

AASHTOWare PS Design Tool v7.2

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ProMiles®

Outline

- ▶ PowerPoint Presentation
 - ▶ Capabilities and Limitations
 - ▶ UI and Features
 - ▶ Future Improvements
- ▶ Live Demo
 - ▶ Enter the project
 - ▶ Perform design input run, review, and iterate
 - ▶ Perform design review run
 - ▶ Import into BrD
- ▶ Q & A



PS Design Tool

Analysis and design of prestressed concrete beams with harped and debonded strand patterns

The screenshot displays the AASHTOWare Bridge Design: Prestressed Concrete Design Tool interface. The main window title is "1_PSS-0005-PSBB-NSkw-Hpd-GS.brdr - AASHTOWare Bridge Design: Prestressed Concrete Design Tool". The interface is divided into several sections:

- Design Input:** Includes a "Design run" table with columns for Design run, Description, Critical design ratio, Critical strand design ratio, and Pin. The table shows a single entry for "Beam 1 of 10, Deck overhang = 3.000 ft, BIV-48, 44 strands, CG at left end = 20.80 in" with a Critical design ratio of 1.002 and a Critical strand design ratio of 1.002.
- Strand pattern:** Contains tabs for "Strand pattern", "Beam details", and "Beam Profile". It includes a "Span" dropdown set to "1" and a checked "Symmetry" option. Under "Harp point locations", "Mid span" is selected. A table lists harp points: Left (Distance: 7.58 ft, Radius: 0.00 in) and Right (Distance: 7.58 ft, Radius: 0.00 in). There are also sections for "Debonding point locations" for Left and Right sides.
- Beam details:** Shows "Beam shape: BIV-48" and "Location = 50.000".
- Strand Pattern Diagram:** A central diagram shows a rectangular cross-section of a beam with 44 strands. The strands are arranged in a pattern with harps and debonded sections. A legend indicates "X No strand at this position at the current section location."
- Stress Check Graphs:** Two graphs are shown on the right. The top graph is "Initial stress check" and the bottom graph is "Final stress check". Both graphs plot Stress [ksi] on the y-axis (ranging from -4 to 0) against Location [ft] on the x-axis (ranging from 0 to 100). The graphs show stress distributions for different locations: f(t)-allow, f(c)-allow, f(top), f(bottom), f(top-t), f(bottom-t), f(top-c), and f(bottom-c).

Capabilities and Limitations

- ▶ Design Specification
 - ▶ AASHTO LRFD, Ed 6'th through 9'th
 - ▶ Strength, Service, Fatigue Limit States, and Transport Stability
- ▶ Loads
 - ▶ Live Load
 - ▶ Vehicular: Design, Permit, Fatigue
 - ▶ Pedestrian
 - ▶ Dead Load
 - ▶ Girder, Deck, Wearing Surface, Diaphragms,
 - ▶ Appurtenance: Median, Parapet, Railing, Sidewalk, Generic



Capabilities and Limitations

- ▶ Structure Definition
 - ▶ Girder System (constant girder spacing and one skew)
 - ▶ Girder Line
- ▶ Shape Types
 - ▶ Adjacent and Spread Box Beam
 - ▶ Narrow and Wide Top Flange I Beam
 - ▶ Tee Beam with 2 or 3 Stems



Capabilities and Limitations

- ▶ Strand Configurations
 - ▶ Initial Design: Straight, Straight and Debonded, Straight and Harped
 - ▶ Final Design: Any Combination of Straight, Debonded, and Harped
- ▶ Input
 - ▶ Fixed
 - ▶ Variable (Parametric)



Program Organization

- ▶ File: Common and PS Design Tool specific file operations
- ▶ Design Input: Data input for initial design
- ▶ Design: Results of initial design plus input tweaks and final design results

Design run	Description	Critical design ratio	Critical strand design ratio	Pin
1-11.1	Beam 1 of 10, Deck overhang = 3.000 ft, BIV-48, 44 strands, CG at left end = 20.80 in	✓ 1.002	✓ 1.002	→

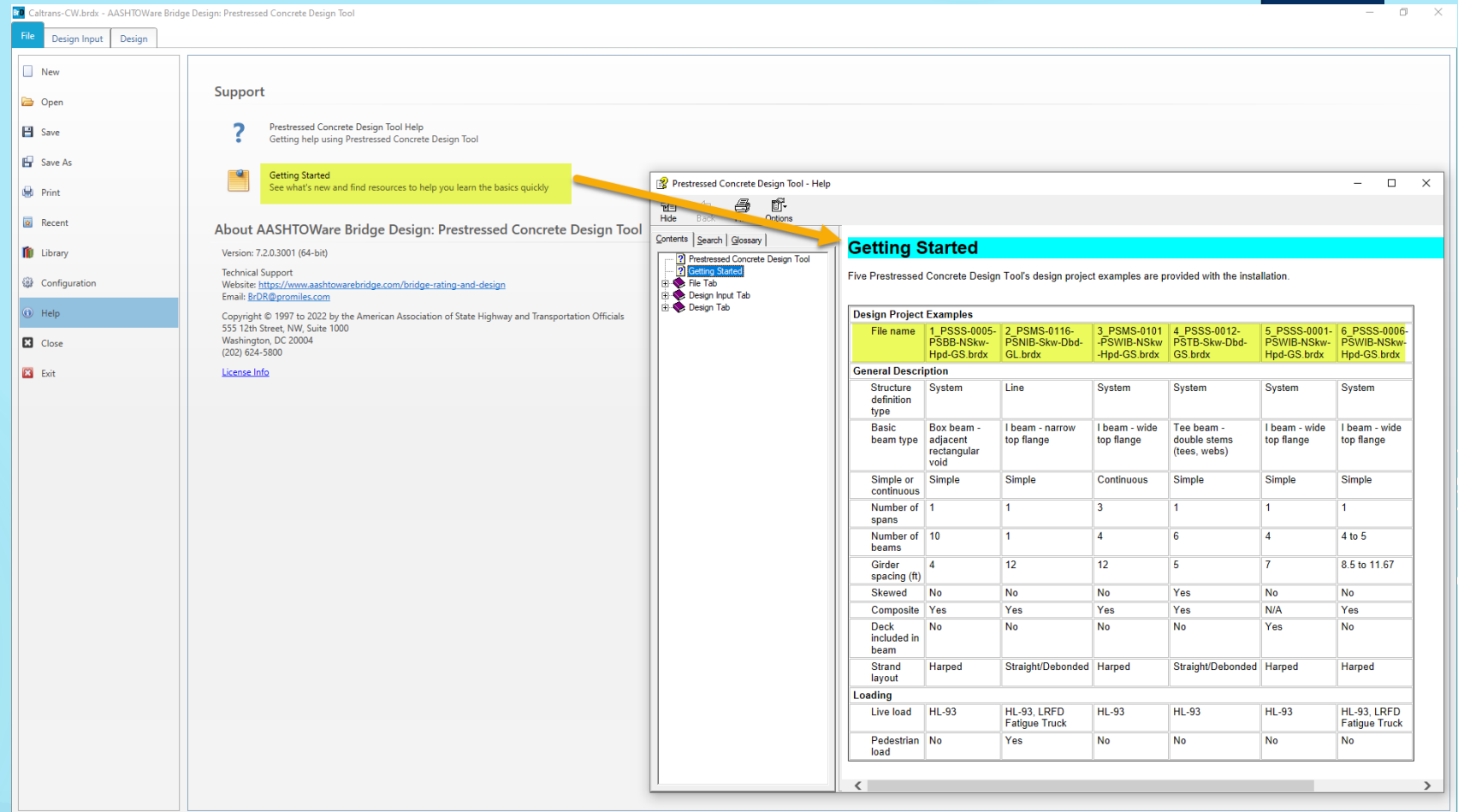
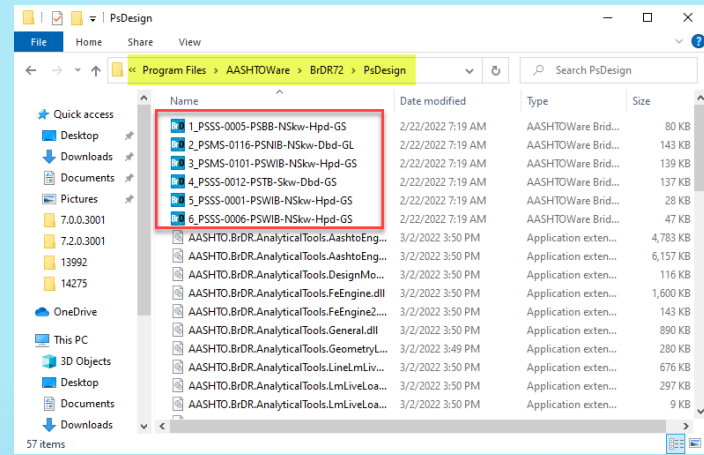
Harp point	Distance (ft)	Radius (in)
Left	7.58	0.00
Right	7.58	0.00

Beam shape: BIV-48

Number of strands = 44
Number of harped strands = 0
Number of deboned strands (Total/Here/Other) = 0/0/0



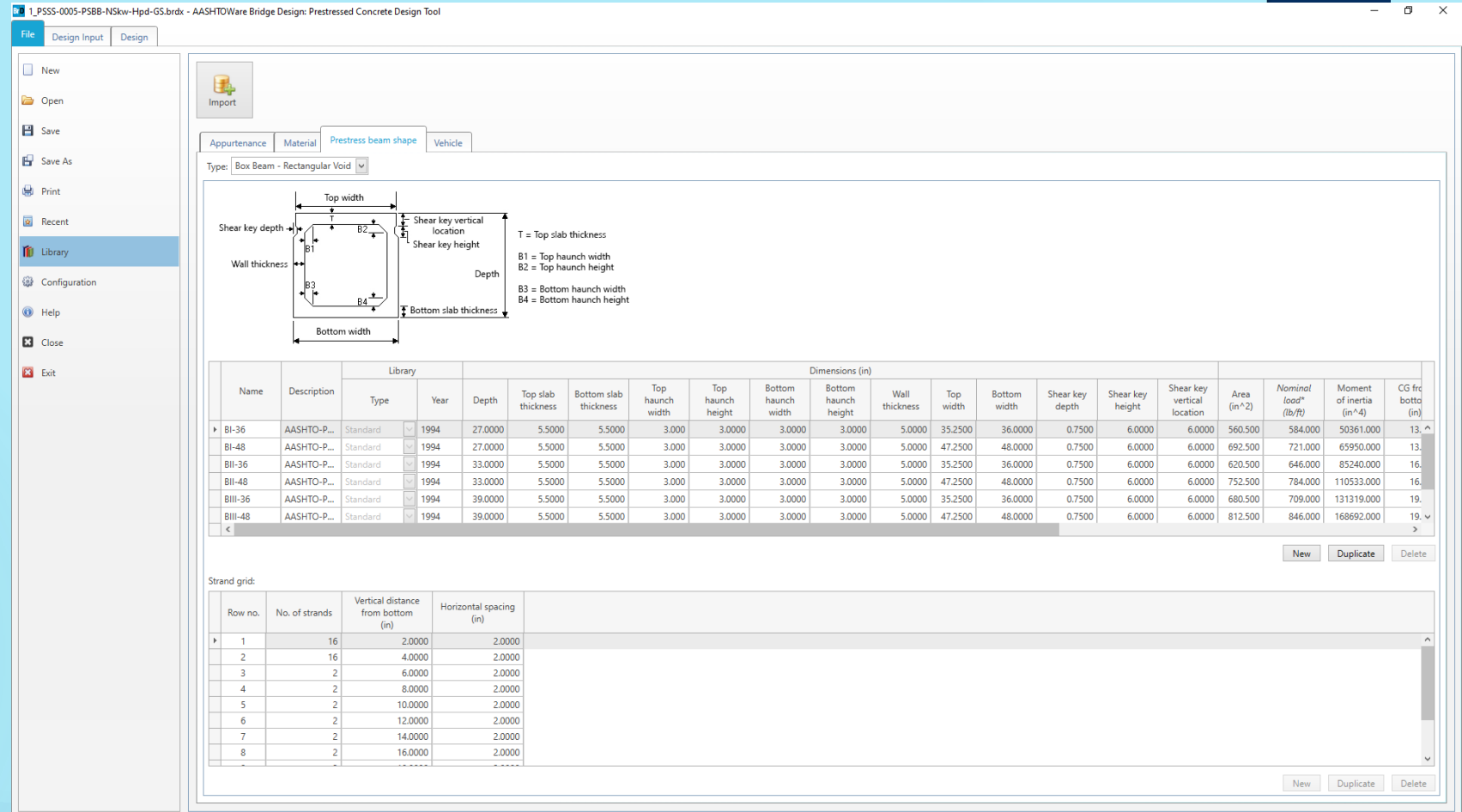
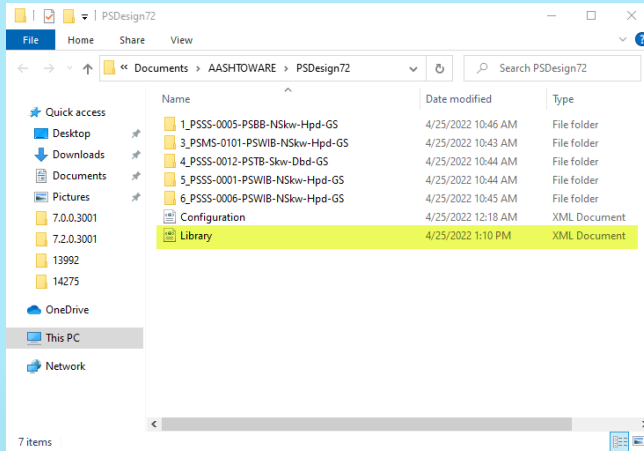
File | Help



- ▶ Program Help
- ▶ F1 Button
- ▶ Example Input Files Included with Install
- ▶ Input Stored in XML Files



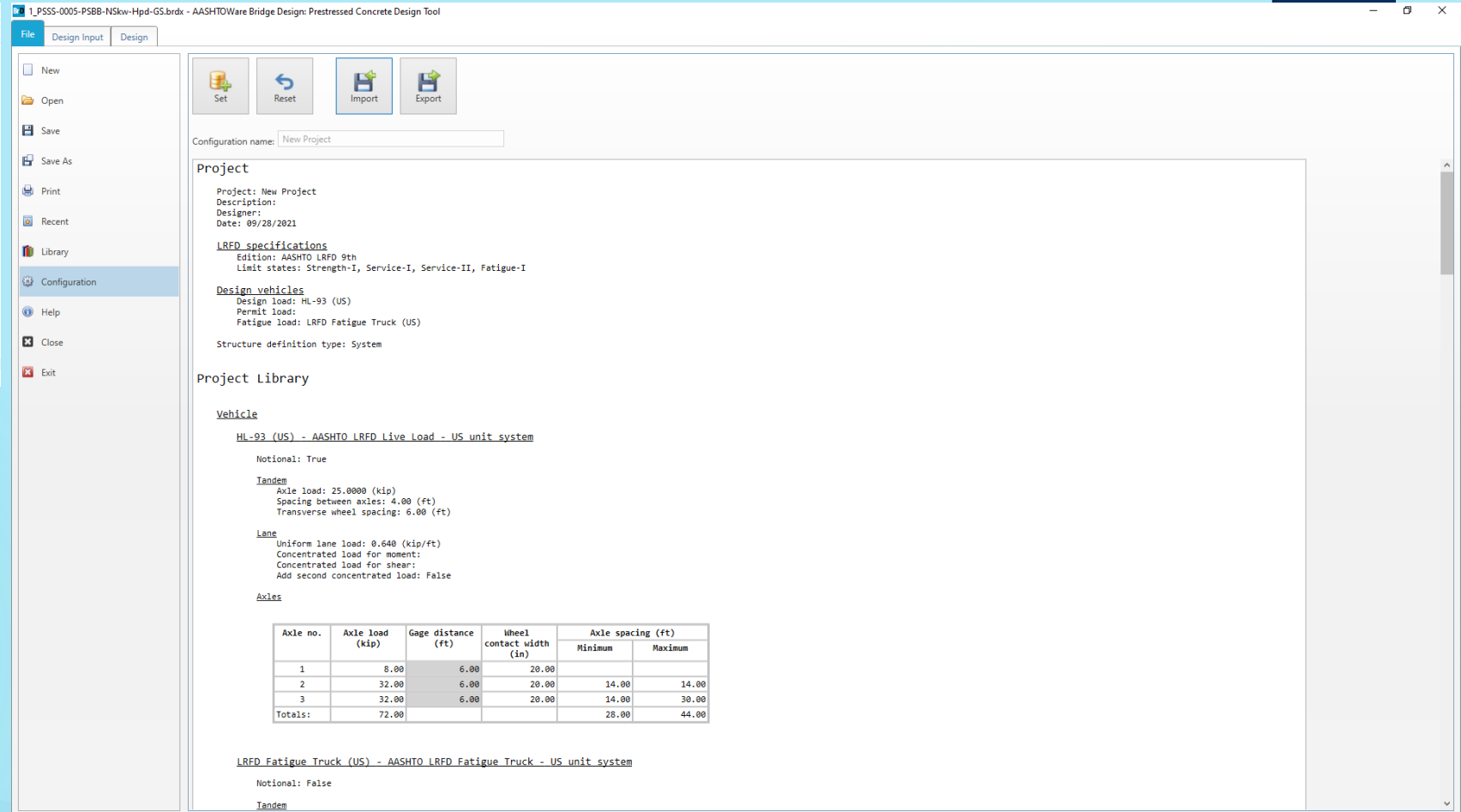
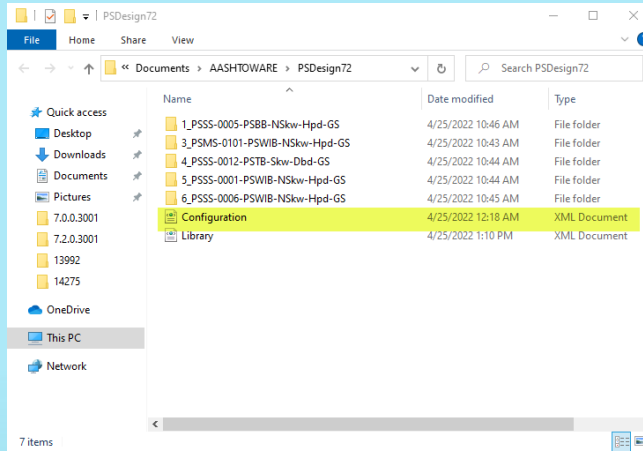
File | Library



- ▶ Data shared between projects
- ▶ Can be imported from BrDR
- ▶ Stored in XML File



File | Configuration



- ▶ Template with default entries for new project
- ▶ Can be customized by user
- ▶ Stored in XML File



File | Print

► Print Preview and Print of Input Data

(Output Data printout available in Design | Summary Report)

The screenshot shows the AASHTOWare Bridge Design software interface. The main window is titled "1_PSS-0005-PSBB-NSkw-Hpd-GS.brdx - AASHTOWare Bridge Design: Prestressed Concrete Design Tool". The "Design" tab is active. A "Print Preview" window is open, displaying the following content:

Project
Project: 1_PSS-0005-PSBB-NSkw-Hpd-GS
Description: single span, PS box beam, non-skewed, harped strands
Designer: ProMiles
Date: 02/15/2022

LRFED specifications
Edition: AASHTO LRFD 9th
Limit states: Strength-I, Service-I, Service-II, Fatigue-I

Design vehicles
Design load: HL-93 (US)
Permit load:
Fatigue load:
Structure definition type: System

Project Library

Appurtenance

Railing

Name	Description	Distance from edge to centroid (in)	Width (in)	Effective wind height (in)	Railing load (kip/ft)
Generic Railing (2-Rail)	50 lbs per foot	6.0000	12.0000	30.0000	0.050
Generic Railing (3-Rail or 4-Rail)	80 lbs per foot	6.0000	12.0000	42.0000	0.080

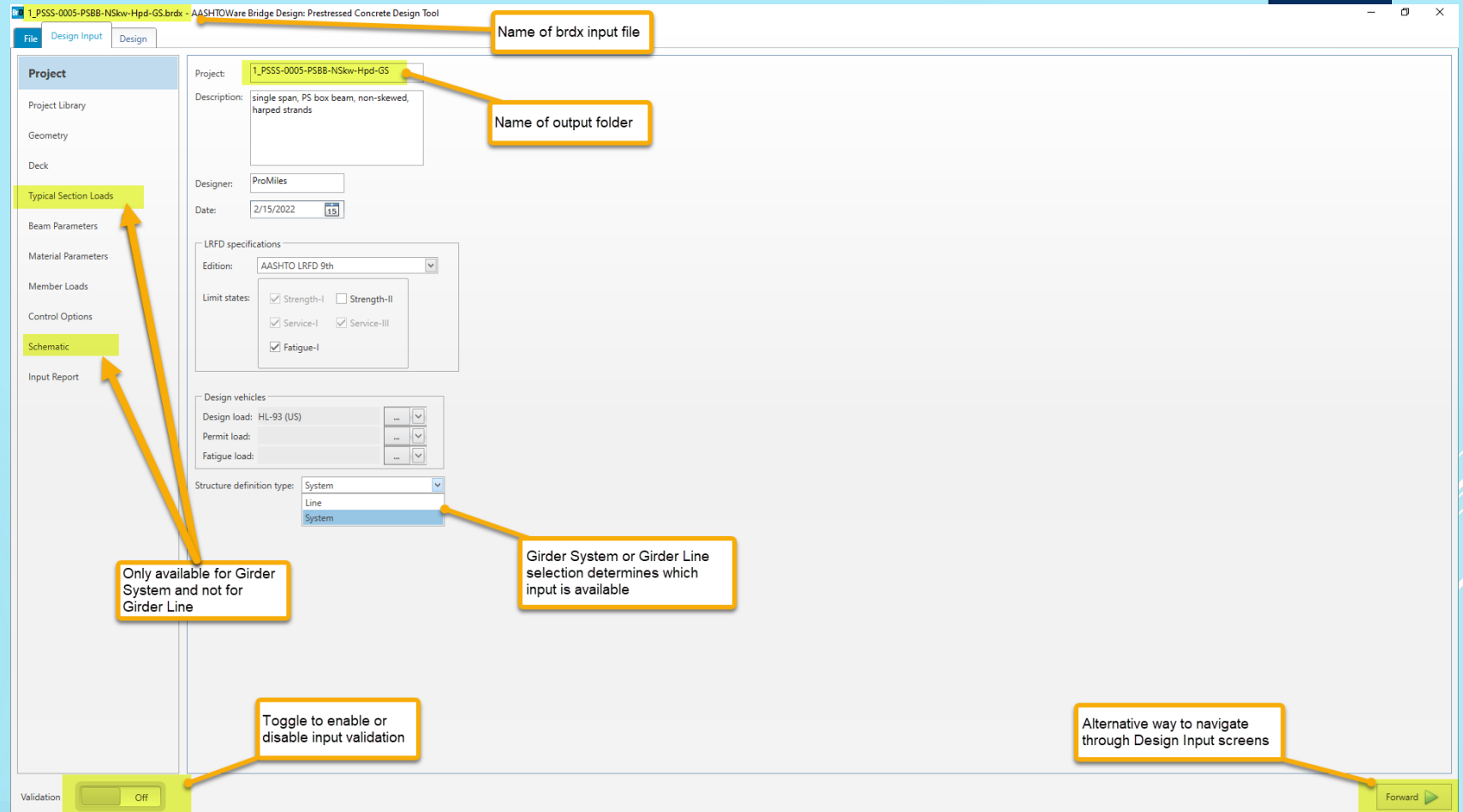
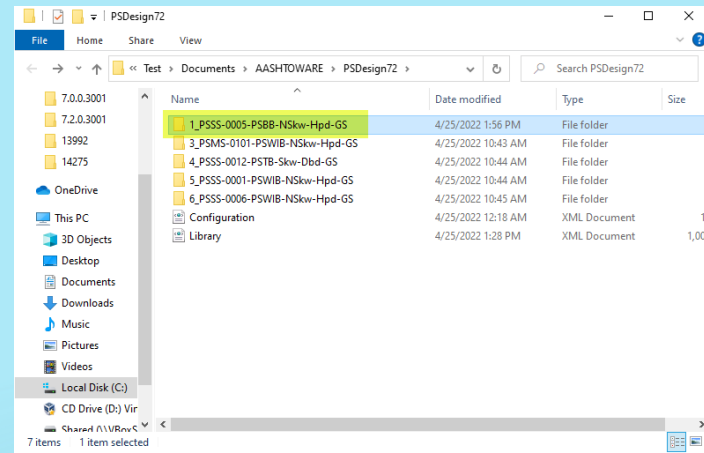
Material

Concrete

Name	Description	Compressive strength at 28 days f'c (ksi)	Initial Compressive strength f'ci (in)	Coefficient of thermal expansion (1/F)	Density for DL (kcf)	Density for modulus of elasticity (kcf)	Poisson's ratio	Compositi on of concrete	Modulus of rupture (ksi)	Shear factor
Class A (US)	Class A cement	4.000		0.000000000	0.150	0.145	0.200	Normal	0.400	1.000



Design Input | Project



- ▶ General Info
- ▶ Design Specs
- ▶ Which input is available
- ▶ Where output is stored



Design Input | Project Library

- ▶ Pre-defined Data to Use in the Project
- ▶ Created or Copied from File | Library
- ▶ Includes:
 - ▶ Appurtenances
 - ▶ Materials
 - ▶ PS Beam Shapes
 - ▶ Vehicles

1_PSS-0005-PSBB-Nskw-Hpd-GS.brdx - AASHTOWare Bridge Design: Prestressed Concrete Design Tool

File Design Input Design

Project

Project Library

Geometry

Deck

Typical Section Loads

Beam Parameters

Material Parameters

Member Loads

Control Options

Schematic

Input Report

Appurtenance Material Prestress beam shape **Vehicle**

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

Copy from library... New Duplicate Delete

Truck:

Axle no.	Axle load (kip)	Gage distance (ft)	Wheel contact width* (in)	Axle spacing (ft)		
				Minimum	Maximum	
▶ 1	8.00	6.00	20.00			
2	32.00	6.00	20.00	14.00	14.00	
3	32.00	6.00	20.00	14.00	30.00	
Totals:				72.00	28.00	44.00

Validation Off New Duplicate Delete

◀ Back Forward ▶



Design Input | Geometry

- ▶ Different Input for Girder Line and Girder System
- ▶ Girder System allows variable (parametric) input in range form defined by Min/Increment/Max values

The image displays two side-by-side screenshots of the AASHTOWare Bridge Design software interface, specifically the 'Geometry' input panel. The left screenshot is for a 'Girder Line' project, and the right is for a 'Girder System' project. Both show a 'Design Input' tab with various parameters and a schematic diagram of a bridge span.

Girder Line (Left Screenshot):

- Number of spans: 1
- Number of beams: 1
- Girder spacing: 12 ft
- Number of design lanes: 3
- Span Length: 50.00 ft
- Beam Projection Left End: 6.00 ft
- Right End: 6.00 ft
- Lift distance: 24.00 ft
- Supports: Support 1 (Pinned), Support 2 (Roller)

Girder System (Right Screenshot):

- Number of spans: 1
- Number of beams: Min: 4, Increment: 1, Max: 5
- Out-to-out deck width: 42 ft
- Deck overhang from beam centerline: Min: 3.5 ft, Increment: 0.5 ft, Max: 4 ft
- Girder spacing: Min: 8.5 ft, Max: 11.666666 ft
- Support skew: 0 Degrees
- Number of design lanes: 2
- Span Length: 110.00 ft
- Beam Projection Left End: 6.00 ft
- Right End: 6.00 ft
- Lift distance: 60.00 ft
- Supports: Support 1 (Pinned), Support 2 (Roller)

Annotations in orange boxes highlight the parametric input fields in the Girder System screenshot: 'Variable number of beams', 'Variable deck overhang', and 'Girder spacing range calculated from other input'. A red label 'Girder System' is placed over the right screenshot, and 'Girder Line' is placed over the left screenshot.



Design Input | Deck

- ▶ Different Input for Girder Line and Girder System
- ▶ Girder Line needs Tributary Width and Effective Flange Width
- ▶ Bar Spacing for deck reinforcement can be left empty to be automatically calculated

Girder Line only

Girder System

Bar spacing (?)

Spacing can be left blank to have the program select spacing to meet flexural capacity requirement

Support	Start distance (ft)	Length (ft)	End distance (ft)	Bar size	Clear cover (in)	Measured from	Bar spacing (in)
1	0.00	340.00	340.00	4	3.3750	Top of Stru...	
1	0.00	340.00	340.00	7	2.0000	Bottom of...	6.0000



Design Input | Typical Section Loads

- ▶ Girder System Only
- ▶ Stage 2 Load Distribution
 - ▶ Uniform, by area, or by percentage
- ▶ Load Types:
 - ▶ Wearing Surface
 - ▶ Appurtenances
 - ▶ Exterior Diaphragms
 - ▶ Diaphragm Wizard available only if geometry is fixed

The screenshot displays the 'Design Input' window for 'Typical Section Loads'. The 'Stage 2 load distribution' is set to 'Uniformly to all girders'. The 'Wearing surface' has a thickness of 2 inches and a density of 150 pcf. Under 'Appurtenance loads', the 'Parapet' tab is active, showing a cross-section diagram and a table of loads.

Name	Stage	Load type	Measure to	Edge of deck distance measure from	Distance at start (ft)	Distance at end (ft)	Front face orientation
300 plf par...	Stage 2	DC	Back	Left Edge	0.00	0.00	Right
300 plf par...	Stage 2	DC	Back	Right Edge	0.00	0.00	Left

The 'Exterior diaphragm loads' section includes a 'Diaphragm wizard...' button, which is highlighted with a yellow box and an arrow pointing to the 'Diaphragm Wizard' dialog box on the right.

The 'Diaphragm Wizard' dialog box shows 'Diaphragm spacing' options: 'Enter number of equal spaces per span' (selected), 'Enter equal spacing per span', and 'Enter groups of equal spacing'. It also includes input fields for 'Support diaphragm load' and 'Interior diaphragm load', and a table for span data.

Span	Length (ft)	Number of equal spaces
1	110	
2	120	
3	110	

Design Input | Beam Parameters

- ▶ Same Input for Girder Line and Girder System
- ▶ Parameters for
 - ▶ Beam Shape Selection
 - ▶ Initial Strand Configuration
 - ▶ Vertical Shear (and Splitting) Reinforcement

2_PSMS-0116-PSNB-NSlow-Dbd-GLLbrdx - AASHTOWare Bridge Design: Prestressed Concrete Design Tool

File Design Input Design

Project
Project Library
Geometry
Deck
Beam Parameters
Material Parameters
Member Loads
Control Options
Input Report

Beam shape selection
Beam type: I Beam - Narrow Top Flange Sufficiently connected to act as a unit
 Depth range Specific shape AASHTO TYPE III
Min depth: 24 in
Max depth: 65 in

Strand configuration
 Straight / Debonded Harped
Max total debonded strands percentage: 50 %
Max debonded strands percentage per row: 45 %
Max number of debonding locations: 3
Consider strands debonded/cut at midspan:
Debonding location for strands debonded/cut at midspan: 0.25 L
Number of strands debonded/cut at midspan: 4
Min distance from harped strand to beam top: 2 in
Max number of harped strands: 10
Harped point locations: 0.28 L

Vertical shear reinforcement
Distance to first reinforcement: 4 in
 Use 2 ranges - min range 1 length: 0.5 ft

Range 1
Material: Grade 60
Bar size: 9
Number of legs: 2

Range 2
Material: Grade 60
Bar size: 4
Number of legs: 2

Validation Off

Back Forward

Callouts:
- If selected, multiple shapes within the specified range will be considered (points to Depth range)
- Strand configuration for initial design. Can be modified after initial design on Design (points to Strand configuration)
- Can be used for slitting resistance reinforcement (points to Range 1)

Design Input | Material Properties

- ▶ Same Input for Girder Line and Girder System
- ▶ Input Data for:
 - ▶ PS Loss Calculations
 - ▶ Beam Concrete Strength
 - ▶ Stress Limit Factors

The screenshot displays the 'Material Parameters' section of the AASHTOWare Bridge Design software. The interface includes a sidebar with navigation options: Project, Project Library, Geometry, Deck, Typical Section Loads, Beam Parameters, Material Parameters (selected), Member Loads, Control Options, Schematic, and Input Report. The main panel contains the following settings:

- Beam curing method: Moist cured, Steam cured
- Exposure factor: Top: 1, Bottom: 1
- PS strand: 1/2" (7W-250) LR
- PS loss method: AASHTO Approximate
- Consider creep
- Consider deck differential shrinkage loads
- Average humidity: 70 %
- Transfer time: Hours
- Deck placement age: Days
- Final age: Days
- Beam concrete compressive strength:
 - Concrete composition: Normal
 - f'c: 7 ksi
 - f'ci: 5.5 ksi
- Stress limit factors:
 - Corrosion condition: Moderate
 - Set defaults
 - Initial allowable compression: 0.6
 - Initial allowable tension: 0.0948
 - Final allowable compression: 0.6
 - Final allowable tension: 0.19
 - Final allowable DL compression: 0.45
 - Final allowable slab compression: 0.6
 - Final allowable compression (LL + 1/2 (Pe + DL)): 0.4

At the bottom, there is a 'Validation' toggle switch set to 'Off'.

Design Input | Member Loads

▶ Same Input for Girder Line and Girder System but with Different Beam Assignments

▶ Load Types:

- ▶ Distributed
- ▶ Concentrated
- ▶ Pedestrian

The image displays two screenshots of the AASHTOWare Bridge Design software interface, specifically the 'Member Loads' section. The top screenshot shows the 'Girder Line' configuration, and the bottom screenshot shows the 'Girder System' configuration.

Girder Line Configuration:

- Beam: 1
- Name: W
- Stage: Stage 2
- Load type: DW
- Support: 1
- Start distance (ft): 0.00
- Length (ft): 50.00
- End distance (ft): 50.00
- Load start (kip/ft): 3.000
- Load end (kip/ft): 3.000

Girder System Configuration:

- Beam: All
- Name: Interior Diaph...
- Stage: Stage 1
- Load type: DC
- Support: 1
- Start distance (ft): 0.00
- Length (ft): 100.00
- End distance (ft): 100.00
- Load start (kip/ft): 0.360
- Load end (kip/ft): 0.360

Annotations in the screenshots:

- Girder Line:** "For Girder Line, Member Loads can be applied to Beam 1 only" (pointing to Beam 1).
- Girder System:** "For Girder System, member loads can be applied to specific members only with fixed geometry input" (pointing to the list of members 1-10).
- Girder System:** "Generic beam assignments can be used for Girder Systems with fixed or variable geometry input" (pointing to the 'All' assignment).

Design Input | Member Loads | LLDfFs

▶ Different Input for Girder Line and Girder System

▶ Girder Line:

- ▶ Required
- ▶ Allows Variation with within range

▶ Girder System

- ▶ Calculated by program
- ▶ Can be overridden by user
- ▶ Constant within range

Girder Line

Required input for Girder Line

Can be assigned to Beam 1 only

Values can vary between start end and end

Support	Start distance (ft)	Length (ft)	End distance (ft)	Variation	Distribution factor at start (lanes)		Distribution factor at end (lanes)	
					1 lane	Multi-lane	1 lane	Multi-lane
1	0.000	50.000	50.000	Constant	0.900	1.050	0.900	1.050

Girder System

Optional input for Girder System. Available only if Girder System Geometry is Fixed.

Can be applied and copied to any beam

Constant values within length

Design Input | Control Options

- ▶ Same Input for Girder Line and Girder System
- ▶ Defines:
 - ▶ Shear Computation Method
 - ▶ Gross or Transformed Section Properties for PS Loss Calculations
 - ▶ Stage 2 and 3 Analysis for Multi-span bridges
 - ▶ Deflection Multipliers

The screenshot displays the 'Control Options' tab within the 'Design Input' section of the AASHTOWare Bridge Design: Prestressed Concrete Design Tool. The interface includes a left-hand navigation pane with categories such as Project, Project Library, Geometry, Deck, Typical Section Loads, Beam Parameters, Material Parameters, Member Loads, Control Options (selected), Schematic, and Input Report. The main content area contains the following settings:

- Shear computation method:** General procedure, Simplified procedure
- Loss & stress calculations:** Use gross section properties, Use transformed section properties
- Multi-Span analysis:** Continuous, Continuous and simple
- Deflection Multipliers:**

	At erection	Final
Beam weight:	1.85	2.40
Prestress:	1.80	2.20

Set defaults

At the bottom of the window, there is a 'Validation' toggle switch set to 'Off'.

Design Input | Schematic

- ▶ Girder System Only
- ▶ Displays:
 - ▶ Framing Plan
 - ▶ Typical Section
- ▶ Specific values can be selected when variable geometry and beam depth range input is used

The screenshot displays the AASHTOWare Bridge Design software interface. The top window shows the 'Framing plan' view with a schematic of four girders (G1, G2, G3, G4) spaced 110'-0" apart. A dropdown menu for 'Number of beams' is set to 4, with a callout box stating 'Selection available with variable geometry input'. The bottom window shows the 'Typical section' view with a schematic of a deck supported by four girders (G1, G2, G3, G4). The deck width is 42'-0", and the spacing between girders is 3 @ 11'-8" = 35'-0". A callout box points to the 'Shape' dropdown menu, which is set to BT-63, with the text 'Selection available with variable geometry and shape depth range input'. Other parameters shown include 'Deck Thickness 8"', '2" Overlay', and 'Haunch Th. 2"'. The software title bar indicates the file name '6_PSS-0006-PSWIB-NSkw-Hpd-GS.brdx' and the application 'AASHTOWare Bridge Design: Prestressed Concrete Design Tool'.

Design Input | Input Report

- ▶ Available for Girder Line and Girder System
- ▶ Summary of Input Data

6_PSS5-0006-PSWIB-NSkw-Hpd-GS.brdx - AASHTOWare Bridge Design: Prestressed Concrete Design Tool

File Design Input Design

Project

Project Library

Geometry

Deck

Typical Section Loads

Beam Parameters

Material Parameters

Member Loads

Control Options

Schematic

Input Report

Project

Project: 6_PSS5-0006-PSWIB-NSkw-Hpd-GS
 Description: This example includes iterations for number of beams, overhang width, and beam shape.
 Designer: ProMiles
 Date: 02/15/2022

LRFD specifications
 Edition: AASHTO LRFD 9th
 Limit states: Strength-I, Service-I, Service-II, Fatigue-I

Design vehicles
 Design load: HL-93 (US)
 Permit load:
 Fatigue load: LRFD Fatigue Truck (US)
 Structure definition type: System

Project Library

Appurtenance

Parapet

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

Material

Concrete

Name	Description	Compressive strength at 28 days f'c (ksi)	Initial compressive strength f'ci (in)	Coefficient of thermal expansion (1/F)	Density for DL (kcf)	Density for modulus of elasticity (kcf)	Poisson's ratio	Composition of concrete	Modulus of rupture (ksi)	Shear factor
Class A	Class A cement concrete	4.061		0.0000060000	0.150	0.145	0.200	Normal	0.483	1.000

Name	Description	Std Modulus of elasticity (ksi)	LRFD Modulus of elasticity (ksi)	Std Initial modulus of elasticity (ksi)	LRFD Initial modulus of elasticity (ksi)
Class A	Class A cement concrete	3687.74	3687.74		

Prestress Strand

Validation Off Back



Design | Design Run

- ▶ Design Input Run (I)
 - ▶ Initial Design
 - ▶ Based on Design Input Data
- ▶ Design Review Run (R)
 - ▶ Based on Design Input and User's Tweaks of Initial Design

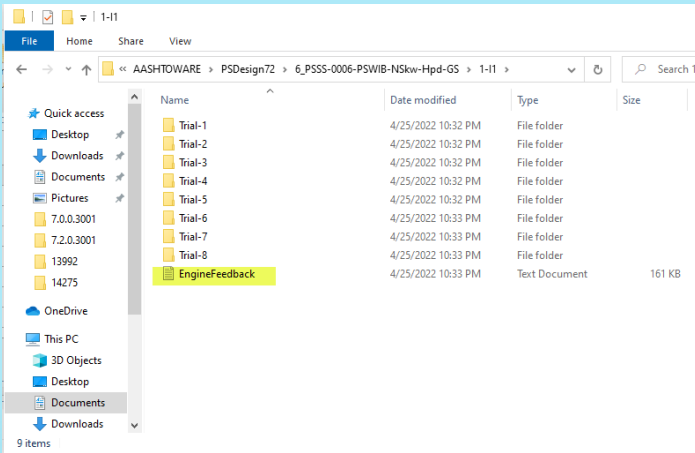
The screenshot displays the AASHTOWare Bridge Design software interface. The main window shows a table of design runs with columns for Design Run, Description, Critical design ratio, Critical strand design ratio, and Pin. The table lists several beams (1-11.1 to 1-11.7 and 1-R1.1) with their respective descriptions and design ratios. A callout box points to the row for 1-11.7, stating: "1-11.7 means: Beam: 1, Design Run: Input, Input Data Set: 1, Trial: 7".

Below the table, the software shows a beam cross-section diagram with a grid of strands. To the right, there are two stress check graphs: "Initial stress check" and "Final stress check". The "Initial stress check" graph shows stress (ksi) vs. location (ft) for f(t)-allow, f(c)-allow, f(top), and f(bottom). The "Final stress check" graph shows stress (ksi) vs. location (ft) for f(t)-allow, f(c)-allow, f(bottom-t), f(top-c), and f(bottom-c).

Annotations in the image include:

- "Overall Design Ratio" pointing to the "Critical design ratio" column.
- "Strand Design Ratio" pointing to the "Critical strand design ratio" column.
- A callout box for "1-11.7" explaining the naming convention: "1-11.7 means: Beam: 1, Design Run: Input, Input Data Set: 1, Trial: 7".

Design | Engine Feedback



Design run	Description	Critical design ratio	Critical strand design ratio	Pin
1-11.1	Beam 1 of 4, Deck overhang = 3.500 ft, BT-63, 40 strands, CG at left end = 32.12 in	✓ 1.013	✓ 1.013	-10
1-11.2	Beam 1 of 4, Deck overhang = 3.500 ft, BT-72, 32 strands, CG at left end = 36.60 in	✓ 1.010	✓ 1.010	-10
1-11.3	Beam 1 of 4, Deck overhang = 4.000 ft, BT-63, 42 strands, CG at left end = 32.12 in	✗ 0.191	✗ 0.191	-10
1-11.4	Beam 1 of 4, Deck overhang = 4.000 ft, BT-72, 34 strands, CG at left end = 36.60 in	✓ 1.042	✓ 1.042	-10
1-11.5	Beam 1 of 5, Deck overhang = 3.500 ft, BT-63, 34 strands, CG at left end = 32.12 in	✓ 1.045	✓ 1.045	-10
1-11.6	Beam 1 of 5, Deck overhang = 3.500 ft, BT-72, 30 strands, CG at left end = 36.60 in	✓ 1.032	✓ 1.032	-10
1-11.7	Beam 1 of 5, Deck overhang = 4.000 ft, BT-63, 36 strands, CG at left end = 32.12 in	✓ 1.031	✓ 1.031	-10
1-11.8	Beam 1 of 5, Deck overhang = 4.000 ft, BT-72, 30 strands, CG at left end = 36.60 in	✓ 1.032	✓ 1.032	-10

EngineFeedback - Notepad

```

File Edit Format View Help
Beginning design
Beginning validation...
Completed validation...

Design iteration = 1 -----
Number of beams = 4, Deck overhang = 3.500 ft, Shape = BT-63 (AASHTO-PCI Bulb-Tee BT-63)

Beginning design trial 1 -----
By Tributary Area was selected for Stage 1 dead load distribution method on the Superstructure Loads win
The Parapet load of a Parapet location entered on the Structure Typical Section window is zero!
The Parapet load will not be applied!
Starting FEA
Stage 1 Model Method: Span
FEA - Initiating finite element analysis...
FEA - Building model...
FEA - Creating nodes...
FEA - Creating elements...
FEA - Creating support constraints...
FEA - Adding load cases...
FEA - Verifying finite element model...
FEA - Preparing linear solution...
FEA - Performing linear solution...
FEA - Successful finite element analysis...
Stage 2 Model Method: Span
FEA - Initiating finite element analysis...
FEA - Building model...
FEA - Creating nodes...
FEA - Creating elements...
FEA - Creating support constraints...
FEA - Adding load cases...
FEA - Verifying finite element model...
FEA - Preparing linear solution...
FEA - Performing linear solution...
FEA - Successful finite element analysis...
Stage 3 Model Method: Span
FEA - Initiating finite element analysis...
FEA - Building model...
FEA - Creating nodes...
FEA - Creating elements...
FEA - Creating support constraints...
FEA - Adding load cases...
FEA - Verifying finite element model...
    
```

- ▶ Log of Engine Progress
- ▶ Contains Warnings and Error Messages



Design | Strand Pattern

- ▶ Displays Strand Pattern as Initially Designed at
 - ▶ Mid-Span
 - ▶ Harp Points
 - ▶ Debonding Points
- ▶ Displays Initial and Final Concrete Stress Diagrams
- ▶ Allows Modification of Strand Patterns
- ▶ Modified Patterns can be Design Reviewed

1_PSS5-0005-PSBB-NSkw-Hpd-GS.brdx - AASHTOWare Bridge Design: Prestressed Concrete Design Tool

File Design Input Design

Design input Design review Minimum strand design stress ratio 1 Specification checks Tabular results Result graphs Engine outputs Summary report Delete Reset BrDR

Design run View results Input and Review BrDR

Strand pattern Beam details Beam Profile

Span: 1 Symmetry

Mid span

Harp point locations

Left end

Right end

Harp point	Distance (ft)	Radius (in)
Left	7.58	0.00
Right	7.58	0.00

Debonding point locations

Left

Section location (in)	Measured and deb...
60.00	End of Beam
120.	Mid-Span

New Modify Delete

Right

Section location (in)	Measured and deb...
	End of Beam
	Mid-Span

New Modify Delete

Beam shape: BIV-48
Location = 50.000

Non-composite Section Properties:

Number of Strands = 46
Area (Ag) = 844.375 (in²)
N.A. to bottom of beam = 20.800 (in)
N.A. to top of beam = 21.200 (in)
S(top) = 9584.848 (in³)
S(bot) = 9769.310 (in³)
I(x) = 203200.196 (in⁴)

Composite Section Properties:

Number of strands = 46
Number of harped strands = 6 Number of debonded strands (Total/Here/Other) = 2/2/0
CG of strands (measured from bottom of section) = 3.92 in

Legend:

- × No strand at this position at the current section location.
- × No strand at this position at the current location but a strand is harped to this position.
- A strand occupies this position at the current section location.
- The strand is debonded from the end of the beam to the current section location.
- The strand is debonded from the mid-span to the current section location.
- The strand is debonded at other section location. Hover over the strand for more information.
- The harped position of a harped strand.
- The mid-span position of a harped strand.

Initial stress check

Final stress check

Design | Beam Details

▶ Displays Concrete Strength and Initial Design of:

- ▶ Vertical Shear Reinforcement
- ▶ Deck reinforcement
- ▶ Positive Moment Continuity Reinforcement

▶ Allows Modification of Strength & Reinforcement

▶ Run Design Review to Evaluate Modifications

Beam shape: BT-72 F'c: 7,000 ksi F'cs: 5,500 ksi

Vertical shear reinforcement

Reinforcement	Extends into deck	Span	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
Range 1	<input checked="" type="checkbox"/>	1	0.33	1	0.00	0.00	0.33
Range 2	<input checked="" type="checkbox"/>	1	0.33	4	6.00	2.00	2.33
Range 2	<input checked="" type="checkbox"/>	1	2.33	2	4.00	0.67	3.00
Range 2	<input checked="" type="checkbox"/>	1	3.00	13	6.00	6.50	9.50
Range 2	<input checked="" type="checkbox"/>	1	9.50	2	6.00	1.00	10.50
Range 2	<input checked="" type="checkbox"/>	1	10.50	24	12.00	24.00	34.50
Range 2	<input checked="" type="checkbox"/>	1	34.50	2	15.00	2.50	37.00
Range 2	<input checked="" type="checkbox"/>	1	37.00	18	24.00	36.00	73.00

Deck reinforcement

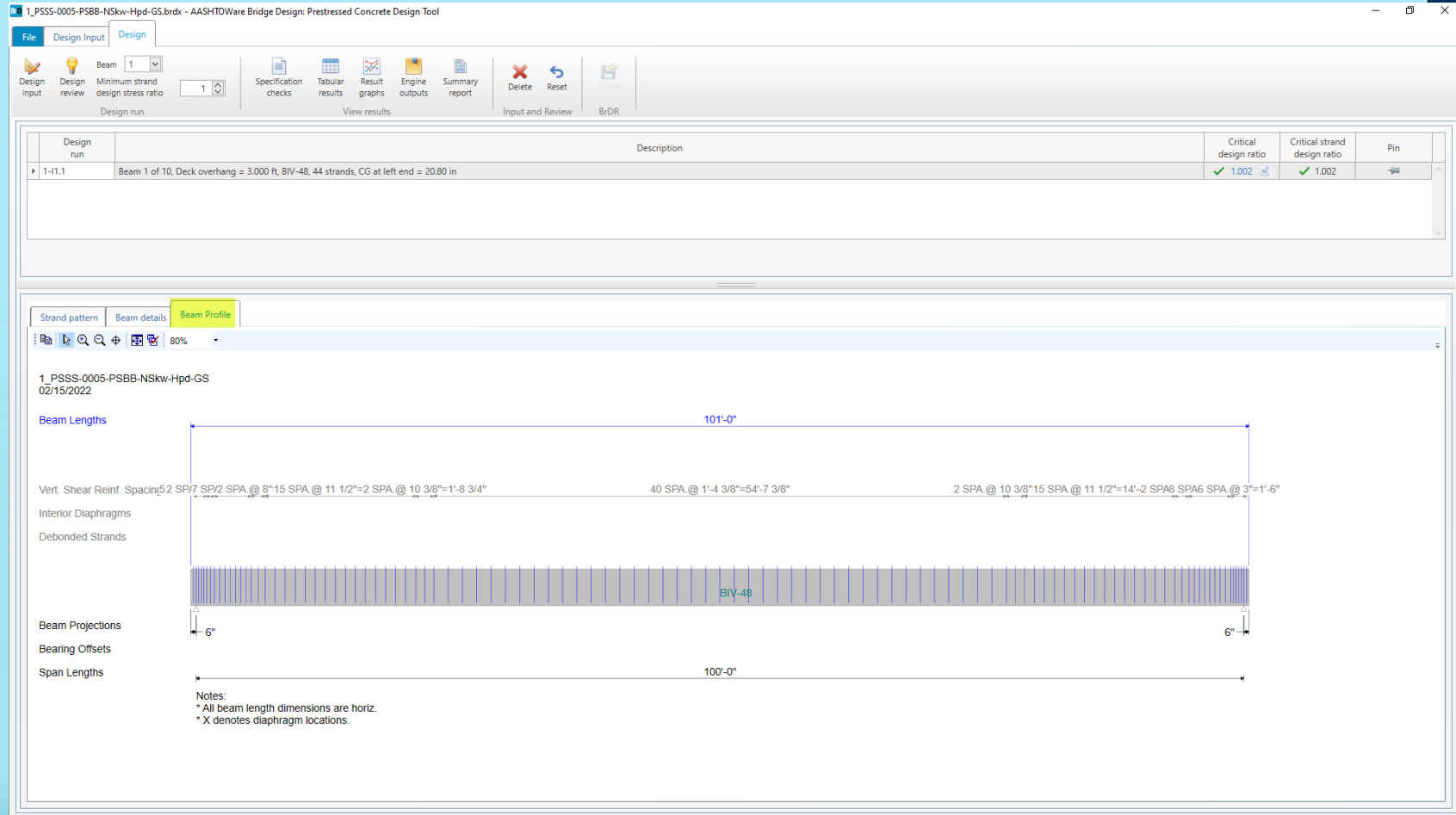
Support	Start distance (ft)	Length (ft)	End distance (ft)	Bar size	Clear cover (in)	Measured from	Bar spacing (in)
1	0.00	340.00	340.00	4	3.3750	Top of Stru...	6.0741
1	0.00	340.00	340.00	7	2.0000	Bottom of...	6.0000

Positive moment continuity steel

Span	Left support				Right support			
	Material	Distance (in)	Number of bars	Bar size	Material	Distance (in)	Number of bars	Bar size
1					Grade 60	3.00	4.00	5
2	Grade 60	3.00	4.00	5	Grade 60	3.00	4.00	5
3	Grade 60	3.00	4.00	5				

Design | Beam Profile

- ▶ Displays Beam Schematic with Dimensions and Annotations



Design | View Results | Specification Checks

▶ Detailed Spec Check Output at:

- ▶ Each Stage
- ▶ Each POI
- ▶ Each Article

The screenshot displays the AASHTOWare Bridge Design software interface. The main window shows a list of design runs with columns for Design run, Beam details, and CG at left end. Below this, the 'Strand pattern' tab is active, showing harp point locations and debonding point locations for a selected span.

The 'Specification checks' window is open, showing a tree view of the design components. The 'Spec Check Detail for 5.9.4.4.1 Splitting Resistance' window is also open, displaying the following details:

Spec Check Detail for 5.9.4.4.1 Splitting Resistance

5 Concrete Structures
 5.9 Prestressing
 5.9.4 Details for Pretensioning
 5.9.4.4 Pretensioned Anchorage Zones
 5.9.4.4.1 Splitting Resistance
 (AASHTO LRFD Bridge Design Specifications, Ninth Edition)

PS I Wide - At Location = 0.0000 (ft) - Right Stage 1

INPUT:

Prestressed beam type: PS Beam I Wide
 Area of shear reinforcing, $A_s = 4.7400$ (in²)
 Area of prestressing strands, $A_{ps} = 6.5100$ (in²)
 Jacking stress, $f_j = 202.8000$ (ksi)
 Initial losses, ES Loss = 17.5594 (ksi)
 Stress in strands at transfer, $f_{pt} = 184.9406$ (ksi)
 $h = 72.0000$ (in)

SUMMARY:

Maximum stress allowed in reinforcing, $f_s = 20.0000$ (ksi)
 Total resistance available, $P_{ru} = f_s * A_s = 94.8000$ (kip)
 Force in strands at transfer, $F_{pt} = f_{pt} * A_{ps} = 1203.9635$ (kip)
 Minimum resistance required, $P_r = .04 * F_{pt} = 48.1585$ (kip)
 Design ratio, DR = 1.968
 Status = PASS



Design | View Results | Tabular Results

- ▶ Detailed Tabular Results:
 - ▶ Dead and Live Load Actions
 - ▶ Each Stage
 - ▶ Each Load Case
 - ▶ Each POI
- ▶ Can be viewed and printed

The screenshot shows the 'Tabular results' window in the AASHTOWare Bridge Design software. The window title is '6_PSSS-0006-PSWIB-NSkw-Hpd-GS.brdx - Design Run 1-11.8'. The 'Report type' is set to 'Dead Load Actions', 'Stage' is 'Stage 1', and 'Load case' is 'Load Case 1 - Self Load(Stage 1:D,DC)'. The table below shows the results for various spans and locations.

Span	Location	Moment (kip-ft)	Shear (kip)	Axial (kip)	Reaction (kip)	X deflection (in)	Y deflection (in)
1	0.00	0.00	44.82	0.00	44.82	0.0000	0.0000
1	2.50	109.51	42.78	0.00		0.0000	-0.0684
1	11.00	443.73	35.86	0.00		0.0000	-0.2957
1	22.00	788.86	26.89	0.00		0.0000	-0.5595
1	33.00	1035.38	17.93	0.00		0.0000	-0.7660
1	43.90	1182.39	9.05	0.00		0.0000	-0.8963
1	44.00	1183.29	8.96	0.00		0.0000	-0.8971
1	55.00	1232.59	0.00	0.00		0.0000	-0.9421
1	66.00	1183.29	-8.96	0.00		0.0000	-0.8971
1	66.10	1182.39	-9.05	0.00		0.0000	-0.8963
1	77.00	1035.38	-17.93	0.00		0.0000	-0.7660
1	88.00	788.86	-26.89	0.00		0.0000	-0.5595
1	99.00	443.73	-35.86	0.00		0.0000	-0.2957
1	107.50	109.51	-42.78	0.00		0.0000	-0.0684
1	110.00	0.00	-44.82	0.00	44.82	0.0000	0.0000



Design | View Results | Results Graphs

▶ Results Graphs with Corresponding Tabular Results:

- ▶ Dead and Live Load Actions and Deflections
- ▶ Each Stage
- ▶ Each Load Case
- ▶ Each POI
- ▶ Design Ratios
- ▶ Envelopes

▶ Can be viewed and printed

The screenshot displays the AASHTOWare Bridge Design software interface. The top window shows the 'Design Run' table with 8 entries (1-11.1 to 1-11.8) detailing beam configurations and deck overhangs. The bottom window shows the 'Strand pattern' settings, including span length (1), symmetry, and harp point locations (Left and Right at 44.40 ft). The right window shows the 'Moment' graph and table. The graph plots Moment [kip-ft] vs. Distance [ft] for Mmax and Mmin. The table below the graph provides detailed moment values for various stages and load cases.

Span	Location	Distance	Mmax Lrfd-S3-STRENGTH-I	Mmin Lrfd-S3-STRENGTH-I
1	0.00	0.00	0.00	0.00
1	2.50	2.50		
1	6.35	6.35	1,994.51	682.84
1	11.00	11.00	3,390.92	1,161.72
1	22.00	22.00	6,000.10	2,065.27
1	33.00	33.00	7,827.51	2,710.67
1	43.90	43.90		
1	44.00	44.00	8,915.50	3,097.91
1	55.00	55.00	9,242.89	3,226.99
1	66.00	66.00	8,915.50	3,097.91
1	66.10	66.10		
1	77.00	77.00	7,827.51	2,710.67
1	88.00	88.00	6,000.10	2,065.27
1	99.00	99.00	3,390.92	1,161.72
1	103.65	103.65	1,994.51	682.84
1	107.50	107.50		
1	110.00	110.00	0.00	0.00



Design | View Results | Summary Report

- ▶ Combines Multiple Section of Output
- ▶ Sections are selectable by User
- ▶ Can be viewed and printed

The screenshot displays the AASHTOWare Bridge Design software interface. The main window shows the 'Summary report' tab, which includes a legend for strand positions, non-composite section properties, and a graph titled 'Initial stress check' showing stress [ksi] versus position. The legend defines symbols for strand positions and debonding points. The non-composite section properties list: Number of Strands = 30, Area (Ag) = 767.000 (in²), N.A. to bottom of beam = 36.604 (in), N.A. to top of beam = 35.396 (in), S(top) = 15421.286 (in³), S(bot) = 14912.644 (in³), and I(x) = 545857.218 (in⁴). The 'Initial stress check' graph plots stress [ksi] on the y-axis (ranging from -4 to 0) against position on the x-axis (ranging from 0 to 100). The graph shows four data series: f(t1)-allow (blue), f(c1)-allow (red), f(top) (green), and f(bottom) (purple). The f(top) and f(bottom) series show a sharp drop in stress at the ends of the beam, while the f(t1)-allow and f(c1)-allow series remain near zero.

The Properties dialog box is open, showing the 'Section' tab. The 'Section' tab is selected, and the 'Input report' checkbox is checked. Other options include 'Strand patterns', 'Concrete stresses', 'Spec check summary', and 'Schematics'. The 'Strand pattern' section shows 'Span: 1' and 'Mid span' selected. The 'Harp point locations' section shows 'Left end' and 'Right end' radio buttons. The 'Debonding point locations' section shows 'Left' and 'Right' radio buttons.

Design | View Results | Engine Outputs

▶ Various Output Files from Engine:

- ▶ Finite Element Analysis Models and Results
- ▶ Live Load Distribution Calculations
- ▶ Specification Check Summary

The screenshot displays the AASHTOWare Bridge Design software interface. The 'Design' window shows a list of design runs (1-11.1 to 1-11.8) with details like beam type, deck overhang, and strand count. The 'Engine outputs' window lists various analysis and calculation files, including 'LRFD Dist Factor Summary.TXT'. A Notepad window shows the 'LRFD Dist Factor Summary' with three tables: Moment Distribution Factor Schedule, Shear Distribution Factor Schedule, and Deflection Distribution Factor Schedule. A 'Specification Check Summary' table shows all checks passing. Below it is an 'Initial Compression Stress At Transfer of Prestress' table.

Start Distance (ft)	End Distance (ft)	Single Lane DF (Lanes)	Multi Lane DF (Lanes)
0.00	110.00	0.812(L)	0.742(A)

Start Distance (ft)	End Distance (ft)	Single Lane DF (Lanes)	Multi Lane DF (Lanes)
0.00	110.00	0.812(L)	0.701(A)

Start Distance (ft)	End Distance (ft)	Single Lane DF (Lanes)	Multi Lane DF (Lanes)
0.00	110.00	0.240(A)	0.510(A)

Article	Status
Initial Stress at Transfer (5.9.2.3.1a, 5.9.2.3.1b)	Pass
Splitting Resistance in Anchorage Zones (5.9.4.4.1)	Pass
Final Stress due to Permanent and Transient Loads (5.9.2.3.2a, 5.9.2.3.2b)	Pass
Flexure (5.6.3.2, 5.6.3.3)	Pass
Shear (5.7.3.3, 5.7.2.5, 5.7.2.6, 5.7.3.5)	Pass
Deflection (5.6.3.5.2)	Pass

Location (ft)	Allowable Stress (ksi)	Actual Stress Top of Beam (ksi)	Actual Stress Bot of Beam (ksi)	Design Ratio	Code
0.000	-4.550	0.039	-0.573	7.945	Pass
2.500	-4.550	0.194	-3.393	1.341	Pass
6.348	-4.550	0.144	-3.342	1.362	Pass



Design | Design Run Pinning

- ▶ Pinned Design Runs:
 - ▶ Can be exported to BrDR
 - ▶ Are saved in input file and will be reanalyzed when input file is reopened

The screenshot shows the AASHTOWare Bridge Design software interface. At the top, there is a menu bar with 'File', 'Design Input', and 'Design'. Below the menu is a toolbar with various icons for design input, review, and results. The main window is divided into several sections:

- Design Run Table:** A table listing design runs with columns for Design run, Description, Critical design ratio, Minimum strand design ratio, and Pin. Design run 1-11.8 is highlighted in blue and has a green pin icon in the 'Pin' column. A yellow box labeled 'Pinned design runs' points to this row.
- Strand pattern:** A section on the left with tabs for 'Strand pattern', 'Beam details', and 'Beam Profile'. It includes options for 'Span' (1) and 'Symmetry' (checked). Under 'Mid span', there are radio buttons for 'Left end' and 'Right end'. A table shows harp point locations:

Harp point	Distance (ft)	Radius (m)
Left	44.40	0.00
Right	44.40	0.00
- Beam Profile:** A central diagram of a T-beam cross-section with a grid of 'x' marks representing strands.
- Stress Check Graphs:** Two graphs on the right showing 'Initial stress check' and 'Final stress check'. Both graphs plot Stress [ksi] against Location [ft]. The 'Initial stress check' graph shows stress levels for f(t)-allow, f(c)-allow, f(top), and f(bottom). The 'Final stress check' graph shows stress levels for f(t)-allow, f(c)-allow, f(bottom-t), f(bottom-c), f(top-c), and f(top-t).



Design | BrDR Export/Import

▶ From PS Design Tool to BrDR

The screenshot illustrates the workflow for exporting design data from the PS Design Tool to the BrDR software. It is divided into two main sections: PS Design Tool (left) and BrDR (right).

PS Design Tool (Left):

- The **Design** tab is active, showing a table of design runs. The first run, '1-11.1', is selected.
- The **Export** button in the top toolbar is highlighted with a yellow box.
- An **Export** dialog box is open, showing the file path: 'This PC > Shared (\VBoxSrv) (Z:) > PsDesign > 7.2.0.3001'. The file name is '1_PSSS-0005-PSBB-NSkw-Hpd-GS_Export' and the save type is 'Bridge Design Import (*.brdi)'. The file is highlighted in yellow.
- A diagram of a bridge cross-section is shown at the bottom, labeled 'PS Design Tool' in red. Below it, technical details are listed: 'Beam shape: BIV-48', 'Location = 50.000', 'Number of strands = 44', 'Number of harped strands = 0', and 'Number of debonded strands (Total/Here/Other) = 0/0/0'. The CG of strands is noted as 4.91 in.

BrDR (Right):

- The **Workspace** pane shows a tree view of the project structure. The folder '1_PSSS-0005-PSBB-NSkw-Hpd-GS' is highlighted in yellow.
- The **Design Tool File Import** dialog box is open, showing the same file path and file name as the PS Design Tool. The file is highlighted in yellow.
- The **Import Design Tool File** dialog box is open, showing a table of design runs to be imported:

Design run	Import?	Description
1-11.1	<input checked="" type="checkbox"/>	Beam 1 of 10, Deck overhang = 3...

The 'Import' button is highlighted in yellow. Below the table is an **Activity log** showing the progress of the import process, including messages like 'Importing: 1-11.1', 'Importing library items...', 'Finished importing library items...', 'Importing superstructure...', 'Creating Girder System...', 'Finished importing superstructure...', 'Importing members...', 'Successfully imported: 1-11.1', and 'Finished importing members...'. The 'Import' and 'Close' buttons are at the bottom right.

Design | BrDR Export/Import

- ▶ From
- ▶ BrDR to PS Design Tool (starts automatically)

The screenshot displays the AASHTOWare Bridge Design interface. The 'Workspace' pane on the left shows a tree view of the project 'PCITrainingBridge6'. A context menu is open over the 'ME' component, with 'Export to PS Design Tool' highlighted. A yellow arrow points from this menu item to the 'PS Design Tool' window on the right. The 'PS Design Tool' window shows the 'Design Input' tab with fields for Project (PCITrainingBridge6), Designer (bridge), and Date (4/26/2022). Below these are sections for LRF specifications, Design vehicles, and Structure definition type. A second yellow arrow points from the 'Export to PS Design Tool' window to a file explorer window at the bottom. The file explorer shows a list of files in the 'PsDesign > 7.2.0.3001' folder, with 'PCITrainingBridge6' selected in the 'File name' field. The 'Save as type' is set to 'BRDX files (*.brdx)'. A 'PS Design Tool' label is also present on the right side of the image.



Future Improvements

- ▶ We welcome feedback!
- ▶ Some ideas for improvement from TAG Beta Testing
 - ▶ Strand design algorithm to envelope designs for multiple trials and girders
 - ▶ Strand editing in tabular format
 - ▶ Strand and beam Visualization
 - ▶ Design algorithm for mild steel in girder
 - ▶ Dedicated stirrup range for splitting resistance
 - ▶ Import girders from PS Design Tool into one superstructure in BrDR
- ▶ More ideas will be appreciated...



Hands-on Example

- ▶ Enter the project
- ▶ Perform design input run
- ▶ Perform design review run



Any Questions?

Why do we
build
bridges?

Bridges
create
connections
and...

