

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE RATING MANUAL	Section: 14 Effective: August 19, 2016 Supersedes: April 1, 2011
SECTION 14 - CONCRETE BOX CULVERTS	

14-1 INTRODUCTION TO RATING CONCRETE BOX CULVERTS

This section covers the rating of cast-in-place (CIP) concrete and pre-cast box culverts. This section does not cover flexible culverts or corrugated metal pipes. All concrete box culverts are to be rated using the policies and guidelines of the Bridge Rating Manual, Section 1 and Subsections 14-2 and 14-3.

The rating of flexible culverts is discussed in Section 14A.

When there are no plans available for the concrete box culverts being rated, the requirements in Subsection 8-4 and Subsection 14-2 III "Guidelines for using Engineering Judgement / Visual Rating" shall be used.

For CBC extension projects, the rating process shall follow the CDOT Bridge Rating Manual, Section 1-17.

The types of rigid culverts covered by this section are:

CBC - Concrete Box Culvert
 PCBC - Concrete Box Culvert, Pre-Cast

The types of culverts not covered by this section are:

AAC - Aluminum Arch Culvert
 CAC - Concrete Arch Culvert
 RCPC - Reinforced Concrete Pipe Culvert
 RAC - Rubber Arch Culvert
 SAC - Steel Arch Culvert
 TBC - Timber Box Culvert
 TTC - Timber Culvert

14-2 POLICIES AND GUIDELINES FOR RATING CONCRETE BOX CULVERTS**I. General**

- A. Load and Resistance Factor Rating Method (LRFR) shall be used for all re-rating and new ratings of culverts designed with Load and Resistance Factor Design (LRFD). Load Factor Rating Method (LFR) shall be used for rating culverts that were designed with Load Factor Design (LFD) or Allowable Stress Design (ASD). If the CBC ratings require no posting, color code and the Inventory rating factor is ≥ 1 , a CBC designed using the LFD method can be rated using LRFR.
- B. All major concrete box culverts (i.e. length greater than 20' between inside faces of outside walls) shall be rated by the latest version of AASHTOWARE BrR program or one acceptable to the CDOT Bridge Branch. Programs other than AASHTOWARE BrR must be approved in advance by the Staff Bridge. If CDOT standard plans (i.e. M-601-1, M-601-2 and M-601-3) are used in the design, the rating values shown in the standard plans shall be used to populate the Rating Summary Sheet. LRFR Rating Summary Sheets for each type and size of CBC are available and can be provided by Staff Bridge if requested.
- C. Inventory and operating rating levels shall be performed for the HS20-44 and Alternate Military Vehicle loading when LFR method is used and the HL93 loading when LRFR method is used. Also, ratings for the vehicles defined in the November 24th, 2014 Technical Memorandum "Bridge Load Rating Using Specialized Hauling Vehicles (SHV) and Notional Rating Load (NRL)" shall be provided.

Note: For LFR live load distribution factors refer to "The AASHTO Standard Specifications", "The AASHTO Manual for Bridge Evaluation", and the "AASHTO LRFD/LRFR/LFD Culvert Method of Solution Manual."

For LRFR live load distribution factors refer to "The AASHTO LRFD Specifications", "The AASHTO Manual for Bridge Evaluation", the "AASHTO LRFD/LRFR/LFD Culvert Method of Solution Manual."

- D. When the depth of the fill exceeds 8.0 feet and exceeds the clear span for a single-cell culvert or exceeds the distance between interior faces of the outer walls for a multiple-cell culvert, live load analysis is not required. When the fill height is greater than 5.0 feet and less than 8.0 feet and the CBC shows no signs of distress, CDOT will generally consider the structure to have negligible live load and no live load analysis will be required. A rating summary sheet is required for culverts meeting these criteria. Both the inventory and operating rating shall be coded as 99.9 Metric (110.12 English). The permit vehicle rating shall be left blank and the color code shall be coded as white. The controlling depth of fill shall be recorded on the Rating Summary Sheet with the notation "live load is negligible".

II. Calculations

- A. A set of calculations, separate from computer output, shall be submitted with each rating package. These calculations shall include derivations for dead loads and any other calculations or assumptions used for rating.
- B. Dead Loads
1. The final sum of all the individual weight components for dead load calculations may be rounded up to the next 5 pounds.
 2. Dead loads include fill, curbs, sidewalks, railing, etc.
- C. Use the minimum design yield strength value F_y and the minimum compressive strength of concrete F'_c from plans.

III. Guidelines for using Engineering Judgement / Visual Rating

When performing visual ratings, either the Rating Engineer or the Rating Checker shall be a Colorado Registered Professional Engineer.

The following provides guidelines for visual ratings:

Step 1: Pull the structure folder.

Step 2: Look for plans in the folder that are sufficient to perform the rating analysis. If the folder has plans that completely detail the reinforcement as well as notes that call out a specific design fill height together with all corresponding sheets from the M-Standard (if the culvert was designed using the CDOT M-Standard); the structure shall be rated using the AASHTOWARE BrR (formerly Virtis, preferred software), Brass Culvert or other approved program.

Step 3: Look at the fill height, item 66t on the SIA Sheet. Live load contribution through fill will be assumed as per the Bridge Rating Manual section 14-2 (I) D.

Step 4: Look at the condition state, item 62 on the SIA sheet. In general NBI condition rating of 6 and above will not require a reduction in live load carrying capacity.

Step 5: Review the inspection notes and photos. Look for signs of live load deterioration such as:

- Essential repairs with any load restrictions.
- Transverse cracking that is breaking up, delaminating or spalling. Transverse cracking is cracking normal to the culvert span. These cracks could indicate a reduced shear or flexural capacity.
- Guidance on crack width will be taken from the Pontis coding guide. The Pontis coding guides states a crack width $3/32''$ or less will not significantly reduce strength. Cracks greater than $3/32''$ will warrant further analysis. Cracking longitudinal to the culvert span is typically due to shrinkage and differential settlement. Cracking longitudinal to the culvert span will not warrant further investigation.
- Pending essential repairs that affect the structural integrity.

- Exposed rebar located in high moment and shear regions.
- Spalling not caused by debris impact.
- Spalling caused by debris impact in a high shear or high moment region.
- Excessive deflection noted in top/bottom slab and walls during inspection.

If clarification of inspection notes is necessary, the Rater or Rating Checker shall meet with the inspector to clear up any questions.

Step 6: If no live load carrying capacity reduction is warranted, fill out and sign the rating summary sheet. The numerical value will be based on section 8-4 for shallow fill heights and 14-2 for deeper fill heights. The following notes should appear on the rating summary sheet.

- Total structure length (Inside face to inside face of exterior walls).
- Fill height (shown in feet).
- Plans availability (yes, no or partial).
- Describe any load induced damage (if none, state none).
- List any pending essential repairs (if none, state none).
- NBI condition state coding for Item 62.
- Describe any damage that has a direct effect on load rating capacity (if none, state none). Also note the inspection date the distress as first identified.
- Color Code assignment.
- When Fill Height controls live load rating, use this note "Live load is negligible per section 14-2 of the CDOT Bridge Rating Manual."
- "Visually Rated" will be noted in the Comments section of the Rating Summary Sheet.

Step 7: If live load reduction is required based the criteria in Step 5, the rater shall assign a reduced load rating as described in the Step 6. The rater shall document a color code recommendation along with the fill height, location and magnitude of distress. For on-system structures, this documentation shall be submitted to the Staff Bridge Rating Unit. The Staff Bridge Rating Unit will coordinate a review panel. At a minimum, this review panel shall consist of the Staff Bridge Engineer, Staff Bridge Rating Engineer and Staff Bridge Inspection Engineer. This panel will make the final decision on any live load restrictions.

Step 8: Turn the structure folder and rating summary sheet over to the checker for review. The checker shall verify compliance with steps 2 through 6 above. If satisfactory and in agreement, the checker shall sign the summary sheet. If it is not satisfactory, the checker will send comments to the rater and find agreement prior to signing.

Step 9: The checker shall follow the CDOT Bridge Rating Archiving Policy Memo before submitting the rating package to the Bridge Rating Unit. The foregoing applies to off-system structures except for the review panel in step 7, the color code in step 6 and step 9.

14-3 RATING REPORTING AND PACKAGING REQUIREMENTS**I. Rating Reporting/Package Requirements**

- A. A copy of the AASHTOWare BrR reinforcement schematic drawing showing the elevation and applied loads shall be included with the rating package.
- B. The rater and checker shall complete the rating documentation (i.e. the rating QA checklist) as described in Section 1 of the Bridge Rating Manual. Any variation from the original design assumptions shall be added to the Rating Summary Sheet as applicable. The rating package requirements shall be per Section 1-13 of the Bridge Rating Manual, November 24th, 2014 Technical Memorandum "Bridge Load Rating Using Specialized Hauling Vehicles (SHV) and Notional Rating Load (NRL)" and as amended herein.

II. Consultant Requirements

- A. Consultant designed projects - Before finalizing the rating package and when AASHTOWare BrR is used as the analysis tool, the Rater shall verify with the Staff Bridge that the version number of the program being used is identical to CDOT'S version number. Data files created using the current version of BrR is preferred.
- B. When the rating is finalized, the rater shall save the input files in ".xml" format. The file name shall include the structure number of the rated CBC (i.e., O-14-BY.xml). The rating package including input program file, Rating Summary Sheet and necessary computations in pdf shall be transmitted electronically to Staff Bridge for archiving.

14-4 CONCRETE BOX CULVERT RATING EXAMPLES

Two examples are presented in this section. First, Structure X-01-X is a 3-cell culvert with 3 feet of fill. The structure has a 3 inch asphalt overlay. Loading includes a 45 plf load across the structure to account for the rail dead load. This structure is rated using a HS20-44 truck and lane live load, Colorado Permit Vehicle, Alternate Military Vehicle, Colorado Legal Type 3, 3S2, 3-2 vehicles, NRL and SU4 thru SU7 vehicles. The second structure, X-02-X, is a single-cell culvert with a skew of 10° degrees. The culvert has 6 feet of fill. It also carries a 4 inch asphalt roadway and a 45 plf rail load. This structure is rated using a HL-93 truck and lane live load, Colorado Permit Vehicle, Colorado Legal Type 3, 3S2, 3-2 vehicles, NRL and SU4 thru SU7 vehicles.

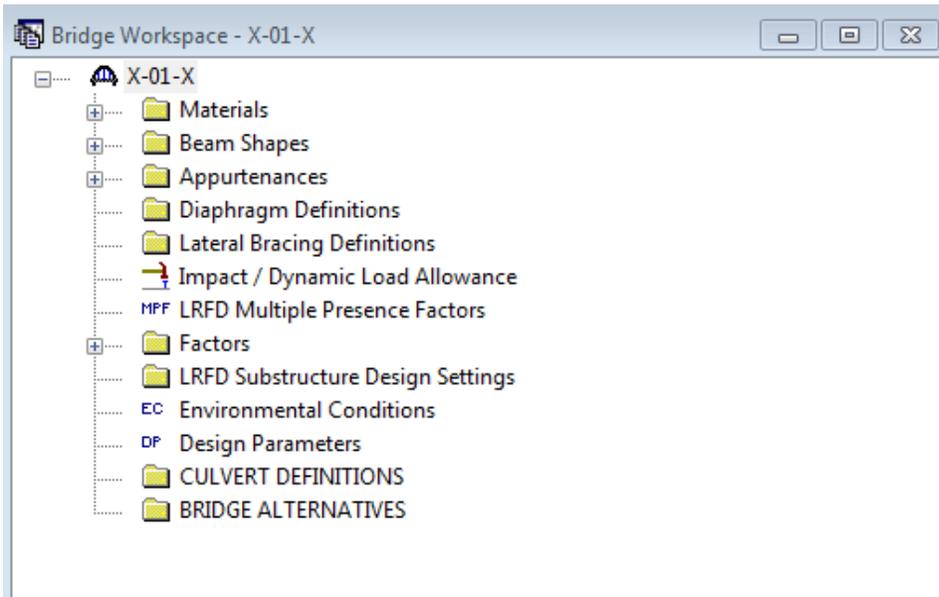
I. AASHTOWare BrR Program, Example 1 (LFR) - Structure No. X-01-X

From the Bridge Explorer, select File|New|New Bridge to create a new bridge and then enter the following description information.

The screenshot shows the 'New Bridge' dialog box in the AASHTOWare Bridge Explorer software. The window title is 'X-01-X'. The 'Bridge ID' and 'NBI Structure ID (8)' fields both contain 'X-01-X'. There are checkboxes for 'Template', 'Bridge Completely Defined', 'Superstructures', and 'Culverts'. The 'Culverts' checkbox is checked. Below these are tabs for 'Description', 'Description (cont'd)', 'Alternatives', 'Global Reference Point', 'Traffic', and 'Custom Agency Fields'. The 'Description' tab is active, showing a text area with the following content: 'Culvert Example 1', '3-cell reinforced concrete box culvert example', and '3" asphalt; 45 plf surcharge; 3 ft fill'. Other fields include 'Year Built: 1982', 'Location: Town, CO', 'Length: 36.00 ft', 'Facility Carried (7): US X', 'Route Number: US X', 'Feat. Intersected (6): Creek Y', and 'Mi. Post: 100.00'. At the bottom, there is a dropdown for 'Default Units: US Customary' and a group box containing 'AASHTOWare Association...', 'BrR' (checked), 'BrD' (checked), and 'BrM' (unchecked). 'OK', 'Apply', and 'Cancel' buttons are at the bottom right.

Close the window by clicking OK. This saves the data to memory and closes the window.

The Bridge Workspace tree after the bridge is created is shown below:



To enter the materials for the culvert, expand the tree for Materials. Double-click on the Concrete folder to create a new concrete material. Enter the following values.

When plans are available, use the minimum concrete strength and yield strength values given in the plans. If plan values are not known, values given in Section 1 of the Bridge Rating Manual for the applicable year of construction may be followed.

Double-click on the Reinforcing Steel folder to create a new reinforcement material. Click on the Copy from Library button to copy the Grade 60 reinforcement material to the bridge.

The screenshot shows a dialog box titled "Bridge Materials - Reinforcing Steel". It has a "Name" field containing "Grade 60" and a "Description" field containing "60 ksi reinforcing steel". Below these fields is a "Material Properties" section with three input fields: "Specified yield strength (Fy) = 60.000 ksi", "Modulus of elasticity (Es) = 29000.00 ksi", and "Ultimate strength (Fu) = 90.000 ksi". Underneath is a "Type" section with four radio button options: "Plain" (selected), "Epoxy", "Galvanized", and "Other". At the bottom of the dialog are five buttons: "Copy To Library...", "Copy from Library..." (highlighted in blue), "OK", "Apply", and "Cancel".

Double-click on the Soil folder to create a new soil material. Click on the Copy from Library button to copy the Standard Soil 1 material to the bridge.

The screenshot shows a dialog box titled "Bridge Materials - Soil". It has a "Name" field containing "Standard Soil 1" and a "Description" field containing "Standard Soil 1". Below these fields are several input fields for soil properties: "Soil unit load = 120.000 pcf", "Saturated soil unit load = 125.000 pcf", "At-rest lateral earth pressure coefficient (LRFD/LRFR) = 0.50", "Active lateral earth pressure coefficient (LRFD/LRFR) = 0.33", "Passive lateral earth pressure coefficient (LRFD/LRFR) = 3.00", "Maximum lateral soil pressure (LFD) = 60.000 pcf", and "Minimum lateral soil pressure (LFD) = 30.000 pcf". At the bottom of the dialog are five buttons: "Copy To Library...", "Copy from Library..." (highlighted in blue), "OK", "Apply", and "Cancel".

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 that we create will automatically be assigned as the Existing and Current Culvert Alternative for this Culvert Definition.

Culvert Definition

Name:

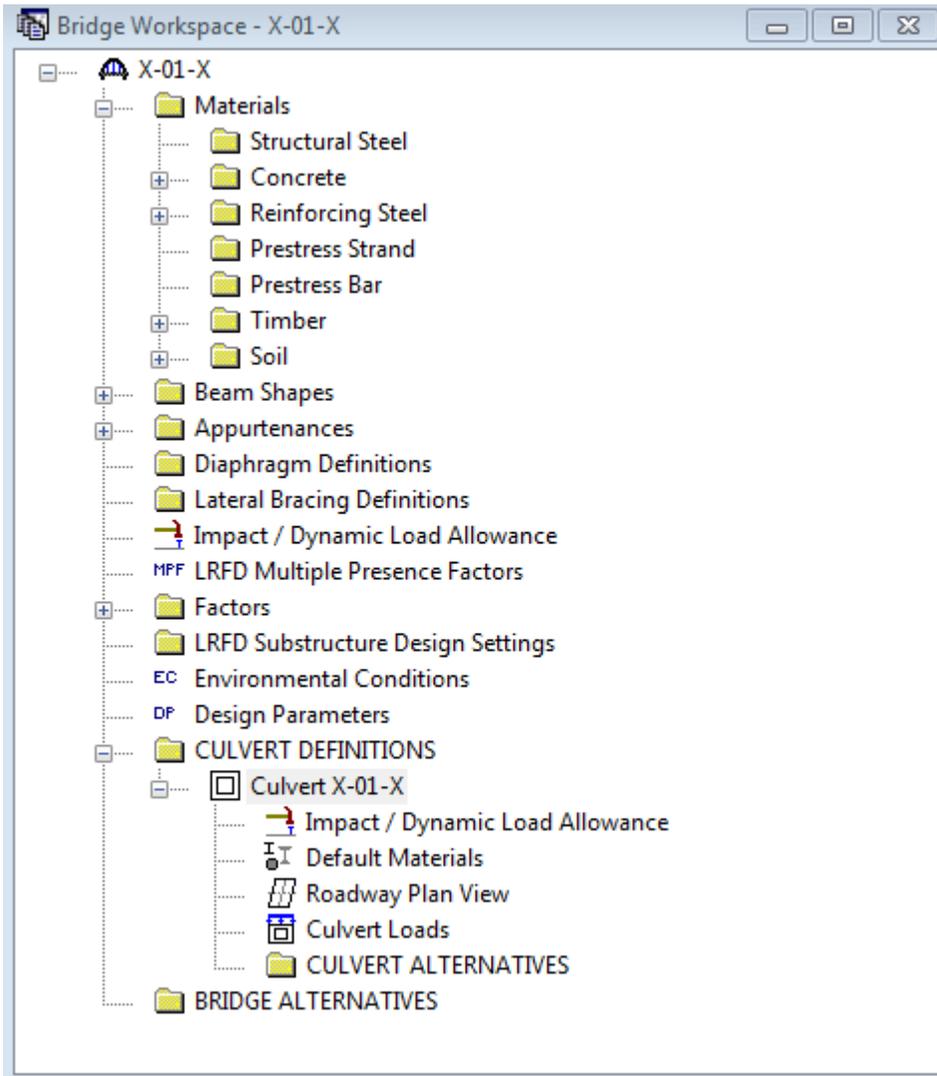
Description:

Default units:

Existing	Current	Culvert Alternative Name	Description
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Culvert Alt 1	3-cell reinforced concrete box culvert (LFR example)

OK Apply Cancel

Expand the tree for Culvert Definition X-01-X.



Double-click on the CULVERT ALTERNATIVES folder to create a new culvert alternative for Culvert X-01-X. Enter the data as show below.

Culvert Alternative:

Description | Specs | Factors | Control Options

Description:

Default units:

Culvert type:

Construction Type

Cast-in-place

Precast

Default rating method:

Top slab exterior surface exposure factor:

Bot slab exterior surface exposure factor:

Wall exterior surface exposure factor:

Interior surface exposure factor:

Soil

Installation method:

Side Fill Condition

Compact Uncompact

LRFD EH Load Factor

At-rest Active

LRFD/LRFR Earth Pressure Coefficient

At-rest

Active

Passive

Soil-structure interaction factor (LRFD):

Soil-structure interaction factor (LFD):

Expand the tree for Culvert Alt 1.

Double-click on RC Box Culvert Geometry in the tree. Enter the data as shown below. Click Ok to save the data to memory and close the window.

RC Box Culvert Geometry

Number of cells:

Cell height: ft

Cell	Width (ft)
1	12.000
2	12.000
3	12.000

Bottom slab present

Horiz. construction joint height: in

Haunches

Top haunch width: in

Top haunch depth: in

Bottom haunch width: in

Bottom haunch depth: in

OK Apply Cancel

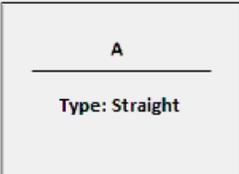
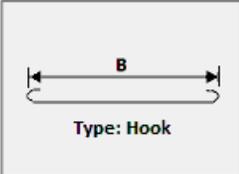
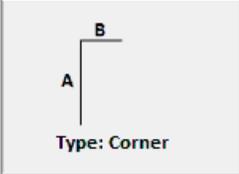
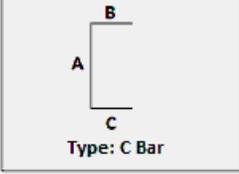
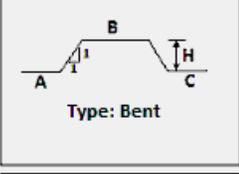
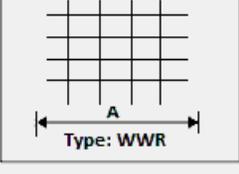
Double-click on the Bar Mark Definitions folder in the tree to create a new bar mark definition for Culvert Alt 1.

Enter the data for C1 as shown below. Click Ok to save the data to memory and close the window. Repeat the process for all bars (C2, W1, W2, W3, W4, B1, B2, T1, T2) as shown.

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

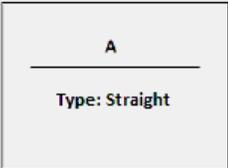
B = ft

C = ft

Bar Mark Definition

Name: C2

Bar Types:



Type: Straight

Material: Grade 60

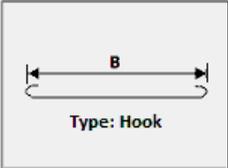
Bar size: 6

Bar type: Corner

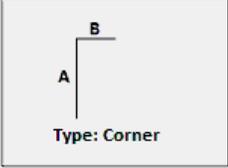
Dimension

A = 2.833 ft

B = 3.333 ft



Type: Hook

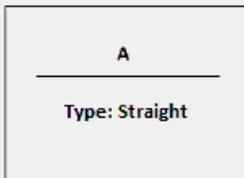


Type: Corner

Bar Mark Definition

Name: W1

Bar Types:



Type: Straight

Material: Grade 60

Bar size: 4

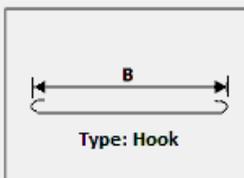
Bar type: C Bar

Dimension

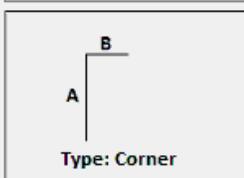
A = 6.583 ft

B = 0.667 ft

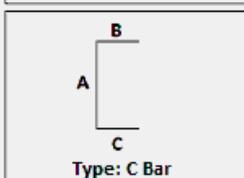
C = 0.000 ft



Type: Hook



Type: Corner

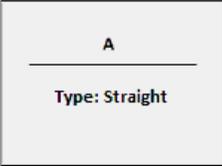
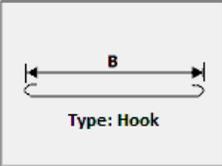
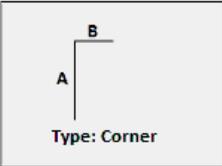
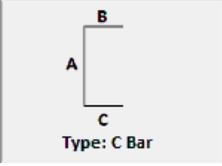


Type: C Bar

Bar Mark Definition

Name: W2

Bar Types:

- 
Type: Straight
- 
Type: Hook
- 
Type: Corner
- 
Type: C Bar

Material: Grade 60

Bar size: 4

Bar type: C Bar

Dimension

A = 2.833 ft

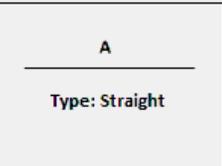
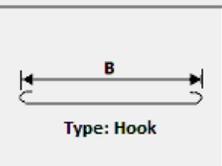
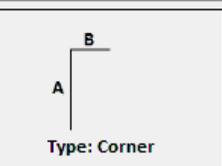
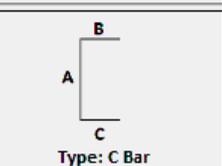
B = 0.000 ft

C = 0.667 ft

Bar Mark Definition

Name: W3

Bar Types:

- 
Type: Straight
- 
Type: Hook
- 
Type: Corner
- 
Type: C Bar

Material: Grade 60

Bar size: 5

Bar type: C Bar

Dimension

A = 6.583 ft

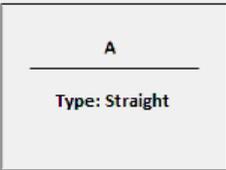
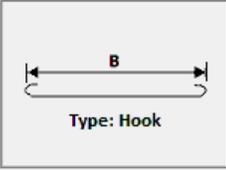
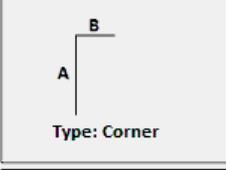
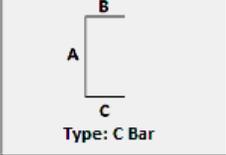
B = 0.833 ft

C = 0.000 ft

Bar Mark Definition

Name: W4

Bar Types:

- 
Type: Straight
- 
Type: Hook
- 
Type: Corner
- 
Type: C Bar

Material: Grade 60

Bar size: 5

Bar type: C Bar

Dimension

A = 2.833 ft

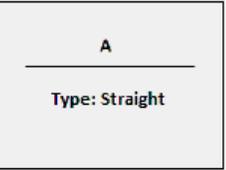
B = 0.000 ft

C = 0.833 ft

Bar Mark Definition

Name: B1

Bar Types:

- 
Type: Straight

Material: Grade 60

Bar size: 7

Bar type: Straight

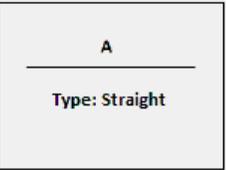
Dimension

A = 39.000 ft

Bar Mark Definition

Name: B2

Bar Types:

- 
Type: Straight

Material: Grade 60

Bar size: 5

Bar type: Straight

Dimension

A = 39.000 ft

Bar Mark Definition

Name: T1

Bar Types:

A

Type: Straight

Material: Grade 60

Bar size: 7

Bar type: Straight

Dimension

A = 39.000 ft

Bar Mark Definition

Name: T2

Bar Types:

A

Type: Straight

Material: Grade 60

Bar size: 6

Bar type: Straight

Dimension

A = 39.000 ft

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

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

Looking Ahd STA

OK Apply Cancel

Expand the tree for Culvert Seg 1. Double-click on RC Box Culvert Thickness in the tree. Enter the slab and wall thicknesses as shown below. Click OK to save the data to memory and close the window.

RC Box Culvert Thickness

Cell	Top Slab Thickness (in)	Bottom Slab Thickness (in)
1	9.50	11.00
2	9.50	11.00
3	9.50	11.00

Wall	Thickness (in)
1	10.00
2	10.00
3	10.00
4	10.00

OK Apply Cancel

Double-click on RC Box Culvert Loads in the tree. Enter the culvert loads for Culvert Seg 1 as shown below. The wearing surface thickness includes the equivalent for the rail dead load. Click OK to save the data to memory and close the window.

RC Box Culvert Loads

Depth of fill at start edge = 3.00 ft

Depth of fill at end edge = 3.00 ft

Wearing surface unit load = 144.00 pcf

Wearing Surface thickness = 6.75 in

LRFD live load surcharge height = ft

LFD live load surcharge height = 2.00 ft

Water height = ft

LRFD live load distribution factor =

LFD live load distribution factor = 1.750

$q_{LS} = \text{Surcharge Height} \times \text{Equivalent Fluid Pressure}$

$q_w = (\text{Water Height} + \frac{1}{2} \text{ Bottom Slab Thickness}) \times \text{Unit Weight of Water}$

Sta Ahead

Double-click on RC Box Culvert Reinforcement in the tree. Enter the reinforcement data as shown below for each location. Click Ok to save the data to memory and close the window.

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	T1	2.50	6.00	CL Culvert		<input checked="" type="checkbox"/>	19.50	39.00	<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	Cell / Wall Number	Centered	Start Distance (ft)	Straight Length (ft)	Fully Developed Start	Fully Developed End
1	T2	1.50	6.00	CL Culvert		<input checked="" type="checkbox"/>	19.50	39.00	<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	Cell / Wall Number	Centered	Start Distance (ft)	Straight Length (ft)	Fully Developed Start	Fully Developed End
1	B2	1.50	6.00	CL Culvert		<input checked="" type="checkbox"/>	19.50	39.00	<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	B1	3.00	6.00	CL Culvert		<input checked="" type="checkbox"/>	19.50	39.00	<input type="checkbox"/>	<input type="checkbox"/>

New Duplicate Delete

Reinforcement Wizard...

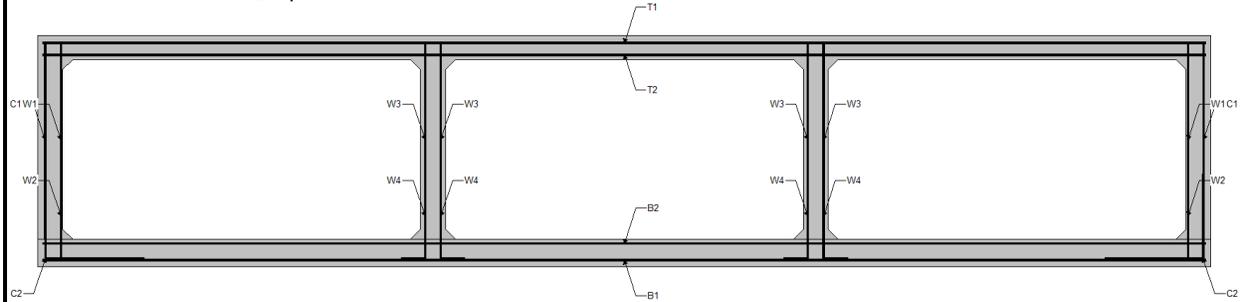
OK Apply Cancel

RC Box Culvert Reinforcement

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	C2	2.00	3.00	6.00	Bottom Right	1	<input type="checkbox"/>	<input type="checkbox"/>
2	C2	2.00	3.00	6.00	Bottom Left	4	<input type="checkbox"/>	<input type="checkbox"/>
3	C1	2.00	2.50	6.00	Right	1	<input type="checkbox"/>	<input type="checkbox"/>
4	C1	2.00	2.50	6.00	Left	4	<input type="checkbox"/>	<input type="checkbox"/>
5	W1	8.50	2.50	6.00	Right	1	<input type="checkbox"/>	<input type="checkbox"/>
6	W1	8.50	2.50	6.00	Left	4	<input type="checkbox"/>	<input type="checkbox"/>
7	W2	8.50	55.50	6.00	Right	1	<input type="checkbox"/>	<input type="checkbox"/>
8	W2	8.50	55.50	6.00	Left	4	<input type="checkbox"/>	<input type="checkbox"/>
9	W3	1.50	2.50	6.00	Left	2	<input type="checkbox"/>	<input type="checkbox"/>
10	W3	1.50	2.50	6.00	Left	3	<input type="checkbox"/>	<input type="checkbox"/>
11	W3	1.50	2.50	6.00	Right	2	<input type="checkbox"/>	<input type="checkbox"/>
12	W3	1.50	2.50	6.00	Right	3	<input type="checkbox"/>	<input type="checkbox"/>
13	W4	1.50	55.50	6.00	Left	2	<input type="checkbox"/>	<input type="checkbox"/>
14	W4	1.50	55.50	6.00	Right	2	<input type="checkbox"/>	<input type="checkbox"/>
15	W4	1.50	55.50	6.00	Left	3	<input type="checkbox"/>	<input type="checkbox"/>
16	W4	1.50	55.50	6.00	Right	3	<input type="checkbox"/>	<input type="checkbox"/>

Select Bridge|Schematic to review the reinforcement data.



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

Select File|Save to save the file in BrR.

To perform LFD Design Load Rating, open the Analysis setting window by selecting Bridge|Analysis Settings. Select LFD as the Rating Method and specify the vehicles. Under Vehicles → Advanced.. select Single Lane Loaded for Colorado Permit Vehicle and Modified Tandem.

Analysis Settings

Design Review Rating Rating Method: LFD

Analysis Type: Line Girder

Lane/Impact Loading Type: As Requested Apply Preference Setting: None

Vehicles Output Engine Description

Traffic Direction: Both directions

Refresh Temporary Vehicles... Advanced...

Vehicle Selection:

- HS 20-44
- NRL
- SU4
- SU5
- SU6
- SU7
- Type 3
- Type 3-3
- Type 3S2
- Agency
 - 130074
 - Colorado Legal Type 3
 - Colorado Legal Type 3-2
 - Colorado Legal Type 3S2
 - Colorado Permit Vehicle
 - Colorado Snow Plow Tweener
 - Faster Modified CLT 3-2
 - Faster Modified CLT 3S2
 - Faster semi 85k
 - Faster semi 92k
 - FTWaren(146.5 GVW)
 - HETS
 - HETS-1
 - Holly 167ft BT84 273K-Truck
 - Interstate Legal Type 3
 - Interstate Legal Type 3-2
 - Interstate Legal Type 3S2
 - Modified Tandem
- User Defined

Add to Operating >>

Remove from Analysis <<

Vehicle Summary:

- Rating Vehicles
 - Inventory
 - HS 20-44
 - Operating
 - HS 20-44
 - NRL
 - SU4
 - SU5
 - SU6
 - SU7
 - Colorado Legal Type 3
 - Colorado Legal Type 3-2
 - Colorado Legal Type 3S2
 - Colorado Permit Vehicle
 - Modified Tandem
 - Legal Operating
 - Permit Inventory
 - Permit Operating

Reset Clear Open Template Save Template OK Apply Cancel

Click Ok to save the analysis settings to memory and close the window.

Select Culvert Seg 1 in the tree. Select Bridge | Analyze to start the rating process. Click Ok to close the Analysis Progress window after the analysis is completed.

Select Bridge|Tabular Report to open the Analysis Results window.

Analysis Results - Culvert Seg 1

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
Alternate Military Loading	Axle Load	LFD	Inventory	36.24	1.510	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
Alternate Military Loading	Axle Load	LFD	Operating	59.72	2.488	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
HS 20-44	Axle Load	LFD	Inventory	63.32	1.759	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operating	103.25	2.868	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
NRL	Axle Load	LFD	Operating	168.75	4.219	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
SU4	Axle Load	LFD	Operating	97.94	3.627	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
SU5	Axle Load	LFD	Operating	120.81	3.897	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
SU6	Axle Load	LFD	Operating	137.82	3.966	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
SU7	Axle Load	LFD	Operating	158.72	4.096	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
Colorado Legal Type 3	Axle Load	LFD	Operating	78.15	2.894	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
Colorado Legal Type 3-2	Axle Load	LFD	Operating	123.94	2.916	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
Colorado Legal Type 3S2	Axle Load	LFD	Operating	121.81	2.866	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
Colorado Permit Vehicle	Axle Load	LFD	Operating	212.93	2.218	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested
Modified Tandem	Axle Load	LFD	Operating	110.94	2.219	Top Slab 3	0.81	6.789	Shear	As Requested	As Requested

AASHTO Culvert LFR Engine Version 6.7.0.3001
 Analysis Preference Setting: None

Close

Fill out the Rating Summary Sheet using policies and guidelines in the Bridge Rating Manual, Section 1. The results of the LFD rating analysis are as follows.

COLORADO DEPARTMENT OF TRANSPORTATION LOAD FACTOR RATING SUMMARY		Structure #	X-01-X		
Rated using: Asphalt thickness: <u>914</u> mm (<u>36</u> in.) <input checked="" type="checkbox"/> Colorado legal loads <input type="checkbox"/> Interstate legal loads		State Highway #	US X		
		Batch I.D.	XXXX		
		Structure Type	CBC		
		Parallel Structure #	NA		
Structural Member	3-CELL CBC				
Metric Tons (Tons)					
Inventory Alt. Military	32.9 (36.2)	()	()	()	()
Operating Alt. Military	54.2 (59.7)	()	()	()	()
Type 3 truck	70.9 (78.2)	()	()	()	()
Type 3S2 truck	110.5 (121.8)	()	()	()	()
Type 3-2 truck	112.4 (123.9)	()	()	()	()
Type SU4 truck (27T)	()	()	()	()	()
Type SU5 truck (31T)	()	()	()	()	()
Type SU6 truck (35T)	()	()	()	()	()
Type SU7 truck (39T)	()	()	()	()	()
NRL (40T)	153.1 (168.8)	()	()	()	()
Permit Truck Single Lane D.F.	193.1 (212.9)	()	()	()	()
Comments: (T = tons) Modified Tandem 100.6 (110.9) Total structure length (face to face of end walls) = 36'-0"; Fill height 3'-0"; Asphalt 3 in NBI Item 62 condition state level = 8; Plans available = Yes Load induced damage present = No; Pending essential repairs = No Color Code: White Rated with BrR 6.7.0.3001 AASHTO Culvert Engine					
Rated by:		Date:	Checked by:		Date:

II. AASHTOWare BrR Program, Example 2 (LRFR) - Structure No. X-02-X

From the Bridge Explorer, select File|New|New Bridge to create a new bridge and then enter the following description information.

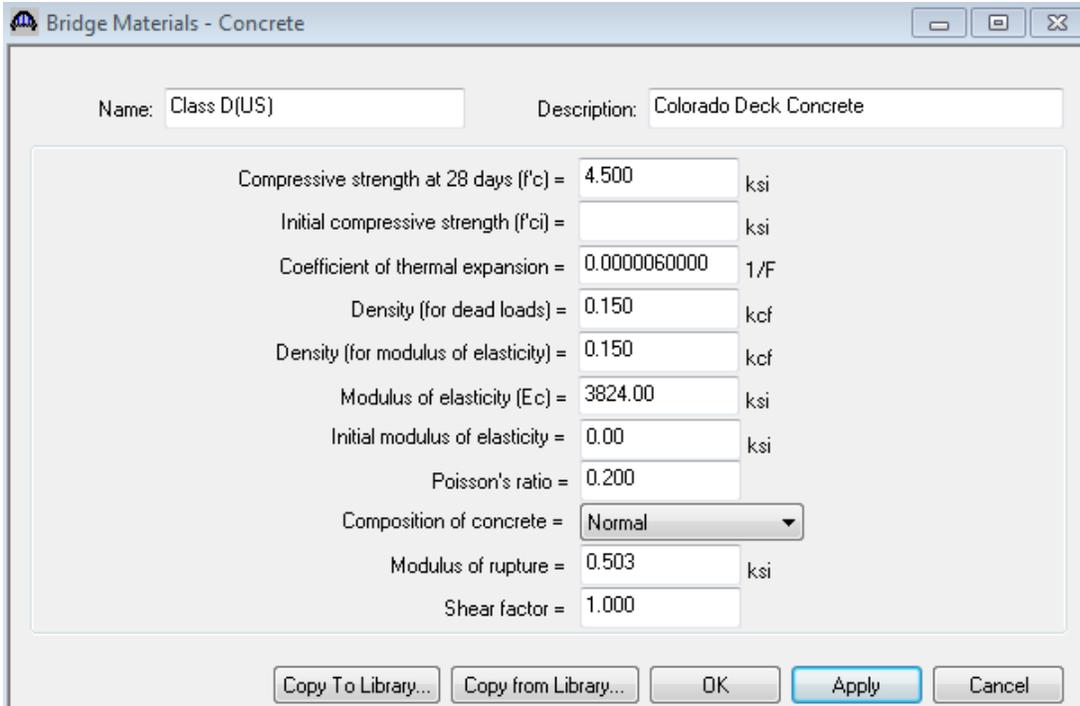
The screenshot shows the 'New Bridge' dialog box in the AASHTOWare BrR program. The window title is 'X-02-X'. At the top, there are input fields for 'Bridge ID: X-02-X' and 'NBI Structure ID (8): X-02-X'. To the right are checkboxes for 'Template', 'Superstructures', 'Bridge Completely Defined', and 'Culverts' (which is checked). Below this is a tabbed interface with 'Description' selected. The 'Description' tab contains the following fields:

- Name: Culvert Example 2
- Year Built: 2016
- Description: CIP single cell 13'x20' reinforced concrete box culvert with no bottom slab
10 degrees skew; 3 in haunch
4" asphalt; 6 ft fill
- Location: Town, CO
- Length: 50.00 ft
- Facility Carried (7): US X
- Route Number: US X
- Feat. Intersected (6): Creek Y
- Mi. Post: 200.00
- Default Units: US Customary

At the bottom of the dialog, there is an 'AASHTOWare Association...' button, checkboxes for 'BrR' (checked), 'BrD' (checked), and 'BrM' (unchecked), and 'OK', 'Apply', and 'Cancel' buttons.

Close the window by clicking OK. This saves the data to memory and closes the window.

To enter the materials for the culvert, expand the tree for Materials. Double-click on the Concrete folder to create a new concrete material. Enter the following values.



The screenshot shows a dialog box titled "Bridge Materials - Concrete". It contains the following fields and values:

Property	Value	Unit
Name	Class D(US)	
Description	Colorado Deck Concrete	
Compressive strength at 28 days (f'c)	4.500	ksi
Initial compressive strength (f'ci)		ksi
Coefficient of thermal expansion	0.0000060000	1/F
Density (for dead loads)	0.150	kcf
Density (for modulus of elasticity)	0.150	kcf
Modulus of elasticity (Ec)	3824.00	ksi
Initial modulus of elasticity	0.00	ksi
Poisson's ratio	0.200	
Composition of concrete	Normal	
Modulus of rupture	0.503	ksi
Shear factor	1.000	

At the bottom of the dialog box, there are five buttons: "Copy To Library...", "Copy from Library...", "OK", "Apply", and "Cancel".

When plans are available, use the minimum concrete strength and yield strength values given in the plans. If plan values are not known, values given in Section 1 of the Bridge Rating Manual for the applicable year of construction may be followed.

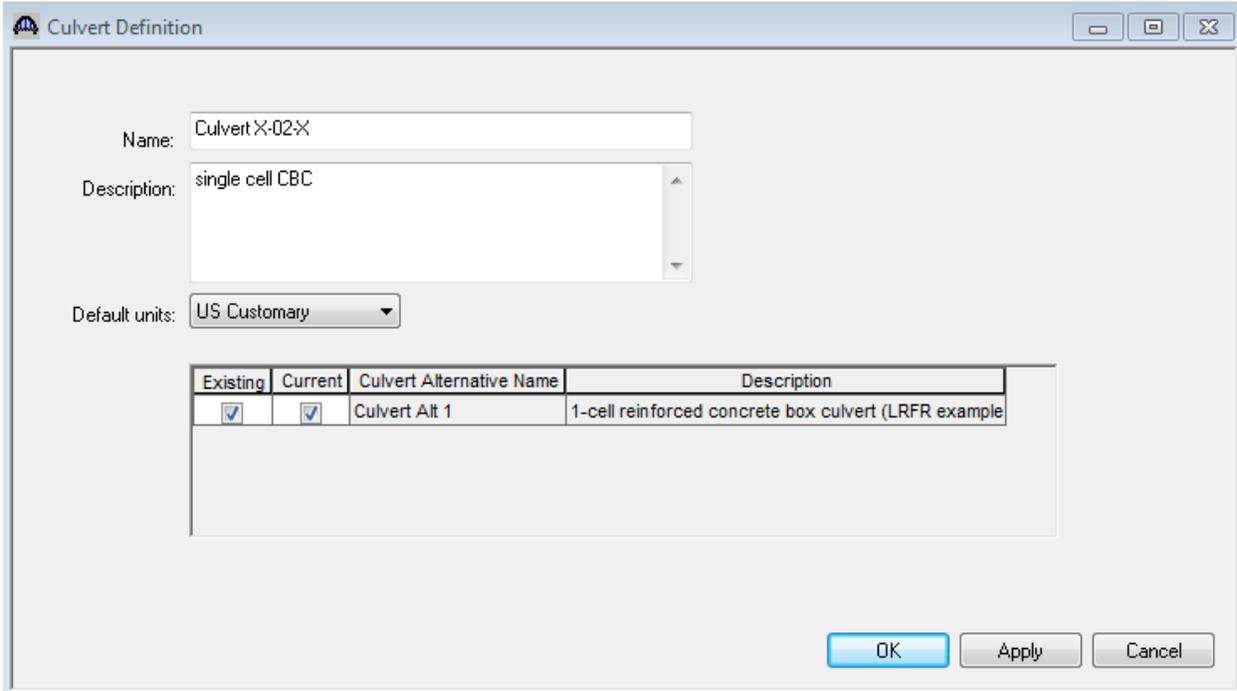
Double-click on the Reinforcing Steel folder to create a new reinforcement material. Click on the Copy from Library button to copy the Grade 60 reinforcement material to the bridge.

The screenshot shows a dialog box titled "Bridge Materials - Reinforcing Steel". It has a "Name" field containing "Grade 60" and a "Description" field containing "60 ksi reinforcing steel". Below these fields is a "Material Properties" section with three input fields: "Specified yield strength (Fy) = 60.000 ksi", "Modulus of elasticity (Es) = 29000.00 ksi", and "Ultimate strength (Fu) = 90.000 ksi". Underneath is a "Type" section with four radio button options: "Plain" (selected), "Epoxy", "Galvanized", and "Other". At the bottom of the dialog are five buttons: "Copy To Library...", "Copy from Library..." (highlighted in blue), "OK", "Apply", and "Cancel".

Double-click on the Soil folder to create a new soil material. Click on the Copy from Library button to copy the Standard Soil 1 material to the bridge.

The screenshot shows a dialog box titled "Bridge Materials - Soil". It has a "Name" field containing "Standard Soil 1" and a "Description" field containing "Standard Soil 1". Below these fields are several input fields for soil properties: "Soil unit load = 120.000 pcf", "Saturated soil unit load = 125.000 pcf", "At-rest lateral earth pressure coefficient (LRFD/LRFR) = 0.50", "Active lateral earth pressure coefficient (LRFD/LRFR) = 0.33", "Passive lateral earth pressure coefficient (LRFD/LRFR) = 3.00", "Maximum lateral soil pressure (LFD) = 60.000 pcf", and "Minimum lateral soil pressure (LFD) = 30.000 pcf". At the bottom of the dialog are five buttons: "Copy To Library...", "Copy from Library..." (highlighted in blue), "OK", "Apply", and "Cancel".

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 that we create will automatically be assigned as the Existing and Current Culvert Alternative for this Culvert Definition.



Culvert Definition

Name: Culvert X-02X

Description: single cell CBC

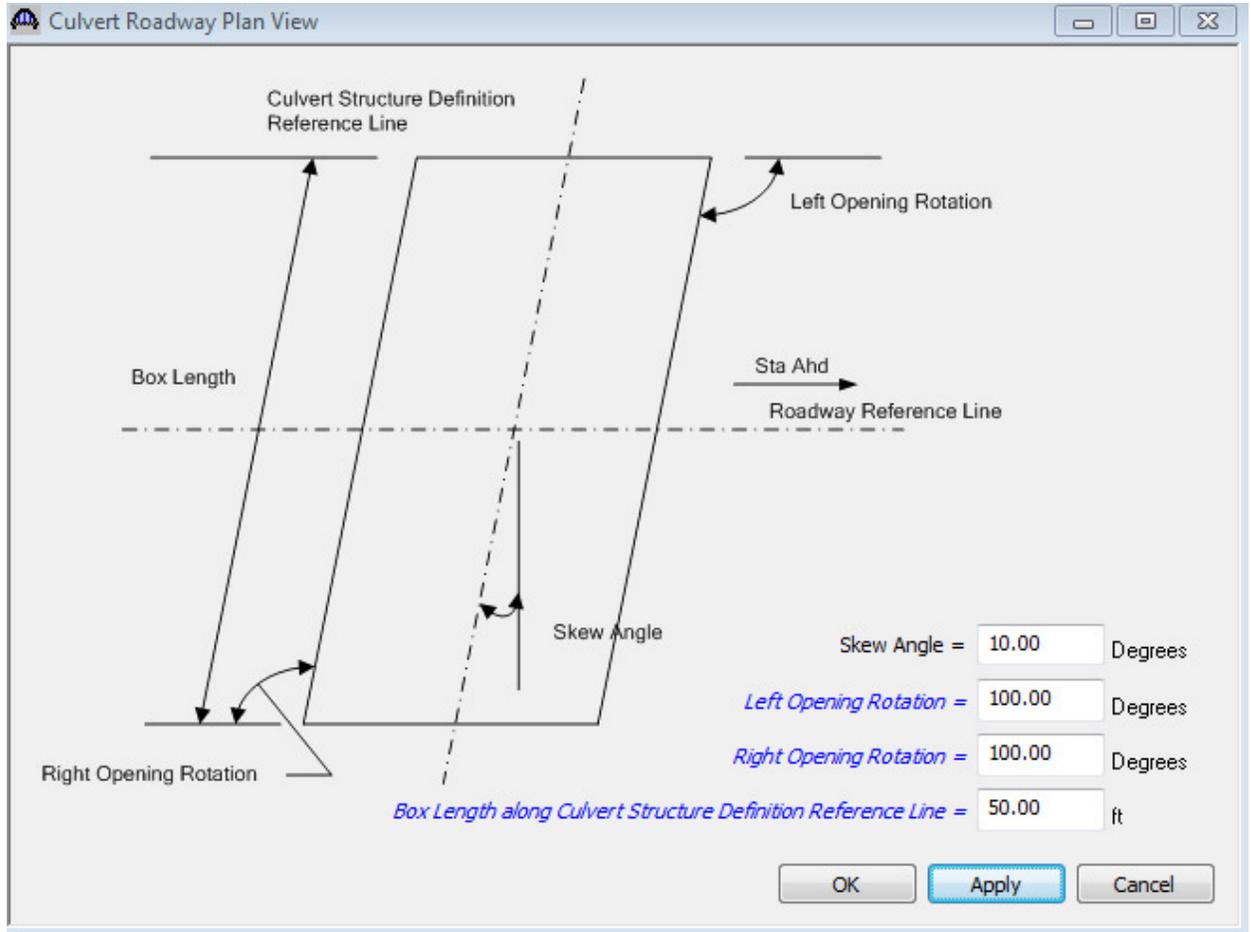
Default units: US Customary

Existing	Current	Culvert Alternative Name	Description
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Culvert Alt 1	1-cell reinforced concrete box culvert (LRFR example)

OK Apply Cancel

Expand the tree for Culvert Definition X-02-X.

Double-click on the Roadway Plan View to enter the skew angles as shown below.



Double-click on the CULVERT ALTERNATIVES folder to create a new culvert alternative for Culvert X-02-X. Enter the data as shown below.

Culvert Alternative Description

Culvert Alternative: Culvert Alt 1

Description Specs Factors Control Options

Description: 1-cell reinforced concrete box culvert (LRFR example)

Default units: US Customary

Top slab exterior surface exposure factor:

Bot slab exterior surface exposure factor:

Wall exterior surface exposure factor:

Interior surface exposure factor:

Culvert type: RC Box

Construction Type

Cast-in-place

Precast

Default rating method: LRFR

Soil

Installation method: Embankment

Side Fill Condition

Compact Uncompact

Soil-structure interaction factor (LRFD):

Soil-structure interaction factor (LFD):

LRFD EH Load Factor

At-rest Active

LRFD/LRFR Earth Pressure Coefficient

At-rest

Active

Passive

OK Apply Cancel

Expand the tree for Culvert Alt 1.

Double-click on RC Box Culvert Geometry in the tree. Enter the data as shown below. Click Ok to save the data to memory and close the window.

RC Box Culvert Geometry

Number of cells: 1

Cell height: 13.000 ft

Cell	Width (ft)
1	20.000

Bottom slab present

Horiz. construction joint height: 0.00 in

Haunches

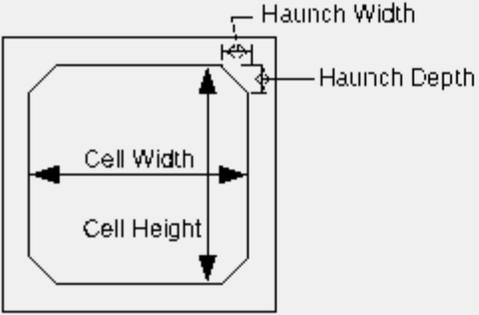
Top haunch width: 3.00 in

Top haunch depth: 3.00 in

Bottom haunch width: in

Bottom haunch depth: in

OK Apply Cancel



Double-click on the Bar Mark Definitions folder in the tree to create a new bar mark definition for Culvert Alt 1.

Enter the data for C1 as shown below. Click Ok to save the data to memory and close the window. Repeat the process for all bars (W1, W2, T1, T2) as shown.

The screenshot shows the 'Bar Mark Definition' dialog box for bar C1. The 'Name' field contains 'C1'. Under 'Bar Types', there are two entries: 'A' with a horizontal line and 'Type: Straight', and 'B' with a horizontal line and arrows at both ends and 'Type: Hook'. On the right, 'Material' is 'Grade 60', 'Bar size' is '8', and 'Bar type' is 'Corner'. Under 'Dimension', 'A' is '6.583 ft' and 'B' is '13.833 ft'.

The screenshot shows the 'Bar Mark Definition' dialog box for bar W1. The 'Name' field contains 'W1'. Under 'Bar Types', there is one entry: 'A' with a horizontal line and 'Type: Straight'. On the right, 'Material' is 'Grade 60', 'Bar size' is '8', and 'Bar type' is 'Straight'. Under 'Dimension', 'A' is '13.333 ft'.

The screenshot shows the 'Bar Mark Definition' dialog box for bar W2. The 'Name' field contains 'W2'. Under 'Bar Types', there is one entry: 'A' with a horizontal line and 'Type: Straight'. On the right, 'Material' is 'Grade 60', 'Bar size' is '5', and 'Bar type' is 'Straight'. Under 'Dimension', 'A' is '13.333 ft'.

Bar Mark Definition

Name: T1

Bar Types:

A

Type: Straight

Material: Grade 60

Bar size: 5

Bar type: Straight

Dimension

A = 22.166 ft

Bar Mark Definition

Name: T2

Bar Types:

A

Type: Straight

Material: Grade 60

Bar size: 7

Bar type: Straight

Dimension

A = 22.166 ft

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:

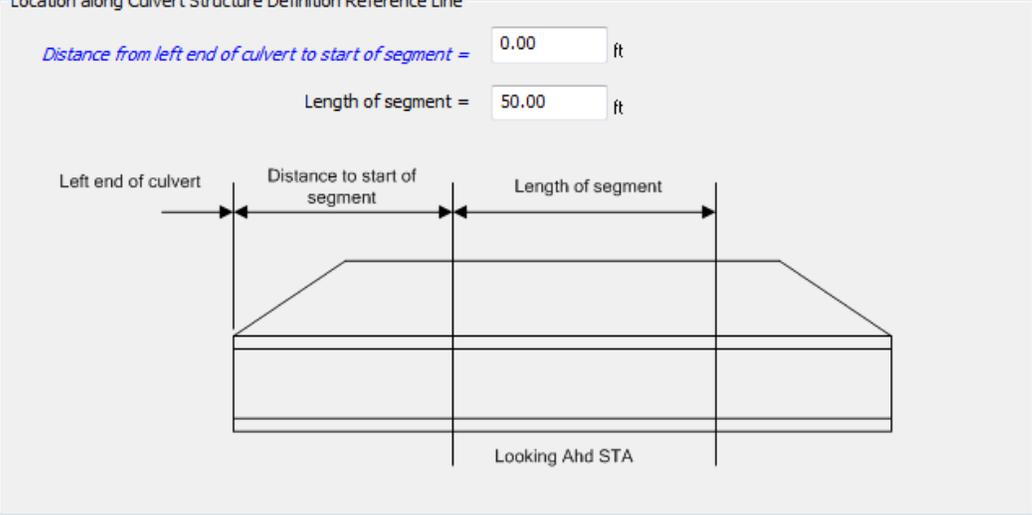
Description:

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

Expand the tree for Culvert Seg 1. Double-click on RC Box Culvert Thickness in the tree. Enter the slab and wall thicknesses as shown below. Click OK to save the data to memory and close the window.

The dialog box titled "RC Box Culvert Thickness" contains two data entry tables. The first table, "Top Slab Thickness (in)", has the following data:

Cell	Top Slab Thickness (in)
1	15.00

The second table, "Wall Thickness (in)", has the following data:

Wall	Thickness (in)
1	15.00
2	15.00

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

Double-click on RC Box Culvert Loads in the tree. Enter the culvert loads for Culvert Seg 1 as shown below. The wearing surface thickness includes the equivalent for the rail dead load. Click OK to save the data to memory and close the window.

RC Box Culvert Loads

Depth of fill at start edge = 6.00 ft

Depth of fill at end edge = 6.00 ft

Wearing surface unit load = 144.00 pcf

Copy from Library...

Wearing Surface thickness = 7.75 in

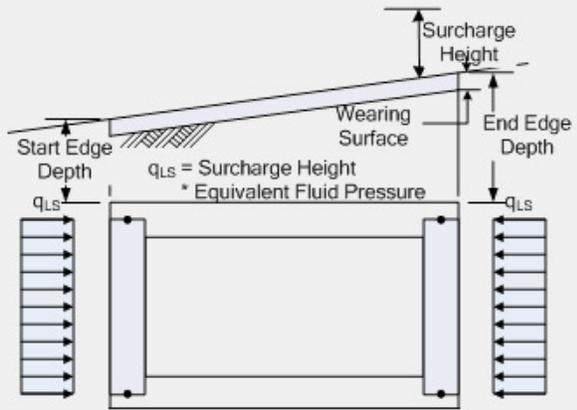
LRFD live load surcharge height = ft

LFD live load surcharge height = 2.00 ft

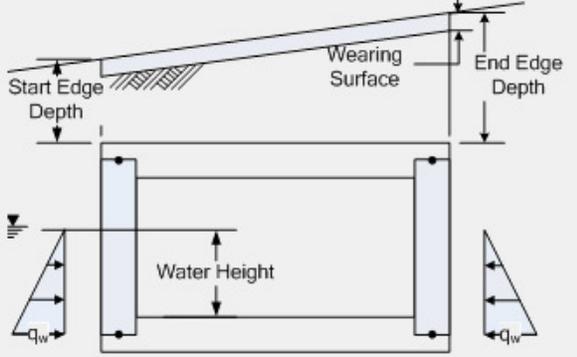
Water height = ft

LRFD live load distribution factor = 1.150

LFD live load distribution factor =



$q_{Ls} = \text{Surcharge Height} \times \text{Equivalent Fluid Pressure}$



$q_w = (\text{Water Height} + \frac{1}{2} \text{ Bottom Slab Thickness}) \times \text{Unit Weight of Water}$

Sta Ahead →

OK Apply Cancel

Double-click on RC Box Culvert Reinforcement in the tree. Enter the reinforcement data as shown below for each location. Click Ok to save the data to memory and close the window.

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)	Measured From	Wall Number	Centered	Start Distance (ft)	Straight Length (ft)	Fully Developed Start	Fully Developed End
1	T1	2.00	12.00	CL Culvert		<input checked="" type="checkbox"/>	11.08	22.17	<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)	Measured From	Cell / Wall Number	Centered	Start Distance (ft)	Straight Length (ft)	Fully Developed Start	Fully Developed End
1	T2	1.00	6.00	CL Culvert		<input checked="" type="checkbox"/>	11.08	22.17	<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	Wall Clear Cover (in)	Slab Clear Cover (in)	Bar Spacing (in)	Location	Wall Number	Fully Developed Vert	Fully Developed Horz
1	C1	2.00	2.00	6.00	Top Right	1	<input type="checkbox"/>	<input type="checkbox"/>
2	C1	2.00	2.00	6.00	Top Left	2	<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

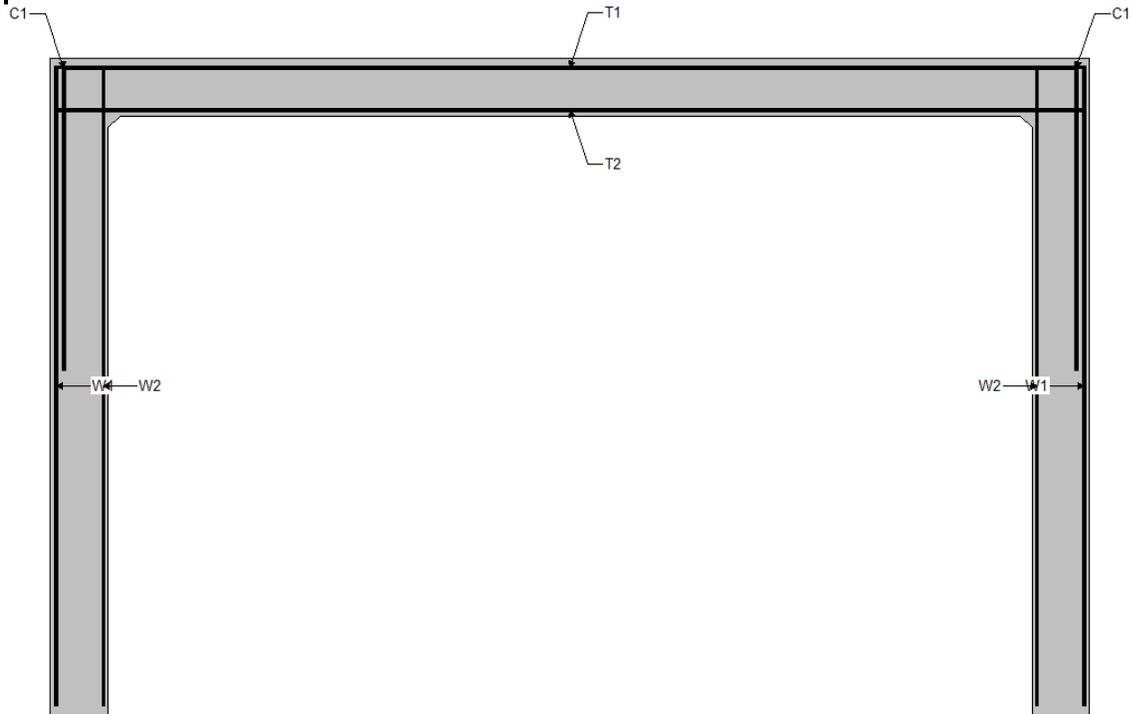
Set	Bar Mark	Clear Cover (in)	Bar Spacing (in)	Location	Wall Number	Measured From	Centered	Start Distance (ft)	Straight Length (ft)	Fully Developed Start	Fully Developed End
1	W1	13.00	6.00	Right	1	CL Culvert	<input type="checkbox"/>	6.25	13.83	<input type="checkbox"/>	<input type="checkbox"/>
2	W1	13.00	6.00	Left	2	CL Culvert	<input type="checkbox"/>	6.25	13.83	<input type="checkbox"/>	<input type="checkbox"/>
3	W2	1.00	12.00	Right	1	CL Culvert	<input type="checkbox"/>	6.25	13.83	<input type="checkbox"/>	<input type="checkbox"/>
4	W2	1.00	12.00	Left	2	CL Culvert	<input type="checkbox"/>	6.25	13.83	<input type="checkbox"/>	<input type="checkbox"/>

New Duplicate Delete

Reinforcement Wizard...

OK Apply Cancel

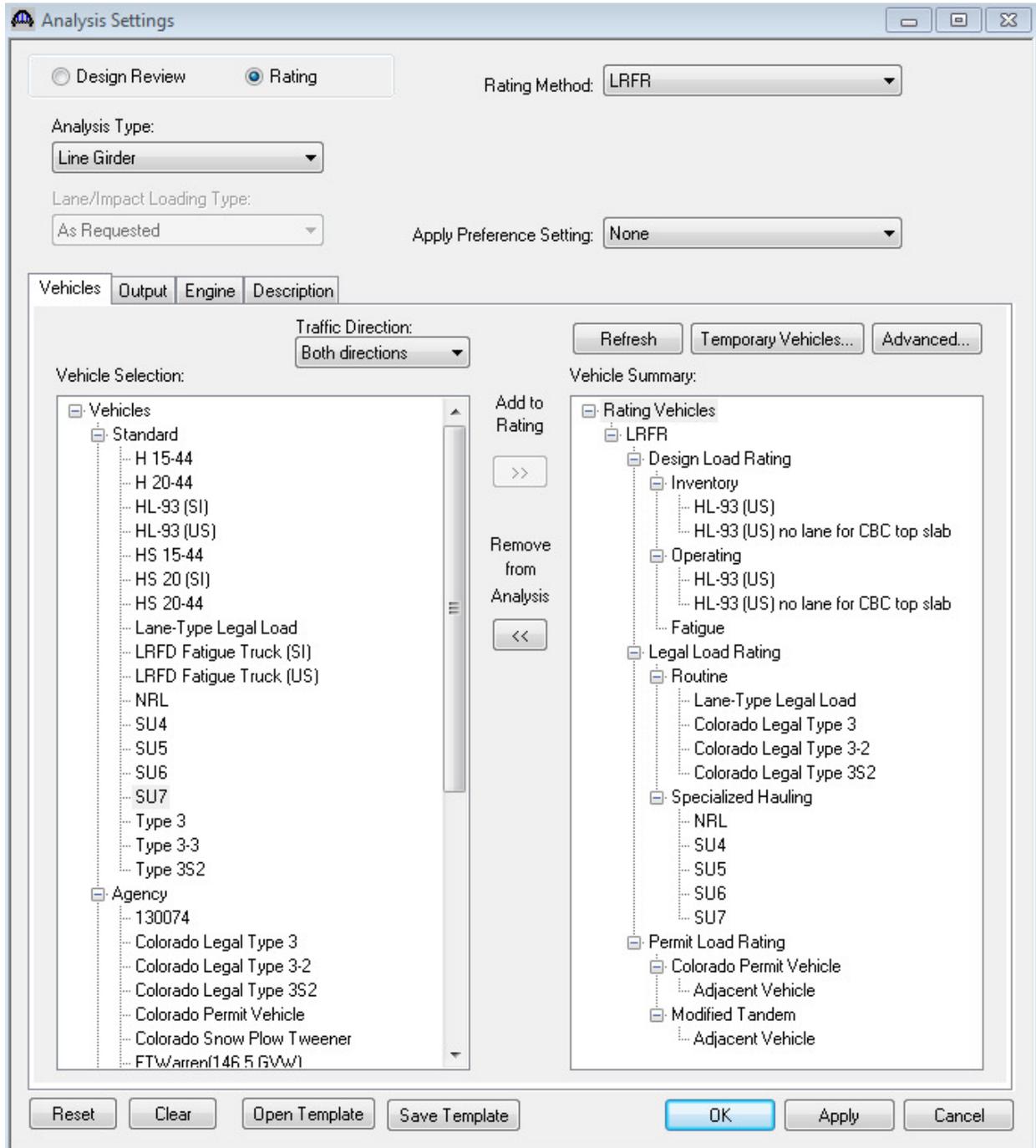
Select Bridge|Schematic to review the reinforcement data.



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

Select File|Save to save the file in BrR.

To perform LRFR Design Load Rating, open the Analysis setting window by selecting Bridge | Analysis Settings. Select LRFR as the Rating Method and specify the vehicles.



Click Ok to save the analysis settings to memory and close the window.

Select Culvert Seg 1 in the tree. Select Bridge | Analyze to start the rating process. Click Ok to close the Analysis Progress window after the analysis is completed.

Select Bridge|Tabular Report to open the Analysis Results window.

Analysis Results - Culvert Seg 1

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	119.13	3.309	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
HL-93 (US)	Axle Load	LRFR	Operating	154.43	4.290	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
HL-93 (US)	Tandem	LRFR	Inventory	62.94	2.517	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
HL-93 (US)	Tandem	LRFR	Operating	81.58	3.263	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
Lane-Type Legal Load	Axle Load	LRFR	Legal	188.81	6.294	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
NRL	Axle Load	LRFR	Legal	164.91	4.123	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
SU4	Axle Load	LRFR	Legal	101.62	3.764	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
SU5	Axle Load	LRFR	Legal	117.95	3.805	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
SU6	Axle Load	LRFR	Legal	136.71	3.934	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
SU7	Axle Load	LRFR	Legal	156.55	4.040	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
Colorado Legal Type 3	Axle Load	LRFR	Legal	89.21	3.304	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
Colorado Legal Type 3-2	Axle Load	LRFR	Legal	140.42	3.304	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
Colorado Legal Type 3S2	Axle Load	LRFR	Legal	140.38	3.303	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
Colorado Permit Vehicle	Axle Load	LRFR	Permit	333.63	3.475	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested
Modified Tandem	Axle Load	LRFR	Permit	188.68	3.774	Top Slab 1	10.00	50.000	Flexure	As Requested	As Requested

AASHTO Culvert LRFR Engine Version 6.7.0.3001
 Analysis Preference Setting: None

Close

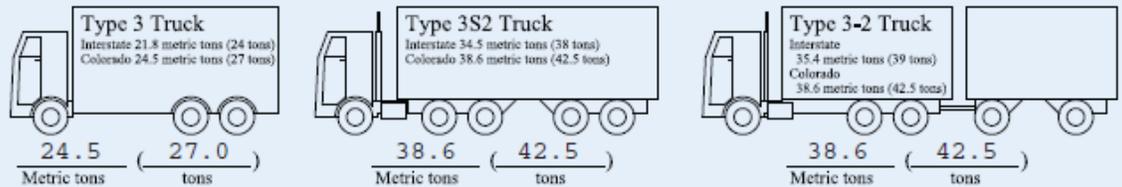
Fill out the Rating Summary Sheet using the policies and guidelines in the Bridge Rating Manual, Section 1.

COLORADO DEPARTMENT OF TRANSPORTATION LOAD & RESISTANCE FACTOR RATING SUMMARY Rated using: Asphalt thickness: <u>1,829</u> mm (<u>.72</u> in.) <input checked="" type="checkbox"/> Colorado legal loads <input type="checkbox"/> Interstate legal loads	Structure #	X-02-X
	State Highway #	US X
	Batch I.D.	XXXX
	Structure Type	CBC
	Parallel Structure #	NA

Structural Member	Single Cell CBC			
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Rating Factor				
Inventory	2.5			
Operating	3.3			

Metric tons (Tons)				
Type 3 truck	80.9 (89.2)	()	()	()
Type 3S2 truck	127.3 (140.4)	()	()	()
Type 3-2 truck	127.4 (140.4)	()	()	()
Type SU4 truck (27T)	()	()	()	()
Type SU5 truck (31T)	()	()	()	()
Type SU6 truck (35T)	()	()	()	()
Type SU7 truck (39T)	()	()	()	()
NRL (40T)	149.6 (164.9)	()	()	()
Lane-Type Legal	171.3 (188.8)	()	()	()
Permit Truck Multi-Lane D.F.	302.6 (333.6)	()	()	()



Comments: (T = tons)
 Modified Tandem 171.2 (188.7)

Total structure length (face to face of end walls) = 50'-0"; Fill height 6'-0"; Asphalt 4 in
 NBI item 62 condition state level = 8; Plans available = Yes
 Load induced damage present = No; Pending essential repairs = No
 Damage that has a direct effect on load rating = No
 Color Code: White
 Rated with BrR 6.7 AASHTO Culvert Engine

Rated by:	Date:	Checked by:	Date:
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