Structural Calculations
of
Steel Half-Through Truss Bridge

107'-6" Long x 6'-0" Wide

Prepared for:

Anderson Bridges LLC

Parkway Utility District Pedestrian Bridge

Houston, Texas

July 2011

Parkway Utility District Pedestrian Bridge

Houston, TX

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DESIGN NOTES

The design of this bridge structure is in accordance with appropriate portions of the American Association of State Highway and Transportation Officials (AASHTO) “Standard Specifications for Highway Bridges,” the “Guide Specification for Design of Pedestrian Bridges,” and the American Institute of Steel Construction (AISC) “Manual of Steel Construction,” as applicable.

LRFD is utilized for the structural design due to being the primary Design Specification for the design of Hollow Structural Sections (HSS) members and connections. (*Load and Resistance Factor Design Specification for Steel Hollow Structural Sections*, AISC, and the *Structural Welding Code – Steel*, AWS.) The calculations from the computer design program conservatively utilize the appropriate AASHTO Load Factors and the lower AISC resistance factors due to limitation of the computerized analysis and design program to AISC resistance factors.

Design Loads:

- 85 psf Live Load
- 5,000 lb.Vehicle Load
- 35 psf Wind Load (On full vertical projected area, as if enclosed.)
  + 20 psf Wind Load Uplift at ¼ point

DESIGN LOAD APPLICATION

INPUT:

Blue = Manual Input
Red = Automatic Calculation

85 : Design Live Load, psf
35 : Horizontal Wind Load, psf
20 : Vertical Wind Uplift, psf
5000 : Vehicle Load, lbs
0.50 : Vehicle Load Rear Axle Distribution, %
0.00 : Vehicle Impact, %

8 : Deck Dead Load, psf
4.1 : Stringer Dead Load, plf
4 : # of Stringers
20 : Additional Dead Load per truss, plf

107.5 : Bridge Length, ft
6.00 : Bridge Deck Width, ft
7.00 : Bridge Structure Width, ft
6.000 : Interior Panel Spacing, ft
5.750 : End Panel Spacing, ft

OUTPUT:

0.009 : **Dead Load** applied to Interior Floor Beams, k/in
(Deck DL x Int. Panel Spacing + Stringer DL x # of Stringers x Int. Panel Spacing)
0.006 : **Dead Load** applied to End Floor Beams, k/in
(Deck DL x 1/2 End Panel Spacing + Stringer DL x # of Stringers x 1/2 End Panel Spacing)

0.043 : **Live Load** applied to Interior Floor Beams, k/in
(LL x Int. Panel Spacing)
0.020 : **Live Load** applied to End Floor Beams, k/in
(LL x 1/2 End Panel Spacing)

1.25 : **Vehicle Rear Wheel Load** applied to Floor Beam, Kips
(Vehicle Load x Impact x Rear Axle Distribution / 2)
1.25 : **Vehicle Front Wheel Load** applied to Floor Beam, Kips
(Vehicle Load x Impact x 100 - Rear Axle Distribution / 2)

0.018 : **Wind Load, Horizontal** applied to Interior Verticals, k/in
(WLH x Int. Panel Spacing)
0.008 : **Wind Load, Horizontal** applied to End Verticals, k/in
(WLH x 1/2 End Panel Spacing)

0.840 : **Wind Load, Vertical** applied to Interior Floor Beams, Kips
(WLV x Bridge Structure Width x Int. Panel Spacing)
0.403 : **Wind Load, Vertical** applied to End Floor Beams, Kips
(WLV x Bridge Structure Width x 1/2 End Panel Spacing)

Load Combinations:

1.25 DL + 1.75 LLr	AASHTO Strength I
1.25 DL +- 1.4 WL	AASHTO Strength III
1.25 DL + 1.35 LL +- .4 WL	AASHTO Strength V
1.0 DL + 1.3 VL	AASHTO Service II

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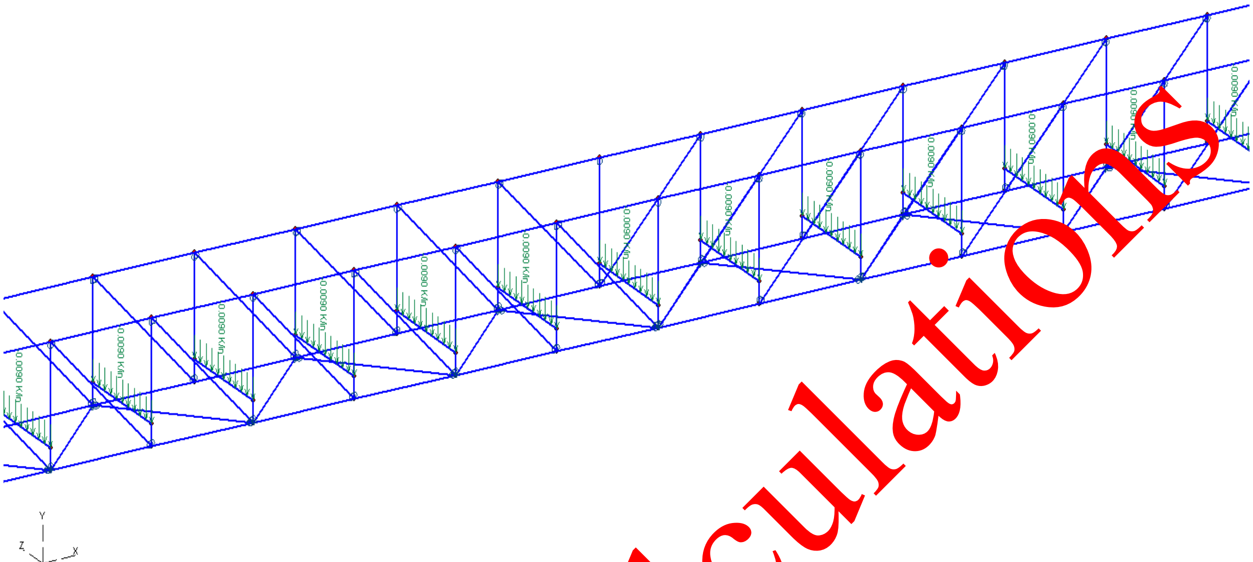
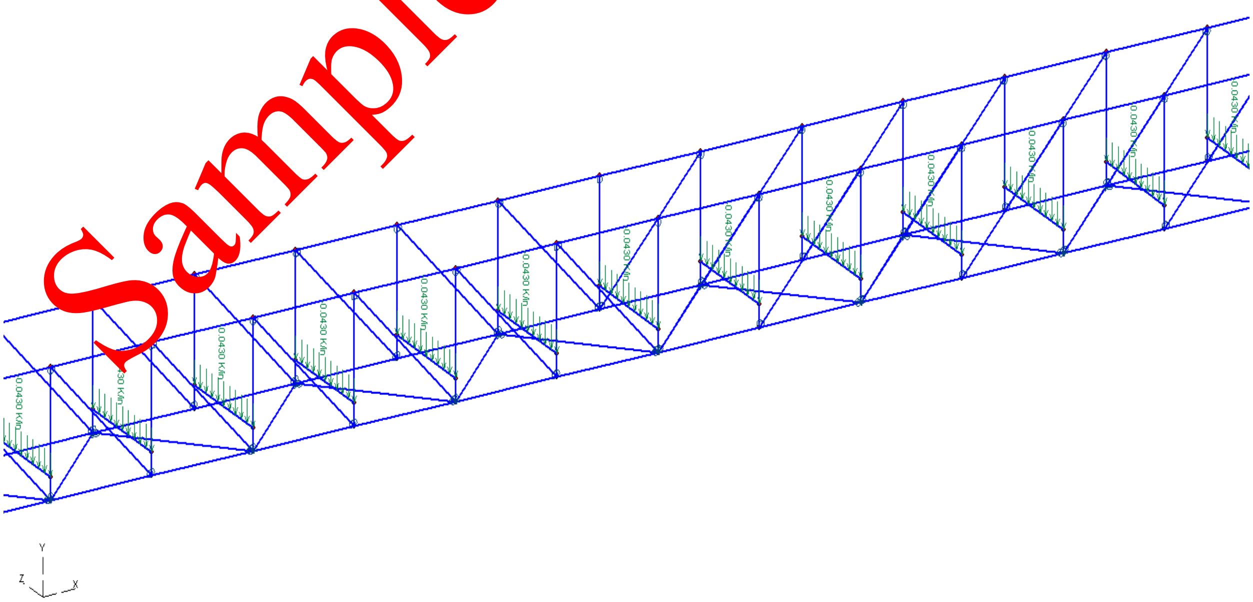
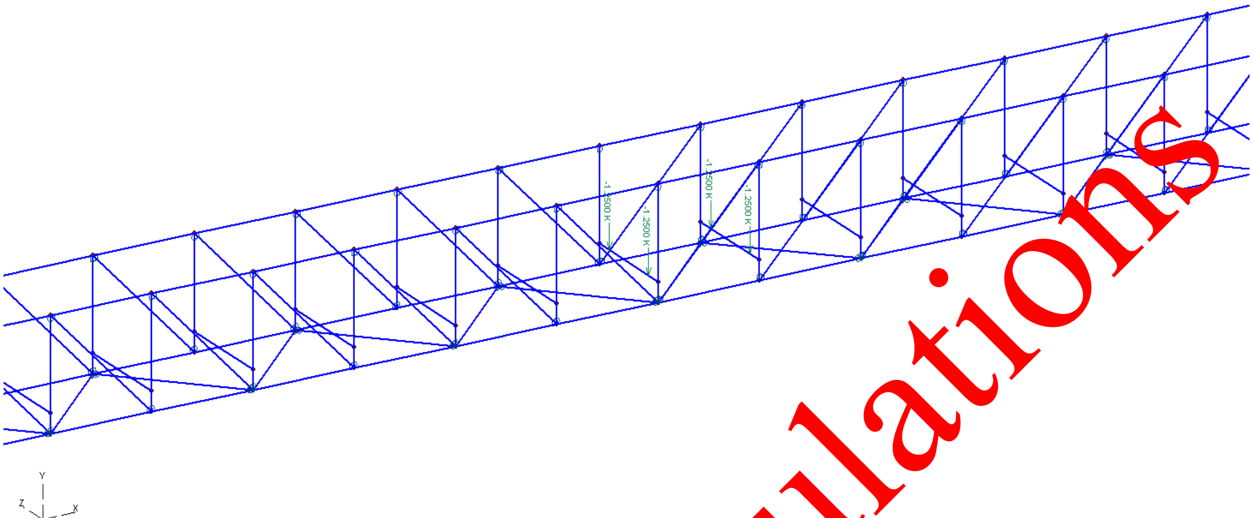
Dead Loads:



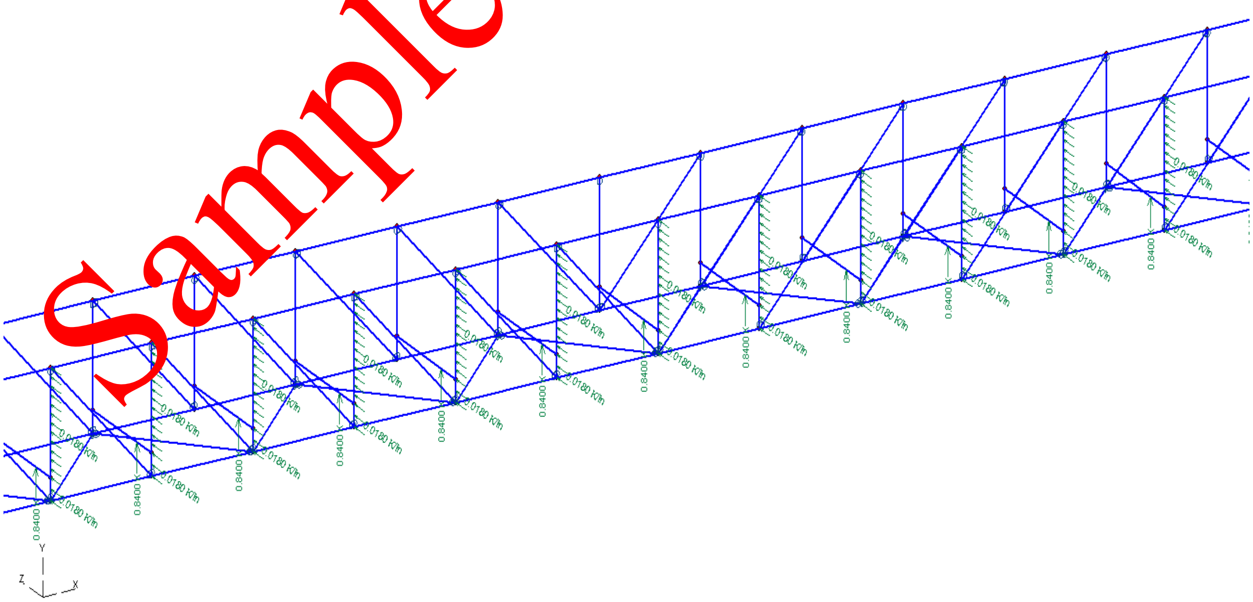
Live Loads:



Vehicle Load – At Center:



Wind Load:



U-FRAME STIFFNESS, HALF-THROUGH TRUSS

The top chord of a half-through truss, or pony truss, is designed as a continuous beam-column on elastic supports. It is a compression member that is laterally supported by the stiffness of the verticals, the floor beams, and the connections between the two. This stiffness of the verticals and floor beam is referred to as the "U-Frame stiffness." Design parameters have been drawn from several highly regarded experts in the field of structural stability. This information is compiled in the 4th Edition of "Guide to Stability Design Criteria for Metal Structures," chapter 15, titled "Members with Elastic Lateral Restraints", as edited by Theodore V. Galambos. Basically, the design approach is that the U-Frame must be designed to resist a lateral force equal to a percentage of the axial load in the top chord acting normal to the plane of the vertical truss. This produces an out-of-plane bending in the verticals. The stiffness provided for lateral support of the top chord is equated to a design k factor for the out-of-plane buckling of the top chord. This is accomplished from an interaction of CL/PcxF.S., n, and a value of 1/K as described in the attached table from the reference guide.

Cf = E / [h^2(h/3Iv) + b/2Ifb)]

Where:

- Cf = Furnished stiffness at the top of the least stiff transverse frame.
- h = Dimension from centerline of top chord to centerline of floor beam, in.
- b = Dimension from centerline to centerline of verticals, in.
- Iv = Moment of Inertia of verticals, in^4.
- Ifb = Moment of Inertia of floor beams, in^4.

INPUT DATA:

58.5	: h	
78	: b	
7.8	: Iv	HSS 4x4x1/4
22.1	: I fb	W 6x12
29000	: E	
72	: L	
90	: Pc	
18	: n	

OUTPUT:

1.99	= Cf
0.795	= CL/Pc x F.S.

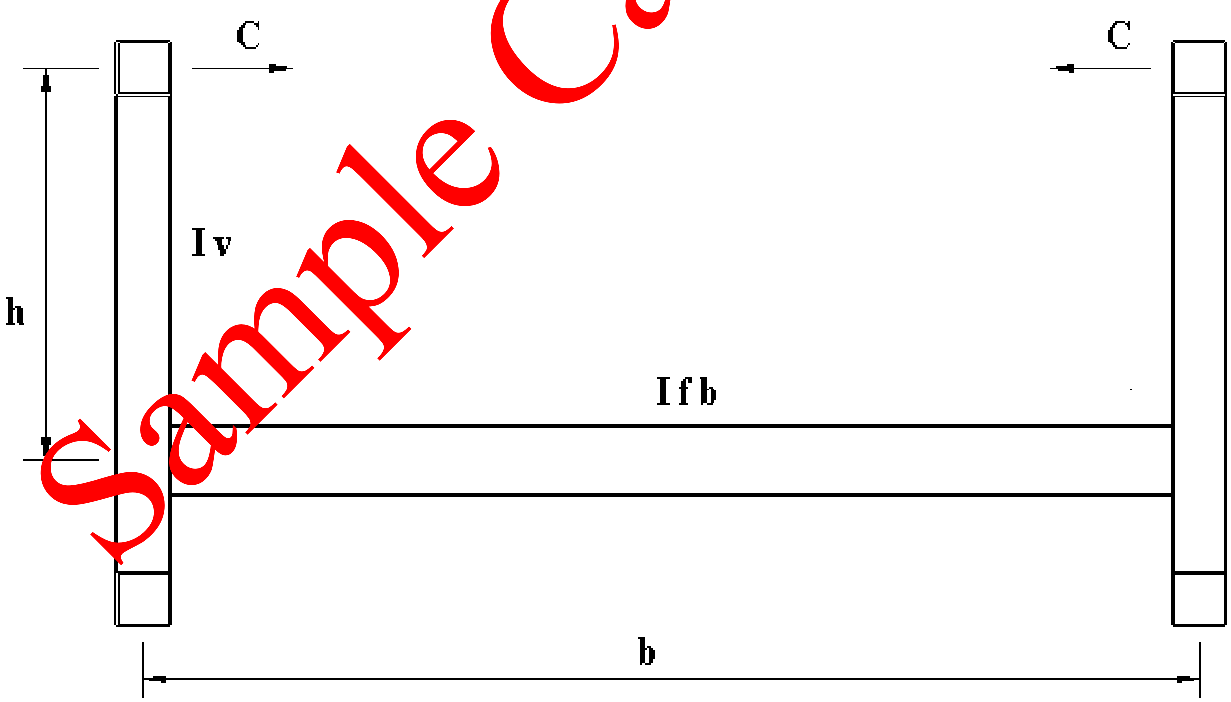
Determine a design K factor from the attached table considering CL/Pc, n, and 1/K.

Where:

- C = Cf as determined above.
- L = Length of Top Chord between transverse frames, in.
- Pc = Unfactored compression of top chord.
- F.S. = Factor of Saftey = 2.0
- n = Number of panels of trasverse frames.

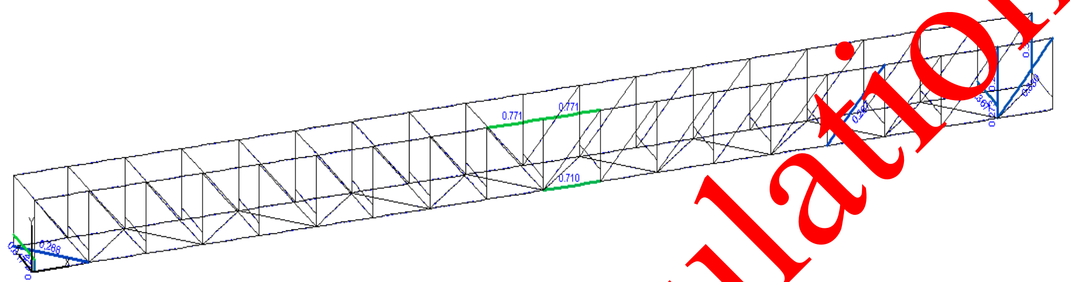
With 18 Panels, 1/K ~= 0.625, **Therefore utilize K out = 1.6**

1/K FOR VARIOUS VALUES OF Cl/Pc AND n							
1/K	**n**						
	4	**6**	**8**	**10**	**12**	**14**	**16**
1.000	3.686	3.616	3.660	3.714	3.754	3.785	3.809
0.980		3.284	2.944	2.806	2.787	2.771	2.774
0.96		3.000	2.665	2.542	2.456	2.454	2.479
0.95			2.595				
0.94		2.754		2.303	2.252	2.254	2.282
0.92		2.643		2.146	2.094	2.101	2.121
0.900	3.352	2.593	2.263	2.045	1.951	1.968	1.981
0.850		2.460	2.013	1.794	1.709	1.681	[illegible]
0.800	2.961	2.313	1.889	1.629	1.480	1.456	1.465
0.750		2.147	1.750	1.501	1.344	1.273	1.262
0.700	2.448	1.955	1.595	1.359	1.200	1.111	1.088
0.650		1.739	1.442	1.236	1.087	0.988	0.940
0.600	2.035	1.639	1.338	1.133	0.985	0.878	0.808
0.550		1.571	1.211	1.007	0.860	0.768	0.708
0.500	1.750	1.362	1.047	0.847	0.750	0.668	0.600
0.450		1.158	0.829	0.714	0.624	0.537	0.500
0.400	1.232	0.886	0.627	0.555	0.454	0.428	0.383
0.350		0.530	0.434	0.352	0.323	0.292	0.280
0.300	0.121	0.187	0.249	0.170	0.203	0.183	0.187



$$C = \frac{E}{h^2 (h/3I\,v + b/2\,I\,fb)}$$

Critical Member Design Stress Locations:



Parkway Utiilty District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.7710	M5-7	Designed	Top Chord	HSS6X6X	HSS6X6X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: Top Chord, Group Report, Designed As: HSS6X6X.250

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS6X6X.250 INFORMATION:

A = 5.24 in^2; d = 6.00, bf = 6.00, tf = 0.23, tw = 0.23 in
I = 28.60, J = 45.60 in^4; rz = 2.34, ry = 2.34 in
Z = 11.20 in^3, ϕMpz = 504.00, ϕMpy = 504.00 K-in
r0 = 3.30 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M5-7	8	64.80	-135.36	22.86	-2.62	186.43	504.00	504.00	HSS 7.1	0.77

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M5-7	8	43.20	23.87	72.00	1.01	504.00	F1-1	0.05

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M5-7	8	0.00	-135.36	49.31	0.65	0.07	1.00	41.86	186.43	HSS 4.2	0.73

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M5-7	7	72.00	-31.67	504.00	F1-1	0.06

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.7101	M4-8	Designed	Bottom Chord	HSS6X6X	HSS6X6X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: Bottom Chord, Group Report, Designed As: HSS6X6X.250

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS6X6X.250 INFORMATION:

A = 5.24 in^2; d = 6.00, bf = 6.00, tf = 0.23, tw = 0.23 in
I = 28.60, J = 45.60 in^4; rz = 2.34, ry = 2.34 in
Z = 11.20 in^3, ϕMpz = 504.00, ϕMpy = 504.00 K-in
r0 = 3.30 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M4-8	8	0.00	132.18	22.75	-43.32	222.70	504.00	504.00	HSS 7.1	0.71

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M4-8	8	0.00	22.75	72.00	1.02	504.00	F1-1	0.05

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M4-8	8	0.00	132.18	30.82	-1.00	-1.00	1.00	50.00	235.80	D1-1	0.56

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M4-8	8	0.00	-43.32	504.00	F1-1	0.09

Shear Check (Weak Axis):

Member Name	Load Case #	Offset *in*	Vuz *K*	Aw *in^2*	ϕVnz *K*	Code Ref.	Unity Check
M4-8	8	0.00	1.20	2.80	75.49	HSS 7.2	0.02

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.2977	M2-19	Designed	Vertical	HSS4X4X	HSS4X4X.25	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: Vertical Top, Group Report, Designed As: HSS4X4X.25

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 46.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 2.[illegible]
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS4X4X.25 INFORMATION:

A = 3.37 in^2; d = 4.00, bf = 4.00, tf = 0.23, tw = 0.23 in
I = 7.80, J = 12.80 in^4; rz = 1.52, ry = 1.52 in
Z = 4.69 in^3, ϕMpz = 194.17, ϕMpy = 194.17 K-in
r0 = 2.15 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M2-19	8	0.00	-24.39	-4.80	-0.03	88.52	194.17	194.17	HSS 7.1	0.30

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M2-19	7	0.00	46.18	58.50	1.82	194.17	F1-1	0.24

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M2-19	8	0.00	-24.39	76.90	0.97	0.07	1.00	30.90	88.52	HSS 4.2	0.28

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M2-19	7	0.00	6.11	194.17	F1-1	0.03

Shear Check (Strong Axis):

Member Name	Load Case #	Offset *in*	Vuy *K*	~h/tw	ϕVny *K*	Code Ref.	Unity Check
M2-19	7	0.00	-1.31	15.17	46.30	HSS 5.2	0.03

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.2733	M1-19	Designed	Vertical Bottom	HSS4X4X	HSS4X4X.25	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: Vertical Bottom, Group Report, Designed As: HSS4X4X.25

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced

Lateral bracing at bottom flange (-y): Pattern = Unbraced

Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 46.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.

Braced frame for weak axis bending.

Effective length factors: Kz = 1.00, Ky = 1.00

Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS4X4X.25 INFORMATION:

A = 3.37 in^2; d = 4.00, bf = 4.00, tf = 0.23, tw = 0.23 in

I = 7.80, J = 12.80 in^4; rz = 1.52, ry = 1.52 in

Z = 4.69 in^3, ϕMpz = 194.17, ϕMpy = 194.17 K-in

r0 = 2.15 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M1-19	8	12.25	27.30	14.22	-0.03	131.19	194.17	194.17	HSS 7.1	0.27

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M1-19	7	0.00	-26.31	12.25	1.21	194.17	F1-1	0.14

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M1-19	8	0.00	-27.32	8.05	0.10	0.07	1.00	45.80	131.19	HSS 4.2	0.21

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M1-19	7	12.25	5.73	194.17	F1-1	0.03

Shear Check (Strong Axis):

Member Name	Load Case #	Offset *in*	Vuy *K*	~h/tw	ϕVny *K*	Code Ref.	Unity Check
M1-19	7	12.25	1.14	15.17	46.30	HSS 5.2	0.02

Shear Check (Weak Axis):

Member Name	Load Case #	Offset *in*	Vuz *K*	Aw *in^2*	ϕVnz *K*	Code Ref.	Unity Check
M1-19	7	0.00	0.47	1.86	46.30	HSS 7.2	0.01

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.3262	M2--1	Designed	End Vertical Top	HSS6X6X	HSS6X6X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: End Vertical Top, Group Report, Designed As: HSS6X6X.250

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 2.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS6X6X.250 INFORMATION:

A = 5.24 in^2; d = 6.00, bf = 6.00, tf = 0.23, tw = 0.23 in
I = 28.60, J = 45.60 in^4; rz = 2.34, ry = 2.34 in
Z = 11.20 in^3, ϕMpz = 504.00, ϕMpy = 504.00 K-in
r0 = 3.30 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M2--1	7	0.00	-8.53	45.20	107.64	185.39	504.00	504.00	HSS 7.1	0.33

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M2--1	7	0.00	45.20	58.50	1.90	504.00	F1-1	0.09

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M2--1	8	0.00	-27.84	50.08	0.66	0.07	1.00	41.62	185.39	HSS 4.2	0.15

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M2--1	7	0.00	107.64	504.00	F1-1	0.21

Shear Check (Strong Axis):

Member Name	Load Case #	Offset *in*	Vuy *K*	~h/tw	ϕVny *K*	Code Ref.	Unity Check
M2--1	7	0.00	-0.92	23.75	75.49	HSS 5.2	0.01

Shear Check (Weak Axis):

Member Name	Load Case #	Offset *in*	Vuz *K*	Aw *in^2*	ϕVnz *K*	Code Ref.	Unity Check
M2--1	7	0.00	-1.08	2.80	75.49	HSS 7.2	0.01

Parkway Utiilty District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.4242	M1	Designed	End Vertical Bottom	HSS6X6X	HSS6X6X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: End Vertical Bottom, Group Report, Designed As: HSS6X6X.250

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS6X6X.250 INFORMATION:

A = 5.24 in^2; d = 6.00, bf = 6.00, tf = 0.23, tw = 0.23 in
I = 28.60, J = 45.60 in^4; rz = 2.34, ry = 2.34 in
Z = 11.20 in^3, ϕMpz = 504.00, ϕMpy = 504.00 K-in
r0 = 3.30 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M1	7	12.25	7.15	-8.41	-197.27	222.70	504.00	504.00	HSS 7.1	0.42

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M1	8	0.00	30.11	12.25	1.13	504.00	F1-1	0.06

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M1	8	0.00	-29.39	5.24	0.07	0.07	1.00	49.89	222.21	HSS 4.2	0.13

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M1	7	12.25	-197.27	504.00	F1-1	0.39

Shear Check (Strong Axis):

Member Name	Load Case #	Offset *in*	Vuy *K*	~h/tw	ϕVny *K*	Code Ref.	Unity Check
M1	7	0.00	1.60	23.75	75.49	HSS 5.2	0.02

Shear Check (Weak Axis):

Member Name	Load Case #	Offset *in*	Vuz *K*	Aw *in^2*	ϕVnz *K*	Code Ref.	Unity Check
M1	7	0.00	-14.19	2.80	75.49	HSS 7.2	0.19

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.3299	M12	Designed	End 3 Diagonals	HSS4X3X	HSS4X3X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: End Diagonal, Group Report, Designed As: HSS4X3X.250

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS4X3X.250 INFORMATION:

A = 2.91 in^2; d = 4.00, bf = 3.00, tf = 0.23, tw = 0.23 in
Iz = 6.15, Iy = 3.91, J = 7.96 in^4; rz = 1.45, ry = 1.16 in
Zz = 3.81, Zy = 3.12 in^3, ϕMpz = 171.45, ϕMpy = 140.40 K-in
r0 = 1.86 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M12	8	98.83	37.75	0.00	3.89	123.68	171.45	140.40	HSS 7.1	0.33

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M12	8	0.00	37.83	85.26	-1.00	-1.00	1.00	50.00	130.95	D1-1	0.29

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M12	8	98.83	3.89	140.40	F1-1	0.03

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.2668	M32	Designed	Interior Diagonal	HSS3X3X	HSS3X3X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: Interior Diagonal, Group Report, Designed As: HSS3X3X.250

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS3X3X.250 INFORMATION:

A = 2.44 in^2; d = 3.00, bf = 3.00, tf = 0.23, tw = 0.23 in
I = 3.02, J = 5.08 in^4; rz = 1.11, ry = 1.11 in
Z = 2.48 in^3, ϕMpz = 111.60, ϕMpy = 111.60 K-in
r0 = 1.57 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M32	8	100.94	25.73	-0.00	-2.35	103.70	111.60	111.60	HSS 7.1	0.27

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M32	7	50.47	0.81	100.94	1.14	111.60	F1-1	0.01

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M32	8	0.00	25.79	90.73	-1.00	-1.00	1.00	50.00	109.80	D1-1	0.23

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M32	7	0.00	9.36	111.60	F1-1	0.08

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.2677	M38	Designed	Brace Diagonal	HSS3X3X	HSS3X3X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: Brace Diagonal, Group Report, Designed As: HSS3X3X.250

SIZE CONSTRAINTS: none
BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

HSS3X3X.250 INFORMATION:

A = 2.44 in^2; d = 3.00, bf = 3.00, tf = 0.23, tw = 0.23 in
I = 3.02, J = 5.08 in^4; rz = 1.11, ry = 1.11 in
Z = 2.48 in^3, ϕMpz = 111.60, ϕMpy = 111.60 K-in
r0 = 1.57 in; H = 1.00

Extreme Checks Only
Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M38	7	49.86	-14.84	1.27	-0.00	57.63	111.60	111.60	HSS 7.1	0.27

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M38	7	49.86	1.27	99.72	1.15	111.60	F1-1	0.01

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M38	7	0.00	-14.84	89.64	1.18	0.07	1.00	27.79	57.63	HSS 4.2	0.26

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.3674	M3-17	Designed	Floor Beam	W6X12	W6X12	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: Floor Beam, Group Report, Designed As: W6X12

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Third Points
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

W6X12 INFORMATION:

A = 3.55 in^2; d = 6.03, bf = 4.00, tf = 0.28, tw = 0.23 in
Iz = 22.10, Iy = 2.99, J = 0.09 in^4; rz = 2.50, ry = 0.92 in
Zz = 8.30, Zy = 2.32 in^3, ϕMpz = 373.50, ϕMpy = 101.25 K-in
rT = 0.99, r0 = 2.66 in; H = 1.00

Extreme Checks Only

Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M3-17	7	0.00	-2.45	60.47	19.79	120.95	373.50	101.25	H1-1b	0.37

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M3-17	7	0.00	60.47	24.00	1.25	373.50	F1-1	0.16

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M3-17	7	0.00	-2.45	28.86	0.38	0.73	1.00	40.08	120.95	AE3-2	0.02

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M3-17	7	0.00	19.79	101.25	F1-1	0.20

Shear Check (Strong Axis):

Member Name	Load Case #	Offset *in*	Vuy *K*	~h/tw	ϕVny *K*	Code Ref.	Unity Check
M3-17	8	0.00	3.24	21.61	37.45	F2-1	0.09

Shear Check (Weak Axis):

Member Name	Load Case #	Offset *in*	Vuz *K*	Aw *in^2*	ϕVnz *K*	Code Ref.	Unity Check
M3-17	7	0.00	-0.53	2.24	60.48	H2-2	0.01

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.8174	M3	Designed	End Floor Beam	HSS6X6X	HSS6X6X.250	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	9	Dead loads P-Delta
-	10	Live loads P-Delta
2	11	Vehicle @ Center P-Delta
3	12	Vehicle @ End P-Delta
-	13	Wind loads P-Delta
4	-	1.0 DL + 1.3 VL @ Center P-Delta
5	-	1.0 DL + 1.3 VL @ End P-Delta
6	-	1.25 DL + 1.35 LL + .4 WL P-Delta
7	-	1.25 DL + 1.4 WL P-Delta
8	-	1.25 DL + 1.75 LL P-Delta

LRFD Steel Design

Design Group: End Floor Beam, Group Report, Designed As: HSS6X6X.250

SIZE CONSTRAINTS: none
BRACING INFORMATION:
Lateral bracing at top flange (+y): Pattern = Third Points
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced
STEEL PARAMETERS:
Fy = 50.00Ksi
FRAME INFORMATION:
Braced frame for strong axis bending.
Braced frame for weak axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)
HSS6X6X.250 INFORMATION:
A = 5.24 in^2; d = 6.00, bf = 6.00, tf = 0.23, tw = 0.23 in
I = 28.60, J = 45.60 in^4; rz = 2.34, ry = 2.34 in
Z = 11.20 in^3, ϕMpz = 504.00, ϕMpy = 504.00 K-in
r0 = 3.30 in; H = 1.00
Extreme Checks Only
Combined Stresses Check:

Member Name	Load Case #	Offset *in*	Pu *K*	Muz *K-in*	Muy *K-in*	ϕPn *K*	ϕMnz *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M3	7	0.00	12.71	290.69	-106.90	222.70	504.00	504.00	HSS 7.1	0.82

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M3	7	0.00	290.69	24.00	1.19	504.00	F1-1	0.58

Axial Check:

Member Name	Load Case #	Offset *in*	Pu *K*	KL/r	λc	λe	Q	Fcr *Ksi*	ϕPn *K*	Code Ref.	Unity Check
M3	7	0.00	12.71	30.82	-1.00	-1.00	1.00	50.00	235.80	D1-1	0.05

Flexure Check (Weak Bending):

Member Name	Load Case #	Offset *in*	Muy *K-in*	ϕMny *K-in*	Code Ref.	Unity Check
M3	7	0.00	-106.90	504.00	F1-1	0.21

Shear Check (Strong Axis):

Member Name	Load Case #	Offset *in*	Vuy *K*	~h/tw	ϕVny *K*	Code Ref.	Unity Check
M3	7	16.20	-4.95	23.75	75.49	HSS 5.2	0.07

Shear Check (Weak Axis):

Member Name	Load Case #	Offset *in*	Vuz *K*	Aw *in^2*	ϕVnz *K*	Code Ref.	Unity Check
M3	7	0.00	2.84	2.80	75.49	HSS 7.2	0.04

HSS TRUSS BRANCH WELD DESIGN - LRFD

General Scope

The design strength of the truss branch member welds shall be determined from the AISC *Specification for the Design of Hollow Structural Sections.* .

Design Input & Assumptions

The design strength of the truss branch member weld shall be the lower value of Phi x Fbm x Abm and Phi x Fw x Aw, when applicable.

Branch Member

T4314 : End Diagonal
41.6 : Pu - Required Axial Strength, kips, -Conservatively use full live load

Design Output & Decisions

Weld Capacity

Fillet Welds:
Shear on Effective Area:
29.42 :Pu (Perpendicular)
85.37 :Phi x Fw x Aw
0.75 :Phi
42 :Fw = .6 Fexx

Pu <= Phi x Fw x Aw, OK!

Tension or Compression Parallel to Axis of Weld
29.42 :Pu (Parallel)
88.97 :Phi x Fbm x Abm
0.9 :Phi
50 :Fbm = Fy of Base Metal, ksi

Pu <= Phi x Fbm x Abm, OK!

Where:
Fbm = Nominal Strength of the Base Material, ksi
Fw = Nominal Strength of the Weld Electrode, ksi
70 Fexx = Min. Tensile Strength of Weld Deposit, ksi
1.98 Abm = Cross-Sectional Area of the Base Material, sqin
0.233 Base Metal Thickness, in
Aw = Effective Cross-Sectional Area of the Weld, sqin
2.71 Aw = Le x Ew
0.1644 Ew = Effective Weld Throat, in. (1/4" fillet)
16.49 Le = Effective Weld Length, in.

For Gapped K-Connections:
Le = 2Hb + 2Bb for Theta <= 50 deg.
Le = 2Hb + Bb for Theta >= 60 deg.
45 :Theta, degrees
4.0 :Bb - Diagonal Width Transverse to Chord
4.24 :Hb - Diagonal Width Parallel to Chord

HSS TRUSS BRANCH WELD DESIGN - LRFD

General Scope

The design strength of the truss branch member welds shall be determined from the AISC *Specification for the Design of Hollow Structural Sections.* .

Design Input & Assumptions

The design strength of the truss branch member weld shall be the lower value of Phi x Fbm x Abm and Phi x Fw x Aw, when applicable.

Branch Member

T3314 : Interior Diagonal
27.9 : Pu - Required Axial Strength, kips, -Conservatively use full live load

Design Output & Decisions

Weld Capacity

Fillet Welds:
Shear on Effective Area:
19.73 :Pu (Perpendicular)
75.01 :Phi x Fw x Aw
0.75 :Phi
42 :Fw = .6 Fexx

Pu <= Phi x Fw x Aw, OK!

Tension or Compression Parallel to Axis of Weld
19.73 :Pu (Parallel)
88.97 :Phi x Fbm x Abm
0.9 :Phi
50 :Fbm = Fy of Base Metal, ksi

Pu <= Phi x Fbm x Abm, OK!

Where:
Fbm = Nominal Strength of the Base Material, ksi
Fw = Nominal Strength of the Weld Electrode, ksi
70 Fexx = Min. Tensile Strength of Weld Deposit, ksi
1.98 Abm = Cross-Sectional Area of the Base Material, sqin
0.233 Base Metal Thickness, in.
Aw = Effective Cross-Sectional Area of the Weld, sqin
2.38 Aw = Le x Ew
0.1644 Ew = Effective Weld Throat, in.
14.49 Le = Effective Weld Length, in.

For Gapped K-Connections:
Le = 2Hb + 2Bb for Theta <= 50 deg.
Le = 2Hb + Bb for Theta >= 60 deg.
45 :Theta, degrees
3.0 :Bb - Diagonal Width Transverse to Chord
4.24 :Hb - Diagonal Width Parallel to Chord

HSS TRUSS VERTICAL WELD DESIGN - LRFD

General Scope

The design strength of the truss branch member welds shall be determined from the AISC *Specification for the Design of Hollow Structural Sections.* The design approach outlined below shall be as per the above referenced specification.

Design Input & Assumptions

The design strength of the truss branch member weld shall be the lower value of Phi x Fbm x Abm and Phi x Fw x Aw, when applicable.

Branch Member

T4414 : Vertical
29.6 : Pu - Required Axial Strength, kips, Conservatively use full live load

Design Output & Decisions

Weld Capacity

Fillet Welds:
Shear on Effective Area:
29.60 :Pu (Perpendicular)
62.14 :Phi x Fw x Aw
0.75 :Phi
42 :Fw = .6 Fexx

Pu <= Phi x Fw x Aw, OK!

Tension or Compression Parallel to Axis of Weld
0.00 :Pu (Parallel)
83.88 :Phi x Fbm x Abm
0.9 :Phi
50 :Fbm = Fy of Base Metal, ksi

Pu <= Phi x Fbm x Abm, OK!

Where:
Fbm = Nominal Strength of the Base Material, ksi
Fw = Nominal Strength of the Weld Electrode, ksi
70 Fexx = Min. Tensile Strength of Weld Deposit, ksi
1.86 Abm = Cross-Sectional Area of the Base Material, sqin
0.233 Base Metal Thickness, in.
Aw = Effective Cross-Sectional Area of the Weld, sqin
1.97 Aw = Le x Ew
0.1644 Ew = Effective Weld Throat, in. (1/4" Fillet)
12.00 Le = Effective Weld Length, in.
For Gapped K-Connections:
Le = 2Hb + 2Bb for Theta <= 50 deg.
Le = 2Hb + Bb for Theta >= 60 deg.
90 :Theta, degrees
4.0 :Bb - Diagonal Width Transverse to Chord
4.00 :Hb - Diagonal Width Parallel to Chord

FLOOR BEAM TO VERTICAL WELD DESIGN - LRFD

General Scope

The design strength of the floor beam to vertical welds shall be determined from the AISC *Specification for the Design of Hollow Structural Sections.* The design approach outlined below shall be as per the above referenced specification .

Design Input & Assumptions

The design strength of the floor beam to vertical welds shall be per Phi x Fw x Aw. Assume welds on top and bottom of floor beams resists bending moment, and welds on sides of floor beam resist shear.

Conservatively combine max. moment from wind at end, max. TC comp. From live load at center

3.25	: Vu - Required Shear Strength, kips
58	: Mub - Required Flexure Strength, K-in. (End Beam Moment from Truss Analysis)
85.18	: Mua - Required Flexure Strength, K-in. (From 1% of Top Chord Compression from Truss Analysis)
145.6	: Pu - Required Top Chord Axial Strength, kips
58.5	: Moment arm from CL of top chord to CL of floor beam, in.
143.18	: Mut - Total Required Flexure Strength, K-in. (Mub + Mua)
6	: Floor Beam Depth, in.
23.86	: Puw - Required Weld Strength on Top and Bottom of Floor Beam, kips (Mut / Floor Beam Depth)

Design Output & Decisions

Weld Capacity on Top and Bottom of Floor Beam

Fillet Welds:
Shear on Effective Area:

			Where:
			Fbm = Nominal Strength of the Base Material, ksi
			Fw = Nominal Strength of the Weld Electrode, ksi
		70	Fexx = Min. Tensile Strength of Weld Deposit, ksi
23.86	:Pu (Perpendicular)		Aw = Effective Cross-Sectional Area of the Weld, sqin
27.62	:Phi x Fw x Aw	0.82	Aw = Le x Ew
0.8	:Phi	0.1644	Ew = Effective Weld Throat, in. (1/4" fillet on HSS)
42	:Fw = .6 Fexx	5.00	Le = Effective Weld Length, in.

Pu <= Phi x Fw x Aw, OK!

Weld Capacity along Sides of Floor Beam

Fillet Welds:
Shear on Effective Area:

			Where:
			Fbm = Nominal Strength of the Base Material, ksi
			Fw = Nominal Strength of the Weld Electrode, ksi
		70	Fexx = Min. Tensile Strength of Weld Deposit, ksi
3.25	:Pu (Parallel)		Aw = Effective Cross-Sectional Area of the Weld, sqin
41.43	:Phi x Fw x Aw	1.32	Aw = Le x Ew
0.75	:Phi	0.1644	Ew = Effective Weld Throat, in. (1/4" fillet)
42	:Fw = .6 Fexx	8.00	Le = Effective Weld Length, in.

Pu <= Phi x Fw x Aw, OK!

HSS TOP CHORD SPLICE DESIGN - AASHTO LRFD

General Scope

The design strength of the top chord splice shall be determined from the AASHTO *LRFD Bridge Design Specifications*. The design approach outlined below shall be as per the above referenced specification .

Design Input & Assumptions

The top chord splice components are assumed to be in axial compression only. The design strength of the top chord splice, Phi x Pn, is as determined by the lower value obtained according to the limit states of bearing shear strength of the bolts and bearing strength of the connected material, as well as flexural buckling for the splice plate.

Top Chord Member

T6614
0.233 : t - Thickness of Top Chord Member, in.
166 : Pu - Required Axial Strength, kips
70 : Fu - Min. Tensile Strength, ksi

Splice Plates

0.75 : Thickness, in.
4 : Width, in.
2 : Number of Plates
50 : Fy - Min. Yield Strength, ksi
7 : Distance Between Center Holes, in.

Bolts

1 : Nominal Diameter, in.
120 : Fub - Min. Tensile Strength of bolt, ksi (Art. 6.4.3.1)
1 : Ns - # of Shear Planes per Bolt

Design Output & Decisions

Check Shear Strength Limit States of the Bolts:

Ru <= Phi x Rn   With Rn = .38 x Ab x Fub x Ns
(Threads included in shear plane)

Where:
Ab = Area of bolt, in^2
Fub = Min. Tensile Strength of Bolt
Ns = Number of Shear Planes per Bolt
Phi = Resistance Factor from 6.5.4.2

0.8 :Phi
35.81 : Rn = .38 x Ab x Fub x Ns
28.65 : Phi x Rn

5.79 : Number of Bolts Required
10.00 : Number of Bolts Used

286.51 : Phi x Rn x Number of Bolts Used

Ru <= Phi x Rn, OK!

Check Bearing Strength Limit States of the Connected Material:

Ru <= Phi x Rn   With Rn = 2.4 x d x t x Fu
(With Edge Distance in Direction of Force =>2d and Clear Distance Between Holes =>2d.)

0.8 :Phi
39.14 :Rn = 2.4 x d x t x Fu
31.32 : Phi x Rn
(Bearing Resistance at Each Bolt Hole)
5.30 : Number of Bolt Holes Required
10.00 : Number of Bolt Holes Used per Side

Where:
d = Nominal Diameter of Bolt, in.
t = Thickness of Connected Material, in.
Fu = Minimum Tensile Strength of Connected Part, ksi
Phi = Resistance Factor for Bearing

313.15 : Phi x Rn x Number of Bolts Used

Ru <= Phi x Rn, OK!

Check Flexural Buckling Limit State for Splice Plate:

0.22 : ry = t^2/sqrt(12)
0.12 : Lambda = (kl/rxpi)^2x((Fy/E))

Assume k = 0.8 for Plate Buckling

Pu <= Phi x Pn

0.9 :Phi
3.00 :As
142.89 : Pn for Lambda <= 2.25
128.60 : Phi xPn
257.20 : Phi x Pn x Number of Splice Plates

Where:
As = Gross Area of Splice Plate, in.^2
If Lambda <=2.25, Pn = (.66^Lambda) x Fy x As
If Lambda > 2.25, Pn = (.88 x Fy x As) / Lambda
Phi = Resistance Factor for Flexural Buckling

Pu <= Phi x Pn, OK!

HSS BOTTOM CHORD SPLICE DESIGN - AASHTO LRFD

General Scope

The design strength of the bottom chord splice shall be determined from the AASHTO *LRFD Bridge Design Specifications.* The design approach outlined below shall be as per the above referenced specification.

Design Input & Assumptions

The bottom chord splice components are assumed to be in axial tension only. The design strength of the bottom chord splice, Phi x Rn, is as determined by the lower value obtained according to the limit states of tension yielding, tension rupture, and block shear rupture of the connecting element (splice plate) and the shear rupture and tension rupture of the bottom chord member.

Bottom Chord Member

T6614	
0.233	: t - Thickness of Bottom Chord Member, in.
182.4	: Pu - Required Axial Strength, kips
70	: Fu - Min. Tensile Strength, ksi
5.24	: Area of Member, in.^2

Bolts

1	: Nominal Diameter, in.
120	: Fub - Min. Tensile Strength of bolt, ksi (Art. 6.4.3.1)
1	: Ns - # of Shear Planes per Bolt

Splice Plates

0.75	: Thickness, in.
4	: Width, in.
2	: Number of Plates
50	: Fy - Min. Yield Strength, ksi
70	: Fu - Min. Tensile Strength, ksi
7	: Distance Between Center Holes, in.
3.5	: Single Bolt Line Spacing, in.
5	: Num. of Bolts Each Side of Splice
2.5	: Edge Distance in Direction of Force
40	: Total Plate Length, in.

Design Output & Decisions

Check Shear Strength Limit States of the Bolts:

Ru <= Phi x Rn With Rn = .38 x Ab x Fub x Ns (Threads included in shear plane)

Where:
Ab = Area of bolt, in^2
Fub = Min. Tensile Strength of Bolt
Ns = Number of Shear Planes per Bolt
Phi = Resistance Factor from 6.5.4.2

0.8 : Phi
35.81 : Rn = .38 x Ab x Fub x Ns
28.65 : Phi x Rn

6.37 : Number of Bolts Required
10.00 : Number of Bolts Used

286.51 : Phi x Rn x Number of Bolts Used

Ru <= Phi x Rn, OK!

Check Tension Yielding Limit State of the Splice Plate Material:

Ru <= Phi x Rn With Rn = Ag x Fy

Where:
Ag = Gross Area of the Splice Plate, in.^2
Fy = Yield Strength of the Splice Plate, ksi
Phi = Resistance Factor for Tension

0.95 :Phi
150.00 :Rn = Ag x Fy
142.50 : Phi x Rn

285.00 : Phi x Rn x Number of Splice Plates Used

Ru <= Phi x Rn, OK!

Check Tension Rupture Limit State for Splice Plate:

Ru <= Phi x Rn With Rn = An x Fu x U

Where:
An = Net Area of Splice Plate, <= .85Ag, in.^2
Fu = Min. Tensile Strength of Splice Plate, ksi
Phi = Resistance Factor for Rupture
U = Shear Lag Reduction Factor = 1

0.8 :Phi
2.20 :An
154.22 : Rn = An x Fu
123.38 : Phi xPn

246.75 : Phi x Pn x Number of Splice Plates

Pu <= Phi x Pn, OK!

HSS BOTTOM CHORD SPLICE DESIGN - AASHTO LRFD

Check Block Shear Rupture Limit State for Splice Plate:

12.38 : Agv = Gross Area Subject to Shear, in.^2
8.79 : Anv = Net Area Subject to Shear, in.^2
3 : Agt = Gross Area Subject to Tension in.^2
1.47 : Ant = Net Area Subject to Tension in.^2

102.81 : Fu x Ant
356.84 : 0.58 x Fu x Anv

When Fu x Ant => 0.58 x Fu x Anv : Phi x Rn = Phi x [0.58 x Fy x Agv + Fu x Ant]
When 0.58 x Fu x Anv > Fu x Ant : Phi x Rn = Phi x [0.58 x Fu x Anv + Fy x Agt]

0.80 : Phi
405.47 : Phi x Rn = Phi x [0.58 x Fu x Anv + Fy x Agt]

810.94 : Phi x Rn x Number of Splice Plates

Ru <= Phi x Rn, OK!

Check Shear Rupture Limit State of Member:

Ru <= Phi x Rn   With Rn = 0.6 x Fu x Anv

0.8 :Phi
2.96 :Anv
124.47 : Rn = 0.6 x Fu x Anv
99.57 : Phi xPn

199.15 : Phi x Pn x Number of Shear Planes

Where:
Anv = Net Area Member Subject to Shear, in.^2
Fu = Min. Tensile Strength of Member, ksi
Phi = Resistance Factor for Shear

Pu <= Phi x Pn, OK!

Check Tension Rupture Limit State of Member:

Ru <= Phi x Rn   With Rn = Fu x Ant x U

0.8 :Phi
4.74 :Ant
282.32 : Rn = Fu x Ant x U
225.86 : Phi xPn

Where:
Ant = Net Area Member Subject to Tension, in.^2
Fu = Min. Tensile Strength of Member, ksi
Phi = Resistance Factor for Tension
U = Shear Lag Reduction Factor = .85

Ru <= Phi x Rn, OK!

Check as Slip-Critical Connection Designed at Load Combination Service II:

81.00 : Factored Axial Force due to Service Case II
Ru <= Phi x Rn   With Rn = Kh x Ks x Ns x Pt

1.0 :Phi
51.00 :Pt
0.85 : Kh
0.50 : Ks
2.00 : Nb
43.35 : Rn = Kh x Ks x Ns x Pt
5.00 : Number of Bolts per Side
216.75 : Total Slip Resistance per Side; Rn x # of Bolts per side

Where:
Kh = Hole Size Factor, 1.0 for Std. Holes, .85 Oversize
Ks = Surface Condition Factor, .50 for Class B
Ns = Number of Slip Planes per Bolt
Pt = Min. Required Bolt Tension
Phi = Service Limit State Resistance Factor

Ru <= Phi x Rn, OK!

Parkway Utility District Ped Bridge, Houston, TX
Member Unity Checks

Unity	Member	Status	Group	Model Shape	Design Shape	Messages?
0.6285	M4	Designed	Stringer	C3X4.1	C3X4.1	None

Design Member Results

Design Load Cases

Strength ID Number	Service ID Number	Load Case Name
1	6	Dead Load P-Delta
2	7	Live Load (85 psf) P-Delta
3	8	Vehicle Point Load (1.5 kips) P-Delta
4	9	1.25 DC + 1.75 PL (AASHTO Strength I) P-Delta
5	10	1.25 DC + 1.75 LL (Vehicle) (AASHTO Strength I) P-Delta

LRFD Steel Design

Design Group: Stringers, Group Report, Designed As: C3X4.1

SIZE CONSTRAINTS: none

BRACING INFORMATION:

Lateral bracing at top flange (+y): Pattern = Unbraced
Lateral bracing at bottom flange (-y): Pattern = Unbraced
Strong axis bracing (parallel to y): Pattern = Unbraced

STEEL PARAMETERS:

Fy = 50.00Ksi

FRAME INFORMATION:

Braced frame for strong axis bending.
Effective length factors: Kz = 1.00, Ky = 1.00
Design checks assume a 2nd order analysis was performed. (No B1, B2 factors needed.)

C3X4.1 INFORMATION:

A = 1.20 in^2; d = 3.00, bf = 1.41, tf = 0.27, tw = 0.17 in
Iz = 1.65, Iy = 0.19, J = 0.03 in^4; rz = 1.17, ry = 0.40 in
Zz = 1.32, Zy = 0.40 in^3, ϕMpz = 59.40, ϕMny = 13.23 K-in
rT = 0.35, r0 = 1.53 in; H = 0.65

Extreme Checks Only

Flexure Check (Strong Bending):

Member Name	Load Case #	Offset *in*	Muz *K-in*	Lu *in*	Cb	ϕMnz *K-in*	Code Ref.	Unity Check
M4	5	36.00	-37.3[illegible]	36.00	2.26	59.40	F1-1	0.63

Shear Check (Strong Axis):

Member Name	Load Case #	Offset *in*	Vuy *K*	~h/tw	ϕVny *K*	Code Ref.	Unity Check
M4	5	36.00	-[illegible].94	9.56	13.77	F2-1	0.14

Nom. 2x8 Design

Species: IPE (Tabebuia spp , Lapacho Group)

Minimum Tabulated Design Values from above:

Fb	22560	psi
Fv	2060	psi
E	3140000	psi

Service Condition Modification of Design Values:

Size Factor Cf =	1.1	
Flat Use Factor Cfu =	1.2	
Wet Use Factor Cm =	0.85	for Fb
	0.97	for Fv
	0.97	for E
Load Duration Factor Cd =	1.00	for Standard Duration
Shear Stress Factor Ch =	1.1	for minor splits & shakes

Allowable F'b = Fb x Cf x Cfu X Cm x Cd =	25312.32	psi
Allowable F'v = Fv x Ch X Cm x Cd =	2198	psi
Allowable E' = E x Cm =	3045800	psi

Material Properties of Plank:

Nominal Plank Depth d:	1.5	in
Nominal Plank Width w:	7.25	in
Plank Area = d x w =	10.88	in^2
Plank Section Modulus = (w x d^2)/ 6 =	2.72	in^3
Plank Moment of Inertia = (w x d^3)/ 12 =	2.04	in^4
Assumed Deck Weight:	10.00	psf

Design Loadings & Assumptions:

Maximum stringer spacing:	2.33	ft.
Maximum Uniform Live Load:	85	psf
Maximum Vehicle Load:	5000	lb.
Vehicle Impact:	0	%
Distribution to rear axle:	50	%
Maximum Vehicle Point Load:	1250	lb.

Assume [illegible] span continous beam

Maximum DL Moment = 0.1x w x L^2

M (dl) = 0.003 k-ft

Maximum LL Moment = 0.1x w x L^2

M (ll) = 0.028 k-ft

Maximum Vehicle Moment = 0.2x p x L

M (vl) = 0.583 k-ft

Maximum Vehicle Shear = p

V (vl) = 1.250 kips

Actual Service Condition Design Values:

fb = Mmax/S =	2586 psi	<= Fb 'OK'	F'b =	25312.32
fv = (3*Vmax)/(2*A) =	172 psi	<= Fv 'OK'	F'v =	2198
Defl. = (p x l^3)/48 x E x I	0.089 in		L/	314

Parkway Utility District Ped Bridge, Houston, TX
Nodal Displacements

Node	Result Case Name	DX *in*	DY *in*	DZ *in*	RX *deg*	RY *deg*	RZ *deg*
N33	Live loads P-Delta	0.1610	-2.2307	0.0189	**-0.01341**	**-0.00000**	**-0.00001**

Vertical Deflection - Live Load = L / 568 > L / 500 OK

Node	Result Case Name	DX *in*	DY *in*	DZ *in*	RX *deg*	RY *deg*	RZ *deg*
N33	Wind loads P-Delta	**-0.2245**	**1.9035**	**2.2511**	**2.04309**	**0.00013**	**-0.00003**

Horizontal Deflection - Wind Load = L / 573 > L / 500 OK