AASHTOWare BrDR 7.5.0

Substructure Tutorial

Pier3 - Modify Footing Example

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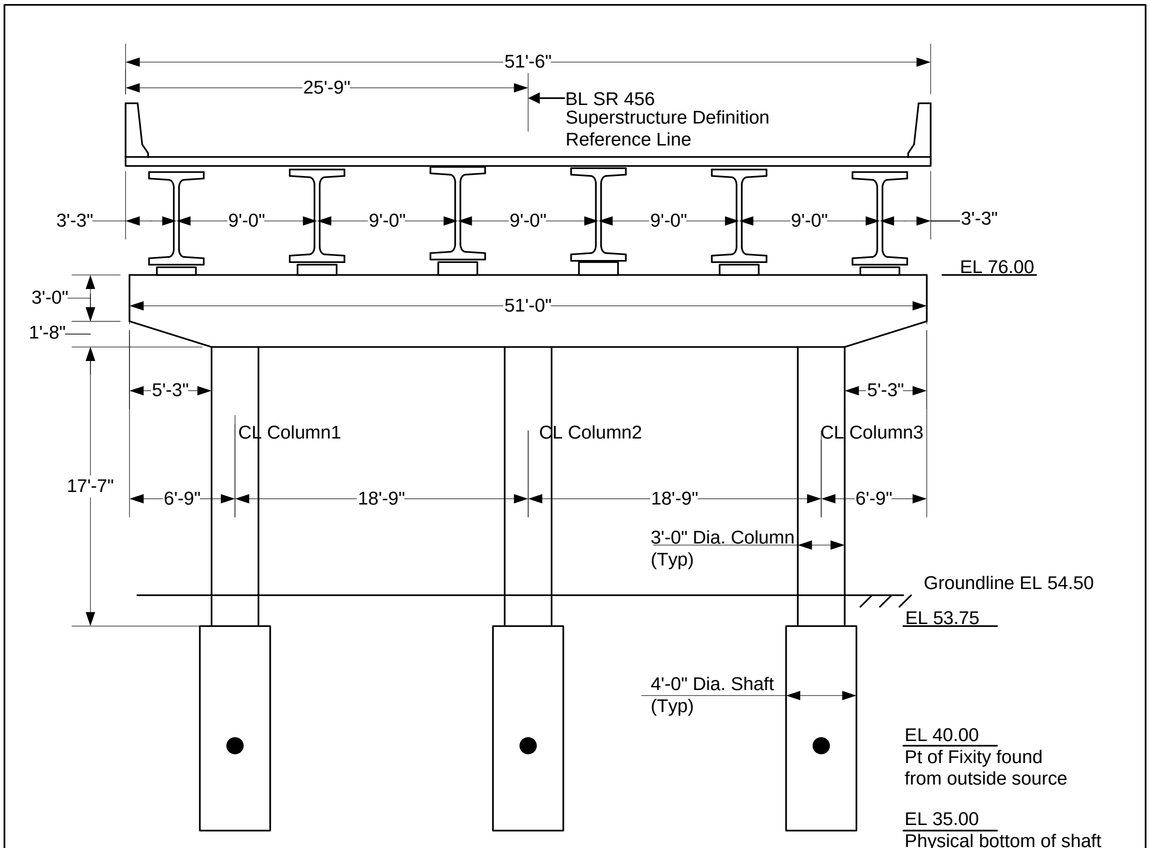
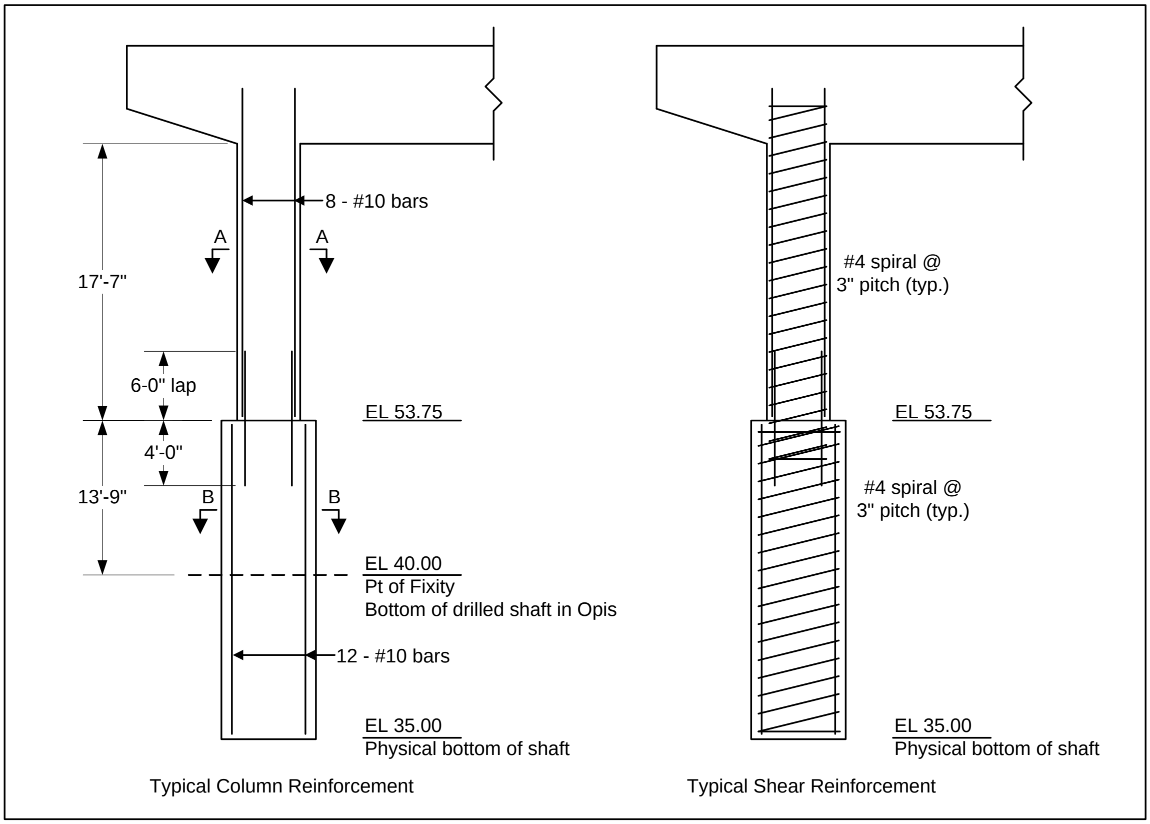
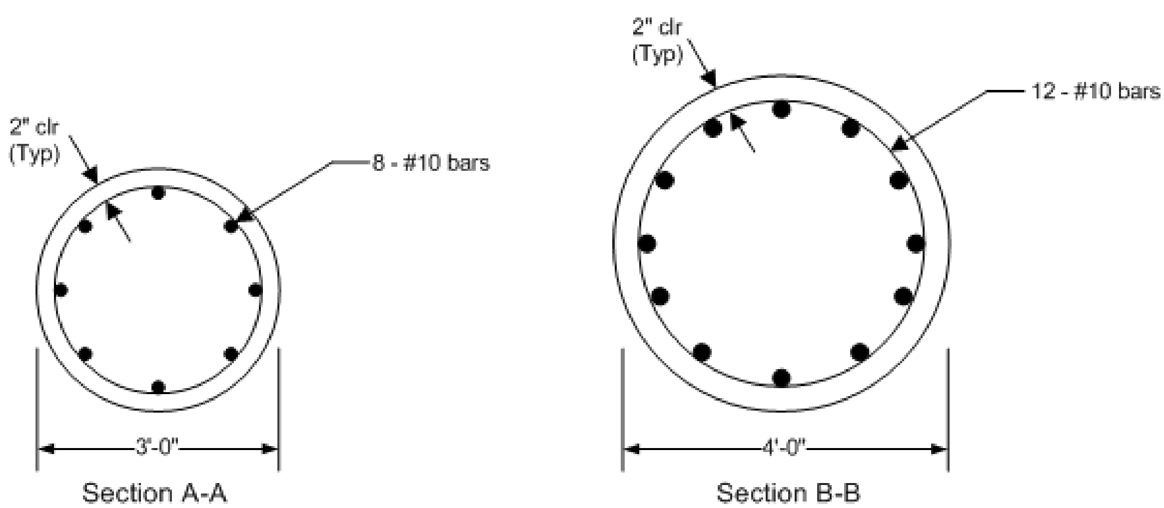


Pier 3 Elevation
Drilled Shaft Foundations
Looking Sta Ahead

Pier3 – Modify Footing Example





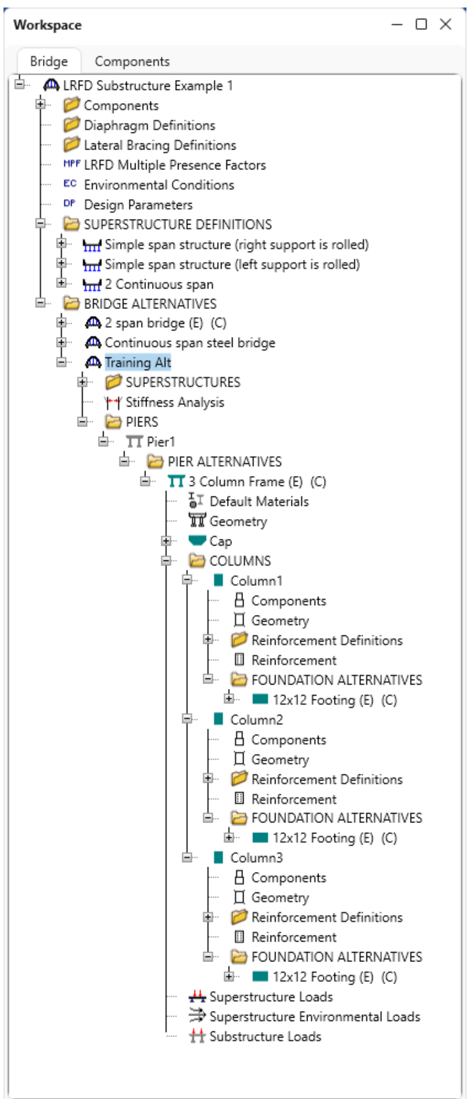
BrDR Substructure Tutorial

Pier 3 – Modify Footing Example

This example modifies one of the spread footings in the BID20 example provided with the sample database to be a drilled shaft foundation. The BrDR substructure unit can perform a soil-structure interaction analysis. An example describing the analysis can be found in in tutorial **"3 Drilled Shaft"** in **2012 User Group – Training**.

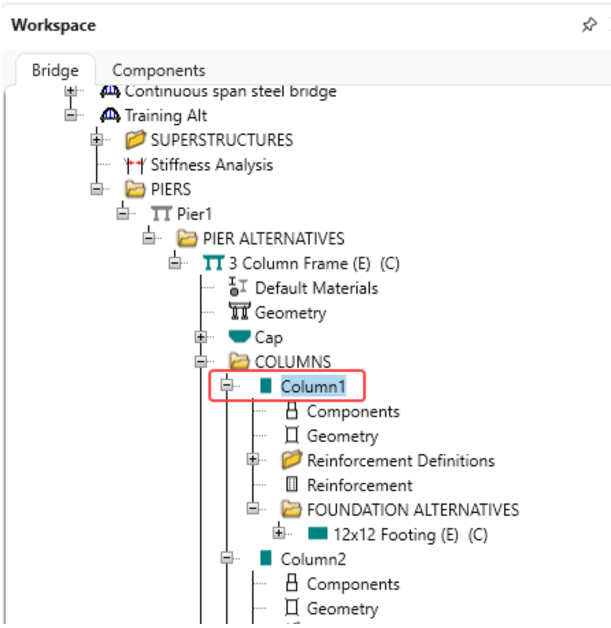
If the user does not want to use the BrDR soil-structure interaction analysis, this example describes how to analyze a pier with drilled shafts considering a user-defined point of fixity. A point of fixity found from an outside source, such as LPile or COM624 can be entered as the base of the drilled shaft in BrDR. BrDR can then perform a finite element analysis and specification check of the pier considering that point of fixity.

From the **Bridge Explorer**, using the Import button, import the Pier 3 xml provided with the **Pier3 Frame Pier** tutorial. The partially expanded **Bridge Workspace** tree is shown below.

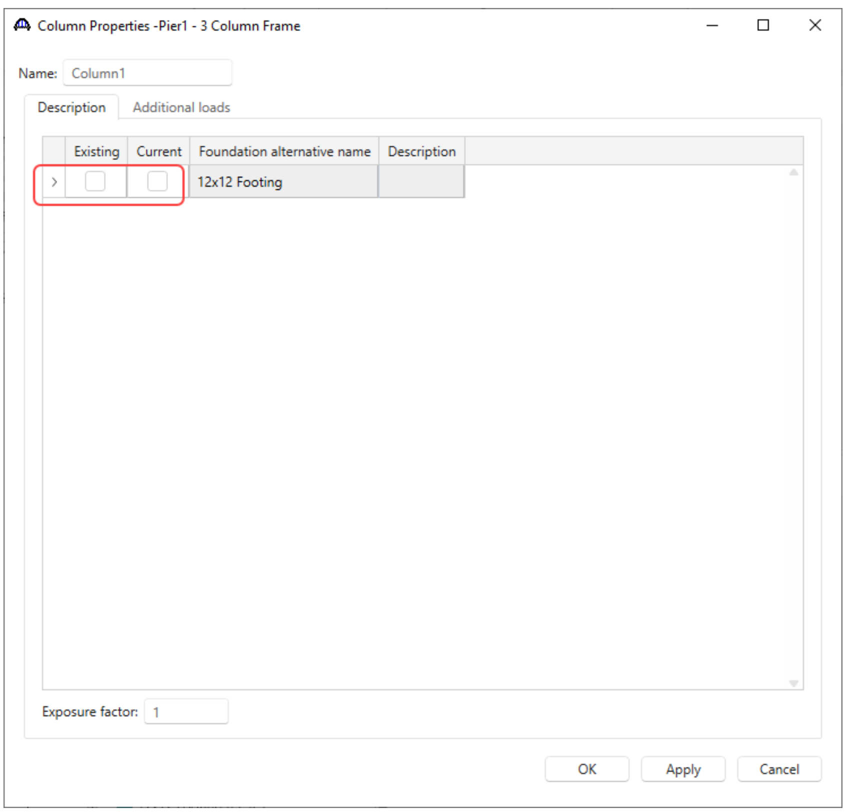


Column Properties – Pier1 – 3 Column Frame

Double click on **Column1** node in the **Bridge Workspace (BWS)** tree as shown below.



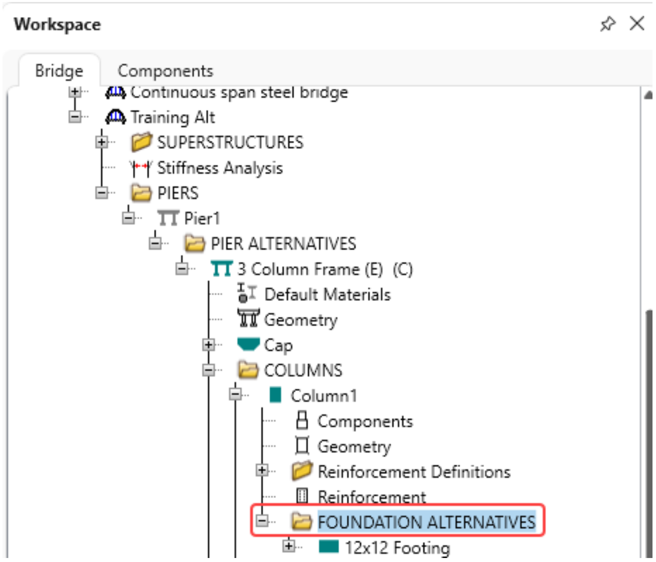
Uncheck the checkboxes **Existing** and **Current** in this window as shown below.

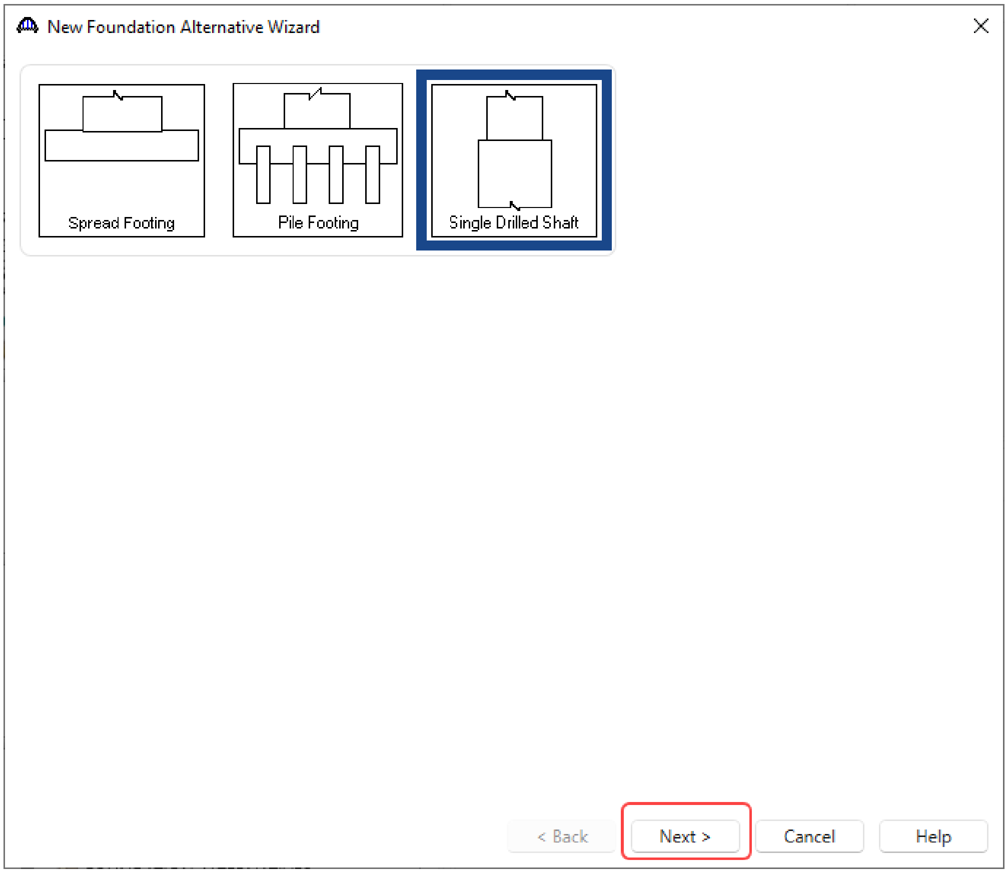


Click **OK** to apply the changes and close the window.

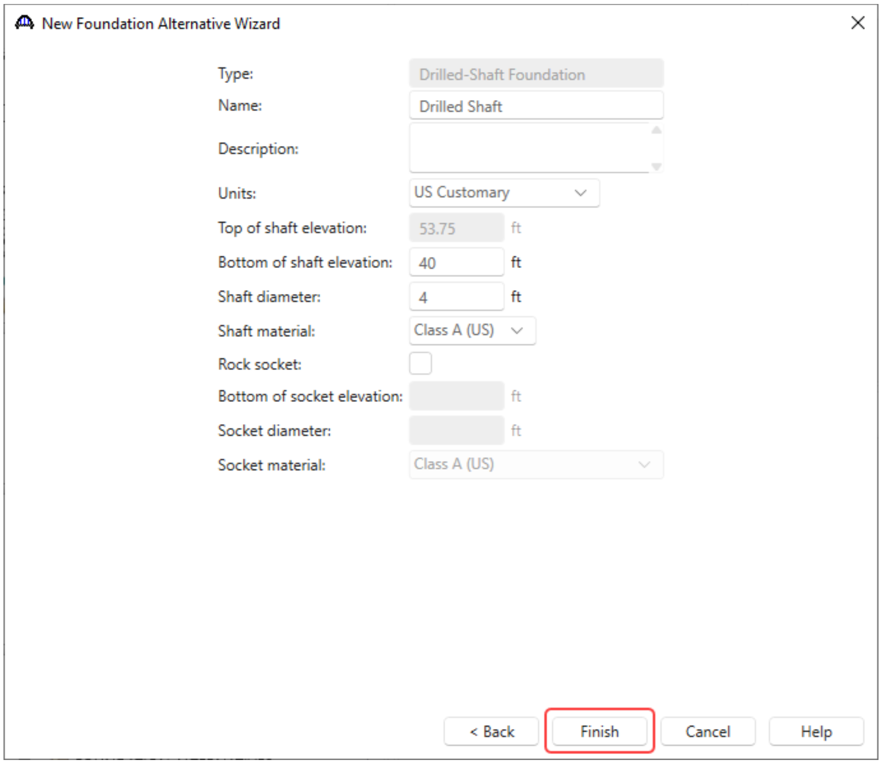
Foundation Alternative

Double click on **FOUNDATION ALTERNATIVES** node and the **New Foundation Alternatives Wizard** opens. Select the **Single Drilled Shaft** option and click **Next.**

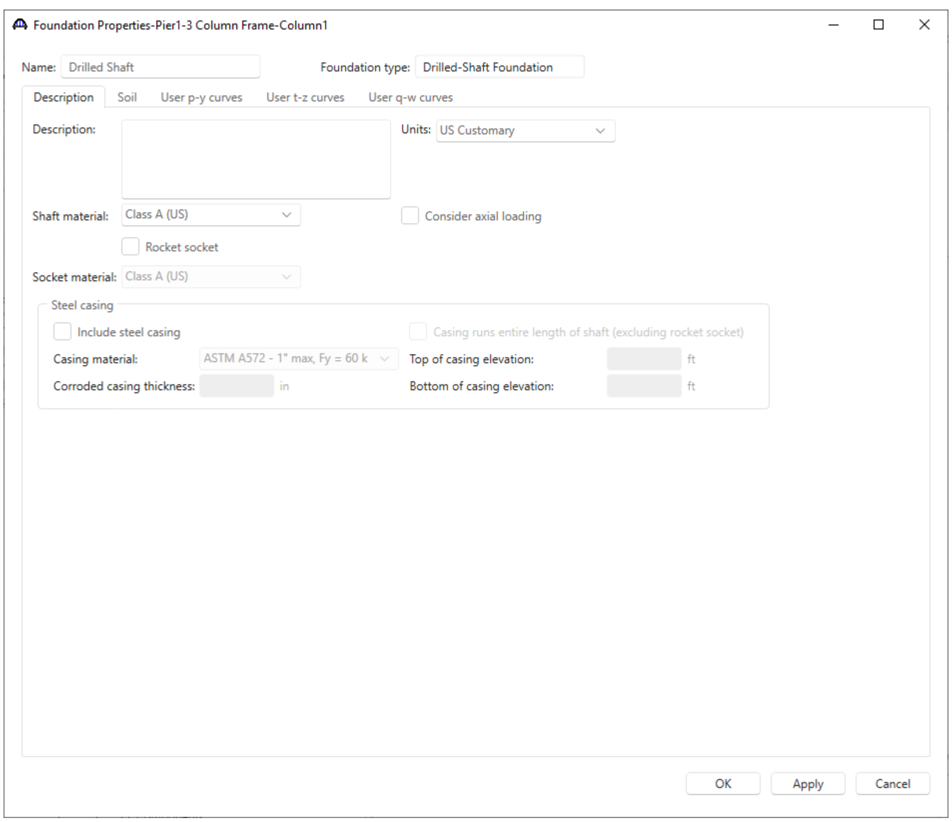




Enter the following description of the foundation and click **Finsh**.

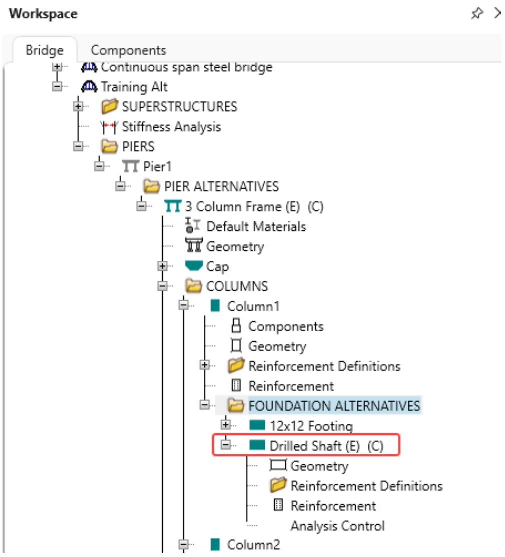


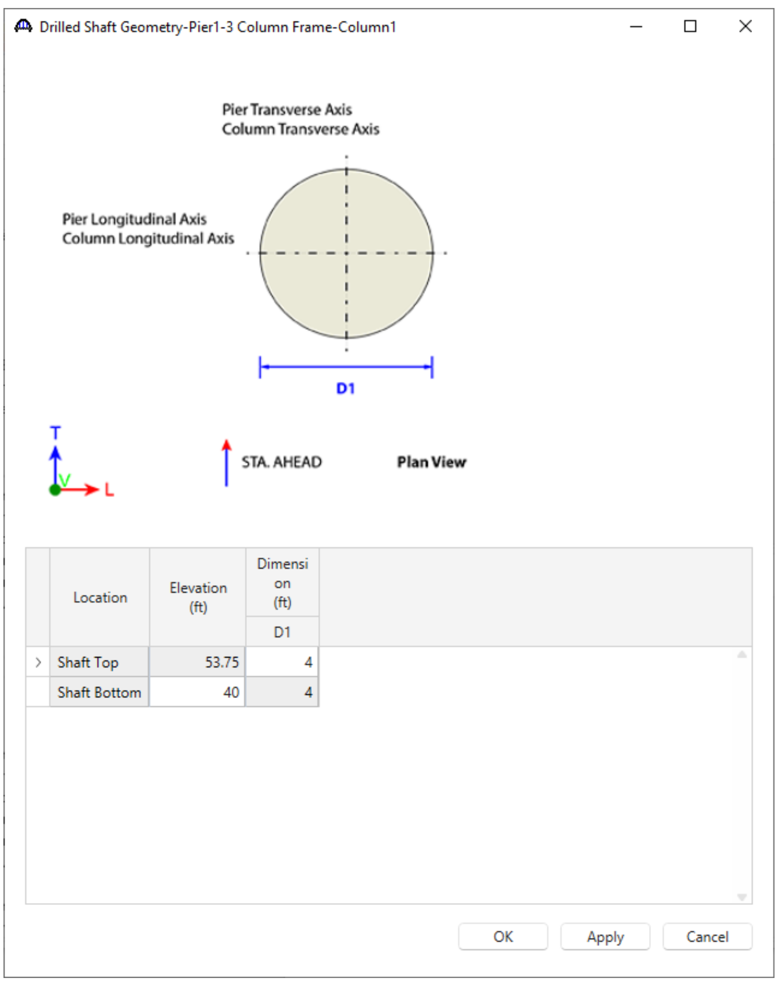
The Foundation Properties window opens. Click **OK** to add this foundation alternative and close the window.



Drilled Shaft Geometry

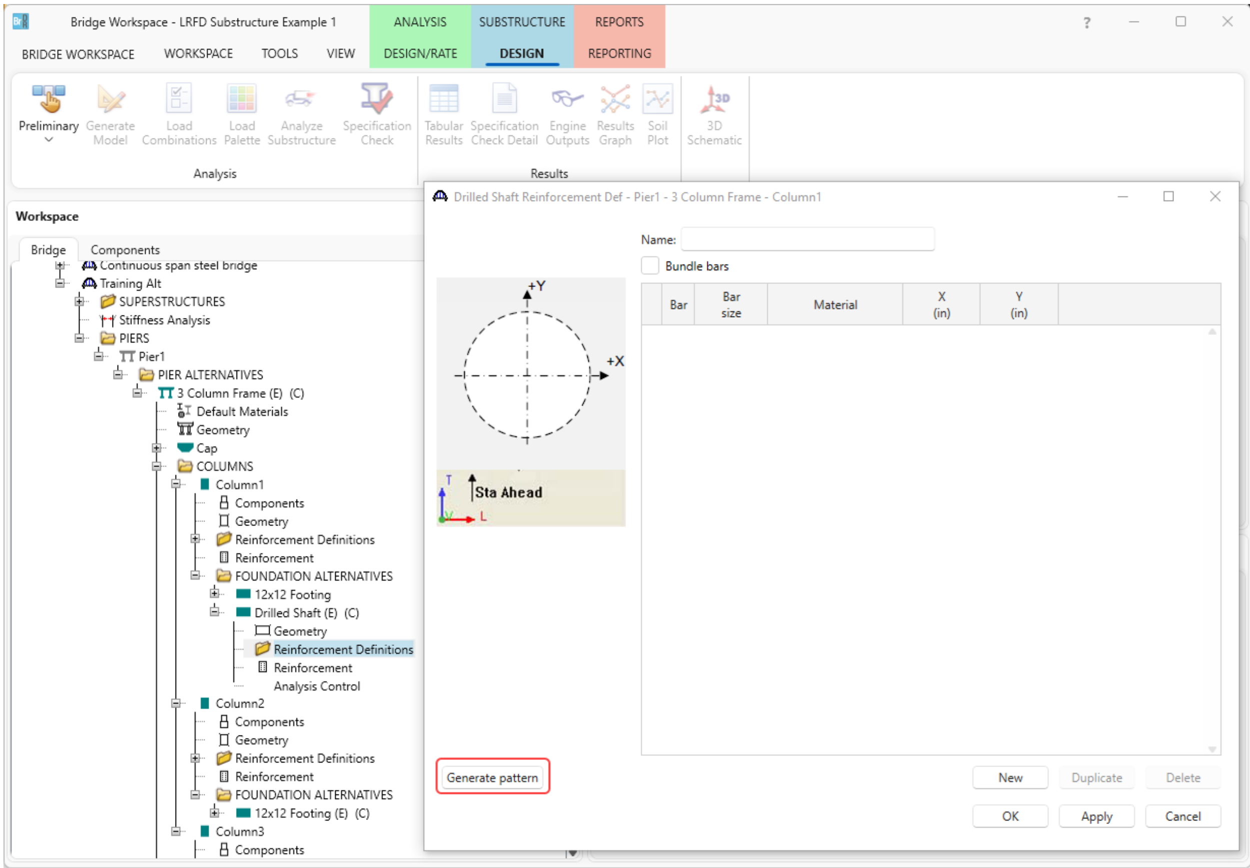
Expand the **Drilled Shaft** foundation alternative. Double click on **Geometry** to open the **Drilled Shaft Geometry** window to view the geometry data. The drilled shaft point of fixity is at 40'.



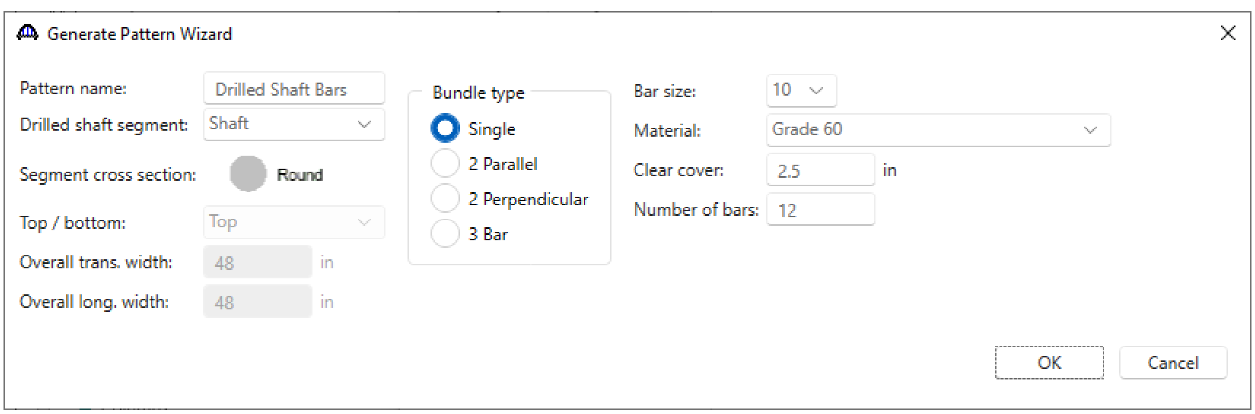


Reinforcement Definitions

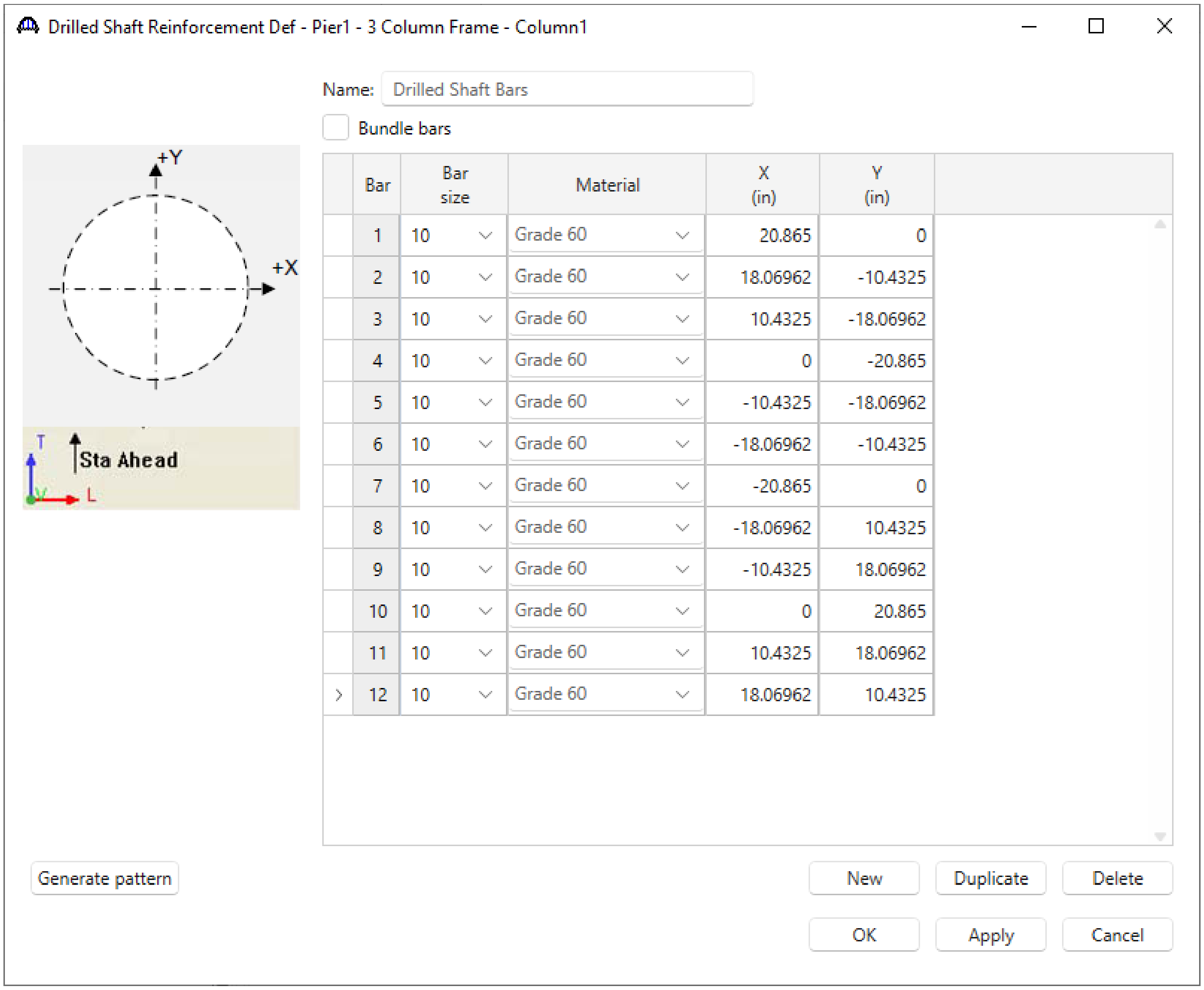
Double click on **Reinforcement Definitions** node to open the **Drilled Shaft Reinforcement Def** window and click on the **Generate pattern** button to open the **Generate Pattern Wizard** window as shown below.



Enter the data shown below and click **OK**.



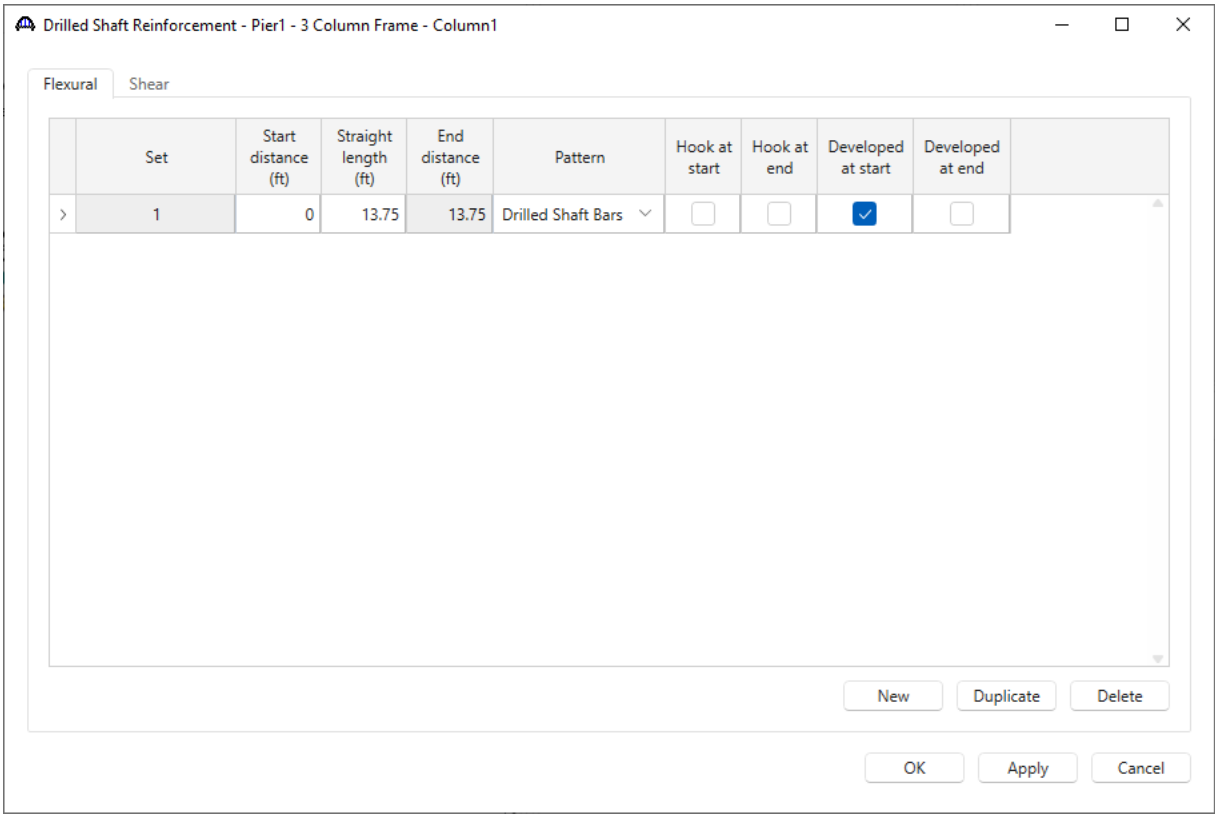
Uncheck the **Bundle bars** checkbox and click **OK** to save the reinforcement definitions and close the window.



Bar	Bar size	Material	X (in)	Y (in)
1	10	Grade 60	20.865	0
2	10	Grade 60	18.06962	-10.4325
3	10	Grade 60	10.4325	-18.06962
4	10	Grade 60	0	-20.865
5	10	Grade 60	-10.4325	-18.06962
6	10	Grade 60	-18.06962	-10.4325
7	10	Grade 60	-20.865	0
8	10	Grade 60	-18.06962	10.4325
9	10	Grade 60	-10.4325	18.06962
10	10	Grade 60	0	20.865
11	10	Grade 60	10.4325	18.06962
12	10	Grade 60	18.06962	10.4325

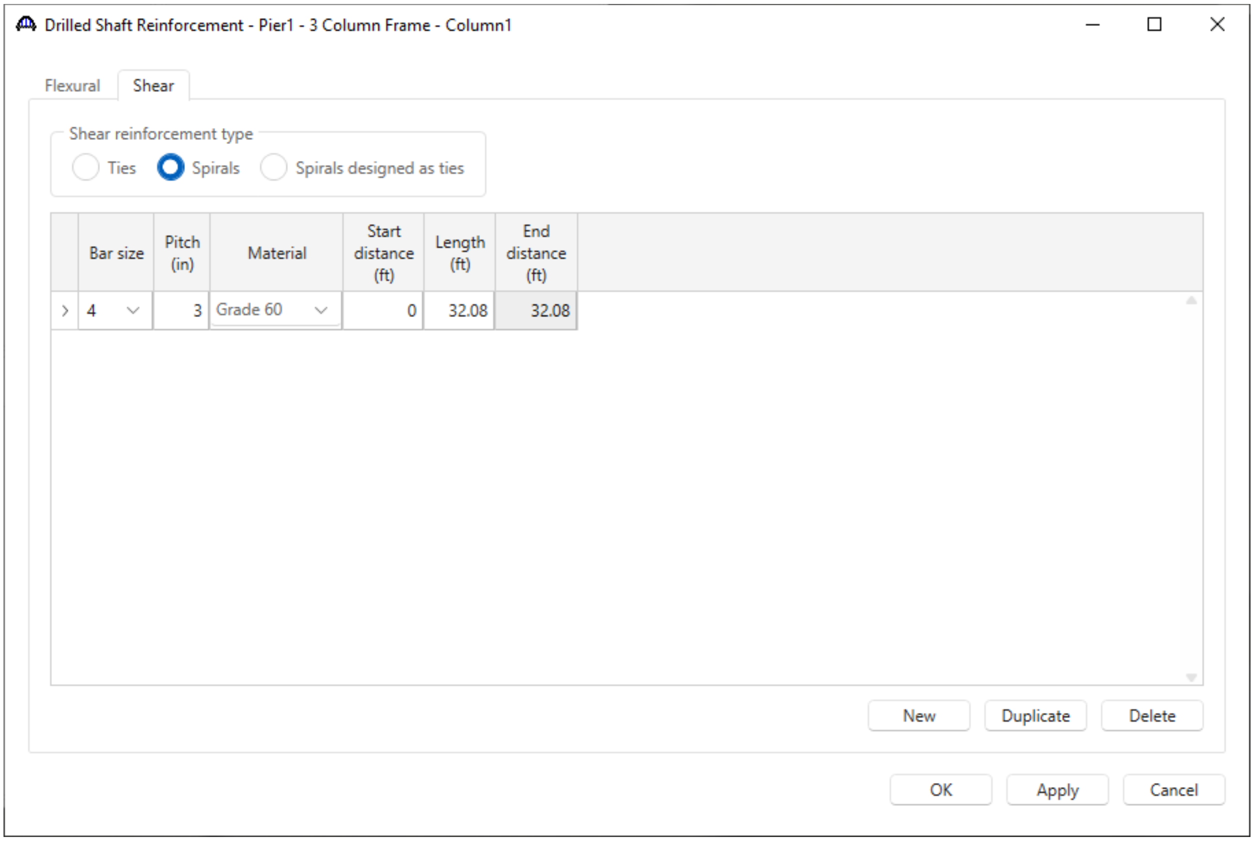
Reinforcement

Double click on the **Reinforcement** node in the **BWS** tree and assign the flexural reinforcement as shown below.



The first row describes the rebar in the drilled shaft. Mark these bars as **Developed at start** since it can be assumed that the actual length of the drilled shaft segment below the point of fixity at elevation 40.0ft provides enough length for these bars to be fully developed.

Navigate to the **Shear** tab of this window and enter the shear reinforcement in the drilled shaft as shown below.

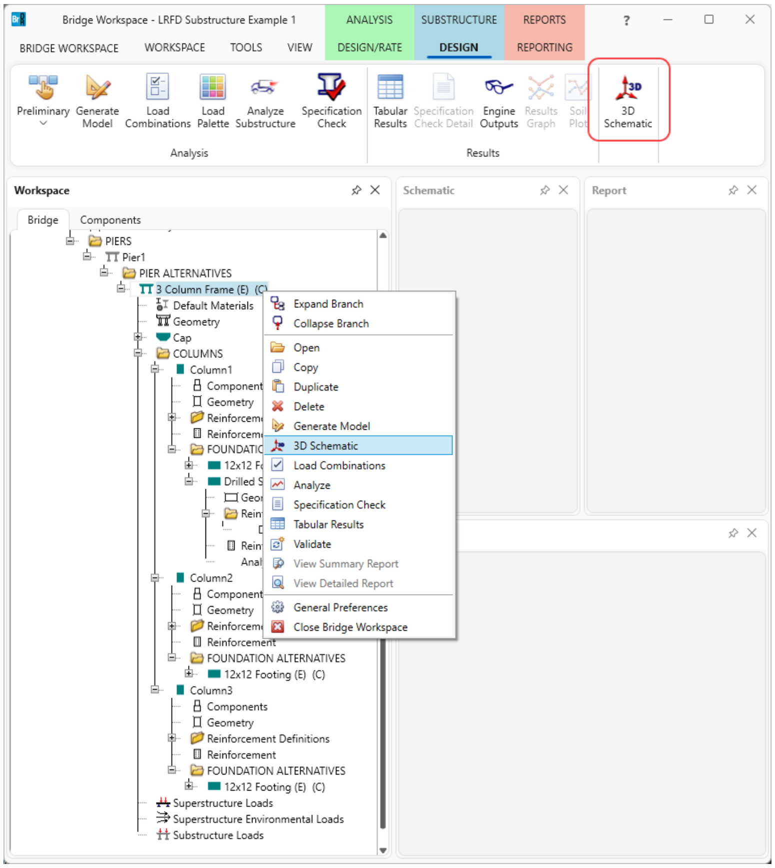


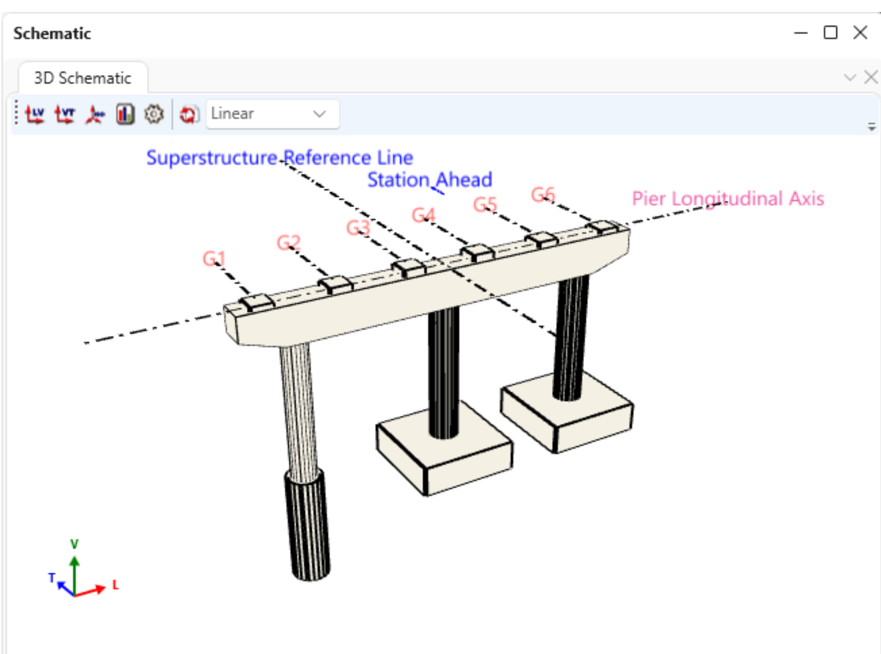
Click **OK** to apply the data and close the window.

The overlap of spirals at the column-drilled shaft connection is a detailing requirement that can be ignored in this BrDR description.

Schematic – Pier Alternative

While selecting the pier alternative **3 Column Frame,** click on the **Schematic** button from the **SUBSTRUCTURE DESIGN** ribbon (or right click and select **Schematic**) to view the schematic of this pier alternative as shown below.

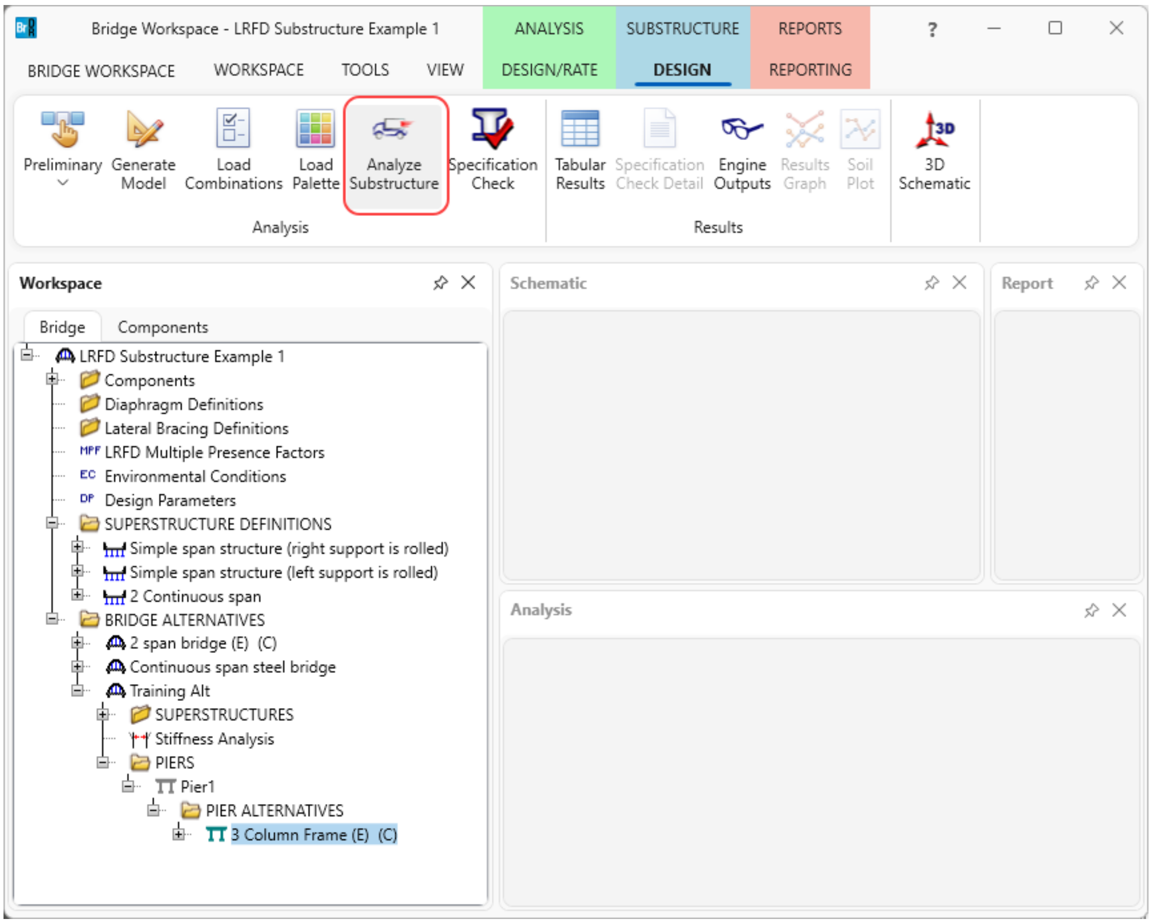




Specification Check

The pier needs to be analyzed first to perform a specification check. The program is configured to perform a specification check after revising geometry or reinforcement without the need to perform finite element analysis each time a change is made. This capability allows a quick refinement of the reinforcement and geometry. However, in this case a significant change has been made to pier by extending the length of Column1 to include a drilled shaft. If the specification check is performed without redoing the FE analysis, it will result in an error that the existing FE model does not match the pier structure.

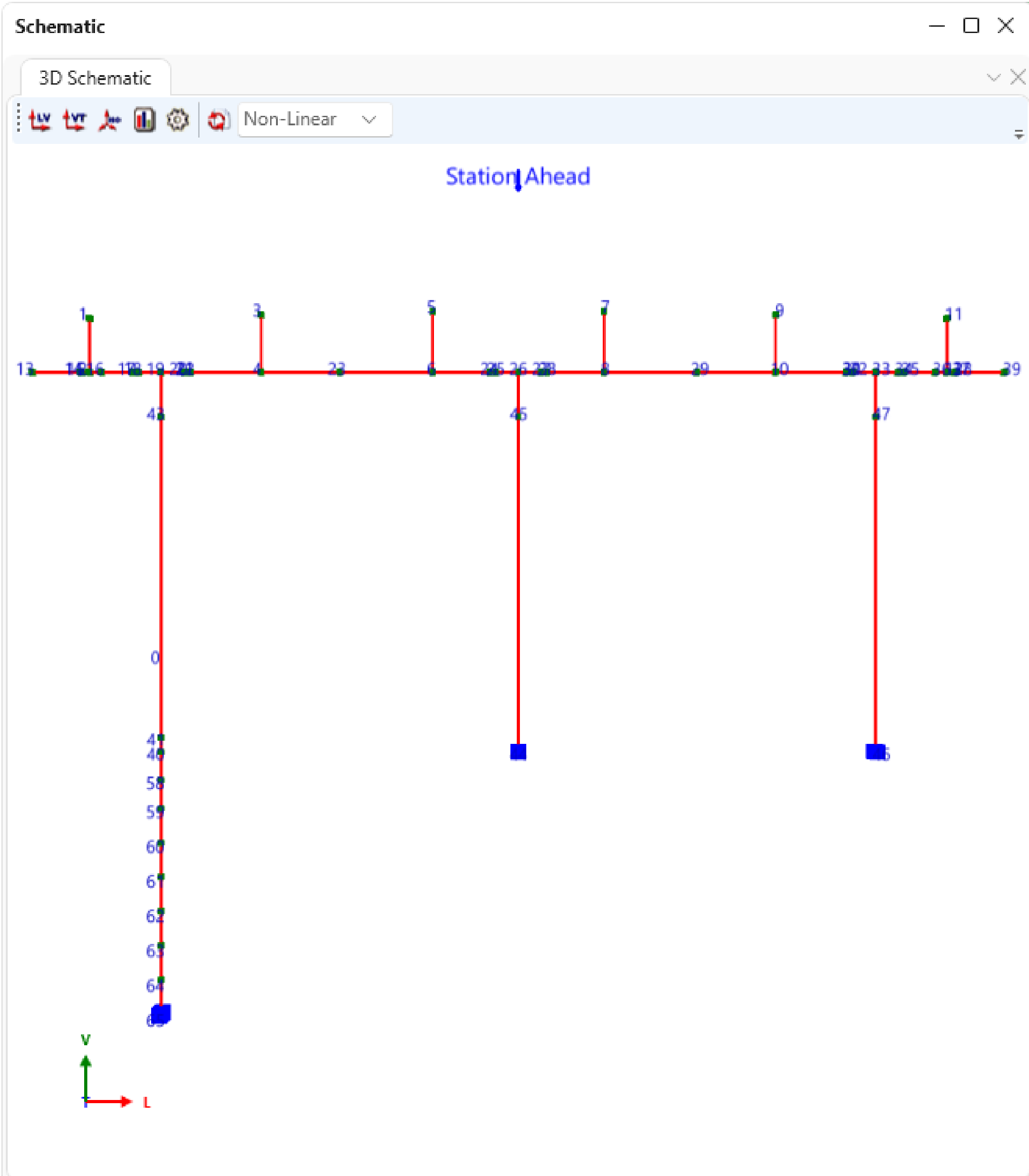
Therefore, in this case, the pier will be analyzed first. Select the **3 Column Frame** and click on the **Analyze Substructure** button from the **Analysis** group of the **SUBSTRUCTURE DESIGN** ribbon as shown below.



Pier3 – Modify Footing Example

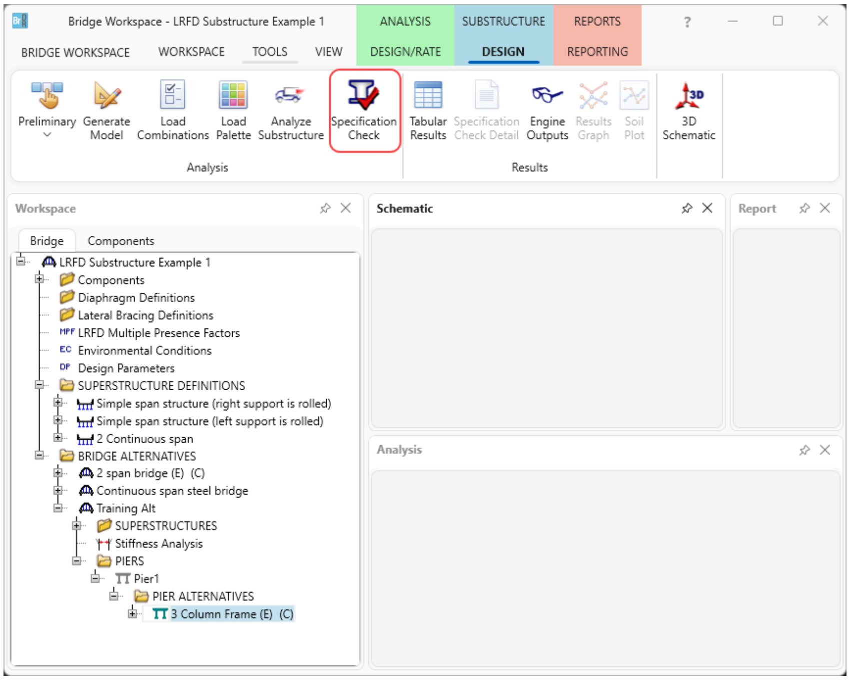
Schematic – Pier Alternative

The FE model generated by the program is shown below.

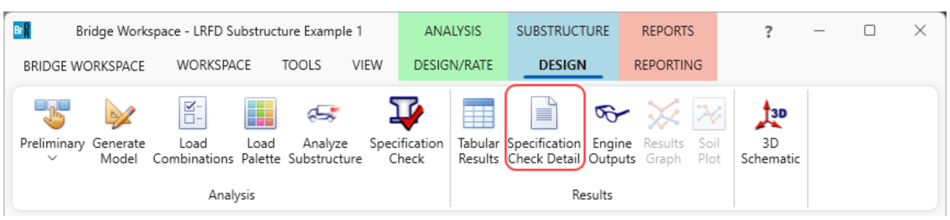


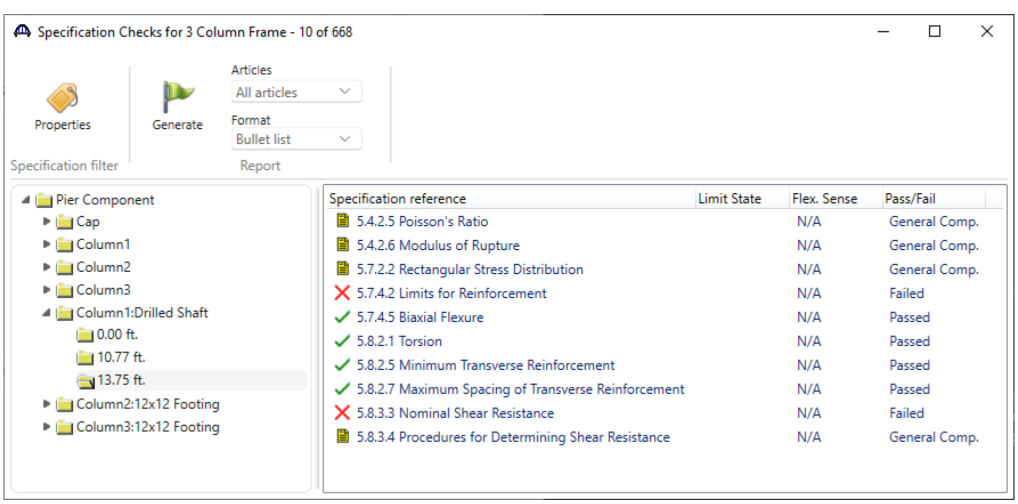
Specification Check

Select the **3 Column Frame** and click on the **Specification Check** button from the **Analysis** group of the **SUBSTRUCTURE DESIGN** ribbon as shown below.



To view the specification check results, click on the **Specification Check Detail** button from the **Results** group of the **SUBSTRUCTURE DESIGN** ribbon. The specification checks performed in the following locations in **Column 1** are shown below.





The 0.00 ft location is the base of the column in this example which is the point of fixity for the drilled shaft segment. The 13.75 ft location is the interface of the column and drilled shaft segment.

The specification check at the point of fixity is shown below.

Spec Check Detail for 5.7.4.5 Biaxial Flexure

5 Concrete Structures
5.7 Material Properties
5.7.4 Compression Members
5.7.4.4 Axial Resistance
5.7.4.5 Biaxial Flexure
(AASHTO LRFD Bridge Design Specifications, Fifth Edition - 2010, with 2010 interims)

Pier Drilled Shaft Section - At Location = 13.7500 (ft) - Bottom

Cross Section Properties for circular column

f'c = 4.00(ksi)
Diameter = 48.00(in)
Area = 1809.19(in^2)
Axial Phi = 0.75
Flexural Phi = 0.90

Flexural Reinforcement

Rebar	As (in^2)	X (in)	Y (in)	Rebar	As (in^2)	X (in)	Y (in)	Rebar	As (in^2)	X (in)	Y (in)

Steel Casing Modeled as Flexural Reinforcement

Rebar	As (in^2)	X (in)	Y (in)	Rebar	As (in^2)	X (in)	Y (in)	Rebar	As (in^2)	X (in)	Y (in)

Limit State	Load Combination	Pu kip	Mux kip-ft	Muy kip-ft	Mur kip-ft	Alpha Deg	Phi	Phi * Pn kip	Phi * Mnr kip-ft	Mnr/Mur	de in	dv in	h in
STR-I	37	1026.09	-40.54	-5.34	40.89	187.50	0.75	1026.16	1389.84	33.99	24.00	34.56	48.00
STR-I	38	1032.88	-40.89	-5.25	41.23	187.32	0.75	1032.82	1395.85	33.86	24.00	34.56	48.00
STR-I	38	1032.88	-40.89	-5.25	41.23	187.32	0.75	1032.82	1395.85	33.86	24.00	34.56	48.00
STR-I	37	1026.09	-40.54	-5.34	40.89	187.50	0.75	1026.16	1389.84	33.99	24.00	34.56	48.00
STR-I	86	600.71	5.44	-4.63	7.15	319.61	0.75	600.72	933.69	99.00	24.00	34.56	48.00
STR-I	30	747.38	5.44	-4.69	7.18	319.27	0.75	747.41	1107.61	99.00	24.00	34.56	48.00
STR-I	93	878.81	5.44	2.03	5.81	20.46	0.75	878.73	1248.22	99.00	24.00	34.56	48.00
STR-I	5	550.06	5.44	-0.99	5.53	349.72	0.75	550.09	869.37	99.00	24.00	34.56	48.00
STR-I	61	403.39	5.44	-0.93	5.52	350.29	0.75	403.38	669.83	99.00	24.00	34.56	48.00
STR-I	109	663.08	-50.76	1.77	50.79	178.01	0.75	663.10	1009.88	19.88	24.00	34.56	48.00
STR-I	53	809.70	-64.63	2.29	64.67	177.97	0.75	809.70	1176.04	18.19	24.00	34.56	48.00
STR-I	110	669.87	-51.39	1.82	51.43	177.98	0.75	669.83	1017.90	19.79	24.00	34.56	48.00
STR-I	54	816.49	-65.31	2.38	65.35	177.91	0.75	816.46	1183.28	18.11	24.00	34.56	48.00
STR-I	110	669.87	-51.39	1.82	51.43	177.98	0.75	669.83	1017.90	19.79	24.00	34.56	48.00
STR-I	98	769.02	-47.42	5.31	47.71	173.61	0.75	768.98	1131.66	23.72	24.00	34.56	48.00
STR-I	42	915.59	-58.84	6.61	59.21	173.59	0.75	915.62	1285.24	21.71	24.00	34.56	48.00
STR-I	100	765.62	-47.16	5.25	47.45	173.64	0.75	765.59	1127.90	23.77	24.00	34.56	48.00
STR-I	44	912.20	-58.56	6.53	58.93	173.63	0.75	912.19	1281.84	21.75	24.00	34.56	48.00
STR-I	100	765.62	-47.16	5.25	47.45	173.64	0.75	765.59	1127.90	23.77	24.00	34.56	48.00
STR-I	86	600.71	5.44	-4.63	7.15	319.61	0.75	600.72	933.69	99.00	24.00	34.56	48.00
STR-I	40	1029.48	-40.72	-5.30	41.06	187.41	0.75	1029.49	1392.84	33.92	24.00	34.56	48.00
STR-I	86	600.71	5.44	-4.63	7.15	319.61	0.75	600.72	933.69	99.00	24.00	34.56	48.00
STR-I	37	1026.09	-40.54	-5.34	40.89	187.50	0.75	1026.16	1389.84	33.99	24.00	34.56	48.00
STR-I	86	600.71	5.44	-4.63	7.15	319.61	0.75	600.72	933.69	99.00	24.00	34.56	48.00
STR-I	30	747.38	5.44	-4.69	7.18	319.27	0.75	747.41	1107.61	99.00	24.00	34.56	48.00
STR-I	93	878.81	5.44	2.03	5.81	20.46	0.75	878.73	1248.22	99.00	24.00	34.56	48.00
STR-I	93	878.81	5.44	2.03	5.81	20.46	0.75	878.73	1248.22	99.00	24.00	34.56	48.00
STR-I	54	816.49	-65.31	2.38	65.35	177.91	0.75	816.46	1183.28	18.11	24.00	34.56	48.00

All 28 load cases evaluated passed (Capacity ratio >= 1.0)

OK