

AASHTOWare BrDR 7.5.1

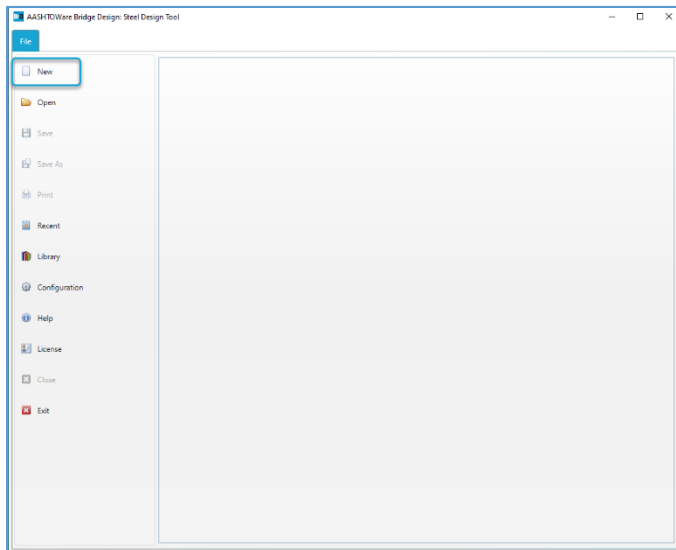
Steel Design Tool

Two Span Girder Design Example

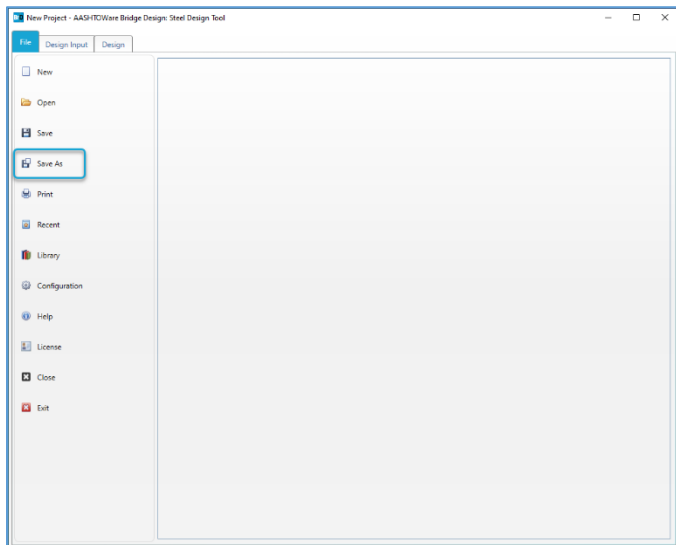
Two Span Girder Design Example

Start the **Steel Design Tool** program, create a new input file using the **File | New** command. The program will switch from the **File** tab to the **Design Input** tab.

File | New and File | Save As



Before proceeding with **Design Input** return to the **File** tab and click **Save As** to rename the file from **New Project** to **STL15 Design Example**.



STL15 - Steel Design Tool Example

The new file name will appear in the program title bar and the program will again bring up the the **Design Input** with the **Project** input screen. The **Project** property will still say **New Project** and this will be changed in the next step. The **Project** property determines the name of the subfolder in the Documents\AASHTOWare\SteelDesign75\ folder where design run output files will be stored. In the bottom left corner of the program window, there is a **Validation** button that enables input validation. When validation is enabled, the program will mark sections and input boxes with missing or incorrect information. For the purposes of this example, the **Validation** will be disabled during input and will be enabled after all input is entered to verify that there are no validation errors.

Design Input | Project

On the Design Input | **Project** input screen, enter the data as shown below.

The screenshot shows the 'Project' input screen in the STL15 Design Tool. The window title is 'STL15 Design Example.brdx - AASHTOWare Bridge Design: Steel Design Tool'. The 'Design Input' tab is active. The 'Project' section is highlighted in the left sidebar. The main area contains the following fields and options:

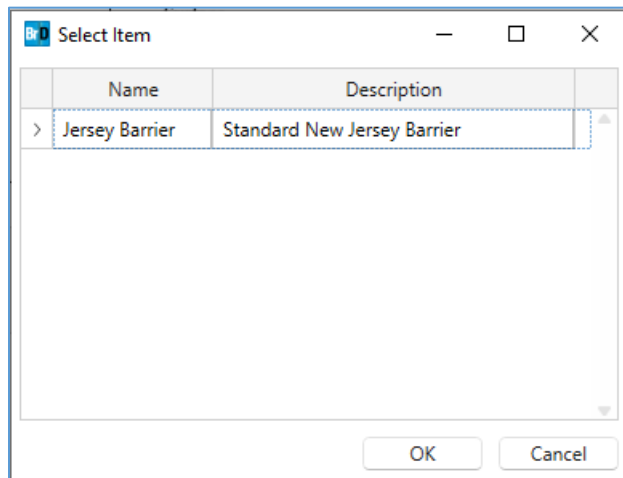
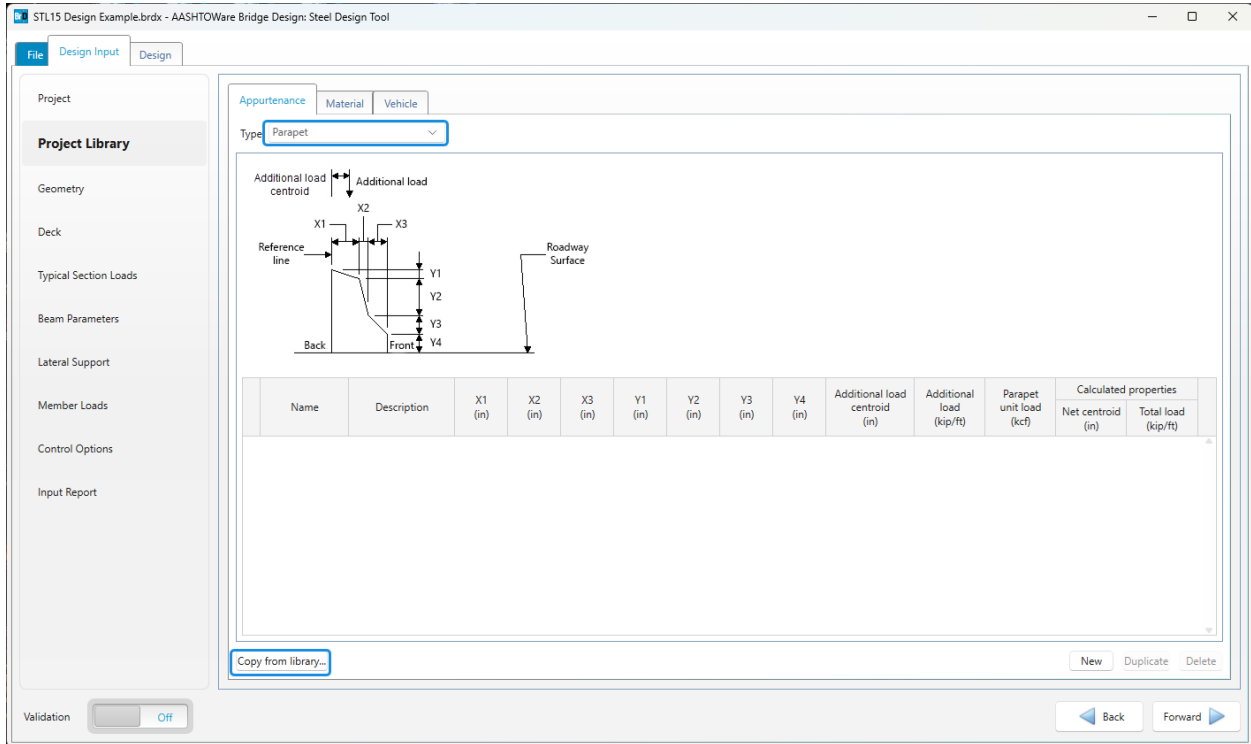
- Project:** STL15 Design Example
- Description:** 2 Span 4 Girder Bridge
- Designer:** (empty text box)
- Date:** 7/11/2024 (calendar icon)
- LRFD specifications:**
 - Edition:** AASHTO LRFD 9th
 - Limit states:** Strength-I, Strength-II, Strength-III, Strength-V, Service-II, Fatigue-I, Fatigue-II (all checked)
- Design vehicles:**
 - Design load:** (dropdown menu)
 - Permit load:** (dropdown menu)
 - Single lane permit load
 - Fatigue load:** (dropdown menu)
- Design ADTT:** 0

At the bottom left, the 'Validation' button is set to 'Off'. At the bottom right, there are 'Back' and 'Forward' navigation buttons.

STL15 - Steel Design Tool Example

Design Input | Project Library | Appurtenance

On the **Appurtenance** tab, select **Parapet** for **Type** from the drop down menu and click the **Copy from library** button to add a new parapet. Select the Jersey Barrier.



STL15 - Steel Design Tool Example

STL15 Design Example.brdx - AASHTOWare Bridge Design: Steel Design Tool

File Design Input Design

Project

Project Library

- Geometry
- Deck
- Typical Section Loads
- Beam Parameters
- Lateral Support
- Member Loads
- Control Options
- Input Report

Appurtenance Material Vehicle

Type: Parapet

Name	Description	X1 (in)	X2 (in)	X3 (in)	Y1 (in)	Y2 (in)	Y3 (in)	Y4 (in)	Additional load centroid (in)	Additional load (kip/ft)	Parapet unit load (kcf)	Calculated properties	
												Net centroid (in)	Total load (kip/ft)
> Jersey Barrier	Standard New Jer...	12.0000	2.0000	7.0000	0.0000	19.0000	10.0000	3.0000			0.1500	7.8801	0.505

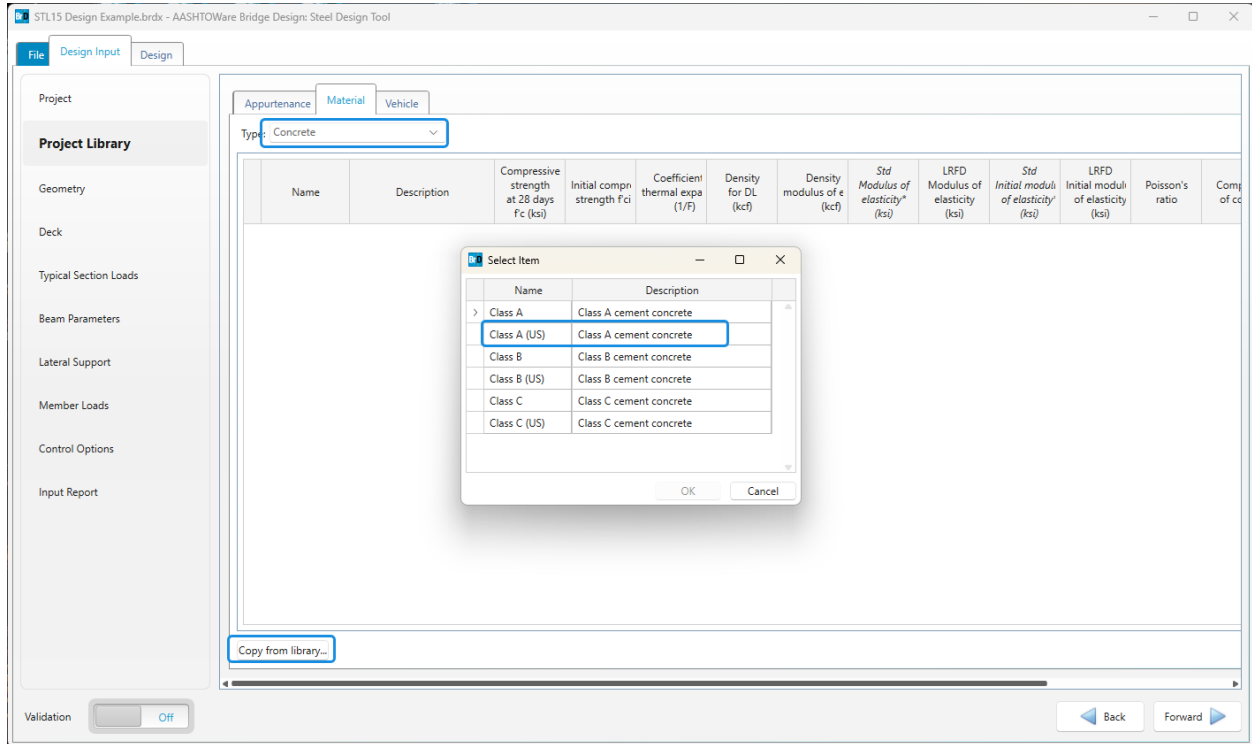
Copy from library... New Duplicate Delete

Validation Off

Back Forward

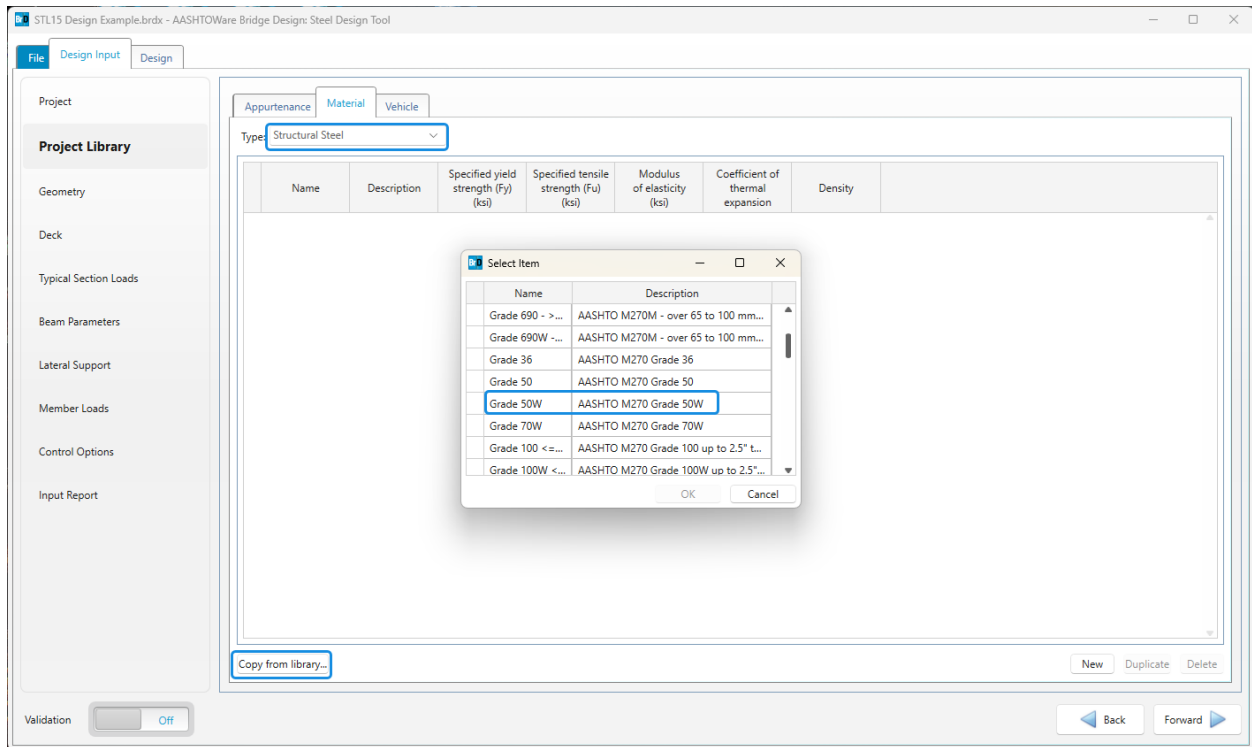
Design Input | Project Library | Material

On the **Material** tab, select **Concrete** for **Type** from the drop down menu and click the **Copy from library** button to copy the **Class A (US)** concrete material definition from **File | Library** to the **Project Library**.



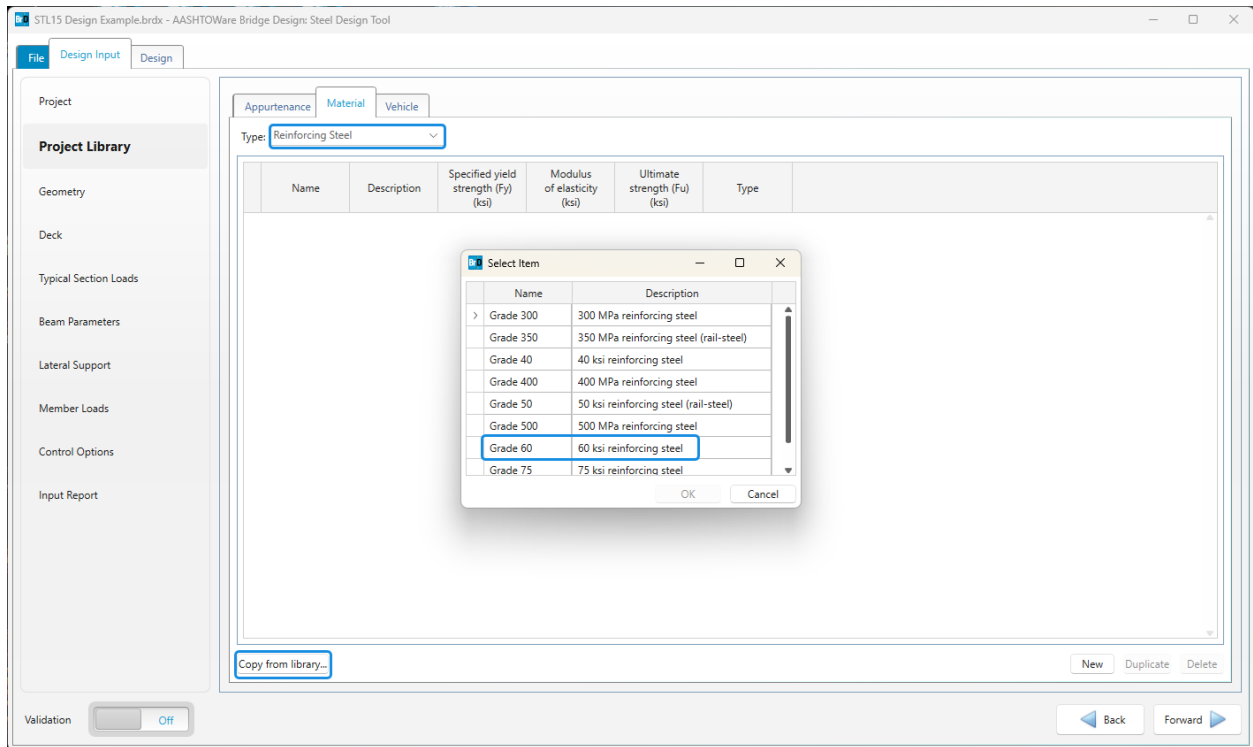
STL15 - Steel Design Tool Example

On the **Material** tab, select **Structural Steel** for **Type** from the drop down menu and click the **Copy from library** button to copy the **Grade 50W** steel material definition from **File | Library** to the **Project Library**.



STL15 - Steel Design Tool Example

On the **Material** tab, select **Reinforcing Steel** for **Type** from the drop down menu and click the **Copy from library** button to copy the **Grade 60** reinforcing steel material definition from **File | Library** to the **Project Library**.



STL15 - Steel Design Tool Example

Design Input | Project Library | Vehicle

On the **Vehicle** tab, copy the HL-93 (US) and LRFD Fatigue Truck (US) vehicle definitions from library.

The screenshot shows the 'Vehicle' tab in the Project Library. The main table lists the following vehicle definitions:

Name	Description	Library type	Notional	Tandem			Lane			
				Axle load (kip)	Spacing between axles (ft)	Transverse wheel spacing* (ft)	Uniform lane load (kip/ft)	Concentrat load for mon (kip)	Concentrate load for shea (kip)	Add second concentrated load*
HL-93 (US)	AASHTO LRFD Live Load - US unit system	Standard	<input checked="" type="checkbox"/>	25.0000	4.00	6.00	0.640			<input type="checkbox"/>
LRFD Fatigue Truc...	AASHTO LRFD Fatigue Truck - US unit sys...	Standard	<input type="checkbox"/>							<input type="checkbox"/>

Below this table is a 'Copy from library...' button and 'New', 'Duplicate', and 'Delete' options. The 'Truck' configuration table is currently empty:

Axle no.	Axle load (kip)	Gage distance (ft)	Wheel contact width* (in)	Axle spacing (ft)	
				Minimum	Maximum
Totals: 0.00 0.00 0.00					

At the bottom of the interface, there is a 'Validation' toggle set to 'Off' and 'Back' and 'Forward' navigation buttons.

STL15 - Steel Design Tool Example

Design Input | Project

Return to the **Project** tab to define the vehicles for the girder design. Click on the ellipsis button to assign the HL-93 (US) vehicle as the design load and the LRFD Fatigue Truck (US) as the fatigue load. Leave the permit load blank. Define the design average daily truck traffic as 5000.

The screenshot displays the 'Project' tab in the STL15 Design Tool. The interface includes a sidebar on the left with navigation options: Project, Project Library, Geometry, Deck, Typical Section Loads, Beam Parameters, Lateral Support, Member Loads, Control Options, and Input Report. The main workspace contains the following configuration fields:

- Project:** STL15 Design Example
- Description:** 2 Span 4 Girder Bridge
- Designer:** (empty text field)
- Date:** 7/11/2024
- LRFD specifications:**
 - Edition: AASHTO LRFD 9th
 - Limit states: Strength-I, Strength-II, Strength-III, Strength-V, Service-II, Fatigue-I, Fatigue-II (all checked)
- Design vehicles:**
 - Design load: HL-93 (US)
 - Permit load: (empty)
 - Single lane permit load: (unchecked)
 - Fatigue load: LRFD Fatigue Truck (US)
- Design ADTT:** 5000

At the bottom of the window, there is a 'Validation' button set to 'Off' and 'Back'/'Forward' navigation buttons.

Design Input | Geometry

On the **Geometry** tab, enter the data as shown below. Depending on your screen resolution, scroll down to enter the **Support** information.

STL15 Design Example.brdx - AASHTOWare Bridge Design: Steel Design Tool

File Design Input Design

Project

Project Library

Geometry

Deck

Typical Section Loads

Beam Parameters

Lateral Support

Member Loads

Control Options

Input Report

Superstructure definition type: System definition

Number of spans: 2

Number of beams: 4

Girder spacing: 10 ft

Support skew: 0 Degrees

Number of design lanes: 3

Spans:

Span	Length (ft)
1	100.00
2	100.00

Supports:

Support	Support type
1	Pinned
2	Roller
3	Roller

End bearing location: Left: 0 in Right: 0 in

Validation

Back Forward

Design Input | Deck

On the **Deck** tab, enter the data as shown below. The **Splice location gaps** table can be used to input regions where the program should avoid placing shear studs. For this example, leave this table empty.

The screenshot shows the 'Deck' tab in the 'Steel Design Tool' software. The interface includes a sidebar on the left with navigation options like 'Project', 'Project Library', 'Geometry', 'Deck', 'Typical Section Loads', 'Beam Parameters', 'Lateral Support', 'Member Loads', 'Control Options', and 'Input Report'. The main area contains various input fields and tables for configuring deck parameters.

Deck concrete: Class A (US)

Deck total thickness: 10 in

Deck structural thickness: 9 in

Deck reinforcement

Material: Grade 60

Support	Start distance (ft)	Length (ft)	End distance (ft)	Bar size	Clear cover (in)	Measured from	Bar spacing (in)
1	80.00	40.00	120.00	6	2.0000	Top of Str...	4.0000

Deck overhang: 3 ft

Haunch depth: 2 in

Edge of haunch to edge of beam: 0 in

Composite deck

Shear connectors

Stud diameter: 0.5 in

Provide shear studs in negative flexure regions

Splice location gaps

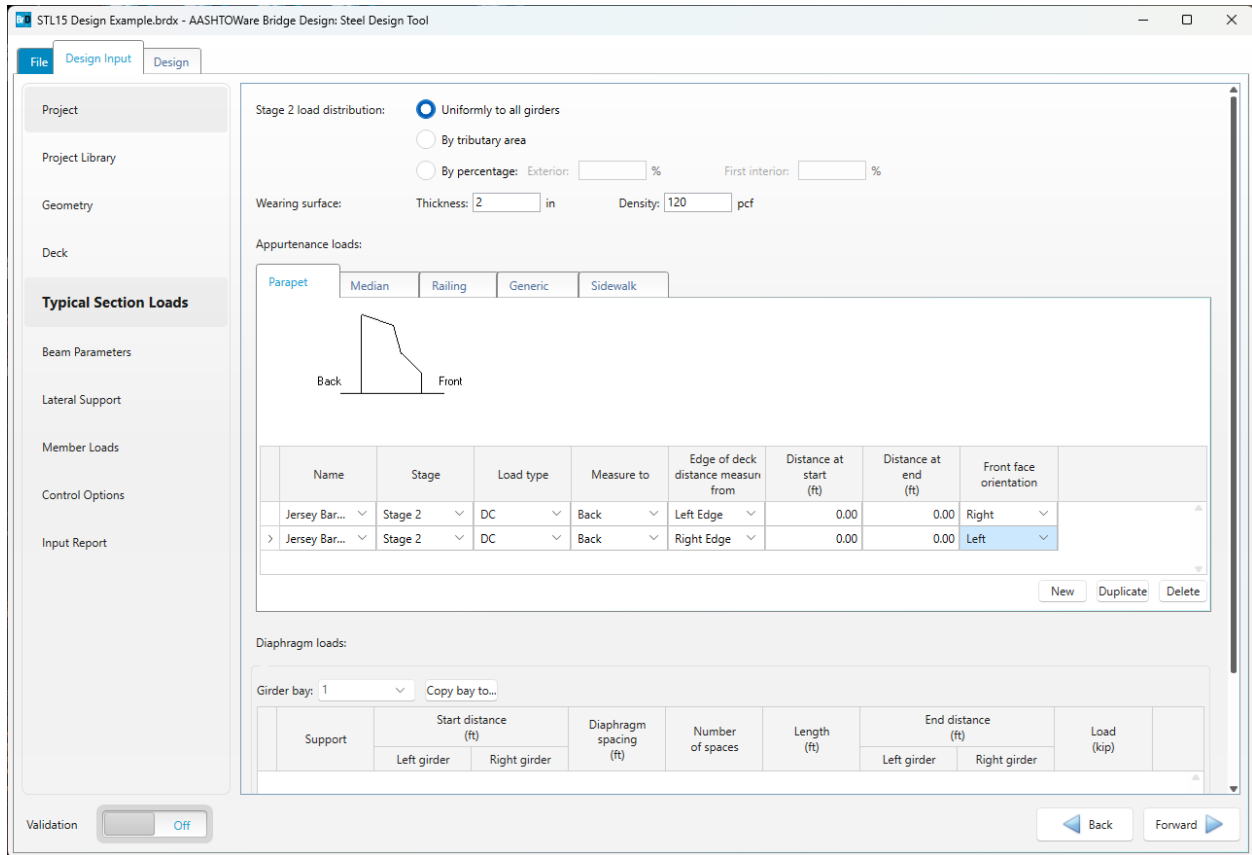
Support	Splice location		Left gap (ft)	Right gap (ft)
	Left or right	Distance		

Validation: Off

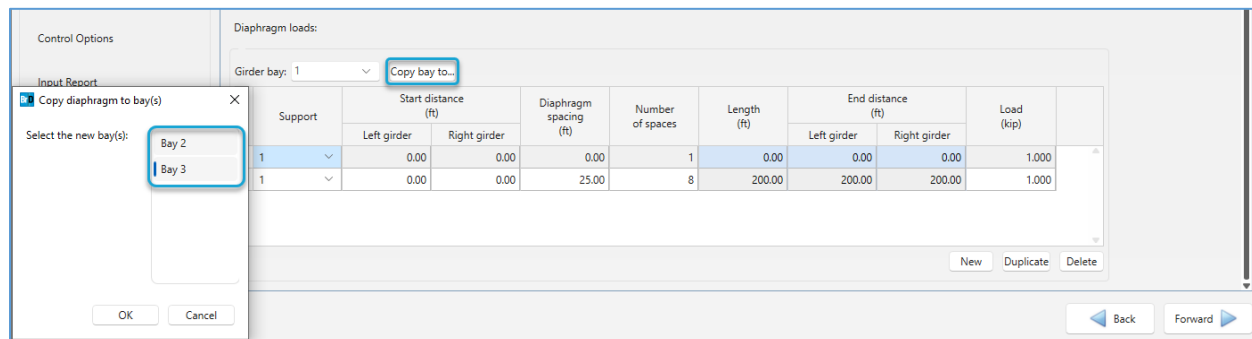
Navigation: Back, Forward

Design Input | Typical Section Loads

On the **Parapet** tab in **Typical Section Loads**, enter the data as shown below.



Make sure to scroll to the bottom of the page to define the diaphragm loads. Input the diaphragm loads as shown for Girder Bay 1 and use the **Copy bay to...** button to copy the loads to Girder Bay 2 and Girder Bay 3.



Design Input | Beam Parameters

In the **Beam Parameters** input section, enter the data as shown below. All of the plate dimensions except for the web depth can be designed. Providing a larger range of values for any given parameter can help the design tool converge on a solution. The program will design transverse stiffeners for shear resistance if the **Use transverse stiffeners** button is selected. This example does not use this option.

The screenshot shows the 'Beam Parameters' section of the STL15 Design Example software. The interface is divided into a sidebar on the left and a main configuration area on the right.

Sidebar (Left):

- Project
- Project Library
- Geometry
- Deck
- Typical Section Loads
- Beam Parameters** (Selected)
- Lateral Support
- Member Loads
- Control Options
- Input Report

Main Configuration Area (Right):

Section configuration

Web	Min	Max	Increment
Depth	60 in	60 in	
Thickness	0.3750	0.7500	1/8"

Top flange	Min	Max	Increment
Width	12 in	20 in	2 in
Thickness	0.5000	2.0000	1/4"

Bottom flange	Min	Max	Increment
Width	12 in	20 in	2 in
Thickness	0.5000	2.0000	1/4"

Use transverse stiffeners

	Beam	One sided	Max spacing (in)
>	Exterior	<input type="checkbox"/>	
	Interior	<input type="checkbox"/>	

Structural steel materials

Web: Grade 50W [Dropdown]

Top flange: Grade 50W [Dropdown]

Bottom flange: Grade 50W [Dropdown]

Transverse stiffener: Grade 50W [Dropdown]

Bearing stiffener: Grade 50W [Dropdown]

Validation: Off

Navigation: Back Forward

Design Input | Lateral Support

In the **Lateral Support** input section, enter the data as shown below. Top flange lateral support ranges are regions where the top flange is continuously laterally supported and top flange lateral support locations are discrete points of lateral support. These entries define the top flange lateral support for Stage 2 and Stage 3.

Top Flange Lateral Support:

Ranges Locations

Support	Start distance (ft)	Length (ft)	End distance (ft)
1	0.00	200.00	200.00

New Duplicate Delete

Top Flange Lateral Support:

Ranges Locations

Support	Start distance (ft)	Spacing (ft)	Number of spaces	Length (ft)	End distance (ft)
1	0.00	0.00	1	0.00	0.00
1	0.00	25.00	8	200.00	200.00

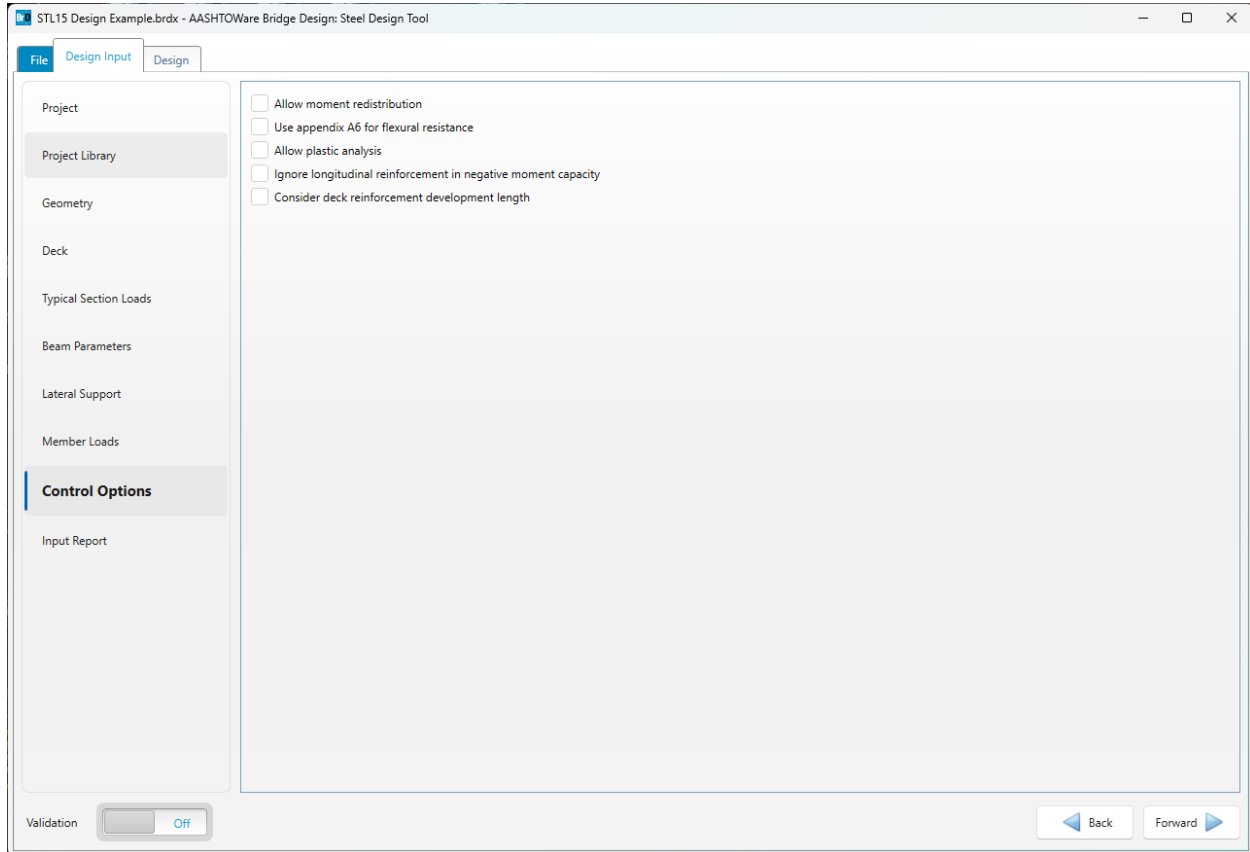
New Duplicate Delete

Design Input | Member Loads

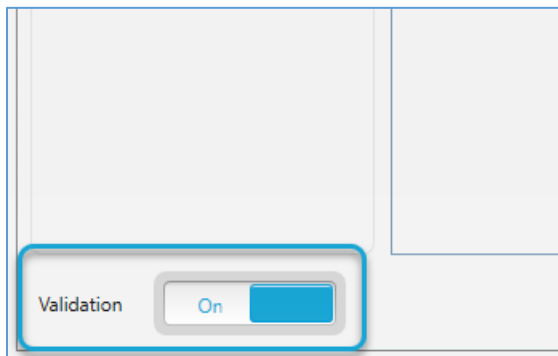
There are no member loads assigned in this example. Member concentrated loads, member distributed loads and pedestrian loads could be assigned here.

Design Input | Control Options

The **Control Options** input section provides options for analysis and design. For this example, leave the options as is.



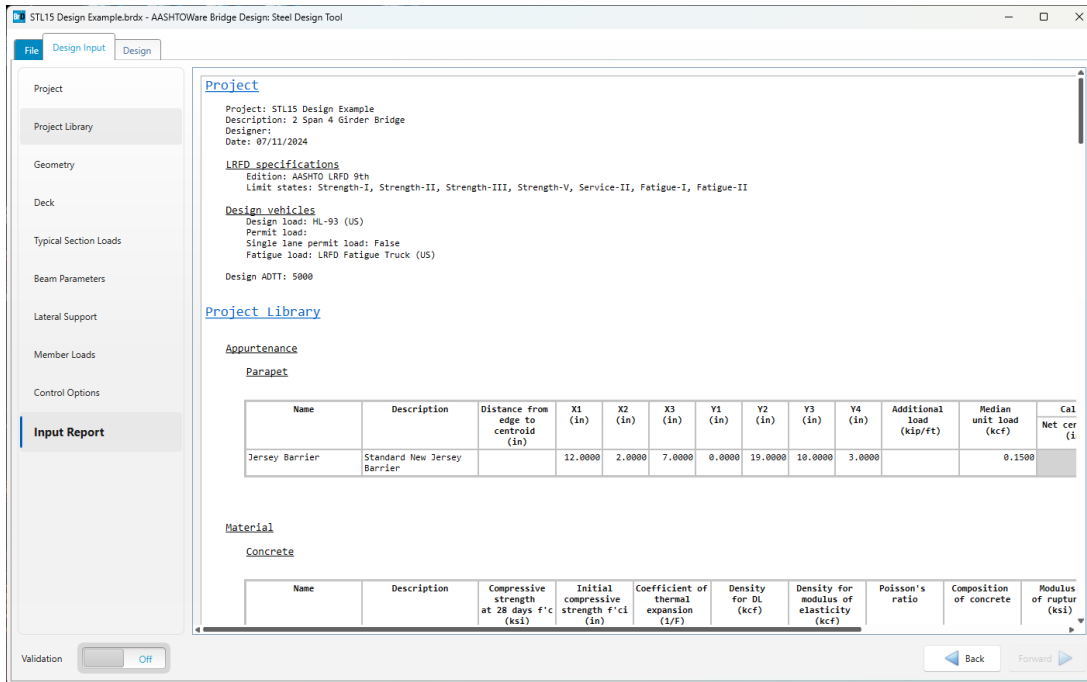
At this point, all design data has been defined. Turn **Validation** on and ensure that there are no validation error marks displayed next to the input section. Otherwise, go back to these sections and resolve the errors.



STL15 - Steel Design Tool Example

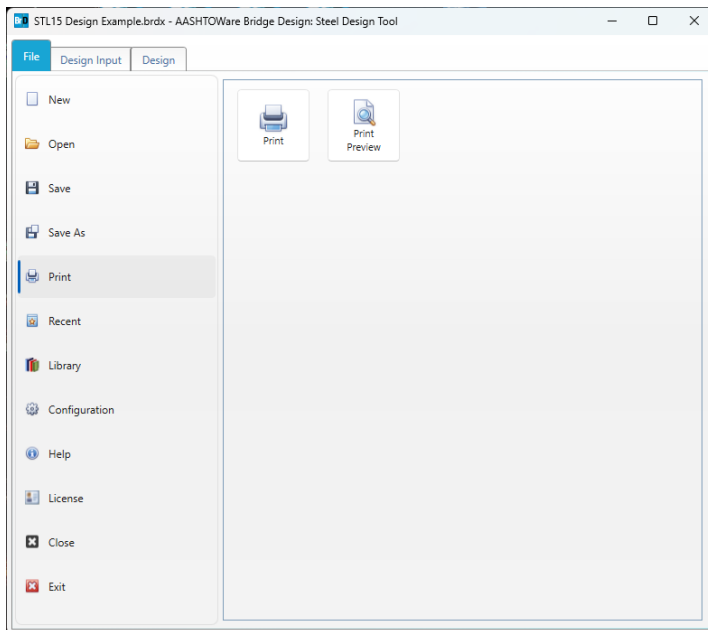
Design Input | Input Report

The **Input Report** section provides a detailed report of the input data.



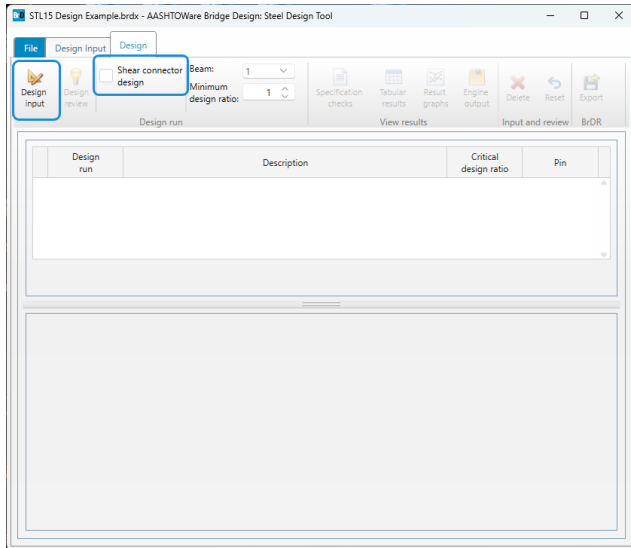
File | Print

The **Print** and **Print Preview** buttons in the **File | Print** section apply to the **Input Report**.



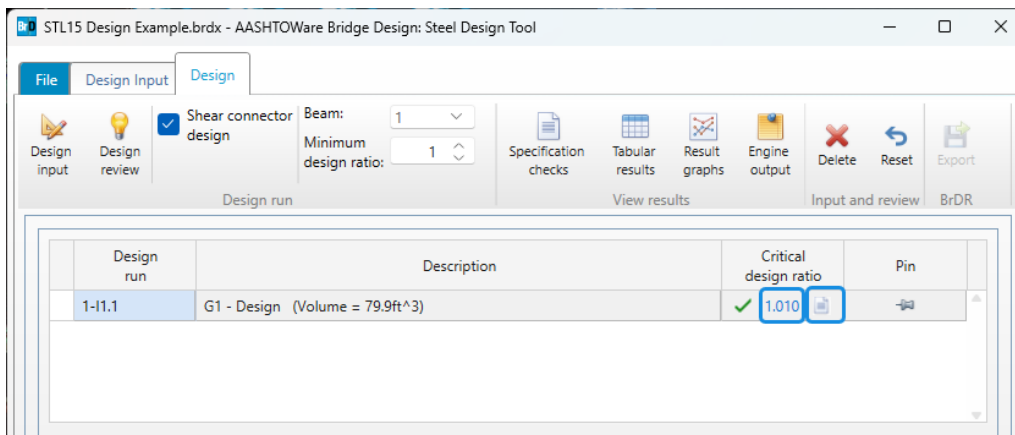
Design | Design Input

After the input data is entered and reviewed, **Design Input** run can be performed by clicking on the **Design Input** button located on the **Design ribbon**. **Design Input** run is based on the input data and produces a design that is displayed in the **Design Run** grid with a brief description and values of the critical design ratios. Select the checkbox for **Shear connector design** to design the shear connectors along with the girder in the composite regions. The beam dropdown is the selection for which girder the program will design and the input for minimum design ratio defines the target design ratio for which the girder will be designed.



Design | Results Table

The results of the **Design Input** run are displayed in the table. The user can click on the **Critical design ratio** to open the **Analysis engine feedback report**, and on the page icon next to the **Critical design ratio** to open the **Specification Check Summary**.



Design | Girder Profile

The **Girder Profile** tab displays the ranges for steel plates along the web and flanges. After a design input run is completed, these tables will display the program computed ranges. The user may modify these ranges and reanalyze the member using the **Design Review** option.

Depth (in)	Thickness (in)	Support	Start distance (ft)	Length (ft)	End distance (ft)
60.000	0.500	1	0.000	75.000	75.000
60.000	0.625	1	75.000	50.000	125.000
60.000	0.500	2	25.000	75.000	100.000

Design | Stiffeners

The **Stiffeners** tab displays the results of the stiffener design. This includes transverse stiffeners and bearing stiffeners. The transverse stiffeners will only be designed when the design input option to **Use Transverse Stiffeners** in the **Design Input | Beam Parameters** window is selected.

Design run	Description	Critical design ratio	Pin
1-11.1	G1 - Design (Volume = 79.9ft ³)	1.010	

Support	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)

STL15 - Steel Design Tool Example

Design | Shear connectors

The **Shear connectors** tab shows the results of the shear connector design if enabled and if the member has composite regions.

The screenshot displays the STL15 Design Example software interface. The top menu bar includes File, Design Input, and Design. The Design Input tab is active, showing options for Design input, Design review, and Shear connector design. The Shear connector design section includes a dropdown for Beam (set to 1) and a Minimum design ratio (set to 1). Below this are icons for Specification checks, Tabular results, Result graphs, Engine output, Delete, Reset, and Export. The main workspace is divided into two panes. The top pane shows a table of Design runs with the following data:

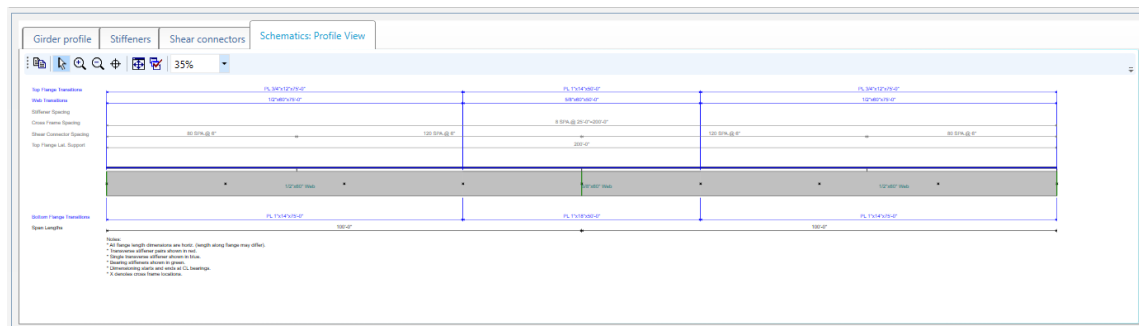
Design run	Description	Critical design ratio	Pin
1-11.1	G1 - Design (Volume = 79.9ft^3)	1.010	

The bottom pane is titled 'Shear connectors' and shows the 'Schematics: Profile View' tab. It includes input fields for Stud Height (6.000 in) and Steel Minimum Tensile Strength (60.000 ksi). Below these is a table of Shear Connector details:

Shear Connector	Number per Row	Number of Spaces	Transverse Spacing (in)	Support	Start Distance (ft)	Length (ft)	End Distance (ft)
Shear Stud	3	80	4.600	1	0.000	40.000	40.000
Shear Stud	3	120	4.600	1	40.000	60.000	100.000
Shear Stud	3	120	4.600	2	0.000	60.000	60.000
Shear Stud	3	80	4.600	2	60.000	40.000	100.000

Design | Schematics: Profile View

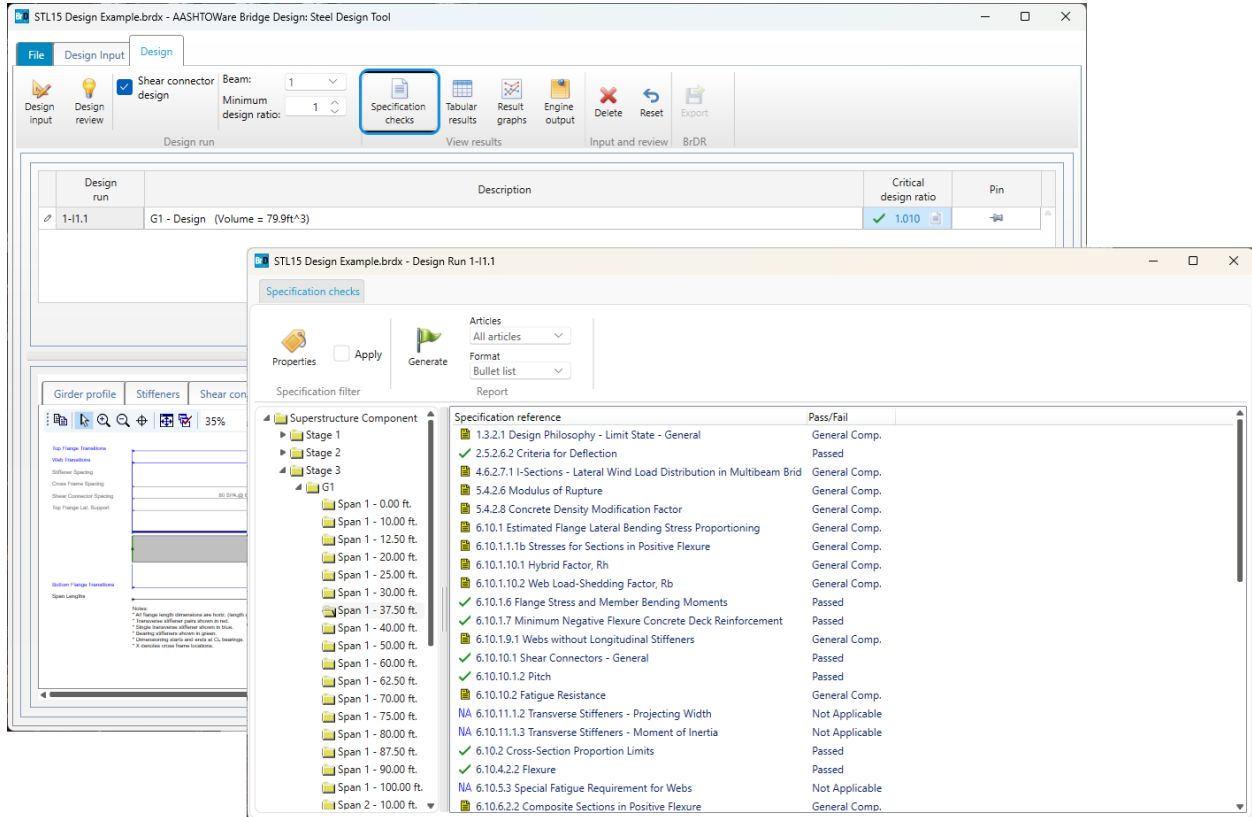
The **Schematics: Profile View** tab shows a schematic of the girder design.



STL15 - Steel Design Tool Example

Design | Specification Check

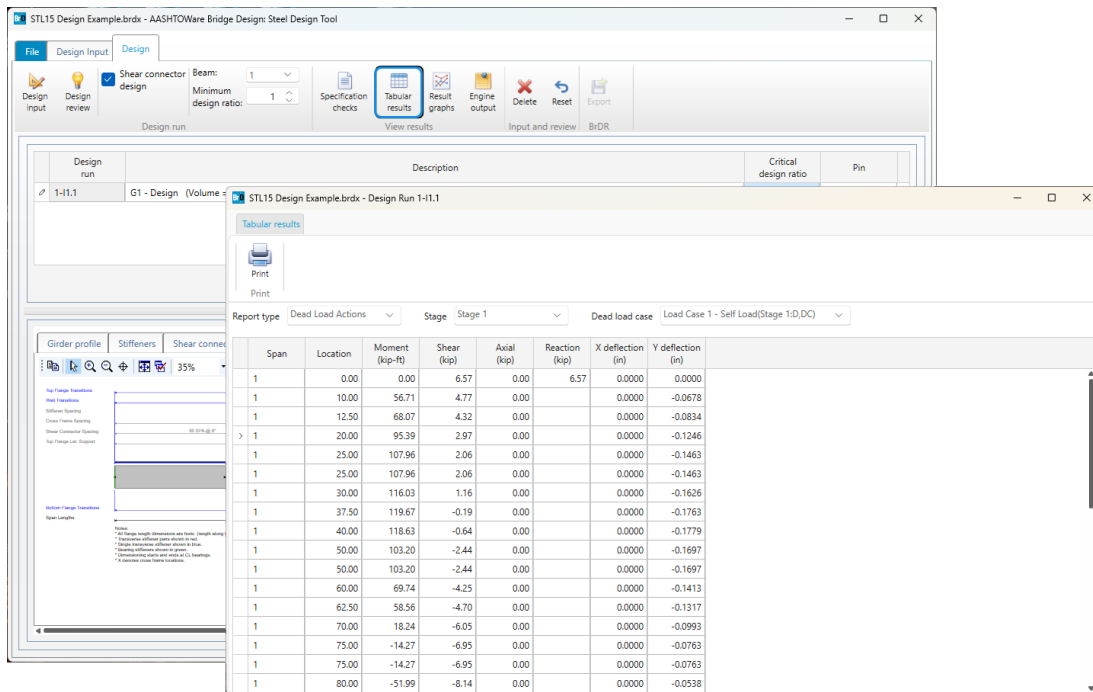
To view the specification check results, click on the **Specification checks** button from the **View results** group of the **Design** ribbon.



STL15 - Steel Design Tool Example

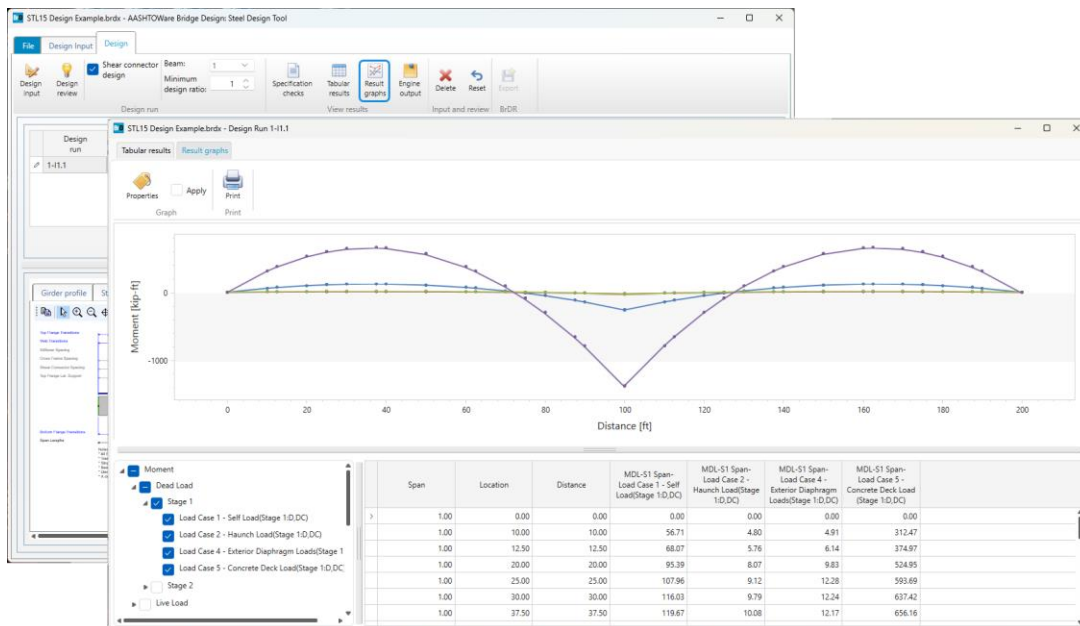
Design | Tabular Results

To view the tabular results, click on the **Tabular results** button from the **View results** group of the **Design** ribbon.



Design | Result Graphs

To view the result graphs, click on the **Result graphs** button from the **View results** group of the **Design** ribbon.



STL15 - Steel Design Tool Example

Design | Engine Outputs

To view the contents of the engine output files, click on the **Engine outputs** button from the **View results** group of the **Design** ribbon, and then double-click on the row corresponding to the required file.

The screenshot displays the STL15 Design Tool interface. The main window shows the **Design** ribbon with the **Engine output** button highlighted. Below the ribbon, a table lists design runs. A secondary window titled "STL15 Design Example.brdx - Design Run 1-1.1" is open, showing the **Engine outputs** dialog box. This dialog box contains a table of output files with columns for Category, Description, and File name.

Design run	Description	Critical design ratio	Pin
1-1.1.1	G1 - Design (Volume = 79.9ft ³)	✓ 1.010	

Category	Description	File name
Reinforcement Development Len...	Stage 2 Deck Reinforcement Development Length Calculations	S2 SpanLrfdDeckReinfDev.LengthCalcs.log
Reinforcement Development Len...	Stage 3 Deck Reinforcement Development Length Calculations	S3 SpanLrfdDeckReinfDev.LengthCalcs.log
FE Analysis	Stage 3 3 Infil Lines Finite Element Model and Load Cases	S3 Infil Lines Span.XML
FE Analysis	Stage 3 3 Infil Lines Element Actions, Support Reactions, and Nodal Displacements	S3 Infil Lines Span.Actions.XML
LL Distribution	Live Load Distribution Factors Calculations	LRFD Dist Factor Calcs.TXT
LL Distribution	Live Load Distribution Factors Calculations Summary	LRFD Dist Factor Summary.TXT
Specification Checks	Stage 3 Spec Check Results	Stage 3 Spec Check Results.XML

STL15 - Steel Design Tool Example

Design | Design Review

To illustrate the ability of the program to adjust results of the **Design Input** run, modify the **Top flange** table to define a top flange width of 14 inches for all ranges and a thickness of 0.625 for the first and third range as shown below. Select **Design Review** to analyze this modified design.

The screenshot displays the STL15 Design Tool interface. The 'Design Review' tab is active, and the 'Design Review' button in the toolbar is highlighted. The 'Design run' table shows a single entry for 'G1 - Design' with a critical design ratio of 1.010. Below this, the 'Top flange' table is visible, containing three rows of data. The first and third rows have a thickness of 0.625 inches, while the second row has a thickness of 1.000 inches. All rows have a width of 14.000 inches.

Design run	Description	Critical design ratio	Pin
1-11.1	G1 - Design (Volume = 79.9ft ³)	✓ 1.010	📌

Width (in)	Thickness (in)	Support	Start distance (ft)	Length (ft)	End distance (ft)
14.000	0.625	1	0.000	75.000	75.000
14.000	1.000	1	75.000	50.000	125.000
14.000	0.625	2	25.000	75.000	100.000

STL15 - Steel Design Tool Example

After the program finishes performing the design review, it will add another row to the design run grid. The design review runs are indicated with an **R** displayed in the **Design run** column in contrast to an **I** shown in that column for design input runs. The results for the **Design review** runs are displayed and can be reviewed or further modified the same way as design input runs. Additional design input runs can be performed by modifying the input on the **Design Input** tab. Each of the design runs, either input or review, stores a copy of its design input data that is reloaded every time the design input run is selected in the design run grid.

The screenshot displays the STL15 Design Tool interface. The top menu bar includes 'File', 'Design Input', and 'Design'. The 'Design' tab is active, showing a toolbar with icons for 'Design input', 'Design review', 'Shear connector design', 'Specification checks', 'Tabular results', 'Result graphs', 'Engine output', 'Delete', 'Reset', and 'Export'. Below the toolbar, the 'Design run' section contains a table with the following data:

Design run	Description	Critical design ratio	Pin
1-I1.1	G1 - Design (Volume = 79.9ft^3)	✓ 1.010	→
1-R1.1	G1 - Design Review	✓ 1.008	→

Below the design run grid, the 'Top flange' section contains a table with the following data:

Width (in)	Thickness (in)	Support	Start distance (ft)	Length (ft)	End distance (ft)
14.000	0.625	1	0.000	75.000	75.000
14.000	1.000	1	75.000	50.000	125.000
14.000	0.625	2	25.000	75.000	100.000

Buttons for 'New', 'Duplicate', and 'Delete' are located at the bottom of the 'Top flange' section.