

Part D2:

Concrete Design Example

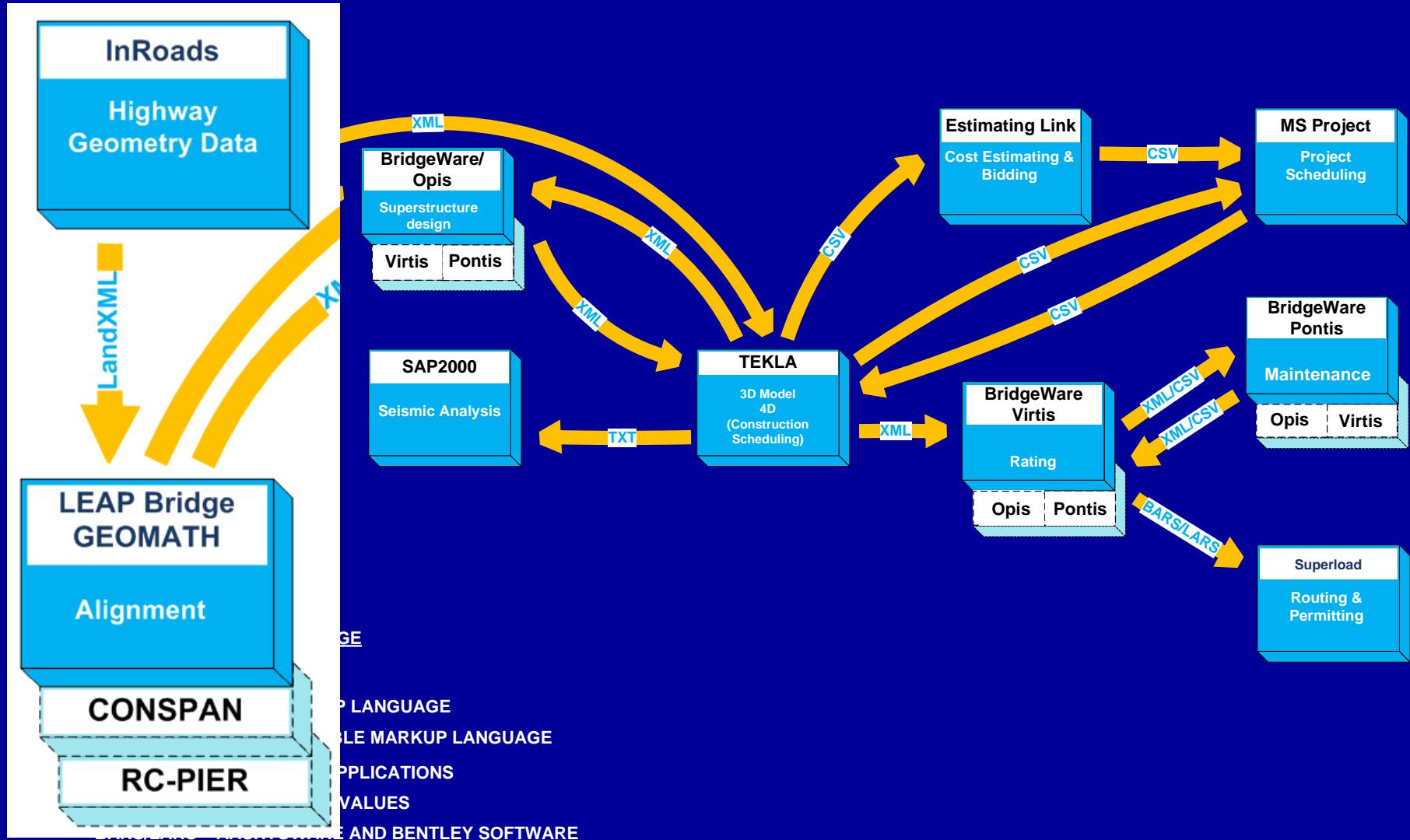


Overview (D2-Concrete Design)

- Hwy geometry compliant concrete bridge design
 - Superstructure
 - Substructure
- Modifying Alignments
- To/From 3D Modeling Env't using XML
- Extracting Drawings from Models
- Linking Substructure/Seismic Analysis

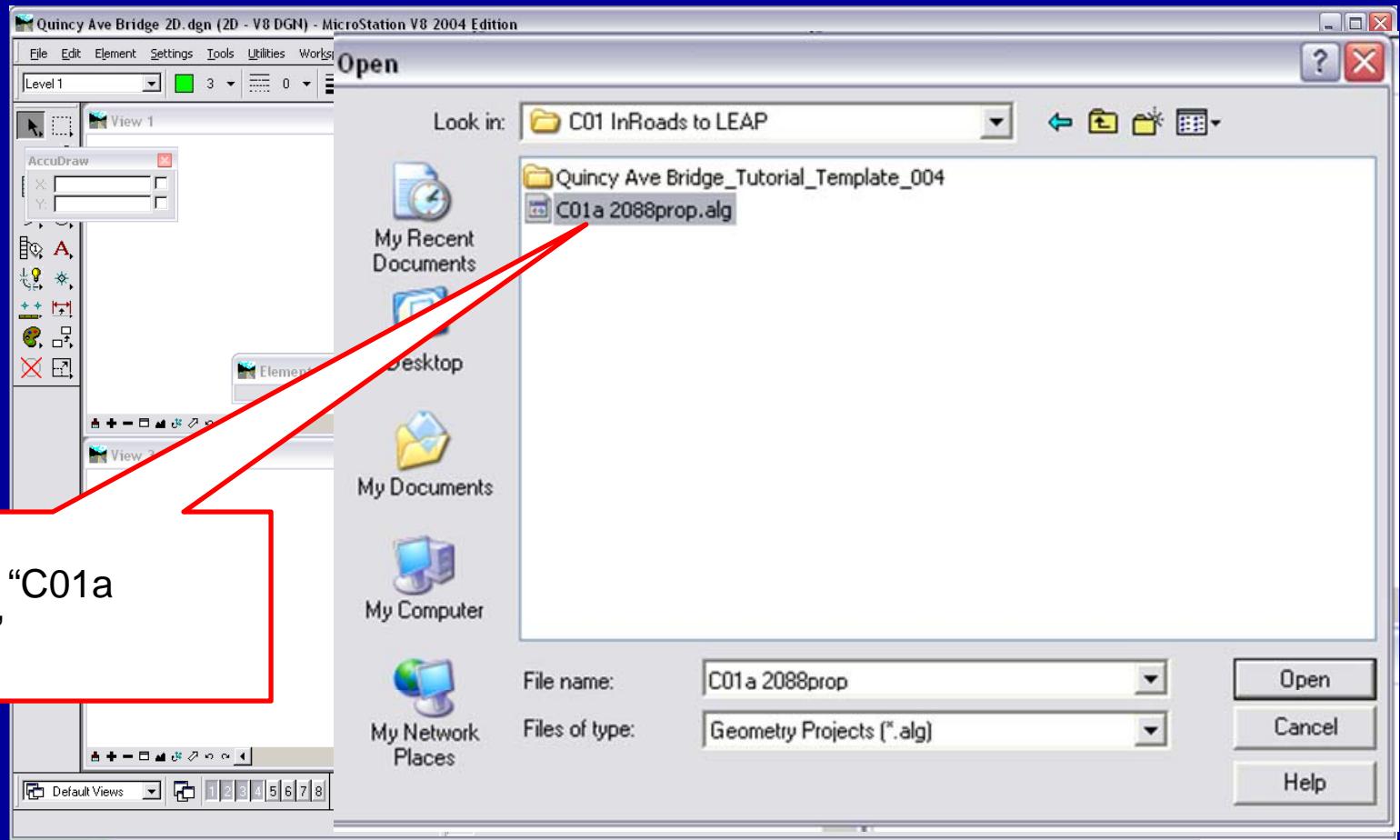


C01 InRoads to LEAP



C01 InRoads to LEAP

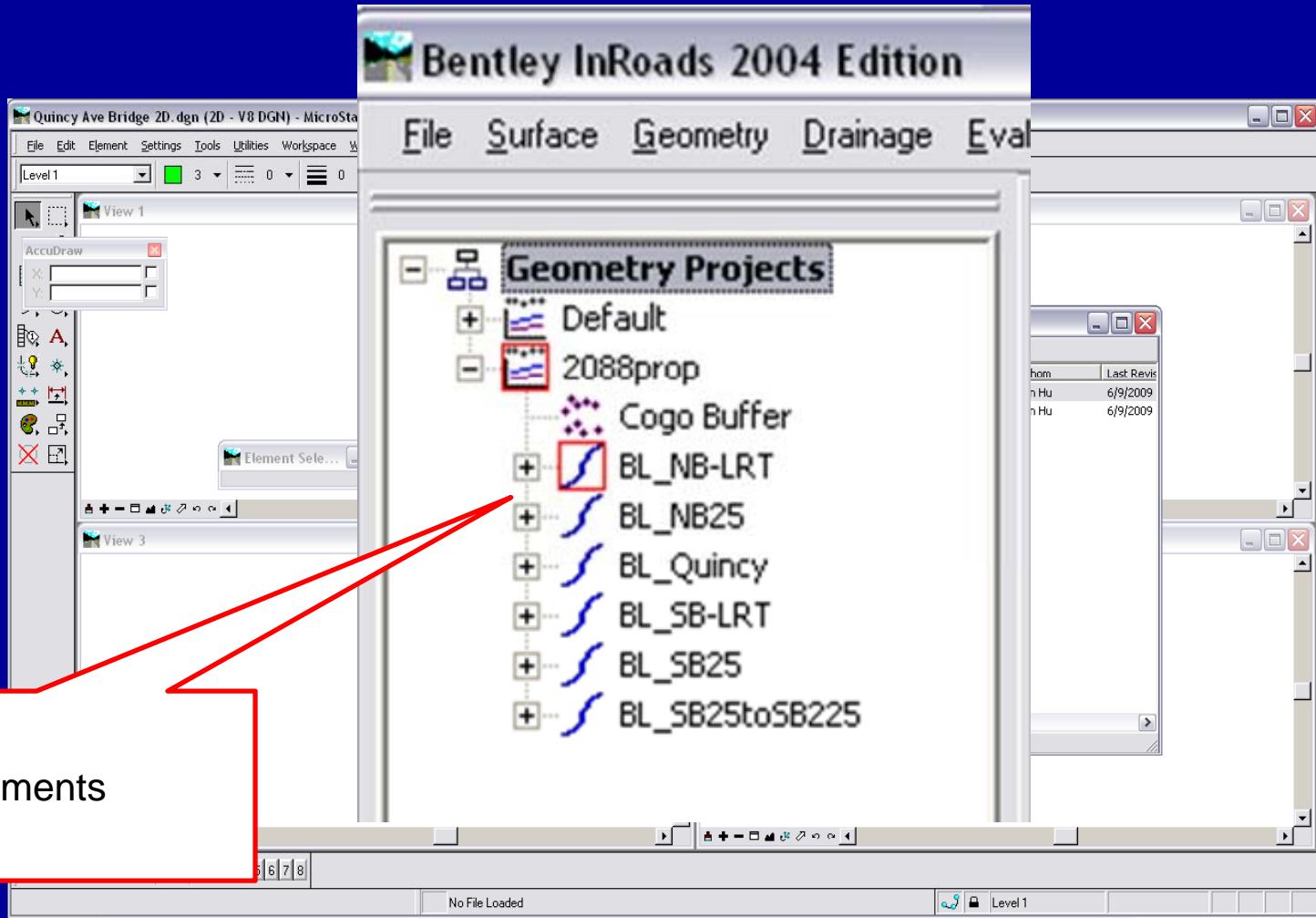
Load alg
file



C01 InRoads to LEAP

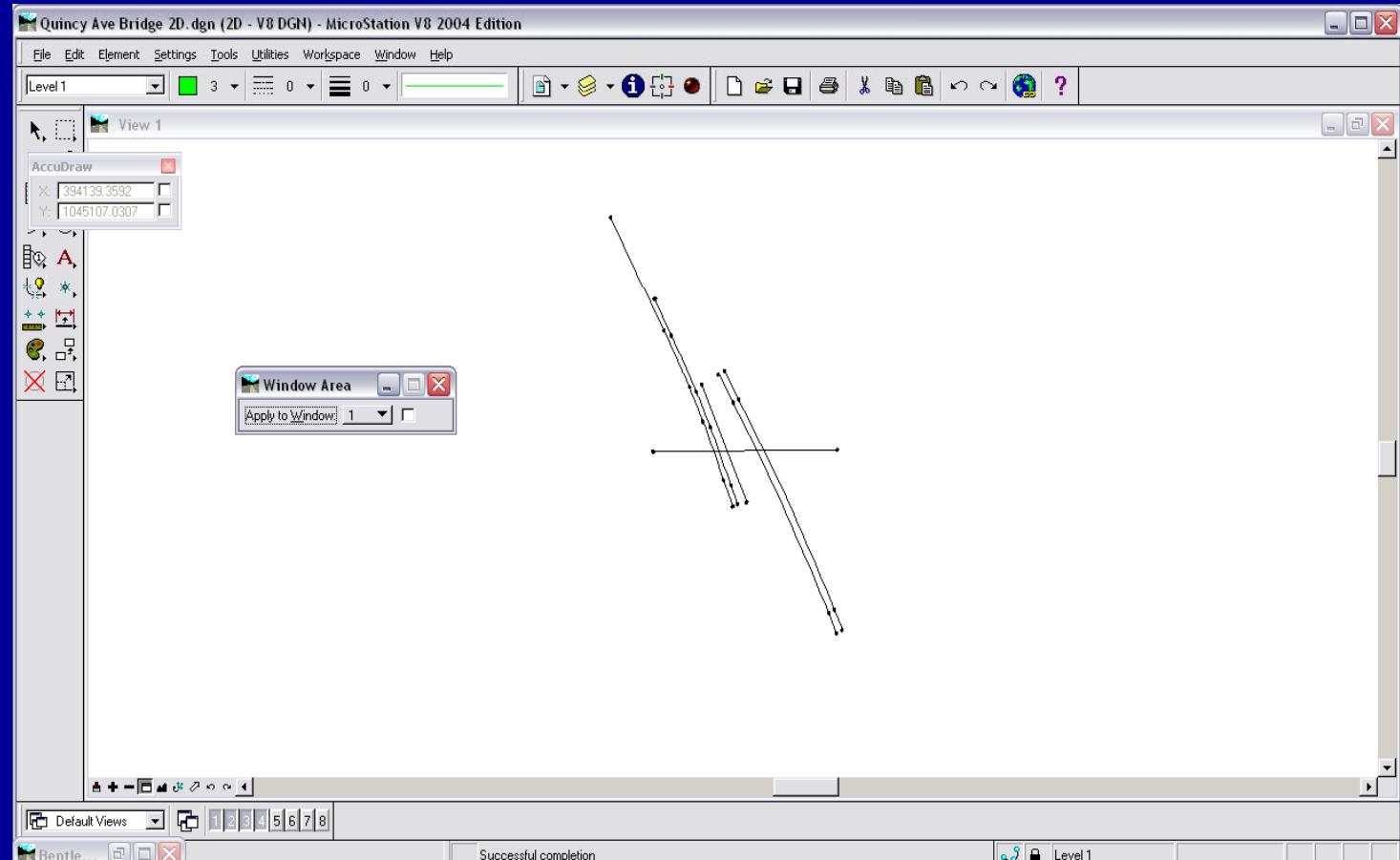
Alignments contained in alg file:
6 pairs of horizontal and vertical alignments

6 pairs of alignments



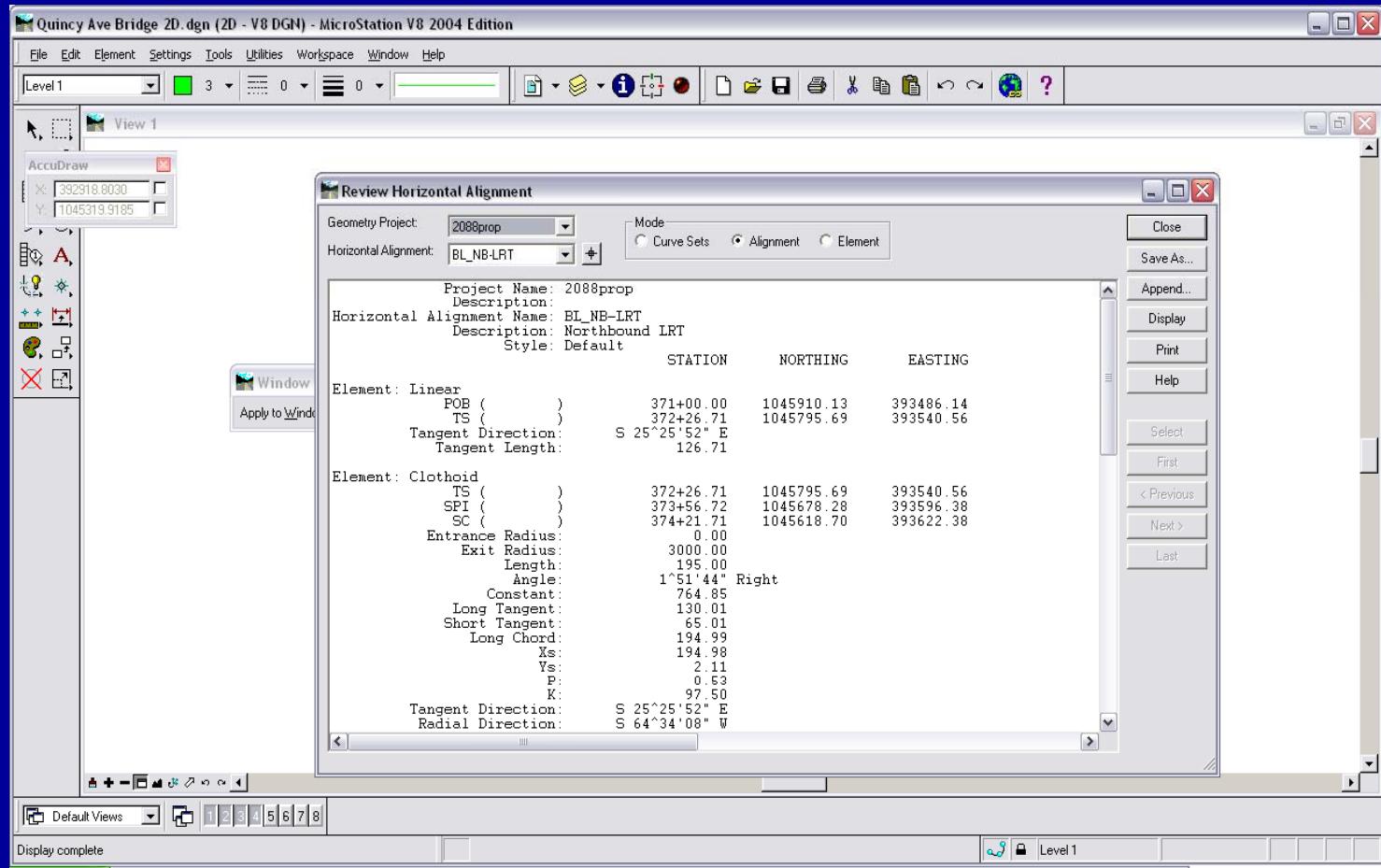
C01 InRoads to LEAP

Plan view
of
horizontal
alignments



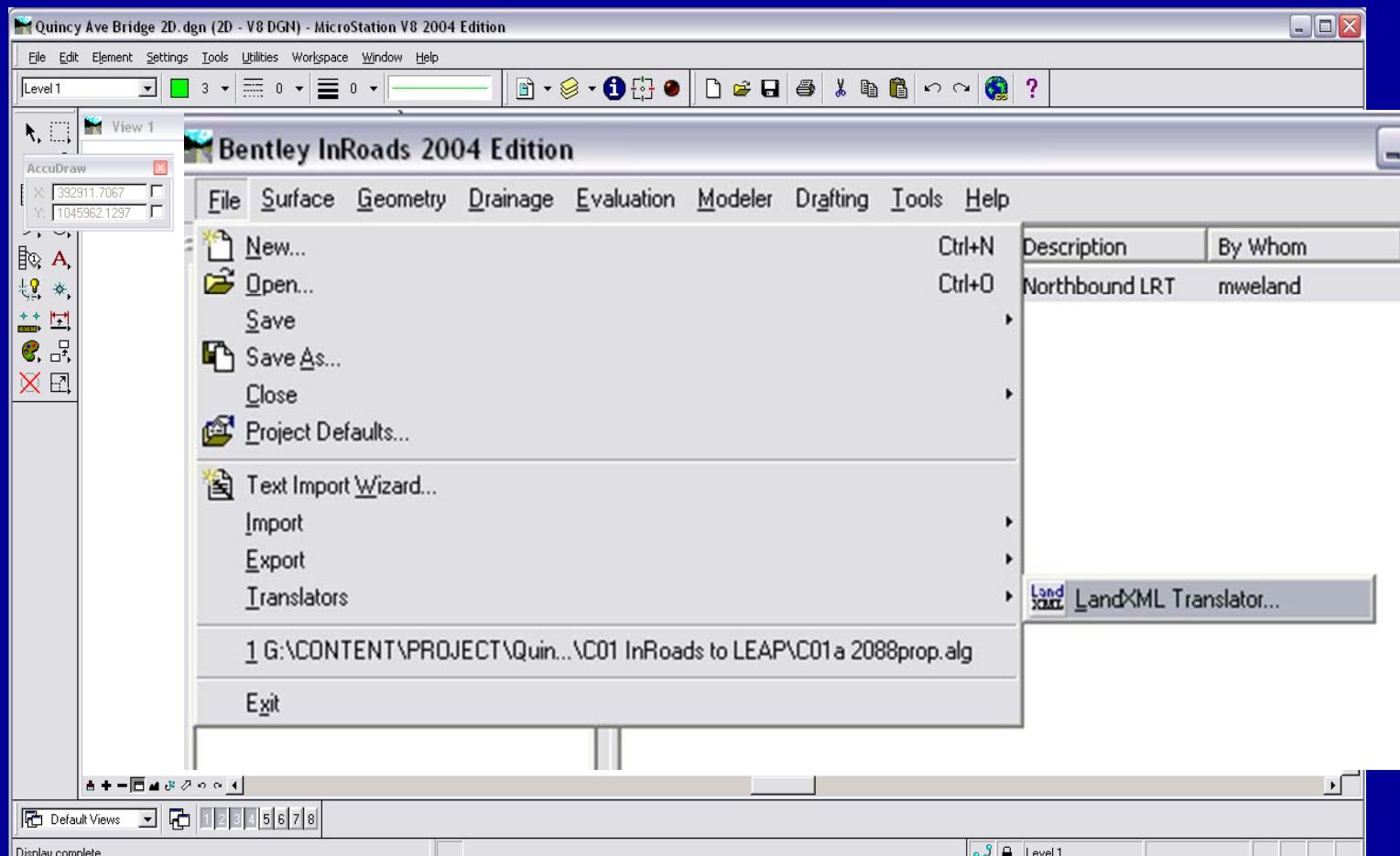
C01 InRoads to LEAP

Selected
Details of
horizontal
and
vertical
alignments



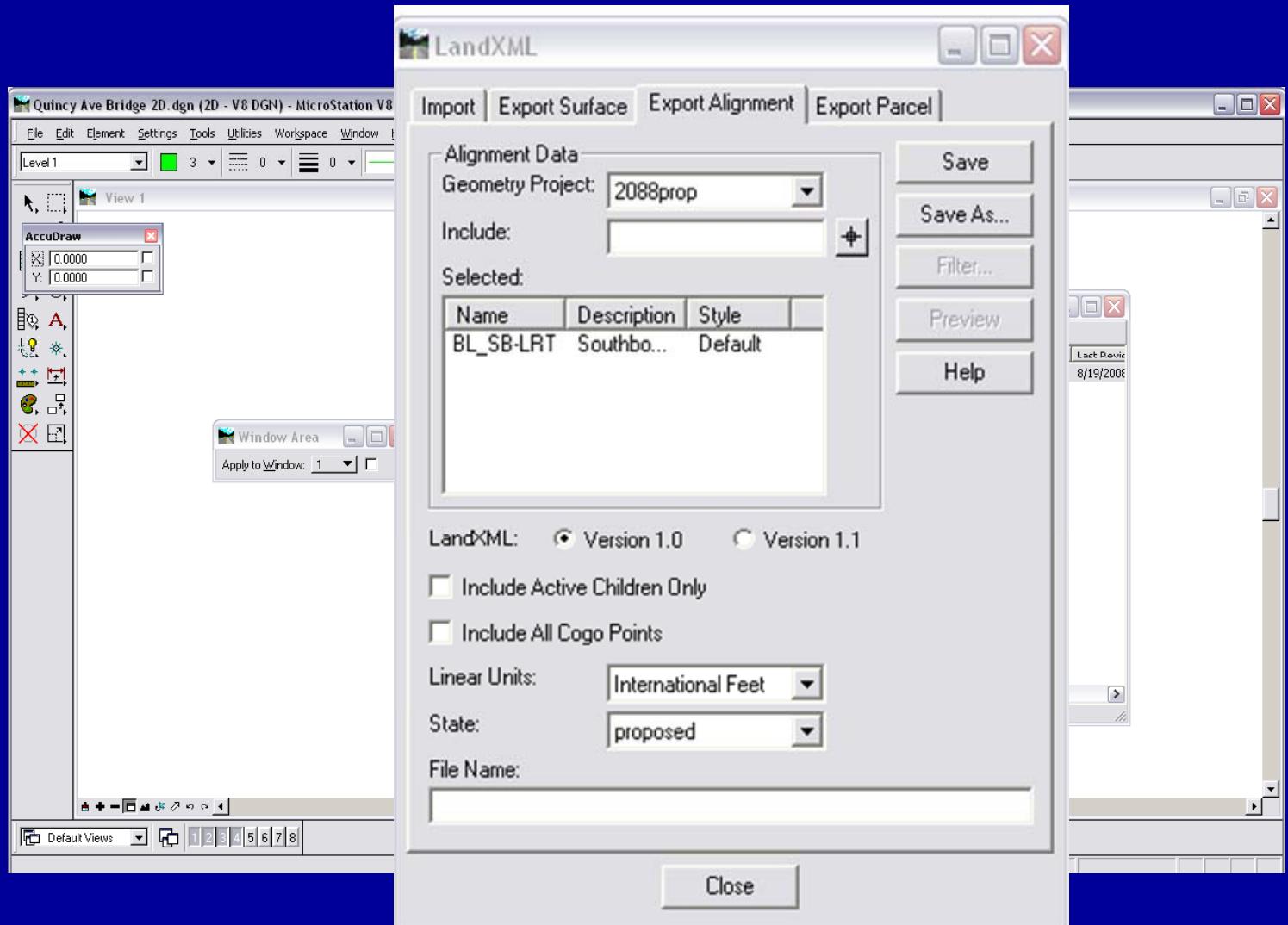
C01 InRoads to LEAP

Export
LandXML
file



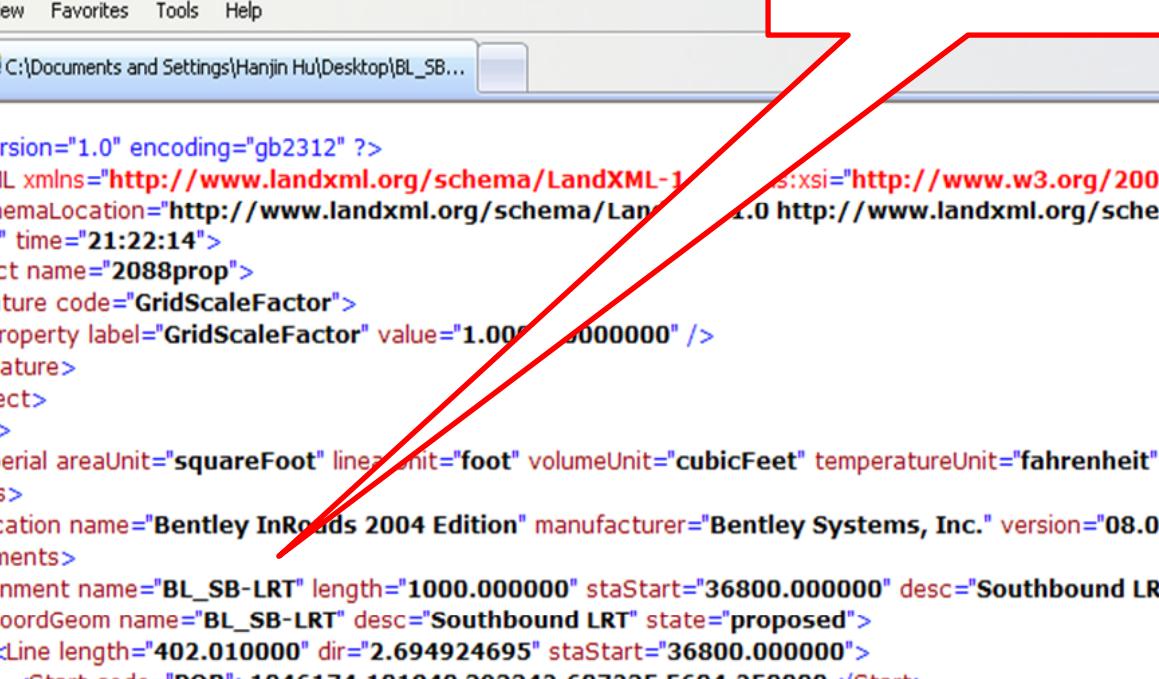
C01 InRoads to LEAP

Choose
one
alignment
to export



C01 InRoads to LEAP

Sample LandXML file



C:\Documents and Settings\Hanjin Hu\Desktop\BL_SB-LRT.xml - Windows Internet Explorer

C:\Documents and Settings\Hanjin Hu\Desktop\BL_SB-LRT.xml

File Edit View Favorites Tools Help

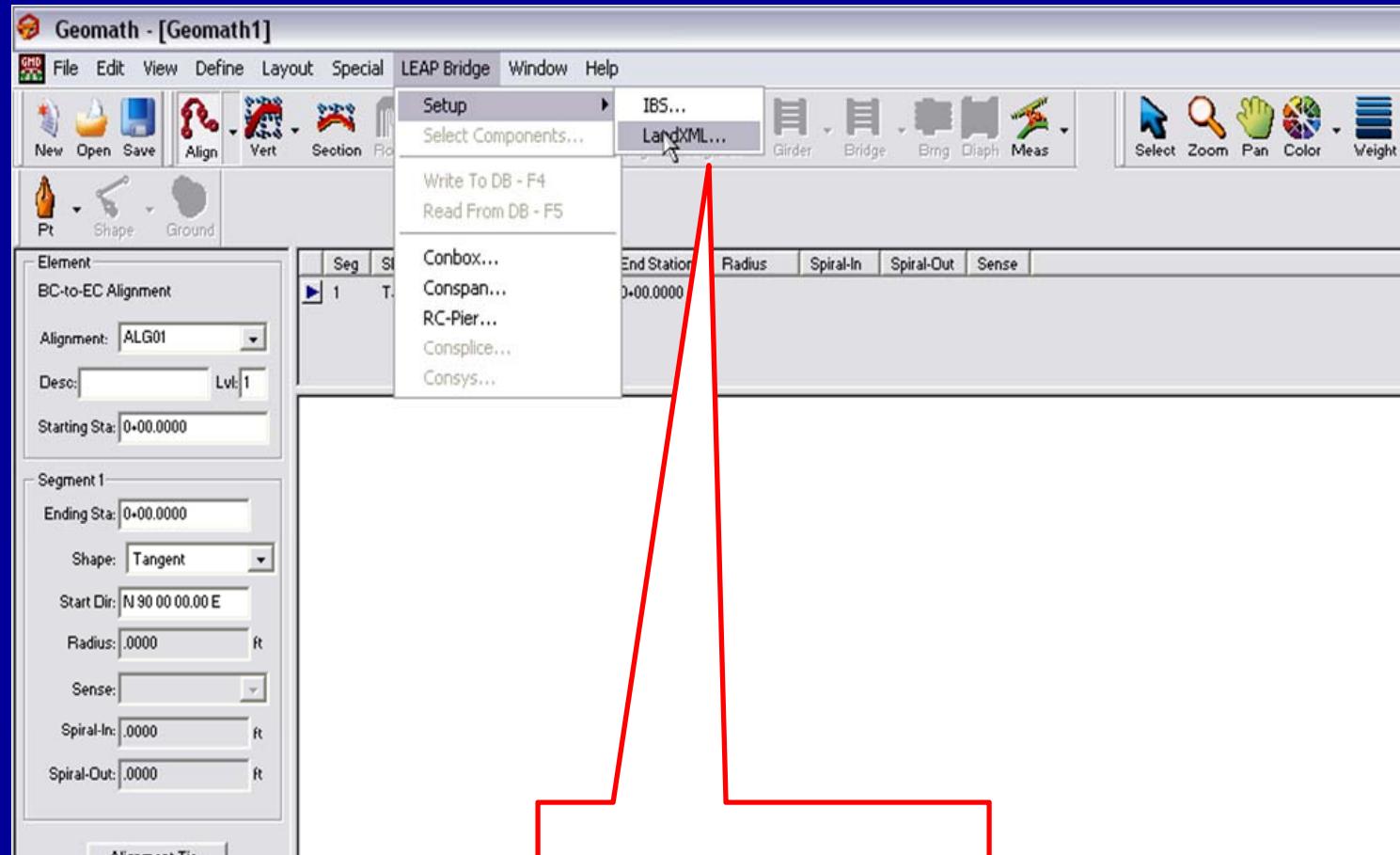
C:\Documents and Settings\Hanjin Hu\Desktop\BL_SB...

```
<?xml version="1.0" encoding="gb2312" ?>
- <LandXML xmlns="http://www.landxml.org/schema/LandXML-1.0" xsi:schemaLocation="http://www.landxml.org/schema/LandXML-1.0 http://www.landxml.org/schema/landx... 03-01" time="21:22:14">
- <Project name="2088prop">
- <Feature code="GridScaleFactor">
<Property label="GridScaleFactor" value="1.000000000000000" />
</Feature>
</Project>
- <Units>
<Imperial areaUnit="squareFoot" linealUnit="foot" volumeUnit="cubicFeet" temperatureUnit="fahrenheit" pressureUnit="psi" />
</Units>
<Application name="Bentley InRoads 2004 Edition" manufacturer="Bentley Systems, Inc." version="08.08.00.46" />
- <Alignments>
- <Alignment name="BL_SB-LRT" length="1000.000000" staStart="36800.000000" desc="Southbound LRT" state="proposed">
- <CoordGeom name="BL_SB-LRT" desc="Southbound LRT" state="proposed">
- <Line length="402.010000" dir="2.694924695" staStart="36800.000000">
<Start code="POB">1046174.101840 393342.607235 5604.250000</Start>
<End code="TS">1045811.532469 393516.260599 5608.273339</End>
- <Feature code="Line">
<Property label="style" value="Default" />
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C01 InRoads to LEAP

In LEAP
Geomath:
Import
LandXML
file

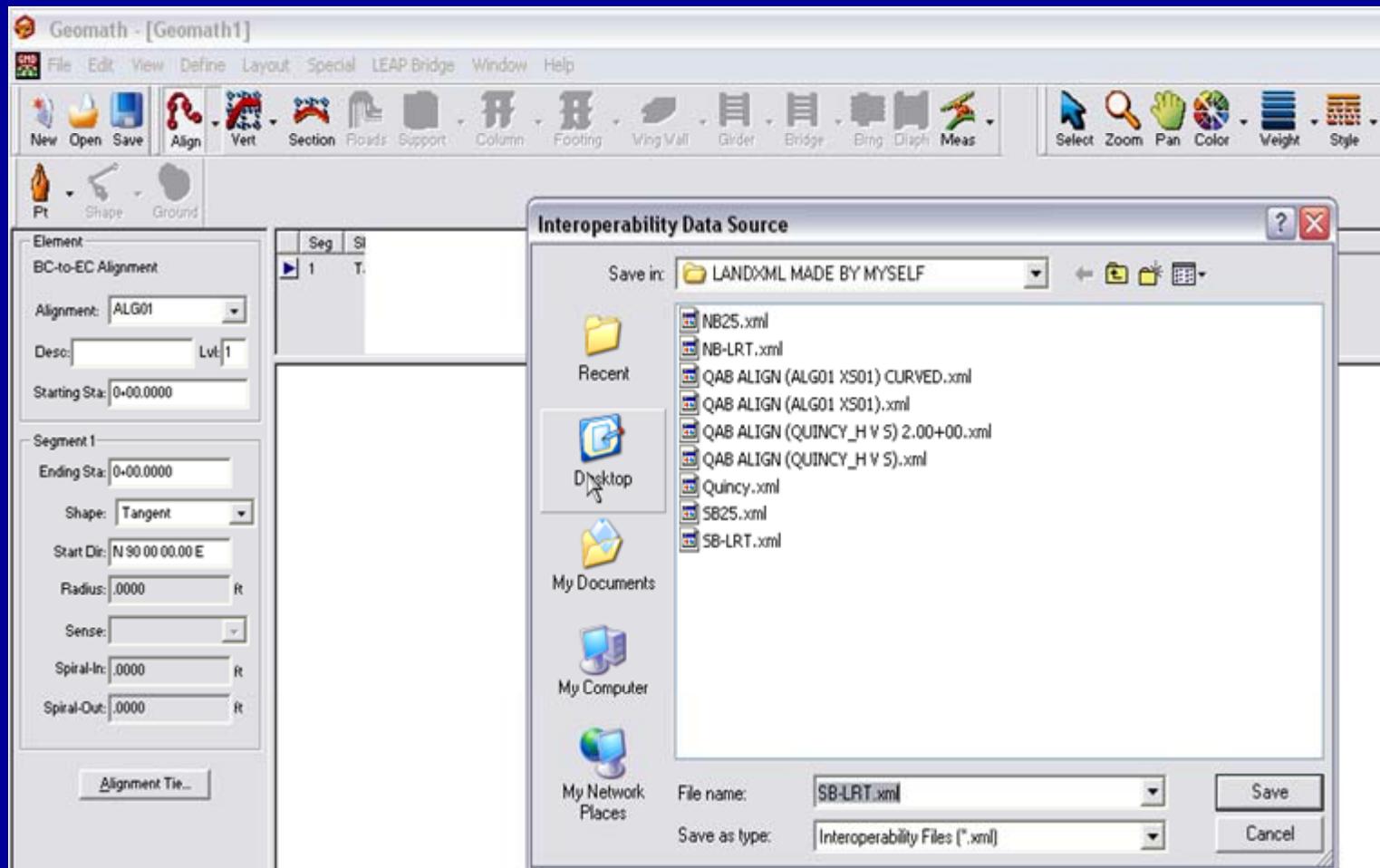


Setup the connection
to LandXML file



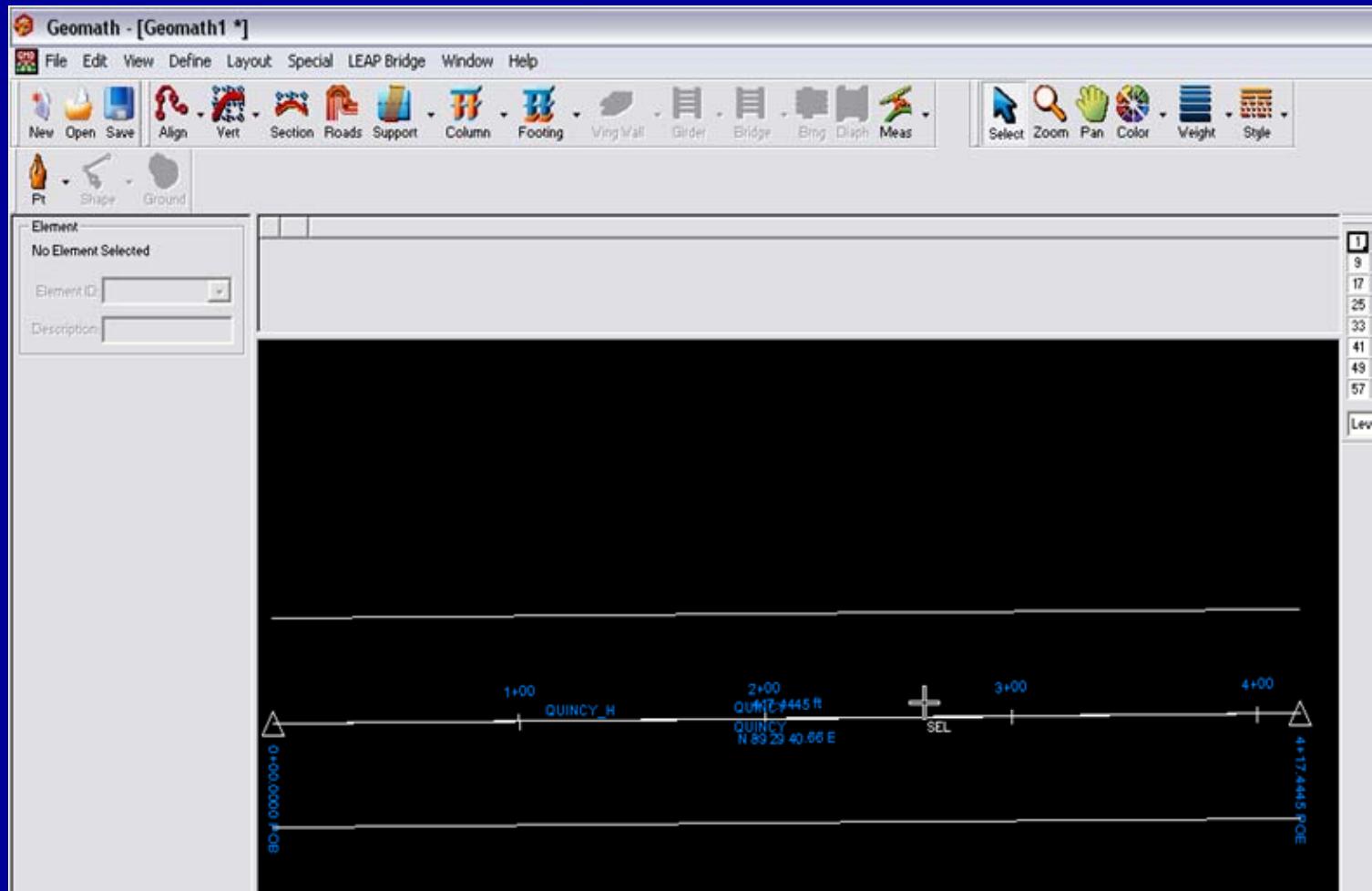
C01 InRoads to LEAP

Choose
the
LandXML
file
exported
from
InRoads



C01 InRoads to LEAP

In LEAP
Geomath:
Quincy
Avenue
Bridge
alignment

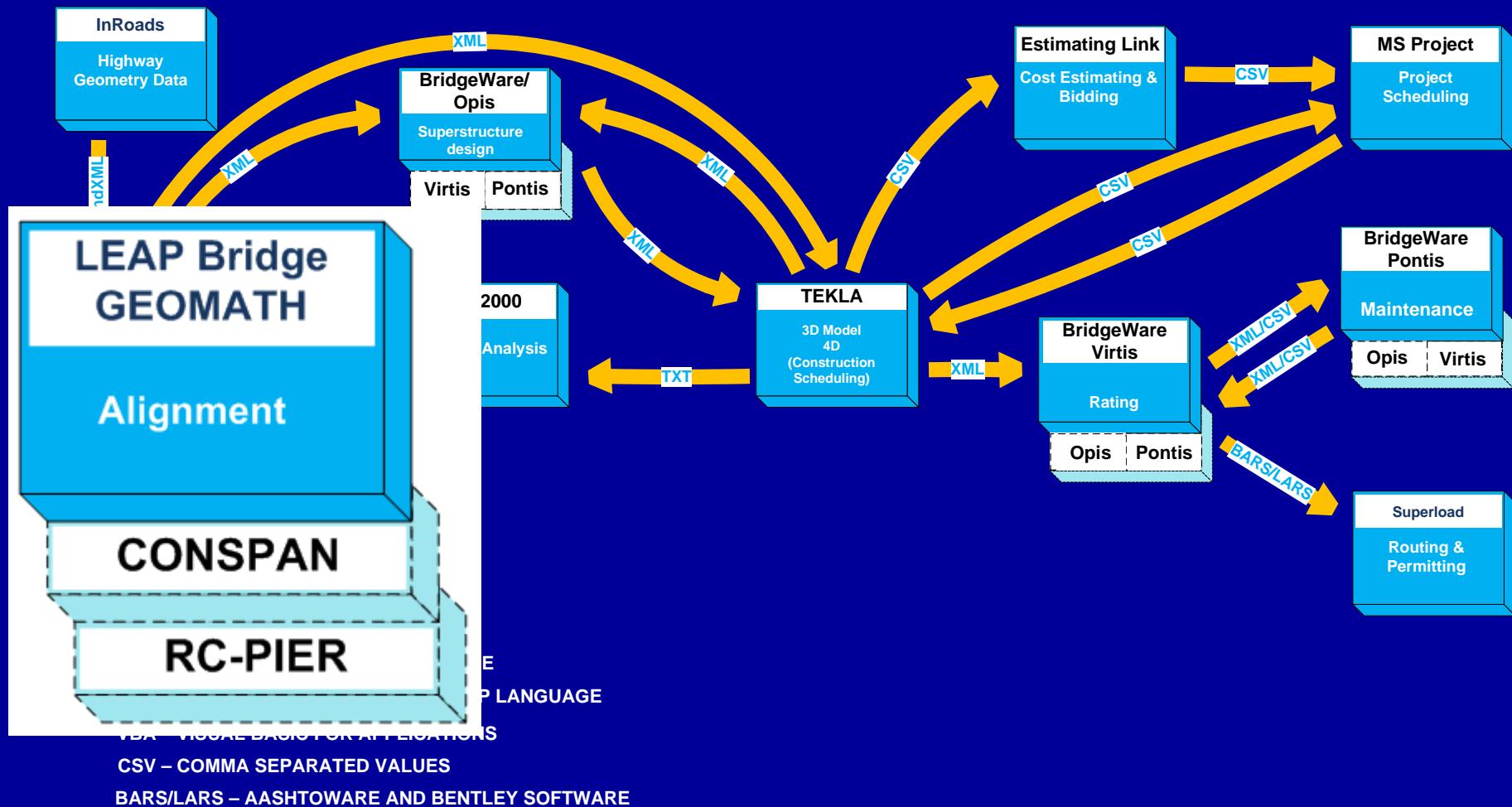


Defining Superstructure in ConSpan



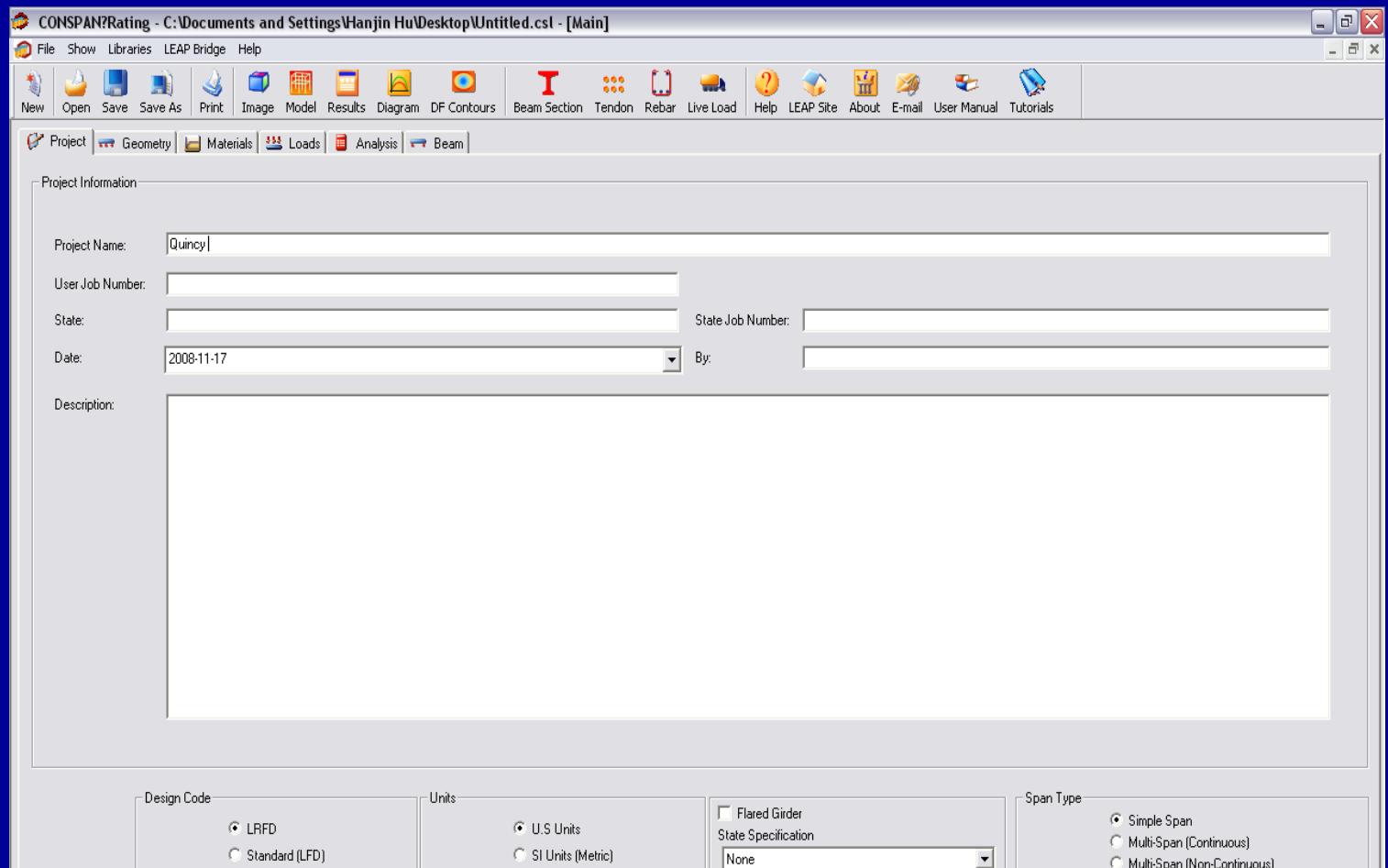
C01b Defining Superstructure in Conspan

Concrete Alternate



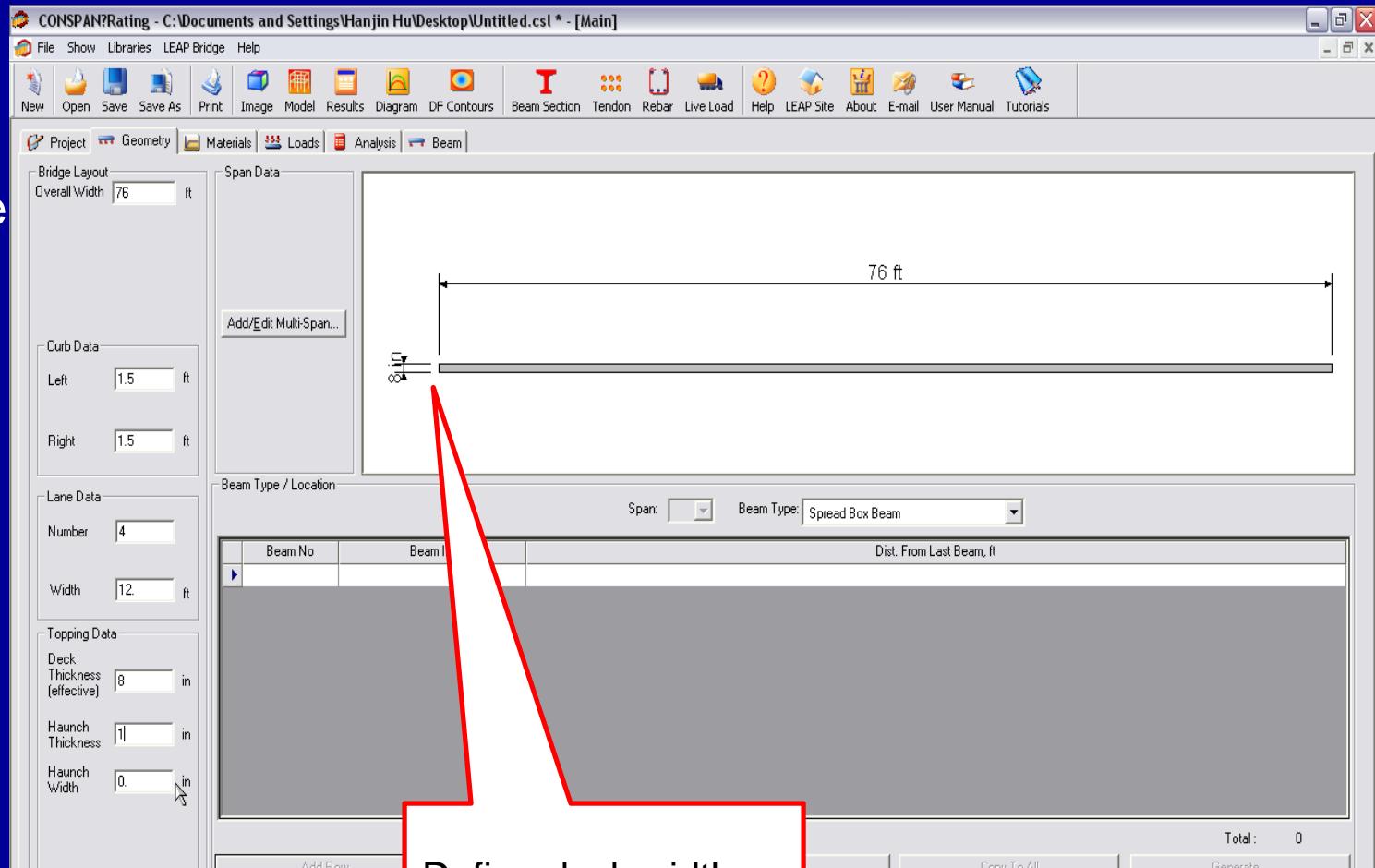
C01b Defining Superstructure in Conspan

Define project information:
Project name,
state, etc.



C01b Defining Superstructure in Conspan

Define overall width, lane data, deck thickness, etc.

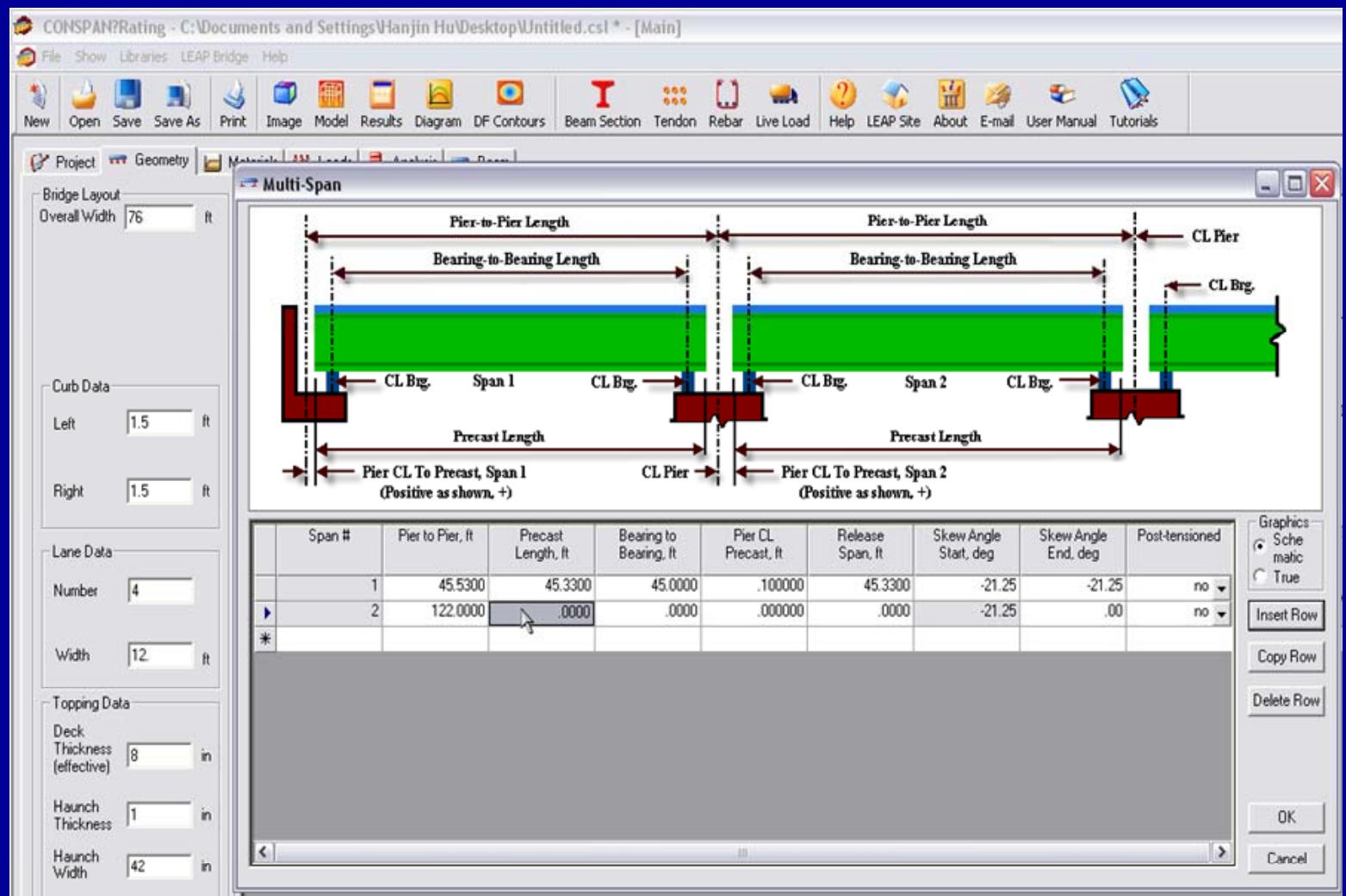


Define deck width
and thickness



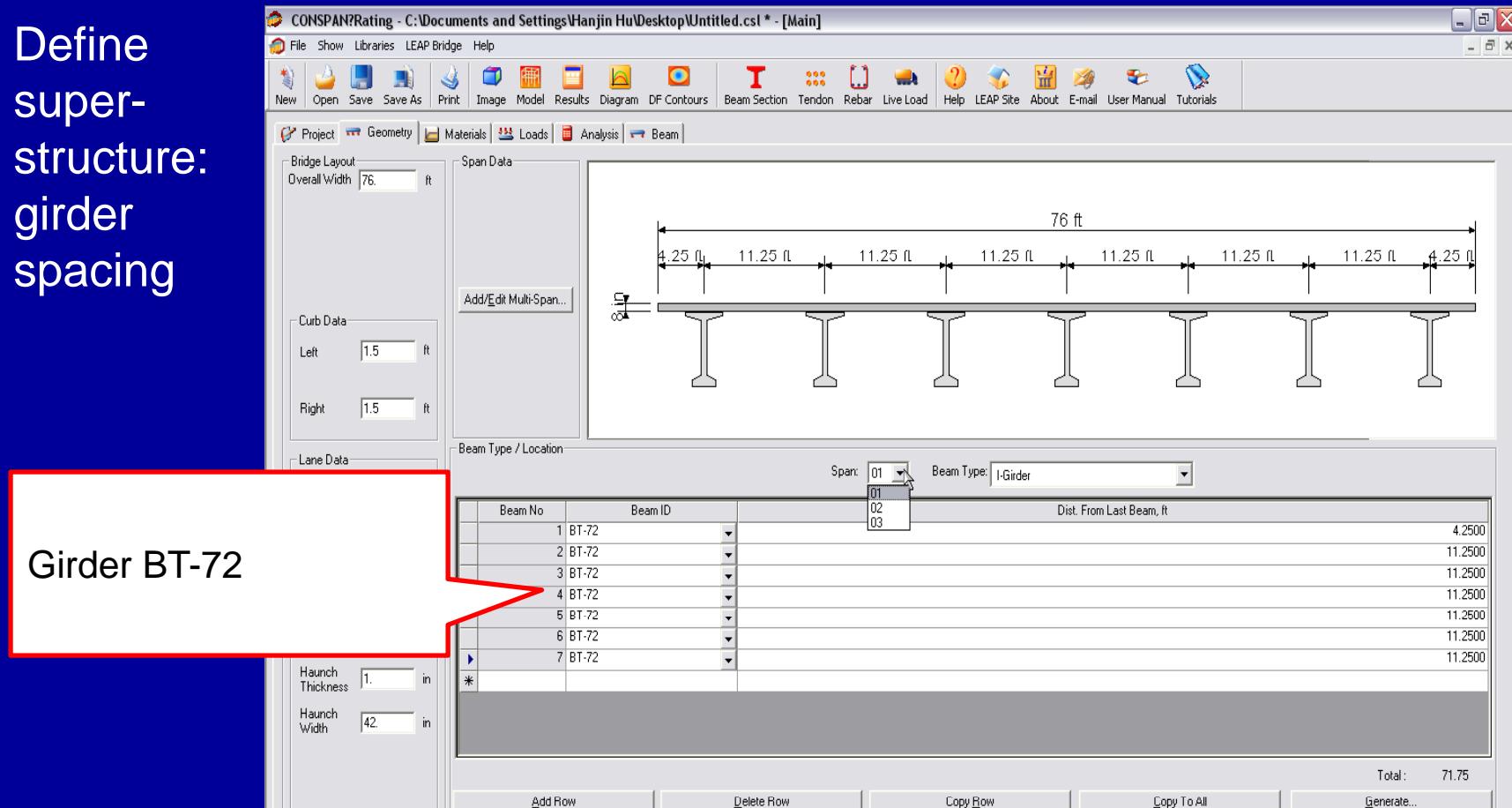
C01b Defining Superstructure in Conspan

Define
span
length



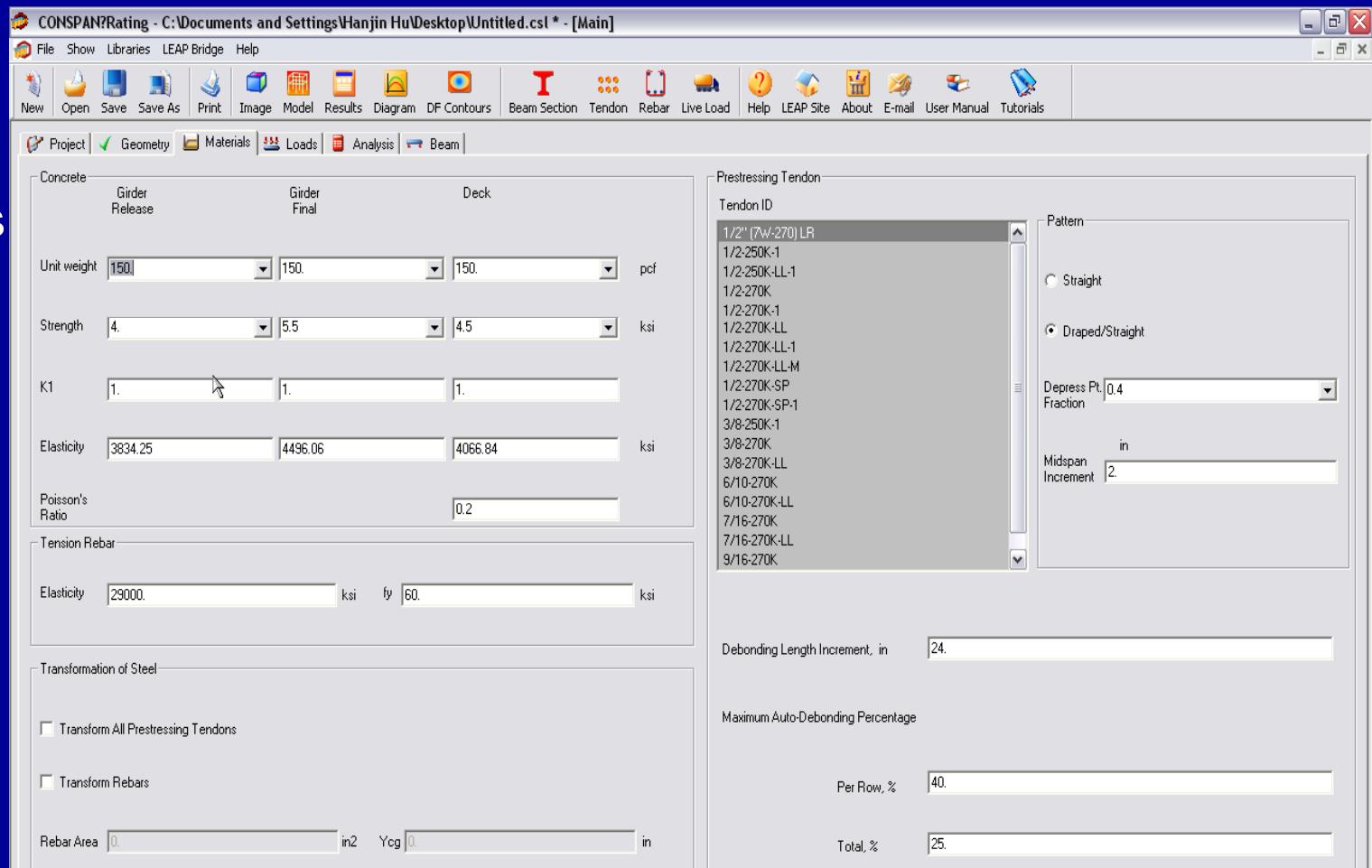
C01b Defining Superstructure in Conspan

Define
super-
structure:
girder
spacing



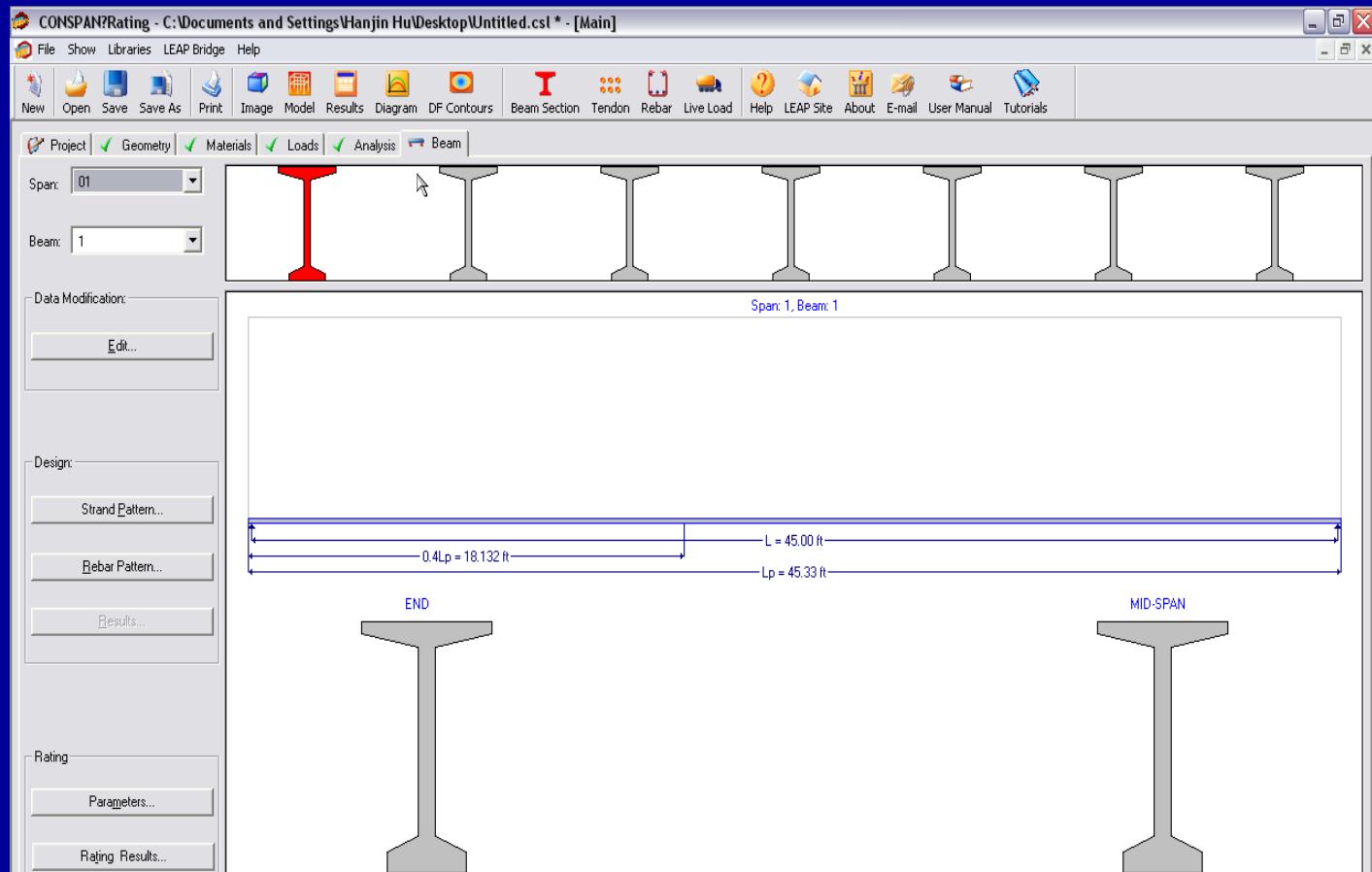
C01b Defining Superstructure in Conspan

Define material properties



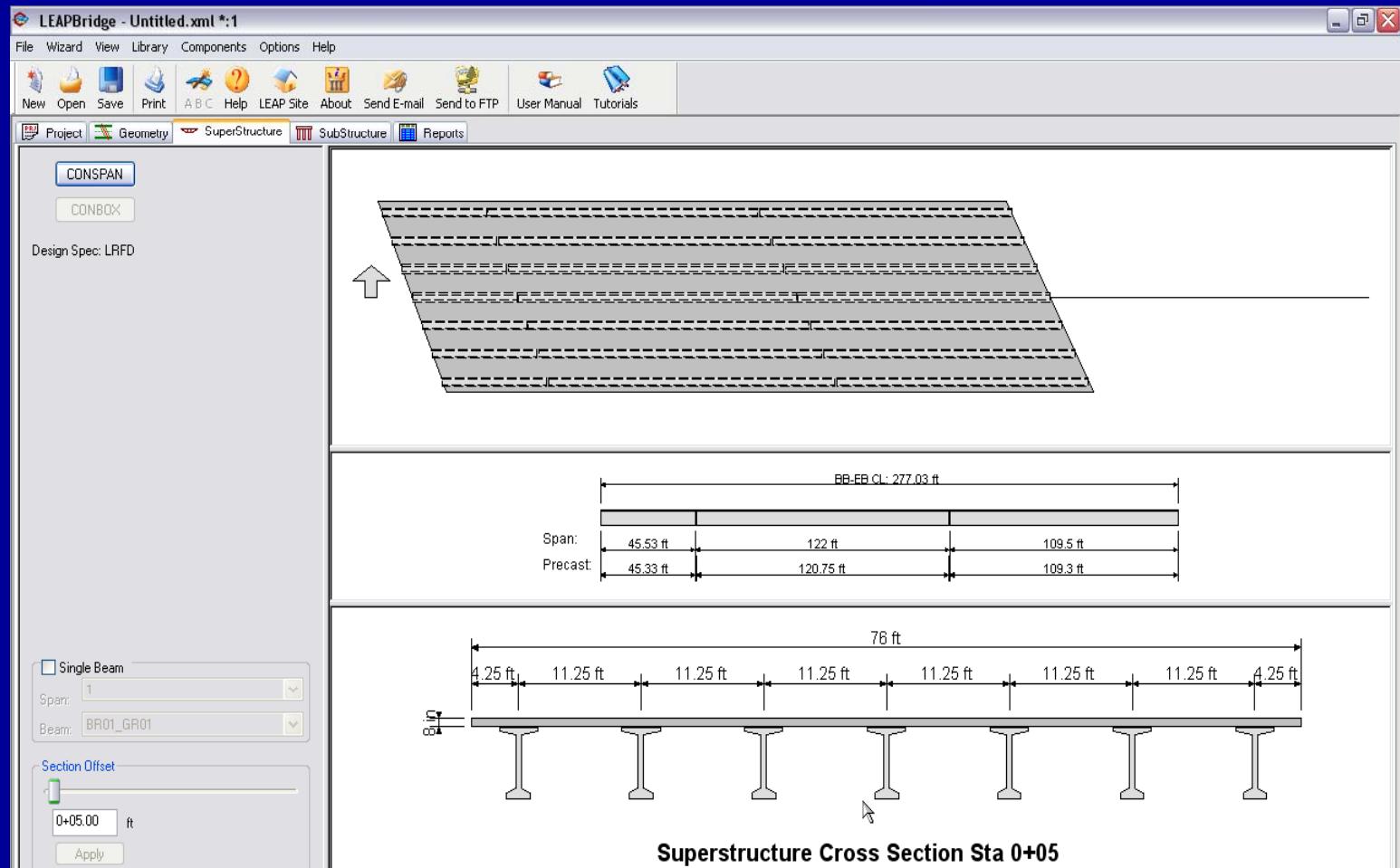
C01b Defining Superstructure in Conspan

Define
strand
patterns
and rebar
patterns



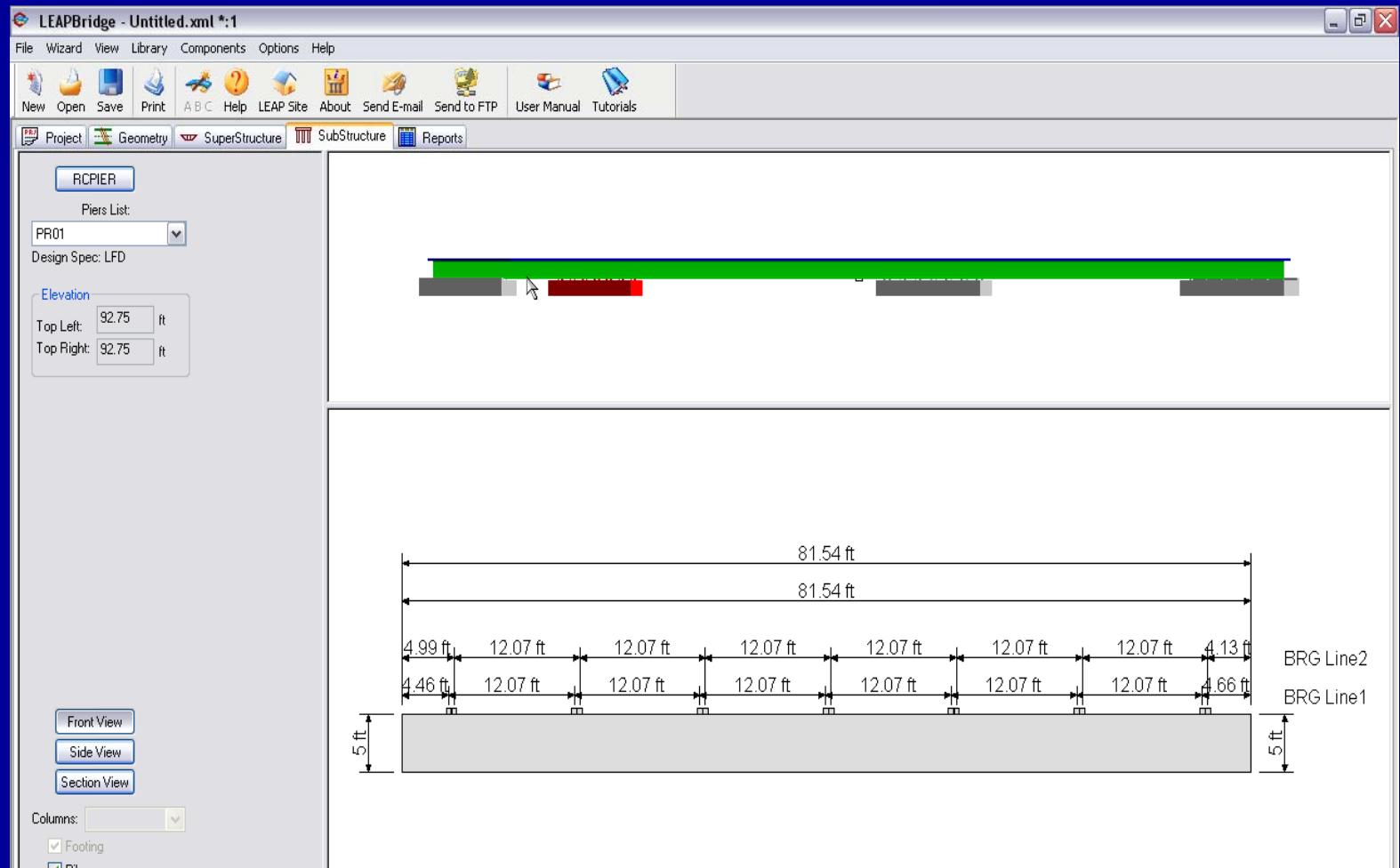
C01b Defining Superstructure in Conspan

Plan view,
side view
and front
view



C01b Defining Superstructure in Conspan

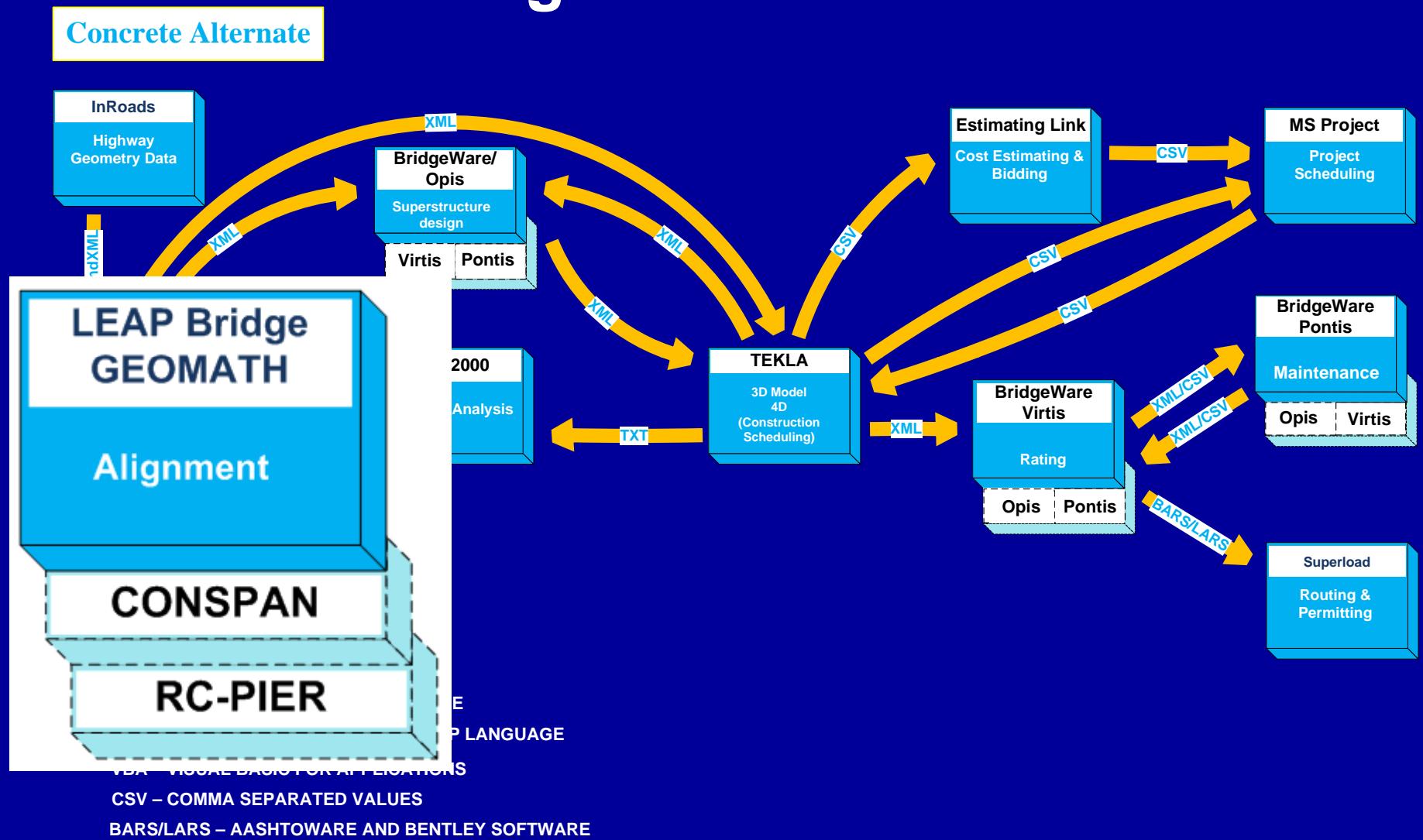
3D view
of super-
structure



Defining Substructure in RC-Pier

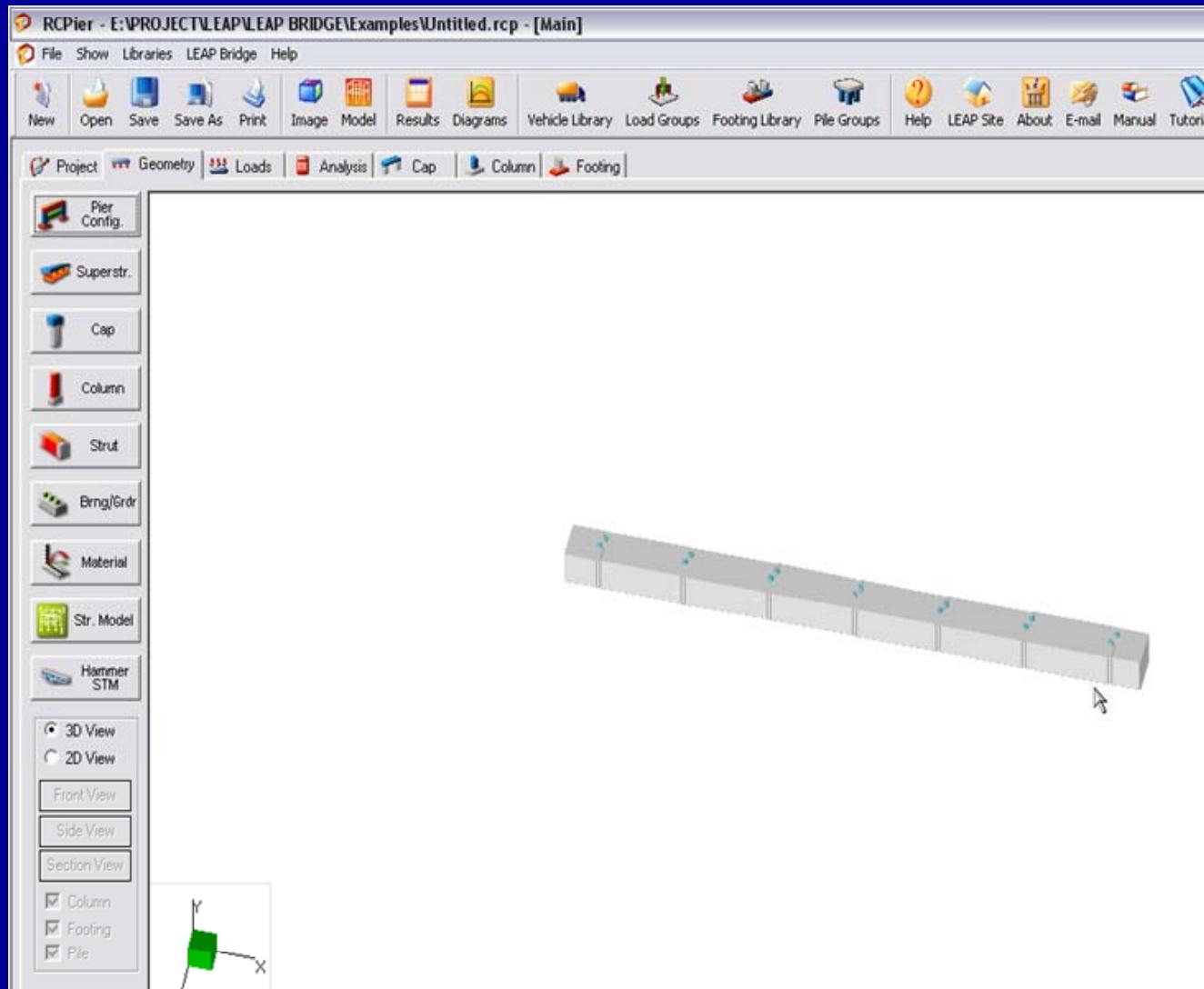


C01c Defining Substructure in RC-Pier



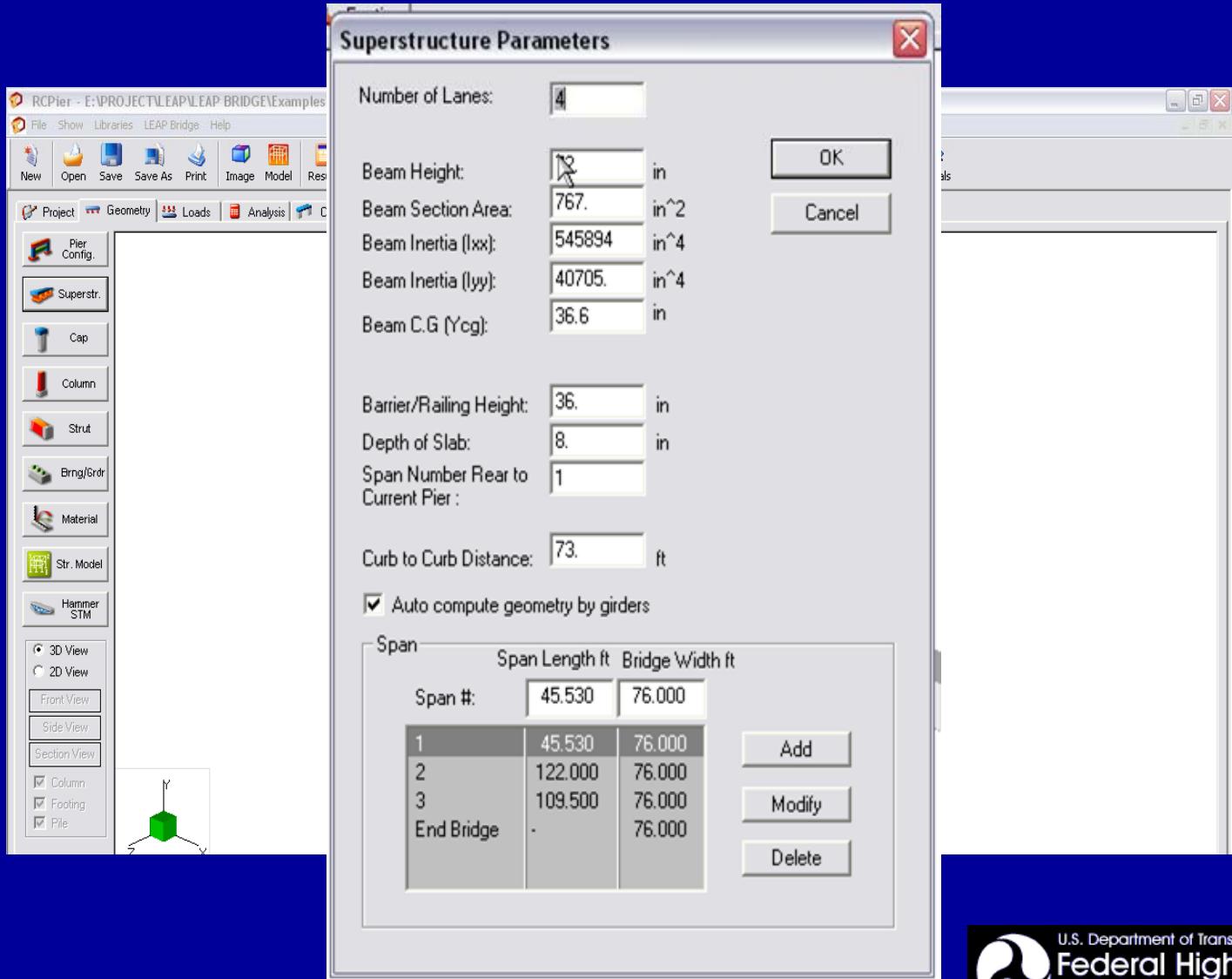
C01c Defining Substructure in RC-Pier

3D view
of cap
beam
and
bearings



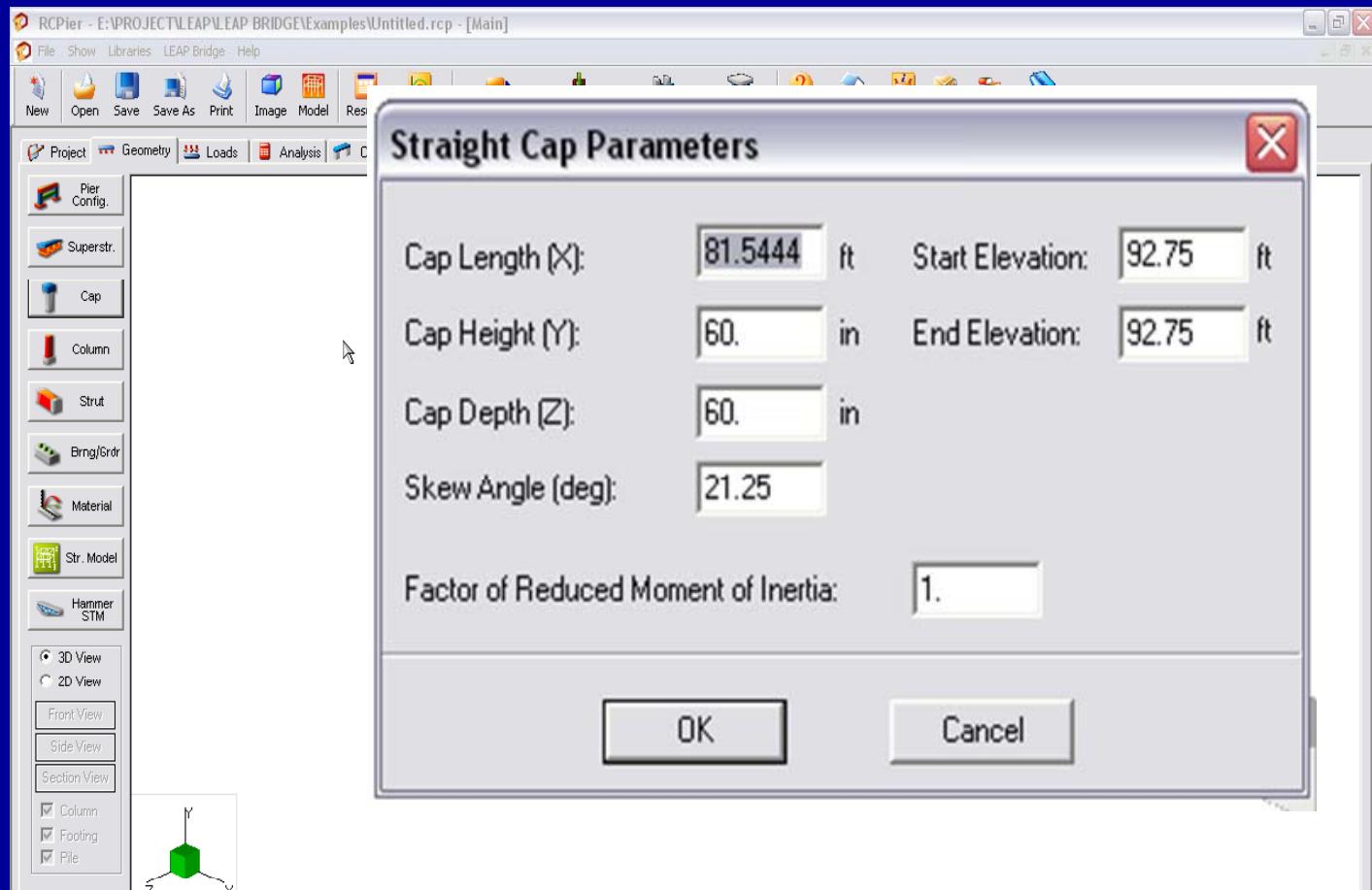
C01c Defining Substructure in RC-Pier

Define
super-
structure
parameters



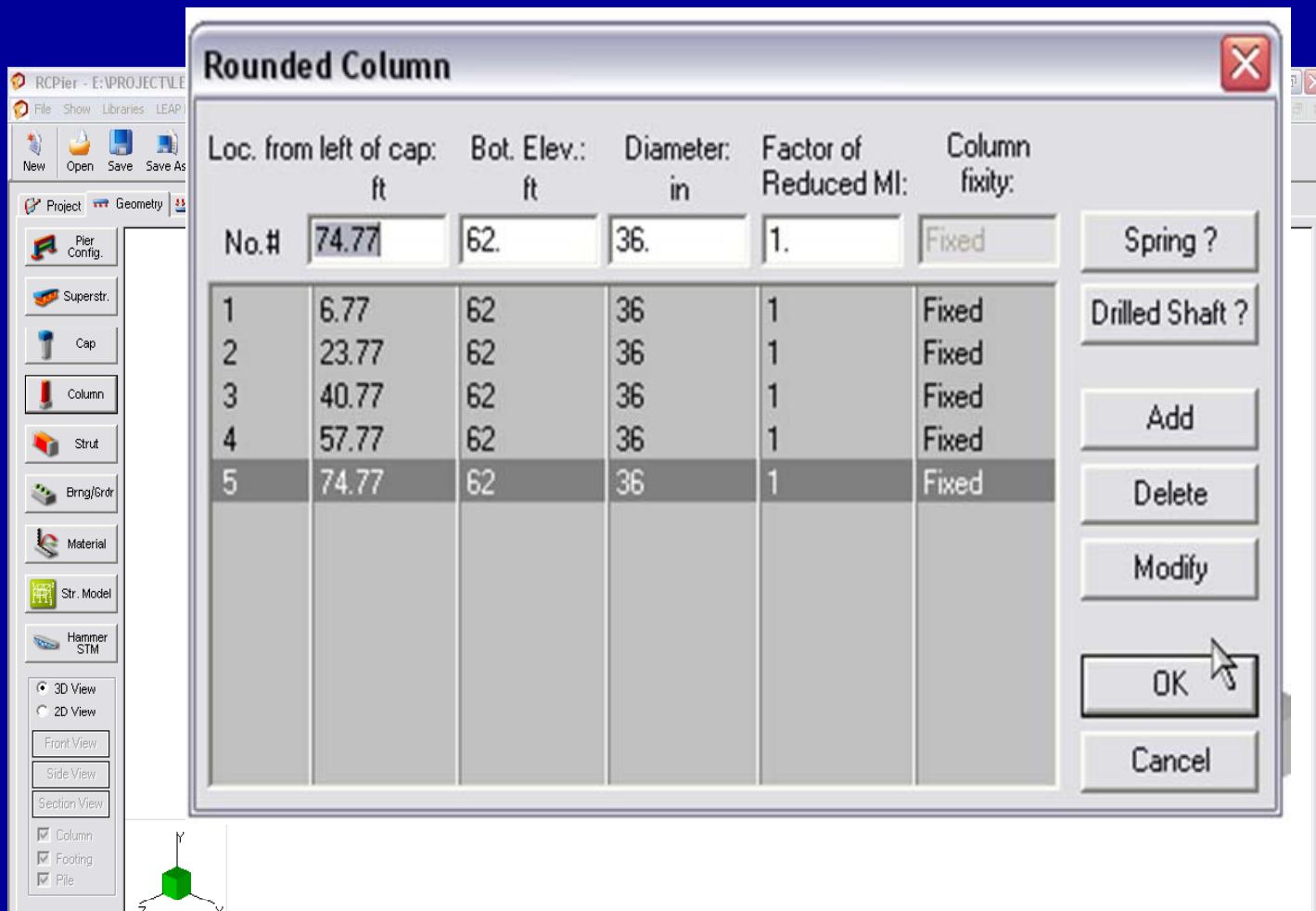
C01c Defining Substructure in RC-Pier

Define cap beam parameters



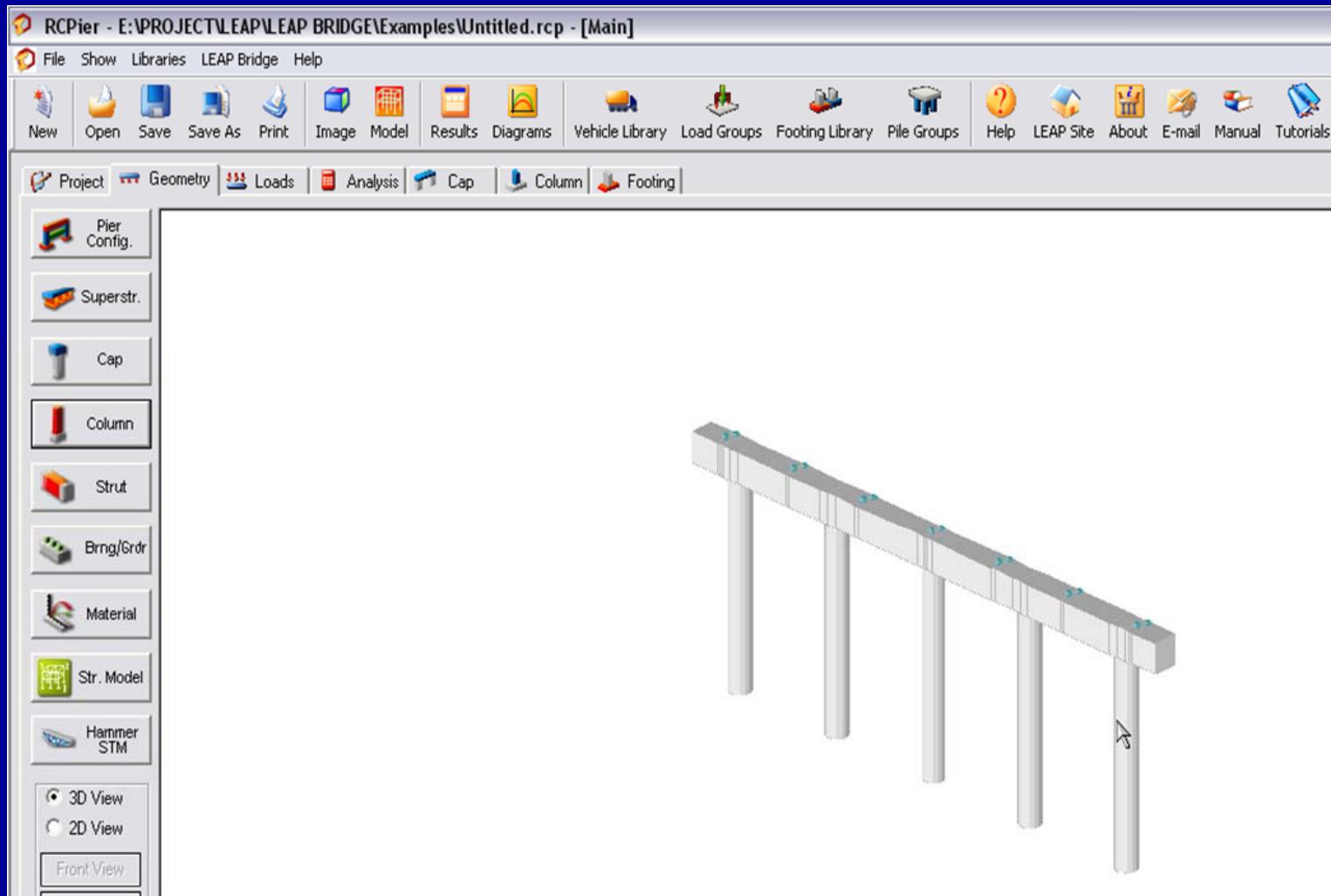
C01c Defining Substructure in RC-Pier

Define columns: diameter and location



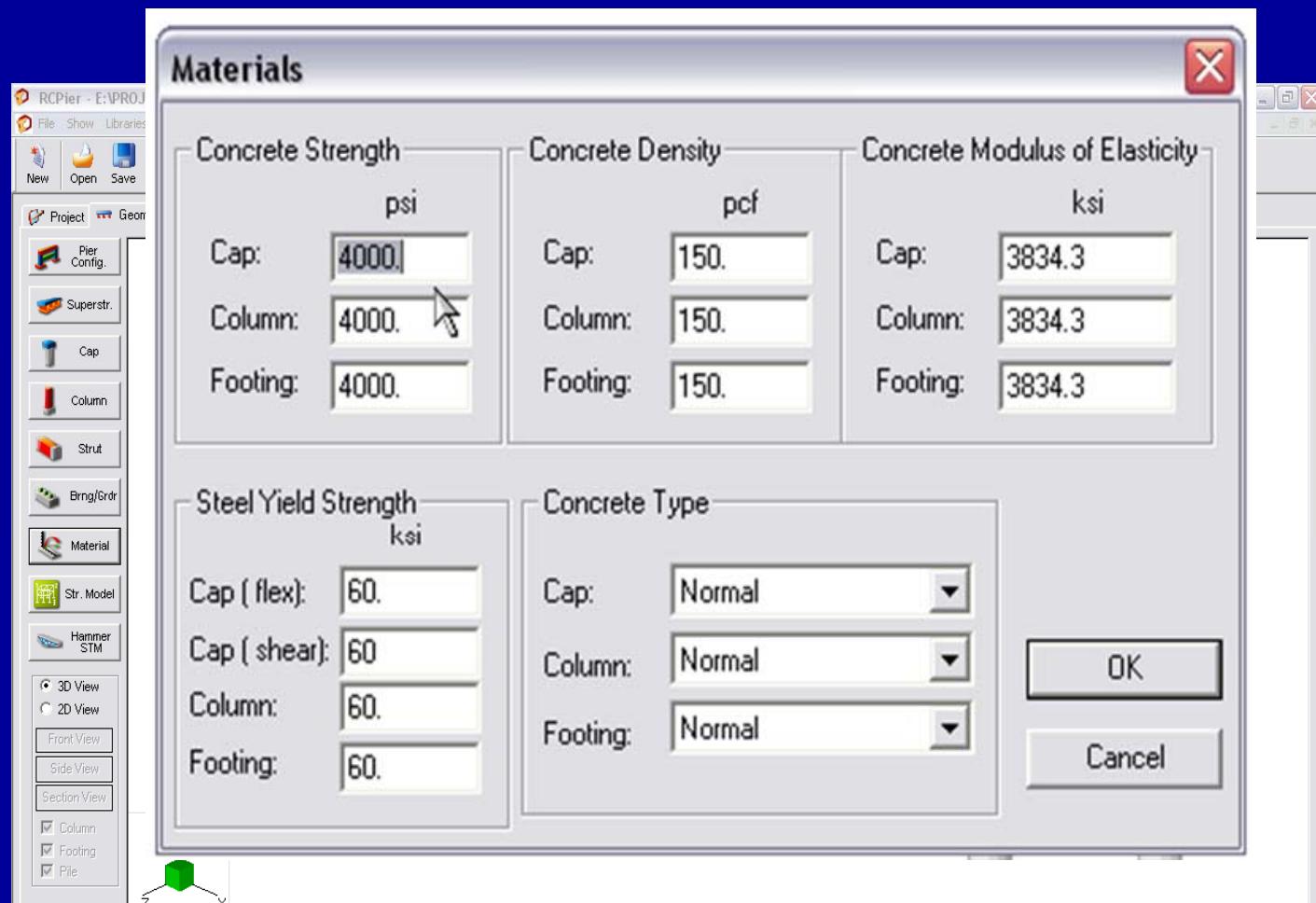
C01c Defining Substructure in RC-Pier

3D view
of
columns



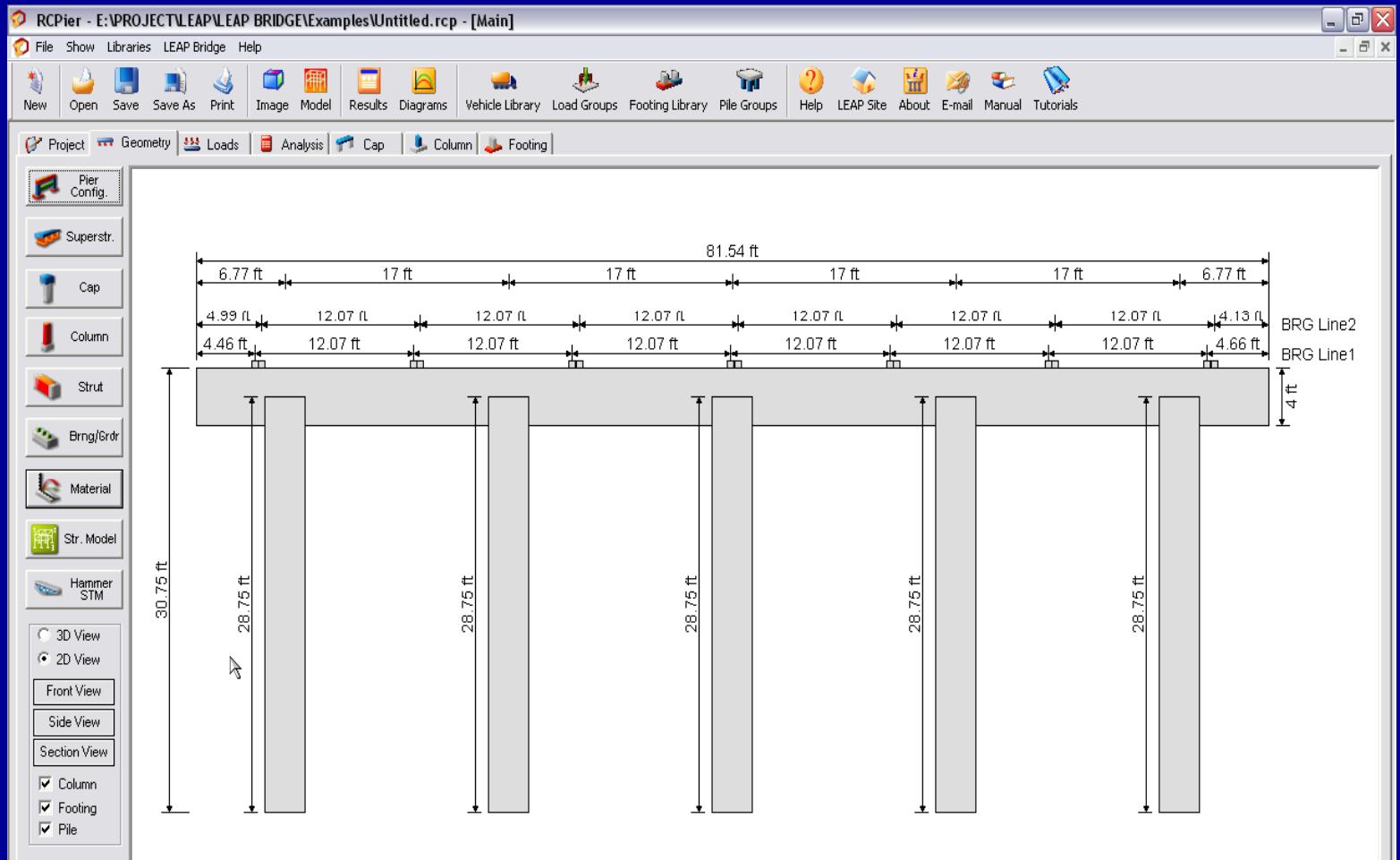
C01c Defining Substructure in RC-Pier

Define
sub-
structure
material
properties



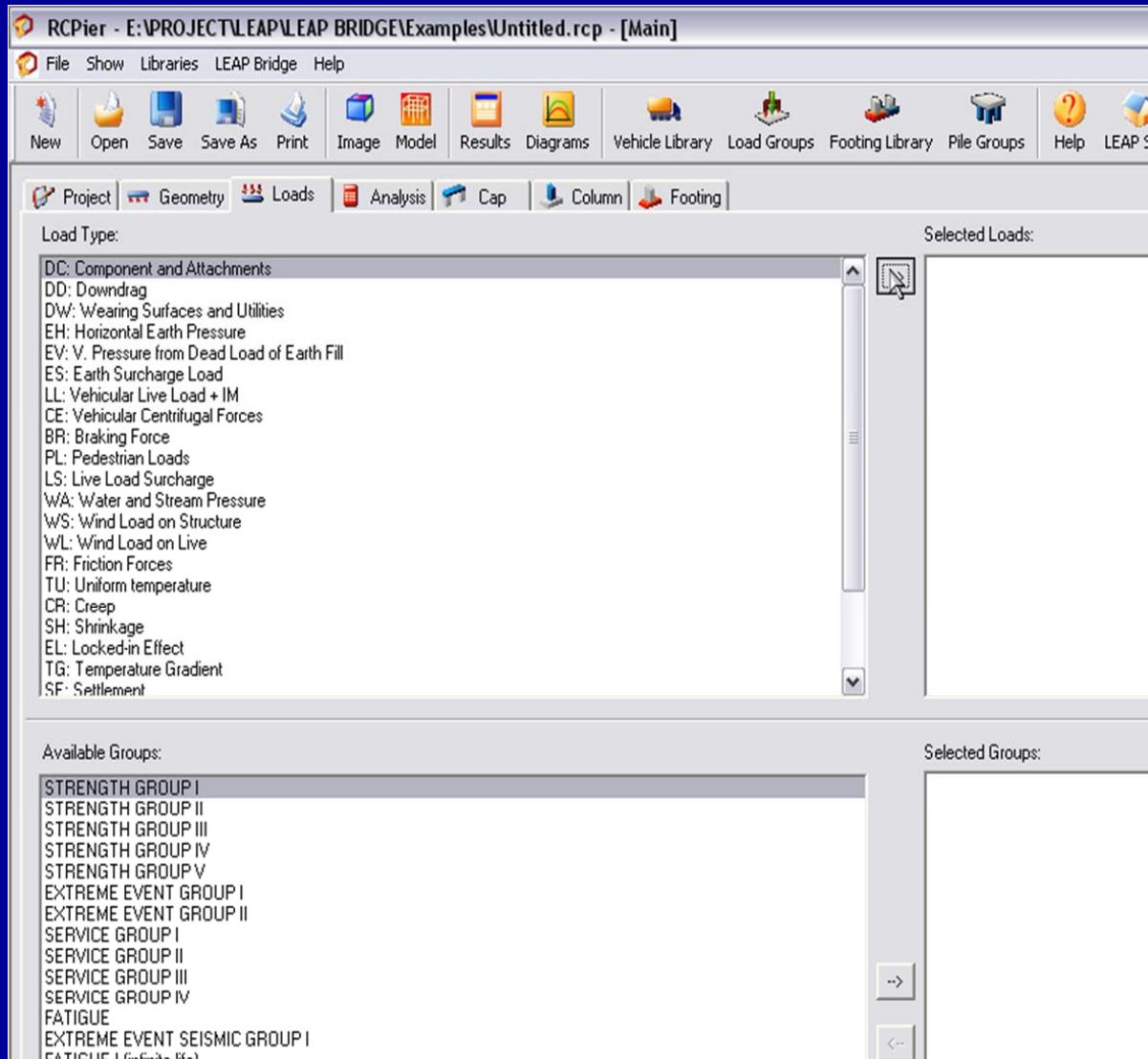
C01c Defining Substructure in RC-Pier

2D view
of sub-
structure



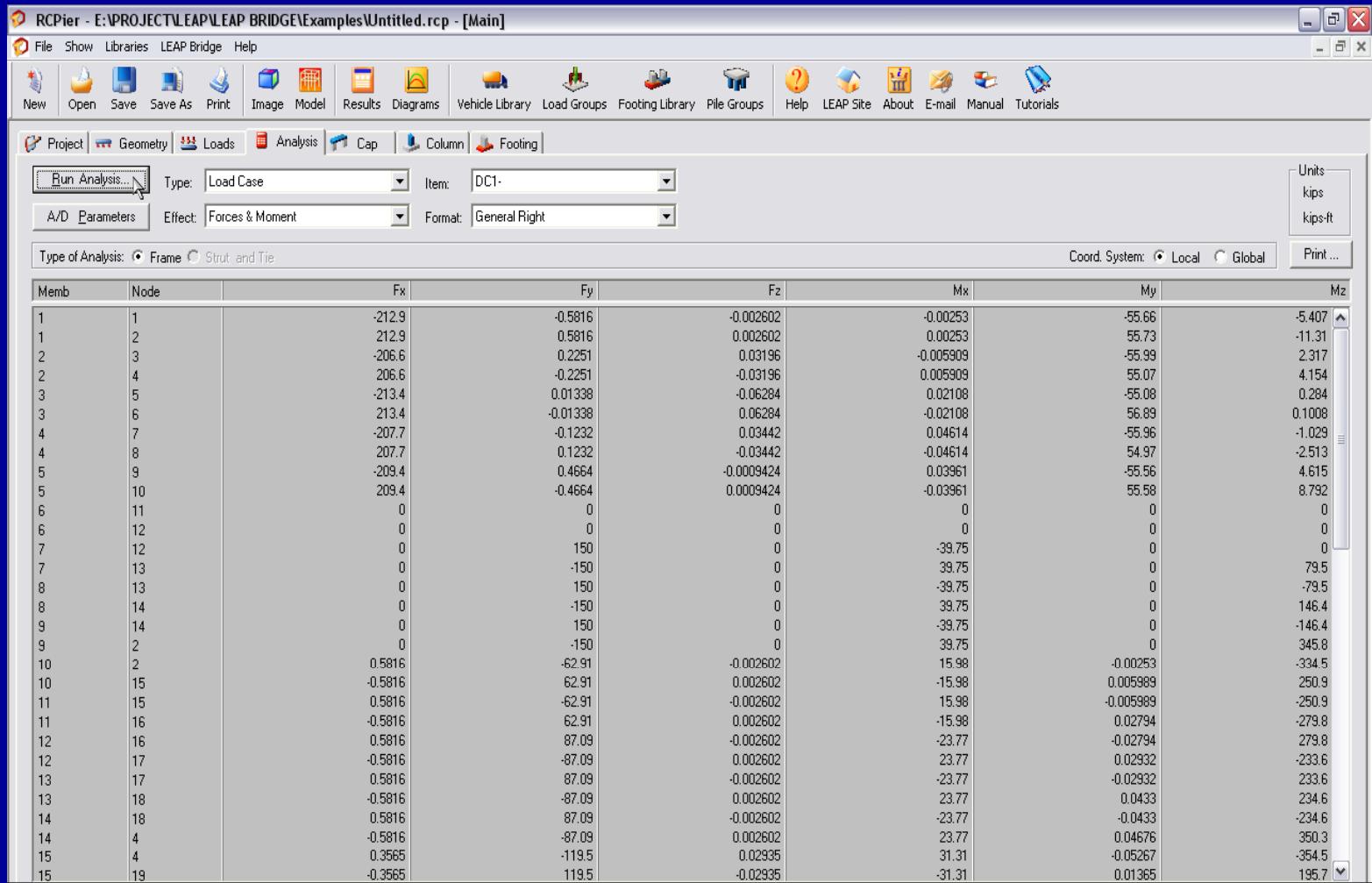
C01c Defining Substructure in RC-Pier

Define
load
cases



C01c Defining Substructure in RC-Pier

Analysis results:
moment,
shear,
axial load



The screenshot shows the RCPier software interface with the title bar "RCPier - E:\PROJECT\LEAP\LEAP BRIDGE\Examples\Untitled.rcp - [Main]". The menu bar includes File, Show, Libraries, LEAP Bridge, Help, and various toolbars for New, Open, Save, Print, Image, Model, Results, Diagrams, Vehicle Library, Load Groups, Footing Library, Pile Groups, Help, LEAP Site, About, E-mail, Manual, and Tutorials.

The main window displays analysis results for a load case named "DC1-". The "Analysis" tab is selected, showing "Type: Load Case", "Item: DC1-", "Effect: Forces & Moment", and "Format: General Right". The "Units" dropdown shows "kips" and "kips-ft".

The "Type of Analysis" dropdown shows "Frame" selected. The "Coord. System" dropdown shows "Local" selected. A "Print..." button is also visible.

A large table below lists member properties (Memb, Node, Fx, Fy, Fz, Mx, My, Mz) for 15 members. The table shows values such as Fx ranging from -212.9 to 0.5816, and Mz ranging from -5.407 to 195.7.

Memb	Node	Fx	Fy	Fz	Mx	My	Mz
1	1	-212.9	-0.5816	-0.002602	-0.00253	-55.66	-5.407
1	2	212.9	0.5816	0.002602	0.00253	55.73	-11.31
2	3	-206.6	0.2251	0.03196	-0.005909	-55.99	2.317
2	4	206.6	-0.2251	-0.03196	0.005909	55.07	4.154
3	5	-213.4	0.01338	-0.06284	0.02108	-55.08	0.284
3	6	213.4	-0.01338	0.06284	-0.02108	56.89	0.1008
4	7	-207.7	-0.1232	0.03442	0.04614	-55.96	-1.029
4	8	207.7	0.1232	-0.03442	-0.04614	54.97	-2.513
5	9	-209.4	0.4664	0.0009424	0.03961	55.56	4.615
5	10	209.4	-0.4664	0.0009424	-0.03961	55.58	8.792
6	11	0	0	0	0	0	0
6	12	0	0	0	0	0	0
7	12	0	150	0	-39.75	0	0
7	13	0	-150	0	39.75	0	79.5
8	13	0	150	0	-39.75	0	-79.5
8	14	0	-150	0	39.75	0	146.4
9	14	0	150	0	-39.75	0	-146.4
9	2	0	-150	0	39.75	0	345.8
10	2	0.5816	-62.91	-0.002602	15.98	-0.00253	-334.5
10	15	-0.5816	62.91	0.002602	-15.98	0.005989	250.9
11	15	0.5816	-62.91	-0.002602	15.98	-0.005989	-250.9
11	16	-0.5816	62.91	0.002602	-15.98	0.02794	279.8
12	16	0.5816	87.09	-0.002602	23.77	-0.02794	279.8
12	17	-0.5816	-87.09	0.002602	23.77	0.02932	-233.6
13	17	0.5816	87.09	-0.002602	23.77	-0.02932	233.6
13	18	-0.5816	-87.09	0.002602	23.77	0.0433	234.6
14	18	0.5816	87.09	-0.002602	23.77	-0.0433	-234.6
14	4	-0.5816	-87.09	0.002602	23.77	0.04676	350.3
15	4	0.3565	-119.5	0.02935	31.31	-0.05267	-354.5
15	19	-0.3565	119.5	-0.02935	-31.31	0.01365	195.7



C01c Defining Substructure in RC-Pier

Cap beam
design report

The screenshot shows a software interface titled "Enhanced report viewer" for a project named "RCPier". The main window displays the following sections:

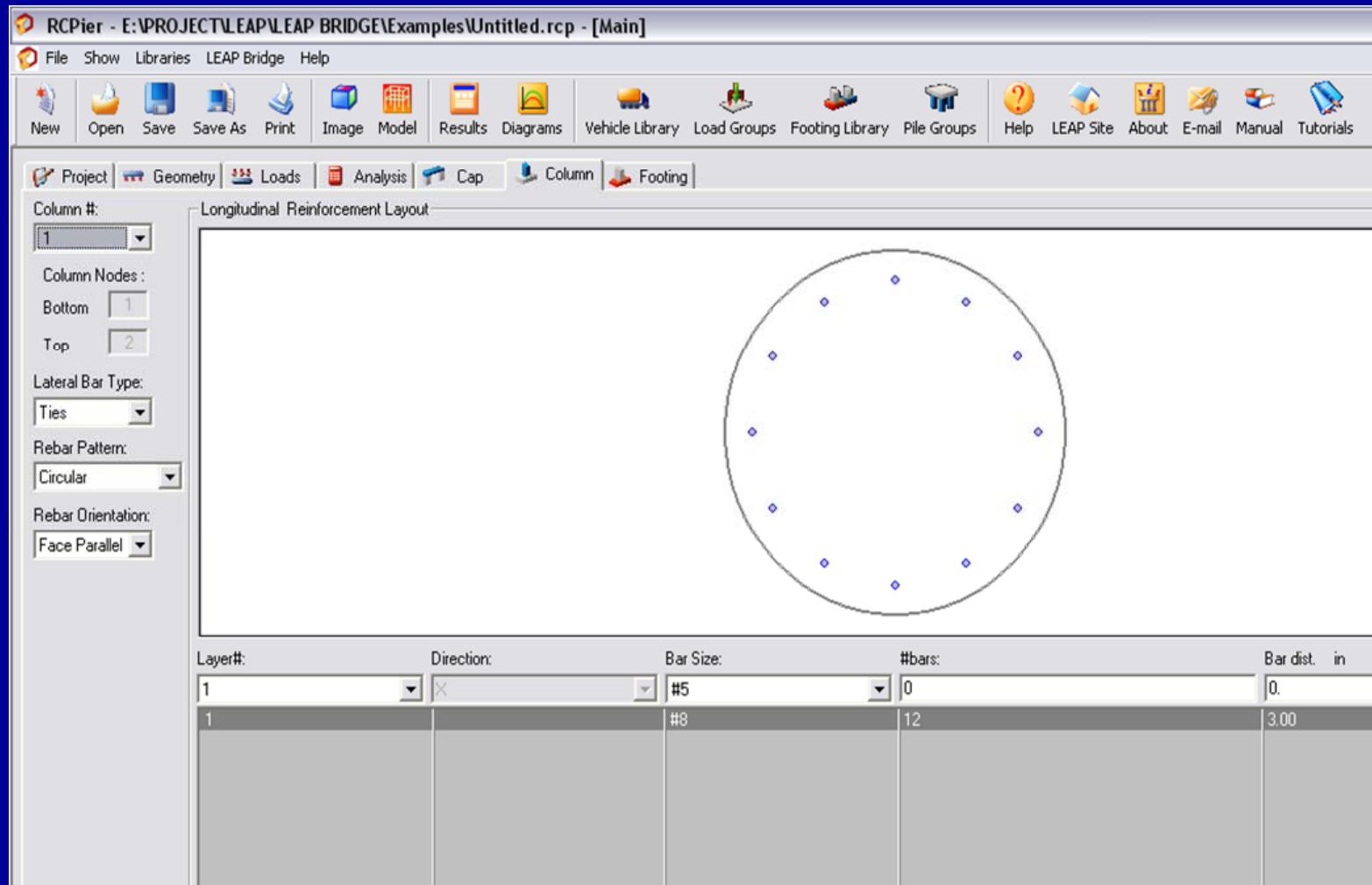
- CAP DESIGN**:
 - Code: AASHTO LRFD 2007 (with Interims)
 - Units: US
 - Pier View: Upstation.
- DESIGN PARAMETERS**:
 - $f_c = 4000.0 \text{ psi}$
 - $F_y \text{ flex} = 60000.0 \text{ psi}$ $F_y \text{ shear} = 60000.0 \text{ psi}$
 - $\phi \text{ tens} = 0.90$
 - $\phi \text{ comp} = 0.75$ $\phi \text{ shear} = 0.90$
 - Tens below = 0.000 Comp Above = 0.000
 - $E_c = 3834.3 \text{ ksi}$ $E_s = 29000.0 \text{ ksi}$
 - Crack check as per 2005 Interims
 - Crack control Exposure = 1.00
 - Concrete Type : Normal Weight.
 - Design of cap at face of column.
- CAP GEOMETRY**:
 - Straight Cap : Length(X) = 81.54 ft Depth(Z) = 42.00 in
- MAIN REINFORCEMENT**:

Bar size	Quantity	Bar dist. in	As total in ²	From ft	To ft	Hook
TOP	# 8	3	3.00	2.370	0.00	12.77 in



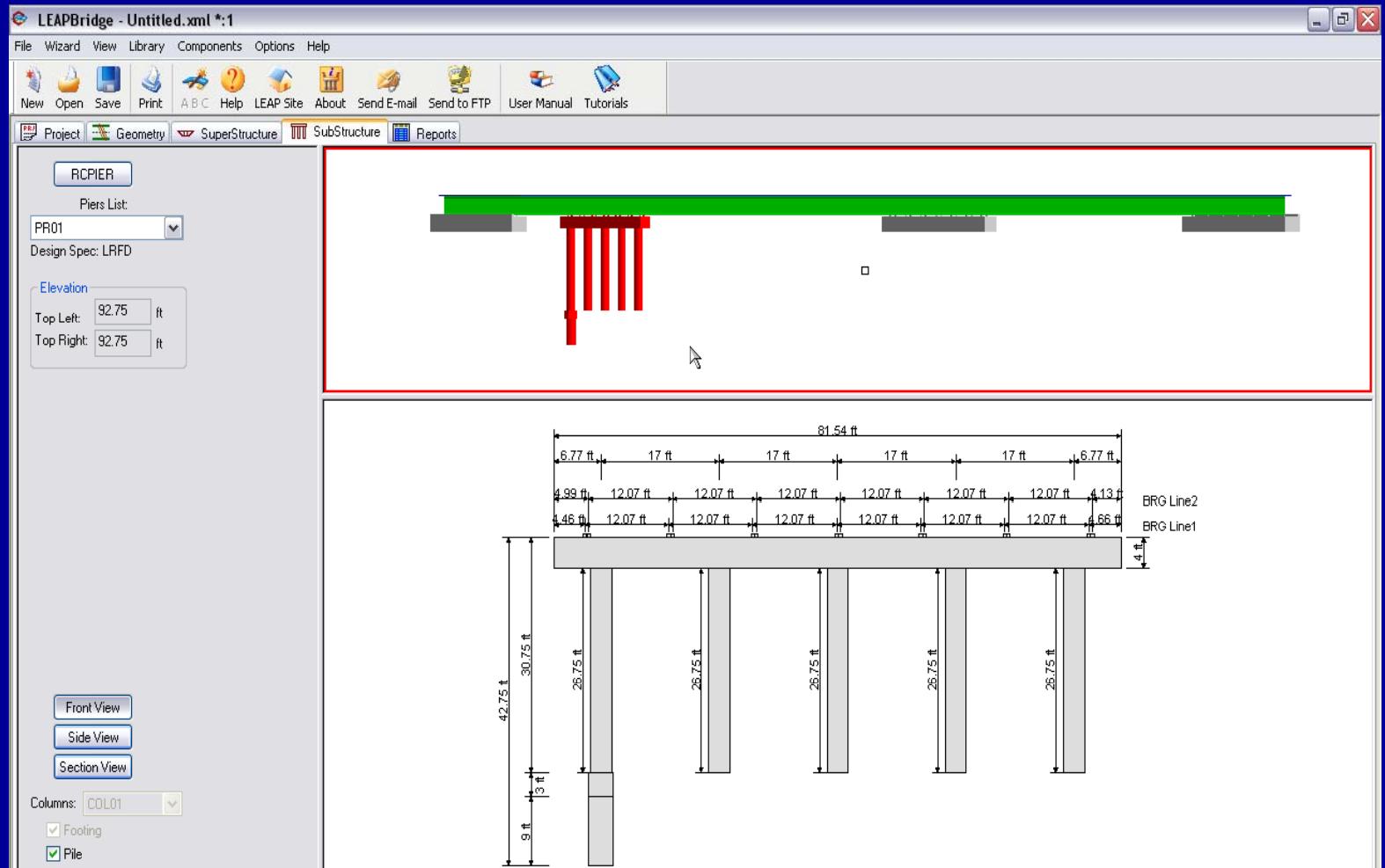
C01c Defining Substructure in RC-Pier

Column
design
report



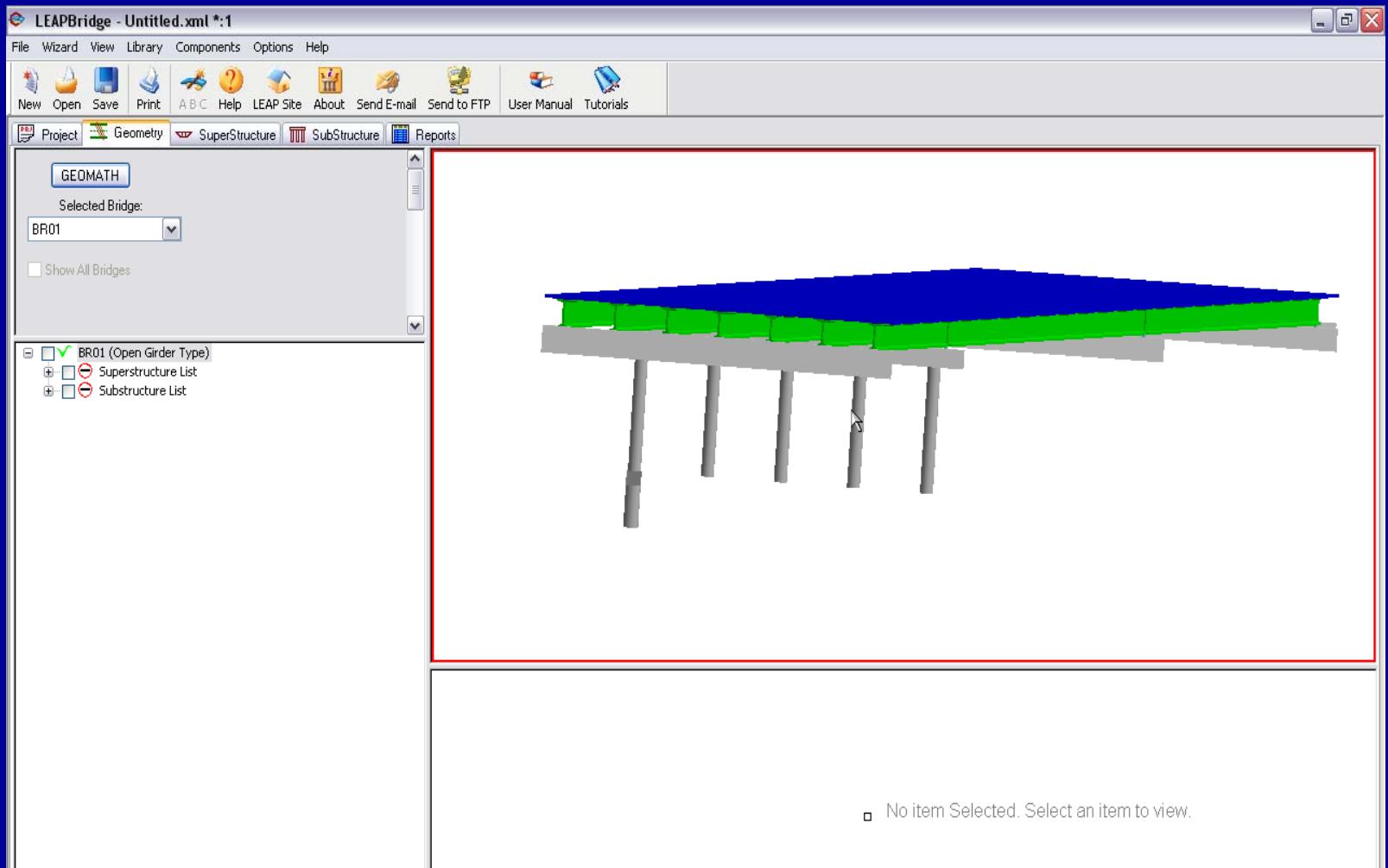
C01c Defining Substructure in RC-Pier

3D view
of sub-
structure



C01c Defining Substructure in RC-Pier

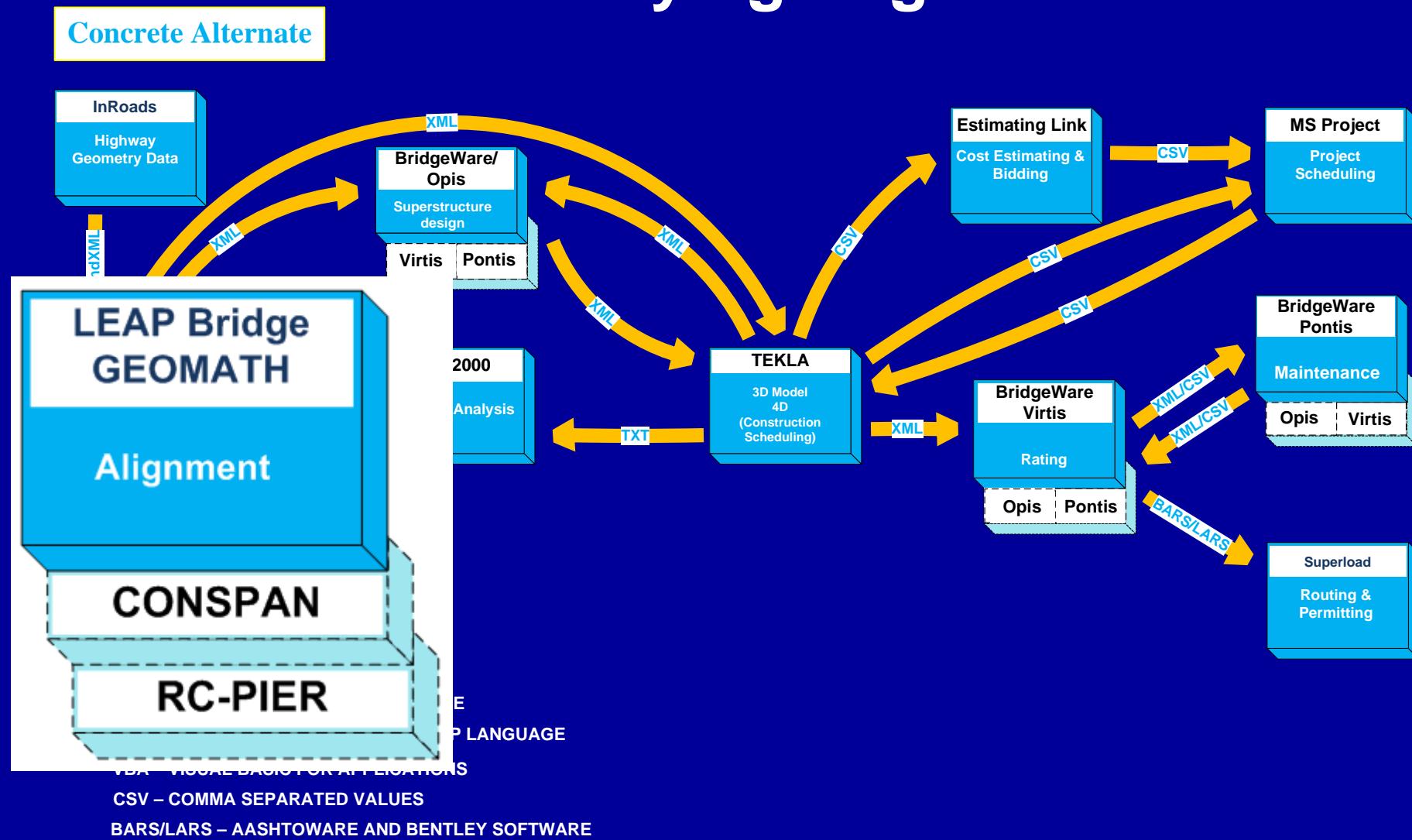
3D
view of
bridge



Modifying Alignments

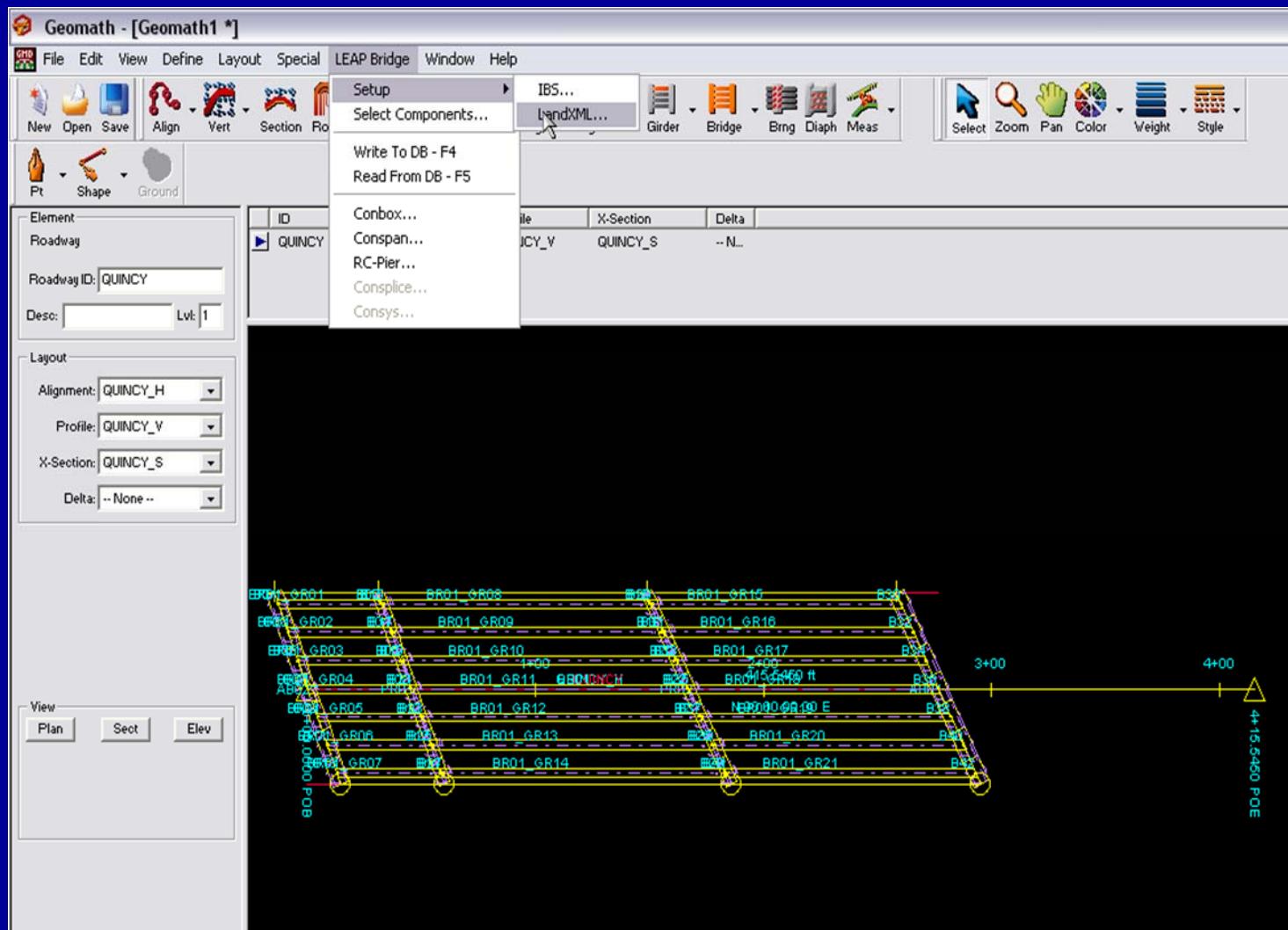


C01d Modifying Alignments



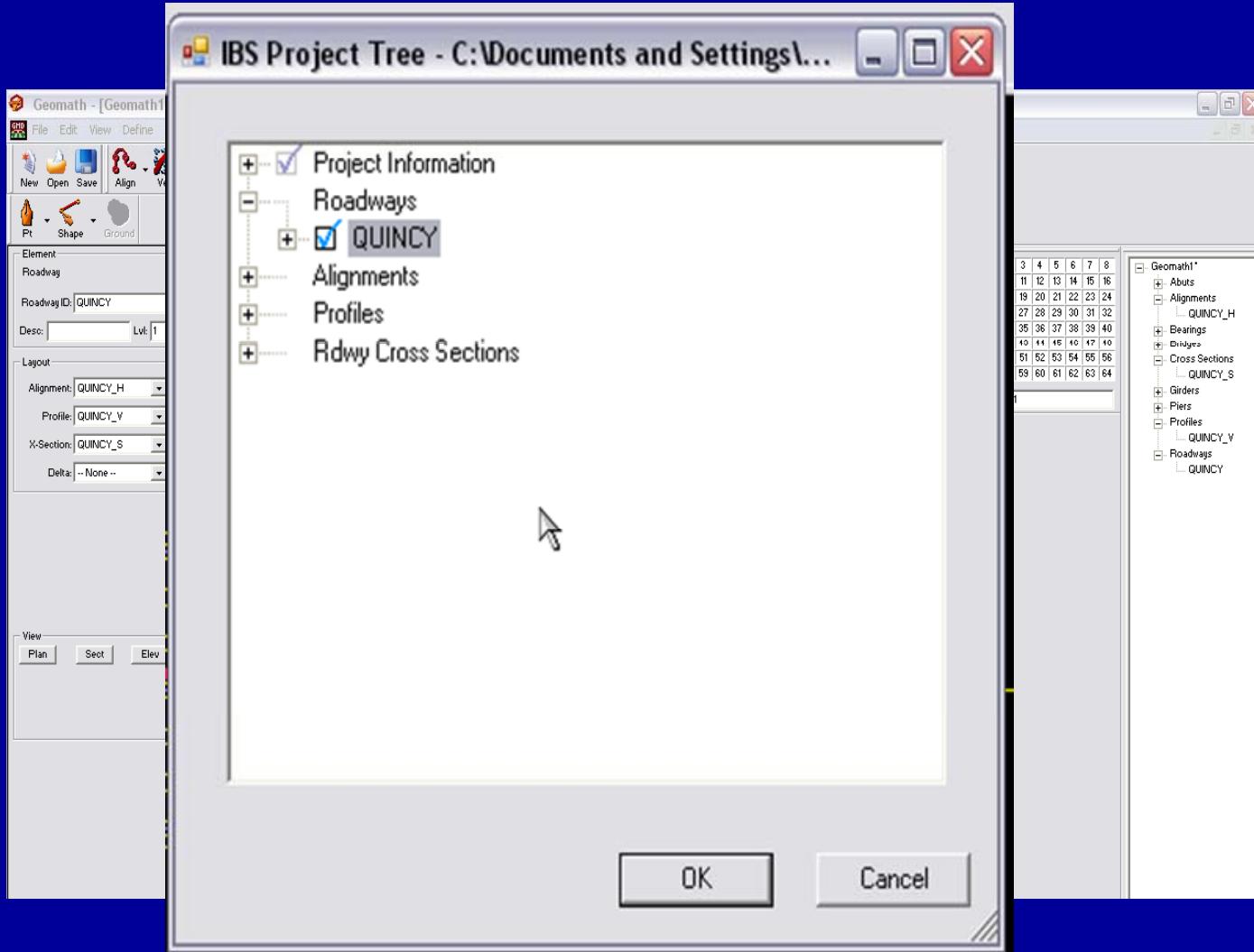
C01d Modifying Alignments

Connect
LandXML
file



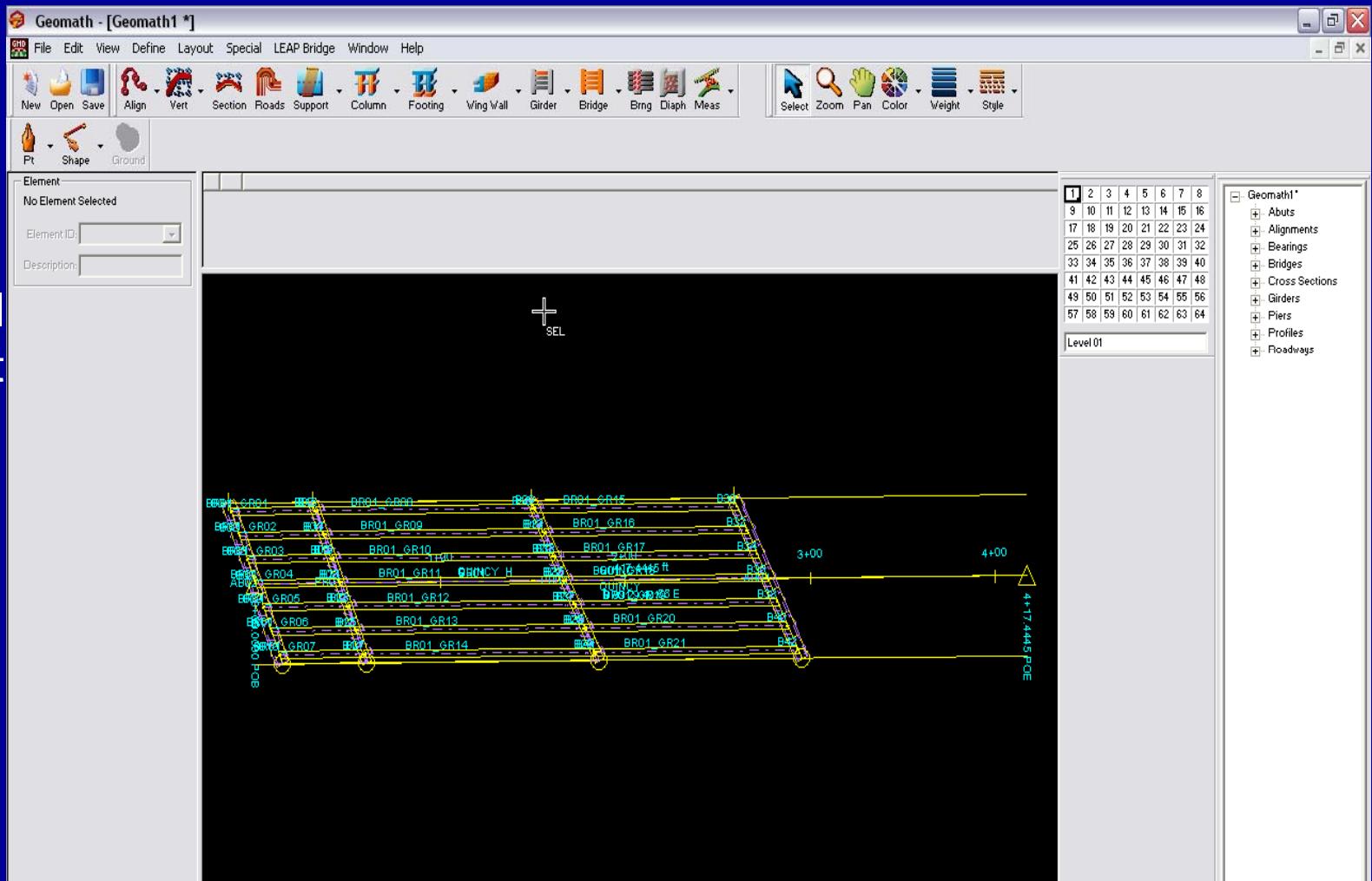
C01d Modifying Alignments

Choose
road,
alignment



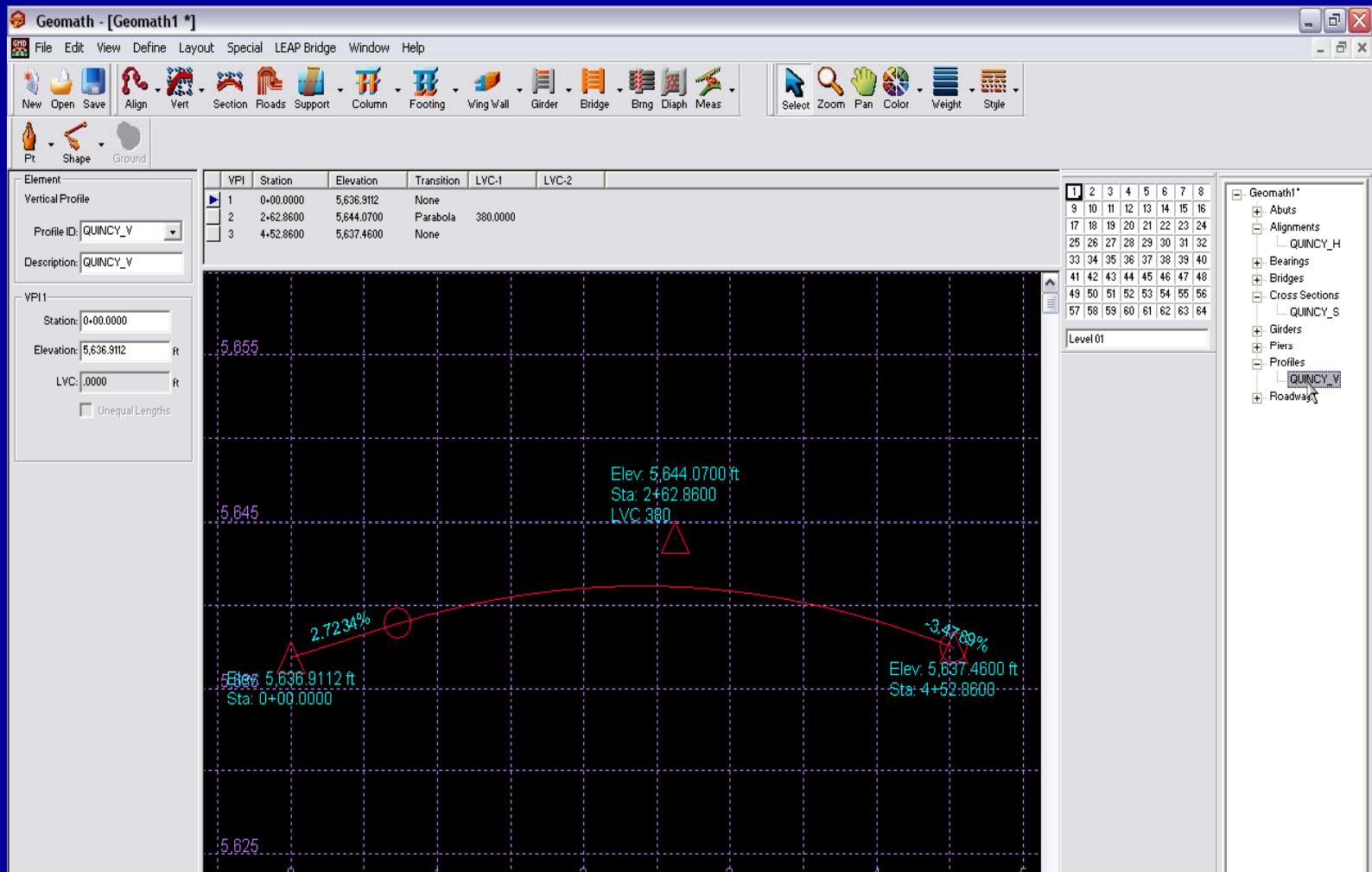
C01d Modifying Alignments

Quincy Avenue bridge horizontal alignment



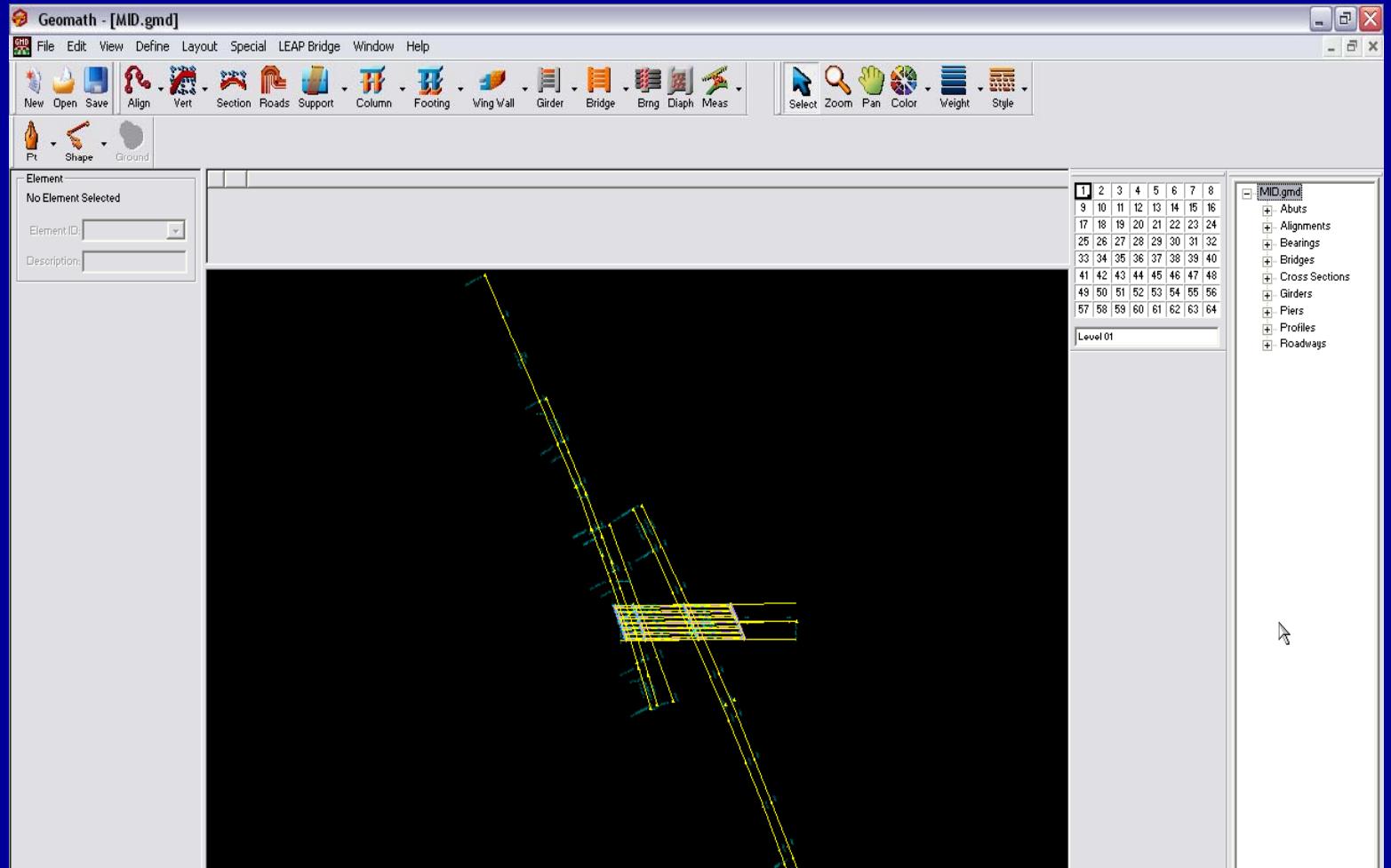
C01d Modifying Alignments

Quincy
Avenue
bridge
vertical
alignment



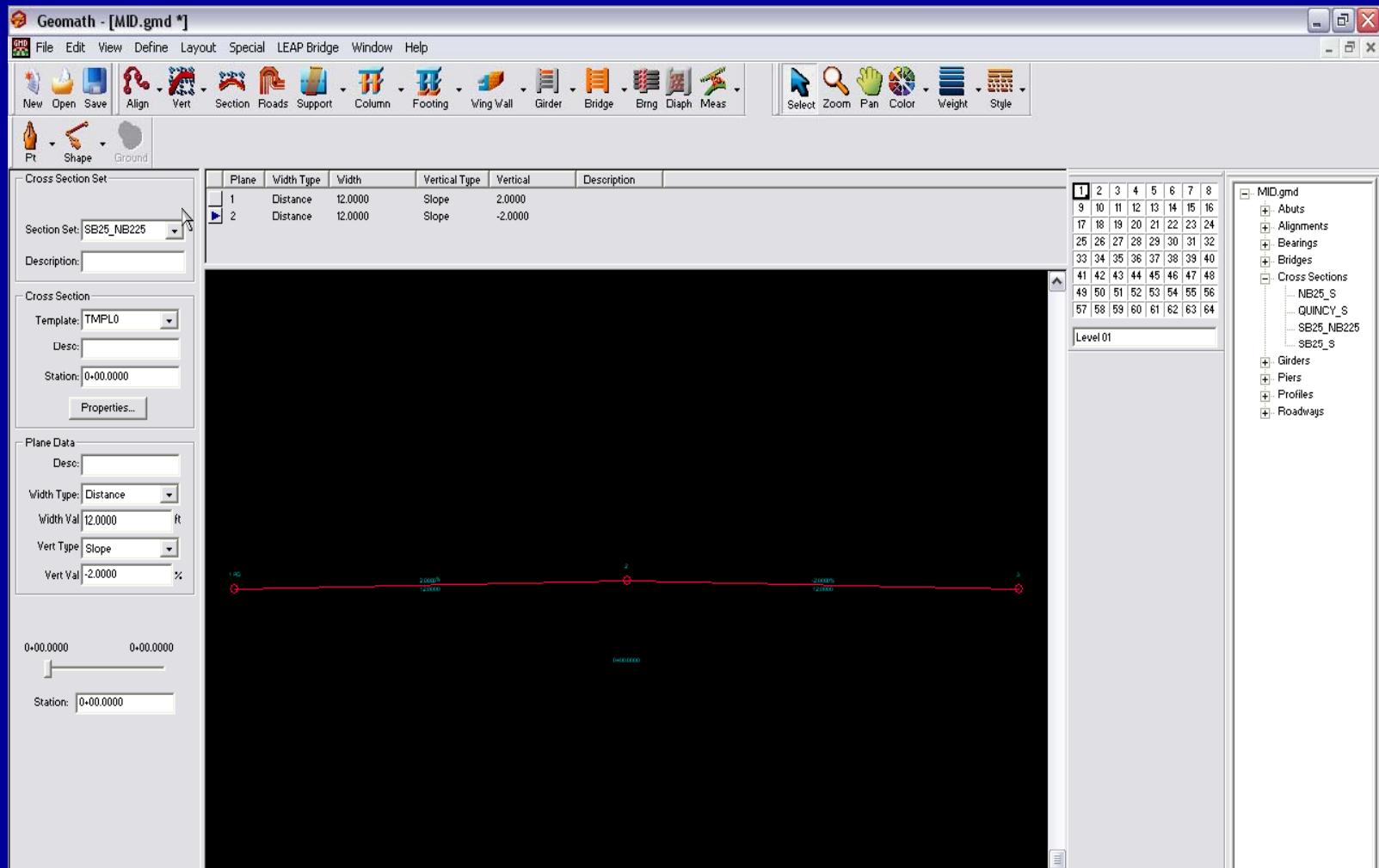
C01d Modifying Alignments

Loading
other 5
alignments



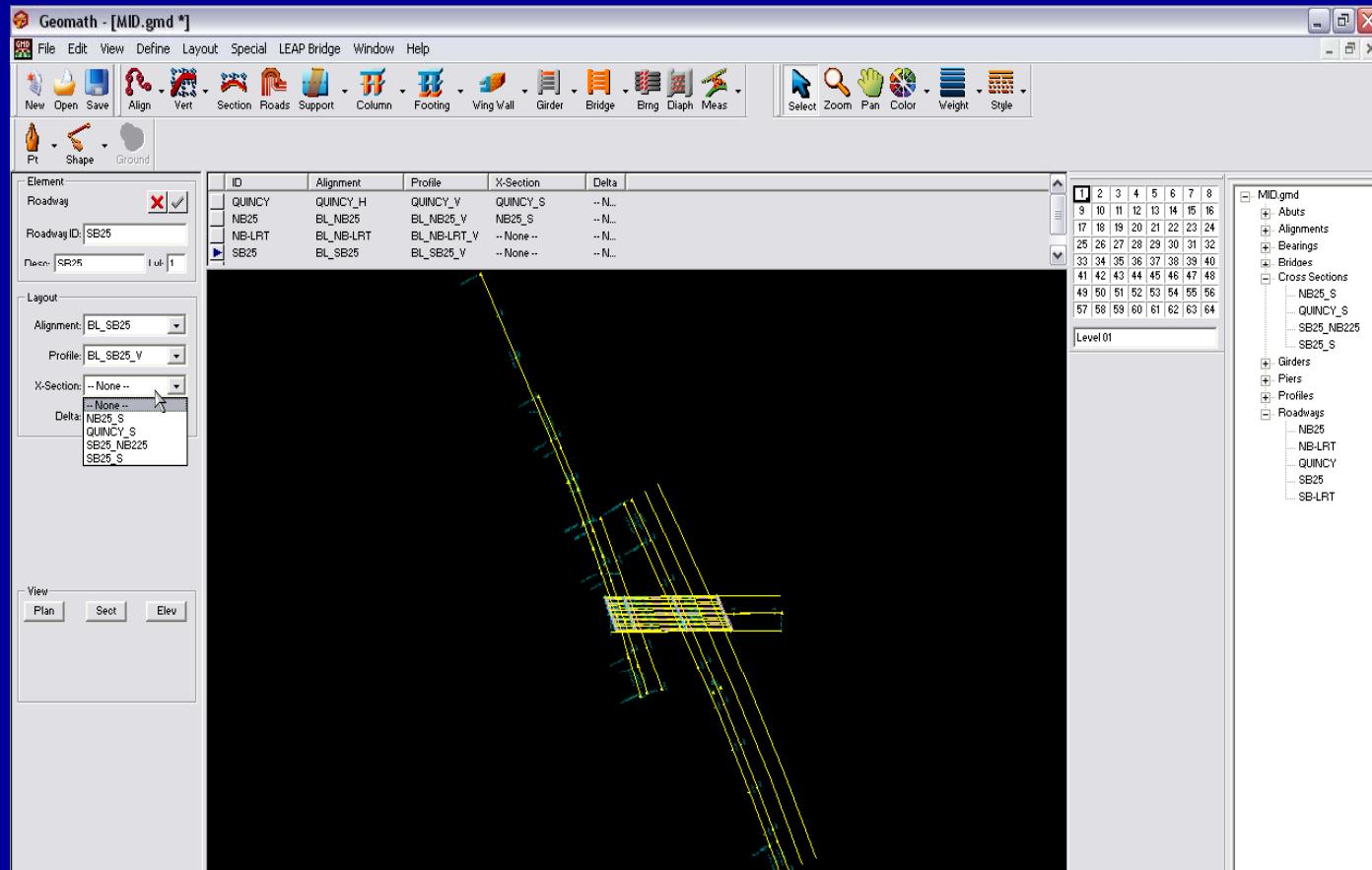
C01d Modifying Alignments

Define road section



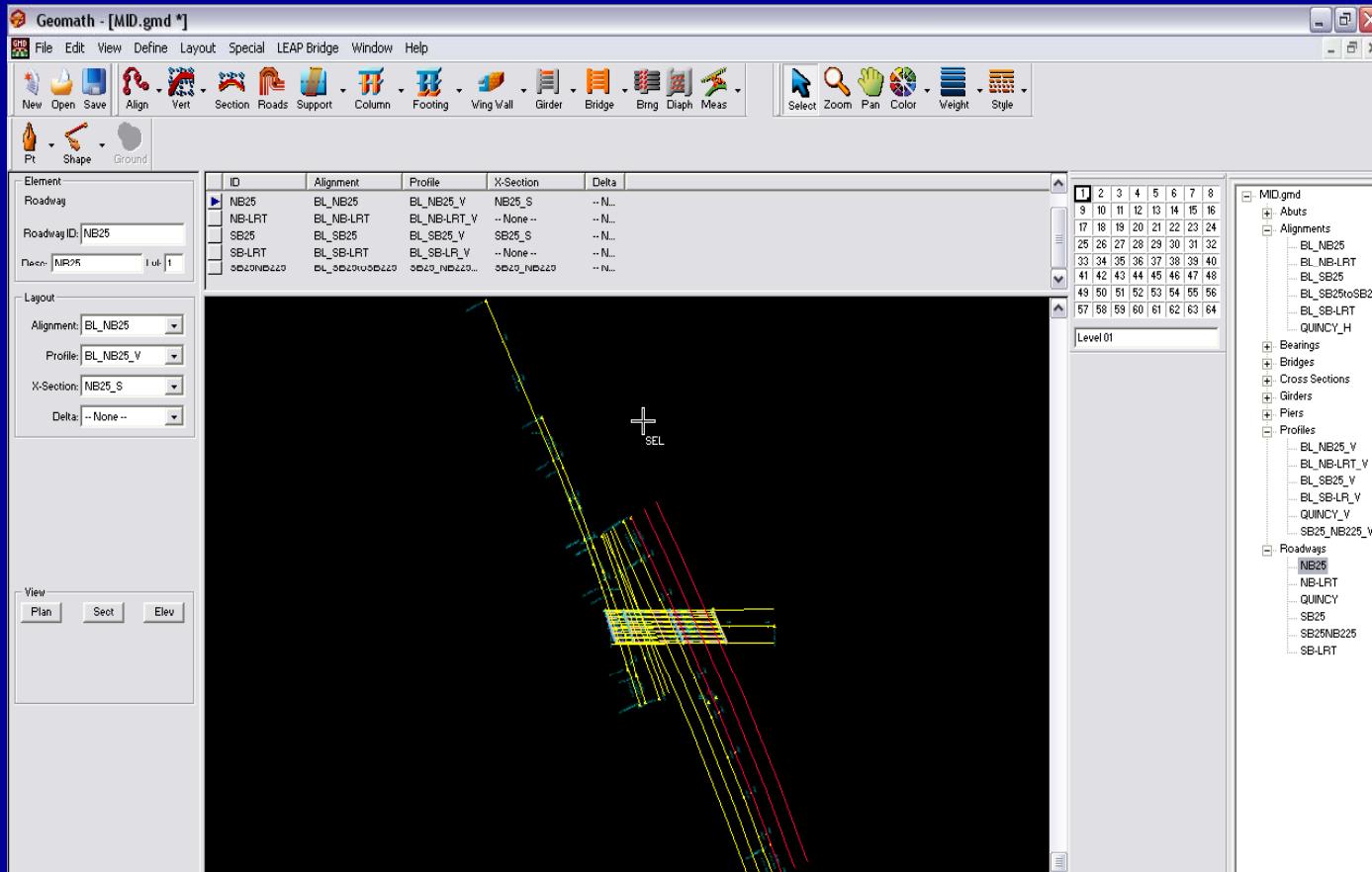
C01d Modifying Alignments

Plan view
of roads



C01d Modifying Alignments

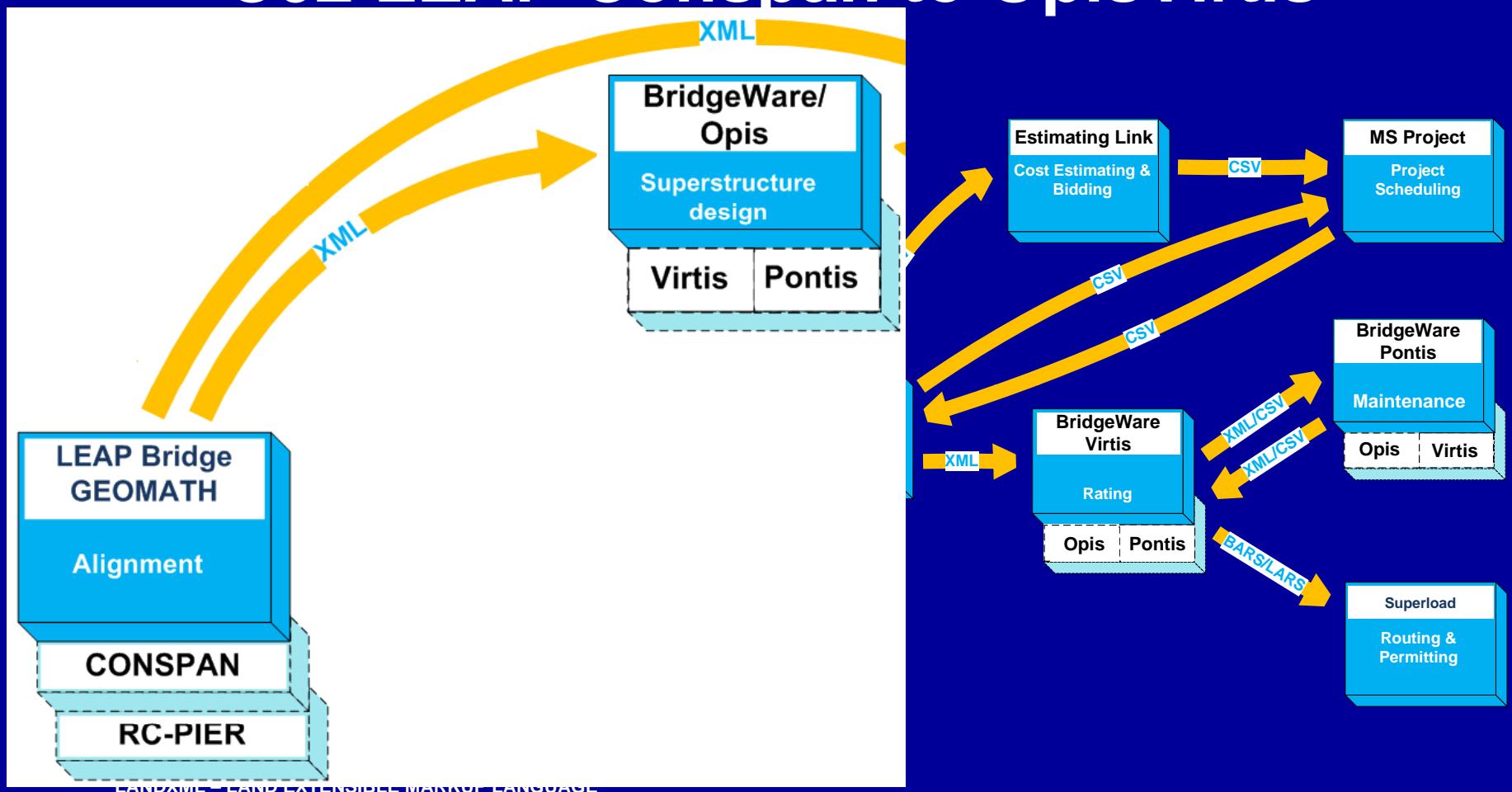
Plan view
of
roadways



LEAP ConSpan to Opis/Virtis

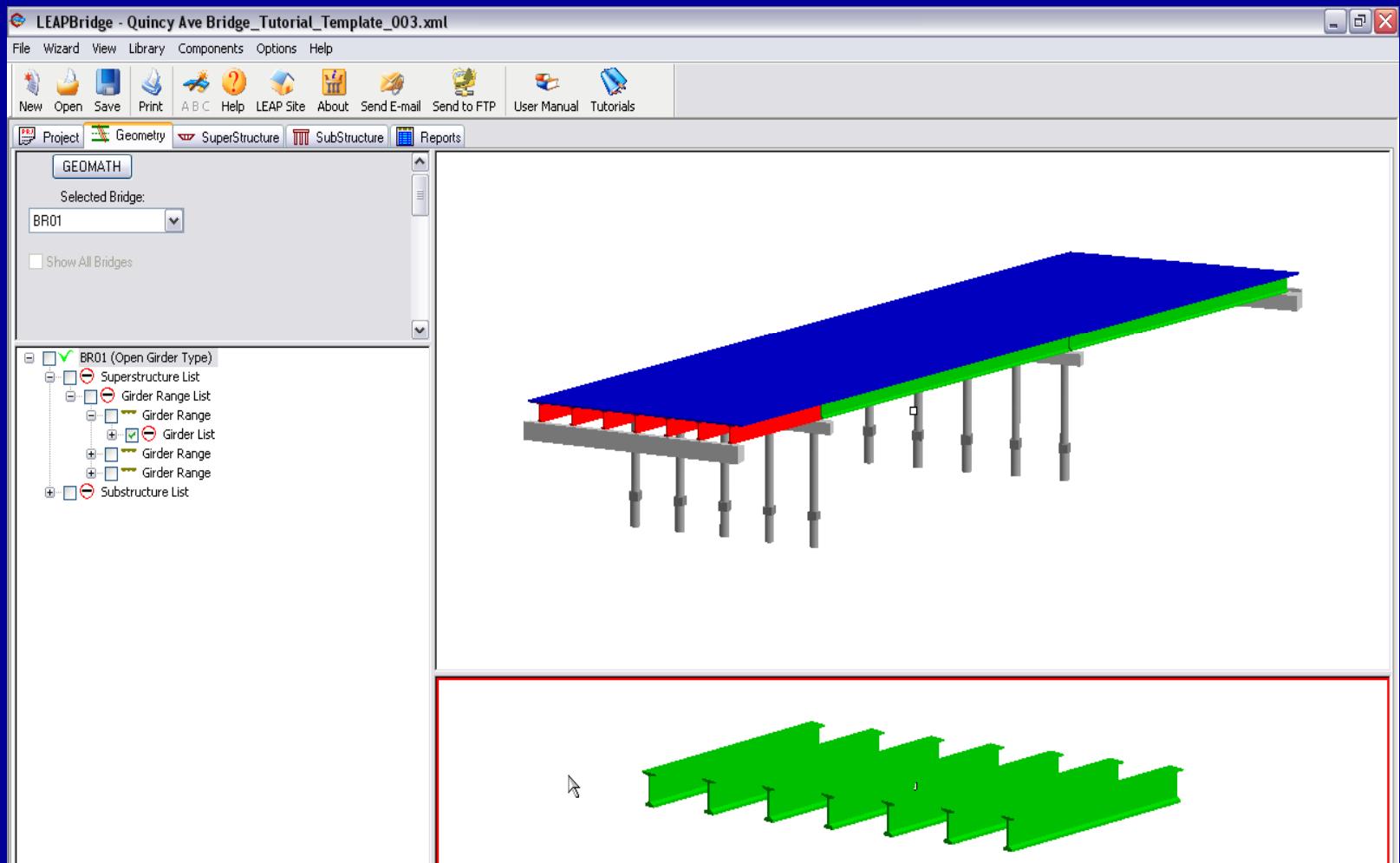


C02 LEAP Conspan to OpisVirtis



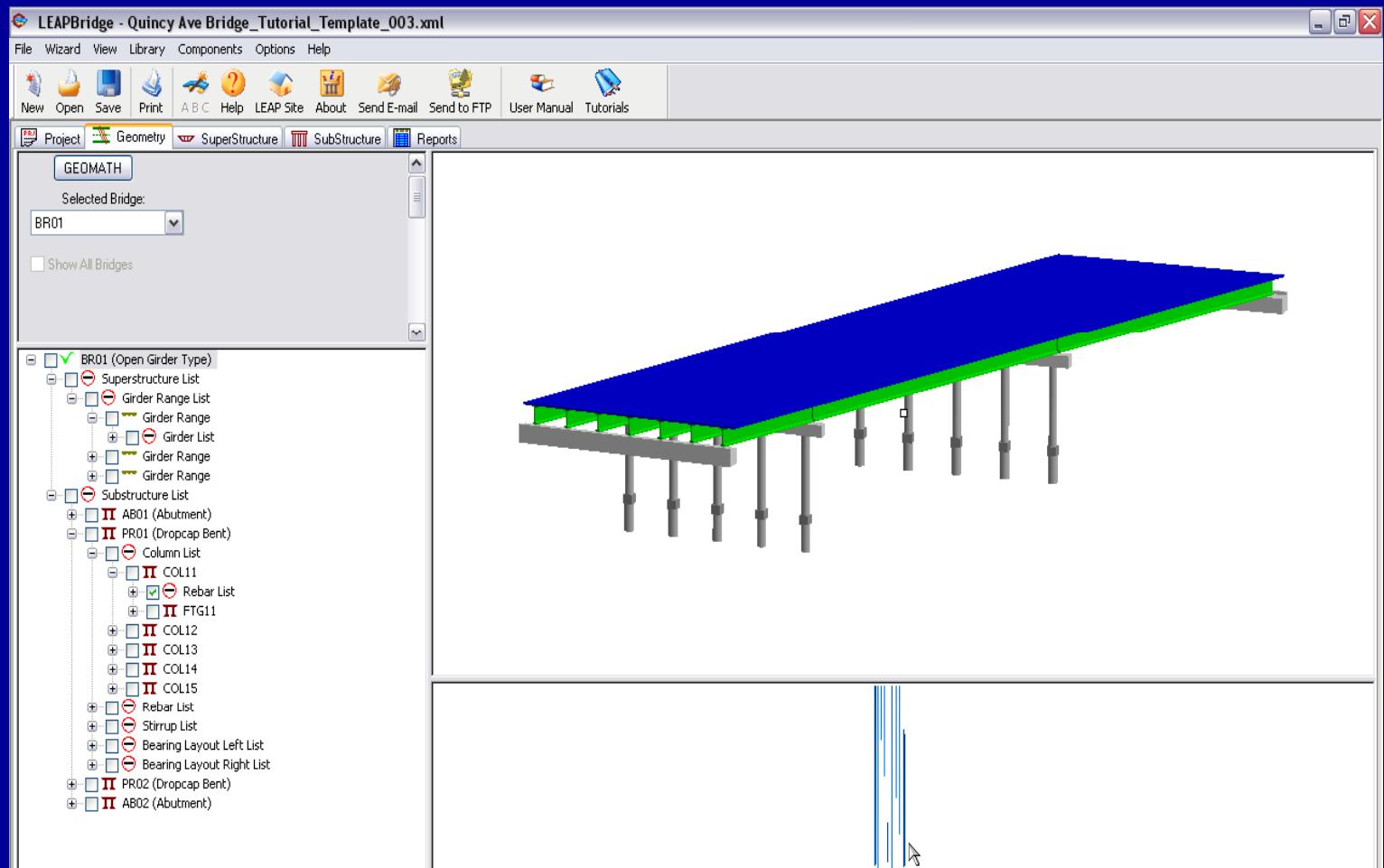
C02 LEAP Conspan to OpisVirtis

3D
model
of
whole
bridge



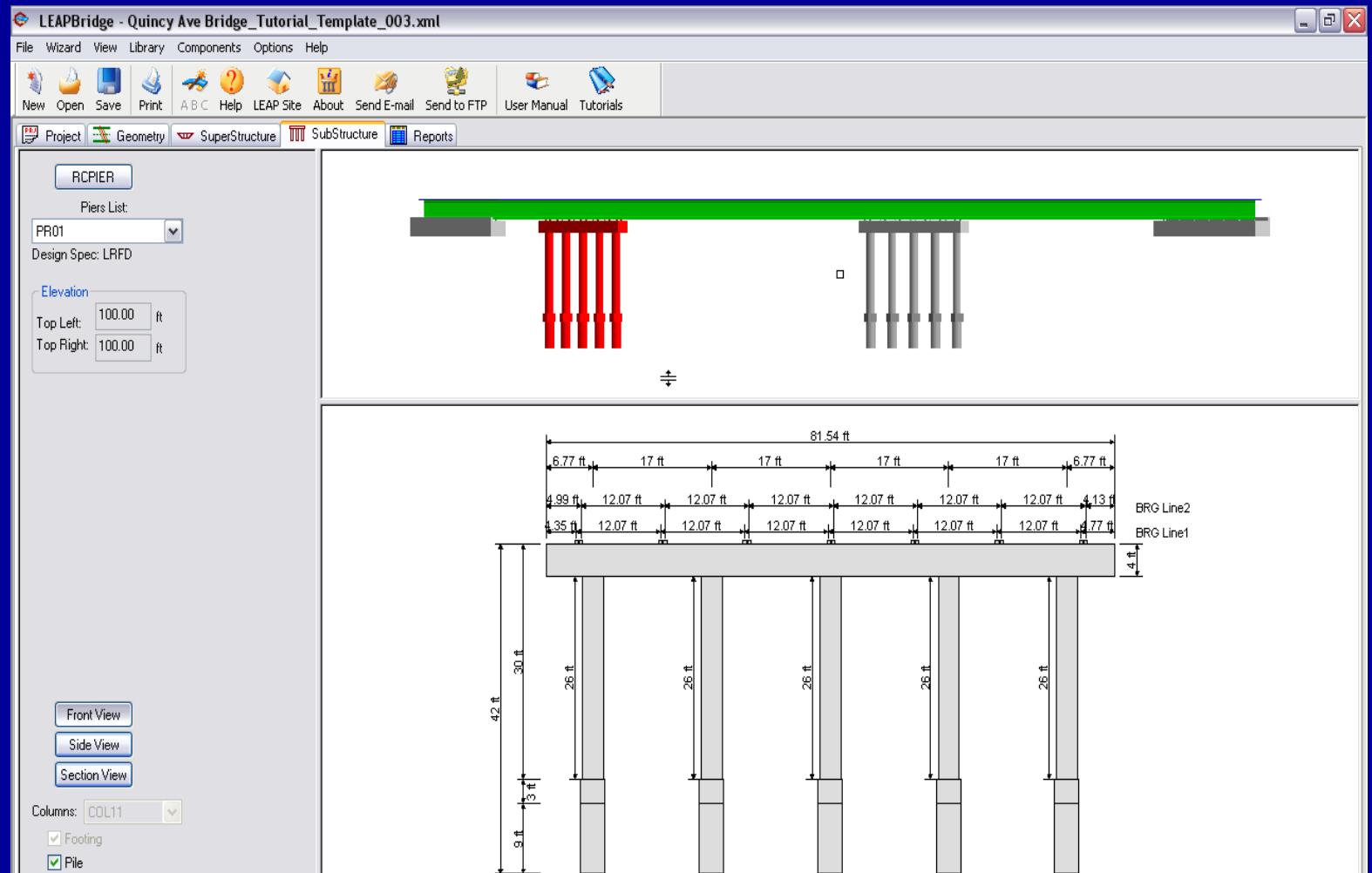
C02 LEAP Conspan to OpisVirtis

3D
model
and
rebar
detailing



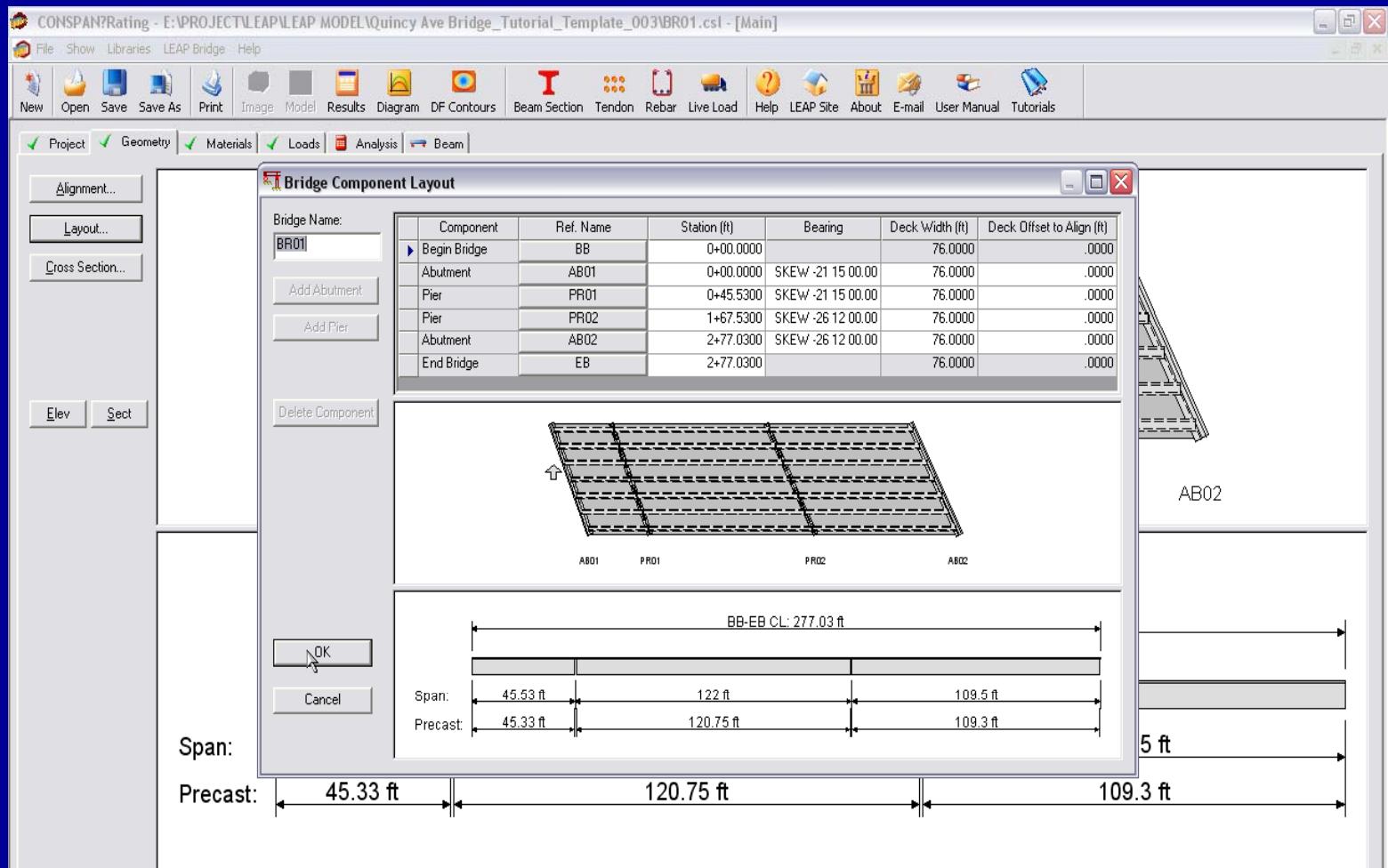
C02 LEAP Conspan to OpisVirtis

3D and
2D
model of
sub-
structure



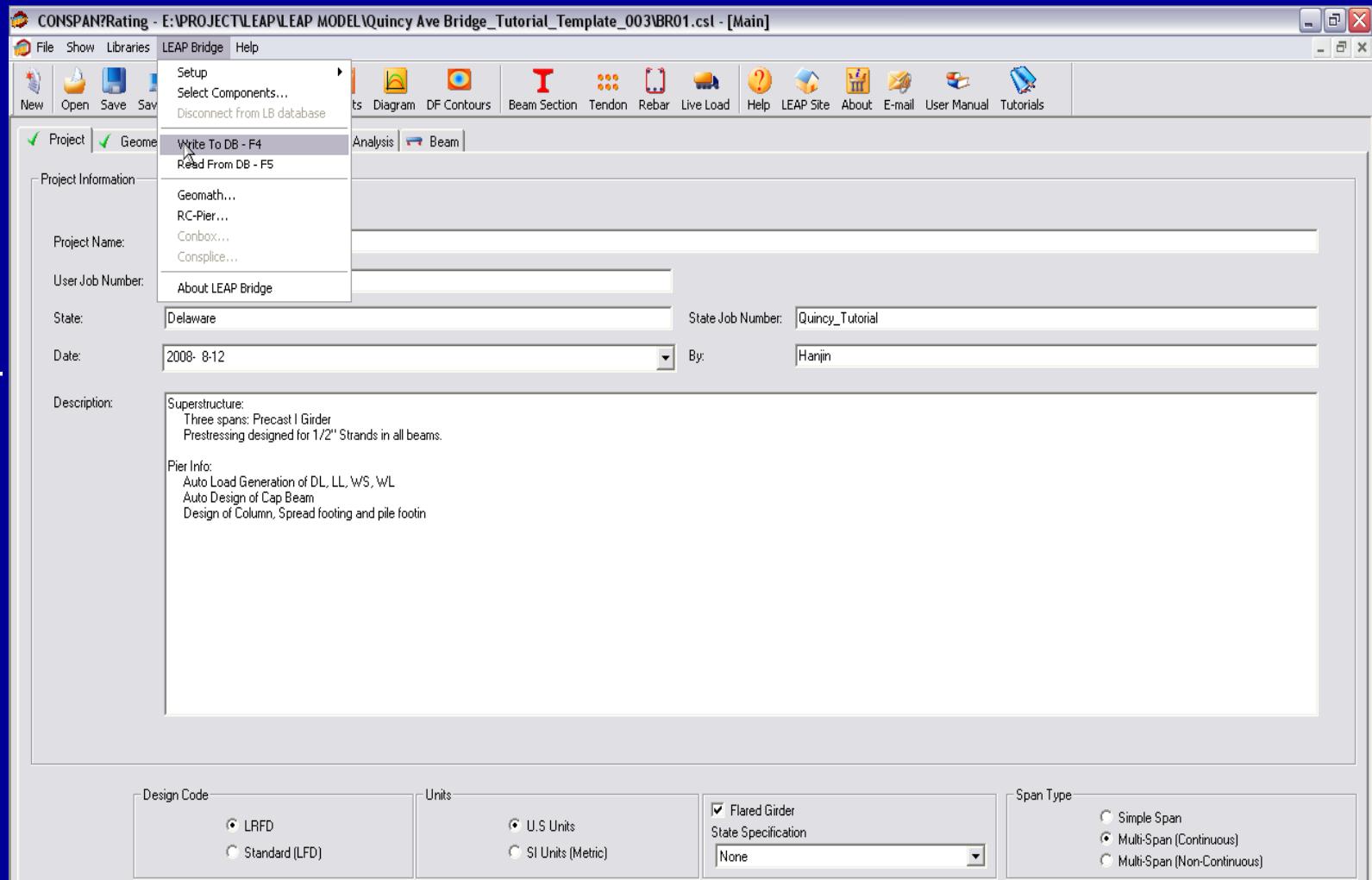
C02 LEAP Conspan to OpisVirtis

Details
of super-
structure



C02 LEAP Conspan to OpisVirtis

Write
super-
structure
data to
LandXML
database



C02 LEAP Conspan to OpisVirtis

Write to
LandXML
file
successfully



C02 LEAP Conspan to OpisVirtis

Find
LandXML
file in
Opis/Virtis

Virtis - [Bridge Explorer (35 Virtis bridges retrieved for the current folder, all rows retrieved)]

File Edit View Bridge Tools Window Help

US Customary

All Bridges

Templates

Sample Bridges

AISI LRFD Example Bridges

Quincy Example

Concrete Example Bridges

Steel Example Bridges

Timber Example Bridges

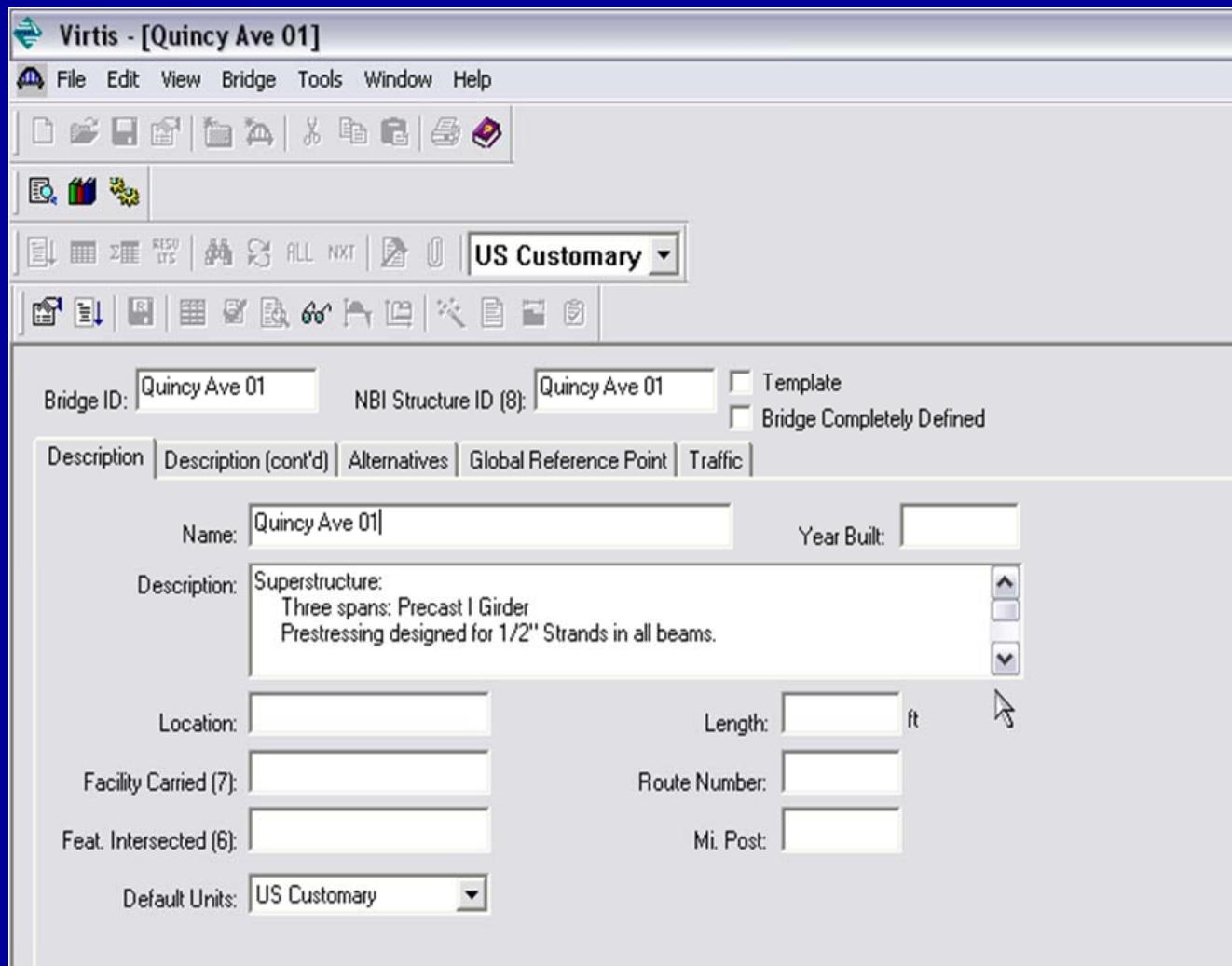
Deleted Bridges

BID	Bridge Id	Bridge Name	District	County	Facility	Location	Route	Feat. Intersected	Mi. Post (mi)	Owner	Maintainer	Area	Length (ft)	Built	
2	TrainingBridge2	Training Bridge 2(LRFD)	-1	-1	N/A	N/A	-1	N/A	0.00	-1		-1	0.00	199	
3	TrainingBridge3	Training Bridge 3(LRFD)	11	01	I-79	Pittsburg	0079	Ohio River	125.00	1	1	-1	455.00	199	
4	PCITrainingBridge1	PCI TrainingBridge1(LFD)					-1		0.00			-1	0.00	0	
5	PCITrainingBridge2	PCI TrainingBridge2(LRFD)					-1		0.00			-1	0.00	0	
6	PCITrainingBridge3	PCI TrainingBridge3(LFD)					-1		0.00			-1	0.00	0	
7	PCITrainingBridge4	PCI TrainingBridge4(LRFD)					-1		0.00			-1	0.00	0	
8	PCITrainingBridge5	PCI TrainingBridge5(LFD)					-1		0.00			-1	0.00	0	
9	PCITrainingBridge6	PCI TrainingBridge6(LRFD)					-1		0.00			-1	0.00	0	
10	Example7	Example 7 PS (LFD)					-1		0.00			-1	0.00	0	
11	RCTrainingBridge1	RC Training Bridge1(LFD)					-1		0.00			-1	0.00	0	
12	TimberTrainingBridge1	Timber Tr. Bridge1 (ASD)					-1		0.00			-1	0.00	0	
13	FSys GFS TrainingBridge1	FloorSystem GFS Training Bridge 1	06	15	NJ-Tur	NJCity	-1		0.00			-1	0.00	200	
14	FSys FS TrainingBridge2	FloorSystem FS Training Bridge 2	11	333	I-95	NYC	-1		0.00	1	2	-1	0.00	199	
15	FSys GF TrainingBridge3	FloorSystem GF Training Bridge 3	07	06	I-95	ATL	-1		0.00	2		-1	0.00	199	
16	FLine GFS TrainingBridge1	FloorLine GFS Training Bridge 1	01	01	I-75	JAX	-1		0.00	1	1	-1	0.00	200	
17	FLine FS TrainingBridge2	FloorLine FS Training Bridge 2	02	02	I-75	GNV	-1		0.00	1	1	-1	0.00	200	
18	FLine GF TrainingBridge3	FloorLine GF Training Bridge 3	01	01	I-95	NY	15		2200.00	2	-1	-1	0.00	199	
19	TrussTrainingExample	Truss Training Example					5		0.00				0.00	193	
20	LRFD Substructure Example 1	LRFD Substructure Example 1							0.00				0.00	0	
21	LRFD Substructure Example 2	LRFD Substructure Example 2					SR 403	ERIE CO	4034	FOUR MILE			1095.8	200	
22	LRFD Substructure Example 3	LRFD Substructure Example 3							0.00				0.00	0	
23	LRFD Substructure Example 4	LRFD Substructure Example 4 (NHI)							-1	0.00			240.00	200	
24	Visual Reference 1	Visual Reference 1	01	12	I-76	\WAITSFI	I-76	MAD RIVER	1199.25	1	1	-1	168.00	193	
25	Quincy Ave. Bridge_HHJ	Quincy Avenue Bridge Over I-25 & LRT					-1		0.00				280.00	200	
28	Quincy Ave._HHJ_02	Quincy Avenue Bridge Over I-25 & LRT					-1		0.00				280.00	200	
29	Quincy Ave._HHJ_03	Quincy Avenue Bridge Over I-25 & LRT					-1		0.00				280.00	200	
30	Quincy Ave. Bridge	Quincy Ave. Bridge							0.00				0.00	0	
34	AASHTO to LEAP	Quincy Avenue Bridge Over I-25 & LRT					-1		0.00				277.00	200	
35	AASHTO to LEAP 02	Quincy Avenue Bridge Over I-25 & LRT					-1		0.00				280.00	200	
36	Quincy Ave._HHJ_Modified	Quincy Avenue Bridge Over I-25 & LRT					0051		0.00				280.00	200	
37	001	Quincy Avenue bridge over I-25 & LRT							0.00				0.00	200	
38	Quincy_Ave_LRF	Quincy Ave Bridge LRFD Design					SR 005	Delawar	0051	SR 6060	17.00	1	-2	277.00	200
39	Quincy_Ave_LRFD_stee	Quincy Ave Bridge LRFD Design					SR 005	Delawar	0051	SR 6060	17.00	1	-2	277.00	200
40	Quincy_Ave_LRFD_Concrete	Quincy Ave Bridge LRFD Design Concrete					SR 005	Delawar	0051	SR 6060	17.00	1	-2	277.00	200
42	Quincy Ave 01	Quincy Ave 01							0.00				0.00	0	



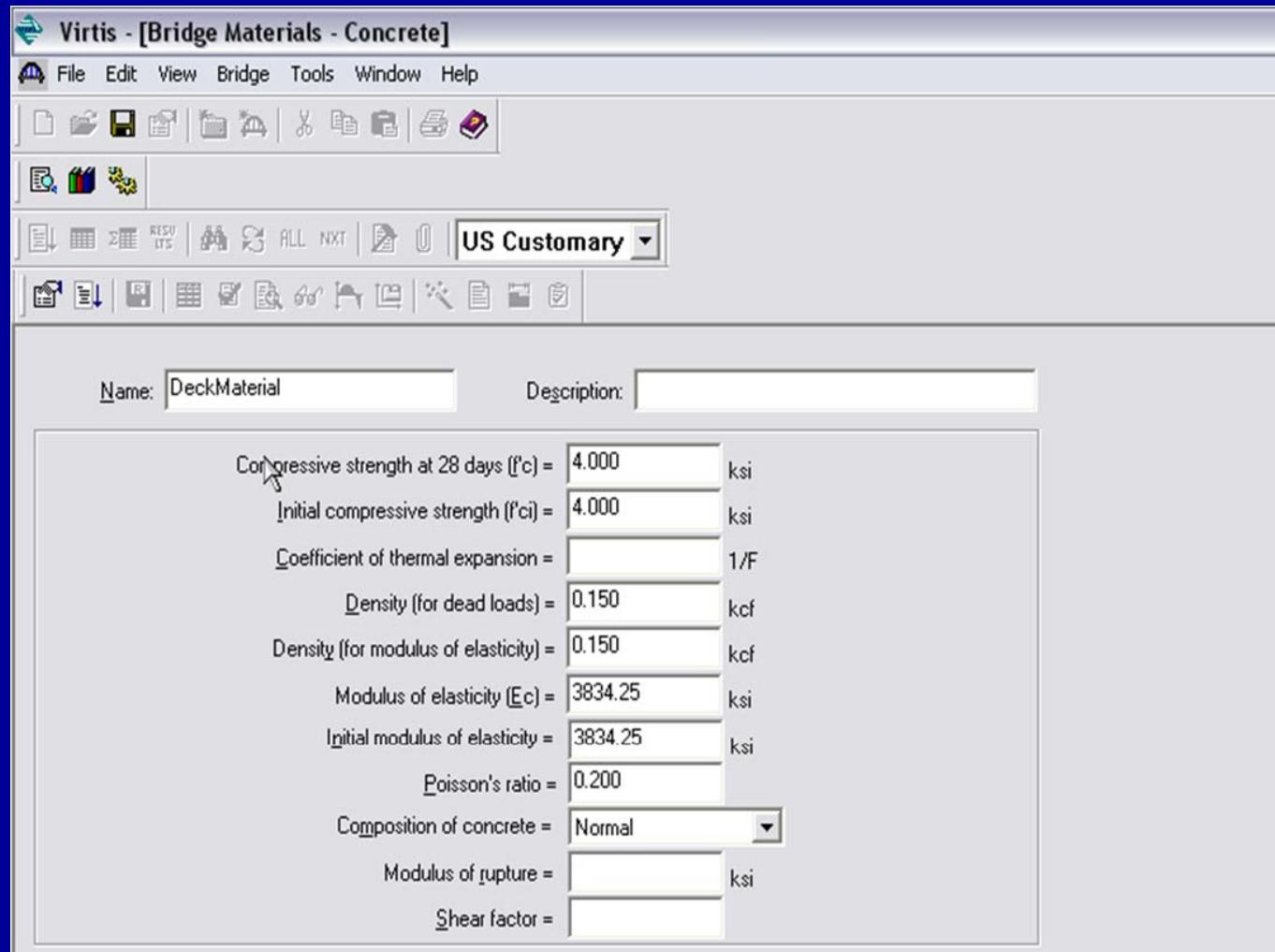
C02 LEAP Conspan to OpisVirtis

Project
description
created in
LEAP



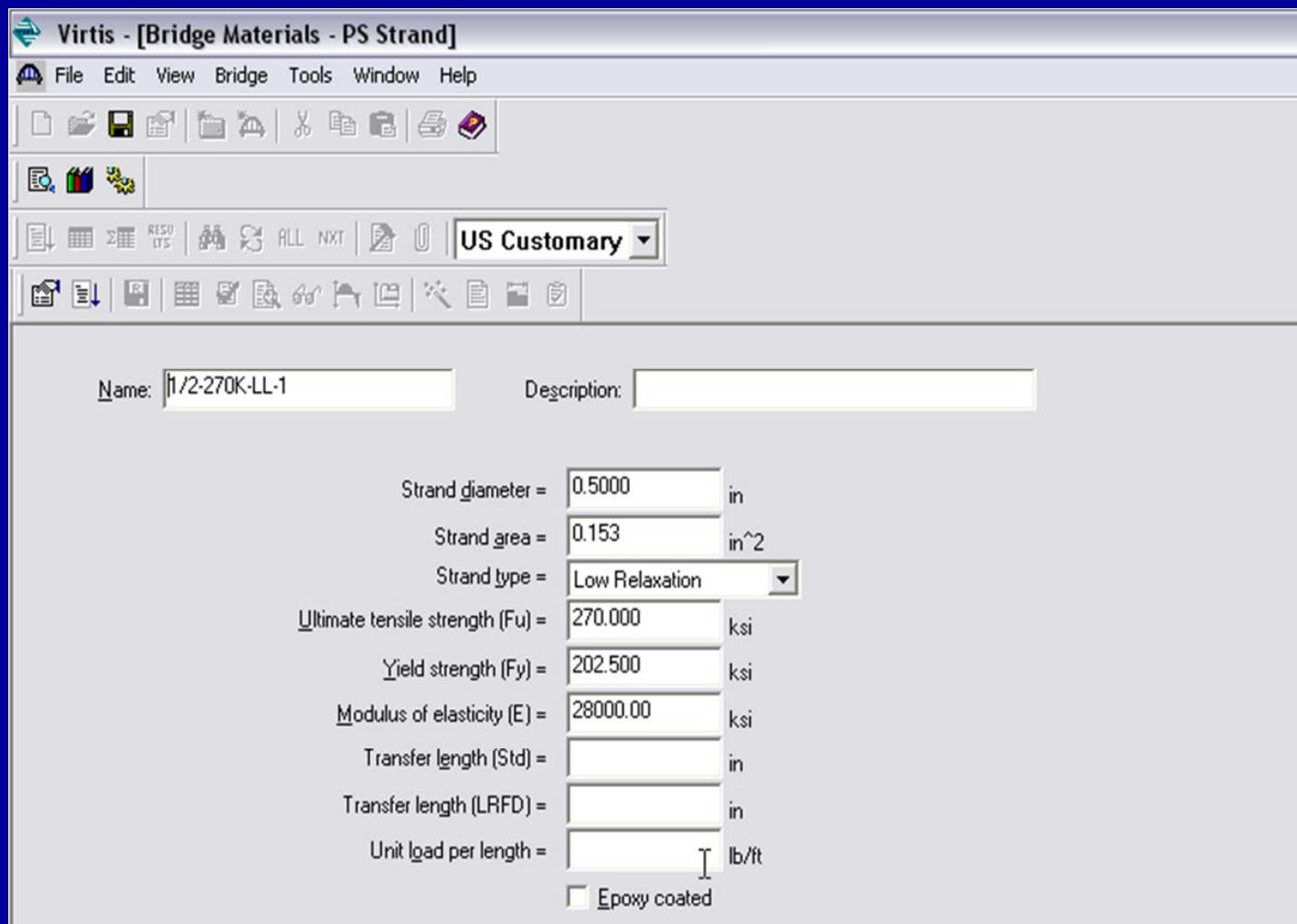
C02 LEAP Conspan to OpisVirtis

Material properties created in LEAP



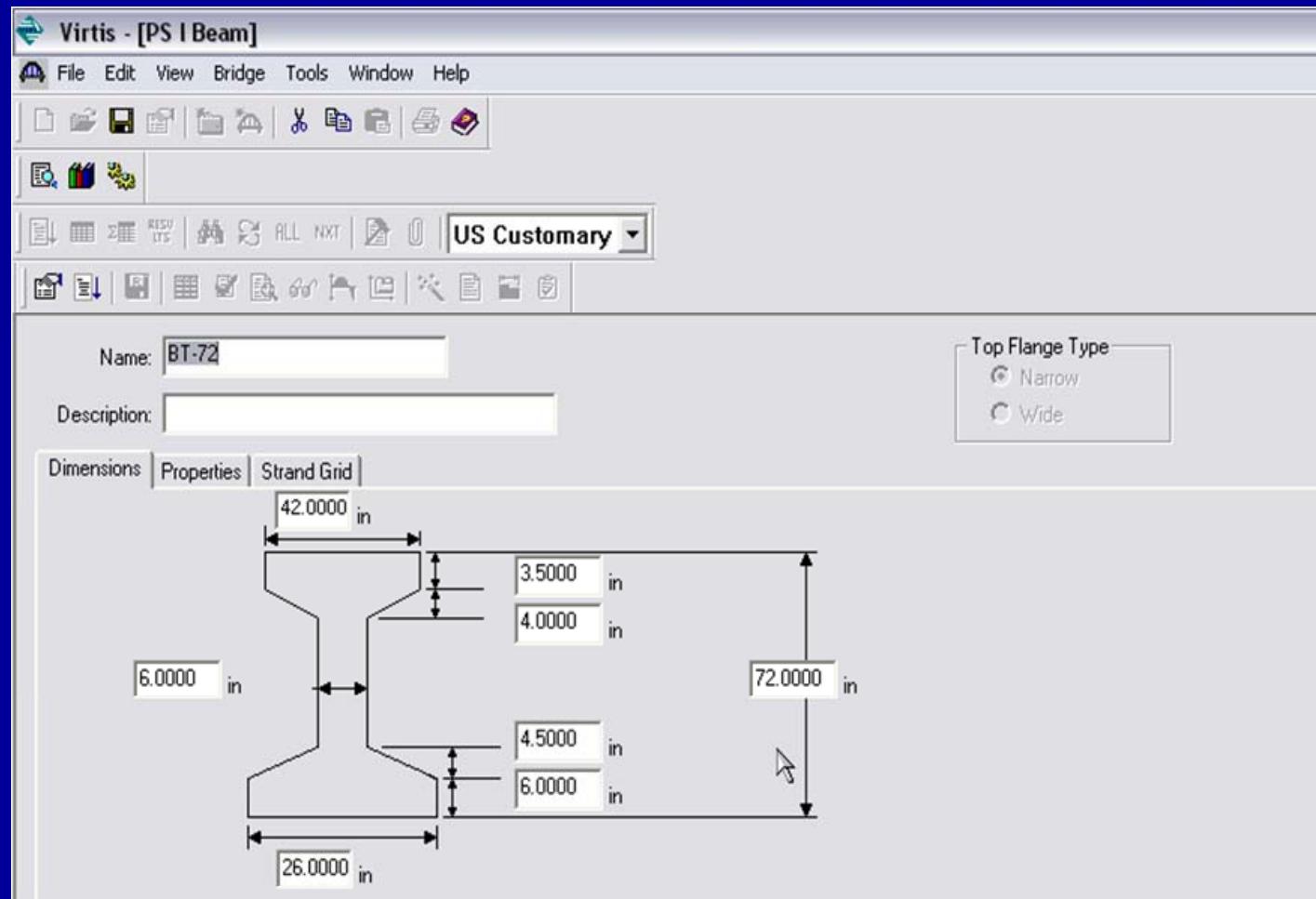
C02 LEAP Conspan to OpisVirtis

Strand properties created in LEAP



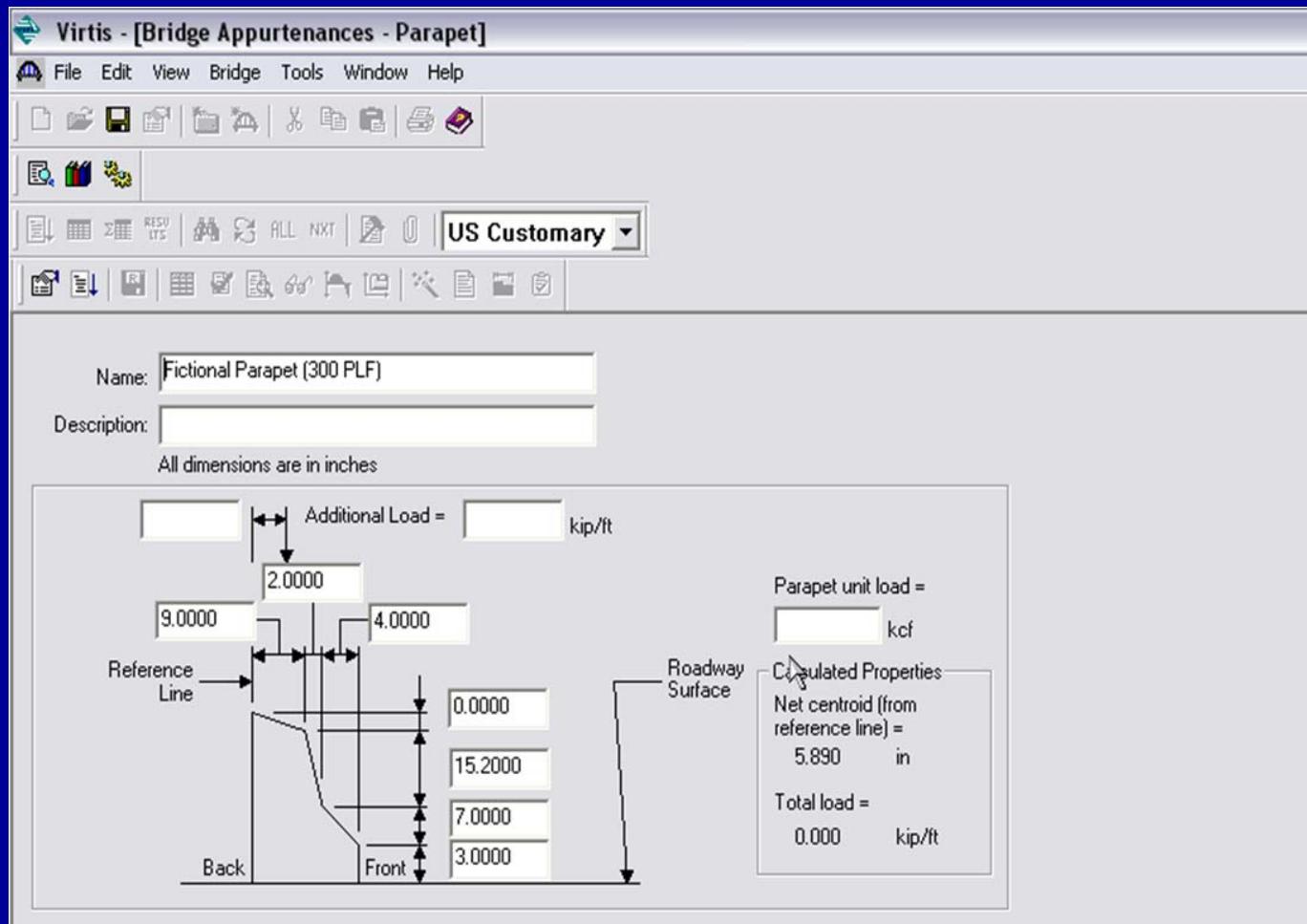
C02 LEAP Conspan to OpisVirtis

Beam
section
properties
created in
LEAP



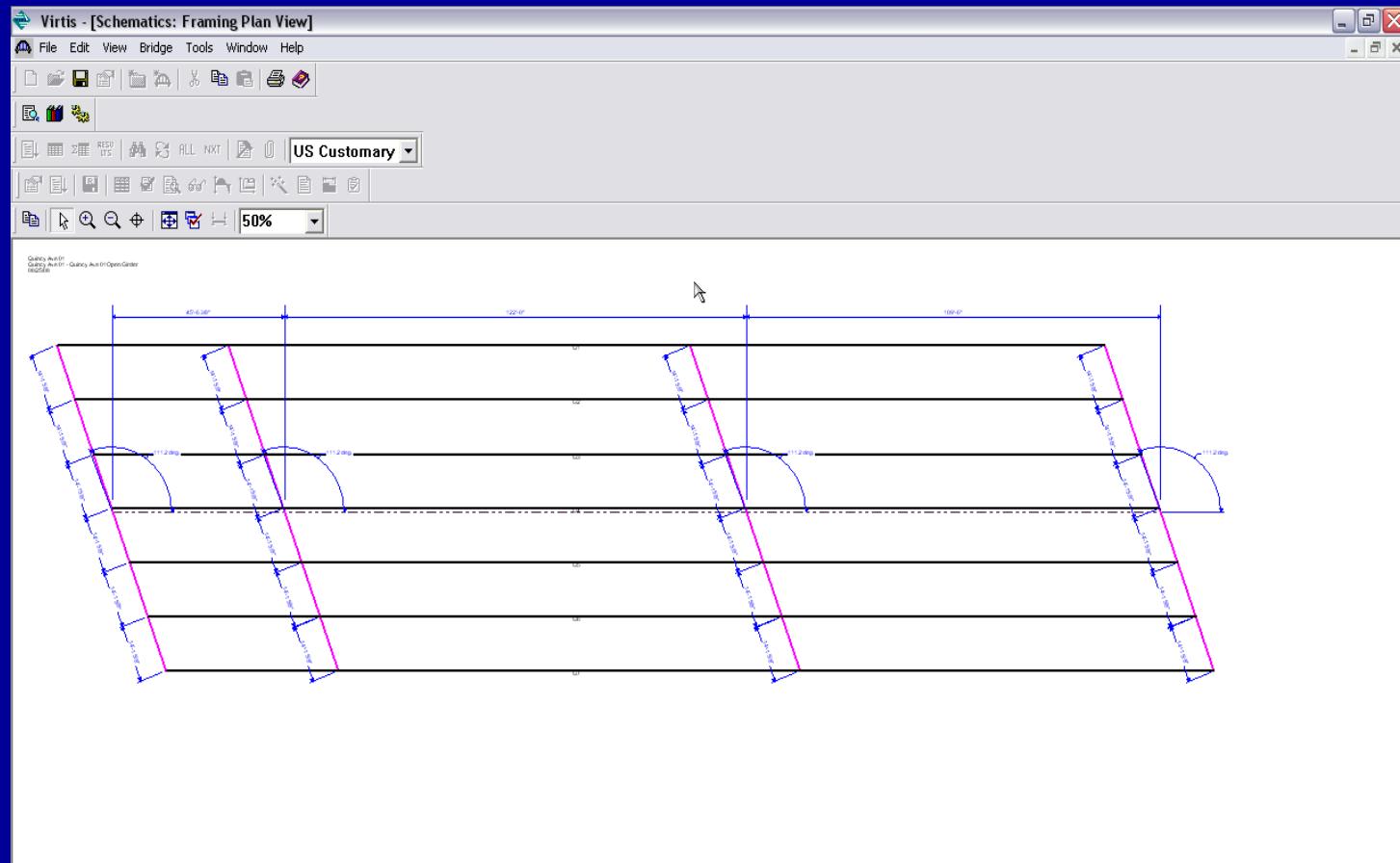
C02 LEAP Conspan to OpisVirtis

Parapet
properties
created in
LEAP



C02 LEAP Conspan to OpisVirtis

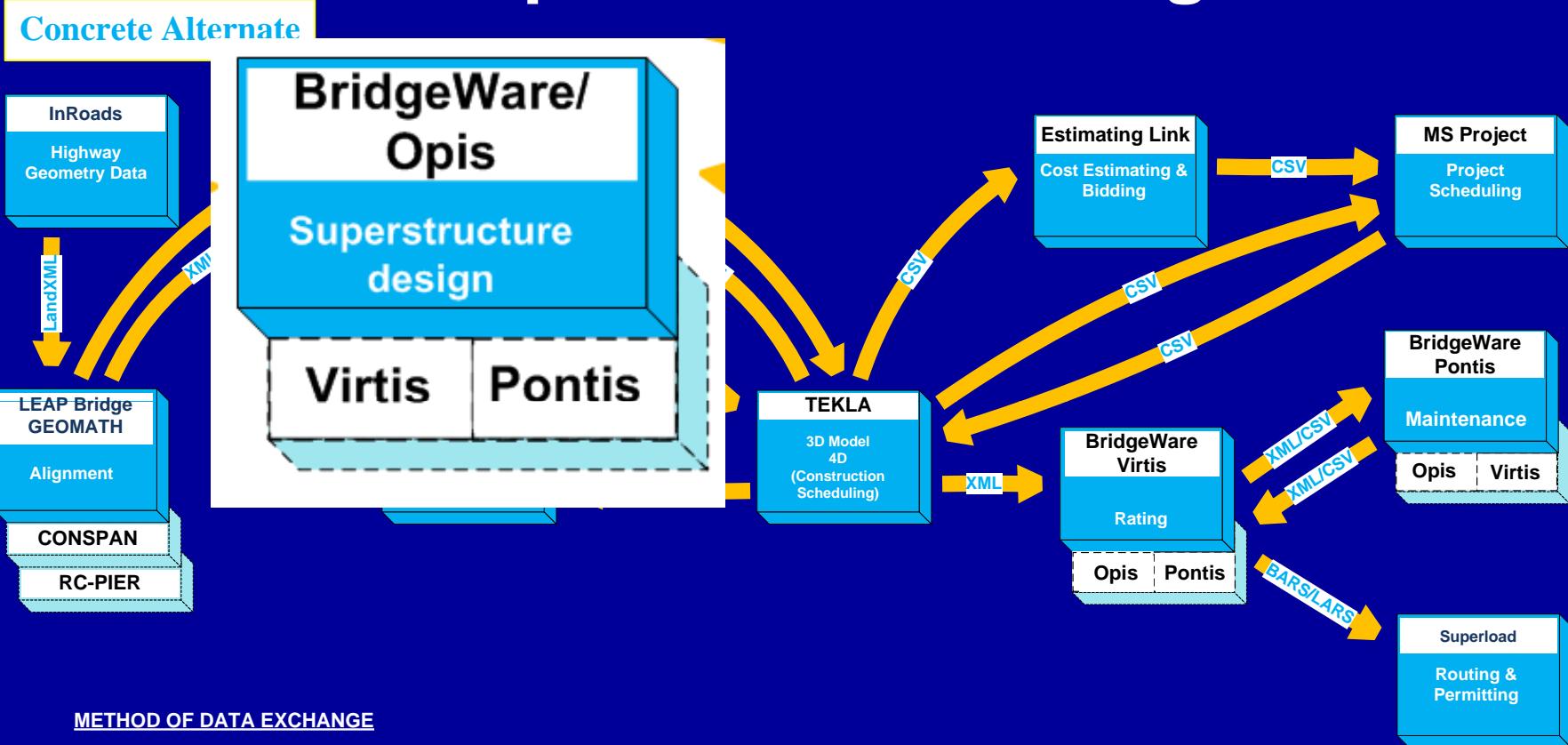
Girder
layout and
skewed
angles



Opis Concrete Design



C03 Opis Concrete Design



METHOD OF DATA EXCHANGE

TXT – TEXT FILE

XML – EXTENSIBLE MARKUP LANGUAGE

LANDXML – LAND EXTENSIBLE MARKUP LANGUAGE

VBA – VISUAL BASIC FOR APPLICATIONS

CSV – COMMA SEPARATED VALUES

BARS/LARS – AASHTOWARE AND BENTLEY SOFTWARE



C03 Opis Concrete Design

Open Opis
XML file of
Quincy
Avenue
Bridge

Bridge inventory in Opis.

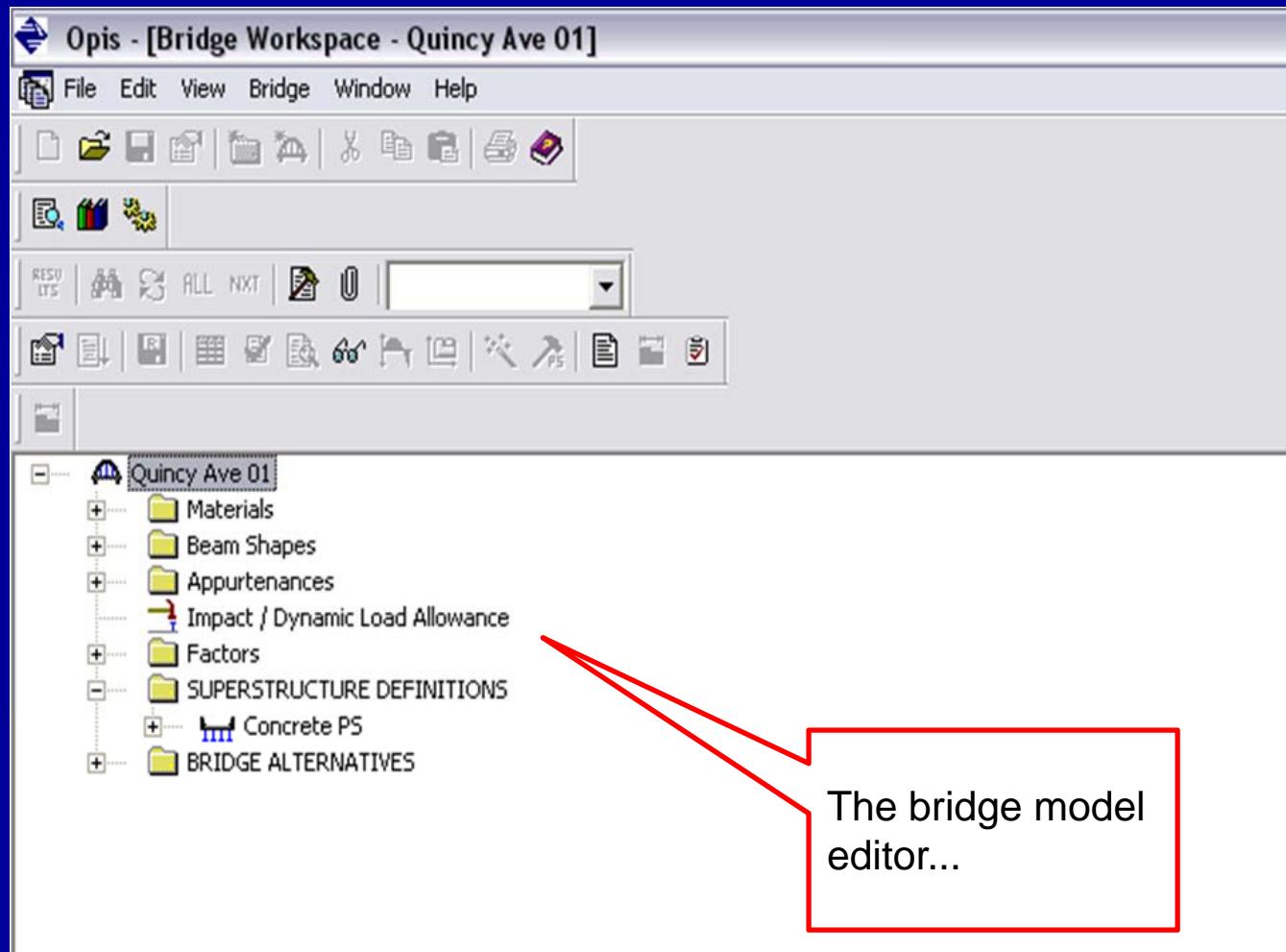
Bl	Bridge Id	Bridge Name	District	County	Facility	Location	Route	Feat. Intersected	Mi. Post (mi)	Owner	Maintainer	Area	Length (ft)	Built	
5	PCITrainingBridge2	PCI TrainingBr					-1		0.00			-1	0.00	0	
6	PCITrainingBridge3	PCI TrainingBr					-1		0.00			-1	0.00	0	
7	PCITrainingBridge4	PCI TrainingBr					-1		0.00			-1	0.00	0	
8	PCITrainingBridge5	PCI TrainingBr					-1		0.00			-1	0.00	0	
9	PCITrainingBridge6	PCI TrainingBr					-1		0.00			-1	0.00	0	
1	Example7	Example 7 P					-1		0.00			-1	0.00	0	
1	RCTrainingBridge1	RC Training					-1		0.00			-1	0.00	0	
1	TimberTrainingBridge1	Timber Tr.					-1		0.00			-1	0.00	0	
1	FSys GFS TrainingBridge1	FloorSystem 06	15	NJ-Tur	NYC	-1			0.00			-1	0.00	200	
1	FSys FS TrainingBridge2	FloorSystem 11	333	I-95	NYC	-1			0.00	1	2	-1	0.00	199	
1	FSys GF TrainingBridge3	FloorSystem 07	06	I-95	ATL	-1			0.00	2		-1	0.00	199	
1	FLine GFS TrainingBridge1	FloorLine GF 01	01	I-75	JAX	-1			0.00	1	1	-1	0.00	200	
1	FLine FS TrainingBridge2	FloorLine FS 02	02	I-75	GNV	-1			0.00	1	1	-1	0.00	200	
1	FLine GF TrainingBridge3	FloorLine GF 01	01	I-95	NY	15			2200.00	2	-1	-1	0.00	199	
1	TrussTrainingExample	Truss Trainin						5						0.00	193
2	LRFD Substructure Example 1	LRFD Substr												0.00	0
2	LRFD Substructure Example 2	LRFD Substr		SR 403	ERIE CO	4034	FOUR MILE		8.12					1095.8	200
2	LRFD Substructure Example 3	LRFD Substr												0.00	0
2	LRFD Substructure Example 4	LRFD Substr						-1						240.00	200
2	Visual Reference 1	Visual Refer	01	12	I-76	\WAITSFI	I-76	MAD RIVER	1199.25	1	1	-1	168.00	193	
2	Quincy Ave_Bridge_HHJ	Quincy Aven					-1		0.00					280.00	200
2	Quincy Ave_HHJ_02	Quincy Aven					-1		0.00					280.00	200
2	Quincy Ave_HHJ_03	Quincy Aven					-1		0.00					280.00	200
3	Quincy Ave_Bridge	Quincy Ave.												0.00	0
3	AASHTO to LEAP	Quincy Aven					-1		0.00					277.00	200
3	AASHTO to LEAP 02	Quincy Aven					-1		0.00					280.00	200
3	Quincy Ave_HHJ_Modified	Quincy Aven						0051						280.00	200
3	001	Quincy Aven												0.00	200
3	Quincy_Ave_LRFD	Quincy Ave		SR 005	Delawar	0051	SR 6060		17.00	1	1	-2	277.00	200	
3	Quincy_Ave_LRFD_stee	Quincy Ave		SR 005	Delawar	0051	SR 6060		17.00	1	1	-2	277.00	200	
4	Quincy Ave	Quincy Ave		SR 005	Delawar	0051	SR 6060		17.00	1	1	-2	277.00	200	

The bridge model we
just imported...



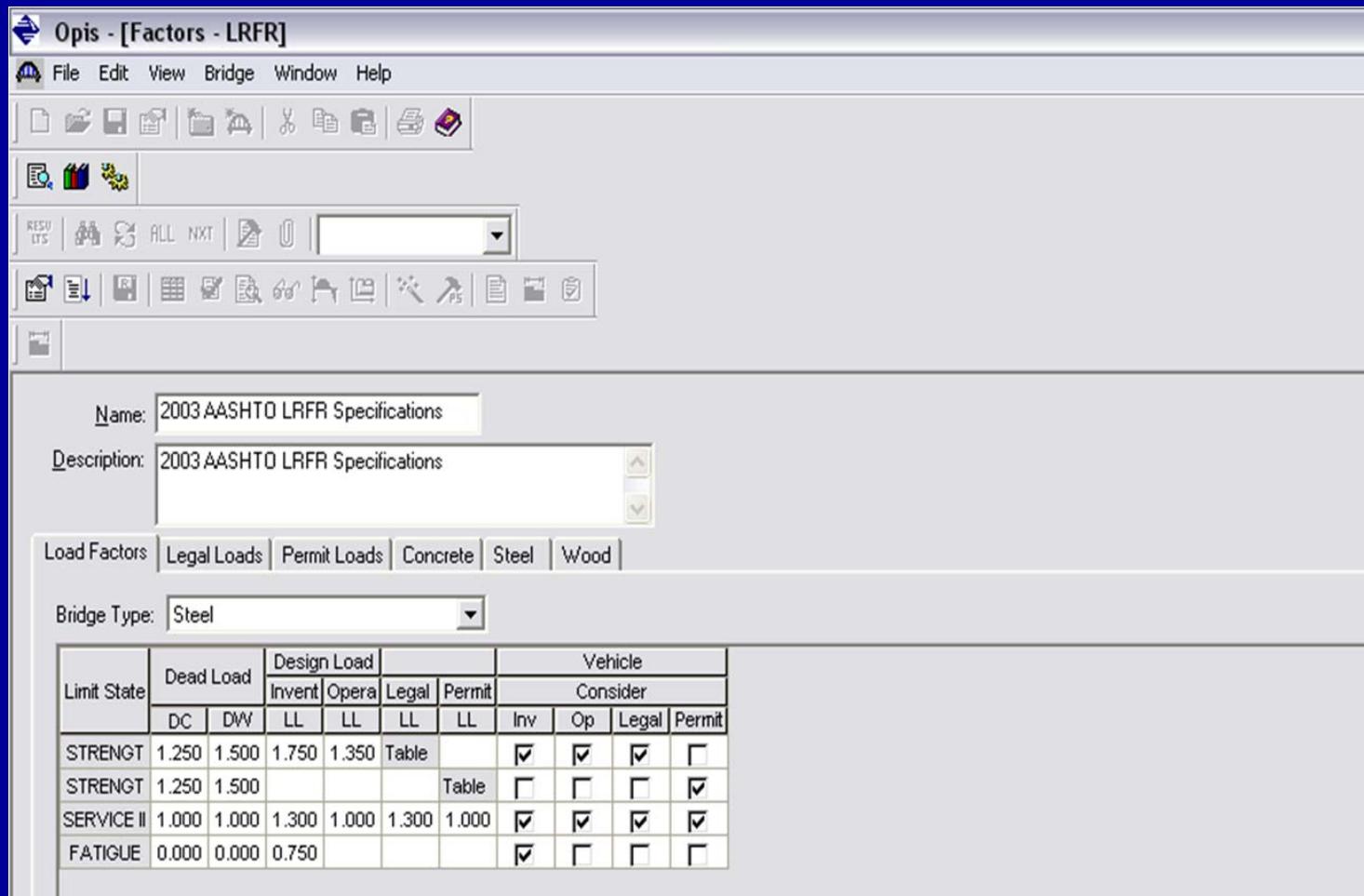
C03 Opis Concrete Design

Quincy
Avenue
Bridge file
created in
LEAP



C03 Opis Concrete Design

Define
LRFR
factors
and
LRFD
factors



C03 Opis Concrete Design

Define
LRFR
factors and
LRFD
factors

Name: 2003 AASHTO LRFR Specifications

Description: 2003 AASHTO LRFR Specifications

Load Factors | Legal Loads | Permit Loads | Concrete | Steel | Wood |

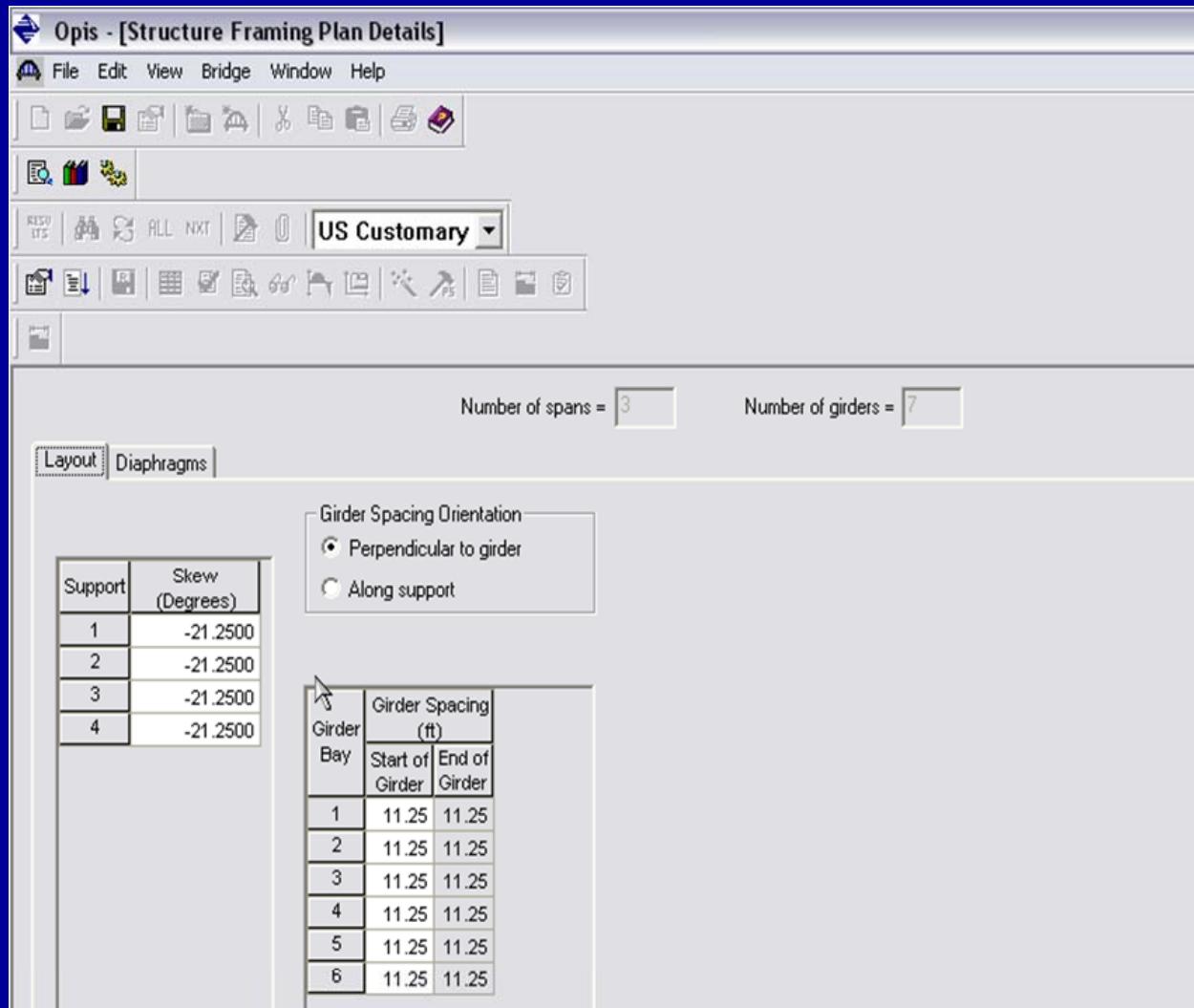
Resistance factors for steel:

Resistance	Resistance Factor
Flexure	1.000
Shear	1.000
Axial Compression: Steel only	0.900
Axial Compression: Composite	0.900
Tension: Fracture on net section	0.800
Tension: Yielding on gross section	0.950
Bearing on pins	1.000
Bolts bearing on material	0.800
Shear connectors	0.850
ACI 318-16 Table 16.1.1	0.900



C03 Opis Concrete Design

Define
girder
spacing
and skew
angle



C03 Opis Concrete Design

Define diaphragms spacing, number and location

Opis - [Structure Framing Plan Details]

File Edit View Bridge Window Help

RESU LTS ALL NXT US Customary

Number of spans = 3 Number of girders = 7

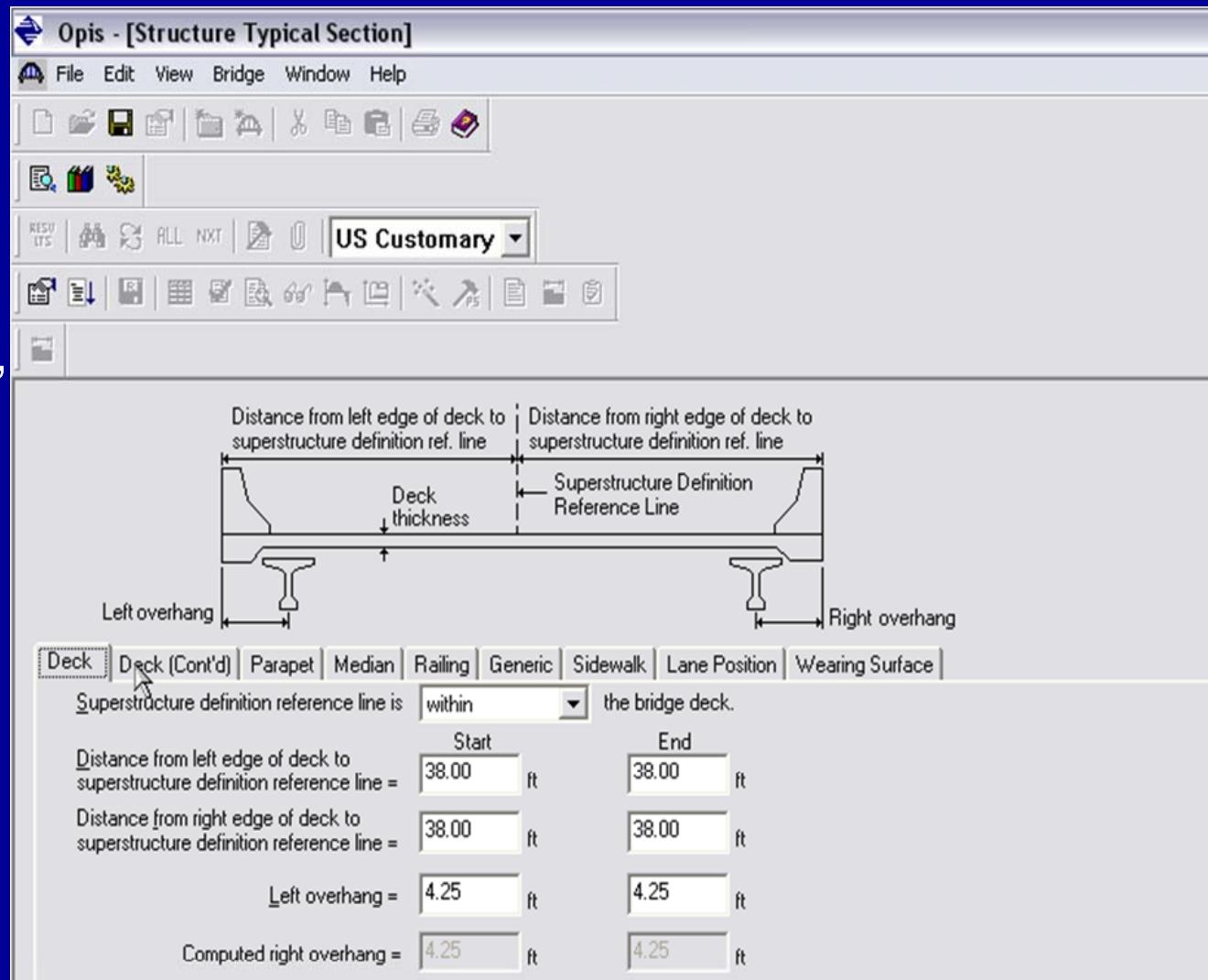
Girder Bay: 1 Copy Bay To... Diaphragm Wizard...

Support Number	Start Distance (ft)		Diaphragm Spacing (ft)	Number of Spaces	Length (ft)	End Distance (ft)		Load (kip)
	Left Girder	Right Girder				Left Girder	Right Girder	
1	0.00	0.00	0.00	1	0.00	0.00	0.00	
1	23.50	19.07	0.00	1	0.00	23.50	19.07	
2	0.00	0.00	0.00	1	0.00	0.00	0.00	
2	20.50	16.07	0.00	1	0.00	20.50	16.07	
2	20.50	16.07	20.50	4	82.00	102.50	98.07	
3	0.00	0.00	0.00	1	0.00	0.00	0.00	
3	18.30	13.87	0.00	1	0.00	18.30	13.87	
3	18.30	13.87	18.25	4	73.00	91.30	86.87	
3	109.50	109.50	0.00	1	0.00	109.50	109.50	



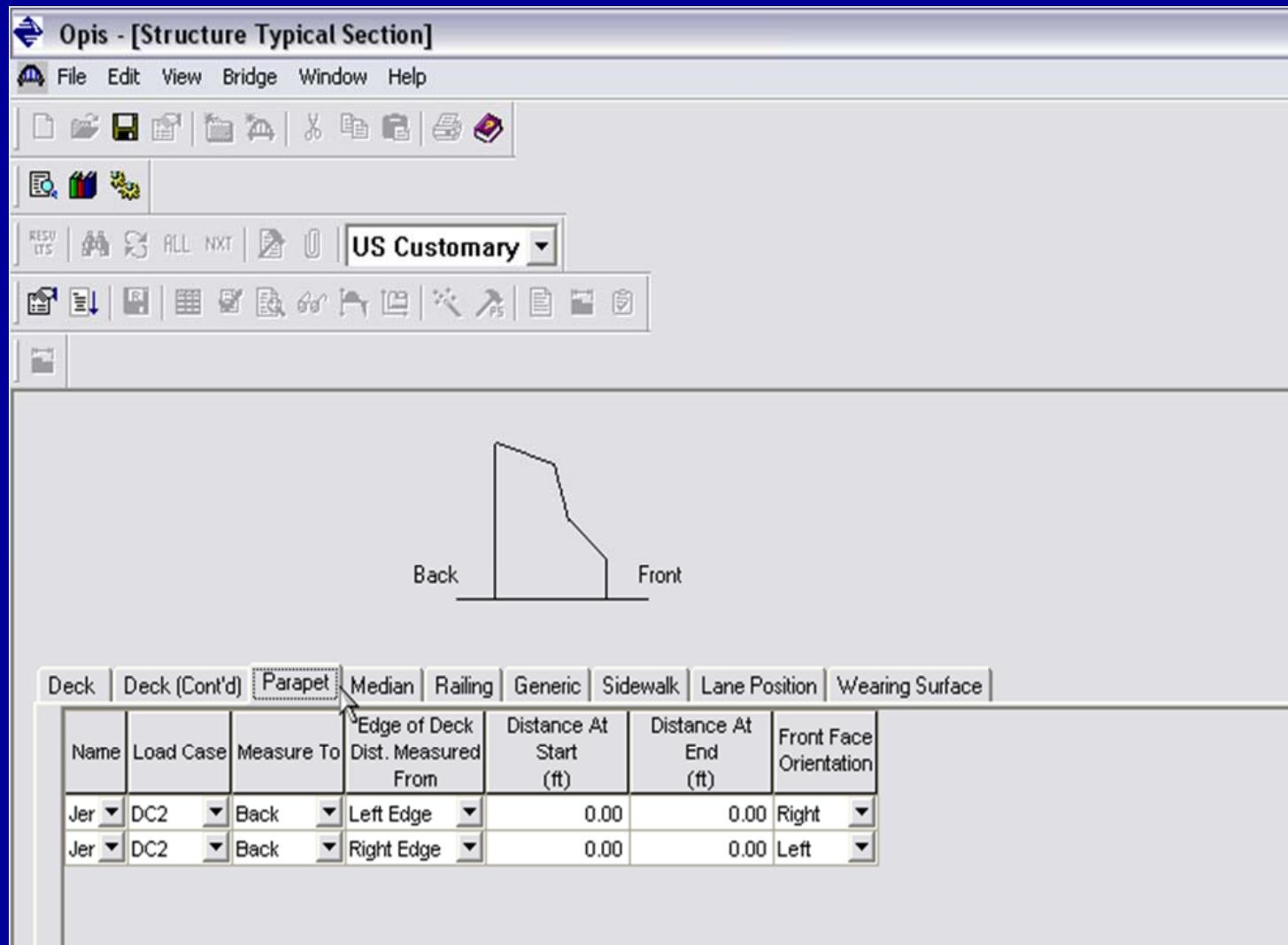
C03 Opis Concrete Design

Define super-structure: deck width, depth, overhang width



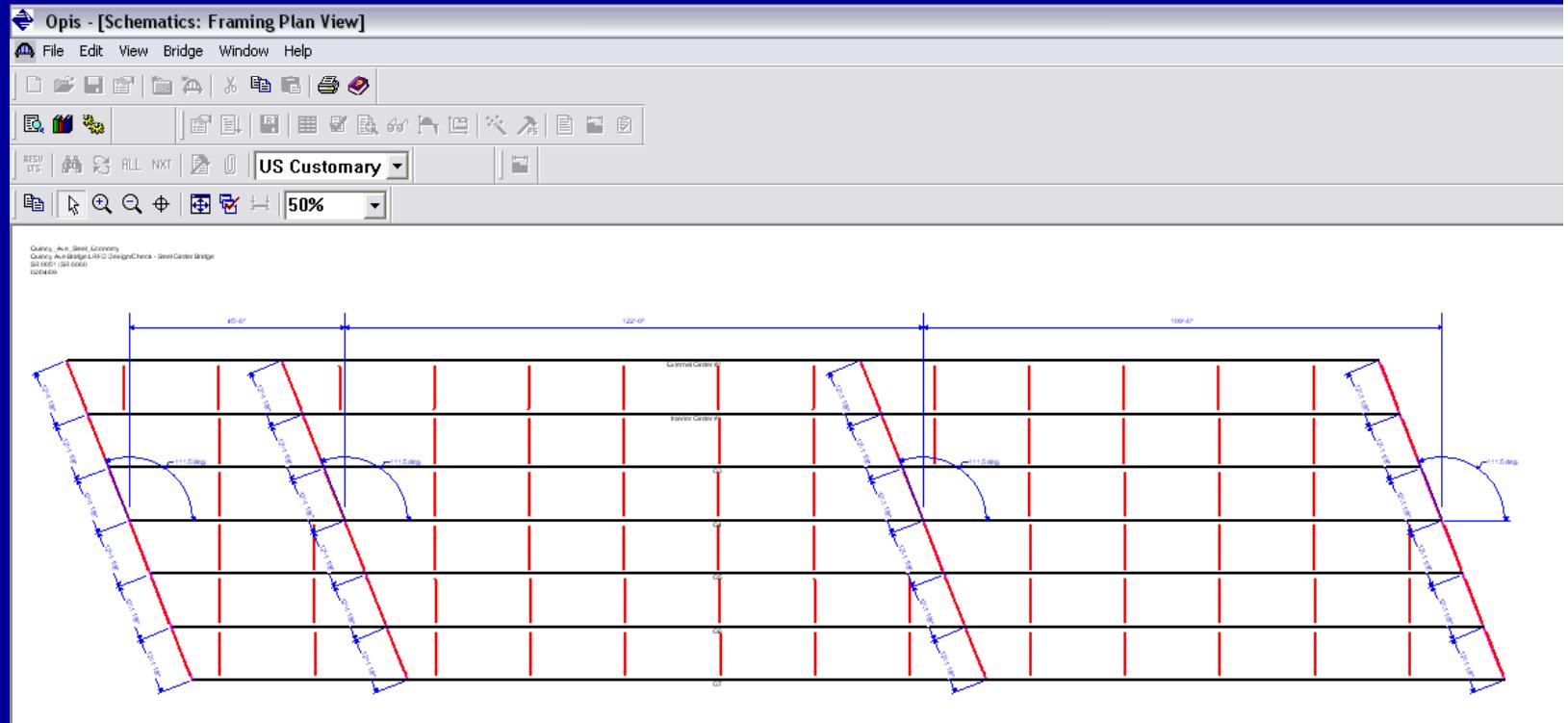
C03 Opis Concrete Design

Define
parapet:
load case
and
location



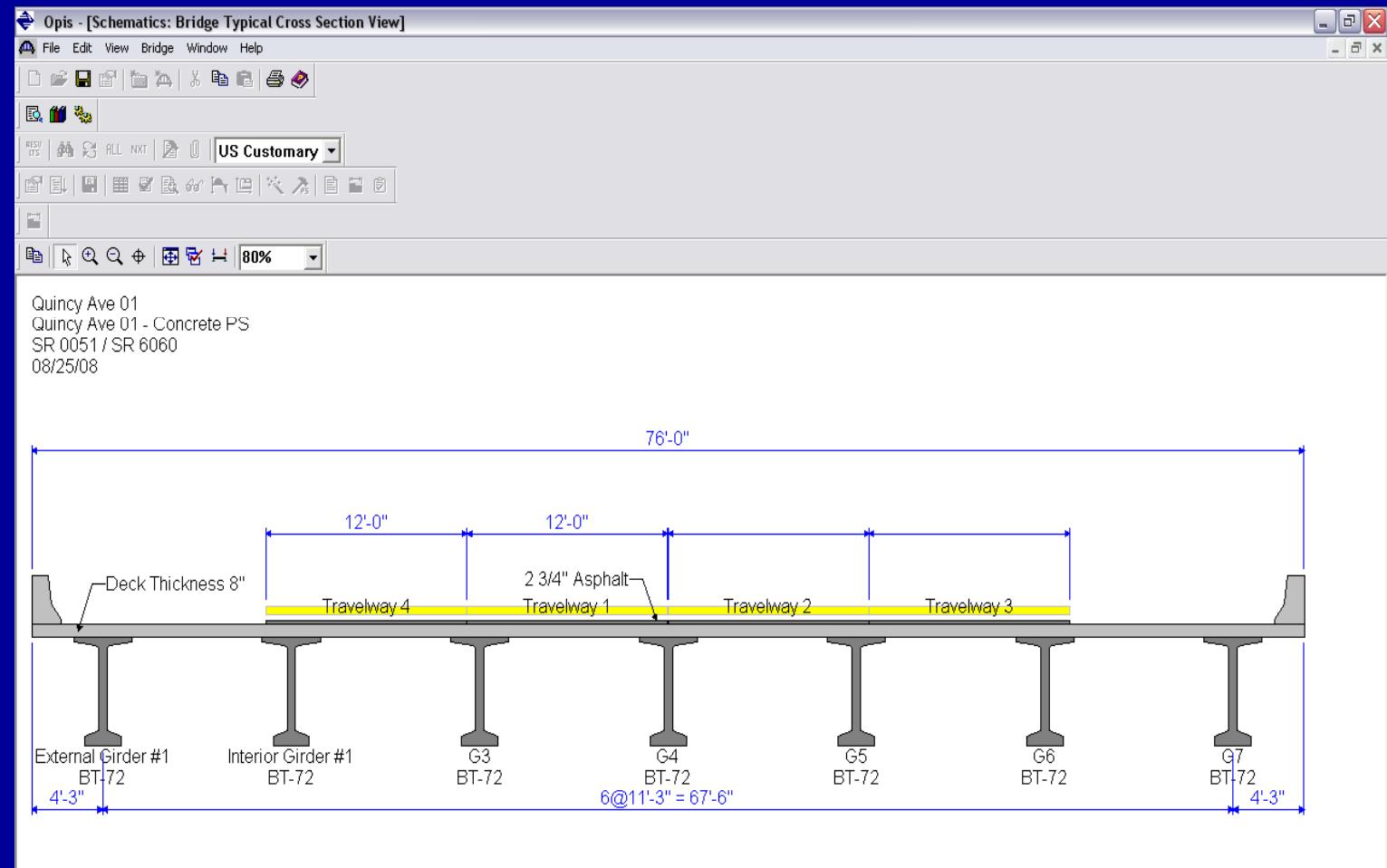
C03 Opis Concrete Design

Super-structure framing plan view



C03 Opis Concrete Design

Super-
structure:
front view



C03 Opis Concrete Design

Define girder profile: girder shape, material and prestress properties

The screenshot shows the Opis software interface titled "Opis - [Beam Details]". The menu bar includes File, Edit, View, Bridge, Window, and Help. The toolbar contains various icons for file operations like Open, Save, Print, and Undo. A language dropdown menu shows "US Customary". Below the toolbar is another set of icons for document management. The main window has tabs at the top: Span Detail (selected), Continuous Support Detail, Stress Limit Ranges, Slab Interface, and Continuity Diaphragm. A table below lists beam properties for three spans:

Span Number	Beam Shape	Girder Material	Prestress Properties	Use Creep	n	Beam Projection	
						Left End (in)	Right End (in)
1	BT-72	Class A	Wizard PS Properti	No	7.82	6.0000	6.0000
2	BT-72	Class A	Wizard PS Properti	No	7.82	6.0000	6.0000
3	BT-72	Class A	Wizard PS Properti	No	7.82	6.0000	6.0000



C03 Opis Concrete Design

Define deck:
material
and reinforce-
ment

Material	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Std Bar Count	LRFD Bar Count	Bar Size	Distance (in)	Row	Bar Spacing (in)
Grad	1	0.00	45.50	45.50		70.00	10	2.0000	Top of Slab	11.8
Grad	1	0.00	45.50	45.50		70.00	10	2.0000	Bottom of Slab	11.8
Grad	2	0.00	122.00	122.00		70.00	10	2.0000	Top of Slab	11.8
Grad	2	0.00	122.00	122.00		70.00	10	2.0000	Bottom of Slab	11.8
Grad	3	0.00	109.50	109.50		70.00	10	2.0000	Top of Slab	11.8
Grad	3	0.00	109.50	109.50		70.00	10	2.0000	Bottom of Slab	11.8



C03 Opis Concrete Design

Define
points of
interest

Opis - [Point of Interest]

File Edit View Bridge Window Help

RESU LTS ALL NXT US Customary

Distance from leftmost support: 9.11 ft or Span: Span 1 Fraction: 0.200000 Side: Left Right

Shear Stress Limit Fatigue Engine

Override schedule % Shear: 100.000 % Shear distance: _____ in

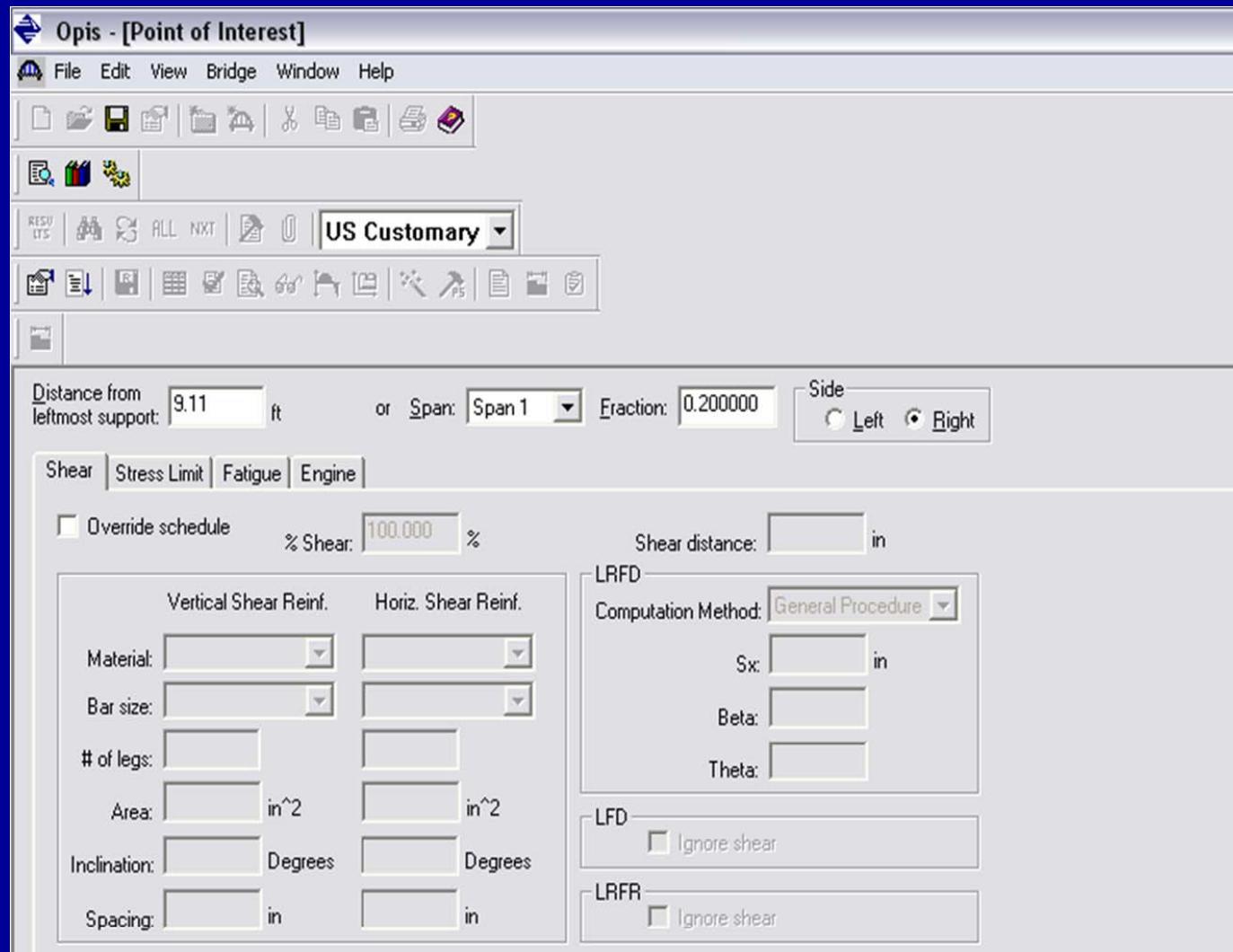
Vertical Shear Reinf. Horiz. Shear Reinf.

Material:	Bar size:
# of legs:	
Area: _____ in ²	_____ in ²
Inclination: _____ Degrees	_____ Degrees
Spacing: _____ in	_____ in

LRFD Computation Method: General Procedure Sx: _____ in Beta: _____ Theta: _____

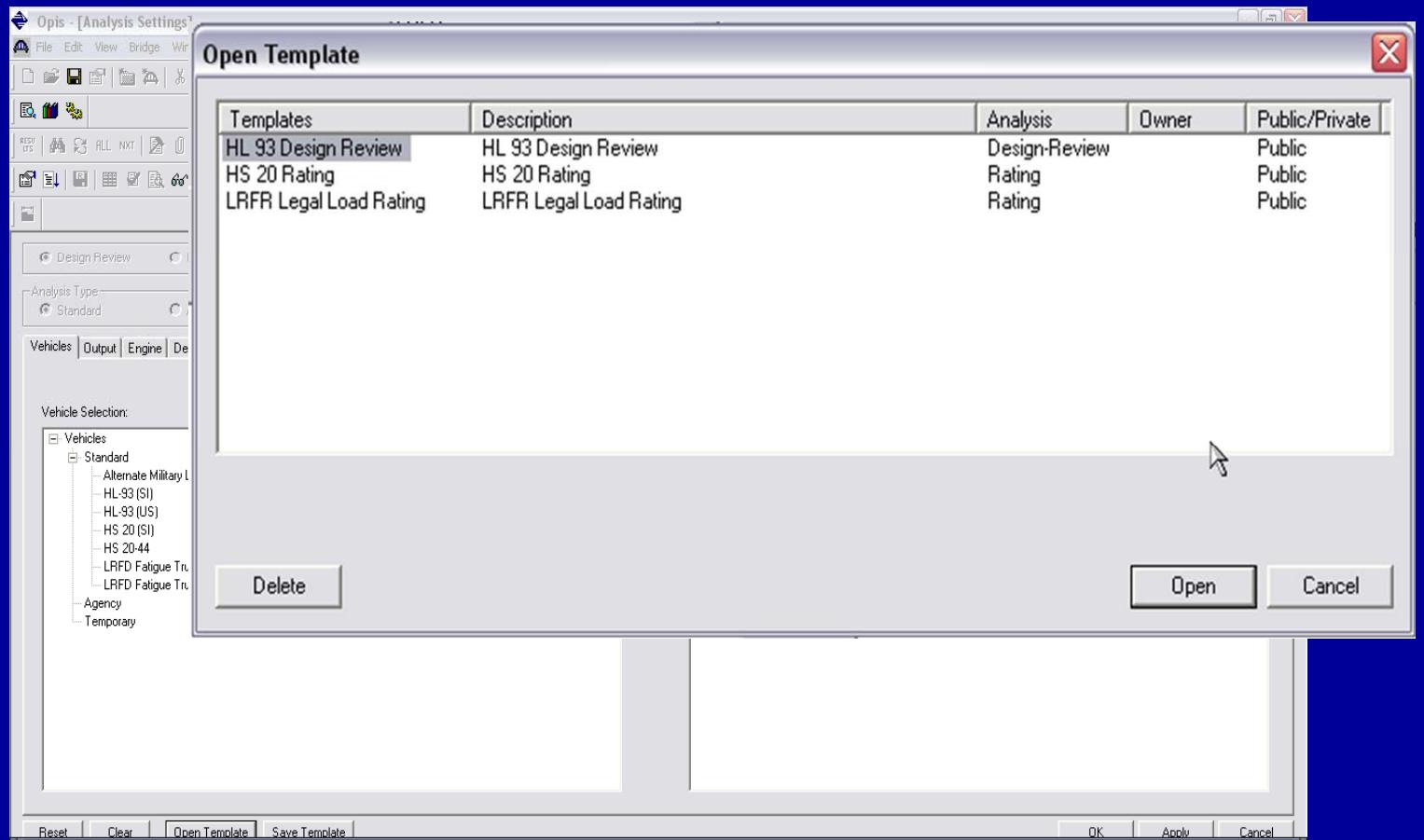
LFD Ignore shear

LRFR Ignore shear



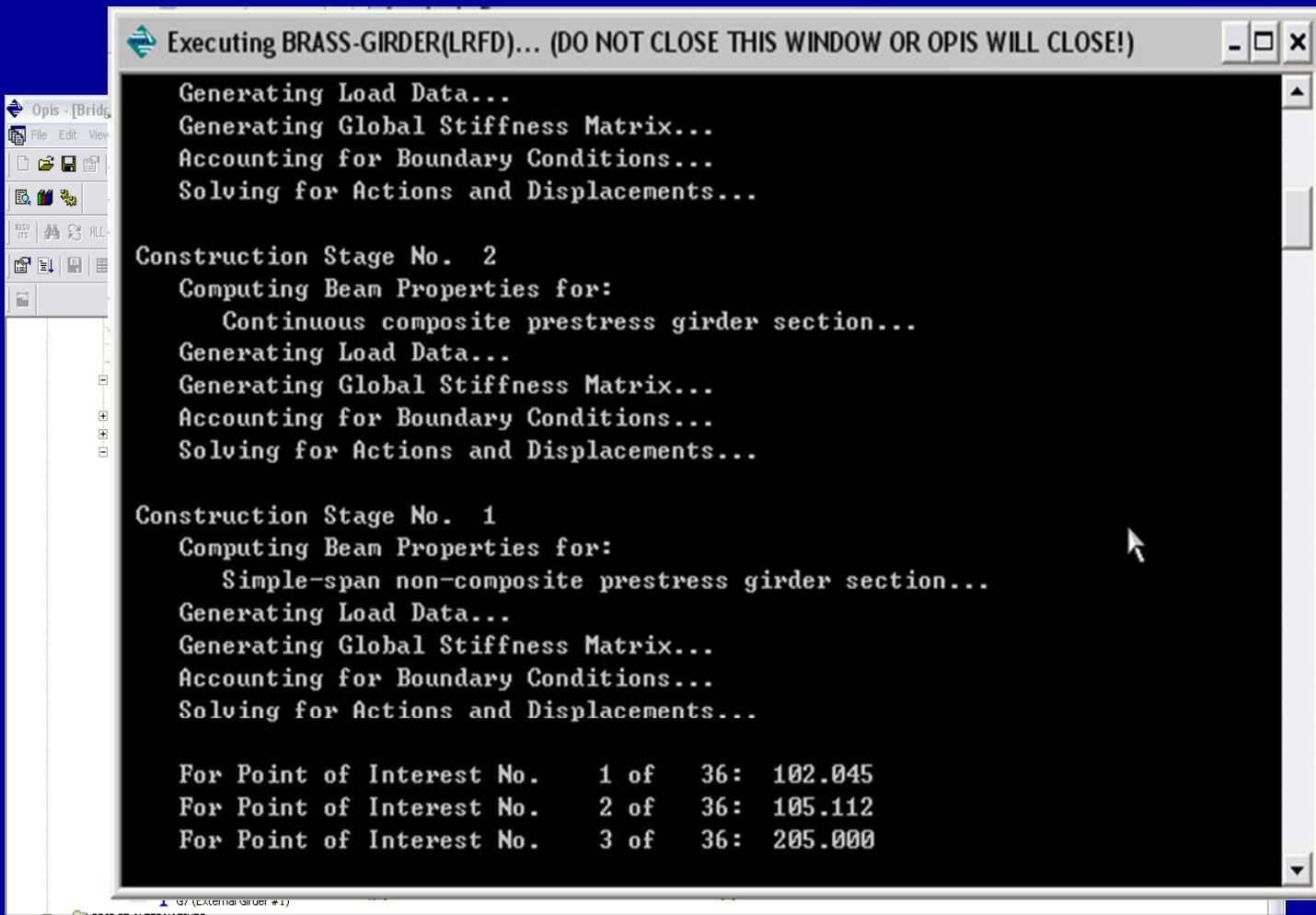
C03 Opis Concrete Design

Define live
load
analysis
case: HL-
93



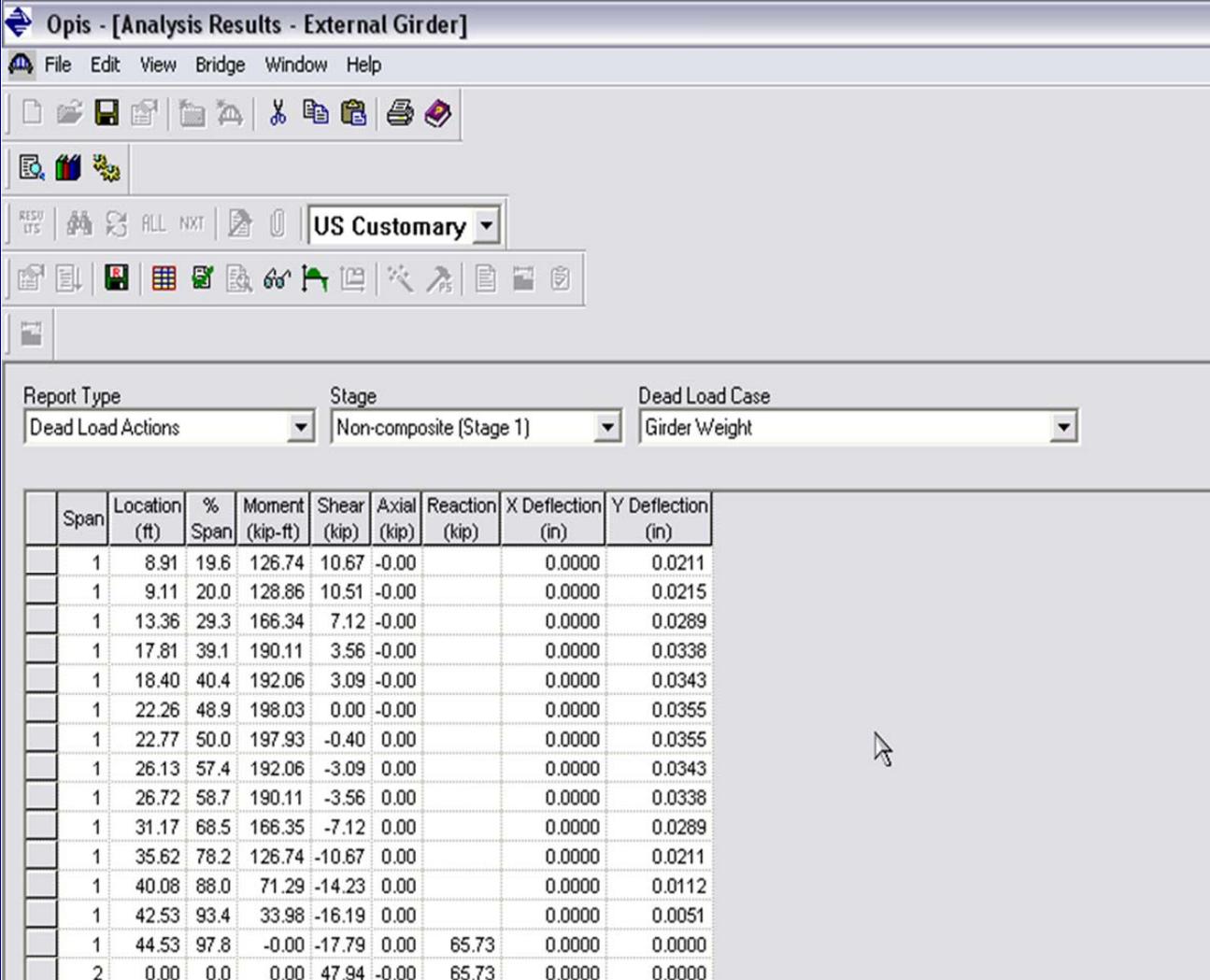
C03 Opis Concrete Design

Run
analysis:
BRASS



C03 Opis Concrete Design

Analysis results:
moment,
shear and
axial force



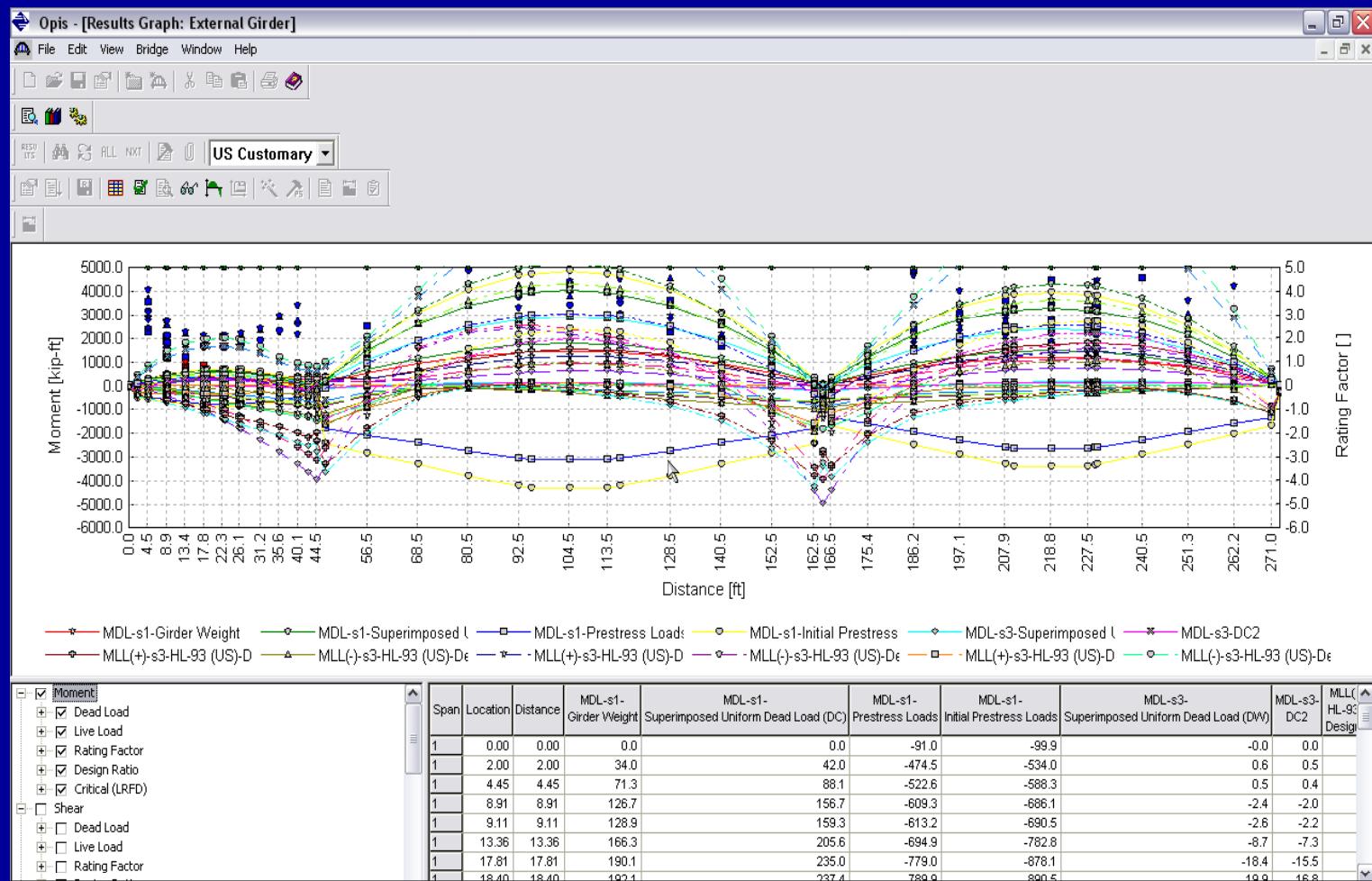
The screenshot shows the Opis software interface titled "Opis - [Analysis Results - External Girder]". The menu bar includes File, Edit, View, Bridge, Window, and Help. The toolbar contains various icons for file operations and analysis. A dropdown menu shows "US Customary". The main window displays a report table with the following columns: Span, Location (ft), % Span, Moment (kip-ft), Shear (kip), Axial (kip), Reaction (kip), X Deflection (in), and Y Deflection (in). The report type is set to "Dead Load Actions", the stage to "Non-composite (Stage 1)", and the dead load case to "Girder Weight". The table lists 15 spans, with the last two being a summary row.

	Span	Location (ft)	% Span	Moment (kip-ft)	Shear (kip)	Axial (kip)	Reaction (kip)	X Deflection (in)	Y Deflection (in)
	1	8.91	19.6	126.74	10.67	-0.00		0.0000	0.0211
	1	9.11	20.0	128.86	10.51	-0.00		0.0000	0.0215
	1	13.36	29.3	166.34	7.12	-0.00		0.0000	0.0289
	1	17.81	39.1	190.11	3.56	-0.00		0.0000	0.0338
	1	18.40	40.4	192.06	3.09	-0.00		0.0000	0.0343
	1	22.26	48.9	198.03	0.00	-0.00		0.0000	0.0355
	1	22.77	50.0	197.93	-0.40	0.00		0.0000	0.0355
	1	26.13	57.4	192.06	-3.09	0.00		0.0000	0.0343
	1	26.72	58.7	190.11	-3.56	0.00		0.0000	0.0338
	1	31.17	68.5	166.35	-7.12	0.00		0.0000	0.0289
	1	35.62	78.2	126.74	-10.67	0.00		0.0000	0.0211
	1	40.08	88.0	71.29	-14.23	0.00		0.0000	0.0112
	1	42.53	93.4	33.98	-16.19	0.00		0.0000	0.0051
	1	44.53	97.8	-0.00	-17.79	0.00	65.73	0.0000	0.0000
	2	0.00	0.0	0.00	47.94	-0.00	65.73	0.0000	0.0000



C03 Opis Concrete Design

Analysis
results:
moment
diagrams
&
envelopes



C03 Opis Concrete Design

Specification
check details:
stress limits
for concrete

PERFORMING AASHTO LRFD SPECIFICATION CHECKS - 5.9.4 Stress Limits for Concr

Point of Interest : 102.04
Construction Stage: 1

Units: Stresses are in (ksi).

Stresses After Losses: DL + PS Only

Stress Comparisons for NEGATIVE Flexure Sense:

Location	Compressive Stress Limit	Factored Stress	T Str
Top Flange	-1.800	< = -0.111	...
Bot Flange	-1.800	< = -0.625	...

Notes:

OK

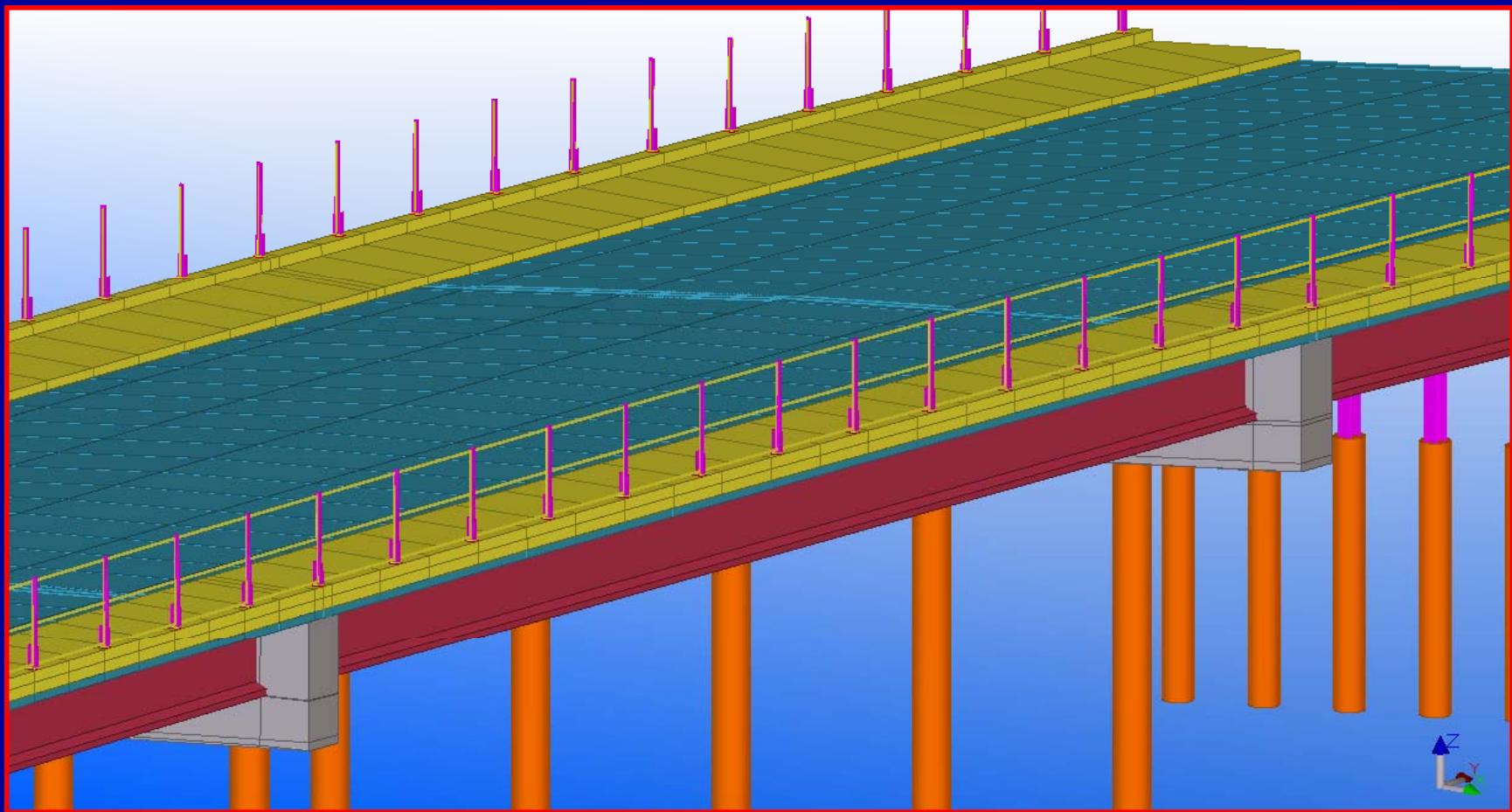
5.7.3.3.2 Minimum Reinforcement (Ductility)
5.8.2.7 Shear: Effective Shear Depth



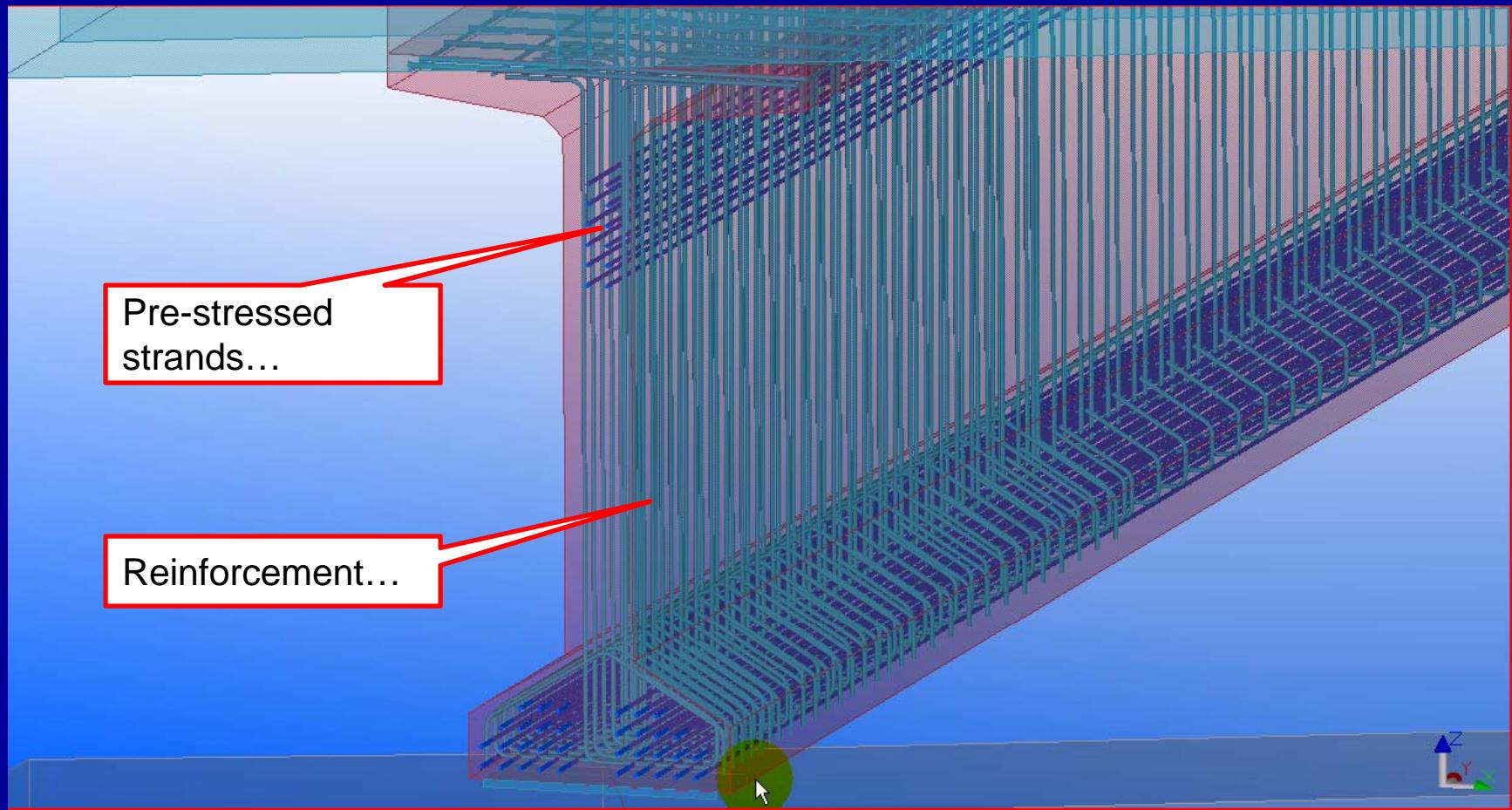
Tekla to XML



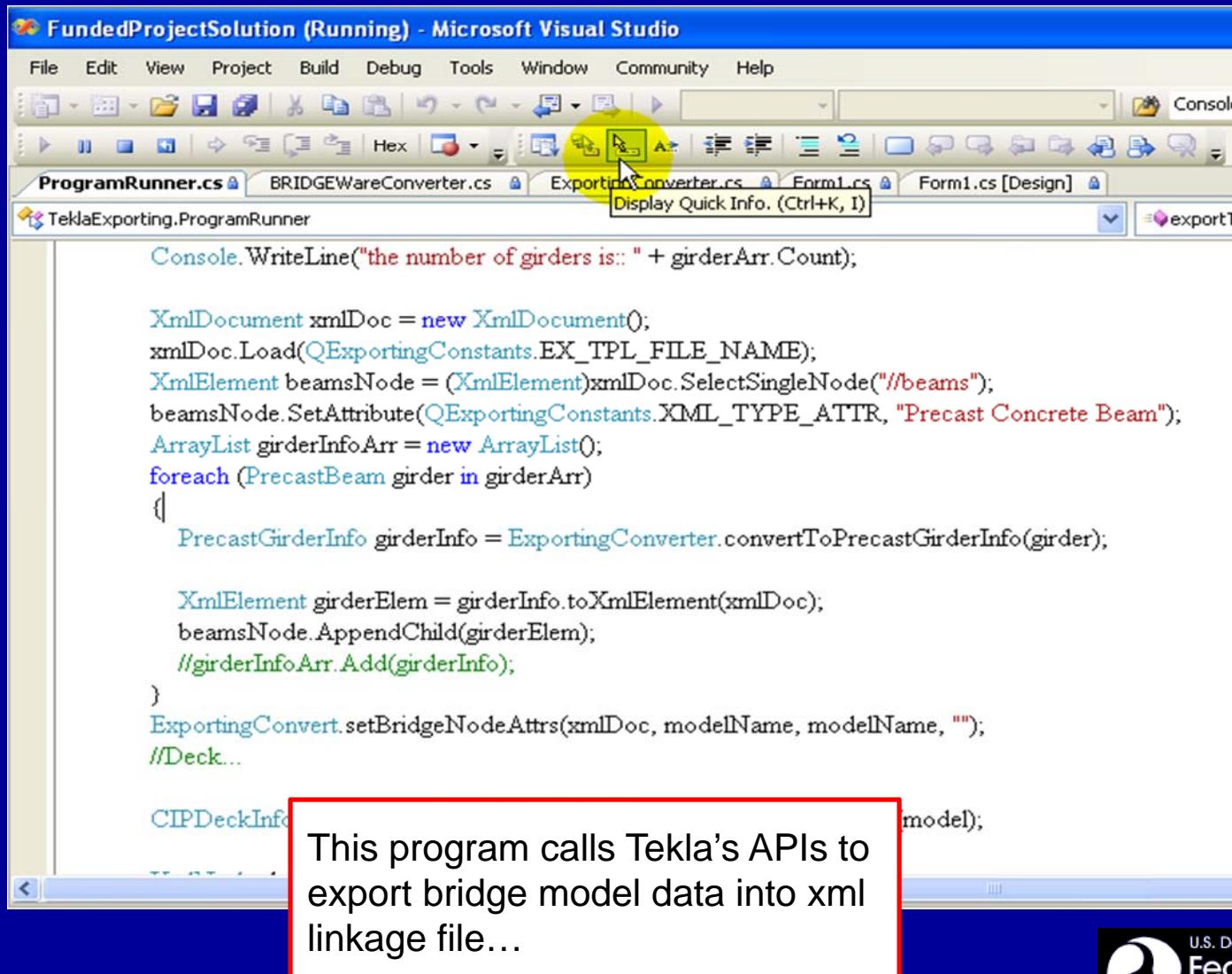
Tekla 3D Model



Tekla 3D Model: Girder Detailing



Source Code Sample and Development Environment Showing Exporting



The screenshot shows the Microsoft Visual Studio interface with the title bar "FundedProjectSolution (Running) - Microsoft Visual Studio". The menu bar includes File, Edit, View, Project, Build, Debug, Tools, Window, Community, and Help. The toolbar has various icons for file operations like Open, Save, and Print. The solution explorer shows files: ProgramRunner.cs, BRIDGEWareConverter.cs, ExportingConverter.cs, Form1.cs, and Form1.cs [Design]. The code editor displays C# code for exporting bridge model data into XML:

```
Console.WriteLine("the number of girders is:: " + girderArr.Count);

 XmlDocument xmlDoc = new XmlDocument();
 xmlDoc.Load(QExportingConstants.EX_TPL_FILE_NAME);
 XmlElement beamsNode = (XmlElement)xmlDoc.SelectSingleNode("//beams");
 beamsNode.SetAttribute(QExportingConstants.XML_TYPE_ATTR, "Precast Concrete Beam");
 ArrayList girderInfoArr = new ArrayList();
 foreach (PrecastBeam girder in girderArr)
 {
     PrecastGirderInfo girderInfo = ExportingConverter.convertToPrecastGirderInfo(girder);

     XmlElement girderElem = girderInfo.toXmlElement(xmlDoc);
     beamsNode.AppendChild(girderElem);
     //girderInfoArr.Add(girderInfo);
 }
 ExportingConvert.setBridgeNodeAttrs(xmlDoc, modelName, modelName, "");
 //Deck...

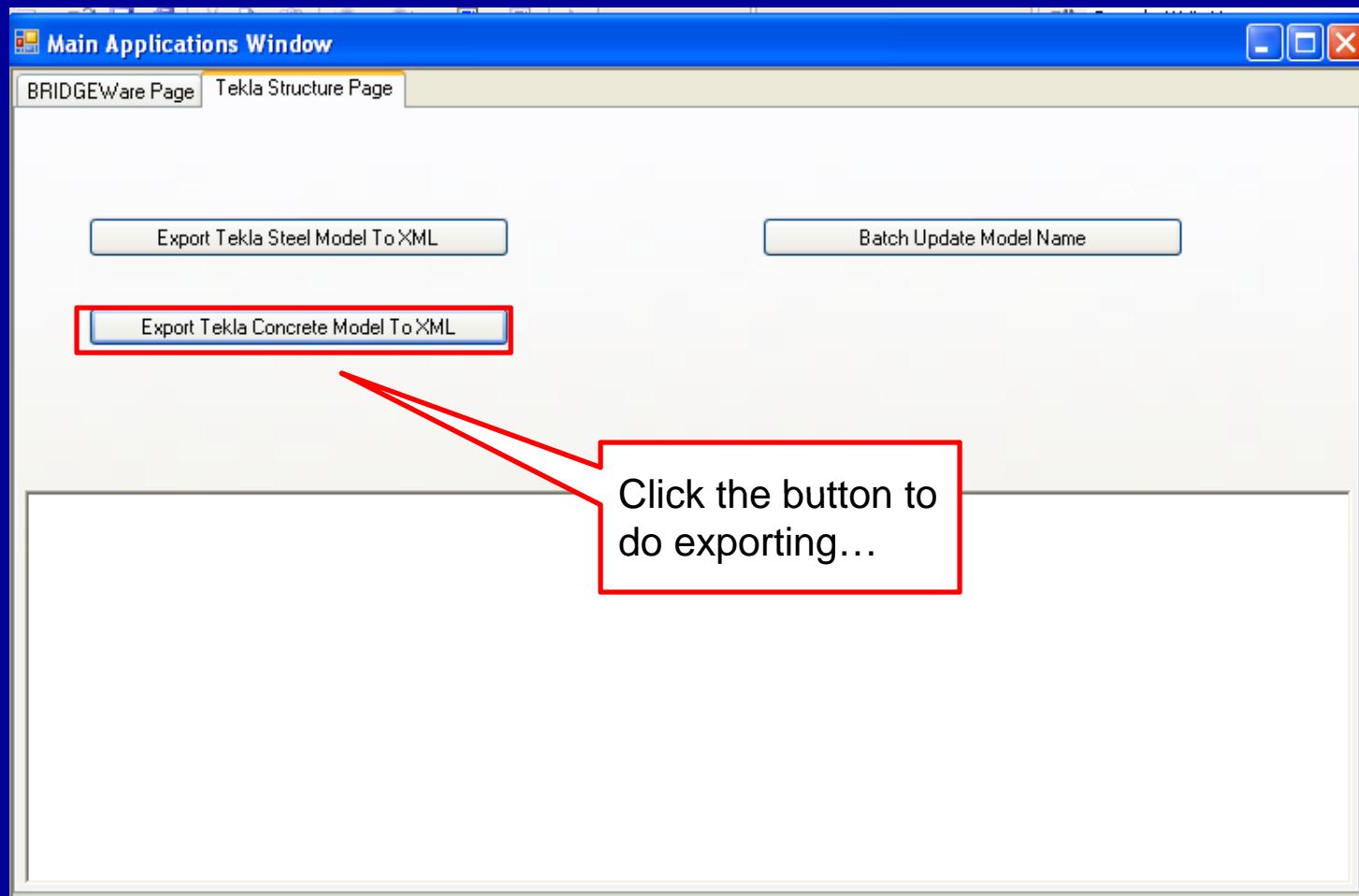
```

A yellow circle highlights the "Run" button in the toolbar. A red box surrounds the explanatory text at the bottom:

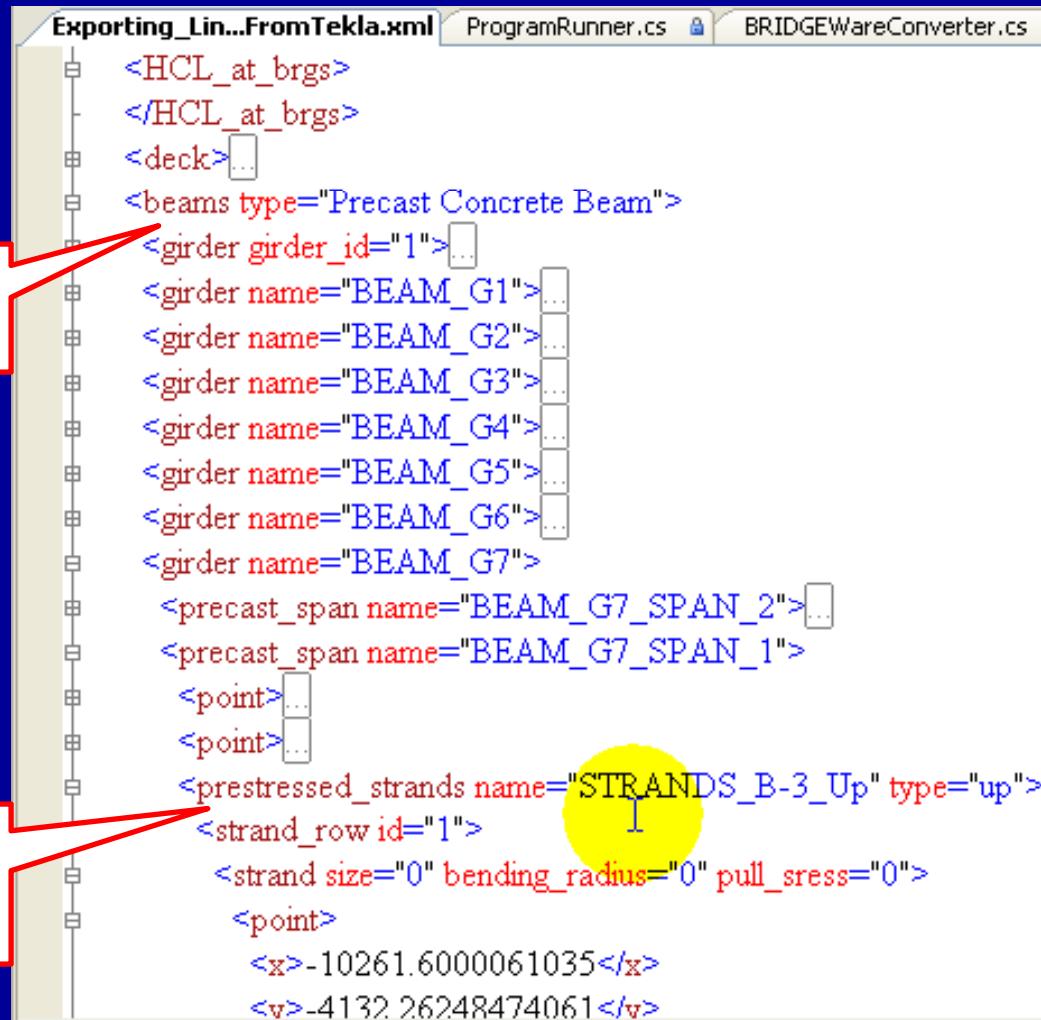
This program calls Tekla's APIs to export bridge model data into xml linkage file...



Sample of User Interface for Exporting



Sample of Exported XML File



```
Exporting_Lin...FromTekla.xml ProgramRunner.cs BRIDGEWareConverter.cs
<HCL_at_brgs>
</HCL_at_brgs>
<deck>...
<beams type="Precast Concrete Beam">
  <girder girder_id="1">...
    <girder name="BEAM_G1">...
    <girder name="BEAM_G2">...
    <girder name="BEAM_G3">...
    <girder name="BEAM_G4">...
    <girder name="BEAM_G5">...
    <girder name="BEAM_G6">...
    <girder name="BEAM_G7">...
      <precast_span name="BEAM_G7_SPAN_2">...
      <precast_span name="BEAM_G7_SPAN_1">
        <point>...
        <point>...
      <prestressed_strands name="STRANDS_B-3_Up" type="up">
        <strand_row id="1">
          <strand size="0" bending_radius="0" pull_sress="0">
            <point>
              <x>-10261.6000061035</x>
              <y>-4132.26248474061</y>
```

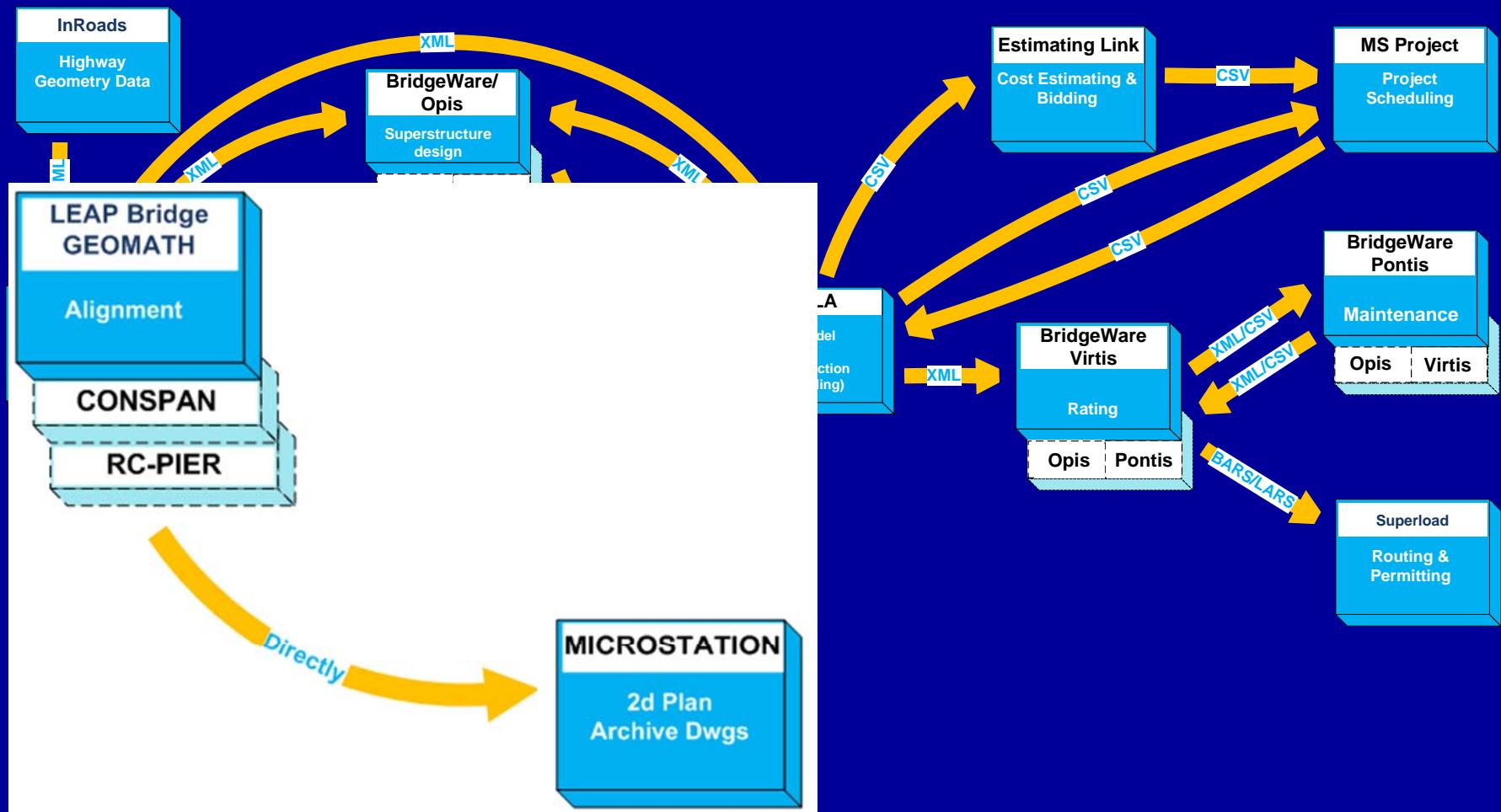


LEAP to MicroStation 3D&2D



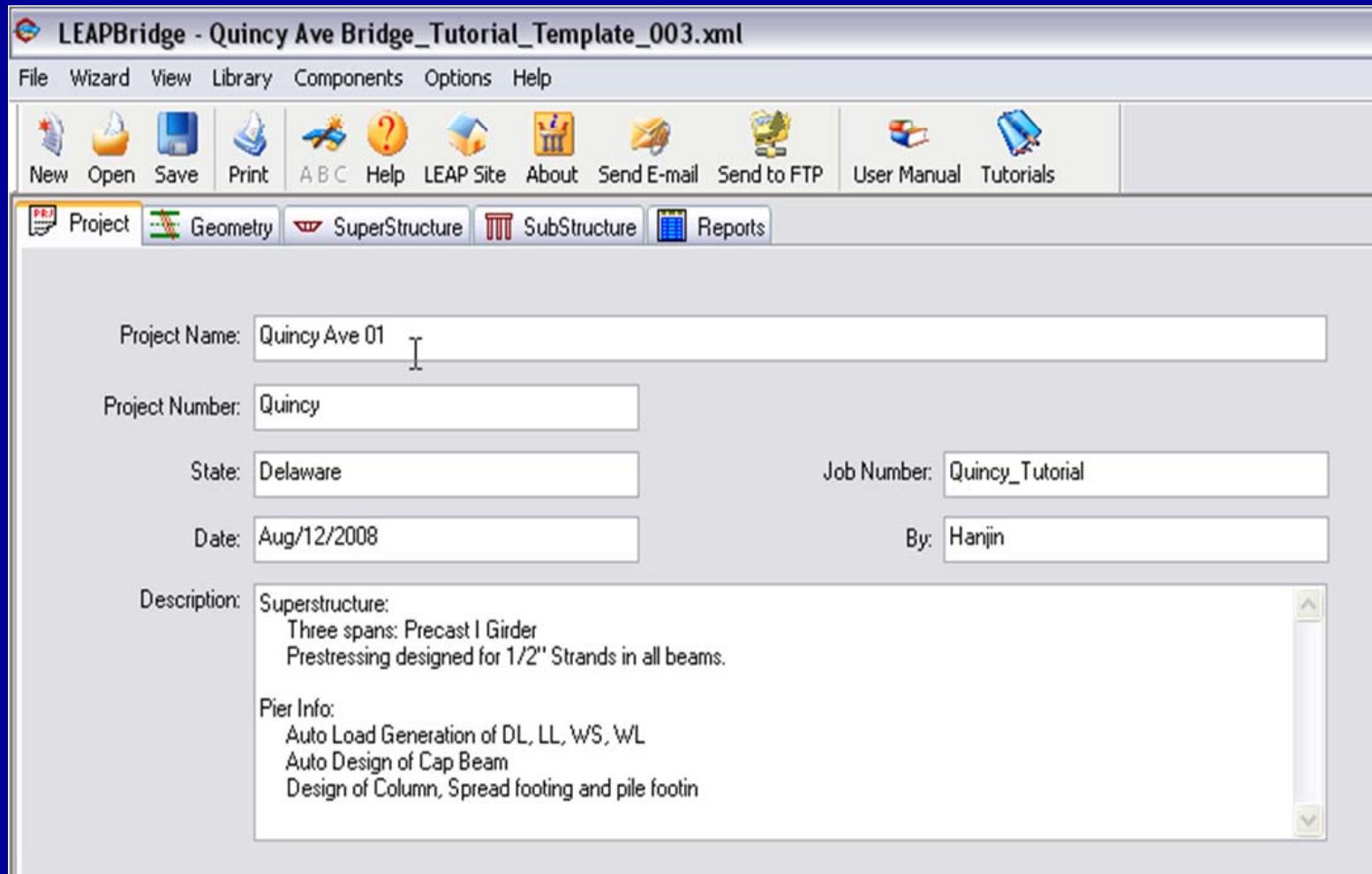
C09 LEAP to MicroStation 3D

Concrete Alternate



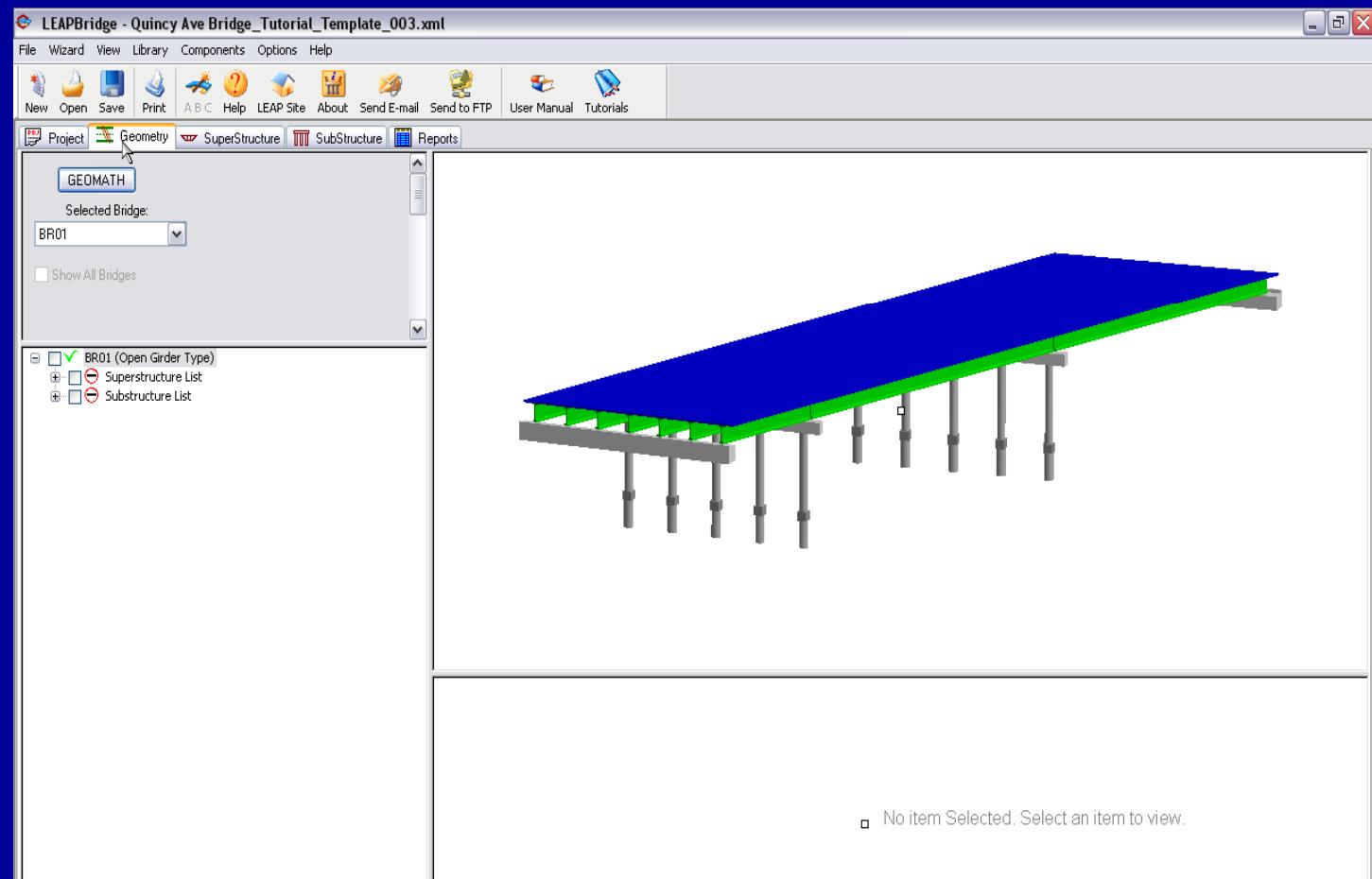
C09 LEAP to MicroStation 3D

Project
profile in
LEAP
Bridge



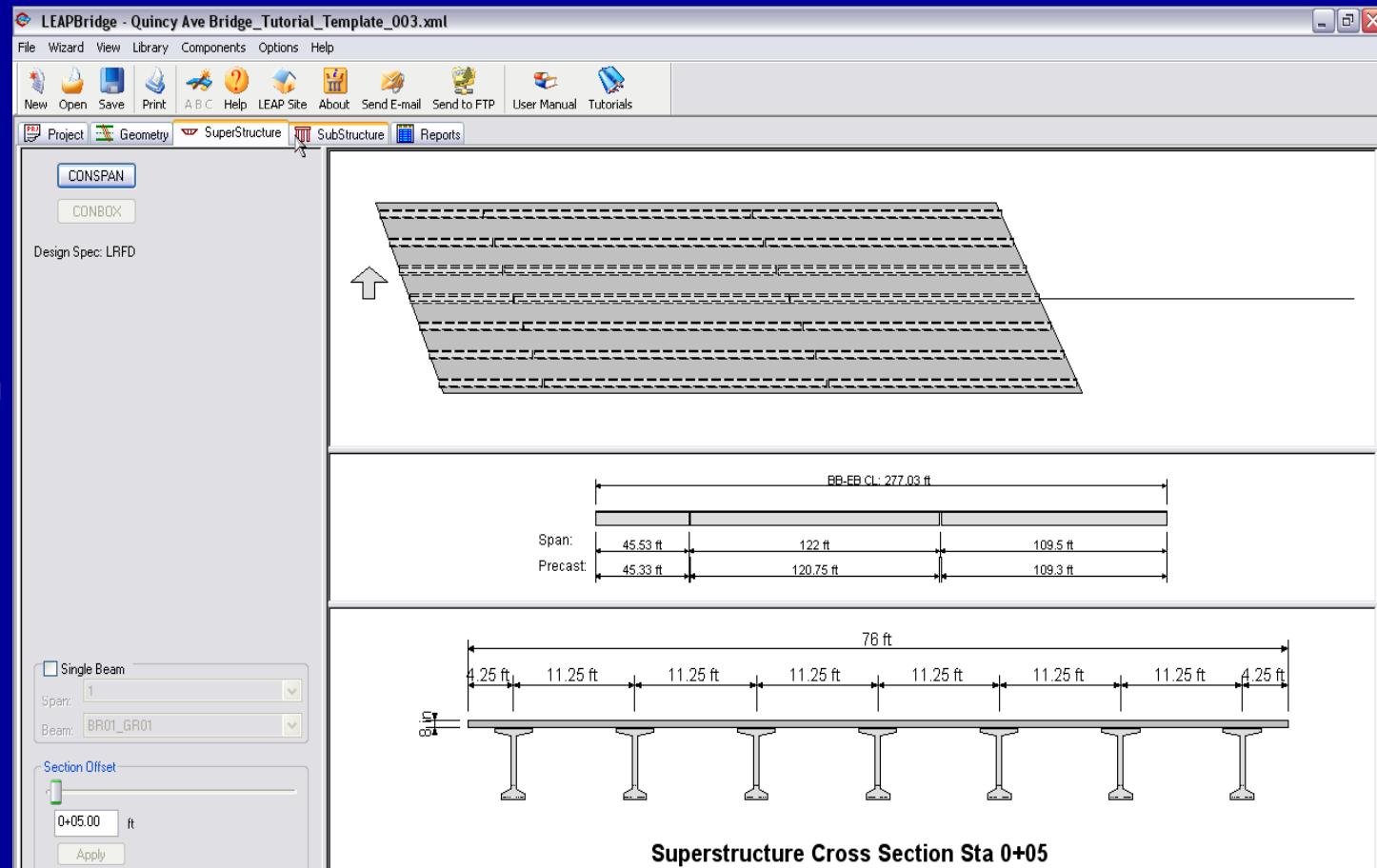
C09 LEAP to MicroStation 3D

3D view of
Quincy
Avenue
Bridge
model



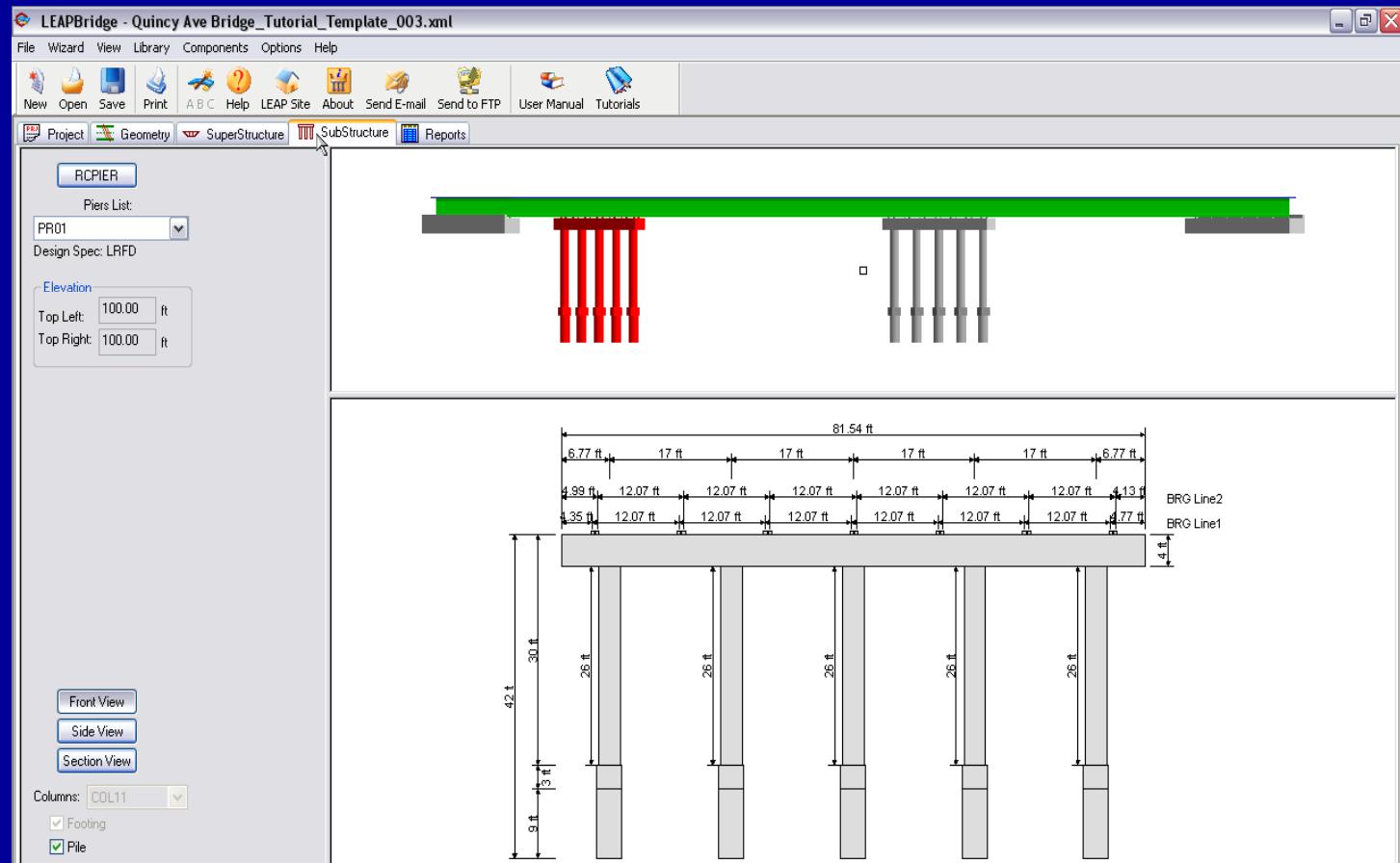
C09 LEAP to MicroStation 3D

2D view of super-structure:
Plan view,
side view
and section
view



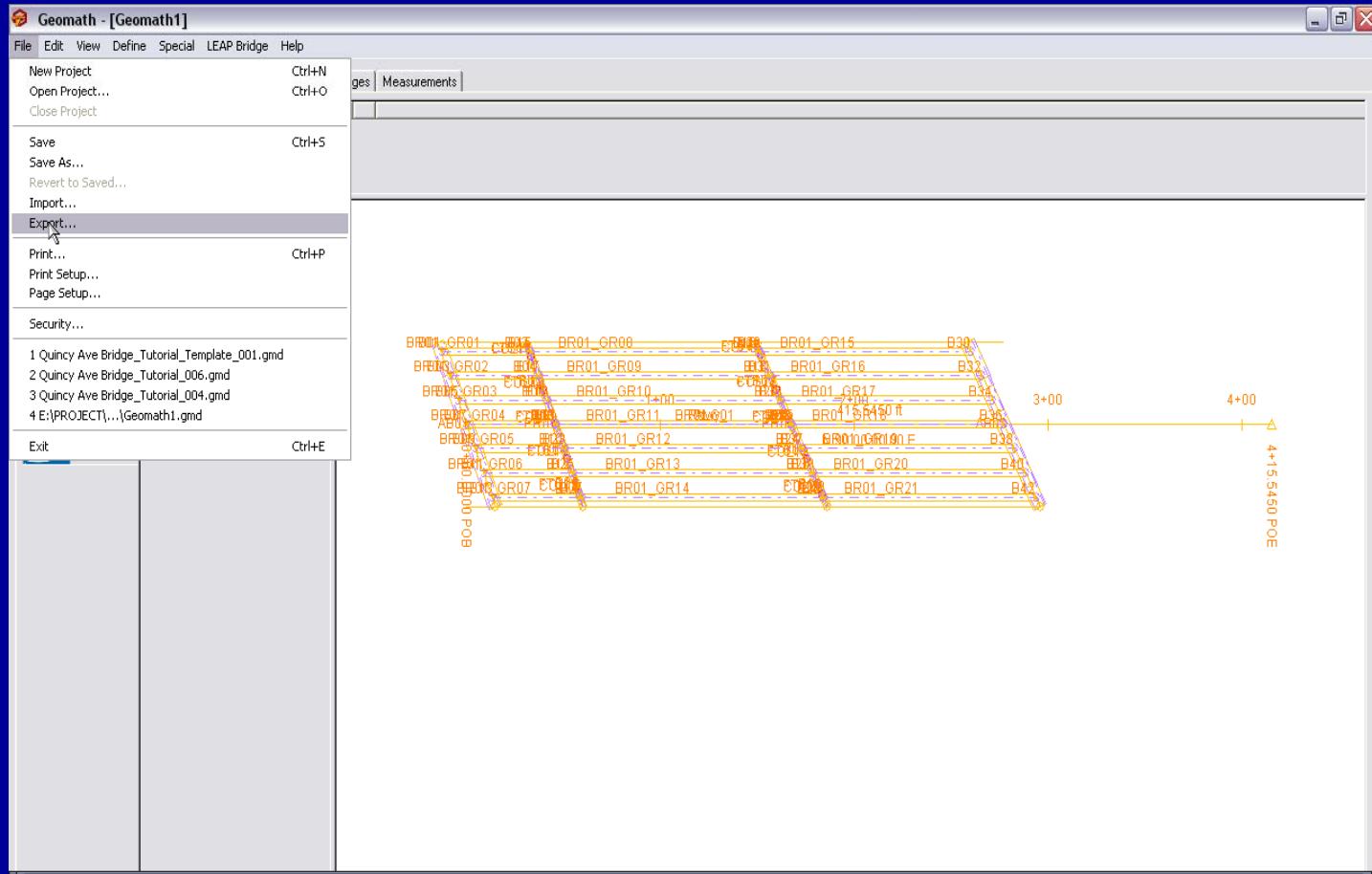
C09 LEAP to MicroStation 3D

2D and 3D
views of
sub-
structure



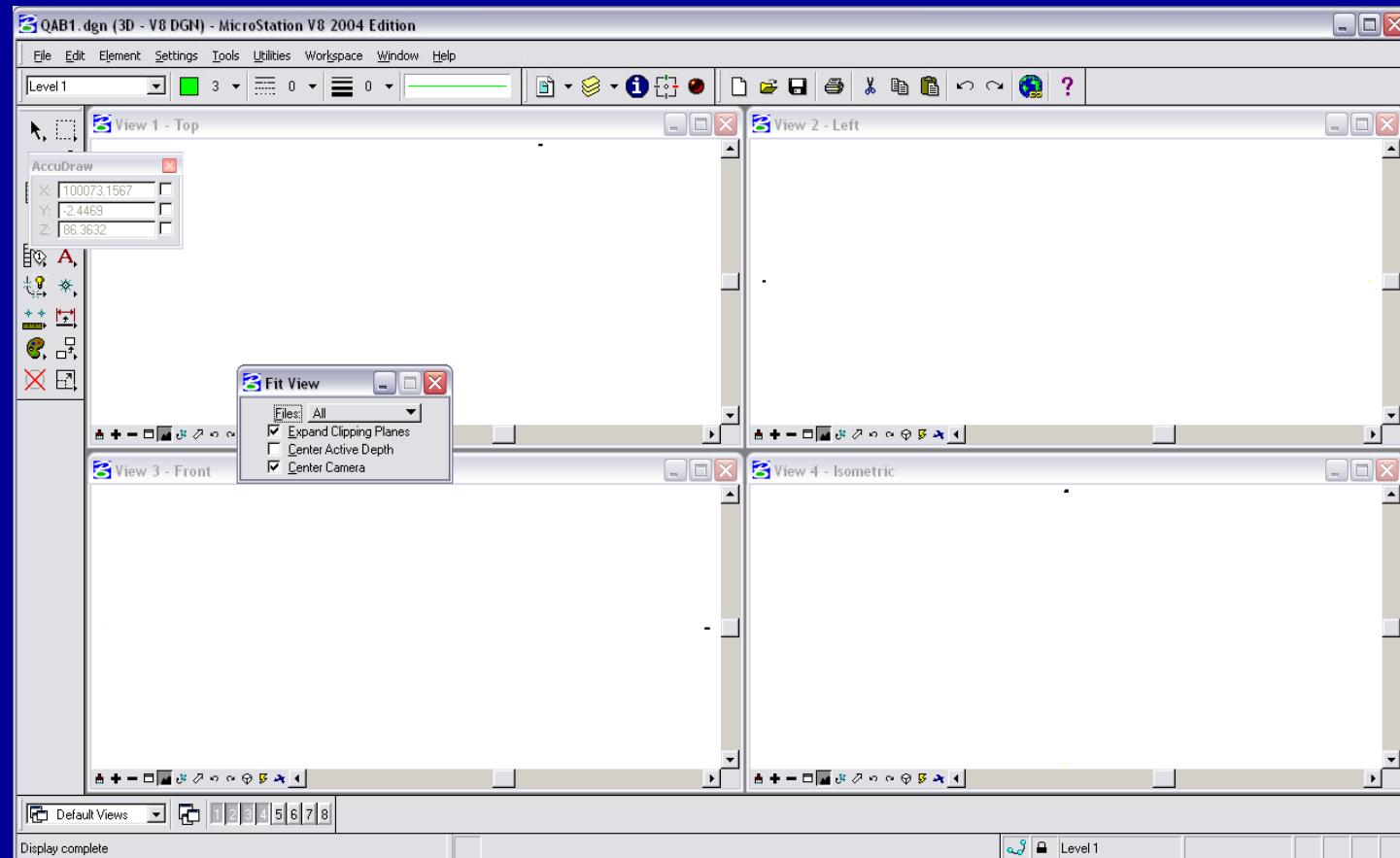
C09 LEAP to MicroStation 3D

Export 3D
model to
Micro-
Station file:
*.dgn file



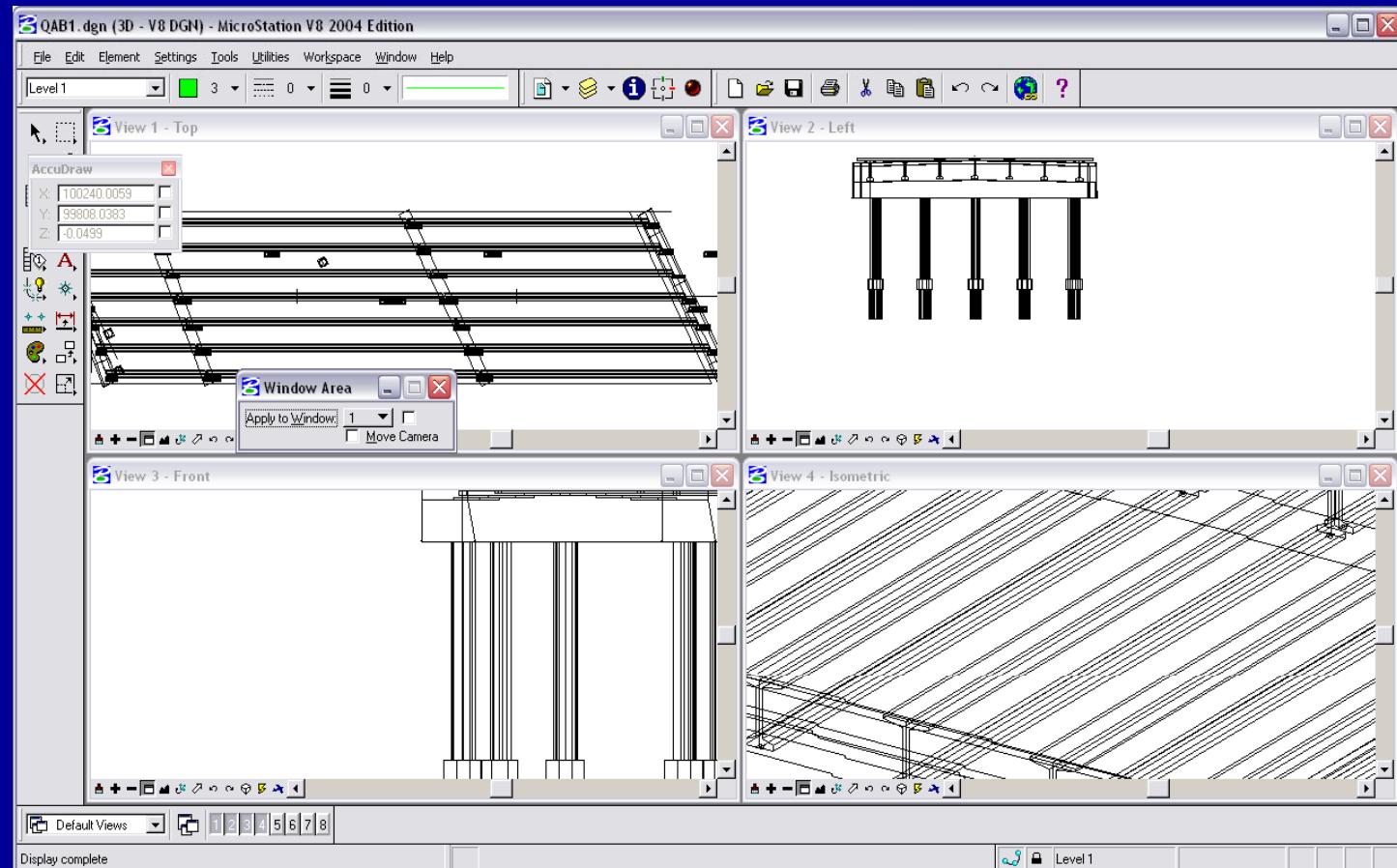
C09 LEAP to MicroStation 3D

Open
Micro-
Station and
load dgn
file



C09 LEAP to MicroStation 3D

Views from LEAP: plan view, side view, front view and 3D view



MicroStation 2D Drawing Generation

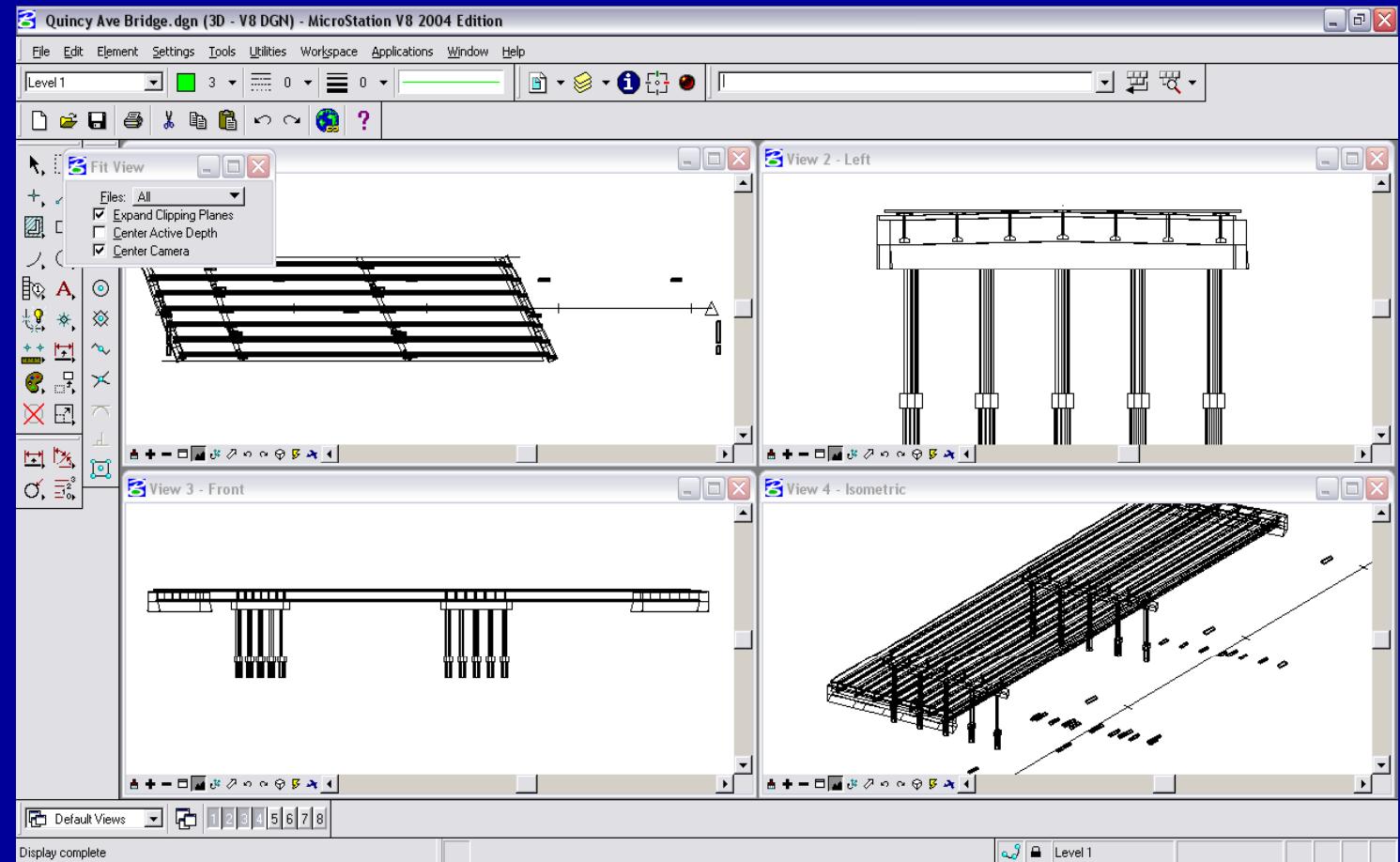


C16 MicroStation Drawings



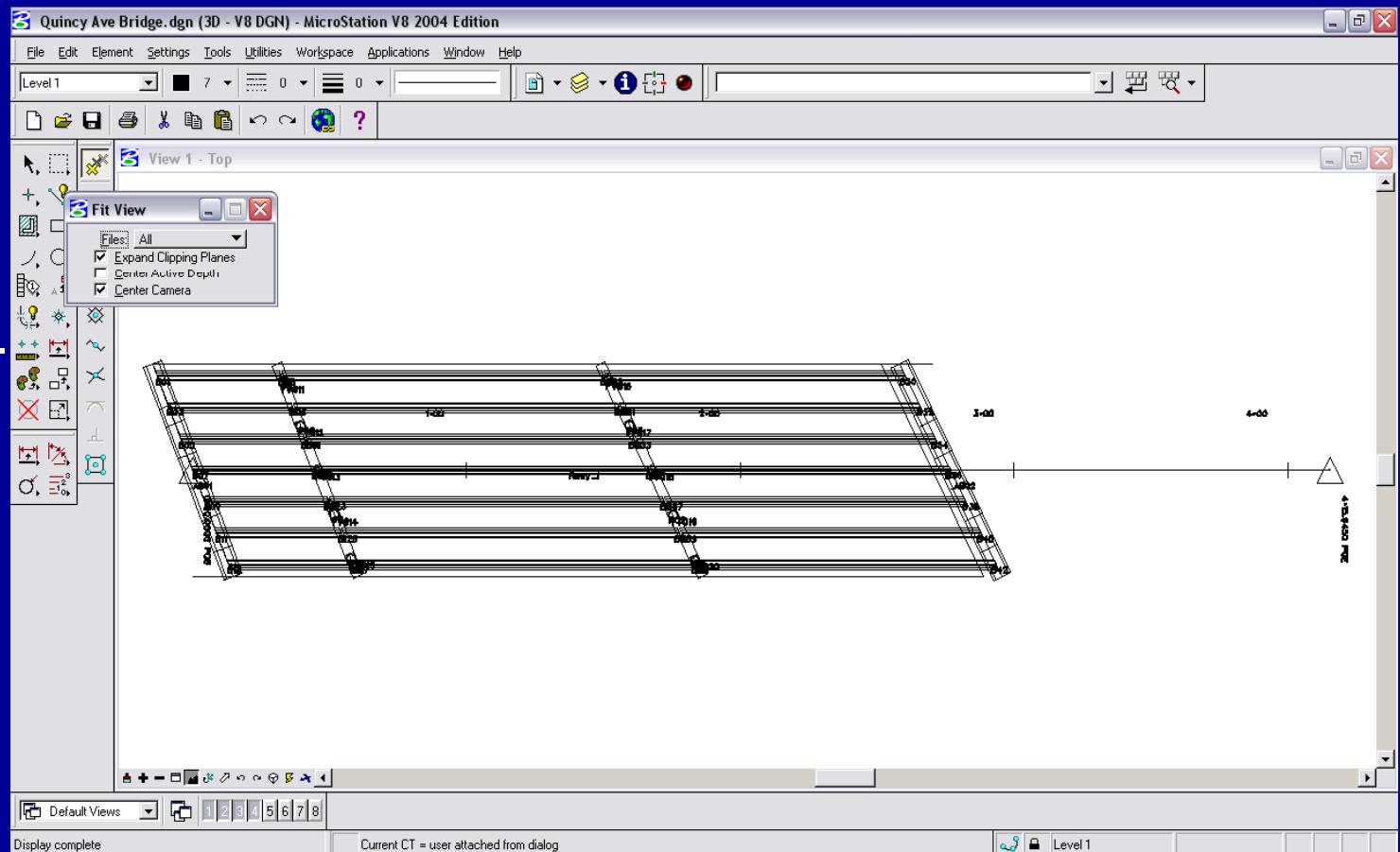
C16 MicroStation Drawings

Micro-station drawings exported from LEAP: plan view, side view, front view and 3D view



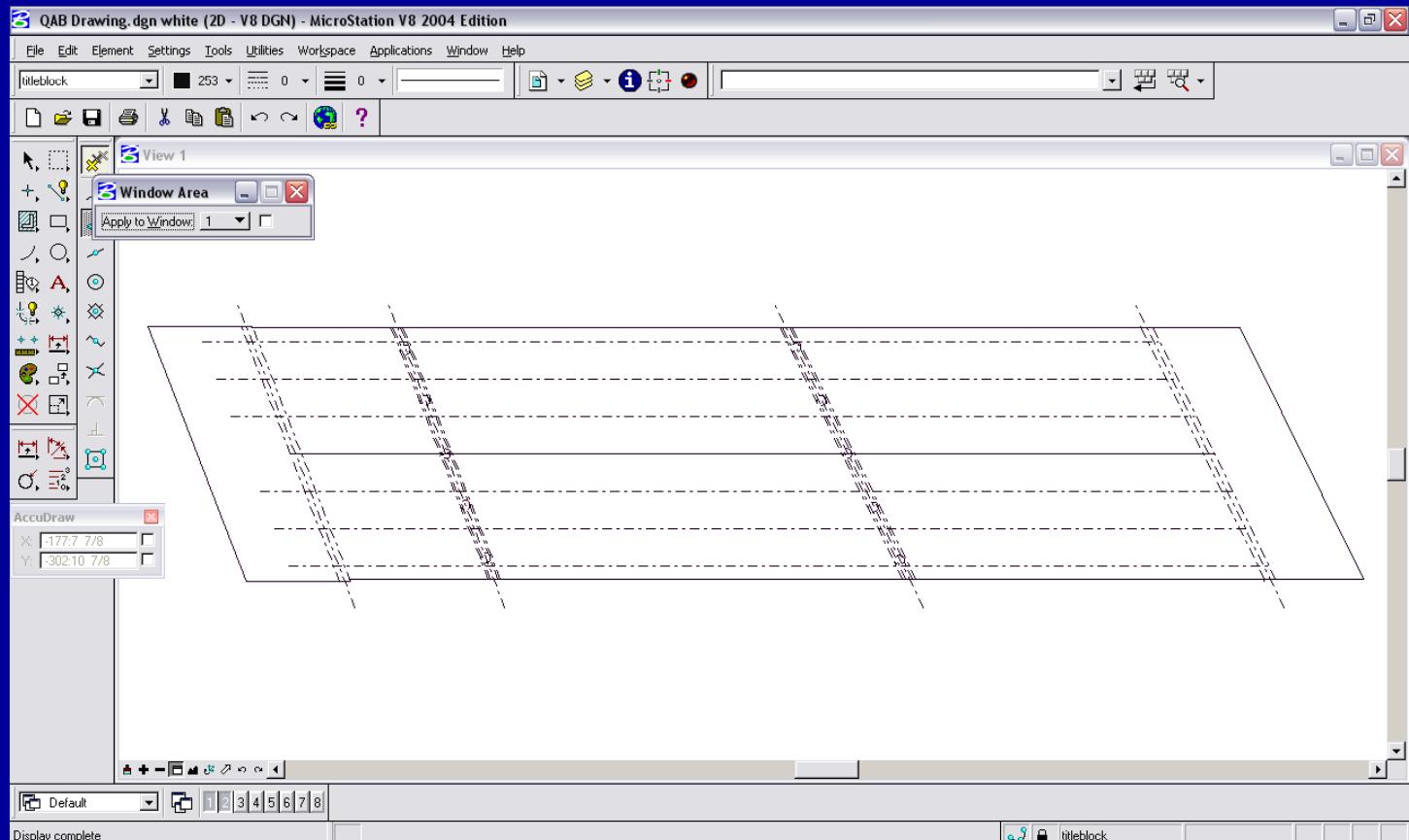
C16 MicroStation Drawings

Plan view
of Quincy
Avenue
Bridge
exported
from LEAP.
Base on
this draft,
user can
make
some
modificatio
ns



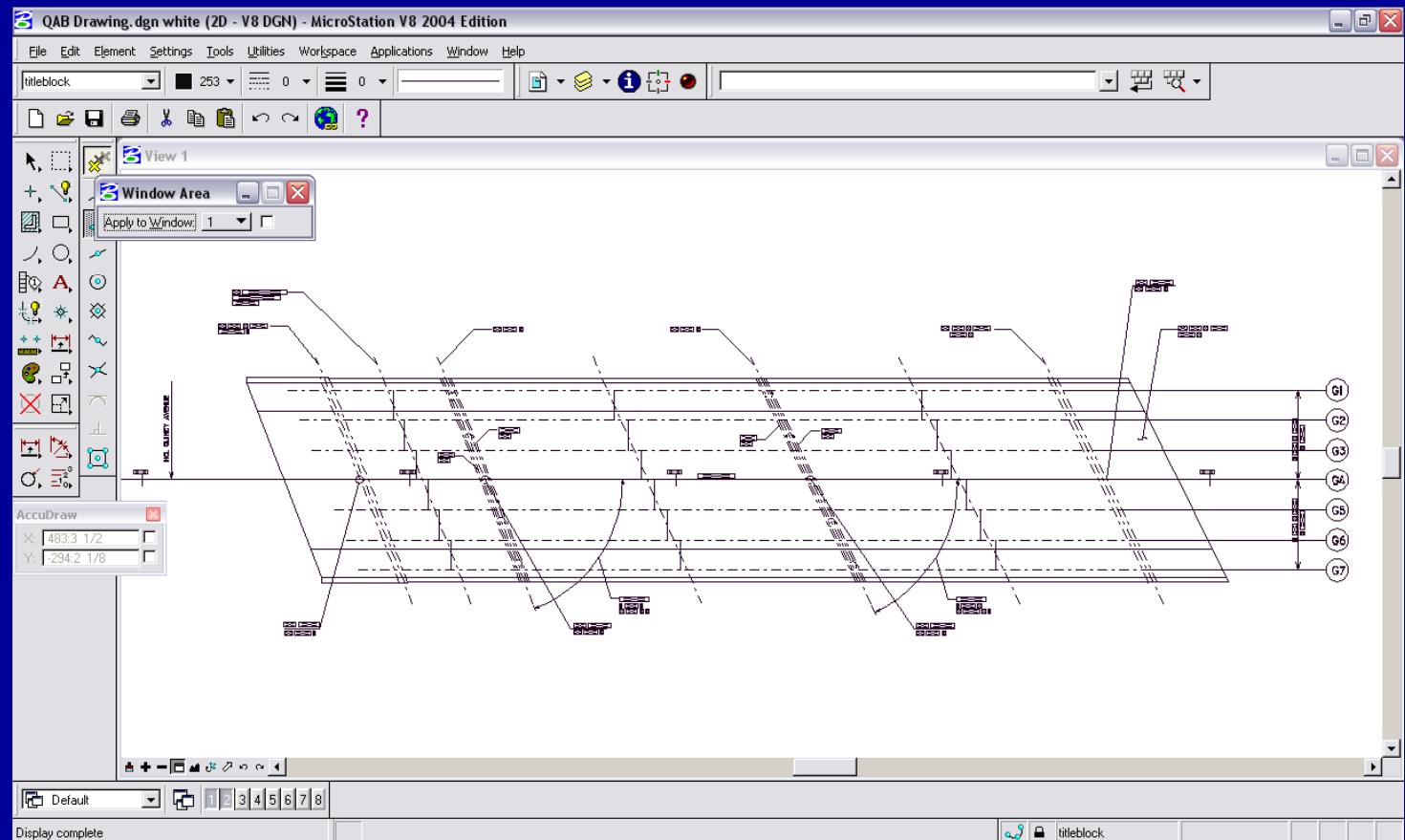
C16 MicroStation Drawings

Modification
step 1:
delete some
unnecessary
lines

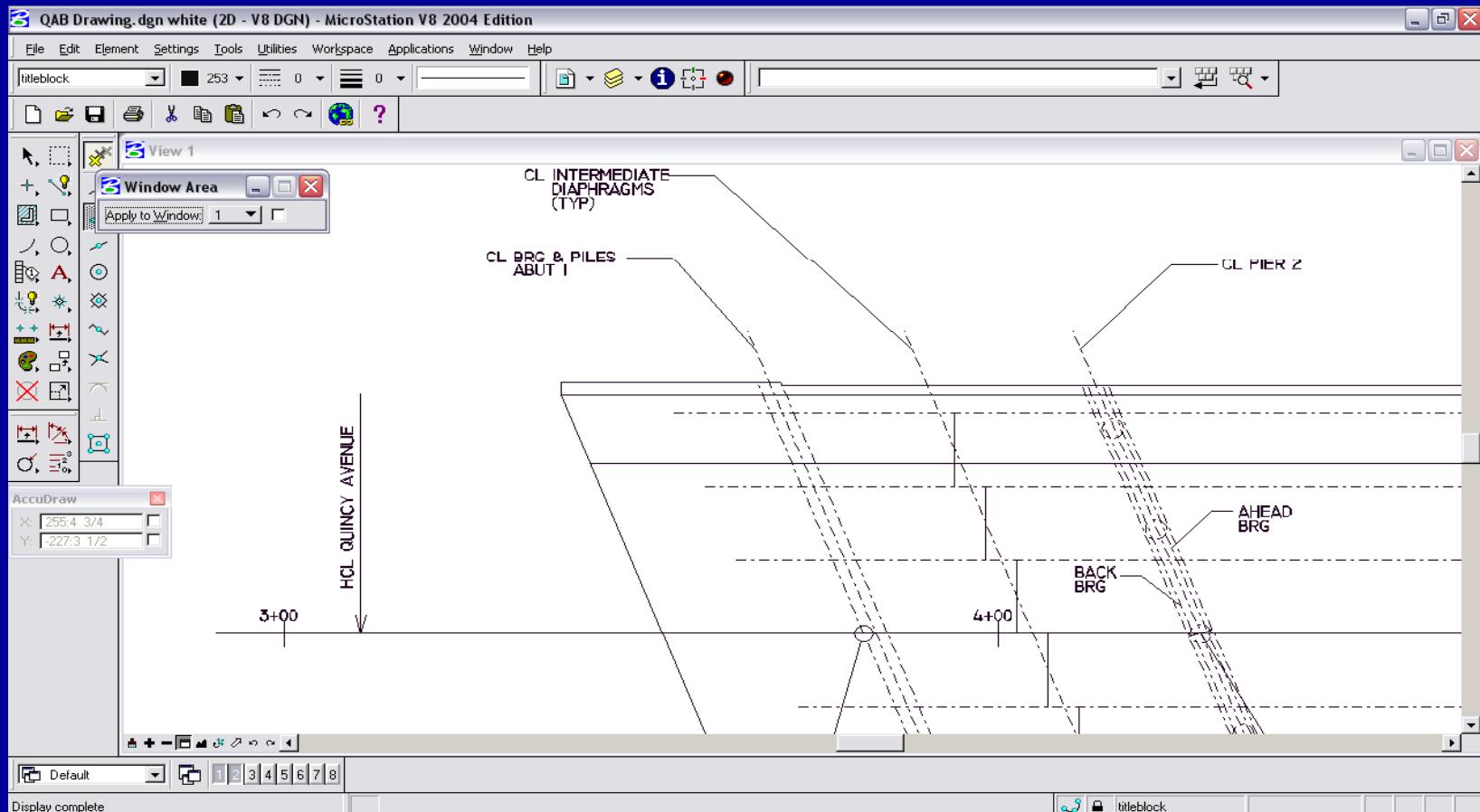


C16 MicroStation Drawings

Modification
step 2:

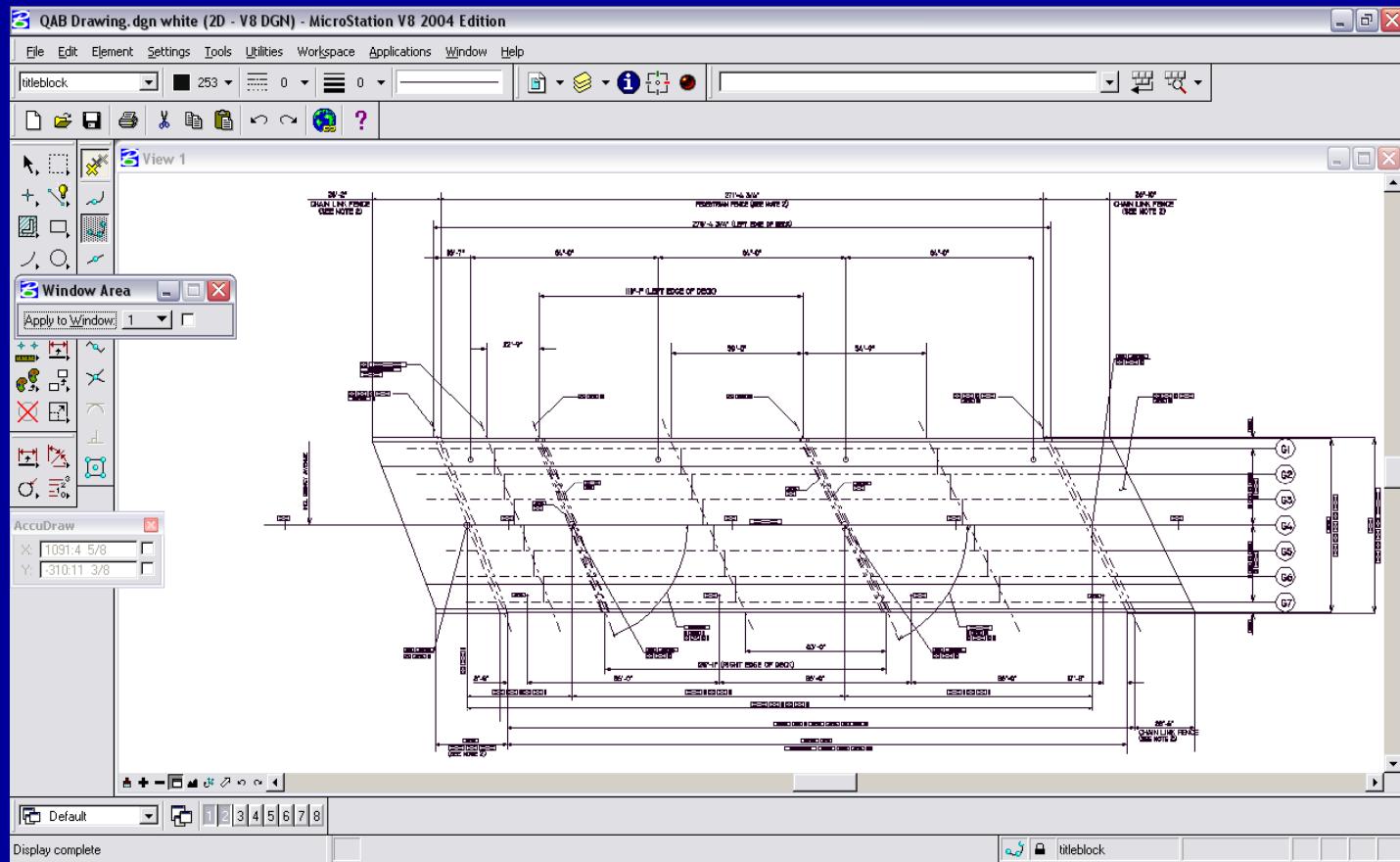


C16 MicroStation Drawings

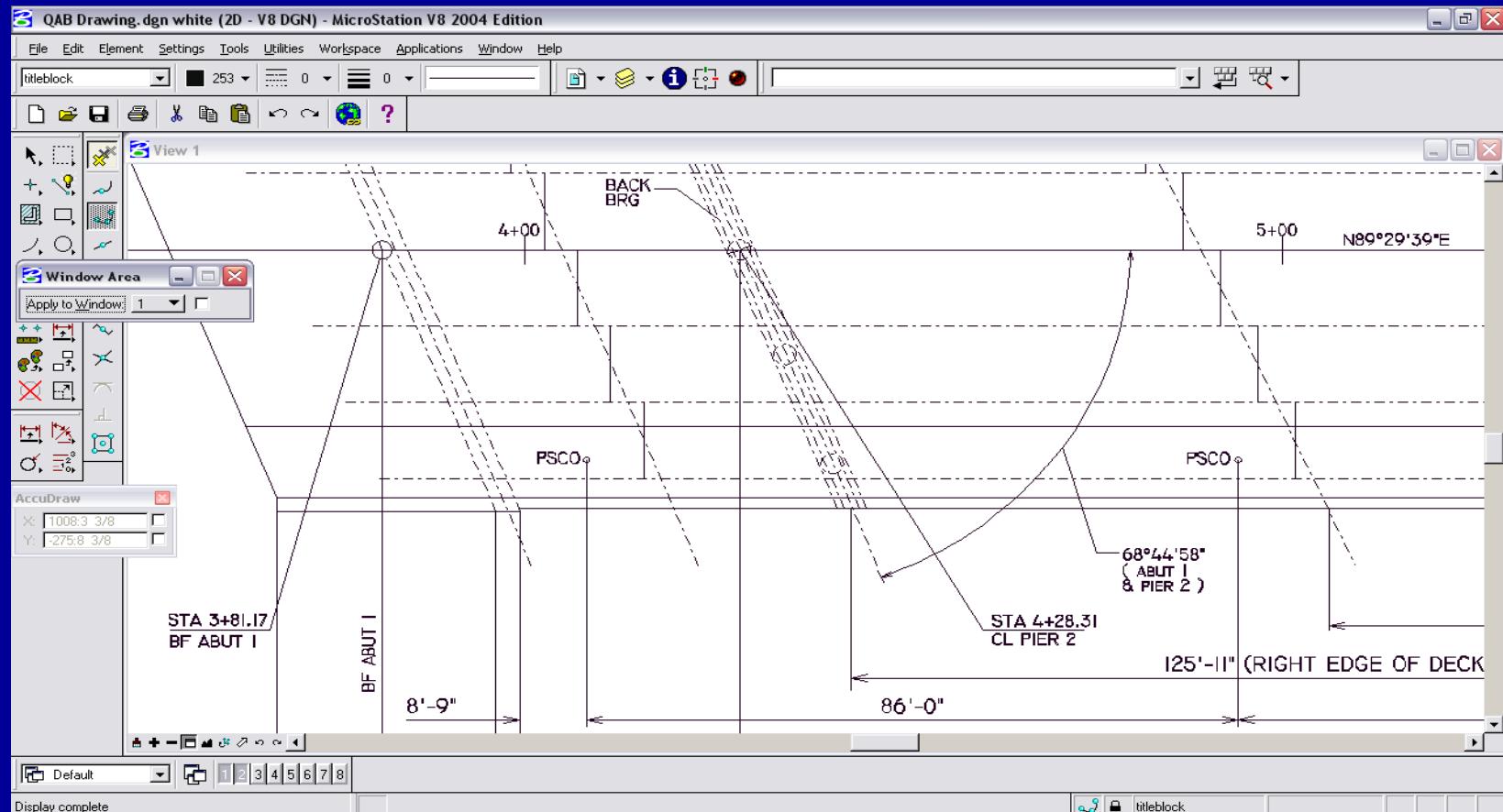


C16 MicroStation Drawings

Modification step 3:

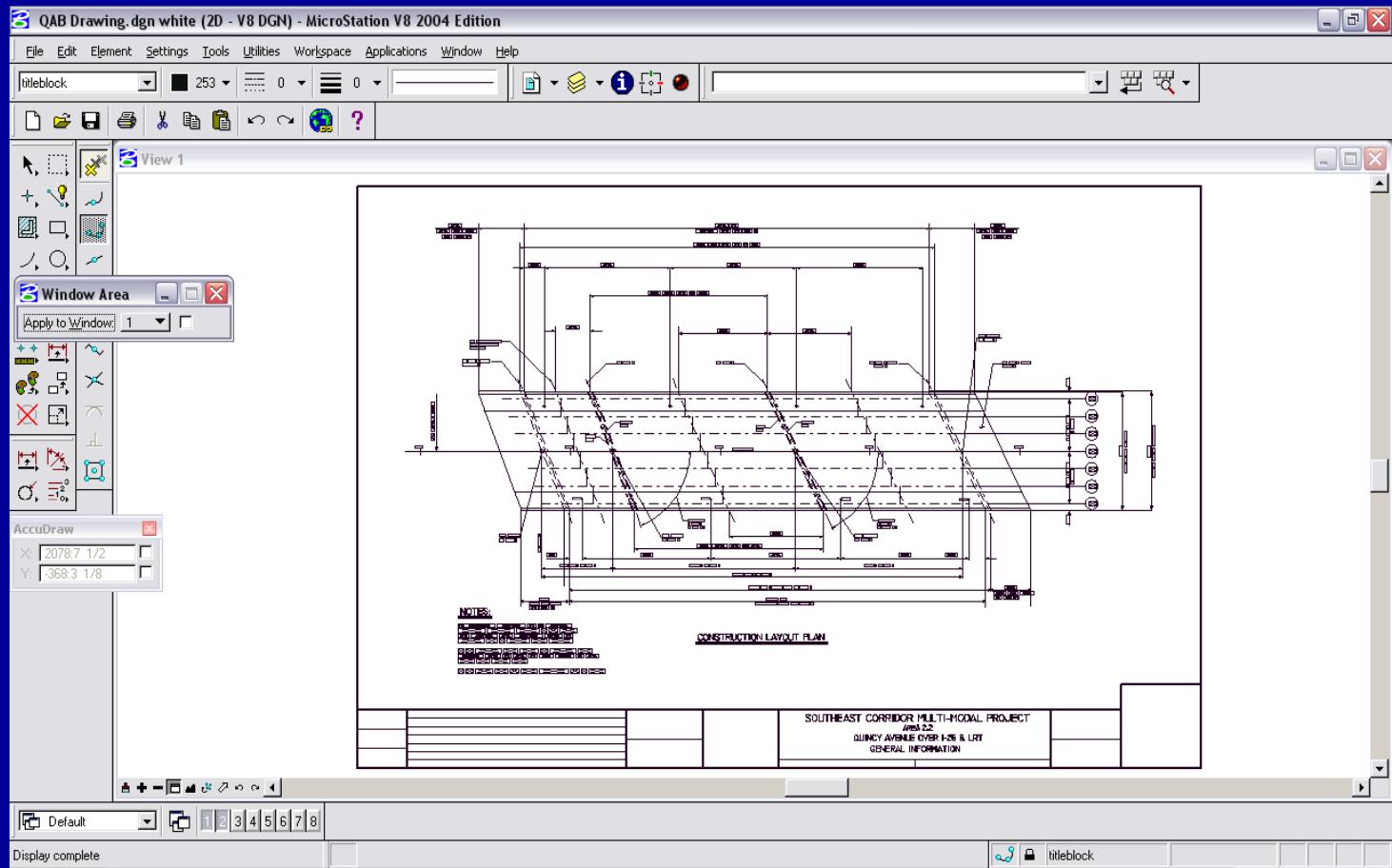


C16 MicroStation Drawings

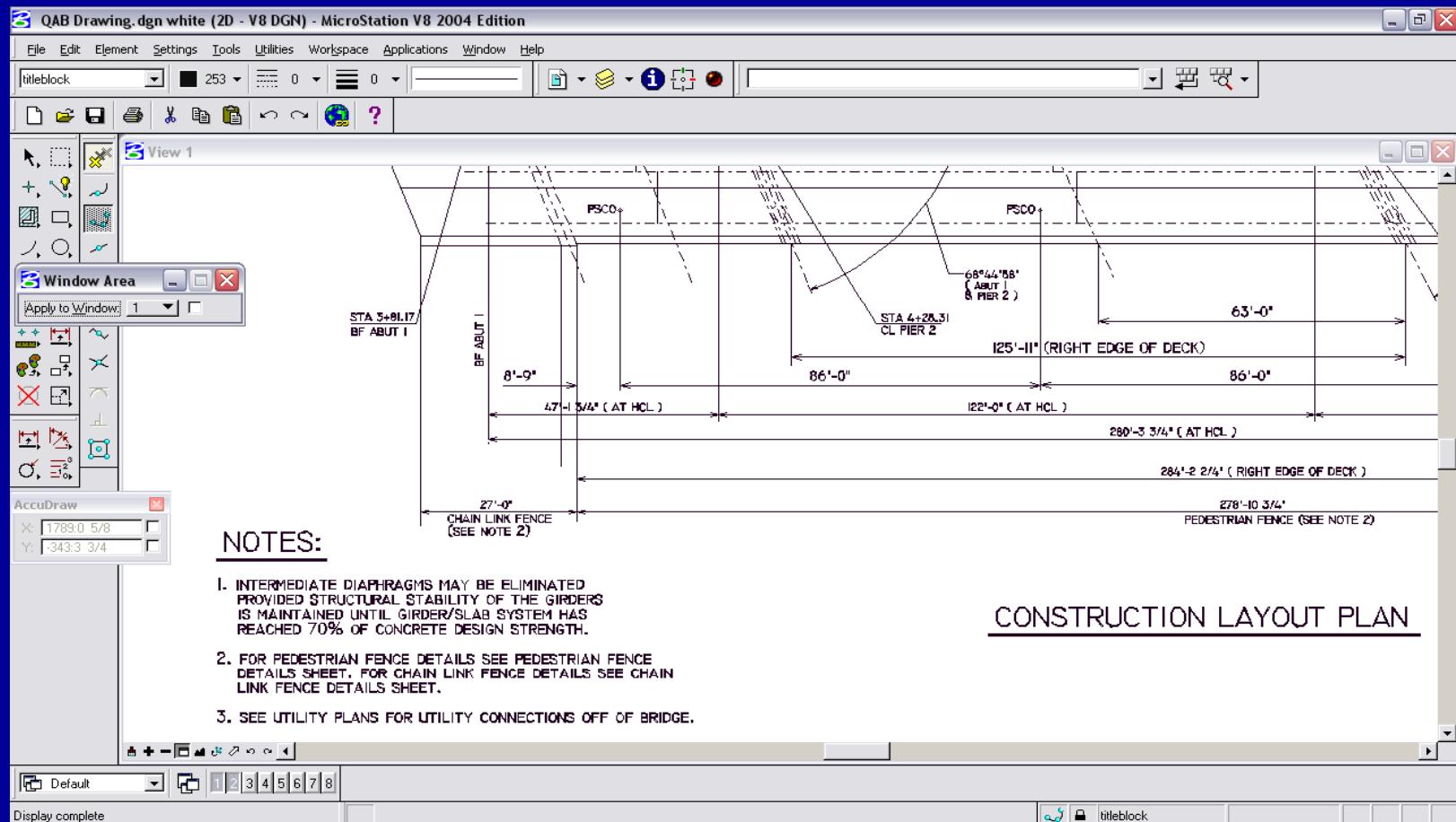


C16 MicroStation Drawings

Modification
step 4:

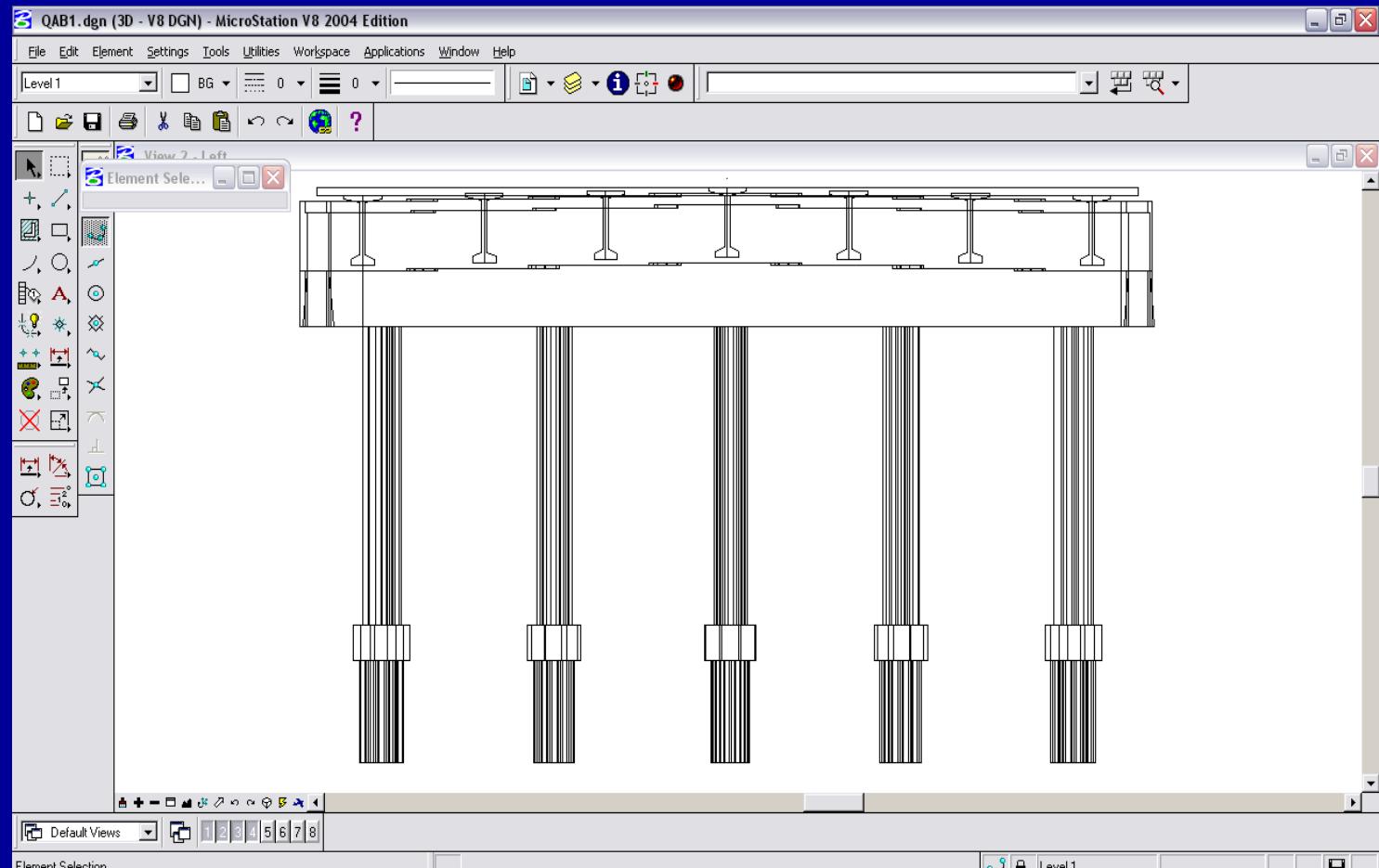


C16 MicroStation Drawings



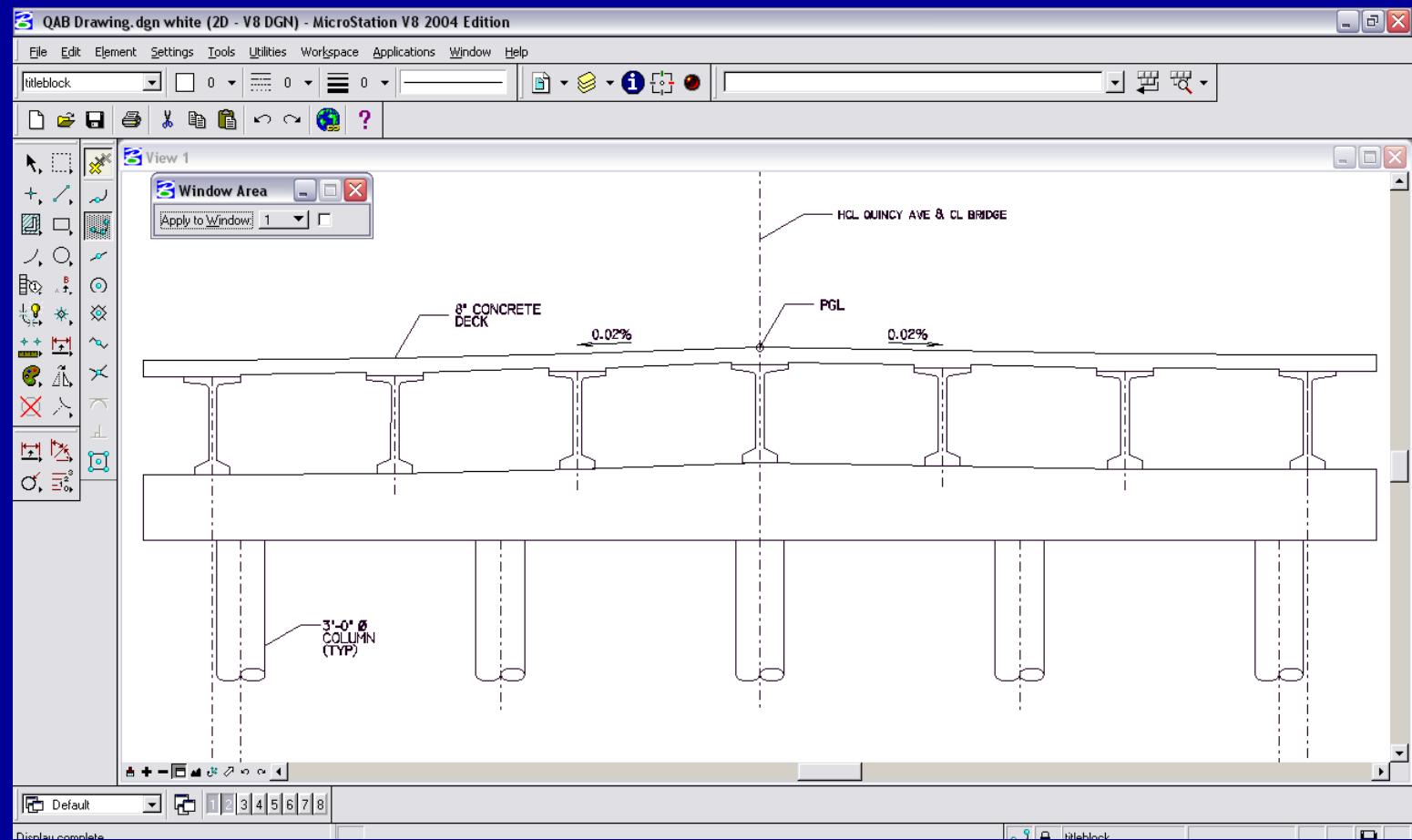
C16 MicroStation Drawings

Superstructure
Cross Section
of Quincy
Avenue Bridge
exported from
LEAP



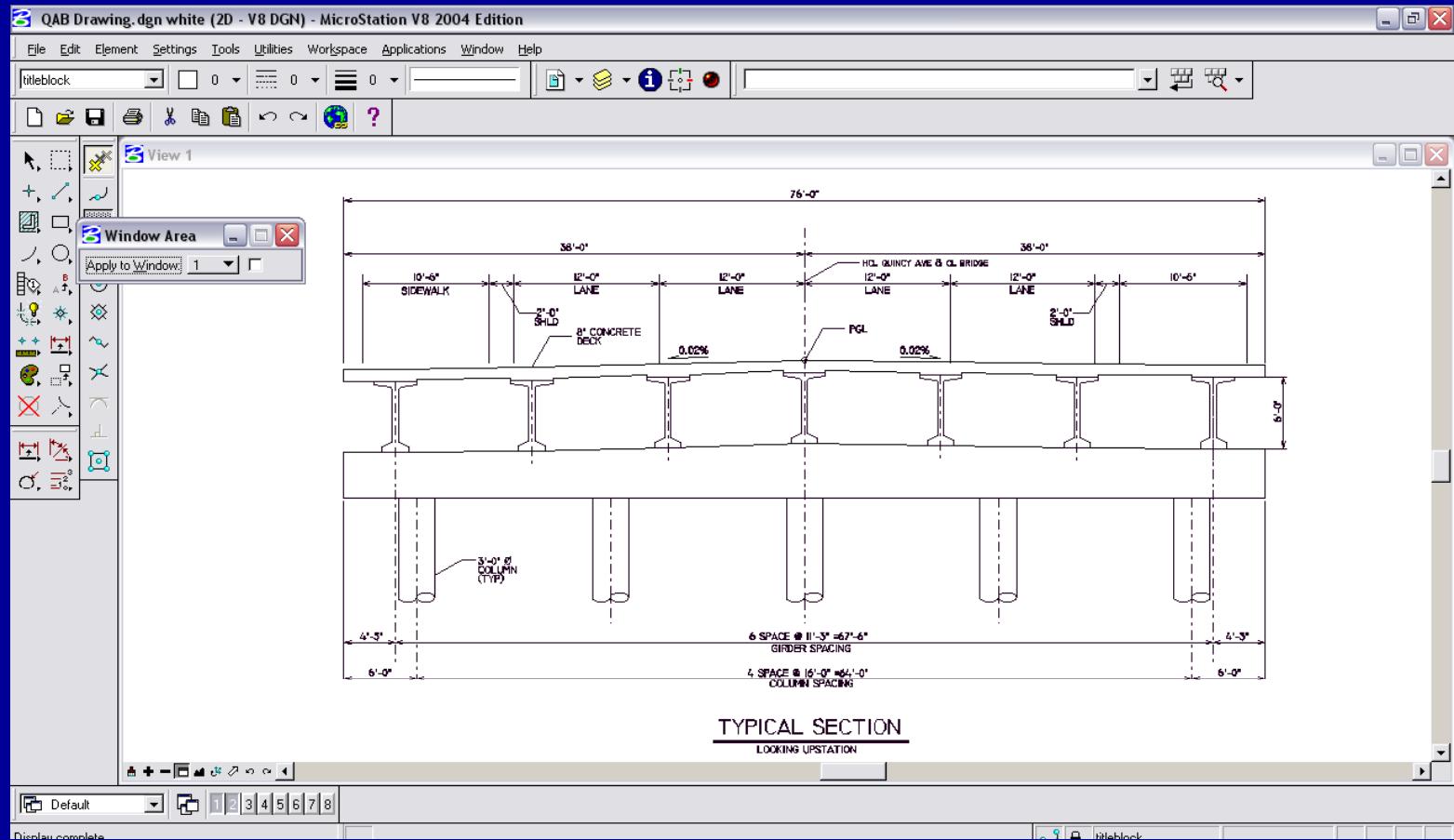
C16 MicroStation Drawings

Modification
step 1:

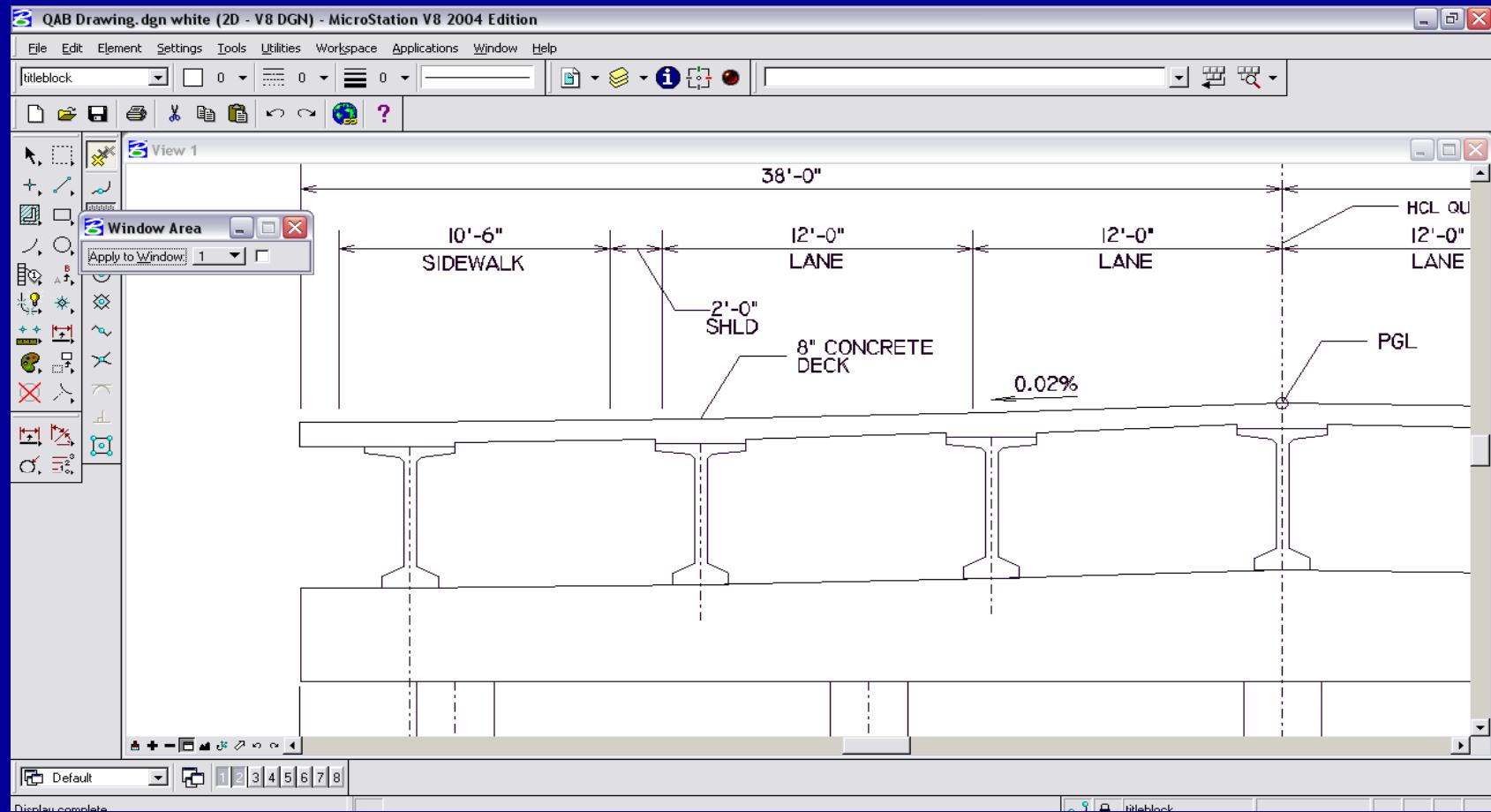


C16 MicroStation Drawings

Modification
step 2:

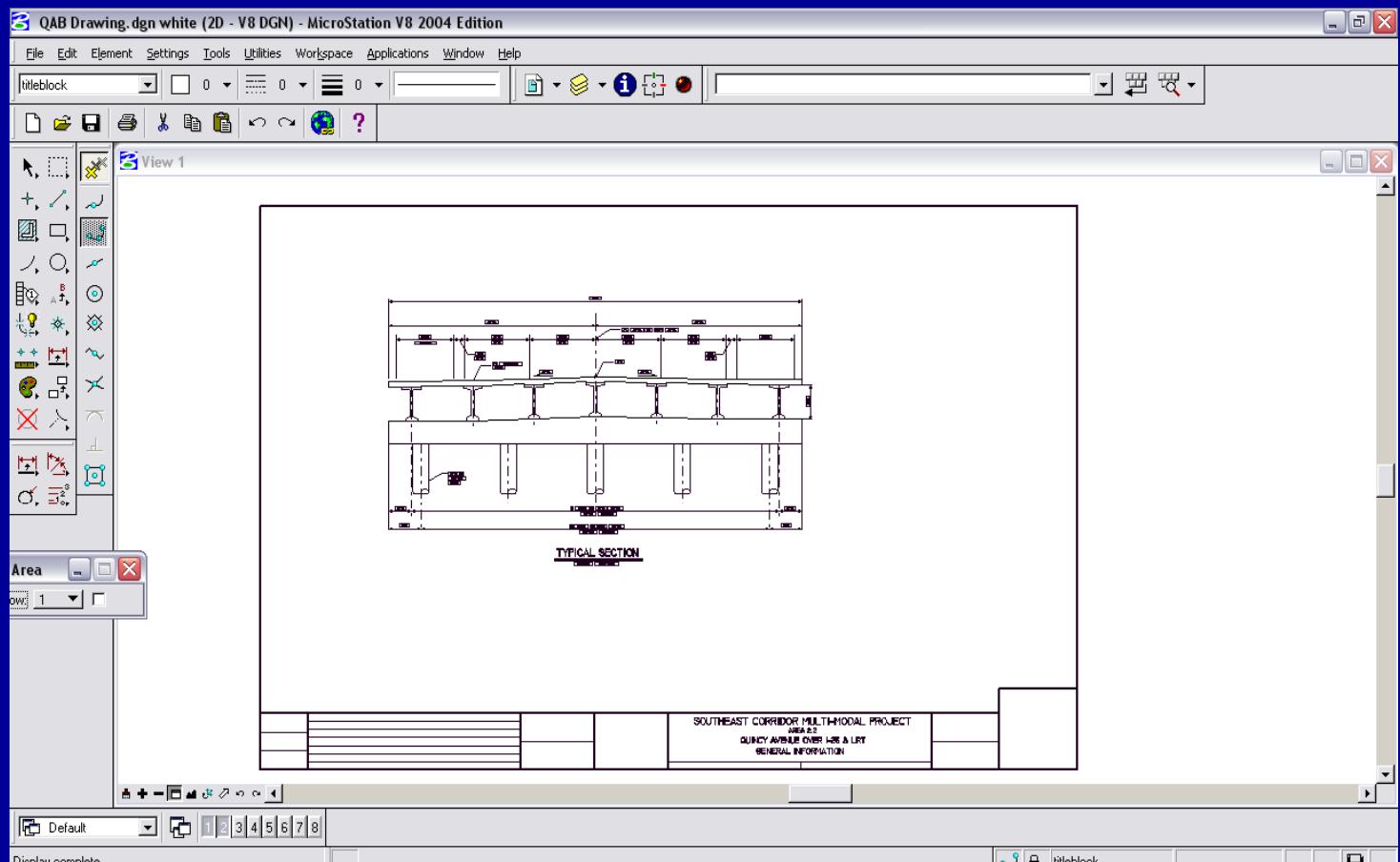


C16 MicroStation Drawings

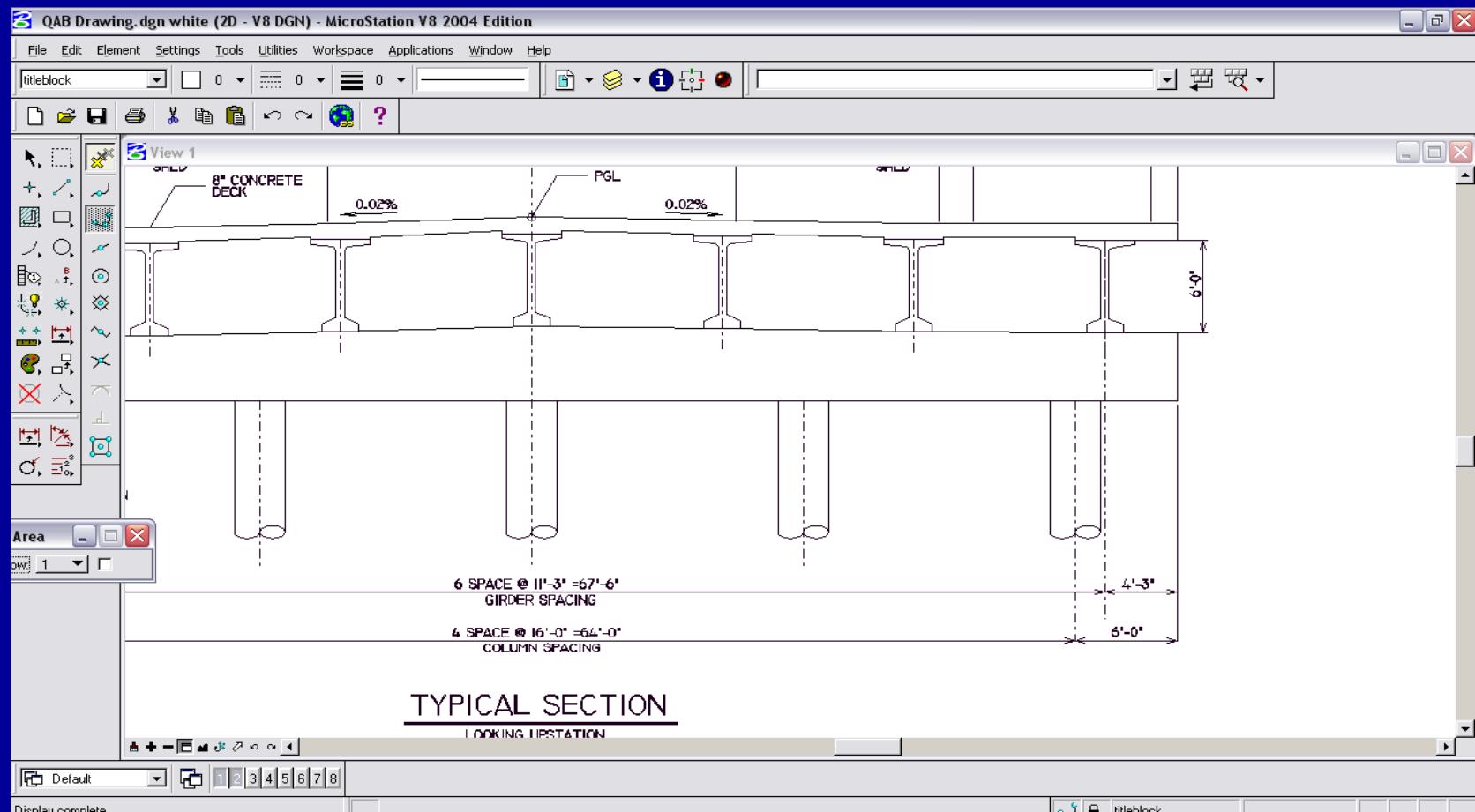


C16 MicroStation Drawings

Modification
step 3:



C16 MicroStation Drawings



Summary (Part D2-Concrete Design)

- Workflow demonstrated for concrete alternate of Case Study bridge
- One of several possible such workflows
- Encompassing analysis & design, superstructure & substructure, 3D modeling environment (used subsequently for drawing generation and further downstream...)

