

# MIDAS Civil 2016 v2.1

## Release Webinar

PSC Composite Design Check / Load rating



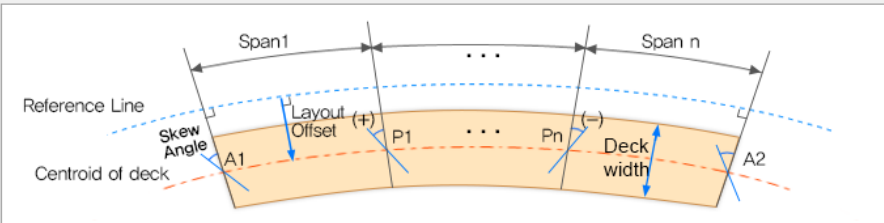
# What is Composite Girder Module?

- Wizard-modeling
  - Steel Composite Bridge
  - PSC Composite Bridge
  
- Report Generation for Design & Load Rating Check
  - AASHTO
    - Steel Composite
    - PSC Composite
    - RC Pier
    - Cross-frames
  - Canada Code (Will be updated in August 2016)
    - Steel Composite
    - PSC Composite

# PSC Composite Wizard

Pre/Post-Tensioned Composite Girder Bridge Wizard

Layout | Section | Tendon | Load | Construction Stage |



Span1 ... Span n

Reference Line

Skew Angle

Centroid of deck

Layout Offset (+)

P1 ... Pn (-)

Deck width

A1 A2

Girder Type: Precast Girder Type

Modeling Type: All Frame

Span Information: 2@110 ft

Deck Width: 51 ft

Layout Offset: 0 ft

Spacing(a): 0.5 ft

Support Skew Angle: 0 deg

Spacing(b): 0.75 ft

☐ Radius 0 ft

Type: ☒ Concave ☐ Convex

☐ Multi-Curve

Girder Alignment: Same Spacing

Reference Support: Abutment 1

Boundary/Substructure: ☒ With Substructure

Bearing Type/Elastic Link Stiffness

Abutment: Elastic Link Kx 50000 kips/ft Ky 100 kips/ft Kz 100 kips/ft

Pier: Elastic Link Kx 100000 kips/ft Ky 200 kips/ft Kz 200 kips/ft

Elastic Link Length: 1 ft

Pier Material: 1: Concrete

☒ Pier Cap

Section: 4: Pier Cap

Length: 51 ft

Column Section: 5: Pier

Height: 22 ft

Spacing: 0 ft

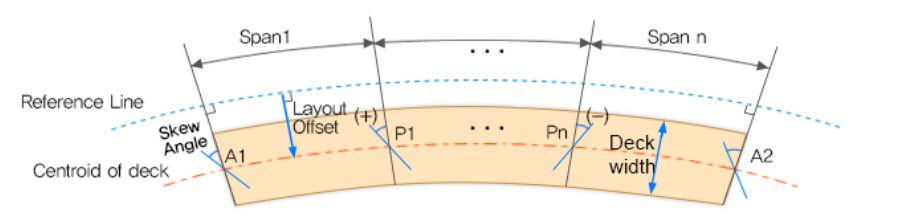
Pier Support: Fixed Horizontal 0 kips/ft Vertical 0 kips/ft

Open... Save As... OK Cancel

# Wizard : Layout

Pre/Post-Tensioned Composite Girder Bridge Wizard

**Layout** | Section | Tendon | Load | Construction Stage



Girder Type: **Precast Girder Type**

Span Information: **2@110** ft

Layout Offset: **0** ft

Support Skew Angle: **0** deg

☐ Radius **0** ft

Type: ☒ Concave ☐ Convex ☐ Multi-Curve

Girder Alignment: **Same Spacing** **Guide...**

Reference Support: **Abutment 1**

**Boundary/Substructure**

☐ Without Substructure ☒ With Substructure **Guide...**

Bearing Type/Elastic Link Stiffness

Location	Link Type	Kx (kips/ft)	Ky (kips/ft)	Kz (kips/ft)
Abutment	Elastic Link	50000	100	100
Pier	Elastic Link	100000	200	200

☐ Advanced... Elastic Link Length: **1** ft

Pier

Material: **1** **1: Concrete**

☒ Pier Cap

Section: **3** **3: Diaphragm**

Length: **51** ft

Column

Section: **4** **4: Pier Cap**

Height: **22** ft ☐ Advanced...

Spacing: **0** ft

Pier Support: **Fixed** Horizontal: **0** kips/ft Vertical: **0** kips/ft ☐ Advanced...

Open... Save As... OK Cancel

- **Girder Type**
  - Precast / Splice
- **Modeling Type**
  - All Frame
  - Girder as frame, Deck as plate
- **Bridge dimension input**
  - Span length, curvature gap spacing
  - Girder alignment options
    - Same spacing
    - Offset spacing
- **Bridge dimension input**
  - Sub-structure definition

# Wizard : Section

Pre/Post-Tensioned Composite Girder Bridge Wizard

Layout **Section** Tendon Load Construction Stage

Deck Thickness: 0.8 ft  
Haunch Height: 0.25 ft

**Material**

Deck	1	1: Concrete
Girder	1	1: Concrete
Diaphragm	1	1: Concrete

Diaphragm Information

Define Diaphragm Section...

Intermediate Spacing: Divisions per Span

Diaphragm	Name	Divisions per Span
End Support	1:AASHTO TYPE4	
Pier Support	1:AASHTO TYPE4	
Intermediate	1:AASHTO TYPE4	2

Transverse Deck Element

Spacing: Distances 5 ft

Angle type: Perpendicular

**Girder Information**

Span 1 | Span 2

No. of Divisions: 1

No.	Name	Start (ft)	End (ft)
1		0	109.75

Define Girder Section...

☒ Generate 10th points elements

Open... Save As... OK Cancel

- Girder information
  - Number of girder
  - Section assignment per girders
- Design material selection
  - Deck / Girder / Diaphragm
- Diaphragm distribution options
  - Distance
  - Division per Span

# Wizard : Tendon

Pre/Post-Tensioned Composite Girder Bridge Wizard

Layout | Section | **Tendon** | Load | Construction Stage

Tendon Assignment Table

Tendon Assignment Name: Span1

Segments: Span1

3.000 ft

10 @ 0.251 ft

Guide...

SECTION "A-A" <ELEVATION VIEW>

Single Span girder

Center Ref. Line

Trans. Distance: 2g01, 2g, 2g03

2 Span girder

Right Ref. Line

3 Span girder

Left Ref. Line

4 Span girder

No.	Type	Tendon Property	Number of	Transvers Distance(S) (ft)	D (ft)	H1 (ft)	H2 (ft)	L1 (ft)
1	Straight	Tendon	10	9@0.15	0	3.25	0.25	0
2								

Jacking Stress : 29160 kips/ft^2

Grouting : After 1 Stages

Detailed...

Tendon Assignment List

No.	Name	Total Tendon
1	Span1	10

Open... Save As...

Detailed Tendon

3.000 ft

10 @ 0.251 ft

Tendon Naming

Name	No.	Jacking (kips/ft^2)	Begin Debonding (ft)	End Debonding (ft)
T1	1	29160	0	0
T1	2	29160	0	0
T1	3	29160	0	0
T1	4	29160	0	0
T1	5	29160	0	0
T1	6	29160	0	0
T1	7	29160	0	0
T1	8	29160	0	0
T1	9	29160	0	0
T1	10	29160	0	0

T1 T2 T3

1 2 3 4 5 6 7 8 9 10

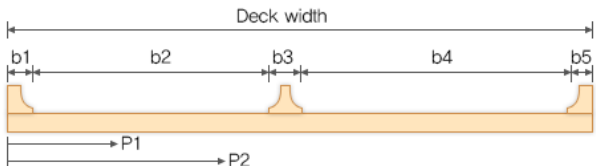
- Tendon type
  - Straight
  - Harped 1 & 2
  - Curved
- Tendon definition table
  - Number of tendons
  - Distribution distance
  - Vertical displacement
- Tendon Assignment List
  - Different tendon assignment per spans
  - As many assignment as user wants
- Detailed tendon table

# Wizard : Load

Pre/Post-Tensioned Composite Girder Bridge Wizard

Layout | Section | Tendon | Load | Construction Stage

Pavement and Barrier



b1 1.5 ft b2 8.75 ft b3 2 ft b4 8.75 ft b5 1.5 ft

Dead Loads

	DC	DW
Before Composite	<input checked="" type="checkbox"/> Self Weight	
	<input checked="" type="checkbox"/> Wet Con'c	
	Weight Density 0.15 kips/ft <sup>3</sup>	
	Thickness 0.8 ft	
	<input type="checkbox"/> Form Work 0 kips/ft <sup>2</sup>	
After Composite	<input checked="" type="checkbox"/> Barrier 0.14 kips/ft	<input checked="" type="checkbox"/> Wearing Surface
	<input checked="" type="checkbox"/> Median Strip 0.18 kips/ft	Weight Density 0.14 kips/ft <sup>3</sup>
	<input type="checkbox"/> Additional Load 0 kips/ft	Thickness 0.26 ft
	Positions (P1) 0 ft	<input type="checkbox"/> Utilities 0 kips/ft
	Positions (P2) 0 ft	

☐ Live Loads

Define Moving Load Case... Define Traffic Lanes... Define Vehicles...

Open... Save As... OK Cancel

- Pavement and Barrier
- Composite load cases
  - Pre-composite load cases (DC 1-1)
  - Post-composite load case (DC 1-2)
  - Wearing surface & additional (DC 2)
- Moving load analysis
  - Moving load code selection
  - Lane definition
  - Vehicle selection

# Wizard : Construction Stage

Pre/Post-Tensioned Composite Girder Bridge Wizard

Layout | Section | Tendon | Load | Construction Stage

☒ Construction Stage [Guide...](#)

☒ Girder Splice  
[Girder Splice Construction...](#) [Temporary Support Position...](#)

☒ Post-tensioning Tendons  
[Define Post Tendons...](#)

Stage	Stage Description	Load Condition	Duration (Day)
1	Self Weight Activated, Prestress load in Precast	Self Weight is Activated	10
3-1	Deck is Activated as a Load	Wet Concrete Load is Activated	10
3-2	Deck is in Composite Stage, span continuous	Wet Concrete Load is deactivated	
4	After-Composite Load is Activated	DC2, DW Load is Activated	10
5	Long Term Effect is Considered	-	10000

☐ Reinforcement  
[Define Reinforcement...](#)

[Open...](#) [Save As...](#) [OK](#) [Cancel](#)

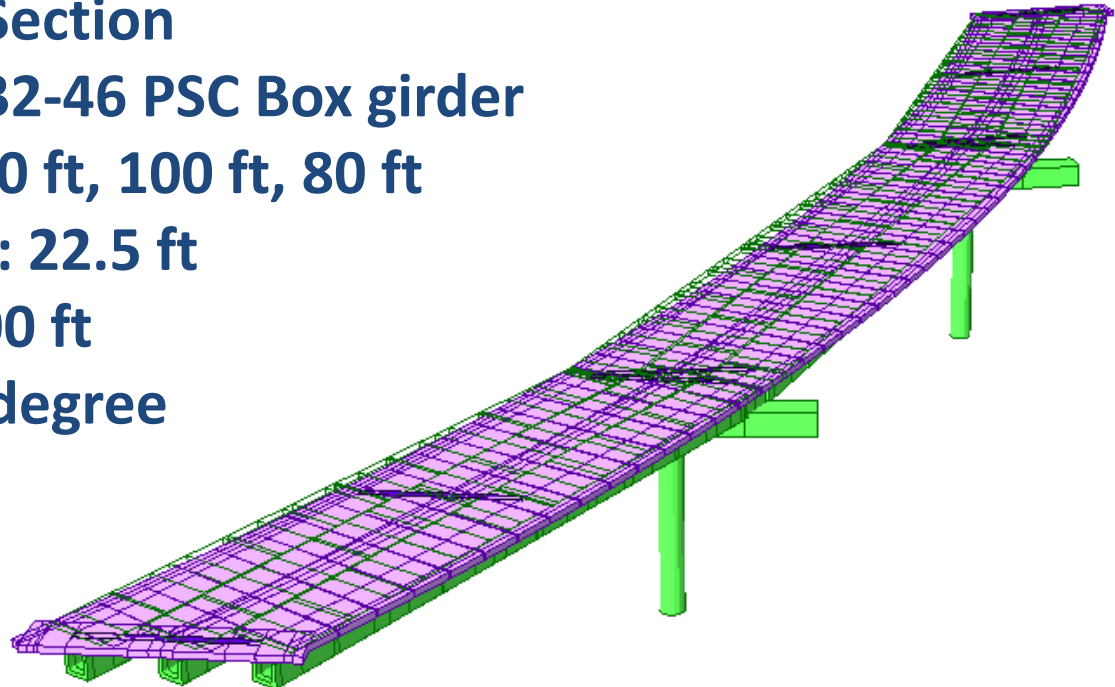
- Visual guide for construction sequence
- Concrete pouring sequence
  - Splice girder pouring sequence
  - Temporary support position
- Stage duration input
- Girder reinforcement definition



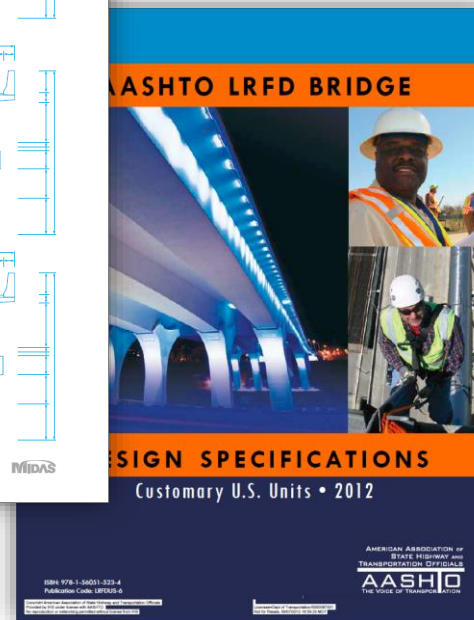
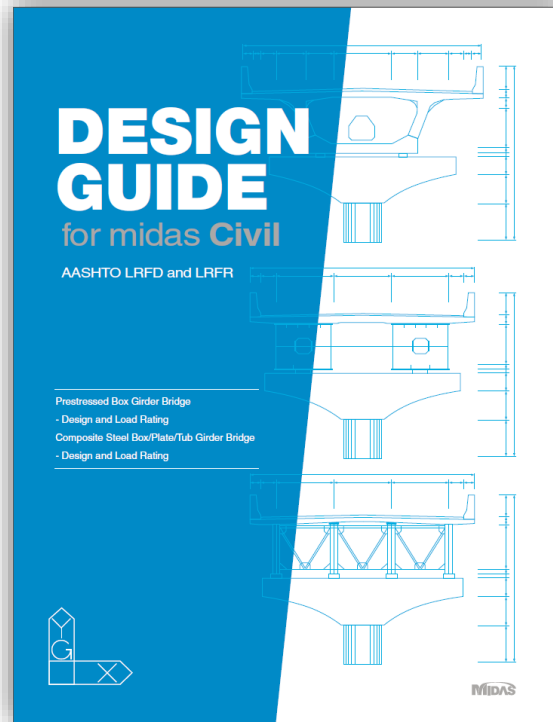
# PSC Composite Wizard

## Demonstration

- Bridge Summary
  - PSC composite Section
    - Ohio DOT B32-46 PSC Box girder
  - 3 span bridge: 80 ft, 100 ft, 80 ft
  - Total slab width: 22.5 ft
  - Curve radius: 500 ft
  - Skew angle: 30 degree



# PSC Composite Design Check & Load Rating



# PSC Composite Design Check

**Modify Composite Concrete Materials**

ID	Name	Conc.(Girder)	Main-bar(Gi...	Sub-bar(Gir...	Conc.(Slab)
1	Concrete	Grade C4500	Grade 60	Grade 60	Grade C4500

**Girder**

Concrete Material Selection  
 Code : **ASTM(RC)** Grade : **Grade C4500**  
 Specified Compressive Strength (fc|fck) : **648** kips/ft^2  
☐ Light Weight Concrete Factor (Lambda) : **1**

Rebar Selection  
 Code : **ASTM(RC)**  
 Grade of Main Rebar : **Grade 60** Fy : **8640** kips/ft^2  
 Grade of Sub-Rebar : **Grade 60** Fys : **8640** kips/ft^2

**Slab**

Concrete Material Selection  
 Code : **ASTM(RC)** Grade : **Grade C4500**  
 Specified Compressive Strength (fc|fck) : **648** kips/ft^2  
☐ Light Weight Concrete Factor (Lambda) : **1**

Rebar Selection  
 Code : **ASTM(RC)**  
 Grade of Main Rebar : **Grade 60** Fy : **8640** kips/ft^2  
 Grade of Sub-Rebar : **Grade 60** Fys : **8640** kips/ft^2

Modify Close

**Interface Shear**

Option  
☒ Add/Replace ☐ Delete

☒ Both end parts(i & j) have the same interface shear

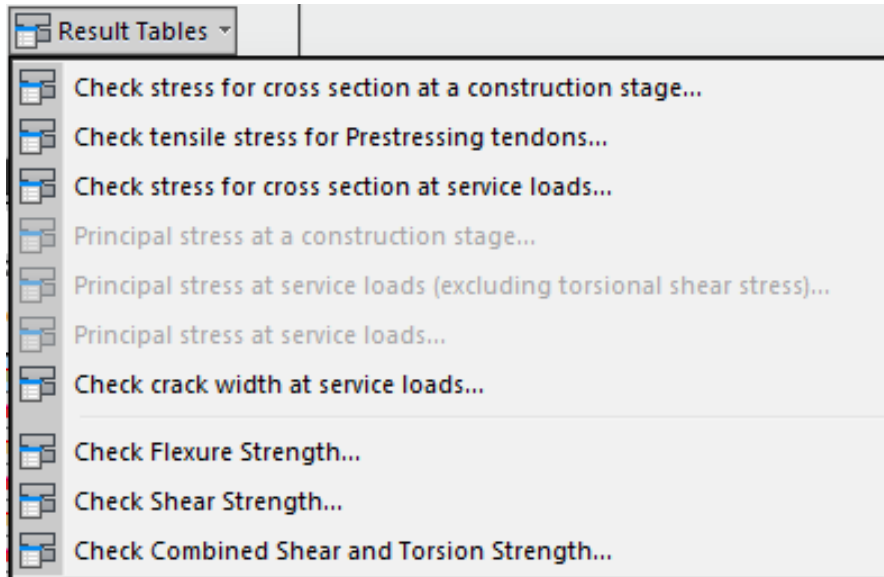
Surface Classification (5.8.4.3)  
☒ Roughened(CIP slab)  
☐ Monolithically  
☐ Intentionally roughened(LWC)  
☐ Intentionally roughened(NWC)  
☐ Not intentionally roughened  
☐ Anchored

Interface Shear  
 Bvi **0** ft  
 Avf **0** ft^2  
 Fy **0** kips/ft^2

Apply Close

- **Material selection**
  - Separate material definition girder and slab
  - Light concrete factor
- **Interface shear consideration**
  - Surface classification by 5.8.4.3
  - Interface width & reinforcement area
  - Shear connector definition

# Design Result Table



- **Strength**
  - Flexure
  - Shear
  - Combined shear and Torsion
- **Stress**
  - Sectional & Principal stress
    - Per construction stage
    - Under service load case
  - Tendon tensile stress
- **Crack width under service load**

Elem	Part	Positive/ Negative	LCom Name	Type	CHK	Muy (ft*kips)	Mcr (ft*kips)	Mny (ft*kips)	PhiMny (ft*kips)	Ratio (Muy/PhiMny)	PhiMny/ min(1.33Muy,Mcr)
84	I[11]	Negative	cLCB1	FX-MIN	OK	0.0000	-2307.5010	23.9942	17.9956	0.0000	2159474.8861
84	I[11]	Positive	cLCB1	FX-MAX	OK	26.5598	12754.2249	13540.6330	13540.6330	0.0020	383.3216
84	J[534]	Negative	cLCB1	FX-MIN	OK	-11.5115	-2310.6930	23.9942	17.9956	0.6397	1.1754
84	J[534]	Positive	cLCB1	FX-MAX	OK	20.9491	12774.9135	13540.6330	13540.6330	0.0015	485.9838
85	I[534]	Negative	cLCB1	FX-MIN	OK	0.0000	-2322.7463	23.9942	17.9956	0.0000	2159474.8861
85	I[534]	Positive	cLCB1	FX-MAX	OK	58.3551	12770.0263	13540.6330	13540.6330	0.0043	174.4650
85	J[25]	Negative	cLCB1	FX-MIN	OK	0.0000	-2741.8921	23.9942	17.9956	0.0000	2159474.8861
85	J[25]	Positive	cLCB1	FX-MAX	OK	561.1422	12770.9129	13540.6330	13540.6330	0.0414	18.1432
86	I[25]	Negative	cLCB1	FX-MIN	OK	0.0000	-2741.9097	23.9942	17.9956	0.0000	2159474.8861
86	I[25]	Positive	cLCB1	FX-MAX	OK	555.7808	12770.9179	13540.6330	13540.6330	0.0410	18.3182
86	J[535]	Negative	cLCB1	FX-MIN	OK	0.0000	-3521.2853	23.9942	17.9956	0.0000	2159474.8861
86	J[535]	Positive	cLCB1	FX-MAX	OK	1376.3223	12759.6580	13540.6330	13540.6330	0.1016	7.3972

# Design Result Report

■ Case of  $V_{max}$

Section type : Segmental-Box

The Strength Limit Load Combination : dCB1

The factored Torsional moment :  $T_u = 1304.30$  (kips-in.)

The factored Shear force :  $V_u = 58.41$  (kips)

Factored moment :  $M_u = 66987.84$  (kips-in.)

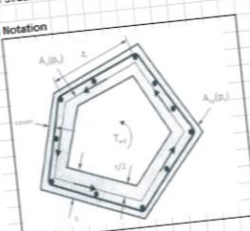
Factored axial force :  $N_u = 36.22$  (kips)

Resistance factor for shear :  $\phi = 0.90$

Component of prestressing force :  $V_p = 2A_{ps}f_{ps} = 0.00$

In direction of the shear force :

1) Notation



$A_c$  = Area enclosed including any internal voids = 2308.641

$p_t$  = Perimeter of closed transverse section = 331.301

$A_o$  = Total area of concrete = 2308.641

$p_s$  = The length of concrete = 263.1

2) Checking Torsional Effects

• Torsional cracking moment ( $T_{cr}$ )

$b_e = 11.000$  (ksi) : The effective thickness of shear flow path of elements

$T_{cr} = 0.0632K \sqrt{f_c} 2A_o b_e = 6809.30$  (kips-in.) (Eq. 5.8.6.3-2)

$T_u = 1304.30$  (kips-in.)  $\leq (1/3)T_{cr} = 2269.77$  (kips-in.) (Eq. 5.8.6.3-1)

$\therefore T_u \leq (1/3)T_{cr}$ , Ignore Torsional Effects.

• Check torsional moment

$T_u = 1304.30$  (kips-in.)  $> \phi T_n = \frac{\phi \cdot 2 \cdot A_o \cdot A_c \cdot f_y}{s_t} = 0.00$  (kips-in.) **NG** (Eq. 5.8.6.4-2)

• Required longitudinal reinforcement

In box section,

$A_l = 0.00$  (in.<sup>2</sup>)  $< (T_u/\phi) \cdot p_t / (2A_o \cdot f_y) = 1.73$  (in.<sup>2</sup>) **NG** (Eq. 5.8.3.6.3-2)

• Check combined torsional and shear

$V_u + \frac{T_u}{2A_o b_e} = 0.14$  (ksi.)  $< 0.474 \sqrt{f_c} = 1.01$  (ksi.) **OK** (Eq. 5.8.6.5-5)

2) Checking Torsional Effects

• Torsional cracking moment ( $T_{cr}$ )

$b_e = 11.000$  (ksi) : The effective thickness of shear flow path of elements

$T_{cr} = 0.0632K \sqrt{f_c} 2A_o b_e = 6809.30$  (kips-in.) (Eq. 5.8.6.3-2)

$T_u = 1304.30$  (kips-in.)  $\leq (1/3)T_{cr} = 2269.77$  (kips-in.) (Eq. 5.8.6.3-1)

$\therefore T_u \leq (1/3)T_{cr}$ , Ignore Torsional Effects.

• Check torsional moment

$T_u = 1304.30$  (kips-in.)  $> \phi T_n = \frac{\phi \cdot 2 \cdot A_o \cdot A_c \cdot f_y}{s_t} = 0.00$  (kips-in.) **NG** (Eq. 5.8.6.4-2)

• Required longitudinal reinforcement

In box section,

$A_l = 0.00$  (in.<sup>2</sup>)  $< (T_u/\phi) \cdot p_t / (2A_o \cdot f_y) = 1.73$  (in.<sup>2</sup>) **NG** (Eq. 5.8.3.6.3-2)

• Check combined torsional and shear

$V_u + \frac{T_u}{2A_o b_e} = 0.14$  (ksi.)  $< 0.474 \sqrt{f_c} = 1.01$  (ksi.) **OK** (Eq. 5.8.6.5-5)

# PSC Composite Load Rating

**Bridge Load Rating Parameter**

System factor : 1

**Strength Limit State**

☒ Flexure

Nominal flexural resistance

☒ Code ☐ Strain compatibility

☒ Shear

☒ Non-Segmental Bridge ☐ Segmental Bridge

**Service Limit State**

**Design Load**

☒ Stress

Compressive stress : 0 kips/ft<sup>2</sup>

Tensile stress : 0 kips/ft<sup>2</sup>

☐ Stress for Composite Section (Slab)

Compressive stress (Slab) : 0 kips/ft<sup>2</sup>

Tensile stress (Slab) : 0 kips/ft<sup>2</sup>

**Legal Load / Permit Load**

☒ Stress

Compressive stress : 0 kips/ft<sup>2</sup>

Tensile stress : 0 kips/ft<sup>2</sup>

☐ Stress for Composite Section (Slab)

Compressive stress (Slab) : 0 kips/ft<sup>2</sup>

Tensile stress (Slab) : 0 kips/ft<sup>2</sup>

☒ Prestressing steel

Tensile stress : 0 kips/ft<sup>2</sup>

**Application of Diagnostic Test Result**

Load Test Measurement ☒ Strain ☐ Displacement

OK Cancel

**Bridge Rating Group Setting**

Select Group

- ☒ Girder
- ☐ Continuous Section
- ☐ 10th Point Girder-1-i
- ☐ 10th Point Girder-1-j
- ☐ 10th Point Girder-2-i
- ☐ 10th Point Girder-2-j
- ☐ 10th Point Girder-3-i
- ☐ 10th Point Girder-3-j

Condition factor : 1

Check position :

☐ I - End ☐ J - End

Group Factor

**Define Rating Case**

Static Load Combination

☒ Service Limit State ☐ Strength Limit State

Load Type	max	min	Load Cases
DC	1.00	1.00	*
DW	1.00	1.00	
Temperature			
T. Gradient	1.00		
Secondary	1.00		
Permanent	1.00		
User Defined	1.00		

**Live Load Combination**

Live Load Factors for Rating

Primary Vehicle 1

Adjacent Vehicle 1

Evaluation Live Load Model

☒ Design Live Load ☐ Legal Load / Permit Load

Name of Rating Case

Description

Name	Limit State	Description

Add

Modify

Delete

Close

- Rating parameters
  - Limit state stress for Service / Fatigue / Pre-stress
- Material selection
- Rating group
  - Structure Group compatible
- Rating case definition
  - User friendly
  - Primary / Adjacent vehicle

# Rating Result Table

	Service Limit State Summary...
	Strength Limit State Summary...
	Concrete Stress Rating Factor...
	Prestressing Tension Rating Factor...
	Flexural Strength Rating Factor...
	Shear Strength Rating Factor...
	Concrete Stress Rating Detail...
	Prestressing Tension Rating Detail...
	Flexural Strength Rating Detail...
	Shear Strength Rating Detail...

- Summary table
  - Limit state stress for
  - Service limit state
  - Strength limit state
- Rating factor
  - Concrete stress
  - Pre-stressing Tension
  - Flexural & shear strength
  - Strength limit state
- Rating factor detailed table

	Group	Elem.	Part	Girder/Slab	Relative Location	Comp./Tens.	Rating Case	Rating Factor	Check
	SG1	3	I[3]	Girder(Composite)	-	Tens.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	1.4756	OK
	SG1	3	J[4]	Girder(Composite)	-	Comp.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	57.0232	OK
	SG1	3	J[4]	Girder(Composite)	-	Tens.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	0.8202	NG
	SG1	4	I[4]	Girder(Composite)	-	Comp.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	57.0232	OK
	SG1	4	I[4]	Girder(Composite)	-	Tens.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	0.8202	NG
	SG1	4	J[5]	Girder(Composite)	-	Comp.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	47.4226	OK
	SG1	4	J[5]	Girder(Composite)	-	Tens.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	0.5192	NG
	SG1	5	I[5]	Girder(Composite)	-	Comp.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	47.4226	OK
	SG1	5	I[5]	Girder(Composite)	-	Tens.	SER_DC(MAX)_DW(MAX)_T(+)_TG(+)_A.V(Fx-Max)	0.5192	NG

# Load Rating Report

AASHTO Load Rating Summary Result Table

Load Rating Summary Detail for Prestressed Concrete Girder Bridge (Strength Limit)																		
Level	Load Combaioin	Moving Load Case	Weight (tons)	Load Factors				Moment (Strength, kip· in)					Shear (kips)					
				LL	DC		DW		Scale Factor for Load Test	Rating Factor	Safe Load Capacity	Live Load Demand	Critical Element	Scale Factor for Load Test	Rating Factor	Safe Load Capacity	Live Load Demand	Critical Element
					max	min	max	min										
DL	STR	MVL 1	NA	1.00	1.25	0.90	1.25	0.90	1.618	-30.556	NA	603957.35	18-J	0.000	0.000	NA	-2015.01	17-I
Where,	Level Type	DL	: Design Load Rating															
LL		: Legal Load Rating																
PL		: Permit Load Rating																
Load Factor Discription	Load Factor	LL	: Load Factor of primary vehicle load case															
		DC	: Load Factor of dead load case															
		DW	: Load Factor of dead load case of wearing surfaces and utilities															

Load Rating Summary Detail for Prestressed Concrete Girder Bridge (Service Limit)																		
Level	Load Combaioin	Moving Load Case	Weight (tons)	Load Factors				Stress Girder (Service, kip/in <sup>2</sup> )					Stress Slab(Service, kip/in <sup>2</sup> ) [Composite Section]					
				LL	DC		DW		Scale Factor for Load Test	Rating Factor	Safe Load Capacity	Live Load Demand	Critical Element	Scale Factor for Load Test	Rating Factor	Safe Load Capacity	Live Load Demand	Critical Element
					max	min	max	min										
DL	SER	MVL 1	NA	1.00	1.00	1.00	1.00	1.00	0.000	0.000	NA	0.09	17-I	0.000	0.015	NA	-0.10	17-I
Where,	Level Type	DL	: Design Load Rating															
LL		: Legal Load Rating																
PL		: Permit Load Rating																
Load Factor Discription	Load Factor	LL	: Load Factor of primary vehicle load case															
		DC	: Load Factor of dead load case															
		DW	: Load Factor of dead load case of wearing surfaces and utilities															



**THANK YOU  
for Joining  
Today's Webinar**

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