Modeling Bridges with Varying Girder Spacings in AASHTOWare’s BrR Program (formerly Virtis)

The BrR program allows one to model & analyze girder superstructures with girder spacings that vary along the span length (also referred to as flared girders). The following describes the additional steps that must be completed during the modeling process. Also, a suggested procedure is described that eliminates the need to externally calculate (varying) live load distribution factors & effective flange widths.

For models that contain varying girder spacings, the following components in the BrR model require additional input &/or different procedures:

1. Framing Plan Detail (girder spacing orientation & spacing values)
2. Structure Typical Section (deck & live load position dimensions)
3. Member Loads
4. Live Load Distribution
5. Deck Profile (effective flange widths)

The procedure assumes that one is building a BrR model, has completed definitions & inputs for materials, beam shapes, etc. & is now ready to proceed to the Superstructure Definition. Note that the procedures are limited to single span bridges (or multiple simple spans). It is also assumed that the deck width varies linearly along the span & that the barrier/railing components are located along the outside deck edges (typical).

I. Additional/Changed Procedures for Modeling Superstructures with Varying Girder Spacings

All of the items in the following discussion are located under Superstructure Definition in the BrR model workspace.

1. Framing Plan Detail, Layout tab
   a. Under Layout, Girder Spacing Orientation, select the item Along support. Note that this activates End of Girder spacing inputs on the same screen.
   b. Enter Start of Girder & End of Girder spacings according to the orientation selected above.

2. Framing Plan Detail, Diaphragms tab
   a. Define diaphragm details as usual. For interior diaphragm weight, it is acceptable to use only one (or several) value(s) in the regions of varying girders spacings. The calculated weight(s) should be based on the heaviest diaphragm.

3. Structure Typical Section, Deck tab
   a. Enter Start & End dimensions as normal to account for varying deck width. For bridges in which the actual plan overhang dimensions vary along the span length, use values based on mid-span conditions.

4. Structure Typical Section, Lane Position tab
   a. Press Compute… button to calculate (varying) lane dimensions.
Perform the following steps for each Member/Member Alternative as required:

5. **Member Loads**
   a. Externally calculate member loads with consideration of varying girder spacings as required. Enter on this screen as normal. *Note: For Stay-in-Place form loads use averaged girder spacings in the load calculation as appropriate.*

6. **Live Load Distribution, Standard tab**

   *Refer to Part II (below) for a method to obtain the distribution factors needed for this section.*

   a. Under **Distribution Factor Input Method**, select **Use Advanced Method**.
   b. For **Action:** select **Deflection**. Press **New** button to add a blank input line. For **Length**, enter applicable span length. For **Variation**, enter **Linear** (this activates additional inputs for the span end). Manually input start and end distribution factors for deflection.
   c. Select **Moment**. Press **New** button & add data as above for deflection.
   d. The input for shear distribution factors requires three (3) lines of data so that factors for reaction (shear) at supports can be specified separate from the normal shear factors. Select **Shear**. Press the **New** button three (3) times. The first line will be used to specify factors for reaction at the first support. For **Length**, enter 1.0 & fill out the remaining items on this line similar to the above procedures. On the second line, for **Length**, enter a value equal to the span length minus 2.0 feet (to account for the beginning & end 1.0-foot lengths used for end values), & complete the input for this line. On the third line, for **Length**, again enter 1.0 & complete the line using the same factors as entered on Line 1.

   *Automatic calculation of live load distribution factors is not available for the Advanced Method.*

7. **Deck Profile, Deck Concrete** tab

   *Refer to Part II (below) for a method to obtain the flange widths needed for this section.*

   a. Input start and end effective flange width values.

   *Automatic calculation of effective flange widths is not available where varying girder spacings are included in the model.*

Once the model input is completed, save & analyze the bridge using normal procedures.
II. Procedure to Calculate Begin & End Live Load Distribution Factors & Effective Flange Widths in the BrR Program

The BrR program will automatically calculate distribution factors & flange widths in models with girder spacings that do not vary along the span length. However, when a model includes varying spacings, these factors must be manually input. Using the procedure described below, the BrR program can be used to calculate the needed values. This eliminates the need for manually calculations.

This procedure consists of creating two additional superstructure definitions, Begin & End. The two models have non-varying girder spacings using the conditions at the beginning & end of the bridge span. The definitions can be created in the same bridge model workspace where the varying-spacing model (from Part I above) exists. They can be deleted from the model once the necessary data is obtained.

Since these two models are used only for the purpose of obtaining certain input values, it is not necessary to completely define the Begin & End models. The Superstructure Definition Wizard is a convenient way to define the superstructures. The list at the end of this section contains the Wizard input parameters & shows which values need to be entered & which can be ignored (left blank) for this procedure.

The general procedure is:

1. Create Begin Superstructure
   a. Define the Begin superstructure using the Superstructure Definition Wizard.
   b. For each uniquely defined member (& member alternative) enter the Live Load Distribution screen, run the automatic calculations & record the resulting values for later use.
   c. For each uniquely defined member (& member alternative) enter the Deck Profile, Deck Concrete screens, run the automatic calculations & record the resulting values for later use.

2. Create End Superstructure – Repeat Step 1 Using Dimensions at the end of the span.

3. Input Data into Varying-Spacing Model – Using the values obtained in Steps 1 & 2 above, enter the appropriate screens in the varying girder spacing model & input the appropriate values.

Superstructure Definition Wizard – Where indicated fill in an appropriate value:

Superstructure definition name: Enter any name such as Begin
Superstructure Definition Type Girder System
Material type: Enter appropriate values
Girder type: Enter appropriate values

Number of spans: Enter appropriate values
Skew: Enter appropriate values
Number of girders: Enter appropriate values
Girder spacing = Enter plan values (perpendicular to girders) at the left or right end of the span (beginning/end model)
Left overhang = Enter plan value at the left end of the span
Right overhang = Enter plan value at the right end of the span

LRFD analysis module: AASHTO LRFD
LFD analysis module: AASHTO LFD
Girder System Member Generation Link Members

Span Length Enter appropriate values
Beam Shape Enter appropriate values
Strand Configuration Leave this field blank
Beam Projection, Left End & Right End Enter appropriate values

Materials, Strand Material: Enter appropriate values
Materials, Concrete Material: Enter appropriate values

Actual deck thickness = Enter appropriate values
Structural deck thickness = Enter appropriate values
Effective flange width (LRFD) = Leave this field blank
Deck concrete: Leave this field blank
Deck reinforcement: Leave this field blank

Haunch Type: Leave these fields blank
LRFD Live Load Distribution Factors Leave these fields blank

Uniform Loads Leave these fields blank

Select the deck template: No action required

Appurtenances
For “Left Exterior” Appurtenance, enter the following values:
Name: Select (concrete) parapet or (metal) railing
Load Case: DC2
Measure To: Front
Edge of Deck Dist…: Left Edge
Distance At Start: 1.50
Distance At End: 1.50
Front Face Orientation: Right

Repeat above input for “Right Exterior” Appurtenance.

Sidewalks Leave these fields blank