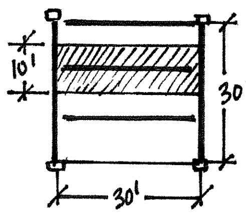
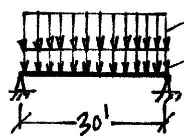
TYPICAL FLOOR BEAM DESIGN.





100 psf LL. = 1000 plf LL
65 psf DL = 650 plf DL
1650 plf TL.

$V = \frac{wl}{2} = \frac{(1650\ plf)(30')}{2} = 24750\ plf = 24.75\ klf.$

$M = \frac{wl^2}{8} = \frac{(1650\ plf)(30')^2}{8} = 185625\ plf = 185.63\ 'k.$

$Y_{CON} = 5.5''$ (OVERALL HEIGHT OF CONCRETE/DECK SYSTEM)
ASSUME $a = 1''$
$Y_2 = Y_{CON} - a/2 = 5.5'' - 1''/2 = 5''$

USING STEEL CONSTRUCTION MANUAL, 13th EDITION, ASD.
[TABLE 3-19.]

@ $Y_2 = 5''$ TRY W14x34 — $M = 197\ 'k \geq 186\ 'k$ OK
PNA = 7
$\Sigma Q_n = 111\ k$

$b_{eff} = 1/4\ SPAN = (1/4)(30') = 7.5'$ ← CONTROLS USE $b_{eff} = 7.5' = 90''$
$= SPACING = (10') = 10'$

$a = \frac{\Sigma Q_n}{0.85 f'_c b} = \frac{111\ k}{(0.85)(3\ ksi)(90'')} = 0.484'' < 1.0''$ OK.

TRY W16x31 — $M = 197\ 'k \geq 186\ 'k$ OK.
PNA = 7
$\Sigma Q_n = 114\ k$

$a = \frac{114k}{(0.85)(3ksi)(90'')} = 0.497'' < 1.0''$ OK.

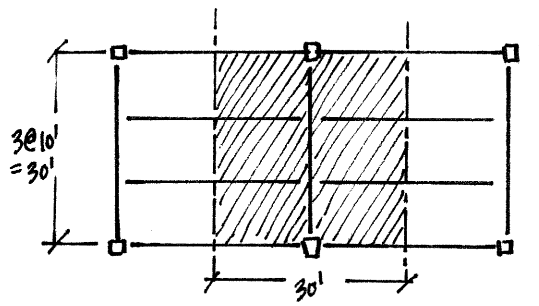
[TABLE 3-21]

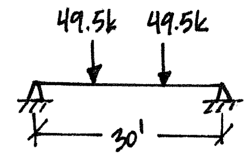
DECK ⊥, 1 WEAK STUD PER RIB, 3/4" ϕ, LIGHTWEIGHT CONCRETE, $f'_c = 3000\ psi$.
$Q_n = 17.2k$

W14x34: $\frac{\Sigma Q_n}{Q_n} = \frac{111\ k}{17.2k} = 6.45 \rightarrow 7$ W16x31: $\frac{\Sigma Q_n}{Q_n} = \frac{114k}{17.2k} = 6.63 \rightarrow 7$

USE W16x31 W/ 14 STUDS *SAME AS ORIGINAL DESIGN!

TYPICAL GIRDER DESIGN.





$P = (2)(V_B)$
$= (2)(24.75k)$
$= 49.5k$

$V = \frac{P}{l}(l-a+b) = \frac{(49.5k)(30'-10'+10')}{30'} = 49.5k$

$M = \frac{Pl}{2} = \frac{(49.5k)(30')}{2} = 742.5'k.$

$Y_{con} = 5.5"$

ASSUME $a = 1"$

$Y_2 = Y_{con} - a/2 = 5.5" - 1"/2 = 5"$

USING STEEL CONSTRUCTION MANUAL, 13th EDITION, ASD.

[TABLE 3-19]

@ $Y_2 = 5"$. TRY W24x68 .
$M = 777'k \geq 742.5'k$ OK
PNA = 3
$\Sigma Q_n = 741k$

$b_{eff} = 1/4$ SPAN $= (1/4)(30') = 7.5'$ ← CONTROLS
= SPACING = 30'
USE $b_{eff} = 7.5' = 90"$

$a = \frac{\Sigma Q_n}{0.85 f'_c b} = \frac{741k}{(.85)(3ksi)(90")} = 3.23" \neq 1.0"$ FAILS.

ASSUME $a = 3"$

$Y_2 = Y_{con} - a/2 = 5.5" - 3"/2 = 4"$

@ $Y_2 = 4"$ ~~TRY~~

ASSUME $a = 4"$

$Y_2 = Y_{con} - a/2 = 5.5" - 4"/2 = 3.5"$

@ $Y_2 = 3.5"$. TRY W24x68 .
$M = 769'k \geq 742.5'k$
PNA = TFL
$\Sigma Q_n = 1000k$

$a = \frac{1000k}{(0.85)(3ksi)(90")} = 4.36" \neq 4.0"$ FAILS.

TYPICAL GIRDER DESIGN CONT'.

TRY W24x76 $M = 743k \geq 742.5k$ OK. $Y_2 = 5''$

PNA = 6

$\Sigma Q_n = 393\,k$

$$a = \frac{393k}{(0.85)(3ksi)(90'')} = 1.71'' \not\leq 1.0'' \text{ FAILS.}$$

TRY W24x84 $M = 756k \geq 742.5k$ OK $Y_2 = 4''$

PNA = 7

$\Sigma Q_n =$ ~~393~~ $309\,k$

$$a = \frac{309k}{(0.85)(3ksi)(90'')} = 1.35'' \leq 2.0'' \text{ OK}$$

[TABLE 3-21]

DECK 11, $\frac{w_r}{h_r} = \frac{4.75''}{3''} = 1.58$, 3/4"φ, LIGHTWEIGHT CONCRETE, $f'_c = 3000\,psi$

$Q_n = 17.1\,k$

W24x84: $\frac{\Sigma Q_n}{Q_n} = \frac{309k}{17.1k} = 18.07 \rightarrow 19$

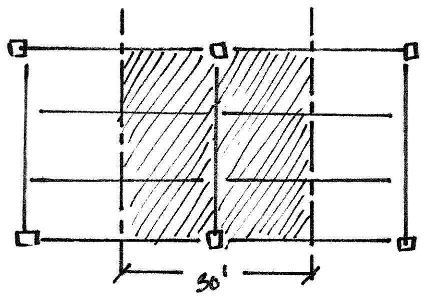
USE W24x84 w/ 38 3/4" STUDS.

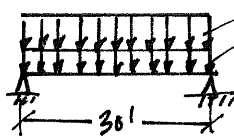
NOTE: DIFFERS FROM ORIGINAL.
SEE ALTERNATE METHOD ON NEXT PAGE.

PENN STATE UNIVERSITY

CLASS: AE 481W
DATE: 10-03-06
ASSIGNMENT: TECH REPORT #1
TYPICAL GIRDER DESIGN CONT'
PAGE: ____ of ____

TYPICAL GIRDER DESIGN CONT.





100 psf LL = 3000 psf LL
65 psf DL = 1950 psf DL
4950 psf TL.

$V = \frac{wl}{2} = \frac{(4.95 klf)(30')}{2} = 74.25 k$

$M = \frac{wl^2}{8} = \frac{(4.95 klf)(30')^2}{8} = 557 'k.$

$Y_{CON} = 5.5''$
ASSUME $a = 1''$
$Y_2 = 5.5'' - 1''/2 = 5''$

[TABLE 3-19.]

@ $Y_2 = 5''$ TRY W24x68. $M = 614'k \geq 557'k$ OK
PNA = 7
$\Sigma Q_n = 251 k$

$$a = \frac{251k}{(0.85)(3ksi)(90'')} = 1.09''$$

@ $Y_2 = 4.5''$ $M = 608'k \geq 557'k$ OK
PNA = 7
$\Sigma Q_n = 251 k$
$a = 1.09'' \leq 2''$ OK

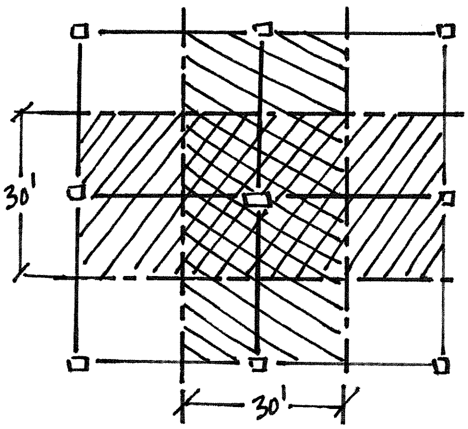
[TABLE 3-21]

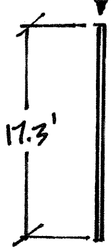
$Q_n = 17.1k$ $\frac{251k}{17.1k} = 14.67 \rightarrow$ 15 STUDS.

USE W24x68 W/ 30 3/4" ϕ STUDS.

*SAME AS ORIGINAL DESIGN!

TYPICAL COLUMN DESIGN.





P = (30')(30')(100 psf LL + 65 psf DL)
= 148.5k / floor.
(30')(30')(20psf LL + 20psfDL)
= 36k / roof.
@ GROUND LEVEL:
ΣP = 36k + (4)(148.5k)
= 630k

ALLOWABLE COMPRESSION =
(0.6)(46ksi) = 27.6 ksi ← CONTROL
(0.5)(58ksi) = 29 ksi

$A_{RQD} = \frac{P}{\sigma} = \frac{630k}{27.6k} = 22.8 \text{ in}^2$

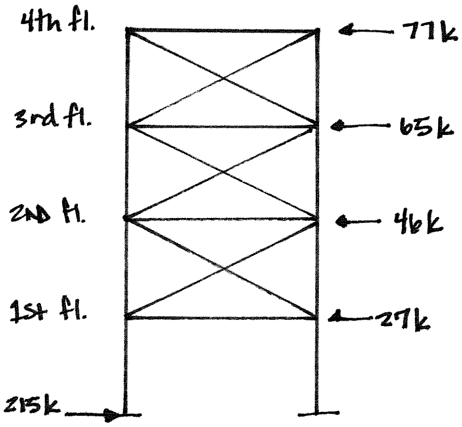
[TBL 4-4]

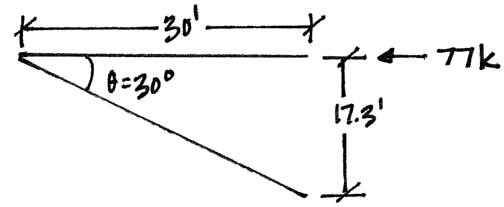
. TRY HSS 14x14x5/8. A = 30.3 in² > 22.8 in² OK
P = 760k @ 17' > 630 k OK

. TRY HSS 12x12x5/8. A = 25.7 in² > 22.8 in² OK
P = 630k @ 16' = 630 k OK

↑ CHANGE IN KL DUE TO DEPTH OF FLOOR SLAB & CONNECTION LENGTH.

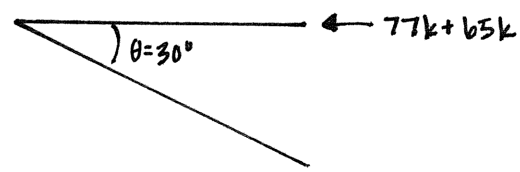
TYPICAL BRACED FRAME DESIGN.



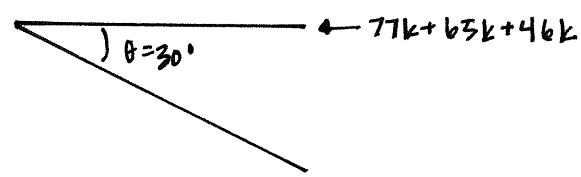


BRACING MEMBER:

$P = \frac{77k}{\cos 30°} = 88.9k.$



$P = \frac{(77k+65k)}{\cos 30°} = 164\ k$



$P = \frac{(77k+65k+46k)}{\cos 30°} = 217.1k$

DESIGN BRACING BASED ON MAXIMUM TENSION LOAD = 217 k.

ALLOWABLE TENSION =

$(0.6)(36ksi) = 21.6ksi$ ← CONTROL.

$(0.5)(58ksi) = 29\ ksi$

$A_{REQD} = \frac{P}{\sigma} = \frac{217k}{21.6ksi} = 10.05\ in^2$

[TBL. 5-?]

TRY LL 3½x3½x½ $A = (2)(3.25 in^2)$

$= 6.5 in^2 \not> 6.03 in^2$ ~~OK~~ FAILS.

TRY LL 4x3x½ $A = (2)(3.25 in^2)$

$= 6.5 in^2 \not> 6.03 in^2$ ~~OK~~ FAILS.

[TBL. 5-8]

TRY LL 4x4x3/4 $A = 10.9\ in^2 \geq 10.05\ in^2$ OK

$P = 233\ k \geq 217.1\ k$ OK

USE LL 4x4x3/4 BRACES

ae PENN STATE UNIVERSITY

CLASS: AE 481 W
DATE: 10-03-06
ASSIGNMENT: TECH REPORT #1
ORIGINAL SNOW LOADING.
PAGE: ____ of ____

SNOW LOADING – DESIGNED W/ SBC 1999 & ASCE 7-95.

[ASCE 7-95 SECTION 7.0]

[FIGURE 7.2]

$P_g = 15$ psf

[SECTION 7.3]

$P_f = 0.7 C_e C_t I P_g$

$= (0.7)(1.0)(1.0)(1.0)(15 \text{ psf})$

$= 10.5$ psf

[SECTION 7.4] [FIGURE 7-2a] WARM ROOF, $\theta = 33.7°$, UNOBSTRUCTED...

$P_s = C_s P_f$ $C_s = 0.53$

$= (0.53)(10.5 \text{psf})$

$= 5.6$ psf

[SECTION 7.6.1]

UNBALANCED SNOW LOADS FOR HIP & GABLE ROOFS.

$P_u = \frac{1.3 P_s}{C_e}$

$= \frac{(1.3)(5.6 \text{psf})}{1.0} =$

$= 7.3$ psf

$P_b = P_s = 10.5$ psf

[SECTION 7.7.2]

DRIFTS ON LOWER ROOF

$\gamma = 0.13 p_g + 14 < 30$ psf

$= (0.13)(15 \text{psf}) + 14$

$= 16$ psf < 30 psf OK.

FOR ROOF STRUCTURE @ COLUMN A TO COLUMN A.2

$l_{UPPER} = 87'$ COLUMN D TO A

$l_{LOWER} = 46'$ COLUMN A TO A-2.

$h = 80'$ PEAK TO PEAK.

LEEWARD DRIFT

[FIGURE 7.9]

$h_d = 0.43 \sqrt[3]{l_u} \sqrt[4]{P_g + 10'} - 1.5$

$= (0.43) \sqrt[3]{87'} \sqrt[4]{15 \text{psf} + 10 \text{psf}'} - 1.5$

$= 2.76'$

$h_b = \frac{P_f}{\gamma} = \frac{10.5 \text{ psf}}{16 \text{pcf}} = 0.66'$

PENN STATE UNIVERSITY

CLASS: AE 481W
DATE: 10-03-06
ASSIGNMENT: TECH REPORT #1
ORIGINAL SNOW LOADING CONT'
PAGE: ____ of ____

SNOW LOADING – DESIGNED W/ SBC 1999 CONT'

$h_c = h - h_b = 80' - 0.66' = 79.34'$

WINDWARD DRIFT.

$h_d = 0.5 h_d$ $\quad l_{lower} = 46'$

$= (0.5)(1.8')$

$= 0.9'$ DNC.

$w = 4 h_d$ $\quad [h_d > h_c]$

$= (4)(2.8')$

$= 11.2'$

$p_d = h_d \gamma$

$= (2.8')(16\ pcf)$

$= 45\ psf$

[SECTION 7.9]

SLIDING SNOW:

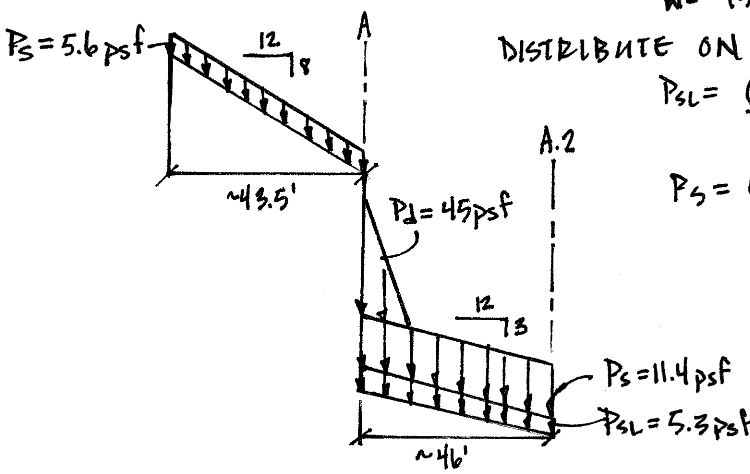
STRIP ON UPPER ROOF:

$W = (5.6\ psf)(1')(43.5') = 243.6\ lbs$

DISTRIBUTE ON LOWER ROOF:

$P_{SL} = \frac{(243.6\ lbs)}{(1')(46')} = 5.30\ psf$

$P_S = C_s P_f = (0.85)(10.5\ psf) = 11.4\ psf.$



TOTAL LOAD ON LOWER ROOF

$P_T = P_{SL} + P_S + \cancel{P_d}$

$= 5.3\ psf + 11.4\ psf$

$= 16.7\ psf$

IMPACT FACTOR:

$P_T = (1.5)(16.7\ psf)$

$= 19.4\ psf$ OVER LOWER ROOF SPAN.

BE SURE TO INCLUDE DRIFT.

PENN STATE UNIVERSITY

CLASS: AE 431 W
DATE: 10-03-06
ASSIGNMENT: TECH REPORT #1
ORIGINAL WIND LOADING.
PAGE: _____ of _____

WIND LOADING - DESIGNED W/ SBC 1999.

[SBC 1606.1.1] WIND FORCES ON EVERY BUILDING OR STRUCTURE SHALL BE DETERMINED BY THE PROVISIONS OF ASCE 7.

[ASCE 7-98 SECTION 6.0]

$V = 90$ MPH

$K_d = 0.85$

$I = 1.0$

EXPOSURE CATEGORY = C

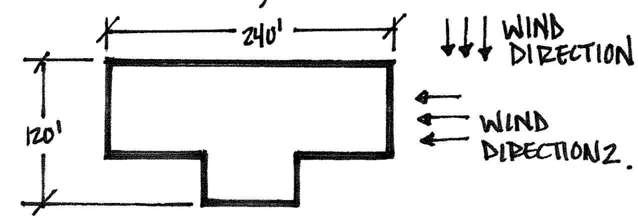
$h = 84'-0''$ (MEAN ROOF HEIGHT)

$\theta = 33.7°$

$K_h = 1.22$ (@ MEAN ROOF HEIGHT) FOR OTHERS SEE NEXT PAGE.

$g = 0.85$

OVERALL BUILDING DIMENSIONS:



1: $\frac{L}{B} = \frac{120'}{240'} = 0.5$ 2: $\frac{L}{B} = \frac{240'}{120'} = 2.0$

$\frac{h}{L} = \frac{84'}{120'} = 0.70$ $\frac{h}{L} = \frac{84'}{240} = 0.35$

[FIGURE 6-6]

$C_p = 0.8$ WINDWARD WALL

1: $C_p = -0.5$ LEEWARD WALL

2: $C_p = -0.3$ LEEWARD WALL

$C_p = -0.7$ SIDE WALL

1: $C_p = \pm 0.2$ ROOF

1: $C_p = -0.6$ LEEWARD ROOF

$gC_{pi} = \pm 0.18$

$C_f = 1.2$.

K_{zt} = TOPOGRAPHIC FACTOR $= (1 + K_1 K_2 K_3)^2$

2: $C_p = -0.9$ ROOF 0-84'
$= -0.5$ ROOF 84'-168'
$= -0.3$ ROOF 168'-240'

[FIGURE 6-2]

CONDITION = 2-D ESCARPMENT

$\frac{H}{L_h} = \frac{19.5'}{75'} = 0.26 \rightarrow K_1 = 0.22$

$\frac{x}{L_h} = \frac{0'}{75'} = 0 \rightarrow K_2 = 1.0$

$\frac{z}{L_h} = \frac{103.5'}{75'} = 1.38 \rightarrow K_3 = 0.034$

} DATA PROVIDED BY CIVIL ENG.

$K_{zt} = [1 + (0.22)(1.0)(0.034)]^2 = 1.015$

$q_z = 0.00256 K_z K_{zt} K_d V^2 I$

$= (0.00256)(1.22)(1.015)(0.85)(90 \text{ MPH})^2(1.0)$

$= 21.8$ psf. @ MEAN ROOF HEIGHT

SEE OTHER ATTACHED.

PENN STATE UNIVERSITY

CLASS: AE 431 W
DATE: 10-03-06
ASSIGNMENT: TECH REPORT #1
ORIGINAL WIND LOADING CONT'.
PAGE: ____ **of** ____

WIND LOADING – DESIGNED W/ SBC 1999 CONT'.

$P_{WINDWARD} = qGC_p - q_i(GC_{pi})$
$= (21.8\ psf)(0.85)(0.8) - 0$
$= 14.8\ psf$

} @ MEAN ROOF HEIGHT.

$P_{LEEWARD} = (21.8\ psf)(0.85)(-0.5) - 0$
$= -9.27\ psf$

$P_{TOTAL} = 14.8\ psf + 9.27\ psf$
$= 24.07\ psf$ (AT MEAN ROOF HEIGHT).

$F = (24.07\ psf)(240')(97') = 560\ k$

↖ APPROX. VALUE @ LARGEST FACE.

PENN STATE UNIVERSITY

CLASS: AE 431
DATE: 10-03-06
ASSIGNMENT: TECH REPORT #1
ORIGINAL SEISMIC DESIGN
PAGE: ____ of ____

SEISMIC LOADING – DESIGNED WITH SBC 1999.

[TABLE 1607.66]

EXPOSURE GROUP = I

[FIGURE 1607.1.5A]

$A_v = 0.15$

$A_a = 0.15$

[TABLE 1607.1.8]

PERFORMANCE CATEGORY = C

[TABLE 1607.3.1]

SITE COEFFICIENT, $S_3 = 1.5$

[TABLE 1607.3.3]

$R = 4\frac{1}{2}$ FOR MASONRY SHEAR WALLS ← USE CONSERVATIVELY.

$R = 3\frac{1}{4}$ FOR CONCENTRIC BRACED FRAMES DNC.

[SECTION 1607.4]

EQUIVALENT LATERAL FORCE PROCEDURE.

BUILDING PERIOD:

$T = C_T h_n^{3/4}$

$C_T = 0.02$ FOR SHEARWALLS

$h_n = 75.4'$

$T = (0.02)(75.4')^{3/4} = 0.51$

SEISMIC COEFFICIENT:

$C_s = \frac{1.2 A_v S}{R T^{2/3}} = \frac{(1.2)(0.15)(1.5)}{(4.5)(0.51)^{2/3}} = 0.094$ DNC.

$C_s < \frac{2.5 A_a}{R} = \frac{(2.5)(0.15)}{(4.5)} = 0.083$ ← CONTROLS.

BASE SHEAR:

$V = C_s W$

$= (0.083)(10{,}319\text{ k})$

$= 856.5\text{k}$

PENN STATE UNIVERSITY

CLASS: AE 481W
DATE: 10-03-06
ASSIGNMENT: TECH REPORT #1
ORIGINAL SEISMIC LOADING CONT.
PAGE: ____ of ____

SEISMIC LOADING – DESIGNED W/ SBC 1999 CONT'.

W = TOTAL LOAD OF BUILDING:

FLOOR = 65 psf

1ST FLOOR = (65 psf)(20886 sf) = 1358 k

2ND FLOOR = (65 psf)(18182 sf) = 1182 k

3RD FLOOR = (65 psf)(18182 sf) = 1182 k

4TH FLOOR = (65 psf)(16257 sf) = 1057 k

ROOF = 20 psf

ROOF = (20 psf)(24275 sf) = 486 k.

ESCALATORS = 30k EACH

TOTAL ESCALATOR LOAD = (6)(30k) = 180 k.

STAIRWELL = 100 psf

EACH FLOOR = (353 sf)(2)(100 psf) = [71k]

TOTAL STAIRWELL = (4)(71k) = 284k.

TIMBER FRAMING = 10 k EACH

TOTAL TIMBER LOAD = (8)(10k) = 80k.

FIREPLACE 150 pcf / 75 psf

1ST & 2ND FL = (150 pcf)(14.7')(5.3')(17.3') = 202k

= 202k

3RD & 4TH FL = (75 psf)(14.7'+5.3'+5.3')(17.3') = 33k

= 33k.

EXTERIOR WALLS = 10 psf

TOTAL EXT. WALL = (10 psf)(716')(69') = 494 k.

ELEVATOR = 100 psf

TOTAL ELEVATOR = (100 psf)~~(4)[illegible]~~ = 552k

(80')(69')

SEISMIC LOADING - DESIGNED W/ SBC 1999. CONT.

$C_{vx} = \frac{W_x h_x^k}{\Sigma_i w_i h_i^k}$

$k = 1$

$T = 0.51$

$h = 17.3'$

$\Sigma_i W_x = 10319\ k$

$\Sigma_i h_x = 69.2'$

$\Sigma_i W_x h_x = 714075\ 'k$

SEE SPREAD SHEET FOR DISTRIBUTION.