AASHTOWare BrDR 7.5.1 Advanced Concrete Beam Tutorial 2 AC2 – Three Span Advanced Concrete PT & RC MCB Web Example

AASHTOWare Bridge Design and Rating Training

AC2 – Advanced Concrete PT MCB Web Example

Topics Covered:

- Advanced Concrete Beam Member Alternative with PT and RC regions
- Model a web in an MCB structure
- LRFR Rating

Overview of Advanced Concrete Beam features:

- Advanced concrete beams implemented in BrDR version 7.1.0 in September 2021
- Advanced concrete PT: LRFR/LFR
- Model girders in a multi-girder system or individual webs in a multi-cell box.
- Model schedule based non-symmetric RC Beams
- Post-tensioned/reinforced concrete regions
- Different stages of post-tensioning

This tutorial describes the data entry for a post-tensioned multi-cell box(MCB) web using the Advanced Concrete beam alternative in BrDR version 7.5.1 Taking this approach to model the webs in an MCB is useful when the multi-cell box superstructure definition in BrDR does not provide a way to model the structure.

Advanced Concrete Beam Member Alternative with PT and RC regions

Import the **AC2** – **Advanced Concrete PTRC.xml** file provided with this tutorial into BrDR by clicking on the Import button from **BRIDGE** ribbon in the **Bridge Explorer** as shown below.

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3	TrainingBridge3	Training Bridge 3(LRFD)	Unk
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5	PCITrainingBridge2	PCITrainingBridge2(LRFD)	
6	PCITrainingBridge3	PCI TrainingBridge3(LFR)	
7	PCITrainingBridge4	PCITrainingBridge4(LRFD)	
8	PCITrainingBridge5	PCI TrainingBridge5(LFR)	
g	PCITrainingBridge6	PCITrainingBridge6(LRFD)	
10	Example7	Example 7 PS (LFR)	
	RCTrainingBridge1	BC Training Bridge1(LER)	
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The Bridge Workspace tree is shown below.



The following sketch shows the superstructure definition that will be described in this example. This training example will first review the superstructure windows in this superstructure definition and then an advanced concrete member alternative will be entered for **G1**.



Girder System Superstructure Definition

Double click on the **MCB using Advanced Concrete Beams** node in the **Bridge Workspace** tree to open the **Girder System Superstructure Definition** window as shown below. Note that the **Modeling** type for this superstructure is **MCB**. This selection tailors the data entry of the girders to model the webs in a multi-cell box structure. The number of girders is set to 4. When the modeling type is **MCB**, the number of girders corresponds to the number of webs in the multi-cell box being described. Click **Cancel** to close the window without saving any errant changes that may have been made.

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Framing Plan Detail

Open the **Structure Framing Plan Details** window shown below by double clicking on the **Framing Plan Details** node in the **BWS** tree.

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The following sketch documents the rules for entering the overhang and girder spacing for the exterior girder. The overhang is measured from the edge of deck to the centerline of the web top. The girder spacing is measured from the centerline of the bay.



Structure Typical Section

Open the Structure Typical Section window shown below and review the following tabs.

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If entered, the depth of the girder is decreased by the **sacrificial wear thickness** in the section property and capacity calculations. The self-weight of the girder is not adjusted by this value.

The depth of the girder is increased by the structural overlay thickness in the section property and capacity calculations.

The self-weight of the girder is increased by entering a structural overlay density and thickness.

		Generic Sł	паре											
ck		Front												
Deck	Deck (con	t'd) Parapet	Median	Railing	Generic	Sidewalk	Lane positi	on Stripe	d lanes	Wearing s	urface			
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Click **Cancel** to close the window.

Schematic – Structure Typical Section

With **Structure Typical Section** selected in the **BWS** tree, click on the **Schematic** button from the **WORKSPACE** ribbon, or right click and select **Schematic** to view the section schematic as shown below.



This superstructure definition contains post-tensioned regions, so the following post-tension data is present in this superstructure.

Concrete Stress Limits

Bridge Workspace - AdvPTBeam	ANALYSIS RE	PORTS		? – 🗆	\times
BRIDGE WORKSPACE TOOLS	VIEW DESIGN/RATE REP	ORTING			
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Bridge Components					
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Framing Plan Detail Grading Structure Typical Section	Anchor set:	C).37	in		Initial I	OSS:		ksi	
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σ _m Beam Concrete Stress Limits	Wobble coeffi	cient: (0.0002	per ft						
Post Tension Losses Refined Losses	P/S transfer st	ress ratio:								\times
Shear Reinforcement Definitions	Transfer time:	2	24	Hours						
Bar Mark Definitions Br Bar Members	Age at deck pl	lacement: 3	30	Days						
G1 G1 G	Final age:	2	20000	Days	OK	Ар	ply	Car	ncel	

Post Tension Losses

Member Alternative

Double click **MEMBER ALTERNATIVES** under member G1 to open the **New Member Alternative** window.

Bridge Workspace	ce - AdvPTBeam	VIEW	ANALYSIS DESIGN/RATE	REPORTS		? -	- [×
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AdvPTBeam AdvPTBeam Components Diaphragm Definitions Diateral Bracing Definitions SUPERSTRUCTURE DEFI Mark Data and Case Descrited Mark Definitions Mark Definition Superstructure L Gather Structure Typical Mark Definition Superstructure L Gather Structure Typical Mark Definition Superstructure L Gather Structure L Gather S	INITIONS di Concrete Beams : Load Allowance iption :tail I Section .oads Limits ete Stress Limit ses es ment Definitions ions Loads : ALTERNATIVES	A New Material Post te Reinfor	Member Alternative type: nsioned concrete rced concrete	Girder type	x d Concrete PT OK	Cancel		\$\$ X

Since this superstructure definition's modeling type is MCB, only Advanced Concrete beams are available. Since this beam contains both post-tensioned and reinforced concrete regions, select **Post tensioned concrete** so the post-tensioning information will be available. Click **OK** and the **Member Alternative Description** window will open.

Enter a name for the member alternative.

-												
A Member Alter	native Des	cription								_		×
Member alterna	tive: PT V	Veb 1										
Description	Specs	Factors	Engine	Import	Control options							
Description:					Material type:	Post Tensioned Co	ncrete					
					Girder type:	Advanced Concret	e PT					
					Modeling type:	MCB						
					Default units:	US Customary	~					
C Girder pro	perty inpu	t method										
Scher	dule based											
O Cross	s-section b	ased										
Self load		с.:			Default rating met	thod:						
Load case		Engine As	signed	~	LFK	~						
Additional	I self load:		kip/ft									
Additional	I self load:		%									
Crack cont	trol parame	eter (Z)		Exposu	re factor							
Top of bea	am:		kip/in	Top of	beam:							
Bottom of	beam:		kip/in	Botton	n of beam:							
								0*	A	by .	Care	al
								UK	Арр	У	Canc	CI

Switch to the **Control Options** tab and uncheck the **Ignore design & legal load shear** checkbox. Click **OK** to close the window and create the member alternative.

mber alternative: PT Web 1	
Description Specs Factors Engine Import Co	ntrol options
LRFD	
Doints of interest	Points of interest
Generate at tenth points except supports	Generate at tenth points except supports
Generate at support points	Generate at support points
Generate at support face & critical shear points	Generate at support face & critical shear points
Generate at section change points	Generate at section change points
Generate at user-defined points	Generate at user-defined points
Shear computation method	Shear computation method
Ignore	Ignore
O General procedure	O General procedure
General procedure - Appendix B5	General procedure - Appendix B5
Simplified procedure	Simplified procedure
Simplified procedure - Vci, Vcw	Simplified procedure - Vci, Vcw
Loss & stress calculations	Loss & stress calculations
O Use gross section properties	Use gross section properties
Use transformed section properties	Use transformed section properties
Consider colitting resistance article	Ignore design & legal load shear
IFR	Ignore permit load shear
Points of interest	Consider legal load tensile concrete stress
Generate at tenth points except supports	Consider splitting resistance article
Generate at support points	Ignore tensile rating in top of beam
Generate at support face & critical shear points	Consider permit load tensile steel stress
Generate at section change points	Ignore long, reinf, in rating
Generate at user-defined points	Consider inclined flexural forces
Shear computation method	anore moment skew reduction factor
Ignore	Distribution factor application method
Use AASHTO 1979 interim code	By axle
O Use current AASHTO	O By POI
Distribution factor application method	Allow negative epsilon in general shear method
By axle	Allow moment redistribution
O By POI	Consider iterative shear rating
Consider moment capacity reduction	
	Modify MCFT size effect

The partially expanded **BWS** is shown below. For a girder system modeled as an MCB, each girder has its own posttensioning data.



Shrinkage/Time

Open the Shrinkage/Time window and enter the following data in each tab then click OK.

Shrinkage Time						
Beam						
Curing method:	Moist-cured	```	/			
Deck						
Curing method:	Moist-cured	\sim				
Drying time:	14 Da	ays				
Consider deck	differential shrink	age load	İs			

Shrinkage/Time				_		×
Shrinkage Tim	e					
Curing time:	14	Days				
Time continuous:	7	Days				
Time composite:	7	Days				
Service life:	75	Years				
Time of analysis:	15	Years				
Time of analysis:	15	Years				
			OK	Apply	Cana	-1
			UK	Арріу	Canci	ei

Tendon Profile Definition

Double click on **Tendon Profile Definitions** folder in the **BWS** tree and enter the following data in each tab of this window. The tendons in this example extend only over the first 2 spans. The third span is reinforced concrete.

	on Prof	ile Definition												-	
file	name:	Cable 1			Starting	g span: 1	~	Start dist	tance into start s	pan: 0	ft	Stage: Comp	osite (long	g term) (S	tage 2 🗸 🗸
					Ending	span: 2	~	End dista	ance from end sp	pan: 0	ft				
rofil	e P	ost tensioning	Stress limi	its											
ln (flection Per	n point entry me centage Dis	thodstance												
					Infl	ection poir	its			Vertic	al offset				
	Span	Pro	file type		Left (%)	Low (%)	Right (%)	Left end (in)	Measured from	Low (in)	Measured from	Right end (in)	Measu from	red n	
>	1	\sim	Type 1	~	15	50	15	36	Bottom 🗸	12	Bottom 🗸	20	Тор	~	
	2	\sim	Type 1	~	15	50	15	20	Тор 🗸	12	Bottom \checkmark	36	Bottom	~	

🗛 Tendor	n Profile Definition									_		×
Profile na	ame: Cable 1		Starting spar	n: 1 ~	Start distan	ce into start span:	0	ft	Stage:	Composite (long term) (Stage 2 🗸 🗸	
			Ending span	: 2 ~	End distanc	e from end span:	0	ft				
Profile	Post tensioning	Stress limits										
Prestr	ress material: 1/2" (7V	N-270) LR	 ✓ Duo 	t grouting: Gro	outed 🗸							
Jackin	ng end: Left End	4 V	Duc	t diameter:	in							
Pos	st Tensioning											
	Input method											
	O Jacking force	Strands	Jacking stress ratio:	0.75								
To	otal jacking force: 26	500 kip	Number of ducts:	0 ~								
	Duct	Strand per	ls									
		duct										
											^	
										OK Apply	Cance	el
🗛 Tendor	n Profile Definition											×
🕰 Tendor	n Profile Definition									_		×
A Tendor Profile na	n Profile Definition ame: Cable 1		Starting spar	n: 1 ~	Start distant	ce into start span:	0	ft	Stage:	– Composite (long term) (S	□ Stage 2 ∨	×
A Tendor Profile na	n Profile Definition ame: Cable 1		Starting span		Start distand	ce into start span: e from end span:	0	ft ft	Stage:	– Composite (long term) (S	□ Gtage 2 ∨	×
Profile na	n Profile Definition ame: Cable 1 Post tensioning	Stress limits	Starting spar Ending span		Start distand	ce into start span: e from end span:	0	ft ft	Stage:	– Composite (long term) (S	□ Stage 2 ∨	×
Profile na Profile	n Profile Definition ame: Cable 1 Post tensioning	Stress limits	Starting spar Ending span:	1 ~ 2 ~ LRFD	Start distance End distance	ce into start span: e from end span:	0	ft	Stage:	– Composite (long term) (S	D Stage 2 🗸	×
Profile na Profile	n Profile Definition ame: Cable 1 : Post tensioning o seating:	Stress limits	Starting spar Ending span:	1 × 1 × 1 × 1 × 1 × 1 × 1 × 1 × 1 × 1 ×	Start distance End distance LFD ksi 218.7	ce into start span: e from end span:	0	ft ft	Stage:	– Composite (long term) (S	□ Stage 2 ∨	×
Tendor Profile na Profile Profile Prior tc At ancl	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers	Stress limits	Starting span Ending span: er anchor set:	n: 1 ∨ 2 ∨ LRFD 218.7 189	Start distant End distanc LFD ksi 218.7 ksi 189	ce into start span: e from end span: ksi ksi	0	ft	Stage:	– Composite (long term) (S	□ Stage 2 ∨	×
Tendor Profile na Profile Prior tc At anch Elsewh	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers were along length of m	Stress limits immediately after nember immediat	Starting spar Ending span: er anchor set: tely after anchor set:	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8	Start distant End distanc LFD ksi 218.7 ksi 189 201.69	ce into start span: e from end span: ksi ksi ksi	0	ft ft	Stage:	–	Citage 2 🗸	×
Tendor Profile na Profile Prior tc At anct Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers erer along length of m rice limit state after los	Stress limits immediately aftd nember immediat sses:	Starting spar Ending span: er anchor set: tely after anchor set:	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distant End distanc LFD ksi 218.7 ksi 189 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0	ft ft	Stage:	– Composite (long term) (S	□ itage 2 ∨	×
Tendor Profile na Profile Prior tc At anch Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m nice limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting span Ending span: er anchor set: tely after anchor set: npute Values	ILRFD 218.7 199.8 194.4	Start distant End distanc LFD ksi 218.7 ksi 189 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi ksi	0	ft ft	Stage:	– Composite (long term) (S	itage 2 🗸	×
Tendor Profile n Profile Prior tc At anct Elsewh At serv	n Profile Definition ame: Cable 1 : Post tensioning o seating: horages and couplers tere along length of m <i>rice</i> limit state after los	Stress limits immediately afte nember immediat sses: Corr	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distanc End distanc LFD ksi 218.7 ksi 218.7 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0	ft	Stage:	– Composite (long term) (S	L Stage 2 V	×
Tendor Profile na Profile Prior tc At anct Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m <i>ri</i> ce limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distance End distance LFD ksi 218.7 ksi 201.69 ksi 201.69	ce into start span: e from end span: ksi ksi ksi	0	ft ft	Stage:	– Composite (long term) (S	C	×
Tendor Profile na Profile Prior tc At anct Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m rice limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	In 1 → 2 → 1 → 2 → 1 → 1 → 1 → 1 → 1 → 1 →	Start distance End distance LFD ksi 218.7 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi ksi	0	ft ft	Stage:	–	C Stage 2 V	×
Tendor Profile Prior tc At anch Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m rice limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting span Ending span: er anchor set: tely after anchor set: 1pute Values	n 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distance End distance LFD ksi 218.7 ksi 189 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi ksi	0	ft ft	Stage:	–	L Stage 2 V	×
Tendor Profile Profile Prior tc At anch Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m rice limit state after los	Stress limits immediately aft nember immediat sses: Corr	Starting span Ending span: er anchor set: tely after anchor set: npute Values	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distance End distance LFD ksi 218.7 ksi 189 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0	ft ft	Stage:	–	□ itage 2 ∨	×
Tendor Profile na Profile Prior tc At ancl Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers horages and couplers horages and couplers horages and couplers horages and couplers	Stress limits immediately aft nember immediat sses: Con	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	n: 1 ∨ 2 ∨ LRFD 218.7 199.8 194.4	Start distand End distand LFD ksi 218.7 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0	ft	Stage:	– Composite (long term) (S	Litage 2 V	×
Tendor Profile na Profile Prior tc At ancl Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m hirce limit state after los	Stress limits immediately afta nember immediat sses: Com	Starting span Ending span: er anchor set: tely after anchor set: npute Values	ILRFD 218.7 199.8 194.4	Start distand End distance LFD ksi 218.7 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi ksi	0	ft ft	Stage:	– Composite (long term) (S	itage 2 V	×
Tendor Profile na Profile Prior tc At anct Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m <i>rice</i> limit state after los	Stress limits immediately afte nember immediat sses: Con	Starting span Ending span: er anchor set: tely after anchor set: npute Values	1 2 V 1 2 V 1 2 V 1 2 18.7 1 89 1 99.8 1 94.4	Start distanc End distanc LFD ksi 218.7 ksi 201.69 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi ksi	0	ft ft	Stage:	 Composite (long term) (S	itage 2 V	×
Tendor Profile na Profile Prior tc At anch Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers tere along length of m <i>rice</i> limit state after los	Stress limits immediately afte nember immediat sses: Corr	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	1 V 2 V 218.7 189 199.8 194.4	Start distanc End distanc LFD ksi 218.7 ksi 201.69 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi ksi	0	ft ft	Stage:	– Composite (long term) (S	Citage 2 V	×
Tendor Profile Prior tc At anct Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m rice limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distance End distance LFD ksi 218.7 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0 0	ft ft	Stage:	– Composite (long term) (S	C Stage 2 V	×
Tendor Profile Prior tc At ancl Elsewh At serv	n Profile Definition ame: Cable 1 : Post tensioning o seating: horages and couplers here along length of m rice limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distance End distance LFD ksi 218.7 ksi 201.69 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0 0	ft ft	Stage:	– Composite (long term) (S	C Stage 2 V	×
Tendor Profile Prior tc At anct Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers here along length of m rice limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting spar Ending span: er anchor set: tely after anchor set: npute Values	n: 1 ∨ 2 ∨ 218.7 189 199.8 194.4	Start distance End distance LFD ksi 218.7 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0 0	ft ft	Stage:	– Composite (long term) (S	C Stage 2 V	×
Tendor Profile Prior tc At anch Elsewh At serv	n Profile Definition ame: Cable 1 : Post tensioning o seating: horages and couplers ere along length of m rice limit state after los	Stress limits immediately afte nember immediat sses: Com	Starting span Ending span: er anchor set: tely after anchor set: 1pute Values	n: 1 ∨ 2 ∨ LRFD 218.7 189 199.8 194.4	Start distance End distance LFD ksi 218.7 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi	0 0	ft ft	Stage:	– Composite (long term) (S	C Stage 2 V	×
Tendor Profile Profile Prior tc At ancl Elsewh At serv	n Profile Definition ame: Cable 1 Post tensioning o seating: horages and couplers were along length of m rice limit state after los	Stress limits immediately aft nember immediat sses: Con	Starting span Ending span: er anchor set: tely after anchor set: npute Values	1 2 V 1 2 V 1 2 V 1 89 1 99.8 1 94.4	Start distanc End distanc LFD ksi 218.7 ksi 201.69 ksi 201.69 ksi 194.4	ce into start span: e from end span: ksi ksi ksi ksi	0	ft ft	Stage:	 Composite (long term) (S	itage 2 V	X

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

Cross Sections

Double click on the Cross Sections folder in the BWS tree, select Cast in Place and click OK.



Enter the following data. Click the **Compute** button to validate the section dimensions and compute the section properties. Click **OK** to close the window.



The following rules are considered when creating the cross section from the entered dimensions:

WT1 and **WT2** are not used to locate any points in the cross section. They are used as validation to ensure the computed WT1 and WT2 match the entered values. The shear capacity calculations will use bw = (WT1 + WT2)/2. Cross section coordinates are located in the following manner:



Point	Х, Ү
0	OffsetL, 0
1	OffsetL, LST1
2	OffsetL + LSW, LST1 + LST2
3	OffsetL + LSW + BL2, LST1 + LST2 + BL1
4	LFW + AL2, D – LFT1 - LFT2 - AL1
5	LFW, D – LFT1 - LFT2
6	0, D – LFT1
7	0, D
8	TFW, D
9	TFW, D – RFT1
10	TFW - RFW, D - RFT1 - RFT2
11	TFW – RFW - AR2, D – RFT1 – RFT2 - AR1
12	TFW – OffsetR – RSW – BR2, RST1 + RST2 + BR1
13	TFW – OffsetR – RSW, RST1 + RST2
14	TFW – OffsetR, RST1
15	TFW – OffsetR, 0

Schematic – Cross Section.

With the **Section 1** cross section selected in the **BWS** tree, click the **Schematic** button from the **WORKSPACE** ribbon. The cross section schematic is shown below:



Cross Section Ranges

Open the Cross Section Ranges window and enter the following data:

Left	t end projection:	9 ir	n Right end	projection: 9	in						
	Start section	End section	Depth vary	Solid section	Support number	Start distance (ft)	Length (ft)	End distance (ft)			
>	Section 1 $$	Section 1 🗸	None 🗸		1 ~	0	4	4			
	Section 1 $$	Section 1 🗸	None 🗸		1 ~	4	94	98			
	Section 1 $$	Section 1 $$	None 🗸	\checkmark	1 ~	98	6	104			
	Section 1 $$	Section 1 $$	None 🗸		2 ~	4	93	97			
	Section 1 $$	Section 1 $$	None 🗸	\checkmark	2 ~	97	6	103			
	Section 1 $$	Section 1 $$	None 🗸		3 ~	3	68	71			
	Section 1 $$	Section 1 🗸	None 🗸	\checkmark	3 ~	71	4	75			
							N	aw	Duplicate	Del	ete

This training example contains a single tendon, but advanced concrete PT beams can have multiple tendons and overlapping tendons.

			-	,				
Post te	ension loss	ses: Refi	ned Loss	ies .	~			
Ten	don assigr	ments						
	Tendor	n profile	Start span	Start distance into start span (ft)	End span	End distance from end span (ft)	Stage	
>	Cable 1	\sim	1	0	2	0	Composite (long term) (Stage 2)	

	CIO	ss secut	on Kange				
(Cro	ss sectio	ons F	ost tens	ioning	Effective supports	
		Span	From start (in)	From end (in)			
	>	1	24	36			
		2	36	36			:
		3	36	24			
				ati.			-

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

Flexural Reinforcement

Enter the following flexural reinforcement in the flanges:

۵	Flex	ural Reinf	orcement												- 0	×
	Тор	flange	Bottom flange													
		Set	Material	Reference point	Direction	Start distance (ft)	Length (ft)	End distance (ft)	Number of bars	Bar size	Clear cover (in)	Bar spacing (in)	Side cover (in)	Start fully developed	End fully developed	
	>	1	Grade 60 🗸 🗸	Support 1 🛛 🗸	Left 🗸	0.5	276	275.5	31	8 ~	2.5					-
												N	ew	Duplicate	Delete	<u>v</u>
													ОК	Apply	Car	icel

AC2 - Three Span Advanced Concrete PT & RC MCB Well) Example
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p fl	ange	Bottom flange														
	Set	Material		Reference point	Direction	Start distance (ft)	Length (ft)	End distance (ft)	Number of bars	Bar size	Clear cover (in)	Bar spacing (in)	Side cover (in)	Start fully developed	End fully developed	
>	1	Grade 60	\sim	Support 1 🛛 🗸	Left 🗸	0.5	276	275.5	20	11 ×	2					1

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

Shear Reinforcement Ranges

Open the **Shear Reinforcement Ranges** window. Be sure to select **Centerline bearings** as the input type and then click the **Stirrup Wizard** button.

partere	rence type							
Void	ls O Ce	nterline bearing	gs					
pan rang pan: 1	yes ~							
Na	Start me distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)			
	. ,							

Enter the following data in the Stirrup Wizard for each span and then click Apply All.

Stirr	up Wizard									;
, F Pistanc Left	_{rt} Maxin e	num Interior Spa	icing		ז א≓ Right Dista	a i Start ance				
Inpu	it reference type									
	Voids 🔘 Cente	rline bearings								
Span:	1 ~	Maximur	n interior s	pacing: 24		in				
Mea	sured from left end o	of span			Meas	sured from ri	ght end	d of span		
Sta	art distance: 0	in			Star	rt distance:	0	in		
	Name	Number of spaces	Spacing (in)			Name	•	Number of spaces	Spacing (in)	
>	#4 stirrup \sim	20	6	-	>	#4 stirrup	~	20	6	-
	#4 stirrup $~~$	18	16			#4 stirrup	\sim	18	16	
	New	Duplicate	e De	elete		1	lew	Duplica	te D	elete
						A	oply all	Арр	ly span	Cancel





Shear Reinforcement I	Ranges	i 💽 🗆		0 17	(d) 🕀 🔇	
Listance	Centerline bea	arings				
Span ranges						
Name	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)	
#4 stirrup 🚿	0	1	0	0	0	A
#4 stirrup	· 0	20	6	10	10	
#4 stirrup	[/] 10	18	16	24	34	
#4 stirrup	34	16	24	32	66	
#4 stirrup	66	18	16	24	90	
#4 stirrup	90	20	6	10	100	
Stirrup wizard					(New Duplicate Delete
						OK Apply Cancel

The Shear Reinforcement Ranges window is updated as shown below.

Shear	Reinforcement Ra	nges	i 🗗 🗆			(ø) ⊛∣(Ø <	-		×
i i i <u>e</u> Star Distar	rt <mark>, Spacing ,</mark> nce									
	reference type Voids O Ce	nterline bea	arings							
Span Span	ranges									
	Name	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)				
	#4 stirrup 🛛 🗸	0	1	0	0	0				
	#4 stirrup 🛛 🗸	0	30	6	15	15				
	#4 stirrup 🛛 🗸	15	32	9	24	39				
	#4 stirrup 🛛 🗠	39	11	24	22	61				
	#4 stirrup 🛛 🗸	61	32	9	24	85				
	#4 stirrup \sim	85	30	6	15	100				
Sti	irrup wizard						New Duplicat	te I	Delete	
							ОК Ар	oply	Canc	el

🕰 Shear	r Reinforcement R	anges	j 🗗	⊐ı F ⊃ [(2) 🛞 (⊘ < ×
L <u>, Sta</u> Distar	It <mark>Spacing</mark> nce t reference type Voids O C	enterline bea	arings				
Span Spar	ranges						
	Name	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)	
	#4 stirrup 🔍	0	1	0	0	0	A
	#4 stirrup 🛛 🗸	0	20	6	10	10	
	#4 stirrup \sim	10	24	12	24	34	
	#4 stirrup \sim	34	1	24	2	36	
	#4 stirrup 🛛 🗸	36	1	12	1	37	
	#4 stirrup \sim	37	2	24	4	41	
	#4 stirrup \sim	41	18	16	24	65	
	#4 stirrup $~~$	65	20	6	10	75	
St	tirrup wizard					(New Duplicate Delete
							OK Apply Cancel

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

Schematic – Member Alternative

Select PT Web 1 in the BWS tree and click the Schematic button on the ribbon to display the girder profile schematic.



LRFR Analysis

The member alternative can now be analyzed. To perform an LRFR rating, select the **PT Web 1** alternative in the **BWS** tree, open the **ANALYSIS DESIGN/RATE** tab on the ribbon, and select the **Analysis Settings** button.

Bridge W	ANALYSIS	REPORTS	?	_	\times		
BRIDGE WORKSPACE	WORKSPACE TO	DLS VIEW	DESIGN/RATE	REPORTING			
a 🚌		~~ ≽	2 🖪				
Analysis Analyze Analysis Settings Events	Tabular Specification Results Check Deta	n Engine Resi il Outputs Gra	ults Save ph Results				
Analysis		Results					

The **Analysis Settings** window will open. Click the **Open template** button and select the **LRFR Design Load Rating** to be used in the rating and click **Open**.

A (Open Template					×
	Templates	Description	Analysis	Owner	Public / Private	
	HL 93 Design Review	HL 93 Design Review	LRFD		Public	A
	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	
						v
	Delete				Open	Cancel

Design review Rating Analysis type: Line Girder Lane / Impact loading type: As Requested Vehicles Output Engine Description Traffic direction: Both directions Vehicle selection Image: Standard Image: Standard Image: Standard Image: Standard Image: Standard Image: Stan	Rating method Apply preferen Vehi E	ance setting: N Refresh Reting vehicle LRFR LRFR Design	LRFR None None Advan Temporary vehicles Advan es hoad rating ventory -HL-93 (US) berating -HL-93 (US)	 ced 	
Analysis type: Line Girder Lane / Impact loading type: As Requested Vehicles Output Engine Description Traffic direction: Both directions Vehicle selection Vehicles Standard -EV2 -EV3 -EV3 -EV3 -EV3 -EV3 -EV3 -H 15-44 -H 20-44 -HL-93 (SI) -HL-93 (US) -HS 15-44 -HS 20 (SI) -HS 20-44 -Lane-Type Legal Load -IBFD Fatigue Truck (SI)	Apply preferen	Refresh icle summary Rating vehicle Design	Temporary vehicles Advan as n load rating ventory -HL-93 (US) berating -HL-93 (US)	ced	
Lane / Impact loading type: As Requested Vehicles Output Engine Description Traffic direction: Both directions Vehicle selection Vehicles	Apply preferen	Refresh icle summary Rating vehicle LRFR LRFR Design	Temporary vehicles Advan es n load rating ventory -HL-93 (US) berating -HL-93 (US)	ced	
Vehicles Output Engine Description Traffic direction: Both directions Vehicle selection Uehicles Uehi	R Vehi È-	Refresh Rating vehicle LRFR Design	Temporary vehicles Advan es n load rating ventoryHL-93 (US) beratingHL-93 (US)	ced	
Traffic direction: Both directions Vehicle selection Uehicles Ue	Add to	Refresh icle summary Rating vehicle E-LRFR Design	Temporary vehicles Advan as n load rating ventory -HL-93 (US) berating -HL-93 (US)	ced	
Vehicle selection -Vehicles -Standard -EV2 -EV3 -H 15-44 -H 20-44 -HL-93 (US) -HS 15-44 -HS 20 (SI) -HS 20-44 -Lane-Type Legal Load -IRED Extinue Truck (SI)	Vehi Add to	icle summary Rating vehicle LRFR Design	es n load rating ventory -HL-93 (US) berating -HL-93 (US)		
	Add to	Rating vehicle	es n load rating ventory HL-93 (US) berating HL-93 (US)		
-LRFD Fatigue Truck (US) -NRL -SU4 -SU5 -SU6 -SU7 -Type 3-3 -Type 3-3 -Type 3S2 -Agency -User defined -Temporary	>> hove from	G-Legal I G-Legal I I - Rou - Spi - Permit	tigue LRFD Fatigue Truck (US) load rating utine ecialized hauling t load rating		

The Analysis Settings window will be populated as shown below. Click OK to close the window.

Click **Analyze** on the ribbon to launch the rating.



Tabular Results

When the rating is finished results can be reviewed by clicking the **Tabular Results** button on the ribbon.



The window shown below will open. Select **Single rating level per row** as the display format to display the output in single rows as shown below.

۵	Analysis Res	ults - PT Web 1									- 🗆	\times
	Print Print											
Rep	Report type: Display Format Display Format											
Rating Results Summary V												
	As requested Ubetailed											
	Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane	
	HL-93 (US)	Truck + Lane	LRFR	Inventory	49.82	1.384	90.00	1 - (90.0)	STRENGTH-I Concrete Shear	As Requested	As Requested	-
	HL-93 (US)	Truck + Lane	LRFR	Operating	66.47	1.846	90.00	1 - (90.0)	STRENGTH-I Concrete Shear	As Requested	As Requested	
	HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	115.79	3.216	203.00	3 - (4.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
	HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	150.09	4.169	203.00	3 - (4.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
	HL-93 (US)	Tandem + Lane	LRFR	Inventory	62.77	1.744	90.00	1 - (90.0)	STRENGTH-I Concrete Shear	As Requested	As Requested	
	HL-93 (US)	Tandem + Lane	LRFR	Operating	83.35	2.315	90.00	1 - (90.0)	STRENGTH-I Concrete Shear	As Requested	As Requested	1
AA	SHIO LRFR En	gine Version 7.5.1.3001										
Ana	alysis preferen	ce setting: None										
											Clo	/se

Specification Check Detail

Click **Specification Check Detail** on the ribbon to review the detailed spec checks. The tendons in this example stop at pier 2. Examination of the analysis points to the left of this location show post-tension articles being considered while analysis points to the right of this location consider only reinforced concrete articles.

Bridge Wo	ANALYSIS	REPORTS	?		\times		
BRIDGE WORKSPACE	WORKSPACE TOOLS	VIEW	DESIGN/RATE	REPORTING			
Analysis Analyze Analysis Settings Analyze Analysis Events	Tabular Results Check Detail	Fingine Resu Outputs Gra	k 🔛				



A Specification Checks for PT We	b 1 - 12 of 2267			- 0	×
Properties Generate	Articles All articles Format Bullet list				
Specification inter Span 2 - 3.00 ft. Span 2 - 7.44 ft. Span 2 - 7.44 ft. Span 2 - 10.00 ft. Span 2 - 20.00 ft. Span 2 - 30.00 ft. Span 2 - 40.00 ft. Span 2 - 50.00 ft. Span 2 - 50.00 ft. Span 2 - 60.00 ft. Span 2 - 80.00 ft. Span 2 - 90.00 ft. Span 3 - 3.00 ft. Span 3 - 45.00 ft. Span 3 - 45.00 ft. Span 3 - 52.50 ft. Span 3 - 60.00 ft. Span 3 - 67.18 ft.	Specification reference ✓ 5.4.2.1 Compressive Strength ■ 5.4.2.5 Poisson's Ratio ■ 5.4.2.5 Poisson's Ratio ■ 5.4.2.6 Modulus of Rupture ■ 5.4.2.8 Concrete Density Modification Factor NA 5.5.3.2 Reinforcing Bars and Welded Wire Reinforcement ■ 5.5.4.2 Strength Limit State - Resistance Factors ■ 5.6.2.2 Rectangular Stress Distribution ✓ 5.6.3.2 Flexural Resistance (Reinforced Concrete) ✓ 5.6.3.3 Minimum Reinforcement NA 5.6.7.Crack Control of Cracking by Distribution of Reinforcement ✓ 6A.4.2.1 General Load Rating Equation - Concrete Flexure ■ Cracked_Moment_of_Inertia Section Property Calculations	Limit State	Flex. Sense N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A	Pass/Fail Passed General Comp. General Comp. Not Required General Comp. Passed Passed Not Required Passed General Comp.	