



The HNTB Companies
Engineers Architects Planners

Made	DJG	Date	5/14/2012	Job Number	49633
Checked	SJL	Date	5/16/2012		
Backchk'd	DJG	Date	5/16/2012	Sheet No.	1

For **Cleveland Innerbelt**

Bridge: Cleveland Innerbelt I-90 Viaduct Unit 2

Settlement Investigation of Piers 3 and 4

Investigate 1" of settlement to Piers 3 & 4 and its effects on Girder Stresses.

Process:

Use Unit 2 T187 Model with previously checked include files. Modify the main input file to include three load cases to be investigated for the structure in the non-composite condition. The three load cases are as follows:

1. Displace support joints at Piers 3 & 4 down by 1"
2. Displace support joints at Pier 3 only, down by 1"
3. Displace support joints at Pier 4 only, down by 1"

Results:

The magnitude of the flange stresses were greater for load cases 2 & 3 where only one pier is allowed to settle. The corresponding maximum stresses typically occur near the contraflexure points in spans adjacent to the settled pier. This contraflexure point is near the field splice location at the ends of the constant depth portion of the girder or near the beginning of the delta frames.

Load Case 2:

Max Stress Location at ends of Member 9015 & 9016

Top Flange Stress **476.06 psi** **Node 9016**
Bottom Flange Stress **495.8 psi** **Node 9016**

Max Stress Location at ends of Member 9040 & 9041

Top Flange Stress **434.78 psi** **Node 9041**
Bottom Flange Stress **452.54 psi** **Node 9041**

Load Case 3:

Max Stress Location at ends of Member 9050 & 9051

Top Flange Stress **430.72 psi** **Node 9051**
Bottom Flange Stress **448.95 psi** **Node 9051**

Max Stress Location at ends of Member 9074 & 9075

Top Flange Stress **447.69 psi** **Node 9075**
Bottom Flange Stress **467.49 psi** **Node 9075**

From the results, Girder 5 is the controlling girder, however, similar stresses are also present in Girders 1-4 as well. Assume the stresses listed are the worst case that each girder will encounter to simplify the demonstration of the girder capacity for each.

Top Flange Capacity Check (Stresses in ksi) -- SERVICE LOADS

Node	Service Demand	Settlement Stress	New Demand	Service Capacity	New D/C
1016	10.19	0.48	10.67	64.51	0.17
3016	8.9	0.48	9.38	64.51	0.15
5016	7.64	0.48	8.12	64.51	0.13
7016	7.84	0.48	8.32	64.51	0.13
9016	8.42	0.48	8.90	64.51	0.14
1041	23.99	0.43	24.42	64.51	0.38
3041	22.17	0.43	22.60	64.51	0.35
5041	20.77	0.43	21.20	64.51	0.33
7041	20.5	0.43	20.93	64.51	0.32
9041	20.36	0.43	20.79	64.51	0.32
1051	18.55	0.43	18.98	47.50	0.40
3051	16.88	0.43	17.31	47.50	0.36
5051	8.86	0.43	9.29	47.50	0.20
7051	16.7	0.43	17.13	47.50	0.36
9051	17.64	0.43	18.07	47.50	0.38
1075	17.24	0.45	17.69	47.50	0.37
3075	17.21	0.45	17.66	47.50	0.37
5075	17.23	0.45	17.68	47.50	0.37
7075	17.55	0.45	18.00	47.50	0.38
9075	17.5	0.45	17.95	47.50	0.38

Bottom Flange Capacity Check (Stresses in ksi) -- SERVICE LOADS

Node	Service Demand	Settlement Stress	New Demand	Service Capacity	New D/C
1016	16.73	0.50	17.23	64.51	0.27
3016	15.33	0.50	15.83	64.51	0.25
5016	13.84	0.50	14.34	64.51	0.22
7016	14.7	0.50	15.20	64.51	0.24
9016	15.46	0.50	15.96	64.51	0.25
1041	28.34	0.45	28.79	64.51	0.45
3041	26.85	0.45	27.30	64.51	0.42
5041	25.43	0.45	25.88	64.51	0.40
7041	24.79	0.45	25.24	64.51	0.39
9041	24.3	0.45	24.75	64.51	0.38
1051	21.34	0.45	21.79	47.50	0.46
3051	19.56	0.45	20.01	47.50	0.42
5051	16.91	0.45	17.36	47.50	0.37
7051	18.82	0.45	19.27	47.50	0.41
9051	19.73	0.45	20.18	47.50	0.42
1075	20.99	0.47	21.46	47.50	0.45
3075	21.25	0.47	21.72	47.50	0.46
5075	21.1	0.47	21.57	47.50	0.45
7075	21.08	0.47	21.55	47.50	0.45
9075	20.37	0.47	20.84	47.50	0.44



The HNTB Companies
Engineers Architects Planners

Made	DJG	Date	5/14/2012	Job Number	49633
Checked	SJL	Date	5/16/2012		
Backchk'd	DJG	Date	5/16/2012	Sheet No.	2

For **Cleveland Innerbelt**

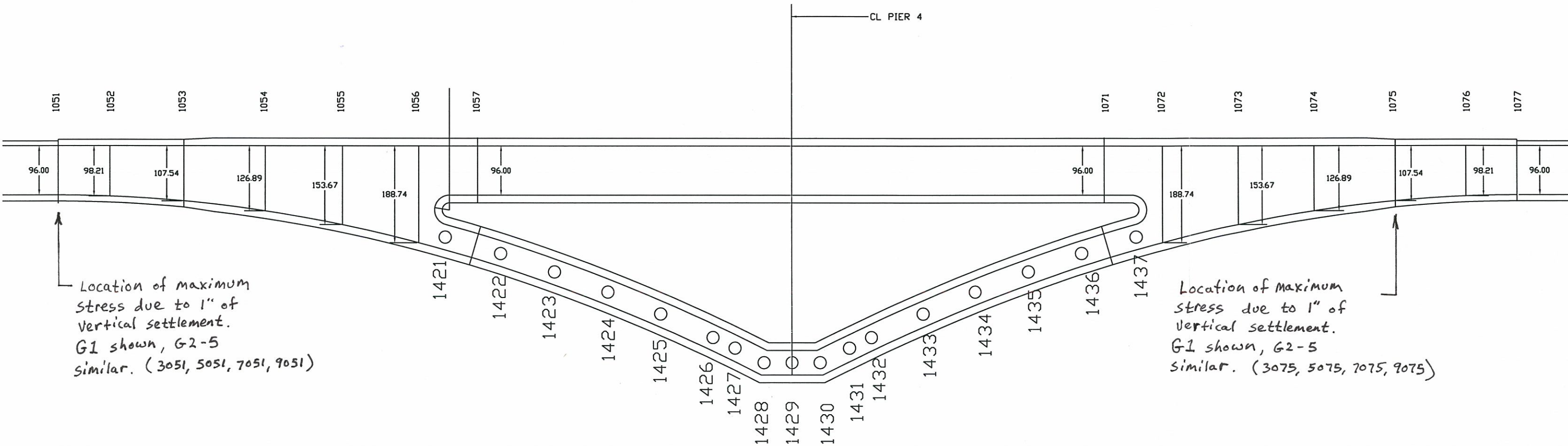
Top Flange Capacity Check (Stresses in ksi) -- STRENGTH LOADS

Node	Strength Demand	Settlement Stress	New Demand	Strength Capacity	New D/C
1016	14.44	0.48	14.92	68.05	0.22
3016	14.12	0.48	14.60	68.03	0.21
5016	14.29	0.48	14.77	68.03	0.22
7016	14.72	0.48	15.20	68.03	0.22
9016	15.73	0.48	16.21	68.05	0.24
1041	34.17	0.43	34.60	67.93	0.51
3041	31.67	0.43	32.10	67.91	0.47
5041	29.8	0.43	30.23	67.91	0.45
7041	29.27	0.43	29.70	67.91	0.44
9041	28.91	0.43	29.34	67.93	0.43
1051	26.66	0.43	27.09	50.00	0.54
3051	24.24	0.43	24.67	50.00	0.49
5051	23.03	0.43	23.46	50.00	0.47
7051	23.78	0.43	24.21	50.00	0.48
9051	25.09	0.43	25.52	50.00	0.51
1075	24.65	0.45	25.10	50.00	0.50
3075	24.54	0.45	24.99	50.00	0.50
5075	24.47	0.45	24.92	50.00	0.50
7075	24.8	0.45	25.25	50.00	0.51
9075	24.64	0.45	25.09	50.00	0.50

Bottom Flange Capacity Check (Stresses in ksi) -- STRENGTH LOADS

Node	Strength Demand	Settlement Stress	New Demand	Strength Capacity	New D/C
1016	23.57	0.50	24.07	68.05	0.35
3016	21.51	0.50	22.01	68.03	0.32
5016	19.25	0.50	19.75	68.03	0.29
7016	20.29	0.50	20.79	68.03	0.31
9016	21.26	0.50	21.76	68.05	0.32
1041	40.62	0.45	41.07	62.44	0.66
3041	38.49	0.45	38.94	62.41	0.62
5041	36.45	0.45	36.90	62.4	0.59
7041	35.63	0.45	36.08	62.41	0.58
9041	34.91	0.45	35.36	62.43	0.57
1051	30.24	0.45	30.69	47.28	0.65
3051	27.82	0.45	28.27	47.27	0.60
5051	26.68	0.45	27.13	47.27	0.57
7051	27.03	0.45	27.48	47.28	0.58
9051	28.45	0.45	28.90	47.28	0.61
1075	29.54	0.47	30.01	47.16	0.64
3075	30.04	0.47	30.51	47.15	0.65
5075	29.93	0.47	30.40	47.15	0.64
7075	29.94	0.47	30.41	47.16	0.64
9075	28.97	0.47	29.44	47.17	0.62

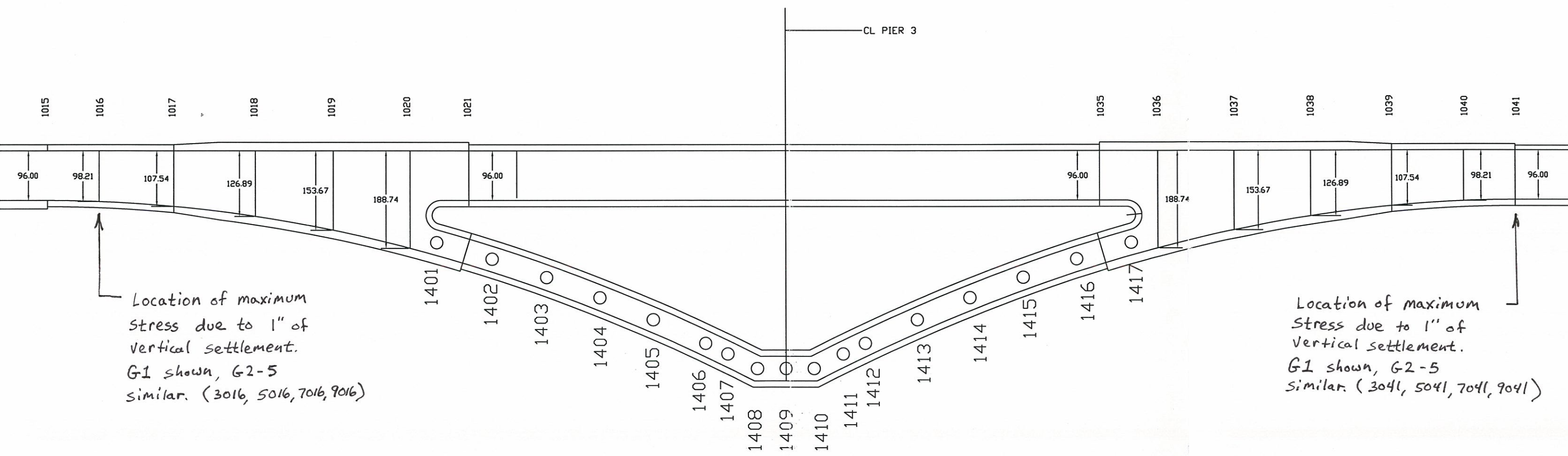
S3L 5-16-12
DJG 5/16/12



Location of maximum stress due to 1" of vertical settlement. G1 shown, G2-5 similar. (3051, 5051, 7051, 9051)

Location of maximum stress due to 1" of vertical settlement. G1 shown, G2-5 similar. (3075, 5075, 7075, 9075)

SJL 5-16-12
DJB 5/16/12



Location of maximum stress due to 1" of vertical settlement. G1 shown, G2-5 similar. (3016, 5016, 7016, 9016)

Location of maximum stress due to 1" of vertical settlement. G1 shown, G2-5 similar. (3041, 5041, 7041, 9041)