Appendix D

Structural Hand Calculations for Slab Redesign

JAMES G. DAVIS CONSTRUCTION CORPORATION

DAVIS

1430 Spring Hill Road, Suite 450
McLean, VA 22102
(703) 442-6500
Fax (703) 442-8010

NOTES

TO _____
FROM _____
DATE _____ TIME _____
PROJECT _____
PROJECT NUMBER _____

MEMO ☐ CONFERENCE ☐ TELECON ☐

ATTENDEES:

14' x 18' PANEL → $l_2/l_1 = 1.29$
f'_c = 4,000 psi f_y = 60,000 psi
8" DROP PANELS
LIVE LOAD = 30 psf SNOW: 30 psf GREEN ROOF: 26 psf SELF: 100 psf

h = 8" > 4" NO BEAMS ∴ $\alpha = 0$ & $\beta_t = 0$
$w_u = 1.2D + 1.6L_r + 0.5S$
$w_u = 1.2(26 + 100) + 1.6(30) + 0.5(30) = 214$ psf

SHORT SPAN

$$M_o = \frac{w l_2 l_n^2}{8} = \frac{(0.214)(18)(12.83)^2}{8} = 79.3 \text{ ft-k}$$

FROM ACI 13.6.3:
INT. NEG. $M_u = 0.70 M_o = 55.5$ ft-k
EXT. NEG $M_u = 0.26 M_o = 20.6$ ft-k
POS $M_u = 0.52 M_o = 41.2$ ft-k

COL. STRIP WIDTH = $2 \times 14/4 = 7$ ft
FROM A.4 IN APPENDIX A, COL STRIP SUPPORTS:
75% INT. NEG $M_u = 41.6$ ft-k
75% EXT. NEG $M_u = 15.5$ ft-k
60% POS. $M_u = 24.7$ ft-k

SHORT SPAN	COL. STRIP	MIDDLE STRIP
INT. NEG.	41.6	13.9
EXT. NEG.	15.5	5.1
POS.	24.7	16.5

JAMES G. DAVIS CONSTRUCTION CORPORATION

1430 Spring Hill Road, Suite 450
McLean, VA 22102
(703) 442-6500
Fax (703) 442-8010

NOTES

TO _____
FROM _____
DATE _____ TIME _____
PROJECT _____
PROJECT NUMBER _____

MEMO ☐ CONFERENCE ☐ TELECON ☐

ATTENDEES:

LONG SPAN

$$M_o = \frac{(0.214)(14)(16)^2}{8} = 95.9 \text{ ft-k}$$

FROM ACI 13.6.3

INT. NEG. M_u = 67.1 ft-k
EXT. NEG. M_u = 24.9 ft-k
POS M_u = 49.9 ft-k

FROM APPENDIX A.4

LONG SPAN	COL. STRIP	MIDDLE STRIP
INT. NEG	50.3	16.8
EXT. NEG	18.7	6.2
POS.	29.9	20

$$d^2 = \frac{M_u}{\phi f_y b(1-0.59 f_y/f_c')} = \frac{M_u}{(0.9)(0.0206)(60{,}000)(12)(1-(0.59)(0.0206)(60/4))}$$

$$d = \sqrt{\frac{M_u}{10{,}915}}$$

18ft SPAN: $d = \sqrt{\frac{116 \times 12}{33} \times \frac{12{,}000}{10{,}915}} = 2.53''$ → USE 7"

14ft SPAN: $d = \sqrt{\frac{12.83 \times 12}{36} \times \frac{12{,}000}{10{,}915}} = 2.2''$ → USE 6"

FOR SHRINKAGE & TEMP.

$0.0018 \times 18'' \times 12'' = 0.173 \text{ IN}^2$

18ft SPAN: $\rho_{min} = \frac{0.173}{7 \times 12} = 0.0021$

14ft SPAN: $\rho_{min} = \frac{0.173}{6 \times 12} = 0.0024$

JAMES G. DAVIS CONSTRUCTION CORPORATION

1430 Spring Hill Road, Suite 450
McLean, VA 22102
(703) 442-6500
Fax (703) 442-8010

DAVIS

NOTES

TO _____
FROM _____
DATE _____ TIME _____
PROJECT _____
PROJECT NUMBER _____

MEMO ☐ CONFERENCE ☐ TELECON ☐

ATTENDEES:

	LOCATION	M_u (ft-k)	b (in)	d (in)	$M_u \times 12/b$ (ft-k)	ρ	A_s (in^2)	BARS
LONG SPAN								
1. (2) HALF COL.	INT. NEG.	50.3	84	7	7.2	0.0025	0.236	#5@12"
2.	EXT. NEG.	18.7	84	7	2.67	0.0021	0.2	#5@12"
3.	POS.	29.9	84	7	4.3	0.0021	0.2	#5@12"
4. MIDDLE	INT. NEG.	16.8	132	7	1.5	0.0021	0.2	#5@12"
5.	EXT. NEG	6.2	132	7	0.6	0.0021	0.2	#5@12"
6.	POS.	20	132	7	1.8	0.0021	0.2	#5@12"
SHORT SPAN								
7. EXT. COL	NEG.	15.5	42	6	4.4	0.0024	0.23	#5@12"
8.	POS.	24.7	42	6	7.1	0.0029	0.28	#5@12"
9. MIDDLE	NEG.	13.9	84	6	2.0	0.0024	0.23	#5@12"
10.	POS.	16.5	84	6	2.4	0.0024	0.23	#5@12"
11. INT. COL.	NEG.	41.6	42	6	11.9	0.005	0.48	#5@7½"
12.	POS.	24.7	42	6	7.1	0.0029	0.28	#5@12"

$$M_u(12\,in/ft) = 0.9A_s(60\,ksi)\left(d - \frac{1.96A_s}{2}\right)$$

1. $A_s = 0.236 \rightarrow 0.236/(84\times12) = 0.0025 > 0.0021$ OK
2. $A_s = 0.09 \rightarrow 0.09/(84\times12) = 0.0009 < 0.0021$ N.G.
3. $A_s = 0.14 \rightarrow 0.14/(84\times12) = 0.0015 < 0.0021$ N.G.
4. $A_s = 0.05 \rightarrow 0.05/(84\times12) = 0.0005 < 0.0021$ N.G.
5. $A_s = 0.019 \rightarrow 0.019/(84\times12) = 0.0002 < 0.0021$ N.G.
6. $A_s = 0.058 \rightarrow 0.058/(84\times12) = 0.0006 < 0.0021$ N.G.
7. $A_s = 0.17 \rightarrow 0.17/(84\times12) = 0.0018 < 0.0024$ N.G.
8. $A_s = 0.28 \rightarrow 0.28/(84\times12) = 0.0029 > 0.0024$ OK
9. $A_s = 0.075 \rightarrow 0.075/(84\times12) = 0.0008 < 0.0024$ N.G.
10. $A_s = 0.09 \rightarrow 0.09/(84\times12) = 0.0009 < 0.0024$ N.G.
11. $A_s = 0.48 \rightarrow 0.48/(84\times12) = 0.0050 > 0.0024$ OK
12. $A_s = 0.28 \rightarrow 0.28/(84\times12) = 0.0029 > 0.0024$ OK

JAMES G. DAVIS CONSTRUCTION CORPORATION

1430 Spring Hill Road, Suite 450
McLean, VA 22102
(703) 442-6500
Fax (703) 442-8010

NOTES

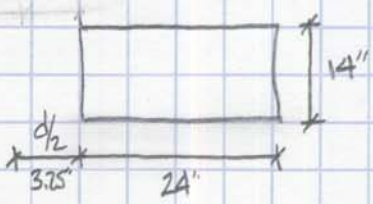
TO _____
FROM _____
DATE _____ TIME _____
PROJECT _____
PROJECT NUMBER _____

MEMO ☐ CONFERENCE ☐ TELECON ☐

ATTENDEES:

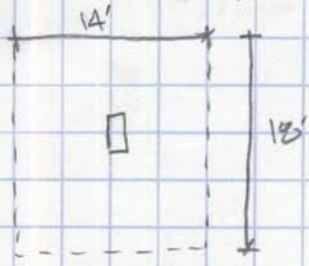
NOMINAL SHEAR STRENGTH

$V_c = 4\sqrt{f'_c}\, b_o d \rightarrow \phi V_c = (0.75)(4)(\sqrt{4{,}000})(90.3)(6.5'') = 111{,}366$ lbs.



BASED ON TRIBUTARY AREA

$V_u = (214.2\ psf)(18' \times 14') = 53{,}978$ lbs. $< \phi V_c = 111{,}366$ lbs OK



∴ NO ADD'L SHEAR REINFORCEMENT REQUIRED

COL. DESIGN

$P_n = 0.85 f'_c A_c + A_s f_y$

$\phi P_n = 0.65\left[(0.85)(4{,}000)(336) + (4.00)(60{,}000)\right] = 898{,}560$ lb

$a = \frac{A_s f_y}{0.85 f'_c b} = 5.04$ $\quad \phi P_n = 898{,}560 > P_u = 53{,}978$ lbs. OK

↳ $M_n = 0.85 f'_c ab\left(\frac{h}{2} - \frac{a}{2}\right) + A'_s f'_s\left(\frac{h}{2} - d'\right) + A_s f_s\left(d - \frac{h}{2}\right)$

$\phi M_n = 0.65\left[(0.85)(4)(5.04)(14)\left(\frac{24}{2} - \frac{5.04}{2}\right) + (2)(60)\left(\frac{24}{2} - 2.5\right) + (2)(60)\left(21.5 - \frac{24}{2}\right)\right]$

$\phi M_n = 247$ ft-k $> M_o = 95.9$ ft-k OK