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Steel Bridge Modeling in BrR (formerly Virtis) Program

1. Shop drawings – The NMDOT will, in some cases, furnish steel beam/girder fabrication shop drawings as part of the bridge documentation. Whether the drawings are included is dependant of several factors including: availability, legibility, & whether they will help to increase the model accuracy.

   On older rolled beam bridges it was common to provide optional fabrication details in the bridge plans. Examples of this include riveted versus welded cover-plate connections, stud versus channel shear connectors, & steel type substitutions. When so indicated by the NMDOT & shop drawings are furnished, verify the final as-fabricated optional details for input into the bridge rating model using the shop drawings. Also, verify other non-optional steel details, such as rolled beam shape sizes, diaphragm details, etc., as permitted by the drawing quality.

   Plate girder details are more complex than rolled beam details. Plate girder details include more dimensions, member (plate) sizes, stiffener configurations, cross-frame configurations, & welds. Moreover, sometimes it is necessary to detail each individual girder separately, resulting in numerous pages of details. Given the above, along with variations in the legibility of the available drawings, it is the intent that the shop drawings be reviewed to the extent that is possible & reasonable. Even where some sheets are not legible, the shop drawings are valuable to supplement information, such as weld sizes, that may be vague on the bridge plans. Where such information is legible on only certain girder sheets, it is reasonable to assume the same for all similar locations.

   When included as part of the documentation provided for bridge load rating model development, & where details are legible, it is expected that the modeler will verify beam/girder data from the bridge plans. Where differences occur between the two documents, use the shop drawings information.

2. Materials, Structural Steel Types – Information regarding steel types is found in the “Structural Steel” general note, under “Design Data”, & in various details in the bridge plans, & in the shop drawings (if available). Refer to the following table for selecting applicable BrR library steel definitions for the common steel types:

AASHTO Designation on Plans	ASTM Equivalent	BrR Library Item
--	ASTM A7	“1936 to 1963”
AASHTO M183	ASTM A36	“ASTM A36"
AASHTO M188	ASTM A572, Grade 45	"ASTM A572 - 1 1/2" max., Fy = 45 ksi" (Note 1)
AASHTO M223	ASTM A572, Grade 50	"ASTM A572 - <=3/4", Fy = 50 ksi" (Note 2)
AASHTO M222	ASTM A588, Grade 50	ASTM A588 - <=4", Fy = 50 ksi"

Notes:
1. Do not use the BrR library item “AASHTO M188”
2. For bridges where AASHTO M223 is specified, in general ignore the various BrR library definitions based on differing strengths & thicknesses; use the above item with Fy = 50 ksi.

3. Beam Shapes – Some older steel bridges have rolled beam sections that are no longer manufactured. The AISC document “Historical Record, Dimensions & Properties…” is attached for use in determining section properties for older rolled beam shapes.

4. Superstructure Definition Wizard in BrR Program – When using the subject wizard in BrR, note the following:

   a. Metal railing cannot be selected in the wizard (program error) – In the “Appurtenances” section of the wizard input, leave the input items blank & complete the wizard as usual. When the wizard is finished, enter the railing data manually under the “Structure Typical Section” icon. Also update the live load positions under the “Lane Position” tab.

   b. Composite steel bridges – The wizard prompts the user to select either “Composite throughout” or “Partial composite (positive moment regions only)”. It does not matter which of these is selected: the later input of the shear connector spacings will override this selection.

   c. “Deck Profile” inputs – After completing the wizard, there are several additional inputs that are required under this icon: Run the “Compute from…” button under the “Deck Concrete” tab, input deck reinforcement under the “Reinforcement” tab, & input the shear connector spacings under the “Shear Connectors” tab.

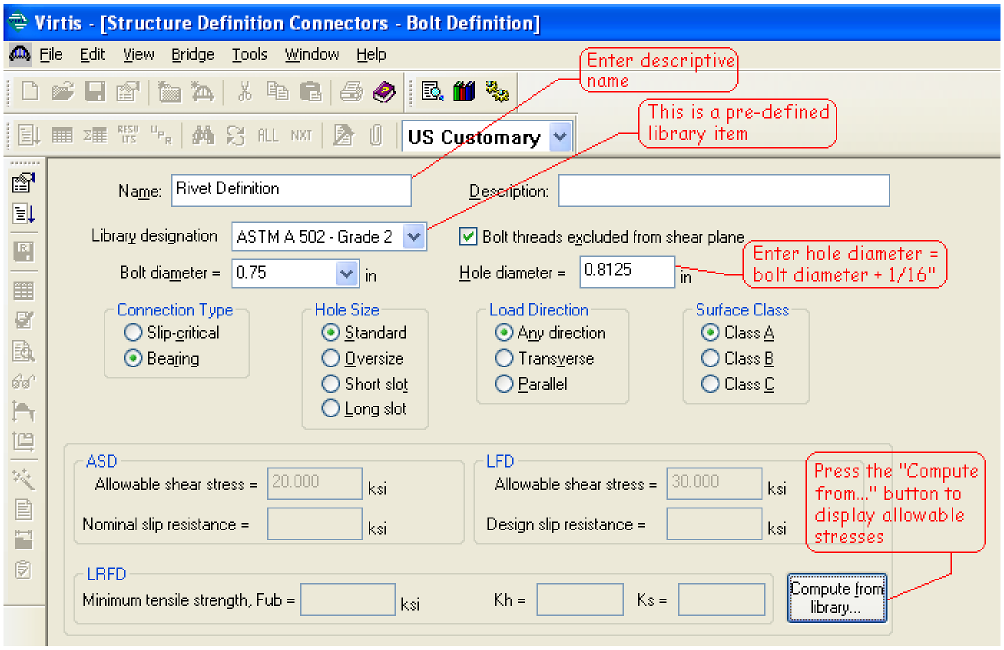
      Note: Based on the above inputs, the Virtis program will develop composite section properties using the beam+slab section in positive moment regions & the beam+deck reinforcement section in the negative moment regions.

5. Framing Plan Detail, Diaphragms (Lateral Bracing in Plate Girder Bridges) – Lateral bracing is not explicitly input into a BrR model, but its weight must be included. The following two methods are satisfactory: 1) add lateral bracing weight to diaphragm weights for the bay(s) in which the bracing is located, or 2) input under Member Loads as a distributed non-composite uniform load to applicable adjacent members. In either case, the weight must be externally calculated.

6. Structure Typical Section, Deck (Cont’d) - For steel bridges, the sustained modular ratio factor is 3 in accordance with Section 10.38.1.4 of the AASHTO Standard Specifications.

7. Connectors, Bolt Definitions (Rivets)

   A rivet definition must be input for some older bridges where riveted cover-plates are used. In BrR, input the rivet definition as shown below & using the library definition “ASTM A 502 - Grade 2”:



Refer also to Item 10 below regarding additional rivet inputs under “Girder Profile”.

8. Connectors, Weld Definitions

a. Groove welds – For plate girders, do not define groove welds (used at shop splice locations). Refer also to Item 11 below regarding this issue under “Girder Profile”.

b. Fillet welds – Make a separate weld definition for each unique combination of fillet weld size & fatigue category. Use the “E70 (US)” electrode unless otherwise indicated in the plans. Refer to the following table for selecting fatigue category for common steel girder weld details:

Fillet Weld Location	Fatigue Category
Flange-to-Web Longitudinal	B
Transverse Stiffener-to-Web/Flange	C
Cover-plate-to-Flange	B
Longitudinal Stiffener-to-Web	B

Notes:
1. The above table does not include the more severe E & E’ categories at ends of longitudinal stiffeners & cover-plates. Neglect such occurrences for now.
2. See Section 10.3 of the AASHTO Standard Specifications for more information.

9. Stiffener Definitions

a. General – All steel bridges have stiffeners and cross-frame connection plates at various locations. Rolled beam bridges typically have only bearing stiffeners at supports & connection plates at cross frames. Welded steel plate girder bridges have the above & typically intermediate stiffeners as well. In general, details such as plate dimensions, weld sizes, & weld locations vary among the various stiffeners used in a bridge. As with other model inputs, proper bridge rating is dependant upon accurate stiffener definition – including weld locations & fatigue categories. Review bridge plans & shop drawings carefully & make stiffener definitions as required to completely define all unique configurations needed in the model.

b. Parameters for Defining Stiffeners

i. Steel Type – Generally AASHTO M 183/ASTM A 36 steel is used for stiffeners.

ii. Weld Configurations – Stiffener type, location along beam/girder, girder plate sizes, & bridge age are factors that affect stiffener welds. While bearing stiffener details have changed little, details for connection plates & intermediate stiffeners have evolved over time, due primarily to lessons learned regarding steel fatigue. On more complex beams & girders, multiple stiffener definitions are necessary to characterize the various combinations of plate dimensions, weld sizes, & weld locations. Shop drawings should be reviewed to verify stiffener details.

1. Bearing Stiffeners – These are almost always welded at the beam/girder web only; top & bottom flange connections are “milled to bear” (no weld).

2. Connection Plates – These are defined in BrR as transverse stiffeners. Depending on factors such as the age of the bridge, connection plate-to-flange connections may have: no contact with a gap between the two, a weld at the compression flange with a tight fit (no weld) at the tension flange, or welds at both flanges (current method for new bridges).

3. Intermediate Stiffeners - These are also defined in BrR as transverse stiffeners. Like connection plates, details have changed over time. A common configuration has a weld at the compression flange & a tight fit (no weld) at the tension flange. Earlier details included a gap at the tension flange (no weld).

4. Tension Flange in Continuous Bridges – The tension flange location (top or bottom) varies along a continuous beam/girder. This must be accounted for in defining stiffeners & locating them in the bridge rating model. For example, in a bridge where all intermediate stiffeners/connection plates use only one plate & weld size & have welds only at the web & compression flange, it is necessary to make two stiffener definitions – one with the compression flange & weld on top (positive moment regions) & a second definition with the compression flange & weld at bottom (negative moment regions). This must be taken into consideration, along with variations in plate & weld size

combinations to ensure that all unique stiffener definitions are correctly input into the bridge model.

Note: Stiffeners are always welded to the beam/girder web.

Identifying Tension Flange – Where applicable, review steel beam/girder details in the bridge plans for information describing the tension flange locations. Some bridge plans have drawings showing regions (lengths) along girder. Others may describe this information in callouts, notes, etc. If not found in the plans, check stiffener weld locations as shown in the shop drawings (if available). If information is still lacking, assume that the beam/girder splice locations are the boundaries between the positive & negative moment regions.

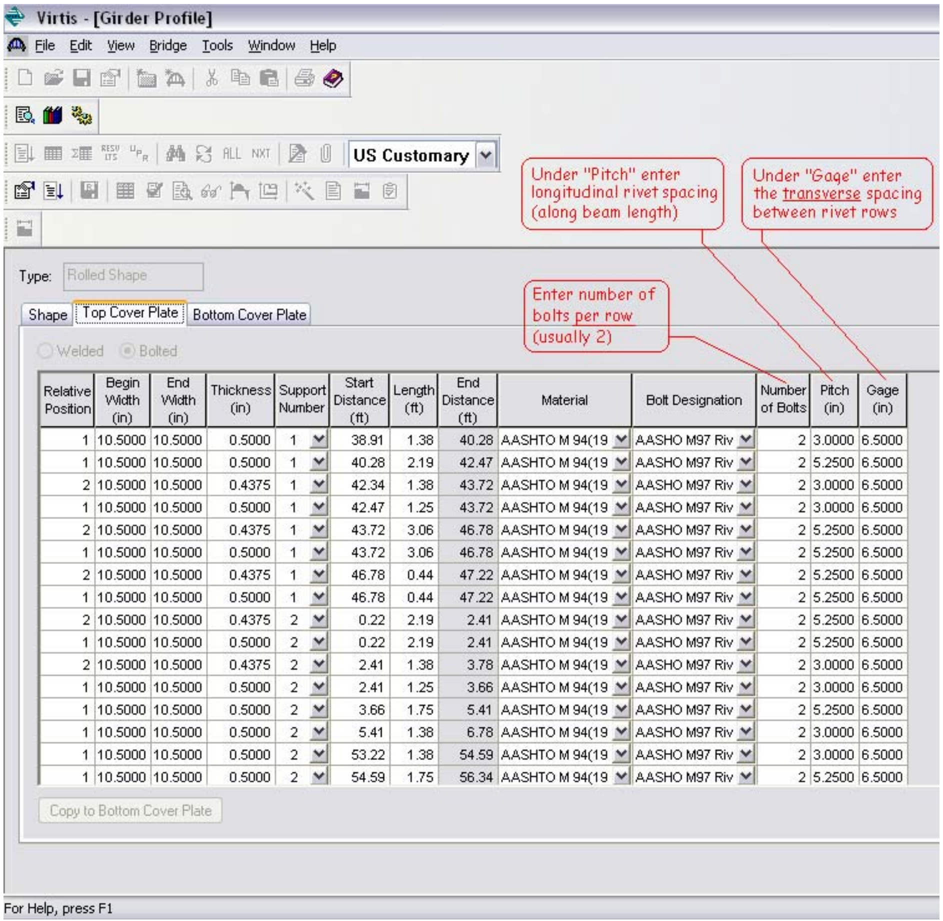
5. Bearing Stiffener Pairs of Unequal Size – Transverse stiffeners (intermediate- & connection plates) are defined as a single plate even though they may (on some bridges) occur in "pairs". Bearing stiffeners, in contrast, generally occur in "pairs" & are defined as such in BrR. However, the program assumes identical plates for each part of the "pair" – this is not always the case. Where individual plates are of different sizes (width & thickness), provide "averaged" dimensions as follows:

    a. Plate width – use average width.
    b. Plate thickness – use *weighted* average thickness.

    For example, a stiffener "pair" consists of an exterior 5 x 1/2" plate & an interior 7 x 5/8" plate. Input the average width of 6", & a weighted thickness of 0.5729", with the latter calculated as follows:

    (5" width x 0.5" thickness + 7" width x 0.625" thickness)/(12" total width)

10. Girder Profile, Type: Rolled Shape, Riveted Cover Plates – When inputting rivet spacing data, refer to the following example:



Relative Position	Begin Width (in)	End Width (in)	Thickness (in)	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Material	Bolt Designation	Number of Bolts	Pitch (in)	Gage (in)
1	10.5000	10.5000	0.5000	1	38.91	1.38	40.28	AASHTO M 94(19	AASHO M97 Riv	2	3.0000	6.5000
1	10.5000	10.5000	0.5000	1	40.28	2.19	42.47	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
2	10.5000	10.5000	0.4375	1	42.34	1.38	43.72	AASHTO M 94(19	AASHO M97 Riv	2	3.0000	6.5000
1	10.5000	10.5000	0.5000	1	42.47	1.25	43.72	AASHTO M 94(19	AASHO M97 Riv	2	3.0000	6.5000
2	10.5000	10.5000	0.4375	1	43.72	3.06	46.78	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
1	10.5000	10.5000	0.5000	1	43.72	3.06	46.78	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
2	10.5000	10.5000	0.4375	1	46.78	0.44	47.22	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
1	10.5000	10.5000	0.5000	1	46.78	0.44	47.22	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
2	10.5000	10.5000	0.4375	2	0.22	2.19	2.41	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
1	10.5000	10.5000	0.5000	2	0.22	2.19	2.41	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
2	10.5000	10.5000	0.4375	2	2.41	1.38	3.78	AASHTO M 94(19	AASHO M97 Riv	2	3.0000	6.5000
1	10.5000	10.5000	0.5000	2	2.41	1.25	3.66	AASHTO M 94(19	AASHO M97 Riv	2	3.0000	6.5000
1	10.5000	10.5000	0.5000	2	3.66	1.75	5.41	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000
1	10.5000	10.5000	0.5000	2	5.41	1.38	6.78	AASHTO M 94(19	AASHO M97 Riv	2	3.0000	6.5000
1	10.5000	10.5000	0.5000	2	53.22	1.38	54.59	AASHTO M 94(19	AASHO M97 Riv	2	3.0000	6.5000
1	10.5000	10.5000	0.5000	2	54.59	1.75	56.34	AASHTO M 94(19	AASHO M97 Riv	2	5.2500	6.5000

11. Girder Profile, Type: Plate Girder, Web, Top Flange, Bottom Flange – On the various screens, ignore the item "Weld at Right". This is for the groove-weld plate splices. Per Item 8 above, these welds are not input.