AASHTOWare BrDR 7.5.0 Multi-Cell Box Tutorial MCB1 – Post-Tensioned Multi-Cell Box Example

Topics Covered

- Analysis Methods
- Post-tensioned concrete Multi-Cell Box Data Entry
- Integral with substructure
- LRFR analysis and results

This example describes entering a post-tensioned multicell box superstructure into AASHTOWare BrDR. The superstructure is modeled as integral with the pier.

Analysis Methods

Post-tensioned concrete multi-cell box (MCB) superstructures can be analyzed in the following ways:

- LFR
- LRFR
- Full box section including each individual webline

Post-tensioned concrete Multi-Cell Box Data Entry

From the Bridge Explorer, click on the bridge **BID 27 MultiCell Box Examples** in the sample database and select **Open** from the **Bridge** group of the **BRIDGE** ribbon to open this bridge as shown below.

Br		AAS	HTOWare Bridge Design and Ri	ating ? — 🗆	\times
BRIDGE EXPLORER BRIDGE FOLD	DER	RATE	TOOLS VIEW		
New Open Batch V Bridge	py Paste	Cop To	Py Remove Delete From Delete		
← f Open (Ctrl+O) → Ø Recent Bridges		BID	Bridge ID LKFD Substructure Example 3	Bridge Name	D
🖙 📁 All Bridges		23	LRFD Substructure Example 4	LRFD Substructure Example 4 (NHI Hammer Head)	
🗄 🗭 Templates		24	Visual Reference 1	Visual Reference 1	Un
····· 🎾 Deleted Bridges		25	Culvert Example 1	Culvert Example 1	
		26	Curved Guide Spec	Curved Guide Spec Example(LFR)	
	\rightarrow	27	MultiCell Box Examples	Multi Cell Box Examples	
		28	Gusset Plate Example	Gusset Plate Example	Un
		29	Splice Example	Splice Example	
		30	Simple DL-Cont LL-Splice	Simple DL Splice	Un
		31	MetalCulvertExample1	MetalCulvertExample 1	
		-			•
				Total Bridge Count: 31	

The partially expanded Bridge Workspace (BWS) tree is shown below.



1 0					•			
🗛 MultiCell Box Examp	les						- 🗆	\times
							Bridge Workspace View	
					Template		Superstructures	
Bridge ID: MultiCell I	Box Examples	NBI structure	e ID (8): MCB Examples		Bridge compl	etely defined	Culverts	
							Substructures	
							\square	
Description Des	cription (cont'd)	Alternatives	Global reference point	Traffic	Custom agency fie	lds		
Name:	Multi Cell Box E	xamples]	Year built:	2014		
B 1.4								
Description:								
Location:					Length:		ft	
Facility carried (7):					Route number:	100		
Feat. intersected (6):					Mi. post:			
Default units:	US Customary	\sim						
145								
Bridge associ	iation 🗸 🗸	BrR 🔽 BrD	BrM					
						ОК	Apply Cance	I

Open the Bridge window and check Substructures in the Bridge Workspace View.

The current Bridge Workspace tree is shown below.



Superstructure Definitions

Double click on the **SUPERSTRUCTURE DEFINITIONS** folder in the **BWS** tree to start creating a new MCB (Multi-Cell box) superstructure definition. Select **Concrete multi-cell box superstructure** and click **OK**.

A New Superstructure Definition		×
Girder system superstructure	Superstructure definition wittard	
Girder line superstructure	Superstructure demittion wizard	
Floor system superstructure		
Floor line superstructure		
Truss system superstructure		
Truss line superstructure		
Reinforced concrete slab system superstructure		
Concrete multi-cell box superstructure		
Advanced concrete multi-cell box superstructure		
	and the second	

Enter the following data for the superstructure definition. Select **Integral with substructure** and mark **Support 2** as being integral. Also be sure to select the **Post-tensioned** checkbox. This will display the **PT** windows in the **BWS** tree.

Concrete Multi-Cell Box	Superstructure Definition		– 🗆 X
Definition Analysis	Specs Factors Eng	ine Control ontions	
Name:	PT MCB		
			End projections
Description:	S	ee Below	Left: 12 in
			Right: 12 in
Default units:	US Customary 🗸 🗸	Span lengths Integral piers	Average humidity: %
Number of spans:	2 🗘	Enter span lengths along the reference line:	Structure type
Number of cells:	2 🗘	Span Length (ft)	Frame structure simplified definition
		→ 1 111.5	Consider substructure Skew in FE section proper
		2 111.5	Not integral with pier
	105		
Structure model for L	LDF computation		Post-tensioned Analyze webs only
Left side connec	ted to adjacent structure		
Right side conne	ected to adjacent structure		w.
			OK Apply Cancel
Span lengths	Integral piers		
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Frame connection	ons:		
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	2		
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1 > 2 3			

Navigate to the Control options tab and select the following LRFR options.



Click OK to create the superstructure definition and close the window.

Load Case Description

Expand the newly added superstructure definition **PT MCB** folder in the **BWS** tree and double click on the **Load Case Description** node. Use the **Add default load case descriptions** button to create the following load cases.





Concrete Stress Limits

Double click on the **Concrete Stress Limits** folder in the **BWS** tree and enter a **Name**, **Concrete material** and click the **Compute** button to fill the stress limit data for the beam concrete.

🕰 Stress Limit Sets -	Concrete						_		×
Name:	Beam Stres	s Limit							
Description:									
Corrosion condition:	Moderate		\sim						
Final allowable to	ension stress	limit coef. (US	5) override:						
Concrete material:	PT Beam Co	ncrete 4.5 ksi	~						
	Compute								
		LFD		LRFD					
Initial allowable com	pression:	2.4	ksi	2.6	ksi				
Initial allowable tensi	on:	0.1897367	ksi	0.1896	ksi				
Final allowable comp	ression:	2.7	ksi	2.7	ksi				
Final allowable tensio	on:	0.4030509	ksi	0.4030509	ksi				
Final allowable DL co	mpression:	1.8	ksi	2.025	ksi				
Final allowable slab c	ompression:		ksi		ksi				
Final allowable comp (LL+1/2(Pe+DL))	ression:	1.8	ksi	1.8	ksi				
				C	ж	Apply		Cance	el

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

Post Tension Losses

Double click on the **Post Tension Losses** folder in the **BWS** tree and select the **Lump Sum** Loss method.

A Post Tension Losses				-		×
Name: Lump Sum Los	sses					
Loss method:	Lump Sum 🗸 🗸	_ և	ump sum l	osses		
Anchor set:	in	lr	nitial loss:	20		ksi
Coefficient of friction:		Fi	inal loss:	45		ksi
Wobble coefficient:	per ft					
P/S transfer stress ratio	:					
Transfer time:	Hours					
Age at deck placement	: Days					
Final age:	Days					
		ОК	Apply		Can	cel

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

Structure Cross Sections

Double click on the **Structure Cross Sections** folder in the **BWS** tree and enter the following data.

Struc	cture Cro	ss Sectio	ons					-	- 🗆	×
Name:	Sectio	n 1				Number	of cells: 2			
- Innu	t metho									
C	Simple	A	dvanced To	p slab concrete:	F Beam Concrete 4.5 k	si v	Other parts concrete:	PT Beam Concrete	4.5 ksi	~
Entry	y methoo Width	ی د ()	lope	p slab stress limit: B	eam Stress Limit	~	Other parts stress limit	Beam Stress Limit		~
Ľ	T1 -			30	ft		RT1			
T2	<u></u> ↓ ¦			↓ CJ↓	*	¥	↓	A CTO		
¥	[T-T M WT-B		in +		RW2	D		
Over	all C	ells	Fillets					D		
		(1 1)		(ir	۱)		Properties		
	D	U.	4		> LT1	8	A	Compute pro	perties	
	CJ		0.667		LT2	12		Area:	ft^2	
	LW1		3		RT1	8		lxx:	π··4	
	LW2		3		RT2	12		1999- 1-	ft^4	
	RW1		3					5.	10 4	
	RW2		3							
	LV		1				-			
/	NV		1	v	W2: 24	ft				
							0	K Apply	Canc	el
Ove	erall	Cells	Fillets							
Тор	left w	eb thi	ckness:	14 i	in W2: 24	ft				
Bot	tom le	ft web	thickness:	14	in					
	Cell	S (ft)	Top right web thickness (in)	Bottom right web thickness (in)	Top slab thickness (in)					
>	1	12	14	14	8					
	2	12	14	14	8					

Ove	erall Cel	ls Fillets				
	Location in cells	Exterior web fillet	Interior web fillet	Horiz (in)	Vert (in)	
>	Тор	 Image: A set of the set of the	 Image: A set of the set of the	4	4	
	Bottom	 Image: A set of the set of the	 Image: A set of the set of the	4	4	

Now that all the dimensions are entered, click the **Compute properties** button.

Number of cells: 2 ksi V Other parts concrete:	PT Beam Concrete 4.5 ksi v
ksi v Other parts concrete:	PT Beam Concrete 4.5 ksi 🗸 🗸
✓ Other parts stress limit	Beam Stress Limit V
in)	Compute properties
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12	lxx: 107.700434 ft^4
8	lyy: 3275.22273(ft^4
12	J: 312.225668(ft^4
ft	
	(in) (in) 8 12 8 12 8 12 12 12 12

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

Create another cross section by copying **Section 1** and making edits to it. To copy, select **Section 1**, right-click and select **Copy** (or click on the **Copy** button from the **Manage** group of the **WORKSPACE** ribbon). Now select **Structure Cross Sections** folder, right-click and select **Paste** (or click on the **Paste** button from the **Manage** group of the **WORKSPACE** ribbon).



Br	R	Bridg	ge Worksp	pace - N	/lultiC	ell Box Ex	amples		ANA	ALYSIS	REP	ORTS		?	_		×
	BRIDGE	WORKSP	ACE	WORK	SPACE	тос	DLS	VIEW	DESIG	SN/RATE	REPO	RTING					
	A Ch	eck Out eck In	Validate	E Save	2 2010	Restore Revert	X Close	é Export	2 Refresh	Open	New	Copy	Paste	Duplicate) Delete	Schemat	ic
					Bridg	e						М	anage				

Now double click on the copied cross section to open its window. Rename the new cross section to **Section 2**, revise the depth to 8' and click on the **Compute properties** button as shown below.



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

Schematic – Section 1

With **Section 1** selected in the **BWS** tree, click on the **Schematic** button from the **WORKSPACE** ribbon (or right click and select **Schematic**) to view the cross section as shown below.





Tendon Profile Definition

Double click on the **Tendon Profile Definition** folder in the **BWS** tree and create the following tendon profile. Enter the data shown below for the 3 tabs.

ofile	name:	Tendon		Ending	span: 2	~	End distan	ce from end s	pan: 0	ft				
Prof	ile F	ost tensioning Stre	ess limits	-										
	nflection	n point entry method centage Distance	Ass	igned to: B	ox Unit	~								
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>	2	Ту	pe 4 \sim	15	60		10	Тор 🗸	48	Bottom \vee	28	Тор	\sim	

file name indon into start span 0 ft Ending span: 2 ind distance from end span: 0 ft Ending span: 2 ind distance from end span: 0 ft Ending span: 2 ind distance from end span: 0 ft Ide distance from end span: 0 ft Duct diameter: 2 in Post tensioning Indu diameter: 2 in Indu diameter: 2 in Post tensioning Indu diameter: 2 in Indu diameter: 2	file name: Starting spare: inding spare: inding spare: into to seating: inding spare: into to seating: inding spare: into to seating: into to seating: into to seating: into to seating: <th>fik ans todon boladion for a figure bola set of a f</th> <th>Profile name: Tendon Starting span: 1 v Start distance into start span: 0 ft Ending span: 2 v End distance from end span: 0 ft Post tensioning Post tensioning Post tensioning Vest tensionic</th> <th></th> <th>ft</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	fik ans todon boladion for a figure bola set of a f	Profile name: Tendon Starting span: 1 v Start distance into start span: 0 ft Ending span: 2 v End distance from end span: 0 ft Post tensioning Post tensioning Post tensioning Vest tensionic		ft								
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Click **OK** to apply the data and close the window.

Cross Section Ranges

Double click on the **Cross Section Range Properties** node in the **BWS** tree and assign the cross sections as follows visiting both the **Cross sections** and **Post tensioning** tabs.

	Start see	tion	En	nd section	D	epth vary	Solid section	Sup nur	oport mber	Start distance (ft)	Length (ft)	End distance (ft)		
>	Section 1	~	Section	n 1 ~	None	~		1	\sim	0	1	1		
	Section 1	~	Section	n 2 ~	Paraboli	c Concave 🛛 🗸		1	\sim	1	107.5	108.5		
	Section 2	~	Section	n 2 ~	None	~		1	\sim	108.5	6	114.5		
	Section 2	~	Section	n 1 ~	Paraboli	c Concave 🗸 🗸		2	\sim	3	107.5	110.5		
	Section 1	\sim	Section	n 1 🛛 🗸	None	\sim	\checkmark	2	\sim	110.5	1	111.5		
105	ss Section Ran	nes				و معمو		-	9	-			_	
ros	ss Section Ran	ges Post ter	Isioning	Effectives	upports	و. منبع			9	-			_	
ros ros Pos	ss Section Ran ss sections st tension loss Tendon assign	ges Post ter es: Lumj ments	nsioning 2 Sum Lo	Effective s	upports	Server S				-			_	
ros Pos T	ss Section Ran ss sections st tension loss Tendon assign Tendon	ges Post ter es: Lum ments profile	p Sum Lo Start span	Effective s osses Start distance (ft)	upports	End distance from end span (ft)				-			_	

The **Effective supports** tab allows to shift the specification check point at the centerline of the support to the location entered below. Shear will be checked at a distance dv from the location entered below.

A	Cro	ss Sectio	on Rang	es	-	×
6	Cro	ss sectio	ons l	Post tensionir	g Effective supports	
		Span	From start (in)	From end (in)		
	>	1		36		-
		2	36			

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

Schematic – Cross Section Range Properties

Select the **Cross Section Range Properties** node in the **BWS** tree and click the **Schematic** button from the **WORKSPACE** ribbon (or right click and select **Schematic**) as shown below.

Bridge Workspace - MultiCell Box Ex	amples	ANALYSIS	REPORTS	?	-	
BRIDGE WORKSPACE TOO	DLS VIEW	DESIGN/RATE	REPORTING			
 ← Check Out ← Check In ← Check In ← Validate ← Save ← Revert 	Close Export R	lefresh Open	New Copy	Paste Duplicate	Delete	Schematic
Bridge			Ma	anage		
Workspace	\$ X	Schematic	\$	× Report		\$ ×
	ce					
Section 1		Analysis				$\Rightarrow \times$
 Tendon Profile Definitions Tendon Tendon Cross Section Range Properties 						
	Open Analyze View Sumr View Detai Schematic General Pr Class Prid	nary Report Ied Report eferences				

MCB Cross Section Ranges				- 🗆 ×
🖻 🖹 🔍 Q, 🕂 🗃 🗟 🖂 🔼 🗸				÷
MallCHERE Davides Mill Cellins Lawyles. PT MCH 12/12/023				
Ensulation Section. 07117	jan wegan w	 -	per-any-server	
Zent Lengte.	H14°		TT P	

Structure Typical Section

Double click on the **Structure Typical Section** node in the **BWS** tree and locate the superstructure definition reference line as follows.

A Structure Typical Section - Segment 1							_	×
Distance from left edge of deck to superstructure definition ref. line Superst Referen	ucture Definition		in Cideur		China lana	Weinenfer		
Deck Deck (cont d) Parapet Me	dian Kailing	Gener	ic Sidewa	IK Lane position	n Striped lanes	vvearing surrace		
Superstructure definition reference line is	To the Right of	~	the left edge	of deck.				
	Start		End					
Distance from left edge of deck to superstructure definition reference line:	15	ft	15	ft				
		Μ.						

Navigate to the **Deck (cont'd)** tab and enter the following data for the structural overlay. The overlay is applied in the self load DC load case.

A Structure Typical Section - Segment 1					_		×
Distance from left edge of deck to superstructure definition ref. line Reference Line Deck Deck (cont'd) Parapet Median Ra	ition	neric Sidewalk Lane position	Striped lanes	Wearing surface			
Sacrificial wear thickness:	in	Structural overlay density:	0.14	kcf			
Top slab crack control parameter	kip/in	Structural overlay thickness:	1	in			
Sustained modular ratio factor:		Bottom slab crack control parameter:		kip/in			
Top slab exposure factor:		Bottom slab exposure factor:					
Inside void slab crack control parameter:	kip/in	Inside void slab exposure factor:					
				-	_		
and the second sec		and a second		and the second second	_	-	

Navigate to the **Generic** tab and enter the barriers.

	∢ Generic S	ihape								
	Front									
ck	Deck (cont'd) Parapet	Median	Railing G	eneric Sidewa	lk Lane pos	sition Strip	ed lanes	Wearing surfa	ace	
ck	Deck (cont'd) Parapet	Median	Railing G	eneric Sidewa	k Lane pos	sition Strip	ed lanes	Wearing surfa	ace	
ck	Deck (cont'd) Parapet Name	Median Load case	Railing G	Edge of deck dist. measured from	k Lane po: Distance at start (ft)	Distance at end (ft)	Front fac	Wearing surfa	ace	
ck	Deck (cont'd) Parapet Name 12" Barrier ~	Median Load case DC1 ~	Railing G Measure to Back \checkmark	Edge of deck dist. measured from Left Edge ~	k Lane pos Distance at start (ft) 0	sition Strip Distance at end (ft) 0	Front fac orientatic	Wearing surfa	ace	

In the Lane position tab, use the Compute button to enter the lane positions.



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

Schematic – Structure Typical Section

With the **Structure Typical Section** node selected in the **BWS** tree, click on the **Schematic** button from the **WORKSPACE** ribbon (or right click and select **Schematic**) to view the structure typical section.

Bridge Workspace - MultiCell	Box Examples	ANALYSIS	REPORTS	?	_	
BRIDGE WORKSPACE	TOOLS VIEW	DESIGN/RATE	REPORTING			
Check Out 💣 💾 🚳 Re A Check In Validate Save 🚳 Re	extore 🔀 🎸	Refresh Open	New Copy	Paste Duplicate) Delete	Schematic
Bridge			Ma	nage		
Workspace	\$ ×	Schematic		\$2	×	R ☆ ×
Bridge Components ☐ Candon Profile Definition ☐ ✓ Tendon ☐ ^[11] ✓ Tendon ☐ ^[12] Cross Section Range Pro ☐ ^[12] XTructure Typical Section — ﷺ Framing Plan Detail	ns perties					
H Superstructure Loads Shrinkage Time Supports Slab Reinforcement Hive Load Distribution Points of Interest Vertical Shear Reinforce Werks	Analyze View Summary R View Detailed Re Schematic General Preferen Close Bridge Wo	leport eport ices rkspace				× ¢
	4					

The webs are not visible in the schematic because the cross section at the start of the structure was marked as solid.

Bridge Typical Section	$-\Box \times$
En la C, O, O I I I I I I I I I I I I I I I I I	÷
MultiCell Box Examples Multi Cell Box Examples - PT MCB 12/12/2023	
28'-0"	
Travelway 1	

Framing Plan Detail

Double click on the **Framing Plan Detail** node in the **BWS** tree and enter the following diaphragm locations on the **Interior diaphragms** tab. The diaphragms only contribute to the dead load on the structure. They do not provide a structural role in the box analysis. Enter the diaphragm thickness and the AASHTO engine will compute the diaphragm load based on the box cross section properties and diaphragm thickness.

ber of									_	
	f spans:	2								
yout	Inter	ior diaphrag	gms							
Star	igger pe	rpendicula	r diaphragms							
S nu	Span umber	Start distance (ft)	Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft)	Diaphragm thickness (in)	Diaphragm Ioad (kip)		
> 1	\sim	0	55.75	1	55.75	55.75	12			-
2	~	0	55.75	1	55.75	55.75	12			

Schematic – Framing Plan Details

With **Framing Plan Details** node selected in the **BWS** tree, click on the **Schematic** button from the **WORKSPACE** ribbon (or right click and select **Schematic**) to view the framing plan.

Fran	nin	g Plar	ı																	- 0	×
		k €	€	\ #	₽ 9	Z	H	50	0%	~											Ŧ
Mulici Muli C Tarta d	l Rins II 6 Rins I 123	alongdos Lason plosi - 197 Mi																			
	ł												+			nr.e			-		
120		7***	•									10.01		1 ⁰⁰⁰⁰		11		12.0		Y	
2.0												10						14			

Supports

Open the **Supports** window to view the following. **Support 2** is marked as **Integral** since this was specified on the **Superstructure Definition** window. There is no data to change here.

Z Gene	→× <u>~</u>						
Z	→× <u>~</u>						
Gene	→× <u>~</u>						
Gene	-				2		
	eral Elasti	c					
	. .		Translation	constraints	Rotation constraints		
	number	type	X	Y	Z		
	1	Pinned V		 Image: A start of the start of			4
>	2	Integral \vee					
	3	Roller 🗸					
							v

Click **Cancel** to close the window.

Slab Reinforcement

Open the **Slab Reinforcement** window and enter the following reinforcement in the **Cells-top slab** and **Cells-bottom slab** of the box.

lab Reinforcement															-	. 🗆	
e: Multi Cell Box																	
ransverse reference lines	Cells-top slab	ells-bottom slab	Overhangs														
Cell	Material	Reference Doint	Direction	Start distance (ft)	Length (ft) di	End stance (ft)	Numb ber bars fo ars left web	er or Bar size	Clear cover (in)	Measured from	d Bar spacing (in)	Side cover (in) d	Start fully eveloped	End fully developed			
> All Cells ~	Grade 60 🗸 🗸	Support 1 \vee 🛛 L	eft 🗸	0	223	223	4	2 8 ~	2	Top of Slab	~		\checkmark				1
lab Reinforcement	t at a	م معر ال		** a	e pre				-		S. S. S.			Jan Barris			H
ilab Reinforcement	d a d a d	ي من ال		***	a gaa	14					And Star			<u></u>		-	H
Slab Reinforcement De: Multi Cell Box Transverse reference lines	Cells-top slab	Cells-bottom slab	Overh	angs	A 1944									<u></u>	_		
Slab Reinforcement Dee: Multi Cell Box Transverse reference lines Cell	Cells-top slab (Material	Cells-bottom slab Reference point) Overh Directio	angs Star distar (ft)	t Lengi (ft)	h End distance (ft)	Number of bars	Number bars for left web	Bar size	Clear cover (in)	Measured	Ba spac (irr	r Sic ing cov) (ir	de Start rer fully develope	End fully d developed		

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

Leave the Live Load Distribution factors blank so they will be computed by the AASHTO engine at runtime.

Vertical Shear Reinforcement Definitions

Open the Vertical Shear Reinforcement Definitions window and create the following stirrup definition.

ame: #5 Stirrup						
		Material:	Grade 60			~
		Bar size:	5 ~			
		Number of legs:	2			
	Vertical Shear Reinforcemen	Inclination (alpha): t	90	Degrees		
				DK Af	pply	Cance

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

WEB1 - Shear Reinforcement Ranges

Expand the **WEBS** folder -> **WEB1** and double click on the **Shear Reinforcement Ranges** node. Select the input reference type as **Centerline bearings**. Click the **Stirrup wizard** button and enter the following data.

A Stin		p Wizard	Maximu	m interior S	Spacing	Right Start							×
Dista	nc ut	reference type	terline bearings Maximu	;	inacion 18 in	Distance							
Mez	121	ured from left end	of span				Mea	sured from righ	ht end o	ofspan			
Sta	art	t distance: 15	in				Sta	rt distance: 3	9	in			
		Name	Number of spaces	Spacing (in)				Name	N	umber of spaces	Spacing (in)		
>		#5 Stirrup 👘 🗠	12	6		A	>	#5 Stirrup	~	18	5		A
		#5 Stirrup 🛛 🗠	12	9				#5 Stirrup	~	18	7		
		#5 Stirrup 🛛 🗠	12	14				#5 Stirrup	~	24	9		
					New Duplicate	Delete						New Duplicate	Delete

Select **Span 2** in the Wizard and enter similar data for Span 2.

🕰 Stirrup Wizard												>
Left Start Distance	Maximu	m interior S	Spacing >	Right Start Distance								
Voids O Cent	terline bearings	;										
Span: 2 V	Maximu	m interior s	spacing: 18 in									
Measured from left end Start distance: 39	of span in				Measured Start dis	d from rig tance:	ht en	d of span in				
Name	Number of spaces	Spacing (in)				Name		Number of spaces	Spacing (in)			
#5 Stirrup \sim	18	5		A	#5	Stirrup	~	12	6			A
#5 Stirrup 🗸 🗸	18	7			#5	Stirrup	\sim	12	9			
#5 Stirrup 🗸 🗸	24	9			#5	Stirrup	\sim	12	14			
			New Duplicate	Delete						New	Duplicate	Delete
								Ap	ply all	Apply span	Cancel	Help

Click the **Apply all** button to create the stirrup ranges for each span.

Span 1 will show the following data.

🚇 Web Shear Reinf	orceme	ent Ranges -	WEB1					_		Х
Start Spacin Distance	3→						-			
Input reference Voids Span ranges	type O C	enterline bei	arings		Linke	d with: No	ne v			
Span: 1	e	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)				
#5 Stirrup	, ~	1.25	1	0	0	1.25			-	
#5 Stirrup	\sim	1.25	12	6	6	7.25				
#5 Stirrup	\sim	7.25	12	9	9	16.25				
#5 Stirrup	\sim	16.25	12	14	14	30.25				
#5 Stirrup	\sim	30.25	13	18	19.5	49.75				
#5 Stirrup	\sim	49.75	1	18	1.5	51.25	_			
#5 Stirrup	\sim	51.25	14	18	21	72.25				
#5 Stirrup	\sim	72.25	24	9	18	90.25				
#5 Stirrup	\sim	90.25	18	7	10.5	100.75				
#5 Stirrup	\sim	100.75	18	5	7.5	108.25				
Сору	Stin	rup wizard					New Duplicate)elete)
							OK App	у	Cance	I

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

WEB2 - Shear Reinforcement Ranges

Expand the **WEB2** folder and double click on the **Shear Reinforcement Ranges** node. Select **WEB1** in the **Linked** with field. The data from **WEB1** will appear in this window as read only. If data is changed in the **WEB1 Shear Reinforcement Ranges** window in the future, those changes will be reflected in this window. Do the same for **WEB3**, linking it to **WEB1**.

Star	t Spacing →						>			
nput	t reference type — Voids OC	enterline be	arings		Linke	d with: WEB	1	~		
pan Spa	in: 1 v									
	Name	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)				
>	#5 Stirrup 🛛 🗸	0.25	1	0	0	0.25				ī
	#5 Stirrup 🗸	0.25	12	6	6	6.25				
	#5 Stirrup 🗸	6.25	12	9	9	15.25				
	#5 Stirrup 🛛 🗸	15.25	12	14	14	29.25				
	#5 Stirrup 🗸	29.25	13	18	19.5	48.75				
	#5 Stirrup 🛛 🗸	48.75	1	18	1.5	50.25				
	#5 Stirrup 🛛 🗸	50.25	14	18	21	71.25				
	#5 Stirrup 🛛 🗠	71.25	24	9	18	89.25				
	#5 Stirrup 🛛 🗠	89.25	18	7	10.5	99.75				
	#5 Stirrup 🛛 🗸	99.75	18	5	7.5	107.25				
	Copy Stirr	up wizard					New	Duplicate	Delete	

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

Integral with substructure

Now that the **Superstructure Definition** has been defined, a pier that is integral with the superstructure will be created.

Bridge Alternative

Double click on the **Alternative 1** bridge alternative in the **BWS** tree and navigate to the **Substructures** tab of this window.



name: Alt	ternative 1				
ion Sub:	structures				
bstructure init name	Station (ft)	Offset (ft)	Unit type		
out 1	0	0	Abutment 🗸	^	
er 1	111.5	0	Pier ~		
ut 2	223	0	Abutment 🗸		
	bstructure nit name ut 1 er 1 nut 2	bstructure Station nit name (ft) ut 1 0 er 1 111.5 ut 2 223	ion Substructures bstructure Station Offset (ft) (ft) ut 1 0 0 er 1 111.5 0 ut 2 223 0	bstructure Station (ft) Offset Unit type ut 1 0 0 Abutment ~ er 1 111.5 0 Pier ~ ut 2 223 0 Abutment ~	Substructures bstructure init name Station (ft) Offset (ft) Unit type ut 1 0 0 Abutment ~ er 1 111.5 0 Pier ~ ut 2 223 0 Abutment ~

Enter the following substructure locations and click OK.

Superstructure

Expand the **SUPERSTRUCTURE** folder and double click on the **Superstructure 1** node to open the **Superstructure** window. Navigate to the **Substructures** tab on this window and select the following supports. This is necessary because a Bridge can contain multiple Superstructures and Substructures. This tab identifies which substructure units support which superstructures.



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

Superstructure Alternative

Double click on the **Superstructure 1** superstructure alternative node in the **BWS** tree and select the **Superstructure definition** that was just created and click **OK**.

A	Superstr	ucture Alternativ	'e											_		×
Alte	ernative	name:	Super	struct	ture	e 1										
Des	scription	:														
Sup	erstruct	ure definition:	PT MC	В							×	J				
Sup	perstruct	ure type:	Multi	Cell B	lox											
Nur	mber of	cells:	2													
	Span	Length (ft)														
	1		111.5	-												
	2		111.5													
				Ŧ					С	0K			Арр	bly	Canc	el

Pier

Double click on the **Pier 1** window and review the data. No changes are required in this window.

Pier					_		
er name: Pier 1							
Description Stream flow							
Pier skew angle Input skew angle Input bearing angle	Skew angle: 0	Degrees	Description:				
Finished groundline elevation:	f	t	Superstructure de	efined in BrDR		_	
Soil density:	k	ccf					
Consider as expansion Pier location relative to brid Station: 111.5 ft	lge alternative Offset:	0 ft					
Station: 1115 ft	ative to structure	Computed pier coo	ft				
Offset: 0 f	ft	Y: 0	ft				
Existing Current Pier	alternative name	Description					
							0
				0	K Apply	Cano	el

Click **Cancel** to close the window.

Pier Alternatives

Open the Pier Alternatives window and select the Solid Shaft Pier then click Next.





A New Pier Alternative		<
Туре:	RC SolidShaft Pier	
Name:	Solid Shaft Pier	
Description:		
Units:	US Customary 🗸	
	< Back Finish Cancel	

Enter the **Name** as shown above, no data needs to be changed on the **New Pier Alternative** window so click **Finish** to close it. The window shown below will appear.

me: Solid S	haft Pier	Type: RC SolidShaft Pier
Description	Stiffness Reports	
Description:		Units: US Customary LRFD substructure design settings Preliminary mode Default design settings: Preliminary Design Setting (US) Override default Design settings:
		Final mode Default design settings: Final Design Setting (US) Override default Design settings:
		Advanced DLA

No data needs to be changed so click $\mathbf{O}\mathbf{K}$ on the above window to continue.

Pier Geometry

This training focuses on modeling the pier geometry so its stiffness can be included in the superstructure analysis. Therefore, no reinforcement details will be entered for the pier. Expand the **Solid Shaft Pier** folder, double click on the **Geometry** node and enter the geometry for the pier as shown below.



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

Cap Properties

Double click on **Cap** node in the **BWS** tree to open the **Cap Properties** window. Verify that the following cap concrete material is selected.



Cap Geometry

Expand the Cap node and double click on Geometry. Enter the following for the pier cap Geometry.





Column Components

Expand the Column1 node and double click on Components. Select the following concrete material.



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

Column Geometry

Double click on the Geometry node and enter the following data.



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

The pier is now sufficiently defined to be considered in the superstructure analysis. The column will be considered fixed at the base of the column. This percent fixity can be adjusted on the Pier Model Settings window if desired. The FE model created during the superstructure analysis will include an element modeling the column length and stiffness.

LRFR analysis and results

To run an LRFR analysis on the **PT MCB** superstructure definition, click on the **Analysis Settings** window from the **Analysis** group of the **DESIGN/RATE** ribbon.

Bridge Worksp	oace - MultiCell Box Examples	ANALYSIS	REPORTS	?	_	\times
BRIDGE WORKSPACE	WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			
a 🛤		🗧 🖪				
Analysis Analyze Analysis Settings Events	Tabular Specification Engine Re Results Check Detail Outputs G	sults Save raph Results				
Analysis	Results					

Click on the **Open template** button in the **Analysis Settings** window, select the **LRFR Design Load Rating** from the analysis templates and click **Open**. The full multi-cell box width is analyzed for flexure and shear and then each webline is analyzed for shear.

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 HS 20 LFR Rating			Public				
>	LRFR Design Load Rating	LRFR Design Load Rating	LRFR		Public				
	LRFR Legal Load Rating	LRFR Legal Load Rating	LRFR		Public	'			
						Ŧ			
	Delete				Open	Cancel			

Design review O	Rating Line Girder As Requested	Rating meti Analysis op Apply prefe	nod: tion: rence setting:	LRFR DL, LL and Spec-Checkin None					
Vehicles Output Eng Traffic direction: Both dire Vehicle selection	gine Description	Ve	Refresh hicle summary	Temporary vehicles	Advanced]			
 Wehicles →=Standard →=EV2 →=EV3 →H 15-44 →H 20-44 →HL-93 (US) →HL-93 (US) →HS 15-44 →HS 20 (SI) →HS 20 (SI) →HS 20 (SI) →HS 20 - 44 →Lane-Type Leg →LRFD Fatigue T →NRL →SU4 →SU5 	al Load īruck (SI) īruck (US)	Add to >> Remove from <<	■ Rating vehicles ↓ LRFR ↓ - Design load rating ↓ - Inventory ↓HL-93 (US) ■ - Fatigue ↓						

Click OK to apply the settings and close the window.

With **PT MCB** superstructure selected in the **BWS** tree, click on the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon.

Bridge Worksp	ace - MultiCell Box	ANALYSIS	REPORTS	?	_	×	
BRIDGE WORKSPACE	WORKSPACE 1	TOOLS VIEW	DESIGN/RATE	REPORTING			
a 📾 📰							
Analysis Analyze Analysis Settings Events	Tabular Specifica Results Check D	ation Engine Res letail Outputs Gra	ults Save ph Results				
Analysis		Results					

Tabular Results

Once the analysis is complete, click on the **Tabular Results** button from the **Results** group of the **DESIGN/RATE** ribbon. The **Analysis Results** window shows the critical rating factors considering the full box and each webline.

Bridge Workspace - MultiCell Box Examples						AN	ALYSIS		REPORTS	?	_		\times	
BRIDGE WORKSPACE WORKSPACE TOOLS VIEW								in/rat	E F	REPORTING				
Analysis Analysis Analysis Tabular Specification Engine Results Save Analysis Analysis Results Check Detail Outputs Graph Results Analysis Results Results Results Results														
Analysis Results - PT MCB – 🗆 X														
Report type: Lane/Impact loading type Display Format Rating Results Summary As requested Detailed Single rating level per row 														
	Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Element Name	Limit State	• ^	Impact	Lane	
\rightarrow	HL-93 (US)	Truck + Lane	LRFR	Inventory	0.00	0.000	11.15	1 - (10.0)	WEB1	STRENGTH-I Concre	te Shear Eval	As Requested	As Requested	-
	HL-93 (US)	Truck + Lane	LRFR	Operating	0.00	0.000	11.15	1 - (10.0)	WEB1	STRENGTH-I Concre	te Shear Eval	As Requested	As Requested	
	HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	61.93	1.720	101.62	1 - (91.1)	WEB2	STRENGTH-I Concre	te Shear Eval	As Requested	As Requested	
	HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	78.46	2.179	101.62	1 - (91.1)	WEB2	STRENGTH-I Concre	ete Shear Eval	As Requested	As Requested	
	HL-93 (US)	Tandem + Lane	LRFR	Inventory	0.00	0.000	11.15	1 - (10.0)	WEB1	STRENGTH-I Concre	ete Shear Eval	As Requested	As Requested	
	HL-93 (US)	Tandem + Lane	LRFR	Operating	0.00	0.000	11.15	1 - (10.0)	WEB1	STRENGTH-I Concre	ete Shear Eval	As Requested	As Requested	
AAS Ana	AASHTO LRFR Engine Version 7.5.0.3001 Analysis preference setting: None Close											lose		

Specification Check Detail

Select the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon for the full box and each webline Spec check details.





