

AASHTOWare BrDR 7.5.0

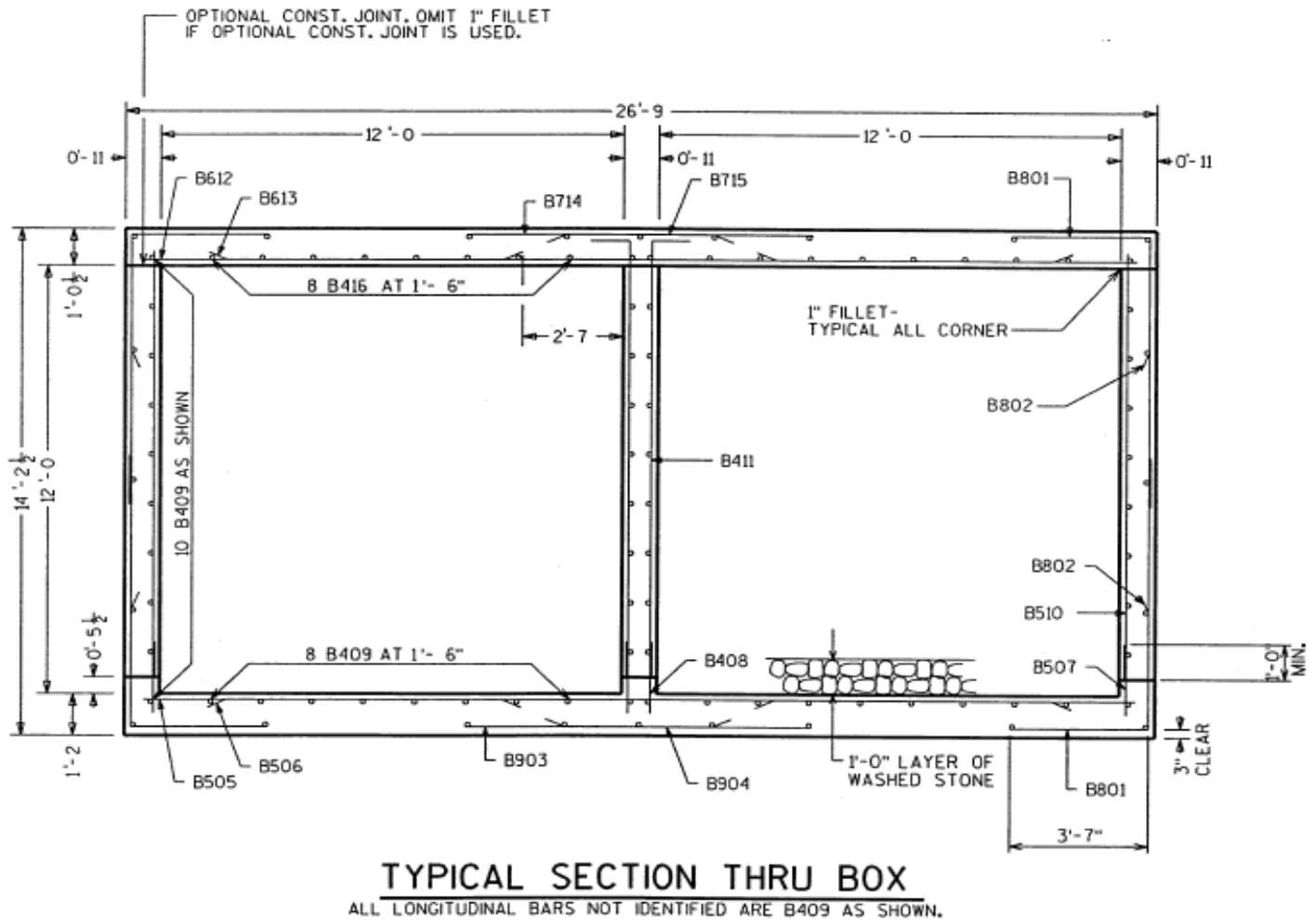
CVT1 – Culvert Tutorial

*CVT1 – Two Cell RC Box Culvert Example (and Culvert Design
Tool)*

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Topics Covered

- Enter culvert description
- Perform AASHTO Culvert LRFR analysis and review results
- Culvert Design Tool



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

BILL OF BARS					
THE FIRST OR FIRST AND SECOND DIGIT OF THE MARK SIGNIFIES THE BAR SIZE. THE DIMENSION IN THE BENT COLUMN IS THE OUT TO OUT HORIZONTAL LEG OF A "L" SHAPED BAR.					
MARK	NUMBER REQ'D.	LENGTH	BENT	CUTTING DIAG.	LOCATION
▲ B801	416	11 -2	3-7	NO	CORNERS
▲ B802	400	7-4	3-7	NO	CORNERS
▲ B903	76	9-0	NO	NO	BOTTOM SLAB TRANS.
▲ B904	72	4-10	NO	NO	BOTTOM SLAB TRANS.
▲ B505	124	25-10	NO	NO	BOTTOM SLAB TRANS.
▲ B506	240	8-2	NO	NO	BOTTOM SLAB TRANS.
B507	296	2-0	NO	NO	WALLS-DOWELS VERT.
B408	136	2-0	NO	NO	WALLS-DOWELS VERT.
B409	320	33-0	NO	NO	TOP&BOTTOM SLAB & WALL
B510	296	12 -4	NO	NO	WALLS VERT.
B411	136	13 -4	1-0	NO	WALLS VERT.
▲ B612	84	25-10	NO	NO	TOP SLAB TRANS.
▲ B613	160	8-2	NO	NO	TOP SLAB TRANS.
▲ B714	116	9-0	NO	NO	TOP SLAB TRANS.
▲ B715	112	4-10	NO	NO	TOP SLAB TRANS.
B416	64	33-0	NO	NO	TOP SLAB LONGIT.
B417	4	26-4	NO	NO	HEADERS HORIZ.
B318	72	3-1	YES	NO	HEADER STIRRUPS VERT.
B519	267	4-0	NO	NO	VERT.CONST.JOINT
▲ B801 BARS MAY BE SUBSTITUTED FOR B802 BARS B903 BARS MAY BE SUBSTITUTED FOR B904 BARS B505 BARS MAY BE SUBSTITUTED FOR PAIRS OF B506 BARS B612 BARS MAY BE SUBSTITUTED FOR PAIRS OF B613 BARS B714 BARS MAY BE SUBSTITUTED FOR B715 BARS.					

Material Properties:

- Culvert concrete – Class A, $f'_c = 3.5$ ksi
- Reinforcing steel – Grade 60, $F_y = 60$ ksi
- Soil – 120 pcf, $\phi = 30$ deg

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Enter culvert description

From the **Bridge Explorer** create a **new bridge** and enter the following description data.

New Bridge

Bridge ID: NBI structure ID (8):

☐ Template ☐ Bridge completely defined

Bridge Workspace View

- ☐ Superstructures
- ☒ Culverts
- ☐ Substructures

Description | Description (cont'd) | Alternatives | Global reference point | Traffic | Custom agency fields

Name: Year built:

Description:

Location: Length: ft

Facility carried (7): Route number:

Feat. intersected (6): Mi. post:

Default units:

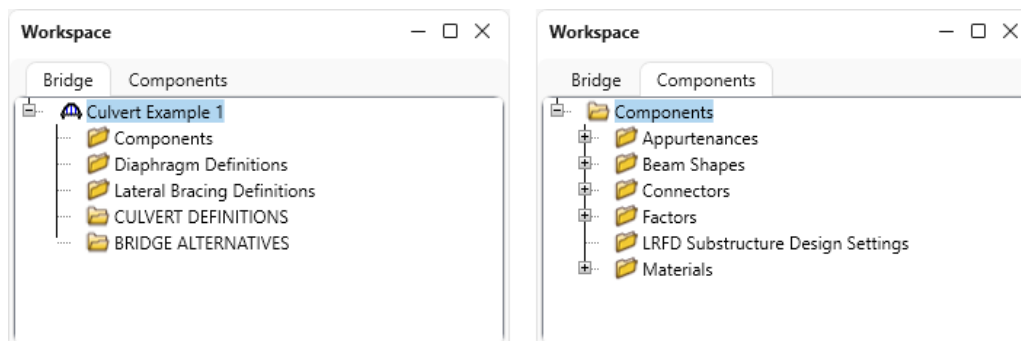
Bridge association... ☒ BrR ☒ BrD ☐ BrM

OK Apply Cancel

The **Superstructures** and **Culverts** checkboxes specify the types of structures the bridge contains. These checkboxes filter what to display in the **Bridge Workspace** tree.

Close the window by clicking **OK**.

After the bridge is created, the **Bridge Workspace** tree and **Components** tree are as shown below.



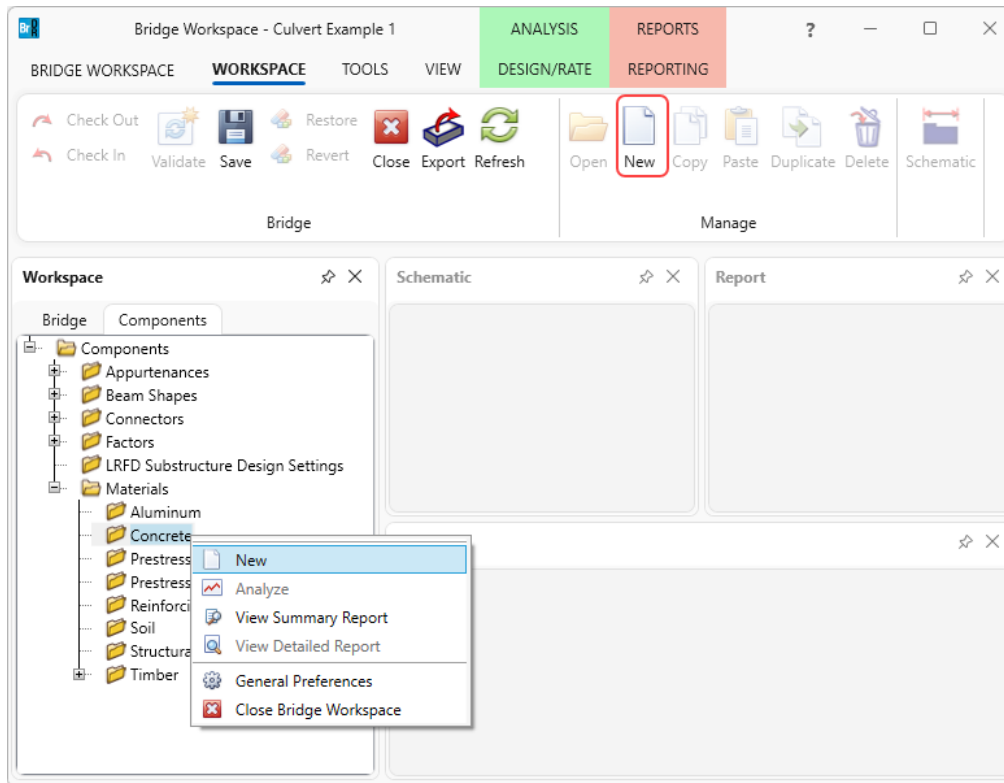
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

The **Bridge Workspace** tree is organized according to the definition of a bridge with data shared by many of the bridge components shown in the **Components** tab. A bridge can be described by working from top to bottom within the tree.

Bridge Materials

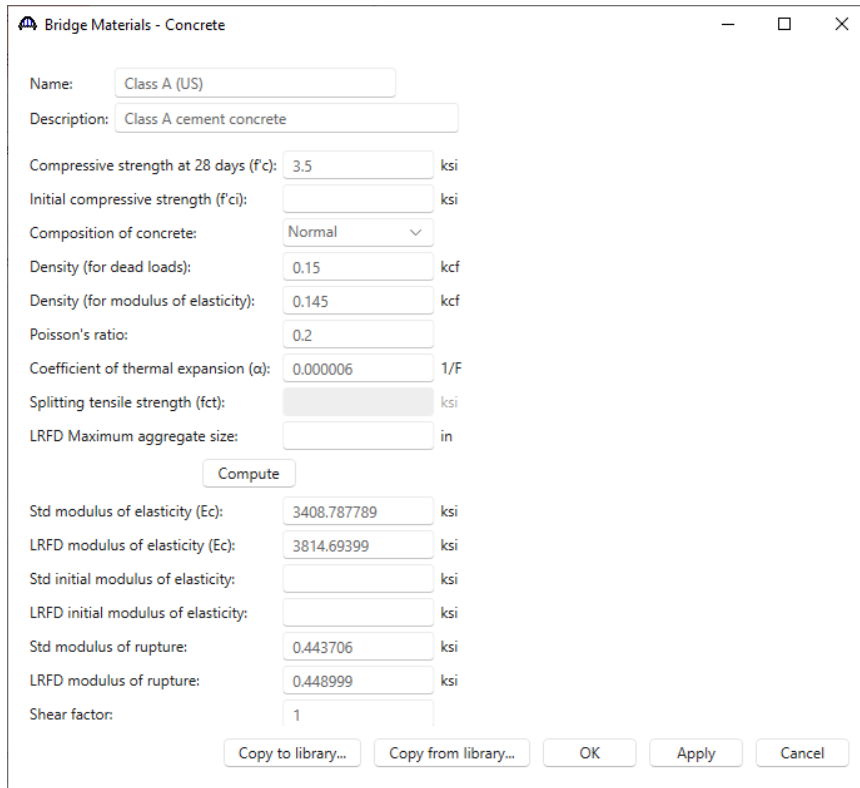
To enter the materials for the culvert, in the **Components** tab, expand the tree for **Materials**.

To add a concrete material, double-click on the **Concrete** folder in the **Components** tab (or select **Concrete** and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon or right click and select **New**) to create a new concrete material as shown below.



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

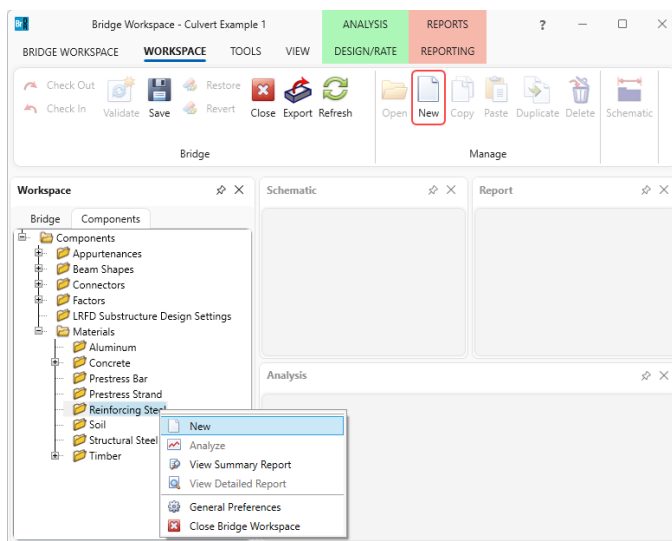
On the **Bridge Materials-Concrete** window, enter the values shown above the **Compute** button and click the **Compute** button to calculate the remaining values (**Class A(US)** in the library is slightly different from the values shown below).



The image shows a dialog box titled "Bridge Materials - Concrete". It contains several input fields for concrete properties. The "Name" field is set to "Class A (US)" and the "Description" field is set to "Class A cement concrete". The "Compressive strength at 28 days (f'c)" is 3.5 ksi. The "Initial compressive strength (f'ci)" is empty. The "Composition of concrete" is set to "Normal". The "Density (for dead loads)" is 0.15 kcf and the "Density (for modulus of elasticity)" is 0.145 kcf. The "Poisson's ratio" is 0.2 and the "Coefficient of thermal expansion (α)" is 0.000006 1/F. The "Splitting tensile strength (f'ct)" is empty. The "LRFD Maximum aggregate size" is empty. Below these fields is a "Compute" button. Below the "Compute" button are several output fields: "Std modulus of elasticity (Ec)" is 3408.787789 ksi, "LRFD modulus of elasticity (Ec)" is 3814.69399 ksi, "Std initial modulus of elasticity" is empty, "LRFD initial modulus of elasticity" is empty, "Std modulus of rupture" is 0.443706 ksi, "LRFD modulus of rupture" is 0.448999 ksi, and "Shear factor" is 1. At the bottom are buttons for "Copy to library...", "Copy from library...", "OK", "Apply", and "Cancel".

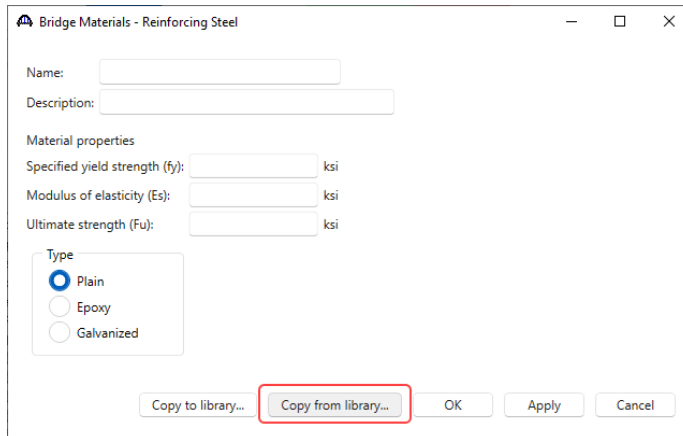
Property	Value	Unit
Name	Class A (US)	
Description	Class A cement concrete	
Compressive strength at 28 days (f'c)	3.5	ksi
Initial compressive strength (f'ci)		ksi
Composition of concrete	Normal	
Density (for dead loads)	0.15	kcf
Density (for modulus of elasticity)	0.145	kcf
Poisson's ratio	0.2	
Coefficient of thermal expansion (α)	0.000006	1/F
Splitting tensile strength (f'ct)		ksi
LRFD Maximum aggregate size		in
Std modulus of elasticity (Ec)	3408.787789	ksi
LRFD modulus of elasticity (Ec)	3814.69399	ksi
Std initial modulus of elasticity		ksi
LRFD initial modulus of elasticity		ksi
Std modulus of rupture	0.443706	ksi
LRFD modulus of rupture	0.448999	ksi
Shear factor	1	

To add a reinforcing steel material, double-click on the **Reinforcing Steel** folder in the **Components** tab (or select **Reinforcing Steel** and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon or right click and select **New**) to create a new reinforcing steel material as shown below.

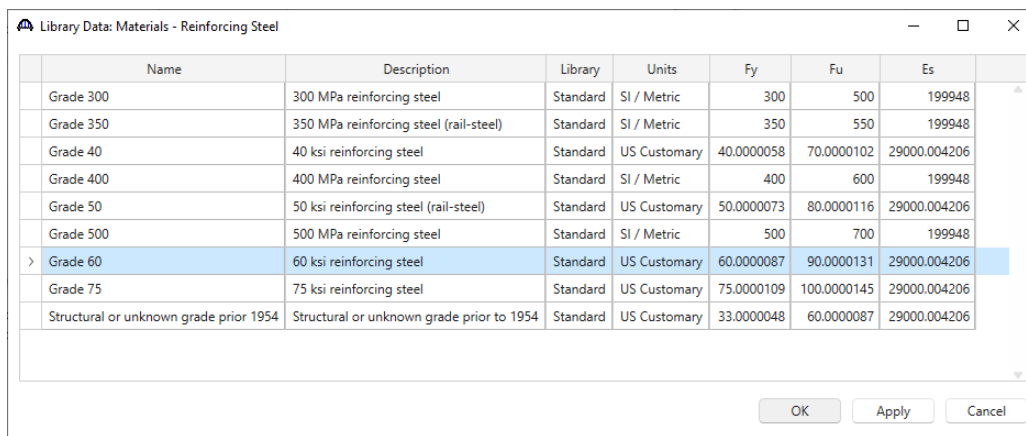


CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

On the **Bridge Materials-Reinforcing Steel** window, click on the **Copy from library...** button and copy the **Grade 60** reinforcing steel to be used in the bridge as shown below.



The 'Bridge Materials - Reinforcing Steel' window is shown. It has fields for Name, Description, Specified yield strength (fy), Modulus of elasticity (Es), and Ultimate strength (Fu). The Type section has radio buttons for Plain (selected), Epoxy, and Galvanized. At the bottom, there are buttons for 'Copy to library...', 'Copy from library...' (highlighted with a red box), 'OK', 'Apply', and 'Cancel'.

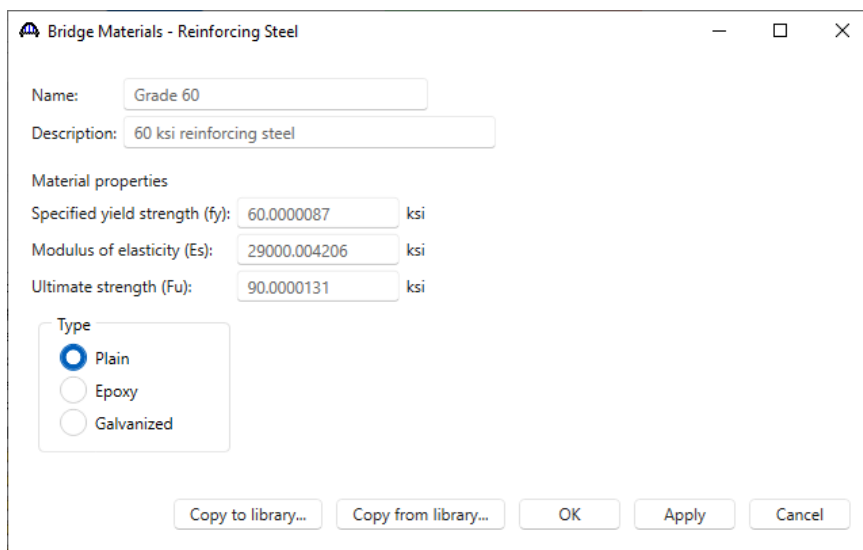


The 'Library Data: Materials - Reinforcing Steel' window displays a table of reinforcing steel materials. The 'Grade 60' row is selected and highlighted in blue.

Name	Description	Library	Units	Fy	Fu	Es
Grade 300	300 MPa reinforcing steel	Standard	SI / Metric	300	500	199948
Grade 350	350 MPa reinforcing steel (rail-steel)	Standard	SI / Metric	350	550	199948
Grade 40	40 ksi reinforcing steel	Standard	US Customary	40.0000058	70.0000102	29000.004206
Grade 400	400 MPa reinforcing steel	Standard	SI / Metric	400	600	199948
Grade 50	50 ksi reinforcing steel (rail-steel)	Standard	US Customary	50.0000073	80.0000116	29000.004206
Grade 500	500 MPa reinforcing steel	Standard	SI / Metric	500	700	199948
> Grade 60	60 ksi reinforcing steel	Standard	US Customary	60.0000087	90.0000131	29000.004206
Grade 75	75 ksi reinforcing steel	Standard	US Customary	75.0000109	100.0000145	29000.004206
Structural or unknown grade prior 1954	Structural or unknown grade prior to 1954	Standard	US Customary	33.0000048	60.0000087	29000.004206

Buttons at the bottom: OK, Apply, Cancel.

The **Bridge Materials – Reinforcing Steel** window will be updated with material information as shown below.

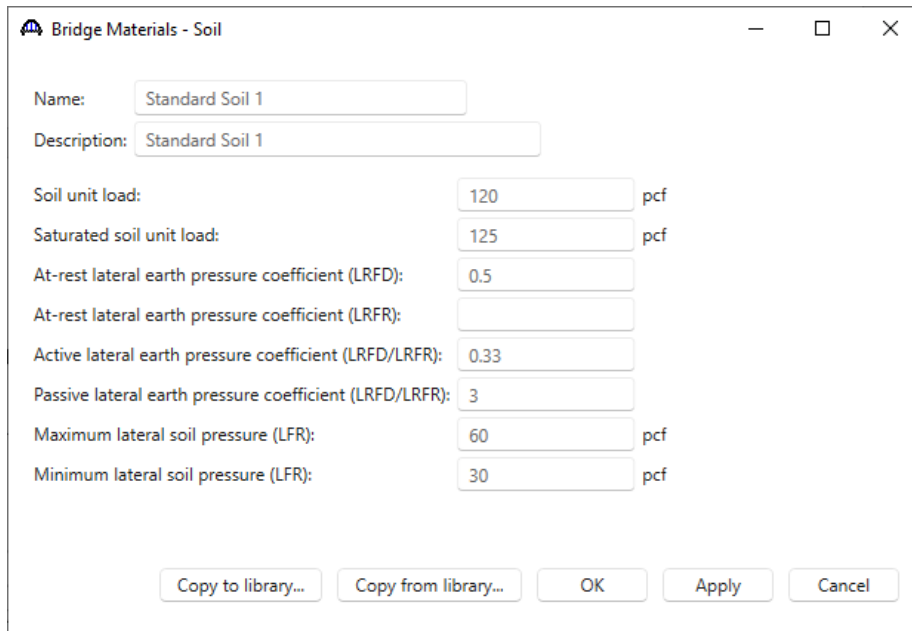


The 'Bridge Materials - Reinforcing Steel' window is updated with the information from the selected Grade 60 material. The Name field is 'Grade 60', the Description is '60 ksi reinforcing steel', the Specified yield strength (fy) is '60.0000087' ksi, the Modulus of elasticity (Es) is '29000.004206' ksi, and the Ultimate strength (Fu) is '90.0000131' ksi. The Type section still has 'Plain' selected. The 'Copy from library...' button is now disabled.

Click **OK** to add the reinforcing steel material and close the window.

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Similarly, add a new soil material by copying the **Standard Soil 1** from the library. The **Bridge Materials – Soil** window with material information updated is shown below.



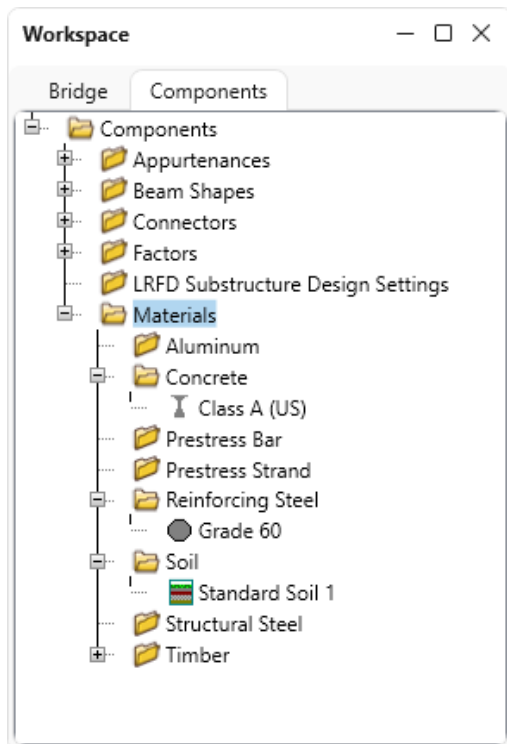
The 'Bridge Materials - Soil' dialog box is shown with the following fields and values:

Field	Value	Unit
Name:	Standard Soil 1	
Description:	Standard Soil 1	
Soil unit load:	120	pcf
Saturated soil unit load:	125	pcf
At-rest lateral earth pressure coefficient (LRFD):	0.5	
At-rest lateral earth pressure coefficient (LRFR):		
Active lateral earth pressure coefficient (LRFD/LRFR):	0.33	
Passive lateral earth pressure coefficient (LRFD/LRFR):	3	
Maximum lateral soil pressure (LFR):	60	pcf
Minimum lateral soil pressure (LFR):	30	pcf

Buttons at the bottom: Copy to library..., Copy from library..., OK, Apply, Cancel.

Click **OK** to add the soil material and close the window.

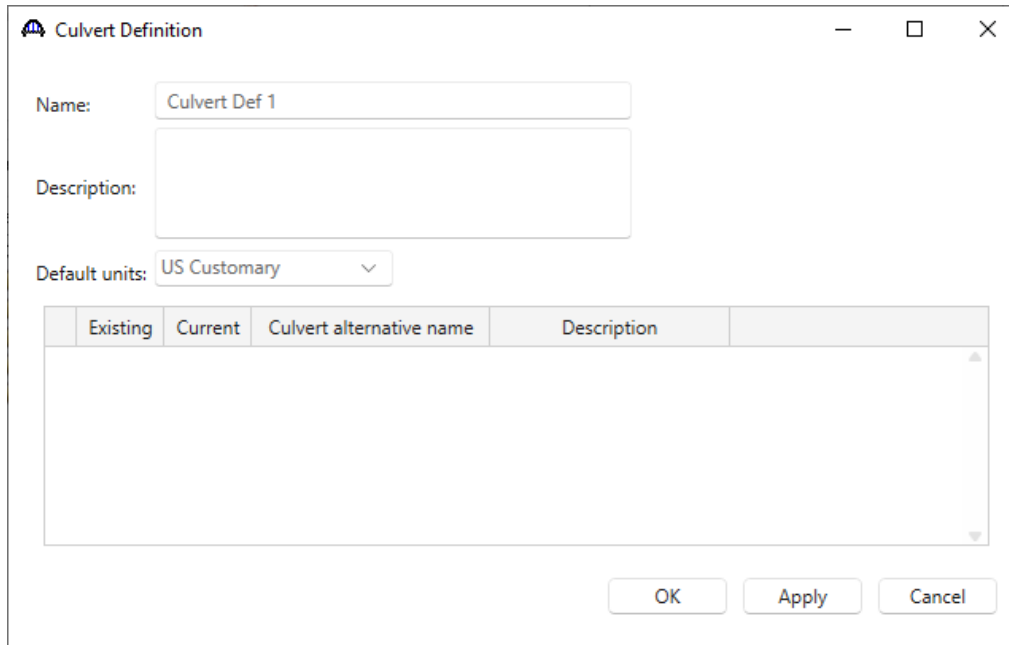
The **Components** tree updated with the three materials to be used by the culvert is shown below.



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Culvert Definition

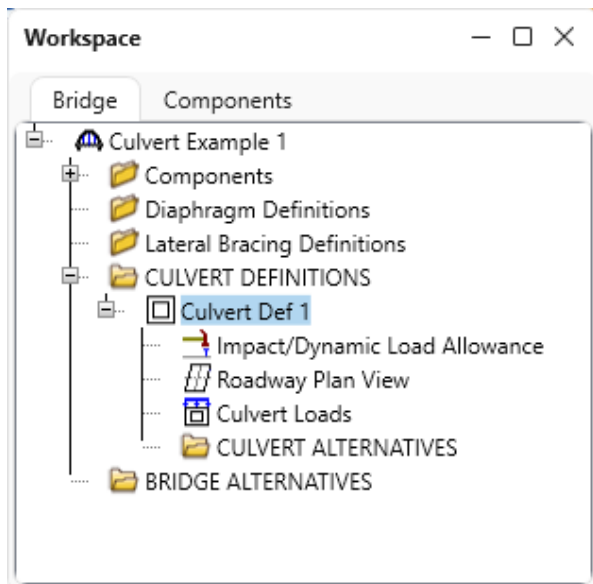
Navigate to the **Bridge** tab of the **Bridge Workspace**. Double click on the **CULVERT DEFINITIONS** folder to create a new culvert definition. Enter the Culvert Definition **Name** as show below. The first Culvert Alternative added will automatically be assigned as the **Existing** and **Current** Culvert Alternative for this Culvert Definition.



The screenshot shows the 'Culvert Definition' dialog box. It has a title bar with a bridge icon and the text 'Culvert Definition'. Inside, there is a 'Name:' label followed by a text box containing 'Culvert Def 1'. Below that is a 'Description:' label followed by an empty text box. Then, 'Default units:' is followed by a dropdown menu showing 'US Customary'. At the bottom, there is a table with columns: 'Existing', 'Current', 'Culvert alternative name', and 'Description'. The table is currently empty. At the bottom right of the dialog are three buttons: 'OK', 'Apply', and 'Cancel'.

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

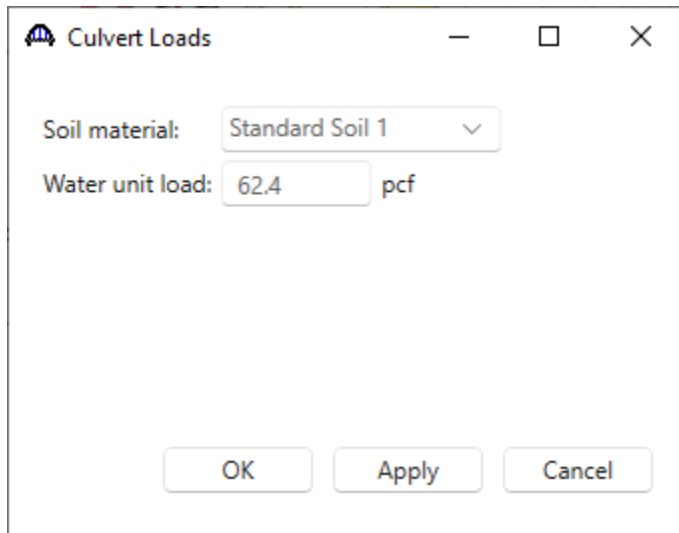
Click on the + button of the newly added culvert definition to expand the culvert definition tree as shown below.



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Culvert Loads

Double-click on the **Culvert Loads** node to open the **Culvert Loads** window. For this example, the default values specified in this window will be used. No change is required.

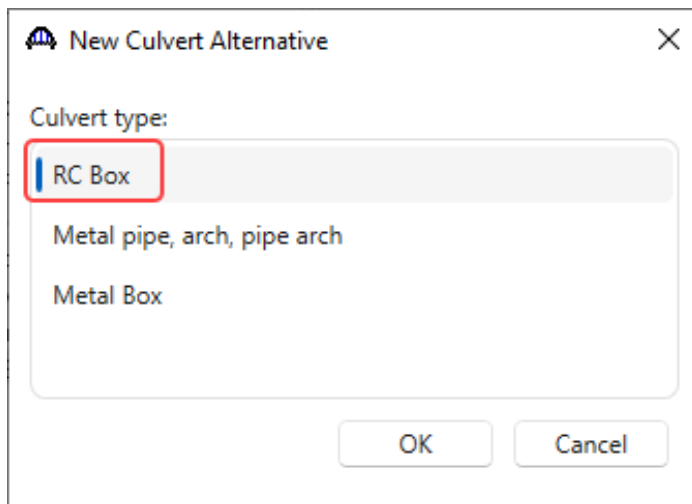


The screenshot shows the 'Culvert Loads' dialog box. It has a title bar with a small icon, the text 'Culvert Loads', and standard window controls (minimize, maximize, close). Inside the dialog, there are two input fields: 'Soil material:' with a dropdown menu showing 'Standard Soil 1' and a downward arrow, and 'Water unit load:' with a text box containing '62.4' and a unit label 'pcf'. At the bottom of the dialog are three buttons: 'OK', 'Apply', and 'Cancel'.

Click **OK** to close the window.

Culvert Alternative

Double-click on the **CULVERT ALTERNATIVES** folder to create a new culvert alternative for **Culvert Def 1**. Select **RC Box** in the **New Culvert Alternative** window and click **OK** to open the **Culvert Alternative Description** window as shown below.



The screenshot shows the 'New Culvert Alternative' dialog box. It has a title bar with a small icon, the text 'New Culvert Alternative', and a close button. Inside the dialog, there is a label 'Culvert type:' followed by a list box. The list box contains three options: 'RC Box', 'Metal pipe, arch, pipe arch', and 'Metal Box'. The 'RC Box' option is highlighted with a blue selection bar and is enclosed in a red rectangular box. At the bottom of the dialog are two buttons: 'OK' and 'Cancel'.

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

In the **Culvert Alternative Description** window, enter the data as shown below.

The screenshot shows the 'Culvert Alternative Description' window with the 'Description' tab selected. The window title is 'Culvert Alternative Description'. Below the title bar, there is a text field for 'Culvert alternatives:' containing 'Culvert Alt 1'. The main area is divided into several sections: 'Description' (a large text area), 'Default units:' (a dropdown menu set to 'US Customary'), 'Top slab exterior surface exposure factor:' (a text field with '0.75'), 'Bot. slab exterior surface exposure factor:' (a text field), 'Wall exterior surface exposure factor:' (a text field), 'Interior surface exposure factor:' (a text field), 'Culvert type:' (a dropdown menu set to 'RC Box'), 'Construction type:' (radio buttons for 'Cast-in-plac' and 'Precast', with 'Cast-in-plac' selected), 'Default rating method:' (a dropdown menu set to 'LFR'), 'Soil' (a section with 'Installation method:' dropdown set to 'Embankment', 'Side fill condition' radio buttons for 'Compact' and 'Uncompact' (with 'Compact' selected), 'LRFD EH load factor' radio buttons for 'At-rest' and 'Active' (with 'At-rest' selected), 'LRFD/LRFR earth pressure coefficient' radio buttons for 'At-rest', 'Active', and 'Passive' (with 'At-rest' selected), and two text fields for 'Soil-structure interaction factor (LRFD):' and 'Soil-structure interaction factor (LFD):'). At the bottom right are 'OK', 'Apply', and 'Cancel' buttons.

Navigate to the **Specs** tab of this window. **AASHTO Culvert LRFR** is selected as the analysis module for **LRFR** analysis.

The screenshot shows the 'Culvert Alternative Description' window with the 'Specs' tab selected. The window title is 'Culvert Alternative Description'. Below the title bar, there is a text field for 'Culvert alternatives:' containing 'Culvert Alt 1'. The main area contains a table with the following data:

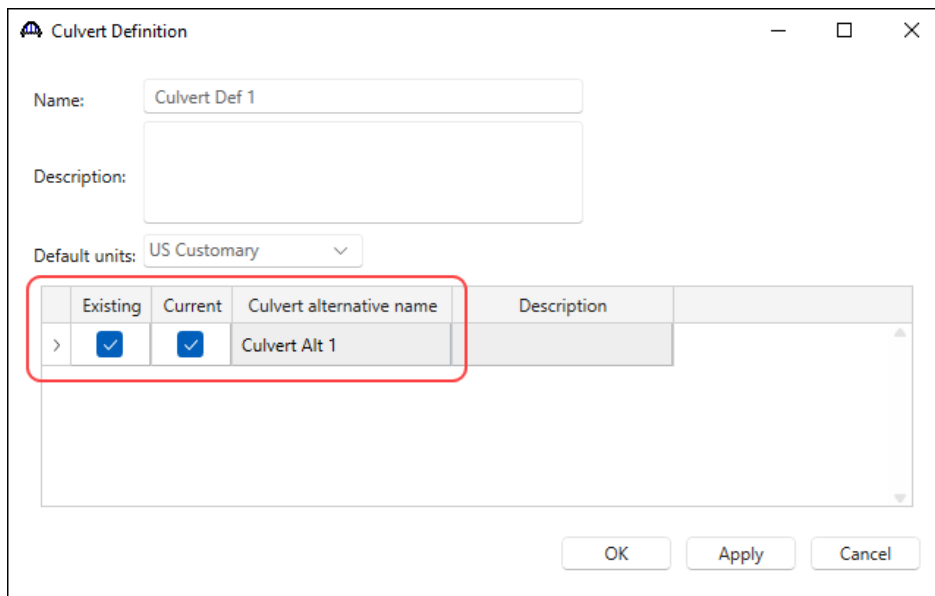
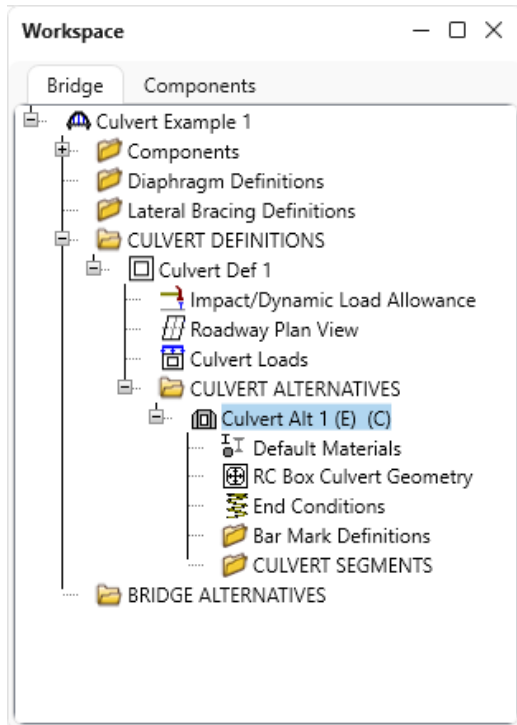
Analysis method type	Analysis module	Selection type	Spec version	Factors
LFR	AASHTO Culvert LFR	System Default	MBE 3rd 2023, Std 17th	2002 AASHTO Std. Specifications
LRFD	AASHTO Culvert LRFD	System Default	LRFD 9th	2020 AASHTO LRFD Specifications
LRFR	AASHTO Culvert LRFR	System Default	MBE 3rd 2023, LRFD 9th	2018 (2022 Interim) AASHTO LRFR Spec.

At the bottom right are 'OK', 'Apply', and 'Cancel' buttons.

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

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

The expanded tree for **Culvert Alt 1** is shown below. Note that the **Culvert Alt 1** is automatically assigned as the **Existing** and **Current** alternative shown by the **(E)** and **(C)** in the name. This culvert alternative is also updated as **Existing** and **Current** alternative in the **Culvert Definition** window as shown below.



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

RC Box Culvert Geometry

Double-click on the **RC Box Culvert Geometry** node in the **Bridge Workspace** tree. Enter the data as shown below.

RC Box Culvert Geometry

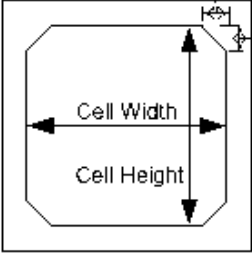
Number of cells: 2

☒ Bottom slab present

Cell height: 12 ft

Horiz. construction joint height: 5.5 in

	Cell	Width (ft)
>	1	12
	2	12



☐ Haunches

Top haunch width: in

Top haunch depth: in

Bottom haunch width: in

Bottom haunch depth: in

OK

Apply

Cancel

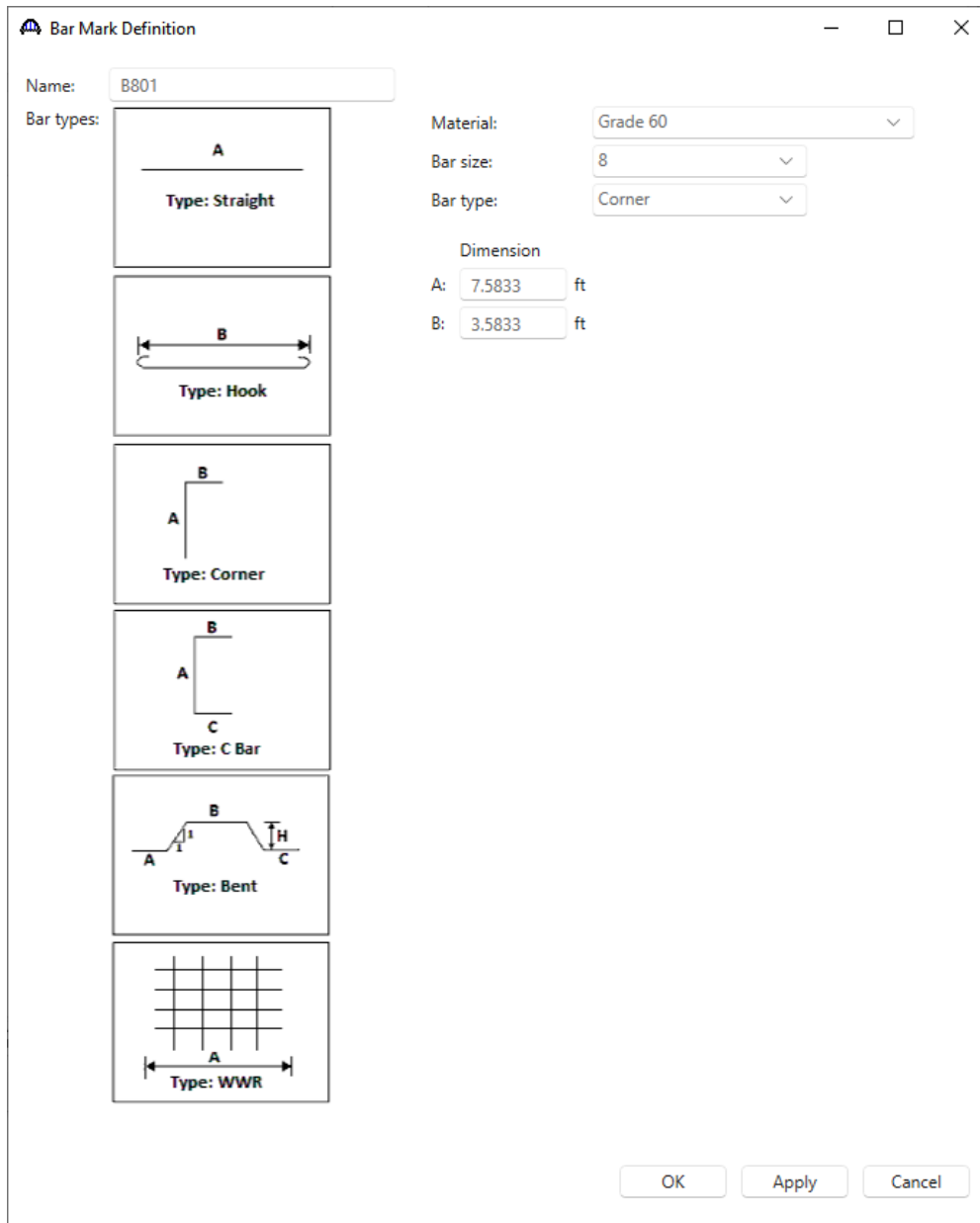
Click **OK** to apply the data and close the window.

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Bar Mark Definitions

Double-click on the **Bar Mark Definitions** folder in the **Bridge Workspace** tree to create a new bar mark definition for **Culvert Alt 1**. Enter the data for B801 as shown below.

MARK	NUMBER REQ'D.	LENGTH	BENT	CUTTING DIAG.	LOCATION
B801	416	11 -2	3-7	NO	CORNERS



The dialog box is titled "Bar Mark Definition". It contains a "Name:" field with the value "B801". Below it, "Bar types:" are listed with six options, each with a diagram: "Type: Straight" (a horizontal line labeled A), "Type: Hook" (a U-shaped hook labeled B), "Type: Corner" (an L-shaped corner labeled A and B), "Type: C Bar" (a C-shaped bar labeled A, B, and C), "Type: Bent" (a bent bar labeled A, B, and C), and "Type: WWR" (a grid of bars labeled A). To the right of these options are input fields for "Material:" (Grade 60), "Bar size:" (8), and "Bar type:" (Corner). Below these are "Dimension" fields for "A:" (7.5833 ft) and "B:" (3.5833 ft). At the bottom are "OK", "Apply", and "Cancel" buttons.

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

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

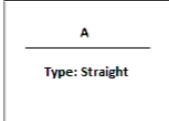
Repeat this process and add the following transverse bar mark definitions.

MARK	NUMBER REQ'D.	LENGTH	BENT	CUTTING DIAG.	LOCATION
B802	400	7-4	3-7	NO	CORNERS

Bar Mark Definition

Name:

Bar types:



Type: Straight

Material:

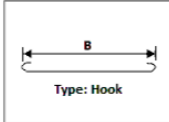
Bar size:

Bar type:

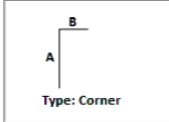
Dimension

A: ft

B: ft



Type: Hook



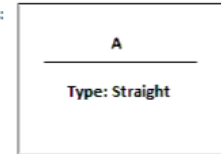
Type: Corner

MARK	NUMBER REQ'D.	LENGTH	BENT	CUTTING DIAG.	LOCATION
B903	76	9-0	NO	NO	BOTTOM SLAB TRANS.
B904	72	4-10	NO	NO	BOTTOM SLAB TRANS.
B505	124	25-10	NO	NO	BOTTOM SLAB TRANS.
B506	240	8-2	NO	NO	BOTTOM SLAB TRANS.
B507	296	2-0	NO	NO	WALLS-DOWELS VERT.
B408	136	2-0	NO	NO	WALLS-DOWELS VERT.
B510	296	12-4	NO	NO	WALLS VERT.
B411	136	13-4	1-0	NO	WALLS VERT.
B612	84	25-10	NO	NO	TOP SLAB TRANS.
B613	160	8-2	NO	NO	TOP SLAB TRANS.
B714	116	9-0	NO	NO	TOP SLAB TRANS.
B715	112	4-10	NO	NO	TOP SLAB TRANS.

Bar Mark Definition

Name:

Bar types:



Type: Straight

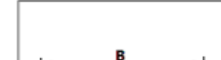
Material:

Bar size:

Bar type:

Dimension

A: ft

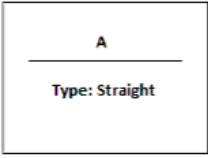


Type: Hook

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

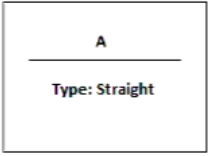
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

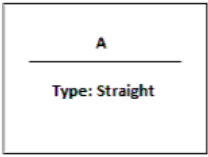
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

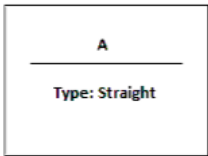
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

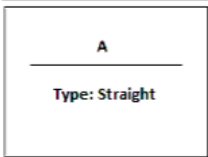
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

Bar type:

Dimension

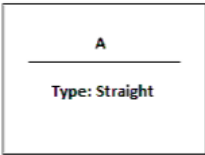
A: ft

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Bar Mark Definition

Name: B510

Bar types:



Type: Straight

Material: Grade 60

Bar size: 5

Bar type: Straight

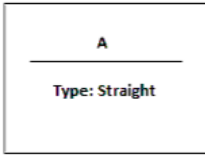
Dimension

A: 12.3333 ft

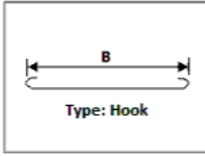
Bar Mark Definition

Name: B411

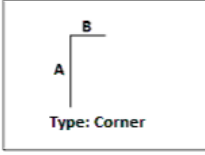
Bar types:



Type: Straight



Type: Hook



Type: Corner

Material: Grade 60

Bar size: 4

Bar type: Corner

Dimension

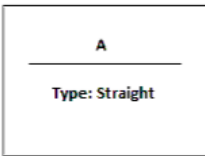
A: 12.3333 ft

B: 1 ft

Bar Mark Definition

Name: B612

Bar types:



Type: Straight

Material: Grade 60

Bar size: 6

Bar type: Straight

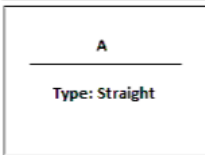
Dimension

A: 25.8333 ft

Bar Mark Definition

Name: B613

Bar types:



Type: Straight

Material: Grade 60

Bar size: 6

Bar type: Straight

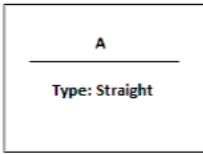
Dimension

A: 8.1667 ft

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

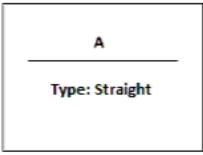
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

Bar type:

Dimension

A: ft

Culvert Segments

Double-click on the **CULVERT SEGMENTS** folder to create a new culvert segment for **Culvert Alt 1**. A culvert alternative may have one or more culvert segments. Enter the data as show below.

Culvert Segment

Name:

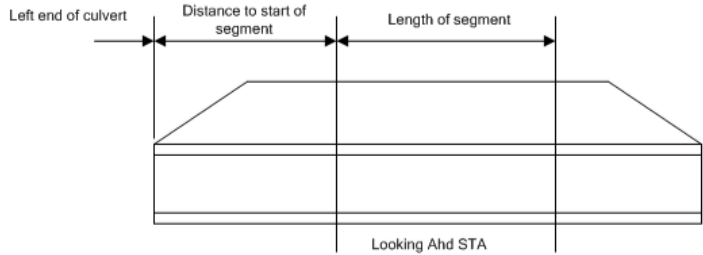
Description:

Material:

Location along culvert structure definition reference line:

Distance from left end of culvert to start of segment: ft

Length of segment: ft



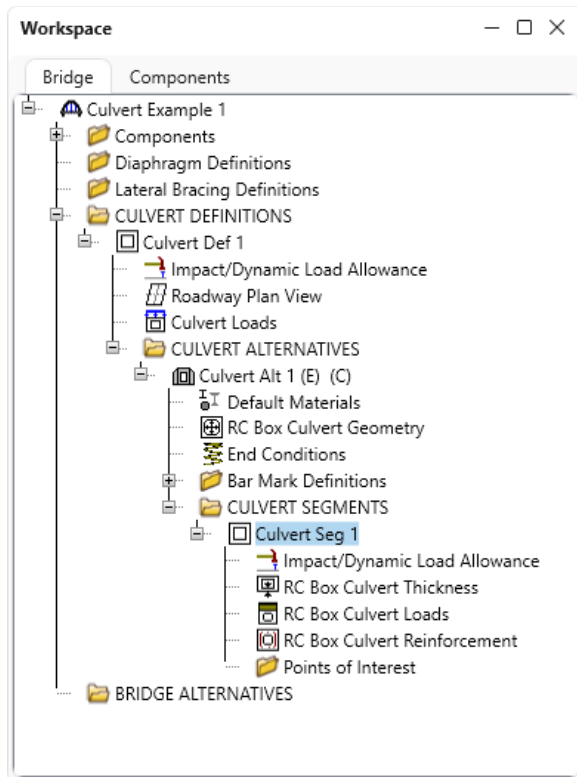
Looking Ahd STA

OK Apply Cancel

Click **OK** to create a new culvert segment and close the window.

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

The expanded tree for **Culvert Seg 1** is shown below.



RC Box Culvert Thickness

Double-click on the **RC Box Culvert Thickness** node in the **Bridge Workspace** tree. Enter the slab and wall thicknesses as shown below.

The 'RC Box Culvert Thickness' dialog box contains two tables for inputting thicknesses in inches.

	Cell	Top slab thickness (in)	Bottom slab thickness (in)
>	1	12.5	14
	2	12.5	14

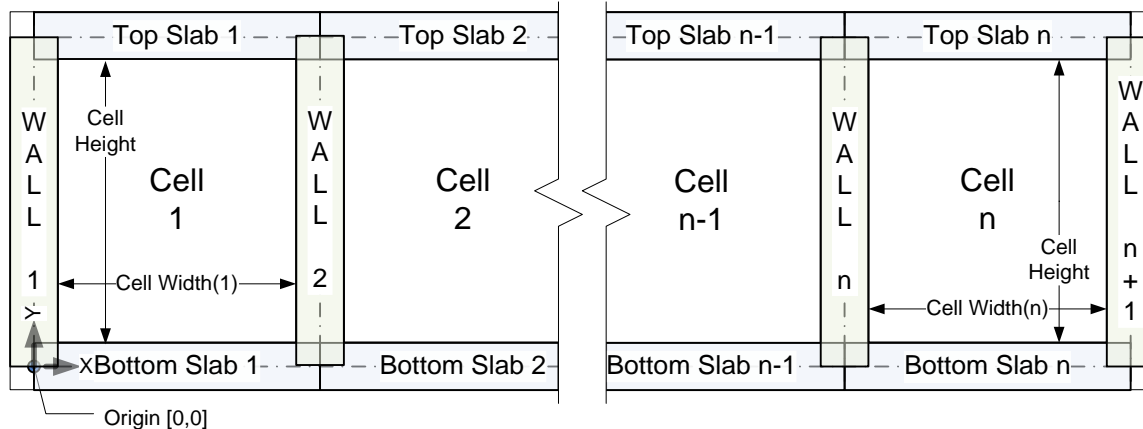
	Wall	Thickness (in)
>	1	11
	2	11
	3	11

At the bottom of the dialog are three buttons: OK, Apply, and Cancel.

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

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

The following shows the components for a box culvert with n cells.



RC Box Culvert Loads

Double-click on **RC Box Culvert Loads** in the **Bridge Workspace** tree. Enter the culvert loads for **Culvert Seg 1** as shown below. Select the checkboxes under **Lateral soil pressure** shown below to apply soil pressure to both sides of the culvert. These checkboxes are provided to allow for the case where a culvert is widened by placing another culvert directly next to it so that side does not have lateral earth pressure.

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

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

RC Box Culvert Reinforcement

Double-click on the **RC Box Culvert Reinforcement** node in the **Bridge Workspace** tree. Enter the reinforcement data as shown below for each location.

RC Box Culvert Reinforcement

Top slab - top bars

Top slab - bot bars

Bot slab - top bars

Bot slab - bot bars

Corner

Wall

Dowel

Note: Bars will always be placed in the orientation shown

Set	Bar mark	Clear cover (in)	Bar spacing (in)	Measured from	Wall number	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end
> 1	8714	2	14	CL Wall	2	<input checked="" type="checkbox"/>	4.5	9	<input type="checkbox"/>	<input type="checkbox"/>
2	8715	2	14	CL Wall	2	<input checked="" type="checkbox"/>	2.41665	4.8333	<input type="checkbox"/>	<input type="checkbox"/>

New

Duplicate

Delete

Reinforcement wizard...

OK

Apply

Cancel

Click **Apply** to apply the data and not close the window.

Navigate to the **Top slab - bot bars** tab to add more reinforcement details.

RC Box Culvert Reinforcement

Top slab - top bars

Top slab - bot bars

Bot slab - top bars

Bot slab - bot bars

Corner

Wall

Dowel

Note: Bars will always be placed in the orientation shown

Set	Bar mark	Clear cover (in)	Bar spacing (in)	Measured from	Cell/Wall number	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end
> 1	8612	2	20	CL Culvert		<input checked="" type="checkbox"/>	12.91665	25.8333	<input type="checkbox"/>	<input type="checkbox"/>
2	8613	2	20	CL Cell	1	<input checked="" type="checkbox"/>	4.08335	8.1667	<input type="checkbox"/>	<input type="checkbox"/>
3	8613	2	20	CL Cell	2	<input checked="" type="checkbox"/>	4.08335	8.1667	<input type="checkbox"/>	<input type="checkbox"/>

New

Duplicate

Delete

Reinforcement wizard...

OK

Apply

Cancel

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Similarly, add reinforcement in each location as shown below.

RC Box Culvert Reinforcement

Top slab - top barsTop slab - bot barsBot slab - top barsBot slab - bot barsCornerWallDowel

Note: Bars will always be placed in the orientation shown

Set	Bar mark	Clear cover (in)	Bar spacing (in)	Measured from	Cell/Wall number	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end
> 1	B505	2	13	CL Culvert		<input checked="" type="checkbox"/>	12.91665	25.8333	<input type="checkbox"/>	<input type="checkbox"/>
2	B506	2	13	CL Cell	1	<input checked="" type="checkbox"/>	4.08335	8.1667	<input type="checkbox"/>	<input type="checkbox"/>
3	B506	2	13	CL Cell	2	<input checked="" type="checkbox"/>	4.08335	8.1667	<input type="checkbox"/>	<input type="checkbox"/>

NewDuplicateDelete

Reinforcement wizard...

OKApplyCancel

RC Box Culvert Reinforcement

Top slab - top barsTop slab - bot barsBot slab - top barsBot slab - bot barsCornerWallDowel

Note: Bars will always be placed in the orientation shown

Set	Bar mark	Clear cover (in)	Bar spacing (in)	Measured from	Wall number	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end
> 1	B903	2	22	CL Culvert		<input checked="" type="checkbox"/>	4.5	9	<input type="checkbox"/>	<input type="checkbox"/>
2	B904	2	22	CL Culvert		<input checked="" type="checkbox"/>	2.41665	4.8333	<input type="checkbox"/>	<input type="checkbox"/>

NewDuplicateDelete

Reinforcement wizard...

OKApplyCancel

Last Modified: 1/3/2024

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CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

RC Box Culvert Reinforcement

Top slab - top barsTop slab - bot barsBot slab - top barsBot slab - bot barsCornerWallDowel

C Bars

Corner Bars

Note: Bars will always be placed in the orientation shown

Set	Bar mark	Wall clear cover (in)	Slab clear cover (in)	Bar spacing (in)	Location	Wall number	Fully developed vert	Fully developed horz
> 1	B801	2	2	16	Top Left	3	<input type="checkbox"/>	<input type="checkbox"/>
2	B801	2	3	16	Bottom Left	3	<input type="checkbox"/>	<input type="checkbox"/>
3	B801	2	2	16	Top Right	1	<input type="checkbox"/>	<input type="checkbox"/>
4	B801	2	3	16	Bottom Right	1	<input type="checkbox"/>	<input type="checkbox"/>
5	B411	2	3	24	Top Left	2	<input type="checkbox"/>	<input type="checkbox"/>
6	B411	2	3	24	Top Right	2	<input type="checkbox"/>	<input type="checkbox"/>
7	B802	2	3	16	Top Left	3	<input type="checkbox"/>	<input type="checkbox"/>
8	B802	2	3	16	Bottom Left	3	<input type="checkbox"/>	<input type="checkbox"/>
9	B802	2	3	16	Top Right	1	<input type="checkbox"/>	<input type="checkbox"/>
10	B802	2	3	16	Bottom Right	1	<input type="checkbox"/>	<input type="checkbox"/>

NewDuplicateDelete

Reinforcement wizard...

OKApplyCancel

RC Box Culvert Reinforcement

Top slab - top barsTop slab - bot barsBot slab - top barsBot slab - bot barsCornerWallDowel

Wall

Set	Bar mark	Clear cover (in)	Bar spacing (in)	Location	Wall number	Measured from	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end
> 1	B510	2	11	Left	3	Horiz Const Joint	<input type="checkbox"/>		12.3333	<input type="checkbox"/>	<input type="checkbox"/>
2	B510	2	11	Right	1	Horiz Const Joint	<input type="checkbox"/>		12.3333	<input type="checkbox"/>	<input type="checkbox"/>

NewDuplicateDelete

Reinforcement wizard...

OKApplyCancel

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

RC Box Culvert Reinforcement

Top slab - top barsTop slab - bot barsBot slab - top barsBot slab - bot barsCornerWallDowel

Set	Bar mark	Clear cover (in)	Bar spacing (in)	Location	Wall number	Measured from	Centered	Start distance (ft)	Straight length (ft)	Fully developed start	Fully developed end
> 1	B507	2	11	Right	1	Horiz Const Joint	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	<input type="checkbox"/>
2	B408	2	24	Left	2	Horiz Const Joint	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	<input type="checkbox"/>
3	B408	2	24	Right	2	Horiz Const Joint	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	<input type="checkbox"/>
4	B507	2	11	Left	3	Horiz Const Joint	<input checked="" type="checkbox"/>	1	2	<input type="checkbox"/>	<input type="checkbox"/>

NewDuplicateDelete

Reinforcement wizard...

OKApplyCancel

Schematic – RC Box Culvert Reinforcement

Click on **RC Box Culvert Reinforcement** and select **Schematic** from the **WORKSPACE** ribbon (or right click and select **Schematic** from the drop down menu) to view the schematic showing reinforcement details for this bridge.

Schematic

Culvert

Culvert Example 1
Culvert Example 1 - Culvert Def 1 -
11/3/2023

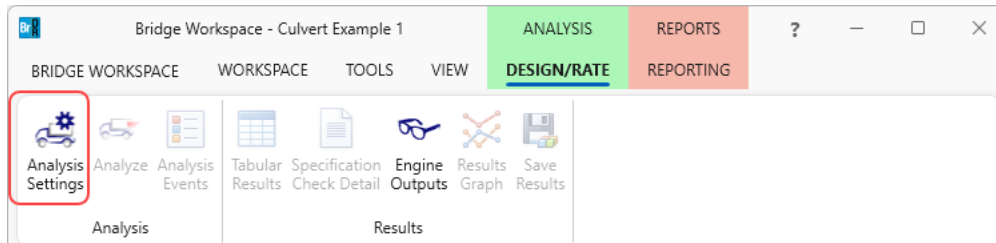
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

The description of the two-cell reinforced concrete box culvert is complete.

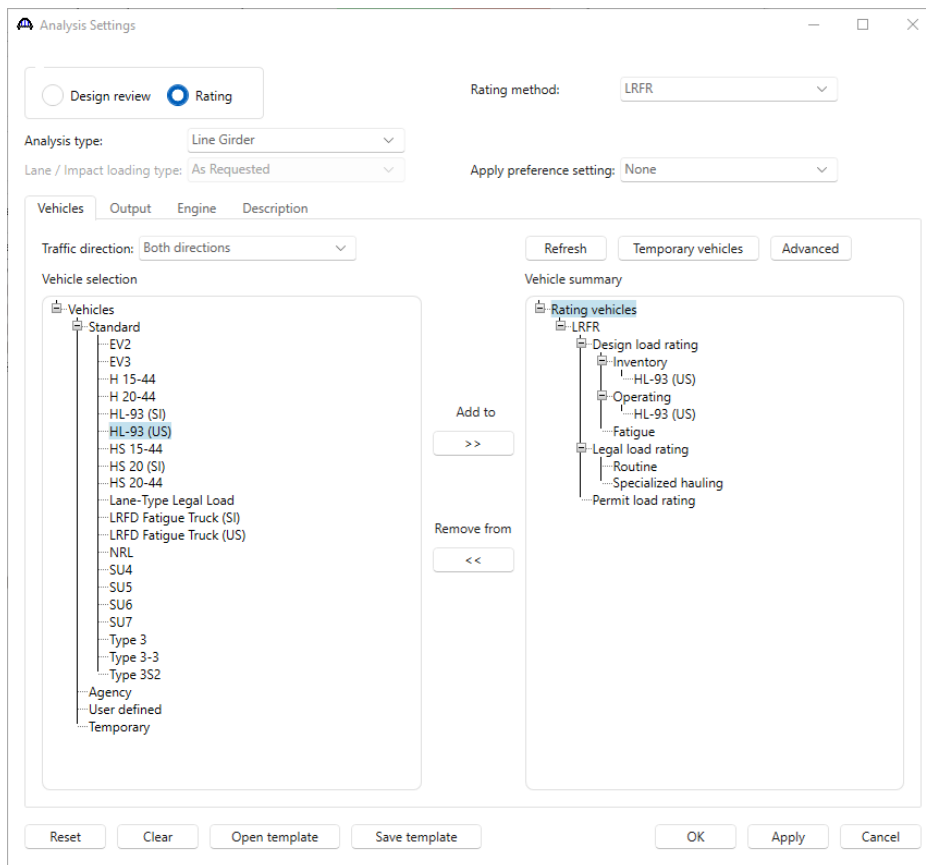
Perform AASHTO Culvert LRFR analysis and review results.

LRFR Analysis

To perform an LRFR Design Load Rating, click the **Analysis Settings** button from the **Analysis** group of the **DESIGN/RATE** ribbon.



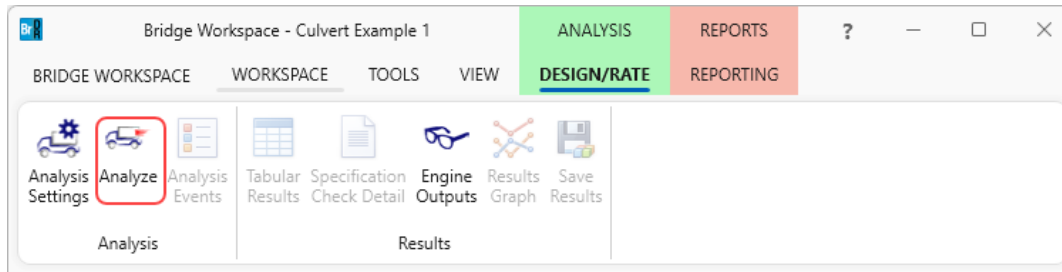
Apply the analysis settings as shown below.



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

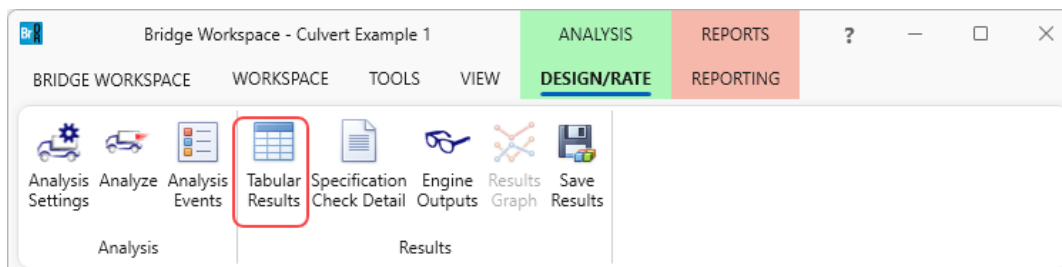
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

With **Culvert Seg 1** selected in the **Bridge Workspace** tree, click the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon to start the rating process.



Tabular Results

When the rating is finished, results can be reviewed by clicking the **Tabular Results** button from the **Results** group of the **DESIGN/RATE** ribbon. The window shown below will open.



Analysis Results - Culvert Seg 1

Print

Report type: Rating Results Summary

Lane/Impact loading type: ☒ As requested ☐ Detailed

Display Format: Single rating level per row

	Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Component	Location (ft)	Location (%)	Limit State	Impact	Lane
	HL-93 (US)	Axle Load	LRFR	Inventory	57.52	1.598	Top Slab 2	7.20	60.000	Flexure	As Requested	As Requested
	HL-93 (US)	Axle Load	LRFR	Operating	74.56	2.071	Top Slab 2	7.20	60.000	Flexure	As Requested	As Requested
	HL-93 (US)	Tandem	LRFR	Inventory	48.15	1.338	Top Slab 2	6.00	50.000	Flexure	As Requested	As Requested
	HL-93 (US)	Tandem	LRFR	Operating	62.42	1.734	Top Slab 2	6.00	50.000	Flexure	As Requested	As Requested

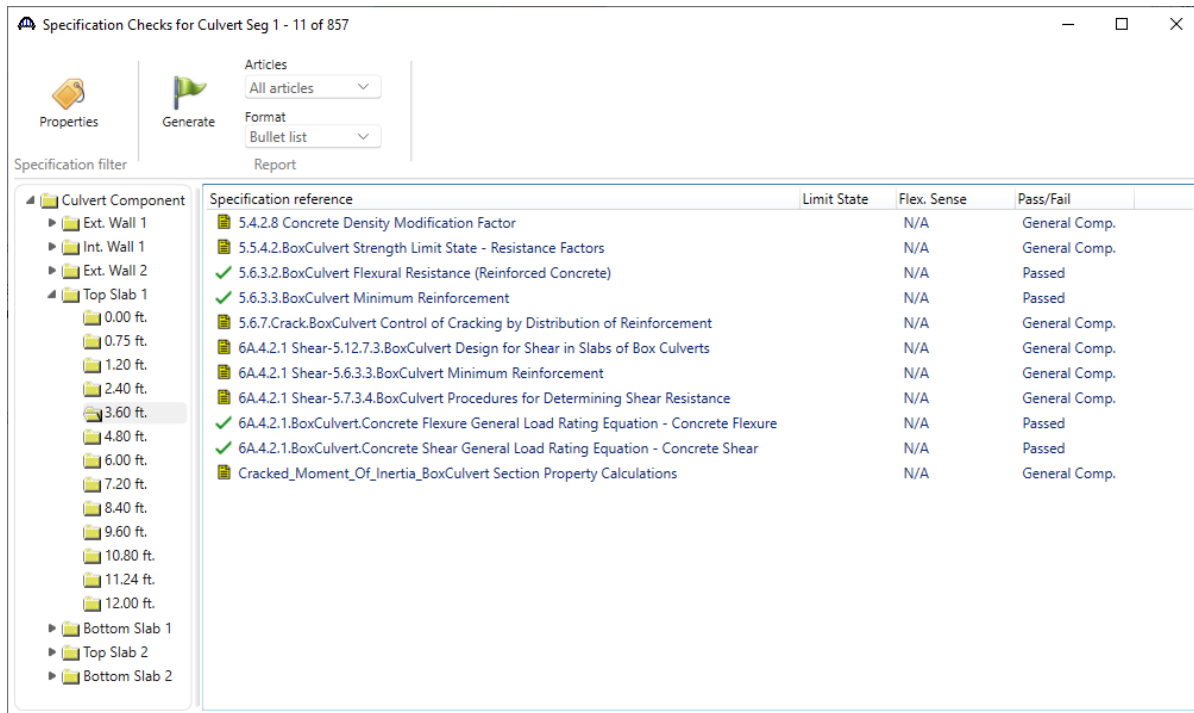
AASHTO Culvert LRFR Engine Version 7.5.0.3001
Analysis preference setting: None

Close

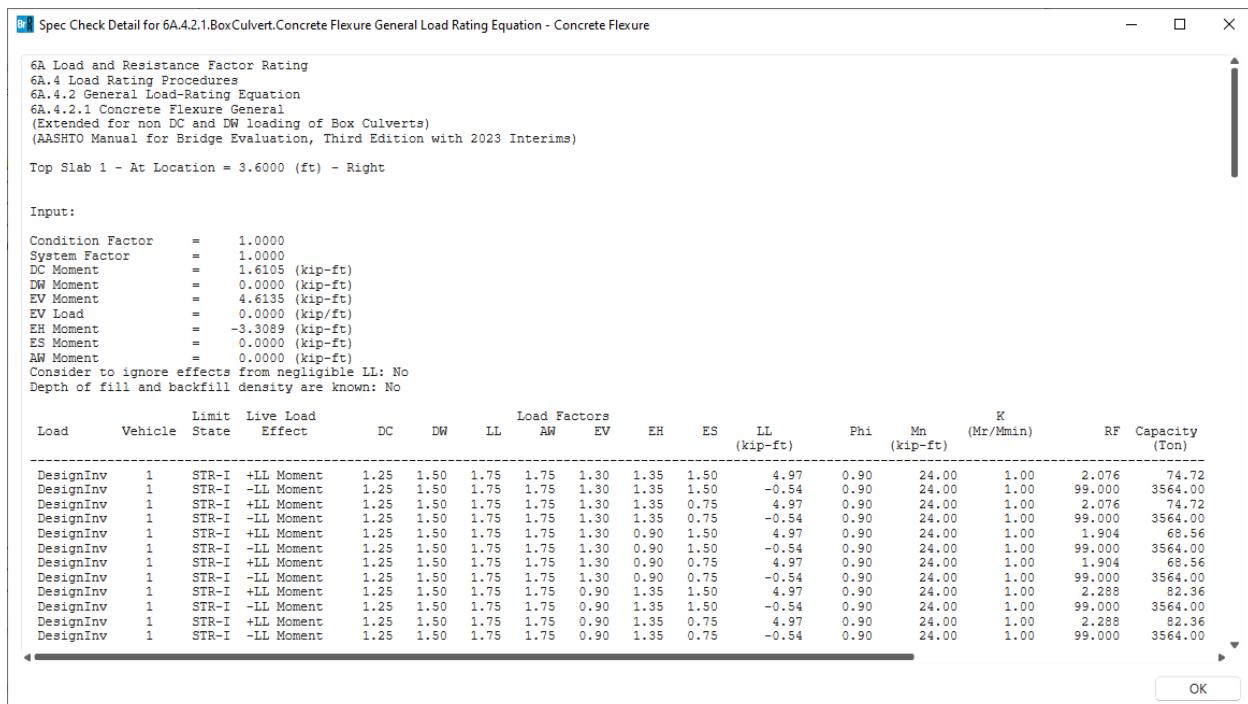
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Specification Check Detail

To review detailed rating results at the controlling location, click the **Specification Check Detail** button in the ribbon to open the **Specification** window. Expand the tree for **Top Slab 1** and select the **3.60 ft.** folder.



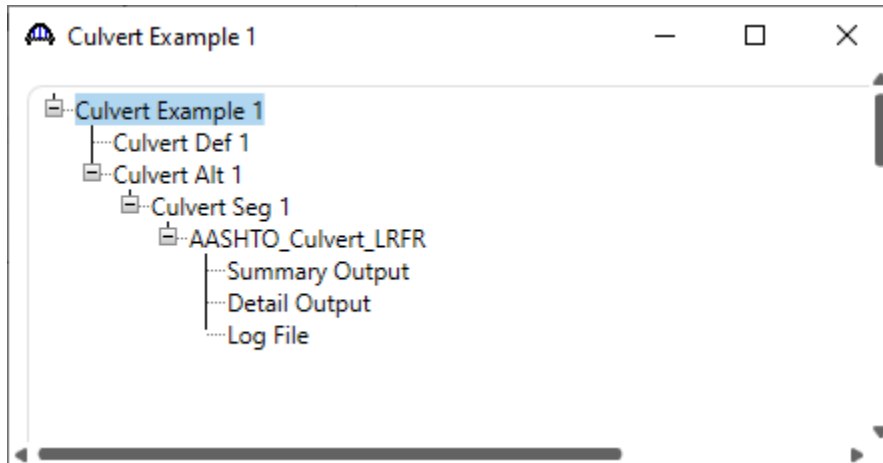
Double-click on the **6A.4.2.1 BoxCulvert Concrete Flexure General Load Rating Equation - Concrete Flexure** specification reference to open the **Spec Check Detail** window.



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Engine Outputs

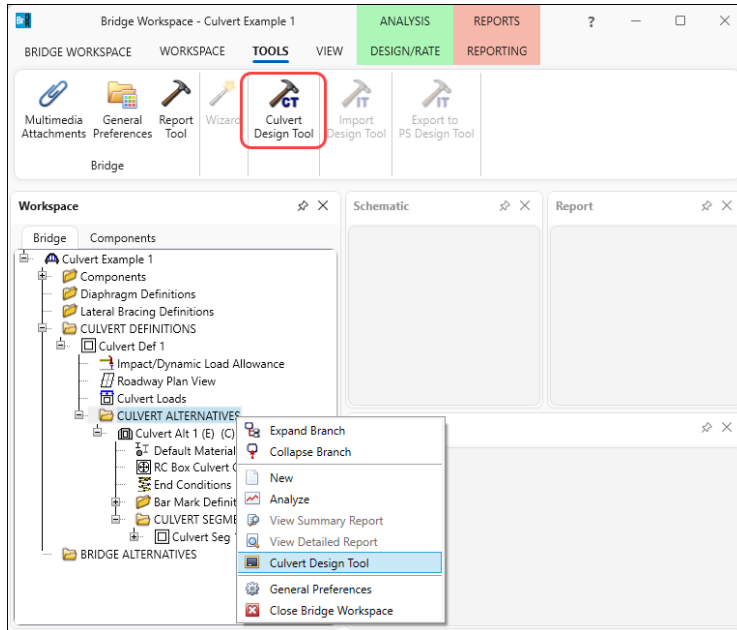
To review engine outputs, select the **Engine Outputs** button in the ribbon. Double-clicking on the **Summary Output** or **Detail Output** will open the engine output file in a separate window.



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Culvert Design Tool

Select the **CULVERT ALTERNATIVES** folder in the **Bridge Workspace** tree. Click the **Culvert Design Tool** button in the **TOOLS** ribbon (or right click and select **Culvert Design Tool**) to open the **RC Box Culvert Design Tool** as shown below.



Enter the data as shown below and click the **Next** button.

RC Box Culvert Design Tool

Alternative name: Segment name:

Alternative description:

Material: ☐ Consider haunches in design

Reinforcement: Minimum wall thickness: in

Clear cover: in Minimum slab thickness: in

Bottom slab clear cover: in ☒ Bottom slab present

Epoxy coated rebars: ☒ None ☐ All ☐ Top slab only

Number of cells: Cell height: ft

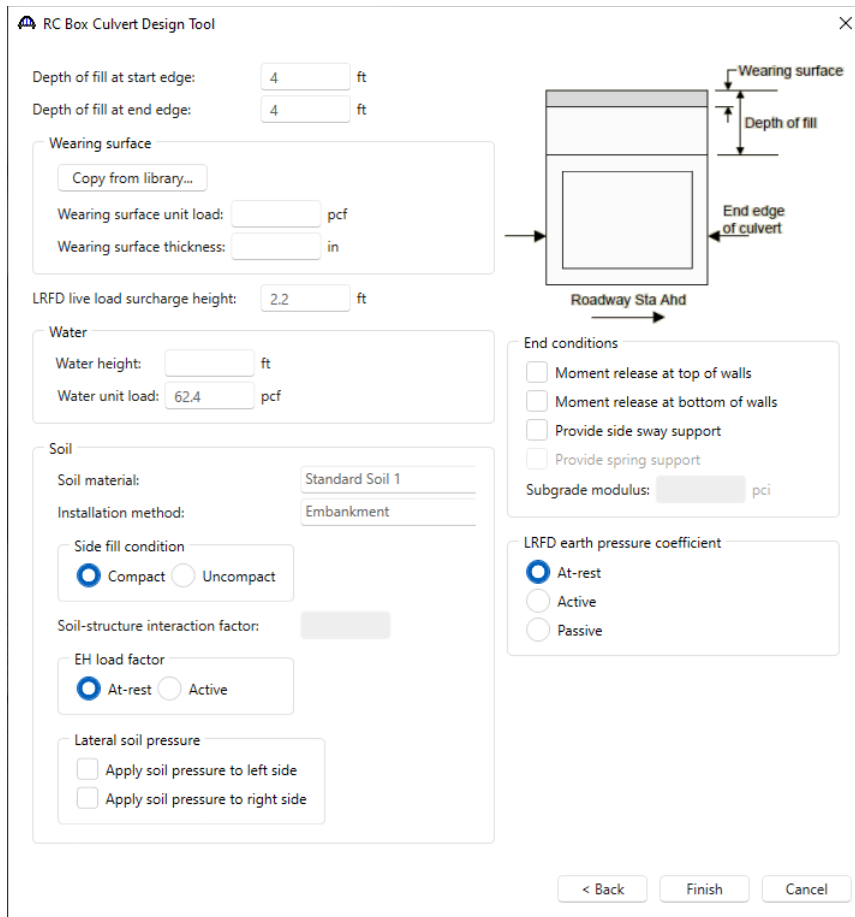
Design template:

Cell	Width (ft)
1	12
2	12

< Back Next > Cancel

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Enter the data as shown below.



The image shows the 'RC Box Culvert Design Tool' dialog box. It contains several input fields and checkboxes for configuring the design. On the right, a diagram illustrates the culvert structure with labels for 'Wearing surface', 'Depth of fill', 'End edge of culvert', and 'Roadway Slope'.

RC Box Culvert Design Tool

Depth of fill at start edge: 4 ft
Depth of fill at end edge: 4 ft

Wearing surface
Copy from library...
Wearing surface unit load: pcf
Wearing surface thickness: in

LRFD live load surcharge height: 2.2 ft

Water
Water height: ft
Water unit load: 62.4 pcf

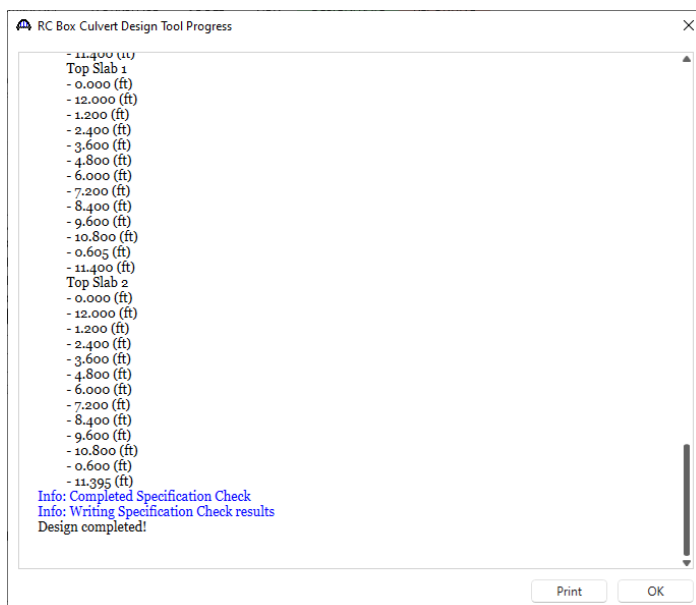
Soil
Soil material: Standard Soil 1
Installation method: Embankment
Side fill condition: ☒ Compact ☐ Uncompact
Soil-structure interaction factor:
EH load factor: ☒ At-rest ☐ Active
Lateral soil pressure: ☐ Apply soil pressure to left side ☐ Apply soil pressure to right side

End conditions
☐ Moment release at top of walls
☐ Moment release at bottom of walls
☐ Provide side sway support
☐ Provide spring support
Subgrade modulus: pci

LRFD earth pressure coefficient
☒ At-rest
☐ Active
☐ Passive

< Back Finish Cancel

Click **Finish** to start the design process. Click **OK** to close the **RC Box Culvert Design Tool Progress** window after the design is completed.



The image shows the 'RC Box Culvert Design Tool Progress' dialog box. It displays a list of design steps and their completion status. At the bottom, there are buttons for 'Print' and 'OK'.

RC Box Culvert Design Tool Progress

- 11.400 (ft)
Top Slab 1
- 0.000 (ft)
- 12.000 (ft)
- 1.200 (ft)
- 2.400 (ft)
- 3.600 (ft)
- 4.800 (ft)
- 6.000 (ft)
- 7.200 (ft)
- 8.400 (ft)
- 9.600 (ft)
- 10.800 (ft)
- 0.605 (ft)
- 11.400 (ft)
Top Slab 2
- 0.000 (ft)
- 12.000 (ft)
- 1.200 (ft)
- 2.400 (ft)
- 3.600 (ft)
- 4.800 (ft)
- 6.000 (ft)
- 7.200 (ft)
- 8.400 (ft)
- 9.600 (ft)
- 10.800 (ft)
- 0.600 (ft)
- 11.395 (ft)
Info: Completed Specification Check
Info: Writing Specification Check results
Design completed!

Print OK

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

The **Culvert Design Tool Results** window is shown below. Click **Create** to accept the design and click **Close** to close the window.

Culvert Design Tool Results

Wall thickness: 10 in

Top slab thickness: 10 in

Bottom slab thickness: in

AASHTO Culvert LRFD Engine - Version: 7.5.0.3001

11/3/2023 7:52:14 AM

Analysis Preference Setting: None

LRFD Specification: AASHTO LRFD Bridge Design Specifications 9th Edition

UserInput:

Box Number: Seg 1

Identification:
Number of cells: 2

Cell Width: 12.000 (ft)

Cell Height: 12.000 (ft)

Depth of Fill at Start: 4.000 (ft)

Depth of Fill at End: 4.000 (ft)

Live Load Distribution Factor: 1.150

Run Type: LRFD

Design Vehicle Option: Envelope

Pavement Reduction Factor: 1.000

Skew Angle: 0.0

Surcharge Height: 2.200 (ft)

Water Height: 0.00 (ft)

Minimum Slab Thickness: 10.0 (Inches)

Minimum Wall Thickness: 10.0 (Inches)

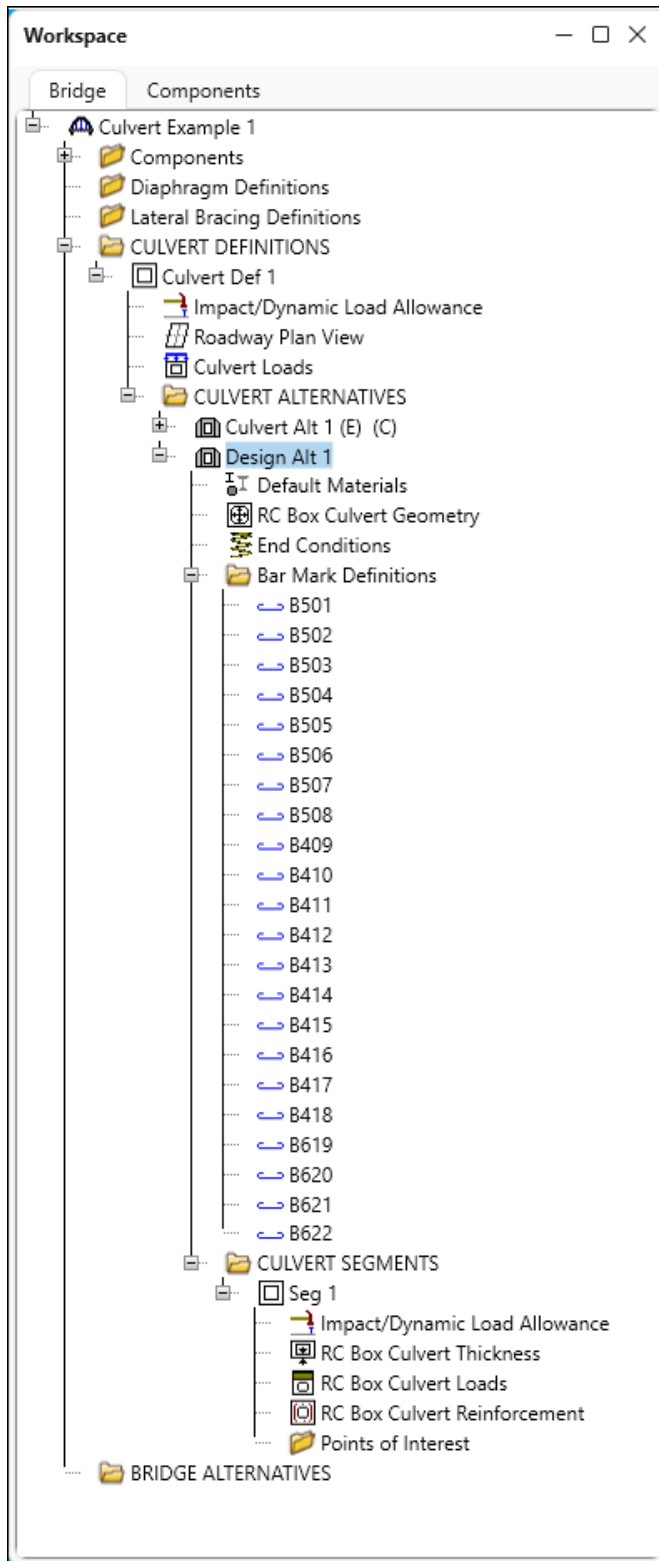
Pinned Top Slab: False

Subgrade Modulus: 0.0

Create Close

CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

The **Bridge Workspace tree** with the **Design Alt 1** is shown below.



CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Schematic - RC Box Culvert Reinforcement

Select the **RC Box Culvert Reinforcement** node under **Design Alt 1** in the **Bridge Workspace** tree. Click the **Schematic** button from the **WORKSPACE** ribbon (or right click and select **Schematic**) to review the reinforcement data.

