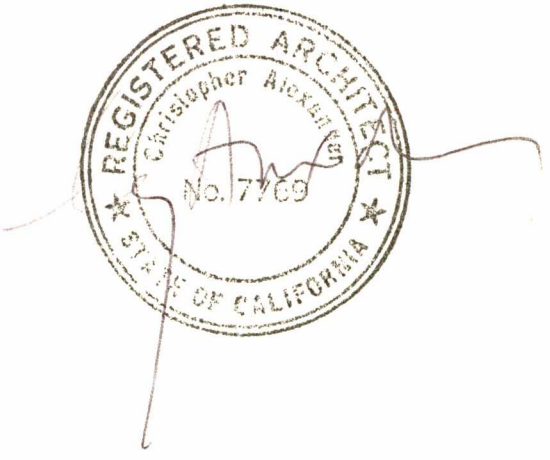
CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS
2701 SHASTA ROAD • BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

STRUCTURAL CALCULATIONS FOR

LIGHTY RESIDENCE

BERRYESSA ESTATES, NAPA COUNTY

November 15, 1981



1. Foundation analysis is based on soils report and inspections performed by Donald Herzog and Associates, Santa Rosa, California.
2. Foundation excavations have been inspected by the soils engineers.
3. Foundation analysis of major buildings has been done by Callarman Komendant, Consulting Engineers, and stamped and signed by Juri Komendant, Engineering License #31852.
4. All foundation installations must be inspected and approved by the consulting engineer.
5. Analysis of superstructure and outbuilding foundations is done by Center for Environmental Structure, Architects, signed by Christopher Alexander, architectural license #7769.
6. Computation of lateral loads used in shear wall calculations has been provided by Callarman Komendant.
7. Foundation concrete shall obtain a compressive strength of 2500 psi.
8. Laps in reinforcing steel shall be

#3	12"
#4	16"
#5	20"

as specified by UBC 1979.
9. The house is to be owner built, and the owner is therefore, as general contractor, responsible for seeing that all provisions of this engineering analysis and of the working drawings, are complied with as required, in the erection of the superstructure.

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

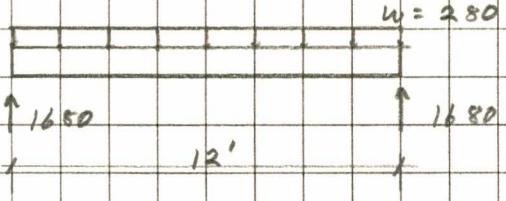
ROOF BEAMS

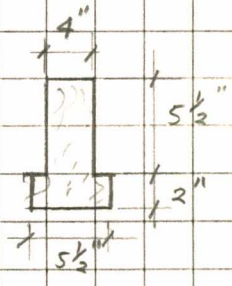
MAX. SPAN 12' IN KITCHEN
TRIB AREA = 7'

ROOF:

5/8" + 5/8" PLYWOOD x 3	=	3.75 Lbs
1/2" DRYWALL	=	2.00 Lbs
4 1/2" POLYSTYRENE	=	0.90 Lbs
FRAMING	=	3.00 Lbs
3/4" CONC	=	9.50 Lbs
W_D	=	19.5 Lbs
W_L	=	20.0 Lbs
W_T	=	40.0 Lbs

6"x8" BEAM = 7' x 40 = 280 Lb/ft





M_{MAX} = 5040 ft-Lb
V_{MAX} = 1680 Lb
I = 160 in⁴

NO. 1 & BETTER

f_B	=	1512 Psi	< 1550
f_V	=	61 Psi	< 85
Δ_L	=	0.51 in	< 0.60

OK ✓

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

4"x6" BEAM

MAX. SPAN = 7½'
TRIB AREA = 2¼'

$w = 2\frac{1}{4} \times 40 = 90$ Lb/ft.

$M_{max} = 633$ ft-Lb
$V_{max} = 338$ Lb
$I = 48$ in^4

$f_B = 435$ Psi
$f_v = 26$ Psi
$\Delta_L = 0.10$ in

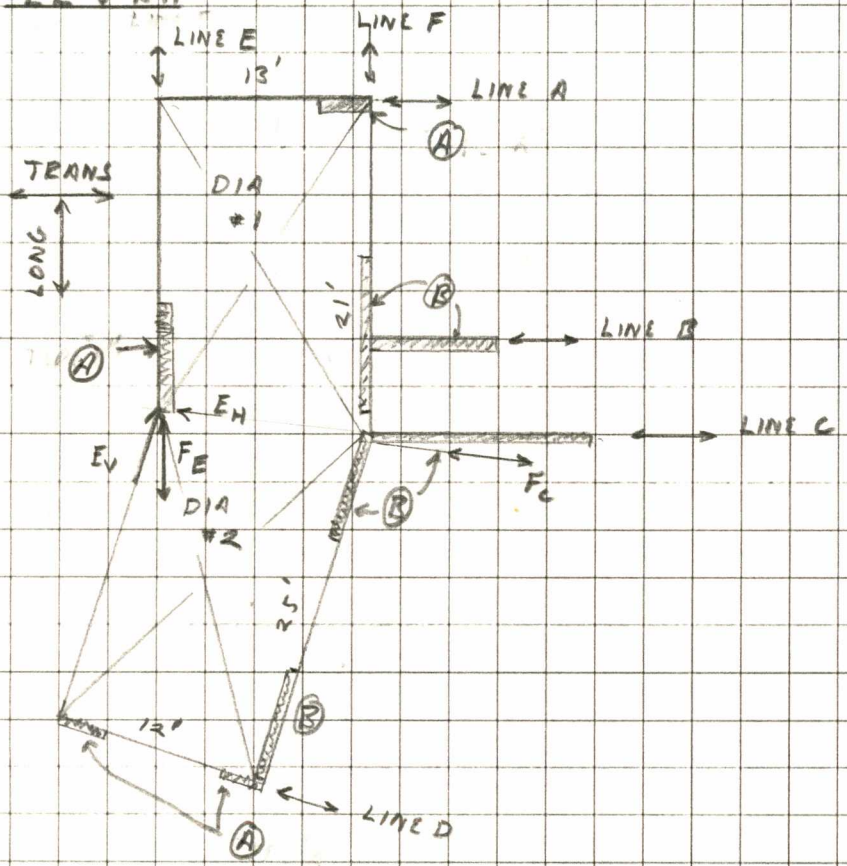
OK ←

6"x8" BEAMS SHOULD BE #1 DENSE & BETTER
4"x6" BEAMS CONSTRUCTION GRADE OR BETTER

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

LATERAL DESIGN (COMPUTER OUTPUT SUPPLIED BY CALLARMAN-KOMENDANT)

LR & KIT



DIA #1 $\frac{21}{13}$ = 1.62

DIA #2 $\frac{25}{12}$ = 2.08

TOTAL $\frac{(21+25)}{12}$ = 3.83 < 4 OK

SEISMIC GOVERNS BOTH DIRECTIONS

	V
LINE A	2.22 K
LINE B	2.15 K
LINE C	$F_C + E_H = 2.05 + .76 = 2.8$ $C_H = 2.8 (\cos 10)^{-1} = 2.84$ K
LINE D	2.17 K
LINE E	$F_E = 2.2 + 2.13 (\cos 10)^{-1} = 4.36$ K $E_V = 2.13$ K $E_H = .76$ K

LINE F 2.2

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS
2701 SHASTA ROAD • BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

LATERAL ANALYSIS OF DIAPHRAGMS

$w = [29(13) + 2(250)]0.186 = 163 \text{ Lb/ft}$

DIA #1 $\quad C = T = \frac{wl^2}{8(13)} = \frac{163(21)^2}{8(13)} = 0.69^K$

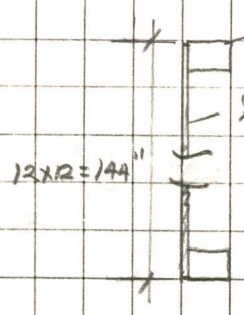
DIA #2 $\quad C = T = \frac{163(25)^2}{8(12)} \times \frac{12}{13} = 0.98^K$

DIA #1 & DIA #2 ACTING TOGETHER

$C = T = \frac{163(46)^2}{8(12)} = 3.57^K$

USE SIMPSON #2 AT BEAM SPLICES

MAX. SHEAR FLOW



$I = 155,520 + 497,664 = 653,000 \text{ in}^4$

$Q = 3456 \text{ in}^3$

$q = \frac{VQ}{I} = \frac{(3749)(3456)}{653,000} \times 12 = 2404 \text{ lb/ft}$

FROM SHEAR WALL ANALYSIS

$\text{LINE D} = \frac{2.17^K}{12'} = 181 \text{ Lb/ft.}$

SO, USE 8d @ 6" OC

LATERAL ANALYSIS *** SEISMIC V= .186 W
W= 29 PSF

DIRECTION: KITCHEN - TRANS. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
-6	0	13
20	13	13
21	1	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
A @ 0	3	175.5	2.22
B @ 15	3	169.5	2.15
	TOTAL	345	4.37

LATERAL ANALYSIS FOR WIND WIND PRESSURE = 20 PSF

DIRECTION: KITCHEN - TRANS. LEVEL: ROOF

ELEVATION PROFILE FOR WIND

REF. COORD.	HEIGHT LEFT	HEIGHT RIGHT
-6	0	5
20	5	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
A @ 0	3	67.5	1.35
B @ 15	3	62.5	1.25
	TOTAL	130	2.6

LATERAL ANALYSIS *** SEISMIC V= .100 W
W= 27 PSF

DIRECTION: KITCHEN - LONG. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	26
13	27	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
E @ 0	5.5	170.6	1.16
F @ 13	8	172.9	1.2
	TOTAL	343.5	1.36

LATERAL ANALYSIS *** SEISMIC V= .100 W
W= 27 PSF

DIRECTION: L.R. - LONG. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	12
2.5	12	5
10	7	7
15	9	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
C @ 0	2	152	2.05
D @ 12	1	171.3	2.17
	TOTAL	323.3	4.22

LATERAL ANALYSIS *** SEISMIC V= .166 W
W= 29 PSF

DIRECTION: L.R. - LONG. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	25
2.5	28	28
4	29	29
8	29	29
9.5	28	28
12	26	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
E @ 0	5.5	167	2.11
F @ 12	10	168.3	2.13
	TOTAL	335.3	4.24

LATERAL ANALYSIS *** SEISMIC V= .106 W
R= 29 PSF

DIRECTION: STUDIO-TRANS LEVEL: ROOF

AVERAGE WALL HEIGHT = 9 FT AT 30 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	16.5
23	16.5	16
27	16	16
29	14	6
31	6	0

LINE		WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
A	@ 0	6	216.5	1.03
B	@ 22	5	170	2.31
C	@ 28	6	38	1.41
	TOTAL	[illegible]	[illegible]	[illegible]

LATERAL ANALYSIS *** SEISMIC V= .106 W
R= 29 PSF

DIRECTION: STUDIO-LONG. LEVEL: ROOF

AVERAGE WALL HEIGHT = 9 FT AT 30 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	29
2	29	31
8	31	29
13.5	29	7
16	7	7
18	1	0

LINE		WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
D	@ 0	9	205.3	2.6
E	@ 13.5	8	223.8	2.83
	TOTAL		429.1	5.43

LATERAL ANALYSIS *** SEISMIC V= .186 W
W= 29 PSF

DIRECTION: LIB - TRANS. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	11
10	11	8
15	8	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
A @ 0	4	55	.7
B @ 10	6.5	95	1.2
	TOTAL	150	1.9

LATERAL ANALYSIS *** SEISMIC V= .186 W
W= 29 PSF

DIRECTION: LIB. - LONG. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	15
8	15	10
11	10	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
E @ 0	11	60	.76
F @ 8	10	90	1.14
	TOTAL	150	1.9

LATERAL ANALYSIS *** SEISMIC V= .186 W
W= 29 PSF

DIRECTION: BDRM - TRANS. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
-9	0	8
0	8	12
10	12	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
C @ 0	4	132	1.67
D @ 10	8	60	.76
	TOTAL	192	2.43

LATERAL ANALYSIS *** SEISMIC V= .186 W
W= 29 PSF

DIRECTION: BDRM - LONG. LEVEL: ROOF

AVERAGE WALL HEIGHT = 5 FT AT 50 PSF

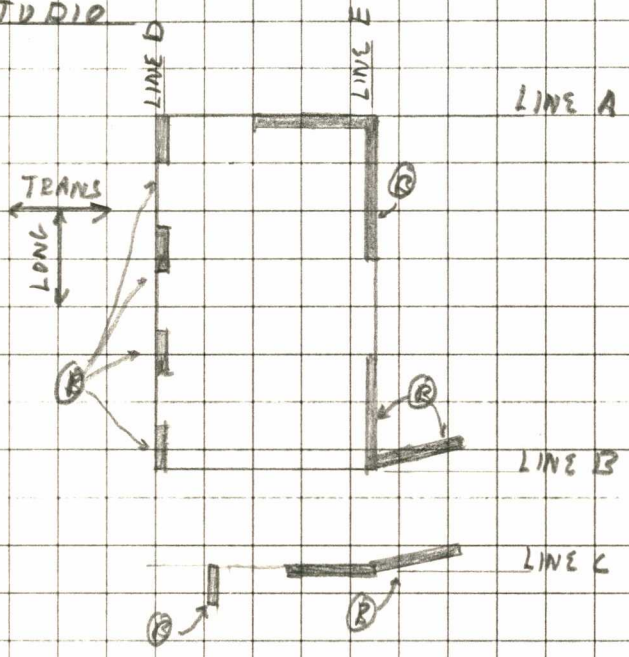
AREA PROFILE FOR SEISMIC

REF. COORD.	AREA LEFT	AREA RIGHT
0	0	10
12	10	0

LINE	WALL LENGTH (FT)	TRIB. AREA (SQ.FT)	SHEAR FORCE (KIPS)
E @ 0	4	60	.76
F @ 12	5	60	.76
	TOTAL	120	1.52

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS
2701 SHASTA ROAD • BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

LATERAL DESIGN STUDIO

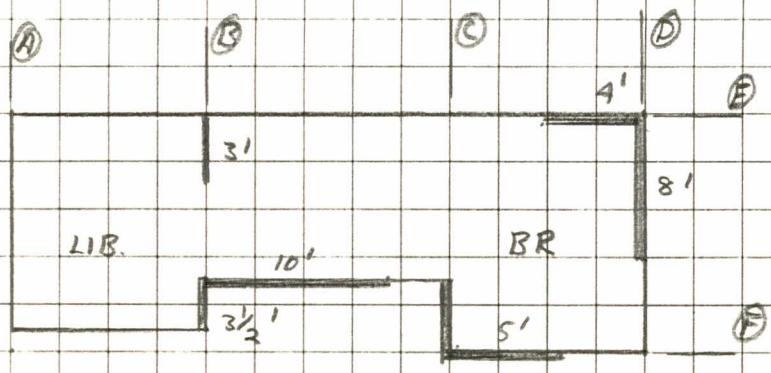


	V
LINE A	1.88
LINE B	2.51
LINE C	1.01
LINE D	2.60
LINE E	2.83

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

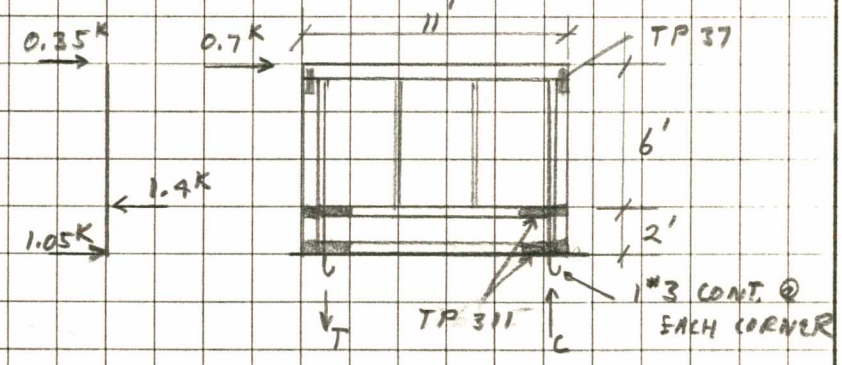
LATERAL DESIGN
LIB. & BR

ALL SHEAR WALLS ARE TYPE "B"



		V
LINE	A	0.7
LINE	B	1.2
LINE	C	1.67
LINE	D	0.76
LINE	E	0.76
LINE	F	1.14

LINE A (FRAME)



$C = T = \frac{0.7 \times 8}{11} = 510$ LBS

6×6 POST

$M_{max} = 2.10$ K-ft

$f_B = 910$ PSI

$f_V = 52$ PSI

$\Delta_T = 0.36$

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

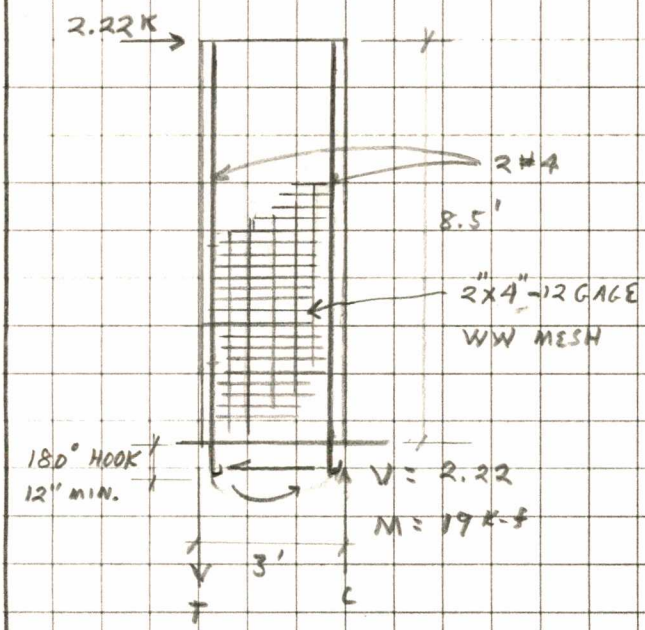
SHEAR WALLS - TYPE "A"

$f'_c = 2500$ psi
$2\sqrt{f'_c} = 110$ psi

EFFECTIVE WALL THICKNESS = $1\frac{3}{4}$"

$$v_u = \frac{V_u}{\phi h d} = \frac{V_u}{(0.85)(1.75)(.8 l_w)} = \frac{0.84\, V_u}{l_w}$$

KITCHEN	l_w	V_u	v_u	$\frac{A_s}{(v_u - 110)(1.75)(12) = 0}$
LINE A	36"	3.77	88	60,000



SO, USE MIN CODE REQ.

$P_h = 0.0020(1.75)(12) = 0.042$"/ft

$P_v = 0.0012(1.75)(12) = 0.025$"/ft

12 GAGE 2"x4" WW MESH
PROVIDES 0.054"/ft & 0.027"/ft

NOTE: IF UNAVAILABLE SUBSTITUTE
14 GAGE 1"x2" WWW MESH

OVERTURNING

$T = C = \frac{19}{3} = 6.33^K$

$A_s = \frac{6.33}{(0.6)(40)} = 0.26$

SO, USE 2#4 EACH SIDE

SHEAR TRANSFER @ BASE

$A_{vf} = \frac{V_u}{\phi f_y \mu} = \frac{3.77}{(0.85)(40)(1)} = 0.11\ in^2$

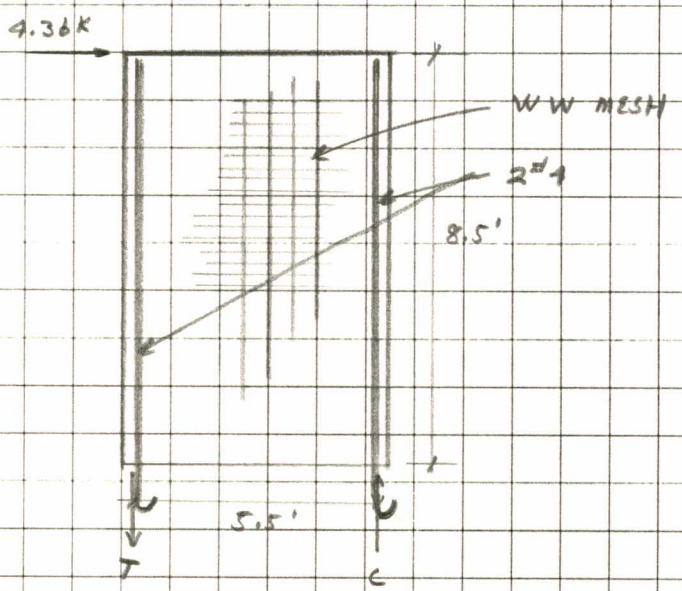
4#4 ARE OK ✓

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS
2701 SHASTA ROAD • BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

SHEAR WALLS - TYPE "A"

KITCHEN	l_w	V_w	V_u	M_u
LINE E	66	7.41	94	$\frac{(94-110)(1.75)(12)}{60,000} = 0$

12 GAGE 2"×4" WW MESH OK ✓



OVERTURNING

$$T = C = \frac{4.36(8.5)}{5.5} = 6.75^K$$

$$A_s = \frac{6.75}{(0.6)(40)} = 0.28$$

SO, 2#4 OK ✓

SHEAR TRANSFER @ BASE

$$A_{vf} = \frac{V_u}{\phi f_y \mu} = \frac{7.41}{(0.85)(40)(1)} = 0.22\,in^2$$

4#4 ARE OK ✓

BUCKLING OF THIN WALL

$$P_c = \frac{\pi^2 EI}{(k l_w)^2}$$

$$EI = \frac{\frac{E_c I_g}{2.5}}{1 + \beta_d} = \frac{(57000\sqrt{2500})(1.75)^3}{2.5}$$

$$= 6.11 \times 10^6$$

$$P_c = \frac{\pi^2 (6.11 \times 10^6)}{(0.75 \times 102)^2} = 10.3^K \quad \text{OK} \checkmark$$

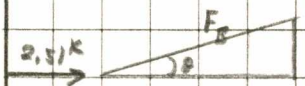
CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS
2701 SHASTA ROAD • BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

SHEAR WALLS - TYPE "B"

STUDIO

	l_w	V_w	v_w	A_v
LINE B	60"	4.54	64	$\frac{(64-110)(1.75)(12)}{60,000} = 0$

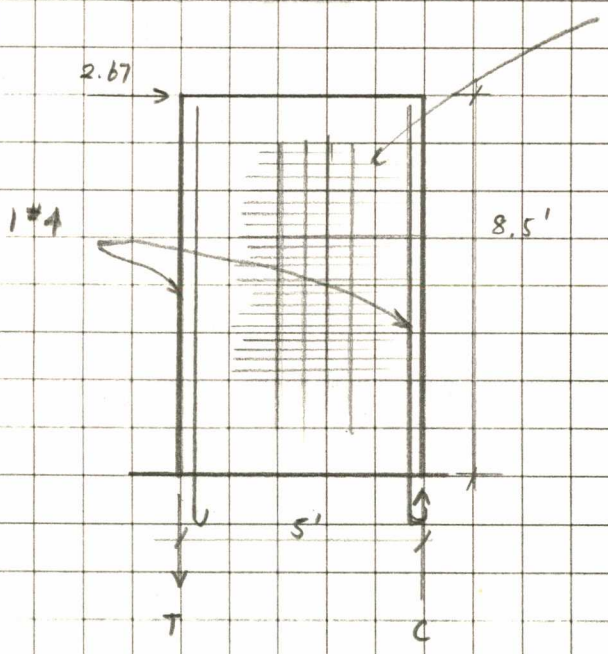
USE WW MESH AS IN TYPE "A" WALLS



$\theta = 20°$

$F_B = \frac{2.51}{\cos 20°} = 2.67^K$

OVERTURNING



$T = C = \frac{2.67 \times 8.5}{5} = 4.54$

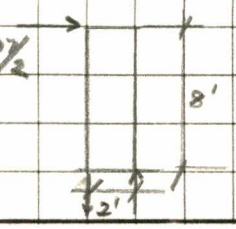
$A_s = \frac{4.54}{0.6(40)} = 0.19$

SO, USE 1#4 EACH SIDE

LIVING ROOM

	l_w	V_w	v_w	A_v
LINE D	(2x24")	3.69	65	$\frac{(65-110)(1.75)(12)}{60,000}$

WW MESH OK

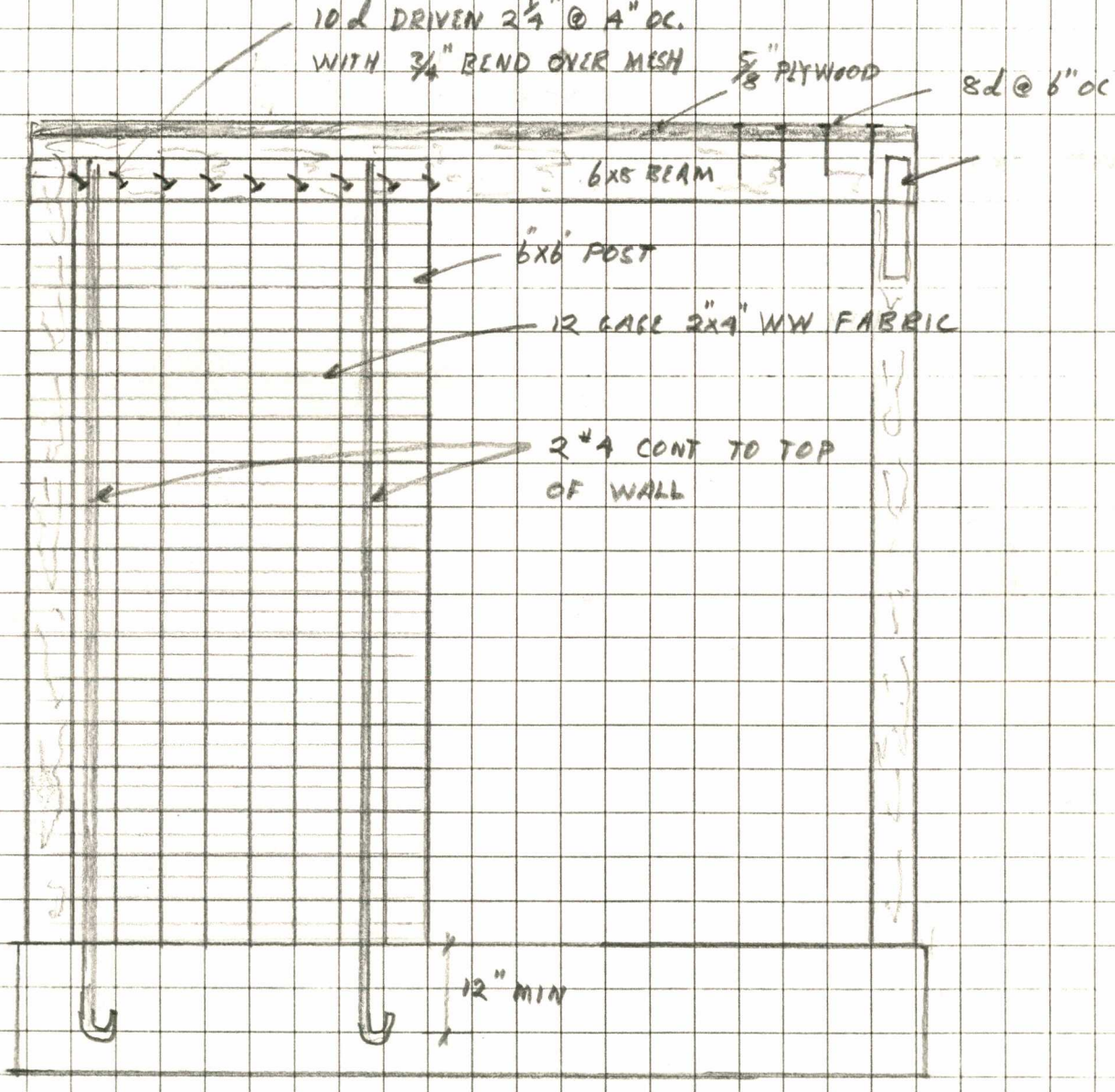


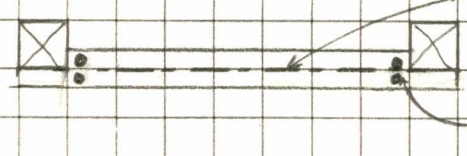
$T = C = \frac{1.09 \times 8}{2} = 4.34^K$

1#4 OK

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS
2701 SHASTA ROAD • BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

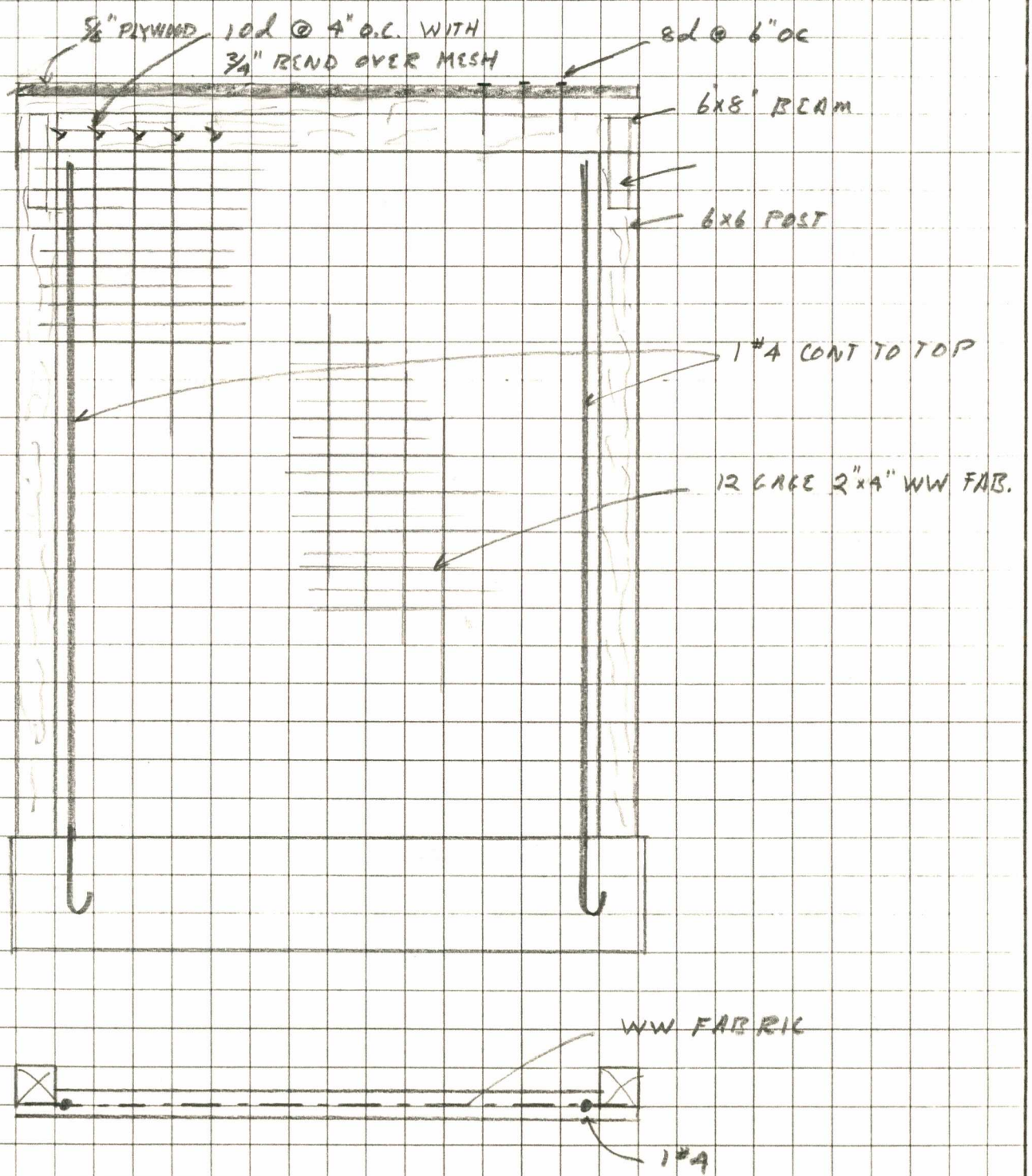
TYPICAL TYPE "A" SHEAR WALL





CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

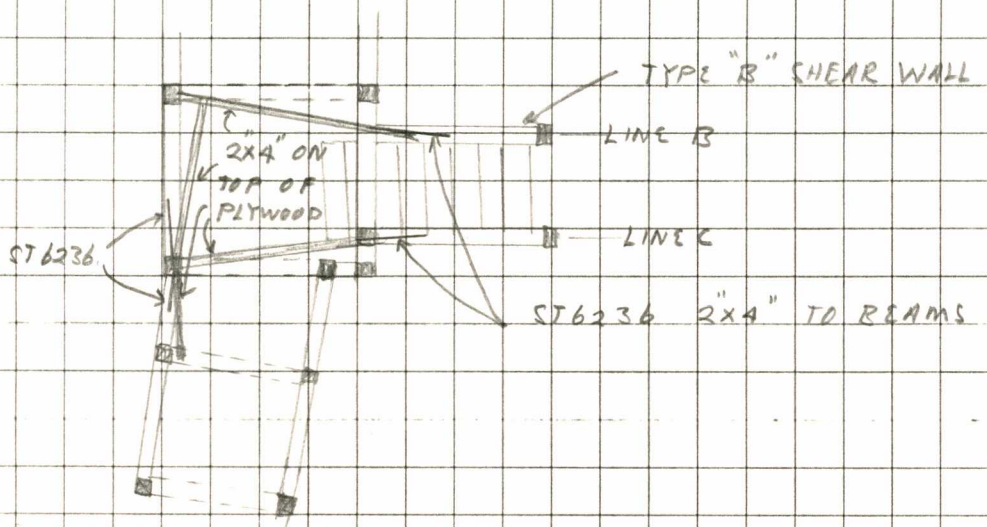
TYPICAL TYPE "B" SHEAR WALL



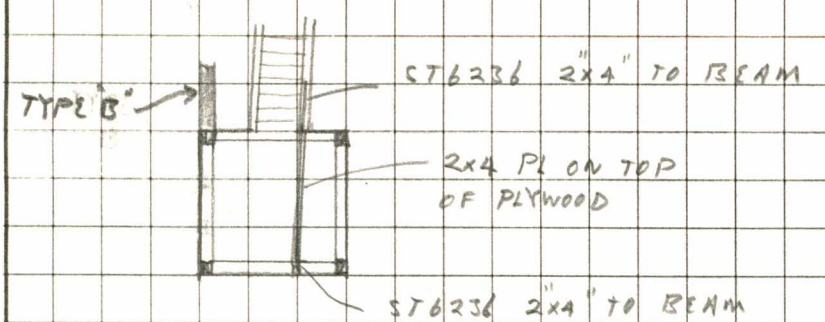
CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

SHEAR WALL CROSS TIES

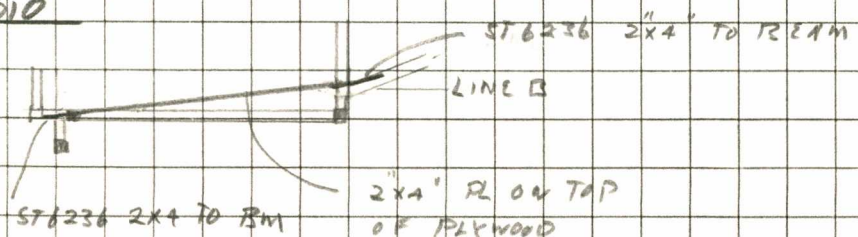
KITCHEN



LIBRARY



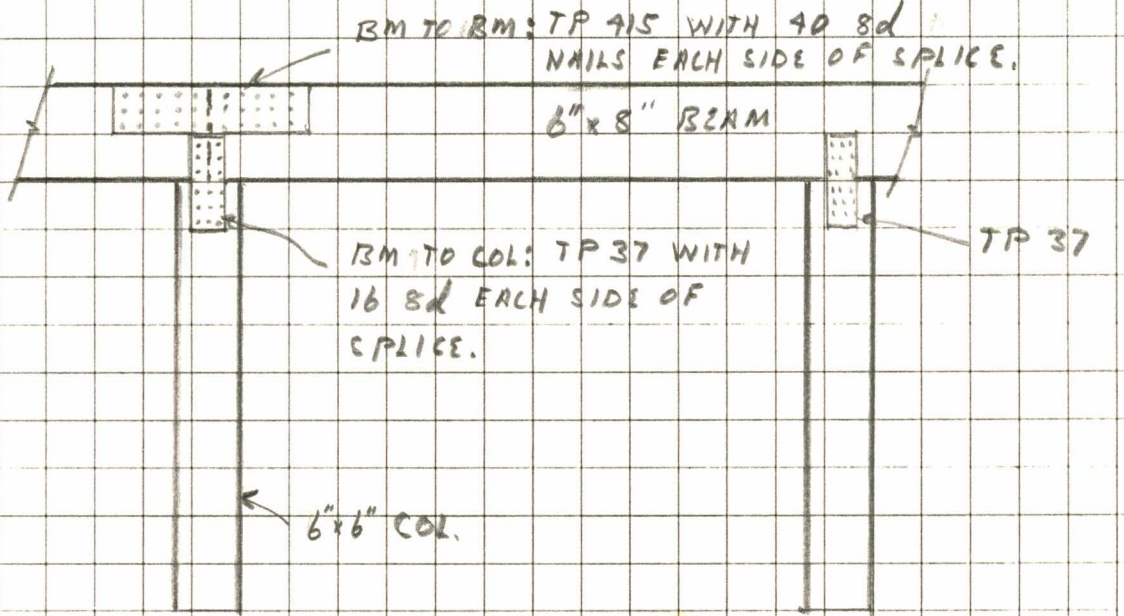
STUDIO



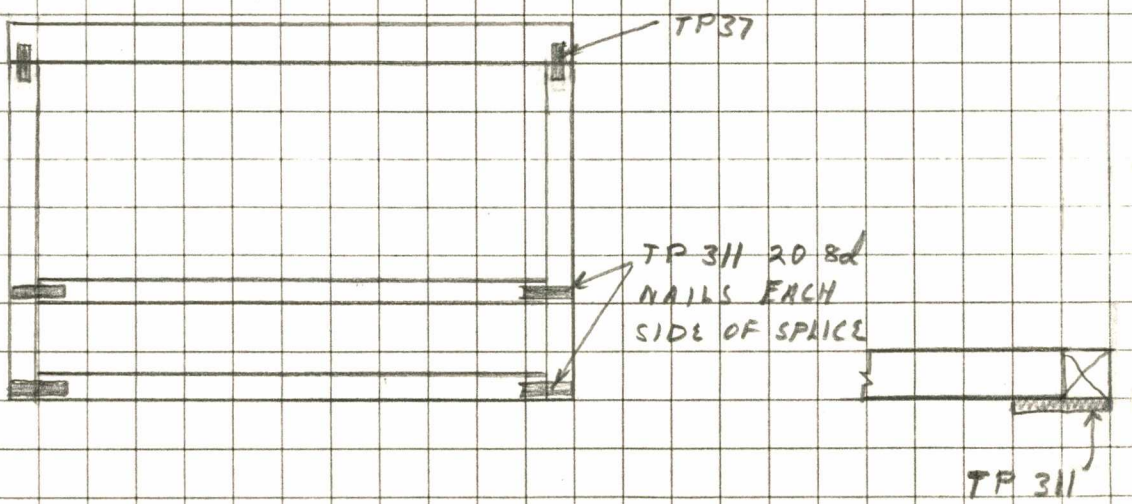
CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

SIMPSON CONNECTORS

BEAM SPLICE & BEAM-COLUMN



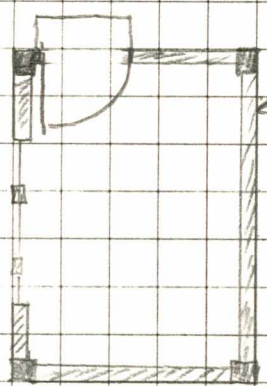
LIBRARY FRAME



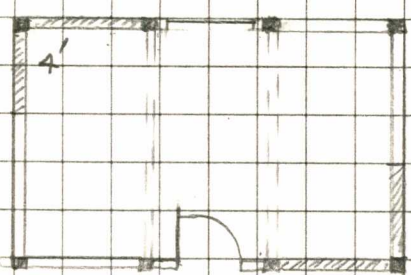
CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS
2701 SHASTA ROAD • BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

OUTBUILDING SHEAR WALLS

TOWER



WORKSHOP



3/8" PLYWOOD SHEAR WALLS
10d @ 6 OC EDGES.

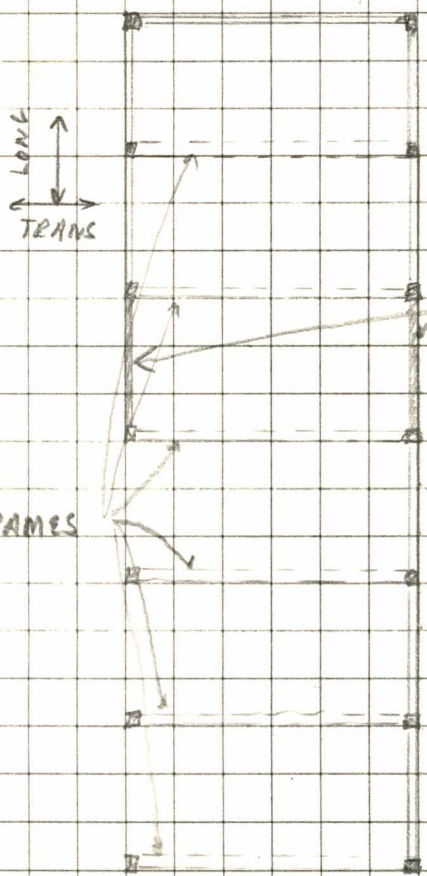
WIND GOVERNS 20 PSF

$$\frac{V}{ft} = \frac{20[16 \times 8]}{8} = 320 \text{ LB/ft.}$$

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS · CONTRACTORS
2701 SHASTA ROAD · BERKELEY, CALIFORNIA 94708
TELEPHONE 415/841-6166

OUTBUILDING SHEAR WALLS

CARPORT



LONG (15 x 12 x 40) .186 = 1339

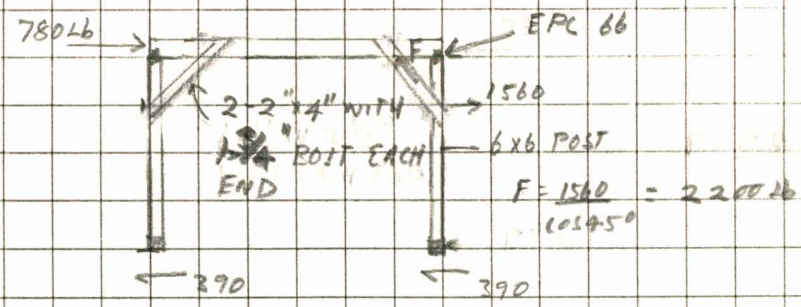
$V/ft = \frac{1339/2}{6.5} = 103\ Lb/ft.$

USE 3/8" PLYWOOD, 8d NAILS @ 6" O.C.

TRANS

WIND = 20 PSF

LOAD/FRAME = 20 x 6 x 6.5 = 780 Lb



$F = \frac{1560}{\cos 45°} = 2200\ Lb$