DESIGN COMPUTATIONS

PROJECT # BR R600-297
SUBACCOUNT # 16212
STRUCTURE # F-16-XB
MSE PANEL WALLS-F-16-EC, EE AND EF
Volume 1

Designer: Andy Pott

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DESIGN COMPUTATIONS (Grid)

DECK DESIGN

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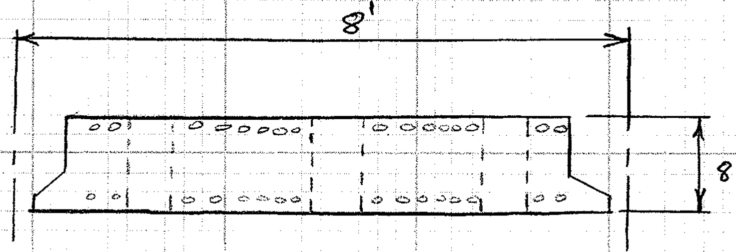
DESIGN COMPUTATIONS (Grid)

SECTION PROPERTIES

of blockouts = 4

blockout width ≈ 10"



For No Blockouts (midspan)

$\bar{y} = 3.95428"$ } from ustation

$I_x = 3886.92\ in^4$

$A = 723.375\ in^2$

$S_{TOP} = \frac{3886.92}{8-3.95428} = 960.75\ in^3$

$S_{BOTTOM} = \frac{3886.92}{3.95428} = 982.96\ in^3$

With Blockouts

$\bar{y} = 3.91801"$ } from ustation

$I_x = 2179.06"$

$A = 403.375\ in^2$

$S_{TOP} = \frac{2179.06}{8-3.91801} \approx 533.82\ in^3$

$S_{BOTTOM} = \frac{2179.06}{3.91801} \approx 556.16\ in^3$

8' x 8" PANEL

$\bar{y} = 4"$

A =

$I_x = \frac{Bt^3}{12} = \frac{(96)(8)^3}{12} = 4096\ in^4$ (no blockouts)

$I_{x\ blockouts} = \frac{Bt^3}{12} - n\frac{B_{block}\,t^3}{12} = 4096 - \frac{4(10)8^3}{12} = 2389.33\ in^4$

$S_{TOP} = S_{BOTTOM} = \frac{2389.33}{4} = 597.33\ in^3$ (w/ blockouts)

$S_{TOP} = S_{BOTTOM} = \frac{4096}{4} = 1024\ in^2$ (w/o blockouts)

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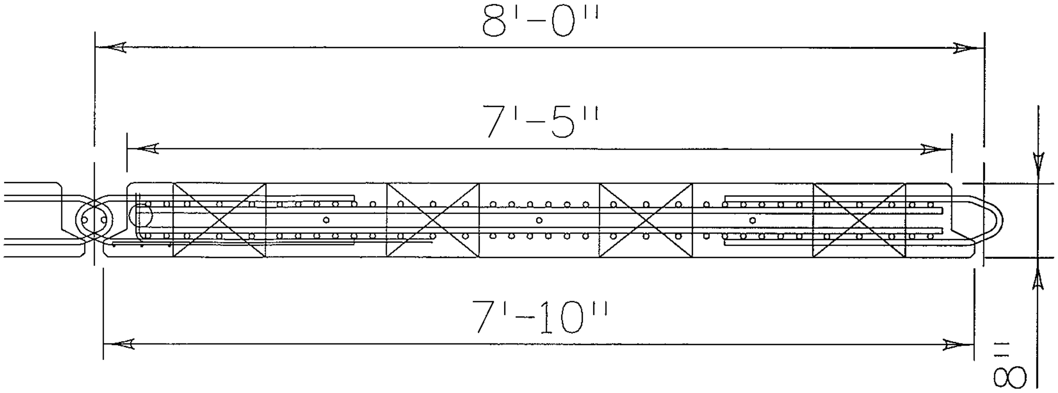
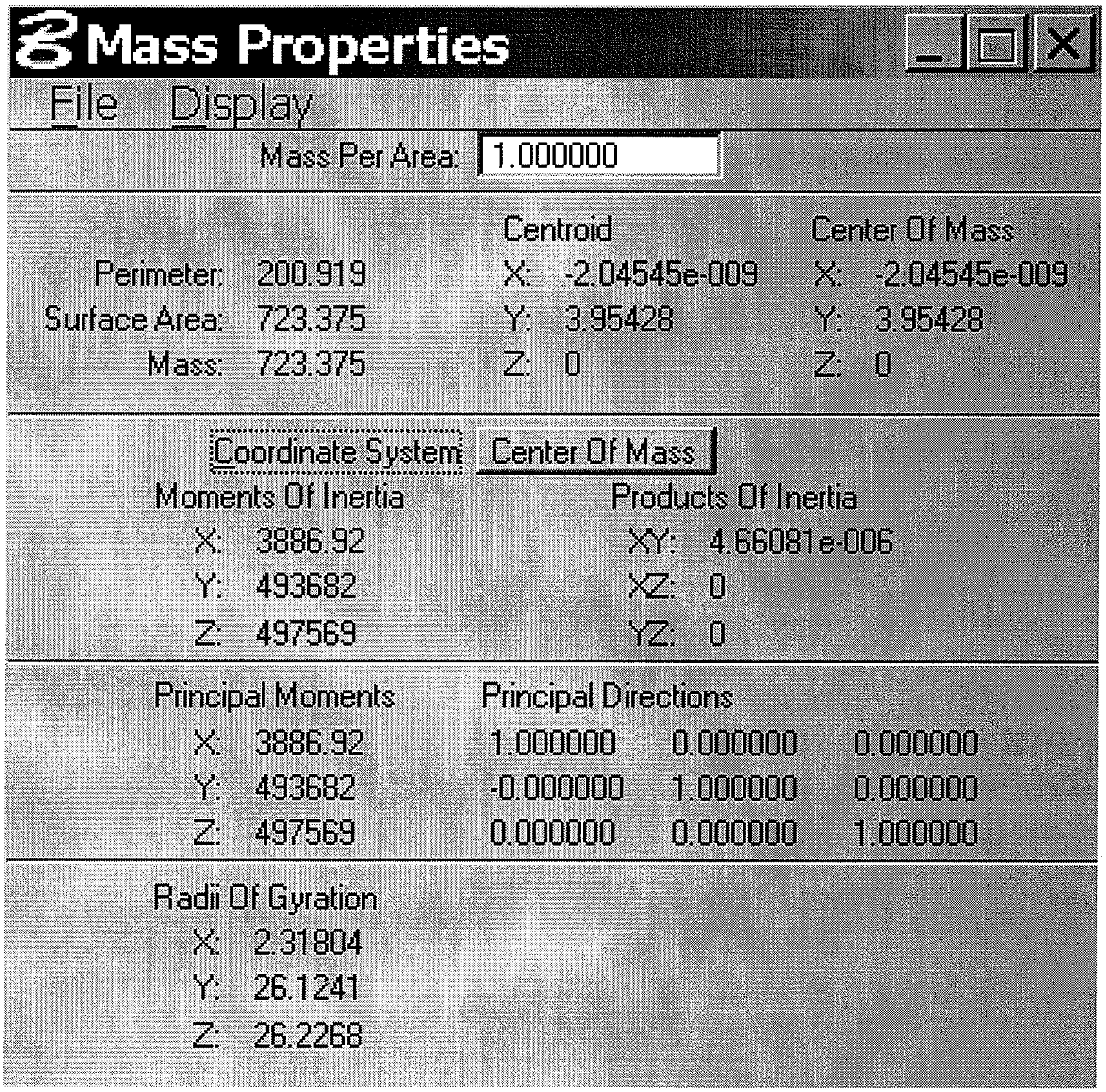


No Blockouts



Mass Properties

File Display

Mass Per Area: 1.000000

		Centroid	Center Of Mass
Perimeter:	200.919	X: -2.04545e-009	X: -2.04545e-009
Surface Area:	723.375	Y: 3.95428	Y: 3.95428
Mass:	723.375	Z: 0	Z: 0

Coordinate System | Center Of Mass

Moments Of Inertia	Products Of Inertia
X: 3886.92	XY: 4.66081e-006
Y: 493682	XZ: 0
Z: 497569	YZ: 0

Principal Moments	Principal Directions		
X: 3886.92	1.000000	0.000000	0.000000
Y: 493682	-0.000000	1.000000	0.000000
Z: 497569	0.000000	0.000000	1.000000

Radii Of Gyration

X: 2.31804
Y: 26.1241
Z: 26.2268

NO BLOCKOUTS

with blockouts

Mass Properties

File Display

Mass Per Area: 1.000000

		Centroid	Center Of Mass
Perimeter:	264.919	X: -6.85774e-009	X: -6.85774e-009
Surface Area:	403.375	Y: 3.91801	Y: 3.91801
Mass:	403.375	Z: 0	Z: 0

Coordinate System | Center Of Mass

Moments Of Inertia		Products Of Inertia	
X:	2179.06	XY:	3.31267e-006
Y:	279415	XZ:	0
Z:	281594	YZ:	0

Principal Moments		Principal Directions		
X:	2179.06	1.000000	0.000000	0.000000
Y:	279415	-0.000000	1.000000	0.000000
Z:	281594	0.000000	0.000000	1.000000

Radii Of Gyration	
X:	2.32423
Y:	26.3191
Z:	26.4215

PRESTRESS LOSSES

$$\Delta f_{pT} = \Delta f_{pES} + \Delta f_{pLT} \qquad (5.9.5.1-1)$$

Time Dependent Losses - Table 5.9.5.3-1

$\Delta_{vg} = 26 + 4.0$ PPR — PPR - partial prestress ratio

assume PPR = 1.0

$Avg = 26 + 4(1.0) = 30$ ksi $- 6$ ksi $= 24$ ksi (5.9.5.3)

ELASTIC SHORTENING (5.9.5.2.3a)

$$\Delta f_{pES} = \frac{E_p}{E_{ci}} f_{cgp} \qquad (5.9.5.2.3a-1)$$

or

$$\Delta f_{pES} = \frac{A_{ps} f_{pbt}(I_g + e_m^2 A_g) - e_m M_g A_g}{A_{ps}(I_g + e_m^2 A_g) + \frac{A_g I_g E_{ci}}{E_p}} \qquad (5.9.5.2.3a-1)$$

$A_g \approx 723.375 \text{ in}^2$

$E_p = 28500$ ksi

$E_{ci} = 1820\sqrt{f'_{ci}} = 1820\sqrt{6} = 4458.07$ ksi

$I_g = 3886.92 \text{ in}^4$

~43' if supported @ ends

$e_m \approx 4'' - 3.95428'' = .04572''$

$M_g \approx \frac{wl^2}{8} \quad \frac{(5.0234)(.15 k/_{LF})\,43^2}{8} \approx 174.16$ ft kip $= 2089.9$ in k

$f_{pbt} \approx .75(270 \text{ ksi}) = 202.5$ ksi (Table 5.9.3-1)

$A_{ps} = (44 \text{ strands})(.217) \approx 9.548 \text{ in}^2$

$$\Delta f_{pES} = \frac{(9.548)(202.5)(3886.92 + .04572^2(723.375)) - .04572''(2089.9)\,723.375}{9.548(3886.92 + .04572^2(723.375)) + \frac{723.375(3886.92)\,4458.07}{28500}}$$

$\Delta f_{pES} \approx 15.61$ ksi

477170.9807

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TOTAL LONG TERM LOSSES

STANDARD

$$\Delta f_{pLT} = 10.0 \frac{f_{pi} A_{ps}}{A_g} \gamma_h \gamma_{st} + 12.0 \gamma_h \gamma_{st} + \Delta f_{pR} \quad (5.9.5.3\text{-}1)$$

$$\gamma_h = 1.7 - .01H = 1.7 - .01(55) = 1.15$$

$$\gamma_{st} = \frac{5}{1+f'_{ci}} = \frac{5}{1+5} = .833$$

$$f_{pi} = .75(270) = 202.5$$

$$\Delta f_{pR} = 2.4 \text{ ksi}$$

$$\Delta f_{pLT} = \frac{10.0(202.5)(9.548)}{768}(1.15)(.833) + 12(1.15)(.833) + 2.4$$

$$\Delta f_{pLT} \approx 24.12 + 11.50 + 2.4 = 38.0 \text{ Ksi}$$

APPROXIMATION

Table 5.9.5.3-1

PPR = partial prestress ratio

$$A_{vg} = 26 + 4.0 \, PPR$$

$$\text{Upper Bnd} = 29 + 4.0 \, PPR$$

reduce by 6 ksi for solid slabs

$$PPR = \frac{A_{ps} f_{py}}{A_{ps} f_{py} + \cancel{A_s f_y}^{\,0}} = 1 \quad (5.5.4.2.1\text{-}4)$$

$$\text{Upper Stress} = 29 + 4.0(1) - 6 = 27 \text{ ksi}$$

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PRESTRESS LOSSES – REFINED ESTIMATE (5.9.5.4)

(TIME OF TRANSFER TO DECK PLACEMENT)

SHRINKAGE (5.9.5.4.2a) & (5.4.2.3)

$$\Delta f_{pSR} = \varepsilon_{bid} E_p K_{id}$$ (5.9.5.4.2a-1)

$$\varepsilon_{bid} = K_s K_{hs} K_f K_{td} \; 0.48 \times 10^{-3}$$ (5.4.2.3.3-1)

$$K_{hs} = 2.00 - 0.014H$$ (5.4.2.3.3-2)

$K_{hs} = 2.0 - .014(55) = \underline{1.23}$ $H = 55\%$ (Fig 5.4.2.3.3-1)

$$K_s = 1.45 - .13(V/S) \geq 1.0$$ (5.4.2.3.2-2)

$V/S = \dfrac{723.375\text{ in}^2}{200.919\text{ in}} = 3.6$ $\dfrac{723.375\text{ in}^2}{94''} = 7.7$

$K_s = 1.45 - .13(3.6) = \underline{1.0}$

$$K_f = \frac{5}{1+f'_{ci}} = \frac{5}{1+6} = .714$$ (5.4.2.3.2-4)

$$K_{td} = \frac{t}{61 - 4f'_{ci} + t}$$ (5.4.2.3.2-5)

@ 30 days $K_{td} = .45$

@ 3650 days $K_{td} = .99$ (10 years)

@ 50 years $K_{td} = 1.00$ (50 years)

$\varepsilon_{bid} = (1.0)(.23)(.714)(.45)(.48 \times 10^{-3})$

$\varepsilon_{bid} = .000190$ @ 30 days

$\varepsilon_{bid} = .000486$ @ 10 years

$.000491$ @ 50 years

$E_p = 28500$ ksi

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PRESTRESS LOSSES

SHRINKAGE (Cont.)

$$\psi(t, t_i) = 1.9\ K_s K_{hc} K_f K_{td}\ t_i^{-.118} \qquad (5.4.2.3.2\text{-}1)$$

$K_s = 1.0$

$K_{hc} = 1.56 - 0.008H$ (5.4.2.3.2-3)

$= 1.56 - .008(55) = 1.12$

$K_f = .714$ (5.4.2.3.2-4)

$K_{td} = .449$ @ 30 days (5.4.2.3.2-5)

$\psi(t, 30\text{ days}) = (1.9)(1.0)(1.12)(.714)(.449)\ 30^{-.118}$

$= .456$

$\psi(10\text{ yrs}) = .572$

$\psi(50\text{ yrs}) = .477$

100

$$K_{id} = \frac{1}{1 + \frac{E_p}{E_{ci}}\frac{A_{ps}}{A_g}\left(1 + \frac{A_g e_{pg}^2}{I_G}\right)\left[1 + .7\,\psi(t)\right]} \qquad (5.9.5.4.2a\text{-}2)$$

$$K_{id} = \frac{1}{1 + \frac{28500}{4458}\frac{(9.548)}{723.375}\left(1 + \frac{723.375\,(.04572)^2}{3886.92}\right)\left(1 + .7\,(.456)\right)}$$

$K_{id} = .900$
30 days

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PRESTRESS LOSSES

SHRINKAGE (cont.)

$$\Delta f_{pSR} = \varepsilon_{bid} E_p K_{id} \qquad (5.9.5.4.2a-1)$$

$$= (.000190)(28500)(.900)$$

$$= \underline{4.86 \text{ ksi}} \quad @ \ 30 \text{ days}$$

CREEP (FROM TIME OF TRANSFER TO DECK PLACEMENT)

$$\Delta f_{pCR} = \frac{E_p}{E_{ci}} f_{cgp} \, \psi_b(t_d, t_i) \, K_{id} \qquad (5.9.5.4.2b-1)$$

$\psi_b = .502$ (30 days)

$K_{id} = .889$ (30 days)

$$f_{cgp} = \frac{P_t}{A} + \frac{P_t e}{I} y + \frac{M_g y}{I}$$

$$= \frac{(9.548 \text{ in}^2)[.9(.75)(270)]}{723.375} + \frac{(9.548 \text{ in}^2)(.04572)(.04572)}{3886.92} + \frac{(2089.9)(.04572)}{3886.92}$$

$f_{cgp} \approx 2.41$ ksi $+ .000005 + .0246$

$f_{cgp} \approx 2.43$ ksi

use $f_{cgp} \approx 2.47$ ksi

$\Delta f_{pES} \approx 17.02$ ksi (5.9.5.2.3a-1)

$\frac{17.02}{202.5} \times 100 \approx 8.4\%$

$\approx 10\%$ okay

$f_{cgp} = 2.47$ with 8.4%

iteration method

$\Rightarrow$ 8.55% loss

okay

$$\Delta f_{pCR} = \frac{28500}{4458} (2.47)(.456)(.9)$$

$$\Delta f_{pCR} \approx \underline{6.48 \text{ ksi}}$$

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PRESTRESS LOSSES

RELAXATION (TIME OF TRANSFER TO DECK PLACEMENT) (5.9.5.4.2c)

$$\Delta f_{pR1} = \frac{f_{pt}}{K_L}\left(\frac{f_{pt}}{f_{py}} - .55\right) \qquad (5.9.5.4.2c\text{-}1)$$

$$\Delta f_{pR1} = \frac{[.75(270) - 16.98]}{30}\left(\frac{.75(270) - 16.98}{.9(270)} - .55\right)$$

$$\Delta f_{pR1} \approx 1.32 \text{ ksi}$$

per 5.9.5.4.2c

$\Delta f_{pR1} = 1.2$ ksi for low-relax strand

PRESTRESS LOSSES - (TIME OF DECK PLACEMENT TO FINAL TIME)

SHRINKAGE OF GIRDER (5.9.5.4.3a)

$$\Delta f_{pSD} = \varepsilon_{bdf} E_p K_{df} \quad (5.9.5.4.3a\text{-}1)$$

$$K_{df} = \frac{1}{1 + \frac{E_p}{E_{ci}} \frac{A_{ps}}{A_c}\left(1 + \frac{A_c e_{pc}^2}{I_c}\right)\left(1 + .7\,\psi_b(t_f, t_c)\right)} \quad (5.9.5.4.3a\text{-}2)$$

$$K_{df} = \frac{1}{1 + \left(\frac{28500}{4069.64}\right)\left(\frac{9.548}{768}\right)\left(1 + \frac{768\,(0)^2}{4096}\right)\left(1 + .7\,(1.184)\right)}$$

$$K_{df} = .863 \quad \text{(50 years)}$$

$$\Delta f_{pSD} = (.000491)(28500)(.863)$$

$$= \underline{12.08 \text{ ksi}}$$

CREEP

$$\Delta f_{pCD} = \frac{E_p}{E_{ci}} f_{cgp} \left[\psi(50\text{yrs}) - \psi(30\text{days})\right] K_{df} \quad (5.9.5.4.3b\text{-}1)$$

$$+ \frac{E_p}{E_c} \Delta f_{cd}\, \psi(50\text{yrs})\, K_{df}$$

Δf_{cD} = stress due to composite loads
strand group is concentric with panel cross section
so $\Delta f_{cD} = 0$

$$\Delta f_{pCD} = \frac{28500}{4458} (2.47)(.393 - .456)\,.863$$

$$\underline{\Delta f_{pCD} = 10.18 \text{ Ksi}}$$

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PRESTRESS LOSSES - (LONG TERM)

RELAXATION

$$\Delta f_{pR2} = \Delta f_{pR1} \qquad (5.9.5.4.3c-1)$$

$$\Delta f_{pR2} = \underline{1.2 \text{ ksi}}$$

SHRINKAGE OF DECK

$A_d = \phi$

$$\Delta f_{cdf} = 0 \qquad (5.9.5.4.3d-2)$$

$$\Delta f_{pss} = \phi$$

TOTAL LONG TERM LOSSES

$$\Delta f_{pLT} = \Delta f_{pSR} + \Delta f_{pCR} + \Delta f_{pR1} + \Delta f_{pSD} + \Delta f_{pCD} + \Delta f_{pR2}$$

$$= 5.27 \text{ ksi} + 7.72 \text{ ksi} + 1.2 \text{ ksi} + 12.08 \text{ ksi} + 10.18 \text{ ksi} + 1.2 \text{ ksi}$$

$$= \underline{37.65 \text{ ksi}}$$

$$f_{pe} = f_{jack} - \Delta f_{pES} - \Delta f_{pLT}$$

$$= .75(270) - 16.98 - 37.65$$

$$f_{pe} = \underline{147.87 \text{ ksi}}$$

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STRENGTH

$$c = \frac{A_{ps} f_{pu} + A_s f_s - A'_s f'_s}{.85 f'_c \beta b + K A_{ps} \frac{f_{pu}}{d_p}} \qquad (5.7.3.1.1-4)$$

K = .28 from Table C5.7.3.1.1-1

Concrete strength = 7 ksi

$\beta = .85 - 3(.05) = .7$ (5.7.2.2)

$A'_s = \phi$ compression steel

$A_s = \phi$ mild steel

$A_{ps} = (22 \text{ strands})(.217 \text{ in}^2) \approx 4.774 \text{ in}^2$ 4.557 21 strands

$f_{pu} = 270$ ksi

b = 7'-5" = 89" no voids 89" − 4 (10") = 49"

d_p = 8" − 2" CLR − .6/2 = 5.7"

$$c = \frac{(4.774)(270 \text{ ksi}) + 0 - 0}{.85(7\text{ksi})(.7)(89") + .28(4.774)\frac{270}{5.7}}$$

c ≈ 2.97 inches in positive moment region & no voids

2.78 for 96" wide

2.85 21 strands

c = 4.82" for areas with voids

$$f_{ps} = f_{pu}\left(1 - K\frac{c}{d_p}\right) \qquad (5.7.3.1.1-1)$$

$$= 270\left(1 - .28\,\frac{2.97"}{5.7"}\right)$$

$f_{ps} \approx 230.6$ ksi 232.2 ksi 21 strands

$f_{ps} = 206.1$ ksi if voids included

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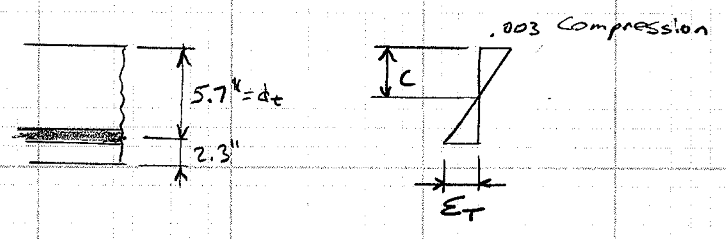
(5.7.3.2.2-1)

$$M_n = A_{ps} f_{ps}\left(d_p - \frac{a}{2}\right) + \overset{0}{\cancel{A_s f_s}}\left(d_s - \frac{a}{2}\right) - \overset{0}{\cancel{A'_s f'_s}}\left(d'_s - \frac{a}{2}\right) + .85 f'_c \overset{0}{\cancel{(b - b_w)}}\, h_f \left(\frac{a}{2} - \frac{h_f}{2}\right)$$

$$M_n = (4.774\ \text{in}^2)(230.6)\left(5.7'' - (2.97'')(.7)\right) + 0 + 0 + .85(7)\underset{0}{(89'' - 89'')}\, h_f \left(a/2 - h_f/2\right)$$

$M_n = 3986.3$ in kip $= 332.2$ ft kip — 326.7 for 21 strands

$\phi = .75$ for compression controlled sections
$\phi = .9$ for tension controlled reinforced concrete
$\phi = 1.0$ for tension controlled prestressed concrete



$c = 2.97''$

$$\frac{.003}{c} = \frac{\varepsilon_T}{d_t - c}$$

$$\frac{.003}{2.97} = \frac{\varepsilon_T}{5.7 - 2.97}$$

$$\varepsilon_t \approx .00276$$

section is compression controlled ←

$\phi = .75$ ←

$M_R = \phi M_n = .75\,(332.2) = 249.15$ ft kip

$M_r = 249.15$ ft kip — 245 for 21 strands

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DEVELOPMENT LENGTH & TRANSFER LENGTH

$$\ell_d \geq K\left(f_{ps} - \tfrac{2}{3} f_{pe}\right) d_b \qquad (5.11.4.2\text{-}1)$$

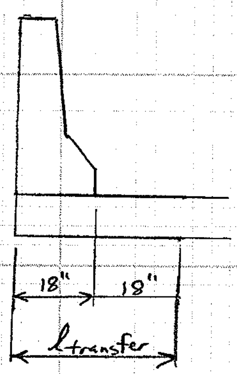
$d_b = .6"$

f_{ps} = average stress

f_{pe} = stress after losses

$K = 1.0$

Transfer length $= 60\, d_b = 36"$ (5.11.4.1)



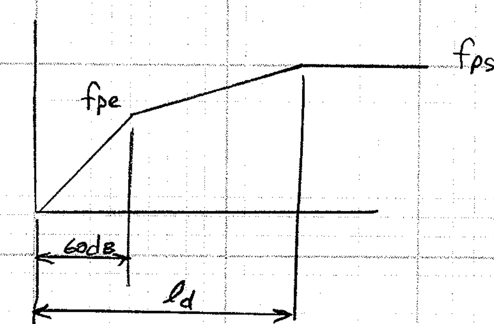


Fig. C5.11.4.2-1

$f_{pe} \approx 147.87$ ksi

$f_{ps} \approx 230.6$ ksi

$$\ell_d \geq 1.0\left(230.6 - \tfrac{2}{3}(147.87)\right) .6"$$

$$\ell_d \geq 79.2" = 6.6'$$

at the front face of barrier, (~ 13" from end of precast)

$$f_{px} \approx \frac{f_{pe}\, \ell_{px}}{60 d_B} = \frac{(147.87)(13")}{60(.6)"} \qquad (5.11.4.2\text{-}2)$$

$$f_{strand} \approx 53.4 \text{ ksi}$$

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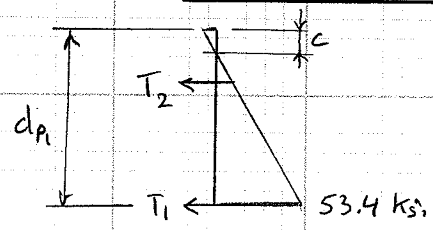
STRENGTH AT OVERHANG (FACE OF BARRIER)



$A_{ps} f_{ps} = .85 f'_c\, b\, a$

$(4.774)(53.4) = (.85)(7)(96'')a$

$a \approx .446''$

$c = a/\beta = \frac{.446}{.7} = .6376''$

$A_{ps} = 22(.217) = 4.774\ in^2$

$\frac{T_1}{d_{p_1} - c} = \frac{T_2}{d_{p_2} - c}$

$\frac{53.4}{5.7 - .6376} = \frac{T_2}{2.3 - .6376}$

$T_2 \approx 17.54\ ksi$

$M_n = A_{ps} f_{ps} (d_p - a/2)$

$M_n = 4.774(53.4)(5.7 - \frac{.446}{2}) + 4.774(17.54)(2.3 - \frac{.446}{2})$

$M_n = 1396.26 + 173.92 = 1570.2\ in\,kip = 130.85\ ft\,k$

assume compression control $\Rightarrow \phi = .75$

$M_r = .75(130.85) = \underline{98.1\ ft\ k}$ (FACE OF BARRIER)

ADD #5s @8" mild steel = (9.39 ft k) 8 = 75.1 ft k

AT TRANSFER LENGTH

$f_{pe} \approx 147.87\ ksi$

$(4.774)(147.87) = .85(7)(96)a$

$a \approx 1.236''$

$c \approx \frac{1.236}{.7} = 1.766''$

$\frac{147.87}{5.7 - 1.766} = \frac{T_2}{2.3 - 1.766}$

$T_2 \approx 20.07\ ksi$

$M_n = 4.774(147.87)(5.7 - \frac{1.236}{2}) + 4.774(20.07)(2.3 - \frac{1.236}{2})$

$M_n = 3587.5 + 161.2 = 3748.7\ in\,k = 312.4\ ft\ k$

$M_r = (.75)(312.4) \approx \underline{234.3\ ft\ k}$

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Assume stress on rebar = stress of prestressing (53.4 ksi)

$A_{ps} f_{ps} + A_s f_{ps} = .85 f'_c b a$

$A_s = \#4 @ 8''$
$= \frac{(.20)}{(8/12)} = .3 \text{ in}^2/\text{ft}$
$= 2.4 \text{ in}^2$ for 8'

$4.774(53.4) + 2.4(53.4) = .85(7)(96)a$

$a = .671''$

$c \approx \frac{.671}{.7} = .958''$

$\frac{53.4}{5.7 - .958} = \frac{T_2}{2.3 - .958}$

$T_2 = 15.11$ ksi

$M_n = A_{ps} f_{ps} (d_p - a/2)$

$M_n = 4.774(53.4)(5.7 - \frac{.671}{2}) + 4.774(15.11 \text{ ksi})(2.3 - \frac{.671}{2})$
$+ 2.4(53.4)(5.75 - \frac{.671}{2})$

$M_n \approx 1367.58 + 141.71 + 693.92 = 2203.2$ in kip

$M_n \approx 183.6$ ft kip

$M_R = \phi M_n = .75(183.6) = 137.7$ ft kip

$M_u = 142.52$ ft kip - NO GOOD

$A_s = \#5 @ 8''$
$= \frac{.31}{8/12} = .465 \text{ in}^2/\text{ft}$
$= 3.72 \text{ in}^2$ for 8' slab

$4.774(53.4) + 3.72(53.4) = .85(7)(96)a$

$a = .794''$

$c = \frac{.794}{.7} \approx 1.134''$

$\frac{53.4}{5.7 - 1.134} = \frac{T_2}{2.3 - .958}$

$T_2 \approx 15.69$ ksi

$M_n = 4.774(53.4)(5.7 - \frac{.794}{2}) + 4.774(15.69 \text{ ksi})(2.3 - \frac{.794}{2})$
$+ 3.72(53.4)(5.6875 - \frac{.794}{2})$

$M_n \approx 1351.9 + 142.5 + 1050.8 = 2545.3$ in k

$M_n = 212.1$ ft k

$M_R = .75(212.1) = 159.1$ ft K

$\phi M_R = .973(159.1) = 154.8$ ft K

$M_u < M_R$ okay ✓

REINFORCING DESIGN

GIVEN:

fy=	60.00	ksi
f'c=	4.50	ksi
COVER=	2.00	inches
$\Phi_{flexure}$=	0.75	
Beam Thickness (t_s)=	8.00	inches
b=	12.00	inches
bar diameter=	0.875	inches

LOAD TYPE	M_{hTOT}	$AS_{req'd}$
	ft-K	in^2
M_h (UNFACTORED)	5.88	0.29
STRENGTH I	5.88	0.29
SERVICE I	5.88	0.29

Impact Steel

Can use #5s
@ blockouts

ds= 5.56 inches
per 5.10.8.2 AS_{temp}= 0.14 sq inches

Use # 5 at top face   min. spacing = 12.74 inches
use spacing= 8.00 inches
As= 0.465 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

development length 5.11.2.1.1

$\ell_{dh} = \frac{(.31)(1.25)60}{\sqrt{7}} = 8.79''$

or $.4(5/8)60 = 15''$

$\ell_d = \ell_{dh} * 1.2 = 15(1.2)$

$\ell_d = 18''$

M_n= 12.52 ft-K
M_r= 9.39 ft-K
Reinforcing is okay

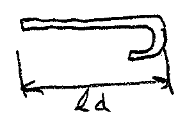
Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 0.74 inches
de=ds= 5.56 inches (for no prestressing)
c/de= 0.13
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

$1.2*M_{cracking}$= 6.52 ft-K <--- Test 1
$1.33M_{hTOT}$ (max.)= 7.82 ft-K <--- Test 2
Minimum Reinforcing is provided

For hook 5.11.2.4.1-1



$\ell_{hb} = \frac{38(5/8)}{\sqrt{f_c}} = 8.98''$

$\ell_d = 1.2\,\ell_{hb} \approx 10.77''$

use 11''

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing =	15.25	ft
Flange Width =	21	inches
Flange Overhang =	18	inches
Effective Length S =	15.00	ft
220 / sqrt(S) =	56.80	%
Required As =	0.26	sq inches
Use #	6	transverse reinforcement
min. spacing =	19.98	inches

Use **56.804** % of required main reinforcement

11.2'' for 4.5 Ksi

STRENGTH AT OVERHANG

@ 6" from Face of Barrier

$$f_{ps} \approx \frac{20"}{36"}(147.87) = 82.15 \text{ ksi}$$

$$(4.774)(82.15) = .85(7)(96)a$$

$$a \approx .687"$$

$$\frac{82.15}{5.7-.981} = \frac{T_2}{2.3-.981}$$

$$c = \frac{.687}{.7} \approx .981$$

$$T_2 = 22.96 \text{ ksi}$$

$$M_n = 4.774(82.15)\left(5.7 - \frac{.687}{2}\right) + 4.774(22.96)\left(2.3 - \frac{.687}{2}\right)$$

$$M_n \approx 2100.73 + 214.45 = 2315 \text{ in k} = 192.9 \text{ ft k}$$

$$M_R = .75(192.9) = 144.7 \text{ ft k}$$

@ 7" from Face of Barrier

$$f_{ps} = \frac{21"}{36"}(147.87) = 86.26 \text{ ksi}$$

$$4.774(86.26) = .85(7)(96)a$$

$$\frac{86.26}{5.7-1.03} = \frac{T_2}{2.3-1.03}$$

$$a = .721"$$

$$T_2 = 23.46 \text{ ksi}$$

$$c = \frac{.721}{.7} \approx 1.03"$$

$$M_n = 4.774(86.26)\left(5.7 - \frac{.721}{2}\right) + 4.774(23.46)\left(2.3 - \frac{.721}{2}\right)$$

$$M_n \approx 2198.8 \text{ in k} + 217.2 \text{ in k} \approx 2416 \text{ in k} \approx 201.3 \text{ ft k}$$

$$M_R = .75(201.3) = 151.0 \text{ ft k}$$

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

STRENGTH AT OVERHANG

@ 12" from face of barrier (beginning of live load)

$f_{ps} = \frac{26''}{36''}(147.87) = 106.795$ ksi

$\frac{106.795}{5.7 - 1.275} = \frac{T_2}{2.3 - 1.275}$

$T_2 = 24.74$ ksi

$(4.774)(106.795) = .85(7)(96)a$

$a \approx .893''$

$c = \frac{.893}{.7} = 1.275''$

$M_n = 4.774(106.795)\left(5.7 - \frac{.893}{2}\right) + 4.774(24.74)\left(2.3 - \frac{.893}{2}\right)$

$M_n \approx 2678.4 + 218.9 = 2897.4$ in k $= 241.4$ ft k

$M_R = .75 M_n \approx 181.1$ ft k

@ 9.33" from girder support

$L = 6.69'$ from barrier

$L \approx 6.27'$ from precast end

75.3"

$f_{px} = f_{pe} + \frac{\ell_{px} - 60d_b}{\ell_d - 60d_b}(f_{ps} - f_{pe})$ 5.11.4.2-3

$f_{px} = 147.87 + \frac{75.3 - 36}{79.2 - 36}(230.6 - 147.87)$

$f_{px} \approx 223.13$ ksi

209.73 @ 7" to left
198.24 @ 13" to left

$M_n = (4.774 \text{ in}^2)(223.13)(5.7'' - 2.97''(.7))$

$M_n \approx 3857.2$ in k $= 321.4$ ft k

$M_R = .75(321.4) \approx 241.1$ ft k

≈ 30.14 ft k/ft

226.6 @ 7" to left
214.2 @ 13" to left
no good

216.2 @ 12" to left
okay

can only move start of precast segment by 12"

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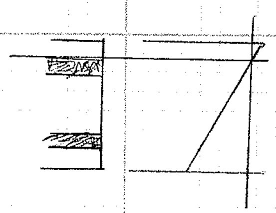
STRENGTH BY STRAIN COMPATIBILITY



Assume: depth of rectangular stress block (a) is less than 2"

all strand in tension

strand at bottom − $f_{py} = .9 f_{pu} = 243$ ksi

strand at top − $f_{pe} \approx 147.87$ ksi

$T = C$

$T = A_{ps} \times f_{ps}$

$C = .85 f'_c \, b \, a$

b = width of panel = 8' = 96"

$A_{ps} f_{ps} = .85 f'_c \, b \, a$

$22(.217)\,147.87 + 22(.217)(243) = .85\,(7)\,(96)\,(a)$

$a \approx 3.27"$ 2.48"

$\beta = .85 - .05(f'_c - 4) = .85 - .05(7-4) = .7$

$C = a/\beta = 3.27"/.7 \approx 4.67"$

depth of stress block > 2"

not all of strands are in tension

assume top strands in compression

@ yield $22(.217)(243) = .85\,(7)\,(96)\,a$

$a \approx 2.03"$ $\quad C = \frac{2.03}{.7} = 2.9$ top strands are above neutral axis (compression)

@ ultimate $22(.217)\,270 = .85\,(7)\,96\,a$

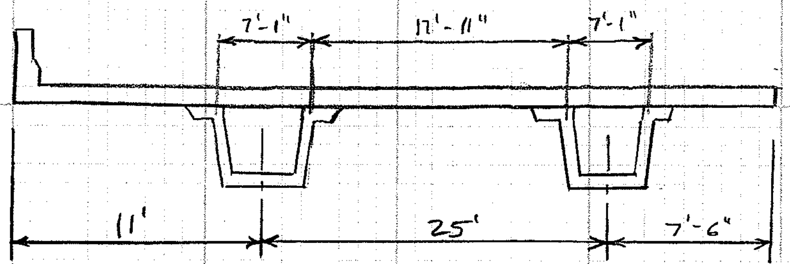
$a \approx 2.26"$ top strands are above neutral axis (compression)

$c = 3.22"$

Assume strength based on single eccentric layer

DECK LOADS

wt ≈ 35 K.



flange width ≈ 28"

$l_{max} = 17'-11"$

1/3 flange width ≈ 9.33"

INTERIOR SPANS

from SAP2000 analysis, max. pos. moment from uniform dead load ≈ $\frac{w l_{max}^2}{16}$

max. neg. moment from uniform dead load ≈ $\frac{w l^2}{14}$ — use for both

moments are at support points

per 4.6.2.1.6, we could use moments at 1/3 flange width away from support

use higher dead load moment for design

$DC_{concrete}$

8" precast deck - weight = $(.15)(\frac{8"}{12"})(1') = .1$ K/ft / ft width

$$M_{positive/negative} = \frac{(.1)(17.917')^2}{14} \approx 2.293 \text{ ft-K/ft}$$

DW

3" asphalt weight ≈ $.147 (\frac{3"}{12"}) 1' \approx .037$ K/ft / ft width

$$M_{positive/negative} = \frac{(.037)(17.917')^2}{14} \approx 0.848 \text{ ft}\cdot\text{K/ft}$$

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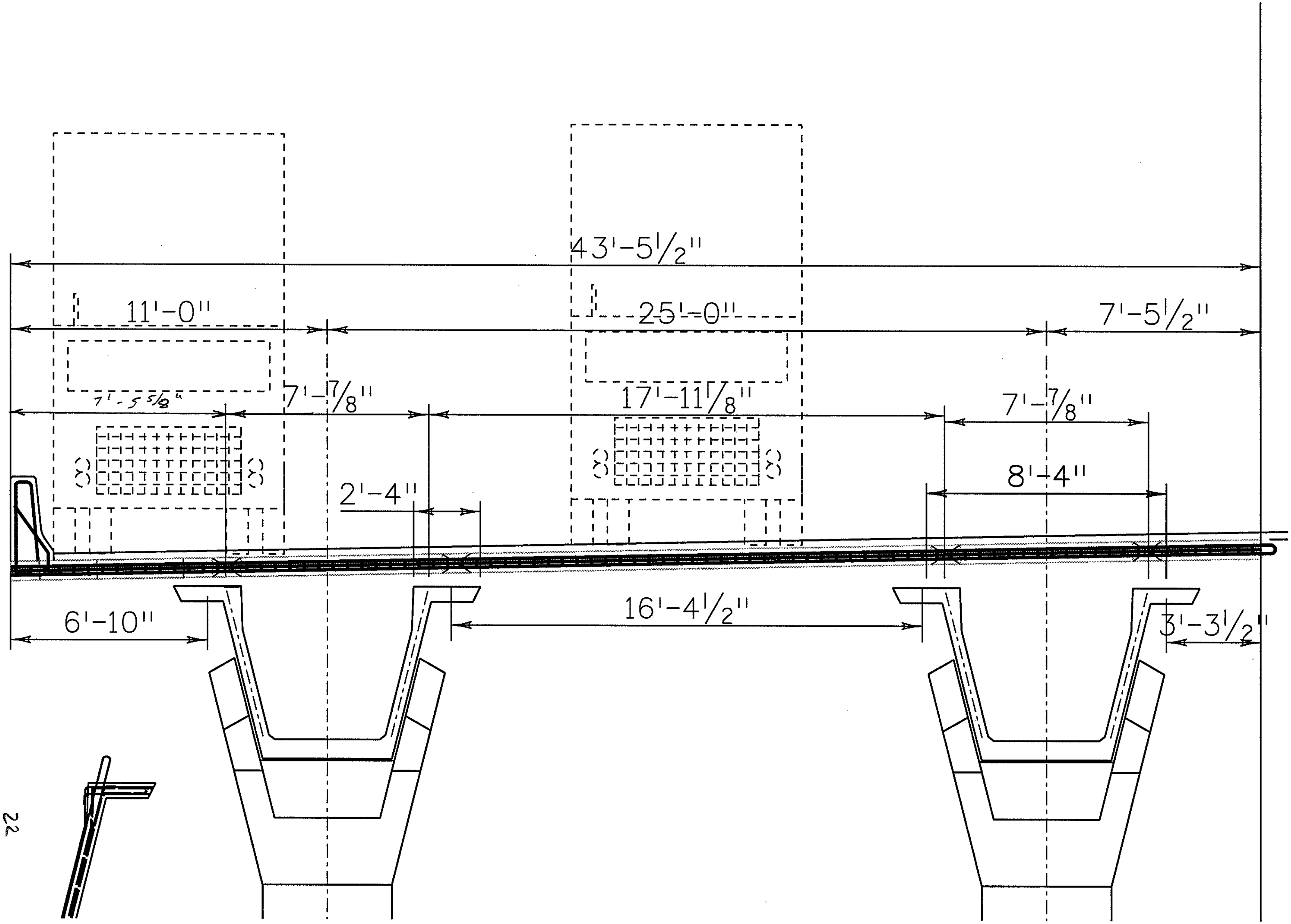

43'-5 1/2"
11'-0"
25'-0"
7'-5 1/2"
7'-5 5/8"
7'-7/8"
17'-11 1/8"
7'-7/8"
8'-4"
2'-4"
6'-10"
16'-4 1/2"
3'-3 1/2"

dead load moments for 1'x1' beam

$$M = \frac{w l^2}{n}$$

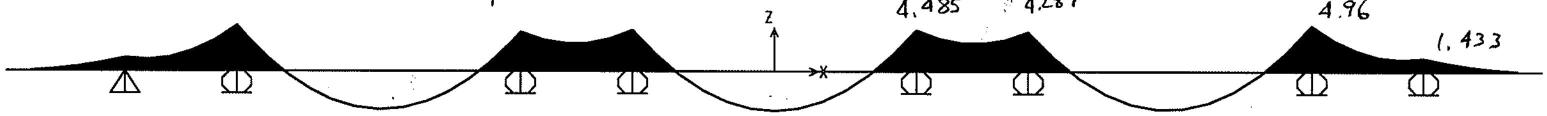
$LL^- = 96.8426$ ftk (77.4 ft k @ 9.33")

$LL^+ = 83.293$ ftk

$LL^- = 77.81$

$n = 15.6$ $n = 16.3$ $n = 14.12$

4.485 4.287 4.96 1.433



$LL = 83.6045$ (+)

4.32
$n = 16.2$

4.136
$n = 16.94$

$l_{max} \simeq 21.61'$

$w = .15$ k/ft

$$n = \frac{w l^2}{M} = \frac{70.06}{M}$$

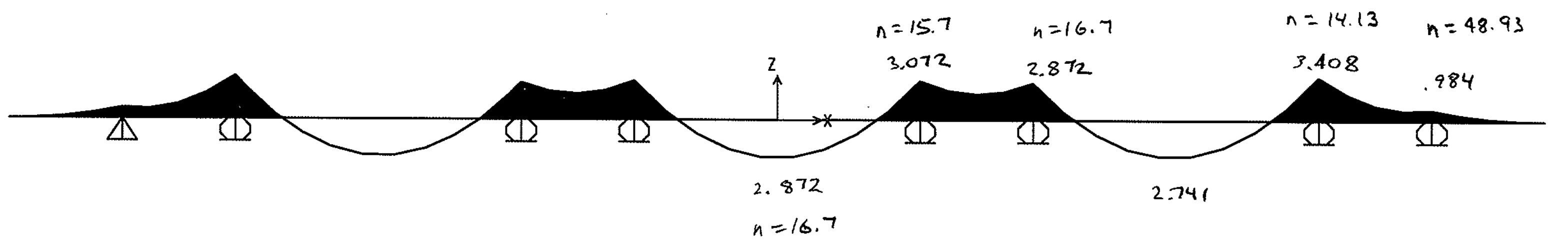
use $n_{min} \simeq 14$

dead load moments for 1'x1' beam

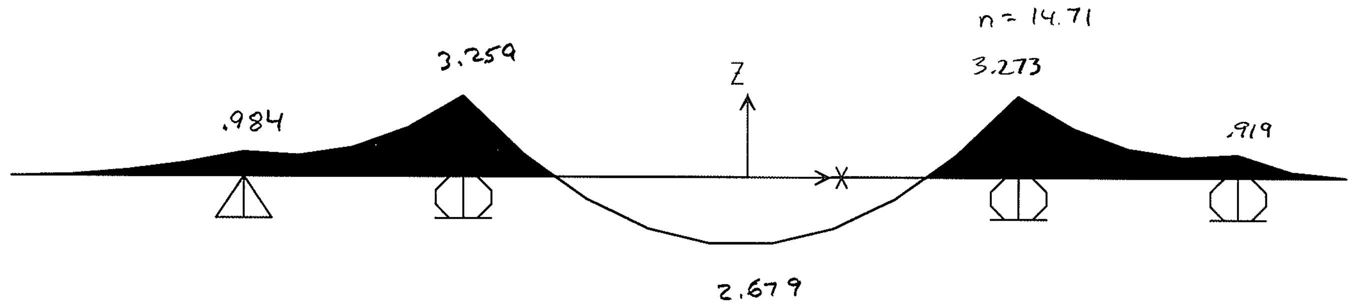
$$M = \frac{w l^2}{n}$$

$l = 17.9167'$
$w = .15 k/ft$

$$n = \frac{w l^2}{M} \approx \frac{48.15}{M}$$

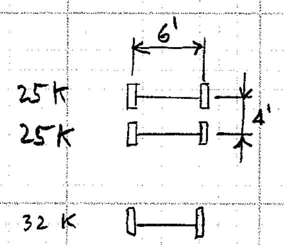


use $n_{min} \approx 14$



SAP2000 v8.3.8 - File:deck_phase1 - Moment 3-3 Diagram (DEAD) - Kip, in, F Units per 3.6.1.3.3, use only axle loads for deck design

Impact Factor (IM) = 33% for HL-93
per C3.6.2.1 this is 4/3 of axle load alone. For Deck Design use 25%



~~per 4.6.2.1.3 & Table 4.6.2.1.3-1~~

~~Strip width $+M = 26.0 + 6.6\,S$~~

~~$-M = 48.0 + 3.0\,S$~~

~~$S+ = 17.9167'$~~
~~$S- = 7.083'$~~

~~$S_{min} = 7'$-$1''$~~

~~$+M$ width $= 26.0 + 6.6(7.08) = 72.73''$~~

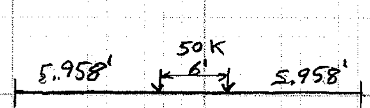
~~$-M$ width $= 48.0 + 3.0(7.08) = 69.24''$~~

for decks that span primarily in transverse direction, width limits do not apply

apply live load to 8' wide panel

assume beam fixed @ both ends

can use moments @ 9.33" in for design



$l = 17.9167$

$$M_+ = \frac{2(25)(5.958)^2(11.958)^2}{17.9167^3} + \frac{25(5.958)^2}{17.9167^3}\left(3(11.958) + 5.958\right)5.958 - \frac{25(11.958)(5.958)^2}{17.9167^2}$$

$$M_+ = 44.13 + 38.46 - 33.06$$

$$M_+ \approx 49.53 \text{ ft Kip}$$

$$M_- = \frac{25(5.958)(11.958)^2}{17.9167^2} + \frac{25(11.958)(5.958)^2}{17.9167^2} + \frac{25(11.88)(5.958)^2}{17.9167^2}$$

$$M_- = -99.4 \text{ ftk}$$

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DESIGN COMPUTATIONS (Grid)

moment: @ 9.33" = .778 ft

$$M_x = \frac{25\,(11.958)^2}{17.9167^3}\left(3\,(5.958) + 11.958\right).778 - \frac{25\,(5.958)(11.958)^2}{(17.9167)^2}$$

$$+ \frac{25\,(5.958)^2}{17.9167^3}\left(3(11.958) + 5.958\right).778 - \frac{25\,(11.958)\,(5.958)^2}{17.9167^2}$$

$$M_x = 14.426 - 66.35 + 5.022 - 33.059$$

$$M_x = -79.96 \text{ ft kip @ } 9.33"$$

from SAP2000 — for one tandem load

$M+ \approx 70.28$ ft k

$M- \approx -78.68$ ft k @ support

-59.238 ft k @ 9.33"

Teddy's Eqn.

$$M_{LL}+ = \frac{\text{Clear Span} + 2'}{32}(.4P)(.8)(IM) \,/\, \text{ft panel}$$

$$M_{LL}+ = \frac{(14.33 + 2)(.4)(50)}{32}(.8)(1.25) * 8' \text{ panel} = 81.65 \text{ ft k}$$

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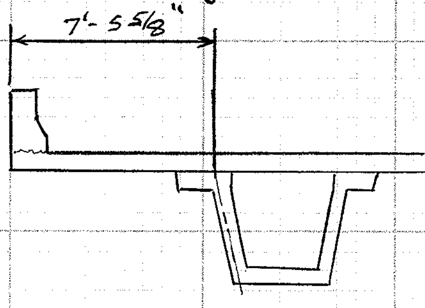
Overhang



DC concrete

8" precast deck $wt = (.15 k/ft^3)\left(\frac{8''}{12''}\right)(1') = .1$ k/ft / ft width

@ support:

$$M_{negative} = \frac{(.1)(7.47)^2}{2} = 2.79 \text{ ft-k/ft width}$$

@ 9.33" from support

$$M_{negative} = \frac{(.1)(6.69)^2}{2} \approx 2.24 \text{ ft k/ft width}$$

DW

3" asphalt weight $= .147 \text{ k/ft}^3 \left(\frac{3''}{12''}\right) 1' \approx .037$ k/ft / ft width

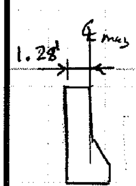
@ support:

$$M_{negative} = \frac{(.037)(5.97)^2}{2} \approx 0.66 \text{ ft k/ft width}$$

@ 9.33" from support

$$M_{neg} = \frac{(.037)(5.19)^2}{2} \approx 0.50 \text{ ft-k/ft width}$$

DC BARRIER



$wt \approx .485$ k/ft

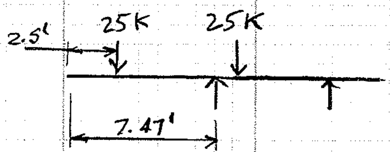
@ support

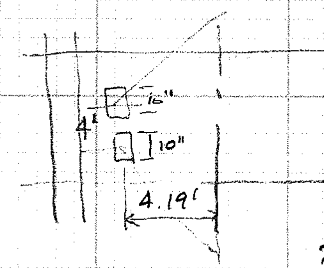
$$M_{negative} = (.485 \text{ k/ft})(7.47 - 1.28) \approx 3.00 \text{ ft k/ft width}$$

@ 9.33" from support

$$M_{negative} = .485 \text{ k/ft}(7.47 - 1.28 - .78) \approx 2.62 \text{ ft k/ft width}$$

LL Liveload





effective width
$\approx 4 + .83 + 2(4.19) \approx 13.21'$

@ support $M_{neg} = 25(7.47-2.5) \approx 124.25$ ft k

@ 9.33" from support $M_{neg} = 25(7.47-2.5-.77) \approx 104.83$ ft k

104.83 ftk / 13.21 $\approx$ 7.94 ftk/ft

per 3.6.1.34 LL = 1 K/ft @ 1' from barrier

$M_{neg} = (1^{K}/ft)(4.97') = \underline{4.97 \text{ ftK/ft}}$

IMPACT LOADS

Assume TL-4 loads
Table A13.2-1

$F_t = 54.0$ kips

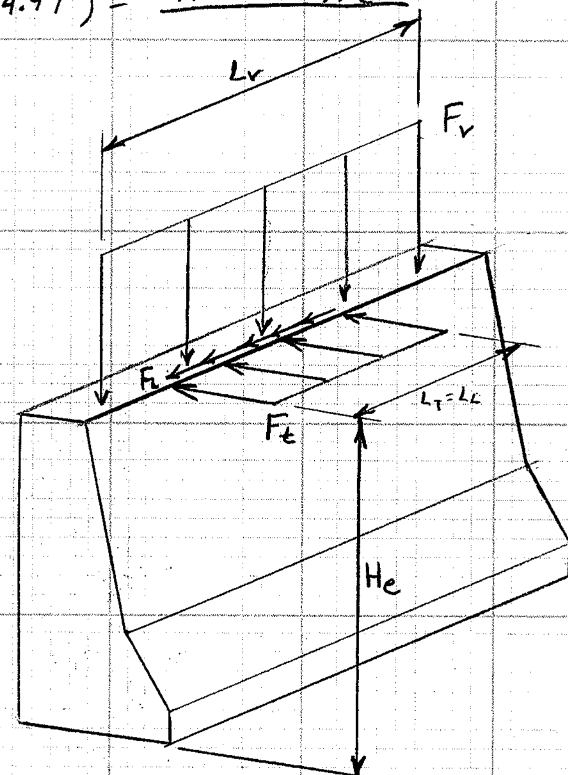
$F_L = 18.0$ kips

$F_v = 18.0$ kips

$L_T = L_L = 3.5$ ft

$L_v = 18.0$ ft

$He = 32$ inches



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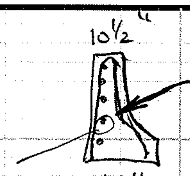


$$L_c = \frac{L_t}{2} + \sqrt{\left(\frac{L_t}{2}\right)^2 + \frac{8H(M_B + M_w)}{M_c}} \qquad (A\ 13.3.1\text{-}2)$$

$$L_c = \frac{3.5}{2} + \sqrt{\left(\frac{3.5}{2}\right)^2 + \frac{8(2.67)(0 + 17.7)}{17.7}}$$

$$L_c \approx 6.69 \text{ ft}$$

$W_{avg} = \frac{18 + 10.5}{2} = 14.25"$ (CA 13.3.1)

$M_b = \phi$

M_c: 5 - #4s in 38"
≈ #4 @ 8"
$M_c \approx 17.7$ ftk/ft

M_w: #4@8"

$M_w \approx 17.7$ ftk/ft

$H = 2.67'$ (32")

$$R_w = \left(\frac{2}{2L_c - L_t}\right)\left(8M_b + 8M_w + \frac{M_c L_c^2}{H}\right) \qquad (A\ 13.3.1\text{-}1)$$

$$R_w = \left(\frac{2}{2(6.69) - 3.5}\right)\left(\phi + 8(17.7) + \frac{17.7 \cdot 6.69^2}{2.67}\right)$$

$$R_w = 88.72 \text{ kips}$$

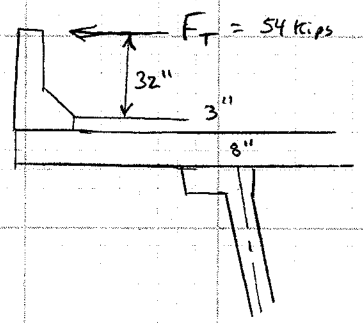
$$T = \frac{R_w}{L_c + 2H} \qquad (A\ 13.4.2\text{-}1)$$

$$T = \frac{88.72}{6.69 + 2(2.67)} \approx 7.38 \text{ k/ft}$$ (tensile force in deck)

DESIGN CASE 1

Extreme Event II - transverse & longitudinal force

assume longitudinal force does not increase deck moment or transverse stress



$$M_{neg\ impact} = (54 \text{ Kips})\left(\frac{32 + 3 + 8}{12"}\right) = 193.5 \text{ ft Kip}$$

$M_{c\,base} \approx 23.33$ ftK/ft

$M_{c\,avg} = 17.7$ ftk/ft

per A13.4.2, design for $M_s > M_{c_{avg}} + T$

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REINFORCING DESIGN

GIVEN:

fy= 60.00 ksi
f'c= 4.50 ksi
COVER= 2.00 inches
$\Phi_{flexure}$= 0.90
Beam Thickness (t_s)= 14.25 inches
b= 12.00 inches
bar diameter= 0.500 inches

Average Barrier Strength

TOP STEEL

LOAD TYPE	M_{hTOT}
	ft-K
M_h (UNFACTORED)	1.00
STRENGTH I	1.00
SERVICE I	1.00

$AS_{req'd}$
in^2
0.02
0.02
0.02

d_s= 12.00 inches
per 5.10.8.2 AS_{temp}= 0.26 sq inches

Use # 4 at top face min. spacing = 129.46 inches
use spacing= 8.00 inches
As= 0.300 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 17.71 ft-K
M_r= 15.94 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)
c= 0.48 inches
d_e=d_s= 12.00 inches (for no prestressing)
c/d_e= 0.04
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2
1.2*$M_{cracking}$= 20.68 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 1.33 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2
Percentage of main reinforcement, 220 / sqrt(S) <= 67%
Girder Spacing = 10.94 ft
Flange Width = 43 inches
Flange Overhang = 18 inches
Effective Length S = 8.86 ft
220 / sqrt(S) = 73.92 % Use **67** % of required main reinforcement
Required As = 0.20 sq inches
Use # 4 transverse reinforcement
min. spacing = 11.94 inches

REINFORCING DESIGN

GIVEN:

fy= 60.00 ksi
f'c= 4.50 ksi
COVER= 2.00 inches
$\Phi_{flexure}$= 0.90
Beam Thickness (ts)= 18.00 inches
b= 12.00 inches
bar diameter= 0.500 inches

Barrier Strength @ Base

TOP STEEL

LOAD TYPE	M_{hTOT}
	ft-K
Mh (UNFACTORED)	1.00
STRENGTH I	1.00
SERVICE I	1.00

$AS_{req'd}$
in^2
0.01
0.01
0.01

ds= 15.75 inches
per 5.10.8.2 AS_{temp}= 0.32 sq inches

Use # 4 at top face min. spacing = 170.00 inches
use spacing= 8.00 inches
As= 0.300 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

Mn= 23.33 ft-K
Mr= 21.00 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 0.48 inches
de=ds= 15.75 inches (for no prestressing)
c/de= 0.03
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*Mcracking= 32.99 ft-K <--- Test 1
1.33MhTOT (max.)= 1.33 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing = 10.94 ft
Flange Width = 43 inches
Flange Overhang = 18 inches
Effective Length S = 8.86 ft
220 / sqrt(S) = 73.92 % Use **67** % of required main reinforcement
Required As = 0.20 sq inches
Use # 4 transverse reinforcement
min. spacing = 11.94 inches

REINFORCING DESIGN

Barrier Strength @ TOP

GIVEN:

fy=	60.00	ksi
f'c=	4.50	ksi
COVER=	2.00	inches
$\Phi_{flexure}$=	0.90	
Beam Thickness (t_s)=	10.50	inches
b=	12.00	inches
bar diameter=	0.500	inches

TOP STEEL

LOAD TYPE	M_{hTOT}
	ft-K
Mh (UNFACTORED)	1.00
STRENGTH I	1.00
SERVICE I	1.00

$AS_{req'd}$
in^2
0.03
0.03
0.03

d_s= 8.25 inches
per 5.10.8.2 AS_{temp}= 0.19 sq inches

Use # 4 at top face min. spacing = 88.90 inches
use spacing= 8.00 inches
As= 0.300 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 12.08 ft-K
M_r= 10.87 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)
c= 0.48 inches
d_e=d_s= 8.25 inches (for no prestressing)
c/d_e= 0.06
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2
1.2*$M_{cracking}$= 11.23 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 1.33 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2
Percentage of main reinforcement, 220 / sqrt(S) <= 67%
Girder Spacing = 10.94 ft
Flange Width = 43 inches
Flange Overhang = 18 inches
Effective Length S = 8.86 ft
220 / sqrt(S) = 73.92 % Use **67** % of required main reinforcement
Required As = 0.20 sq inches
Use # 4 transverse reinforcement
min. spacing = 11.94 inches

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

INTERACTION FORMULA

$$\frac{P_u}{\phi P_n} + \frac{M_u}{\phi M_n} \leq 1.0$$

$$M_u \leq \phi M_n \left(1.0 - \frac{P_u}{\phi P_n}\right)$$

$P_u = T$

$\phi P_n = \phi A_{st} f_y$

$A_{st} = (52 \text{ strands})(.217 \text{ in}^2) \approx 11.284 \text{ in}^2$ in 8' slab

$F_u = 270$ ksi

$F_y \approx 243$ ksi

$\phi P_n = (1.0)(11.284 \text{ in}^2)(243 \text{ ksi}) = 2742 \text{ K}$ over 8'

≈ 342.75 k/ft

$T = 7.38$ k/ft

$$M_u \leq \phi M_n \left(1.0 - \frac{7.38 \text{ k/ft}}{342.75 \text{ k/ft}}\right) \approx \phi M_n (.978)$$

for $A_{ST} = (42 \text{ strands})(.217) \approx 9.114 \text{ in}^2$

$\phi P_n = (1.0)(9.114)(243 \text{ ksi}) = 2214.7 \text{ k} = 276.84$ k/ft

$$M_u = \phi M_n \left(1.0 - \frac{7.38}{276.84}\right) = .973 \phi M_n$$

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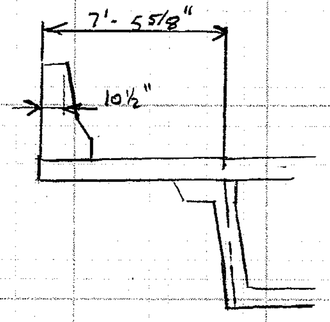
COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

DESIGN CASE 2

Extreme Event II - vertical force

$F_V = 18$ Kips over 18 ft $\Rightarrow$ 1 k/ft



assume F_V acts at middle of top face

moment arm = $7'\text{-}5\frac{5}{8} - \frac{10\frac{1}{2}}{2} \approx 7.03'$

$M_{\text{Impact}} = (7.03')(1\ k/ft) = 7.03$ ft k/ft wall

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HANDLING LOADS

ASSUME LIFTING LUGS @ 1/4 points of slab

$L_{slab} \approx 43.5'$

cantilever moment $\approx \dfrac{w\ell^2}{2}$

$w = (.67)(1)(.15\ k/cf) \approx .1\ k/ft$ / ft width

$$M = \frac{(.1)(43.5/4)^2}{2} \approx 5.91 \text{ ft kip/ft}$$

midsupport moment

$$M \approx \frac{wx}{2\ell}\left(\ell^2 - a^2 - x\ell\right) - \frac{wa^2x}{2\ell}$$

$x = a = \ell/2$

$$M = \frac{w(\ell/2)}{2\ell}\left(\ell^2 - \frac{\ell^2}{4} - \frac{\ell^2}{2}\right) - \frac{w(\ell/2)^2\ \ell/2}{2\ell} \qquad \frac{w\frac{\ell^2}{4}}{4}$$

$$M \approx \frac{w\ell^2}{16} - \frac{w\ell^2}{16}$$

$$M = \phi$$

if @ 1/5 points

cantilever moment $\approx \dfrac{(.1)\left(\frac{43.5}{5}\right)^2}{2} \approx 3.78$ ft kip/ft

midsupport moment

$a = \ell/3 \quad x = \ell/2$

$\ell = \frac{3}{5} L = 26.1' \pm$

$$M = \frac{w(\ell/3)}{2\ell}\left(\ell^2 - \frac{\ell^2}{9} - \frac{\ell^2}{2}\right) - \frac{w\frac{\ell^2}{9}\frac{\ell}{2}}{2\cancel{\ell}}$$

$$M = \frac{w}{6}\left(\frac{7}{18}\ell^2\right) - \frac{w\ell^2}{36}$$

$$M = \frac{.1}{6}\left(\frac{7}{18}(26.1)\right) - \frac{.1\ 26.1^2}{36} = 1.72 \text{ ftkip/ft}$$

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STRENGTH CHECKS

$M_R \approx 249$ ft k

INTERIOR

STRENGTH I

(8' skb)

$M_{u\ positive} = 1.25DC + 1.5DW + 1.75(LL + IM)$

$M_{u\ positive} = 1.25(2.293)8 + 1.5(.848)(8) + 1.75(70.28)\ 1.25$

$M_{u\ positive} = 186.84$ ft K $< M_R$ okay ✓

$M_{u\ negative} = 1.25(2.293)8 + 1.5(.848)8 + 1.75(59.238)\ 1.25$

$M_{u\ negative} = 162.69$ ft K $< M_R$ okay ✓

SERVICE I

$M_{u\ positive} = DC + DW + LL + IM$

$= (2.293)(8) + .848(8) + 70.28(1.25)$

$M_{u\ positive} = 87.85$ ft K

$M_{u\ negative} = 2.293(8) + .848(8) + (59.238)\ 1.25$

$M_{u\ negative} \approx 99.18$ ft K

STRENGTH CHECKS

$M_R \approx 249$ ft k

EXTERIOR

STRENGTH I (8' SLAB)

$M_{u\ negative} = 1.25\ DC + 1.5\ DW + 1.75\ (LL + IM)$

$= 1.25\ (2.24 + 2.62)\ 8 + 1.5\ (0.5)\ 8 + 1.75\ (4.97)(8)\ 1.25$

$M_{u\ negative} = 141.58$ ft k $< M_R$ okay ✓ 203.3 ft k if 3.6.1.3.4 not used

@ Transfer Length $M_u = 1.25\left[\frac{.1\ (3.42)^2}{2} + .485\ (3.417 - 1.28)\right] + 1.5\left[\frac{.037\ (3.42)^2}{2}\right] + 1.75\left[1\ k/ft\ (.9167)\right]$

$M_u = 3.96$ k ft/ft $* 8$ ft ≈ 31.6 ft k $< M_r$ okay ✓

$M_u < M_R$ okay if 3.6.1.3.4 not used

SERVICE I

$M_{u\ negative} = (2.24 + 2.57)\ 8 + (0.5)(8) + 4.97(8)\ 1.25$

$M_{u\ negative} \approx 92.18$ ft k

128.7 ft k if 3.6.1.3.4 not used

EXTREME EVENT II - Design Case 1, A 13.4.1

$M_u = 1.0\ DC + 1.0\ DW + .5(LL + IM) + M_c + T$ ← incorporate into M_R

$M_u = 1.0\ (2.24 + 2.62)\ 8 + 1.0\ (0.5)\ 8 + .5\ (4.97(8))\ 1.25 + 17.7$ ftk(8)

$M_u = 219.8$ ft K

235.98 ft k if 3.6.1.3.4 not used

from interaction formula $M_{R\ Tension} = .973\ \phi M_n = .973\ M_R$

$M_{R\ Tension} = .973\ (241.1) = 234.6$ ← reduced for development length

$M_R > M_u$ okay ✓

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COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

STRENGTH CHECKS

EXTREME EVENT II – Design Case 1

PRESTRESSING NOT FULLY DEVELOPED

@ Face of Barrier

$$M_U \approx 1.0\left[\frac{.1(1.5)^2}{2} + \frac{.485(1.5-1.28)^2}{2}\right] + 17.7 \text{ ftk/ft}$$

$$M_U \approx .124 + 17.7 \approx 17.82 \text{ ftk/ft} * $$

$$M_U \approx 142.59 \text{ ftk for } 8' \text{ slab}$$

$M_{R\ prestressed} \approx 98.1$ ft K

$M_{R\ mild\ steel} \approx 9.39$ ftk/ft $* 8 \approx 75.1$ ft K

$M_{R\ Total} = (173.2 \text{ ft k}).973 \approx 168.5$ ft k

$M_U < M_R$ ✓ okay

@ Transfer length (36") 3'-5" from edge of deck (1'-11" from barrier)

$$M_U \approx 1.0\left[\frac{.1(3.42)^2}{2} + .485(3.417-1.28)\right] + 1.0\left[\frac{.037(3.42)^2}{2}\right] + .5\left[.125(1^k/ft)(.9167)\right]$$

$$+ 17.7 \text{ ft k/ft}$$

$$M_U \approx 20.11 \text{ ft k/ft}$$

$$M_U \approx 160.88 \text{ ft k for } 8' \text{ slab}$$

M_{R} prestressed $= (234.3 \text{ ftk})(.973) \approx 228.0$ ft K

$M_U < M_R$ ✓ okay

@ 13" from barrier (live load)

$$M_U \approx 1.0\left[\frac{.1(2.58)^2}{2} + .485(2.58-1.28)\right] + 1.0\left[\frac{.037(1.1)^2}{2}\right] + .5(1 \text{ k/LF})(.08) + 17.7 \text{ ft k}$$

$$M_U \approx 18.74 \text{ ftk/ft} \approx 149.9 \text{ ft k for } 8' \text{ slab}$$

$M_R > 181.1$ ftk

$M_U < M_r$ okay ✓

AT 7" FROM BARRIER

$$M_U \approx 1.0\left[\frac{.1(2.08)^2}{2} + .485\,(2.08 - 1.28)\right] + 1.0\left[\frac{.037(.583)^2}{2}\right] + 17.7$$

$M_U \approx 18.31$ ft k

$M_U = 146.48$ ft k for 8' slab

$M_R = .973(151) \approx 146.9$ ft k

$M_U < M_R$ ✓ okay — mild steel not reqd

AT 6" $\quad M_U = 1.0\left[\frac{.1\,(2)^2}{2} + .485(2-1.28)\right] + 1.0\left[\frac{.037\,(.5)^2}{2}\right] + 17.7$

$M_U = 18.25$ ft k / ft

$M_U = (18.25)(8) = 146.0$ ft k for 8' slab

$M_R = .973\,(144.7) = 140.8$ ft k

$\frac{As_{reqd}}{As_{provided}} = \frac{146.0}{213.9} = .68$ $\quad M_U > M_R$ add mild steel $\quad$ #5's @ 8 = 8(9.39) × .973 = 73.1

12.5" post point $\quad M_R$ w/ mild steel = 213.9 > M_U okay ✓

EXTREME EVENT II — Design Case 2 $\quad$ A13.4.1

$M_U = 1.0\ DC + 1.0\ DW + .5\ (LL + IM) + M_V$

$M_U = 1.0(2.24 + 2.62)\,8 + 1.0(.5)(8) + .5\,(4.97)(8)\,1.25 + 7.03\,(8)$

$M_U = 123.97$ ft k

$M_R = 249$ ft k

$M_U < M_r$ okay ✓

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

STRESS CHECKS @ RELEASE

COMPRESSIVE Stress @ Release

$\Delta_{PES} = 16.98$ ksi

strands are concentric, so no eccentricity checks

$f_t \approx \frac{P}{A}$

$P = (.75(270) - 16.98)(44 \text{ strands})\ .217$ 1078.6

30 strands max

$P = 1771.3$ k

4.14

185.52 $f_t = \frac{1771.3}{403.375 \text{ in}^2} = 4.39$ ksi @ blockouts

$f_t = \frac{1771.3}{723.375} = 2.45$ ksi with no blockouts

Compressive limit $= .6f'_{ci} = .6(5) = 3$ ksi 36 strands

38 strands
.153

7.5 ksi

for 6 ksi release
2.67

7.4 ksi min

NO GOOD for 44 strands

31 strands

+ ½" A = 427.875 – 38 strands for 6 ksi 1529.8
+ 1" A = 452.375 – 40 strands for 6 ksi

3.56 ksi

use 30 strands max

TENSION

tension < $.24\sqrt{f'_{ci}}$

strands are concentric so no eccentricy

$\therefore$ tension $\approx \phi$

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STRESS CHECKS @ SERVICE 5.9.4

Total Losses @ Transfer = $\Delta_{pES} = 16.98$ ksi

Total Losses @ Service Loads

$$\Delta f_{pT} = \Delta f_{pES} + \Delta f_{pSR} + \Delta f_{CR} + \Delta f_{pR}$$

$$= 16.98 + 5.27 + 7.72 + 1.2 + 12.08 + 10.18 + 1.2$$

$$\Delta f_{pT} = 54.63 \text{ ksi}$$

Stress in tendons

$$\Delta f_{pe} = f_{pi} - \Delta f_{pT} = 202.5 - 54.63 = 147.87 \text{ ksi}$$

$$f_{pe} \leq .8 f_{py} \qquad \text{(Table 5.9.3-1)}$$

$$\leq .8[.9(270)] = 194.4 \text{ ksi} \quad ✓ \quad \text{ok}$$

final prestress losses = $\frac{54.63}{202.5} * 100 \approx 26.98\%$

Concrete Stress in Positive Moment Area (Table 5.9.4.2.1-1)

$$P_{pe} = (147.87 \text{ ksi})(44 \text{ strands})(.217 \text{ in}^2) = 1411.86 \text{ K}$$

$$f_c = \frac{P_e}{A} + \left(\frac{M_{slab} + M_{barrier} + M_{DW} + M_{LL}}{S_T}\right)$$

$$f_c = \frac{1411.86}{723.375} + \frac{(2.293)8(12)}{960.75 \text{ in}^3} + 0 + \frac{(.848)(8)(12)}{1024} + \frac{(70.28 \text{ ft-k})(12)\ 1.33}{1024}$$

$$f_c = 1.95 + .23 + 0 + .08 + 1.09$$

$$f_c \approx 3.35 \text{ ksi}$$

Compressive limit = $.6f'_c = .6(7) = 4.2$ ksi ✓ okay

for permanent loads $\Rightarrow f_c \approx 2.26$ ksi

limit = $.45f'_c = .45(7) = 3.15$ ksi ✓ okay

$LL + \frac{1}{2}(DL + PS) < .4f'_c$ ✓ okay

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STRESS CHECK @ SERVICE

TENSION

$$\text{limits} = .19\sqrt{f'_c} = .19\sqrt{7} = 502.7 \text{ psi}$$

Service III

DC + DW + PS + .8(LL + IM)

$$f_t = \frac{P_e}{A} - \frac{M_{S6L}}{S_{bott}} + \frac{M_{bar}}{S_{bott}} - \frac{M_{DW}}{S_{bott}} - \frac{M_{LL}}{S_{bott}}$$

$$f_t = \frac{1411.86}{723.375} - \frac{(2.293)8(12)}{982.96} - \frac{(.473)(8)(12)}{1024} - \frac{(.848)(8)(12)}{1024} - \frac{(70.28)(12)\,1.33}{1024}(.8)$$

$$f_t = 1.95 - .224 - .044 - .080 - 0.880$$

$$f_t = .722 \text{ ksi (compression)}$$ ✓ okay

CONCRETE STRESS AT NEGATIVE MOMENT AREA (INTERIOR)

COMPRESSION – SERVICE I

$$f_c = \frac{1411.86}{723.375} + \frac{(2.293)(8)(12)}{982.96} + \sim 0 + \frac{(.848)(8)(12)}{1024} + \frac{(59.238)(12)\,1.33}{1024}$$

$$f_c = 1.95 + .224 + 0 + .080 + .923$$

$$f_c = 3.18 \text{ ksi} < 4.2 \text{ ksi}$$ ✓ okay

Tension – Service III

$$f_t = \frac{1411.86}{723.375} - \frac{(2.293)(8)(12)}{960.75} - \frac{(.473)(8)(12)}{1024} - \frac{(.848)(8)(12)}{1024} - \frac{(59.238)(12)\,1.33}{1024}(.8)$$

$$f_t = 1.95 - .229 - .044 - .08 - .739$$

$$f_t \approx .858 \text{ (compression)}$$ ✓ okay

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SECTION PROPERTIES (Interior Girder: Precast panel)

GEOMETRY

Structure Number?	Precast panel	
# of spans =	3.000	
Center to Center Panel Spacing =	8.000	feet
overhang =	9.010	feet
Panel Length =	51.87	feet
deflection point =	0.40	*L
a = 0.4*L =	20.75	feet
Exterior Girder ? (Y or N)	N	
Weight of Formwork =	5.00	psf

NONCOMPOSITE PROPERTIES

Girder Type ?	FULLDEPTHPRECASTPANEL	
Girder Depth =	8.0	inches
Tub Depth & Type ?	4SB	
Area =	723.38	in^2
y_b (CG) =	3.95	inches
y_t =	4.05	inches
I_g =	3886.92	in^4
S_{bottom}=	982.97	in^3
S_{top}=	960.75	in^3

Top Width =	89.00	inches
Bottom Width =	94	inches
Depth to Slope =	5	inches
Slope Depth =	1.25	inches
Chamfer Dimension =	0.5	inches
Slope Depth from Bottom =	1.75	inches

# of strands =	28	
Strand diameter =	0.600	inches
Individual Strand Area =	0.217	in^2
Strand Center of Gravity at Midspan =	4.00	inches
Strand Center of Gravity at End =	4.00	inches
Estrand =	28500	ksi
f_u =	270	ksi

Depth of Haunch for Strength =	0.00	inches

Thickness of Deck =	0.00	inches
Effective Width of Deck =	0.00	inches
$E_{c\text{-}deck}$ =	4069.64	ksi *
$E_{c\text{-}girder\ initial}$ =	4069.64	ksi *
$E_{c\text{-}girder\ 28day}$ =	4883.57	ksi *

$W_{cconcrete\text{-}deck}$ =	0.150	kcf
$W_{concrete\text{-}girder}$ =	0.150	kcf
$f'_{c\text{-}deck}$ =	5.00	ksi
$f'_{c\text{-}girderinitial}$ =	5.00	ksi
$f'_{c\text{-}girder28day}$ =	7.20	ksi

* E_c based on Eqn. C5.4.2.4-1

TRANSFORMED NONCOMPOSITE PROPERTIES (Prestressing Steel Transformed)

n =	5.84	(using Ec-girder final = long term modular ratio)
$A_{steeltransformed}$ =	29.38	in^2
$y_{bottomnoncomposite}$ =	3.96	inches
$I_{noncomposite}$ =	3886.98	in^4

n =	7.00	(using Ec-girder initial = initial modular ratio)
$A_{steeltransformed}$ =	36.47	in^2
$y_{bottomnoncomposite}$ =	3.96	inches
$I_{noncomposite\text{-}initial}$ =	3887.00	in^4

TRANSFORMED COMPOSITE PROPERTIES (Prestressing Steel Transformed)

n =	0.8333	(using Ec-girder final = long term modular ratio)
$y_{bottomcompositetransformed}$ =	3.96	inches
$I_{compositetransformed}$ =	3886.98	in^4

GROSS COMPOSITE PROPERTIES

Assume closure pour concrete ~ equals precast concrete properties

$y_{bottomcomposite}$ =	4.00 inches	
$I_{composite}$ =	4096.00 in^4	
$A_{composite}$ =	768 in^2	only good for precast panels
S_{bottom}=	1024.00 in^3	only good for precast panels
S_{top}=	1024.00 in^3	only good for precast panels

PRESTRESS LOSSES (28 Strands)

Note: Prestress Losses are based on Non-Transformed Section Properties

ELASTIC SHORTENING (per 5.9.5.2.3a) (for usual design cases)

$\Delta f_{pES} = (E_p/E_{ci})\, f_{cgp}$

E_p = 28500.00 ksi
E_{ci} = 4069.64 ksi cover to prestressing= 2 inches
$f_{cgp} = P_t/A + (P_t*e/I)*y + M_g*y/I$

$P_t = .7 * f_u * A_{strand}$ = 1148.36 k (low relax strand)
$M_g = W_{self} * (L^2)/8$ = 253.39 ft-k
e = 0.05 inches
y = 1.65 inches

per RLO: 0.75
fji=0.75*fu= 202.50 ksi
initial relaxation = 3.50%
fjo= 184.79 ksi
Δf_{pES} = 10.62 ksi (RLO

f_{cgp} = 1.62 ksi
Δf_{pES} = 11.37 ksi (gross method)
USE Δf_{pES} = 11.02 ksi

11.34 ksi (per Transformed Section Analysis)
11.02 ksi (per C5.9.5.2.3a-1)

LOSSES: Time of Transfer to Time of Deck Placement (5.9.5.4.2)

time to transfer (t_i)= 0.75 days
time to deck placement (t_d)= 30 days
final age (t_f)= 18250 days
= 50.0 years

SHRINKAGE OF GIRDER CONCRETE (per 5.9.5.4.2a)

average annual humidity (H) = 55.00%

$\Delta f_{pSR} = \varepsilon_{bid} * E_p * K_{id}$

ε_{bid} = Ks*Khs*Kf*Ktd*0.48x10^-3 (5.4.2.3.3-1)

Ks =1.45-.13(V/S)>=1.0 (5.4.2.3.2-2)
V/S= 3.60
Ks = 1.000

Khs = 2.0-.014 H (5.4.2.3.3-2)
Khs = 1.230

Kf = 5/(1+f'ci) (5.4.2.3.2-4)
Kf = 0.833

Ktd = t_d/(61-4f'ci+t_d) (5.4.2.3.2-5)
Ktd = 0.423

ε_{bid} = 2.08E-04

Kid = 1/(1 + Ep/Eci*Aps/Ag*(1+Ag*epg^2/Ig)* [1+.7 $\psi(t_f,t_i)$] (5.9.5.4.2a-2)

$\psi(t_f, t_i)$ = 1.9*Ks*Khc*Kf*Ktd*t_i^ -.118 (5.4.2.3.2-1)

Khc = 1.56-.008 H (5.4.2.3.3-3)
Khc = 1.120
Ktd = t_f/(61-4f'ci+t_f) (5.4.2.3.2-5)
Ktd = 0.998

$\psi(t_f, t_i)$ = 0.556

Kid = 0.924

Δf_{pSR} = **5.48 ksi**

LOSSES: Time of Transfer to Time of Deck Placement (5.9.5.4.2) (continued)

CREEP OF GIRDER CONCRETE (per 5.9.5.4.2b)

Δf_{pCR} = Ep/Eci*f_{cgp}*$\psi(t_d,t_i)$*Kid (5.9.5.4.2b-1)

$\psi(t_d, t_i)$ = 1.9*Ks*Khc*Kf*Ktd*t_i^ -.118 (5.4.2.3.2-1)

Ks = 1.000
Khc = 1.120
Kf = 0.833
Ktd = t_d/(61-4f'ci+t_d) (5.4.2.3.2-5)
Ktd = 0.423
$\psi(t_d, t_i)$ = 0.502

Δf_{pCR} = **5.27 ksi**

RELAXATION OF PRESTRESSING STRANDS (per 5.9.5.4.2c)

Δf_{pR1}=fpt/Kl*(fpt/fpy-.55) (5.9.5.4.2c-1)

Type of Strand = Low-Relaxation Kl= 30

fpj =.75 fpu = 202.50 ksi (Table 5.9.3-1)
fpy = .9 fpu = 243.00 ksi

Δf_{pR1}= 1.52 Per 5.9.5.4.2c, Δf_{pR1} may be assumed equal to 1.2 ksi
Δf_{pR1} = **1.20 ksi**

LOSSES: Time of Deck Placement to Final Time (5.9.5.4.3)

time to transfer (ti)= 0.75 days
time to deck placement (td)= 30.0 days
final age (tf)= 18250.0 days
= 50.0 years

SHRINKAGE OF GIRDER CONCRETE (per 5.9.5.4.3a)

Δf_{pSD}=ε_{bdf}*Ep*Kdf (5.9.5.4.3a-1)

ε_{bdf} = Ks*Khs*Kf*Ktd*0.48x10^-3 (5.4.2.3.3-1)

Ks = 1.000
Khs = 1.230
Kf = 0.833
Ktd = t_f/(61-4f'ci+t_f) (5.4.2.3.2-5)
Ktd = 0.998

ε_{bdf} = 4.91E-04

Kdf = 1/(1 + Ep/Eci*Aps/Ac*(1+Ac*epc^2/Ic)* [1+.7 $\psi(t_f,t_i)$]
$\psi(t_f, t_i)$ = 1.9*Ks*Khc*Kf*Ktd*t_i^ -.118
Khc = 1.120
$\psi(t_f, t_i)$ = 0.556

Kdf = 0.929

Δf_{pSD} = **12.99 ksi**

CREEP OF GIRDER CONCRETE (per 5.9.5.4.3b)

$\Delta f_{pCD} = Ep/Eci*f_{cgp}*[\psi(t_f,t_i)-\psi(t_d,t_i)]*Kdf+Ep/Ec*\Delta fcd*\psi(t_f,t_d)*Kdf$ (5.9.5.4.2.6-1)

f_{cgp} = 1.62 ksi
Kdf = 0.929
$\psi(t_f, t_i)$ = 0.556
$\psi(t_d, t_i)$ = 0.502

$\psi(t_f, t_d) = 1.9*Ks*Khc*Kf*Ktd*t_d$^ -.118 (5.4.2.3.2-1)
Ks = 1.000
Khc = 1.120
Kf = 0.833
Ktd = $t_f/(61-4f'ci+t_f)$ (5.4.2.3.2-5)
Ktd = 0.998
$\psi(t_f, t_d)$ = 1.184

Total losses: $\Delta fpid=\Delta f_{pSR}+\Delta f_{pCR}+\Delta f_{pR2}$ NCHRP 496 Example 4
Δfpid = 11.95 ksi
$\Delta P=\Delta fpid*Aps$ = 72.61 kip

$\Delta f_{cd} = \Delta P/Ac + (\Delta P*e/Ic)*y + Mg*y/Ig+ Mc*y/Ic$

Input following moments from Conspan or other calculations:

$M_{noncomposite}$ (Mg) =	26.69 ft-k	M_{simple} =	0.00 ft-k (see deflection sheet)
$M_{composite}$ (Mc) =	9.88 ft-k	M_{simple} =	0.00 ft-k (see deflection sheet)
e =	0.05 inches		
y =	1.65 inches (for moments)		

Δf_{cd} = 0.279 ksi

$\Delta f_{pCD} = Ep/Eci*f_{cgp}*[\psi(t_f,t_i)-\psi(t_d,t_i)]*Kdf+Ep/Ec*\Delta fcd*\psi(t_f,t_d)*Kdf$ (5.9.5.4.2.6-1)

Δf_{pCD} = **2.36 ksi**

RELAXATION OF PRESTRESSING STRAND (per 5.9.5.4.3c)

$\Delta f_{pR2}=\Delta f_{pR1}$

Δf_{pR2} = **1.20 ksi**

SHRINKAGE OF DECK CONCRETE (per 5.9.5.4.3d)

$\Delta f_{pSS}=Ep/Ec*\Delta fcdf*Kdf*[1+0.7\psi(t_f,t_d)]$

Kdf = 0.929
$\psi(t_f, t_d)$ = 1.184
$\Delta fcdf=\varepsilon ddf*Ad*Ecd/[1+0.7\psi_d(t_f,t_d)]*(1/Ac-epc*ed/Ic)$

ε_{ddf} = Ks*Khs*Kf*Ktd*0.48x10^-3 (5.4.2.3.3-1)
Ks = 1.000
Khs = 1.230
Kf = 5/(1+f'ci) (5.4.2.3.2-4)
Kf = 0.833
Ktd = $t_f/(61-4f'ci+t_f)$ (5.4.2.3.2-5)
Ktd = 0.423

εddf = 2.08E-04

Δfcdf= 0.00 ksi
Δf_{pss} = **0.00 ksi**

TOTAL LOSSES

$\Delta f_{pLT} = \Delta f_{pSR} + \Delta f_{pCR} + \Delta f_{pR1} + \Delta f_{pSD} + \Delta f_{pCD} + \Delta f_{pR2} - \Delta f_{pSS}$

$\Delta f_{pLT} =$ **28.50 ksi**

$\Delta f_{pT} = \Delta f_{pES} + \Delta f_{pSR} + \Delta f_{pCR} + \Delta f_{pR1} + \Delta f_{pSD} + \Delta f_{pCD} + \Delta f_{pR2} - \Delta f_{pSS}$

$\Delta f_{pT} =$ 39.52 ksi

LRFD Ed3 Losses= 42.21 ksi

$\Delta f_{pT} =$ **42.21 ksi**

(JACKING) INITIAL FORCE = **1230.4 k**

FINAL FORCE = **973.9 k** % LOSS = **20.85%**

LRFD Ed. 3 PRESTRESS LOSSES (28 Strands)

Note: Prestress Losses are based on Non-Transformed Section Properties

ELASTIC SHORTENING (per 5.9.5.2.3a) (for usual design cases)

$\Delta f_{pES}=(E_p/E_{ci})\ f_{cgp}$

E_p = 28500.00 ksi
E_{ci} = 4069.64 ksi
$f_{cgp} = P_t/A + (P_t{*}e/I){*}y + M_g{*}y/I$

P_t=.7 * fu * A_{strand} =	1148.36 k	(low relax strand)	per RLO:	0.75	
M_g=W_{self} * (L^2) / 8 =	253.39 ft-k		fji=0.75*fu=	202.50	ksi
e = y =	0.05 inches		initial relaxation =	3.50%	
			fjo=	184.79	ksi
f_{cgp} =	1.62 ksi		Δf_{pES} =	10.62	ksi (RLO method)
Δf_{pES} =	11.37 ksi (gross method)		11.34 ksi (per Transformed Section Analysis)		
USE Δf_{pES} =	**11.02 ksi**		11.02 ksi (per C5.9.5.2.3a-1)		

SHRINKAGE (per 5.9.5.4.2)

average annual humidity (H) = 55.00%

Δf_{pSR}=17-.15H

Δf_{pSR} = **8.75 ksi**

CREEP (per 5.9.5.4.3)

$\Delta f_{pCR}=12.0{*}f_{cgp}-7.0{*}\Delta f_{cdp}$

$\Delta f_{cdp} = M_{noncomposite} * y / I + M_{composite} * y / I_{comp}$

Input following moments from Conspan, Approximation below or other calculations

$M_{noncomposite}$ =	26.69 ft-k	M_{simple} =	0.00 ft-k (see deflection sheet)
$M_{composite}$ =	9.88 ft-k	M_{simple} =	456.26 ft-k (see deflection sheet)

Δf_{cdp} = 0.00 ksi

Δf_{pCR} = **19.46 ksi**

RELAXATION AT TRANSFER (per 5.9.5.4.4b

Δf_{pR1}=log (24.0 t) /Kr [fpj/fpy-.55] * fpj

Kr =	40.00	(per LRFD, but PCI recommends 45)
t =	0.75 days	
fpj =.75 fpu (per PCI) =	202.50 ksi	LRFD suggests .8 fpu (C5.9.5.4.4b)
fpy = .9 fpu =	243.00 ksi	

Δf_{pR1} = **1.80 ksi**

RELAXATION AFTER TRANSFER (per 5.9.5.4.4c

Δf_{pR2}=30% [20-.4Δf_{pES}-.2(Δfpsr+Δf_{pCR})]

Δf_{pR2} = **2.99 ksi**

TOTAL LOSSES

$\Delta f_{pT}=\Delta f_{pES}+\Delta f_{psr}+\Delta f_{pCR}+\Delta f_{pR2}$

Δf_{pT} = **42.21 ksi**

(JACKING) INITIAL FORCE = **1230.4 k**
FINAL FORCE = **973.9 k** % LOSS = **20.85%**

Colorado Department of Transportation **12/5/2008**

Design Computations

STRENGTH CALCULATIONS - FULL DEPTH PANEL

Strength by Strain Compatibility

Assume depth of rectangular stress block (a) is less than cover
=> all strands in tension

prestress cover =	2 inches	
fpu=	270 ksi	
fpy=.9*fpu=	243 ksi	
f'c=	7.20 ksi	
β=	0.69	(5.7.2.2)

T=C
T=Aps*fps
C=.85f'c*b*a

Aps= 3.038 in^2 (half of total)
b= 96 inches

a=Aps*fps/.85f'cb

@ Yield (fpy):
a= 1.26 inches
c=a/β = 1.82 inches Top strands are below neutral axis (tension)

@ Ultimate (fpu):
a= 1.40 inches
c=a/β = 2.02 inches Top strands are below neutral axis (tension)

[redacted]

c=(Aps*fpu+As*fs-A'sf's)/(.85*f'c*β*b+K*Aps*fpu/dp) (5.7.3.1.1-4)

K= 0.28 (Table C5.7.3.1.1-1)

assume As=A's=0

c= 1.84 inches

fps=fpu(1-K*c/dp) (5.7.3.1.1-1)

fps= 245.59 ksi

for As=A's=0 and b=bw,
Mn=Aps*fps(dp-a/2) (5.7.3.2.2-1)
Mn= 314.92 ft kip

εt= 0.00629 Tension Controlled (C5.7.2.1)

ϕ = 0.9

Mr = ϕ*Mn = 283.43 ft kip

Development Length & Transfer Length (5.11.4)

ld>=κ*(fps-2/3fpe)*db (5.11.4.2-1)

fpe = fjack-ΔfpT

fpe = 160.29 ksi
κ = 1.0
ld = 83.24 inches

ltransfer = 60*db = 36 inches

fpx=fpe*lpx / 60*db (5.11.4.2-2)

fpx=fpe+ (lpx-60db) / (ld-60db) * (fps-fpe) (5.11.4.2-3)

lpx= 46 inches
fpx= 178.34 ksi

for prestress only:
Aps*fps=.85*f'c*b*a

a~= 0.9222 inches
Ttopstrand = 39.38 ksi

Mn=Aps*fps*(dp-a/2)
Mn = 254.87 ft kip
assume compression control => Φ = .75

Mr = 191.16 ft kip

for prestress + mild reinforcing:
As*fs + Aps*fps=.85*f'c*b*a
Mild bar size = # 6 fy= 60 ksi
bar spacing = 8 inches
As = 5.28 in^2
a~= 2.5250 inches
Ttopstrand = 0.00 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)
Mn = 315.53 ft kip
εt= 0.00351 Compression Controlled (C5.7.2.1)
Φ = 0.75

Interaction Formula
Pu/ΦPn + Mu/ΦMn <=1.0

Mu<=ΦMn(1.0-Pu/ΦPn)

Φinteraction = (1.0-Pu/ΦPn)

Pu=T= 7.38 k/ft (Impact Tension)
ΦPn= 168.12 k/ft

Φinteraction = 0.956

Mr = Φ*Φinteraction*Mn

Mr = 226.26 ft kip

Stress Checks @ Release

Compressive Stress

Compressive Limit = .6*f'ci = 3 ksi

Blockouts

# of blockouts =	4	
blockout width =	10	inches
Ag =	723.375	in^2
Anet =	403.375	in^2

f=P/A

fconc-g =	1.61	ksi
fconcnet =	2.88	ksi
	Okay	

Tension Stress

Tension Limit = .24*sqrt(f'ci) = -0.537 ksi

$f_{top} = Pt/A + (Pt^*e/I)^*y + M_g^*y/I$

Pt=.7 * fu * Astrand =	1148.36	k
Mg=Wself * (L^2) / 8 =	253.39	ft-k
e =	-0.05	inches
y =	4.05	inches

ftop =	4.70	ksi
	Okay	

Stress Checks @ Service

Stress in Strand

Total Losses = 42.21 ksi

fpe=	160.29	ksi
.8fpy=	194.4	ksi
fpe<=.8fpy?	Okay	(Table 5.9.3-1)

Stress Checks @ Service (cont.)

Concrete Stress in Positive Moment Area (Interior Spans)

Mslab (+) = Mslab (-) =	3.336	ft kip/ft
Mdc2 =	0	ft kip/ft
Mdw (+) = Mdw (-) =	1.234	ft kip/ft
MLL+ =	83.60	ft kip for 8 foot panel
MLL- =	77.40	ft kip for 8 foot panel

Compression Stress

f_{top} = Pe/A + Mslab/Stop + (Mdc + Mdw + MLL)/Stopc

fmax = .6 f'c =	4.32	ksi	transient loads	(Table 5.9.4.2.1-1)
f_{top} =	3.10	ksi		
ftop<=fmax?	Okay			
fmax = .45 f'c =	3.24	ksi	permanent loads	(Table 5.9.4.2.1-1)
f_{top} =	1.80	ksi		
ftop<=fmax?	Okay			
fmax = .40 f'c =	2.88	ksi	LL + 1/2DL	(Table 5.9.4.2.1-1)
f_{top} =	2.20	ksi		
ftop<=fmax?	Okay			

Tension Stress

f_{bottom} = Pe/A + Mslab/Sbott + (Mdc + Mdw + MLL)/Sbott

fbottom =	-0.138	ksi	
Tension Limit = .19*sqrt(f'c) =	-0.510	ksi	(Table 5.9.4.2.2-1)
fbottom<=fmax?	Okay		

Concrete Stress in Negative Moment Area (Interior Spans)

Compression Stress

f_{bottom} = Pe/A + Mslab/Sbot + (Mdc + Mdw + MLL)/Sbotc

fmax = .6 f'c =	4.32	ksi	transient loads	(Table 5.9.4.2.1-1)
f_{bottom} =	2.99	ksi		
fbottom<=fmax?	Okay			
fmax = .45 f'c =	3.24	ksi	permanent loads	(Table 5.9.4.2.1-1)
f_{bottom} =	1.79	ksi		
ftop<=fmax?	Okay			
fmax = .40 f'c =	2.88	ksi	LL + 1/2DL	(Table 5.9.4.2.1-1)
f_{bottom} =	2.74	ksi		
fbottom<=fmax?	Okay			

Tension Stress

f_{top} = Pe/A + Mslab/Stop + (Mdc + Mdw + MLL)/Stop

ftop =	-0.068	ksi	
Tension Limit = .19*sqrt(f'c) =	-0.510	ksi	(Table 5.9.4.2.2-1)
ftop<=fmax?	Okay		

Concrete Stress in Negative Moment Area (Overhang)

Overhang Length =	9.01	ft
Distance to Start of Precast Slab =	6.00	Inches
Support Girder Flange Width =	28.00	Inches
Distance to Barrier Center of Mass =	1.54	ft
width of barrier =	1.81	ft
Wt of Barrier =	0.485	k/ft
Asphalt Thickness =	3.00	inches
Asphalt Weight =	12.22	lb/sf/inch asphalt
Live Load =	1.00	k/lf (Input live load)

Mslab (-) =	3.39	ft kip/ft	moment at 9.33 inches from support
Mdc2 (barrier) (-) =	3.24	ft kip/ft	moment at 9.33 inches from support
Mdw (-) =	0.76	ft kip/ft	moment at 9.33 inches from support
MLL- =	5.42	ft kip/ft	moment at 9.33 inches from support

Compression Stress

f_{bottom} = Pe/A + Mslab/Sbot + (Mdc + Mdw + MLL)/Sbotc

fmax = .6 f'c =	4.32	ksi	transient loads (DL+LL)	(Table 5.9.4.2.1-1)
f_{bottom} =	2.73	ksi		
fbottom<=fmax?	Okay			
fmax = .45 f'c =	3.24	ksi	permanent loads (DL)	(Table 5.9.4.2.1-1)
f_{bottom} =	2.05	ksi		
ftop<=fmax?	Okay			
fmax = .40 f'c =	2.88	ksi	LL + 1/2DL	(Table 5.9.4.2.1-1)
f_{bottom} =	1.70	ksi		
fbottom<=fmax?	Okay			

Tension Stress

f_{top} = Pe/A + Mslab/Stop + (Mdc + Mdw + MLL)/Stop

ftop =	0.396	ksi	
Tension Limit = .19*sqrt(f'c) =	-0.510	ksi	(Table 5.9.4.2.2-1)
ftop<=fmax?	Okay		

Strength Checks

Interior Spans

STRENGTH I

Mu=1.25DC+1.5DW+1.75(LL+IM)

Mupositive = 231.05 ft kip
Munegative = 217.48 ft kip
Mr = Φ*Mn = 283.43 ft kip

Okay

SERVICE I

Mu=DC+DW+(LL+IM)

Mupositive = 141.07 ft kip
Munegative = 133.31 ft kip

Overhang

STRENGTH I

Mu=1.25DC+1.5DW+1.75(LL+IM)

Munegative = 170.30 ft kip

Development Length & Transfer Length (5.11.4)

ld = 83.24 inches
ltransfer = 60*db = 36 inches

distance from face of barrier = 6.42 ft (distance is > development length -> Full Strength)
lpx= 92.79 inches This is greater than ld, use a smaller value
fpx= 245.59 ksi

for prestress only:

Aps*fps=.85*f'c*b*a

a~= 1.2699 inches
Ttopstrand = 29.24 ksi

Mn=Aps*fps*(dp-a/2)

Mn = 314.92 ft kip
Ɛt= 0.01321 Tension Controlled (C5.7.2.1)
Φ = 0.9

Mr = 283.43 ft kip

Okay

for prestress + mild reinforcing:

As*fs + Aps*fps=.85*f'c*b*a

Mild bar size = # 6 fy= 60 ksi
bar spacing = 8 inches
As = 5.28 in^2
a~= 3.4770 inches
Ttopstrand = 0.00 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)

Mn = 348.91 ft kip
Ɛt= 0.00083 Compression Controlled (C5.7.2.1)
Φ = 0.75

Mr = Φ*Mn = 261.68 ft kip

Okay

SERVICE I

Mu=DC+DW+(LL+IM)

$M_{u\,negative}$ = 113.34 ft kip

EXTREME EVENT II (Case 1) Transverse & Longitudinal Force

T= 7.38 kip (see interaction calc. above)

Mcbase= 23.3 ft kip/ft

distance from face of barrier = 6.42 ft (distance is > development length -> Full Strength)

Mslab (-) = 3.39 ft kip/ft

Mdc2 (barrier) (-) = 3.24 ft kip/ft

Mdw (-) = 0.76 ft kip/ft

M_{LL-} = 5.42 ft kip/ft

Mu=1.0DC+1.0DW+0.5(LL+IM)+Mcbase(min)

$M_{u\,negative}$ = 272.62 ft kip

Development Length & Transfer Length (5.11.4)

ld = 83.24 inches

$l_{transfer}$ = 60*db = 36 inches

lpx= 92.79 inches This is greater than ld, use a smaller value

fpx= 245.59 ksi

for prestress only:

Aps*fps=.85*f'c*b*a

a~= 1.2699 inches

$T_{topstrand}$ = 29.24 ksi

Mn=Aps*fps*(dp-a/2)

Mn = 314.92 ft kip

ε_t= 0.01321 Tension Controlled (C5.7.2.1)

ϕ = 0.9

$\phi_{interaction}$ = 0.963

Mr = ϕ*$\phi_{interaction}$*Mn

Mr = 273.06 ft kip

Okay

for prestress + mild reinforcing:

As*fs + Aps*fps=.85*f'c*b*a

Mild bar size = # 6 fy= 60 ksi

bar spacing = 8 inches

As = 5.28 in^2

a~= 3.4770 inches

$T_{topstrand}$ = 0.00 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)

Mn = 348.91 ft kip

ε_t= 0.00083 Compression Controlled (C5.7.2.1)

ϕ = 0.75

$\phi_{interaction}$ = 0.956

Mr = ϕ*$\phi_{interaction}$*Mn

Mr = 250.20 ft kip

[illegible]

EXTREME EVENT II (Case 1) Transverse & Longitudinal Force

distance from face of barrier = 0.00 ft (distance is < development length -> Partial Strength)

Mslab (-) = 0.16 ft kip/ft
Mdc2 (barrier) (-) = 0.13 ft kip/ft
Mdw (-) = 0.00 ft kip/ft
MLL- = 0.00 ft kip/ft

Mu=1.0DC+1.0DW+0.5(LL+IM)+Mcbase(min)
Munegative = 188.74 ft kip

Development Length & Transfer Length (5.11.4)

ld = 83.24 inches
ltransfer = 60*db = 36 inches

lpx= 15.71 inches
fpx= 69.94 ksi

for prestress only:

Aps*fps=.85*f'c*b*a

a~= 0.3616 inches
Ttopstrand = 24.00 ksi

Mn=Aps*fps*(dp-a/2)
Mn = 110.60 ft kip
εt= 0.06223 Tension Controlled (C5.7.2.1)
ϕ = 0.9

ϕinteraction = 0.963

Mr = ϕ*ϕinteraction*Mn

Mr = 95.90 ft kip

[redacted]

for prestress + mild reinforcing:

As*fs + Aps*fps=.85*f'c*b*a
Mild bar size = # 6 fy= 60 ksi
bar spacing = 8 inches
As = 5.28 in^2
a~= 0.9902 inches
Ttopstrand = 14.18 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)
Mn = 234.07 ft kip
εt= 0.01873 Tension Controlled (C5.7.2.1)
ϕ = 0.9

ϕinteraction = 0.963

Mr = ϕ*ϕinteraction*Mn

Mr = 202.96 ft kip

Okay

EXTREME EVENT II (Case 1) Transverse & Longitudinal Force

distance from face of barrier = 1.67 ft (distance is < development length -> Partial Strength)

Mslab (-) = 0.61 ft kip/ft
Mdc2 (barrier) (-) = 0.94 ft kip/ft
Mdw (-) = 0.05 ft kip/ft
M_{LL-} = 0.67 ft kip/ft

Mu=1.0DC+1.0DW+0.5(LL+IM)+Mcbase(min)
$M_{u\,negative}$ = 202.51 ft kip

Development Length & Transfer Length (5.11.4)

ld = 83.24 inches
$l_{transfer}$ = 60*db = 36 inches

lpx= 35.75 inches
fpx= 159.16 ksi

for prestress only:
Aps*fps=.85*f'c*b*a

a~= 0.8230 inches
$T_{topstrand}$ = 39.10 ksi

Mn=Aps*fps*(dp-a/2)
Mn = 231.79 ft kip
ε_t= 0.02381 Tension Controlled (C5.7.2.1)
ϕ = 0.9

$\phi_{interaction}$ = 0.963
Mr = ϕ*$\phi_{interaction}$*Mn

Mr = 200.98 ft kip
[redacted]

for prestress + mild reinforcing:
As*fs + Aps*fps=.85*f'c*b*a
Mild bar size = # 6 fy= 60 ksi
bar spacing = 8 inches
As = 5.28 in^2
a~= 2.2534 inches
$T_{topstrand}$ = 0.00 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)
Mn = 303.04 ft kip 118.75474
ε_t= 0.00470 Compression Controlled (C5.7.2.1)
ϕ = 0.75

$\phi_{interaction}$ = 0.956
Mr = ϕ*$\phi_{interaction}$*Mn

Mr = 217.30 ft kip
Okay
Areqd/Aprov ~ Mreqd/Mprov = 0.93

EXTREME EVENT II (Case 1) Transverse & Longitudinal Force

distance from face of barrier = 1.75 ft (distance is < development length -> Partial Strength)

Mslab (-) =	0.63	ft kip/ft
Mdc2 (barrier) (-) =	0.98	ft kip/ft
Mdw (-) =	0.06	ft kip/ft
M_{LL-} =	0.75	ft kip/ft

Mu=1.0DC+1.0DW+0.5(LL+IM)+Mcbase(min)

$Mu_{negative}$ = 203.48 ft kip

Development Length & Transfer Length (5.11.4)

ld =	83.24	inches
$l_{transfer}$ = 60*db =	36	inches
lpx=	36.71	inches
fpx=	161.57	ksi

for prestress only:

Aps*fps=.85*f'c*b*a

a~=	0.8354	inches
$T_{topstrand}$ =	39.20	ksi

Mn=Aps*fps*(dp-a/2)

Mn = 234.74 ft kip

ε_t= 0.02336 Tension Controlled (C5.7.2.1)

ϕ = 0.9

$\phi_{interaction}$ = 0.963

Mr = ϕ*$\phi_{interaction}$*Mn

Mr = 203.54 ft kip

Okay

for prestress + mild reinforcing:

As*fs + Aps*fps=.85*f'c*b*a

Mild bar size = # 6 fy= 60 ksi

bar spacing =	8	inches
As =	5.28	in^2
a~=	2.2874	inches
$T_{topstrand}$ =	0.00	ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)

Mn = 304.67 ft kip

ε_t= 0.00453 Compression Controlled (C5.7.2.1)

ϕ = 0.75

$\phi_{interaction}$ = 0.956

Mr = ϕ*$\phi_{interaction}$*Mn

Mr = 218.47 ft kip

Okay

EXTREME EVENT II (Case 2) Vertical Force

Mimpactvertical= 7.03 ft kip/ft

distance from face of barrier = 6.42 ft (distance is > development length -> Full Strength)

Mslab (-) = 3.39 ft kip/ft
Mdc2 (barrier) (-) = 3.24 ft kip/ft
Mdw (-) = 0.76 ft kip/ft
MLL- = 5.42 ft kip/ft

Mu=1.0DC+1.0DW+0.5(LL+IM)+Mimpactvertical
Munegative = 142.46 ft kip

Development Length & Transfer Length (5.11.4)

ld = 83.24 inches
ltransfer = 60*db = 36 inches

lpx= 92.79 inches This is greater than ld, use a smaller value
fpx= 245.59 ksi

for prestress only:
Aps*fps=.85*f'c*b*a

a~= 1.2699 inches
Ttopstrand = 29.24 ksi

Mn=Aps*fps*(dp-a/2)
Mn = 314.92 ft kip
εt= 0.01321 Tension Controlled (C5.7.2.1)
ϕ = 0.9

ϕinteraction = 0.963

Mr = ϕ*ϕinteraction*Mn

Mr = 273.06 ft kip

Okay

for prestress + mild reinforcing:
As*fs + Aps*fps=.85*f'c*b*a
Mild bar size = # 6 fy= 60 ksi
bar spacing = 8 inches
As = 5.28 in^2
a~= 3.4770 inches
Ttopstrand = 0.00 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)
Mn = 348.91 ft kip
εt= 0.00083 Compression Controlled (C5.7.2.1)
ϕ = 0.75

ϕinteraction = 0.956

Mr = ϕ*ϕinteraction*Mn

Mr = 250.20 ft kip

Okay

Concrete Stress in Negative Moment Area (Interior Overhang)

Overhang Length =	4.77	ft
Distance to Start of Precast Slab =	0.00	Inches
Support Girder Flange Width =	28.00	Inches
Distance to Barrier Center of Mass =	0.00	ft
width of barrier =	0.00	ft
Wt of Barrier =	0.000	k/ft
Asphalt Thickness =	3.00	inches
Asphalt Weight =	12.22	lb/sf/inch asphalt
Live Load =	4.16	k/lf (Input live load) 3.91

3.91 = 50k * 1.33 / 2/8

50 k * 1.33 / 2 / 8'

3.91?

Mslab (-) =	0.80	ft kip/ft	moment at 9.33 inches from support
Mdc2 (barrier) (-) =	0.00	ft kip/ft	moment at 9.33 inches from support
Mdw (-) =	0.29	ft kip/ft	moment at 9.33 inches from support
M_{LL}- =	12.46	ft kip/ft	moment at 9.33 inches from support

Compression Stress

$f_{bottom} = Pe/A + Mslab/S_{bot} + (M_{dc} + M_{dw} + M_{LL})/S_{botc}$

fmax = .6 f'c =	4.32 ksi	transient loads (DL+LL)	(Table 5.9.4.2.1-1)
f_{bottom} =	3.00 ksi		
fbottom<=fmax?	Okay		
fmax = .45 f'c =	3.24 ksi	permanent loads (DL)	(Table 5.9.4.2.1-1)
f_{bottom} =	1.45 ksi		
ftop<=fmax?	Okay		
fmax = .40 f'c =	2.88 ksi	LL + 1/2DL	(Table 5.9.4.2.1-1)
f_{bottom} =	2.28 ksi		
fbottom<=fmax?	Okay		

Tension Stress

$f_{top} = Pe/A + Mslab/S_{top} + (M_{dc} + M_{dw} + M_{LL})/S_{top}$

f_{top} =	-0.003 ksi	
Tension Limit = .19*sqrt(f'c) =	-0.510 ksi	(Table 5.9.4.2.2-1)
ftop<=fmax?	Okay	

Strength Checks

Interior Overhang

STRENGTH I

Mu=1.25DC+1.5DW+1.75(LL+IM)

Munegative = 229.47 ft kip

Development Length & Transfer Length (5.11.4)

ld = 83.24 inches

ltransfer = 60*db = 36 inches

distance from edge of slab = 4.00 ft (distance is < development length -> Partial Strength)

lpx= 47.96 inches

fpx= 181.89 ksi

for prestress only:

Aps*fps=.85*f'c*b*a

a~= 0.9405 inches

Ttopstrand = 39.29 ksi

Mn=Aps*fps*(dp-a/2)

Mn = 259.02 ft kip

εt= 0.02005 Tension Controlled (C5.7.2.1)

ϕ = 0.9

Mr = 233.12 ft kip

Okay

for prestress + mild reinforcing:

As*fs + Aps*fps=.85*f'c*b*a

Mild bar size = # 4 fy= 60 ksi

bar spacing = 24 inches

As = 0.8 in^2

a~= 1.1882 inches

Ttopstrand = 26.43 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)

Mn = 267.15 ft kip

εt= 0.01456 Tension Controlled (C5.7.2.1)

ϕ = 0.9

Mr = ϕ*Mn = 240.44 ft kip

Okay

SERVICE I

Mu=DC+DW+(LL+IM)

Munegative = 133.29 ft kip

Strength per Power Stress-Strain Formula Method

fpe = 160.29 ksi strand depth = 2.3 inches

Aps1*fps1 + Aps2*fps2=.85*f'c*b*a

Assume: Note: Iterate Until Stresses Match

(bottom) fps1 = 229.1 ksi Stress Match Okay

(top) fps2 = 144.7 ksi Stress Match Okay

a = 1.93288

$c=a/\beta$ = 2.80127 [redacted]

fps=εp * [887+27613 / {1+(112.4*εp)^7.36}^1/7.36] (Devalapura & Tadros)

Bottom Layer:

εp = .003*((dp-c)/c) + (fpe/Eps)

εp = 0.00873

fps = 229.13 ksi

Top Layer:

εp = .003*((dp-c)/c) + (fpe/Eps)

εp = 0.00509

fps = 144.678 ksi

Mn=Aps*fps(dp-a/2)

Mn= 274.58 ft kip

εt= 0.00873 Tension Controlled

ϕ = 0.9

Mr = ϕ*Mn = 247.13 ft kip

@ 1' from edge

$M_u \approx (25k)(1.33)(1') \, 1.75 \approx 58.2 \text{ ft k}$

$M_r = 64.31 \text{ ft kip}$

$M_u < M_r$ okay

Development Length & Transfer Length (5.11.4)

ld>=κ*(fps-2/3fpe)*db (5.11.4.2-1)

fpe = fjack-ΔfpT

fpe = 160.34 ksi
κ = 1.0
ld = 83.22 inches

ltransfer = 60*db = 36 inches

fpx=fpe*lpx / 60*db (5.11.4.2-2)

fpx=fpe+ (lpx-60db) / (ld-60db) * (fps-fpe) (5.11.4.2-3)

lpx= 12 inches
fpx= 53.45 ksi

for prestress only:

Aps*fps=.85*f'c*b*a

a~= 0.2764 inches
Ttopstrand = 19.16 ksi

Mn=Aps*fps*(dp-a/2)
Mn = 85.74 ft kip

assume compression control => ϕ = .75

Mr = 64.31 ft kip

for prestress + mild reinforcing:

As*fs + Aps*fps=.85*f'c*b*a

Mild bar size = # 5 fy= 60 ksi
bar spacing = 24 inches
As = 1.24 in^2
a~= 0.3892 inches
Ttopstrand = 18.07 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)
Mn = 114.46 ft kip
εt= 0.05738 Tension Controlled (C5.7.2.1)
ϕ = 0.9

Interaction Formula

Pu/ϕPn + Mu/ϕMn <=1.0

Mu<=ϕMn(1.0-Pu/ϕPn)

ϕinteraction = (1.0-Pu/ϕPn)

Pu=T= 7.38 k/ft (Impact Tension)
ϕPn= 173.56 k/ft

ϕinteraction = 0.957

Mr = ϕ*ϕinteraction*Mn

Mr = 98.63 ft kip

Strength per Power Stress-Strain Formula Method

fpe = 160.29 ksi strand depth = 2.3 inches

Aps1*fps1 + Aps2*fps2=.85*f'c*b*a

Assume:

(bottom) fps1 = 229.1 ksi

(top) fps2 = 144.7 ksi

Note: Iterate Until Stresses Match

Stress Match Okay

Stress Match Okay

a = 1.93288

$c=a/\beta$ = 2.80127 [redacted]

fps=ε_p * [887+27613 / {1+(112.4*ε_p)^7.36}^1/7.36] (Devalapura & Tadros)

Bottom Layer:

ε_p = .003*((dp-c)/c) + (fpe/Eps)

ε_p = 0.00873

fps = 229.13 ksi

Top Layer:

ε_p = .003*((dp-c)/c) + (fpe/Eps)

ε_p = 0.00509

fps = 144.678 ksi

Mn=Aps*fps(dp-a/2)

Mn= 274.58 ft kip

ε_t= 0.00873 Tension Controlled

ϕ = 0.9

Mr = ϕ*Mn = 247.13 ft kip

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

SHEAR STRENGTH

$$v_u = \frac{|V_u - \phi V_p|}{\phi\, b_v\, d_v} \qquad (5.8.2.9\text{-}1)$$

$\phi = .9$ for normal weight concrete (5.5.4.2.1)

$b_v \approx 96''$ (no transverse ducts)

$d_v \geq .9\ d_e$

$$d_e = \frac{A_{ps} f_{ps} d_p + A_s f_y d_s}{A_{ps} f_{ps} + A_s f_y} \qquad (5.8.2.9\text{-}2)$$

$$d_e = \frac{(3.038)(245.59)(8''\text{-}2''\text{-}.3) + (5.28\,in^2)(60)(8''\text{-}2''\text{-}.75/2)}{3.038\,(245.59) + 5.28(60)}$$

$d_e = 5.68$

$d_v \geq .9 d_e = .9(5.68) = 5.11''$

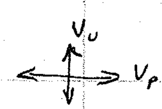
$d_v \geq .72 h = .72(8) = 5.76''$ controls

$$d_v = \frac{M_n}{A_s f_y + A_{ps} f_{ps}} \qquad (C5.8.2.9\text{-}1)$$

$$d_v = \frac{314.92(12)}{(5.28)(60) + 3.038(245.59)}$$

$d_v = 3.56''$

$V_p = 0$ (zero)



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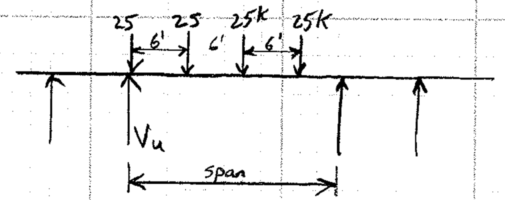
DESIGN COMPUTATIONS (Grid)

SHEAR STRENGTH



$$Span = 17.927' / \sin(skew) = \frac{17.927'}{\sin 56} = 21.62'$$

$$V_u = 25k + \frac{(25)(21.62-6')}{21.62} + \frac{25(21.62-12')}{21.62} + \frac{25(21.62-18')}{21.62}$$

$$V \approx 58.37\ K$$

$$V_u = 1.75(58.37)(1.25) = 127.69$$

$$v_u = \frac{(127.69\ k - 0)}{.9\ (96)\ (5.76'')} \qquad (5.8.2.9-1)$$

$$v_u \approx .257\ ksi$$

$$.125 f'_c = .125(7.2) \approx .9\ ksi$$

$$v_u \le .125\ f'_c$$

$$S_{max} = .8\ d_v \le 24.0\ in \qquad (5.8.2.7-1)$$

$$S_{max} = .8\ (5.76) = 4.608''\ in$$

$$A_v \ge .0316 \sqrt{f'_c}\ \frac{b_v S}{f_y} \qquad (5.8.2.5-1)$$

$$A_v \ge .0316\sqrt{7.2}\ \frac{(96)(4'')}{60}$$

$$A_v \ge .5427''\ in^2$$

$\#5 \Rightarrow .31\ in^2$

$A = (2)(.31) = .62\ in^2$

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COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

Shear Strength

$V_n = V_c + V_s + V_p$ (5.8.3.3-1)

$V_n = .25 f'_c b_v d_v + V_p$ (5.8.3.3-2)

$V_c = .0316 \beta \sqrt{f'_c} b_v d_v$ (5.8.3.3-3)

$\beta = \dfrac{4.8}{(1 + 750 \varepsilon_s)}$ (5.8.3.4.2-1)

$\varepsilon_s = \dfrac{\left(\left|\frac{M_u}{d_v}\right| + .5 N_u + |V_u - V_p| - A_{ps} f_{po}\right)}{E_s A_s + E_p A_{ps}}$ (5.8.3.4.2-4)

$M_u \approx 169.31$ ft k (neg moment @ girder support)

$N_u = 0$

$V_u \approx 127.69$

$V_p = 0$

$f_{po} \approx .7 f_{pu} = .7(270) = 189$ ksi

$A_s = 5.28 \text{ in}^2$

$A_{ps} = 3.038 \text{ in}^2$

$\varepsilon_s = \dfrac{\frac{(169.31)(12)}{5.76} + 0 + 127.69k - 3.038\,(189 \text{ ksi})}{28500(3.038)}$

$\varepsilon_s \approx -.001$

$\beta = \dfrac{4.8}{1 + 750(-.001)} = 25.56$

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SHEAR STRENGTH

$V_c = .0316\,(25.56)\sqrt{7.2}\,(96)\,(5.76)$ (5.8.3.3-3)

$V_c = \underline{1198.3 \text{ Kip}}$

$V_u > .5\,\phi(V_c + V_p)$ (5.8.2.4-1)

$.5\,(.9)\,(1198.3 + 0)$

$= 539.2\ K$

$V_u = 127.69\ k$

$V_u \le .5\,\phi(V_c + V_p)$ Requirement doesn't apply to slabs

Transverse Reinforcement NOT REQUIRED

$V_u < V_c$ ✓ okay

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid) SHEAR STRENGTH

with less than Minimum Transverse Reinforcement

$$S_{xe} = S_x \left(\frac{1.38}{a_g + .63} \right) \qquad (B5.2-4)$$

$a_g \approx .5"$

$S_x = 8" - 2" - .3 - 2" - .3 \approx 3.4"$

$S_{xe} = 3.4 \left(\frac{1.38}{.5 + .63} \right) \approx 4.15" \leq 5"$

(Table B5.2-2)

$\beta \approx 26°$

$$\varepsilon_x = \frac{\frac{169.31(12)}{5.76} + 0 + .5(127.69)\cot(26) - 3.038(189)}{2(28500(3.038) + 96(4")4883.57)}$$

$\varepsilon_x \approx -.000023 \qquad .023 \times \frac{1}{1000}$

$\beta_{min} \approx 5.15 \qquad \beta_{max} = 5.56$

$avg \approx 5.35$

$V_c \approx .0316(5.35)\sqrt{7.2}\,(96)\,5.76$

$V_c = 250.84\ K$

(5.8.2.4-1)

$V_u \overset{?}{>} .5\phi(V_c + V_p) = (.5)(.9)(250.84) \approx 112.88\ K$

$V_u \approx 127.69\ K$

$V_u \leq .5\phi(V_c + V_p)$ requirement doesn't apply to slabs

$V_u < V_c$ ✓ okay

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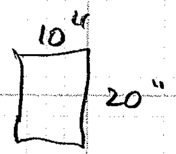
DESIGN COMPUTATIONS (Grid)

SHEAR STRENGTH

PUNCHING SHEAR



$$V_n = \left(.063 + \frac{.126}{\beta_c}\right)\sqrt{f'_c}\, b_o\, d_v \leq .126\sqrt{f'_c}\, b_o\, d_v \qquad (5.13.3.6.3\text{-}1)$$

$$\beta_c = \frac{20''}{10''} = 2$$

$$V_n = .126\sqrt{7.2}\,(60'')\ 5.76''$$

$$V_n \approx 116.8 \text{ kip}$$

$$V_r = .9\, V_n = 105.2 \text{ K}$$

$$V_u = (25\text{ K})(1.75) = 43.75 \text{ K} < V_R \quad \checkmark \quad \text{okay}$$

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distribution steel - deck panels

tension in concrete ≈ 68 psi (negative moment region)
138 psi (positive moment region)

$$S = \frac{700\,\gamma_e}{\beta_s f_{ss}} - 2d_c \qquad (5.7.3.4\text{-}1)$$

$$\beta_s = 1 + \frac{d_c}{.7(h - d_c)} = 1 + \frac{2}{.7(8-2)} \approx 1.476$$

$d_c = 2''$
$h = 8''$

assume $\gamma_e = .75$ (Class 2 exposure ⇒ concern for corrosion)

$$f_{ss} \approx n f_c \approx \frac{28500}{4883.57}(.138\text{ ksi}) \approx .81\text{ ksi}$$

$$S = \frac{700(.75)}{(1.476)(.81)} - 2(2)$$

$S = 435''$

prestressing & posttensioning reduces need for distribution steel

for 60 ksi steel @ yield

$$S = \frac{700(.75)}{1.476(60)} - 2(2) = 1.93''$$

Mild steel Spacing

$$S \leq \frac{700\, \gamma_e}{\beta_s f_{ss}} - 2 d_c \qquad (5.7.3.4\text{-}1)$$

$$\beta_s = 1 + \frac{d_c}{.7(h - d_c)} = 1 + \frac{2}{.7(8 - 1.6875)} \approx 1.453$$

$\gamma_e = .75$

$d_c = 1.375'' + .625/2 = 1.6875''$

$f_{ss} \approx 1.130$ Ksi (deck stress @ negative moment region)

$h = 8''$

$$S \leq \frac{700(.75)}{(1.453)(.130\text{ ksi})} - 2(2) \approx 2775 \text{ in}$$

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#6 development length (extra steel for impact loads)

$f'_c = 7.2$ ksi

$\ell_{db} = .4\, d_b f_y = 18"$

epoxy

$\ell_h = (1.2)(18") = 21.6"$

$M_u = 202.5$

$M_{r\ prestress} \approx .75(184.3) \approx 138.2$ ft kip

$M_{r\ reqd\ steel} = 202.5 - 138.2 \approx 64.3$ ft k

$M_{r\ provided} = .75(118.7) \approx 89$

$\frac{A_{reqd}}{A_{provid}} \approx \frac{M_{reqd}}{M_{provid}} = \frac{64.3}{89} \approx .72$

$\ell_h = 15.6"$ min

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PRETENSIONED ANCHORAGE ZONES

$P_r = f_s A_s$ (5.10.10.1-1)

$f_{s_{max}} = 20$ ksi

> #3 @ 6" per 5.10.10.2

$h = 96"$

$h/4 = 24$ in

$P_R > .04\,(.75)\,P_u\,A_{ps}$ per 5.10.10.1

use 1 side

$P_R > .04\,(.75)(270)\ 14\ \text{strand}\left(\frac{.217\ \text{in}^2}{\text{strand}}\right)$ 5.10.10.1

$P_R > 24.61$ K

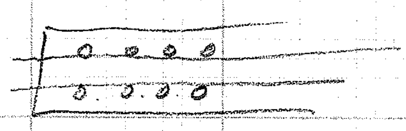
$A_{s_{min}} = \frac{7.03\ \text{K}}{20\ \text{ksi}} = 1.23\ \text{in}^2$ in $h/4$ (24")

Spacing $\leq$ 6"

#5 = .31 in²

use 4-#5 @ 6"

$A_s = 1.24\ \text{in}^2$



spiral not needed but wouldn't hurt

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

DECK DESIGN - CLOSURE POUR

FROM SAP 2000

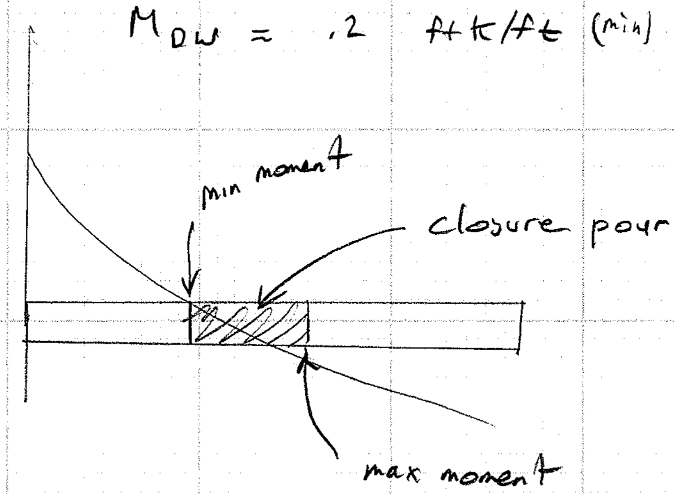
M_{LIVE} = 20.76 ftk (min.) 70.28 ft k (max)
32.1 ft k (min.) 51.42 ftk (max)

can neglect this for CIP

continuous slab

M_{DEAD} ≈ 3.98 ftk for 8' slab ≈ .5 ft k/ft
10.62 ftk for 8' slab ≈ 1.33 ftk/ft

M_{DW} = .2 ftk/ft (min) .51 ftk/ft/max



Per Table 4.6.2.1.3-1

Strip Width ≈ 26 + 6.6 S +M
48 + 3.0 S −M

S = 17.93'

strip width = 26 + 6.6 (17.93')
= 144.34" ≈ 12.028'

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Maximum @ closure pour

$M_u = 1.25\ Dead + 1.75\ Live + 1.5\ DW$

$= \cancel{0} + 1.75\left(\frac{70.28}{12.028}\right) + 1.5\,(.51)$

$M_u \approx 10.99$ ft k/ft (max)

Minimum @ closure pour

$M_u = \cancel{1.25}\,0\,(.5) + 1.75\left(\frac{20.76}{12.028}\right) + 1.5\,(.2)$

$M_u \approx 3.32$ ft k/ ft (min).

average $\approx$ 7.16 ft k/ ft

space for 12 bars in 8' slab

average spacing $\approx$ 8"

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REINFORCING DESIGN

GIVEN:

fy= 60.00 ksi
f'c= 4.50 ksi
COVER= 2.00 inches
$\Phi_{flexure}$= 0.90
Beam Thickness (t_s)= 8.00 inches
b= 12.00 inches
bar diameter= 0.625 inches

CLOSURE POUR

LOAD TYPE	M_{hTOT}
	ft-K
Mh (UNFACTORED)	6.35
STRENGTH I	10.99
SERVICE I	6.35

ASreq'd
in^2
0.26
0.45
0.26

#5

d_s= 5.69 inches
per 5.10.8.2 AS_{temp}= 0.14 sq inches

Use # 5 at top face min. spacing = 8.21 inches
use spacing= 8.00 inches
As= 0.465 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 12.52 ft-K
M_r= 11.27 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)
c= 0.74 inches
d_e=d_s= 5.69 inches (for no prestressing)
c/d_e= 0.13
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2
1.2*$M_{cracking}$= 6.52 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 14.62 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2
Percentage of main reinforcement, 220 / sqrt(S) <= 67%
Girder Spacing = 10.94 ft
Flange Width = 43 inches
Flange Overhang = 18 inches
Effective Length S = 8.86 ft
220 / sqrt(S) = 73.92 % Use **67** % of required main reinforcement
Required As = 0.31 sq inches
Use # 4 transverse reinforcement
min. spacing = 7.70 inches

REINFORCING DESIGN

GIVEN:

fy=	60.00	ksi
f'c=	4.50	ksi
COVER=	2.00	inches
$\Phi_{flexure}$=	0.90	
Beam Thickness (t_s)=	8.00	inches
b=	12.00	inches
bar diameter=	0.750	inches

CLOSURE POUR

LOAD TYPE	M_{hTOT}
	ft-K
M_h (UNFACTORED)	6.35
STRENGTH I	10.99
SERVICE I	6.35

$AS_{req'd}$
in^2
0.26
0.46
0.26

#6

d_s= 5.63 inches
per 5.10.8.2 AS_{temp}= 0.14 sq inches

Use # 6 at top face min. spacing = 11.51 inches
use spacing= 8.00 inches
As= 0.660 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 17.14 ft-K
M_r= 15.43 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 1.05 inches
d_e=d_s= 5.63 inches (for no prestressing)
c/de= 0.19
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*$M_{cracking}$= 6.52 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 14.62 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing =	10.94	ft
Flange Width =	43	inches
Flange Overhang =	18	inches
Effective Length S =	8.86	ft
220 / sqrt(S) =	73.92	%

Use **67** % of required main reinforcement

Required As = 0.44 sq inches
Use # 4 transverse reinforcement
min. spacing = 5.42 inches

REINFORCING DESIGN

GIVEN:

fy= 60.00 ksi
f'c= 4.50 ksi
COVER= 2.00 inches
$\Phi_{flexure}$= 0.90
Beam Thickness (t_s)= 8.00 inches
b= 12.00 inches
bar diameter= 0.875 inches

CLOSURE POUR

LOAD TYPE	M_{hTOT}
	ft-K
M_h (UNFACTORED)	6.35
STRENGTH I	10.99
SERVICE I	6.35

$AS_{req'd}$
in^2
0.26
0.46
0.26

#7

d_s= 5.56 inches
per 5.10.8.2 AS_{temp}= 0.14 sq inches

Use # 7 at top face min. spacing = 15.50 inches
use spacing= 8.00 inches
As= 0.900 sq. inches
compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 22.38 ft-K
M_r= 20.15 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)
c= 1.43 inches
$d_e=d_s$= 5.56 inches (for no prestressing)
c/d_e= 0.26
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2
$1.2*M_{cracking}$= 6.52 ft-K <--- Test 1
$1.33M_{hTOT}$ (max.)= 14.62 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2
Percentage of main reinforcement, 220 / sqrt(S) <= 67%
Girder Spacing = 10.94 ft
Flange Width = 43 inches
Flange Overhang = 18 inches
Effective Length S = 8.86 ft
220 / sqrt(S) = 73.92 % Use **67** % of required main reinforcement
Required As = 0.60 sq inches
Use # 4 transverse reinforcement
min. spacing = 3.98 inches

REINFORCING DESIGN

GIVEN:

fy=	60.00	ksi
f'c=	4.50	ksi
COVER=	2.00	inches
$\Phi_{flexure}$=	0.90	
Beam Thickness (t_s)=	8.00	inches
b=	12.00	inches
bar diameter=	1.000	inches

CLOSURE POUR

LOAD TYPE	M_{hTOT}	$AS_{req'd}$
	ft-K	in^2
M_h (UNFACTORED)	6.35	0.26
STRENGTH I	10.99	0.47
SERVICE I	6.35	0.26

#8

d_s= 5.50 inches
per 5.10.8.2 AS_{temp}= 0.14 sq inches

Use # 8 at top face min. spacing = 20.15 inches
use spacing= 8.00 inches
As= 1.185 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 28.00 ft-K
M_r= 25.20 ft-K

Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 1.88 inches
d_e=d_s= 5.50 inches (for no prestressing)
c/d_e= 0.34

okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*$M_{cracking}$= 6.52 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 14.62 ft-K <--- Test 2

Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing =	10.94	ft
Flange Width =	43	inches
Flange Overhang =	18	inches
Effective Length S =	8.86	ft
220 / sqrt(S) =	73.92	%
Required As =	0.79	sq inches
Use #	4	transverse reinforcement
min. spacing =	3.02	inches

Use **67** % of required main reinforcement

#5 development

$$\frac{1.25\, A_b f_y}{f'_c} = \frac{1.25\,(.31)\,60}{4.5} = 5.17''$$

$$.4\, d_b F_y = .4(.625)\,60 = 15''$$

modification factors

epoxy bar = 1.2

$$\frac{A_{s\,reqd}}{A_{s\,provided}} = \frac{10.99}{11.27} \approx .975$$

ℓ_d (development length) = $15'' * 1.2 * .975 = 17.55''$

class C splice = $1.7\, \ell_d$

increase splice length by 20% for phasing vibration

lap splice = $1.7\,(17.55)\,(1.2)$

$= 35.8''$

use 36" for #5 lap splice

Minimum

use 32" for #6 lap splice

use 28 1/4" for #7 lap splice

use 20" for #8 lap splice

#6 development

$$\frac{1.25\, A_b f_y}{f'_c} = \frac{1.25(.44)(60)}{4.5} = 7.33''$$

$$.4\, d_b F_y = .4(.75)\, 60 = 18''$$

modification factors

epoxy bar 1.2

$$\frac{A_{s\,reqd}}{A_{s\,provided}} \approx \frac{10.99}{15.43} = .71$$

l_d development length = $18'' * 1.2 * .71 = \underline{15.38''}$

#6 hook

$$l_{hb} = \frac{38.0\, d_b}{\sqrt{f'_c}} \approx \frac{38(.75)}{\sqrt{4.5}} = 13.435''$$

modification factors

Cover > 2.5'' .7

$\frac{A_{s\,reqd}}{A_{s\,provided}} \approx .71$

expoxy coated = 1.2

$l_d \approx (13.435)(.7)(.71)\,1.2 \approx \underline{8.02''}$

$l_d \approx 11.5''$ if cover < 2.5''

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

Class C splice = 1.7 ℓ_d

Increase splice length by 20% for phasing vibration

lap splice = 1.7 (15.38") (1.2)

lap splice = 31.4"

use 32" for lap splice

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 85 of ____

7 development

$$\frac{1.25\ A_b f_y}{f'_c} = \frac{1.25\ (.60)\ 60}{4.5} =$$

$$.4\ d_b F_y = .4\ (.875)\ 60 = 21''$$

modification factors

$$epoxy = 1.2$$

$$\frac{A_s\ reqd}{A_s\ provided} \approx \frac{10.99}{20.15} = .545$$

$$l_d = 21'' * 1.2 * .545 = 13.73''$$

class C splice = 1.7 l_d

increase 20% for phasing vibration

lap splice = 1.7 (13.73) 1.2 ≈ 28.04"

use 28 1/4" min for #7 lap splice

8

$$l_{dh} = 24''$$

$$\frac{A_s\ reqd}{A_s\ provided} \approx \frac{10.99}{25.2} \approx .436$$

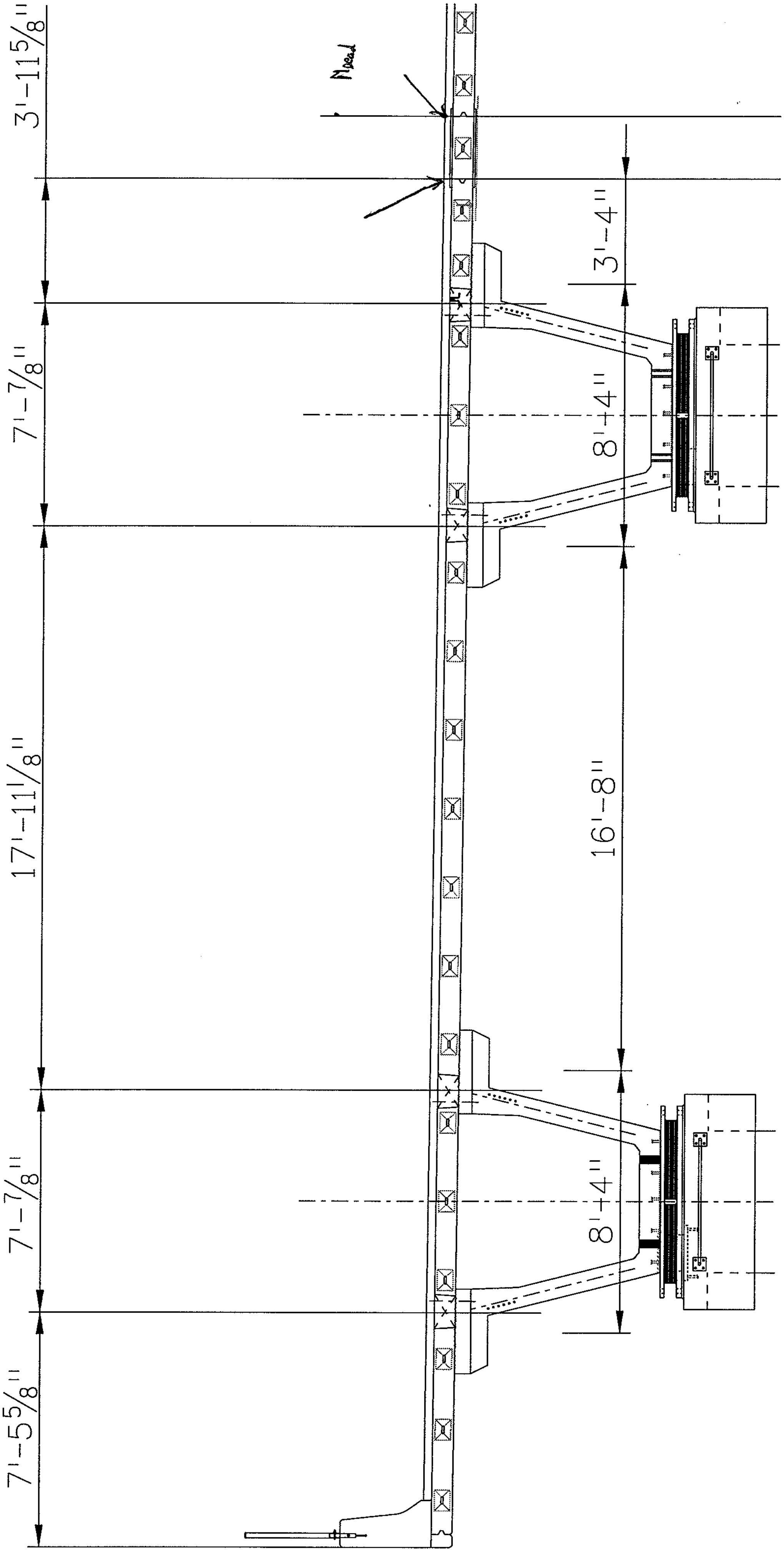
$$l_d = 24'' * 1.2 * .436 = 12.56''$$

Class B splice = 1.3 l_d

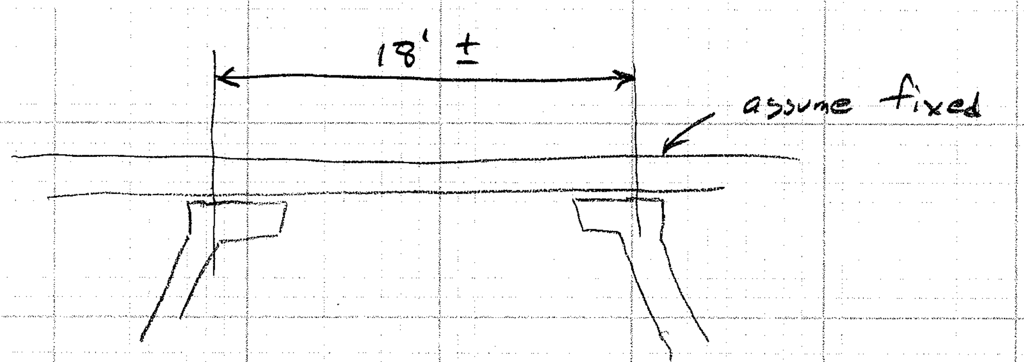
lap splice = 1.3 (12.56) 1.2 ≈ 19.6"

use 20" for #8 lap splice

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 86 of


3'-11 5/8"
7'-7/8"
17'-11 1/8"
7'-7/8"
7'-5 5/8"
3'-4"
8'-4"
16'-8"
8'-4"

DECK JOINTS



LL = .64 K/LF

= .064 K/SF

(assuming 10' lane)

a ≈ 8'

b ≈ 18'

a/b ≈ .44 use 3/8 in table

M_y =

y/b = .5

Coefficient M_y ≈ .0166 midspan .0516 near girder

Moment = (Coefficient) ρ a^2

.05

= .0166 (.064) 8^2

M ≈ .068 Kft (.211 kft near girder)

Worst case spacing of #5 = 18"

capacity > 4 ft K joint is okay for moments about joint

Shear capacity

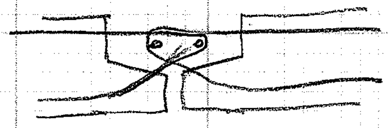
$V_s \approx \frac{A_v f_y d_v}{s} (\cot\theta + \cot\alpha) \sin\alpha = \frac{2(.31)(60)\,6''}{18''} \cot 45°$ (5.8.3.3-4)

V_s = 12.4 K

$V_c \approx .0316 \beta \sqrt{f'_c}\, b_v d_v = (.0316)(2)\sqrt{7.2}\,(18'')(6'') \approx 289.8$ K (5.8.3.3-3)

Joint is good for shear

Post Tensioning is not required. for lane load



$M_{provided}$ by post tensioning ≈ 9.83 ftk / strand

conduit spacing ≈ 2'-6"

⇒ 3.932 ftk/ft / strand

For 16k wheel load, $M_{strength}$ ≈ 6.73 kft/ft (from SAP 14)

$M_{service}$ = 4.54 kft/ft

need minimum 2 strands per conduit for deck loading

need 4 strands per conduit for negative moment

REINFORCING DESIGN

GIVEN:

fy=	60.00	ksi
f'c=	7.00	ksi
COVER=	2.50	inches
$\Phi_{flexure}$=	0.90	
Beam Thickness (t_s)=	8.00	inches
b=	18.00	inches
bar diameter=	0.625	inches

deck joint
mild steel

LOAD TYPE	M_{hTOT}
	ft-K
Mh (UNFACTORED)	4.54
STRENGTH I	6.73
SERVICE I	4.54

$AS_{req'd}$
in^2
0.20
0.29
0.20

d_s= 5.19 inches
per 5.10.8.2 AS_{temp}= 0.22 sq inches

Use # 5 at top face min. spacing = 19.04 inches
use spacing= 18.00 inches
As= 0.310 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

~ 50% of development length

Mn= 7.91 ft-K
Mr= 7.12 ft-K

$M_{R\,actual} \approx 3.5$ ft k

Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 0.25 inches
d_e=d_s= 5.19 inches (for no prestressing)
c/d_e= 0.05

⇒ 2.3 ft k/ft

okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

$1.2{*}M_{cracking}$= 12.19 ft-K <--- Test 1
$1.33M_{hTOT}$ (max.)= 8.95 ft-K <--- Test 2

Needs more reinforcing

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing =	15.25	ft
Flange Width =	21	inches
Flange Overhang =	18	inches
Effective Length S =	15.00	ft
220 / sqrt(S) =	56.80	%
Required As =	0.18	sq inches
Use #	6	transverse reinforcement
min. spacing =	44.97	inches

Use **56.804** % of required main reinforcement

REINFORCING DESIGN

GIVEN:

fy= 183.33 ksi after losses
f'c= 7.20 ksi
COVER= 3.69 inches
$\Phi_{flexure}$= 0.75
Beam Thickness (t_s)= 8.00 inches
b= 30.00 inches
bar diameter= 0.875 inches

POST TENSIONING

Impact Steel

LOAD TYPE	M_{hTOT}
	ft-K
M_h (UNFACTORED)	4.00
STRENGTH I	4.00
SERVICE I	4.00

$AS_{req'd}$
in^2
0.09
0.09
0.09

d_s= 3.88 inches
per 5.10.8.2 AS_{temp}= 0.14 sq inches

Use # 4 at top face min. spacing = 65.81 inches
use spacing= 18.00 inches
As= ~~0.217 sq. inches~~
1 strand
compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 13.11 ft-K
M_r= 9.83 ft-K ⇒ 3.93 ft k/ft
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 0.31 inches
d_e=d_s= 3.88 inches (for no prestressing)
c/d_e= 0.08
okay - member is not overreinforced

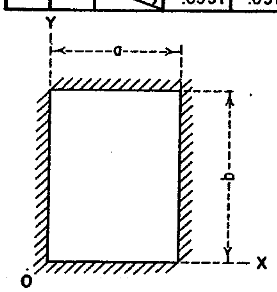
Minimum Reinforcement per 5.7.3.3.2

1.2*$M_{cracking}$= 20.61 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 5.32 ft-K <--- Test 2
Minimum Reinforcing is provided

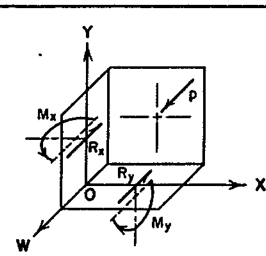
Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%
Girder Spacing = 15.25 ft
Flange Width = 21 inches
Flange Overhang = 18 inches
Effective Length S = 15.00 ft
220 / sqrt(S) = 56.80 % Use **56.804** % of required main reinforcement
Required As = 0.12 sq inches
Use # 6 transverse reinforcement
min. spacing = 107.08 inches

a/b	y/b	R_x \ x/a	M_x 0	M_x 0.05	M_x 0.1	M_x 0.2	M_x 0.3	M_x 0.4	M_x 0.5	M_y 0	M_y 0.05	M_y 0.1	M_y 0.2	M_y 0.3	M_y 0.4	M_y 0.5
a/b = 3/8	0.5	+.5055	+.0830	+.0590	+.0376	+.0024	-.0226	-.0375	-.0424	+.0166	+.0118	+.0074	+.0002	-.0050	-.0082	-.0093
	0.4	+.5068	+.0825	+.0585	+.0371	+.0022	-.0225	-.0372	-.0420	+.0165	+.0117	+.0073	-.0001	-.0055	-.0088	-.0099
	0.3	+.5060	+.0796	+.0558	+.0348	+.0013	-.0219	-.0355	-.0400	+.0159	+.0110	+.0065	-.0013	-.0071	-.0108	-.0120
	0.2	+.4778	+.0690	+.0470	+.0282	-.0004	-.0192	-.0299	-.0334	+.0138	+.0091	+.0046	-.0034	-.0095	-.0132	-.0145
	0.1	+.3316	+.0400	+.0254	+.0139	-.0017	-.0108	-.0155	-.0170	+.0080	+.0047	+.0017	-.0033	-.0066	-.0084	-.0090
	0.05	+.1331	+.0170	+.0108	+.0060	+.0001	-.0026	-.0037	-.0039	+.0034	+.0026	+.0026	+.0044	+.0071	+.0094	+.0102
	0	-.0513	0	+.0005	+.0016	+.0047	+.0076	+.0096	+.0103	0	+.0024	+.0078	+.0234	+.0381	+.0481	+.0516
		R_x \ R_y	-.0513	-.0797	+.0291	+.2203	+.3559	+.4352	+.4612							
a/b = 1/2	0.5	+.5142	+.0815	+.0573	+.0359	+.0015	-.0224	-.0365	-.0411	+.0163	+.0113	+.0068	-.0012	-.0071	-.0108	-.0121
	0.4	+.5111	+.0797	+.0557	+.0346	+.0011	-.0220	-.0355	-.0399	+.0159	+.0110	+.0064	-.0017	-.0078	-.0116	-.0129
	0.3	+.4928	+.0728	+.0499	+.0303	-.0000	-.0203	-.0319	-.0356	+.0146	+.0097	+.0051	-.0031	-.0093	-.0132	-.0145
	0.2	+.4260	+.0568	+.0375	+.0217	-.0014	-.0159	-.0238	-.0263	+.0114	+.0071	+.0030	-.0042	-.0096	-.0128	-.0139
	0.1	+.2350	+.0270	+.0168	+.0090	-.0011	-.0066	-.0092	-.0100	+.0054	+.0032	+.0014	-.0006	-.0013	-.0013	-.0012
	0.05	+.0591	+.0099	+.0066	+.0039	+.0011	+.0003	+.0003	+.0003	+.0020	+.0022	+.0034	+.0082	+.0135	+.0174	+.0188
	0	-.0496	0	+.0005	+.0016	+.0049	+.0080	+.0100	+.0108	0	+.0025	+.0082	+.0247	+.0399	+.0502	+.0538
		R_x \ R_y	-.0496	-.0631	+.0371	+.2253	+.3598	+.4382	+.4638							
a/b = 5/8	0.5	+.5143	+.0765	+ 0526	+.0319	-.0001	-.0214	-.0336	-.0376	+.0153	+.0102	+.0054	-.0033	-.0101	-.0144	-.0159
	0.4	+.5045	+.0736	+.0502	+.0302	-.0004	-.0207	-.0321	-.0358	+.0147	+.0097	+.0050	-.0037	-.0104	-.0147	-.0161
	0.3	+.4660	+.0642	+.0429	+.0251	-.0012	-.0181	-.0274	-.0304	+.0128	+.0082	+.0037	-.0045	-.0107	-.0146	-.0159
	0.2	+.3697	+.0462	+.0297	+.0166	-.0017	-.0127	-.0186	-.0204	+.0092	+.0055	+.0020	-.0039	-.0082	-.0106	-.0114
	0.1	+.1635	+.0191	+.0119	+.0065	-.0004	-.0037	-.0052	-.0056	+.0038	+.0025	+.0018	+.0022	+.0036	+.0050	+.0056
	0.05	+.0150	+.0063	+.0046	+.0030	+.0018	+.0020	+.0025	+.0028	+.0013	+.0021	+.0042	+.0110	+.0180	+.0231	+.0249
	0	-.0454	0	+.0005	+.0017	+.0050	+.0082	+.0102	+.0109	0	+.0025	+.0083	+.0252	+.0408	+.0511	+.0547
		R_x \ R_y	-.0454	-.0527	+.0410	+.2277	+.3616	+.4394	+.4648							
a/b = 3/4	0.5	+.4999	+.0686	+.0457	+.0265	-.0017	-.0196	-.0293	-.0324	+.0137	+.0087	+.0037	-.0055	-.0128	-.0175	-.0191
	0.4	+.4845	+.0653	+.0432	+.0248	-.0019	-.0186	-.0277	-.0306	+.0131	+.0082	+.0034	-.0056	-.0126	-.0171	-.0186
	0.3	+.4311	+.0550	+.0357	+.0200	-.0022	-.0156	-.0227	-.0249	+.0110	+.0066	+.0024	-.0054	-.0113	-.0150	-.0162
	0.2	+.3179	+.0374	+.0235	+.0126	-.0019	-.0101	-.0142	-.0155	+.0075	+.0043	+.0014	-.0033	-.0064	-.0081	-.0086
	0.1	+.1133	+.0140	+.0089	+.0049	+.0001	-.0018	-.0025	-.0026	+.0028	+.0021	+.0023	+.0045	+.0074	+.0098	+.0107
	0.05	-.0109	+.0043	+.0034	+.0024	+.0022	+.0031	+.0039	+.0043	+.0009	+.0021	+.0048	+.0129	+.0210	+.0268	+.0288
	0	-.0412	0	+.0005	+.0017	+.0051	+.0082	+.0102	+.0109	0	+.0024	+.0083	+.0254	+.0409	+.0511	+.0546
		R_x \ R_y	-.0412	-.0457	+.0445	+.2305	+.3626	+.4384	+.4629							
a/b = 7/8	0.5	+.4730	+.0592	+.0380	+.0208	-.0031	-.0172	-.0245	-.0267	+.0118	+.0070	+.0021	-.0072	-.0146	-.0193	-.0209
	0.4	+.4542	+.0560	+.0356	+.0193	-.0031	-.0162	-.0229	-.0250	+.0112	+.0065	+.0018	-.0070	-.0139	-.0183	-.0198
	0.3	+.3928	+.0462	+.0288	+.0153	-.0029	-.0131	-.0183	-.0198	+.0092	+.0052	+.0012	-.0059	-.0113	-.0146	-.0157
	0.2	+.2736	+.0302	+.0184	+.0094	-.0020	-.0079	-.0107	-.0114	+.0060	+.0033	+.0010	-.0026	-.0047	-.0057	-.0061
	0.1	+.0798	+.0106	+.0068	+.0037	+.0005	-.0005	-.0006	-.0006	+.0021	+.0019	+.0027	+.0060	+.0099	+.0129	+.0139
	0.05	-.0250	+.0031	+.0026	+.0021	+.0025	+.0037	+.0047	+.0051	+.0006	+.0021	+.0051	+.0140	+.0226	+.0285	+.0306
	0	-.0377	0	+.0005	+.0017	+.0050	+.0080	+.0099	+.0106	0	+.0024	+.0083	+.0251	+.0400	+.0497	+.0530
		R_x \ R_y	-.0377	-.0391	+.0503	+.2341	+.3608	+.4319	+.4546							
a/b = 1	0.5	+.4389	+.0500	+.0306	+.0156	-.0040	-.0147	-.0198	-.0213	+.0100	+.0054	+.0007	-.0082	-.0153	-.0197	-.0213
	0.4	+.4189	+.0470	+.0286	+.0144	-.0039	-.0137	-.0184	-.0197	+.0094	+.0050	+.0006	-.0078	-.0143	-.0184	-.0198
	0.3	+.3551	+.0382	+.0229	+.0112	-.0033	-.0109	-.0143	-.0153	+.0076	+.0040	+.0003	-.0061	-.0109	-.0137	-.0147
	0.2	+.2373	+.0244	+.0143	+.0068	-.0020	-.0061	-.0078	-.0082	+.0049	+.0026	+.0007	-.0020	-.0033	-.0039	-.0040
	0.1	+.0585	+.0082	+.0052	+.0028	+.0007	+.0003	+.0006	+.0007	+.0016	+.0018	+.0028	+.0068	+.0112	+.0144	+.0156
	0.05	-.0316	+.0024	+.0021	+.0018	+.0026	+.0040	+.0050	+.0054	+.0005	+.0021	+.0052	+.0143	+.0229	+.0286	+.0306
	0	-.0351	0	+.0005	+.0016	+.0049	+.0076	+.0094	+.0100	0	+.0024	+.0082	+.0244	+.0382	+.0470	+.0500
		R_y	-.0351	-.0316	+.0585	+.2373	+.3551	+.4189	+.4389							



Moment = (Coefficient)(pa^2)
Reaction = (Coefficient)(pa)



POSITIVE SIGN CONVENTION

FIGURE 34.—*Plate fixed along four edges, moment and reaction coefficients, Load I, uniform load.*

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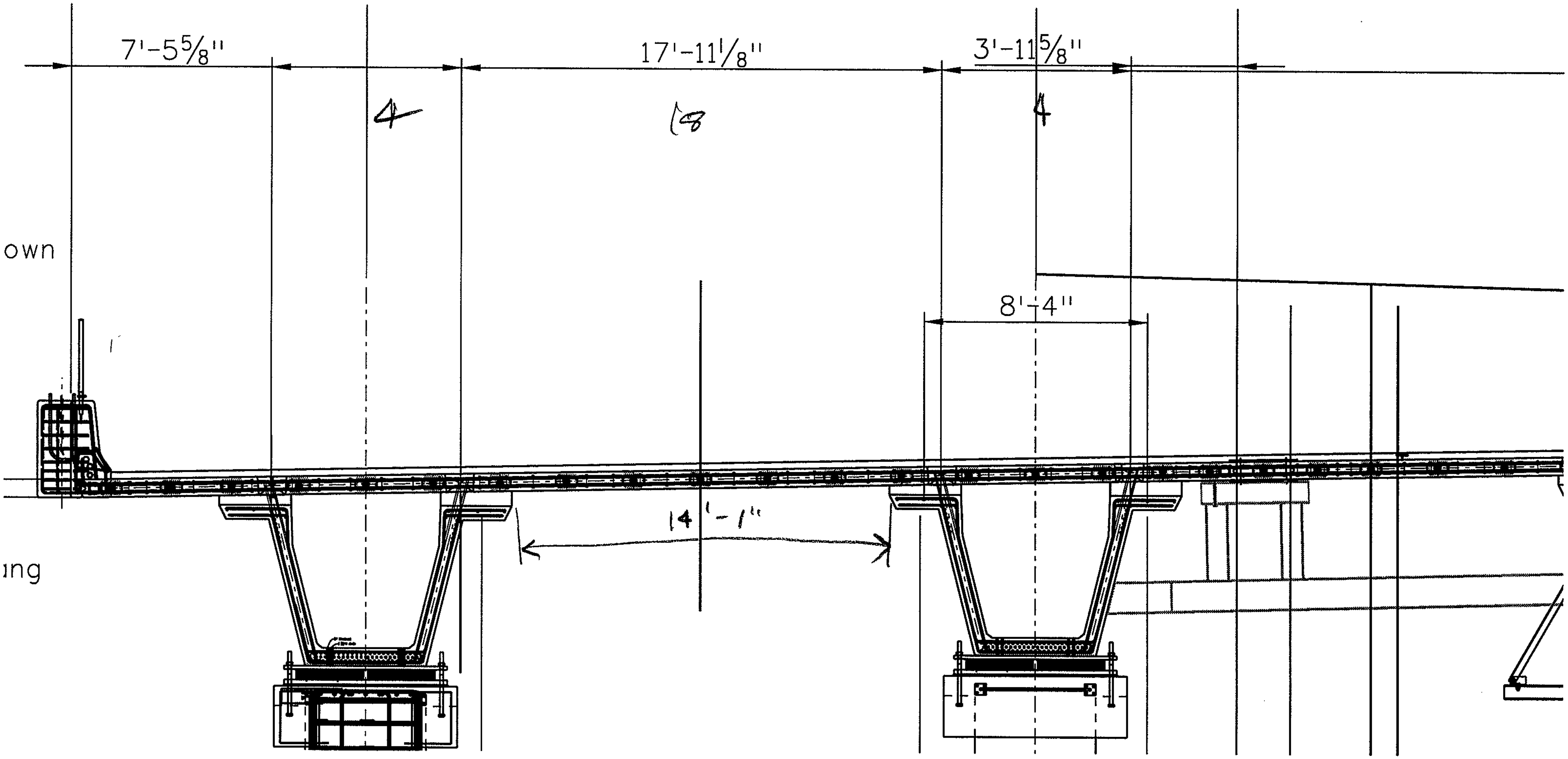
Side conduit



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 POST TENSIONING

COMPRESSIVE STRESSES

$$f_{ca} = \frac{.6 P_u k}{A_b \left(1 + l_c \left(\frac{1}{b_{eff}} - \frac{1}{t}\right)\right)} \qquad (5.10.9.6.2-1)$$

$K = 1.0$

$t = 8''$

$b_{eff} = 6''$ (assumed)

$a_{eff} = 12''$ (assumed)

$l_c = 1.15\,(\max(b_{eff}, a_{eff})) = 1.15(12) = 13.8$

$P_u = .75\,(270\ ksi)\,(4)\,(.217\ in^2) = 175.77\ K$

$A_{duct} = 1.843\ in^2$

$A_b = 6'' \times 12'' - 1.8343 = 70.1568\ in^2$

$f_{ca} \approx 1.503\ ksi$

$f_{all} = .7 \phi f'_{ci} = .7(.9)(5.0\ ksi)$

$f_{all} \approx 3.15\ ksi$

$f_{ca} < f_{all}$ can use smaller plate

max spiral $\phi = 8'' - 1'' - 1'' = 6''$

max $A_{conf} = \frac{\pi 5^2}{4} \approx 19.63\ in^2$

$A_{plate\ max} = \frac{4}{\pi} A_{conf} = 25\ in^2$

$f_{ca} \approx \frac{.6\,(175.77)}{19.63\left(1 + 13.8\left(\frac{1}{6} - \frac{1}{8}\right)\right)} = 3.41 > f_{allow}$

can't use spiral reinforcement
not enough room

Compressive stresses (cont.)

for hat bars

$A_{conf} = 4'' \times 9'' \approx 36 \text{ in}^2$

$A_{plate_{max}} = \frac{4}{\pi} A_{conf} \approx 45.84 \text{ in}^2$

$A_{plate} = 5'' \times 8'' = 40 \text{ in}^2$ ← controls

$A_b = 40 \text{ in}^2 - \underbrace{1.8343}_{\text{duct area}} = 38.166 \text{ in}^2$

$l_c = 1.15 (8'') = 9.2''$

$$f_{ca} = \frac{.6 (175.77)(1.0)}{38.166 \left(1 + 9.2 \left(\frac{1}{5} - \frac{1}{8''}\right)\right)}$$

$f_{ca} \approx 1.65$ ksi

$F_{allow} = 3.15$ ksi ✓ okay

k=	1	
beff=	6	
aeff=	~~9~~	8
t=	8	
lc=	10.35	
Pu=	175.77	
Ab=	52.1568	
fca=	2.022018 ksi	
fallow=	3.15 ksi	

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

BURSTING FORCES

$$T_{burst} = .25 \Sigma P_u \left(1 - \frac{a}{h}\right) + .5 \left| \Sigma P_u \sin\alpha \right| \qquad (5.10.9.6.3-1)$$

$\alpha = 0$

$P_u = .75\ (270\ ksi)(4)(.217\ in^2) \approx 175.77\ K$

$a = 6''$

$h = 8''$

$T_{burst} = .25\ 175.77\left(1 - \frac{5}{8}\right) + .5 * 0$

$T_{burst} \approx 16.48\ kip$

$$d_{burst} = .5\ (h - 2e) + 5e\ \sin\alpha \qquad (5.10.9.6.3-2)$$

$e = 0$

$d_{burst} \approx .5(8) = 4''$

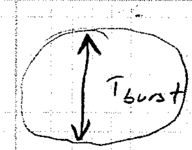
distance for reinforce

$2.5\ d_{burst} = 2.5(4) = 10''$

$1.5\ h = 1.5(8) = 12''$

$l_c = 9.2''$

#4 bar = $.20\ in^2$ #3 bar = $.11\ in^2$



$\sigma = \frac{10.99}{.20} = 54.95$ ksi for 1 bar

149.82 ksi for 1 #3

assume shared by 4 bars

assume 6 bars

$\sigma \approx 25$ ksi

$\sigma \approx 13.74$ ksi

4.5''

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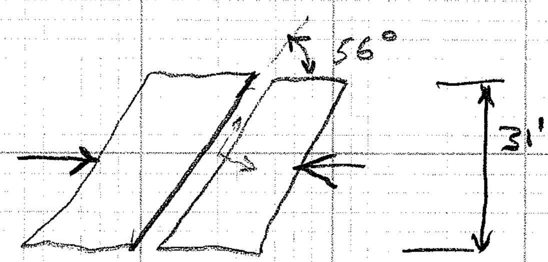
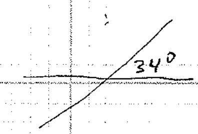
POST-TENSION FORCE ON TRANVERSE JOINTS (Phase 3 & 4)

(other phases similar)

phase 2 - L_{vi} = 48'-3"
17 ducts
width = 40'

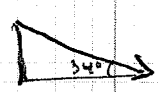




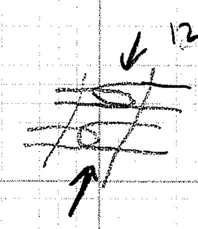
~13 ducts, 4 strands each

Post Tension Force = 13 * 4 * .217 in²/strand * .75 * 270 ksi

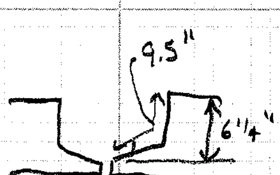
F_{pt} = 2285.01 K



normal force = cos 34° (2285.01) ≈ 1894.4 K
transverse force ≈ sin 34° (2285.01) ≈ 1277.8 K = V_{ui}



A_{vf} ≈ 31' / .31 in²/ft ≈ 9.61 in²



$A_{vf} \geq \dfrac{.05\, A_{cv}}{f_y}$ (5.8.4.4-1)

$A_{cv} = b_{vi} L_{vi}$ ≈ 6.25 * 37.33' * 12"/1 (5.8.4.1-6)

b_{vi} ≈ 6.25"
L_{vi} ≈ 37'-4"

A_{cv} ≈ 2800 in² (4256 in² for 9.5")

$A_{vf} \geq \dfrac{.05\ 2800}{60}$ ≈ 2.33 in²

⇒ .06 in²/ft (minimum)

#5@12" ≈ .31 in²/ft ✓ okay

$$V_{ni} = cA_{cv} + \mu(A_{vf} f_y + P_c)$$ (5.8.4.1-3)

$c = .075$ ksi
$\mu = .6$
$K_1 = .2$
$K_2 = .8$ ksi

Concrete placed against a clean concrete surface not intentionally roughened (5.8.4.3)

$$V_{ni} = (.075 \text{ ksi})(4256 \text{ in}^2) + .6\left(\tfrac{2\#}{\text{legs}} \cdot (9.61 \text{ in}^2) * 60 \text{ ksi} + 0\right)$$

$$V_{ni} = 319.2 K + 1153.2$$

$$V_{ni} = 1472.4 K$$

$$V_{ni} \leq K_1 f'_c A_{cv}$$ (5.8.4.1-4)

$$\leq .2(7.2)\,2400 = 3456 K$$

$$V_{ni} \leq K_2 A_{cv}$$ (5.8.4.1-5)

$$\leq .8(2400) = 1920 K$$

$$V_{ri} = \phi V_{ni}$$ (5.8.4.1-1)

$$V_{ri} = (.9)(1472.4) = \underline{1325.2K}$$

$$V_{ri} > V_{ui}$$

$$1325.2 > 1277.8$$ ✓ okay

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

$c = .24$ ksi
$\mu = 1.0$
$K_1 = .25$
$K_2 = 1.5$ ksi

roughened surface .25" amplitude (5.8.4.3)

$V_{ni} = cA_{cv} + \mu(A_{vf}f_y + P_c)$ (5.8.4.1-3)

$V_{ni} = .24(2800) + 1.0(2 \text{ legs} * 9.61 \text{ in}^2 * 60 \text{ ksi} + 0)$

4256 $V_{ni} = 672 K + 1153.2 K$

$V_{ni} \approx 1825.2 K$

$V_{ri} = \phi V_{ni} = .9(1825.2k)$ (5.8.4.1-1)

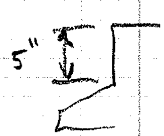
$\underline{V_{ri} = 1642.7 K}$ ⟵

$V_{ni} \leq K_1 f'_c A_{cv} = .25(7.2)(2800)$ (5.8.4.1-4)
$= 5040 K$

$V_{ni} \leq K_2 A_{cv} = (1.5)(2800)$ (5.8.4.1-5)
$\approx 4200 K$

$V_{ri} = 1642.7K > V_{ui}$ ✓ okay

for 5" roughend



$V_{ni} = .24(2240) + 1153.2$
$= 537.6 + 1153.2$
$= 1690.8$

$V_{ri} = \phi V_{ni} = .9(1690.8) = 1521.7 K$

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COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

ELASTIC SHORTENING

$\delta = \frac{PL}{AE}$

Phase 1

18 conduit * 4 strands = 72 strands

$A_g \approx 8'' \times 43' \approx 4128 \text{ in}^2$

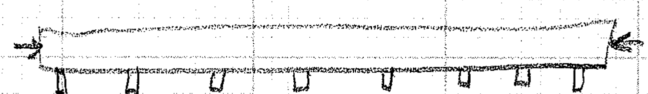
$E_c \approx 4917$ ksi $f'_c = 7.3$ ksi (28 day strength)

$L \approx 368' = 4416$ in (℄ Abut to ℄ Abut)

$P \approx .75\,(270 \text{ ksi})\,(72 \text{ strands})\,(.217 \text{ in}^2/\text{strand})$

$P \approx 3163.9$ K

$$\delta = \frac{(3163.9 \text{ k})(4416)}{(4128)\ (4917)} \approx .69''$$



make bottom portion of level screw smooth to allow sliding

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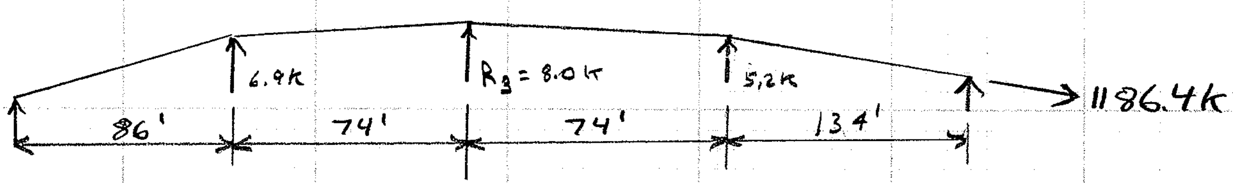
COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

POST-TENSIONING FORCES (ON ADJUSTING SCREW)



deck width ≈ 25'

~9 ducts, 3 strands each

Post Tension Force ≈ $9 * 3 * .217\ in^2/strand * .75 * 270\ ksi$

$F_{PT} \approx 1186.4\ K$

From SAP 2000

WORST REACTION ≈ 8 Kip @ center R_3

assume supports evenly spaced

$8\ k/74' \approx .11\ K/ft$

$6.9\ k / \left(\frac{86}{2} + \frac{74}{2}\right) \approx .09\ k/ft$

for 8' panel ⇒ $(8)(.11) \approx .88\ K$ / panel

assume 4 supports per panel

$\approx .88k/4 \approx .22\ k$ / support

Use Safety Factor ≈ 1.5

6 Kips

Load ≈ $(.22k)(1.5) \approx .33$ Kips ~.44 k/ for 4 strands

Dead load ≈ $(31')(8')(8''/12''/ft)(.15\ k/ft^3) \approx 24.8\ k$

$24.8k/4$ supports ≈ 6.2 k

% ≈ $.33/6.2 \approx .053 \Rightarrow 5.3\%$

<u>Use 450 lb/adjusting screw</u>

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COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

Deck Panel Supports - conceptual design

phase 3 & 4 - deck panel width ≈ 35'

$wt = (35')\left(\frac{8''}{12''}\right)(8')\ .15K \approx 28K$

assume 4 supports (2/web)

$wt \approx 28^K/4 \approx 7\ K$

allowable stress = $.3f'_c$

$f'_c = 9$ ksi

$(.3)(9\ ksi) \approx 2.7$ ksi

$A_{reqd} \approx \frac{7K}{2.7} \approx 2.6\ in^2$

$1\frac{3}{4}''$ SQR PL

or 2'' Round PL

allowable stress ≈ $.55\ F_y$

A325 $F_y \approx 90$

Grade 36 & 55

assume 36 Ksi

$\sigma_{allow} = .55(36) = 19.8$ ksi

$A_{reqd} = \frac{7}{19.8 ksi} \approx .35\ in^2$

3/4'' bolt = .44 in²

Use 1'' bolt with 2'' round PL
or approved equal

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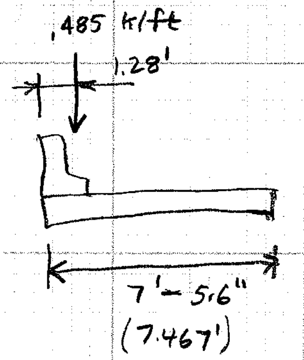
COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

OVERHANG DEFLECTION (DEADLOAD)



$$\Delta_x = \frac{Pb^2}{6EI}\left(3\ell - 3x - b\right)$$

$$\Delta_{barrier} \approx \frac{(8')(.485\,k/ft)\left[6.187(12)\right]^2}{6\,(4883.57)\,4096}\left[3\left(7.467'(12)\right) - 6.187(12)\right]$$

$$\Delta_{barrier} \approx .035''$$

$$\Delta_{deck} \approx \frac{w\ell^4}{8EI} = \frac{8'\left(\frac{8''}{12''}\right)\left(.15\,k/ft^3\right)\left[(7.467)(12)\right]^4}{8\,(4883.57)\,(4096)} \qquad \frac{1ft}{12''}$$

$$\Delta_{deck} \approx .027''$$

$$\Delta_{asphalt} \approx \frac{8'\left(\frac{3''}{12''}\right)\left(.1467\,k/ft^3\right)\left[5.967(12)\right]^4}{8\,(4883.57)\,4096}$$

$$\Delta_{asphalt} \approx .048''$$

$$\text{total } \Delta \approx .11''$$

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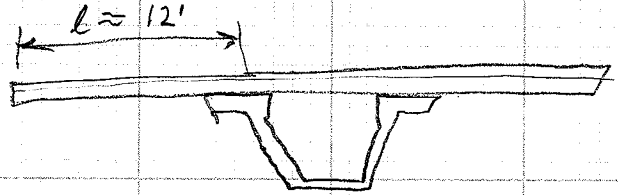
PHASE 3 & 4 OVERHANG DEFLECTION (DEADLOAD)



$$\Delta_{deck} = \frac{w\,l^4}{8EI}$$

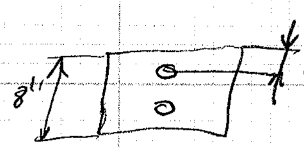
$$\Delta_{deck} = \frac{(8')\left(\frac{8''}{12''}\right)(.15)\left[12(12)\right]^4}{8\ (4883.57)\ 4096}$$

k/cf * 1'/12" inch

$\Delta_{deck} \approx$ 1.8''

$$\text{Prestress Camber} \approx \frac{M l^2}{8EI}$$

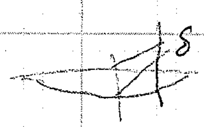
$M = Pe$



$e = 1.7''$

$P = 14\,(.217)\,(.75)(270\ ksi) \approx 615.2\ k$

$P = 1045.83$ in Kip



$$\delta = \frac{(1045.83)\left(32' * \frac{12''}{ft}\right)^2}{8\ (4883.57)\ 4096} \approx .96''$$

For debonded strand

$b_1 = 12'/32 = .375$

$b_2 = 13'/32 = .406'$

$l = 32'$

$$\delta = \frac{Ml^2}{8EI}\left(1 - 2b_1^2 - 2b_2^2\right)$$

$$\delta \approx \frac{(1045.83)\ (384)^2}{8\,(4883.57)\,(4096)}\left[1 - 2(.375)^2 - 2(.406)^2\right] \approx .375''$$

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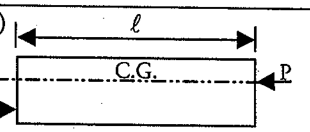
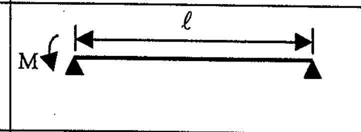
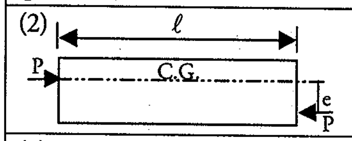
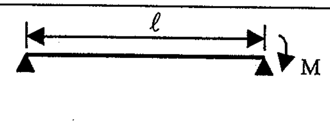
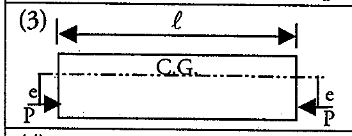
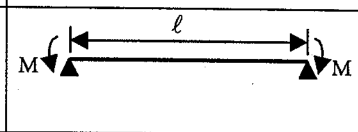
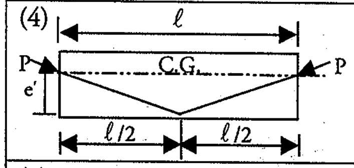
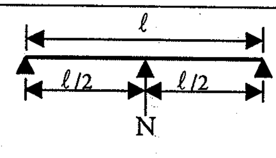
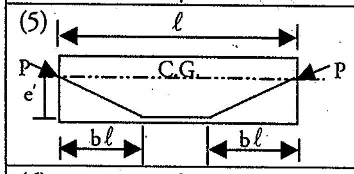
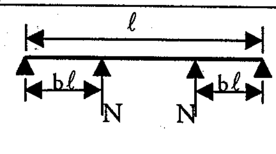
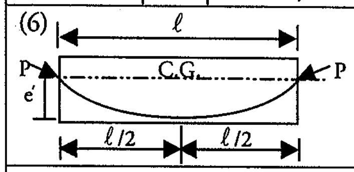
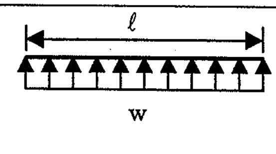
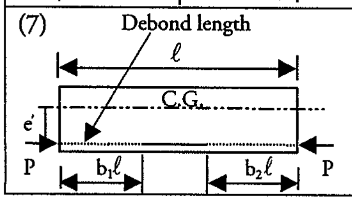
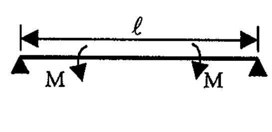
Table 8.7-1
Camber (deflection) and rotation coefficients for prestress force and loads*

Prestress Pattern	Equivalent Moment or Load	Equivalent Loading	Camber	End rotation	
(1) 	$M = Pe$		$+\frac{M\ell^2}{16EI}$	$+\frac{M\ell}{3EI}$	$-\frac{M\ell}{6EI}$
(2) 	$M = Pe$		$+\frac{M\ell^2}{16EI}$	$+\frac{M\ell}{6EI}$	$-\frac{M\ell}{3EI}$
(3) 	$M = Pe$		$+\frac{M\ell^2}{8EI}$	$+\frac{M\ell}{2EI}$	$-\frac{M\ell}{2EI}$
(4) 	$N = \frac{4Pe'}{\ell}$		$+\frac{N\ell^3}{48EI}$	$+\frac{N\ell^2}{16EI}$	$-\frac{N\ell^2}{16EI}$
(5) 	$N = \frac{Pe'}{b\ \ell}$		$+\frac{b(3-4b^2)N\ell^3}{24EI}$	$+\frac{b(1-b)N\ell^2}{2EI}$	$-\frac{b(1-b)N\ell^2}{2EI}$
(6) 	$w = \frac{8Pe'}{\ell^2}$		$+\frac{5w\ell^4}{384EI}$	$+\frac{w\ell^3}{24EI}$	$-\frac{w\ell^3}{24EI}$
(7) 	$M = Pe'$		$+\frac{M\ell^2}{8EI}(1-2b_1^2-2b_2^2)$	$+\frac{M\ell}{2EI}\left[(1-2b_1)^2-b_2^2\right]$	$-\frac{M\ell}{2EI}\left[(1-2b_1)^2-b_2^2\right]$

* The tabulated values apply to the effects of prestressing. By adjusting the directional rotation, they may also be used for the effects of loads. For patterns 4 to 7, superimpose on 1, 2 or 3 for other C.G. locations

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COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

LIVE LOAD DEFLECTION

$\Delta <$ Span/800 (2.5.2.6.2)

Design Manual 9.1 - C1

$\Delta <$ Cantilever/300

for skewed bridges, a right cross section may be used

for simply supported beam:

$$\Delta = \frac{Px}{48EI}\left(3\ell^2 - 4x^2\right)$$

$\sigma = \frac{M}{S} = \frac{(83.6)(12)}{1024} = 1$ ks

$P = 50K * 1.33 = 66.5K$

$x = \ell/2 \approx 107.6''$

$\ell = 17.927' \approx 215.2''$

$E = 4883.57$ ksi

$I \approx 4096\ in^4$

$$\Delta = \frac{25\ (107.6)}{48\ (4883.57)\ 4096}\left(3\ (215.2)^2 - 4\ (107.6)^2\right)$$

$\Delta \approx .26''$

$\Delta_{max} = \ell/800 = \frac{215.2''}{800} \approx .269''$

$\Delta < \Delta_{max}$ ✓ okay

Clear span = 14'-11''

skew dist $\approx \frac{14.92}{\sin 56} = 18' \approx 216''$

$x = 108''$

$$\Delta \approx \frac{25\ (108)}{48\ (4883.57)\ 4096}\left(3\ (216)^2 - 4\ (108)^2\right)$$

$\Delta \approx .263''$

$\Delta_{max} = \frac{216}{800} \approx .27''$ ✓ okay

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LIVELOAD DEFLECTION

$\Delta <$ cantilever/300

$l =$ 6'-7½" to live load = 79.5"

live load = 1 k/ft

$$\Delta = \frac{P}{6EI}(2l^3)$$

$E = 4883.57$ ksi

$I = 4096\ in^4$ for 8' slab

$$\Delta = \frac{(1\ k/ft)(8)(1.33)}{6\,(4883.57)\,4096}\,2\,(79.5)^3$$

$$\Delta = .089''$$

$$\Delta_{max} = \frac{79.5''}{300} = .265''$$

$\Delta < \Delta_{max}$ ✓ okay

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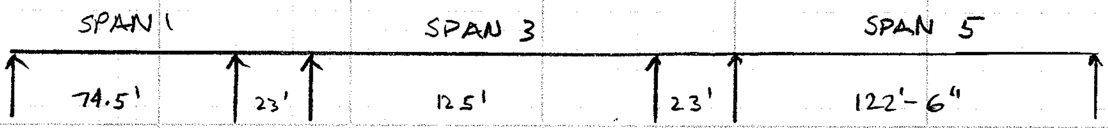
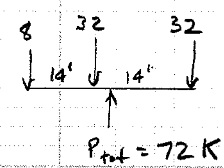
DESIGN COMPUTATIONS (Grid)



$\ell/800 = \frac{74.5(12)}{800} = 1.1175"$ $\quad\ell/800 = \frac{125(12)}{800} = 1.875"$ $\quad\frac{\ell}{800} = \frac{122.5(12)}{800} = 1.8375"$

SPAN 1/SPAN 5 deflection $\approx .009317 \frac{P\ell^3}{EI}$

SPAN 3 deflection $\approx \frac{P\ell^3}{192\,EI}$



$f'_c = 9$ ksi

$E \approx 5460$ ksi

$I \approx 2{,}947{,}200\ in^4$

$I_{worst\ case} \approx 2{,}921{,}130$

(exterior with no barrier)

Span 5 deflection $\approx \frac{.009317\ (72)\ [(122.5)(12)]^3}{5460\quad 2{,}947{,}200} \approx .132" * 1.33_{impact} = .176"$

Span 3 deflection $\approx \frac{72\ [125(12)]^3}{(192)\ 5460\ (2947200)} \approx .079" * 1.33_{impact} \approx .1"$

from SAP2000 RUNS

all deflections $< \ell/800$ ✓ okay

max deflection $\approx 1.69" < 1.875"$ ✓ okay

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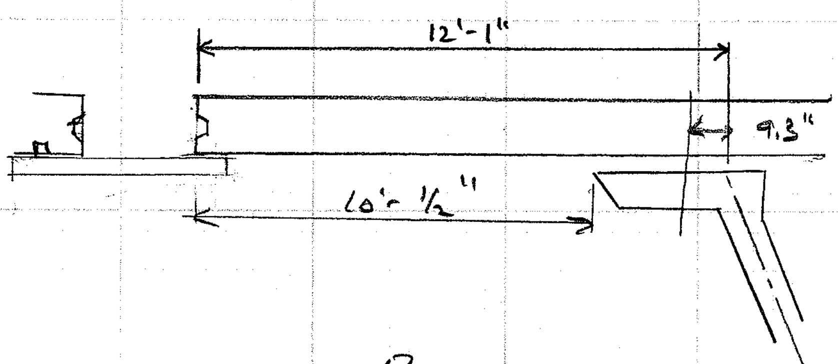
Phase 3 & 4

Assume 50 psf construction loads



$M = \frac{w l^2}{2}$ width of slab ≈ 8'

$M \approx \frac{(8')(50\,psf)(12.083)^2}{2}$

$M \approx 29.2$ ft K 25.6 ft K @ 9.33" = 3.2 ft k/ft

= 3.65 ft k/ft for 8' slab

strength & stress okay for 50 psf load ✓ ok

Deflections

$\Delta deck = \frac{w l^4}{8EI}$ $E \approx 4883.57$ $I \approx 4096$

DEAD WT

$\Delta_{DEAD} \approx \frac{\left(\frac{1'}{12''}\right) 8' \left(\frac{8''}{12''}\right)(.15k/cf)\left[(12.08')\frac{12''}{ft}\right]^4}{8\,(4883.57)\,(4096)} = .184''$

$\Delta_{\substack{const.\\loads}} \approx \frac{\frac{1'}{12''}\, 8' \left(\frac{.050k}{SF}\right)\left[(12.08')\left(\frac{12''}{ft}\right)\right]^4}{8\,(4883.57)\,(4096)} \approx .092''$

TOTAL ≈ .276"

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Concrete Stress in Negative Moment Area (Overhang)

Overhang Length =	14.58	ft	skewed length	
Distance to Start of Precast Slab =	0.00	Inches		
Support Girder Flange Width =	28.00	Inches		
Distance to Barrier Center of Mass =	0.00	ft		
width of barrier =	0.00	ft		
Wt of Barrier =	0.000	k/ft		
Asphalt Thickness =	0.00	inches		
Asphalt Weight =	12.22	lb/sf/inch asphalt		
Live Load =	4.16	k/lf (Input live load)		4.16
ired Shear Support @ CLOSURE POUR =	0.00	k/lf	"=6.4"	

Mslab (-) =	9.53	ft kip/ft	moment at 9.33 inches from support
Mdc2 (barrier) (-) =	0.00	ft kip/ft	moment at 9.33 inches from support
Mdw (-) =	0.00	ft kip/ft	moment at 9.33 inches from support
M const LL- =	3.65	ft kip/ft	moment at 9.33 inches from support
	50 psf		

Compression Stress

f_{bottom} = Pe/A + Mslab/S_{bot} + (M_{dc} + M_{dw} + M_{LL})/S_{botc}

f_{max} = .6 f'c =	4.32	ksi	transient loads (DL+LL)	(Table 5.9.4.2.1-1)
f_{bottom} =	2.74	ksi		
fbottom<=fmax?	Okay			
f_{max} = .45 f'c =	3.24	ksi	permanent loads (DL)	(Table 5.9.4.2.1-1)
f_{bottom} =	2.28	ksi		
ftop<=fmax?	Okay			
f_{max} = .40 f'c =	2.88	ksi	LL + 1/2DL	(Table 5.9.4.2.1-1)
f_{bottom} =	1.60	ksi		
fbottom<=fmax?	Okay			

Tension Stress

f_{top} = Pe/A + Mslab/Stop + (M_{dc} + M_{dw} + M_{LL})/Stop

ftop =	0.028	ksi	
Tension Limit = .19*sqrt(f'c) =	-0.510	ksi	(Table 5.9.4.2.2-1)
ftop<=fmax?	Okay		

Strength Checks

Interior Spans

STRENGTH I

Mu=1.25DC+1.5DW+1.75(LL+IM)

Mupositive =	259.96	ft kip
Munegative =	221.92	ft kip
Mr = Φ*Mn =	283.43	ft kip
	Okay	

SERVICE I

Mu=DC+DW+(LL+IM)

$Mu_{positive}$ = 157.59 ft kip
$Mu_{negative}$ = 135.85 ft kip

Strength Checks

Overhang

STRENGTH I

Mu=1.25DC+1.5DW+1.75(LL+IM)
$Mu_{negative}$ = 159.13 ft kip

Development Length & Transfer Length (5.11.4)

ld = 83.41 inches
$l_{transfer}$ = 60*db = 36 inches

distance from edge if slab = 13.80 ft (distance is > development length -> Full Strength)
lpx= 165.63 inches This is greater than ld, use a smaller value
fpx= 245.59 ksi

for prestress only:
Aps*fps=.85*f'c*b*a

a~= 1.2699 inches
$T_{topstrand}$ = 29.24 ksi

Mn=Aps*fps*(dp-a/2)
Mn = 314.92 ft kip
ε_t= 0.01321 Tension Controlled (C5.7.2.1)
ϕ = 0.9

Mr = 283.43 ft kip
Okay

for prestress + mild reinforcing:
As*fs + Aps*fps=.85*f'c*b*a
Mild bar size = # 0 fy= 60 ksi
bar spacing = 24 inches
As = 0 in^2
a~= 1.2699 inches
$T_{topstrand}$ = 29.24 ksi

Mn=Aps*fps*(dp-a/2)+As*fs*(dp-a/2)
Mn = 314.92 ft kip
ε_t= 0.01321 Tension Controlled (C5.7.2.1)
ϕ = 0.9
Mr = ϕ*Mn = 283.43 ft kip
Okay

SERVICE I

Mu=DC+DW+(LL+IM)
$Mu_{negative}$ = 112.70 ft kip
Okay for SERVICE

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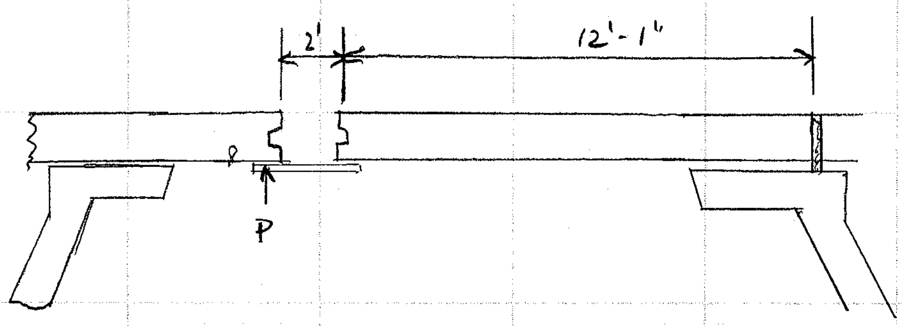
DESIGN COMPUTATIONS (Grid)



for 8' slab

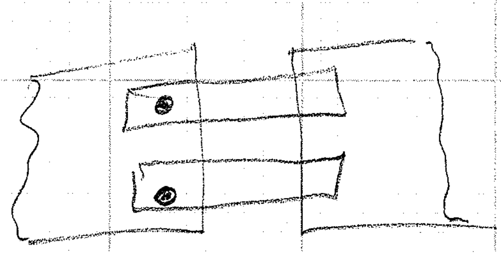
$$P \approx \frac{\overbrace{(12.08+2)\left(\frac{8''}{12''}\right)(8')(.15\,kcf)}^{\text{Dead Load}} + \overbrace{.05\,ksf(12.08')(8')}^{\text{Construction load}}}{2}$$

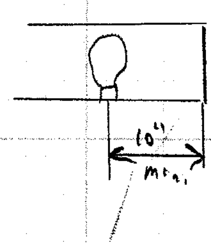
$$P \approx \frac{11.264 + 4.832}{2} = 8.05 \text{ K}$$

use 2 - 7/8"φ F-42 Loop Ferrules

load = 5300 lbs each

total ≈ 10.6 K





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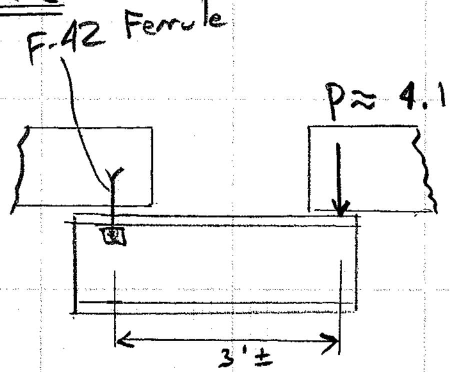
FALSEWORK

OPTION 1



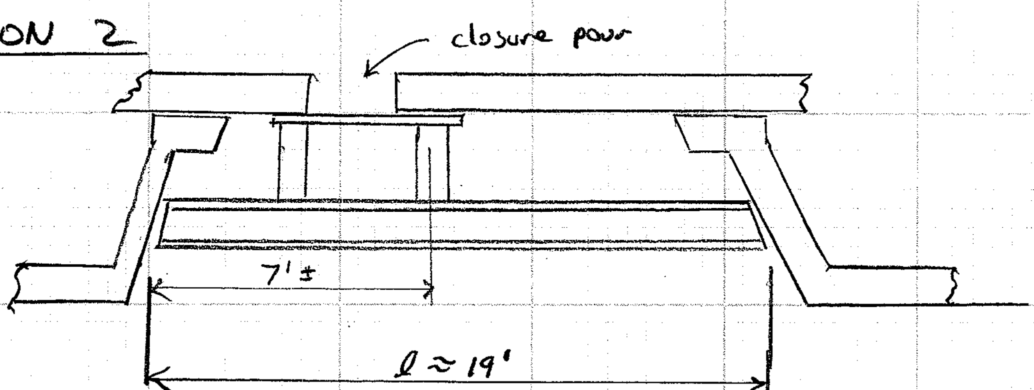
$M \approx (3')(4.1) \approx 12.3$ ft k

Use W 6 x 12   I = 22.1
W 8 x 10 or equal   I = 30

C 8 x 11.5   I = 32.6 $b_f = 2.26''$
MC 10 x 22   I = 103 $b_f = 3.315''$

use MC 10 x 22

OPTION 2



$M_{max} = \frac{Pl}{4}$ $M_{max} = \frac{Pab}{l}$ $M \approx 35.6$ ft k

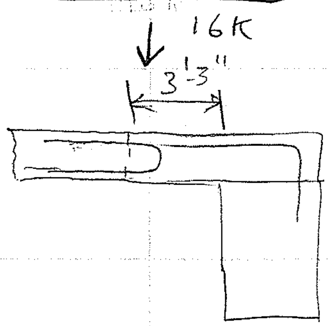
$M_{max} = \frac{(8.05)(19')}{4} \approx 38.3$ ftk

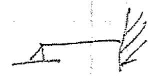
Use W 10 x 33 or equal $I = 170 \text{ in}^4$

W 14 x 34 every other slab

Could use as platforming over river

DECK @ North West Abutment





$M_{max} = \frac{3 P \ell}{16}$

2'-8"

$M = \frac{3(16k)(3.25)}{16} \approx 9.75$ ft k

8.125

$M_{ULT} = (1.75)(9.75) \approx 17.1$ ft k

for 10"

$V_c \approx 10.72$

for full cantilever

$\ell \approx 2'-8"$

$M = (16k)(2'-8") \approx 42.72$ k

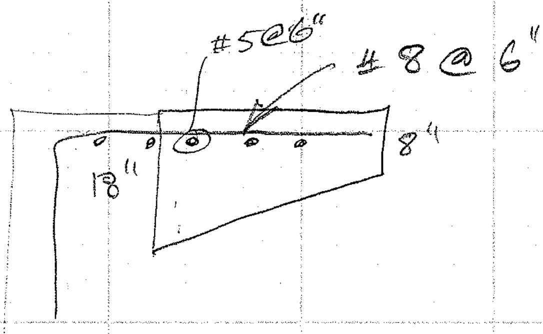
#8 @ 6"
18" depth

$M_{ult} = (1.75)(42.72) \approx 74.8$ k

@ 1'-4"

$M = 21.33$ k
$M_u = 37.33$ k

#8 @ 6"
13" depth



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REINFORCING DESIGN

GIVEN:

fy=	60.00	ksi
f'c=	4.50	ksi
COVER=	2.00	inches
$\Phi_{flexure}$=	0.75	
Beam Thickness (t_s)=	13.00	inches
b=	12.00	inches
bar diameter=	0.875	inches

Impact Steel

LOAD TYPE	M_{hTOT}	$AS_{req'd}$
	ft-K	in^2
M_h (UNFACTORED)	21.33	0.56
STRENGTH I	37.33	1.01
SERVICE I	21.33	0.56

d_s= 10.56 inches

per 5.10.8.2 AS_{temp}= 0.23 sq inches

Use # 8 at top face min. spacing = 9.43 inches

use spacing= 6.00 inches

As= 1.580 sq. inches

compressive steel:

Use # 5 at bottom face

As'= 0.00 sq. inches

M_n= 74.79 ft-K

M_r= 56.09 ft-K

Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 2.50 inches

d_e=d_s= 10.56 inches (for no prestressing)

c/d_e= 0.24

okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*$M_{cracking}$= 17.21 ft-K <--- Test 1

1.33M_{hTOT} (max.)= 49.65 ft-K <--- Test 2

Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing =	15.25	ft
Flange Width =	21	inches
Flange Overhang =	18	inches
Effective Length S =	15.00	ft
220 / sqrt(S) =	56.80	%
Required As =	0.90	sq inches
Use #	6	transverse reinforcement
min. spacing =	5.88	inches

Use **56.804** % of required main reinforcement

Crack Control per 5.7.3.4

fy= 60.00 ksi

$f_{sa} = Z / (d_c*A)^{1/3} <= 0.6*f_y$

d_c = clear + dia. / 2 = 2.5 in

A = 30 in^2

Z = 170 kip/in (moderate exposure conditions)

Maximum allowable f_{sa} = 36.00 ksi

Stress under service loads:

$E_c = 33{,}000*(0.15)^{1.5}*\text{sqrt}(f'_c)$

E_c = 4066.84 ksi

E_s = 29000 ksi

$n = E_s / E_c$ = 7

$(b/2)\mathbf{X}^2 + (A_s n)\mathbf{X} - (A_s n*(ts-d_c)) = 0$

X = 3.573 in compression depth of concrete at Service I Level

c = 6.99 in

Service load = DC + DW + (LL + IM)

M_u = 21.33 ft-K

$I_{transform}$ = 722.77 in^4

$f_s = n*M(+)*c / I_{transformed}$ = 17.33 **<36ksi, Okay**

REINFORCING DESIGN

GIVEN:

fy= 60.00 ksi
f'c= 4.50 ksi
COVER= 2.00 inches
Φflexure= 0.75
Beam Thickness (ts)= 18.00 inches
b= 12.00 inches
bar diameter= 0.875 inches

Impact Steel

LOAD TYPE	MhTOT	ASreq'd
	ft-K	in^2
Mh (UNFACTORED)	42.72	0.76
STRENGTH I	74.80	1.36
SERVICE I	42.72	0.76

ds= 15.56 inches
per 5.10.8.2 AStemp= 0.32 sq inches

Use # 8 at top face min. spacing = 6.97 inches
use spacing= 6.00 inches
As= 1.580 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

Mn= 114.29 ft-K
Mr= 85.72 ft-K

Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 2.50 inches
de=ds= 15.56 inches (for no prestressing)
c/de= 0.16

okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*Mcracking= 32.99 ft-K <--- Test 1
1.33MhTOT (max.)= 99.48 ft-K <--- Test 2

Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing = 15.25 ft
Flange Width = 21 inches
Flange Overhang = 18 inches
Effective Length S = 15.00 ft
220 / sqrt(S) = 56.80 % Use **56.804** % of required main reinforcement
Required As = 0.90 sq inches
Use # 6 transverse reinforcement
min. spacing = 5.88 inches

Crack Control per 5.7.3.4

fy= 60.00 ksi

$f_{sa} = Z / (d_c{*}A)^{1/3} <= 0.6{*}f_y$

d_c = clear + dia. / 2 = 2.5 in

A = 30 in^2

Z = 170 kip/in (moderate exposure conditions)

Maximum allowable f_{sa} = 36.00 ksi

Stress under service loads:

$E_c = 33{,}000{*}(0.15)^{1.5}{*}sqrt(f'_c)$

E_c = 4066.84 ksi

E_s = 29000 ksi

$n = E_s / E_c$ = 7

$(b/2)\mathbf{X}^2 + (A_s n)\mathbf{X} - (A_s n{*}(ts-d_c)) = 0$

X = 4.502 in compression depth of concrete at Service I Level

c = 11.06 in

Service load = DC + DW + (LL + IM)

M_u = 42.72 ft-K

$I_{transform}$ = 1718.01 in^4

$f_s = n{*}M(+){*}c / I_{transformed}$ = 23.10 **<36ksi, Okay**

REINFORCING DESIGN

@2' from bedcap

GIVEN:

fy= 60.00 ksi
f'c= 4.50 ksi
COVER= 2.00 inches
$\Phi_{flexure}$= 0.75
Beam Thickness (t_s)= 13.00 inches
b= 12.00 inches
bar diameter= 0.875 inches

Impact Steel

LOAD TYPE	M_{hTOT}
	ft-K
M_h (UNFACTORED)	30.67
STRENGTH I	53.67
SERVICE I	30.67

$AS_{req'd}$
in^2
0.82
1.49
0.82

d_s= 10.56 inches
per 5.10.8.2 AS_{temp}= 0.23 sq inches

Use # 8 at top face min. spacing = 6.35 inches
use spacing= 6.00 inches
As= 1.580 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 74.79 ft-K
M_r= 56.09 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 2.50 inches
d_e=d_s= 10.56 inches (for no prestressing)
c/de= 0.24
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*$M_{cracking}$= 17.21 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 71.38 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%
Girder Spacing = 15.25 ft
Flange Width = 21 inches
Flange Overhang = 18 inches
Effective Length S = 15.00 ft
220 / sqrt(S) = 56.80 % Use **56.804** % of required main reinforcement
Required As = 0.90 sq inches
Use # 6 transverse reinforcement
min. spacing = 5.88 inches

REINFORCING DESIGN

@ 3' from barrier

GIVEN:

fy= 60.00 ksi
f'c= 4.50 ksi
COVER= 2.00 inches
$\Phi_{flexure}$= 0.75
Beam Thickness (t_s)= 10.00 inches
b= 12.00 inches
bar diameter= 0.875 inches

Impact Steel

LOAD TYPE	M_{hTOT}	AS req'd
	ft-K	in^2
Mh (UNFACTORED)	20.00	0.75
STRENGTH I	35.00	1.40
SERVICE I	20.00	0.75

ds= 7.56 inches
per 5.10.8.2 AStemp= 0.18 sq inches

Use # 8 at top face min. spacing = 6.74 inches
use spacing= 6.00 inches
As= 1.580 sq. inches
compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

Mn= 51.09 ft-K
Mr= 38.32 ft-K
Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)
c= 2.50 inches
de=ds= 7.56 inches (for no prestressing)
c/de= 0.33
okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2
1.2*Mcracking= 10.18 ft-K <--- Test 1
1.33MhTOT (max.)= 46.55 ft-K <--- Test 2
Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2
Percentage of main reinforcement, 220 / sqrt(S) <= 67%
Girder Spacing = 15.25 ft
Flange Width = 21 inches
Flange Overhang = 18 inches
Effective Length S = 15.00 ft
220 / sqrt(S) = 56.80 % Use **56.804** % of required main reinforcement
Required As = 0.90 sq inches
Use # 6 transverse reinforcement
min. spacing = 5.88 inches

REINFORCING DESIGN

@ 4' from barrier

GIVEN:

fy=	60.00	ksi
f'c=	4.50	ksi
COVER=	2.00	inches
Φflexure=	0.75	
Beam Thickness (ts)=	8.00	inches
b=	12.00	inches
bar diameter=	0.875	inches

Impact Steel

LOAD TYPE	MhTOT	ASreq'd
	ft-K	in^2
Mh (UNFACTORED)	9.33	0.47
STRENGTH I	16.33	0.87
SERVICE I	9.33	0.47

ds= 5.56 inches
per 5.10.8.2 AStemp= 0.14 sq inches

Use # 8 at top face min. spacing = 10.86 inches
use spacing= 6.00 inches
As= 1.580 sq. inches

compressive steel:
Use # 5 at bottom face
As'= 0.00 sq. inches

Mn= 35.29 ft-K
Mr= 26.47 ft-K

Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 2.50 inches
de=ds= 5.56 inches (for no prestressing)
c/de= 0.45

not good - member is overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*Mcracking= 6.52 ft-K <--- Test 1
1.33MhTOT (max.)= 21.72 ft-K <--- Test 2

Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing = 15.25 ft
Flange Width = 21 inches
Flange Overhang = 18 inches
Effective Length S = 15.00 ft
220 / sqrt(S) = 56.80 % Use **56.804** % of required main reinforcement
Required As = 0.90 sq inches
Use # 6 transverse reinforcement
min. spacing = 5.88 inches

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DESIGN COMPUTATIONS (Grid)

GIRDER DESIGN

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DESIGN COMPUTATIONS (Grid)

DECK POST-TENSIONING LOSSES

5.9.5.2.1 Anchorage Set

per C5.9.5.1 Anchorage loss ≈ 3%

anchor set loss = 3/8" = ΔL

$L \approx 366.25'$ from anchor to anchor

tension from both sides

$$\Delta f = \frac{E\,\Delta L}{6\,x}$$

$$x = \sqrt{\frac{E\,(\Delta L)\,L}{12\,d}}$$

$L_{max} \approx 184'$

$$d = .75\,(270)\left(1 - e^{[-(.0002)\,184' + .25\,(.00873)]}\right)$$

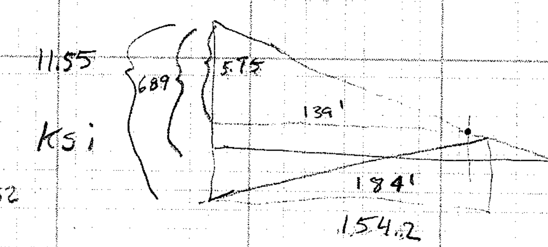
$d \approx 6.89$ ksi (~3.4%) 6.85

$$x = \sqrt{\frac{(28500\text{ ksi})\,(.375")\,184'}{(12)\,(6.89\text{ ksi})}}$$

$x = 154.2'$ 154.67

$$\Delta f = \frac{(28500)(.375)}{(6)\,154.2} \approx 11.55 \text{ ksi}$$

11.52



$$\frac{(154.2 - 139')}{154.2} = \frac{\Delta f_{pier}}{11.55}$$

$\Delta f_{pier_A} \approx$ 1.14 ksi ← loss @ pier

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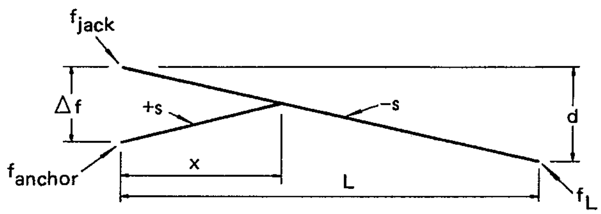
5.6.2 Derivation of Formulas for Calculating the Effects of Anchor Set

The effects of anchor set on tendon stresses may be calculated with sufficient accuracy for most conventional applications in accordance with the diagram and formulas presented below.



Δf = Change in stress due to anchor set, ksi
d = Friction loss in length, L, ksi
x = Length influenced by anchor set, ft
L = Length to point where loss is known, ft
ΔL = Anchor set, in.
E = Modulus of elasticity, ksi

$$E = \frac{\text{Unit Stress}}{\text{Unit Strain}} = \frac{favg}{\Delta L/x} = \frac{favg\ x}{\Delta L}$$

$$favg = \frac{E\,\Delta L}{x}$$

$$\frac{\Delta f}{2} = \frac{E\,\Delta L}{12x} \qquad \text{Units Correct}$$

$$\Delta L = \frac{Pavg\ x}{A\,E} = \frac{favg\ x}{E}$$

$$favg = \frac{E\,\Delta L}{x}$$

$$\frac{\Delta f}{2} = \frac{E\,\Delta L}{12x} \qquad \text{Units Correct}$$

$$\Delta f = \frac{E\,\Delta L}{6x} \qquad \underline{\Delta L \ \&\ x \text{ Known}}$$

by similar triangles

$$\frac{x}{\Delta f/2} = \frac{L}{d}$$

$$\Delta f = \frac{2 \times d}{L} \qquad \underline{x \text{ Known}}$$

$$x = \frac{\Delta f\ L}{2d}$$

$$x = \frac{E\,\Delta L\ L}{6x\ \ 2d}$$

$$x^2 = \frac{E\,(\Delta L)L}{12\ \ d}$$

$$x = \sqrt{\frac{E(\Delta L)L}{12\ \ d}} \qquad \underline{\Delta L \text{ Known}}$$

$$\text{Also from } \Delta f = \frac{E\,\Delta L}{6x} \quad \& \quad \Delta f = \frac{2 \times d}{L}$$

$$x = \frac{E\,\Delta L}{6\,\Delta f} = x = \frac{L\,\Delta f}{2d}$$

$$\Delta f^2 = \frac{E\,\Delta L\ d}{3L}$$

$$\Delta f = \sqrt{\frac{E\,\Delta L\ d}{3L}} \qquad \underline{\Delta L \text{ Known}}$$

When measuring anchor set, the tendon elongation within the jack must be considered:

Jacking to .75f's = .75(270) = 202.5 ksi
5/8" required anchor set
4' jack used (ΔL)
E = 27 x 10^3 ksi

$$\Delta L = \frac{f\,L}{E} = \frac{202.5\ \ 4 \times 12}{27 \times 10^{-3}} = .36''$$

Total elongation lost during anchor set
= ΔL + 5/8"
= .36" + .625"
= 1" ±

For simplicity use ΔL
= 1/12" per foot of jack.

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

DECK POST-TENSIONING LOSSES (cont.)

5.9.5.2.2 Friction

$$\Delta f_{pF} = f_{pj}\left(1 - e^{(-kx + \mu\alpha)}\right) \quad (5.9.5.2.2b-1)$$

$K = .0002$ Table 5.9.5.2.2 b-1

$\mu = .23$

$X_{total} = 86' + 148' + 134' = 368'$

assume post tensioning from both ends

$X_{max} = 368/2 \approx 184'$

X_{max} to pier $\approx 139' \pm$

assum $\alpha \approx 0°50' = .00873$ radians

$$\Delta f_{pF} = (.75)(270)\left(1 - e^{[-(.0002)(139') + .25(.00873)]}\right)$$

$\Delta f_{pF} \approx \underline{5.12 \text{ Ksi}}$ ← (~2½ %) loss @ pier

5.12

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		Anchorage Loss	Friction Loss	KL+μα
	ℓ point 1.0	11.55 ksi	0	0
	ℓ point 2.0 ≈ 73.6'	6.04 ksi	2.52 ksi	.017
Pier 2	ℓ point 3.0 ≈ 96.6'	4.31 ksi	3.44 ksi	.021
	ℓ point 4.0 ≈ 144.6'	.72 ksi	5.34 ksi	.031
Pier 3	ℓ point 5.0 ≈ 121.6'	2.44 ksi	4.43 ksi	.026
	ℓ point 6.0	11.55 ksi	0	0

$$\text{Initial Stress Ratio} = \frac{[.75(270) - 6.04 - 2.52 - 2.63]}{.75(270)} = .945$$

	ISR (without Es)
pt 2	.958
pt 3	.962
pt 4	.970
pt 5	.966
pt 1	.943
pt 6	.943

↑
USE

Elastic Shortening is recovered during jacking process 2.63 ksi)

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COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

Elongation

$$\Delta = \frac{f_s L}{E_s} = \frac{.75(270) * 366.25' * 12''/ft}{28500}$$

$$\Delta = 31.23''$$

friction loss + anchorage loss @ 5.0 = 2.44 + 4.43 = 6.87 ksi ← controls

$$\Delta = \frac{6.87\ (366.25)(12'')}{28500} = 1.06''$$

friction loss + anch. loss @ 4.0 = 5.34 + .72 = 6.06 k

$$\Delta = \frac{6.06\ (366.25)(12'')}{28500} = .93''$$

friction loss & anchor loss @ 2.0 = 6.04 + 2.52 = 8.56 ksi ← controls

friction loss & anchor loss @ 3.0 = 4.31 + 3.44 = 7.75 ksi

$$\Delta = \frac{(8.56)\ (366.25)(12'')}{28500} \approx 1.32''$$

max ≈ 31.23 + 1.32 ≈ 32.55''

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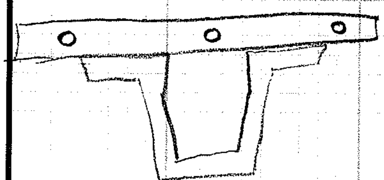
5.9.5.2.3 b <u>ELASTIC SHORTENING</u>

$$\Delta f_{pES} = \frac{N-1}{2N} \frac{E_p}{E_{ci}} f_{cgp} \qquad (5.9.5.2.3b\text{-}1)$$

or

$$\Delta f_{pES} = \frac{N-1}{2N} \frac{A_{ps} f_{pbt} (I_g + e_m^2 A_g) - e_m M_g A_g}{A_{ps} (I_g + e_m^2 A_g) + \frac{A_g I_g E_{ci}}{E_p}} \qquad (C5.9.5.2.3b\text{-}1)$$



assume 10 conduit with 4 strand each
$N = 40$

$A_{ps} = (10)(4)(.217) = \underline{8.68 \text{ in}^2}$

$f_{pbt} \approx .9 f_{py}$ or $.74 f_{pu}$

$f_{py} = .9 f_{pu} \approx .9(270) = 243$ ksi

$f_{pbt} \approx \overset{.9 f_{py}}{218.7}$ or $\overset{.74 f_{pu}}{199.8}$ ksi

use $f_{pbt} = \underline{218.7 \text{ ksi}}$ (conservative)

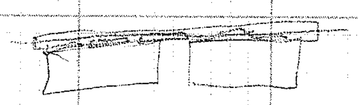
$M_{girder} \approx 483$ ft k

$M_{selfwt} = 3875.3$ ft k

neg. moment $= .1\, w\ell^2$

$\ell = 148'$

$w = (25')\left(\frac{8''}{12''}\right) .15 \text{ k/cf} \approx 2.5$ k/ft



$M_g \approx (.1)(2.5)(148)^2 \approx 5476$ ft k $= \underline{65712 \text{ in kip}}$

$E_{ci} = \underline{4069.64 \text{ ksi}}$

$E_p = \underline{28500 \text{ ksi}}$

$e_m \approx 0$

$A_g = (25')\left(\frac{12''}{ft}\right) 8'' = 2400 \text{ in}^2$

$I_g = \frac{bh^3}{12} = \frac{(25)(12)(8)^3}{12} \approx 12800$

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$$\Delta f_{pES} = \frac{40-1}{2(40)} \frac{(8.68)\,218.7\,(12800+0) - 0}{8.68\,(12800+0) + 2400\,(12800)\,\frac{4069.64}{28500}}$$

$$\Delta f_{pES} = \underline{2.613 \text{ ksi}}$$

2.18 ksi for 33 strands

TIME DEPENDENT LOSSES

$$\Delta f_{pSR} \approx \phi$$

$$\Delta f_{pCR} \approx \phi$$

$$\Delta f_{pR1} \approx \phi$$

$$\Delta f_{pR2} = 1.2 \text{ ksi} \quad (= \Delta f_{pR1})$$

$$\Delta f_{pSD} = TBD$$

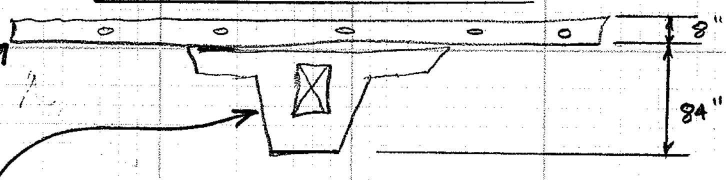
$$\Delta f_{pCD} = TBD$$

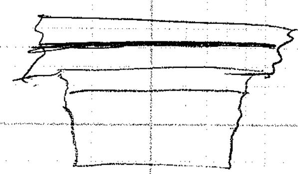
SHRINKAGE LOSS

$$\Delta f_{pSD} = \varepsilon_{bdf}\, E_p\, K_{df}$$

$$K_{df} = \frac{1}{1 + \frac{E_p}{E_{ci}} \frac{A_{ps}}{A_c}\left(1 + \frac{A_c e_{pc}^2}{I_c}\right)\left[1 + .7\,\psi_b(t_f, t_i)\right]}$$

SHRINKAGE LOSS





$A_G \approx 5450.77 \text{ in}^2$

$I_{33} = 3751787 \text{ in}^4$ $\qquad f'_c = 4.5 \text{ ksi}$

$y_{cg} \approx 47.761 \text{ in}$ $\qquad E_c \approx 3860.80$

$A_{Deck} = 8'' * 25' \approx 2400 \text{ in}^2$

$I_{g\,deck} = 12800 \text{ in}^4$ $\qquad f'_c = 7.2 \text{ ksi}$

$E_c \approx 4883.57$ $\qquad n = .79$

$$A_c = 2400 \text{ in}^2 + \frac{3860.8}{4883.57}(5450.77) = \underline{6709.21 \text{ in}^2}$$

$$y_c = \frac{(.79)(5450.77)(47.761) + 2400 \text{ in}^2 (88'')}{(.79)(5450.77) + 2400 \text{ in}^2}$$

$$y_c \approx 62.16''$$

$$I_c = 3751787 + .79(5450.77)(62.16 - 47.761)^2 + 12800 + 2400(62.16 - 88'')^2$$

$$I_c \approx \underline{6{,}259{,}871 \text{ in}^4}$$

$$e_{pc} \approx 62.16'' - 88'' \approx \underline{25.84''}$$

$$\psi(t_f, t_i) = 1.9\, K_s\, K_{hc}\, K_F\, K_{td}\, t_i^{-.118} \qquad (5.4.2.3.2\text{-}1)$$

$$K_s = 1.45 - .13(V/S) \geq 1.0 \qquad (5.4.2.3.2\text{-}2)$$

$$V/S = \frac{45.358 - 7.5}{16.42467} \approx 2.3$$

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COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

$K_s \approx 1.45 - .13(2.3) \approx \underline{1.15}$

$K_{hc} = 1.56 - .008H$ (5.4.2.3.2-3)

$H = 55\%$

$K_{hc} = 1.56 - .008(55)$

$\underline{1.12}$

$K_f = \dfrac{5}{1+f'_{ci}}$ (5.4.2.3.2-4)

$f'_{ci} = .8f'_c = .8(4.5) \approx 3.6$ ksi of concrete class D

$K_f = \dfrac{5}{1+5} \approx .833$

$f'_{ci} = 5$ ksi for deck slabs

$= 7.2$ ksi for post-tensioning

$K_{td} = \left(\dfrac{t}{61-4f'_{ci}+t}\right)$ (5.4.2.3.2-5)

$t = 18250$

$K_{td} = \dfrac{18250}{61-4(5)+18250} \approx .998$

$t_i \approx 30$ days

$\psi(t_f, t_i) = 1.9(1.15)(1.12)(.8333)(.998)\ 30^{-.118}$

$\psi(t_f, t_i) \approx 1.362$

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(5.9.5.4.3a-2)

$$K_{df} = \frac{1}{1 + \frac{E_p}{E_{ci}} \frac{A_{ps}}{A_c}\left(1 + \frac{A_c e_{pc}^2}{I_c}\right)\left[1 + .7\psi_b(t_f, t_i)\right]}$$

$$K_{df} = \frac{1}{1 + \frac{28500}{3860.8}\left(\frac{8.68}{5806.73}\right)\left(1 + \frac{5806.73(25.84)^2}{6259871}\right) + \left[1 + .7(1.382)\right]}$$

$$K_{df} \approx \underline{.338}$$

$$\Delta f_{pSD} = \varepsilon_{bdf} E_p K_{df}$$

$$\varepsilon_{bdf} = K_s K_{hs} K_f K_{td}\left(0.48 \times 10^{-3}\right) \qquad 5.4.2.3.3-1$$

$K_s = 1.15$

$K_{hs} = 2 - .014 H = 2 - .014(.55) = \underline{1.992}$

$K_f = .833$

$K_{td} = .998$

$$\varepsilon_{bdf} \approx (1.15)(1.992)(.833)(.998)(0.48 \times 10^{-3}) = .000914$$

$$\Delta f_{pSD} = (.000914)(28500)(.338)$$

$$\Delta f_{pSD} = 8.81 \quad \text{Ksi}$$

CREEP LOSS

$$\Delta f_{pCD} = \frac{E_p}{E_{ci}} f_{cgp}\left[\psi_b(t_f, t_i) - \psi(t_d, t_i)\right] K_{df}$$

$$+ \frac{E_p}{E_c} \Delta f_{cD}\, \psi(t_f, t_d)\, K_{df} \qquad (5.9.5.4.3b-1)$$

$K_{df} = .338$

$E_p = 28500$ ksi

$E_{ci} = 4883.57$ [3860.8 Pier Concrete]

$$f_{cg_p} = \frac{P_t}{A} + \frac{P_t e}{I} y + \frac{M_g y}{I}$$

$P_t = (5)(4)(.217)(.74)(270) = 188.17$ Kips

$A = 6709.21\ in^2$

$e \approx 25.84''$

$I_c = 6259871\ in^4$

$M_g = \phi$ @ pier (selfweight)

$$f_{cg_p} = \frac{188.17}{6709.21} + \frac{188.17(25.84)(25.84)}{6259871} + 0$$

$f_{cgp} \approx .048$ Ksi

$$\psi(t, t_i) = 1.9 K_s K_{hc} K_f K_{td} t_i^{-.118}$$

t_i = age of concrete at time of load application $\approx$ 30 days

t_f = 18250 days (50 yrs)

t_d = age at deck placement

$K_s = 1.15$

$K_{hc} = 1.12$

$f'_{ci} = 5$ ksi for slabs

$K_f = \frac{5}{1+f'_{ci}}$

$K_f = \frac{5}{1+5} = \underline{.8333}$

$\underline{K_{td} = .998}$

$\psi(t_f, t_i) = 1.9(1.15)(1.12)(.833)(.998)\ 30^{-.118}$

$\underline{\psi(t_f, t_i) = 1.362}$

$\underline{K_{df} = .338}$

$t_i = t_d \approx 30$ days

$\psi(t_f, t_d) = \underline{1.362}$

$\psi(t_d, t_i) = 1.9\ K_s\ K_{hc}\ K_f\ K_{td}\ t_i^{-.118}$

$K_s = 1.15$

$K_{hc} = 1.12$

$K_f = .833$

$K_{td} = \frac{t}{61 - 4f'_{ci} + t} = \frac{30}{61 - 4(5) + 30} = .423$

$\psi(t_d, t_i) = 1.9(1.15)(1.12)(.833)(.423)\ 30^{-.118}$

$\psi(t_d, t_i) = \underline{.577}$

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

longterm losses between transfer & deck placement ≈ 0

deck weight $\approx \phi$

superimposed loads = DW

$$\Delta f_{cd} = \cancel{\frac{\Delta P}{A_c}}^{0} + \cancel{\frac{\Delta P e y}{I_c}}^{0} + \cancel{\frac{M_g y}{I_g}}^{0} + \frac{M_c y}{I_c}$$

$M_{c_{DW}} \approx 574$ ft k

$$\Delta f_{cD} = \frac{(574)(12)(25.84)}{6259871} \approx \underline{.0284}$$

$$\Delta f_{p_{CD}} \approx \frac{28500}{4883.57}(.048)\left[1.362 - .577\right] .338$$

$$+ \frac{28500}{4883.57}(.0284)(1.362) .338$$

$$\Delta f_{p_{CD}} = .15 \text{ Ksi}$$

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TOTAL POST-TENSIONING LOSSES

$\Delta f_{p,er_A} = 1.12$ ksi — anchorage set

$\Delta f_{pf} = 5.16$ ksi — friction loss

$\Delta f_{pES} \approx 2.73$ ksi — Elastic Shortening

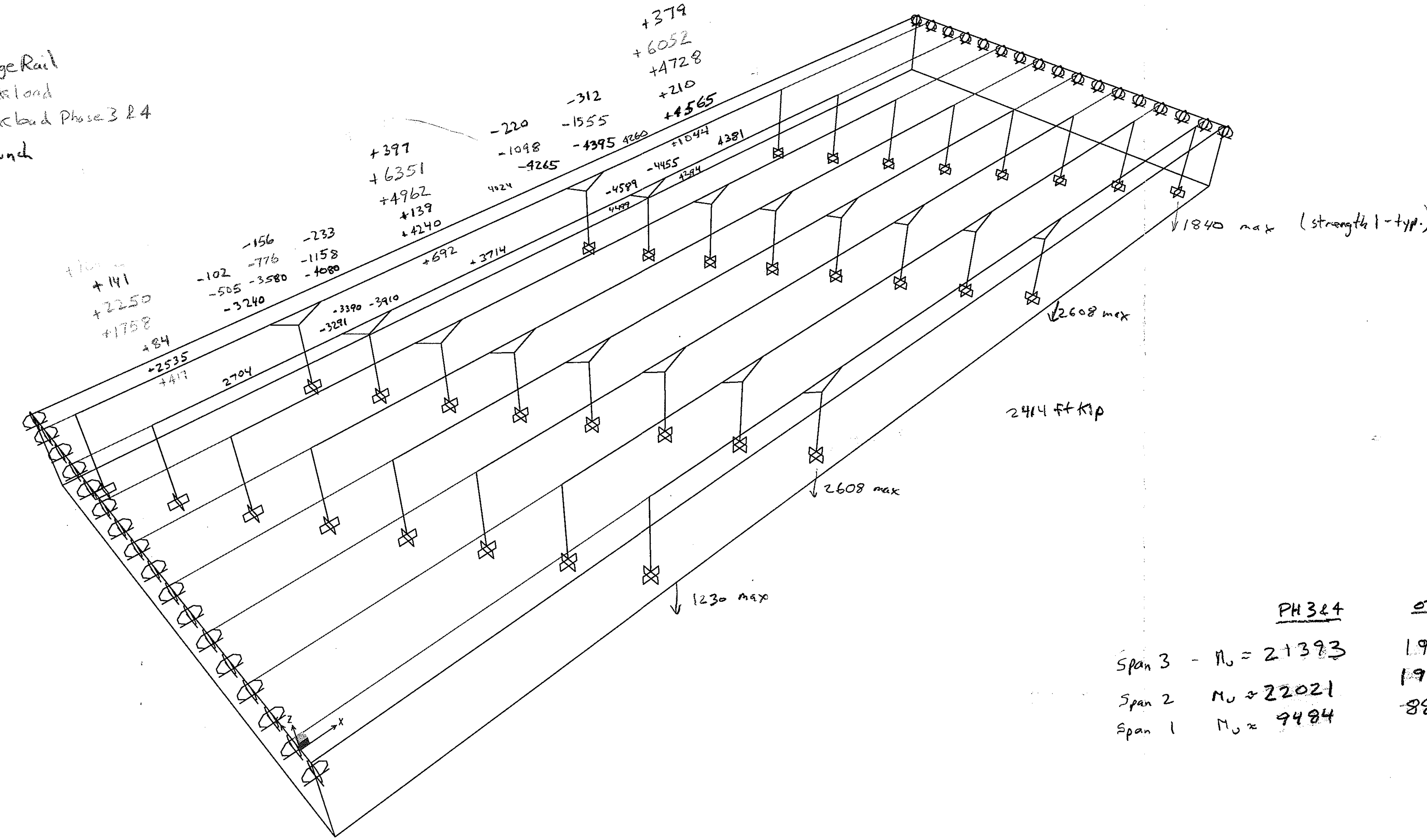
$\Delta f_{pR2} = 1.2$ ksi — Relaxation

$\Delta f_{p,SD} \approx 8.81$ ksi — Shrinkage

$\Delta f_{pCD} \approx 0.15$ ksi — Creep

Total Loss $\approx$ 19.17 Ksi

lead pencil - HL93
blue pencil - DW
purple pencil - Bridge Rail
green pencil - deckload
orange pencil - deckload Phase 3 & 4
brown pencil - Haunch



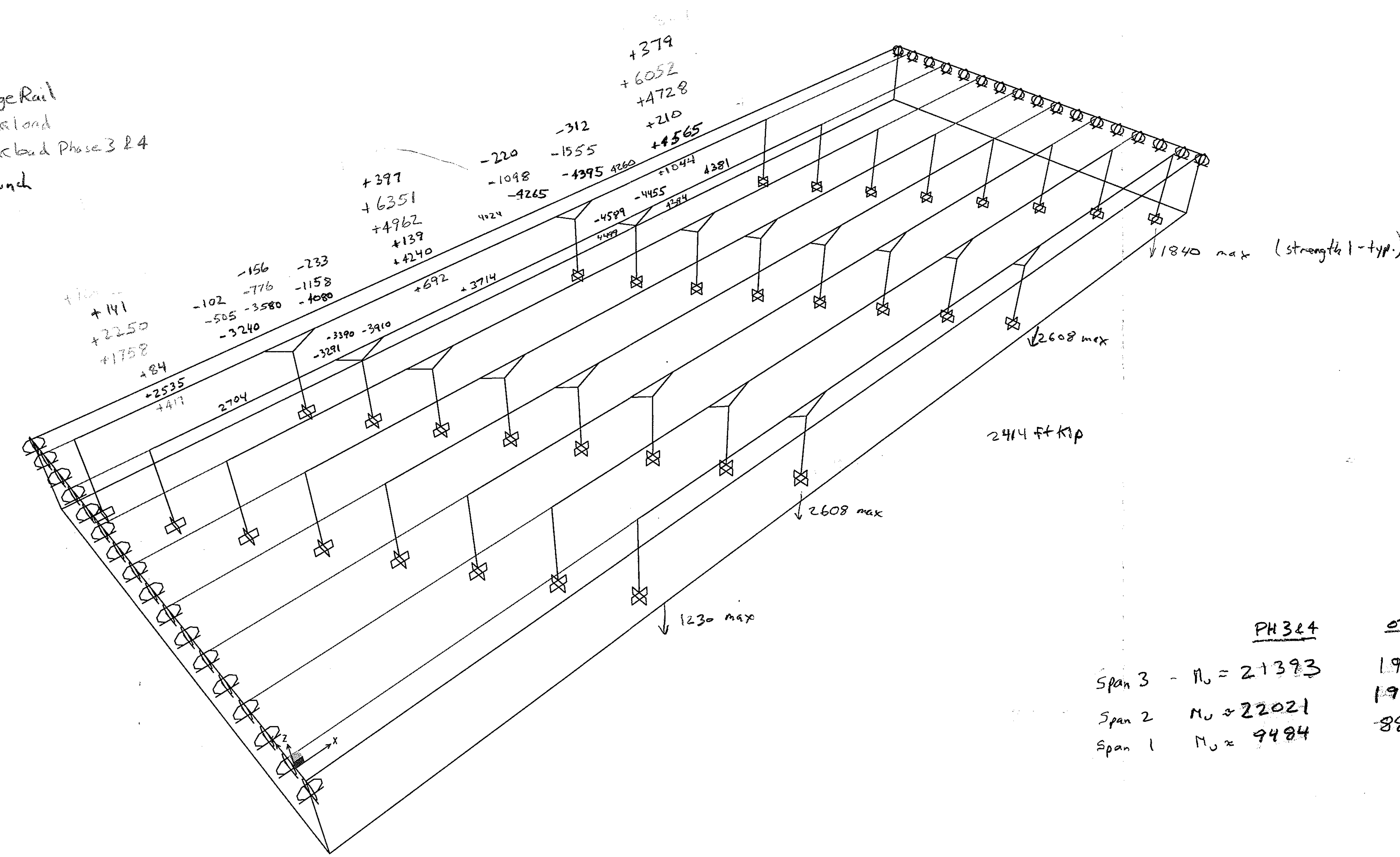
		PH 3&4	OTHER
Span 3	M_u =	21393	19738
Span 2	M_u =	22021	19021
Span 1	M_u =	9484	8869

90'

75'

SAP2000 v8.3.8 - File:72InchTubs-pinnedpier_126CenterSpan - 3-D View - Kip, ft, F Units

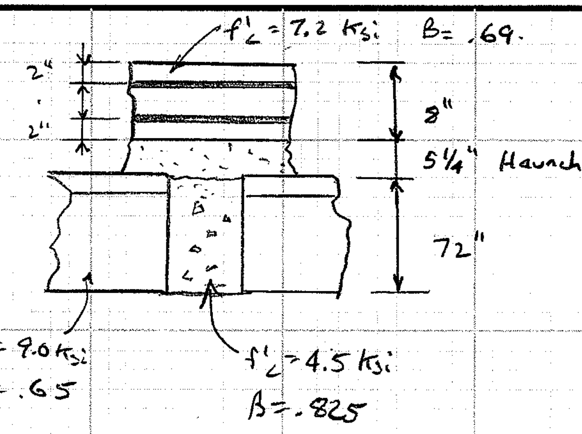
lead pencil - HL93
blue pencil - DW
purple pencil - Bridge Rail
green pencil - deck load
orange pencil - deck load Phase 3 & 4
brown pencil - Haunch



	PH 3&4	OTHER
Span 3 - M_u =	21393	19738
Span 2 M_u =	22021	19021
Span 1 M_u =	9484	8869

90'
75'

STRENGTH



#5 @ 12" nominal

$\approx .31 \text{ in}^2$ @ 25'

$\approx 7.75 \text{ in}^2$ @ each level

use 15 in^2 @ center

$$c = \frac{A_{ps} f_{ps} + A_s f_s}{.85 f'_c \beta b} \qquad 5.7.3.1.2\text{-}4$$

FOR MILD STEEL ONLY

$$c = \frac{(15)(60)}{.85(4.5)(.825)54''}$$

$$c \approx 5.282'' \qquad a = \beta c$$

$$M_n = A_s f_s \left(d_s - a/2\right) \qquad (5.7.3.2.2\text{-}1)$$

$$M_n = 15(60)\left(72 + 5.25 + 4 - \frac{.825(5.282)}{2}\right)$$

$$M_n \approx 71164 \text{ in kip} \approx 5930.3 \text{ ft kip}$$

FOR POST TENSIONING ONLY

9 1/2 conduits (min)
11 conduits (max)

min. $9\frac{1}{2} \times 4$ strands $\approx$ 38 strands for ultimate

loss = 19.17 ksi

$$c = \frac{38(.217)\left[.75(270) - 19.17\right]}{.85(4.5)(.825)(54'')}$$

$$c \approx 8.872''$$

$$M_n = A_{ps} f_{ps}\left(d_p - a/2\right) + A_s f_s \left(d_s - a/2\right) \qquad (5.7.3.2.2\text{-}1)$$

$$M_n = 38(.217)\left[.75(270) - 19.17\right]\left[72'' + 5.25'' + 4'' - \frac{.825\ (8.872)}{2}\right]$$

$$M_n \approx 117296 \text{ in kip} \approx 9774.7 \text{ ft kip}$$

$$M_R = \phi M_n = .9(9774.7) \approx 8797.2 \text{ ft kip}$$

$M_U \approx 4394(1.75) + 1536(1.5) + 308(1.25)$ (from SAP 2000)

$\underline{M_U \approx 10378.5 \text{ ft k}}$

$M_{R(min)} = 1.33 M_U = 13803.4$ ft k @ bearing (5.7.3.3.2)

FOR MILD STEEL + POST TENSIONING

3% drop to end of girder

$M_{R(min)} = 13390$ ft k

$$C = \frac{38(.217)[.75(270) - 19.17] + 15(60)}{.85(4.5)(.825)(54")}$$

$C \approx 14.153"$

$a \approx \beta c = .825(14.15) = 11.68$

$$M_n = 38(.217)[.75(270) - 19.17]\left[72" + 5.25" + 4" - \frac{.825(14.153)}{2}\right]$$

$$+ 15(60)\left[72" + 5.25" + 4" - \frac{.825(14.153)}{2}\right]$$

$M_n = 114003.1 + 67870.7 = 181873.8$ in kip

$M_n \approx 15156.1$ ft kip

$M_R = \phi M_n \approx .9(15156.1) = 13640.5$ ft kip

$M_R > M_U$ ✓ okay

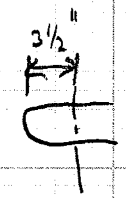
$M_{\text{Mild Steel Required}} = 10378.5 - .9\left(\frac{114003.1}{12}\right) \approx 1828.3$ ft k

$M_{\text{Mild Steel Provided}} = \frac{67870.7}{12} = 5655.9$ ft k

$$\frac{As_{reqd}}{As_{provided}} = \frac{M_{reqd}}{M_{provided}} = \frac{1828.3}{5655.9} \approx .323$$

need 32.3% of steel strength

$$l_{hb} = \frac{38.0\, d_b}{\sqrt{f'_c}} = \frac{38(5/8)}{\sqrt{7.4}} = 8.73"$$ (5.11.2.4.1-1)



$l_{dh} = (1.2)(.7)(.323)(8.73") \approx 2.37" > 6"$

epoxy — side cover > 2.5" — $\frac{As_{reqd}}{As_{provide}}$

distance past ℄ joint = 3.5" — 3.5/6" = 58.3% strength provided

$M_n = [114003.1 + .583(67870.7)]\, 1/12 = 12797.6$ ft kip

$M_R = .9(12797.6) = 11517.9$ ft kip $> M_U$ ✓ okay

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DESIGN COMPUTATIONS (Grid)

STRENGTH @ GIRDER BEARING

girder = 9 ksi $\quad\quad \beta = .6$

$$c = \frac{38(.217)\left[.75(270) - 19.17\right] + 15(60)}{.85(9.0)\ .6(54")}$$

$$c = 9.73"$$

$$M_n = A_{ps} f_{ps} (d_p - a/2) + A_s f_s (d_s - a/2)$$

$$M_n = 38(.217)\left[.75(270) - 19.17\right]\left[72" + 5.25" + 4" - \frac{.6(9.73)}{2}\right]$$
$$+ 15(60)\left[72" + 5.25" + 4" - \frac{.6(9.73)}{2}\right]$$

$$M_n = (118416.0 + 70497.9)\frac{1}{12}$$

$$M_n = 15742.8 \text{ ft k}$$

$$M_R = (.9)(15742.8) \approx 14168.5 \text{ ft k}$$

$M_R > M_u$ okay $\quad M_u = 10378.5$ ft k

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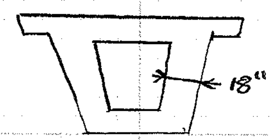
DESIGN COMPUTATIONS (Grid)

$$f_{top} = \frac{Pe}{A} + \frac{Mc}{I}$$

<u>Assumed Pier Section</u>



$I = 2256570 \text{ in}^4$

$y_{cg} = 41.25"$

$A = 4150.57 \text{ in}^2$

<u>Girder Info</u>

$I = 1154251.7 \text{ in}^4$

$y_{cg} = 35.84"$

$A = 1765.15 \text{ in}^2$

$M_{service\ Max}$ @ bearing $\approx 4394 + 1536 + 308 \approx 6238$ ft K

PIER PROPERTIES

8" Deck, 25' wide

assume 4" of haunch

$f'_c = 4.5$ $\quad E = 3860.80$

$f'_{c\,deck} = 7.2$ ksi $\quad E = 4883.57$

$f'_{c\,girder} = 9$ ksi $\quad E = 5460.0$

$$\bar{Y}_{cg} = \frac{41.25\,(4150.57) + \frac{4883.57}{3860.80}(25' * 12")(8") * (72 + 4 + 4)}{4150.57 + \frac{4883.57}{3860.8}(25' * 12")(8")}$$

$$\bar{Y}_{cg} = 57.61$$

$$I_{comp} \approx 2256570 + (4150.57)(57.61 - 41.25)^2 + \frac{1}{12}(25)(12)\left(\frac{4883.57}{3860.8}\right)8^3 + \frac{4883.57}{3860.80}(25')(12)(8")(57.61 - 80")^2$$

$$I_{comp} \approx 4905536.2$$

$$S_{comp\,TOP} \approx \frac{I}{C} = \frac{4905536}{(84 - 57.61)} \approx 185886.2 \text{ in}^3$$

for 28 strands

$$f_{top} = \frac{P}{A} + \frac{Mc}{I} = \frac{P}{A} + \frac{M}{S}$$

$$f_{top} = \frac{(.74(270) - 19.17)\,28\,(.217)}{(25)'(12"/ft)(8")} + \frac{-(6238)(12)}{185886.2}$$

$$f_{top} = .457 - .403 \approx .054 \quad 54 \text{ psi (compression)}$$

< 201 psi ✓ okay

for 33 strands

$$f_{top} = \frac{(.74(270) - 19.17)\,33\,(.217)}{25\,(12)\,(8)} - .403$$

$$f_{top} = 539 - 403 \approx 136 \text{ psi}$$ (compression) ✓ okay

@ ℄ Bearing

$$Y_{cg} = \frac{(35.84)(1765.15) + \frac{4883.57}{5460}(25' \times 12''/ft)\,8'' \times (72+4+4)}{1765.15 + \frac{4883.57}{5460}(25' \times 12'')(8'')}$$

$Y_{cg} = 60.07$ in

$$I_{comp} \approx 1154251.7 + 1765.15(60.07 - 35.84)^2 + \frac{1}{12}(25)(12)\left(\frac{4883.57}{5460}\right)(8)^3 + \frac{4883.57}{5460}(25')(12''/ft)\,8''(60.07 - 80)^2$$

$I_{comp} \approx 3053098.3 \ in^4$

$$S_{comp\,top} \approx \frac{I}{c} = \frac{3053098.3}{(84 - 80.07)} \approx 127584.55 \ in^3$$

for 28 strands

$$f_{top} \approx \frac{(.74(270) - (19.17))\,28(.217)}{25'(12''/ft)(8'')} - \frac{6238\,(12)}{127584.5}$$

$f_{top} \approx .457 - .587 \approx -.130$ ksi $= -130$ psi (tension)

< 500 ✓ okay

for 33 strands

$f_{top} = 539 - 587 \approx -48$ psi (tension)

< 500 ✓ okay

< 284 ✓ okay
per 9.1 C16

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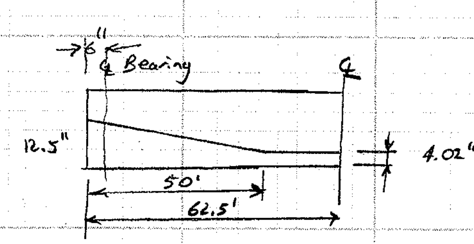
Stress @ top of Girder

$$S = \frac{3053098.3}{72 - 60.07} \approx 255917.7$$

$$\sigma = \frac{6238\,(12)}{255917.7} \approx -293 \text{ psi} \quad \left(\text{due to moment}\right)$$

Stress Due to Pretensioning

strand ht @bearing $\approx 12.5 - \left(\frac{12.5-4.02}{50}\right).5 \approx 12.42''$



strand ht @ transfer (36") $\approx 12.5 - \frac{(12.5-4.02)}{50}3 \approx 11.99''$

$P_{t\ \text{after losses}} \approx 2335.2\ K$

$M_x = .5\ w\,x\,(L-x)$

$M_g \approx (.5)\,(1.84\,k/ft)\,(.5')\,(125-.5)$

$M_g \approx 57.27\ ft\,k$

$$f_t \approx \left(\frac{1.5}{3}\right)\frac{2335.2}{1765.15} - \left(\frac{1.5}{3}\right)\frac{2335.2\,(35.84-12.42)}{(1154251.7)/36.16''} + \frac{57.27\ ft\,k\,(12)}{(1154251.7/36.16)}$$

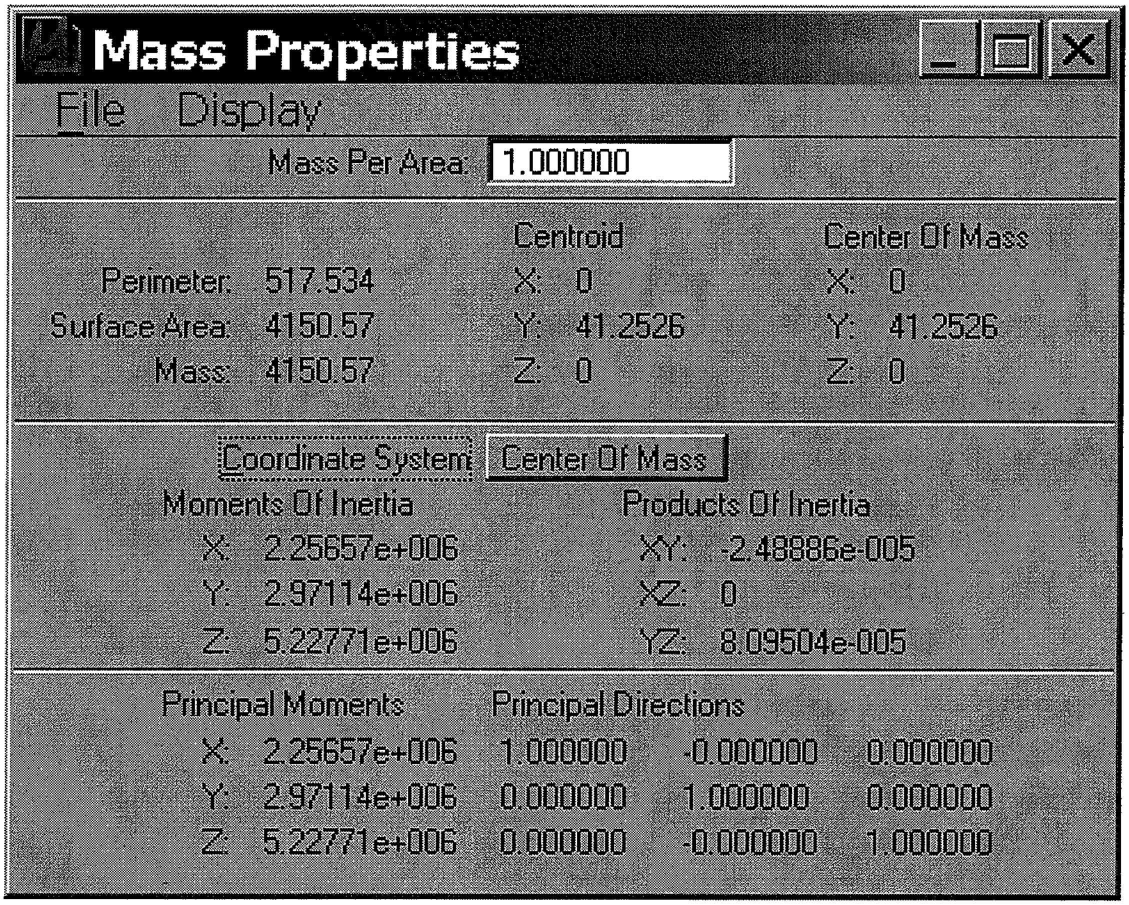
$$f_t\ \left(\frac{1.5}{3}\right)1.32 - \left(\frac{1.5}{3}\right)1.71 + .022$$

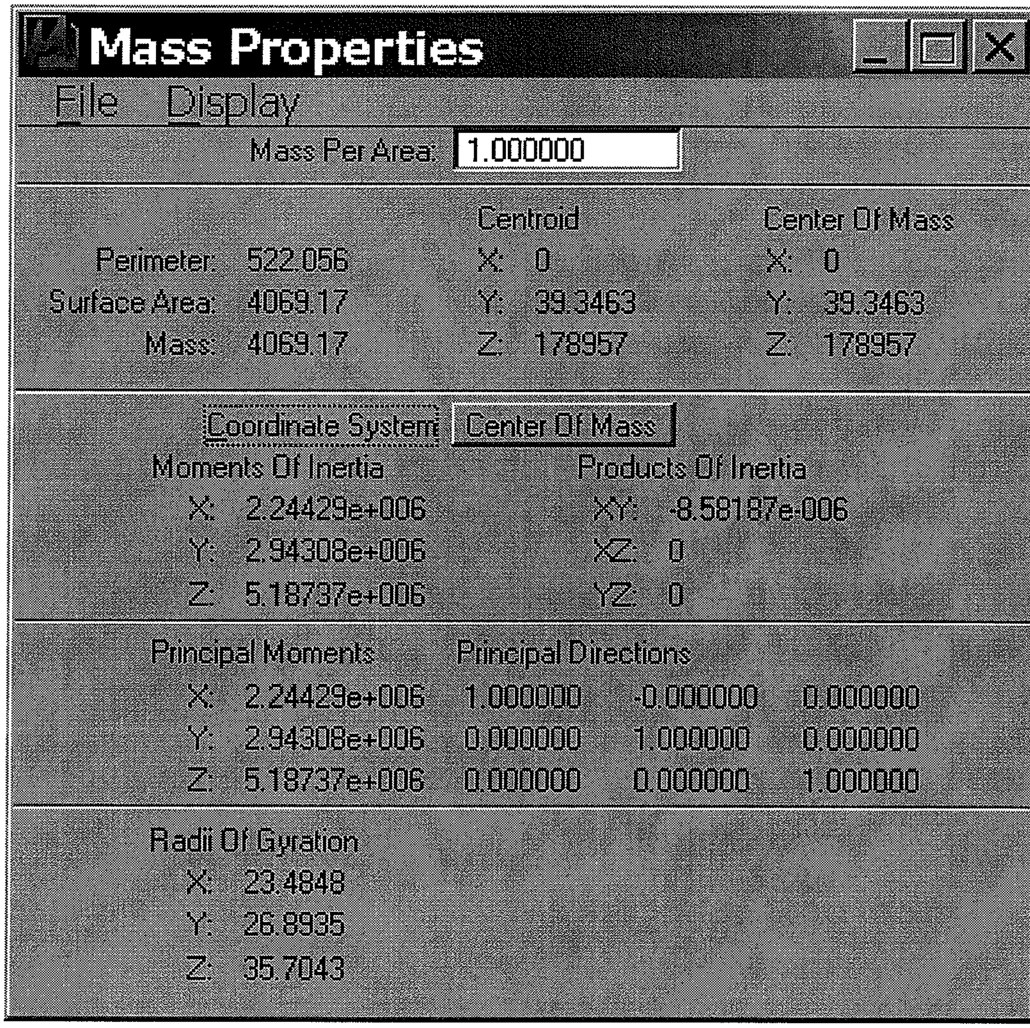
$$f_t = .22 - .285 + .022 \approx -.043\ ksi = -43\ psi$$

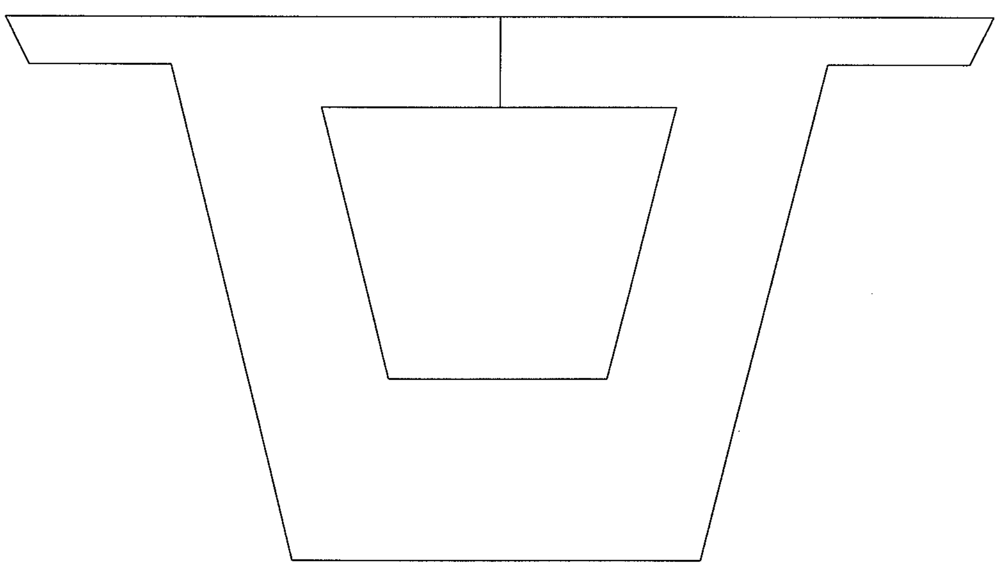
total stress $\approx -293 - 43 \approx -336$ psi < 570

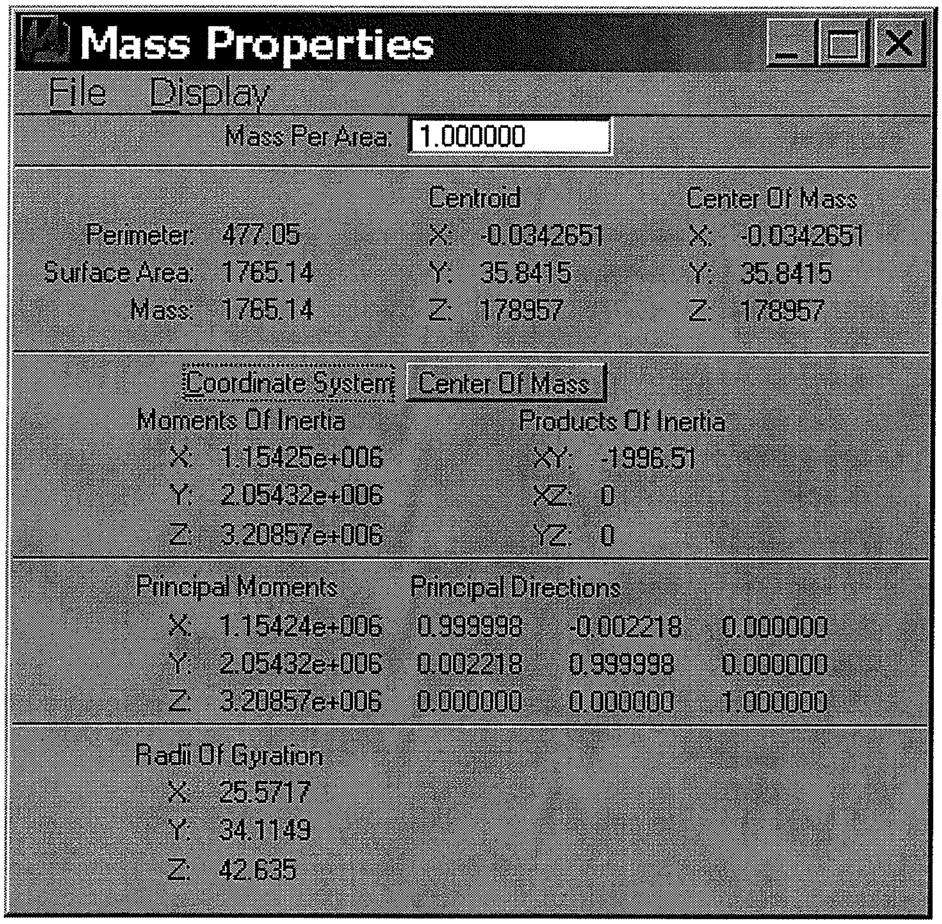
okay ✓

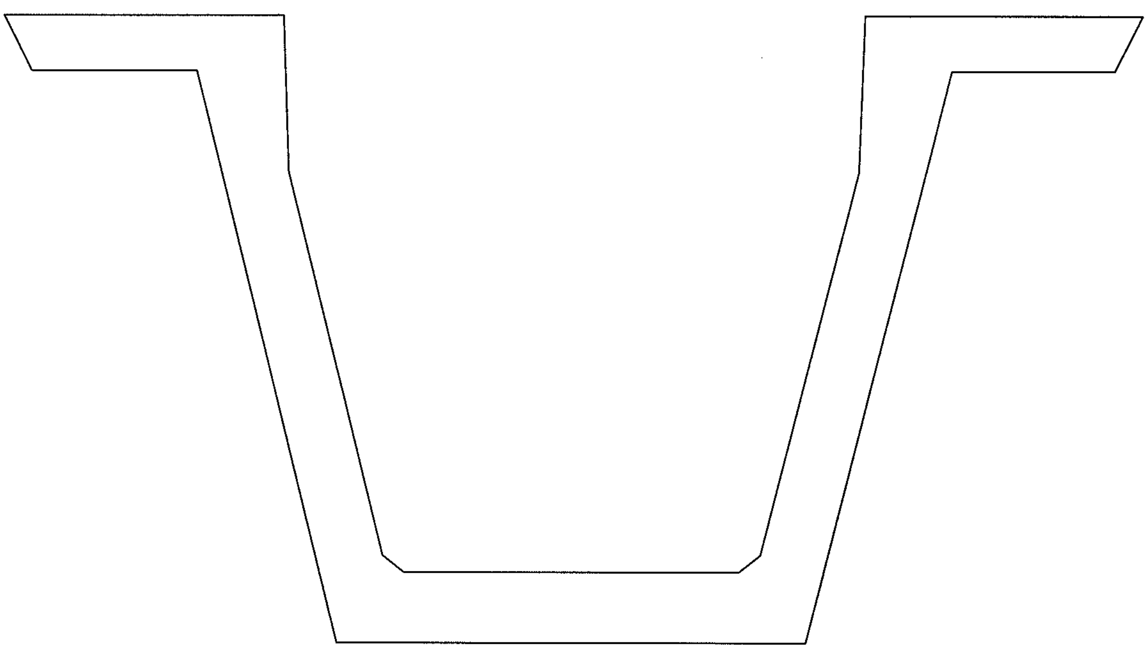
U72 shape with 18" walls




Mass Properties
File Display
Mass Per Area: 1.000000
Centroid
Center Of Mass
Perimeter: 522.056
Surface Area: 4069.17
Mass: 4069.17
X: 0
Y: 39.3463
Z: 178957
X: 0
Y: 39.3463
Z: 178957
Coordinate System
Center Of Mass
Moments Of Inertia
X: 2.24429e+006
Y: 2.94308e+006
Z: 5.18737e+006
Products Of Inertia
XY: -8.58187e-006
XZ: 0
YZ: 0
Principal Moments
Principal Directions
X: 2.24429e+006 1.000000 -0.000000 0.000000
Y: 2.94308e+006 0.000000 1.000000 0.000000
Z: 5.18737e+006 0.000000 0.000000 1.000000
Radii Of Gyration
X: 23.4848
Y: 26.8935
Z: 35.7043




Mass Properties
File Display
Mass Per Area: 1.000000
Centroid
Center Of Mass
Perimeter: 477.05
X: -0.0342651
X: -0.0342651
Surface Area: 1765.14
Y: 35.8415
Y: 35.8415
Mass: 1765.14
Z: 178957
Z: 178957
Coordinate System
Center Of Mass
Moments Of Inertia
X: 1.15425e+006
Y: 2.05432e+006
Z: 3.20857e+006
Products Of Inertia
XY: -1996.51
XZ: 0
YZ: 0
Principal Moments
Principal Directions
X: 1.15424e+006 0.999998 -0.002218 0.000000
Y: 2.05432e+006 0.002218 0.999998 0.000000
Z: 3.20857e+006 0.000000 0.000000 1.000000
Radii Of Gyration
X: 25.5717
Y: 34.1149
Z: 42.635



DECK COMPRESSION AT MIDSPAN

ASSUME HAUNCH $\approx 1''$

$$y_{cg} = \frac{(35.84)\,1765.15 + \frac{4883.57}{5460}(25'*12'')\,8''*(72+1+4)}{1765.15 + \frac{4883.57}{5460}(25'*12'')(8'')}$$

$$y_{cg} = 58.43 \text{ in}$$

$$I_{comp} = 1154251.7 + 1765.15(58.43 - 35.84)^2 + \tfrac{1}{12}(25)(12)\frac{4883.57}{5460}8^3 + \frac{4883.57}{5460}(25')(12''/ft)(8'')(58.43-77)^2$$

$$I_{comp} = 2806723.1 \text{ in}^4$$

$$S_{comp\,top} = \frac{I}{c} = \frac{2806723.1}{(81-58.43)} \approx 124356.36 \text{ in}^3$$

$$M_{service\,@\,midspan} \approx 4565 + 1044 + 210 = 5819 \text{ ft k}$$

$$f_{top} = \frac{P}{A} + \frac{M}{S}$$

$$= \frac{(.74(270) - 19.17)\,33\,(.217)}{25\,(12''/ft)\,(8'')} + \frac{5819\,(12)}{124356.36}$$

$$f_{top} = .539 + .562$$

$.729 + .562$

$f_{top} \approx 1.10$ ksi $< .6\,(7.2) = 4.32$ ksi

1.29 w/ 4 strands

stress from prestressing = 3.11 ksi ✓ okay

total $\approx 3.11 + 1.10 \approx 4.21$ ksi $>$ 4.32 ksi

7.4 ksi (minimum) use 7.4 ksi ~~Use 7.3 ksi compression in slabs @~~

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STAFF BRIDGE DESIGN MEMO: February 2, 1978

1. LONGITUDINAL GIRDER NEGATIVE DESIGN MOMENT FROM CALIFORNIA FRAME PROGRAM

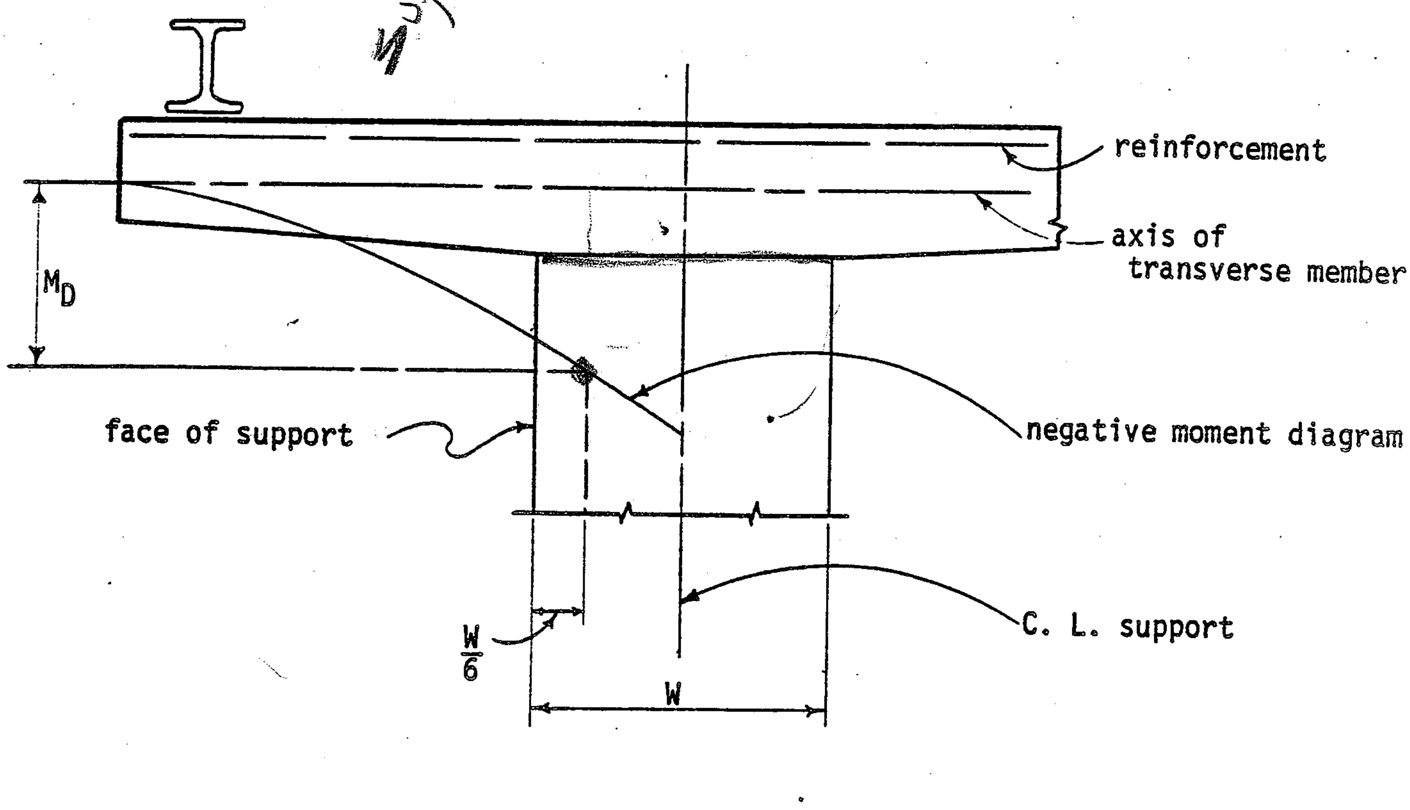
Use the numerically larger (-)M from the reported (output) (-)M left and (-)M right of any pier. Use this (-)M for reinforcement requirements at C. L. pier and also at the face of support.

2. TRANSVERSE CAP NEGATIVE DESIGN MOMENT AT COLUMN OR WALL SUPPORT

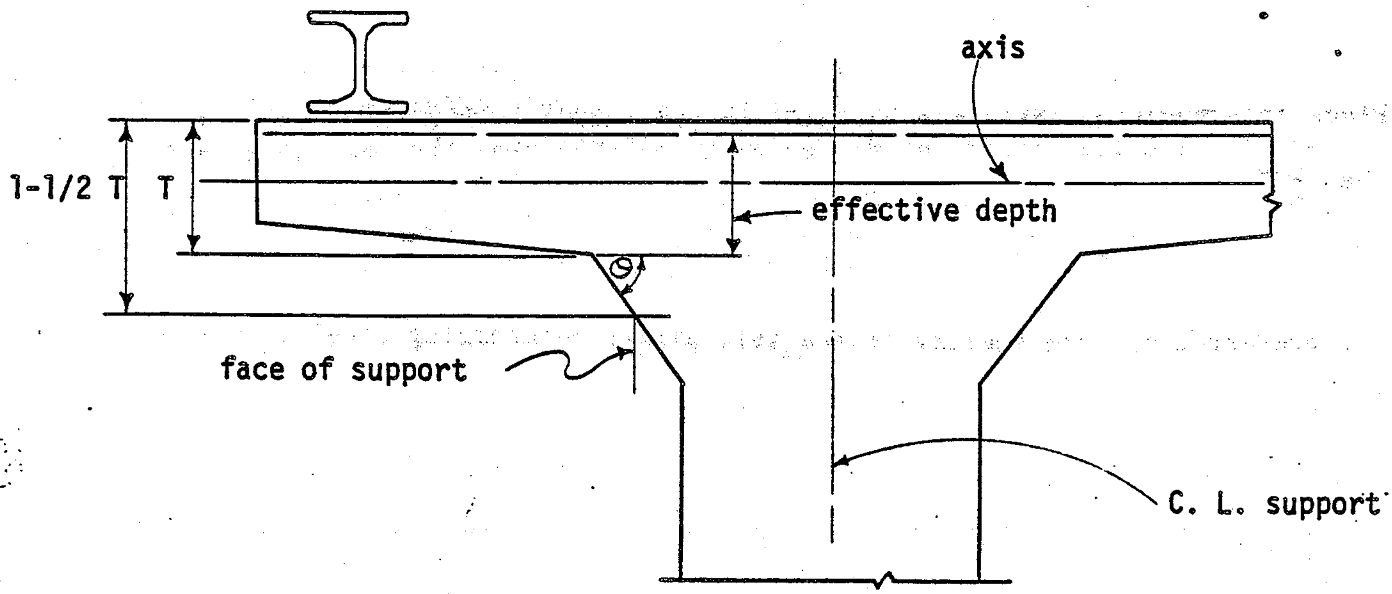
(a) Use the value of M_D shown in the sketch. Reinforce for M_D at the face of support, and continue this reinforcement amount to the C. L. support when W = 6 ft. or less.

When W > 6 ft., reinforce for M_D at face of support, continue reinforcement for development requirements, and then reinforcement may be reduced to 40% of maximum reinforcment at centerline of support.

Superseded



(b) When fillets making an angle θ of 45° or more with the axis of a continuous or restrained member and built monolithic with the member and support, the face of support shall be considered at a section where the combined depth of the member and fillet is at least 1-1/2 times the thickness of the member (T). No portion of a fillet shall be considered as adding to the effective depth. See sketch below.



Paul Chuvarsky, Staff Bridge Engineer

James E. Siebels, Assistant Staff Bridge Engineer

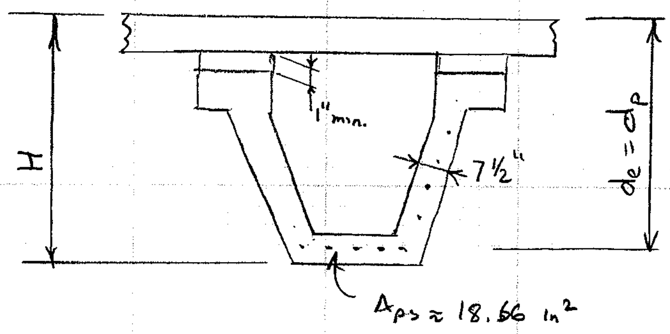
H. Henrie Henson, Assistant Bridge Engineer (Operations)

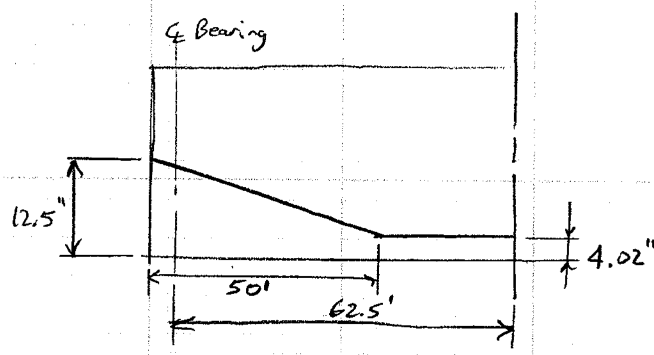
SFC:pw

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

WEB SHEAR DESIGN





USE STANDARD SPACING

OKAY PER CONSPAN

By:	Date	Project no.	Project code (SA#):
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GIRDER SHEAR @ bearing

$M_u \approx 18210.6 \text{ ft K}$

$V_u \approx 1015 \text{ K}$

$d_e \approx d_s = \underset{\text{girder}}{72''} + \underset{\text{haunch}}{5''} + \underset{\text{deck}}{8''} - 4'' \approx 81''$

$d_v = .9 d_e = .9(81) \approx 72.9''$ ← controls

$d_v = .72 H = .72(85'') \approx 61.2''$

$$\varepsilon_s = \frac{\frac{|M_u|}{d_v} + .5 N_u + (V_u - V_p) - A_{ps} f_{po}}{E_s A_s + E_p A_{ps}} \quad (5.8.3.4.2\text{-}4)$$

$A_{ps} \approx (91/2)(4)(.217) \approx 8.246 \text{ in}^2$

$A_s \approx \underset{T\&B}{\#5 @ 12''} \approx 2(.31)(25') \approx 15.5 \text{ in}^2$

$f_{po} = .7 P_u \approx .7(270) \approx 189 \text{ ksi}$

$$\varepsilon_s \approx \frac{\frac{(18210.6)}{72.9} + .5(30\text{ k}) + 1015 - (8.246)(189 \text{ ksi})}{(29000)(15.5 \text{ in}^2) + 28500(8.246)}$$

$$\varepsilon_s \approx \frac{-278.69}{684511} \approx -.000407$$

Use $\varepsilon_s = 0$

$$\beta = \frac{4.8}{1+750\,\varepsilon_s} = \frac{4.8}{1+750(0)} \approx 4.8 \quad (5.8.3.4.2\text{-}1)$$

$\theta = 29 + 3500\varepsilon_s \approx 29 + 3500(0) = 29°$ (5.8.3.4.2-3)

$V_c = .0316(4.8)\sqrt{9 \text{ ksi}}\,(54'')(72.9'')$ (5.8.3.3-3)

$V_c \approx 1791.3 \text{ K}$

for 2-7½" webs $V_c \approx 497.6 \text{ K}$

$s \approx 3.33''$ #4 + #3 $A_s \approx .62 \text{ in}^2$

$$V_s = \frac{(.62)(60)(72.9)(\cot 29° + \cot 90)\sin 90}{3''} \quad (5.8.3.3\text{-}4)$$

$V_s \approx 1630 \text{ K}$

$V_n = 1791.3 + 1630 = 3422.1 \text{ K}$

$V_r = \phi V_n = .9(3422.1) = 3079.9 \text{ K}$ ✓ okay

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Chk'd:	Date	Structure no.	Sheet 151 of

Rebar Pattern: Span 3, Beam 2

Stirrups | Neg. Moment Continuity Steel

Insert... | Copy... | Delete... | Copy To... | Graphs... | Make Symmetrical

Number of Legs	Stirrup Size	Stirrup Area (in^2)	Stirrup Spacing (in)	Start (ft)	End (ft)
3	US#4[M13]	0.600	3.33	0.0000	16.6500
3	US#4[M13]	0.600	5.00	16.6500	37.4800
3	US#4[M13]	0.600	10.00	37.4800	87.4800
3	US#4[M13]	0.600	5.00	87.4800	108.3100
3	US#4[M13]	0.600	3.33	108.3100	126.0000
*					

Auto Design

Stirrup Increment: in 6.0000

Size: US#3[M10]

Legs: 2

Auto-Design...

Stirrup Pattern

Delete | Save | Load | Save As

OK | Cancel

VERTICAL/HORIZONTAL SHEAR

VERTICAL SHEAR (Art. 5.8) - Span : 3, Beam : 2, STRENGTH I

Using General Beta Theta Tables procedure - Art.5.8.3.4.2

Location(ft)										
Vu (kips)	bv (in)	de (in)	Aps (in2)	Vp (kips)	eps_x	Theta	Vs-reqd (kips)	Av/s (in2/ft)	Av-prvd (in2/ft)	Al_reqd (in2)
Mcor (kft)	a (in)	dv (in)	fpo (ksi)	vu/fc	Vc-com (kips)	Beta	Max.spc. (in)	min.Av/s (in2/ft)	pVn/Vu	Aps* (in2)
Bearing :	0.50									
837.8	15.0	79.0	1.432	4.6	0.95e-3	36.0	682.2	1.290	2.16	21.54
-5021.7	4.1	77.0	31.5	0.089	244.1	2.23	24.00	0.284	1.495	0.459
Transfer :	3.00									
809.8	15.0	79.0	1.302	27.4	0.91e-3	35.6	624.5	1.160	2.16	6.72
-3526.7	4.1	77.0	189.0	0.084	247.8	2.26	24.00	0.284	1.600	2.754
Critical :	6.91									
766.1	15.0	79.0	1.302	27.4	1.00e-3	36.5	580.5	1.114	2.16	7.68
-1322.4	4.1	77.0	189.0	0.079	243.2	2.22	24.00	0.284	1.641	1.061
0.1L :	12.60									
702.5	15.0	78.0	14.322	27.4	-0.12e-3	20.8	197.4	0.284	2.16	0.00
1837.0	2.2	76.9	189.0	0.073	555.6	5.08	24.00	0.284	3.358	13.572
0.2L :	25.20									
558.1	15.0	76.4	17.577	27.4	-0.13e-3	21.0	28.1	0.284	1.44	0.00
8146.6	2.4	75.2	189.0	0.058	564.5	5.28	24.00	0.284	3.224	16.542
0.3L :	37.80									
412.9	15.0	77.7	17.577	27.4	-0.08e-3	20.6	0.0	0.284	0.72	0.00
12902.0	2.5	76.5	189.0	0.042	490.7	4.51	24.00	0.284	2.724	17.504
0.4L :	50.40									
271.3	15.0	79.1	17.577	0.0	-0.06e-3	20.9	0.0	0.284	0.72	0.00
15505.9	2.6	77.8	189.0	0.029	466.7	4.22	24.00	0.284	3.982	17.577
0.5L :	63.00									
142.0	15.0	79.1	17.577	0.0	-0.06e-3	20.9	0.0	0.284	0.72	0.00
16458.5	2.6	77.8	189.0	0.015	464.4	4.20	24.00	0.284	7.588	17.577
0.6L :	75.60									
282.3	15.0	79.1	17.577	0.0	-0.06e-3	20.9	0.0	0.284	0.72	0.00
15640.3	2.6	77.8	189.0	0.030	462.6	4.18	24.00	0.284	3.810	17.577
0.7L :	88.20									
428.2	15.0	77.7	17.577	27.4	-0.08e-3	20.6	0.0	0.284	1.44	0.00
12974.9	2.5	76.5	189.0	0.043	487.3	4.48	24.00	0.284	4.153	17.504
0.8L :	100.80									
573.6	15.0	76.4	17.577	27.4	-0.13e-3	20.9	54.6	0.284	1.44	0.00
8431.9	2.4	75.2	189.0	0.060	555.3	5.19	24.00	0.284	3.134	16.542

Location(ft) Vu (kips) Mcor (kft)	bv (in) a (in)	de (in) dv (in)	Aps (in2) fpo (ksi)	Vp (kips) vu/fc	eps_x Vc-com (kips)	Theta Beta	Vs-reqd (kips) Max.spc. (in)	Av/s (in2/ft) min.Av/s (in2/ft)	Av-prvd (in2/ft) pVn/Vu	Al_reqd (in2) Aps* (in2)
0.9L :	113.40									
715.6	15.0	78.0	14.322	27.4	-0.12e-3	20.8	216.1	0.284	2.16	0.00
2190.0	2.2	76.9	189.0	0.074	551.5	5.05	24.00	0.284	3.297	13.572
Critical :	119.09									
775.8	15.0	79.0	1.302	27.4	1.00e-3	36.5	591.6	1.136	2.16	7.21
-1094.5	4.1	77.0	189.0	0.080	243.0	2.22	24.00	0.284	1.620	1.061
Transfer :	123.00									
817.3	15.0	79.0	1.302	27.4	0.98e-3	36.3	637.2	1.216	2.16	6.23
-3399.2	4.1	77.0	189.0	0.085	243.4	2.22	24.00	0.284	1.546	2.754
Bearing :	125.50									
843.7	15.0	79.0	1.432	4.6	1.00e-3	36.6	692.0	1.334	2.16	21.36
-5000.0	4.1	77.0	31.5	0.090	240.9	2.20	24.00	0.284	1.458	0.459

ANCHORAGE ZONE REINFORCEMENT (Art. 5.10.10)
Span : 3, Beam : 2

Fpi (kips)	fs (ksi)	h/4 (in)	Abrst_rqrd (in2)
2988.09	20.00	18.00	5.98

HORIZONTAL SHEAR (Art. 5.8.4) - Span : 3, Beam : 2
(Beam and Slab effects are INCLUDED in Vu).

Location (ft) Vu (kips)	Vnh-req (kips)	de (in)	a (in)	dv (in)	s_max (in)	Avh-min (in2/ft)	Avh-sm (in2/ft)	Avh-rg (in2/ft)
Bearing :	0.00							
837.8	12.09	79.00	4.07	76.96	24.00	0.640	2.423	0.000
Transfer :	2.50							
809.8	11.69	79.00	4.07	76.96	24.00	0.640	2.288	0.000
Critical :	6.41							
766.1	11.06	79.00	4.07	76.96	24.00	0.640	2.078	0.000
0.1L :	12.10							
702.5	10.16	77.97	2.23	76.85	24.00	0.640	1.776	0.000

By: A. Pott
Date: Jan/22/2009
CKD:
Date:

Location (ft) / Vu (kips)	Vnh-req (kips)	de (in)	a (in)	dv (in)	s_max (in)	Avh-min (in2/ft)	Avh-sm (in2/ft)	Avh-rg (in2/ft)
0.2L :	24.70							
558.1	8.25	76.40	2.43	75.18	24.00	0.640	1.140	0.000
0.3L :	37.30							
412.9	6.00	77.73	2.55	76.45	24.00	0.640	0.391	0.000
0.4L :	49.90							
271.3	3.88	79.06	2.55	77.78	24.00	0.640	0.000	0.000
0.5L :	62.50							
142.0	2.03	79.06	2.55	77.78	24.00	0.640	0.000	0.000
0.6L :	75.10							
282.3	4.03	79.06	2.55	77.78	24.00	0.640	0.000	0.000
0.7L :	87.70							
428.2	6.22	77.73	2.55	76.45	24.00	0.640	0.465	0.000
0.8L :	100.30							
573.6	8.48	76.40	2.43	75.18	24.00	0.640	1.217	0.000
0.9L :	112.90							
715.6	10.35	77.97	2.23	76.85	24.00	0.640	1.840	0.000
Critical :	118.59							
775.8	11.20	79.00	4.07	76.96	24.00	0.640	2.124	0.000
Transfer :	122.50							
817.3	11.80	79.00	4.07	76.96	24.00	0.640	2.324	0.000
Bearing :	125.00							
843.7	12.18	79.00	4.07	76.96	24.00	0.640	2.451	0.000

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REBAR SPACING AT FLARE

$V_u \approx 1015\,k$

max shear @ abuts $\approx 680\,K$

for one 1/2 of girder $V_u \approx \frac{1015}{2} \approx 507.5\,k$

$V_c \approx 248.8\,K$

for $1\frac{1}{2}°$ rotation

#3 spaced @ 6.92" ± $\Rightarrow V_s \approx 125.4$

#4 spaced @ 6.68" ± $\Rightarrow V_s \approx 236.3$

$V_r = 248.8 + 125.4 + 236.3 \approx 610.5$

$V_n = .9(610.5) \approx 549.4\,k > V_u$ ✓ okay

need $34°/1.5° \approx 23$ rotated sets

distance = 23 (3.33") ≈ 76.6" ≈ 6'-7"

if #5s are used in lieu of #4s

for $2\frac{1}{2}°$ rotation $\Rightarrow$ 14 rotated sets $\Rightarrow$ 4'

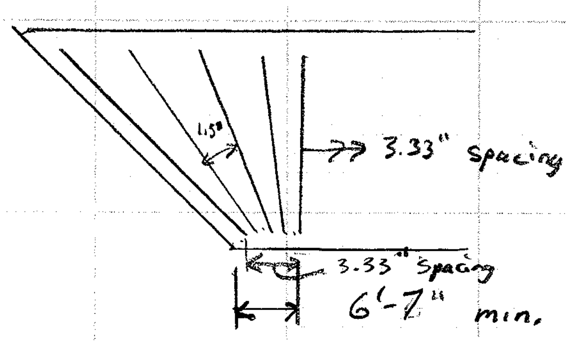
#3 spaced @ 9.3" ± $\Rightarrow V_s = 93.3\,k$

#5 spaced @ 8.9" ± $\Rightarrow V_s \approx 274.9\,k$

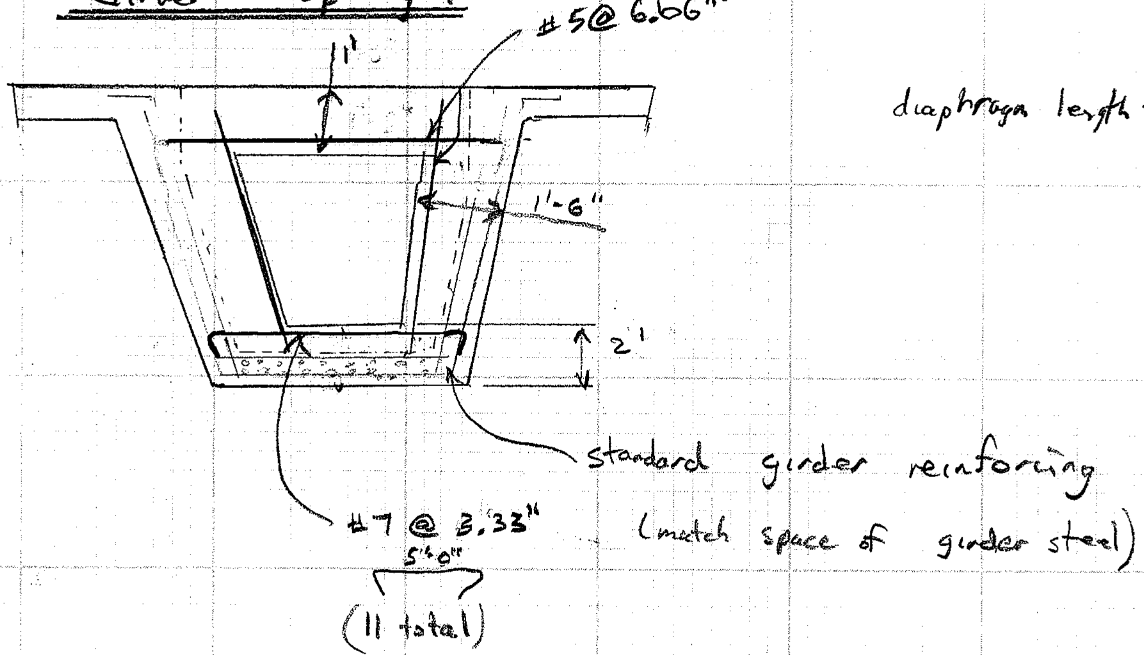
$V_r \approx 248.8 + 93.3 + 274.9 \approx 617.0\,k$

$V_n = .9\,(617.0) \approx 555.3\,k > V_u$ ✓ okay

use:



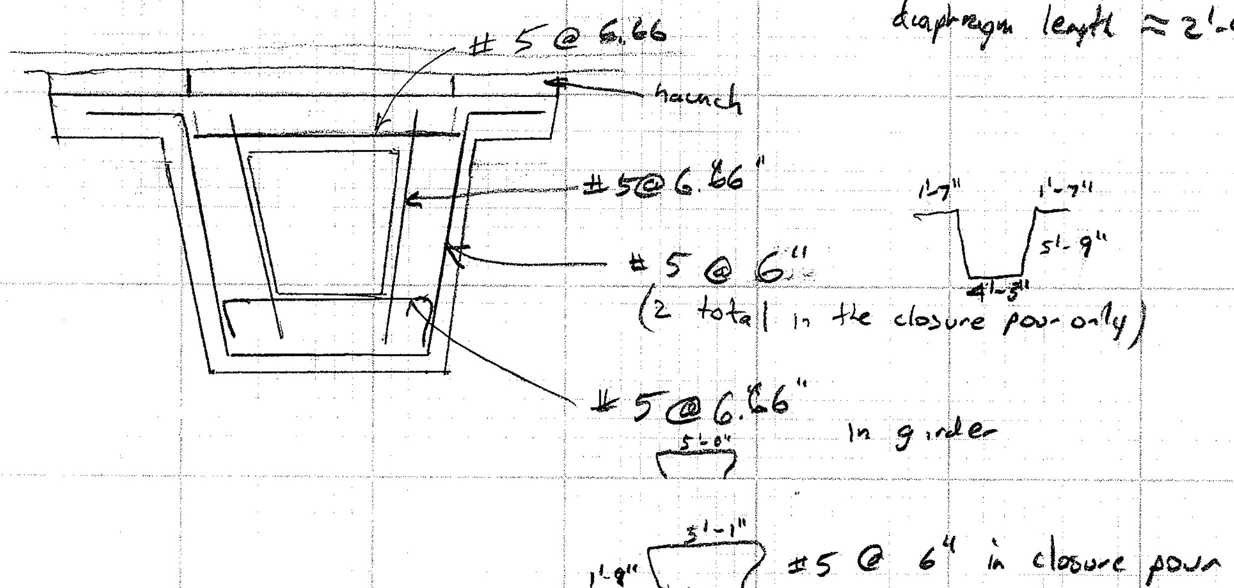
Girder Diaphragm @ Bearing



diaphragm length = 3'-4"

Closure Pour & Girder Diaphragm in 19' Girder

diaphragm length ≈ 2'-9"



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GIRDER CONNECTION AT PIER

$M_u \approx 10378.5$ ftk

$V_u \approx 1015$ K ±

for normal weight concrete placed against clean concrete surface with surface intentionally roughened to an amplitude of .25 ins

use shear keys in girder to provide roughening

$C = .24$ ksi

$\mu = 1.0$

$K_1 = .25$

$K_2 = 1.5$ ksi

$A_{cv} \simeq 12.25$ SF for U72C with no diaphragm

$A_{cv} = 28.82$ SF for U72C with diaphragm (1'-6" thick)

$V_{ni} \leq K_1 f'_c A_{cv} = .25(4.5)(12.25)(144)$ (5.8.4.1-4)

$V_{ni} \leq 1984.5$ K

$V_{ni} \leq K_2 A_{cv} = (1.5 \text{ ksi})(12.25 \text{ SF})(144)$ (5.8.4.1-5)

$V_{ni} \leq 2646$ Kips

$A_{vf\,min} \geq \dfrac{.05 A_{cv}}{f_y} = \dfrac{.05(12.25)\,144}{60} \approx 1.47 \text{ in}^2$ (5.8.4.4-1)

$P_c = 0$

$$V_{ni} = cA_{cv} + \mu\left(A_{vf} f_y + P_c\right) \quad (5.8.4.1\text{-}3)$$

$$1015 = \underbrace{(.24)(12.25)(144)}_{\text{girder}} + \underbrace{.24\,(8'')\left(25'\,\tfrac{12''}{ft}\right)}_{\text{deck}} + 1.0\left(A_{vf}\,60\text{ksi} + 0\right)$$

$$1015 = 423.36\text{k} + 576\text{k} + 60A_{vf}$$

$A_{vf} \approx .26\ in^2$ — one strand = $.217\ in^2$; extend 2 strand minimum ✓ okay

without deck:

$$1015 = 423.36\text{k} + 60A_{vf}$$

$$A_{vf} \approx 9.86\ in^2$$

for Dead Loads:

$$V \approx \left[(25')(.67')\left(\tfrac{23'}{2}\right)(.15) + (12.25\text{ SF})\left(\tfrac{23'}{2}\right).15\right]1.25$$

$$V_{max} \approx 62.6\text{ K}$$

$cA_{cv} > V_{max}$ ✓ okay

$A_{prestress} \approx .217\ in^2$ — extend all draped strands ≈ 12 strands; extend 16 bottom strands

$$28(.217) \approx 6.076\ in^2$$

$$A_{need} = 9.86 - 6.076 \approx 3.784\ in^2$$

$A_{s\,deck} = 7.75\,in^2 * \dfrac{5237.6 - 3046.1}{5237.6} \approx 3.24\ in^2$ of deck steel could be used for shear (not needed for moment

$$A_{need} = 3.784 - 3.24 \approx .54\ in^2$$

$$2\ \#5\text{s} = .62\ in^2$$

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Closure Pour Shear

$\beta \approx 4.8$ diaphragm = 18" webs

$\theta = 29$

$V_c = .0316\,(4.8)\sqrt{4.5\text{ ksi}}\;(72.9")\,(36")$

$V_c \approx 844.43$ K

assume 2-#5 $\Rightarrow .31 * 2 = .62\text{ in}^2$ @ 6"

$$V_s = \frac{.62\,(60)(72.9)\,(\cot 29° + \cot 90°)\,\sin 90}{6"}$$

$V_s \approx 815.4$ K

$V_n = 844 + 815 \approx 1659$ K

$V_r = \phi V_n = .9\,(1659) \approx 1493$ K $> V_u$ ✓ okay

Shear Keys

$V_c = .0316\,\beta\sqrt{f'_c}\;b_v d_v$ (5.8.3.3-3)

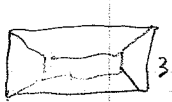
$b_v \approx 14"$ each web

$d_v \approx 3\tfrac{1}{2}"$

$V_c = .0316\,(2)\sqrt{4.5}\;(14")(3\tfrac{1}{2})\,(2\text{ webs}) = 13.1$ K each key pair

$V = 62.6$

6 keys pairs $\Rightarrow$ 13.1 (6) = 78.6K (.9) $\approx$ 70.7 K



3½"

14"

13.14 K

6 ~~EA~~

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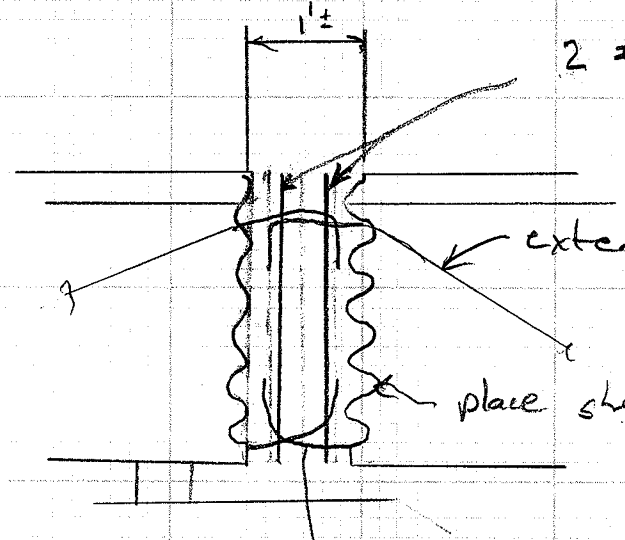
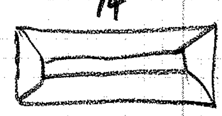
DESIGN COMPUTATIONS (Grid)

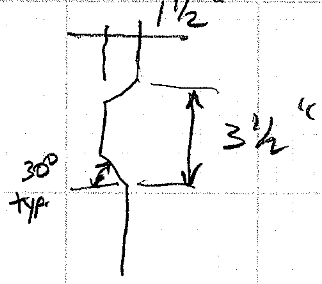


Place Closure Pour after Deck Placement

<u>Shear Keys:</u>



use 6/web min.



can make out of 2x4

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PIER GIRDER

composite section

$I_{comp} = 2806723.1 \text{ in}^4$

$Y_{cg} = 58.43$

$S_{comp\ top} = I/c = \dfrac{2806723.1}{(81-58.43)} = 124356.36 \text{ in}^3$

$S_{comp\ top\ girder} = I/c = \dfrac{2806723.1}{(81-8-1-58.43)} = 206832.9$

S_{comp} bottom top girder flange ≈ 388742.8

$f_{top} = M/S$

$M_{service} = 4395 + 1555 + 312 = 6262$ ft kip (Pier 3)
5471 ft kip (Pier 2)

$M_{service\ dead} = 1867$ ft kip

$f_{top\ girder} \approx \dfrac{-6262\ (12)}{206832.9} = -.363$ ksi tension
$-.317$ ksi (pier 2)

$f_{top\ deck} \approx \dfrac{-6262\ (12)}{124356.36} = -.604$ ksi tension
$-.528$ ksi (pier 3)

$f_{deck} \approx .457$ compression from post-tensioning

$-.604 + .457 \approx -.147$ ksi < 201 psi ✓ okay
deck okay

→ tension in top of girder need
well distributed tension steel
or put girder into tension (prestressing)

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

$I = 1154251.67$

$P_F = 489.4\ K$

$A = 12.26\ SF = 1765\ in^2$

$E_{EE} = E_{ms} = 33.88\ in$

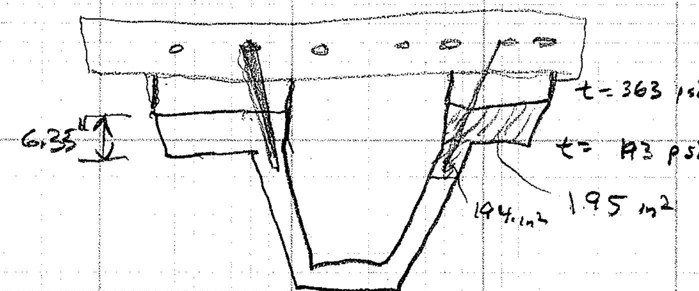
$y_{cg} = 35.84$

$S_T = \dfrac{1154251.67}{72 - 35.84} = 31920.68$

$$f_{top} = \frac{P}{A} + \frac{P_t\, e}{S_T} = \frac{489.4}{1765} + \frac{(1765\ in^2)\ (33.88 - 35.84)}{31920.68}$$

$$= .277 + -.108$$

$$= .169\ ksi \quad \text{compression}$$



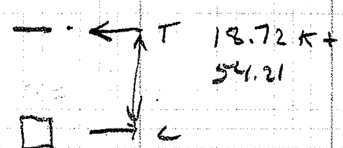
$f_{flange} \approx \dfrac{6262\ (12)}{388742.8} = .193\ ksi$

$f_r = .23\sqrt{f'_c}$

$= .23\sqrt{9\ ksi}$

$f_r \approx .69\ ksi$

$f_r > f_{top}$ ✓ okay strength



$\approx 72.93\ K / 60\ ksi = 1.215\ in^2$

7 - #4 1.4 in²
4 - #5 = 1.24 in² ← use
3 - #6 = 1.32 in²

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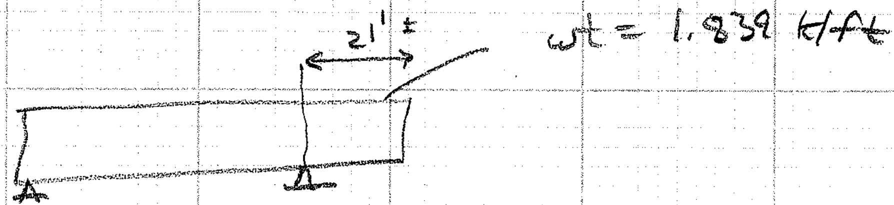
DESIGN COMPUTATIONS (Grid)

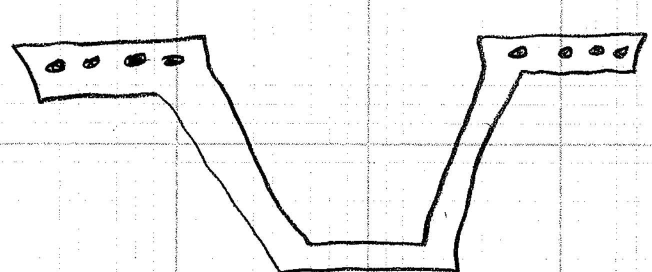


$$M_{max} = \frac{w l^2}{2}$$

$$M_{max} = \frac{(1.839\ k/ft)\ 21^2}{2}$$

$$M_{max} = 405.5\ \text{ft kip}$$

Use 8 - #5



$M_R = 775.03$ ft kip ✓ okay

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REINFORCING DESIGN

GIVEN:

fy=	60.00	ksi
f'c=	6.75	ksi
COVER=	2.00	inches
$\Phi_{flexure}$=	0.90	
Beam Thickness (t_s)=	72.00	inches
b=	54.00	inches
bar diameter=	0.625	inches

LOAD TYPE	M_{hTOT}	$AS_{req'd}$
	ft-K	in^2
M_h (UNFACTORED)	405.50	1.30
STRENGTH I	506.87	1.62
SERVICE I	405.50	1.30

d_s= 69.69 inches

per 5.10.8.2 AS_{temp}= 5.83 sq inches

Use # 5 at top face min. spacing = 10.33 inches

use spacing= 6.75 inches

As= 2.480 sq. inches

compressive steel:

Use # 5 at bottom face

As'= 0.00 sq. inches

M_n= 861.15 ft-K

M_r= 775.03 ft-K

Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 0.67 inches

d_e=d_s= 69.69 inches (for no prestressing)

c/d_e= 0.01

okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*$M_{cracking}$= 2909.18 ft-K <--- Test 1

1.33M_{hTOT} (max.)= 674.14 ft-K <--- Test 2

Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing = 15.25 ft

Flange Width = 21 inches

Flange Overhang = 18 inches

Effective Length S = 15.00 ft

220 / sqrt(S) = 56.80 % Use **56.804** % of required main reinforcement

Required As = 1.41 sq inches

Use # 6 transverse reinforcement

min. spacing = 16.86 inches

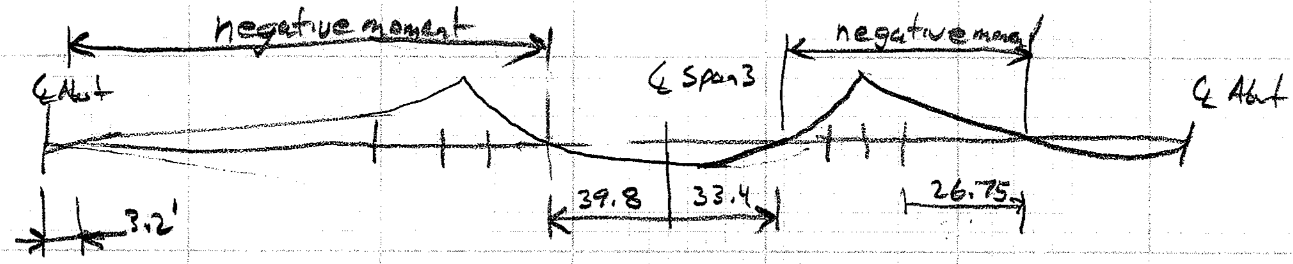
COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

ADDITIONAL FOR NEGATIVE MOMENT POST-TENSIONING

Points of Inflection

From SAP 2000:



span 3 = 125'

.0625 * 125 = 7.81' min. embed post inflection 5.11.1.2.3

1/20 * 125 ≈ 6.25' min embed past strength requirement 5.11.1.2.1

negative moment strength for 2 strands/conduit

min. 9 1/2 * 2 strand ≈ 19 strands for ultimate

loss ≈ 19.17

$$c = \frac{19(.217)\left[.75(270) - 19.17\right]}{(.85)(9.0)\,.6(54")}$$

$c ≈ 3.05"$

assume haunch less than deck.

$$M_n = A_{ps} f_{ps} \left(d_p - a/2\right)$$

$$= (19)(.217)\left[.75(270) - 19.17\right]\left[72" + 5" + 4" - \frac{.6(3.05)}{2}\right]$$

$M_n ≈ 60533.8$ in K = 5044.5 ft K

$M_R = \phi M_n = .9(5044.5) ≈$ 4540 ft K

max live load < $\frac{4540}{1.75}$/1.33 < 1950 ft k

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NEGATIVE MOMENTS
FROM CONSPAN

interior

Span 1 @ ~1.5' $M_u < -4540$
from ℄ bearing

Span 3 @ ~ 8' $M_u < -4540$
@ ~ 8' $M_u < -4540$

Span 5 @ ~ 11.5' $M_u < -4540$

exterior

Span 1 @ ~2.5' $M_u < -4540$

Span 2 @ ~9' $M_u < -4540$
~9' $M_u < -4540$

Span 3 @ ~12.5' $M_u < -4540$

Use 12.5 + 6.25' ≈ 18.75' past bearing
(6.25' = min embed)

for negative moment steel

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

from SAP 2000

min distance to $M_U \approx 4540$

$x \approx 14.7$ to span 5

$x \approx 16.4$ to span 3

min length $\approx 16.4 + \underset{\text{min embed}}{6.25'} \approx 22.65'$

Use ~23' for negative moment

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REINFORCED DESIGN

REINFORCED DESIGN - Span : 1, Beam : 2, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
2	8.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
3	15.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
4	23.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
5	30.90	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
6	38.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
7	46.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
8	53.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
9	61.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	4.835	**0.000***	-0.0
10	68.90	-1428.2	8.10	80.53	2.00	0.9	-1428.2	0.0110	0.000	4.835	**0.000***	-0.0
11	76.50	-5187.8	8.10	80.53	2.00	0.9	-5187.8	0.0403	0.000	14.506	**0.000***	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

REINFORCED DESIGN

REINFORCED DESIGN - Span : 2, Beam : 2, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
2	3.00	-4560.6	8.10	80.53	2.00	0.9	-4560.6	0.0353	0.000	12.732	**0.000***	-0.0
3	5.00	-4150.7	8.10	80.53	2.00	0.9	-4150.7	0.0321	0.000	11.575	**0.000***	-0.0
4	7.00	-4443.1	8.10	80.53	2.00	0.9	-4443.1	0.0344	0.000	12.400	**0.000***	-0.0
5	9.00	-4759.2	8.10	80.53	2.00	0.9	-4759.2	0.0369	0.000	13.293	**0.000***	-0.0
6	11.00	-5099.2	8.10	80.53	2.00	0.9	-5099.2	0.0396	0.000	14.255	**0.000***	-0.0
7	13.00	-5467.4	8.10	80.53	2.00	0.9	-5467.4	0.0425	0.000	15.299	**0.000***	-0.0
8	15.00	-6615.9	8.10	80.53	2.00	0.9	-6615.9	0.0515	0.000	18.569	**0.000***	-0.0
9	17.00	-7470.0	8.10	80.53	2.00	0.9	-7470.0	0.0583	0.000	21.013	**0.000***	-0.0
10	19.00	-8347.2	8.10	80.53	2.00	0.9	-8347.2	0.0653	0.000	23.535	**0.000***	-0.0
11	21.00	-6258.4	8.10	80.53	2.00	0.9	-6258.4	0.0487	0.000	17.549	**0.000***	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

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REINFORCED DESIGN

REINFORCED DESIGN - Span : 3, Beam : 2, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	-9593.2	8.10	80.53	2.00	0.9	-9593.3	0.0753	0.000	27.138	**0.000***	-0.0
2	12.70	-1442.2	8.10	80.53	2.00	0.9	-1442.2	0.0111	0.000	9.046	**0.000***	-0.0
3	25.40	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	9.046	**0.000***	-0.0
4	38.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
5	50.80	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
6	63.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
7	76.20	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
8	88.90	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
9	101.60	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	8.738	**0.000***	-0.0
10	114.30	-1196.9	8.10	80.53	2.00	0.9	-1196.9	0.0092	0.000	8.738	**0.000***	-0.0
11	127.00	-9274.5	8.10	80.53	2.00	0.9	-9274.5	0.0727	0.000	26.214	**0.000***	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

REINFORCED DESIGN

REINFORCED DESIGN - Span : 4, Beam : 2, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
2	3.00	-8080.1	8.10	80.53	2.00	0.9	-8080.1	0.0632	0.000	22.766	**0.000***	-0.0
3	5.00	-7620.0	8.10	80.53	2.00	0.9	-7620.0	0.0595	0.000	21.443	**0.000***	-0.0
4	7.00	-7171.5	8.10	80.53	2.00	0.9	-7171.5	0.0559	0.000	20.157	**0.000***	-0.0
5	9.00	-7387.2	8.10	80.53	2.00	0.9	-7387.2	0.0577	0.000	20.776	**0.000***	-0.0
6	11.00	-7626.2	8.10	80.53	2.00	0.9	-7626.2	0.0596	0.000	21.461	**0.000***	-0.0
7	13.00	-7888.6	8.10	80.53	2.00	0.9	-7888.6	0.0616	0.000	22.215	**0.000***	-0.0
8	15.00	-9082.0	8.10	80.53	2.00	0.9	-9081.9	0.0712	0.000	25.657	**0.000***	-0.0
9	17.00	-9988.9	8.10	80.53	2.00	0.9	-9988.9	0.0785	0.000	28.288	**0.000***	-0.0
10	19.00	-10919.1	8.10	80.53	2.00	0.9	-10919.1	0.0860	0.000	31.000	**0.000***	-0.0
11	21.00	-7903.3	8.10	80.53	2.00	0.9	-7903.3	0.0618	0.000	22.257	**0.000***	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

REINFORCED DESIGN

REINFORCED DESIGN - Span : 5, Beam : 2, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	-12341.9	8.10	80.53	2.00	0.9	-12341.9	0.0976	0.000	35.175	**0.000***	-0.0
2	12.90	-3368.4	8.10	80.53	2.00	0.9	-3368.4	0.0260	0.000	11.725	**0.000***	-0.0
3	25.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	11.725	**0.000***	-0.0
4	37.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
5	50.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
6	62.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
7	74.90	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
8	87.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
9	99.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
10	112.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
11	124.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

REINFORCED DESIGN

REINFORCED DESIGN - Span : 1, Beam : 1, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
2	8.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
3	15.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
4	23.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
5	30.90	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
6	38.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
7	46.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
8	53.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
9	61.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	5.228	**0.000***	-0.0
10	68.90	-1677.9	8.10	80.53	2.00	0.9	-1677.9	0.0129	0.000	5.228	**0.000***	-0.0
11	76.50	-5603.1	8.10	80.53	2.00	0.9	-5603.1	0.0435	0.000	15.685	**0.000***	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

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REINFORCED DESIGN

REINFORCED DESIGN - Span : 3, Beam : 1, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	-10251.6	8.10	80.53	2.00	0.9	-10251.6	0.0806	0.000	29.052	**0.000***	-0.0
2	12.70	-1856.1	8.10	80.53	2.00	0.9	-1856.1	0.0143	0.000	9.684	**0.000***	-0.0
3	25.40	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	9.684	**0.000***	-0.0
4	38.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
5	50.80	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
6	63.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
7	76.20	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
8	88.90	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
9	101.60	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	9.378	**0.000***	-0.0
10	114.30	-1614.0	8.10	80.53	2.00	0.9	-1614.0	0.0124	0.000	9.378	**0.000***	-0.0
11	127.00	-9935.6	8.10	80.53	2.00	0.9	-9935.6	0.0781	0.000	28.133	**0.000***	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

REINFORCED DESIGN

REINFORCED DESIGN - Span : 5, Beam : 1, STRENGTH I (fy = 60.00 ksi)

(a) NEGATIVE MOMENTS ALONG SPAN (Non-composite Moment effects are INCLUDED in Mu)

f'c (ksi)	b (in)	bw (in)
9.00	54.00	15.00

Sec	Dist (ft)	Mu-reqd (k.ft)	hf (in)	d (in)	d' (in)	Phi	Phi*Mn-r (k.ft)	c/dt	Asb (in2)	Ast-r (in2)	Ast-p (in2)	Phi*Mn-p (k.ft)
1	0.00	-13191.9	8.10	80.53	2.00	0.9	-13191.9	0.1046	0.000	37.686	**0.000***	-0.0
2	12.90	-3922.7	8.10	80.53	2.00	0.9	-3922.7	0.0303	0.000	12.562	**0.000***	-0.0
3	25.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	12.562	**0.000***	-0.0
4	37.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
5	50.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
6	62.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
7	74.90	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
8	87.30	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
9	99.70	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
10	112.10	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0
11	124.50	0.0	8.10	80.53	2.00	0.9	-0.0	0.0000	0.000	0.000	0.000	-0.0

(b) POSITIVE MOMENTS AT PIERS

NONE

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

Negative moment (Pier)

post tensioning losses

5.9.5.2.1 Anchorage Set

anchor set loss ≈ 3/8" = ΔL

min $L \approx 69'$

based on deck slabs $L \approx 77'$

$$d = .75(270)\left(1 - e^{[-(.0002)77' + .25(.00873)]}\right)$$

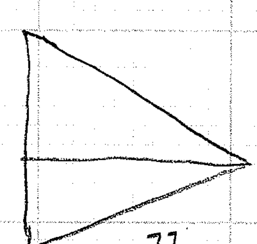
$$d \approx 2.659 \text{ ksi}$$

$$X = \sqrt{\frac{E(\Delta L)L}{12\,d}} = \sqrt{\frac{(28500)(.375)77'}{(12)\;2.659}}$$

$$X \approx 160.6'$$

$$\Delta f = \frac{E\Delta L}{6x} = \frac{(28500)(.375)}{6\;(160.6)}$$

$$\Delta_f = 11.09 \text{ ksi}$$



dist. to pier ≈ 25'

$$\frac{160.6' - 25'}{160.6'} = \frac{\Delta f_{pier}}{11.09}$$

$$\Delta f_{pier} \approx 9.36 \text{ ksi}$$ ← loss @ pier

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5.9.5.2.2 Friction

$$\Delta f_{pF} = f_{pj}\left(1 - e^{(-Kx + \mu\alpha)}\right) \qquad (5.9.5.2.2b-1)$$

$K = .0002$ Table 5.9.5.2.2b-1

$\mu = .23$

$X_{total} \approx 77'$

$X_{max} = 77/2 = 38.5'$ assume post tensioning from both ends

$X_{max\ to\ pier} \approx 25'$

assume $\alpha \approx 0° = 0$ radians

$$\Delta f_{pF} = .75(270)\left(1 - e^{(-.0002(25') + .2(0))}\right)$$

$\Delta f_{pF} \approx$ 1.01 ksi

5.9.5.2.3b ELASTIC SHORTENING

$$\Delta f_{pES} = \frac{N-1}{2N} \frac{E_p}{E_{ct}} f_{cgp} \qquad (5.9.5.2.3b-1)$$

$$\Delta f_{pES} = 2.63 \text{ ksi}$$

TIME DEPENDENT LOSSES

$$\Delta f_{pR2} = 1.2 \text{ ksi} = \Delta f_{pR1}$$

SHRINKAGE LOSS

$$\Delta f_{pSD} = \varepsilon_{bdf} E_p K_{df}$$

$$K_{df} = \frac{1}{1 + \frac{E_p}{E_{ci}} \frac{A_{ps}}{A_c} \left(1 + \frac{A_c e_{pc}^2}{I_c}\right) \left[1 + .7 \psi_b (t_f, t_i)\right)}$$

$$\Delta f_{pSD} = 8.81 \text{ ksi}$$

CREEP

$$\Delta f_{pCD} \approx .15 \text{ ksi}$$

TOTAL POST-TENSIONING LOSSES (NEGATIVE MOMENT)

$\Delta f_{pier} = 9.36$ ksi anchorage

$\Delta f_{pf} = 1.01$ Ksi friction

$\Delta f_{pES} \approx 2.73$ ksi Elastic shortening

$\Delta f_{pr2} \approx 1.2$ Ksi Relaxation

$\Delta f_{pSO} \approx 8.81$ Ksi Shrinkage

$\Delta f_{pCD} \approx .15$ ksi Creep

Total Loss $\approx$ 23.26 Ksi

$$c \approx \frac{19(.217)\left[.75(270)-19.17\right] + 19(.217)\left[.75(270)-23.26\right] + 15(60)}{.85(4.5)(.825)\,54''}$$

$c \approx 14.054''$

$$M_n = 19(.217)\left[.75(270)-19.17\right]\left[72''+5.25''+4''-\frac{.825(14.054)}{2}\right]$$
$$+19(.217)\left[.75(270)-23.26\right]\left[72''+5.25''+4''-\frac{.825(14.054)}{2}\right]$$
$$+\ 15(60)\left[72''+5.25''+4''-\frac{.825(14.054)}{2}\right]$$

$M_n \approx 57032.4 + 55760.0 + 67907.4 \approx 180699.8$

$M_n \approx 15058.3$ ft k

$M_R = \phi M_n \approx .9(15058.3) \approx$ 13552.5 ft Kip

okay

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

EXTRA NEGATIVE MOMENT ONLY POST-TENSIONING

amount of post tensioning saved

$\sim 48' + \sim 67' + 96'$
span 1 span 3 span 5

total $\approx$ 211'

# of ducts = 50

saves 2 strands/duct

$(50)(2) * .75(270)(.217) * \frac{211'}{1000} \approx 927.2$ MKFT

ITEM 618-00002 Prestressing Steel Wire or Strand

assume $100/unit from EEMA cost data

Savings $\approx$ (927.2) 100 $\approx$ $92720

FOR CONSTRUCTABILITY, LONG TERM MAINTENANCE, SAFETY, ETC.

USE 4 strands entire length of deck rather than just at negative moment region.

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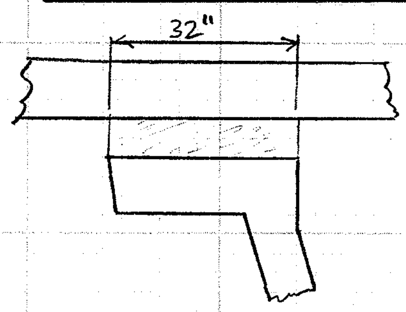
HORIZONTAL SHEAR



$\phi = .9$ (5.5.4.2.1)

$V_{ui} = V_u \div b_{vi}\, d_v$ (5.8.4.2-1)

$= \frac{850}{76.96(.9)(64")} = .192$ ksi < .210

$V_{u\,max} \approx 850\,k$

$V_h = \frac{V_{u\,max}}{de} \approx \frac{850k}{76.96}\left(\frac{1}{.9}\right) \approx 12.27$ Kips/in

$A_{vf\,min} \geq \frac{.05\,A_{cv}}{f_y}$ (5.8.4.4-1)

$A_{vf} \geq \frac{.05[(2)(32")(12")]}{60\text{ ksi}} = .64\text{ in}^2/\text{ft}$ (2 studs per blockout)

for concrete placed against clean concrete surface not intentionally roughened (bottom of precast slabs)

$c = .075$ ksi
$\mu = .6$
$K_1 = .2$
$K_2 = .8$ ksi

(5.8.4.3)

$V_{ni} \leq K_1 f'_c A_{cv} = (.2)(4.5)(64)(12) \approx 691.2$ k/ft (5.8.4.1-4)

$V_{ni} \leq K_2 A_{cv} = (.8)(64)(12) \approx 614.4$ k/ft (5.8.4.1-5)

$V_{ni} = c\,A_{cv} + \mu\,(A_{vf}\, f_y + P_c)$ (5.8.4.1-3)

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COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

$$V_{ni} = c A_{cv} + \mu (A_{vf} f_y + P_c)$$

wt of slab

$$(12.27)(12) = .075(64)(12) + .6 [A_{vf}(60 \text{ ksi}) + 2.5 \text{ k}]$$

$$147.24\text{k} = 57.6\text{k} + 36 A_{vf} + 1.5\text{ k}$$

$$A_{vf} \approx 2.45 \text{ in}^2/\text{ft}$$

blockouts spaced @ 2'-9" max (at closure pour)
@ 2'-4" nom

for maximum spacing

$$A_{vf} = (2.45)(2.75) = 6.73 \text{ in}^2/\text{ blockout pair}$$

$$A_{vf} = 3.37 \text{ in}^2/\text{ blockout}$$

for 1" studs $A = .79$

$$\# \text{ of studs} = \frac{3.37}{.79} \approx 4.27 \Rightarrow$$ 5 1" studs per hole (worst case)

6 - 7/8" studs

@ .1L

$A_{vf} = 1.84$ in²/ft

$\Rightarrow$ 2.53 in²/blockout

$\Rightarrow$ 4 - 1" studs per blockout 5 - 7/8" studs

@ .2L $A_{vf} \approx 1.22$ in²/ft

$\Rightarrow$ 1.68 in²/blockout

$\Rightarrow$ 3 - 1" studs per blockout 3 - 7/8" studs

@ .3L $A_{vf} \approx .465$ in²/ft $<$ .64 in²/ft

$\Rightarrow$ .88 in²/blockout

$\Rightarrow$ 2 - 1" studs 2 - 7/8" studs

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If bottom surface of precast slabs is intentionally roughened to .25" amplitude

$c = .24$ ksi

$\mu \approx 1.0$

$(12.27)(12) = .24(64)(12) + 1.0\left[A_{vf}\ 60\text{ksi} + 2.5\text{k}\right]$

$147.24\ \text{K} = 184.32\ \text{K} + A_{vf}\ 60 + 2.5$

additional shear steel not required (friction sufficient)

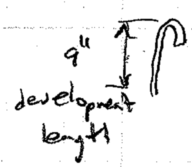
$A_{vf} \geq \dfrac{.05\,A_{cv}}{f_y}$ (5.8.4.4-1)

minimum steel = .64 in^2/ft

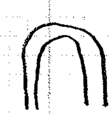
$\Rightarrow$ .88 in^2/blockout (worst case) $= \dfrac{2.75(.64)}{2} =$

2 - 7/8" stud or 3/4" stud

need #6 rebar min.



double amount of steel in pocket to reduce development length

use hooked steel 

or rebar with terminator

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

Breakout Strength Per PCI Design Handbook

for 1 7/8" ϕ stud (for yielding)

$\phi V_s = \phi n \ A_{se} f_{ut}$ Eq 6.5.2.1

$= .65 (1)(.60)(51 \text{ ksi})$

$= 19.89$ kips steel strength

$N_{cb} = C_{bs} A_N C_{crb} \Psi_{ed,N}$ Eq 6.5.4.1

$C_{bs} = 3.33 \lambda \sqrt{\frac{f'_c}{h_{ef}}}$ Eq 6.5.4.2

assume $f'_c = 7.2$ ksi

$h_{ef} =$

$\lambda = 1$

$C_{bs} = 3.33 \sqrt{\frac{7200}{5}} = 126.36$

$A_n = 9 h_{ef}^2 = 9 \cdot 5^2 = 225$

$C_{crb} = 1.0$ uncracked concrete

$\Psi_{ed,N} = .7 + .3 \left(\frac{de_{min}}{1.5 h_{ef}} \right) \leq 1.0$ Eq 6.5.4.3

$de_{min} \approx 9"$

$\Psi_{ed,N} = .7 + .3 \frac{9}{(1.5)(5)} = 1.0$

$N_{cb} = \frac{(126.36)(225)(1.0)(1.0)}{1000} = 28.43$ Kips

$\phi = .7$ for unconfined $\phi N_{cb} = .7 \ 28.43 = 19.9$ Kips

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Pullout Strength

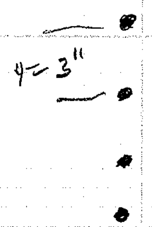
$$N_{pn} = 11.2 \; A_{brg} \, f'_c \; C_{rp}$$ Eq 6.5.4.5

$$N_{pn} = 11.2 \; (.88)(7200)(1.0)/1000$$

$$N_{pn} = 70.96 \text{ K}$$

GROUP STRENGTH (BREAKOUT)

$$\phi N_{cb} = \phi \, C_{bs} \, (X + 3h_{ef})(Y + 3h_{ef}) \; C_{crb}$$



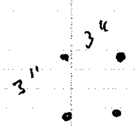
$$\phi N_{cb} = .7 \; (126.36)(0 + 3(5)) \cdot (9'' + 3(5)) \; (1.0)/1000$$

$$\phi N_{CB} = 31.84 \text{ K}$$

required steel strength for shear (2 - 7/8" ϕ)

$$\phi V_s = .65 \, (2) \, (.60) \; 51 \text{ ksi}$$

$$= 39.78 \text{ K}$$



$$\phi N_{cb} = .7 \; (126.36) \; (3 + 3(5))(3 + 3(5))(1.0)/1000$$

$$\phi N_{cb} = 28.66 \text{ K}$$

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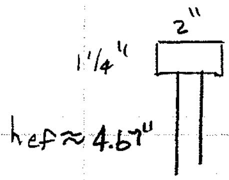
for 60 ksi rebar & lenton terminator

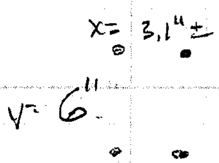


Required Steel = .88 in^2 = 2 - 3/4" ϕ

$\phi V_s = .65(2)(.44)(60\text{ ksi}) = 34.32$ K

Group strength (Breakout)

$\phi N_{cb} = \phi C_{bs}(X + 3h_{ef})(Y + 3h_{ef})\ C_{crb}$

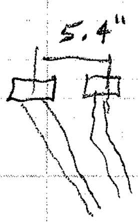


$= .7(147.49)[3.1 + 3(4.67)] + [6 + 3(4.67)]\ 1.0/1000$

$\phi N_{cb} = 35.3$ K

for group spacings of 3.75'

min steel = 1.2 in^2 = 2 - 7/8" ϕ

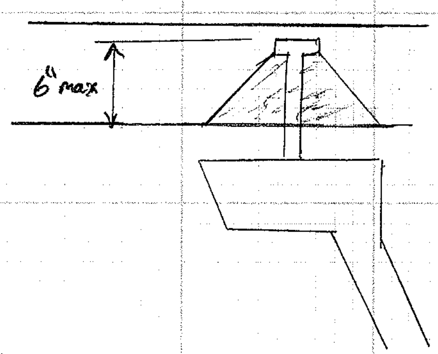


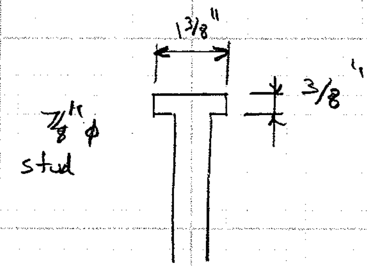
$\phi V_s = .65(2)(.60)(60\text{ ksi}) = 46.8$ K

$\phi N_{cb} = .7(147.49)[5.4 + 3(4.67)][12" + 3(4.67)]\ 1.0/1000$

$= 52.1$ K

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 187 of





$$\phi T_n = 4\phi\sqrt{f'_c}\ A$$

$$D_p = 2\ell_e + D_B$$

$$\ell_e \approx 5\,5/8''$$

$$D_B = 1\,3/8''$$

$$D_p = 12.625''$$

$$A_p = \pi\left(\frac{D_p^2}{4} - \frac{D_B^2}{4}\right)$$

$$A_p = \pi\left(\frac{12.625^2}{4} - \frac{1.375^2}{4}\right) = 123.7\ in^2$$

$$\phi T_n = 4(.65)\sqrt{7200}\,(123.7)/1000 = 27.29\ K$$

22.1 K for 5" embed

$$T_n = A_b F_y$$

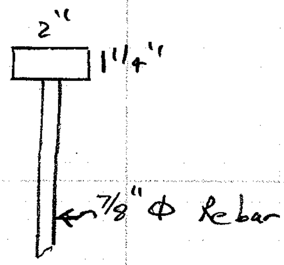
$$= \left(\frac{\pi\ .875^2}{4}\right) 36\ ksi$$

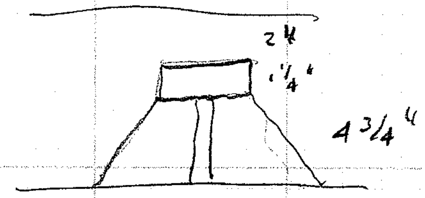
$$= 21.65\ Kip$$

3,4,5,6, 7, 8

Provide min 5" embed for headed studs

for Leaton Terminator





$F_y = 60$ Ksi

$$T = (60\text{ ksi})\frac{\pi\, {7/8}^2}{4} = 36.1 \text{ Kips}$$

$$(1000)\,36.1 = 4(.65)\sqrt{7200}\; A$$

$$A = 163.54 \text{ in}^2$$

$$163.54 \text{ in}^2 = \frac{\pi\, D_p^2}{4} - \frac{\pi\, 2''^2}{4}$$

$$D_p = 14.57''$$

$$14.57 = 2\, l_e + 2''$$

$$l_e = 6.28''$$

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 189 of

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

Use $5\frac{1}{2}$" Haunch everywhere except Abut 1.

Use $4\frac{1}{4}$" Haunch @ Abut 1

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 190 of

Ex

HAUNCH CALCULATION (GEOMETRY) (Interior Girder)

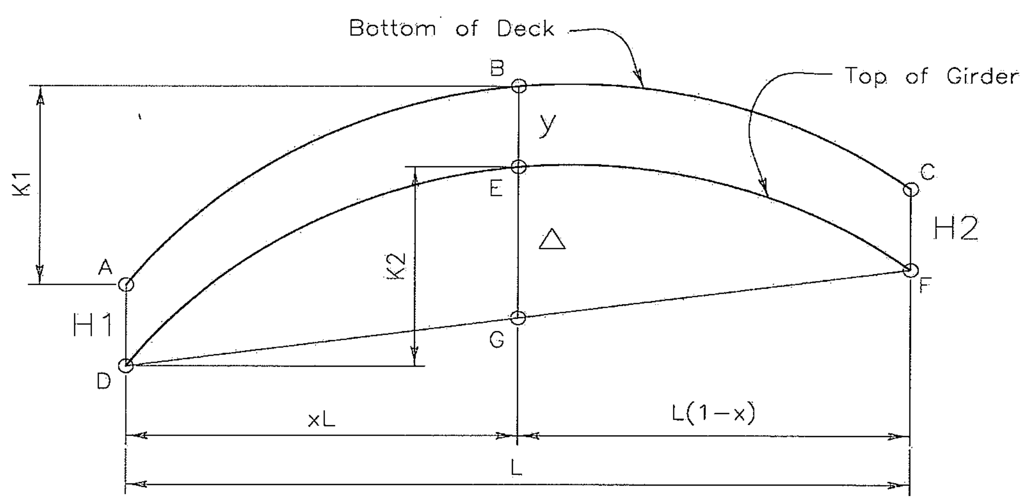
bottom of deck elevation at centerline 1 (A):	5219.540 ft		crossslope m =	2.00%
bottom of deck elevation at midpoint (B):	5219.080 ft		total girder width =	131.0 inches
bottom of deck elevation at centerline 2 (C)	5218.410 ft		x =	0.5 (midspan)

camber-deadloads (Δ) =	2.51 2.86 inches at midspan	2.98	hand calc values
28 Day Camber Estimate =	4.64 inches	5.15	hand calc values
RLO Tolerance =	20.0% = 0.93 inches		
Use Std. Tolerance (Y/N)?	Y		
precast panel requirement =	1.00 inches		
depth tolerance =	0.50 inches		
slope tolerance =	1.31 inches		
Camber tolerance =	**1.00 inches (AASHTO Standard)**		
minimum clear at midspan =	2.81 inches		

Calculate H & y where H1=H2=H

k1=	-0.460
k2=	-0.327
y =	**3.81** inches
Minimum Haunch (H) =	**5.41** inches

USE H =	**5.500** inches	MAX SAG Avg. haunch =	**5.00** inches
average haunch =	**4.17** inches	MAX SAG Avg. weight =	0.68 kip/ft
average weight =	0.57 kip/ft	thickness for strength =	4.00 inches (3.9 in. max.)
thickness for strength =	0.00 inches	nonstrength weight =	**0.14** kip/ft
nonstrength weight =	**0.57** kip/ft		



HAUNCH CALCULATION (GEOMETRY) (Interior Girder)

girder 3

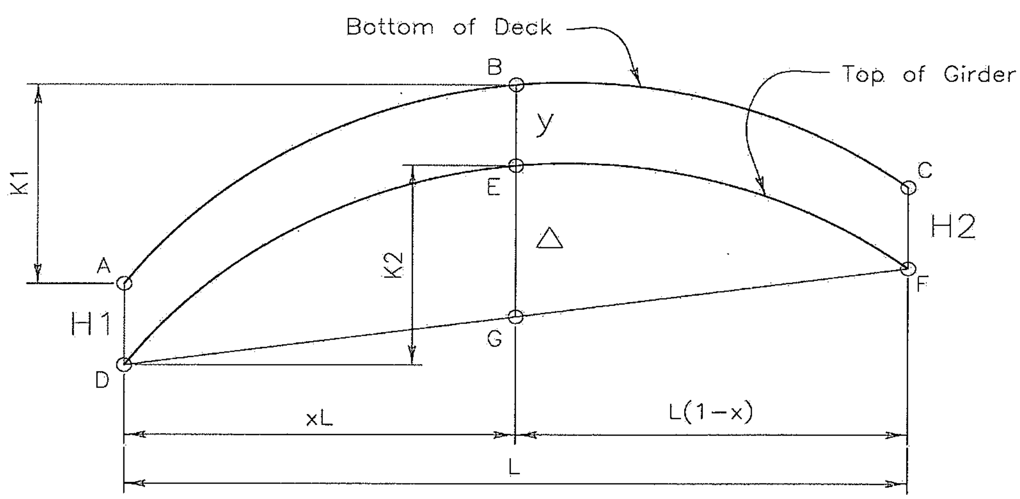
bottom of deck elevation at centerline 1 (A):	5219.740 ft	crossslope m =	2.00%	
bottom of deck elevation at midpoint (B):	5219.810 ft	total girder width =	131.0	inches
bottom of deck elevation at centerline 2 (C)	5219.650 ft	x =	0.5	(midspan)

camber-deadloads (Δ) =	2.94	inches at midspan	3.00	hand calc values
28 Day Camber Estimate =	4.81	inches	5.35	hand calc values
RLO Tolerance =	20.0%	= 0.96 inches		
Use Std. Tolerance (Y/N)?	Y			
precast panel requirement =	1.00	inches		
depth tolerance =	0.50	inches		
slope tolerance =	1.31	inches		
Camber tolerance =	**1.00**	**inches (AASHTO Standard)**		
minimum clear at midspan =	2.81	inches		

Calculate H & y where H1=H2=H

k1=	0.070	
k2=	0.200	
y =	**3.81**	inches
Minimum Haunch (H) =	**5.37**	inches

USE H =	5.500	inches	MAX SAG Avg. haunch =	**5.03**	inches
average haunch =	**4.20**	inches	MAX SAG Avg. weight =	0.69	kip/ft
average weight =	0.57	kip/ft	thickness for strength =	4.00	inches (3.94 in. max.)
thickness for strength =	0.00	inches	nonstrength weight =	**0.14**	kip/ft
nonstrength weight =	**0.57**	kip/ft			



HAUNCH CALCULATION (GEOMETRY) (Interior Girder)

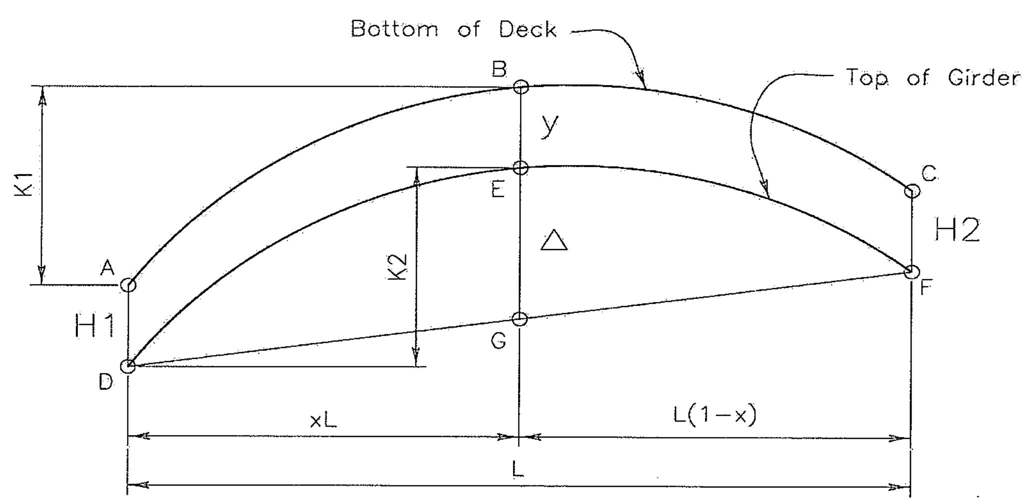
bottom of deck elevation at centerline 1 (A):	18.961 ft	crossslope m =	2.00%
bottom of deck elevation at midpoint (B):	19.245 ft	total girder width =	131.0 inches
bottom of deck elevation at centerline 2 (C)	19.449 ft	x =	0.5 (midspan)

camber-deadloads (Δ) =	0.69 inches at midspan	0.86 hand calc values
28 Day Camber Estimate =	1.13 inches	1.16 hand calc values
RLO Tolerance =	20.0% = 0.23 inches	
Use Std. Tolerance (Y/N)?	Y	
precast panel requirement =	1.00 inches	
depth tolerance =	0.50 inches	
slope tolerance =	1.31 inches	
Camber tolerance =	**1.00 inches (AASHTO Standard)**	
minimum clear at midspan =	2.81 inches	

Calculate H & y where H1=H2=H

k1=	0.284
k2=	0.302
y =	**3.81** inches
Minimum Haunch (H) =	**4.02** inches

USE H =	**4.250** inches	MAX SAG Avg. haunch =	**4.91** inches
average haunch =	**4.08** inches	MAX SAG Avg. weight =	0.67 kip/ft
average weight =	0.56 kip/ft	thickness for strength =	4.00 inches (4.04 in. max.)
thickness for strength =	0.00 inches	nonstrength weight =	**0.12** kip/ft
nonstrength weight =	**0.56** kip/ft		



By: A. Pott
Date: Jun/12/2009
CKD:
Date:

DESIGN STATUS

Span:4, Beam:3

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	3.000	2.000	4.000	6.000	8.000	10.000
Precast-top	0.282	0.189	0.287	0.293	0.298	0.299
Bottom	0.311	0.207	0.307	0.300	0.296	0.294
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.500	3.517	1.500	3.500	5.500	7.500	9.500
Topping-top	-0.118	-0.082	-0.000	-0.083	-0.077	-0.074	-0.074	-0.078
Precast-top	-0.020	0.245	0.247	0.148	0.261	0.282	0.293	0.295
Bottom	0.399	0.507	0.307	0.423	0.479	0.450	0.440	0.447

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.081	-0.085	-0.000	-0.086	-0.081	-0.080	-0.081	-0.084
Precast-top	-0.001	0.243	0.247	0.146	0.258	0.279	0.290	0.292
Bottom	0.289	0.517	0.307	0.431	0.493	0.468	0.459	0.467

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.557	-0.500	-0.000	-0.521	-0.481	-0.441	-0.387	-0.375
Precast-top	-0.249	0.026	0.247	-0.082	0.049	0.090	0.130	0.140
Bottom	1.686	1.731	0.307	1.708	1.662	1.525	1.355	1.316

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NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.472	-0.426	-0.000	-0.443	-0.410	-0.377	-0.333	-0.322
Precast-top	-0.205	0.065	0.247	-0.041	0.086	0.123	0.158	0.168
Bottom	1.438	1.513	0.307	1.478	1.454	1.337	1.196	1.161

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.134	-0.099	-0.000	-0.097	-0.100	-0.103	-0.107	-0.111
Precast-top	-0.029	0.236	0.247	0.140	0.248	0.266	0.276	0.278
Bottom	0.445	0.556	0.307	0.465	0.548	0.538	0.537	0.544

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.134	-0.127	-0.000	-0.130	-0.125	-0.120	-0.115	-0.111
Precast-top	-0.029	0.221	0.247	0.123	0.235	0.258	0.272	0.278
Bottom	0.445	0.640	0.307	0.561	0.620	0.586	0.560	0.544

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.051	-0.032	-0.000	-0.034	-0.027	-0.022	-0.021	-0.022
Precast-top	-0.006	0.127	0.124	0.078	0.136	0.149	0.155	0.156
Bottom	0.176	0.229	0.154	0.191	0.205	0.182	0.172	0.175

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.490	-0.437	-0.000	-0.456	-0.419	-0.381	-0.329	-0.319
Precast-top	-0.235	-0.085	0.124	-0.143	-0.069	-0.039	-0.006	0.001
Bottom	1.464	1.411	0.154	1.427	1.352	1.232	1.075	1.043

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	2.500	3.517	1.500	3.500	5.500	7.500	9.500
Mu-req'd	-353.8	0.0	-447.1	-177.0	-2.2	74.2	55.4
Mu-prv'd	2073.6	2178.3	1384.6	2176.5	2382.3	2587.8	2793.2

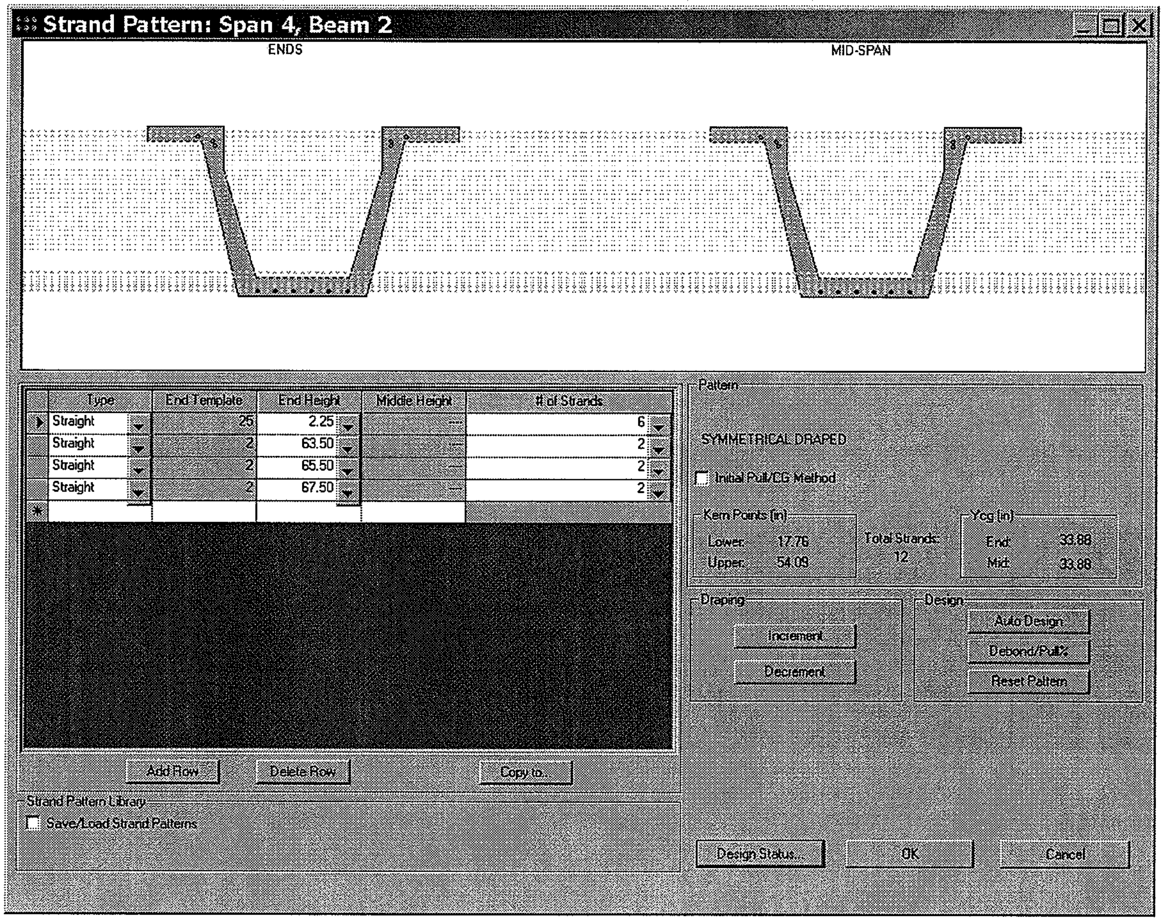
CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 9.50 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	0.001	1.80	0.002	2.20	0.003
Self Wt.	-0.001	1.85	-0.002	2.40	-0.003
Deck + Haunch			-0.001	2.30	-0.003
DL-Prec. (DC)			-0.000	3.00	-0.001

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			0.001	3.00	0.004
DL-Comp. (DW)			0.006	3.00	0.017
Total	0.000		0.005		0.017

Positive values indicate upward deflection.


Strand Pattern: Span 4, Beam 2
ENDS
MID-SPAN
Type
End Template
End Height
Middle Height
# of Strands
Straight 26 2.25 6
Straight 2 63.50 2
Straight 2 65.50 2
Straight 2 67.50 2
Pattern
SYMMETRICAL DRAPED
Initial Pull/CG Method
Kern Points (in)
Lower: 17.76
Upper: 54.09
Total Strands: 12
Ycg (in)
End: 33.88
Mid: 33.88
Draping
Increment
Decrement
Design
Auto Design
Debond/Pull%
Reset Pattern
Add Row
Delete Row
Copy to...
Strand Pattern Library
Save/Load Strand Patterns
Design Status...
OK
Cancel

Project:

Non-live Load Deflections

Stage 9: PS

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.526	-0.137	1.3071
L.100	0.50	0.526	-0.000	1.3062
Sp1.000	0.50	0.526	-0.000	1.3062
Sp1.010	12.80	0.441	3.154	1.1131
Sp1.020	25.10	0.331	5.684	0.8481
Sp1.030	37.40	0.220	7.518	0.5728
Sp1.040	49.70	0.110	8.631	0.2886
Sp1.050	62.00	-0.000	9.003	0.0000
Sp1.060	74.30	-0.110	8.631	-0.2886
Sp1.070	86.60	-0.220	7.518	-0.5728
Sp1.080	98.90	-0.331	5.684	-0.8481
Sp1.090	111.20	-0.441	3.154	-1.1131
Sp1.100	123.50	-0.526	0.000	-1.3062
R.000	123.50	-0.526	0.000	-1.3062
R.100	124.00	-0.526	-0.137	-1.3071

Project:

Non-live Load Deflections

Stage 9: ComponentWeight

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.019	0.085	-0.8108
L.100	0.50	0.019	-0.000	-0.8108
Sp1.000	0.50	0.019	-0.000	-0.8108
Sp1.010	12.80	0.018	-2.063	-0.7657
Sp1.020	25.10	0.015	-3.901	-0.6418
Sp1.030	37.40	0.011	-5.337	-0.4593
Sp1.040	49.70	0.006	-6.247	-0.2389
Sp1.050	62.00	0.000	-6.558	-0.0000
Sp1.060	74.30	-0.006	-6.247	0.2389
Sp1.070	86.60	-0.011	-5.337	0.4593
Sp1.080	98.90	-0.015	-3.901	0.6418
Sp1.090	111.20	-0.018	-2.063	0.7657
Sp1.100	123.50	-0.019	-0.000	0.8108
R.000	123.50	-0.019	-0.000	0.8108
R.100	124.00	-0.019	0.085	0.8108

Project:

Non-live Load Deflections

Stage 9: Shrinkage

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.295	0.014	-0.1344
L.100	0.50	0.292	0.000	-0.1334
Sp1.000	0.50	0.292	0.000	-0.1334
Sp1.010	12.80	0.234	-0.310	-0.1072
Sp1.020	25.10	0.175	-0.552	-0.0807
Sp1.030	37.40	0.117	-0.726	-0.0540
Sp1.040	49.70	0.058	-0.830	-0.0270
Sp1.050	62.00	-0.000	-0.865	-0.0000
Sp1.060	74.30	-0.058	-0.830	0.0270
Sp1.070	86.60	-0.117	-0.726	0.0540
Sp1.080	98.90	-0.175	-0.552	0.0807
Sp1.090	111.20	-0.234	-0.310	0.1072
Sp1.100	123.50	-0.292	0.000	0.1334
R.000	123.50	-0.292	0.000	0.1334
R.100	124.00	-0.295	0.014	0.1344

Project:

Non-live Load Deflections

Stage 9: haunch

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.001	0.003	-0.0283
L.100	0.50	0.001	-0.000	-0.0283
Sp1.000	0.50	0.001	-0.000	-0.0283
Sp1.010	12.80	0.001	-0.072	-0.0267
Sp1.020	25.10	0.001	-0.136	-0.0224
Sp1.030	37.40	0.000	-0.186	-0.0160
Sp1.040	49.70	0.000	-0.218	-0.0083
Sp1.050	62.00	0.000	-0.229	0.0000
Sp1.060	74.30	-0.000	-0.218	0.0083
Sp1.070	86.60	-0.000	-0.186	0.0160
Sp1.080	98.90	-0.001	-0.136	0.0224
Sp1.090	111.20	-0.001	-0.072	0.0267
Sp1.100	123.50	-0.001	-0.000	0.0283
R.000	123.50	-0.001	-0.000	0.0283
R.100	124.00	-0.001	0.003	0.0283

Project:

Non-live Load Deflections

Stage 9: extradeck

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.002	0.010	-0.0989
L.100	0.50	0.002	-0.000	-0.0989
Sp1.000	0.50	0.002	-0.000	-0.0989
Sp1.010	12.80	0.002	-0.252	-0.0934
Sp1.020	25.10	0.002	-0.476	-0.0783
Sp1.030	37.40	0.001	-0.651	-0.0560
Sp1.040	49.70	0.001	-0.762	-0.0292
Sp1.050	62.00	0.000	-0.800	0.0000
Sp1.060	74.30	-0.001	-0.762	0.0292
Sp1.070	86.60	-0.001	-0.651	0.0560
Sp1.080	98.90	-0.002	-0.476	0.0783
Sp1.090	111.20	-0.002	-0.252	0.0934
Sp1.100	123.50	-0.002	-0.000	0.0989
R.000	123.50	-0.002	-0.000	0.0989
R.100	124.00	-0.002	0.010	0.0989

Project:

Sp4.080	241.50	0.000	0.003	-0.0023
Sp4.090	243.50	0.000	0.001	-0.0031
Sp4.100	245.50	0.000	-0.000	-0.0040
Sp5.000	245.50	0.000	-0.000	-0.0040
EndCmp	247.00	0.000	-0.002	-0.0053
BegCmp	247.00	0.000	-0.002	-0.0053
Sp5.010	258.00	0.000	-0.017	-0.0075
Sp5.020	270.50	0.000	-0.038	-0.0081
Sp5.030	283.00	0.000	-0.059	-0.0070
Sp5.040	295.50	0.000	-0.074	-0.0047
Sp5.050	308.00	-0.000	-0.083	-0.0016
Sp5.060	320.50	-0.000	-0.083	0.0019
Sp5.070	333.00	-0.000	-0.073	0.0054
Sp5.080	345.50	-0.000	-0.054	0.0084
Sp5.090	358.00	-0.000	-0.029	0.0105
Sp5.100	370.50	-0.001	-0.000	0.0113
R.000	370.50	-0.001	-0.000	0.0113
R.100	371.00	-0.001	0.001	0.0113

Project:

Non-live Load Deflections

Stage 9: bridgerail

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.000	0.000	-0.0031
L.100	0.50	0.000	-0.000	-0.0031
Sp1.000	0.50	0.000	-0.000	-0.0031
Sp1.010	8.20	0.000	-0.005	-0.0029
Sp1.020	15.90	0.000	-0.009	-0.0023
Sp1.030	23.60	0.000	-0.012	-0.0016
Sp1.040	31.30	0.000	-0.014	-0.0007
Sp1.050	39.00	0.000	-0.015	0.0003
Sp1.060	46.70	0.000	-0.013	0.0011
Sp1.070	54.40	0.000	-0.011	0.0018
Sp1.080	62.10	0.000	-0.008	0.0023
Sp1.090	69.80	0.000	-0.004	0.0023
EndCmp	76.00	0.000	-0.001	0.0021
BegCmp	76.00	0.000	-0.001	0.0021
Sp1.100	77.50	0.000	-0.000	0.0019
Sp2.000	77.50	0.000	-0.000	0.0019
Sp2.010	79.50	0.000	0.001	0.0016
Sp2.020	81.50	0.000	0.001	0.0014
Sp2.030	83.50	0.000	0.002	0.0011
Sp2.040	85.50	0.000	0.002	0.0007
Sp2.050	87.50	0.000	0.003	0.0003
Sp2.060	89.50	0.000	0.003	-0.0003
Sp2.070	91.50	0.000	0.002	-0.0009
Sp2.080	93.50	0.000	0.002	-0.0017
Sp2.090	95.50	0.000	0.001	-0.0025
EndCmp	96.50	0.000	0.001	-0.0031
BegCmp	96.50	0.000	0.001	-0.0031
Sp2.100	97.50	0.000	-0.000	-0.0036
Sp3.000	97.50	0.000	-0.000	-0.0036
EndCmp	98.00	0.000	-0.000	-0.0038
BegCmp	98.00	0.000	-0.000	-0.0038
Sp3.010	110.30	0.000	-0.013	-0.0057
Sp3.020	123.10	0.000	-0.030	-0.0059
Sp3.030	135.90	0.000	-0.044	-0.0047
Sp3.040	148.70	0.000	-0.055	-0.0026
Sp3.050	161.50	0.000	-0.058	-0.0000
Sp3.060	174.30	-0.000	-0.055	0.0025
Sp3.070	187.10	-0.000	-0.045	0.0047
Sp3.080	199.90	-0.000	-0.030	0.0059
Sp3.090	212.70	-0.000	-0.014	0.0058
EndCmp	225.00	-0.000	-0.000	0.0040
BegCmp	225.00	-0.000	-0.000	0.0040
Sp3.100	225.50	-0.000	-0.000	0.0037
Sp4.000	225.50	-0.000	-0.000	0.0037
EndCmp	226.50	-0.000	0.001	0.0032
BegCmp	226.50	-0.000	0.001	0.0032
Sp4.010	227.50	-0.000	0.001	0.0029
Sp4.020	229.50	-0.000	0.002	0.0022
Sp4.030	231.50	-0.000	0.003	0.0015
Sp4.040	233.50	-0.000	0.004	0.0008
Sp4.050	235.50	-0.000	0.004	0.0000
Sp4.060	237.50	-0.000	0.004	-0.0007
Sp4.070	239.50	0.000	0.003	-0.0015

Project:

Sp4.080	241.50	0.000	0.013	-0.0115
Sp4.090	243.50	0.000	0.007	-0.0156
Sp4.100	245.50	0.000	-0.000	-0.0199
Sp5.000	245.50	0.000	-0.000	-0.0199
EndCmp	247.00	0.000	-0.008	-0.0263
BegCmp	247.00	0.000	-0.008	-0.0263
Sp5.010	258.00	0.001	-0.085	-0.0375
Sp5.020	270.50	0.001	-0.191	-0.0404
Sp5.030	283.00	0.001	-0.292	-0.0350
Sp5.040	295.50	0.000	-0.371	-0.0234
Sp5.050	308.00	-0.000	-0.413	-0.0079
Sp5.060	320.50	-0.001	-0.411	0.0096
Sp5.070	333.00	-0.002	-0.363	0.0269
Sp5.080	345.50	-0.002	-0.272	0.0419
Sp5.090	358.00	-0.002	-0.146	0.0525
Sp5.100	370.50	-0.003	-0.000	0.0564
R.000	370.50	-0.003	-0.000	0.0564
R.100	371.00	-0.003	0.006	0.0564

Project:

Non-live Load Deflections

Stage 9: asphalt

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.001	0.002	-0.0153
L.100	0.50	0.001	-0.000	-0.0153
Sp1.000	0.50	0.001	-0.000	-0.0153
Sp1.010	8.20	0.001	-0.025	-0.0143
Sp1.020	15.90	0.001	-0.046	-0.0116
Sp1.030	23.60	0.001	-0.062	-0.0078
Sp1.040	31.30	0.001	-0.071	-0.0033
Sp1.050	39.00	0.001	-0.073	0.0013
Sp1.060	46.70	0.001	-0.067	0.0056
Sp1.070	54.40	0.000	-0.055	0.0091
Sp1.080	62.10	0.000	-0.038	0.0113
Sp1.090	69.80	0.000	-0.018	0.0116
EndCmp	76.00	0.000	-0.003	0.0103
BegCmp	76.00	0.000	-0.003	0.0103
Sp1.100	77.50	0.000	-0.000	0.0092
Sp2.000	77.50	0.000	-0.000	0.0092
Sp2.010	79.50	0.000	0.004	0.0081
Sp2.020	81.50	0.000	0.007	0.0069
Sp2.030	83.50	0.001	0.010	0.0053
Sp2.040	85.50	0.001	0.012	0.0035
Sp2.050	87.50	0.001	0.013	0.0012
Sp2.060	89.50	0.001	0.013	-0.0014
Sp2.070	91.50	0.001	0.012	-0.0045
Sp2.080	93.50	0.001	0.010	-0.0082
Sp2.090	95.50	0.001	0.006	-0.0126
EndCmp	96.50	0.001	0.003	-0.0152
BegCmp	96.50	0.001	0.003	-0.0152
Sp2.100	97.50	0.001	-0.000	-0.0179
Sp3.000	97.50	0.001	-0.000	-0.0179
EndCmp	98.00	0.001	-0.002	-0.0190
BegCmp	98.00	0.001	-0.002	-0.0190
Sp3.010	110.30	0.001	-0.067	-0.0285
Sp3.020	123.10	0.001	-0.148	-0.0295
Sp3.030	135.90	0.001	-0.222	-0.0235
Sp3.040	148.70	0.001	-0.272	-0.0130
Sp3.050	161.50	0.000	-0.290	-0.0002
Sp3.060	174.30	-0.000	-0.273	0.0127
Sp3.070	187.10	-0.001	-0.223	0.0234
Sp3.080	199.90	-0.001	-0.150	0.0295
Sp3.090	212.70	-0.001	-0.069	0.0289
EndCmp	225.00	-0.001	-0.002	0.0197
BegCmp	225.00	-0.001	-0.002	0.0197
Sp3.100	225.50	-0.000	-0.000	0.0187
Sp4.000	225.50	-0.000	-0.000	0.0187
EndCmp	226.50	-0.000	0.004	0.0160
BegCmp	226.50	-0.000	0.004	0.0160
Sp4.010	227.50	-0.000	0.007	0.0143
Sp4.020	229.50	-0.000	0.012	0.0109
Sp4.030	231.50	-0.000	0.016	0.0074
Sp4.040	233.50	-0.000	0.019	0.0038
Sp4.050	235.50	-0.000	0.019	0.0002
Sp4.060	237.50	-0.000	0.019	-0.0036
Sp4.070	239.50	0.000	0.017	-0.0075

Project:

Non-live Load Deflections

Stage 9: PS

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.540	-0.134	1.2819
L.100	0.50	0.540	0.000	1.2813
Sp1.000	0.50	0.540	0.000	1.2813
Sp1.010	13.10	0.462	3.217	1.1290
Sp1.020	25.70	0.353	5.890	0.8878
Sp1.030	38.30	0.235	7.870	0.6067
Sp1.040	50.90	0.118	9.082	0.3068
Sp1.050	63.50	-0.000	9.487	0.0001
Sp1.060	76.10	-0.118	9.082	-0.3066
Sp1.070	88.70	-0.235	7.871	-0.6066
Sp1.080	101.30	-0.353	5.891	-0.8876
Sp1.090	113.90	-0.462	3.218	-1.1293
Sp1.100	126.50	-0.540	0.000	-1.2816
R.000	126.50	-0.540	0.000	-1.2816
R.100	127.00	-0.540	-0.134	-1.2823

Alternate Strands

Project:

Non-live Load Deflections

Stage 9: ComponentWeight

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.021	0.091	-0.8715
L.100	0.50	0.021	-0.000	-0.8715
Sp1.000	0.50	0.021	-0.000	-0.8715
Sp1.010	13.10	0.020	-2.270	-0.8220
Sp1.020	25.70	0.017	-4.288	-0.6876
Sp1.030	38.30	0.012	-5.863	-0.4914
Sp1.040	50.90	0.006	-6.860	-0.2553
Sp1.050	63.50	-0.000	-7.200	0.0000
Sp1.060	76.10	-0.006	-6.860	0.2553
Sp1.070	88.70	-0.012	-5.863	0.4914
Sp1.080	101.30	-0.017	-4.288	0.6876
Sp1.090	113.90	-0.020	-2.270	0.8220
Sp1.100	126.50	-0.021	-0.000	0.8715
R.000	126.50	-0.021	-0.000	0.8715
R.100	127.00	-0.021	0.091	0.8715

Project:

Non-live Load Deflections

Stage 9: Shrinkage

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.302	0.014	-0.1359
L.100	0.50	0.299	0.000	-0.1349
Sp1.000	0.50	0.299	0.000	-0.1349
Sp1.010	13.10	0.239	-0.323	-0.1100
Sp1.020	25.70	0.179	-0.579	-0.0835
Sp1.030	38.30	0.119	-0.763	-0.0560
Sp1.040	50.90	0.060	-0.874	-0.0280
Sp1.050	63.50	-0.000	-0.911	-0.0000
Sp1.060	76.10	-0.060	-0.874	0.0280
Sp1.070	88.70	-0.119	-0.763	0.0560
Sp1.080	101.30	-0.179	-0.579	0.0835
Sp1.090	113.90	-0.239	-0.323	0.1100
Sp1.100	126.50	-0.299	0.000	0.1349
R.000	126.50	-0.299	0.000	0.1349
R.100	127.00	-0.302	0.014	0.1359

Project:

Non-live Load Deflections

Stage 9: haunch

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.001	0.003	-0.0304
L.100	0.50	0.001	-0.000	-0.0304
Sp1.000	0.50	0.001	-0.000	-0.0304
Sp1.010	13.10	0.001	-0.079	-0.0286
Sp1.020	25.70	0.001	-0.150	-0.0240
Sp1.030	38.30	0.000	-0.204	-0.0171
Sp1.040	50.90	0.000	-0.239	-0.0089
Sp1.050	63.50	-0.000	-0.251	0.0000
Sp1.060	76.10	-0.000	-0.239	0.0089
Sp1.070	88.70	-0.000	-0.204	0.0171
Sp1.080	101.30	-0.001	-0.150	0.0240
Sp1.090	113.90	-0.001	-0.079	0.0286
Sp1.100	126.50	-0.001	-0.000	0.0304
R.000	126.50	-0.001	-0.000	0.0304
R.100	127.00	-0.001	0.003	0.0304

Colorado DOT
4201 E. Arkansas Ave.
PROGRAM: Consplice PT - V 1.2.2
PHONE : TOLL-FREE 1-800-451-5327

PHONE: (303) 757-9589 | Denver, CO 80222 | by LEAP Software, Inc. | TAMPA AREA: 813-985-9170

JOB NO. 16212
BY AJP 02/16/2009
CKD.

Project:

Non-live Load Deflections

Stage 9: extradeck

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.002	0.011	-0.1063
L.100	0.50	0.002	-0.000	-0.1063
Sp1.000	0.50	0.002	-0.000	-0.1063
Sp1.010	13.10	0.002	-0.277	-0.1003
Sp1.020	25.70	0.002	-0.523	-0.0839
Sp1.030	38.30	0.001	-0.716	-0.0600
Sp1.040	50.90	0.001	-0.837	-0.0312
Sp1.050	63.50	-0.000	-0.879	0.0000
Sp1.060	76.10	-0.001	-0.837	0.0312
Sp1.070	88.70	-0.001	-0.716	0.0600
Sp1.080	101.30	-0.002	-0.523	0.0839
Sp1.090	113.90	-0.002	-0.277	0.1003
Sp1.100	126.50	-0.002	-0.000	0.1063
R.000	126.50	-0.002	-0.000	0.1063
R.100	127.00	-0.002	0.011	0.1063

Project:

Non-live Load Deflections

Stage 9: bridgerail

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.000	0.000	-0.0031
L.100	0.50	0.000	-0.000	-0.0031
Sp1.000	0.50	0.000	-0.000	-0.0031
Sp1.010	8.20	0.000	-0.005	-0.0029
Sp1.020	15.90	0.000	-0.009	-0.0023
Sp1.030	23.60	0.000	-0.012	-0.0016
Sp1.040	31.30	0.000	-0.014	-0.0007
Sp1.050	39.00	0.000	-0.015	0.0003
Sp1.060	46.70	0.000	-0.013	0.0011
Sp1.070	54.40	0.000	-0.011	0.0018
Sp1.080	62.10	0.000	-0.008	0.0023
Sp1.090	69.80	0.000	-0.004	0.0023
EndCmp	76.00	0.000	-0.001	0.0021
BegCmp	76.00	0.000	-0.001	0.0021
Sp1.100	77.50	0.000	-0.000	0.0018
Sp2.000	77.50	0.000	-0.000	0.0018
Sp2.010	79.50	0.000	0.001	0.0016
Sp2.020	81.50	0.000	0.001	0.0014
Sp2.030	83.50	0.000	0.002	0.0011
Sp2.040	85.50	0.000	0.002	0.0007
Sp2.050	87.50	0.000	0.003	0.0002
Sp2.060	89.50	0.000	0.003	-0.0003
Sp2.070	91.50	0.000	0.002	-0.0009
Sp2.080	93.50	0.000	0.002	-0.0016
Sp2.090	95.50	0.000	0.001	-0.0025
EndCmp	96.50	0.000	0.001	-0.0030
BegCmp	96.50	0.000	0.001	-0.0030
Sp2.100	97.50	0.000	-0.000	-0.0036
Sp3.000	97.50	0.000	-0.000	-0.0036
EndCmp	98.00	0.000	-0.000	-0.0038
BegCmp	98.00	0.000	-0.000	-0.0038
Sp3.010	110.30	0.000	-0.013	-0.0058
Sp3.020	123.10	0.000	-0.030	-0.0059
Sp3.030	135.90	0.000	-0.045	-0.0047
Sp3.040	148.70	0.000	-0.055	-0.0026
Sp3.050	161.50	0.000	-0.058	-0.0000
Sp3.060	174.30	-0.000	-0.055	0.0025
Sp3.070	187.10	-0.000	-0.045	0.0047
Sp3.080	199.90	-0.000	-0.030	0.0059
Sp3.090	212.70	-0.000	-0.014	0.0058
EndCmp	225.00	-0.000	-0.000	0.0039
BegCmp	225.00	-0.000	-0.000	0.0039
Sp3.100	225.50	-0.000	-0.000	0.0037
Sp4.000	225.50	-0.000	-0.000	0.0037
EndCmp	226.50	-0.000	0.001	0.0032
BegCmp	226.50	-0.000	0.001	0.0032
Sp4.010	227.50	-0.000	0.001	0.0029
Sp4.020	229.50	-0.000	0.002	0.0022
Sp4.030	231.50	-0.000	0.003	0.0015
Sp4.040	233.50	-0.000	0.004	0.0008
Sp4.050	235.50	-0.000	0.004	0.0000
Sp4.060	237.50	-0.000	0.004	-0.0007
Sp4.070	239.50	0.000	0.003	-0.0015

Project:

Sp4.080	241.50	0.000	0.003	-0.0023
Sp4.090	243.50	0.000	0.001	-0.0031
Sp4.100	245.50	0.000	-0.000	-0.0040
Sp5.000	245.50	0.000	-0.000	-0.0040
EndCmp	247.00	0.000	-0.002	-0.0053
BegCmp	247.00	0.000	-0.002	-0.0053
Sp5.010	258.00	0.000	-0.017	-0.0075
Sp5.020	270.50	0.000	-0.038	-0.0081
Sp5.030	283.00	0.000	-0.059	-0.0070
Sp5.040	295.50	0.000	-0.074	-0.0047
Sp5.050	308.00	-0.000	-0.083	-0.0016
Sp5.060	320.50	-0.000	-0.082	0.0019
Sp5.070	333.00	-0.000	-0.073	0.0054
Sp5.080	345.50	-0.000	-0.054	0.0084
Sp5.090	358.00	-0.001	-0.029	0.0105
Sp5.100	370.50	-0.001	-0.000	0.0113
R.000	370.50	-0.001	-0.000	0.0113
R.100	371.00	-0.001	0.001	0.0113

Project:

Non-live Load Deflections

Stage 9: asphalt

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.001	0.002	-0.0153
L.100	0.50	0.001	-0.000	-0.0153
Sp1.000	0.50	0.001	-0.000	-0.0153
Sp1.010	8.20	0.001	-0.025	-0.0143
Sp1.020	15.90	0.001	-0.046	-0.0116
Sp1.030	23.60	0.001	-0.062	-0.0078
Sp1.040	31.30	0.001	-0.071	-0.0033
Sp1.050	39.00	0.001	-0.073	0.0013
Sp1.060	46.70	0.001	-0.067	0.0056
Sp1.070	54.40	0.001	-0.055	0.0091
Sp1.080	62.10	0.000	-0.038	0.0113
Sp1.090	69.80	0.000	-0.018	0.0116
EndCmp	76.00	0.000	-0.003	0.0103
BegCmp	76.00	0.000	-0.003	0.0103
Sp1.100	77.50	0.000	-0.000	0.0092
Sp2.000	77.50	0.000	-0.000	0.0092
Sp2.010	79.50	0.001	0.004	0.0081
Sp2.020	81.50	0.001	0.007	0.0068
Sp2.030	83.50	0.001	0.010	0.0053
Sp2.040	85.50	0.001	0.012	0.0034
Sp2.050	87.50	0.001	0.013	0.0012
Sp2.060	89.50	0.001	0.013	-0.0014
Sp2.070	91.50	0.001	0.012	-0.0045
Sp2.080	93.50	0.001	0.010	-0.0082
Sp2.090	95.50	0.001	0.006	-0.0126
EndCmp	96.50	0.001	0.003	-0.0151
BegCmp	96.50	0.001	0.003	-0.0151
Sp2.100	97.50	0.001	-0.000	-0.0178
Sp3.000	97.50	0.001	-0.000	-0.0178
EndCmp	98.00	0.001	-0.002	-0.0189
BegCmp	98.00	0.001	-0.002	-0.0189
Sp3.010	110.30	0.001	-0.067	-0.0287
Sp3.020	123.10	0.001	-0.149	-0.0296
Sp3.030	135.90	0.001	-0.222	-0.0235
Sp3.040	148.70	0.001	-0.272	-0.0130
Sp3.050	161.50	0.000	-0.291	-0.0002
Sp3.060	174.30	-0.000	-0.273	0.0126
Sp3.070	187.10	-0.001	-0.224	0.0233
Sp3.080	199.90	-0.001	-0.151	0.0296
Sp3.090	212.70	-0.001	-0.069	0.0290
EndCmp	225.00	-0.001	-0.002	0.0196
BegCmp	225.00	-0.001	-0.002	0.0196
Sp3.100	225.50	-0.001	-0.000	0.0186
Sp4.000	225.50	-0.001	-0.000	0.0186
EndCmp	226.50	-0.001	0.004	0.0159
BegCmp	226.50	-0.001	0.004	0.0159
Sp4.010	227.50	-0.001	0.007	0.0142
Sp4.020	229.50	-0.000	0.012	0.0108
Sp4.030	231.50	-0.000	0.016	0.0074
Sp4.040	233.50	-0.000	0.018	0.0038
Sp4.050	235.50	-0.000	0.019	0.0002
Sp4.060	237.50	-0.000	0.019	-0.0036
Sp4.070	239.50	0.000	0.017	-0.0075

Project:

Sp4.080	241.50	0.000	0.013	-0.0115
Sp4.090	243.50	0.000	0.007	-0.0156
Sp4.100	245.50	0.000	-0.000	-0.0199
Sp5.000	245.50	0.000	-0.000	-0.0199
EndCmp	247.00	0.000	-0.008	-0.0263
BegCmp	247.00	0.000	-0.008	-0.0263
Sp5.010	258.00	0.001	-0.085	-0.0375
Sp5.020	270.50	0.001	-0.191	-0.0404
Sp5.030	283.00	0.001	-0.292	-0.0350
Sp5.040	295.50	0.000	-0.371	-0.0234
Sp5.050	308.00	-0.000	-0.413	-0.0079
Sp5.060	320.50	-0.001	-0.411	0.0096
Sp5.070	333.00	-0.002	-0.363	0.0269
Sp5.080	345.50	-0.002	-0.272	0.0419
Sp5.090	358.00	-0.003	-0.146	0.0525
Sp5.100	370.50	-0.003	-0.000	0.0564
R.000	370.50	-0.003	-0.000	0.0564
R.100	371.00	-0.003	0.006	0.0564

Project:

Non-live Load Deflections

Stage 9: PS

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.539	-0.140	1.3411
L.100	0.50	0.539	-0.000	1.3402
Sp1.000	0.50	0.539	-0.000	1.3402
Sp1.010	13.10	0.452	3.315	1.1420
Sp1.020	25.70	0.339	5.973	0.8700
Sp1.030	38.30	0.226	7.900	0.5875
Sp1.040	50.90	0.113	9.069	0.2957
Sp1.050	63.50	0.000	9.459	-0.0000
Sp1.060	76.10	-0.113	9.069	-0.2957
Sp1.070	88.70	-0.226	7.900	-0.5875
Sp1.080	101.30	-0.339	5.973	-0.8700
Sp1.090	113.90	-0.452	3.315	-1.1420
Sp1.100	126.50	-0.539	-0.000	-1.3402
R.000	126.50	-0.539	-0.000	-1.3402
R.100	127.00	-0.539	-0.140	-1.3411

9.355

Project:

Non-live Load Deflections

Stage 9: ComponentWeight

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.021	0.091	-0.8714
L.100	0.50	0.021	-0.000	-0.8714
Sp1.000	0.50	0.021	-0.000	-0.8714
Sp1.010	13.10	0.019	-2.270	-0.8229
Sp1.020	25.70	0.016	-4.293	-0.6897
Sp1.030	38.30	0.012	-5.874	-0.4936
Sp1.040	50.90	0.006	-6.875	-0.2568
Sp1.050	63.50	0.000	-7.218	-0.0000
Sp1.060	76.10	-0.006	-6.875	0.2568
Sp1.070	88.70	-0.012	-5.874	0.4936
Sp1.080	101.30	-0.016	-4.293	0.6897
Sp1.090	113.90	-0.019	-2.270	0.8229
Sp1.100	126.50	-0.021	-0.000	0.8714
R.000	126.50	-0.021	-0.000	0.8714
R.100	127.00	-0.021	0.091	0.8714

Project:

Non-live Load Deflections

Stage 9: Shrinkage

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.302	0.014	-0.1377
L.100	0.50	0.299	-0.000	-0.1367
Sp1.000	0.50	0.299	-0.000	-0.1367
Sp1.010	13.10	0.240	-0.325	-0.1099
Sp1.020	25.70	0.180	-0.579	-0.0827
Sp1.030	38.30	0.120	-0.762	-0.0553
Sp1.040	50.90	0.060	-0.871	-0.0277
Sp1.050	63.50	0.000	-0.908	-0.0000
Sp1.060	76.10	-0.060	-0.871	0.0277
Sp1.070	88.70	-0.120	-0.762	0.0553
Sp1.080	101.30	-0.180	-0.579	0.0827
Sp1.090	113.90	-0.240	-0.325	0.1099
Sp1.100	126.50	-0.299	0.000	0.1367
R.000	126.50	-0.299	0.000	0.1367
R.100	127.00	-0.302	0.014	0.1377

Project:

Non-live Load Deflections

Stage 9: haunch

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.001	0.003	-0.0304
L.100	0.50	0.001	-0.000	-0.0304
Sp1.000	0.50	0.001	-0.000	-0.0304
Sp1.010	13.10	0.001	-0.079	-0.0287
Sp1.020	25.70	0.001	-0.150	-0.0240
Sp1.030	38.30	0.000	-0.205	-0.0172
Sp1.040	50.90	0.000	-0.240	-0.0090
Sp1.050	63.50	-0.000	-0.252	-0.0000
Sp1.060	76.10	-0.000	-0.240	0.0090
Sp1.070	88.70	-0.000	-0.205	0.0172
Sp1.080	101.30	-0.001	-0.150	0.0240
Sp1.090	113.90	-0.001	-0.079	0.0287
Sp1.100	126.50	-0.001	-0.000	0.0304
R.000	126.50	-0.001	-0.000	0.0304
R.100	127.00	-0.001	0.003	0.0304

Project:

Non-live Load Deflections

Stage 9: extradeck

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.002	0.011	-0.1063
L.100	0.50	0.002	-0.000	-0.1063
Sp1.000	0.50	0.002	-0.000	-0.1063
Sp1.010	13.10	0.002	-0.277	-0.1004
Sp1.020	25.70	0.002	-0.524	-0.0841
Sp1.030	38.30	0.001	-0.717	-0.0602
Sp1.040	50.90	0.001	-0.839	-0.0313
Sp1.050	63.50	-0.000	-0.881	-0.0000
Sp1.060	76.10	-0.001	-0.839	0.0313
Sp1.070	88.70	-0.001	-0.717	0.0602
Sp1.080	101.30	-0.002	-0.524	0.0841
Sp1.090	113.90	-0.002	-0.277	0.1004
Sp1.100	126.50	-0.002	-0.000	0.1063
R.000	126.50	-0.002	-0.000	0.1063
R.100	127.00	-0.002	0.011	0.1063

Project:

Non-live Load Deflections

Stage 9: bridgerail

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.000	0.000	-0.0031
L.100	0.50	0.000	-0.000	-0.0031
Sp1.000	0.50	0.000	-0.000	-0.0031
Sp1.010	8.20	0.000	-0.005	-0.0029
Sp1.020	15.90	0.000	-0.009	-0.0023
Sp1.030	23.60	0.000	-0.012	-0.0016
Sp1.040	31.30	0.000	-0.014	-0.0007
Sp1.050	39.00	0.000	-0.015	0.0003
Sp1.060	46.70	0.000	-0.013	0.0011
Sp1.070	54.40	0.000	-0.011	0.0018
Sp1.080	62.10	0.000	-0.008	0.0023
Sp1.090	69.80	0.000	-0.004	0.0023
EndCmp	76.00	0.000	-0.001	0.0021
BegCmp	76.00	0.000	-0.001	0.0021
Sp1.100	77.50	0.000	-0.000	0.0019
Sp2.000	77.50	0.000	-0.000	0.0019
Sp2.010	79.50	0.000	0.001	0.0016
Sp2.020	81.50	0.000	0.001	0.0014
Sp2.030	83.50	0.000	0.002	0.0011
Sp2.040	85.50	0.000	0.002	0.0007
Sp2.050	87.50	0.000	0.003	0.0003
Sp2.060	89.50	0.000	0.003	-0.0003
Sp2.070	91.50	0.000	0.002	-0.0009
Sp2.080	93.50	0.000	0.002	-0.0017
Sp2.090	95.50	0.000	0.001	-0.0025
EndCmp	96.50	0.000	0.001	-0.0031
BegCmp	96.50	0.000	0.001	-0.0031
Sp2.100	97.50	0.000	-0.000	-0.0036
Sp3.000	97.50	0.000	-0.000	-0.0036
EndCmp	98.00	0.000	-0.000	-0.0038
BegCmp	98.00	0.000	-0.000	-0.0038
Sp3.010	110.30	0.000	-0.013	-0.0057
Sp3.020	123.10	0.000	-0.030	-0.0059
Sp3.030	135.90	0.000	-0.044	-0.0047
Sp3.040	148.70	0.000	-0.055	-0.0026
Sp3.050	161.50	0.000	-0.058	-0.0000
Sp3.060	174.30	-0.000	-0.055	0.0025
Sp3.070	187.10	-0.000	-0.045	0.0047
Sp3.080	199.90	-0.000	-0.030	0.0059
Sp3.090	212.70	-0.000	-0.014	0.0058
EndCmp	225.00	-0.000	-0.000	0.0040
BegCmp	225.00	-0.000	-0.000	0.0040
Sp3.100	225.50	-0.000	-0.000	0.0037
Sp4.000	225.50	-0.000	-0.000	0.0037
EndCmp	226.50	-0.000	0.001	0.0032
BegCmp	226.50	-0.000	0.001	0.0032
Sp4.010	227.50	-0.000	0.001	0.0029
Sp4.020	229.50	-0.000	0.002	0.0022
Sp4.030	231.50	-0.000	0.003	0.0015
Sp4.040	233.50	-0.000	0.004	0.0008
Sp4.050	235.50	-0.000	0.004	0.0000
Sp4.060	237.50	-0.000	0.004	-0.0007
Sp4.070	239.50	0.000	0.003	-0.0015

Project:

Sp4.080	241.50	0.000	0.003	-0.0023
Sp4.090	243.50	0.000	0.001	-0.0031
Sp4.100	245.50	0.000	-0.000	-0.0040
Sp5.000	245.50	0.000	-0.000	-0.0040
EndCmp	247.00	0.000	-0.002	-0.0053
BegCmp	247.00	0.000	-0.002	-0.0053
Sp5.010	258.00	0.000	-0.017	-0.0075
Sp5.020	270.50	0.000	-0.038	-0.0081
Sp5.030	283.00	0.000	-0.059	-0.0070
Sp5.040	295.50	0.000	-0.074	-0.0047
Sp5.050	308.00	-0.000	-0.083	-0.0016
Sp5.060	320.50	-0.000	-0.083	0.0019
Sp5.070	333.00	-0.000	-0.073	0.0054
Sp5.080	345.50	-0.000	-0.054	0.0084
Sp5.090	358.00	-0.000	-0.029	0.0105
Sp5.100	370.50	-0.001	-0.000	0.0113
R.000	370.50	-0.001	-0.000	0.0113
R.100	371.00	-0.001	0.001	0.0113

Project:

Non-live Load Deflections

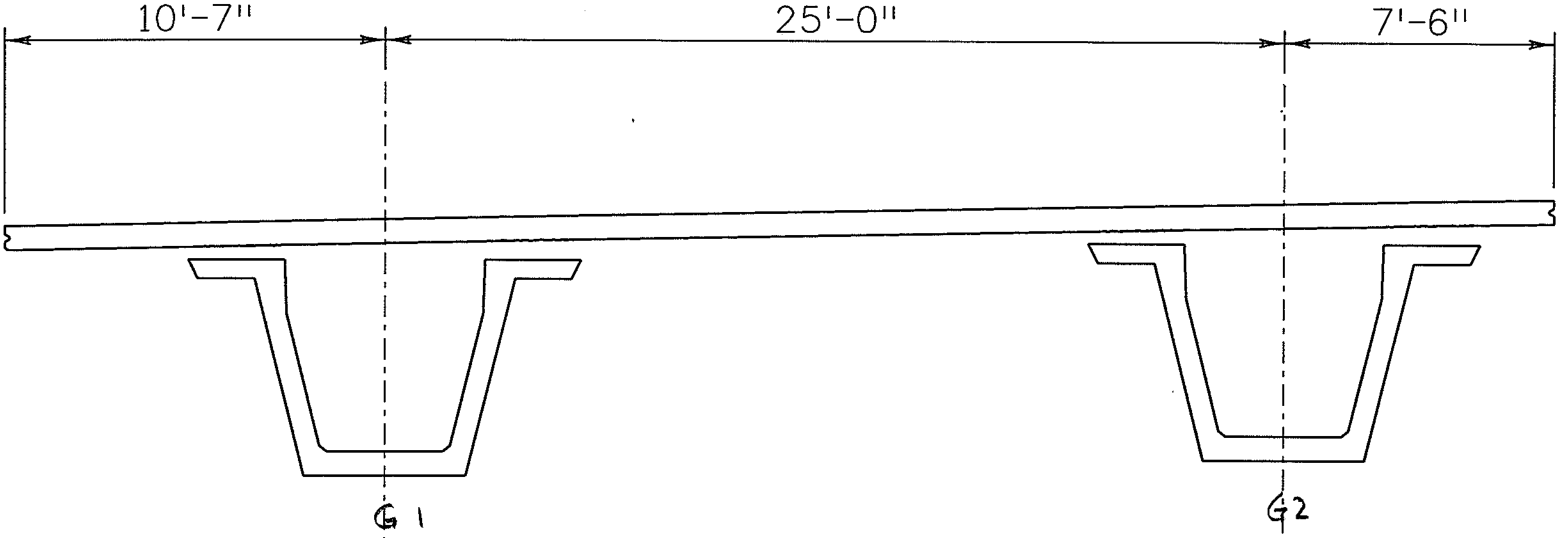
Stage 9: asphalt

POI	Location (ft)	Horiz (in)	Vertical (in)	Rotation (deg)
L.000	0.00	0.001	0.002	-0.0153
L.100	0.50	0.001	-0.000	-0.0153
Sp1.000	0.50	0.001	-0.000	-0.0153
Sp1.010	8.20	0.001	-0.025	-0.0143
Sp1.020	15.90	0.001	-0.046	-0.0116
Sp1.030	23.60	0.001	-0.062	-0.0078
Sp1.040	31.30	0.001	-0.071	-0.0033
Sp1.050	39.00	0.001	-0.073	0.0013
Sp1.060	46.70	0.001	-0.067	0.0056
Sp1.070	54.40	0.000	-0.055	0.0091
Sp1.080	62.10	0.000	-0.038	0.0113
Sp1.090	69.80	0.000	-0.018	0.0116
EndCmp	76.00	0.000	-0.003	0.0103
BegCmp	76.00	0.000	-0.003	0.0103
Sp1.100	77.50	0.000	-0.000	0.0092
Sp2.000	77.50	0.000	-0.000	0.0092
Sp2.010	79.50	0.000	0.004	0.0081
Sp2.020	81.50	0.000	0.007	0.0069
Sp2.030	83.50	0.001	0.010	0.0053
Sp2.040	85.50	0.001	0.012	0.0035
Sp2.050	87.50	0.001	0.013	0.0012
Sp2.060	89.50	0.001	0.013	-0.0014
Sp2.070	91.50	0.001	0.012	-0.0045
Sp2.080	93.50	0.001	0.010	-0.0082
Sp2.090	95.50	0.001	0.006	-0.0126
EndCmp	96.50	0.001	0.003	-0.0152
BegCmp	96.50	0.001	0.003	-0.0152
Sp2.100	97.50	0.001	-0.000	-0.0179
Sp3.000	97.50	0.001	-0.000	-0.0179
EndCmp	98.00	0.001	-0.002	-0.0190
BegCmp	98.00	0.001	-0.002	-0.0190
Sp3.010	110.30	0.001	-0.067	-0.0285
Sp3.020	123.10	0.001	-0.148	-0.0295
Sp3.030	135.90	0.001	-0.222	-0.0235
Sp3.040	148.70	0.001	-0.272	-0.0130
Sp3.050	161.50	0.000	-0.290	-0.0002
Sp3.060	174.30	-0.000	-0.273	0.0127
Sp3.070	187.10	-0.001	-0.223	0.0234
Sp3.080	199.90	-0.001	-0.150	0.0295
Sp3.090	212.70	-0.001	-0.069	0.0289
EndCmp	225.00	-0.001	-0.002	0.0197
BegCmp	225.00	-0.001	-0.002	0.0197
Sp3.100	225.50	-0.000	-0.000	0.0187
Sp4.000	225.50	-0.000	-0.000	0.0187
EndCmp	226.50	-0.000	0.004	0.0160
BegCmp	226.50	-0.000	0.004	0.0160
Sp4.010	227.50	-0.000	0.007	0.0143
Sp4.020	229.50	-0.000	0.012	0.0109
Sp4.030	231.50	-0.000	0.016	0.0074
Sp4.040	233.50	-0.000	0.019	0.0038
Sp4.050	235.50	-0.000	0.019	0.0002
Sp4.060	237.50	-0.000	0.019	-0.0036
Sp4.070	239.50	0.000	0.017	-0.0075

Project:

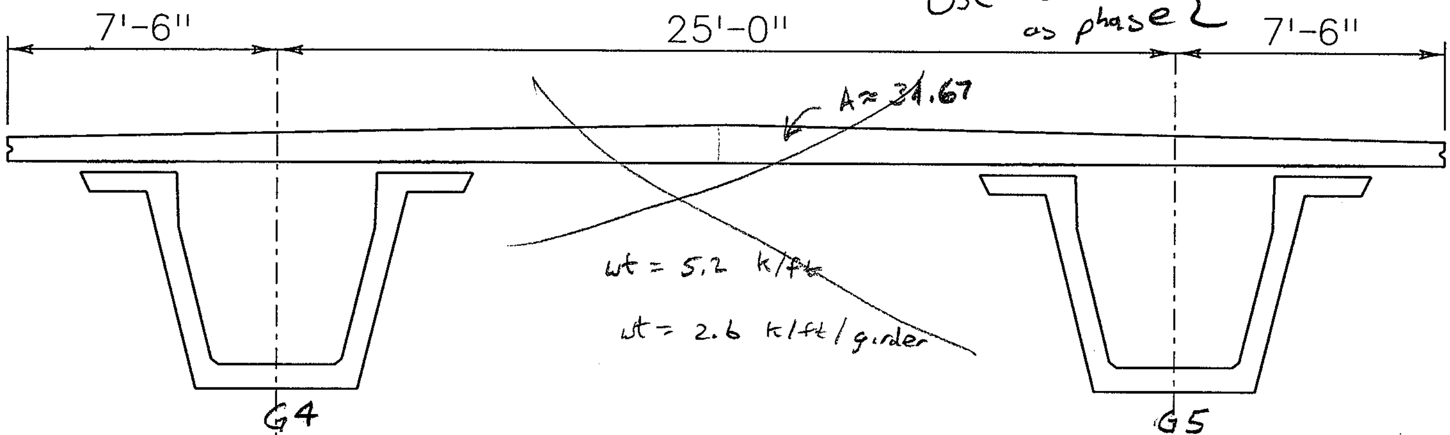
Sp4.080	241.50	0.000	0.013	-0.0115
Sp4.090	243.50	0.000	0.007	-0.0156
Sp4.100	245.50	0.000	-0.000	-0.0199
Sp5.000	245.50	0.000	-0.000	-0.0199
EndCmp	247.00	0.000	-0.008	-0.0263
BegCmp	247.00	0.000	-0.008	-0.0263
Sp5.010	258.00	0.001	-0.085	-0.0375
Sp5.020	270.50	0.001	-0.191	-0.0404
Sp5.030	283.00	0.001	-0.292	-0.0350
Sp5.040	295.50	0.000	-0.371	-0.0234
Sp5.050	308.00	-0.000	-0.413	-0.0079
Sp5.060	320.50	-0.001	-0.411	0.0096
Sp5.070	333.00	-0.002	-0.363	0.0269
Sp5.080	345.50	-0.002	-0.272	0.0419
Sp5.090	358.00	-0.002	-0.146	0.0525
Sp5.100	370.50	-0.003	-0.000	0.0564
R.000	370.50	-0.003	-0.000	0.0564
R.100	371.00	-0.003	0.006	0.0564

Phase 1 & 2

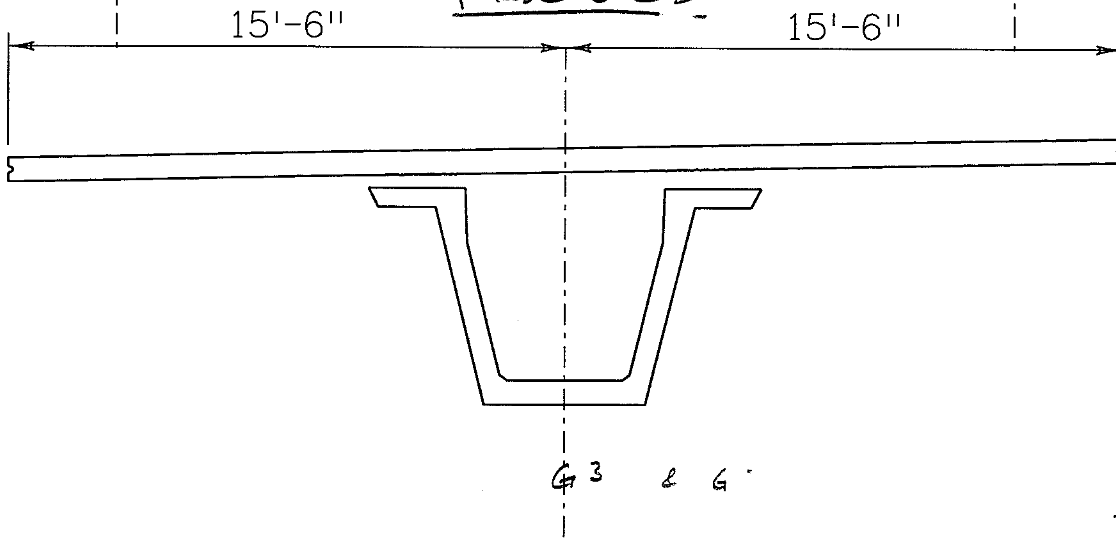


Phase 4

use same as phase 2

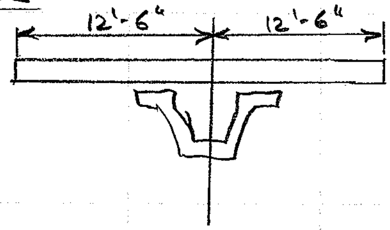


Phase 3 & 5



1.2 k

FOR FINAL

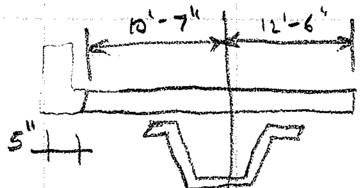


8" deck ⇒ .1 k/ft of deck transverse / ft longitudinal

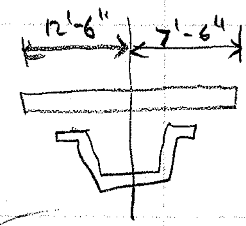
$wt = (25')(.1') = 2.5$ k/ft for final

@ erection

Phase 1 & 2

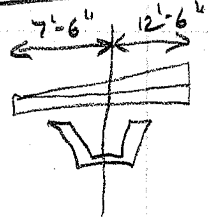


exterior girder



.5 k/ft lighter

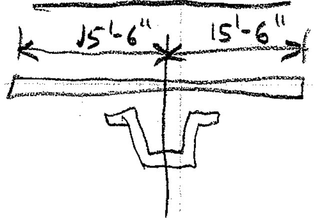
Phase 4



~~.1 k/ft heavier~~

Same as interior girder phase 1 & 2

Phase 3 & 5



.6 k/ft heavier

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

SPAN 1

GIRDER 3

extra load ≈ .6 K/ft

camber @ erection ≈ 0.46"

30 strands

GIRDER 2

less load ≈ .5 K/ft

camber @ erection = .521

increased camber (deck) ≈ .05"

≈ .526"

30 strands

GIRDER 1

camber @ erection ≈ .538"

30 strands

GIRDER 4

~~extra load ≈ .1 K/ft~~

~~camber @ erection ≈ .511"~~

~~30 strands~~

Same as girder 2

By: Date	Project no.	Project code (SA#):
Chk'd: Date	Structure no.	Sheet 221 of

DESIGN STATUS

Span:1, Beam:1

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	7.600	15.200	22.800	30.400	38.000	26.600
Precast-top	-0.296	-0.193	-0.186	-0.151	-0.091	-0.072	-0.116
Bottom	1.257	1.157	1.470	1.584	1.527	1.508	1.551
As_top, in2	3.372	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	6.850	14.450	22.050	29.650	37.250
Topping-top	0.017	0.051	0.069	0.111	0.180	0.217	0.229	0.217
Precast-top	-0.078	-0.178	-0.095	0.106	0.360	0.562	0.712	0.754
Bottom	0.264	0.949	0.829	0.538	0.434	0.295	0.125	0.111

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.014	0.043	0.057	0.092	0.150	0.182	0.192	0.182
Precast-top	-0.079	-0.182	-0.101	0.096	0.344	0.543	0.692	0.735
Bottom	0.272	0.973	0.861	0.589	0.517	0.394	0.228	0.208

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.251	-0.206	-0.183	-0.126	-0.021	0.019	0.031	0.038
Precast-top	-0.222	-0.317	-0.232	-0.022	0.250	0.453	0.604	0.656
Bottom	1.021	1.667	1.531	1.199	0.994	0.846	0.675	0.609

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.208	-0.170	-0.151	-0.103	-0.015	0.020	0.032	0.038
Precast-top	-0.199	-0.298	-0.214	-0.010	0.253	0.454	0.605	0.657
Bottom	0.900	1.567	1.442	1.136	0.977	0.843	0.672	0.607

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.009	0.012	0.019	0.032	0.040	0.043	0.042
Precast-top	-0.085	-0.200	-0.126	0.057	0.279	0.465	0.611	0.658
Bottom	0.303	1.067	0.988	0.794	0.846	0.788	0.640	0.598

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.035	-0.027	-0.023	-0.012	0.009	0.024	0.035	0.042
Precast-top	-0.106	-0.220	-0.145	0.040	0.266	0.457	0.607	0.658
Bottom	0.412	1.167	1.085	0.882	0.911	0.831	0.661	0.598

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.016	0.047	0.063	0.101	0.164	0.198	0.207	0.196
Precast-top	-0.035	-0.077	-0.032	0.078	0.220	0.329	0.407	0.425
Bottom	0.113	0.416	0.335	0.141	0.011	-0.099	-0.195	-0.188

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.233	-0.192	-0.171	-0.120	-0.025	0.007	0.013	0.017
Precast-top	-0.169	-0.207	-0.159	-0.042	0.117	0.225	0.301	0.327
Bottom	0.816	1.083	0.989	0.758	0.538	0.431	0.344	0.310

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	6.850	14.450	22.050	29.650	37.250	25.850
Mu-req'd	1508.7	2119.2	3583.2	6147.4	7731.1	8447.7	8366.4	8089.4
Mu-prv'd	5423.5	5776.5	6704.2	9731.4	11283.5	11721.3	11722.3	11502.4

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 37.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	0.701	1.80	1.263	2.20	1.543
Self Wt.	-0.234	1.85	-0.432	2.40	-0.561
Deck + Haunch			-0.269	2.30	-0.618
DL-Prec. (DC)			0.000	3.00	0.000

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.012
DL-Comp. (DW)			-0.020	3.00	-0.059
Total	0.468		0.538		0.293

Positive values indicate upward deflection.

PROPERTIES

Span: 1, Beam: 1

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	11.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Exterior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	282.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	76.000	ft

225

Release length	76.000	ft
Design length	74.500	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	1.248	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	1.248	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	1.248	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.880	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.416	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.119	(Calculated)
Comp. DC	0.119	(Calculated)
Comp. DW	0.119	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75
Tension controlled sections	1.00
Shear	0.90

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-3 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10 **File Name: 76-21-125-21-124_U72C.csl**	 www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/4/2010 CKD: Date:

Span: 1, Beam: 1

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4034.8	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3085155	in4	#
Ht. of c.g.	35.84	in	60.52	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4482.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.25	H/2 3.52	0.10L 6.85	0.20L 14.45	0.30L 22.05	0.40L 29.65	Midspan 37.25
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1770.2	1785.6	1785.6	1785.6	1792.6	1795.8	1795.8	1795.8
Yb,	in	35.75	35.47	35.47	35.47	35.35	35.29	35.29	35.29
MI(Ixx),	in4	1159467	1174940	1174940	1174940	1182351	1185930	1185930	1185930
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4039.1	4052.0	4052.0	4052.0	4057.8	4060.5	4060.5	4060.5
Yb,	in	60.46	60.28	60.28	60.28	60.20	60.16	60.16	60.16
MI(Ixx),	in4	3098906	3139987	3139987	3139987	3159249	3168460	3168460	3168460

Span: 1, Beam: 1
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 1, Beam: 1

PRESTRESSED STEEL:

30 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (26.60 ft from member end)

END PATTERN (Ycg = 3.46 in):

16 @ 2.250 in	8 @ 4.060 in	6 @ 5.880 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	Heights End		Mid		Shielding End		Mid		Initial Frac	Pull Pull/Str
1	2	2.250	in	2.250	in	10.00	ft	0.00	ft	75.0 %	43.9
5	2	4.060	in	4.060	in	10.00	ft	0.00	ft	75.0 %	43.9
9	2	2.250	in	2.250	in	12.00	ft	0.00	ft	75.0 %	43.9
10	2	2.250	in	2.250	in	14.00	ft	0.00	ft	75.0 %	43.9
11	2	2.250	in	2.250	in	16.00	ft	0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	6.510	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.556	ft
Dev. Len, debonded	14.445	ft
Holddown Force	0.000	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	1318.3	kips
Beam Shrtng (PL/AE)	0.135	in

REINFORCING STEEL:

Tension	steel:	
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

Stirrups:

# legs	Size	fy (ksi)	Area (in2)	Spacing (in)	Start (ft)	End (ft)
4	US#3[M10]	60.0	0.44	3.33	0.2500	16.9167
4	US#3[M10]	60.0	0.44	5.00	16.9167	59.0833
4	US#3[M10]	60.0	0.44	3.33	59.0833	75.7500

LOSSES

Note: Values are calculated at Midspan

Str. area	6.5100	in2
Ycg	3.46	in
P_init	1318.3	kips
Ecc	32.38	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 8.29 ksi (Eq 5.9.5.2.3a-1), (fcgp= 1.449 ksi)

	Elastic Gains	Gains		Adjustment	
due	to Precast Loads	-2.93	ksi	0.00	ksi
due	to Composite Loads	-0.54	ksi	0.00	ksi
due	to Live Loads	-1.82	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		5.30	ksi	(Eq 5.9.5.3-1)
Sub-total	8.29	ksi	(4.09 %)	10.93	ksi	(5.40 %)
Total Prestress Losses				19.22	ksi	(9.49 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 183.3 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

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DESIGN STATUS

Span:1, Beam:2

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	7.600	15.200	22.800	30.400	38.000	26.600
Precast-top	-0.296	-0.193	-0.186	-0.151	-0.091	-0.072	-0.116
Bottom	1.257	1.157	1.470	1.584	1.527	1.508	1.551
As_top, in2	3.372	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	6.850	14.450	22.050	29.650	37.250
Topping-top	0.015	0.046	0.062	0.099	0.161	0.195	0.205	0.195
Precast-top	-0.079	-0.177	-0.093	0.111	0.371	0.579	0.733	0.778
Bottom	0.268	0.955	0.836	0.548	0.448	0.307	0.134	0.116

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.013	0.038	0.052	0.083	0.135	0.164	0.173	0.164
Precast-top	-0.080	-0.181	-0.098	0.103	0.358	0.562	0.716	0.761
Bottom	0.275	0.976	0.865	0.594	0.522	0.396	0.227	0.204

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.223	-0.183	-0.162	-0.111	-0.017	0.020	0.032	0.039
Precast-top	-0.204	-0.297	-0.211	0.001	0.277	0.486	0.642	0.695
Bottom	0.966	1.616	1.483	1.156	0.961	0.810	0.632	0.564

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.186	-0.152	-0.134	-0.091	-0.012	0.021	0.033	0.040
Precast-top	-0.184	-0.281	-0.196	0.011	0.280	0.487	0.642	0.695
Bottom	0.856	1.527	1.403	1.099	0.946	0.807	0.630	0.562

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.009	0.012	0.019	0.033	0.041	0.044	0.043
Precast-top	-0.085	-0.196	-0.119	0.069	0.303	0.497	0.648	0.697
Bottom	0.303	1.061	0.979	0.779	0.818	0.750	0.597	0.554

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.036	-0.028	-0.023	-0.012	0.009	0.025	0.036	0.043
Precast-top	-0.106	-0.215	-0.138	0.053	0.290	0.489	0.644	0.697
Bottom	0.418	1.167	1.082	0.871	0.886	0.796	0.620	0.554

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.014	0.041	0.055	0.089	0.145	0.174	0.183	0.173
Precast-top	-0.036	-0.079	-0.033	0.077	0.220	0.330	0.409	0.429
Bottom	0.116	0.425	0.346	0.159	0.039	-0.068	-0.164	-0.161

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.205	-0.169	-0.150	-0.105	-0.021	0.008	0.014	0.018
Precast-top	-0.151	-0.190	-0.142	-0.026	0.132	0.242	0.320	0.347
Bottom	0.757	1.033	0.942	0.721	0.517	0.412	0.322	0.287

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	6.850	14.450	22.050	29.650	37.250	25.850
Mu-req'd	1448.1	2040.1	3461.5	5963.0	7522.4	8242.5	8185.6	7882.5
Mu-prv'd	5423.6	5776.8	6705.1	9736.4	11290.0	11729.1	11730.2	11509.6

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 37.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	0.701	1.80	1.263	2.20	1.543
Self Wt.	-0.234	1.85	-0.432	2.40	-0.561
Deck + Haunch			-0.284	2.30	-0.653
DL-Prec. (DC)			0.000	3.00	0.000

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.013
DL-Comp. (DW)			-0.021	3.00	-0.062
Total	0.468		0.521		0.254

Positive values indicate upward deflection.

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-1 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10 **File Name: 76-21-125-21-124_U72C.csl**	Copyright © Bentley Systems, Inc. 1984 - 2008. www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/4/2010 CKD: Date:

DESIGN STATUS

Span:1, Beam:7

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	7.600	15.200	22.800	30.400	38.000	26.600
Precast-top	-0.296	-0.193	-0.186	-0.151	-0.091	-0.072	-0.116
Bottom	1.257	1.157	1.470	1.584	1.527	1.508	1.551
As_top, in2	3.372	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	6.850	14.450	22.050	29.650	37.250
Topping-top	0.015	0.046	0.062	0.099	0.161	0.195	0.205	0.195
Precast-top	-0.079	-0.162	-0.070	0.155	0.452	0.686	0.857	0.906
Bottom	0.268	0.940	0.814	0.506	0.370	0.204	0.016	-0.008

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.013	0.038	0.052	0.083	0.135	0.164	0.173	0.164
Precast-top	-0.080	-0.165	-0.075	0.146	0.438	0.670	0.840	0.890
Bottom	0.275	0.962	0.842	0.552	0.444	0.293	0.108	0.080

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.223	-0.183	-0.162	-0.111	-0.017	0.020	0.032	0.039
Precast-top	-0.204	-0.282	-0.188	0.044	0.358	0.593	0.765	0.824
Bottom	0.966	1.602	1.460	1.115	0.883	0.707	0.513	0.440

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.186	-0.152	-0.134	-0.091	-0.012	0.021	0.033	0.040
Precast-top	-0.184	-0.266	-0.173	0.054	0.360	0.594	0.765	0.824
Bottom	0.856	1.512	1.380	1.057	0.868	0.704	0.511	0.438

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.009	0.012	0.019	0.033	0.041	0.044	0.043
Precast-top	-0.085	-0.181	-0.096	0.113	0.384	0.604	0.771	0.826
Bottom	0.303	1.046	0.957	0.737	0.740	0.647	0.479	0.430

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.036	-0.028	-0.023	-0.012	0.009	0.025	0.036	0.043
Precast-top	-0.106	-0.200	-0.115	0.096	0.371	0.596	0.767	0.826
Bottom	0.418	1.153	1.059	0.829	0.809	0.693	0.501	0.430

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.014	0.041	0.055	0.089	0.145	0.174	0.183	0.173
Precast-top	-0.036	-0.071	-0.022	0.098	0.260	0.384	0.471	0.494
Bottom	0.116	0.417	0.335	0.138	-0.000	-0.119	-0.224	-0.223

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.205	-0.169	-0.150	-0.105	-0.021	0.008	0.014	0.018
Precast-top	-0.151	-0.182	-0.130	-0.004	0.172	0.295	0.381	0.411
Bottom	0.757	1.026	0.931	0.700	0.479	0.360	0.263	0.225

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	6.850	14.450	22.050	29.650	37.250	25.850
Mu-req'd	1498.9	2118.1	3606.4	6234.1	7883.9	8658.1	8619.2	8271.0
Mu-prv'd	5423.6	5776.8	6705.1	9736.4	11290.0	11729.1	11730.2	11509.6

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 37.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	0.701	1.80	1.263	2.20	1.543
Self Wt.	-0.234	1.85	-0.432	2.40	-0.561
Deck + Haunch			-0.284	2.30	-0.653
DL-Prec. (DC)			-0.051	3.00	-0.152

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.013
DL-Comp. (DW)			-0.021	3.00	-0.062
Total	0.468		0.471		0.102

Positive values indicate upward deflection.

PROPERTIES

Span: 1, Beam: 2

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	25.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Interior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	300.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on precast:
UNITS: (Point: kips, Location: ft)
(Line: klf)

DC/DW	Type	Mag.	Loc.
DC	Line	-0.500	-
DC	Line	0.500	-

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Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	76.000	ft
Release length	76.000	ft
Design length	74.500	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	0.931	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.700	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.056	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.127	(Calculated)
Comp. DC	0.127	(Calculated)
Comp. DW	0.127	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75

Tension controlled sections	1.00
Shear	0.90

Span: 1, Beam: 2

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4163.6	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3135173	in4	#
Ht. of c.g.	35.84	in	61.13	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4632.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.25	H/2 3.52	0.10L 6.85	0.20L 14.45	0.30L 22.05	0.40L 29.65	Midspan 37.25
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1770.2	1785.6	1785.6	1785.6	1792.6	1795.8	1795.8	1795.8
Yb,	in	35.75	35.47	35.47	35.47	35.35	35.29	35.29	35.29
MI(Ixx),	in4	1159467	1174940	1174940	1174940	1182351	1185930	1185930	1185930
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4167.9	4180.8	4180.8	4180.8	4186.6	4189.3	4189.3	4189.3
Yb,	in	61.08	60.90	60.90	60.90	60.82	60.78	60.78	60.78
MI(Ixx),	in4	3149225	3191210	3191210	3191210	3210890	3220300	3220300	3220300

Span: 1, Beam: 2
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 1, Beam: 2

PRESTRESSED STEEL:

30 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (26.60 ft from member end)

END PATTERN (Ycg = 3.46 in):

16 @ 2.250 in	8 @ 4.060 in	6 @ 5.880 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	End	Heights	Mid		End	Shielding		Mid		Initial Frac	Pull Pull/Str
1	2	2.250	in	2.250	in	10.00	ft		0.00	ft	75.0 %	43.9
5	2	4.060	in	4.060	in	10.00	ft		0.00	ft	75.0 %	43.9
9	2	2.250	in	2.250	in	12.00	ft		0.00	ft	75.0 %	43.9
10	2	2.250	in	2.250	in	14.00	ft		0.00	ft	75.0 %	43.9
11	2	2.250	in	2.250	in	16.00	ft		0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	6.510	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.563	ft
Dev. Len, debonded	14.454	ft
Holddown Force	0.000	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	1318.3	kips
Beam Shrtng (PL/AE)	0.135	in

REINFORCING STEEL:

Tension	steel:	
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

Stirrups:

# legs	Size	fy (ksi)	Area (in2)	Spacing (in)	Start (ft)	End (ft)
4	US#3[M10]	60.0	0.44	3.33	0.2500	16.9167
4	US#3[M10]	60.0	0.44	5.00	16.9167	59.0833

# legs	Size	fy (ksi)	Area (in2)	Spacing (in)	Start (ft)	End (ft)
4	US#3[M10]	60.0	0.44	3.33	59.0833	75.7500

LOSSES

Note: Values are calculated at Midspan

Str. area	6.5100	in2
Ycg	3.46	in
P_init	1318.3	kips
Ecc	32.38	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 8.29 ksi (Eq 5.9.5.2.3a-1), (fcgp= 1.449 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-3.09	ksi	0.00	ksi
due	to Composite Loads	-0.57	ksi	0.00	ksi
due	to Live Loads	-1.64	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		5.30	ksi	(Eq 5.9.5.3-1)
Sub-total	8.29	ksi	(4.09 %)	10.92	ksi	(5.39 %)
Total Prestress Losses				19.21	ksi	(9.48 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 183.3 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

DESIGN STATUS

Span:1, Beam:3

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	7.600	15.200	22.800	30.400	38.000	26.600
Precast-top	-0.296	-0.193	-0.186	-0.151	-0.091	-0.072	-0.116
Bottom	1.257	1.157	1.470	1.584	1.527	1.508	1.551
As_top, in2	3.372	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	6.850	14.450	22.050	29.650	37.250
Topping-top	0.015	0.046	0.062	0.099	0.161	0.195	0.205	0.195
Precast-top	-0.079	-0.158	-0.065	0.163	0.468	0.708	0.882	0.932
Bottom	0.268	0.937	0.809	0.498	0.354	0.184	-0.008	-0.032

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.013	0.038	0.052	0.083	0.135	0.164	0.173	0.164
Precast-top	-0.080	-0.162	-0.070	0.155	0.454	0.691	0.865	0.916
Bottom	0.275	0.959	0.838	0.544	0.428	0.272	0.084	0.055

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.223	-0.183	-0.162	-0.111	-0.017	0.020	0.032	0.039
Precast-top	-0.204	-0.279	-0.183	0.052	0.374	0.615	0.790	0.850
Bottom	0.966	1.599	1.456	1.106	0.867	0.686	0.490	0.415

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.186	-0.152	-0.134	-0.091	-0.012	0.021	0.033	0.040
Precast-top	-0.184	-0.263	-0.168	0.063	0.376	0.615	0.790	0.850
Bottom	0.856	1.509	1.376	1.049	0.852	0.683	0.487	0.413

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.009	0.012	0.019	0.033	0.041	0.044	0.043
Precast-top	-0.085	-0.178	-0.091	0.121	0.400	0.626	0.796	0.851
Bottom	0.303	1.044	0.952	0.728	0.724	0.626	0.455	0.405

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.036	-0.028	-0.023	-0.012	0.009	0.025	0.036	0.043
Precast-top	-0.106	-0.197	-0.110	0.104	0.387	0.618	0.792	0.851
Bottom	0.418	1.150	1.054	0.821	0.793	0.672	0.478	0.405

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.014	0.041	0.055	0.089	0.145	0.174	0.183	0.173
Precast-top	-0.036	-0.070	-0.020	0.103	0.268	0.395	0.484	0.507
Bottom	0.116	0.416	0.333	0.134	-0.008	-0.130	-0.236	-0.235

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.205	-0.169	-0.150	-0.105	-0.021	0.008	0.014	0.018
Precast-top	-0.151	-0.180	-0.128	0.000	0.180	0.306	0.394	0.424
Bottom	0.757	1.024	0.929	0.696	0.471	0.350	0.251	0.213

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	6.850	14.450	22.050	29.650	37.250	25.850
Mu-req'd	1509.1	2133.7	3635.3	6288.4	7956.1	8741.2	8706.0	8348.7
Mu-prv'd	5423.6	5776.8	6705.1	9736.4	11290.0	11729.1	11730.2	11509.6

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 37.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	0.701	1.80	1.263	2.20	1.543
Self Wt.	-0.234	1.85	-0.432	2.40	-0.561
Deck + Haunch			-0.284	2.30	-0.653
DL-Prec. (DC)			-0.061	3.00	-0.183

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.013
DL-Comp. (DW)			-0.021	3.00	-0.062
Total	0.468		0.460		0.071

Positive values indicate upward deflection.

PROPERTIES

Span: 1, Beam: 3

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	25.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Interior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	300.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on precast:
UNITS: (Point: kips, Location: ft)
(Line: klf)

DC/DW	Type	Mag.	Loc.
DC	Line	0.600	-

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Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	76.000	ft
Release length	76.000	ft
Design length	74.500	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	0.931	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.700	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.056	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.127	(Calculated)
Comp. DC	0.127	(Calculated)
Comp. DW	0.127	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75

Tension controlled sections	1.00
Shear	0.90

Span: 1, Beam: 3

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4163.6	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3135173	in4	#
Ht. of c.g.	35.84	in	61.13	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4632.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.25	H/2 3.52	0.10L 6.85	0.20L 14.45	0.30L 22.05	0.40L 29.65	Midspan 37.25
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1770.2	1785.6	1785.6	1785.6	1792.6	1795.8	1795.8	1795.8
Yb,	in	35.75	35.47	35.47	35.47	35.35	35.29	35.29	35.29
MI(Ixx),	in4	1159467	1174940	1174940	1174940	1182351	1185930	1185930	1185930
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4167.9	4180.8	4180.8	4180.8	4186.6	4189.3	4189.3	4189.3
Yb,	in	61.08	60.90	60.90	60.90	60.82	60.78	60.78	60.78
MI(Ixx),	in4	3149225	3191210	3191210	3191210	3210890	3220300	3220300	3220300

Span: 1, Beam: 3
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 1, Beam: 3

PRESTRESSED STEEL:

30 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (26.60 ft from member end)

END PATTERN (Ycg = 3.46 in):

16 @ 2.250 in	8 @ 4.060 in	6 @ 5.880 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	Heights End		Mid		Shielding End		Mid		Initial Frac	Pull Pull/Str
1	2	2.250	in	2.250	in	10.00	ft	0.00	ft	75.0 %	43.9
5	2	4.060	in	4.060	in	10.00	ft	0.00	ft	75.0 %	43.9
9	2	2.250	in	2.250	in	12.00	ft	0.00	ft	75.0 %	43.9
10	2	2.250	in	2.250	in	14.00	ft	0.00	ft	75.0 %	43.9
11	2	2.250	in	2.250	in	16.00	ft	0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	6.510	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.563	ft
Dev. Len, debonded	14.454	ft
Holddown Force	0.000	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	1318.3	kips
Beam Shrtng (PL/AE)	0.135	in

REINFORCING STEEL:

Tension	steel:	
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

Stirrups:

# legs	Size	fy (ksi)	Area (in2)	Spacing (in)	Start (ft)	End (ft)
4	US#3[M10]	60.0	0.44	3.33	0.2500	16.9167
4	US#3[M10]	60.0	0.44	5.00	16.9167	59.0833

# legs	Size	fy (ksi)	Area (in2)	Spacing (in)	Start (ft)	End (ft)
4	US#3[M10]	60.0	0.44	3.33	59.0833	75.7500

LOSSES

Note: Values are calculated at Midspan

Str. area	6.5100	in2
Ycg	3.46	in
P_init	1318.3	kips
Ecc	32.38	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 8.29 ksi (Eq 5.9.5.2.3a-1), (fcgp= 1.449 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-3.76	ksi	0.00	ksi
due	to Composite Loads	-0.57	ksi	0.00	ksi
due	to Live Loads	-1.64	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		5.30	ksi	(Eq 5.9.5.3-1)
Sub-total	8.29	ksi	(4.09 %)	10.25	ksi	(5.06 %)
Total Prestress Losses				18.54	ksi	(9.16 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 184.0 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

SPAN 3

GIRDER 3

extra load ≈ .6 k/ft

camber @ erection ≈ 2.9'

86 strands w/ debonding

GIRDER 2

less load ≈ .5 k/ft

camber @ erection ≈ 2.52" 2.521"

increased camber (deck) ≈ .39"

2.91"

76 strands w/ debonding

GIRDER 1

camber @ erection ≈ 2.64"

76 strands w/ debonding (same as girder 2)

GIRDER 4

~~extra load ≈ .1 k/ft~~

~~camber @ erection ≈ 2.91"~~

~~81 strands w/ debonding~~

Same as girder 2

DESIGN STATUS

Span:3, Beam:1

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.700	25.400	38.100	50.800	63.500	44.450
Precast-top	-0.195	-0.067	0.041	0.041	0.068	0.123	0.002
Bottom	3.617	3.573	3.460	3.449	3.418	3.368	3.477
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.000	3.517	11.700	24.400	37.100	49.800	62.500
Topping-top	-0.051	-0.043	-0.036	0.006	0.106	0.221	0.298	0.321
Precast-top	-0.113	-0.101	0.025	0.614	1.360	1.840	2.155	2.301
Bottom	1.279	3.210	3.075	2.499	1.580	0.884	0.428	0.244

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.058	-0.049	-0.042	-0.001	0.088	0.186	0.251	0.271
Precast-top	-0.117	-0.105	0.021	0.610	1.350	1.821	2.129	2.273
Bottom	1.298	3.227	3.092	2.520	1.630	0.979	0.554	0.380

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.466	-0.416	-0.383	-0.221	-0.031	0.037	0.059	0.067
Precast-top	-0.339	-0.308	-0.167	0.488	1.284	1.738	2.022	2.159
Bottom	2.437	4.225	4.017	3.114	1.951	1.380	1.072	0.927

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.392	-0.350	-0.322	-0.185	-0.023	0.038	0.059	0.068
Precast-top	-0.299	-0.272	-0.134	0.508	1.288	1.738	2.022	2.159
Bottom	2.232	4.046	3.852	3.016	1.931	1.378	1.071	0.926

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.086	-0.074	-0.067	-0.032	0.014	0.045	0.064	0.069
Precast-top	-0.132	-0.119	0.008	0.593	1.308	1.742	2.025	2.160
Bottom	1.375	3.295	3.158	2.602	1.830	1.358	1.058	0.922

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.098	-0.087	-0.079	-0.041	0.007	0.041	0.062	0.069
Precast-top	-0.139	-0.125	0.001	0.588	1.305	1.740	2.023	2.160
Bottom	1.408	3.329	3.191	2.627	1.849	1.371	1.065	0.922

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.009	-0.006	-0.003	0.022	0.099	0.199	0.266	0.286
Precast-top	-0.047	-0.042	0.021	0.317	0.706	0.969	1.143	1.221
Bottom	0.592	1.562	1.496	1.199	0.665	0.205	-0.101	-0.217

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.417	-0.373	-0.343	-0.200	-0.034	0.017	0.028	0.033
Precast-top	-0.269	-0.246	-0.168	0.194	0.631	0.868	1.010	1.079
Bottom	1.733	2.561	2.422	1.800	1.027	0.695	0.540	0.466

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.000	3.517	11.700	24.400	37.100	49.800	62.500	43.450
Mu-req'd	732.7	1283.2	4253.5	9110.1	13745.7	16707.0	17635.8	15226.4
Mu-prv'd	16555.3	18027.6	25812.9	27130.8	28209.1	28748.3	28748.3	28478.7

Note: Check minimum reinforcement criteria
(LRFD Art. 5.7.3.3.2) in Ultimate Moment detailed report.

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 62.50 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.466	1.80	8.039	2.20	9.826
Self Wt.	-1.761	1.85	-3.258	2.40	-4.227

	Release	Mult	Erection	Mult	Final
Deck + Haunch			-2.058	2.30	-4.733
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.014	3.00	-0.042
DL-Comp. (DW)			-0.067	3.00	-0.201
Total	2.705		2.642		0.623

Positive values indicate upward deflection.

PROPERTIES

Span: 3, Beam: 1

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	11.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Exterior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	282.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	127.000	ft

Release length	127.000	ft
Design length	125.000	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	1.248	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	1.248	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	1.248	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.880	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.416	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.119	(Calculated)
Comp. DC	0.119	(Calculated)
Comp. DW	0.119	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75
Tension controlled sections	1.00
Shear	0.90

Span: 3, Beam: 1

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4034.8	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3085155	in4	#
Ht. of c.g.	35.84	in	60.52	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4482.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.00	H/2 3.52	0.10L 11.70	0.20L 24.40	0.30L 37.10	0.40L 49.80	Midspan 62.50
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1790.4	1840.9	1840.9	1843.0	1843.0	1843.0	1843.0	1843.0
Yb,	in	35.54	34.96	34.94	34.83	34.71	34.58	34.52	34.52
MI(Ixx),	in4	1165252	1187803	1188926	1196949	1207958	1220229	1226837	1226837
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4056.0	4098.3	4098.3	4100.0	4100.0	4100.0	4100.0	4100.0
Yb,	in	60.28	59.80	59.80	59.75	59.70	59.65	59.63	59.63
MI(Ixx),	in4	3129125	3218404	3220471	3236816	3255506	3275281	3285575	3285575

Span: 3, Beam: 1
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 3, Beam: 1

PRESTRESSED STEEL:

76 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (44.45 ft from member end)

END PATTERN (Ycg = 14.82 in):

15 @ 5.880 in	23 @ 2.250 in	2 @ 57.500 in	24 @ 4.060 in
2 @ 59.500 in	2 @ 61.500 in	2 @ 63.500 in	2 @ 65.500 in
2 @ 67.500 in	2 @ 69.500 in		

MID PATTERN (Ycg = 4.64 in):
(A) Draped:

2 @ 2.250 in	2 @ 4.250 in	2 @ 6.250 in	2 @ 8.250 in
2 @ 10.250 in	2 @ 12.250 in	2 @ 14.250 in	

(B) Straight:

15 @ 5.880 in	23 @ 2.250 in	24 @ 4.060 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	Heights End		Heights Mid		Shielding End			Shielding Mid		Initial Frac	Pull Pull/Str
1	2	5.880	in	5.880	in	8.00	ft		0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	16.492	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.822	ft
Dev. Len, debonded	14.778	ft
Holddown Force	63.383	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	3339.6	kips
Beam Shrtng (PL/AE)	0.555	in

REINFORCING STEEL:

Tension	steel:	
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

Stirrups:

# legs	Size	fy (ksi)	Area (in2)	Spacing (in)	Start (ft)	End (ft)
4	US#3[M10]	60.0	0.44	3.33	0.2500	16.9167

# legs	Size	fy (ksi)	Area (in2)	Spacing (in)	Start (ft)	End (ft)
4	US#3[M10]	60.0	0.44	5.00	16.9167	110.0833
4	US#3[M10]	60.0	0.44	3.33	110.0833	126.7500

LOSSES

Note: Values are calculated at Midspan

Str. area	16.4920	in2
Ycg	4.64	in
P_init	3339.6	kips
Ecc	31.20	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 18.26 ksi (Eq 5.9.5.2.3a-1), (fcgp= 3.191 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-7.48	ksi	0.00	ksi
due	to Composite Loads	-0.85	ksi	0.00	ksi
due	to Live Loads	-2.48	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		13.43	ksi	(Eq 5.9.5.3-1)
Sub-total	18.26	ksi	(9.02 %)	13.54	ksi	(6.68 %)
Total Prestress Losses				31.80	ksi	(15.70 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 170.7 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

DESIGN STATUS

Span:3, Beam:2

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.700	25.400	38.100	50.800	63.500	44.450
Precast-top	-0.195	-0.067	0.041	0.041	0.068	0.123	0.002
Bottom	3.617	3.573	3.460	3.449	3.418	3.368	3.477
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.000	3.517	11.700	24.400	37.100	49.800	62.500
Topping-top	-0.058	-0.048	-0.041	0.001	0.094	0.199	0.268	0.289
Precast-top	-0.116	-0.097	0.034	0.648	1.420	1.915	2.238	2.386
Bottom	1.302	3.223	3.082	2.480	1.540	0.842	0.387	0.203

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.064	-0.054	-0.047	-0.006	0.078	0.168	0.228	0.245
Precast-top	-0.119	-0.100	0.032	0.644	1.411	1.898	2.216	2.362
Bottom	1.320	3.239	3.097	2.498	1.585	0.927	0.500	0.325

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.419	-0.374	-0.344	-0.197	-0.026	0.039	0.061	0.069
Precast-top	-0.307	-0.272	-0.129	0.541	1.355	1.828	2.125	2.266
Bottom	2.349	4.142	3.935	3.036	1.876	1.290	0.967	0.817

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.355	-0.317	-0.291	-0.166	-0.019	0.039	0.061	0.069
Precast-top	-0.273	-0.242	-0.100	0.557	1.359	1.828	2.125	2.267
Bottom	2.164	3.981	3.786	2.949	1.858	1.288	0.966	0.816

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.087	-0.076	-0.068	-0.032	0.014	0.046	0.065	0.071
Precast-top	-0.132	-0.111	0.020	0.630	1.377	1.832	2.127	2.267
Bottom	1.388	3.300	3.157	2.572	1.765	1.268	0.954	0.812

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.100	-0.088	-0.080	-0.042	0.007	0.042	0.063	0.071
Precast-top	-0.138	-0.118	0.013	0.625	1.373	1.830	2.126	2.267
Bottom	1.424	3.336	3.192	2.599	1.784	1.281	0.960	0.812

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.014	-0.011	-0.008	0.017	0.087	0.176	0.236	0.254
Precast-top	-0.050	-0.041	0.024	0.333	0.732	0.999	1.174	1.252
Bottom	0.608	1.573	1.504	1.194	0.658	0.208	-0.090	-0.203

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.369	-0.330	-0.304	-0.177	-0.029	0.018	0.029	0.034
Precast-top	-0.238	-0.213	-0.136	0.228	0.669	0.913	1.062	1.133
Bottom	1.637	2.474	2.339	1.737	0.984	0.649	0.487	0.411

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.000	3.517	11.700	24.400	37.100	49.800	62.500	43.450
Mu-req'd	651.5	1225.2	4283.3	9165.5	13740.4	16646.7	17560.5	15193.5
Mu-prv'd	16564.1	18039.7	25861.5	27180.5	28259.0	28798.2	28798.2	28528.6

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 62.50 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.466	1.80	8.039	2.20	9.826
Self Wt.	-1.761	1.85	-3.258	2.40	-4.227
Deck + Haunch			-2.175	2.30	-5.002
DL-Prec. (DC)			0.000	3.00	0.000

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.015	3.00	-0.044
DL-Comp. (DW)			-0.070	3.00	-0.210
Total	2.705		2.521		0.342

Positive values indicate upward deflection.

DESIGN STATUS

Span:3, Beam:7

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.700	25.400	38.100	50.800	63.500	44.450
Precast-top	-0.195	-0.067	0.041	0.041	0.068	0.123	0.002
Bottom	3.617	3.573	3.460	3.449	3.418	3.368	3.477
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.000	3.517	11.700	24.400	37.100	49.800	62.500
Topping-top	-0.058	-0.048	-0.041	0.001	0.094	0.199	0.268	0.289
Precast-top	-0.116	-0.074	0.074	0.771	1.647	2.215	2.581	2.744
Bottom	1.302	3.202	3.045	2.364	1.328	0.565	0.071	-0.127

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.064	-0.054	-0.047	-0.006	0.078	0.168	0.228	0.245
Precast-top	-0.119	-0.077	0.072	0.768	1.639	2.198	2.559	2.720
Bottom	1.320	3.217	3.060	2.383	1.373	0.650	0.184	-0.005

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.419	-0.374	-0.344	-0.197	-0.026	0.039	0.061	0.069
Precast-top	-0.307	-0.249	-0.089	0.664	1.582	2.128	2.468	2.624
Bottom	2.349	4.120	3.897	2.920	1.665	1.013	0.651	0.487

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.355	-0.317	-0.291	-0.166	-0.019	0.039	0.061	0.069
Precast-top	-0.273	-0.219	-0.060	0.681	1.586	2.128	2.468	2.625
Bottom	2.164	3.959	3.749	2.833	1.646	1.011	0.649	0.486

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.087	-0.076	-0.068	-0.032	0.014	0.046	0.065	0.071
Precast-top	-0.132	-0.088	0.060	0.753	1.604	2.132	2.471	2.625
Bottom	1.388	3.279	3.119	2.456	1.553	0.991	0.638	0.482

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.100	-0.088	-0.080	-0.042	0.007	0.042	0.063	0.071
Precast-top	-0.138	-0.095	0.053	0.748	1.600	2.130	2.469	2.625
Bottom	1.424	3.314	3.155	2.483	1.573	1.004	0.644	0.482

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.014	-0.011	-0.008	0.017	0.087	0.176	0.236	0.254
Precast-top	-0.050	-0.029	0.044	0.394	0.845	1.149	1.346	1.431
Bottom	0.608	1.562	1.485	1.136	0.552	0.070	-0.248	-0.368

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.369	-0.330	-0.304	-0.177	-0.029	0.018	0.029	0.034
Precast-top	-0.238	-0.202	-0.116	0.290	0.782	1.063	1.233	1.312
Bottom	1.637	2.463	2.320	1.679	0.878	0.511	0.329	0.246

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.000	3.517	11.700	24.400	37.100	49.800	62.500	43.450
Mu-req'd	728.4	1358.7	4697.5	9932.6	14759.4	17817.0	18781.2	16288.2
Mu-prv'd	16564.1	18039.7	25861.5	27180.5	28259.0	28798.2	28798.2	28528.6

Note: Check minimum reinforcement criteria
(LRFD Art. 5.7.3.3.2) in Ultimate Moment detailed report.

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 62.50 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.466	1.80	8.039	2.20	9.826
Self Wt.	-1.761	1.85	-3.258	2.40	-4.227

	Release	Mult	Erection	Mult	Final
Deck + Haunch			-2.175	2.30	-5.002
DL-Prec. (DC)			-0.389	3.00	-1.168
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.015	3.00	-0.044
DL-Comp. (DW)			-0.070	3.00	-0.210
Total	2.705		2.132		-0.825

Positive values indicate upward deflection.

PROPERTIES

Span: 3, Beam: 2

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	25.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Interior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	300.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on precast:
UNITS: (Point: kips, Location: ft)
(Line: klf)

DC/DW	Type	Mag.	Loc.
DC	Line	-0.500	-
DC	Line	0.500	-

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	127.000	ft
Release length	127.000	ft
Design length	125.000	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	0.931	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.700	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.056	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.127	(Calculated)
Comp. DC	0.127	(Calculated)
Comp. DW	0.127	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75

Tension controlled sections	1.00
Shear	0.90

Span: 3, Beam: 2

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4163.6	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3135173	in4	#
Ht. of c.g.	35.84	in	61.13	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4632.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.00	H/2 3.52	0.10L 11.70	0.20L 24.40	0.30L 37.10	0.40L 49.80	Midspan 62.50
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1790.4	1840.9	1840.9	1843.0	1843.0	1843.0	1843.0	1843.0
Yb,	in	35.54	34.96	34.94	34.83	34.71	34.58	34.52	34.52
MI(Ixx),	in4	1165252	1187803	1188926	1196949	1207958	1220229	1226837	1226837
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4184.8	4227.1	4227.1	4228.8	4228.8	4228.8	4228.8	4228.8
Yb,	in	60.90	60.43	60.43	60.38	60.33	60.29	60.26	60.26
MI(Ixx),	in4	3180342	3272062	3274157	3290773	3309701	3329716	3340130	3340130

Span: 3, Beam: 2
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 3, Beam: 2

PRESTRESSED STEEL:

76 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (44.45 ft from member end)

END PATTERN (Ycg = 14.82 in):

15 @ 5.880 in	23 @ 2.250 in	2 @ 57.500 in	24 @ 4.060 in
2 @ 59.500 in	2 @ 61.500 in	2 @ 63.500 in	2 @ 65.500 in
2 @ 67.500 in	2 @ 69.500 in		

MID PATTERN (Ycg = 4.64 in):
(A) Draped:

2 @ 2.250 in	2 @ 4.250 in	2 @ 6.250 in	2 @ 8.250 in
2 @ 10.250 in	2 @ 12.250 in	2 @ 14.250 in	

(B) Straight:

15 @ 5.880 in	23 @ 2.250 in	24 @ 4.060 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	Heights End		Mid		End	Shielding		Mid		Initial Frac	Pull Pull/Str
1	2	5.880	in	5.880	in	8.00	ft		0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	16.492	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.839	ft
Dev. Len, debonded	14.799	ft
Holddown Force	63.383	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	3339.6	kips
Beam Shrtng (PL/AE)	0.555	in

REINFORCING STEEL:

Tension	/Shear	steel:
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

LOSSES

Note: Values are calculated at Midspan

Str. area	16.4920	in2
Ycg	4.64	in
P_init	3339.6	kips
Ecc	31.20	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 18.26 ksi (Eq 5.9.5.2.3a-1), (fcgp= 3.191 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-7.90	ksi	0.00	ksi
due	to Composite Loads	-0.90	ksi	0.00	ksi
due	to Live Loads	-2.23	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		13.43	ksi	(Eq 5.9.5.3-1)
Sub-total	18.26	ksi	(9.02 %)	13.31	ksi	(6.57 %)
Total Prestress Losses				31.57	ksi	(15.59 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 170.9 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

DESIGN STATUS

Span:3, Beam:3

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.700	25.400	38.100	50.800	63.500	44.450
Precast-top	-0.181	-0.082	-0.041	-0.095	-0.065	-0.011	-0.131
Bottom	3.604	3.629	3.785	3.994	3.961	3.911	4.020
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.000	3.517	11.700	24.400	37.100	49.800	62.500
Topping-top	-0.058	-0.048	-0.041	0.001	0.094	0.198	0.267	0.288
Precast-top	-0.111	-0.054	0.098	0.788	1.626	2.161	2.538	2.703
Bottom	1.287	3.154	2.993	2.356	1.543	0.973	0.472	0.274

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.064	-0.054	-0.047	-0.006	0.078	0.168	0.227	0.245
Precast-top	-0.114	-0.057	0.095	0.784	1.617	2.144	2.516	2.680
Bottom	1.304	3.169	3.008	2.374	1.588	1.057	0.585	0.395

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.419	-0.374	-0.344	-0.197	-0.026	0.038	0.060	0.069
Precast-top	-0.302	-0.230	-0.066	0.681	1.561	2.074	2.425	2.584
Bottom	2.334	4.072	3.846	2.911	1.878	1.416	1.047	0.882

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.355	-0.317	-0.291	-0.166	-0.019	0.039	0.061	0.069
Precast-top	-0.268	-0.199	-0.037	0.698	1.564	2.074	2.425	2.584
Bottom	2.149	3.911	3.698	2.824	1.859	1.414	1.046	0.882

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.087	-0.076	-0.068	-0.032	0.014	0.046	0.065	0.071
Precast-top	-0.126	-0.069	0.083	0.770	1.582	2.078	2.427	2.585
Bottom	1.373	3.231	3.068	2.448	1.767	1.394	1.034	0.878

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.100	-0.088	-0.080	-0.042	0.007	0.042	0.063	0.071
Precast-top	-0.133	-0.076	0.077	0.765	1.579	2.075	2.426	2.585
Bottom	1.409	3.266	3.103	2.474	1.786	1.408	1.040	0.878

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.014	-0.011	-0.008	0.017	0.087	0.175	0.235	0.253
Precast-top	-0.048	-0.020	0.056	0.403	0.835	1.122	1.324	1.411
Bottom	0.600	1.539	1.460	1.132	0.660	0.275	-0.044	-0.165

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.369	-0.330	-0.304	-0.176	-0.029	0.018	0.029	0.034
Precast-top	-0.235	-0.192	-0.104	0.298	0.772	1.036	1.212	1.291
Bottom	1.629	2.439	2.294	1.674	0.984	0.712	0.527	0.444

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.000	3.517	11.700	24.400	37.100	49.800	62.500	43.450
Mu-req'd	743.7	1385.4	4780.4	10086.0	14963.3	18051.1	19025.4	16507.2
Mu-prv'd	16393.9	17879.9	26052.3	28902.9	31659.3	32410.9	32410.9	32035.1

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 62.50 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.914	1.80	8.846	2.20	10.812
Self Wt.	-1.749	1.85	-3.236	2.40	-4.198
Deck + Haunch			-2.160	2.30	-4.968
DL-Prec. (DC)			-0.464	3.00	-1.392

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.015	3.00	-0.044
DL-Comp. (DW)			-0.069	3.00	-0.207
Total	3.165		2.903		0.004

Positive values indicate upward deflection.

PROPERTIES

Span: 3, Beam: 3

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	25.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Interior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	300.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on precast:
UNITS: (Point: kips, Location: ft)
(Line: klf)

DC/DW	Type	Mag.	Loc.
DC	Line	0.600	-

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	127.000	ft
Release length	127.000	ft
Design length	125.000	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	0.931	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.700	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.056	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.127	(Calculated)
Comp. DC	0.127	(Calculated)
Comp. DW	0.127	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75

Tension controlled sections	1.00
Shear	0.90

Span: 3, Beam: 3

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4163.6	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3135173	in4	#
Ht. of c.g.	35.84	in	61.13	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4632.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.00	H/2 3.52	0.10L 11.70	0.20L 24.40	0.30L 37.10	0.40L 49.80	Midspan 62.50
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1790.4	1840.9	1840.9	1844.0	1849.0	1853.2	1853.2	1853.2
Yb,	in	35.55	34.96	34.95	34.81	34.61	34.42	34.36	34.36
MI(Ixx),	in4	1165098	1187345	1188460	1197770	1212883	1228624	1235183	1235183
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4184.8	4227.1	4227.1	4229.7	4233.9	4237.4	4237.4	4237.4
Yb,	in	60.90	60.43	60.43	60.36	60.27	60.18	60.15	60.15
MI(Ixx),	in4	3180055	3271202	3273291	3293291	3324567	3355069	3365452	3365452

Span: 3, Beam: 3
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 3, Beam: 3

PRESTRESSED STEEL:

86 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (44.45 ft from member end)

END PATTERN (Ycg = 13.78 in):

25 @ 5.880 in	23 @ 2.250 in	2 @ 59.500 in	2 @ 61.500 in
2 @ 63.500 in	2 @ 65.500 in	24 @ 4.060 in	2 @ 67.500 in
2 @ 69.500 in	2 @ 57.500 in		

MID PATTERN (Ycg = 4.79 in):
(A) Draped:

2 @ 4.250 in	2 @ 6.250 in	2 @ 8.250 in	2 @ 10.250 in
2 @ 12.250 in	2 @ 14.250 in	2 @ 2.250 in	

(B) Straight:

25 @ 5.880 in	23 @ 2.250 in	24 @ 4.060 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	Heights				Shielding					Initial	Pull
		End		Mid		End			Mid		Frac	Pull/Str
1	2	5.880	in	5.880	in	24.00	ft		0.00	ft	75.0 %	43.9
31	2	2.250	in	2.250	in	8.00	ft		0.00	ft	75.0 %	43.9
32	1	2.250	in	2.250	in	8.00	ft		0.00	ft	75.0 %	43.9
41	2	5.880	in	5.880	in	32.00	ft		0.00	ft	75.0 %	43.9
42	2	5.880	in	5.880	in	24.00	ft		0.00	ft	75.0 %	43.9
43	2	5.880	in	5.880	in	16.00	ft		0.00	ft	75.0 %	43.9
44	1	5.880	in	5.880	in	16.00	ft		0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	18.662	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.899	ft
Dev. Len, debonded	14.874	ft
Holddown Force	63.383	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	3779.1	kips
Beam Shrtng (PL/AE)	0.628	in

REINFORCING STEEL:

Tension	/Shear	steel:
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

LOSSES

Note: Values are calculated at Midspan

Str. area	18.6620	in2
Ycg	4.79	in
P_init	3779.1	kips
Ecc	31.05	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 21.07 ksi (Eq 5.9.5.2.3a-1), (fcgp= 3.682 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-9.44	ksi	0.00	ksi
due	to Composite Loads	-0.89	ksi	0.00	ksi
due	to Live Loads	-2.20	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		15.19	ksi	(Eq 5.9.5.3-1)
Sub-total	21.07	ksi	(10.41 %)	13.58	ksi	(6.71 %)
Total Prestress Losses				34.65	ksi	(17.11 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 167.9 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses

have been calculated explicitly here, they are not included as a part of stress calculations.
Please see theory section for complete explanation.

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)

SPAN 5

GIRDER 3

extra load ≈ .6 k/ft

camber @ erection ≈ 2.88"

asphalt ≈ .1"

84 strands w/ debonding

GIRDER 2

less load ≈ .5 k/ft

camber @ erection ≈ 2.57

increased camber (deck) ≈ .36"
increased camber (asphalt) ≈ .02"

≈ 2.95"

76 strands w/ debonding

GIRDER 1

camber @ erection ≈ 2.68"

76 strands w/ debonding (same as girder 2)

GIRDER 4

~~extra load = .1 k/ft~~

~~camber @ erection ≈ 2.94"~~

~~81 strands w/ debonding~~

Same as girder 2

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 284 of

DESIGN STATUS

Span:5, Beam:1

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.400	24.800	37.200	49.600	62.000	43.400
Precast-top	-0.199	-0.090	0.000	-0.013	0.007	0.059	-0.056
Bottom	3.621	3.595	3.498	3.499	3.474	3.427	3.531
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses
POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	11.650	24.050	36.450	48.850	61.250
Topping-top	0.013	0.056	0.080	0.212	0.353	0.430	0.449	0.420
Precast-top	-0.056	-0.027	0.085	0.700	1.425	1.854	2.119	2.229
Bottom	0.820	2.923	2.765	1.968	0.980	0.417	0.134	0.095

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.011	0.047	0.067	0.179	0.298	0.363	0.379	0.355
Precast-top	-0.057	-0.032	0.078	0.681	1.394	1.817	2.080	2.192
Bottom	0.825	2.947	2.799	2.059	1.130	0.598	0.322	0.271

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.598	-0.535	-0.504	-0.317	-0.085	0.040	0.072	0.091
Precast-top	-0.387	-0.355	-0.239	0.406	1.182	1.636	1.908	2.045
Bottom	2.533	4.531	4.350	3.401	2.163	1.469	1.149	0.981

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.504	-0.450	-0.423	-0.265	-0.068	0.040	0.072	0.092
Precast-top	-0.336	-0.308	-0.195	0.435	1.191	1.637	1.908	2.045
Bottom	2.268	4.299	4.132	3.261	2.118	1.467	1.148	0.979

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.012	0.017	0.044	0.076	0.094	0.100	0.094
Precast-top	-0.062	-0.052	0.050	0.606	1.271	1.667	1.924	2.047
Bottom	0.847	3.043	2.936	2.423	1.730	1.322	1.073	0.974

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.125	-0.110	-0.103	-0.058	-0.001	0.043	0.075	0.094
Precast-top	-0.131	-0.119	-0.017	0.550	1.228	1.638	1.910	2.047
Bottom	1.205	3.374	3.260	2.700	1.937	1.459	1.141	0.974

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.011	0.050	0.071	0.190	0.315	0.383	0.399	0.373
Precast-top	-0.026	-0.001	0.060	0.396	0.790	1.021	1.157	1.206
Bottom	0.396	1.401	1.297	0.757	0.115	-0.244	-0.403	-0.391

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.536	-0.480	-0.452	-0.288	-0.084	0.018	0.034	0.044
Precast-top	-0.322	-0.295	-0.231	0.131	0.567	0.817	0.953	1.022
Bottom	1.931	2.843	2.720	2.051	1.195	0.739	0.579	0.494

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	11.650	24.050	36.450	48.850	61.250	42.650
Mu-req'd	1914.7	2813.5	7998.2	13948.3	17723.2	19424.2	19251.2	18573.7
Mu-prv'd	16559.4	17790.6	25805.8	27130.8	28209.1	28748.3	28748.3	28478.7

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 61.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.257	1.80	7.663	2.20	9.366
Self Wt.	-1.601	1.85	-2.961	2.40	-3.841
Deck + Haunch			-1.898	2.30	-4.366
DL-Prec. (DC)			0.000	3.00	0.000

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.022	3.00	-0.065
DL-Comp. (DW)			-0.103	3.00	-0.308
Total	2.657		2.680		0.786

Positive values indicate upward deflection.

PROPERTIES

Span: 5, Beam: 1

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	11.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Exterior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	282.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	124.000	ft

Release length	124.000	ft
Design length	122.500	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	1.248	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	1.248	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.657	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	1.248	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.880	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.416	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.119	(Calculated)
Comp. DC	0.119	(Calculated)
Comp. DW	0.119	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75
Tension controlled sections	1.00
Shear	0.90

Span: 5, Beam: 1

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4034.8	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3085155	in4	#
Ht. of c.g.	35.84	in	60.52	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4482.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.25	H/2 3.52	0.10L 11.65	0.20L 24.05	0.30L 36.45	0.40L 48.85	Midspan 61.25
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1784.1	1840.9	1840.9	1843.0	1843.0	1843.0	1843.0	1843.0
Yb,	in	35.62	34.95	34.94	34.83	34.71	34.58	34.52	34.52
MI(Ixx),	in4	1162488	1187856	1188817	1196949	1207958	1220229	1226837	1226837
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4050.7	4098.3	4098.3	4100.0	4100.0	4100.0	4100.0	4100.0
Yb,	in	60.34	59.80	59.80	59.75	59.70	59.65	59.63	59.63
MI(Ixx),	in4	3118097	3218502	3220270	3236816	3255506	3275281	3285575	3285575

Span: 5, Beam: 1
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 5, Beam: 1

PRESTRESSED STEEL:

76 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (43.40 ft from member end)

END PATTERN (Ycg = 14.82 in):

15 @ 5.880 in	23 @ 2.250 in	2 @ 57.500 in	24 @ 4.060 in
2 @ 59.500 in	2 @ 61.500 in	2 @ 63.500 in	2 @ 65.500 in
2 @ 67.500 in	2 @ 69.500 in		

MID PATTERN (Ycg = 4.64 in):
(A) Draped:

2 @ 2.250 in	2 @ 4.250 in	2 @ 6.250 in	2 @ 8.250 in
2 @ 10.250 in	2 @ 12.250 in	2 @ 14.250 in	

(B) Straight:

15 @ 5.880 in	23 @ 2.250 in	24 @ 4.060 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	End	Heights	Mid		End	Shielding		Mid		Initial Frac	Pull Pull/Str
1	2	5.880	in	5.880	in	8.00	ft		0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	16.492	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.822	ft
Dev. Len, debonded	14.778	ft
Holddown Force	64.900	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	3339.6	kips
Beam Shrtng (PL/AE)	0.542	in

REINFORCING STEEL:

Tension	/Shear	steel:
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

LOSSES

Note: Values are calculated at Midspan

Str. area	16.4920	in2
Ycg	4.64	in
P_init	3339.6	kips
Ecc	31.20	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 18.50 ksi (Eq 5.9.5.2.3a-1), (fcgp= 3.233 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-7.18	ksi	0.00	ksi
due	to Composite Loads	-1.15	ksi	0.00	ksi
due	to Live Loads	-3.21	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		13.43	ksi	(Eq 5.9.5.3-1)
Sub-total	18.50	ksi	(9.14 %)	12.80	ksi	(6.32 %)
Total Prestress Losses				31.30	ksi	(15.46 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 171.2 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

DESIGN STATUS

Span:5, Beam:2

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.400	24.800	37.200	49.600	62.000	43.400
Precast-top	-0.199	-0.090	0.000	-0.013	0.007	0.059	-0.056
Bottom	3.621	3.595	3.498	3.499	3.474	3.427	3.531
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	11.650	24.050	36.450	48.850	61.250
Topping-top	0.011	0.050	0.072	0.191	0.318	0.387	0.404	0.378
Precast-top	-0.057	-0.023	0.091	0.721	1.467	1.911	2.187	2.303
Bottom	0.822	2.926	2.768	1.974	0.983	0.414	0.122	0.075

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.010	0.043	0.061	0.161	0.270	0.329	0.344	0.322
Precast-top	-0.058	-0.028	0.085	0.705	1.441	1.879	2.154	2.272
Bottom	0.827	2.948	2.799	2.055	1.118	0.577	0.291	0.233

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.538	-0.481	-0.452	-0.283	-0.073	0.041	0.073	0.093
Precast-top	-0.346	-0.310	-0.192	0.465	1.255	1.723	2.007	2.148
Bottom	2.419	4.423	4.245	3.305	2.079	1.381	1.046	0.871

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.456	-0.407	-0.383	-0.238	-0.059	0.042	0.074	0.094
Precast-top	-0.303	-0.270	-0.155	0.489	1.263	1.723	2.007	2.148
Bottom	2.180	4.216	4.049	3.179	2.038	1.379	1.044	0.869

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.012	0.017	0.045	0.077	0.096	0.102	0.095
Precast-top	-0.062	-0.044	0.061	0.642	1.336	1.753	2.022	2.149
Bottom	0.847	3.035	2.923	2.382	1.657	1.228	0.966	0.864

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.127	-0.112	-0.105	-0.059	-0.001	0.044	0.076	0.095
Precast-top	-0.130	-0.111	-0.004	0.586	1.294	1.725	2.008	2.149
Bottom	1.225	3.384	3.265	2.675	1.875	1.372	1.038	0.864

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.010	0.045	0.063	0.168	0.279	0.339	0.353	0.331
Precast-top	-0.026	-0.001	0.060	0.400	0.799	1.035	1.176	1.228
Bottom	0.399	1.409	1.307	0.783	0.155	-0.200	-0.361	-0.357

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.474	-0.425	-0.400	-0.254	-0.073	0.019	0.035	0.045
Precast-top	-0.281	-0.255	-0.190	0.172	0.608	0.861	1.003	1.073
Bottom	1.806	2.731	2.612	1.968	1.141	0.695	0.527	0.438

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	11.650	24.050	36.450	48.850	61.250	42.650
Mu-req'd	1862.5	2742.5	7825.7	13685.6	17431.0	19153.9	19034.8	18292.5
Mu-prv'd	16568.2	17802.1	25854.3	27180.5	28259.0	28798.2	28798.2	28528.6

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 61.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.257	1.80	7.663	2.20	9.366
Self Wt.	-1.601	1.85	-2.961	2.40	-3.841
Deck + Haunch			-2.006	2.30	-4.613
DL-Prec. (DC)			0.000	3.00	0.000

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.023	3.00	-0.068
DL-Comp. (DW)			-0.108	3.00	-0.323
Total	2.657		2.566		0.520

Positive values indicate upward deflection.

DESIGN STATUS

Span:5, Beam:7

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.400	24.800	37.200	49.600	62.000	43.400
Precast-top	-0.199	-0.090	0.000	-0.013	0.007	0.059	-0.056
Bottom	3.621	3.595	3.498	3.499	3.474	3.427	3.531
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses
POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	11.650	24.050	36.450	48.850	61.250
Topping-top	0.011	0.050	0.072	0.191	0.318	0.387	0.404	0.378
Precast-top	-0.057	0.002	0.130	0.841	1.686	2.199	2.517	2.647
Bottom	0.822	2.902	2.732	1.861	0.779	0.147	-0.182	-0.242

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.010	0.043	0.061	0.161	0.270	0.329	0.344	0.322
Precast-top	-0.058	-0.002	0.124	0.826	1.660	2.168	2.484	2.616
Bottom	0.827	2.924	2.762	1.943	0.914	0.310	-0.013	-0.084

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.538	-0.481	-0.452	-0.283	-0.073	0.041	0.073	0.093
Precast-top	-0.346	-0.285	-0.153	0.585	1.474	2.012	2.337	2.492
Bottom	2.419	4.400	4.208	3.192	1.875	1.115	0.742	0.554

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.456	-0.407	-0.383	-0.238	-0.059	0.042	0.074	0.094
Precast-top	-0.303	-0.245	-0.115	0.609	1.482	2.012	2.337	2.492
Bottom	2.180	4.192	4.012	3.066	1.834	1.113	0.741	0.553

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.012	0.017	0.045	0.077	0.096	0.102	0.095
Precast-top	-0.062	-0.019	0.100	0.763	1.556	2.041	2.352	2.493
Bottom	0.847	3.011	2.886	2.270	1.453	0.961	0.663	0.547

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.127	-0.112	-0.105	-0.059	-0.001	0.044	0.076	0.095
Precast-top	-0.130	-0.086	0.035	0.706	1.513	2.013	2.338	2.493
Bottom	1.225	3.361	3.228	2.562	1.671	1.106	0.735	0.547

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.010	0.045	0.063	0.168	0.279	0.339	0.353	0.331
Precast-top	-0.026	0.011	0.080	0.460	0.908	1.179	1.340	1.400
Bottom	0.399	1.397	1.289	0.726	0.052	-0.333	-0.513	-0.516

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.474	-0.425	-0.400	-0.254	-0.073	0.019	0.035	0.045
Precast-top	-0.281	-0.242	-0.170	0.232	0.717	1.005	1.168	1.245
Bottom	1.806	2.719	2.594	1.911	1.039	0.562	0.375	0.280

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	11.650	24.050	36.450	48.850	61.250	42.650
Mu-req'd	1947.0	2873.3	8229.3	14425.5	18411.2	20278.2	20207.2	19344.7
Mu-prv'd	16568.2	17802.1	25854.3	27180.5	28259.0	28798.2	28798.2	28528.6

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 61.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.257	1.80	7.663	2.20	9.366
Self Wt.	-1.601	1.85	-2.961	2.40	-3.841
Deck + Haunch			-2.006	2.30	-4.613
DL-Prec. (DC)			-0.359	3.00	-1.077

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.023	3.00	-0.068
DL-Comp. (DW)			-0.108	3.00	-0.323
Total	2.657		2.207		-0.557

Positive values indicate upward deflection.

PROPERTIES

Span: 5, Beam: 2

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	25.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Interior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	300.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on precast:
UNITS: (Point: kips, Location: ft)
(Line: klf)

DC/DW	Type	Mag.	Loc.
DC	Line	0.500	-
DC	Line	-0.500	-

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	124.000	ft
Release length	124.000	ft
Design length	122.500	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	0.931	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.700	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.056	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.127	(Calculated)
Comp. DC	0.127	(Calculated)
Comp. DW	0.127	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75

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Tension controlled sections	1.00
Shear	0.90

Span: 5, Beam: 2

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4163.6	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3135173	in4	#
Ht. of c.g.	35.84	in	61.13	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4632.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.25	H/2 3.52	0.10L 11.65	0.20L 24.05	0.30L 36.45	0.40L 48.85	Midspan 61.25
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1784.1	1840.9	1840.9	1843.0	1843.0	1843.0	1843.0	1843.0
Yb,	in	35.62	34.95	34.94	34.83	34.71	34.58	34.52	34.52
MI(Ixx),	in4	1162488	1187856	1188817	1196949	1207958	1220229	1226837	1226837
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4179.5	4227.1	4227.1	4228.8	4228.8	4228.8	4228.8	4228.8
Yb,	in	60.96	60.43	60.43	60.38	60.33	60.29	60.26	60.26
MI(Ixx),	in4	3169013	3272162	3273953	3290773	3309701	3329716	3340130	3340130

Span: 5, Beam: 2

STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 5, Beam: 2

PRESTRESSED STEEL:

76 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (43.40 ft from member end)

END PATTERN (Ycg = 14.82 in):

15 @ 5.880 in	23 @ 2.250 in	2 @ 57.500 in	24 @ 4.060 in
2 @ 59.500 in	2 @ 61.500 in	2 @ 63.500 in	2 @ 65.500 in
2 @ 67.500 in	2 @ 69.500 in		

MID PATTERN (Ycg = 4.64 in):
(A) Draped:

2 @ 2.250 in	2 @ 4.250 in	2 @ 6.250 in	2 @ 8.250 in
2 @ 10.250 in	2 @ 12.250 in	2 @ 14.250 in	

(B) Straight:

15 @ 5.880 in	23 @ 2.250 in	24 @ 4.060 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	End	Heights	Mid		End	Shielding		Mid		Initial Frac	Pull Pull/Str
1	2	5.880	in	5.880	in	8.00	ft		0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	16.492	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.839	ft
Dev. Len, debonded	14.799	ft
Holddown Force	64.900	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	3339.6	kips
Beam Shrtng (PL/AE)	0.542	in

REINFORCING STEEL:

Tension	/Shear	steel:
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

LOSSES

Note: Values are calculated at Midspan

Str. area	16.4920	in2
Ycg	4.64	in
P_init	3339.6	kips
Ecc	31.20	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 18.50 ksi (Eq 5.9.5.2.3a-1), (fcgp= 3.233 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-7.59	ksi	0.00	ksi
due	to Composite Loads	-1.22	ksi	0.00	ksi
due	to Live Loads	-2.89	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		13.43	ksi	(Eq 5.9.5.3-1)
Sub-total	18.50	ksi	(9.14 %)	12.65	ksi	(6.25 %)
Total Prestress Losses				31.15	ksi	(15.38 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 171.4 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-1 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10	 www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/4/2010 CKD: Date:

File Name: 76-21-125-21-124_U72C.csl

DESIGN STATUS

Span:5, Beam:3

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	12.400	24.800	37.200	49.600	62.000	43.400
Precast-top	-0.202	-0.156	-0.137	-0.157	-0.120	-0.068	-0.183
Bottom	3.361	3.566	3.837	3.966	3.926	3.879	3.983
As_top, in2	0.876	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.250	3.517	11.650	24.050	36.450	48.850	61.250
Topping-top	0.011	0.051	0.072	0.190	0.317	0.386	0.403	0.377
Precast-top	-0.058	0.007	0.141	0.811	1.611	2.133	2.474	2.607
Bottom	0.754	2.643	2.467	1.787	1.023	0.500	0.151	0.089

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.010	0.043	0.061	0.161	0.269	0.328	0.343	0.321
Precast-top	-0.059	0.003	0.135	0.795	1.585	2.102	2.441	2.576
Bottom	0.759	2.665	2.498	1.869	1.157	0.662	0.318	0.245

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.538	-0.481	-0.453	-0.283	-0.073	0.041	0.073	0.093
Precast-top	-0.347	-0.279	-0.142	0.555	1.399	1.945	2.294	2.452
Bottom	2.352	4.146	3.949	3.118	2.112	1.459	1.067	0.878

Units: U.S. Units   Design Code: AASHTO LRFD

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.456	-0.407	-0.383	-0.238	-0.059	0.042	0.074	0.093
Precast-top	-0.304	-0.239	-0.104	0.579	1.407	1.945	2.294	2.452
Bottom	2.113	3.938	3.752	2.992	2.072	1.458	1.066	0.877

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.003	0.012	0.017	0.045	0.077	0.096	0.102	0.095
Precast-top	-0.063	-0.014	0.111	0.732	1.481	1.975	2.310	2.453
Bottom	0.779	2.752	2.622	2.196	1.693	1.307	0.988	0.872

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.127	-0.112	-0.105	-0.059	-0.001	0.044	0.076	0.095
Precast-top	-0.131	-0.081	0.046	0.676	1.438	1.947	2.295	2.453
Bottom	1.157	3.103	2.965	2.488	1.910	1.451	1.060	0.872

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	0.010	0.045	0.063	0.168	0.278	0.338	0.352	0.330
Precast-top	-0.027	0.014	0.085	0.445	0.871	1.146	1.319	1.380
Bottom	0.365	1.267	1.156	0.689	0.177	-0.153	-0.343	-0.347

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.474	-0.425	-0.400	-0.254	-0.073	0.019	0.035	0.045
Precast-top	-0.282	-0.239	-0.164	0.217	0.680	0.972	1.146	1.225
Bottom	1.774	2.595	2.466	1.874	1.157	0.734	0.537	0.442

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.250	3.517	11.650	24.050	36.450	48.850	61.250	42.650
Mu-req'd	1963.9	2899.4	8310.0	14573.5	18607.2	20503.1	20441.6	19555.2
Mu-prv'd	15218.0	16366.2	24900.4	28745.8	31225.7	31772.2	31772.2	31498.9

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 61.25 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	4.650	1.80	8.369	2.20	10.229
Self Wt.	-1.591	1.85	-2.943	2.40	-3.817
Deck + Haunch			-1.993	2.30	-4.585
DL-Prec. (DC)			-0.428	3.00	-1.284

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.022	3.00	-0.067
DL-Comp. (DW)			-0.106	3.00	-0.318
Total	3.059		2.877		0.158

Positive values indicate upward deflection.

PROPERTIES

Span: 5, Beam: 3

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	25.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Interior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	300.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on precast:
UNITS: (Point: kips, Location: ft)
(Line: klf)

DC/DW	Type	Mag.	Loc.
DC	Line	0.600	-

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	124.000	ft
Release length	124.000	ft
Design length	122.500	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	0.931	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.700	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.056	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.127	(Calculated)
Comp. DC	0.127	(Calculated)
Comp. DW	0.127	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75

Tension controlled sections	1.00
Shear	0.90

Span: 5, Beam: 3

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4163.6	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3135173	in4	#
Ht. of c.g.	35.84	in	61.13	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4632.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.25	H/2 3.52	0.10L 11.65	0.20L 24.05	0.30L 36.45	0.40L 48.85	Midspan 61.25
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1782.5	1834.8	1834.8	1840.9	1848.2	1851.2	1851.2	1851.2
Yb,	in	35.63	35.01	35.00	34.82	34.60	34.44	34.39	34.39
MI(Ixx),	in4	1162066	1186135	1187003	1198878	1215094	1228654	1234541	1234541
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4178.2	4222.0	4222.0	4227.1	4233.2	4235.7	4235.7	4235.7
Yb,	in	60.97	60.48	60.48	60.38	60.26	60.19	60.17	60.17
MI(Ixx),	in4	3166721	3262884	3264488	3292014	3327326	3352719	3361990	3361990

Span: 5, Beam: 3
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 5, Beam: 3

PRESTRESSED STEEL:

84 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (43.40 ft from member end)

END PATTERN (Ycg = 12.74 in):

25 @ 5.880 in	23 @ 2.250 in	2 @ 59.500 in	2 @ 61.500 in
2 @ 63.500 in	2 @ 65.500 in	24 @ 4.060 in	2 @ 67.500 in
2 @ 69.500 in			

MID PATTERN (Ycg = 4.56 in):
(A) Draped:

2 @ 2.250 in	2 @ 4.250 in	2 @ 6.250 in	2 @ 8.250 in
2 @ 10.250 in	2 @ 12.250 in		

(B) Straight:

25 @ 5.880 in	23 @ 2.250 in	24 @ 4.060 in	

SHIELDING AND REDUCED INITIAL PULLS:

Group	Strands	Heights End		Mid		Shielding End		Mid		Initial Frac	Pull Pull/Str
1	2	5.880	in	5.880	in	16.00	ft	0.00	ft	75.0 %	43.9
28	2	2.250	in	2.250	in	8.00	ft	0.00	ft	75.0 %	43.9
29	2	2.250	in	2.250	in	8.00	ft	0.00	ft	75.0 %	43.9
30	2	2.250	in	2.250	in	8.00	ft	0.00	ft	75.0 %	43.9
31	1	2.250	in	2.250	in	16.00	ft	0.00	ft	75.0 %	43.9
40	2	5.880	in	5.880	in	24.00	ft	0.00	ft	75.0 %	43.9
41	2	5.880	in	5.880	in	24.00	ft	0.00	ft	75.0 %	43.9
42	2	5.880	in	5.880	in	16.00	ft	0.00	ft	75.0 %	43.9
43	1	5.880	in	5.880	in	16.00	ft	0.00	ft	75.0 %	43.9

Check for Art. 5.11.4.3 (debond termination distances): OK

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	18.228	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.888	ft
Dev. Len, debonded	14.860	ft
Holddown Force	57.619	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	3691.2	kips
Beam Shrtng (PL/AE)	0.601	in

REINFORCING STEEL:

Tension	/Shear	steel:
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

LOSSES

Note: Values are calculated at Midspan

Str. area	18.2280	in2
Ycg	4.56	in
P_init	3691.2	kips
Ecc	31.28	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 20.90 ksi (Eq 5.9.5.2.3a-1), (fcgp= 3.652 ksi)

	Elastic Gains	Gains		Adjustment	
due	to Precast Loads	-9.14	ksi	0.00	ksi
due	to Composite Loads	-1.21	ksi	0.00	ksi
due	to Live Loads	-2.87	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		14.84	ksi	(Eq 5.9.5.3-1)
Sub-total	20.90	ksi	(10.32 %)	12.53	ksi	(6.19 %)
Total Prestress Losses				33.43	ksi	(16.51 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 169.1 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

DESIGN STATUS

Span:2, Beam: ~~2~~ ALL & 4

RELEASE STRESSES (ksi)

Limiting Stresses

Compression	Tens with Reinf	Tens without Reinf
4.050	-0.624	-0.200

Computed Stresses

	Trans	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress.
Location, ft	3.000	2.000	4.000	6.000	8.000	10.000	7.000
Precast-top	0.282	0.189	0.287	0.293	0.298	0.299	0.296
Bottom	0.311	0.207	0.307	0.300	0.296	0.294	0.297
As_top, in2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

FINAL STRESSES (ksi)

Limiting Stresses

		Precast	Topping-Top
Final 1 (P/S+DL+LL)	Compression	5.400	4.320
Final 1	Tension	-0.570	-0.510
Final 2 (P/S+DL)	Compression	4.050	3.240
Final 3 (0.5(P/S+DL)+LL)	Compression	3.600	2.880

Computed Stresses

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Location, ft	0.000	2.500	3.517	1.500	3.500	5.500	7.500	9.500
Topping-top	-0.091	-0.033	-0.000	-0.033	-0.029	-0.028	-0.031	-0.037
Precast-top	-0.006	0.266	0.247	0.171	0.280	0.297	0.306	0.307
Bottom	0.319	0.368	0.307	0.279	0.345	0.326	0.324	0.338

POSITIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.029	-0.036	-0.000	-0.035	-0.033	-0.034	-0.037	-0.043
Precast-top	0.027	0.264	0.247	0.170	0.277	0.294	0.303	0.303
Bottom	0.136	0.377	0.307	0.287	0.358	0.343	0.342	0.357

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.431	-0.379	-0.000	-0.399	-0.360	-0.322	-0.270	-0.252
Precast-top	-0.184	0.085	0.247	-0.021	0.106	0.143	0.181	0.194
Bottom	1.317	1.381	0.307	1.352	1.315	1.186	1.023	0.968

NEGATIVE MOMENT ENVELOPE : SERVICE III (Final 1)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.365	-0.322	-0.000	-0.339	-0.306	-0.274	-0.231	-0.216
Precast-top	-0.149	0.115	0.247	0.011	0.134	0.168	0.201	0.213
Bottom	1.124	1.214	0.307	1.175	1.157	1.046	0.909	0.861

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.104	-0.049	-0.000	-0.046	-0.051	-0.057	-0.063	-0.069
Precast-top	-0.013	0.258	0.247	0.164	0.268	0.282	0.290	0.290
Bottom	0.356	0.414	0.307	0.317	0.411	0.410	0.417	0.432

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 2)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.104	-0.094	-0.000	-0.098	-0.090	-0.083	-0.076	-0.069
Precast-top	-0.013	0.234	0.247	0.137	0.248	0.269	0.283	0.290
Bottom	0.356	0.546	0.307	0.469	0.524	0.485	0.455	0.432

POSITIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.039	-0.009	-0.000	-0.010	-0.003	0.000	0.000	-0.002
Precast-top	0.000	0.137	0.124	0.089	0.146	0.156	0.161	0.162
Bottom	0.141	0.161	0.154	0.120	0.140	0.121	0.115	0.122

NEGATIVE MOMENT ENVELOPE : SERVICE I (Final 3)

	Bearing	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan
Topping-top	-0.379	-0.332	-0.000	-0.350	-0.315	-0.281	-0.232	-0.218
Precast-top	-0.177	-0.032	0.124	-0.089	-0.018	0.009	0.040	0.049
Bottom	1.139	1.108	0.154	1.117	1.053	0.944	0.796	0.753

ULTIMATE MOMENT (k.ft)

STRENGTH I

	Trans	H/2	0.10L/0.90L	0.20L/0.80L	0.30L/0.70L	0.40L/0.60L	Midspan	Depress
Location, ft	2.500	3.517	1.500	3.500	5.500	7.500	9.500	6.500
Mu-req'd	41.6	0.0	-35.3	201.9	349.1	402.5	363.7	375.8
Mu-prv'd	2073.6	2178.3	1384.6	2176.5	2382.3	2587.8	2793.2	2485.1

CAMBER / DEFLECTION (in) at Midspan (0.5 x L = 9.50 ft)

SERVICE I

	Release	Mult	Erection	Mult	Final
Prestress	0.001	1.80	0.002	2.20	0.003
Self Wt.	-0.001	1.85	-0.002	2.40	-0.003
Deck + Haunch			-0.001	2.30	-0.003
DL-Prec. (DC)			0.000	3.00	0.000

	Release	Mult	Erection	Mult	Final
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			0.001	3.00	0.002
DL-Comp. (DW)			0.003	3.00	0.010
Total	0.000		0.003		0.010

Positive values indicate upward deflection.

PROPERTIES

Span: 2, Beam: 2

PRECAST DATA:

Section Id	U72C					
Type	Open Box Beam					
Flng width	Top	131.000	in	Bot	54.000	in
thick	Top	6.350	in	Bot	8.100	in
Stems	No	2				
	Top	7.500	in			
	Bot	7.500	in			
Shear width		15.000	in			

GENERAL BRIDGE DATA:

Bridge Width	197.00	ft
Curb-to-curb	194.00	ft
Beam Spac. Lt./Rt	25.00/ 25.00	ft
Lane width	12.00	ft
Number of lanes	16	
Interior/Exterior	Interior	
Start Skew Angle	-34.00	degrees
End Skew Angle	-34.00	degrees

TOPPING DATA:

Deck	Thickness	8.000	in	
Haunch:				
	Thickness	4.400	in	
	Width	64.000	in	
Effective	width	300.000	in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on precast:
UNITS: (Point: kips, Location: ft)
(Line: klf)

DC/DW	Type	Mag.	Loc.
DC	Line	-0.500	-
DC	Line	0.500	-

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	20.000	ft
Release length	20.000	ft
Design length	19.000	ft

KERN POINTS:

Upper	54.09	in
Lower	17.76	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Negative Moment	Left Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Right Side	(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Negative Moment	Left Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Negative Moment	Right Side	(1 lane loaded)	0.931	(Calculated)	(#)
Live Positive Moment		(2+ lanes loaded)	1.498	(Calculated)	(#)
Live Positive Moment		(1 lane loaded)	0.931	(Calculated)	(#)
Live Shear		(2+ lanes loaded)	1.700	(Calculated)	(#)
Live Shear		(1 lane loaded)	1.056	(Calculated)	(#)

(#) Lever rule (C4.6.2.2.1)

Dead Loads and Pedestrian Load distributed based on Tributary Fraction

Pedestrian	0.127	(Calculated)
Comp. DC	0.127	(Calculated)
Comp. DW	0.127	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75

Tension controlled sections	1.00
Shear	0.90

Span: 2, Beam: 2

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1765.1	in2	4163.6	in2	#
Total Height	72.00	in	84.40	in	
Mom. of Inertia (Ixx)	1154250	in4	3135173	in4	#
Ht. of c.g.	35.84	in	61.13	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1838.6	plf	4632.0	plf	
Mom. of Inertia (Iyy)	2057200.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8944

Use transformed strand and rebar: Strand Only

Location,	ft	Bearing 0.00	Trans 2.50	H/2 3.52	0.10L 1.50	0.20L 3.50	0.30L 5.50	0.40L 7.50	Midspan 9.50
Precast:(At Release, using	Ec =	4980.8ksi)							
Area,	in2	1767.1	1777.4	1777.4	1773.3	1777.4	1777.4	1777.4	1777.4
Yb,	in	35.84	35.83	35.83	35.83	35.83	35.83	35.83	35.83
MI(Ixx),	in4	1154258	1154297	1154297	1154281	1154297	1154297	1154297	1154297
Composite:(At Final, using	Ec =	5751.4ksi)							
Area,	in2	4165.3	4173.9	4173.9	4170.5	4173.9	4173.9	4173.9	4173.9
Yb,	in	61.12	61.07	61.07	61.09	61.07	61.07	61.07	61.07
MI(Ixx),	in4	3136448	3142807	3142807	3140267	3142807	3142807	3142807	3142807

Span: 2, Beam: 2
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

		PRECAST	

		PRECAST	
Strength		6.75	ksi
Elasticity		4980.8	ksi
Max comp		4.05	ksi
Max tens		-0.20	ksi
Max tens,	w/reinf	-0.62	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	9.00	ksi	7.20	ksi
Elasticity	5751.38	ksi	5144.19	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	5.40	ksi	4.32	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST		DECK	
Max comp	4.05	ksi	3.24	ksi

STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.88	ksi

SERVICE III (Tension):

	PRECAST		DECK	
Max tens	-0.57	ksi	-0.51	ksi

Span: 2, Beam: 2

PRESTRESSED STEEL:

12 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.35L (7.00 ft from member end)

END PATTERN (Ycg = 33.88 in):

6 @ 2.250 in	2 @ 63.500 in	2 @ 65.500 in	2 @ 67.500 in

Strand Diameter	0.600	in
Strand Area	0.217	in2
Total Strand Area	2.604	in2
Trans. Len,bonded	3.000	ft
Trans. Len,debonded	3.000	ft
Dev. Len, bonded	11.432	ft
Dev. Len, debonded	14.290	ft
Holddown Force	0.000	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	527.3	kips
Beam Shrtng (PL/AE)	0.014	in

REINFORCING STEEL:

Tension	/Shear	steel:
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

LOSSES

Note: Values are calculated at Midspan

Str. area	2.6040	in2
Ycg	33.88	in
P_init	527.3	kips
Ecc	1.96	in
Days to release	0.75	
Rel. Humid.(RH)	60.0	%
Es	28500.0	ksi
Eci	4981	ksi

AASHTO LOSSES

Elastic Shortening ** 1.70 ksi (Eq 5.9.5.2.3a-1), (fcgp= 0.297 ksi)

Elastic Gains		Gains		Adjustment	
due	to Precast Loads	-0.01	ksi	0.00	ksi
due	to Composite Loads	-0.00	ksi	0.00	ksi
due	to Live Loads	-0.17	ksi	0.00	ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		8.52	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		2.12	ksi	(Eq 5.9.5.3-1)
Sub-total	1.70	ksi	(0.84 %)	12.86	ksi	(6.35 %)
Total Prestress Losses				14.56	ksi	(7.19 %)

Prestressing Stress Limit Check (Table 5.9.3.1)
initial fpi = 202.5 ksi < 0.75 fpu, OK
initial fpe = 187.9 ksi < 0.80 fpy, OK

** Since the transformed section properties option has been selected, even though ES losses have been calculated explicitly here, they are not included as a part of stress calculations. Please see theory section for complete explanation.

Bentley	Colorado DOT	Sheet #	DS-1
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

CAMBER/DEFLECTION

CAMBER AND DEFLECTIONS: SERVICE I
(Span : 1, Beam : 2; Units: in)

	Release	Mult	Erection	Mult	Final
At 0.1 x L = 6.85 ft					
Prestress	0.242	1.80	0.435	2.20	0.531
Self Wt.	-0.074	1.85	-0.137	2.40	-0.178
Deck + Haunch			-0.083	2.30	-0.191
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.002	3.00	-0.005
DL-Comp. (DW)			-0.008	3.00	-0.025
Live Load	Not Included				
Total	0.168		0.205		0.132

,093"

	Release	Mult	Erection	Mult	Final
At 0.2 x L = 14.45 ft					
Prestress	0.441	1.80	0.794	2.20	0.970
Self Wt.	-0.139	1.85	-0.258	2.40	-0.334
Deck + Haunch			-0.165	2.30	-0.379
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.003	3.00	-0.010
DL-Comp. (DW)			-0.015	3.00	-0.046
Live Load	Not Included				
Total	0.302		0.353		0.202

.183"

	Release	Mult	Erection	Mult	Final
At 0.3 x L = 22.05 ft					
Prestress	0.583	1.80	1.050	2.20	1.283
Self Wt.	-0.190	1.85	-0.351	2.40	-0.456
Deck + Haunch			-0.229	2.30	-0.526
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.013
DL-Comp. (DW)			-0.020	3.00	-0.060
Live Load	Not Included				
Total	0.393		0.445		0.228

,253"

	Release	Mult	Erection	Mult	Final

Bentley	Colorado DOT	Sheet #	DS-2
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06		Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

	Release	Mult	Erection	Mult	Final
At 0.4 x L = 29.65 ft					
Prestress	0.672	1.80	1.209	2.20	1.478
Self Wt.	-0.223	1.85	-0.412	2.40	-0.534
Deck + Haunch			-0.270	2.30	-0.620
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.005	3.00	-0.014
DL-Comp. (DW)			-0.023	3.00	-0.068
Live Load	Not Included				
Total	0.449		0.500		0.241

.298"

	Release	Mult	Erection	Mult	Final
At 0.5 x L = 37.25 ft					
Prestress	0.701	1.80	1.263	2.20	1.543
Self Wt.	-0.234	1.85	-0.432	2.40	-0.561
Deck + Haunch			-0.284	2.30	-0.653
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.005	3.00	-0.015
DL-Comp. (DW)			-0.023	3.00	-0.069
Live Load	Not Included				
Total	0.468		0.518		0.246

.312"

	Release	Mult	Erection	Mult	Final
At 0.6 x L = 44.85 ft					
Prestress	0.672	1.80	1.209	2.20	1.478
Self Wt.	-0.223	1.85	-0.412	2.40	-0.534
Deck + Haunch			-0.270	2.30	-0.620
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.013
DL-Comp. (DW)			-0.021	3.00	-0.063
Live Load	Not Included				
Total	0.449		0.503		0.248

.295"

	Release	Mult	Erection	Mult	Final
At 0.7 x L = 52.45 ft					
Prestress	0.583	1.80	1.050	2.20	1.283
Self Wt.	-0.190	1.85	-0.351	2.40	-0.456
Deck + Haunch			-0.229	2.30	-0.526
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000

.25"

	Release	Mult	Erection	Mult	Final
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.011
DL-Comp. (DW)			-0.017	3.00	-0.050
Live Load	Not Included				
Total	0.393		0.449		0.240

	Release	Mult	Erection	Mult	Final
At 0.8 x L = 60.05 ft					
Prestress	0.441	1.80	0.794	2.20	0.970
Self Wt.	-0.139	1.85	-0.258	2.40	-0.334
Deck + Haunch			-0.165	2.30	-0.379
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.002	3.00	-0.007
DL-Comp. (DW)			-0.011	3.00	-0.034
Live Load	Not Included				
Total	0.302		0.358		0.216

.178"

	Release	Mult	Erection	Mult	Final
At 0.9 x L = 67.65 ft					
Prestress	0.242	1.80	0.435	2.20	0.531
Self Wt.	-0.074	1.85	-0.137	2.40	-0.178
Deck + Haunch			-0.083	2.30	-0.191
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.001	3.00	-0.003
DL-Comp. (DW)			-0.005	3.00	-0.016
Live Load	Not Included				
Total	0.168		0.208		0.144

.089"

CAMBER/DEFLECTION

Girders 3 & 6
Span 1

CAMBER AND DEFLECTIONS: SERVICE I
(Span : 1, Beam : 3; Units: in)

	Release	Mult	Erection	Mult	Final
At 0.1 x L = 6.85 ft					
Prestress	0.242	1.80	0.435	2.20	0.531
Self Wt.	-0.074	1.85	-0.137	2.40	-0.178
Deck + Haunch			-0.083	2.30	-0.191
DL-Prec. (DC)			-0.018	3.00	-0.053
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.002	3.00	-0.005
DL-Comp. (DW)			-0.008	3.00	-0.025
Live Load	Not Included				
Total	0.168		0.187		0.079

.111"

	Release	Mult	Erection	Mult	Final
At 0.2 x L = 14.45 ft					
Prestress	0.441	1.80	0.794	2.20	0.970
Self Wt.	-0.139	1.85	-0.258	2.40	-0.334
Deck + Haunch			-0.165	2.30	-0.379
DL-Prec. (DC)			-0.035	3.00	-0.106
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.003	3.00	-0.010
DL-Comp. (DW)			-0.015	3.00	-0.046
Live Load	Not Included				
Total	0.302		0.318		0.096

.218"

	Release	Mult	Erection	Mult	Final
At 0.3 x L = 22.05 ft					
Prestress	0.583	1.80	1.050	2.20	1.283
Self Wt.	-0.190	1.85	-0.351	2.40	-0.456
Deck + Haunch			-0.229	2.30	-0.526
DL-Prec. (DC)			-0.049	3.00	-0.147
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.013
DL-Comp. (DW)			-0.020	3.00	-0.060
Live Load	Not Included				
Total	0.393		0.396		0.081

.302"

	Release	Mult	Erection	Mult	Final

Bentley	Colorado DOT	Sheet #	DS-2
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

	Release	Mult	Erection	Mult	Final
At 0.4 x L = 29.65 ft					
Prestress	0.672	1.80	1.209	2.20	1.478
Self Wt.	-0.223	1.85	-0.412	2.40	-0.534
Deck + Haunch			-0.270	2.30	-0.620
DL-Prec. (DC)			-0.058	3.00	-0.174
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.005	3.00	-0.014
DL-Comp. (DW)			-0.023	3.00	-0.068
Live Load	Not Included				
Total	0.449		0.442		0.067

,356"

	Release	Mult	Erection	Mult	Final
At 0.5 x L = 37.25 ft					
Prestress	0.701	1.80	1.263	2.20	1.543
Self Wt.	-0.234	1.85	-0.432	2.40	-0.561
Deck + Haunch			-0.284	2.30	-0.653
DL-Prec. (DC)			-0.061	3.00	-0.183
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.005	3.00	-0.015
DL-Comp. (DW)			-0.023	3.00	-0.069
Live Load	Not Included				
Total	0.468		0.458		0.063

,373"

	Release	Mult	Erection	Mult	Final
At 0.6 x L = 44.85 ft					
Prestress	0.672	1.80	1.209	2.20	1.478
Self Wt.	-0.223	1.85	-0.412	2.40	-0.534
Deck + Haunch			-0.270	2.30	-0.620
DL-Prec. (DC)			-0.058	3.00	-0.174
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.013
DL-Comp. (DW)			-0.021	3.00	-0.063
Live Load	Not Included				
Total	0.449		0.445		0.074

,353"

	Release	Mult	Erection	Mult	Final
At 0.7 x L = 52.45 ft					
Prestress	0.583	1.80	1.050	2.20	1.283
Self Wt.	-0.190	1.85	-0.351	2.40	-0.456
Deck + Haunch			-0.229	2.30	-0.526
DL-Prec. (DC)			-0.049	3.00	-0.147
Diaphragm			0.000	3.00	0.000

,299"

	Release	Mult	Erection	Mult	Final
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.011
DL-Comp. (DW)			-0.017	3.00	-0.050
Live Load	Not Included				
Total	0.393		0.400		0.093

	Release	Mult	Erection	Mult	Final
At 0.8 x L = 60.05 ft					
Prestress	0.441	1.80	0.794	2.20	0.970
Self Wt.	-0.139	1.85	-0.258	2.40	-0.334
Deck + Haunch			-0.165	2.30	-0.379
DL-Prec. (DC)			-0.035	3.00	-0.106
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.002	3.00	-0.007
DL-Comp. (DW)			-0.011	3.00	-0.034
Live Load	Not Included				
Total	0.302		0.322		0.110

.213"

	Release	Mult	Erection	Mult	Final
At 0.9 x L = 67.65 ft					
Prestress	0.242	1.80	0.435	2.20	0.531
Self Wt.	-0.074	1.85	-0.137	2.40	-0.178
Deck + Haunch			-0.083	2.30	-0.191
DL-Prec. (DC)			-0.018	3.00	-0.053
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.001	3.00	-0.003
DL-Comp. (DW)			-0.005	3.00	-0.016
Live Load	Not Included				
Total	0.168		0.191		0.090

.107"

CAMBER/DEFLECTION

CAMBER AND DEFLECTIONS: SERVICE I
(Span : 3, Beam : 2; Units: in)

	Release	Mult	Erection	Mult	Final
At 0.1 x L = 11.70 ft					
Prestress	1.620	1.80	2.915	2.20	3.563
Self Wt.	-0.566	1.85	-1.048	2.40	-1.359
Deck + Haunch			-0.656	2.30	-1.509
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.003	3.00	-0.010
DL-Comp. (DW)			-0.016	3.00	-0.049
Live Load	Not Included				
Total	1.053		1.192		0.635

.675"

	Release	Mult	Erection	Mult	Final
At 0.2 x L = 24.40 ft					
Prestress	2.900	1.80	5.220	2.20	6.380
Self Wt.	-1.061	1.85	-1.962	2.40	-2.546
Deck + Haunch			-1.283	2.30	-2.951
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.008	3.00	-0.025
DL-Comp. (DW)			-0.039	3.00	-0.118
Live Load	Not Included				
Total	1.839		1.927		0.741

1.33"

	Release	Mult	Erection	Mult	Final
At 0.3 x L = 37.10 ft					
Prestress	3.809	1.80	6.857	2.20	8.380
Self Wt.	-1.436	1.85	-2.657	2.40	-3.447
Deck + Haunch			-1.761	2.30	-4.050
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.013	3.00	-0.038
DL-Comp. (DW)			-0.061	3.00	-0.182
Live Load	Not Included				
Total	2.373		2.365		0.663

1.835"

	Release	Mult	Erection	Mult	Final

Bentley	Colorado DOT	Sheet #	DS-2
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

	Release	Mult	Erection	Mult	Final
At 0.4 x L = 49.80 ft					
Prestress	4.358	1.80	7.845	2.20	9.588
Self Wt.	-1.672	1.85	-3.094	2.40	-4.013
Deck + Haunch			-2.062	2.30	-4.742
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.016	3.00	-0.048
DL-Comp. (DW)			-0.076	3.00	-0.229
Live Load	Not Included				
Total	2.686		2.598		0.557

2.154"

	Release	Mult	Erection	Mult	Final
At 0.5 x L = 62.50 ft					
Prestress	4.552	1.80	8.194	2.20	10.015
Self Wt.	-1.756	1.85	-3.249	2.40	-4.214
Deck + Haunch			-2.168	2.30	-4.987
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.017	3.00	-0.052
DL-Comp. (DW)			-0.082	3.00	-0.247
Live Load	Not Included				
Total	2.796		2.677		0.515

2.267"

	Release	Mult	Erection	Mult	Final
At 0.6 x L = 75.20 ft					
Prestress	4.358	1.80	7.845	2.20	9.588
Self Wt.	-1.672	1.85	-3.094	2.40	-4.013
Deck + Haunch			-2.062	2.30	-4.742
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.016	3.00	-0.049
DL-Comp. (DW)			-0.078	3.00	-0.233
Live Load	Not Included				
Total	2.686		2.596		0.552

2.156"

	Release	Mult	Erection	Mult	Final
At 0.7 x L = 87.90 ft					
Prestress	3.809	1.80	6.857	2.20	8.380
Self Wt.	-1.436	1.85	-2.657	2.40	-3.447
Deck + Haunch			-1.761	2.30	-4.050
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000

1.837"

Bentley	Colorado DOT	Sheet #	DS-3
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

	Release	Mult	Erection	Mult	Final
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.013	3.00	-0.040
DL-Comp. (DW)			-0.063	3.00	-0.190
Live Load	Not Included				
Total	2.373		2.362		0.654

	Release	Mult	Erection	Mult	Final
At 0.8 x L = 100.60 ft					
Prestress	2.900	1.80	5.220	2.20	6.380
Self Wt.	-1.061	1.85	-1.962	2.40	-2.546
Deck + Haunch			-1.283	2.30	-2.951
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.009	3.00	-0.027
DL-Comp. (DW)			-0.042	3.00	-0.126
Live Load	Not Included				
Total	1.839		1.924		0.731

1.334"

	Release	Mult	Erection	Mult	Final
At 0.9 x L = 113.30 ft					
Prestress	1.620	1.80	2.915	2.20	3.563
Self Wt.	-0.566	1.85	-1.048	2.40	-1.359
Deck + Haunch			-0.656	2.30	-1.509
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.012
DL-Comp. (DW)			-0.019	3.00	-0.056
Live Load	Not Included				
Total	1.053		1.189		0.627

.679'

CAMBER/DEFLECTION

CAMBER AND DEFLECTIONS: SERVICE I
(Span : 3, Beam : 3; Units: in)

Girders 3 & 6

	Release	Mult	Erection	Mult	Final
At 0.1 x L = 11.70 ft					
Prestress	1.771	1.80	3.188	2.20	3.896
Self Wt.	-0.566	1.85	-1.047	2.40	-1.358
Deck + Haunch			-0.656	2.30	-1.508
DL-Prec. (DC)			-0.141	3.00	-0.422
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.003	3.00	-0.010
DL-Comp. (DW)			-0.016	3.00	-0.049
Live Load	Not Included				
Total	1.205		1.325		0.548

.816"

	Release	Mult	Erection	Mult	Final
At 0.2 x L = 24.40 ft					
Prestress	3.183	1.80	5.730	2.20	7.003
Self Wt.	-1.056	1.85	-1.954	2.40	-2.536
Deck + Haunch			-1.278	2.30	-2.939
DL-Prec. (DC)			-0.274	3.00	-0.823
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.008	3.00	-0.025
DL-Comp. (DW)			-0.039	3.00	-0.117
Live Load	Not Included				
Total	2.127		2.176		0.564

1.599"

	Release	Mult	Erection	Mult	Final
At 0.3 x L = 37.10 ft					
Prestress	4.170	1.80	7.506	2.20	9.174
Self Wt.	-1.427	1.85	-2.639	2.40	-3.424
Deck + Haunch			-1.749	2.30	-4.022
DL-Prec. (DC)			-0.376	3.00	-1.127
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.013	3.00	-0.038
DL-Comp. (DW)			-0.060	3.00	-0.181
Live Load	Not Included				
Total	2.744		2.670		0.382

2.198"

	Release	Mult	Erection	Mult	Final

	Release	Mult	Erection	Mult	Final
At 0.4 x L = 49.80 ft					
Prestress	4.780	1.80	8.605	2.20	10.517
Self Wt.	-1.661	1.85	-3.073	2.40	-3.987
Deck + Haunch			-2.048	2.30	-4.710
DL-Prec. (DC)			-0.440	3.00	-1.320
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.016	3.00	-0.048
DL-Comp. (DW)			-0.076	3.00	-0.227
Live Load	Not Included				
Total	3.119		2.953		0.226

2.58"

	Release	Mult	Erection	Mult	Final
At 0.5 x L = 62.50 ft					
Prestress	4.995	1.80	8.992	2.20	10.990
Self Wt.	-1.744	1.85	-3.227	2.40	-4.186
Deck + Haunch			-2.154	2.30	-4.953
DL-Prec. (DC)			-0.463	3.00	-1.388
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.017	3.00	-0.052
DL-Comp. (DW)			-0.082	3.00	-0.245
Live Load	Not Included				
Total	3.251		3.050		0.166

2.716"

	Release	Mult	Erection	Mult	Final
At 0.6 x L = 75.20 ft					
Prestress	4.780	1.80	8.605	2.20	10.517
Self Wt.	-1.661	1.85	-3.073	2.40	-3.987
Deck + Haunch			-2.048	2.30	-4.710
DL-Prec. (DC)			-0.440	3.00	-1.320
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.016	3.00	-0.049
DL-Comp. (DW)			-0.077	3.00	-0.231
Live Load	Not Included				
Total	3.119		2.951		0.221

2.581"

	Release	Mult	Erection	Mult	Final
At 0.7 x L = 87.90 ft					
Prestress	4.170	1.80	7.506	2.20	9.174
Self Wt.	-1.427	1.85	-2.639	2.40	-3.424
Deck + Haunch			-1.749	2.30	-4.022
DL-Prec. (DC)			-0.376	3.00	-1.127
Diaphragm			0.000	3.00	0.000

2.201"

Bentley	Colorado DOT	Sheet #	DS-3
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

	Release	Mult	Erection	Mult	Final
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.013	3.00	-0.040
DL-Comp. (DW)			-0.063	3.00	-0.189
Live Load	Not Included				
Total	2.744		2.667		0.373

	Release	Mult	Erection	Mult	Final
At 0.8 x L = 100.60 ft					
Prestress	3.183	1.80	5.730	2.20	7.003
Self Wt.	-1.056	1.85	-1.954	2.40	-2.536
Deck + Haunch			-1.278	2.30	-2.939
DL-Prec. (DC)			-0.274	3.00	-0.823
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.009	3.00	-0.026
DL-Comp. (DW)			-0.042	3.00	-0.126
Live Load	Not Included				
Total	2.127		2.173		0.554

1.603"

	Release	Mult	Erection	Mult	Final
At 0.9 x L = 113.30 ft					
Prestress	1.771	1.80	3.188	2.20	3.896
Self Wt.	-0.566	1.85	-1.047	2.40	-1.358
Deck + Haunch			-0.656	2.30	-1.508
DL-Prec. (DC)			-0.141	3.00	-0.422
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.004	3.00	-0.012
DL-Comp. (DW)			-0.019	3.00	-0.056
Live Load	Not Included				
Total	1.205		1.322		0.540

.82"

Bentley	Colorado DOT	Sheet #	DS-1
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06		Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

CAMBER/DEFLECTION

CAMBER AND DEFLECTIONS: SERVICE I
(Span : 5, Beam : 2; Units: in)

	Release	Mult	Erection	Mult	Final
At 0.1 x L = 11.65 ft					
Prestress	1.539	1.80	2.771	2.20	3.387
Self Wt.	-0.515	1.85	-0.952	2.40	-1.235
Deck + Haunch			-0.614	2.30	-1.413
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.005	3.00	-0.015
DL-Comp. (DW)			-0.024	3.00	-0.071
Live Load	Not Included				
Total	1.025		1.176		0.652

.643"

	Release	Mult	Erection	Mult	Final
At 0.2 x L = 24.05 ft					
Prestress	2.760	1.80	4.968	2.20	6.073
Self Wt.	-0.964	1.85	-1.784	2.40	-2.314
Deck + Haunch			-1.189	2.30	-2.735
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.012	3.00	-0.035
DL-Comp. (DW)			-0.055	3.00	-0.166
Live Load	Not Included				
Total	1.796		1.929		0.823

1.256"

	Release	Mult	Erection	Mult	Final
At 0.3 x L = 36.45 ft					
Prestress	3.627	1.80	6.529	2.20	7.979
Self Wt.	-1.305	1.85	-2.415	2.40	-3.133
Deck + Haunch			-1.627	2.30	-3.742
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.018	3.00	-0.055
DL-Comp. (DW)			-0.087	3.00	-0.260
Live Load	Not Included				
Total	2.322		2.382		0.790

1.732"

	Release	Mult	Erection	Mult	Final

	Release	Mult	Erection	Mult	Final
At 0.4 x L = 48.85 ft					
Prestress	4.150	1.80	7.471	2.20	9.131
Self Wt.	-1.520	1.85	-2.812	2.40	-3.647
Deck + Haunch			-1.902	2.30	-4.375
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.024	3.00	-0.071
DL-Comp. (DW)			-0.112	3.00	-0.336
Live Load	Not Included				
Total	2.631		2.622		0.702

2.038"

	Release	Mult	Erection	Mult	Final
At 0.5 x L = 61.25 ft					
Prestress	4.335	1.80	7.803	2.20	9.537
Self Wt.	-1.596	1.85	-2.952	2.40	-3.830
Deck + Haunch			-2.000	2.30	-4.600
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.027	3.00	-0.080
DL-Comp. (DW)			-0.126	3.00	-0.379
Live Load	Not Included				
Total	2.739		2.698		0.649

2.153"

	Release	Mult	Erection	Mult	Final
At 0.6 x L = 73.65 ft					
Prestress	4.150	1.80	7.471	2.20	9.131
Self Wt.	-1.520	1.85	-2.812	2.40	-3.647
Deck + Haunch			-1.902	2.30	-4.375
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.027	3.00	-0.080
DL-Comp. (DW)			-0.127	3.00	-0.381
Live Load	Not Included				
Total	2.631		2.603		0.648

2.056"

	Release	Mult	Erection	Mult	Final
At 0.7 x L = 86.05 ft					
Prestress	3.627	1.80	6.529	2.20	7.979
Self Wt.	-1.305	1.85	-2.415	2.40	-3.133
Deck + Haunch			-1.627	2.30	-3.742
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000

1.764"

	Release	Mult	Erection	Mult	Final
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.024	3.00	-0.071
DL-Comp. (DW)			-0.113	3.00	-0.339
Live Load	Not Included				
Total	2.322		2.350		0.694

	Release	Mult	Erection	Mult	Final
At 0.8 x L = 98.45 ft					
Prestress	2.760	1.80	4.968	2.20	6.073
Self Wt.	-0.964	1.85	-1.784	2.40	-2.314
Deck + Haunch			-1.189	2.30	-2.735
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.018	3.00	-0.054
DL-Comp. (DW)			-0.085	3.00	-0.256
Live Load	Not Included				
Total	1.796		1.892		0.713

1.292"

	Release	Mult	Erection	Mult	Final
At 0.9 x L = 110.85 ft					
Prestress	1.539	1.80	2.771	2.20	3.387
Self Wt.	-0.515	1.85	-0.952	2.40	-1.235
Deck + Haunch			-0.614	2.30	-1.413
DL-Prec. (DC)			0.000	3.00	0.000
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.010	3.00	-0.029
DL-Comp. (DW)			-0.046	3.00	-0.139
Live Load	Not Included				
Total	1.025		1.148		0.570

.67"

Bentley	Colorado DOT	Sheet #	DS-1
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

CAMBER/DEFLECTION

Girders 3 & 6

CAMBER AND DEFLECTIONS: SERVICE I
(Span : 5, Beam : 3; Units: in)

	Release	Mult	Erection	Mult	Final
At 0.1 x L = 11.65 ft					
Prestress	1.702	1.80	3.064	2.20	3.745
Self Wt.	-0.511	1.85	-0.945	2.40	-1.226
Deck + Haunch			-0.610	2.30	-1.403
DL-Prec. (DC)			-0.131	3.00	-0.393
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.005	3.00	-0.015
DL-Comp. (DW)			-0.024	3.00	-0.071
Live Load	Not Included				
Total	1.191		1.349		0.637

.77"

	Release	Mult	Erection	Mult	Final
At 0.2 x L = 24.05 ft					
Prestress	3.041	1.80	5.474	2.20	6.691
Self Wt.	-0.957	1.85	-1.770	2.40	-2.296
Deck + Haunch			-1.180	2.30	-2.714
DL-Prec. (DC)			-0.254	3.00	-0.761
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.012	3.00	-0.035
DL-Comp. (DW)			-0.055	3.00	-0.165
Live Load	Not Included				
Total	2.084		2.204		0.720

1.501"

	Release	Mult	Erection	Mult	Final
At 0.3 x L = 36.45 ft					
Prestress	3.993	1.80	7.188	2.20	8.785
Self Wt.	-1.297	1.85	-2.400	2.40	-3.113
Deck + Haunch			-1.617	2.30	-3.719
DL-Prec. (DC)			-0.347	3.00	-1.042
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.018	3.00	-0.054
DL-Comp. (DW)			-0.086	3.00	-0.259
Live Load	Not Included				
Total	2.696		2.719		0.598

2.068"

	Release	Mult	Erection	Mult	Final

Bentley	Colorado DOT	Sheet #	DS-2
		Job #	BR R600-297
Program: LEAP® CONSPAN® V8i (SELECTseries 1)		By	A. Pott
Version: Version: 09.00.01.06	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Jan/4/2010
	www.bentley.com Phone: 1-800-778-4277	Checked	
File Name: 76-21-125-21-124_U72C.csl		Date	

	Release	Mult	Erection	Mult	Final
At 0.4 x L = 48.85 ft					
Prestress	4.567	1.80	8.220	2.20	10.047
Self Wt.	-1.512	1.85	-2.796	2.40	-3.628
Deck + Haunch			-1.892	2.30	-4.351
DL-Prec. (DC)			-0.406	3.00	-1.219
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.023	3.00	-0.070
DL-Comp. (DW)			-0.111	3.00	-0.334
Live Load	Not Included				
Total	3.055		2.991		0.445

2.432"

	Release	Mult	Erection	Mult	Final
At 0.5 x L = 61.25 ft					
Prestress	4.768	1.80	8.582	2.20	10.489
Self Wt.	-1.587	1.85	-2.936	2.40	-3.809
Deck + Haunch			-1.989	2.30	-4.575
DL-Prec. (DC)			-0.427	3.00	-1.282
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.026	3.00	-0.079
DL-Comp. (DW)			-0.126	3.00	-0.377
Live Load	Not Included				
Total	3.181		3.077		0.367

2.568"

	Release	Mult	Erection	Mult	Final
At 0.6 x L = 73.65 ft					
Prestress	4.567	1.80	8.220	2.20	10.047
Self Wt.	-1.512	1.85	-2.796	2.40	-3.628
Deck + Haunch			-1.892	2.30	-4.351
DL-Prec. (DC)			-0.406	3.00	-1.219
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.027	3.00	-0.080
DL-Comp. (DW)			-0.126	3.00	-0.378
Live Load	Not Included				
Total	3.055		2.973		0.391

2.451"

	Release	Mult	Erection	Mult	Final
At 0.7 x L = 86.05 ft					
Prestress	3.993	1.80	7.188	2.20	8.785
Self Wt.	-1.297	1.85	-2.400	2.40	-3.113
Deck + Haunch			-1.617	2.30	-3.719
DL-Prec. (DC)			-0.347	3.00	-1.042
Diaphragm			0.000	3.00	0.000

2.1"

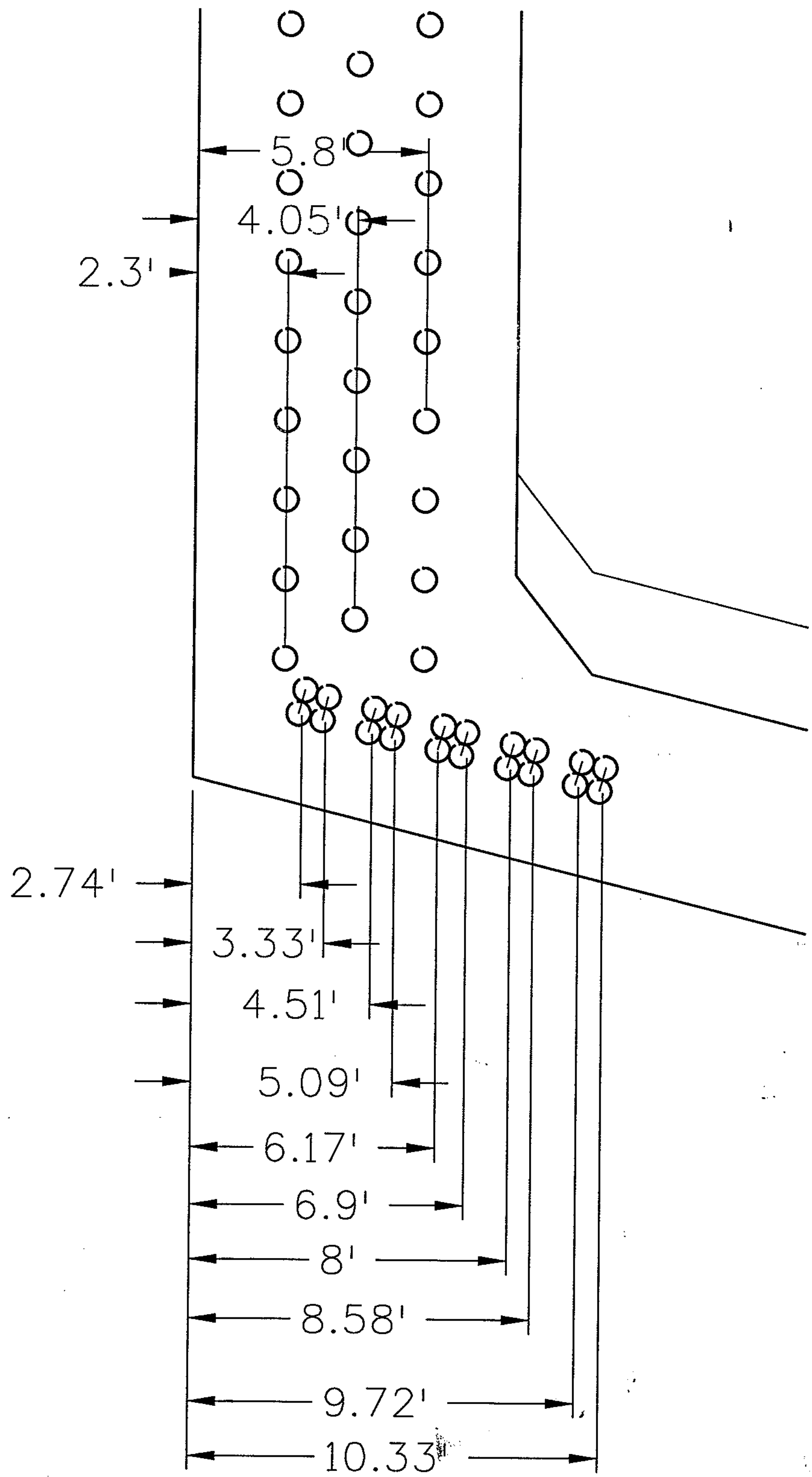
	Release	Mult	Erection	Mult	Final
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.024	3.00	-0.071
DL-Comp. (DW)			-0.112	3.00	-0.337
Live Load	Not Included				
Total	2.696		2.688		0.503

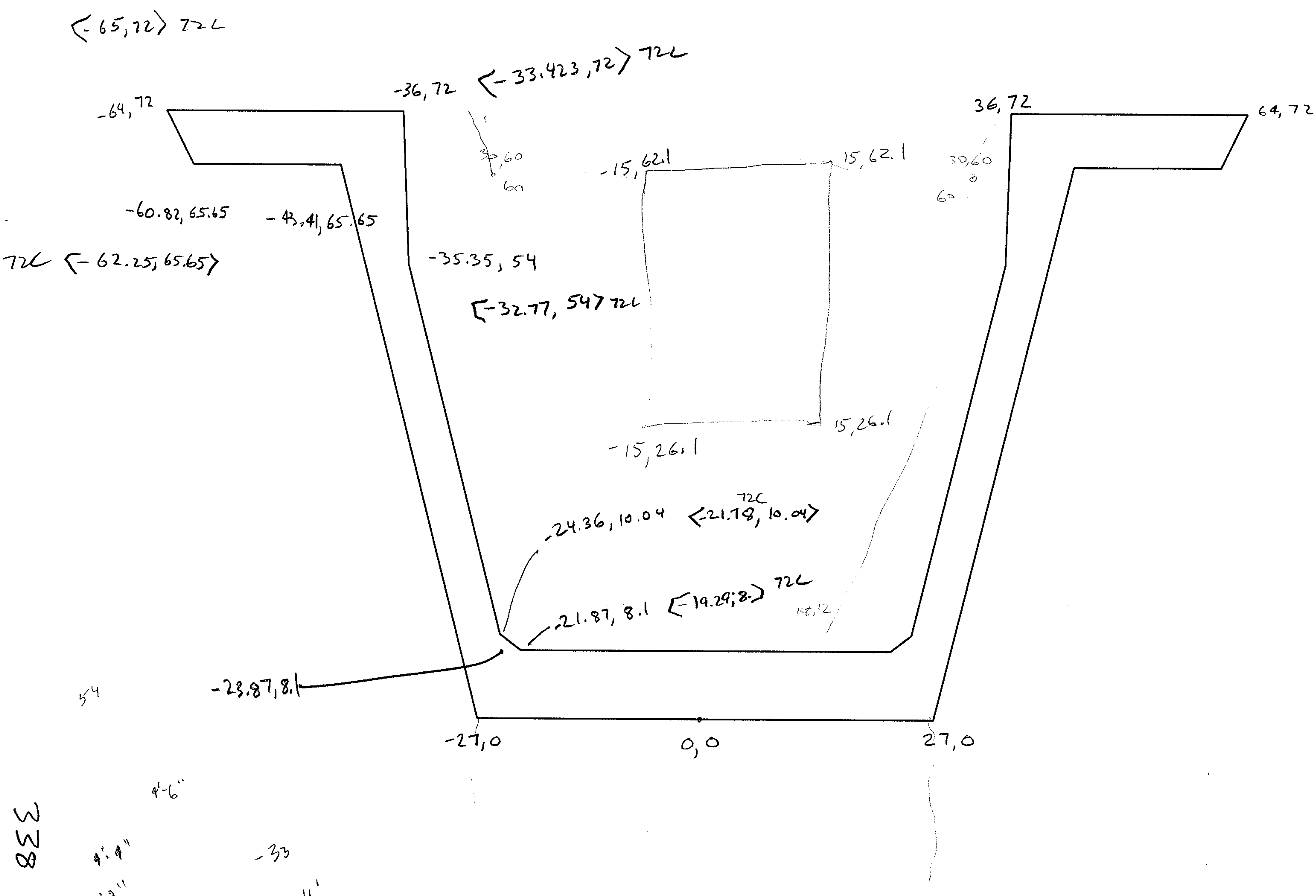
	Release	Mult	Erection	Mult	Final
At 0.8 x L = 98.45 ft					
Prestress	3.041	1.80	5.474	2.20	6.691
Self Wt.	-0.957	1.85	-1.770	2.40	-2.296
Deck + Haunch			-1.180	2.30	-2.714
DL-Prec. (DC)			-0.254	3.00	-0.761
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.018	3.00	-0.054
DL-Comp. (DW)			-0.085	3.00	-0.255
Live Load	Not Included				
Total	2.084		2.168		0.611

1.537"

	Release	Mult	Erection	Mult	Final
At 0.9 x L = 110.85 ft					
Prestress	1.702	1.80	3.064	2.20	3.745
Self Wt.	-0.511	1.85	-0.945	2.40	-1.226
Deck + Haunch			-0.610	2.30	-1.403
DL-Prec. (DC)			-0.131	3.00	-0.393
Diaphragm			0.000	3.00	0.000
DL-Prec. (DW)			0.000	3.00	0.000
DL-Comp. (DC)			-0.010	3.00	-0.029
DL-Comp. (DW)			-0.046	3.00	-0.138
Live Load	Not Included				
Total	1.191		1.322		0.555

.797"


5.8'
4.05'
2.3'
2.74'
3.33'
4.51'
5.09'
6.17'
6.9'
8'
8.58'
9.72'
10.33'



<-65,72> 72L
-36,72
<-33.423,72> 72L
-64,72
36,72
64,72
30,60
60
-15,62.1
15,62.1
30,60
60
-60.82,65.65
-43.41,65.65
72L <-62.25,65.65>
-35.35,54
<-32.77,54> 72L
15,26.1
-15,26.1
-24.36,10.04
72L
<-21.78,10.04>
-21.87,8.1
<-19.29,8.> 72L
18,12
-23.87,8.1
54
-27,0
0,0
27,0
4'-6"
4'-4"
-33
11'
11"

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

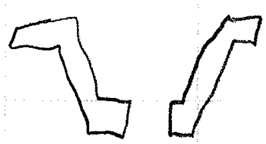
Stress @ access hatch

34 strands location @ 4.06"

12 strands debonded

$$f_t = \frac{P_e}{A} + \frac{P_t e}{S_b}$$

for modified section



$I_x \approx 812026$

$y \approx 41.94$

$A \approx 1482.6 \text{ in}^2$

$S_b \approx 19361.6$

$e = 41.94 - 4.06 \approx 37.88"$

$$f_t = \frac{(22)(.217)(.75)(270)}{1482.6} + \frac{(22)(.217)(.75)(270)(37.88")}{19361.6}$$

$f_t \approx .652 + 1.89$

$f_t \approx 2.54 \text{ ksi} < 4.05 \text{ ksi}$ ✓ ok

By: Date		Project no.	Project code (SA#):
Chk'd: Date		Structure no.	Sheet 339 of ____

CDOT Form #1034 3/02

ULTIMATE MOMENT

ULTIMATE - Span : 1, Beam : 6, STRENGTH I
(Mr-prvd computed by AASHTO equations, Art. 5.7.3.2/5.7.3.3)

Location (ft) Mu k.ft	dp in	Aps in2	fps ksi	c in	a in	Mr-prvd k.ft	c/dt	Phi	1.2 Mcr k.ft	min Mr k.ft	Crkg Ratio	Mu-p/r Ratio
Transfer	2.25											
1509.1	80.3	2.399	269.5	0.5	0.4	4319.9	0.006T	1.00	-	-	-	-
H/2	3.52											
2133.7	80.3	2.558	269.5	0.5	0.4	4603.5	0.007T	1.00	-	-	-	-
0.1L	6.85											
3635.3	80.3	2.974	269.4	0.6	0.4	5349.4	0.008T	1.00	-	-	-	-
0.2L	14.45											
6288.4	80.3	5.715	268.9	1.2	0.8	10234.2	0.015T	1.00	13947.3	8363.5	0.9	1.63
0.3L	22.05											
7956.1	80.3	6.991	268.6	1.5	1.0	12491.9	0.018T	1.00	14579.7	10581.7	1.0	1.57
0.4L	29.65											
8741.2	80.3	7.378	268.5	1.6	1.1	13175.0	0.019T	1.00	14266.6	11625.8	1.1	1.51
0.5L	37.25											
8706.0	80.3	7.378	268.5	1.6	1.1	13175.0	0.019T	1.00	14162.2	11578.9	1.1	1.51
0.6L	44.85											
7837.4	80.3	7.378	268.5	1.6	1.1	13175.0	0.019T	1.00	14266.6	10423.7	1.1	1.68
0.7L	52.45											
6159.3	80.3	6.991	268.6	1.5	1.0	12491.9	0.018T	1.00	14579.7	8191.9	1.0	2.03
0.8L	60.05											
4042.1	80.3	5.715	268.9	1.2	0.8	10234.2	0.015T	1.00	13947.3	5376.0	0.9	2.53
0.9L	67.65											
2015.6	80.3	2.974	269.4	0.6	0.4	5349.4	0.008T	1.00	-	-	-	-
H/2	70.98											
1194.0	80.3	2.558	269.5	0.5	0.4	4603.5	0.007T	1.00	-	-	-	-
Transfer	72.25											
881.3	80.3	2.399	269.5	0.5	0.4	4319.9	0.006T	1.00	-	-	-	-

Legend: C = Compression-Controlled (c/dt > 0.600)
I = In-Transition (0.60 >= c/dt > 0.375)
T = Tension-Controlled (c/dt <= 0.375)

Note : fr used for calculating Mcr is computed using AASHTO method (Art.5.4.2.6.)

VERTICAL/HORIZONTAL SHEAR

VERTICAL SHEAR (Art. 5.8) - Span : 1, Beam : 6, STRENGTH I

Using General Beta Theta Tables procedure - Art.5.8.3.4.2

Location(ft)										
Vu (kips)	bv (in)	de (in)	Aps (in2)	Vp (kips)	eps_x	Theta	Vs-reqd (kips)	Av/s (in2/ft)	Av-prvd (in2/ft)	Al_reqd (in2)
Mcor (kft)	a (in)	dv (in)	fpo (ksi)	vu/fc	Vc-com (kips)	Beta	Max.spc. (in)	min.Av/s (in2/ft)	pVn/Vu	Aps* (in2)
Bearing :	0.75									
571.5	15.0	80.3	1.245	0.0	1.00e-3	36.4	381.8	0.705	1.59	4.48
375.0	1.1	79.8	47.2	0.059	253.1	2.23	24.00	0.284	1.750	0.600
Transfer :	3.00									
540.4	15.0	80.3	3.472	0.0	1.00e-3	36.4	347.3	0.642	1.59	0.00
1531.6	1.1	79.8	189.0	0.056	253.1	2.23	24.00	0.284	1.851	2.399
Critical :	7.43									
479.2	15.0	80.3	3.472	0.0	1.00e-3	36.4	278.3	0.512	1.59	0.00
3517.9	0.4	80.1	189.0	0.049	254.1	2.23	24.00	0.284	2.095	2.952
0.1L :	7.60									
476.8	15.0	80.3	3.472	0.0	1.00e-3	36.4	275.6	0.507	1.59	1.60
3593.5	0.4	80.1	189.0	0.049	254.1	2.23	24.00	0.284	2.106	2.974
0.2L :	15.20									
367.4	15.0	80.3	7.378	0.0	-0.01e-3	21.6	0.0	0.284	1.59	4.75
6108.9	0.8	79.9	189.0	0.038	434.6	3.82	24.00	0.284	4.978	4.265
0.3L :	22.80									
262.2	15.0	80.3	7.378	0.0	0.02e-3	22.3	0.0	0.284	1.06	0.00
7601.4	1.0	79.8	189.0	0.027	414.3	3.65	24.00	0.284	4.950	6.125
0.4L :	30.40									
177.7	15.0	80.3	7.378	0.0	0.01e-3	22.0	0.0	0.284	1.06	0.00
8124.1	1.1	79.8	189.0	0.018	420.2	3.70	24.00	0.284	7.401	7.378
0.5L :	38.00									
176.9	15.0	80.3	7.378	0.0	0.01e-3	22.1	0.0	0.284	1.06	0.00
8137.9	1.1	79.8	189.0	0.018	418.8	3.69	24.00	0.284	7.412	7.378
0.6L :	45.60									
281.7	15.0	80.3	7.378	0.0	0.01e-3	21.9	0.0	0.284	1.06	0.00
7413.9	1.1	79.8	189.0	0.029	423.2	3.73	24.00	0.284	4.700	7.378
0.7L :	53.20									
384.7	15.0	80.3	7.378	0.0	-0.01e-3	21.6	0.0	0.284	1.06	0.00
5827.2	1.0	79.8	189.0	0.040	435.9	3.84	24.00	0.284	3.510	6.125
0.8L :	60.80									
485.0	15.0	80.3	7.378	0.0	-0.04e-3	21.2	83.3	0.284	1.59	1.13
3463.2	0.8	79.9	189.0	0.050	455.6	4.01	24.00	0.284	3.875	4.265

341

Location(ft) Vu (kips) / Mcor (kft)	bv (in) / a (in)	de (in) / dv (in)	Aps (in2) / fpo (ksi)	Vp (kips) / vu/fc	eps_x / Vc-com (kips)	Theta / Beta	Vs-reqd (kips) / Max.spc. (in)	Av/s (in2/ft) / min.Av/s (in2/ft)	Av-prvd (in2/ft) / pVn/Vu	Al_reqd (in2) / Aps* (in2)
0.9L :	68.40									
581.6	15.0	80.3	3.472	0.0	1.00e-3	36.4	392.1	0.722	1.59	0.00
433.6	0.4	80.1	189.0	0.060	254.1	2.23	24.00	0.284	1.726	2.974
Critical :	68.57									
583.9	15.0	80.3	3.472	0.0	1.00e-3	36.4	394.7	0.726	1.59	0.00
348.2	0.4	80.1	189.0	0.060	254.1	2.23	24.00	0.284	1.720	2.949
Transfer :	73.00									
635.4	15.0	80.4	0.000	0.0	1.00e-3	36.4	452.7	0.836	1.59	0.00
-1563.6	1.1	79.9	189.0	0.065	253.3	2.23	24.00	0.284	1.575	2.699
Bearing :	75.25									
661.8	15.0	80.4	0.000	0.0	1.00e-3	36.4	482.0	0.890	1.59	11.82
-2612.2	1.1	79.9	47.2	0.068	253.3	2.23	24.00	0.284	1.513	0.675

ANCHORAGE ZONE REINFORCEMENT (Art. 5.10.10)
Span : 1, Beam : 6

Fpi (kips)	fs (ksi)	h/4 (in)	Abrst_rqrd (in2)
703.08	20.00	18.00	1.41

HORIZONTAL SHEAR (Art. 5.8.4) - Span : 1, Beam : 6
(Beam and Slab effects are INCLUDED in Vu).

Location (ft) Vu (kips)	Vnh-req (kips)	de (in)	a (in)	dv (in)	s_max (in)	Avh-min (in2/ft)	Avh-sm (in2/ft)	Avh-rg (in2/ft)
Bearing :	0.00							
571.5	7.96	80.34	1.06	79.81	24.00	0.640	1.043	0.000
Transfer :	2.25							
540.4	7.52	80.34	1.06	79.81	24.00	0.640	0.899	0.000
Critical :	6.68							
479.2	6.65	80.34	0.43	80.12	24.00	0.640	0.606	0.000
0.1L :	6.85							
476.8	6.61	80.34	0.44	80.12	24.00	0.640	0.595	0.000

Location (ft) Vu (kips)	Vnh-req (kips)	de (in)	a (in)	dv (in)	s_max (in)	Avh-min (in2/ft)	Avh-sm (in2/ft)	Avh-rg (in2/ft)
0.2L :	14.45							
367.4	5.11	80.34	0.84	79.92	24.00	0.640	0.094	0.000
0.3L :	22.05							
262.2	3.65	80.34	1.02	79.83	24.00	0.640	0.000	0.000
0.4L :	29.65							
177.7	2.47	80.34	1.08	79.80	24.00	0.640	0.000	0.000
0.5L :	37.25							
176.9	2.46	80.34	1.08	79.80	24.00	0.640	0.000	0.000
0.6L :	44.85							
281.7	3.92	80.34	1.08	79.80	24.00	0.640	0.000	0.000
0.7L :	52.45							
384.7	5.35	80.34	1.02	79.83	24.00	0.640	0.176	0.000
0.8L :	60.05							
485.0	6.74	80.34	0.84	79.92	24.00	0.640	0.639	0.000
0.9L :	67.65							
581.6	8.07	80.34	0.44	80.12	24.00	0.640	1.080	0.000
Critical :	67.82							
583.6	8.09	80.34	0.43	80.12	24.00	0.640	1.089	0.000
Transfer :	72.25							
635.4	8.84	80.40	1.06	79.87	24.00	0.640	1.338	0.000
Bearing :	74.50							
661.8	9.21	80.40	1.06	79.87	24.00	0.640	1.460	0.000

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-1 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10 **File Name: 76-21-125-21-124_U72C_rev1.csl**	Copyright © Bentley Systems, Inc. 1984 - 2008. www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/22/2009 CKD: Date:

SHEAR/MOMENT ENVELOPE (&REACTIONS)

SHEAR AND MOMENT ENVELOPE : Span : 1, Beam : 3, SERVICE I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	6.85	14.45	22.05	29.65	37.25
Self wt. :	M	0.0	149.4	229.5	426.0	797.7	1063.2	1222.5	1275.6
(Max)	V	68.5	64.4	62.0	55.9	41.9	27.9	14.0	0.0
DL-Prec. :	M	0.0	48.8	74.9	139.0	260.3	347.0	398.9	416.3
DC(Max)	V	22.4	21.0	20.2	18.2	13.7	9.1	4.6	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	227.0	348.6	647.2	1211.9	1615.3	1857.3	1938.0
Haunch (Max)	V	104.1	97.8	94.2	84.9	63.7	42.5	21.2	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	7.4	20.0	26.6	42.7	71.7	89.9	97.3	94.0
DC(Max)	V	5.8	5.4	5.1	4.5	3.1	1.7	0.3	1.2
DL-Comp :	M	35.1	94.9	126.5	203.0	340.7	427.1	462.3	446.4
DW(Max)	V	27.5	25.6	24.4	21.5	14.7	8.0	1.3	5.5
LL + I :	M+	151.0	463.0	625.4	1006.9	1628.8	1955.0	2044.3	1932.4
	V	39.7	71.5	89.4	136.6	38.7	15.7	26.6	81.5
LL + I :	M-	-1.4	-4.0	-5.5	-9.3	-18.1	-26.8	-35.6	-44.4
	V	30.1	20.7	15.3	1.3	1.3	1.3	1.3	1.3
LL + I :	Vmx	159.6	152.2	148.1	137.2	109.9	85.0	71.9	95.6
	M	178.9	475.9	628.9	983.0	1526.2	1752.3	1691.8	1607.7
Total :	M+	193.5	1003.1	1431.5	2464.9	4311.1	5497.5	6082.7	6102.5
	V	267.9	285.6	295.5	321.7	175.8	104.9	67.8	88.1
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	387.8	366.3	354.2	322.3	247.0	174.2	113.2	102.2
	M	221.4	1016.0	1435.1	2441.0	4208.5	5294.8	5730.1	5777.9

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	44.85	52.45	60.05	67.65	70.98	72.25	74.50
Self wt. :	M	1222.5	1063.2	797.7	426.0	229.5	149.4	0.0
(Max)	V	14.0	27.9	41.9	55.9	62.0	64.4	68.5
DL-Prec. :	M	398.9	347.0	260.3	139.0	74.9	48.8	0.0
DC(Max)	V	4.6	9.1	13.7	18.2	20.2	21.0	22.4
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	1857.3	1615.3	1211.9	647.2	348.6	227.0	0.0
Haunch (Max)	V	21.2	42.5	63.7	84.9	94.2	97.8	104.1
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	79.8	54.9	19.2	-27.2	-48.6	-58.3	-77.5
DC(Max)	V	2.6	4.0	5.4	6.8	7.4	7.7	8.1
DL-Comp :	M	379.2	260.9	91.4	-129.3	-231.1	-276.9	-368.1
DW(Max)	V	12.2	18.9	25.7	32.4	35.4	36.5	38.5
LL + I :	M+	1611.6	1095.7	596.3	347.9	326.7	332.7	362.3
	V	107.5	131.5	60.0	9.5	7.8	7.1	6.0
LL + I :	M-	-53.1	-61.9	-326.7	-1247.1	-1753.1	-1961.7	-2354.6
	V	1.3	1.3	94.6	158.1	175.8	182.5	194.4
LL + I :	Vmx	120.3	144.0	166.1	186.1	192.9	195.6	200.2

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		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
	M	1369.6	905.9	265.5	-487.8	-801.6	-918.3	-1121.8
Total :	M+	5549.4	4437.0	2976.9	1403.6	700.0	422.7	0.0
	V	162.1	234.0	210.4	207.7	227.1	234.4	0.0
Total :	M-	0.0	0.0	0.0	-191.4	-1379.7	-1871.6	-2800.1
	V	0.0	0.0	0.0	330.8	395.1	409.8	435.9
Total :	Vmx	174.8	246.4	316.4	384.4	412.2	422.8	441.7
	M	5307.4	4247.2	2646.1	567.9	-428.3	-828.2	-1567.4

REACTIONS (kips), SERVICE I

Load Type		Left Support	Right Support
Self Wt.		68.5	68.5
Deck+Haunch		104.1	104.1
Diaphragm		0.0	0.0
DL-Prec.(DC)		22.4	22.4
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		47.5	25.5
DL-Comp.(DW)		225.8	121.3
Live	(Max)	80.8	179.7
Live	(Min)	-0.6	-125.6
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

SHEAR AND MOMENT ENVELOPE : Span : 1, Beam : 3, SERVICE III
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	6.85	14.45	22.05	29.65	37.25
Self wt. :	M	0.0	149.4	229.5	426.0	797.7	1063.2	1222.5	1275.6
(Max)	V	68.5	64.4	62.0	55.9	41.9	27.9	14.0	0.0
DL-Prec. :	M	0.0	48.8	74.9	139.0	260.3	347.0	398.9	416.3
DC(Max)	V	22.4	21.0	20.2	18.2	13.7	9.1	4.6	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	227.0	348.6	647.2	1211.9	1615.3	1857.3	1938.0
Haunch (Max)	V	104.1	97.8	94.2	84.9	63.7	42.5	21.2	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	7.4	20.0	26.6	42.7	71.7	89.9	97.3	94.0
DC(Max)	V	5.8	5.4	5.1	4.5	3.1	1.7	0.3	1.2
DL-Comp :	M	35.1	94.9	126.5	203.0	340.7	427.1	462.3	446.4
DW(Max)	V	27.5	25.6	24.4	21.5	14.7	8.0	1.3	5.5
LL + I :	M+	120.8	370.4	500.3	805.5	1303.0	1564.0	1635.5	1545.9
	V	31.7	57.2	71.6	109.3	30.9	12.5	21.2	65.2

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
LL + I :	M-	-1.2	-3.2	-4.4	-7.5	-14.5	-21.5	-28.5	-35.5
	V	24.1	16.5	12.3	1.0	1.0	1.0	1.0	1.0
LL + I :	Vmx	127.7	121.8	118.5	109.8	87.9	68.0	57.5	76.5
	M	143.1	380.7	503.1	786.4	1221.0	1401.9	1353.4	1286.2
Total :	M+	163.3	910.5	1306.5	2263.5	3985.3	5106.5	5673.9	5716.1
	V	260.0	271.3	277.6	294.4	168.1	101.7	62.5	71.8
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	355.9	335.8	324.5	294.8	225.0	157.2	98.8	83.1
	M	185.6	920.8	1309.3	2244.4	3903.3	4944.3	5391.8	5456.4

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	44.85	52.45	60.05	67.65	70.98	72.25	74.50
Self wt. :	M	1222.5	1063.2	797.7	426.0	229.5	149.4	0.0
(Max)	V	14.0	27.9	41.9	55.9	62.0	64.4	68.5
DL-Prec. :	M	398.9	347.0	260.3	139.0	74.9	48.8	0.0
DC(Max)	V	4.6	9.1	13.7	18.2	20.2	21.0	22.4
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	1857.3	1615.3	1211.9	647.2	348.6	227.0	0.0
Haunch (Max)	V	21.2	42.5	63.7	84.9	94.2	97.8	104.1
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	79.8	54.9	19.2	-27.2	-48.6	-58.3	-77.5
DC(Max)	V	2.6	4.0	5.4	6.8	7.4	7.7	8.1
DL-Comp :	M	379.2	260.9	91.4	-129.3	-231.1	-276.9	-368.1
DW(Max)	V	12.2	18.9	25.7	32.4	35.4	36.5	38.5
LL + I :	M+	1289.3	876.6	477.0	278.3	261.3	266.1	289.8
	V	86.0	105.2	48.0	7.6	6.2	5.7	4.8
LL + I :	M-	-42.5	-49.5	-261.4	-997.6	-1402.5	-1569.4	-1883.7
	V	1.0	1.0	75.7	126.5	140.6	146.0	155.6
LL + I :	Vmx	96.2	115.2	132.9	148.9	154.4	156.4	160.1
	M	1095.7	724.7	212.4	-390.2	-641.3	-734.6	-897.5
Total :	M+	5227.1	4217.8	2857.6	1334.0	634.7	356.2	0.0
	V	140.5	207.7	198.4	205.8	225.5	233.0	0.0
Total :	M-	0.0	0.0	0.0	0.0	-1029.1	-1479.3	-2329.2
	V	0.0	0.0	0.0	0.0	359.9	373.3	397.0
Total :	Vmx	150.8	217.6	283.2	347.1	373.7	383.7	401.6
	M	5033.5	4066.0	2593.0	665.4	-268.0	-644.5	-1343.0

SHEAR AND MOMENT ENVELOPE : Span : 1, Beam : 3, STRENGTH I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	6.85	14.45	22.05	29.65	37.25
Self wt. :	M	0.0	186.8	286.9	532.5	997.1	1329.0	1528.1	1594.5
(Max)	V	85.6	80.4	77.5	69.9	52.4	34.9	17.5	0.0
Self wt. :	M	0.0	134.5	206.5	383.4	717.9	956.9	1100.3	1148.1
(Min)	V	61.6	57.9	55.8	50.3	37.7	25.2	12.6	0.0
DL-Prec. :	M	0.0	61.0	93.6	173.8	325.4	433.7	498.7	520.3
DC(Max)	V	27.9	26.3	25.3	22.8	17.1	11.4	5.7	0.0

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Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-4 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10	 www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/22/2009 CKD: Date:

File Name: 76-21-125-21-124_U72C_rev1.csl

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
DL-Prec. :	M	0.0	43.9	67.4	125.1	234.3	312.3	359.0	374.6
DC(Min)	V	20.1	18.9	18.2	16.4	12.3	8.2	4.1	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	283.8	435.8	809.0	1514.9	2019.1	2321.6	2422.5
Haunch (Max)	V	130.1	122.2	117.8	106.1	79.6	53.1	26.5	0.0
Deck + :	M	0.0	204.3	313.8	582.5	1090.7	1453.7	1671.6	1744.2
Haunch (Min)	V	93.6	88.0	84.8	76.4	57.3	38.2	19.1	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	9.2	25.0	33.3	53.4	89.6	112.4	121.6	117.4
DC(Max)	V	7.2	6.7	6.4	5.7	3.9	2.1	0.3	1.4
DL-Comp :	M	6.7	18.0	24.0	38.5	64.5	80.9	87.6	84.6
DC(Min)	V	5.2	4.8	4.6	4.1	2.8	1.5	0.2	1.0
DL-Comp :	M	52.7	142.3	189.8	304.6	511.0	640.6	693.5	669.6
DW(Max)	V	41.3	38.3	36.6	32.2	22.1	12.0	1.9	8.2
DL-Comp :	M	22.8	61.7	82.2	132.0	221.4	277.6	300.5	290.1
DW(Min)	V	17.9	16.6	15.9	14.0	9.6	5.2	0.8	3.6
LL + I :	M+	264.3	810.3	1094.4	1762.0	2850.3	3421.3	3577.6	3381.6
	V	69.4	125.2	156.5	239.1	67.6	27.4	46.5	142.5
LL + I :	M-	-2.5	-7.1	-9.6	-16.3	-31.7	-47.0	-62.3	-77.6
	V	52.7	36.1	26.8	2.3	2.3	2.3	2.3	2.3
LL + I :	Vmx	279.3	266.4	259.2	240.1	192.3	148.7	125.7	167.2
	M	313.1	832.8	1100.6	1720.2	2670.9	3066.5	2960.6	2813.6
Total :	M+	326.2	1509.1	2133.7	3635.3	6288.4	7956.1	8741.2	8706.0
	V	361.6	399.1	420.2	475.8	242.7	140.9	98.4	152.2
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	571.5	540.4	522.9	476.8	367.4	262.2	177.7	176.9
	M	375.0	1531.6	2139.9	3593.5	6108.9	7601.4	8124.1	8137.9

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	44.85	52.45	60.05	67.65	70.98	72.25	74.50
Self wt. :	M	1528.1	1329.0	997.1	532.5	286.9	186.8	0.0
(Max)	V	17.5	34.9	52.4	69.9	77.5	80.4	85.6
Self wt. :	M	1100.3	956.9	717.9	383.4	206.5	134.5	0.0
(Min)	V	12.6	25.2	37.7	50.3	55.8	57.9	61.6
DL-Prec. :	M	498.7	433.7	325.4	173.8	93.6	61.0	0.0
DC(Max)	V	5.7	11.4	17.1	22.8	25.3	26.2	27.9
DL-Prec. :	M	359.0	312.3	234.3	125.1	67.4	43.9	0.0
DC(Min)	V	4.1	8.2	12.3	16.4	18.2	18.9	20.1
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	2321.6	2019.1	1514.9	809.0	435.8	283.8	0.0
Haunch (Max)	V	26.5	53.1	79.6	106.1	117.8	122.2	130.1
Deck + :	M	1671.6	1453.7	1090.7	582.5	313.8	204.3	0.0
Haunch (Min)	V	19.1	38.2	57.3	76.4	84.8	88.0	93.6
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
DL-Comp :	M	99.8	68.6	24.0	-34.0	-60.8	-72.9	-96.8
DC(Max)	V	3.2	5.0	6.8	8.5	9.3	9.6	10.1
DL-Comp :	M	71.8	49.4	17.3	-24.5	-43.8	-52.5	-69.7
DC(Min)	V	2.3	3.6	4.9	6.1	6.7	6.9	7.3
DL-Comp :	M	568.9	391.4	137.1	-194.0	-346.6	-415.3	-552.1
DW(Max)	V	18.3	28.4	38.5	48.6	53.0	54.7	57.7
DL-Comp :	M	246.5	169.6	59.4	-84.1	-150.2	-180.0	-239.3
DW(Min)	V	7.9	12.3	16.7	21.1	23.0	23.7	25.0
LL + I :	M+	2820.3	1917.5	1043.5	608.8	571.7	582.1	634.0
	V	188.2	230.1	105.1	16.5	13.6	12.5	10.5
LL + I :	M-	-93.0	-108.3	-571.7	-2182.4	-3067.9	-3433.0	-4120.5
	V	2.3	2.3	165.6	276.6	307.6	319.4	340.3
LL + I :	Vmx	210.5	251.9	290.6	325.6	337.7	342.2	350.3
	M	2396.8	1585.4	464.6	-853.6	-1402.9	-1607.0	-1963.2
Total :	M+	7837.4	6159.3	4042.1	2015.6	1194.0	881.3	325.0
	V	259.4	362.9	299.5	272.5	263.9	272.0	286.4
Total :	M-	0.0	0.0	0.0	-1319.4	-2887.5	-3538.5	-4769.5
	V	0.0	0.0	0.0	430.3	528.8	548.5	583.5
Total :	Vmx	281.7	384.7	485.0	581.6	620.6	635.4	661.8
	M	7413.9	5827.2	3463.2	433.6	-994.0	-1563.6	-2612.2

REACTIONS (kips), STRENGTH I

Load Type		Left Support	Right Support
Self Wt.		85.6	85.6
Deck+Haunch		130.1	130.1
Diaphragm		0.0	0.0
DL-Prec.(DC)		27.9	27.9
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		59.4	31.9
DL-Comp.(DW)		338.7	182.0
Live	(Max)	141.3	314.4
Live	(Min)	-1.1	-219.9
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

VERTICAL/HORIZONTAL SHEAR

VERTICAL SHEAR (Art. 5.8) - Span : 1, Beam : 2, STRENGTH I

Using General Beta Theta Tables procedure - Art.5.8.3.4.2

Location(ft)										
Vu (kips)	bv (in)	de (in)	Aps (in2)	Vp (kips)	eps_x	Theta	Vs-reqd (kips)	Av/s (in2/ft)	Av-prvd (in2/ft)	Al_reqd (in2)
Mcor (kft)	a (in)	dv (in)	fpo (ksi)	vu/fc	Vc-com (kips)	Beta	Max.spc. (in)	min.Av/s (in2/ft)	pVn/Vu	Aps* (in2)
Bearing :	0.75									
543.5	15.0	80.7	1.060	0.0	1.00e-3	36.4	349.5	0.642	1.59	3.79
375.0	1.1	80.2	47.2	0.056	254.4	2.23	24.00	0.284	1.850	0.676
Transfer :	3.00									
514.1	15.0	80.7	3.906	0.0	1.00e-3	36.4	316.8	0.582	1.59	0.00
1470.7	1.1	80.2	189.0	0.053	254.4	2.23	24.00	0.284	1.955	2.703
Critical :	7.46									
455.9	15.0	80.7	3.906	0.0	0.98e-3	36.2	249.9	0.455	1.59	0.00
3361.2	0.5	80.5	189.0	0.047	256.6	2.24	24.00	0.284	2.227	3.329
0.1L :	7.60									
454.0	15.0	80.7	3.906	0.0	1.00e-3	36.4	249.1	0.456	1.59	0.00
3419.7	0.5	80.5	189.0	0.046	255.3	2.23	24.00	0.284	2.222	3.349
0.2L :	15.20									
350.3	15.0	80.9	6.510	0.0	-0.00e-3	21.8	0.0	0.284	1.59	2.60
5783.5	0.8	80.5	189.0	0.036	431.1	3.76	24.00	0.284	5.216	4.435
0.3L :	22.80									
250.8	15.0	81.0	6.944	0.0	0.02e-3	22.1	0.0	0.284	1.06	0.00
7167.7	1.0	80.5	189.0	0.026	422.0	3.68	24.00	0.284	5.268	5.821
0.4L :	30.40									
172.0	15.0	81.0	6.944	0.0	-0.00e-3	21.8	0.0	0.284	1.06	0.00
7625.5	1.0	80.5	189.0	0.018	429.7	3.75	24.00	0.284	7.812	6.941
0.5L :	38.00									
176.9	15.0	81.0	6.944	0.0	-0.00e-3	21.8	0.0	0.284	1.06	0.00
7617.5	1.0	80.5	189.0	0.018	429.5	3.75	24.00	0.284	7.593	6.944
0.6L :	45.60									
276.0	15.0	81:0	6.944	0.0	-0.00e-3	21.8	0.0	0.284	1.06	0.00
6915.2	1.0	80.5	189.0	0.028	429.9	3.75	24.00	0.284	4.869	6.941
0.7L :	53.20									
373.3	15.0	81.0	6.944	0.0	-0.01e-3	21.6	0.0	0.284	1.06	0.00
5393.5	1.0	80.5	189.0	0.038	439.9	3.84	24.00	0.284	3.650	5.821
0.8L :	60.80									
467.9	15.0	80.9	6.510	0.0	-0.03e-3	21.4	67.8	0.284	1.59	0.00
3137.8	0.8	80.5	189.0	0.048	452.1	3.95	24.00	0.284	4.012	4.435

Location(ft) Vu (kips) Mcor (kft)	bv (in) a (in)	de (in) dv (in)	Aps (in2) fpo (ksi)	Vp (kips) vu/fc	eps_x Vc-com (kips)	Theta Beta	Vs-reqd (kips) Max.spc. (in)	Av/s (in2/ft) min.Av/s (in2/ft)	Av-prvd (in2/ft) pVn/Vu	Al_reqd (in2) Aps* (in2)
0.9L :	68.40									
558.8	15.0	80.7	3.906	0.0	1.00e-3	36.4	365.6	0.670	1.59	0.00
259.8	0.5	80.5	189.0	0.057	255.3	2.23	24.00	0.284	1.805	3.349
Critical :	68.54									
560.6	15.0	80.7	3.906	0.0	1.00e-3	36.4	367.6	0.673	1.59	0.00
192.9	0.5	80.5	189.0	0.057	255.3	2.23	24.00	0.284	1.800	3.325
Transfer :	73.00									
609.2	15.0	80.4	0.000	0.0	1.00e-3	36.4	423.5	0.782	1.59	2.28
-1624.5	1.1	79.9	189.0	0.063	253.4	2.23	24.00	0.284	1.643	2.103
Bearing :	75.25									
633.8	15.0	80.4	0.000	0.0	1.00e-3	36.4	450.9	0.832	1.59	12.14
-2612.2	1.1	79.9	47.2	0.065	253.4	2.23	24.00	0.284	1.579	0.526

ANCHORAGE ZONE REINFORCEMENT (Art. 5.10.10)
Span : 1, Beam : 2

Fpi (kips)	fs (ksi)	h/4 (in)	Abrst_rqrd (in2)
790.96	20.00	18.00	1.58

HORIZONTAL SHEAR (Art. 5.8.4) - Span : 1, Beam : 2
(Beam and Slab effects are INCLUDED in Vu).

Location (ft) Vu (kips)	Vnh-req (kips)	de (in)	a (in)	dv (in)	s_max (in)	Avh-min (in2/ft)	Avh-sm (in2/ft)	Avh-rg (in2/ft)
Bearing :	0.00							
543.5	7.53	80.74	1.05	80.21	24.00	0.640	0.901	0.000
Transfer :	2.25							
514.1	7.12	80.74	1.05	80.21	24.00	0.640	0.765	0.000
Critical :	6.71							
455.9	6.29	80.74	0.49	80.50	24.00	0.640	0.488	0.000
0.1L :	6.85							
454.0	6.27	80.74	0.49	80.49	24.00	0.640	0.480	0.000

Location (ft) Vu (kips)	Vnh-req (kips)	de (in)	a (in)	dv (in)	s_max (in)	Avh-min (in2/ft)	Avh-sm (in2/ft)	Avh-rg (in2/ft)
0.2L :	14.45							
350.3	4.83	80.94	0.79	80.55	24.00	0.640	0.002	0.000
0.3L :	22.05							
250.8	3.46	81.02	0.97	80.53	24.00	0.640	0.000	0.000
0.4L :	29.65							
172.0	2.37	81.02	1.02	80.51	24.00	0.640	0.000	0.000
0.5L :	37.25							
176.9	2.44	81.02	1.02	80.51	24.00	0.640	0.000	0.000
0.6L :	44.85							
276.0	3.81	81.02	1.02	80.51	24.00	0.640	0.000	0.000
0.7L :	52.45							
373.3	5.15	81.02	0.97	80.53	24.00	0.640	0.108	0.000
0.8L :	60.05							
467.9	6.45	80.94	0.79	80.55	24.00	0.640	0.543	0.000
0.9L :	67.65							
558.8	7.71	80.74	0.49	80.49	24.00	0.640	0.962	0.000
Critical :	67.79							
560.4	7.73	80.74	0.49	80.50	24.00	0.640	0.969	0.000
Transfer :	72.25							
609.2	8.47	80.40	1.05	79.87	24.00	0.640	1.216	0.000
Bearing :	74.50							
633.8	8.82	80.40	1.05	79.87	24.00	0.640	1.330	0.000

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-1 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10 **File Name: 76-21-125-21-124_U72C.csl**	Copyright © Bentley Systems, Inc. 1984 - 2008. www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/4/2010 CKD: Date:

ULTIMATE MOMENT

ULTIMATE - Span : 1, Beam : 2, STRENGTH I
(Mr-prvd computed by AASHTO equations, Art. 5.7.3.2/5.7.3.3)

Location (ft) Mu k.ft	dp in	Aps in2	fps ksi	c in	a in	Mr-prvd k.ft	c/dt	Phi	1.2 Mcr k.ft	min Mr k.ft	Crkg Ratio	Mu-p/r Ratio
Transfer	2.25											
1448.1	80.7	2.703	269.5	0.6	0.4	4889.4	0.007T	1.00	-	-	-	-
H/2	3.52											
2040.1	80.7	2.881	269.4	0.6	0.4	5209.2	0.007T	1.00	-	-	-	-
0.1L	6.85											
3461.5	80.7	3.349	269.3	0.7	0.5	6049.8	0.009T	1.00	-	-	-	-
0.2L	14.45											
5963.0	80.8	5.404	268.9	1.1	0.8	9737.4	0.014T	1.00	13349.0	7930.8	0.9	1.63
0.3L	22.05											
7522.4	80.9	6.598	268.7	1.4	1.0	11885.5	0.017T	1.00	14339.4	10004.8	1.0	1.58
0.4L	29.65											
8242.5	81.0	6.943	268.6	1.5	1.0	12513.8	0.018T	1.00	14062.3	10962.5	1.1	1.52
0.5L	37.25											
8185.6	81.0	6.944	268.6	1.5	1.0	12515.3	0.018T	1.00	13970.0	10886.9	1.1	1.53
0.6L	44.85											
7338.7	81.0	6.943	268.6	1.5	1.0	12513.8	0.018T	1.00	14062.3	9760.5	1.1	1.71
0.7L	52.45											
5725.6	80.9	6.598	268.7	1.4	1.0	11885.5	0.017T	1.00	14339.4	7615.1	1.0	2.08
0.8L	60.05											
3716.7	80.8	5.404	268.9	1.1	0.8	9737.4	0.014T	1.00	13349.0	4943.2	0.9	2.62
0.9L	67.65											
1841.8	80.7	3.349	269.3	0.7	0.5	6049.8	0.009T	1.00	-	-	-	-
H/2	70.98											
1100.4	80.7	2.881	269.4	0.6	0.4	5209.2	0.007T	1.00	-	-	-	-
Transfer	72.25											
820.3	80.7	2.703	269.5	0.6	0.4	4889.4	0.007T	1.00	-	-	-	-

Legend: C = Compression-Controlled (c/dt > 0.600)
I = In-Transition (0.60 >= c/dt > 0.375)
T = Tension-Controlled (c/dt <= 0.375)
Note : fr used for calculating Mcr is computed using AASHTO method (Art.5.4.2.6.)

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-1 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10 **File Name: 76-21-125-21-124_U72C.csl**	Copyright © Bentley Systems, Inc. 1984 - 2008. www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/4/2010 CKD: Date:

SHEAR/MOMENT ENVELOPE (&REACTIONS)

SHEAR AND MOMENT ENVELOPE : Span : 1, Beam : 2, SERVICE I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	6.85	14.45	22.05	29.65	37.25
Self wt. :	M	0.0	149.4	229.5	426.0	797.7	1063.2	1222.5	1275.6
(Max)	V	68.5	64.4	62.0	55.9	41.9	27.9	14.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	227.0	348.6	647.2	1211.9	1615.3	1857.3	1938.0
Haunch (Max)	V	104.1	97.8	94.2	84.9	63.7	42.5	21.2	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	7.4	20.0	26.6	42.7	71.7	89.9	97.3	94.0
DC(Max)	V	5.8	5.4	5.1	4.5	3.1	1.7	0.3	1.2
DL-Comp :	M	35.1	94.9	126.5	203.0	340.7	427.1	462.3	446.4
DW(Max)	V	27.5	25.6	24.4	21.5	14.7	8.0	1.3	5.5
LL + I :	M+	151.0	463.0	625.4	1006.9	1628.8	1955.0	2044.3	1932.4
	V	39.7	71.5	89.4	136.6	38.7	15.7	26.6	81.5
LL + I :	M-	-1.4	-4.0	-5.5	-9.3	-18.1	-26.8	-35.6	-44.4
	V	30.1	20.7	15.3	1.3	1.3	1.3	1.3	1.3
LL + I :	Vmx	159.6	152.2	148.1	137.2	109.9	85.0	71.9	95.6
	M	178.9	475.9	628.9	983.0	1526.2	1752.3	1691.8	1607.7
Total :	M+	193.5	954.3	1356.7	2325.9	4050.8	5150.5	5683.8	5686.3
	V	245.6	264.6	275.3	303.4	162.1	95.8	63.3	88.1
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	365.5	345.3	333.9	304.0	233.3	165.0	108.6	102.2
	M	221.4	967.2	1360.2	2302.0	3948.2	4947.8	5331.2	5361.7

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	44.85	52.45	60.05	67.65	70.98	72.25	74.50
Self wt. :	M	1222.5	1063.2	797.7	426.0	229.5	149.4	0.0
(Max)	V	14.0	27.9	41.9	55.9	62.0	64.4	68.5
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	1857.3	1615.3	1211.9	647.2	348.6	227.0	0.0
Haunch (Max)	V	21.2	42.5	63.7	84.9	94.2	97.8	104.1
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	79.8	54.9	19.2	-27.2	-48.6	-58.3	-77.5
DC(Max)	V	2.6	4.0	5.4	6.8	7.4	7.7	8.1
DL-Comp :	M	379.2	260.9	91.4	-129.3	-231.1	-276.9	-368.1
DW(Max)	V	12.2	18.9	25.7	32.4	35.4	36.5	38.5
LL + I :	M+	1611.6	1095.7	596.3	347.9	326.7	332.7	362.3
	V	107.5	131.5	60.0	9.5	7.8	7.1	6.0
LL + I :	M-	-53.1	-61.9	-326.7	-1247.1	-1753.1	-1961.7	-2354.6
	V	1.3	1.3	94.6	158.1	175.8	182.5	194.4
LL + I :	Vmx	120.3	144.0	166.1	186.1	192.9	195.6	200.2

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
	M	1369.6	905.9	265.5	-487.8	-801.6	-918.3	-1121.8
Total :	M+	5150.5	4090.0	2716.5	1264.6	625.1	374.0	0.0
	V	157.5	224.8	196.7	189.5	206.8	213.4	0.0
Total :	M-	0.0	0.0	0.0	-330.4	-1454.6	-1920.4	-2800.1
	V	0.0	0.0	0.0	312.5	374.8	388.8	413.6
Total :	Vmx	170.3	237.3	302.8	366.1	392.0	401.8	419.3
	M	4908.5	3900.2	2385.7	428.9	-503.2	-876.9	-1567.4

REACTIONS (kips), SERVICE I

Load Type		Left Support	Right Support
Self Wt.		68.5	68.5
Deck+Haunch		104.1	104.1
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		47.5	25.5
DL-Comp.(DW)		225.8	121.3
Live	(Max)	80.8	179.7
Live	(Min)	-0.6	-125.6
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

SHEAR AND MOMENT ENVELOPE : Span : 1, Beam : 2, SERVICE III
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	6.85	14.45	22.05	29.65	37.25
Self wt. :	M	0.0	149.4	229.5	426.0	797.7	1063.2	1222.5	1275.6
(Max)	V	68.5	64.4	62.0	55.9	41.9	27.9	14.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	227.0	348.6	647.2	1211.9	1615.3	1857.3	1938.0
Haunch (Max)	V	104.1	97.8	94.2	84.9	63.7	42.5	21.2	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	7.4	20.0	26.6	42.7	71.7	89.9	97.3	94.0
DC(Max)	V	5.8	5.4	5.1	4.5	3.1	1.7	0.3	1.2
DL-Comp :	M	35.1	94.9	126.5	203.0	340.7	427.1	462.3	446.4
DW(Max)	V	27.5	25.6	24.4	21.5	14.7	8.0	1.3	5.5
LL + I :	M+	120.8	370.4	500.3	805.5	1303.0	1564.0	1635.5	1545.9
	V	31.7	57.2	71.6	109.3	30.9	12.5	21.2	65.2

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
LL + I :	M-	-1.2	-3.2	-4.4	-7.5	-14.5	-21.5	-28.5	-35.5
	V	24.1	16.5	12.3	1.0	1.0	1.0	1.0	1.0
LL + I :	Vmx	127.7	121.8	118.5	109.8	87.9	68.0	57.5	76.5
	M	143.1	380.7	503.1	786.4	1221.0	1401.9	1353.4	1286.2
Total :	M+	163.3	861.7	1231.6	2124.5	3725.0	4759.5	5274.9	5299.8
	V	237.6	250.3	257.4	276.1	154.4	92.6	58.0	71.8
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	333.6	314.8	304.3	276.6	211.3	148.1	94.2	83.1
	M	185.6	872.0	1234.4	2105.4	3643.0	4597.3	4992.9	5040.1

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	44.85	52.45	60.05	67.65	70.98	72.25	74.50
Self wt. :	M	1222.5	1063.2	797.7	426.0	229.5	149.4	0.0
(Max)	V	14.0	27.9	41.9	55.9	62.0	64.4	68.5
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	1857.3	1615.3	1211.9	647.2	348.6	227.0	0.0
Haunch (Max)	V	21.2	42.5	63.7	84.9	94.2	97.8	104.1
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	79.8	54.9	19.2	-27.2	-48.6	-58.3	-77.5
DC(Max)	V	2.6	4.0	5.4	6.8	7.4	7.7	8.1
DL-Comp :	M	379.2	260.9	91.4	-129.3	-231.1	-276.9	-368.1
DW(Max)	V	12.2	18.9	25.7	32.4	35.4	36.5	38.5
LL + I :	M+	1289.3	876.6	477.0	278.3	261.3	266.1	289.8
	V	86.0	105.2	48.0	7.6	6.2	5.7	4.8
LL + I :	M-	-42.5	-49.5	-261.4	-997.6	-1402.5	-1569.4	-1883.7
	V	1.0	1.0	75.7	126.5	140.6	146.0	155.6
LL + I :	Vmx	96.2	115.2	132.9	148.9	154.4	156.4	160.1
	M	1095.7	724.7	212.4	-390.2	-641.3	-734.6	-897.5
Total :	M+	4828.2	3870.9	2597.3	1195.0	559.8	307.4	0.0
	V	136.0	198.5	184.7	187.6	205.3	212.0	0.0
Total :	M-	0.0	0.0	0.0	-81.0	-1104.0	-1528.1	-2329.2
	V	0.0	0.0	0.0	280.9	339.7	352.3	374.7
Total :	Vmx	146.2	208.5	269.5	328.9	353.4	362.7	379.3
	M	4634.6	3719.1	2332.6	526.4	-342.9	-693.3	-1343.0

SHEAR AND MOMENT ENVELOPE : Span : 1, Beam : 2, STRENGTH I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	6.85	14.45	22.05	29.65	37.25
Self wt. :	M	0.0	186.8	286.9	532.5	997.1	1329.0	1528.1	1594.5
(Max)	V	85.6	80.4	77.5	69.9	52.4	34.9	17.5	0.0
Self wt. :	M	0.0	134.5	206.5	383.4	717.9	956.9	1100.3	1148.1
(Min)	V	61.6	57.9	55.8	50.3	37.7	25.2	12.6	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	283.8	435.8	809.0	1514.9	2019.1	2321.6	2422.5
Haunch (Max)	V	130.1	122.2	117.8	106.1	79.6	53.1	26.5	0.0
Deck + :	M	0.0	204.3	313.8	582.5	1090.7	1453.7	1671.6	1744.2
Haunch (Min)	V	93.6	88.0	84.8	76.4	57.3	38.2	19.1	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	9.2	25.0	33.3	53.4	89.6	112.4	121.6	117.4
DC(Max)	V	7.2	6.7	6.4	5.7	3.9	2.1	0.3	1.4
DL-Comp :	M	6.7	18.0	24.0	38.5	64.5	80.9	87.6	84.6
DC(Min)	V	5.2	4.8	4.6	4.1	2.8	1.5	0.2	1.0
DL-Comp :	M	52.7	142.3	189.8	304.6	511.0	640.6	693.5	669.6
DW(Max)	V	41.3	38.3	36.6	32.2	22.1	12.0	1.9	8.2
DL-Comp :	M	22.8	61.7	82.2	132.0	221.4	277.6	300.5	290.1
DW(Min)	V	17.9	16.6	15.9	14.0	9.6	5.2	0.8	3.6
LL + I :	M+	264.3	810.3	1094.4	1762.0	2850.3	3421.3	3577.6	3381.6
	V	69.4	125.2	156.5	239.1	67.6	27.4	46.5	142.5
LL + I :	M-	-2.5	-7.1	-9.6	-16.3	-31.7	-47.0	-62.3	-77.6
	V	52.7	36.1	26.8	2.3	2.3	2.3	2.3	2.3
LL + I :	Vmx	279.3	266.4	259.2	240.1	192.3	148.7	125.7	167.2
	M	313.1	832.8	1100.6	1720.2	2670.9	3066.6	2960.6	2813.6
Total :	M+	326.2	1448.1	2040.1	3461.5	5963.0	7522.4	8242.5	8185.6
	V	333.7	372.9	394.9	453.0	225.6	129.5	92.7	152.2
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	543.5	514.1	497.6	454.0	350.3	250.8	172.0	176.9
	M	375.0	1470.7	2046.3	3419.7	5783.5	7167.7	7625.5	7617.5

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	44.85	52.45	60.05	67.65	70.98	72.25	74.50
Self wt. :	M	1528.1	1329.0	997.1	532.5	286.9	186.8	0.0
(Max)	V	17.5	34.9	52.4	69.9	77.5	80.4	85.6
Self wt. :	M	1100.3	956.9	717.9	383.4	206.5	134.5	0.0
(Min)	V	12.6	25.2	37.7	50.3	55.8	57.9	61.6
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	2321.6	2019.1	1514.9	809.0	435.8	283.8	0.0
Haunch (Max)	V	26.5	53.1	79.6	106.1	117.8	122.2	130.1
Deck + :	M	1671.6	1453.7	1090.7	582.5	313.8	204.3	0.0
Haunch (Min)	V	19.1	38.2	57.3	76.4	84.8	88.0	93.6
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0

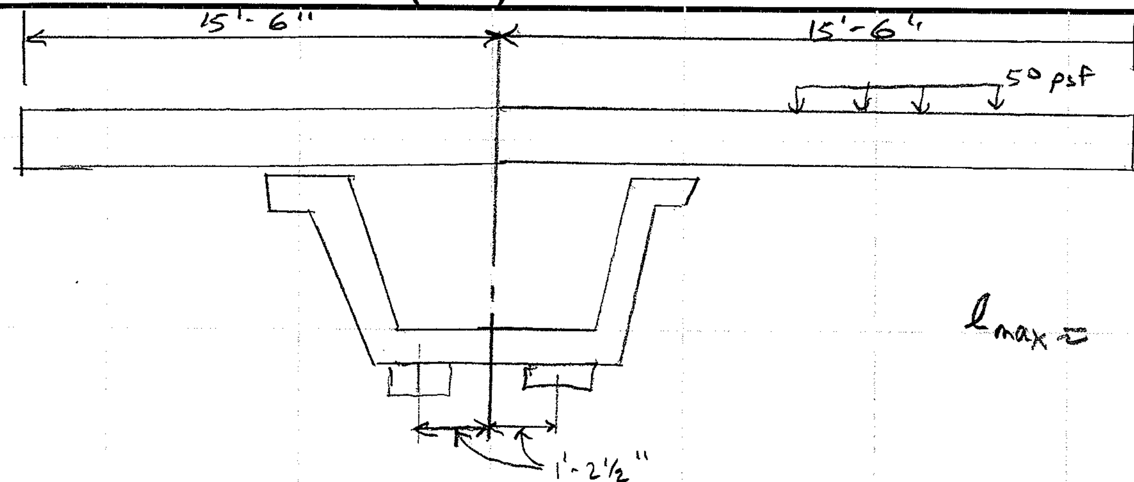
		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
DL-Comp :	M	99.8	68.6	24.0	-34.0	-60.8	-72.9	-96.8
DC(Max)	V	3.2	5.0	6.8	8.5	9.3	9.6	10.1
DL-Comp :	M	71.8	49.4	17.3	-24.5	-43.8	-52.5	-69.7
DC(Min)	V	2.3	3.6	4.9	6.1	6.7	6.9	7.3
DL-Comp :	M	568.9	391.4	137.1	-194.0	-346.6	-415.3	-552.1
DW(Max)	V	18.3	28.4	38.5	48.6	53.0	54.7	57.7
DL-Comp :	M	246.5	169.6	59.4	-84.1	-150.2	-180.0	-239.3
DW(Min)	V	7.9	12.3	16.7	21.1	23.0	23.7	25.0
LL + I :	M+	2820.3	1917.5	1043.5	608.8	571.7	582.1	634.0
	V	188.2	230.1	105.1	16.5	13.6	12.5	10.5
LL + I :	M-	-93.0	-108.3	-571.7	-2182.4	-3067.9	-3433.0	-4120.5
	V	2.3	2.3	165.6	276.6	307.6	319.4	340.3
LL + I :	Vmx	210.5	251.9	290.6	325.6	337.7	342.2	350.3
	M	2396.8	1585.4	464.6	-853.6	-1402.9	-1607.0	-1963.2
Total :	M+	7338.7	5725.6	3716.7	1841.8	1100.4	820.3	325.0
	V	253.7	351.5	282.4	249.7	238.6	245.7	258.4
Total :	M-	0.0	0.0	0.0	-1444.5	-2954.9	-3582.4	-4769.5
	V	0.0	0.0	0.0	413.9	510.6	529.6	563.4
Total :	Vmx	276.0	373.3	467.9	558.8	595.3	609.2	633.8
	M	6915.2	5393.5	3137.8	259.8	-1087.6	-1624.5	-2612.2

REACTIONS (kips), STRENGTH I

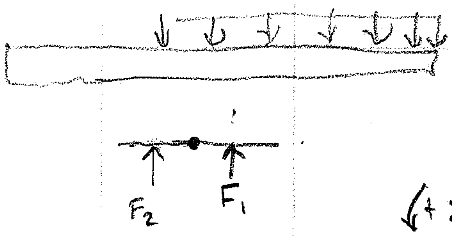
Load Type		Left Support	Right Support
Self Wt.		85.6	85.6
Deck+Haunch		130.1	130.1
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		59.4	31.9
DL-Comp.(DW)		338.7	182.0
Live	(Max)	141.3	314.4
Live	(Min)	-1.1	-219.9
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid) KICKER CALC. - PHASE 3 & 4



$l_{max} = 125'$



$\circlearrowleft + \Sigma M_0 = \phi$

$$F_1(1.2083) - F_2(1.2083) - \frac{(50\,psf)(15.5')}{1000}\left(\frac{15.5}{2}\right)*\left(\frac{125}{2}\right) = 0$$

$$F_1 - F_2 = 375.39\ K$$

$\Sigma F_y = \phi$

$$F_1 + F_2 = \frac{125}{2}\left[\frac{(15.5)(50\,psf)}{1000} + 31' * \frac{(8")}{12"/ft}(.15\,kcf) + (12.24\,SF)(.15\,kcf)\right]$$

$$F_1 + F_2 = 356.94\ K$$

by addition $2F_1 = 732.33$

$F_1 = 366.165\ k$

$F_2 = -9.23\ k$ uplift

need bracing @ piers & abutments

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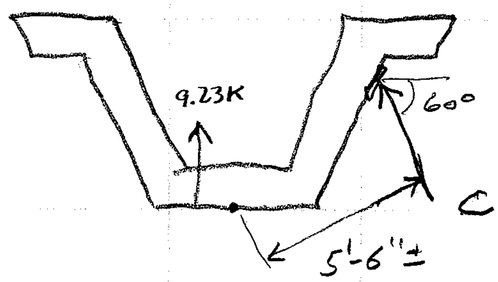
CDOT Form #1034 3/02

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN COMPUTATIONS (Grid)



bearing = 30" x 15.5"
@ 200psi
Load ≈ (30)(15.5) .2ksi = 93 K
Uplift = 9.23 k
use Safety Factor = 3

$C(5.5') = (9.23\ k)(1.2083)(3)$

$C \approx 6.08\ k$

use Pin - Pin Connections

$K = 1.0$

$l \approx 9'$ max

could use 2x2x 3/16"

use 3x3x 1/4" for clearance requirements

7/8" φ Bolt $A = .60\ in^2$

$F_{allow} = .4 F_y$ $F_y = 90$ ksi

Load = $(.4)(90\ ksi)(.60\ in^2) = 21.6$ kips ✓ okay

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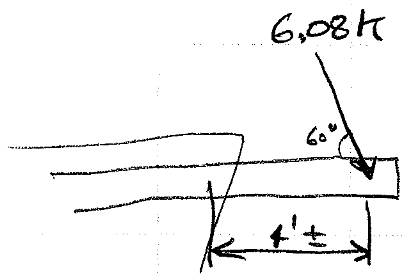
Chk'd:	Date	Structure no.	Sheet 353 of ____

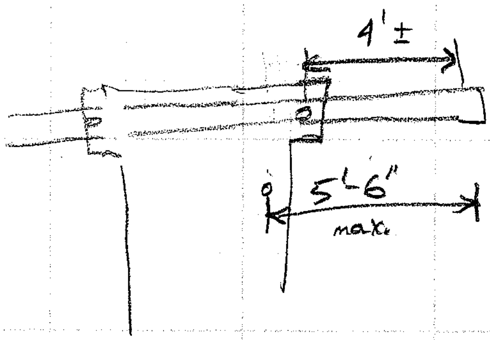


$M \approx 6.08k(\sin 60°) * 4$

$M \approx 21.06$ ft K

use W6x20 for clearance requirements

Revision for straight pier



still okay w/ bolt locations shown
if bolts move to main portion of pier
maximum change ≈ 5'-6" momentum

$M_{max} \approx 6.08k(\sin 60°) * 5.5$

$M \approx 28.96$ ft k

okay for W6x20

TUB TORSION STRENGTH

$$T_n = \frac{2 A_o A_t f_y \cot\theta}{s} \quad \text{(in kip)} \qquad (5.8.3.6.2\text{-}1)$$

$A_o = 683.7 \text{ in}^2$

$A_t = .11 \text{ in}^2$ (#3 min.)

$s = 10"$ max

$f_y = 60$ ksi

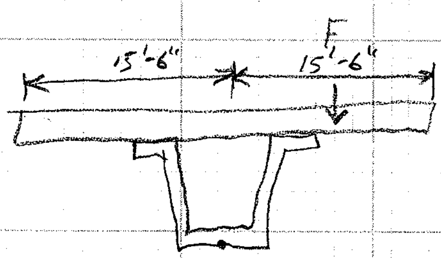
assume $\theta = 45°$

$$T_n = 2 \frac{(683.7 \text{ in}^2)(.11)(60) \cot 45}{10"}$$

$T_n \approx 902.48$ in kip ≈ 75 ft kip

$T_R = \phi T_n = .9\, T_N$ (5.8.2.1-1)

$T_R \approx 67.5$ ft kip



$T_u = (F)\left(\frac{15.5}{2}\right)(1.75) = 13.56\, F_{max}$

$13.56' F_{max} = 67.5$ ft kip

$F_{max} = 4.98$ kip

distributed $= \frac{4.98}{15.5} \approx .322$ K/SF $\approx$ 32.2 lb/SF

for $\theta = 60°$, $F_{max} \approx$ 18.6 lb/SF Allowable Eccentric Load

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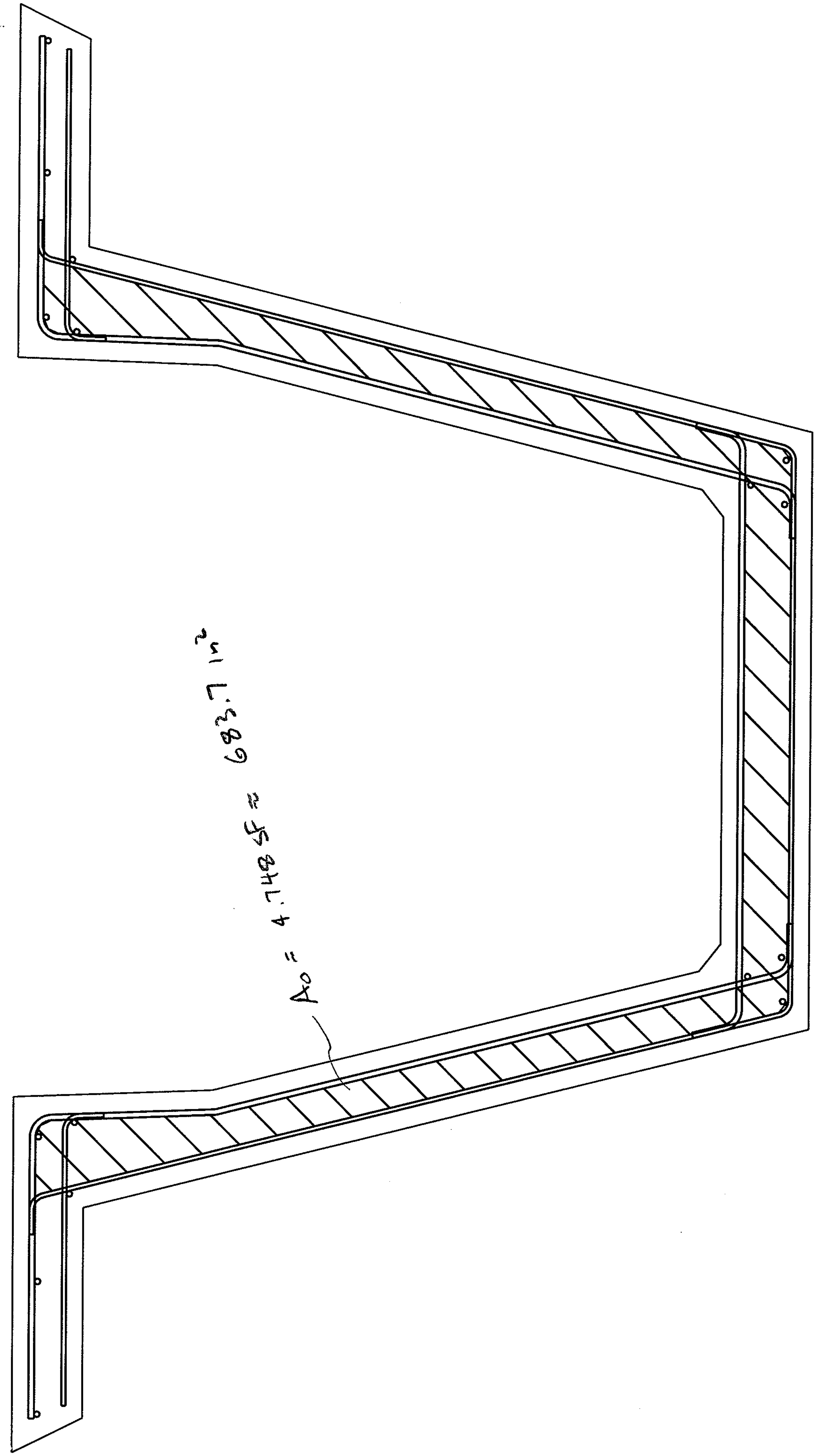
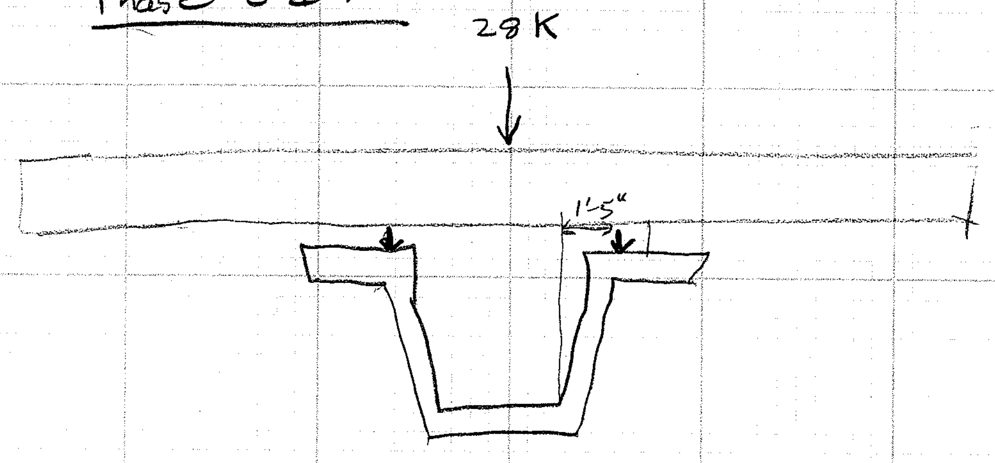

A_o = 4.748 SF ≈ 683.7 in²

Phase 3 & 4

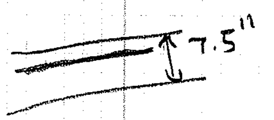


each slab ~ 8' wide

$28\,k / 8' / 2\ \text{sides} \approx 1.75\ k/LF$

$M \approx 1.75\ k/LF * 1.42' \approx 2.5\ ft\,k/LF$

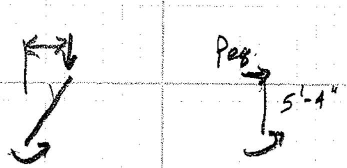
2.08 ft k/10"



$M_R \approx 4.88$ ~~ft k/ft~~

#4 hook development length $\approx$ 6.33"

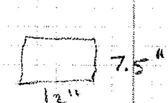
okay for moment



$P_{eq} = \dfrac{2.5\ ft\,k/LF}{5'-4"}$

64

$P_{eq} = .46875\ K$



$\Delta_{max} = \dfrac{P l^3}{3EI}$

$I = \dfrac{12"(7.5)^3}{12} \approx 421.875$

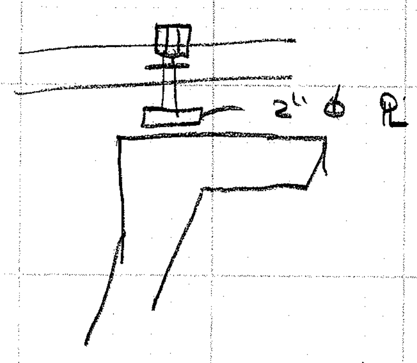
$\Delta_{max} \approx \dfrac{(.46875)\ 64^3}{3\ (5460)(421.875)}$

$E = 5460$

$\Delta_{max} \approx .0178"$

from SAP 2000 $\Delta \approx .03"$

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 357 of



$wt \approx 7\ K$

$f'_c = 9\ ksi$

allowable stress $= .3 f'_c$

$(.3)(9\ ksi) = 2.7\ ksi$

$7\ K \Big/ \frac{\pi\, 2''^2}{4} \approx 2.23\ ksi$ < allowable okay

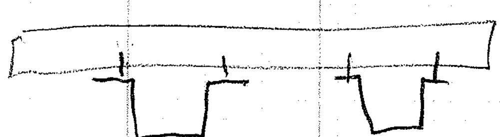
Good for bearing force ✓

$V_c = .0316 B \sqrt{f'_c}\, b_v\, d_v = .0316(2)\sqrt{9}\,(12'')(12'')$ (5.8.3.3-3)

$V_c \approx 27.3\ K$ ✓

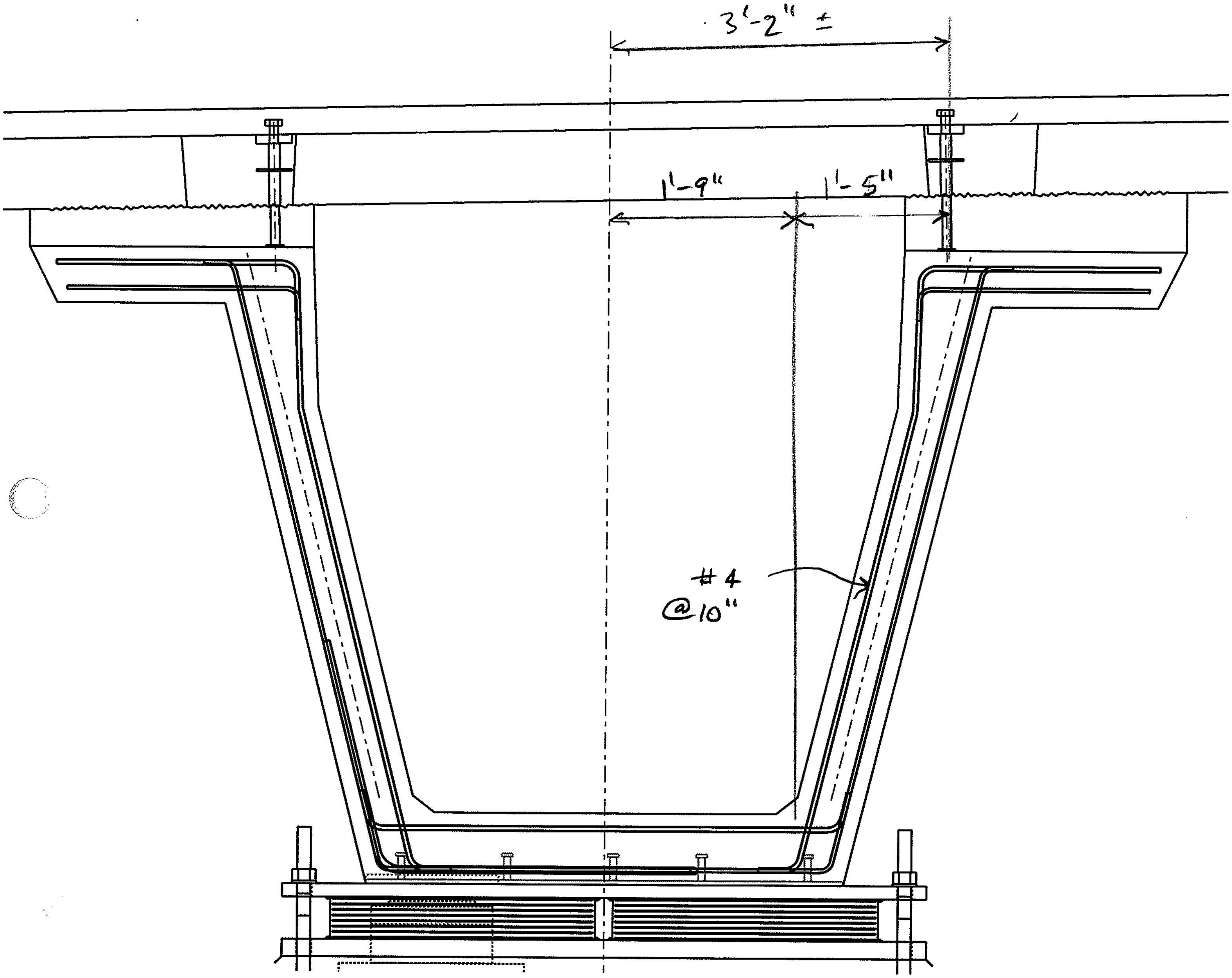
Phase 1 & 2

Max Load = 39 K



39 K / 8 points of bearing ≈ 4.9 K

Phase 3 & 4 are worst case


3'-2" ±
1'-9"
1'-5"
#4
@10"

REINFORCING DESIGN

GIVEN:

fy= 60.00 ksi
f'c= 9.00 ksi
COVER= 1.75 inches
$\Phi_{flexure}$= 0.90
Beam Thickness (t_s)= 7.50 inches
b= 10.00 inches
bar diameter= 0.875 inches

Impact Steel

LOAD TYPE	M_{hTOT}	$AS_{req'd}$
	ft-K	in^2
Mh (UNFACTORED)	2.08	0.09
STRENGTH I	3.13	0.13
SERVICE I	2.08	0.09

d_s= 5.31 inches
per 5.10.8.2 AS_{temp}= 0.11 sq inches

Use # 4 at top face min. spacing = 15.15 inches
use spacing= 10.00 inches
As= 0.200 sq. inches

compressive steel:

Use # 5 at bottom face
As'= 0.00 sq. inches

M_n= 5.42 ft-K
M_r= 4.88 ft-K

Reinforcing is okay

Maximum Reinforcement per 5.7.3.3.1-1 (Ductility Check)

c= 0.26 inches
d_e=d_s= 5.31 inches (for no prestressing)
c/d_e= 0.05

okay - member is not overreinforced

Minimum Reinforcement per 5.7.3.3.2

1.2*$M_{cracking}$= 6.75 ft-K <--- Test 1
1.33M_{hTOT} (max.)= 4.16 ft-K <--- Test 2

Minimum Reinforcing is provided

Transverse Reinforcement per 9.7.3.2

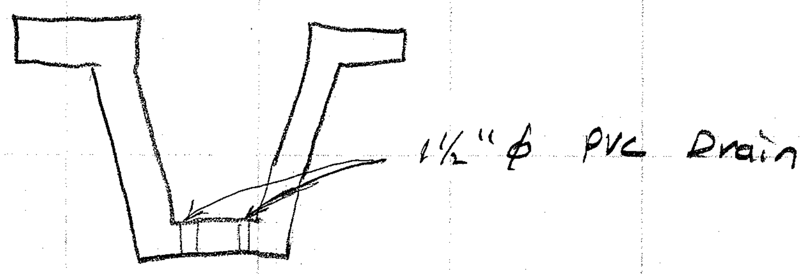
Percentage of main reinforcement, 220 / sqrt(S) <= 67%

Girder Spacing = 15.25 ft
Flange Width = 21 inches
Flange Overhang = 18 inches
Effective Length S = 15.00 ft
220 / sqrt(S) = 56.80 % Use **56.804** % of required main reinforcement
Required As = 0.11 sq inches
Use # 6 transverse reinforcement
min. spacing = 38.72 inches

COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

use $1\frac{1}{2}$" ϕ PVC drains in low ends of girders



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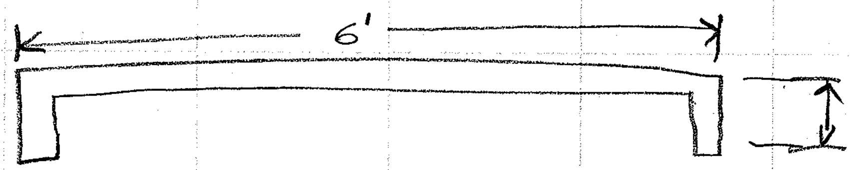
Supports for Trolley Insulator

assume oak – 60 lb/ft³



assumed shape, assume 1" thick wood

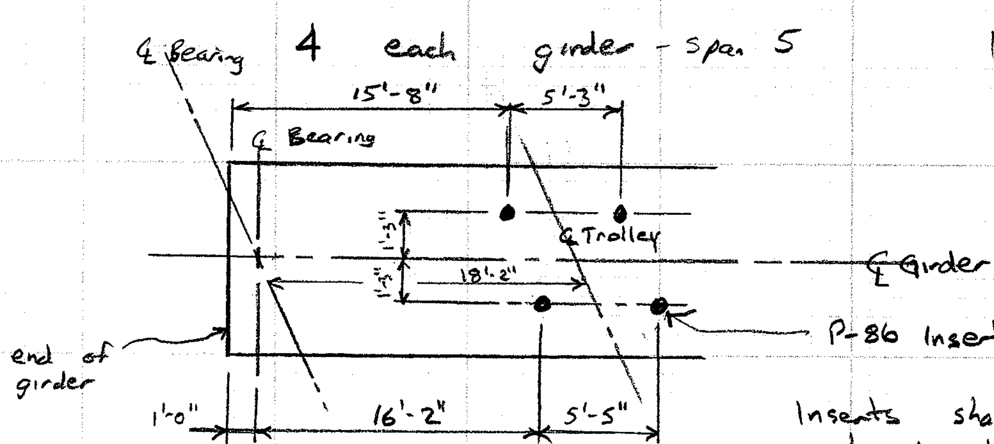
length between ℄ girders ≈ 30'

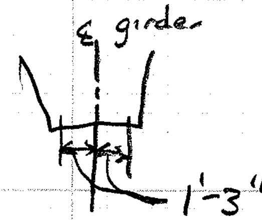
$$wt = (6+1+1)\left(\frac{1''}{12''/ft}\right)(30')\ 60\ lb/ft^3 \approx$$

$$wt \approx 1200\ lbs$$

use P-86 Star Insert
style P36T or approved equal (1/2")
minimum safe working load = 2500 lbs

4 each girder – span 5





Inserts shall be approximately centered about Trolley Line
Dimensions shown used to avoid vertical ties.

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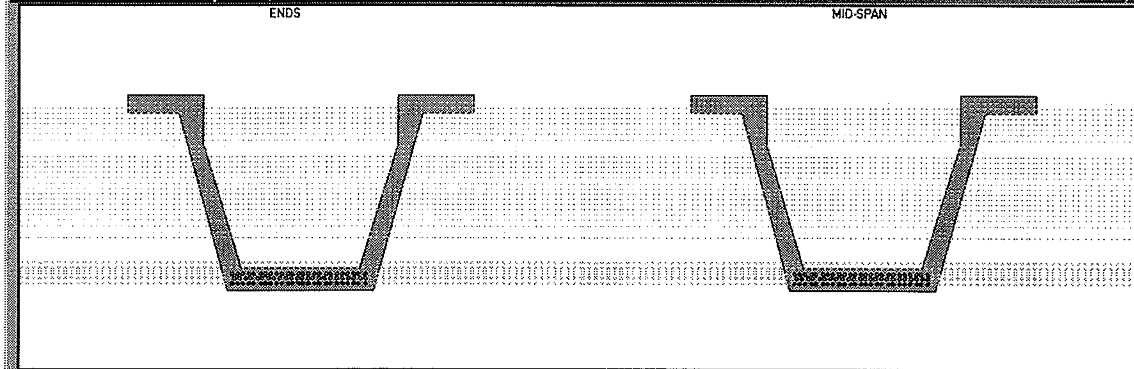
MAX STRANDS

::: Strand Pattern: Span 1, Beam 2



Type	End Template	End Height	Middle Height	# of Strands
Straight	25	2.25	---	25
Straight	24	4.06	---	24
Straight	25	5.88	---	25
Draped	2	33.50	2.7400	2
Draped	2	31.50	2.7400	2
Draped	2	35.50	3.3300	2
Draped	2	37.50	3.3300	2
Draped	2	39.50	4.5100	2
Draped	2	41.50	4.5100	2
Draped	2	43.50	5.0900	2
Draped	2	45.50	5.0900	2
Draped	2	47.50	6.1700	2
Draped	2	49.50	6.1700	2
Draped	2	51.50	6.9000	2
Draped	2	53.50	6.9000	2
Draped	2	55.50	8.0000	2
Draped	2	57.50	8.0000	2
Draped	2	59.50	8.5800	2
Draped	2	61.50	8.5800	2
Draped	2	63.50	9.7200	2
Draped	2	65.50	9.7200	2
Draped	2	67.50	10.3300	2
Draped	2	69.50	10.3300	2

Pattern

SYMMETRICAL DRAPED

☐ Initial Pull/CG Method

Kern Points (in)
Lower: 15.40
Upper: 55.19

Total Strands: 114

Ycg (in)
End: 20.36
Mid: 4.93

Draping
Increment
Decrement

Design
Auto Design
Debond/Pull%
Reset Pattern

Decrement
Debond/Pull%
Reset Pattern

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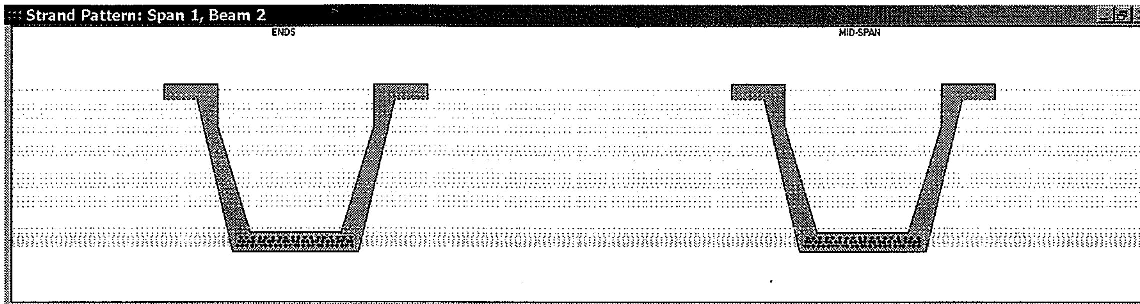
::: Strand Pattern: Span 1, Beam 2



Type	End Template	End Height	Middle Height	# of Strands
Straight	25	2.25	---	25
Straight	24	4.06	---	24
Straight	25	5.88	---	18
Draped	2	31.50	2.7400	2
Draped	2	33.50	2.7400	2
Draped	2	35.50	3.3300	2
Draped	2	37.50	3.3300	2
Draped	2	39.50	4.5100	2
Draped	2	41.50	4.5100	2
Draped	2	43.50	5.0900	2
Draped	2	45.50	5.0900	2
Draped	2	47.50	6.1700	2
Draped	2	49.50	6.1700	2
Draped	2	51.50	6.9000	2
Draped	2	53.50	6.9000	2

Select # of Strands

Add Row | Delete Row | Copy to...

Strand Pattern Library

Save/Load Strand Patterns

Pattern

SYMMETRICAL DRAPED

Initial Pull/CG Method

Kern Points (in)

Lower: 17.47

Upper: 51.30

Total Strands: 91

Ycg (in)

End: 14.06

Mid: 4.12

Draping: Increment | Decrement

Design: Auto Design | Debond/Pull | Reset Pattern

Design Status... | OK | Cancel

4' overhang 130

126

2

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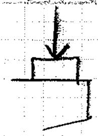
DESIGN COMPUTATIONS (Grid)

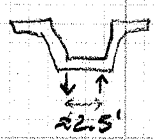
PIER BEARINGS

860.6 K ↻ 533.8 ft k   min = 339.5 K   415.6 ft k



LL ≈ 421.5 K

Torsion ≈ 533.8 ft k



LL = 454.8 Kip ft

by Method A:

need to specify: $.08 < G < .175$ (shear modulus) (14.7.6.2)

$50 < \text{hardness} < 60$

$.25 \le \text{Creep} \le .35$

Shape Factor (14.7.5.1)

$$S_i = \frac{LW}{2h_{ri}(L+W)} \quad (14.7.5.1\text{-}1)$$

$h_{ri} = 1/2"$

K > 3/4" $\sigma_s \le .80$ Ksi

$\sigma_L \le 2.0$ Ksi

643.82   Load ≈ $\frac{860.6k}{2} + \frac{533.8}{2.5'} \approx 643.8$ Kip   257.3 k min

Square pad ≈ $\frac{643.8 \text{ Kip}}{.80 \text{ ksi}} \approx 804.8$ sq in

⇒ 28 1/2" square

for Live Load ≈ $\frac{421.5K}{2} + \frac{454.8}{2.5} \approx 392.7$ K

$\frac{392.7}{2 \text{ ksi}} \approx 196.3$ sq in ⇒ 14" SQR

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Design Computations

Bearing - Method A - No Testing Required (2009 Interims)

Total vertical Load =	709.7 Kip		
Total Torsion Load =	552.1 Ft Kip		
Live vertical Load =	272.9 Kip		
Live Torsion Load =	505.6 Ft Kip		
Dist. Between CL bearings =	2.67 Ft		
Total Load =	561.90	Kip	
Live Load =	326.10	Kip	
L =	15.5	inches (longitudinal)	
W =	30	inches (transverse)	
Hardness =	50	durometer	
G =	0.095	ksi	(Table 14.7.6.2-1)
h_{ri} =	0.5	inches (thickness of ith layer)	
n =	7	# of layers	
h_{rext} =	0.125	inches (thickness of exterior layer	
h_s =	0.125	inches (thickness of shims)	
h_{total} =	4.75	inches (total bearing thickness)	
S_i =	$L*W/(2*h_{ri}*(L+W))$		(14.7.5.1-1)
S_i =	10.220		
S_i^2/n =	14.92		(14.7.6.1)

[redacted]

<u>Compressive Stress</u> (14.7.6.3.2)

σ_s <=	1.25*G*S_i	(14.7.6.3.2-6)
σ_s <=	1.21 ksi	
σ_s <=	1.25 ksi	(14.7.6.3.2-7)
σ_s =	Total Load/(L*W)	
σ_s =	1.21 ksi	

[redacted]

<u>Compressive Deflection</u> (14.7.6.3.3 & 14.7.5.3.6)

Dead Load =	235.80 Kip	
σ_{DL} =	0.51 ksi	
ε_{DL} =	2.00%	(Fig C14.7.6.3.3-1)

[redacted]

δ_{DL} =	$\sum \varepsilon_{DL}*h_{ri}$	(14.7.5.3.6-2)
δ_{DL} =	0.07 inches	
δ_{LT} =	$\delta_{DL} + a_{cr}*\delta DL$	(14.7.5.3.6-3)
a_{cr} =	0.25	(Table 14.7.6.2-1)
δ_{LT} =	0.088 inches (long term deflection)	
σ_{LL} =	0.70 ksi	
ε_{LL} =	2.80%	(Fig C14.7.6.3.3-1)
δ_{LL} =	$\sum \varepsilon_{LL}*h_{ri}$	(14.7.5.3.6-1)
δ_{LL} =	0.10 inches	

by Method B:

Temperature Zone : Zone C (Fig 14.7.5.2-1)

50 year low temp = -30°F (Table 14.7.5.2-1)

Min Low temp Elastomer Grade = 3

$$H_{bu} = GA \frac{\Delta_u}{h_{rt}} \quad (14.6.3.1-2)$$

$$M_u = 1.60\,(.5 E_c I)\,\frac{\theta_s}{h_{rt}} \quad (14.6.3.2-3)$$

Compressive Stress

Subject to shear deformation

$$\sigma_s \le 1.66\,GS \quad (14.7.5.3.2-1)$$

$$\sigma_s \le 1.6 \text{ ksi} \quad (14.7.5.3.2-2)$$

$$\sigma_L \le 0.66\,GS \quad (14.7.5.3.2-3)$$

Load = 643.8 kip

$$\text{Sq. Pad} = \frac{643.8}{1.6} \approx 402.4 \text{ in}^2$$

$\Longrightarrow$ 20" SQR

or 15" x 27" rectangle

$$S_i = \frac{L\,W}{2\,h_{ri}\,(L+W)} \qquad (14.7.5.1-1)$$

$h_{ri} = ½"$

for 20" SQR

$$S_i = \frac{(20)(20)}{2(.5)(20+20)} \approx 10$$

$G_{min} = .08$

$$\sigma_s \le 1.66\,G\,S = 1.66(.10)(.13) \approx 2.158 \text{ ksi}$$

for 15" x 27" $\quad L = 15" \quad W = 27"$

$$S_i = \frac{15(27)}{2(.5)(15+27)} \approx 9.643$$

$$\sigma_s \le 1.66(.13)(9.643) = 2.08 \text{ ksi}$$

$G_{min} = .1$ for 1.66 ksi

$$\sigma_{max} \approx \frac{643.8}{(15)(27)} = 1.59 \text{ ksi} < 1.60 \text{ ksi} \quad ✓ \text{ okay}$$

$$\sigma_{min} \approx \frac{(339.5/2)}{15(27)} \approx .42 \text{ ksi} > 200 \text{ psi okay} \quad ✓$$

$h_{rt} \geq 2\Delta_s$ (14.7.5.3.4-1)

middle of bridge to bearing

length of contribution ≈ $371/2 - 11.5' - 74.5' \approx 109.5'$

Temp Movement ≈ $90^\circ \times .000006 \times 109.5' \times \frac{12''}{12} \approx .71''$

to account for shrinkage & creep multiply by 1.6

ΔS = TOTAL MOVEMENT ≈ $1.6(.71) \approx 1.14''$

$h_{rt} \geq 2\Delta_s = 2(1.14'') = 2.28''$

3.5"

ΔS = 1.75 max

\# of plys = $2.28''/.5 \approx 4.56 \Rightarrow 5$ min.

Use 8

ΔS = 1.75 max
Temp movement = 1.09" max

\# of shims = # of plys + 1 = 9

Thickness of shim = 1/8"

thickness of pad = $\underset{\text{elastomer}}{1/2'' \times 8} + \underset{\text{shims}}{1/8'' \times 9} + \underset{\text{cover}}{2 \times 1/8''}$

$= 5\,3/8''$

<u>STABILITY</u>

for 15" x 27": L = 15" W = 27"

$$A = \frac{\frac{1.92\, h_{rt}}{L}}{\sqrt{1 + 2.0\,L/W}} = \frac{\frac{1.92\,(4.0'')}{15}}{\sqrt{1 + 2 \cdot 15/27}} = .352 \quad (14.7.5.3.6\text{-}2)$$

$$B = \frac{2.67}{(S+2.0)\left(1 + \frac{L}{4.0W}\right)} = \frac{2.67}{(9.643+2)\left(1 + \frac{15}{4.0(27)}\right)} = .201 \quad (14.7.5.3.6\text{-}3)$$

$2A \leq B$? (14.7.5.3.6-1)

NO, check stress

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$$\sigma_s \le \frac{G\,S}{A-B} \qquad (14.7.5.3.6\text{-}5)$$

$$\sigma_s \le \frac{(.13)(9.643)}{(.352-.201)} = 8.30 \text{ ksi}$$

$$\sigma_s = \frac{643.8 \text{ k}}{15(27) \text{ in}^2} \approx 1.59 \text{ ksi} \quad \checkmark \text{ ok}$$

bearing is stable

Reinforcement

$$h_s \ge \frac{3 h_{max} \sigma_s}{F_y} \qquad (14.7.5.3.7\text{-}1)$$

$$h_s > \frac{3\,(1/2'')\,(1.55)}{60 \text{ ksi}} = .039'' < 1/8'' \quad \checkmark \text{ okay}$$

$$h_s \ge \frac{2 h_{max} \sigma_L}{\Delta F_{TH}} \qquad (14.7.5.3.7\text{-}2)$$

$$\sigma_L = \frac{\frac{421.5}{2} + \frac{454.8}{3.5}}{(15)(25)} \approx .909 \text{ ksi}$$

$$\Delta F_{TH} = 24.0 \text{ ksi} \qquad (\text{Table } 6.6.1.2.5\text{-}3)$$

$$h_s \ge \frac{2\,(1/2'')(.909)}{24} = .038'' < 1/8'' \quad \checkmark \text{ okay}$$

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COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)

COMPRESSIVE DEFLECTION

$DL \approx \frac{439.1}{2} + \frac{79}{25} \approx 251.2\ k$

$\sigma_{DL} = \frac{(251.2)}{(15)(27)} = .62\ ksi$

ε_{dL} = Compressive strain ≈ 3% (50 durometer)

2½% (60 durometer)

(Fig C14.7.6.3.3-1)

$\delta_d = \Sigma \varepsilon_{di} h_{ri}$ (14.7.5.3.3-2)

$= (.025)(.5)(8) = .1'' < 1/8''$

$a_{cr} = .35$ (60 durometer) (Table 14.7.6.2-1)

$\delta_{lt} = \delta_d + a_{cr}\,\delta_d$ (14.7.5.3.3-3)

$\delta_{lt} = .1 + .35(.1) = .135''$ (60 durometer)

$\delta_{lt} \approx .12 + .25(.12) = .15''$ (50 durometer)

$LL \approx 392.7\ k$

$\sigma_{LL} = \frac{(392.7)}{(15)(27)} \approx .97\ ksi$

ε_{dL} = compressive strain ≈ 4% 50 durometer

3½% 60 durometer

$\delta_L = \Sigma \varepsilon_{Li} h_{ri}$ (14.7.5.3.3-1)

$\delta_L = (.04)(.5)(8) \approx .16'' > 1/8''$ for 50 durometer

$\delta_L = .035(.5)(8) \approx .14'' > 1/8''$ for 60 durometer

Use 60 durometer, $G_{min} = .13$

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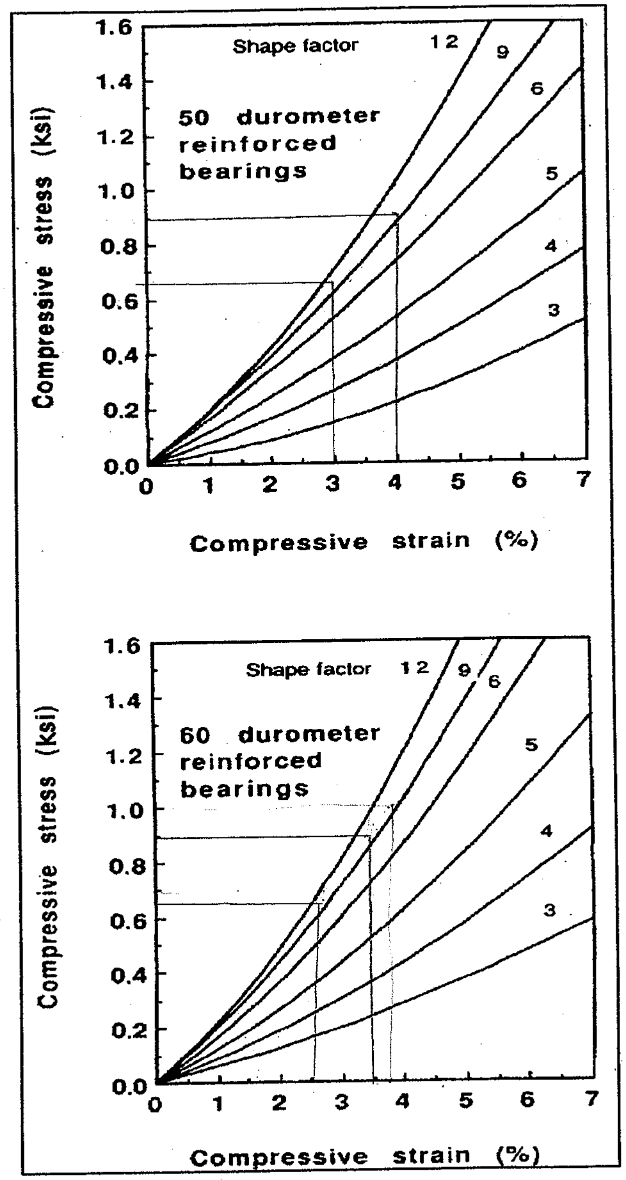

Figure C14.7.6.3.3-1 Stress-Strain Curves.

For CDP, the computed compressive strain, ε_s, may be taken as:

$$\varepsilon_s = \frac{\sigma_s}{E_c} \qquad (14.7.6.3.3\text{-}1)$$

where:

E_c = uniaxial compressive stiffness of the CDP bearing pad. It may be taken as 30 ksi in lieu of pad-specific test data (ksi)

σ_s = average compressive stress due to total load from applicable service load combinations in Table 3.4.1-1 (ksi)

CDP is typically very stiff in compression. The shape factor may be computed, but it has a different meaning and less significance to the compressive deflection than it does for FGP and PEP (*Roeder et al., 2000*). As a result, the maximum compressive deflection for CDP can be based upon an average compressive strain, ε_s, for the total bearing pad thickness as computed in Eq. 1.

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DESIGN COMPUTATIONS (Grid)

ROTATIONS ON BEARING

$\frac{2\pi \text{ radians}}{360°}$

DEAD LOAD ROTATIONS

DEAD LOADS CAUSE ≈ 2.1" of camber change

≈ 0° 18' 39" of rotation

2.5

LIVE LOAD CAUSES ≈ 1.6" of camber change

4.6

⇒ 0° 14'

4.8

PRESTRESSING LOSS CAUSES ≈ 2.1" of camber change

2.6

≈ 0° 18' 39"

$\theta_S \approx .005$ Radians

allowance for uncertainties ≈ .005 Radians (14.4.2.1)

$\theta_{S\,TOTAL} \approx .01$ Radians

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COMBINED COMPRESSION AND ROTATION

$$\sigma_s > 1.0\, G S \left(\frac{\theta_s}{n}\right)\left(\frac{B}{h_{ri}}\right)^2 \qquad (14.7.5.3.5\text{-}1)$$

$S = 9.643$

$G = .13$

$$\sigma_s = \frac{643.8 \text{ kip}}{(15)(27)} \approx 1.59 \text{ ksi}$$

$\theta_s \approx .01$ radians $\approx .005$ rad + $.005$ rad uncertainty

$n = 8$

$L = B = 15''$

$h_{ri} = .5''$

$$\sigma_s > (1.0)(.13)(9.643)\left(\frac{.01}{8}\right)\left(\frac{15}{.5}\right)^2 = 1.41 \text{ Ksi}$$

okay at max load, for min. load, keeper bars & vertical bolt is provided.

$$\sigma_s < 1.875\, G S \left[1 - .2\left(\frac{\theta_s}{n}\right)\left(\frac{B}{h_{ri}}\right)^2\right] \qquad (14.7.5.3.5\text{-}2)$$

$$\sigma_s < 1.875\,(.13)(9.643)\left[1 - .2\left(\frac{.01}{8}\right)\left(\frac{15}{.5}\right)^2\right]$$

$$\sigma_s < 1.82 \text{ Ksi} \qquad 1.828$$

BALANCED DESIGN

(TABLE C14.7.5.3.5-1)

$$\frac{\sigma_s}{G S} = 1.364 \qquad 1.268$$

$$\frac{\theta_s}{n}\left(\frac{B}{h_{ri}}\right)^2 = 1.364 \qquad 1.125$$

9.22

BEARING DEFORMATION

$$H_{bu} = GA \frac{\Delta_u}{h_{rt}} \qquad (14.6.3.1\text{-}2)$$

$G \approx .13$

$A = 27'' * 15'' = 405 \text{ in}^2$

$\Delta_u \approx 1.14''$

$h_{rt} = 4''$

$$H_{bu} \approx .13 (405)\left(\frac{1.14}{4}\right) \approx \underline{15 \text{ Kips}} / \text{bearing pad}$$

$$M_u = 1.60 (.5 E_c I) \frac{\theta_s}{h_{rt}} \qquad (14.6.3.2\text{-}3)$$

$E_c \approx 6GS^2 \qquad (14.6.3.2\text{-}1)$

$= 6 (.13)(9.643)^2$

$E_c = 72.53$

$I = \frac{bh^3}{12} \approx \frac{(27)\,15^3}{12} \approx 7593.75$

$\theta_s \approx .01$ radians

$h_{rt} \approx 4''$

$$M_u \approx 1.6 \left[(.5)(72.53)(7593.75)\right] \frac{.01}{4}$$

$$M_u \approx 1101.55 \text{ in Kip} = \underline{91.8 \text{ ft K}}$$

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DESIGN COMPUTATIONS (Grid)

TAPERED SOLE PLATE

Maximum deflection due to grade & D.L. deflection

$= .06T = .06\,(8 * .5) = .24''$

$0°30'$

% grade @ bearing ≈ $0°\,30'$ max. = .0053'/ft

D.L. rotations

allowance for uncertainties = .005 radians = .286° (14.4.2.1)

≈ $0°\,17'\,11''$

@ erection, camber ≈ $2\frac{1}{2}''$ ($3''$ max)

end rotation ≈ $0°\,30'$ ≈ .0052 radians

122.5

125

total ~~≈~~ .01 radians

$\frac{\pi}{180°}$

(tapered plate not required per 14.8.2)

≤ .01 radians

grade deflection ≈ $.0053'/ft * \frac{20''}{12''/ft}$ ≈ .009''

D.L. rotation ≈ $.0053'/ft * \frac{20''}{12''/ft}$ ≈ .009''

total ≈ .018''

< .24''

(tapered plate not required)

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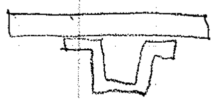
DESIGN COMPUTATIONS (Grid)

Dead Loads



deck $\approx \left(\frac{8''}{12''}\right)(25')(.15) \approx 2.5$ k/ft

girder $\approx$ 12.26 SF $(.15) \approx 1.84$ k/ft

asphalt $\approx \left(\frac{3''}{12''}\right)(25)(.1467) \approx 0.92$ k/ft

haunch $\approx \left(\frac{4''}{12''}\right)\left(\frac{64''}{12''}\right) .15 \approx 0.27$ k/ft

$\ell \approx \frac{122.5}{2} + \frac{23'}{2} \approx 72.75'$

Wt $\approx 72.75(2.5 + 1.84 + .92 + .27)$

wt ≈ 402.3 K

$\sigma_{min} \approx \frac{402.3K}{(27)(15)\,2} \approx 496.7$ psi

$\sigma_{min} > 200$ psi

Live Load

LL ≈ 251 K

for span 1

$\ell \approx \frac{74.5}{2} + \frac{23}{2} \approx 48.75$

wt $\approx 48.75\,(2.5 + 1.84 + .92 + .27)$

wt ≈ 269.59 K

$\sigma = \frac{269.59}{(27)(15)(2)} \approx 333$ psi

$\sigma_{min} > 200$ psi

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DESIGN COMPUTATIONS (Grid)

From SAP 2000 Analysis

max dead load ≈ 243 k/pad (from SAP 2000)

dead load from hand calc ≈ 402.3/2 ≈ 201.6 k/pad

max live load ≈ 324 k/pad ~270 avg max

total load ≈ 567 Kip max.

avg ≈ 513 K

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Exterior

-142.8	-489.6	-625.7	-225.4	-374.9	-323.2
-181.4	-748.9	-588.8	-217.1	+284.2 -47.7	-245.3
-202.7	-391.7	-682.6	-245.7	-500.7	-254.7
-286.5	-723.6	-760.2	-274.3	-252.9	-205.9

INTERIOR

Interior

Live	Service	Service	live	Service	Live
-260.9	-902.2	-676.2	-256.1	+346.9	-184.8
-138.5	-427.0	-652.6	-239.6	-406.3	-283.6
-137.1	-419.08	-644.6	-224.4	-403.0	-266.6
-248.5	-837	-656.7	-243.4	+283.4	-166.3
-136	-426	-648.1	-223.9	-387.9	-255.6
-243.4	-871.4	-665.7	-240.5	+305.4	-158.9
-142.4	-423.4	-652.6	-226.1	-392.5	-248.7
-245.9	-856.3	-653.6	-238.1	+293.0	-152.0
-150.4	-445.1	-655.7	-229.1	-374.7	-244.7
-251.3	-859.3	-660.4	-235.7	287.5	-145.4
-163.0	-455.2	-639.3	-235.5	-352.7	-243.0
-257.8	-884.0	-616.3	-238.5	356.8	-148.2

Table: Element Forces - Frames, Part 1 of 2

	Frame Text	Station ft	OutputCase Text	CaseType Text	StepType Text	P Kip	V2 Kip	V3 Kip	T Kip-ft
	224	0.0000	HL-93	LinMoving	Max	89.679	108.855	4.766	305.7409
	224	0.7000	HL-93	LinMoving	Max	89.679	113.504	4.766	310.7934
	224	0.7000	HL-93	LinMoving	Max	155.828	135.634	7.392	244.5313
	224	1.0000	HL-93	LinMoving	Max	155.828	137.538	7.392	244.5791
	224	1.0000	HL-93	LinMoving	Max	7.436	18.431	0.391	247.7088
	224	2.0000	HL-93	LinMoving	Max	7.436	20.118	0.391	247.7776
	224	0.0000	HL-93	LinMoving	Min	-12.329	-49.911	-2.351	-220.1568
	224	0.7000	HL-93	LinMoving	Min	-12.329	-49.775	-2.351	-220.7819
	224	0.7000	HL-93	LinMoving	Min	-19.514	-63.642	-6.326	-342.6309
	224	1.0000	HL-93	LinMoving	Min	-19.514	-62.968	-6.326	-340.3717
Girder	224	1.0000	HL-93	LinMoving	Min	-35.740	-182.545	-3.205	-340.9043
	224	2.0000	HL-93	LinMoving	Min	-35.740	-177.553	-3.205	-333.4330
	224	0.0000	SERVICEI	Combination	Max	335.900	161.351	9.979	257.5607
	224	0.7000	SERVICEI	Combination	Max	335.900	169.161	9.979	262.6132
	224	0.7000	SERVICEI	Combination	Max	580.067	272.177	7.300	185.1541
	224	1.0000	SERVICEI	Combination	Max	580.067	275.437	7.300	185.2018
	224	1.0000	SERVICEI	Combination	Max	-35.322	-305.692	-10.007	193.4846
	224	2.0000	SERVICEI	Combination	Max	-35.322	-299.489	-10.007	193.5534
	224	0.0000	SERVICEI	Combination	Min	233.892	2.585	2.863	-268.3370
	224	0.7000	SERVICEI	Combination	Min	233.892	5.883	2.863	-268.9620
	224	0.7000	SERVICEI	Combination	Min	404.724	72.901	-6.417	-402.0081
	224	1.0000	SERVICEI	Combination	Min	404.724	74.930	-6.417	-399.7490
	224	1.0000	SERVICEI	Combination	Min	-78.499	-506.668	-13.602	-395.1286
	224	2.0000	SERVICEI	Combination	Min	-78.499	-497.160	-13.602	-387.6573
	323	0.0000	HL-93	LinMoving	Max	56.799	191.297	8.228	55.6207
	323	0.2500	HL-93	LinMoving	Max	56.799	191.297	8.228	55.6207
	323	0.5000	HL-93	LinMoving	Max	56.799	191.297	8.228	55.6207
	323	0.0000	HL-93	LinMoving	Min	-271.311	-25.794	-4.575	-50.3589
	323	0.2500	HL-93	LinMoving	Min	-271.311	-25.794	-4.575	-50.3589
Bearing	323	0.5000	HL-93	LinMoving	Min	-271.311	-25.794	-4.575	-50.3589
	323	0.0000	SERVICEI	Combination	Max	-405.222	658.294	18.534	79.2531
	323	0.2500	SERVICEI	Combination	Max	-405.372	658.294	18.534	79.2531
	323	0.5000	SERVICEI	Combination	Max	-405.522	658.294	18.534	79.2531
	323	0.0000	SERVICEI	Combination	Min	-733.332	441.203	5.731	-26.7264
	323	0.2500	SERVICEI	Combination	Min	-733.482	441.203	5.731	-26.7264
	323	0.5000	SERVICEI	Combination	Min	-733.632	441.203	5.731	-26.7264

Table: Element Forces - Frames, Part 2 of 2

Frame Text	Station ft	OutputCase Text	StepType Text	M2 Kip-ft	M3 Kip-ft
224	0.0000	HL-93	Max	25.5385	357.5220
224	0.7000	HL-93	Max	26.7789	332.3554
224	0.7000	HL-93	Max	30.2037	326.0496
224	1.0000	HL-93	Max	31.9551	315.5563
224	1.0000	HL-93	Max	9.0444	317.4091
224	2.0000	HL-93	Max	8.7589	343.7574
224	0.0000	HL-93	Min	-34.7519	-2980.5208
224	0.7000	HL-93	Min	-37.8809	-2992.0875
224	0.7000	HL-93	Min	-41.6635	-2964.8166
224	1.0000	HL-93	Min	-43.7917	-2977.8671
224	1.0000	HL-93	Min	-27.5105	-3083.9989
224	2.0000	HL-93	Min	-24.5352	-2964.6007
224	0.0000	SERVICEI	Max	-10.7225	-6233.4068
224	0.7000	SERVICEI	Max	-13.1317	-6296.4274
224	0.7000	SERVICEI	Max	-17.1815	-6225.1367
224	1.0000	SERVICEI	Max	-15.4027	-6276.7963
224	1.0000	SERVICEI	Max	-61.9458	-6508.4419
224	2.0000	SERVICEI	Max	-51.8338	-6160.2288
224	0.0000	SERVICEI	Min	-71.0129	-9571.4496
224	0.7000	SERVICEI	Min	-77.7915	-9620.8703
224	0.7000	SERVICEI	Min	-89.0488	-9516.0029
224	1.0000	SERVICEI	Min	-91.1495	-9570.2197
224	1.0000	SERVICEI	Min	-98.5007	-9909.8498
224	2.0000	SERVICEI	Min	-85.1280	-9468.5869
323	0.0000	HL-93	Max	4.0993	95.6476

$$\sigma_s \geq .5\, GS \left(\frac{L}{h_{ri}}\right)^2 \frac{\theta_{sx}}{n} \qquad (14.7.6.3.5\,d\text{-}1)$$

$$\sigma_s \geq .5\, GS \left(\frac{W}{h_{ri}}\right)^2 \frac{\theta_{sz}}{n} \qquad (14.7.6.3.5\,d\text{-}2)$$

$S = 9{,}643$

$G \approx .13$ $\qquad W = 27'$

$\theta_{sx} \approx .005 \qquad \theta_{sz} = .002$

$n = 8$

$L \approx 15$

$h_{ri} = .5''$

$$\sigma_s \geq .5\,(.13)(9{,}643)\left(\frac{15}{.5}\right)^2 \frac{.005}{8} \approx .353 \text{ Ksi}$$

$$\sigma_s \geq .5\,(.13)(9{,}643)\left(\frac{27}{.5}\right)^2 \frac{.002}{8} \approx 0.46 \text{ Ksi}$$

Method A Criteria

TRANSVERSE LOAD ON BEARINGS

FROM SEISMIC CALCULATION and PER 3.10.9.2

Horizontal Connection Force = .25 Vertical Reaction

$H = .25 \left(\frac{860.6 \text{ kip}}{2}\right) \approx 107.6 \text{ k}$ per bearing

per C14.8.3.1 $\mu_{friction} \approx .2$

assume $DL_{min} \approx \overset{DC}{366.8}(.9) + .65\ \overset{DW}{(72.3)}$

≈ 377 k for two bearings

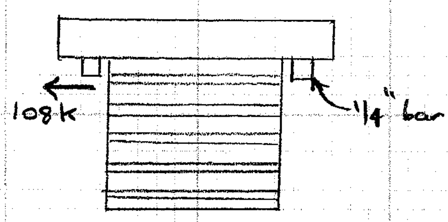
friction $\approx .2\left(\frac{377}{2}\right) \approx 37.7$ K

req'd = 107.6 k − 37.7 k ≈ 69.9 K

GIRDER TO BEARING CONNECTION

$E_{XX} = 70$ ksi for prequalified welds.

Plates are A36 steel
$F_y = 36$ ksi
$F_u = 58$ ksi



$\ell_{weld} \approx 16''$

$R_R = .6\ \phi_{e2}\ F_{exx}$ (6.13.3.2.4 b-1)

$\phi_{e2} = .8$ (6.5.4.2)

for 3/16" weld, throat ≈ .133" = t sin 45°
(prequalified for 1/4")

$R_R = .6\ (.8)\ (16'')(.133'')(70 \text{ ksi})$

$R_R \approx 71.5$ K > 69.9 k

need min 16" long, 3/16" weld per bearing per direction

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SHEAR STUDS IN GIRDER

$$Q_n = .5\, A_{sc} \sqrt{f'_c E_c} \le A_{sc} F_u \quad (6.10.10.4.3\text{-}1)$$

$$A_{sc} = \frac{\pi (3/4)^2}{4} \approx .44 \text{ in}^2$$

$E_c \approx 5460$ $\qquad f'_c \approx 9.0$ ksi

$F_u = 58$ ksi

$$Q_n \approx .5\,(.44)\sqrt{(9\text{ ksi})(5460)} = 48.77\text{ K}$$

$$Q_n \approx .44\,(58\text{ ksi}) = 25.5\text{ K} \leftarrow \text{controls}$$

need $\frac{107.6\text{K}}{25.5\text{K}} \approx 5$ studs / bearing

use 10 studs min on bearing ℞

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STAFF BRIDGE DESIGN MEMO COLORADO DEPARTMENT OF HIGHWAYS		NUMBER 509.3-2
EFFECTIVE JULY 10, 1982	SUPERSEDES JULY 6, 1972	SUBJECT ELASTOMERIC BEARING PADS

The attached sheets give the properties, necessary design criteria, and design procedures for elastomeric bearing pads.

Elastomeric Bearing Pads shall be laminated with metal sheets.

All pads greater than 3/4" in thickness will be laminated in 1/2" layers.

Do not detail these bearing pads on the plans. Show overall size to be used; i.e., 8" x 1½" x 1'-6". Standard Specifications will describe the construction of the pads. See Bridge Standard 32 for details.

In the interest of uniformity, all pads shall be designed with 60 durometer hardness. Figure 1 is the stress strain diagram for Durometer 60 in compression. The specification will call for Durometer 60 ± 5.

PROPERTIES OF ELASTOMER

Durometer Hardness . . . . 60 ± 5
Modulus of Elasticity in shear @ 0° F. . 180 = G

DESIGN CRITERIA

1. Plain Bearings: Minimum L or W = 5T

   Laminated Bearings: Minimum L = 3T; Minimum W = 2T

   T = total effective elastomer thickness = the sum of the layers (Σt)

   Thickness of elastomer for an expansion pad shall not be less than twice the total horizontal movement.

   Pads used for locked-in girders need only to be as thick as needed to ensure that the bottom of the girder does not touch the edge of cap; and these pads will be called leveling pads on project plans.

2. The minimum thickness of elastomer shall be 1/2". Maximum thickness of unlaminated pad is 3/4". For thicknesses greater than 3/4", increments of 1/2" layers (t) will be used with 8 - 1/2" layers as a maximum (4" effective thickness). Lengths and widths of pads should be in increments of 2" where possible. Pads should not extend outside the girder flanges without the use of sole plates or stiffening plates.

3. Initial compressive strain due to the maximum DL and LL shall not exceed 7% of the uncompressed thickness of the pad.

4. Maximum DL+LL (no impact) pressure on the pad shall not exceed 800 psi. Maximum DL pressure on the pad shall not exceed 500 psi. Minimum DL+LL uplift pressure on the pad without restraint against crawling is 200 psi.

5. The temperature range of the elastomeric pad is assumed to be 140° F for steel structures and 90° F for concrete structures. The mean

temperature is assumed to be 40° F. The coefficient of expansion for steel is .0000065 and for concrete is .000006. For prestress girders, the horizontal movement due to temperature shall be multiplied by 1.6 in order to account for shrinkage and creep of the concrete.

The "1.6" factor will satisfy most situations. However, if the designer feels that it is necessary, he may make a detailed analysis to determine the more exact values of shrinkage and creep of the concrete in his particular situation.

6. Shear Force = F = $\frac{\text{Modulus x Area x Temp. Movement}}{\text{T}}$ (This shear force is applied to the substructure and is included as a temperature force (T) in Group Loading Combinations IV, V, and VI.)

7. Shape Factor = $\frac{\text{length x width}}{\text{2 x (length + width) x (thickness)}}$

   For laminated pads, since thickness per layer is always 1/2", the formula is reduced to:

$$SF = \frac{\text{length x width}}{\text{length + width}}$$

   A minimum Shape Factor of 6 is preferred.

8. Maximum compressive deflection due to geometry of non-parallel load surfaces and/or DL rotation is .06T. (Rotation may be neglected except on long spans and/or sliding teflon bearings).

9. Use tapered sole plates in lieu of tapered elastomeric pads on steel girders or prestressed girders placed on grades which require a taper as per above.

Staff Bridge Engineer | Asst. Staff Bridge Engr. | Staff Bridge Const. Engr.

DESIGN PROCEDURE

Given:		
	Structure Type	= Steel Girder
	Length Contributing to Movement	= 150 feet
	Profile Grade at Bearing	= 2%
	Dead Load Reaction	= 65 kips
	Live Load Reaction (w/o Impact)	= 45 kips
	Live Load Uplift Reaction	= 25 kips
	Bottom Flange Width	= 12 inches

a. Width of Pad = Bottom Flange Width = 12"

b. Length of Pad $= \dfrac{DL + LL}{0.8\ (\text{Width of Pad})} = \dfrac{110}{0.8(12)} = 11.45$ Use 12

c. TOTAL ~~Temperature~~ Movement = 140° x 0.0000065 x 150 x 12 = 1.64" —Y(1.6" FOR CONC)

d. Min. Elastomer Thickness = 2 x Horizontal Movement
= 2 x 1.64"
= 3.28"

No. of Plys = Elastomer Thickness/Ply Thickness
= 3.28/0.5
= 6.6 Use 7

No. of Shims = No. of Plys + 1
= 7 + 1
= 8

Thickness of Shim = 1/8"

Thickness of Pad = 1/2" x No. of Plys + 1/8" x No. of Shims + 2 x Cover of Top & Bottom Shims
= 1/2 x 7 + 1/8 x 8 + 2 x 1/8
= 4-3/4"

e. Trial Pad: 12" x 4-3/4" x 12"

1. Check minimum compressive stress (with LL uplift)

$$\frac{(65 - 25) \times 1000}{12 \times 12} = 278 \text{ psi} > 200 \text{ psi} \quad \text{OK}$$

2. Maximum Compressive Stress

$$\frac{(65 + 45) \times 1000}{12 \times 12} = 764 \text{ psi} < 800 \text{ psi}$$

3. Shape Factor

$$\frac{(\text{Length} \times \text{Width})}{2 \times (\text{Length} + \text{Width}) \times (\text{Thickness})} = \frac{12 \times 12}{2(12 + 12)(1/2)} = 6$$

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4. Compressive Strain

From Fig. 1, for compression stress = 764 psi and Shape Factor = 6, initial compressive strain is 5.8% of pad thickness < 7% OK

5. Calculate the maximum horizontal movement permissable before slippage starts.

$$\text{Allowable} = \frac{\text{D.L. Reaction} \times \text{Thickness} \times 1.5^*}{5 \times \text{Modulus} \times \text{Area}}$$

$$= \frac{65000 \times (7 \times 0.5) \times 1.5}{5 \times {}^{\blacksquare}180 \times 144}$$

$$= 2.63" > 1.64"$$

*Constant for 60 Durometer

6. Shear force to substructure

$$F = \frac{\text{Modulus} \times \text{Area} \times \text{Movement}}{\text{Thickness}}$$

$$F = \frac{{}^{\blacksquare}180 \times 144 \times 1.64}{(7 \times 0.5)} \times \frac{1}{1000}$$

$$F = 12.145 \text{ kips}$$

■ Modulus at 0° F   ■ 110 IN ARIZONA

7. Check for tapered sole plate requirement:

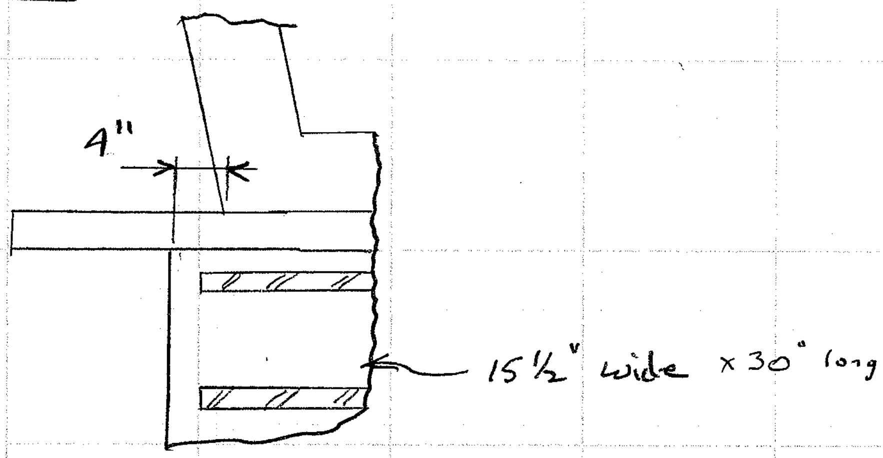
Maximum compressive deflection due to grade and D. L. deflection = 0.06T = 0.06 (7 x 0.5) = 0.21"

2% grade = 0.02'/' x 1' = 0.02' = 0.240"
D.L. Rotation = 0°-15' = 0.004'/' x 0.5' = 0.002' = 0.024"
0.264" > 0.21"

Tapered Sole Plates are required.

Use 12" x 4-3/4" x 1'-0" Laminated Pad

SOLE PLATE



$\sigma_s = 1.25$ ksi

$M \approx (1.25)(15.5)(4)\left(\frac{4}{2}\right)$

$M \approx 155.0$ in kp

16 3/4" x 1 3/4" PL

$I = \frac{bh^3}{12} = \frac{16.75\,(1.75)^3}{12} = 7.48$ in^4 24.6

$\sigma = \frac{Mc}{I} = \frac{(155.0)(.875)}{7.48} = 18.13$ ksi

$\sigma_{allow} = .55\,F_y = .55\,(36) = 19.8$ ksi

✓ okay

for 50 ksi steel, $\sigma_{allow} = .55\,(50) = 27.5$ ksi
could use 1 1/2" PL

Use 1 1/2" Sole Plate (50 ksi)

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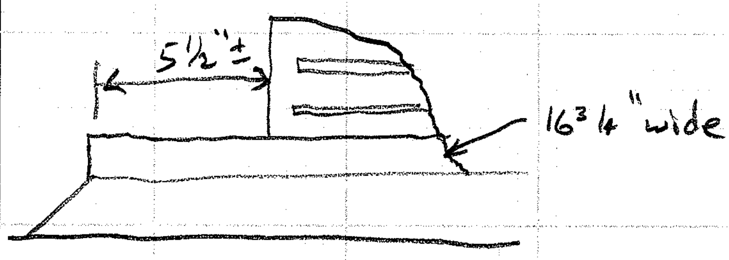
MASONRY PLATE

Size = 73 x 16¾"

$A \approx 1222.75 \text{ in}^2$

load from 1 pad ≈ $(15\tfrac{1}{2} \times 30")(1.25 \text{ ksi}) = 581.25 \text{ k}$

$$\sigma = \frac{581.25}{(\tfrac{1}{2})(1222.75)} \approx .95 \text{ ksi}$$



$$M = (.95 \text{ ksi})(16.75")(5.5)\left(\frac{5.5}{2}\right)$$

$$M \approx 240.68 \text{ in·k}$$

$$I = \frac{(16.75)(2^3)}{12} = 11.167 \text{ in}^4$$

$$\sigma = \frac{Mc}{I} = \frac{(240.68)(1")}{11.167 \text{ in}^4} = 21.55 \text{ ksi}$$

for 50 ksi steel $\sigma_{allow} = .55(50) = 27.5$ ksi

Use 2" Masonry Plate (50 ksi)

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CDOT Form #1034 3/02

Anchor Bolts

~ 70 K per bearing is required

$R_n = .48\, A_B\, F_{ub}\, N_s$ (6.13.2.12-1)

$N_s = 1$

$F_{ub} = 58$ ksi (min) (A307)

$A_b = \frac{\pi (1.5)^2}{4} \approx 1.767 \text{ in}^2$ $1.767 \text{ in}^2 - 1\frac{1}{2}"\phi$

$R_n \approx .48 (1.767)(58)(1) \approx 49.2$ K/ bolt

for A325 Bolts

$F_{ub} = 100$ ksi

$R_n = .48 (1.767)(100 \text{ ksi})(1) \approx 84.8$ K/ bolt

$R_n > 70$K okay

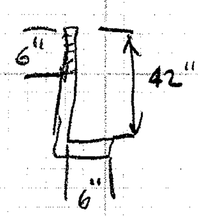
use $1\frac{1}{2}"\ \phi$ A325 bolt

thread length = $2 * \phi + \frac{1}{2}"$
$\approx 3\frac{1}{2}"$

can use A 449 Bolts for greater thread length
thread length ≈ 6"

6 threads / inch

42" 1



F 1554 Grade 105

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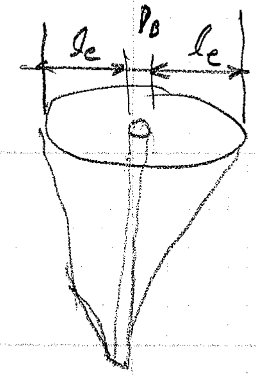
$$\phi T_n = 4 \phi \sqrt{f'_c} \quad A$$

$f'_c = 4500$ ksi

$\phi = .65$

$$A = \pi \left(\frac{D_P^2}{4} - \frac{D_B^2}{4} \right)$$



$D_P = 2 l_e + D_B$

$D_B = 1\frac{1}{2}''$

$l_e = 12''$

$D_P = 2(12) + 1\frac{1}{2}''$
$= 25\frac{1}{2}''$

$$A = \pi \left(\frac{25.5^2}{4} - \frac{1.5^2}{4} \right) = 508.9$$

$$\phi T_n = (4)(.65)\sqrt{4500} \quad (508.9)/1000$$

$$\phi T_n = 88.8 \text{ K}$$

46.57 K for $8\frac{1}{2}''$ embedment

use 12" embedment

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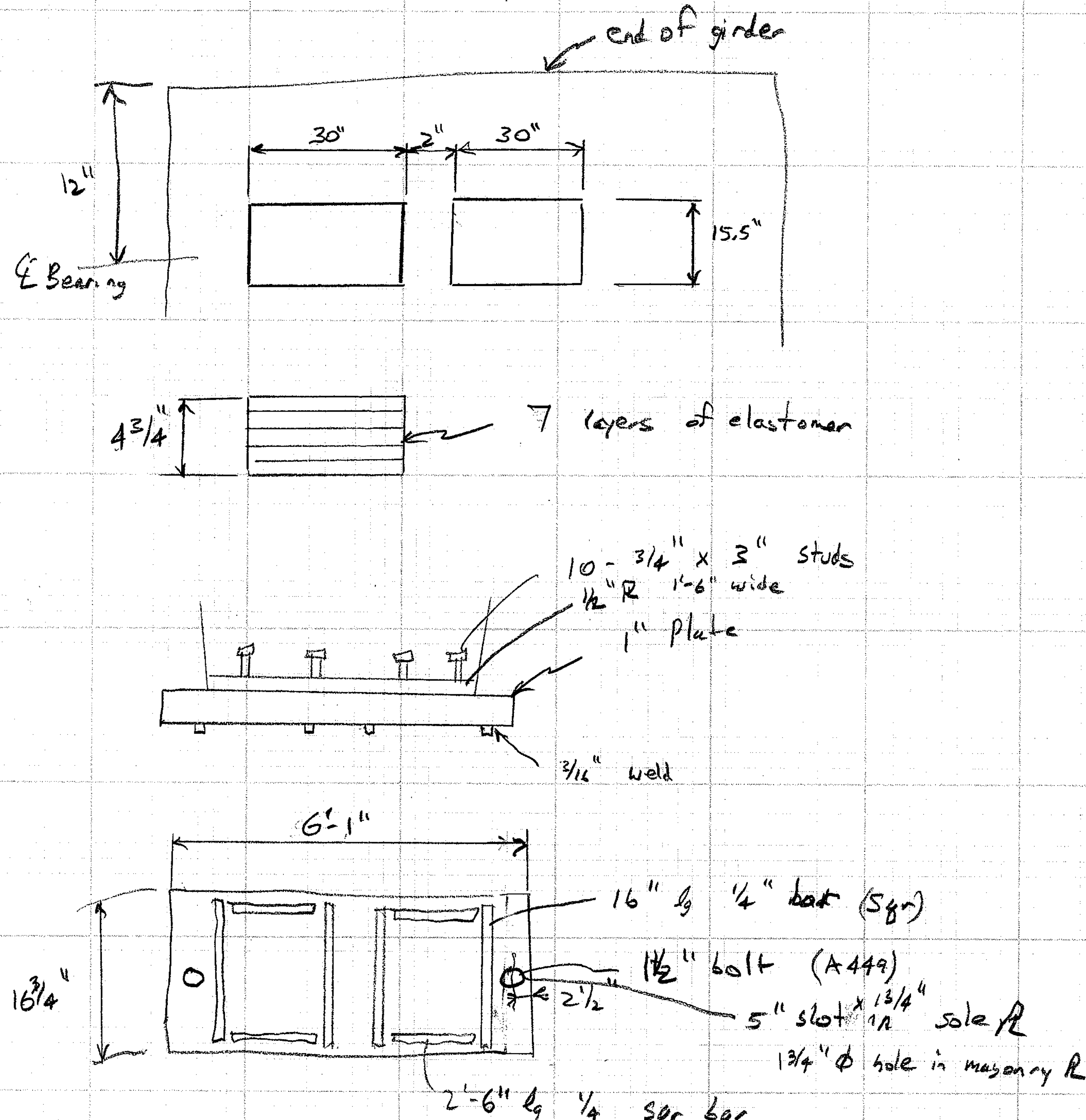
PIER BEARING



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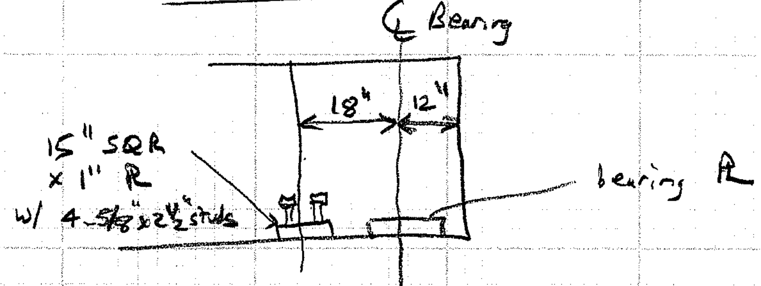
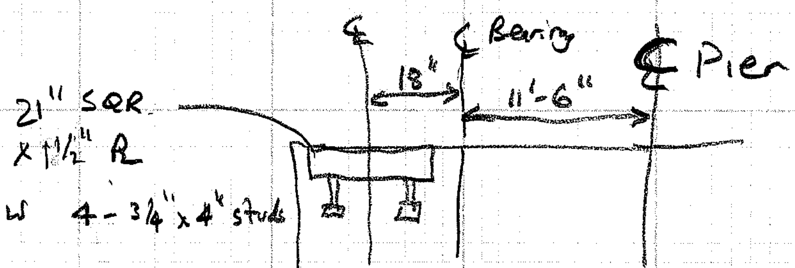
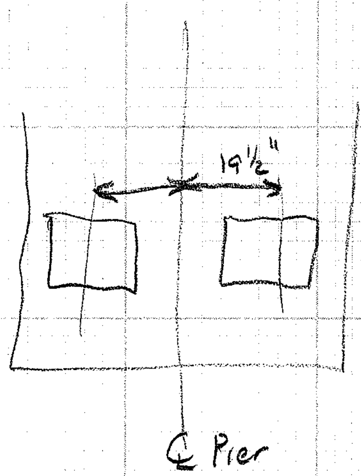
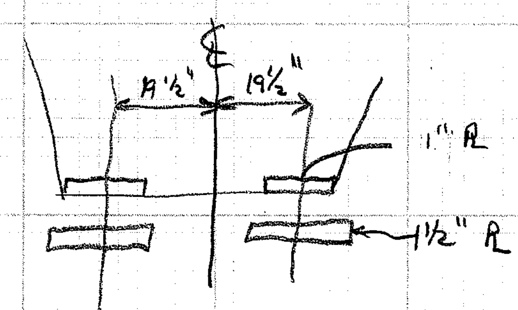
Jack Plates

Girder









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JACKING POINTS

DEAD LOAD ≈ 439.1 K max

for 2 jacks DL = 439.1/2 ≈ 219.6 K ≈ 110 tons

Use 160 ton jack

$\phi \approx 8\frac{1}{2}''$ $A = 56.75\ in^2$

lift $\phi \approx 6.3''$ $A \approx 31.17\ in^2$

Top Pressure ≈ 219.6/31.17 ≈ 7.05 Ksi

Bottom Pressure ≈ 219.6/56.75 ≈ 3.87 Ksi

Allowable Bearing Stress = $.3 f'_c$

for girder σ_{allow} = .3 (9.0) = 2.7 ksi

for pier σ_{allow} = .3 (4.5) = 1.35 ksi

Girder Plate

A_{reqd} ≈ 219.6 Kip / 2.7 ksi ≈ 81.33 in²

⇒ 9½" SQR PL

10¼" ϕ Rnd PL

18" SQR for shims

Use ¾" PL minimum

Pier Plate

A_{reqd} ≈ 219.6 kip / 1.35 Ksi ≈ 162.67 in²

⇒ 13" SQR PL

14½" ROUND PL

Use 1¼" PL minimum

SHIM PLATES

DEAD LOAD + LIVE LOAD ≈ 860.6 K

860.6/1.35 ksi ≈ 637.5 in² ⇒ 26" SQR PL for Live Load

439.1/1.35 ksi ≈ 325.3 in² ⇒ 19" SQR PL for Dead Load ONLY

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 394 of

JACK FOR LIVE LOAD & DEAD LOAD

DEAD + LIVE LOAD $\approx \frac{860.6\text{ K}}{2} + \frac{533.8}{3.5} \approx 582.8\text{ K}$

≈ 291.4 tons

$LL \approx 340.7$
$DL \approx 242.1$

need 400 ton jack · 7" height

GIRDER PL

$A_{Reqd} \approx \frac{582.8}{2.7\text{ ksi}} \approx 215.9\text{ in}^2 \Rightarrow$ 15" SQR PL

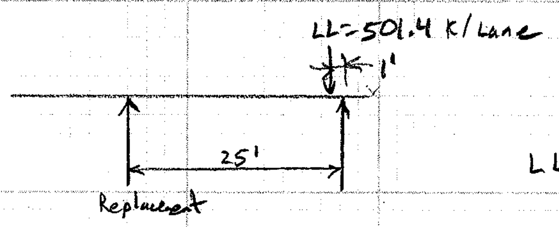
use 1" PL minimum (service loads)
1 1/4" PL for strength I

PIER PL

$A_{reqd} \approx \frac{582.8}{1.35\text{ ksi}} \approx 431.7\text{ in}^2 \Rightarrow$ 21" SQR PL
22.5" max

Use 2" PL minimum (service loads)
2 1/4" PL for strength I

FOR PARTIAL LIVE LOAD



DF ≈ 1.5

$LL \Rightarrow (L)(25) = 501.4\,(1)$

$L \approx 20.1\text{ K}$

160 ton jack can handle additional 50 tons of force $\Rightarrow$ 100 K

Size plates, etc for 400 ton jack
$\Rightarrow$ least disturbance to traffic

By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 395 of

F-16-XB Jacking Plate w/ Live Load
Pier Jacking

INPUT
OUTPUT

DC				
Tube Rail		**0.0**	kips	
Tube Posts		**0.0**	kips	
Rail Curb		**0.0**	kips	
Curb		**0.0**	kips	
Girder		**0.0**	kips	
Girder Fillets		**0.0**	kips	
Diaphragms / water line		**0.0**	kips	
Deck Slab		**242.1**	kips	
Prop Column		**0.0**	kips	
DW	**DC_Total = 242.1**			
Wearing Surface		**0.0**	kips	
LL+IM				
HL-93		**340.7**	kips	
Total Non Composite Dead Load		**242.1**	kips	
Total Wearing Course Deadload		**0.0**	kips	
Total Live Load + IM		**340.7**	kips	UNFACTORED LOAD = 69.7 K < 154
Dead Load Factor	DC	***1.00***		Strength I - AASHTO LRFD 3.4.1
Wearing Course Load Factor	DW	***1.30***		Strength I - AASHTO LRFD 3.4.1
Live Load Load Factor	LL	***1.00***		Strength I - AASHTO LRFD 3.4.1
Load Factor	γ	***1.00***		Service I - AASHTO LRFD 3.4.1
Strength I				
Factored DC		**242**	kips	
Factored DW		**0**	kips	
Factored LL + IM		**341**	kips	
Total Factored Prop Load		**583**	kips	
Service I				
Factored DC		**242**	kips	
Factored DW		**0**	kips	
Factored LL + IM		**341**	kips	
Total Factored Prop Load		**583**	kips	
Prop Column				
Number		***1***	each	
Length	L	***0.01***	feet	
Effective Length Factor	K	***1.0***		AASHTO LRFD Table C4.6.2.5-1
Modulus of Elasticity	E	***29000.0***	ksi	
Yield Strength	F_y	***36.0***	ksi	ASTM A-36
Section Type		**PIPE**		
Shape		**HP14X102**		
Area	A	30.000	in2	AISC 9th Ed. ASD
Depth or Diameter	d	9.840	in	diameter of lifting jack
Web Thickness or Wall Thickness	t_w	0.705	in	

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Flange Width	b_f	9.840	in	
Flange Thickness	t_f	0.705	in	
Nominal Wt. per Ft		102.000	lb/ft	
	r_T	3.970	in	
Moment of Inertia X-X	I_x	1050.000	in^4	
Section Modulus X-X	S_x	150.000	in^3	
Radius of Gyration X-X	r_x	5.920	in	
Moment of Inertia Y-Y	I_y	380.000	in^4	
Section Modulus Y-Y	S_y	51.400	in^3	
Radius of Gyration Y-Y	r_y	3.560	in	
Torsional Constant	J	0.000	in^4	
Plastic Modulus X-X	Z_x	169.000	in^3	
Plastic Modulus Y-Y	Z_y	78.800	in^3	
Limiting Slenderness Ratio	K*L/r	**0.03**	OK	AASHTO LRFD 6.9.3
	λ	**0.000**		AASHTO LRFD Eq. 6.9.4.4-3
Nominal Compressive Resistance	P_n	**1080.00**	kips	AASHTO LRFD Eq.'s 6.9.4.1-1 & 2
Resistance Factor	Φ_c	***0.9***		AASHTO LRFD 6.5.4.2
Compressive Resistance	ΦcPn	**972.000**	kips	AASHTO LRFD Eq. 6.9.2.1-1
Total Resistance	Pr	**972**	kips	Resistance * Number of Prop Columns
Use Live Load in Calculations?		**YES**		
Total Factored Prop Load per Column	Pu	**583**	kips	
Resistance/Load		**1.67**	OK	

Combined Axial Compression and Flexure

Minimum Horizontal Load =		**4.84**	kips	CDOT Standard Spec. 601.11(c)4
Wind Pressure =		**27.50**	psf	Table 3-7 Sign Specs
Shape Factor =	Cd	**0.75**		Table 3-6 Sign Specs
Wind Load =		**0.00**	kips	
Construction Load =		**0**	kips	
Moment =	Mc	**0.01**	ft-kips	
Ultimate Moment =	Mu	**0.01**	ft-kips	
Nominal flexural resistance =	Mn	**236.40**	ft-kips	AASHTO LRFD Eq. 6.12.2.2.1-1 or .3-1
Flexural Resistance =	ΦcMn	**212.76**	ft-kips	
Combined Stress Ratio		0.60	OK	AASHTO LRFD Eq. 6.9.2.2-1 or 2

Shim Bolts

[illegible] **Shim Plates Required**

Concrete Bearing-Girder

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Base Plate Width	B	15	in	
Base Plate Length	N	15	in	
Girder Width		1.3	ft	
Girder Edge Distance		2.0	in	
Footing Width		6	ft	
Footing Edge Distance		1.5	ft	
Compressive Strength	f'_c	9	ksi	
Base Plate Area	A_1	225	in^2	
Support Area	A_2	225	in^2	
Assuming uniformly distributed bearing stress	m	1.00		AASHTO LRFD Eqn. 5.7.5-3
Nominal Bearing Resistance	P_n	1721.25	kips	AASHTO LRFD Eqn. 5.7.5-2
Resistance Factor	Φ_b	0.7		AASHTO LRFD 5.5.4.1
Bearing Resistance	$\Phi_b P_n$	1205	kips	
Total Resistance		1205	kips	Resistance * Number of Prop Columns
Total Factored Prop Load per Column		583	kips	
Resistance/Load		2.1	OK	

Girder - Top Plate interaction:
Plate area 12"x12" : Girder width = 16";
Girder edge distance = (16-12)/2 = 2":
A1 area under plate = 144 and A2 =Girder Notional area = WxW' = 16x1
m = $\sqrt{(A2/A1)}$ = 1.33 and less than 1.5 use 1.33

Bottom plate - Footing Area interaction:
Plate area 12"x12" : Footing area = 4'x4'= 16 sf
Footing edge distance = (48"-12)/2 = 1.5 ft
A1 area under plate = 144 and A2 =footing Notional area = WxW' = (16 f
m = $\sqrt{(A2/A1)}$ = 4 but greater than 1.5 use 1.5

use m = lesser of the above two = 1.33

Concrete Bearing-Pier

Base Plate Width	B	21	in	
Base Plate Length	N	21	in	
Girder Width		1.3	ft	
Girder Edge Distance		2.0	in	
Footing Width		6	ft	
Footing Edge Distance		1.5	ft	
Compressive Strength	f'_c	4.5	ksi	
Base Plate Area	A_1	441	in^2	
Support Area	A_2	441	in^2	
Assuming uniformly distributed bearing stress	m	1.00		AASHTO LRFD Eqn. 5.7.5-3
Nominal Bearing Resistance	P_n	1686.825	kips	AASHTO LRFD Eqn. 5.7.5-2
Resistance Factor	Φ_b	0.7		AASHTO LRFD 5.5.4.1
Bearing Resistance	$\Phi_b P_n$	1181	kips	
Total Resistance		1181	kips	Resistance * Number of Prop Columns
Total Factored Prop Load per Column		1050	kips	
Resistance/Load		1.1	OK	

Girder - Top Plate interaction:
Plate area 12"x12" : Girder width = 16";
Girder edge distance = (16-12)/2 = 2":
A1 area under plate = 144 and A2 =Girder Notional area = WxW' = 16x1
m = $\sqrt{(A2/A1)}$ = 1.33 and less than 1.5 use 1.33

Bottom plate - Footing Area interaction:
Plate area 12"x12" : Footing area = 4'x4'= 16 sf
Footing edge distance = (48"-12)/2 = 1.5 ft
A1 area under plate = 144 and A2 =footing Notional area = WxW' = (16 f
m = $\sqrt{(A2/A1)}$ = 4 but greater than 1.5 use 1.5

use m = lesser of the above two = 1.33

Base Plate-Bottom (Pier)

Corner bending not checked

Unit Weight		490	lb/ft^3
Base Plate Width	B	21	in
Base Plate Length	N	21	in
Base Plate Thickness	T	1.5	inch
Plate Weight		187.58	lb

Number		1.00	each	
Total Weight		187.58	lb	
Yield Strength	F_y	36.0	ksi	ASTM A-36
Moment of Inertia	I_p	0.84375	in^4	per inch of plate
Section Modulus	S_p	1.125	in^4	per inch of plate
Nominal Flexural Strength	M_n	40.5	kip-in	per inch of plate
Resistance Factor	Φ_f	1		AASHTO LRFD 6.5.4.2
Flexural Strength	$\Phi_f M_n$	40.5	kip-in	per inch of plate
Column Depth	d	13.78	in	
Column Flang Width	b_f	13.78	in	
Design base plate projection perp. to flange	m	3.955	in	Beam-Column Base Plate Design - LRFD Method
Design base plate projection perp. to web	n	4.988	in	Engineering Journal / First Quarter / 1999
Between flange bending	n`	3.445	in	
Applied Load per Prop Column	P	583	kip	
Concrete Bearing Stress	f_p	2.590	ksi	Based on Factored Load
Plate Moment II to flange	M_{pl}	20.253	kip-in	per inch of plate
Plate Moment II to web	M_{pl}	32.223	kip-in	per inch of plate
Plate moment between flanges	M_{pl}	15.370	kip-in	per inch of plate
Max Plate Moment	M_{pl}	32.223		
Flexural Strength	$\Phi_f M_n$	41	kip-in	
Resistance/Load		1.26	OK	

Base Plate-Top (Girder)

Corner bending not checked

Unit Weight		490	lb/ft^3	
Base Plate Width	B	15	in	
Base Plate Length	N	15	in	
Base Plate Thickness	T	1	inch	
Plate Weight		63.80	lb	
Number		1.00	each	
Total Weight		63.80	lb	
Yield Strength	F_y	36.0	ksi	ASTM A-36
Moment of Inertia	I_p	0.25	in^4	per inch of plate
Section Modulus	S_p	0.5	in^4	per inch of plate
Nominal Flexural Strength	M_n	18	kip-in	per inch of plate
Resistance Factor	Φ_f	1		AASHTO LRFD 6.5.4.2
Flexural Strength	$\Phi_f M_n$	18	kip-in	per inch of plate
Column Depth	d	9.840	in	

Column Flang Width	b_f	**9.840**	in	
Design base plate projection perp. to flange	m	**2.826**	in	Beam-Column Base Plate Design - LRFD Method
Design base plate projection perp. to web	n	**3.564**	in	Engineering Journal / First Quarter / 1999
Between flange bending	n`	**2.460**	in	
Applied Load per Prop Column	P	**583**	kip	
Concrete Bearing Stress	f_p	**2.590**	ksi	Based on Factored Load
Plate Moment II to flange	M_{pl}	**10.343**	kip-in	per inch of plate
Plate Moment II to web	M_{pl}	**16.451**	kip-in	per inch of plate
Plate moment between flanges	M_{pl}	**7.838**	kip-in	per inch of plate
Max Plate Moment	M_{pl}	**16.451**		
Flexural Strength	$\Phi_f M_n$	**18**	kip-in	
Resistance/Load		1.09	OK	

SHEAR AT JACKING POINT

$V_{u_{service}} \approx 860.6$ K

$V_c = .0316\, \beta \sqrt{f'_c}\; b_v\; d_v$

@ bearing

$d_e = d_s \approx 27\tfrac{1}{2}'' - 2'' - \tfrac{7}{8}'' - 1.27/2 \approx 23.99''$

$d_v = .9 d_e = .9\,(23.99) \approx 21.59''$ ← controls

$d_v = .72H = .72\,(27\tfrac{1}{2}) \approx 19.8''$

$M_u \approx \phi$

$V_u \approx 860.6$K

$$\varepsilon_s = \frac{\frac{0}{21.59} + 0 + 860.6 - 0}{29000\,(13.99)} \approx .0021$$

$$\beta = \frac{4.8}{1 + 750\varepsilon_s} = \frac{4.8}{1 + 750\,(.0021)} \approx 1.85$$

$$\theta = 29 + 3500\,\varepsilon_s = 29 + 3500\,(.0021) \approx 36.35^\circ$$

$V_c = .0316\,(1.85)\sqrt{4.5}\;(54'')\;21.59''$

$V_c \approx 144.6$ K

~~for S = 6''~~

#7 triple bar = 3.6 in²

$$V_s = \frac{3.6(60)\;21.59\,(\cot 36.35 + \cot 90)\,\sin 90}{6''}$$

$V_s = 1056.2$

$V_n \approx 144.6 + 1056.2 = 1200$

$V_r = .9\,(1200) \approx 1080.6$ K

SHEAR/MOMENT ENVELOPE (&REACTIONS)

SHEAR AND MOMENT ENVELOPE : Span : 5, Beam : 2, SERVICE I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	11.65	24.05	36.45	48.85	61.25
Self wt. :	M	0.0	248.7	384.7	1187.2	2176.7	2883.5	3307.5	3448.9
(Max)	V	112.6	108.5	106.2	91.2	68.4	45.6	22.8	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	377.9	584.4	1803.7	3306.9	4380.7	5024.9	5239.7
Haunch (Max)	V	171.1	164.8	161.3	138.5	103.9	69.3	34.6	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-278.7	-248.2	-231.5	-131.1	-1.8	98.8	170.8	214.0
DC(Max)	V	13.8	13.3	13.1	11.6	9.3	7.0	4.6	2.3
DL-Comp :	M	-1324.0	-1179.2	-1099.6	-622.7	-8.4	469.6	811.4	1016.8
DW(Max)	V	65.4	63.4	62.2	55.0	44.0	33.1	22.1	11.1
LL + I :	M+	233.8	218.3	216.5	322.9	878.6	1913.6	2956.0	3646.5
	V	2.4	2.5	2.6	3.3	67.8	83.2	54.4	23.3
LL + I :	M-	-5171.8	-4688.1	-4423.8	-2861.5	-930.9	-41.0	-35.2	-29.3
	V	241.1	234.4	230.7	206.7	136.7	0.5	0.5	0.5
LL + I :	Vmx	236.6	232.4	230.1	214.9	190.2	163.5	135.4	107.1
	M	-2377.3	-2182.4	-2068.4	-1263.8	205.6	1438.5	2323.0	2837.3
Total :	M+	0.0	0.0	0.0	2560.0	6352.0	9746.3	12270.6	13565.9
	V	0.0	0.0	0.0	299.6	293.4	238.1	138.6	36.7
Total :	M-	-6774.5	-5488.9	-4785.8	-624.4	0.0	0.0	0.0	0.0
	V	552.3	534.4	524.3	459.6	0.0	0.0	0.0	0.0
Total :	Vmx	599.5	582.4	572.8	511.3	415.9	318.4	219.5	120.5
	M	-3979.9	-2983.2	-2430.5	973.3	5679.1	9271.1	11637.7	12756.8

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	73.65	86.05	98.45	110.85	118.98	120.25	122.50
Self wt. :	M	3307.5	2883.5	2176.7	1187.2	384.7	248.7	0.0
(Max)	V	22.8	45.6	68.4	91.2	106.2	108.5	112.6
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	5024.9	4380.7	3306.9	1803.7	584.4	377.9	0.0
Haunch (Max)	V	34.6	69.3	103.9	138.5	161.3	164.8	171.1
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	228.6	214.5	171.7	100.2	37.3	26.4	6.2
DC(Max)	V	0.0	2.3	4.6	6.9	8.4	8.7	9.1
DL-Comp :	M	1086.0	1018.9	815.6	475.9	177.4	125.5	29.7
DW(Max)	V	0.1	10.9	21.9	32.9	40.1	41.2	43.2
LL + I :	M+	3899.2	3745.4	3081.8	1856.0	696.3	490.3	107.5
	V	49.2	82.6	127.5	163.1	90.3	79.0	58.8
LL + I :	M-	-23.5	-17.6	-11.7	-5.9	-2.0	-1.4	-0.4
	V	0.5	0.5	0.5	0.5	35.6	41.0	50.7
LL + I :	Vmx	81.1	101.5	131.2	164.0	185.5	188.8	194.7

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
	M	2895.1	3328.4	2868.7	1792.3	697.5	499.3	128.7
Total :	M+	13546.3	12242.9	9552.6	5423.0	1880.0	1268.8	143.5
	V	106.8	210.7	326.3	432.6	406.3	402.1	394.8
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	138.6	229.6	330.1	433.5	501.4	512.0	530.8
	M	12542.1	11825.9	9339.6	5359.3	1881.2	1277.8	164.7

REACTIONS (kips), SERVICE I

Load Type		Left Support	Right Support
Self Wt.		112.6	112.6
Deck+Haunch		171.1	171.1
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		160.1	72.8
DL-Comp.(DW)		760.7	345.7
Live	(Max)	286.5	96.1
Live	(Min)	-117.9	-0.2
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

SHEAR AND MOMENT ENVELOPE : Span : 5, Beam : 2, SERVICE III
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	11.65	24.05	36.45	48.85	61.25
Self wt. :	M	0.0	248.7	384.7	1187.2	2176.7	2883.5	3307.5	3448.9
(Max)	V	112.6	108.5	106.2	91.2	68.4	45.6	22.8	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	377.9	584.4	1803.7	3306.9	4380.7	5024.9	5239.7
Haunch (Max)	V	171.1	164.8	161.3	138.5	103.9	69.3	34.6	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-278.7	-248.2	-231.5	-131.1	-1.8	98.8	170.8	214.0
DC(Max)	V	13.8	13.3	13.1	11.6	9.3	7.0	4.6	2.3
DL-Comp :	M	-1324.0	-1179.2	-1099.6	-622.7	-8.4	469.6	811.4	1016.8
DW(Max)	V	65.4	63.4	62.2	55.0	44.0	33.1	22.1	11.1
LL + I :	M+	187.0	174.7	173.2	258.3	702.9	1530.9	2364.8	2917.2
	V	1.9	2.0	2.1	2.6	54.2	66.5	43.5	18.6

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
LL + I :	M-	-4137.4	-3750.5	-3539.0	-2289.2	-744.7	-32.8	-28.1	-23.5
	V	192.9	187.6	184.6	165.4	109.4	0.4	0.4	0.4
LL + I :	Vmx	189.3	185.9	184.1	172.0	152.2	130.8	108.3	85.7
	M	-1901.8	-1745.9	-1654.8	-1011.1	164.5	1150.8	1858.4	2269.9
Total :	M+	0.0	0.0	0.0	2495.4	6176.3	9363.5	11679.4	12836.6
	V	0.0	0.0	0.0	299.0	279.9	221.4	127.7	32.0
Total :	M-	-5740.1	-4551.3	-3901.0	-52.1	0.0	0.0	0.0	0.0
	V	504.1	487.5	478.2	418.3	0.0	0.0	0.0	0.0
Total :	Vmx	552.1	535.9	526.8	468.3	377.8	285.7	192.5	99.1
	M	-3504.5	-2546.7	-2016.8	1226.0	5637.9	8983.4	11173.0	12189.3

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	73.65	86.05	98.45	110.85	118.98	120.25	122.50
Self wt. :	M	3307.5	2883.5	2176.7	1187.2	384.7	248.7	0.0
(Max)	V	22.8	45.6	68.4	91.2	106.2	108.5	112.6
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	5024.9	4380.7	3306.9	1803.7	584.4	377.9	0.0
Haunch (Max)	V	34.6	69.3	103.9	138.5	161.3	164.8	171.1
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	228.6	214.5	171.7	100.2	37.3	26.4	6.2
DC(Max)	V	0.0	2.3	4.6	6.9	8.4	8.7	9.1
DL-Comp :	M	1086.0	1018.9	815.6	475.9	177.4	125.5	29.7
DW(Max)	V	0.1	10.9	21.9	32.9	40.1	41.2	43.2
LL + I :	M+	3119.4	2996.3	2465.4	1484.8	557.0	392.2	86.0
	V	39.4	66.1	102.0	130.5	72.2	63.2	47.1
LL + I :	M-	-18.8	-14.1	-9.4	-4.7	-1.6	-1.1	-0.3
	V	0.4	0.4	0.4	0.4	28.5	32.8	40.6
LL + I :	Vmx	64.9	81.2	105.0	131.2	148.4	151.0	155.8
	M	2316.1	2662.7	2295.0	1433.8	558.0	399.4	103.0
Total :	M+	12766.4	11493.8	8936.3	5051.8	1740.8	1170.7	122.0
	V	96.9	194.2	300.8	400.0	388.2	386.3	383.1
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	122.4	209.3	303.8	400.7	464.3	474.2	491.8
	M	11963.1	11160.2	8765.8	5000.8	1741.8	1177.9	138.9

SHEAR AND MOMENT ENVELOPE : Span : 5, Beam : 2, STRENGTH I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	11.65	24.05	36.45	48.85	61.25
Self wt. :	M	0.0	310.9	480.8	1484.0	2720.9	3604.3	4134.4	4311.1
(Max)	V	140.8	135.6	132.7	114.0	85.5	57.0	28.5	0.0
Self wt. :	M	0.0	223.9	346.2	1068.5	1959.0	2595.1	2976.8	3104.0
(Min)	V	101.4	97.6	95.5	82.1	61.6	41.0	20.5	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	472.4	730.5	2254.6	4133.6	5475.8	6281.2	6549.6
Haunch (Max)	V	213.9	206.0	201.6	173.2	129.9	86.6	43.3	0.0
Deck + :	M	0.0	340.1	526.0	1623.3	2976.2	3942.6	4522.4	4715.7
Haunch (Min)	V	154.0	148.3	145.1	124.7	93.5	62.3	31.2	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-348.3	-310.2	-289.3	-163.8	-2.2	123.6	213.5	267.5
DC(Max)	V	17.2	16.7	16.4	14.5	11.6	8.7	5.8	2.9
DL-Comp :	M	-250.8	-223.4	-208.3	-118.0	-1.6	89.0	153.7	192.6
DC(Min)	V	12.4	12.0	11.8	10.4	8.3	6.3	4.2	2.1
DL-Comp :	M	-1986.0	-1768.8	-1649.4	-934.0	-12.6	704.4	1217.0	1525.2
DW(Max)	V	98.0	95.0	93.4	82.6	66.1	49.6	33.1	16.6
DL-Comp :	M	-860.6	-766.5	-714.8	-404.8	-5.5	305.3	527.4	660.9
DW(Min)	V	42.5	41.2	40.5	35.8	28.6	21.5	14.3	7.2
LL + I :	M+	409.2	382.0	378.8	565.0	1537.6	3348.9	5172.9	6381.3
	V	4.1	4.5	4.6	5.7	118.6	145.6	95.2	40.8
LL + I :	M-	-9050.7	-8204.2	-7741.6	-5007.7	-1629.1	-71.8	-61.6	-51.3
	V	421.9	410.3	403.7	361.7	239.3	0.9	0.9	0.9
LL + I :	Vmx	414.1	406.8	402.6	376.1	332.9	286.1	236.9	187.5
	M	-4160.2	-3819.2	-3619.8	-2211.7	359.8	2517.3	4065.3	4965.3
Total :	M+	0.0	175.5	667.1	3780.9	8385.0	13257.0	17019.0	19034.8
	V	0.0	457.8	448.6	390.0	411.7	347.4	205.9	60.3
Total :	M-	-11385.0	-9719.3	-8808.2	-3413.8	0.0	0.0	0.0	0.0
	V	698.6	676.9	664.7	586.5	0.0	0.0	0.0	0.0
Total :	Vmx	884.0	860.1	846.7	760.4	626.0	488.0	347.6	207.0
	M	-6494.6	-5114.9	-4347.2	429.0	7199.5	12425.5	15911.4	17618.8

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	73.65	86.05	98.45	110.85	118.98	120.25	122.50
Self wt. :	M	4134.4	3604.3	2720.9	1484.0	480.8	310.9	0.0
(Max)	V	28.5	57.0	85.5	114.0	132.7	135.6	140.8
Self wt. :	M	2976.8	2595.1	1959.0	1068.5	346.2	223.9	0.0
(Min)	V	20.5	41.0	61.6	82.1	95.5	97.6	101.4
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	6281.2	5475.8	4133.7	2254.6	730.5	472.4	0.0
Haunch (Max)	V	43.3	86.6	129.9	173.2	201.6	206.0	213.9
Deck + :	M	4522.4	3942.6	2976.2	1623.3	526.0	340.1	0.0
Haunch (Min)	V	31.2	62.3	93.5	124.7	145.1	148.3	154.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
DL-Comp :	M	285.7	268.1	214.6	125.2	46.7	33.0	7.8
DC(Max)	V	0.0	2.9	5.8	8.7	10.5	10.8	11.4
DL-Comp :	M	205.7	193.0	154.5	90.2	33.6	23.8	5.6
DC(Min)	V	0.0	2.1	4.1	6.2	7.6	7.8	8.2
DL-Comp :	M	1629.0	1528.4	1223.3	713.9	266.0	188.2	44.5
DW(Max)	V	0.1	16.4	32.8	49.3	60.1	61.8	64.8
DL-Comp :	M	705.9	662.3	530.1	309.3	115.3	81.6	19.3
DW(Min)	V	0.1	7.1	14.2	21.4	26.1	26.8	28.1
LL + I :	M+	6823.6	6554.4	5393.1	3248.0	1218.5	858.0	188.2
	V	86.2	144.6	223.1	285.4	158.0	138.2	103.0
LL + I :	M-	-41.0	-30.8	-20.5	-10.3	-3.5	-2.5	-0.6
	V	0.9	0.9	0.9	0.9	62.2	71.8	88.7
LL + I :	Vmx	141.9	177.7	229.7	287.0	324.5	330.4	340.8
	M	5066.4	5824.6	5020.2	3136.5	1220.6	873.7	225.3
Total :	M+	19153.9	17431.0	13685.6	7825.7	2742.5	1862.5	240.5
	V	158.1	307.4	477.1	630.5	563.0	552.5	533.8
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	213.9	340.5	483.7	632.1	729.5	744.7	771.6
	M	17396.7	16701.3	13312.7	7714.2	2744.6	1878.2	277.6

REACTIONS (kips), STRENGTH I

Load Type		Left Support	Right Support
Self Wt.		140.8	140.8
Deck+Haunch		213.9	213.9
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		200.1	91.0
DL-Comp.(DW)		1141.0	518.6
Live	(Max)	501.4	168.1
Live	(Min)	-206.4	-0.4
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-1 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10 **File Name: 76-21-125-21-124_U72C.csl**	Copyright © Bentley Systems, Inc. 1984 - 2008. www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/22/2009 CKD: Date:

SHEAR/MOMENT ENVELOPE (&REACTIONS)

SHEAR AND MOMENT ENVELOPE : Span : 5, Beam : 1, SERVICE I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	11.65	24.05	36.45	48.85	61.25
Self wt. :	M	0.0	248.7	384.7	1187.2	2176.7	2883.5	3307.5	3448.9
(Max)	V	112.6	108.5	106.2	91.2	68.4	45.6	22.8	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	357.6	553.0	1706.8	3129.3	4145.4	4755.1	4958.3
Haunch (Max)	V	161.9	156.0	152.6	131.1	98.3	65.6	32.8	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-262.0	-233.3	-217.6	-123.2	-1.7	92.9	160.5	201.2
DC(Max)	V	12.9	12.5	12.3	10.9	8.7	6.5	4.4	2.2
DL-Comp :	M	-1244.6	-1108.4	-1033.7	-585.3	-7.9	441.4	762.7	955.8
DW(Max)	V	61.4	59.6	58.5	51.7	41.4	31.1	20.7	10.4
LL + I :	M+	258.6	241.4	239.4	357.1	971.6	2116.3	3268.9	4032.6
	V	2.6	2.8	2.9	3.6	75.0	92.0	60.2	25.8
LL + I :	M-	-5719.4	-5184.5	-4892.1	-3164.5	-1029.5	-45.4	-38.9	-32.4
	V	266.6	259.3	255.1	228.6	151.2	0.6	0.6	0.6
LL + I :	Vmx	261.7	257.0	254.4	237.7	210.4	180.8	149.7	118.5
	M	-2629.0	-2413.5	-2287.5	-1397.7	227.4	1590.8	2569.0	3137.8
Total :	M+	0.0	0.0	0.0	2542.5	6268.1	9679.5	12254.8	13596.8
	V	0.0	0.0	0.0	288.6	291.8	240.8	140.9	38.4
Total :	M-	-7225.9	-5919.9	-5205.7	-979.1	0.0	0.0	0.0	0.0
	V	567.0	548.8	538.5	472.7	0.0	0.0	0.0	0.0
Total :	Vmx	610.6	593.6	584.0	522.6	427.2	329.6	230.4	131.1
	M	-4135.5	-3148.9	-2601.0	787.8	5523.9	9154.0	11554.9	12702.0

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	73.65	86.05	98.45	110.85	118.98	120.25	122.50
Self wt. :	M	3307.5	2883.5	2176.7	1187.2	384.7	248.7	0.0
(Max)	V	22.8	45.6	68.4	91.2	106.2	108.5	112.6
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	4755.1	4145.4	3129.3	1706.8	553.0	357.6	0.0
Haunch (Max)	V	32.8	65.6	98.3	131.1	152.6	156.0	161.9
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	214.9	201.6	161.4	94.2	35.1	24.8	5.9
DC(Max)	V	0.0	2.2	4.3	6.5	7.9	8.2	8.5
DL-Comp :	M	1020.9	957.8	766.6	447.4	166.7	117.9	27.9
DW(Max)	V	0.1	10.3	20.6	30.9	37.7	38.7	40.6
LL + I :	M+	4312.0	4141.9	3408.1	2052.5	770.0	542.2	118.9
	V	54.4	91.4	141.0	180.3	99.9	87.3	65.1
LL + I :	M-	-25.9	-19.5	-13.0	-6.5	-2.2	-1.6	-0.4
	V	0.6	0.6	0.6	0.6	39.3	45.4	56.1
LL + I :	Vmx	89.7	112.3	145.1	181.4	205.1	208.8	215.4

405

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
	M	3201.6	3680.8	3172.5	1982.0	771.3	552.1	142.4
Total :	M+	13610.4	12330.2	9642.1	5488.1	1909.5	1291.3	152.7
	V	110.1	215.0	332.6	440.1	404.2	398.7	388.7
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	145.4	235.8	336.8	441.1	509.5	520.1	539.0
	M	12500.0	11869.1	9406.5	5417.6	1910.8	1301.2	176.2

REACTIONS (kips), SERVICE I

Load Type		Left Support	Right Support
Self Wt.		112.6	112.6
Deck+Haunch		161.9	161.9
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		160.1	72.8
DL-Comp.(DW)		760.7	345.7
Live	(Max)	286.5	96.1
Live	(Min)	-117.9	-0.2
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

SHEAR AND MOMENT ENVELOPE : Span : 5, Beam : 1, SERVICE III
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	11.65	24.05	36.45	48.85	61.25
Self wt. :	M	0.0	248.7	384.7	1187.2	2176.7	2883.5	3307.5	3448.9
(Max)	V	112.6	108.5	106.2	91.2	68.4	45.6	22.8	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	357.6	553.0	1706.8	3129.3	4145.4	4755.1	4958.3
Haunch (Max)	V	161.9	156.0	152.6	131.1	98.3	65.6	32.8	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-262.0	-233.3	-217.6	-123.2	-1.7	92.9	160.5	201.2
DC(Max)	V	12.9	12.5	12.3	10.9	8.7	6.5	4.4	2.2
DL-Comp :	M	-1244.6	-1108.4	-1033.7	-585.3	-7.9	441.4	762.7	955.8
DW(Max)	V	61.4	59.6	58.5	51.7	41.4	31.1	20.7	10.4
LL + I :	M+	206.8	193.1	191.5	285.6	777.3	1693.0	2615.2	3226.1
	V	2.1	2.3	2.3	2.9	60.0	73.6	48.1	20.6

Bentley

Colorado DOT
4201 E. Arkansas Ave. Denver CO 80222

Sheet: DS-3
Job No: **BR R600-297**

Program: LEAP® CONSPAN®
Version: 08.01.00.10
File Name: 76-21-125-21-124_U72C.csl

By: A. Pott
Date: Jan/22/2009
CKD:
Date:

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
LL + I :	M-	-4575.5	-4147.6	-3913.7	-2531.6	-823.6	-36.3	-31.1	-25.9
	V	213.3	207.4	204.1	182.9	121.0	0.5	0.5	0.5
LL + I :	Vmx	209.3	205.6	203.6	190.2	168.3	144.6	119.8	94.8
	M	-2103.2	-1930.8	-1830.0	-1118.1	181.9	1272.6	2055.2	2510.2
Total :	M+	0.0	0.0	0.0	2471.1	6073.8	9256.3	11601.0	12790.3
	V	0.0	0.0	0.0	287.8	276.8	222.4	128.8	33.2
Total :	M-	-6082.0	-4883.0	-4227.3	-346.2	0.0	0.0	0.0	0.0
	V	513.7	496.9	487.5	427.0	0.0	0.0	0.0	0.0
Total :	Vmx	558.2	542.2	533.1	475.1	385.1	293.4	200.5	107.4
	M	-3609.7	-2666.2	-2143.5	1067.4	5478.4	8835.9	11041.1	12074.4

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	73.65	86.05	98.45	110.85	118.98	120.25	122.50
Self wt. :	M	3307.5	2883.5	2176.7	1187.2	384.7	248.7	0.0
(Max)	V	22.8	45.6	68.4	91.2	106.2	108.5	112.6
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	4755.1	4145.4	3129.3	1706.8	553.0	357.6	0.0
Haunch (Max)	V	32.8	65.6	98.3	131.1	152.6	156.0	161.9
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	214.9	201.6	161.4	94.2	35.1	24.8	5.9
DC(Max)	V	0.0	2.2	4.3	6.5	7.9	8.2	8.5
DL-Comp :	M	1020.9	957.8	766.6	447.4	166.7	117.9	27.9
DW(Max)	V	0.1	10.3	20.6	30.9	37.7	38.7	40.6
LL + I :	M+	3449.6	3313.5	2726.5	1642.0	616.0	433.8	95.1
	V	43.6	73.1	112.8	144.3	79.9	69.9	52.0
LL + I :	M-	-20.8	-15.6	-10.4	-5.2	-1.8	-1.3	-0.3
	V	0.5	0.5	0.5	0.5	31.5	36.3	44.9
LL + I :	Vmx	71.8	89.8	116.1	145.1	164.1	167.0	172.3
	M	2561.3	2944.6	2538.0	1585.6	617.1	441.7	113.9
Total :	M+	12748.0	11501.8	8960.5	5077.6	1755.5	1182.8	128.9
	V	99.2	196.7	304.4	404.0	384.3	381.2	375.7
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	127.4	213.4	307.8	404.8	468.5	478.4	496.0
	M	11859.6	11132.9	8772.0	5021.2	1756.6	1190.8	147.7

SHEAR AND MOMENT ENVELOPE : Span : 5, Beam : 1, STRENGTH I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.25	3.52	11.65	24.05	36.45	48.85	61.25
Self wt. :	M	0.0	310.9	480.8	1484.0	2720.9	3604.3	4134.4	4311.1
(Max)	V	140.8	135.6	132.7	114.0	85.5	57.0	28.5	0.0
Self wt. :	M	0.0	223.9	346.2	1068.5	1959.0	2595.1	2976.8	3104.0
(Min)	V	101.4	97.6	95.5	82.1	61.6	41.0	20.5	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	447.0	691.3	2133.5	3911.7	5181.8	5943.9	6197.9
Haunch (Max)	V	202.4	194.9	190.8	163.9	122.9	81.9	41.0	0.0
Deck + :	M	0.0	321.8	497.7	1536.1	2816.4	3730.9	4279.6	4462.5
Haunch (Min)	V	145.7	140.4	137.3	118.0	88.5	59.0	29.5	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-327.4	-291.6	-272.0	-154.0	-2.1	116.1	200.7	251.5
DC(Max)	V	16.2	15.7	15.4	13.6	10.9	8.2	5.5	2.7
DL-Comp :	M	-235.8	-210.0	-195.8	-110.9	-1.5	83.6	144.5	181.1
DC(Min)	V	11.6	11.3	11.1	9.8	7.8	5.9	3.9	2.0
DL-Comp :	M	-1866.8	-1662.6	-1550.5	-878.0	-11.8	662.2	1144.0	1433.7
DW(Max)	V	92.2	89.3	87.8	77.6	62.1	46.6	31.1	15.6
DL-Comp :	M	-809.0	-720.5	-671.9	-380.5	-5.1	286.9	495.7	621.3
DW(Min)	V	39.9	38.7	38.0	33.6	26.9	20.2	13.5	6.8
LL + I :	M+	452.5	422.5	419.0	624.8	1700.4	3703.5	5720.7	7057.0
	V	4.6	4.9	5.1	6.4	131.2	161.0	105.3	45.1
LL + I :	M-	-10009.0	-9072.9	-8561.3	-5537.9	-1801.6	-79.4	-68.1	-56.7
	V	466.6	453.7	446.5	400.0	264.6	1.0	1.0	1.0
LL + I :	Vmx	457.9	449.8	445.3	416.0	368.2	316.4	262.0	207.3
	M	-4600.7	-4223.6	-4003.0	-2445.9	397.9	2783.8	4495.8	5491.1
Total :	M+	0.0	250.0	723.4	3751.0	8326.3	13267.9	17143.6	19251.2
	V	0.0	440.5	431.7	375.4	412.6	354.7	211.4	63.5
Total :	M-	-12203.2	-10481.5	-9539.8	-3965.3	0.0	0.0	0.0	0.0
	V	733.7	711.1	698.5	617.0	0.0	0.0	0.0	0.0
Total :	Vmx	909.4	885.4	871.9	785.1	649.6	510.1	368.1	225.7
	M	-6795.0	-5419.9	-4653.4	139.6	7016.6	12348.3	15918.7	17685.3

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	73.65	86.05	98.45	110.85	118.98	120.25	122.50
Self wt. :	M	4134.4	3604.3	2720.9	1484.0	480.8	310.9	0.0
(Max)	V	28.5	57.0	85.5	114.0	132.7	135.6	140.8
Self wt. :	M	2976.8	2595.1	1959.0	1068.5	346.2	223.9	0.0
(Min)	V	20.5	41.0	61.6	82.1	95.5	97.6	101.4
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	5943.9	5181.8	3911.7	2133.5	691.3	447.0	0.0
Haunch (Max)	V	41.0	81.9	122.9	163.9	190.8	194.9	202.4
Deck + :	M	4279.6	3730.9	2816.4	1536.1	497.7	321.8	0.0
Haunch (Min)	V	29.5	59.0	88.5	118.0	137.3	140.4	145.7
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
DL-Comp :	M	268.6	252.0	201.7	117.7	43.9	31.0	7.3
DC(Max)	V	0.0	2.7	5.4	8.1	9.9	10.2	10.7
DL-Comp :	M	193.4	181.4	145.2	84.7	31.6	22.3	5.3
DC(Min)	V	0.0	1.9	3.9	5.9	7.1	7.3	7.7
DL-Comp :	M	1531.3	1436.7	1149.9	671.0	250.1	176.9	41.9
DW(Max)	V	0.1	15.4	30.9	46.4	56.5	58.1	60.9
DL-Comp :	M	663.6	622.6	498.3	290.8	108.4	76.7	18.1
DW(Min)	V	0.1	6.7	13.4	20.1	24.5	25.2	26.4
LL + I :	M+	7546.1	7248.4	5964.1	3591.9	1347.5	948.8	208.1
	V	95.3	159.9	246.7	315.6	174.8	152.8	113.9
LL + I :	M-	-45.4	-34.0	-22.7	-11.3	-3.9	-2.7	-0.7
	V	1.0	1.0	1.0	1.0	68.8	79.4	98.1
LL + I :	Vmx	157.0	196.5	254.0	317.4	358.9	365.4	376.9
	M	5602.8	6441.4	5551.8	3468.6	1349.8	966.2	249.2
Total :	M+	19424.2	17723.2	13948.3	7998.2	2813.5	1914.7	257.3
	V	164.9	317.0	491.4	648.0	564.7	551.7	528.6
Total :	M-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	226.6	353.5	498.7	649.8	748.8	764.2	791.6
	M	17481.0	16916.2	13536.0	7874.9	2815.9	1932.1	298.4

REACTIONS (kips), STRENGTH I

Load Type		Left Support	Right Support
Self Wt.		140.8	140.8
Deck+Haunch		202.4	202.4
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		200.1	91.0
DL-Comp.(DW)		1141.0	518.6
Live	(Max)	501.4	168.1
Live	(Min)	-206.4	-0.4
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

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SHEAR/MOMENT ENVELOPE (&REACTIONS)

SHEAR AND MOMENT ENVELOPE : Span : 3, Beam : 2, SERVICE I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.00	3.52	11.70	24.40	37.10	49.80	62.50
Self wt. :	M	0.0	226.2	392.7	1218.7	2256.6	2998.0	3442.8	3591.1
(Max)	V	114.9	111.2	108.4	93.4	70.1	46.7	23.4	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	343.6	596.7	1851.4	3428.3	4554.7	5230.5	5455.7
Haunch (Max)	V	174.6	169.0	164.8	141.9	106.4	71.0	35.5	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-218.0	-193.9	-176.3	-92.5	15.4	93.3	141.0	158.7
DC(Max)	V	11.9	11.5	11.2	9.7	7.3	4.9	2.6	0.2
DL-Comp :	M	-1035.9	-921.0	-837.4	-439.6	73.2	443.0	670.0	753.9
DW(Max)	V	56.4	54.6	53.3	46.0	34.8	23.5	12.2	1.0
LL + I :	M+	183.1	181.1	187.4	337.1	956.4	1902.2	2587.8	2813.0
	V	7.3	17.0	24.4	64.2	135.8	125.2	92.3	56.5
LL + I :	M-	-4025.0	-3636.2	-3352.4	-1986.7	-419.3	-40.0	-30.9	-22.7
	V	218.8	210.1	203.5	168.0	72.4	2.7	0.8	0.8
LL + I :	Vmx	223.8	220.2	217.4	202.4	173.4	142.4	111.1	81.3
	M	-1855.7	-1645.3	-1486.2	-633.7	669.2	1653.4	2216.2	2335.3
Total :	M+	0.0	0.0	163.1	2875.0	6729.9	9991.1	12072.1	12772.5
	V	0.0	0.0	362.1	355.1	354.3	271.3	165.9	57.6
Total :	M-	-5279.0	-4181.3	-3376.7	0.0	0.0	0.0	0.0	0.0
	V	576.6	556.5	541.2	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	581.6	566.5	555.1	493.4	392.0	288.5	184.8	82.5
	M	-3109.6	-2190.4	-1510.4	1904.3	6442.7	9742.3	11700.4	12294.8

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	75.20	87.90	100.60	113.30	121.48	123.00	125.00
Self wt. :	M	3442.8	2998.0	2256.6	1218.7	392.8	226.2	0.0
(Max)	V	23.4	46.7	70.1	93.4	108.4	111.2	114.9
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	5230.5	4554.7	3428.3	1851.4	596.7	343.6	0.0
Haunch (Max)	V	35.5	71.0	106.4	141.9	164.8	169.0	174.6
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	146.3	103.8	31.2	-71.5	-150.0	-167.4	-191.6
DC(Max)	V	2.2	4.5	6.9	9.3	10.8	11.1	11.5
DL-Comp :	M	694.9	493.0	148.1	-339.7	-712.8	-795.2	-910.3
DW(Max)	V	10.3	21.5	32.8	44.0	51.3	52.6	54.4
LL + I :	M+	2617.1	1960.2	1027.6	417.6	335.3	346.8	374.7
	V	89.7	123.8	134.5	62.9	25.7	18.8	9.7
LL + I :	M-	-31.8	-41.0	-400.4	-1947.2	-3301.7	-3583.5	-3969.9
	V	0.8	1.5	71.0	166.6	202.1	208.7	217.4
LL + I :	Vmx	109.8	141.0	172.0	201.0	216.1	218.9	222.5

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		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
	M	2205.6	1658.9	690.2	-598.5	-1442.8	-1600.5	-1809.0
Total :	M+	12131.6	10109.6	6891.8	3076.5	461.9	0.0	0.0
	V	160.9	267.5	350.6	351.6	361.0	0.0	0.0
Total :	M-	0.0	0.0	0.0	0.0	-3175.1	-3976.4	-5071.8
	V	0.0	0.0	0.0	0.0	537.4	552.6	572.7
Total :	Vmx	181.0	284.7	388.2	489.7	551.4	562.8	577.9
	M	11720.1	9808.4	6554.4	2060.4	-1316.2	-1993.4	-2910.8

REACTIONS (kips), SERVICE I

Load Type		Left Support	Right Support
Self Wt.		114.9	114.9
Deck+Haunch		174.6	174.6
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		165.2	72.7
DL-Comp.(DW)		785.0	345.5
Live	(Max)	243.7	237.5
Live	(Min)	-70.7	-158.2
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

SHEAR AND MOMENT ENVELOPE : Span : 3, Beam : 2, SERVICE III
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.00	3.52	11.70	24.40	37.10	49.80	62.50
Self wt. :	M	0.0	226.2	392.7	1218.7	2256.6	2998.0	3442.8	3591.1
(Max)	V	114.9	111.2	108.4	93.4	70.1	46.7	23.4	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	343.6	596.7	1851.4	3428.3	4554.7	5230.5	5455.7
Haunch (Max)	V	174.6	169.0	164.8	141.9	106.4	71.0	35.5	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-218.0	-193.9	-176.3	-92.5	15.4	93.3	141.0	158.7
DC(Max)	V	11.9	11.5	11.2	9.7	7.3	4.9	2.6	0.2
DL-Comp :	M	-1035.9	-921.0	-837.4	-439.6	73.2	443.0	670.0	753.9
DW(Max)	V	56.4	54.6	53.3	46.0	34.8	23.5	12.2	1.0
LL + I :	M+	146.4	144.9	149.9	269.7	765.1	1521.8	2070.3	2250.4
	V	5.9	13.6	19.5	51.3	108.6	100.2	73.8	45.2

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
LL + I :	M-	-3220.0	-2909.0	-2682.0	-1589.4	-335.5	-32.0	-24.7	-18.2
	V	175.1	168.1	162.8	134.4	57.9	2.1	0.6	0.7
LL + I :	Vmx	179.1	176.1	173.9	161.9	138.7	113.9	88.9	65.0
	M	-1484.5	-1316.2	-1188.9	-506.9	535.3	1322.7	1772.9	1868.3
Total :	M+	0.0	0.0	125.6	2807.6	6538.6	9610.7	11554.5	12209.8
	V	0.0	0.0	357.2	342.3	327.2	246.3	147.5	46.4
Total :	M-	-4474.0	-3454.1	-2706.2	0.0	0.0	0.0	0.0	0.0
	V	532.8	514.4	500.5	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	536.8	522.5	511.6	452.9	357.3	260.0	162.6	66.2
	M	-2738.5	-1861.4	-1213.2	2031.0	6308.8	9411.7	11257.2	11827.7

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	75.20	87.90	100.60	113.30	121.48	123.00	125.00
Self wt. :	M	3442.8	2998.0	2256.6	1218.7	392.8	226.2	0.0
(Max)	V	23.4	46.7	70.1	93.4	108.4	111.2	114.9
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	5230.5	4554.7	3428.3	1851.4	596.7	343.6	0.0
Haunch (Max)	V	35.5	71.0	106.4	141.9	164.8	169.0	174.6
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	146.3	103.8	31.2	-71.5	-150.0	-167.4	-191.6
DC(Max)	V	2.2	4.5	6.9	9.3	10.8	11.1	11.5
DL-Comp :	M	694.9	493.0	148.1	-339.7	-712.8	-795.2	-910.3
DW(Max)	V	10.3	21.5	32.8	44.0	51.3	52.6	54.4
LL + I :	M+	2093.6	1568.1	822.0	334.1	268.2	277.4	299.8
	V	71.7	99.1	107.6	50.4	20.5	15.0	7.7
LL + I :	M-	-25.5	-32.8	-320.3	-1557.8	-2641.3	-2866.8	-3175.9
	V	0.7	1.2	56.8	133.2	161.7	166.9	173.9
LL + I :	Vmx	87.8	112.8	137.6	160.8	172.9	175.1	178.0
	M	1764.5	1327.1	552.2	-478.8	-1154.2	-1280.4	-1447.2
Total :	M+	11608.2	9717.6	6686.3	2993.0	394.8	0.0	0.0
	V	143.0	242.8	323.7	339.0	355.8	0.0	0.0
Total :	M-	0.0	0.0	0.0	0.0	-2514.8	-3259.7	-4277.8
	V	0.0	0.0	0.0	0.0	497.0	510.9	529.2
Total :	Vmx	159.1	256.5	353.8	449.5	508.2	519.0	533.4
	M	11279.0	9476.6	6416.4	2180.1	-1027.6	-1673.3	-2549.1

SHEAR AND MOMENT ENVELOPE : Span : 3, Beam : 2, STRENGTH I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.00	3.52	11.70	24.40	37.10	49.80	62.50
Self wt. :	M	0.0	282.7	490.9	1523.3	2820.8	3747.5	4303.5	4488.9
(Max)	V	143.6	139.0	135.6	116.8	87.6	58.4	29.2	0.0
Self wt. :	M	0.0	203.5	353.5	1096.8	2030.9	2698.2	3098.5	3232.0
(Min)	V	103.4	100.1	97.6	84.1	63.0	42.0	21.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Bentley	Colorado DOT 4201 E. Arkansas Ave. Denver CO 80222	Sheet: DS-4 Job No: **BR R600-297**
Program: LEAP® CONSPAN® Version: 08.01.00.10	Copyright © Bentley Systems, Inc. 1984 - 2008. www.bentley.com 1-800-778-4277	By: A. Pott Date: Jan/22/2009 CKD: Date:

File Name: 76-21-125-21-124_U72C.csl

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	429.5	745.8	2314.3	4285.4	5693.3	6538.1	6819.7
Haunch (Max)	V	218.2	211.2	206.0	177.4	133.0	88.7	44.3	0.0
Deck + :	M	0.0	309.2	537.0	1666.3	3085.5	4099.2	4707.4	4910.2
Haunch (Min)	V	157.1	152.1	148.3	127.7	95.8	63.9	31.9	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-272.6	-242.3	-220.3	-115.7	19.3	116.6	176.3	198.4
DC(Max)	V	14.8	14.4	14.0	12.1	9.1	6.2	3.2	0.3
DL-Comp :	M	-196.2	-174.5	-158.6	-83.3	13.9	83.9	126.9	142.8
DC(Min)	V	10.7	10.3	10.1	8.7	6.6	4.5	2.3	0.2
DL-Comp :	M	-1553.9	-1381.5	-1256.1	-659.5	109.8	664.6	1004.9	1130.9
DW(Max)	V	84.6	81.9	79.9	69.0	52.1	35.2	18.4	1.5
DL-Comp :	M	-673.4	-598.6	-544.3	-285.8	47.6	288.0	435.5	490.1
DW(Min)	V	36.6	35.5	34.6	29.9	22.6	15.3	8.0	0.6
LL + I :	M+	320.4	316.9	327.9	589.9	1673.6	3328.8	4528.7	4922.8
	V	12.8	29.8	42.7	112.3	237.6	219.1	161.5	98.8
LL + I :	M-	-7043.7	-6363.3	-5866.8	-3476.8	-733.8	-70.0	-54.1	-39.8
	V	382.9	367.7	356.2	294.0	126.7	4.7	1.4	1.4
LL + I :	Vmx	391.7	385.3	380.4	354.2	303.5	249.2	194.5	142.3
	M	-3247.4	-2879.3	-2600.8	-1108.9	1171.0	2893.4	3878.3	4086.8
Total :	M+	0.0	255.9	861.7	4058.5	8908.8	13550.8	16551.5	17560.5
	V	0.0	426.0	428.9	487.5	519.5	407.6	256.6	100.5
Total :	M-	-8870.2	-7474.4	-6452.8	-1488.8	0.0	0.0	0.0	0.0
	V	742.9	716.2	696.0	520.8	0.0	0.0	0.0	0.0
Total :	Vmx	853.0	831.9	815.8	729.4	585.3	437.7	289.6	144.0
	M	-5073.9	-3790.9	-2840.5	1953.6	8406.2	13115.4	15901.1	16724.6

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	75.20	87.90	100.60	113.30	121.48	123.00	125.00
Self wt. :	M	4303.5	3747.5	2820.8	1523.3	490.9	282.7	0.0
(Max)	V	29.2	58.4	87.6	116.8	135.6	139.0	143.6
Self wt. :	M	3098.5	2698.2	2030.9	1096.8	353.5	203.5	0.0
(Min)	V	21.0	42.0	63.0	84.1	97.6	100.1	103.4
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	6538.1	5693.3	4285.4	2314.3	745.9	429.5	0.0
Haunch (Max)	V	44.3	88.7	133.0	177.4	206.0	211.2	218.2
Deck + :	M	4707.4	4099.2	3085.5	1666.3	537.0	309.2	0.0
Haunch (Min)	V	31.9	63.9	95.8	127.7	148.3	152.1	157.1
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
DL-Comp :	M	182.8	129.7	39.0	-89.4	-187.5	-209.2	-239.5
DC(Max)	V	2.7	5.7	8.6	11.6	13.5	13.8	14.3
DL-Comp :	M	131.6	93.4	28.1	-64.4	-135.0	-150.6	-172.4
DC(Min)	V	1.9	4.1	6.2	8.3	9.7	10.0	10.3
DL-Comp :	M	1042.4	739.5	222.2	-509.6	-1069.2	-1192.9	-1365.4
DW(Max)	V	15.4	32.3	49.2	66.1	76.9	79.0	81.6
DL-Comp :	M	451.7	320.5	96.3	-220.8	-463.3	-516.9	-591.7
DW(Min)	V	6.7	14.0	21.3	28.6	33.3	34.2	35.4
LL + I :	M+	4579.9	3430.3	1798.2	730.8	586.8	606.9	655.7
	V	156.9	216.7	235.3	110.2	44.9	32.8	16.9
LL + I :	M-	-55.7	-71.8	-700.7	-3407.6	-5777.9	-6271.1	-6947.3
	V	1.4	2.7	124.3	291.5	353.7	365.2	380.4
LL + I :	Vmx	192.1	246.8	301.1	351.8	378.1	383.0	389.4
	M	3859.8	2903.1	1207.9	-1047.3	-2524.9	-2800.8	-3165.7
Total :	M+	16646.7	13740.4	9165.5	4283.3	1225.2	651.5	0.0
	V	248.6	401.7	513.7	481.9	429.5	427.3	0.0
Total :	M-	0.0	0.0	0.0	-1243.5	-6144.2	-7160.5	-8552.2
	V	0.0	0.0	0.0	517.6	690.0	710.2	736.9
Total :	Vmx	283.7	431.8	579.5	723.6	810.1	826.1	847.2
	M	15926.7	13213.2	8575.2	2191.4	-2544.9	-3490.7	-4770.6

REACTIONS (kips), STRENGTH I

Load Type		Left Support	Right Support
Self Wt.		143.6	143.6
Deck+Haunch		218.2	218.2
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		206.5	90.9
DL-Comp.(DW)		1177.5	518.3
Live	(Max)	426.6	415.7
Live	(Min)	-123.8	-276.8
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

SHEAR/MOMENT ENVELOPE (&REACTIONS)

SHEAR AND MOMENT ENVELOPE : Span : 3, Beam : 1, SERVICE I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.00	3.52	11.70	24.40	37.10	49.80	62.50
Self wt. :	M	0.0	226.2	392.7	1218.7	2256.6	2998.0	3442.8	3591.1
(Max)	V	114.9	111.2	108.4	93.4	70.1	46.7	23.4	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	325.1	564.6	1752.0	3244.2	4310.1	4949.6	5162.8
Haunch (Max)	V	165.2	159.9	155.9	134.3	100.7	67.1	33.6	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-205.0	-182.2	-165.7	-87.0	14.5	87.7	132.6	149.2
DC(Max)	V	11.2	10.8	10.5	9.1	6.9	4.6	2.4	0.2
DL-Comp :	M	-973.8	-865.7	-787.2	-413.3	68.8	416.5	629.8	708.7
DW(Max)	V	53.0	51.3	50.1	43.2	32.7	22.1	11.5	0.9
LL + I :	M+	202.4	200.3	207.2	372.8	1057.6	2103.6	2861.8	3110.8
	V	8.1	18.8	27.0	70.9	150.2	138.5	102.0	62.4
LL + I :	M-	-4451.2	-4021.2	-3707.4	-2197.1	-463.7	-44.3	-34.2	-25.1
	V	242.0	232.4	225.1	185.8	80.1	3.0	0.9	0.9
LL + I :	Vmx	247.5	243.5	240.4	223.8	191.8	157.5	122.9	89.9
	M	-2052.2	-1819.5	-1643.5	-700.8	740.0	1828.4	2450.8	2582.6
Total :	M+	0.0	0.0	211.7	2843.2	6641.7	9915.8	12016.6	12722.6
	V	0.0	0.0	352.0	351.0	360.5	279.1	172.9	63.6
Total :	M-	-5629.9	-4517.9	-3702.9	0.0	0.0	0.0	0.0	0.0
	V	586.3	565.7	550.1	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	591.8	576.8	565.4	503.9	402.1	298.0	193.8	91.0
	M	-3230.9	-2316.2	-1639.0	1769.7	6324.1	9640.6	11605.5	12194.3

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	75.20	87.90	100.60	113.30	121.48	123.00	125.00
Self wt. :	M	3442.8	2998.0	2256.6	1218.7	392.8	226.2	0.0
(Max)	V	23.4	46.7	70.1	93.4	108.4	111.2	114.9
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	4949.6	4310.1	3244.2	1752.0	564.6	325.1	0.0
Haunch (Max)	V	33.6	67.1	100.7	134.3	155.9	159.9	165.2
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	137.5	97.5	29.3	-67.2	-141.0	-157.3	-180.1
DC(Max)	V	2.0	4.3	6.5	8.7	10.1	10.4	10.8
DL-Comp :	M	653.2	463.4	139.2	-319.3	-670.0	-747.5	-855.7
DW(Max)	V	9.7	20.2	30.8	41.4	48.2	49.5	51.1
LL + I :	M+	2894.2	2167.7	1136.4	461.8	370.8	383.5	414.4
	V	99.2	136.9	148.7	69.6	28.4	20.8	10.7
LL + I :	M-	-35.2	-45.4	-442.8	-2153.4	-3651.3	-3962.9	-4390.2
	V	0.9	1.7	78.6	184.2	223.5	230.8	240.4
LL + I :	Vmx	121.4	155.9	190.3	222.3	238.9	242.0	246.1

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
	M	2439.1	1834.6	763.3	-661.8	-1595.6	-1769.9	-2000.5
Total :	M+	12077.3	10036.8	6805.7	3046.0	517.1	29.9	0.0
	V	167.8	275.3	356.8	347.4	351.1	351.8	0.0
Total :	M-	0.0	0.0	0.0	0.0	-3505.0	-4316.5	-5426.0
	V	0.0	0.0	0.0	0.0	546.2	561.8	582.4
Total :	Vmx	190.0	294.3	398.3	500.1	561.7	573.1	588.1
	M	11622.3	9703.6	6432.7	1922.3	-1449.2	-2123.5	-3036.3

REACTIONS (kips), SERVICE I

Load Type		Left Support	Right Support
Self Wt.		114.9	114.9
Deck+Haunch		165.2	165.2
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		165.2	72.7
DL-Comp.(DW)		785.0	345.5
Live	(Max)	243.7	237.5
Live	(Min)	-70.7	-158.2
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

SHEAR AND MOMENT ENVELOPE : Span : 3, Beam : 1, SERVICE III
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.00	3.52	11.70	24.40	37.10	49.80	62.50
Self wt. :	M	0.0	226.2	392.7	1218.7	2256.6	2998.0	3442.8	3591.1
(Max)	V	114.9	111.2	108.4	93.4	70.1	46.7	23.4	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	325.1	564.6	1752.0	3244.2	4310.1	4949.6	5162.8
Haunch (Max)	V	165.2	159.9	155.9	134.3	100.7	67.1	33.6	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-205.0	-182.2	-165.7	-87.0	14.5	87.7	132.6	149.2
DC(Max)	V	11.2	10.8	10.5	9.1	6.9	4.6	2.4	0.2
DL-Comp :	M	-973.8	-865.7	-787.2	-413.3	68.8	416.5	629.8	708.7
DW(Max)	V	53.0	51.3	50.1	43.2	32.7	22.1	11.5	0.9
LL + I :	M+	162.0	160.2	165.8	298.2	846.1	1682.9	2289.5	2488.7
	V	6.5	15.1	21.6	56.8	120.1	110.8	81.6	49.9

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
LL + I :	M-	-3560.9	-3217.0	-2965.9	-1757.7	-371.0	-35.4	-27.4	-20.1
	V	193.6	185.9	180.1	148.6	64.1	2.4	0.7	0.7
LL + I :	Vmx	198.0	194.8	192.3	179.1	153.4	126.0	98.3	71.9
	M	-1641.7	-1455.6	-1314.8	-560.6	592.0	1462.8	1960.7	2066.1
Total :	M+	0.0	0.0	170.3	2768.7	6430.2	9495.1	11444.2	12100.4
	V	0.0	0.0	346.6	336.8	330.4	251.4	152.5	51.1
Total :	M-	-4739.7	-3713.6	-2961.4	0.0	0.0	0.0	0.0	0.0
	V	537.9	519.2	505.0	0.0	0.0	0.0	0.0	0.0
Total :	Vmx	542.3	528.1	517.3	459.1	363.7	266.6	169.2	73.1
	M	-2820.5	-1952.3	-1310.3	1909.8	6176.1	9274.9	11115.4	11677.8

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	75.20	87.90	100.60	113.30	121.48	123.00	125.00
Self wt. :	M	3442.8	2998.0	2256.6	1218.7	392.8	226.2	0.0
(Max)	V	23.4	46.7	70.1	93.4	108.4	111.2	114.9
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	4949.6	4310.1	3244.2	1752.0	564.6	325.1	0.0
Haunch (Max)	V	33.6	67.1	100.7	134.3	155.9	159.9	165.2
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	137.5	97.5	29.3	-67.2	-141.0	-157.3	-180.1
DC(Max)	V	2.0	4.3	6.5	8.7	10.1	10.4	10.8
DL-Comp :	M	653.2	463.4	139.2	-319.3	-670.0	-747.5	-855.7
DW(Max)	V	9.7	20.2	30.8	41.4	48.2	49.5	51.1
LL + I :	M+	2315.3	1734.2	909.1	369.5	296.6	306.8	331.5
	V	79.3	109.6	119.0	55.7	22.7	16.6	8.5
LL + I :	M-	-28.2	-36.3	-354.2	-1722.7	-2921.0	-3170.4	-3512.2
	V	0.7	1.4	62.9	147.4	178.8	184.6	192.3
LL + I :	Vmx	97.1	124.8	152.2	177.9	191.2	193.6	196.9
	M	1951.3	1467.7	610.6	-529.5	-1276.4	-1415.9	-1600.4
Total :	M+	11498.5	9603.2	6578.5	2953.6	442.9	0.0	0.0
	V	148.0	247.9	327.0	333.5	345.4	0.0	0.0
Total :	M-	0.0	0.0	0.0	0.0	-2774.7	-3523.9	-4547.9
	V	0.0	0.0	0.0	0.0	501.5	515.7	534.3
Total :	Vmx	165.7	263.1	360.3	455.7	513.9	524.7	538.9
	M	11134.5	9336.7	6280.0	2054.7	-1130.1	-1769.5	-2636.2

SHEAR AND MOMENT ENVELOPE : Span : 3, Beam : 1, STRENGTH I
Shears: kips, Moments: kft

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
Location,	ft	0.00	2.00	3.52	11.70	24.40	37.10	49.80	62.50
Self wt. :	M	0.0	282.7	490.9	1523.3	2820.8	3747.5	4303.5	4488.9
(Max)	V	143.6	139.0	135.6	116.8	87.6	58.4	29.2	0.0
Self wt. :	M	0.0	203.5	353.5	1096.8	2030.9	2698.2	3098.5	3232.0
(Min)	V	103.4	100.1	97.6	84.1	63.0	42.0	21.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		Bearing	Trans	H/2	0.10L	0.20L	0.30L	0.40L	Midspan
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	0.0	406.4	705.8	2190.0	4055.3	5387.6	6187.0	6453.5
Haunch (Max)	V	206.5	199.9	194.9	167.9	125.9	83.9	42.0	0.0
Deck + :	M	0.0	292.6	508.2	1576.8	2919.8	3879.1	4454.6	4646.5
Haunch (Min)	V	148.7	143.9	140.3	120.9	90.6	60.4	30.2	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Comp :	M	-256.2	-227.8	-207.1	-108.7	18.1	109.6	165.7	186.5
DC(Max)	V	13.9	13.5	13.2	11.4	8.6	5.8	3.0	0.2
DL-Comp :	M	-184.5	-164.0	-149.1	-78.3	13.0	78.9	119.3	134.2
DC(Min)	V	10.0	9.7	9.5	8.2	6.2	4.2	2.2	0.2
DL-Comp :	M	-1460.7	-1298.6	-1180.8	-619.9	103.2	624.7	944.6	1063.0
DW(Max)	V	79.5	77.0	75.1	64.9	49.0	33.1	17.3	1.4
DL-Comp :	M	-633.0	-562.7	-511.7	-268.6	44.7	270.7	409.3	460.6
DW(Min)	V	34.4	33.4	32.5	28.1	21.2	14.4	7.5	0.6
LL + I :	M+	354.3	350.5	362.6	652.4	1850.9	3681.3	5008.2	5444.0
	V	14.2	33.0	47.2	124.2	262.8	242.4	178.6	109.3
LL + I :	M-	-7789.5	-7037.1	-6488.0	-3844.9	-811.5	-77.5	-59.8	-44.0
	V	423.5	406.7	393.9	325.2	140.1	5.2	1.5	1.6
LL + I :	Vmx	433.2	426.1	420.7	391.7	335.6	275.6	215.1	157.4
	M	-3591.3	-3184.1	-2876.2	-1226.3	1295.0	3199.8	4288.9	4519.6
Total :	M+	0.0	312.8	898.6	4018.8	8848.2	13550.7	16609.1	17635.8
	V	0.0	415.0	419.7	485.0	533.8	423.6	270.0	110.9
Total :	M-	-9506.4	-8067.3	-7014.2	-1899.9	0.0	0.0	0.0	0.0
	V	769.0	741.2	720.1	544.2	0.0	0.0	0.0	0.0
Total :	Vmx	876.8	855.5	839.4	752.5	606.7	456.8	306.5	159.0
	M	-5308.1	-4021.4	-3067.3	1758.4	8292.4	13069.1	15889.8	16711.4

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
Location,	ft	75.20	87.90	100.60	113.30	121.48	123.00	125.00
Self wt. :	M	4303.5	3747.5	2820.8	1523.3	490.9	282.7	0.0
(Max)	V	29.2	58.4	87.6	116.8	135.6	139.0	143.6
Self wt. :	M	3098.5	2698.2	2030.9	1096.8	353.5	203.5	0.0
(Min)	V	21.0	42.0	63.0	84.1	97.6	100.1	103.4
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DC(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL-Prec. :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DW(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deck + :	M	6187.0	5387.6	4055.3	2190.0	705.8	406.4	0.0
Haunch (Max)	V	42.0	83.9	125.9	167.9	194.9	199.9	206.5
Deck + :	M	4454.6	3879.1	2919.8	1576.8	508.2	292.6	0.0
Haunch (Min)	V	30.2	60.4	90.6	120.9	140.3	143.9	148.7
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Max)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaphragm :	M	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Min)	V	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		0.60L	0.70L	0.80L	0.90L	H/2	Trans	Bearing
DL-Comp :	M	171.9	121.9	36.6	-84.0	-176.3	-196.7	-225.1
DC(Max)	V	2.5	5.3	8.1	10.9	12.7	13.0	13.5
DL-Comp :	M	123.7	87.8	26.4	-60.5	-126.9	-141.6	-162.1
DC(Min)	V	1.8	3.8	5.8	7.8	9.1	9.4	9.7
DL-Comp :	M	979.9	695.1	208.8	-479.0	-1005.1	-1121.3	-1283.5
DW(Max)	V	14.5	30.4	46.2	62.1	72.3	74.2	76.7
DL-Comp :	M	424.6	301.2	90.5	-207.6	-435.5	-485.9	-556.2
DW(Min)	V	6.3	13.2	20.0	26.9	31.3	32.2	33.2
LL + I :	M+	5064.8	3793.5	1988.6	808.2	648.9	671.1	725.2
	V	173.6	239.6	260.2	121.8	49.7	36.3	18.7
LL + I :	M-	-61.6	-79.4	-774.9	-3768.4	-6389.7	-6935.1	-7682.9
	V	1.6	3.0	137.5	322.3	391.1	403.8	420.7
LL + I :	Vmx	212.4	272.9	333.0	389.1	418.2	423.5	430.7
	M	4268.5	3210.5	1335.8	-1158.2	-2792.2	-3097.4	-3500.9
Total :	M+	16707.0	13745.7	9110.1	4253.5	1283.2	732.7	6.9
	V	261.7	417.6	528.0	479.4	420.6	416.8	411.8
Total :	M-	0.0	0.0	0.0	-1657.8	-6709.4	-7757.0	-9191.5
	V	0.0	0.0	0.0	540.8	714.0	735.1	762.9
Total :	Vmx	300.6	450.9	600.7	746.7	833.6	849.7	871.0
	M	15910.8	13162.7	8457.3	1992.1	-2776.8	-3726.2	-5009.5

REACTIONS (kips), STRENGTH I

Load Type		Left Support	Right Support
Self Wt.		143.6	143.6
Deck+Haunch		206.5	206.5
Diaphragm		0.0	0.0
DL-Prec.(DC)		0.0	0.0
DL-Prec.(DW)		0.0	0.0
DL-Comp.(DC)		206.5	90.9
DL-Comp.(DW)		1177.5	518.3
Live	(Max)	426.6	415.7
Live	(Min)	-123.8	-276.8
Pedestrian	(Max)	-0.0	-0.0
Pedestrian	(Min)	-0.0	-0.0

Upward reactions are positive.
Live Load reactions are per lane with no distribution factor and no impact.
Non-composite load types are per beam.
Composite and Pedestrian load types are per total bridge width.

LEVELING PAD

PER BRIDGE DESIGN MANUAL (14.2), LEVELING PADS FOR LOCKED IN GIRDERS SHALL BE DESIGNED FOR DEAD LOAD ONLY (NO LONGITUDINAL, TRANSVERSE OR ROTATIONAL MOMENTS).

DEFLECTION CRITERIA OF AASHTO CHAPTER 14 DO NOT NEED TO BE MET EITHER (PER RLO) (DESIGN MANUAL WILL BE CHANGED TO REFLECT THIS)

USE PLAIN ELASTOMERIC PAD (PEP)

$\sigma_s \leq 0.80$ ksi (14.7.6.3.2-1)

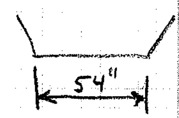
span length = 122'-6" U72C - A 12.26 SF

$DL \approx .15 k/ft^3 \left(\frac{122.5}{2}+.5\right)\left[12.26\ SF + 8''/12''/ft\ \underset{\text{max. phase 3}}{(33')}\right] + (3''/12'')\left(.\frac{1467\ k}{cf}\right)(33')\left(\frac{122.5}{2}+.5\right)$

$DL \approx 317.3 + 74.7$ k

$DL \approx 392.0$ K

min. Area $\approx \frac{392.0}{.8} \approx 490.0$ in^2



width = 54" max

length $\approx \frac{490.0}{54} \approx 9.07''$

use 9½" wide x 56"

$\sigma = \frac{392.0}{(56)(9\tfrac{1}{2})} = .74$ ksi

DEFLECTION

$S = \frac{LW}{2h_{ri}(L+W)} = \frac{(9.5)(56)}{2(.5)(9.5+56)} = 8.12$ (14.7.5.1-1)

$\epsilon = 3.4\%$ (Fig. C14.7.6.3.3-1)

$\delta = 3\epsilon h_{ri} = 3(.034).75 = .077'' \approx 1/16''$ (C14.7.6.3.3)

$\delta > .07 h_{ri}$ (14.7.6.3.3)

For CDP, the computed compressive strain, ε_s, may be taken as:

$$\varepsilon_s = \frac{\sigma_s}{E_c} \qquad (14.7.6.3.3\text{-}1)$$

where:

E_c = uniaxial compressive stiffness of the CDP bearing pad. It may be taken as 30 ksi in lieu of pad-specific test data (ksi)

σ_s = average compressive stress due to total load from applicable service load combinations in Table 3.4.1-1 (ksi)

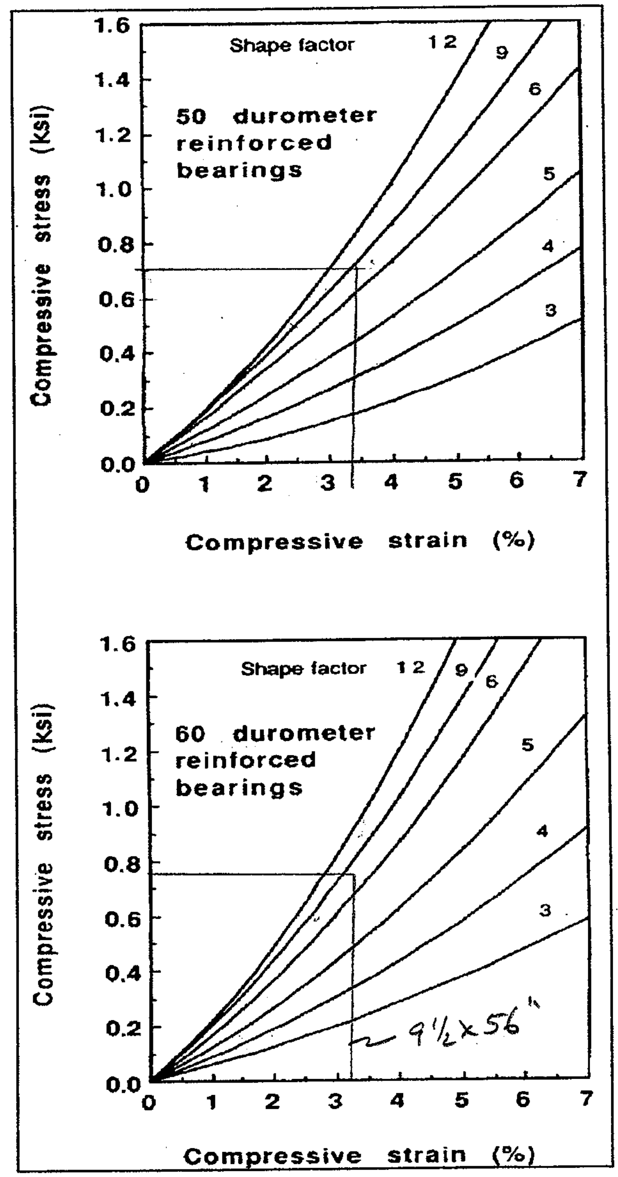


Figure C14.7.6.3.3-1 Stress-Strain Curves.

CDP is typically very stiff in compression. The shape factor may be computed, but it has a different meaning and less significance to the compressive deflection than it does for FGP and PEP (*Roeder et al., 2000*). As a result, the maximum compressive deflection for CDP can be based upon an average compressive strain, ε_s, for the total bearing pad thickness as computed in Eq. 1.

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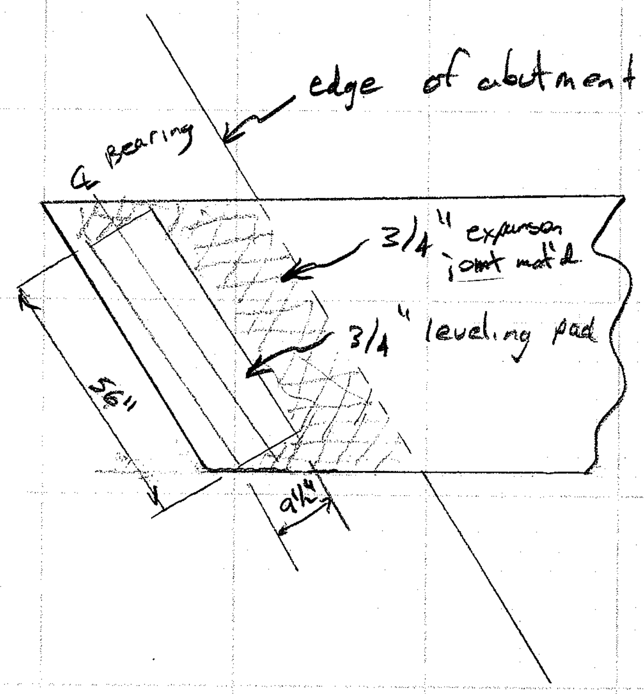
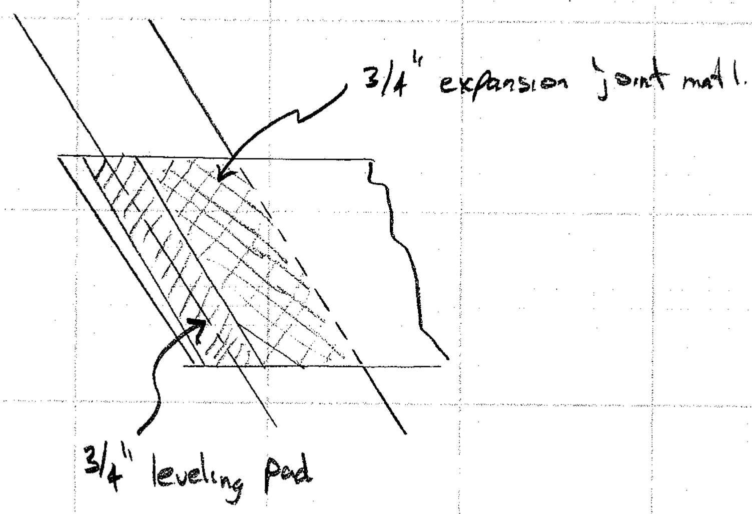
COLORADO DEPARTMENT OF TRANSPORTATION

DESIGN COMPUTATIONS (Grid)



or run continuous under girder



By:	Date	Project no.	Project code (SA#):
Chk'd:	Date	Structure no.	Sheet 416 of ____