LOADS

OFFICE | CORRIDOR LL = 80 PSF
PARTITION LL = 20 PSF } 100 PSF

FRAMING SELF WT = 17.8 PSF (CALCULATED, NOT INCL SLAB/DECK)
ADD'L MEP, ETC = 15 PSF (ASSUMED)

$1.2D + 1.6L = 1.2(32.8) + 1.6(100) = 199$ PSF
$1.4D = 1.4(32.8) = 45.9$ PSF

CHECK DECK

DESIGN USED 20 ga 1.5 VLI DECK w/ 3.5" NW ~~TOPPING~~

	1 SP	2 SP	3 SP.
FOR SPAN = 6', 5" TOT DEPTH, NW. CONCRETE	6'-10"	8'-1"	8'-2"

FROM CATALOG, @ 6'-6" SPAN, MAXIMUM SUPERIMPOSED LOAD = 400 PSF

400 PSF >> 199 PSF ✓ OK

SELFWEIGHT OF DECK & SLAB:

SLAB = 51 PSF + DECK = 2.14 PSF = 53.1 PSF

CHECK INFILL BEAMS

SPAN = 36' w/ 6'-6" SPACING

ADD SLAB/DECK TO FACTORED LOAD

199 PSF + 1.2 (53.1) = 263 PSF

$w_u = 6'[263] = 1.58$ KLF

$M_u = \frac{w_u l^2}{8} = \frac{(1.58)(36)^2}{8} = 255.6$ K.FT

DETERMINE b_{eff} FOR COMPOSITE BEAM

EACH SIDE = MIN OF
- $\frac{1}{8}$ SPAN = 54"
- $\frac{1}{2}$ DIST TO ADJ. = 36" ←
- DIST TO EDGE = N/A

$b_{eff} = 36" \times 2 = 72"$

∘ TRIAL $a = 1.0''$ ∴ $Y2 = t_{SLAB} - \frac{1}{2}a = 4.5''$

FOR W21×44, $Y2 = 4.5''$ $\left.\begin{array}{l}\phi M_n = 510 \text{ K·FT} \\ \Sigma Q_n = 162^K\end{array}\right\}$ IN POS ⑦

$\frac{162}{17.2} = 9.4 \Rightarrow 10$ STUDS/SIDE (DESIGN USED 22 TOTAL)

↑ ASSUMING 1 WK STUD/RIB

$10 \times 17.2 = 172^K$

CHECK $a = \frac{\Sigma Q_n}{0.85 f'c\, b} = \frac{172}{(0.85)(4)(72)} = 0.7 < 1.0$ ✓ OK

$\phi M_n = 510$ FT·K $> M_u = 256$ FT·K ✓ OK

∘ CHECK UNSHORED STRENGTH

FOR W21×44 → $\phi M_p = 358$ FT·K

$$W_u = \begin{cases} 1.4D = 1.4(44 + 53.1 \times 6) = 482.4 \text{ PLF} \\ 1.2D + 1.6L = 1.2(44 + 53.1 \times 6) + 1.6(20 \times 6) = 605.5 \text{ PLF} \leftarrow \end{cases}$$

$$M_u = \frac{w l^2}{8} = \frac{(0.6055)(36')^2}{8} = 98.1 \text{ FT·K}$$

$\phi M_p = 358$ FT·K > 98.1 FT·K ✓ OK

∘ CHECK WET CONCRETE DEFLECTION $< l/240$

FOR W21×44 → $I_x = 843$ IN^4

$W_u = 605.5$ PLF

$$\Delta_{WC,MAX} = \frac{l}{240} = \frac{36 \times 12}{240} = 1.8''$$

$$\Delta_{WC@MS.} = \frac{5}{384}\frac{w_{wc} l^4}{E I_x} = \frac{5}{384}\frac{(0.6055)(36)^4(12)^3}{(29 \times 10^3)(843)} = 1.6''$$

$\Delta_{WC,MAX} = 1.8'' > \Delta_{WC@MS} = 1.6''$ ✓ OK

∘ CHECK LIVE LOAD DEFLECTION < $l/360$

$w_u = 1.6(100 \times 6') = 960$ PLF

FOR W21×44 & $Y2 = 4.5"$ $I_{LB} = 1410\ IN^4$

$\Delta_{LL,MAX} = \frac{l}{360} = \frac{36 \times 12}{360} = 1.2"$

$\Delta_{LL@MS} = \frac{5}{384}\frac{(0.96)(36)^4(12)^3}{(29\times10^3)(1410)} = 0.89"$

$\Delta_{LL\,MAX} = 1.2" > \Delta_{LL@MS} = 0.89"$ ✓ OK

CHECK GIRDER BETWEEN B2 & C2

DESIGN USED W24 × 84

TOTAL LOAD = $4\left[\left(\frac{36+35}{2}\right)(1.58)\right] = 116.9^K$

4+ POINTS ∴ IDEALIZE AS UNIFORM LOAD

$\frac{116.9^K}{30'} \Rightarrow w_u = 3.90$ KLF

$M_u = \frac{w_u l^2}{8} = \frac{(3.90)(30)^2}{8} = 438.5$ FT·K

∘ DETERMINE b_{eff} FOR COMPOSITE GIRDER

EACH SIDE = MIN OF
- $\frac{1}{8}$ SPAN = 90" ←
- $\frac{1}{2}$ DIST TO ADJ = 216"
- DIST TO EDGE = N/A

$b_{eff} = 90" \times 2 = 180"$

∘ TRIAL $a = 1.0"$ ∴ $Y2 = t_{SLAB} - \frac{1}{2}a = 4.5"$

FOR W24 × 84, Y2 = 4.5 : $\phi M_n = 1030$ FT·K, $\Sigma Q_n = 309^K$ } IN PGS ⑦

$\frac{309^K}{17.2} = 17.9 \rightarrow 18$ STUDS/SIDE (36 TOTAL)

$18 \times 17.2 = 309.6$ K

CHECK $a = \frac{\Sigma Q_n}{0.85 f'_c b} = \frac{309.6}{(0.85)(4)(180)} = 0.501 < 1.0$ ✓ OK

$\phi M_n = 1030$ FT·K $> M_u = 438.5$ FT·K ✓ OK

- CHECK UNSHORED STRENGTH

FOR W24×84 → $\phi M_p = 840$ FT·K

$$W_u = \begin{cases} 1.4D = 1.4\left[84 + (53.1)\left(\frac{36+38}{2}\right)\right] = 1493 \text{ PLF} \\ 1.2D + 1.6L = (1.2/1.4)(1493) + 1.6(20 \times 18.5) = 1872 \text{ PLF} \leftarrow \end{cases}$$

$$M_u = \frac{w\ell^2}{8} = \frac{(1.87)(30)^2}{8} = 210.4 \text{ FT·K}$$

$$\phi M_p = 840 \text{ FT·K} > M_u = 210.4 \text{ FT·K} \quad ✓ \text{ OK}$$

- CHECK WET CONCRETE DEFLECTION $< \ell/240$

FOR W24×84 → $I_x = 2370$ IN^4

$w_u = 1.87$ KLF

$$\Delta_{WC,MAX} = \frac{\ell}{240} = 1.5''$$

$$\Delta_{WC@MS} = \frac{5}{384} \frac{(1.87)(30)^4(12)^3}{(29 \times 10^3)(2370)} = 0.5''$$

$$\Delta_{WC,MAX} = 1.5'' < \Delta_{WC,MS} = 0.5'' \quad ✓ \text{ OK}$$

- CHECK LIVE LOAD DEFLECTION $< \ell/360$

$$w_{LL} = 1.6\left(100 \times \frac{36+38}{2}\right) = 2.96 \text{ KLF}$$

FOR W24×84 & $Y_2 = 4.5''$ $I_{LB} = 3720$ IN^4

$$\Delta_{LL,MAX} = \frac{\ell}{360} = \frac{30 \times 12}{360} = 1''$$

$$\Delta_{LL@MS} = \frac{5}{384} \frac{(2.96)(30)^4(12)^3}{(29 \times 10^3)(3720)} = 0.5''$$

$$\Delta_{LL\,MAX} = 1'' < \Delta_{LL@MS} = 0.5'' \quad ✓ \text{ OK}$$

★ DESIGN VIA CRSI MANUAL, 2008

SUPERIMPOSED LOADS

$1.2D + 1.6L = 1.2(15) + 1.6(100) = 178$ PSF

SELECT SYSTEM

TRIAL: 30" FORMS w/ 6" RIBS (36" c-c)

ASSUME 24×24 COLUMNS (CONSERVATIVE FOR BAY SIZE)

$\therefore \ell_n = 34'$

ALSO USE $f'c = 4$ ksi, $f_y = f_{yt} = 60$ ksi

USE 4.5" TOP SLAB FOR FIRE RATING (0.69 CF/SF)

FOR THIS SYSTEM & 16" DEEP RIBS, CAPACITY = 184 PSF ✓OK

◦ TRIAL BAND-BEAM IN 36' DIRECTION w/ b = 48"

ADD BEAM SELF-WEIGHT:

$$\frac{20.5 \times 12}{(12)^2} = 1.75 \frac{CF}{SF}$$

$$1.75 - 0.69\ CF/SF = 1.06\ CF/SF$$

$$1.06 \times \frac{48}{12} \times 150\ PCF = 636\ PLF \times 1.2 = 763.2\ PLF$$

$$\therefore w_{u,\ w/BM} = 0.763 + \left(\frac{30+24}{2}\right)0.302 = 8.92\ KLF$$

! OFF TABLE FOR $\ell_n = 34'$, INT. SPAN, $h = 16 + 4.5 = 20.5$

◦ TRY NEW BEAM IN 30' DIRECTION w/ b = 48
& SELECT BEAM DEPTH BY LOAD.

$\ell_n = 30 - 2 = 28'$

AGAIN, $q_u = 302.2$ PSF, TRIAL DEPTH = 20.5"

$$\therefore w_{u,\ w/BM} = 0.763 + \left(\frac{36+36}{2}\right)0.302 = 11.94\ KLF$$

└ WORKS w/ h = 24.5 (CAPACITY = 14.86 KLF)

◦ SELECT DEEPER JOISTS TO MATCH BAND-BEAM

└ USE 30" FORMS, 6" RIBS @ 20", 4.5" SLAB
FOR 24.5" TOTAL DEPTH. ... →

NOW IS END-SPAN, NOT INTERIOR (CHANGED DIRECTION)

AND $\ell_n = 24'$; SUPERIMPOSED LOAD STILL = 178 PSF

WORKS w/ #6 & #7 BARS (CAPACITY = 207 PSF)

- RE-CHECK BEAM SELF-WT w/ NEW SLAB/JOIST

(OLD = 0.69 CF/SF, NEW = 0.73 CF/SF)

BEAM SELF-WEIGHT

$$\frac{24.5 \times 12}{12^2} = 2.04 \text{ CF/SF}$$

$$2.04 - 0.73 \text{ CF/SF} = 1.31 \text{ CF/SF}$$

$$1.06 \times \frac{48}{12} \times 150 = 787 \times \underline{\underline{1.2}} = 944 \text{ PLF}$$

NEW SLAB/JOIST SELF WEIGHT

$$0.73 \text{ CF/SF} \times 150 \text{ PCF} \times \underline{\underline{1.2}} = 131.4 \text{ PSF}$$

NEW TOTAL ON BEAM

$$\left(\frac{36+38}{2}\right)\left[178 + 131.4\right] + 944 = 12.4 \text{ KLF}$$

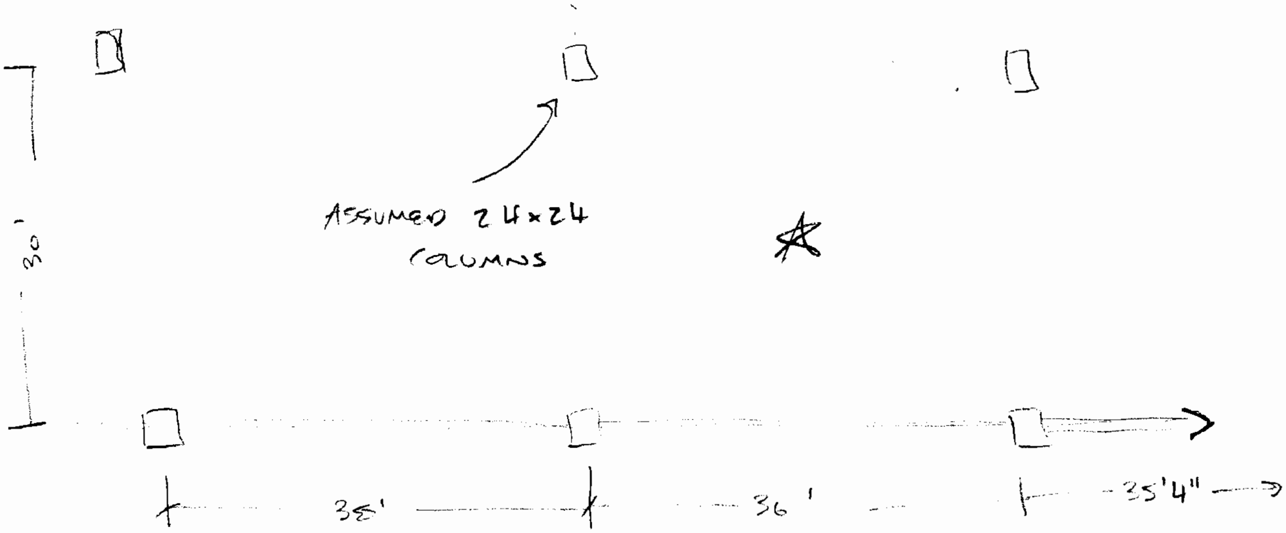
└ STILL WORKS w/ h = 24.5 (CAPACITY = 14.86 KLF)

- BEAM REINFORCEMENT VIA TABLE

CALLS FOR: (3) #14 BOTTOM BARS
(6) #14 TOP BARS
(17) #5 4-LEG STIRRUPS @ EACH END

- SLAB/JOIST REINFORCEMENT VIA TABLE

CALLS FOR: #5 @ 9" OC IN SLAB
(1) #6 & (1) #7 IN BOTT. OF JOISTS



FROM ACI 318 TABLE 9.5 (c)

$f_y = f_{yt} = 60$ KSI

EXTERIOR PANEL, W/O EDGE BEAMS

MIN. THICKNESS = $\frac{l_n}{33}$

$l_n = 36' - 2 \times 1' = 34' \rightarrow h_{min} = 12.4"$

CHECK $l_1/l_2 < 2 \rightarrow 36/30 = 1.2$ ✓ OK

USE $h = 12.5"$

LOADS

DL: SLAB $= \frac{12.5}{12} \times 150 = 156.25$ PSF

MISC $= 15$ PSF

LL: OFFICE / CORRIDORS $= 80$ PSF

PARTITIONS $= 20$ PSF

$q_u = 1.2D + 1.6L$

$= 1.2(156.25 + 15) + 1.6(100) = 365.5$ PSF

$= 0.366$ KSF

① INTERIOR COLUMN STRIP, 36' DIRECTION

$\ell_1 = 36'$, $\ell_n = 34'$, $\ell_2 = \frac{1}{2}(30+24) = 27'$

$M_o = \frac{q_u \ell_2 \ell_n^2}{8} = \frac{(0.366)(27)(34)^2}{8} = 1428$ FT·K

INTERIOR SPAN: $M^- = 0.65 M_o = 928.2$ FT·K
$M^+ = 0.35 M_o = 500.0$ FT·K

$\ell_2 \le \ell_1$ ∴ COL STRIP $= \frac{1}{2}\ell_2 = 13.5'$
1/2 MID STRIP $= 1/2(30) - 1/2(13.5) = 8.25'$

NO BEAMS ∥ TO ℓ_1 ∴ $\alpha_{f1} = 0$

FOR $\alpha_{f1} = 0$, % M^-_{INT} = 75% FOR ALL β
% M^+ = 60% FOR ALL β

M^-_{INT} COLUMN $= 0.75 M^-_{INT} = 696.2$
1/2 MID $= 1/2 \times 0.25 M^-_{INT} = 116.0$ FT·K
M^+ COLUMN $= 0.60 M^+ = 300.0$
1/2 MID $= 1/2 \times 0.4 M^+ = 50.0$

② EDGE COLUMN STRIP, 36' DIRECTION

$\ell_1 = 36'$, $\ell_n = 34'$, $\ell_2 = 15 + 1 = 16'$

$M_o = \frac{q_u \ell_2 \ell_n^2}{8} = \frac{(0.366)(16)(34)^2}{8} = 846.2$ FT·K

INTERIOR SPAN: $M^- = 0.65 M_o = 550.0$ FT·K
$M^+ = 0.35 M_o = 296.2$ FT·K

$\ell_2 \le \ell_1$ ∴ COL STRIP $= 1/4 \; 30 = 7.5' + 1 = 8.5'$
1/2 MID STRIP $= (1/2)(30) - 7.5 = 7.5'$

NO BEAMS ∥ TO ℓ_1 ∴ $\alpha_{f1} = 0$

FOR $\alpha_{f1} = 0$, % M^-_{INT} = 75% FOR ALL β
% M^+ = 60% FOR ALL β

M^-_{INT}	COLUMN	$= 0.75\ M^-_{INT}$	$= 412.5$	FT·K
	1/2 MID	$= \frac{1}{2} \times 0.125\ M^+$	$= 68.75$	
M^+	COLUMN	$= 0.60\ M^+$	$= 177.7$	
	1/2 MID	$= \frac{1}{2} \times 0.4 M^+$	$= 59.24$	

(3) EXTERIOR COLUMN STRIP, 30' DIRECTION (WEST)

$\ell_1 = 30'$, $\ell_n = 28'$, $\ell_2 = \frac{1}{2}(36+38) = 37'$

$$M_{0\ell} = \frac{q_u \ell_2 \ell_n^2}{8} = \frac{(0.366)(37)(28)^2}{8} = 1327 \text{ FT·K}$$

EXTERIOR SPAN, w/o INT BM, w/o EDGE BM:

$M^-_{INT} = 0.70\ M_o = 929.0$

$M^-_{EXT} = 0.30\ M_o = 398.1$ FT·K

$M^+ = 0.50\ M_o = 663.6$

$\ell_2 > \ell_1 \therefore$ COL STRIP $= \frac{1}{2}\ell_1 = 15'$
1/2 MID STRIP $= \frac{1}{2}(36) - \frac{1}{2}(15) = 10.5'$

NO BEAMS $\therefore \alpha_{f1} = 0$

M_{INT}	COLUMN	$= 0.75\ M^-_{INT}$	$= 696.8$	
	1/2 MID	$= \frac{1}{2} \times 0.125\ M^-_{INT}$	$= 116.1$	
M^-_{EXT}	COLUMN	$= 1.0\ M^-_{EXT}$	$= 398.1$	FT·K
	1/2 MID	$=$ —	$= 0$	
M^+	COLUMN	$= 0.60\ M^+$	$= 398.2$	
	1/2 MID	$= \frac{1}{2}\ 0.4\ M^+$	$= 132.7$	

(4) EXTERIOR COLUMN STRIP, 30' DIRECTION (EAST)

$\ell_1 = 30'$, $\ell_n = 28'$, $\ell_2 = \frac{1}{2}(36 + 34.3) = 35.7'$

$M_{o\ell} = \frac{q_u \ell_2 \ell_n^2}{8} = \frac{(0.366)(35.7)(28)^2}{8} = 1280$ FT.K

EXTERIOR SPAN, NO INT BM, NO EDGE BM

$M_{INT} = 0.70 M_o = 896.3$

$M_{EXT} = 0.30 M_o = 384.1$ FT.K

$M+ = 0.50 M_o = 640.2$

$\ell_2 > \ell_1 \therefore$ COL STRIP $= \frac{1}{2}\ell_1 = 15'$

$\frac{1}{2}$ MID STRIP $= \frac{1}{2}(36) - \frac{1}{2}(15) = 10.5'$

NO BEAMS $\therefore \alpha_{f1} = 0$

M_{INT}	COLUMN	$= 0.75 M_{INT}$	$= 672.2$	FT.K
	½ MID	$= \frac{1}{2} \times 0.25 M_{INT}$	$= 112.0$	
M_{EXT}	COLUMN	$= 1.0 M_{EXT}$	$= 384.1$	
	½ MID	= ———	$= 0$	
$M+$	COLUMN	$= 0.60 M+$	$= 384.1$	
	½ MID	$= \frac{1}{2} \times 0.4 M+$	$= 128.0$	

(11) INTERIOR COLUMN STRIP, 36' DIRECTION

M−

$b = \frac{27 \times 12}{2} = 162''$

$d = 12.5 - 1.0 - \frac{1}{2}(1.0) = 11''$ (#8 BARS)

$R_n = \frac{M_u}{\phi b d^2} = \frac{(696.2)(12)(1000)}{(0.9)(162)(11)^2} = 473.6$ PSI

$\rho = \frac{0.85 f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2R_n}{0.85 f'_c}}\right)$

$= \frac{0.85(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 473.6}{0.85(4000)}}\right) = 0.0050$

$A_s = \rho b d = 0.0050 \times 162 \times 11 = 8.91$ IN²

$\rho_{min} = 0.0018$

└ $A_{s\,min} = 0.0018 \times 162 \times 12.5 = 3.64 < 8.91$ ✓OK

FOR #8 BARS: $\frac{8.91}{0.79} = 11.3 \rightarrow 12$ BARS

MAX SPACING = $S_{max} = 2h = 25'' > 18''$ So USE 18''

FOR 12 BARS $\frac{162}{12} = 13.5'' \rightarrow$ PLACE @ 13'' OC

VERIFY $\phi = 0.9$ ($\varepsilon_t > 0.005$)

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(12)(0.79)(60)}{(0.85)(4)(162)} = 1.033$

$c = a / \beta_1 = 1.033 / 0.85 = 1.215''$

$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.024 > 0.005$ ✓OK

M+

$b = 162''$

$d_+ = 12.5 - 0.75 - \frac{1}{2}(0.75) = 11.375''$ (#6 BARS)

$R_n = \frac{M_u}{\phi b d^2} = \frac{(300)(12)(1000)}{(0.9)(162)(11.375)^2} = 204.1$ PSI

$\rho = \frac{0.85(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 204.1}{0.85(4000)}}\right) = 0.0035$

$A_s = \rho b d = 0.0035 \times 162 \times 11.375 = 6.25$ IN²

$\rho_{min} = 0.0018$

$\quad \llcorner A_{s,min} = 0.0018 \times 162 \times 12.5 = 3.65 \text{ in}^2 < 6.25$ ✓ ok

FOR #6 BARS: $\frac{6.25}{0.44} = 14.2 \rightarrow 15$ BARS

MAX SPACING: $S_{max} = 2h = 25'' > 18 \therefore$ USE 18"

FOR 15 BARS $\frac{162}{15} = 11.5 \rightarrow$ PLACE @ 11" oc

VERIFY $\phi = 0.9$ ($\varepsilon_t > 0.005$)

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(15)(0.44)(60)}{(0.85)(4)(162)} = 0.431''$$

$$c = a/\beta_1 = 0.431 / 0.85 = 0.507$$

$$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.061 > 0.005 \checkmark \text{ ok}$$

(1/2) INTERIOR MIDDLE STRIP, 36' DIRECTION

[M-] $b = (30 - 6.75 - 7.5) \times 12 = 189''$

$d = 12.5 - 0.75 - \frac{1}{2}(0.5) = 11.5''$ (#4 BARS)

$M_u = 116 + 68.75 = 184.7$ FT·K

$$R_n = \frac{M_u}{\phi b d^2} = \frac{184.7 \times 12 \times 1000}{(0.9)(189)(11.5)^2} = 98.5 \text{ PSI}$$

$$\rho = \frac{0.85(4)}{(60)}\left(1 - \sqrt{1 - \frac{2 \times 98.5}{0.85(4000)}}\right) = 0.0017$$

$A_s = \rho b d = 0.0017 \times 189 \times 11.5 = 3.69 \text{ in}^2$

$\rho_{min} = 0.0018$

$\quad \llcorner A_{s,min} = 0.0018 \times 12.5 \times 189 = 4.25$

$\therefore$ USE $A_s = A_{s,min} = 4.25 \text{ in}^2$

FOR #4 BARS: $\frac{4.25}{0.2} = 21.2 \rightarrow 22$ BARS

TRY #6 BARS: $\frac{4.25}{0.44} = 9.6 \rightarrow 10$ BARS

MAX SPACING = $S_{max} = 2h = 25'' > 18 \therefore$ USE 18"

FOR 10 BARS: $\frac{189}{10} = 18.9'' \rightarrow$ ADD 1 BAR

FOR 11 BARS: $\frac{189}{11} = 17.1'' \rightarrow$ PLACE @ 16" oc.

CHECK REVISED d (#4 vs #6)

$d = 12.5 - 0.75 - \frac{1}{2}(0.75) = 11.375$ (#6 BARS)

$R_n = \frac{M_u}{\phi b d^2} = \frac{184.7 \times 12 \times 1000}{(0.9)(189)(11.375)^2} = 100.7$

$\rho = \frac{0.85(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 100.7}{0.85(4000)}}\right) = 0.0017$

UNCHANGED ∴ ✓OK

VERIFY $\phi = 0.9$ ($\varepsilon_t > 0.005$)

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(11)(0.44)(60)}{(0.85)(4)(189)} = 0.452''$

$c = a/\beta_1 = 0.452/0.85 = 0.532$

$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.0612 > 0.005$ ✓OK

|M+| $b = 189.''$

$d = 12.5 - 0.75 - \frac{1}{2}(0.75) = 11.375''$ (#6 BARS)

$R_n = \frac{M_u}{\phi b d^2} = \frac{109.2 \times 12 \times 1000}{(0.9)(189)(11.375)^2} = 59.5$ PSI

$\rho = \frac{0.85(4)}{(60)}\left(1 - \sqrt{1 - \frac{2 \times 59.5}{0.85(4000)}}\right) = 0.0010$

$A_s = \rho b d = 0.0010 \times 189 \times 11.375 = 2.15$ IN²

$\rho_{min} = 0.0018$

$A_{s,min} = 0.0018 \times 12.5 \times 189 = 4.25$ IN²

∴ USE $A_{s,min} = 4.25$ IN²

SAME As AS BOTTOM BARS

∴ USE (11) #6 @ 16'' OC.

(2) EDGE COLUMN STRIP, 36' DIRECTION

[M+] $b = (7.5' + 1') \times 12 = 102''$

$d = 12.5 - 1.0 - \frac{1}{2}(1.0) = 11''$ (#8 BARS)

$R_n = \frac{M_u}{\phi b d^2} = \frac{412.5 \times 12 \times 1000}{(0.9)(102)(11)^2} = 445.6$ PSI

$\rho = \frac{0.85(4)}{(60)}\left(1 - \sqrt{1 - \frac{2 \times 445.6}{0.85(4000)}}\right) = 0.0079$

$A_s = \rho b d = 0.0079 \times 102 \times 11 = 8.86$ IN²

$\rho_{min} = 0.0018$

└ $A_{s,min} = 0.0018 \times 102 \times 12.5 = 2.29$ IN²

FOR #8 BARS: $\frac{8.86}{0.79} = 11.2 \rightarrow 12$ BARS

MAX SPACING $S_{max} = 2h = 25'' > 18$ SO USE 18''

FOR 12 BARS $\frac{102}{12} = 8.5'' \rightarrow$ PLACE @ 8'' OC

VERIFY $\phi = 0.9$ ($\varepsilon_t > 0.005$)

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(12)(0.79)(60)}{(0.85)(4)(102)} = 1.64''$

$c = a / \beta_1 = 1.64 / 0.85 = 1.93''$

$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.014 > 0.005$ ✓OK

[M−] $b = 102$

$d_{top} = 12.5 - 0.75 - \frac{1}{2}(0.75) = 11.375$

$R_n = \frac{M_u}{\phi b d^2} = \frac{177.7 \times 12 \times 1000}{(0.9)(102)(11.375)^2} = 196.4$ PSI

$\rho = \frac{0.85(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 196.4}{0.85(4000)}}\right) = 0.0034$

$A_s = \rho b d = 0.0034 \times 102 \times 11.375 = 3.94$ IN²

$\rho_{min} = 0.0018$

└ $A_{s,min} = 0.0018 \times 102 \times 12.5 = 2.30$ IN² ✓OK

FOR #6 BARS: $\frac{3.914}{0.44} = 8.96 \rightarrow 9$ BARS

MAX SPACING – $S_{MAX} = 2h = 25'' > 18$ ∴ USE 18''

FOR 9 BARS: $\frac{102}{9} = 11.2'' \rightarrow$ PLACE @ 11'' OC.

VERIFY $\phi = 0.9$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(9 \times 0.44)(60)}{0.85(4)(102)} = 0.685''$$

$$c = a/\beta_1 = 0.685/0.85 = 0.806''$$

$$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.029 > 0.005 \checkmark OK$$

(3) EXTERIOR COLUMN STRIP, 30' DIRECTION (WEST)

$|M^-_{INT}|$ $b = 15 \times 12 = 180''$

$$d = 12.5 - 1.0 - 1.0 - \tfrac{1}{2}(1.128) = 10.2''$$

$$R_n = \frac{M_u}{\phi b d^2} = \frac{696.8}{0.9(102)(10.2)^2} = 456.5 \text{ PSI}$$

$$\rho = \frac{0.85(4)}{(60)}\left(1 - \sqrt{1 - \frac{2 \times 456.5}{0.85(4000)}}\right) = 0.0088$$

$$A_s = \rho b d = 0.0088 \times 180 \times 10.2 = 16.2 \text{ IN}^2$$

$\rho_{min} = 0.0018$

$A_{s,min} = 0.0018 \times 12.5 \times 180 = 4.05''$ ✓OK

FOR #9 BARS: $\frac{16.2}{1.0} = 16.2 \rightarrow 17$ BARS

MAX SPACING $S_{MAX} = 2h = 25 > 18$ ∴ USE 18''

FOR 17 BARS: $\frac{180}{17} = 10.5 \rightarrow$ PLACE @ 10'' OC

VERIFY $\phi = 0.9$ ($\varepsilon_t > 0.005$)

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(17 \times 1.0)(60)}{0.85 \times 4 \times 180} = 1.67''$$

$$c = a/\beta_1 = 1.67/0.85 = 1.96''$$

$$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.0127 > 0.005 \checkmark OK$$

M^-_{EXT} $b = 180''$

$d = 12.5 - 1.0 - 1.0 - \frac{1}{2}(1.128) = 10.2''$ (#9 BARS)

$R_n = \dfrac{M_u}{\phi b d^2} = \dfrac{(398.1)(12 \times 1000)}{(0.9)(180)(10.2)^2} = 283.4$ PSI

$\rho = \dfrac{0.85(4)}{(60)}\left(1 - \sqrt{1 - \dfrac{2 \times 283.4}{0.85(4000)}}\right) = 0.0049$

$A_s = \rho b d = 0.0049 \times 180 \times 10.2 = 9.07$ IN²

$\rho_{min} = 0.0018$

└ $A_{s,min} = 0.0018 \times 12.5 \times 180 = 4.05$ IN² ✓OK

FOR #9 BARS: $\dfrac{9.07}{1.0} = 9.07 \rightarrow$ 10 BARS

MAX SPACING $= s_{max} = 2h = 25 > 18$ ∴ USE 18"

FOR 10 BARS $\dfrac{180}{10} = 18 \rightarrow$ PLACE @ 18" OC

VERIFY $\phi = 0.9$ $(\varepsilon_t \geq 0.005)$

$a = \dfrac{A_s f_y}{0.85 f'_c b} = \dfrac{(10)(1.0)(60)}{0.85(4)(180)} = 0.980''$

$c = a / \beta_1 = 0.980 / 0.85 = 1.15''$

$\varepsilon_t = \dfrac{0.003}{c} d - 0.003 = 0.021 > 0.005$ ✓OK

M^+ $b = 180''$

$d_{top} = 12.5 - 0.75 - 0.75 - \frac{1}{2} \times 0.875 = 10.6$ (#7 BARS)

$R_n = \dfrac{M_u}{\phi b d^2} = \dfrac{(398.2)(12 \times 1000)}{(0.9)(180)(10.6)^2} = 262.5$ PSI

$\rho = \dfrac{0.85(4)}{60}\left(1 - \sqrt{1 - \dfrac{2 \times 262.5}{0.85 \times 4000}}\right) = 0.0046$

$A_s = \rho b d = 0.0046 \times 180 \times 10.6 = 8.70$ IN²

$\rho_{min} = 0.0018$

└ $A_{s,min} = 0.0018 \times 12.5 \times 180 = 3.43$ ✓OK

FOR #7 BARS $\frac{8.70}{0.6} = 14.5 \rightarrow 15$ BARS

MAX SPACING = $S_{MAX} = 2h = 25'' > 18$ ∴ USE 18''

FOR 15 BARS $\frac{180}{15} = 12 \rightarrow$ PLACE @ 12'' oc

VERIFY $\phi = 0.9$ $(\varepsilon_t > 0.005)$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{15 \times 0.6 \times 60}{0.85(4)(180)} = 0.882''$$

$$c = a/\beta_1 = 1.04''$$

$$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.0276 > 0.005 \checkmark OK$$

3/4 EXTERIOR MIDDLE STRIP, 30' DIRECTION

$|M^-_{INT}|$ $b = (36 - 7.5 - 7.5) \times 12 = 252''$

$$d = 12.5 - 0.75 - 1.0 - \tfrac{1}{2}(0.625) = 10.4''$$

$$M_u = 116.1 + 112 = 228.1 \text{ FT}\cdot\text{K}$$

$$R_n = \frac{M_u}{\phi b d^2} = \frac{(228.1)(12 \times 1000)}{(0.9)(252)(10.4)^2} = 111.6$$

$$\rho = \frac{0.85(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 111.6}{0.85(4000)}}\right) = 0.0019$$

$\rho_{min} = 0.0018$

$\llcorner$ $A_{s,min} = 0.0018 \times 252 \times 12.5 = 5.67$ (CONTROLS)

FOR #5 BARS: $\frac{5.67}{0.31} = 18.3 \rightarrow 19$ BARS

MAX SPACING = $S_{MAX} = 2h = 25'' > 18$ ∴ USE 18''

FOR 19 BARS: $\frac{252}{19} = 13.2 \rightarrow$ PLACE @ 13'' oc

VERIFY $\phi = 0.9$ $(\varepsilon_t > 0.005)$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(19 \times 0.31)(60)}{(0.85)(4)(252)} = 0.412''$$

$$c = a/\beta_1 = 0.412/0.85 = 0.485''$$

$$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.0632 > 0.005 \checkmark OK$$

M^-_{EXT}

$M_u = \phi$ → S&T CONTROLS

∴ USE SAME AS INTERIOR BOTT. BARS

(19) #5 BARS @ 13" O.C

M^+

$b = 252''$

$d_{top} = 12.5 - 0.75 - 0.75 - \frac{1}{2}\, 0.625 = 10.7''$

$M_u = 132.7 + 128.0 = 260.7$ FT.K

$$R_n = \frac{M_u}{\phi b d^2} = \frac{260.7 \times 12 \times 1000}{0.9\,(252)(10.7)^2} = 120.5 \text{ PSI}$$

$$\rho = \frac{0.85(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 120.5}{0.85(4000)}}\right) = 0.0020$$

$A_s = \rho b d = 0.0020 \times 252 \times 12.5 = 5.51 \text{ IN}^2$

$\rho_{min} = 0.0018$

└ $A_{s\,min} = 0.0018 \times 252 \times 12.5 = 5.67 \text{ IN}^2$

∴ USE SAME AS INTERIOR BOTTOM BARS

(19) #5 BARS @ 13" OC

(4) EXTERIOR COLUMN STRIP, 30' DIRECTION (EAST)

M^-_{INT} $b = 15 \times 12 = 180''$

$d = 12.5 - 0.75 - 1.0 - \frac{1}{2} \times 1.128 = 10.2''$ (#9 BARS)

$$R_n = \frac{M_u}{\phi b d^2} = \frac{(672.2)(12 \times 1000)}{0.9 \times 180 \times (10.2)^2} = 478.6 \text{ PSI}$$

$$\rho = \frac{0.85(4)}{(60)}\left(1 - \sqrt{1 - \frac{2 \times 478.6}{0.85(4000)}}\right) = 0.0086$$

$A_s = \rho b d = 0.0086 \times 180 \times 10.2 = 15.9 \text{ IN}^2$

$\rho_{min} = 0.0018$

└ $A_{s,min} = 0.0018 \times 180 \times 12.5 = 4.05 \text{ IN}^2$ ✓OK

FOR #9 BARS $\frac{15.9}{1.0} = 15.9 \rightarrow 16$ BARS

MAX SPACING = $S_{MAX} = 2h = 25'' > 18''$ ∴ USE 18''

FOR 16 BARS: $\frac{180}{16} = 11.25'' \rightarrow$ PLACE @ 11'' O.C.

VERIFY $\phi = 0.9$ $(\varepsilon_t > 0.005)$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(16)(1.0)(60)}{0.85(4)(180)} = 1.57''$$

$$c = a/\beta_1 = 1.57/0.85 = 1.85''$$

$$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.0136 > 0.005 \checkmark OK$$

M^{-}_{EXT}) $b = 180''$

$d = 12.5 - 0.75 - 1.0 - \frac{1}{2} \times 1.128 = 10.2''$ (#9 BARS)

$$R_n = \frac{M_u}{\phi b d^2} = \frac{384.1 \times 12 \times 1000}{0.9(180)(10.2)^2} = 273.5 \text{ PSI}$$

$$\rho = \frac{0.85(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 273.5}{0.85(4000)}}\right) = 0.0048$$

$A_s = \rho b d = (0.0048)(180)(10.2) = 8.81 \text{ IN}^2$

$\rho_{MIN} = 0.0018$

└ $A_{s,MIN} = 0.0018 \times 180 \times 12.5 = 4.05 \text{ IN}^2$ ✓OK

FOR #9 BARS: $\frac{8.81}{1.0} = 8.81 \rightarrow 9$ BARS

MAX SPACING = $2h = 25'' > 18''$ ∴ USE 18''

FOR 9 BARS $\frac{180}{9} = 20 > 18''$ ✗ NO GOOD

FOR CONSISTANT BAR SIZE, USE (10) #9

FOR 10 BARS $\frac{180}{10} = 18''$ ✓OK

VERIFY $\phi = 0.9$ $(\varepsilon_t > 0.005)$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(10)(1.0)(60)}{(0.85)(4)(180)} = 0.980''$$

$$c = a/\beta_1 = 0.980/0.85 = 1.15''$$

$$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.0235 > 0.005 \checkmark OK$$

M+ $b = 180''$

$d = 12.5 - 0.75 - 0.75 - \frac{1}{2}(0.875) = 10.6''$ (#7 BARS)

$R_n = \frac{M_u}{\phi b d^2} = \frac{384.1 \times 12 \times 1000}{(0.9)(180)(10.6)^2} = 253.2$ PSI

$\rho = \frac{(0.85)(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 253.2}{0.85(4000)}}\right) = 0.0044$

$A_s = \rho b d = 0.0044 \times 180 \times 10.6 = 8.38$ IN²

$\rho_{min} = 0.0018$

└ $A_{s,min} = 0.0018 \times 180 \times 12.5 = 4.05$ IN² ✓OK

FOR #7 BARS $\frac{8.38}{0.60} = 13.9 \rightarrow 14$ BARS

MAX SPACING = $S_{MAX} = 2h = 25 > 18$ ∴ USE 18''

FOR 14 BARS $\frac{180}{14} = 12.8'' \rightarrow$ PLACE @ 12'' OC

VERIFY $\phi = 0.9$ ($\varepsilon_t > 0.005$)

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{14 \times 0.6 \times 60}{0.85(4)(180)} = 0.824''$

$c = a / \beta_1 = 0.824 / 0.85 = 0.969''$

$\varepsilon_t = \frac{0.003}{c} d - 0.003 = 0.0298 > 0.005$ ✓OK

CHECK SHEAR AT INTERIOR COLUMN

COLUMN = 24'' × 24'' $d = 11''$ $q_u = 365.5$ PSF

- CRITICAL SECTION & V_u FOR BEAM SHEAR

LONG DIR: TRIB = $36' \left[15' - \frac{11}{12} - \frac{12}{12}\right] = 471$ SF

SHORT DIR: TRIB = $30' \left[18' - \frac{11}{12} - \frac{12}{12}\right] = 482.5$ SF

∴ $V_u = 0.366 \times 482.5 = 176.6$ KIPS

- ϕV_c & COMPARE TO V_u FOR BEAM SHEAR

NO SHEAR REINF ∴ $\phi V_n = \phi V_c = \phi 2 \lambda \sqrt{f'_c}\, b\, d$

$\phi V_c = 0.75(2)(1.0)\sqrt{4000}(30 \times 12)(11) = 375.7^K$

$\phi V_c = 375.7^K > V_u = 176.6^K$ ✓ OK

- CRITICAL PERIMETER & V_u FOR PUNCHING SHEAR

$c_1 + 2 \times \frac{1}{2} d = 24 + 11 = 35''$

$c_1 = c_2$

$b_o = 2(70) = 140''$

$V_u = 0.366 \left[30' \times 36' - (35 \times 35) \frac{1}{144} \right] = 392.2^K$

- ϕV_c & COMPARE TO V_u FOR PUNCHING SHEAR

FOR $c_1 = c_2 = 24$ & INTERIOR: $\beta = 1.0$ $\alpha_s = 40$

USE MIN. OF

$2 + \frac{4}{\beta} = 2 + 4/1 = 6.0$

$\frac{\alpha_s d}{b_o} + 2 = \frac{40 \times 11}{140} + 2 = 5.14$

4 ← GOVERNS

$\phi V_c = 0.75(4)(1.0)\sqrt{4000}(140)(11) = 292.2^K$

$\phi V_c = 292.2 < V_u = 392.2^K$ ✗ NO GOOD

- TRY DROP PANEL

DETERMINE MINIMUM DIMENSION

PLAN $\frac{1}{6} l_1 = 36/6 \times 12 = 72'' \times 2 = 144''$

$\frac{1}{6} l_2 = 30/6 \times 12 = 60'' \times 2 = 120''$

DEPTH $\frac{1}{4} h_{SLAB} = 12.5/4 = 3.125'' \rightarrow 3.25''$

- CHECK IF MINIMUM DEPTH COULD WORK

$0.75(4)(1.0)\sqrt{4000}(140)(11 + 3.25) = 378.5^K$ ✗ NG

- CHECK IF 4'' DEPTH COULD WORK

$0.75(4)(1.0)\sqrt{4000}(140)(11 + 4) = 398.4$ ✓ MIGHT WORK

- DROP PANEL ADD'L SELF-WEIGHT

$1.2 \times \frac{4}{12} \times 145 = 57.9$ PSF

- NEW CRITICAL PERIMETER & V_u

$c_1 + 2\frac{d}{2} = 24 + 2 \times 15/2 = 39''$

$c_1 = c_2$

$b_o = 2(78'') = 156''$

DROP PANEL $V_u = 0.0579\left[(144 \times 120)\frac{1}{144} - (39 \times 39)\frac{1}{144}\right]$

$= 6.34$ K

NEW SLAB $V_u = 0.366\left[30 \times 36 - (39 \times 39)\frac{1}{144}\right]$

$= 391.4$ K

$V_u = 6.34 + 391.4 = 397.7$ K

- ϕV_c & COMPARE to V_u

FOR c_1, c_2 & INT. PANEL. $\beta = 1.0$ & $\alpha_s = 40$

USE MIN OF a) $2 + \frac{4}{\beta} = 6.0$

b) $\frac{\alpha_s d}{b_o} + 2 = \frac{40 \times 15}{156} + 2 = 5.85$

c) 4 ← GOVERNS

$\phi V_c = 0.75(4)(1.0)\sqrt{4000}(156)(15) = 443.9$ K

$\phi V_c = 443.9$ K $> V_u = 397.7$ K ✓ OK

* SPAN PLANKS IN 36' DIRECTION TO MINIMIZE GIRDER LENGTH & MINIMIZE # OF PLANKS TO LIFT INTO PLACE

ROUGH ASSUMPTION: 100 PSF FOR PLANKS & TOPPING

$\therefore q_u = 1.2(15) + 1.6(100) + 1.2(100)$

$= 178 + 120 = 298$ PSF

FOR 30' GIRDER

$\frac{38+36}{2} \times 298 =$ KLF

FOR 30' UNBRACED LENGTH & 5.513 KLF, NEED AT LEAST:

$M_u = \frac{w\ell^2}{8} =$ K·FT

FOR $\phi M_n \geq 620$ ~ W21 x 200+
∟ X TOO MUCH STEEL

$\therefore$ SELECT HC PLANK W/ BEARING PLATES TO PROVIDE BRACING UPON INSTALLATION

MINIMUM BEARING PER PCI $= \frac{\ell}{180} \geq 2''$

USE 38' SPAN (DUE TO SYMMETRY) FOR BEARING

$\frac{38 \times 12}{180} = 2.53 \rightarrow 2.75'' > 2''$ ✓OK

ALLOW 1/2" SETBACK FROM END OF PLANK TO PAD

ALSO MUST PROVIDE 2" JOINT TO ALLOW GROUTING

$\therefore t_{f,min} = 2 + 2.75 \times 2 + \frac{1}{2} \times 2 = 8.5''$

SELECT HC PLANKS

MFG: STRESSCORE, S. BEND, INDIANA

TRY 12ST 26/108 (@ 36', CAPACITY = 194 PSF > 178 ✓OK)
∟ 12" HC PLANK W/ 2" NW. 4KSI TOPPING
(2) 3/8" TOP STRANDS
(16) 1/2" BOTTOM STRANDS
SELF-WEIGHT (W/ TOPPING) = 98 PSF

SELECT WIDE-FLANGE GIRDER (30', WEST)

$q_u = 178 + 1.2(98) = 295.6$ PSF

$w_u = \frac{36+38}{2}(0.296) = 5.48$ KLF

$W_{TOTAL} = 164.4$ KIPS

$M_u = \frac{w_u l^2}{8} = \frac{(5.48)(30)^2}{8} = 616.5$ FT·K

$l_b = 0$ (ALL WELDED)

OR

$l_b = 4$ (ALTERNATE WELDS)

CANDIDATES:

FOR 164.4 K TOTAL UNIFORM LOAD & 30' SPAN

W16×89 → 175K Vol $b_f = 10.4''$ ✓ OK

W21×73 → 172K Vol $b_f = 8.3''$ × NG

W18×86 → 186K Vol $b_f = 11.1''$ ✓ OK

SELECT W16×89 (3" DEPTH FOR 3 PLF STEEL SOUNDS LIKE A GOOD TRADE OFF)
(OK FOR EITHER l_b)

SELECT WIDE-FLANGE GIRDER (30', EAST)

q_u = SAME AS ABOVE = 0.296 KSF

$w_u = \frac{36+35.4}{2}(0.296) = 5.18$ KLF

$W_{TOTAL} = 155.4$ KIPS

KEEP 16" DEPTH

└ SAME AS ABOVE — SELECT W16×89

A) EXISTING SYSTEM (COMPOSITE DECK)

SLAB & DECK	53.1 PSF × 1080	=	57.3 K
(5) W21×44 @ 36'	5 × 44 × 36	=	7.92 K
(1) W21×84 @ 36'	1 × 84 × 36	=	3.02 K
(1) W24×84 @ 30'	1 × 84 × 30	=	2.52 K
(1) W24×76 @ 30'	1 × 76 × 30	=	2.28 K

TOTAL = 73.04 K
÷ 1080 SF = **67.6 PSF**

B) 1-WAY MULTI-SPAN JOISTS

JOIST & SLAB	103.5 × 32 × 30	=	99.4 K
(2) 48" × 25" @ 28'		=	34.9 K

TOTAL = 134.3
÷ 1080 SF = **124.4 PSF**

C) 2-WAY FLAT SLAB

12.5" SLAB	156.25 PSF × 1080	=	168.8 K
4' DROP PANELS W/IN BAY		=	6.0 K

TOTAL = 174.8 K
÷ 1080 SF = **161.8 PSF**

D) HOLLOWCORE PRESTRESSED PLANKS ON STEEL

H.C. & TOPPING	98 PSF × 1080	=	105.8 K
(2) W16×89 @ 30'		=	5.34 K
(2) W? × 40 @ 36'		=	2.88 K

TOTAL = 114.0 K
÷ 1080 SF = **105.6 PSF**

* COST ESTIMATES BASED ON RS MEANS 2013 ASSEMBLY COSTS

A) EXISTING SYSTEM (COMPOSITE DECK)

B1010 254 2900 (30 x 35 BAY)

MATL = \$29.50   INST = \$11.95   TOT. = \$41.45 / SF

B) 1-WAY MULTI-SPAN JOISTS

B1010 226 6700 (30 x 30 BAYS - LARGEST)

MATL = \$8.30   INST = \$12.15   TOT = \$20.46 / SF

C) 2-WAY FLAT SLAB

NOTE: TABLE LISTS 10.5" SLAB, DESIGN = 12.5"
SO MULTIPLIED MATL COST BY 12.5 / 10.5 = 1.2

B1010 222 8000 (30x35 BAY)

MATL = \$10.50   INST = \$10.95   TOT = \$21.45 / SF

D) HOLLOWCORE PLANKS ON STEEL FRAME

B1010 230 4500 (HC PLANKS; 40' SPANS)

MATL = \$9.90   INST = \$4.32   SUB TOT = \$14.22 / SF

B1010 241 8400 (FRAME; 30x35 BAY)

MAT'L = \$21.00   INST = \$7.10   SUB TOT = \$28.10 / SF

TOTAL = \$42.32 / SF