

AASHTOWare BrDR 7.5.0

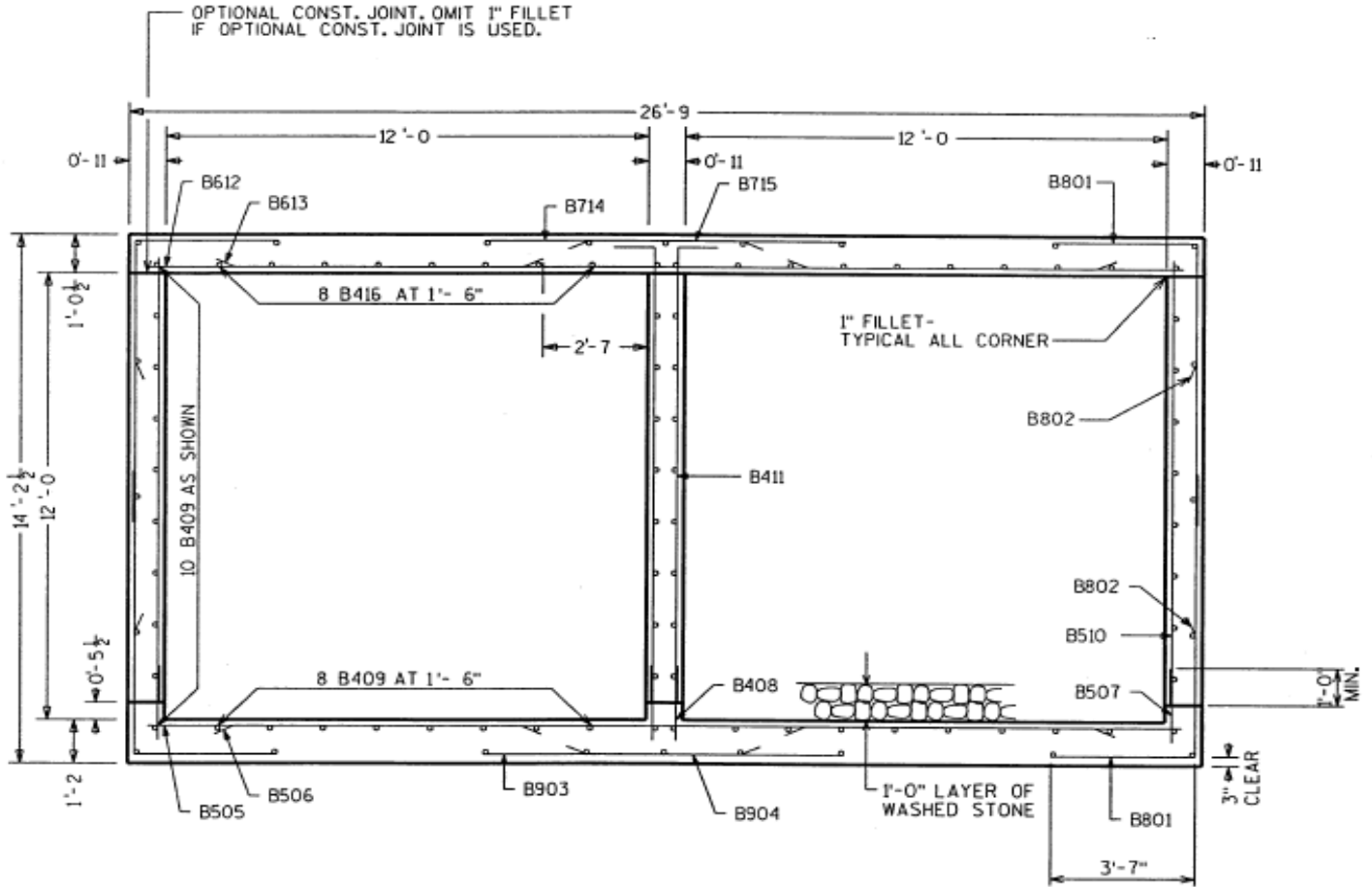
CVT1 – Culvert Tutorial

*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



TYPICAL SECTION THRU BOX
 ALL LONGITUDINAL BARS NOT IDENTIFIED ARE B409 AS SHOWN.

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.

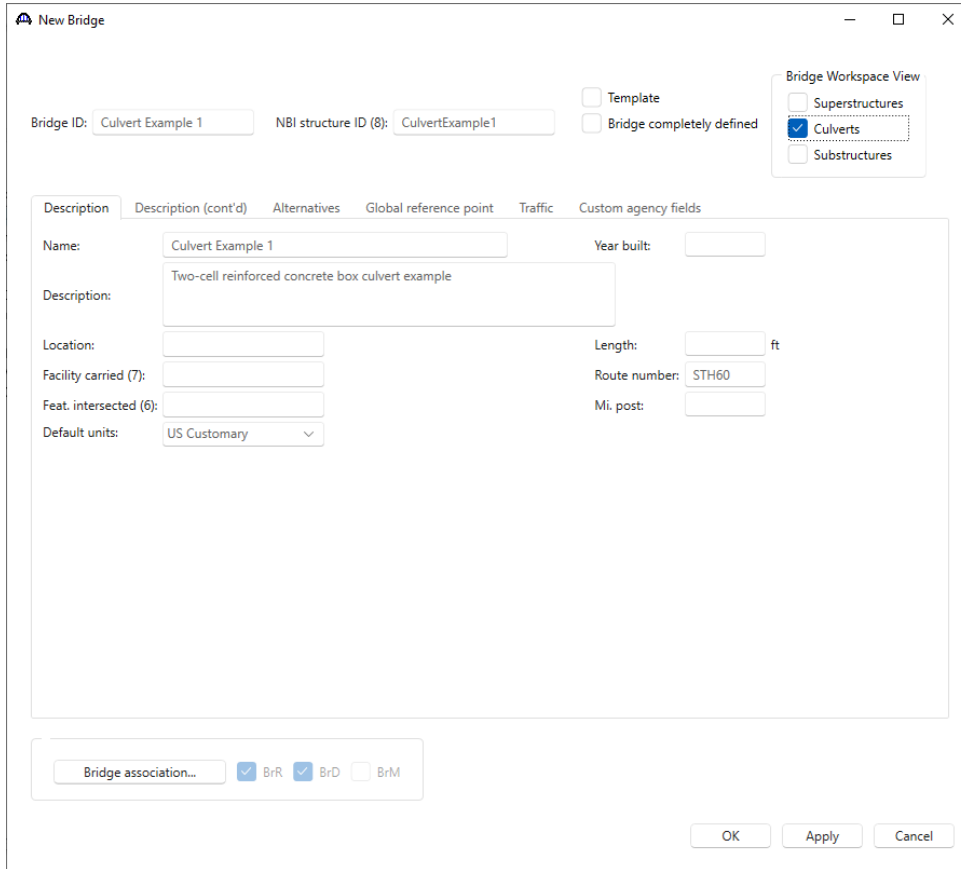
Material Properties:

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

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

Enter culvert description

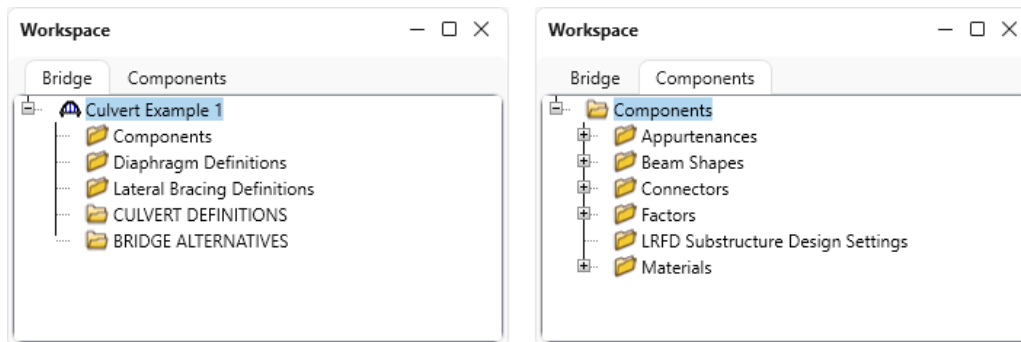
From the **Bridge Explorer** create a **new bridge** and enter the following description data.



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.



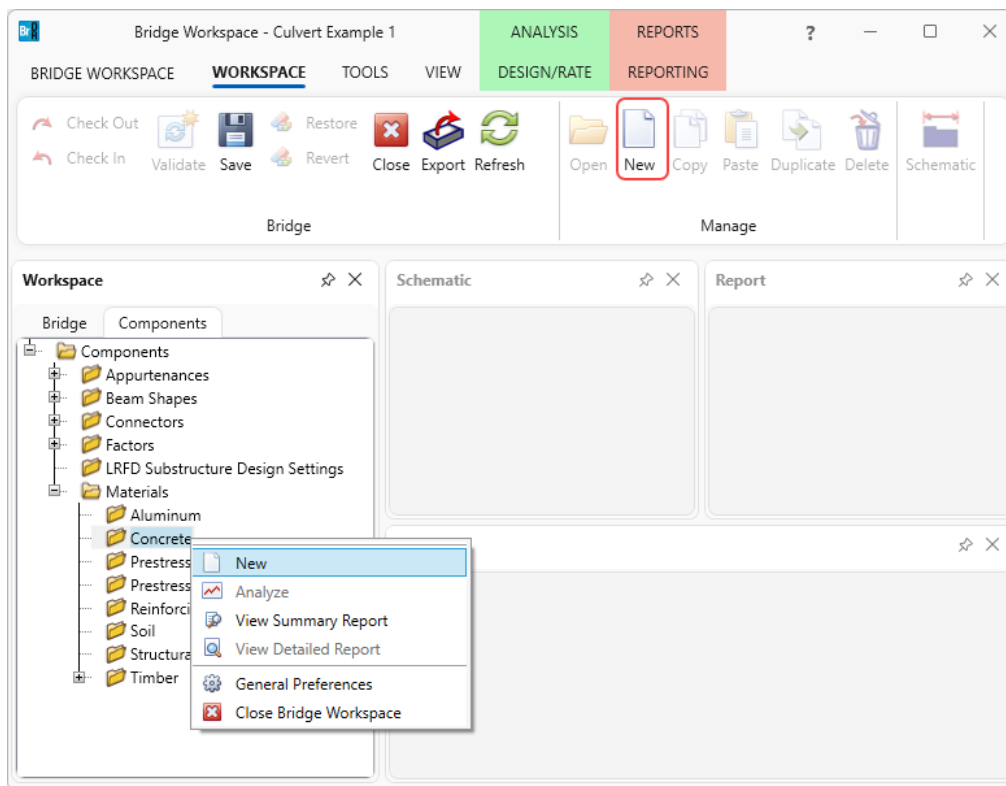
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

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).

Bridge Materials - Concrete

Name:

Description:

Compressive strength at 28 days (f'c): ksi

Initial compressive strength (f'ci): ksi

Composition of concrete:

Density (for dead loads): kcf

Density (for modulus of elasticity): kcf

Poisson's ratio:

Coefficient of thermal expansion (α): 1/F

Splitting tensile strength (fct): ksi

LRFD Maximum aggregate size: in

Std modulus of elasticity (Ec): ksi

LRFD modulus of elasticity (Ec): ksi

Std initial modulus of elasticity: ksi

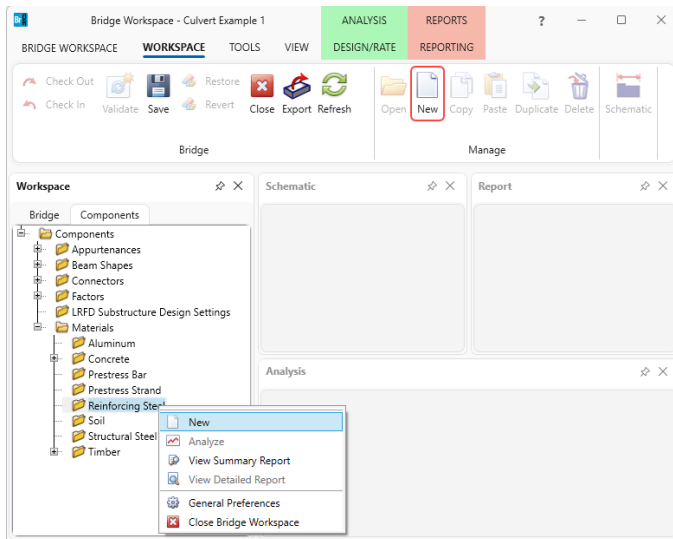
LRFD initial modulus of elasticity: ksi

Std modulus of rupture: ksi

LRFD modulus of rupture: ksi

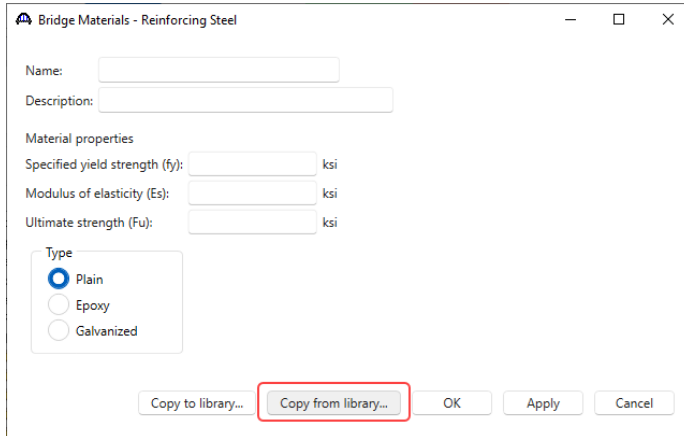
Shear factor:

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.

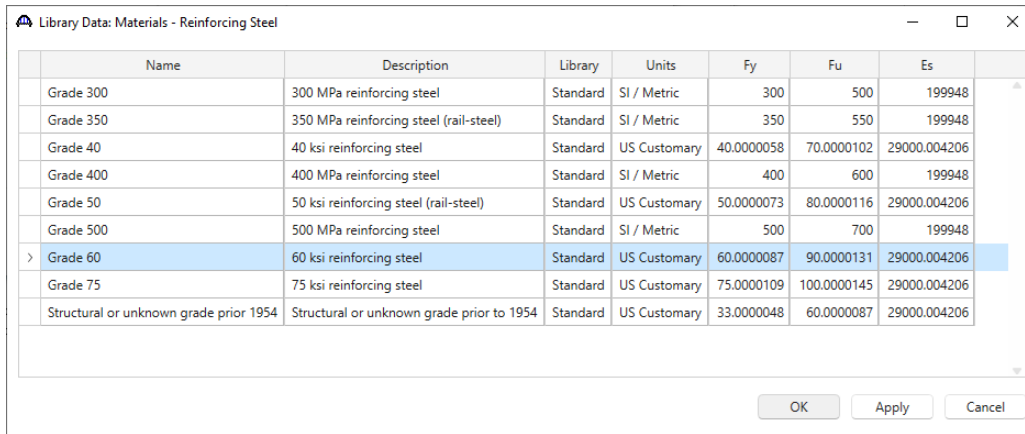


CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

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.



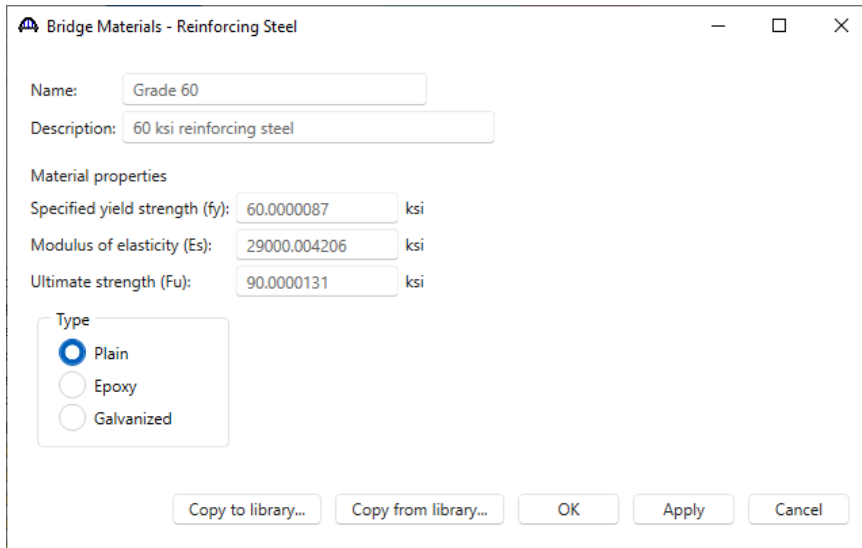
The dialog box 'Bridge Materials - Reinforcing Steel' is shown. It has fields for Name, Description, Specified yield strength (fy), Modulus of elasticity (Es), and Ultimate strength (Fu). Under the 'Type' section, 'Plain' is selected. The 'Copy from library...' button is highlighted with a red box.



The dialog box 'Library Data: Materials - Reinforcing Steel' displays a table of material properties. The 'Grade 60' row is selected.

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

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



The dialog box 'Bridge Materials - Reinforcing Steel' is updated with the following information:

- Name: Grade 60
- Description: 60 ksi reinforcing steel
- Specified yield strength (fy): 60.0000087 ksi
- Modulus of elasticity (Es): 29000.004206 ksi
- Ultimate strength (Fu): 90.0000131 ksi
- Type: Plain (selected)

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.

Bridge Materials - Soil

Name:

Description:

Soil unit load: pcf

Saturated soil unit load: pcf

At-rest lateral earth pressure coefficient (LRFD):

At-rest lateral earth pressure coefficient (LRFR):

Active lateral earth pressure coefficient (LRFD/LRFR):

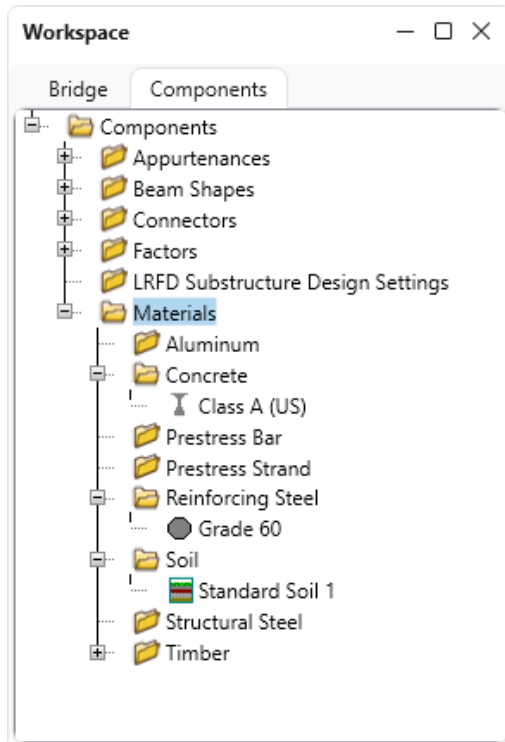
Passive lateral earth pressure coefficient (LRFD/LRFR):

Maximum lateral soil pressure (LFR): pcf

Minimum lateral soil pressure (LFR): pcf

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)

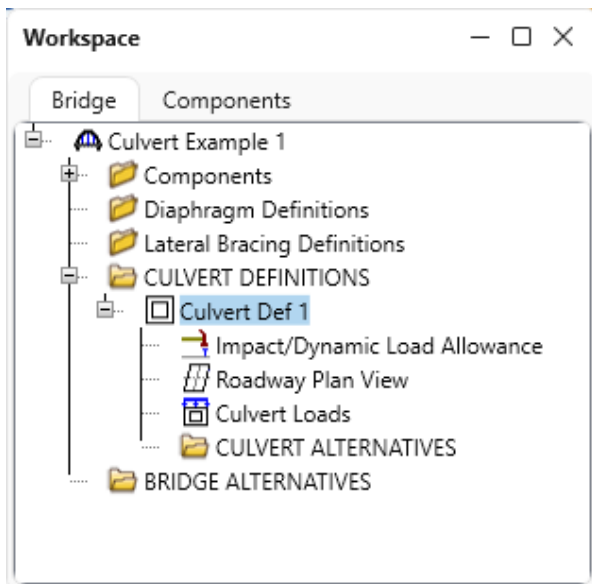
Culvert Definition

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.

Existing	Current	Culvert alternative name	Description
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Click **OK** to apply the data and close the window.

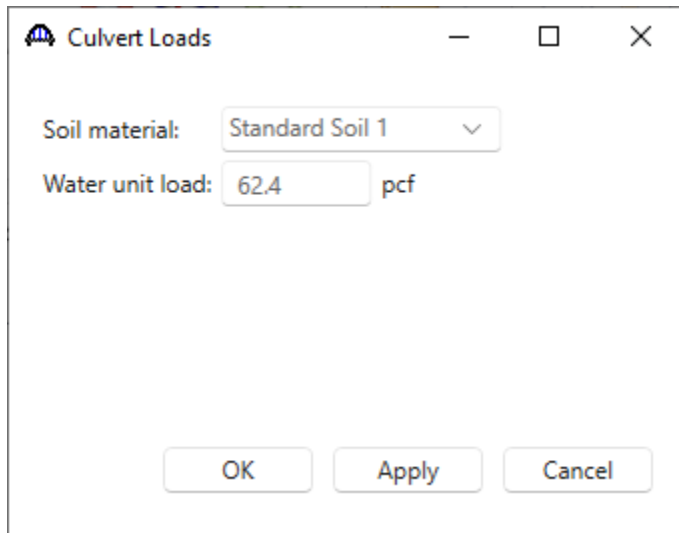
Click on the + button of the newly added culvert definition to expand the culvert definition tree as shown below.



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.

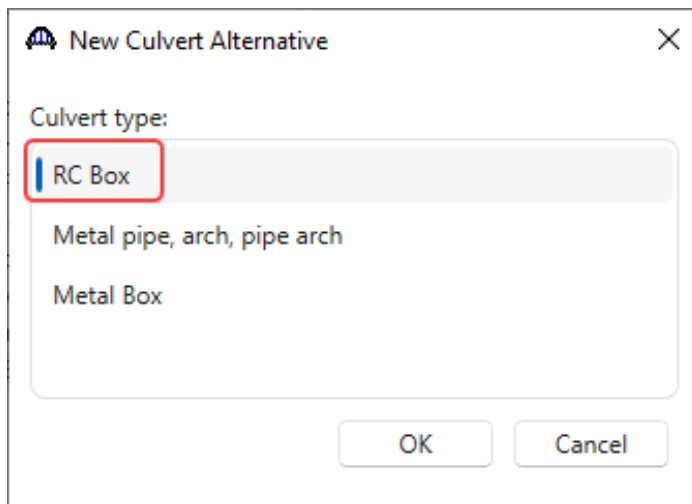


The screenshot shows a dialog box titled "Culvert Loads". It contains two input fields: "Soil material:" with a dropdown menu set to "Standard Soil 1", and "Water unit load:" with a text box containing "62.4" and the unit "pcf" to its right. At the bottom of the dialog are three buttons: "OK", "Apply", 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 a dialog box titled "New Culvert Alternative". It features a "Culvert type:" label above 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.

Culvert Alternative Description

Culvert alternatives: Culvert Alt 1

Description Specs Factors Control options

Description:

Culvert type: RC Box

Default units: US Customary

Construction type: Cast-in-plac Precast

Top slab exterior surface exposure factor: 0.75

Bot. slab exterior surface exposure factor:

Wall exterior surface exposure factor:

Interior surface exposure factor:

Default rating method: LFR

Soil

Installation method: Embankment

LRFD EH load factor: At-rest Active

Side fill condition: Compact Uncompact

LRFD/LRFR earth pressure coefficient: At-rest Active Passive

Soil-structure interaction factor (LRFD):

Soil-structure interaction factor (LFD):

OK Apply Cancel

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

Culvert Alternative Description

Culvert alternatives: Culvert Alt 1

Description Specs Factors Control options

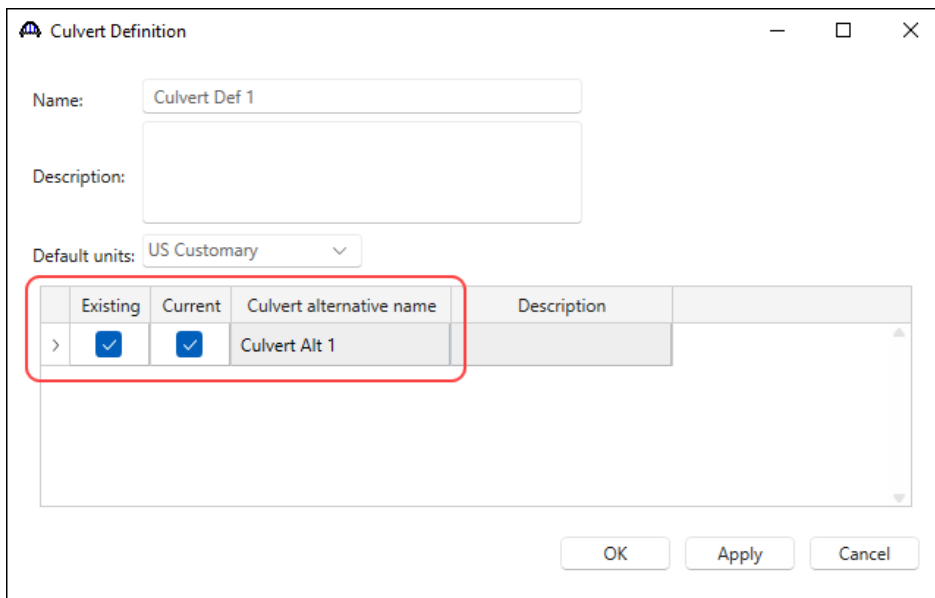
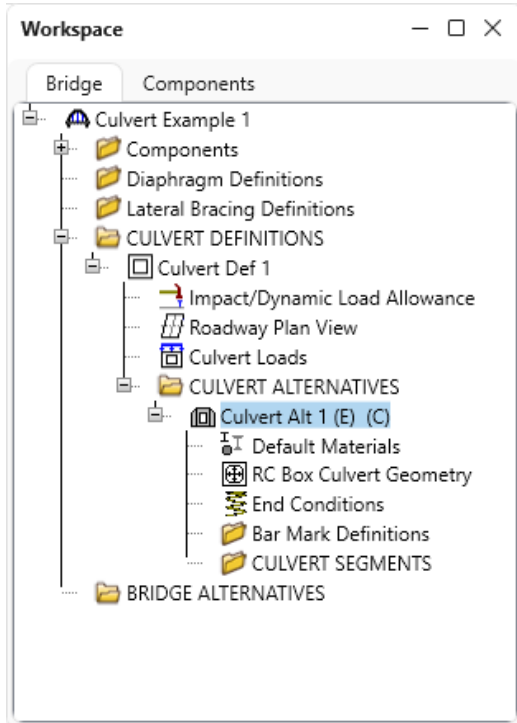
Analysis method type	Analysis module	Selection type	Spec version	Factors
LFR	AASHTO Culvert LFR	System Default	MBE 3rd 2023, Std 17th	2002 AASHTO Std. Specifications
LRFD	AASHTO Culvert LRFD	System Default	LRFD 9th	2020 AASHTO LRFD Specifications
LRFR	AASHTO Culvert LRFR	System Default	MBE 3rd 2023,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

OK Apply Cancel

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: Bottom slab present

Cell height: ft Horiz. construction joint height: 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

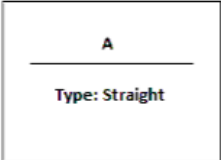
Double-click on the **Bar Mark Definitions** folder in the **Bridge Workspace** tree to create a new bar mark definition for **Culvert Alt 1**. Enter the data for B801 as shown below.

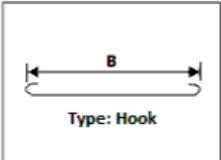
MARK	NUMBER REQ'D.	LENGTH	BENT	CUTTING DIAG.	LOCATION
B801	416	11 -2	3-7	NO	CORNERS

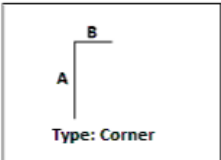
Bar Mark Definition

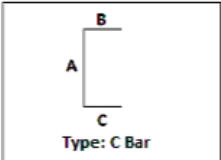
Name:

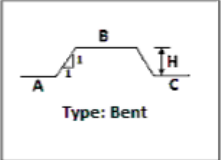
Bar types:

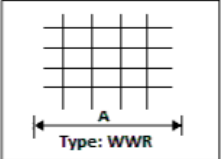
 Type: Straight

 Type: Hook

 Type: Corner

 Type: C Bar

 Type: Bent

 Type: WWR

Material:

Bar size:

Bar type:

Dimension

A: ft

B: ft

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

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

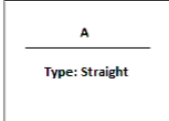
Repeat this process and add the following transverse bar mark definitions.

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:

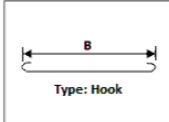
Bar size:

Bar type:

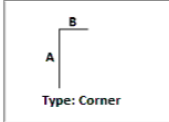
Dimension

A: ft

B: ft



Type: Hook



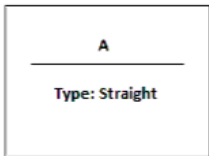
Type: Corner

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

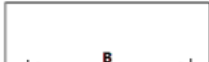
Material:

Bar size:

Bar type:

Dimension

A: ft

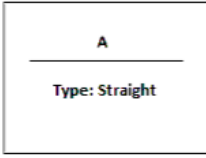


Type: Hook

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

Bar Mark Definition

Name:

Bar types: 

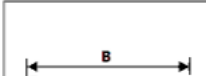
Material:

Bar size:

Bar type:

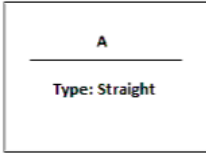
Dimension

A: ft



Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

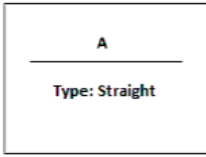
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

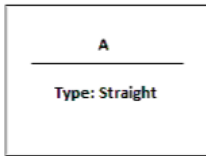
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

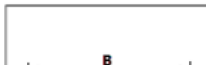
Material:

Bar size:

Bar type:

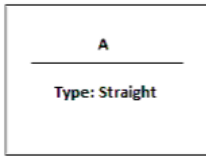
Dimension

A: ft



Bar Mark Definition

Name:

Bar types: 

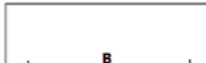
Material:

Bar size:

Bar type:

Dimension

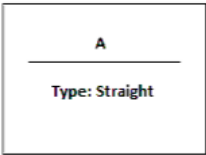
A: ft



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

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

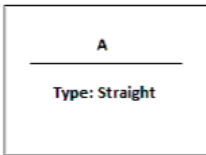
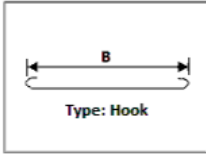
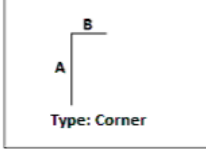
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 



Material:

Bar size:

Bar type:

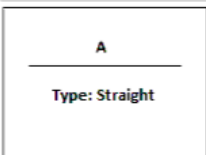
Dimension

A: ft

B: ft

Bar Mark Definition

Name:

Bar types: 

Material:

Bar size:

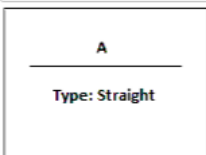
Bar type:

Dimension

A: ft

Bar Mark Definition

Name:

Bar types: 

Material:

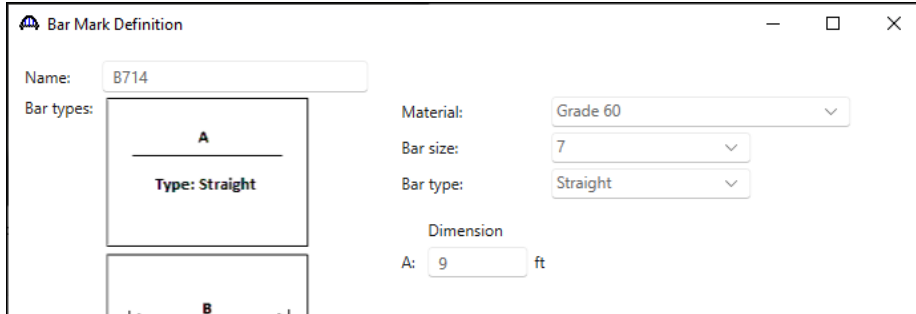
Bar size:

Bar type:

Dimension

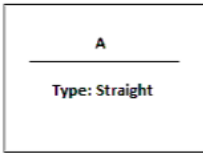
A: ft

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



Bar Mark Definition

Name: B714

Bar types: 

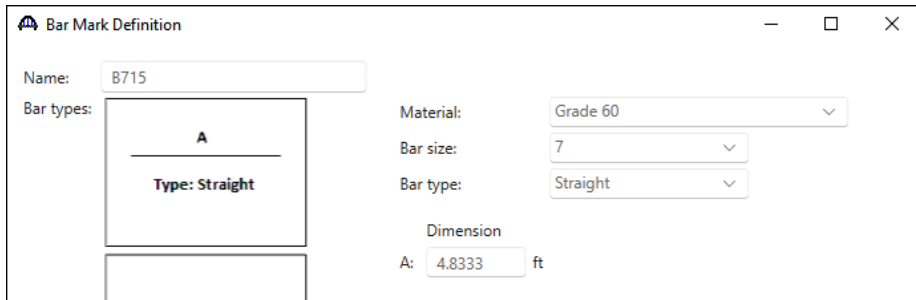
Material: Grade 60

Bar size: 7

Bar type: Straight

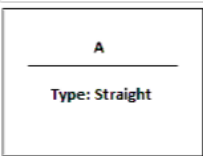
Dimension

A: 9 ft



Bar Mark Definition

Name: B715

Bar types: 

Material: Grade 60

Bar size: 7

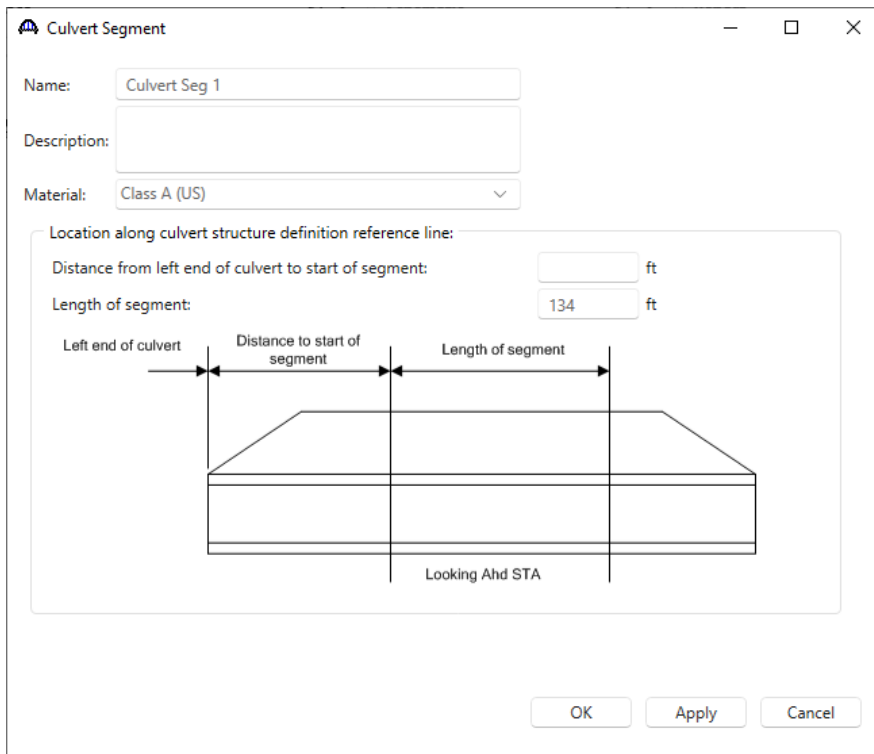
Bar type: Straight

Dimension

A: 4.8333 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: Culvert Seg 1

Description:

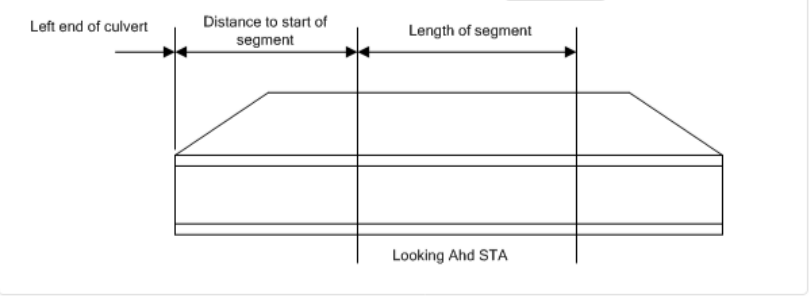
Material: Class A (US)

Location along culvert structure definition reference line:

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

Length of segment: 134 ft

Left end of culvert Distance to start of segment Length of segment



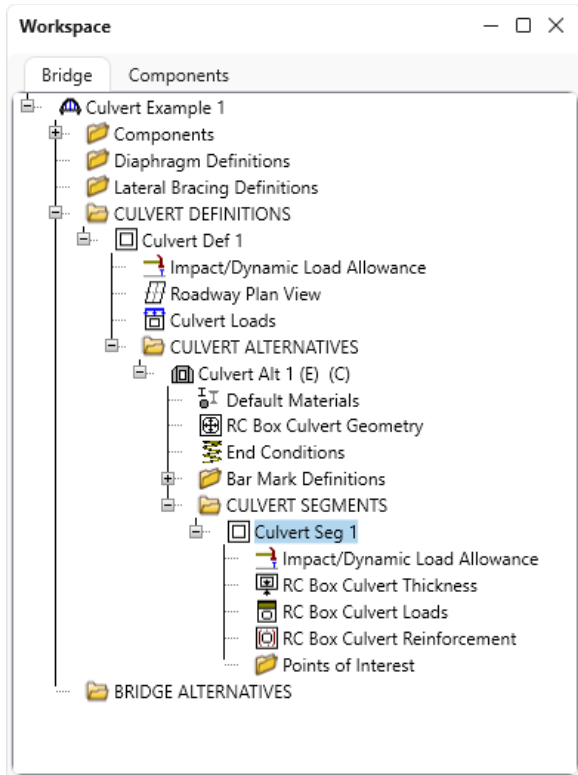
Looking Ahd STA

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

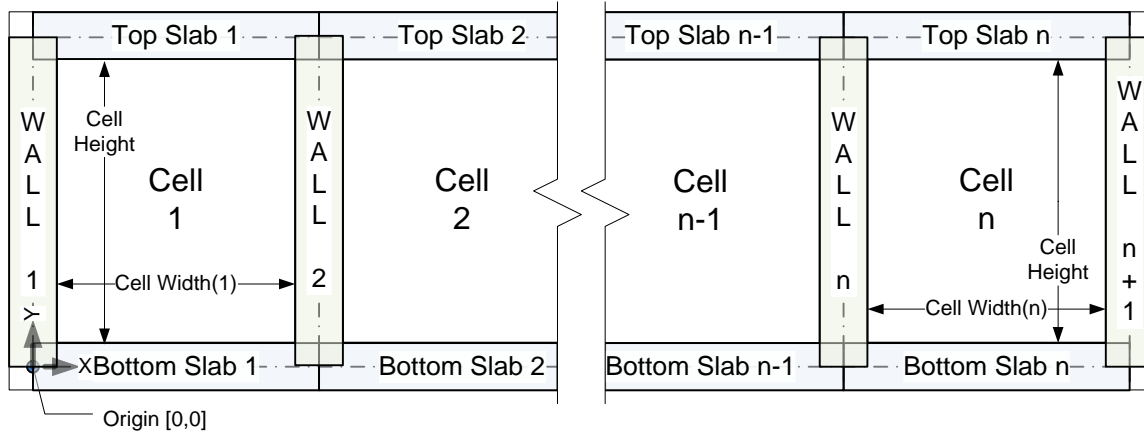
Double-click on the **RC Box Culvert Thickness** node in the **Bridge Workspace** tree. Enter the slab and wall thicknesses as shown below.



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.

The screenshot shows the **RC Box Culvert Loads** dialog box with the following settings:

- Depth of fill at start edge: 4 ft
- Depth of fill at end edge: 4 ft
- Wearing surface unit load: [] pcf
- Wearing surface thickness: [] in
- LRFD live load surcharge height: 2.2 ft
- LFR live load surcharge height: 2.2 ft
- Water height: [] ft
- LRFD live load distribution factor: 1.15
- LFR live load distribution factor: 1.75
- Lateral soil pressure**
 - Apply soil pressure to left side
 - Apply soil pressure to right side
- Pavement reduction factor: [] %
- Comment: []

The diagram on the right illustrates the load distributions. The top diagram shows a surcharge load q_{LS} applied to the wearing surface, with $q_{LS} = \text{Surcharge Height} \times \text{Equivalent Fluid Pressure}$. The bottom diagram shows a water load q_w applied to the bottom slab, with $q_w = (\text{Water Height} + \frac{1}{2} \text{Bottom Slab Thickness}) \times \text{Unit Weight of Water}$. The diagrams also show the start and end edge depths and the direction of the 'Sta Ahead' axis.

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.

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	B714	2	14	CL Wall	2	<input checked="" type="checkbox"/>	4.5	9	<input type="checkbox"/>	<input type="checkbox"/>
2	B715	2	14	CL Wall	2	<input checked="" type="checkbox"/>	2.41665	4.8333	<input type="checkbox"/>	<input type="checkbox"/>

Buttons: 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.

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	B612	2	20	CL Culvert		<input checked="" type="checkbox"/>	12.91665	25.8333	<input type="checkbox"/>	<input type="checkbox"/>
2	B613	2	20	CL Cell	1	<input checked="" type="checkbox"/>	4.08335	8.1667	<input type="checkbox"/>	<input type="checkbox"/>
3	B613	2	20	CL Cell	2	<input checked="" type="checkbox"/>	4.08335	8.1667	<input type="checkbox"/>	<input type="checkbox"/>

Buttons: 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 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	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"/>

New Duplicate Delete

Reinforcement wizard...

OK Apply Cancel

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	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"/>

New Duplicate Delete

Reinforcement wizard...

OK Apply Cancel

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

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	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"/>

New Duplicate Delete

Reinforcement wizard...

OK Apply Cancel

RC Box Culvert Reinforcement

Top slab - top bars Top slab - bot bars Bot slab - top bars Bot slab - bot bars Corner **Wall** Dowel

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"/>

New Duplicate Delete

Reinforcement wizard...

OK Apply Cancel

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

RC Box Culvert Reinforcement

Top slab - top bars Top slab - bot bars Bot slab - top bars Bot slab - bot bars Corner Wall **Dowel**

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"/>

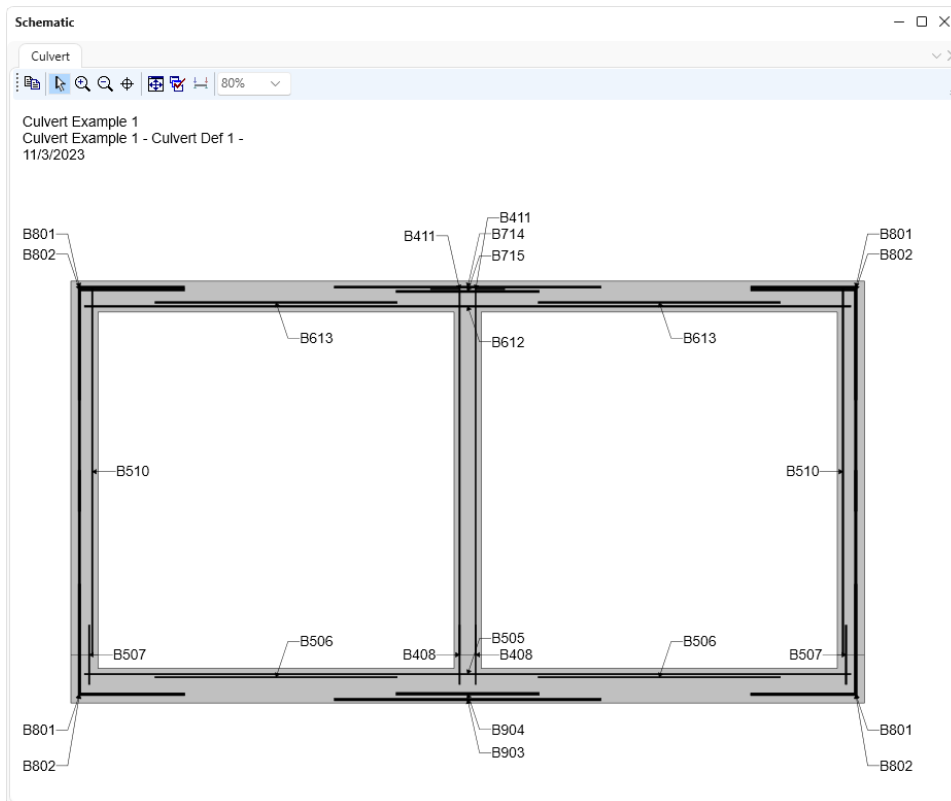
New Duplicate Delete

Reinforcement wizard...

OK Apply Cancel

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.



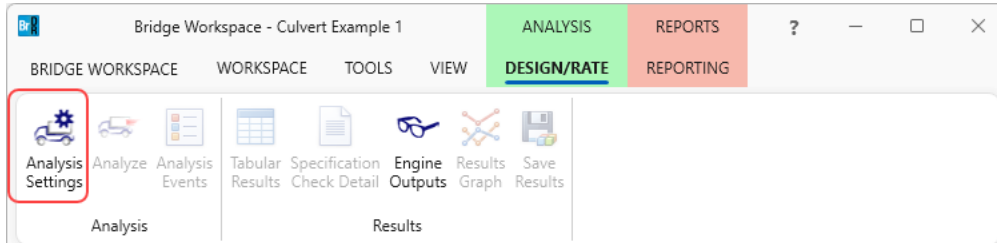
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

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

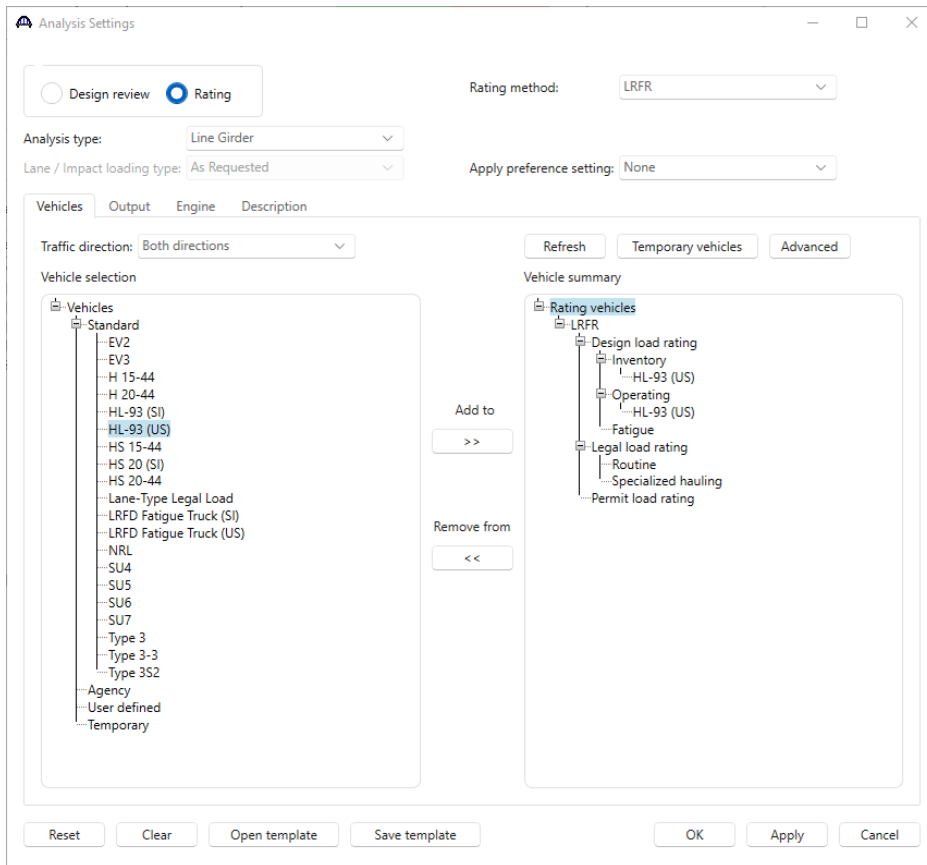
Perform AASHTO Culvert LRFR analysis and review results.

LRFR Analysis

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



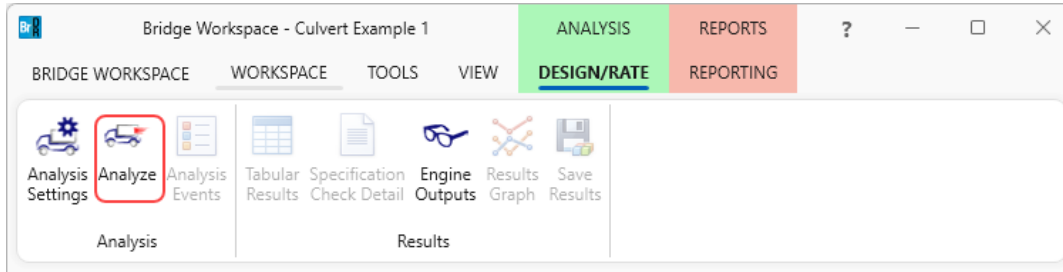
Apply the analysis settings as shown below.



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

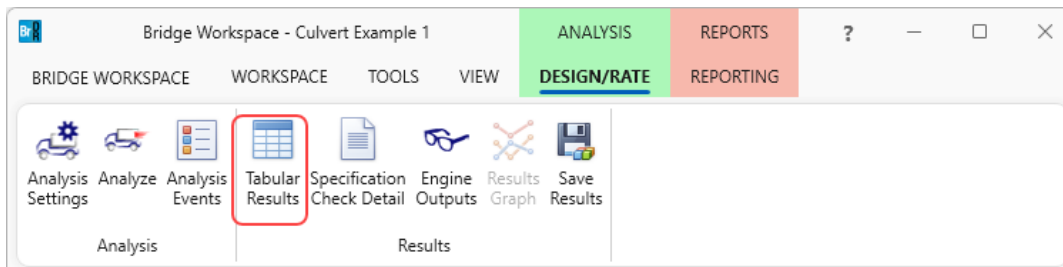
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

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

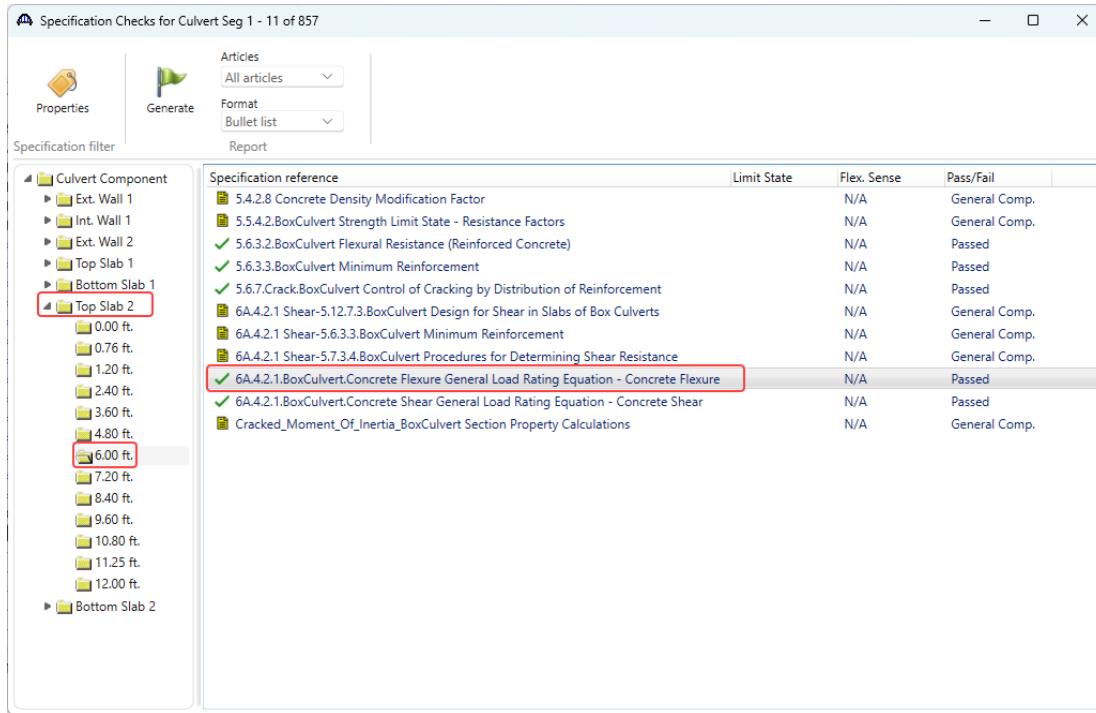
AASHTO Culvert LRFR Engine Version 7.5.0.3001
Analysis preference setting: None

Close

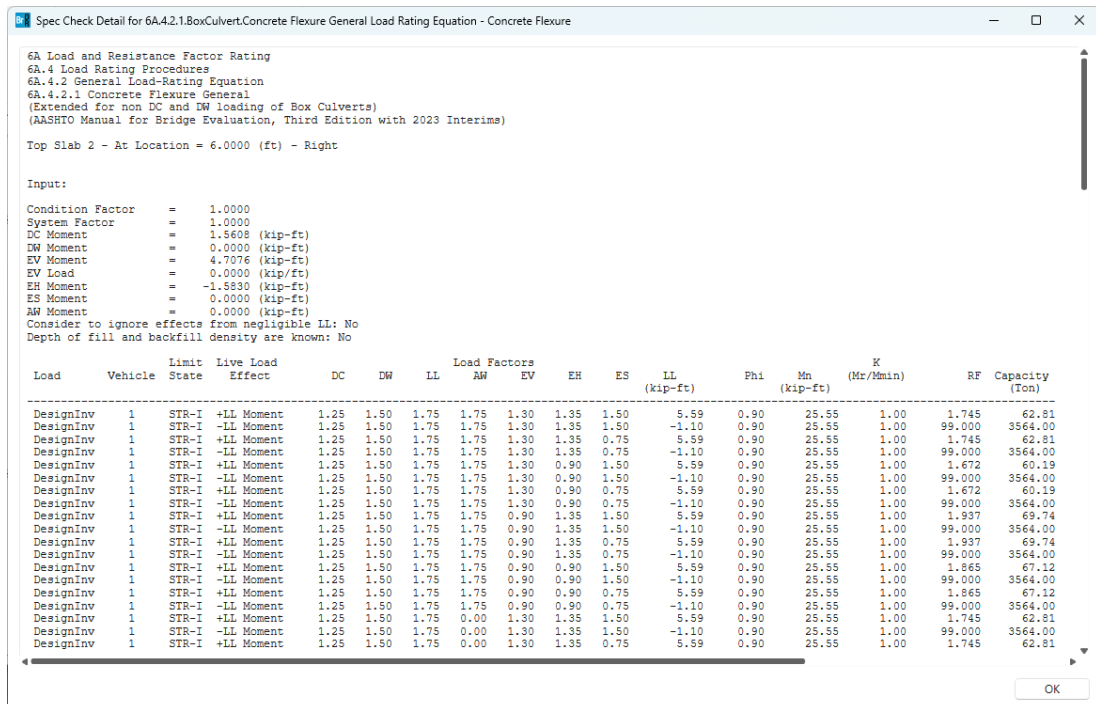
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

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 2** and select the **6.00 ft.** folder.



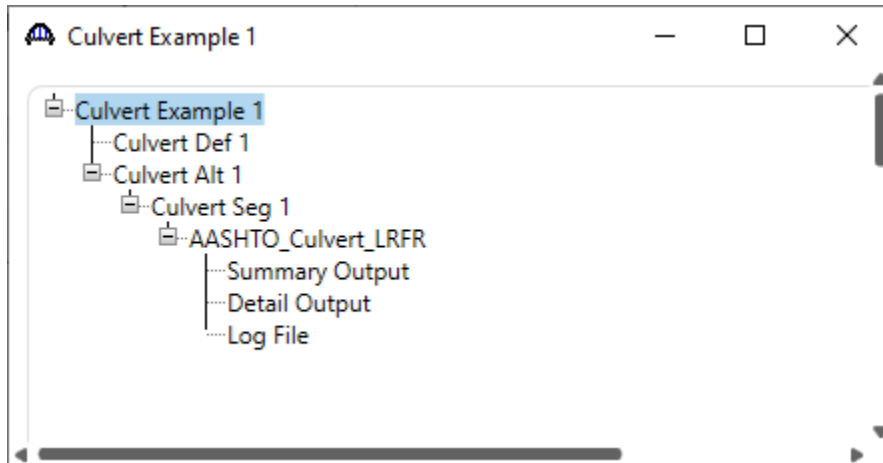
Double-click on the **6A.4.2.1 BoxCulvert Concrete Flexure General Load Rating Equation - Concrete Flexure** specification reference to open the **Spec Check Detail** window.



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

Engine Outputs

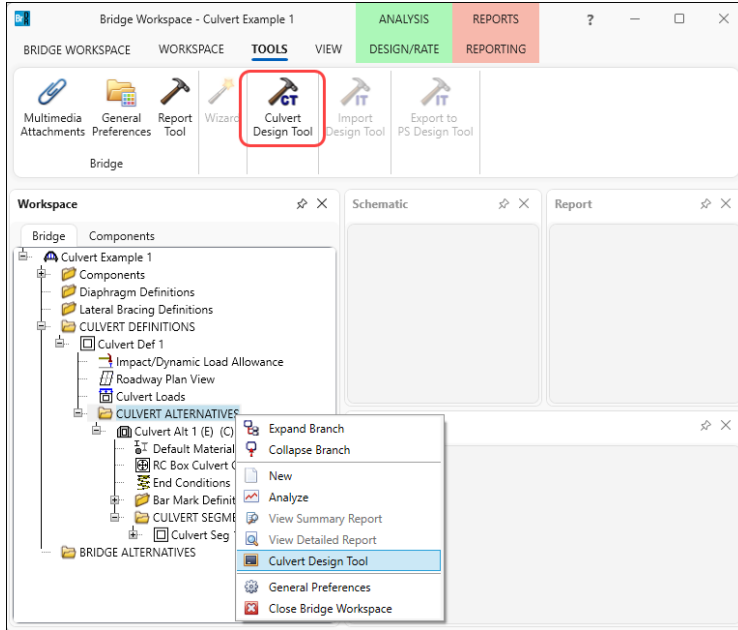
To review engine outputs, select the **Engine Outputs** button in the ribbon. Double-clicking on the **Summary Output** or **Detail Output** will open the engine output file in a separate window.



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.

The RC Box Culvert Design Tool dialog box contains the following fields and options:

- Alternative name: Design Alt 1
- Alternative description: (empty)
- Material: Class A (US)
- Reinforcement: Grade 60
- Clear cover: 2 in
- Bottom slab clear cover: 2 in
- Epoxy coated rebars: None, All, Top slab only
- Design template: HL 93 Design Review
- Segment name: Seq 1
- Segment description: (empty)
- Consider haunches in design
- Minimum wall thickness: 10 in
- Minimum slab thickness: 10 in
- Bottom slab present
- Number of cells: 2
- Cell height: 12 ft

Cell	Width (ft)
> 1	12
2	12

Buttons: < Back, Next >, Cancel

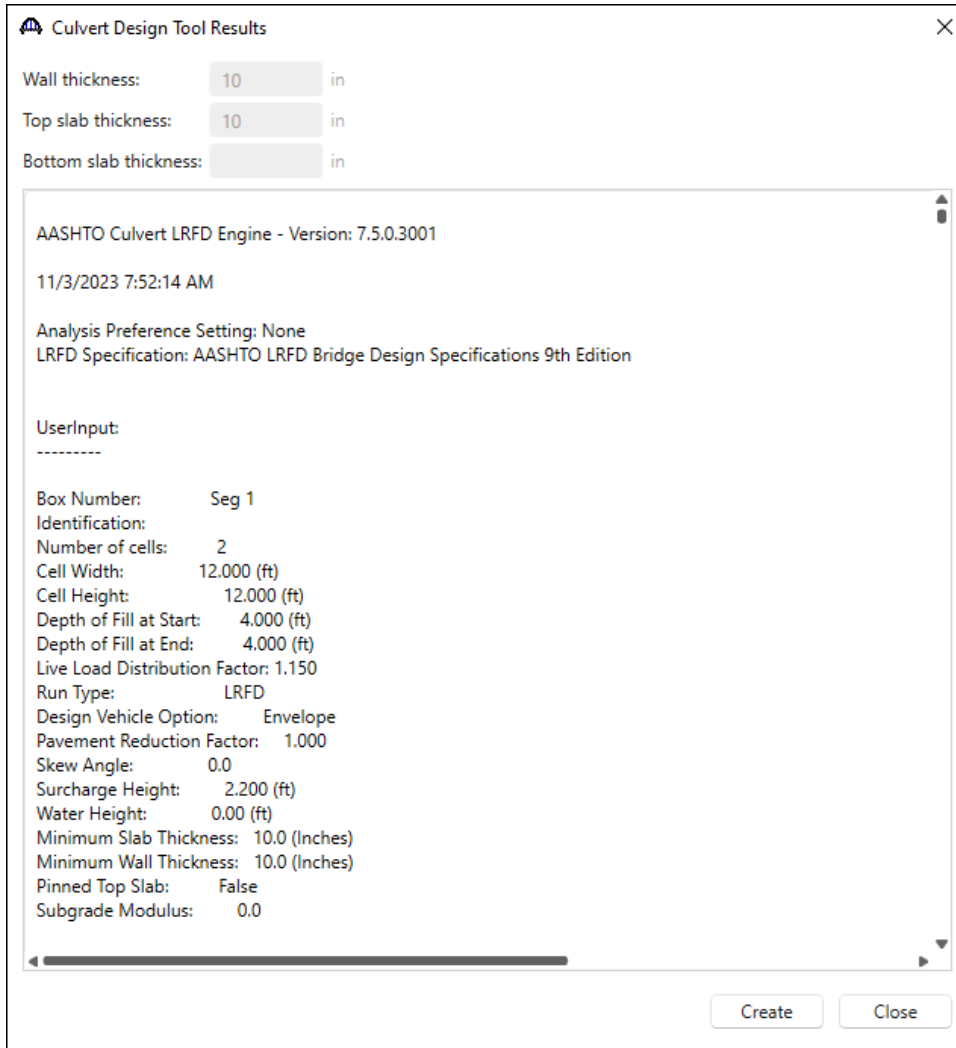
CVT1 – Two Cell RC Box Culvert Example (and Culvert Design Tool)

Enter the data as shown below.

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

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

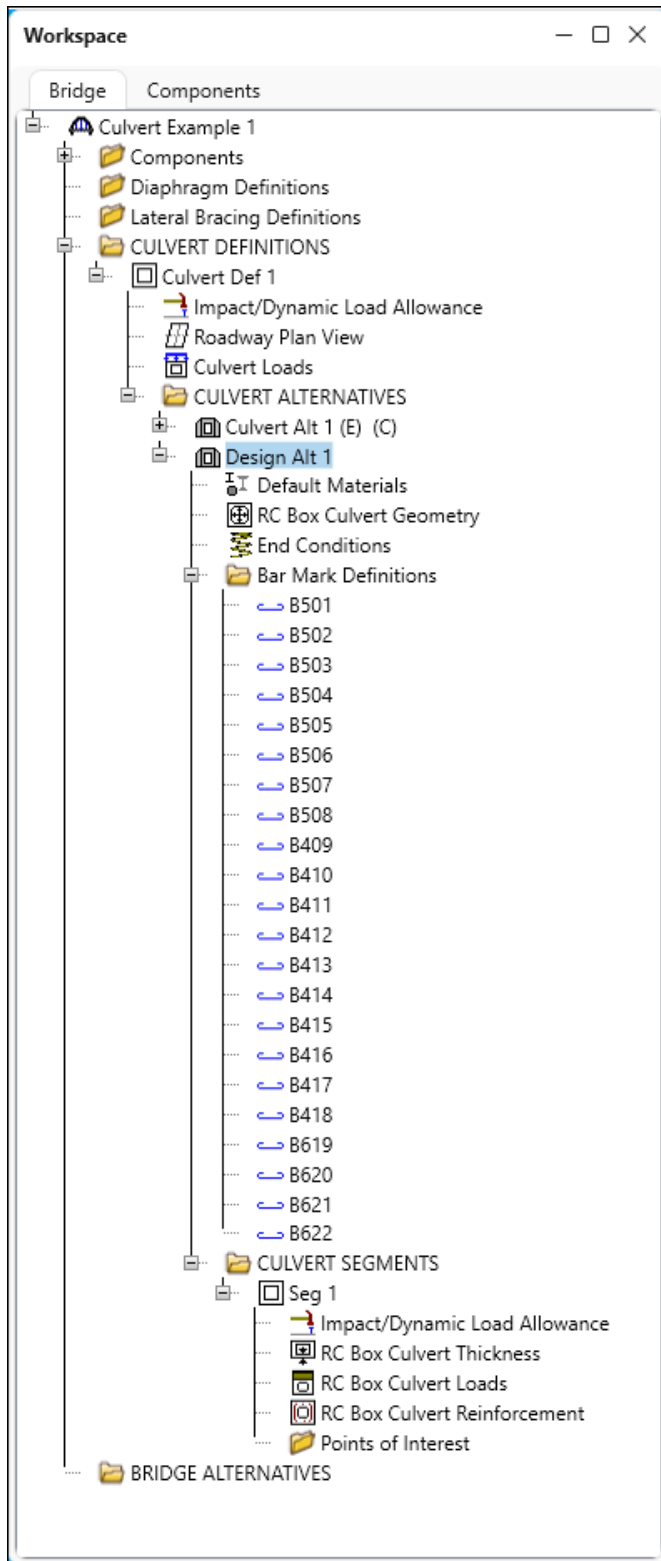
UserInput:

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.

