



NSBA Bolted Splice Designer - Plate Girder

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Design Input

Unfactored Loads - Splice Centerline

	Moment (kip-ft)	Shear (kip)
Noncomposite Dead Load (DC ₁)	68.05	3.85
Superimposed Composite Dead Load (DC ₂)	0.00	0.00
Future Wearing Surface (DW)	0.00	0.00
Positive Live Load plus Impact (LL ⁺ + I)	147.86	7.65
Negative Live Load plus Impact (LL ⁻ + I)	-17.16	-21.52
Deck Casting		

Girder Properties

	Left	Right
Top Flange Material	Grade 33	Grade 33
Top Flange Thickness (in)	1 1/4	1 1/4
Top Flange Width (in)	12 11/94	12 11/94

Web Material	Grade 33	Grade 33
Web Thickness (in)	3/4	3/4
Web Depth (in)	33 24/25	

Bottom Flange Material	Grade 33	Grade 33
Bottom Flange Thickness (in)	1 1/4	1 1/4
Bottom Flange Width (in)	12 11/94	12 11/94

Haunch Properties

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

Bolt Properties

Bolt Type	Rivet	
Bolt Diameter (in)	7/8	
Web Threads	Included	
Flange Threads	Included	
Surface Condition Factor (K _s)	A	
Hole Size Factor (K _h)	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)	2 1/4	NG
Edge Distance - Flange (in)	2 3/8	OK
End Distance - Flange (in)	1 1/2	OK
Edge Distance - Web (in)	2 3/8	OK
End Distance - Web (in)	2 1/4	OK
Web Weld Size (in)	50/59	

Splice Plate Properties

	Inner	Outer
Top Flange Splice Plate Material	Grade 33	
Top Flange Splice Plate Thickness (in)	7/8	1 1/2
Top Flange Splice Plate Width (in)	4 7/8	12 11/94
Total Agross (sq-in)	8.5313	18.1755
% Difference Ag Inner/Outer Area	72.22%	
Shear Planes per Bolt (N _s)	1	

Web Splice Plate Material	Grade 33
Web Splice Plate Thickness (in)	1/2

	Inner	Outer
Bottom Flange Splice Plate Material	Grade 33	
Bottom Flange Splice Plate Thickness (in)	7/8	1 1/2
Bottom Flange Splice Plate Width (in)	4 7/8	12 11/94
Total Agross (sq-in)	8.5313	18.1755
% Difference A _g Inner/Outer Area	72.22%	
Shear Planes per Bolt (N _s)	1	

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

Miscellaneous Properties

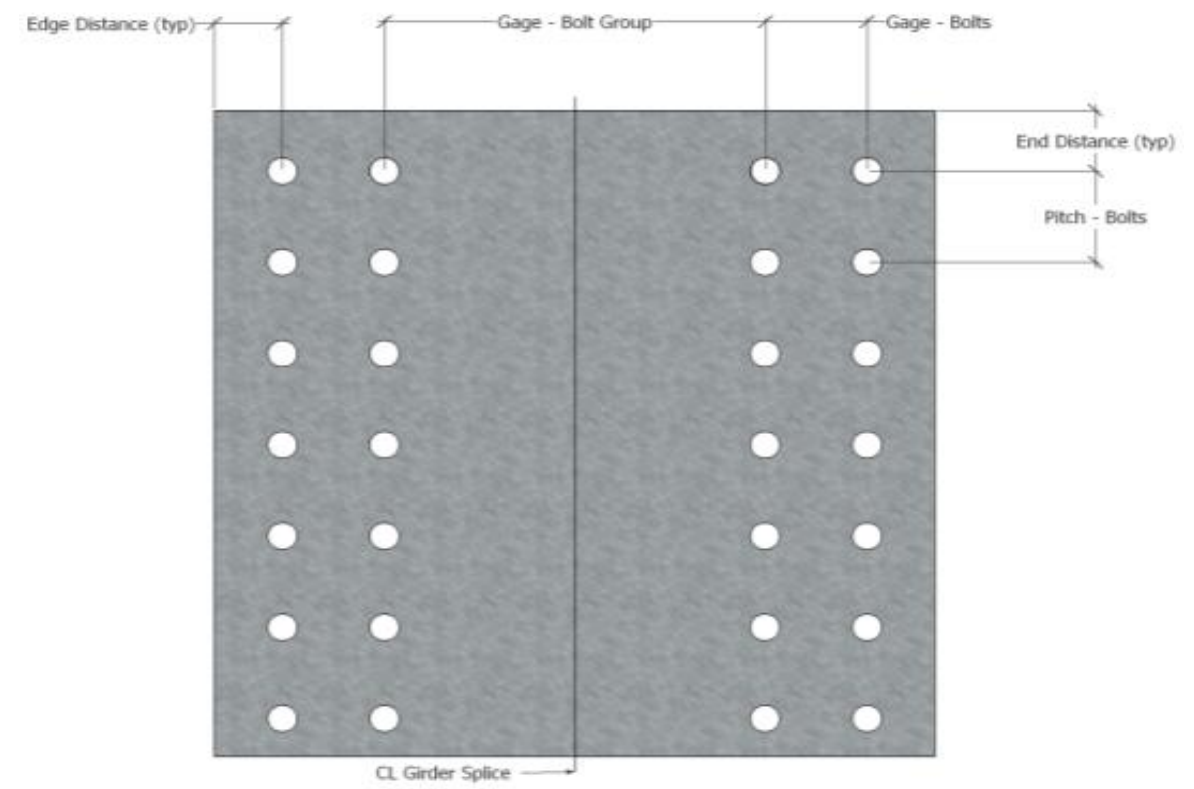
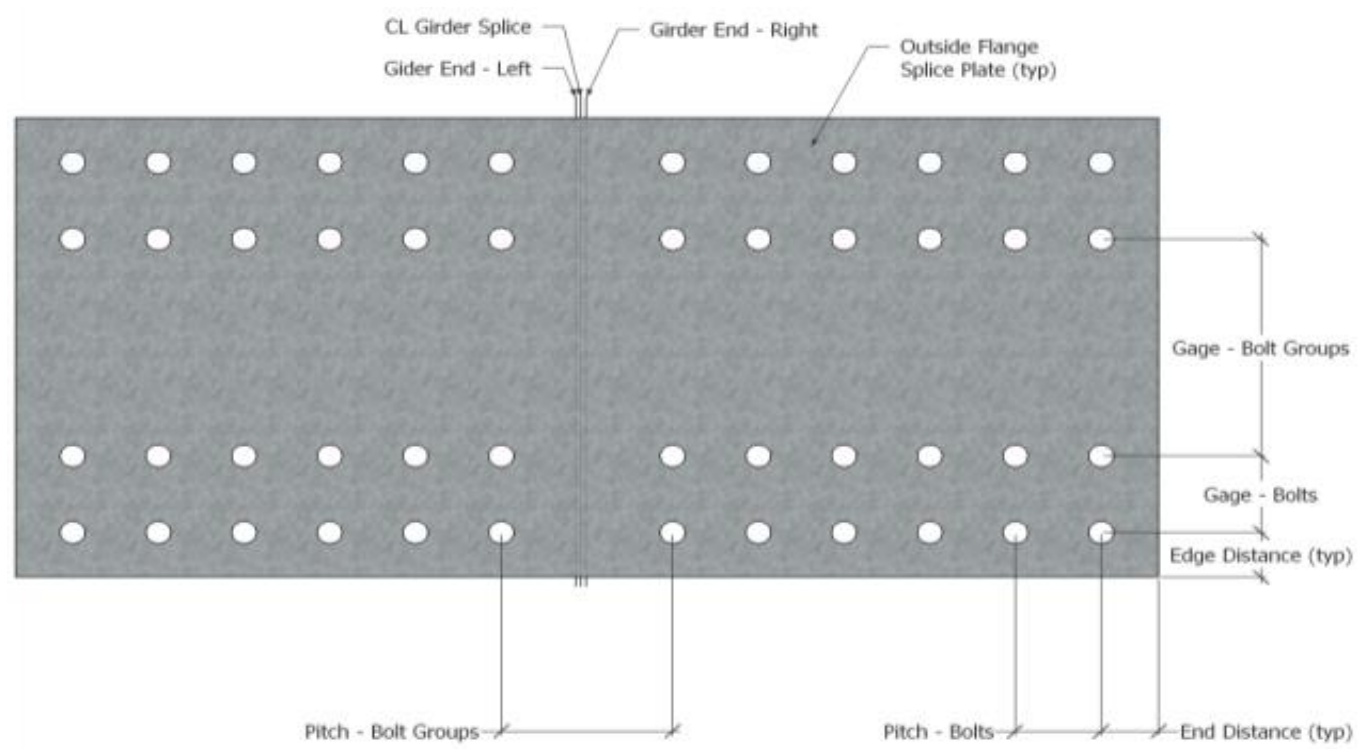
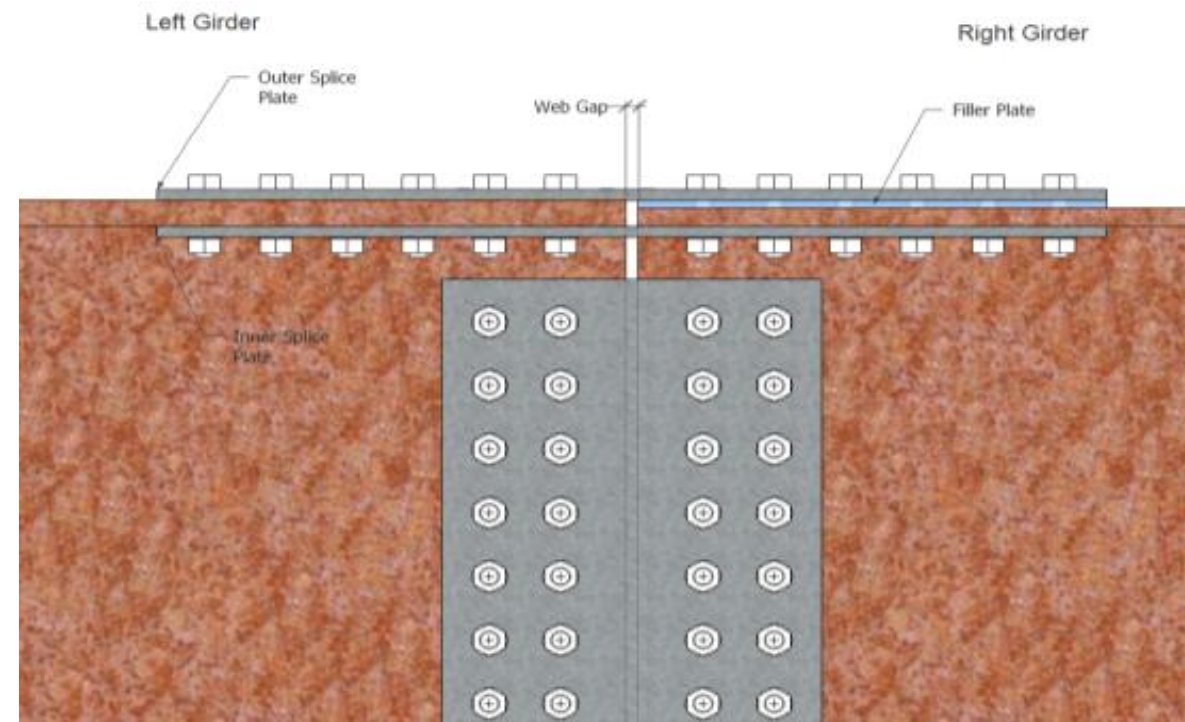
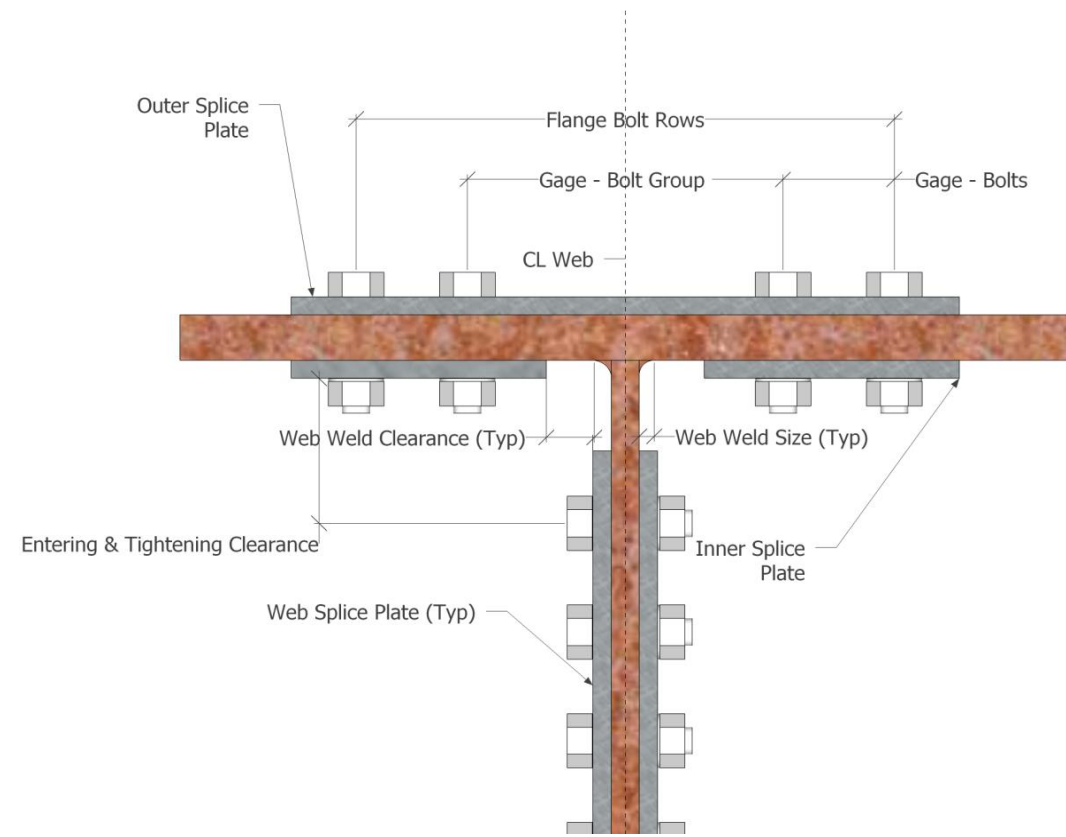
Splice Plate Hole Method	Drilled - Full Size
Transverse Stiffener Spacing (d _o) (ft)	15.0000
Alignment Mode	Web Center

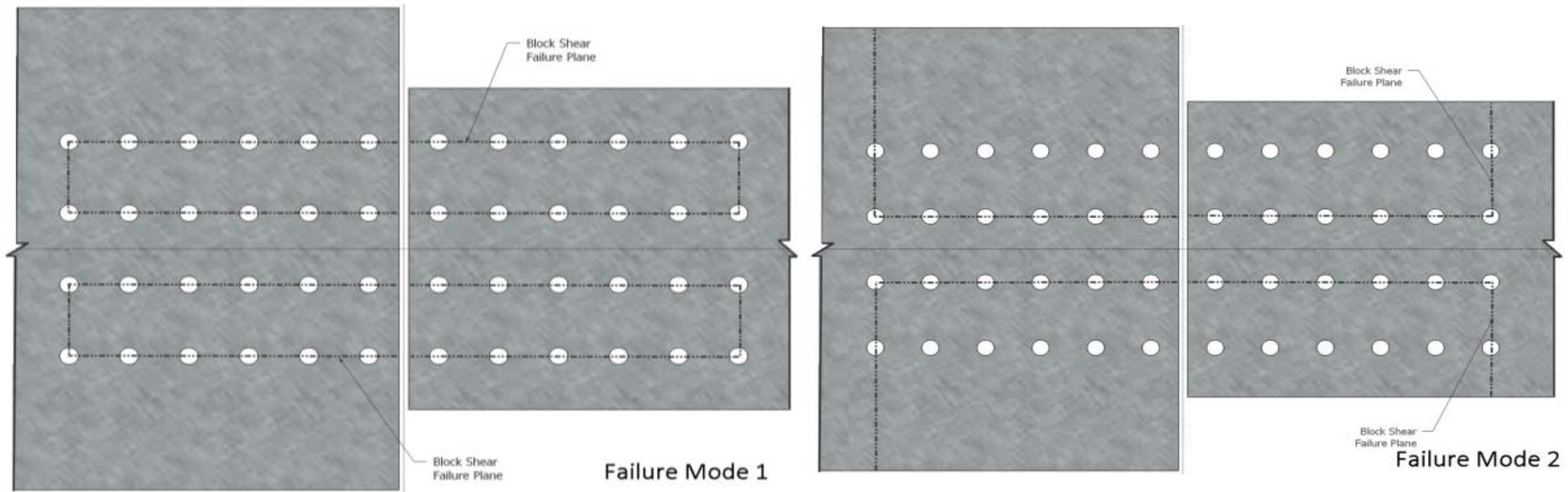
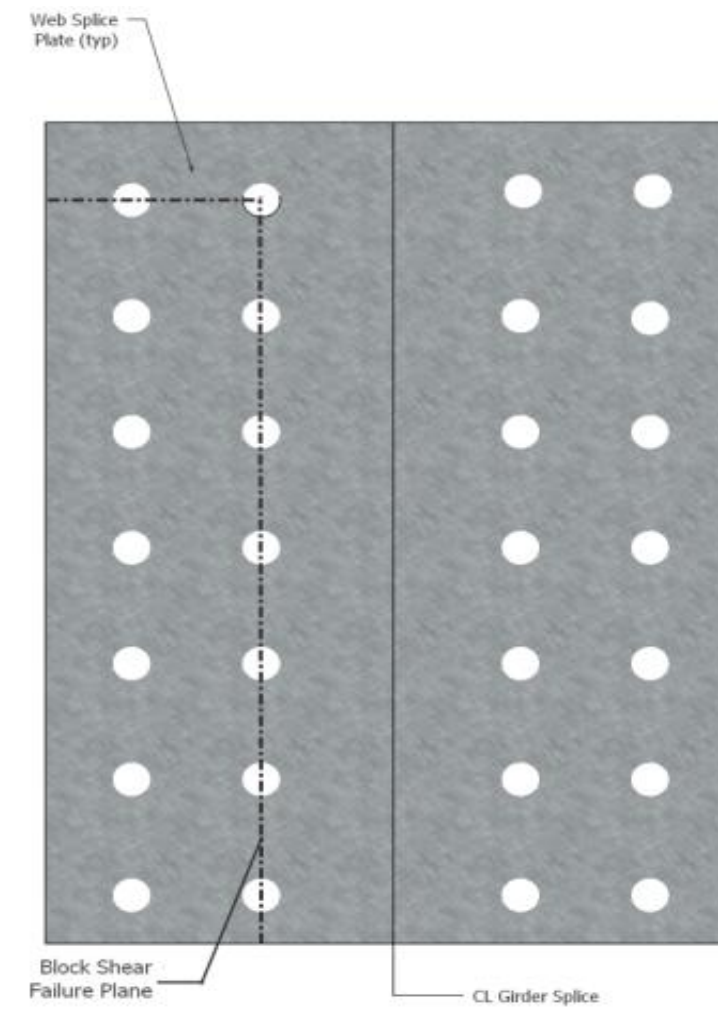
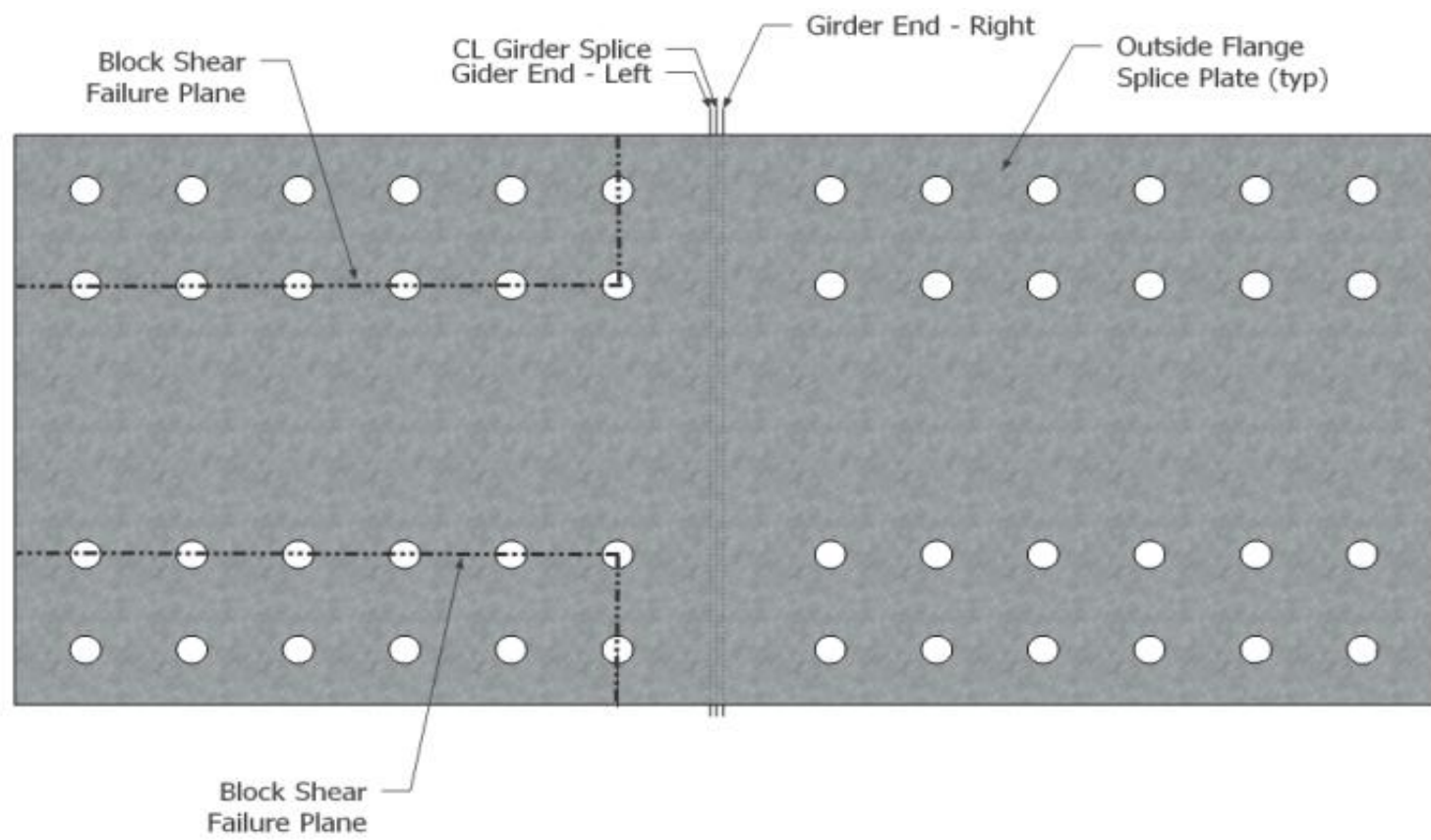
Bolt Count Overrides

	Count Override Status	Bolt Count - Calculated	Bolt Count - User Specified	Valid Override
Top Flange Bolt Count Override	Spreadsheet Calculated	116		DNA
Web Bolt Count Override	Spreadsheet Calculated	20		DNA
Bottom Flange Bolt Count Override	Spreadsheet Calculated	116		DNA

Status - Error Count

Design Status - Flange	0
Bolt Layout Status - Flange	4
Design Status - Web	2
Bolt Layout Status - Web	2







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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	116	Spreadsheet Calculated
Web	2	20	Spreadsheet Calculated
Bottom Flange	2	116	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	2 1/4	1 1/2	7 29/79	3 1/4
Web	3	1 1/2	3	1 1/2	7	DNA
Bottom Flange	0	2 3/8	2 1/4	1 1/2	7 29/79	3 1/4

Splice Plate Dimensions

	Thickness (in)	Width (in)	Length (in)
Top Flange - Outer	1 1/2	12 11/94	134 1/2
Top Flange - Inner (Each)	7/8	4 7/8	
Web	1/2	16	30
Bottom Flange - Inner (Each)	7/8	4 7/8	134 1/2
Bottom Flange - Outer	1 1/2	12 11/94	



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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	1
Shear Planes per Bolt (Ns) - Bottom Flange	1
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	NG	OK

Bearing Resistance

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

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	NG	OK	OK	NG



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Flange Calculations

Load Combinations - Factored Moment

Load Combination	Moment (kip-ft)						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	
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	343.82
Strength I - Negative	0.90	0.90	0.65	0.00	1.75	0.00	31.22
Service II - Positive	1.00	1.00	1.00	1.30	0.00	0.00	260.27
Service II - Negative	1.00	1.00	1.00	0.00	1.30	0.00	45.74

Bolt Factored Shear Resistance

Location	Bolt Type	Bolt Area (sq-in)	K_h	ϕ_s	F_u (ksi)	P_t (kip)	R_s - Single Shear (kip)	R_n - Double Shear (kip)
Flange	Rivet - Included	0.6013	Standard	0.80	50	49.00	10.82	21.65

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	49.00	29.40

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	13 1/8	1 1/2	19.69	200.00%	NG	1.00
Top Flange - Inner Splice Plate	0	0	0.00			0.00
Bottom Flange - Inner Splice Plate	0	0	0.00	200.00%	NG	0.00
Bottom Flange - Outer Splice Plate	13 1/8	1 1/2	19.69			1.00

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

Location	0.84 (F _u /F _y)	Flange A _{gross} (sq-in)	Flange A _{net} (sq-in)	A _e (sq-in)	A _e ≤ A _{gross} (Eq. 2.1.1.1-3)	P _{fy} = F _y A _e P _{fy} (kip)	Controlling Flange	Max. Design Force for Splice Plates (kip) AASHTO C6.13.6.1.3b
Top Flange - Left	1.15	15.15	12.80	14.66	OK	483.93	CONTROLS	483.93
Top Flange - Right	1.15	15.15	12.80	14.66	OK	483.93	CONTROLS	483.93
Bottom Flange - Left	1.15	15.15	12.80	14.66	OK	483.93	CONTROLS	483.93
Bottom Flange - Right	1.15	15.15	12.80	14.66	OK	483.93	CONTROLS	483.93

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	33 24/25	1 1/4	1 1/4	36 23/50
Right Girder			1 1/4	1 1/4	36 23/50

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 11/94	1 1/4	0	0	0	0	0	0
Top Flange - Right	12 11/94	1 1/4	0	0	0	0	0	0
Bottom Flange - Left	12 11/94	1 1/4	0	0	0	0	0	0
Bottom Flange - Right	12 11/94	1 1/4	0	0	0	0	0	0

Location	Area Filler A _f (sq-in)	Area Splice Plate A _p (sq-in)	Area Connection Plate A _p (sq-in)	$\gamma = \frac{A_f}{A_p}$
Top Flange - Left	0.00	26.71	15.15	0.00
Top Flange - Right	0.00		15.15	0.00
Bottom Flange - Left	0.00	26.71	15.15	0.00
Bottom Flange - Right	0.00		15.15	0.00

Bolt Count - Summary

Location	P _{fy} (kip)	$R = \frac{(1 + \gamma)}{(1 + 2\gamma)}$ Filler Reduction - R	Total Bolt - Initial	Bolt Rows (Per Side)	Total Bolts (Per Side) - Calculated
Top Flange - Left	483.93	1.00	44.71	2	116
Top Flange - Right					
Bottom Flange - Left	483.93	1.00	44.71	2	116
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)	260.27	35.21	29.40	3.02	2	4	4
Service II - Negative (kip-ft)	45.74	35.21		0.53	2	2	2
Deck Casting Moment (kip-ft)	0.00	35.21		0.00	2	0	0

Bolt Count - Final

	Strength	Slip	Override	Controlling	Bolt Count Override
Top Flange	116	2	DNA	116	FALSE
Bottom Flange	116	4	DNA	116	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	1 1/2	7/8	2 1/4	7 1/2	7
Top Flange - Inner Splice Plate	7/8				
Bottom Flange - Inner Splice Plate	7/8	7/8		7 1/2	7
Bottom Flange - Outer Splice Plate	1 1/2				

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 7/8	2 1/4	2 5/8	2 3/8	1 1/8	OK	2 3/8	0
Bottom Flange	4 7/8					OK		

Location	Width - Outer Plate (in)	Edge Distance - Final (in)	Transverse Gage - Bolt Groups (in)
Top Flange	12 11/94	2 3/8	7 29/79
Bottom Flange	12 11/94	2 3/8	7 29/79

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

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	2 1/4	2 5/8	1 1/2	3 1/4	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	116	2 1/4	3 1/4	1 1/2	12 11/94	1 1/2	134 1/2
Top Flange - Inner Splice Plate						4 7/8	7/8	
Bottom Flange - Inner Splice Plate	2	116				4 7/8	7/8	134 1/2
Bottom Flange - Outer Splice Plate						12 11/94	1 1/2	

Bolt Layout - Diagonal Edge

Location	End Distance (in) - Final	Edge Distance (in)	Diagonal Edge Distance (in)	Final Diagonal Edge Distance - Check
Top Flange Splice	1.50	1.50	2.12	OK
Bottom Flange Splice				

Splice Plate - Bolt Shear Resistance Joint Length Reduction Check

Location	Bolt Shear Resistance Joint Length Reduction Factor
Top Flange Splice	0.83
Bottom Flange Splice	0.83

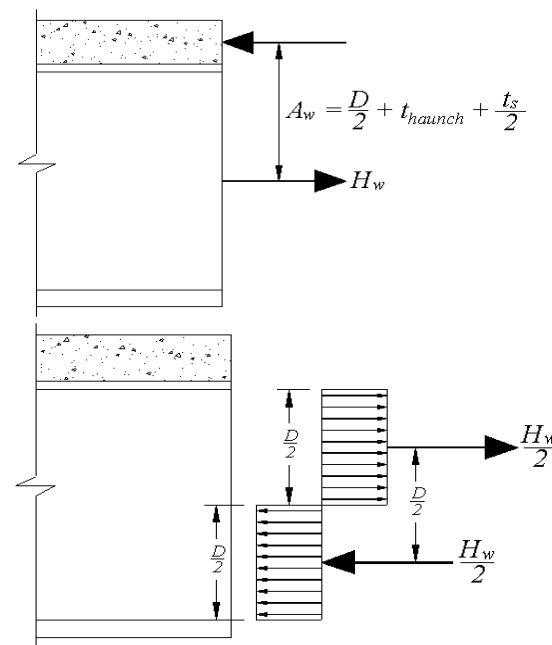
Moment Resistance

Positive Moment

Moment Arm (in)	35.21
Bottom Flange Force (k)	483.93
M_{flange} (kip-ft)	1,419.94
Strength I - Positive (kip-ft)	343.82
Check M_{flange}	OK
Hw (kip)	DNA

Negative Moment

Moment Arm (in)	35.21
Minimum Flange Force(k)	483.93
M_{flange} (kip-ft)	1,419.94
Strength I - Negative (kip-ft)	31.22
Check M_{flange}	OK
Hw (kip)	DNA



Splice Plates

Location	Width (in)	Thickness (in)	Total A_{gross} (sq-in)
Top Flange - Outer Splice Plate	13 1/8	1 1/2	19.69
Top Flange - Inner Splice Plate	4 7/8	7/8	8.53
Bottom Flange - Inner Splice Plate	4 7/8	7/8	8.53
Bottom Flange - Outer Splice Plate	13 1/8	1 1/2	19.69

Factored Yield Resistance - Tension

Location	Design Force in Splice Plate (kip)	ϕ_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	483.93	0.95	33	19.69	617.20	OK
Top Flange - Inner Splice Plate	0.00			8.53	267.45	OK
Bottom Flange - Inner Splice Plate	0.00		33	8.53	267.45	OK
Bottom Flange - Outer Splice Plate	483.93			19.69	617.20	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	15.36	19.69	16.73	OK	15.36
Top Flange - Inner Splice Plate	6.89	8.53	7.25	OK	6.89
Bottom Flange - Inner Splice Plate	6.89	8.53	7.25	OK	6.89
Bottom Flange - Outer Splice Plate	15.36	19.69	16.73	OK	15.36

Net Section Fracture Resistance - Tension

Location	Design Force in Splice Plate (kip)	ϕ_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	483.93	0.80	45	15.36	1.00	1.00	553.07	OK
Top Flange - Inner Splice Plate	0.00			6.89			248.06	OK
Bottom Flange - Inner Splice Plate	0.00		45	6.89			248.06	OK
Bottom Flange - Outer Splice Plate	483.93			15.36			553.07	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	0.9375	2	3.81	1 1/2	5.72
Top Flange - Inner Splice Plate	2.38	0.5			3.81	7/8	3.34
Bottom Flange - Inner Splice Plate	2.38	0.5			3.81	7/8	3.34
Bottom Flange - Outer Splice Plate	2.38	0.5			3.81	1 1/2	5.72

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	129.75	57.5	0.9375	2	151.69	1 1/2	227.53
Top Flange - Inner Splice Plate	129.75	57.5			151.69	7/8	132.73
Bottom Flange - Inner Splice Plate	129.75	57.5			151.69	7/8	132.73
Bottom Flange - Outer Splice Plate	129.75	57.5			151.69	1 1/2	227.53

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	129.75	1 1/2	2	389.25
Top Flange - Inner Splice Plate	129.75	7/8		227.06
Bottom Flange - Inner Splice Plate	129.75	7/8		227.06
Bottom Flange - Outer Splice Plate	129.75	1 1/2		389.25

Location	ϕ_{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 _r (kip)
Top Flange - Outer Splice Plate	0.80	1.00	45	1.00	4956.73
Top Flange - Inner Splice Plate					2891.42
Bottom Flange - Inner Splice Plate			2891.42		
Bottom Flange - Outer Splice Plate			4956.73		

Location	ϕ_{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	33	45	1.00	6166.07
Top Flange - Inner Splice Plate						3596.87
Bottom Flange - Inner Splice Plate			3596.87			
Bottom Flange - Outer Splice Plate			6166.07			

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	4956.73	483.93	OK
Top Flange - Inner Splice Plate	2891.42		OK
Bottom Flange - Inner Splice Plate	2891.42	483.93	OK
Bottom Flange - Outer Splice Plate	4956.73		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	0.9375	2	0.00	1 1/4	0.00
Top Flange - Right	0.00	0			0.00	1 1/4	0.00
Bottom Flange - Left	0.00	0			0.00	1 1/4	0.00
Bottom Flange - Right	0.00	0			0.00	1 1/4	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	129.75	57.5	0.9375	4	303.38	1 1/4	379.22
Top Flange - Right	129.75	57.5			303.38	1 1/4	379.22
Bottom Flange - Left	129.75	57.5			303.38	1 1/4	379.22
Bottom Flange - Right	129.75	57.5			303.38	1 1/4	379.22

Location	Gross Path Length per Failure Plane - Shear (in)	Flange Thickness (in)	Path Count	Gross Area A_{vg} (sq-in)
Top Flange - Left	129.75	1 1/4	4	648.75
Top Flange - Right	129.75	1 1/4		648.75
Bottom Flange - Left	129.75	1 1/4		648.75
Bottom Flange - Right	129.75	1 1/4		648.75

Location	ϕ_{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 _r (kip)
Top Flange - Left	0.80	1.00	45	1.00	7918.09
Top Flange - Right			45		7918.09
Bottom Flange - Left			45		7918.09
Bottom Flange - Right			45		7918.09

Location	ϕ_{bs}	R_p	F_y (ksi)	F_u (ksi)	U_{bs}	$\phi_{bs}R_p(0.58F_yA_{vg} + U_{bs}F_uA_{tn})$
Top Flange - Left	0.80	1.00	33	45	1.00	9933.66
Top Flange - Right			33	45		9933.66
Bottom Flange - Left			33	45		9933.66
Bottom Flange - Right			33	45		9933.66

Location	$R_r = \phi_{bs}R_p(0.58F_uA_{vn} + U_{bs}F_uA_{tn})$ $\leq \phi_{bs}R_p(0.58F_yA_{vg} + U_{bs}F_uA_{tn})$	P_{fy} (kip)	Block Shear Rupture Resistance Check
Top Flange - Left	7918.09	483.93	OK
Top Flange - Right	7918.09		OK
Bottom Flange - Left	7918.09	483.93	OK
Bottom Flange - Right	7918.09		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	0.9375	2	3.81	1 1/4	4.77
Top Flange - Right	2.38	0.5			3.81	1 1/4	4.77
Bottom Flange - Left	2.38	0.5			3.81	1 1/4	4.77
Bottom Flange - Right	2.38	0.5			3.81	1 1/4	4.77

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	129.75	57.5	0.9375	2	151.69	1 1/4	189.61
Top Flange - Right	129.75	57.5			151.69	1 1/4	189.61
Bottom Flange - Left	129.75	57.5			151.69	1 1/4	189.61
Bottom Flange - Right	129.75	57.5			151.69	1 1/4	189.61

Location	Gross Path Length per Failure Plane - Shear (in)	Flange Thickness (in)	Path Count	Gross Area A_{vg} (sq-in)
Top Flange - Left	129.75	1 1/4	2	324.38
Top Flange - Right	129.75	1 1/4		324.38
Bottom Flange - Left	129.75	1 1/4		324.38
Bottom Flange - Right	129.75	1 1/4		324.38

Location	ϕ_{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 _r (kip)
Top Flange - Left	0.80	1.00	45	1.00	4130.61
Top Flange - Right			45		4130.61
Bottom Flange - Left			45		4130.61
Bottom Flange - Right			45		4130.61

Location	ϕ_{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	5138.39
Top Flange - Right			33	45		5138.39
Bottom Flange - Left			33	45		5138.39
Bottom Flange - Right			33	45		5138.39

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	4130.61	483.93	OK
Top Flange - Right	4130.61		OK
Bottom Flange - Left	4130.61	483.93	OK
Bottom Flange - Right	4130.61		OK

Bearing Resistance Check

Location	Thickness (in)	F_u (ksi)	(kip/in)	Controlling
Top Flange - Splice Plates	2.38	45	106.88	
Top Flange - Left	1.25	45	56.25	CONTROLS
Top Flange - Right	1.25	45	56.25	CONTROLS
Bottom Flange - Splice Plates	2.38	45	106.88	
Bottom Flange - Left	1.25	45	56.25	CONTROLS
Bottom Flange - Right	1.25	45	56.25	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	15/16	7/8	1.75	1 1/2	2 1/4	116	2
Top Flange - Right							
Bottom Flange - Left						116	2
Bottom Flange - Right							

End Holes							
Location	Thickness (in)	F_u (ksi)	ϕ_{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	1.50	45	0.80	1.03	DNA	167.06	133.65
Top Flange - Left	1.25	45			DNA	139.22	111.38
Top Flange - Right					DNA	97.45	77.96
Top Flange - Inner Splice Plate	0.88	45			DNA	97.45	77.96
Bottom Flange - Inner Splice Plate	0.88	45			DNA	97.45	77.96
Bottom Flange - Left	1.25	45			DNA	139.22	111.38
Bottom Flange - Right					DNA	167.06	133.65
Bottom Flange - Outer Splice Plate	1.50	45			DNA	167.06	133.65

Interior Holes							
Location	Thickness (in)	F_u (ksi)	ϕ_{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	1.50	45	0.80	1.31	DNA	12119.63	9695.70
Top Flange - Left	1.25	45			DNA	10099.6875	8079.75
Top Flange - Right					DNA	7069.7813	5655.83
Top Flange - Inner Splice Plate	0.88	45			DNA	7069.7813	5655.83
Bottom Flange - Inner Splice Plate	0.88	45			DNA	7069.7813	5655.83
Bottom Flange - Left	1.25	45			DNA	10099.6875	8079.75
Bottom Flange - Right					DNA	12119.6250	9695.70
Bottom Flange - Outer Splice Plate	1.50	45			DNA	12119.6250	9695.70

End			
Location	Bolt Capacity R_r (kip)	Bearing Resistance R_r (kip)	Controlling R_r (kip)
Top Flange - Outer Splice Plate	21.65	133.65	21.65
Top Flange - Left	43.30	111.38	43.30
Top Flange - Right			
Top Flange - Inner Splice Plate	21.65	77.96	21.65
Bottom Flange - Inner Splice Plate	21.65	77.96	21.65
Bottom Flange - Left	43.30	111.38	43.30
Bottom Flange - Right			
Bottom Flange - Outer Splice Plate	21.65	133.65	21.65

Interior			
Location	Bolt Capacity R_r (kip)	Bearing Resistance R_r (kip)	Controlling R_r (kip)
Top Flange - Outer Splice Plate	1233.91	9695.70	1233.91
Top Flange - Left	2467.82	8079.75	2467.82
Top Flange - Right			
Top Flange - Inner Splice Plate	1233.91	5655.83	1233.91
Bottom Flange - Inner Splice Plate	1233.91	5655.83	1233.91
Bottom Flange - Left	2467.82	8079.75	2467.82
Bottom Flange - Right			
Bottom Flange - Outer Splice Plate	1233.91	9695.70	1233.91

Location	Total Bearing Resistance - R_r (kip)	Design Force (kip)	Bearing Resistance Check
Top Flange - Outer Splice Plate	1255.56	483.93	OK
Top Flange - Left	2511.11	483.93	OK
Top Flange - Right			
Top Flange - Inner Splice Plate	1255.56	0.00	OK
Bottom Flange - Inner Splice Plate	1255.56	0.00	OK
Bottom Flange - Left	2511.11	483.93	OK
Bottom Flange - Right			
Bottom Flange - Outer Splice Plate	1255.56	483.93	OK

Slip Resistance Check

Service II - Positive Moment Check

Moment Arm (in)	35.21
Service II - Positive (kip-ft)	260.27
Total Bolts - Calculated	116
Per Bolt P_t (kip)	29.40
Total P_t (kip)	3,410.40
Moment (kip-ft)	10,006.68
Slip Check	OK
Hw (kip)	DNA

Service II - Negative Moment Check

Moment Arm (in)	35.21
Service II - Negative (kip-ft)	45.74
Total Bolts - Calculated	116
Per Bolt P_t (kip)	29.40
Total P_t (kip)	3,410.40
Moment (kip-ft)	10,006.68
Slip Check	OK
Hw (kip)	DNA

Deck Casting Check

Moment Arm (in)	35.21
Deck Casting Moment (kip-ft)	0.00
Total Bolts - Calculated	116
Per Bolt P_t (kip)	29.40
Total P_t (kip)	3,410.40
Moment (kip-ft)	10,006.68
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	13.80
Service II - Negative	1.00	1.00	1.00	0.00	1.30	0.00	-24.13

CONTROLS

Bolt Factored Shear Resistance

Location	Bolt Type	Bolt Area (sq-in)	K_h	ϕ_s	F_u (ksi)	P_t (kip)	R_r - Single Shear (kip)	R_r - Double Shear (kip)
Web	Rivet - Included	0.6013	Standard	0.80	50	49.00	10.82	21.65

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	49.00	29.40

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	34	3/4	25.47	0
Web - Right	33	29000	45	1.15	34	3/4	25.47	

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	45.28	5.30	5.00	74.24	92.80	1.00	487.50	487.50	487.50
Web - Right	45.28	5.30	5.00	74.24	92.80	1.00	487.50	487.50	487.50

Bolt Count - Summary (Initial)

Location	Controlling H_w (kip)	V_n (kip)	ϕ_v	V_r (kip)
Web	0.00	487.50	1.00	487.50

Location	R (kip)	Total Bolt - Initial	Bolt Rows (Per Side)	Total Bolts (Per Side) - Calculated
Web	487.50	22.52	2	20

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	29.40	0.00	2	0	2
Service II – Positive (kip)	13.80	DNA		0.47		2	
Service II – Negative (kip)	-24.13	DNA		0.82		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	1/2	6	6

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 1/2	5/16	0	2 3/4	2 7/9	-1 5/18

Web - Bottom	1 1/4	30/33	0	2 3/4	2 7/9	-1 5/18
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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	33 24/25	32 22/83	-1 5/18	29 49/69
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	29 49/69	1 1/2	6	12

Bolt Count - Final

	Strength	Slip	Pitch	Override	Controlling	Bolt Count Override
Web	20	2	12	DNA	20	FALSE

Layout Checks

Pitch and End Distance Verification

Location	End Distance - Final (in)	Pitch - Bolts (in) - Final	Splice Plate Height - Final (in)
Web	1 1/2	3	30

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	7	NG

Bolt Layout - Diagonal Edge

Location	End Distance (in)	Edge Distance (in)	Diagonal Edge Distance (in)	Final Diagonal Edge Distance - Check
Web	1.5000	1.5000	2.1213	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	20	3	7	1 1/2	30	1/2	16
Web - Filler						0	0	0

Splice Plates

Factored Shear Yielding Resistance

Location	ϕ_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	33	30	0.5000	30.00	574.20	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	30	0.5000	20	2	0.9375	20.63

Location	ϕ_{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	45	430.65	487.50	NG

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	0.9375	2	6.19	1/2	3.09

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	28.50	9.5	0.9375	2	39.19	1/2	19.59

Location	Gross Path Length per Failure Plane - Shear (in)	Splice Plate Thickness (in)	Path Count	Gross Area A_{vg} (sq-in)
Web Splice Plate	28.50	1/2	2	28.50

Location	ϕ_{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 _r (kip)
Web Splice Plate	0.80	1.00	45	1.00	520.49

Location	ϕ_{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	33	45	1.00	547.77

Location	$R_r = \phi_{bs} R_p (0.58 F_u A_{vn} + U_{bs} F_u A_{tn})$ $\leq \phi_{bs} R_p (0.58 F_y A_{vg} + U_{bs} F_u A_{tn})$	V_r (kip)	$R_r > V_r$
Web Splice Plate	520.49	487.50	OK

Bearing Resistance Check

Location	Thickness t_w (in)	F_u (ksi)	$t_w * F_u$ (kip/in)	Controlling Web
Web - Left	3/4	45	33.75	CONTROLS
Web - Right	3/4	45	33.75	CONTROLS

Location	Web Splice Plate Thickness - t_{sp} (in)	Splice Plate - F_u (ksi)	$2t_{sp} * F_u$ (kip/in)
Web	1/2	45	45.00

Location	V_r (kip)	R (kip)
Web	487.50	487.50

Location	Bolt Diameter - d (in)	$2d$ (in)	Total Bolts (Per Side) - Calculated	Bolt Rows (Per Side)
Web Splice	7/8	1.75	20	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	3/4	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	15/16	3.01	1.03	1.03	2.06	3.01	2.06

Location	Controlling Web Thickness (in)	Controlling F_u (ksi)	ϕ_{bb}	Clear Distance - L_c (in)	End Holes		
					$R_n = 2.4dtF_u$ Rn (kip)	$R_n = 1.2L_c tF_u$ Rn (kip)	$R_r = \phi_{bb}R_n$ Rr (kip)
Web Splice	3/4	45	0.80	3.01	141.75	DNA	113.4

Location	Controlling Web Thickness (in)	Controlling F_u (ksi)	ϕ_{bb}	Clear Distance - L_c (in)	Interior Holes		
					$R_n = 2.4dtF_u$ Rn (kip)	$R_n = 1.2L_c tF_u$ Rn (kip)	$R_r = \phi_{bb}R_n$ Rr (kip)
Web Splice	3/4	45	0.80	2.06	1275.75	DNA	1020.60

End			
Location	Bolt Capacity (kip)	Web Capacity R _r (kip)	Controlling R _r (kip)
Web Splice	43.30	113.40	43.30

Interior			
Location	Bolt Capacity (kip)	Web Capacity R _r (kip)	Controlling R _r (kip)
Web Splice	389.66	1020.60	389.66

Location	Total Bearing Resistance - R _r (kip)	R (kip)	R _r > R
Web Splice	432.95	487.50	NG

Slip Resistance Check

Deck Casting - Shear Check

Deck Casting (kip)	0.00
Total Bolts - Calculated	20.00
Per Bolt P _t (kip)	29
Total P _t (kip)	588.00
Slip Check	OK

Service II - Positive Shear Check

Service II - Positive (kip)	13.80
Total Bolts - Calculated	20
Per Bolt P _t (kip)	29.40
Total P _t (kip)	588.00
Slip Check	OK

Service II - Negative Shear Check

Service II - Negative (kip)	-24.13
H _w (kip)	0.00
Resultant R (kip)	24.13
Total Bolts - Calculated	20
Per Bolt P _t (kip)	29.40
Total P _t (kip)	588.00
Slip Check	OK