AASHTOWare BrDR 7.5.0

Steel Tutorial

STL7 – Steel Shear Stud Design Tool

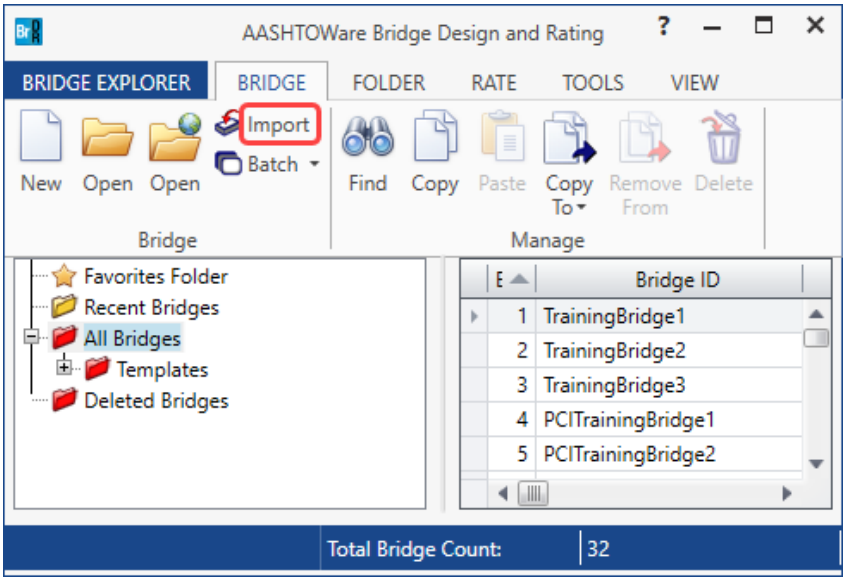
BrDR Tutorial

Topics Covered

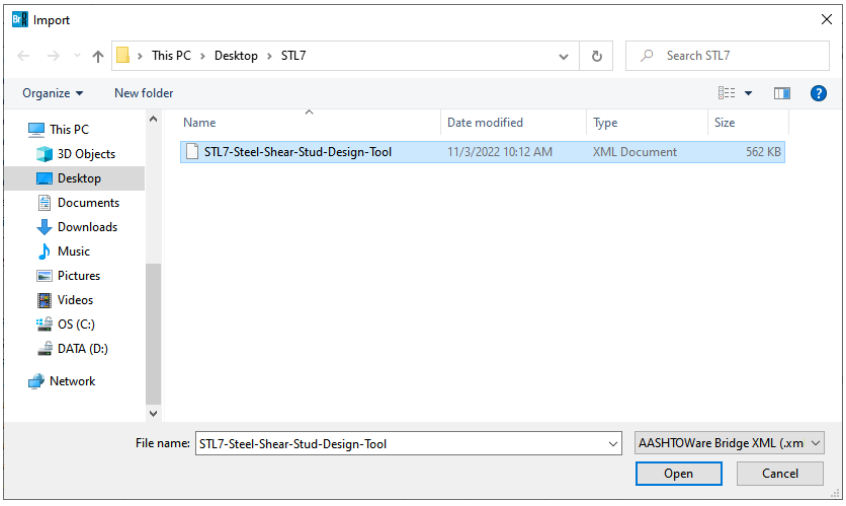
- Importing a bridge in BrDR
- Shear Stud Design Tool
- Shear Stud Design Tool – Design Rules
- LRFD Design Review

Importing a bridge in BrDR

This example uses the bridge defined in the **STL7-Steel-Shear-Stud-Wizard.xml** provided for this tutorial. Use the **Import** function of **BrDR** to import this bridge. Open **BrDR** and click on the **Import** button from the **Bridge** group of the **BRIDGE** ribbon as shown below.

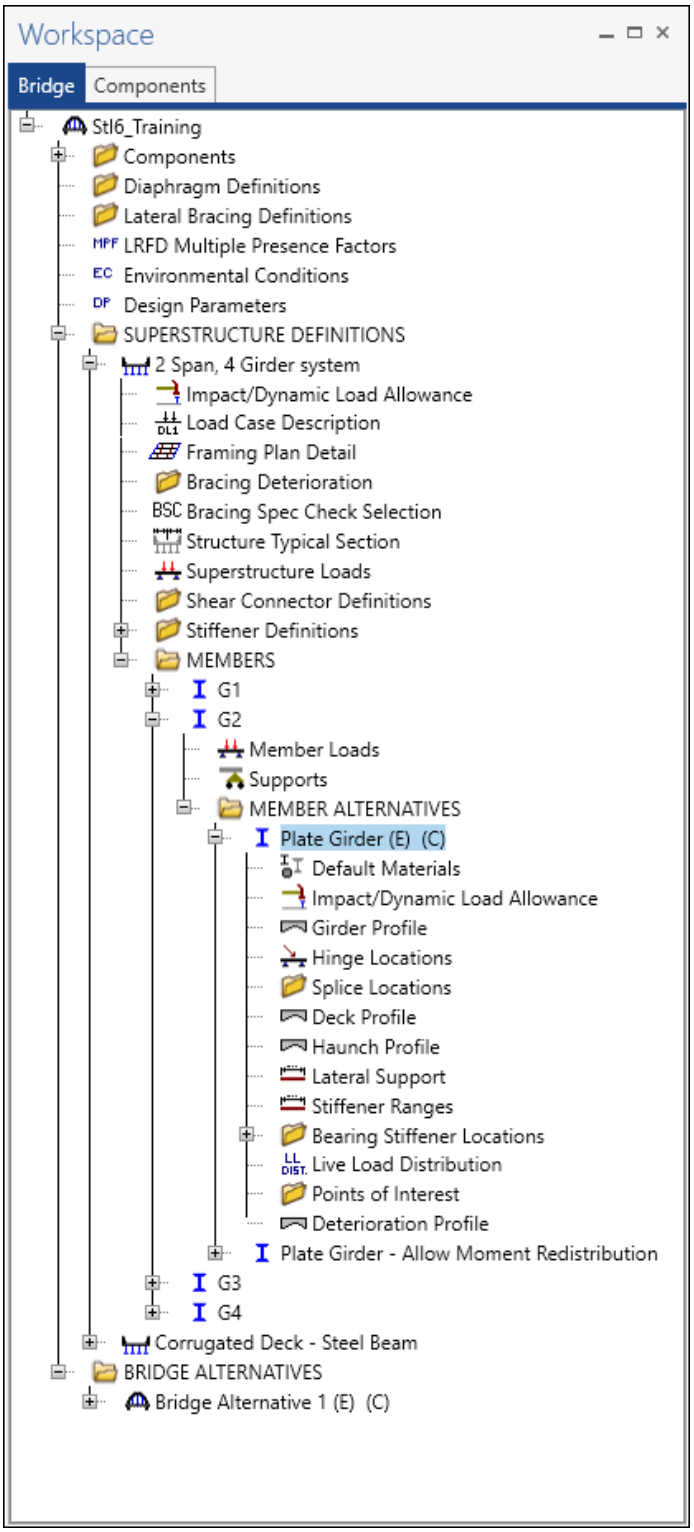


Select the bridge and click the **Open** button to import this bridge into **BrDR**.



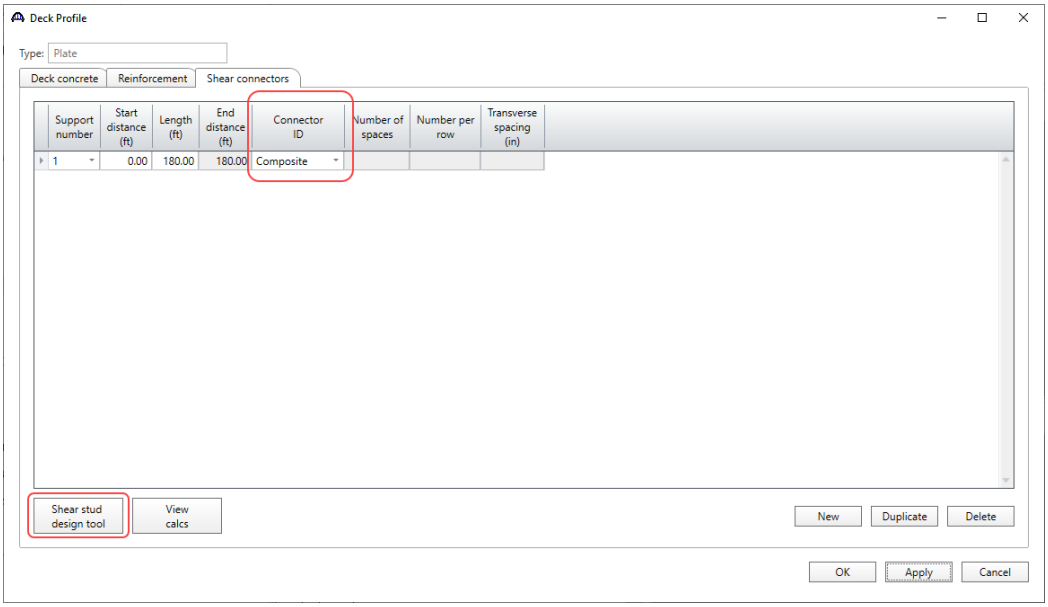
Shear Stud Design Tool

Expand the **Bridge Workspace** tree to show the member alternative for member **G2**. The partially expanded **Bridge Workspace** tree is shown below.

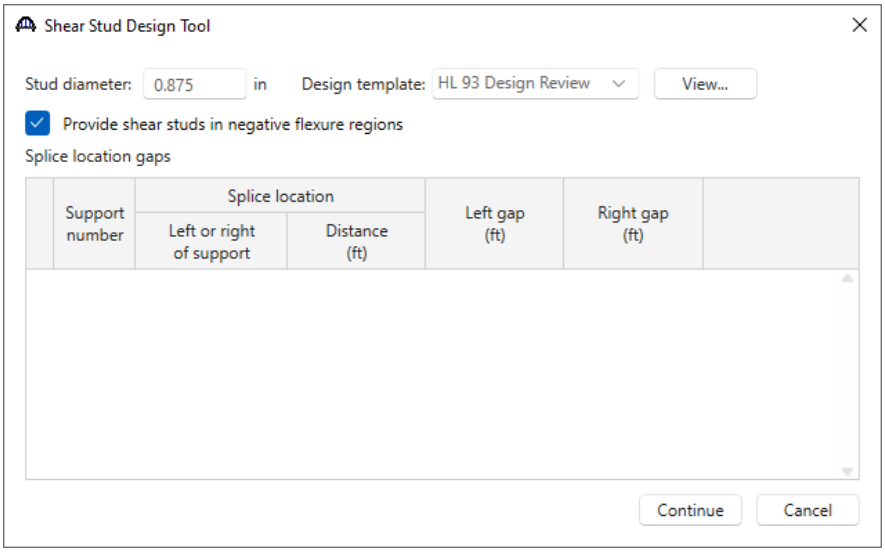


Deck Profile

Double click on the **Deck Profile** node in the **Bridge Workspace** tree to open the **Deck Profile** window. Navigate to the **Shear connectors** tab of this window. The shear connectors are currently defined as a generic **Composite** region. **BrDR** has a **Shear stud design tool** that can compute a shear stud pattern. Click the **Shear stud design tool** button in this window as shown below.

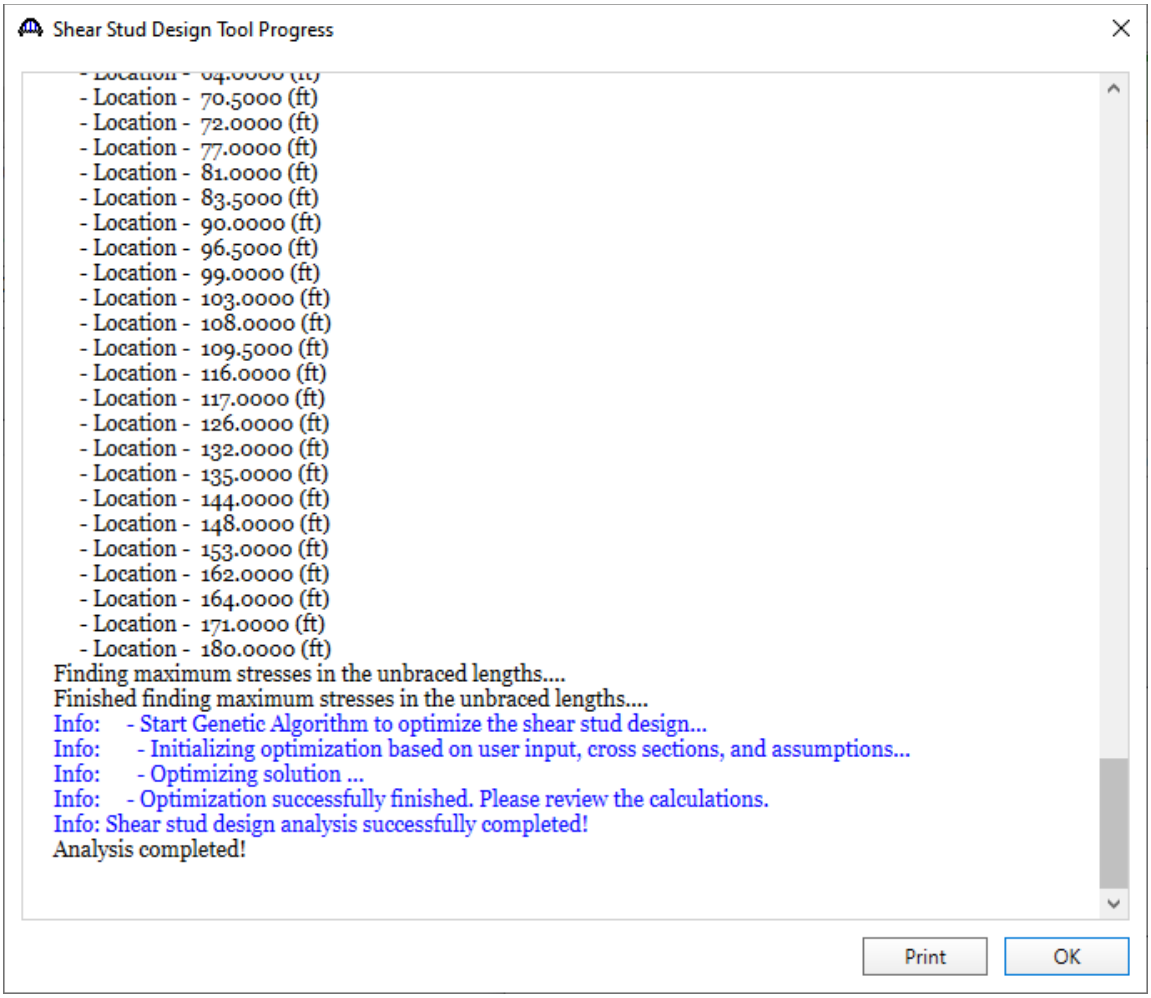


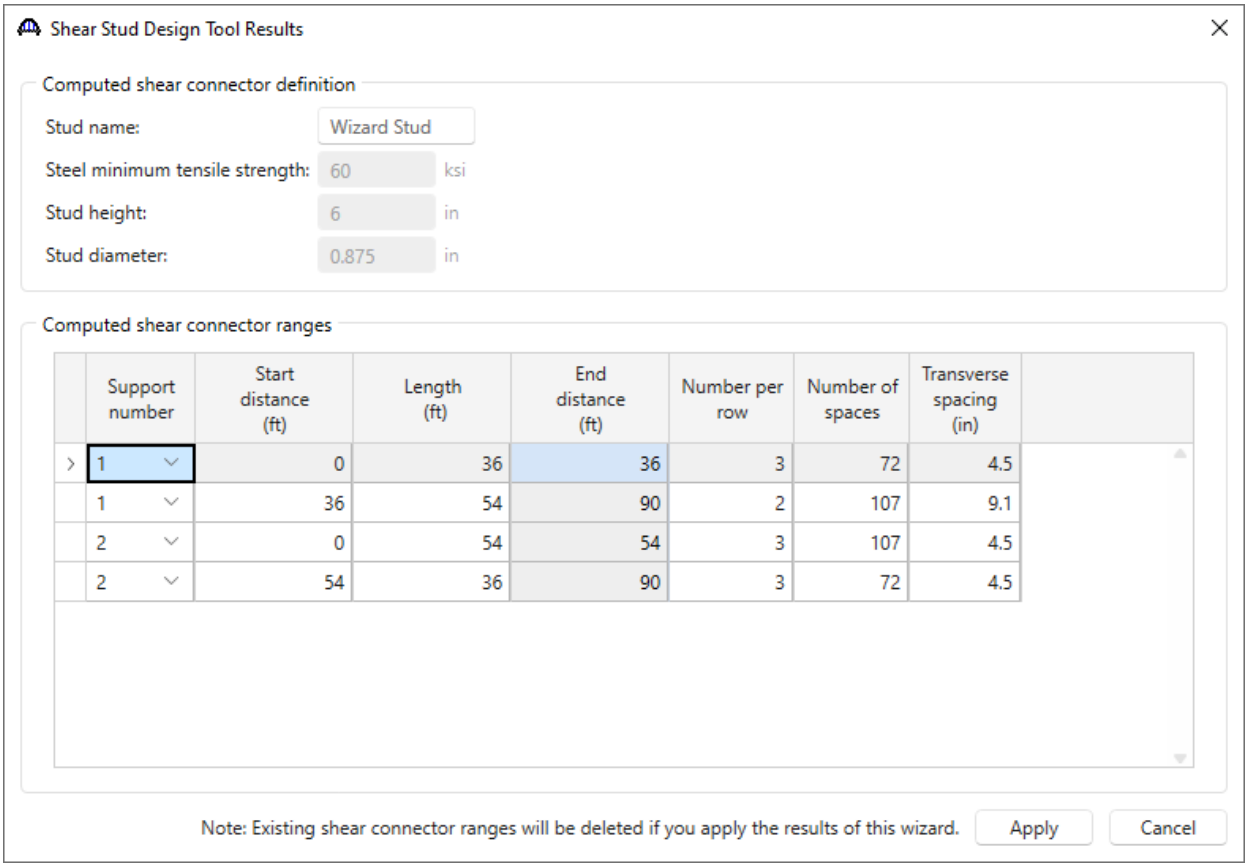
Enter the data as shown below. If the **Provide shear studs in negative flexure regions** is not checked, the design tool will not create a stud pattern in the negative moment region between points of dead load contraflexure.



Click the **Continue** button and the **Shear Stud Design Tool Progress** window will launch a dead load and live load analysis, design a shear stud pattern, and display the resulting design as shown below.

Click **OK** to view the results.

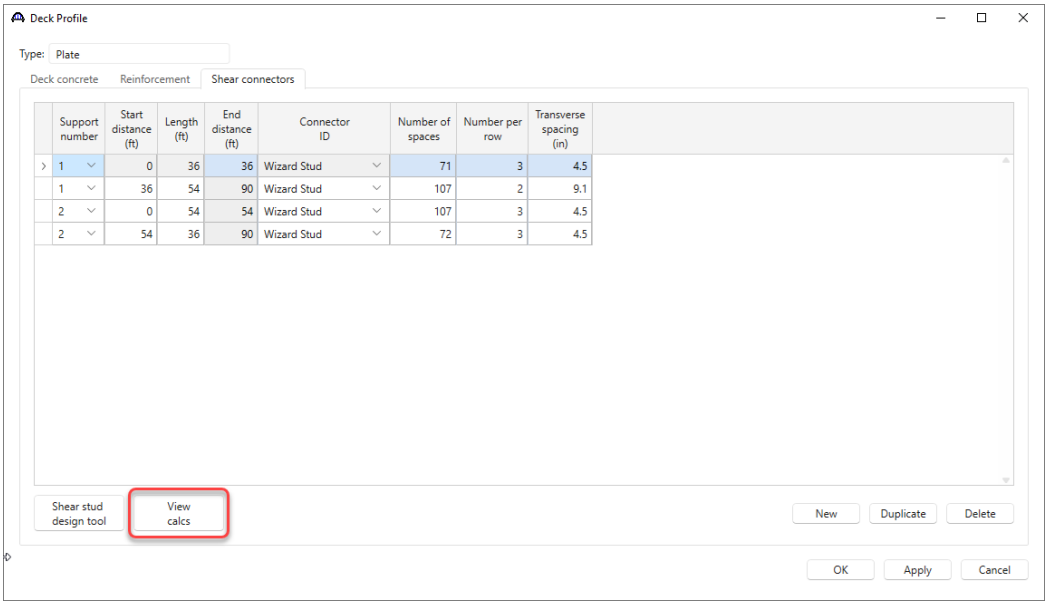




The **Stud name** and the range data can be modified in this window. Click the **Apply** button to save the generated data. Note that clicking the **Apply** button deletes the existing ranges.

Close the window by clicking **OK**. This applies the data and closes the window.

The **Shear connectors** tab will updates with the shear stud ranges created using the **Shear stud design tool** as shown below. The **View calcs** button on this window opens a text file containing the output of the articles that were evaluated in the design.



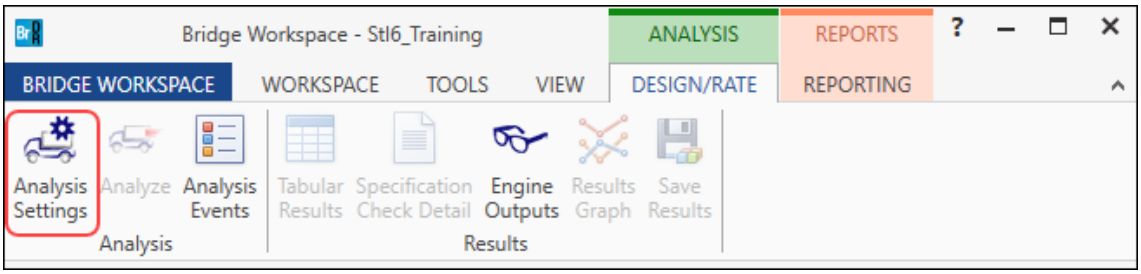

```
********************************************************************************************
* Results of the Shear Stud Wizard
* Executed on 1/9/2024 2:02 PM
********************************************************************************************


Load Combination Legend:

 Code      Vehicle
------------------------
    1     HL-93 (US) - Design Truck + Lane
    2     HL-93 (US) - Tandem + Lane
    3     HL-93 (US) - 90%(Truck Pair + Lane)
    4     LRFD Fatigue Truck (US) - Fatigue Truck


6 Steel Structures
6.10 I-Section Flexural Members
6.10.10 Shear Connectors
6.10.10.1  General
(AASHTO LRFD Bridge Design Specifications, Ninth Edition)

Steel Plate - At Location = 0.0000 (ft) - Right     Stage 3

Section within Top Flange Continuous Bracing Region

Section at Bottom Flange Brace Point


INPUT:
Shear Connector Type: Stud
Stud Diameter, Diam  =   0.8750 (in)
Stud Height, H       =   6.0000 (in)
Number per Row       =     3
Transverse Spacing   =     4.50 (in)
Pitch                =   6.0000 (in)

Top Flange bf        =  12.0000 (in)
Haunch Depth         =   1.0000 (in)
Eff. Slab Thick      =   8.0000 (in)


6.10.10.1.1 Types
-----------------
Stud H/Diam  >= 4.0
Stud H/Diam  = 6.8571            PASS


6.10.10.1.2 Pitch
-----------------
1. C/C Pitch <= 48.0 in
```

Shear Stud Design Tool – Design Rules

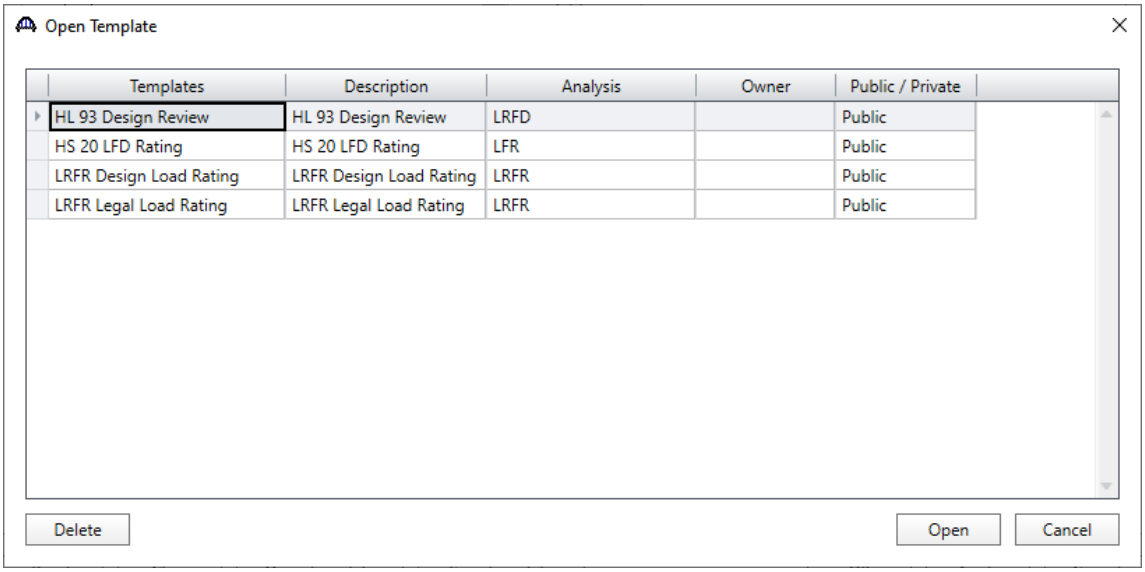
1. The user enters the stud diameter.
2. The minimum tensile strength of the stud is always 60 ksi (415 MPa) as per AASHTO LRFD Article 6.4.4.
3. Designs are optimized such that all the following articles pass with a design ratio (i.e., resistance/action) close to 1.1.
4. The Wizard evaluates the following specification articles:
    a. 6.10.10.1.1 Shear Connectors - General - Types
    b. 6.10.10.1.2 Shear Connectors - General - Pitch
    c. 6.10.10.1.3 Shear Connectors - General – Transverse Spacing
    d. 6.10.10.1.4 Shear Connectors - General – Cover and Penetration
    e. 6.10.10.2 Shear Connectors – Fatigue Resistance
    f. 6.10.10.3 Shear Connectors – Special Requirements for Points of Permanent Load Contraflexure (only evaluated at points of dead load contraflexure when the user has chosen to not provide shear studs in the negative flexure regions)
    g. 6.10.10.4 Shear Connectors – Strength Limit State (only evaluated at points of maximum live load moment and interior supports as per this article)

LRFD Design Review

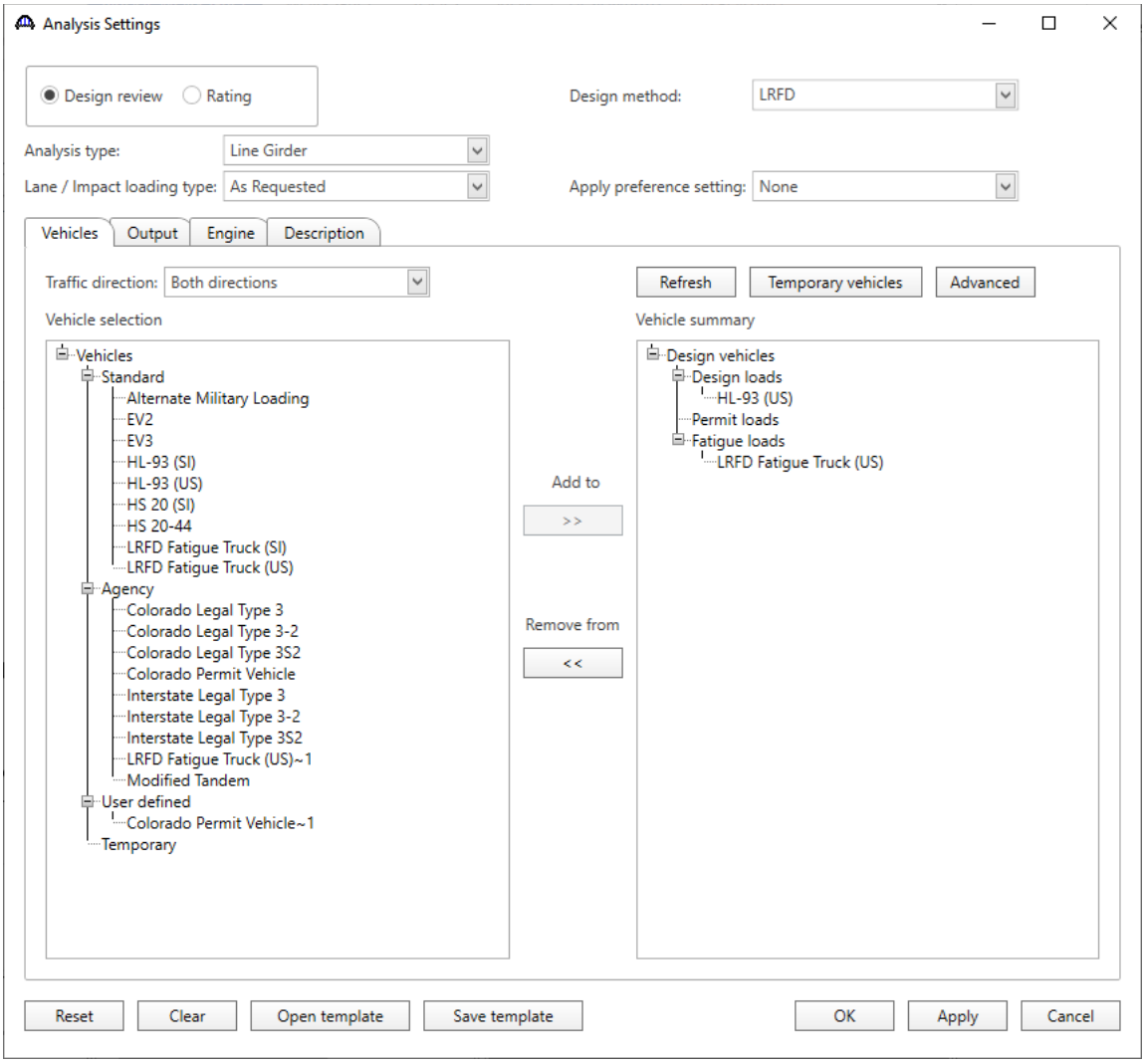
To perform an LRFD design review, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.



Click the **Open Template** button and select the **HL-93 Design Review** used in the rating and click **Open**.

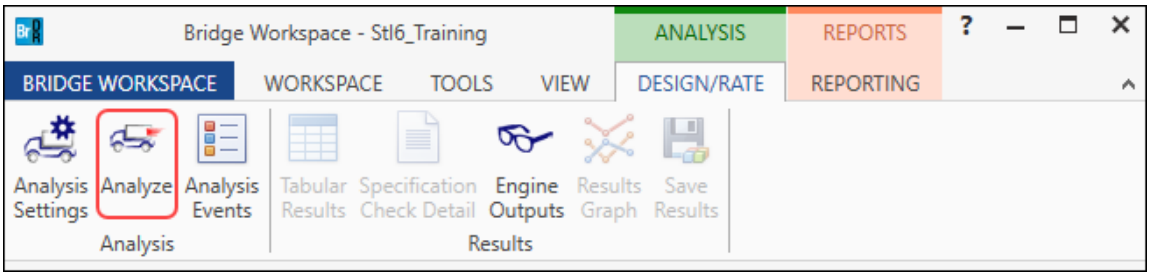


The **Analysis Settings** window will be populated as shown below.



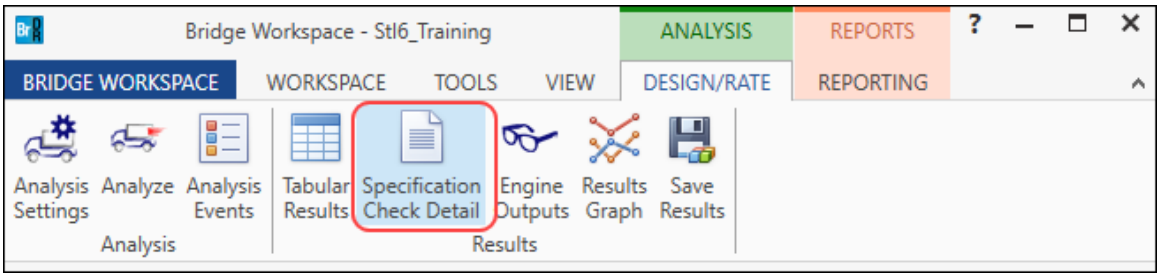
Click **OK** to apply the analysis settings and close the window.

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

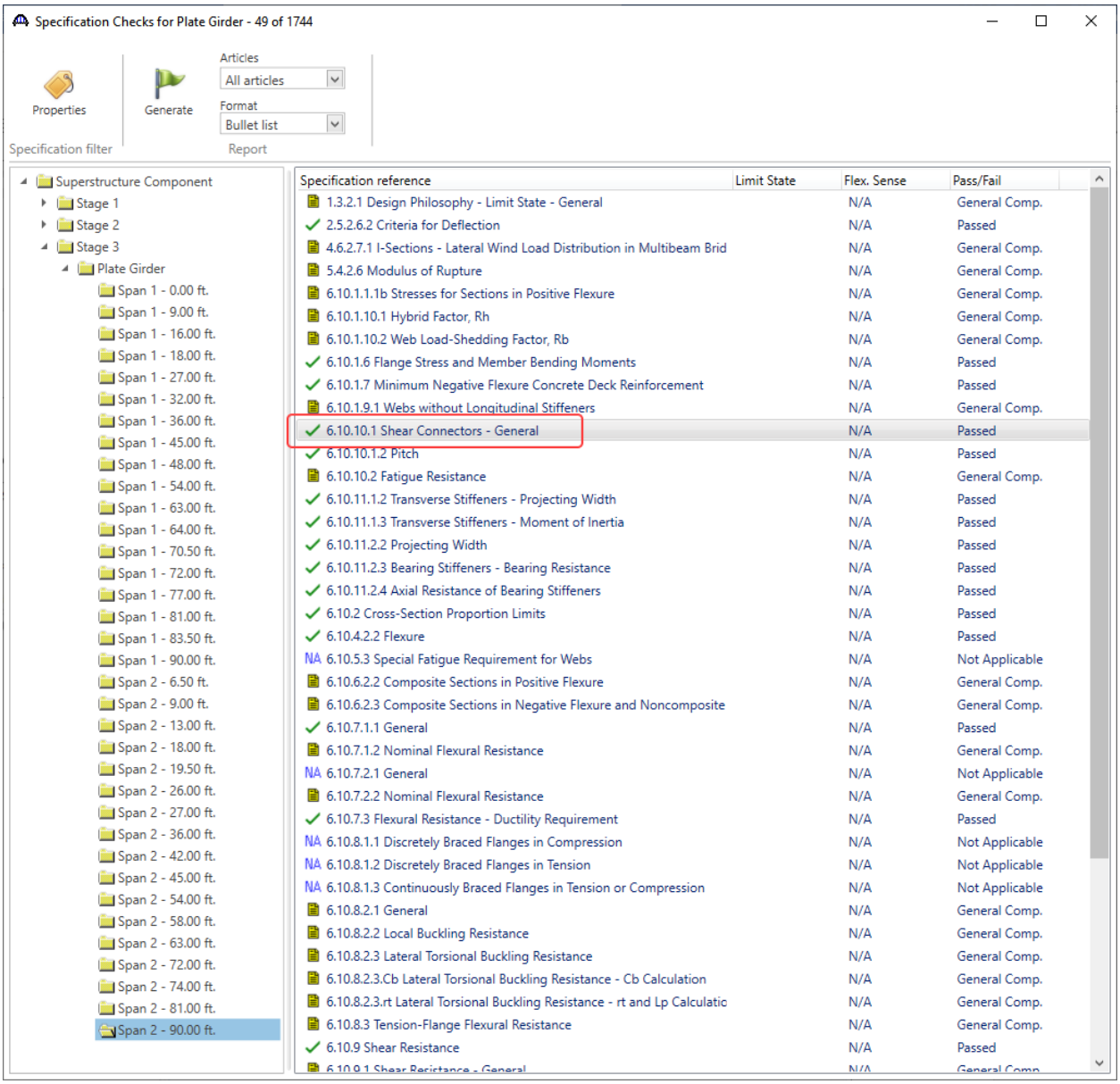


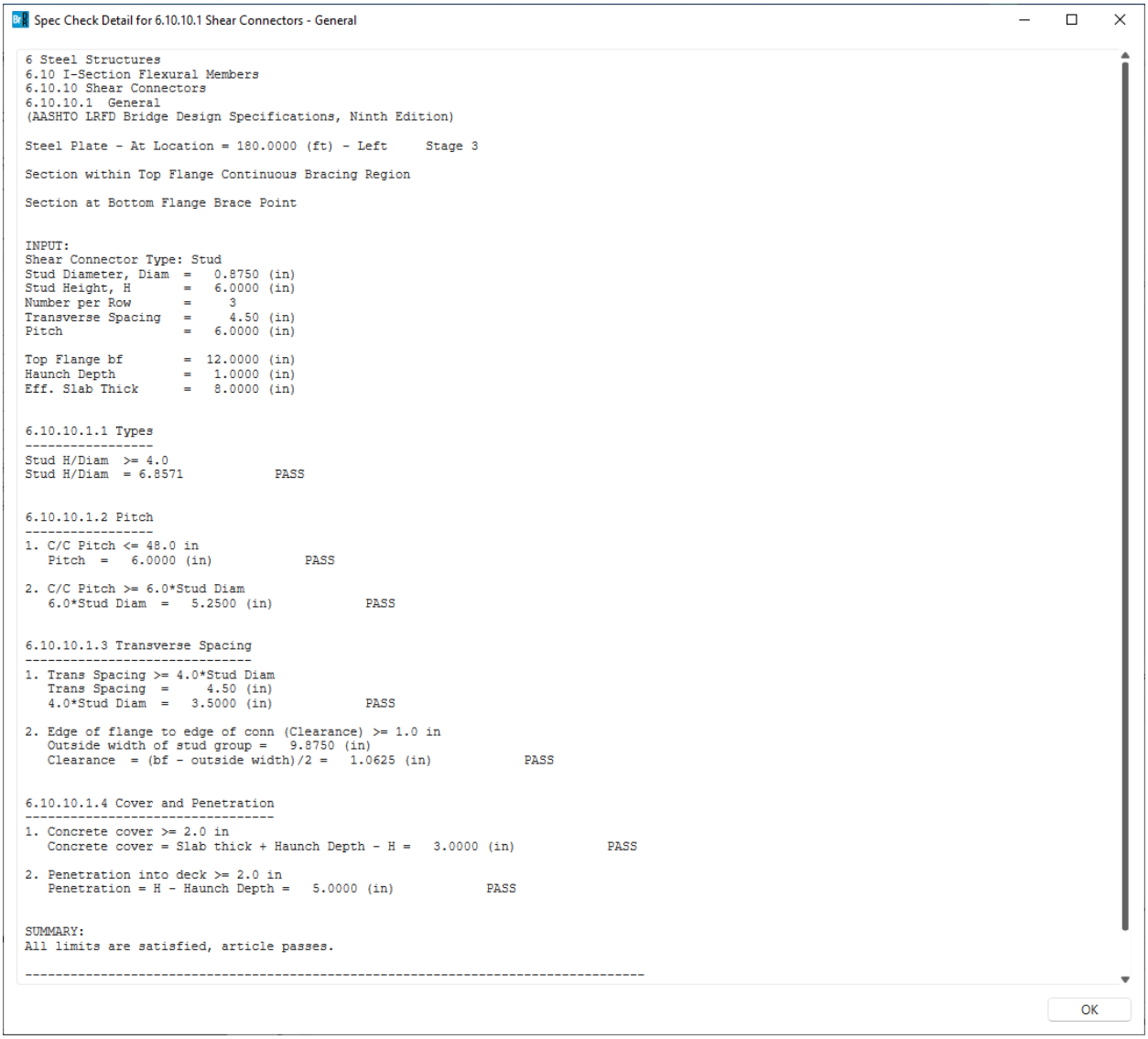
Specification Check Detail

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



Select the **6.10.10.1 Shear Connectors - General** article for **Stage 3** at **Span 2 – 90.00 ft**.




Spec Check Detail for 6.10.10.1 Shear Connectors - General
6 Steel Structures
6.10 I-Section Flexural Members
6.10.10 Shear Connectors
6.10.10.1 General
(AASHTO LRFD Bridge Design Specifications, Ninth Edition)
Steel Plate - At Location = 180.0000 (ft) - Left Stage 3
Section within Top Flange Continuous Bracing Region
Section at Bottom Flange Brace Point
INPUT:
Shear Connector Type: Stud
Stud Diameter, Diam = 0.8750 (in)
Stud Height, H = 6.0000 (in)
Number per Row = 3
Transverse Spacing = 4.50 (in)
Pitch = 6.0000 (in)
Top Flange bf = 12.0000 (in)
Haunch Depth = 1.0000 (in)
Eff. Slab Thick = 8.0000 (in)
6.10.10.1.1 Types
Stud H/Diam >= 4.0
Stud H/Diam = 6.8571 PASS
6.10.10.1.2 Pitch
1. C/C Pitch <= 48.0 in
Pitch = 6.0000 (in) PASS
2. C/C Pitch >= 6.0*Stud Diam
6.0*Stud Diam = 5.2500 (in) PASS
6.10.10.1.3 Transverse Spacing
1. Trans Spacing >= 4.0*Stud Diam
Trans Spacing = 4.50 (in)
4.0*Stud Diam = 3.5000 (in) PASS
2. Edge of flange to edge of conn (Clearance) >= 1.0 in
Outside width of stud group = 9.8750 (in)
Clearance = (bf - outside width)/2 = 1.0625 (in) PASS
6.10.10.1.4 Cover and Penetration
1. Concrete cover >= 2.0 in
Concrete cover = Slab thick + Haunch Depth - H = 3.0000 (in) PASS
2. Penetration into deck >= 2.0 in
Penetration = H - Haunch Depth = 5.0000 (in) PASS
SUMMARY:
All limits are satisfied, article passes.
OK