9/17/85

ARCH. 453
F75JS
PARTITIONS

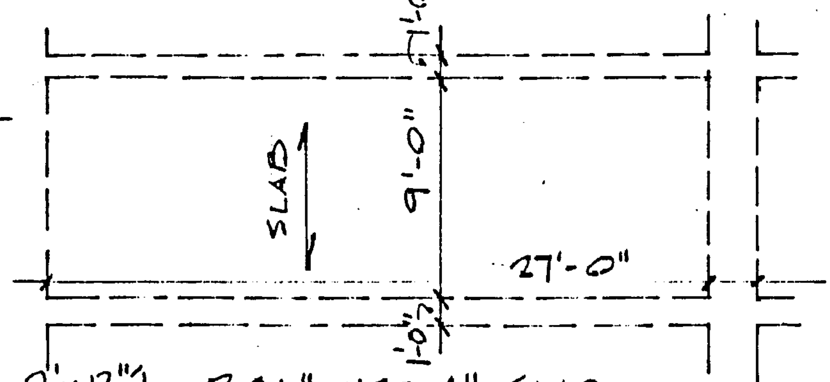
DESIGN FOR CONCENTRATED AND PARTITION LOADS

I. Influence of Concentrated and Partition Loads on Slabs.

A. Perform Basic Slab Design Using Nominal Estimated Loads:

Example:

PARTIAL FRAMING PLAN
$f'_c = 4^{ksi}$; $f_y = 60^{ksi}$



1. LOADS: SAY $h_s = \frac{9' \times 12''/'}{28} = 3.86''$ USE 4" SLAB

LT. WT TOPPING INC

SUPER. D.L.	65 PSF	ULT.	
4" SLAB	50		
DL	115 PSF	@ 1.4 =	161 PSF
LL 80 PSF @ 100% =	80	@ 1.7 =	136
	195 PSF		$\boxed{297\ PSF}$ DESIGN ULTIMATE

2. SPAN: TYPICAL INTERIOR; SEE ABOVE; USE $\boxed{9'-0''}$

3. MOMENTS: $-M = \frac{.297 @ 9^2}{12} = \boxed{2.00^{k'/'}}$

$+M = \frac{.297 @ 9^2}{16} = \boxed{1.50^{k'/'}}$

4. DEPTHS: ASSUME BARS & 3/4" COVER ∴ $\boxed{d = 3''}$

5. SELECT MAIN STEEL: $-A_s = 0.0567 \cdot 12'' \cdot 3''\left(1 \pm \sqrt{1 - \frac{7.844 \cdot 2^{k'}}{12 \cdot 3^2}}\right) = .154^{in^2}$

$+A_s = 0.0567 \cdot 12 \cdot 3 \left(1 \pm \sqrt{1 - \frac{7.844 \cdot 1.5}{12 \cdot 3^2}}\right) = .114^{in^2}$

CHECKS: $A_{s_{MIN}} = .0018 \times 12'' \times 4'' = .0864^{\square''/'}$ OK <

$A_{s_{MAX}} = .0214 \times 12'' \times 3'' = .7704^{\square''}$ OK >

$S_{MAX} \le 3 \times 4'' \le 12''$

TOP:	#4 @ 12	A_s = .20 > .154	OR	#3 @ 9	A_s = .15 ≃ .154
BOT	#3 @ 12	.11 ≃ .114		#3 @ 11	.12 > .114

CHECK → $-M_u = 4.5 \times .2 \times 3'' - 3.32 \times .2^2 = 2.57^{k'} > 2^{k'}$

$+M_u = 4.5 \times .11 \times 3 - 3.32 \times .11^2 = 1.44^{k'} \simeq 1.5^{k'}$

SAY OK

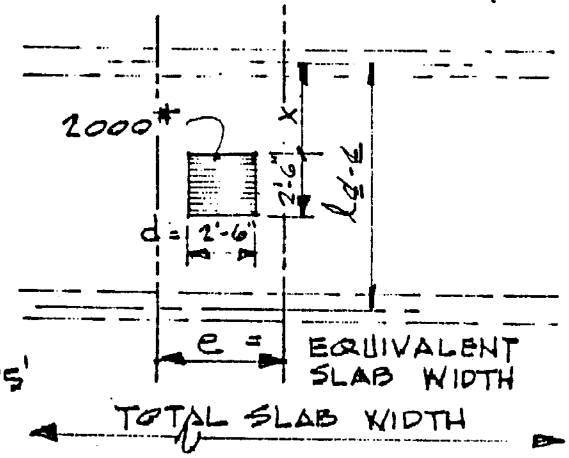
6: SELECT TEMP. A_s: (FROM $A_{S\,MIN} \geq .0864^{\square''}$)
BARS: #3 @ 15" = $.09^{\square''/'}$
USE ⟶ WWF: $4 \times 4 - W2.9 \times W2.9 = .087^{\square''}$

7. SHEAR ; 8. DEVELOPMENT ; 9. DEFLECTION : NOT CRITICAL

B. Check the Effect of a 2000# Load on a 2 1/2 foot square Area

1. Assumptions and Keys:
   a. If the 2000# load causes no greater effect than the live load, it is acceptable.
   b. Key #1: Find the width of slab that participates in carrying the 2 1/2 foot square area; it is usually wider than 2 1/2 feet.
   c. Key #2: Equate the moments found for fixed ends under the special loading to those found with ACI Coefficients under pattern loading.
2. Equivalent Slab Width: (See Chart on Following Page)

$$e = \left\{ \begin{matrix} 4/3\,x + d \\ \text{OR} \\ \text{CHART} \end{matrix} \right\} \text{ WHICHEVER LESS (CONSERVATIVE)}$$



1-WAY SLABS: BY DEFINITION -

$$\frac{\text{TOTAL SLAB WIDTH}}{\text{SLAB SPAN}} \geq 2.0$$

THIS PROBLEM: $x = \dfrac{10' - (2.5')}{2} = 3.75'$

$d = 2.5'$

$e = \frac{4}{3}(3.75) + 2.5 = 7.5'$; CHART: CONC. LOAD $= .75(10') = 7.5'$

UNIF: LOAD $= .55(10') = 5.5'$

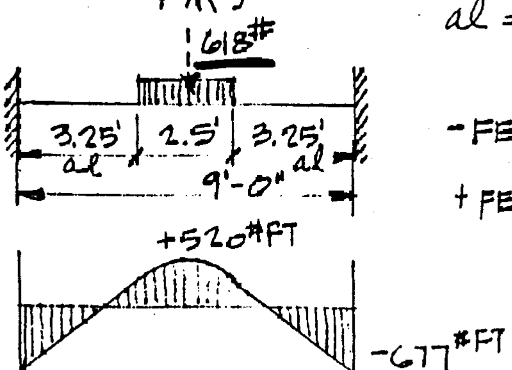
(U) Live Load

3. LOAD ON EQUIVALENT 1^{FT} WIDE STRIP: $\dfrac{2000^{\#} \times 1.7}{5.5'} = \underline{618^{\#}}$

(CONSERVATIVE) ⟶ 5.5'

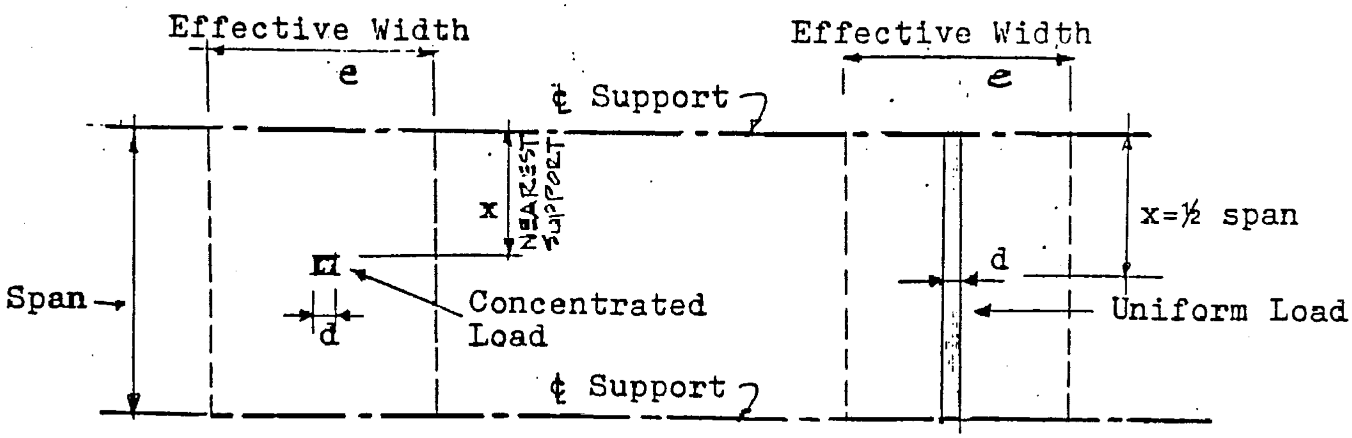
4. FIND $\left.\begin{matrix} -M \\ +M \end{matrix}\right\}$ DUE TO LOADS ASSUMING FIXED ENDS & CLEARSPAN

$al = 3.25'$; $a = \dfrac{3.25'}{9'} = .361$



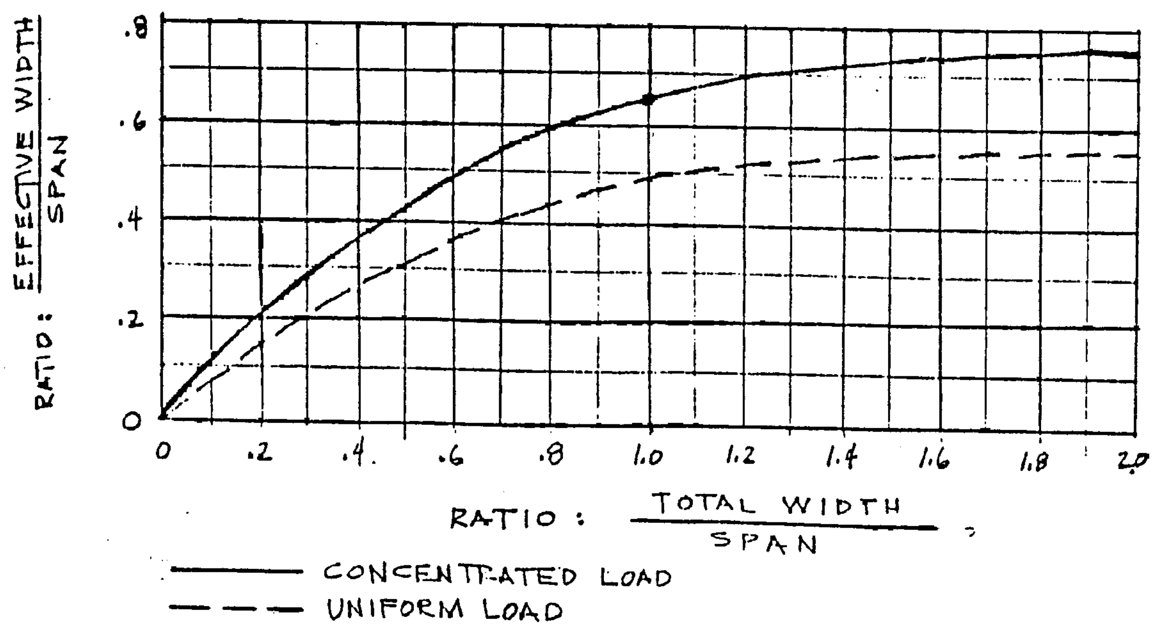
$$-FEM = \left(\frac{1 + 2(.361) - 2(.361)^2}{12}\right) 618^{\#}(9^{FT}) = -677^{\#FT}$$

$$+FEM = \left[\frac{1}{8}\left(1 + 2(.361)\right) 618^{\#}(9^{FT})\right] - 677^{\#FT} = +520$$



Concentrated load where the total slab width is greater than twice the span, the effective width may be assumed to be: $e = 4/3x + d$

Uniform load parallel to main reinforcement where the total slab width is greater than twice the span, the effective width may be assumed to be: $e = 4/3x + d$



Influence of total width on effective width of reinforced concrete slabs. (Where total width is less than twice the span.)

Effective width as determined by the formula $e = 4/3x + d$ shall be used whenever this is smaller than that obtained from the curves above.

5. Find the uniform live loads which, if spread over the full span of a 1 ft. wide strip of slab, would cause moments equal to the above.

$$-\frac{W_{EQUIV.}\,\ell_n^2}{12} = -677^{\#'} \quad \therefore -W_E = \frac{677^{\#'} \times 12}{9^2} = 100\,PSF$$

$$+\frac{W_{EQUIV}\,\ell_n^2}{16} = +520^{\#'} \quad \therefore +W_E = \frac{520 \times 16}{9^2} = 103\,PSF$$

6. COMPARE TO DESIGN LIVE LOADS:
ACTUAL LOAD USED = $80^{PSF} \times 1.7 = 136^{PSF}$
EQUIVALENT LOAD REQUIRED = 100PSF FOR −M
103 PSF FOR +M

7. PUNCHING SHEAR: $V = 1.7 \times 2000^{\#} = 3400^{\#}$
$b = 4\left(30" + 2\left(\frac{3"}{2}\right)\right) = 132"$; $d = 3"$

$$v = \frac{3400}{(132 \times 3)(.85)} = 10\,PSI$$; CLEARLY NOT CRITICAL

CONCLUSION: DESIGN OK FOR 2000# LOAD ON 2½ FT SQ. AR

C. Check Effect of Partitions Parallel and Perpendicular to Span
if too large for 20psf smear load

1. Parallel to Slab Span ⊥ BEAM

a. Compute Partition Weight:
(1). Construction: Say steel stud with gypsum plaster
USE 12 psf over partition area.

(2). Height: If sound isolation required: assume from top of finish floor to underside of slab: 12'-9" - 3" fill - 4" slab = 12.17'

(3). $W_{PART} = 12\,PSF \times 12.17' = 146^{PLF} \times 1.4 = 204.4\,PLF$
USE $.205^{KLF}$

b. Find Effective Slab Width
(1). This is uniform load case as represented on p. 3.

(2). e = 4/3(5') + .33' > .55(10')
USE e = 5.5'

c. Check to verify that partitions are spaced farther apart than e:
Assume minimum partition spacing here = 8'

d. Find The Partition Load on a 1 foot wide strip of slab:

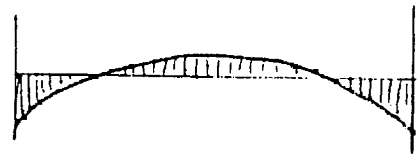
$$w^{KLF} = \frac{.205^{KLF}}{5.5'} = .0373^{KLF}$$

$$W = .0373^{KLF} \times 9^{FT} = .336^{K}$$

e. Find -M and +M Due to Loads Assuming Fixed Ends and Clearspan:

$$-M = \frac{.336 \times 9'}{12} = -.252^{k'}$$

$$+M = \frac{.336 \times 9'}{24} = +.126^{k'}$$



f. Find Uniform Partition Loads (which, if spread over the full span of a 1 ft. wide strip of slab, would cause moments equal to the above).

$$-\frac{w_E \ell_n^2}{12} = -.252^{k'} \quad \therefore -w_E = \frac{.252^{\#'} \times 12}{9^2} = 37.3 \text{ PSF}$$

$$+\frac{w_E \ell_n^2}{16} = +.126^{k'} \quad \therefore +w_E = \frac{126^{\#'} \times 16}{9^2} = 24.9 \text{ PSF}$$

g. COMPARE TO DESIGN PARTITION LOADS

NOMINAL LOAD USED = $20^{PSF} \times 1.4 = 28$ PSF

CAPACITY OF ACTUAL STEEL SELECTION: (P. 1)

$-w$: $\left(\frac{2.57^{k'} \text{ AVAIL. CAP.}}{2.00^{k'} \text{ DES. REQ'T}} \times .297^{KSF} \text{ L'D REQ'D}\right) = .382^{KSF}$ AVAILABLE

HOW MUCH IS THEREFORE AVAILABLE FOR PARTITIONS

$382 \text{ PSF} - \left(297 \text{ PSF}_{TL} - 28 \text{ PSF}_{\text{PART. LD}}\right) = \underline{113 \text{ PSF}}$

SINCE 113 PSF >> 37.3 PSF, NO CHANGE REQ'D

$+w$: $\frac{1.44^{k'}}{1.5} \times .297^{KSF} = .285^{KSF} \quad \therefore \quad 28 - (297 - 285)$

$+w = 16$ PSF < 24.9 PSF REQ'D ∴ QUESTIONABLE CHOICE

2. Effect of Partitions Perpendicular to Slab Span // BEAM

a. Partition weight = .205 klf

b. Effective Slab Width = 1 foot

c. Check to verify that partitions are spaced farther than the slab span:

Assume partition spacing here = 10 feet

d. Partition load on a 1 foot wide strip of slab = 205#

e. Find -M and +M Due to Loads Assuming Fixed Ends and Clearspan:

$$\pm M = \frac{Pl}{8} = \frac{205\#(9')}{8} = 230.6\#ft$$

f. Find Uniform Partition Loads (which, if spread over the full span of a 1 ft. wide strip of slab, would cause moments equal to the above).

$$-\ \frac{w_E \ell_n^2}{12} = 230.6^{\#'} \therefore -w_E = \frac{230.6^{\#'} \times 12}{9^2} = 34.2 \text{ psf}$$

$$+\ \frac{w_E \ell_n^2}{16} = 230.6^{\#'} \therefore +w_E = \frac{230.6^{\#'} \times 16}{9^2} = 45.6 \text{ psf}$$

g. COMPARE TO DESIGN PARTITION LOADS

CAPACITY OF ACTUAL STEEL SELECTION:

$-w_E$ (SEE P.5) = 113 psf > 34.2 psf

$+w_E$ (SEE P.5) = 16 psf << 45.6 psf

h. REVISE $+A_s$: $w = 297 - 28 + 46 = 315$ psf ← NEW TOTAL LD

OLD TOTAL LOAD; OLD PTN LD; NEW $+w_E$

$$+M = \frac{315^{psf} \times 9^2}{16} = 1.59^{k'}$$

$$+A_s = 0.0567 \cdot 12 \cdot 3 \left(1 \pm \sqrt{1 - \frac{7.844 \cdot 1.59}{12 \cdot 3^2}}\right) = 0.12^{in^2}$$

∴ #3 @ 11 REQ'D OR: #3 @ 12 OK IF A SQUARE PATTERN WWF USED (FOR TEMP.) & PLACED LOW.

D. Short-form Multiplier Chart for Effects of Partition Loads on Slabs.

1. Key Assumptions: ℓ_n approximately = ℓ

   Other assumptions as on p. 2.

2. Variables: weight (psf) of partition over its surface area $= w_p^{psf}$

   height of partition = h

   clearspan of supporting slab = ℓ_n

   ACI Coefficients for Moments $1/10,\ 1/11,\ 1/12,\ 1/14,\ 1/16$

3. DERIVATIONS:

a. PARTITIONS PARALLEL TO SLAB SPAN

$e = .55\,\ell_n$

$w_{PART} = w_p^{psf}\, h$

$$-M = \frac{w_{PART}}{e} \cdot \frac{\ell_n^2}{12} = \frac{w_p h \ell_n^2}{.55 \ell_n 12}$$

$$+M = \frac{w_{PART}}{e} \cdot \frac{\ell_n^2}{24} = \frac{w_p h \ell_n^2}{.55 \ell_n 24}$$

WHEN $\ell_n \leq 10'$; $-\frac{W_E \ell_n^2}{12} = -M = \frac{W_p h \ell_n^2}{.55 \ell_n 12}$

$$\therefore -W_E = \frac{W_p h \ell_n^2}{.55 \ell_n 12} \times \frac{12}{\ell_n^2} = \frac{1.818 W_p h}{\ell_n}$$

$\ell_n > 10'$, AT 1ST INTERIOR SUPPORT: $-\frac{W_E \ell_n^2}{10} = -M$

$$\therefore -W_E = \frac{W_p h \ell_n^2}{.55 \ell_n 12} \times \frac{10}{\ell_n^2} = \frac{1.515 W_p h}{\ell_n}$$

AND SO ON....

b. PARTITIONS PERPENDICULAR TO SLAB SPAN

$e = 1^{FT}$ $\qquad \pm M = \frac{P}{e}\frac{\ell_n}{8} = W_p^{PSF} h \frac{\ell_n}{8}$

$P_{PART} = W_p^{PSF} h \times 1^{FT}$

WHEN $\ell_n \leq 10'$; $-\frac{W_E \ell_n^2}{12} = -M = \frac{W_p h \ell_n}{8}$

$$\therefore -W_E = \frac{W_p h \ell_n}{8} \times \frac{12}{\ell_n^2} = \frac{1.5 W_p h}{\ell_n}$$ AND SO ON...

4. SUMMARY: NOMINAL PARTITION LOADS ON SLABS MAY BE ESTIMATED AS FOLLOWS: $W_E = (COEF) \frac{W_p h}{\ell_n}$

WHERE W_p = PARTITION WEIGHT ^{PSF}; h = PARTITION HEIGHT ^{FT}

(COEF) AS INDICATED BELOW

M	LOCATION OR SPAN RANGE	ORIENTATION OF PARTITION TO SLAB SPAN: PARALLEL	PERPENDICULAR
−M	$\ell_n \leq 10'$ (1/12)	1.818	1.5
	$\ell_n > 10'$ 1ST INT.: (1/10)	1.515	1.25
	TYP INT.: (1/11)	1.667	1.375
+M	EXT. SPAN (1/14)	1.061	1.75
	INT. SPAN (1/16)	1.212	2.0

THEREFORE: A TYP. INTERIOR SLAB W/ $\ell_n = 11.5'$, $h = 9'$, AND $W_p = 12$ PSF SHOULD BE DESIGNED FOR:

CRIT. $-W_{E_{//}} = \frac{1.667 \times 12^{PSF} \times 9'}{11.5'} = 15.7$ PSF

$+W_{E_{\perp}} = 2.0 \times 12 \times 9 = 18.8$ PSF

MIN. PART. SPACING:

//: $.55 \times 11.5 = 6.3^{FT}$

⊥: 11.5'