Two-Way Flat Plate Concrete Floor Design

A plan of a flat plate concrete floor without spandrel beams is shown in Figure 1. Perform flexural analysis and design for a typical design strip along grid 2 by utilizing the two methods permitted in chapter 13 of ACI 318, Direct Design Method (DDM), and Equivalent Frame Method (EFM). Also compare the calculation results with exact results from spSlab software program model created for the same floor strip.

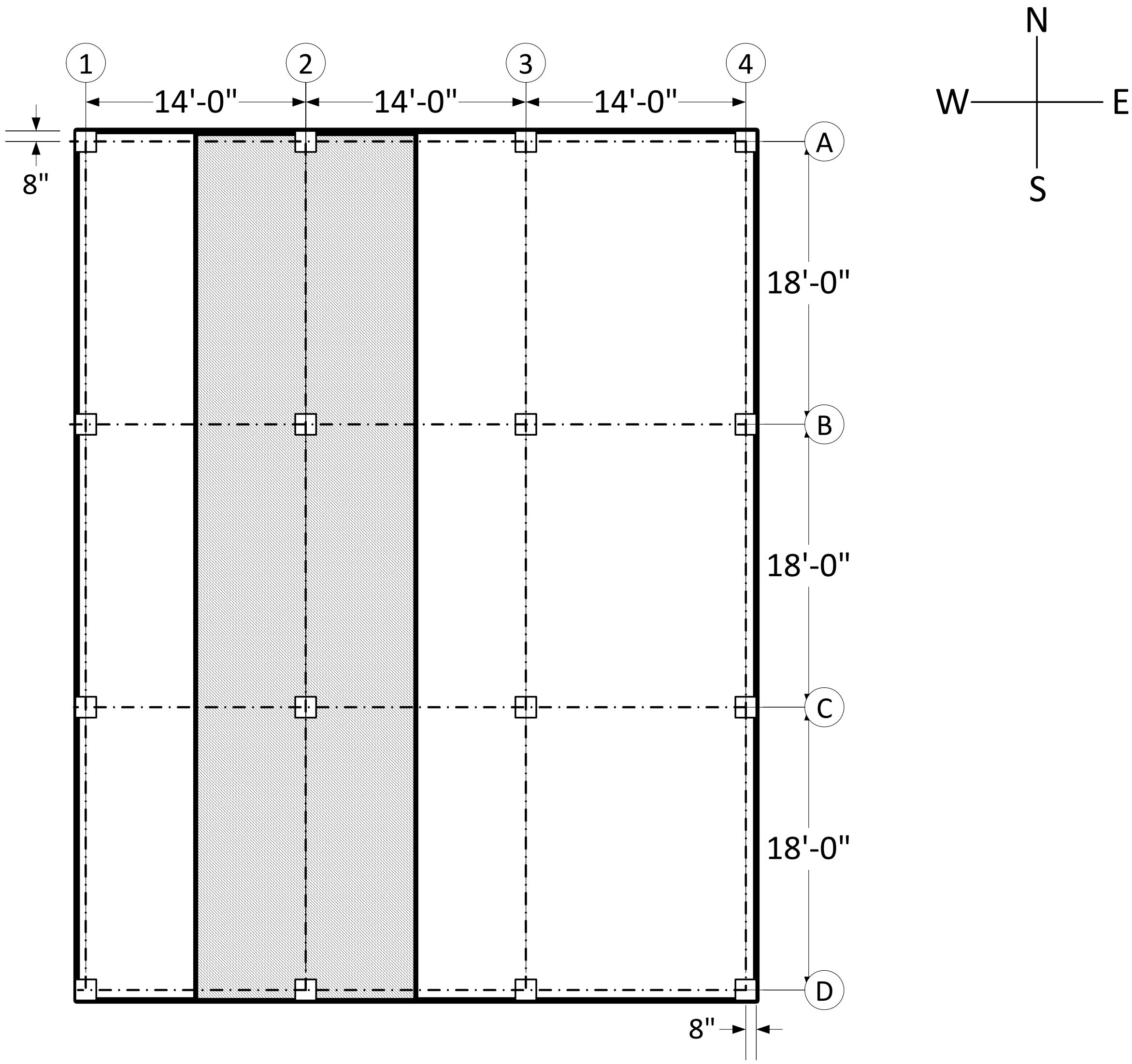


Figure 1- Two-Way Flat Plate Concrete Floor System

Code

Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary (ACI 318R-11)

Reference

Notes on ACI 318-11 Building Code Requirements for Structural Concrete, Twelfth Edition, 2013 Portland Cement Association, Examples 19.1, and 20.1

Design Data

Story Height $= 9 \text{ ft}$

Columns $= 16 \times 16$ in.

Superimposed Dead Load $= 20$ psf

Live Load, $\text{LL} = 40$ psf

$f'_c = 4000$ psi (for slabs)

$f'_c = 6000$ psi (for columns)

$f_y = 60{,}000$ psi

Required fire resistance rating = 2 hours

Solution

1. Determine the preliminary slab thickness, t_{slab}:

a. Control of deflections.
In lieu of detailed calculation for deflections, ACI 318 Code gives minimum slab thickness for two-way construction without interior beams in Table 9.5 (c).

For this flat plate slab systems the minimum slab thicknesses per ACI 318-11 are:

Exterior Panels: $h = \dfrac{l_n}{30} = \dfrac{200}{30} = 6.67$ in.
but not less than 5 in

Interior Panels: $h = \dfrac{l_n}{33} = \dfrac{200}{33} = 6.06$ in.
but not less than 5 in

where l_n = length of clear span in the long direction $= 216 - 16 = 200$ in.

Try 7 in. slab for all panels (self-weight $= 87.5$ psf)

b. Shear strength of slab
Use average effective depth $d = 5.75$ in. (3/4 in. cover for # 4 rebar)

Factored dead load, $q_{Du} = 1.2 \times (87.5 + 20) = 129$ psf

Factored live load, $q_{Lu} = 1.6 \times 40 = 64$ psf

Total factored load $q_u = 193$ psf

Check the adequacy of slab thickness for beam action (one-way shear) at an interior column:

Consider a 12-in. wide strip. The critical section for one-way shear is located at a distance, d , from the face of support (see Fig. 2)

Tributary area for one way shear is $A_{Tributary} = [(\frac{18}{2}) - (\frac{16}{2 \times 12}) - (\frac{5.75}{12})] \times (\frac{12}{12}) = 7.854 \text{ ft}^2$

$V_u = q_u \times A_{Tributary} = 0.193 \times 7.854 = 1.5 \text{ kips}$

$V_c = 2\lambda\sqrt{f'_c}\, b_w d$ ACI 318, Eq. 11-3

where $\lambda = 1$ for normal weight concrete

$\phi V_c = 0.75 \times 2 \times 1.0 \times \sqrt{4000} \times 12 \times \frac{5.75}{1000} = 6.6 \text{ kips} > V_u$

Slab thickness of 7 in. is adequate for one-way shear.

Check the adequacy of slab thickness for punching shear (two-way shear) at an interior column:

Tributary area for two way shear is $A_{Tributary} = [(18 \times 14) - (\frac{16 + 5.75}{12})^2 = 248.7 \text{ ft}^2$

$V_u = q_u \times A_{Tributary} = 0.193 \times 248.7 = 48.0 \text{ kips}$

$V_c = 4\lambda\sqrt{f'_c}\, b_o d$ (For square interior column) ACI 318, Eq. 11-33

$V_c = 4 \times \sqrt{4000} \times (4 \times 21.75) \times \frac{5.75}{1000} = 126.6 \text{ kips}$

$\phi V_c = 0.75 \times 126.6 = 95.0 \text{kips} > V_u$ O.K.

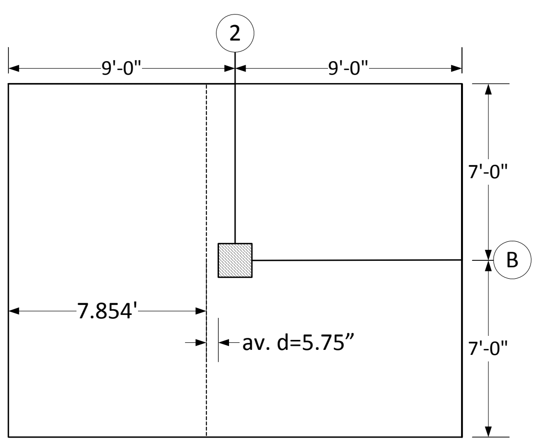


Figure 2 – Critical Section for One-Way Shear

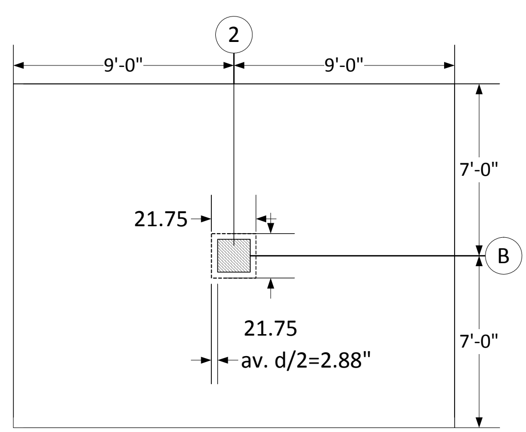


Figure 3 – Critical Section for Two-Way Shear

2. Flexural Analysis and Design

ACI 318 permits the use of Direct Design Method (DDM) and Equivalent Frame Method (EFM) for the design of two-way slab systems. Sections 2.1, 2.2, and 2.3 outline the solution per DDM, EFM, and spSlab Program.

2.1. Direct Design Method

The DDM can be utilized for two-way slab design only if the criteria in ACI 318, 13.6.1 are met.

2.1.1 Check applicability of Direct Design Method:

There is a minimum of three continuous spans in each direction — ACI 318, 13.6.1.1

Long-to-short span ratio is $1.29 < 2.0$ — ACI 318, 13.6.1.2

Successive span lengths are equal — ACI 318, 13.6.1.3

Columns are not offset — ACI 318, 13.6.1.4

Loads are uniformly distributed with service live-to-dead load ratio of $0.37 < 2.0$ — ACI 318, 13.6.1.5

Slab system is without beams — ACI 318, 13.6.1.6

Since all the criteria are met, Direct Design Method can be utilized.

2.1.2 Factored moments in slab:

a. Calculate the total factored static moment per ACI 318, Eq. 13-4.

$$M_o = \frac{q_u \ell_2 \ell_n^2}{8} = \frac{0.193 \times 14 \times 16.67^2}{8} = 93.6 \text{ ft-kips}$$

b. Distribute the total factored moment, M_o, in an interior and end span per ACI 318, 13.6.3.2, and 13.6.3.3 respectively.

Table 1 - Distribution of M_o along the span

Location		Total Design Strip Moment, M_{DS} (ft-kips)
End Span	Exterior Negative**	$0.26 \times M_o = 24.3$
	Positive	$0.52 \times M_o = 48.7$
	Interior Negative**	$0.70 \times M_o = 65.5$
Interior Span	Positive	$0.35 \times M_o = 32.8$

c. Calculate the column strip moments per ACI 318, 13.6.4. That portion of negative and positive total design strip moments not resisted by column strips shall be proportionally assigned to corresponding two half-middle strips ACI 318, 13.6.6.

Table 2 - Lateral distribution of the total design strip moment, M_{DS}				
Location		Total Design Strip Moment, M_{DS} (ft-kips)	Column Strip Moment (ft-kips)	Moment (ft-kips) in Two Half-Middle Strips
End Span	Exterior Negative*	24.3	$1.00 \times M_{DS} = 24.3$	$0.00 \times M_{DS} = 0.00$
	Positive	48.7	$0.60 \times M_{DS} = 29.2$	$0.40 \times M_{DS} = 19.5$
	Interior Negative*	65.5	$0.75 \times M_{DS} = 49.1$	$0.25 \times M_{DS} = 16.4$
Interior Span	Positive	32.8	$0.60 \times M_{DS} = 19.7$	$0.40 \times M_{DS} = 13.1$
*All negative moments are at face of support..				

2.1.3. **Determine the total flexural reinforcement required in column and middle strips**

a. Determine flexural reinforcement required for strip moments

The flexural reinforcement calculation for the column strip of end span – exterior negative location is provided below.

$M_u = 24.3$ ft-kips

Assume tension-controlled section $(\phi = 0.9)$

Column strip width, $b = (14 \times 12)/2 = 84$ in

Use average $d = 7 - 1.25 = 5.75$ in

Assume that $jd = 0.95 \times d = 5.46$ in

$$A_s = \frac{M_u}{\phi f_y jd} = \frac{24.3 \times 12000}{0.9 \times 60000 \times 0.95 \times 5.75} = 0.99 \text{ in}^2$$

Since the computed A_s was based on a guess for jd, compute ‘a’ for $A_s = 0.99$ in^2 :

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.99 \times 60000}{0.85 \times 4000 \times 84} = 0.208 \text{ in}$$

$$c = \frac{a}{\beta_1} = \frac{0.208}{0.85} = 0.244 \text{ in}$$

$$\varepsilon_t = (\frac{0.003}{c})d_t - 0.003 = (\frac{0.003}{0.244}) \times 5.75 - 0.003 = 0.0676 > 0.005$$

Therefore, section is tension-controlled.

$$A_s = \frac{M_u}{\phi f_y (d - a/2)} = \frac{24.3 \times 12000}{0.9 \times 60000 \times (5.75 - 0.208/2)} = 0.96 \text{ in}^2$$

Min $A_s = 0.018 \times 84 \times 7 = 1.06 \text{ in}^2 > 0.96 \text{ in}^2$ according to ACI 318. 13.3.1

Maximum spacing $s_{max} = 2h = 2 \times 7 = 14$ in < 18 in according to ACI 318. 13.3.2

Provide 6 - #4 bars with $A_s = 1.20 \text{ in}^2$ and $s = 84/6 = 14 \text{ in} \le s_{max}$

All the values on Table 3 are calculated based on the procedure outlined above.

Table 3 - Required Slab Reinforcement for Flexure [Direct Design Method (DDM)]

Span Location		M_u (ft-kips)	b * (in.)	d ** (in.)	A_s Req'd for flexure † (in^2)	Min A_s ‡ (in^2)	Reinforcement Provided+	A_s Prov. for flexure (in^2)
End Span								
Column Strip	Exterior Negative	24.3	84	5.75	0.96	1.06	6-#4	1.20
	Positive	29.0	84	5.75	1.15	1.06	6-#4	1.20
	Interior Negative	49.6	84	5.75	1.99	1.06	10-#4	2.00
Middle Strip	Exterior Negative	0.0	84	5.75	0.00	1.06	6-#4	1.20
	Positive	19.7	84	5.75	0.77	1.06	6-#4	1.20
	Interior Negative	15.9	84	5.75	0.62	1.06	6-#4	1.20
Interior Span								
Column Strip	Positive	19.7	84	5.75	0.77	1.06	6-#4	1.20
Middle Strip	Positive	13.1	84	5.75	0.51	1.06	6-#4	1.20

* Column strip width, $b = (14 \times 12)/2 = 84$ in.

* Middle strip width, $b = (14 \times 12) - 84 = 84$ in.

** Use average $d = 7 - 1.25 = 5.75$ in.

b. Calculate additional slab reinforcement at columns for moment transfer between slab and column

Portion of the unbalanced moment transferred by flexure is $\gamma_f \times M_u$

where $$\gamma_f = \frac{1}{1 + (2/3) \times \sqrt{b_1 / b_2}}$$

b_1 = Dimension of the critical section b_o measured in the direction of the span for which moments are determined.

b_2 = Dimension of the critical section b_o measured in the direction perpendicular to b_1.

Effective slab width, $b_b = c_2 + 3 \times h$

Table 4 - Additional Slab Reinforcement at columns for moment transfer between slab and column [Direct Design Method (DDM)]									
Span Location		**Effective slab width, b_b (in.)**	**d (in.)**	$\square_f$	**M_u^* (ft-kips)**	**$\square_f M_u$ (ft-kips)**	**A_s req'd within b_b (in^2)**	**A_s prov. for flexure within b_b (in^2)**	**Add'l Reinf.**
End Span									
Column Strip	Exterior Negative	37	5.75	0.62	24.3	15.1	0.60	0.53	1-#4
	Interior Negative	37	5.75	0.60	0.0	0.0	0.00	0.97	-
*M_u is calculated at the face of the support only in Direct Design Method solution.									

2.1.4 Factored moments in columns per ACI 318, 13.6.9

a. Interior columns, with equal spans in the direction of analysis and (different) equal spans in the transverse direction

$$M_u = 0.07(0.5 \times q_{Lu} \times \ell_2 \times \ell_n^2)$$ ACI 318, Eq. 13-7

$$M_u = 0.07(0.5 \times 1.6 \times 0.04 \times 14 \times 16.67^2) = 8.7 \text{ ft-kips}$$

With the same column size and length above and below the slab,

$$M_{column} = \frac{8.7}{2} = 4.35 \text{ ft-kips}$$

This moment is combined with the factored axial load (for each story) for design of the interior columns.

b. Exterior Columns.

Total exterior negative moment from slab must be transferred directly to the column: $M_u = 24.3$ ft-kips. With the same column size and length above and below the slab,

$$M_{column} = \frac{24.3}{2} = 12.15 \text{ tf-kips}$$

This moment is combined with the factored axial load (for each story) for design of the exterior column.

2.2 Equivalent Frame Method

2.2.1 Frame members of equivalent frame:

Determine moment distribution factors and fixed-end moments for the equivalent frame members. The moment distribution procedure will be used to analyze the partial frame. Stiffness factors k, carry over factors COF, and fixed-end moment factors FEM for the slab-beams and column members are determined using the tables at Appendix 20-A of PCA Notes on ACI 318-08. These calculations are shown below.

a. Flexural stiffness of slab-beams at both ends, K_{sb}.

$$\frac{c_{N1}}{\ell_1} = \frac{16}{(18\times 12)} = 0.07 \quad , \quad \frac{c_{N1}}{\ell_2} = \frac{16}{(14\times 12)} = 0.1$$

For $c_{F1} = c_{F2}$, stiffness factors, $k_{NF} = k_{FN} = 4.13$ by interpolation from Table A1 in Appendix 20A of PCA Notes on ACI 318-08

Thus, $K_{sb} = k_{NF}\frac{E_{cs}I_s}{\ell_1} = 4.13\frac{E_{cs}I_s}{\ell_1}$ PCA Notes,Table A1

$$K_{sb} = 4.13\times 3.60\times 10^6 \times \frac{4802}{216} = 331\times 10^6 \text{ in.-lb}$$

where, $I_s = \frac{\ell_s h^3}{12} = \frac{168\times (7)^3}{12} = 4802 \text{ in}^4$

$E_{cs} = 57{,}000\sqrt{f'_c} = 57{,}000\times\sqrt{4000} = 3.60\times 10^6$ psi ACI 318, 8.5.1

Carry-over factor $COF = 0.509$, by interpolation from Table A1

Fixed-end moment $FEM = 0.0843 w_u \ell_2 \ell_1^{\,2}$, by interpolation from Table A1

b. Flexural stiffness of column members at both ends, K_c.

Referring to Table A7, Appendix 20A, $t_a = 3.5$ in., $t_b = 3.5$ in.,

$H = 9$ ft $= 108$ in., $H_c = 101$ in., $\frac{t_a}{t_b} = 1$, $\frac{H}{H_c} = 1.07$

Thus, $k_{AB} = k_{BA} = 4.74$ by interpolation.

$K_c = \frac{4.74 E_{cc} I_c}{\ell_c}$ PCA Notes, Table A7

$$K_c = 4.74\times 4.42\times 10^6 \times \frac{5461}{108} = 1059\times 10^6 \text{ in.-lb}$$

where $I_c = \frac{c^4}{12} = \frac{(16)^4}{12} = 5461 \text{ in.}^4$

$E_{cs} = 57{,}000\sqrt{f'_c} = 57{,}000\sqrt{6000} = 4.42\times 10^6$ psi

$\ell_c = 9 \text{ ft} = 108$ in.

c. Torsional stiffness of torsional members, K_t.

$K_t = \frac{9E_{cs}C}{[\ell_2(1-\frac{c_2}{\ell_2})^3]}$ ACI 318, R.13.7.5

$$K_t = \frac{9\times 3.60\times 10^6 \times 1325}{168(0.905)^3} = 345\times 10^6 \text{ in.-lb}$$

where $C = \sum(1-0.63\frac{x}{y})(\frac{x^3y}{3})$ ACI 318, Eq.13-6

$$C = (1-0.63\times\frac{7}{16})(7^3\times\frac{16}{3}) = 1325\ \text{in}^4.$$

$c_2 = 16$ in., and $\ell_2 = 14$ ft $= 168$ in.

d. Equivalent column stiffness K_{ec}.

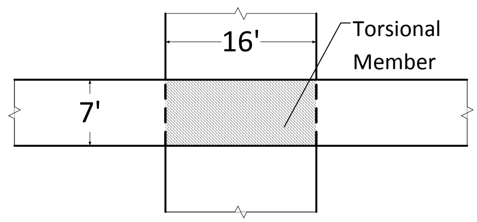


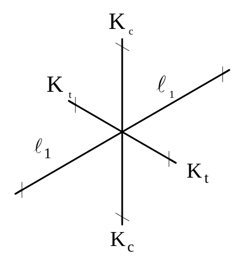
Figure 4 - Torsional Member

$$K_{ec} = \frac{\sum K_c \times \sum K_t}{\sum K_c + \sum K_t}$$

$$K_{ec} = \frac{(2\times1059)(2\times345)}{[(2\times1059)+(2\times345)]}\times10^6$$

$$K_{ec} = 520\times10^6\ \text{in.-lb}$$

where $\sum K_t$ is for two torsional members one on each side of the column, and $\sum K_c$ is for the upper and lower columns at the slab-beam joint of an intermediate floor.



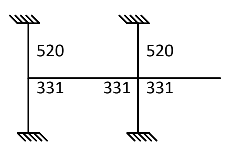
e. Slab-beam joint distribution factors, DF.

At exterior joint,

$$DF = \frac{331}{(331+520)} = 0.389$$

At interior joint,

$$DF = \frac{331}{(331+331+520)} = 0.280$$



COF for slab-beam $= 0.509$

2.2.2 Partial frame analysis of equivalent frame:

Determine negative and positive moments for the slab-beams using the moment distribution method. Since the unfactored live load does not exceed three-quarters of the unfactored dead load, design moments are assumed to occur at all critical sections with full factored live on all spans per ACI 318, 13.7.6.2.

$$\frac{L}{D} = \frac{40}{(87.5+20)} = 0.37 < \frac{3}{4}$$

a. Factored load and fixed-end moments.

Factored dead load $q_{Du} = 1.2(87.5+20) = 129$ psf

Factored live load $q_{Lu} = 1.6(40) = 64$ psf

Factored load $q_u = q_{Du} + q_{Lu} = 193$ psf

FEM's for slab-beams $= m_{NF} q_u \ell_2 \ell_1^{\,2}$ (Table A1, Appendix 20A)

$= 0.0841(0.193 \times 14)18^2 = 73.8$ ft-kips

b. Moment distribution. Computations are shown in Table 5. Counterclockwise rotational moments acting on the member ends are taken as positive. Positive span moments are determined from the following equation:

$$M_u\,(\text{midspan}) = M_o - \frac{(M_{uL} + M_{uR})}{2}$$

where M_o is the moment at the midspan for a simple beam.

When the end moments are not equal, the maximum moment in the span does not occur at the midspan, but its value is close to that midspan for this example.

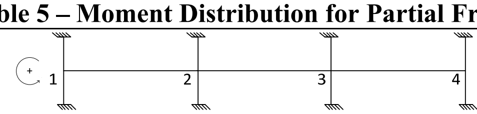
Positive moment in span 1-2:

$$+M_u = (0.193 \times 14)\frac{18^2}{8} - \frac{(46.6 + 84.0)}{2} = 44.1 \text{ ft-kips}$$

Positive moment span 2-3:

$$+M_u = (0.193 \times 14)\frac{18^2}{8} - \frac{(76.2 + 76.2)}{2} = 33.2 \text{ ft-kips}$$

Table 5 – Moment Distribution for Partial Frame



Joint	1	2		3		4
Member	1-2	2-1	2-3	3-2	3-4	4-3
DF	0.389	0.280	0.280	0.280	0.280	0.389
COF	0.509	0.509	0.509	0.509	0.509	0.509
FEM	+73.8	-73.8	+73.8	-73.8	+73.8	-73.8
Dist	-28.7	0.0	0.0	0.0	0.0	28.7
CO	0.0	-14.6	0.0	0.0	14.6	0.0
Dist	0.0	4.1	4.1	-4.1	-4.1	0.0
CO	2.1	0.0	-2.1	2.1	0.0	-2.1
Dist	-0.8	0.6	0.6	-0.6	-0.6	0.8
CO	0.3	-0.4	-0.3	0.3	0.4	-0.3
Dist	-0.1	0.2	0.2	-0.2	-.02	0.1
CO	0.1	-0.1	-0.1	0.1	0.1	-0.1
Dist	0.0	0.0	0.0	0.0	0.0	0.0
Neg. M	46.6	-84.0	76.2	-76.2	84.0	-46.6
M at midspan	44.1		33.2		44.1	

2.2.3 Design moments:

Positive and negative factored moments for the slab system in the direction of analysis are plotted in Fig. 2. The negative design moments are take at the faces of rectilinear supports but not at distances greater than $0.175\ell_1$ from the centers of supports.

$$\frac{16\text{in.}}{2} = 0.67\text{ ft} < 0.175 \times 18 = 3.2\text{ ft (use face of support location)}$$

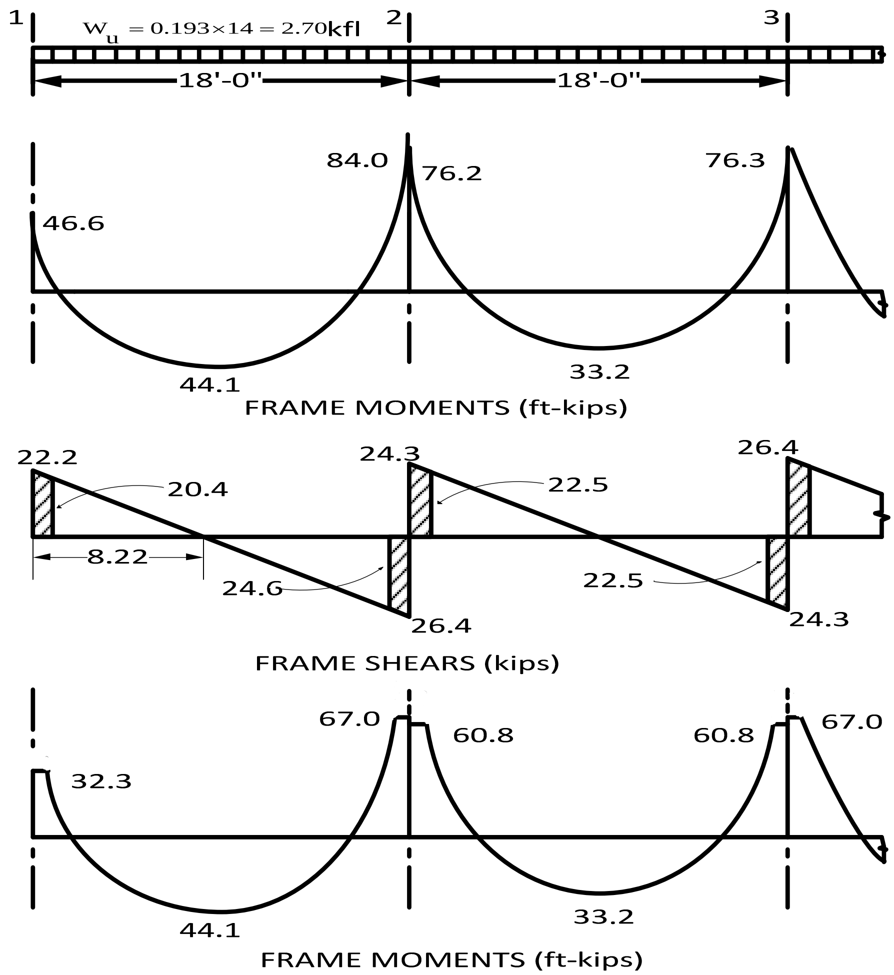


Figure 5 - Positive and Negative Design Moments for Slab-Beam (All Spans Loaded with Full Factored Live Load)

2.2.4 Total factored moment per span:

Slab systems within the limitations of 13.6.1 may have the resulting reduced in such proportion that the numerical sum of the positive and average negative moments not be greater than:

$$M_o = \frac{q_u \ell_2 \ell_n^{\,2}}{8} = 0.193 \times 14 \times \frac{(16.67)^2}{8} = 93.9\text{ ft-kips}$$

$$\text{End spans: } 44.1 + \frac{(32.3 + 67.0)}{2} = 93.8\text{ ft-kips}$$

Interior span: $33.2+\dfrac{(60.8+60.8)}{2}=94$ ft-kips

It may be seen that the total design moments from the Equivalent Frame Method yield a static moment equal to that given by the static moment expression used with the Direct Design Method.

2.2.5 Factored moments in slab-beam strip:

The negative and positive factored moments at critical sections may be distributed to the column strip and the two half-middle strips of the slab-beam according to the proportions specified in 13.6.4 and 13.6.6 The requirement of 13.6.1.6 does not apply for slab systems without beams, $\alpha = 0$. Distribution of factored moments at critical sections is summarized in Table 6.

Table6 - Lateral distribution of factored moments

		Factored Moments (ft-kips)	Column Strip		Moments (ft-kips) in Two Half-Middle Strips**
			Percent*	Moment (ft-kips)	
End Span	Exterior Negative	32.3	100	32.3	0.0
	Positive	44.1	60	26.5	17.7
	Interior Negative	67.0	75	50.3	16.7
Interior Span	Negative	60.8	75	45.6	15.2
	Positive	33.2	60	19.9	13.2

*For the slab systems without beams

**That portion of the factored moment not resisted by the column strip is assigned to the two half-middle strips

2.2.6. Determine the total flexural reinforcement required for design strip

a. Determine flexural reinforcement required for strip moments

The flexural reinforcement calculation for the column strip of end span – exterior negative location is provided below.

$M_u = 32.3$ ft-kips

Assume tension-controlled section $(\phi = 0.9)$

Column strip width, $b = (14\times12)/2 = 84$ in

Use average $d = 7-1.25 = 5.75$ in

Assume that $jd = 0.95\times d = 5.46$ in

$$A_s = \frac{M_u}{\phi f_y jd} = \frac{32.3\times12000}{0.9\times60000\times0.95\times5.75} = 1.31\,\text{in}^2$$

Since the computed A_s was based on a guess for jd , compute 'a' for $A_s = 1.31$ in^2 :

$$a = \frac{A_s f_y}{0.85 f'_c\, b} = \frac{1.31\times60000}{0.85\times4000\times84} = 0.276\,\text{in}$$

$$c = \frac{a}{\beta_1} = \frac{0.276}{0.85} = 0.325 \text{ in}$$

$$\varepsilon_t = (\frac{0.003}{c})d_t - 0.003 = (\frac{0.003}{0.325}) \times 5.75 - 0.003 = 0.0501 > 0.005$$

Therefore, section is tension-controlled.

$$A_s = \frac{M_u}{\phi f_y (d - a/2)} = \frac{32.3 \times 12000}{0.9 \times 60000 \times (5.75 - 0.276/2)} = 1.28 \text{ in}^2$$

Min $A_s = 0.018 \times 84 \times 7 = 1.06 \text{ in}^2 < 1.28 \text{ in}^2$ according to ACI 318. 13.3.1

Maximum spacing $s_{max} = 2h = 2 \times 7 = 14 \text{ in} < 18$ in according to ACI 318. 13.3.2

Provide 7 - #4 bars with $A_s = 1.40 \text{ in}^2$ and $s = 84/7 = 12 \text{ in} \leq s_{max}$

All the values on Table 7 are calculated based on the procedure outlined above.

Table 7 - Required Slab Reinforcement for Flexure [Equivalent Frame Method (EFM)]

Span Location		**M_u (ft-kips)**	**b * (in.)**	**d ** (in.)**	**A_s Req'd for flexure (in^2)**	**Min A_s† (in^2)**	**Reinforcement Provided+**	**A_s Prov. for flexure (in^2)**
End Span								
Column Strip	Exterior Negative	32.3	84	5.75	1.28	1.06	7-#4	1.40
	Positive	26.5	84	5.75	1.04	1.06	6-#4	1.20
	Interior Negative	50.3	84	5.75	2.02	1.06	11-#4	2.20
Middle Strip	Exterior Negative	0.0	84	5.75	0.00	1.06	6-#4	1.20
	Positive	17.7	84	5.75	0.69	1.06	6-#4	1.20
	Interior Negative	16.7	84	5.75	0.65	1.06	6-#4	1.20
Interior Span								
Column Strip	Positive	19.9	84	5.75	0.78	1.06	6-#4	1.20
Middle Strip	Positive	13.2	84	5.75	0.51	1.06	6-#4	1.20

* Column strip width, $b = (14 \times 12)/2 = 84$ in.

* Middle strip width, $b = (14 \times 12) - 84 = 84$ in.

** Use average $d = 7 - 1.25 = 5.75$ in.

†Min. $A_s = 0.0018 \times b \times h = 0.0126 \times b$;. $s_{max} = 2 \times h = 14$ in. < 18 in. 13.3.2

+Number of #4 bars based on $s_{max} = \frac{84}{14} = 6$

b. Calculate additional slab reinforcement at columns for moment transfer between slab and column

Portion of the unbalanced moment transferred by flexure is $\gamma_f \times M_u$

where $\gamma_f = \dfrac{1}{1+(2/3)\times\sqrt{b_1/b_2}}$

b_1 = dimension of the critical section b_o measured in the direction of the span for which moments are determined in ACI 318, Chapter 13.

b_2 = dimension of the critical section b_o measured in the direction perpendicular to b_1 in ACI 318, Chapter 13.

Effective slab width, $b_b = c_2 + 3 \times h$

Table 8 - Additional Slab Reinforcement at columns for moment transfer between slab and column [Equivalent Frame Method (EFM)]

Span Location		Effective slab width, b_b (in.)	d (in.)	$\square_f$	M_u^* (ft-kips)	$\square_f M_u$ (ft-kips)	A_s req'd within b_b (in^2)	A_s prov. for flexure within b_b (in^2)	Add'l Reinf.
End Span									
Column Strip	Exterior Negative	37	5.75	0.62	46.6	28.9	1.17	0.62	3-#4
	Interior Negative	37	5.75	0.60	7.8	4.7	0.18	0.97	-

*M_u is taken at the centerline of the support in Equivalent Frame Method solution.

2.2.7 Factored moments in columns:

The unbalanced moment from the slab-beams at the supports of the equivalent frame are distributed to the actual columns above and below the slab-beam in proportion to the relative stiffnessses of the actual columns. Referring to Fig. 5, the unbalanced moment at joints 1 and 2 are:

Joint $1 = +46.6$ ft-kips

Joint $2 = -84.0 + 76.2 = -7.8$ ft-kips

The stiffness and carry-over factors of the actual columns and the distribution of the unbalanced moments to the exterior and interior columns are shown in Fig 6.

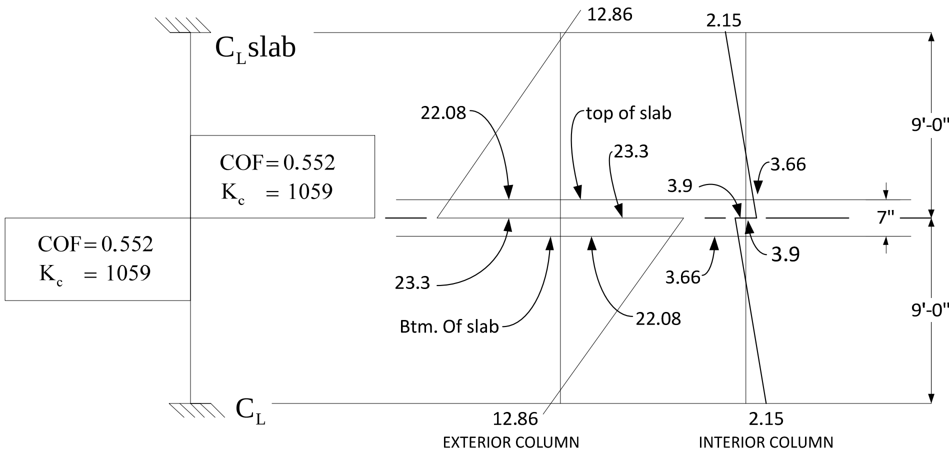


Figure 6 - Column Moments (Unbalanced Moments from Slab-Beam)

In summary:

Design moment in exterior column = 22.08 ft-kips

Design moment in interior column = 3.66 ft-kips

2.3 spSlab Software Program Model Solution

spSlab program utilizes the Equivalent Frame Method for modeling and design of two-way concrete floor slab. spSlab uses the exact geometry and boundary conditions provided as input to perform an elastic matrix analysis of the equivalent frame taking into account the torsional stiffness of the slabs framing into the column.

spSlab Program analyses the equivalent frame as a design strip. The design strip is, then, separated by spSlab into column and middle strips. The program calculates the internal forces (Shear Force & Bending Moment), moment and shear capacity vs. demand diagrams for column and middle strips, immediate and long-term deflection results, and required flexural reinforcement for column and middle strips. The graphical and text results are provided below for both input and output of the spSlab model.

3. Summary and Comparison of Design Results

Table 9 - Comparison of Reinforcement Results with DDM, EFM, and spSlab solution based on EFM]										
Span Location		**Reinforcement Provided for Flexure**			**Additional Reinforcement Provided for Unbalanced Moment Transfer***			**Total Reinforcement Provided**		
End Span		**DDM**	**EFM**	**spSlab**	**DDM**	**EFM**	**spSlab**	**DDM**	**EFM**	**spSlab**
Column Strip	Exterior Negative	6-#4	7-#4	7-#4	1-#4	3-#4	3-#4	**7-#4**	**10-#4**	**10-#4**
	Positive	6-#4	6-#4	6-#4	n/a	n/a	n/a	6-#4	6-#4	6-#4
	Interior Negative	10-#4	11-#4	11-#4	---	---	---	**10-#4**	**11-#4**	**11-#4**
Middle Strip	Exterior Negative	6-#4	6-#4	6-#4	n/a	n/a	n/a	6-#4	6-#4	6-#4
	Positive	6-#4	6-#4	6-#4	n/a	n/a	n/a	6-#4	6-#4	6-#4
	Interior Negative	6-#4	6-#4	6-#4	n/a	n/a	n/a	6-#4	6-#4	6-#4
Interior Span										
Column Strip	Positive	6-#4	6-#4	6-#4	n/a	n/a	n/a	6-#4	6-#4	6-#4
Middle Strip	Positive	6-#4	6-#4	6-#4	n/a	n/a	n/a	6-#4	6-#4	6-#4

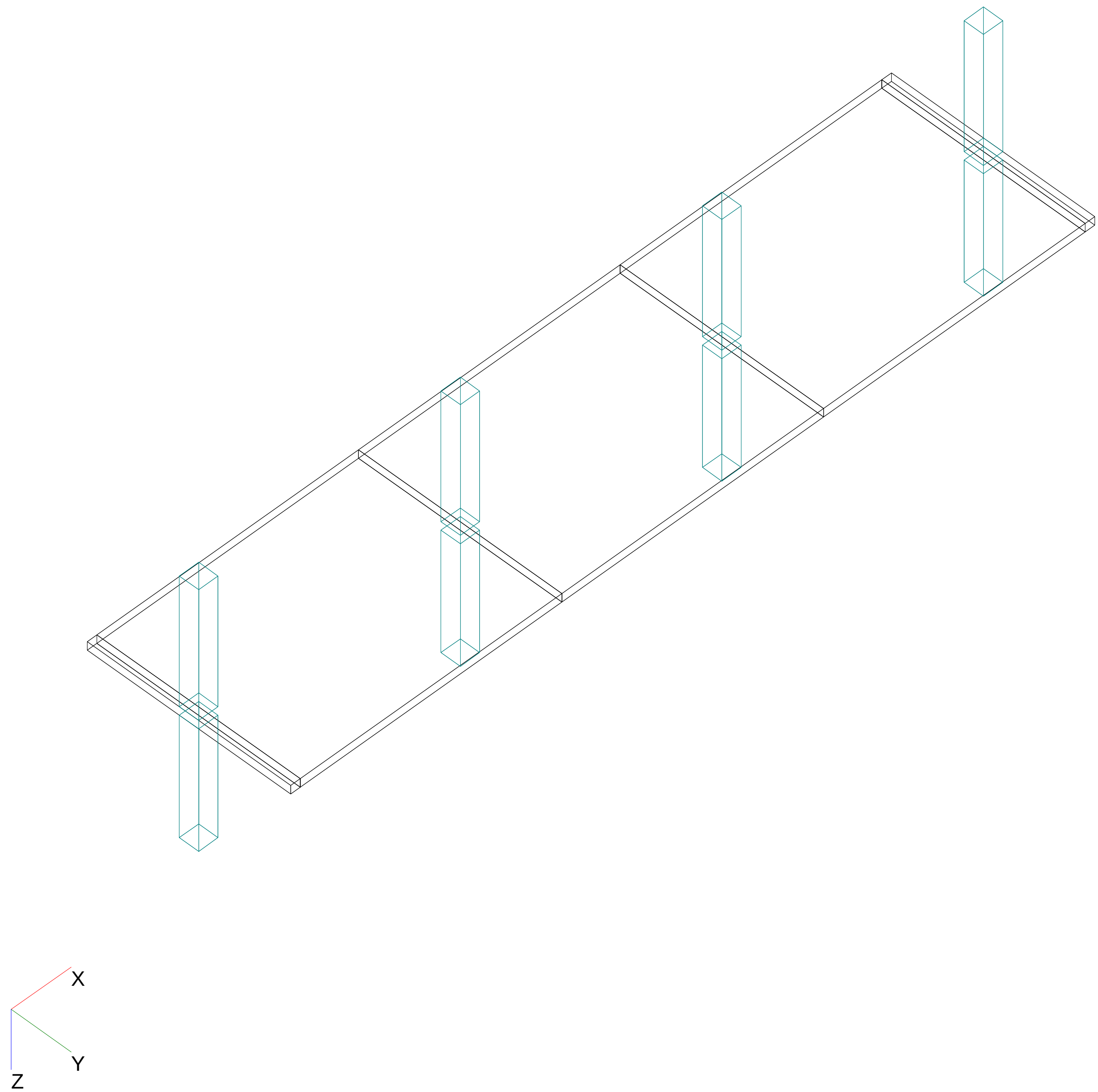
*In Equivalent Frame Method, the unbalanced moment at the support centerline is calculated and therefore, this value is utilized in the calculation of the additional reinforcement. However, in Direct Design Method, the negative moments at the face of the support are calculated only. As illustrated in the table above, this leads to an under estimation of the additional reinforcement.

4. Conclusions & Observations

Direct Design Method is an approximate method and was applicable in this flat plate concrete floor as the floor system met the stringent requirements of ACI 318, 13.6.1. However, in real life projects, these requirements limit the usability of Direct Design Method significantly. Also, Direct Design Method relies on the face of the support moments in order to calculate additional reinforcement for unbalanced moment transfer in the absence of the support centerline moments. This leads to lesser amount as compared to actual required reinforcement.(See End Span – Column Strip – Exterior Negative – Additional Reinforcement from Table 9).

Equivalent Frame Method, on the other hand, is an exact solution and therefore, does not have the limitations of Direct Design Method. However, the hand solution utilizing Equivalent Frame Method is long, tedious and time-consuming.

spSlab software program solution utilizes an Equivalent Frame Method and provides considerable time-savings in the analysis and design of two-way slab systems as compared to hand solution.



spSlab v5.00. Licensed to: StructurePoint. License ID: 00000-0000000-4-2A05D-2471B

File: C:\TSDA-spSlab-Two-Way Flat Plate Floor.slb

Project: Two-Way Flat Plate Floor Slab

Frame: Interior Frame

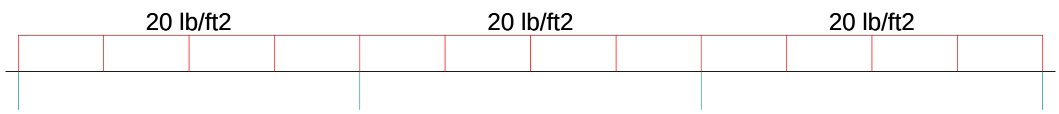
Engineer: SP

Code: ACI 318-11

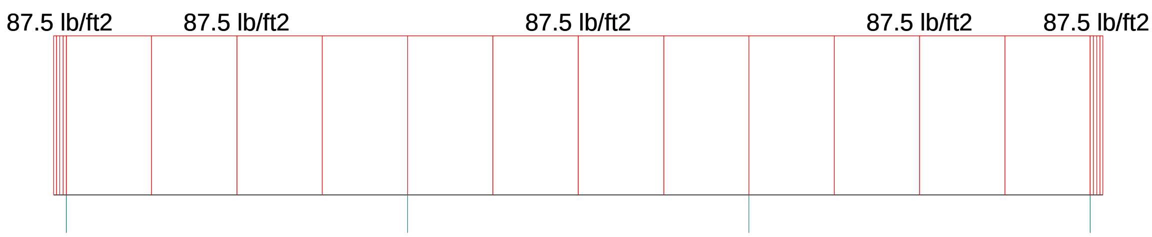
Date: 07/20/16

Time: 09:49:53

CASE/PATTERN: Live/All



CASE: Dead



CASE: SELF

File: C:\TSDA-spSlab-Two-Way Flat Plate Floor.slb

Project: Two-Way Flat Plate Floor Slab

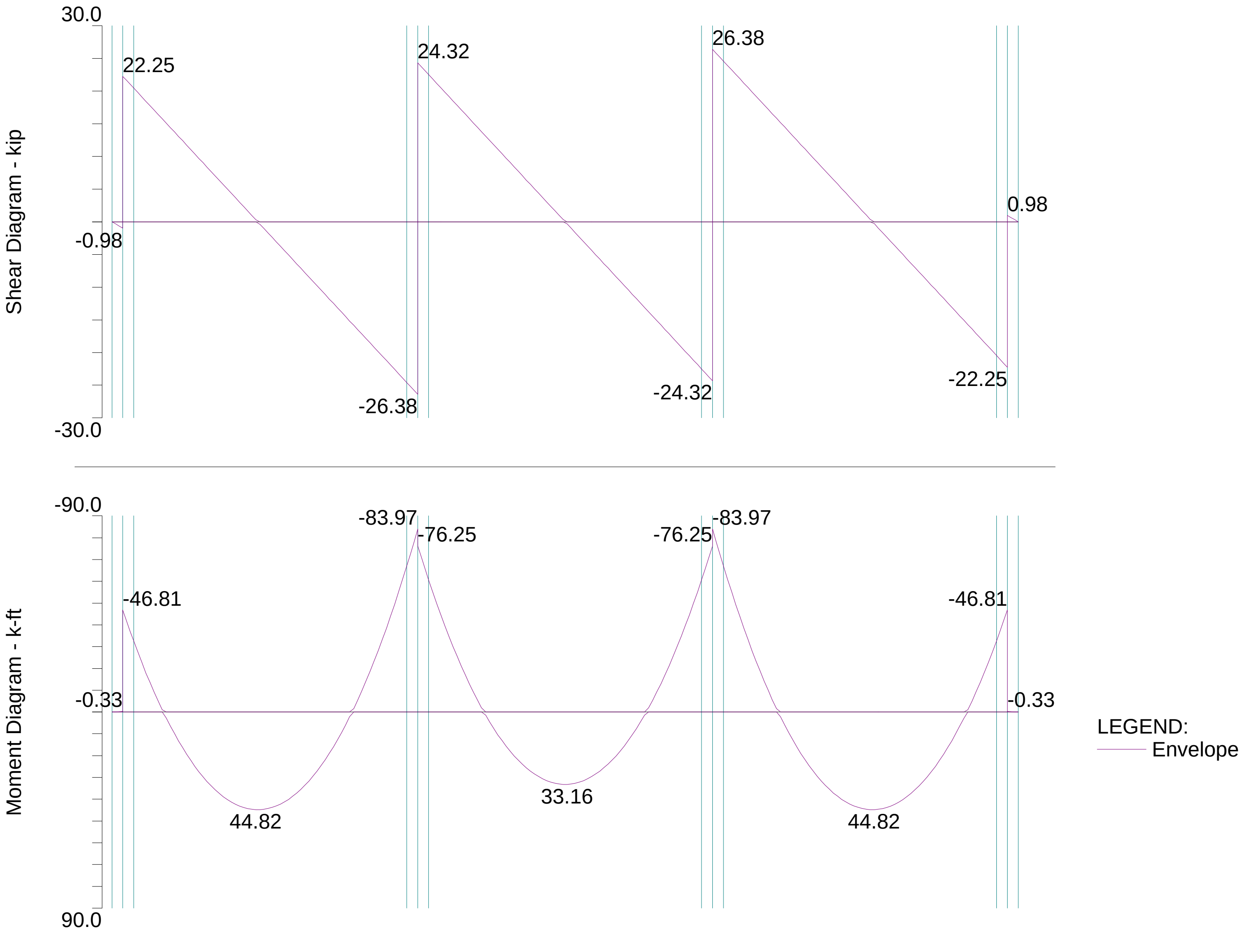
Frame: Interior Frame

Engineer: SP

Code: ACI 318-11

Date: 07/20/16

Time: 10:08:43



spSlab v5.00. Licensed to: StructurePoint. License ID: 00000-0000000-4-2A05D-2471B

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Project: Two-Way Flat Plate Floor Slab

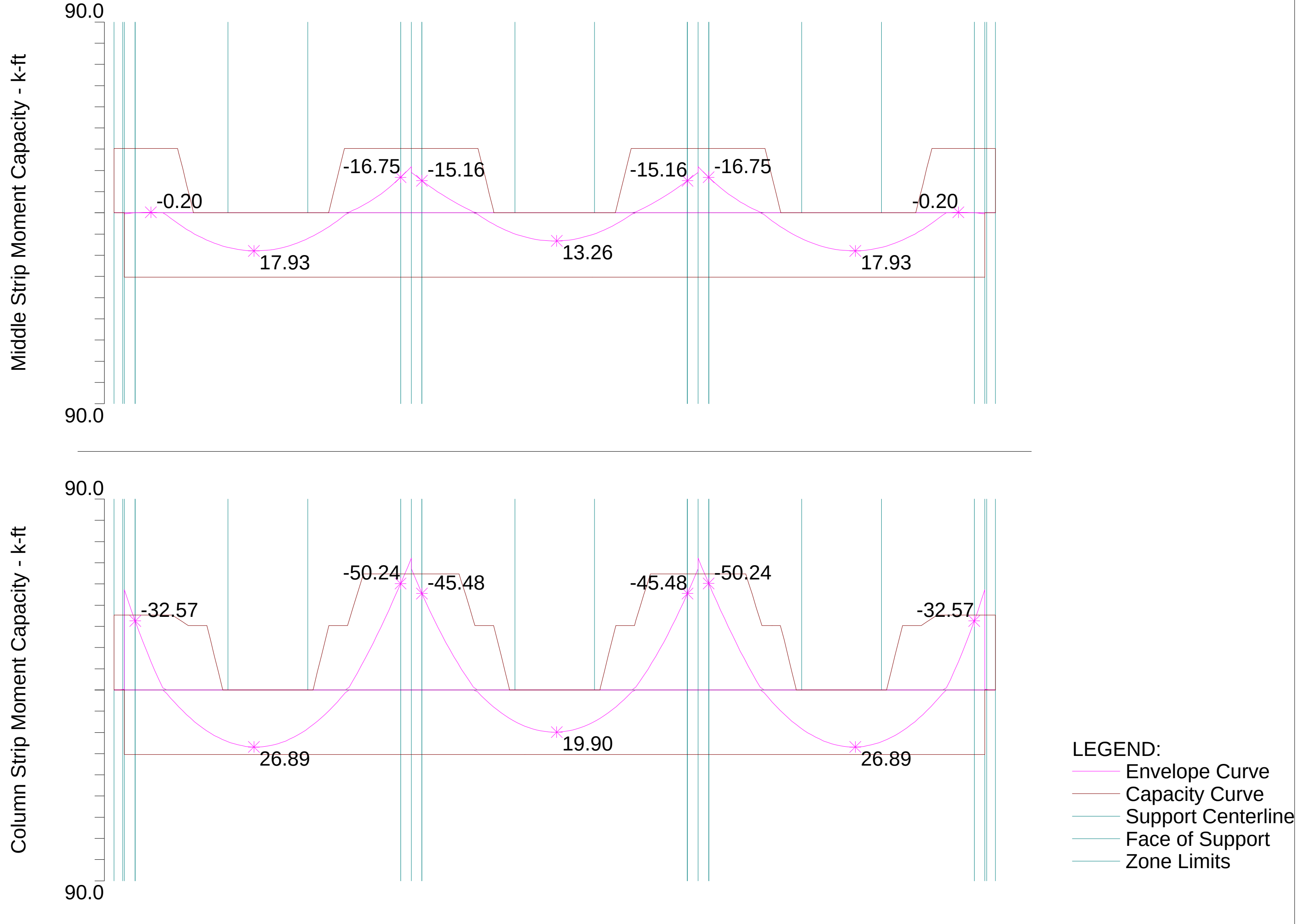
Frame: Interior Frame

Engineer: SP

Code: ACI 318-11

Date: 07/20/16

Time: 10:08:00



spSlab v5.00. Licensed to: StructurePoint. License ID: 00000-0000000-4-2A05D-2471B

File: C:\TSDA-spSlab-Two-Way Flat Plate Floor.slb

Project: Two-Way Flat Plate Floor Slab

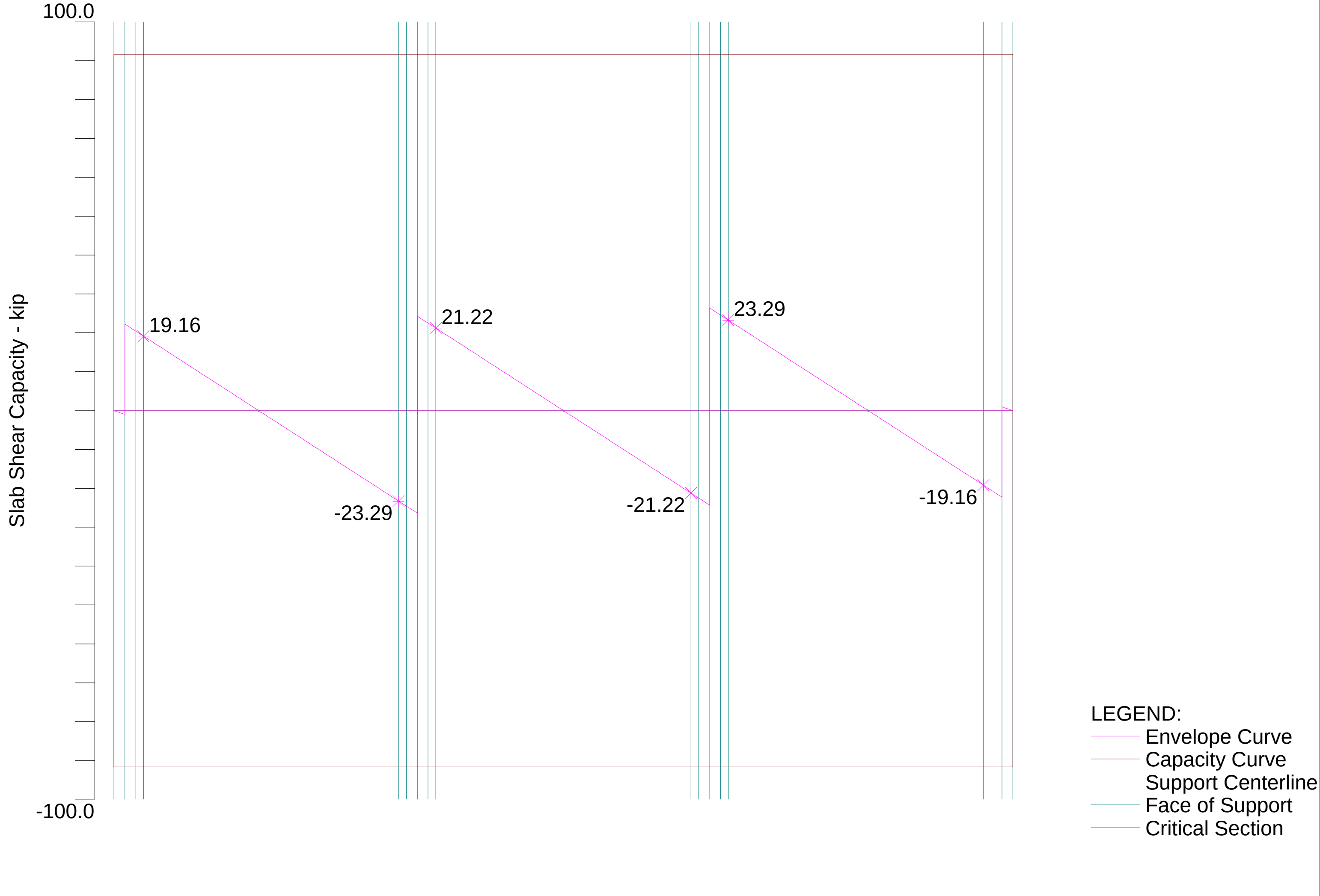
Frame: Interior Frame

Engineer: SP

Code: ACI 318-11

Date: 07/20/16

Time: 10:10:15



spSlab v5.00. Licensed to: StructurePoint. License ID: 00000-0000000-4-2A05D-2471B

File: C:\TSDA-spSlab-Two-Way Flat Plate Floor.slb

Project: Two-Way Flat Plate Floor Slab

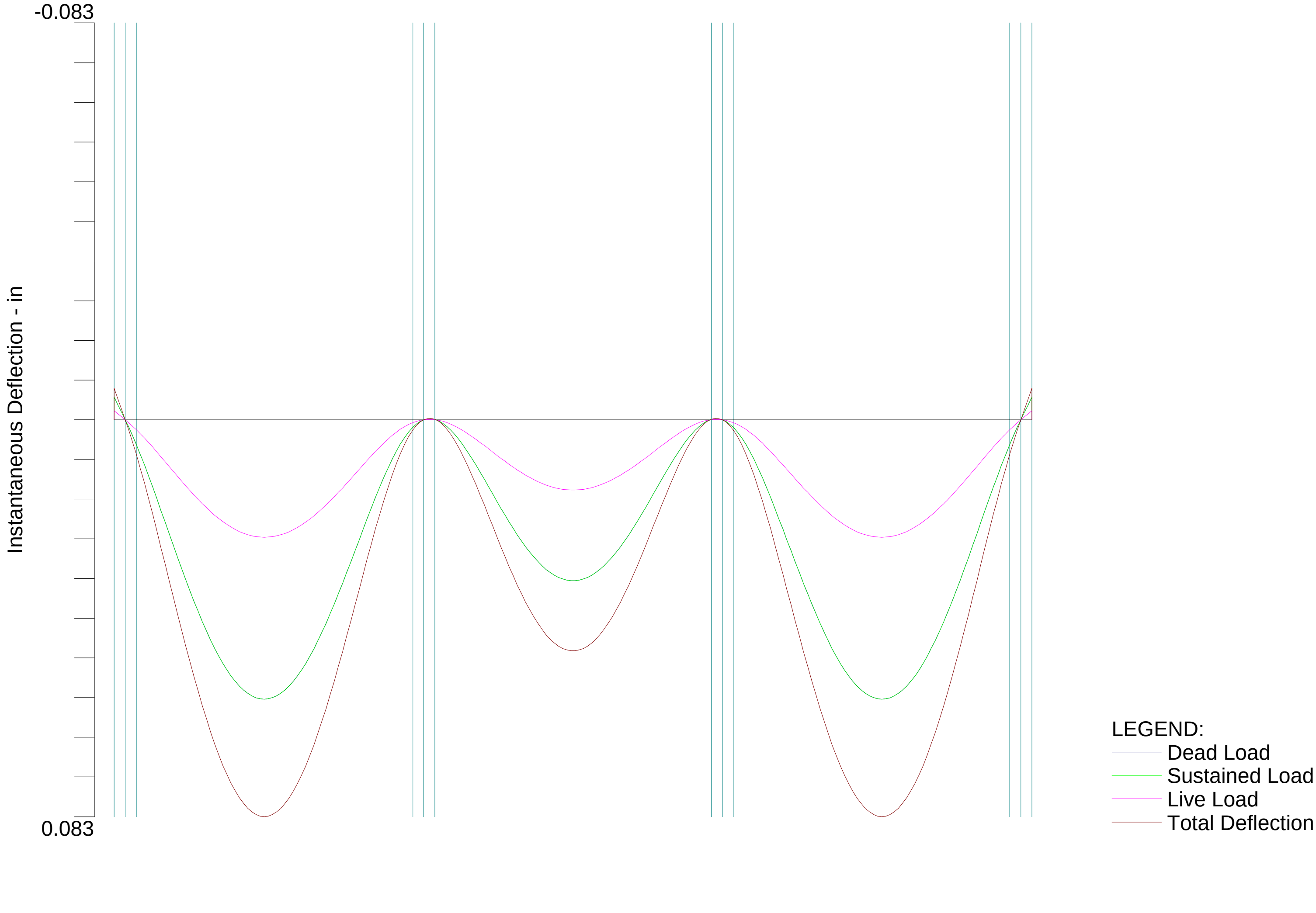
Frame: Interior Frame

Engineer: SP

Code: ACI 318-11

Date: 07/20/16

Time: 10:25:16



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File: C:\TSDA-spSlab-Two-Way Flat Plate Floor.slb

Project: Two-Way Flat Plate Floor Slab

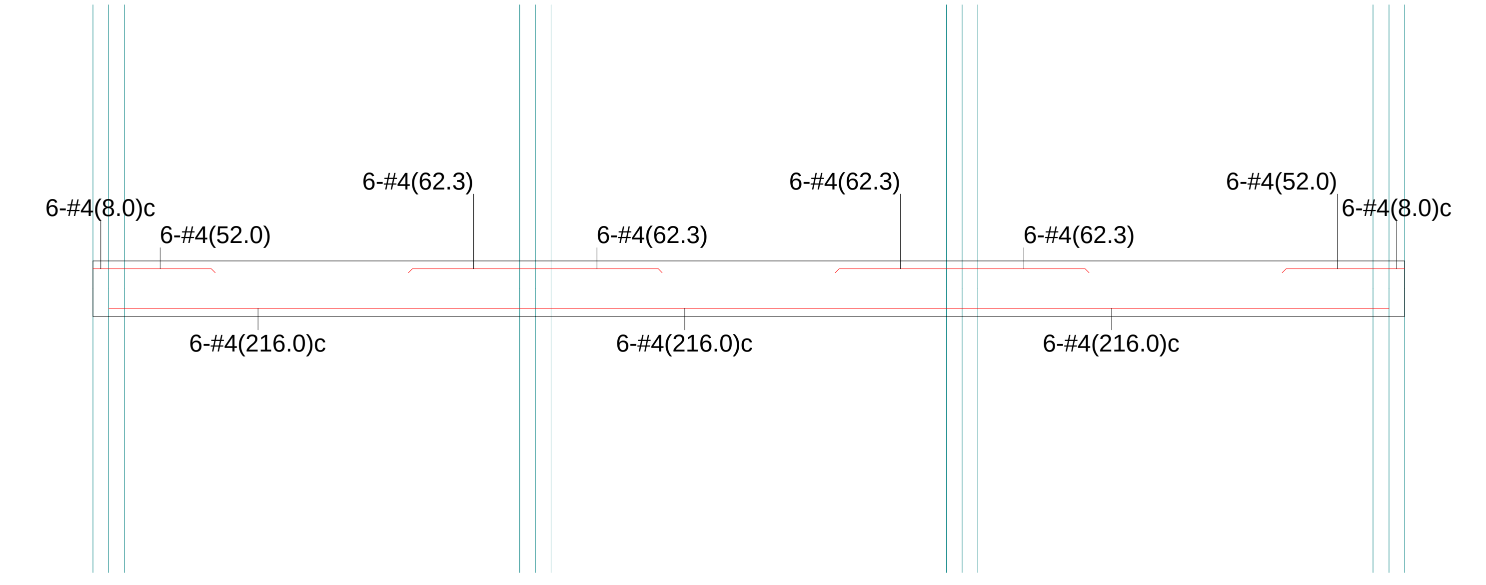
Frame: Interior Frame

Engineer: SP

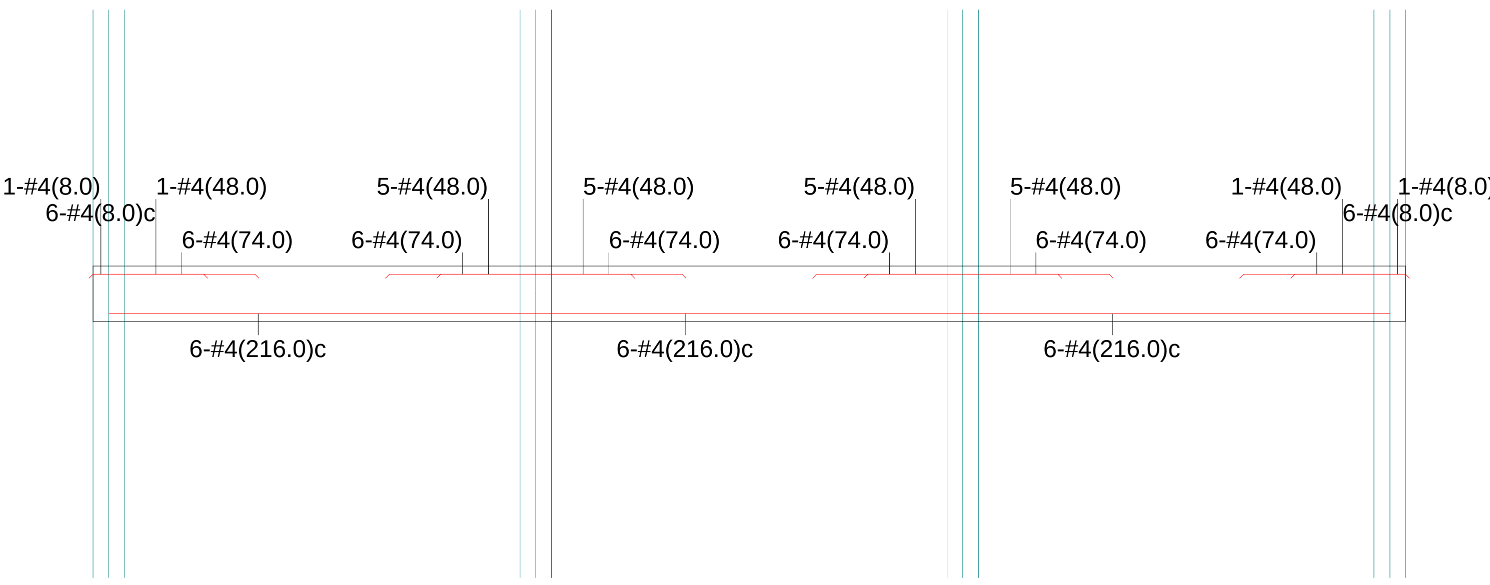
Code: ACI 318-11

Date: 07/20/16

Time: 09:52:37



Middle Strip Flexural Reinforcement



Column Strip Flexural Reinforcement

spSlab v5.00. Licensed to: StructurePoint. License ID: 00000-0000000-4-2A05D-2471B

File: C:\TSDA-spSlab-Two-Way Flat Plate Floor.slb

Project: Two-Way Flat Plate Floor Slab

Frame: Interior Frame

Engineer: SP

Code: ACI 318-11

Date: 07/20/16

Time: 10:27:46

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```

spSlab v5.00 (TM)
A Computer Program for Analysis, Design, and Investigation of
Reinforced Concrete Beams, One-way and Two-way Slab Systems

[1] INPUT ECHO

General Information

File name: C:\TSDA-spSlab-Two-Way Flat Plate Floor.slb
Project: Two-Way Flat Plate Floor Slab
Frame: Interior Frame
Engineer: SP
Code: ACI 318-11
Reinforcement Database: ASTM A615
Mode: Design
Number of supports = 4 + Left cantilever + Right cantilever
Floor System: Two-Way

Live load pattern ratio = 0%
Minimum free edge distance for punching shear = 4 times slab thickness.
Circular critical section around circular supports used (if possible).
Deflections are based on cracked section properties.
In negative moment regions, Ig and Mcr DO NOT include flange/slab contribution (if available)
Long-term deflections are calculated for load duration of 60 months.
0% of live load is sustained.
Compression reinforcement calculations NOT selected.
Default incremental rebar design selected.
User-defined slab strip widths NOT selected.
User-defined distribution factors NOT selected.
One-way shear in drop panel NOT selected.
Distribution of shear to strips NOT selected.
Beam T-section design NOT selected.
Longitudinal beam contribution in negative reinforcement design over support NOT selected.
Transverse beam contribution in negative reinforcement design over support NOT selected.

Material Properties

		Slabs|Beams	Columns	
wc	=	150	150	lb/ft3
f'c	=	4	6	ksi
Ec	=	3600	4420	ksi
fr	=	0.47434	0.58095	ksi

fy	=	60	ksi, Bars are not epoxy-coated
fyt	=	60	ksi
Es	=	29000	ksi

Reinforcement Database

Units: Db (in), Ab (in^2), Wb (lb/ft)

Size	Db	Ab	Wb	Size	Db	Ab	Wb
#3	0.38	0.11	0.38	#4	0.50	0.20	0.67
#5	0.63	0.31	1.04	#6	0.75	0.44	1.50
#7	0.88	0.60	2.04	#8	1.00	0.79	2.67
#9	1.13	1.00	3.40	#10	1.27	1.27	4.30

#11	1.41	1.56	5.31	#14	1.69	2.25	7.65
#18	2.26	4.00	13.60				

Span Data
=========

Slabs

Units: L1, wL, wR, L2L, L2R (ft); t, Hmin (in)

Span	Loc	L1	t	wL	wR	L2L	L2R	Hmin	
1	Int	0.667	7.00	7.000	7.000	14.000	14.000	---	LC *i
2	Int	18.000	7.00	7.000	7.000	14.000	14.000	6.67	
3	Int	18.000	7.00	7.000	7.000	14.000	14.000	6.06	
4	Int	18.000	7.00	7.000	7.000	14.000	14.000	6.67	
5	Int	0.667	7.00	7.000	7.000	14.000	14.000	---	RC *i

NOTES:
Deflection check required for panels where code-specified Hmin for two-way construction doesn't apply due to:
*i - cantilever end span (LC, RC) support condition

Support Data
============

Columns

Units: c1a, c2a, c1b, c2b (in); Ha, Hb (ft)

Supp	c1a	c2a	Ha	c1b	c2b	Hb	Red%
1	16.00	16.00	9.000	16.00	16.00	9.000	100
2	16.00	16.00	9.000	16.00	16.00	9.000	100
3	16.00	16.00	9.000	16.00	16.00	9.000	100
4	16.00	16.00	9.000	16.00	16.00	9.000	100

Boundary Conditions

Units: Kz (kip/in); Kry (kip-in/rad)

Supp	Spring Kz	Spring Kry	Far End A	Far End B
1	0	0	Fixed	Fixed
2	0	0	Fixed	Fixed
3	0	0	Fixed	Fixed
4	0	0	Fixed	Fixed

Load Data
=========

Load Cases and Combinations

Case	SELF	Dead	Live
Type	DEAD	DEAD	LIVE
U1	1.200	1.200	1.600

Area Loads

Units: Wa (lb/ft2)

Case/Patt	Span	Wa
SELF	1	87.50
	2	87.50
	3	87.50
	4	87.50
	5	87.50
Dead	2	20.00
	3	20.00
	4	20.00
Live	2	40.00
	3	40.00
	4	40.00

Reinforcement Criteria
======================

Slabs and Ribs

	Top bars Min	Top bars Max	Bottom bars Min	Bottom bars Max	
Bar Size	#4	#4	#4	#4	
Bar spacing	1.00	18.00	1.00	18.00	in
Reinf ratio	0.18	2.00	0.18	2.00	%
Cover	1.00		1.00		in

There is NOT more than 12 in of concrete below top bars.

Beams

	Top bars Min	Top bars Max	Bottom bars Min	Bottom bars Max	Stirrups Min	Stirrups Max	
Bar Size	#5	#8	#5	#8	#3	#5	
Bar spacing	2.00	18.00	2.00	18.00	6.00	18.00	in

Reinf ratio	0.20	2.00	0.20	2.00	%			
Cover	1.50		1.50		in			
Layer dist.	1.00		1.00		in			
No. of legs						2	6	
Side cover						1.50		in
1st Stirrup						3.00		in

There is NOT more than 12 in of concrete below top bars.

```
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o    oo   oo          oo    oo    oo  o   oo   oo   oo   oo
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```

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A Computer Program for Analysis, Design, and Investigation of
Reinforced Concrete Beams, One-way and Two-way Slab Systems

[2] DESIGN RESULTS*

*Unless otherwise noted, all results are in the direction of analysis only. Another analysis in the perpendicular direction has to be carried out for two-way slab systems.

Strip Widths and Distribution Factors

Units: Width (ft).

Span	Strip	Width Left**	Width Right**	Width Bottom*	Moment Factor Left**	Moment Factor Right**	Moment Factor Bottom*
1	Column	7.00	7.00	7.00	1.000	1.000	0.600
	Middle	7.00	7.00	7.00	0.000	0.000	0.400
2	Column	7.00	7.00	7.00	1.000	0.750	0.600
	Middle	7.00	7.00	7.00	0.000	0.250	0.400
3	Column	7.00	7.00	7.00	0.750	0.750	0.600
	Middle	7.00	7.00	7.00	0.250	0.250	0.400
4	Column	7.00	7.00	7.00	0.750	1.000	0.600
	Middle	7.00	7.00	7.00	0.250	0.000	0.400
5	Column	7.00	7.00	7.00	1.000	1.000	0.600
	Middle	7.00	7.00	7.00	0.000	0.000	0.400

*Used for bottom reinforcement. **Used for top reinforcement.

Top Reinforcement

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Strip	Zone	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	Column	Left	7.00	0.03	0.193	1.058	8.724	0.001	14.000	6-#4 *3
		Midspan	7.00	0.10	0.358	1.058	8.724	0.004	14.000	6-#4 *3
		Right	7.00	0.23	0.550	1.058	8.724	0.009	12.000	7-#4 *3
	Middle	Left	7.00	0.00	0.000	1.058	8.724	0.000	14.000	6-#4 *3
		Midspan	7.00	0.00	0.275	1.058	8.724	0.000	14.000	6-#4 *3
		Right	7.00	0.00	0.550	1.058	8.724	0.000	14.000	6-#4 *3
2	Column	Left	7.00	32.57	0.667	1.058	8.724	1.289	12.000	7-#4
		Midspan	7.00	0.00	9.000	0.000	8.724	0.000	0.000	---
		Right	7.00	50.24	17.333	1.058	8.724	2.016	7.636	11-#4
	Middle	Left	7.00	0.20	1.662	1.058	8.724	0.008	14.000	6-#4 *3
		Midspan	7.00	0.00	9.000	0.000	8.724	0.000	0.000	---
		Right	7.00	16.75	17.333	1.058	8.724	0.655	14.000	6-#4 *3
3	Column	Left	7.00	45.48	0.667	1.058	8.724	1.818	7.636	11-#4
		Midspan	7.00	0.00	9.000	0.000	8.724	0.000	0.000	---
		Right	7.00	45.48	17.333	1.058	8.724	1.818	7.636	11-#4
	Middle	Left	7.00	15.16	0.667	1.058	8.724	0.592	14.000	6-#4 *3

		Midspan	7.00	0.00	9.000	0.000	8.724	0.000	0.000	---
		Right	7.00	15.16	17.333	1.058	8.724	0.592	14.000	6-#4 *3
4	Column	Left	7.00	50.24	0.667	1.058	8.724	2.016	7.636	11-#4
		Midspan	7.00	0.00	9.000	0.000	8.724	0.000	0.000	---
		Right	7.00	32.57	17.333	1.058	8.724	1.289	12.000	7-#4
	Middle	Left	7.00	16.75	0.667	1.058	8.724	0.655	14.000	6-#4 *3
		Midspan	7.00	0.00	9.000	0.000	8.724	0.000	0.000	---
		Right	7.00	0.20	16.338	1.058	8.724	0.008	14.000	6-#4 *3
5	Column	Left	7.00	0.23	0.117	1.058	8.724	0.009	12.000	7-#4 *3
		Midspan	7.00	0.10	0.309	1.058	8.724	0.004	14.000	6-#4 *3
		Right	7.00	0.03	0.474	1.058	8.724	0.001	14.000	6-#4 *3
	Middle	Left	7.00	0.00	0.117	1.058	8.724	0.000	14.000	6-#4 *3
		Midspan	7.00	0.00	0.392	1.058	8.724	0.000	14.000	6-#4 *3
		Right	7.00	0.00	0.667	1.058	8.724	0.000	14.000	6-#4 *3

NOTES:
*3 - Design governed by minimum reinforcement.

Top Bar Details

Units: Length (ft)

		Left				Continuous		Right			
Span	Strip	Bars	Length	Bars	Length	Bars	Length	Bars	Length	Bars	Length
1	Column	---		---		6-#4	0.67	1-#4	0.67	---	
	Middle	---		---		6-#4	0.67	---		---	
2	Column	6-#4	6.17	1-#4	4.00	---		6-#4	6.17	5-#4	4.00
	Middle	6-#4	4.33	---		---		6-#4	5.19	---	
3	Column	6-#4	6.17	5-#4	4.00	---		6-#4	6.17	5-#4	4.00
	Middle	6-#4	5.19	---		---		6-#4	5.19	---	
4	Column	6-#4	6.17	5-#4	4.00	---		6-#4	6.17	1-#4	4.00
	Middle	6-#4	5.19	---		---		6-#4	4.33	---	
5	Column	1-#4	0.67	---		6-#4	0.67	---		---	
	Middle	---		---		6-#4	0.67	---		---	

Top Bar Development Lengths

Units: Length (in)

		Left				Continuous		Right			
Span	Strip	Bars	DevLen	Bars	DevLen	Bars	DevLen	Bars	DevLen	Bars	DevLen
1	Column	---		---		6-#4	12.00	1-#4	12.00	---	
	Middle	---		---		6-#4	12.00	---		---	
2	Column	6-#4	12.00	1-#4	12.00	---		6-#4	12.00	5-#4	12.00
	Middle	6-#4	12.00	---		---		6-#4	12.00	---	
3	Column	6-#4	12.00	5-#4	12.00	---		6-#4	12.00	5-#4	12.00
	Middle	6-#4	12.00	---		---		6-#4	12.00	---	
4	Column	6-#4	12.00	5-#4	12.00	---		6-#4	12.00	1-#4	12.00
	Middle	6-#4	12.00	---		---		6-#4	12.00	---	
5	Column	1-#4	12.00	---		6-#4	12.00	---		---	
	Middle	---		---		6-#4	12.00	---		---	

Bottom Reinforcement

Units: Width (ft), Mmax (k-ft), Xmax (ft), As (in^2), Sp (in)

Span	Strip	Width	Mmax	Xmax	AsMin	AsMax	AsReq	SpProv	Bars
1	Column	7.00	0.00	0.275	0.000	8.724	0.000	0.000	---
	Middle	7.00	0.00	0.275	0.000	8.724	0.000	0.000	---
2	Column	7.00	26.89	8.129	1.058	8.724	1.060	14.000	6-#4
	Middle	7.00	17.93	8.129	1.058	8.724	0.702	14.000	6-#4 *3
3	Column	7.00	19.90	9.124	1.058	8.724	0.780	14.000	6-#4 *3
	Middle	7.00	13.26	9.124	1.058	8.724	0.518	14.000	6-#4 *3
4	Column	7.00	26.89	9.871	1.058	8.724	1.060	14.000	6-#4
	Middle	7.00	17.93	9.871	1.058	8.724	0.702	14.000	6-#4 *3
5	Column	7.00	0.00	0.392	0.000	8.724	0.000	0.000	---
	Middle	7.00	0.00	0.392	0.000	8.724	0.000	0.000	---

NOTES:
*3 - Design governed by minimum reinforcement.

Bottom Bar Details

Units: Start (ft), Length (ft)

Span	Strip	Long Bars			Short Bars		
		Bars	Start	Length	Bars	Start	Length
1	Column	---			---		
	Middle	---			---		
2	Column	6-#4	0.00	18.00	---		
	Middle	6-#4	0.00	18.00	---		
3	Column	6-#4	0.00	18.00	---		
	Middle	6-#4	0.00	18.00	---		
4	Column	6-#4	0.00	18.00	---		
	Middle	6-#4	0.00	18.00	---		
5	Column	---			---		
	Middle	---			---		

Bottom Bar Development Lengths

Units: DevLen (in)

Span	Strip	Long Bars		Short Bars	
		Bars	DevLen	Bars	DevLen
1	Column	---		---	
	Middle	---		---	
2	Column	6-#4	12.00	---	
	Middle	6-#4	12.00	---	
3	Column	6-#4	12.00	---	
	Middle	6-#4	12.00	---	
4	Column	6-#4	12.00	---	
	Middle	6-#4	12.00	---	
5	Column	---		---	
	Middle	---		---	

Flexural Capacity

Units: x (ft), As (in^2), PhiMn, Mu (k-ft)

Span	Strip	x	Top						Bottom					
			AsTop	PhiMn-	Mu-	Comb	Pat	Status	AsBot	PhiMn+	Mu+	Comb	Pat	Status
1	Column	0.000	1.40	-35.30	0.00	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.193	1.40	-35.30	-0.03	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.333	1.40	-35.30	-0.09	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.358	1.40	-35.30	-0.10	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.550	1.40	-35.30	-0.23	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.667	1.40	-35.30	-0.33	U1	All	---	0.00	0.00	0.00	U1	All	---
	Middle	0.000	1.20	-30.37	0.00	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.193	1.20	-30.37	-0.00	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.333	1.20	-30.37	-0.00	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.358	1.20	-30.37	-0.00	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.550	1.20	-30.37	-0.00	U1	All	OK	0.00	0.00	0.00	U1	All	OK
		0.667	1.20	-30.37	-0.00	U1	All	---	0.00	0.00	0.00	U1	All	---
2	Column	0.000	1.40	-35.30	-47.27	U1	All	---	1.20	30.37	0.00	U1	All	---
		0.444	1.40	-35.30	-37.31	U1	All	---	1.20	30.37	0.00	U1	All	---
		0.667	1.40	-35.30	-32.57	U1	All	OK	1.20	30.37	0.00	U1	All	OK
		3.000	1.40	-35.30	0.00	U1	All	OK	1.20	30.37	4.67	U1	All	OK
		4.000	1.20	-30.37	0.00	U1	All	OK	1.20	30.37	12.34	U1	All	OK
		5.167	1.20	-30.37	0.00	U1	All	OK	1.20	30.37	19.26	U1	All	OK
		6.167	0.00	0.00	0.00	U1	All	OK	1.20	30.37	23.42	U1	All	OK
		6.500	0.00	0.00	0.00	U1	All	OK	1.20	30.37	24.44	U1	All	OK
		8.129	0.00	0.00	0.00	U1	All	OK	1.20	30.37	26.89	U1	All	OK
		9.000	0.00	0.00	0.00	U1	All	OK	1.20	30.37	26.41	U1	All	OK
		11.500	0.00	0.00	0.00	U1	All	OK	1.20	30.37	18.25	U1	All	OK
		11.833	0.00	0.00	0.00	U1	All	OK	1.20	30.37	16.40	U1	All	OK
		12.833	1.20	-30.37	0.00	U1	All	OK	1.20	30.37	9.76	U1	All	OK
		14.000	1.20	-30.37	-0.06	U1	All	OK	1.20	30.37	0.00	U1	All	OK
		15.000	2.20	-54.64	-13.35	U1	All	OK	1.20	30.37	0.00	U1	All	OK
		17.333	2.20	-54.64	-50.24	U1	All	OK	1.20	30.37	0.00	U1	All	OK
		17.778	2.20	-54.64	-58.11	U1	All	---	1.20	30.37	0.00	U1	All	---
		18.000	2.20	-54.64	-62.14	U1	All	---	1.20	30.37	0.00	U1	All	---
	Middle	0.000	1.20	-30.37	0.47	U1	All	---	1.20	30.37	0.00	U1	All	---
		0.667	1.20	-30.37	-0.00	U1	All	OK	1.20	30.37	0.00	U1	All	OK
		1.662	1.20	-30.37	-0.20	U1	All	OK	1.20	30.37	0.00	U1	All	OK
		3.333	1.20	-30.37	0.00	U1	All	OK	1.20	30.37	4.94	U1	All	OK
		4.333	0.00	0.00	0.00	U1	All	OK	1.20	30.37	9.70	U1	All	OK
		6.500	0.00	0.00	0.00	U1	All	OK	1.20	30.37	16.30	U1	All	OK
		8.129	0.00	0.00	0.00	U1	All	OK	1.20	30.37	17.93	U1	All	OK
		9.000	0.00	0.00	0.00	U1	All	OK	1.20	30.37	17.61	U1	All	OK
		11.500	0.00	0.00	0.00	U1	All	OK	1.20	30.37	12.17	U1	All	OK
		12.809	0.00	0.00	0.00	U1	All	OK	1.20	30.37	6.63	U1	All	OK

		13.809	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	1.14	U1 All	OK
		17.333	1.20	-30.37	-16.75	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		18.000	1.20	-30.37	-21.83	U1 All	---	1.20	30.37	0.00	U1 All	---
3	Column	0.000	2.20	-54.64	-57.19	U1 All	---	1.20	30.37	0.00	U1 All	---
		0.667	2.20	-54.64	-45.48	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		3.000	2.20	-54.64	-11.61	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		4.000	1.20	-30.37	-0.46	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		5.167	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	7.99	U1 All	OK
		6.167	0.00	0.00	0.00	U1 All	OK	1.20	30.37	13.40	U1 All	OK
		6.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	14.83	U1 All	OK
		9.000	0.00	0.00	0.00	U1 All	OK	1.20	30.37	19.90	U1 All	OK
		9.124	0.00	0.00	0.00	U1 All	OK	1.20	30.37	19.90	U1 All	OK
		11.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	14.83	U1 All	OK
		11.833	0.00	0.00	0.00	U1 All	OK	1.20	30.37	13.40	U1 All	OK
		12.833	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	7.99	U1 All	OK
		14.000	1.20	-30.37	-0.46	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		15.000	2.20	-54.64	-11.60	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		17.333	2.20	-54.64	-45.48	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		18.000	2.20	-54.64	-57.19	U1 All	---	1.20	30.37	0.00	U1 All	---
	Middle	0.000	1.20	-30.37	-19.06	U1 All	---	1.20	30.37	0.00	U1 All	---
		0.667	1.20	-30.37	-15.16	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		4.191	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	0.77	U1 All	OK
		5.191	0.00	0.00	0.00	U1 All	OK	1.20	30.37	5.43	U1 All	OK
		6.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	9.89	U1 All	OK
		9.000	0.00	0.00	0.00	U1 All	OK	1.20	30.37	13.26	U1 All	OK
		9.124	0.00	0.00	0.00	U1 All	OK	1.20	30.37	13.26	U1 All	OK
		11.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	9.89	U1 All	OK
		12.809	0.00	0.00	0.00	U1 All	OK	1.20	30.37	5.43	U1 All	OK
		13.809	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	0.77	U1 All	OK
		17.333	1.20	-30.37	-15.16	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		18.000	1.20	-30.37	-19.06	U1 All	---	1.20	30.37	0.00	U1 All	---
4	Column	0.000	2.20	-54.64	-62.14	U1 All	---	1.20	30.37	0.00	U1 All	---
		0.222	2.20	-54.64	-58.11	U1 All	---	1.20	30.37	0.00	U1 All	---
		0.667	2.20	-54.64	-50.24	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		3.000	2.20	-54.64	-13.35	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		4.000	1.20	-30.37	-0.06	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		5.167	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	9.76	U1 All	OK
		6.167	0.00	0.00	0.00	U1 All	OK	1.20	30.37	16.40	U1 All	OK
		6.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	18.25	U1 All	OK
		9.000	0.00	0.00	0.00	U1 All	OK	1.20	30.37	26.41	U1 All	OK
		9.871	0.00	0.00	0.00	U1 All	OK	1.20	30.37	26.89	U1 All	OK
		11.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	24.44	U1 All	OK
		11.833	0.00	0.00	0.00	U1 All	OK	1.20	30.37	23.42	U1 All	OK
		12.833	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	19.26	U1 All	OK
		14.000	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	12.34	U1 All	OK
		15.000	1.40	-35.30	0.00	U1 All	OK	1.20	30.37	4.67	U1 All	OK
		17.333	1.40	-35.30	-32.57	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		17.556	1.40	-35.30	-37.31	U1 All	---	1.20	30.37	0.00	U1 All	---
		18.000	1.40	-35.30	-47.27	U1 All	---	1.20	30.37	0.00	U1 All	---
	Middle	0.000	1.20	-30.37	-21.83	U1 All	---	1.20	30.37	0.00	U1 All	---
		0.667	1.20	-30.37	-16.75	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		4.191	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	1.14	U1 All	OK
		5.191	0.00	0.00	0.00	U1 All	OK	1.20	30.37	6.63	U1 All	OK
		6.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	12.17	U1 All	OK
		9.000	0.00	0.00	0.00	U1 All	OK	1.20	30.37	17.61	U1 All	OK
		9.871	0.00	0.00	0.00	U1 All	OK	1.20	30.37	17.93	U1 All	OK
		11.500	0.00	0.00	0.00	U1 All	OK	1.20	30.37	16.30	U1 All	OK
		13.667	0.00	0.00	0.00	U1 All	OK	1.20	30.37	9.70	U1 All	OK
		14.667	1.20	-30.37	0.00	U1 All	OK	1.20	30.37	4.94	U1 All	OK
		16.338	1.20	-30.37	-0.20	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		17.333	1.20	-30.37	-0.00	U1 All	OK	1.20	30.37	0.00	U1 All	OK
		18.000	1.20	-30.37	0.47	U1 All	---	1.20	30.37	0.00	U1 All	---
5	Column	0.000	1.40	-35.30	-0.33	U1 All	---	0.00	0.00	0.00	U1 All	---
		0.117	1.40	-35.30	-0.23	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.309	1.40	-35.30	-0.10	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.333	1.40	-35.30	-0.09	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.474	1.40	-35.30	-0.03	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.667	1.40	-35.30	0.00	U1 All	OK	0.00	0.00	0.00	U1 All	OK
	Middle	0.000	1.20	-30.37	-0.00	U1 All	---	0.00	0.00	0.00	U1 All	---
		0.117	1.20	-30.37	-0.00	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.309	1.20	-30.37	-0.00	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.333	1.20	-30.37	-0.00	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.474	1.20	-30.37	-0.00	U1 All	OK	0.00	0.00	0.00	U1 All	OK
		0.667	1.20	-30.37	0.00	U1 All	OK	0.00	0.00	0.00	U1 All	OK

Slab Shear Capacity

Units: b, d (in), Xu (ft), PhiVc, Vu(kip)

Span	b	d	Vratio	PhiVc	Vu	Xu
1	168.00	5.75	1.000	91.64	0.00	0.00
2	168.00	5.75	1.000	91.64	23.29	16.85
3	168.00	5.75	1.000	91.64	21.22	1.15
4	168.00	5.75	1.000	91.64	23.29	1.15

5	168.00	5.75	1.000	91.64	0.00	0.00

Flexural Transfer of Negative Unbalanced Moment at Supports

Units: Width (in), Munb (k-ft), As (in^2)

Supp	Width	Width-c	d	Munb	Comb	Pat	GammaF	AsReq	AsProv	Add Bars
1	37.00	37.00	5.75	46.48	U1	All	0.617	1.164	0.617	3-#4
2	37.00	37.00	5.75	7.72	U1	All	0.600	0.180	0.969	---
3	37.00	37.00	5.75	7.72	U1	All	0.600	0.180	0.969	---
4	37.00	37.00	5.75	46.48	U1	All	0.617	1.164	0.617	3-#4

Punching Shear Around Columns

Critical Section Properties

Units: b1, b2, b0, davg, CG, c(left), c(right) (in), Ac (in^2), Jc (in^4)

Supp	Type	b1	b2	b0	davg	CG	c(left)	c(right)	Ac	Jc
1	Rect	18.88	21.75	59.50	5.75	4.89	12.89	5.99	342.13	14110
2	Rect	21.75	21.75	87.00	5.75	0.00	10.88	10.88	500.25	40131
3	Rect	21.75	21.75	87.00	5.75	0.00	10.88	10.88	500.25	40131
4	Rect	18.88	21.75	59.50	5.75	-4.89	5.99	12.89	342.13	14110

Punching Shear Results

Units: Vu (kip), Munb (k-ft), vu (psi), Phi*vc (psi)

Supp	Vu	vu	Munb	Comb	Pat	GammaV	vu	Phi*vc
1	22.79	66.6	37.20	U1	All	0.383	139.2	189.7
2	50.07	100.1	-7.72	U1	All	0.400	110.1	189.7
3	50.07	100.1	7.72	U1	All	0.400	110.1	189.7
4	22.79	66.6	-37.20	U1	All	0.383	139.2	189.7

Material Takeoff

Reinforcement in the Direction of Analysis

Top Bars:	336.6 lb	<=>	6.08 lb/ft	<=>	0.435 lb/ft^2	
Bottom Bars:	432.9 lb	<=>	7.82 lb/ft	<=>	0.559 lb/ft^2	
Stirrups:	0.0 lb	<=>	0.00 lb/ft	<=>	0.000 lb/ft^2	
Total Steel:	769.5 lb	<=>	13.91 lb/ft	<=>	0.993 lb/ft^2	
Concrete:	451.9 ft^3	<=>	8.17 ft^3/ft	<=>	0.583 ft^3/ft^2	

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spSlab v5.00 (TM)
A Computer Program for Analysis, Design, and Investigation of
Reinforced Concrete Beams, One-way and Two-way Slab Systems

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[3] DEFLECTION RESULTS

Section Properties

Frame Section Properties

Units: Ig, Icr (in^4), Mcr (k-ft)

Span	Zone	M+ve Ig	M+ve Icr	M+ve Mcr	M-ve Ig	M-ve Icr	M-ve Mcr
1	Left	4802	0	54.23	4802	492	-54.23
	Midspan	4802	0	54.23	4802	527	-54.23
	Right	4802	0	54.23	4802	527	-54.23
2	Left	4802	492	54.23	4802	527	-54.23
	Midspan	4802	492	54.23	4802	0	-54.23
	Right	4802	492	54.23	4802	664	-54.23
3	Left	4802	492	54.23	4802	664	-54.23
	Midspan	4802	492	54.23	4802	0	-54.23
	Right	4802	492	54.23	4802	664	-54.23
4	Left	4802	492	54.23	4802	664	-54.23
	Midspan	4802	492	54.23	4802	0	-54.23
	Right	4802	492	54.23	4802	527	-54.23
5	Left	4802	0	54.23	4802	527	-54.23
	Midspan	4802	0	54.23	4802	527	-54.23
	Right	4802	0	54.23	4802	492	-54.23

NOTES: M+ve values are for positive moments (tension at bottom face).
M-ve values are for negative moments (tension at top face).

Frame Effective Section Properties

Units: Ie, Ie,avg (in^4), Mmax (k-ft)

			Load Level					
			Dead		Sustained		Dead+Live	
Span	Zone	Weight	Mmax	Ie	Mmax	Ie	Mmax	Ie
1	Right	1.000	-0.27	4802	-0.27	4802	-0.27	4802
	Span Avg	----	----	4802	----	4802	----	4802
2	Middle	0.850	24.95	4802	24.95	4802	34.25	4802
	Right	0.150	-46.76	4802	-46.76	4802	-64.17	3162
	Span Avg	----	----	4802	----	4802	----	4556
3	Left	0.150	-42.47	4802	-42.47	4802	-58.27	4000
	Middle	0.700	18.47	4802	18.47	4802	25.34	4802
	Right	0.150	-42.47	4802	-42.47	4802	-58.27	4000
	Span Avg	----	----	4802	----	4802	----	4561
4	Left	0.150	-46.76	4802	-46.76	4802	-64.17	3162
	Middle	0.850	24.95	4802	24.95	4802	34.25	4802
	Span Avg	----	----	4802	----	4802	----	4556
5	Left	1.000	-0.27	4802	-0.27	4802	-0.27	4802
	Span Avg	----	----	4802	----	4802	----	4802

Strip Section Properties at Midspan

Units: Ig (in^4)

Span	Column Strip Ig	Column Strip LDF	Column Strip Ratio	Middle Strip Ig	Middle Strip LDF	Middle Strip Ratio
1	2401	0.800	1.600	2401	0.200	0.400
2	2401	0.738	1.475	2401	0.262	0.525
3	2401	0.675	1.350	2401	0.325	0.650
4	2401	0.738	1.475	2401	0.262	0.525
5	2401	0.800	1.600	2401	0.200	0.400

NOTES: Load distirubtion factor, LDL, averages moment distribution factors listed in [2] Design Results.
Ratio refers to proportion of strip to frame deflections under fix-end condtions.

Instantaneous Deflections

Extreme Instantaneous Frame Deflections and Corresponding Locations

Units: Def (in), Loc (ft)

Span	Direction	Value	Dead	Live Sustained	Live Unsustained	Live Total	Total Sustained	Total Dead+Live
1	Down	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
	Up	Def	-0.005	---	-0.002	-0.002	-0.005	-0.007
		Loc	0.000	---	0.000	0.000	0.000	0.000
2	Down	Def	0.059	---	0.025	0.025	0.059	0.083
		Loc	8.378	---	8.378	8.378	8.378	8.378
	Up	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
3	Down	Def	0.034	---	0.015	0.015	0.034	0.049
		Loc	8.876	---	8.876	8.876	8.876	8.876
	Up	Def	-0.000	---	-0.000	-0.000	-0.000	-0.000
		Loc	0.444	---	0.444	0.444	0.444	0.444
4	Down	Def	0.059	---	0.025	0.025	0.059	0.083
		Loc	9.622	---	9.622	9.622	9.622	9.622
	Up	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
5	Down	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
	Up	Def	-0.005	---	-0.002	-0.002	-0.005	-0.007
		Loc	0.667	---	0.667	0.667	0.667	0.667

Extreme Instantaneous Column Strip Deflections and Corresponding Locations

Units: Def (in), Loc (ft)

Span	Direction	Value	Dead	Live Sustained	Live Unsustained	Live Total	Total Sustained	Total Dead+Live
1	Down	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
	Up	Def	-0.005	---	-0.002	-0.002	-0.005	-0.007
		Loc	0.000	---	0.000	0.000	0.000	0.000
2	Down	Def	0.077	---	0.033	0.033	0.077	0.110
		Loc	8.627	---	8.627	8.627	8.627	8.627
	Up	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
3	Down	Def	0.048	---	0.021	0.021	0.048	0.068
		Loc	8.876	---	8.876	8.876	8.876	8.876
	Up	Def	-0.000	---	-0.000	-0.000	-0.000	-0.000
		Loc	0.222	---	0.222	0.222	0.222	0.222
4	Down	Def	0.077	---	0.033	0.033	0.077	0.110
		Loc	9.373	---	9.373	9.373	9.373	9.373
	Up	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
5	Down	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
	Up	Def	-0.005	---	-0.002	-0.002	-0.005	-0.007
		Loc	0.667	---	0.667	0.667	0.667	0.667

Extreme Instantaneous Middle Strip Deflections and Corresponding Locations

Units: Def (in), Loc (ft)

Span	Direction	Value	Dead	Live Sustained	Live Unsustained	Live Total	Total Sustained	Total Dead+Live
1	Down	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
	Up	Def	-0.005	---	-0.002	-0.002	-0.005	-0.007
		Loc	0.000	---	0.000	0.000	0.000	0.000
2	Down	Def	0.040	---	0.017	0.017	0.040	0.057
		Loc	7.881	---	8.129	8.129	7.881	8.129
	Up	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
3	Down	Def	0.020	---	0.009	0.009	0.020	0.029
		Loc	8.876	---	8.876	8.876	8.876	8.876
	Up	Def	-0.000	---	-0.000	-0.000	-0.000	-0.000
		Loc	0.667	---	0.667	0.667	0.667	0.667

4	Down	Def	0.040	---	0.017	0.017	0.040	0.057
		Loc	9.871	---	9.871	9.871	9.871	9.871
	Up	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
5	Down	Def	---	---	---	---	---	---
		Loc	---	---	---	---	---	---
	Up	Def	-0.005	---	-0.002	-0.002	-0.005	-0.007
		Loc	0.667	---	0.667	0.667	0.667	0.667

Long-term Deflections

Long-term Column Strip Deflection Factors

Time dependant factor for sustained loads = 2.000
Units: Astop, Asbot (in^2), b, d (in), Rho' (%), Lambda (-)

		M+ve					M-ve			
Span	Zone	Astop	b	d	Rho'	Lambda	Asbot	b	d	Rho'	Lambda
1	Right	----	----	----	0.000	2.000	----	----	----	0.000	2.000
2	Midspan	----	----	----	0.000	2.000	----	----	----	0.000	2.000
3	Midspan	----	----	----	0.000	2.000	----	----	----	0.000	2.000
4	Midspan	----	----	----	0.000	2.000	----	----	----	0.000	2.000
5	Left	----	----	----	0.000	2.000	----	----	----	0.000	2.000

NOTES: Deflection multiplier, Lambda, depends on moment sign at sustained load level and Rho' in given zone.
Rho' is assumed zero because Compression Reinforcement option is NOT selected in Solve Options.

Long-term Middle Strip Deflection Factors

Time dependant factor for sustained loads = 2.000
Units: Astop, Asbot (in^2), b, d (in), Rho' (%), Lambda (-)

		M+ve					M-ve			
Span	Zone	Astop	b	d	Rho'	Lambda	Asbot	b	d	Rho'	Lambda
1	Right	----	----	----	0.000	2.000	----	----	----	0.000	2.000
2	Midspan	----	----	----	0.000	2.000	----	----	----	0.000	2.000
3	Midspan	----	----	----	0.000	2.000	----	----	----	0.000	2.000
4	Midspan	----	----	----	0.000	2.000	----	----	----	0.000	2.000
5	Left	----	----	----	0.000	2.000	----	----	----	0.000	2.000

NOTES: Deflection multiplier, Lambda, depends on moment sign at sustained load level and Rho' in given zone.
Rho' is assumed zero because Compression Reinforcement option is NOT selected in Solve Options.

Extreme Long-term Column Strip Deflections and Corresponding Locations

Units: D (in), x (ft)

Span	Direction	Value	cs	cs+lu	cs+l	Total
1	Down	Def	---	---	---	---
		Loc	---	---	---	---
	Up	Def	-0.010	-0.011	-0.011	-0.016
		Loc	0.000	0.000	0.000	0.000
2	Down	Def	0.154	0.187	0.187	0.264
		Loc	8.627	8.627	8.627	8.627
	Up	Def	---	---	---	---
		Loc	---	---	---	---
3	Down	Def	0.095	0.116	0.116	0.163
		Loc	8.876	8.876	8.876	8.876
	Up	Def	-0.000	-0.000	-0.000	-0.001
		Loc	0.222	0.222	0.222	0.222
4	Down	Def	0.154	0.187	0.187	0.264
		Loc	9.373	9.373	9.373	9.373
	Up	Def	---	---	---	---
		Loc	---	---	---	---
5	Down	Def	---	---	---	---
		Loc	---	---	---	---
	Up	Def	-0.010	-0.011	-0.011	-0.016
		Loc	0.667	0.667	0.667	0.667

NOTES: Incremental deflections due to creep and shrinkage (cs) based on sustained load level values.
Incremental deflections after partitions are installed can be estimated by deflections due to:
- creep and shrinkage plus unsustained live load (cs+lu), if live load applied before partitions,
- creep and shrinkage plus live load (cs+l), if live load applied after partitions.
Total deflections consist of dead, live, and creep and shrinkage deflections.

Extreme Long-term Middle Strip Deflections and Corresponding Locations

Units: D (in), x (ft)

Span	Direction	Value	cs	cs+lu	cs+l	Total
1	Down	Def	---	---	---	---
		Loc	---	---	---	---
	Up	Def	-0.010	-0.011	-0.011	-0.016
		Loc	0.000	0.000	0.000	0.000
2	Down	Def	0.081	0.097	0.097	0.138
		Loc	7.881	8.129	8.129	8.129
	Up	Def	---	---	---	---

		Loc	---	---	---	---
3	Down	Def	0.040	0.049	0.049	0.069
		Loc	8.876	8.876	8.876	8.876
	Up	Def	-0.001	-0.001	-0.001	-0.001
		Loc	0.667	0.667	0.667	0.667
4	Down	Def	0.081	0.097	0.097	0.138
		Loc	9.871	9.871	9.871	9.871
	Up	Def	---	---	---	---
		Loc	---	---	---	---
5	Down	Def	---	---	---	---
		Loc	---	---	---	---
	Up	Def	-0.010	-0.011	-0.011	-0.016
		Loc	0.667	0.667	0.667	0.667

NOTES: Incremental deflections due to creep and shrinkage (cs) based on sustained load level values.
Incremental deflections after partitions are installed can be estimated by deflections due to:
- creep and shrinkage plus unsustained live load (cs+lu), if live load applied before partitions,
- creep and shrinkage plus live load (cs+l), if live load applied after partitions.
Total deflections consist of dead, live, and creep and shrinkage deflections.