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: Unit D Bearing Stiffeners

Check Level (Mark One):

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Enter description below:

Rigid frame bearing stiffener design

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HNTB

For	Innerbelt Bridge	Job no.	49633	Sheet no.	1/1
Made by	PDB	Checked by	JDS	Backchecked by	PDB
Date	3/6/2012	Date	3/6/2012	Date	3/6/2012

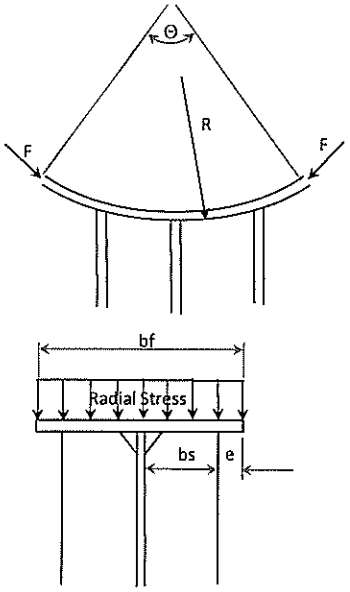
Design of Rigid Frame Bearing Stiffeners

Note: Design of radial stiffeners does not utilize capacity of web-to-flange weld to transfer radial force directly into web. This is a conservative assumption.

R : 60 in
Fy : 70 ksi
Fyw=Fys : 50 ksi
Fexx : 70 ksi

ϕ_c : 0.90 ϕ_{c2} : 0.80
Θ : 50 deg ϕ_b : 1.00

clip : 2 x 4 in



1 Calc min stiff width based on transverse flexure (Blodgett - 5.12-26)
Demand : $M = we^2/2$
where w = radial component of flange stress
Capacity : Mp = fyZ

min bs = $(bf-tw-e_{max})/2$

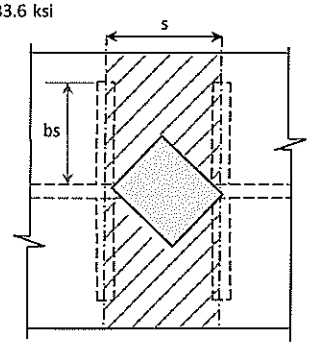
Pier	bf	t	tw	A	Flange Stress*	Flange Force	Radial Force (k/in)	Radial Stress (ksi)	Flange Mp (in-k/in)	e_{max} (in)	max bs	min bs
3	42	2.25	1.25	94.5	5.3	501	8	0.20	88.6	29.9	20.38	5.45
4	36	2.25	1.25	81.0	2.3	186	3	0.09	89	45.3	17.38	-5.29
5	32	2.5	1.25	80.0	8.4	672	11	0.35	109	25.0	15.38	2.88
6, 7	32	2.5	1.25	80.0	5.8	464	8	0.24	109	30.1	15.38	0.33
8	36	2.75	1.25	99.0	3.3	327	5	0.15	132	41.8	17.38	-3.54
9	45	2.75	1.25	124	11.1	1374	23	0.51	132	22.8	21.88	10.47
10	45	3	1.25	135	3.0	405	7	0.15	158	45.8	21.88	-1.04

Pier	Web yld Cap. (k/in)	Stiffener s	ts	bs	Stiff- Flange Weld Weld L	Demand	Min fillet
3	62.5	18.0	1.75	18	16	3.65	0.077
4	62.5	18.0	1.5	16	14	1.54	0.032
5	62.5	18.0	1.5	14	12	6.48	0.136
6, 7	62.5	18.0	1.5	14	12	4.47	0.094
8	62.5	18.0	1.5	16	14	2.69	0.057
9	62.5	18.0	1.75	20	18	8.82	0.186
10	62.5	17.0	1.75	20	18	2.46	0.052

* Flange Stress taken from "Delta Frame Design" spreadsheets by D. Glastetter dated 7/25/11

2 Calc Stiff Demand based on trib areas
Web : At = s(tw+2*bs)/4
Stiffener : At = (s(tw+2*bs)-(At)web)/2
3 Check bearing stress on combined web/stiffener area

Weld Cap = 33.6 ksi



Pier	trib area, At web	stiffeners	Demand per Stiff(k)	Bearing stress, f_{brg} Apn	2Apn + Aw	f_{brg} (ksi)	Web Demand k/in	Web Fillet min size
3	168	588	58.5	28.0	78.5	1.91	1.85	0.039
4	150	498	21.5	21.0	64.5	0.87	0.72	0.015
5	132	444	77.8	18.0	58.5	3.45	2.56	0.054
6, 7	132	444	53.7	18.0	58.5	2.38	1.77	0.037
8	150	498	37.7	21.0	64.5	1.52	1.26	0.026
9	186	624	158.8	31.5	85.5	4.82	5.25	0.110
10	175	590	44.2	31.5	84.3	1.36	1.55	0.033

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Design of Rigid Frame Bearing Stiffeners

						Fexx :	70 ksi
clip :	2	4	D :	48 in	KL =	36 in	ϕ_{ez} :	0.80
Fy :	50 ksi		tw :	1.25 in	ϕ_c :	0.90	weld cap =	33.6 ksi
			L :	48 in				

Pier	R	Girder	bf	tf	max bs	bs	min ts	ts	Apn/Stiff
3	4206	G3	42	2.25	20.38	18	1.56	1.75	28.0
4	3767	G3	36	2.25	17.38	16	1.38	1.5	21.0
5	3936	G3	32	2.50	15.38	14	1.21	1.5	18.0
6	3746	G2	32	2.50	15.38	14	1.21	1.5	18.0
7	3793	G4	32	2.50	15.38	14	1.21	1.5	18.0
8	4412	G3	36	2.75	17.38	16	1.38	1.5	21.0
9	4553	G3	45	2.75	21.88	20	1.73	1.75	31.5
10	5941	G3	45	3.00	21.88	20	1.73	1.75	31.5

	Bearing Capacity - 4 stiff's			Shear Capacity - 4 stiff's					
Pier	Rsb	(Rsb)r	D/C	Demand V (k/in)	Plate Vr (k/in)	D/C	Req'd Double Fillet size	Req'd part pen size	Bearing stiffener demands are reduced to account for portion of reaction transferred to bearing directly through bottom flange
3	2944	7840	0.38	73.6	203	0.36	0.387	0.55	
4	2637	5880	0.45	65.9	174	0.38	0.347	0.49	
5	2755	5040	0.55	68.9	174	0.40	0.362	0.51	
6	2622	5040	0.52	65.6	174	0.38	0.345	0.49	X : 0.70
7	2655	5040	0.53	66.4	174	0.38	0.349	0.49	
8	3089	5880	0.53	77.2	174	0.44	0.406	0.57	X = fraction of total reaction carried by
9	3187	8820	0.36	79.7	203	0.39	0.419	0.59	web/top flange
10	4159	8820	0.47	104.0	203	0.51	0.547	0.77	

	Eff Column Section - 4 stiff's				Eff Column Capacity - 4 stiff's					
Pier	A	I	r	KL/r	Pe	Po	Pe/Po	Pn	Pr	D/C*
3	156.3	15,075	9.82	3.67	3,329,342	7,816	426	7,808	7,027	0.42
4	126.0	9,190	8.54	4.22	2,029,587	6,300	322	6,292	5,663	0.47
5	114.0	6,256	7.41	4.86	1,381,689	5,700	242	5,690	5,121	0.54
6	114.0	6,256	7.41	4.86	1,381,689	5,700	242	5,690	5,121	0.51
7	114.0	6,256	7.41	4.86	1,381,689	5,700	242	5,690	5,121	0.52
8	126.0	9,190	8.54	4.22	2,029,587	6,300	322	6,292	5,663	0.55
9	170.3	20,472	10.96	3.28	4,521,176	8,516	531	8,509	7,658	0.42
10	170.3	20,472	10.96	3.28	4,521,176	8,516	531	8,509	7,658	0.54

* D/C's in some excess of 1.00 will be allowed given the conservative assumption that the entire reaction is transferred through the bearing stiffeners.

Pier	bs	ts
3	18	1.75
4	16	1.5
5	14	1.5
6	14	1.5
7	14	1.5
8	16	1.5
9	20	1.75
10	20	1.75