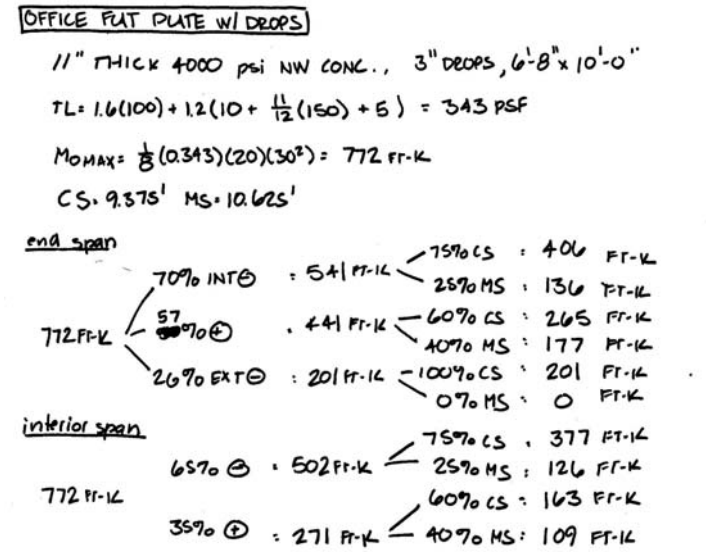
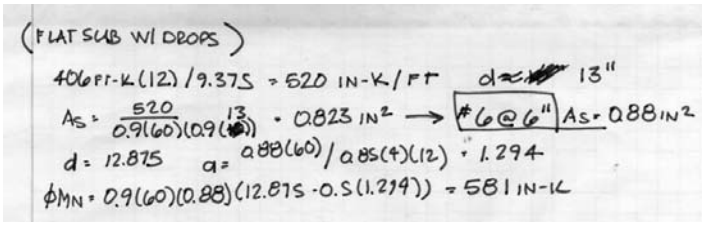
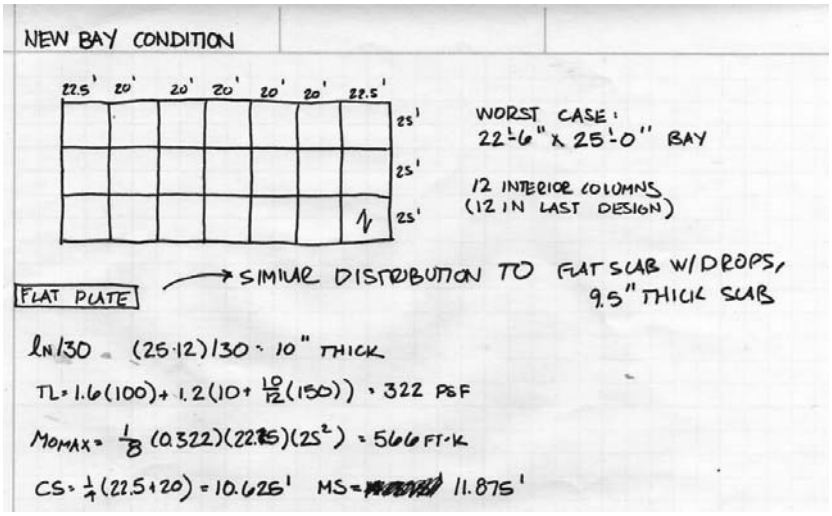
APPENDIX B: CONCRETE FLOOR SYSTEM CALCULATIONS

Direct Design Method, Office Slab with Drops, 30'-0" Maximum Span Condition

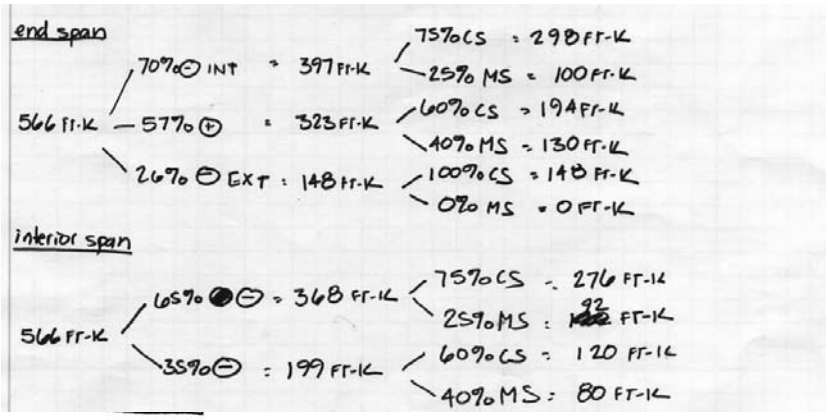




Direct Design Method, Office Flat Plate, 25'-0" Maximum Span Condition



Direct Design Method, Office Flat Plate, 25'-0" Maximum Span Condition, Cont'd



(MAX MOMENT COND – FLAT PLATE)

$M = 298(12)/10.625 = 337$ IN-K/FT $d \sim 9"$

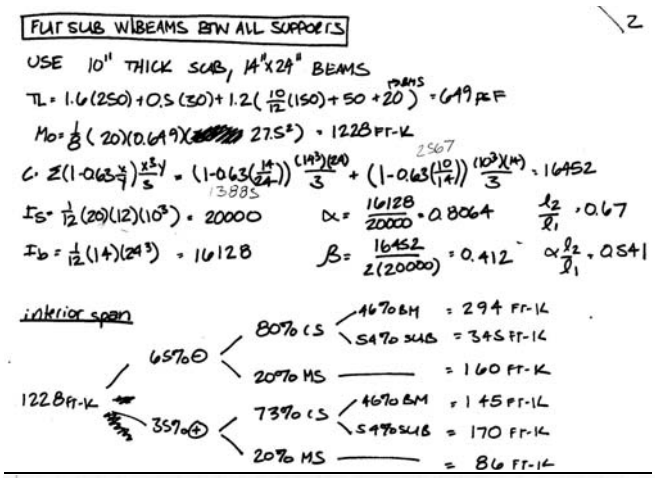
$A_S = \frac{337}{0.9(60)(0.9)(9)} = 0.77$ IN² USE #4@3" #6@6" #8@12"

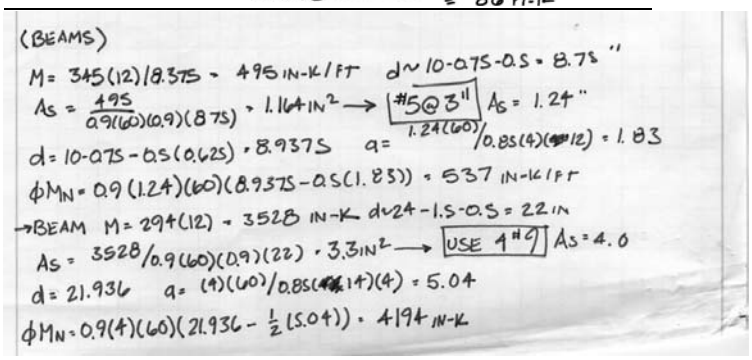
$d = 10 - 0.75 - 0.5(0.5) = 9"$

$a = \frac{0.80(60)}{0.85(4)(12)} = 1.17$ IN

$\phi M_N = 0.9(60)(0.80)(9 - 0.5(1.17)) = 364$ IN-K/FT ✓

Direct Design Method, Parking Slab with Beams Between All Columns





Selected ADOSS Results, Alternative #2 Office Flat Slab with Drops

```
FILE NAME            P:\ODROPSFA.ADS

PROJECT ID.          Office Final Drops
                     ----------------------------------
SPAN ID.             BC
                     ------------------

ENGINEER             Henry

DATE                 02/09/06
TIME                 09:11:02

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

03-30-** ADOSS(tm) 6.01  Proprietary Software of PORTLAND CEMENT ASSN. Page   3
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                              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)	LIVE (psf)
1*	1.3	10.0	11.3	15.0	2	26.3	.0	10.0	100.0
2	30.0	10.0	11.3	15.0	2	26.3	13.1	10.0	100.0
3	30.0	10.0	11.3	15.0	2	26.3	13.1	10.0	100.0
4	25.0	10.0	11.3	15.0	2	26.3	11.9	10.0	100.0
5	30.0	10.0	11.3	15.0	2	26.3	13.1	10.0	100.0
6	30.0	10.0	11.3	15.0	2	26.3	13.1	10.0	100.0
7*	1.3	10.0	11.3	15.0	2	26.3	.0	10.0	100.0

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

LATERAL LOAD/OUTPUT DATA
****

LATERAL LOADS ARE SPECIFIED AS BEING CAUSED BY WIND

JOINT NO.	SLAB MOMENTS LEFT (ft-k)	SLAB MOMENTS RIGHT (ft-k)	COLUMN MOMENTS ABOVE (ft-k)	COLUMN MOMENTS BELOW (ft-k)
1	.00	-71.00	.00	.00
2	-71.00	-65.00	.00	.00
3	-63.00	-71.00	.00	.00
4	-71.00	-63.00	.00	.00
5	-64.00	-70.00	.00	.00
6	-61.00	.00	.00	.00

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	-6.7	.0	(0)	-6.5	(95)	.0	(0)	-.3	(4)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT TOP	399.1	.0	(0)	382.8	(95)	.0	(0)	16.3	(4)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
2	LEFT TOP	-775.0	.0	(0)	-581.2	(75)	.0	(0)	-193.7	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT TOP	742.1	.0	(0)	556.6	(75)	.0	(0)	185.5	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
3	LEFT TOP	-555.5	.0	(0)	-416.6	(75)	.0	(0)	-138.9	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT TOP	487.3	.0	(0)	365.5	(75)	.0	(0)	121.8	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
4	LEFT TOP	-487.3	.0	(0)	-365.5	(75)	.0	(0)	-121.8	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT TOP	555.5	.0	(0)	416.6	(75)	.0	(0)	138.9	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
5	LEFT TOP	-742.1	.0	(0)	-556.6	(75)	.0	(0)	-185.5	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT TOP	775.0	.0	(0)	581.2	(75)	.0	(0)	193.7	(25)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
6	LEFT TOP	-399.1	.0	(0)	-382.8	(95)	.0	(0)	-16.3	(4)
	BOT	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	RGHT TOP	6.7	.0	(0)	6.5	(95)	.0	(0)	.3	(4)
	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	14.25 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	374.3	.0	(0)	224.6	(60)	.0	(0)	149.7	(40)
	14.25 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	374.3	.0	(0)	224.6	(60)	.0	(0)	149.7	(40)
3	15.75 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	322.6	.0	(0)	193.5	(60)	.0	(0)	129.0	(40)
	15.75 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	322.6	.0	(0)	193.5	(60)	.0	(0)	129.0	(40)
4	11.88 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	210.7	.0	(0)	126.4	(60)	.0	(0)	84.3	(39)
	11.88 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	210.7	.0	(0)	126.4	(60)	.0	(0)	84.3	(40)
5	14.25 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	322.6	.0	(0)	193.5	(60)	.0	(0)	129.0	(40)
	14.25 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	322.6	.0	(0)	193.5	(60)	.0	(0)	129.0	(39)
6	15.75 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	374.3	.0	(0)	224.6	(60)	.0	(0)	149.7	(40)
	15.75 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	374.3	.0	(0)	224.6	(60)	.0	(0)	149.7	(40)

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

COL. NO.	ALLOW. STRESS (psi)	PATT NO.	AROUND REACTION (kips)	SHEAR STRESS (psi)	PATT NO.	COLUMN REACTION (kips)	UNBAL. MOMENT (ft-k)	SHEAR TRANSFR (ft-k)	SHEAR STRESS (psi)
1E	252.96	4	148.2	116.20	4	148.2	422.6	159.8	250.55
2I	252.96	4	305.0	233.61	4	305.0	-38.5	-15.4	246.43
3I	252.96	4	254.5	194.92	4	254.5	-82.7	-33.1	222.46
4I	252.96	4	254.5	194.92	4	254.5	82.7	33.1	222.46
5I	252.96	4	305.0	233.61	4	305.0	38.5	15.4	246.43
6E	252.96	4	148.2	116.20	4	148.2	-422.6	-159.8	250.55

- - AROUND DROP/SOLID HEAD - -

COLUMN NUMBER	ALLOW. STRESS (psi)	PATT NO.	REACTION (kips)	SHEAR STRESS (psi)
1E	185.35	4	124.5	62.93
2I	170.90	4	266.1	76.10
3I	172.82	4	218.9	65.29
4I	172.82	4	218.9	65.29
5I	170.90	4	266.1	76.10
6E	185.35	4	124.5	62.93

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	11	# 5	1.33	10.18	11	# 5	1.33	6.50	14	# 4	1.33	7.77
2	10	# 7	10.77	10.77	10	# 7	6.50	6.50	17	# 5	10.77	10.77
3	10	# 6	10.18	11.77	9	# 6	6.50	6.77	19	# 4	9.27	11.77
4	10	# 6	11.77	10.18	9	# 6	6.77	6.50	19	# 4	11.77	9.27
5	10	# 7	10.77	10.77	10	# 7	6.50	6.50	17	# 5	10.77	10.77
6	11	# 5	10.18	1.33	11	# 5	6.50	1.33	14	# 4	7.77	1.33

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

SPAN NUMBER	COLUMN STRIP LONG BARS NO	SIZE	LENGTH (ft)	COLUMN STRIP SHORT BARS NO	SIZE	LENGTH (ft)	MIDDLE STRIP LONG BARS NO	SIZE	LENGTH (ft)	MIDDLE STRIP SHORT BARS NO	SIZE	LENGTH (ft)
2	10	# 5	25.92	10	# 5	25.92	10	# 4	29.92	10	# 4	25.17
3	9	# 5	22.50	8	# 5	22.50	9	# 4	30.50	9	# 4	21.00
4	9	# 4	18.75	8	# 4	18.75	8	# 4	25.50	8	# 4	17.50
5	9	# 5	22.50	8	# 5	22.50	9	# 4	30.50	9	# 4	21.00
6	10	# 5	25.92	10	# 5	25.92	10	# 4	29.92	10	# 4	25.17

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)	LIVE (in)	TOTAL (in)	MIDDLE STRIP DEFLECTION DUE TO: DEAD (in)	LIVE (in)	TOTAL (in)
1	48644.	-.015	-.011	-.026	-.015	-.011	-.026
2	32569.	.208	.262	.470	.108	.120	.229
3	31470.	.155	.236	.392	.078	.116	.194
4	33935.	.050	.083	.133	.011	.028	.039
5	31470.	.155	.236	.392	.078	.116	.194
6	32569.	.208	.262	.470	.108	.120	.229
7	48644.	-.015	-.011	-.026	-.015	-.011	-.026

Selected ADOSS Results, Alternative #2 Parking Flat Slab with Drops

```
FILE NAME            P:\PDROPSFA.ADS

PROJECT ID.          Parking Final Drops
                     ----------------------------------
SPAN ID.             BC
                     ------------------

ENGINEER             Henry

DATE                 02/09/06
TIME                 10:51:12

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  9

  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

                              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)	LIVE (psf)
1*	1.3	11.0	15.0	11.3	2	26.3	.0	10.0	100.0
2	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
3	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
4	25.0	11.0	15.0	11.3	2	26.3	11.9	10.0	100.0
5	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
6	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
7	27.3	11.0	15.0	11.3	2	26.3	12.5	50.0	280.0
8	17.0	11.0	15.0	11.3	2	26.3	8.5	50.0	280.0
9*	1.3	11.0	15.0	11.3	2	26.3	.0	50.0	280.0

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	20.0	24.0	13.3	20.0	30.0	13.3	.0	.0	13.1	13.1
2	20.0	20.0	13.3	24.0	20.0	13.3	.0	.0	13.1	13.1
3	20.0	20.0	13.3	24.0	20.0	13.3	.0	.0	11.9	14.4
4	20.0	20.0	13.3	24.0	20.0	13.3	.0	.0	11.9	14.4
5	20.0	20.0	13.3	24.0	20.0	13.3	.0	.0	13.1	13.1
6	20.0	24.0	13.3	24.0	24.0	13.3	.0	.0	12.5	13.8
7	.0	.0	13.3	24.0	24.0	13.3	.0	.0	8.5	17.8
8	.0	.0	13.3	20.0	20.0	13.3	.0	.0	8.5	17.8

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	20.0	20.0	.0	1.3	5.0	8.8	3.5	100%
2	.0	.0	.0	5.0	5.0	8.8	3.5	100%
3	.0	.0	.0	5.0	4.2	8.8	3.5	100%
4	.0	.0	.0	4.2	5.0	8.8	3.5	100%
5	.0	.0	.0	5.0	5.0	8.8	3.5	100%
6	24.0	32.0	.0	5.0	4.6	8.8	7.0	100%
7	.0	.0	.0	4.6	2.8	8.8	7.0	100%
8	20.0	20.0	.0	2.8	1.3	8.8	3.5	100%

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

LATERAL LOAD/OUTPUT DATA
****

LATERAL LOADS ARE SPECIFIED AS BEING CAUSED BY WIND

JOINT NO.	SLAB MOMENTS LEFT (ft-k)	RIGHT (ft-k)	COLUMN MOMENTS ABOVE (ft-k)	BELOW (ft-k)
1	.00	-71.00	.00	.00
2	-71.00	-65.00	.00	.00
3	-63.00	-70.00	.00	.00
4	-70.00	-63.00	.00	.00
5	-65.00	-67.00	.00	.00
6	-66.00	-40.00	.00	.00
7	-26.00	-26.00	.00	.00
8	-32.00	.00	.00	.00

LATERAL LOADS DISTRIBUTED TO THE COLUMN AND MIDDLE STRIPS ACCORDING TO
CODE DISTRIBUTION FACTORS.

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	-6.8	.0 (0)	-6.6 (96)	.0 (0)	-.2 (3)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT TOP	377.3	.0 (0)	365.6 (96)	.0 (0)	11.6 (3)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
2	LEFT TOP	-794.5	.0 (0)	-595.9 (74)	.0 (0)	-198.6 (25)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)

	RGHT	TOP	750.8	.0 (0)	563.1 (75)	.0 (0)	187.7 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
3	LEFT	TOP	-555.8	.0 (0)	-416.9 (75)	.0 (0)	-139.0 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT	TOP	478.8	.0 (0)	359.1 (75)	.0 (0)	119.7 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
4	LEFT	TOP	-504.9	.0 (0)	-378.7 (75)	.0 (0)	-126.2 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT	TOP	597.4	.0 (0)	448.0 (75)	.0 (0)	149.3 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
5	LEFT	TOP	-653.6	.0 (0)	-490.2 (75)	.0 (0)	-163.4 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT	TOP	603.5	.0 (0)	452.6 (75)	.0 (0)	150.9 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
6	LEFT	TOP	-889.6	.0 (0)	-667.2 (75)	.0 (0)	-222.4 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT	TOP	1099.9	.0 (0)	824.9 (75)	.0 (0)	275.0 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
7	LEFT	TOP	-1023.3	.0 (0)	-767.4 (75)	.0 (0)	-255.8 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT	TOP	851.3	.0 (0)	638.5 (75)	.0 (0)	212.8 (25)
		BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)

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) (%)
8	LEFT TOP	-41.7	.0 (0)	-40.4 (96)	.0 (0)	-1.3 (3)
	BOT	36.0	.0 (0)	34.9 (96)	.0 (0)	1.1 (3)
	RGHT TOP	12.6	.0 (0)	12.2 (96)	.0 (0)	.4 (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	12.75 TOP	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	BOT	410.8	.0 (0)	246.5 (60)	.0 (0)	164.3 (40)
	12.75 TOP	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	BOT	410.8	.0 (0)	246.5 (60)	.0 (0)	164.3 (40)
3	15.75 TOP	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	BOT	337.5	.0 (0)	202.5 (60)	.0 (0)	135.0 (40)
	15.75 TOP	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	BOT	337.5	.0 (0)	202.5 (60)	.0 (0)	135.0 (40)
4	11.88 TOP	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	BOT	215.9	.0 (0)	129.6 (60)	.0 (0)	86.4 (40)
	11.88 TOP	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	BOT	215.9	.0 (0)	129.6 (60)	.0 (0)	86.4 (39)
5	14.25 TOP	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	BOT	355.1	.0 (0)	213.0 (60)	.0 (0)	142.0 (40)

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)	(%)
	14.25 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	355.1	.0	(0)	213.0	(60)	.0	(0)	142.0	(40)
6	14.25 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	296.4	.0	(0)	177.8	(60)	.0	(0)	118.6	(39)
	14.25 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	296.4	.0	(0)	177.8	(60)	.0	(0)	118.6	(40)
7	14.35 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	502.4	.0	(0)	301.5	(60)	.0	(0)	201.0	(40)
	14.35 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	502.4	.0	(0)	301.5	(60)	.0	(0)	201.0	(40)
8	9.77 TOP	-29.9	.0	(0)	-18.0	(60)	.0	(0)	-12.0	(39)
	BOT	257.9	.0	(0)	154.8	(60)	.0	(0)	103.2	(40)
	9.77 TOP	-29.9	.0	(0)	-18.0	(60)	.0	(0)	-12.0	(39)
	BOT	257.9	.0	(0)	154.8	(60)	.0	(0)	103.2	(40)

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

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)
			A R O U N D			C O L U M N			
1E	252.96	4	151.1	111.67	4	151.1	397.4	144.0	220.02
2I	252.96	4	320.8	207.35	4	320.8	-52.3	-21.7	220.91
3I	252.96	4	264.9	171.20	4	264.9	-97.1	-40.2	196.38
4I	252.96	4	272.1	175.92	4	272.1	114.5	47.4	205.59
5I	252.96	4	289.8	187.33	4	289.8	-71.4	-29.5	205.83
6I	252.96	4	446.6	157.08	4	446.6	314.0	125.6	195.73
7I	252.96	4	482.4	212.30	4	482.4	-213.3	-85.3	244.35
8E	252.96	4	135.6	109.14	1	135.5	-52.1	-20.5	127.29

- - AROUND DROP/SOLID HEAD - -

COLUMN NUMBER	ALLOW. STRESS (psi)	PATT NO.	REACTION (kips)	SHEAR STRESS (psi)
1E	191.80	4	127.5	57.23
2I	175.72	4	280.2	71.09
3I	177.83	4	227.7	60.25
4I	177.83	4	235.0	62.18
5I	175.72	4	249.2	63.23
6I	176.82	4	389.4	101.02
7I	182.98	4	426.1	124.07
8E	206.97	1	111.2	61.49

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)	SHORT BARS NO	SIZE	LEFT (ft)	RIGHT (ft)	MIDDLE STRIP LONG BARS NO	SIZE	LEFT (ft)	RIGHT (ft)
1	11	# 5	1.33	10.13	10	# 5	1.33	6.47	16	# 4	1.33	7.76
2	10	# 7	10.76	10.76	9	# 7	6.63	6.63	24	# 4	10.76	10.76
3	9	# 6	10.24	11.75	8	# 6	6.60	6.75	17	# 4	9.25	11.75
4	10	# 6	11.75	10.24	9	# 6	6.75	6.60	18	# 4	11.75	9.25
5	11	# 6	10.75	10.75	10	# 6	6.60	6.60	20	# 4	10.75	10.75
6	10	# 7	12.25	10.24	10	# 7	7.00	6.60	22	# 5	12.25	9.95
7	7	# 8	9.78	9.36	7	# 8	6.07	6.07	31	# 4	9.78	8.38
8**	7	# 4	7.03	1.33	7	# 4	4.06	1.33	21	# 4	6.90	1.33

** - Positive reinforcement required, design manually.

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

SPAN NUMBER	COLUMN STRIP LONG BARS NO	SIZE	LENGTH (ft)	SHORT BARS NO	SIZE	LENGTH (ft)	MIDDLE STRIP LONG BARS NO	SIZE	LENGTH (ft)	SHORT BARS NO	SIZE	LENGTH (ft)
2	10	# 5	25.92	10	# 5	25.92	10	# 4	29.92	10	# 4	25.17
3	8	# 5	22.50	8	# 5	22.50	8	# 4	30.50	8	# 4	21.00
4	8	# 4	18.75	8	# 4	18.75	9	# 4	25.50	8	# 4	17.50
5	9	# 5	22.50	8	# 5	22.50	9	# 4	30.50	8	# 4	21.00
6	11	# 4	22.50	11	# 4	22.50	8	# 4	30.50	8	# 4	21.00
7	9	# 6	21.22	8	# 6	21.22	12	# 4	27.83	12	# 4	19.13
8**	6	# 5	15.08	6	# 5	15.08	11	# 4	16.92	10	# 4	14.12

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 9 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	COLUMN STRIP DEAD LOAD Ieff. (in^4)	DEFLECTION DUE TO: DEAD (in)	LIVE (in)	TOTAL (in)	MIDDLE STRIP DEFLECTION DUE TO: DEAD (in)	LIVE (in)	TOTAL (in)
1	52778.	-.014	-.009	-.023	-.014	-.009	-.023
2	40937.	.181	.186	.367	.095	.087	.182
3	42290.	.125	.175	.301	.062	.086	.149
4	43859.	.042	.052	.094	.009	.016	.025
5	43859.	.132	.194	.326	.071	.101	.172
6	52428.	.098	.121	.218	.044	.044	.088
7	60998.	.089	.392	.481	.049	.207	.256
8	52428.	.020	.039	.059	.002	.003	.005
9	52778.	-.003	-.003	-.006	-.003	-.004	-.006

Selected ADOSS Results, First Floor Slab with Superimposed Vault Load

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PROJECT ID.          Parking Final Drops
                     ----------------------------------
SPAN ID.             BC
                     ------------------

ENGINEER             Henry

DATE                 02/09/06
TIME                 10:51:12

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  9

  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

                              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)	LIVE (psf)
1*	1.3	11.0	15.0	11.3	2	26.3	.0	10.0	100.0
2	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
3	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
4	25.0	11.0	15.0	11.3	2	26.3	11.9	10.0	100.0
5	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
6	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
7	27.3	11.0	15.0	11.3	2	26.3	12.5	50.0	280.0
8	17.0	11.0	15.0	11.3	2	26.3	8.5	50.0	280.0
9*	1.3	11.0	15.0	11.3	2	26.3	.0	50.0	280.0

```
*  -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

SPAN No.	LOAD No.	TYPE	PARTIAL DEAD LOADS Wa	Wb	La	Lb	LOAD No.	TYPE	PARTIAL LIVE LOADS Wa	Wb	La	Lb
1*												
2	1	UNIF	702.5	.0	20.0	30.0	1	UNIF	850.0	.0	20.0	30.0
3	1	UNIF	702.5	.0	.0	10.0	1	UNIF	850.0	.0	.0	10.0
4												
5												
6	1	UNIF	6111.0	.0	6.7	15.7						
7												
8												
9*												

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)	SHORT BARS NO	SIZE	LEFT (ft)	RIGHT (ft)	MIDDLE STRIP LONG BARS NO	SIZE	LEFT (ft)	RIGHT (ft)
1**	10	# 6	1.33	10.13	9	# 6	1.33	6.47	16	# 4	1.33	9.26
2	10	# 7	12.26	12.26	10	# 7	7.01	7.01	17	# 5	12.26	12.26
3**	10	# 6	10.75	11.75	9	# 6	6.60	6.75	19	# 4	10.75	11.75
4**	10	# 6	11.75	10.75	9	# 6	6.75	6.60	18	# 4	11.75	10.75
5	10	# 7	12.25	10.24	9	# 7	7.00	6.60	16	# 5	12.25	9.25
6	11	# 7	12.25	11.32	10	# 7	7.00	6.60	23	# 5	12.25	11.32
7	7	# 8	9.36	9.36	7	# 8	6.07	6.07	30	# 4	8.42	9.23
8**	7	# 4	7.03	1.33	7	# 4	4.06	1.33	21	# 4	6.90	1.33

** - Positive reinforcement required, design manually.

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

SPAN NUMBER	COLUMN STRIP LONG BARS NO	SIZE	LENGTH (ft)	SHORT BARS NO	SIZE	LENGTH (ft)	MIDDLE STRIP LONG BARS NO	SIZE	LENGTH (ft)	SHORT BARS NO	SIZE	LENGTH (ft)
2	10	# 5	25.92	10	# 5	25.92	10	# 4	29.92	10	# 4	25.17
3	9	# 5	22.50	8	# 5	22.50	9	# 4	30.50	8	# 4	21.00
4	8	# 4	18.75	8	# 4	18.75	9	# 4	25.50	8	# 4	17.50
5	12	# 4	22.50	12	# 4	22.50	8	# 4	30.50	8	# 4	21.00
6	9	# 6	23.00	8	# 6	23.00	12	# 4	30.50	12	# 4	21.00
7	9	# 6	21.22	8	# 6	21.22	12	# 4	27.83	12	# 4	19.13
8**	7	# 5	15.08	6	# 5	15.08	11	# 4	16.92	10	# 4	14.12

** - Negative reinforcement required, design manually.

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 9 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 DEFLECTION DUE TO: LIVE (in)	COLUMN STRIP DEFLECTION DUE TO: TOTAL (in)	MIDDLE STRIP DEFLECTION DUE TO: DEAD (in)	MIDDLE STRIP DEFLECTION DUE TO: LIVE (in)	MIDDLE STRIP DEFLECTION DUE TO: TOTAL (in)
1	52778.	-.014	-.009	-.023	-.014	-.009	-.023
2	39764.	.194	.230	.424	.100	.104	.204
3	40837.	.136	.193	.329	.067	.095	.162
4	43859.	.046	.050	.096	.013	.015	.027
5	39442.	.115	.178	.293	.047	.094	.142
6	41495.	.219	.144	.363	.124	.053	.177
7	60998.	.070	.370	.440	.030	.199	.229
8	52428.	.023	.038	.061	.005	.002	.007
9	52778.	-.003	-.003	-.007	-.003	-.003	-.007

Selected ADOSS Results, Torsion Beam between Office Floor and Parking Deck

```
FILE NAME            P:\PDROPSFA.ADS

PROJECT ID.          Parking Final Drops
                     ----------------------------------
SPAN ID.             BC
                     ------------------

ENGINEER             Henry

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  9

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
```

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)	LIVE (psf)
1*	1.3	11.0	15.0	11.3	2	26.3	.0	10.0	100.0
2	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
3	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
4	25.0	11.0	15.0	11.3	2	26.3	11.9	10.0	100.0
5	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
6	30.0	11.0	15.0	11.3	2	26.3	13.1	10.0	100.0
7	27.3	11.0	15.0	11.3	2	26.3	12.5	50.0	280.0
8	17.0	11.0	15.0	11.3	2	26.3	8.5	50.0	280.0
9*	1.3	11.0	15.0	11.3	2	26.3	.0	50.0	280.0

T R A N S V E R S E B E A M S H E A R A N D T O R S I O N
R E Q U I R E M E N T S (kips, ft-k, SQ.in, /,in.)

BEAM No.	PATT. NO.	LEFT SIDE Vu@d SHEAR	Vc@d SHEAR	Tu@d TORSION	Tc@d TORSION	Av/s @d	At/s @d	Atot/s @d	Al @d
1	4	49.5	15.5	157.9	49.3	.039	.101	.241	6.68
2	* *	Transverse beam not specified							* *
3	* *	Transverse beam not specified							* *
4	* *	Transverse beam not specified							* *
5	* *	Transverse beam not specified							* *
6	2	90.1	54.7	148.1	89.9	.028	.026	.080	2.53
7	* *	Transverse beam not specified							* *
8	3	68.1	41.5	39.8	24.2	.035	.017	.068	1.11

BEAM No.	PATT. NO.	Vu@d SHEAR	Vc@d SHEAR	RIGHT SIDE Tu@d TORSION	Tc@d TORSION	Av/s @d	At/s @d	Atot/s @d	Al @d
1	4	28.2	6.8	213.3	51.6	.024	.148	.319	9.76
2	* *	Transverse beam not specified							* *
3	* *	Transverse beam not specified							* *
4	* *	Transverse beam not specified							* *
5	* *	Transverse beam not specified							* *
6	2	49.0	27.4	190.4	106.4	.020*	.036	.088	3.53
7	* *	Transverse beam not specified							* *
8	3	40.2	29.1	56.4	40.8	.017*	.019	.054	1.40

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	-13.6	.0 (0)	-2.0 (14)	-11.1 (81)	-.6 (4)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT TOP	104.2	.0 (0)	15.0 (14)	85.0 (81)	4.3 (4)
	BOT	-45.2	.0 (0)	-6.5 (14)	-36.9 (81)	-1.8 (4)
2	LEFT TOP	-1203.3	.0 (0)	-112.2 (9)	-635.6 (52)	-455.5 (37)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT TOP	1285.3	.0 (0)	146.5 (11)	830.0 (64)	308.9 (24)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
3	LEFT TOP	-1262.2	.0 (0)	-143.8 (11)	-815.1 (64)	-303.3 (24)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT TOP	1179.3	.0 (0)	116.5 (9)	660.3 (55)	402.5 (34)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
4	LEFT TOP	-534.9	.0 (0)	-52.9 (9)	-299.5 (55)	-182.6 (34)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT TOP	520.2	.0 (0)	390.2 (75)	.0 (0)	130.1 (25)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
5	LEFT TOP	-523.0	.0 (0)	-392.2 (75)	.0 (0)	-130.7 (25)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
	RGHT TOP	523.5	.0 (0)	392.6 (75)	.0 (0)	130.9 (25)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)
6	LEFT TOP	-34.2	.0 (0)	-33.8 (99)	.0 (0)	-.3 (0)
	BOT	1.0	.0 (0)	1.0 (99)	.0 (0)	.0 (0)
	RGHT TOP	12.5	.0 (0)	12.4 (99)	.0 (0)	.1 (0)
	BOT	.0	.0 (0)	.0 (0)	.0 (0)	.0 (0)

FILE NAME P:\PDROPSF9.ADS
CODE ACI 318-89

SLAB SYSTEM BEAM-SUPPORTED SLAB
FRAME LOCATION INTERIOR

DESIGN METHOD STRENGTH DESIGN
MOMENTS AND SHEARS NOT PROPORTIONED

NUMBER OF SPANS 7

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 (flexural) Fy = 60.00 ksi
YIELD STRENGTH (stirrups) Fyv = 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
       AT BEAM TOP    =   1.50 in  OUTER LAYER
       AT BEAM BOTTOM =   1.50 in
  FLEXURAL BAR SIZES:    MINIMUM | MAXIMUM
       AT SLAB TOP    =   # 4
       AT SLAB BOTTOM =   # 4
       AT BEAM TOP    =   # 4       #14
       IN BEAM BOTTOM =   # 4       #14
  MINIMUM SPACING:
       IN SLAB =   6.00 in
       IN BEAM =   1.00 in
```

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)	LIVE (psf)
1*	1.3	11.0	15.0	15.0	4	30.0	.0	60.0	250.0
2	21.0	11.0	15.0	15.0	4	30.0	8.5	60.0	250.0
3	31.0	11.0	15.0	15.0	4	30.0	13.0	60.0	250.0
4	23.0	11.0	15.0	15.0	4	30.0	9.5	60.0	250.0
5	20.0	11.0	15.0	15.0	4	30.0	10.0	60.0	250.0
6	17.5	11.0	15.0	15.0	4	30.0	8.8	60.0	250.0
7*	1.3	11.0	15.0	15.0	4	30.0	.0	60.0	250.0

BEAMS ALONG SPAN DATA

SPAN NUMBER	BEAM WIDTH (in)	BEAM DEPTHS LEFT (in)	CENTER (in)	RIGHT (in)	HAUNCH LENGTHS LEFT (ft)	RIGHT (ft)
1	24.0	32.0	32.0	32.0	.0	.0
2	24.0	32.0	32.0	32.0	.0	.0
3	24.0	32.0	32.0	32.0	.0	.0
4	24.0	32.0	32.0	32.0	.0	.0
5	.0	.0	.0	.0	.0	.0
6	.0	.0	.0	.0	.0	.0
7	.0	.0	.0	.0	.0	.0

DISTRIBUTION OF DESIGN MOMENTS IN SPANS

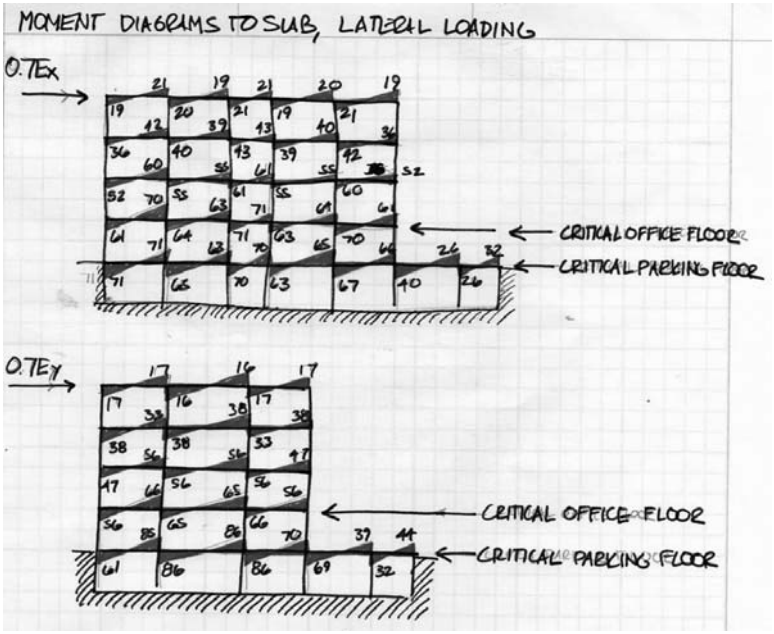
SPAN NUM	CROSS SECTN	TOTAL MOMENT (ft-k)	TOTAL-VERT DIFFERENCE (ft-k)	(%)	COLUMN STRIP MOMENT (ft-k)	(%)	BEAM MOMENT (ft-k)	(%)	MIDDLE STRIP MOMENT (ft-k)	(%)
2	8.93 TOP	-11.1	.0	(0)	-1.0	(9)	-5.9	(52)	-4.2	(37)
	BOT	512.1	.0	(0)	47.7	(9)	270.5	(52)	193.9	(37)
3	16.27 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	1016.3	.0	(0)	115.8	(11)	656.3	(64)	244.3	(24)
4	12.07 TOP	-96.1	.0	(0)	-9.5	(9)	-53.8	(55)	-32.8	(34)
	BOT	575.5	.0	(0)	56.9	(9)	322.2	(55)	196.4	(34)
5	10.50 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	357.6	.0	(0)	214.6	(60)	.0	(0)	143.1	(40)
6	10.06 TOP	.0	.0	(0)	.0	(0)	.0	(0)	.0	(0)
	BOT	384.4	.0	(0)	230.6	(60)	.0	(0)	153.7	(39)

Sample Spreadsheet Used to Size Torsion Beam

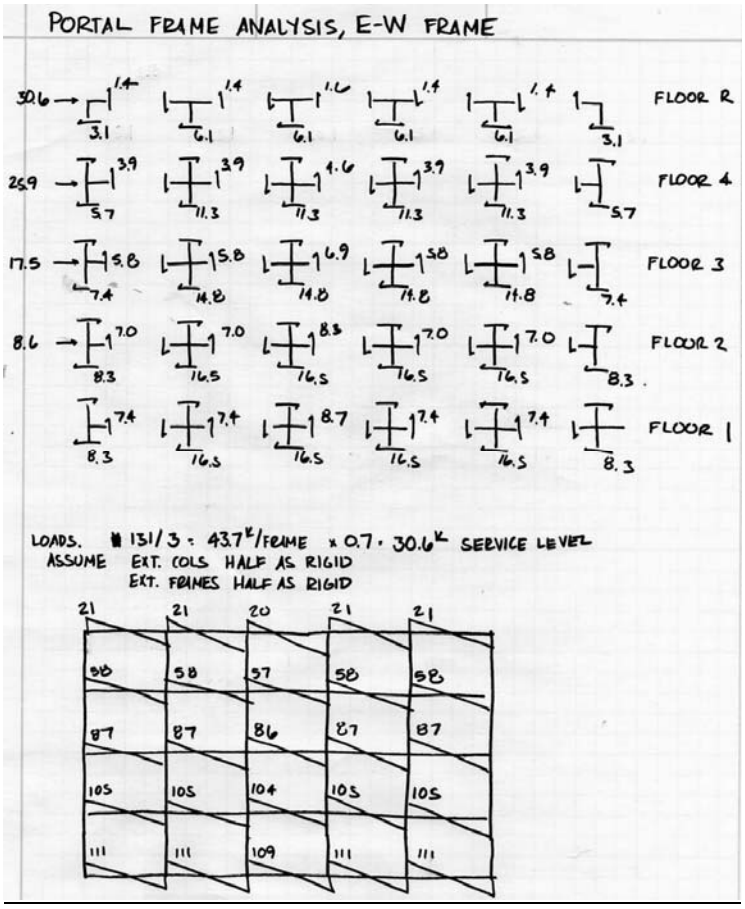
Tu=	151				
Vu=	96				
		SIZE			
BEAM DIMENSIONS		OK?			
H=	24	0.453012	<?	0.474	
B=	26.5	assumes f'c=4000 psi			
Acp=	636	MAX SPACING			
Pcp=	101	10.875			
Aoh=	471.5	10.25			
Ao=	400.775	24			
ph=	87	final:	10		
TORSION		SHEAR			
At=	0.050236	Vc=	51.53722		
		Av=	0.048198		
LONGITUDINAL REINFORCEMENT					
Al=	0.437053				
Al=	2.914961				
FLEXURAL REINFORCEMENT					
Mmax=	769.1	steel des	8#10		
As=	8.929525	AsFinal=	10		
phiMn=	840.1665	a=	6.659267		

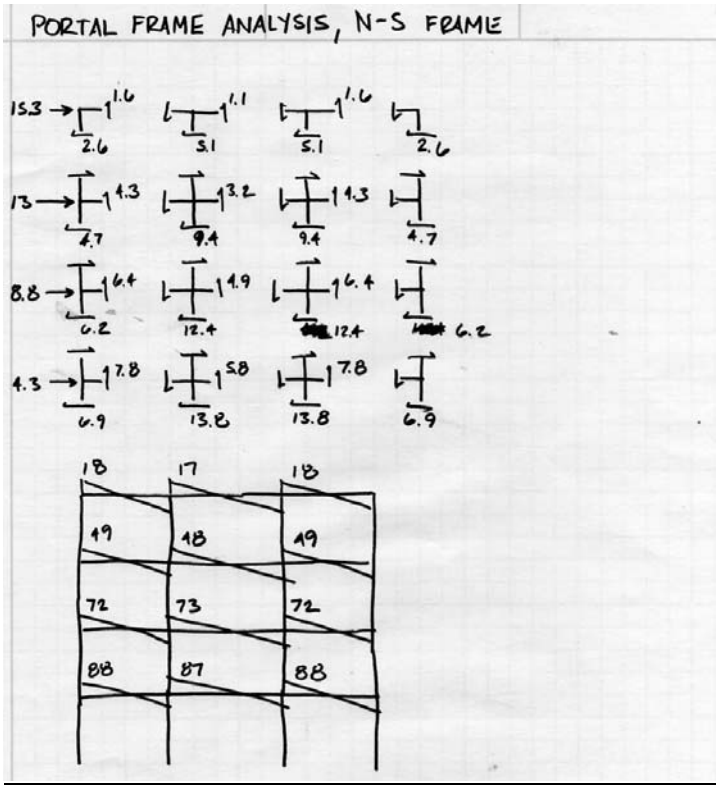
steel des At+Av	#4 stirrups @ 10"
steel des long	10-#5 distributed upsize 1,4,5,8 bottom reinf to 11

Slab Moments from Lateral Loads Derrived from ETABS



Slab Moments Determined from Portal Frame Analysis





CRSI Tables Used to Size Columns and Reinforcing

RECTANGULAR TIED COLUMNS 20" × 24"

Short columns – no sidesway
Bending on major or minor axis

f'_c = 4,000 psi
ϕM in inch-kips

f_y = 60,000 psi
ϕP in kips

BARS	RHO	AXIS	Max Cap		0% fy		25% fy		50% fy		100% fy		.1f'c Ag		Zero Axial Load
			ϕM	ϕP	ϕM	ϕP	ϕM	ϕP	ϕM	ϕP	ϕM	ϕP	ϕM	ϕP	ϕM
4-#10	1.06	MA	2658	1075	3448	970	4330	816	4829	694	5361	509	3888	192	2792
2E		MI	2177	1075	2933	950	3604	798	3978	679	4368	497	3148	192	2277
4-#11	1.30	MA	2735	1112	3690	985	4599	826	5135	699	5755	502	4286	192	3354
2E		MI	2231	1112	3127	963	3813	807	4211	682	4665	490	3453	192	2720
4-#14	1.88	MA	2932	1199	4208	1034	5227	861	5880	720	6745	496	5282	192	4695
2E		MI	2375	1199	3532	1011	4300	841	4787	703	5430	482	4222	192	3773
4-#18	3.33	MA	3368	1421	5455	1161	6751	953	7696	777	9166	481	7717	192	7940
2E		MI	2688	1421	4496	1136	6176	932	7268	758	9268	464	6080	192	6282
6-# 9	1.25	MA	2744	1104	3611	991	4551	831	5103	705	5737	509	4266	192	3279
2L-3S		MI	2056	1104	2762	980	3401	821	3738	695	4051	504	3310	192	2667
6-#10	1.59	MA	2871	1155	3925	1020	4934	853	5559	717	6345	506	4878	192	4097
2L-3S		MI	2110	1155	2933	1010	3604	843	3978	708	4368	502	3680	192	3303
6-#11	1.95	MA	2981	1211	4265	1047	5326	871	6014	728	6938	499	5475	192	4919
2L-3S		MI	2154	1211	3127	1036	3813	861	4211	717	4665	494	4013	192	3930
6-#14	2.81	MA	3261	1342	5024	1123	6259	927	7128	762	8426	490	6973	192	6905
2L-3S		MI	2283	1342	3532	1115	4300	917	4787	752	5430	486	4843	192	5405
6-#18	5.00	MA	3882	1675	6861	1320	8529	1070	9847	851	12063	471	10635	192	11727
2L-3S		MI	2580	1675	4496	1315	5469	1061	6176	838	7268	464	6745	192	8116
6-# 9	1.25	MA	2504	1104	3232	1001	4072	840	4523	712	4956	519	4087	192	3273
3L-2S		MI	2244	1104	3061	971	3780	815	4197	690	4669	497	3447	192	2664
6-#10	1.59	MA	2579	1155	3448	1032	4330	863	4829	726	5361	517	4574	192	4073
3L-2S		MI	2338	1155	3310	1000	4081	835	4554	702	5144	494	3925	192	3312
6-#11	1.95	MA	2643	1211	3690	1061	4599	883	5135	737	5755	512	5020	192	4872
3L-2S		MI	2417	1211	3578	1025	4383	853	4901	712	5594	486	4381	192	3955
6-#14	2.81	MA	2817	1342	4208	1142	5227	942	5880	774	6745	507	6119	192	6762
3L-2S		MI	2619	1342	4170	1100	5107	907	5763	745	6743	477	5536	192	5504
6-#18	5.00	MA	3250	1675	5455	1349	6751	1093	7696	868	9166	495	8680	192	10502
3L-2S		MI	3073	1675	5565	1295	6847	1048	7842	833	9506	454	8325	192	9210
8-# 8	1.32	MA	2779	1114	3663	1000	4630	838	5205	709	5880	510	4410	192	3457
2L-4S		MI	2034	1114	2695	994	3322	833	3635	708	3912	507	3211	192	2795
8-# 9	1.67	MA	2911	1167	3990	1031	5030	861	5682	723	6517	507	5053	192	4311
2L-4S		MI	2084	1167	2850	1027	3504	857	3845	724	4188	504	3588	192	3435
8-#10	2.12	MA	3074	1236	4403	1071	5538	890	6290	741	7328	503	5871	192	5393
2L-4S		MI	2147	1236	3044	1070	3734	888	4111	744	4539	501	4057	192	4126
8-#11	2.60	MA	3217	1309	4839	1109	6053	917	6893	757	8122	495	6668	192	6475
2L-4S		MI	2197	1309	3257	1109	3965	915	4368	760	4867	491	4500	192	4753
8-#14	3.75	MA	3572	1484	5840	1212	7291	992	8376	804	10107	485	8669	192	9108
2L-4S		MI	2356	1484	3714	1218	4513	993	5006	811	5711	480	5443	192	8252
8-# 8	1.32	MA	2590	1114	3362	1008	4249	845	4744	715	5259	518	4277	192	3452
3E		MI	2124	1114	2863	987	3541	827	3914	699	4294	505	3469	192	2808
8-# 9	1.67	MA	2683	1167	3611	1040	4551	869	5103	730	5737	516	4872	192	4294
3E		MI	2192	1167	3061	1019	3780	850	4197	714	4669	502	3912	192	3477
8-#10	2.12	MA	2800	1236	3925	1083	4934	900	5559	750	6345	514	5556	192	5354
3E		MI	2278	1236	3310	1060	4081	880	4554	732	5144	499	4437	192	4314
8-#11	2.60	MA	2901	1309	4265	1123	5326	928	6014	766	6938	508	6196	192	6408
3E		MI	2353	1309	3578	1098	4383	906	4901	746	5594	490	4913	192	5133
8-#14	3.75	MA	3180	1484	5024	1231	6259	1008	7128	816	8426	502	7792	192	8936
3E		MI	2548	1484	4170	1204	5107	983	5763	793	6743	481	6117	192	7095
8-#18	6.67	MA	3829	1928	6861	1508	8529	1209	9847	943	12063	485	11562	192	14108
3E		MI	3015	1928	5585	1474	6847	1178	7842	912	9506	453	8921	192	10832
8-# 8	1.32	MA	2477	1114	3152	1016	3975	852	4394	725	4781	522	3939	192	3423
4L-2S		MI	2271	1114	3102	981	3843	822	4280	695	4786	499	3564	192	2807
8-# 9	1.67	MA	2548	1167	3347	1050	4206	877	4662	742	5135	521	4420	192	4225
4L-2S		MI	2371	1167	3361	1011	4159	844	4655	708	5286	495	4056	192	3484
8-#10	2.12	MA	2636	1236	3592	1095	4499	910	5003	765	5585	520	5021	192	5119
4L-2S		MI	2494	1236	3687	1050	4558	872	5131	726	5920	490	4704	192	4338
8-#11	2.60	MA	2712	1309	3862	1136	4800	940	5342	783	6021	513	5602	192	5930
4L-2S		MI	2592	1309	4028	1087	4953	898	5591	741	6523	482	5312	192	5179

SQUARE TIED COLUMNS 16" × 16"

Short columns; no sideway
Bars symmetrical in 4 faces

f'_c = 4,000 psi, ϕM in inch-kips; f_y = 60,000 psi, ϕP in kips

BARS	RHO	Max Cap φM	Max Cap φP	0% fy φM	0% fy φP	25% fy φM	25% fy φP	50% fy φM	50% fy φP	100% fy φM	100% fy φP	.1f'c Ag φM	.1f'c Ag φP	Zero Axial Load φM
4-# 8	1.23	933	588	1326	504	1597	422	1750	357	1919	257	1407	102	1092
4-# 9	1.56	967	614	1422	518	1712	433	1887	364	2100	255	1589	102	1344
4-#10	1.98	1008	648	1542	537	1857	446	2059	372	2325	252	1820	102	1660
4-#11	2.44	1037	685	1666	554	1995	458	2217	378	2501	241	2031	102	1963
4-#14	3.52	1124	773	1945	604	2336	494	2623	400	2997	226	2574	102	2698
4-#18	6.25	1320	995	2598	734	3138	588	3541	451	4117	179	3856	102	4412
8-# 6	1.38	895	599	1260	518	1525	433	1670	365	1816	261	1468	102	1217
8-# 7	1.88	933	640	1373	542	1661	450	1831	376	2031	259	1706	102	1602
8-# 8	2.47	976	688	1503	571	1820	471	2020	389	2282	256	1976	102	2043
8-# 9	3.13	1022	741	1643	603	1991	495	2224	403	2554	253	2261	102	2513
8-#10	3.97	1078	809	1818	645	2207	524	2481	421	2893	248	2615	102	3056
8-#11	4.88	1121	883	1993	684	2409	552	2718	436	3158	231	2917	102	3461
8-#14	7.03	1254	1058	2404	790	2917	628	3325	481	3904	206	3718	102	4512
12-#10	5.95	1225	970	2172	752	2635	609	2996	476	3579	238	3407	102	4131
12-#11	7.31	1295	1081	2409	814	2915	653	3325	501	3953	213	3816	102	4720

SQUARE TIED COLUMNS 18" × 18"

BARS	RHO	Max Cap φM	Max Cap φP	0% fy φM	0% fy φP	25% fy φM	25% fy φP	50% fy φM	50% fy φP	100% fy φM	100% fy φP	.1f'c Ag φM	.1f'c Ag φP	Zero Axial Load φM
4-# 9	1.23	1344	744	1872	646	2281	542	2516	459	2777	331	2040	130	1576
4-#10	1.57	1397	778	2016	665	2455	555	2721	467	3049	328	2314	130	1952
4-#11	1.93	1437	815	2170	681	2626	566	2916	472	3302	322	2572	130	2322
4-#14	2.78	1549	902	2510	730	3038	602	3406	494	3943	314	3229	130	3211
4-#18	4.94	1797	1124	3312	858	4021	695	4579	552	5390	279	4799	130	5313
8-# 6	1.09	1254	728	1676	647	2056	543	2256	461	2437	338	1897	130	1421
8-# 7	1.48	1301	769	1810	671	2218	561	2447	472	2691	336	2211	130	1880
8-# 8	1.95	1354	817	1964	700	2406	582	2670	485	2989	334	2541	130	2407
8-# 9	2.47	1414	870	2132	732	2610	605	2913	500	3312	331	2891	130	2972
8-#10	3.14	1484	939	2343	774	2868	635	3221	518	3722	328	3325	130	3677
8-#11	3.85	1539	1012	2559	813	3118	663	3511	534	4103	320	3710	130	4331
8-#14	5.56	1703	1187	3058	920	3732	740	4246	580	5067	307	4702	130	5643
12-#10	4.70	1662	1100	2763	883	3390	716	3833	576	4540	321	4320	130	4997
12-#11	5.78	1750	1210	3058	946	3723	767	4238	602	5074	310	4843	130	5825
16-#10	6.27	1844	1261	3206	992	3921	802	4483	627	5403	321	5281	130	6324

SQUARE TIED COLUMNS 20" × 20"

BARS	RHO	Max Cap φM	Max Cap φP	0% fy φM	0% fy φP	25% fy φM	25% fy φP	50% fy φM	50% fy φP	100% fy φM	100% fy φP	.1f'c Ag φM	.1f'c Ag φP	Zero Axial Load φM
4-# 9	1.00	1804	888	2401	790	2960	664	3268	566	3582	416	2564	160	1807
4-#10	1.27	1869	923	2570	808	3163	678	3507	573	3898	413	2882	160	2244
4-#11	1.56	1922	959	2756	823	3367	688	3739	578	4198	407	3187	160	2680
4-#14	2.25	2062	1047	3156	872	3852	723	4315	600	4963	400	3956	160	3723
4-#18	4.00	2370	1269	4110	1000	5017	815	5702	657	6802	384	5814	160	6212
8-# 7	1.20	1753	914	2325	816	2884	685	3186	580	3481	423	2766	160	2156
8-# 8	1.58	1817	962	2505	845	3102	706	3445	593	3824	420	3187	160	2770
8-# 9	2.00	1886	1015	2701	877	3339	729	3726	608	4199	418	3605	160	3430
8-#10	2.54	1971	1084	2947	919	3639	759	4083	627	4675	415	4123	160	4257
8-#11	3.12	2045	1157	3207	958	3938	787	4429	642	5126	407	4592	160	5060
8-#14	4.50	2242	1332	3794	1065	4659	865	5290	690	6276	399	5784	160	6859
8-#18	8.00	2718	1776	5199	1337	6394	1061	7368	811	9041	373	8572	160	10508
12-#10	3.81	2187	1245	3434	1029	4245	841	4793	686	5622	411	5313	160	5898
12-#11	4.68	2295	1355	3788	1092	4660	886	5275	714	6257	401	5975	160	6892
12-#14	6.75	2604	1617	4613	1258	5679	1006	6485	791	7872	387	7636	160	9357
16-#10	5.08	2398	1406	3949	1140	4861	929	5548	740	6624	413	6417	160	7539
16-#11	6.24	2545	1553	4401	1227	5394	993	6175	777	7451	401	7313	160	8738

RECTANGULAR TIED COLUMNS 20" × 30"

Short columns — no sidesway
Bending on major or minor axis (MI, MA)

f'_c = 4,000 psi, ϕM in inch-kips; f_y = 60,000 psi, ϕP in kips

BARS	RHO	AXIS	Max Cap φM	Max Cap φP	0% fy φM	0% fy φP	25% fy φM	25% fy φP	50% fy φM	50% fy φP	100% fy φM	100% fy φP	.1f'c Ag φM	.1f'c Ag φP	Zero Axial Load φM
6-#11	1.56	MA	4540	1439	6034	1290	7693	1078	8722	908	10013	642	7731	240	6435
2L-3S		MI	2611	1439	3683	1246	4481	1040	4919	873	5367	618	4490	240	4016
6-#14	2.25	MA	4947	1570	7051	1366	8944	1134	10217	943	12008	634	9746	240	9092
2L-3S		MI	2734	1570	4096	1323	4972	1095	5496	906	6130	610	5340	240	5530
6-#18	4.00	MA	5859	1903	9536	1563	12017	1277	13897	1032	16930	615	14720	240	15615
2L-3S		MI	3029	1903	5075	1520	6147	1236	6887	990	7965	585	7273	240	8609
6-# 9	1.00	MA	3867	1333	4660	1245	6023	1049	6739	894	7375	665	5846	240	4245
3L-2S		MI	2706	1333	3602	1185	4440	996	4902	848	5373	624	3846	240	2711
6-#10	1.27	MA	3974	1384	4946	1277	6367	1072	7144	909	7912	664	6573	240	5307
3L-2S		MI	2803	1384	3855	1212	4744	1016	5260	860	5848	619	4323	240	3366
6-#11	1.56	MA	4071	1439	5274	1306	6732	1093	7560	921	8448	660	7239	240	6388
3L-2S		MI	2883	1439	4134	1235	5051	1032	5609	868	6296	610	4780	240	4020
6-#14	2.25	MA	4322	1570	5968	1389	7573	1154	8559	960	9776	658	8759	240	8948
3L-2S		MI	3093	1570	4734	1308	5778	1085	6472	900	7444	600	5934	240	5585
6-#18	4.00	MA	4953	1903	7655	1600	9637	1310	11019	1060	13054	652	12327	240	14911
3L-2S		MI	3554	1903	6164	1499	7525	1223	8553	985	10204	575	8721	240	9319
8-# 8	1.05	MA	4242	1343	5224	1243	6753	1045	7629	890	8582	654	6291	240	4481
2L-4S		MI	2490	1343	3232	1208	3981	1015	4339	867	4617	633	3639	240	2859
8-# 9	1.33	MA	4431	1396	5656	1274	7283	1068	8261	904	9425	650	7144	240	5607
2L-4S		MI	2539	1396	3391	1240	4165	1039	4550	882	4893	630	4023	240	3522
8-#10	1.69	MA	4663	1464	6203	1314	7957	1097	9067	922	10501	646	8234	240	7039
2L-4S		MI	2602	1464	3589	1282	4396	1069	4817	902	5242	627	4501	240	4337
8-#11	2.08	MA	4873	1538	6794	1352	8654	1124	9885	937	11579	639	9317	240	8497
2L-4S		MI	2649	1538	3813	1319	4633	1094	5075	916	5569	615	4953	240	5014
8-#14	3.00	MA	5396	1713	8135	1455	10315	1199	11874	985	14240	629	12010	240	12024
2L-4S		MI	2804	1713	4278	1426	5185	1171	5715	966	6412	603	6004	240	6556
8-# 8	1.05	MA	3984	1343	4829	1252	6253	1054	7025	897	7768	664	6100	240	4476
3E		MI	2583	1343	3400	1201	4200	1010	4619	859	4999	631	3875	240	2859
8-# 9	1.33	MA	4116	1396	5158	1285	6653	1078	7500	913	8400	663	6891	240	5590
3E		MI	2652	1396	3602	1232	4440	1032	4902	872	5373	628	4347	240	3539
8-#10	1.69	MA	4282	1464	5574	1327	7162	1109	8105	933	9206	661	7891	240	7000
3E		MI	2738	1464	3855	1273	4744	1061	5260	890	5848	624	4900	240	4389
8-#11	2.08	MA	4432	1538	6034	1368	7693	1138	8722	950	10013	656	8819	240	8429
3E		MI	2808	1538	4134	1308	5051	1085	5609	902	6296	614	5386	240	5228
8-#14	3.00	MA	4818	1713	7051	1478	8944	1219	10217	1002	12008	652	11008	240	11852
3E		MI	3008	1713	4734	1412	5778	1161	6472	948	7444	604	6607	240	7226
8-#18	5.33	MA	5763	2157	9536	1759	12017	1426	13897	1134	16930	643	16224	240	19850
3E		MI	3465	2157	6164	1679	7525	1352	8553	1065	10204	575	9436	240	11297
8-# 8	1.05	MA	3831	1343	4557	1261	5898	1062	6570	909	7147	670	5660	240	4447
4L-2S		MI	2735	1343	3639	1195	4502	1004	4984	854	5491	626	3962	240	2853
8-# 9	1.33	MA	3932	1396	4815	1296	6205	1088	6927	927	7617	670	6298	240	5521
4L-2S		MI	2837	1396	3902	1224	4819	1026	5360	867	5990	621	4464	240	3536
8-#10	1.69	MA	4059	1464	5141	1341	6595	1122	7381	951	8216	670	7096	240	6856
4L-2S		MI	2962	1464	4232	1263	5221	1053	5837	884	6624	616	5101	240	4398
8-#11	2.08	MA	4174	1538	5508	1384	7006	1153	7844	971	8812	666	7896	240	8083
4L-2S		MI	3065	1538	4585	1297	5621	1077	6299	897	7225	606	5709	240	5251
8-#14	3.00	MA	4481	1713	6299	1501	7962	1240	8961	1031	10292	665	9796	240	10739
4L-2S		MI	3334	1713	5372	1398	6585	1150	7448	942	8758	595	7249	240	7311
8-#18	5.33	MA	5289	2157	8222	1797	10303	1459	11707	1181	13938	661	13840	240	17010
4L-2S		MI	3937	2157	7253	1658	8903	1339	10219	1059	12442	565	10968	240	12243
10-#10	2.12	MA	4939	1545	6831	1364	8752	1134	10029	945	11796	643	9549	240	8743
2L-5S		MI	2663	1545	3726	1343	4535	1120	4995	932	5468	632	4895	240	5003
10-#11	2.60	MA	5195	1637	7554	1413	9616	1169	11048	966	13144	635	10906	240	10555
2L-5S		MI	2721	1637	3975	1391	4796	1155	5285	951	5834	619	5375	240	5827
10-#10	2.12	MA	4577	1545	6203	1378	7957	1146	9067	957	10501	658	9208	240	8693
3L-4S		MI	2775	1545	3965	1333	4873	1106	5393	926	6019	624	5271	240	5313

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

SQUARE TIED COLUMNS 22″ × 22″

Short columns; no sidesway
Bars symmetrical in 4 faces

f'_c = 4,000 psi f_y = 60,000 psi
ϕM in inch-kips ϕP in kips

BARS	RHO	Max Cap		0% fy		25% fy		50% fy		100% fy		.1f'c Ag		Zero Axial Load
		φM	φP	φM	φP	φM	φP	φM	φP	φM	φP	φM	φP	φM
4-#10	1.05	2435	1083	3211	968	3992	814	4430	692	4890	507	3532	194	2535
4-#11	1.29	2500	1119	3430	982	4231	823	4699	697	5236	501	3882	194	3038
4-#14	1.86	2671	1207	3891	1031	4789	858	5360	718	6114	494	4765	194	4235
4-#18	3.31	3044	1429	4998	1157	6136	949	6963	773	8248	478	6910	194	7112
8-# 8	1.31	2374	1122	3133	1006	3919	843	4355	714	4803	516	3887	194	3131
8-# 9	1.65	2455	1175	3356	1038	4190	867	4676	728	5229	514	4407	194	3886
8-#10	2.10	2556	1244	3638	1080	4532	897	5083	747	5771	511	5012	194	4835
8-#11	2.58	2641	1317	3942	1118	4880	924	5484	763	6293	504	5569	194	5772
8-#14	3.72	2880	1492	4618	1226	5708	1002	6472	811	7611	497	6969	194	8017
8-#18	6.61	3437	1936	6245	1500	7714	1201	8871	934	10818	476	10253	194	12476
12-#10	3.15	2799	1405	4192	1191	5222	980	5891	808	6848	510	6326	194	6833
12-#11	3.87	2938	1515	4605	1254	5705	1025	6450	836	7583	500	7188	194	7998
12-#14	5.58	3298	1777	5557	1421	6875	1147	7839	916	9436	489	9173	194	10859
16-#10	4.20	3050	1566	4779	1303	5923	1070	6749	863	7988	514	7627	194	8755
16-#11	5.16	3223	1713	5306	1391	6543	1134	7477	902	8947	503	8693	194	10231
20-#10	5.25	3262	1727	5372	1414	6659	1153	7618	924	9143	512	8912	194	10541

SQUARE TIED COLUMNS 24″ × 24″

BARS	RHO	Max Cap φM	Max Cap φP	0% fy φM	0% fy φP	25% fy φM	25% fy φP	50% fy φM	50% fy φP	100% fy φM	100% fy φP	.1f'c Ag φM	.1f'c Ag φP	Zero Axial Load φM
4-#11	1.08	3180	1294	4199	1158	5228	973	5810	827	6432	604	4668	230	3394
4-#14	1.56	3381	1382	4723	1205	5859	1007	6556	847	7422	597	5663	230	4746
4-#18	2.78	3829	1604	5983	1330	7390	1097	8374	902	9841	581	8096	230	8010
8-# 8	1.10	3032	1297	3853	1183	4870	994	5416	846	5939	622	4664	230	3491
8-# 9	1.39	3126	1350	4106	1215	5174	1018	5776	860	6416	620	5266	230	4341
8-#10	1.76	3243	1419	4424	1257	5559	1048	6233	879	7023	617	6000	230	5412
8-#11	2.17	3344	1492	4773	1295	5955	1075	6689	895	7616	610	6649	230	6481
8-#14	3.13	3625	1667	5539	1402	6891	1154	7805	944	9103	603	8261	230	9039
8-#18	5.56	4267	2111	7389	1677	9168	1354	10526	1068	12737	585	12056	230	14554
12-#10	2.65	3522	1580	5045	1369	6332	1133	7138	941	8231	617	7433	230	7803
12-#11	3.25	3673	1690	5519	1432	6883	1178	7775	970	9066	608	8420	230	9143
12-#14	4.69	4100	1952	6596	1599	8207	1300	9345	1051	11159	598	10835	230	12407
16-#10	3.53	3796	1741	5703	1482	7118	1223	8101	998	9510	623	8927	230	9907
16-#11	4.33	4009	1888	6308	1569	7826	1288	8931	1037	10600	613	10160	230	11732
16-#14	6.25	4544	2238	7714	1796	9543	1458	10982	1147	13333	604	13189	230	15832
20-#10	4.41	4049	1902	6360	1592	7945	1307	9076	1060	10805	622	10387	230	12008
20-#11	5.42	4297	2086	7104	1705	8817	1390	10100	1112	12153	611	11873	230	14121

(1) "0% f_y" indicates zero tension in bars on the tension side, "50% f_y" indicates 50% f_y stress in bars on the tension side, and "100% f_y" indicates 100% f_y stress (i.e., balance point) in bars on the tension side.

Sample Footing Spreadsheet

LOADING				
DL=	54		q(given)=	5000
LL=	49			
Pcn=	103		**Pce=**	54
TL=	143.2			
COLUMN				
Cdx(big)=	20		Afootingexst=	36
Cdy(sm)=	20			
Ratio=	1			
FSexst=	3.333333	<2?	*CHANGED FS TO 3.5	
FOOTING SIZE				
B=	8.577379		**Bfinal=**	9
L=	8.577379		**Lfinal=**	9
DIRECT SHEAR				
q=	12.27709	<164?	phi*4*(3000psi)^0.5	
TWO WAY SHEAR				
328+q=	340.2771			
Cdx+Cdy=	40		d=	7.441323
656+q=	668.2771		**dfinalL=**	8.625
BL=	11664		**dfinalS=**	7.875
CdxCdy=	400		**hfinal=**	12
WIDE BEAM SHEAR				
Q=	1.767901			
phiVnL=	8.503388	>?	VL=	5.211626
phiVnS=	7.763963	>?	VS=	5.322119
REINFORCEMENT				
AsL=	0.436482	<?	**AsLfinal=**	0.44
aL=	0.862745			
MuL=	14.73865	<?	phiMn=	16.22338