



Using Functional and Generative Components for Custom OpenBridge Substructure Elements

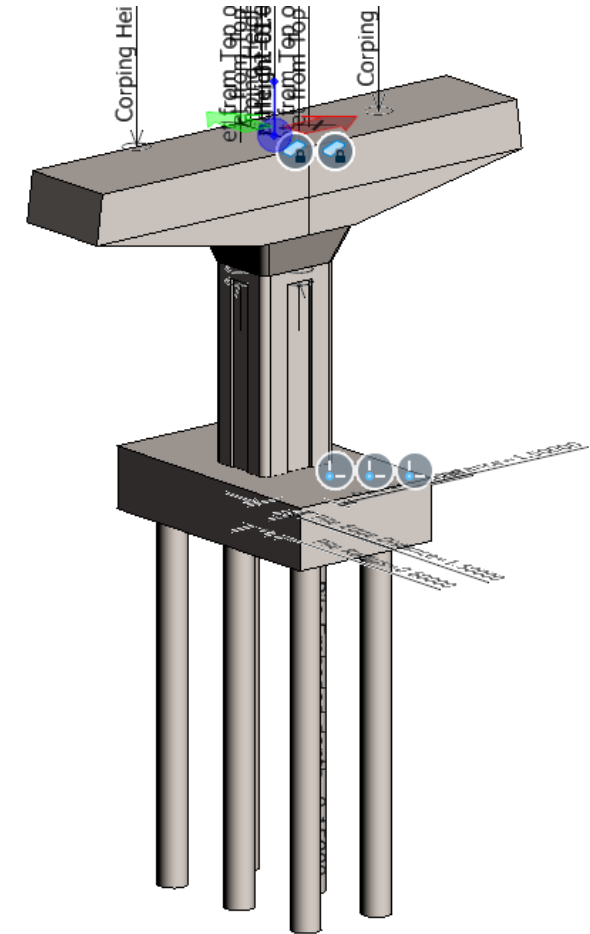
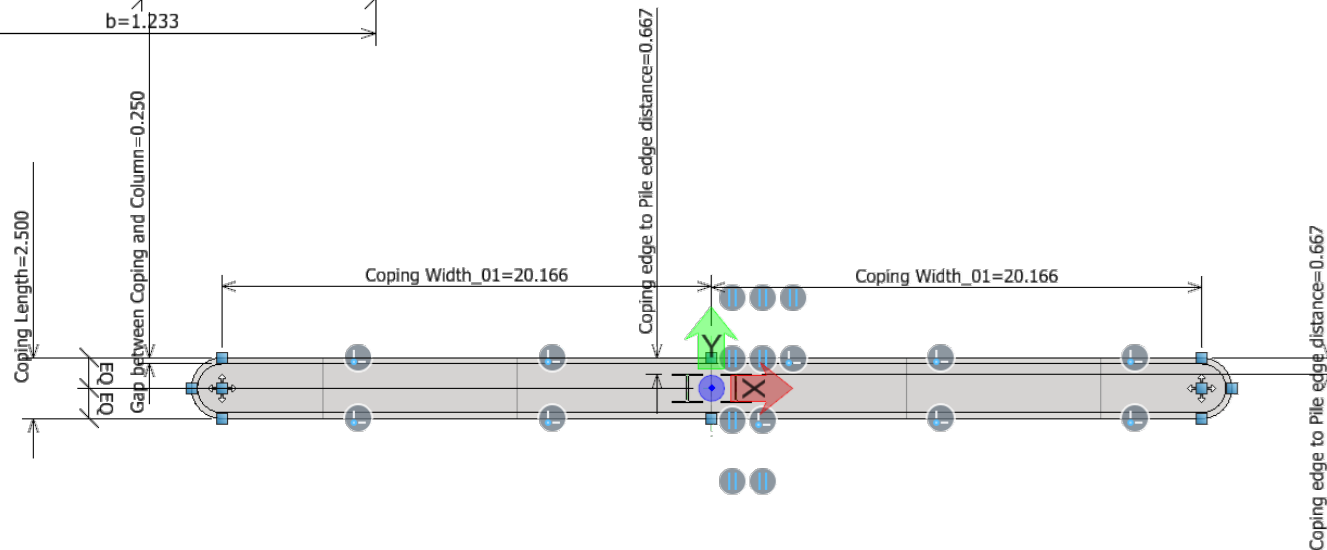
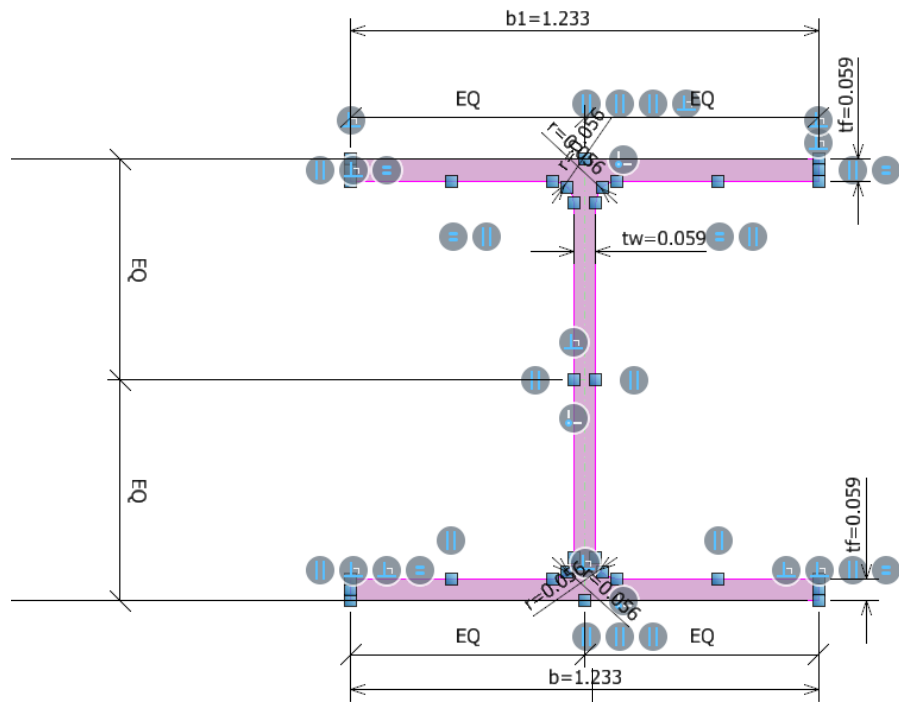
Steve Willoughby
Senior Application Engineer, Bridges and Tunnels



Functional Components



When and How to use Functional Components in Bridge

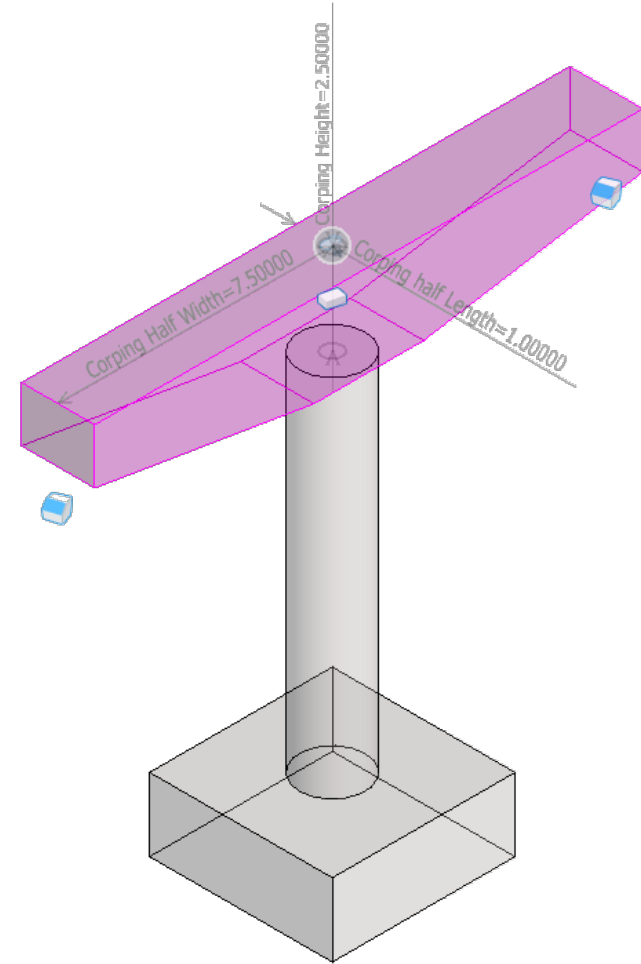
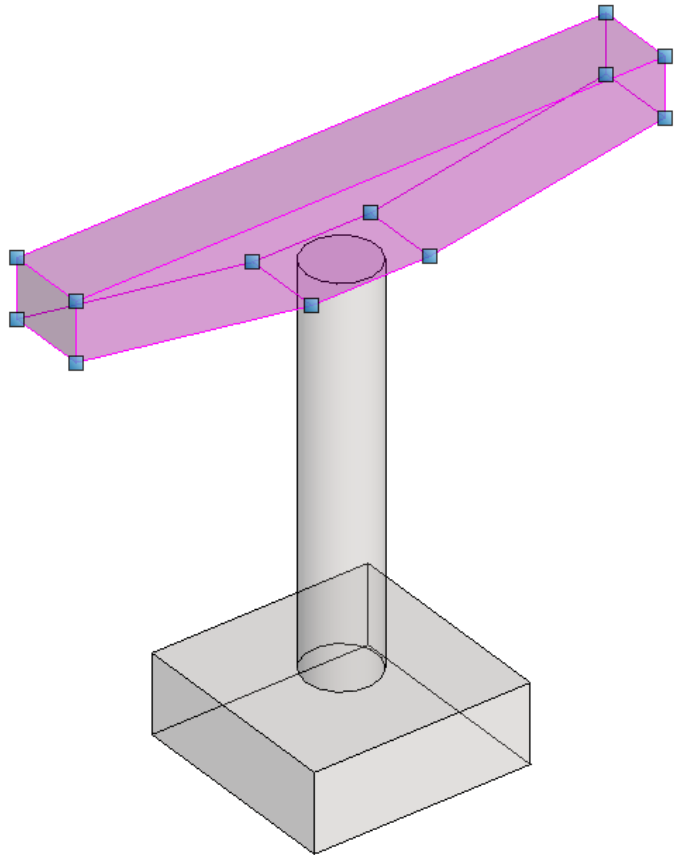


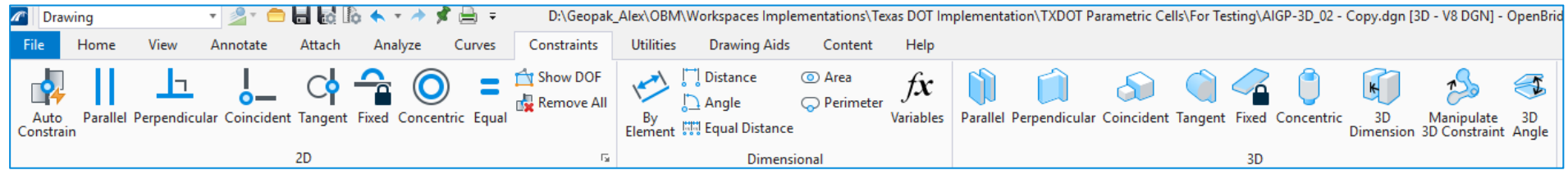
Modeling Method Transition

Template

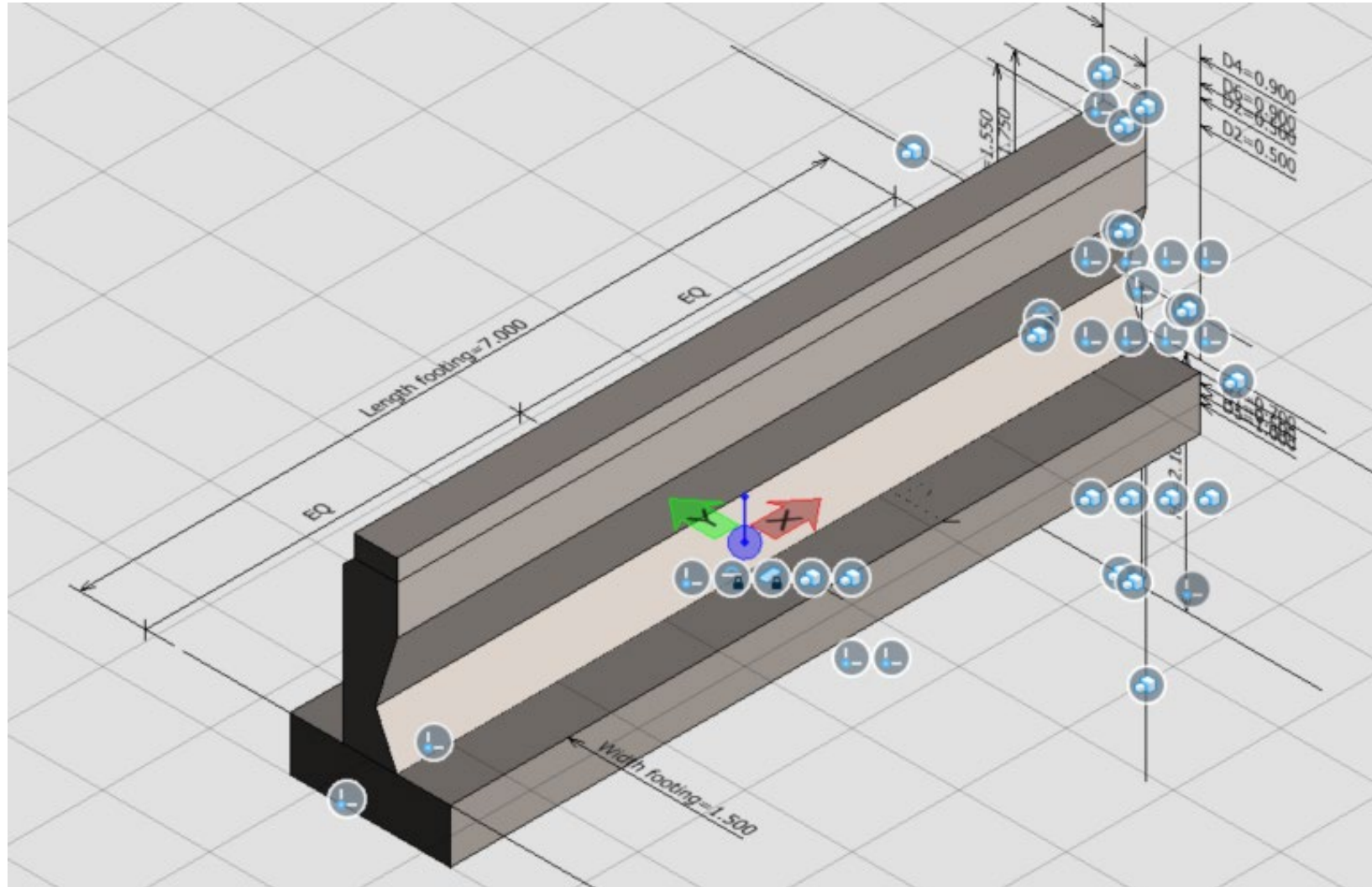


Functional Component



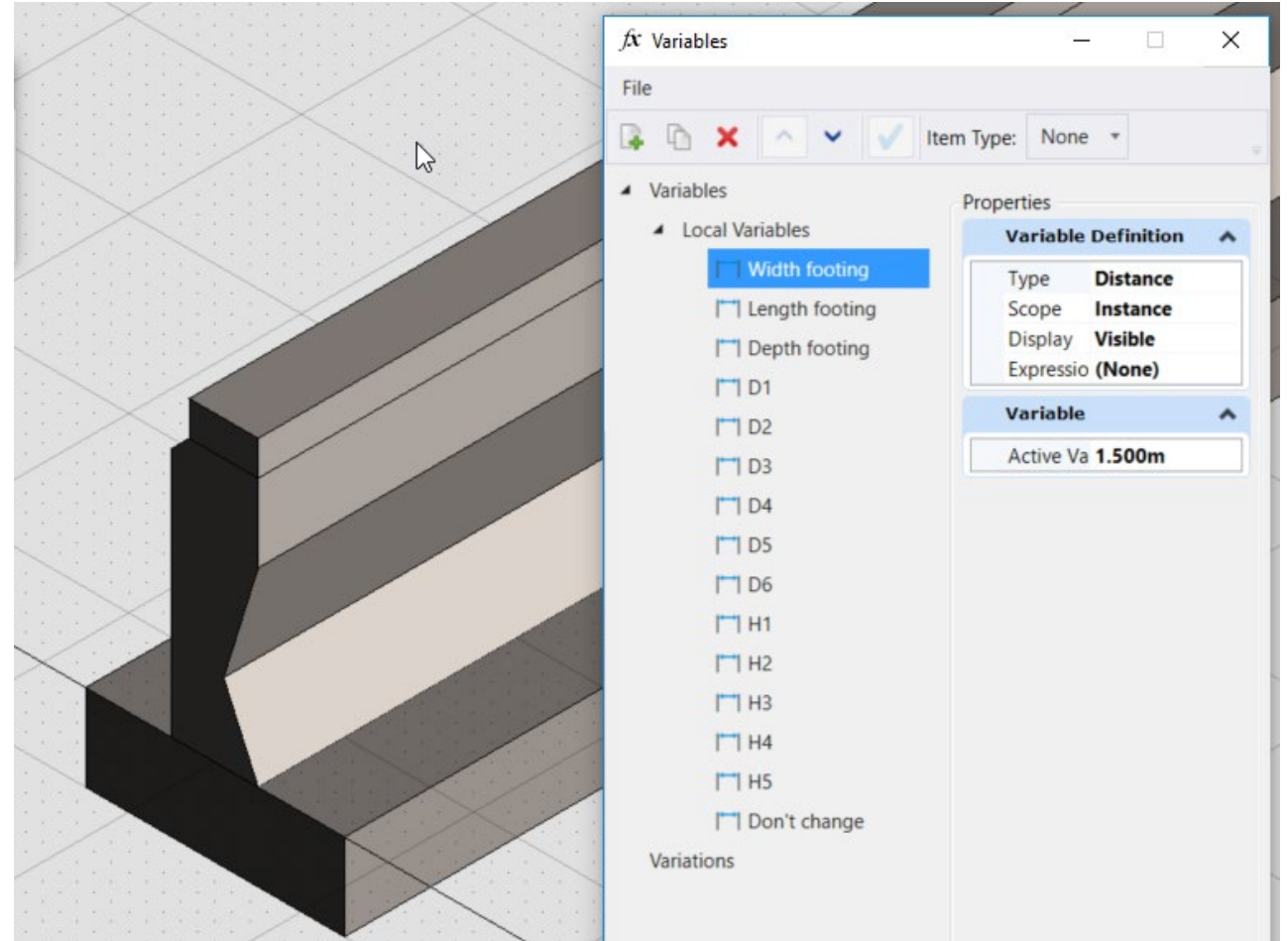


- Modeling > 2D Constraints
- Modeling > 3D Constraints

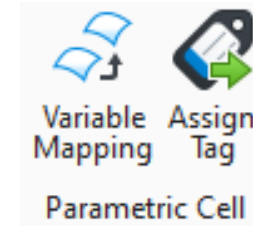


Variables

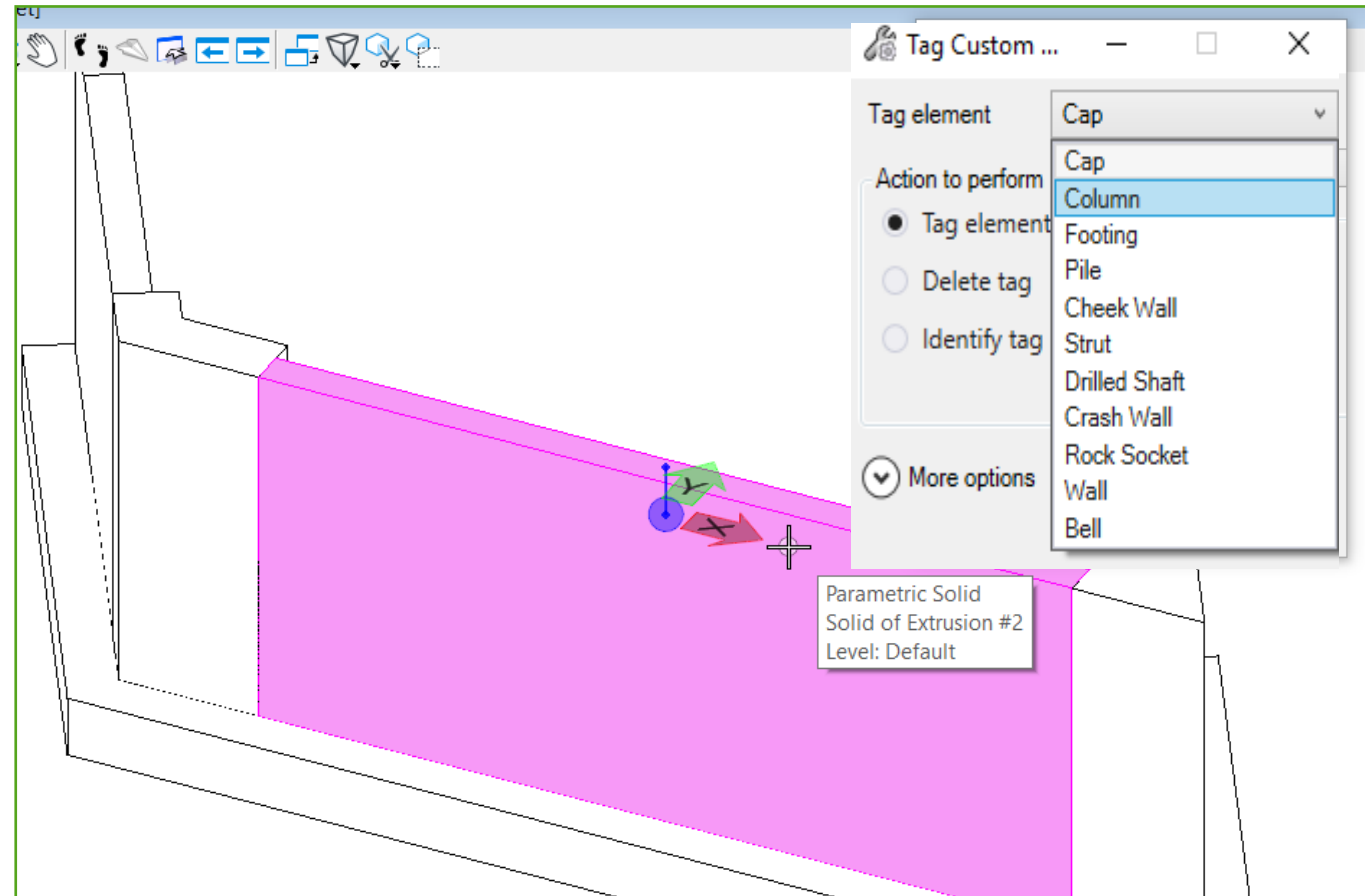
- Modeling > 2D Constraints
- Modeling > 3D Constraints
- Modeling > Variables



Assigning Tags

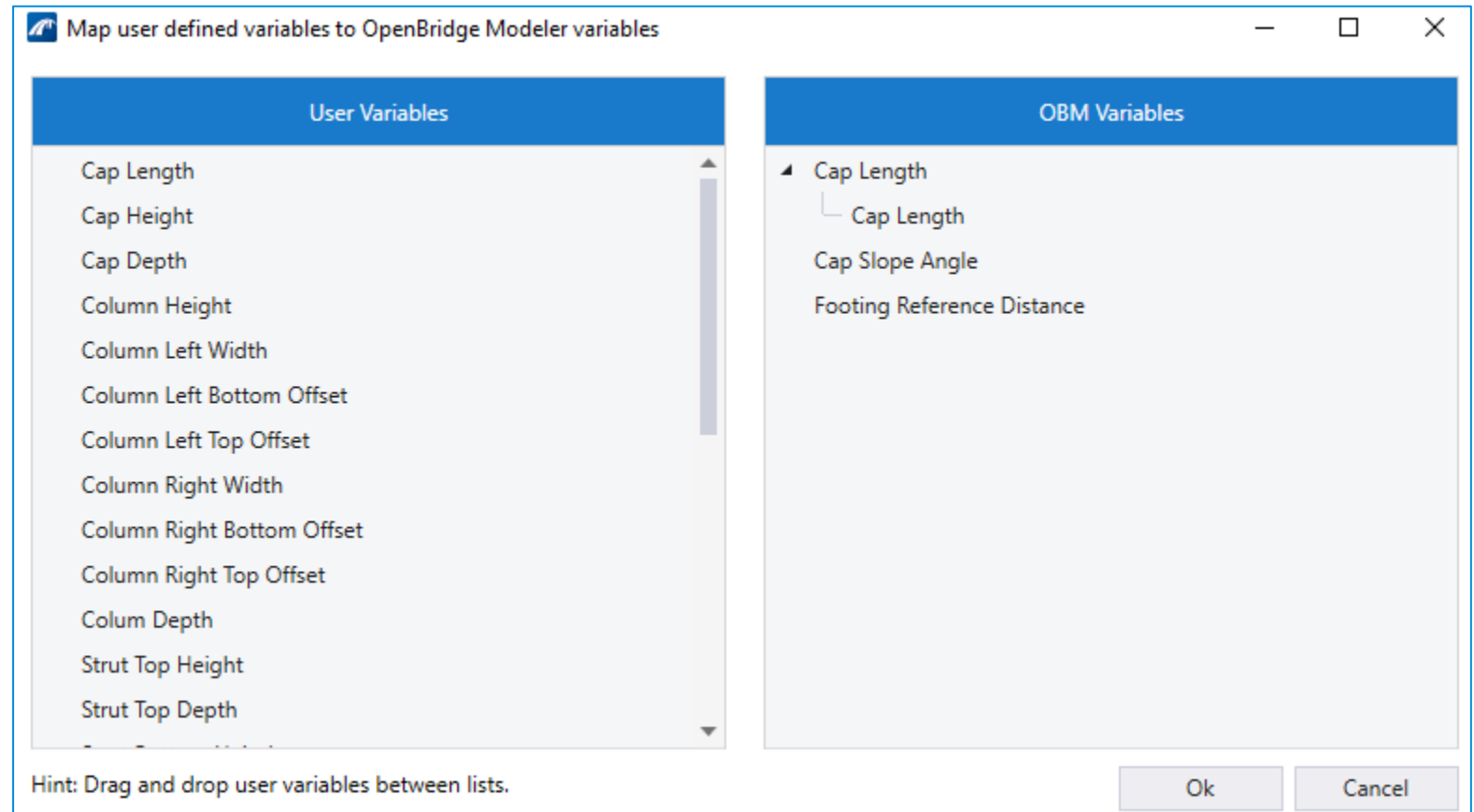
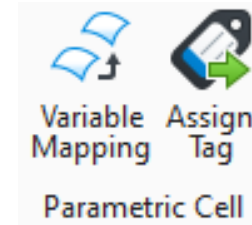


- Tag different parts of the cell with OBM specific object tags, so they are recognized and reported on as needed.
- E.g. tagging a solid as a column allows OBM to report the volume, and as a pile to report the length.

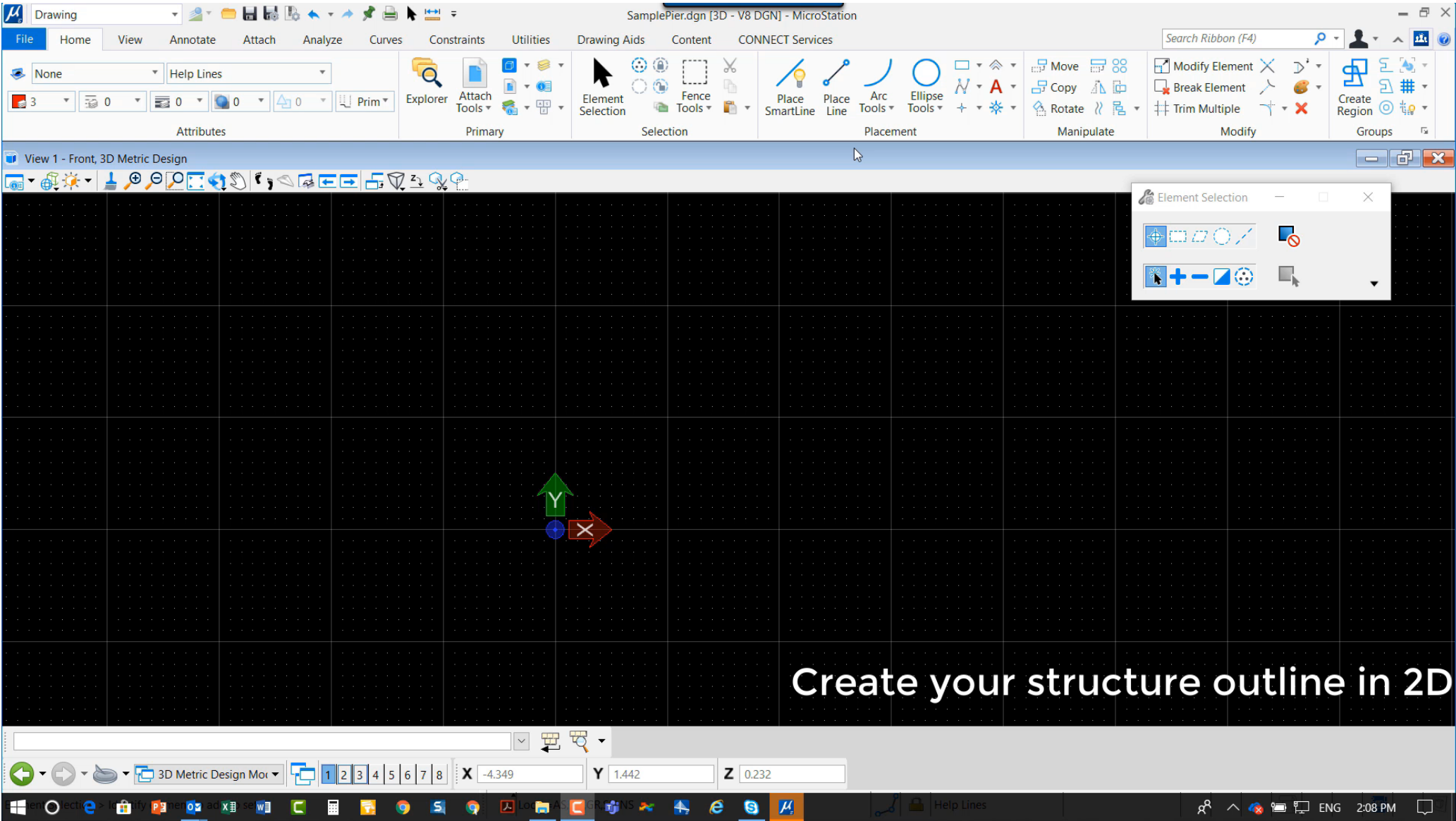


Variable Mapping

- Variable Mapping
 - Map user defined variables to OBM variables to allow the functional component to react to changes parametrically in OBM.
 - Variables exposed
 - Cap Length
 - Cap Slope
 - Footing Reference Distance



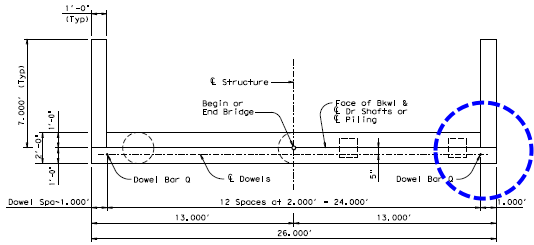
Creating a Bridge Functional Component



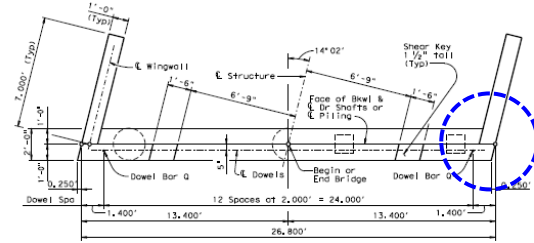
Create your structure outline in 2D

Using Parametric Models in Abutments

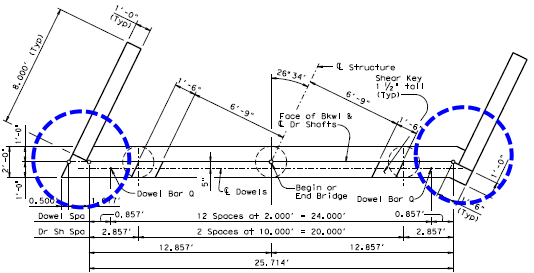
Case 1



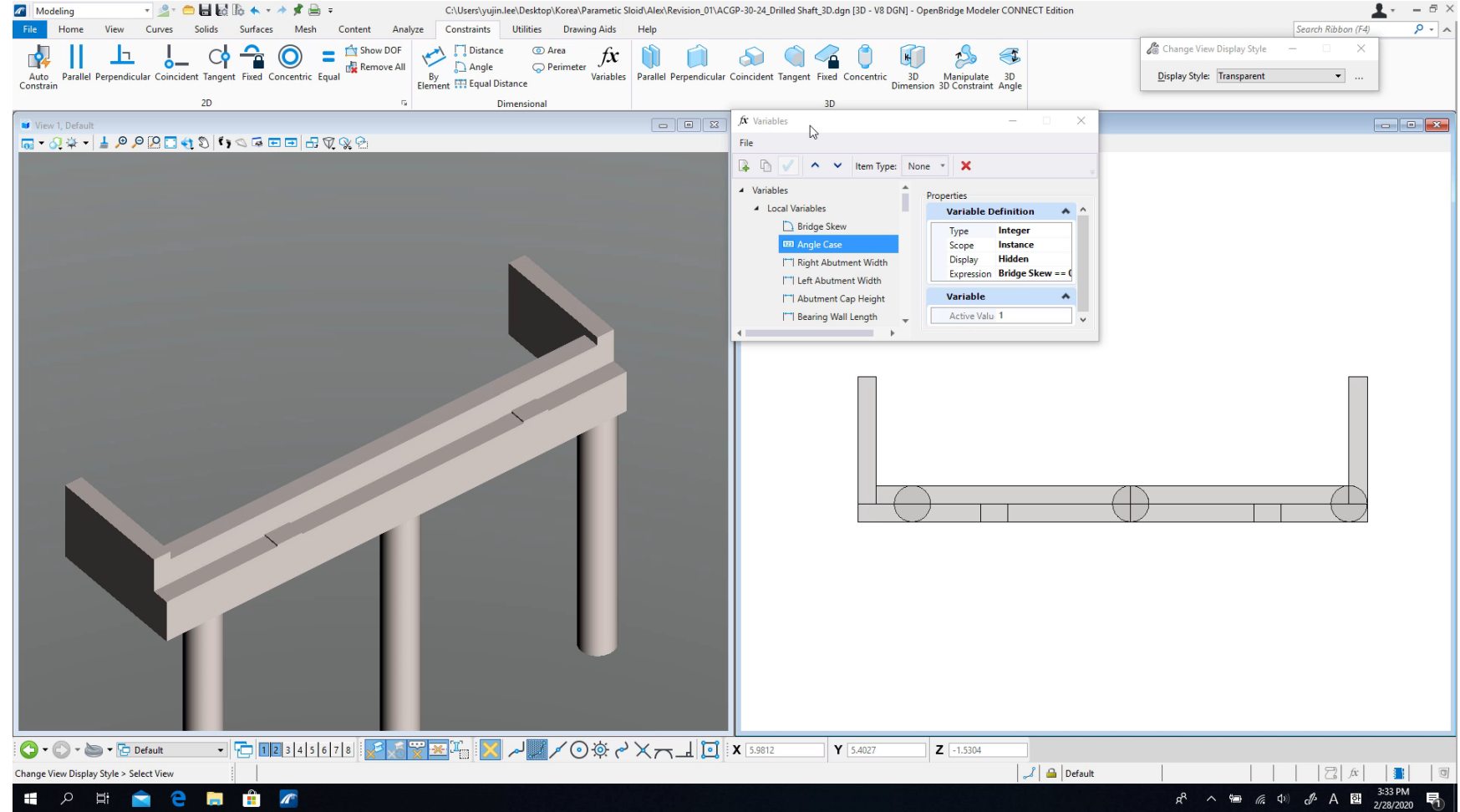
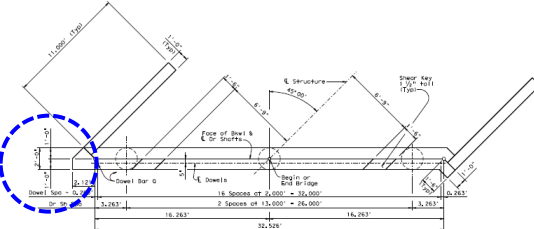
Case 2 and Case 5



Case 3 and Case 6

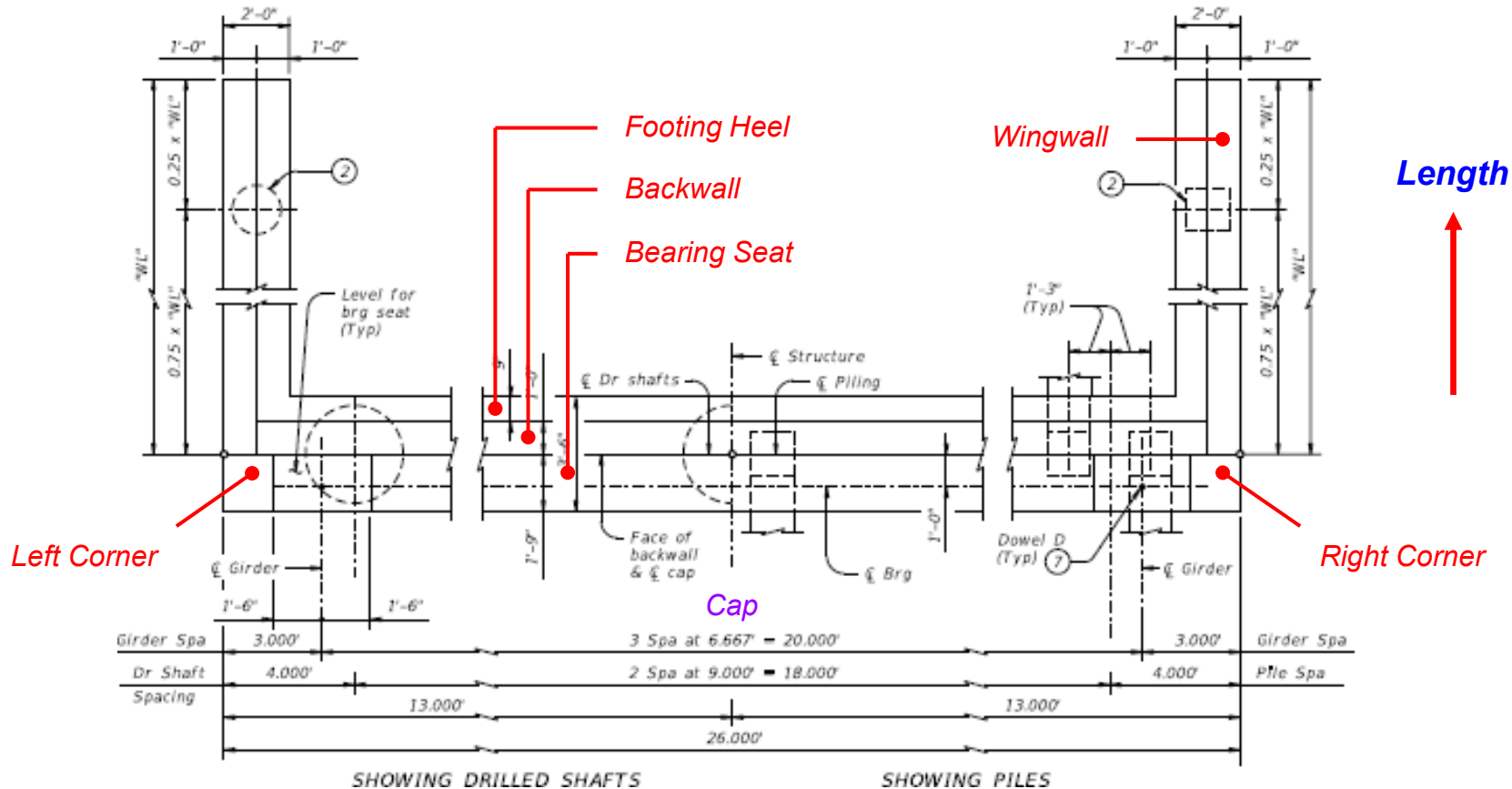


Case 4 and Case 7



Modeling Description for the Custom Abutment

Extended Footing



→ Width

↑ Length

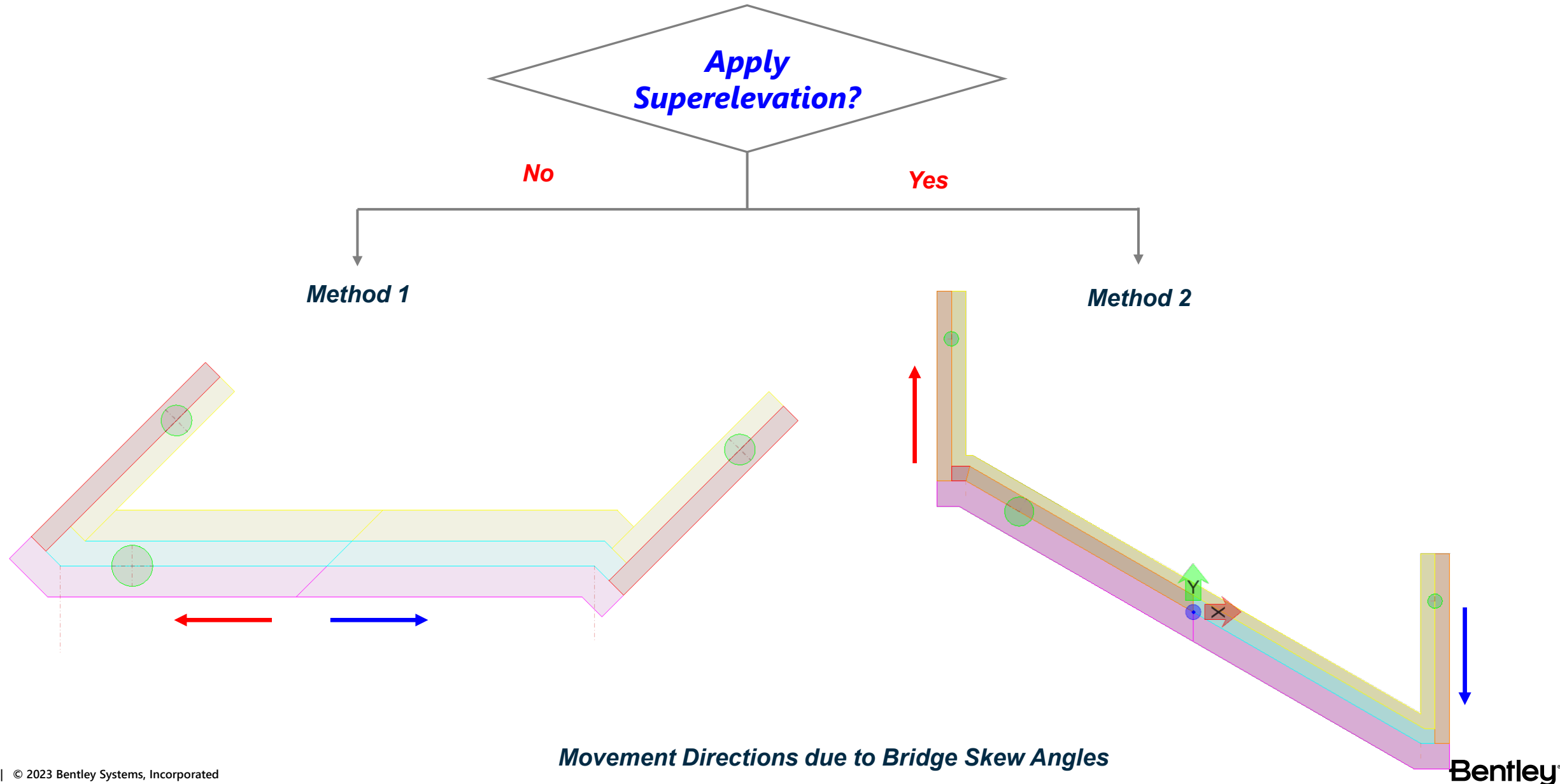
Bridge Skew Angles

- (1) 0
- (2) 0.1 ~ 15.0
- (3) 15.1 ~ 30.0
- (4) -0.1 ~ -15.0
- (5) -15.1 ~ -30.0

Pile Type

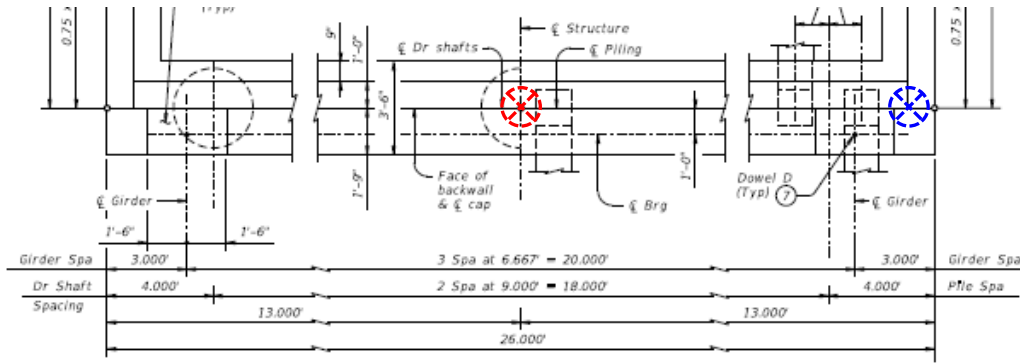
Ignored Pile arrangement.

Modeling Methods for the Abutment



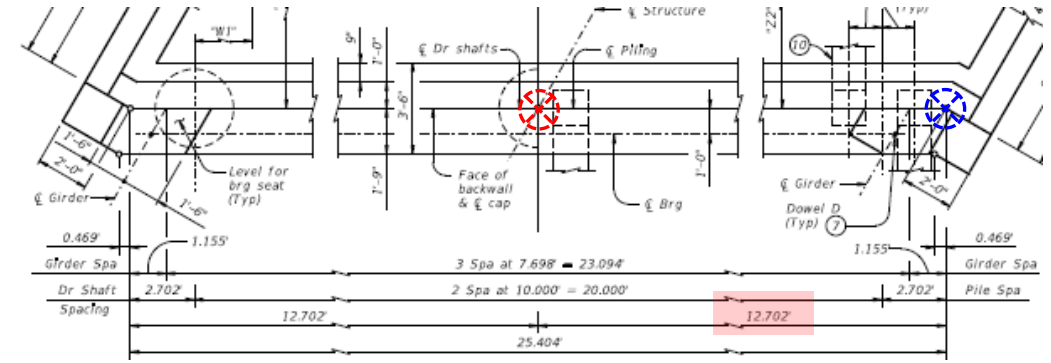
Backwall Width Definition

Skew Angle = 0



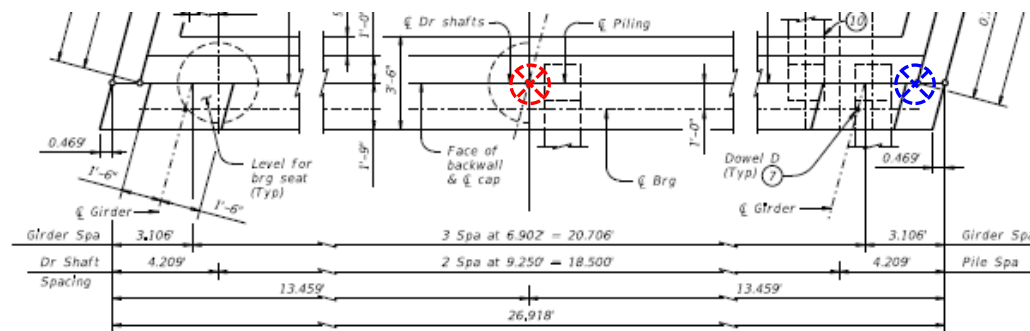
$$\text{Roadway Width} / 2 - \text{Wingwall Thickness} = 12.000'$$

Skew Angle = 30



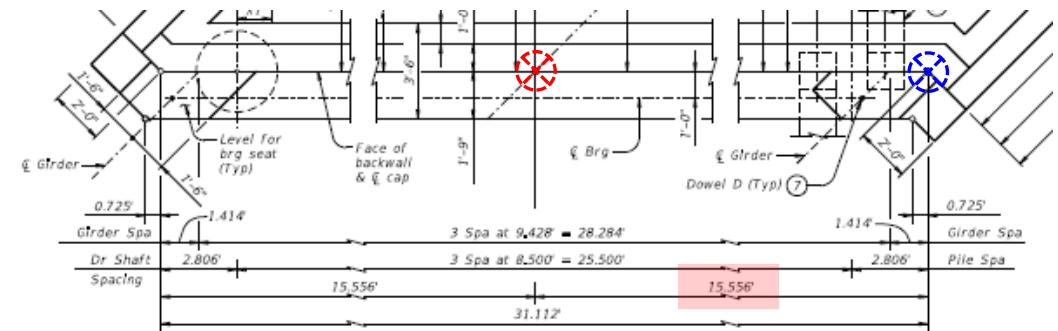
$$\begin{aligned} &(\text{Roadway Width} / 2 - \text{Extended Footing Width}) / \cos(\text{Skew Angle}) \\ &= 12.702' \end{aligned}$$

Skew Angle = 15



$$\begin{aligned} &(\text{Roadway Width} / 2 - \text{Wingwall Thickness}) / \cos(\text{Skew Angle}) = \\ &12.423' \end{aligned}$$

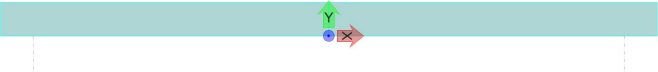
Skew Angle = 45



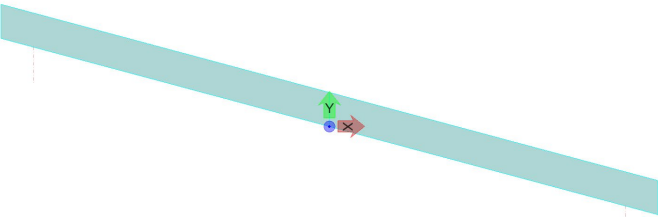
$$\begin{aligned} &(\text{Roadway Width} / 2 - \text{Extended Footing Width}) / \cos(\text{Skew Angle}) \\ &= 15.556' \end{aligned}$$

Bridge Skew Angle Cases

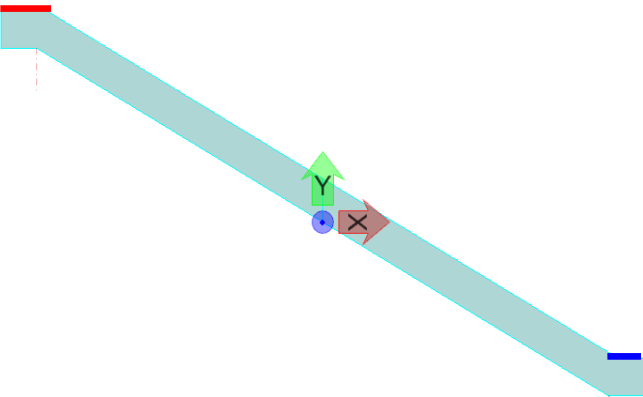
Case 1 for Skew Angle = 0



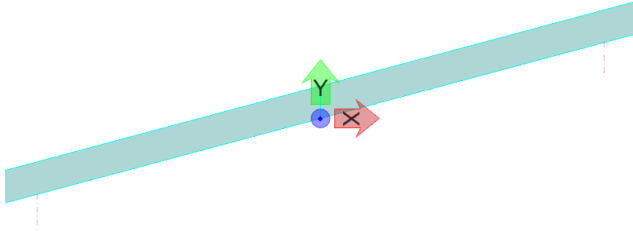
Case 2 for 0 < Skew Angle ≤ 15



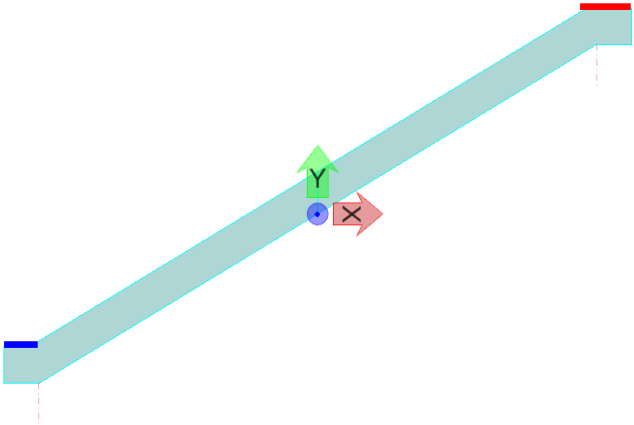
Case 3 for Skew Angle > 0 and Skew Angle > 15



Case 4 for Skew Angle < 0 and ABS(Skew Angle) ≤ 15



Case 5 for Skew Angle < 0 and ABS(Skew Angle) > 15



Conditional statement ? True : False

Skew Angle == 0 ? 1 : (Skew Angle > 0 && Skew Angle <= 15) ? 2
 : (Skew Angle > 0 && Skew Angle > 15) ? 3 : (Skew Angle < 0 &&
 abs(Skew Angle) <= 15) ? 4 : 5

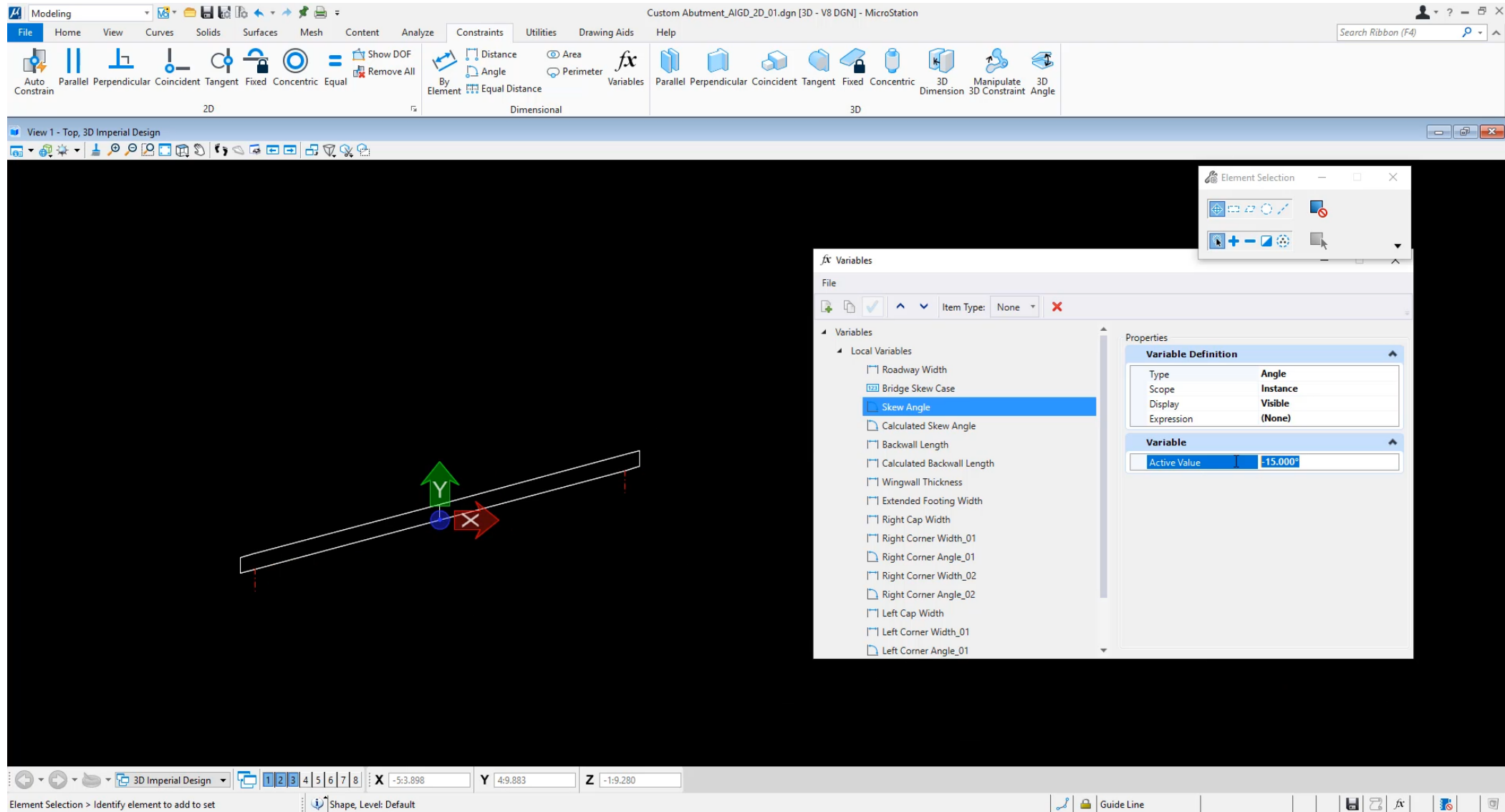
Variable Names Summary in Excel

The screenshot shows an Excel spreadsheet with the following content:

	A	B	C	D	E	F	G
1		Skew Angle					
2		Wingwall Thickness					
3		Extended Footing Width					
4							
5							
6		Bridge Skew Case	1	2	3	4	5
7			Bridge Skew Case == 1	Bridge Skew Case == 2	Bridge Skew Case == 3	Bridge Skew Case == 4	
8			(Extended Footing Width - Wingwall Thickness)	(Extended Footing Width - Wingwall Thickness) / cos (Skew Angle)	(Extended Footing Width - Wingwall Thickness)	(Extended Footing Width - Wingwall Thickness) / cos (abs(Skew Angle))	(Extended Footing Width - Wingwall Thickness)
9							
10							
11		Bridge Skew Case == 1 ? (Extended Footing Width - Wingwall Thickness) : Bridge Skew Case == 2 ? (Extended Footing Width - Wingwall Thickness) / cos (Skew Angle) : Bridge Skew Case == 3 ? (Extended Footing Width - Wingwall Thickness) : Bridge Skew Case == 4 ? (Extended Footing Width - Wingwall Thickness) / cos (abs(Skew Angle)) : (Extended Footing Width - Wingwall Thickness)					
12							
13							
14							
15							
16		Bridge Skew Case == 1 ? (Extended Footing Width - Wingwall Thickness) : Bridge Skew Case == ang(90 - Skew Angle) ? (Extended Footing Width - Wingwall Thickness) / cos (Skew Angle) : Bridge Skew Case == 3 ? (Extended Footing Width - Wingwall Thickness) / cos (abs(Skew Angle)) : (Extended Footing Width - Wingwall Thickness)					
17							
18							
19							

The bottom status bar shows the following variable names: Right Cap Length, Right Corner Width_01, Right Corner anlge_01, Right Corner Width_02, Right Corner anlge_02, Left Corner Width_01, Left Corner anlge_01.

Backwall 2D Plan



Wingwall 2D Plan

The screenshot displays the MicroStation software interface for a 2D plan of a wingwall. The main workspace shows a top-down view of the wingwall structure with a coordinate system (X, Y, Z) and a mouse cursor. The interface includes a ribbon with tabs for File, Home, View, Curves, Solids, Surfaces, Mesh, Content, Analyze, Constraints, Utilities, Drawing Aids, and Help. The Constraints tab is active, showing various constraint tools like Auto Constrain, Parallel, Perpendicular, Coincident, Tangent, Fixed, Concentric, Equal, and Variables. The Variables panel is open, showing a list of local variables with 'Skew Angle' selected. The Properties panel for 'Skew Angle' shows its definition and active value.

Custom Abutment_AIGD_2D_01.dgn [3D - V8 DGN] - MicroStation

Search Ribbon (F4)

View 1 - Top, 3D Imperial Design

Element Selection > Identify element to add to set

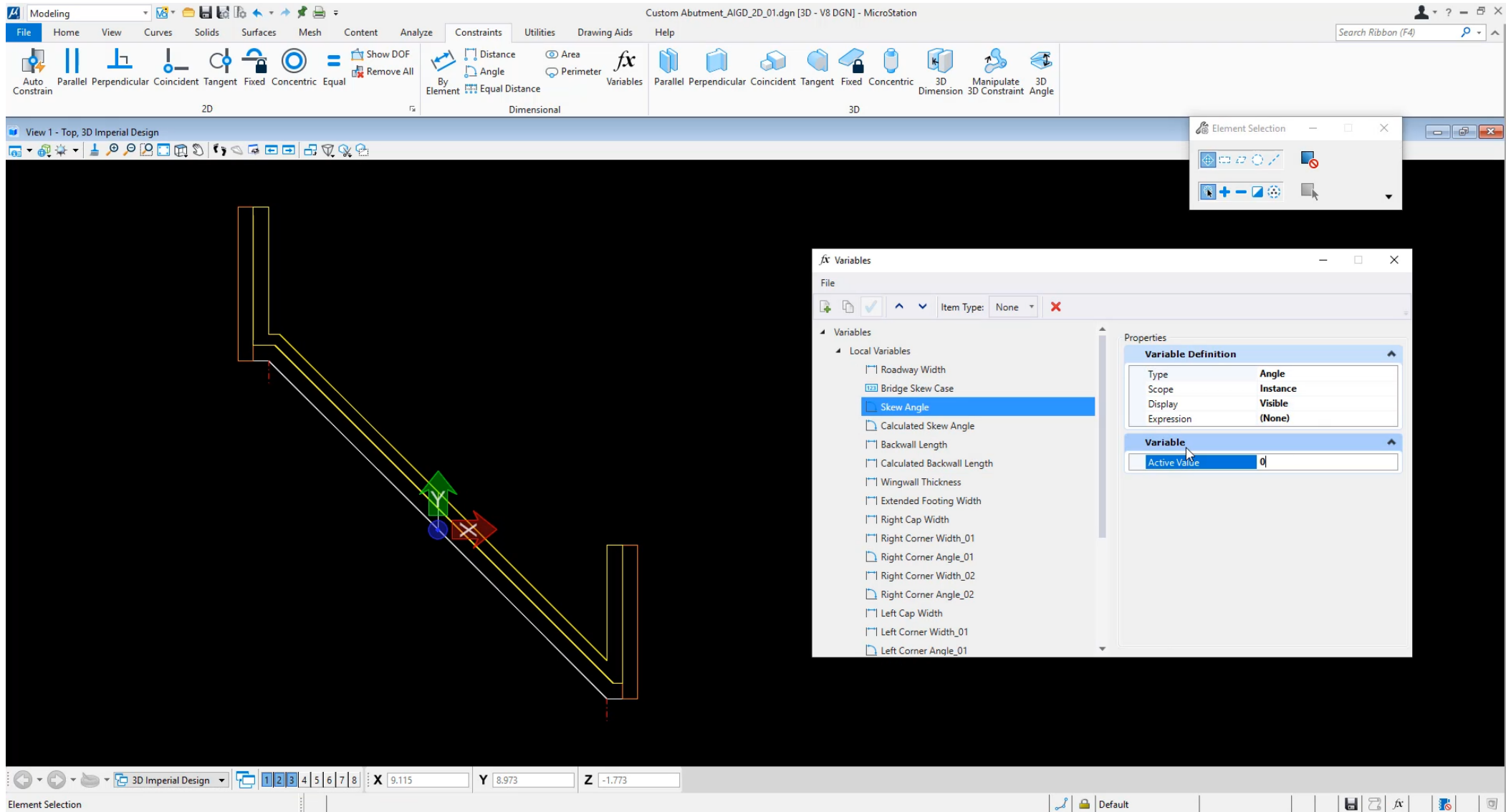
X 18.131 Y 6.251 Z -1.773

Default

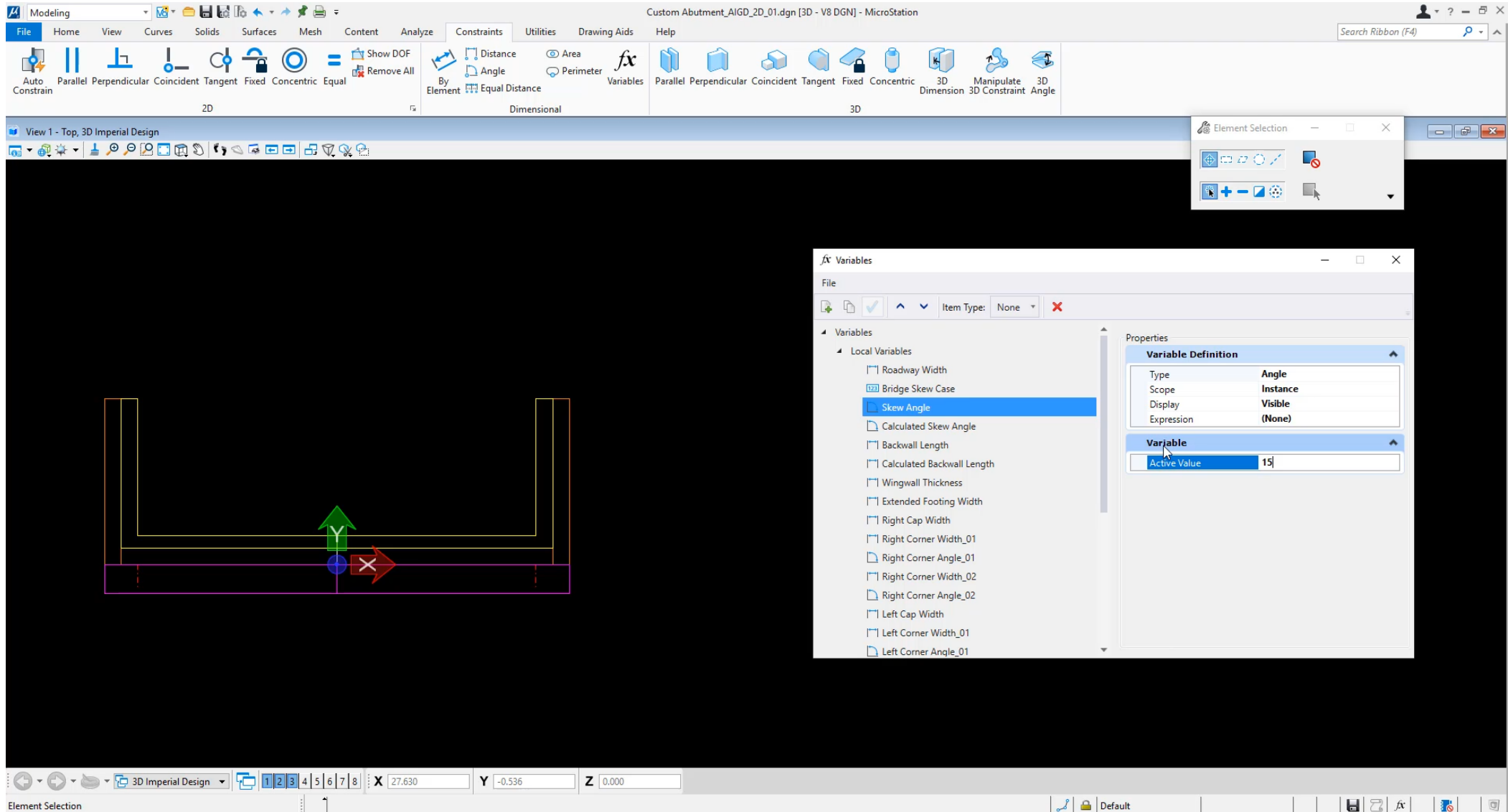
Variable Definition	
Type	Angle
Scope	Instance
Display	Visible
Expression	(None)

Variable	
Active Value	0.000°

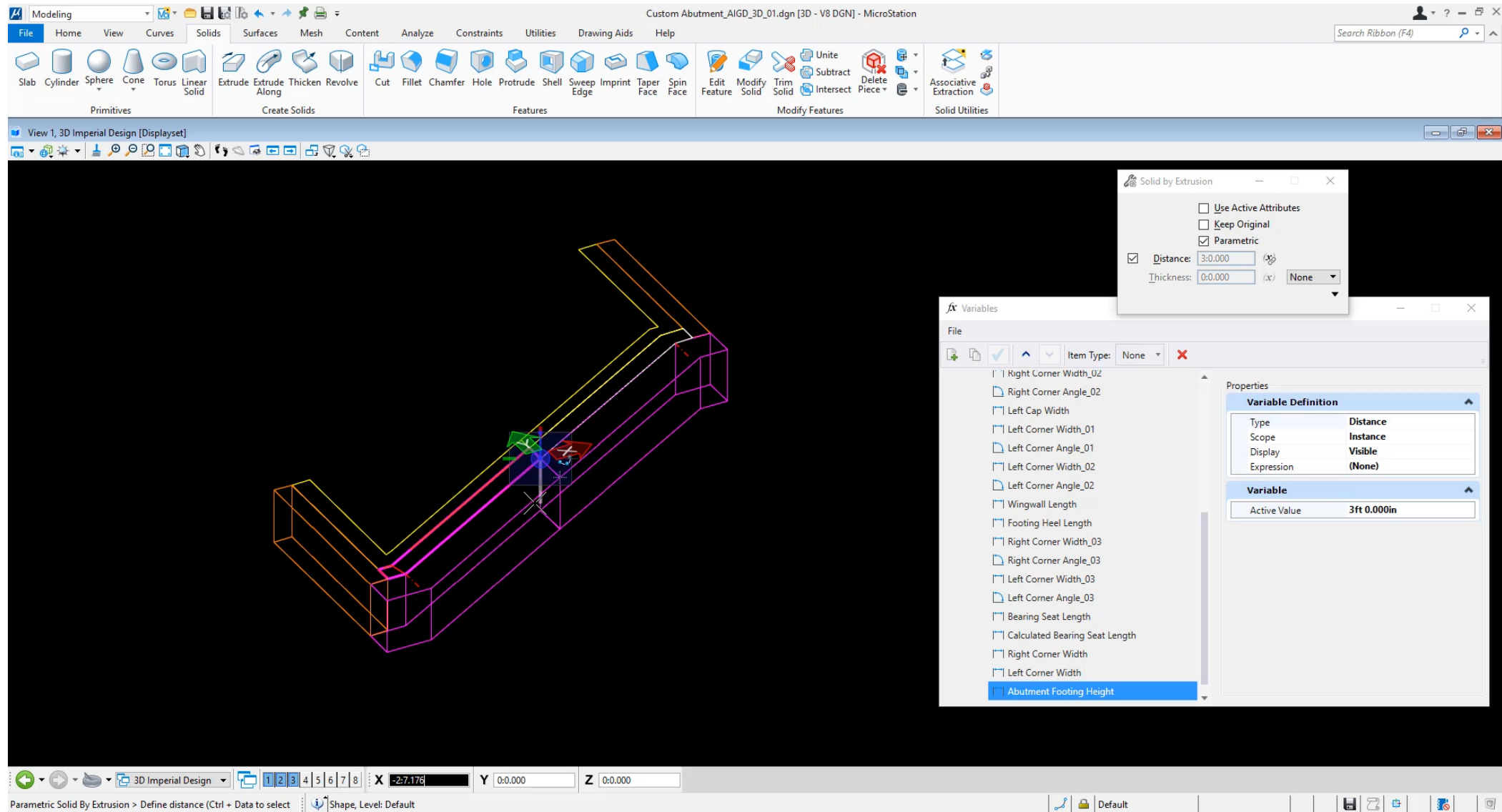
Footing Heel 2D Plan



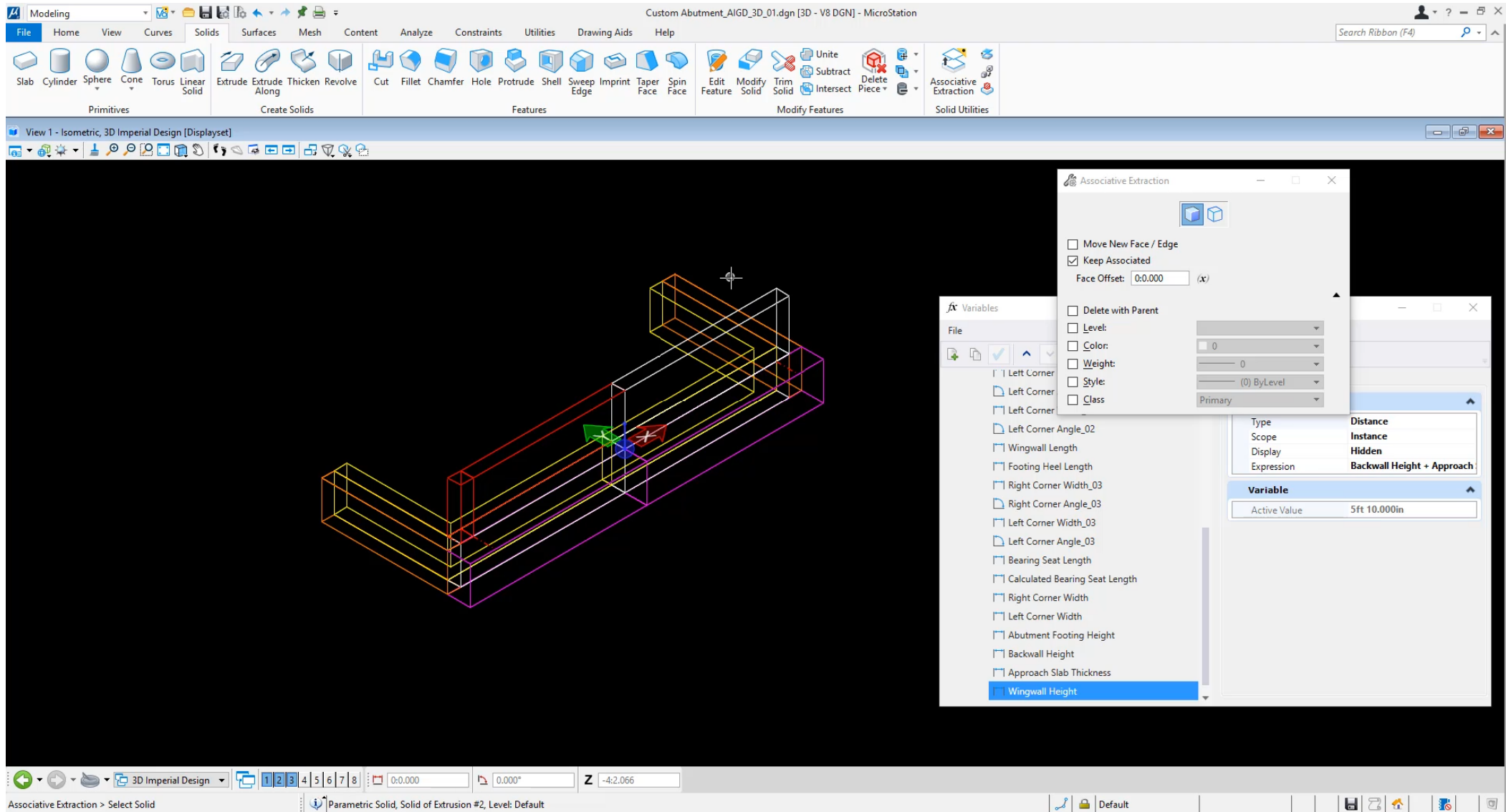
Bearing Seat 2D Plan



Extrude 3D for Footing



Extrude 3D for Backwall and Wingwall



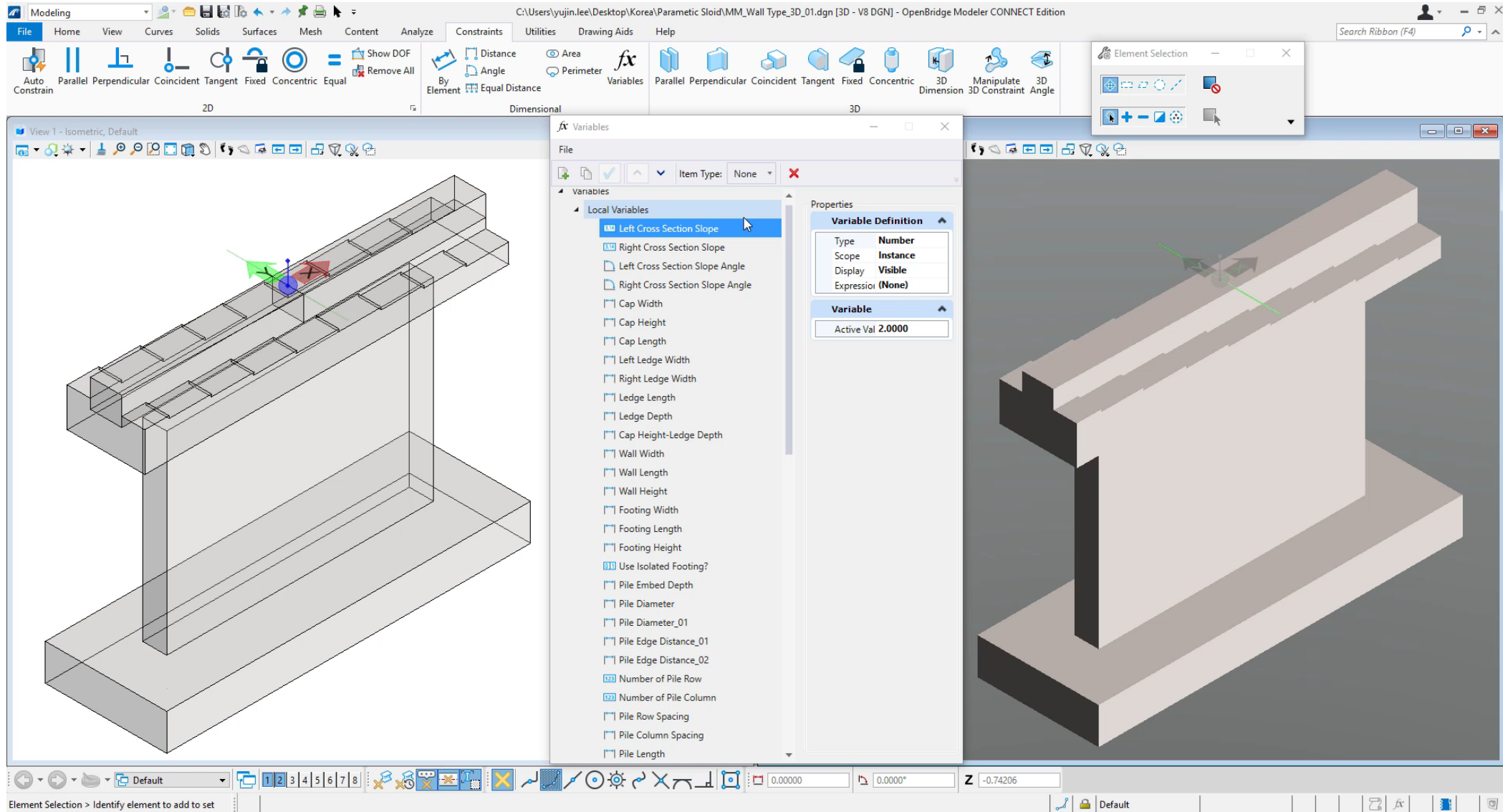
Assign Superelevation

The screenshot displays the MicroStation software interface for a 3D model of a road abutment. The main window shows a 3D view of the abutment structure with a blue circular handle on a horizontal line, indicating a taper face operation. Two dialog boxes are open:

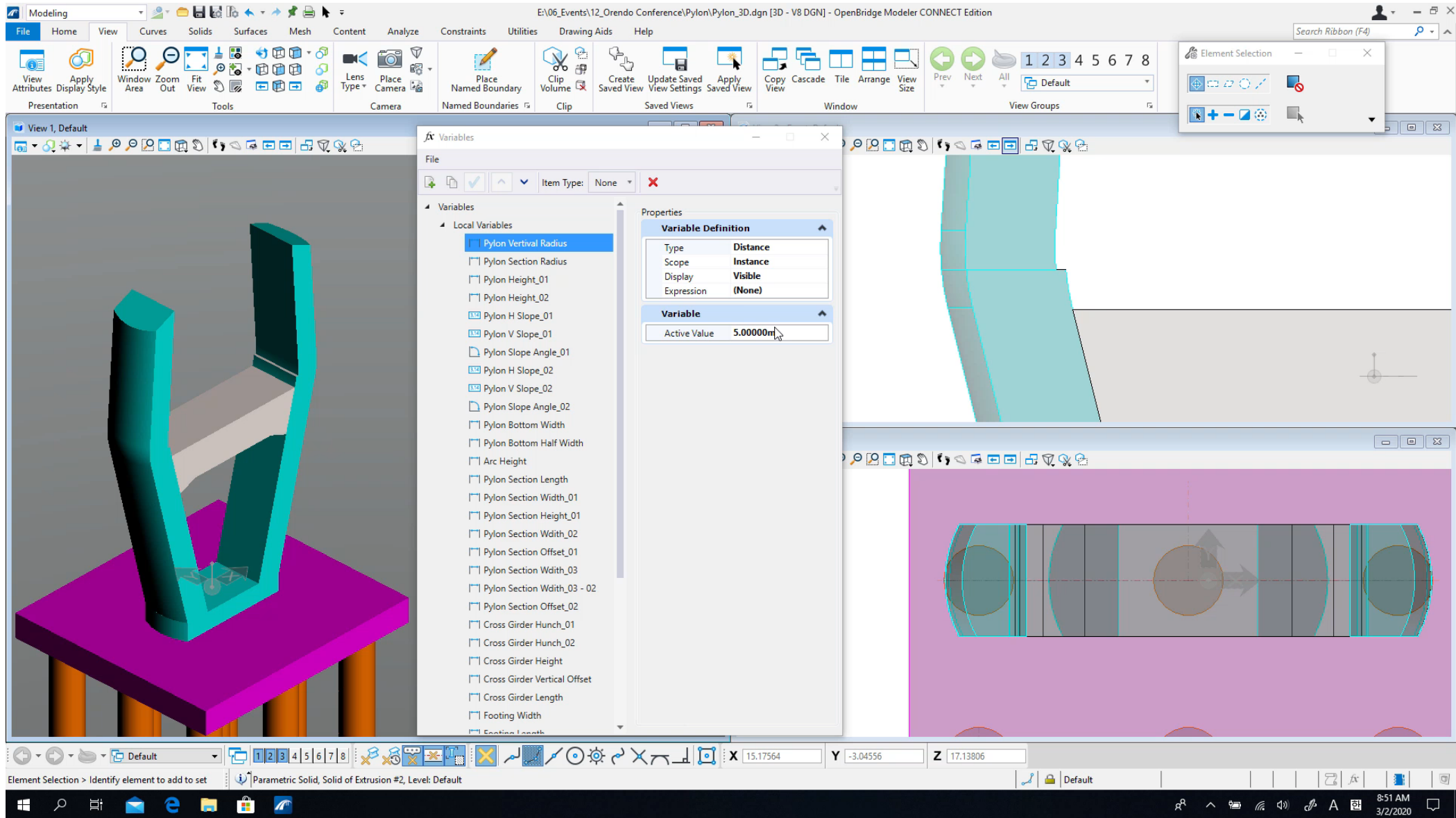
- Taper Face Dialog:** Shows 'Direction: Design X' and 'Draft Angle: -1.146° (x)'. There is an unchecked checkbox for 'Add Smooth Faces'.
- Variables Dialog:** Lists various parameters for the abutment. The 'Right Lane Slope' variable is selected and highlighted in blue. Its 'Active Value' is set to 2.0000. Other variables include Wingwall Length, Footing Heel Length, Right Corner Width_03, Right Corner Angle_03, Left Corner Width_03, Left Corner Angle_03, Bearing Seat Length, Calculated Bearing Seat Length, Right Corner Width, Left Corner Width, Abutment Footing Height, Backwall Height, Approach Slab Thickness, Wingwall Height, Left Lane Slope, Right Lane Slope Angle, and Left Lane Slope Angle.

The bottom status bar shows the current operation: 'Taper Face > Identify Solid To Taper' and 'Parametric Solid, Solid of Extrusion #2, Level: Default'. The coordinate system is set to Z: -5:11.912.

Piers as Functional Components

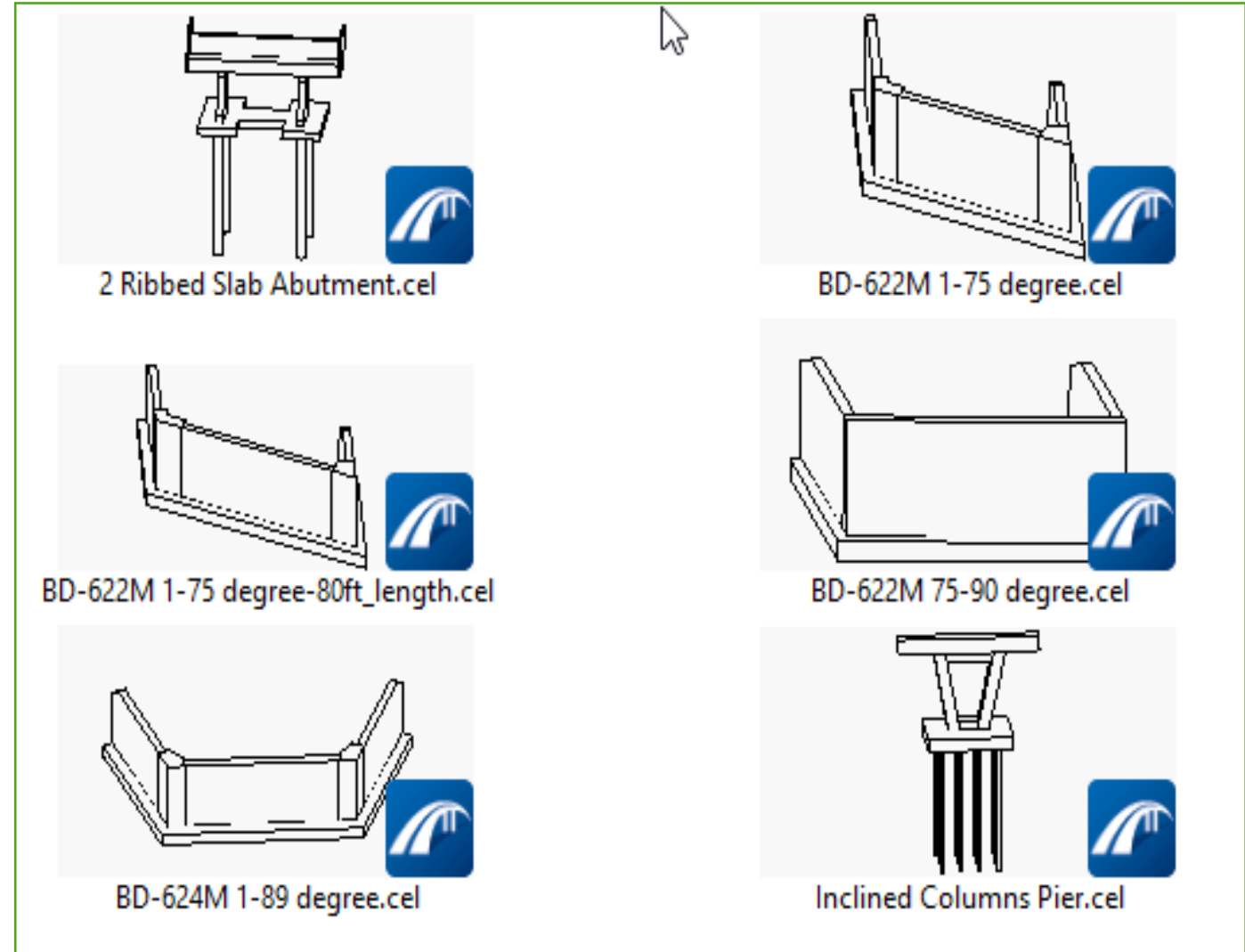


Pylons as Functional Components



Library of Functional Components

- Install Path
 - C:\ProgramData\Bentley\OpenBridge Modeler CE10.12\Configuration\Organization-Civil\Bridge Default Standards - Imperial\OpenBridge Modeler\Bridge Templates\Functional Components
- Parametric Cells:
 - Inclined Columns Pier
 - Flared Wing Wall Abutment (< 75 degrees)
 - Flared Wing Wall Abutment (75-90 degrees)
 - U Type Abutment (2)
 - Ribbed Slab Abutment (China)



Place Custom Piers

The screenshot displays the OpenBridge Modeler software interface. The main window shows a 3D model of a bridge pier structure on a terrain map. The interface includes a ribbon with various tools, a Properties panel on the left, and a status bar at the bottom.

Properties Panel:

- Elements (1)**
 - Pier Element: BR_01 :: Pier1
 - Custom
 - 1
 - Selection

- Variables**
- Column Diameter: 2.00000m
- Column Fillet: 0.30000m
- Column Height: 7.00000m
- Column Length: 1.50000m
- Corping Min Height: 1.20000m
- Corping Length: 2.00000m
- Pile Length: 12.00000m
- Footing Length: 6.00000m
- Number of Pile Columns: 2
- Pile Row Spacing: 4.00000m
- Pile Edge Distance: 1.00000m
- Corping Height: 2.00000m
- Pile Column Spacing: 4.00000m
- Corping Width: 15.00000m
- Column Width: 2.50000m
- Footing Width: 6.00000m
- Pile Diameter: 0.80000m
- Circular Column?: False
- Footing Height: 1.50000m
- Pile Embed Length: 0.50000m
- Number of Pile Rows: 2
- General**
- Element Description: <- ParametricCellEntity ->: 1
- Level: OBM_Piers
- Cell Definition: Custom Pier_01
- Variation: (None)
- Class: Primary
- Template: (None)
- Annotation Purpose: False
- Is Annotation: False
- Geometry**
- Extended**

Status Bar:

- Element Selection > Identify element to add to set
- BR_01 :: Pier1 \ <- ParametricCellEntity ->: 1, Level: Default
- X: 84.02133, Y: 44.04744, Z: -2.56253
- Default
- : 1

