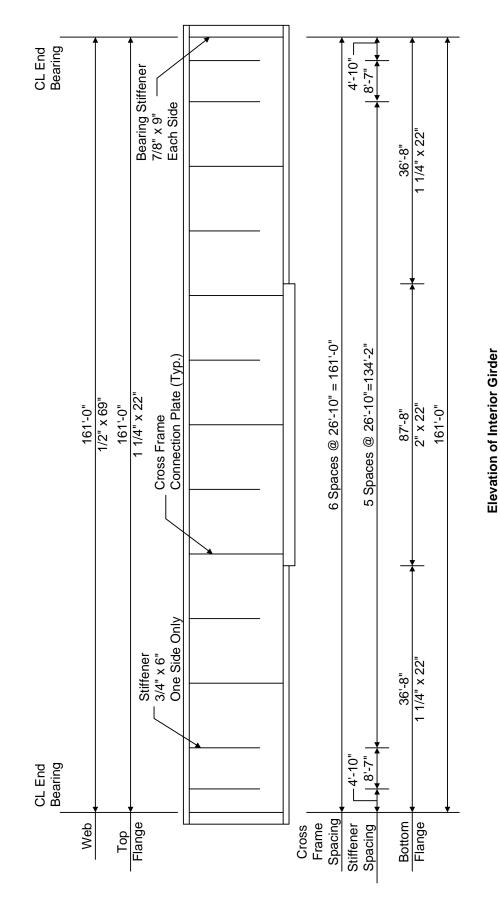


|  |  |  | 13'-0" |
|--|--|--|--------|
|  |  |  | 13'-0" |
|  |  |  | 13'-0" |

| 1 | 6 spaces @ 26'-10" | 1 |
|---|--------------------|---|
|   | 161'-0"            | ĺ |
|   |                    | l |

### Framing Plan

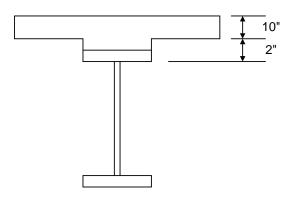


### **Material Properties**

Structural Steel: AASHTO M270, Grade 50W uncoated weathering steel with Fy = 50 ksi Deck Concrete: f'c = 4.5 ksi, modular ratio n = 8 Slab Reinforcing Steel: AASHTO M31, Grade 60 with Fy = 60 ksi

Transverse Stiffener Plates: 3/4" x 6" Cross Frame Connection Plates: 3/4" x 6" Bearing Stiffener Plates: 7/8" x 9"

#### Haunch Detail



# AASHTOWare Bridge Rating and Design Training

# STL1– Simple Span Plate Girder Example (BrR/BrD 6.4)

| 4 | <b>\</b>                |                             |                             |                                       |             | <u>- 🗆 ×</u> |
|---|-------------------------|-----------------------------|-----------------------------|---------------------------------------|-------------|--------------|
|   | Bridge ID: Example 4a   | NBI Structure ID            |                             | Femplate<br>Bridge Completely Defined | Superstruct | tures        |
|   | Description Description | n (cont'd) Alternatives Glo | bal Reference Point Traffic |                                       |             |              |
|   | Name:                   | Example 4a                  |                             | Year Built:                           |             |              |
|   | Description:            |                             |                             |                                       |             |              |
|   |                         |                             |                             |                                       | -           |              |
|   | Location:               | Sample                      | Length                      | 161.00 ft                             |             |              |
|   | Facility Carried (7):   | Sample                      | Route Number:               | 76                                    |             |              |
|   | Feat. Intersected (6):  | Sample                      | Mi. Post:                   | 2.00                                  |             |              |
|   | Default Units:          | US Customary                |                             |                                       |             |              |
|   |                         |                             |                             |                                       |             |              |
|   |                         |                             |                             |                                       |             |              |
|   | BridgeWare Associatio   | on 🔽 Virtis 🗹 Opis 🗖        | Pontis                      | ОК                                    | Apply       | Cancel       |

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

| A                       |  | _ 🗆 ×   |
|-------------------------|--|---|
| Bridge ID: Example 4a   | NBI Structure ID (8): Example 4a Template<br>Bridge Completely Defined | <ul> <li>Superstructures</li> <li>Culverts</li> </ul> |
| Description Description | (cont'd) Alternatives Global Reference Point Traffic                   | Curverts  |
| District (2):           | District 1   |   |
| County:                 | 01 Abbeville   |   |
| Owner (22):             | State Highway Agency   |   |
| Maintainer:             | State Highway Agency   |   |
| Admin. Area:            | Unknown  |   |
| NHS Indicator:          | 0 Not on NHS   |   |
| Functional Class:       | 17 Urban Collector   |   |
|                         |  |   |
| BridgeWare Association  | 🔽 Virtis 🔽 Opis 🗖 Pontis   |   |
|                         | - Virtis 🗹 Opis 🔽 Pontis   | pply Cancel   |

AASHTOWare Bridge Rating and Design Training - STL1 - Simple Span Plate Girder Example

Close the window by clicking Ok. This saves the data to memory and closed the window.

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

| 📲 Bridge V | Workspace - Example 4a              | <u>- 0 ×</u> |
|------------|-------------------------------------|--------------|
| ·- 🗛       | Example 4a                          |              |
| ÷          | 🧰 Materials                         |              |
| ÷          | 🧰 Beam Shapes                       |              |
| ÷          | 🧰 Appurtenances                     |              |
|            | 🚞 Diaphragm Definitions             |              |
|            | 📑 Impact / Dynamic Load Allowance   |              |
|            | MPF LRFD Multiple Presence Factors  |              |
| ÷          | Factors                             |              |
|            | 🚞 LRFD Substructure Design Settings |              |
|            | EC Environmental Conditions         |              |
|            | DP Design Parameters                |              |
|            | SUPERSTRUCTURE DEFINITIONS          |              |
|            | CULVERT DEFINITIONS                 |              |
|            | BRIDGE ALTERNATIVES                 |              |
|            |                                     |              |

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

| To enter the materials to be used by members of the bridge, click on the | $\pm$   | to expand the tree for |
|--|---------|------------------------|
| Materials.   | lanced. |                        |

| 📲 Bridge V | Vorkspace - Example 4a              | _ 🗆 🗵 |
|------------|-------------------------------------|-------|
| · 🖃 🗛      | Example 4a                          |       |
| ÷          | 🧰 Materials                         |       |
|            | 🧰 Structural Steel                  |       |
|            | 🧰 Concrete                          |       |
|            | 🧰 Reinforcing Steel                 |       |
|            | 🧰 Prestress Strand                  |       |
|            | 🕂 ····· 🧰 Timber                    |       |
|            | 🛄 Soil                              |       |
| ÷          | 🧰 Beam Shapes                       |       |
| ÷          | Appurtenances                       |       |
|            | Diaphragm Definitions               |       |
|            | 📑 Impact / Dynamic Load Allowance   |       |
|            | MPF LRFD Multiple Presence Factors  |       |
| ÷          | Factors                             |       |
|            | 🚞 LRFD Substructure Design Settings |       |
|            | EC Environmental Conditions         |       |
|            | PP Design Parameters                |       |
|            | SUPERSTRUCTURE DEFINITIONS          |       |
|            | CULVERT DEFINITIONS                 |       |
|            | BRIDGE ALTERNATIVES                 |       |

The tree with the expanded Materials branch is shown below:

To add a new structural steel material, click on Structural Steel in the tree and select File/New from the menu (or right mouse click on Structural Steel and select New). The window shown below will open.

| 🗛 Bridge Materials | - Structural Steel  |        |       |        |
|--------------------|---|--------|-------|--------|
| <u>N</u> ame:      | De <u>s</u> cri   | ption: |       |        |
|                    | Material Proper   | ties   |       |        |
|                    | Specified minimum yield strength (Fy) =                   |        | ksi   |        |
|                    | Specified minimum tensile strength (F $\underline{u}$ ) = |        | ksi   |        |
|                    | <u>C</u> oefficient of thermal expansion =                |        | 1/F   |        |
|                    | <u>D</u> ensity =   |        | kcf   |        |
|                    | Modulus of elasticity ( $\underline{E}$ ) =               |        | ksi   |        |
|                    |   |        |       |        |
|                    |   |        |       |        |
|                    |   |        |       |        |
|                    | Copy from Library   | л ОК   | Apply | Cancel |

Add structural steel materials by selecting from the Structural Steel Materials Library by clicking the Copy from Library button.

| Name                               | Description             | Library | Units   | Fy    | Fu    | alpha | Density/<br>Unit Load | Modulus of<br>Elasticity |  |
|------------------------------------|-------------------------|---------|---------|-------|-------|-------|-----------------------|--------------------------|--|
| ASTM A588 - > 5" to 8" incl.       | ASTM A 588 - over       | Standa  | US Cu   | 42.00 | 63.00 | 0.000 | 0.4900                | 29000.00                 |  |
| ASTM A94 - <= 1 1/8"               | ASTM A 94 - 1 1/8" t    | Standa  | US Cu   | 50.00 | 75.00 | 0.000 | 0.4900                | 29000.00                 |  |
| ASTM A94 - over 1 1/8" to 2" incl. | ASTM A 94 - over 1      | Standa  | US Cu   | 47.00 | 72.00 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 100 - > 2.5" to 4" incl.     | AASHTO M270 Grad        | Standa  | US Cu   | 90.00 | 100.0 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 100 <= 2.5"                  | AASHTO M270 Grad        | Standa  | US Cu   | 100.0 | 110.0 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 100VV - > 2.5" to 4" incl.   | AASHTO M270 Grad        | Standa  | US Cu   | 90.00 | 100.0 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 100W <= 2.5"                 | AASHTO M270 Grad        | Standa  | US Cu   | 100.0 | 110.0 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 250                          | AASHTO M270M Gr         | Standa  | SI / Me | 250.0 | 400.0 | 0.000 | 7849.000              | 199948.00                |  |
| Grade 345                          | AASHTO M270M Gr         | Standa  | SI / Me | 345.0 | 450.0 | 0.000 | 7849.000              | 199948.00                |  |
| Grade 345W                         | AASHTO M270M Gr         | Standa  | SI / Me | 345.0 | 485.0 | 0.000 | 7849.000              | 199948.00                |  |
| Grade 36                           | AASHTO M270 Grad        | Standa  | US Cu   | 36.00 | 58.00 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 485W                         | AASHTO M270M Gr         | Standa  | SI / Me | 485.0 | 620.0 | 0.000 | 7849.000              | 199948.00                |  |
| Grade 50                           | AASHTO M270 Grad        | Standa  | US Cu   | 50.00 | 65.00 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 50W                          | AASHTO M270 Grad        | Standa  | US Cu   | 50.00 | 70.00 | 0.000 | 0.4900                | 29000.00                 |  |
| Grade 690 - > 65 to 100 incl.      | AASHTO M270M - o        | Standa  | SI / Me | 620.0 | 690.0 | 0.000 | 7849.000              | 199947.95                |  |
| Grade 690 <= 65 mm                 | AASHTO M270M Gr         | Standa  | SI / Me | 690.0 | 760.0 | 0.000 | 7849.000              | 199948.00                |  |
| Grade 690W - > 65 to 100 incl.     | AASHTO M270M - o        | Standa  | SI / Me | 620.0 | 690.0 | 0.000 | 7849.000              | 199947.95                |  |
| Grade 690W ≺= 65 mm                | AASHTO M270M Gr         | Standa  | SI / Me | 690.0 | 760.0 | 0.000 | 7849.000              | 199948.00                |  |
| Grade 70W                          | AASHTO M270 Grad        | Standa  | US Cu   | 70.00 | 90.00 | 0.000 | 0.4900                | 29000.00                 |  |
| Prior to 1905                      | Built prior to 1905 - s | Standa  | US Cu   | 26.00 | 52.00 | 0.000 | 0.4900                | 29000.00                 |  |

Select the AASHTO M270 Grade 50W material and click Ok. The selected material properties are copied to the Bridge Materials – Structural Steel window as shown below.

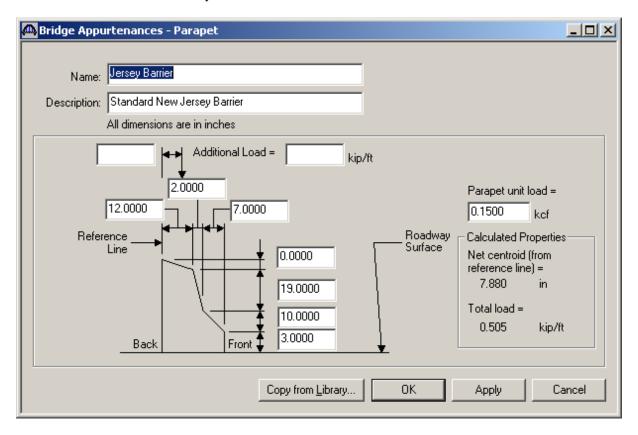
| A Bridge Materials - Structural Steel                  | - 🗆 🗵  |
|--|--------|
| Name: Grade 50W Description: AASHTO M270 Grade 50W     |        |
| Material Properties                                    |        |
| Specified minimum yield strength (Fy) = $50.000$ ksi   |        |
| Specified minimum tensile strength (Fu) = $70.000$ ksi |        |
| Coefficient of thermal expansion = 0.0000065000 1/F    |        |
| <u>D</u> ensity = 0.4900 kcf                           |        |
| Modulus of elasticity ( <u>E</u> ) = 29000.00 ksi      |        |
|  |        |
|  |        |
|  |        |
| Copy from Library OK Apply (                           | Cancel |

Add concrete materials and reinforcement materials using the same techniques. Enter the concrete material as shown below:

| Bridge Materials - Concrete |                       |                  |          | <u> </u> |
|-----------------------------|-----------------------|------------------|----------|----------|
| Name: Deck Concrete         | Descrip               | otion: Deck Conc | rete     |          |
| Compressive strength at 28  | B  days  (f'c) = 4.   | 500              | ksi      |          |
| Initial compressive str     | ength (f'ci) =        | 1                | ksi      |          |
| Coefficient of thermal      | expansion = $0$ .     | 0000060000       | 1/F      |          |
| Density (for d              | ead loads) = $0$ .    | 150              | kcf      |          |
| Density (for modulus o      | f elasticity) = $0$ . | 145              | kcf      |          |
| Modulus of ela              | sticity (Eld) = 38    | 865.20           | ksi      |          |
| Initial modulus o           | of elasticity = 0.    | .00              | ksi      |          |
| Pois                        | sson's ratio = $0$ .  | .200             |          |          |
| Composition of              | f concrete = N        | lormal           | <b>T</b> |          |
| Modulus                     | of rupture = $0$ .    | .51              | ksi      |          |
| Sł                          | hear factor = $1$ .   | .000             |          |          |
|                             | opy from Library.     | ] [OK            | Apply    | Cancel   |

| Bridge Materials - Reinforcing Steel                          | - 🗆 🗵 |
|---|-------|
| Name: Grade 60. Description: 60 ksi reinforcing steel         |       |
| Material Properties   |       |
| Specified yield strength (Fy) = 60.000 ksi                    |       |
| Modulus of elasticity ( <u>E</u> s) = 29000.00 ksi            |       |
| <i>Littimate strength (F<u>u</u>) =</i> 90.000 ksi            |       |
| Type<br>Plain<br>Epoxy<br><u>G</u> alvanized<br><u>U</u> ther |       |
| Copy from Library OK Apply Ca                                 | ancel |

To enter the appurtenances to be used within the bridge expand the tree branch labeled Appurtenances. To define a parapet double click on Parapet in the tree and input the parapet dimensions as shown below. Click Ok to save the data to memory and close the window.



Enter the impact to be used for the entire bridge by clicking on Impact in the tree and selecting File/Open from the menu. The Bridge Impact window shown below will open. Enter the appropriate values as shown and click Ok to save the data to memory and close the window. The values shown below are default values.

| 🚇 Bridge Impact / Dynamic Load Allowance 📃 🔍  |  |  |  |  |
|---|--|--|--|--|
| C Standard Impact Factor  |  |  |  |  |
| For structural components where impact is to be included per AASHTO 3.8.1, choose the impact factor to be used: |  |  |  |  |
| ● <u>S</u> tandard AASHTO impact  =   |  |  |  |  |
| C Modified impact = times AASHTO impact   |  |  |  |  |
| ○ <u>C</u> onstant impact override =  |  |  |  |  |
| - LRFD Dynamic Load Allowance   |  |  |  |  |
| Eatigue and fracture limit states: 15.0 $\%$  |  |  |  |  |
| <u>A</u> ll other limit states: 33.0 %  |  |  |  |  |
|   |  |  |  |  |
| OK Apply Cancel   |  |  |  |  |

For this example problem we are not going to override the standard LRFD or LRFR factors so we skip to Structure Definition. We will come back to Bridge Alternatives after entering a Structure Definition.

Double click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select File/New from the menu or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new structure definition. The dialog shown below will appear.

| New Superstructure Definition                    | ×         |
|--|-----------|
|  |           |
| <ul> <li>Girder System Superstructure</li> </ul> |           |
| C Girder Line Superstructure                     |           |
| C Floor System Superstructure                    |           |
| C Floor Line Superstructure                      |           |
| C Truss System Superstructure                    |           |
| C Truss Line Superstructure                      |           |
|  | OK Cancel |

Select Girder System and the Structure Definition window will open. Enter the appropriate data as shown below:

| 🚇 Girder System Super                                    | structure Definition |   |          |  |
|--|----------------------|---|----------|--|
| Definition Analysis Sp                                   | becs Engine          |   |          |  |
| Name:  | SD1                  |   |          | Frame Structure<br>Simplified Definition           |
| Description:   |                      |   | ×        | Deck type:<br>Concrete                             |
| Default Units:<br>Number of spans:<br>Number of girders: |                      | Enter Span Lengths<br>Along the Reference<br>Line:<br>Span Length<br>(ft)<br>1 161.00 | <b>Y</b> | For PS only<br>Average humidity:                   |
|  |                      |   |          | Member Alt. Types<br>Steel<br>P/S<br>R/C<br>Timber |
|  |                      |   | (COK     | Apply Cancel                                       |

| Structural Slab Thickness<br>Consider structural slab thickness for rating<br>Consider structural slab thickness for design                      | Number of shell elements<br>In the deck between girders      In the web between flanges                              |
|--|--|
| Vearing Surface     ✓ Consider wearing surface for rating     ✓ Consider wearing surface for design     Default Analysis Type: Line Girder     ✓ | Slower Faster<br>More accurate Less accurate<br>10 9 8 7 6 5 4 3 2 1   |
| Longitudinal Loading<br>Vehicle increment: 1.000 ft  | Target aspect ratio for shell elements           Slower         Faster           More accurate         Less accurate |
| Transverse Loading<br>Vehicle increment in lane: 2.000 ft<br>Lane increment: 4.000 ft  | 1.0 1.5 2.0 2.5 3.0 3.5 4.0  |

| Girder System Su        | perstructure D  | efinition        |                       |                    |              |
|-------------------------|-----------------|------------------|-----------------------|--------------------|--------------|
| Definition Analysis     |                 | •                |                       |                    |              |
| Analysis Method<br>Type | Analysis Module | Selection Type   | Spec Version          | Factors            |              |
| ASD                     | AASHTO AS 💌     | System Default 💌 | MBE 2nd, Std 17th 🛛 🚬 | N/A 🔄              |              |
| LFD                     | AASHTO LFD 💌    | System Default 💌 | MBE 2nd, Std 17th 👘 🚬 | 2002 AASHTO Std. 🗾 |              |
| LRFD                    | AASHTO LRF 💌    | System Default 💌 | LRFD 5th 2010i 📃 🚬    | 2010 AASHTO LRF 🗾  |              |
| LRFR                    | AASHTO LRF 💌    | System Default 💌 | MBE 2nd, LRFD 5th 2 🚬 | 2011 AASHTO LRF 🗾  |              |
|                         |                 |                  |                       |                    |              |
|                         |                 |                  |                       | ОК                 | Apply Cancel |

The Analysis tab and Specs tab are shown above with the default selections. Since we are not overriding default selections for this exercise, no changes are required.

Click on Ok to save the data to memory and close the window.

🜃 Bridge Workspace - Example 4a \_ 🗆 × 🕰 Example 4a 🗄 💮 🛅 Materials 🗄 🖳 🚞 Structural Steel 🗄 💮 💼 Concrete 🗄 🖳 Reinforcing Steel 🔤 Prestress Strand 🗄 \cdots 📄 Timber 🛄 Soil 🗄 💮 Beam Shapes 🗄 🖳 🧰 Appurtenances \cdots 📄 Diaphragm Definitions 🛛 📑 Impact / Dynamic Load Allowance MPF LRFD Multiple Presence Factors 🗄 💮 Factors --- 🧰 LRFD Substructure Design Settings ----- Environmental Conditions ----- Design Parameters SUPERSTRUCTURE DEFINITIONS 🖻 🗝 🖬 SD1 📑 Impact / Dynamic Load Allowance Load Case Description 🛲 Framing Plan Detail - 🎹 Structure Typical Section ----- 🕂 Superstructure Loads 🗄 \cdots 🚞 Connectors -- 📄 Shear Connector Definitions 🗄 \cdots 📃 Stiffener Definitions 🖻 🗝 🚞 MEMBERS . ⊡..... **I** G1 🕂 Member Loads 🔼 Supports MEMBER ALTERNATIVES I G2 ÷ I G3 **I** G4 ÷.... CULVERT DEFINITIONS BRIDGE ALTERNATIVES

The partially expanded Bridge Workspace tree is shown below:

We now go back to the Bridge Alternatives and create a new Bridge Alternative by double-clicking on Bridge Alternatives. Enter the following data:

| 🗛 Bridge Alternative   |   |
|--|---|
| Alternative Name: Bridge Alternative 1   |   |
| Description Substructures  | 1   |
| Description:   | ~   |
| Reference Line<br>Reference Line Length = 0.00 ft<br>Starting Station = ft<br>Bearing = N 0^ 0' 0.00'' E | Global Positioning<br>Distance = -0.000 ft<br>Offset = 0.000 ft<br>Elevation = ft |
| Superstructure<br>Wizard   |   |
|  | OK Apply Cancel   |

Click Ok to save the data to memory and close the window.

Double-click on Superstructures and enter the following new superstructure:

| A Superstructure   | <u>- 0 ×</u> |
|--|--------------|
| Superstructure Name: Structure 1                           |              |
| Description Alternatives Vehicle Path Engine Substructures |              |
| Description:   |              |
| Reference Line   |              |
| Distance = 0.000 ft<br>Offset = -0.000 ft                  |              |
| Angle = 0.00 Degrees                                       |              |
| Starting Station = 0.00 ft                                 |              |
|  |              |
|  |              |
| OK Apply   | Cancel       |

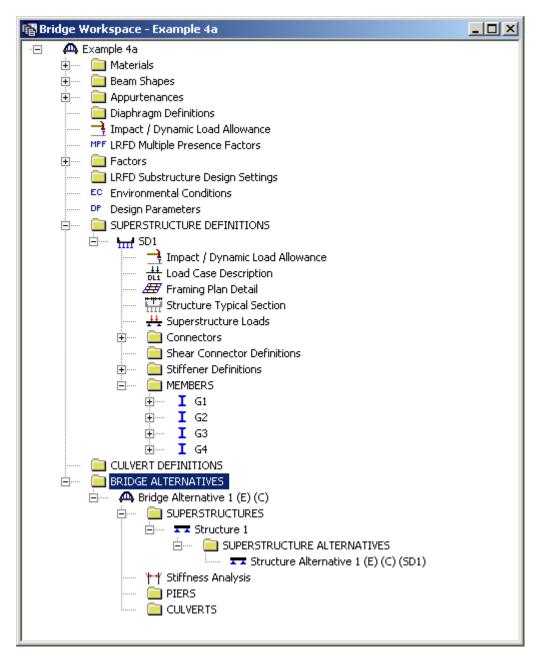
Double-click on Superstructure Alternatives and enter the following new Superstructure Alternative. Select the Superstructure definition SD1 as the current superstructure definition for this Superstructure Alternative.

| Superstructure Altern           | ative                   |                 |
|---------------------------------|-------------------------|-----------------|
| Alternative <u>N</u> ame:       | Structure Alternative 1 |                 |
| <u>D</u> escription:            |                         | A<br>V          |
| Superstructure Definition:      | SD1                     |                 |
| Superstructure type:            | Girder                  |                 |
| Number of main members:         | 4                       |                 |
| Span Length<br>(ft)<br>1 161.00 |                         |                 |
|                                 |                         | OK Apply Cancel |

Re-open the Structure 1 window and select the Alternatives tab. The Structure Alternative 1 will be shown as the existing and current alternative for Structure 1.

| Superstructure  | <u>- 🗆 ×</u> |
|---|--------------|
| Superstructure Name: Structure 1  |              |
| Description Alternatives Vehicle Path Engine Substructures  |              |
| Existing     Current     Superstructure     Alternative     Name     Description       Image: Comparison of the second structure     Alternative1     Image: Comparison of the second structure | -            |
|   |              |
|   |              |
|   |              |
|   |              |
|   |              |
| OK Apply Ca   | ancel        |

The partially expanded Bridge Workspace tree is shown below:



Click Load Case Description to define the dead load cases. The completed Load Case Description window is shown below.

| ALoad Case Description |                      |  |                                   |        |                 |  |
|------------------------|----------------------|--|-----------------------------------|--------|-----------------|--|
| Г                      |                      |  |                                   |        |                 |  |
|                        | Load Case<br>Name    | Description                              | Stage                             | Туре   | Time*<br>(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 🔽 |                 |  |
|                        |                      |  |                                   |        |                 |  |
|                        |                      |  |                                   |        |                 |  |
|                        |                      |  |                                   |        |                 |  |
|                        |                      |  |                                   |        |                 |  |
|                        |                      |  |                                   |        |                 |  |
|                        | ,<br>*Prestressed me | Add Default Load<br>Case Descriptions    | New Duplica                       | ate    | Delete          |  |
|                        |                      |  |                                   | oly    | Cancel          |  |

Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below.

| Structure Framing Plan Details  | × |
|---|---|
| Number of spans = 1 Number of girders = 4   |   |
| Support       Skew<br>(Degrees)         1       0.0000         2       0.0000         index       Girder Spacing<br>(trider Spacing)         index       Girder Girder         index       Girder         index |   |
| OK Apply Cancel   | ] |

| Structure Framing Plan Details |   |  |              |
|--------------------------------|---|--|--------------|
|                                | Number of spans = 1                         | Number of girders = 4                                  |              |
| Layout Diaphragms              |   |  |              |
| Girder Bay: 1 Copy B           | Bay To Diaphragm<br>Wizard                  |  |              |
| Number (ft) Spa                | hragm Number Length<br>acing of Spaces (ft) | End Distance<br>(ft)<br>Left Girder Right Girder (kip) | Diaphragm    |
|                                |   |  |              |
|                                |   |  |              |
|                                |   |  |              |
|                                |   |  |              |
|                                |   |  |              |
|                                |   | NewDupli   | cate Delete  |
|                                |   | ОК   | Apply Cancel |

Switch to the Diaphragms tab to enter diaphragm spacing.

Click the Diaphragm Wizard button to add diaphragms for the entire structure. The Dialog shown below will appear.

| Diaphragm Wizard                        | ×    |
|---|------|
| Select the desired framing plan system: |      |
|   |      |
|   |      |
|   |      |
| < <u>Back</u> <u>N</u> ext > Cancel     | Help |

Click the Next button and enter the following spacing:

| Diaphragm Wizard   | × |
|--|---|
| Diaphragm Spacing     O     Enter number of equal spaces per span     C     Enter equal spacing per span     C     Enter groups of equal spacing |   |
| Support diaphragm load: kip  |   |
| Interior diaphragm load: kip   |   |
| Span         Length         Number of           (ft)         Equal Spaces  |   |
| 1 161.00 6   |   |
|  |   |
|  |   |
| ,  |   |
|  |   |
| < Back Finish Cancel Help  |   |

Click the Finish button to add the diaphragms. The Diaphragm Wizard will create diaphragms for all of the girder bays in the structure.

The diaphragms created for Girder Bay 1 are shown below:

| <mark>مم</mark> | truct   | ure            | Framing Plan I                | Details |                              |                     |                     |                              |        |               |                | _ 🗆 🗙            |
|-----------------|---|----------------|-------------------------------|---------|------------------------------|---------------------|---------------------|------------------------------|--------|---------------|----------------|------------------|
| Γ               | Number of spans =     1     Number of girders =     4       Layout     Diaphragms     . |                |                               |         |                              |                     |                     |                              |        |               |                |                  |
|                 | Girde   | r Bay          | : 1                           |         | Сору Вау То                  |                     | Diaphragm<br>Wizard |                              |        |               |                |                  |
|                 | Sup<br>Nun  | port<br>nber - | Start Di<br>(f<br>Left Girder |         | Diaphragm<br>Spacing<br>(ft) | Number<br>of Spaces | Length<br>(ft)      | End Dis<br>(f<br>Left Girder |        | Load<br>(kip) | Diaphragm      | $\left[ \right]$ |
|                 | 1   | -              | 0.00                          | 0.00    | 0.00                         | 1                   | 0.00                | 0.00                         | 0.00   |               | Not Assigned   | ]                |
|                 | 1   | -              | 0.00                          | 0.00    | 26.83                        | 5                   | 134.17              | 134.17                       | 134.17 |               | Not Assigned 💌 |                  |
|                 | 1   | •              | 161.00                        | 161.00  | 0.00                         | 1                   | 0.00                | 161.00                       | 161.00 |               | Not Assigned 💌 |                  |
|                 |   |                |                               |         |                              |                     |                     |                              | N      | sw Du         | plicate Delete | 2                |
|                 |   |                |                               |         |                              |                     |                     |                              |        | OK            | Apply Ca       | incel            |

Select Ok to close the window.

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.

Basic deck geometry:

| A Structure Typical Section   |
|---|
| Distance from left edge of deck to Distance from right edge of deck to superstructure definition ref. line                      |
| Deck Superstructure Definition  |
| Left overhang   |
| Deck Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Wearing Surface  |
| Superstructure definition reference line is within the bridge deck.   |
| Distance from left edge of deck to<br>superstructure definition reference line =     Start     End       23.75     ft     23.75 |
| Distance from right edge of deck to<br>superstructure definition reference line = 23.75 ft 23.75 ft                             |
| Left overhang = $4.25$ ft $4.25$ ft   |
| Computed right overhang = $4.25$ ft $4.25$ ft   |
| OKApply Cancel  |

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 above.

| 4 | Structure Typical Section  |       |
|---|--|-------|
|   | Distance from left edge of deck to<br>superstructure definition ref. line<br>Deck<br>thickness<br>Left overhang<br>Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Wearing Surface<br>Deck Concrete: Deck Concrete |       |
|   | Total deck thickness: 10.0000 in   |       |
|   | Deck <u>c</u> rack control parameter: 130.000 kip/in   |       |
|   | Sustained modular ratio factor: 3.000  |       |
|   | Deck exposure factor:  |       |
|   | OK Apply C   | ancel |

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" and "Measure To" to "Back" (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.

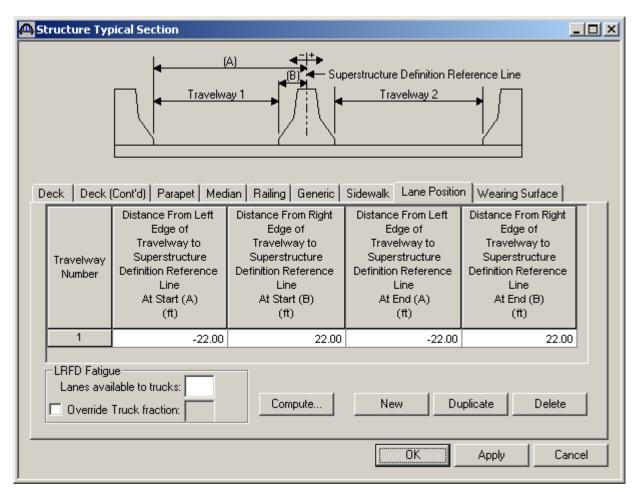
| <mark> M</mark> St | ructure Typica | al S     | ection    |                     |  |                              |                            |                           | _ 🗆 × |
|--------------------|----------------|----------|-----------|---------------------|--|------------------------------|----------------------------|---------------------------|-------|
| De                 | eck Deck (Cor  | nt'd)    | Parapet   | Back<br>Median   Ra |  | Front<br>Sidewalk Lane       | Position Wear              | ing Surface )             |       |
|                    | Name           |          | Load Case | Measure To          | Edge of Deck<br>Dist. Measured<br>From | Distance At<br>Start<br>(ft) | Distance At<br>End<br>(ft) | Front Face<br>Orientation |       |
|                    | Jersey Barrier |          | DC2 💌     | Back 💌              | Left Edge 💌                            | 0.00                         | 0.00                       | Right 💌                   |       |
|                    | Jersey Barrier | <b>_</b> | DC2 💌     | Back 💌              | Right Edge 💌                           | 0.00                         | 0.00                       | Left 💌                    |       |
|                    |                |          |           |                     |  | New                          | Duplicate                  | Delete                    |       |
|                    |                |          |           |                     |  | OK                           | Apply                      | Ca                        | ancel |

## Lane Positions:

Select the Lane Position tab.

| 🕰 Struc   | ture Typ          | oical Section   |  |   |  |  |  |
|---|-------------------|---|--|---|--|--|--|
| (A)<br>(B)<br>Superstructure Definition Reference Line<br>Travelway 1<br>Travelway 2<br>(A)<br>(B)<br>(B)<br>(B)<br>(C)<br>(C)<br>(C)<br>(C)<br>(C)<br>(C)<br>(C)<br>(C |                   |   |  |   |  |  |  |
| Deck  | Deck (            | (Cont'd) 🛛 Parapet 🗍 Med  | ian Railing Generic  | Sidewalk Lane Positio   | n Wearing Surface  |  |  |
|   | avelway<br>Jumber | Distance From Left<br>Edge of<br>Travelway to<br>Superstructure<br>Definition Reference<br>Line<br>At Start (A)<br>(ft) | Distance From Right<br>Edge of<br>Travelway to<br>Superstructure<br>Definition Reference<br>Line<br>At Start (B)<br>(ft) | Distance From Left<br>Edge of<br>Travelway to<br>Superstructure<br>Definition Reference<br>Line<br>At End (A)<br>(ft) | Distance From Right<br>Edge of<br>Travelway to<br>Superstructure<br>Definition Reference<br>Line<br>At End (B)<br>(ft) |  |  |
| LRFD Fatigue<br>Lanes available to trucks:<br>Override Truck fraction:<br>Compute<br>New<br>Duplicate<br>Delete   |                   |   |  |   |  |  |  |
|   |                   |   |  | ОК  | Apply Cancel   |  |  |

Click the Compute... button to automatically compute the lane positions. A dialog showing the results of the computation opens. Click Apply to apply the computed values. The Lane Position tab is populated as shown below.



### Wearing Surface:

Enter the data shown below.

| A Structure Typical Section  |        |
|--|--------|
| Distance from left edge of deck to<br>superstructure definition ref. line<br>Deck<br>thickness |        |
| Left overhang  |        |
| Deck Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Wearing Surface       |        |
| Wearing surface material: Asphalt  |        |
| Description: Asphalt - 25 psf  |        |
| Wearing surface thickness = 2.7800 in Thickness field measured (DW = 1.25 if checked)          |        |
| Wearing surface density = 108.000 pcf  |        |
| Load case: DW Copy from Library  |        |
|  |        |
| OK Apply C   | Cancel |

Click Ok to save the data to memory and close the window.

Define stiffeners to be used by the girders. Expand the Stiffener Definitions tree item and double click on Transverse. Select "Trans. Plate Stiffener" for stiffener type. Define the stiffener as shown below. Click Ok to save to memory and close the window. Repeat this process to define the other two stiffeners. The windows are shown below.

| A Transverse Stiffener Definition   |   |
|---|---|
| Name: 1   Stiffener Type    Single   Plate   Thickness   0.7500   in   Material   Grade 50W/     Velds   Image: Image for the second sec | Top Gap:<br>in<br>6.0000 in<br>Bottom Gap:<br>in in |
|   | OK Apply Cancel                                     |

| Carteria Contraction   |  |
|--|--|
| Name: Stiffener   Stiffener Type   Single   Pair     Plate   Thickness   0.7500   in   Material   Grade 50W     Welds   Zap   Welds   Zap   Welds   Zap   Welds     Stiffener Type | Top Gap:<br>6.0000 in<br>Bottom Gap:<br>in |
|  | OK Apply Cancel                            |

| Carteria Construction   |  |
|---|--|
| Name: 2 Sided Dia Conn PL   Stiffener Type   Single   Pair   Plate Thickness   0.7500   In   Material   Grade 50W   Welds   Zap   Welds   Zap   Welds   Zap   Welds   Zap   Web   Contemport   Battom | Top Gap:<br>6.0000 in<br>Bottom Gap:<br>in |
|   | OK Apply Cancel                            |

Now define the bearing stiffeners by double clicking on Bearing (under Stiffener Definitions in the tree). Select "Trans. Plate Stiffener" for stiffener type. Define the stiffener as shown below. Click Ok to save to memory and close the window.

| 🗛 Bearing Stiffe | ner Definition |   |                               | _ 🗆 ×  |
|------------------|----------------|---|-------------------------------|--------|
|                  | g Stiffener    | in<br>in<br>9.0000 in<br>in<br>in<br>in<br>in | in       in       in       in |        |
|                  |                | [   | OK Apply                      | Cancel |

Describing a member:

The member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this Member.

| 🕰 Member                 |                  |                                 |             |      |                  | <u> </u> |
|--------------------------|------------------|---------------------------------|-------------|------|------------------|----------|
| Member name:             | G2               |                                 | Link with:  | None | •                |          |
| Description:             |                  |                                 |             |      | <u> </u>         |          |
|                          |                  |                                 |             |      | Y                |          |
|                          | Existing Current | Member Alternative Name         | Description |      |                  |          |
|                          |                  |                                 |             |      |                  |          |
| <u>N</u> umber of spans: | 1                |                                 | -           |      | Pedestrian load: | lb/ft    |
|                          |                  | Span Span<br>No. Length<br>(ft) |             |      |                  |          |
|                          |                  | 1 161.00                        |             |      |                  |          |
|                          |                  |                                 |             |      |                  |          |
|                          |                  |                                 |             |      |                  |          |
|                          |                  |                                 |             | OK   | Apply            | Cancel   |

Next double click on the Member loads in the tree and select SIP Forms from the combobox. Enter the load due to stay-in-place forms as shown below.

| Girder Member Loads   | <u>_     ×</u> |
|---|----------------|
| <u>* * * * * * * * * * * *</u>  |                |
| Uniform Distributed Concentrated Settlement Load Case Name: SIP Forms | _              |
| Span Uniform Load<br>(kip/ft)<br>All Spans 💌 0.078                    |                |
| New Duplicate Delete  | <u> </u>       |
| OK Apply Ca   | ncel           |

#### Member loads for Example 4

| Example | Struct Def | Member Definition   | Loads(Interior beam, Exterior beam) |
|---------|------------|---------------------|-------------------------------------|
| а       | GS         | Schedule-based      | SIP (0.078, 0.039)                  |
| b       | GL         | Schedule-based      | SIP (0.078,0.039)                   |
|         |            |                     | Barrier (DC2) (0.253, 0.253)        |
|         |            |                     | WS (DW) (0.275, 0.275)              |
| с       | GL         | Cross-section based | SIP (0.078, 0.078)                  |
|         |            |                     | Barrier (DC2) (0.253, 0.253)        |
|         |            |                     | WS (DW) (0.275, 0.275)              |
|         |            |                     | Haunch (DC1) (0.017, 0.059)         |
| d       | GS         | Cross-section based | SIP (0.078, 0.078)                  |
|         |            |                     | Haunch (DC1) (0.017, 0.059)         |

The Help topic "Dead Loads" summarizes for each type of structure definition and member modeling method which dead load components are computed automatically by the engine and which must be entered by the user.

| Supports          | ;               |                 |                |                           |       | _ 🗆 ×  |
|-------------------|-----------------|-----------------|----------------|---------------------------|-------|--------|
| General           | Z <sup>✔</sup>  | ×               |                |                           | 2     |        |
| Support<br>Number | Support<br>Type | Translation Cor | nstraints<br>Y | Rotation Constraints<br>Z |       |        |
|                   | Pinned          |                 |                |                           |       |        |
| 2                 | Roller          |                 |                |                           |       |        |
|                   |                 |                 |                |                           |       |        |
|                   |                 |                 |                |                           |       |        |
|                   |                 |                 |                | OK                        | Apply | Cancel |

Support constraints were generated when the structure definition was created and are shown below.

Defining a Member Alternative:

Double-click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Steel for the Material Type and Plate for the Girder Type.

| New Member Alternative  | ×                     |
|-------------------------|-----------------------|
| Material Type:<br>Steel | Girder Type:<br>Plate |
|                         | OK Cancel             |

Click Ok to close the dialog and create a new member alternative.

The Member Alternative Description window will open. Enter the appropriate data as shown below. Select Schedule-based Girder property input method.

If we now re-open the Member G2 window, we will see this Member Alternative designated as the existing and current member alternative for this Member.

| 🕰 Member         |                           |                 |                   |                     |                      |       | - D ×  |
|------------------|---------------------------|-----------------|-------------------|---------------------|----------------------|-------|--------|
| Member name:     | G2                        |                 | Link with:        | None                | •                    |       |        |
| Description:     |                           |                 |                   |                     | <b>A</b>             |       |        |
|                  |                           |                 |                   |                     | <b>v</b>             |       |        |
|                  | Existing Current Member A | Iternative Name | D                 | escription          |                      |       |        |
|                  | Plate Gird                | er A            | Add additional se | lf-weight for steel | details              |       |        |
|                  |                           |                 |                   |                     |                      |       |        |
| Number of spans: | _                         | Span            |                   |                     | <u>P</u> edestrian l | oad:  | lb/ft  |
|                  | Span<br>No.               | Length          |                   |                     |                      |       |        |
|                  |                           | (ft)<br>161.00  |                   |                     |                      |       |        |
|                  |                           | 101.00          |                   |                     |                      |       |        |
|                  |                           |                 |                   |                     |                      |       |        |
|                  |                           |                 |                   |                     |                      |       |        |
|                  |                           |                 |                   | OK.                 |                      | Apply | Cancel |

Use "Compute" button to generate distribution factors.

| ive Load Di                             | stribution                                  |                       |              |            |     |       | _0     |
|---|---|-----------------------|--------------|------------|-----|-------|--------|
| itandard LF                             | ifd   |                       |              |            |     |       |        |
|   | n Factor Input Metho<br>e Simplified Method |                       | anced Method |            |     |       |        |
| Lanes                                   |   | Distribution<br>(Whee |              |            |     | -     |        |
| Loaded                                  | Shear                                       | Shear at<br>Supports  | Moment       | Deflection |     |       |        |
| 1 Lane                                  | 1.538462                                    | 1.538462              | 1.538462     | 0.500000   |     |       |        |
| Multi-Lane                              | 2.363636                                    | 2.461538              | 2.363636     | 1.350000   |     |       |        |
|   |   |                       |              |            |     |       |        |
| Compute fro                             | om<br>Stion View Calca                      | 8                     |              |            |     |       |        |
| .,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |   |                       |              | 01         | . 1 | Apply | Cancel |

Live load distribution factor calculation details can be viewed by clicking "View Calcs" button.

Next describe the girder profile by double clicking on Girder Profile in the tree. The window is shown below with the data describing the web.

| Girder P               | rofile     |                      |                   |                   |                           |                |                         |           |                  |        |
|------------------------|------------|----------------------|-------------------|-------------------|---------------------------|----------------|-------------------------|-----------|------------------|--------|
| fype: Pla              | ate Girder |                      |                   |                   |                           |                |                         |           |                  |        |
| Web                    | Top Flange | Bottom               | Flange            |                   |                           |                |                         |           |                  |        |
| Begin<br>Depth<br>(in) | Depth Vary | End<br>Depth<br>(in) | Thickness<br>(in) | Support<br>Number | Start<br>Distance<br>(ft) | Length<br>(ft) | End<br>Distance<br>(ft) | Material  | Weld at<br>Right |        |
| 69.00                  | None 💌     | 69.00                | 0.5000            | 1 💌               |                           | 161.00         |                         | Grade 50W |                  |        |
|                        |            |                      |                   |                   |                           |                |                         |           |                  |        |
|                        |            |                      |                   |                   |                           |                | New                     | Duplica   | ate Do           | elete  |
|                        |            |                      |                   |                   |                           |                | 0                       | K Ap      | ply              | Cancel |

Describe the flanges as shown below.

| 4 | Girder I               | Profile              |                   |             |             |                           |                |                         |            |    |      |                  |    |        | Ľ  |
|---|------------------------|----------------------|-------------------|-------------|-------------|---------------------------|----------------|-------------------------|------------|----|------|------------------|----|--------|----|
|   | Type: P                | ate Giro<br>Top Fla  |                   | <br>om Fla  | ange        | •                         |                |                         |            |    |      |                  |    |        | _1 |
|   | Begin<br>Width<br>(in) | End<br>Width<br>(in) | Thickness<br>(in) | Sup;<br>Num | oort<br>ber | Start<br>Distance<br>(ft) | Length<br>(ft) | End<br>Distance<br>(ft) | Material   |    | Weld | Weld at<br>Right |    |        |    |
|   | 22.00                  | 22.00                | 1.2500            | 1           | •           | 0.00                      | 161.00         | 161.00                  | Grade 50VV | •  | -    | •                |    |        |    |
|   |                        |                      |                   | 1           |             |                           |                |                         |            |    | 1    |                  | 1  |        |    |
|   | Сору                   | to Bott              | om Flange         | ]           |             |                           |                |                         | New        | ,  |      | Duplicate        | ;  | Delete |    |
|   |                        |                      |                   |             |             |                           |                |                         | 0          | IK |      | ( Appl           | у) | Cancel |    |

Enter the following starting distance and length to the bottom flange tab.

| starting distance | bottom<br>flange |
|-------------------|------------------|
| 0                 | 36.666           |
| 36.666            | 87.667           |
| 124.333           | 36.667           |

| <u>M</u> | Girder P   | rofile               |                   |             |   |                           |                |                         |            |   |      |                  | _ 🗆    | × |
|----------|--|----------------------|-------------------|-------------|---|---------------------------|----------------|-------------------------|------------|---|------|------------------|--------|---|
|          | Type: Plate Girder<br>Web Top Flange Bottom Flange |                      |                   |             |   |                           |                |                         |            |   |      |                  | 1      |   |
|          | Begin<br>Width<br>(in)                             | End<br>Width<br>(in) | Thickness<br>(in) | Supp<br>Num |   | Start<br>Distance<br>(ft) | Length<br>(ft) | End<br>Distance<br>(ft) | Material   |   | Weld | Weld at<br>Right |        |   |
|          | 22   | 22                   | 1.25              | 1           | • | 0                         | 36.67          | 36.67                   | Grade 50VV | • | -    | •                |        |   |
|          | 22   | 22                   | 2.0000            | 1           | • | 36.67                     | 87.67          | 124.33                  | Grade 50W  | • | -    | -                |        |   |
|          | 22   | 22                   | 1.25              | 1           | • | 124.33                    | 36.67          | 161.00                  | Grade 50W  | • | •    | -                |        |   |
|          | Copy to Top Flange New Duplicate Delete            |                      |                   |             |   |                           |                |                         |            |   |      |                  |        |   |
|          |  |                      |                   |             |   |                           |                |                         | (OK        |   |      | Apply            | Cancel |   |

Next open the Deck Profile and enter the data describing the structural properties of the deck. The window is shown below.

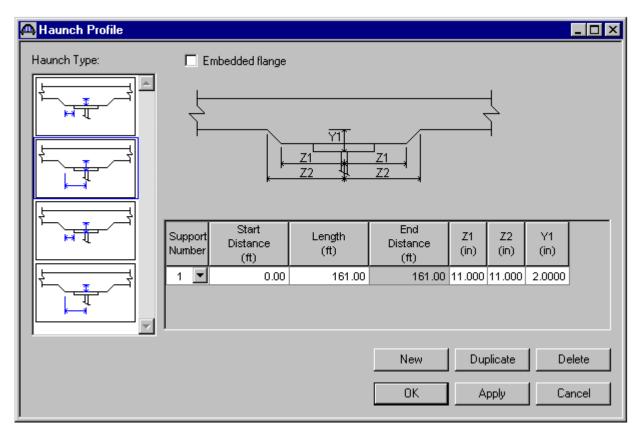
| MD | eck Profile                     |                   |                           |                |                         |                                 |                                       |                                     |                                       |                                     |        | <u>_     ×</u> |
|----|---------------------------------|-------------------|---------------------------|----------------|-------------------------|---------------------------------|---------------------------------------|-------------------------------------|---------------------------------------|-------------------------------------|--------|----------------|
| Ту | pe: Plate                       |                   | _                         |                |                         |                                 |                                       |                                     |                                       |                                     |        |                |
|    | eck Concrete Reir               | nforcemer         | nt   Shear C              | onnector       | s                       |                                 |                                       |                                     |                                       |                                     |        |                |
|    | Material                        | Support<br>Number | Start<br>Distance<br>(ft) | Length<br>(ft) | End<br>Distance<br>(ft) | Structural<br>Thickness<br>(in) | Start<br>Effective<br>Flange<br>Width | End<br>Effective<br>Flange<br>Width | Start<br>Effective<br>Flange<br>Width | End<br>Effective<br>Flange<br>Width | n      |                |
|    | Deck Concrete 💌                 | 1 💌               | 0.00                      | 161.00         | 161.00                  | 9.5000                          | 114.0000                              | 114.0000                            | 125.0000                              | 125.0000                            | 8.00   |                |
|    | Compute from<br>Typical Section |                   |                           |                |                         |                                 |                                       | New                                 | Duplic                                | ate                                 | Delete |                |
|    |                                 |                   |                           |                |                         |                                 |                                       | OK                                  |                                       | Apply                               | Car    | ncel           |

No reinforcement is described. Composite regions are described using the Shear Connectors tab as shown below.

| Deck | Prof           | île                       |                |                         |                 |                   |                     |                               |      |       |
|------|----------------|---------------------------|----------------|-------------------------|-----------------|-------------------|---------------------|-------------------------------|------|-------|
|      | Plate<br>Conc  |                           | inforcem       | ent Shea                | ar Connectors   |                   |                     |                               |      |       |
|      | pport<br>imber | Start<br>Distance<br>(ft) | Length<br>(ft) | End<br>Distance<br>(ft) | Connector<br>ID | Number per<br>Row | Number of<br>Spaces | Transverse<br>Spacing<br>(in) |      |       |
|      | -              | 0.00                      | 161.00         | 161.00                  | Composite 📘     | ·                 |                     |                               |      |       |
|      |                |                           |                |                         |                 |                   |                     |                               |      |       |
|      |                |                           |                |                         |                 |                   |                     |                               |      |       |
|      |                |                           |                |                         |                 |                   |                     |                               |      |       |
|      |                |                           |                |                         |                 |                   |                     |                               |      |       |
|      | )<br>hear      |                           | View (         | Cales                   |                 |                   | New                 | Duplicate                     | Dele | te    |
|      | Vizaro         | J                         |                |                         |                 |                   | 14000               |                               |      |       |
|      |                |                           |                |                         |                 |                   | (OK                 | Apply                         | C    | ancel |

The haunch profile is defined by double clicking on Haunch Profile in the tree. The window is shown below.

Interior Girder (G2):



## Exterior Girder (G1):

| Aunch Profile |   |
|---------------|---|
| Haunch Type:  | Embedded flange   |
|               | $\begin{array}{c c} & & & & \\ & & & & \\ & & & & \\ & & & & $  |
|               | Support<br>NumberStart<br>Distance<br>(ft)Length<br>(ft)End<br>Distance<br>(ft)Z1Z2Z3Z4Y1Y2(in)(in)(in)(in)(in)(in)(in)(in)(in)(in) |
|               | 1 2 0.00 161.00 161.00 11.00 11.00 11.00 51.00 2.00 2.00  |
|               |   |
|               | New Duplicate Delete  |
|               | OK Apply Cancel   |

Regions where the slab is considered to provide lateral support for the top flange are defined using the Lateral Support window shown below. It can be opened by double clicking on Lateral Support in the tree.

| 🕰 Lateral Supp    | oort                              |                          |                                   |                      |
|-------------------|-----------------------------------|--------------------------|-----------------------------------|----------------------|
| ↓                 | Start Distan                      |                          | ength                             |                      |
| Support<br>Number | Start<br>Distance<br>(ft)<br>0.00 | Length<br>(ft)<br>161.00 | End<br>Distance<br>(ft)<br>161.00 |                      |
|                   |                                   |                          |                                   | New Duplicate Delete |

| \land st | iffener Range        | s                 |                                |                     |                 |                |                         |        |
|----------|----------------------|-------------------|--------------------------------|---------------------|-----------------|----------------|-------------------------|--------|
| Tr       | ransverse Stiffen    |                   | Т                              | Spacing             | ges             |                |                         | 1      |
|          | Name                 | Support<br>Number | Start<br>Distance<br>(ft)      | Number of<br>Spaces | Spacing<br>(in) | Length<br>(ft) | End<br>Distance<br>(ft) |        |
|          |                      |                   |                                |                     |                 |                |                         |        |
|          | Apply at<br>Diaphrag |                   | tiffeners betweer<br>iaphragms |                     |                 | New Du         | plicate D               | elete  |
|          |                      |                   |                                |                     |                 | OK             | Apply                   | Cancel |

Stiffener locations are described using the Stiffener Ranges window shown below.

Click on the Apply at Diaphragms... button to open the following dialog. Select the 2 Sided Conn PL as the stiffener to apply at the interior diaphragms.

| Diaphragm Connection Plates   | ×      |
|---|--------|
| Apply the following stiffener definitions to the diaphragm locations: |        |
| End Diaphragms and Diaphragms At Piers                                |        |
| Bearing Stiffener: Bearing Stiffener                                  |        |
|   |        |
| Interior Diaphragms   |        |
| <u>I</u> ransverse Stiffener: 2 Sided Dia Conn PL                     |        |
|   |        |
|   |        |
| Apply   | Cancel |

Selecting Apply will create the following transverse stiffener locations.

| Stiffener Ranges  |   |     |           |   |          |        |        |  |  |
|---|---|-----|-----------|---|----------|--------|--------|--|--|
| Start Distance     Spacing       Transverse Stiffener Ranges     Longitudinal Stiffener Ranges              |   |     |           |   |          |        |        |  |  |
| NameSupportStart<br>Distance<br>(ft)Number of<br>SpacesSpacing<br>(in)Length<br>(ft)End<br>Distance<br>(ft) |   |     |           |   |          |        |        |  |  |
| 2 Sided Dia Conn PL   | - | 1 🔳 | 26.833333 | 1 | 0.0000   | 0.00   | 26.83  |  |  |
| 2 Sided Dia Conn PL   | • | 1 🗾 | 26.833333 | 4 | 322.0000 | 107.33 | 134.17 |  |  |
| Apply at Diaphragms Diaphragms New Duplicate Delete   |   |     |           |   |          |        |        |  |  |
|   |   |     |           |   | OK       | Apply  | Cancel |  |  |

The intermediate transverse stiffeners are now located. Note that a range does not include a stiffener at the beginning of the range. The range that begins at the left end of the beam with one space and a spacing of 58 inches locates the first stiffener. The remaining intermediate stiffeners are located as follows.

| tiffener Ranges  |   |   |   |        |   |          |        |        |
|--|---|---|---|--------|---|----------|--------|--------|
| Support     Start     Number of     Spacing     Length     End       Name     Support     Distance     Spaces     (in)     (ft)     (ft) |   |   |   |        |   |          |        |        |
| 2 Sided Dia Conn PL 🔽 1 💌 26.83 1 0.0000 0.00 26.83  |   |   |   |        |   |          |        |        |
| 2 Sided Dia Conn PL 🔽 1 🔽 26.83 4 322.0000 107.33 134.17   |   |   |   |        |   |          |        |        |
| Stiffener  | ▼ | 1 | • | 0.00   | 1 | 58.0000  | 4.83   | 4.83   |
| Stiffener  | ▼ | 1 | • | 0.00   | 1 | 161.0000 | 13.42  | 13.42  |
| Stiffener  | T | 1 | T | 13.42  | 5 | 322.0000 | 134.17 | 147.59 |
| Stiffener  | T | 1 | T | 147.58 | 1 | 103.0000 | 8.58   | 156.16 |
| Apply at Diaphragms New Duplicate Delete   |   |   |   |        |   |          |        |        |
|  |   |   | _ |        |   | OK       |        | Cancel |

Bearing stiffener definitions were assigned to locations when we used the Apply at Diaphragms... button on the Transverse Stiffener Ranges window. The Bearing Stiffener Location window is opened by expanding the Bearing Stiffener Locations branch in the tree and double clicking on each support. The assignment for support 1 is shown below.

| 🗛 Bearing Stiffener                               | Location - Suppo | ort 1          | _ 🗆  | × |
|---|------------------|----------------|--|---|
| <u>P</u> airs of bearing sti<br>at this support = |                  |                | * Negative offset to left of<br>cl bearing<br>10000 in |   |
| Stiffener<br>Pair                                 | Name             | Offset<br>(in) |  |   |
| 1 Be  | aring Stiffener  | 0.0000         |  |   |
|   |                  |                |  |   |
|   |                  |                |  |   |
|   | [                | ОК             | Apply Cancel   |   |

Define Points of Interest using the Points of Interest window shown below. A window for defining a Point of Interest is opened by double clicking on the Points of Interest tree item.

| 🕰 Point of Interest                             |                       |                |             |                   |         | _O×                 |
|---|-----------------------|----------------|-------------|-------------------|---------|---------------------|
| Distance from<br>leftmost support:              | 📅 ft 🛛 o'             | r <u>S</u> par | n: Span 1 💌 | Eraction: 0.22774 | 13 Side | eft • <u>B</u> ight |
| Transverse Stiffeners (<br>Transverse Stiffener | )ther Stiffeners 🛛 Fa | atigue         | Bracing ASD | Engine            |         | 1                   |
| <u> </u>  | ule                   |                |             |                   |         |                     |
| <u>S</u> tiffener spacing =                     | in                    |                |             |                   |         |                     |
| Stiffener <u>w</u> idth =                       | in                    |                |             |                   |         |                     |
| Stiffener <u>t</u> hickness =                   | in                    |                |             |                   |         |                     |
| <u>M</u> aterial                                | Grade 50W             | -              |             |                   |         |                     |
| Number  | Single                | -              |             |                   |         |                     |
| Туре:   | Plate                 | -              |             |                   |         |                     |
| ·   |                       |                |             |                   |         |                     |
|   |                       |                |             |                   |         |                     |
|   |                       |                |             | ОК                | Apply   | Cancel              |

The description of an interior beam for a structure definition is complete.

This example bridge is modeled after Example 1 from "Four LRFD Design Examples of Steel Highway Bridges", Volume II, Chapter 1B of the Highway Structures Design Handbook produced by the American Iron and Steel Institute except this example bridge is not skewed like the one in the handbook.

| To do LRFR Design | Load Rating. | enter the | Analysis | Settings | window a | s shown | below: |
|-------------------|--------------|-----------|----------|----------|----------|---------|--------|
|                   |              |           |          |          |          |         |        |

| C Design Review                   |                                |                                   |
|-----------------------------------|--------------------------------|-----------------------------------|
| O Design neview (• hating         | Rating Method: LRFR            | <b>•</b>                          |
| Analysis Type:                    |                                |                                   |
| Line Girder                       |                                |                                   |
| Lane/Impact Loading Type:         |                                |                                   |
| As Requested 🔽                    | Apply Preference Setting: None | •                                 |
|                                   |                                |                                   |
| ehicles Output Engine Description |                                |                                   |
| Traffic Direction                 | - Hetresh                      | Temporary Vehicles Advanced       |
| Vehicle Selection:                | Vehicle Summary:               |                                   |
|                                   | Add to 😑 Rating Vehicl         | es                                |
| H 15-44                           | Rating ⊡ LRFR                  | - L I D - V -                     |
| H 20-44                           |                                | yn Load Rating<br>hventory        |
|                                   |                                | - HL-93 (US)                      |
| HS 15-44                          | Bomouro                        | perating                          |
| HS 20 (SI)<br>HS 20-44            | from                           | HL-93 (US)                        |
| Lane-Type Legal Load              |                                | atigue<br>LRFD Fatigue Truck (US) |
| - LRFD Fatigue Truck (SI)         |                                | Load Rating                       |
| - LRFD Fatigue Truck (US)         |                                | loutine                           |
| - NRL                             |                                | pecialized Hauling                |
| SU4                               | I Permi                        | it Load Rating                    |
| SU5                               | -1                             |                                   |
| 1 1 1 300                         | <b>•</b>                       |                                   |
| Reset Clear Open Template :       | ave Template                   | OK Apply Cancel                   |

AASHTO LRFR results for HL93 loading for an interior girder are shown below:

| 🕰 Analysis F               | Results - Plate   | Girder        |                                   |                                   |                               |                                |                            |                            |                        |                         |                               |             | _                             |                    |
|----------------------------|-------------------|---------------|-----------------------------------|-----------------------------------|-------------------------------|--------------------------------|----------------------------|----------------------------|------------------------|-------------------------|-------------------------------|-------------|-------------------------------|--------------------|
| Report Type<br>Rating Resu | ults Summary      |               | e/Impact Loa<br>As Requested      |                                   |                               | y Format<br>ole rating leve    | ls per row                 |                            | •                      |                         |                               |             |                               |                    |
| Live Load                  | Live Load<br>Type | Rating Method | Inventory<br>Load Rating<br>(Ton) | Operating<br>Load Rating<br>(Ton) | Legal<br>Load Rating<br>(Ton) | Permit<br>Load Rating<br>(Ton) | Inventory<br>Rating Factor | Operating<br>Rating Factor | Legal<br>Rating Factor | Permit<br>Rating Factor | Inventory<br>Location<br>(ft) |             | Operating<br>Location<br>(ft) | Ope<br>Loc<br>Spai |
| HL-93 (US)                 | Truck + Lane      | LRFR          | 16.38                             | 21.23                             |                               |                                | 0.455                      | 0.590                      |                        |                         | 80.50                         | 1 - ( 50.0) | 80.50                         | 1-(                |
| HL-93 (US)                 | Tandem + Lane     | LRFR          | 19.43                             | 25.19                             |                               |                                | 0.540                      | 0.700                      |                        |                         | 80.50                         | 1 - ( 50.0) | 80.50                         | 1 - (              |
| •                          |                   |               |                                   |                                   |                               |                                |                            |                            |                        |                         |                               |             |                               | Þ                  |
| AASHTO LR                  | FR Engine Versio  | on 6.4.0.2003 |                                   |                                   |                               |                                |                            |                            |                        |                         |                               |             |                               |                    |
|                            | -                 |               |                                   |                                   |                               |                                |                            |                            |                        |                         |                               |             |                               |                    |
| Analysis Prer              | erence Setting: N | ione          |                                   |                                   |                               |                                |                            |                            |                        |                         |                               |             |                               |                    |
|                            |                   |               |                                   |                                   |                               |                                |                            |                            |                        |                         |                               |             |                               |                    |
|                            |                   |               |                                   |                                   |                               |                                |                            |                            |                        |                         |                               |             | Close                         | •                  |

An LRFD design review of this interior girder for HL93 loading can be performed by AASHTO LRFD. To do LRFD design review, enter the Analysis Settings window as shown below:

| • Design Review         • Rating        Design Method: LRFD          Analysis Type:            Line Girder            Lane/Impact Loading Type:            As Requested        Apply Preference Setting: None          /ehicles        Dutput Engine Description          /ehicles       Dutput Engine Description          Vehicle Selection:           Traffic Direction:          Vehicle Selection:           Add to             Vehicles           Add to             Atternate Military Loading           Add to             HL-33 (IS)           Add to             HL-33 (IS)           Permit Loads             HL-33 (IS)           Permit Loads             HL-33 (IS)           Permit Loads             HL-83 (IS)           Analysis             LRFD Fatigue Truck (IS)           Analysis             LBFD Fatigue Truck (IS)           Analysis             User Defined           Cenined             User Defined   | Analysis Settings   |  |
|--|---|--|
| Line Girder Lane/Impact Loading Type: As Requested Add to Design Vehicles Both directions Add to Design Add to Desig | Design Review     C Rating  | Design Method: LRFD  |
| Both directions     Herrish     Temporary Vehicles     Advanced       Vehicle Selection:     Vehicle Summary:       Image: Vehicles     Add to<br>Design       Image: Vehicles     Add to<br>Design       Image: Vehicles     Image: Vehicles       Image:   | Line Girder   | pply Preference Setting: None  |
|  | Both directions Vehicle Selection:  Vehicles  Standard  Alternate Military Loading  HL-93 (S1)  HL-93 (US)  HS 20 (S1)  HS 20 (S1)  HS 20-44  ERFD Fatigue Truck (S1)  ERFD Fatigue Truck (US)  Agency User Defined | ▼       Vehicle Summary:         Add to       Design Vehicles         Design       ⊡ Design Loads         >>       □         >>       □         Permit Loads       □         □       □         Permit Loads       □         □       □ </td |

A summary of the specification checks is shown by selecting the View Spec Check button, *(i)*, from the toolbar. The details for one of the spec checks is shown below.

| Specification Checks for Plate Girder | - 41 of 949  |             |               |
|---------------------------------------|--|-------------|---------------|
| 🖃 🧰 Superstructure Component          | Specification Reference  | Limit State | Flex. Sense 🔺 |
| 🗄 💼 Stage 1                           | 📔 1.3.2.1 Design Philosophy - Limit State - General                                  |             | N/A           |
| 🗄 💼 Stage 2                           | 2.5.2.6.2 Criteria for Deflection  |             | N/A           |
| 🖻 💼 Stage 3                           | 🖺 4.6.2.7.1 I-Sections - Lateral Wind Load Distribution in Multibeam Bridges         |             | N/A           |
| 🖻 💼 Plate Girder                      | 📑 5.4.2.6 Modulus of Rupture   |             | N/A           |
|                                       | 🗎 6.10.1.1.1b Stresses for Sections in Positive Flexure                              |             | N/A           |
| — 🦲 Span 1 - 13.42 ft.                | Spec Check Detail for 6.10.4.2.2 Flexure   |             | N/A           |
|                                       |  |             | N/A           |
| — 🧰 Span 1 - 26.83 ft.                | 6 Steel Structures   | <b>▲</b>    | N/A           |
| 🗀 Span 1 32.20 ft.                    | 6.10 I-Section Flexural Members  |             | N/A           |
|                                       | 6.10.4 Service Limit State   |             | N/A           |
|                                       | 6.10.4.2 Permanent Deformations  |             | N/A           |
| — 🧰 Span 1 - 48.30 ft.                | 6.10.4.2.2 Flexure   |             | N/A           |
| — 🧰 Span 1 - 53.67 ft.                | (AASHTO LRFD Bridge Design Specifications, Fifth Edition - 2010, with 2010 interims) |             | N/A           |
| — 🧰 Span 1 - 64.40 ft.                |  |             | N/A           |
| — 🧰 Span 1 - 67.08 ft.                | Steel Plate - At Location = 96.6000 (ft) - Left Stage 3                              |             | N/A           |
|                                       |  |             | N/A           |
| — 🧰 Span 1 - 93.92 ft.                |  |             | N/A           |
|                                       | INPUT:   |             | N/A           |
| — 🧰 Span 1 - 107.33 ft.               | Web D = $69.0000$ (in)   |             | N/A           |
| 💼 Span 1 - 112.70 ft.                 | Web tw = $0.5000$ (in)   |             | N/A           |
| Span 1 - 120.75 ft.                   |  |             | N/A           |
| 💼 Span 1 - 124.33 ft.                 | Top Flange Fy = 50.0000 (ksi)  |             | N/A           |
| 🚞 Span 1 - 128.80 ft.                 | Bot Flange Fy = 50.0000 (ksi)  |             | N/A           |
| 🧰 Span 1 - 134.17 ft.                 |  |             | N/A           |
| 🧰 Span 1 - 144.90 ft.                 | Section Type: Composite  |             | N/A           |
| 🧰 Span 1 - 147.58 ft.                 | Compactness: Compact   |             | N/A           |
|                                       | Allow Moment Redistribution Control Option: No                                       |             | N/A           |
|                                       | Moment Redistribution Qualified: No, Moment Redistribution did not occur.            |             | N/A           |
|                                       | Noncomposite in Negative Flexure Regions Only: No                                    |             | N/A           |
|                                       | SUMMARY:   |             | N/A           |
|                                       | SUITART.   |             | N/A           |
|                                       |  |             | N/A           |
|                                       |  | <u> </u>    | N/A           |
|                                       |  |             | N/A           |
|                                       |  |             | N/A           |
|                                       | OK   |             | N/A           |
|                                       |  |             | N/A           |
|                                       | APPD6.2 Yield Moment   |             | N/A           |
|                                       | APPD6.3.1 In the Elastic Range (Dc)  |             | N/A           |
|                                       | APPD6.3.2 Denth of the Web in Compression at Plastic Moment                          |             | N/A           |
| I                                     |  |             |               |

AASHTO LRFD analysis will generate a spec check results file. Click of on tool bar to open the following window.

| 🕰 Example 4a   | <u> </u> |
|--|----------|
| Example 4a <ul> <li>SD1</li> <li>G2</li> <li>Plate Girder</li> <li>AASHTO_LRFD</li> <li>Summary of computed distribution factors</li> <li>Detailed calculations of computed distribution factors</li> <li>Spec Check Results (Tuesday Jul 24, 2012 17:26:08)</li> <li>Log File</li> <li>AASHTO_LRFR</li> <li>Summary of computed distribution factors</li> <li>Detailed calculations of computed distribution factors</li> <li>Detailed calculations of computed distribution factors</li> <li>Log File</li> <li>Log File</li> <li>Log File</li> </ul> |          |
|  |          |

To view the spec check results, double click the Spec Check Results in this window.

| C'\Documents and Settings\XLI\My  | y Documents\AASHTOWARE\VirtisOpis64         | \Example4a\SD1\G2\PlateGirder - Windows Int                | ernet Explorer                     |         |               |                  | X                           |
|---|---|--|------------------------------------|---------|---------------|------------------|-----------------------------|
| C:\Documents and Sett   | ingsl/tLi(My Documents\AASHTOWARE\VirtisOpi | s64lExample4alSD1\G2lPlateGirder\AASHTO_LRFD\Sta           | ge 3 Spec Check Result             | s.XML   |               | 💌 💀 🗙 🚼 Google   | . م                         |
| File Edit View Favorites Tools  | Help  |  |                                    |         |               |                  |                             |
| 🙀 Favorites 🛛 🙀 💰 Free Hotmal   | 🙋 Web Slice Gallery 💌                       |  |                                    |         |               |                  |                             |
| C:\Documents and Settings\VIL/(My Docu  | uments\AASHT                                |  |                                    |         |               | 📩 • 🖸 - 🗆 🖷 • Pa | pe + Safety + Tools + 🔞 + 🥬 |
| Bridge ID : 26<br>Bridge : Example 4a<br>Superstructure Def : SD<br>Member : G2<br>Analysis Preference Sett | ing : None                                  | NBI Structure ID : I<br>Bridge Alt :<br>Member Alt : Plate | -                                  |         |               |                  | <u> </u>                    |
| AASHTO LRFD Specifi   | ication, Edition 5, Interim 2               | 010  |                                    |         |               |                  |                             |
| Specification C   | Check Summary                               |  |                                    |         |               |                  |                             |
|   | Article                                     |  | Status                             |         |               |                  |                             |
| Flexure (6.10.7.1.1, 6  | .10.7.2.1 , AppA6.1.1, App.                 | A6.1.2, AppA6.1.3, AppA6.1.4)                              | Fail                               |         |               |                  |                             |
|   | Shear (6.10.9)                              |  | Pass                               |         |               |                  |                             |
|   | Fatigue (6.10.5.3)                          | )  | Pass                               |         |               |                  |                             |
|   | Serviceability (6.10.4.                     | 2.2)   | Fail                               |         |               |                  |                             |
| Constru   | uctability (6.10.3.2.1, 6.10.3              | 3.2.2, 6.10.3.2.3)   | Pass                               |         |               |                  |                             |
| Trans   | verse Stiffeners (6.10.11.1.                | 2, 6.10.11.1.3)  | Pass                               |         |               |                  |                             |
| Longitudinal  | Stiffeners (6.10.11.3.1, 6.1                | 0.11.3.2, 6.10.11.3.3)                                     | NA                                 |         |               |                  |                             |
| Bearing St  | tiffeners (6.10.11.2.2, 6.10.               | 11.2.3, 6.10.11.2.4)                                       | Pass                               |         |               |                  |                             |
| S   | hear Connector (6.10.10.1,                  | 6.10.10.4)   | NA                                 |         |               |                  |                             |
| Location<br>(ft)  | Composite                                   | d Compactness (Sta<br>Proportion<br>Code                   | nge 3)<br><sup>Code</sup><br>Check | Compact | Code<br>Check | ]                |                             |
| 0.000   | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 16.100  | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 32.200  | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 36.666  | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 48.300  | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 64.400  | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 80.500  | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 96.600  | Yes   | Pass   |                                    | Compact | E             |                  |                             |
| 112.700   | Yes   | Pass   |                                    | Compact | E             |                  | -                           |
| Done  |   |  |                                    |         |               | My Computer      | 🖓 • 🔍 135% • 🏾              |