Continuous Span Reinforced Concrete Tee Beam Bridge
As-Built Model Only

December, 2011
Virtis V6.2

DETAILED EXAMPLE

CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT

AS-BUILT MODEL ONLY

<table>
<thead>
<tr>
<th>Cover Sheet</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>1</td>
</tr>
<tr>
<td>Bridge Information</td>
<td>2</td>
</tr>
<tr>
<td>Material Properties Input</td>
<td>3-8</td>
</tr>
<tr>
<td>Define Appurtenances</td>
<td>9-11</td>
</tr>
<tr>
<td>Selecting Impact Dynamic Load Allowances/ Factors</td>
<td>12</td>
</tr>
<tr>
<td>Superstructure Definitions: AS-BUILT</td>
<td>13-15</td>
</tr>
<tr>
<td>Selecting Impact Dynamic Load Allowances</td>
<td>16-69</td>
</tr>
<tr>
<td>Load Cases</td>
<td>19</td>
</tr>
<tr>
<td>Framing Plan Detail and Structure Typical Section</td>
<td>20-21</td>
</tr>
<tr>
<td>Superstructure Loads</td>
<td>22-30</td>
</tr>
<tr>
<td>Vertical Shear Reinforcement and Bar Mark Definitions</td>
<td>23</td>
</tr>
<tr>
<td>Member: G1</td>
<td>31</td>
</tr>
<tr>
<td>Applying Dead Loads</td>
<td>36-51</td>
</tr>
<tr>
<td>Defining Supports</td>
<td>37-38</td>
</tr>
<tr>
<td>Creating A Member Alternative: G1</td>
<td>39</td>
</tr>
<tr>
<td>Defining Live Load Distribution Factors</td>
<td>40-42</td>
</tr>
<tr>
<td>Defining The Girder Profile</td>
<td>43</td>
</tr>
<tr>
<td>Defining Shear Reinforcement Ranges</td>
<td>44-49</td>
</tr>
<tr>
<td>Member: G2</td>
<td>50-51</td>
</tr>
<tr>
<td>Defining Supports</td>
<td>52</td>
</tr>
<tr>
<td>Creating A Member Alternative: G2</td>
<td>53-54</td>
</tr>
<tr>
<td>Defining Live Load Distribution Factors</td>
<td>55</td>
</tr>
<tr>
<td>Defining The Girder Profile</td>
<td>56-59</td>
</tr>
<tr>
<td>Defining Shear Reinforcement Ranges</td>
<td>60-61</td>
</tr>
<tr>
<td>Linking Members</td>
<td>62-63</td>
</tr>
<tr>
<td>Defining Live Load Distribution Factors</td>
<td>64-69</td>
</tr>
<tr>
<td>Creating A Bridge Alternative</td>
<td>70-73</td>
</tr>
<tr>
<td>Rating the Bridge and Reviewing the Output</td>
<td>74-89</td>
</tr>
<tr>
<td>Completing VDOT LRFR Rating Form</td>
<td>90-118</td>
</tr>
<tr>
<td>Appendix A: Design Plans</td>
<td>119-124</td>
</tr>
<tr>
<td>Appendix B: Barrier Weight Calculation</td>
<td>125-127</td>
</tr>
<tr>
<td>Appendix C: LFD Effective Flange Width</td>
<td>128-129</td>
</tr>
<tr>
<td>Appendix D: VDOT LRFR Rating Form</td>
<td>130-132</td>
</tr>
</tbody>
</table>
CREATE A NEW BRIDGE

To create a new bridge right click on the folder where you want to save the bridge and choose New → New Bridge.

A new window will appear. Fill in the fields as appropriate under the Description tab:

**Note:** The description box is a good place to show the plan number used to analyze the structure.

**Template:** Template bridges serve as templates to help develop other bridges.

**Bridge Completely Defined:** Check the box if the specified bridge is completely defined within the Virtis/Opis database. Do not check this box if some of the structures making up the bridge are not in the database.

**BridgeWare Association Button:** Opens the BridgeWare Association window allowing you to specify this current bridge as a Virtis, Opis or Virtis/Opis bridge and also to link this current bridge to a bridge in the Pontis database if Pontis is installed.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Description (cont’d) tab:
Fill in fields as appropriate.

No input required for the Alternatives and Global Reference Point tabs.

Traffic tab:
To find the traffic data follow the link below:
Left click the most current year.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Left click Jurisdiction Publications.

Right click the excel icon for the appropriate jurisdiction.

Left click Save Target As... and save the file to a desired folder on user's computer.

Open the excel file and the user can locate the proper traffic data for the structure.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Truck PCT: The percentage of trucks in the average daily traffic.

ADT: Average Daily Traffic

Directional PCT: Percentage used to compute traffic in one direction

Recent ADTT: Virtis computes this value based on above inputs

Left click **OK** to accept and close.

For all Windows:

**OK button**: Saves the bridge description in this window and its tabs to memory and closes the window.

**Apply button**: Saves the bridge description in this window and its tabs to memory and keeps the window open.

**Cancel button**: Closes the window without saving the bridge description in this window and its tabs to memory.
NOTE:

1. It is strongly recommended that the user save the bridge data at this time. In addition, the user should routinely save the bridge data during the input process.

Left click the Save icon and the Bridge Validation window will appear. Left click Continue Saving to finish the save process.

2. The user can view the Virtis/Opis - Help window for any of the input windows shown in the example by pressing F1 on the keyboard when a window is open.
SELECT MATERIAL PROPERTIES

Expand the Materials folder.

Double click Concrete to open the Bridge Materials – Concrete Window.

Copy from Library Button:
Opens the Library - Materials – Concrete window, allowing you to copy a set of concrete material properties from the library to this window.

Left click the appropriate concrete properties and left click the OK to accept.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Left click **OK** to accept and close.

Repeat the process for **Reinforcing Steel**.

Double click **Reinforcing Steel** to open the **Bridge Materials – Reinforcing Steel** Window.

**Copy from Library Button:**
Opens the Library - Materials – Reinforcing Steel window, allowing you to copy a set of steel reinforcing steel material properties from the library to this window.
Left click the appropriate reinforcing steel properties and left click the **OK** Button to accept.

Type: User can select whether the reinforcing steel is **Plain**, **Epoxy**, **Galvanized**, or **Other**. For this example, select **Plain**.

Left click **OK** to accept and close.
DEFINE APPURTENANCES

The user can define parapets, medians, railing, and generic appurtenances. For parapets and medians, the user enters dimensions and a unit weight and Virtis computes the distributed load in kip/ft.

For the railing and generic definitions, the user must manually calculate a distributed load.

Expand the Appurtenances folder.

Since the barrier is not a standard parapet shape, it must be defined as a generic barrier.

Double click Generic to open the Bridge Appurtenances – Generic window.

Input the following fields:

Name: Concrete Railing and Posts

Description: Concrete Railing and Posts

Distance from edge to centroid: This field can be left blank.

Effective wind height: Enter the overall height of the barrier from the top of the deck to the top of the barrier. For this example, enter 42.00 in.

Width: Enter the overall width of the barrier from the edge of deck to the inside face of the barrier (4 ft + 8 ft + 0.6667 ft + 1.125 ft – 13 ft = 0.7917 ft = 9.50 in).

Barrier Load: User must calculate the barrier load. See Appendix B for the calculation.

Click OK to accept and close.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

SELECT IMPACT / DYNAMIC LOAD ALLOWANCES

Double click Impact / Dynamic Load Allowance to open.

15.0% and 33.0% are AASHTO LRFD defaults.

Left click the OK button to accept and close.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

SELECT FACTORS

Expand the Factors folder.

Double click LRFR to open.

Left click the Copy from Library... button to open the library data for LRFR factors.

Select the appropriate factors and left click the OK button to accept.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Left click the OK button to accept and close.
CREATE SUPERSTRUCTURE DEFINITIONS

Double click **SUPERSTRUCTURE DEFINITIONS** to open.

Select Girder System Superstructure and left click the OK button to accept and close.
Fill out the following fields:

**Name:** AS-BUILT

**Description:** No information required, but user can input additional information or assumptions if desired.

**Deck Type:** Concrete

**Number of Spans:** 3

**Number of Girders:** Enter the number of beams in the bridge cross section. For this example, enter 4 beams.

**Span Length (ft):** Enter the CL BRG to CL pier length for exterior spans and CL pier to CL pier lengths for interior spans. For this example, enter **50.00** ft for spans 1 and 3 and **69.00** for span 2.

**Member Alt. Types:** Select R/C since a reinforced concrete tee beam is rated.
Factor Override: None selected. Factor Override allows you to override the System Defaults library factors with a set of factors that have been entered for this bridge only. Factor overrides will remain when files are imported into future versions of Virtis. Unless factors specific to the bridge are required, overrides are not recommended as they can prevent updates to System Defaults in future versions (e.g., legal load SHV factors in the MBE).

Consider structural slab thickness for rating: Check this box if the structural slab thickness should be used to compute section properties for rating. If this box is not checked, the rating will use section properties computed from the total deck thickness.

Consider structural slab thickness for design: Check this box if the structural slab thickness should be used to compute section properties for design. If this box is not checked, the design will use section properties computed from the total deck thickness.

Consider wearing surface for rating: Check this box if the wearing surface should be included in the dead load for rating. If this box is not checked, the rating will ignore any wearing surface input.

Consider wearing surface for design: Check this box if the wearing surface should be included in the dead load for design. If this box is not checked, the design will ignore any wearing surface input.

No input required for the Engine tab.

Left click OK to accept and close.
SELECT IMPACT / DYNAMIC LOAD ALLOWANCES

Double click **Impact / Dynamic Load Allowance** to open.

15.0% and 33.0% are AASHTO LRFD defaults.

Left click the **OK** button to accept and close.
DEFINE LOAD CASES

Double click **Load Case Description** to open the Load Case Description window.

Left click **Add Default Load Case Descriptions** to apply default load cases. The default load cases include dead load (DC1) acting on non-composite section, dead load (DC2) acting on long term composite section, dead load (DW) acting on long term composite section and stay-in-place forms acting on non-composite section. These default load cases can be edited and modified as desired.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Left click the **OK** button to accept and close.
DEFINE FRAMING PLAN DETAIL

Double click **Framing Plan Detail** to open the framing plan detail window.

**Layout Tab:**

Fill out the following fields:

**Skew (Degrees):** Enter the AASHTO skew angle for the bridge per the design plans (See Appendix A). For this example, enter **0.000°** at all supports.

**Note:** Enter clockwise rotation as a positive value.

**Girder Spacing Orientation:** If the girder spacings are constant along the length of the bridge, the user should select **Perpendicular to Girder** (as done in this example). If the girder spacings vary, **Along Support** may be selected.

**Girder Spacing (ft), Start of Girder:** Enter the girder spacing from CL of beam to CL of beam. Enter **8.00 ft** for all bays for this example.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Left click the Diaphragms tab and left click the New button.

Girder Bay:
Select Bay 1

Support Number: For the selected girder bay, select the number of the support from which the range will be dimensioned.

Start Distance (ft): For the selected girder bay, enter the distance along the centerline of girder from the selected support to the left end of the range. For each row, a diaphragm is not placed at the start distance. A diaphragm is placed at each space within the range, including the end distance.

Left Girder: Enter the start distance for the left girder in the selected girder bay (looking ahead station) for the diaphragm definition.

Right Girder: Enter the start distance for the right girder in the selected girder bay (looking ahead station) for the diaphragm definition.

Diaphragm Spacing (ft): For the selected girder bay, enter the spacing between adjacent diaphragms within the given diaphragm group. Diaphragm spacings must be equal within a given group.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

For skewed structures, the location along the left girder will not be the same as the right girder unless the diaphragms are laid out parallel to the skew.

**Number of Spaces:** For the selected girder bay and diaphragm group, enter the number of spaces, beginning at the left diaphragm of the group, that are of equal spacing and that define a diaphragm location.

If the diaphragm spacing for the left girder is different than the diaphragm spacing for the right girder, enter 1 for the number of spaces and enter each diaphragm location individually in separate rows.

**Load (kip):** Enter the load of an individual diaphragm, which will be distributed to each beam equally by the program. See calculation below.

**Concrete Diaphragm Weight Calculation**

<table>
<thead>
<tr>
<th>Diaphragms at Abutments</th>
<th>Diaphragms at Piers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>Length</td>
</tr>
<tr>
<td></td>
<td>80.000 in</td>
</tr>
<tr>
<td>Width</td>
<td>Width</td>
</tr>
<tr>
<td></td>
<td>12.000 in</td>
</tr>
<tr>
<td>Depth</td>
<td>Depth</td>
</tr>
<tr>
<td></td>
<td>70.500 in</td>
</tr>
<tr>
<td>Cubic Feet</td>
<td>Cubic Feet</td>
</tr>
<tr>
<td></td>
<td>39.167</td>
</tr>
<tr>
<td>Wt/cf</td>
<td>Wt/cf</td>
</tr>
<tr>
<td></td>
<td>0.150 kcf</td>
</tr>
</tbody>
</table>

**Weight/diaph** 5.875 k  

**Weight/diaph** 3.875 k

For this example, enter the four lines of ranges shown on the previous sheet that define the diaphragm locations at all supports.

Left click **Apply** on the **Structure Framing Plan Details** window.

If the diaphragm locations and loads are identical for other bays, the user can use the **Copy Bay to…** function.

For this example, left click the **Copy Bay to…** button and the **Copy Diaphragm Bay** window will open. Select bay 2 and left click **Apply**. Then, left click **Apply** on the **Structure Framing Plan Details** window.

Repeat this process for bay 3.

Left click **OK** on the **Structure Framing Plan Details** window to accept and close.
The user can compare the entered data to the design plans by right clicking **Framing Plan Detail** and selecting **Schematic**.

A schematic of the framing plan will appear that can be compared to the framing plan in the design plans.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

DEFINE STRUCTURE TYPICAL SECTION

Double click Structure Typical Section to open the Structure Typical Section window.

Deck Tab:

Superstructure definition reference line is: User can select either within, to the left of, or to the right of the bridge deck. For this example, select within since the reference line will be placed at the CL of the deck.

Distance from left edge of deck to superstructure definition reference line: To define the reference line at the bridge CL divide the deck out-to-out width by two. For this example, enter 13.7917 ft (27.5833 ft / 2).

Distance from left edge of deck to superstructure definition reference line: 13.7917 ft.

Note: Since the bridge deck width does not vary along the length of the bridge, the distance at the start and end will be equal.
**CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2**

**Left Overhang:** Distance from the CL of exterior beam to the edge of deck. For this example, enter 1.7917 ft.

**Computed Right Overhang:** This value is computed by Virtis and can be used to verify the input above.

![Structure Typical Section Diagram](image)

**Deck (Cont’d) Tab:**

**Deck Concrete:** Select the appropriate concrete definition.

**Total Deck Thickness:** 7.5 in.

**Deck Crack Control Parameter:** Enter 130.00 kip/in since the top of the deck slab is directly exposed to environmental elements. For surfaces not directly exposed to the environment, such as the bottom of the deck, 170.00 kip/in is to be used.

**Sustained Modular Ratio Factor:** 2.00 for concrete members.

**Deck Exposure Factor:** Use 1.000 for a Class 1 exposure condition.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Generic Tab:

Since there is a barrier on both sides of the bridge, 2 barriers need to be entered.

Select **New** to enter a line. Duplicate to copy a line down.

**Name:** Select **Concrete Railing and Posts** from the drop down menu.

Load Case: DC2

**Measure To:** Back

**Edge of Deck Dist. Measured from:** Select the edge of the deck from which the distance is measured as either left or right, as shown in the sketch for the Deck tab. For this example, select **Left Edge** for the 1st input line and **Right Edge** for the 2nd input line.

**Distance at Start:** Since the back of the parapet is flush with the edge of deck, enter **0.00 ft** for both parapets.

**Distance at End:** Since the back of the parapet is flush with the edge of deck, enter **0.00 ft** for both parapets.

**Front Face Orientation:** Select the front face orientation as either left or right, as shown in the sketch. For this example, select **Right** for the 1st input line and **Left** for the 2nd input line.

Parapet, Median, Railing, Sidewalk, and Wearing Surface Tabs: No input for this example.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Lane Position Tab:

Left click the Compute... button.

The Compute Lane Positions window will appear displaying the values computed by Virtis.

Left click Apply to accept.

Left click OK to accept and close.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Note: A schematic of the typical section can be viewed similar to the framing plan by right clicking the Structure Typical Section and selecting Schematic.

08108
08108 - AS-BUILT
John Marshall Hwy / Cedar Creek
DEFINE SUPERSTRUCTURE LOADS

Define Superstructure Loads

Double click Superstructure Loads to open the Superstructure Loads window.

Uniform Temperature, Gradient Temperature, and Wind Tabs: No input required.

DL Distribution Tab:

Stage 1 Dead Load Distribution: Select By tributary areas to distribute DC1 loads based on girder spacing.

Stage 2 Dead Load Distribution: Select Uniformly to all girders to distribute the DC2 loads evenly to all girders. With 4 girders lines in this example, each girder will carry one-fourth of each barrier and is consistent with VDOT practice.

Left click OK to accept and close.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

SPECIFY VERTICAL SHEAR REINFORCEMENT DEFINITIONS

Left click **Shear Reinforcement Definitions** to expand the folder and double click **Vertical**.

Fill out the fields as appropriate based on the information in the plans (See Appendix A for the design plans).

**Name:** S

**Material:** Select the appropriate material from the drop down menu.

**Bar Size:** 9

**Number of Legs:** 0.50, since 0.5” square bar was used. (2 legs * 0.25 in² = 0.50 in². Compare with using No. 9 bar. 0.50 legs * 1.00 in² = 0.50 in²).

**Inclination (alpha):** 90.0°

Left click **OK** to accept and close.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

SPECIFY BAR MARK DEFINITIONS

Double click **Bar Mark Definitions**.

Fill out the fields as appropriate based on the information in the plans (See Appendix A for the design plans).

**Name:** B

**Material:** Select the appropriate material from the drop down menu.

**Bar Size:** 9

**Bar Type:** Select the **Straight** bar type even if the bar has hooks at the end or is a bent bar. The user will be able to define the bar as fully developed later to model hooks at the start and end of the bar.

**“A” Dimension:** Use the CL-to-CL of bearing dimension for the bridge if the bar is effective for the full span length. For a bent bar, enter the middle straight length. Enter **19.00 ft**.

Left click **OK** to accept and close.
Since the bridge has continuous spans, longitudinal reinforcement is required in the bottom and top of the beam which results in a number of unique bar mark definitions. See the summary table for a complete list of bar mark definitions and their input.

### Bar Mark Definition Summary

<table>
<thead>
<tr>
<th>Name</th>
<th>Bar Size</th>
<th>A Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>9</td>
<td>19.0000</td>
</tr>
<tr>
<td>B1</td>
<td>9</td>
<td>25.0000</td>
</tr>
<tr>
<td>B2</td>
<td>9</td>
<td>31.0000</td>
</tr>
<tr>
<td>B3</td>
<td>9</td>
<td>37.0000</td>
</tr>
<tr>
<td>B4</td>
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<tr>
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</tr>
<tr>
<td>L5</td>
<td>4</td>
<td>25.0000</td>
</tr>
</tbody>
</table>

Note: For 1" square bars, No. 9 bars were used. Likewise, No. 10 bars were used for 1 1/8" square bars.

Enter each definition found in the Bar Mark Definition Summary above. Double click on the Bar Mark Definitions folder each time a new definition is started and click OK to accept and close once the input is complete for each.
When all the bar mark definitions have been entered, the file should have the following bars defined.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

CREATING A MEMBER: G1

Virtis will automatically generate the appropriate members based on the number of girders entered in the Superstructure Definition window.
APPLYING MEMBER LOADS

User defined dead loads can be applied to each member.

Expand member G1 and Double click Member Loads.

Uniform Tab:

Left click the dropdown menu and left click the desired dead load case. For this example, select DC1.
Left click the **New** button and enter the appropriate uniform load. For this example, enter 0.019 kip/ft to account for the architectural blister on the exterior beams. See the hand calculation below.

Left click **OK** to accept and close.

**DC1 LOAD FOR G1**

*To Account for Extra Concrete on Tee-Beam*

\[
\begin{align*}
\text{Height} & = 9.000 \text{ in} \\
\text{Width} & = 2.000 \text{ in} \\
\text{Area} & = 9.00 \text{ in} \times 2.00 \text{ in} / 12^2 = 0.125 \text{ ft}^2 \\
\text{Dist. DC1 Load} & = 0.125 \text{ ft}^2 \times 0.150 \text{ lb/ft}^2 = 0.019 \text{ kip/ft}
\end{align*}
\]

The uniform load for the architectural blister is not entered for G4 at this time because G4 will be linked to G1 later in this example.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

DEFINING SUPPORTS

Double click Supports.

General Tab:
Select a **Roller** support type for supports 1, 2, and 4 since they are expansion supports.

Select a **Pinned** support type for support 3 since it is a fixed support.

No input is required for the Elastic tab.

Left click **OK** to accept and close.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

CREATING A MEMBER ALTERNATIVE: G1

Double click **MEMBER ALTERNATIVES** to further define the member.

Select **Reinforced Concrete** from the left drop down menu.

Select **Reinforced Concrete Tee** from the right drop down menu.

Left Click **OK** to accept.
**CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2**

**Member Alternative:** G1

**Description Tab:**

**Girder Property Input**

**Method:** User can select either **Schedule Based** or **Cross-section Based**.

The Schedule Based method views the beam as an elevation with **Bar Mark Definitions**.

The cross section based method views the beam as a series of cross sections with particular dimensions and rebar counts. For this example, select **Schedule Based**.

**Additional Self Load:** User can apply an additional load to the specific beam as a defined distributed load or as a distributed load calculated based on a percentage of the self-load of the beam. These fields are often used for items such as bolts and splice plates. Leave these fields blank for this example.

**End Bearing Locations:** This input is not used for a reinforced concrete tee beam and should be left blank.

**Crack control parameter (Z):** 170.00 kip/in since the bottom of the deck slab is not directly exposed to the environment.

**Exposure Factor:** 1.000 for a Class 1 exposure condition.

**Default Rating Method:** LRFR

**Analysis Module:**

**ASD:** Not used for rating. Use default.

**LFD:** Virtis LFD

**LRFD:** Not used for rating. Use default.

**LRFR:** Virtis LRFR
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

No changes to the following tabs:

Factors
Engine
Import

Control Options Tab:

Select the options shown in the screen shot below.

Left click OK to accept and close.
DEFINE LIVE LOAD DISTRIBUTION FACTORS

Expand the MEMBER ALTERNATIVE for G1.

G1 LRFR live load distribution factors cannot be computed from the typical section until the entire cross-section is defined. Continue with the other input for G1.
DEFINE THE GIRDER PROFILE

Double click Girder Profile.

**Section Tab:**

**Tributary Width:**
The physical width of the deck between the girders which is the Overhang + 0.5 * Girder Spacing. For G1, 21.5 in + 96 in / 2 = 69.5 in.

**Total Deck Thickness:** 7.50 in.

**Web Thickness at Top Flange:** 16.00 in.

**Web Thickness at Bottom of Beam:** 16.00 in.

**Chamfer Dimension, A:** 7.5 in. (Average of vertical and horizontal chamfer dimensions).
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Top Flange:

**Material:** Select the appropriate material from the drop down menu.

**Modular Ratio:** 9.2 (See calculation below)

**Eff. Width (Std):** The effective flange width for LFD. For this example, enter 69.50 in. See Appendix C for sample calculation.

**Eff. Width (LRFD):** The effective flange width for LRFR. For this example, enter 69.50 in. This value will equal the tributary width per AASHTO 2007 with 2008 Interims, *LRFD Bridge Design Specifications*, 4th Edition, section 4.6.2.6.

**Struct. Thick.:** Typically, 0.50 in. is removed from the actual thickness of the top flange. Therefore, enter 7.00 in. for this example.

**Other Parts:** (Other than the top flange)

**Material:** Select the appropriate material from the drop down menu.

**Modular Ratio:** 9.2 (See calculation below)

---

**Modular Ratio Calculation**

*Note: References from AASHTO LRFD Bridge Design Specifications, 2007 with 2008 Interims.*

Unit Weight of Concrete, \( w_c = 0.145 \text{ kip/ft}^3 \)

Compressive Strength of Concrete, \( f'_c = 3.00 \text{ ksi} \)

Modulus of Elasticity of Reinf. Steel, \( E_s = 29000 \text{ ksi} \)

Modulus of Elasticity of Concrete, \( E_c = 33,000 \times w_c^{1.5} \times f_c^{0.5} \)  
Eq. 5.4.2.4-1

\[
E_c = 33,000 \times 0.145^{1.5} \times 3.00^{0.5} \\
E_c = 3155.92 \text{ ksi}
\]

Modular Ratio, \( n = \frac{E_s}{E_c} \)  
5.7.1

\[
n = \frac{29,000}{3,155.92} \\
n = 9.2
\]
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Web Tab:

Left click **New** to add rows. Enter rows as shown below.

![Girder Profile](image)

**Begin Depth**: The distance from the top of the deck slab to the bottom of the beam at the start of the range.

**Depth Vary**: User can select the Girder web depth to be constant, have a linear variation or a parabolic concave variation.

**End Depth**: Only available if **Linear** or **Parabolic Concave** is selected for **Depth Vary**. Otherwise, this value will equal the **Begin Depth**.

**Support Number**: Select the number of the support from which the range will be dimensioned.

**Start Distance**: The start distance for the web range.

**Length**: The length of the web range.

**End Distance**: The end distance for the web range. This value is calculated by Virtis.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Reinforcement Tab:

Left click New to define a reinforcement set.

Bar Mark: Select the appropriate bar mark from the drop down menu.

Invert: This option is used to change the orientation of a bent bar. However, since only straight bars are used, this box can be left unchecked.

Measured from: The user can select to measure either from the bottom or top of the girder to the reinforcement set CL.

Distance (in): Distance from either the top or bottom of the girder to the reinforcement set CL.

Std Number: The number of rebar used for LFD calculations. This input should match the number of bars shown on the design plan for the given cross-section or effective slab width.

LRFD Number: The number of rebar used for LRFR calculations. This input should match the number of bars shown on the design plan for the given cross-section or effective slab width.

Bar Spacing (in): Distance from CL of rebar to CL of rebar in the reinforcement set.

Side Cover (in): Distance from the CL of rebar to the side edge of the girder.

Support Number: Select the number of the support from which the range will be dimensioned.

Direction: Select whether the start distance is located to the left or right of the selected support number.

Start Distance (ft): Enter the distance from the left end of the range to the selected support.

Straight Length (ft): The value is entered by Virtis based on the bar mark definitions previously defined.

End Distance (ft): The value is calculated by Virtis.

Fully Developed: This field should be checked if the bar mark used has hooks or is a bent bar, and has been modeled as straight. Otherwise, it should be left unchecked.

Enter the fields as shown on the next page and left click OK.
### CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

![Girder Profile](image)

**Type:** Reinforced Concrete Tee

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<th>Invert</th>
<th>Measured Flood</th>
<th>Distance (m)</th>
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</table>

**Button Options:**
- **New**
- **Duplicate**
- **Delete**

**Buttons at the Bottom:**
- **OK**
- **Apply**
- **Cancel**
The user can compare the entered data to the design plans by right clicking **Girder Profile** and selecting **Schematic**.
DEFINE SHEAR REINFORCEMENT RANGES

Double click Shear Reinforcement Ranges.

Left click New to define a shear reinforcement set.

**Name:** Select the appropriate shear reinforcement definition from the drop down menu.

**Support Number:** Select the number of the support from which the range will be dimensioned.

**Start Distance (ft):** Enter the distance from the selected support to the left end of the range.

The selected shear reinforcement for this range is not located at the start distance. However, it is located at all other locations within the range, including the end distance.

For example, if the user defines a reinforcement range starting at 0.00 ft from support 1 with 3 spaces at 4 inches. The first vertical shear bar will be located at 0.33 ft from support 1, not at 0.00 ft.

**Number of Spaces:** Enter the number of spaces, beginning at the start distance, that are of equal spacing and that define the location of the selected shear reinforcement.

**Spacing (in):** Enter the spacing between adjacent shear reinforcement within the given range. Spacings must be equal within a given range.

**Length (ft):** This value is calculated by Virtis. It is the total length of the shear reinforcement range.

**End Distance (ft):** This value is calculated by Virtis. It is the end distance of the shear reinforcement range.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Enter the fields as shown and left click **OK** to accept and close.

***INPUT FOR MEMBER G1 IS COMPLETE. PROCEED TO G2***
MEMBER G2

Member loads are not required for G2.

DEFINING SUPPORTS

Double click Supports.

General Tab:

Select a Roller support type for supports 1, 2, and 4 since they are expansion supports.

Select a Pinned support type for support 3 since it is a fixed support.

No input is required for the Elastic tab.

Left click OK to accept and close.
CREATING A MEMBER ALTERNATIVE: G2

Right click MEMBER ALTERNATIVE G1 and select Copy.

Right click the MEMBER ALTERNATIVE folder for G2 and select Paste.
Double Click Copy of G1 (E) (C).

Change the Member Alternative name to G2.

No other changes are required.

Left click OK to accept and close.
Define live load distribution factors

Expand the MEMBER ALTERNATIVE for G2.

G2 LRFR live load distribution factors cannot be computed from the typical section until the entire cross-section is defined. Continue with the other input for G2.
DEFINITE THE GIRDER PROFILE

Double click Girder Profile to update the information currently in the following tabs.

Section Tab:

**Tributary Width:** The physical width of the deck between the girders. For this example, use the beam spacing of 96.00 in.

**Total Deck Thickness:** 7.50 in.

**Web Thickness at Top Flange:** 16.00 in.

**Web Thickness at Bottom of Beam:** 16.00 in.

**Chamfer Dimension, A:** 7.5 in. (Average of vertical and horizontal chamfer dimensions).
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Top Flange:

**Material:** Select the appropriate material from the drop down menu.

**Modular Ratio:** 9.2 (See calculation below)

**Eff. Width (Std):** The effective flange width for LFD. For this example, enter 96.00 in. See Appendix C for sample calculation.

**Eff. Width (LRFD):** The effective flange width for LRFR. For this example, enter 96.00 in. This value will equal the tributary width per AASHTO 2007 with 2008 Interims, *LRFD Bridge Design Specifications*, 4th Edition, section 4.6.2.6.

**Struct. Thick.:** Typically, 0.50 in. is removed from the actual thickness of the top flange. Therefore, enter 7.00 in. for this example.

**Other Parts:** (Other than the top flange)

**Material:** Select the appropriate material from the drop down menu.

**Modular Ratio:** 9.2 (See calculation below)

---

**Modular Ratio Calculation**

*Note: References from AASHTO LRFD Bridge Design Specifications, 2007 with 2008 int.*

\[
\begin{align*}
\text{Unit Weight of Concrete, } w_c &= 0.145 \text{ kip/ft}^3 \\
\text{Compressive Strength of Concrete, } f'_c &= 3.00 \text{ ksi} \\
\text{Modulus of Elasticity of Reinf. Steel, } E_s &= 29000 \text{ ksi} \\
\text{Modulus of Elasticity of Concrete, } E_c &= 33,000 \times w_c^{1.5} \times f'_c^{0.5} \\
&= 33,000 \times 0.145^{1.5} \times 3.00^{0.5} \\
&= 31559.92 \text{ ksi}
\end{align*}
\]

\[
\text{Modular Ratio, } n = \frac{E_s}{E_c} = \frac{29,000}{3,155.92} = 9.2
\]
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Web Tab:

Update the Begin and End Depths as shown.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Reinforcement Tab:

Update the reinforcement sets as shown below.

Left click OK to accept and close.
DEFINE SHEAR REINFORCEMENT RANGES

Double click Shear Reinforcement Ranges.
The shear reinforcement ranges for G2 are identical to G1. Therefore, left click **OK** to accept and close.
Once MEMBER G2 is complete, other MEMBERS can be linked with G1 and G2 since the beams are identical and the girder spacing and overhangs are equal.

**LINK MEMBERS**

When a bridge has members that are identical, the user can specify a link to members that have already been entered to save both input and analysis time. Once a member is linked to a previously defined member, no other input is required.

For the example, the interior beams are identical to each other and both exterior beams are identical to each other.

Double click member **G3**.

Select G2 from the **Link with**: drop down menu.

Left click **OK** to accept and close.

Use this process for member **G4**. Link **G4** with **G1**.

Click **Continue** each time the warning message appears.

**Note:** Engineering judgment should always be used to determine if linking girders is appropriate for a particular bridge.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

The screen shot to the left demonstrates how Virtis displays linked members.
DEFINE LIVE LOAD DISTRIBUTION FACTORS

Expand the MEMBER ALTERNATIVE for G1.

Double click Live Load Distribution.

Standard Tab:


Left click Compute from Typical Section.
LRFD Tab:
Left click Compute from Typical Section.

The LRFD Distribution Factor Progress window will appear.

Left click OK to close the LRFD Distribution Factor Progress window once the analysis is complete.
This will compute live load distribution factors for deflection, moment, and shear.

The screen shots for moment and shear are as follows:

Left click **OK** to accept and close.
Expand the MEMBER ALTERNATIVE for G2.

Double click Live Load Distribution.

Standard Tab:
Left click Compute from Typical Section.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

LRFD Tab:

Left click Compute from Typical Section.

The LRFD Distribution Factor Progress window will appear.

Left click OK to close the LRFD Distribution Factor Progress window once the analysis is complete.
This will compute live load distribution factors for deflection, moment, and shear.

The screen shots for moment and shear are as follows:

**Moment**

<table>
<thead>
<tr>
<th>Support Number</th>
<th>Start Distance (ft)</th>
<th>Length (ft)</th>
<th>End Distance (ft)</th>
<th>Distribution Factor (Lanes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td>30.96</td>
<td>30.96</td>
<td>0.543 0.730</td>
</tr>
<tr>
<td>1</td>
<td>30.96</td>
<td>38.18</td>
<td>69.14</td>
<td>0.602 0.822</td>
</tr>
<tr>
<td>2</td>
<td>19.14</td>
<td>30.72</td>
<td>49.86</td>
<td>0.465 0.642</td>
</tr>
<tr>
<td>2</td>
<td>49.86</td>
<td>38.18</td>
<td>88.04</td>
<td>0.602 0.822</td>
</tr>
<tr>
<td>3</td>
<td>19.04</td>
<td>30.96</td>
<td>50.00</td>
<td>0.543 0.730</td>
</tr>
</tbody>
</table>

**Shear**

<table>
<thead>
<tr>
<th>Support Number</th>
<th>Start Distance (ft)</th>
<th>Length (ft)</th>
<th>End Distance (ft)</th>
<th>Distribution Factor (Lanes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td>50.00</td>
<td>50.00</td>
<td>0.680 0.814</td>
</tr>
<tr>
<td>2</td>
<td>0.00</td>
<td>69.00</td>
<td>69.00</td>
<td>0.680 0.814</td>
</tr>
<tr>
<td>3</td>
<td>0.00</td>
<td>50.00</td>
<td>50.00</td>
<td>0.680 0.814</td>
</tr>
</tbody>
</table>

Left click **OK** to accept and close.
CREATE A BRIDGE ALTERNATIVE

A bridge can have several unique bridge alternatives. Each bridge alternative must include the entire bridge but can consist of a different layout of superstructures. The number of spans, the span lengths, and the pier locations are defined within the bridge alternative (and its accompanying windows). Entering different bridge alternatives can be useful when comparing various alternatives for a preliminary study.

BRIDGE ALTERNATIVES permit the user to determine which spans to include in an analysis. For a three span structure with identical exterior spans, the user can decide to only include AS-BUILT Spans 1 and 3 in the analysis and exclude AS-BUILT Span 2. The rating summary will then only have results from Spans 1 and 3 rather than comparing Spans 1 and 3 to Span 2. Typically however, every span entered will be included in a BRIDGE ALTERNATIVE.

Double click BRIDGE ALTERNATIVES.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Alternative Name: AS-BUILT

Left click OK to accept and close.

Expand BRIDGE ALTERNATIVES and AS-BUILT folders.

Double click SUPERSTRUCTURES.
Superstructure Name: AS-BUILT

Left click **OK** to accept and close.

Expand **SUPERSTRUCTURES** and **AS-BUILT** folders.

Double click **SUPERSTRUCTURE ALTERNATIVES**.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Alternative Name: AS-BUILT

Superstructure Definition:
Select AS-BUILT from the drop down menu.

Left click OK to accept and close.

***THE INPUT FOR THE BRIDGE IS NOW COMPLETE. MAKE SURE THE FILE IS SAVED PRIOR TO ANALYSIS.
The file is now ready to be analyzed. The user can either analyze individual members with the file open or analyze the entire bridge with the file closed.

To analyze a single member, highlight an individual member and left click the View Analysis Settings icon.

Either select Open Template from the database OR create a new template by following these instructions:

The Analysis Settings window will appear. On the Rating Method dropdown menu, change the method to LRFR.
Add the vehicles shown in the screen shot to the **Vehicle Summary** list.

This is done by first left clicking the destination such as Design Load Rating, Legal Load Rating, and Permit Load Rating in the right column. Then, left click the desired vehicle from the left column and left click the **Add to Rating >>** Button.

Once all vehicles for the LRFR Continuous Span (Run 1 of 2) template have been entered, this can be saved as a Template for future ratings.
Left click the Save Template button.

**Template Name**: Continuous Span (Run 1 of 2)

Left Click the **Save** button.

Left click **OK** on the **Analysis Settings** window to accept and close.

**NOTE**: TO REDUCE THE ANALYSIS TIME AND TO PREVENT ERROR GENERATION DURING THE ANALYSIS, THE LIVE LOAD ANALYSIS FOR CONTINUOUS SPANS IS DIVIDED INTO TWO SEPARATE RUNS.

**FOLLOW THE DIRECTIONS BELOW TO CREATE THE SECOND RUN.**
Add the vehicles shown in the screen shot to the **Vehicle Summary** list.

This is done by first left clicking the destination such as Design Load Rating, Legal Load Rating, and Permit Load Rating in the right column. Then, left click the desired vehicle from the left column and left click the **Add to Rating >>** Button.

Once all vehicles for the LRFR Continuous Span (Run 2 of 2) template have been entered, left click the **Advanced** button above the right column.
For the Lane-Type Legal Load, left click the Legal Pair box.

For the two Blanket Permit vehicles, change the Frequency to Unlimited Crossings.

Left click OK to accept and close.

Once complete, this can be saved as a Template for future ratings. Left click the Save Template button.

**Template Name:** Continuous Span (Run 2 of 2)

Left Click the Save button.

Left click OK on the Analysis Settings window to accept and close.
Once the Analysis Settings have been set, to analyze a specific member, right click the desired MEMBER ALTERNATIVE and select Analyze.

Note: Left click the View Analysis Settings icon and open the “Continuous Span (Run 1 of 2)” template prior to running the analysis.

Allow the program to analyze the beam.

After the analysis is completed, the user can read any warnings or errors by scrolling up the Analysis Progress window.

Click OK to proceed to view results.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

To view the results keep the analyzed MEMBER ALTERNATIVE selected.

Left click the View Analysis Report icon.

The Analysis Results window will appear. To view a more compact version of the results, select Single rating level per row under the Display Format Window drop down menu.
To analyze the entire file at once, first **Save** and then **Close** the bridge.

In the **Bridge Explorer** window, select the bridge, right click, and select **Rate**.
The Analysis Settings window will appear.

Left click the Open Template button or create the vehicle summary by following the steps previously explained.
Left click **Continuous Span (Run 1 of 2)** and left click the **Open** button.

Left click **OK** to accept the template and rate.

Allow the bridge to run. Once the analysis is completed, the user can read any warnings or errors by scrolling up on the **Analysis Progress** window.

Left click **OK** to view results.
The Bridge Rating Results window will appear. To view a more compact set of results, select Single Rating Level per Row.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

FINAL STRUCTURE RATINGS

Continuous Span (Run 1 of 2)

Continuous Span (Run 2 of 2)
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

REVIEWING SPECIFICATION CHECKS AND RATING FACTORS

To review the specification checks and to find the rating factors follow these steps:

Once the member of interest has been analyzed, highlight the Member Alternative. Left click the **View Spec Check** icon.

Expand the **Superstructure Component** folder. Expand the **Stage 3** folder. Expand the **G1** folder to display the points of analysis for each span.
For this example, the controlling member is G1. One of the controlling locations is in Span 3 at distance 24.00 ft. Scroll down to this location and left click on the associated folder.

Double click 6.4.2.1 Concrete Flexure General Rating Equation – Concrete Flexure from the “Specification Reference” column. A new window will appear for this specification check.

The information provided for this specification check looks to the adjacent section to the left and right at this specific location. The ratings for each load and vehicle combination are displayed.

The controlling rating for the section at this specific location is summarized at the bottom for each type of load (Design inventory, Design Operating, Legal Load, Permit Load).

The rating factor and capacity is displayed in the right columns.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

Screenshots of this window can be seen below:

Continuous Span (Run 1 of 2)

Continuous Span (Run 2 of 2)
COMPLETE VDOT LRFR RATING FORM

Complete the information fields at the top portion of rating form. Information can be obtained from the current inspection report for the bridge.

VDOT Reviewer line should be left blank.

The box in the upper right hand corner of the rating form is for the seal and signature of a professional engineer licensed in the state of Virginia.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

DESIGN LOAD: HL-93

<table>
<thead>
<tr>
<th></th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL-93 (INV)</td>
<td>N/A</td>
<td>FACTOR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HL-93 (OPR)</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the HL-93 vehicle, first highlight the HL-93 (US) Inventory and Operating Rating Level rows in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight both the Inventory and Operating Rating Level rows for AS-BUILT.

Left click the View Member Rating Results button.
The **Member Rating Results** window will appear.

Since **G1** has lower ratings than **G2**, the rating information for **G1** will be recorded on the rating form. The HL-93 vehicle is the only vehicle without a tonnage since it is a truck load combined with a lane load. The **CONTROLLING FORCE** column will be filled in later.

<table>
<thead>
<tr>
<th>GVW (TONS)</th>
<th>RATING FACTOR</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL-93 (INV)</td>
<td>N/A</td>
<td>0.49</td>
<td>G1</td>
<td>143.00</td>
</tr>
<tr>
<td>HL-93 (OPR)</td>
<td>N/A</td>
<td>0.64</td>
<td>G1</td>
<td>143.00</td>
</tr>
</tbody>
</table>

Note: For all results, do not round up. Only record 2 significant digits for the rating factor.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

DESIGN LOAD: HS-20

<table>
<thead>
<tr>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-20 (INV)</td>
<td>36 TONS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS-20 (OPR)</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the HS-20 vehicle, first highlight the HS-20 Truck Only Inventory and Operating Rating Level rows in the Bridge Rating Results window. The HS-20 Lane Load Only and HS-20 Tandem ratings are for informational purposes only and are not included on the rating form.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight both the Inventory and Operating Rating Level rows for AS-BUILT.

Left click the View Member Rating Results button.

The Member Rating Results window will appear.
Since **G1** has lower ratings than **G2**, the rating information for **G1** will be recorded on the rating form. The **CONTROLLING FORCE** column will be filled in later.

<table>
<thead>
<tr>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-20 (INV)</td>
<td>36</td>
<td>23</td>
<td>G1</td>
<td>143.00</td>
</tr>
<tr>
<td>HS-20 (OPR)</td>
<td>36</td>
<td>30</td>
<td>G1</td>
<td>143.00</td>
</tr>
</tbody>
</table>

Note: For all tonnages, do not round up. Instead, round down to the nearest ton.
LEGAL LOAD: VA TYPE 3

<table>
<thead>
<tr>
<th>LEGAL LOADS</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA Type 3</td>
<td>27</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VA Type 3S2</td>
<td>40</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>**, LANE</td>
<td>40</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the VA-Type 3 vehicle, first highlight the **VA Type 3** row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for **AS-BUILT**.

Left click the View Member Rating Results button.

The Member Rating Results window will appear.
Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.

<table>
<thead>
<tr>
<th>LEGAL LOADS</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA Type 3</td>
<td>27</td>
<td>IONS</td>
<td>30</td>
<td>G1</td>
<td>143.00</td>
</tr>
<tr>
<td>VA Type 3S2</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LANE</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LEGAL LOAD: VA TYPE 3S2

<table>
<thead>
<tr>
<th>LEGAL LOADS</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA Type 3</td>
<td>27</td>
<td>30</td>
<td>G1</td>
<td>143 00</td>
<td></td>
</tr>
<tr>
<td>VA Type 3S2</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the VA-Type 3S2 vehicle, first highlight the **VA Type 3S2** row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for **AS-BUILT**.

Left click the View Member Rating Results button.

The Member Rating Results window will appear.
Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.

<table>
<thead>
<tr>
<th>LEGAL LOADS</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA Type 3</td>
<td>27</td>
<td>30</td>
<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
<tr>
<td>VA Type 3S2</td>
<td>40</td>
<td>43</td>
<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
</tbody>
</table>

* Lane
LEGAL LOAD: LANE

<table>
<thead>
<tr>
<th>LEGAL LOADS</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA Type 3</td>
<td>27</td>
<td>30</td>
<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
<tr>
<td>VA Type 3S2</td>
<td>40</td>
<td>43</td>
<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
<tr>
<td>LANE</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the Lane-Type Legal Load vehicle, first highlight the Lane-Type Legal Load row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for AS-BUILT.

Left click the View Member Rating Results button.
The Member Rating Results window will appear.

Since G2 has lower ratings than G1, the rating information for G2 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.

<table>
<thead>
<tr>
<th>LEGAL LOADS</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA Type 3</td>
<td>27</td>
<td>30</td>
<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
<tr>
<td>VA Type 3S2</td>
<td>40</td>
<td>43</td>
<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
<tr>
<td>* LANE</td>
<td>40</td>
<td>67</td>
<td>G2</td>
<td>119.00</td>
<td></td>
</tr>
</tbody>
</table>
PERMIT LOAD: BP-90

<table>
<thead>
<tr>
<th>PERMIT LOAD</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP-90</td>
<td></td>
<td>45 TONS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP-115</td>
<td></td>
<td>57.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the BP-90 vehicle, first highlight the Blanket Permit 90 (BP-90) row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for AS-BUILT.

Left click the View Member Rating Results button.
The Member Rating Results window will appear.

Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.
To fill out the rating information for the BP-115 vehicle, first highlight the Blanket Permit 115 (BP-115) row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for AS-BUILT.

Left click the View Member Rating Results button.
The Member Rating Results window will appear.

Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.
SH VEHICLE: NRL

<table>
<thead>
<tr>
<th></th>
<th>GVV (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH VEHICLES</td>
<td></td>
<td><strong>CONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRL</td>
<td>40</td>
<td>TONS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SU4</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SU5</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SU6</td>
<td>34.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SU7</td>
<td>38.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the NRL vehicle, first highlight the **Notional Rating Load-NRL** row in the **Bridge Rating Results** window.

Then, left click the **View Structure Rating Results** button.

The **Structure Rating Results** window will appear. Highlight the row for **AS-BUILT**.

Left click the **View Member Rating Results** button.
The Member Rating Results window will appear.

Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.

<table>
<thead>
<tr>
<th>SH VEHICLES</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRL</td>
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<td>**</td>
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<tr>
<td>SU4</td>
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</tr>
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<tr>
<td>SU6</td>
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<tr>
<td>SU7</td>
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</tbody>
</table>
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

SH VEHICLE: SU4

<table>
<thead>
<tr>
<th>SH VEHICLES</th>
<th>GVW (TONS)</th>
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</table>

To fill out the rating information for the SU4 vehicle, first highlight the SU4 row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for AS-BUILT.

Left click the View Member Rating Results button.
The Member Rating Results window will appear.

Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.

<table>
<thead>
<tr>
<th>SH VEHICLES</th>
<th>GVW (TONS)</th>
<th>RATING</th>
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CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

SH VEHICLE: SU5

<table>
<thead>
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<th>CONTROLLING FORCE</th>
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</table>

To fill out the rating information for the SU5 vehicle, first highlight the SU5 row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for AS-BUILT.

Left click the View Member Rating Results button.
The Member Rating Results window will appear.

Since **G1** has lower ratings than **G2**, the rating information for **G1** will be recorded on the rating form. The **CONTROLLING FORCE** column will be filled in later.

<table>
<thead>
<tr>
<th>VEHICLE</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
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<td></td>
<td></td>
</tr>
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</table>
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

SH VEHICLE: SU6

<table>
<thead>
<tr>
<th>SH VEHICLES</th>
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<th>CONTROLLING FORCE</th>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

To fill out the rating information for the SU6 vehicle, first highlight the SU6 row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for AS-BUILT.

Left click the View Member Rating Results button.
The Member Rating Results window will appear.

Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>GVW (TONS)</th>
<th>Rating</th>
<th>Rating Members</th>
<th>Location (FT)</th>
<th>Controlling Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH VEHICLES</td>
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<tr>
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<td>G1</td>
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<tr>
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<td>G1</td>
<td>143.00</td>
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</tr>
<tr>
<td>SU7</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To fill out the rating information for the SU7 vehicle, first highlight the SU7 row in the Bridge Rating Results window.

Then, left click the View Structure Rating Results button.

The Structure Rating Results window will appear. Highlight the row for AS-BUILT.

Left click the View Member Rating Results button.
The Member Rating Results window will appear.

Since G1 has lower ratings than G2, the rating information for G1 will be recorded on the rating form. The CONTROLLING FORCE column will be filled in later.

<table>
<thead>
<tr>
<th>SH VEHICLES</th>
<th>GVW (TONS)</th>
<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
<th>CONTROLLING LOCATION (FT)</th>
<th>CONTROLLING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>SU6</td>
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<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
<tr>
<td>SU7</td>
<td>38.75</td>
<td>28</td>
<td>G1</td>
<td>143.00</td>
<td></td>
</tr>
</tbody>
</table>
Once the controlling member(s) is known, the user can obtain the controlling force for each vehicle by double clicking the bridge in the Bridge Explorer window to open the file.

For this example, G1 is the controlling member for the majority of the vehicles. Expand the folders to get to the controlling MEMBER ALTERNATIVE.

Select the Continuous Span (Run 1 of 2) template and right click G1 (E) (C) and select Analyze.
Left click **OK** on the **Analysis Progress** window when the analysis is complete.

Highlight **G1 (E) (C)** and left click the **View analysis report** icon.
CONTINUOUS SPAN REINFORCED CONCRETE TEE BEAM BRIDGE INPUT: VERSION 6.2

The Analysis Results – G1 window will appear. Select Single rating level per row from the Display Format drop down menu.

The controlling force can be obtained from the Limit State column. Fill in the rating form as appropriate for each vehicle.

Follow the same process with the Continuous Span (Run 2 of 2) vehicle template.

See Appendix D for the completed rating form.
The second page of the rating form provides space for assumption and comments. Some common assumptions and comments are for material strengths, which plan was used, wearing surface thicknesses, and any deterioration or other changes and assumptions applied to the structure.

If the current inspection report indicates that there is deterioration, the user will have to create an IR (inspection report) structure in addition to the AS-BUILT. For continuous span reinforced concrete tee beam bridges, the typical deterioration that warrants an IR structure is section loss to the longitudinal or vertical reinforcement.

***RATING FOR THE BRIDGE IS NOW COMPLETE.***
APPENDIX A: DESIGN PLANS
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HIGHWAYS
PROPOSED BRIDGE
OVER CEDAR CREEK - 9 MI. FROM STRASBURG
STA.578+70'- RT. 55' PROJ. 12/19 B-1
FREDERICK & SHENANDOAH COUNTIES
2-50'-0" & 1-69'-0" R.C. CONTINUOUS BEAM SPANS

General Notes:
- Foundations. All foundations shall be designed and placed in accordance with the requirements of the specifications. Foundation drawings shall be submitted to the Agency for approval. Foundations which are not shown on the plan shall be designed and placed in accordance with the requirements of the specifications.
- Concrete, steel, and reinforcement materials shall be of the quality specified in the specifications. These materials shall be approved by the Agency and shall be used in accordance with the approved plans.

Estimated Quantities:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Drawn by: [Name]
Checked by: [Name]
Note:
Subsurface expansion material beneath bridge seats shall be set flush with the surface of the concrete.

Schedule of reinforcing steel:

CEDAR CREEK BRIDGE
DETAILS OF SUBSTRUCTURE

Virginia Department of Highways
Office of the Chief Engineer
Norfolk, Virginia
APPENDIX B: BARRIER WEIGHT CALCULATION
Concrete Rail and Post Load

Note: Shaded areas denote railing. Non-shaded areas denote post.

\[ \gamma_{\text{conc}} = 150 \ \text{pcf} \]

Length of Bridge = 169.00 ft
No. of Posts at Pier = 2 posts
No. of Int. Posts = 14 posts

<table>
<thead>
<tr>
<th>Shape</th>
<th>Base in</th>
<th>Height in</th>
<th>Weight lb/ft</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
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</tr>
<tr>
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<td>2.00</td>
<td>18.23</td>
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</table>

<table>
<thead>
<tr>
<th>Shape</th>
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<th>Height in</th>
<th>Width in</th>
<th>Weight lb/ft</th>
<th>Weight lb</th>
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</thead>
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### Intermediate Post

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<tr>
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<th>Width in</th>
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<th>Weight lb</th>
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</tr>
</tbody>
</table>

**Summary**

- **Weight of Rail as Distributed Load** = 253.13 lb/ft
- **Weight of Posts at Pier as Distributed Load** = 35.48 lb/ft
- **Weight of Intermediate Posts as Distributed Load** = + 111.55 lb/ft

**Weight of Rail and Post as Distributed Load** = 0.400 kip/ft
APPENDIX C: LFD EFFECTIVE FLANGE WIDTH
### LFD Effective Flange Width  (AASHTO 8.10)

<table>
<thead>
<tr>
<th>GIRDER</th>
<th>Span 1 &amp; 3</th>
<th>Span 2</th>
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<tr>
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<tr>
<td>TEFF</td>
<td>7.00</td>
<td>7.00</td>
</tr>
<tr>
<td>TWEB</td>
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</tr>
<tr>
<td>AVG BEAM SPACING</td>
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</tr>
<tr>
<td>WOVERHANG</td>
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<td>1.79</td>
</tr>
</tbody>
</table>

**INTERIOR BEAM EFFECTIVE FLANGE WIDTH; THE LEAST OF:**

\[
\frac{1}{4} (S_{Eff}) = \begin{array}{c|c}
\text{150.00} & \text{207.00} \\
\end{array} \text{ IN} \\
12 (T_{Eff}) + \text{MAX T}_{WEB} = \begin{array}{c|c}
\text{100.00} & \text{100.00} \\
\end{array} \text{ IN} \\
AVG BEAM SPACING = \begin{array}{c|c}
\text{96.00} & \text{96.00} \\
\end{array} \text{ IN} \\
B_{Iatteff} = \begin{array}{c|c}
\text{96.00} & \text{96.00} \\
\end{array} \text{ IN}
\]

**EXTERIOR BEAM EFFECTIVE FLANGE WIDTH; THE LEAST OF:**

\[
\frac{1}{4} (S_{Eff}) = \begin{array}{c|c}
\text{150.00} & \text{207.00} \\
\end{array} \text{ IN} \\
12 (T_{Eff}) + \text{MAX T}_{WEB} = \begin{array}{c|c}
\text{100.00} & \text{100.00} \\
\end{array} \text{ IN} \\
W_{OVERHANG} + \text{AVG BM SPACING}/2 = \begin{array}{c|c}
\text{69.50} & \text{69.50} \\
\end{array} \text{ IN} \\
B_{Eatteff} = \begin{array}{c|c}
\text{69.50} & \text{69.50} \\
\end{array} \text{ IN}
Rte.: 00055, John Marshall Highway
Over: Cedar Creek
Va. Str. No.: 1996
Fed. ID: 08108
County: Frederick
District: Staunton
Rated By: ABC Date: 10/15/11
Checked By: DEF Date: 10/19/11
VDOT Reviewer: ____________

Calculation Tools/Method Used: Virtis 6.2 – Virtis LRFR Engine
Basis for Rating: Conversion to LRFR

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<th>RATING</th>
<th>CONTROLLING MEMBERS</th>
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* Not applicable for single spans less than and equal to 200 feet.
** For LFR or ASD: Denote if it is a mid range or operating level for posting and provide the safe posting load.
*** Not applicable for LF/AS rating methods.
**** Denotes does not meet the rating requirements.
LOAD RATING SUMMARY FORM FOR STRUCTURES

INSPECTION REPORT USED FOR THIS RATING: 0341996-000000000008108 06/01/2010

ASSUMPTIONS/COMMENTS BY LOAD RATING ENGINEER:

Bridge No. 08108 – Three Span Continuous Reinforced Concrete Tee-Beam Bridge

1. Plan 079-18 was used for the rating.

2. Sacrificial wearing surface = 0.50 in.

3. Based on year built 1942 and using the information contained in the VDOT BARS Custom Data:
   a. Reinforcing steel yield point = 33 ksi.
   b. Concrete compressive strength of 3.0 ksi.