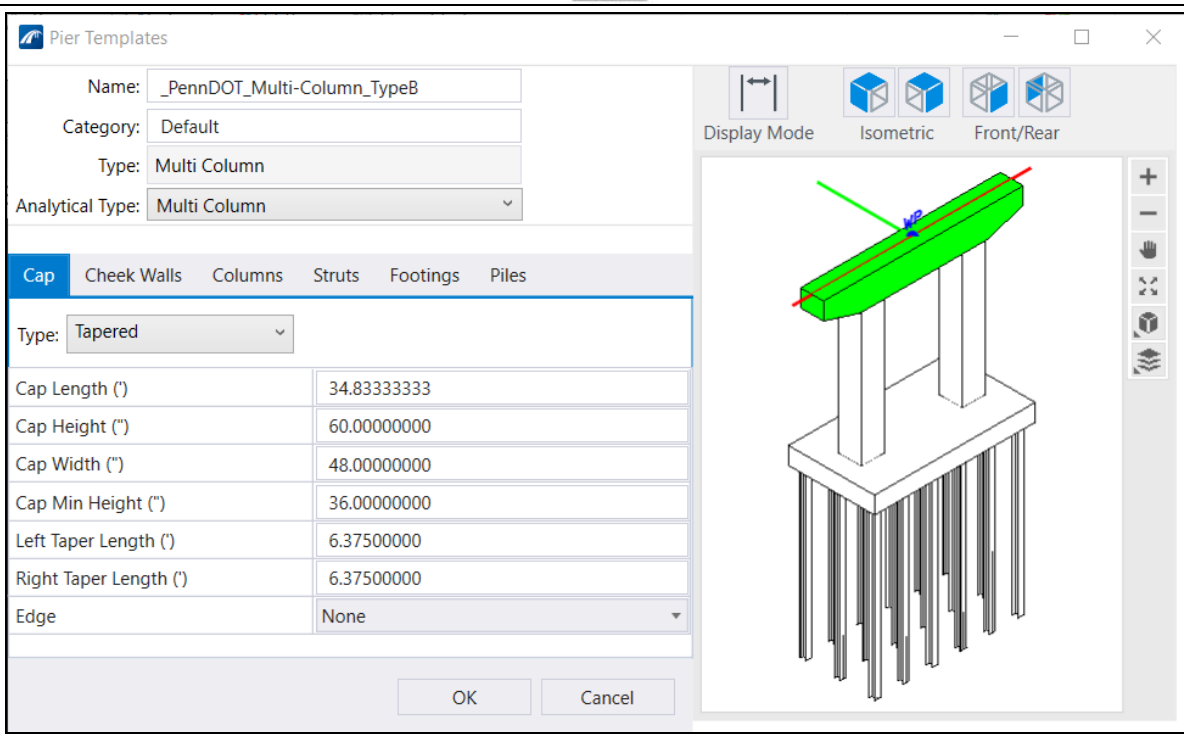


10.2.4 Multicolumn Pier Template

10.2.4.1 Cap Tab

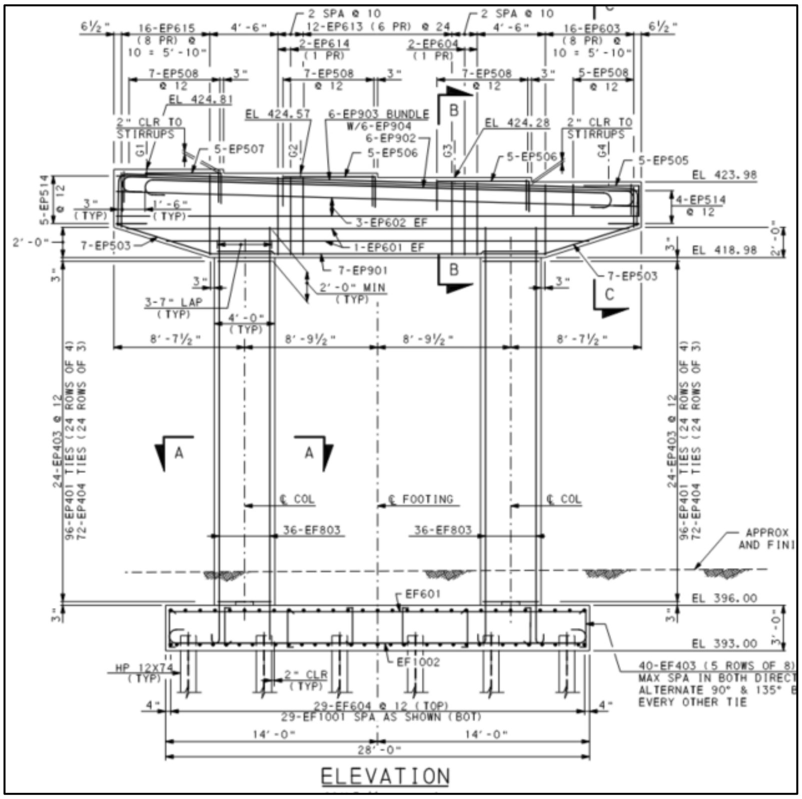


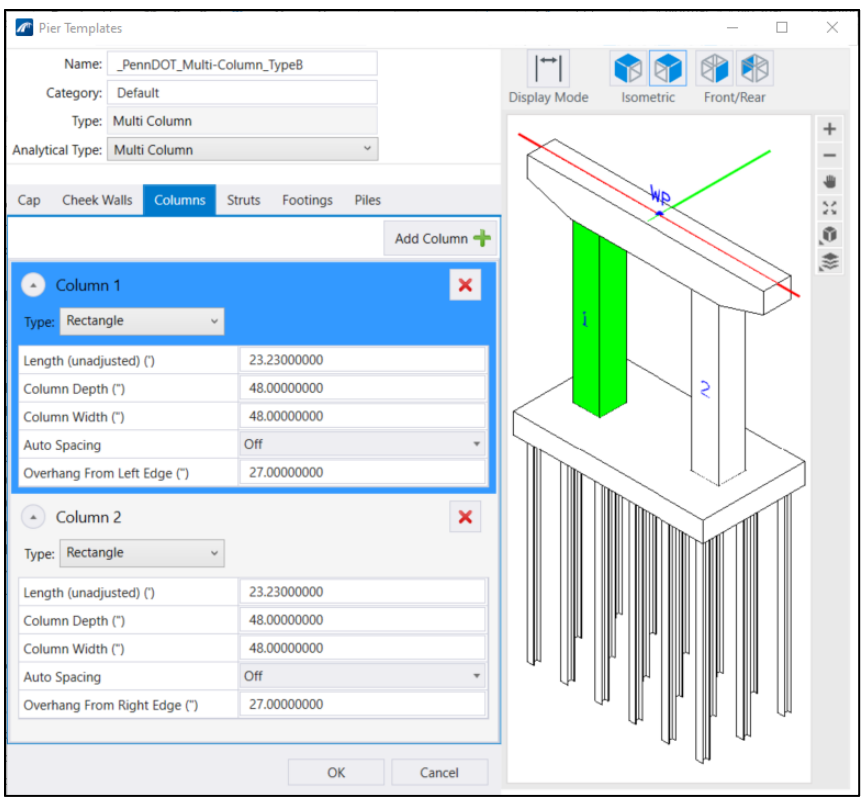




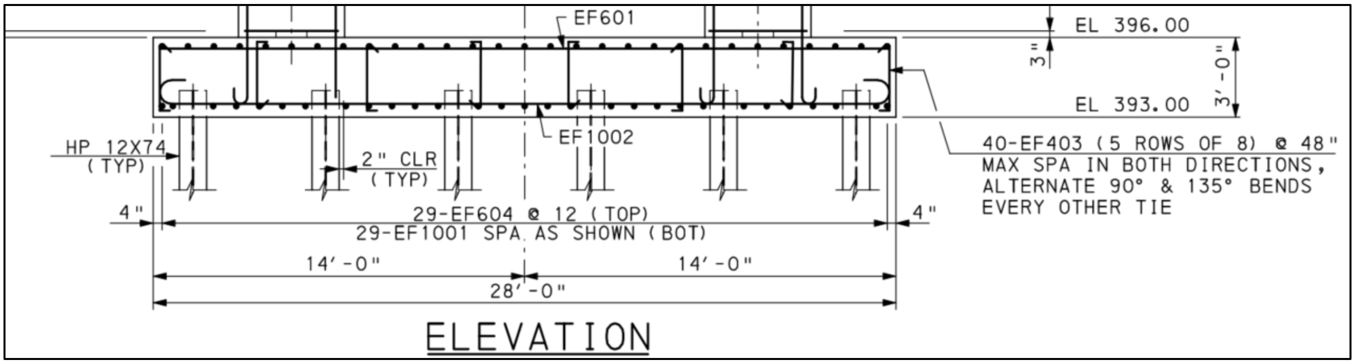
Note: A stepped pier cap or pedestals are modeled with bearing elements. See Section 5.21 Place Bearing for more information.

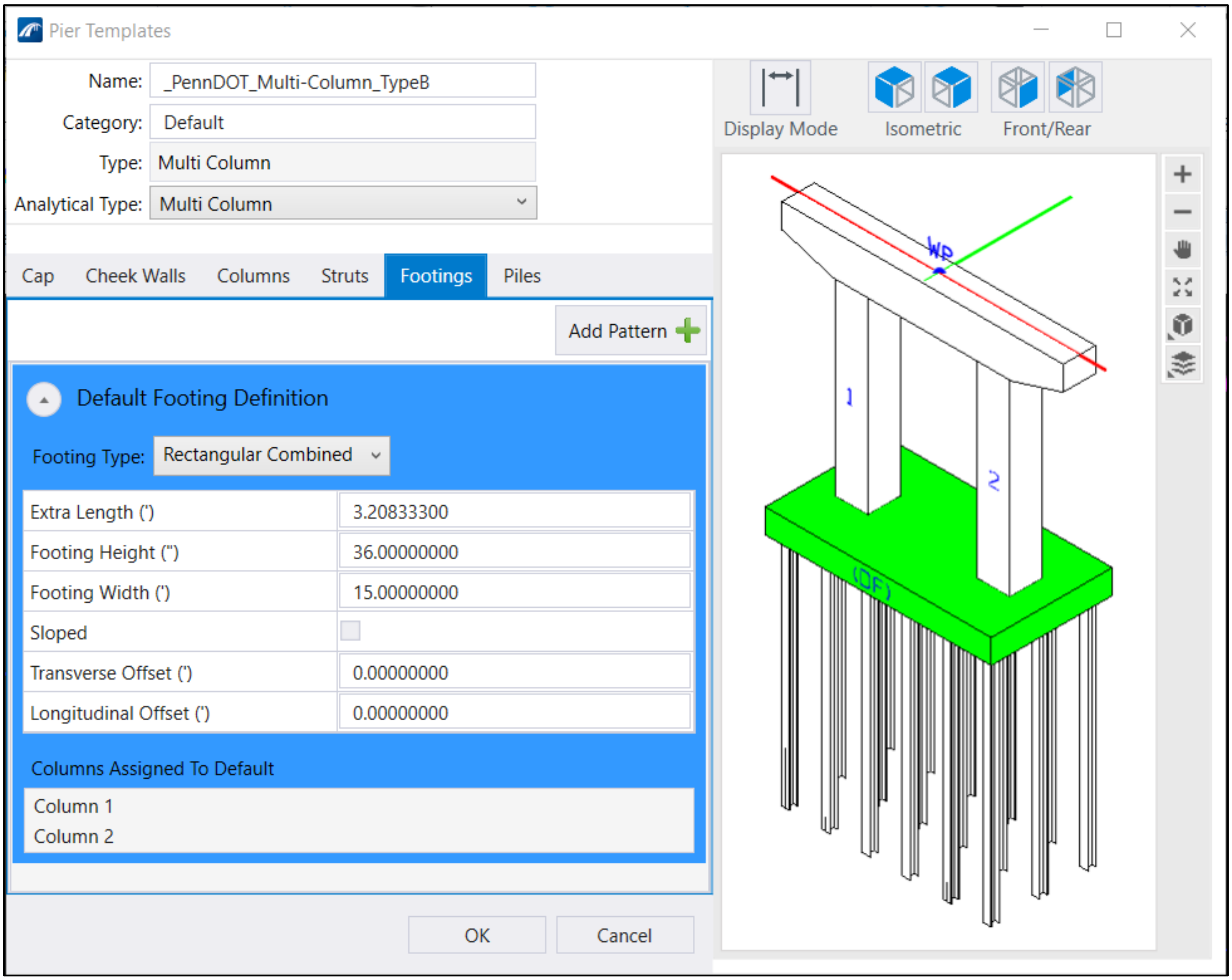
10.2.4.2 Columns Tab



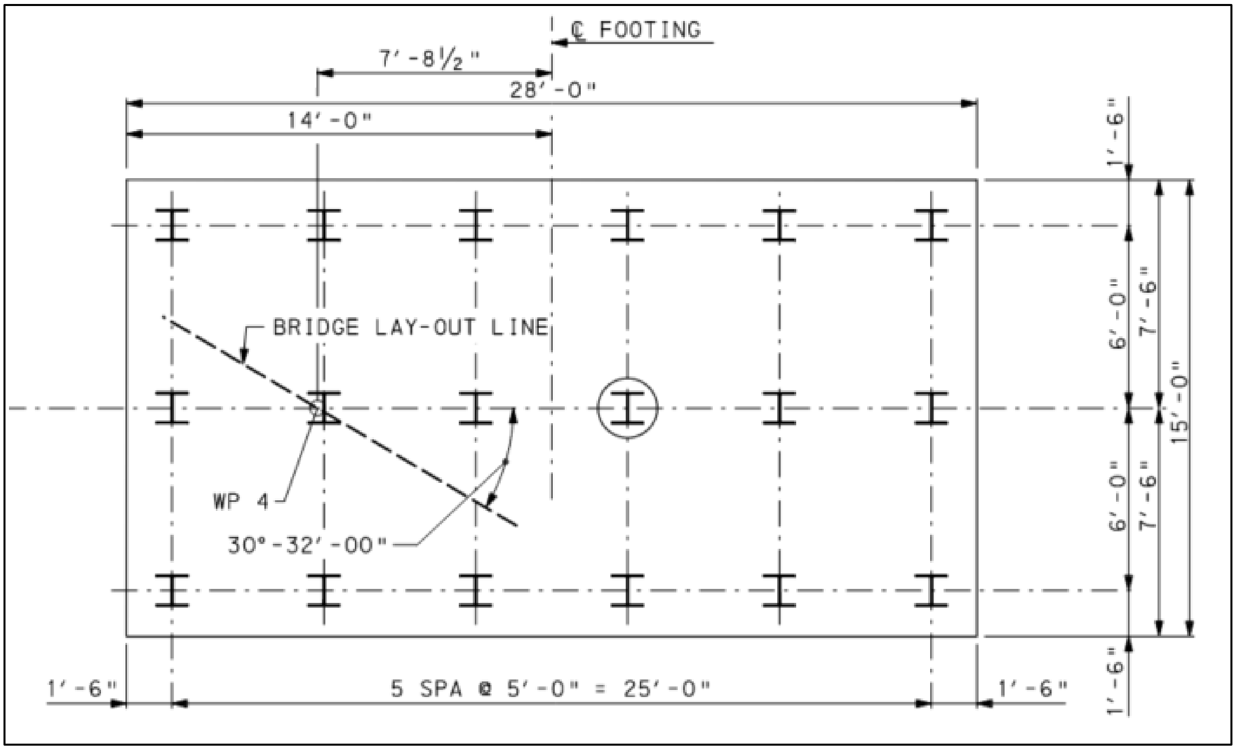


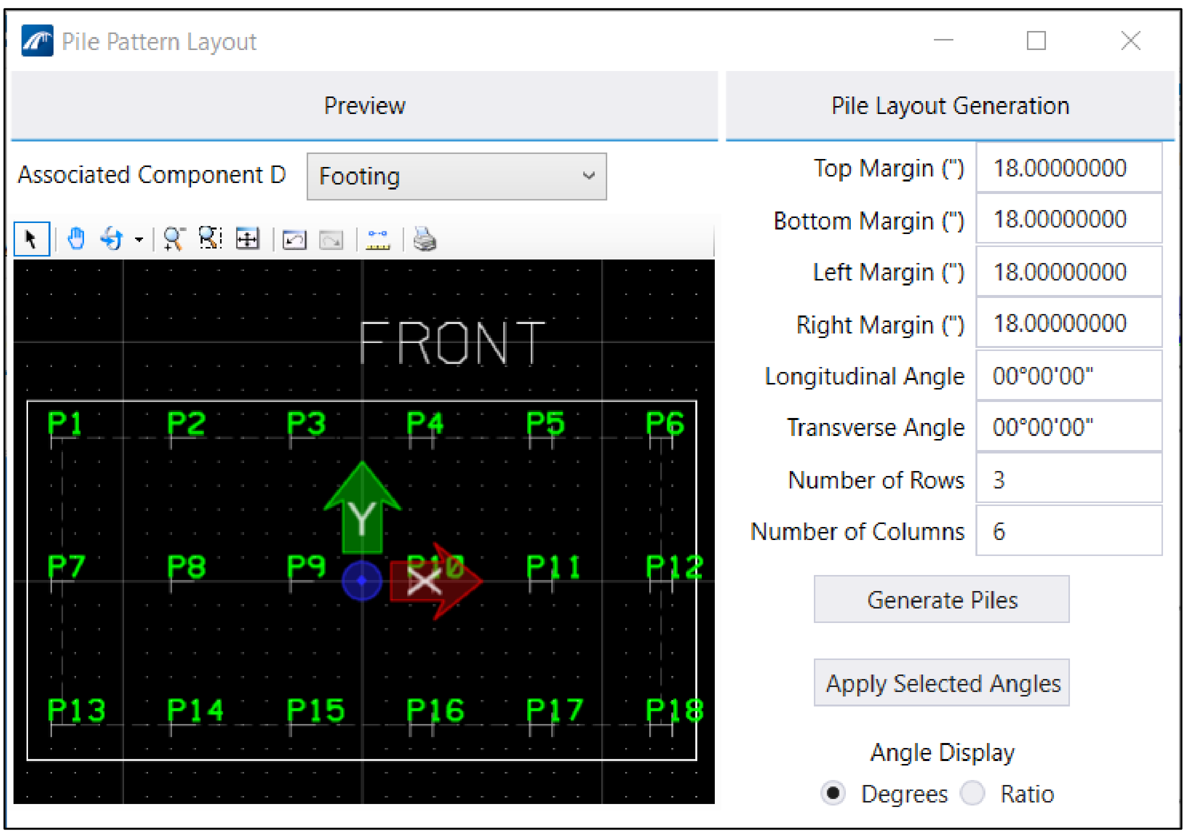
10.2.4.3 Footings Tab

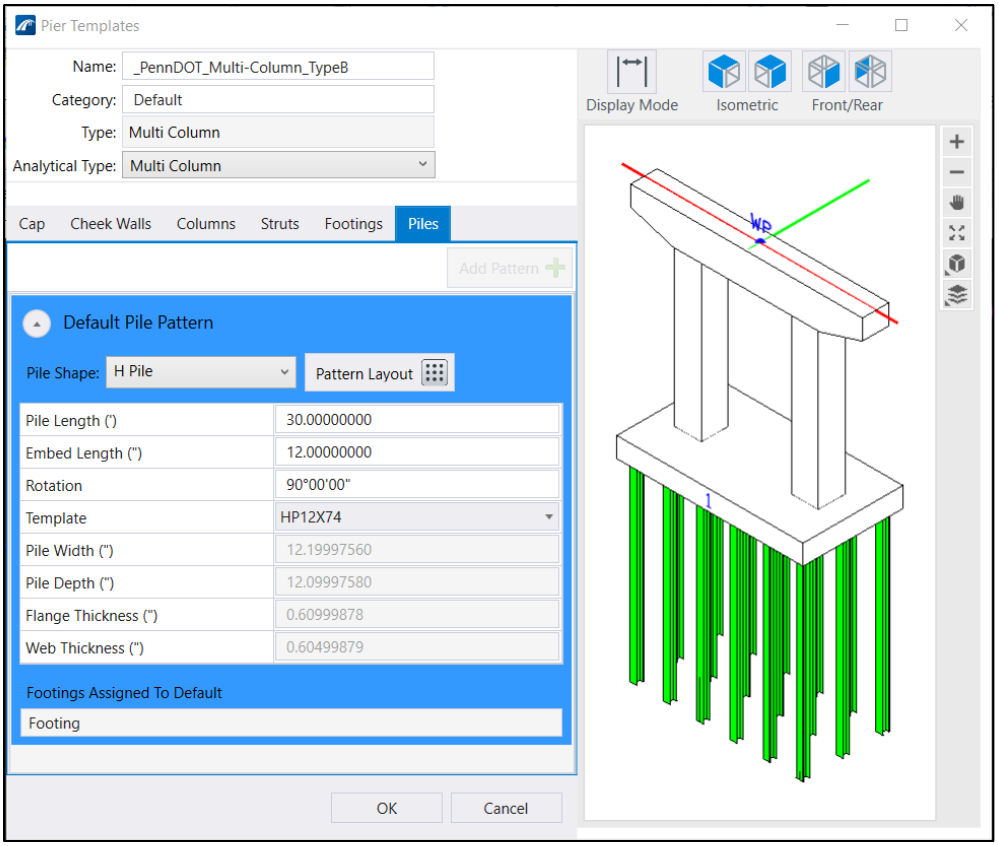




10.2.4.4 Piles Tab

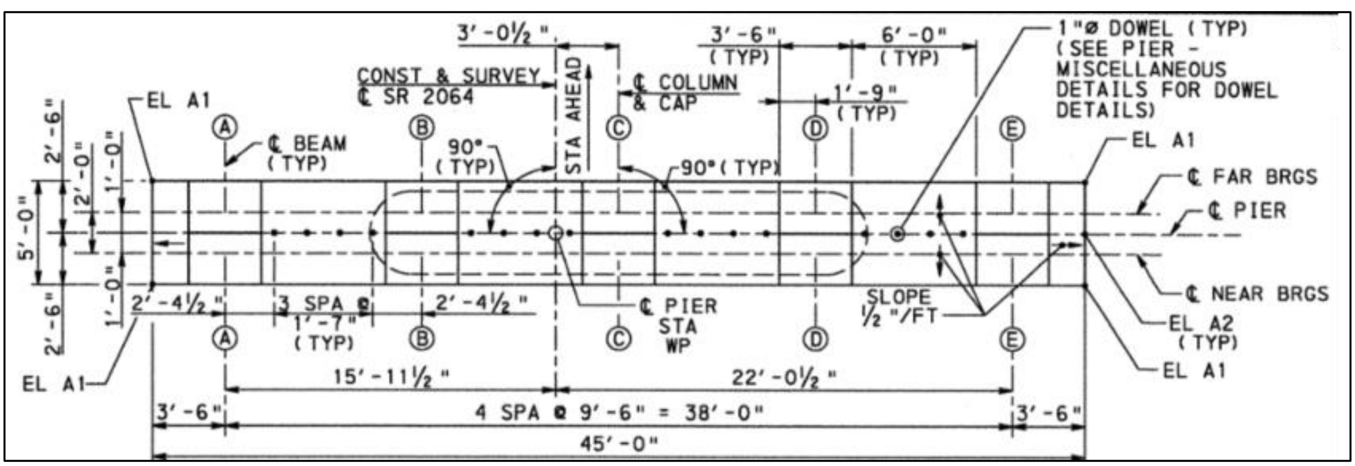


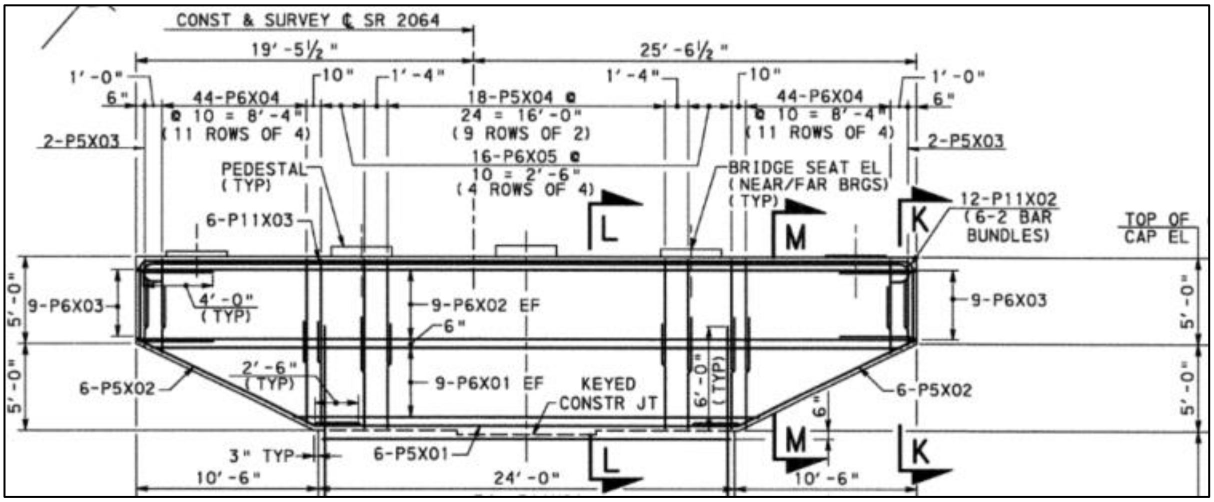


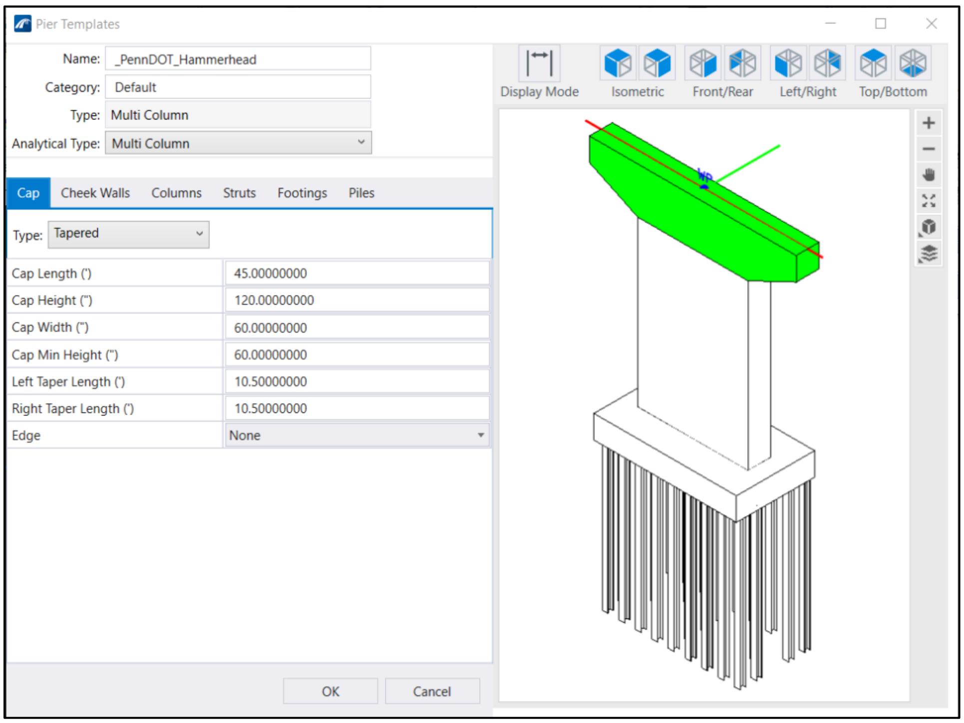


10.2.5 Hammerhead Pier Template

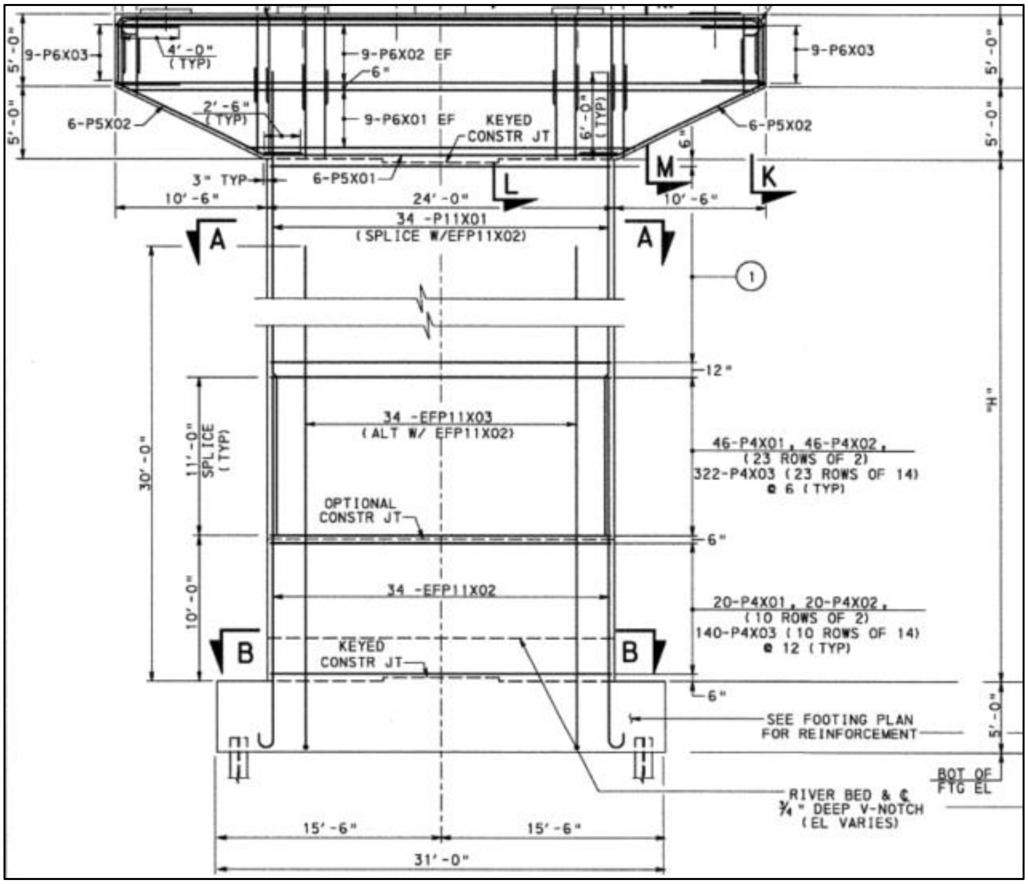
10.2.5.1 Cap Tab



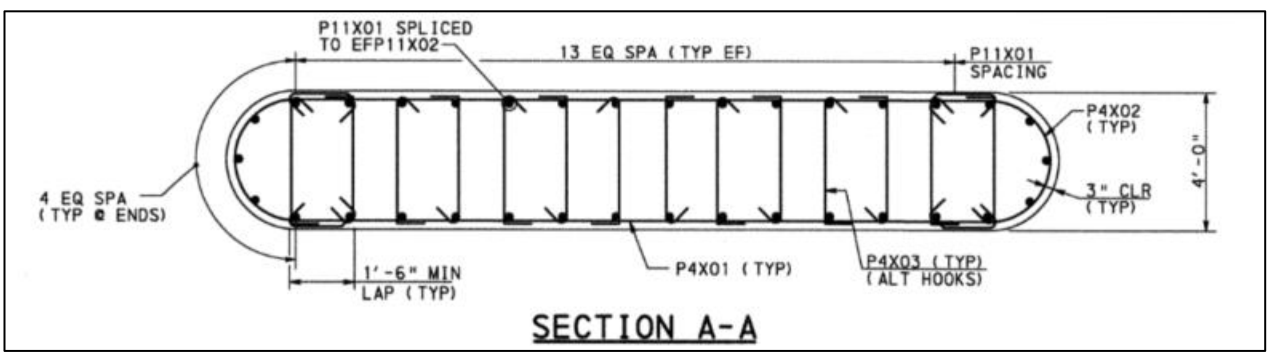

CONST & SURVEY ℄ SR 2064
19'-5½"
25'-6½"
44-P6X04 @ 10 = 8'-4" (11 ROWS OF 4)
18-P5X04 @ 24 = 16'-0" (9 ROWS OF 2)
16-P6X05 @ 10 = 2'-6" (4 ROWS OF 4)
2-P5X03
PEDESTAL (TYP)
6-P11X03
BRIDGE SEAT EL (NEAR/FAR BRGS) (TYP)
12-P11X02 (6-2 BAR BUNDLES)
TOP OF CAP EL
9-P6X03
4'-0" (TYP)
9-P6X02 EF
9-P6X01 EF
KEYED CONSTR JT
6-P5X02
2'-6" (TYP)
3" TYP
6-P5X01
10'-6"
24'-0"
5'-0"

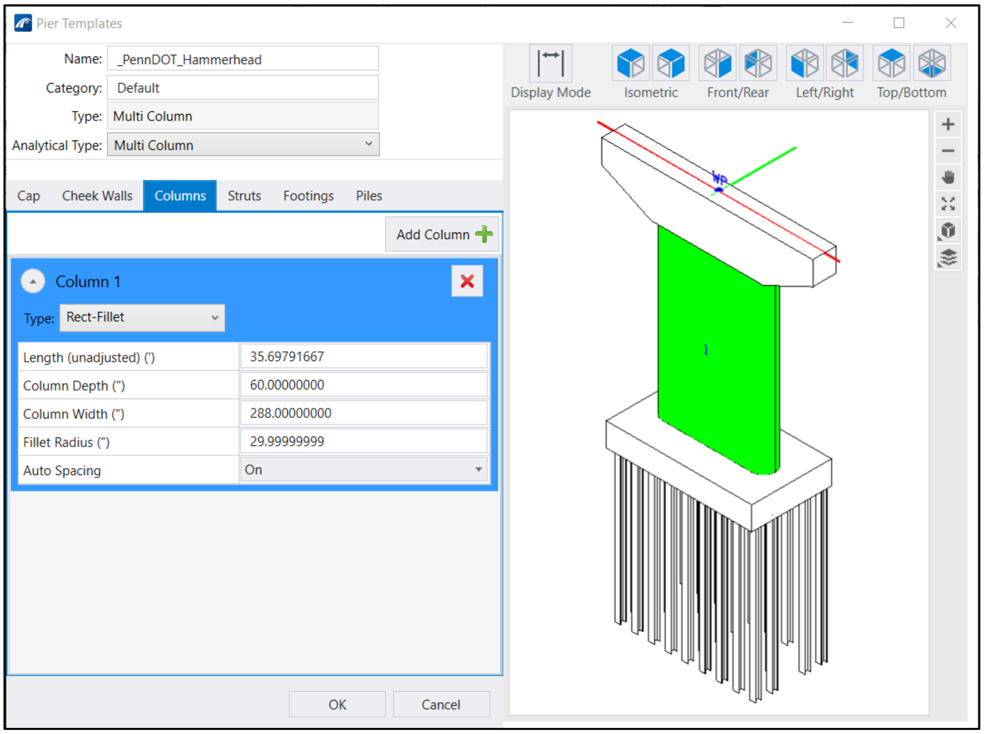

Pier Templates
Name: _PennDOT_Hammerhead
Category: Default
Type: Multi Column
Analytical Type: Multi Column
Cap
Cheek Walls
Columns
Struts
Footings
Piles
Type: Tapered
Cap Length (') 45.00000000
Cap Height (") 120.00000000
Cap Width (") 60.00000000
Cap Min Height (") 60.00000000
Left Taper Length (') 10.50000000
Right Taper Length (') 10.50000000
Edge None
OK
Cancel
Display Mode
Isometric
Front/Rear
Left/Right
Top/Bottom

10.2.5.2 Columns Tab

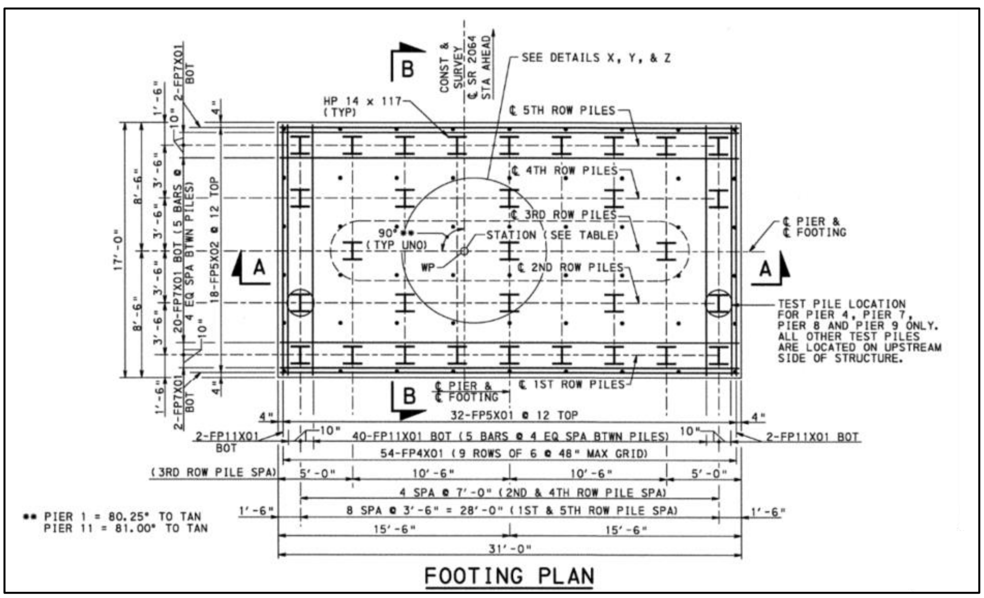


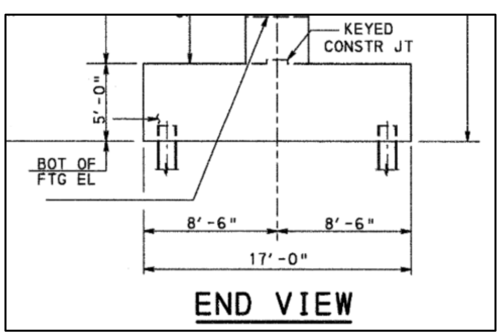
PIER	℄ PIER STATION	WP	TOP OF CAP ELEVATIONS		DIM "H"	BOT OF FTG ELEV
			A1	A2		
3	68+32.64	4	536.70	536.80	35'-8⅜"	486.00

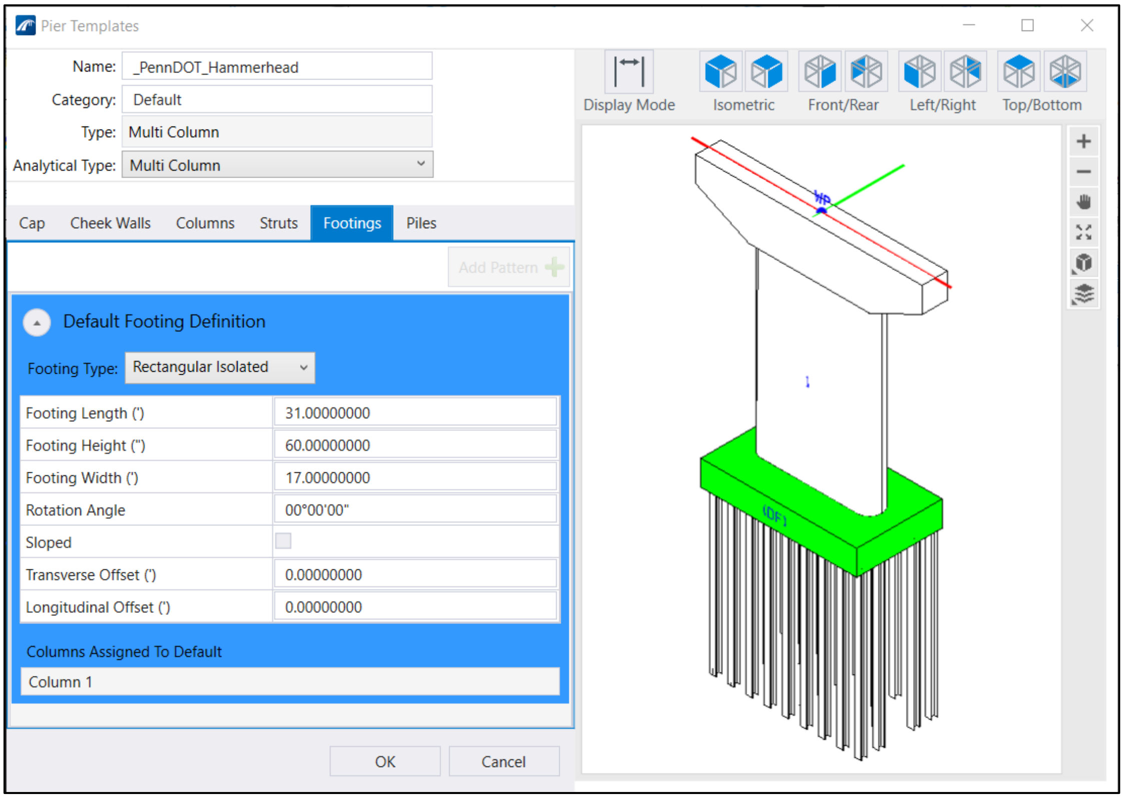




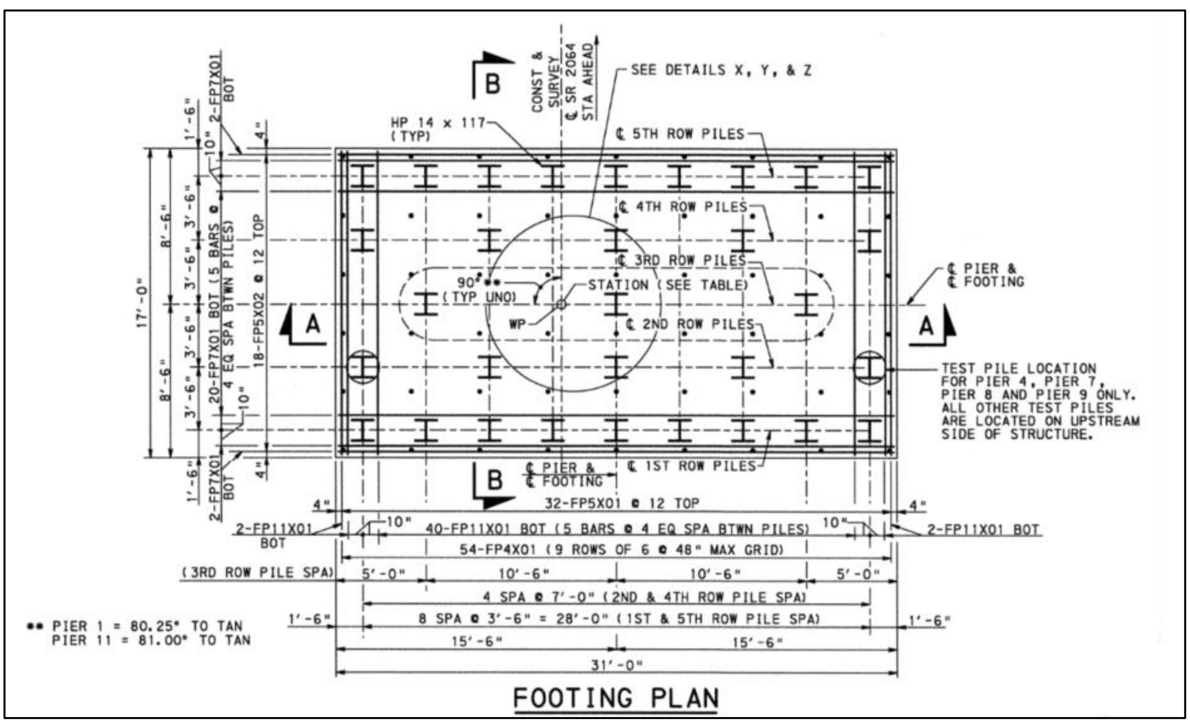
10.2.5.3 Footings Tab

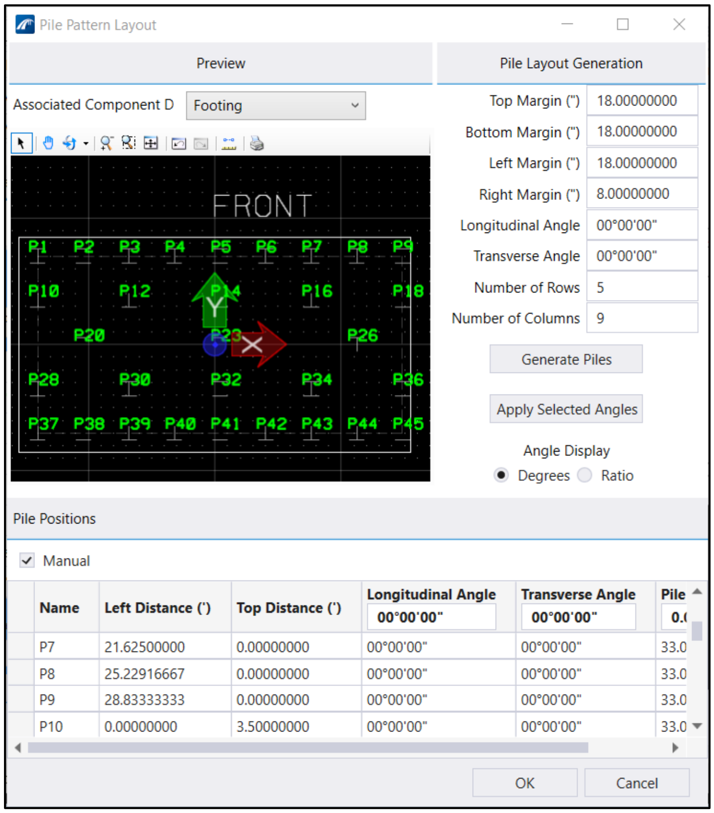




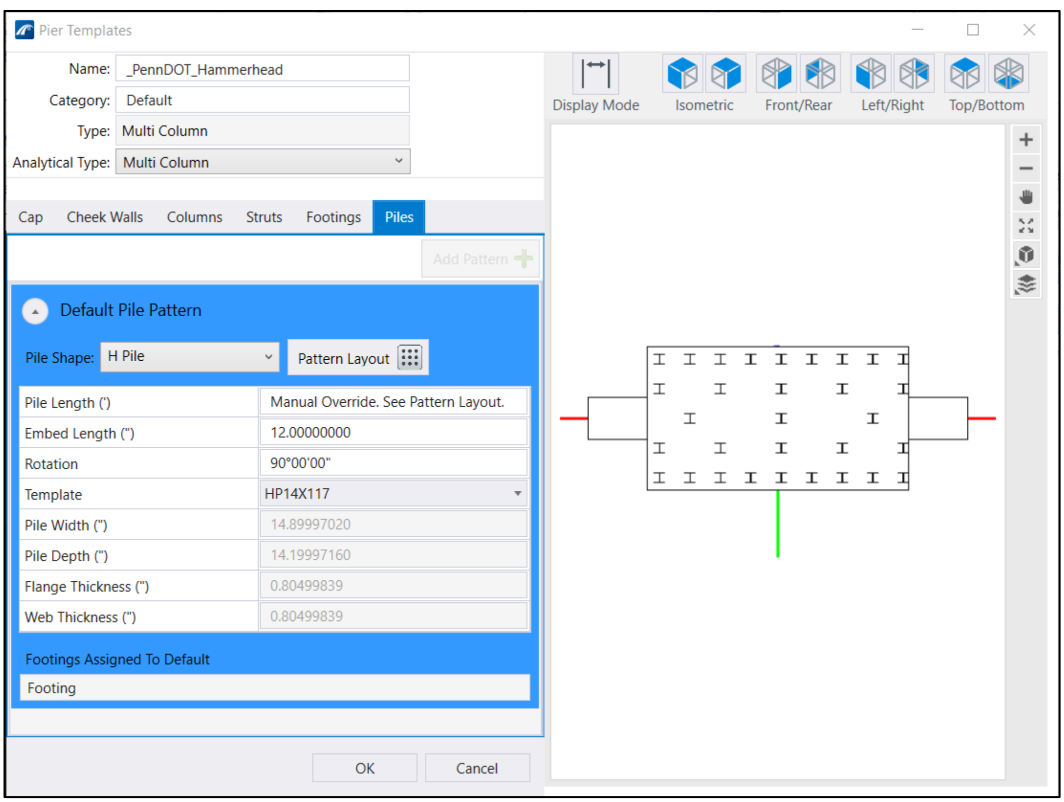


10.2.5.4 Piles Tab



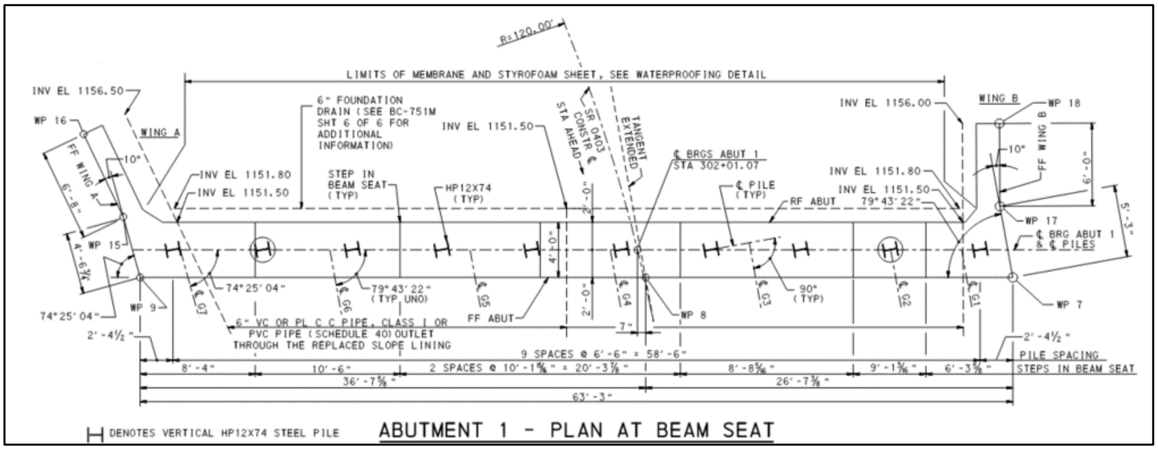


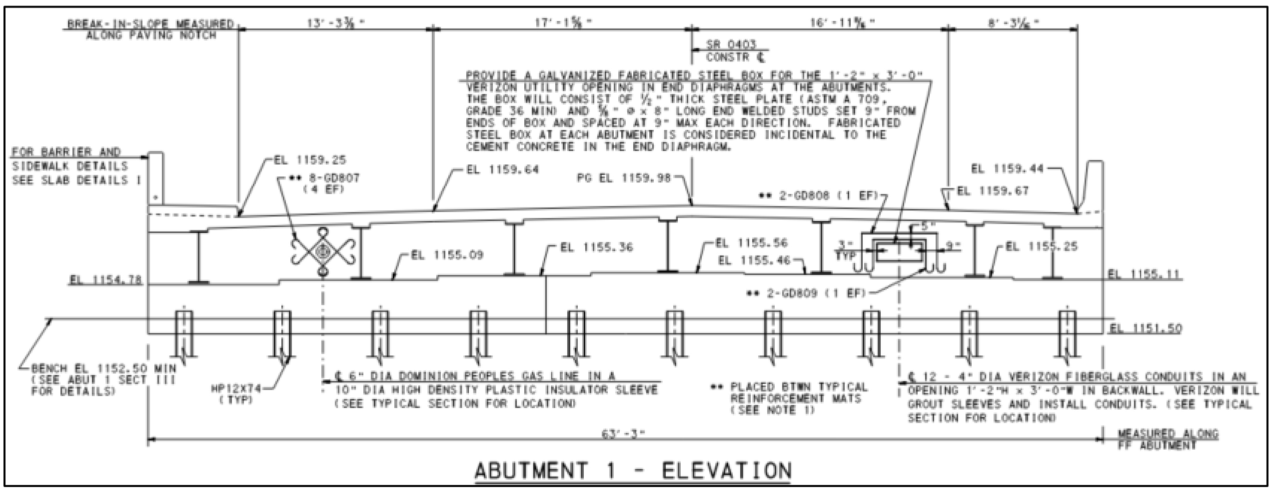
Tips and Tricks: Correct number of rows and columns can be generated automatically then individual piles can be deleted to get the above pattern layout.

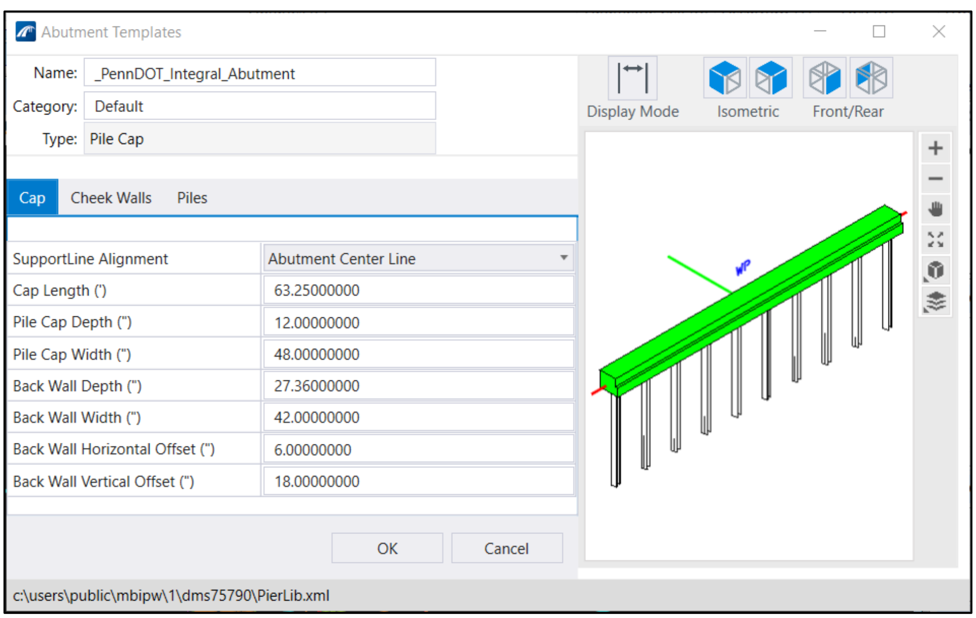


10.2.6 Integrated Abutment and Wingwalls Templates

10.2.6.1 Abutment – Cap Tab

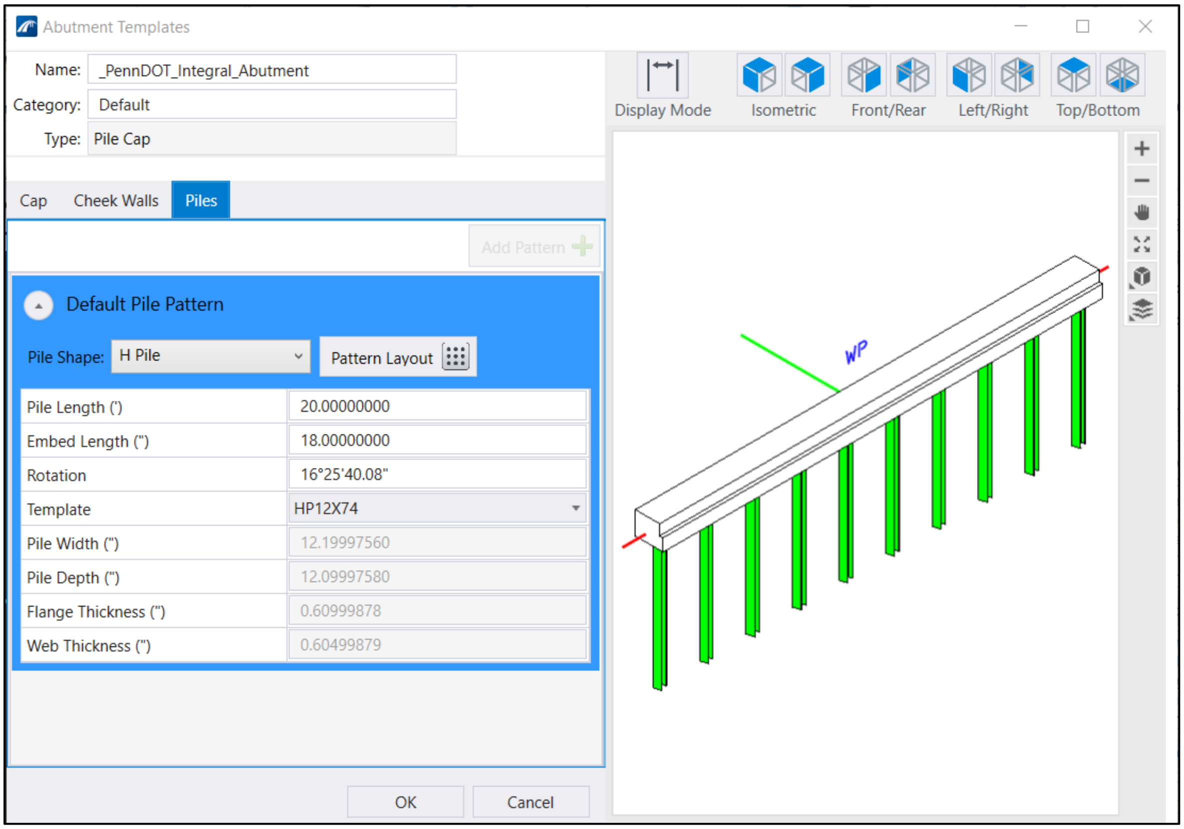


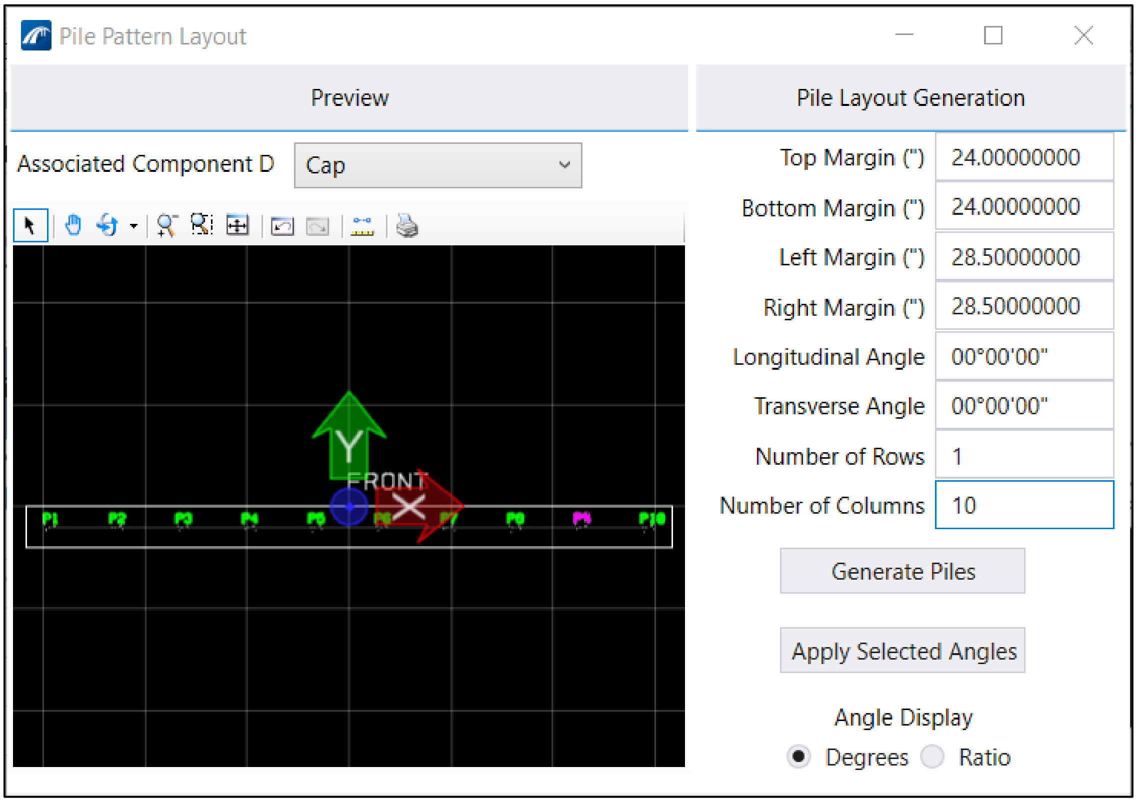




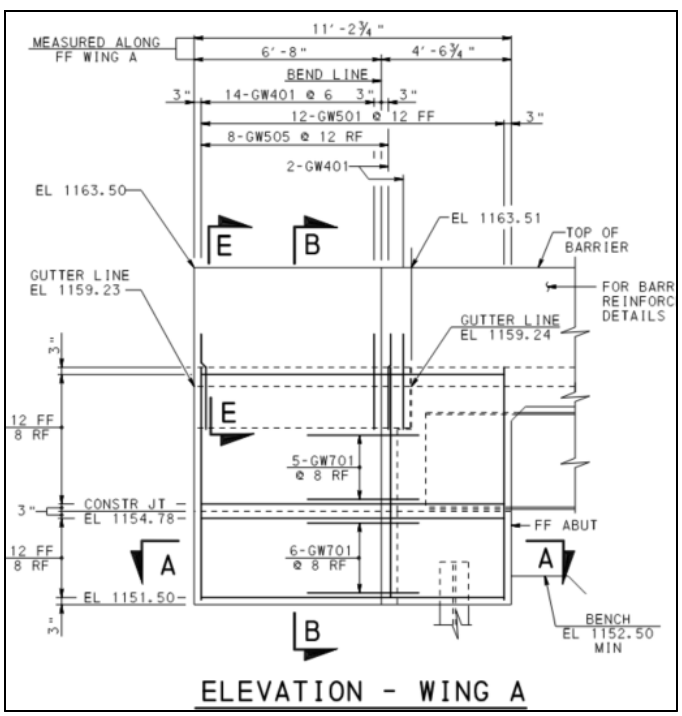
Note: A stepped abutment cap or pedestals are modeled with bearing elements. See Section 5.21 Place Bearing for more information.

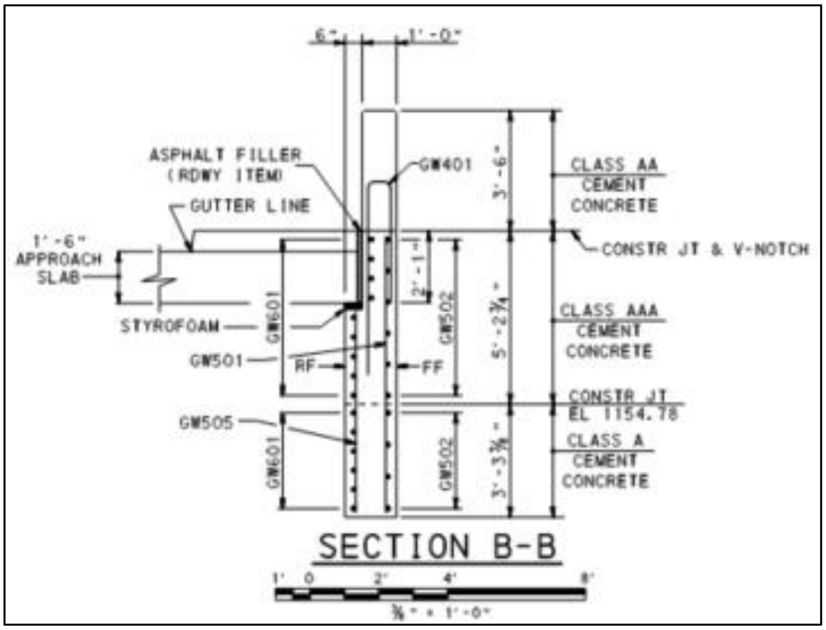
10.2.6.1 Abutment – Piles Tab

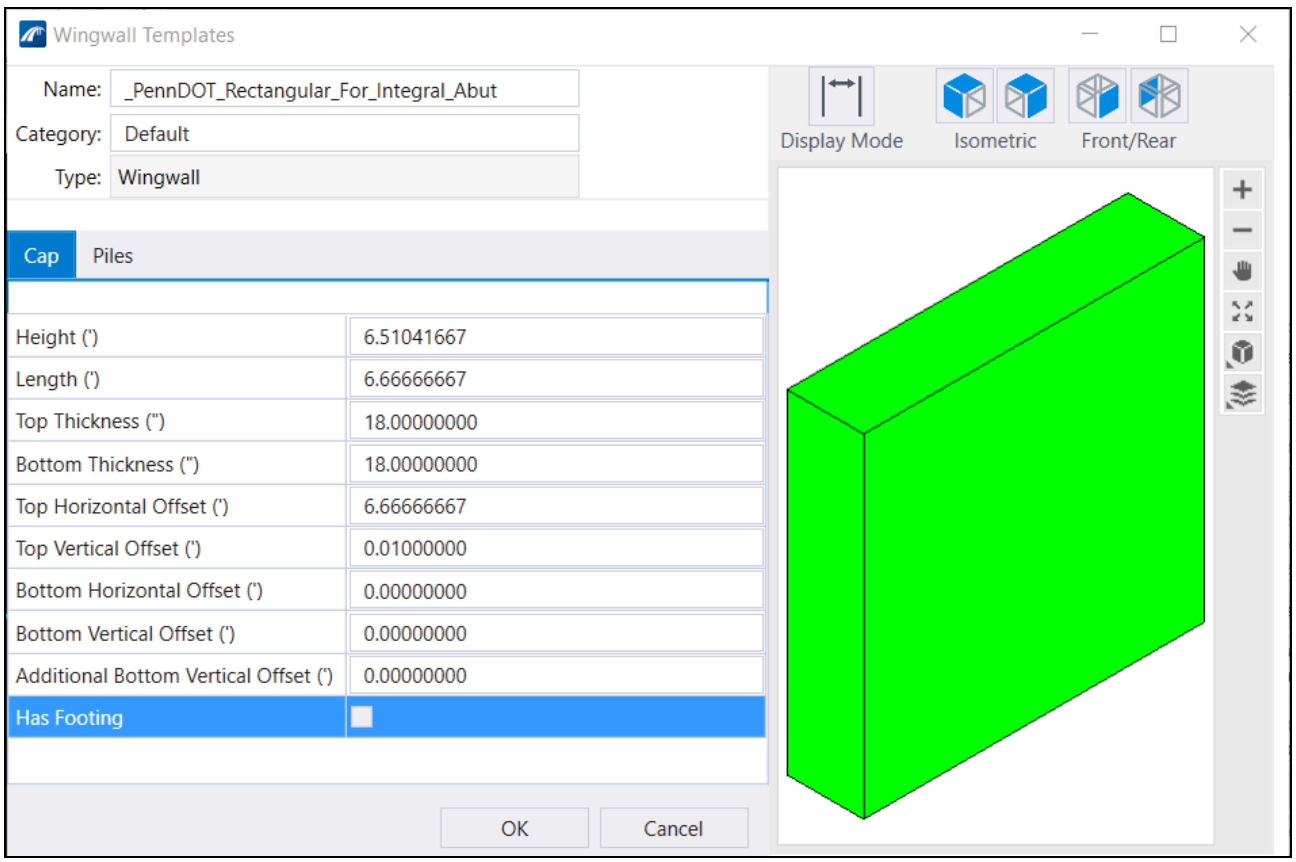


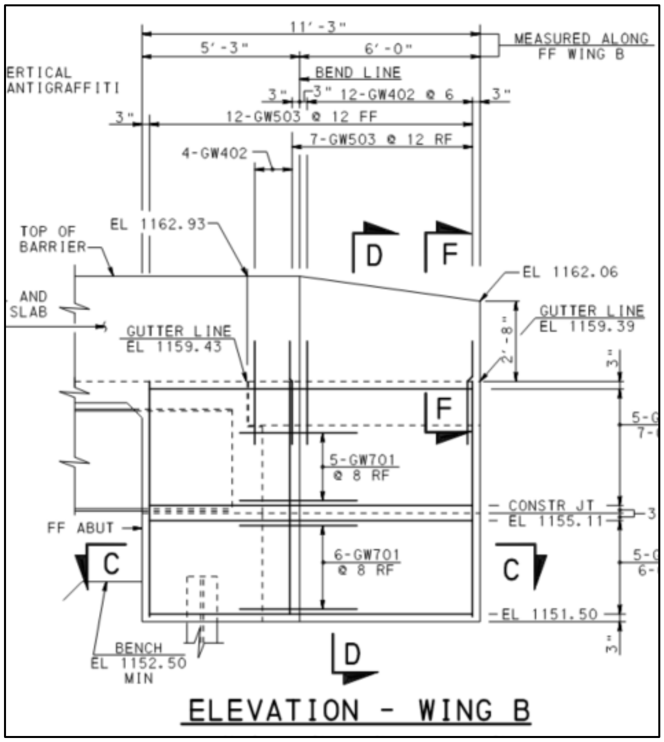


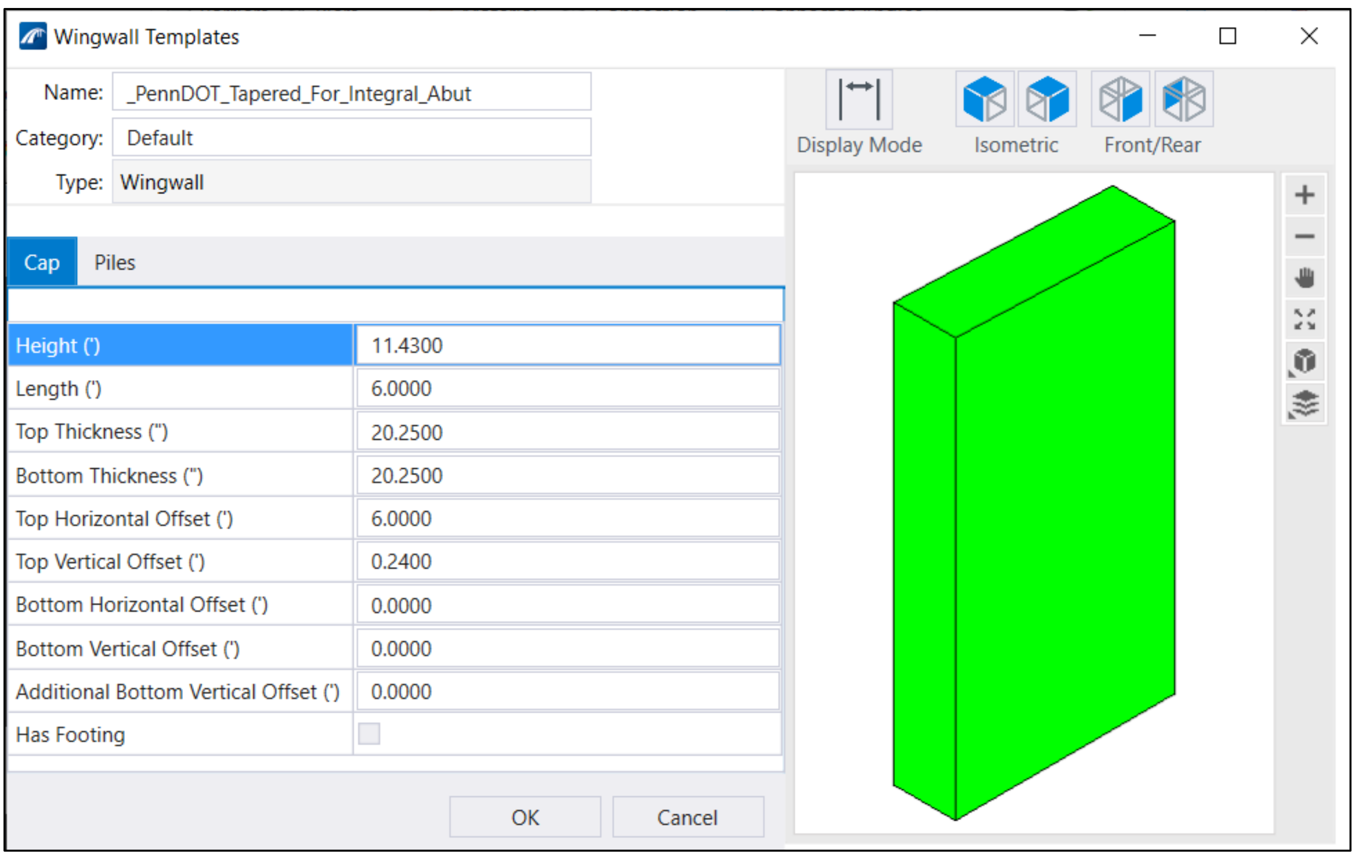
10.2.6.1 Rectangular Wingwall – Cap Tab



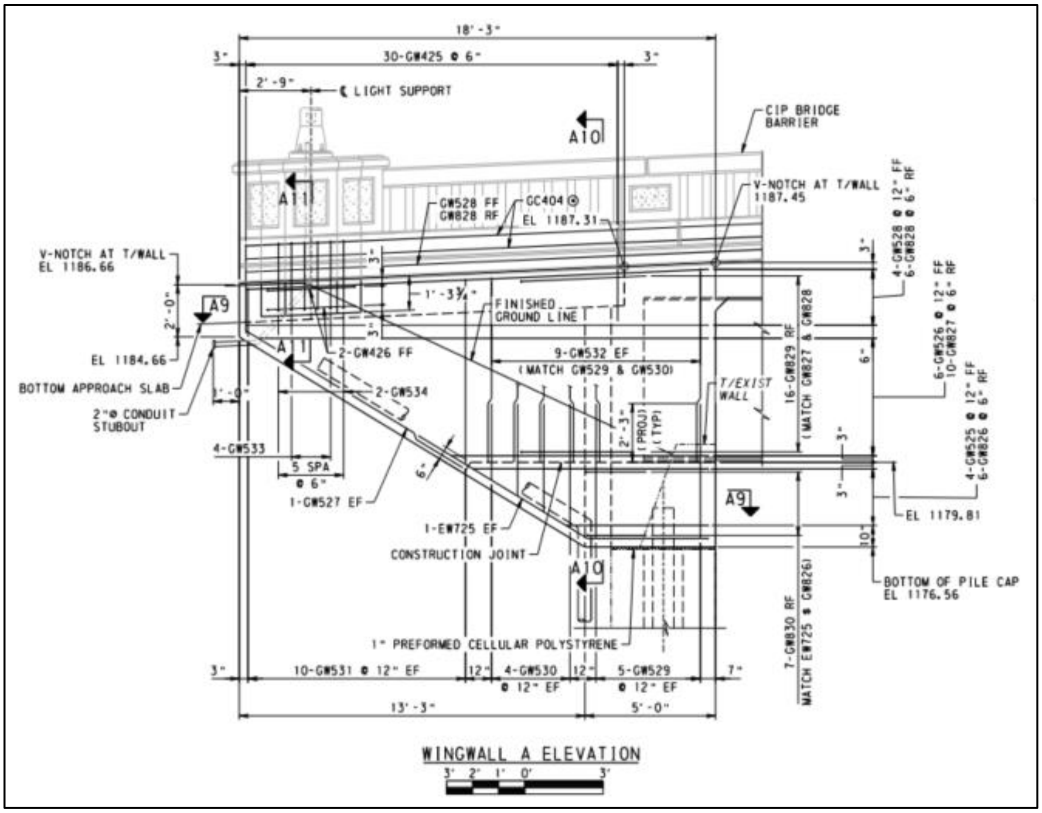

6"
1'-0"
ASPHALT FILLER
(RDWY ITEM)
GUTTER LINE
GW401
3'-6"
CLASS AA
CEMENT
CONCRETE
CONSTR JT & V-NOTCH
1'-6"
APPROACH
SLAB
2'-1"
STYROFOAM
GW601
GW502
5'-2¾"
CLASS AAA
CEMENT
CONCRETE
GW501
RF
FF
CONSTR JT
EL 1154.78
GW505
CLASS A
CEMENT
CONCRETE
3'-3¾"
SECTION B-B
⅜" = 1'-0"

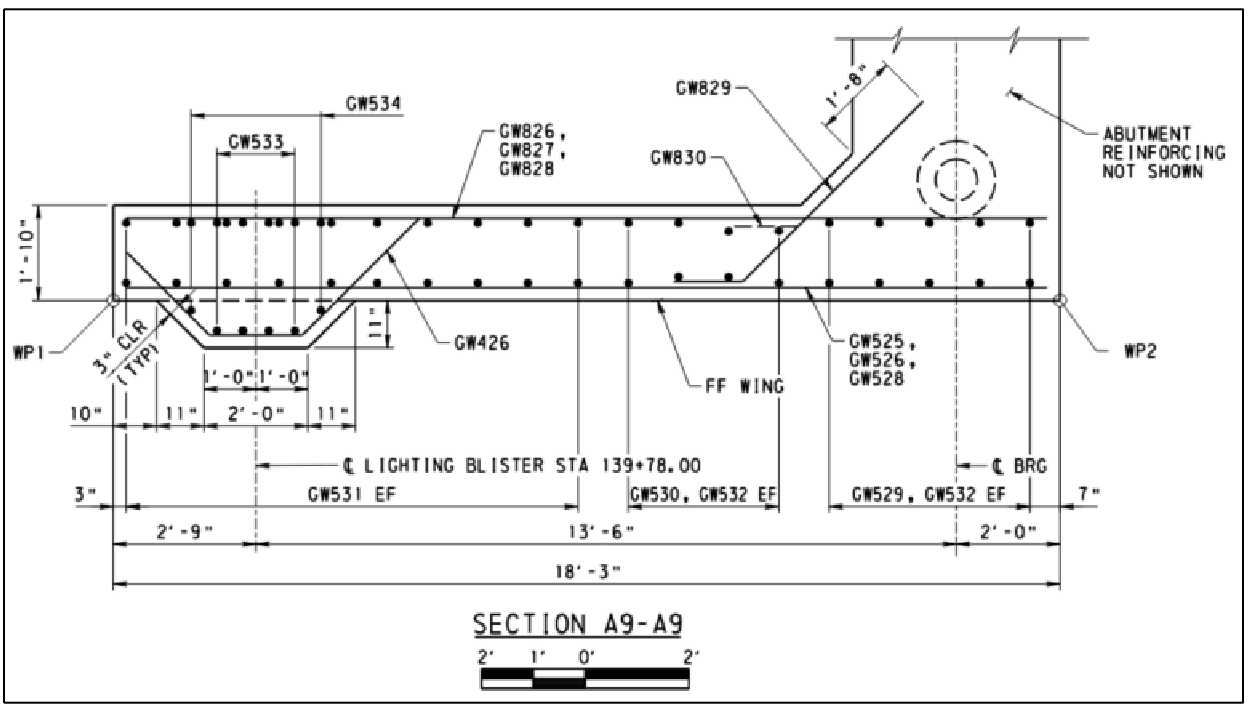

Wingwall Templates
Name: _PennDOT_Rectangular_For_Integral_Abut
Category: Default
Type: Wingwall
Display Mode
Isometric
Front/Rear
Cap
Piles
Height (') 6.51041667
Length (') 6.66666667
Top Thickness (") 18.00000000
Bottom Thickness (") 18.00000000
Top Horizontal Offset (') 6.66666667
Top Vertical Offset (') 0.01000000
Bottom Horizontal Offset (') 0.00000000
Bottom Vertical Offset (') 0.00000000
Additional Bottom Vertical Offset (') 0.00000000
Has Footing
OK
Cancel

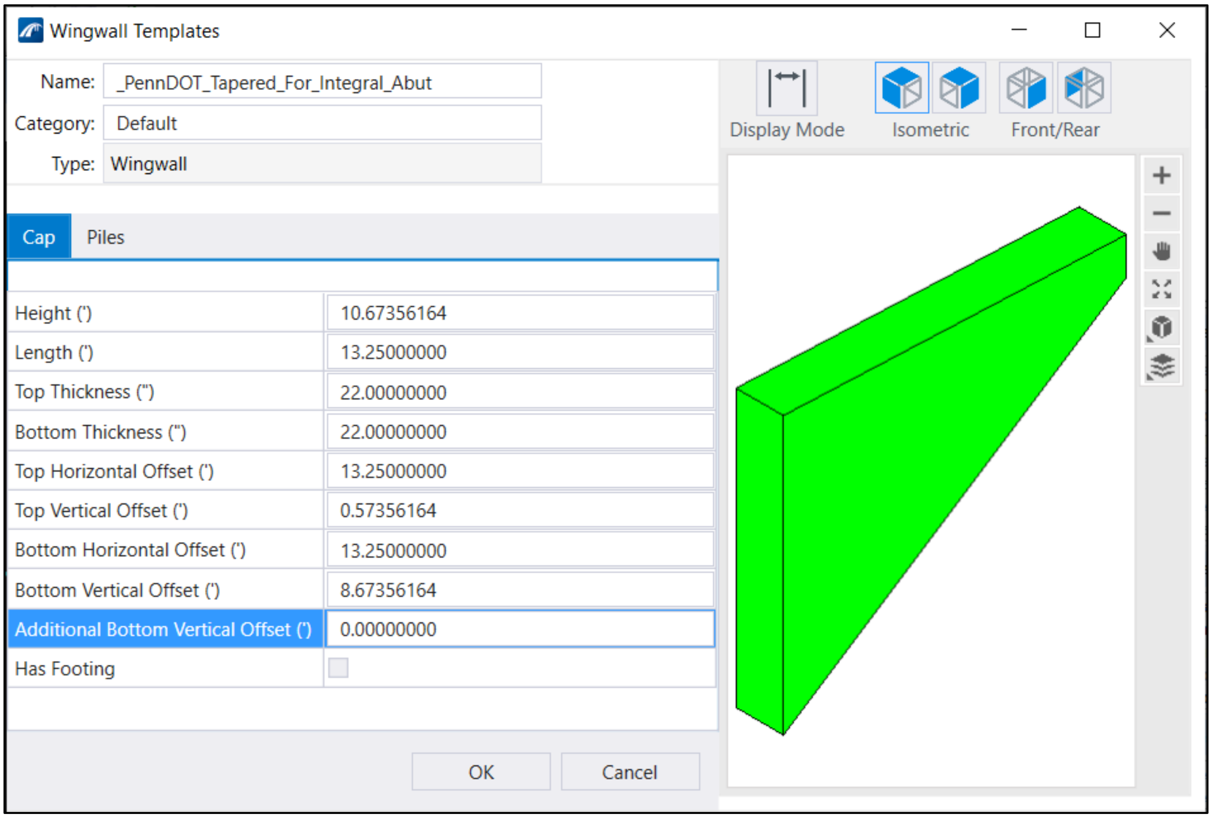

11'-3"
5'-3"
6'-0"
MEASURED ALONG FF WING B
ERTICAL ANTIGRAFFITI
BEND LINE
3"
3" 12-GW402 @ 6
3"
3"
12-GW503 @ 12 FF
7-GW503 @ 12 RF
4-GW402
TOP OF BARRIER
EL 1162.93
D
F
EL 1162.06
AND SLAB
GUTTER LINE EL 1159.43
GUTTER LINE EL 1159.39
2'-8"
3"
F
5-GW701 @ 8 RF
CONSTR JT EL 1155.11
FF ABUT
6-GW701 @ 8 RF
C
C
EL 1151.50
3"
BENCH EL 1152.50 MIN
D
ELEVATION - WING B


Wingwall Templates
Name: _PennDOT_Tapered_For_Integral_Abut
Category: Default
Type: Wingwall
Display Mode
Isometric
Front/Rear
Cap
Piles
Height (') 11.4300
Length (') 6.0000
Top Thickness (") 20.2500
Bottom Thickness (") 20.2500
Top Horizontal Offset (') 6.0000
Top Vertical Offset (') 0.2400
Bottom Horizontal Offset (') 0.0000
Bottom Vertical Offset (') 0.0000
Additional Bottom Vertical Offset (') 0.0000
Has Footing
OK
Cancel

10.2.6.2 Tapered Wingwall – Cap Tab

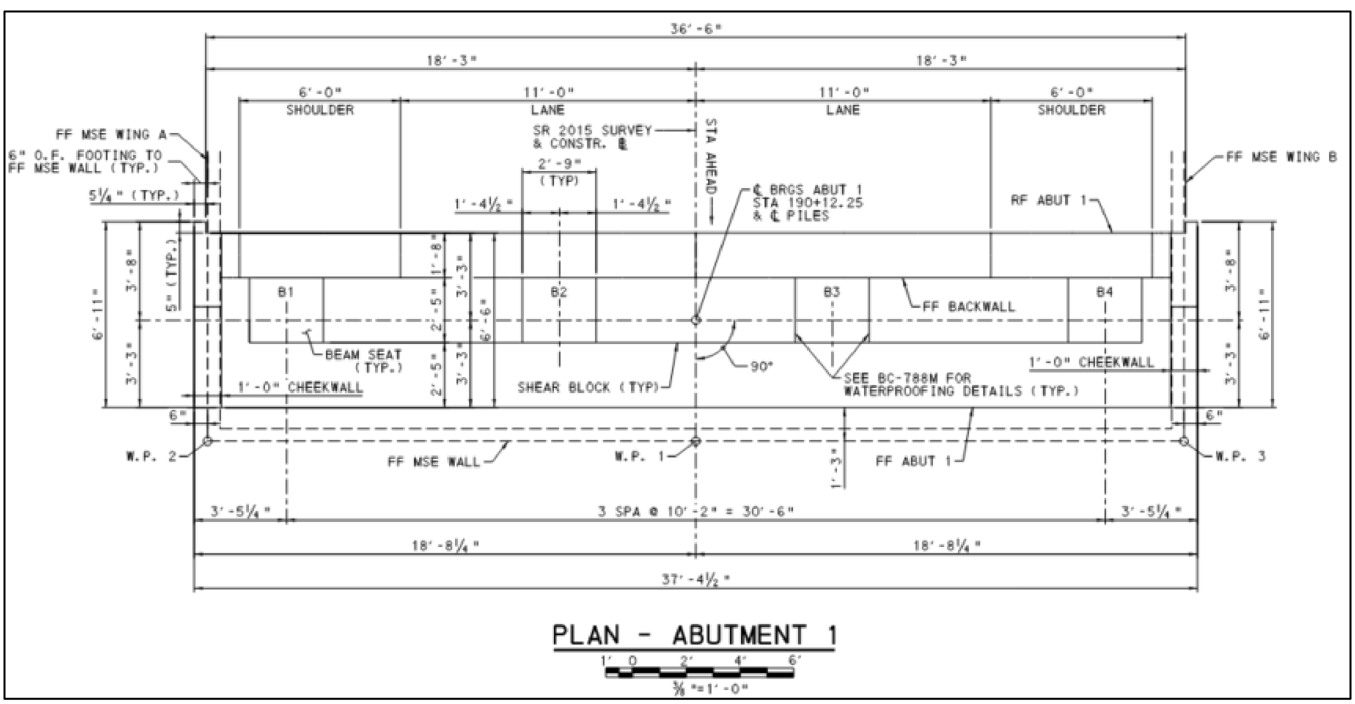


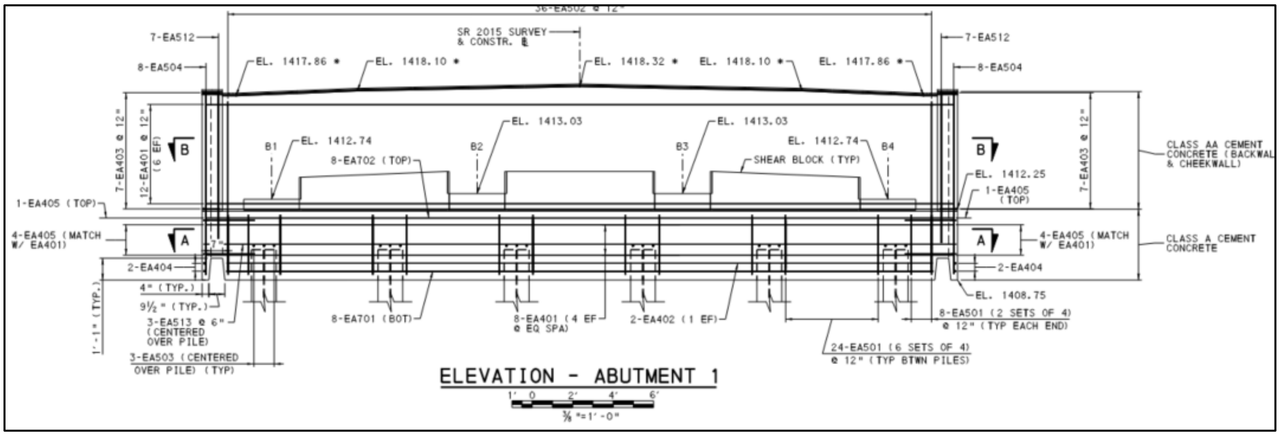


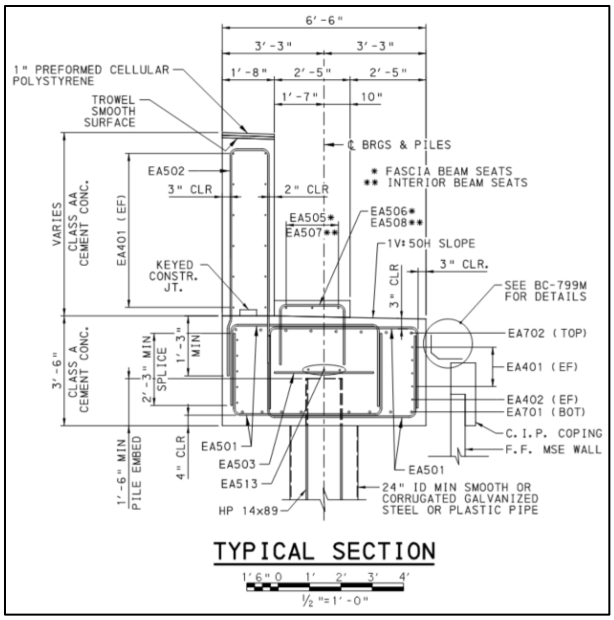


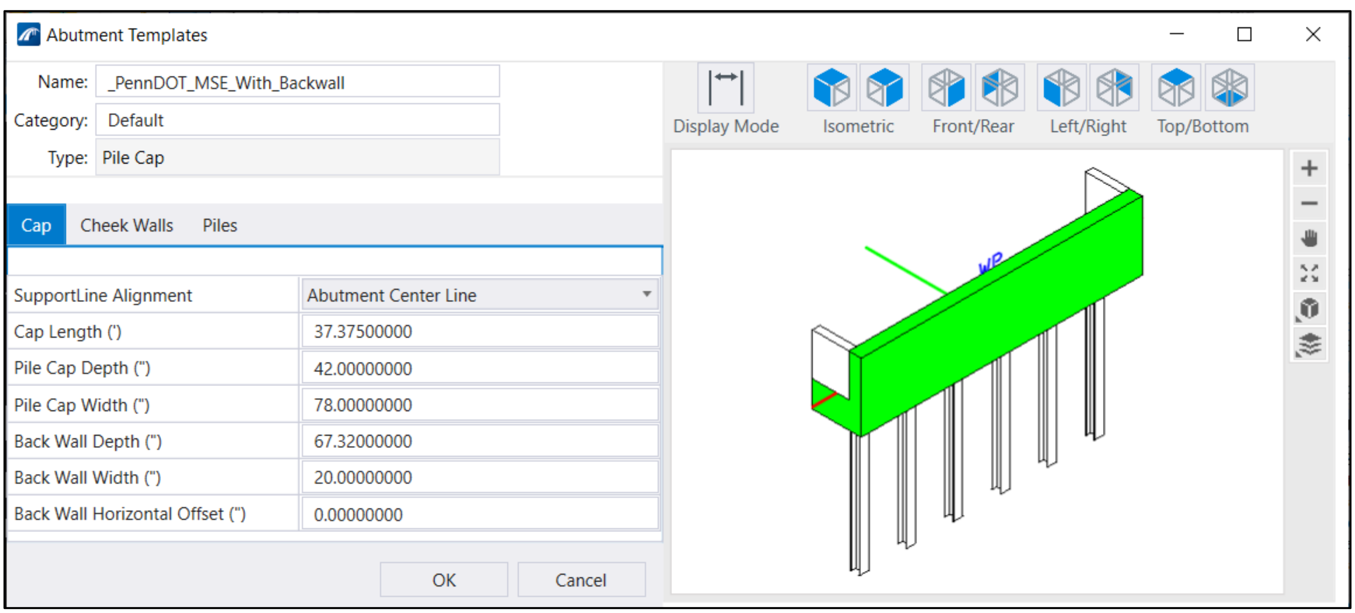
10.2.7 MSE Abutment Template

10.2.7.1 Cap Tab

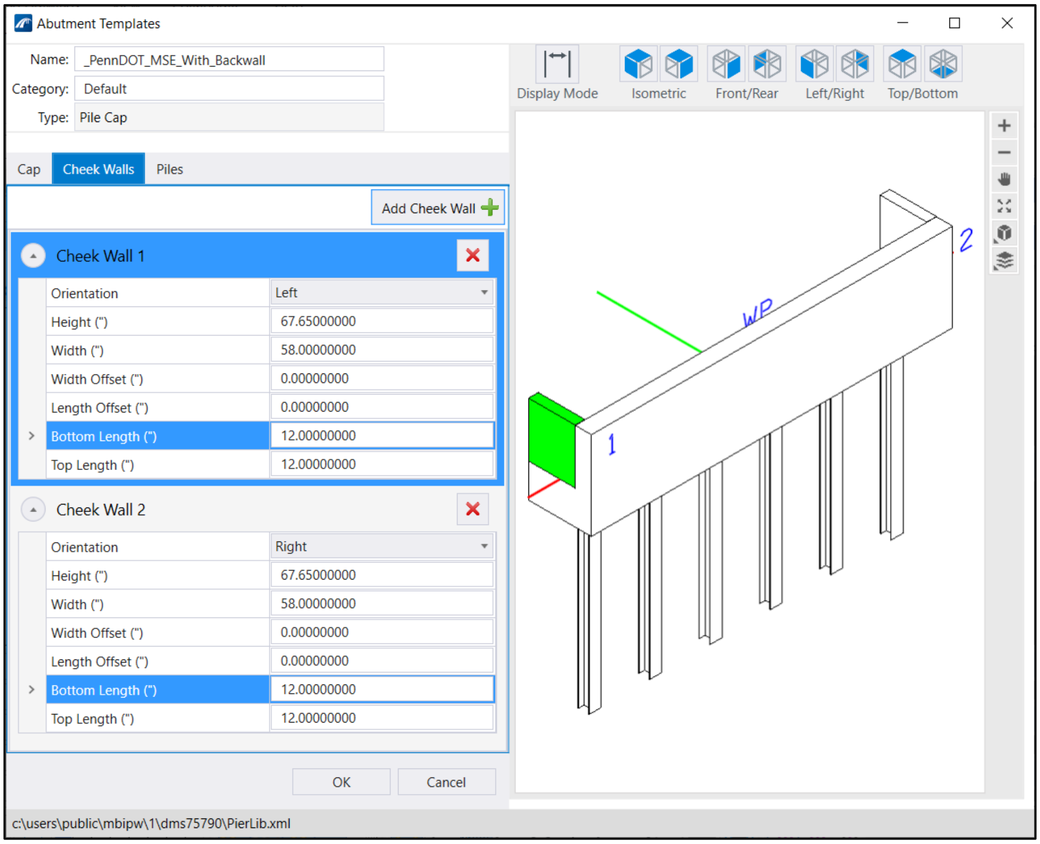



ELEVATION - ABUTMENT 1
⅜"=1'-0"
SR 2015 SURVEY & CONSTR. ℄
EL. 1417.86 *
EL. 1418.10 *
EL. 1418.32 *
EL. 1413.03
EL. 1412.74
EL. 1412.25
EL. 1408.75
7-EA512
8-EA504
8-EA702 (TOP)
8-EA701 (BOT)
SHEAR BLOCK (TYP)
1-EA405 (TOP)
4-EA405 (MATCH W/ EA401)
2-EA404
2-EA402 (1 EF)
8-EA401 (4 EF @ EQ SPA)
8-EA501 (2 SETS OF 4) @ 12" (TYP EACH END)
24-EA501 (6 SETS OF 4) @ 12" (TYP BTWN PILES)
3-EA513 @ 6" (CENTERED OVER PILE)
3-EA503 (CENTERED OVER PILE) (TYP)
CLASS AA CEMENT CONCRETE (BACKWALL & CHEEKWALL)
CLASS A CEMENT CONCRETE

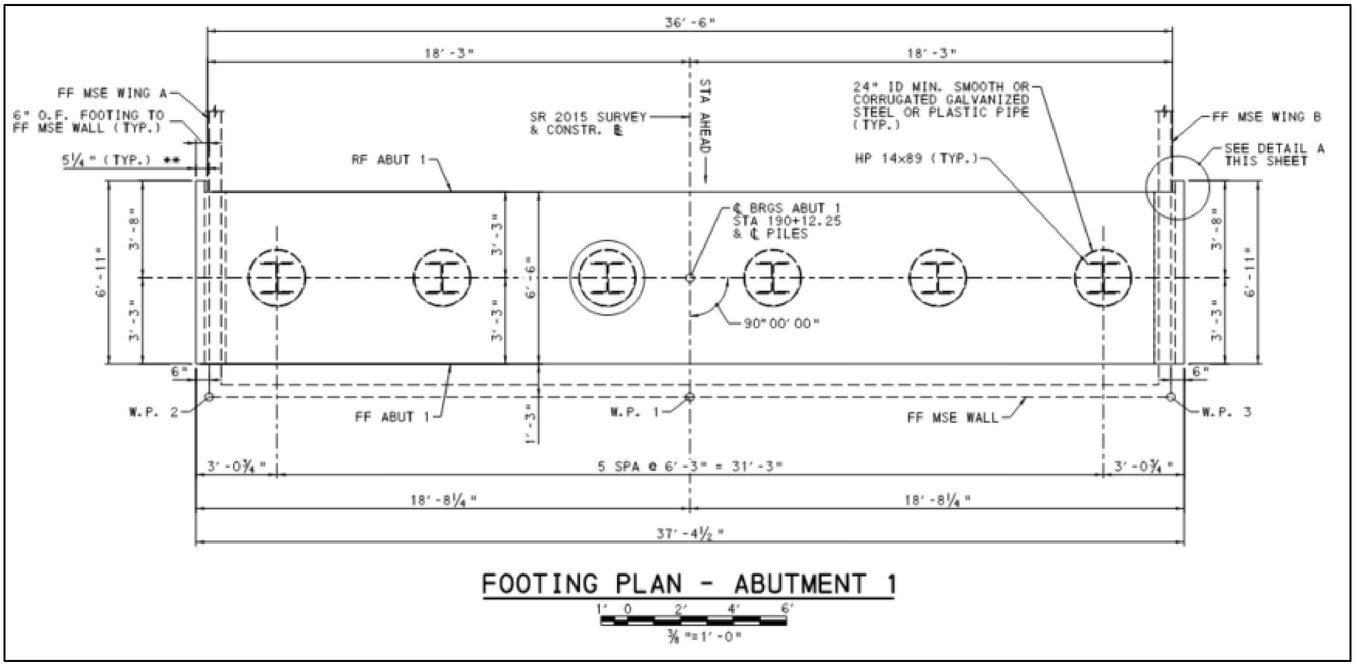

TYPICAL SECTION
½"=1'-0"
6'-6"
3'-3"
3'-3"
1" PREFORMED CELLULAR POLYSTYRENE
TROWEL SMOOTH SURFACE
℄ BRGS & PILES
* FASCIA BEAM SEATS
** INTERIOR BEAM SEATS
KEYED CONSTR. JT.
1V:50H SLOPE
SEE BC-799M FOR DETAILS
EA702 (TOP)
EA401 (EF)
EA402 (EF)
EA701 (BOT)
C.I.P. COPING
F.F. MSE WALL
24" ID MIN SMOOTH OR CORRUGATED GALVANIZED STEEL OR PLASTIC PIPE
HP 14x89
VARIES CLASS AA CEMENT CONC.
3'-6" CLASS A CEMENT CONC.
1'-6" MIN PILE EMBED

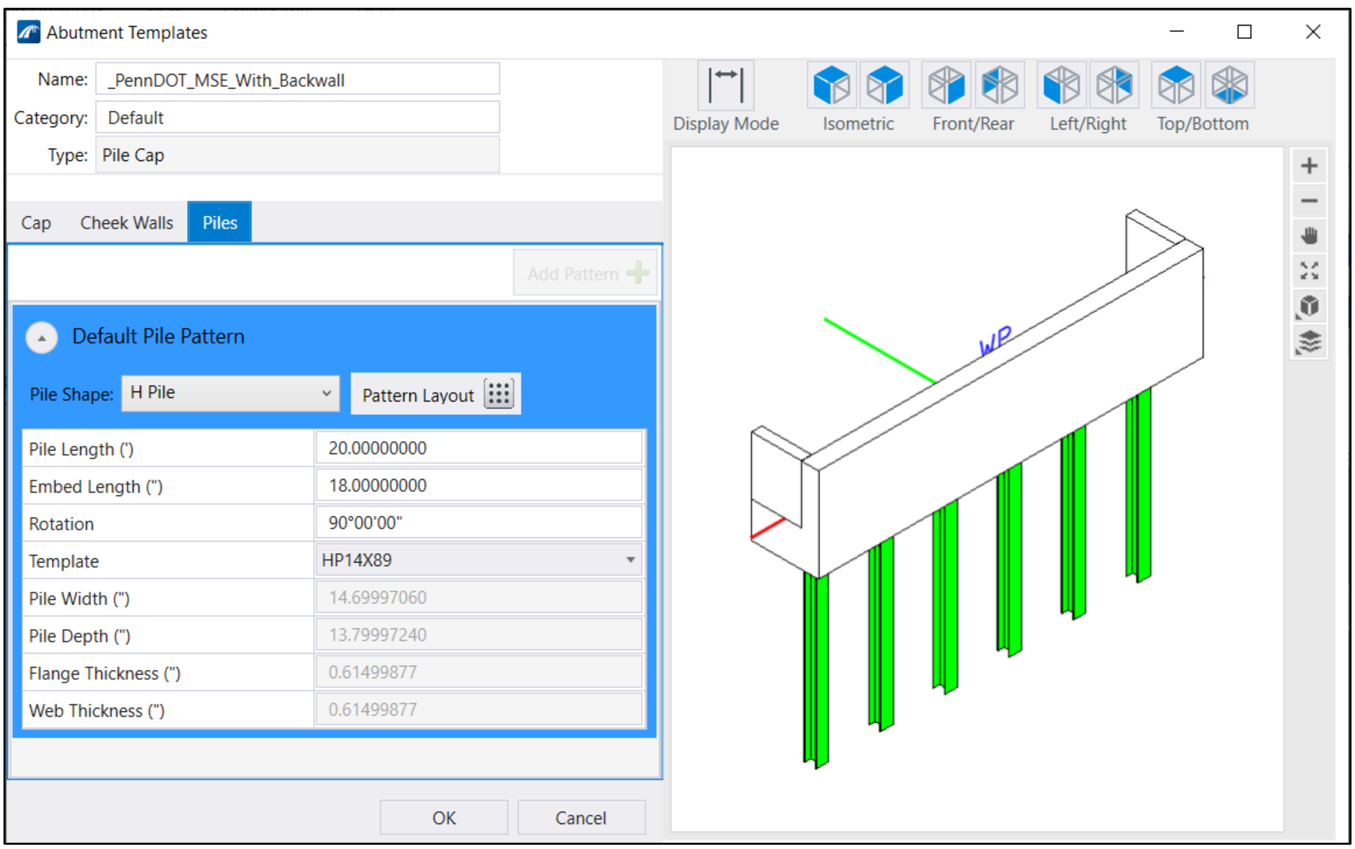

Abutment Templates
Name: _PennDOT_MSE_With_Backwall
Category: Default
Type: Pile Cap
Cap
Cheek Walls
Piles
SupportLine Alignment: Abutment Center Line
Cap Length ('): 37.37500000
Pile Cap Depth ("): 42.00000000
Pile Cap Width ("): 78.00000000
Back Wall Depth ("): 67.32000000
Back Wall Width ("): 20.00000000
Back Wall Horizontal Offset ("): 0.00000000
OK
Cancel
Display Mode
Isometric
Front/Rear
Left/Right
Top/Bottom

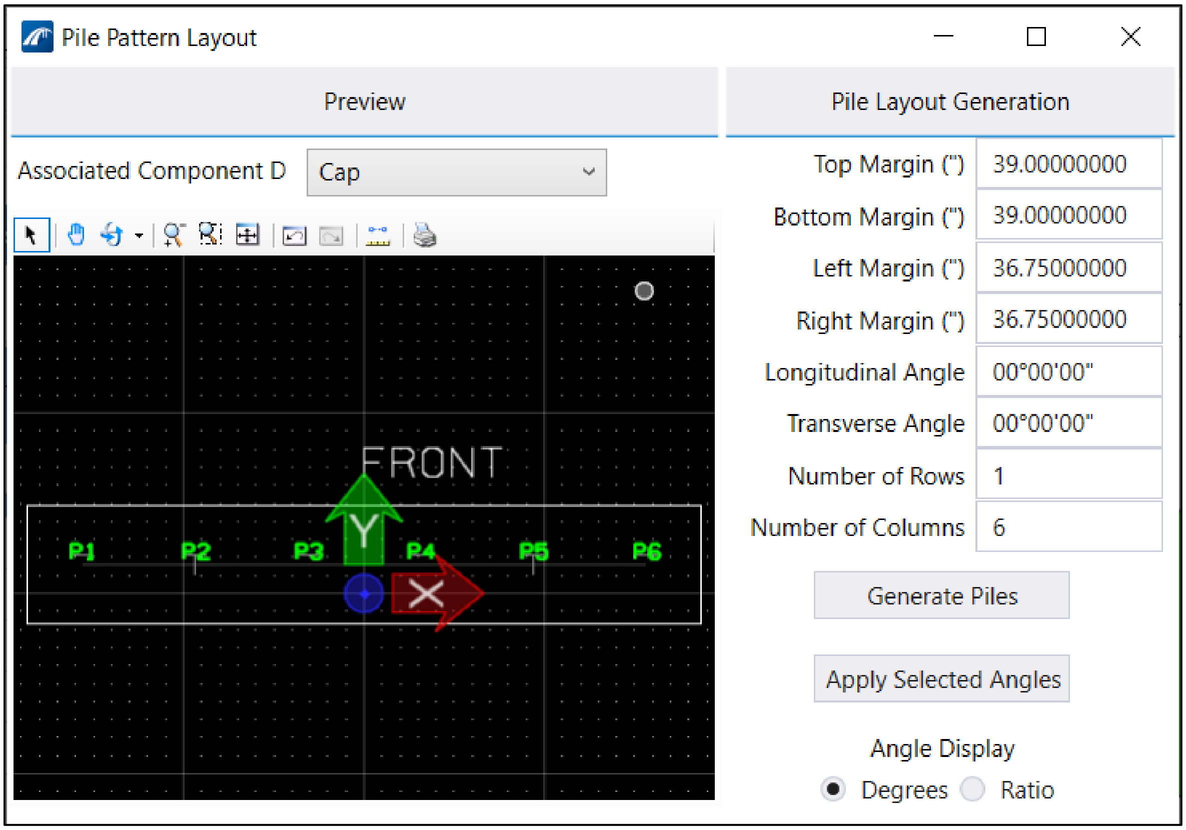
10.2.7.2 Cheek Walls Tab



10.2.7.3 Piles Tab

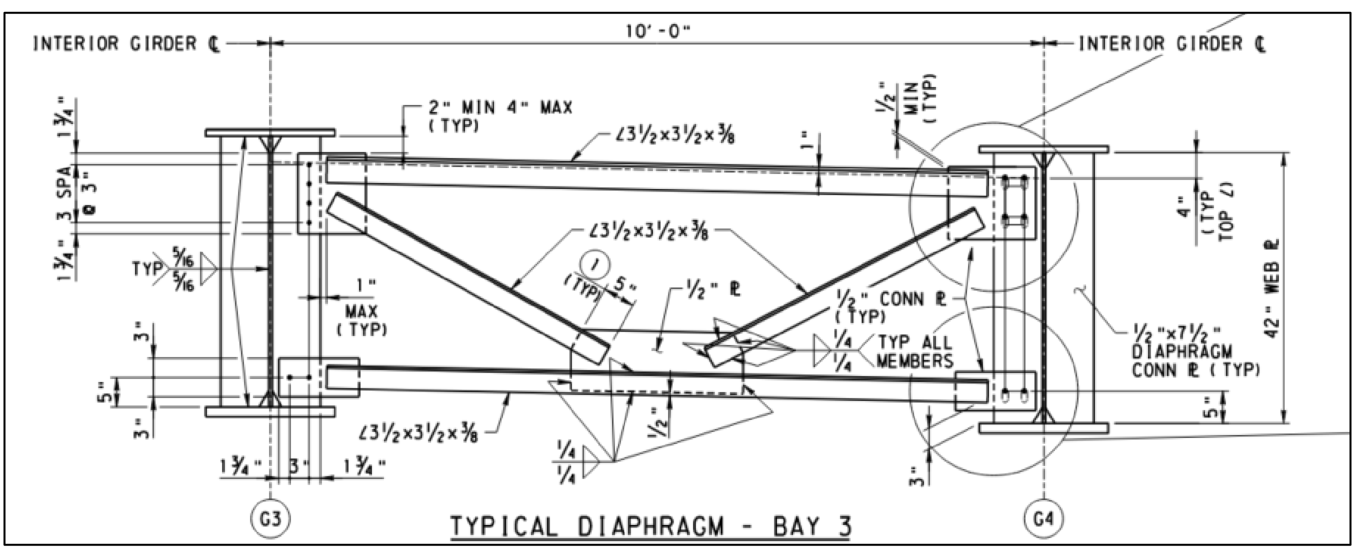


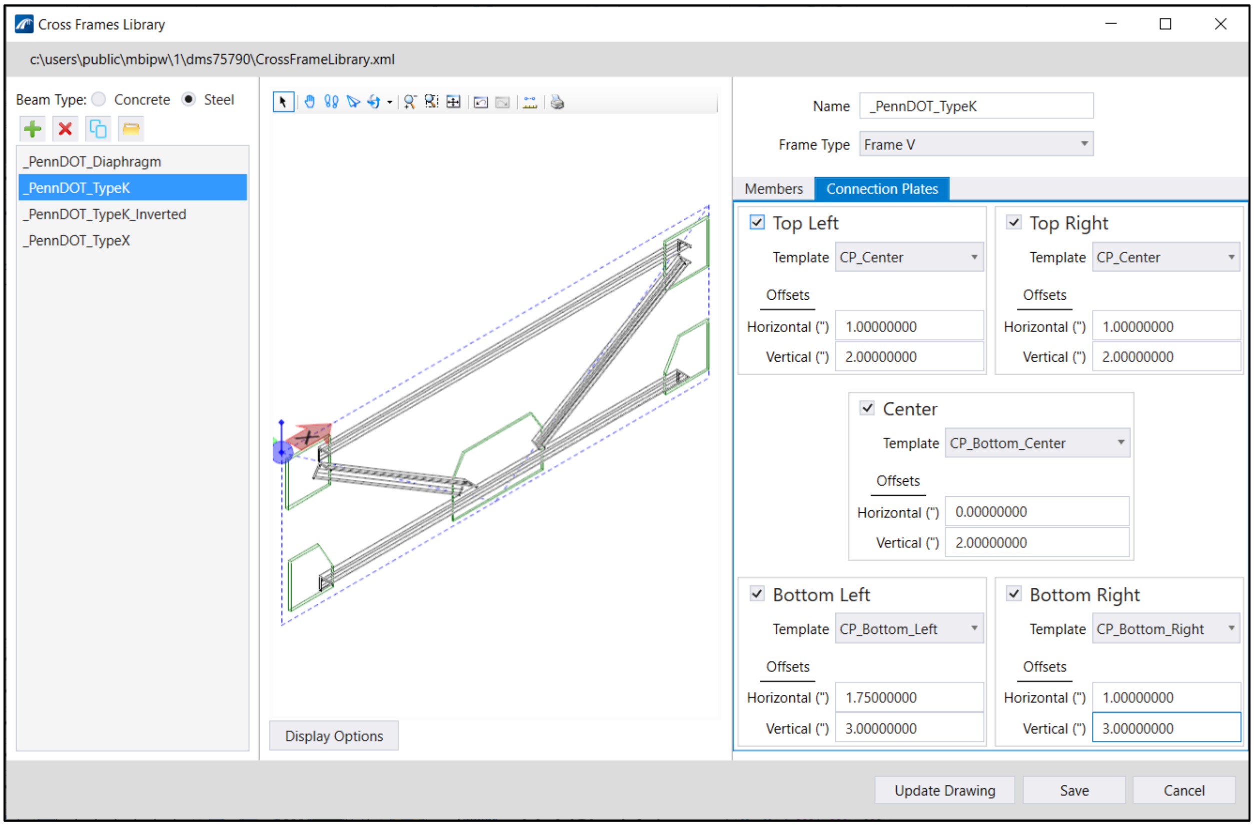




10.2.8 Cross Frame/Steel Diaphragms Templates

10.2.8.1 PennDOT Type K Cross Frame

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_PennDOT_Diaphragm
_PennDOT_TypeK
_PennDOT_TypeK_Inverted
_PennDOT_TypeX
Display Options
Name _PennDOT_TypeK
Frame Type Frame V
Members
Connection Plates
Top Left
Template CP_Center
Offsets
Horizontal (") 1.00000000
Vertical (") 2.00000000
Top Right
Template CP_Center
Offsets
Horizontal (") 1.00000000
Vertical (") 2.00000000
Center
Template CP_Bottom_Center
Offsets
Horizontal (") 0.00000000
Vertical (") 2.00000000
Bottom Left
Template CP_Bottom_Left
Offsets
Horizontal (") 1.75000000
Vertical (") 3.00000000
Bottom Right
Template CP_Bottom_Right
Offsets
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Vertical (") 3.00000000
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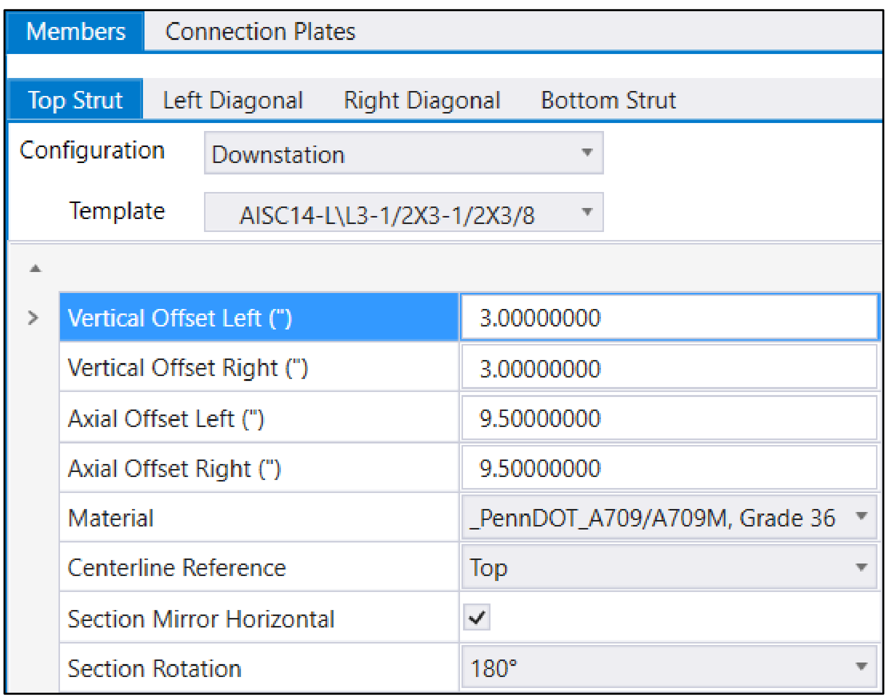
Save
Cancel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Connection Plates
Top Strut
Left Diagonal
Right Diagonal
Bottom Strut
Configuration Downstation
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Vertical Offset Right (") 3.00000000
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Axial Offset Right (") 9.50000000
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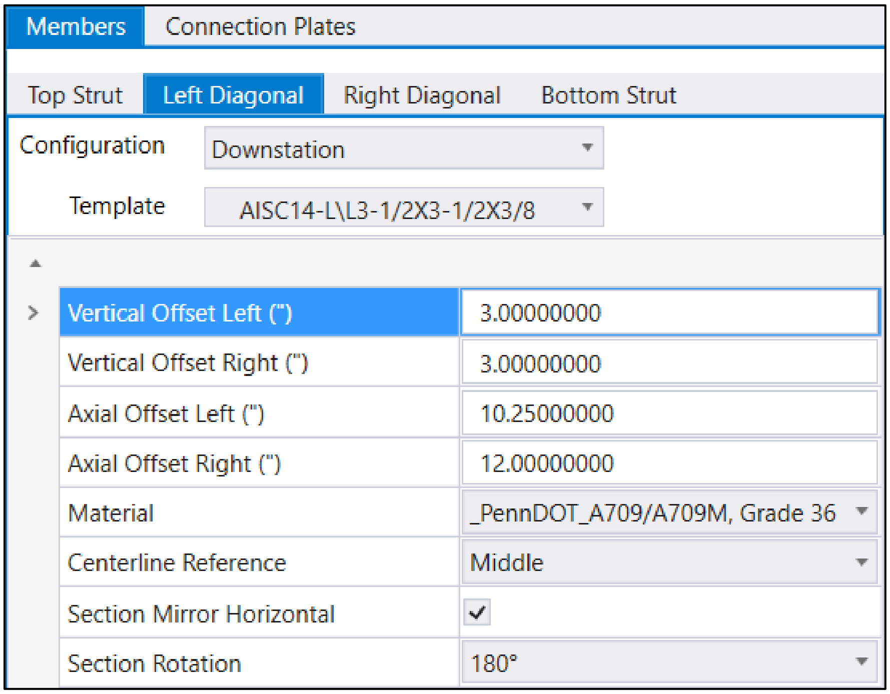
Centerline Reference Top
Section Mirror Horizontal
Section Rotation 180°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Top Strut
Left Diagonal
Right Diagonal
Bottom Strut
Configuration
Downstation
Template
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Vertical Offset Right (")
3.00000000
Axial Offset Left (")
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Axial Offset Right (")
12.00000000
Material
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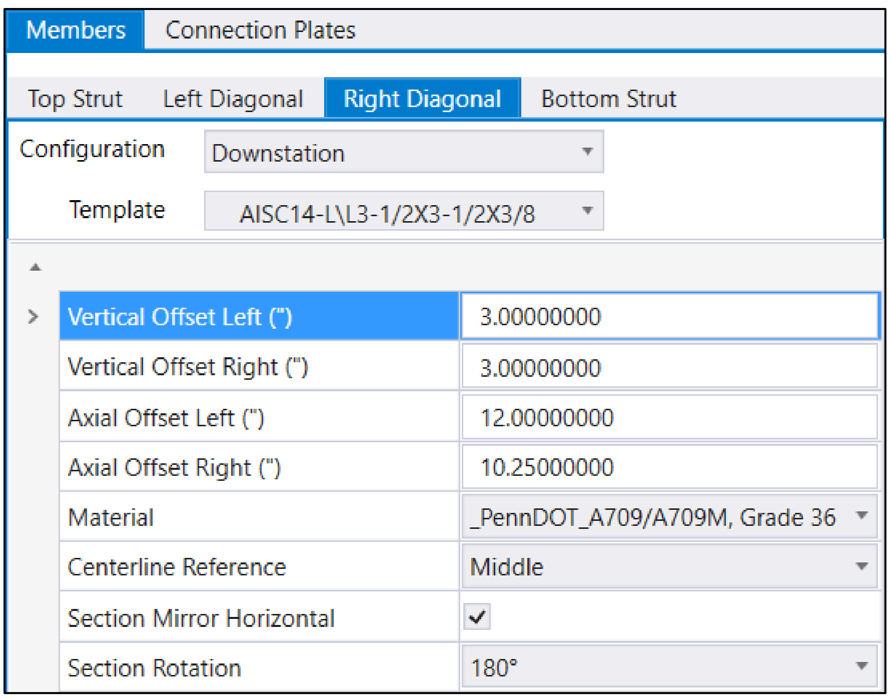
Centerline Reference
Middle
Section Mirror Horizontal
Section Rotation
180°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Connection Plates
Top Strut
Left Diagonal
Right Diagonal
Bottom Strut
Configuration
Downstation
Template
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Vertical Offset Right (")
3.00000000
Axial Offset Left (")
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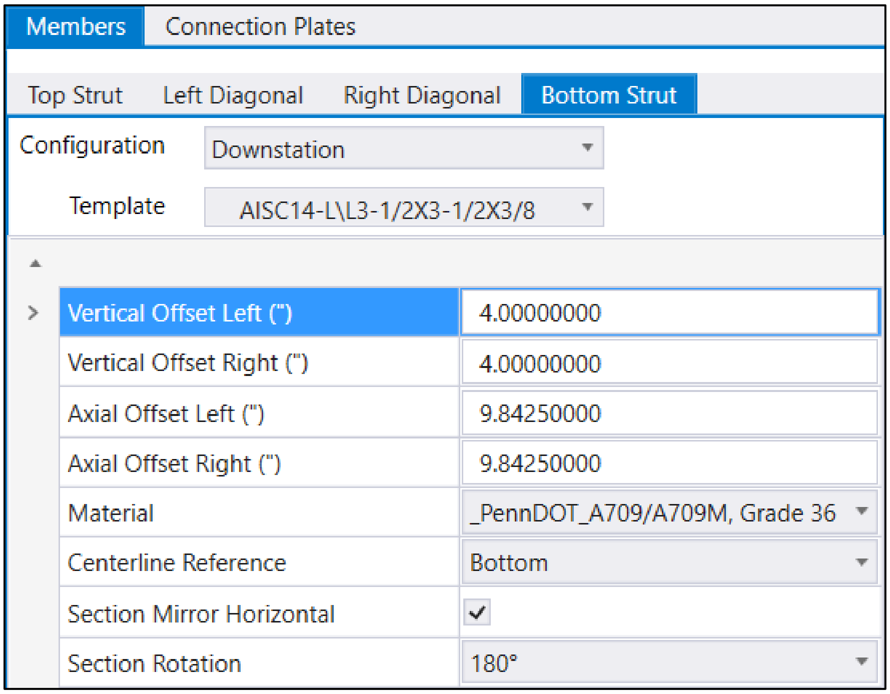
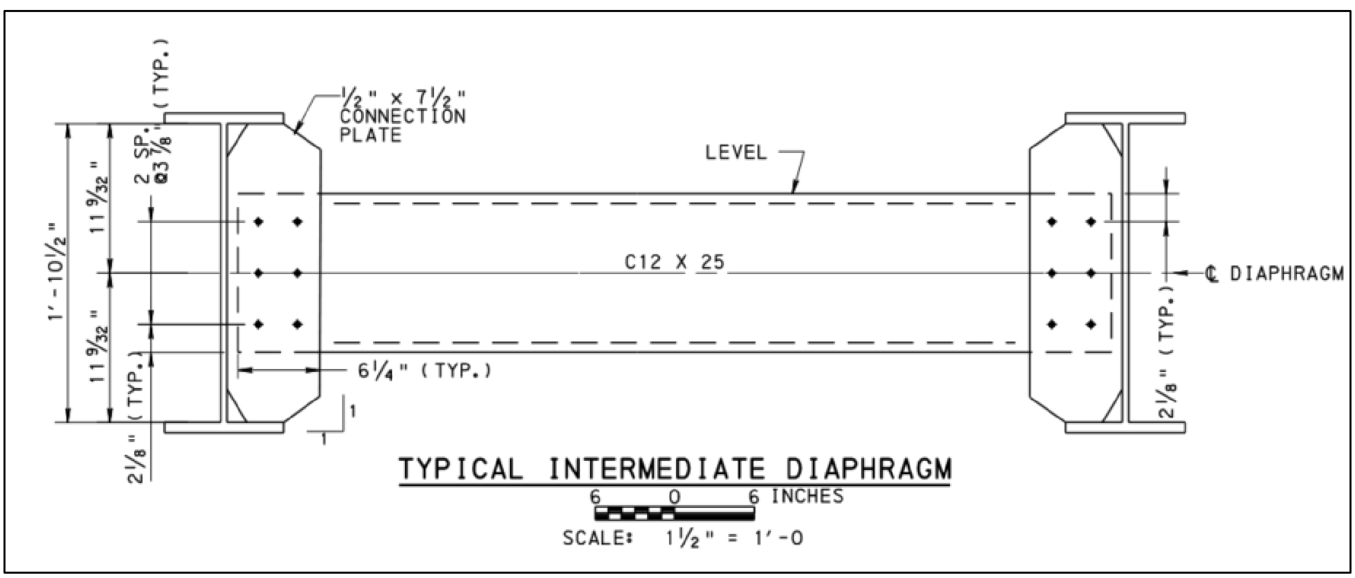
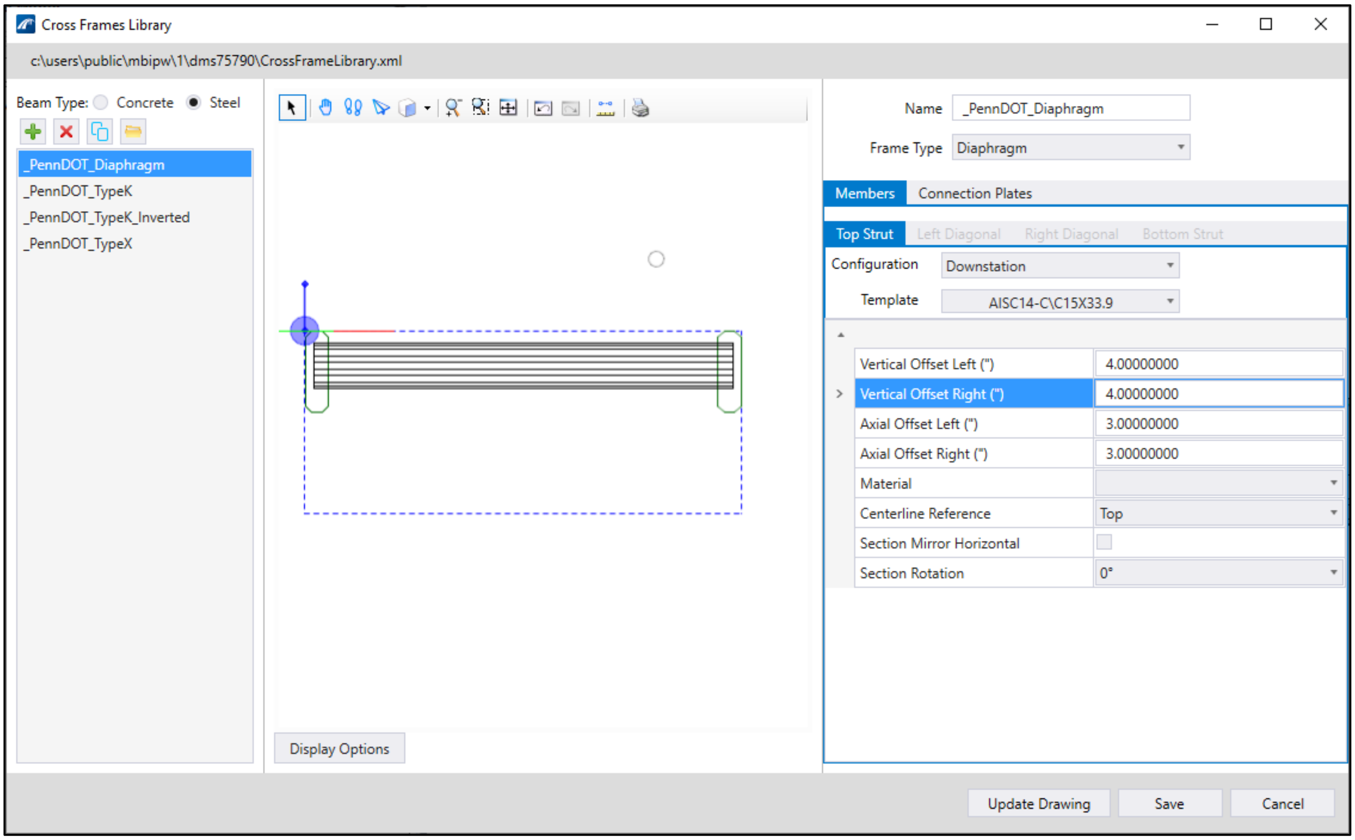
Centerline Reference
Middle
Section Mirror Horizontal
Section Rotation
180°



10.2.8.2 PennDOT Type X Cross Frame

10.2.8.3 PennDOT Steel Diaphragm

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_PennDOT_TypeK
_PennDOT_TypeK_Inverted
_PennDOT_TypeX
Display Options
Name _PennDOT_Diaphragm
Frame Type Diaphragm
Members
Connection Plates
Top Strut
Left Diagonal
Right Diagonal
Bottom Strut
Configuration Downstation
Template AISC14-C\C15X33.9
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Vertical Offset Right (") 4.00000000
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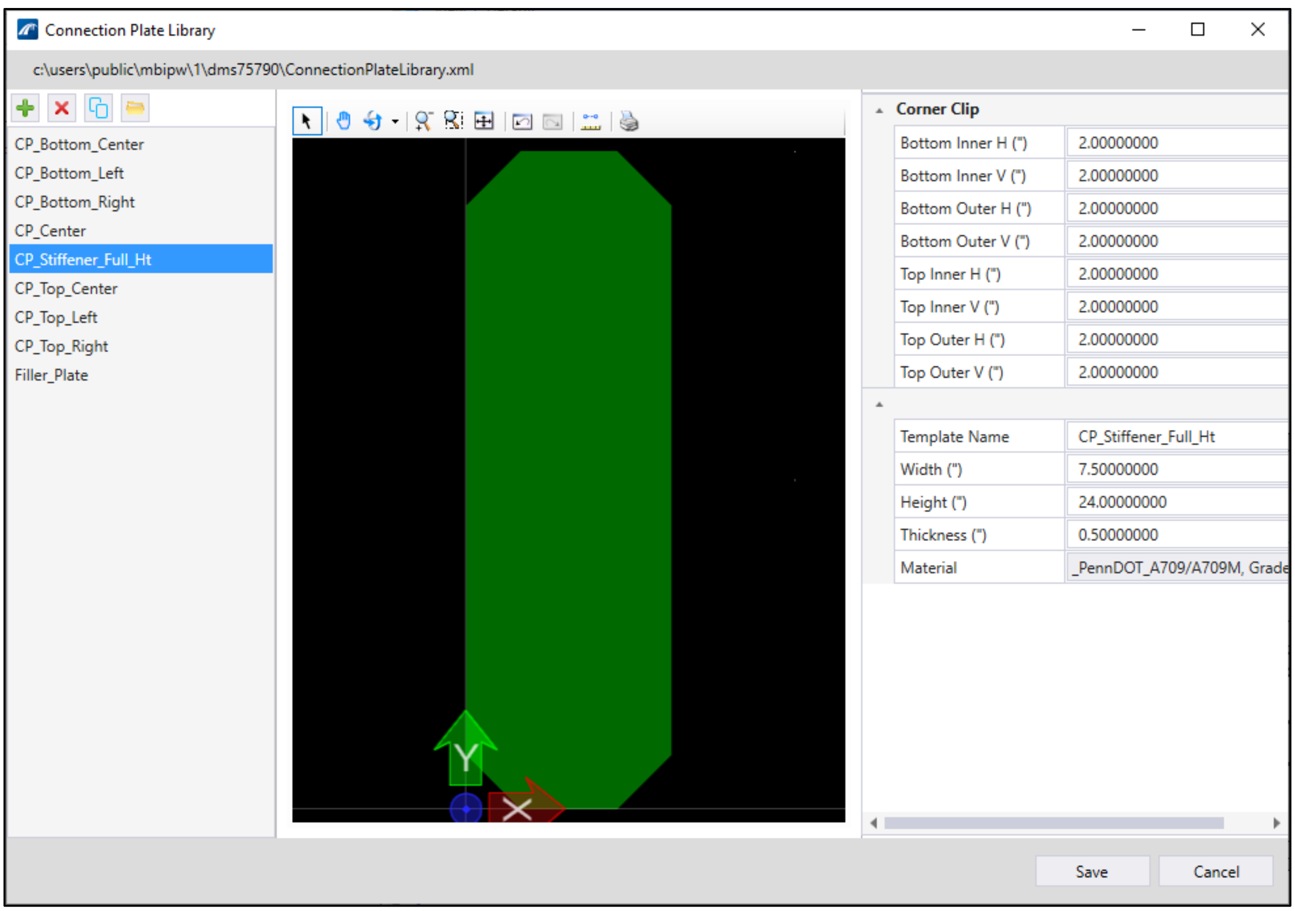
Axial Offset Right (") 3.00000000
Material
Centerline Reference Top
Section Mirror Horizontal
Section Rotation 0°
Update Drawing
Save
Cancel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CP_Bottom_Left
CP_Bottom_Right
CP_Center
CP_Stiffener_Full_Ht
CP_Top_Center
CP_Top_Left
CP_Top_Right
Filler_Plate
Y
X
Corner Clip
Bottom Inner H (") 2.00000000
Bottom Inner V (") 2.00000000
Bottom Outer H (") 2.00000000
Bottom Outer V (") 2.00000000
Top Inner H (") 2.00000000
Top Inner V (") 2.00000000
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Height (") 24.00000000
Thickness (") 0.50000000
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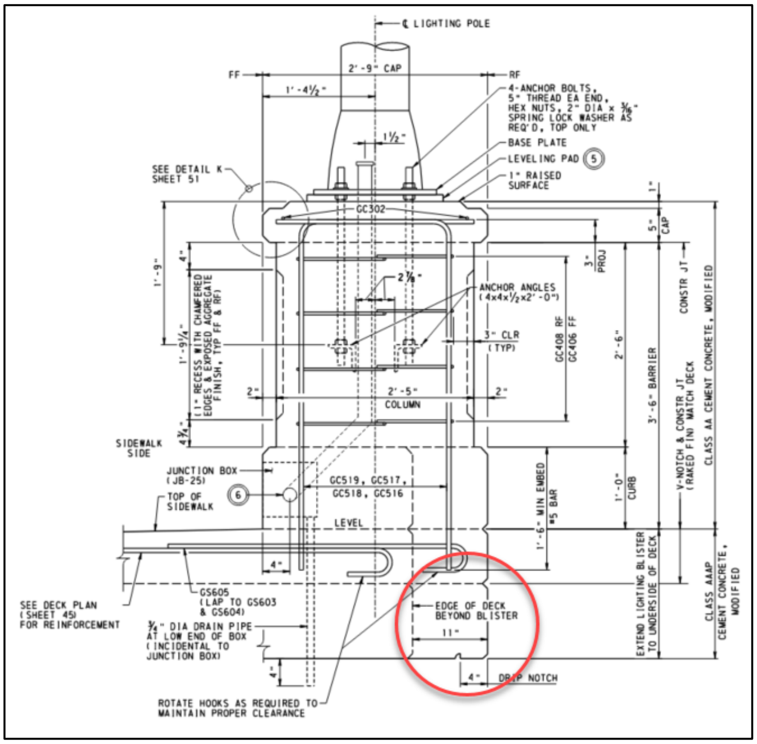
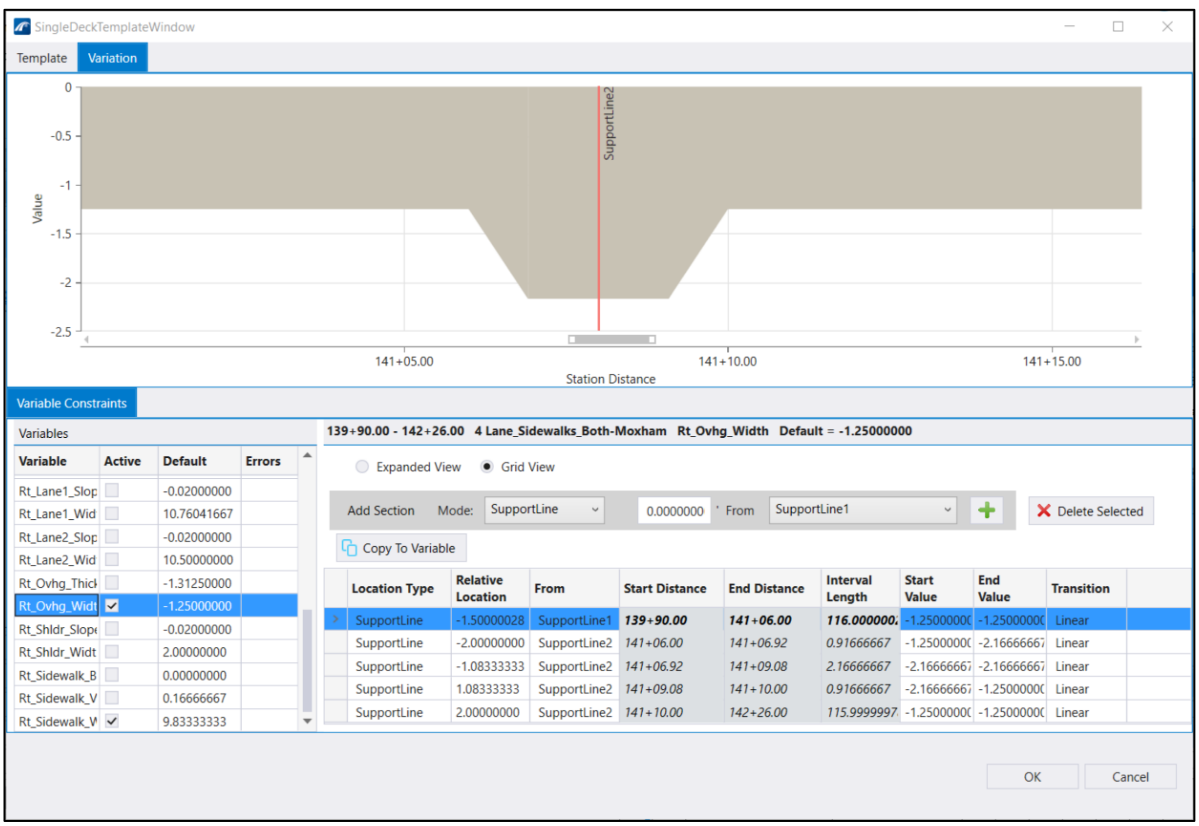
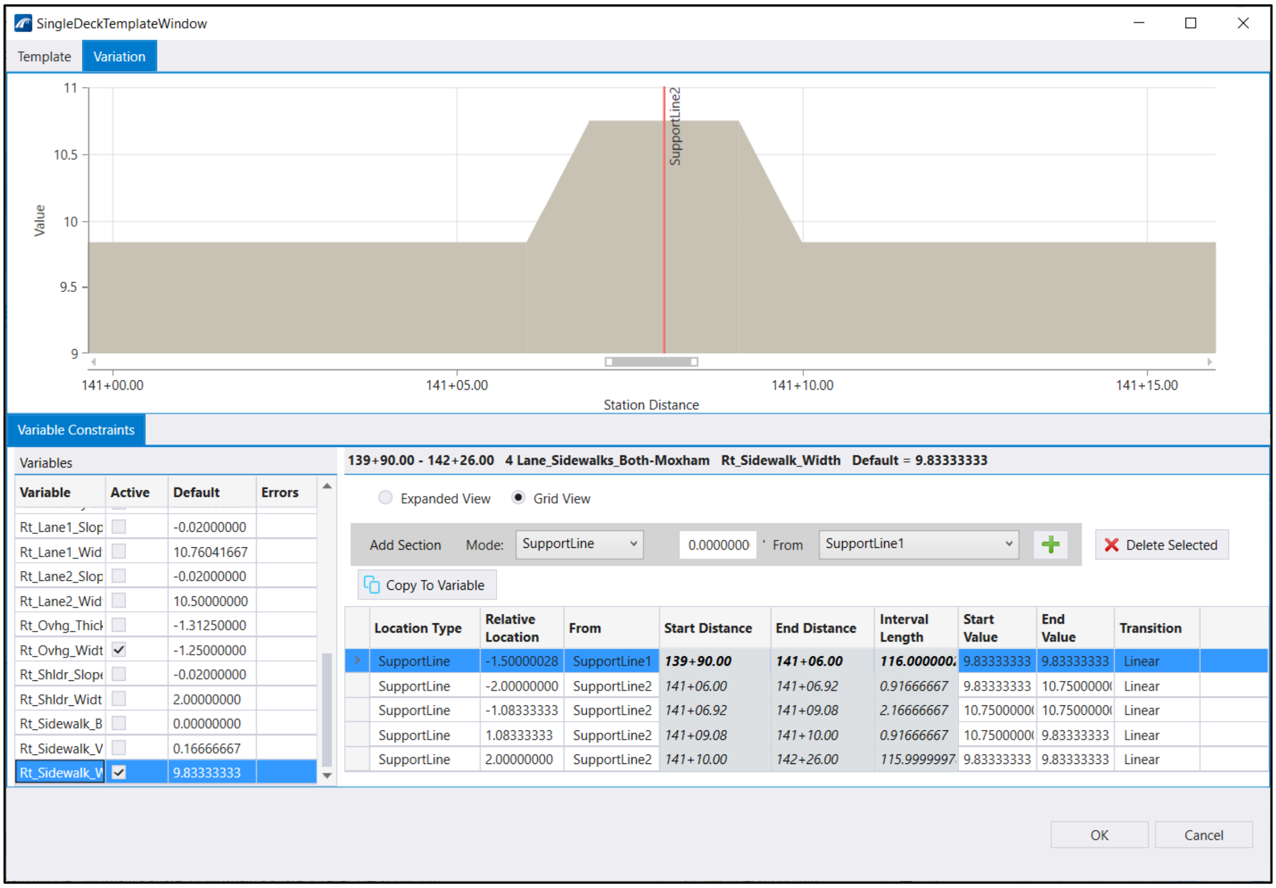
Save
Cancel

10.2.9 Light Pole Blister Variable Constraints

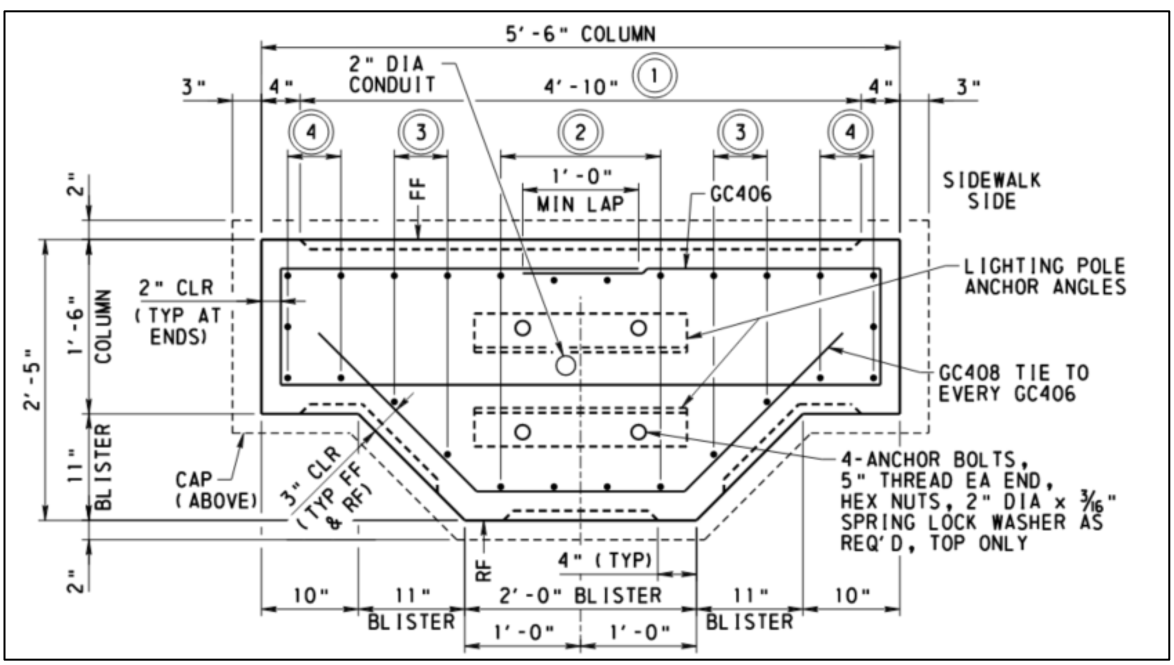
10.2.9.1 Deck Constraints

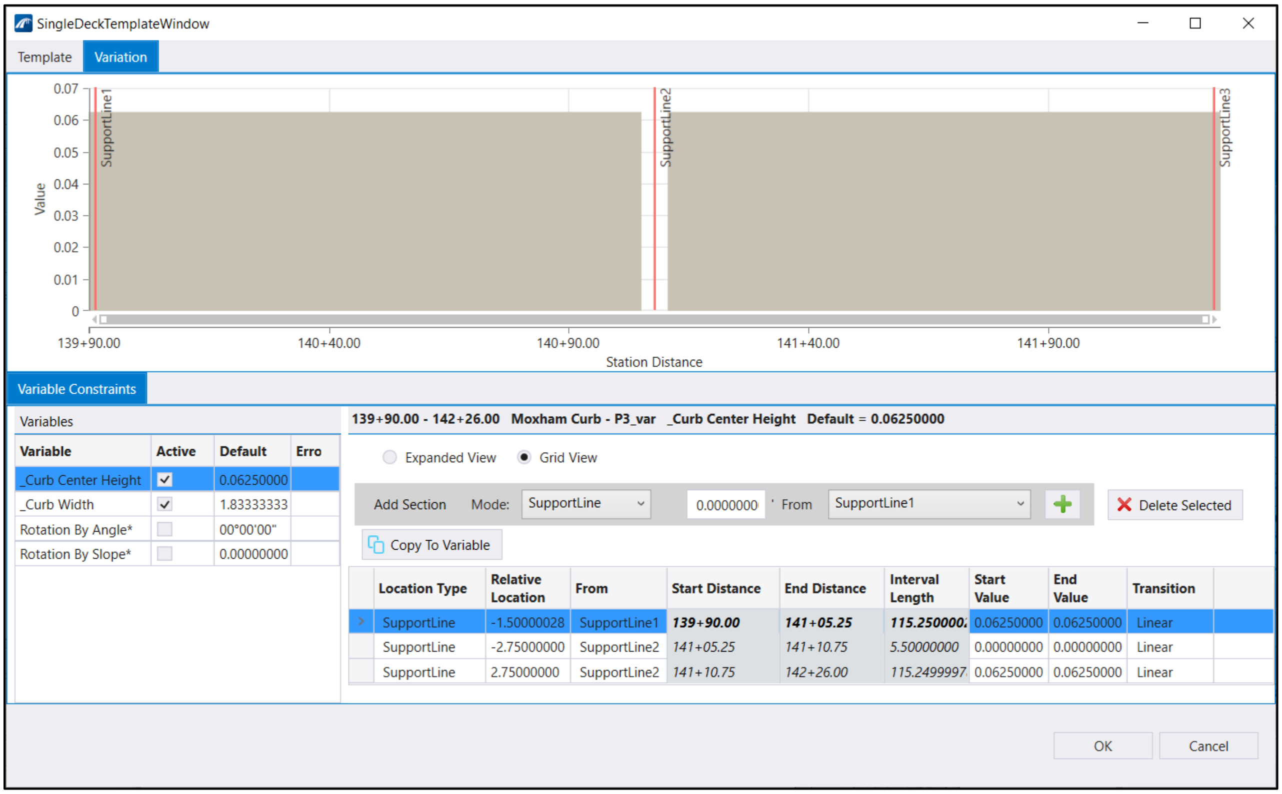






10.2.9.2 Barrier Constraints

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Template
Variation
SupportLine1
SupportLine2
SupportLine3
Value
Station Distance
Variable Constraints
Variables
Variable
Active
Default
Erro
_Curb Center Height 0.06250000
_Curb Width 1.83333333
Rotation By Angle* 00°00'00"
Rotation By Slope* 0.00000000
139+90.00 - 142+26.00 Moxham Curb - P3_var _Curb Center Height Default = 0.06250000
Expanded View
Grid View
Add Section
Mode: SupportLine
0.0000000
From SupportLine1
Delete Selected
Copy To Variable
Location Type | Relative Location | From | Start Distance | End Distance | Interval Length | Start Value | End Value | Transition
SupportLine -1.50000028 SupportLine1 139+90.00 141+05.25 115.250000 0.06250000 0.06250000 Linear
SupportLine -2.75000000 SupportLine2 141+05.25 141+10.75 5.50000000 0.00000000 0.00000000 Linear
SupportLine 2.75000000 SupportLine2 141+10.75 142+26.00 115.2499997 0.06250000 0.06250000 Linear
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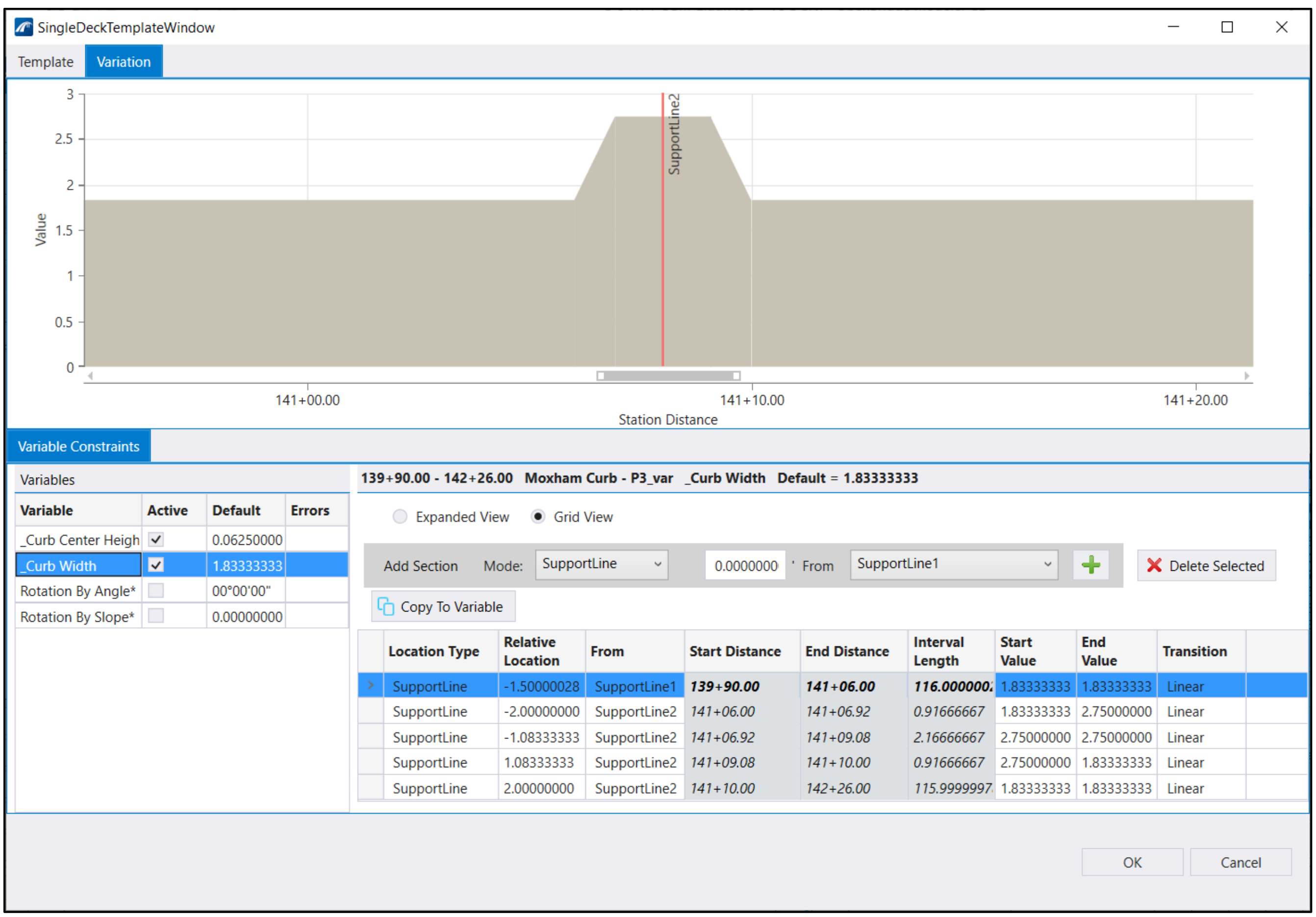
Cancel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Template
Variation
SupportLine2
Value
Station Distance
Variable Constraints
Variables
Variable
Active
Default
Errors
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_Curb Width 1.83333333
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Rotation By Slope* 0.00000000
139+90.00 - 142+26.00 Moxham Curb - P3_var _Curb Width Default = 1.83333333
Expanded View
Grid View
Add Section
Mode: SupportLine
0.0000000
From SupportLine1
Delete Selected
Copy To Variable
Location Type | Relative Location | From | Start Distance | End Distance | Interval Length | Start Value | End Value | Transition
SupportLine -1.50000028 SupportLine1 139+90.00 141+06.00 116.000000 1.83333333 1.83333333 Linear
SupportLine -2.00000000 SupportLine2 141+06.00 141+06.92 0.91666667 1.83333333 2.75000000 Linear
SupportLine -1.08333333 SupportLine2 141+06.92 141+09.08 2.16666667 2.75000000 2.75000000 Linear
SupportLine 1.08333333 SupportLine2 141+09.08 141+10.00 0.91666667 2.75000000 1.83333333 Linear
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OK
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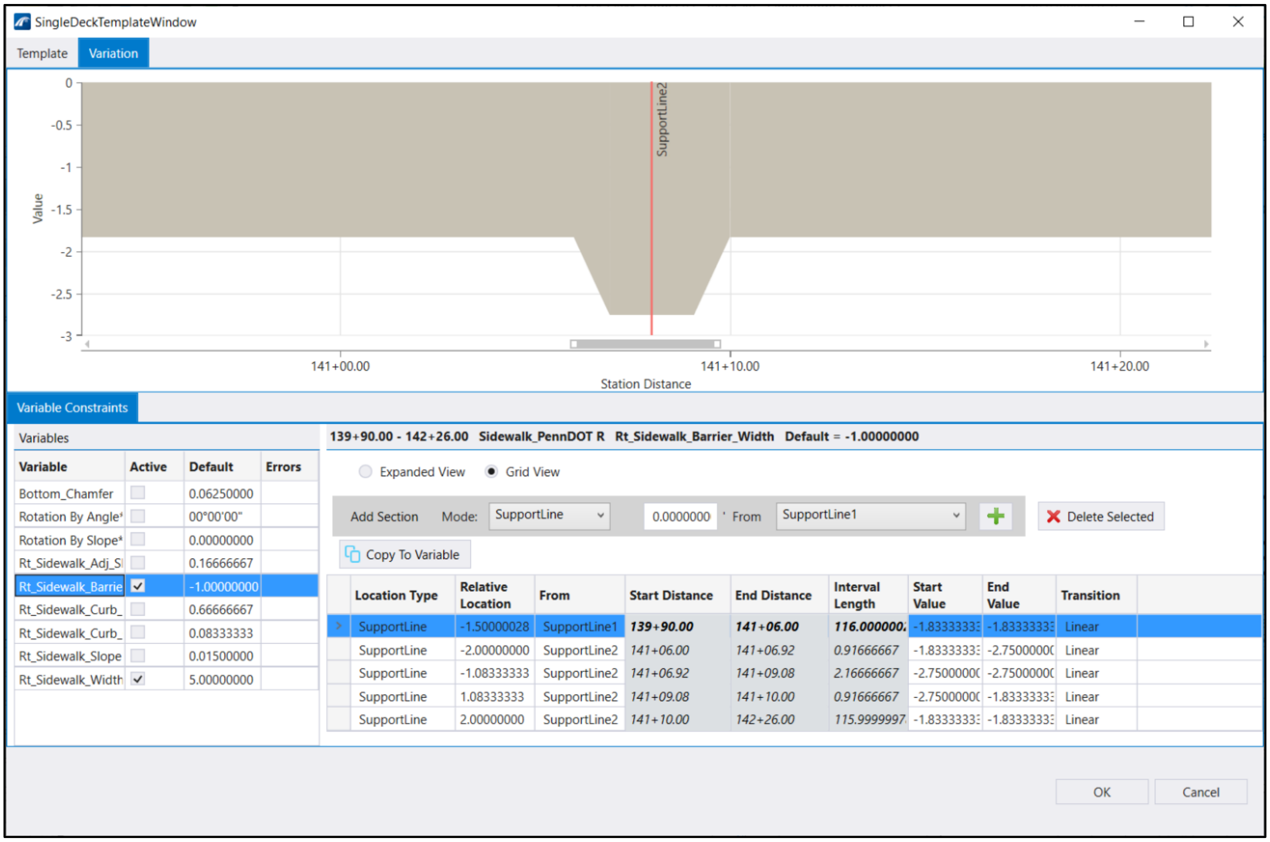
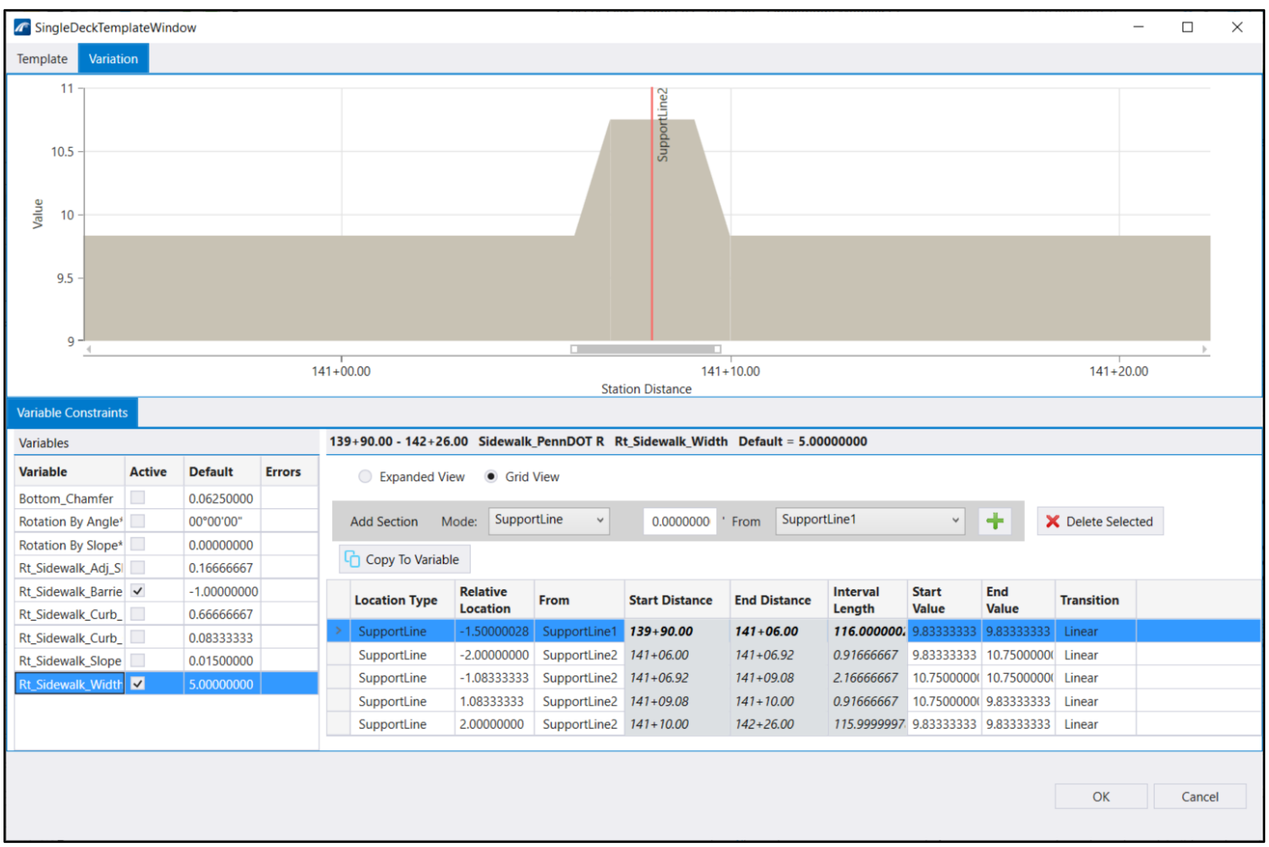
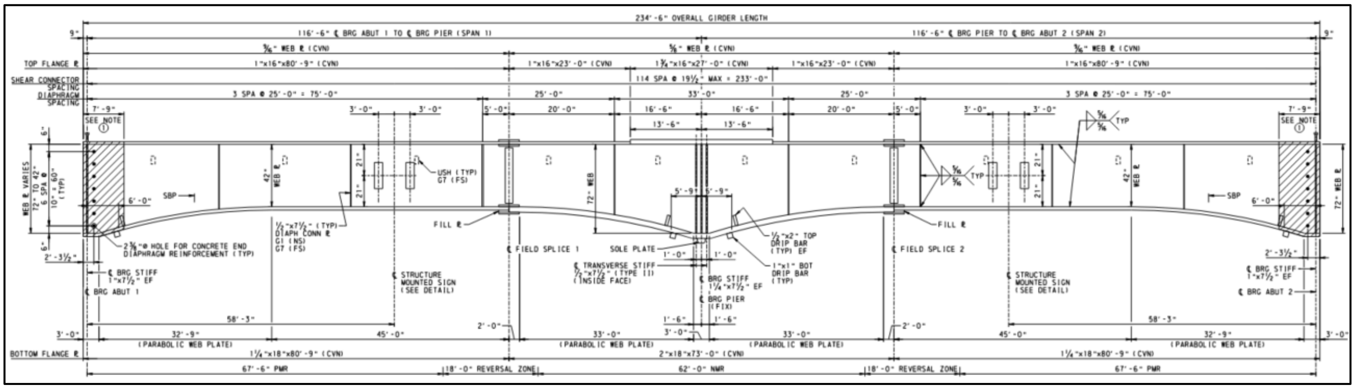
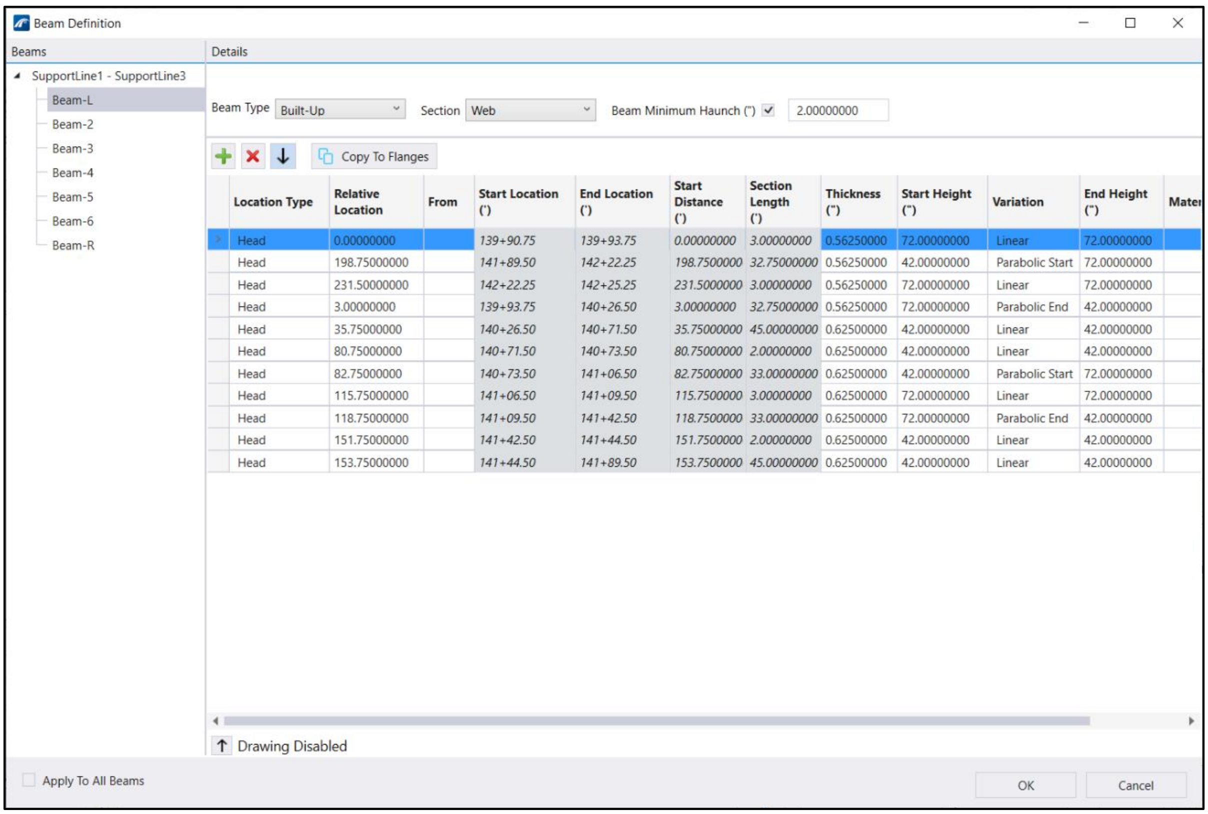
10.2.9.3 Sidewalk Constraints





10.2.10 Haunch Steel Girder Variable Constraints





Location Type	Relative Location	From	Start Location (')	End Location (')	Start Distance (')	Section Length (')	Thickness (")	Start Height (")	Variation	End Height (")	Mater
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Head	198.75000000		141+89.50	142+22.25	198.7500000	32.75000000	0.56250000	42.00000000	Parabolic Start	72.00000000	
Head	231.50000000		142+22.25	142+25.25	231.5000000	3.00000000	0.56250000	72.00000000	Linear	72.00000000	
Head	3.00000000		139+93.75	140+26.50	3.00000000	32.75000000	0.56250000	72.00000000	Parabolic End	42.00000000	
Head	35.75000000		140+26.50	140+71.50	35.75000000	45.00000000	0.62500000	42.00000000	Linear	42.00000000	
Head	80.75000000		140+71.50	140+73.50	80.75000000	2.00000000	0.62500000	42.00000000	Linear	42.00000000	
Head	82.75000000		140+73.50	141+06.50	82.75000000	33.00000000	0.62500000	42.00000000	Parabolic Start	72.00000000	
Head	115.75000000		141+06.50	141+09.50	115.7500000	3.00000000	0.62500000	72.00000000	Linear	72.00000000	
Head	118.75000000		141+09.50	141+42.50	118.7500000	33.00000000	0.62500000	72.00000000	Parabolic End	42.00000000	
Head	151.75000000		141+42.50	141+44.50	151.7500000	2.00000000	0.62500000	42.00000000	Linear	42.00000000	
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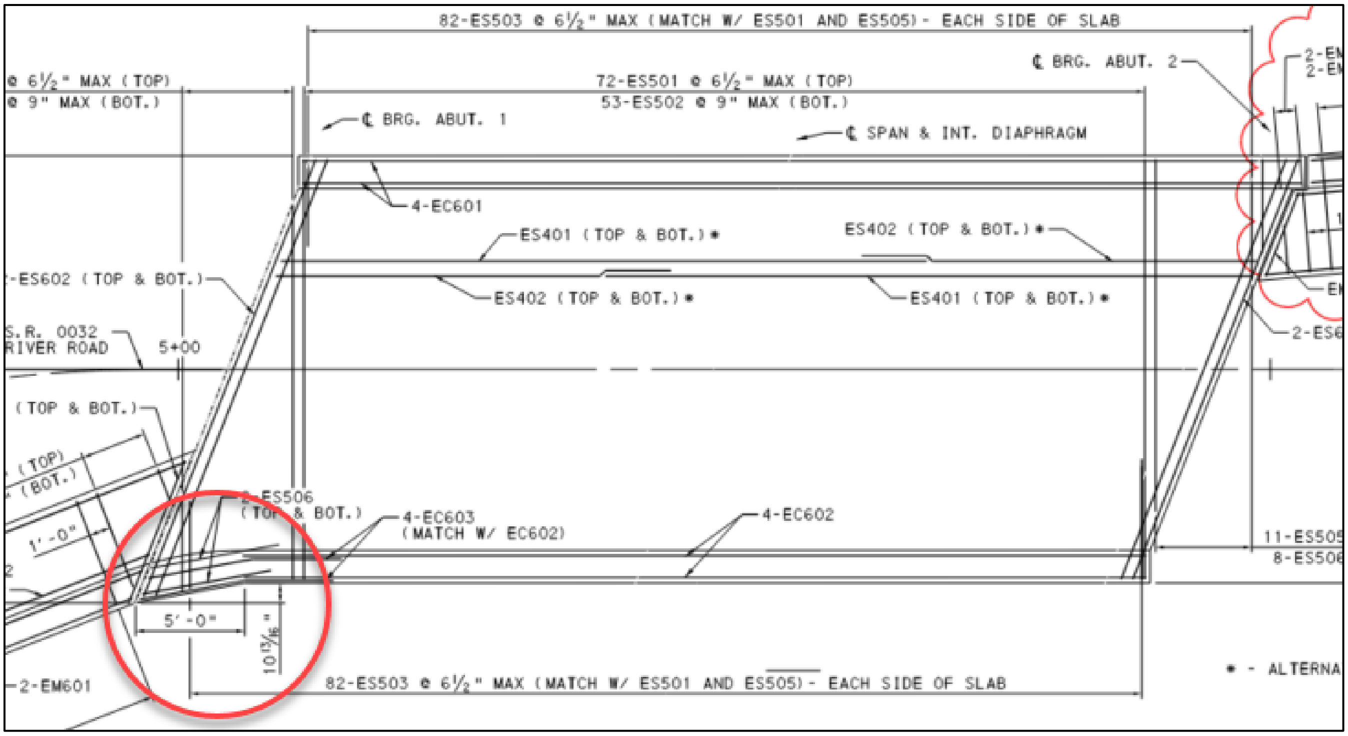
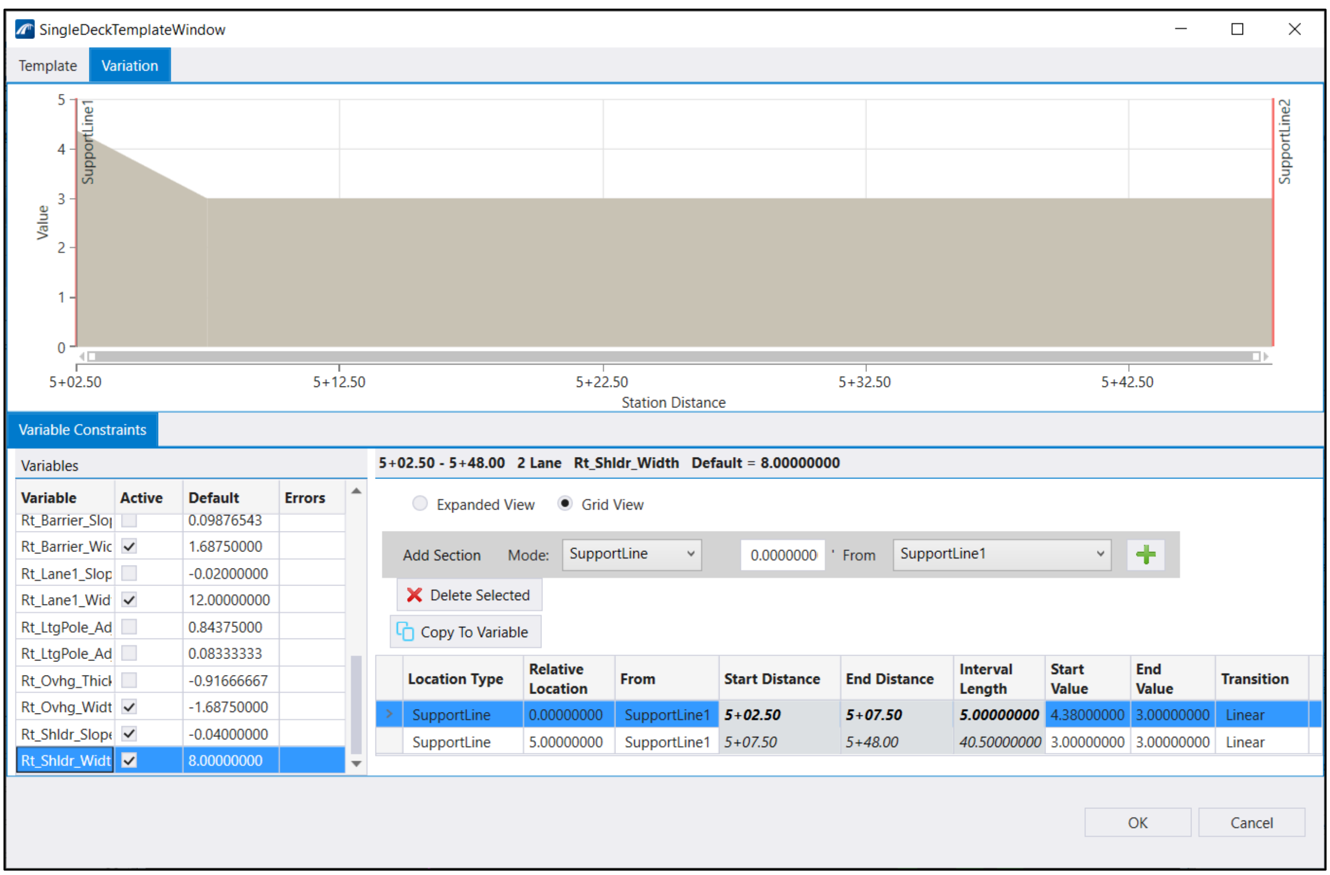
10.2.11 Flared Deck Variable Constraints





10.3 SOLIDS MODELING TOOLS AND TECHNIQUES

The following sections guide several commonly used solids modeling tools that the user may find helpful. In addition, Section 10.4 lists the videos that are included to supplement this manual content. Solids modeling is primarily used in the workflow when the user is moving from a **Base** model element to a **Refined** model element condition and increasing the Element Detail and Information Designations. There are additional solids modeling tools available in OBM that are not covered in this section that the user may also find helpful. The notes on the tools provided below will cover a wide array of modeling strategies and uses. Each tool will include a list of *Possible Areas of Use* where the user may find the tools helpful.

Before using these tools on a Base element, the user needs to understand that applying solids modeling tools on these elements will likely cause them to lose their recognition as OBM components (deck, beam, etc.). For example, using solids modeling tools to “square off” the ends of the deck will cause the OBM recognized element (user able to change templates, extend the deck, adjust variables, etc.) to a Smart Solid or Refined element. Once this occurs, the user cannot go back to a Base OBM component (other than using the Undo command). This process is described in further detail in Section 3.3 Base and Refined versions of model elements.

To use the Solids Modeling tools, the user will need to switch to the **Modeling** workflow. Below is an image of the tools available in the **Modeling > Solids** tab of OBM. These tools are not a “one and done” methodology like the OBM workflow. Using these modeling tools will more than likely require a combination of tools to reach the desired outcome.

Note: Certain solid modifications limit functional capabilities and variable functions. Therefore, any modifications made to the solid should reflect the Refined element model and not depend on the variables being retained.

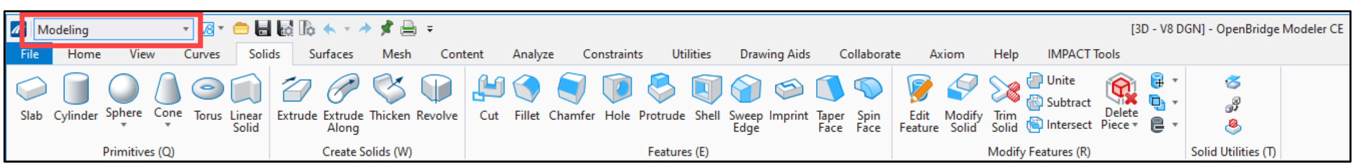
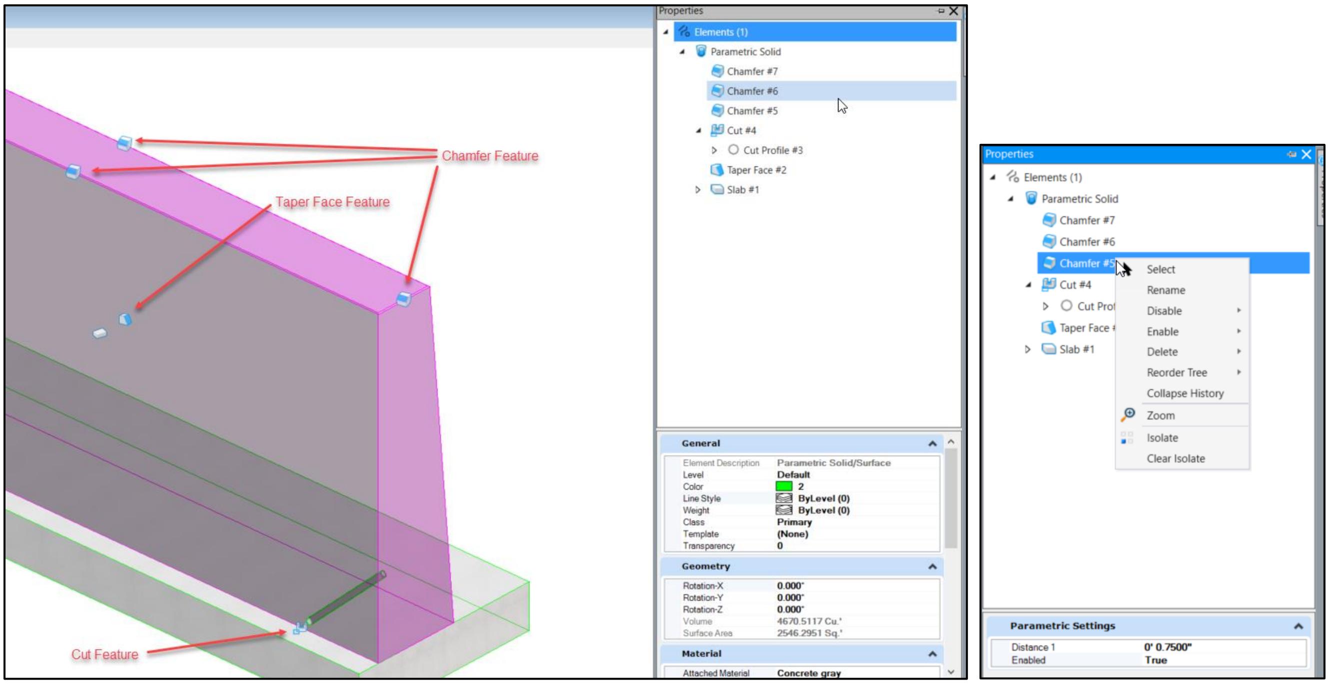


Figure 10.3-1 Modeling Workflow – Solids Tab

Basic understanding of what a solid is and defining the difference between a **Primitive Solid** and a **Smart Solid**:

- **Primitive Solid** – Basic 3D solid shape with no smart characteristics/features applied to the solid.
- **Smart Solid** – Primitive solid with smart characteristics/features applied to the solid. Features such as chamfers, fillets, tapered faces, etc. are discussed below. Features added to solids can be modified, disabled or deleted entirely after being applied to a solid. To modify the feature, simply select the solid, left click the feature you wish to modify in the properties palette (hover over the feature in the model to view the specific feature name), and change the settings in the properties palette. If you wish to disable or delete the feature, select the solid, right click the feature you wish to modify in the properties palette, and choose the option you wish to accomplish.



10.3.1 Primitive Solids

Primitive Solids modeling tools can be used to define basic solids shapes that can be used as a building block for **Smart Solids**. All primitive solids are defined using basic input parameters. After a **Primitive Solid** has been created, it can be edited using the **Feature** tools (**Modeling > Solids > Features or Modify Features**).

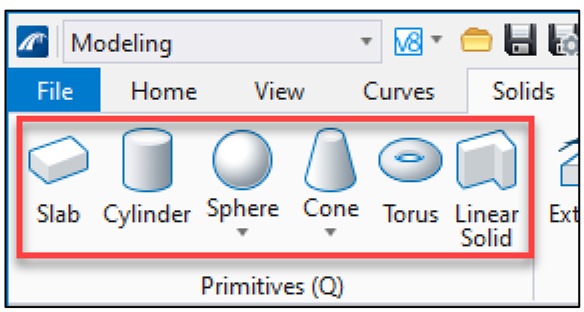


Figure 10.3-2 Primitive Solids Modeling Tools

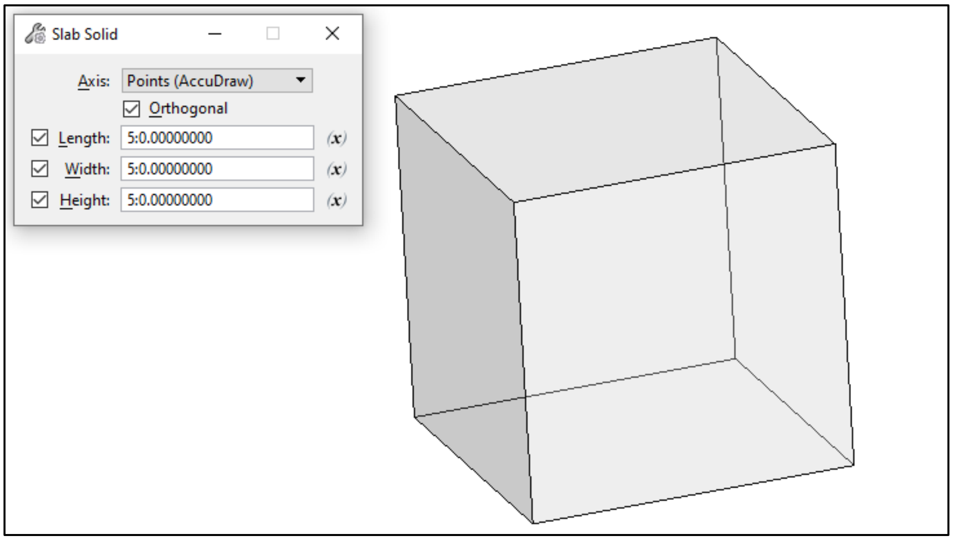


Figure 10.3-3 Primitive Solids – Slab Solid

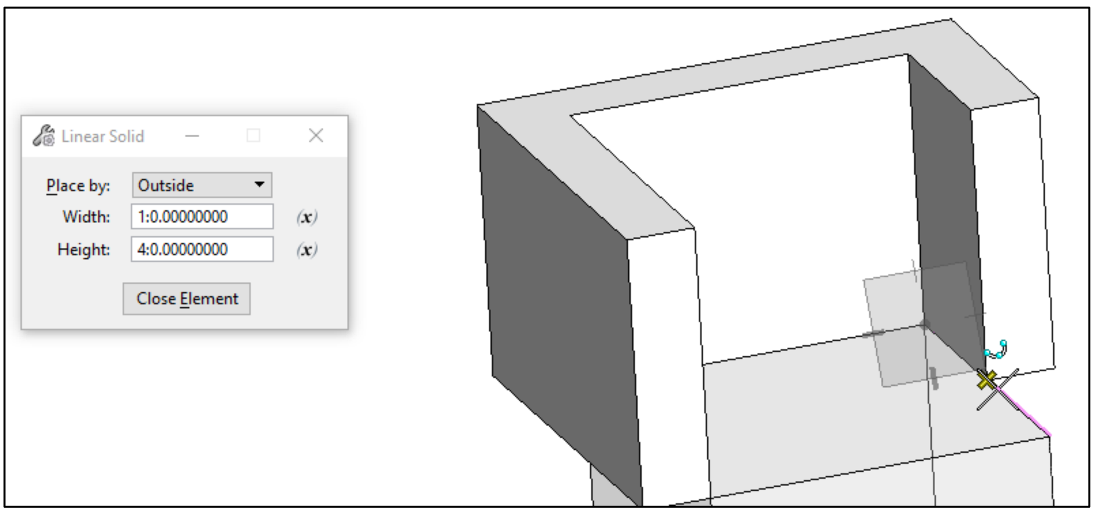


Figure 10.3-4 Primitive Solids – Slab Solid

10.3.2 Extract Faces/Edges

Possible Areas of Use:

- Anywhere on the structure

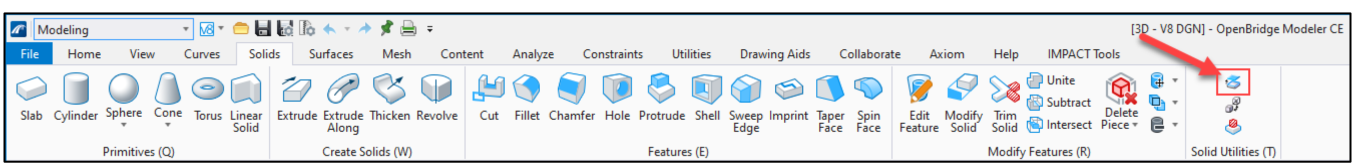


Figure 10.3-5 Extract Faces/Edges in Ribbon

Figure 10.3-6 Close-up of Extract Faces/Edges Tool Icon

The **Extract Faces/Edges** tool can be used to create a copy of a face or edge of an existing element. The tool is useful in reproducing a part of an existing member. The **Extract Faces/Edges** tool is used as a building block in using Solids Modeling techniques and is often the first step in using many of the other tools listed in this Appendix.

Using a barrier element as an example, below are a few images of how the user can extract faces and edges of OBM created solids.

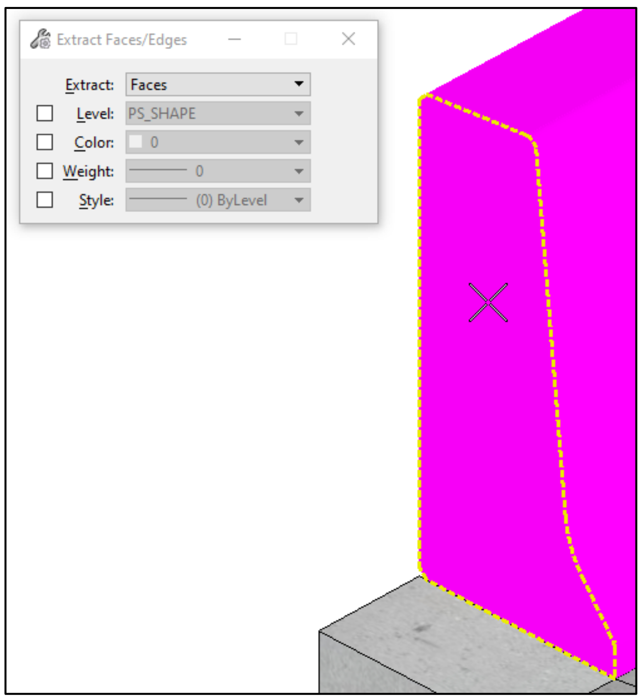


Figure 10.3-7 Extracting Barrier Face

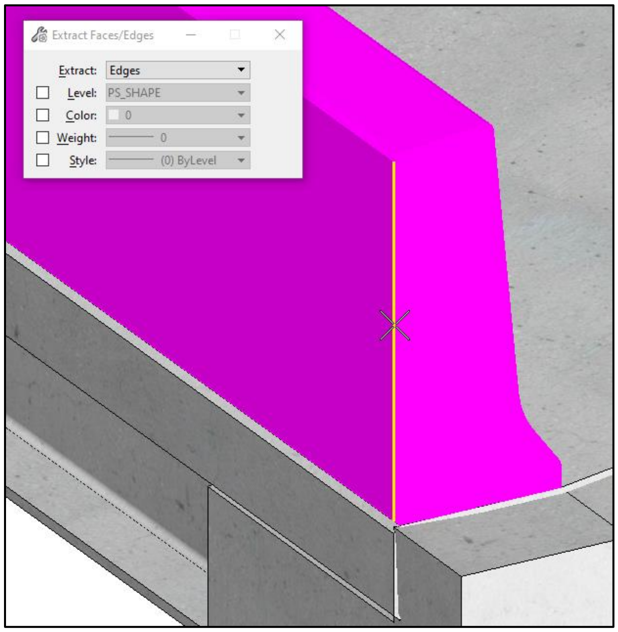


Figure 10.3-8   Extracting Barrier Face

The “Extract Faces/Edges Tool” video provides more details and instructions on successfully using this tool.

10.3.3   Extrude

Possible Areas of Uses:

- Barriers
- Diaphragms
- Safety Wings
- Bearing Seats

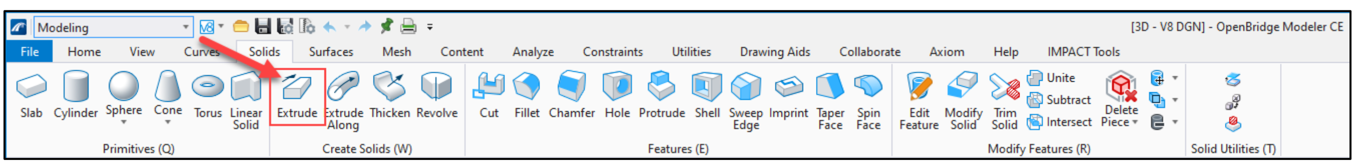


Figure 10.3-9   Extrude

The **Extrude** tool is used to take an existing closed shape and extend it normal to the face of the shape. The user can define a specific distance or snap and click to a defined location. The **AccuDraw** tool is available to the user when using this tool. In the example below, the barrier face was extracted using the **Extract Faces** tool, then the barrier shape is **Extruded** normal to the face of the barrier.

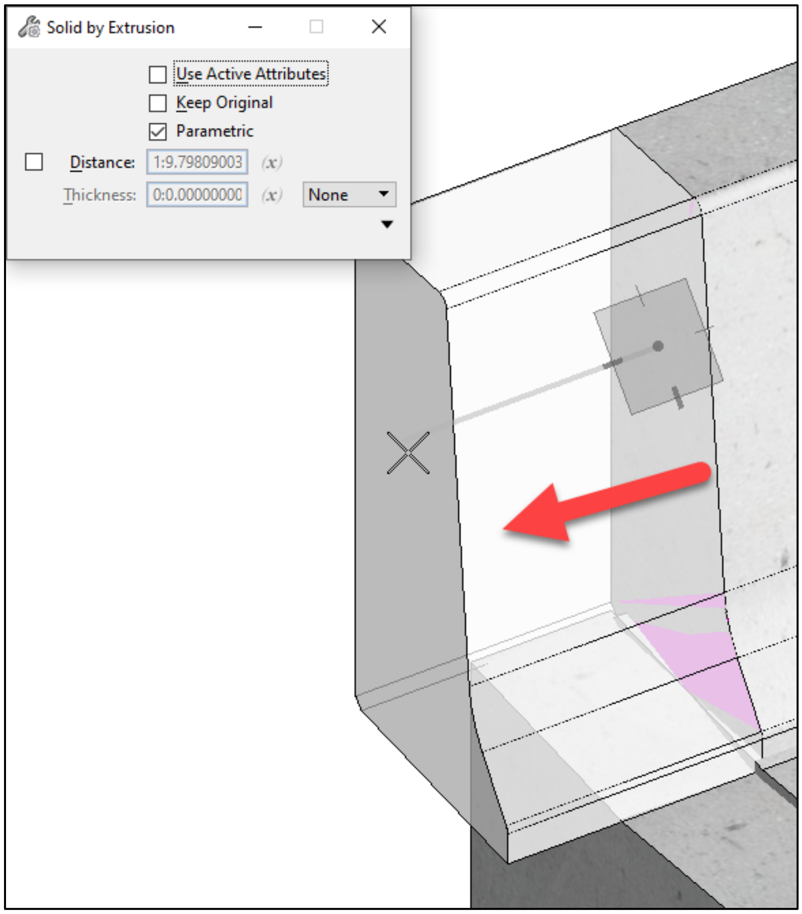


Figure 10.3-10   Extruding Barrier

10.3.4   Extrude Along

Possible Areas of Uses:

- Barriers
- Diaphragms
- Wingwalls

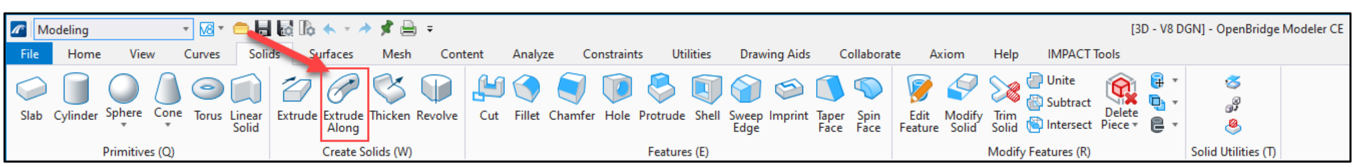


Figure 10.3-11   Extrude Along

Unlike **Extrude**, the **Extrude Along** tool extends a closed shape along a user-defined path. This tool requires a closed 2D shape and a path element (line) for the shape to be extruded along. The path element does not need to be in contact with the profile element. For example, you can select the wingwall profile shape its true location (offset from the BL 20’, 30’ etc.) and use the baseline as the path. This is important because the offset in a horizontal curve adjusts the radius of the profile being extruded. The default setting (not selecting Start and End Distances) extrudes the profile element from the current position to the end of the path element, depending on which direction the extrude along arrow is pointing on the path element. Setting the Start and End distances constrains the extrusion to a certain distance.

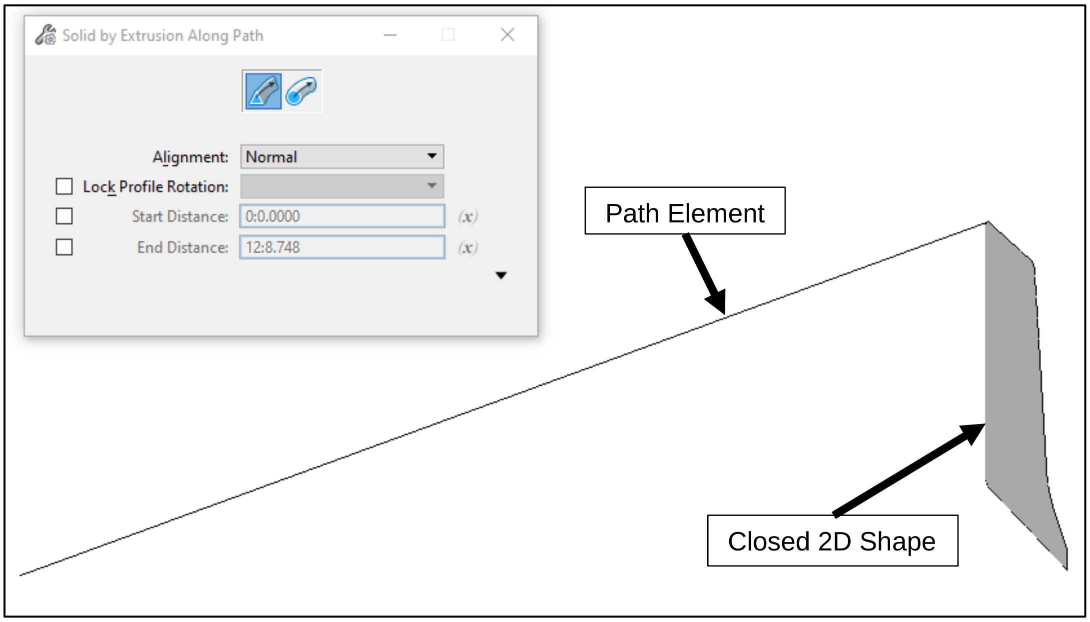


Figure 10.3-12 Extrude Along – Required Elements

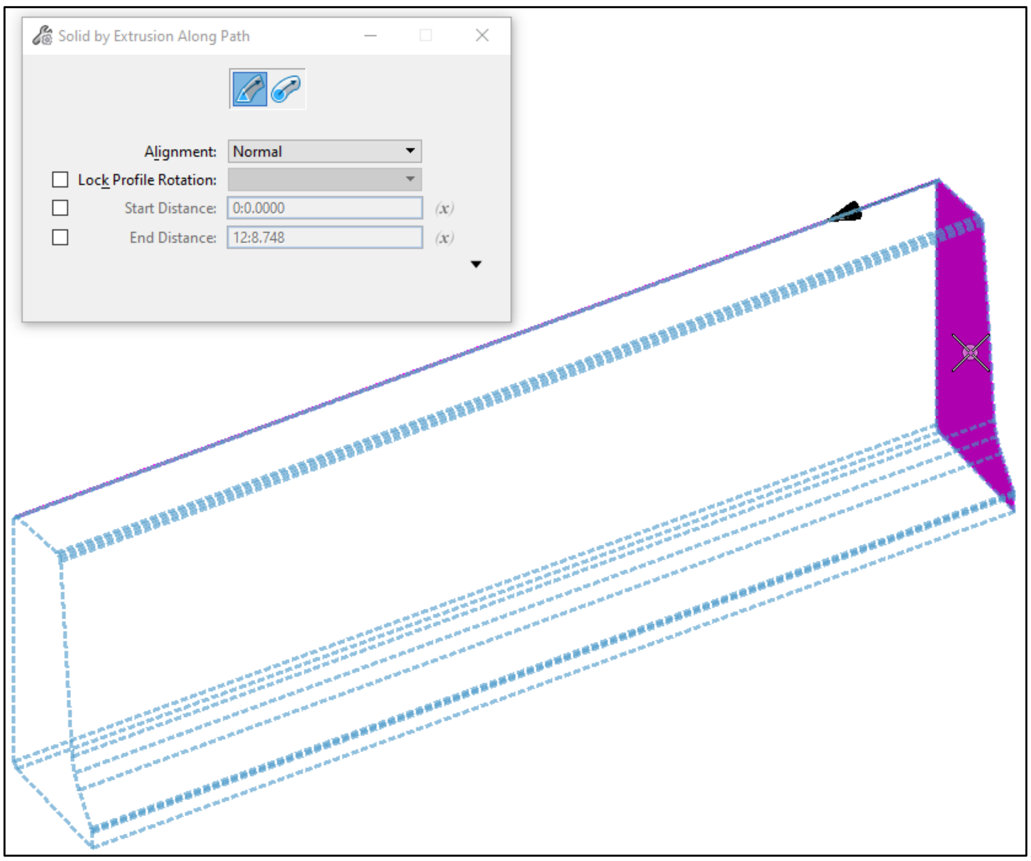


Figure 10.3-13 Barrier Extruded Along Path

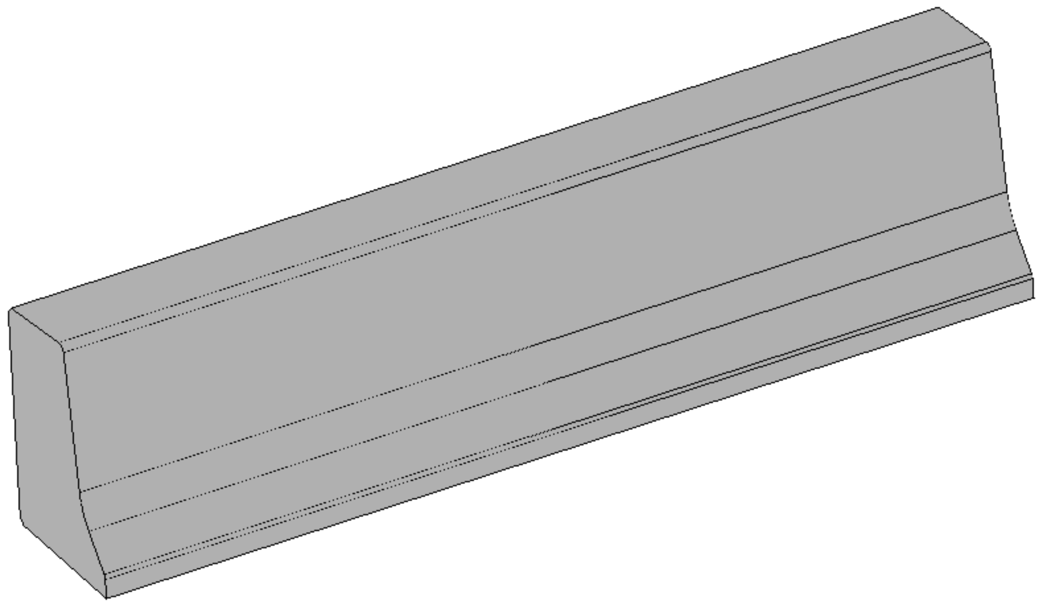


Figure 10.3-14 Finished Barrier Extrusion

10.3.5 Modify Solid

Possible Areas of Uses:

- Anywhere on the structure

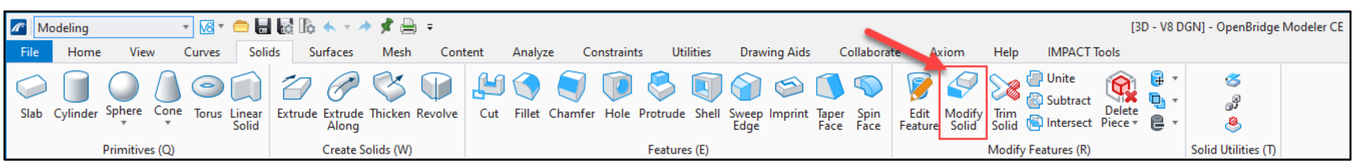


Figure 10.3-15 Modify Solid

The Modify Solid tool has three options for the user to select from: **Modify Face**, **Modify Edge**, or **Modify Vertex**. This versatile tool is useful to make quick and detailed modifications to a solid by displacing the selected face, edge, or vertex at a specified distance or to a snap point.

10.3.6 Taper Face

Possible Areas of Uses:

- Abutment Stem Rear Face
- Wingwall Stem Rear Face

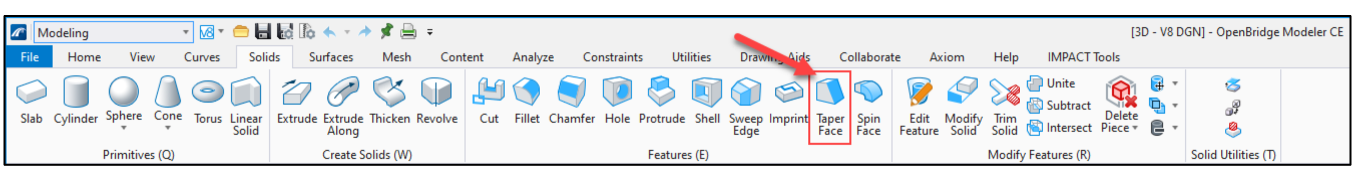


Figure 10.3-16 Taper Face

The **Taper Face** tool gives the user an ability to add a taper to the face of a solid element. This tool is helpful to add a batter to the rear face of abutment or wingwall stems.

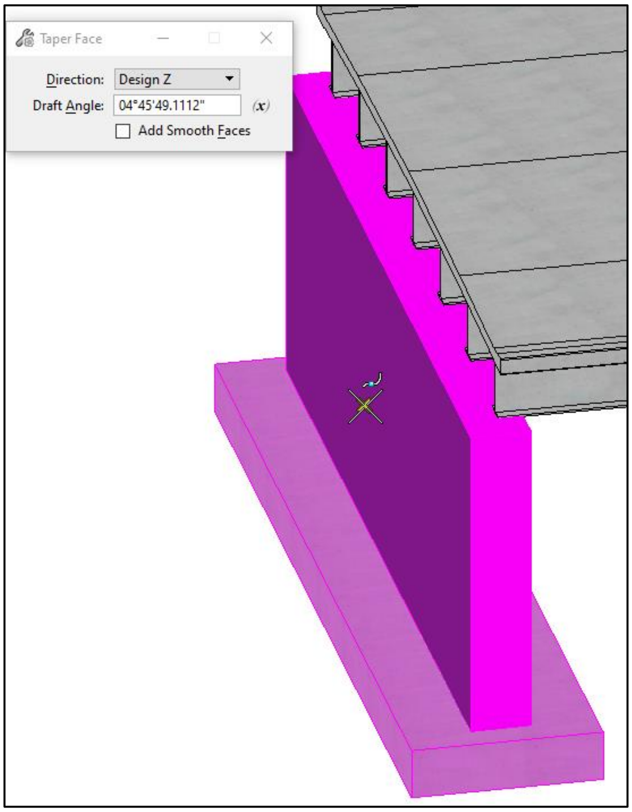


Figure 10.3-17 Abutment Before Taper

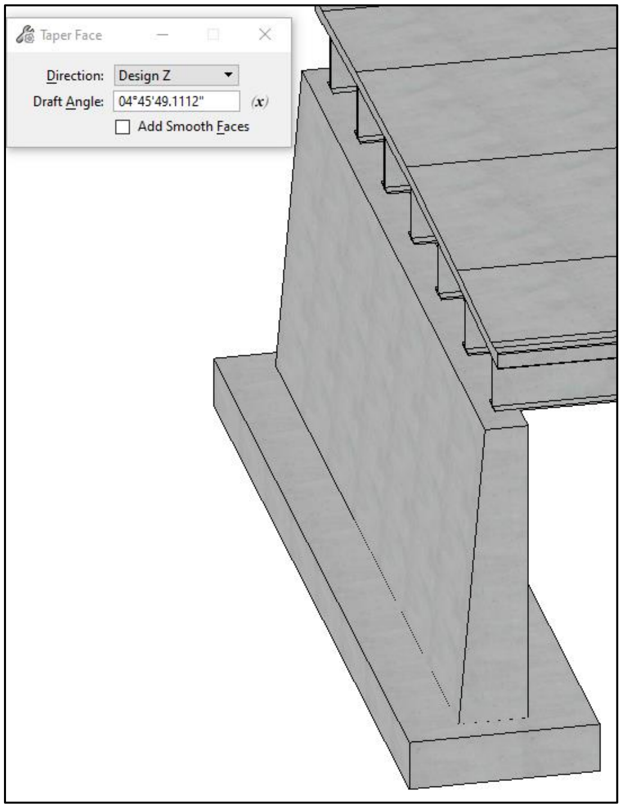


Figure 10.3-18 Abutment with Taper

10.3.7 Difference/Subtract (Boolean Feature)

Possible Areas of Uses:

- Deck
- Diaphragms
- Barrier Modified Deflection Joint

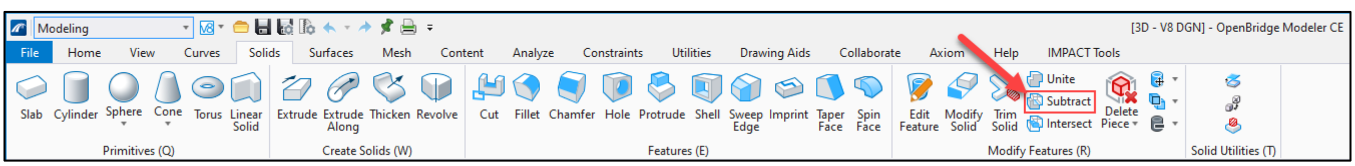


Figure 10.3-19 Subtract

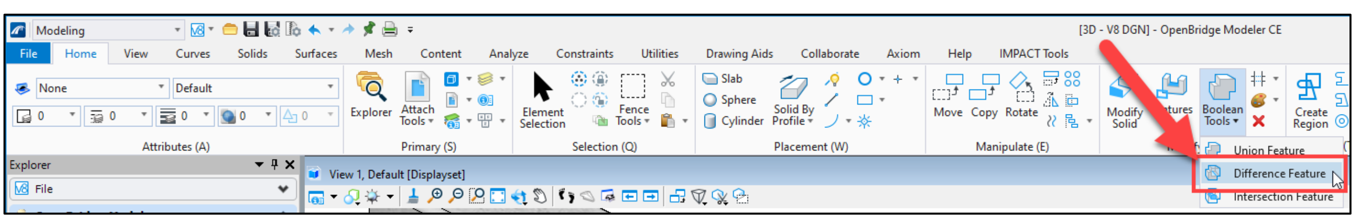


Figure 10.3-20 Difference Feature

The **Difference Feature** and **Subtract** tools have different names but perform the same function in OBM. These tools subtract the overlapping regions of two elements. To use this tool, create a solid element that will function as the sacrificial subtraction solid. The sacrificial solid will then be moved into place and subtracted from the structural element that is to remain.

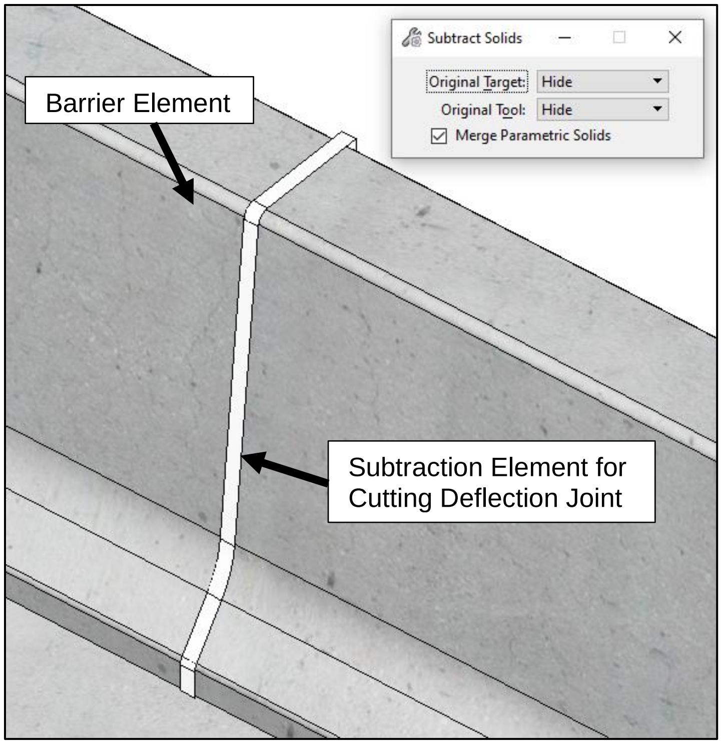


Figure 10.3-21 Barrier Before Subtracting Deflection Joint

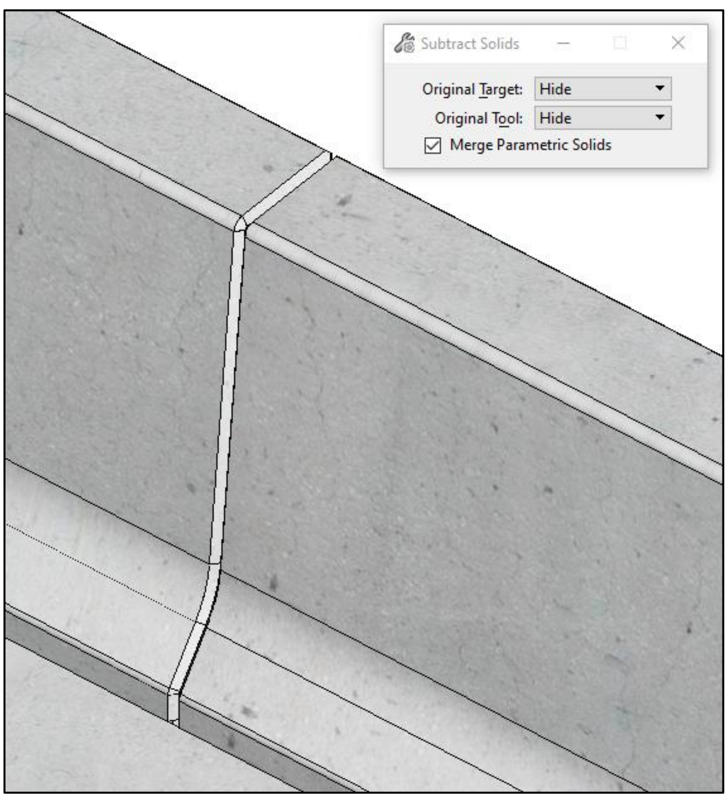


Figure 10.3-22 Barrier After Subtracting Deflection Joint

10.3.8 Union/Unite (Boolean Feature)

Possible Areas of Uses:

- Deck
- Diaphragms
- Integral abutments

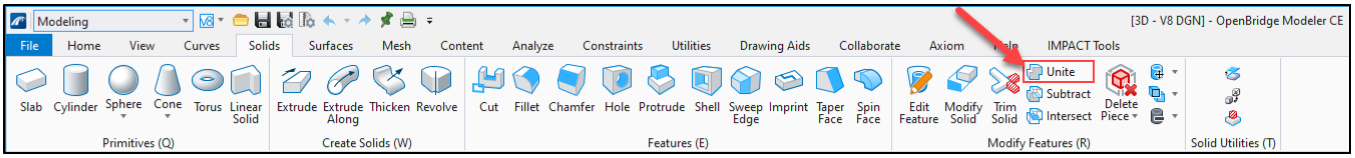


Figure 10.3-23 Unite

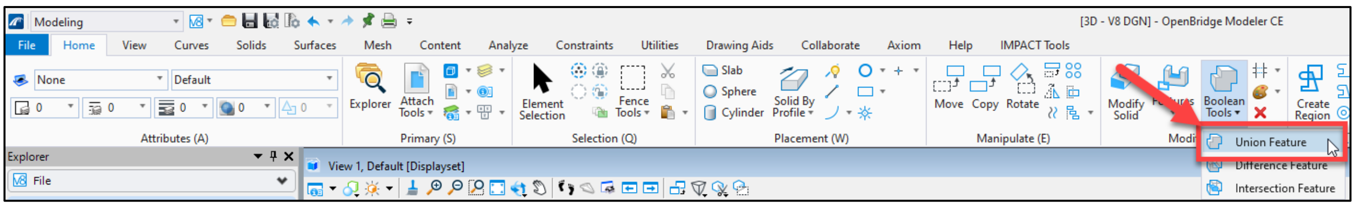


Figure 10.3-24 Union Feature

The **Union Feature** and **Unite** tools have different names but perform the same function in OBM. These tools combine the overlapping regions of two elements or elements that border one another. After the combination, the elements are viewed as a single object. It is important to note the order in which these separate components are selected because the second component will take on the level/material properties of the first component selected.

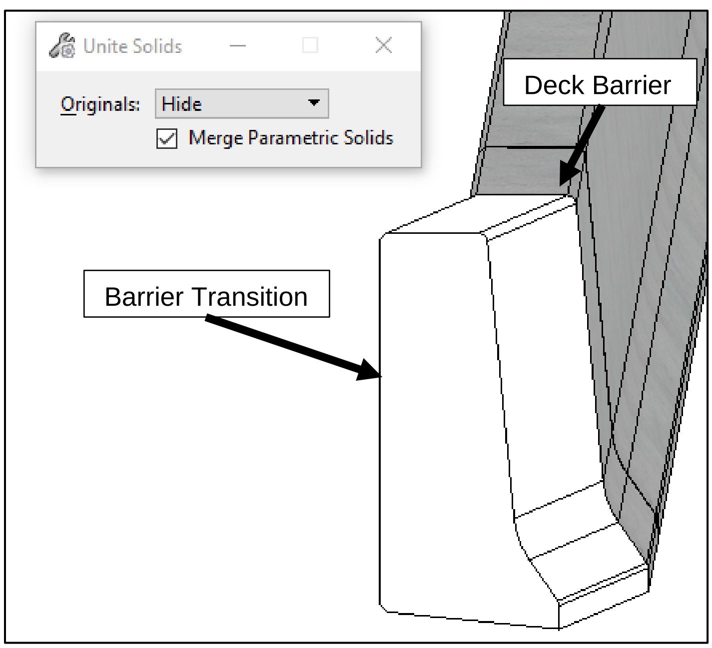


Figure 10.3-25 Barrier Elements Before Union

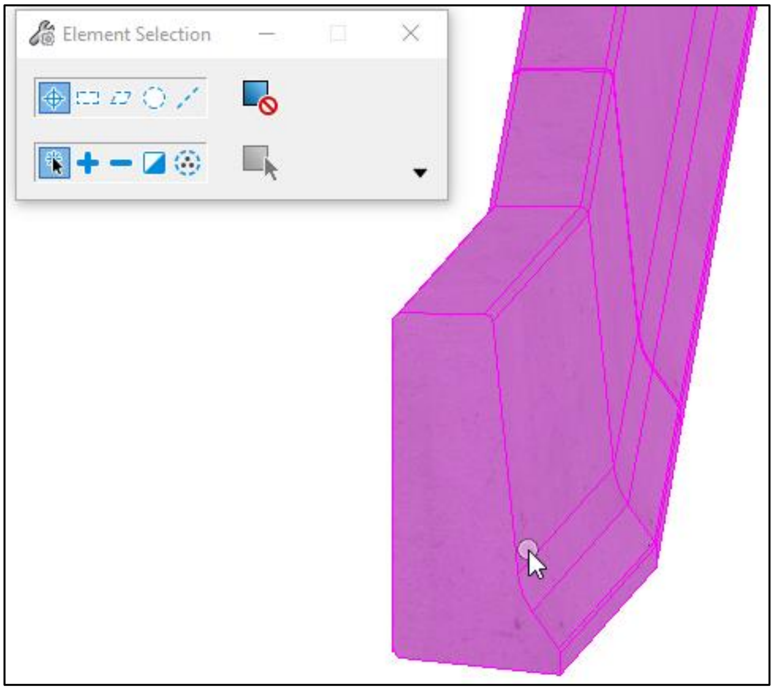


Figure 10.3-26 Combined Barrier and Barrier Transition

10.3.9 Imprint

Possible Areas of Uses:

- Anywhere on the structure

One of the difficulties in 3D modeling is verifying you are drawing in the correct plane. The **Imprint** tool allows the user to draw directly on the face of a 3D object and adjusts the **AccuDraw** to the face for the extent of the drawing on the face. This tool has different options (line/line string, circle, rectangle, and offset) to draw on the face of a 3D object.

After using the **Imprint**, additional tools can be used in combination (**Imprint > Extract Faces/Edges > Extrude**) to model the desired elements.

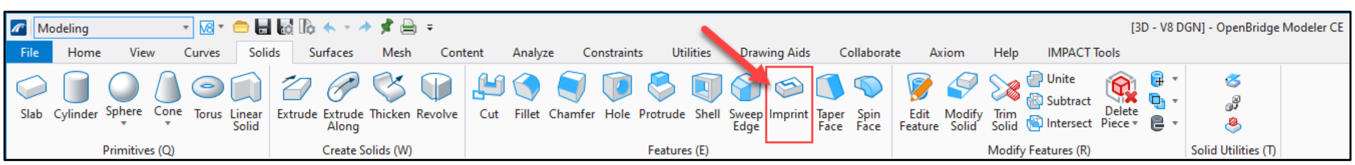


Figure 10.3-27 Imprint

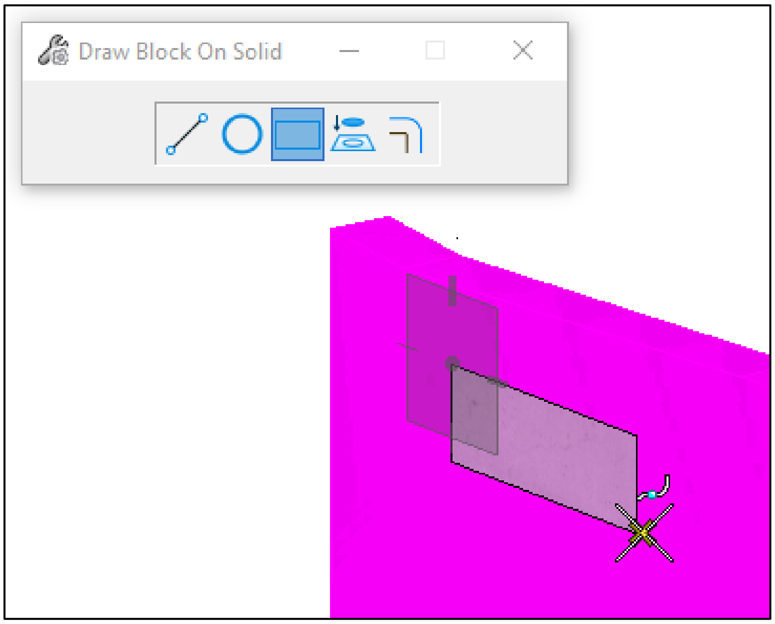


Figure 10.3-28 Imprinting Drawing Element on Abutment Backwall

Using a combination of additional modeling tools, (**Imprint > Extract Faces > Cut** or **Imprint > Extract Faces > Extract Edges > Extrude Along > Subtract**) the user can create an opening for the abutment backwall for utilities as shown below.

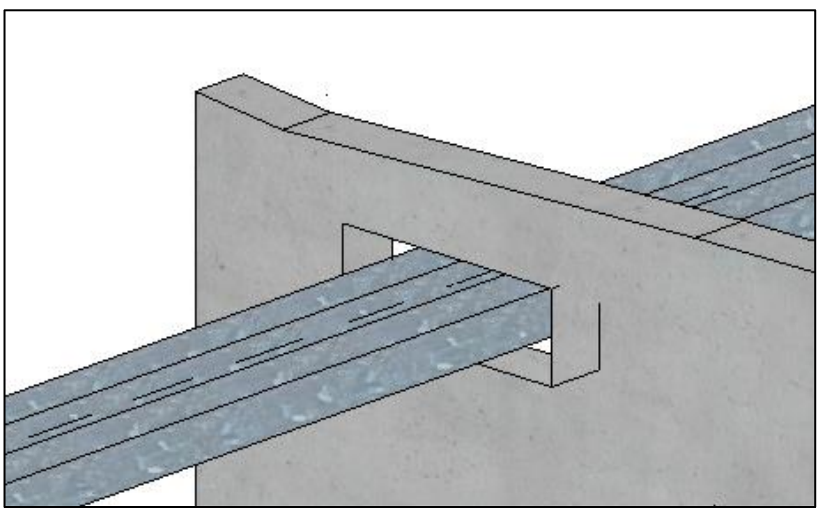


Figure 10.3-29 Utilities Passing Through Backwall

10.3.10 Delete Piece/Face

The **Delete Piece/Face** tool can be used to delete an **Imprinted** face on an element. The regular **Delete** tool cannot be used since it would delete the entire element. This is because the imprint that is created by the user is viewed as part of the element it is imprinted on.

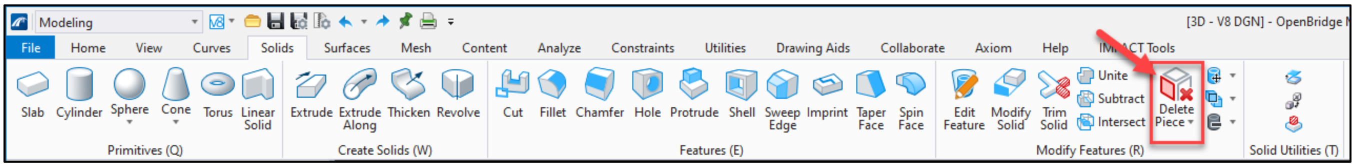


Figure 10.3-30 Delete Piece/Face

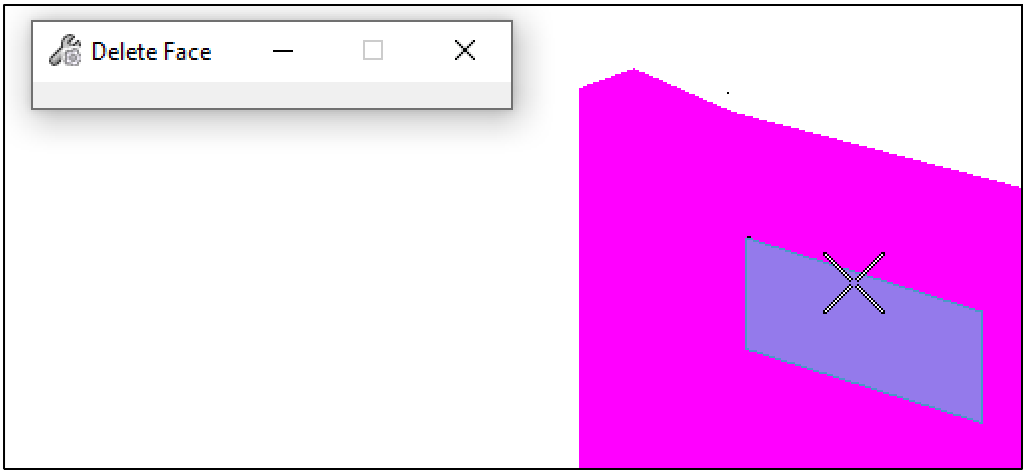


Figure 10.3-31 Deleting Imprinted Face

10.3.11 Cut

Possible Areas of Uses:

- Coping steel beams/girders
- Barrier deflection joints
- Adding weepholes or utility cavities in substructure units
- Splitting deck or substructure for phase construction

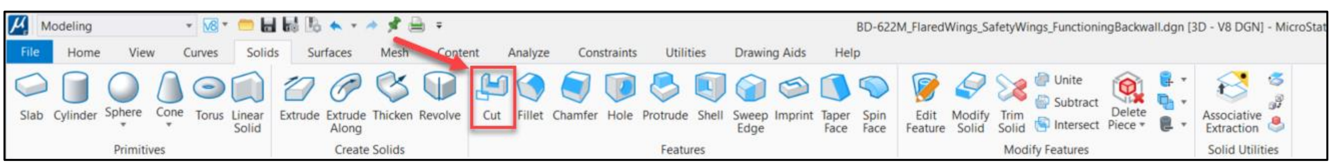


Figure 10.3-32 Cut Feature

The **Cut Feature** tool gives the user the ability to remove or split a portion of a solid using an established profile. The cut is created normal to the profile, so the profile needs to be oriented correctly before using the tool. The user can choose to use the inside/outside profile to remove the portion of the solid or split the solid so the "removal" portion of the solid is left in position and can be modified separately. The user may also choose the depth of the cut, with the length of the cut beginning at the start of the profile, or simply set the cut depth to "Through" to cut completely through the solid without needing to define a depth.

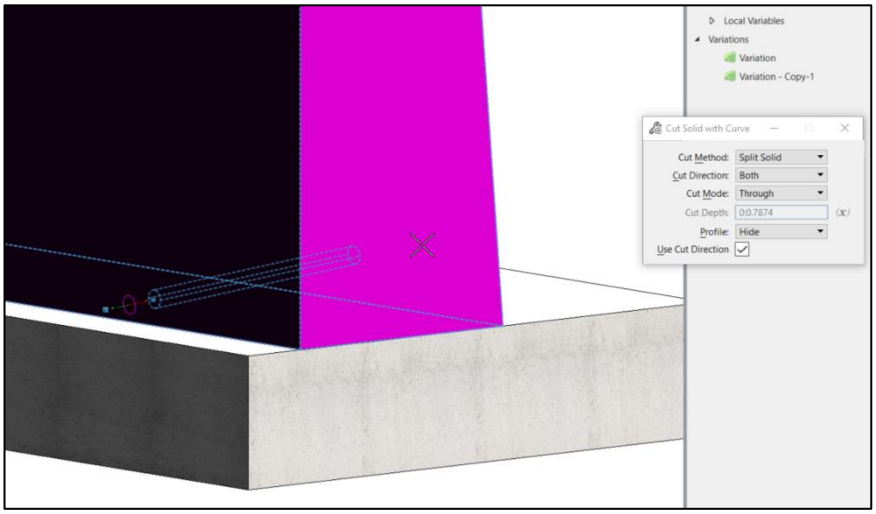


Figure 10.3-33 Weephole being cut into substructure unit

Since a weephole needs to cut through a substructure unit, but is also fitted with a PVC sleeve, the user chose **Split Solid** as the Cut Method to retain the portion of the wall within the weephole as this remaining cylinder will be used to create the PVC sleeve.

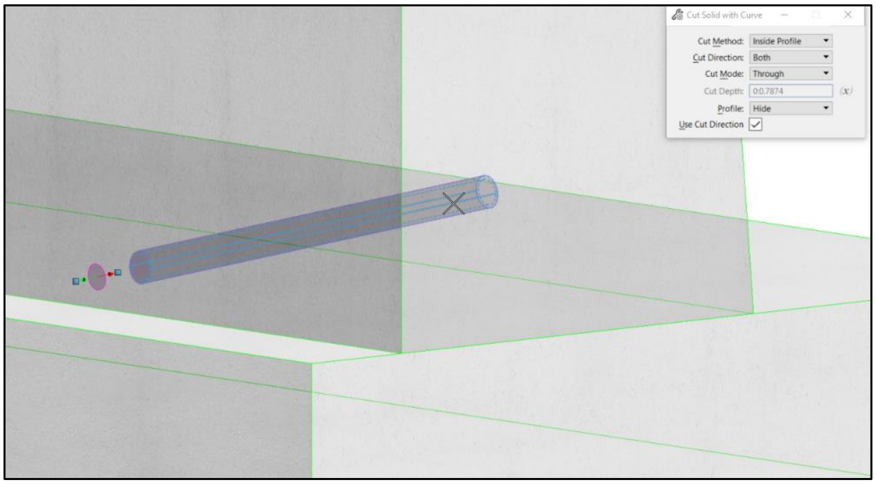


Figure 10.3-34 Transforming remaining cylinder into hollow sleeve

A second cut by the user using the **Inside Profile** as the Cut Method, will create a hollow sleeve. This will remove the profile representing the inner portion of the cylinder, thus creating a hollow sleeve for water to drain.

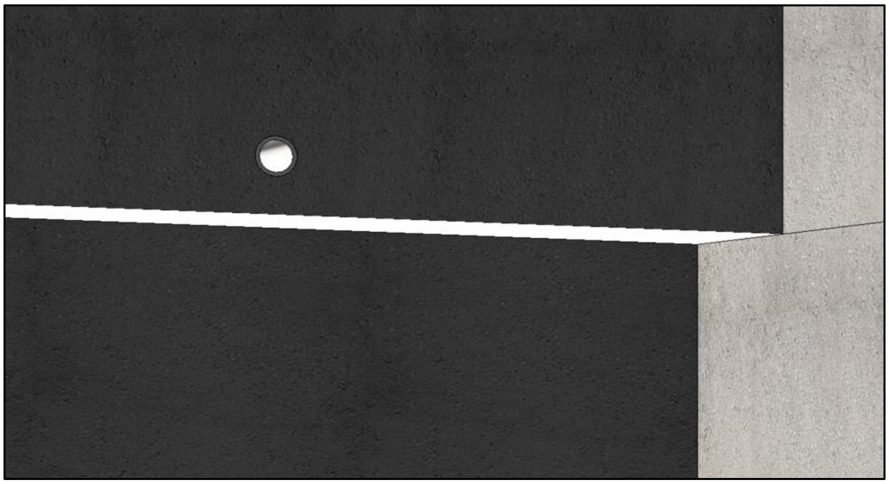


Figure 10.3-35 Weep hole with PVC sleeve

10.3.12 Chamfer/Fillet

Possible Areas of Uses:

- Concrete or Steel Edges
- Barrier Deflection Joints

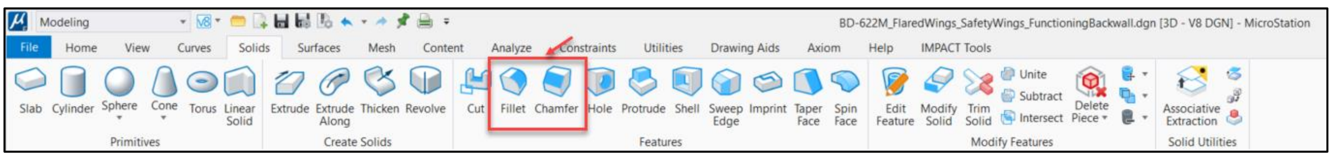


Figure 10.3-36 Chamfer and Fillet

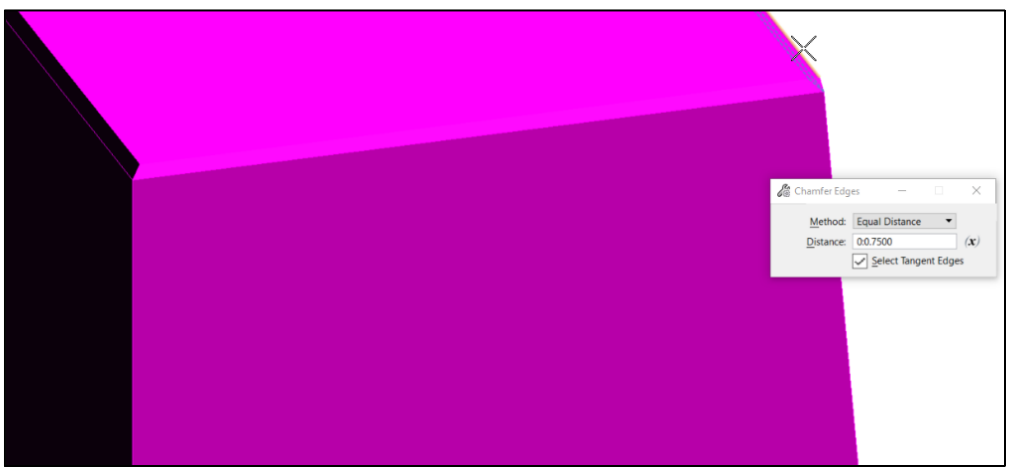


Figure 10.3-37 Chamfer edge of solid

The **Chamfer** tool gives the user the ability to place a chamfer on the corners of solids. While chamfers are typically a 45-degree angle where both legs are the same length, there is an option to specify the lengths of individual legs if the situation requires it. Using the tool is as easy as setting the chamfer values and selecting the edge you want to chamfer.

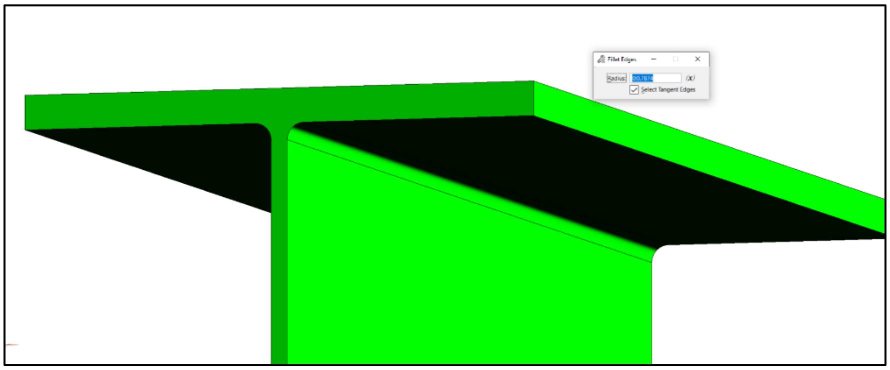


Figure 10.3-38   Using the fillet tool to round the corners of steel shapes

The **Fillet** tool is used to add a fillet or a rounded corner to the edge of a solid. Like the Chamfer tool, the fillet tool is as simple to use as setting the radius of the fillet and selecting the edge you want to apply it to.

10.3.13 Trim Solid

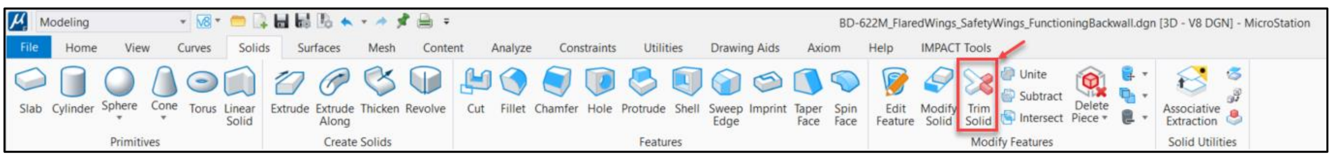


Figure 10.3-39   Trim Solid

The **Trim Solid** tool uses another solid to remove the overlapping volume from the original solid while maintaining the full volume of the solid used to do the trimming. This is a useful tool in situations where an element is conforming around the limits of another element, as both cannot physically occupy the same volume.

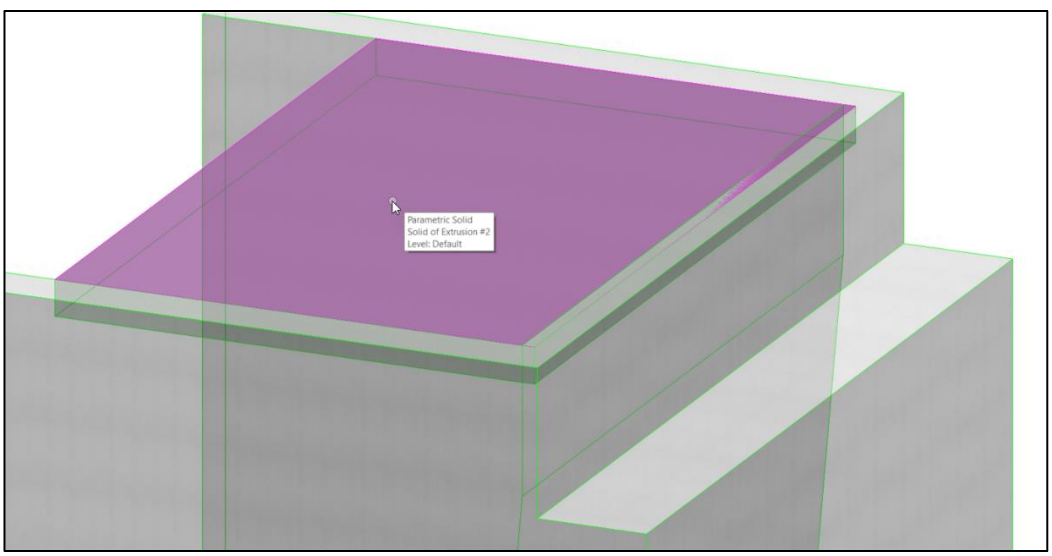


Figure 10.3-40   Abutment Backwall and Approach Slab Occupying the Same Volume

In the example below, an approach slab is being modeled and is to be supported by a paving notch on the rear face of the abutment backwall. While the approach slab needs to be retained in its entirety, the backwall must be trimmed to accommodate the approach slab.

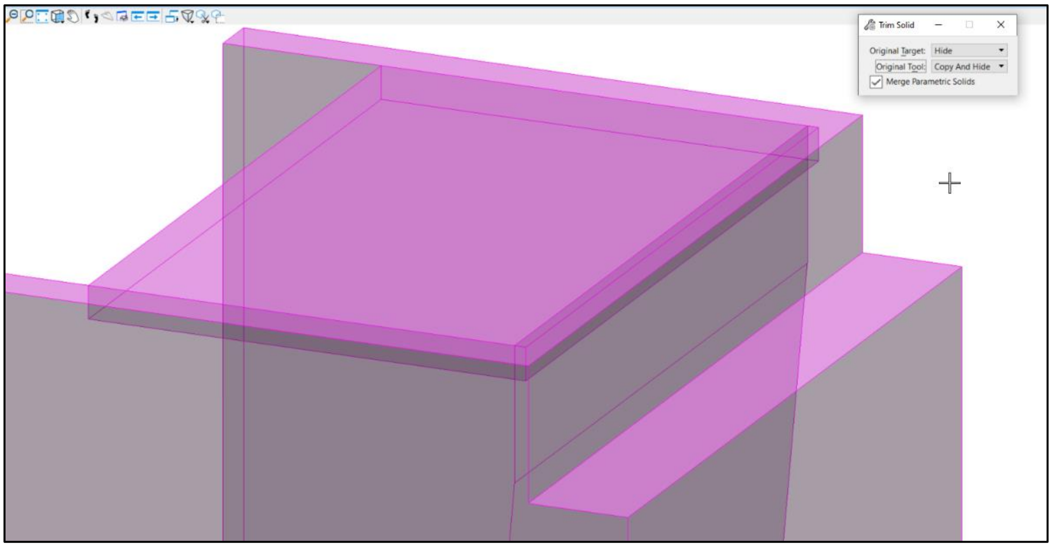


Figure 10.3-41 Selecting the Abutment and the Approach Slab

After selecting the trim tool, the user can set what happens to the solids after the trimming function occurs. In this case, we want the original untrimmed version of the abutment to be hidden, so we select **Hide** for the Original Target, and we want the approach slab to remain, so we select **Copy and Hide** for the Original Tool. First select the Target, or the abutment to be trimmed then select the trimming element, or the approach slab, and finally data point to confirm.

10.4 LIST OF SUPPLEMENTAL VIDEO TUTORIALS

Below are the videos available as supplemental material to this guidance manual. They are organized into series based on specific workflow topics or common tasks.

File name	Description	Duration (mm:ss)
Deck Variable Constraints.mp4	Demonstrating the use of the Variable Constraint functionality with a deck template and how both constant and varying or tapered situations can be accommodated	02:15
Solids Modeling Videos: Squaring of Deck Ends Series		
01_Imprint – Squaring Off Deck Ends.mp4	Using the Imprint tool to “draw” on the deck elements for modifications	01:33
02_Extract Face – Squaring Off Deck Ends.mp4	Using the Extract Face tool to generate linework for the deck elements for modifications	01:05
03_Extrude – Squaring Off Deck Ends.mp4	Utilizing the Extrude tool to generate solids to modify the deck elements	01:13
04_Modify Solid – Squaring Off Deck Ends.mp4	Using the Modify Solids tool for multiple updates to the deck elements	02:20
05_Subtract – Squaring Off Deck Ends.mp4	Utilizing the Subtract tool to cut away elements to modify the deck	00:48
06_Taper Face – Squaring Off Deck Ends.mp4	Using the Taper Face to modify and finalize the deck ends	01:50
07_Modify Solid – Squaring Off Deck Ends.mp4	Using the Modify Solids tool for additional deck element modifications	02:03
Solids Modeling Videos: Beam Notch Series		
01_Imprint – Beam Notch.mp4	Using the Imprint tool to “draw” on the beam elements for modifications	01:30
02_Extract Edge – Beam Notch.mp4	Using the Extract Edge tool to generate linework for the beam modifications	00:42
03_Extract Face – Beam Notch.mp4	Using the Extract Face tool to generate linework for the beam modifications	00:56
04_Extrude Along – Beam Notch.mp4	Utilizing the Extrude tool to generate solids to modify the beam elements	00:35
05_Subtract – Beam Notch.mp4	Using the Subtract tool to cut away elements to modify the beam for the notch	00:45
06_Chamfer – Beam Notch.mp4	Utilizing the Chamfer tool to modify the beam edges	00:41

Note: Updated OBM versions (starting with 2022 R1) include tools that provide the user the option to square off deck ends. The videos listed above were generated prior to the implementation of that feature. They have been left in this Users Guide as simply another example of 3D modeling techniques, and what can be achieved through their use.

10.5 OPTIONS FOR CONSTRUCTION PHASING IN MODELS

[This section is under development. Content will be added after Digital Delivery Directive 2025 Pilot Project feedback is incorporated.]

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