AASHTOWare BrDR 7.5.0 Prestress Tutorial 9 Cut Strand for PS Beam Example

BrDR Training

PS9 – Cut Strand for PS Beam Example

This example describes a design review of a prestressed concrete beam with temporary PS strands.

Topics Covered

- Definition of a strand layout with top strands that are debonded and cut at the center of the beam to control stresses at release.
- LRFD design review of a prestressed concrete beam with the strand layout described above.

Definition of a strand layout with top strands that are debonded and cut at the center of the beam to control stresses at release.

Open the bridge **PCITrainingBridge3** (**BID6**) from the **Bridge Explorer**. A partially expanded **Bridge Workspace** tree is shown below.



Expand the tree under the **Member Alternative #1 (9.9.3)**, expand **Strand Layout** and open the **Span 1** window by double clicking on it. Use the **ZOOM** options on the right side of the window to shrink/expand the schematic of the beam shape so that the entire beam is visible.



Strand Layout – Span 1

Adjust the strand pattern as follows to produce a strand pattern that results in very large top tensile stresses at release.



Click **OK** to apply the changes and close the window.

LRFD Design review of a prestressed concrete beam with the strand layout described above

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

Bridge Work	space - PCITrainingBridge3	A	NALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE	WORKSPACE TOOLS	/IEW DES	IGN/RATE	REPORTING			^
Analysis Settings Analysis Analysis	Tabular Specification Engin Results Check Detail Output Results	e Results S ts Graph Re	ave esults				

Click the **Open Template** button and select the **HL 93 Design Review** to be used in the analysis and click **Open**.

Templates	Description	Analysis	Owner	Public / Private	
HL 93 Design Review	HL 93 Design Review	LRFD		Public	
HS 20 LFR Rating	HS 20 LFR Rating	LFR		Public	
LRFR Design Load Rating	LRFR Design Load Rating	LRFR		Public	
LRFR Legal Load Rating	LRFR Legal Load Rating	LRFR		Public	

The Analysis Settings window will be populated as shown below.

Analysis Settings				_		×
O Design review	Rating	Design method:	LRFD	~		
Analysis type:	Line Girder		ing: None			
Vehicles Output I Traffic direction: Both d	Engine Description	Refresh	Temporary vehicles	Advanced]	
Vehicle selection		Vehicle sum	mary vehicles			
E-Standard EV2 EV3 HL-93 (SI) HL-93 (US) HS 20 (SI) HS 20-44 LRD Fatigur	litary Loading ≘ Truck (SI) ∋ Truck (ISI)	☐-Ďesi ·· Pern □ -Fatic 	ign loads HL-93 (US) nit loads gue loads .RFD Fatigue Truck (US)			
		Remove from				
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Click **OK** to apply the settings and close the window.

Run the LRFD design review on the **Member Alternative #1 (9.9.3)** by clicking on the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon.



Specification Check Detail

After the analysis, open the **Specification Checks** window by clicking on the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.

Bridge Works	space - PCITrainingBridge3	ANALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE	VORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			^
Analysis Analyze Analysis Settings Analyze Analysis Events Analysis	Tabular Results Specification Check Detail Results	ults Save ph Results				

Go to Superstructure component, Stage 1, Member Alternative #1 (9.9.3), Span 1 – 12 ft.

Properties Generate Bullet lis				
Editication filter Report	Specification reference	Limit State	Flex. Sense	Pass/Fail
Prestress Calculations	5.4.2.5 Poisson's Ratio		N/A	General Comp.
🔺 🚞 Stage 1	5.4.2.6 Modulus of Rupture		N/A	General Comp.
🔺 🚞 Member Alternative #1 (9.9.3)	5.4.2.8 Concrete Density Modification Factor		N/A	General Comp.
🚞 Span 1 - 0.00 ft.	5.6.2.2 Rectangular Stress Distribution		N/A	General Comp.
🚞 Span 1 - 0.82 ft.	✗ 5.9.2.3.1a Compressive Stresses		N/A	Failed
🚞 Span 1 - 1.58 ft.	X 5.9.2.3.1b Tensile Stresses		N/A	Failed
🚞 Span 1 - 3.33 ft.	PS_Basic_Properties Calculation		N/A	General Comp.
🔄 Span 1 - 12.00 ft.	Strand Stress Calculations		N/A	General Comp.
Span 1 - 24.00 ft.				
Span 1 - 36.00 ft.				
Span 1 - 48.00 ft.				
Span 1 - 60.00 ft.				
Span 1 - 72.00 ft.				
Span 1 - 84.00 π.				
Span 1 - 90.00 ft.				
Span 1 - 100.00 ft				
Span 1 - 120.00 H.				
E Stage 2				

Open the **5.9.2.3.1b Tensile Stresses** article. The tension in the top of the beam at release shows a design ratio of 0.445.

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Spec Check Detail for 5.9.2.3.1b Tensile Stresses
                                                                           \times
 5 Concrete Structures
                                                                                  \sim
 5.9 Prestressing
 5.9.2 Stress Limitations
 5.9.2.3 Stress Limits for Concrete
 5.9.2.3.1 For Temporary Stresses before Losses
 5.9.2.3.1b Tensile Stresses
 (AASHTO LRFD Bridge Design Specifications, Ninth Edition)
 PS I Wide - At Location = 12.0000 (ft) - Left Stage 1
 Input:
                  5.50 (ksi)
 f'ci
          =
Section Properties: Gross
Ag = 767.00 (in^2)
St = 15421.29 (in^3)
                                epg = 30.26 (in)
Sb = 14912.64 (in^3)
St
Pi = 1295.58 (kip)
lambda = 1.00
 Service III Loads:
 MDL1 = 517.73 (kip-ft)
 Consider Mild Steel in Initial Allowable Tensile Stress Limit = No
 Summary:
 Initial Tension Stresses Due to Permanent Loads:
 (Service III: PS + DL )
                            _____
 Initial allowable Tension stress limit not entered.
 Use computed default value = 0.0948 * lambda * SQRT(f'ci) <= 0.2 ksi
 Initial allowable Tension stress limit = 0.20 (ksi)
                    Top Beam
                                 Bottom Beam
                                      (ksi)
-4.318
                        (ksi)
  PS:
                       0.853
  DL:
                       -0.403
                                       0.417
  Sum =
                       0.450
                                      -3.901
  Allow =
                       0.200
                                       0.200
                       0.445
                                       99.000
  DR
       =
 <
                                                                                >
                                                                             OK
```

🕰 Strand Layout - Span 1	- 🗆 X
Description type	: 🗈 💽 🤤 🕁 🕂 100% 🔽
○ P and CGS only	Notes: Strend positions generated by the CHIGTNUL method.
Strand configuration type	Present infor to Hisp for a description of this method.
Straight/Debonded	
Harped	
O Harped and straight debonded	
Mid span	×× ××
	××
	×× ××
	×× ××
	×× ××
Debonding	×× ××
Left Section location (in) Measured and debonded from	::
	••
New Modify Delete	
Kight Section location (in) Measured and debonded from	Number of strands = 48 Number of detonded shareds (fotal/Hare/Other) = 0/0/0
	CG of strands (measured from bottom of section) = 9.00 in
	Legend:
New Modify Delete	\times No strend at this position at the current section location. \times No strend at this position at the current location but a strend 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.
OK Appiy Cancel	The strart is debonded from the mid-gain to the current section location. The strard is debonded at other section location. Hover over the strand for more information. The strand section of the strand section (The
	Interspect permotes on at HERPIGE REFERSE. The mid-span position of a harped alarnd. The mid-span position of one stand and the harped position of another strand.
	Mild about.

Select the **Left** radio button, click **New** to open the following window. Debond the newly added top strands over a length equal to ¹/₂ the beam length. The beam length is 120' so debond 60' with 30' going to the left of midspan and 30' to the right of midspan. When measuring from mid-span, the strand will be cut after release of the initial prestressing.

A New Location	×
Section location: 360.0000 in	
Measured and debonded from	
○ End of beam	
Mid-span: Cut strand after release of initial prestressing force	
OK Cancel	

Click **OK** to close the window.

Select the top 2 strands as being debonded and cut. These 2 strands will then appear as purple strands. Click **OK** to close the window.

🕰 Strand Layout - Span 1	- 0	×
Description type		÷
○ P and CGS only	Notes: Stend positors generated by the CHGRNAL method. Present refer to Help for a disamption of the method.	
Strand configuration type Symmetry		
	×× ××	
Harped and straight debonded	××	
	××	
Mid span		
	×× ××	
	×× ××	
	**	
	**	
	×× ××	
Debonding	××	
Lett Section location (in) Measured and debonded from	::	
Source Mina-Span		
New Modify Delete	•••••	
Right Section location (in) Measured and debonded from	Number of strands = 48	
360.0000 Mid-Span	Number of debonded strands (Total/Here/Other) = 2/2/0	
	CG of strands (measured from bottom of section) = 6.35 in	
v.	Legend:	
New Modify Delete	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.	
OK Apply Cancel	A static coupler are pointed in an excerning resource counter. The strand is debonded from the end of the beam to the current section location. The strand is debonded from the strand current section location.	
Cancer	The alread is debonded at other section location. Hower over the strend for more information. The strend is debonded at other section location. Hower over the strend for more information. The termination of a homeon denoting of the termination of termin	
	The integrate pointing of it fulliple to starter. The mid-apar position of a harpet strand. The mid-apar position of an advected and the bound continue of excitoes choud	
	The movement of other straind and the transec position of another solution. Mild steel.	

Adding these pretensioned top strands adds compression to the top of the beam at the ends of the beam to counteract the high tension in the top of the beam. Debonding and cutting them at midspan removed the compression in this region for the final construction stage.

Re-run the **HL-93 design review** of this member alternative. Reopen the details for article **5.9.2.3.1b Tensile Stresses** and see that the design ratio has improved. The top strands contribute to compression in this region and counteracts the high tension in the top flange.

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Spec Check Detail for 5.9.2.3.1b Tensile Stresses
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 \begin{array}{rcl} \text{Ag} &=& 767.00 \ (\text{in}^2) \\ \text{St} &=& 15421.29 \ (\text{in}^3) \end{array}
 Pi = 1357.21 (kip)
lambda = 1.00
 Pi
 Service III Loads:
          = 517.73 (kip-ft)
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 (Service III: PS + DL )
 Initial allowable Tension stress limit not entered. Use computed default value = 0.0948 * lambda * SQRT(f'ci) <= 0.2 ksi
 Initial allowable Tension stress limit = 0.20 (ksi)
                       Top Beam
                                     Bottom Beam
                          (ksi)
                                            (ksi)
                          0.660
  PS:
                                           -4.282
  DL:
                         -0.403
                                           0.417
  ____
                          0.257
                                           -3.865
  Sum
        =
  Allow =
                          0.200
                                            0.200
                          0.778
                                           99.000
  DR
        =
 <
                                                                                              >
                                                                                           OK
```