Aric Heffelfinger
Fordham Place
Bronx, NY
Structural Option
Advisor - Dr. Hanagan

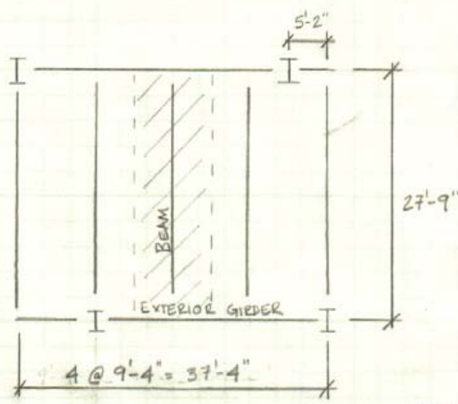
TABLE OF CONTENTS

Appendix

Gravity Load Spot Check

GRAVITY LOAD SPOT CHECK

* THERE IS NO "TYPICAL" BAY SO I RANDOMLY SELECTED A BAY ON THE 9TH FLOOR



CONCRETE
3" - 20 GA COMP. FLOOR DECK
+ 3¼" L.W. CONCRETE SLAB
TOTAL SLAB THK = 6¼"
f'_c = 3500 PSI
W_c = 115 PCF

STEEL
A992 f_y = 50 ksi

BEAM

W16x26

SELF = 115 PCF (3¼" + 1.5")(9'-4")/12 + 26 PLF

= 451 plf

SUPERIMPOSED DEAD LOAD = 30 PSF (9'-4") = 279 plf

TOTAL DL = 451 plf + 279 plf = 730 plf

LIVE LOAD = 60 PSF_{OFFICE} + 20 $PSF_{PARTITION}$ = 80 PSF (9'-4") = 747 plf

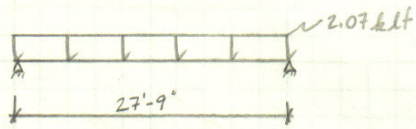
w_u = 1.2 D + 1.6 L
= 1.2(730) + 1.6(747)

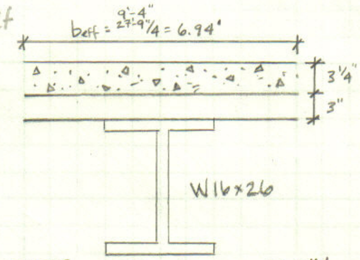
w_u = 2.07 klf

Aric Heffelfinger
Fordham Place
Bronx, NY
Structural Option
Advisor - Dr. Hanagan

GRAVITY LOAD
SPOT CHECK CONT'

BEAM CONT'





$$M_U = \frac{w_u l^2}{8} = \frac{(2.07\ klf)(27.75)^2}{8}$$

$$M_U = 199^{ft\text{-}k}$$

28 SHEAR STUDS ASSUME 17.7^k/STUD

$$\Sigma Q_n = 14(17.7) = 247.8^k$$

$$0.85 f'_c ba = \Sigma Q_n$$

$$a = \frac{247.8}{0.85(3.5)(6.94)(12)}$$

$$a = 1.00\ in$$

$$T = A_s f_y = (50)(7.68\ in^2) = 384^k$$

$$C_c = 0.85 f'_c ba = 0.85(3.5)(6.94')(12)(3.25) = 805^k$$

PNA IN CONC.

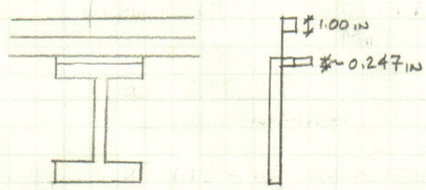
$$A_s f_y = 247^k$$

$$A_s = 247.8^k/50$$

$$A_s = 4.956\ in^2$$

$$\frac{7.68 - 4.95}{2} = (A_s)_{comp} = 1.362\ in^2$$

$$1.362/b_f = 1.362/5.5 = 0.247\ in$$ ALL IN FLANGE OF STEEL.



$$M_n = 0.85 f'_c ba(6.25 - a/2) + A_s f_y(d/2) - (0.247)(5.5)(f_y)(0.247/2)2$$
$$= 0.85(3.5)(83.3)(1.0)(6.25 - 0.5) + (384^k)(15.7/2) - (0.247)(5.5)(50)(0.247/2)(2)$$

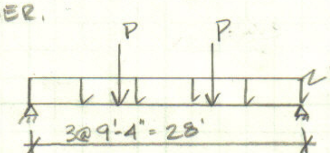
$$M_n = 368^{k\text{-}ft}$$

$$\phi M_n = 0.9(368) = 331.7^{k\text{-}ft} \qquad M_u = 199^{k\text{-}ft}$$

I ATTRIBUTE THE DIFFERENCE IN ϕM_n AND M_u TO THE DIFFERENCE IN DESIGNING WITH ASD TO LRFD. IN ASD, COMPOSITE DESIGN IS TAKEN AS 0.76 F_y, WHERE AS IN LRFD, COMPOSITE DESIGN IS AT FULL ULTIMATE CAPACITY. ASD DESIGN WOULD YIELD A MUCH STRONGER MEMBER (MORE CONSERVATIVE) THAN LRFD, HENCE THE MOMENT CAPACITY, ϕM_n, OF THE CURRENT SYSTEM DESIGNED WITH ASD, AND ANALYZED WITH LRFD.

GRAVITY LOAD
SPOT CHECK CONT'

EXTERIOR GIRDER.



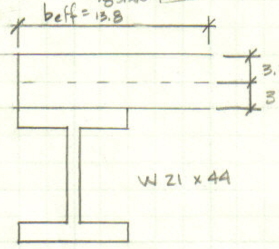
$P = \frac{w_u l}{2}$

$= \frac{(2.07\,klf)(27.75')}{2}$

$P = 28.7^k$

$M_U = Pa + w_{WALL} l^2/8$
$= (28.7^k)(9.\bar{3}') + (0.5)(28^2)/8$

$M_U = 317^{\,k\text{-}ft}$



48 - 3" SHEAR STUDS (17.7^k/STUD)

$\Sigma Q_n = 24(17.7^k) = 425^k$

$C_c = 0.85(3.5)(42")(3.25+1.5)$
$= 594^k$

$T_s = (13\,in^2)(50^{ksi})$
$= 650^k$

$a = \frac{\Sigma Q_n}{0.85 f'_c b} = \frac{425^k}{(0.85)(3.5)(42")}$

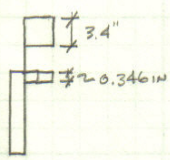
$a = 3.4\,in$

$A_s f_y = 425^k$
$A_s = 8.5\,in^2$

$(A_s)_c = \frac{13 - 8.5}{2} = 2.25\,in^2$

$\frac{(A_s)_c}{b_f} = 2.25/6.5 = 0.346\,in \le h_f = 0.45$

$\therefore$ ALL COMP. IN FLANGE



$M_n = 0.85 f'_c ba(6.25 - a/2) + A_s f_y(d/2) - (0.346)(6.5)(f_y)(0.346/2)(2)$

$= 0.85(3.5)(42)(3.4)(6.25 - 3.4/2) + (50)(13)(20.7/2) - (0.346)(6.5)(50)(0.346)$

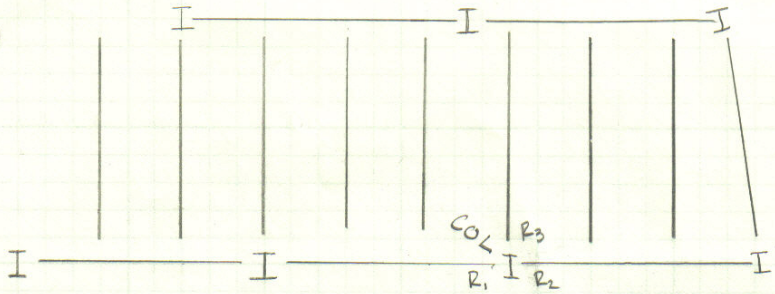
$M_n = 718$ ft-k

$\phi M_n = 0.9(718) = 647$ ft-k $\ge M_u = 317$ ft-k

I ATTRIBUTE THE DIFFERENCE IN M_U AND ϕM_n TO TWO THINGS. FIRST, I MADE THE ASSUMPTION THAT THE EXTERIOR GIRDER WAS SUPPORTING ONLY 1 STORY OF THE BRICK FACADE. WHEN THE NEW YORK CITY BUILDING CODE REQUIRES RELIEVING ANGLES AT LEAST EVERY 3 STORIES. THEREFORE I BELIEVE IT MAY BE DESIGNED FOR 3 STORIES. SECONDLY, SOME OF THE DIFFERENCE MAY BE COMING FROM DESIGNING WITH ASD AS OPPOSED TO LRFD AS WAS THE CASE WITH THE BEAM.

GRAVITY LOAD
SPOT CHECK CONT'

COLUMN



FROM PREVIOUS CALCULATIONS $R_1 = \frac{\omega_{wall}\, l}{2} + P$

$$= \frac{(0.5\,k/ft)(27.75')}{2} + 28.7^k$$

$$R_1 = 35.6^k$$

$R_2 \approx 35.6^k$ - A LITTLE CONSERVATIVE

$R_1 = R_2 = 35.6^k \qquad R_3 = 28.7^k$

TOTAL REACTION AT COLUMN FROM LOADING ON FLOOR 9

$R_9 = 2R_1 + R_3 = 100.1^k$

SINCE SLAB THICKNESS, FRAMING MEMBERS, SUPERIMPOSED DEAD LOADS, AND LIVE LOADS ARE THE SAME THROUGHOUT THE REMAINDER OF THE BUILDING, EACH FLOOR WILL CONTRIBUTE 100.1^k TO THAT COLUMN LOCATED BETWEEN THE 8^{TH} & 9^{TH} FLOOR.

$\therefore$

TOTAL AXIAL LOAD ON COLUMN

P_u = 7 FLOOR LOAD + ROOF = $7(100.1^k) + 13.7^k$

$P_u = 714^k$

* ASSUME BRACED FRAME PICKS UP ENTIRE LATERAL LOAD.

$\therefore$ COLUMN IS PURE AXIAL LOAD, NOT A BEAM COLUMN.

ASD DESIGN = W14x99 $\qquad \phi P_n = 1090^k \qquad P_u = 714^k$

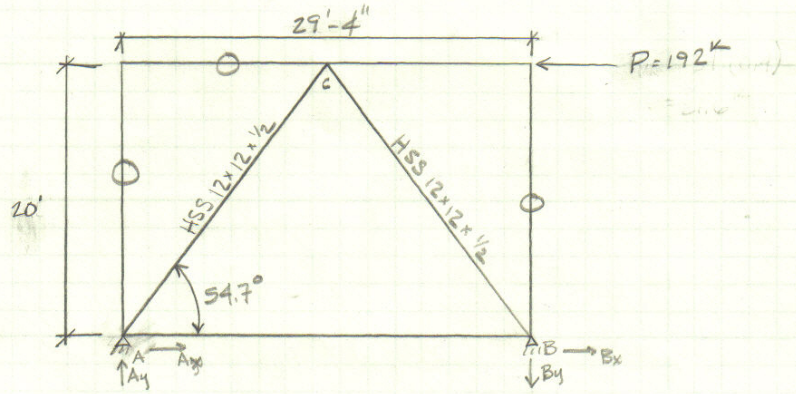
$l_b = 12.5'$

THE DIFFERENCE BETWEEN ϕP_n AND P_u IS ATTRIBUTED TO THE ASSUMPTION THAT THE COLUMN IS PURELY AXIALY LOADED. WITH THE ADDITION OF BENDING MOMENT, THE COLUMN AXIAL CAPACITY, ϕP_n WOULD DECREASE CLOSER TO P_u AS ϕM_n WOULD HAVE TO REACH AT LEAST M_u.

Lateral Load Spot Check

LATERAL LOAD SPOT CHECK

CHEVRON BRACING



ASSUMPTION: EACH OF 3 CHEVRON BRACED FRAMES WILL RECEIVE 40% OF LATERAL FORCE. 40% × 3 = 120% MAKING IT A CONSERVATIVE ESTIMATE.

TOTAL SHEAR AT GROUND LEVEL = 576^k

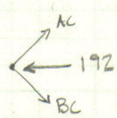
SHEAR PER FRAME = $576^k/3 = 192^k$

$\Sigma M_B = 0$

$A_y(29.\bar{3}) = 192^k(20')$

$A_y = 131^k \uparrow \quad B_y = 131^k \downarrow$

Pt C



$\Sigma F_y = 0$

$A_C = BC$

$\Sigma F_x = 0$

$2\, AC \cos(54.7) = 192$

$AC = 166^k$

$P_u = 166^k$

$l_b = 24.8\text{ft}$

$\phi P_n = 620^k$

THERE IS QUITE A DIFFERENCE BETWEEN ϕP_n AND P_u FOR MY LATERAL LOAD CHECK. THIS COULD BE FOR A NUMBER OF REASONS; 1) CERTAIN SIZE MEMBER NEEDED TO MAKE THE CONNECTION BIG ENOUGH, 2) ME DISTRIBUTING THE LOAD VERY CONSERVATIVELY, 3) DID NOT INCORPERATE GRAVITY LOADS INTO THE COLUMNS.

Lateral Load Calculations (Composite Steel Structure)

WIND

$K_{zt} = (1 + K_1 K_2 K_3)^2$ NO TOPOGRAPHIC FRACTOR

$K_{zt} = 1.0$

$I_{\bar{z}} = c\left(33\sqrt{\bar{z}}\right)^{1/6}$
$= (0.3)\left(33\sqrt{110.3}\right)^{1/6}$

TABLE 6-2
$c = 0.3$
$\ell = 320$ ft
$\bar{\epsilon} = 0.\bar{3}$

$h = 183.9$ ft
$B = 164$
$L = 112$ > OPPOSITE FOR E-W

$I_z = 0.795$

$\bar{z} = $ MAX $\left| \begin{array}{l} 0.6h = 0.6(183.9\text{ft}) = 110.3 \\ 30\text{ ft} \end{array} \right.$

$L_{\bar{z}} = \ell\left(\bar{z}/33\right)^{\bar{\epsilon}}$
$= 320\left(110.3/33\right)^{0.\bar{3}}$
$= 478$

$$Q = \sqrt{\frac{1}{1 + 0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}}$$

$$= \sqrt{\frac{1}{1 + 0.63\left(\frac{164 + 183.9}{478}\right)^{0.63}}}$$

$= 0.81$

$$G = 0.925\left(\frac{1 + 1.7 g_Q I_{\bar{z}} Q}{1 + 1.7 g_v I_{\bar{z}}}\right)$$

$g_v = g_Q = 3.4$

$$= 0.925\left(\frac{1 + 1.7(3.4)(0.795)(0.81)}{1 + 1.7(3.4)(0.795)}\right)$$

$G = 0.78$

$q_z = 0.00256\left(K_{zt} K_z K_d V^2 I\right)$
$= 0.00256\,(100)^2(1.0)(0.85)(1.0)K_z$

$V = 100$ MPH
$K_d = 0.85$
CAT II : $I = 1.0$
$K_z =$ VARIES

$q_z = 21.76 K_z$

$GC_{pi} = \pm 0.18$
WINDWARD $C_p = 0.8$
LEEWARD C_p (N-S) : $L/B = 112/164 = 0.68$ $C_p = -0.5$
LEEWARD C_p (E-W) : $L/B = 164/112 = 1.46$ $C_p = -0.3$

$P = qGC_p - q_i(GC_{pi})$

* SEE SPREADSHEET FOR THE REST OF WIND

SEISMIC

SEISMIC USE GROUP I
$I = 1.0$
SITE CLASS "D"

$S_1 = 9.5 = 0.095$ $\qquad$ $S_S = 43 = 0.43$
$F_V = 2.4$ $\qquad$ $F_A = 1.456$

$S_{M1} = F_V S_1 = (2.4)(0.095)$ $\qquad$ $S_{MS} = F_A S_S = (1.456)(0.43)$

$S_{M1} = 0.228$ $\qquad$ $S_{MS} = 0.626$

$S_{D1} = 2/3\, S_{M1} = 2/3\,(0.228)$ $\qquad$ $S_{DS} = 2/3\, S_{MS} = 2/3\,(0.626)$

$S_{D1} = 0.152$ $\qquad$ $S_{DS} = 0.417$

$W_{roof} = (\underbrace{60\text{ PSF}}_{DL} + \underbrace{18.9\text{ PSF}}_{SNOW})(7045\text{ ft}^2) = 556^k$
$W_{14\text{-}15} = (60\text{ PSF})(7045\text{ ft}^2) = 423^k$
$W_{8\text{-}13} = (60\text{ PSF})(9343\text{ ft}^2) = 561^k$
$W_7 = (60\text{ PSF})(9226\text{ ft}^2) = 554^k$
$W_{5\text{-}6} = (60\text{ PSF})(9483\text{ ft}^2) = 569^k$
$W_{3\text{-}4} = (60\text{ PSF})(13994\text{ ft}^2) = 840^k$
$W_2 = (60\text{ PSF})(14516\text{ ft}^2) = 871^k$
$W_1 = (60\text{ PSF})(15174\text{ ft}^2) = 910^k$

$W_{TOTAL} = 9921^k$

$R = 4.0$ STEEL CONCENTRICALLY BRACED FRAMES

$T = C_t h_n^x = (0.03)(207+15)^{0.75}$

$T = 1.725$ sec

$C_s = \dfrac{S_{DS}}{R/I} = \dfrac{0.417}{4.0} = 0.104$ BUT NOT MORE THAN

$C_{SMAX} = \dfrac{S_{D1}}{T(R/I)} = \dfrac{0.152}{(1.725)(4)} = 0.022$ AND NOT LESS THAN

$C_{SMIN} = 0.044\, I\, S_{DS} = 0.044(1.0)(0.417) = 0.018$

$C_s = 0.022$

SEISMIC CONT'

$V = C_s W$
$= (0.022)(9921)$

$V =$ BASE SHEAR $= 218^K$

$K = 1 + \frac{(1.725 - 0.5)}{2}$

$K = 1.61$

SEE SPREADSHEET FOR THE REST OF SEISMIC

ADOSS Output

```
02-20-** ADOSS(tm) 6.01  Proprietary Software of PORTLAND CEMENT ASSN.
Page   1
 6:08:47 PM Licensed to: ae, university park, PA




                pppppp    ccccc    aaaaa
                p     p  c     c  a     a
                p     p  c     c        a
                p     p  c         aaaaaa
                p     p  c     c  a     a
                p     p  c     c  a     a
                pppppp    ccccc    aaaaaa
                p
                p


         AAA    DDDDD      OOO     SSSSS    SSSSS
        A   A   D    D    O   O   S     S  S     S
       A     A  D     D  O     O  S        S
       AAAAAAA  D     D  O     O   SSSSS    SSSSS
       A     A  D     D  O     O        S        S   ( ttttt mm   mm  )
       A     A  D    D    O   O   S     S  S     S   (   t   m m m m  )
       A     A  DDDDD      OOO     SSSSS    SSSSS    (   t   m  m  m  )



*********************************************************

 Computer program for ANALYSIS AND DESIGN OF SLAB SYSTEMS

*********************************************************




     Licensee stated above acknowledges that Portland Cement
Association(PCA)
is not and cannot be responsible for either the accuracy or adequacy of
the
material supplied as input for processing by the ADOSS(tm) computer
program.
Furthermore, PCA neither makes any warranty expressed nor implied with
respect
```

to the correctness of the output prepared by the ADOSS(tm) program. Although PCA has endeavored to produce ADOSS(tm) error free the program is not and cannot be certified infallible. The final and only responsibility for analysis, design and engineering documents is the licensees. Accordingly, PCA disclaims all responsibility in contract, negligence or other tort for any analysis, design or engineering documents prepared in connection with the use of the ADOSS(tm) program.02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN. Page 2
6:08:47 PM Licensed to: ae, university park, PA

FILE NAME P:\THESIS\ADOSS\ADOSSF~1\GROUND\SLABS\13.ADS

PROJECT ID. Ground

SPAN ID. 10.0 11.0

ENGINEER Aric Heffelfinger

DATE 02/15/06
TIME 14:10:35

UNITS U.S. in-lb
CODE ACI 318-89

SLAB SYSTEM FLAT SLAB SYSTEM
FRAME LOCATION INTERIOR

DESIGN METHOD STRENGTH DESIGN
MOMENTS AND SHEARS NOT PROPORTIONED

NUMBER OF SPANS 7

SOLID HEAD DIMENSIONS : COMPUTED BY PROGRAM

CONCRETE FACTORS	SLABS	BEAMS	COLUMNS
DENSITY(pcf)	150.0	150.0	150.0
TYPE	NORMAL WGT	NORMAL WGT	NORMAL WGT
f'c (ksi)	4.0	4.0	4.0
fct (psi)	423.7	423.7	423.7
fr (psi)	474.3	474.3	474.3

REINFORCEMENT DETAILS: NON-PRESTRESSED
YIELD STRENGTH Fy = 60.00 ksi
DISTANCE TO RF CENTER FROM TENSION FACE:
AT SLAB TOP = 1.50 in OUTER LAYER
AT SLAB BOTTOM = 1.50 in OUTER LAYER
MINIMUM FLEXURAL BAR SIZE:

```
      AT SLAB TOP    =  # 4
      AT SLAB BOTTOM =  # 4
  MINIMUM SPACING:
      IN SLAB =   6.00 in
```

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN.
Page   3
 6:08:48 PM Licensed to: ae, university park, PA

SPAN/LOADING DATA
****

SPAN NUMBER	LENGTH L1 (ft)	Tslab (in)	WIDTH LEFT (ft)	L2*** RIGHT (ft)	SLAB SYSTEM	DESIGN STRIP (ft)	COLUMN STRIP** (ft)	UNIFORM LOADS S. DL (psf)	UNIFORM LOADS LIVE (psf)
1*	2.0	10.0	14.0	14.0	2	28.0	.0	30.0	80.0
2	25.3	10.0	14.0	14.0	2	28.0	12.6	30.0	80.0
3	27.8	10.0	14.0	14.0	2	28.0	13.9	30.0	80.0
4	27.8	10.0	14.0	14.0	2	28.0	13.9	30.0	80.0
5	27.8	10.0	14.0	14.0	2	28.0	13.9	30.0	80.0
6	22.0	10.0	14.0	14.0	2	28.0	11.0	30.0	80.0
7*	2.0	10.0	14.0	14.0	2	28.0	.0	30.0	80.0

* -Indicates cantilever span information.
** -Strip width used for positive flexure.
***-L2 widths are 1/2 dist. to transverse column.
"E"-Indicates exterior strip.

PARTIAL LOADING DATA
****

PARTIAL LOADINGS ARE NOT SPECIFIED

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN. Page 4
6:08:48 PM Licensed to: ae, university park, PA

COLUMN/TORSIONAL DATA
****

COLUMN NUMBER	COLUMN ABOVE SLAB C1 (in)	C2 (in)	HGT (ft)	COLUMN BELOW SLAB C1 (in)	C2 (in)	HGT (ft)	CAPITAL** EXTEN. (in)	DEPTH (in)	COLUMN STRIP* (ft)	MIDDLE STRIP* (ft)
1	26.0	26.0	10.0	26.0	26.0	15.5	.0	.0	12.6	15.4
2	26.0	26.0	10.0	26.0	26.0	15.5	.0	.0	12.6	15.4
3	26.0	26.0	10.0	26.0	26.0	15.5	.0	.0	13.9	14.1
4	26.0	26.0	10.0	26.0	26.0	15.5	.0	.0	13.9	14.1
5	26.0	26.0	10.0	26.0	26.0	15.5	.0	.0	11.0	17.0
6	26.0	26.0	10.0	26.0	26.0	15.5	.0	.0	11.0	17.0

Columns with zero "C2" are round columns.
* -Strip width used for negative flexure.
**-Capital extension distance measured from face of column.

COLUMN NUMBER	TRANSVERSE BEAM WIDTH (in)	DEPTH (in)	ECCEN (in)	DROP PANEL/SOLID HEAD LEFT (ft)	RIGHT (ft)	WIDTH (ft)	THICK (in)	SUPPORT FIXITY* %
1	.0	.0	.0	2.0	4.2	9.3	5.5	100%

```
|    2   |     .0     .0     .0 |      4.2        4.6        9.3    5.5 |
100%  |
|    3   |     .0     .0     .0 |      4.6        4.6        9.3    5.5 |
100%  |
|    4   |     .0     .0     .0 |      4.6        4.6        9.3    5.5 |
100%  |
|    5   |     .0     .0     .0 |      4.6        3.7        9.3    5.5 |
100%  |
|    6   |     .0     .0     .0 |      3.7        2.0        9.3    5.5 |
100%  |
|________|___________________|____________________________________|____
______|

* -Support fixity of 0% denotes pinned condition.
   Support fixity of 999% denotes fixed end condition.

02-20-** ADOSS(tm) 6.01  Proprietary Software of PORTLAND CEMENT ASSN.
Page   5
 6:08:48 PM Licensed to: ae, university park, PA

                           LATERAL LOAD/OUTPUT DATA
                           ************************

LATERAL LOADS ARE NOT SPECIFIED



OUTPUT DATA
PATTERN LOADINGS:                1 THRU 4
PATTERN LIVE LOAD FACTOR (1-3)  =    75%

LOAD FACTORS:
  U = 1.20*D + 1.60*L
  U =  .75( 1.20*D + 1.60*L + 1.70*W)
  U =  .90*D + 1.30*W


OUTPUT OPTION(S):
  Input Echo
  Centerline Moments and Shears
  Column Strip Distribution Fac
  Shear Table
  Reinforcing Required
  Bar Sizing
  Additional Information
  Deflections
  Material Quantities

**TOTAL UNFACTORED DEAD LOAD =         608.752 kips
                   LIVE LOAD =         301.280 kips
```

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN. Page 6
6:08:48 PM Licensed to: ae, university park, PA

---- STATICS PRINT-OUT FOR GRAVITY LOAD ANALYSIS ----
****

J O I N T   M O M E N T S (ft - kips)

JOINT NUMBER	PATTERN-1 LEFT	RIGHT	TOP	BOTTOM	PATTERN-2 LEFT	RIGHT	TOP	BOTTOM
1	-17.0	323.8	-182.7	-124.1	-17.0	175.4	-94.3	-64.1
2	-600.4	611.0	-6.3	-4.3	-453.7	564.6	-66.0	-44.8
3	-614.5	614.1	.2	.2	-546.1	415.6	77.7	52.8
4	-619.4	625.1	-3.4	-2.3	-420.6	556.4	-80.9	-55.0
5	-577.7	504.5	43.5	29.6	-544.2	395.4	88.6	60.2
6	-226.3	17.0	124.6	84.6	-108.6	17.0	54.5	37.0

JOINT NUMBER	PATTERN-3 LEFT	RIGHT	TOP	BOTTOM	PATTERN-4 LEFT	RIGHT	TOP	BOTTOM
1	-11.7	326.4	-187.4	-127.3	-18.8	335.2	-188.4	-128.0
2	-529.3	410.9	70.5	47.9	-657.0	651.9	3.0	2.1
3	-420.9	550.1	-76.9	-52.2	-646.2	645.3	.6	.4
4	-558.9	439.2	71.3	48.4	-654.6	665.3	-6.4	-4.4
5	-375.0	426.5	-30.7	-20.8	-614.3	549.3	38.7	26.3
6	-228.9	11.7	129.4	87.9	-225.4	18.8	123.0	83.6

J O I N T   S H E A R S (kips)

JOINT NUMBER	PATTERN-1 LEFT	RIGHT	PATTERN-2 LEFT	RIGHT	PATTERN-3 LEFT	RIGHT	PATTERN-4 LEFT	RIGHT

1	-16.8	93.9	-16.8	57.4	-11.4	94.3	-18.6 100.9
2	-114.4	115.5	-79.5	113.2	-110.4	74.9	-126.4 125.2
3	-115.6	115.5	-111.9	75.1	-75.6	112.3	-124.8 124.7
4	-115.9	116.7	-75.5	113.0	-112.9	77.6	-125.3 126.8
5	-113.7	103.1	-112.1	72.6	-73.0	98.1	-123.2 113.7
6	-79.6	16.8	-46.5	16.8	-80.2	11.4	-84.3 18.6

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN. Page 7
6:08:48 PM Licensed to: ae, university park, PA

DESIGN MOMENT ENVELOPES AT CRITICAL SECTIONS FROM SUPPORTS

COL NUM	LOAD TYPE	CROSS SECTN	DESIGN MOMENT (ft-k)	DISTANCE CR.SECTN (ft)	LOAD PTRN	MAX.I.P. DISTANCE (ft)	LOAD PTRN
1	TOTL LEFT	TOP	-12.9	.350	4	2.000	1
		BOT	.0	.000	0	.000	0
	RGHT	TOP	231.2	1.083	4	3.787	2
		BOT	.0	.000	0	.000	0
2	TOTL LEFT	TOP	-525.4	1.083	4	7.575	2
		BOT	.0	.000	0	.000	0

```
                   RGHT   TOP       521.7        1.083        4        8.325
3
                          BOT          .0         .000        0         .000
0

    3      TOTL LEFT   TOP      -516.4        1.083        4        8.325
3
                          BOT          .0         .000        0         .000
0

                   RGHT   TOP       515.6        1.083        4        8.325
2
                          BOT          .0         .000        0         .000
0

    4      TOTL LEFT   TOP      -524.2        1.083        4        8.325
2
                          BOT          .0         .000        0         .000
0

                   RGHT   TOP       533.3        1.083        4        8.325
3
                          BOT          .0         .000        0         .000
0

    5      TOTL LEFT   TOP      -486.3        1.083        4        6.938
2
                          BOT          .0         .000        0         .000
0

                   RGHT   TOP       431.5        1.083        4        7.700
2
                          BOT          .0         .000        0         .000
0

    6      TOTL LEFT   TOP      -146.9        1.083        3        3.300
2
                          BOT          .0         .000        0         .000
0

                   RGHT   TOP        12.9         .350        4        2.000
1
                          BOT          .0         .000        0         .000
0

 ----------------------------------------------------------------------
--------
```

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN.

6:08:48 PM Licensed to: ae, university park, PA

DESIGN MOMENT ENVELOPES AT CRITICAL SECTIONS ALONG SPANS

SPAN NUM	LOAD TYPE	CRITICAL SECTION (ft)		DESIGN MOMENT (ft-k)	LOAD PTRN	MAX. I.P. DIST LEFT (ft)	LOAD PTRN	MAX. I.P. DIST RGHT (ft)	LOAD PTRN
2	TOTL	10.731	TOP	.0	0	.000	0	.000	0
			BOT	221.3	4	6.944	1	8.206	3
3	TOTL	14.569	TOP	.0	0	.000	0	.000	0
			BOT	213.2	2	7.631	1	6.244	1
4	TOTL	13.181	TOP	.0	0	.000	0	.000	0
			BOT	213.8	3	6.244	1	7.631	1
5	TOTL	14.569	TOP	.0	0	.000	0	.000	0
			BOT	218.0	2	7.631	1	6.244	1
6	TOTL	12.650	TOP	.0	0	.000	0	.000	0
			BOT	163.2	4	7.150	3	6.050	1

DISTRIBUTION OF DESIGN MOMENTS AT SUPPORTS
****

COL NUM	CROSS SECTN		TOTAL MOMENT (ft-k)	TOTAL-VERT DIFFERENCE (ft-k)	(%)	COLUMN STRIP MOMENT (ft-k)	(%)	BEAM MOMENT (ft-k)	(%)	MIDDLE STRIP MOMENT (ft-k)	(%)
1	LEFT	TOP	-12.9	.0	(0)	-12.4	(96)	.0	(0)	-.5	(3)
		BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT	TOP	231.2	.0	(0)	222.9	(96)	.0	(0)	8.3	(3)
		BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
2	LEFT	TOP	-525.4	.0	(0)	-394.0	(75)	.0	(0)	-131.3	(25)
		BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT	TOP	521.7	.0	(0)	391.2	(75)	.0	(0)	130.4	(25)
		BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
3	LEFT	TOP	-516.4	.0	(0)	-387.3	(75)	.0	(0)	-129.1	(25)
		BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT	TOP	515.6	.0	(0)	386.7	(75)	.0	(0)	128.9	(25)
		BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
4	LEFT	TOP	-524.2	.0	(0)	-393.1	(75)	.0	(0)	-131.0	(25)

```
             BOT      .0      .0 (   0)      .0 (   0)      .0 (   0)
.0 (   0)

      RGHT TOP   533.3      .0 (   0)   400.0 ( 75)      .0 (   0)
133.3 ( 25)
             BOT      .0      .0 (   0)      .0 (   0)      .0 (   0)
.0 (   0)

   5  LEFT TOP  -486.3      .0 (   0)  -364.7 ( 75)      .0 (   0)  -
121.6 ( 25)
             BOT      .0      .0 (   0)      .0 (   0)      .0 (   0)
.0 (   0)

      RGHT TOP   431.5      .0 (   0)   323.6 ( 75)      .0 (   0)
107.9 ( 25)
             BOT      .0      .0 (   0)      .0 (   0)      .0 (   0)
.0 (   0)

   6  LEFT TOP  -146.9      .0 (   0)  -141.6 ( 96)      .0 (   0)    -
5.3 (   3)
             BOT      .0      .0 (   0)      .0 (   0)      .0 (   0)
.0 (   0)

      RGHT TOP    12.9      .0 (   0)    12.4 ( 96)      .0 (   0)
.5 (   3)
             BOT      .0      .0 (   0)      .0 (   0)      .0 (   0)
.0 (   0)

-----------------------------------------------------------------------
---------
```

DISTRIBUTION OF DESIGN MOMENTS IN SPANS

SPAN NUM	CROSS SECTN		TOTAL MOMENT (ft-k)	TOTAL-VERT DIFFERENCE (ft-k)	(%)	COLUMN STRIP MOMENT (ft-k)	(%)	BEAM MOMENT (ft-k)	(%)	MIDDLE STRIP MOMENT (ft-k)	(%)
2	10.73	TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
		BOT	221.3	.0	(0)	132.8	(60)	.0	(0)	88.5	(39)
3	14.57	TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
		BOT	213.2	.0	(0)	127.9	(60)	.0	(0)	85.3	(39)
4	13.18	TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
		BOT	213.8	.0	(0)	128.3	(60)	.0	(0)	85.5	(39)
5	14.57	TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
		BOT	218.0	.0	(0)	130.8	(60)	.0	(0)	87.2	(40)
6	12.65	TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
		BOT	163.2	.0	(0)	97.9	(60)	.0	(0)	65.3	(39)

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN. Page 11
6:08:48 PM Licensed to: ae, university park, PA

S H E A R   A N A L Y S I S
****

NOTE--Allowable shear stress in slabs = 252.96 psi when ratio of col. dim. (long/short) is less than 2.0.

--Wide beam shear (see "CODE") is not computed, check manually.

--After the column numbers, C = Corner, E = Exterior, I = Interior.

D I R E C T   S H E A R   W I T H   T R A N S F E R   O F   M O M E N T
- - - - - - - - - -   A R O U N D   C O L U M N   - - - - - - - - - -

COL. NO.	ALLOW. STRESS (psi)	PATT NO.	REACTION (kips)	SHEAR STRESS (psi)	PATT NO.	REACTION (kips)	UNBAL. MOMENT (ft-k)	SHEAR TRANSFR (ft-k)	SHEAR STRESS (psi)
1E	252.96	4	115.7	81.04	4	115.7	250.0	100.0	140.42
2I	252.96	4	248.3	130.43	4	248.3	-5.1	-2.0	131.36
3I	252.96	4	246.2	129.28	4	246.2	-.9	-.4	129.45
4I	252.96	4	248.9	130.71	4	248.9	10.8	4.3	132.68
5I	252.96	4	233.6	122.67	4	233.6	-65.0	-26.0	134.59
6E	252.96	4	99.0	69.36	4	99.0	-149.5	-59.8	104.87

- - AROUND DROP/SOLID HEAD - -

COLUMN NUMBER	ALLOW. STRESS (psi)	PATT NO.	REACTION (kips)	SHEAR STRESS (psi)
1E	184.48	4	94.8	47.18
2I	172.22	4	215.5	63.45
3I	171.27	4	211.7	61.03
4I	171.27	4	214.4	61.81
5I	173.53	4	202.8	61.43
6E	187.33	4	80.2	41.89

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN. Page 12
6:08:48 PM Licensed to: ae, university park, PA

N E G A T I V E   R E I N F O R C E M E N T

<table>
<tr><th>COLUMN NUMBER</th><th>PATT NO.</th><th>LOCATION @COL FACE</th><th>TOTAL DESIGN (ft-k)</th><th>COLUMN STRIP AREA (sq.in)</th><th>COLUMN STRIP WIDTH (ft)</th><th>MIDDLE STRIP AREA (sq.in)</th><th>MIDDLE STRIP WIDTH (ft)</th></tr>
<tr><td>1</td><td>4</td><td>|| R</td><td>231.2</td><td>3.84</td><td>12.6</td><td>3.32</td><td>15.4</td></tr>
<tr><td>2</td><td>4</td><td>L ||</td><td>-525.4</td><td>6.49</td><td>12.6</td><td>3.50</td><td>15.4</td></tr>
<tr><td>3</td><td>4</td><td>L ||</td><td>-516.4</td><td>6.38</td><td>13.9</td><td>3.45</td><td>14.1</td></tr>
<tr><td>4</td><td>4</td><td>|| R</td><td>533.3</td><td>6.59</td><td>13.9</td><td>3.56</td><td>14.1</td></tr>
<tr><td>5</td><td>4</td><td>L ||</td><td>-486.3</td><td>5.99</td><td>11.0</td><td>3.67</td><td>17.0</td></tr>
<tr><td>6</td><td>3</td><td>L ||</td><td>-146.9</td><td>3.48</td><td>11.0</td><td>3.67</td><td>17.0</td></tr>
</table>

P O S I T I V E   R E I N F O R C E M E N T

SPAN NUMBER	PATT NO.	LOCATION FROM LEFT (ft)	TOTAL DESIGN (ft-k)	COLUMN STRIP AREA (sq.in)	COLUMN STRIP WIDTH (ft)	MIDDLE STRIP AREA (sq.in)	MIDDLE STRIP WIDTH (ft)
2	4	10.7	221.3	3.56	12.6	3.32	15.4
3	2	14.6	213.2	3.42	13.9	3.05	14.1
4	3	13.2	213.8	3.43	13.9	3.05	14.1
5	2	14.6	218.0	3.50	13.9	3.05	14.1
6	4	12.6	163.2	2.61	11.0	3.67	17.0

02-20-** ADOSS(tm) 6.01 Proprietary Software of PORTLAND CEMENT ASSN. Page 13
6:08:48 PM Licensed to: ae, university park, PA

D E S I G N   R E S U L T S

NOTE--The schedule given below is a guide for proper reinforcement placement and is based on reasonable engineering judgement. Unusual boundary and/or loading conditions may require modification of this schedule.

N E G A T I V E   R E I N F O R C E M E N T

COLUMN NUMBER	COLUMN STRIP LONG BARS NO	SIZE	LEFT (ft)	RIGHT (ft)	COLUMN STRIP SHORT BARS NO	SIZE	LEFT (ft)	RIGHT (ft)	MIDDLE STRIP LONG BARS NO	SIZE	LEFT (ft)	RIGHT (ft)
1	10	# 4	2.00	8.70	9	# 4	2.00	5.70	17	# 4	2.00	6.16
2	11	# 5	9.53	9.92	10	# 5	6.20	6.20	18	# 4	9.17	9.92
3	11	# 5	9.92	9.92	10	# 5	6.20	6.20	18	# 4	9.92	9.92
4	11	# 5	9.92	9.92	11	# 5	6.20	6.20	18	# 4	9.92	9.92
5	7	# 6	9.53	9.53	7	# 6	6.20	6.20	19	# 4	8.54	9.30
6	9	# 4	7.63	2.00	9	# 4	5.05	2.00	19	# 4	5.45	2.00

P O S I T I V E   R E I N F O R C E M E N T

SPAN	COLUMN STRIP LONG BARS ---- B A R ----	COLUMN STRIP SHORT BARS ---- B A R ----	MIDDLE STRIP LONG BARS ---- B A R ----	MIDDLE STRIP SHORT BARS ---- B A R ----

NUMBER	NO	SIZE	LENGTH (ft)	NO	SIZE	LENGTH (ft)	NO	SIZE	LENGTH (ft)	NO	SIZE	LENGTH (ft)
2	9	# 4	21.51	9	# 4	21.51	9	# 4	24.92	8	# 4	20.88
3	9	# 4	20.81	8	# 4	20.81	8	# 4	28.25	8	# 4	19.42
4	9	# 4	20.81	8	# 4	20.81	8	# 4	28.25	8	# 4	19.42
5	9	# 4	20.81	9	# 4	20.81	8	# 4	28.25	8	# 4	19.42
6	7	# 4	18.75	6	# 4	18.75	10	# 4	21.67	9	# 4	18.12

```
02-20-** ADOSS(tm) 6.01  Proprietary Software of PORTLAND CEMENT ASSN.
Page  14
 6:08:48 PM Licensed to: ae, university park, PA

       A D D I T I O N A L   I N F O R M A T I O N   A T  S U P P O R T
S

******************************************************************

        * REINF. SUMMARY* ADD'L R/F REQ'D DUE TO UNBALANCED (U.) MOMENT
TRANSFER
 COLUMN * --------------* ---------------------------------------------
---------
 NUMBER * W/O U. MOMENT * MAX.U. *GAMMA* FLEXURAL  *PATT* CRITICAL
SECTION
        * REQ'D - PROV'D* MOMENT * -f  * TRANSFER  *NO. * SLABW  - AREA
-  R/F
        *(sq.in) (sq.in)* (ft-k) *     *  (ft-k) *    * (ft)   (sq.in)
-----------------------------------------------------------------------
--------
   1       7.16     7.20   316.4    .60    189.8      4     6.0    3.10
7  # 4
   2       9.99    10.11  -118.4    .60    -71.1      3     6.0    1.14
0  # 5
   3       9.82    10.11  -130.5    .60    -78.3      2     6.0    1.26
0  # 5
   4      10.16    10.42   135.9    .60     81.5      2     6.0    1.31
0  # 5
   5       9.66     9.96  -148.8    .60    -89.3      2     6.0    1.44
0  # 6
   6       7.16     7.40  -217.2    .60   -130.3      3     6.0    2.11
2  # 4

 NOTE: Zero transfer "CRITICAL SLABW" indicates no support dimensions
       given for transfer.
       If beam(s) are present, transfer mode may be due to beam shear
       and/or torsion, check manually.


              A D D I T I O N A L   I N F O R M A T I O N   F O R
                      I N - S P A N   C O N D I T I O N S
              ***************************************************

                    *  REINF.  SUMMARY  *
              SPAN  * ----------------- *   TOTAL FACTORED SPAN
              NUMBER*     AT MIDSPAN    *   STATIC DESIGN MOMENT
                    *  REQ'D. - PROV'D. *   (W/O PARTIAL LOADS)
                    * (sq.in)   (sq.in) *          (ft-k)
              --------------------------------------------------
                2       6.88      7.00                585.6
                3       6.47      6.60                719.3
```

4	6.48	6.60	719.3
5	6.55	6.80	719.3
6	6.29	6.40	432.3

D E F L E C T I O N   A N A L Y S I S

NOTES--The deflections below must be combined with those of the analysis in the perpendicular direction. Consult users manual for method of combination and limitations.

--Spans 1 and 7 are cantilevers.

--Time-dependent deflections are in addition to those shown and must be computed as a multiplier of the dead load(DL) deflection. See "CODE" for range of multipliers.

--Deflections due to concentrated or partialloads may be larger at the point of application than those shown at the centerline. Deflections are computed as from an average uniform loading derived from the sum of all loads applied to the span.

--Modulus of elasticity of concrete, Ec = 3834. ksi

SPAN NUMBER	DEAD LOAD Ieff. (in^4)	COLUMN STRIP DEFLECTION DUE TO: DEAD (in)	COLUMN STRIP LIVE (in)	COLUMN STRIP TOTAL (in)	MIDDLE STRIP DEFLECTION DUE TO: DEAD (in)	MIDDLE STRIP LIVE (in)	MIDDLE STRIP TOTAL (in)
1	60819.	-.013	-.007	-.019	-.013	-.007	-.020
2	44410.	.099	.070	.169	.045	.029	.074
3	44410.	.096	.105	.201	.045	.049	.095
4	44410.	.096	.105	.200	.045	.049	.094
5	44410.	.102	.103	.205	.051	.050	.101

```
     6        44410.     .060      .034      .093       .020      .011
.032
     7        60819.    -.008     -.004     -.013      -.008     -.004    -
.013


                    Q U A N T I T Y   E S T I M A T E S
                    ***********************************

         TOTAL QUANTITIES
         ----------------
         CONCRETE        ....      123.8 cu.yd
         FORMWORK        ....     3861.  sq.ft
         REINFORCEMENT (IN THE DIRECTION OF ANALYSIS)
          (NEGATIVE)     ....     2749.  lbs
          (POSITIVE)     ....     2424.  lbs

         SUMMARY OF QUANTITIES
         ---------------------
         CONCRETE        ....        .89  cu.ft/sq.ft
         FORMWORK        ....       1.03  sq.ft/sq.ft
         REINFORCEMENT** ....       1.37  lbs / sq.ft

           **(IN THE DIRECTION OF ANALYSIS)

                       * Program completed as requested *
```

PCA COL OutPut

02/22/06 PCACOL(tm)V2.30 Proprietary Software of PORTLAND CEMENT ASSN.
Page 1
15:28:25 Licensed to: ae, university park, PA

```
            0000000    00000    00000    00000    00000   00
            00     00  00    00 00    00 00    00 00    00 00
            00     00  00    00 00    00 00    00 00    00 00
            00     00  00       00    00 00       00    00 00
            00     00  00       0000000  00       00    00 00
            0000000    00    00 00    00 00    00 00    00 00
            00         00    00 00    00 00    00 00    00 00
            00          00000   00    00  00000    00000   00000  (TM)
```

==
=
    Computer program for the Strength Design of Reinforced Concrete
Sections

==
=

02/22/06 PCACOL(tm)V2.30 Proprietary Software of PORTLAND CEMENT ASSN.
Page 2
15:28:25 Licensed to: ae, university park, PA

General Information:
====================

File Name: P:\4KSI2011.COL
Project: Ground — Code: ACI 318-89
Column: lSpan 3, Column Above — Units: US in-lbs
Engineer: Aric Heffelfinger — Date: 02/22/06 Time: 15:23:28

Run Option: Design — Short (nonslender) column
Run Axis: Biaxial — Column Type: User-defined

Material Properties:
====================

f'c = 4 ksi — fy = 60 ksi
Ec = 3834.25 ksi — Es = 29000 ksi
fc = 3.4 ksi — erup = 0 in/in
eu = 0.003 in/in
Stress Profile: Parabolic

Geometry:
=========

Rectangular: Width = 26 in — Depth = 26 in

Gross section area, Ag = 676 in^2
Ix = 38081.3 in^4 — Xo = 0 in
Iy = 38081.3 in^4 — Yo = 0 in

Reinforcement:
==============

Rebar Database: ASTM

Size	Diam	Area	Size	Diam	Area	Size	Diam	Area
3	0.38	0.11	4	0.50	0.20	5	0.63	0.31
6	0.75	0.44	7	0.88	0.60	8	1.00	0.79
9	1.13	1.00	10	1.27	1.27	11	1.41	1.56
14	1.69	2.25	18	2.26	4.00			

Confinement: User-defined; phi(c) = 0.7, phi(b) = 0.9, a = 0.8

#3 ties with #10 bars, #4 with larger bars.

Layout: Rectangular
Pattern: All Sides Equal [Cover to transverse reinforcement (ties)]

Total steel area, As = 31.20 in^2 at 4.62%

20-#11 Cover = 0.75 in

02/22/06 PCACOL(tm)V2.30 Proprietary Software of PORTLAND CEMENT ASSN. Page 3
15:28:25 Licensed to: ae, university park, PA

	Applied Loads			Computed Strength			Computed/
	P	Mx	My	P	Mx	My	Applied
Pt.	(kips)	(ft-k)	(ft-k)	(kips)	(ft-k)	(ft-k)	Ray length
1	2500	120	50	2276	108	45	0.911

Program completed as requested!

Seismic Calculations (All Concrete Structure)

Self Weight

	slab volume	drop volume	column volume	Shear wall volume	Weight
Roof	3680	0	507	911.25	764.7375
15th	5520	458.333333	1014	1822.5	1322.225
14th	7086	733.333333	1267.5	2187	1691.075
13th	7086	733.333333	1267.5	2187	1691.075
12th	7086	733.333333	1267.5	2187	1691.075
11th	7086	733.333333	1267.5	2187	1691.075
10th	7086	733.333333	1267.5	2187	1691.075
9th	7086	733.333333	1267.5	2187	1691.075
8th	7086	733.333333	1267.5	2187	1691.075
7th	7086	733.333333	1267.5	2187	1691.075
6th	7086	733.333333	1267.5	2187	1691.075
5th	10185	1100	1774.5	2187	2286.975
4th	10185	1100	1774.5	2187	2286.975
3rd	11750.25	1283.33333	1964.625	2187	2577.781
2nd	11175	1191.66667	1964.625	2187	2477.744
Mezz.	2651.25	320.833333	1964.625	2187	1068.556
Ground	11750.25	1283.33333	1964.625	2187	0
					28004.67

Seismic Analysis

Assumptions:
Occupancy Category I (Table 1-1)
Seismic Use Group I (Table 9.1.3)
Importance Factor = 1.0 (Table 9.1.4)
Site Class D (Table 9.4.1.2)
Ordinary Reinforced Concrete Shear Walls

Ss = 0.43 (Figure 9.4.1.1a)
S1 = 0.095 (Figure 9.4.1.1b)

Sms = 0.626
Sm1 = 0.228

Sds = 0.417
Sd1 = 0.152

T = 1.07
Cs = 0.03551

Ss = 0.43 (Figure 9.4.1.1a)
S1 = 0.095 (Figure 9.4.1.1b)

Sms = 0.626
Sm1 = 0.228

Sds = 0.417
Sd1 = 0.152

T = 1.07
Cs = 0.03551

Seismic Design Category B

Effective Seismic Weight of Structure (9.5.3)

W_{TOTAL} = 28004 k

Seismic Base Shear (9.5.5.2)

$V = C_s W$

V = 994 k

Level	w_x (k)	h_x	$w_x h_x^k$	C_{vx}	F_x (k)
B	0	0	0	0	0
Mezz.	1068	14.5	15486	0.00492	5
2	2477	34.25	84837.25	0.026953	27
3	2577	50	128850	0.040936	41
4	2286	63.75	145732.5	0.046299	46
5	2286	77.5	177165	0.056285	56
6	1691	91	153881	0.048888	49
7	1691	104.5	176709.5	0.056141	56
8	1691	117	197847	0.062856	63
9	1691	129.5	218984.5	0.069572	69
10	1691	142	240122	0.076287	76
11	1691	154.5	261259.5	0.083002	83
12	1691	167	282397	0.089718	89
13	1691	179.5	303534.5	0.096433	96
14	1691	192	324672	0.103149	103
15	1322	204.5	270349	0.08589	85
roof	764	217	165788	0.052671	52
Σ=	27999	Σ=	3147615		

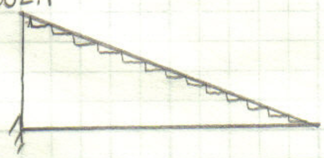
Shear wall Design Calculations

SHEAR WALL DESIGN

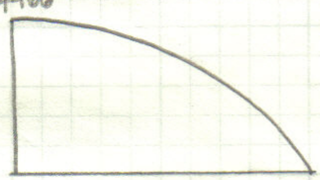
$V_u = 502.1^k$

$M_u = 64466\ ^{k\text{-}ft}$

502.1^k



$64466\ ^{k\text{-}ft}$



SHEAR DESIGN

$V_u \leq \phi V_n = \phi (V_c + V_s)$

$\frac{V_u}{\phi} \leq V_c + V_s$

$\frac{502.1}{0.75} \leq V_c + V_s$

$V_c = 2\sqrt{f'_c}\ hd$

$= 2\sqrt{4000}\,(8'')(0.8)(27)(12)$

$V_c = 262.3^k$

$V_s \geq 669.5^k - 262.3^k$

$V_s \geq 407.2^k$

$V_s \geq 407.2^k = \frac{A_v f_y d}{s}$

$\frac{(407.2^k)(12'')}{(60)(27)(0.8)(12)} = A_v$

$A_v = 0.31\ in^2/ft$

USE #5's @ 12"

FLEXURAL DESIGN

$M_u = 64466^{k\text{-}ft} = A_s f_y (d - a/2)$

$A_s = 53.7\ in^2$

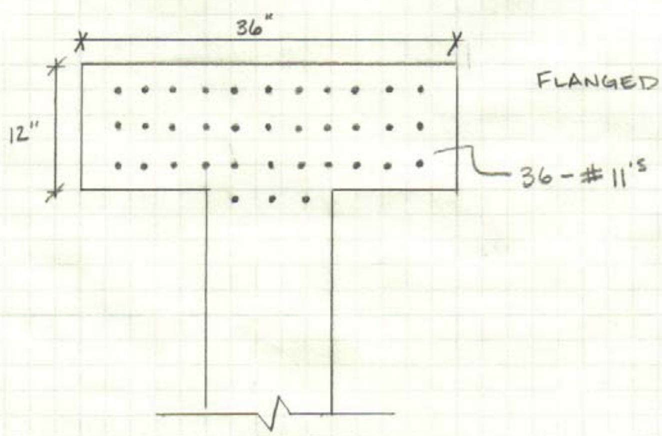
36 - #11's

$A_s = 56.2\ in^2$

$A_s f_y = 0.85 f'_c\, b\, a$

$(56.2\ in^2)(60) = 0.85(4)(12)\, a$

$a = 82.6\ in = 6.9\ ft$



FLANGED SHEAR WALL

**** Shear wall load distribution table can be viewed as an excel spreadsheet on my webpage. It is too large to fit on an 8.5" x 11" piece of paper.

Concrete structure cost breakdown

EDF Report - Standard Construction Project

Estimator : User
Project Size : sqft
Date : 3/28/2006
Time : 02:12 PM

Group 1: Divisions
Group 2: Major ItemCode Groups
Group 3: Minor ItemCode Groups
Group 4: Alternates

ItemCode	Description	Quantity	UM	Labor$	MH/Unit	Units/MH
Concrete						
Structural CIP forms						
Structural CIP forms						
Alternates Blank						
03111.118	WALL FORM 20'+ HIGH	72,912.00	SQFT	3.8747	0.147947	6.75918
03111.189	WALL FORM HARDWARE	36,456.00	SQFT			
03111.203	WOOD COLUMN FORMS, 12'-16'	44,165.33	SQFT	1.1524	0.044	22.72727
03111.612	SLAB FORM W/2.6 BM/SF	176,587.00	SQFT	2.5380	0.096904	10.3195
	**** Total Alternates Blank				$1,179,222.01	
	*** Total Structural CIP forms				$1,179,222.01	
	** Total Structural CIP forms				$1,179,222.01	
Concrete accessories						
Concrete accessories						
Alternates Blank						
03150.650	SCREEDS FOR SLAB	21,190.44	LNFT	0.9219	0.0352	28.40909
03150.900	FORM RELEASING AGENT	117,077.33	SQFT	0.2095	0.008	125.00
03150.900	FORM RELEASING AGENT	176,587.00	SQFT	0.2095	0.008	125.00
	**** Total Alternates Blank				$94,593.36	
	*** Total Concrete accessories				$94,593.36	
	** Total Concrete accessories				$94,593.36	
Reinforcing steel						
Reinforcing steel						
Alternates Blank						
03210.130	SUPPORTED SLAB REBAR	5,886.23	CWT	32.3636	1.018182	0.98214
03210.150	COLUMN REBAR	3,322.62	CWT	24.7222	0.777778	1.28571
	**** Total Alternates Blank				$518,979.18	
	*** Total Reinforcing steel				$518,979.18	
	** Total Reinforcing steel				$518,979.18	
Structural concrete						
Structural concrete						
Alternates Blank						
03310.550	**CONCRETE IN WALLS**		****			
03310.576	4000 PSI W/CRANE	1,350.22	CUYD	16.5977	0.685714	1.45833
03310.650	**CONCRETE IN COLUMNS**		****			
03310.676	4000 PSI W/CRANE	886.03	CUYD	21.7845	0.90	1.11111
03311.500	**CONC IN SUPPORTED SLAB**		****			
03311.526	4000 PSI W/CRANE	4,905.19	CUYD	13.9420	0.576	1.73611
03315.982	* CONCRETE WALL AREA *	36,456.00	SQFT			
03315.984	* NO. OF COLUMNS *	392.00	EACH			
03315.986	* SUPPORTED SLAB AREA *	176,587.00	SQFT			
	**** Total Alternates Blank				$510,021.77	
	*** Total Structural concrete				$510,021.77	
	** Total Structural concrete				$510,021.77	
Finishing						
Finishing						
Alternates Blank						
03350.130	MACHINE TROWEL FINISH	176,587.00	SQFT	0.3304	0.0128	78.125
03350.131	POINT & PATCH	117,077.33	SQFT	0.1102	0.004267	234.375
03350.131	POINT & PATCH	176,587.00	SQFT	0.1102	0.004267	234.375
	**** Total Alternates Blank				$94,465.06	
	*** Total Finishing				$94,465.06	
	** Total Finishing				$94,465.06	

EDF Report - Standard Construction Project

Estimator : User
Project Size : sqft
Date : 3/28/2006
Time : 02:12 PM

Group 1: Divisions
Group 2: Major ItemCode Groups
Group 3: Minor ItemCode Groups
Group 4: Alternates

ItemCode	Description	Quantity	UM	Labor$	MH/Unit	Units/MH
Curing						
Curing						
Alternates Blank						
03390.010	PROTECT & CURE	**176,587.00**	SQFT	0.1102	0.004267	234.375
	******* Total Alternates Blank***				***$22,850.36***	
	****** Total Curing***				***$22,850.36***	
	***** Total Curing***				***$22,850.36***	
	**** Total Concrete***				***$2,420,131.74***	

Concrete Labor Details

Labor Detail - Standard Construction Project

Estimator :
Project Size : sqft

Group 1: Divisions

Item Code	Description	Quantity	Hours	Base Rate	Fringe Rate	Total Rate	Prod. Factor	Total Labor Cost
Concrete								
03111.118	WALL FORM 20'+ HIGH	72,912.00 SQFT						
	(Crew C311) FORMWORK CREW needed for 245.16 DAY. Production: 297 SQFT/DAY							
	L040 - Carpenter		5,883.88	22.55	5.60	28.15	1.00	165,631.08
	L041 - Carpenter foreman		980.65	24.15	6.00	30.15	1.00	29,566.47
	L020 - Common laborer		3,922.58	17.83	4.43	22.26	1.00	87,316.71
03111.203	WOOD COLUMN FORMS, 12'-16'	44,165.33 SQFT						
	(Crew C311) FORMWORK CREW needed for 44.17 DAY. Production: 1,000 SQFT/DAY							
	L040 - Carpenter		1,059.97	22.55	5.60	28.15	1.00	29,838.10
	L041 - Carpenter foreman		176.66	24.15	6.00	30.15	1.00	5,326.34
	L020 - Common laborer		706.65	17.83	4.43	22.26	1.00	15,729.93
03111.612	SLAB FORM W/2.6 BM/SF	176,587.00 SQFT						
	(Crew C311) FORMWORK CREW needed for 388.91 DAY. Production: 454 SQFT/DAY							
	L040 - Carpenter		9,333.80	22.55	5.60	28.15	1.00	262,746.56
	L041 - Carpenter foreman		1,555.63	24.15	6.00	30.15	1.00	46,902.36
	L020 - Common laborer		6,222.54	17.83	4.43	22.26	1.00	138,513.64
03150.650	SCREEDS FOR SLAB	21,190.44 LNFT						
	(Crew C311) FORMWORK CREW needed for 16.95 DAY. Production: 1,250 LNFT/DAY							
	L040 - Carpenter		406.86	22.55	5.60	28.15	1.00	11,453.01
	L041 - Carpenter foreman		67.81	24.15	6.00	30.15	1.00	2,044.45
	L020 - Common laborer		271.24	17.83	4.43	22.26	1.00	6,037.75
03150.900	FORM RELEASING AGENT	293,664.33 SQFT						
	(Crew C311) FORMWORK CREW needed for 53.39 DAY. Production: 5,500 SQFT/DAY							
	L040 - Carpenter		1,281.44	22.55	5.60	28.15	1.00	36,072.66
	L041 - Carpenter foreman		213.57	24.15	6.00	30.15	1.00	6,439.26
	L020 - Common laborer		854.30	17.83	4.43	22.26	1.00	19,016.63
03210.130	SUPPORTED SLAB REBAR	5,886.23 CWT						
	(Crew C321) REINFORCING STEEL CREW needed for 107.02 DAY. Production: 55 CWT/DAY							
	L120 - Reinforcing rodman		5,137.08	21.55	9.95	31.50	1.00	161,817.91
	L121 - Reinforcing rodman foreman		856.18	22.91	10.59	33.50	1.00	28,682.01
03210.150	COLUMN REBAR	3,322.62 CWT						
	(Crew C321) REINFORCING STEEL CREW needed for 46.15 DAY. Production: 72 CWT/DAY							
	L120 - Reinforcing rodman		2,215.08	21.55	9.95	31.50	1.00	69,775.09
	L121 - Reinforcing rodman foreman		369.18	22.91	10.59	33.50	1.00	12,367.54
03310.576	4000 PSI W/CRANE	1,350.22 CUYD						
	(Crew C230) CONCRETE CREW, CRANE needed for 12.86 DAY. Production: 105 CUYD/DAY							
	L070 - Equipment operator		102.87	25.56	3.29	28.85	1.00	2,967.92
	L021 - Common laborer foreman		102.87	19.42	4.83	24.25	1.00	2,494.70
	L020 - Common laborer		617.24	17.83	4.43	22.26	1.00	13,739.86
	L052 - Vibrator operator		102.87	24.75	6.44	31.19	1.00	3,208.13
03310.676	4000 PSI W/CRANE	886.03 CUYD						
	(Crew C230) CONCRETE CREW, CRANE needed for 11.08 DAY. Production: 80 CUYD/DAY							
	L070 - Equipment operator		88.60	25.56	3.29	28.85	1.00	2,556.20
	L021 - Common laborer foreman		88.60	19.42	4.83	24.25	1.00	2,148.63
	L020 - Common laborer		531.62	17.83	4.43	22.26	1.00	11,833.86
	L052 - Vibrator operator		88.60	24.75	6.44	31.19	1.00	2,763.09
03311.526	4000 PSI W/CRANE	4,905.19 CUYD						
	(Crew C230) CONCRETE CREW, CRANE needed for 39.24 DAY. Production: 125 CUYD/DAY							
	L070 - Equipment operator		313.93	25.56	3.29	28.85	1.00	9,056.95
	L021 - Common laborer foreman		313.93	19.42	4.83	24.25	1.00	7,612.86
	L020 - Common laborer		1,883.59	17.83	4.43	22.26	1.00	41,928.82
	L052 - Vibrator operator		313.93	24.75	6.44	31.19	1.00	9,789.98
03350.130	MACHINE TROWEL FINISH	176,587.00 SQFT						
	(Crew C276) CONCRETE FINISHING CREW needed for 70.63 DAY. Production: 2,500 SQFT/DAY							
	L020 - Common laborer		565.08	17.83	4.43	22.26	1.00	12,578.65
	L050 - Concrete finisher		1,695.24	23.89	3.11	27.00	1.00	45,771.35
03350.131	POINT & PATCH	293,664.33 SQFT						
	(Crew C276) CONCRETE FINISHING CREW needed for 39.16 DAY. Production: 7,500 SQFT/DAY							
	L020 - Common laborer		313.24	17.83	4.43	22.26	1.00	6,972.77
	L050 - Concrete finisher		939.73	23.89	3.11	27.00	1.00	25,372.60
03390.010	PROTECT & CURE	176,587.00 SQFT						
	(Crew C276) CONCRETE FINISHING CREW needed for 23.54 DAY. Production: 7,500 SQFT/DAY							
	L020 - Common laborer		188.36	17.83	4.43	22.26	1.00	4,192.88
	L050 - Concrete finisher		565.08	23.89	3.11	27.00	1.00	15,257.12
	* Total Concrete		50,330.50					$1,355,524
	Total Estimate		50,330.50					$1,355,524

Concrete Duration Calcs

- USE 5 FORMWORK CREWS
- USE 2 REINFORCING STEEL CREWS
- USE 2 CONCRETE CREWS

$$\text{TOTAL DURATION} = \frac{(245 + 44 + 389 + 17 + 53)}{5} + \frac{(107 + 46 + 13 + 11 + 39)}{2} + 71 + 39 + 24$$

$$= 392 \text{ WORK DAYS} \times \frac{1 \text{ WEEK}}{5 \text{ WORK DAYS}}$$

$$= 78.3 \text{ WEEKS}$$

Steel Cost Breakdown

EDF Report - Standard Construction Project

Estimator : User
Project Size : sqft
Date : 3/28/2006
Time : 02:04 PM

Group 1: Divisions
Group 2: Major ItemCode Groups
Group 3: Minor ItemCode Groups
Group 4: Alternates

ItemCode	Description	Quantity	UM	Labor$	MH/Unit	Units/MH
Concrete						
Welded wire fabric						
Welded wire fabric						
Alternates Blank						
03220.010	6x6 W1.4/W1.4 MESH	1,873.87	SQS	18.8640	0.80	1.25
	**** Total Alternates Blank				$50,714.47	
	*** Total Welded wire fabric				$50,714.47	
	** Total Welded wire fabric				$50,714.47	
Structural concrete						
Structural concrete						
Alternates Blank						
03311.700	**CONC IN SLAB OVER MTL DECK*	****				
03311.726	4000 PSI W/CRANE	2,366.00	CUYD	13.9420	0.576	1.73611
03315.991	* SLAB OVER METAL DECK AREA *	170,352.00	SQFT			
	**** Total Alternates Blank				$165,482.77	
	*** Total Structural concrete				$165,482.77	
	** Total Structural concrete				$165,482.77	
	* Total Concrete				$216,197.24	
Metals						
Structural steel						
Structural steel						
Alternates Blank						
05129.101	STEEL BEAMS	****				
05129.101	STEEL BEAMS	****				
05129.102	I BEAMS	705.60	CWT	28.7300	0.90	1.11111
05129.102	I BEAMS	8,593.36	CWT	28.7300	0.90	1.11111
05129.121	STEEL COLUMNS	****				
05129.122	I SHAPES	4,003.22	CWT	28.7300	0.90	1.11111
05129.181	BRACING	****				
05129.182	I BEAMS	4,564.63	CWT	38.3067	1.20	0.83333
05129.304	ASTM A572 50 KSI STEEL ADDER	4,003.22	CWT			
05129.310	TYPE B STEEL ADDER	4,564.63	CWT			
05129.404	SHEAR STUD, 3/4"	72.00	EACH	0.5434	0.017143	58.33333
05129.404	SHEAR STUD, 3/4"	1,173.00	EACH	0.5434	0.017143	58.33333
05129.990	* STRUCTURAL STEEL WEIGHT *	463.67	TONS			
05129.990	* STRUCTURAL STEEL WEIGHT *	429.67	TONS			
	**** Total Alternates Blank				$1,273,642.08	
	*** Total Structural steel				$1,273,642.08	
	** Total Structural steel				$1,273,642.08	
Steel deck						
Steel deck						
Alternates Blank						
05310.019	3" METAL DECK	170,352.00	SQFT	0.4445	0.013926	71.80556
	**** Total Alternates Blank				$247,981.41	
	*** Total Steel deck				$247,981.41	
	** Total Steel deck				$247,981.41	
	* Total Metals				$1,521,623.49	

Steel Labor Detail / Duration Calcs

Labor Detail - Standard Construction Project

Estimator :
Project Size : sqft

Group 1: Divisions

Item Code	Description	Quantity	Hours	Base Rate	Fringe Rate	Total Rate	Prod. Factor	Total Labor Cost
Concrete								
03220.010	6x6 W1.4/W1.4 MESH	1,873.87 SQS						
(Crew C320) WIRE MESH CREW needed for 26.77 DAY. Production: 70 SQS/DAY								
	L020 - Common laborer		1,284.94	17.83	4.43	22.26	1.00	28,602.78
	L120 - Reinforcing rodman		214.16	21.55	9.95	31.50	1.00	6,745.94
03311.726	4000 PSI W/CRANE	2,366.00 CUYD						
(Crew C230) CONCRETE CREW, CRANE needed for 18.93 DAY. Production: 125 CUYD/DAY								
	L070 - Equipment operator		151.42	25.56	3.29	28.85	1.00	4,368.58
	L021 - Common laborer foreman		151.42	19.42	4.83	24.25	1.00	3,672.03
	L020 - Common laborer		908.54	17.83	4.43	22.26	1.00	20,224.19
	L052 - Vibrator operator		151.42	24.75	6.44	31.19	1.00	4,722.16
*** Total Concrete**			**2,861.91**					**$68,336**
Metals								
05129.102	I BEAMS	9,298.96 CWT						
(Crew C510) STRUCTURAL STEEL CREW needed for 116.24 DAY. Production: 80 CWT/DAY								
	L160 - Steelworker		7,439.17	18.20	13.50	31.70	1.00	235,821.63
	L161 - Steelworker foreman		929.90	19.34	14.36	33.70	1.00	31,337.50
05129.122	I SHAPES	4,003.22 CWT						
(Crew C510) STRUCTURAL STEEL CREW needed for 50.04 DAY. Production: 80 CWT/DAY								
	L160 - Steelworker		3,202.58	18.20	13.50	31.70	1.00	101,521.66
	L161 - Steelworker foreman		400.32	19.34	14.36	33.70	1.00	13,490.85
05129.182	I BEAMS	4,564.63 CWT						
(Crew C510) STRUCTURAL STEEL CREW needed for 76.08 DAY. Production: 60 CWT/DAY								
	L160 - Steelworker		4,868.93	18.20	13.50	31.70	1.00	154,345.22
	L161 - Steelworker foreman		608.62	19.34	14.36	33.70	1.00	20,510.39
05129.404	SHEAR STUD, 3/4"	1,245.00 EACH						
(Crew C509) MISCELLANEOUS METALS CREW needed for 0.89 DAY. Production: 1,400 EACH/DAY								
	L160 - Steelworker		21.34	18.20	13.50	31.70	1.00	676.57
05310.019	3" METAL DECK	170,352.00 SQFT						
(Crew C510) STRUCTURAL STEEL CREW needed for 32.95 DAY. Production: 5,170 SQFT/DAY								
	L160 - Steelworker		2,108.81	18.20	13.50	31.70	1.00	66,849.16
	L161 - Steelworker foreman		263.60	19.34	14.36	33.70	1.00	8,883.35
* Total Metals			19,843.26					$633,436
Total Estimate			22,705.18					$701,772

USE 2 STRUCTURAL STEEL CREWS

$$\text{TOTAL DURATION} = \frac{(116 + 50 + 76)}{2} + 33 + 1 + 27 + 19$$

$$= 201 \text{ WORK DAYS} \times \frac{1 \text{ WEEK}}{5 \text{ WORK DAYS}}$$

$$= 40.2 \text{ WEEKS}$$