



# NSBA Bolted Splice Designer - Plate Girder

Cell Fill Color

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## Design Input

### Unfactored Loads - Splice Centerline

	Moment (kip-ft)	Shear (kip)
Noncomposite Dead Load (DC <sub>1</sub> )	127.75	3.80
Superimposed Composite Dead Load (DC <sub>2</sub> )		
Future Wearing Surface (DW)		
Positive Live Load plus Impact (LL <sup>+</sup> + I)	307.08	19.22
Negative Live Load plus Impact (LL <sup>-</sup> + I)	-36.35	-9.38
Deck Casting		

### Girder Properties

	Left	Right
Top Flange Material	Grade 33	Grade 33
Top Flange Thickness (in)	1 1/8	1 1/8
Top Flange Width (in)	12	12

Web Material	Grade 33	Grade 33
Web Thickness (in)	11/16	11/16
Web Depth (in)	32 1/8	

Bottom Flange Material	Grade 33	Grade 33
Bottom Flange Thickness (in)	1 1/8	1 1/8
Bottom Flange Width (in)	12	12

### Haunch Properties

	Left	Right
Haunch (in)	4 1/2	4 1/2
Haunch Status	OK	

### Bolt Properties

Bolt Type	A325	
Bolt Diameter (in)	1	
Web Threads	Included	
Flange Threads	Included	
Surface Condition Factor (K <sub>s</sub> )	A	
Hole Size Factor (K <sub>h</sub> )	Standard	
Top Flange Rows	2	OK
Web Rows	2	OK
Bottom Flange Rows	2	OK

### Concrete Deck Properties

Composite	Non-Composite
Thickness (in)	

### Spacing and Clearance Values

Bolt Spacing (in)	3	OK
Edge Distance - Flange (in)	2 3/8	OK
End Distance - Flange (in)		Use Minimum Edge Distance
Edge Distance - Web (in)	1 1/2	OK
End Distance - Web (in)		Use Minimum Edge Distance
Web Weld Size (in)	50/59	

**Splice Plate Properties**

	Inner	Outer
Top Flange Splice Plate Material	Grade 50	
Top Flange Splice Plate Thickness (in)	7/8	3/4
Top Flange Splice Plate Width (in)	4 3/4	12
Total Agross (sq-in)	8.3125	9.0000
% Difference Ag Inner/Outer Area	7.94%	
Shear Planes per Bolt (N <sub>s</sub> )	2	

Web Splice Plate Material	Grade 50
Web Splice Plate Thickness (in)	5/8

	Inner	Outer
Bottom Flange Splice Plate Material	Grade 50	
Bottom Flange Splice Plate Thickness (in)	7/8	3/4
Bottom Flange Splice Plate Width (in)	4 3/4	12
Total Agross (sq-in)	8.3125	9.0000
% Difference A <sub>g</sub> Inner/Outer Area	7.94%	
Shear Planes per Bolt (N <sub>s</sub> )	2	

Web Weld Clearance (in)	
Web Gap (in)	1/4
Entering & Tightening Clearance (in)	Use Minimum Clearance

**Miscellaneous Properties**

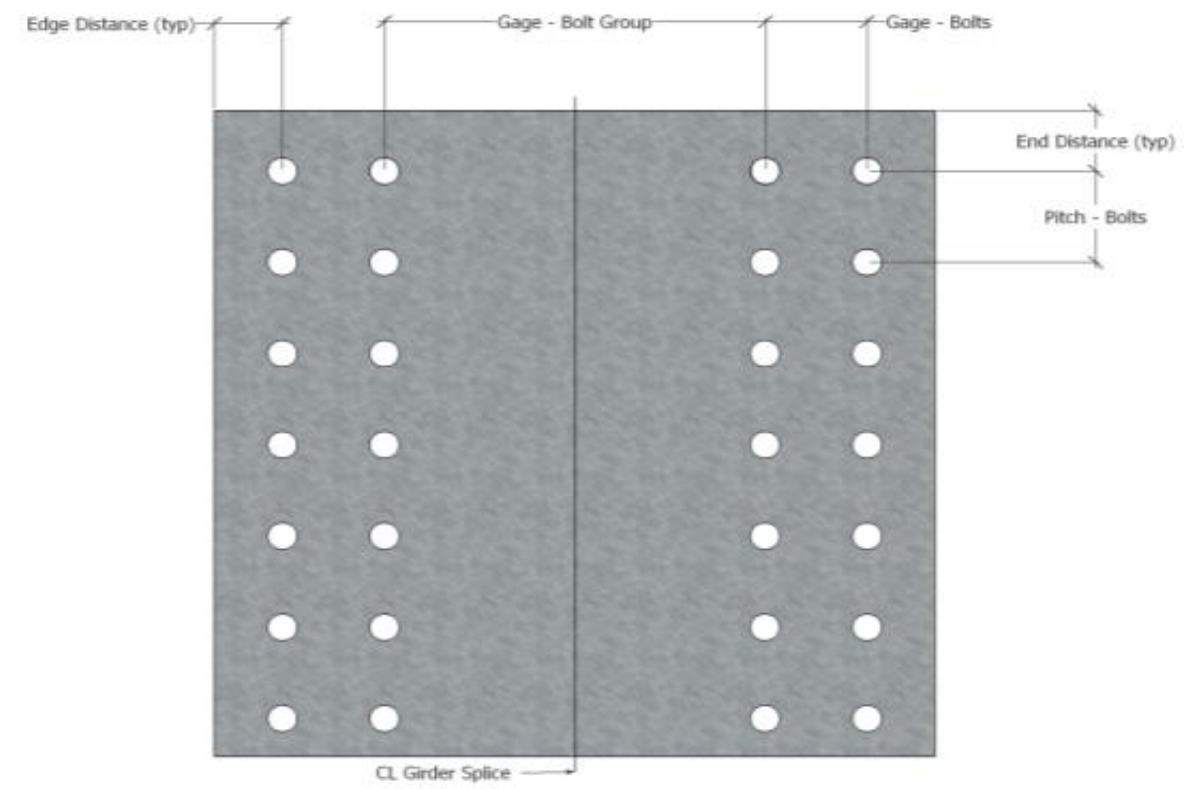
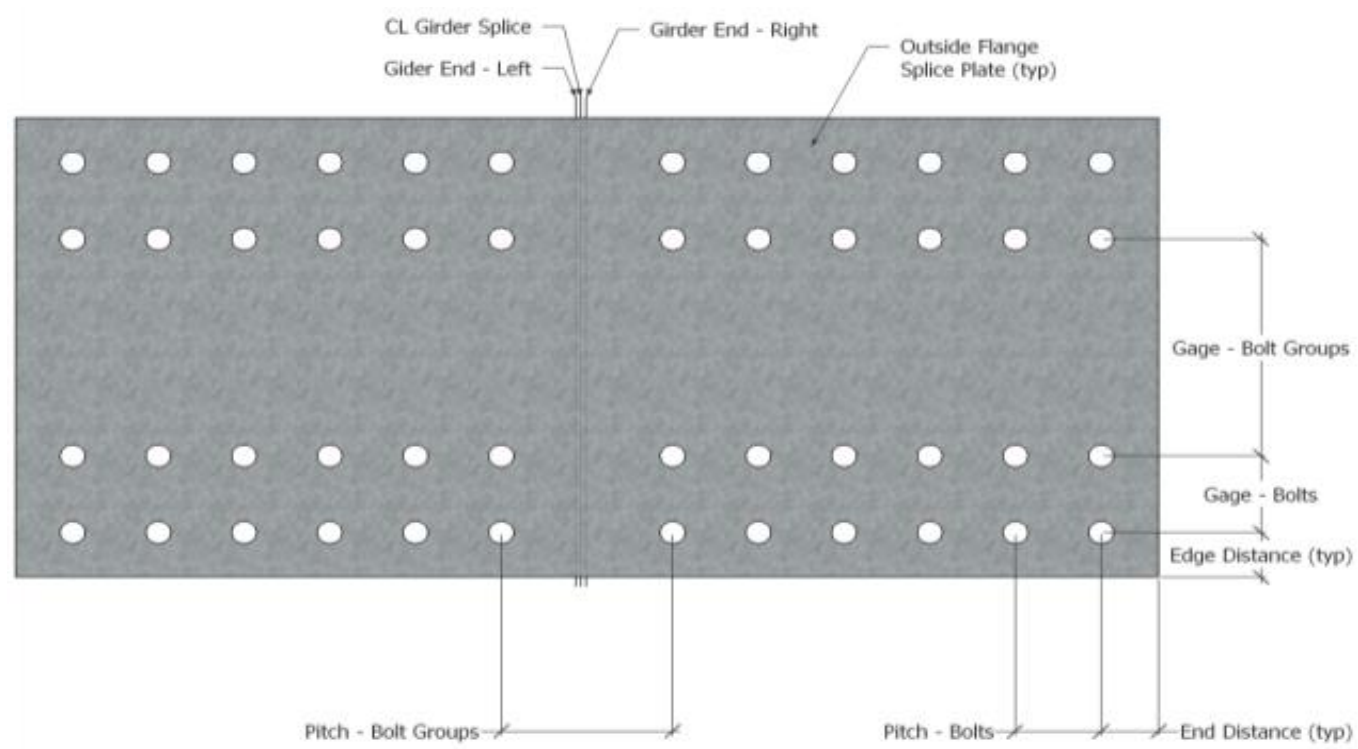
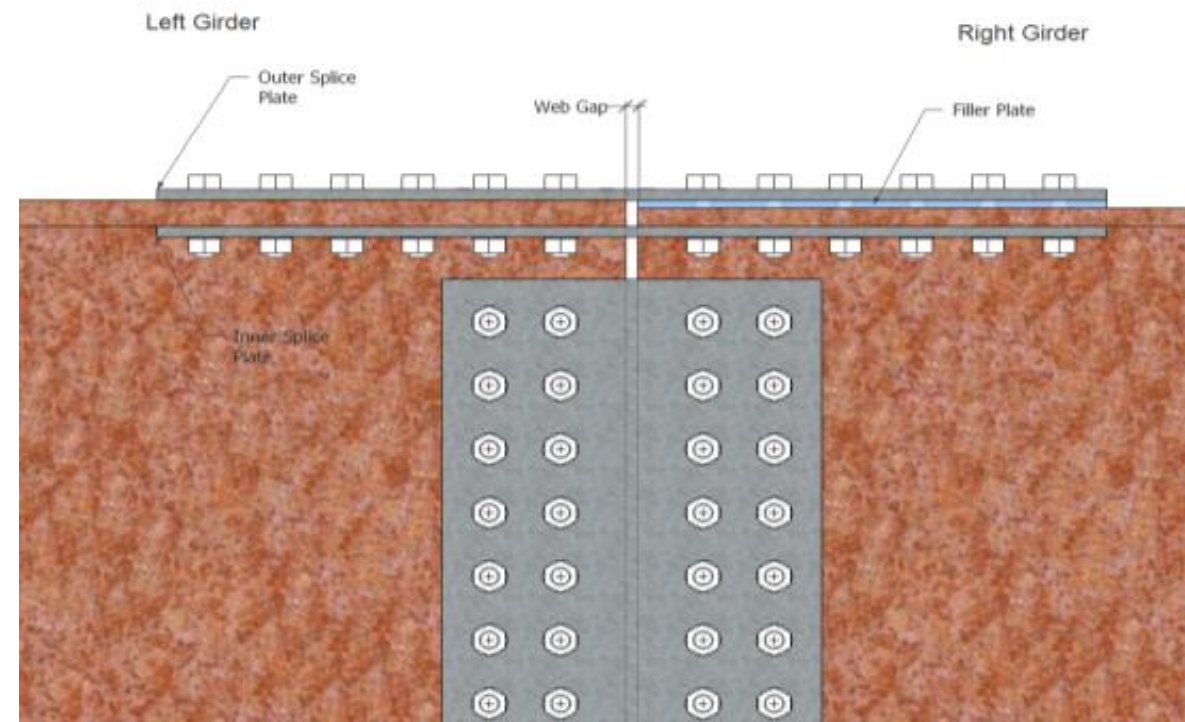
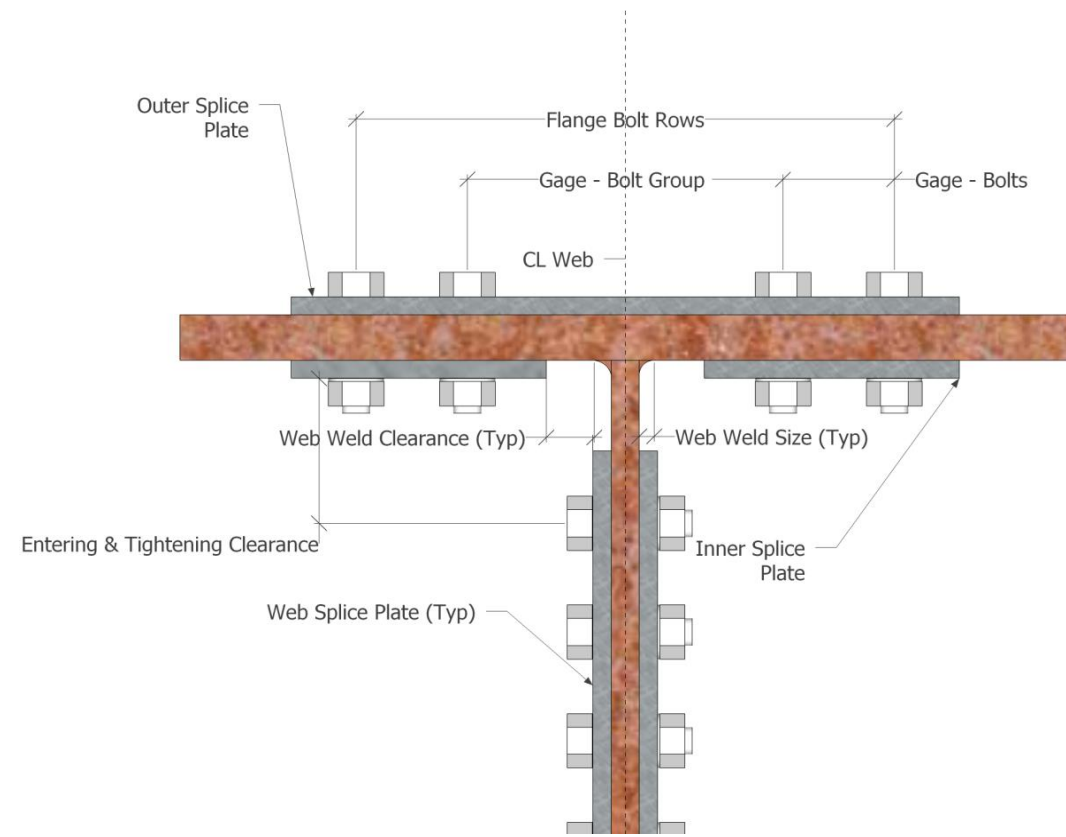
Splice Plate Hole Method	Drilled - Full Size
Transverse Stiffener Spacing (d <sub>o</sub> ) (ft)	15.0000
Alignment Mode	Web Center

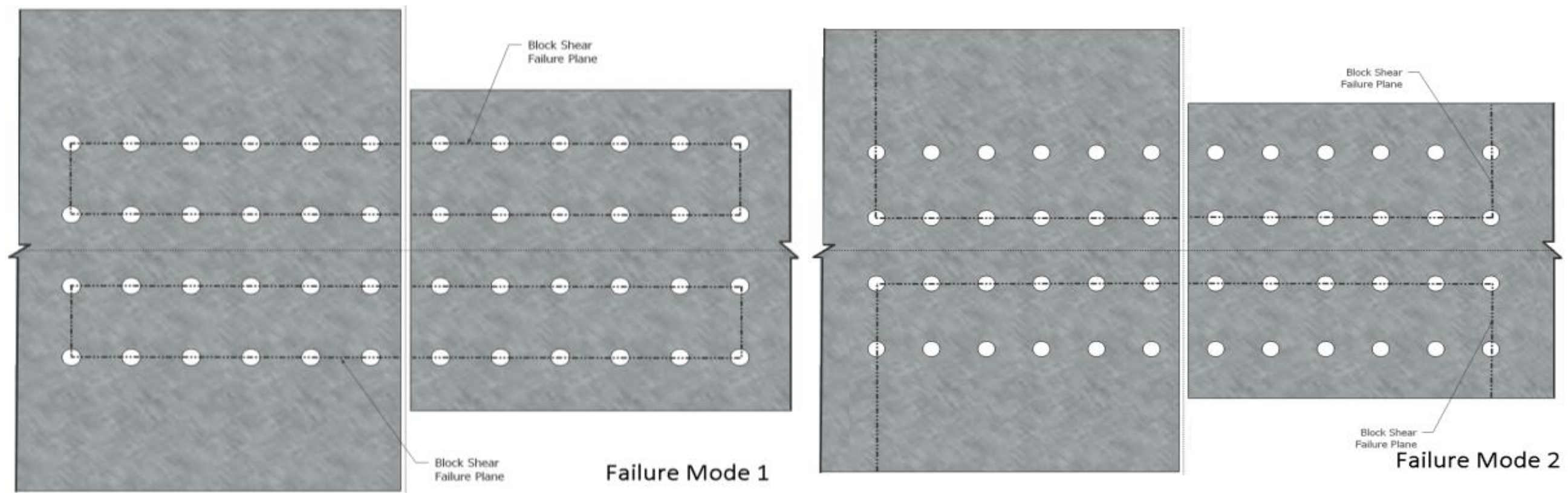
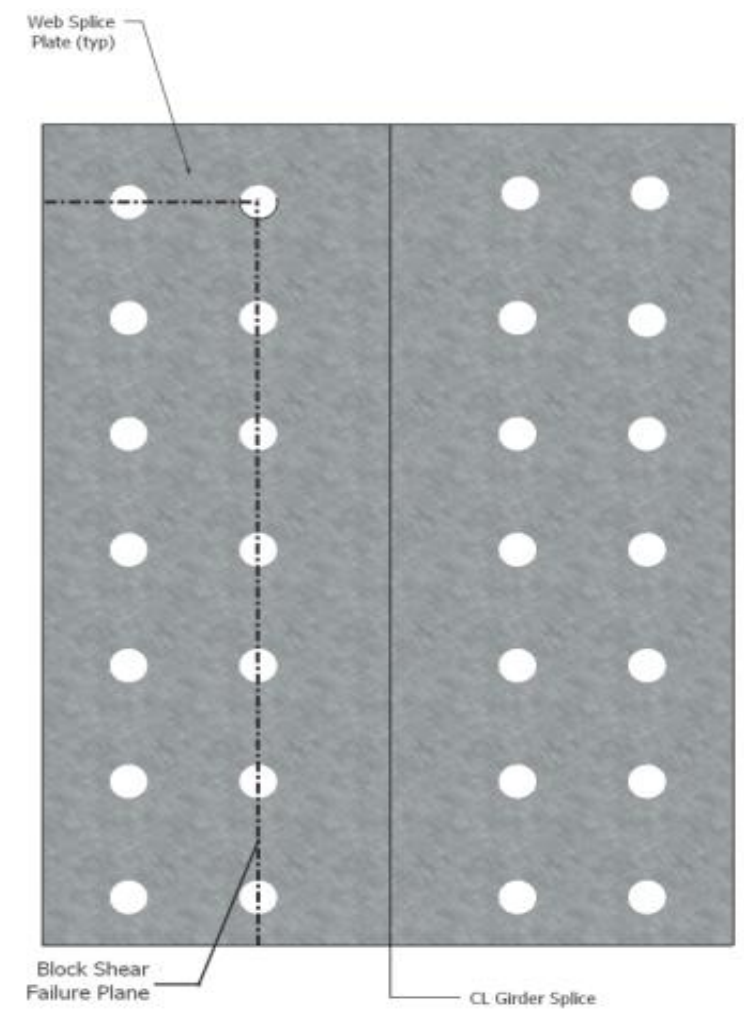
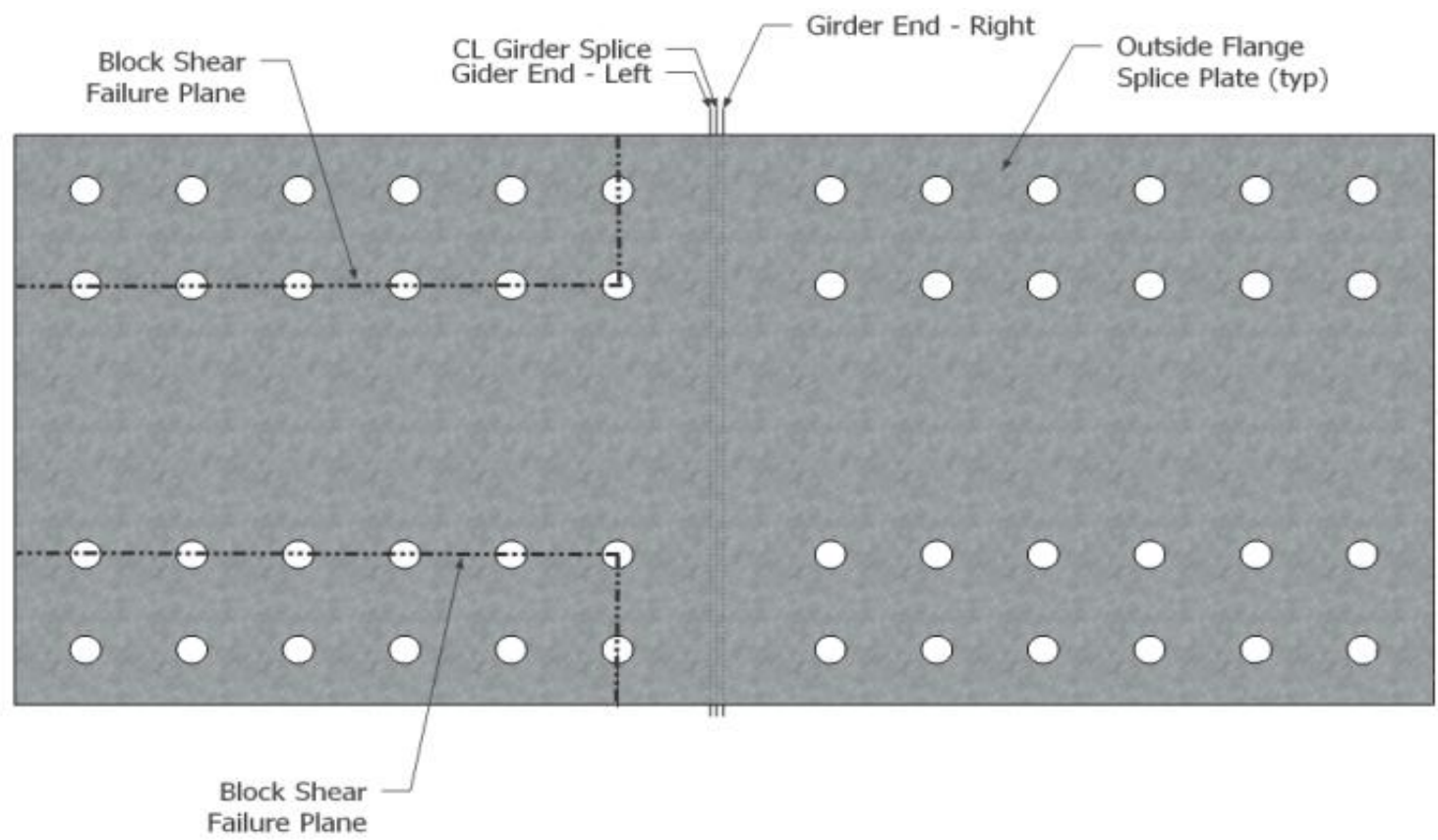
**Bolt Count Overrides**

	Count Override Status	Bolt Count - Calculated	Bolt Count - User Specified	Valid Override
Top Flange Bolt Count Override	Spreadsheet Calculated	8		DNA
Web Bolt Count Override	Spreadsheet Calculated	10		DNA
Bottom Flange Bolt Count Override	Spreadsheet Calculated	8		DNA

**Status - Error Count**

Design Status - Flange	0
Bolt Layout Status - Flange	0
Design Status - Web	0
Bolt Layout Status - Web	0







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## Design Result Summary

### Bolts Arrangement

NOTICE: DO NOT MODIFY THIS SHEET

	Bolt Rows (Per Side)	Total Bolts (Per Side)	Design Basis
Top Flange	2	8	Spreadsheet Calculated
Web	2	10	Spreadsheet Calculated
Bottom Flange	2	8	Spreadsheet Calculated

	Gage - Bolts (in)	Edge Distance (in)	Pitch - Bolts (in)	End Distance (in)	Gage - Bolt Groups (in)	Pitch - Bolt Groups (in)
Top Flange	0	2 3/8	3	1 1/4	7 1/4	3
Web	3	1 1/2	6	1 1/4	3 1/4	DNA
Bottom Flange	0	2 3/8	3	1 1/4	7 1/4	3

### Splice Plate Dimensions

	Thickness (in)	Width (in)	Length (in)
Top Flange - Outer	3/4	12	23 1/2
Top Flange - Inner (Each)	7/8	4 3/4	
Web	5/8	12 1/4	26 1/2
Bottom Flange - Inner (Each)	7/8	4 3/4	23 1/2
Bottom Flange - Outer	3/4	12	



# NSBA Bolted Splice Designer - Plate Girder

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## Design Check Summary

### Design Check Status

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#### Flange Splice

	Factored Yield Resistance Check - Tension	Net Section Fracture Check - Tension	Check $A_n \leq 0.85 A_g$ AASHTO 6.13.5.2	Block Shear Rupture Resistance	Bearing Resistance
Top Flange - Outer Splice Plate	OK	OK	OK	OK	OK
Top Flange - Inner Splice Plate	OK	OK	OK	OK	OK
Bottom Flange - Inner Splice Plate	OK	OK	OK	OK	OK
Bottom Flange - Outer Splice Plate	OK	OK	OK	OK	OK

	Block Shear Rupture Resistance - Mode 1	Block Shear Rupture Resistance - Mode 2	Bearing Resistance
Top Flange - Left	OK	OK	OK
Top Flange - Right	OK	OK	
Bottom Flange - Left	OK	OK	OK
Bottom Flange - Right	OK	OK	

Shear Planes per Bolt (Ns) - Top Flange	2
Shear Planes per Bolt (Ns) - Bottom Flange	2
$M_{flange}$ Check - Positive	OK
$M_{flange}$ Check - Negative	OK
Service II Moment Slip Check - Positive	OK
Service II Moment Slip Check - Negative	OK
Deck Casting Slip Check	OK

**Web Splice**

	Factored Yield Check	Factored Rupture Check	Block Shear Rupture Resistance
Web Splice Plate	OK	OK	OK

**Bearing Resistance**

Web	OK
Deck Casting Slip Check	OK
Service II Shear Slip Check - Positive	OK
Service II Shear Slip Check - Negative	OK

**Bolt Spacing Check Status**

**Flange Splice**

	Gage - Bolts Check	Edge Distance Check - Inner	Pitch - Bolt Group Check - Outer	Transverse Dimension Check - Outer	Transverse Dimension Check - Inner
Top Flange Splice Plates	OK	OK	OK	OK	OK
Bottom Flange Splice Plates	OK	OK	OK	OK	OK

**Web Splice**

	Pitch - Bolt Check	End Distance Check	Pitch - Bolt Group Check	Diagonal Edge Distance - Check	Splice Plate Height Check	Gage - Bolt Group Check
Web Splice Plates	OK	OK	OK	OK	OK	OK





# NSBA Bolted Splice Designer - Plate Girder

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## Flange Calculations

### Load Combinations - Factored Moment

Load Combination	Moment (kip-ft)					Deck Casting	Factored (kip-ft)
	Noncomposite Dead Load (DC1)	Superimposed Composite Dead Load (DC2)	Future Wearing Surface (DW)	Positive Live Load plus Impact (LL+ I)	Negative Live Load plus Impact (LL- + I)		
Deck Casting	0.00	0.00	0.00	0.00	0.00	1.40	0.00
Strength I - Positive	1.25	0.90	0.65	1.75	0.00	0.00	697.07
Strength I - Negative	0.90	0.90	0.65	0.00	1.75	0.00	51.36
Service II - Positive	1.00	1.00	1.00	1.30	0.00	0.00	526.95
Service II - Negative	1.00	1.00	1.00	0.00	1.30	0.00	80.49

### Bolt Factored Shear Resistance

Location	Bolt Type	Bolt Area (sq-in)	$K_h$	$\phi_s$	$F_u$ (ksi)	$P_t$ (kip)	$R_s$ - Single Shear (kip)	$R_n$ - Double Shear (kip)
Flange	A325 - Included	0.7854	Standard	0.80	120	51.00	33.93	67.86

### Bolt Nominal Slip Resistance

Surface Condition Factor ( $K_s$ )	Hole Size Factor ( $K_h$ )	$P_t$ (kip)	$R_n$ - Double Shear (kip)
0.30	1.00	51.00	30.60

### Strength Limit State Design

Location	Width (in)	Thickness (in)	Total $A_{gross}$ (sq-in)	% Difference $A_g$ Inner/Outer Area	Equally Divide $P_{fy}$ ?	Design Force Ratio for Splice Plates
Top Flange - Outer Splice Plate	12	3/4	9.00	7.94%	OK	0.50
Top Flange - Inner Splice Plate	4 3/4	7/8	8.31			0.50
Bottom Flange - Inner Splice Plate	4 3/4	7/8	8.31	7.94%	OK	0.50
Bottom Flange - Outer Splice Plate	12	3/4	9.00			0.50

$$A_e = \left( \frac{\phi_u F_u}{\phi_y F_{yf}} \right) A_n = 0.84 \left( \frac{F_u}{F_{yf}} \right) A_n \leq A_g$$

Location	0.84 (F <sub>u</sub> /F <sub>y</sub> )	Flange A <sub>gross</sub> (sq-in)	Flange A <sub>net</sub> (sq-in)	A <sub>e</sub> (sq-in)	A <sub>e</sub> ≤ A <sub>gross</sub> (Eq. 2.1.1.1-3)	P <sub>fy</sub> = F <sub>y</sub> A <sub>e</sub> P <sub>fy</sub> (kip)	Controlling Flange	Max. Design Force for Splice Plates (kip) AASHTO C6.13.6.1.3b
Top Flange - Left	1.15	13.50	11.11	12.73	OK	419.93	CONTROLS	209.97
Top Flange - Right	1.15	13.50	11.11	12.73	OK	419.93	CONTROLS	209.97
Bottom Flange - Left	1.15	13.50	11.11	12.73	OK	419.93	CONTROLS	209.97
Bottom Flange - Right	1.15	13.50	11.11	12.73	OK	419.93	CONTROLS	209.97

#### Filler Plate - Sizing and Reduction Factor

Location	Alignment Mode	Web Depth (in)	Top Flange Thickness (in)	Bottom Flange Thickness (in)	Height (in)
Left Girder	Web Center	32 1/8	1 1/8	1 1/8	34 3/8
Right Girder			1 1/8	1 1/8	34 3/8

Location	Flange Width (in)	Flange Thickness (in)	Filler Thickness - Outer (in)	Filler Width - Outer (in)	Filler Length - Outer (in)	Filler Thickness - Inner (in)	Filler Width - Inner (in)	Filler Length - Inner (in)
Top Flange - Left	12	1 1/8	0	0	0	0	0	0
Top Flange - Right	12	1 1/8	0	0	0	0	0	0
Bottom Flange - Left	12	1 1/8	0	0	0	0	0	0
Bottom Flange - Right	12	1 1/8	0	0	0	0	0	0

Location	Area Filler A <sub>f</sub> (sq-in)	Area Splice Plate A <sub>p</sub> (sq-in)	Area Connection Plate A <sub>p</sub> (sq-in)	$\gamma = \frac{A_f}{A_p}$
Top Flange - Left	0.00	17.31	13.50	0.00
Top Flange - Right	0.00		13.50	0.00
Bottom Flange - Left	0.00	17.31	13.50	0.00
Bottom Flange - Right	0.00		13.50	0.00

#### Bolt Count - Summary

Location	P <sub>fy</sub> (kip)	$R = \left[ \frac{(1 + \gamma)}{(1 + 2\gamma)} \right]$ Filler Reduction - R	Total Bolt - Initial	Bolt Rows (Per Side)	Total Bolts (Per Side) - Calculated
Top Flange - Left	419.93	1.00	6.19	2	8
Top Flange - Right					
Bottom Flange - Left	419.93	1.00	6.19	2	8
Bottom Flange - Right					

#### Slip Resistance Design

##### Bolt Count - Summary (Initial)

	Moment (kip)	Moment Arm (in)	Per Bolt Pt (kip)	Total Bolt - Initial	Bolt Rows (Per Side)	Total Bolts (Per Side) - Calculated	Max Total Bolts (Per Side) - Calculated
Service II - Positive (kip-ft)	526.95	33.25	30.60	6.21	2	8	8
Service II - Negative (kip-ft)	80.49	33.25		0.95	2	2	2
Deck Casting Moment (kip-ft)	0.00	33.25		0.00	2	0	

**Bolt Count - Final**

	Strength	Slip	Override	Controlling	Bolt Count Override
Top Flange	8	2	DNA	8	FALSE
Bottom Flange	8	8	DNA	8	FALSE

**Bolt and Plate Geometric Layout**

**Maximum Bolt Spacing - Sealing**

Location	Splice Plate Thickness (in)	Controlling Plate t (in)	Pitch - Bolts (in)	(4.0 + 4.0t)	$s \leq (4.0 + 4.0t) \leq 7.0 \text{ in.}$ $S_{\max} \text{ (in)}$
Top Flange - Outer Splice Plate	3/4	3/4	3	7	7
Top Flange - Inner Splice Plate	7/8				
Bottom Flange - Inner Splice Plate	7/8	3/4		7	7
Bottom Flange - Outer Splice Plate	3/4				

**Bolt Layout - Transverse Gage**

Location	Width - Inner Plate (in)	Bolt Spacing (in)	Bolt Spacing - Minimum (in)	Edge Distance - Initial (in)	Edge Distance - Minimum (in)	Transverse Spacing Check	Edge Distance Inner - Final (in)	Gage - Bolts (in)
Top Flange	4 3/4	3	3	2 3/8	1 1/4	OK	2 3/8	0
Bottom Flange	4 3/4					OK		

Location	Width - Outer Plate (in)	Edge Distance - Final (in)	Transverse Gage - Bolt Groups (in)
Top Flange	12	2 3/8	7 1/4
Bottom Flange	12	2 3/8	7 1/4

Location	Final Gage - Bolts Check	Final Edge Distance Check - Inner Plate	Final Transverse Dimension Check - Outer	Final Transverse Dimension Check - Inner
Top Flange	OK	OK	OK	OK
Bottom Flange	OK	OK	OK	OK

**Bolt Layout - Longitudinal Pitch**

Location	Web Gap (in)	Bolt Spacing (in)	Minimum Pitch - Bolts (in)	End Distance (in)	Pitch - Bolt Groups (in)	Longitudinal Pitch - Bolt Group Check - Outer
Top Flange	1/4	3	3	1 1/4	3	OK
Bottom Flange						OK

**Splice Plate Geometry - Plate Sizes**

Location	Bolts Per Row - Calculated	Total Bolts - Calculated	Pitch - Bolts (in)	Pitch - Bolt Groups (in)	End Distance (in)	Splice Plate Width (in)	Splice Plate Thickness (in)	Splice Plate Length (in)
Top Flange - Outer Splice Plate	2	8	3	3	1 1/4	12	3/4	23 1/2
Top Flange - Inner Splice Plate						4 3/4	7/8	
Bottom Flange - Inner Splice Plate	2	8				4 3/4	7/8	23 1/2
Bottom Flange - Outer Splice Plate						12	3/4	

### Bolt Layout - Diagonal Edge

Location	End Distance (in) - Final	Edge Distance (in)	Diagonal Edge Distance (in)	Final Diagonal Edge Distance - Check
Top Flange Splice	1.25	1.50	1.95	OK
Bottom Flange Splice				

### Splice Plate - Bolt Shear Resistance Joint Length Reduction Check

Location	Bolt Shear Resistance Joint Length Reduction Factor
Top Flange Splice	1.00
Bottom Flange Splice	1.00

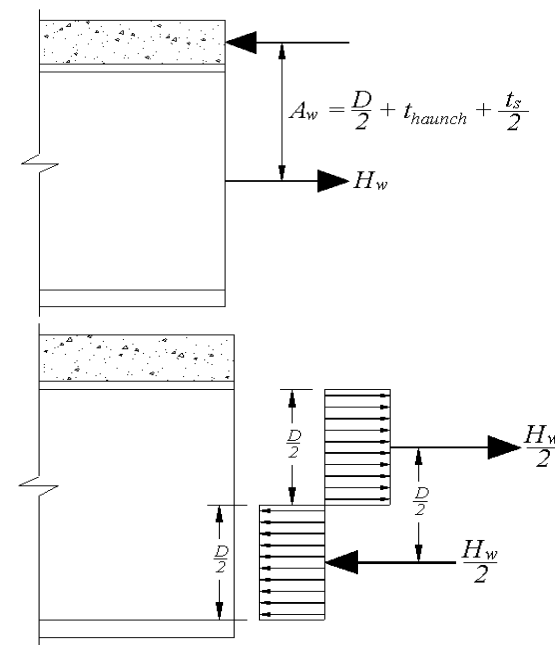
### Moment Resistance

#### Positive Moment

Moment Arm (in)	33.25
Bottom Flange Force (k)	419.93
$M_{flange}$ (kip-ft)	1,163.57
Strength I - Positive (kip-ft)	697.07
Check $M_{flange}$	OK
Hw (kip)	DNA

#### Negative Moment

Moment Arm (in)	33.25
Minimum Flange Force(k)	419.93
$M_{flange}$ (kip-ft)	1,163.57
Strength I - Negative (kip-ft)	51.36
Check $M_{flange}$	OK
Hw (kip)	DNA



### Splice Plates

Location	Width (in)	Thickness (in)	Total $A_{gross}$ (sq-in)
Top Flange - Outer Splice Plate	12	3/4	9.00
Top Flange - Inner Splice Plate	4 3/4	7/8	8.31
Bottom Flange - Inner Splice Plate	4 3/4	7/8	8.31
Bottom Flange - Outer Splice Plate	12	3/4	9.00

**Factored Yield Resistance - Tension**

Location	Design Force in Splice Plate (kip)	$\phi_y$	$F_y$ (ksi)	$A_g$ (sq-in)	$R_r = \phi_y F_y A_g$ Rr (kip)	Factored Yield Check - Tension
Top Flange - Outer Splice Plate	209.97	0.95	50	9.00	427.50	OK
Top Flange - Inner Splice Plate	209.97			8.31	394.84	OK
Bottom Flange - Inner Splice Plate	209.97		50	8.31	394.84	OK
Bottom Flange - Outer Splice Plate	209.97			9.00	427.50	OK

**Net Section to Gross Section Check - Tension**

Location	$A_n$ (sq-in)	$A_g$ (sq-in)	$0.85 * A_g$ (sq-in)	Check $A_n \leq 0.85 A_g$ AASHTO 6.13.5.2	Controlling Section (sq-in)
Top Flange - Outer Splice Plate	7.41	9.00	7.65	OK	7.41
Top Flange - Inner Splice Plate	6.45	8.31	7.07	OK	6.45
Bottom Flange - Inner Splice Plate	6.45	8.31	7.07	OK	6.45
Bottom Flange - Outer Splice Plate	7.41	9.00	7.65	OK	7.41

**Net Section Fracture Resistance - Tension**

Location	Design Force in Splice Plate (kip)	$\phi_u$	$F_u$ (ksi)	Controlling Section (sq-in)	$R_p$	U	$R_r = \phi_u F_u A_n R_p U$ Rr (kip)	Net Section Fracture Check - Tension
Top Flange - Outer Splice Plate	209.97	0.80	65	7.41	1.00	1.00	385.13	OK
Top Flange - Inner Splice Plate	209.97			6.45			335.56	OK
Bottom Flange - Inner Splice Plate	209.97		65	6.45			335.56	OK
Bottom Flange - Outer Splice Plate	209.97			7.41			385.13	OK

**Block Shear Rupture Resistance - Splice Plates**

Location	Gross Path Length per Failure Plane - Tension (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Tension (in)	Splice Plate Thickness (in)	Net Area $A_{tn}$ (sq-in)
Top Flange - Outer Splice Plate	2.38	0.5	1.125	2	3.63	3/4	2.72
Top Flange - Inner Splice Plate	2.38	0.5			3.63	7/8	3.17
Bottom Flange - Inner Splice Plate	2.38	0.5			3.63	7/8	3.17
Bottom Flange - Outer Splice Plate	2.38	0.5			3.63	3/4	2.72

Location	Gross Path Length per Failure Plane - Shear (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Shear (in)	Splice Plate Thickness (in)	Net Area $A_{vn}$ (sq-in)
Top Flange - Outer Splice Plate	10.25	3.5	1.125	2	12.63	3/4	9.47
Top Flange - Inner Splice Plate	10.25	3.5			12.63	7/8	11.05
Bottom Flange - Inner Splice Plate	10.25	3.5			12.63	7/8	11.05
Bottom Flange - Outer Splice Plate	10.25	3.5			12.63	3/4	9.47

Location	Gross Path Length per Failure Plane - Shear (in)	Splice Plate Thickness (in)	Path Count	Gross Area $A_{vg}$ (sq-in)
Top Flange - Outer Splice Plate	10.25	3/4	2	15.38
Top Flange - Inner Splice Plate	10.25	7/8		17.94
Bottom Flange - Inner Splice Plate	10.25	7/8		17.94
Bottom Flange - Outer Splice Plate	10.25	3/4		15.38

Location	$\phi_{bs}$	$R_p$	$F_u$ (ksi)	$U_{bs}$	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ R <sub>r</sub> (kip)
Top Flange - Outer Splice Plate	0.80	1.00	65	1.00	426.95
Top Flange - Inner Splice Plate					498.11
Bottom Flange - Inner Splice Plate			498.11		
Bottom Flange - Outer Splice Plate			426.95		

Location	$\phi_{bs}$	$R_p$	$F_y$ (ksi)	$F_u$ (ksi)	$U_{bs}$	$\phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_m)$
Top Flange - Outer Splice Plate	0.80	1.00	50	65	1.00	498.08
Top Flange - Inner Splice Plate						581.09
Bottom Flange - Inner Splice Plate			581.09			
Bottom Flange - Outer Splice Plate			498.08			

Location	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ $\leq \phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_m)$	Max. Design Force for Splice Plates (kip)	Block Shear Rupture Resistance Check
Top Flange - Outer Splice Plate	426.95	209.97	OK
Top Flange - Inner Splice Plate	498.11		OK
Bottom Flange - Inner Splice Plate	498.11	209.97	OK
Bottom Flange - Outer Splice Plate	426.95		OK



**Block Shear Rupture Resistance - Girder (Mode 1)**

Location	Gross Path Length per Failure Plane - Tension (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Tension (in)	Flange Thickness (in)	Net Area $A_{tn}$ (sq-in)
Top Flange - Left	0.00	0	1.125	2	0.00	1 1/8	0.00
Top Flange - Right	0.00	0			0.00	1 1/8	0.00
Bottom Flange - Left	0.00	0			0.00	1 1/8	0.00
Bottom Flange - Right	0.00	0			0.00	1 1/8	0.00

Location	Gross Path Length per Failure Plane - Shear (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Shear (in)	Flange Thickness (in)	Net Area $A_{vn}$ (sq-in)
Top Flange - Left	10.25	3.5	1.125	4	25.25	1 1/8	28.41
Top Flange - Right	10.25	3.5			25.25	1 1/8	28.41
Bottom Flange - Left	10.25	3.5			25.25	1 1/8	28.41
Bottom Flange - Right	10.25	3.5			25.25	1 1/8	28.41

Location	Gross Path Length per Failure Plane - Shear (in)	Flange Thickness (in)	Path Count	Gross Area $A_{vg}$ (sq-in)
Top Flange - Left	10.25	1 1/8	4	46.13
Top Flange - Right	10.25	1 1/8		46.13
Bottom Flange - Left	10.25	1 1/8		46.13
Bottom Flange - Right	10.25	1 1/8		46.13

Location	$\phi_{bs}$	$R_p$	$F_u$ (ksi)	$U_{bs}$	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ R <sub>r</sub> (kip)
Top Flange - Left	0.80	1.00	45	1.00	593.12
Top Flange - Right			45		593.12
Bottom Flange - Left			45		593.12
Bottom Flange - Right			45		593.12

Location	$\phi_{bs}$	$R_p$	$F_y$ (ksi)	$F_u$ (ksi)	$U_{bs}$	$\phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_{tn})$
Top Flange - Left	0.80	1.00	33	45	1.00	706.27
Top Flange - Right			33	45		706.27
Bottom Flange - Left			33	45		706.27
Bottom Flange - Right			33	45		706.27

Location	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ $\leq \phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_{tn})$	$P_{fy}$ (kip)	Block Shear Rupture Resistance Check
Top Flange - Left	593.12	419.93	OK
Top Flange - Right	593.12		OK
Bottom Flange - Left	593.12	419.93	OK
Bottom Flange - Right	593.12		OK

**Block Shear Rupture Resistance - Girder (Mode 2)**

Location	Gross Path Length per Failure Plane - Tension (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Tension (in)	Flange Thickness (in)	Net Area $A_{tn}$ (sq-in)
Top Flange - Left	2.38	0.5	1.125	2	3.63	1 1/8	4.08
Top Flange - Right	2.38	0.5			3.63	1 1/8	4.08
Bottom Flange - Left	2.38	0.5			3.63	1 1/8	4.08
Bottom Flange - Right	2.38	0.5			3.63	1 1/8	4.08

Location	Gross Path Length per Failure Plane - Shear (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Shear (in)	Flange Thickness (in)	Net Area $A_{vn}$ (sq-in)
Top Flange - Left	10.25	3.5	1.125	2	12.63	1 1/8	14.20
Top Flange - Right	10.25	3.5			12.63	1 1/8	14.20
Bottom Flange - Left	10.25	3.5			12.63	1 1/8	14.20
Bottom Flange - Right	10.25	3.5			12.63	1 1/8	14.20

Location	Gross Path Length per Failure Plane - Shear (in)	Flange Thickness (in)	Path Count	Gross Area $A_{vg}$ (sq-in)
Top Flange - Left	10.25	1 1/8	2	23.06
Top Flange - Right	10.25	1 1/8		23.06
Bottom Flange - Left	10.25	1 1/8		23.06
Bottom Flange - Right	10.25	1 1/8		23.06

Location	$\phi_{bs}$	$R_p$	$F_u$ (ksi)	$U_{bs}$	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ R <sub>r</sub> (kip)
Top Flange - Left	0.80	1.00	45	1.00	443.37
Top Flange - Right			45		443.37
Bottom Flange - Left			45		443.37
Bottom Flange - Right			45		443.37

Location	$\phi_{bs}$	$R_p$	$F_y$ (ksi)	$F_u$ (ksi)	$U_{bs}$	$\phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_m)$
Top Flange - Left	0.80	1.00	33	45	1.00	499.95
Top Flange - Right			33	45		499.95
Bottom Flange - Left			33	45		499.95
Bottom Flange - Right			33	45		499.95

Location	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ $\leq \phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_m)$	$P_{fy}$ (kip)	Block Shear Rupture Resistance Check
Top Flange - Left	443.37	419.93	OK
Top Flange - Right	443.37		OK
Bottom Flange - Left	443.37	419.93	OK
Bottom Flange - Right	443.37		OK

#### Bearing Resistance Check

Location	Thickness (in)	$F_u$ (ksi)	(kip/in)	Controlling
Top Flange - Splice Plates	1.63	65	105.63	
Top Flange - Left	1.13	45	50.63	CONTROLS
Top Flange - Right	1.13	45	50.63	CONTROLS
Bottom Flange - Splice Plates	1.63	65	105.63	
Bottom Flange - Left	1.13	45	50.63	CONTROLS
Bottom Flange - Right	1.13	45	50.63	CONTROLS

Location	Hole Diameter (in)	Bolt Diameter - d (in)	2d (in)	End Distance (in)	Pitch - Bolts (in)	Total Bolts (Per Side) Calculated	Bolt Rows (Per Side)
Top Flange - Left	1 1/8	1	2.00	1 1/4	3	8	2
Top Flange - Right							
Bottom Flange - Left							
Bottom Flange - Right							

End Holes							
Location	Thickness (in)	$F_u$ (ksi)	$\phi_{bb}$	Clear Distance - $L_c$ (in)	$R_n = 2.4dtF_u$ Rn (kip)	$R_n = 1.2L_c tF_u$ Rn (kip)	$R_r = \phi_{bb}R_n$ Rr (kip)
Top Flange - Outer Splice Plate	0.75	65	0.80	0.69	DNA	80.44	64.35
Top Flange - Left	1.13	45			DNA	83.53	66.83
Top Flange - Right					DNA	93.84	75.08
Top Flange - Inner Splice Plate	0.88	65			DNA	93.84	75.08
Bottom Flange - Inner Splice Plate	0.88	65			DNA	83.53	66.83
Bottom Flange - Left	1.13	45			DNA	80.44	64.35
Bottom Flange - Right					DNA	80.44	64.35
Bottom Flange - Outer Splice Plate	0.75	65			DNA	80.44	64.35

Interior Holes							
Location	Thickness (in)	$F_u$ (ksi)	$\phi_{bb}$	Clear Distance - $L_c$ (in)	$R_n = 2.4dtF_u$ Rn (kip)	$R_n = 1.2L_c tF_u$ Rn (kip)	$R_r = \phi_{bb}R_n$ Rr (kip)
Top Flange - Outer Splice Plate	0.75	65	0.80	1.88	DNA	658.13	526.50
Top Flange - Left	1.13	45			DNA	683.4375	546.75
Top Flange - Right					DNA	767.8125	614.25
Top Flange - Inner Splice Plate	0.88	65			DNA	767.8125	614.25
Bottom Flange - Inner Splice Plate	0.88	65			DNA	683.4375	546.75
Bottom Flange - Left	1.13	45			DNA	658.1250	526.50
Bottom Flange - Right					DNA	658.1250	526.50
Bottom Flange - Outer Splice Plate	0.75	65			DNA	658.1250	526.50

End			
Location	Bolt Capacity $R_r$ (kip)	Bearing Resistance $R_r$ (kip)	Controlling $R_r$ (kip)
Top Flange - Outer Splice Plate	67.86	64.35	64.35
Top Flange - Left	135.72	66.83	66.83
Top Flange - Right			
Top Flange - Inner Splice Plate	67.86	75.08	67.86
Bottom Flange - Inner Splice Plate	67.86	75.08	67.86
Bottom Flange - Left	135.72	66.83	66.83
Bottom Flange - Right			
Bottom Flange - Outer Splice Plate	67.86	64.35	64.35

Interior			
Location	Bolt Capacity $R_r$ (kip)	Bearing Resistance $R_r$ (kip)	Controlling $R_r$ (kip)
Top Flange - Outer Splice Plate	203.58	526.50	203.58
Top Flange - Left	407.15	546.75	407.15
Top Flange - Right			
Top Flange - Inner Splice Plate	203.58	614.25	203.58
Bottom Flange - Inner Splice Plate	203.58	614.25	203.58
Bottom Flange - Left	407.15	546.75	407.15
Bottom Flange - Right			
Bottom Flange - Outer Splice Plate	203.58	526.50	203.58

Location	Total Bearing Resistance - $R_r$ (kip)	Design Force (kip)	Bearing Resistance Check
Top Flange - Outer Splice Plate	267.93	209.97	OK
Top Flange - Left	473.98	419.93	OK
Top Flange - Right			
Top Flange - Inner Splice Plate	271.43	209.97	OK
Bottom Flange - Inner Splice Plate	271.43	209.97	OK
Bottom Flange - Left	473.98	419.93	OK
Bottom Flange - Right			
Bottom Flange - Outer Splice Plate	267.93	209.97	OK

### Slip Resistance Check

#### Service II - Positive Moment Check

Moment Arm (in)	33.25
Service II - Positive (kip-ft)	526.95
Total Bolts - Calculated	8
Per Bolt $P_t$ (kip)	30.60
Total $P_t$ (kip)	244.80
Moment (kip-ft)	678.30
Slip Check	OK
Hw (kip)	DNA

#### Service II - Negative Moment Check

Moment Arm (in)	33.25
Service II - Negative (kip-ft)	80.49
Total Bolts - Calculated	8
Per Bolt $P_t$ (kip)	30.60
Total $P_t$ (kip)	244.80
Moment (kip-ft)	678.30
Slip Check	OK
Hw (kip)	DNA

#### Deck Casting Check

Moment Arm (in)	33.25
Deck Casting Moment (kip-ft)	0.00
Total Bolts - Calculated	8
Per Bolt $P_t$ (kip)	30.60
Total $P_t$ (kip)	244.80
Moment (kip-ft)	678.30
Slip Check	OK
Hw (kip)	DNA



**Web Calculations**

**Load Combinations - Factored Shear**

Load Combination	Shear (kip)						Factored Shear (kip)
	Noncomposite Dead Load (DC1)	Superimposed Composite Dead Load (DC2)	Future Wearing Surface (DW)	Positive Live Load plus Impact (LL+ + I)	Negative Live Load plus Impact (LL- + I)	Deck Casting	
Deck Casting	0.00	0.00	0.00	0.00	0.00	1.40	0.00
Service II - Positive	1.00	1.00	1.00	1.30	0.00	0.00	28.79
Service II - Negative	1.00	1.00	1.00	0.00	1.30	0.00	-8.39

CONTROLS

**Bolt Factored Shear Resistance**

Location	Bolt Type	Bolt Area (sq-in)	$K_h$	$\phi_s$	$F_u$ (ksi)	$P_t$ (kip)	$R_r$ - Single Shear (kip)	$R_r$ - Double Shear (kip)
Web	A325 - Included	0.7854	Standard	0.80	120	51.00	33.93	67.86

**Bolt Nominal Slip Resistance**

Faying Surface Class ( $K_s$ )	Hole Size Factor ( $K_h$ )	$P_t$ (kip)	Slip Capacity - Double (kip)
0.30	1.00	51.00	30.60

**Flange Design Results**

**Flange Moment Resistance Check Results**

	$H_w$ (kip)	Controlling
Positive	DNA	
Negative	DNA	

**Flange Moment Slip Resistance Check Results**

	$H_w$ (kip)	Controlling
Positive	DNA	
Negative	DNA	
Deck Casting	DNA	

## Strength Limit State Design

### Web Shear Strength

Location	$F_y$ (ksi)	$E$ (ksi)	$F_u$ (ksi)	$0.84 (F_u/F_y)$	Depth (in)	Thickness (in)	$A_{gross}$ (sq-in)	Filler Plate Thickness (in)
Web - Left	33	29000	45	1.15	32 1/8	11/16	22.09	0
Web - Right	33	29000	45	1.15	32 1/8	11/16	22.09	

Location	$D_w/t_w$	$d_o/D_w$	Shear Buckling Coefficient - k	Web Slenderness Lower Limit	Web Slenderness Upper Limit	Shear Buckling to Yield Strength Ratio - C	$V_p$ (kip)	$V_{cr}$ (kip)	$V_n$ (kip)
Web - Left	46.73	5.60	5.00	74.24	92.80	1.00	422.72	422.72	422.72
Web - Right	46.73	5.60	5.00	74.24	92.80	1.00	422.72	422.72	422.72

### Bolt Count - Summary (Initial)

Location	Controlling $H_w$ (kip)	$V_n$ (kip)	$\phi_v$	$V_r$ (kip)
Web	0.00	422.72	1.00	422.72

Location	R (kip)	Total Bolt - Initial	Bolt Rows (Per Side)	Total Bolts (Per Side) - Calculated
Web	422.72	6.23	2	8

## Slip Resistance Design

### Bolt Count - Summary (Initial)

	Shear (kip)	$H_w$ (kip)	Per Bolt Pt (kip)	Total Bolt - Initial	Bolt Rows (Per Side)	Total Bolts (Per Side) - Calculated	Max Total Bolts (Per Side) - Calculated
Deck Casting (kip)	0.00	DNA	30.60	0.00	2	0	2
Service II – Positive (kip)	28.79	DNA		0.94		2	
Service II – Negative (kip)	-8.39	DNA		0.27		2	

## Bolt and Plate Geometric Layout

### Maximum Bolt Spacing - Seal

Location	Thickness - Initial (in)	$(4.0 + 4.0t)$	$s \leq (4.0 + 4.0t) \leq 7.0 \text{ in.}$ $S_{max}$ (in)
Web	5/8	6 1/2	6 1/2

### Web Splice Plate End Distance - Splice Plate Height Adjustment

Location	End Distance (in)	Web Weld Size (in)	Web Weld Clearance (in)	Entering & Tightening Clearance (in)	End Distance - Calculated (in)	End Adjustment (in)
Web - Top	1 1/4	5/16	0	2 1/8	3 9/59	-1 37/41



Web - Bottom	± 1/4	30 3/7	0	3 9/59	-1 37/41
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**Web Splice Plate Height - Maximum**

Location	Web Depth (in)	Splice Plate Height - Maximum (in)	Max End Adjustment (in)	Splice Plate Height - Estimated (in)
Web - Top	32 1/8	30 3/7	-1 37/41	26 5/8
Web - Bottom				

**Bolt Count - Summary (Initial)**

Location	Bolt Rows (Per Side)	Splice Plate Height - Maximum (in)	End Distance (in)	$S_{max}$ (in)	Total Bolts (Per Side) - Calculated at Max Spacing
Web	2	26 5/8	1 1/4	6 1/2	10

**Bolt Count - Final**

	Strength	Slip	Pitch	Override	Controlling	Bolt Count Override
Web	8	2	10	DNA	10	FALSE

**Layout Checks**

**Pitch and End Distance Verification**

Location	End Distance - Final (in)	Pitch - Bolts (in) - Final	Splice Plate Height - Final (in)
Web	1 1/4	6	26 1/2

Location	Final Pitch Check	Final End Distance Check	Final Splice Plate Height Check
Web	OK	OK	OK

**Bolt Layout - Gage**

Location	Web Gap (in)	Gage - Bolts (in)	Edge Distance (in)	Gage - Bolt Groups (in)	Gage - Bolt Group Check
Web	1/4	3	1 1/2	3 1/4	OK

**Bolt Layout - Diagonal Edge**

Location	End Distance (in)	Edge Distance (in)	Diagonal Edge Distance (in)	Final Diagonal Edge Distance - Check
Web	1.2500	1.5000	1.9526	OK

**Splice Plate Geometry - Plate Sizes**

Location	Bolt Per Row - Calculated	Total Bolts - Calculated	Gage - Bolts (in)	Gage - Bolt Groups (in)	Edge Distance (in)	Splice Plate Height (in)	Splice Plate Thickness (in)	Splice Plate Width (in)
Web Splice Plate	2	10	3	3 1/4	1 1/2	26 1/2	5/8	12 1/4
Web - Filler						0	0	0

**Splice Plates**

**Factored Shear Yielding Resistance**

Location	$\phi_v$	$F_y$ (ksi)	Height - Final (in)	Thickness - Initial (in)	$A_{vg}$ (sq-in)	$R_r = \phi_v 0.58 F_y A_{vg}$ Rr (kip)	Factored Shear Yield Check
Web Splice Plate	1.00	50	26 1/2	0.6250	33.13	960.63	OK

**Factored Shear Rupture Resistance**

Location	Height - Final (in)	Thickness - Initial (in)	Total Bolts - Calculated	Bolt Rows (Per Side)	Hole Diameter (in)	$A_{vn}$ (sq-in)
Web Splice Plate	26 1/2	0.6250	10	2	1.1250	26.09

Location	$\phi_{vu}$	$R_p$	$F_u$ (ksi)	$R_r = \phi_{vu} 0.58 R_p F_u A_{vn}$ Rr (kip)	$V_r$ (kip)	Factored Shear Rupture Check Rr > Vr
Web Splice Plate	0.80	1.00	65	786.99	422.72	OK

Block Shear Rupture Resistance - Splice Plates

Location	Gross Path Length per Failure Plane - Tension (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Tension (in)	Splice Plate Thickness (in)	Net Area $A_{tn}$ (sq-in)
Web Splice Plate	4.50	1.5	1.1250	2	5.63	5/8	3.52

Location	Gross Path Length per Failure Plane - Shear (in)	Hole Count / Path	Hole Diameter (in)	Path Count	Net Path Length - Shear (in)	Splice Plate Thickness (in)	Net Area $A_{vn}$ (sq-in)
Web Splice Plate	25.25	4.5	1.1250	2	40.38	5/8	25.23

Location	Gross Path Length per Failure Plane - Shear (in)	Splice Plate Thickness (in)	Path Count	Gross Area $A_{vg}$ (sq-in)
Web Splice Plate	25.25	5/8	2	31.56

Location	$\phi_{bs}$	$R_p$	$F_u$ (ksi)	$U_{bs}$	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ R <sub>r</sub> (kip)
Web Splice Plate	0.80	1.00	65	1.00	943.88

Location	$\phi_{bs}$	$R_p$	$F_y$ (ksi)	$F_u$ (ksi)	$U_{bs}$	$\phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_m)$
Web Splice Plate	0.80	1.00	50	65	1.00	915.06

Location	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ $\leq \phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_m)$	$V_r$ (kip)	$R_r > V_r$
Web Splice Plate	915.06	422.72	OK

**Bearing Resistance Check**

Location	Thickness $t_w$ (in)	$F_u$ (ksi)	$t_w * F_u$ (kip/in)	Controlling Web
Web - Left	11/16	45	30.94	CONTROLS
Web - Right	11/16	45	30.94	CONTROLS

Location	Web Splice Plate Thickness - $t_{sp}$ (in)	Splice Plate - $F_u$ (ksi)	$2t_{sp} * F_u$ (kip/in)
Web	5/8	65	81.25

Location	$V_r$ (kip)	$R$ (kip)
Web	422.72	422.72

Location	Bolt Diameter - $d$ (in)	$2d$ (in)	Total Bolts (Per Side) - Calculated	Bolt Rows (Per Side)
Web Splice	1	2.00	10	2

Location	$V_r == R$	$(2t_{sp} * F_u) < (t_w * F_u)$
Web	TRUE	FALSE

Location	Controlling $t$ (in)	Controlling $F_u$ (ksi)
Web	11/16	45

Location	Hole Diameter (in)	Web End Clear Distance (in)	End Clear Distance (in)	Edge Clear Distance (in)	Clear Pitch - Bolts (in)	End Holes	Interior Holes
						Clear Distance - $L_c$ (in)	
Web	1 1/8	3.50	0.69	0.94	4.88	3.50	4.88

Location	Controlling Web Thickness (in)	Controlling $F_u$ (ksi)	$\phi_{bb}$	Clear Distance - $L_c$ (in)	End Holes		
					$R_n = 2.4dtF_u$ Rn (kip)	$R_n = 1.2L_c t F_u$ Rn (kip)	$R_r = \phi_{bb} R_n$ Rr (kip)
Web Splice	11/16	45	0.80	3.50	148.50	DNA	118.8

Location	Controlling Web Thickness (in)	Controlling $F_u$ (ksi)	$\phi_{bb}$	Clear Distance - $L_c$ (in)	Interior Holes		
					$R_n = 2.4dtF_u$ Rn (kip)	$R_n = 1.2L_c t F_u$ Rn (kip)	$R_r = \phi_{bb} R_n$ Rr (kip)
Web Splice	11/16	45	0.80	4.88	594.00	DNA	475.20

End			
Location	Bolt Capacity (kip)	Web Capacity R <sub>r</sub> (kip)	Controlling R <sub>r</sub> (kip)
Web Splice	135.72	118.80	118.80

Interior			
Location	Bolt Capacity (kip)	Web Capacity R <sub>r</sub> (kip)	Controlling R <sub>r</sub> (kip)
Web Splice	542.87	475.20	475.20

Location	Total Bearing Resistance - R <sub>r</sub> (kip)	R (kip)	R <sub>r</sub> > R
Web Splice	594.00	422.72	OK

### Slip Resistance Check

#### Deck Casting - Shear Check

Deck Casting (kip)	0.00
Total Bolts - Calculated	10.00
Per Bolt P <sub>t</sub> (kip)	31
Total P <sub>t</sub> (kip)	306.00
Slip Check	OK

#### Service II - Positive Shear Check

Service II - Positive (kip)	28.79
Total Bolts - Calculated	10
Per Bolt P <sub>t</sub> (kip)	30.60
Total P <sub>t</sub> (kip)	306.00
Slip Check	OK

#### Service II - Negative Shear Check

Service II - Negative (kip)	-8.39
H <sub>w</sub> (kip)	0.00
Resultant R (kip)	8.39
Total Bolts - Calculated	10
Per Bolt P <sub>t</sub> (kip)	30.60
Total P <sub>t</sub> (kip)	306.00
Slip Check	OK