AUTODESK. UNIVERSITY

CES321122

Dynamic Bridge Information Modelling in Civil 3D

Valentin Belets
Aurecon

Learning Objectives

- Learn how to set up Civil 3D template for Bridge Information Modeling
- Learn how to stick bridge geometry and components to road design
- Learn how to produce deliverables
- Learn how to transfer the bridge information model to the next design stage

Description

Ever felt like you've modeled a bridge too many times trying to catch up with road design changes? Civil 3D software and this class can make it easier! The class will cover the ways to use Civil 3D for modeling bridges. Civil 3D not only links bridge design with ever-changing road design geometry on the earliest stages of design, but also builds up the information model of a bridge to be carried through the following design stages.

Speaker

Over the last 8 years I have been specialising in bridges and tunnels design in Russia and Australia. Things I enjoy the most at work are mapping out workflows, finding ways to improve and digitise them, parametrics and modelling, coding and codification, getting things sorted in every possible sense. I am a regular attendee and occasional presenter of subject matter specialist gatherings in Sydney and Brisbane, including Revit User Group Sydney, buildingsmart activities, Computational Design Meetup, Digital Construction Meetup, Power BI Meetup and others.

Using Civil 3D for Bridge Information Modeling

> INCEPTION OF A PROJECT…
> PROJECT TEAM IS WORKING REALLY HARD TO WIN THE NEXT TENDER. HIGHWAYS TEAM ARE DOING OPTIONEERING, FROM TIME TO TIME PROVIDING BRIDGE DESIGNERS WITH VARIOUS BITS OF INFORMATION. PLAN ALIGNMENT, DESIGN AND EXISTING GROUND PROFILE, BARRIER STRINGS, TRIANGULATION, ALL THAT. SURVEY FILE IS A 3D DWG WITH [HOPEFULLY] NONE OF THE 3D OBJECT "DROPPING" TO ZERO Z LEVEL. ONCE BRIDGE DESIGN CATCHES UP WITH THE LATEST INPUTS PROVIDED, IT GOT FED BACK TO A MASTER REFERENCE FILE. FOR BRIDGE DESIGNERS THE PROCESS REPEATS EVERY TIME INPUTS ARE CHANGING.

If it sounds familiar to you, then most probably you'll find materials of this class useful. This document will give some examples of linking bridge components to road design and provide guidance in setting up your own Civil 3D styles to implement similar processes in your office.

The industry had Bridge Modeler plugin for Civil 3D (also known as Civil Structures extension for Revit). It now has Infraworks with Bridge Modelling getting better and better. Both methods could/can generate a model of various bridges types, but couldn't do a simple thing, display Bridge Geometry on Developed Elevation/ Longitudinal Section. Dispersed 3D Solids can be projected, yes, but can they be dimensioned, labeled, dynamically updated when the plan arrangement changes? Revit still can't do a true section (Minimizing View Depth is not good enough), not even mentioning a proper Developed elevation.

Civil 3D can do a proper LSEC as Road Designers have, enhanced with labeled Pier Centre Lines, simplified representation of piers and more detailed representation of a superstructure. Dynamically linked to the corridor Feature Lines can be projected to Long Section.

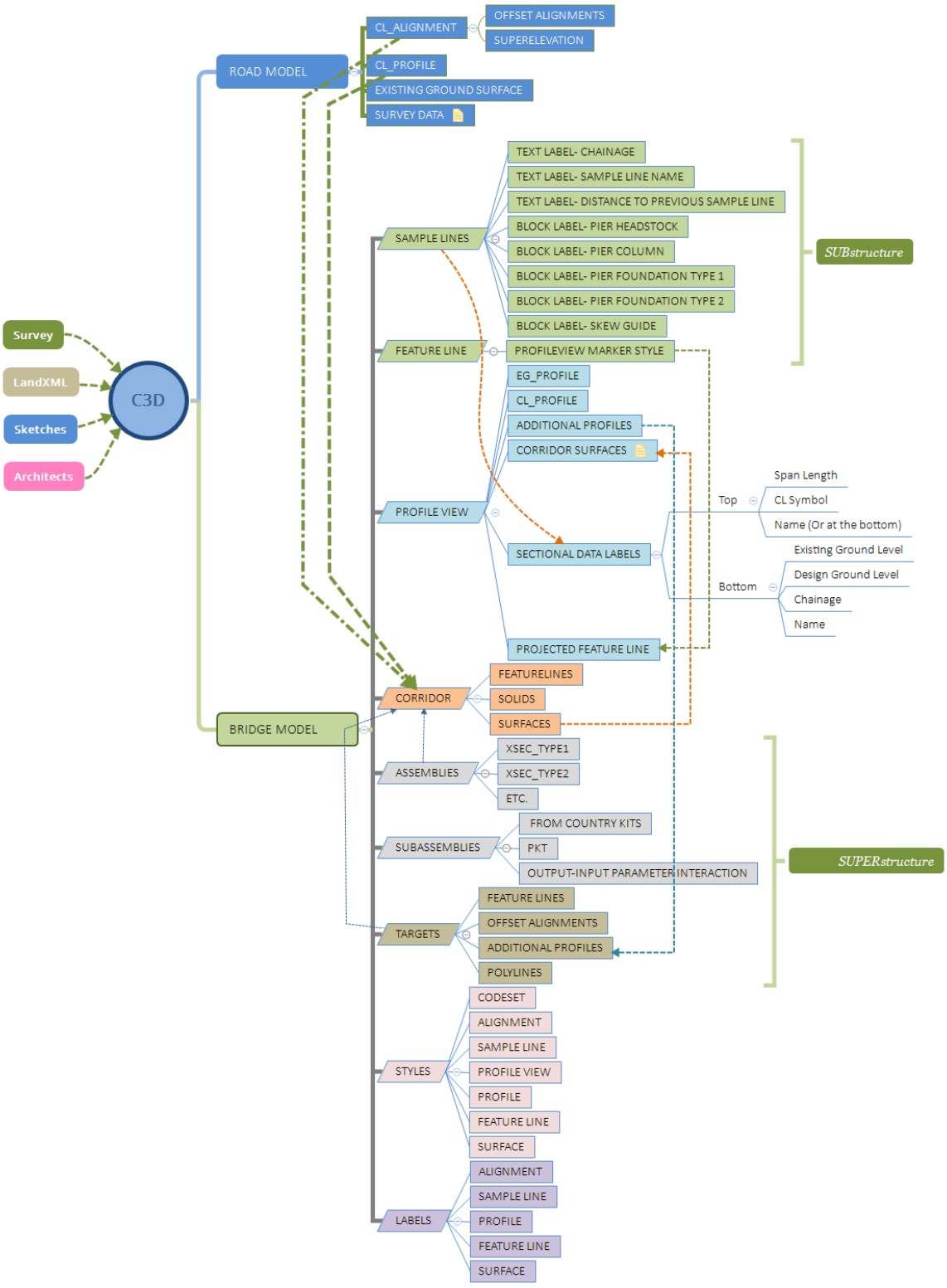
Of course it requires some time to create the Civil 3D styles, but then bridge components such as piers, deck and bridge furniture placed along alignment using Civil 3D functionality are prepared for road design changes, such as:

- alignment plan geometry tweaks,
- chainage adjustments,
- design profile changes,
- superelevation changes,
- barrier strings changes.

With all that, Civil 3D labels are there to query true linear infrastructure properties, such as chainages, object names, bearings etc…

Even when detail level moves forward, C3D model can be used for design verification or quality assurance. Through DataShortcuts, Civil 3D objects can be brought in the drawing files with NoDisplay style applied. Labeling these objects will then tell actual story.

Overall C3D approach scheme.



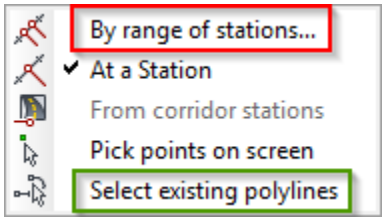
Sample Line

Even if the task is just to define bridge articulation (arrangement of pier centrelines) along an alignment, to me Sample Lines are perfect to use!

This is why:

Placement

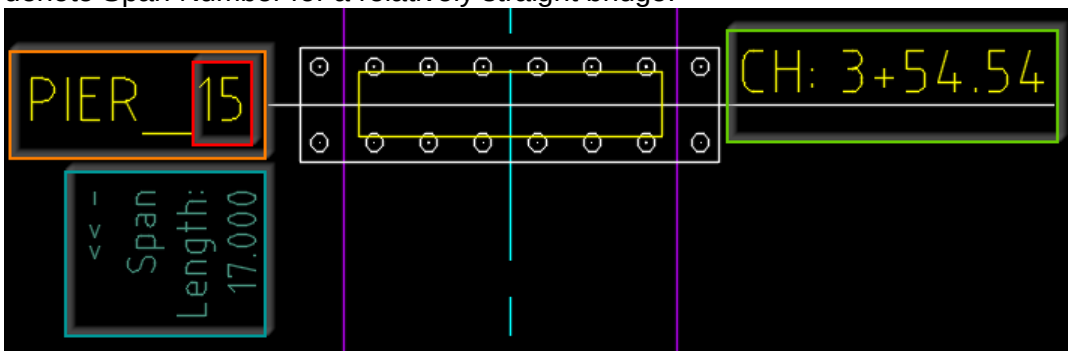
Sample Lines can be placed at regular intervals starting from a particular chainage using By Range of Stations… method. If you've already done it using Path Array, then Select Existing Polylines is the way to go.



Labeling

Text-based Sample Line Labels can show exactly what is needed for a bridge pier:

- Sequential numbering while placing with regular (or not) intervals.
- Name
- Chainage
- Distance To Previous Sample Line (Span Length)
- [Optional] Sample Line Number (minus 1) placed at SpanLength/2 can be used to denote Span Number for a relatively straight bridge.



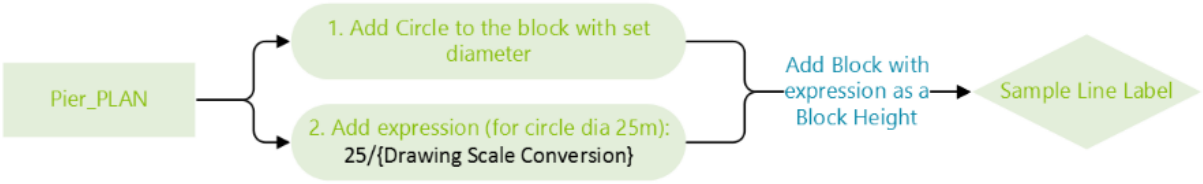
Block-based Sample Line Labels (example shown in the middle above):

- Various types of Headstock, Column, Foundation. Multiple labels can be assigned either to a range of stations or swapped one-by-one.
- To increase LOD and LOI can be exported to a separate dwg, swapped with more detailed blocks.
- Expression is used to undo blocks' annotativeness, showing them at actual size.

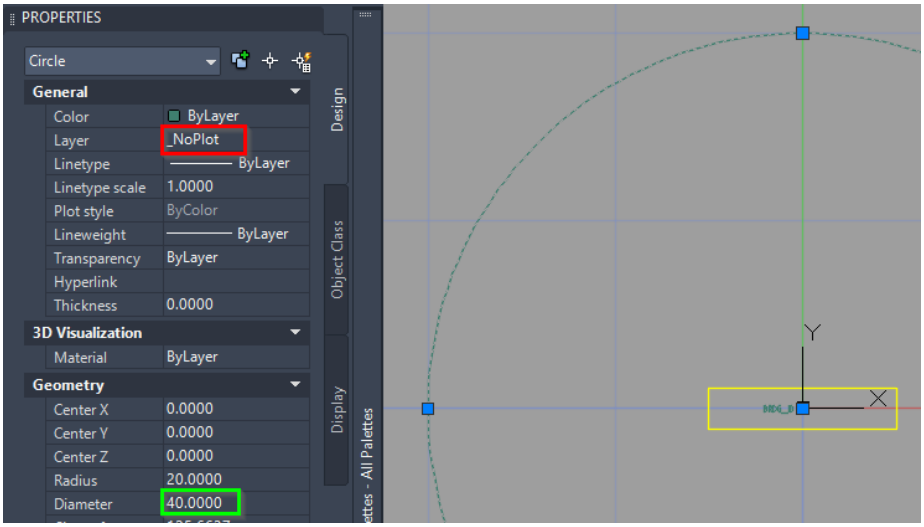
Profile View Data Band Styles (Sectional Data Labels = Sample Lines). Same color coding is applied.

Label. Anti-Annotative Sample Line (and not only) Block

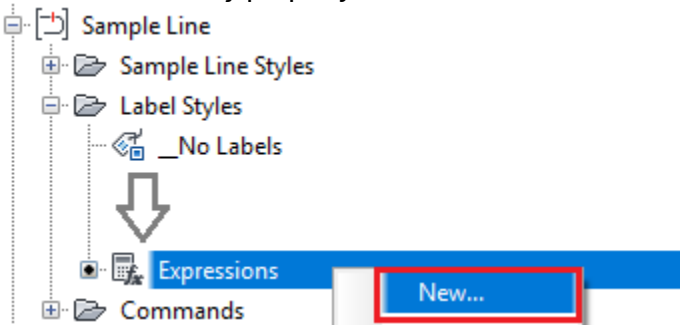
To be able to create a label showing the pier which won't scale up or down we would need to undo that.

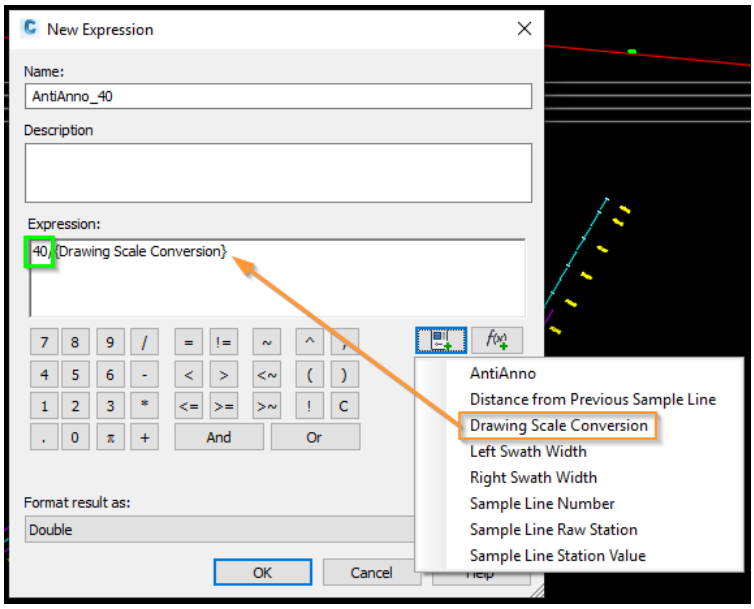


First, there would need to be a geometry (Circle would be the easiest one to put in) of a certain size (Diameter for circle) In this example it is 40 units. It would need to go onto an unplottable layer of choice. In my example it is a "_NoPlot" layer, color 125.

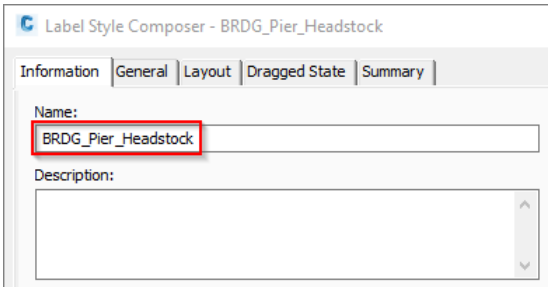


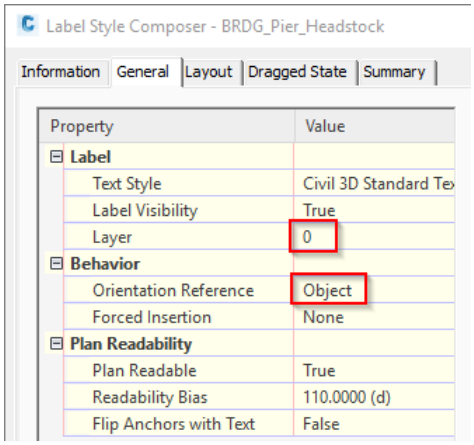
Then go to Sample Line Expressions and create an expression which will revert the scaling of a label (Previously created circle diameter value would be divided by *{Drawing Scale Conversion}* property:



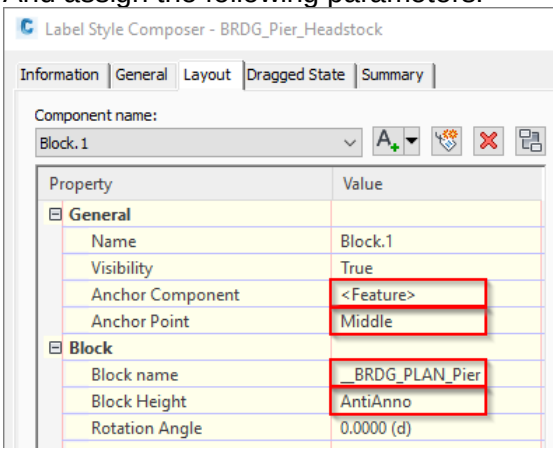


Next step is to go and create a label itself. Name it, put on Layer 0





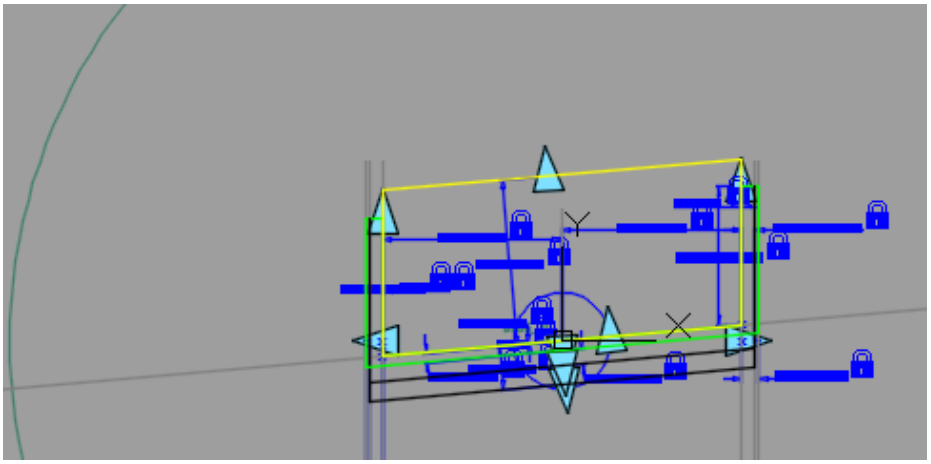
And assign the following parameters:



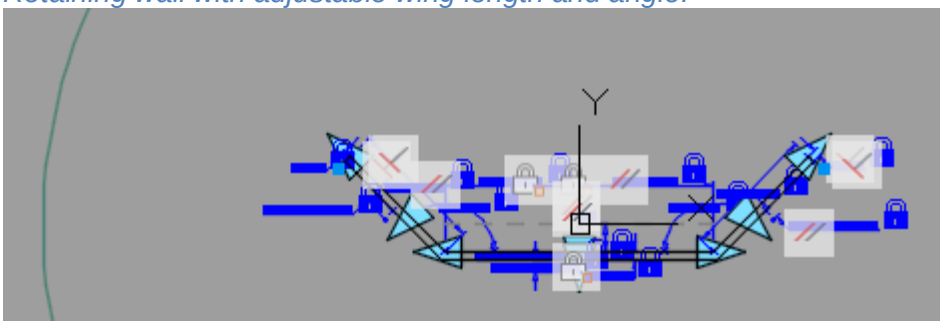
To be able to use existing block library representing pier components in plan, just copy the circle D=40 units across and copy SL Label, choosing the customized block.
To assign a skew to a block, copy the style and assign a value to Rotation Angle parameter.

Some inspirational examples (Available in the dataset):

Parametric abutment with a skew:



Retaining wall with adjustable wing length and angle:



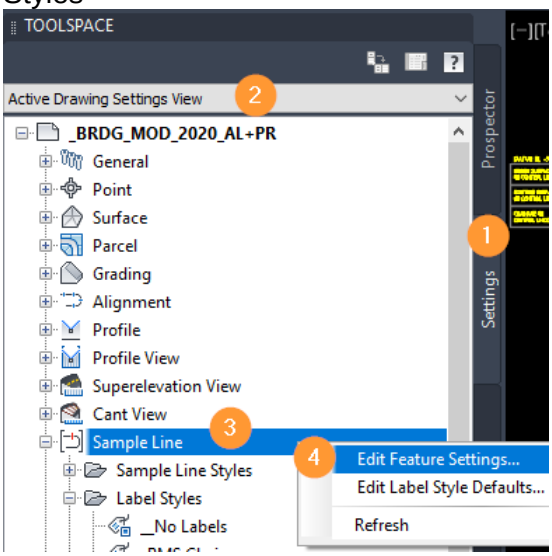
Unfortunately, parametrics only become accessible after Sample Line Label is exploded.

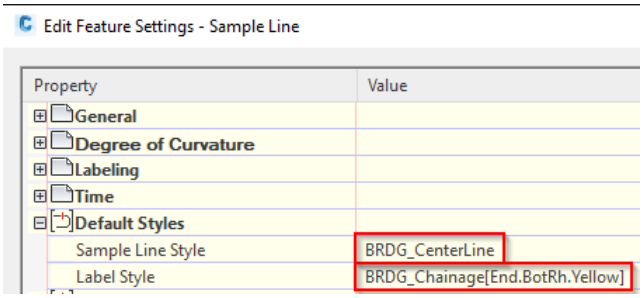
Label. Sectional Data on Profile View

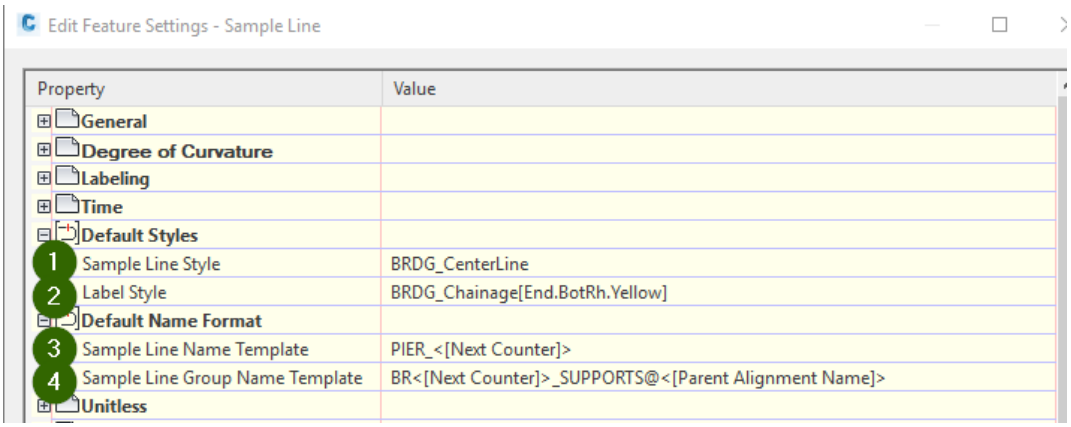
To be provided

Recommended Sample Line Feature Settings:

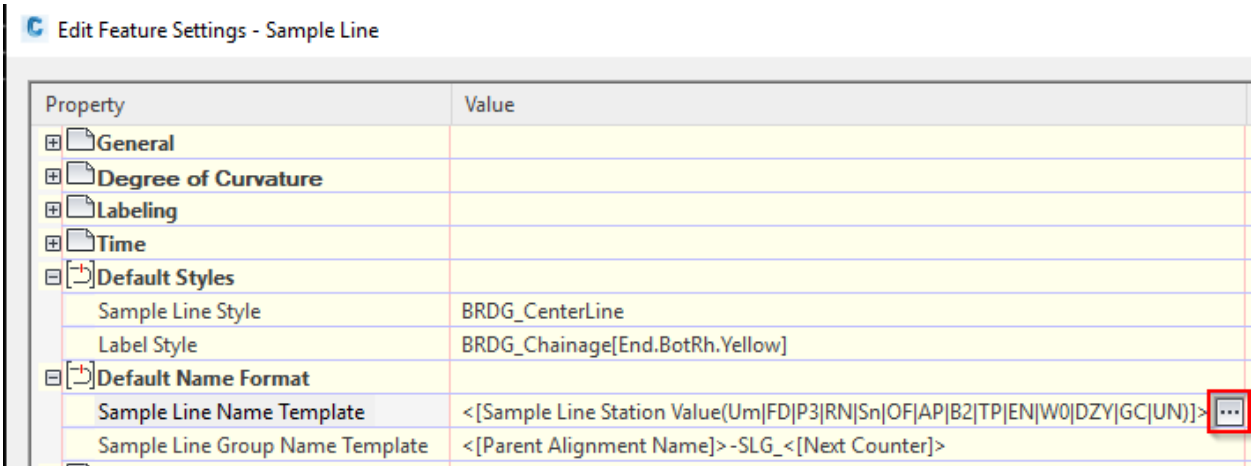
- Styles



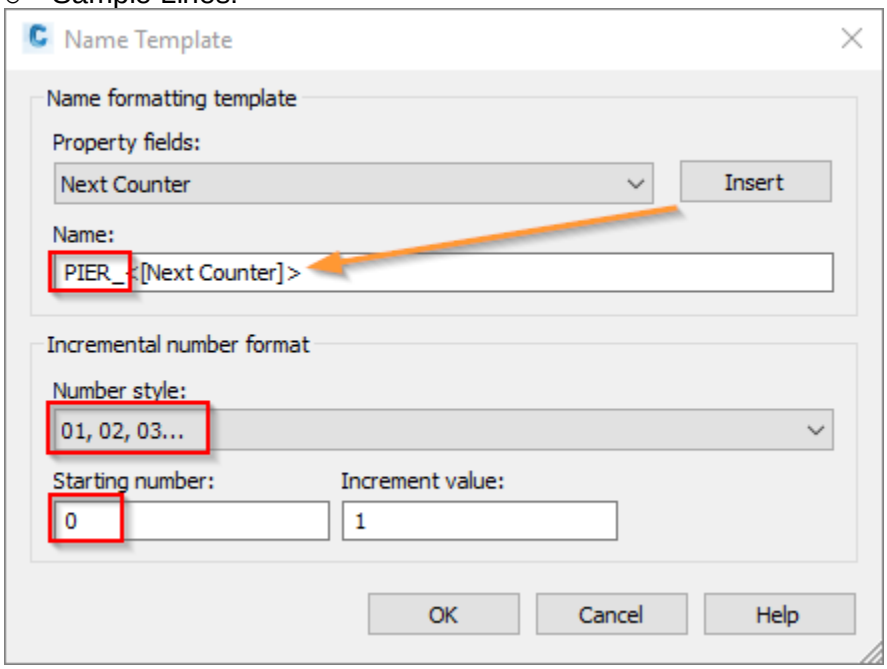


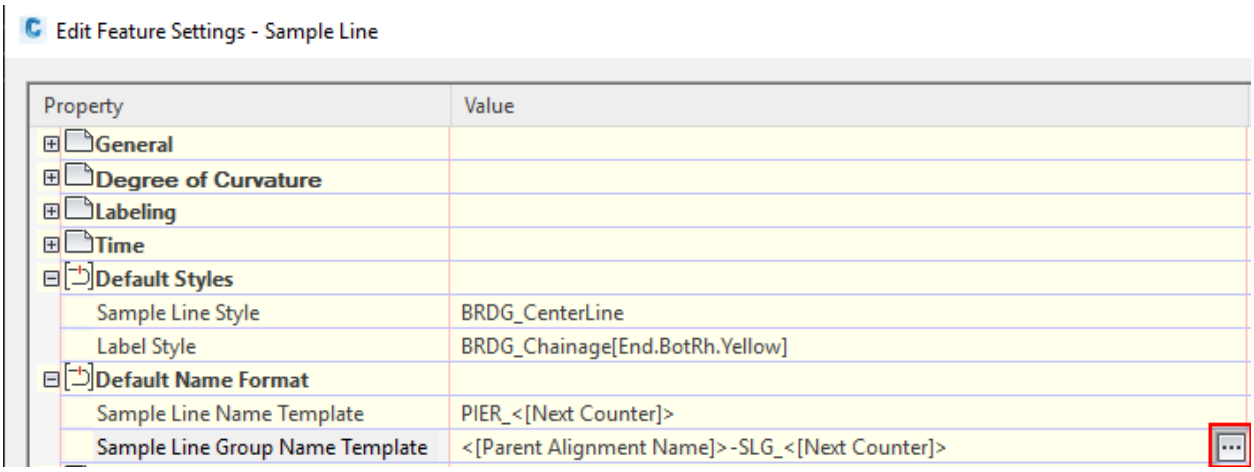


- Names

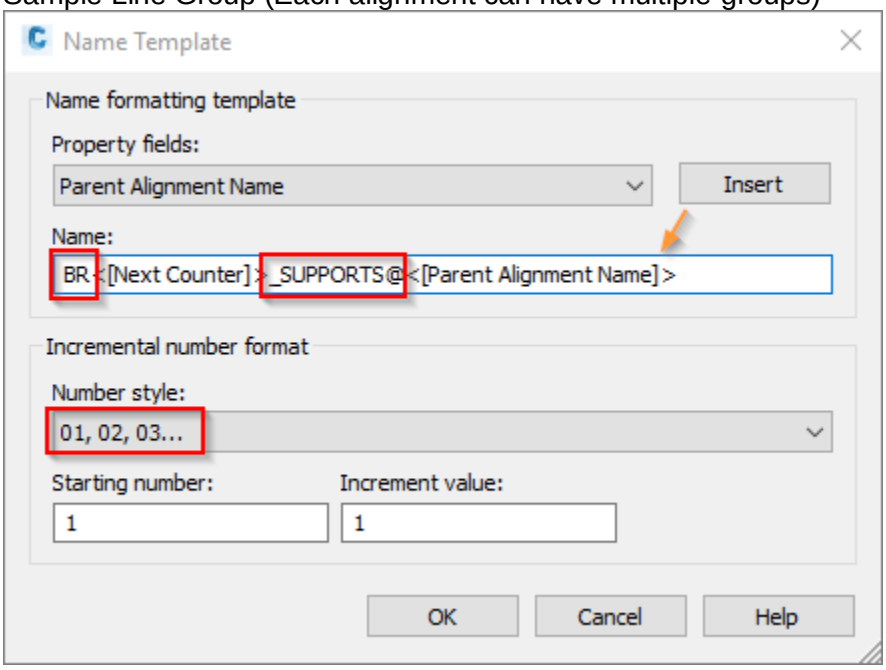


  - Sample Lines:





Sample Line Group (Each alignment can have multiple groups)



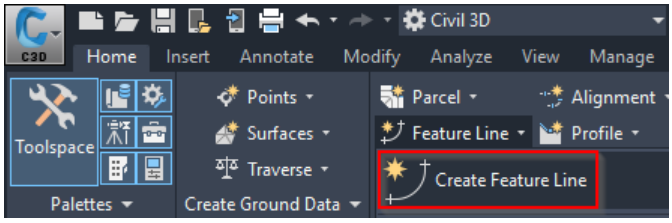
Feature Line

Tricky as many Civil 3D Styles. Can be displayed differently in different views (Plan, Section, Profile). But not the trickiest.

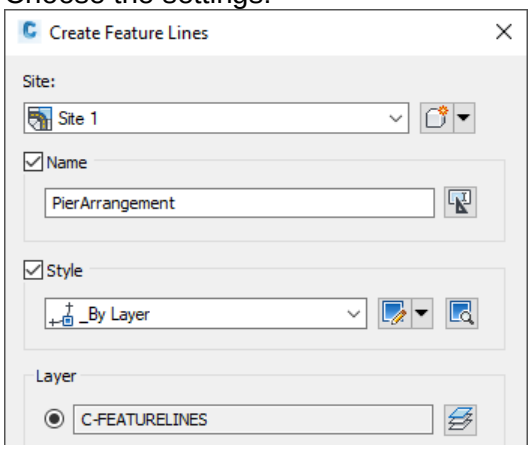
Placement

Manual at Sample Line Locations. Style while placing can be any. It is recommended to ISOLATE alignment and sample lines – easier to snap to intersections. This Feature Line projected to Profile View can display piers in a simplistic way. Linked to a defined profile. Unfortunately, feature line labels can not be swapped one-by-one in Profile View. Once disconnected/exploded, Wblock workflow can exchange separate blocks with different ones.

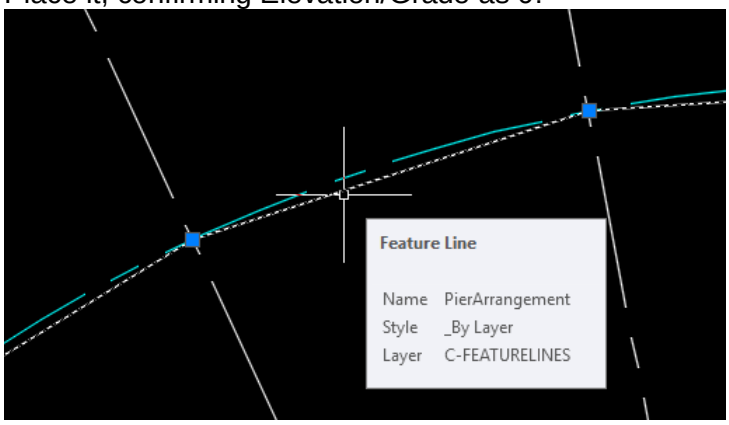
1. Create Feature Line



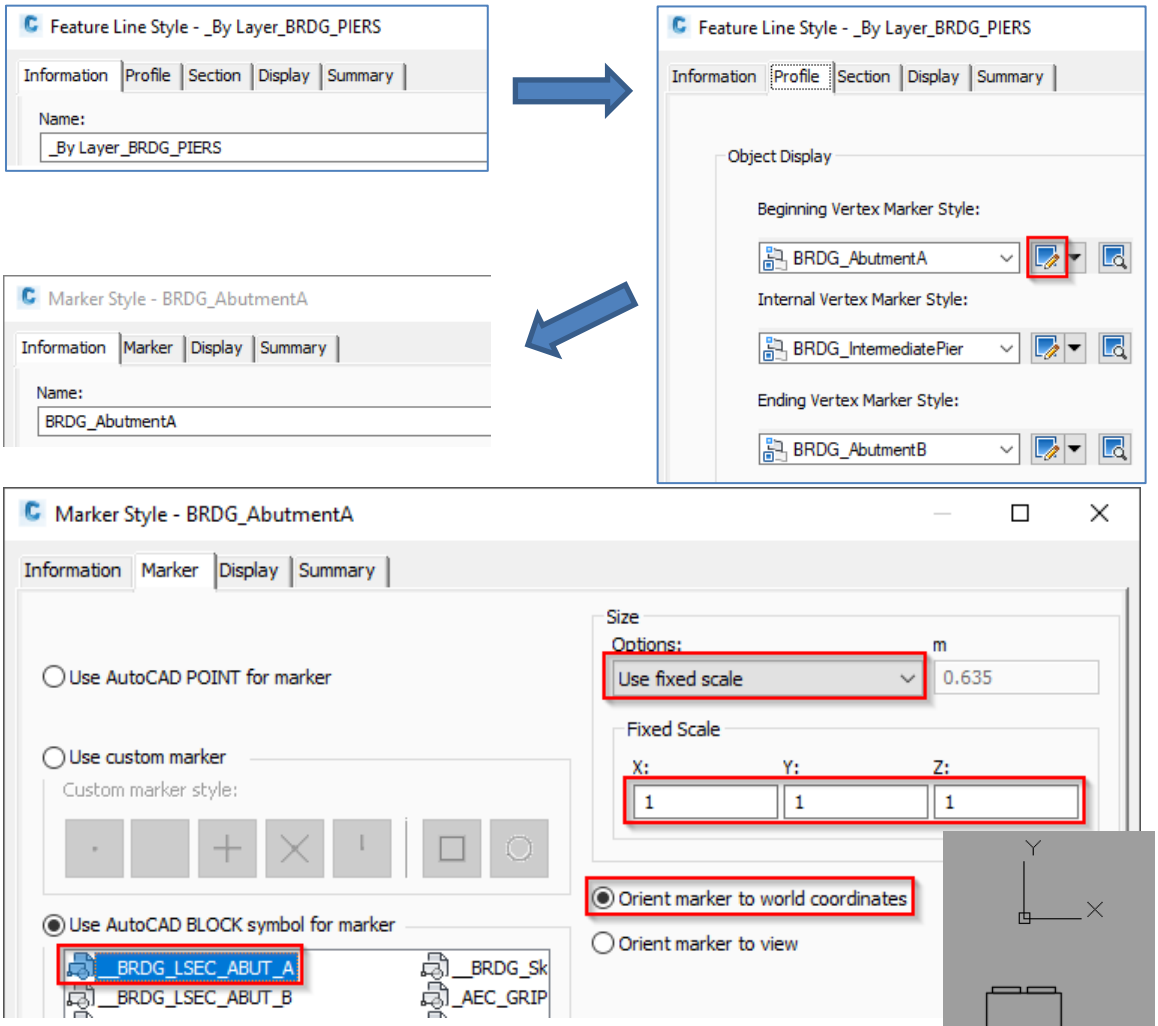
2. Choose the settings:



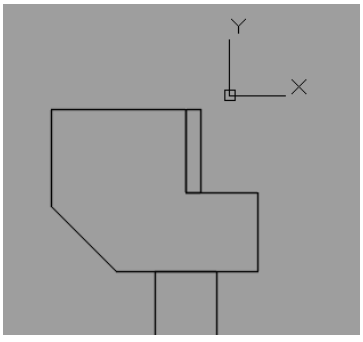
3. Place it, confirming Elevation/Grade as 0:



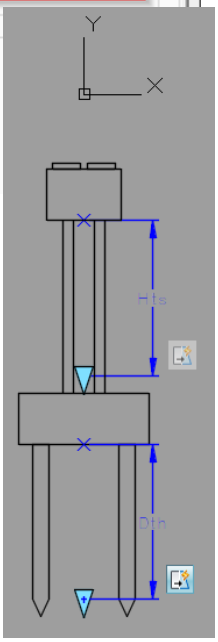
Style



__BRDG_LSEC_ABUT_A



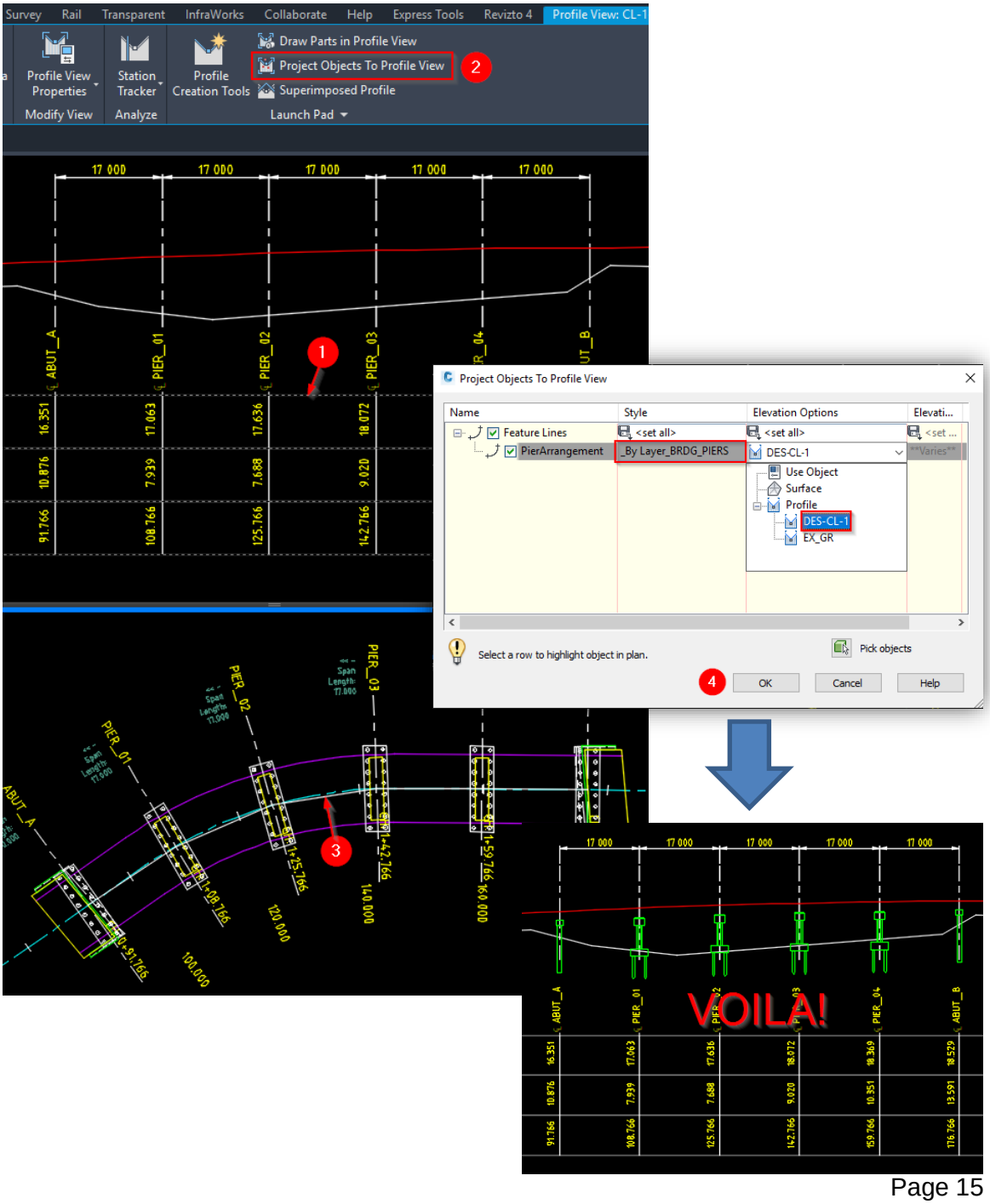
__BRDG_LSEC_PIER



Notes:
Blocks can be of any complexity.
Parametrics become available after explosion.
In combination with EATTEXT quick quantity takeoffs can be extracted from the model.

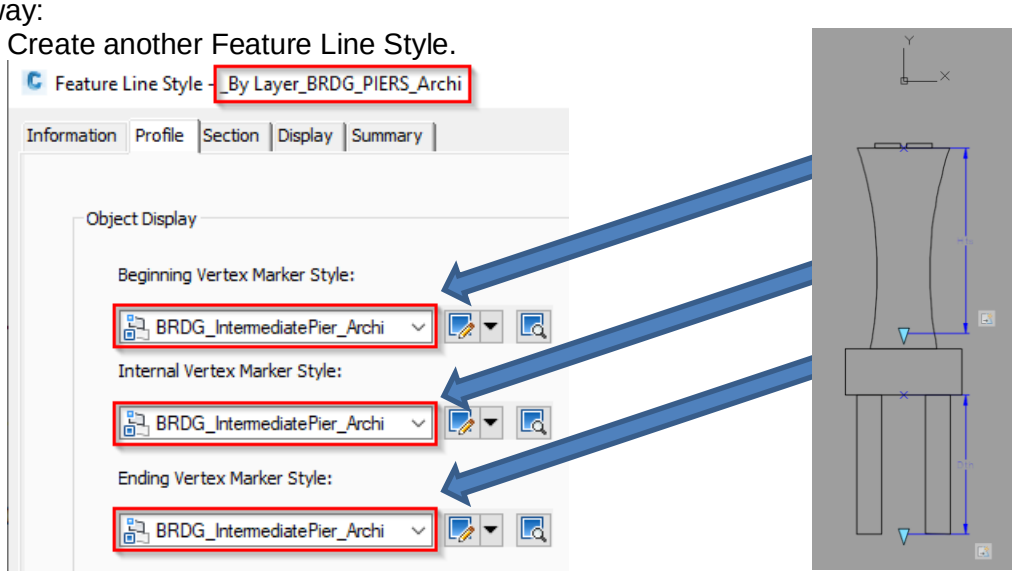
Projection to Longitudinal Section

1. Pick Profile View;
2. Project Objects To Profile View;
3. Pick **PierArrangement** Feature Line;
4. Choose the style and the Profile.

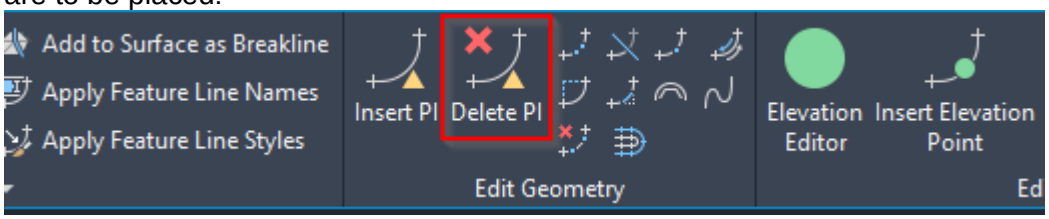


What if there are multiple intermediate pier types? Well, If you like the idea of pier positioning being simultaneously linked to particular chainage and design profile, here is a way:

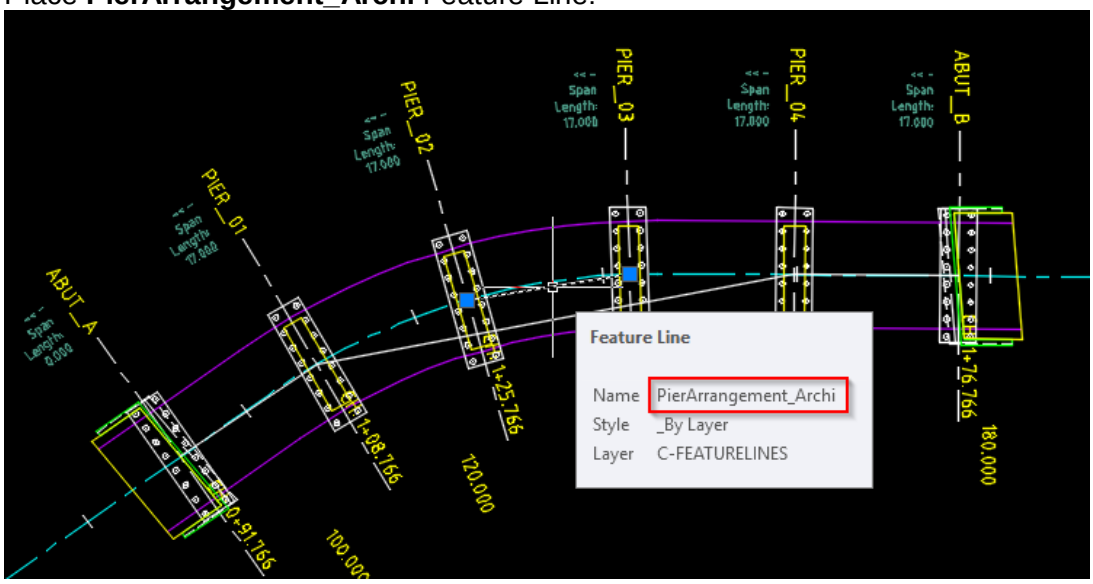
1. Create another Feature Line Style.



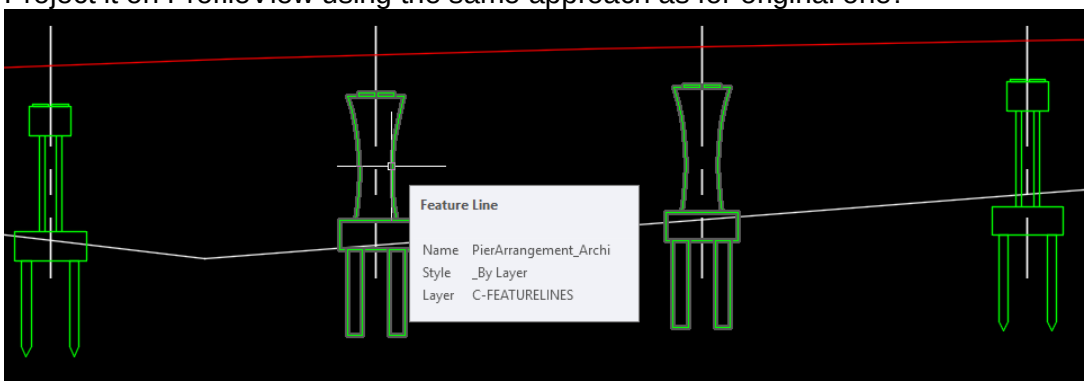
2. Select **PierArrangement** Feature Line and delete PI's at which architectural piers are to be placed:



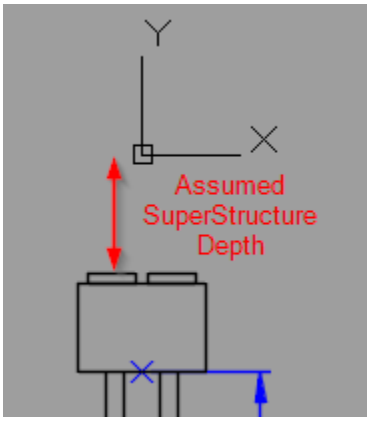
3. Place **PierArrangement_Archi** Feature Line:



4. Project it on ProfileView using the same approach as for original one:

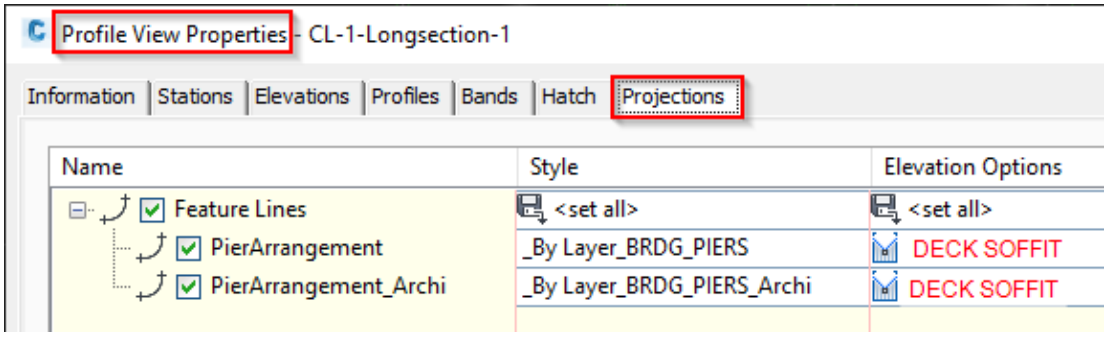


Of course, you might want to display piers on LongSection after the Superstructure depth is defined. IN the above example pier block on Profile View positioning is driven by Design Profile and assumed Superstructure depth.



If Superstructure soffit profile is not following design profile or not constant along the bridge, then two thing s would need to be done:

- blocks insertion point would need to be adjusted
- profile would need to be swapped in profile view properties with a “Deck Soffit” one.



You might be wandering how can we get Deck Soffit profile (amongst others) displayed on the Profile View. This is covered in the next section, Corridor.

Additional Use Cases of FeatureLines

Since recently, it is possible to use Feature Line as a corridor baseline. Let's look at how it can be leveraged in bridge design.

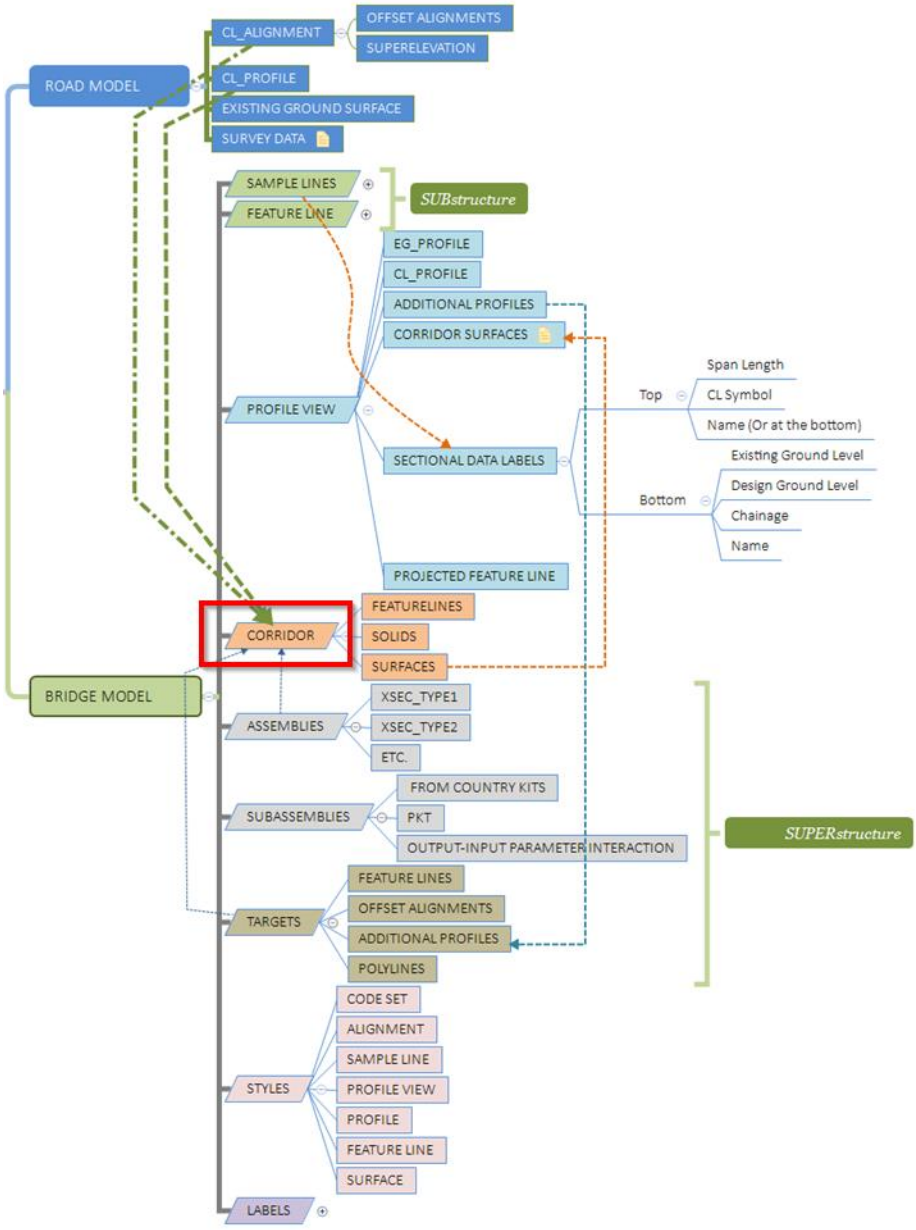
Corridor

Overview

Civil 3D corridor is good at representing Superstructure for various reasons:

- Highly configurable smart geometry of the cross-section;
- Dynamic link to alignment change;
- Low-to-Mid LOD Solid geometry generation with attached metadata;
- In many cases easier to understand than Revit's Adaptive Component Environment;
- Especially useful when dealing with bridge widenings;

- Variety of objects can be extracted from the corridor maintaining dynamic link to it.



Assemblies

Assemblies are represented by multiple Subassemblies (building blocks)
Often times out of the box assemblies can be used to start with and to get a rough idea of how superstructure will look like.
(Number Transform point based):
Generic shapes are good enough as long as parameter output-input is used.
Verticality, but instantaneous grade can be used to “undo that” (also as a NumberTransform pkt)
Examples:

Targets

- Feature Lines
- Alignments
- Polylines
- Surfaces

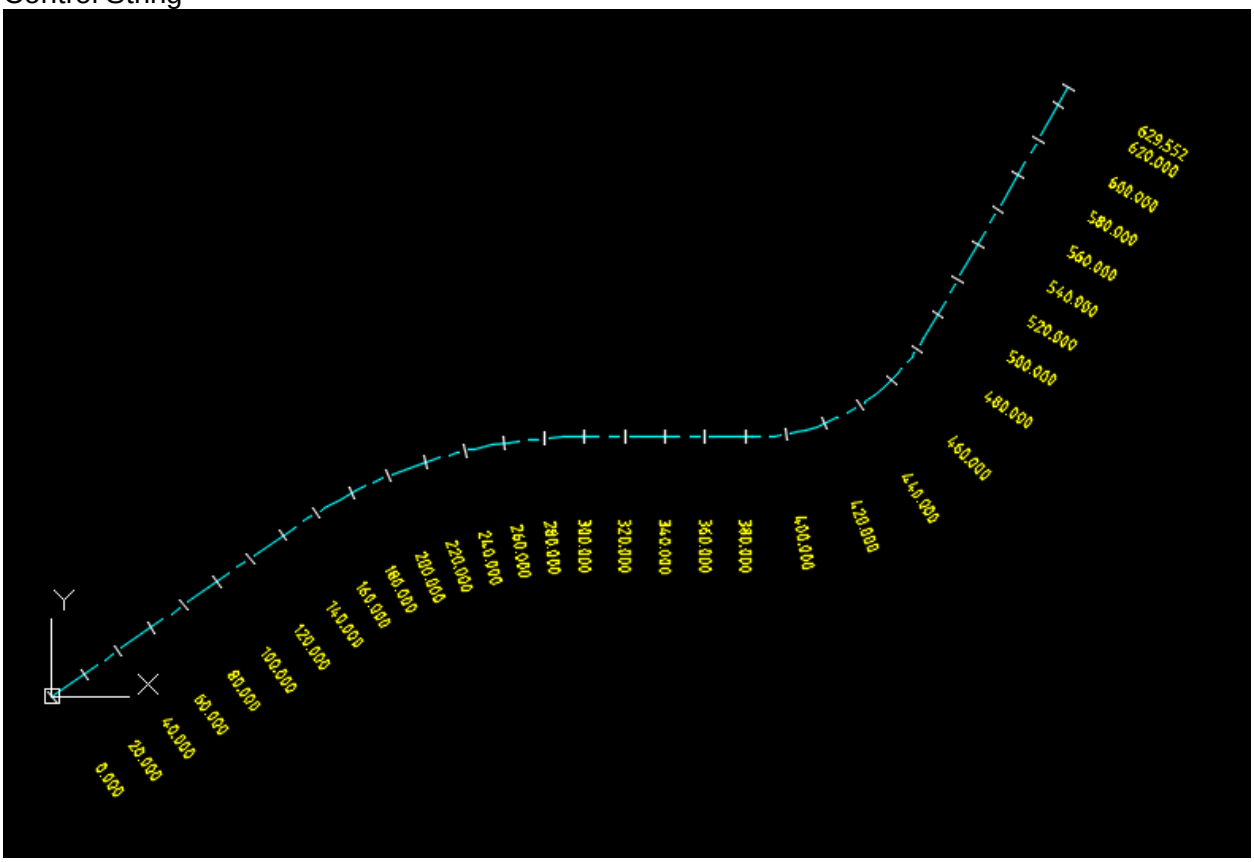
Extracts

- Solids
- FeatureLines
- Surfaces

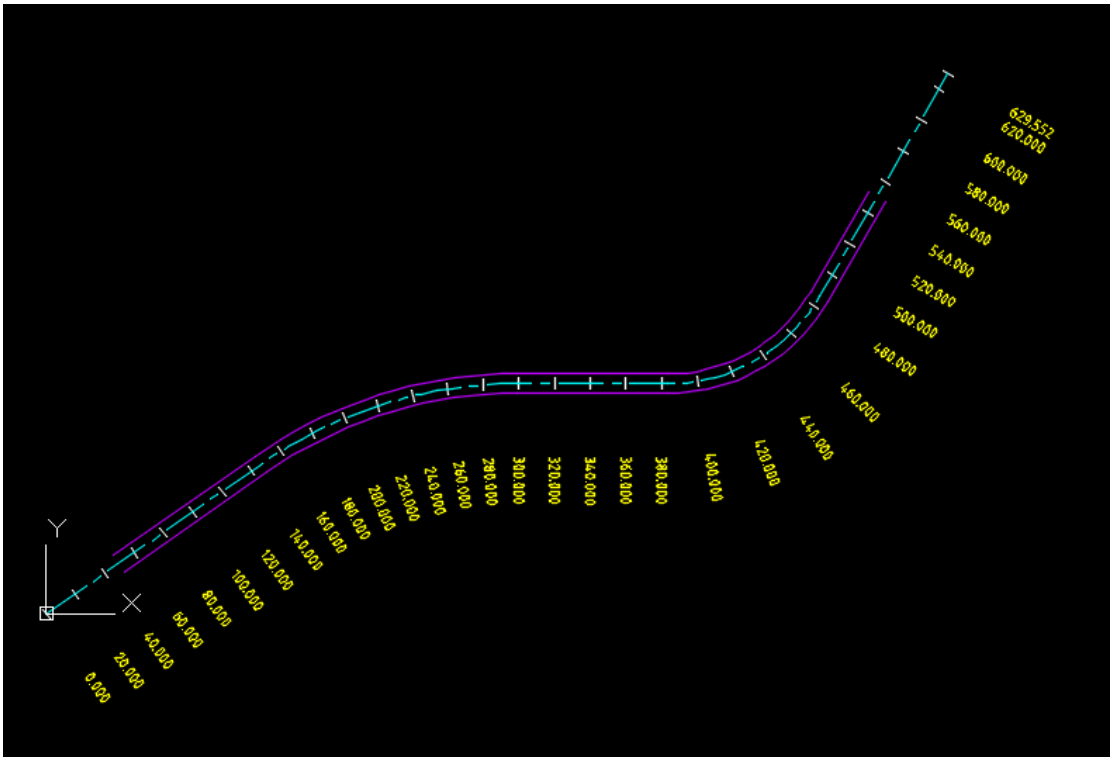
Bridge Modelling run through

1. Road geometry from DataShortcuts
    a. Alignment
    b. Offset Alignments
    c. Profile
    d. Superelevation
    e. Triangulation

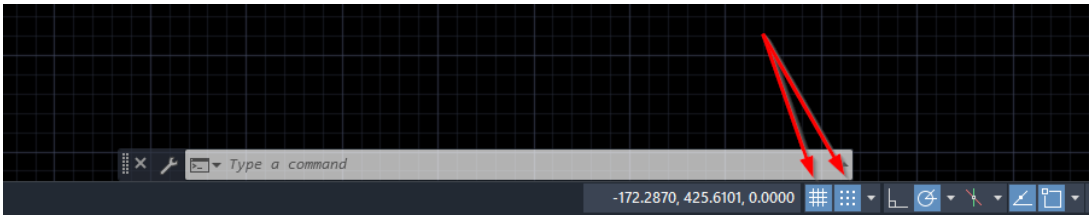
Control String

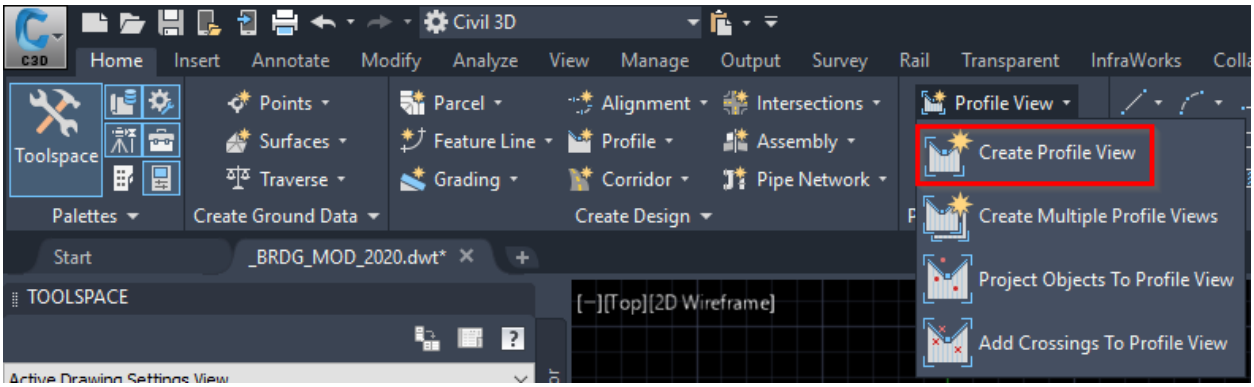


With Offsets:

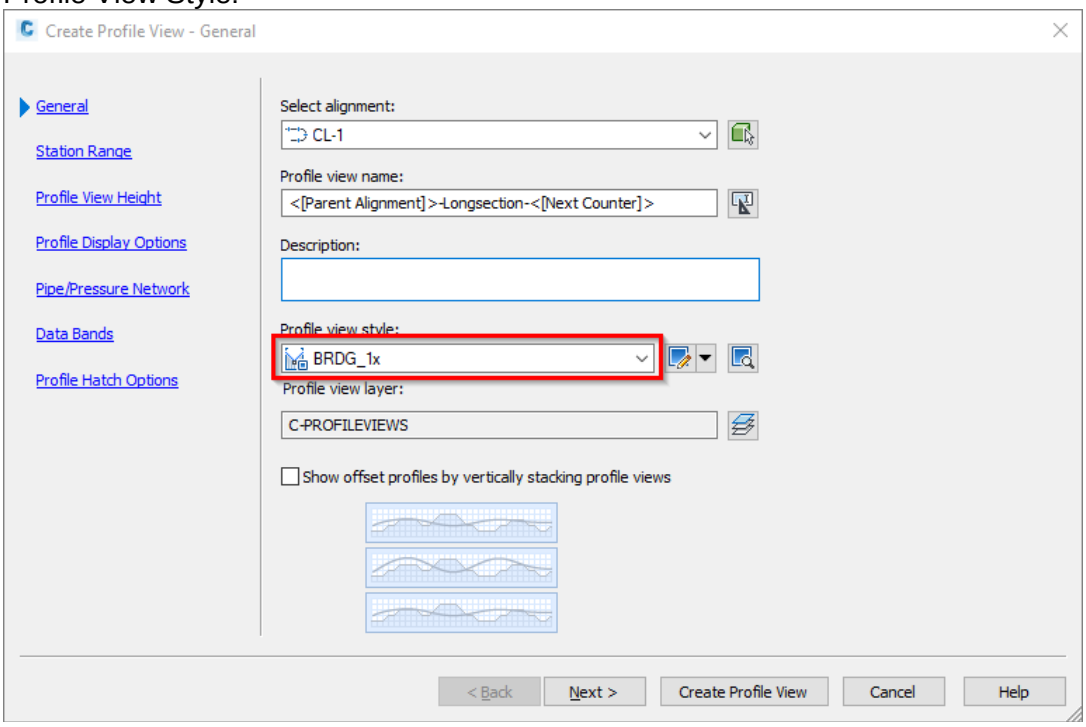


Bridge longitudinal section – Create Profile View (It's best to enable grids and grid snapping prior to that):

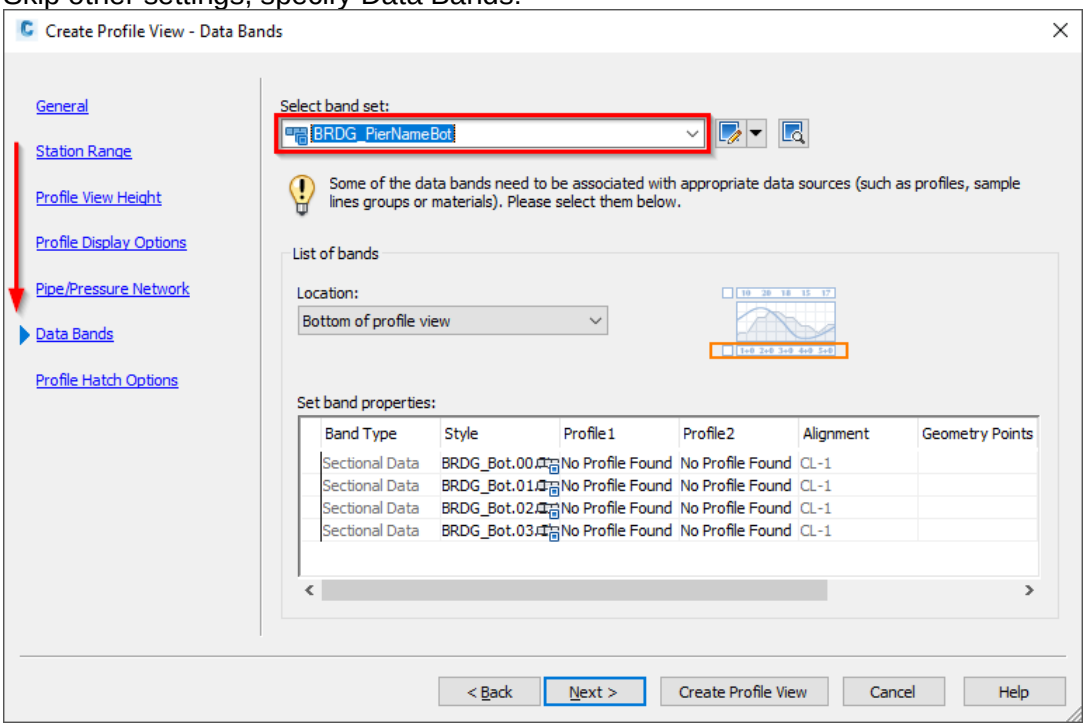




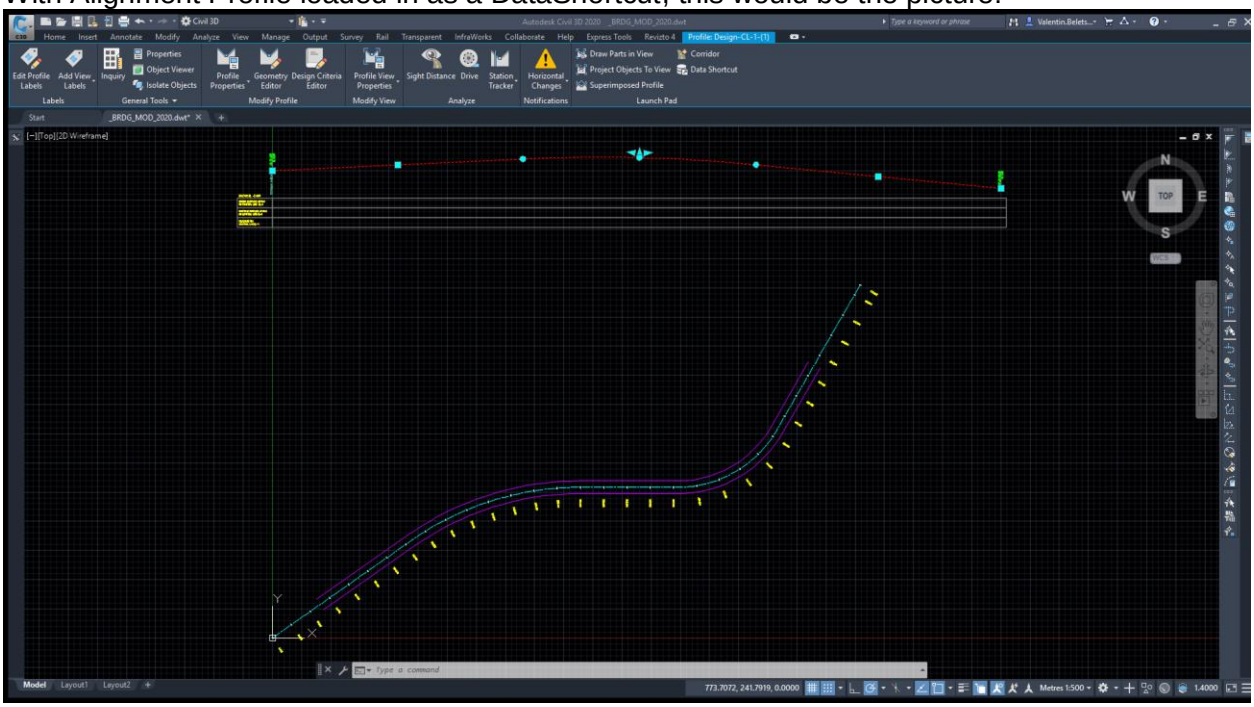
Profile View Style:



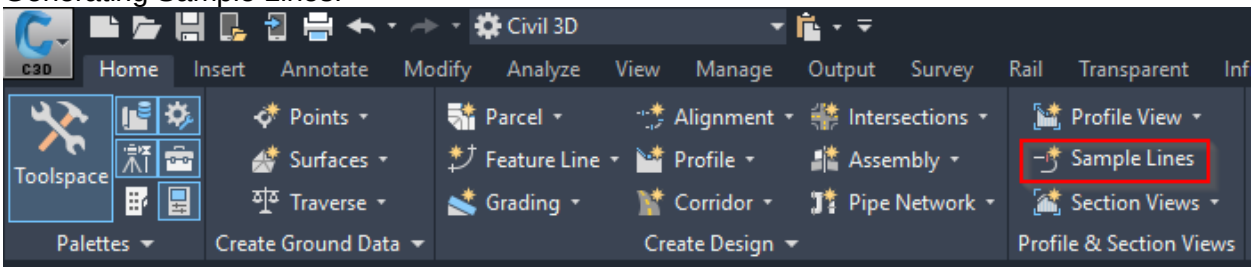
Skip other settings, specify Data Bands:



With Alignment Profile loaded in as a DataShortcut, this would be the picture:

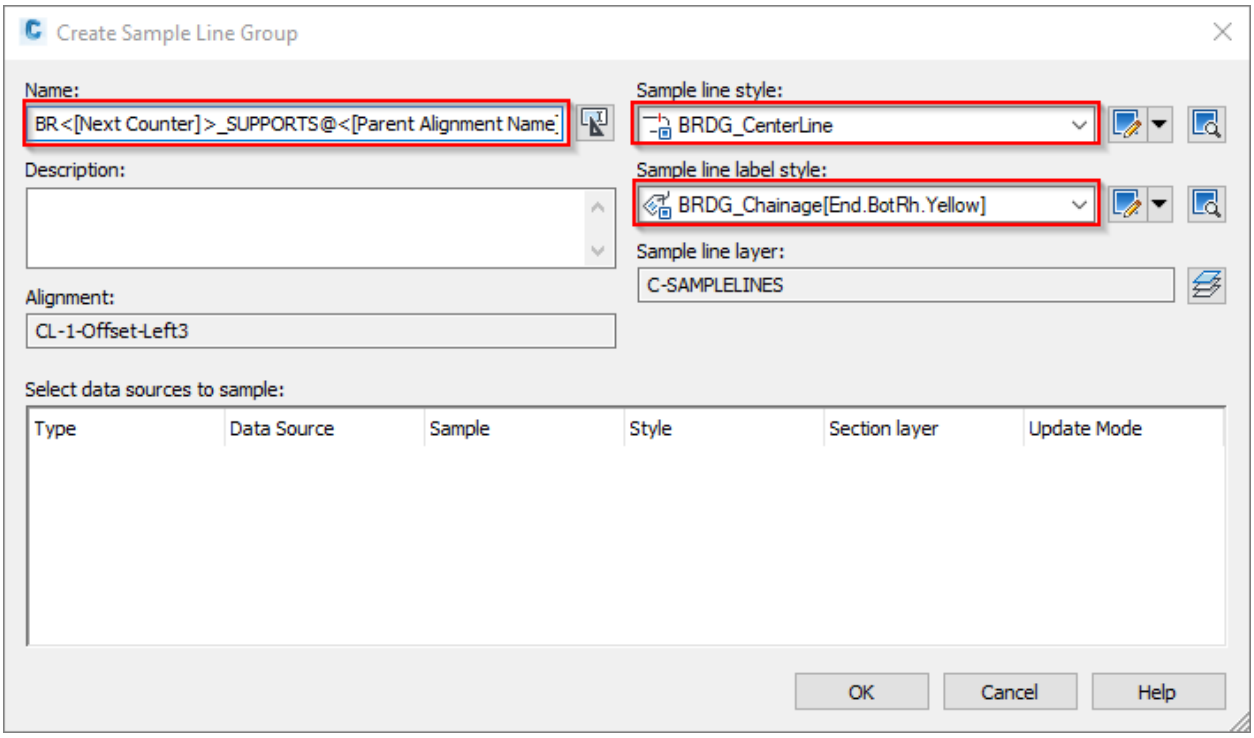


Generating Sample Lines:



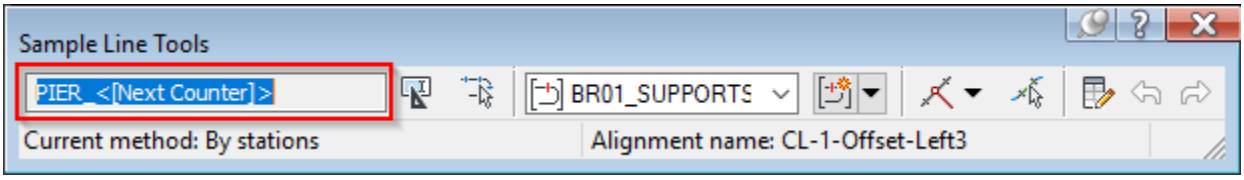
Select an alignment either interactively on the screen or hit enter and choose from the list.

Settings configured on previous steps:



Hit OK

Another one:



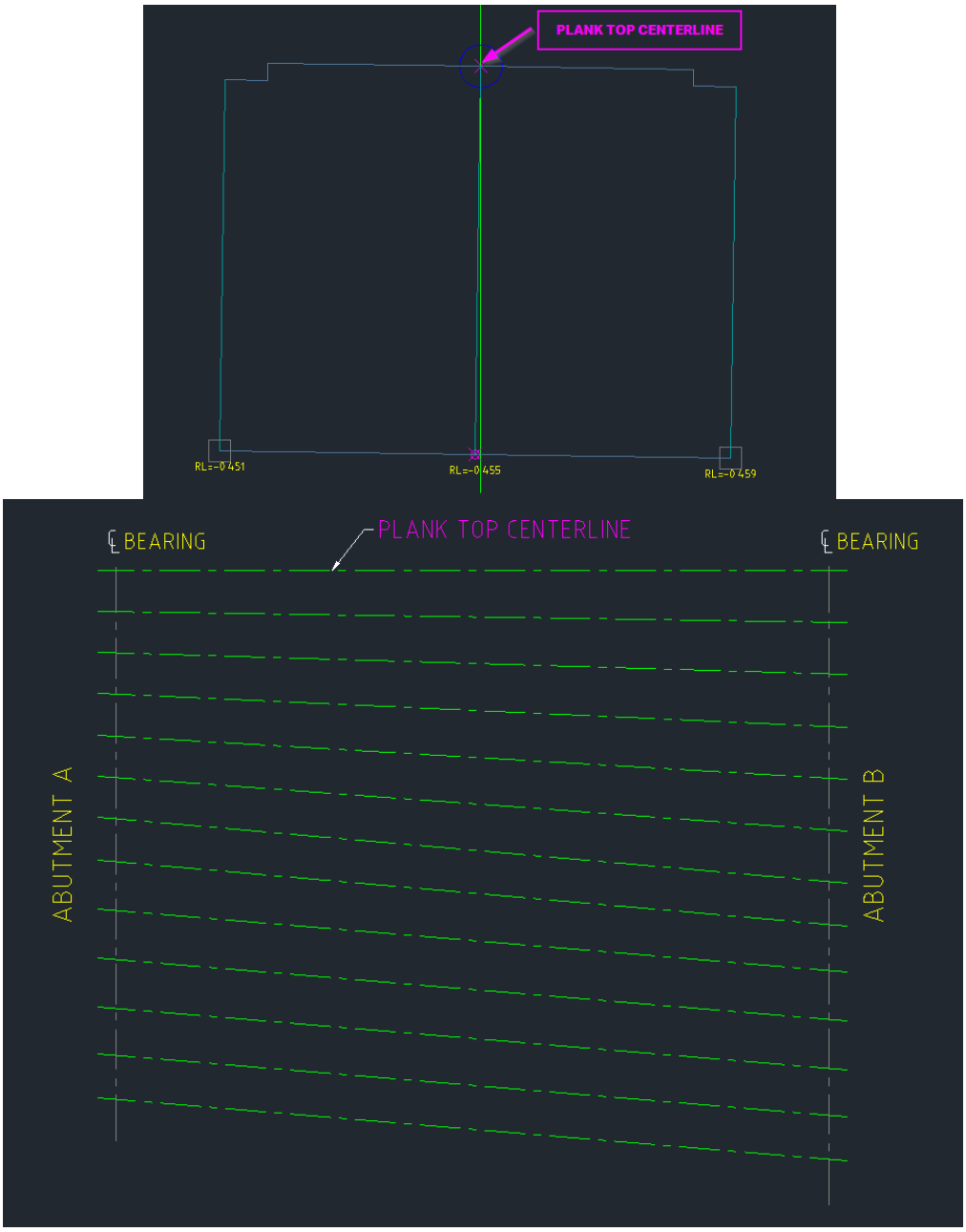
Bonus

Feature Lines and Corridor for Bridge Widenings

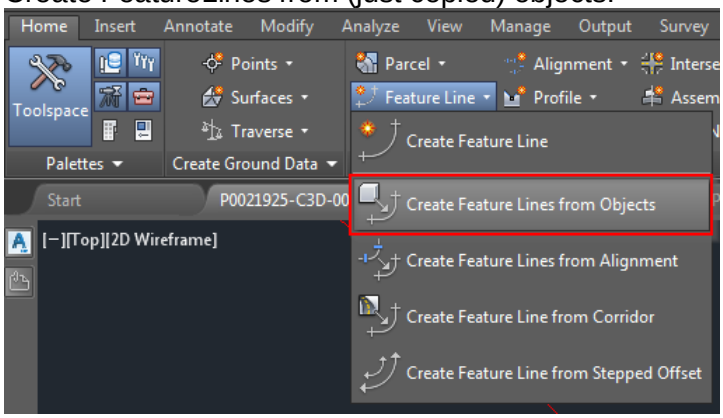
Bridge Superstructure initial SetOut in AutoCAD.

1. In a separate simple AutoCAD file spread out lines representing each plank top centerline. XCLIPped AutoCAD Block with path array (with Number of items in array as a parameter) can be used to get more dynamic results.

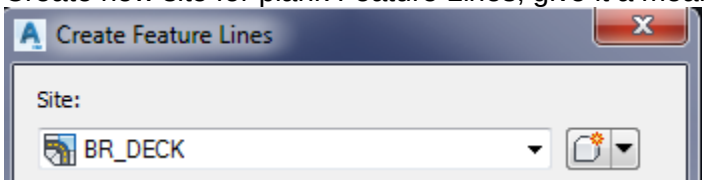
   Example - PSC Plank assembly with denoted location of the lines needed to be distributed in plan.


PLANK TOP CENTERLINE
RL=-0.451
RL=-0.455
RL=-0.459
BEARING
PLANK TOP CENTERLINE
BEARING
ABUTMENT A
ABUTMENT B

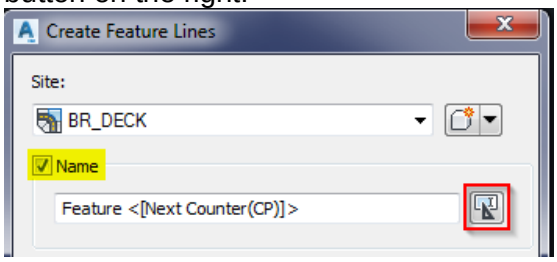
2. Copy and paste to original coordinates plank centrelines into the Civil 3D BR-MODEL file.
3. Create FeatureLines from (just copied) objects:



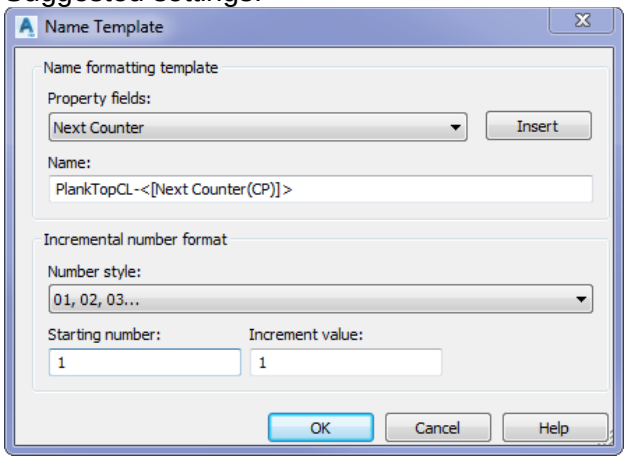
4. Pick the lines, hit Enter.
5. Create new site for plank Feature Lines, give it a meaningful name:



6. Configure naming convention for FeatureLines. Tick the Name box and push the button on the right:



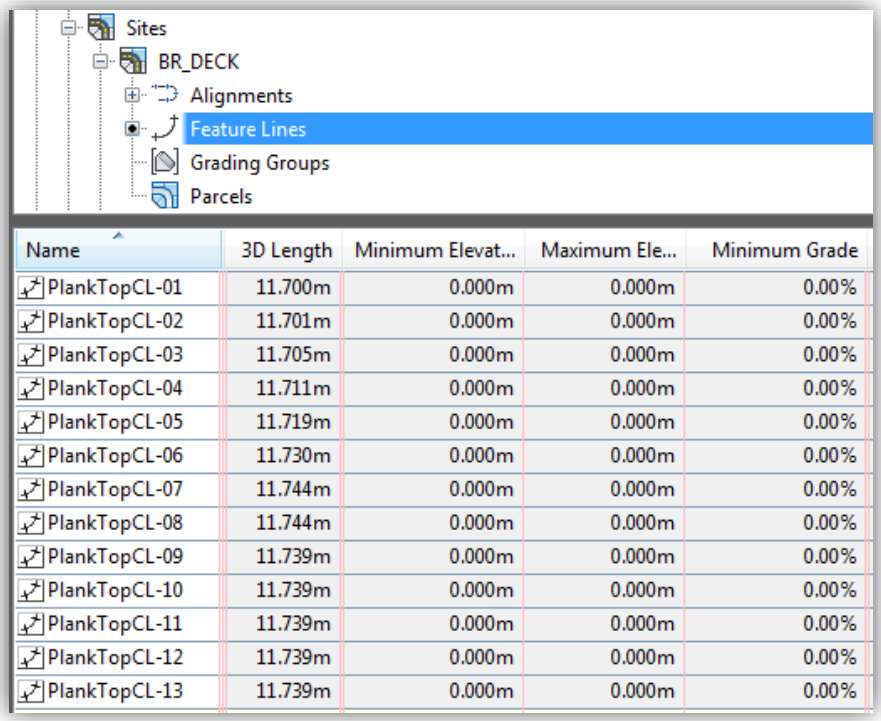
7. Suggested settings:



NUMBER STYLE 01, 02, 03 WILL ARRANGE FEATURELINES IN THE RIGHT ORDER.
INSTEAD OF 1, 11, 12, 13, 2, 3, 4

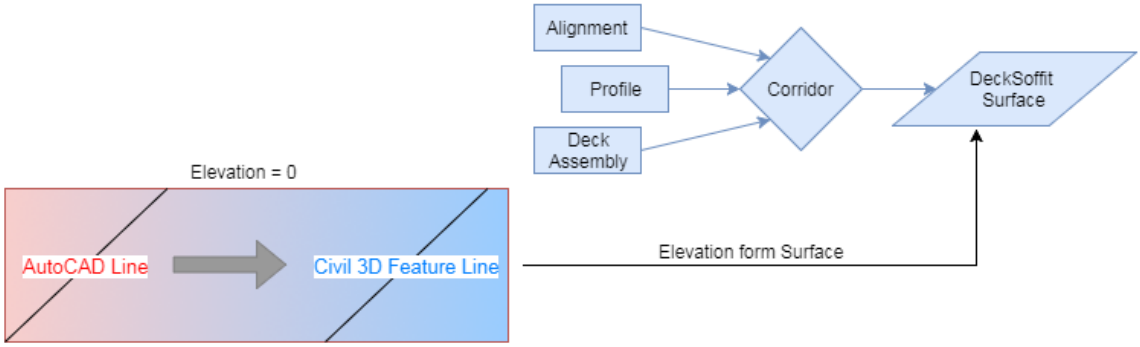
No need to touch other options for now:

This is how the result should look like:



Name	3D Length	Minimum Elevat...	Maximum Ele...	Minimum Grade
PlankTopCL-01	11.700m	0.000m	0.000m	0.00%
PlankTopCL-02	11.701m	0.000m	0.000m	0.00%
PlankTopCL-03	11.705m	0.000m	0.000m	0.00%
PlankTopCL-04	11.711m	0.000m	0.000m	0.00%
PlankTopCL-05	11.719m	0.000m	0.000m	0.00%
PlankTopCL-06	11.730m	0.000m	0.000m	0.00%
PlankTopCL-07	11.744m	0.000m	0.000m	0.00%
PlankTopCL-08	11.744m	0.000m	0.000m	0.00%
PlankTopCL-09	11.739m	0.000m	0.000m	0.00%
PlankTopCL-10	11.739m	0.000m	0.000m	0.00%
PlankTopCL-11	11.739m	0.000m	0.000m	0.00%
PlankTopCL-12	11.739m	0.000m	0.000m	0.00%
PlankTopCL-13	11.739m	0.000m	0.000m	0.00%

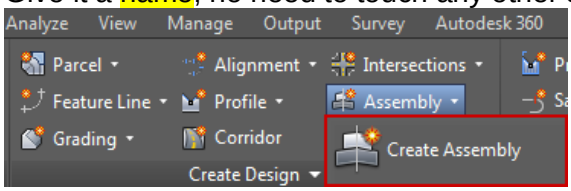
The next step is to build a deck soffit corridor model. Extracting a surface from it will allow these Feature Lines' ends to pick elevation from it. An outline of the process:

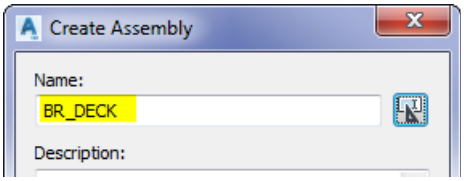


Deck Soffit Corridor modelling.

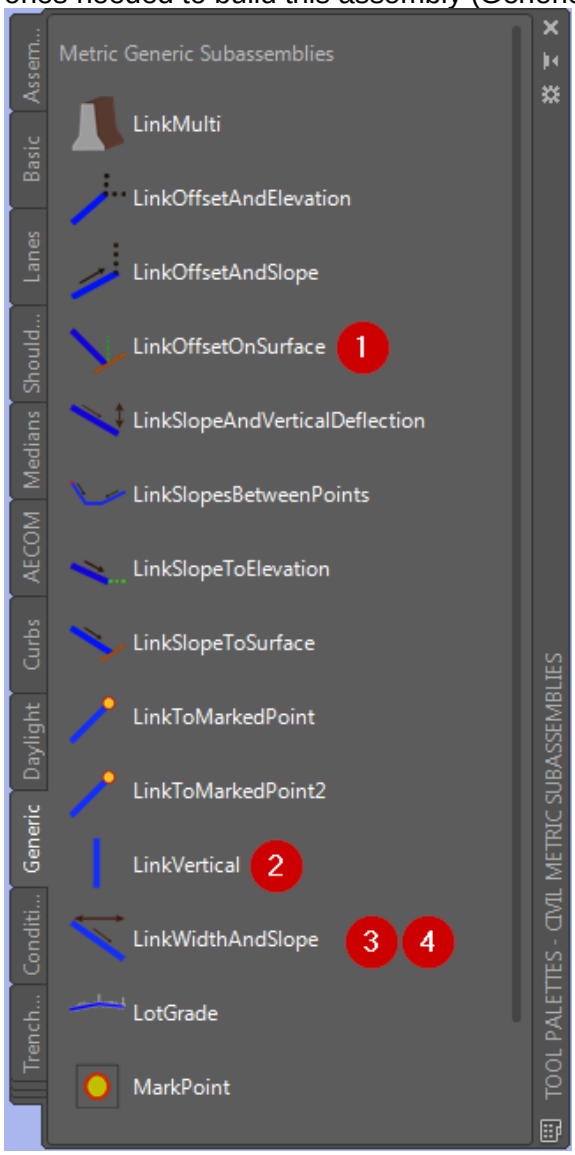
At this stage, BR_DECK Assembly is going to be built from Generic Links.

1. Give it a name, no need to touch any other settings.

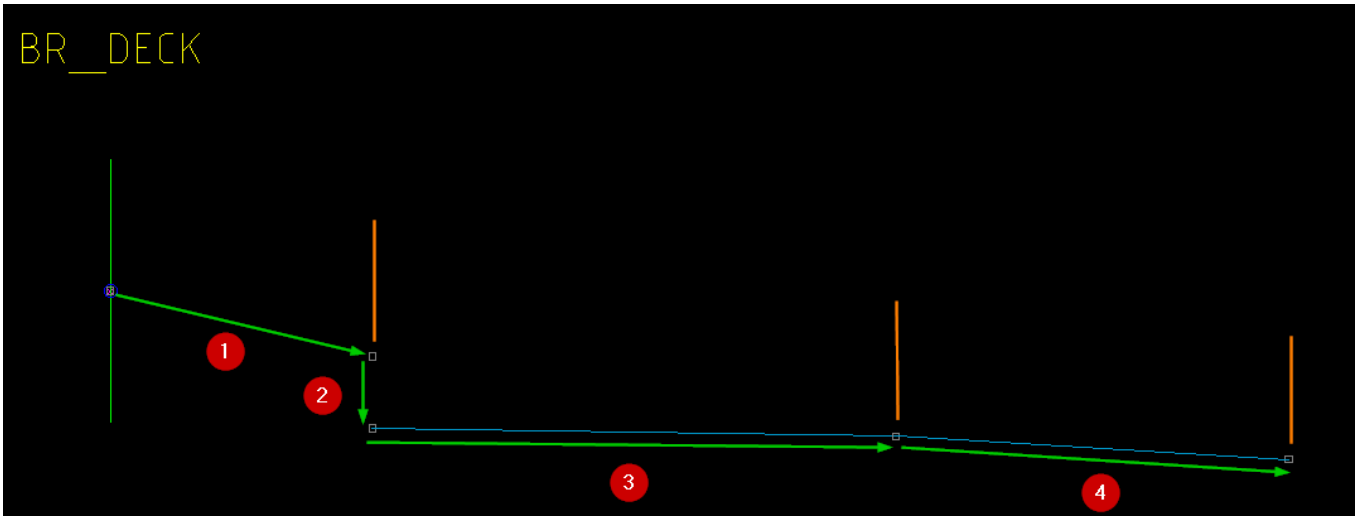


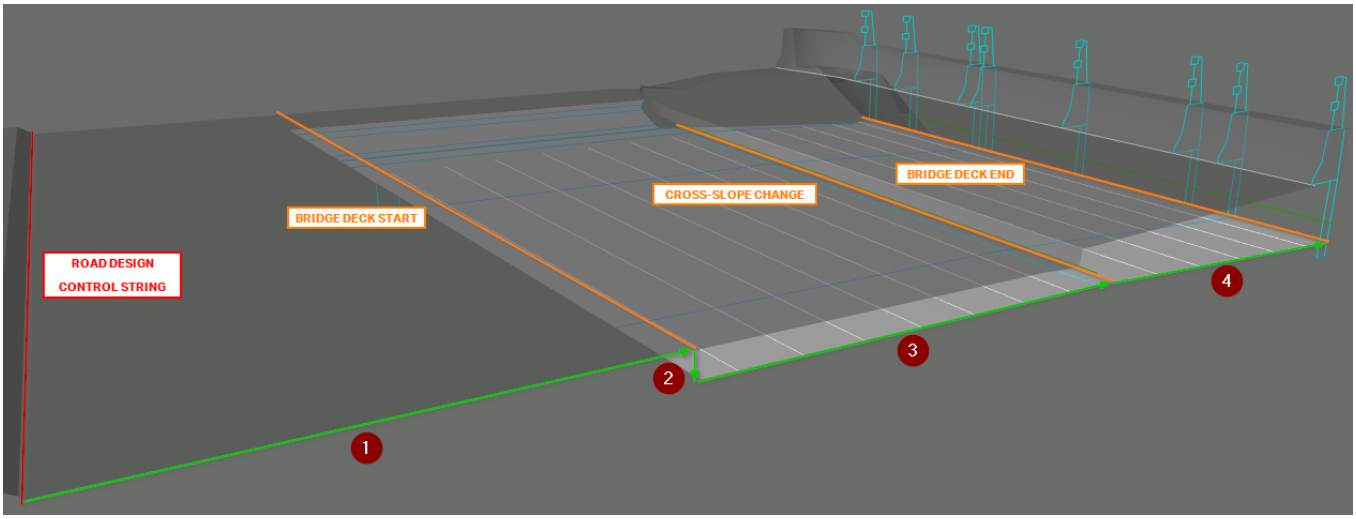


2. Components to build an assembly from are called Subassemblies. They are available on C3D Tool Pallette (Ctrl+3 shortcut to bring it up). Highlighted are the ones needed to build this assembly (Generic Tab).



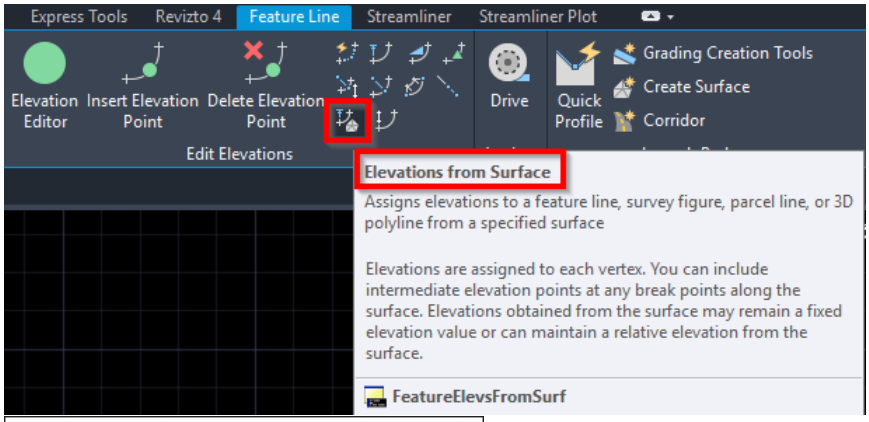
3. Assembly breakdown.
    a. The first component (“Subassembly.**LinkOffsetOnSurface**”) is pointing to Start of the Deck target in plan and picks up the elevation from the road design surface.
    b. The second component (“Subassembly.**LinkVertical**”) is going down by nominated asphalt+ deck thickness.
    c. The third component (“Subassembly.**LinkWidthAndSlope**”) has a slope nominated as well as the offset alignment from the Control String as a target in plan. *(With some auxiliary links this link can pick up the slope from the road design surface in a more complicated scenario.)*
    d. The forth one is the same as the third one, but with a different slope and target in plan.

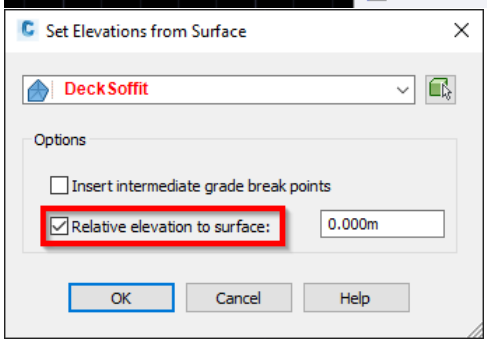




4. Build the corridor

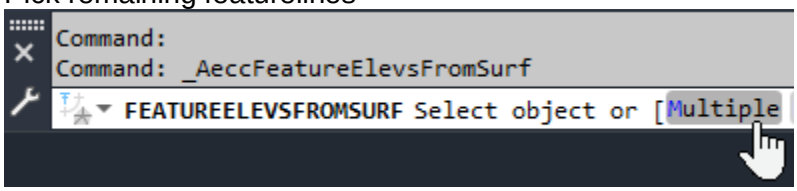
5. Provide “DeckSoffit” Link Code to links 3 and 4.
6. Add “DeckSoffit” Surface to the corridor.
7. Select one of the PlankTopCL Feature Lines.
8. Elevations from Surface





NOTE: RELATIVE ELEVATION TO SURFACE CAN LATER ON BE DEFINED INDIVIDUALLY FOR EACH FEATURELINE.

9. Pick remaining featurelines



10. Now FeatureLines are linked to “DeckSoffit” surface and ready to be used as PlankSet corridor Baselines!

Feature Lines and Corridor for Muiltispan Precast Girder Deck Modeling

1. Build a DeckSlab corridor
2. Frequency – by SampleLine/Pier CentreLine locations
3. Extract FeatureLine
4. Build Assembly by repeating LinkOffsetOnSurface, then LinkWidthandSlope+Girder Subassembly, capturing the slope. (WidthandSurfaceSubassembly can be built)

Not To Forget:

If units or precision are not available in Label, it can be manually configured in a text editor and then pasted in.

Merge Layers.

Links:
https://forum.dynamobim.com/t/dynamo-for-civil3d-nodes-do-not-appear-on-open/36129
Civil 3D Template Tips & Shortcuts - Pt. 1 Template Settings
Civil 3D Template Tips & Shortcuts - Pt. 2 Style Creation
Civil 3D Template Creation with the CIM Manager Suite