AASHTOWare BrDR 7.5.0 Reinforced Concrete Structure Tutorial RC8 – Reinforced Concrete Tee Beam Using BrDR LRFD Engine

Introduction – Elevation and Section





Typical Section







Framing Plan

Diaphragm weight = 1.2 kips/.each

Material Properties

Slab Concrete: Class A (US) f'c = 4.0 ksi, modular ratio n = 8Slab Reinforcing Steel: AASHTO M31, Grade 60 with Fy = 60 ksi

BrDR Training

RC6 - Reinforced Concrete Tee Beam Using BrDR LRFD Engine

Topics Covered

- Reinforced concrete schedule based tee input as girder system.
- Export of schedule based reinforced concrete beams to the BrDR LRFD analysis engine
- BrDR LRFD specification checking

Reinforced concrete schedule based tee input as girder system.

Open the **Bridge Workspace** for **BID 11, RCTrainingBridge1** from the **BRIDGE EXPLORER** by selecting the bridge in the **BRIDGE EXPLORER** and clicking the **Open** button from the **Bridge** group of the ribbon (or by right clicking the bridge and selecting **Open** from the drop-down menu) as shown below.

| Br | | AASHTOWare B | ridge Design and Rating | | 1 | ? — ! | | × |
|--------------------------------|--------------|--------------------------|--------------------------|-----------|-------------|----------|-----|---|
| BRIDGE EXPLORER BRIDGE FOLDER | RATE | TOOLS VIEW | | | | | | |
| New Open Batch Find Copy Paste | Copy To • | Remove Delete From | | | | | | |
| Bridge M | anage | | | | | | | |
| | E 🛋 | Bridge ID | Bridge Name | District | County | Facility | | |
| Recent Bridges | 1 | TrainingBridge1 | Training Bridge 1(LRFD) | Unknown | Unknown (P) | SR 0051 | | |
| All Bridges | 2 | TrainingBridge2 | Training Bridge 2(LRFD) | Unknown | Unknown (P) | N/A | | |
| Deleted Bridges | 3 | TrainingBridge3 | Training Bridge 3(LRFD) | Unknown | Unknown (P) | I-79 | | |
| Deleted bridges | 4 | PCITrainingBridge1 | PCI TrainingBridge1(LFD) | | | | | |
| | 5 | PCITrainingBridge2 | PCITrainingBridge2(LRFD) | | | | | |
| | 6 | PCITrainingBridge3 | PCI TrainingBridge3(LFD) | | | | | |
| | 7 | PCITrainingBridge4 | PCITrainingBridge4(LRFD) | | | | | |
| | 8 | PCITrainingBridge5 | PCI TrainingBridge5(LFD) | | | | | |
| | 9 | PCITrainingBridge6 | PCITrainingBridge6(LRFD) | | | | | |
| | 10 | Example7 | Example 7 PS (LFD) | | | | | |
| |) 11 | RCTrainingBridge1 | RC Training Bridge1/LED) | | | | | |
| | 12 | TimberTrainingBridge1 📴 | Open Ctrl+O | | | | | |
| | 13 | FSys GFS TrainingBridge | Copy Ctrl+C | Unknown | Unknown (P) | NJ-Turnp | ike | |
| | 14 | FSys FS TrainingBridge2 | Delete | Unknown | Unknown (P) | 1-95 | | |
| | 15 | FSys GF TrainingBridge3 | Rate | Unknown | Unknown (P) | 1-95 | | |
| | 16 | FLine GFS TrainingBridge | Rating Results | Unknown | Unknown (P) | I-75 | | |
| | 17 | FLine FS TrainingBridge2 | Manage Analysis Events | Unknown | Unknown (P) | I-75 | | |
| | 18 | FLine GF TrainingBridge | Hedate PrM Patients | Unknown | Unknown (P) | 1-95 | | |
| | 19 | TrussTrainingExample | D | | | | | |
| | 20 | LRFD Substructure Exam | Report Iool | | | | | |
| | 21 | LRFD Substructure Exam 🦉 | Attachments | | | SR 4034 | | |
| | 22 | LRFD Substructure Exam | General Preferences | | | | | Ŧ |
| | ٩ 📄 | | | | | | • | |
| | | | Total Brid | ge Count: | 31 | | | |

The **Bridge Workspace** is shown below.



SUPERSTRUCTURE DEFINITION

Double click on **SUPERSTRUCTURE DEFINITIONS** (or click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **Manage** group of the **WORKSPACE** ribbon or right mouse click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the popup menu) to create a new structure definition.

| A New Superstructure Definition | | Х |
|---|----------------------------------|---|
| Girder system superstructure | |] |
| ◯ Girder line superstructure | Superstructure definition wizard | |
| Floor system superstructure | | ļ |
| Floor line superstructure | | |
| Truss system superstructure | | |
| Truss line superstructure | | |
| Reinforced concrete slab system superstructure | | |
| Concrete multi-cell box superstructure | | |
| Advanced concrete multi-cell box superstructure | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | OK Cancel | |

Select the **Girder system superstructure** and click **OK** to open the **Girder System Superstructure Definition** window. Enter the data as shown below.

| A Girder System Superstructure Definition | | – 🗆 X |
|--|--------|---|
| Definition Analysis Specs Engine | | |
| Name: RC6 Tee Beam | | Modeling Multi-girder system MCB |
| Description: | | With frame structure simplified definition Deck type: |
| Default units: US Customary V Number of spans: 1 Number of girders: 5 Span Length (ft) 1 40.00 | | Concrete Deck |
| | 0 | |
| Superstructure alignment or the set of the support line | ε: π | |
| Curved Curved | π | |
| Tangent, curved, tangent | tt | |
| Tangent, curved Direction: | Left v | |
| Curved, tangent End tangent length: | ft | |
| Distance from last support line to P | : # | |
| Design speed: | mph | |
| Superelevation: | % | |
| | | OK Apply Cancel |

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

Load Case Description

Expand the tree for **RC6 Tee Beam** superstructure and double click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description** window and define the dead load cases. Use the **Add Default Load Case Descriptions** button to create the following load cases. The completed **Load Case Description** window is shown below.

| Load case name | Description | Stage | | Туре | Time* (days) | |
|----------------|--|-----------------------------------|------|------|-----------------|--|
| DC1 | DC acting on non-composite section | Non-composite (Stage 1) * | D,DC | - | | |
| DC2 | DC acting on long-term composite section | Composite (long term) (Stage 2) 🔹 | D,DC | - | | |
| DW | DW acting on long-term composite section | Composite (long term) (Stage 2) 🍷 | D,DW | - | | |
| SIP Forms | Weight due to stay-in-place forms | Non-composite (Stage 1) | D,DC | Ŧ | | |
| | | | | | | |
| | | | | | | |

Structure Framing Plan Detail - Layout

Double-click on **Framing Plan Detail** in the **Bridge Workspace** tree to describe the framing plan in the **Structure Framing Plan Details** window. Enter the data as shown below.

| 🗛 s | truc | ture Frami | ng Plan Deta | ils | | | | | | | | | _ | | × |
|-----|------|-------------|--------------|---------------|-------|-----------|--------------------|------------------|---|---|----|----|------|--------|---|
| Nur | nbe | r of spans: | 1 | Number of gir | ders: | 5 | | | | | | | | | |
| L | ayo | ut Diap | hragms | | | | | | | | | | | | |
| | | | | | G | irder spa | cing orien | tation | | | | | | | |
| | | · · | Skew | | | Perpen | dicular to g | girder | | | | | | | |
| | | Support | (degrees) | | C |) Along s | upport | | | | | | | | |
| | • | 1 | 0.000 | | | | Girder | spacing | | 1 | | | | | |
| | | 2 | 0.000 | | | Girder | (f | t) | | | | | | | |
| | | | | | | bay | Start of girder | End of airder | | | | | | | |
| | | | | | | 1 | 6.00 | 6.00 | | | | | | | |
| | | | | | | 2 | 6.00 | 6.00 | | | | | | | |
| | | | | | | 3 | 6.00 | 6.00 | | | | | | | |
| | | | | | • | 4 | 6.00 | 6.00 | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
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| | | | | - | | | | | - | | | | | | |
| | | | | | | | | | | J | | | | | |
| | | | | | | | | | | | OK | An | nhu | Const | |
| | | | | | | | | | | | UK | Ар | עיקי | Carlot | 3 |

Structure Framing Plan Detail - Diaphragms

Switch to the **Diaphragms** tab to enter diaphragm spacing. Enter the diaphragm locations shown below for **Girder bay 1**. Click on the **Copy bay to...** button to copy the diaphragm locations to bays 2 to 4.

| tructur | e Fram | ing Plan Deta | ils | | | | | | | | _ | | |
|---------|---------------|---------------|-----------------------|----------------------|---------------------|----------------|------------------|----------------------|---------------|----------------|-------|--------|----|
| mber of | f spans | : 1 | Number o | of girders: 5 | | | | | | | | | |
| ayout | Dia | phragms | | | | | | | | | | | |
| irder b | ay: 4 | | > | Copy bay | to | Dia v | phragm vizard | | | | | | |
| Suj | pport mber | S disi | tart tance (ft) | Diaphragm spacing | Number of spaces | Length (ft) | E dis | ind tance (ft) | Load (kip) | Diaphragm | | | |
| | | Left girder | Right girder | (11) | | | Left girder | Right girder | | | | | |
| 1 | * | 0.00 | 0.00 | 0.00 | 1 | 0.00 | 0.00 | 0.00 | 1.2000 | Not Assigned * | | | Î |
| | | | | | | | | | | | | | |
| | | | | | | | | | | New Dupl | icate | Delete | |
| | | | | | | | | | | ОК | Apply | Cano | ce |

Click on the Copy bay to... button. The Copy Diaphragm Bay window opens as shown below.

| 🗛 Copy Diaphragm B | ay | × |
|------------------------|----------------|---|
| | Bay 1 Bay 2 | |
| Select the new bay(s): | Bay 3 | |
| | | |
| | Apply Cancel | |

Select **Bay 2**, **Bay 3** and **Bay 4** and click **Apply** to copy the diaphragm locations to bays 2 to 4.

Structure Typical Section - Deck

Next define the structure typical section by double-clicking on **Structure Typical Section** in the **Bridge Workspace** tree. Input the data describing the typical section as shown below.

| Distance from left edge of deck to superstructure definition ref. line Deck thickness Left overhang Deck Cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface Superstructure definition reference line is within withe bridge deck. Start End Distance from left edge of deck to superstructure definition reference line: 15.00 ft Distance from right edge of deck to 15.00 ft 15.00 ft | |
|--|--|
| superstructure detrition ret. line superstructure detrition ret. line Deck Deck + thickness Relaterace Line Peck Superstructure detrition ret. ine Relaterace Line Relaterace Line Peck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Superstructure definition reference line is within We heridge deck. Start End Distance from left edge of deck to superstructure definition reference line: 15.00 Distance from right edge of deck to 15.00 Distance from right edge of deck to 15.00 | |
| ↓ thickness 1 Heterence Line ↓ ↑ Left overhang ↑ Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface Superstructure definition reference line is within ✓ Distance from left edge of deck to 15.00 ft Distance from right edge of deck to 15.00 ft | |
| Left overhang Left overhang Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface Superstructure definition reference line is within v the bridge deck. Start End Distance from left edge of deck to superstructure definition reference line: Distance from right edge of deck to 15.00 ft 15.00 ft 15.00 et | |
| Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface Superstructure definition reference line: is within It he bridge deck. It he bridge deck. Distance from left edge of deck to superstructure definition reference line: 15.00 ft 15.00 ft Distance from right edge of deck to 15.00 ft 15.00 ft | |
| Superstructure definition reference line is within v the bridge deck. Start End Distance from left edge of deck to superstructure definition reference line: 15.00 ft Distance from right edge of deck to 15.00 e | |
| Start End Distance from left edge of deck to superstructure definition reference line: 15.00 ft Distance from right edge of deck to 15.00 e | |
| Distance from left edge of deck to superstructure definition reference line: Distance from right edge of deck to 15.00 e, 15.00 e, | |
| Distance from right edge of deck to 15.00 e 15.00 e | |
| superstructure definition reference line: | |
| Left overhang: 3.00 ft 3.00 ft | |
| Computed right overhang: 3.00 ft 3.00 ft | |
| | |
| | |
| | |
| | |
| | |
| | |
| ОК Арріу | |

Structure Typical Section – Deck (cont'd)

The **Deck (cont'd)** tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described previously. Enter data as shown below.

| A Structure Typical Section | - | | × |
|--|-------|------|----|
| Distance from left edge of deck to Distance from right edge of deck to superstructure definition ref. line | | | |
| Deck Deck | | | |
| | | | |
| Left overhang | | | |
| Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface | | | |
| Deck concrete: Class A (US) | | | |
| Total deck thickness: 8.0000 in | | | |
| Load case: Engine Assigned | | | |
| Deck crack control parameter: kip/in | | | |
| Sustained modular ratio factor: 2.000 | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| OK | Apply | Canc | el |
| | | cane | |

Structure Typical Section - Parapets

The two parapets are described using the **Parapet** tab. Click **New** to add a row to the table. The name of the parapet defaults to the only barrier described for the bridge. Change the **Load Case** to **DC2**. Reinforced concrete structures only have 1 stage but for this example, select **DC2** since the dead load of the parapets needs to be uniformly distributed to all girders and BrDR only allows that type of load distribution in stage 2. Select **Back** in the **Measure to** field (we are locating the parapet on the deck by referencing the back of the parapet to the left edge of the deck). Enter **0.0** for the **Distance at start** and **Distance at end**. Change the **Front face orientation** to **Right**. The completed tab is shown below.

| A | Stru | ucture Typical Section | on | 1 | | | | | | | | | | - | | × |
|----------|------|------------------------|----------|-----------|------------|--|------------------------------|----------------------------|-------|--------------------|-------|-----------------|-----------|---|--------|----|
| E | ack_ | | Fro - | nt | | | | | | | | | | | | |
| | Dec | k Deck (cont'd) | | Parapet | Median | Railing Generic | Sidewalk | Lane posit | ion | Striped | lanes | Wearing surface | | | | |
| | | Name | | Load case | Measure to | Edge of deck dist. measured from | Distance at start (ft) | Distance at end (ft) | From | nt face ntation | | | | | | |
| | | Jersey Barrier 🔹 | · | DC2 - | Back - | Left Edge 🔹 | 0.00 | 0.00 | Right | | | | | | 2 | ÷ |
| | Þ | Jersey Barrier 🔹 | · I | DC2 - | Back - | Right Edge 🛛 👻 | 0.00 | 0.00 | Left | - | | | | | | |
| | | | | | | | | | | | | | | | | 7 |
| | | | | | | | | | | | | New | Duplicate | [| Delete | |
| | | | | | | | | | | | | ОК | Apply | | Cano | el |

Structure Typical Section - Lane positions

Select the **Lane position** tab. Enter the values shown below or click the **Compute...** button to automatically compute the lane positions. A window showing the results of the computation opens.

| number | definition reference line | | travelway to superstructure | travelway to superstructure | |
|--------|---------------------------|---|---|---|---|
| | at start (A) (ft) | definition reference line at start (B) (ft) | definition reference line at end (A) (ft) | definition reference line at end (B) (ft) | |
| 1 | -13.25 | 13.25 | -13.25 | 13.25 | - |
| | | | | | |

Click **Apply** to apply the computed values. The **Lane Position** tab is populated as shown below.

| Stru | ucture Typical | Section | | | | - | | × |
|------|---------------------------|--|---|--|---|----------|--------|----|
| _ | Travely | (A) | ure Definition Reference Line | | | | | |
| Dec | k Deck (co | ont'd) Parapet Median | Railing Generic Sidewa | alk Lane position Striped | lanes Wearing surface | | | |
| | Travelway number | Distance from left edge of travelway to superstructure definition reference line at start (A) (ft) | Distance from right edge of travelway to superstructure definition reference line at start (B) (ft) | Distance from left edge of travelway to superstructure definition reference line at end (A) (ft) | Distance from right edge of travelway to superstructure definition reference line at end (B) (ft) | | | |
| P | 1 | -13.25 | 13.23 | -15.25 | 13.25 | | | |
| | LRFD fatigue Lanes ava | nilable to trucks: | Compute | | New Du | iplicate | Delete | |
| | | | | | ОК | Apply | Canc | el |

Schematic – Structure Typical Section

A schematic view of the structure typical section is available while the **Structure Typical Section** node is selected on the Bridge Workspace tree.



The schematic of the Structure Typical Section is shown below.



Superstructure Loads – DL Distribution

Double-click on the **Superstructure Loads** node in the Bridge Workspace tree to open the **Superstructure Loads** window. Navigate to the **DL Distribution** tab of this window. The **DL Distribution** tab of the **Superstructure Loads** window is shown below. BrDR only provides the **Uniformly to all girders** distribution option for stage 2 dead loads. Even though reinforced concrete only has 1 stage, we previously assigned our parapets to stage 2 on the Structure Typical Section window to take advantage of the **Uniformly to all girders** option. The export to the BrDR LRFD analysis engine will uniformly distribute the parapets to all girders and assign that load to the stage 1 model.

| | S | | | | | _ | > |
|---|--|----------------------------|------|------------|--------|---|---|
| Uniform temperatu | re Gradient t | emperature | Wind | DL distrib | oution | | |
| - Stand 1 decid la | ad aliatella etiana u | | | | | | |
| Stage I dead lo | ad distribution | | | | | | |
| By tributary a | irea | burin | | | | | |
| By transverse | continuous-be | am analysis | | | | | |
| By percentage | e continuous-be | ann anarysis | | | | | |
| Uy percentag | | | | | | | |
| Girder | Percentage (%) | | | | | | |
| ▶ 1 | | - | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | ~ | | | | | |
| O User-defined | dead load | | | | | | |
| | | | | | | | |
| Stage 2 dead lo | ad distribution | | | | | | |
| Uniformly to | all girders | | | | | | |
| O Bu tributanu | | | | | | | |
| By tributary a | area | | | | | | |
| By tributary a By transverse | area e simple-beam a | inalysis | | | | | |
| By tributary a | area e simple-beam a e continuous-be | analysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentage | area : simple-beam a : continuous-be :e | inalysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag | area e simple-beam a e continuous-be le Percentage (%) | inalysis am analysis | | | | | |
| By transverse By transverse By percentag Girder | area e simple-beam a e continuous-be le Percentage (%) | analysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder 1 2 | area e simple-beam a e continuous-be le Percentage (%) | amalysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder ▶ 1 2 3 | area e simple-beam a e continuous-be le Percentage (%) | amalysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder 1 2 3 4 | area e simple-beam a e continuous-be le Percentage (%) | amalysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder I <li< td=""><td>area e continuous-be le Percentage (%)</td><td>amalysis am analysis</td><td></td><td></td><td></td><td></td><td></td></li<> | area e continuous-be le Percentage (%) | amalysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder I <li< td=""><td>area e simple-beam a e continuous-be le Percentage (%)</td><td>amalysis am analysis</td><td></td><td></td><td></td><td></td><td></td></li<> | area e simple-beam a e continuous-be le Percentage (%) | amalysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder 1 2 3 4 5 User-defined | area e continuous-be le Percentage (%) dead load | amalysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder I Q 3 4 5 User-defined | area e continuous-be le Percentage (%) dead load | am analysis am analysis | | | | | |
| By tributary a By transverse By transverse By percentag Girder I <li< td=""><td>area e simple-beam a e continuous-be le Percentage (%) dead load</td><td>analysis am analysis</td><td></td><td></td><td>OK</td><td></td><td></td></li<> | area e simple-beam a e continuous-be le Percentage (%) dead load | analysis am analysis | | | OK | | |

Shear Reinforcement

Define shear reinforcement to be used by the girders. Expand the **Shear Reinforcement Definitions** node on the Bridge Workspace tree, select **Vertical** and click on **New** from the **Manage** group of the Workspace ribbon (or double click on **Vertical**). Define the stirrup as shown below. Click **OK** to apply the data and close the window.

| Bridge V | /orkspace - RCTrain | ingBridge1 | 1 | ANAI | YSIS | REP | ORTS | | | ? – | | × |
|----------------------|---|---------------|-------------|----------|--------|--------------|---------|-----------|--------|----------|-----|---|
| BRIDGE WORKSPACE | WORKSPACE | TOOLS | VIEW | DESIGN | I/RATE | REPC | RTING | | | | | ^ |
| Check Out | Restore | × | \$ 🕄 | | ∍ [`` | | 1 | S | 1 | * | | |
| Validate | Save Revert | Close E | xport Refre | sh Op | en Nev | и Сор | y Paste | Duplicate | Delete | Schemat | ic | |
| | Bridge | | | | | | Manage | | | | | |
| Workspace | | щ | × Sch | ematic | | | μ× | Repor | t | | 甲 | × |
| Bridge Components | | | _ | | | | | | | | | |
| 🖹 🧥 🕰 RCTrainingBrid | lge1 hts | | ^ | | | | | | | | | |
| Elevate | d Curb | | | | | | | | | | | |
| I Glass A | (US) | | | | | | | | | | | |
| Orade Grade (| 50 Definitions | | | | | | | | | | | |
| 🖉 Lateral Bra | cing Definitions | | | | | | | | | | | |
| 🖶 🖬 SUPERSTRI | UCTURE DEFINITIOI re Definition #1 | NS | | | | | | | | | | |
| 🗄 🖷 🖬 Schedu | le Based RC Structu Beam | ire | | | | | | | | | | |
| | act/Dynamic Load | Allowance | Ana | alysis | | | | | | | щ | × |
| | d Case Description ming Plan Detail | | | | | | | | | | | |
| 🧭 Brad | cing Deterioration | | | | | | | | | | | |
| - Stru | icture Typical Sectio | iection on | | | | | | | | | | |
| 🔤 🕂 Sup | erstructure Loads ar Reinforcement D | efinitions | | | | | | | | | | |
| | Vertical | | | | | | | | | | | |
| E ØME | Mark Definitions MBERS | | | | | | | | | | | |
| 🖶 🗁 BRIDGE AL | TERNATIVES Alternative #1 (F) (| 0 | | | | | | | | | | |
| _ ++ bhage | | c, | | | | | | | | | | |
| <u> </u> | | | | | | | | | | | | |
| 🕰 Shear Reinforce | ment Definition | - Vertical | | | | | | | — | | > | × |
| | | _ | | | | | | | | | | |
| Name: #4 stirrup | S | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | \bigcap | | | | | | | | | | | |
| | | - | | | | | | | | | | |
| | | M | latorialı | | Grade | 60 | | | | V | 1 | |
| | | IV D | aterial. | | A | | | | | • | | |
| | | Б | ar size: | | 4 | * | | | | | | |
| | | N | lumber of | legs: | 2.00 | | | | | | | |
| | Vertical | l In | nclination | (alpha): | 90.0 | | Degree | es | | | | |
| ļ | Shear Reinfor | cement | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | J | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | [| 0 | K | Арр | oly | Can | cel | |
| | | | | | - | | | | | | | - |

Bar Mark Definitions

Select **Bar Mark Definitions** from the Bridge Workspace tree and click the **New** button from the **Manage** group of the Workspace ribbon (or double click on **Bar Mark Definitions**) to open the **Bar Mark Definition** window.



Create the following Bar Mark Definition to be used for the longitudinal reinforcement in the beam.

| 🗛 Bar Mar | k Definition | | | | - | | × |
|------------|----------------|-----------|-----------|----|-------|-------|---|
| Name: | #9 Bar | Material: | Grade 60 | | | ~ | |
| Bar types: | | Bar size: | 9 | ~ | | | |
| | A | Bar type: | Straight | ~ | | | |
| | Type. Straight | | Dimension | | | | |
| | K B H | A: | 40.5000 | ft | | | |
| | Type: 1 | | | | | | |
| | Type: 2 | | | | | | |
| | Type: 3 | | | | | | |
| | | | ОК | ļ | Apply | Cance | 4 |

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

Describing member G2

The **Member** window for member **G2** shows the data that was generated when the structure definition was created. No changes are required at this time. After Member Alternatives are defined it will appear in the list of member alternatives.

| A Member | - | | × |
|--|-------|------|----|
| Member name: G2 Link with: None | | | |
| Description: | | | |
| Existing Current Member alternative name Description | | | |
| | | | * |
| Number of spans: Span Span length no. (ft) > 1 40.00 | | | |
| ОК | Apply | Cano | el |

Supports

Expand the **G2** member on the **Bridge Workspace** tree and double click on **Supports** to open the **Supports** window. Support constraints were generated when the structure definition was created and are shown below. No changes are required.

| 1 | atia 20 Canaan | 2D Flashia | 2 | | | |
|---------|----------------|------------|---------------------|----------------------|---|--|
| Support | Support | Trans | slation constraints | Rotation constraints | | |
| number | type | X | Y | Z | 1 | |
| 1 | Pinned | · V | V | | | |
| 2 | Roller | - | 1 | | | |
| | | | | | | |

Defining a Member Alternative

Double click on **MEMBER ALTERNATIVES** in the Bridge Workspace tree for member **G2** to create a new alternative. The **New Member Alternative** window shown below will open. Select **Reinforced concrete** for the **Material type** and **Reinforced Concrete Tee** for the **Girder type**.

| Naterial type: | Girder type: |
|-------------------------------------|-------------------------|
| Post tensioned concrete | Advanced Concrete RC |
| Prestressed (pretensioned) concrete | Reinforced Concrete I |
| Reinforced concrete | Reinforced Concrete Tee |
| Steel | |
| Timber | |
| | |
| | |

Enter the following data in the Member Alternative window.

| ember altern | ative: Tee | e Beam Alt | | | | | | | |
|-----------------------|------------------------|------------|--------|---------------------|---------------------------------|---------------------|-------|--|--|
| Description | Specs | Factors | Engine | Import | Control options | | | | |
| Description: | | | | | Material type: | Reinforced Concrete | 2 | | |
| | | | | | Girder type: | Reinforced Concrete | e Tee | | |
| | | | | | Modeling type: | Multi Girder System | | | |
| | | | | | Default units: | US Customary | ~ | | |
| Cross- | section ba | sed | Right: | 6.0000 | in in Default rating meth | od: | | | |
| Load case | : | Engine As | signed | ~ | LFR | ~ | | | |
| Additiona | I self load: | | kip/ft | | | | | | |
| Additiona | I self load: | | % | | | | | | |
| Crack cor Bottom o | ntrol paran f beam: | neter (Z) | kip/in | Exposur Bottom (| e factor of beam: 1.000 | | | | |

For a schedule based reinforced concrete member, it is important to enter a value for the End Bearing Locations on this window. This data describes the distance from the physical end of the beam to the centerline of the end bearings. It is important to enter this value here so that when the bar mark definitions are assigned to the reinforcement profile, the bars can start to the left of the first support line and to the right of the last support line.

If the bars start to the left of the first support line and to the right of the last support line, BrDR will consider the bars to be partially developed at the centerline of the bearing. Then the analysis engine will be able to compute the **d** distance from the extreme compression fiber to the centroid of the tension reinforcement. This **d** value is required to compute the shear capacity of the section. If the rebar starts at the centerline of the bearing, it will be considered as zero percent developed at this point so a **d** distance cannot be computed, and the shear capacity of the beam will be zero.

Girder Profile - Section

The girder profile can now be defined. Expand the **Tee Beam Alt** member alternative on the Bridge Workspace tree, double click on the **Girder Profile** node to open the **Girder Profile** window and enter the following section properties.

| 🕰 Girder Profile | – 🗆 X |
|---|--|
| Type: Reinforced Concrete Tee Section Web depth Reinforcement Allow flange width to vary Tributary width: 72.0000 in | Top flange Material: Class A (US) Modular ratio: Eff. width (Std): in |
| 26.0000 in A: in CJ: in | Eff. width (LRFD): 72.0000 in Struct. thick: 7.5000 in Other parts Material: Class A (US) |
| | OK Apply Cancel |

The LRFD effective flange width is computed as follows.

AASHTO LRFD Article 4.6.2.6.1

For interior beams, effective flange width taken as least of:

• average spacing of adjacent beams = 6'(12'') = 72''

Girder Profile - Web

Enter the following data for the web.

| Gir | der Profile | | | | | | | | _ | | × |
|------|------------------------|------------------|----------------------|-------------------|---------------------------|----------------|-------------------------|-----|-----------|--------|----|
| ype: | Reinforce | ed Concrete Tee | | | | | | | | | |
| Sec | tion | eb depth Reinfor | rcement | | | | | | | | |
| | Begin depth (in) | Depth vary | End depth (in) | Support number | Start distance (ft) | Length (ft) | End distance (ft) | | | | |
| ₽ | 40.0000 | None | * 40.0000 | 1 * | 0.000 | 40.000 | 40.000 | | | | - |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | - |
| | | | | | | | | New | Duplicate | Delete | |
| | | | | | | | | OK | Apply | Canc | el |

Girder Profile – Reinforcement

Enter the following data for the reinforcement.

| 🗛 G | rder Pro | ofile | | | | | | | | | | | | | | _ | | × |
|-----|----------|--------------|-----------|--------------------|------------------|---------------|----------------|------------------------|-----------------------|-------------------|-----------|---------------------------|----------------------------|-------------------------|-----------------------------|---------------------------|--------|----------|
| Тур | : Rein | nforced Cond | crete Tee | | | | | | | | | | | | | | | |
| S | ction | Web dep | th Re | inforcement | | | | | | | | | | | | | | |
| | Set | Bar mark | Invert | Measured from | Distance (in) | Std number | LRFD number | Bar spacing (in) | Side cover (in) | Support number | Direction | Start distance (ft) | Straight length (ft) | End distance (ft) | Start fully developed | End fully developed | 1 | |
| | 1 | #9 Bar * | | Bottom of Girder 🔹 | 3.0640 | 8.00 | 8.00 | | | 1 - | Left * | 0.250 | 40.500 | 40.250 | | | | A |
| | | | | | | | | | | | | | | | | | | * |
| | | | | | | | | | | | | | | New | Duplica | ate [|)elete | |
| | | | | | | | | | | | | | | OK | A | oply | Cano | el |

Shear Reinforcement Ranges

Double-click on the **Shear Reinforcement Ranges** on the Bridge Workspace tree to open the **Shear Reinforcement Ranges** window and enter the data as shown below.

| } ₽ | C Shear Reinforcem | ent | Ranges | ; | | | | | _ | | × |
|------------|--------------------|------|-----------------|---------------------------|------------------|-----------------|----------------|-------------------------|---|-------|----------|
| | Start Distance | , | - H | òpacing | | | | | | | |
| | Name | Sunu | upport umber | Start distance (ft) | Number of spaces | Spacing (in) | Length (ft) | End distance (ft) | | | |
| | #4 stirrups * | 1 | * | 0.00 | 1 | 0.0000 | 0.00 | 0.00 | | | - |
| Þ | #4 stirrups * | 1 | * | 0.00 | 40 | 12.0000 | 40.00 | 40.00 | | | |
| | | | | | | | | | | | - |
| | Stirrup wizard | | | | | | New | Duplicate | e | Delet | te ol |
| | | | | | | | UN | Арру | | Canc | |

Live Load Distribution Factors

The BrDR LRFD analysis engine will compute the live load distribution factors. No values need to be entered if the user wants the BrDR engine to compute them.

| A Live Load Distribution | _ | | × |
|---|-----|--------|----|
| Standard LRFD | | | |
| Distribution factor input method | | | |
| Use simplified method Use advanced method | | | |
| | | | |
| Allow distribution factors to be used to compute effects of permit loads with routine traffic | | | |
| Action: Deflection | | | |
| Support Start Length End distance (Janes) | | | |
| number (ft) (ft) (ft) 1 lane Multi-lane | | | |
| | | 1 | - |
| | | | |
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| | | | |
| | | | |
| | | | |
| Compute from typical section View calcs Duplicat | e | Delete | |
| ОК Ар | oly | Cance | el |

LRFD Design Review

To perform an LRFD design review, click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon which opens the **Analysis Settings** window.

| Br | Bridge Wo | rkspace - RCTrainin | ıgBridge1 | | ANALYSIS | REPORTS | ? | - | × |
|----------------------|---------------------------|---------------------------------------|--------------------------------|------------------------|-----------------|-----------|---|---|---|
| BRIDGE | WORKSPACE | WORKSPACE | TOOLS VIE | W I | DESIGN/RATE | REPORTING | | | ^ |
| * | as 🗄 | | ₽\$~ | $\overset{\sim}{\sim}$ | H. | | | | |
| Analysis Settings | Analyze Analysi Events | s Tabular Specific Results Check D | ation Engine Detail Outputs | Results Graph | Save Results | | | | |
| | Analysis | | Results | | | | | | |

Click the **Open Template** button and select **HL-93 Design Review** to be used in the rating and click **OK**. The **Analysis Settings** window will appear as shown below.

| Analysis Settings | | | | | - | | |
|--|---------|-----------------------------------|---|---|----------|------|-----|
| Design review Rating | | Design m | ethod: | LRFD | ~ | | |
| nalysis type: Line Girder | ~ | | | | | | |
| ne / Impact loading type: As Requested | ~ | Apply pre | eference setting: | None | ~ | | |
| Vehicles Output Engine Description | | | | | | | |
| Traffic direction: Both directions | ~ | | Refresh | Temporary vehicles | Advanced | | |
| Vehicle selection | | | Vehicle summa | У | | | |
| - Standard - EV2 - EV2 - EV3 - HL-93 (SI) - HS 20 (SI) - HS 20 (SI) - HS 20-44 - LRFD Fatigue Truck (SI) - LRFD Fatigue Truck (US) - Agency - User defined - Temporary | | Add to >> Remove from << | ☐ - Design HL-i Permit I =-Fatigue 'LRFI | ioaos 33 (US) oads Ioads D Fatigue Truck (US) | | | |
| Reset Clear Open template | Save te | mplate | | OK | Apply | Canc | el: |

Next click the Analyze button on the Analysis group of the DESIGN/RATE ribbon to perform the rating.



The Analysis log should always be reviewed when performing an analysis with the BrDR LRFD Engine.

Informational messages are displayed in blue, warning messages are displayed in green and error messages are displayed in red font.

| Analysis | | _ 🗆 × |
|---|--|----------------|
| Analysis - Tee Beam Alt | | ~ × |
| Analysis Event Control of the second secon | <pre>to effectively Warning - remove the multiple presence factor from the distribution factors. Warning - Additionally, the one-lane distribution factors will be used for fatigue. Info - Finished loading influence lines with selected vehicles for Stage 3 Span Model Info - Finished load analysis successfully completed!*** Info - Performing LRPD Specification Check Info - Tee Beam Alt - STAGE 3 - Support Location - 0.0000 (ft) Critical shear distance dv =3.0288 (ft) to right of this support. Shear will be checked at 3.0288 (ft) to right of this support. Shear will be checked at 3.0288 (ft) to left of this support. Shear will be checked at 36.9712 (ft) - Location - 2.4572 (ft) - Location - 4.0000 (ft) - Location - 4.0000 (ft) - Location - 16.0000 (ft) - Location - 16.0000 (ft) - Location - 16.0000 (ft) - Location - 23.0000 (ft) - Location - 23.0000 (ft) - Location - 23.0000 (ft) - Location - 30.0000 (ft) - Location - 3.0288 (ft) -</pre> | |
| | Serrors A Warnings | |
| | | Close |

The following steps are performed in a design review using the BrDR LRFD analysis engine.

 Finite element models are generated for the dead load and live load analyses. A Stage 1 FE model is generated for the dead loads on the reinforced concrete beam. A Stage 3 FE model is generated for the live load analysis. Reinforced concrete beams only have 1 stage so the Stage 1 and Stage 3 models contain the same cross section properties.

The model generated by the export to the BrDR LRFD analysis engine will contain node points at locations where the cross section properties change, span tenth points, support locations, and user defined points of interest.

- 2. The Stage 1 FE model is analyzed for the dead load. The Stage 3 FE model is loaded with unit loads at each node to generate influence lines for the beam. The influence loads are then loaded with the selected vehicles to find the maximum live load effects.
- 3. Load combinations are generated for the loadings and specification checks are performed at each of the nodes in the finite element model as well as the locations where schedule based reinforcement is developed.

The report containing the calculations of the rebar development locations is shown below.

| | - 0 | × | | | | | | |
|---|---|--|-------------------|----------|-------------|-------|--------|----|
| ICTrainingBridge1 ⇒ RCG Tee Beam ⇒ G2 ⇒ Tee Beam Alt → Lrid Beinf Dev Length Calcs Log File (1 ⇒ AASHTO_LRFD → Live Load Distribution Factors Calc → Live Load Distribution Factors Calc → Live Load Distribution Factors Calc → Live Load Spec Check Results → Log File | Vonday Jan. 23, 2023 11:30:04) :ulations :ulations Summary | | | | | | | |
| LrfdReinfDevLengthCalcs - Notepad | | | | | | - | | × |
| File Edit Format View Help | | | | | | | | |
| Bridge: RC Training Bridge1(LF Structure: RC6 Tee Beam Member: G2 Member Alt: Tee Beam Alt | :D) | | | | | | | |
| Spec: AASHTO LRFD Bridge Desig Edition: 9 Year: 2020 including 0 interim Note: These development length | <pre>in Specifications is i calculations are only valid for Bar Mark Def: #9 Bar Bar St</pre> | #11 bars or smaller | • in normalweight | concrete | with f'c up | to 15 | .0 ks: | i. |
| Keim. See #. 1 | bar hark ber. #5 bar bar bar se | are bistance0.250 | | | | | | |
| INPUT: Distance: 0.000 ft Bar Size: 9 Bar Clr Cover: 2.500 in | Reinf. Set #: 1 Bar Dia: 1.128 in Bar Clr Spacing:N/A | Bar Mark Def: #9 B Bar Area: 1.00 i Bar Side Cover: N | lar n^2 I/A | | | | | |
| Bar C/C Spacing: N/A | Bar Fy: 60,000 psi | Epoxy: FALSE | | | | | | |
| Hooked Bar: FALSE Concrete f'c: 4,000 psi Consider Fully Developed Start Consider Fully Developed End I | Hook At End of Mor: FALSE Concrete Composition: Normal t Ind: FALSE Ind: FALSE | Stirrup Spacing: Top Bar: FALSE | 12.000 in | | | | | |
| Hooked Bar: FALSE Concrete f'c: 4,000 psi Consider Fully Developed Start Consider Fully Developed End 1 OUTPUT: Article 5.10.8.2.1a-2: Basic Article 5.10.8.2.1b: Concr Article 5.10.8.2.1b: Concr Article 5.10.8.2.1b: Concr Article 5.10.8.2.1c: reinf Article 5.10.8.2.1c: exces Article 5.10.8: Comput | Hook At End of Mbr: FALSE Concrete Composition: Normal t Ind: FALSE Ind: FALSE Dev. Length = 81.22 in forcement location factor : 1.0 ing factor: 1.0 rete density modification factor forcement confinement factor: 0.4 is reinforcement factor: 1.0000 red Dev. Length = 32.49 in | Stirrup Spacing: Top Bar: FALSE (5.4.2.8): 1.0000 000 | 12.000 in | | | | | |

A summary and a detailed report of the computed live load distribution factors are available.

Х A RCTrainingBridge1 B-RCTrainingBridge1 RC6 Tee Beam ⊟-G2 ia⊡Tee Beam Alt ····· Lrfd Reinf Dev Length Calcs Log File AASHTO LRFD Live Load Distribution Factors Calculations Live Load Distribution Factors Calculations Summary (Monday Jan. 23, 2023 11:30:06) -Stage 3 Spec Check Results Log File LRFD Dist Factor Summary - Notepad Х File Edit Format View Help ~ ** ** Note that this file contains the distribution factors ** computed by the BrD wizard based on the bridge description ** ** in BrD on the date and time below. These computed values ** ** may not match those shown in BrD if the user has changed ** ** the BrD bridge description after these distribution ** ** ** factors were computed. *********** Bridge: RC Training Bridge1(LFD) Bridge ID: RCTrainingBridge1 NBI Structure ID: RCTrainBridge1 BID: 11 Superstructure Def: RC6 Tee Beam Member: G2 Member Alternative: Tee Beam Alt Date: 1/23/2023 Time: 11:30:06 AM AASHTO LRFD Bridge Design Specifications, Edition 9, Interim 0 Moment Distribution Factor Schedule Start End Single Lane Multi Lane DF DF Distance Distance (ft) (ft) (Lanes) (Lanes) -----_____ 0.00 40.00 0.491(A) 0.630(A) Shear Distribution Factor Schedule Start End Single Lane Multi Lane Distance Distance DF DF (ft) (ft) (Lanes) (Lanes) _ _ _ _ _ _ _ _ _ 0.00 40.00 0.600(A) 0.671(A) < > Ln 1, Col 1 100% Windows (CRLF) UTF-8

BrDR LRFD specification checking

A summary report of the specification check results is also available. This summary report lists the design ratios for each spec article at each spec check location point. The design ratio is the ratio of capacity to demand. A design ratio less than one indicates the demand is greater than the capacity and the spec article fails. A design ratio equal to 99.0 indicates the section is subject to zero demand.

| 🗛 RCTrainii | ngBridge1 | | | | | | - | | Х | | | | | | | |
|---------------------------|---|--|---|--|--------------------------------|----------------------------|------------------|----------------|----------------|--------|------|---|----|-----|----------|--------|
| 自-RCTrain 白-RC6 白-4 | ingBridge1 Tee Beam G2 ⊡-Tee Beam Alt ⊡-AASHTO_LI Live Lor Live Lor Log File | Dev Length RFD ad Distribut ad Distribut Spec Chec | n Calcs Log H tion Factors tion Factors k Results (N | File Calculations Calculations S Ionday Jan. 23 | Summary 3, 2023 11:3 | 0:09) | | | | | | | | | | |
| | | C:\Users\S | haranyaRao |)\Documents\/ | AASHTOWa | re\BrDR75i | \RCTrai | ningl 🔻 | c C | Search | ۱ | | Q, | • ŵ | 口 公 戀 | × |
| | Bridge ID : R Bridge : RC 7 Superstructur Member : G2 Analysis Pref | CTraining I CTraining I Training I Te Def : R | | NE Br Me | 3I Stru idge A ember | cture] lt : Alt :] | ID : R Fee Be | .CTra eam A | inBridş Alt | ge1 | | | | ^ | | |
| | AASHTOLE | TED Spec | cification <u>,</u> C heck | Edition 9, I | <u>(nterim 0</u> ary | | | | | | | | | | | |
| | | | Article | | | Status | 1 | | | | | | | | | |
| | | Flexure (| (5.6.3.2, 5 | .6.3.3) | | Pass | 1 | | | | | | | | | |
| | | Crack | Control (5 | 5.6.7) | | Pass | 1 | | | | | | | | | |
| | Shear (| (5.7.3.3, 5 | 5.7.2.5, 5. | 7.2.6, 5.7.3. | .5) | Fail | 1 | | | | | | | | | |
| | | Fatig | gue (5.5.3 | .2) | | Pass | 1 | | | | | | | | | |
| | | Deflect | tion (2.5.2 | 2.6.2) | | Pass |] | | | | | | | | | |
| | Girder I | Positiv | e Flex | ure An | alysis | | | | | | | | | | | |
| | Location (ft) | LS | Load Comb | Mr (kip-ft) | Mu (kip-ft) | De | sign F | latio I | Mr/M | u | Code |] | | | | |
| | 0.000 | STR-I | 1 | 120.91 | 0.0 | 00 | | | 99 | .000 | Pass | | | | | |
| | 2.457 | STR-I | 1 | 1276.49 | 298.3 | 36 | | | 4 | .278 | Pass | | | | | \sim |
| | 1 2 0 2 0 | CTTD T | I 1 | 1076.40 | 1 2/22 | 171 | | | 2 | 471 | n | 1 | | | | |

The specification checks can be viewed by selecting the **Specification Check Detail** on the **Results** group of the **DESIGN/RATE** ribbon.



| A Specification C | hecks for Tee Bea | rm Alt - 17 of 223 | | - 0 | × |
|---|--|--|---|--|---|
| Properties Specification filter | Generate | Articles All articles Format Bullet list Report | | | |
| Superstruct Superstruct Stage 3 S | ure Component Beam Alt Span 1 - 0.00 ft. Span 1 - 2.46 ft. Span 1 - 2.46 ft. Span 1 - 4.00 ft. Span 1 - 4.00 ft. Span 1 - 16.00 ft. Span 1 - 24.00 ft. Span 1 - 24.00 ft. Span 1 - 28.00 ft. Span 1 - 36.00 ft. Span 1 - 36.07 ft. | Specification reference Limit State ✓ 2.5.2.6.2 Criteria for Deflection 5.4.2.1 Compressive Strength ■ 5.4.2.1 Compressive Strength 5.4.2.5 Poisson's Ratio ■ 5.4.2.5 Poisson's Ratio 5.4.2.6 Concrete Density Modification Factor ✓ 5.5.3.2 Reinforcing Bars and Welded Wire Reinforcement 5.5.4.2 Strength Limit State - Resistance Factors ■ 5.6.2.2 Rectangular Stress Distribution ✓ 5.6.3.3 Minimum Reinforcement ✓ 5.6.3.3 Minimum Reinforcement Transverse Reinforcement dv distance from support Transverse Reinforcement ✓ 5.7.3.3 Nominal Shear Resistance | Flex. Sense N/A N/A | Pass/Fail Passed Passed General Comp. General Comp. Passed Passed | |
| S | Span 1 - 37.54 ft. Span 1 - 40.00 ft. | Rebar developed at this point Cof_Inertia Section Property Calculations | N/A N/A N/A | General Comp. Failed General Comp. | |

The BrDR RC LRFD engine performs spec checks at span tenth points, cross section property change points, and support locations. In addition, the program will perform spec checks at distance dv from the support and at locations where schedule based reinforcement starts/stops and is fully developed. The program will perform spec checks at user defined points of interest as well but note that a BrDR point of interest need not be created to have spec checks performed at the preceding locations.

Open the spec check detail window for the flexural resistance at midspan. The following is noted for this window, other spec articles are similar:

1. For each spec check location, both the left and right sides of the point are evaluated. The Deflection article is an exception to this since deflection must be the same between the left and right sides of a point.

- 2. The design ratio is printed out for the article. The design ratio is the ratio of capacity to demand. A design ratio less than one indicates the demand is greater than the capacity and the spec article fails. A design ratio equal to 99.0 indicates the section is subject to zero demand.
- 3. The Strength-I, Service-I and Fatigue limit states are the only limit states investigated. For each limit state, the max and min force effect is checked. Thus, each limit state shows two rows of data.
- 4. The LL load combination is shown in this column. If the location is not at a node in the FE model (e.g., the node is at a point where the rebar is fully developed), this column will list two load combinations separated by a comma. The first load combination is the combination considered at the left end and the second load combination is the combination considered at the right end of the FE element that contains this location. The resulting load displayed is a linear interpolation between the two displayed load cases.

| Br Spec Check Deta | ail for 5.6.3.2 Flexural Resi | stance (Reinforced C | oncrete) | | | | | - | | × |
|--|---|------------------------------------|----------------------|------------------------|-----------|-----------------|----------------|------|-------|--------|
| 5 Concrete Str 5.6 Design for 5.6.3 Flexura 5.6.3.2 Flexura (AASHTO LRFD H | ructures r Flexural and Axia l Members ral Resistance Bridge Design Speci | l Effects - B H fications, Nint | Regions th Editic | on) | | | | | | ^ |
| RC T-Beam - At | t Location = 20.000 | 0 (ft) - Left | 1 | | | | | | | |
| | Cross Sectio | n Properties | | | | | | | | |
| Total height = Flange Width = Flange Thick = No fillet spec Area = 1372.0 | = 39.50(in) = 72.00(in) = 7.50(in) cified. 00(in^2) | Web Widt Web Widt | n Top = n Bot = | 26.00(in) 26.00(in) | | | | | | |
| Flexural Rein | forcement | | | | | | | | | |
| As Dist Bo (in^2) 8.00 | t. From Dttom (in) 3.06 | | | | | | | | | |
| f'c = 4.00 ks: | i | | | | | | | | | |
| Note: If the o | capacity has been o se the Resistance i | verridden, the | Resistan | ice is compute | d as ove: | rride phi*over: | ride capacity. | | | |
| 3 | 4 | | | | | | | Ē | 2 | |
| Limit State | Lord | Ma | Dhi | Mrs | Ove: | rride | Mr= | Mm | ()(1) | |
| Limit State | Combination | kin-ft | FILL | kin-ft | FILL | kin-ft | kin-ft | PIL) | riu | |
| STR-I | 1 | 1218.90 | 0.900 | 1418.32 | | | 1276.49 | 1. | .05 | |
| STR-I | 1 | 311.17 | 0.900 | 1418.32 | | | 1276.49 | 4. | .10 | |
| STR-I | 2 | 1233.57 | 0.900 | 1418.32 | | | 1276.49 | 1. | .03 | |
| STR-I | 2 | 311.17 | 0.900 | 1418.32 | | | 1276.49 | 4. | .10 | |
| SER-I | 1 | 795.30 | 0.900 | 1418.32 | | | 1276.49 | 1. | .61 | |
| SER-1 | 1 | 345.75 | 0.900 | 1418.32 | | | 1276.49 | 3. | 50 | |
| SER-I SER-I | 2 | 345.75 | 0.900 | 1418.32 | | | 1276.49 | 3 | . 69 | |
| FAT-I | 3 | 283.40 | 0.900 | 1418.32 | | | 1276.49 | 4 | .50 | |
| FAT-I | 3 | 0.00 | 0.900 | 1418.32 | | | 1276.49 | 99. | .00 | |
| FAT-II | 3 | 129.55 | 0.900 | 1418.32 | | | 1276.49 | 9. | .85 | \sim |
| < | | | | | | | | | | > |
| | | | | | | | | [| Oł | < |

Tabular Results

Tabular dead load and live load analysis results are available in the Analysis Results window. They can be reviewed by clicking the **Tabular Results** button on the **Results** group of the **DESIGN/RATE** ribbon. The window shown below will open.

| Bridge Work | kspace - RCTrainingBridge1 | | ANALYSIS | REPORTS | ? | - | × |
|--|--|------------------------------------|-----------------|-----------|---|---|---|
| BRIDGE WORKSPACE | WORKSPACE TOOLS | VIEW | DESIGN/RATE | REPORTING | | | ^ |
| Analysis Settings Analysis Analysis Analysis | Tabular Results Check Detail Out Result | ogine Results tputs Graph ts | Save Results | | | | |

| " | Analy | rsis Results - | Tee Beam Al | t | | | | | | _ | | × |
|----------|----------------|----------------|---------------|--------|----------------|--------|-------|---------------|-----------------|------------------|---------|-----|
| | Print Print | | | | | | | | | | | |
| Rej | oort typ | be: | | Stage | | | 0 | ead Load Cas | e | | | |
| De | ead Loa | ad Actions | \sim | Non-co | omposite (Stag | ge 1) | ~ | Load Case 1 - | Self Load(Stage | : 1:[🖌 | | |
| | | | | | | | | Load Case 1 - | Self Load(Stage | 1:D,DC) | | |
| | - | Location | % | | Moment | Shear | Axial | Load Case 2 - | Exterior Diaphr | agm Loads(Stage | 1:D,DC) | |
| | Span | (ft) | Span | Side | (kip-ft) | (kip) | (kip) | Load Case 3 - | Parapet Loads(I | DC2:Stage 1:D,DC |) | |
| ► | 1 | 0.00 | 0.0 | Right | 0.00 | 29.33 | 0.0 | 29.33 | 0.0000 | 0.0000 | | - |
| | 1 | 4.00 | 10.0 | Both | 105.60 | 23.47 | 0.0 | 0 | 0.0000 | -0.0362 | | |
| | 1 | 8.00 | 20.0 | Both | 187.73 | 17.60 | 0.0 | 0 | 0.0000 | -0.0684 | | |
| | 1 | 12.00 | 30.0 | Both | 246.40 | 11.73 | 0.0 | 0 | 0.0000 | -0.0937 | | |
| | 1 | 16.00 | 40.0 | Both | 281.60 | 5.87 | 0.0 | 0 | 0.0000 | -0.1097 | | |
| | 1 | 20.00 | 50.0 | Left | 293.33 | 0.00 | 0.0 | 0 | 0.0000 | -0.1152 | | |
| | 1 | 20.00 | 50.0 | Right | 293.33 | 0.00 | 0.0 | 0 | 0.0000 | -0.1152 | | |
| | 1 | 24.00 | 60.0 | Both | 281.60 | -5.87 | 0.0 | 0 | 0.0000 | -0.1097 | | |
| | 1 | 28.00 | 70.0 | Both | 246.40 | -11.73 | 0.0 | 0 | 0.0000 | -0.0937 | | |
| | 1 | 32.00 | 80.0 | Both | 187.73 | -17.60 | 0.0 | 0 | 0.0000 | -0.0684 | | |
| | 1 | 36.00 | 90.0 | Both | 105.60 | -23.47 | 0.0 | 0 | 0.0000 | -0.0362 | | |
| | 1 | 40.00 | 100.0 | Left | 0.00 | -29.33 | 0.0 | 29.33 | 0.0000 | 0.0000 | | |
| | | | | | | | | | | | | - |
| | | | | | | | | | | | | |
| AA | SHIOL | .RFD Engine | Version 7.5.0 | .3001 | | | | | | | | |
| An | alysis p | reterence se | tting: None | | | | | | | | | |
| | | | | | | | | | | | Cle | ose |

| 🗛 Ani | lysis Results - | Tee Beam A | Alt | | | | | | | | | | | | | - | | × |
|------------|------------------|--------------|--------------------------------|--------------------------------|----------------------------|----------------------------|----------------------------|-----------------------------|-----------------------------------|----------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|--------------------------|------------------------|---------|-----|
| Prir | t | | | | | | | | | | | | | | | | | |
| Report 1 | ype: | | Stage | | 1 | Live Load | | Li | ve Load Type | | | | | | | | | |
| Live Lo | ad Actions | ~ | Composit | e (short term) (St | age 3) 🖌 | HL-93 (US) | | ~ <i>F</i> | xle Load | ~ | | | | | | | | |
| | | | | | | | | L | ane | | | | | | | | | |
| Spa | Location (ft) | % Span | Positive Moment (kip-ft) | Negative Moment (kip-ft) | Positive Shear (kip) | Negative Shear (kip) | Positive Axial (kip) | Negativ Axial (kip) T | ixle Load andem ruck + Lane | /e in | Positive X Deflection (in) | Negative X Deflection (in) | Positive Y Deflection (in) | Negative Y Deflection (in) | % Impact Pos Reaction | % Impact Neg Reacti | t on | |
| | 1 0.00 | 0.0 | 0.00 | 0.00 | 49.23 | 3 0.00 | 0.00 | т 0 | andem + Lane | 0.00 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 33.000 | 0. | 000 | - |
| | 4.00 | 10.0 | 160.96 | 0.00 | 42.81 | -2.85 | 0.00 | 0.0 | 0 | | 0.0000 | 0.0000 | 0.0000 | -0.0278 | | | | |
| | 1 8.00 | 20.0 | 273.63 | 0.00 | 36.39 | -5.71 | 0.00 | 0.0 | 0 | | 0.0000 | 0.0000 | 0.0000 | -0.0530 | | | | |
| | 1 12.00 | 30.0 | 338.02 | 0.00 | 29.97 | -8.56 | 0.00 | 0.0 | 0 | | 0.0000 | 0.0000 | 0.0000 | -0.0727 | | | _ | |
| | 1 16.00 | 40.0 | 372.89 | 0.00 | 24.26 | 5 -12.84 | 0.00 | 0.0 | 0 | | 0.0000 | 0.0000 | 0.0000 | -0.0849 | | | _ | |
| | 1 20.00 | 50.0 | 368.87 | 0.00 | 18.55 | 5 -18.55 | 0.00 | 0.0 | 0 | | 0.0000 | 0.0000 | 0.0000 | -0.0888 | | | _ | |
| | 1 24.00 | 60.0 | 372.89 | 0.00 | 12.84 | -24.26 | 0.00 | 0.0 | 0 | | 0.0000 | 0.0000 | 0.0000 | -0.0849 | | | | |
| | 1 28.00 | 70.0 | 338.02 | 0.00 | 8.56 | 5 -29.97 | 0.00 | 0.0 | D | | 0.0000 | 0.0000 | 0.0000 | -0.0727 | | | _ | |
| | 1 32.00 | 80.0 | 273.63 | 0.00 | 5.71 | -36.39 | 0.00 | 0.0 | D | | 0.0000 | 0.0000 | 0.0000 | -0.0530 | | | _ | |
| | 1 36.00 | 90.0 | 160.96 | 0.00 | 2.85 | 5 -42.81 | 0.00 | 0.0 | 0 | | 0.0000 | 0.0000 | 0.0000 | -0.0278 | | | | |
| | 1 40.00 | 100.0 | 0.00 | 0.00 | 0.00 | -49.23 | 0.00 | 0.0 | 0 49.23 | 0.00 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 33.000 | 0. | 000 | |
| | | | | | | | | | | | | | | | | | | ~ |
| ΔΔSHT | LRED Engine | Version 7.5 | 0 3001 | | | | | | | | | | | | | | | |
| Analysis | nreference se | atting: None | | | | | | | | | | | | | | | | |
| - analysis | preference a | -tung. None | | | | | | | | | | | | | | [| Clo | ose |

Note these values include dynamic load allowance, distribution factors and any live load scale factor entered in the **Analysis Settings** window.

Method of Solution

The Method of Solution manual can be accessed from the Help menu in BrDR.



Click on the Bridge Workspace ribbon to access the Support menu.

In the **Engine Help** column select **AASHTO LRFD** to access the **Engine Help** and **Method of Solution** for the selected engine. Double-click on **Method of Solution** from the **Engine Help Configuration** column to open the method of solution for the selected engine

| \bigotimes | Bridge Wo | orksp | pace - RCTrainingBridge1 | - | | , x |
|--------------|--|-------|---------------------------|---|---|------------|
| 🖶 Print | Support | | | | | |
| Help | Help Topics Getting help using the software | | | | | |
| 🖾 Close | Frequently Asked Questions Find questions that are frequently asked | | | | | |
| | Support Find more information on technical support | | | | | |
| | Engine | | | | | |
| | Engine Help | | Engine Help Configuration | | | |
| | AASHTO ASR | ` | Engine Help | | | |
| | AASHTO Culvert LFR | Ŀ | Method of Solution | | | |
| | AASHTO Culvert LRFD | Ŀ | | | | |
| | AASHTO Culvert LRFR | Ŀ | | | | |
| | AASHTO LFR | Ŀ | | | | |
| | AASHTO LRFD Default Engine Help | | | | | |
| | AASHTO LRFD Substructure (BrD) | | | | | |
| | AASHTO LRFR | | | | | |
| | AASHTO Metal Culvert LFR | | | | | |
| | AASHTO Metal Culvert LRFR 🗸 | - | | | _ | |
| | Set As Main Engine Help | | | | | |
| | About | | | | | |
| | About | | | | | |
| | Bridge Design & Rati Version 7.5.0.1 Build date Oct 12 2022 | ing | | | | ۲ |

