FORM DQP 2.01-1
LEVEL 1 CHECK PRINT SIGN-OFF SHEET

Client Name: Ohio Department of Transportation

Job Title: Cleveland Innerbelt Design-Build Contract

Job Number: CUY-90-14.90

Document Title: Diaphragm Knee Brace connection design - Supplemental calcs.

Check Level (Mark One):

- [ ] 1A 100% Document Check
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Enter description below:

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Insert an "X" in the box to indicate a required QC activity.

HNTB

For Innerbelt Bridge | Job no. 49633 | Sheet no.
Made by PDB | Checked by SJL | Backchecked by PDB
Date 9/22/2011 | Date 9/22/2011 | Date 9/23/2011

(Revised for Bolt Sealing)

Floorbeam Type A, 6'-0" Kneebrace

Bolt Cap : 28.7 kips
57.4 kips - double shear

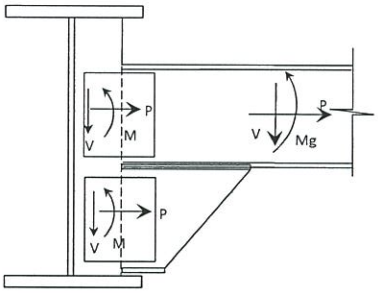
Mg = -1086 ft-kips
V = 138 kips
P = -71 kips
eh = 3.68 in
ev = 30.8 in
Veh = 42.2 ft-kips
Pev = -182 ft-kips
Mc = Mg-Veh-Pev = -946 ft-kips

bolt	row	column	x	y	x-xb	y-yb	$(x-xb)^2$	$(y-yb)^2$	rv	rh	r
1	1	1	0.0	3.50	-1.68	-47.4	2.81	2249	3.71	22.9	23.2
2	2	1	0.0	10.50	-1.68	-40.4	2.81	1634	3.71	19.9	20.2
3	3	1	0.0	17.50	-1.68	-33.4	2.81	1117	3.71	16.8	17.2
4	4	1	0.0	24.50	-1.68	-26.4	2.81	698	3.71	13.8	14.3
5	5	1	0.0	31.50	-1.68	-19.4	2.81	377	3.71	10.7	11.4
6	6	1	0.0	38.50	-1.68	-12.4	2.81	154	3.71	7.7	8.5
7	7	1	0.0	45.50	-1.68	-5.4	2.81	29	3.71	4.6	5.9
8	8	1	0.0	52.50	-1.68	1.6	2.81	2	3.71	1.6	4.0
9	9	1	0.0	59.50	-1.68	8.6	2.81	73	3.71	-1.4	4.0
10	11	1	0.0	72.00	-1.68	21.1	2.81	444	3.71	-6.9	7.8
11	12	1	0.0	75.88	-1.68	24.9	2.81	622	3.71	-8.6	9.3
12	13	1	0.0	79.75	-1.68	28.8	2.81	831	3.71	-10.2	10.9
13	14	1	0.0	83.63	-1.68	32.7	2.81	1069	3.71	-11.9	12.5
14	15	1	0.0	87.50	-1.68	36.6	2.81	1338	3.71	-13.6	14.1
15	16	1	0.0	91.38	-1.68	40.4	2.81	1636	3.71	-15.3	15.7
16	1	2	3.25	0.00	1.57	-50.9	2.47	2594	5.12	24.4	25.0
17	2	2	3.25	7.00	1.57	-43.9	2.47	1930	5.12	21.4	22.0
18	3	2	3.25	14.00	1.57	-36.9	2.47	1364	5.12	18.3	19.0
19	4	2	3.25	21.00	1.57	-29.9	2.47	896	5.12	15.3	16.1
20	5	2	3.25	28.00	1.57	-22.9	2.47	526	5.12	12.3	13.3
21	6	2	3.25	35.00	1.57	-15.9	2.47	254	5.12	9.2	10.5
22	7	2	3.25	42.00	1.57	-8.9	2.47	80	5.12	6.2	8.0
23	8	2	3.25	49.00	1.57	-1.9	2.47	4	5.12	3.1	6.0
24	9	2	3.25	56.00	1.57	5.1	2.47	26	5.12	0.1	5.1
25	10	2	3.25	63.00	1.57	12.1	2.47	146	5.12	-3.0	5.9
26	11	2	3.25	72.00	1.57	21.1	2.47	444	5.12	-6.9	8.6
27	12	2	3.25	75.88	1.57	24.9	2.47	622	5.12	-8.6	10.0
28	13	2	3.25	79.75	1.57	28.8	2.47	831	5.12	-10.2	11.4
29	14	2	3.25	83.63	1.57	32.7	2.47	1069	5.12	-11.9	13.0
30	15	2	3.25	87.50	1.57	36.6	2.47	1338	5.12	-13.6	14.5
31	16	2	3.25	91.38	1.57	40.4	2.47	1636	5.12	-15.3	16.1
	Bot		32.5	599							
	Top		19.5	980							
	Total		52	1579			82	26,033			

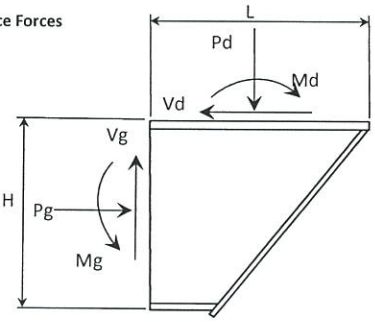
rv : vert comp of bolt force
rh : horiz comp of bolt force

	Bot	Top	Total
n	19	12	31
xb	1.71	1.63	1.68
yb	31.5	81.7	50.9
Ip	7,033	557	26,115
rp	10.7	-11.1	
rh-rp	13.7	-4.2	
P	204	-133	71
V	84.6	53.0	137.6
M	-3056	-242	-12,523

max r = 25.0 kips
D/C = 0.43



Knee Brace Forces



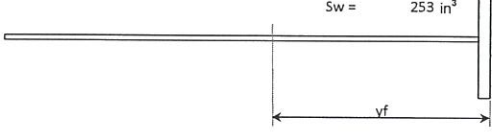
Positive Forces Shown

L : 40 in
H : 72 in
Pg = 204 kips
Vg = 84.6 kips
Mg = 3056 in-kips
Pd = Vg = 84.6 kips
Vd = Pg = 204 kips
Md = Mg+PgH/2+VgL/2 = 8,704 in-kips

Knee Brace Web

t : 0.625 in
@ Diaph Vr = 725 kips D/C = 0.28
@ Gdr Vr = 1305 kips D/C = 0.06

@ Diaph	bf :	12 in	A =	37 in^2	fa =	-2.29 ksi	axial stress	
	tf :	1 in	yf =	14.4 in	f_{bf} =	-18.5 ksi	bending stress in flange	
	Fy :	50 ksi	I =	6741 in^4	f_{bw} =	34.4 ksi	bending stress in web	D/C
			Sf =	470 in^3	f_f =	-20.8 ksi	Total flange stress	0.42
			Sw =	253 in^3	f_w =	32.1 ksi	Total web stress	0.64

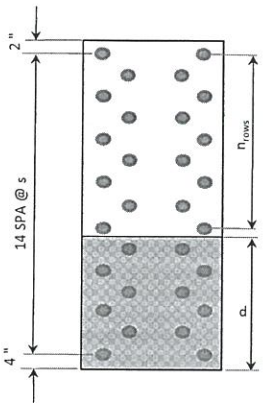


@ Girder	bf :	0 in	A =	45.0 in^2	fa =	-4.5 ksi
	tf :	0 in	yb =	36.0 in	fb =	5.7 ksi
			I =	19,440 in^4		
			S =	540 in^3		

Kneebrace Connection PL - Web Weld

Double Fillet Size :	0.3125 in	Fexx :	70 ksi	ϕ_{e2} :	0.80		
Rr =	14.8 k/in	L =	40 in	Rr =	594 kips	D/C =	0.34

Knee Brace - Diaphragm Connection



s : 3.75 in

row	h	d	d^2
1	41.75	35.32	1,247
2	38.00	31.57	996
3	34.25	27.82	774
4	30.50	24.07	579
5	26.75	20.32	413
6	23.00	16.57	274
7	19.25	12.82	164
8	15.50	9.07	82
9	11.75	5.32	28
10	8.00	1.57	2
11	2.50	0.00	0

fa =	-0.80 ksi	bolt D :	1 in
fb =	36.6 ksi	Ab =	0.785 in^2
Max Bolt Stress =	35.8 ksi	Fub :	120 ksi
Max Bolt Tension, Tu =	28.1 kips	w :	14 in
		d :	6.43 in
		Ay =	290 in^3
		n_{rows} =	10
		n :	22
		y =	18.4 in
		Aby =	290 in^3
		A =	106 in^2
		I =	8,407 in^4
		St =	238 in^3
		Sc =	1307 in^3
		Bolt Shear, Pu =	9.3 kips
Bolt Shear Cap, $\phi_s R_n$:	36.0 kips		
ϕ_t :	0.80		
Bolt Tensile Cap, $\phi_t T_n$ =	55.4 kips	D/C =	0.51

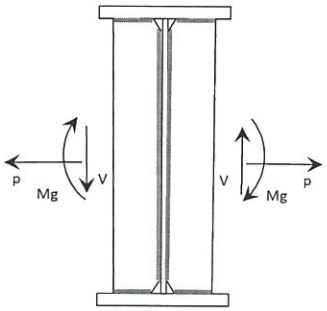
Girder connection PL

At interior girders, most of the floorbeam moment will be transferred directly from one floobeam to the next.

		Conn PL			
Girder Depth, H :	8.2 ft	b :	12 in		
F = M/H =	100 kips	t :	1.125 in		
L :	2 ft	Fy :	50 ksi		
M = FL/2 =	100 ft-kips	tw :	1 in		
		beff :	9	tw =	9 in

Conn PL Weld Capacity

Double Fillet Size :	0.3125 in	Fexx =	70 ksi	ϕ_{e2} :	0.80	Rr =	14.8 k/in



Ls =	11 in	L =	116.4 in
Lw =	94.4 in	I =	96,730 in^3
horiz clip :	1 in	Ss =	1,966 in^2 - of Stiff weld
vert clip :	2 in	Sw =	2,049 in^2 - of web weld

M =	-1086 ft-kips		
V =	138 kips		
max. stiff weld shear due to M =	6.6 k/in	Stiff Weld D/C =	0.45
max. web weld shear due to M =	6.4 k/in		
max. web weld shear due to V =	-1.5 k/in		
max resultant weld shear =	6.5 k/in	Web Weld D/C =	0.44

HNTB

For Innerbelt Bridge | Job no. 49633 | Sheet no.
Made by PDB | Checked by SJL | Backchecked by PDB
Date 9/22/2011 | Date 9/22/2011 | Date 9/23/2011

(Revised for Bolt Sealing)

Floorbeam Type A, 6'-0" Kneebrace

Bolt Cap : 28.7 kips
57.4 kips - double shear

Mg = 1107 ft-kips
V = 42 kips
P = -8 kips

eh = 3.68 in
ev = 30.8 in

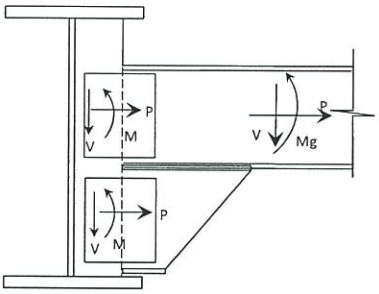
Veh = 13.0 ft-kips
Pev = -21 ft-kips
Mc = Mg-Veh-Pev = 1115 ft-kips

bolt	row	column	x	y	x-xb	y-yb	$(x-xb)^2$	$(y-yb)^2$	rv	rh	r
1	1	1	0.0	3.50	-1.68	-47.4	2.81	2249	2.22	-24.0	24.1
2	2	1	0.0	10.50	-1.68	-40.4	2.81	1634	2.22	-20.4	20.6
3	3	1	0.0	17.50	-1.68	-33.4	2.81	1117	2.22	-16.9	17.0
4	4	1	0.0	24.50	-1.68	-26.4	2.81	698	2.22	-13.3	13.5
5	5	1	0.0	31.50	-1.68	-19.4	2.81	377	2.22	-9.7	9.9
6	6	1	0.0	38.50	-1.68	-12.4	2.81	154	2.22	-6.1	6.5
7	7	1	0.0	45.50	-1.68	-5.4	2.81	29	2.22	-2.5	3.4
8	8	1	0.0	52.50	-1.68	1.6	2.81	2	2.22	1.1	2.5
9	9	1	0.0	59.50	-1.68	8.6	2.81	73	2.22	4.6	5.2
10	11	1	0.0	72.00	-1.68	21.1	2.81	444	2.22	11.1	11.3
11	12	1	0.0	75.88	-1.68	24.9	2.81	622	2.22	13.0	13.2
12	13	1	0.0	79.75	-1.68	28.8	2.81	831	2.22	15.0	15.2
13	14	1	0.0	83.63	-1.68	32.7	2.81	1069	2.22	17.0	17.1
14	15	1	0.0	87.50	-1.68	36.6	2.81	1338	2.22	19.0	19.1
15	16	1	0.0	91.38	-1.68	40.4	2.81	1636	2.22	21.0	21.1
16	1	2	3.25	0.00	1.57	-50.9	2.47	2594	0.56	-25.8	25.8
17	2	2	3.25	7.00	1.57	-43.9	2.47	1930	0.56	-22.2	22.2
18	3	2	3.25	14.00	1.57	-36.9	2.47	1364	0.56	-18.7	18.7
19	4	2	3.25	21.00	1.57	-29.9	2.47	896	0.56	-15.1	15.1
20	5	2	3.25	28.00	1.57	-22.9	2.47	526	0.56	-11.5	11.5
21	6	2	3.25	35.00	1.57	-15.9	2.47	254	0.56	-7.9	7.9
22	7	2	3.25	42.00	1.57	-8.9	2.47	80	0.56	-4.3	4.4
23	8	2	3.25	49.00	1.57	-1.9	2.47	4	0.56	-0.7	0.9
24	9	2	3.25	56.00	1.57	5.1	2.47	26	0.56	2.9	2.9
25	10	2	3.25	63.00	1.57	12.1	2.47	146	0.56	6.4	6.5
26	11	2	3.25	72.00	1.57	21.1	2.47	444	0.56	11.1	11.1
27	12	2	3.25	75.88	1.57	24.9	2.47	622	0.56	13.0	13.0
28	13	2	3.25	79.75	1.57	28.8	2.47	831	0.56	15.0	15.0
29	14	2	3.25	83.63	1.57	32.7	2.47	1069	0.56	17.0	17.0
30	15	2	3.25	87.50	1.57	36.6	2.47	1338	0.56	19.0	19.0
31	16	2	3.25	91.38	1.57	40.4	2.47	1636	0.56	21.0	21.0
	Bot		32.5	599							
	Top		19.5	980							
	Total		52	1579			82	26,033			

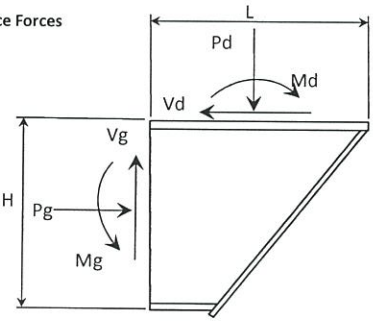
rv : vert comp of bolt force
rh : horiz comp of bolt force

	Bot	Top	Total
n	19	12	31
xb	1.71	1.63	1.68
yb	31.5	81.7	50.9
Ip	7,033	557	26,115
rp	-9.7	16.0	
rh-rp	-16.1	5.0	
P	-184	192	8
V	25.6	16.7	42.3
M	3602	285	13,242

max r = 25.8 kips
D/C = 0.45



Knee Brace Forces



Positive Forces Shown

L : 40 in
H : 72 in
Pg = -184 kips
Vg = 25.6 kips
Mg = -3602 in-kips
Pd = Vg = 25.6 kips
Vd = Pg = -184 kips
Md = Mg+PgH/2+VgL/2 = -10,743 in-kips

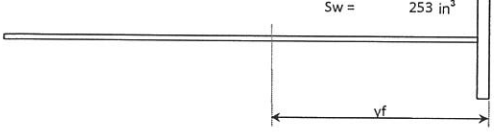
Knee Brace Web

t : 0.625 in
@ Diaph Vr = 725 kips D/C = 0.25
@ Gdr Vr = 1305 kips D/C = 0.02

@ Diaph
bf : 12 in
tf : 1 in
Fy : 50 ksi

A = 37 in^2
yf = 14.4 in
I = 6741 in^4
Sf = 470 in^3
Sw = 253 in^3

fa = -0.69 ksi axial stress
f_{bf} = 22.9 ksi bending stress in flange
f_{bw} = -42.5 ksi bending stress in web
f_f = 22.2 ksi Total flange stress D/C 0.44
f_w = -43.2 ksi Total web stress 0.86



@ Girder
bf : 0 in
tf : 0 in

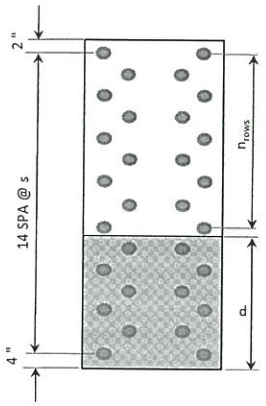
A = 45.0 in^2
yb = 36.0 in
I = 19,440 in^4
S = 540 in^3

fa = 4.1 ksi
fb = -6.7 ksi

Kneebrace Connection PL - Web Weld

Double Fillet Size :	0.3125 in	Fexx :	70 ksi	ϕ_{e2} :	0.80		
Rr =	14.8 k/in	L =	40 in	Rr =	594 kips	D/C =	0.31

Knee Brace - Diaphragm Connection



s : 3.75 in

row	h	d	d^2
1	41.75	35.32	1,247
2	36.25	29.82	889
3	32.50	26.07	679
4	28.75	22.32	498
5	25.00	18.57	345
6	21.25	14.82	220
7	17.50	11.07	122
8	13.75	7.32	54
9	10.00	3.57	13
10	6.25	0.00	0
11	2.50	0.00	0

fa =	-0.24 ksi	bolt D :	1 in
fb =	49.7 ksi	Ab =	0.785 in^2
Max Bolt Stress =	49.5 ksi	Fub :	120 ksi
Max Bolt Tension, Tu =	38.9 kips	w :	14 in
		d :	6.43 in
		Ay =	290 in^3
		n_{rows} =	10
		n :	22
		y =	18.4 in
		Aby =	290 in^3
		A =	106 in^2
		I =	7,631 in^4
		St =	216 in^3
		Sc =	1186 in^3
		Bolt Shear, Pu =	-8.4 kips
Bolt Shear Cap, $\phi_s R_n$:	36.0 kips		
ϕ_t :	0.80		
Bolt Tensile Cap, $\phi_t T_n$ =	55.7 kips	D/C =	0.70

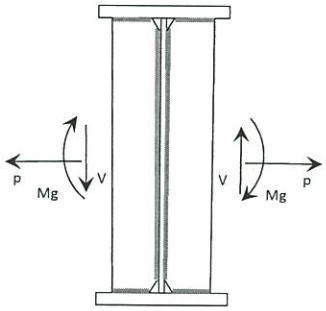
Girder connection PL

At interior girders, most of the floorbeam moment will be transferred directly from one floobeam to the next.

		Conn PL			
Girder Depth, H :	8.2 ft	b :	12 in		
F = M/H =	100 kips	t :	1.125 in		
L :	2 ft	Fy :	50 ksi		
M = FL/2 =	100 ft-kips	tw :	1 in		
		beff :	9	tw =	9 in

Conn PL Weld Capacity

Double Fillet Size :	0.3125 in	Fexx =	70 ksi	ϕ_{e2} :	0.80	Rr =	14.8 k/in



Ls =	11 in	L =	116.4 in
Lw =	94.4 in	I =	96,730 in^3
horiz clip :	1 in	Ss =	1,966 in^2 - of Stiff weld
vert clip :	2 in	Sw =	2,049 in^2 - of web weld

M =	1107 ft-kips		
V =	42 kips		
max. stiff weld shear due to M =	-6.8 k/in	Stiff Weld D/C =	-0.46
max. web weld shear due to M =	-6.5 k/in		
max. web weld shear due to V =	-0.4 k/in		
max resultant weld shear =	6.5 k/in	Web Weld D/C =	0.44

HNTB

For Innerbelt Bridge | Job no. 49633 | Sheet no.
Made by PDB | Checked by PDB | Backchecked by SJL
Date 9/22/2011 | Date 9/22/2011 | Date 9/30/2011

(Revised for deeper Knee brace)

Floorbeam Type B, 6'-6" Kneebrace

Bolt Cap : 28.7 kips
57.4 kips - double shear

Mg = -3114 ft-kips
V = 240 kips
P = -386 kips
eh = 1.66 in
ev = 25.0 in
Veh = 33 ft-kips
Pev = -806 ft-kips
Mc = Mg-Veh-Pev = -2341 ft-kips

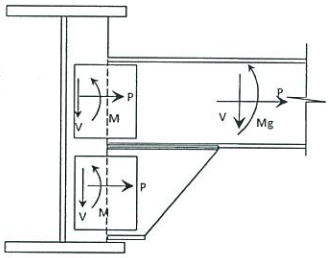
bolt	row	column	x	y	x-xb	y-yb	$(x-xb)^2$	$(y-yb)^2$	rv	rh	r
1	1	1	0	3.67	-1.66	-74.2	2.74	5500	3.92	34.7	34.9
2	2	1	0	11.00	-1.66	-66.8	2.74	4466	3.92	32.0	32.2
3	3	1	0	18.33	-1.66	-59.5	2.74	3539	3.92	29.3	29.6
4	4	1	0	25.67	-1.66	-52.2	2.74	2721	3.92	26.6	26.9
5	5	1	0	33.00	-1.66	-44.8	2.74	2009	3.92	23.9	24.2
6	6	1	0	40.33	-1.66	-37.5	2.74	1406	3.92	21.2	21.5
7	7	1	0	47.67	-1.66	-30.2	2.74	910	3.92	18.4	18.9
8	8	1	0	55.00	-1.66	-22.8	2.74	521	3.92	15.7	16.2
9	9	1	0	62.33	-1.66	-15.5	2.74	240	3.92	13.0	13.6
10	11	1	0	76.88	-1.66	-1.0	2.74	1	3.92	7.6	8.6
11	12	1	0	80.13	-1.66	2.3	2.74	5	3.92	6.4	7.5
12	13	1	0	83.38	-1.66	5.5	2.74	31	3.92	5.2	6.5
13	14	1	0	86.63	-1.66	8.8	2.74	77	3.92	4.0	5.6
14	15	1	0	89.88	-1.66	12.0	2.74	145	3.92	2.8	4.8
15	16	1	0	93.13	-1.66	15.3	2.74	234	3.92	1.6	4.2
16	17	1	0	96.38	-1.66	18.5	2.74	344	3.92	0.4	3.9
17	18	1	0	99.63	-1.66	21.8	2.74	475	3.92	-0.8	4.0
18	19	1	0	102.88	-1.66	25.0	2.74	627	3.92	-2.0	4.4
19	20	1	0	106.13	-1.66	28.3	2.74	801	3.92	-3.2	5.0
20	21	1	0	109.38	-1.66	31.5	2.74	995	3.92	-4.4	5.9
21	22	1	0	112.63	-1.66	34.8	2.74	1211	3.92	-5.6	6.8
22	23	1	0	115.88	-1.66	38.0	2.74	1448	3.92	-6.8	7.8
23	24	1	0	119.13	-1.66	41.3	2.74	1706	3.92	-8.0	8.9
24	25	1	0	122.38	-1.66	44.5	2.74	1985	3.92	-9.2	10.0
25	26	1	0	125.63	-1.66	47.8	2.74	2285	3.92	-10.4	11.1
26	27	1	0	128.88	-1.66	51.0	2.74	2606	3.92	-11.6	12.2
27	1	2	3.25	0.00	1.59	-77.8	2.54	6057	5.12	36.1	36.4
28	2	2	3.25	7.33	1.59	-70.5	2.54	4969	5.12	33.4	33.8
29	3	2	3.25	14.67	1.59	-63.2	2.54	3989	5.12	30.7	31.1
30	4	2	3.25	22.00	1.59	-55.8	2.54	3117	5.12	27.9	28.4
31	5	2	3.25	29.33	1.59	-48.5	2.54	2352	5.12	25.2	25.7
32	6	2	3.25	36.67	1.59	-41.2	2.54	1694	5.12	22.5	23.1
33	7	2	3.25	44.00	1.59	-33.8	2.54	1144	5.12	19.8	20.4
34	8	2	3.25	51.33	1.59	-26.5	2.54	702	5.12	17.1	17.8
35	9	2	3.25	58.67	1.59	-19.2	2.54	367	5.12	14.4	15.3
36	10	2	3.25	66.00	1.59	-11.8	2.54	140	5.12	11.7	12.7
37	11	2	3.25	76.88	1.59	-1.0	2.54	1	5.12	7.6	9.2
38	12	2	3.25	80.13	1.59	2.3	2.54	5	5.12	6.4	8.2
39	13	2	3.25	83.38	1.59	5.5	2.54	31	5.12	5.2	7.3
40	14	2	3.25	86.63	1.59	8.8	2.54	77	5.12	4.0	6.5
41	15	2	3.25	89.88	1.59	12.0	2.54	145	5.12	2.8	5.8
42	16	2	3.25	93.13	1.59	15.3	2.54	234	5.12	1.6	5.4
43	17	2	3.25	96.38	1.59	18.5	2.54	344	5.12	0.4	5.1
44	18	2	3.25	99.63	1.59	21.8	2.54	475	5.12	-0.8	5.2
45	19	2	3.25	102.88	1.59	25.0	2.54	627	5.12	-2.0	5.5
46	20	2	3.25	106.13	1.59	28.3	2.54	801	5.12	-3.2	6.0
47	21	2	3.25	109.38	1.59	31.5	2.54	995	5.12	-4.4	6.7
48	22	2	3.25	112.63	1.59	34.8	2.54	1211	5.12	-5.6	7.6
49	23	2	3.25	115.88	1.59	38.0	2.54	1448	5.12	-6.8	8.5
50	24	2	3.25	119.13	1.59	41.3	2.54	1706	5.12	-8.0	9.5
51	25	2	3.25	122.38	1.59	44.5	2.54	1985	5.12	-9.2	10.5
52	26	2	3.25	125.63	1.59	47.8	2.54	2285	5.12	-10.4	11.6
53	27	2	3.25	128.88	1.59	51.0	2.54	2606	5.12	-11.6	12.7
	Bot		33	627							
	Top		55	3498							
	Total		88	4125			140	75,794			

rv: vert comp of bolt force
rh: horiz comp of bolt force

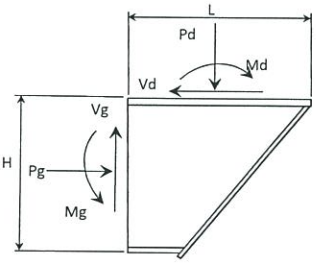
	Bot	Top	Total
n	19	34	53
xb	1.71	1.63	1.66
yb	33.0	102.9	77.8
Ip	7,714	8,709	75,934
rp	23.9	-2.0	
rh-rp	12.2	-9.6	
P	454	-68	386
V	86	154	240
M	2,854	3,222	7,449

rv = 5.1 kips
rh = 36.1 kips
r = 36.4 kips

D/C = 0.63



Knee Brace Forces



L : 54 in
H : 78 in
Pg = 454 kips
Vg = 86 kips
Mg = 2854 in-kips
Pd = Vg = 86 kips
Vd = Pg = 454 kips
Md = Mg+PgH/2+VgL/2 = 18,207 in-kips

Knee Brace Web

t : 0.625 in

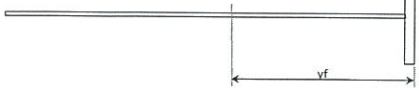
@ Diaph Vr = 979 kips D/C = 0.46
@ Gdr Vr = 1414 kips D/C = 0.06

@ Diaph

bf : 12 in
tf : 0.875 in
Fy : 50 ksi

A = 44 in^2
yf = 21.4 in
I = 14230 in^4
Sf = 666 in^3
Sw = 425 in^3

fa = -1.95 ksi — axial stress
f_{bf} = -27.3 ksi — bending stress in flange
f_{bw} = 42.9 ksi — bending stress in web
f_f = -29.3 ksi — Total flange stress — D/C 0.59
f_w = 40.9 ksi — Total web stress — D/C 0.82



@ Girder

bf : 0 in
tf : 0 in

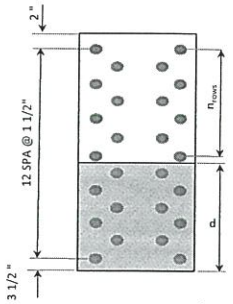
A = 48.8 in^2
yb = 39.0 in
I = 24716 in^4
S = 634 in^3

fa = -9.3 ksi
fb = 4.5 ksi

Kneebrace Connection PL - Web Weld

Double Fillet Size :	0.3125 in	Fexx :	70 ksi	ϕ_{e2} :	0.80		
Rr =	14.8 k/in	L =	54 in	Rr =	802 kips	D/C =	0.57

Knee Brace - Diaphragm Connection



s : 3.75 in

row	h	d	d^2
1	49.25	42.13	1,775
2	45.50	38.38	1,473
3	41.75	34.63	1,199
4	38.00	30.88	954
5	34.25	27.13	736
6	30.50	23.38	547
7	26.75	19.63	385
8	23.00	15.88	252
9	19.25	12.13	147
10	15.50	8.38	70
11	11.75	4.63	21
12	8.00	0.88	1
13	2.50	0.00	0

bolt D :	1 in
Ab =	0.785 in^2
Fub :	120 ksi
w :	16 in
d :	7.12 in
Ay =	406 in^3
n_{rows} =	12
n =	26
y =	21.5 in
Aby =	405 in^3
A =	132.8 in^2
I =	13,801 in^4
St =	328 in^3
Sc =	1938 in^3

fa =	-0.65 ksi		
fb =	55.6 ksi		
Max Bolt Stress =	54.9 ksi		
Max Bolt Tension, Tu =	43.1 kips	Bolt Shear, Pu =	17.4 kips
Bolt Shear Cap, $\phi_s R_n$:	35.9 kips		
ϕ_t :	0.80		
Bolt Tensile Cap, $\phi_t T_n$ =	50.1 kips	D/C =	0.86

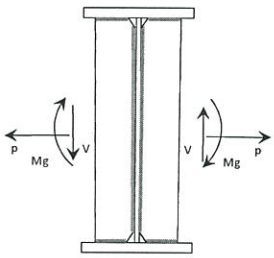
Girder connection PL

At interior girders, most of the floorbeam moment will be transferred directly from one floobeam to the next.

		Conn PL	
Girder Depth, H :	13.2 ft	b :	12 in
F = M/H =	100 kips	t :	1.125 in
L :	2 ft	Fy :	50 ksi
M = FL/2 =	100 ft-kips	tw :	1 in
		beff :	9 tw = 9 in

Conn PL Weld Capacity

Double Fillet Size :	0.3125 in	Fexx =	70 ksi	ϕ_{e2} :	0.80	Rr =	14.8 k/in



Ls =	11 in	L =	176.4 in
Lw =	154.4 in	I =	375,732 in^3
horiz clip :	1 in	Ss =	4,744 in^2 - of Stiff weld
vert clip :	2 in	Sw =	4,867 in^2 - of web weld

M =	3114 ft-kips		
V =	240 kips		
max. stiff weld shear due to M =	7.9 k/in	Stiff Weld D/C =	0.53
max. web weld shear due to M =	7.7 k/in		
max. web weld shear due to V =	1.6 k/in		
max resultant weld shear =	7.8 k/in	Web Weld D/C =	0.53

HNTB

For Innerbelt Bridge | Job no. 49633 | Sheet no.
Made by PDB | Checked by PDB | Backchecked by SJL
Date 9/22/2011 | Date 9/22/2011 | Date 9/30/2011

(Revised for deeper Knee brace)

Floorbeam Type B, 6'-6" Kneebrace

Bolt Cap : 28.7 kips
57.4 kips - double shear

Mg = 2445 ft-kips
V = -204 kips
P = -225 kips
eh = 1.66 in
ev = 25.0 in
Veh = -28 ft-kips
Pev = -470 ft-kips
Mc = Mg-Veh-Pev = 2943 ft-kips

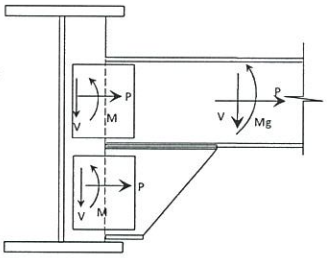
bolt	row	column	x	y	x-xb	y-yb	(x-xb)^2	(y-yb)^2	rv	rh	r
1	1	1	0	3.67	-1.66	-74.2	2.74	5500	-3.08	-30.2	30.4
2	2	1	0	11.00	-1.66	-66.8	2.74	4466	-3.08	-26.8	27.0
3	3	1	0	18.33	-1.66	-59.5	2.74	3539	-3.08	-23.4	23.6
4	4	1	0	25.67	-1.66	-52.2	2.74	2721	-3.08	-20.0	20.2
5	5	1	0	33.00	-1.66	-44.8	2.74	2009	-3.08	-16.6	16.9
6	6	1	0	40.33	-1.66	-37.5	2.74	1406	-3.08	-13.2	13.5
7	7	1	0	47.67	-1.66	-30.2	2.74	910	-3.08	-9.8	10.3
8	8	1	0	55.00	-1.66	-22.8	2.74	521	-3.08	-6.4	7.1
9	9	1	0	62.33	-1.66	-15.5	2.74	240	-3.08	-3.0	4.3
10	11	1	0	76.88	-1.66	-1.0	2.74	1	-3.08	3.8	4.9
11	12	1	0	80.13	-1.66	2.3	2.74	5	-3.08	5.3	6.1
12	13	1	0	83.38	-1.66	5.5	2.74	31	-3.08	6.8	7.5
13	14	1	0	86.63	-1.66	8.8	2.74	77	-3.08	8.3	8.9
14	15	1	0	89.88	-1.66	12.0	2.74	145	-3.08	9.8	10.3
15	16	1	0	93.13	-1.66	15.3	2.74	234	-3.08	11.4	11.8
16	17	1	0	96.38	-1.66	18.5	2.74	344	-3.08	12.9	13.2
17	18	1	0	99.63	-1.66	21.8	2.74	475	-3.08	14.4	14.7
18	19	1	0	102.88	-1.66	25.0	2.74	627	-3.08	15.9	16.2
19	20	1	0	106.13	-1.66	28.3	2.74	801	-3.08	17.4	17.7
20	21	1	0	109.38	-1.66	31.5	2.74	995	-3.08	18.9	19.2
21	22	1	0	112.63	-1.66	34.8	2.74	1211	-3.08	20.4	20.7
22	23	1	0	115.88	-1.66	38.0	2.74	1448	-3.08	21.9	22.2
23	24	1	0	119.13	-1.66	41.3	2.74	1706	-3.08	23.5	23.7
24	25	1	0	122.38	-1.66	44.5	2.74	1985	-3.08	25.0	25.2
25	26	1	0	125.63	-1.66	47.8	2.74	2285	-3.08	26.5	26.7
26	27	1	0	128.88	-1.66	51.0	2.74	2606	-3.08	28.0	28.2
27	1	2	3.25	0.00	1.59	-77.8	2.54	6057	-4.59	-31.9	32.3
28	2	2	3.25	7.33	1.59	-70.5	2.54	4969	-4.59	-28.5	28.9
29	3	2	3.25	14.67	1.59	-63.2	2.54	3989	-4.59	-25.1	25.5
30	4	2	3.25	22.00	1.59	-55.8	2.54	3117	-4.59	-21.7	22.2
31	5	2	3.25	29.33	1.59	-48.5	2.54	2352	-4.59	-18.3	18.9
32	6	2	3.25	36.67	1.59	-41.2	2.54	1694	-4.59	-14.9	15.6
33	7	2	3.25	44.00	1.59	-33.8	2.54	1144	-4.59	-11.5	12.4
34	8	2	3.25	51.33	1.59	-26.5	2.54	702	-4.59	-8.1	9.3
35	9	2	3.25	58.67	1.59	-19.2	2.54	367	-4.59	-4.7	6.5
36	10	2	3.25	66.00	1.59	-11.8	2.54	140	-4.59	-1.3	4.8
37	11	2	3.25	76.88	1.59	-1.0	2.54	1	-4.59	3.8	6.0
38	12	2	3.25	80.13	1.59	2.3	2.54	5	-4.59	5.3	7.0
39	13	2	3.25	83.38	1.59	5.5	2.54	31	-4.59	6.8	8.2
40	14	2	3.25	86.63	1.59	8.8	2.54	77	-4.59	8.3	9.5
41	15	2	3.25	89.88	1.59	12.0	2.54	145	-4.59	9.8	10.9
42	16	2	3.25	93.13	1.59	15.3	2.54	234	-4.59	11.4	12.3
43	17	2	3.25	96.38	1.59	18.5	2.54	344	-4.59	12.9	13.7
44	18	2	3.25	99.63	1.59	21.8	2.54	475	-4.59	14.4	15.1
45	19	2	3.25	102.88	1.59	25.0	2.54	627	-4.59	15.9	16.5
46	20	2	3.25	106.13	1.59	28.3	2.54	801	-4.59	17.4	18.0
47	21	2	3.25	109.38	1.59	31.5	2.54	995	-4.59	18.9	19.5
48	22	2	3.25	112.63	1.59	34.8	2.54	1211	-4.59	20.4	20.9
49	23	2	3.25	115.88	1.59	38.0	2.54	1448	-4.59	21.9	22.4
50	24	2	3.25	119.13	1.59	41.3	2.54	1706	-4.59	23.5	23.9
51	25	2	3.25	122.38	1.59	44.5	2.54	1985	-4.59	25.0	25.4
52	26	2	3.25	125.63	1.59	47.8	2.54	2285	-4.59	26.5	26.9
53	27	2	3.25	128.88	1.59	51.0	2.54	2606	-4.59	28.0	28.4
	Bot		33	627							
	Top		55	3498							
	Total		88	4125			140	75,794			

rv: vert comp of bolt force
rh: horiz comp of bolt force

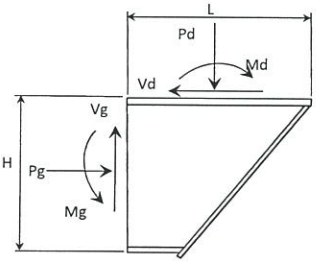
	Bot	Top	Total
n	19	34	53
xb	1.71	1.63	1.66
yb	33.0	102.9	77.8
Ip	7,714	8,709	75,934
rp	-16.6	15.9	
rh-rp	-15.3	12.1	
P	-315	540	225
V	-74	-130	-204
M	-3,587	-4,050	3,711

rv = 4.6 kips
rh = 40.4 kips
r = 40.7 kips

D/C = 0.71



Knee Brace Forces

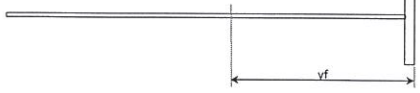


L : 54 in
H : 78 in
Pg = -315 kips
Vg = -74 kips
Mg = -3587 in-kips
Pd = Vg = -74 kips
Vd = Pg = -315 kips
Md = Mg+PgH/2+VgL/2 = -13,901 in-kips

Knee Brace Web

t : 0.625 in
@ Diaph Vr = 979 kips D/C = 0.32
@ Gdr Vr = 1414 kips D/C = 0.05

@ Diaph
bf : 12 in
tf : 0.875 in
Fy : 50 ksi
A = 44 in^2
yf = 21.4 in
I = 14230 in^4
Sf = 666 in^3
Sw = 425 in^3
fa = 1.66 ksi axial stress
f_{bf} = 20.9 ksi bending stress in flange
f_{bw} = -32.7 ksi bending stress in web
f_f = 22.5 ksi Total flange stress D/C 0.45
f_w = -31.1 ksi Total web stress 0.62

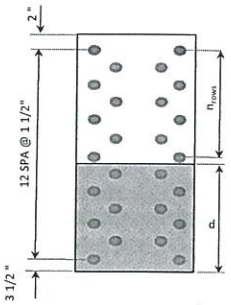


@ Girder
bf : 0 in
tf : 0 in
A = 48.8 in^2
yb = 39.0 in
I = 24716 in^4
S = 634 in^3
fa = 6.5 ksi
fb = -5.7 ksi

Kneebrace Connection PL - Web Weld

Double Fillet Size :	0.3125 in	Fexx :	70 ksi	ϕ_{e2} :	0.80		
Rr =	14.8 k/in	L =	54 in	Rr =	802 kips	D/C =	0.39

Knee Brace - Diaphragm Connection



s : 3.75 in

row	h	d	d^2
1	49.25	41.71	1,740
2	43.75	36.21	1,311
3	40.00	32.46	1,054
4	36.25	28.71	824
5	32.50	24.96	623
6	28.75	21.21	450
7	25.00	17.46	305
8	21.25	13.71	188
9	17.50	9.96	99
10	13.75	6.21	39
11	10.00	2.46	6
12	6.25	0.00	0
13	2.50	0.00	0

bolt D :	1 in
Ab =	0.785 in^2
Fub :	120 ksi
w :	14 in
d :	7.54 in
Ay =	398 in^3
n_{rows} =	12
n =	26
y =	21.1 in
Aby =	398 in^3
A =	124.4 in^2
I =	12,428 in^4
St =	298 in^3
Sc =	1649 in^3

fa =	0.59 ksi		
fb =	46.7 ksi		
Max Bolt Stress =	47.3 ksi		
Max Bolt Tension, Tu =	37.1 kips	Bolt Shear, Pu =	12.1 kips
Bolt Shear Cap, $\phi_v R_n$:	35.9 kips		
ϕ_t :	0.80		
Bolt Tensile Cap, $\phi_t T_n$ =	53.9 kips	D/C =	0.69

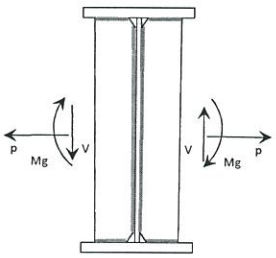
Girder connection PL

At interior girders, most of the floorbeam moment will be transferred directly from one floobeam to the next.

		Conn PL			
Girder Depth, H :	13.2 ft	b :	12 in		
F = M/H =	100 kips	t :	1.125 in		
L :	2 ft	Fy :	50 ksi		
M = FL/2 =	100 ft-kips	tw :	1 in		
		beff :	9	tw =	9 in

Conn PL Weld Capacity

Double Fillet Size :	0.3125 in	Fexx =	70 ksi	ϕ_{e2} :	0.80	Rr =	14.8 k/in



Ls =	11 in	L =	176.4 in
Lw =	154.4 in	I =	375,732 in^2
horiz clip :	1 in	Ss =	4,744 in^2 - of Stiff weld
vert clip :	2 in	Sw =	4,867 in^2 - of web weld

M =	2445 ft-kips		
V =	204 kips		
max. stiff weld shear due to M =	6.2 k/in	Stiff Weld D/C =	0.42
max. web weld shear due to M =	6.0 k/in		
max. web weld shear due to V =	1.3 k/in		
max resultant weld shear =	6.2 k/in	Web Weld D/C =	0.42

HNTB

For Innerbelt Bridge | Job no. 49633 | Sheet no.
Made by PDB | Checked by PDB | Backchecked by SJL
Date 9/22/2011 | Date 9/23/2011 | Date 9/23/2011

(Revised for deeper Knee Brace)

Floorbeam Type D, 6'-6" Kneebrace

Bolt Cap : 28.7 kips
57.4 kips - double shear

Mg = -3114 ft-kips
V = 240 kips
P = -386 kips

eh = 3.25 in
ev = 28.9 in

Veh = 65 ft-kips
Pev = -930 ft-kips
Mc = Mg-Veh-Pev = -2249 ft-kips

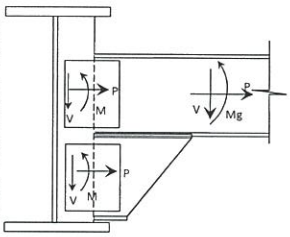
bolt	row	column	x	y	x-xb	y-yb	$(x-xb)^2$	$(y-yb)^2$	rv	rh	r
1	1	1	0	0	-3.25	-75.3	10.56	5676	2.10	19.7	19.8
2	2	1	0	6.25	-3.25	-69.1	10.56	4773	2.10	18.4	18.5
3	3	1	0	12.50	-3.25	-62.8	10.56	3948	2.10	17.2	17.3
4	4	1	0	18.75	-3.25	-56.6	10.56	3202	2.10	15.9	16.0
5	5	1	0	25.00	-3.25	-50.3	10.56	2534	2.10	14.6	14.8
6	6	1	0	31.25	-3.25	-44.1	10.56	1944	2.10	13.4	13.5
7	7	1	0	37.50	-3.25	-37.8	10.56	1432	2.10	12.1	12.3
8	8	1	0	43.75	-3.25	-31.6	10.56	998	2.10	10.8	11.0
9	9	1	0	50.00	-3.25	-25.3	10.56	642	2.10	9.6	9.8
10	10	1	0	56.25	-3.25	-19.1	10.56	364	2.10	8.3	8.6
11	11	1	0	62.50	-3.25	-12.8	10.56	165	2.10	7.0	7.3
12	12	1	0	68.75	-3.25	-6.6	10.56	43	2.10	5.8	6.1
13	13	1	0	78.25	-3.25	2.9	10.56	8	2.10	3.8	4.4
14	14	1	0	81.50	-3.25	6.2	10.56	38	2.10	3.2	3.8
15	15	1	0	84.75	-3.25	9.4	10.56	89	2.10	2.5	3.3
16	16	1	0	88.00	-3.25	12.7	10.56	160	2.10	1.9	2.8
17	17	1	0	91.25	-3.25	15.9	10.56	253	2.10	1.2	2.4
18	18	1	0	94.50	-3.25	19.2	10.56	367	2.10	0.6	2.2
19	19	1	0	97.75	-3.25	22.4	10.56	502	2.10	-0.1	2.1
20	20	1	0	101.00	-3.25	25.7	10.56	659	2.10	-0.8	2.2
21	21	1	0	104.25	-3.25	28.9	10.56	836	2.10	-1.4	2.5
22	22	1	0	107.50	-3.25	32.2	10.56	1035	2.10	-2.1	3.0
23	23	1	0	110.75	-3.25	35.4	10.56	1254	2.10	-2.7	3.4
24	24	1	0	114.00	-3.25	38.7	10.56	1495	2.10	-3.4	4.0
25	25	1	0	117.25	-3.25	41.9	10.56	1757	2.10	-4.0	4.6
26	26	1	0	120.50	-3.25	45.2	10.56	2040	2.10	-4.7	5.2
27	27	1	0	123.75	-3.25	48.4	10.56	2344	2.10	-5.4	5.8
28	28	1	0	127.00	-3.25	51.7	10.56	2669	2.10	-6.0	6.4
29	29	1	0	130.25	-3.25	54.9	10.56	3016	2.10	-6.7	7.0
30	1	2	3.25	0.00	0.00	-75.3	0.00	5676	2.76	19.7	19.9
31	2	2	3.25	6.25	0.00	-69.1	0.00	4773	2.76	18.4	18.6
32	3	2	3.25	12.50	0.00	-62.8	0.00	3948	2.76	17.2	17.4
33	4	2	3.25	18.75	0.00	-56.6	0.00	3202	2.76	15.9	16.1
34	5	2	3.25	25.00	0.00	-50.3	0.00	2534	2.76	14.6	14.9
35	6	2	3.25	31.25	0.00	-44.1	0.00	1944	2.76	13.4	13.6
36	7	2	3.25	37.50	0.00	-37.8	0.00	1432	2.76	12.1	12.4
37	8	2	3.25	43.75	0.00	-31.6	0.00	998	2.76	10.8	11.2
38	9	2	3.25	50.00	0.00	-25.3	0.00	642	2.76	9.6	10.0
39	10	2	3.25	56.25	0.00	-19.1	0.00	364	2.76	8.3	8.7
40	11	2	3.25	62.50	0.00	-12.8	0.00	165	2.76	7.0	7.6
41	12	2	3.25	68.75	0.00	-6.6	0.00	43	2.76	5.8	6.4
42	13	2	3.25	78.25	0.00	2.9	0.00	8	2.76	3.8	4.7
43	14	2	3.25	81.50	0.00	6.2	0.00	38	2.76	3.2	4.2
44	15	2	3.25	84.75	0.00	9.4	0.00	89	2.76	2.5	3.7
45	16	2	3.25	88.00	0.00	12.7	0.00	160	2.76	1.9	3.3
46	17	2	3.25	91.25	0.00	15.9	0.00	253	2.76	1.2	3.0
47	18	2	3.25	94.50	0.00	19.2	0.00	367	2.76	0.6	2.8
48	19	2	3.25	97.75	0.00	22.4	0.00	502	2.76	-0.1	2.8
49	20	2	3.25	101.00	0.00	25.7	0.00	659	2.76	-0.8	2.9
50	21	2	3.25	104.25	0.00	28.9	0.00	836	2.76	-1.4	3.1
51	22	2	3.25	107.50	0.00	32.2	0.00	1035	2.76	-2.1	3.5
52	23	2	3.25	110.75	0.00	35.4	0.00	1254	2.76	-2.7	3.9
53	24	2	3.25	114.00	0.00	38.7	0.00	1495	2.76	-3.4	4.4
54	25	2	3.25	117.25	0.00	41.9	0.00	1757	2.76	-4.0	4.9
55	26	2	3.25	120.50	0.00	45.2	0.00	2040	2.76	-4.7	5.5
56	27	2	3.25	123.75	0.00	48.4	0.00	2344	2.76	-5.4	6.0
57	28	2	3.25	127.00	0.00	51.7	0.00	2669	2.76	-6.0	6.6
58	29	2	3.25	130.25	0.00	54.9	0.00	3016	2.76	-6.7	7.2
59	1	3	6.5	0.00	3.25	-75.3	10.56	5676	3.42	19.7	20.0
60	2	3	6.5	6.25	3.25	-69.1	10.56	4773	3.42	18.4	18.7
61	3	3	6.5	12.50	3.25	-62.8	10.56	3948	3.42	17.2	17.5
62	4	3	6.5	18.75	3.25	-56.6	10.56	3202	3.42	15.9	16.3
63	5	3	6.5	25.00	3.25	-50.3	10.56	2534	3.42	14.6	15.0
64	6	3	6.5	31.25	3.25	-44.1	10.56	1944	3.42	13.4	13.8
65	7	3	6.5	37.50	3.25	-37.8	10.56	1432	3.42	12.1	12.6
66	8	3	6.5	43.75	3.25	-31.6	10.56	998	3.42	10.8	11.4
67	9	3	6.5	50.00	3.25	-25.3	10.56	642	3.42	9.6	10.2
68	10	3	6.5	56.25	3.25	-19.1	10.56	364	3.42	8.3	9.0
69	11	3	6.5	62.50	3.25	-12.8	10.56	165	3.42	7.0	7.8
70	12	3	6.5	68.75	3.25	-6.6	10.56	43	3.42	5.8	6.7
71	13	3	6.5	78.25	3.25	2.9	10.56	8	3.42	3.8	5.1
72	14	3	6.5	81.50	3.25	6.2	10.56	38	3.42	3.2	4.7
73	15	3	6.5	84.75	3.25	9.4	10.56	89	3.42	2.5	4.3
74	16	3	6.5	88.00	3.25	12.7	10.56	160	3.42	1.9	3.9
75	17	3	6.5	91.25	3.25	15.9	10.56	253	3.42	1.2	3.6
76	18	3	6.5	94.50	3.25	19.2	10.56	367	3.42	0.6	3.5
77	19	3	6.5	97.75	3.25	22.4	10.56	502	3.42	-0.1	3.4
78	20	3	6.5	101.00	3.25	25.7	10.56	659	3.42	-0.8	3.5
79	21	3	6.5	104.25	3.25	28.9	10.56	836	3.42	-1.4	3.7
80	22	3	6.5	107.50	3.25	32.2	10.56	1035	3.42	-2.1	4.0
81	23	3	6.5	110.75	3.25	35.4	10.56	1254	3.42	-2.7	4.4
82	24	3	6.5	114.00	3.25	38.7	10.56	1495	3.42	-3.4	4.8
83	25	3	6.5	117.25	3.25	41.9	10.56	1757	3.42	-4.0	5.3
84	26	3	6.5	120.50	3.25	45.2	10.56	2040	3.42	-4.7	5.8
85	27	3	6.5	123.75	3.25	48.4	10.56	2344	3.42	-5.4	6.4
86	28	3	6.5	127.00	3.25	51.7	10.56	2669	3.42	-6.0	6.9
87	29	3	6.5	130.25	3.25	54.9	10.56	3016	3.42	-6.7	7.5
	Bot		117	1238							
	Top		166	5317							
	Total		283	6554			613	132,724			

rv: vert comp of bolt force
rh: horiz comp of bolt force

	Bot	Top	Total
n	36	51	87
xb	3.25	3.25	3.25
yb	34.4	104.3	75.3
Ip	17,011	13,288	133,337
rp	12.7	-1.4	
rh-rp	7.0	-5.3	
P	458	-72	386
V	99	141	240
M	3,443	2,689	6,809

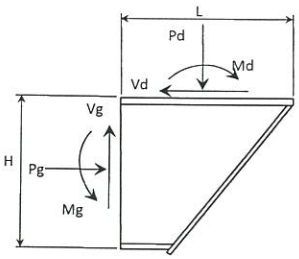
r = 20.0 kips

D/C = 0.35



N:\49633\Bridges\Design\Final Design\Unit 2\Excel\Diaphragms\final forces\LateralBracingRevision\[FloorbeamConns 0922.xlsx]D-T 78" Min M

Knee Brace Forces

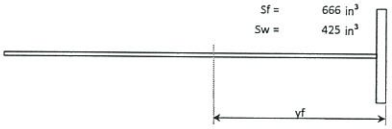


L :	54	in
H :	78	in
Pg =	458	kips
Vg =	99	kips
Mg =	3443	in-kips
Pd = Vg =	99	kips
Vd = Pg =	458	kips
Md = Mg+PgH/2+VgL/2 =	18,631	in-kips

Knee Brace Web

t :	0.625 in	@ Diaph	Vr =	979 kips	D/C = 0.47
		@ Gdr	Vr =	1414 kips	D/C = 0.07

@ Diaph	bf :	12 in	A =	44 in^2	fa =	-2.24 ksi	axial stress	
	tf :	0.875 in	yf =	21.4 in	f_{bf} =	-28.0 ksi	bending stress in flange	
	Fy :	50 ksi	I =	14230 in^4	f_{bw} =	43.9 ksi	bending stress in web	D/C
			Sf =	666 in^3	f_f =	-30.2 ksi	Total flange stress	0.60
			Sw =	425 in^3	f_w =	41.6 ksi	Total web stress	0.83

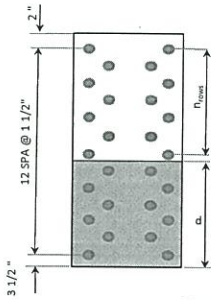


@ Girder	bf :	12 in	A =	68.7 in^2	fa =	-6.7 ksi
	tf :	0.875 in	yb =	39.0 in	fb =	2.5 ksi
			I =	54318 in^4		
			S =	1393 in^3		

Kneebrace Connection PL - Web Weld

Double Fillet Size :	0.3125 in	Fexx :	70 ksi	ϕ_{e2} :	0.80		
Rr =	14.8 k/in	L =	54 in	Rr =	802 kips	D/C =	0.57

Knee Brace - Diaphragm Connection



s : 3.75 in

row	h	d	d^2
1	49.25	41.71	1,740
2	45.50	37.96	1,441
3	41.75	34.21	1,171
4	38.00	30.46	928
5	34.25	26.71	714
6	30.50	22.96	527
7	26.75	19.21	369
8	23.00	15.46	239
9	19.25	11.71	137
10	15.50	7.96	63
11	11.75	4.21	18
12	8.00	0.46	0
13	2.50	0.00	0

bolt D :	1 in
Ab =	0.785 in^2
Fub :	120 ksi
w :	14 in
d :	7.54 in
Ay =	398 in^3
n_{rows} =	12
n =	26
y =	21.1 in
Aby =	398 in^3
A =	124 in^2
I =	13,539 in^4
St =	325 in^3
Sc =	1797 in^3

fa =	-0.80 ksi				
fb =	57.4 ksi				
Max Bolt Stress =	56.6 ksi				
Max Bolt Tension, Tu =	44.5 kips		Bolt Shear, Pu =	17.6 kips	
Bolt Shear Cap, $\phi_s R_n$:	35.9 kips				
ϕ_t :	0.80				
Bolt Tensile Cap, $\phi_t T_n$ =	49.9 kips		D/C =	0.89	

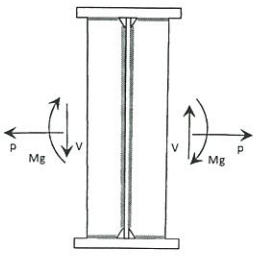
Girder connection PL

At interior girders, most of the floorbeam moment will be transferred directly from one floobeam to the next.

		Conn PL	
Girder Depth, H :	12.2 ft	b :	12 in
F = M/H =	100 kips	t :	1.125 in
L :	2 ft	Fy :	50 ksi
M = FL/2 =	100 ft-kips	tw :	1 in
		beff :	9 tw = 9 in

Conn PL Weld Capacity

Double Fillet Size :	0.4375 in	Fexx =	70 ksi	ϕ_{e2} :	0.80	Rr =	20.8 k/in



Ls =	11 in	L =	164.4 in
Lw =	142.4 in	I =	299,570 in^3
horiz clip :	1 in	Ss =	4,092 in^2 - of Stiff weld
vert clip :	2 in	Sw =	4,207 in^2 - of web weld

M =	3114 ft-kips		
V =	240 kips		
max. stiff weld shear due to M =	9.1 k/in	Stiff Weld D/C =	0.44
max. web weld shear due to M =	8.9 k/in		
max. web weld shear due to V =	1.7 k/in		
max resultant weld shear =	9.0 k/in	Web Weld D/C =	0.43

HNTB

For Innerbelt Bridge | Job no. 49633 | Sheet no.
Made by PDB | Checked by PDB | Backchecked by SJL
Date 9/22/2011 | Date 9/23/2011 | Date 9/23/2011

(Revised for deeper Knee Brace)

Floorbeam Type D, 6'-6" Kneebrace

Bolt Cap : 28.7 kips
57.4 kips - double shear

Mg = 2445 ft-kips
V = -204 kips
P = -225 kips

eh = 3.25 in
ev = 28.9 in

Veh = -55 ft-kips
Pev = -542 ft-kips
Mc = Mg-Veh-Pev = 3042 ft-kips

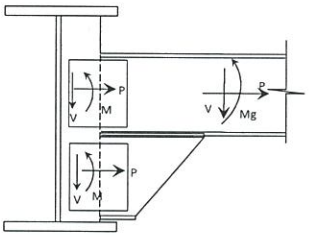
bolt	row	column	x	y	x-xb	y-yb	$(x-xb)^2$	$(y-yb)^2$	rv	rh	r
1	1	1	0	0	-3.25	-75.3	10.56	5676	-1.45	-18.0	18.1
2	2	1	0	6.25	-3.25	-69.1	10.56	4773	-1.45	-16.3	16.4
3	3	1	0	12.50	-3.25	-62.8	10.56	3948	-1.45	-14.6	14.7
4	4	1	0	18.75	-3.25	-56.6	10.56	3202	-1.45	-12.9	13.0
5	5	1	0	25.00	-3.25	-50.3	10.56	2534	-1.45	-11.2	11.3
6	6	1	0	31.25	-3.25	-44.1	10.56	1944	-1.45	-9.5	9.6
7	7	1	0	37.50	-3.25	-37.8	10.56	1432	-1.45	-7.8	7.9
8	8	1	0	43.75	-3.25	-31.6	10.56	998	-1.45	-6.1	6.2
9	9	1	0	50.00	-3.25	-25.3	10.56	642	-1.45	-4.4	4.6
10	10	1	0	56.25	-3.25	-19.1	10.56	364	-1.45	-2.6	3.0
11	11	1	0	62.50	-3.25	-12.8	10.56	165	-1.45	-0.9	1.7
12	12	1	0	68.75	-3.25	-6.6	10.56	43	-1.45	0.8	1.7
13	13	1	0	78.25	-3.25	2.9	10.56	8	-1.45	3.4	3.7
14	14	1	0	81.50	-3.25	6.2	10.56	38	-1.45	4.3	4.5
15	15	1	0	84.75	-3.25	9.4	10.56	89	-1.45	5.2	5.4
16	16	1	0	88.00	-3.25	12.7	10.56	160	-1.45	6.1	6.2
17	17	1	0	91.25	-3.25	15.9	10.56	253	-1.45	6.9	7.1
18	18	1	0	94.50	-3.25	19.2	10.56	367	-1.45	7.8	8.0
19	19	1	0	97.75	-3.25	22.4	10.56	502	-1.45	8.7	8.8
20	20	1	0	101.00	-3.25	25.7	10.56	659	-1.45	9.6	9.7
21	21	1	0	104.25	-3.25	28.9	10.56	836	-1.45	10.5	10.6
22	22	1	0	107.50	-3.25	32.2	10.56	1035	-1.45	11.4	11.5
23	23	1	0	110.75	-3.25	35.4	10.56	1254	-1.45	12.3	12.4
24	24	1	0	114.00	-3.25	38.7	10.56	1495	-1.45	13.2	13.3
25	25	1	0	117.25	-3.25	41.9	10.56	1757	-1.45	14.1	14.1
26	26	1	0	120.50	-3.25	45.2	10.56	2040	-1.45	15.0	15.0
27	27	1	0	123.75	-3.25	48.4	10.56	2344	-1.45	15.8	15.9
28	28	1	0	127.00	-3.25	51.7	10.56	2669	-1.45	16.7	16.8
29	29	1	0	130.25	-3.25	54.9	10.56	3016	-1.45	17.6	17.7
30	1	2	3.25	0	0.00	-75.3	0.00	5676	-2.34	-18.0	18.2
31	2	2	3.25	6.25	0.00	-69.1	0.00	4773	-2.34	-16.3	16.5
32	3	2	3.25	12.50	0.00	-62.8	0.00	3948	-2.34	-14.6	14.8
33	4	2	3.25	18.75	0.00	-56.6	0.00	3202	-2.34	-12.9	13.1
34	5	2	3.25	25.00	0.00	-50.3	0.00	2534	-2.34	-11.2	11.4
35	6	2	3.25	31.25	0.00	-44.1	0.00	1944	-2.34	-9.5	9.8
36	7	2	3.25	37.50	0.00	-37.8	0.00	1432	-2.34	-7.8	8.1
37	8	2	3.25	43.75	0.00	-31.6	0.00	998	-2.34	-6.1	6.5
38	9	2	3.25	50.00	0.00	-25.3	0.00	642	-2.34	-4.4	4.9
39	10	2	3.25	56.25	0.00	-19.1	0.00	364	-2.34	-2.6	3.5
40	11	2	3.25	62.50	0.00	-12.8	0.00	165	-2.34	-0.9	2.5
41	12	2	3.25	68.75	0.00	-6.6	0.00	43	-2.34	0.8	2.5
42	13	2	3.25	78.25	0.00	2.9	0.00	8	-2.34	3.4	4.1
43	14	2	3.25	81.50	0.00	6.2	0.00	38	-2.34	4.3	4.9
44	15	2	3.25	84.75	0.00	9.4	0.00	89	-2.34	5.2	5.7
45	16	2	3.25	88.00	0.00	12.7	0.00	160	-2.34	6.1	6.5
46	17	2	3.25	91.25	0.00	15.9	0.00	253	-2.34	6.9	7.3
47	18	2	3.25	94.50	0.00	19.2	0.00	367	-2.34	7.8	8.2
48	19	2	3.25	97.75	0.00	22.4	0.00	502	-2.34	8.7	9.0
49	20	2	3.25	101.00	0.00	25.7	0.00	659	-2.34	9.6	9.9
50	21	2	3.25	104.25	0.00	28.9	0.00	836	-2.34	10.5	10.8
51	22	2	3.25	107.50	0.00	32.2	0.00	1035	-2.34	11.4	11.6
52	23	2	3.25	110.75	0.00	35.4	0.00	1254	-2.34	12.3	12.5
53	24	2	3.25	114.00	0.00	38.7	0.00	1495	-2.34	13.2	13.4
54	25	2	3.25	117.25	0.00	41.9	0.00	1757	-2.34	14.1	14.3
55	26	2	3.25	120.50	0.00	45.2	0.00	2040	-2.34	15.0	15.1
56	27	2	3.25	123.75	0.00	48.4	0.00	2344	-2.34	15.8	16.0
57	28	2	3.25	127.00	0.00	51.7	0.00	2669	-2.34	16.7	16.9
58	29	2	3.25	130.25	0.00	54.9	0.00	3016	-2.34	17.6	17.8
59	1	3	6.5	0	3.25	-75.3	10.56	5676	-3.23	-18.0	18.3
60	2	3	6.5	6.25	3.25	-69.1	10.56	4773	-3.23	-16.3	16.6
61	3	3	6.5	12.50	3.25	-62.8	10.56	3948	-3.23	-14.6	15.0
62	4	3	6.5	18.75	3.25	-56.6	10.56	3202	-3.23	-12.9	13.3
63	5	3	6.5	25.00	3.25	-50.3	10.56	2534	-3.23	-11.2	11.7
64	6	3	6.5	31.25	3.25	-44.1	10.56	1944	-3.23	-9.5	10.0
65	7	3	6.5	37.50	3.25	-37.8	10.56	1432	-3.23	-7.8	8.4
66	8	3	6.5	43.75	3.25	-31.6	10.56	998	-3.23	-6.1	6.9
67	9	3	6.5	50.00	3.25	-25.3	10.56	642	-3.23	-4.4	5.4
68	10	3	6.5	56.25	3.25	-19.1	10.56	364	-3.23	-2.6	4.2
69	11	3	6.5	62.50	3.25	-12.8	10.56	165	-3.23	-0.9	3.4
70	12	3	6.5	68.75	3.25	-6.6	10.56	43	-3.23	0.8	3.3
71	13	3	6.5	78.25	3.25	2.9	10.56	8	-3.23	3.4	4.7
72	14	3	6.5	81.50	3.25	6.2	10.56	38	-3.23	4.3	5.4
73	15	3	6.5	84.75	3.25	9.4	10.56	89	-3.23	5.2	6.1
74	16	3	6.5	88.00	3.25	12.7	10.56	160	-3.23	6.1	6.9
75	17	3	6.5	91.25	3.25	15.9	10.56	253	-3.23	6.9	7.7
76	18	3	6.5	94.50	3.25	19.2	10.56	367	-3.23	7.8	8.5
77	19	3	6.5	97.75	3.25	22.4	10.56	502	-3.23	8.7	9.3
78	20	3	6.5	101.00	3.25	25.7	10.56	659	-3.23	9.6	10.1
79	21	3	6.5	104.25	3.25	28.9	10.56	836	-3.23	10.5	11.0
80	22	3	6.5	107.50	3.25	32.2	10.56	1035	-3.23	11.4	11.8
81	23	3	6.5	110.75	3.25	35.4	10.56	1254	-3.23	12.3	12.7
82	24	3	6.5	114.00	3.25	38.7	10.56	1495	-3.23	13.2	13.6
83	25	3	6.5	117.25	3.25	41.9	10.56	1757	-3.23	14.1	14.4
84	26	3	6.5	120.50	3.25	45.2	10.56	2040	-3.23	15.0	15.3
85	27	3	6.5	123.75	3.25	48.4	10.56	2344	-3.23	15.8	16.2
86	28	3	6.5	127.00	3.25	51.7	10.56	2669	-3.23	16.7	17.0
87	29	3	6.5	130.25	3.25	54.9	10.56	3016	-3.23	17.6	17.9
	Bot		117	1238							
	Top		166	5317							
	Total		283	6554			613	132,724			

rv: vert comp of bolt force
rh: horiz comp of bolt force

	Bot	Top	Total
n	36	51	87
xb	3.25	3.25	3.25
yb	34.4	104.3	75.3
Ip	17,011	13,288	133,337
rp	-8.6	10.5	
rh-rp	-9.4	7.1	
P	-311	536	225
V	-84	-120	-204
M	-4,658	-3,638	5,989

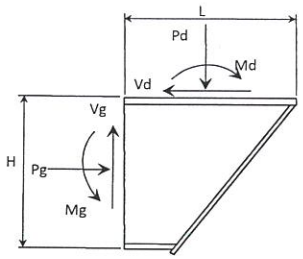
r = 18.3 kips

D/C = 0.32



N:\49633\Bridges\Design\Final Design\Unit 2\Excel\Diaphragms\final forces\LateralBracingRevision\[FloorbeamConns 0922.xlsx]D-T 78" Max M

Knee Brace Forces



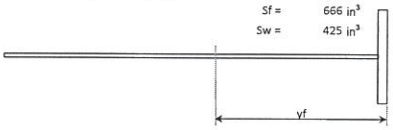
L :	54	in
H :	78	in
Pg =	-311	kips
Vg =	-84	kips
Mg =	-4658	in-kips
Pd = Vg =	-84	kips
Vd = Pg =	-311	kips
Md = Mg+PgH/2+VgL/2 =	-14,494	in-kips

Knee Brace Web

t : 0.625 in | @ Diaph Vr = 979 kips D/C = 0.32 | @ Gdr Vr = 1414 kips D/C = 0.06

@ Diaph	bf :	12 in	A =	44 in^2	fa =	1.91 ksi	axial stress
	tf :	0.875 in	yf =	21.4 in	f_{bf} =	21.8 ksi	bending stress in flange
	Fy :	50 ksi	I =	14230 in^4	f_{bw} =	-34.1 ksi	bending stress in web
			Sf =	666 in^3	f_f =	23.7 ksi	Total flange stress
			Sw =	425 in^3	f_w =	-32.2 ksi	Total web stress

D/C: 0.47 (flange), 0.64 (web)



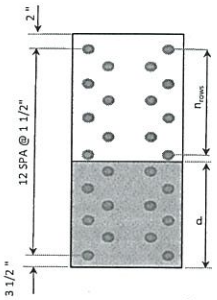
@ Girder	bf :	12 in	A =	68.7 in^2	fa =	4.5 ksi	
	tf :	0.875 in	yb =	39.0 in	fb =	-3.3 ksi	
			I =	54318 in^4			
			S =	1393 in^3			

Kneebrace Connection PL - Web Weld

Double Fillet Size : 0.3125 in | Fexx : 70 ksi | ϕ_{e2} : 0.80

Rr = 14.8 k/in | L = 54 in | Rr = 802 kips | D/C = 0.39

Knee Brace - Diaphragm Connection



s : 3.75 in

row	h	d	d^2
1	49.25	41.71	1,740
2	43.75	36.21	1,311
3	40.00	32.46	1,054
4	36.25	28.71	824
5	32.50	24.96	623
6	28.75	21.21	450
7	25.00	17.46	305
8	21.25	13.71	188
9	17.50	9.96	99
10	13.75	6.21	39
11	10.00	2.46	6
12	6.25	0.00	0
13	2.50	0.00	0

bolt D :	1 in
Ab =	0.785 in^2
Fub :	120 ksi
w :	14 in
d :	7.54 in
Ay =	398 in^3
n_{rows} =	12
n =	26
y =	21.1 in
Aby =	398 in^3
A =	124 in^2
I =	12,428 in^4
St =	298 in^3
Sc =	1649 in^3

fa =	0.68 ksi		
fb =	48.7 ksi		
Max Bolt Stress =	49.3 ksi		
Max Bolt Tension, Tu =	38.7 kips	Bolt Shear, Pu =	11.9 kips
Bolt Shear Cap, $\phi_s R_n$:	35.9 kips		
ϕ_t :	0.80		
Bolt Tensile Cap, $\phi_t T_n$ =	54.0 kips	D/C =	0.72

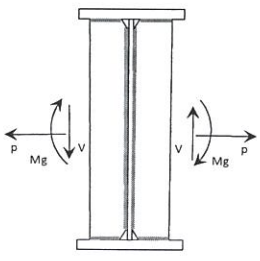
Girder connection PL

At interior girders, most of the floorbeam moment will be transferred directly from one floobeam to the next.

		Conn PL	
Girder Depth, H :	12.2 ft	b :	12 in
F = M/H =	100 kips	t :	1.125 in
L :	2 ft	Fy :	50 ksi
M = FL/2 =	100 ft-kips	tw :	1 in
		beff : 9	tw = 9 in

Conn PL Weld Capacity

Double Fillet Size : 0.4375 in | Fexx = 70 ksi | ϕ_{e2} : 0.80 | Rr = 20.8 k/in



Ls =	11 in	L =	164.4 in
Lw =	142.4 in	I =	299,570 in^3
horiz clip :	1 in	Ss =	4,092 in^2 - of Stiff weld
vert clip :	2 in	Sw =	4,207 in^2 - of web weld

M =	2445 ft-kips		
V =	204 kips		
max. stiff weld shear due to M =	7.2 k/in	Stiff Weld D/C =	0.34
max. web weld shear due to M =	7.0 k/in		
max. web weld shear due to V =	1.4 k/in		
max resultant weld shear =	7.1 k/in	Web Weld D/C =	0.34