



The HNTB Companies
Engineers Architects Planners

Made KDG Date 4/8/13 Job Number 49633

Checked JBL Date 4/9/2013

For Cleveland Innerbelt

Backchk'd KDG Date 4/11/2013

Sheet No.

Unit 3

Non Composite - Girder 6 at Pier 12

	b	h	Area A (in ²)	Moment arm from Bottom of bottom flange y (in)	Ay	Ay ²	Io
Top Flange	30	2.75	82.5	100.125	8260.31	827063.79	51.99
Web	0.75	96	72	50.75	3654.00	185440.50	55296.00
Bottom Flange	30	2.75	82.5	1.375	113.44	155.98	51.99
			237.00	152.25	12027.75	1012660.27	55399.98

$I_x = I_o + A y^2 = 1068060 \text{ in}^4$
 $y_{bar} = A y / A = 50.75 \text{ in. above bottom of bottom flange}$
 $I_{tr} = I_x - A y_{bar}^2 = 457651.94$

$y_t = 50.75 \text{ in.}$
 $y_b = 50.75 \text{ in.}$

$Str_{tf} = I_{tr} / y_t = 9017.77 \text{ in}^3$
 $Str_{bf} = I_{tr} / y_b = 9017.77 \text{ in}^3$

$M = 232458 \text{ k}\cdot\text{in}$ from BDGS after Phase 3 placement (LL Case 1)

Stress after Deck Placement 3

Stress in Bottom Flange = $M_{LL} / Str_{bf} = 25.78 \text{ ksi}$
 Stress in Top Flange = $M_{LL} / Str_{tf} = 25.78 \text{ ksi}$



Composite Girder 6 at Pier 12

Find stress in flanges using field measured haunch values

$f_c = 3 \text{ ksi}$
 $E_c = 3320.56 \text{ ksi}$
 $E_s = 29000 \text{ ksi}$
 $n = 8.73$

$b \text{ (slab)} = 11.1667' / n = 11.1167 \times 12 / 8.73 = 15.343 \text{ in.}$
 $b \text{ (haunch)} = b \text{ (top flange)} / n$
 * haunch height measured from top of top flange to bottom of slab

	b	h	Transformed Area A (in ²)	Moment arm from Bottom of bottom flange y (in)	Ay	Ay ²	Io
Slab	15.343	9.5	145.76	108.25	15778.65	1708038.61	1096.25
top rebar**		6.6875	9.7711				
* Haunch	3.4351	2	6.870	99.75	685.30	68358.18	2.29
Top Flange	30	2.75	82.5	100.125	8260.31	827063.79	51.99
Web	0.75	96	72	50.75	3654.00	185440.50	55296.00
Bottom Flange	30	2.75	82.5	1.375	113.44	155.98	51.99
			389.63	360.25	28491.69	2789057.06	56498.52

$I_x = I_o + Ay^2 = 2845556 \text{ in}^4$
 $y_{bar} = Ay / A = 73.12 \text{ in. above bottom of bottom flange}$
 $I_{tr} = I_x - A \cdot y_{bar}^2 = 762107.6 \text{ in}^4$

$y_{rbr} = 37.06 \text{ in. centroid to top long rebar}$
 $y_{t_s} = 46.56 \text{ in. centroid to top of slab}$
 $y_{t_f} = 28.38 \text{ in. centroid to top of top flange}$
 $y_b = 73.12 \text{ in. centroid to bottom of bottom flange}$

$Str_{rbr} = I_{tr} / y_{rbr} = 20562.63 \text{ in}^3$
 $Str_{ts} = I_{tr} / y_{t_s} = 16367.32 \text{ in}^3$
 $Str_{tf} = I_{tr} / y_{t_f} = 26858.18 \text{ in}^3$
 $Str_{bf} = I_{tr} / y_b = 10422.02 \text{ in}^3$

M = 232458 k*in from BDGS after Phase 3 placement (LL Case 1)

M = 236947 k*in from BDGS after Phase 4 placement (LL Case 1)

Stress in Bottom Flange = $M_{LL} / Str_{bf} = 22.74 \text{ ksi}$
 Stress in Top Flange = $M_{LL} / Str_{tf} = 8.82 \text{ ksi}$
 Stress at Top of Slab = $M_{LL} / Str_{ts} = 14.48 \text{ ksi}$

Additional Moment added by deck placement4 = 4489 k*in

Stress added to Deck by deck placement 4 = 0.274 ksi
 Stress added to Top Flange by deck placement 4 = 0.167 ksi
 Stress added to Rebar by deck placement 4 = 0.218 ksi

Strength 1 Moment from BDGS at Pier 12

M = 196550 k*in

Stress in rebar at Str 1 = 9.56

9.56 + 0.22 << 60 ksi OK



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Non Composite - Girder 6 at Pier 13

	b	h	Area A (in ²)	Moment arm from Bottom of bottom flange y (in)	Ay	Ay ²	Io
Top Flange	24	1	24	97.5	2340.00	228150.00	2.00
Web	0.75	96	72	49	3528.00	172872.00	55296.00
Bottom Flange	24	1	24	0.5	12.00	6.00	2.00
			120.00	147.00	5880.00	401028.00	55300.00

$I_x = I_o + Ay^2 = 456328 \text{ in}^4$
 $y \text{ bar} = Ay / A = 49.00 \text{ in. above bottom of bottom flange}$
 $I_{tr} = I_x - A*y \text{ bar}^2 = 168208$

$y_t = 49.00 \text{ in.}$
 $y_b = 49.00 \text{ in.}$

$Str \text{ tf} = I_{tr} / y_t = 3432.82 \text{ in}^3$
 $Str \text{ bf} = I_{tr} / y_b = 3432.82 \text{ in}^3$

$M = 43353 \text{ k}\cdot\text{in}$ from BDGS after Phase 3 placement (LL Case 1)

Stress after Deck Placement 3

Stress in Bottom Flange = $M_{LL} / Str \text{ bf} = 12.63 \text{ ksi}$
 Stress in Top Flange = $M_{LL} / Str \text{ tf} = 12.63 \text{ ksi}$



Composite Girder 6 at Pier 13

Find stress in flanges using plan haunch values

$f_c = 4.5$ ksi
 $E_c = 4066.84$ ksi
 $E_s = 29000$ ksi
 $n = 7.13$

b (slab) = $11.1667' / n = 11.1667 * 12 / 7.13 = 18.792$ in.
 b (haunch) = b (top flange) / n
 * haunch height measured from top of top flange to bottom of slab

	b	h	Transformed Area A (in ²)	Moment arm from Bottom of bottom flange y (in)	Ay	Ay ²	Io
Slab	18.792	9.5	178.52	104.75	18700.00	1958824.63	1342.62
* Haunch	3.3657	2	6.731	98	659.67	64647.61	2.24
Top Flange	24	1	24	97.5	2340.00	228150.00	2.00
Web	0.75	96	72	49	3528.00	172872.00	55296.00
Bottom Flange	24	1	24	0.5	12.00	6.00	2.00
			305.25	349.75	25239.67	2424500.24	56644.86

$I_x = I_o + Ay^2 = 2481145$ in⁴
 $y_{bar} = Ay / A = 82.68$ in. above bottom of bottom flange
 $I_{tr} = I_x - A * y_{bar}^2 = 394208.32$ in⁴

$y_{t_s} = 26.82$ in. centroid to top of slab
 $y_{t_f} = 15.32$ in. centroid to top of top flange
 $y_b = 82.68$ in. centroid to bottom of bottom flange

$Str_{ts} = I_{tr} / y_{t_s} = 14700.93$ in²
 $Str_{tf} = I_{tr} / y_{t_f} = 25739.68$ in³
 $Str_{bf} = I_{tr} / y_b = 4767.60$ in³

M = 43353 k*in from BDGS after Phase 3 placement (LL Case 1)

M = 29720 k*in from BDGS after Phase 4 placement (LL Case 1)

No tension stress is added to the deck by the placement on deck 4



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Unit 3 Deck Placement RFI

Non Composite - Girder 6 at Pier 14

	b	h	Area A (in ²)	Moment arm from Bottom of bottom flange y (in)	Ay	Ay ²	lo
Top Flange	30	2.75	82.5	100.125	8260.31	827063.79	51.99
Web	0.75	96	72	50.75	3654.00	185440.50	55296.00
Bottom Flange	30	2.75	82.5	1.375	113.44	155.98	51.99
			237.00	152.25	12027.75	1012660.27	55399.98

$I_x = I_o + Ay^2 = 1068060 \text{ in}^4$
 $y \text{ bar} = Ay / A = 50.75 \text{ in. above bottom of bottom flange}$
 $I_{tr} = I_x - A*y \text{ bar}^2 = 457651.94$

$y_t = 50.75 \text{ in.}$
 $y_b = 50.75 \text{ in.}$

$Str \text{ tf} = I_{tr} / y_t = 9017.77 \text{ in}^3$
 $Str \text{ bf} = I_{tr} / y_b = 9017.77 \text{ in}^3$

$M = 81305 \text{ k*in}$ from BDGS after Phase 3 placement (LL Case 1)

$M = 211328 \text{ k*in}$ from BDGS after Phase 4 placement (LL Case 1)

Stress after Deck Placement 3

Stress in Bottom Flange = $M_{LL} / Str \text{ bf} = 9.02 \text{ ksi}$
 Stress in Top Flange = $M_{LL} / Str \text{ tf} = 9.02 \text{ ksi}$

Stress after Deck Placement 4

Stress in Bottom Flange = $M_{LL} / Str \text{ bf} = 23.43 \text{ ksi}$
 Stress in Top Flange = $M_{LL} / Str \text{ tf} = 23.43 \text{ ksi}$

