<u>CENTER FOR ENVIRONMENTAL STRUCTURE</u>

CONSTRUCTION OPERATIONS MANUAL

MARTINEZ EXPERIMENTAL HOUSE

Operations Manual

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OPERATIONS SEQUENCE

The following pages outline the sequence of building operations which were followed on the first experimental structures using the gunnite techniques developed by the Center for Environmental Structure.

There were approximately 20 steps or operations on the small workshop (230 sq.ft.). The house (1196 sq.ft.) had approximately 40 operations. Each step or operation consisted of a number of subsets or substeps. For each operation, we have tried to provide a cost estimate in terms of both labor and materials. The total cost for each identifiable part of the building is provided at the bottom of the columns.

In every possible case, we have tried to list the time and materials that would be utilized during actual production, allowing a factor for the experimental delays which were often encountered as a natural part of the development of the techniques. Where we did not know how much time and material might be saved during actual production, we have listed the actual time the operation or substep took during the building of the first experimental structures.

OPERATIONS SEQUENCE (230 sq.ft. Workshop, Martinez, California)

1. Slab
2. Columns
3. Beams/Cornice
4. Scaffolding
5. Vault
6. Triangle/Gable
7. Roof
8. Low walls with sills
9. Rear wall
10. Front wall with jamb columns
11. Roof waterproofing (xypex)
12. Wall waterproofing (xypex)
13. Exterior painting
14. Doors and windows
15. Interior painting
16. Electrical
17. Ballustrade and garden seat
18. Trenching and drain pipes
19. Site earthwork/finish grading

* FROM LS1: 4" slabs on grade w/4" caprock mesh. 2" sand
6x6/10x10 mesh (1.42 SF) x 230 ⁰' = 328.00

col. steel $

SLAB *

I.

	Mat.	Labor	pos Labor
~~1. Design slab form.~~			
1. ~~2~~. Dig trenches and flat areas. (Backhoe)	~~15~~ 20.00 (would be 60)		
~~3~~. Cut lumber.			
2. ~~4~~. Erect ~~and~~ square and level wood forms.	20.00	1/2	1/2
3 5. Lay vapor barrier. (visqueen @ .10/⁰')	23.00	1/4	1/4
4 6. Lay gravel bed. & compacting		1	1
5. ~~7~~. Cut steel reinforcing bars.	#4s		
8. Place and tie perrimeter/column steel.	19.23 9.61		
9. Cut, place, and tie w.w. mesh.		1 1/2	1 1/2
10. Cut and place electrical ground rod.			
11. Apply form release to wood form.	mesh 27.60		
place steel for cols. as you shoot			
12. Shoot gunnite.		4	2
13. Float and finish concrete surface.	ST 56.44 (steel)		
14. Cure concrete.	4.5 YDS. conc. 230.00		5 1/4
* 15. Strip forms.		7 1/4	
16. Patch damage/brush concrete surface.	349.00		472.50

vertical steel 3 #4 bars.
noting #4 (1). 6x6 10x10 mesh .12/⁰'

$821.94

* this step follows the completion of several other operations.

$13.57/⁰'

4'x7' = 28□'

WORKSHOP

FRONT PORCH SLAB

	M.	Labor	Pos Lab.
1. Design porch.		1/2⁰	
2. Design slab forms.		1 hr.	
3. Excavate area.		1 hr.	
4. Cut lumber.	4.00	} 2 hrs.	
5. Assemble, square, level, and brace forms in place.		}	
6. Lay gravel bed.	4.00	} 3/4 hr.	
7. Cut and lay w.w. mesh.	4.00	}	
8. Apply form release.			
9. ~~Shoot gunnite~~. pour concrete (dry mix watered)	18.00	1 hr.	
10. Float slab.		1 hr.	
11. Cure concrete.			
12. Pull forms.	30.00	112.50	
13. Patch damage.			

143.00

5.10/□'

COLUMNS

II.

	LABOR	MAT.	POS LABOR
1. Design box forms.	4		4
2. Cut lumber. 3. Assemble forms.	9	85	6
4. Erect forms and square with beam braces and ground braces. 5. Assemble steel bar clusters. 6. Insert steel and tie to slab steel. 7. Apply form release.	8	45	6
8. Shoot gunnite in form channels. 9. Cut excess at open face with trowels. 10. Clean excess material from ground.	9	112	2
11. Cure concrete.	—		
* 12. Strip forms.	1		1
* 13. Patch damage.	3	15	1
	34	257	20
		257	1800

Labor 20 @ 90 = 1800
mat. = 257
2057.00

* this step may follow the completion of several other operations.

$205.00 / COLUMN

$2057.00

$8.94/□'

SCAFFOLDING

IV.

		mat.	LABOR
1.	Design scaffolding.		2
2.	Order pieces.	Rental 205.82	1/4
3.	Pick-up and deliver material to site.		1/2
4.	Excavate for pads where necessary.		1 1/2
5.	Erect scaffolding footings/pads.		
6.	Erect scaffolding vertical racks and cross braces.		3
7.	Lay floor boards across racks.		
8.	Erect handrails.		
9.	Lift bridge into position.		
10.	Erect bridge handrails.		
10a.	build bridge boxes	Scrap	
11.	Remove all scaffolding.		2
12.	Load and deliver material back to rental agency.		1
		206.00	10 1/4

10.25 @ 90.00

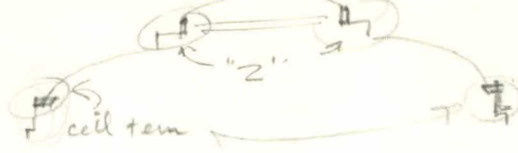
922.50

mat. 206.
lab 923

$1129.00

$1129.00

4.90/'



CEILING VAULT

V.

	M	Labor	Pos. Labor
1. Design vault and forms.			
2. Cut lumber for cage.	54.00	1	
3. Erect cage and square by bracing against beams and column forms.		1 3/4	
4. Cut lumber for finish forms.		1 1/2	
5. Assemble "Z" sections.	20.00		
6. Assemble inside ceiling terminus.*	(11.00)*	3/4	
7. Erect "Z" sections on cage with cross braces. Erect ceiling terminus and brace		1 3/4	
8. Cut masonite (pressboard).	80.00 ~~27.00~~		
9. Wet masonite.		1/2	
10. Attach masonite to vault form sections.		2	
11. Tape masonite joints.	consumable		
12. Apply form release.	"	1/2	
13. Shoot first layer of gunnite on vault.	(see next page)	2	
14. Allow initial set-up time of a few days.			
	$154.00	11.75 hrs	
SUB TOTAL	11.00 / 114.00	$1057.00	
	$1160.00		

continued... next page

* ceiling terminus already figured into cornice beam

NEXT PAGE →

TOTALS FROM PREVIOUS PAGE → 103.00 | 1057.00

CEILING VAULT continued: # V.

Step	M	Labor	Pos. Labor
15. Cut and shape (curve of vault) steel rods for ribs.	12.00	1/2	
16. Place rods, adjust shape, and wire to column/beam steel.		3/4	
17. Cut and shape pencil rods for "Z" collar.	27.00	1/2	
18. Place collar and tie to rib steel.			
19. Cut w.w. mesh (2X2's) in strips to size.	32.00	3/4	
20. Lay out mesh and tie to rib steel.			
21. Shoot second layer of gunnite over ceiling vault. + 1st layer	ST 71.00 37.00 18.00 (50% waste)	2	
22. Cure concrete.	–	–	
* 23. Pull vault forms and cage.	–	4 *	540.00
* 24. Patch damage.		2 *	
	11.5	10.5	
Sub total	120	945.00	

* these steps will follow the completion of other operations.

TOTAL $ ~~229.00~~ 280 $ 2002.00

22 1/4 @ 90.00 = P. DAYS

$ 2281.00

DOESN'T ACCOUNT FOR 15% SAVINGS OF USED LUMBER

* if these steps are removed (and put altogether in a new "form stripping" operation) the total is $ 1691.00 [illegible] 7.35/□'

TRIANGLE & GABLE END (first and second coat) # VI.

* person day @ 90.00/DAY

Step	Mat	Labor*	Pos. Labor
1. Design gable end form work.	-	1 day (9 hrs)	
2. Cut masonite (pressboard) and lumber.	m 11.00 L 6.00		
3. Wet masonite.		3 hrs.	
4. Attach masonite between ceiling form and inside cornice at ends.			
5. Tape masonite.	consum.		
6. Cut and lay w.w. mesh and wire to ceiling steel.	5.00	1 hr.	
7. Apply form release.	-		
8. Shoot first layer of gunnite.	*	6 hrs. (2 people @ 3 ea.)	
9. Assemble triangle sections.		1 1/2 hrs.	
10. Anchor lower edges of tri. sections to cornice form and upper apex to roof form with tie wire.			
11. Cut and place triangle rib steel and anchor to column steel.	COSTED w/ CEILING # 5	1 hr.	
12. Apply form release.			
13. Shoot gunnite second layer between legs of triangle form, and first layer inside channel of tri. form.	10.00 5.00	6 hrs (2 people @ 3)	

TOTAL TOGETHER

50% waste

3 days

37.00 $280.00

317 + 100 PATCH = 417.00

$1.81/0'

patching 100.

Planned to make this much more efficient. It's been done now.

Perhaps 1 shoot over 2

ROOF & RIBS (first and second coats) # VII.

	Mat.	Labor	Pos. Labor
1. Design roof form.		13½ hrs (2 @ 7 hrs)	
~~2. Cut steel rods.~~			
3. Cut styrofoam sheets to fit between rib steel.	103.00 (items 3–7)	2 hrs (items 3–4)	
4. Drill 3" hole (o.c. each way) in the styrofoam.			
5. Cut styrofoam ridge form and assemble.		1 hr.	
6. Attach ridge form to vault top.		1 hr	
7. Attach large sheets of styrofoam between ridge form and cornice.		1½ hr	
8. Cut pencil rods.	~~107.~~ 10.70 (items 8–10)	2 persons @ 2 hrs 4 hrs (items 8–10)	
9. Place pencil rods over sty. sheets at 2' o.c. and tie to rib steel.			
10. Place pencil rods in ridge section.			
11. Cut and place w.w. mesh over roof surface form and wire to rods. & rib mesh	39.00	3½ hrs.	
12. Cut/anchor weep tubes and place under the sty. sheets and plug with tape.	4.00	2 hrs.	
13. Place hose and walk through a mock gunnite shooting.	—	1 hr.	
SUBTOTALS	$ ~~253.00~~ 156.00	$ 295.00	NEXT PAGE →

ROOF continued: # VII.

PREVIOUS PAGE SUBTOTAL 253 m 295 lab

14. Shoot first layer of gunnite on sty. sheets, in holes, and between sheets to form ribs. 45.00 2 days

*****second coat*****

15. Set guide wire between triangles at each gable end (for ridge line). 1 hr.

~~16. Attach screed guide boards to bridge.~~

~~17. Lay guide planks between guide boards and eave form to form shooting guide.~~

18. Shoot gunnite top coat on first coat. 19.00

19. rough Screed concrete. 1 1/4

20. Fill-in with gunnite where necessary. 2.00

21. Cure concrete.

* 22. Remove guide wires and form boards.

23. Patch damage (low spots).

82.00 30 hrs.

82.00 + 156 = 238.00 300.00 + 295 = 595.00

$ 930.00

$ 4.04/□'

* this operation may not begin until several other steps have been completed.

LOW WALLS AND SILLS # VIII.

	mat.	labor
1. Design forms.		1 1/2 days
2. Cut masonite (pressboard) and lumber.	mas. 46.00 lum. 31.00	1 hrs.
3. Assemble sill boxes.		2 hrs.
4. Attach sill boxes on temporary brackets at columns, and brace to cage.		1 1/2 hr.
5. Place toe boards inside and outside and brace in place.		1 1/2 hr.
6. Attach masonite to sill box and toe form.	staples (consumable)	2 hr.
7. Cut welded wire mesh and wire between sill box steel and steel rods between columns.	9.00	2 1/2 hr.
8. Apply form release.		2 days (items 8–12)
9. Shoot gunnite against face form and sill box.	YDS. .64 .32 .96	
10. Fill sill box with whatever excess material is available on ground.	reduced 50% 45.00	
11. Place sill guide board between columns against jambs (spray form release).		
12. Fill sill with gunnite.		
13. Cut wall face with trowel and trowel sill against guide.		4 1/2 days.
		42 hrs.
	131.00 (30)	420.00 (70)

$3.26/0'

patching 2 days @ 100.00 (mat + lab.)

551.00 + 200.00 = 751.00

14. Fill-in where necessary.

15. Cure concrete.

16. Pull forms.

17. Patch damage.

REAR WALL # IX.

	M	L
1. Design forms.		1/2
2. Cut lumber.	15.00	
3. Assemble form support wall.		1
4. Raise support wall and brace to ceiling form cage.		
5. Cut masonite (pressboard).		
6. Wet masonite.	17.25	1
7. Attach masonite to support wall.		
8. Attach electrical boxes and conduit.	* 20.00	1
9. Spray form release.		
10. Cut and wire w.w. mesh to steel rods.	10.00	1/2
10a. Paint bond cement against old concrete.		
11. Shoot gunnite.		
12. Fill-in where necessary.		1 2/3
13. Rough trowel surface.	.64 c.y. .32 .98	
14. Cure concrete.	45.	–
15. Pull forms.		–
16. Patch damage.		5 2/3 days
	198.00	509.40

~~$617.00~~

damage 80.00
617.00
697.00

* 2 BOXES
10' CONDUIT
3/4" CONDUIT
NAILS.

Really think X and XI should be the same operation combined

FRONT WALL

X.

	m	l
1. Design forms.	7.00	1/2 D
2. Cut lumber.	11.50	1/3 D
3. Drill holes ~~for steel rods in beam~~ in beam & slabs for vertical steel rods.	7.00 (3–4)	1/3 D (3–4)
4. Cut, place, and grout-in rods.		
5. Cut and tie w.w. mesh to rods.	5.00	1 hr.
6. Assemble wall frame support.		4 hr. (6–8)
7. Cut masonite (pressboard).	masonite → 12.00	
8. Wet masonite.		
9. Attach masonite to frame support.		
10. Spray form release.		
11. Cut material and assemble blockout panel and spray with form release.		1/2 hr.
12. Apply bond cement to old concrete.		6 hrs (12–15)
13. Shoot gunnite first layer.	.27 .13 .40	
14. Place blockout panel and brace to ground. *	18.00	
15. Shoot gunnite second layer (around blockout panel).		
subtotal	48.50	21.9 hrs 30 $300.00

(14–15: combined cost)

NEXT PAGE →

*DOES NOT INCLUDE TIME SPENT w/ FAULTY BASE BOARD & TOO WET A MIX. - REBOUND ETC.

FRONT WALL continued:

Sub total from previous page

48.00 # X. $ 300.00

M	L.
48.	315.00

16. Cut away excess material around the blockout panel.

17. Pull panel off surface.

18. Fill-in where necessary and cut the excess/trim edges with trowel.

19. Cure concrete.

20. Pull forms.

21. Patch damage.

1 1/2 hrs

363.00

(operation XI)

+ 100.00

463.00

operation X + XI

	mat.	labor
X	48	315
XI	50	50
	98	365
	20.	230
	118	595

COMBINED M & L TOTALS

713.00

463.00
250.00 patching damage
713.00

$3.10/□'

JAMB COLUMNS

\# XI.

	Mat.	Labor
1. Design forms.		
2. Cut lumber.	35.50	
3. Drill holes in beam and slab for column steel.	OCCURED W/ STEP X - ∴ ALREADY FIGURED.	
4. Cut, place, and grout-in steel rods.		
5. Cut and tie w.w. mesh to col. steel.		
6. Assemble column form channel and brace to ground/slab.		2hrs.
7. Apply form release.	INCLUDES (50% REBOUND)	
8. Shoot gunnite in channel.	11.00	2hrs.
9. Cut excess material from channel with trowel.		
10. Fill-in where necessary.	3.50	1hr.
11. Cure concrete.		5hrs.
12. Pull forms.	50.00	50.00
13. Patch damage.		

$ 100.00

op. X + XI

additional mat. lab. to operation X

363.00

$463.00

ROOF WATERPROOFING # XII.

Step	Mat.	Labor
1. Sweep surface of all debris.		1/2 hr.
2. Cut lumber.	SCRAP	1 hr. (steps 2–4)
3. Assemble triangel roof scaffold.		
4. Lift scaffolding into position.		
5. Wet roof surface throughly.		1/4 hr.
6. Mix Xypex powder with water in small bucket.	2 bags Xypex	30 min. (15 ea.) (steps 6–7)
7. Apply material to roof surface.	$132.00	
NOTE: steps 5,6,& 7 will be repeated several times until roof is completely covered with Xype		12 hrs.
8. After initial drying, water roof to begin crystal growth.		2 hrs.
9. Apply second coat per steps 5-8.		9 hrs.
	132.00	25 hrs.±

SIMULTANEOUS OPERATIONS (steps 6–7)

+ 250.00

$ 382.00

$ 1.66/ft²

WALL WATERPROOFING AND EXTERIOR COLORS # XIII.

	m.	L.	
1. Design colors and patterns.		4 D.	2 D.
2. Determine amount of concrete pigments to add to Xypex for desired colors.		4 D.	2 D.
3. Prepare wall surface.		1 hr.	
4. Wet wall surface throughly.		1/2 hr.	
5. Mix Xypex and pigments with water in small bucket.	mod. 3 bags 198.00	30 min (15 min. 2 people)	
6. Apply material to wall surface.		YELLOW 7, LT GRN 20, DK GRN. 6	
NOTE: steps 4,5,& 6 will be repeated several times until walls are covered with Xypex and color.		33 hrs.	
7. After initial material set-up, water wall surface to begin crystal growth.	198.00	1 hr.	
		355.00 / 720.00 / 1075.00	1075 − 360 = 715.00

* 1 bag covers about 150 ◻'

$913.00

$3.96/◻'

20.66 x 2.5 x 2

103 ◻' bottom
72 ◻' cornice
45 ◻' cols
96 ◻' side wall
46 ◻' triangles
66 ◻' front wall
428.00

472 3184

913
360
1273

WALL WATERPROOFING/PAINTING

1. Design color patterns.

2. Determine amount of concrete pigment to add to xypex for desired colo

3. Prepare wall surface.

4. Wet wall surface throughly.

5. Mix xypex and concrete pigment. with water in small quantity.

6. Apply material to wall surface. with stiff brush

7. Let material set.

8. Water wall to begin crystal growth.

~~reverse 8 & 9~~

9. Apply other color coats as per steps ~~3-8~~ 3-7.

* NOTE: OPERATION ~~XIV~~ & ~~XV~~ ARE PRICED TOGETHER

WINDOWS & DOORS # XIV.

	Mat'l	Labor	
1. Design windows.		2 D.	1 1/2
2. Measure openings for exact sizes.			
3. Order window fabrication.	* 1203.45	1 1/2 D	1
4. Pick-up and delivery of finished windows.			
5. Paint first coat on inside surface. varnish	1 gal. varnish 19.60	6 D.	5
6. Paint first coat on outside surface. primer	1 gal. primer 13.80		
7. Paint second coat on inside surface. varnish			
8. Paint second coat on outside surface. color	1 gal. color tint 15.00		
9. Fit windows to openings.		1 1/2 D	2 1/2
10. Drill holes and attach pin hardware.			
11. Final instalation of windows in the openings.	(6.00/ea) 48.00		
12. square and attach door frame in opening	6.00	1 1/2 D	
13. cut and install threshold	12.00		
14. hang door on frame			(Same 2 1/2 D.)
15. cut and attach trim	5.00		
16. install hardware.	80.00		
	1402.85	12 1/2 D.	1125 / 225 / 900.00
		1125.00	

$10.00/0'

$2302.85

WINDOWS

1. Design windows.

2. Measure openings for exact size.

3. Order window fabrication.

4. Pick-up and delivery of finished windows. to workshop

5. ~~Prepare paint surface. (sand, tack cloth, etc.)~~

6. Paint first coat of finish on inside surface. (varnish)

7. Paint first coat of finish on outside surface. (primer)

8. Paint last ~~2nd (final)~~ coat of finish on inside surface. (varnish)

8a. final outside coat applied once outside colors are decided?

9. Deliver windows to site.

10. Fit windows to Openings.

11. Drill holes in concrete for pin closures.

12. Attach pin hardware to window frame.

13. ~~Raise windows and test pin hardware.~~ Install windows in openings.

for LSI. = 10/□'/COAT (2 COATS)

coat

INTERIOR PAINTING

XVI.

	Mat.	Lab.
1. Design paint scheme.		2 people @ 9 hrs. 18 hrs.
~~2. Assemble materials~~.		0
3. Errect scaffolding as necessary. (OR LADDERS)		
4. Prepare surface (floor tarps etc.).		2 hrs.
5. Paint first (primer) coat on ceiling.	3 gals. 36.00	5 hrs.
6. Paint second (color) coat on ceiling.		4 hrs.
7. Paint first (primer) coat on walls and columns and beams.		3 hrs
8. Paint second (color) coat on walls and columns and beams.	3 gals. 45.00	3 hrs
9. Remove all tarps and scaffoldings etc. & prep. floor (wash)		1 hr.
10. Paint first (primer) coat on floor.		2 hrs.
11. Paint second (color) coat on floor.	10.00	1½ hrs.
12. Paint special ornaments.		4 hrs.
	91.00	43½
		$435.00

$526.00

$2.28/□'

	S.F.
Ceil.	240
Rear	80
Low walls	100
Cols.	45
Front	66
gable	60
Floor	200
	791□'

gal. covers 300□'

3 gal. primer.
3 gals top coat.

800□'

ELECTRICAL/LIGHTING

XVII.

	Mat.	Labor
1. Run cable through ~~conduit~~ conduit in walls.	5.00	1/2 hr.
2. Place electrical boxes (insides) in rough wall boxe frame.	16.00	1 1/2 hr.
3. Wire outlets.	—	1/2 hr. (items 3–4)
4. Attach cover plates.		
5. Hook up main power supply at rear wall masthead.		

from LSI
Main Switchgear 100 amps residential

172.13

193.00 25.00

$218.00

~~$200~~

BALLUSTRADE FOUNDATION

	Mat.	Lab.
A. Design ballustrade location		18 hr.
1. Design foundation forms.		
2. Dig trenches.		7 hrs.
3. Cut lumber.	1x6's 12.00 1x3's 5.00	8 hrs (items 3–4)
4. Assemble, square, and brace forms.		
5. Cut steel reinforcing rods.	#4's 21.00	3 hrs. (items 5–7)
6. Lay horizontal steel.		
7. Set-up and temporarily brace vertical steel. (strings supports		
8. Cut PVC drain pipes, drill form holes, and place drain pipes in form.	3.00	1/2 hr.
9. Apply form release.		
9. Add waste conc. pieces for voids }		1 hr.
10. Shoot gunnite.	→ 67.91 less voids 20.00 47.00	7 hrs.
11. Float top of ballustrade grade beam.		1/2 hr.
12. Cure concrete.		
13. Pull form boards.		1 hr.
14. Patch damage.		
		46 hrs.
	88	460.00

$548.00

BALLUSTRADE

	Mat.	Labor
1. Design formwork.		8 hrs.
2. Cut lumber, ~~and masonite~~.	1x2's 5.40 1x3's 8.10 1x6's - scrap	
3. Assemble top-box forms.		3 hrs
4. Set-up top-box forms, ~~and~~ square, and brace.	scraps more	8 hrs
4a. cut masonite		1 hrs
5. Attach masonite sheets.	23.00	
6. Apply form release.	-	
7. Cut styrofoam blockout panels. and flowers,	2 sheets 21.00	3 hrs. (items 7–8)
8. Attach (wire) styrofoam.	-	
9. Cut and lay steel reinforcing in top-box form.	#4's 21.00	1 hr. (items 9–10)
mesh? → 10. Tie vertical steel to top steel.	-	
11. Shoot gunnite.	.4 cu yds (inc. waste) 18.00	4 hrs
12. Trowel styrofoam edges of excess concrete.		1 hr.
13. Float top-box concrete.		1 hr.
14. Cure concrete.		-
15. Pull forms and remove all styrofoam from between vertical legs.		3 hrs.
16. Patch damage.		1 hr 34 hrs
	96.50	340.00 = $436.50

BALLUSTRADE OCTAGONAL SEAT

	Mat.	Labor
1. Design seat layout.		15 hrs.
2. Design formwork.		15 hrs.
3. Cut lumber.		
4. Assemble seat void boxes.	50.00 plywood	2 hrs
5. Assemble seat top-box forms.	Scrap.	2 hrs.
6. Set-up, square, and brace 4 & 5.		2 hrs. (5–6)
7. Cut and place horizintal reinforcing steel.		1 hr. (7–8)
8. Cut, bend and place steel between seat void boxes.	3.80	
9. Cut and place w.w.mesh on seat and back.	6.00	1 hr.
10. Cut and wet masonite.	12.00	2½ hrs (10–11)
11. Attach masonite to seat back front.		
12. Apply form release.		
13. Cut and wire in place the styrofoam ornaments to seat back masonite.		3/4 hr.
14. Shoot gunnite.	18.00	4 hrs.

**** continued ****

OCTAGONAL SEAT continued:

15. Float seat, and seat top

16. Cure concrete.

17. Pull forms.

18. Patch dammage.

1½ hrs.

3 hrs

1½ hrs.

5 1/4

89.80

$512.50

$600.00

45.

plus step

$647.

seat	89.80	512.50
step	5.00	40.00
combined	94.80	552.50

TOTAL $ 647.30

* did it over once.

BALLUSTRADE STEPS

Step	pd.	hr.
1. Design steps.	–	1 hr.
2. Design formwork.	–	1 hr.* (steps 2–3)
3. Cut lumber.	–	
4. Assemble form box. ~~and~~	scrap	
5. Square and brace form in place.	–	1/2 hr.
6. Cut and attach reinforcing steel.	scrap	1/2 hr.
7. Apply form release.		–
8. Fill steps void with waste material (cans, bottles, etc.).	–	1/2 hr.
9. ~~Shoot gunnite.~~ dry mix w/ water	5.00	
10. Float steps.		1/2 hr.
11. Cure concrete.		–
12. Pull forms.		–
13. Patch damage.	5.00	4 hr.

$45.00

essentially everything used was scrap material and expense was labor.

5/16/80

BUILDING SEQUENCE (1196 sq.ft. house, Martinez, California)

Design/layout of stakes
Drawings and permits

Site preparation--rough grades
Temporary power
Water connection
Sewer connection
Rough plumbing (stub lines for slab)

Foundation/piers/slabs--forms
Concrete pour

Exterior corner columns--forms
Exterior freestanding columns (porch)--forms
Exterior insulated walls (with r.o. for windows)--forms
Install radiant heating wall lines
Rough fireplace (firebox, damper, flue stub)--forms
Interior walls--forms
  a. Full walls
  b. Fin walls with knuckle columns
  c. Half-height walls
Interior freestanding columns--forms
Cornice *
Gunnite shooting

*could be built as part of wall (as here) or as part of roof operation (later operation)

Scaffolding
Ceilings (flat)--forms
Ceilings (vaulted)--forms
Roof ribs--forms
Gunnite shooting

Chimney flue--forms
Triangle/gable ends--forms
Roof purlins--forms
Gunnite shooting

5/16/80

Roof waterproofing (xypex)

Wall waterproofing (xypex)

Window installation

Exterior door installation

Ballustrade--forms

Garden seat--forms

Fountains and pools--forms

Steps (porch and garden)--forms

Gunnite shooting

Finish carpentry

a. Wood floors

b. Base cabinets

c. Window seats/alcove seats

d. Stairs

e. Rods and shelves

f. Wall cabinets and shelves

g. Tub enclosure

Moldings and trim

Finish electrical

Hot water heater installation

Radiant heat system (main supply) installation

Thermostat installation

Built-in appliance installation

Final plumbing

Hardware installation

Carpet and pad

Tile

Interior painting

Gutters and downspouts

Exterior painting

Hose bibs

Finish grading

Final site cleanup

5/16/80

Preliminary Listing

Building 'Entities' or 'Wholes'

Building Base:

- Slab with Exterior Grade Beam
- Grade Beam with Interior Grade Beams
- Grade Beam with Interior Piers
- Piers

other/possible

porch, patio, terrace,

Columns:

- Exterior Freestanding Column
- Exterior Corner Column
- Interior Freestanding Column
- Interior Knuckle Column
- Exterior Knuckle Column

partial column, fence-post, pilaster,

Walls:

- Exterior Insulated Wall
- Exterior Uninsulated Wall
- Interior Uninsulated Wall
- Interior Fin Wall
- Exterior Fin Wall
- Interior Half-height Wall
- Exterior Half-height Wall

screen wall, trellis, garden wall, ballustrade,

wainscott walls, chair-rails, paneling

Windows:

- Exterior Windows (operable & fixed)
- Interior Windows
- Window Seat

clerestory window, sky-light window,

'Wholes' continued:

Doors: — other/possible

Exterior Main Entry Door
Exterior Door
Interior Door
Closet Door

louvered door, glass door
french doors/window, bi-folds,
sliding door,

Ceilings:

Flat Ceilings
Vaulted Ceilings
Sloping Ceilings

ornamented, ribbed, beamed,
two-way vaults, one-way vaults,

Roofs:

Gabled Pitched Roof
Hipped Pitched Roof
Flat Parapet Roof
Shed Roof

overhang, trellis, awnings,

Pergolas

Beams:

Cornice
Lintels
Archways
Cantilever Beam (brackets)

Garden Places:

Ballustrades
Garden Seats
Steps
Terraces

fountains, pools, walks, paths,
light posts, gateways, walls,

'Wholes' continued:

other/possible

Heating:

Fireplace & Chimney

Freestanding Stoves

Radiant Wall Heaters

ducted heat, baseboard heaters,

Cabinet Work:

Base Cabinets & Counters

Shelves

Mouldings & Trim

Alcove Seats

Wood Stairs

Tub Enclosures

Wood Flooring

****

Open Questions

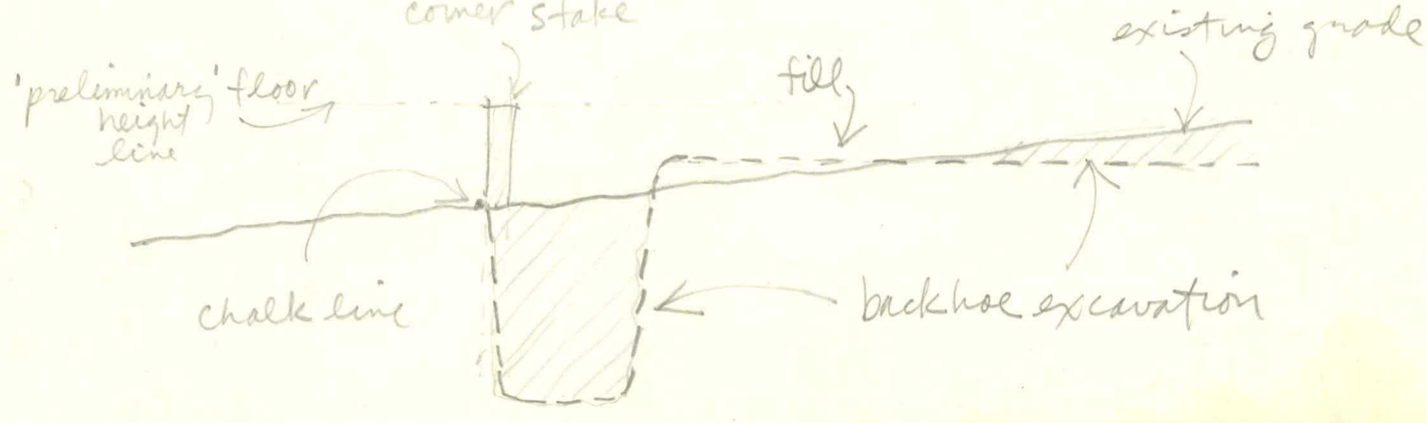
1. Are things like: 'the kitchen' an entity?
2. What about bathrooms and tubs etc.?
3, Are the various mechanical systems entities?
   For example: Radiant Heating, Water, Sewer, electrical.
4. Is Molding & Trim an entity, or is it part of walls, or flooring?
5. Is waterproofing and painting to be considered an entity?
6. Other areas: Gutters & Downspouts, Grading (rough & finish), Thickening walls for ornament,
7. Would the purlins be a seperate entity from roof?

FOUNDATION AND SLAB

This element of the building is the first which begins to give some picture of the physical presence of the emerging structure. It is essentially the first 'building operation' which is undertaken after a series of preliminary steps in preparation for the building.

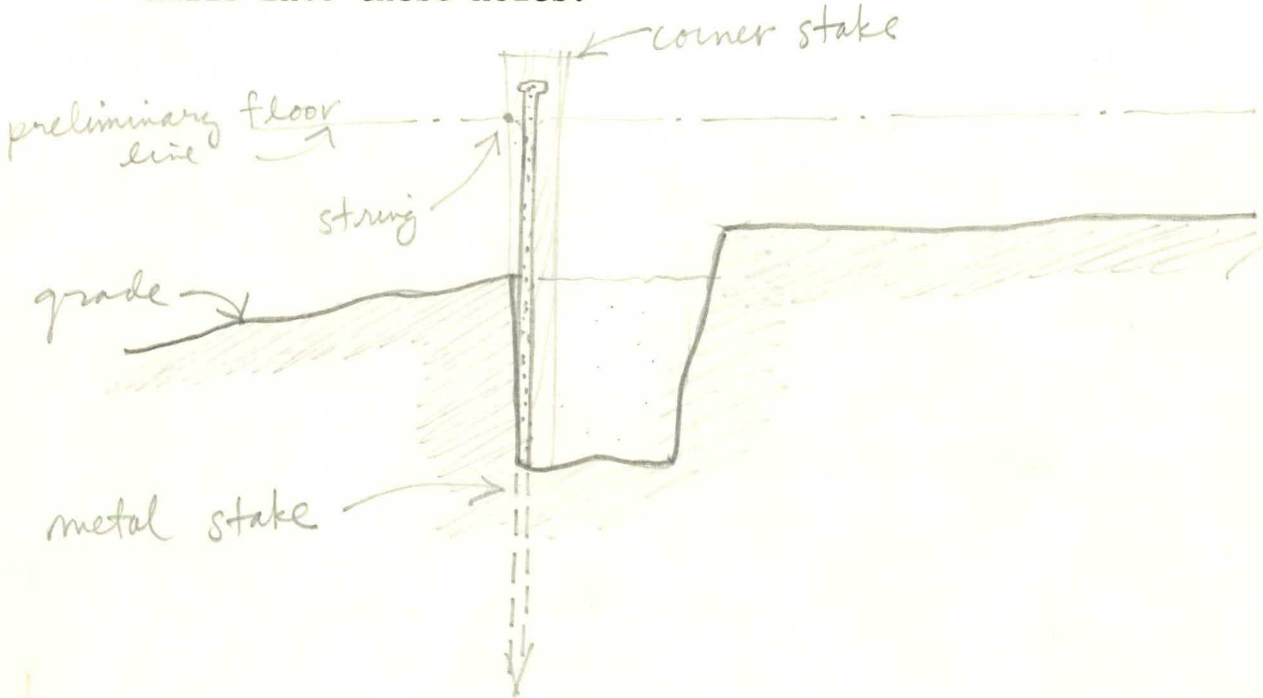
When this operation begins, several phases of the process have been completed, or are is place. These include: staking out the plan of the building, laying sewer and water lines to the building, setting up the temporary power pole on site, and initial site grading for the pads of the building.

The first step in the foundation/slab is chalking lines between the corner stakes in order to begin trenching for the perimeter foundation beams. This excavation is carried out by a backhoe. The backhoe operatior removes earth from the inside area of the building to allow for the slab thickness, or in some cases, he may have to add additional material to the inside area to allow the slab to be set at its proper floor height.

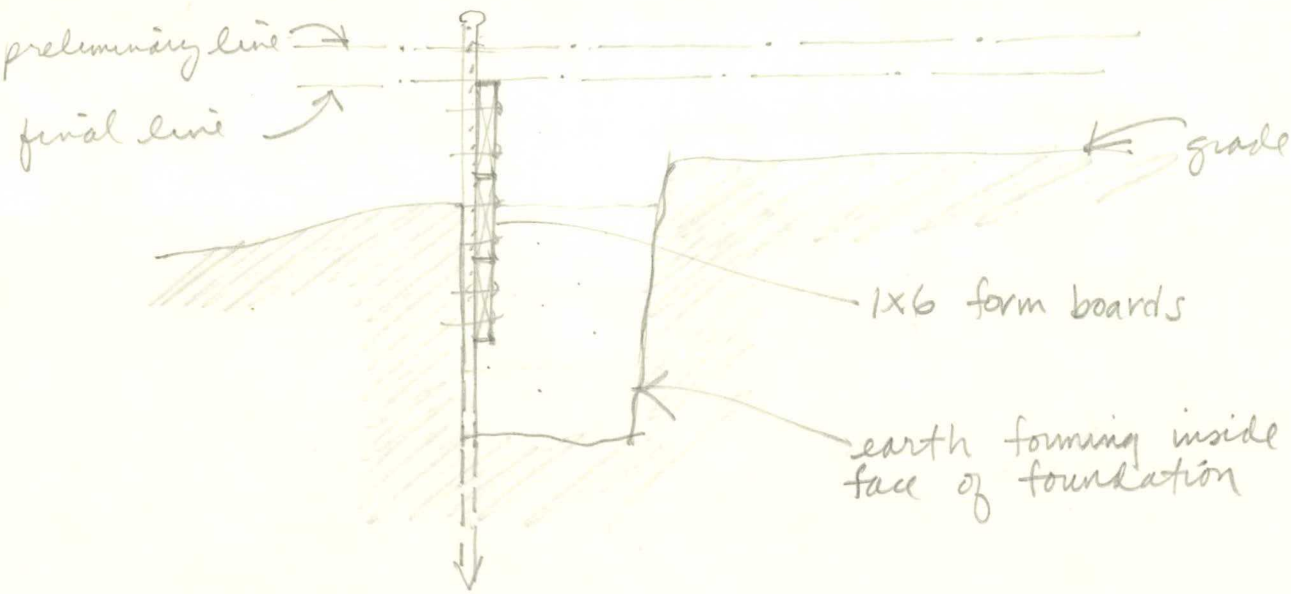


The next step involves more exact measurement. The excavation of the trenches may have removed, or disturbed some of the corner stakes. At this time these are re-established and checked. Strings are tied between these stakes to establish and mark the exact edge of the slab.

Along these string lines, heavy metal form stakes are driven into the ground. These will become the support for the addition of boards to form the outside of the slab/foundation. The metal stakes are about 4' long and are made of round steel pipe which is formed into a point at one end. Along the length of the stake, holes have been drilled at all angles from the center of the pipe. The form boards are nailed to the stakes by driving nails into these holes.

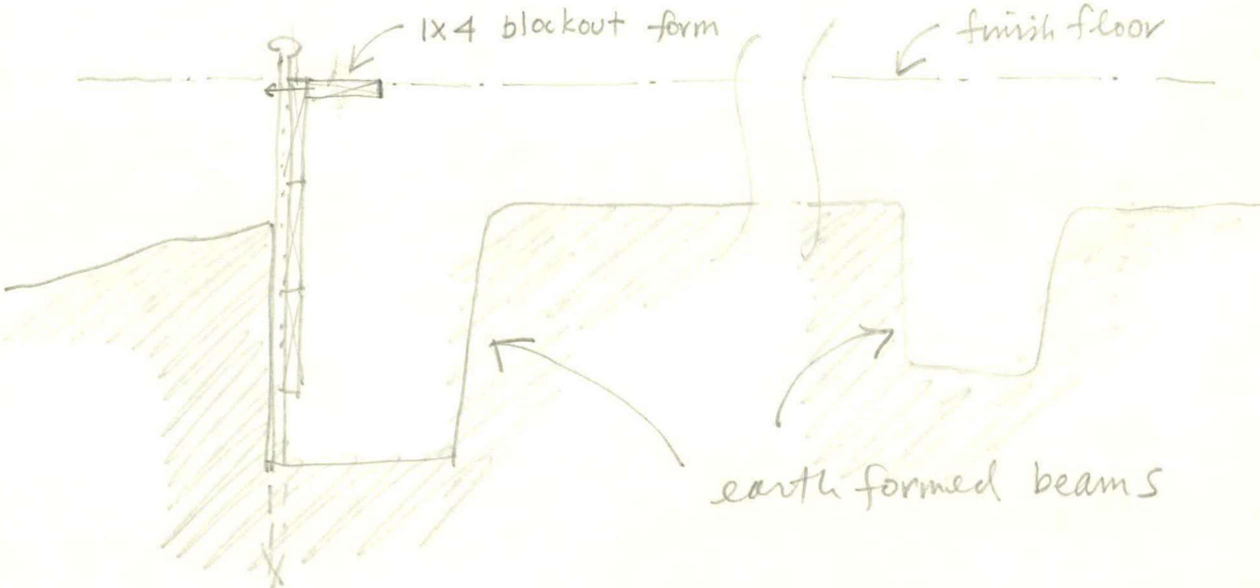


At this point, the exact level of the finish floor slab can be checked. A board can be temporarily nailed to the stakes , or held in place while a visual check can be given to the preliminary line. The board can be raised or lowered until the slab edge seems just right. Then the top board can be nailed in place. Additional form boards can be nailed under this until the foundation form is in place. These boards will be 1x's and can vary in widths to suit the individual situation. The boards on the first experimental prototype were 1x6's. The texture of the grain, and the lines at the seems between the boards, is seen in the finished foundation wall (expressed in concrete).



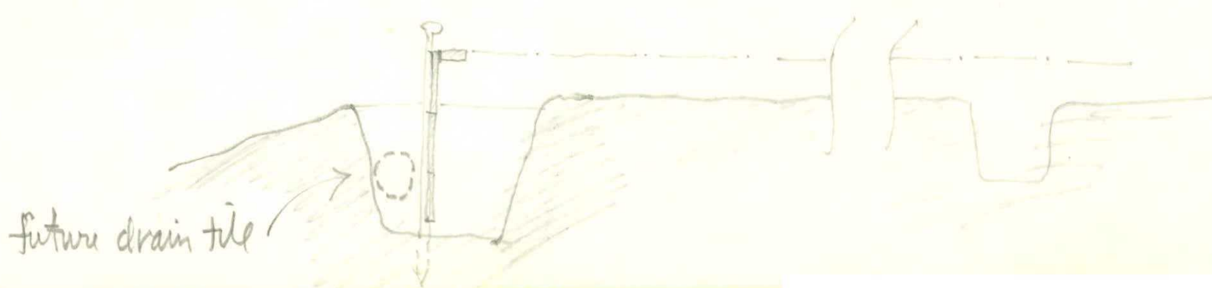
Additional trenching and foundation forming is carried out in the above fashion for all the interior walls and exterior walls. It may be possible in some cases to let the earth form the interior foundation beams. The earth can be used to form the inside face of the exterior foundation beams as shown above.

For the purposes of water exclusion, a key will be formed at the outside edge of the slab. This key is actually a small step in the edge of the slab. The slab finish level is set 3/4" above the exterior edge. It is set back 3 1/2" in from the edge of the foundation beam. This key is formed by nailing a 1x4" board to the edge of the top 1x6" form board on the perimeter. When the slab is poured, the 1x4 will blockout the concrete at this point, forming the key.



The 1x4 and the 1x6 together, will form an edge to screed the top of the concrete slab after it is poured.

NOTE: The trench for the exterior foundation beam can be dug slightly wider to allow for the laying of drain tiles if necessary.



Plastic sheeting (visqueen) is laid over the earth and followed by the addition of welded wire mesh. The mesh is typical highway ~~mesh (xx~~ mesh (6x6 10/10). This is rolled out and turned down into the perimeter beams.

~~Steel reinforcing is laid in the trenches~~ to conform with the ~~building codes allowances for~~ the structural carrying ~~capac~~

Steel reinforcing bars are laid in the bottoms of all the trenches and a bar is suspended near the top of the trenches at the exterior foundation beams.

A ground line is laid over the w.w.mesh and extended out into the earth at the edge of the slab.

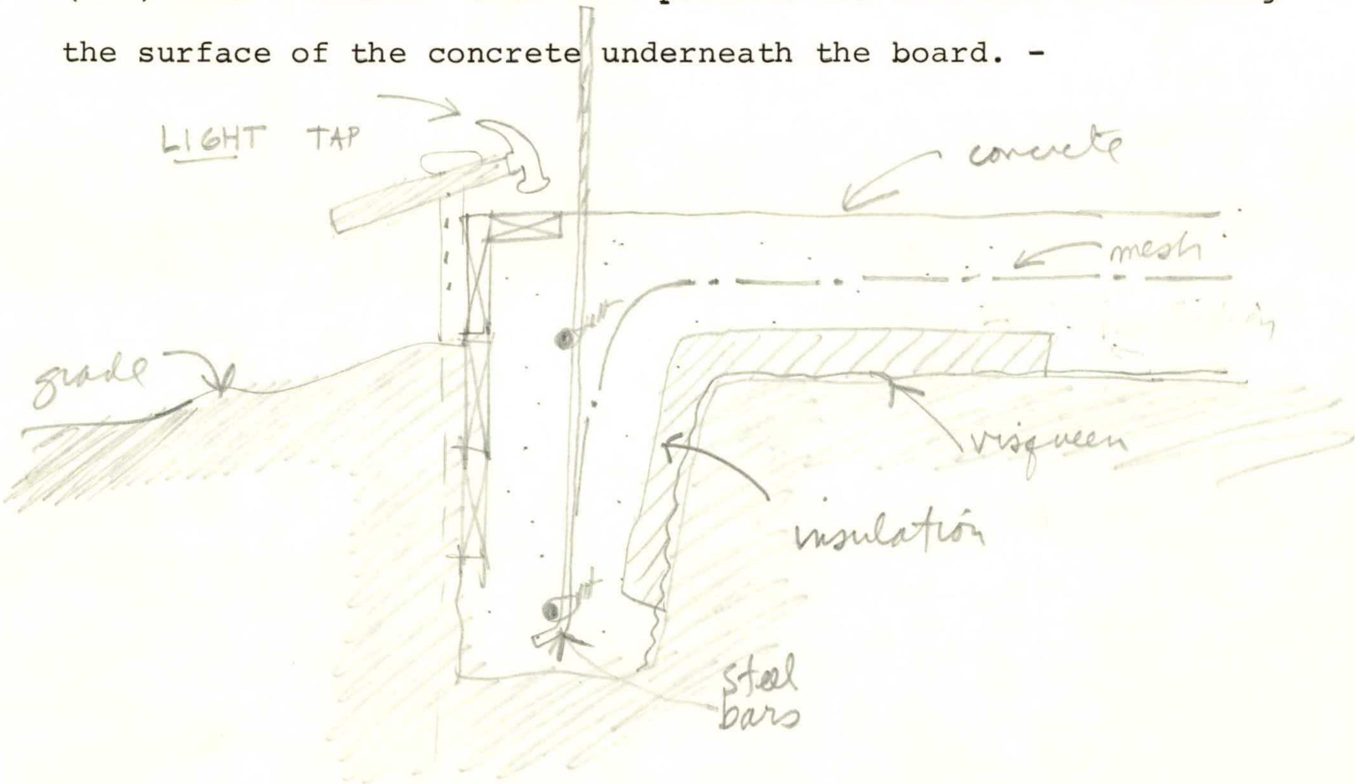
Vertical steel reinforcing bars are stubbed out 12" past the top of the finish floor of the slab. This vertical reinforcing is placed at about 4' o.c. along the length of exterior walls. It is concentrated (usually 4 bars) at points in the slab where columns will later be erected. These will be located at each corner of major rooms, and at the intersection of interior walls.

These stubbed out bars should extend down to the bottom bar in the trenches and be tied with tie wire.

2' of insulation board (polystyrene or polyurethane) is laid on the ground around the complete perimeter of the foundation.

The wood form boards are sprayed with form release.

Now you pour the concrete and finish the slab in the normal manner-- screeding the surface and then floating the surface. The only trick, is the key blockout. After the concrete is poured in the form and after the surface has been screeded, but Before you begin to float, you go around the perimenter of the form and very lightly tap the key blockout board (1x4) with a hammer. This will perform the function of floating the surface of the concrete underneath the board. -



The next step is to go and have at least 2 beers at the local bar in the neighborhood (and shoot some pool).

FOUNDATION ON SLOPING SITE.

Typical best solution xx consists of 18" piers, at 12-15' centers, approx 12' deep. This is better than smaller piers more frequently spaced.

Top of piers connected by a grade beam, say 8" by 12".

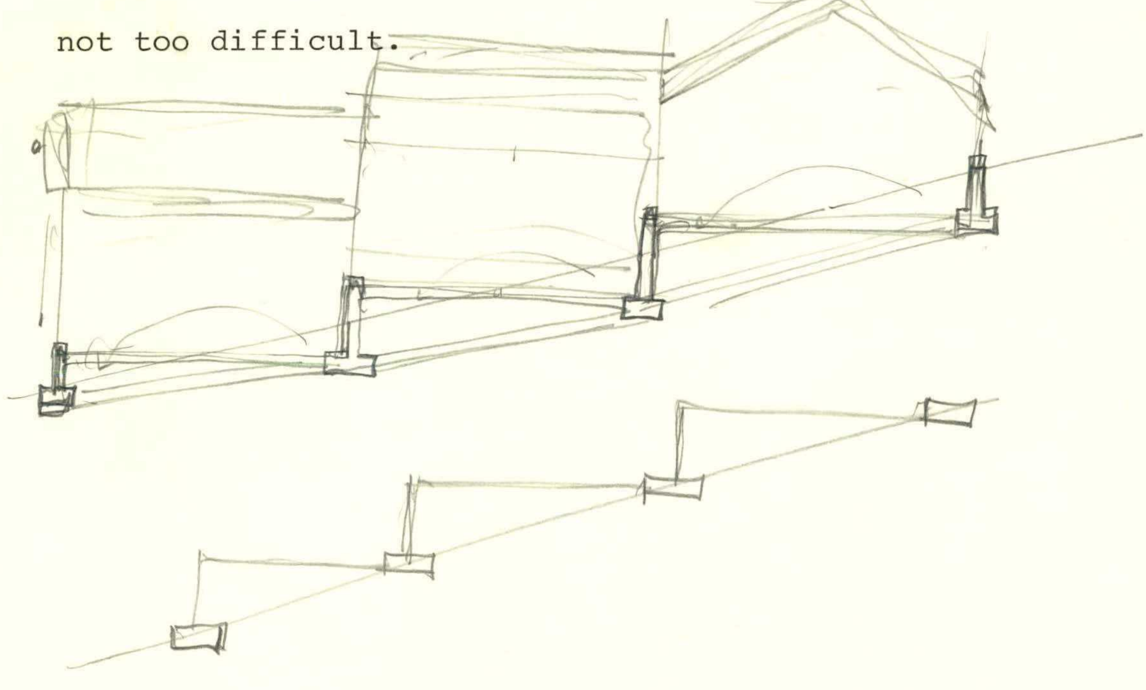
TERRACED
FOUNDATION

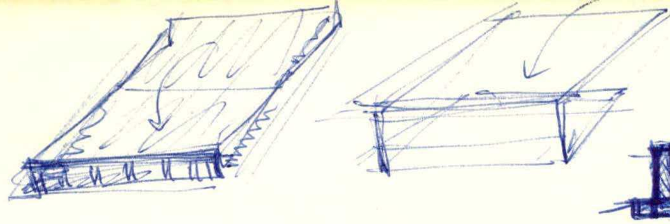
For slopes from 0 - 20%.

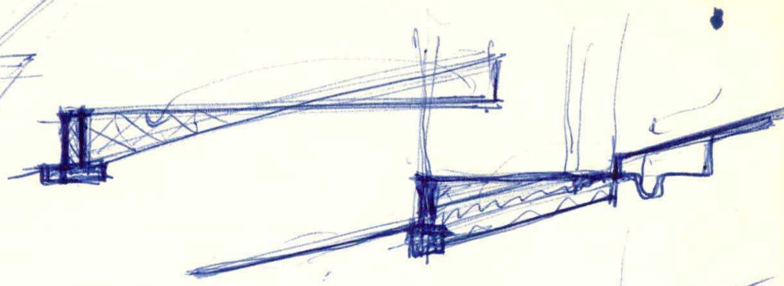
Cut and fill to the contours of the slope, so that floor cuts in as much as it juts out, and the center line of each floor corresponds to the contour line.

This technique has the effect of making a large number of small retaining walls, and no large ones. Since retaining wall design and cost go up as the square of the height (cantilever bending moment), this keep cost to a minimum.

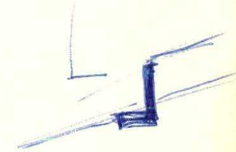
It does mean that the uphill wall of each part of the building is moisture prone, since it may have up to 2 feet of earth outside it: which requires very substantial basement type waterproofing. However, with masonry wall this is not too difficult.



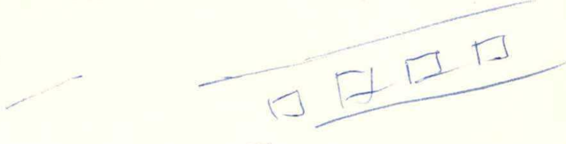




THE BASE (TERRACING)

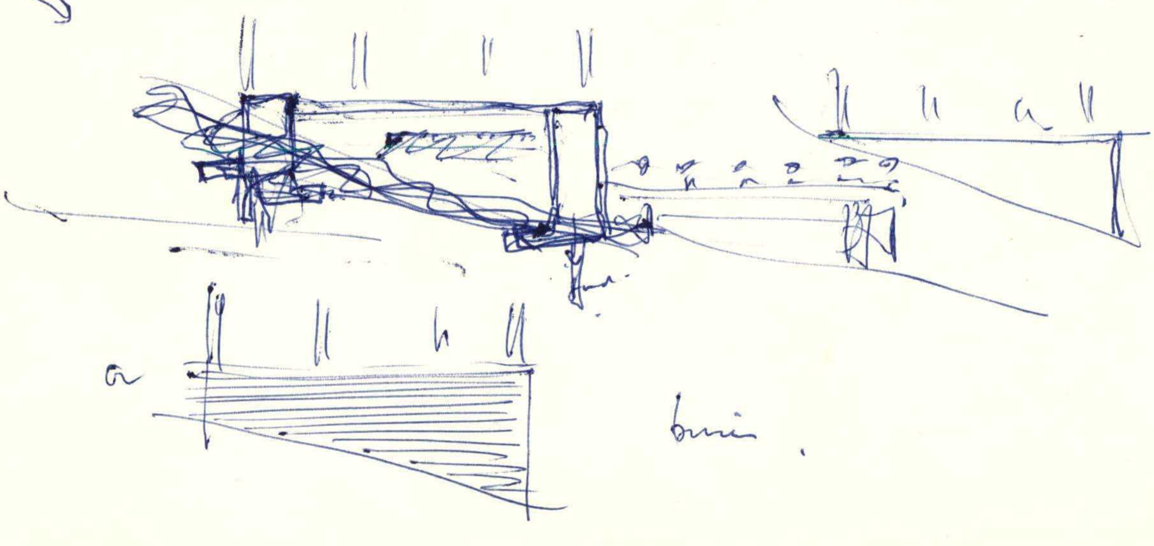


For ease of cut and fx fill, the easiest thing to do on a slope, is to form xhsmxbwmm a series of terraces, each time making the x lower retaining wall in a reverse L shape, fx (for instance by spraying fxmmx concrete from the back onto a light form), and then fillingx to level.



The actual outside material of the base, in this case, is flat concrete. Perhaps not very strong in feeling. ~~It x will~~ xn One very good ancient version is rough stone. Xfxmtmxmx xmxbm Another is brick. We could build a four inch brick wall, xm as form, and spray against it. We could build massive pm piers at corners on the base, and then fill int between them. This gives better sense of the level.

In the end we may have plants f growing over this base, so its final texturex possibly not essential.



EXTERIOR CORNER COLUMN FORMS

The slab is completed. We now begin the construction of of the house.

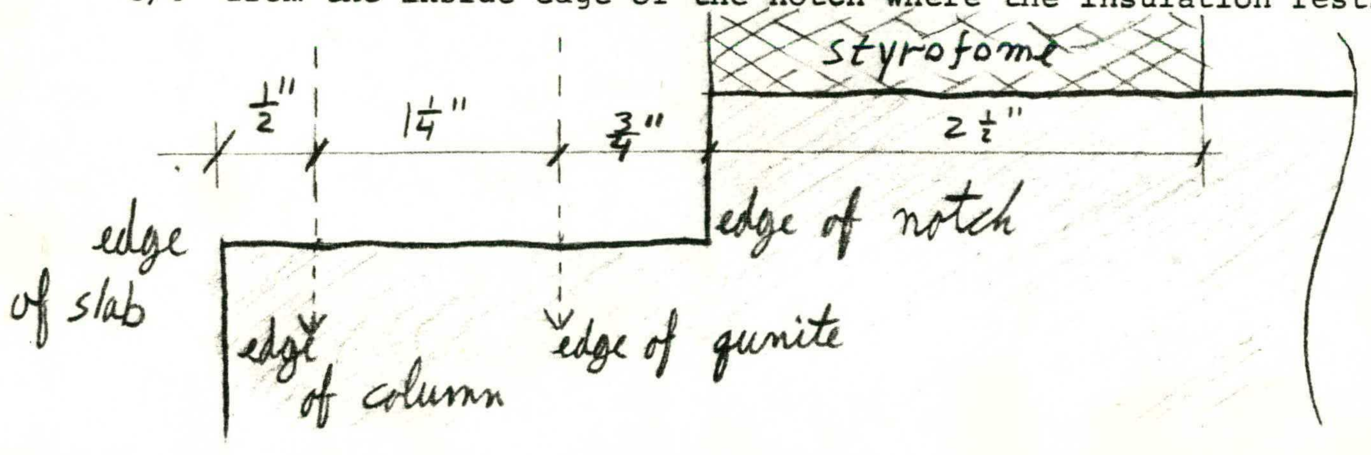
The construction of the walls of the house is done in two steps: (1)the building of the formwork and framework, including plumbing, electrial, insulation, heating etc. and (2)the shooting of the gunite.

The first operation in the framework step is to erect the forms for the exterior corner columns. The column forms perform two functions: they shape the gunite and , most importantly, they are the basic structure for the lightweight wall framework. The wall framework must be as as light as possible and easy to construct, but it must also remain in place until the gunite is finally sprayed. Not only does the framework need to withstand exposure to weather and children, it must also withstand the pressure from the hose during spraying. The strength is provided by a rigid and well built column form.

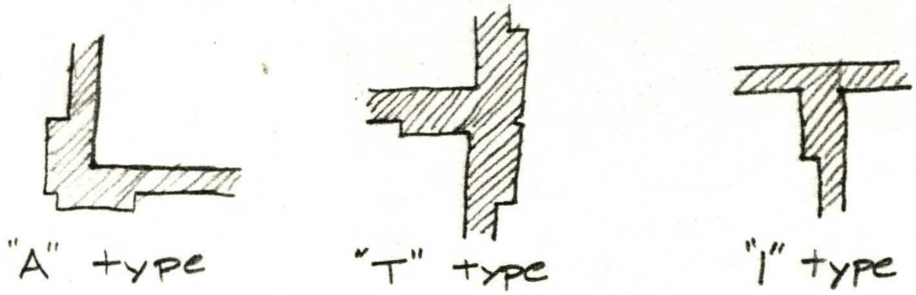
The column forms are built of 1x material and two sheets of 1/2" plywood which form the exterior faces of the finished column, and a 2x2 in the corner where the two sheets of plywood meet. The column forms have four critical connections which must always be kept in mind while building the form: the connections to the slab, the wall, the cornice , and the ground. The form must fit securely into the 1x3 notch which was left in the edge of the slab. There must be a rigid connection between the form and the framework of the walls which can be easily seperated after the shooting. The top of the column form support the cornice and acts as part of the cornice form. The bracing of the column form to the ground provides the stability for the framework of the entire house.

The overall dimensions of the columns are typically 18' wide and 7' 91/4" high (for 8' interior ceiling hieght) and 8' 91/4" for 9' interior ceiling height.

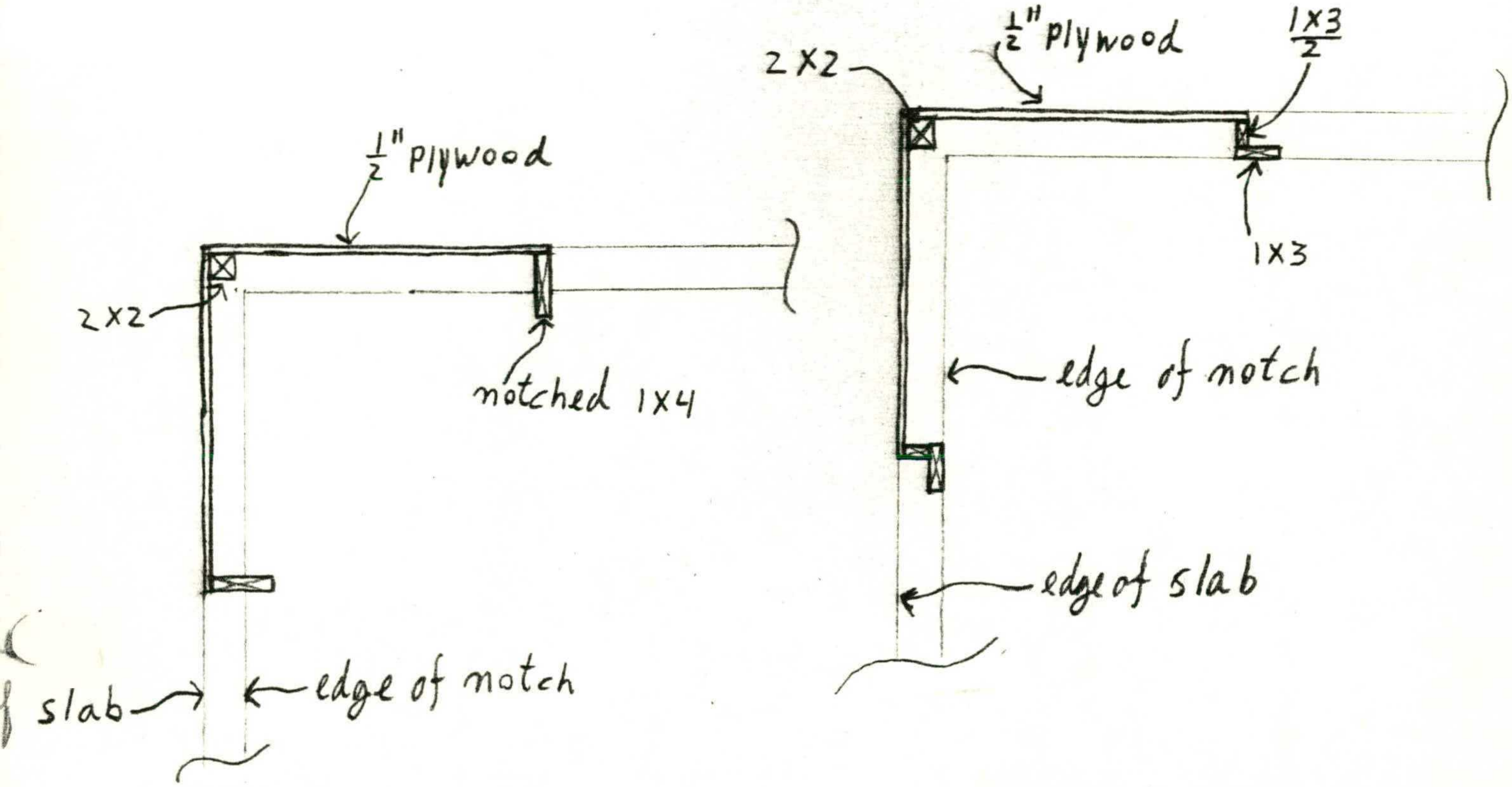
The 1x3 notch at the edge of the slab and the final proportions desired determine the size and configuration of the 1x material. The distance from the edge of the slab to the face of the finished column should be a minimum of 1/2". The distance from the face of the column to the exterior surface of the wall should be a minimum of 1-1/4". The thickness of the exterior wall gunite is 3/4" from the inside edge of the notch where the insulation rests.



The form for the column not only needs to meet the demands already listed, but needs to be adaptable to various specific corner conditions. In the Martinez house there were three such variations: A standard corner column (A type), a T shape where two columns intersect (T type), and a straight shape where the column meets with an exterior wall (1 type).



We developed two different methods of constructing the column forms which we tested on the site. We will describe both since they performed there basic function roughly the same. We chose, however, the slightly more complicated of the two because it made later operations much more simple.



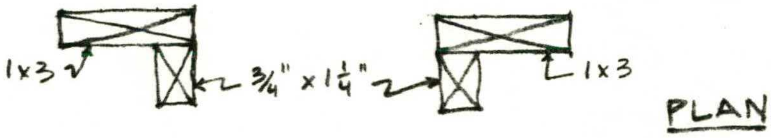
simple to build, but caused later problems

more complicated, but was simpler in the long run

CONSTRUCTING THE "A" COLUMN FORM

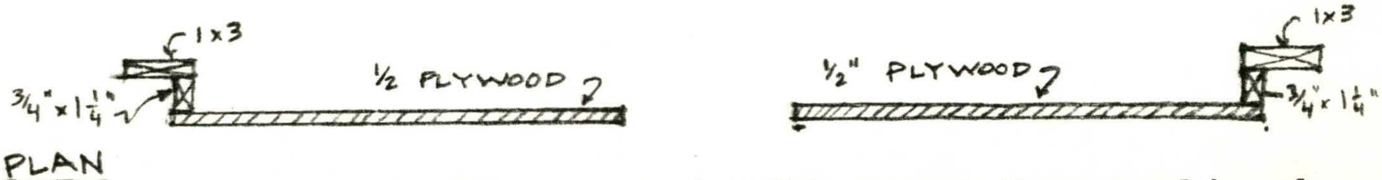
The following is the sequence of operations for constructing a corner column with an eight foot interior ceiling height.

First, two 1x3s (7' 9-1/4" long) are each nailed to a 3/4"x1-1/4" board (a trimmed 1x3 7' 9-1/4" long) with ring shank nails on about 4"-6" centers.

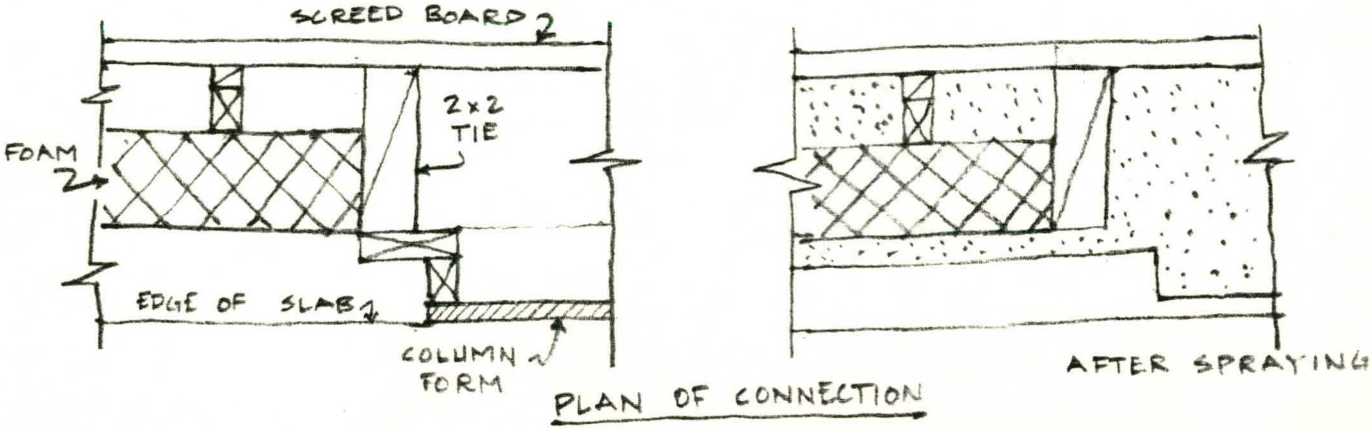


The 1x3 should have a 3/4" x 2" notch cut in it at the top in which the cornice form will rest.

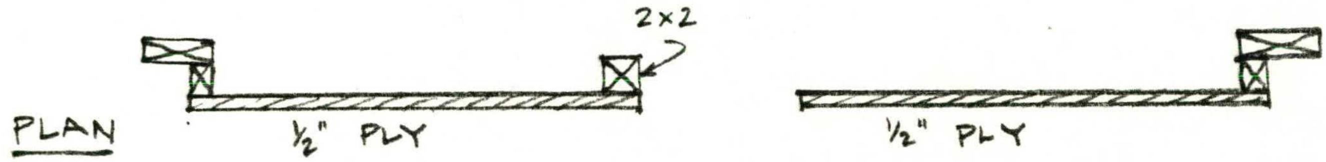
Next, each of these 1x assemblies is nailed to a piece of plywood, one 18-3/4" x 7' 9-1/4" and one 19-1/4" x 7' 9-1/4". This makes the thickness of the form section the width of the notch. The 1/2" plywood creates the desired distance between the edge of the slab and the face of the column.



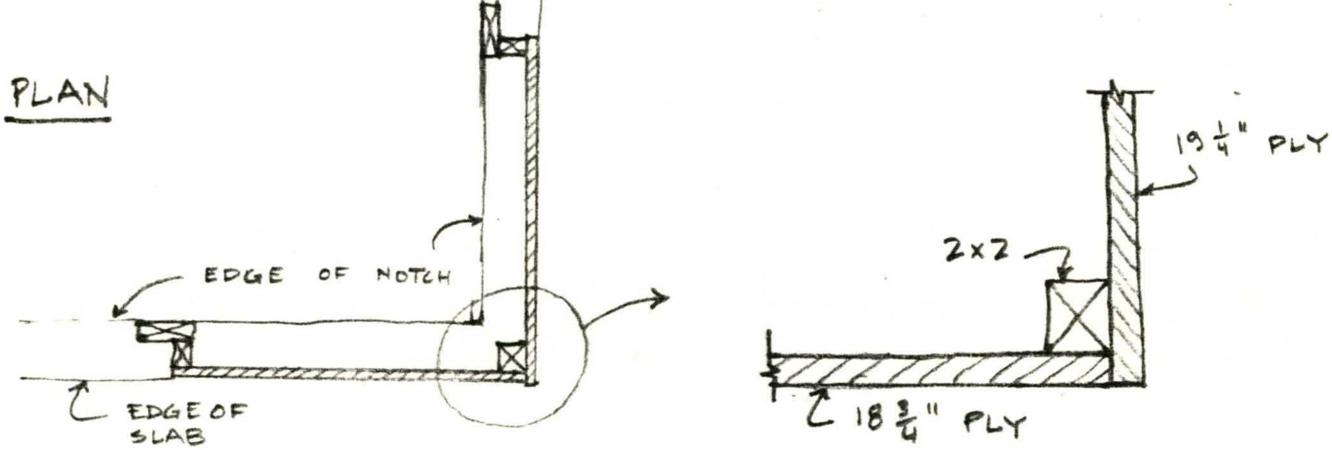
In a later operation, a 2x2 tie will connect the screed boards of the wall to the 1x3 of the column form with duplex nails. This will support the walls and will allow the column form to be easily removed after spraying. The 2x2 tie will remain in the wall and will then be covered by the exterior wall spraying.



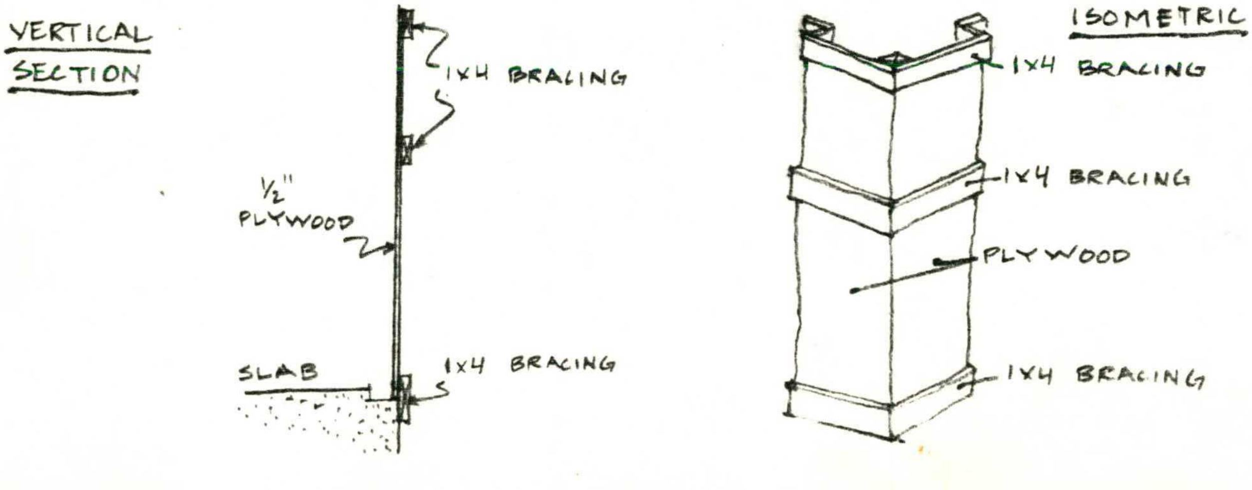
A 2x2 also 7' 9-1/4" long is now nailed to the edge of the 18-3/4" wide piece of plywood.



The two sides of the form are now joined by nailing the 19-1/4" piece of plywood to the 2x2. The two pieces of ply wood should overlap.



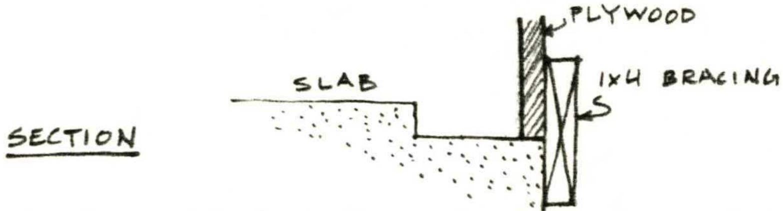
1x4 bracing is now nailed to the plywood exterior to help keep it from twisting. It is nailed in three places: flush with the top, in the middle, and overhanging at the bottom. The brace at the top will help form the cornice and the overhanging brace at the bottom makes it easy to place the form because it is placed flush against the edge of the slab.



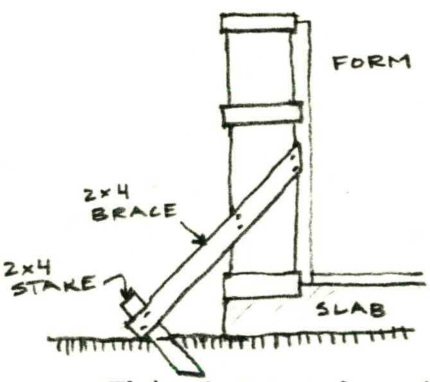
ERECTING THE COLUMN

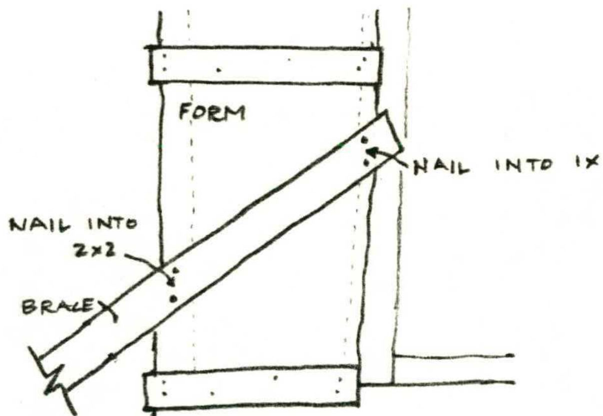
The erection and bracing of the columns is done using 2x4 diagonals which run from the column to stakes in the ground. Typically, the bottom is secured first, then the top is braced at the outside to prevent the form from twisting and to keep it vertical.

The corner column form is put in place at the corner of the slab. The overhanging 1x4 bracing at the bottom of the form should be flush against the side of the slab.

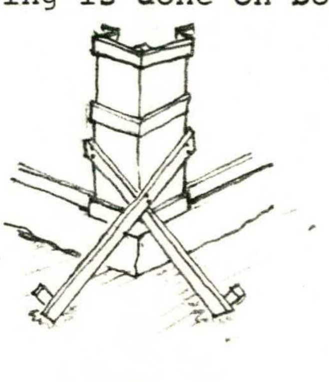


The base of the column form is secured to the ground first. A 6'-8' 2x4 is nailed with duplex nails across the face of the form near the bottom. A 2x4 stake about 4' long is driven in with a sledge hammer where the brace meets the ground. The 2x4 brace is nailed to the stake, making sure the base of the form is even with the edge of the slab.

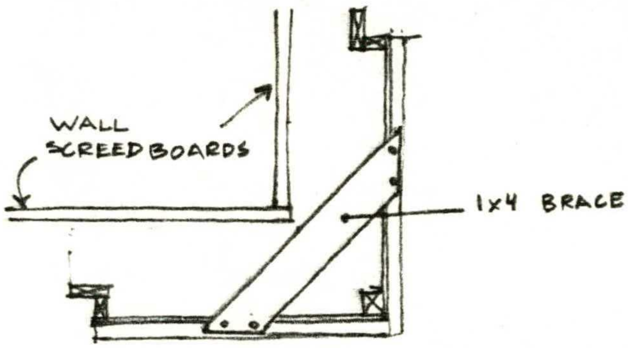




This bottom bracing is done on both faces of the column form.

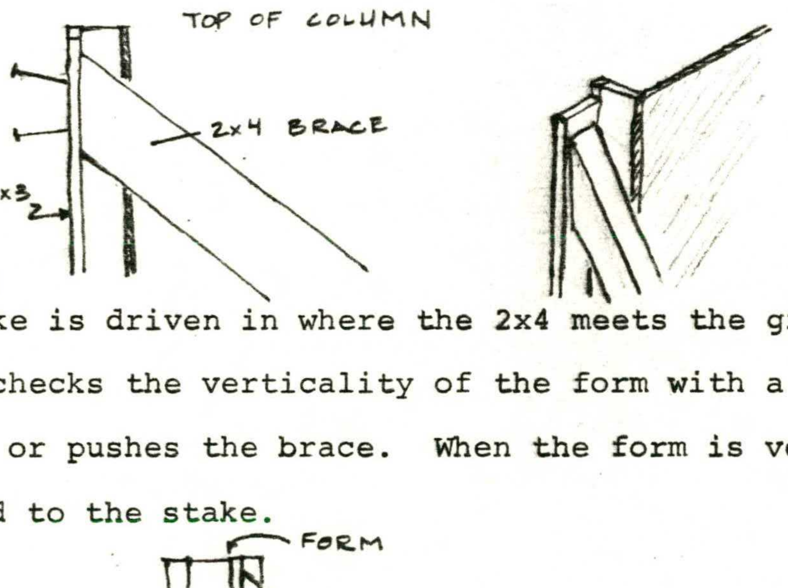


Next, the top of the column is made square by nailing a piece of 1x4 diagonally across the top. The squareness is checked with a large framing square on the outside of the form near the top. The 1x4 shouldn't overhang the edge of the form so it won't interfere with the cornice form. The brace also should not interfere with the ■ wall frames. It should be nailed with duplex nails so it can be removed before pouring the cornice.



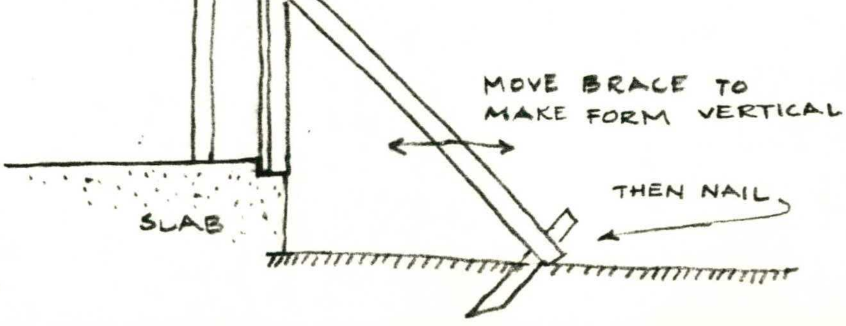
PLAN

After the top is squared, it is braced to the ground. A 12' 2x4 with a diagonal cut at the end is attached to the outside of the 1x3 by nailing through the 1x3 from the inside.

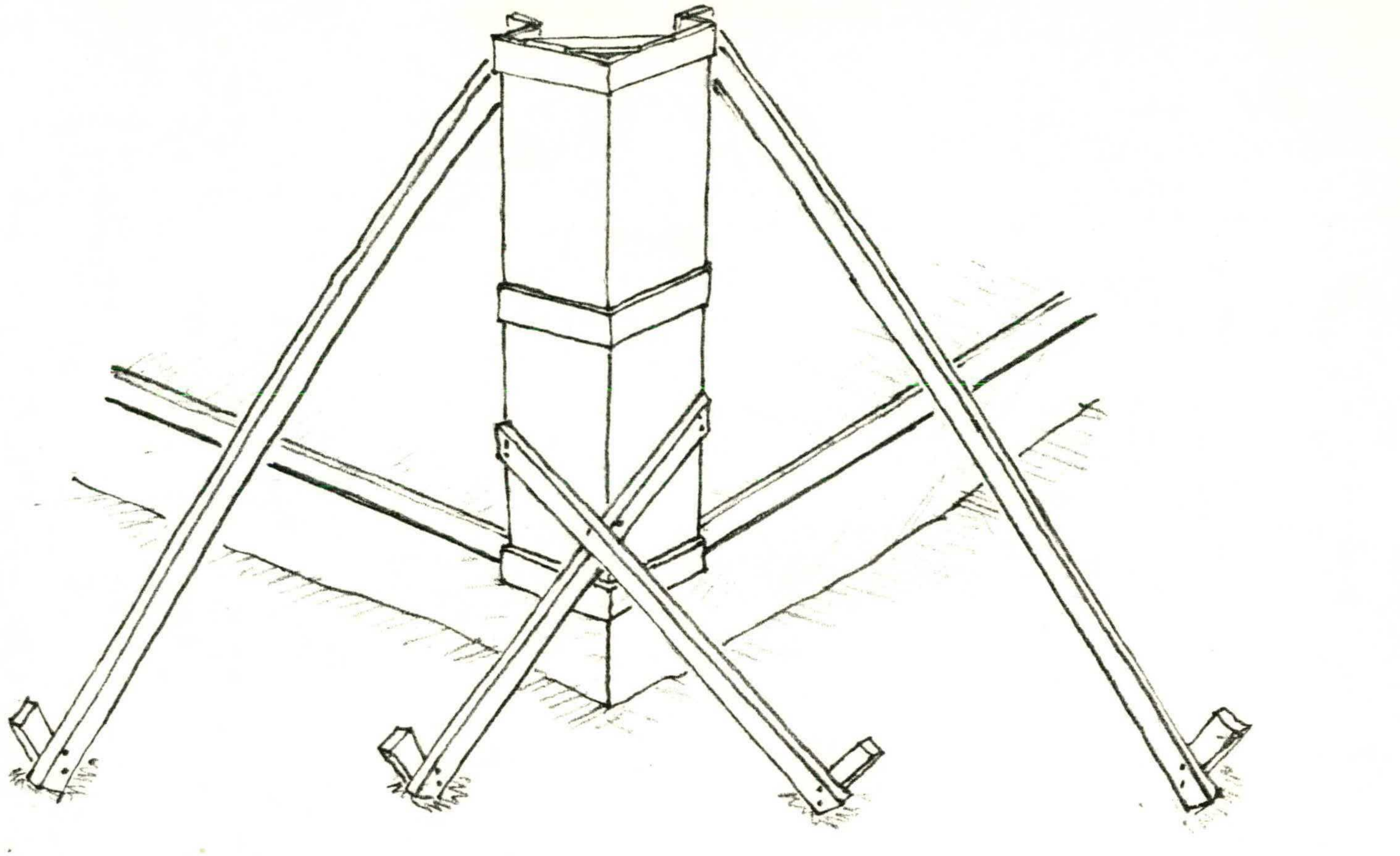


ELEVATION

A stake is driven in where the 2x4 meets the ground, One person then checks the verticality of the form with a level while another pulls or pushes the brace. When the form is vertical, the brace is nailed to the stake.



ELEVATION



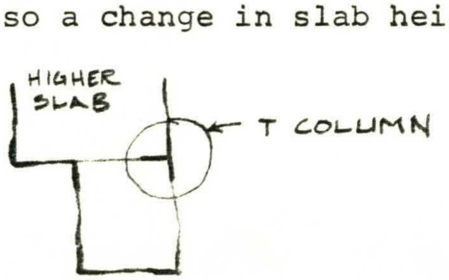
BRACING OF CORNER COLUMN ("A" TYPE)

BUILDING THE "T" AND "l" TYPE COLUMN FORMS

The forms for the "T" and "l" type columns are built following the same general principles and the same construction method as the corner columns. There are a few variations in the details which will now be described.

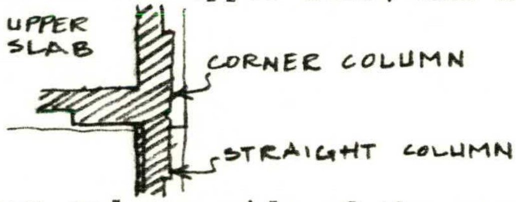
"T" TYPE COLUMN FORM

The "T" type column occurs where the corners of two rooms meet and there is a continuous exterior wall. In the Martinez house, there was also a change in slab height between the rooms at this point.

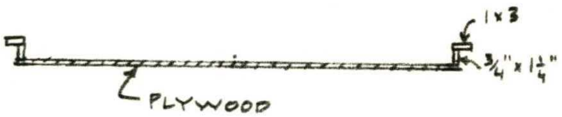


PLAN

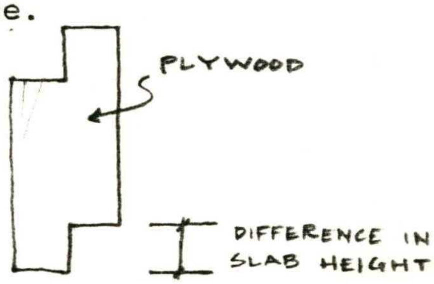
The column on the higher slab will extend above the roof of the room on the lower slab, so the column should face outward from the upper slab. What is actually being built, together, is two columns- a corner column on the upper slab, and a straight column on the lower slab.



The straight column form and one side of the corner column form are built as one continuous piece.

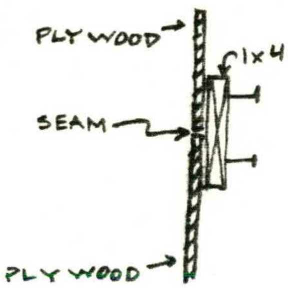


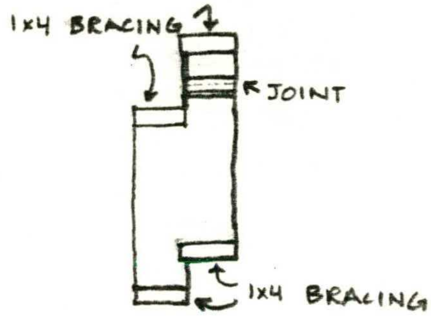
PLAN



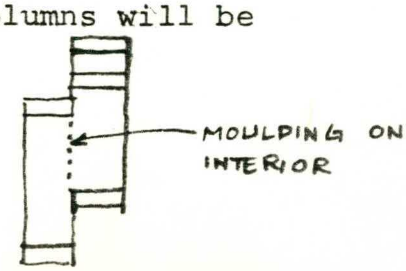
ELEV.

It won't be possible to cut this entire piece of plywood out of one 4'x8' sheet. A piece will need to be added to the plywood. The piece is joined by nailing a 1x4 along the seam. It is also important to remember that both the upper and lower parts of this form need 1x4 bracing at both the top and bottom, since the top bracing is part of the cornice form and the bottom bracing helps the form to be fitted to the edge of the slab.

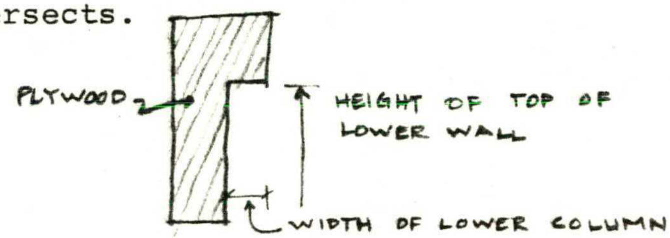




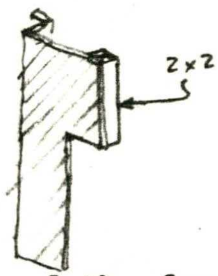
When this part of the form is built, a small piece of moulding is nailed down the middle, so that the two columns will be distinguishable after the forms are removed.



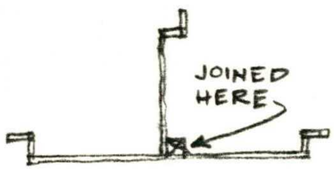
Next, the corner of the upper column is completed just like a corner column except a hole is left in the form where the lower straight column intersects.



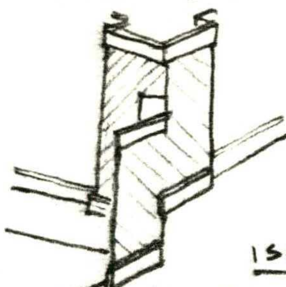
The 2x2 in the corner of this column form is placed only from the top of this hole to the top of the column.



The two parts of the form are then joined at the 2x2.

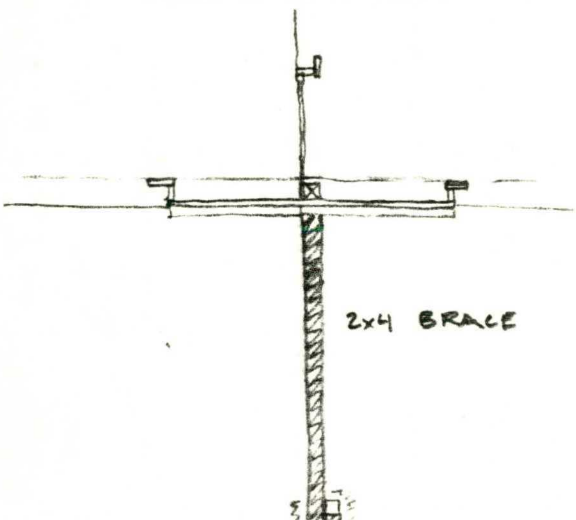


PLAN

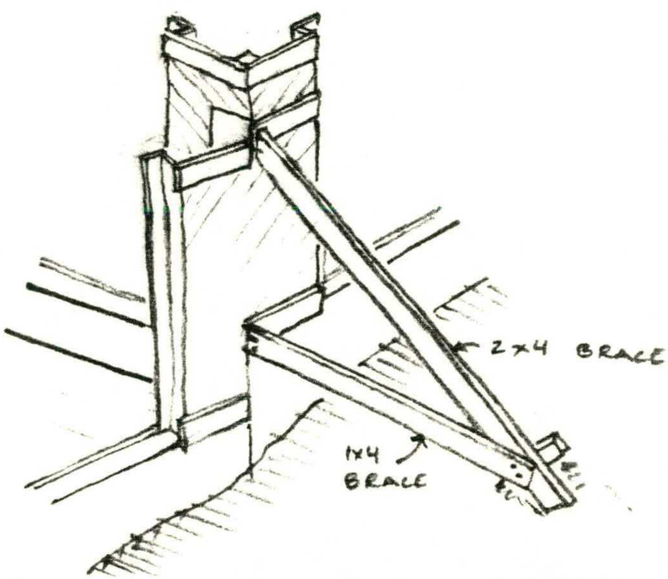


ISOMETRIC

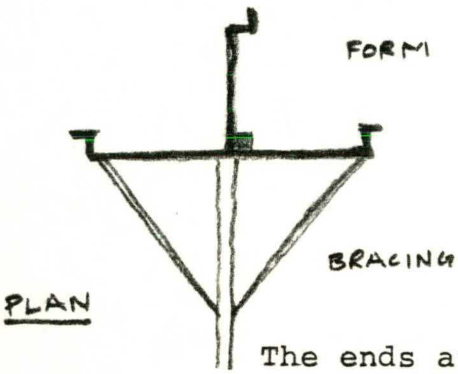
Bracing the "T" column form is also slightly different. First, the middle is braced near the top with a 2x4 and at the base with a 1x4.



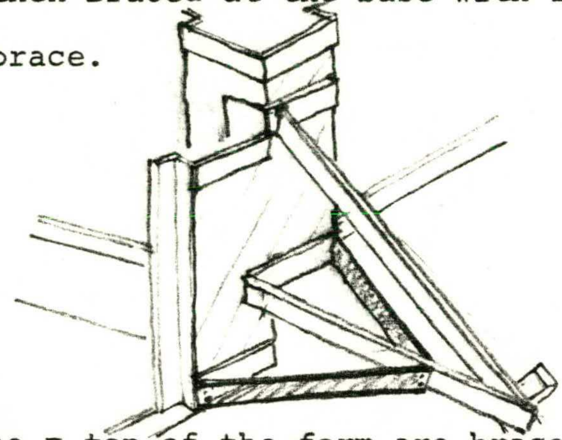
PLAN



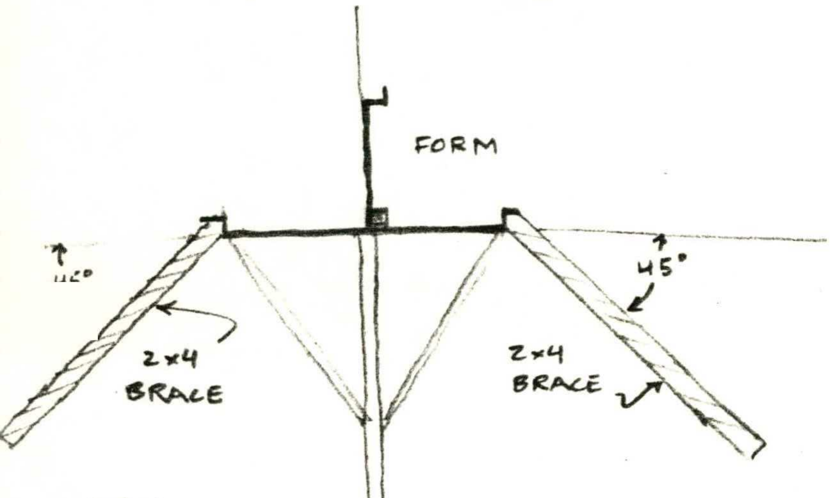
The ends are then braced at the base with 1x4s which are nailed to the middle 1x4 brace.



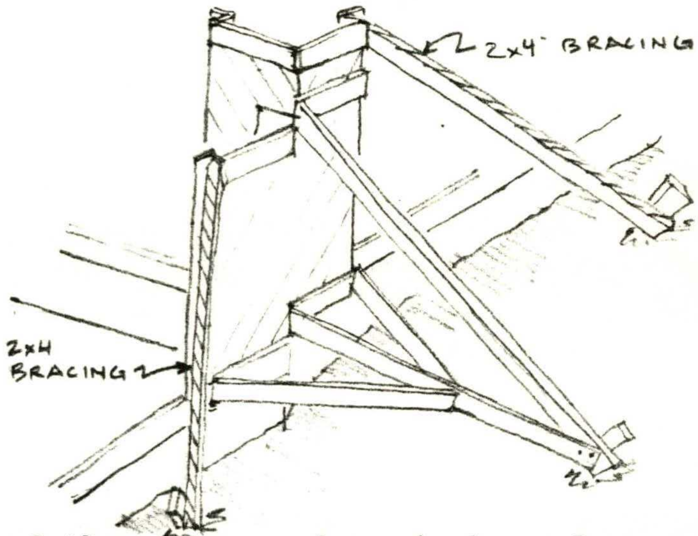
PLAN



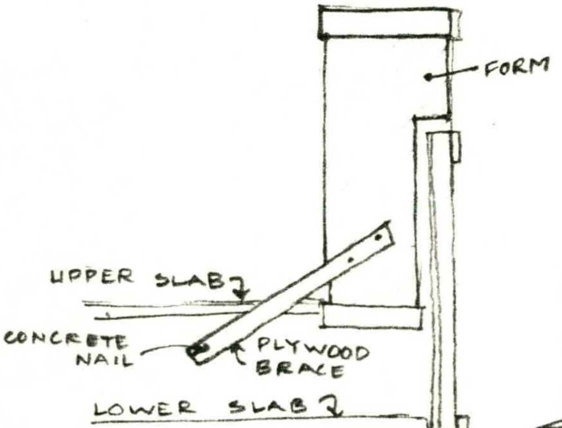
The ends at the ⊠ top of the form are braced with 2x4s wh-ich angle out and away from the column at an angle of 45° in plan.

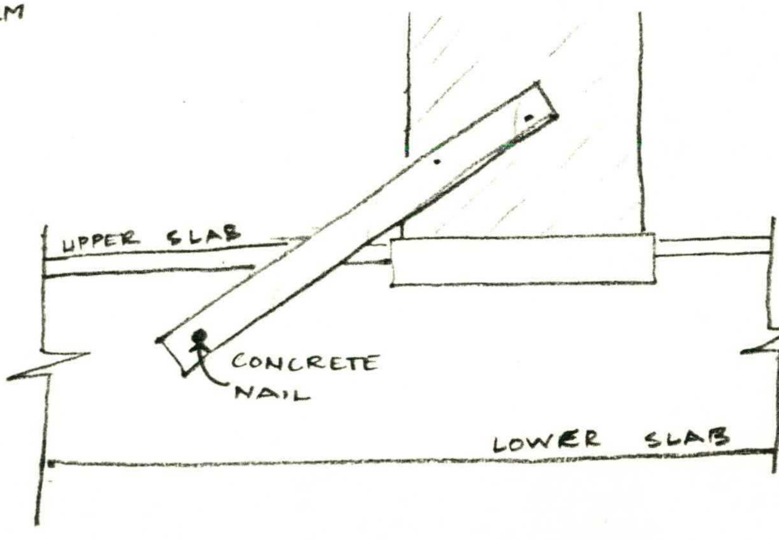


PLAN



The bottom of the inner side of the corner column is braced with a strip of plywood nailed to the face of the form and then to the face of the concrete with a concrete nail.

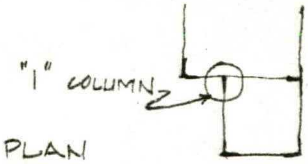




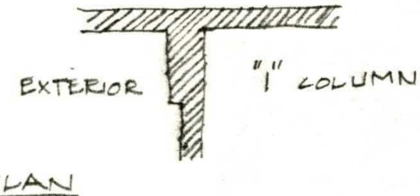
ELEVATION

"1" COLUMN FORM

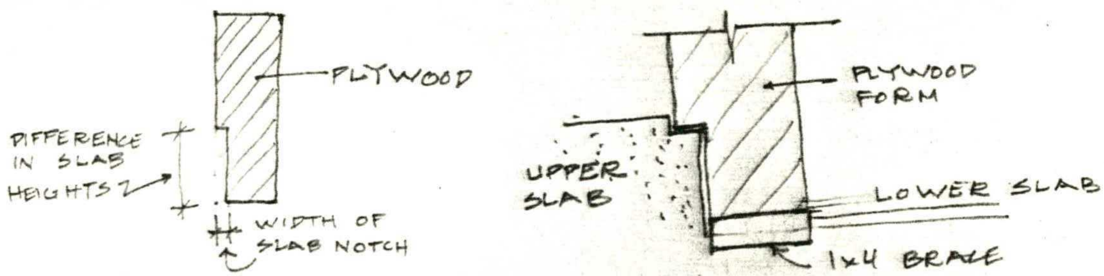
The "1" column form is the simplest of all the column forms. It occurs where a column intersects with another exterior wall.



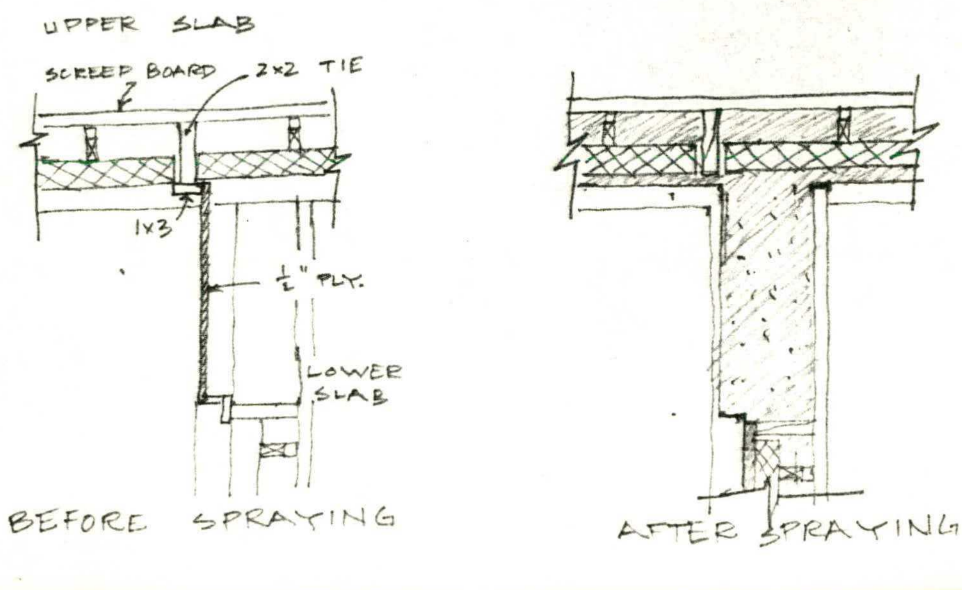
The column is exposed on only one side, so it is built as a straight column.



The form is made out of a single piece of plywood. In the Martinez house, there was a difference in slab height at this point, so the ply wood is notched where the form meets the upper slab.

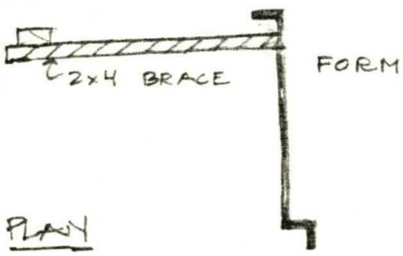


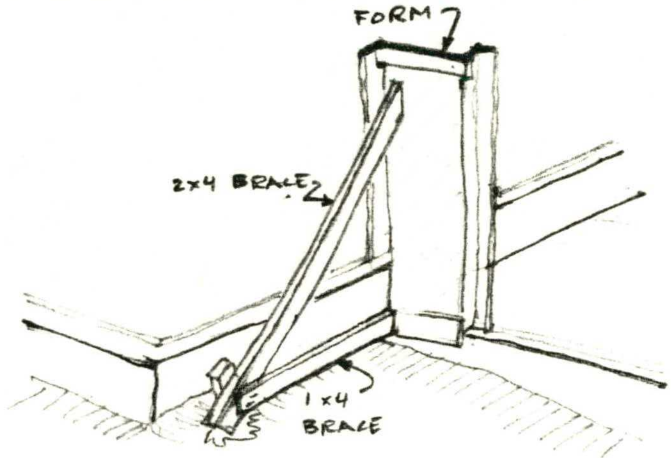
The plywood meets the styrofoam insulation of the wall it is intersecting. A 1x3 is nailed to the plywood at this edge to allow the upper wall frame to be connected to the column form.



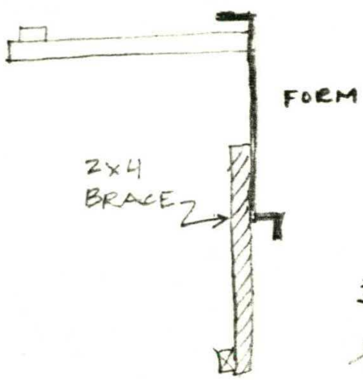
BRACING THE "1" COLUMN FORM

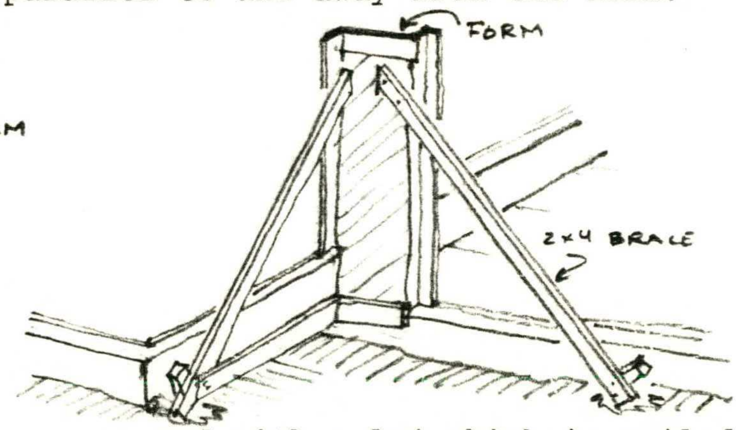
Bracing of the "1" column form is similar to bracing half of a "T" column form. First, the end of the column form which meets the upper slab is braced at the top with a 2x4 and at the base with a 1x4.



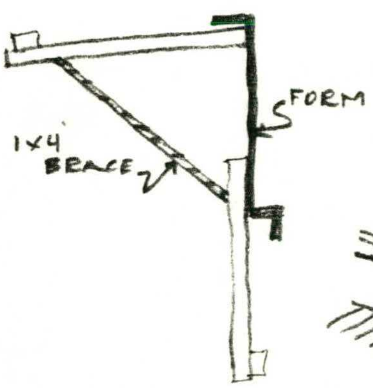


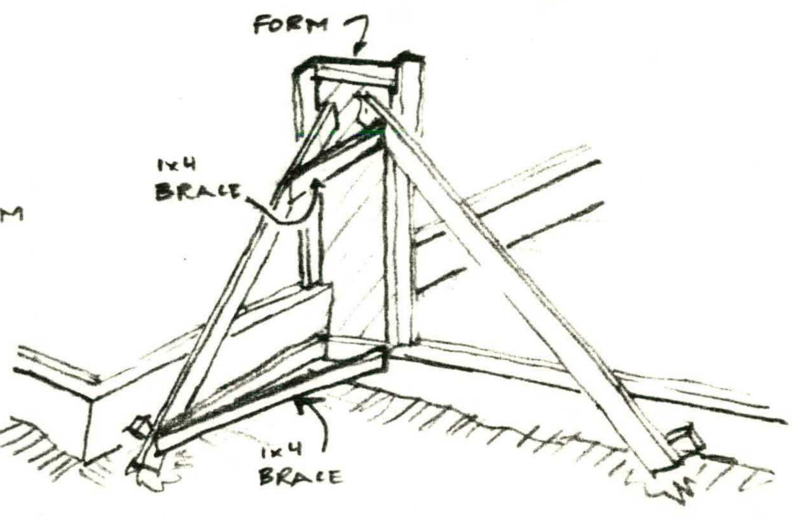
Next, the opposite end of the form is braced at the top with a 2x4 which runs parallel to and away from the form.



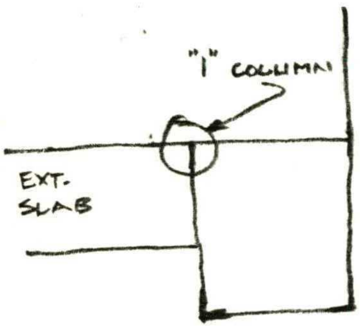


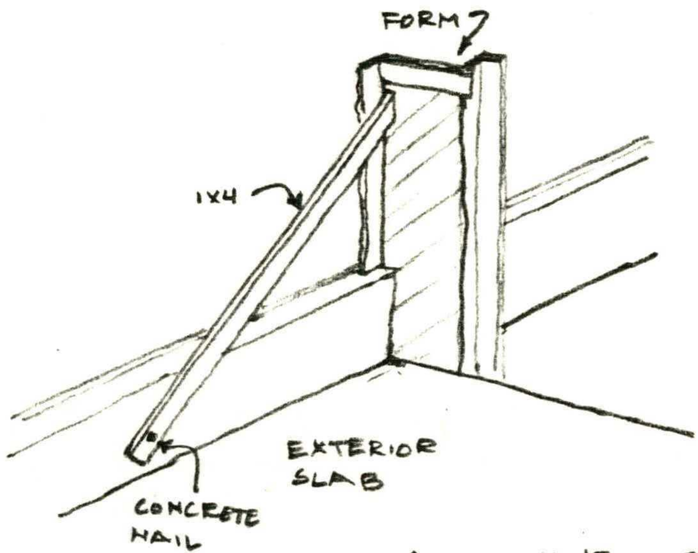
The base is now secured with a 1x4 which is nailed to the first 2x4 brace. Another 1x4 brace may be neccesary between the 2x4s near the top.



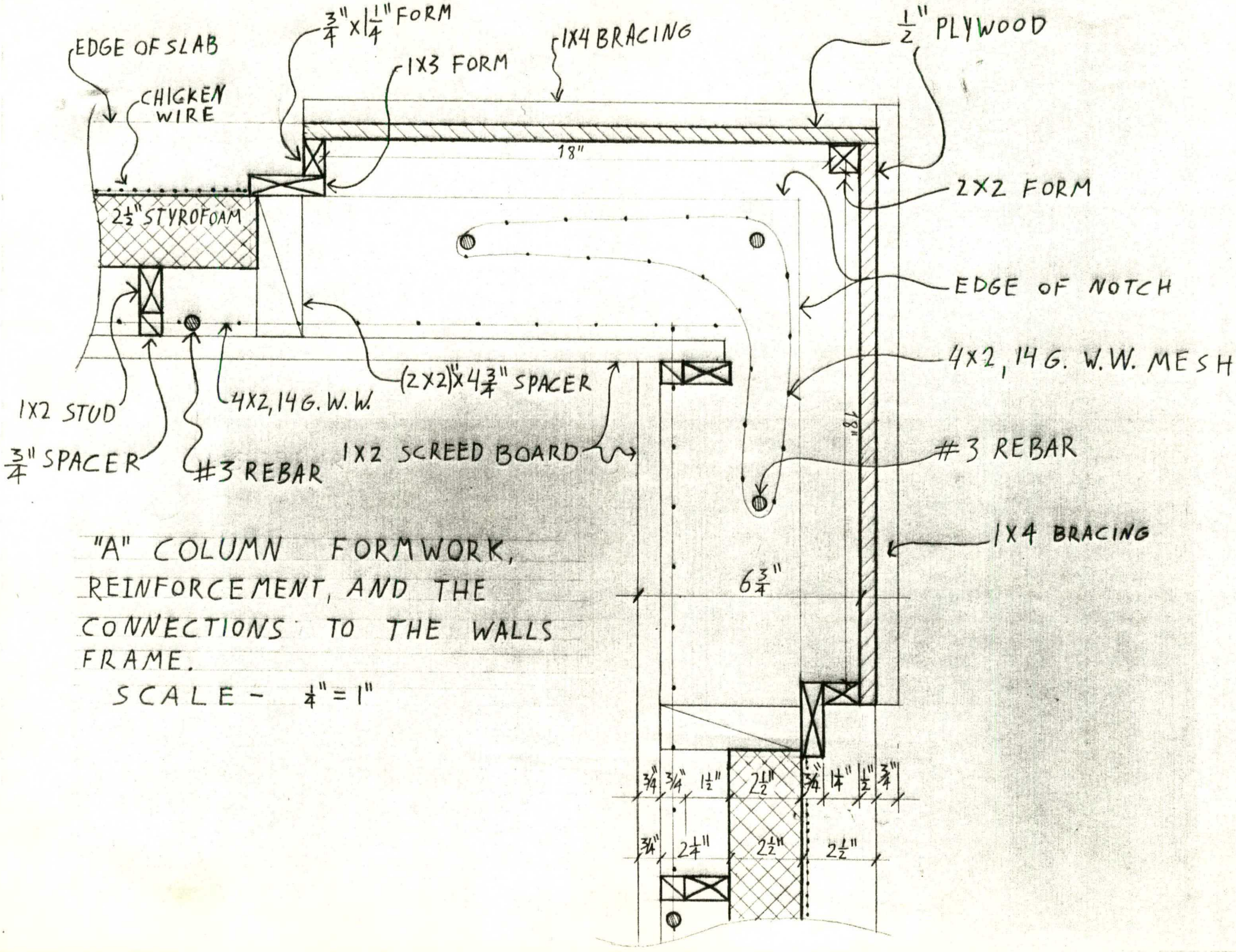


If there is a slab adjacent to the "1" column instead of ground, the bracing must be altered slightly. A 1x4 is used to brace the top of the form on the end which meets the upper slab, and a concrete nail is used to secure the 1x4 brace to the side of the upper slab.



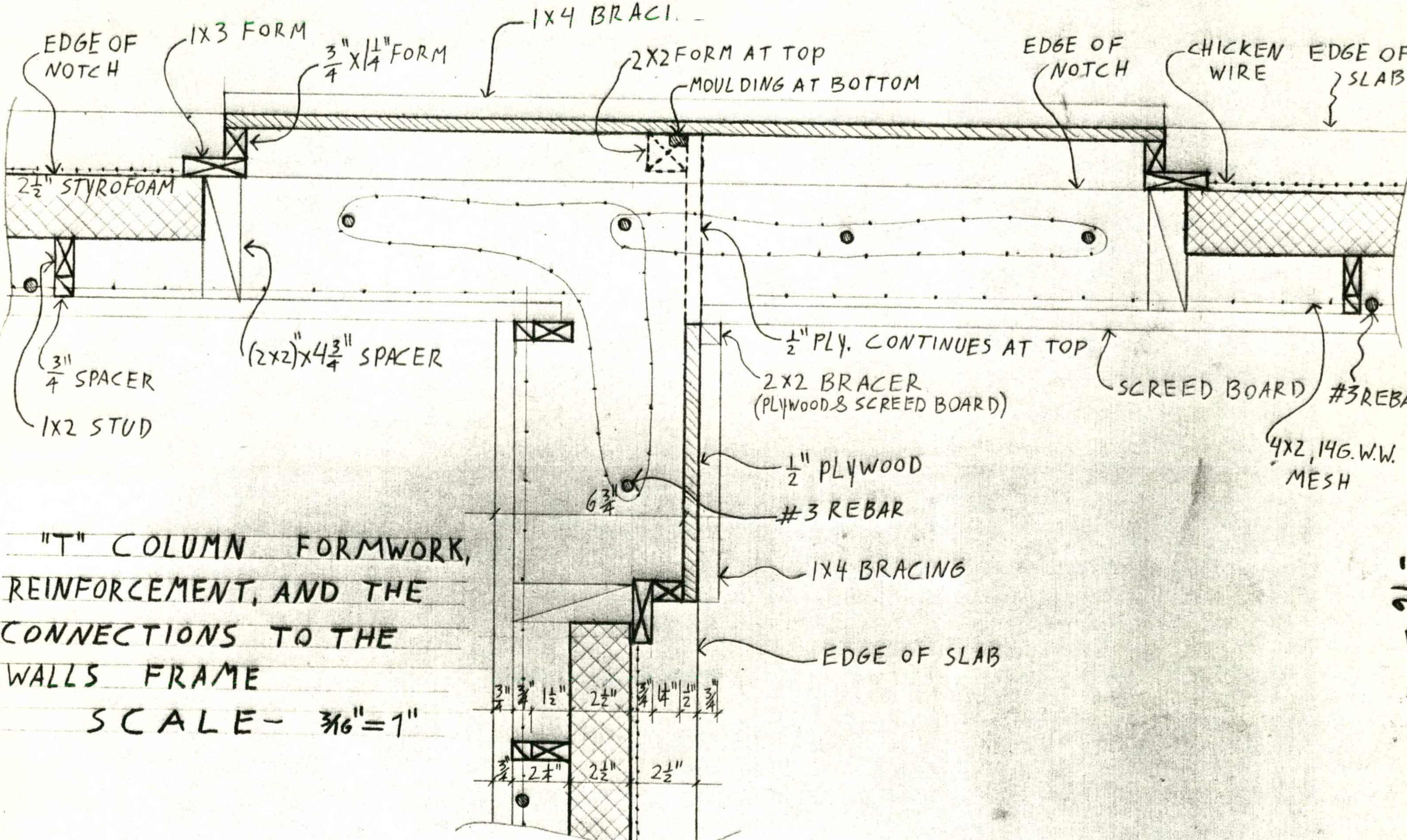


(ALL OTHER BRACING REMAINS THE SAME)



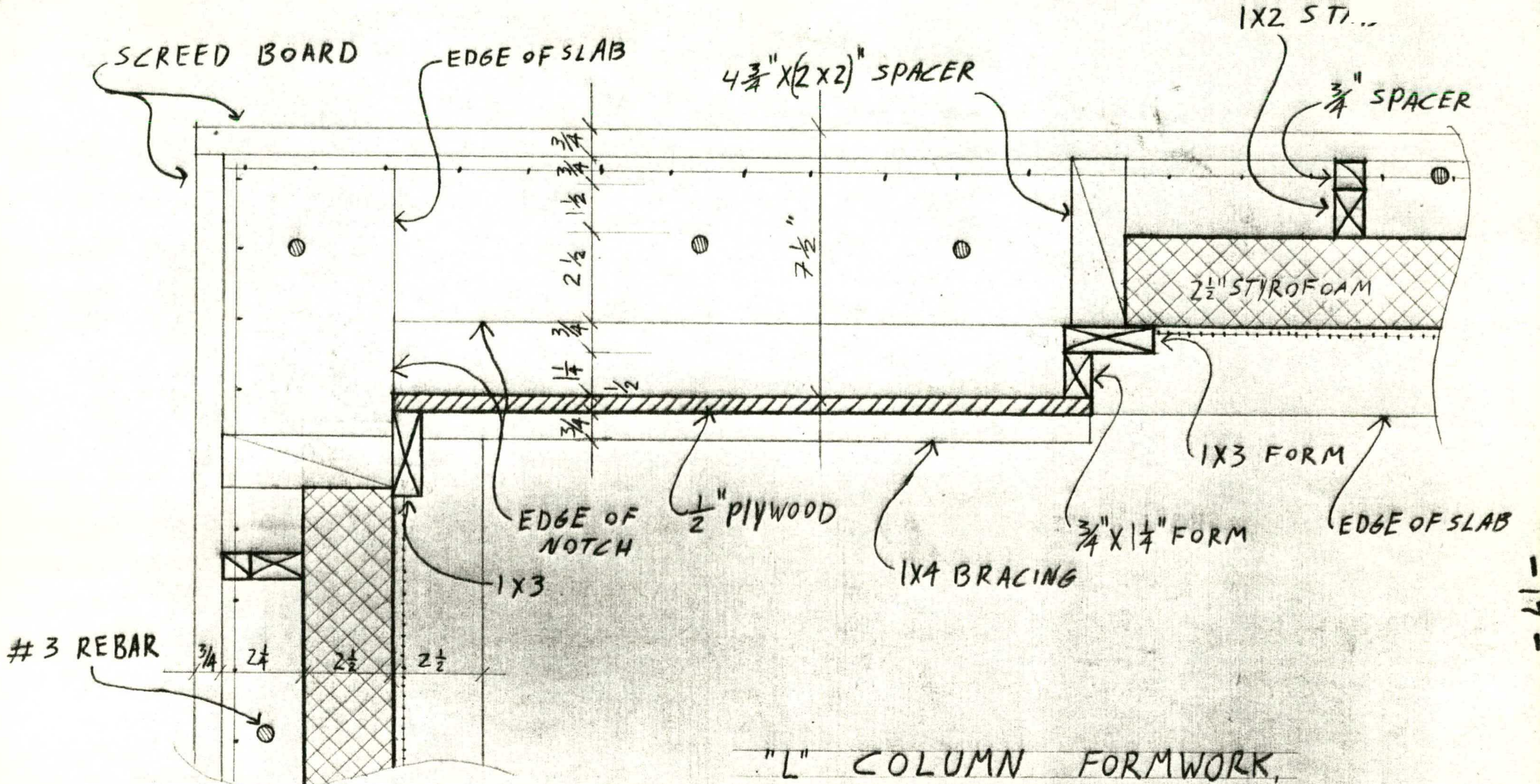
"A" COLUMN FORMWORK, REINFORCEMENT, AND THE CONNECTIONS TO THE WALLS FRAME.

SCALE - 1/4" = 1"



"T" COLUMN FORMWORK, REINFORCEMENT, AND THE CONNECTIONS TO THE WALLS FRAME

SCALE - 3/16" = 1"



"L" COLUMN FORMWORK, REINFORCEMENT, AND THE CONNECTIONS TO THE WALLS.

SCALE - 1/4" = 1"

OPERATION — FORMS OF EXTERIOR CORNER COLUMNS

-CONTINUE-

MATERIALS				LABOR	
ESTIMATED	COST	REAL	COST	DATE	HOURS
(1x3)"-[8'] form	1.2 $	moulding-8'	1.12 $		
(1x3)"/2-[8'] form	0.6 $	(1x4)"-[6']	0.84 $		
(2x2)"-[2'] form	o.38 $	1/2" plywood-1.5(4x8)'	16.13 $		
molding-[8'] form	1.12 $				
(1x4)"-[15'] bracing	2.1 $				
3/8" plywood-11/2[4x8]'	11.93 $				
each 9'-"T" column is	21.38 $				
sub total for:1-9'"T"column	21.38 $	1-9'"T" total (tax not added)	24.47 $		
(1x3)"-3[8'] form	3.6 $	(1x3)"-4.5[8']	5.4 $		
(1x3)"/2-3[8'] form	1.8 $	(1x4)"-[6']	o.84 $		
(2x2)"-[2'] form	o.38 $	moulding-8'	1.12 $		
molding-[8'] form	1.12 $	1/2" plywood-1.5(4x8)'	16.13 $		
(1x4)"-[15'] bracing	2.1 $				
3/8" plywood-11/2[4x8]'	11.93 $				
each 8'-"T" column is	20.93 $			NOV.25 .81	8.5 h/3 m
sub total for:1-8'"T"column	20.93 $	1-8'"T" total (tax not added)	23.49 $	DEC.14 .81	7 h/2 m
(2x4)"-2[12'] bracing	6.24 $	(2x4)"-20[12'] *	* 62.40 $		
(2x4)"-2[6'] bracing	3.16 $	(2x4)"-20[6'] *	* 31.60 $		
(2x4)"-4[4'] anchorag	4.16 $	(2x4)"-40[4'] *	* 41.60 $		
sub total for: 10 columns	135.6 $	sub total for 10 bracings *	*135.60 $		
total	289.31 $				
tax-6.5%	18.8 $				
consumables-5%	15.4 $	consumables (tax not added)	10.81 $		

TOTAL 323.52 $

PAID TOTAL 175.90 $

REAL TOTAL 323.00 $

TOTAL 78 m.h.

OPERATION - FORMS OF EXTERIOR CORNER COLUMNS

MATERIALS				LABOR	
ESTIMATED	COST	REAL	COST	DATE	HOURS
(1x3)"-2[8'] form	2.4 $	(1x3)"-3[8']	3.6 $		
(ix3)"/2-2[8'] form	1.2 $	(1x4)"-4[8'],1[12']	5.16 $		
(2x2)"-[8'] form	1.52 $	(2x2)"-3[8']	3.12 $		
(1x4)"-[10'] bracing	1.4 $	1/2" plywood-2(4x8)'	21.5 $		
3/8" plywood-[4x8]'	7.95 $	5/16" plywood-(4x8)'	7.5 $		
each 8'-"A" column is	14.47 $				
sub total for : 3-8''"A"columns	43.41 $	3-8''"A"total -(tax not added)	40.88 $	Nov.17. 81	5.5 h/3 m
(1x3)"-2[9'] form	2.7 $	(1x3)"-9[10']	13.50 $		
(1x3)"/2-2[9'] form	1.35 $	(2x2)"-3[10']	5.20 $		
(2x2)"-[9'] form	1.71 $	(1x2)"-[4']	0.44 $		
(1x4)"-[10'] bracing	1.4 $	3/8" plywood-4(4x8)'	31.80 $		
3/8" plywood-[4x8]'	7.95 $				
each 9'-"A" column is	15.11 $				
sub total for : 3-9''"A"columns	45.33 $	3-9''"A" total (tax not added)	50.94 $	Nov.19. 81	5.5 h/4 m
(1x3)"-[8'] form	1.2 $	(1x3)"-3[8']	3.6 $		
(1x3)"/2-[8'] form	0.65 $	(1x4)"-[4']	0.56 $		
(1x2)"-[8'] form	0.88 $	1/2" plywood-(4x8)'	10.75 $		
3/8" plywood-[4x8]'	7.95 $				
(1x4)"-[5'] bracing	0.7 $				
each 8'-"L" column is	11.33 $				
sub total for : 2-8''"L"columns	22.66 $	2-8''"L" total (tax not added)	14.91 $		
(1x3)"-2[9'] form	2.7 $	(1x3)"-3[10']	4.50 $		
(1x3)"/2-2[9'] form	1.35 $	(1x3)"-1.5[8']	1.8 $		
TOTAL		TOTAL		TOTAL	

See next page.

flhbmnbhbmmmimmXMNBMNBMBMBMNBMNBMNBMBMMMMM

STRUCTURAL CHARACTERISTICS.

The column is made integral with the floorxand beam and floor steel - and therefore has a its crucial section at the ends. Since the capitals and base and are a full dimension 8", the columxm column section is that gx at base and xxxx capital.

MNBMNBMNBMNBMNBMBMNBMNBMNBMNBMNBMNBMNBMBMNBMNBMNBMNBMNBMNBMNBMNBMNBM

MNBMNBMBMNBMNBMNBMgNM

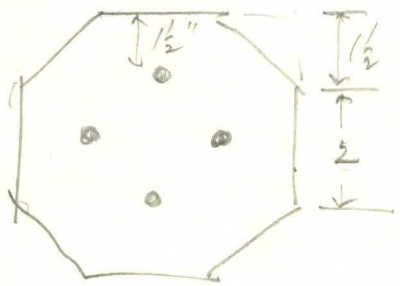
Different sizes of columns, may xhayxm take the loads given in the following tables:

Unusual features of the column, from the point of view of building codes, is the fact that the wire mesh is x sufficient to provide lateral restriction x to the main steel bars, and replace the ring bars specified in the code section .
Thix For calculations which justify this replacement, see appendix x.

The column meets code in respect of number of bars, size of bars, concrete cover over xx bars (1.5 inches on exterior facexm faces),

OCTAGONAL COLUMN.

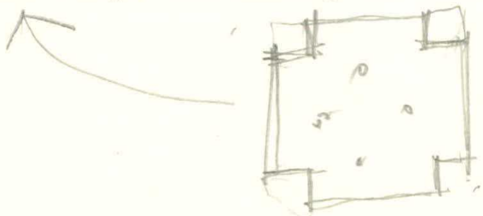
Eaxctly the same construction as the cruciform column, except that the guides in the formwork are chamfer-split 2x2's instead of full 2x2's. In this case, the column can be smaller, down to 5 ~~xxh~~ inches.



Again, if we wish, we can make column and base flare out to give the full square cross section, with the ends of the chemfered 2x2 cut in a special jig to give the flare.

CRUCIFORM COLUMN (WITH INTEGRAL BASE AND CAPITAL).

This column can be freestanding, or part of a wall. It can have any size, greater than 6 inches diameter. The column is essentially square, with corner indentations that make it cruciform. The shaping of the capital can vary, according to the effort and time spent.

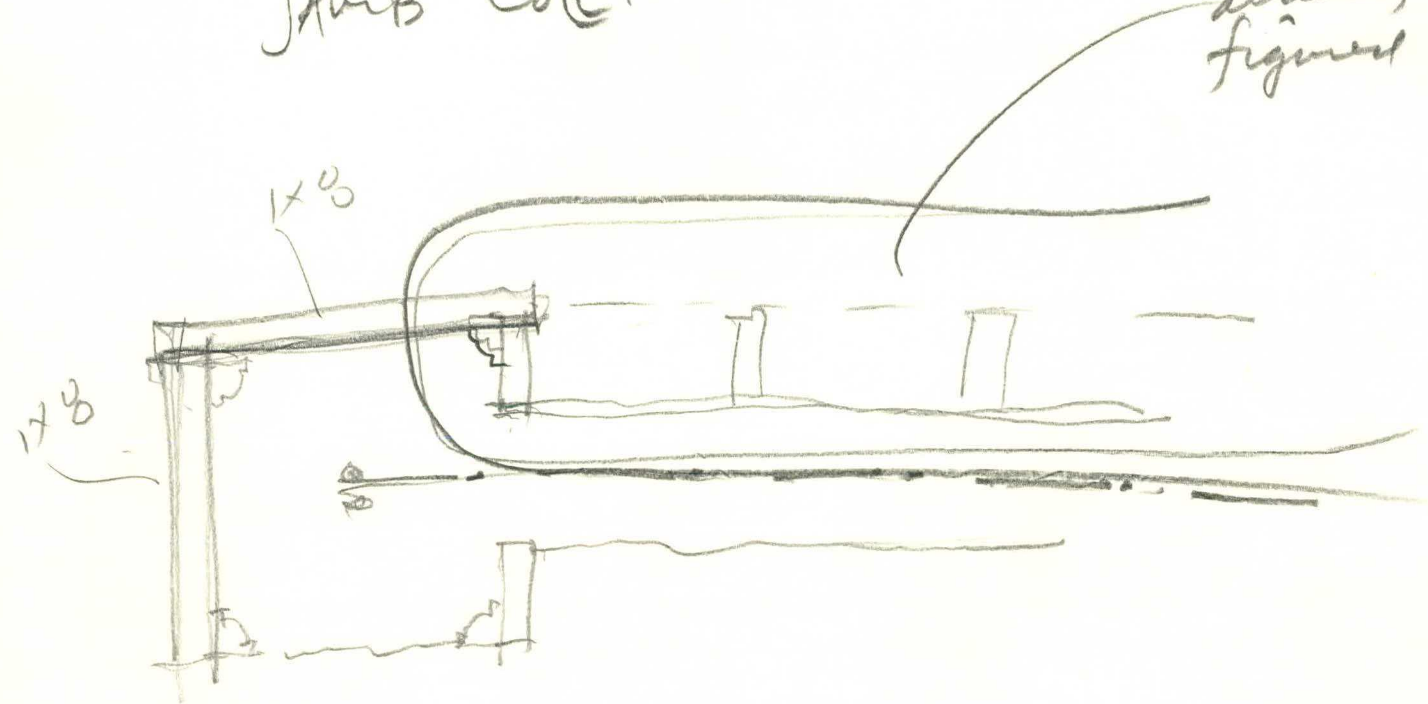


FORMWORK. The formwork of this column is made of four 2x2's, forming the corners of the column. The 2x2's are connected, top and bottom, by planks, or cross braced 1x material, in such a way both to stiffen the column, and to form the base and capital. The column faces are trowelled off, directly, against the corner forms, and the corners forms stripped.

STEEL. The steel for this column consists of four #4 bars, placed in a diamond with respect to the column faces, surrounded and held in place by a 4x4, 10/10 wire mesh, paper backed, to make spraying easy.

To form the flare for capital and base, the ends of the 2x2's must be cut in a special jig, with a jig saw, to a curve given by the jig.

JAMB COL.



4	7'	1X8's	336"	13125 BF X .21	5.00
4	7'	1X4's	336"	6.125 BF X	2.50
8	7'	moulding pieces	56 X .50?	$	28.00
					35.50

7' X 7"X7" X 12"/FT. = 4116 CU. IN.

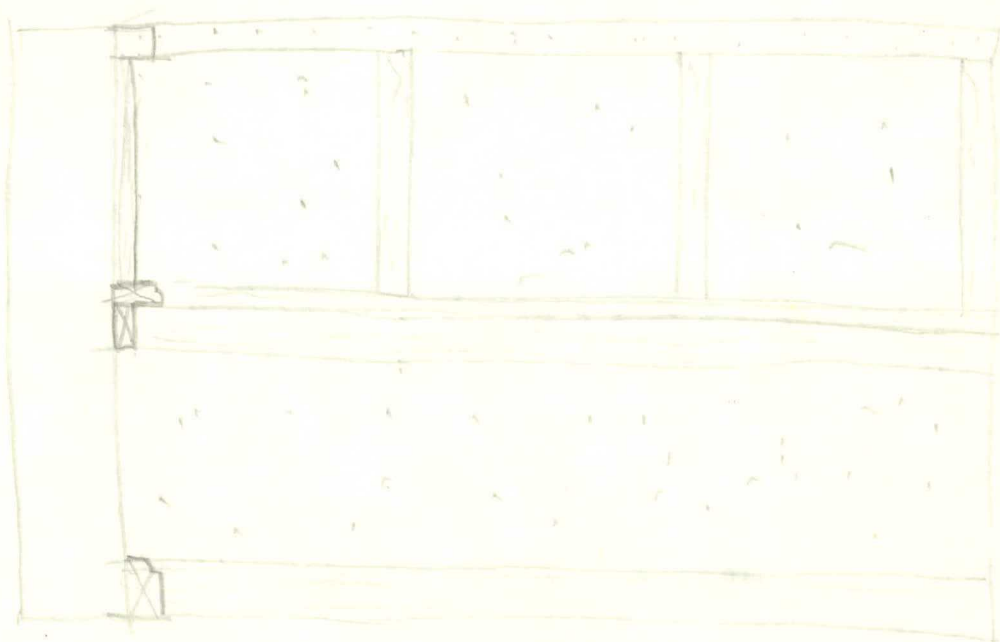
.17 CU. YDS. CON.

1/4 YD + .08

.25

EXTERIOR WALLS

This is an element of the larger building which immediately follows the placement of the corner columns described in that section. The present design results in an exterior which is rough in texture (that which is left from the gun), and an interior surface of two different types. In one type all screeding is done horizontally with temporary screed boards which results in a lightly textuted wall requiring no cover up molding. The other design dictates that one screed horizontally below wainscoat level, and vertically above that point. All screed surfaces are permanent and are to be covered with wood molding later.



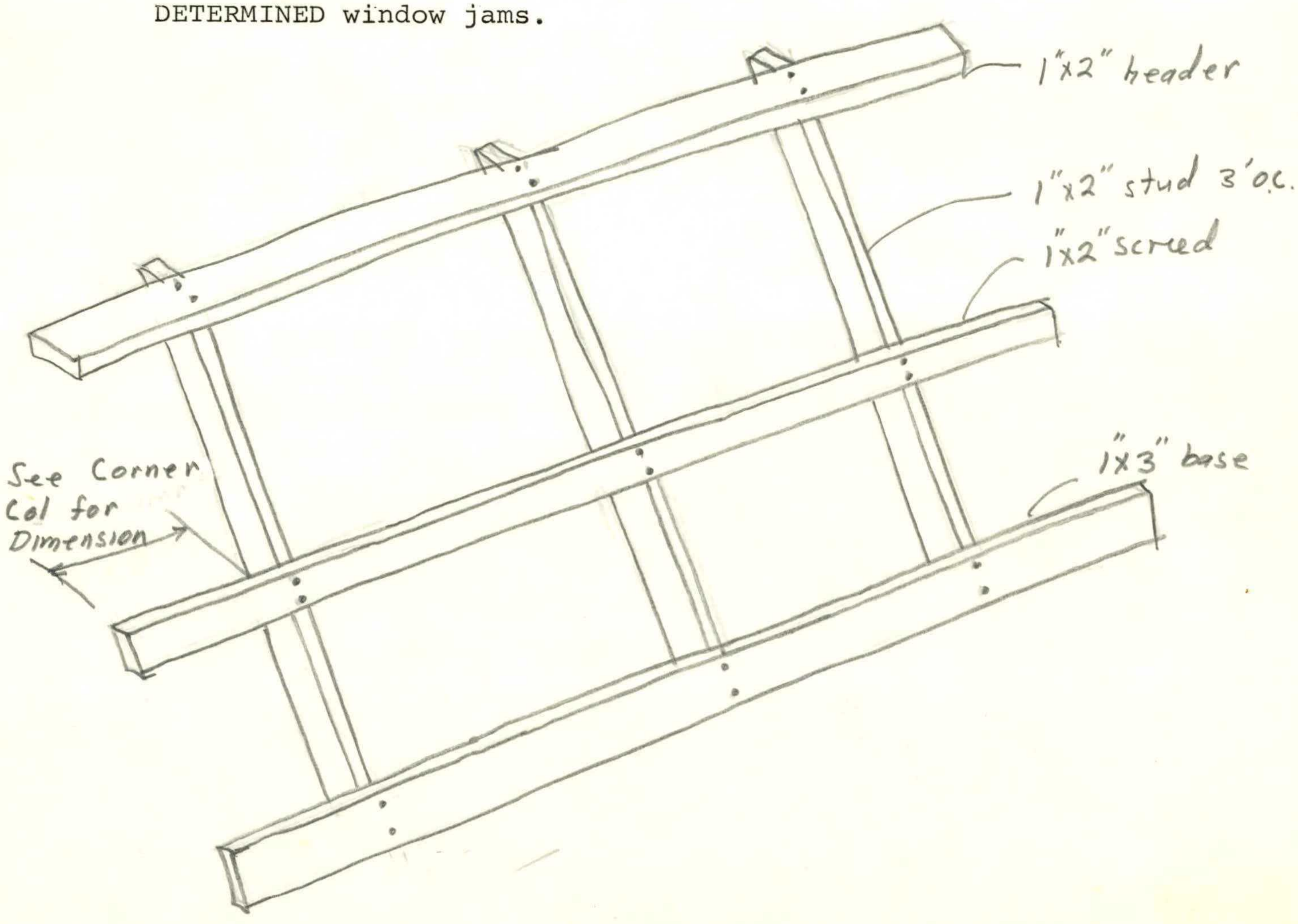
Finished surface (Type 2)

WE assume that the slab is in place with rebar stub outs, that the corner column forms have been built and are in place, and that the window openings have been located.

WE now place the exterior walls.

The walls themselves are constructed of light weight wood 1"x2" studs approximately 3' o.c. to which is attached 2 1/2" rigid insulation.

The first step is to build the wood frame in a horizontal position on a level surface. Make sure that the ~~xexttix~~ appropriate vertical studs fall in line with the previously DETERMINED window jams.



Operation schedule (10 lin ft of wall)

Make up 1"x2" wood frame	1 m/h
staple on wire mesh	1 m/h
nail on wood spacers	.25 m/h
erect and attach wall frame to corner col's.	1 m/h
Brace wall frames	.50 m/h
Make all necessary steel connections	1 m/h
Attach foam insulation and chicken wire	1.5 m/h
shoot inside 3" and screed	
Shoot outside 3/4"	

Total Labot

Operation cost

1"x2" studs 5@ per lin ft

1"x2" screeds 3@ per lin ft

1"x3" base 1@ per lin ft

ww mesh 80 sq ft @ per sq ft

foam insulation 80 sq ft @ per sq ft

chicken wire 80 sq ft @ per sq ft

#3 rebar 30 lin ft horiz + 24 lin ft vert @ per lin ft

3" conc interior .74 cu yd @ per cu yd

3/4" conc exterior .]8 cu yd @ pet cu yd

Total material cost

Total labor cost

TOTAL COST

COSTS PER SQ FT

Cost per sq ft of wall

Sq ft of wall per sq ft of floor

cost per sq ft of floor

FOR FURTHER IMFORMATION

corner columns

windows

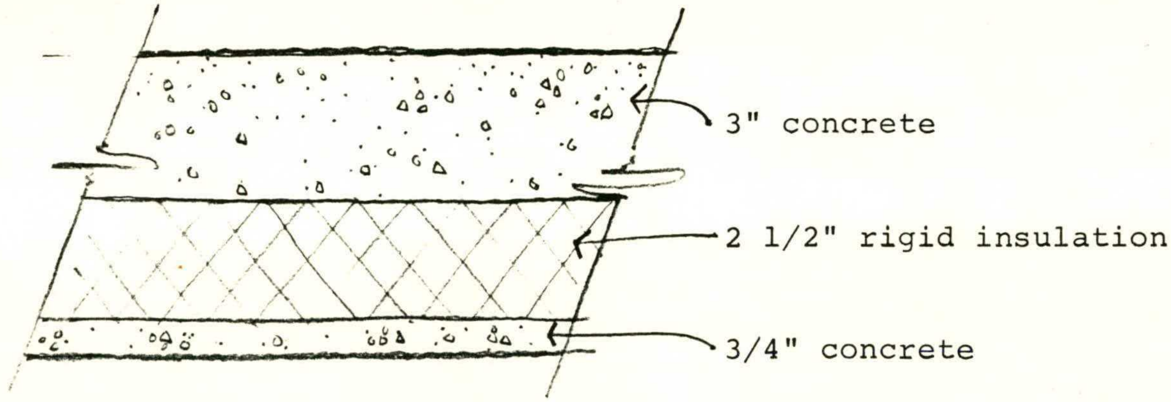
ceiling perimeter

cornice

FRAMEWORK FOR EXTERIOR WALLS

Now that the corner columns and cornice forms are built, we can begin to build the exterior wall frame. The forms for the corner column and cornice perform structurally, while the wall frame is just a screen between them. After the concrete is in place, the structural role of the wall changes; it becomes a shear wall that structurally stabilizes the column and beam.

The finished wall is made of two layers of concrete, one on each side of a layer of rigid insulation. The three inch inside layer of concrete acts as a structural shear wall, and the 3/4" layer of concrete on the outside acts as a protective coating over the 2 1/2" insulation.



The construction of the house, except for the roof and ceiling, has been conceived as a sequence of operations that will encourage a more efficient, mass-production like approach. The general sequence of operations is as follows:

1. Light framework

2. Openings for doors and windows

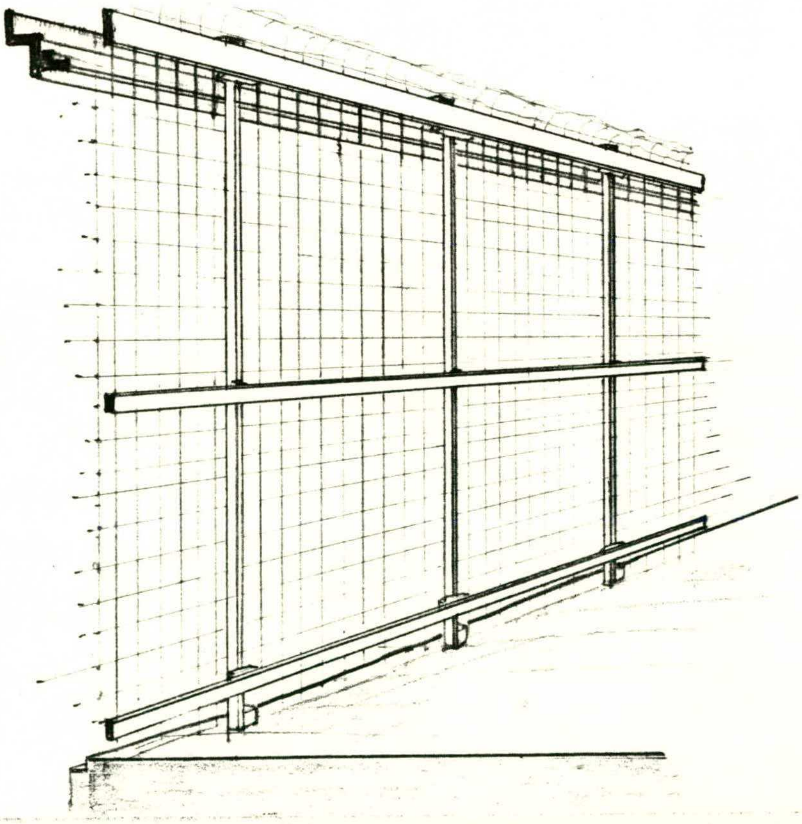
3. Reinforcement

4. Plumbing/Electricity/Heating

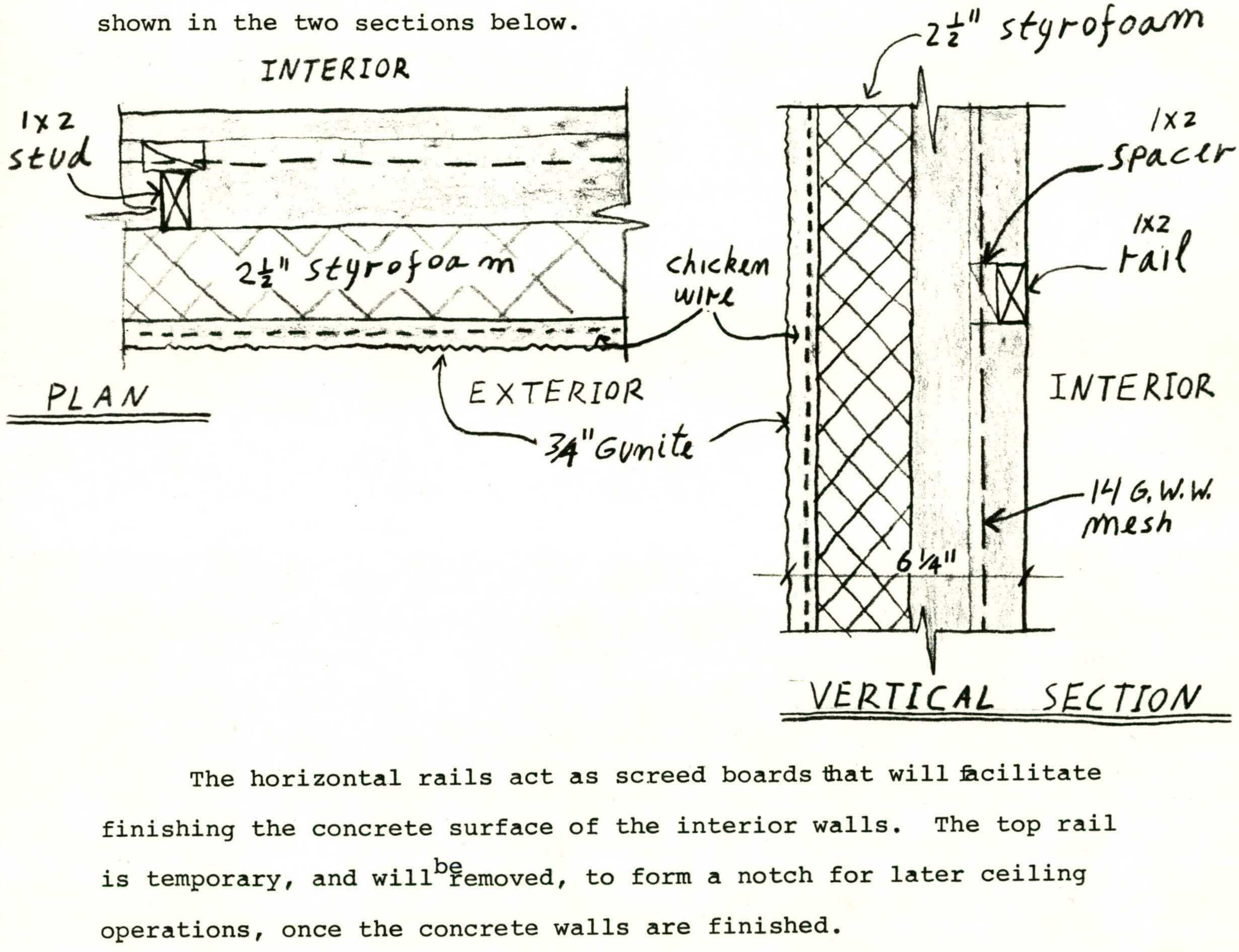
5. Insulation

6. Placement of concrete

This list applies to the construction of the exterior walls, just as it applies to the rest of the house. In this chapter we will describe the construction of the first step in the sequence, the light studs and wire mesh framework.



The wall framework is built from 1x2 vertical studs, 2(1x2) horizontal rails, and a temporary 1x4 horizontal rail at the top. Between the vertical and horizontal members will be attached wire mesh (2x4, 14ga.) that will cover the entire area of the frame. The finished exterior wall will have the configuration shown in the two sections below.



The horizontal rails act as screed boards that will facilitate finishing the concrete surface of the interior walls. The top rail is temporary, and will be removed, to form a notch for later ceiling operations, once the concrete walls are finished.

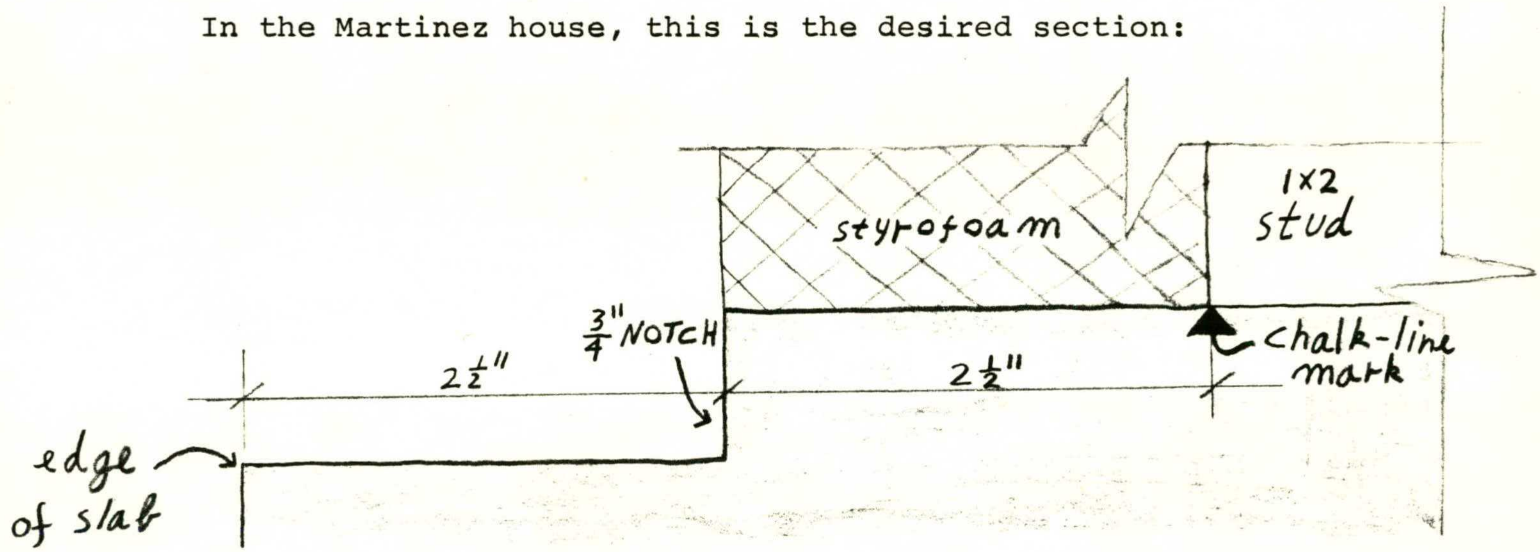
The wall frame has three critical connections: to the slab at the bottom, to the column forms at the sides, and to the cornice form at the top.

CONSTRUCTING THE EXTERIOR WALL FRAMEWORK

The following is the sequence of operations for constructing an exterior wall frame with an eight foot interior ceiling height.

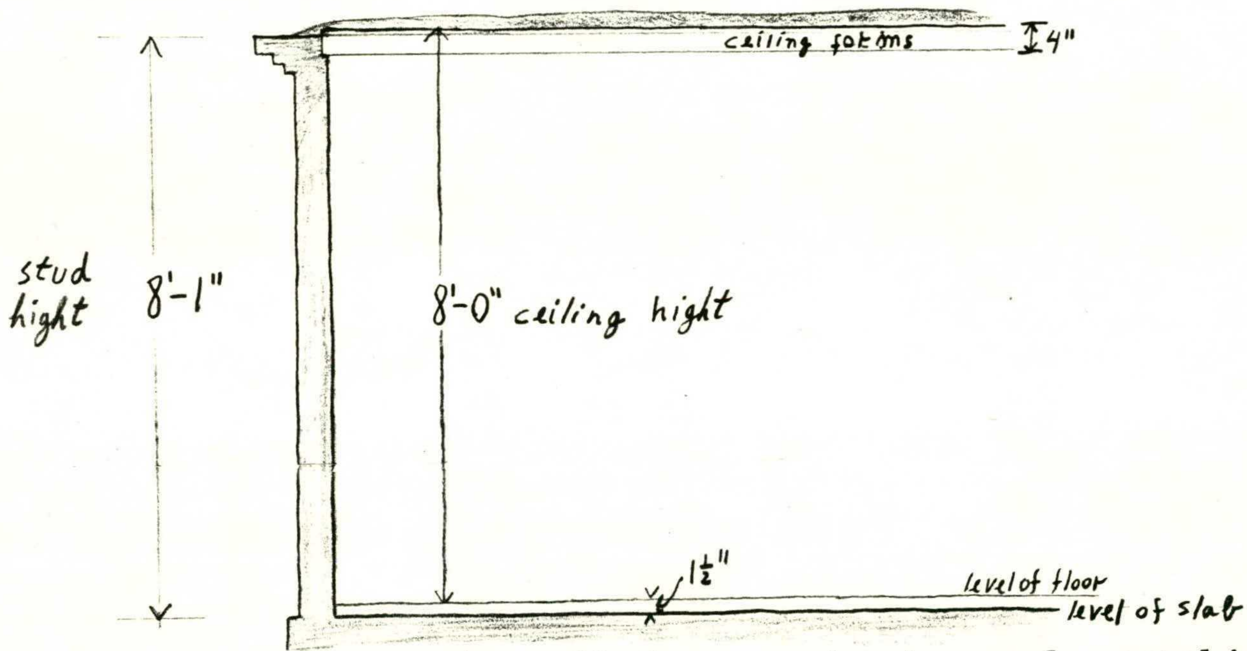
First, mark on the slab (with a chalk-line) a straight line between two columns. The line is to indicate where the studs should be placed in relation to the edge of the slab. This distance is determined by the proportions and configuration of the finished wall.

In the Martinez house, this is the desired section:



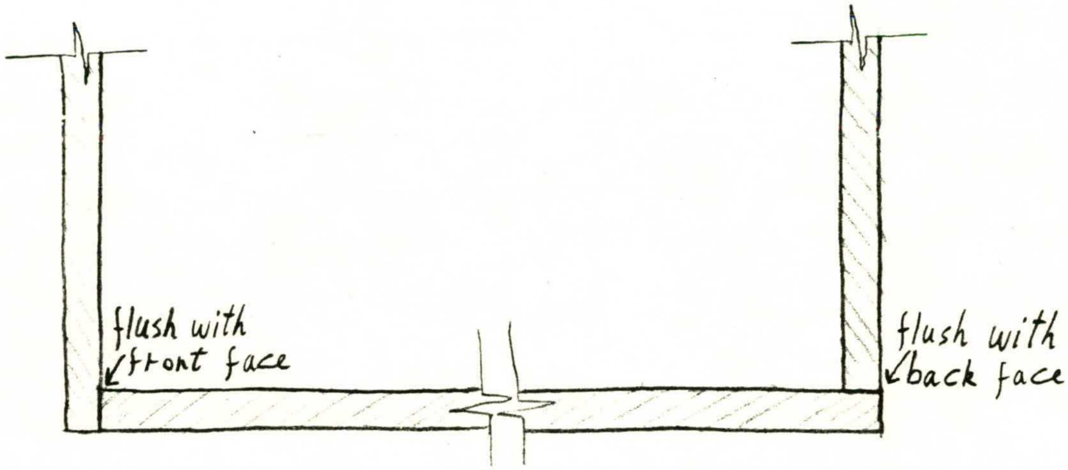
The next step is to choose and mark the places on the line where studs should be located. The principles that guide in selecting the number and placement of studs are as follow: in general, place studs about three feet apart; a stud should be no closer than one foot to a connection of the wall frame to a column form; a stud should be placed at <u>one</u> end (<u>only</u>) of the wall frame, so that it is flush with the face of the screed boards of the adjacent perpendicular wall; if a stud falls at a place on the wall which will have a door or window opening, move it to the nearest point along the wall that will not interfere with the construction of the opening (this last rule is not necessary since the studs can be moved easily).

Now that we have the number and location of the studs, cut the 1x2s to the correct length for the eight foot ceiling. For this ceiling height, the studs should be 8'-1" long.



On each exterior wall there are two types of screed boards: permanent 1x2's, and, the other, a temporary 1x4. The 1x2's serve as chairrail and baseboard nailers, while the 1x4 creates a notch in the gunite for the later ceiling operation. Both the 1x2's and 1x4 function primarily as screedboards for the gunite shooting operations.

Now cut the screed boards to the right size. The length of the screed boards is determined by the length of the wall frame being built plus the length needed at the end of the boards for connection to the screed boards of adjacent, perpendicular walls. The screed boards should be cut so that one end is flush with the front face and the other end is flush with the back face of the screed boards of the adjacent walls to which they are connected.



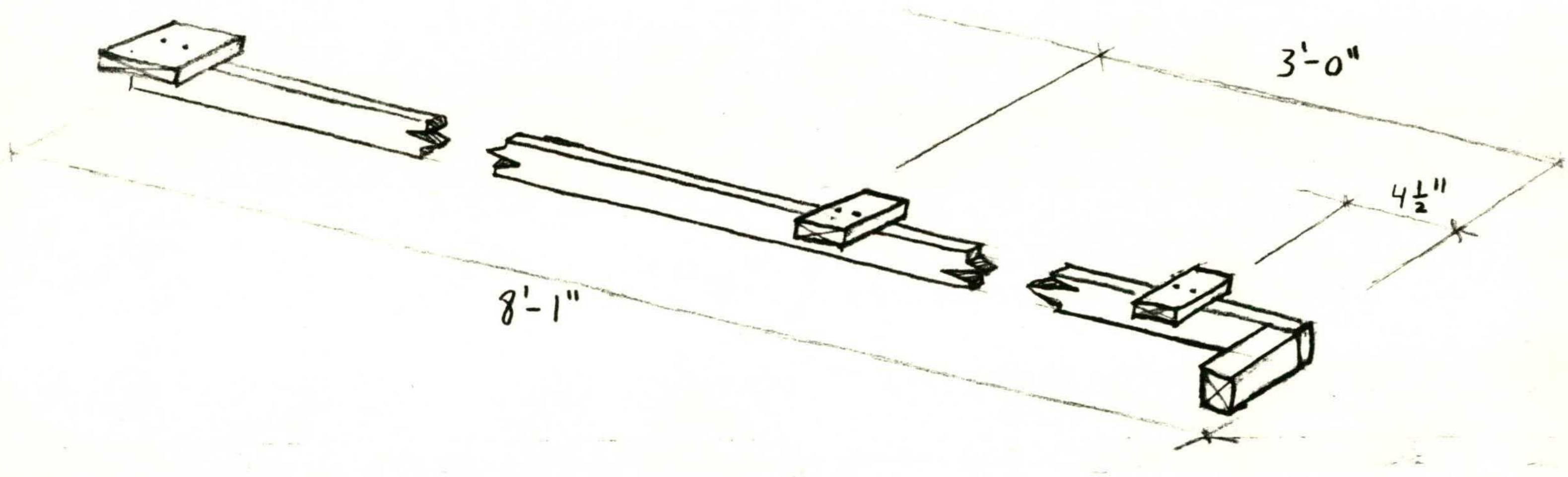
In order to create a sufficiently thick structural concrete wall, a 3/4" spacer is placed between the screed boards and the narrow face of every stud. These spacers are 1x2's for the chair-rail and baseboard, and a 1x4 for the 1x4 top screed board. The spacers are nailed perpendicular to the studs(parallel to the screed boards). Care must be taken , from this point forward, to fix the structure of the walls with galvanized nails since they will be permanently imbedded in the wall.

The marking of the position of the spacers on the studs is as follows:

1. The baseboard spacer should be nailed so that the bottom of the spacer is 4 1/2" from the bottom of the stud.
2. The chairrail should -e nailed so that the top of the spacer is 3'-0" from the bottom of the stud.

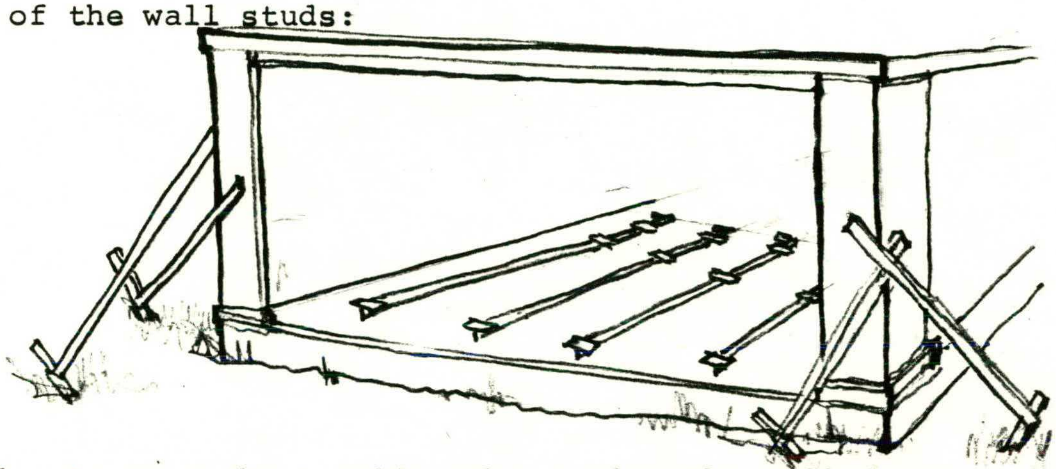
3. The top board spacer should be nailed so that the top of the spacer is flush with the top of the stud.

Before the nailing of the spacers, a small 2x2 wooden block (roughly 4" long) should be nailed to the bottom of the wide face of the stud. This wooden block provides a glueing surface between the wall framework and the slab. It can be fixed on either side of the stud, as long as it doesn't interfere with the vertical reinforcement bars or wall openings. For the Martinez project, we used #6 galvanized box nails for the 2x2 blocks, and #3 galvanized box nails for the spacers.



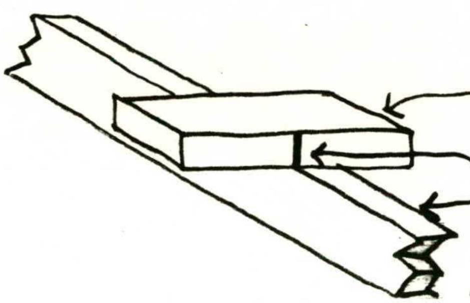
Now that all the studs are nailed with spacers and blocks, and the screed boards are cut the right length, lay the studs on the slab, perpendicular to the edge of the slab, and each stud roughly opposite its place on the chalk line. The studs are laid with the spacers laying upward and oriented so that the top of the stud (the 1x4 end) is closest to the chalkline. Later, this will allow lifting the finished wall frame into place without rotating it.

Laying out of the wall studs:



In order to save the trouble of squaring the wall frame later on, mark the screedboards and studs as follows:

1. First, mark the bottom short face of the spacers with a vertical line flush with one side of the stud. (It doesn't matter which side of the stud you use, but once chosen, remain consistent.)



2. Place one of the screed boards on the chalkline, mark the short face of the screed board with vertical lines in the exact places where the studs will be. (ie. avoiding reinforcing bars, door locations, etc.)

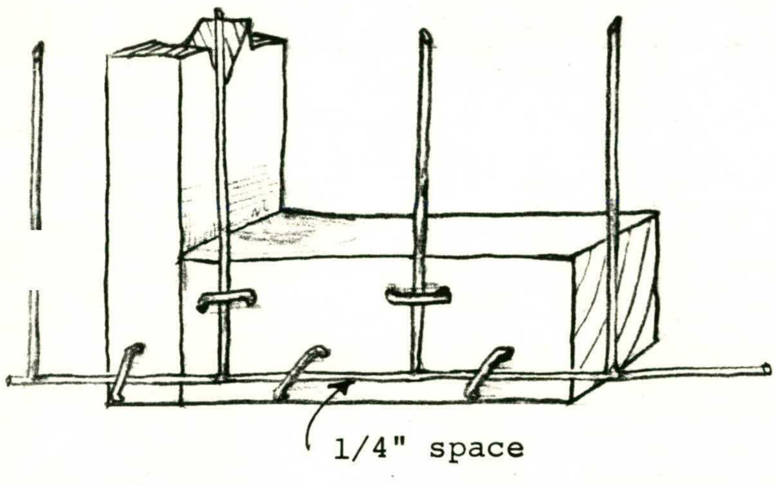
3. Transfer these marks onto the other two screed boards.

Now that all the marking is done, lay aside the screed boards and place the mesh over the studs.

The mesh that was used in the Martinez project was (2"x4") 14 ga. W.W.mesh.

The mesh should cover the studs from the bottom, and extend one foot over the top. It should be one foot longer than the length of the screed boards so when the wall is in place, there is a one foot extension of mesh at one end of the wall, where it meets the column. Lay the mesh over the studs and cut little windows so that the spacers can come through. Now pick up the screed boards and place them over the spacers, line-up the lines and nail. The nailing should be done on the 1x2 screed boards simultaneously, moving from stud to stud. Next, line-up the 1x4 screed board and nail it. (#3 galvn. box nails)

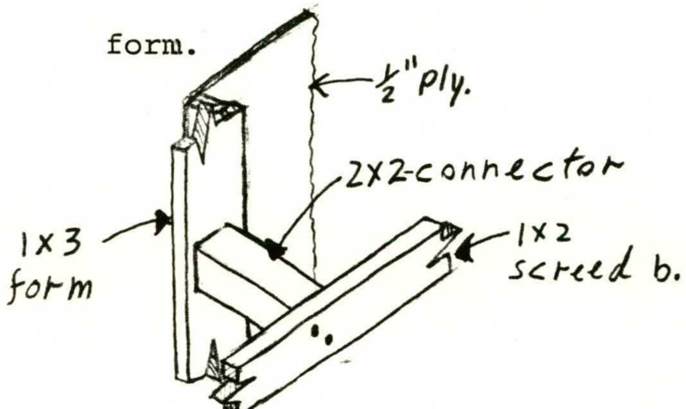
Now that the screed boards are nailed in place, staple the mesh to the studs. Begin at one end, then move from one stud to the next, trying to stretch the mesh to eliminate waves of loose mesh between the studs. In the Martinez project, the stapling was done with a regular staple gun using 1/2" staples. Make sure when stapling that the bottom of the mesh is below the bottom of the stud. To assure this, always try to leav about 1/4" space between the bottom of the mesh and the bottom of the stud.



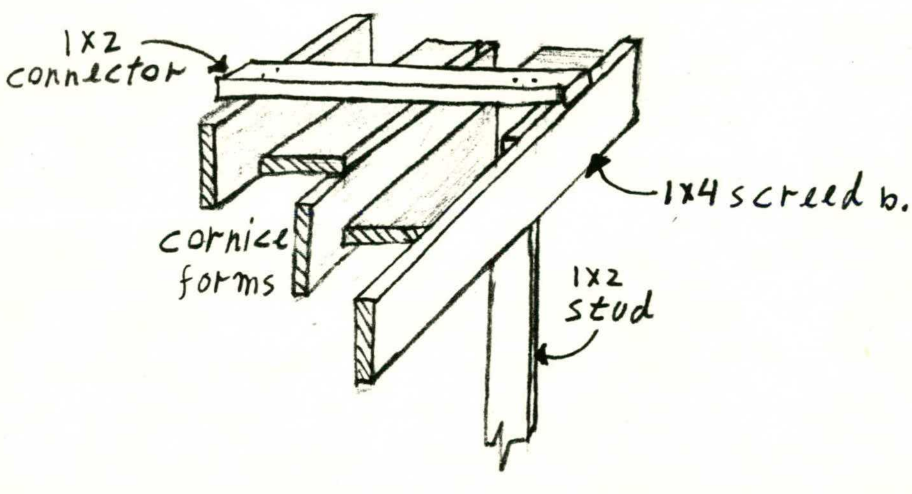
ERECTION OF THE WALL FRAME

A most important part of the erection procedure is the connections of the wall frame-to the slab, to the column forms, and to the cornice forms. Therefore, before erecting the wall frame the following preparations must be made:

1. Cut 4 pieces (column connectors) of 2x2, 4 3/4" long. This length is determined by the distance between the 1x2 screed board and the 1x3 column form.

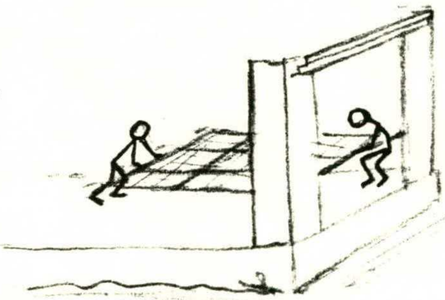


2. Cut a number of 1x2's (one for each stud) 14" long that will connect the 1x4 screed board to the cornice form. This length is determined by the 13 1/4" between the top cornice form and the 1x4 screed board.

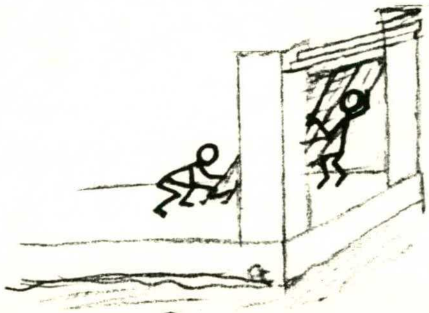


The first step in the erection procedure is spreading glue over the bottom of the studs-the 2x2 blocks. Construction glue P.L.200 was used in the Martinez house. The studs are glued to the slab so that the wall frame can withstand the force of the gun while shooting.

The next step is lifting the wall frame off the ground. Two people are enough,if the wall is 10'-12' or shorter. Then, while the whole frame is in the air, slide it backwards into its right position between the columns' forms.



①



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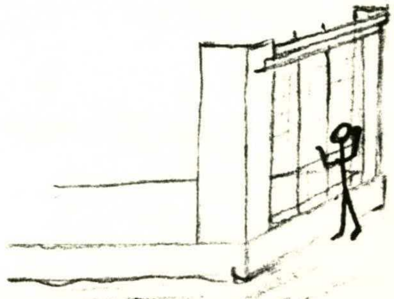
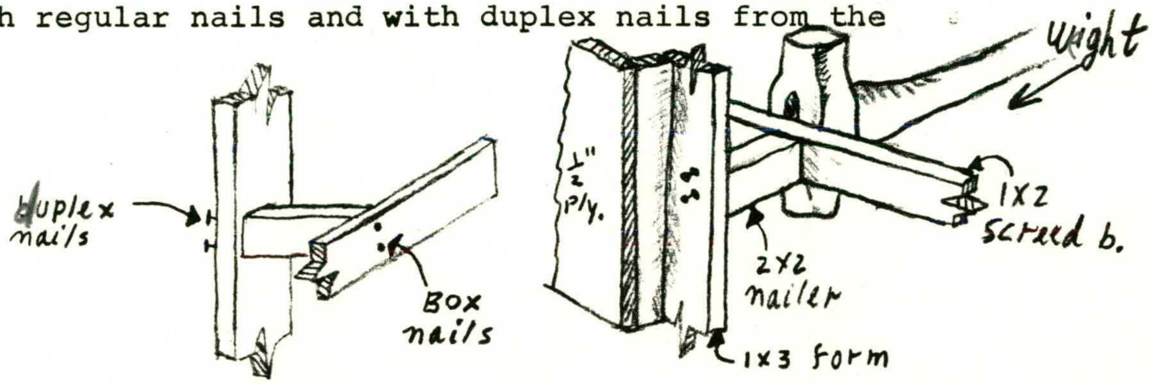


③

While sliding,care must be taken that the studs do not touch the slab so that the glue stays on. When the wall is just about in its right place above the chalk-line,lay the frame down. Sometimes the 2x2 blocks at the bottom of the studs have no sufficient contact with the concrete surface of the slab.In such a case press the stud down until the glue at the bottom is in contact with the slab surface.

The last step is to attach the wall frame to the columns and cornice forms.

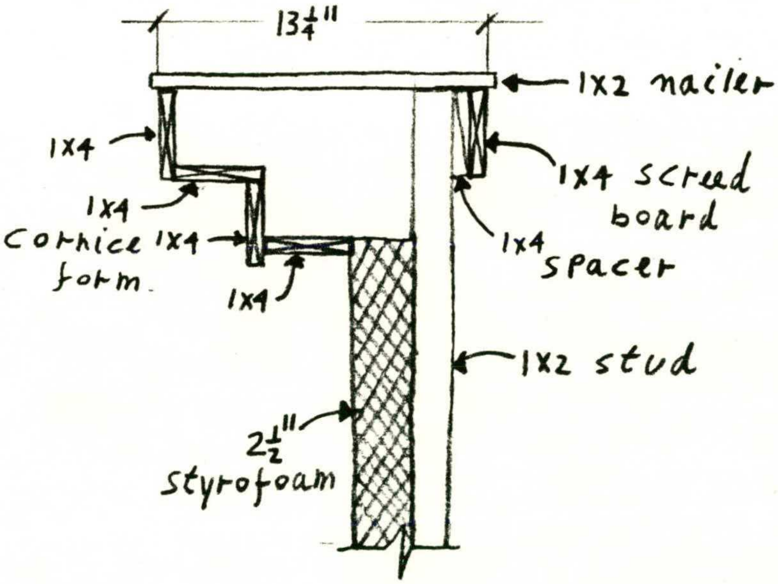
The connection of the 1x2 screed boards to the 1x3 column form is done with the 2x2-4$^{3}/_{4}$" piece. It is nailed from the inside with regular nails and with duplex nails from the outside.



The nailing is done from one side while another man is holding a weight set against the oppsite side.

Then connect the top of the studs to the top of the cornice forms with the 1x2-14" nailer.The nailing should be done with #3 or#4 box nails so it is easy to remove later.For easier nailing set the weight again,this time under the cornice.

In the Martinez house the right distance (due to the configuration of the wall elements) is 13$^{1}/_{4}$".



OPERATION EXTERIOR WALLS FRAM

MATERIALS

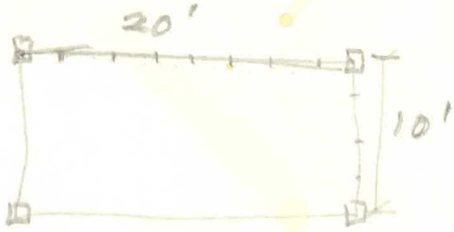
DESCRIPTION	COST	REMARKS
For each 1' @ 9' wall hight		
(1x2)"-[3'] stud	0.33 $	given with discount
(1x2)"-[2'] screed board	o.22 $	" " "
(1x4)"-[1'] screed board	0.14 $	" " "
(1x2)"-[1'] spacer	0.11 $	" " "
(2"x4") 14 G.W.W.-[1'x10']	1.50 $	donated
sub total for 1'	2.30 $	tax not included
sub total of 105' @ 9' hight	242 $	" " "
For each 1' @ 8' wall hight		
(1x2)"- [2.67'] stud	0.29 $	given with discount
(1x2)"- [2'] screed board	0.22 $	" " "
(1x4)"- [1'] " "	0.14 $	" " "
(1x2)"- [1'] spacer	0.11 $	" " "
(2"x4") 14 G.W.W. -[1'x9']	1.35 $	donated
sub total for 1'	2.11 $	tax not included
sub total of 95' @ 8' hight	201 $	" " "
SUB TOTAL	443 $	tax not included
TAX - 6.5%	28.8 $	
CONSUMABLES - 5%	23.6 $	
TOTAL	496 $	total length of 200'

LABOR

DATE	MEN	HOURS
DEC.15,81	2	5.5
DEC.16,81	2	4.5
DEC.30,81	3	4
DEC.31,81	3	2
JAN.12,82	2	2
JAN.14,82	3	7.5
JAN.23,82	2	9
JAN.30,82	2	8.5
TOTAL		

Pg I

365 ✱ (X) = 1316



= 60' perimeter

60 x 8 = 480 □'

WALLS (materials)

vert. 1x2 (8') @ 3' centers = 6+6+3+3 = 18 (8') 1x2

60' x 2 = 120' of 1x2 screed

60' x 1 = 60' of 1x3 screed

Lumber

264' of 1x2 — $26.40

60' of 1x3 — $9.00

steel

480 □' of wire mesh (.12/□') — $57.60

480 □' of chicken wire (.08/□') — 38.40

3x60 + 20x8 =
180 + 160 = 340' of #3 rebar — 34.00

Insulation

480 □' of 2" foam — $245.00

Concrete

0.3' x 480'² = 144 f³ = 5.33 cu yds

@ $60/yd³ — 320.00

Total of $1.52/sF of wall — $730.40

Walls (materials)

cost comparison with garage

Garage

columns	$231
walls	$243
Total	$474

Total cost / SF of wall surface

480□' − 163□' = 317□'

$474/317□' = **$1.50/SF**

House

Total cost / SF of wall surface

$730*/480□' = **1.52/SF**

Note: Col. matl's not included here

* see pg 1

10' x 20' building

Walls (calc. Labor costs)

Two men 5 hrs. to build wall frames

Two men 7 hrs to build & erect 3¼* columns

3 man days

Two men 4 hrs to erect and brace walls

1 man day

4 man days prior to gunite

Two men 2 days to spray concrete.

4 man days to gunite

Total of 8 man days to complete (excluding window frames and stipping form work).

Allowable time = 10 man days ⇒ 2 man day margine.

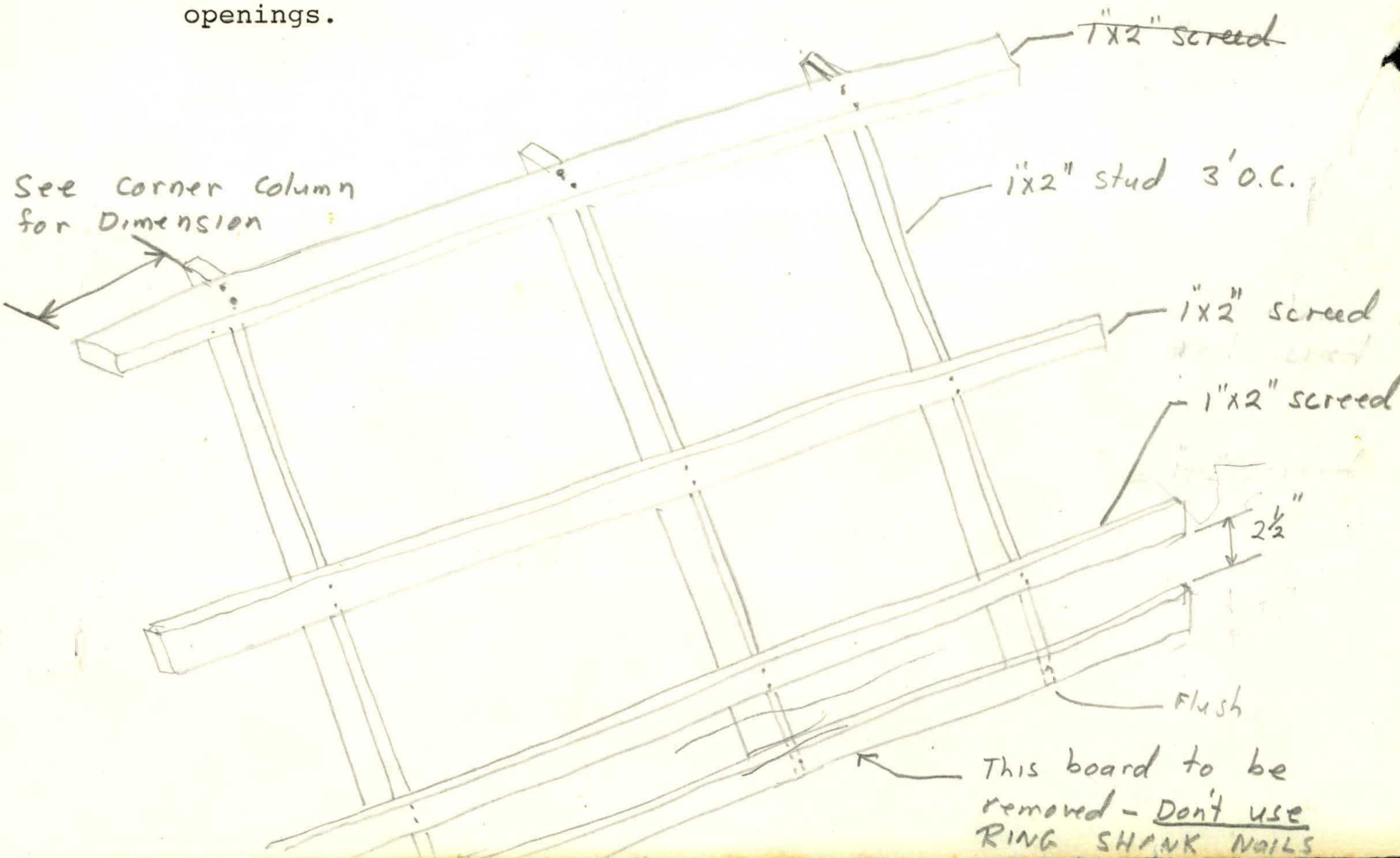
* $\frac{10 \text{ columns}}{185 \text{ Lin ft}} = \frac{x}{60 \text{ Lin ft}} \Rightarrow x = 3.24$ col's.

Revised 8/26/80

EXTERIOR WALLS

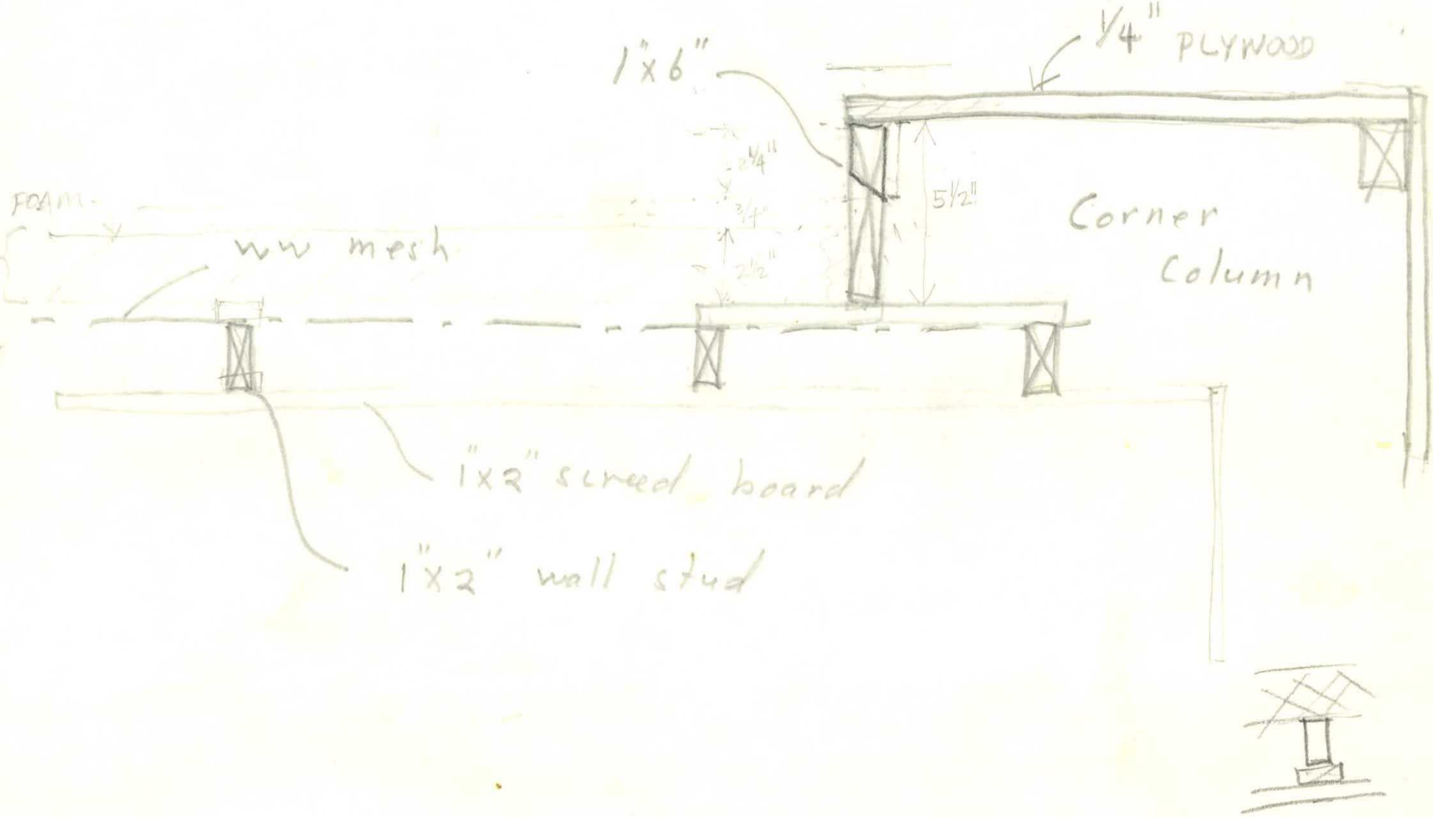
This is an element of the larger building which immediately follows the placement of the corner columns described in that section. The present design results in an exterior which is rough in texture (that which is left from the gun), and an interior surface which is screeded. The screed boards are horizontal 1"x2" located at the top of the wall, the bottom and at chair rail heighth (32" or so) above the finished floor. The boards remain in place after shooting and are covered up by a finish moulding of some sort at the time when finish trim is applied.

The wall panells will be built on a horizontal surface and will consist of light weight 1"x2"s. The verticals will be placed on 3' centers without regard to window openings. 1"x3" 11/24/80



Next turn the frame over and staple the ww mesh to the backside of the wall. The 3/4" spacers can also be applied at this point.

The walls are now ready for erection. They would be tilted into place and nailed to the corner columns.



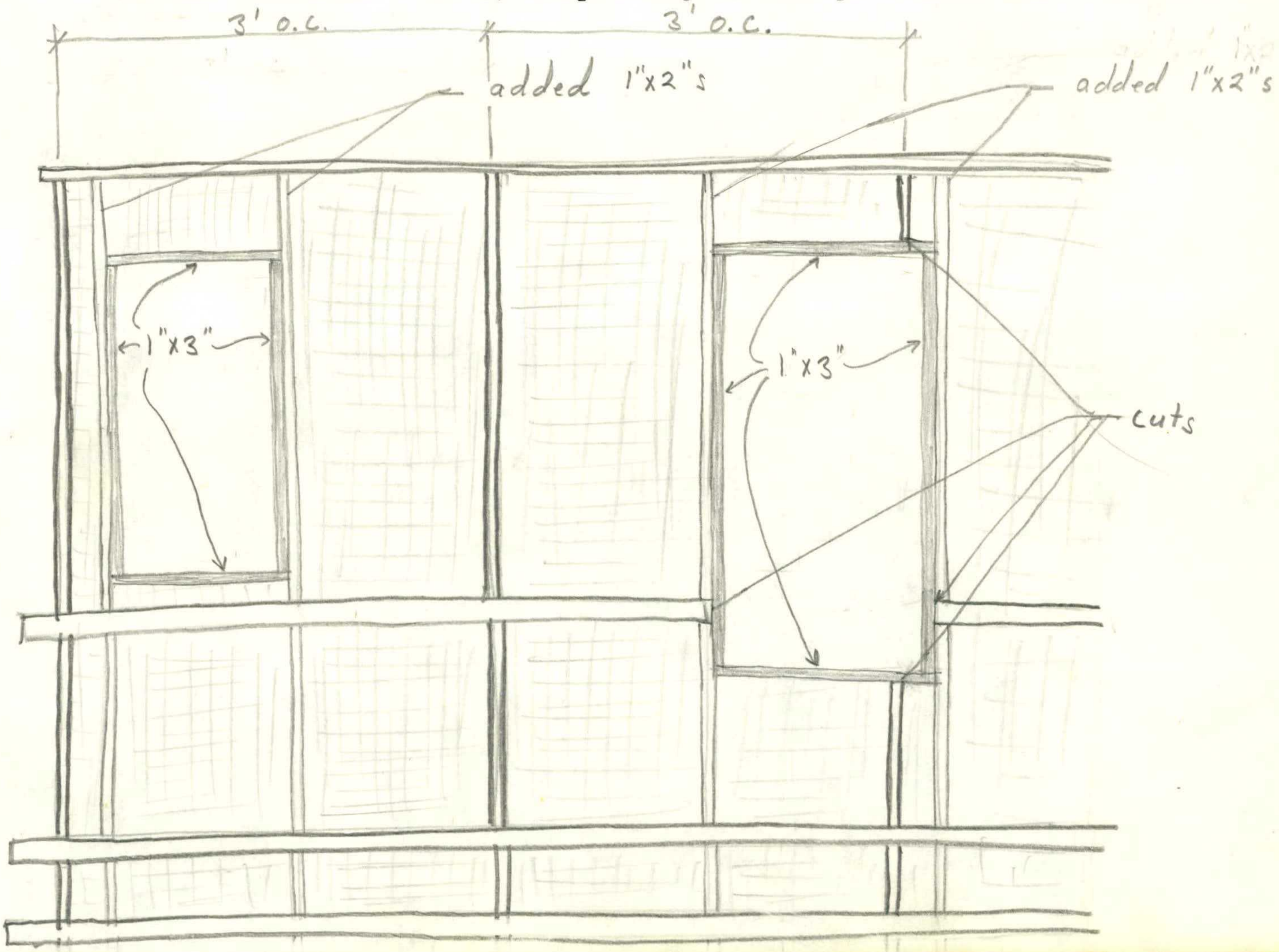
Once the wall frames are in place they would be plumbed and braced along their length with 2"x4" running to a stake in the ground. The estimated interval is to be about 8'.

Make the necessary steel connections at the corner columns and run the vertical and horizontal rebar.

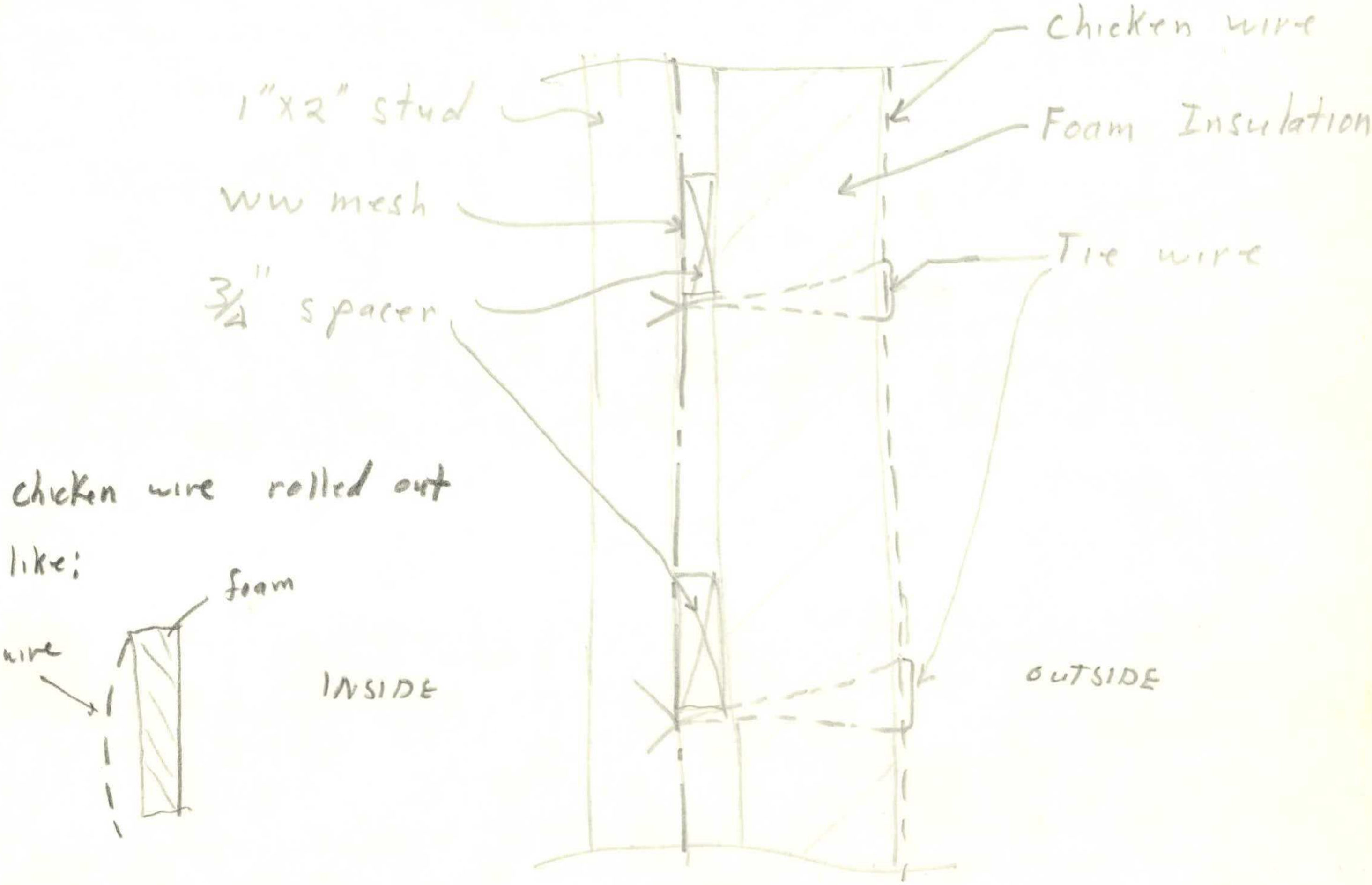
EXTERIOR WALLS

The next phase is of immense importance and the ease of which it can be done is one of the truely great features of the system...we now locate the window openings.

A A couple of 8' 1"x2" studs are used to mark the vertical edges of an opening. once this dimension is right one then proceedes to locate the upper and lower edges. (use 1"x3"s here) Should an opening interupt an already existing stud we just cut it out...the staples holding it to the mesh come out fairly easily. The same is true for the chair rail, should a lower boundary go below that heighth. The final step is to add the vertical 1"x3"s, completing the rough frame. See WINDOWS & DOORS



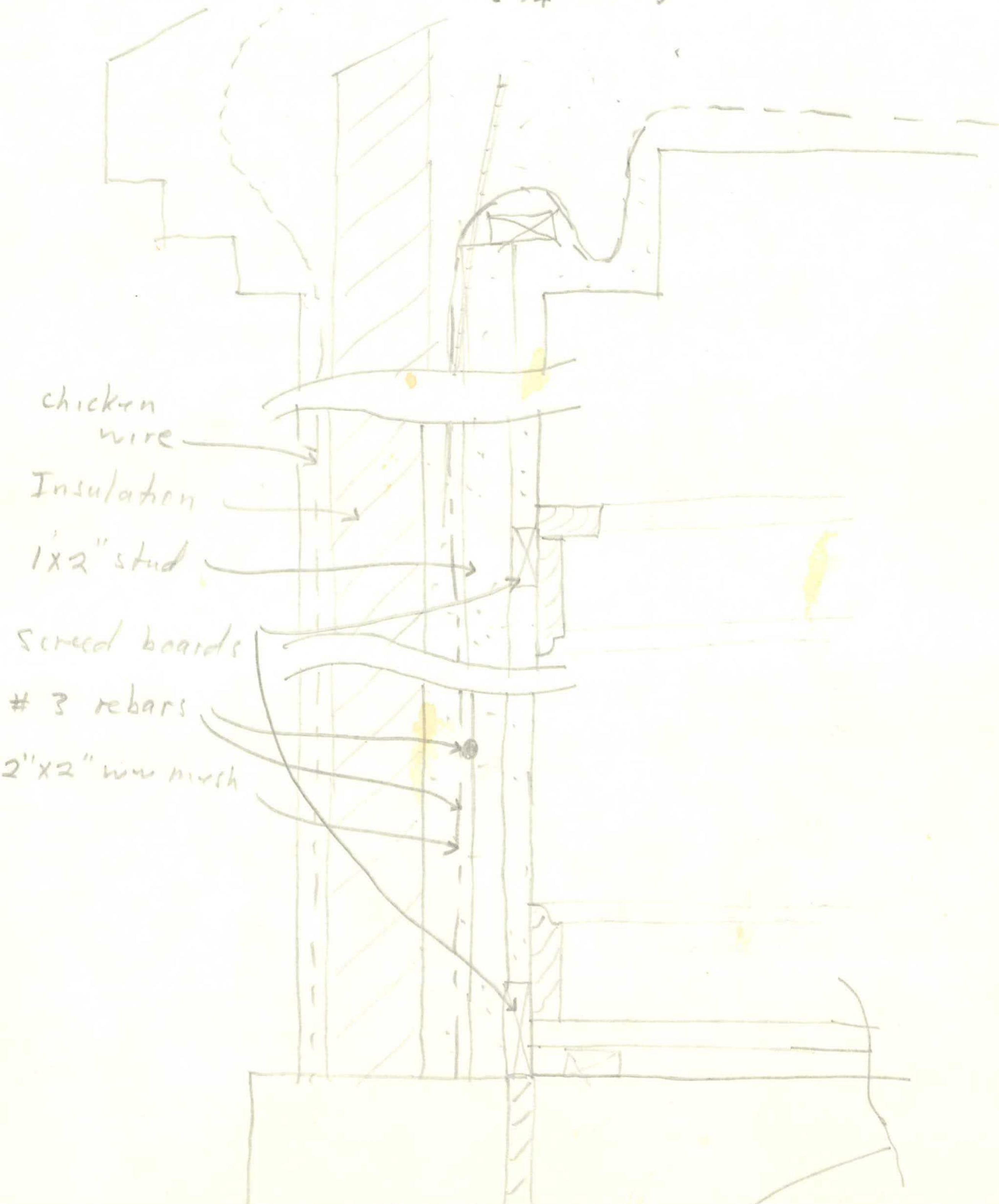
The next task, just prior to gunite is to apply the rigid insulation, This step requires two people, one inside the wall and one outside. The proceedure is to hold the insulation in place with tie wire which attaches to the chicken wire on the outside, goes through the foam, and ties around the ww mesh on the inside.



Since the whole outer half of the wall relies on its connection to the inner concrete portion for stability, the use of tie wire in this operation should be generous.

AT this point one erects the window boundaries against the outside of the wall (SEE WINDOWS&DOORS).

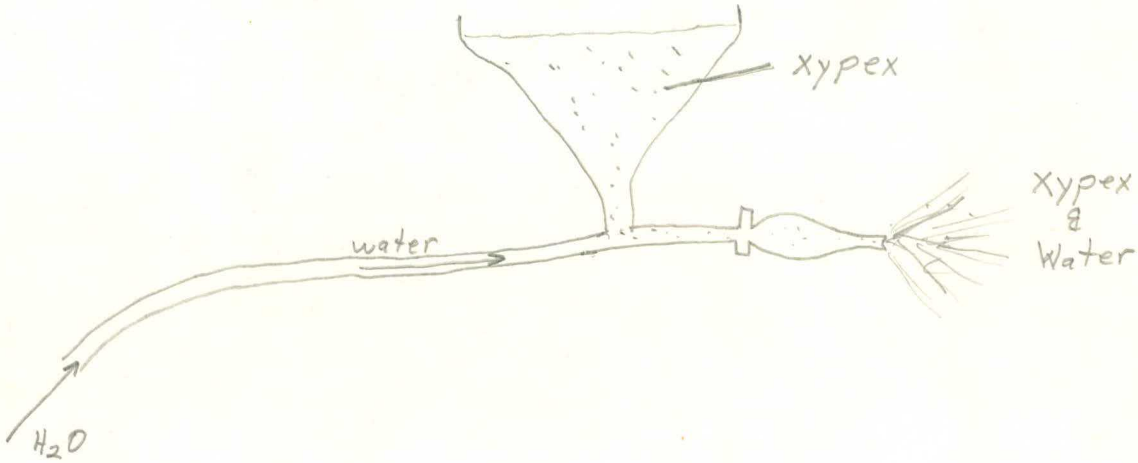
The final step is to shoot the walls with gunite. This would be done in two phases. The first phase is to shoot the inside, (3 inches) along with the corner columns, and the second is to shoot the outside. (3/4 inches)



OK as of 9/11/80

WALL WATERPROOFING

The exterior walls will be sprayed with xypex waterproofing. One method of application involves a hopper type sprayer, which uses a hopper full of xypex and mixes it with water at the nozzel.



Since the reed gun is similar in performance I called mr. Spall at Concrete Waterproofing of California to discuss the possibilities.

Two conclusions were reached. 1) turn the pressure of the machine down as low as possible (about 25psi at the nozzel) to reduce rebound. 2) mix a batch of xyoex with water by hand using the exact poportions called for and then spray a sample with the reed gun into an adjacent bucket, adjusting the water until a mixture is reached which seems to be like the hand mixed batch.

Mr. Spall saw no reason why the reed gun wouldn't work, but thought it might take some experimenting.

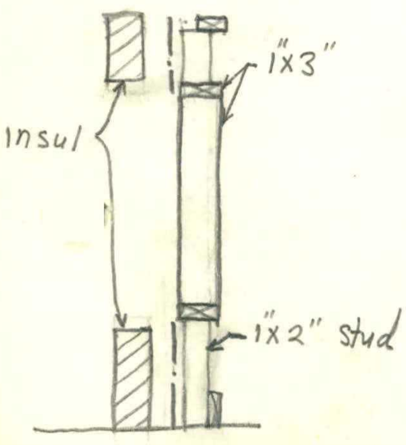
I also asked him if the xypex could be mixed dry with the gunite and sprayed on the exterior wall in one application. His reply was, no.

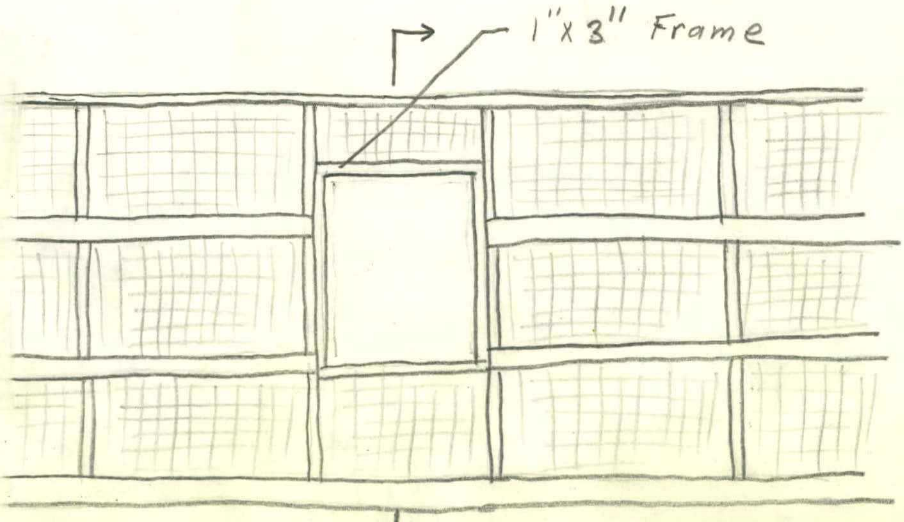
EXTERIOR WINDOW BOUNDARIES

A boundary around a window both marks the window as an element and provides a transition zone between the transparent material of the window pane and the opaque wall. In order for one to feel good with the rough surface of the exterior walls the boundaries must be exact, with clean lines. The space around a window is not the only place where exact boundaries are necessary. Other natural places are; at the base, at corner columns, at the cornice, and around exterior doors. Without the boundaries the building could conceivably begin to take on the so-called"organic" appearance which was proclaimed in the 1960's and is typically associated with a hippie movement.

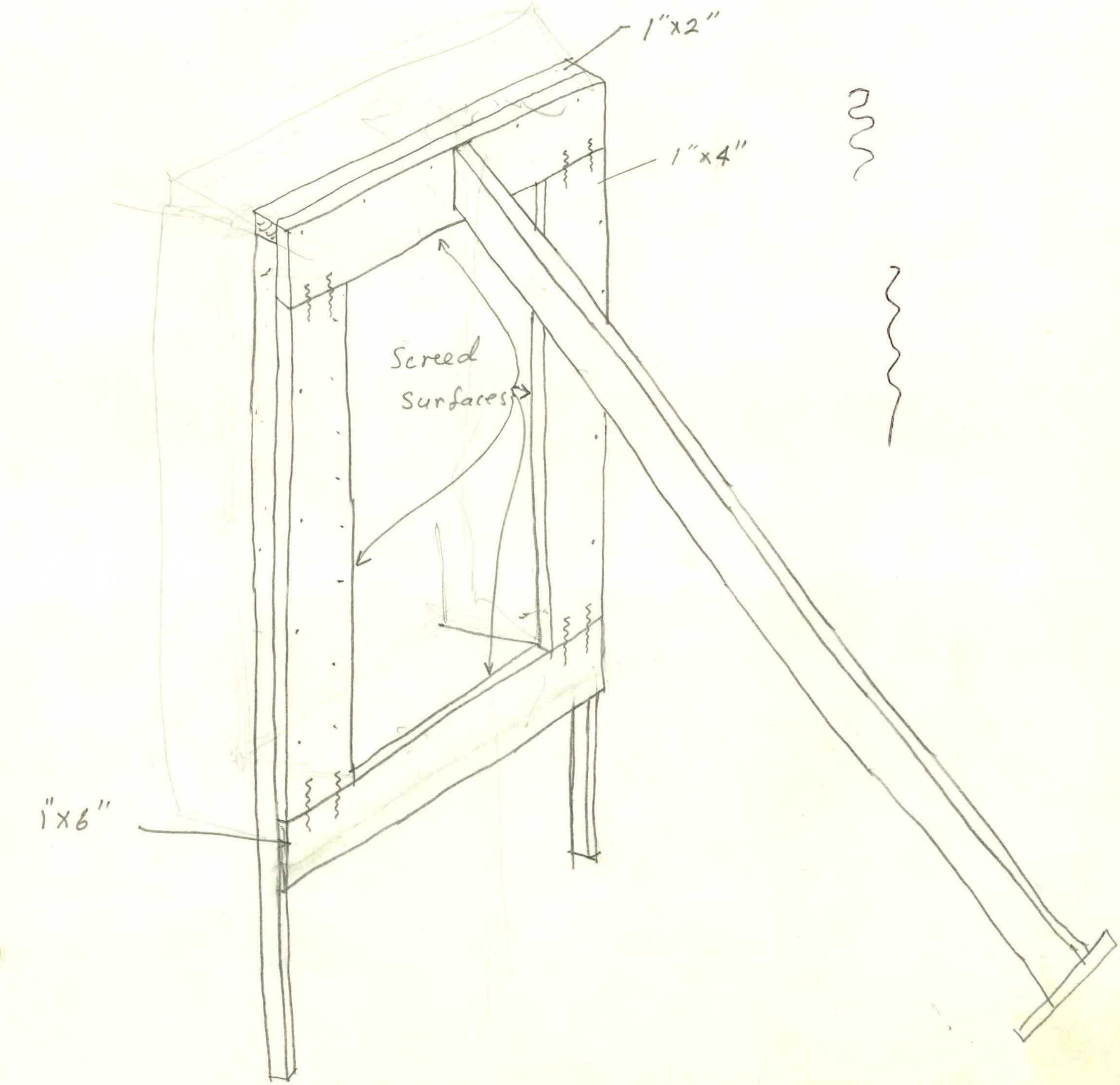
While this section deals with the boundaries around windows the technique could also be applied to exterior door openings.

At the point one begins to form the window boundaries the walls are in place with the foam attached (see exterior walls) and the frame for the window openings have been made, and built into the light weight wall frame.

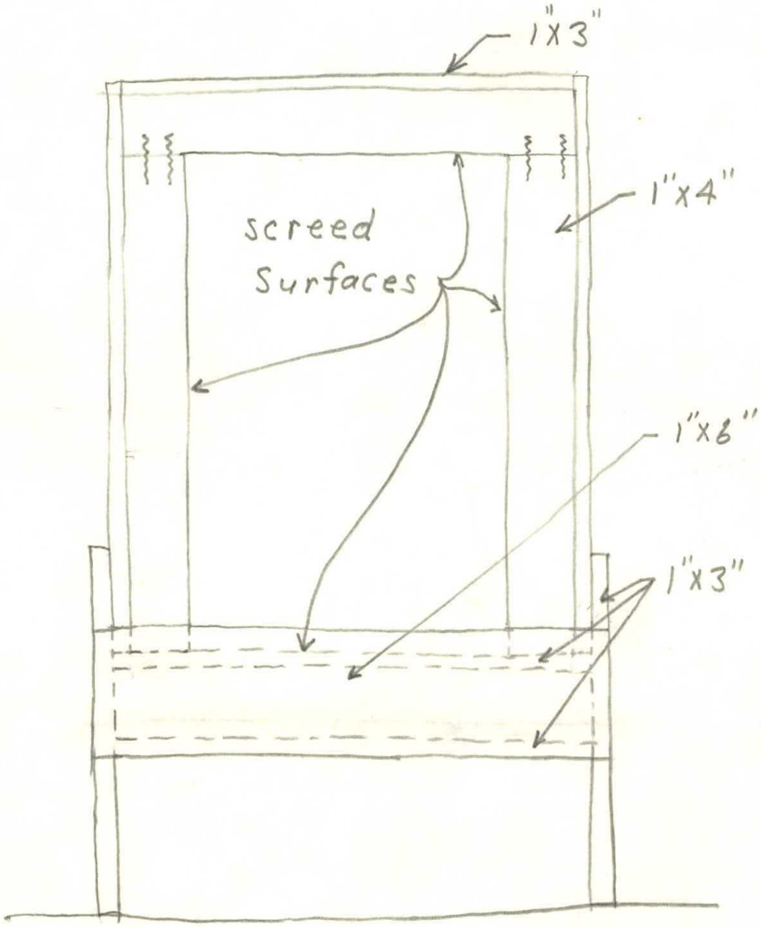


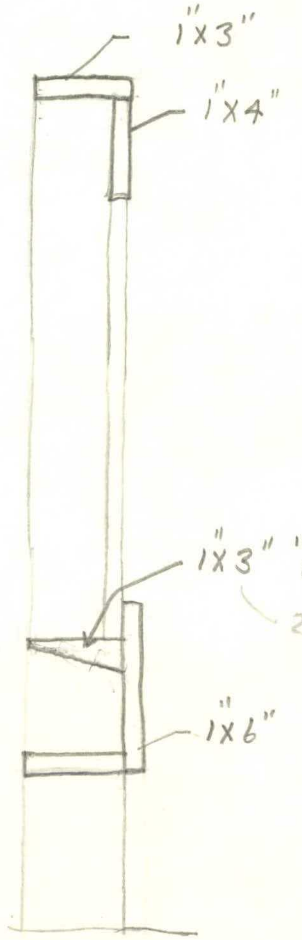


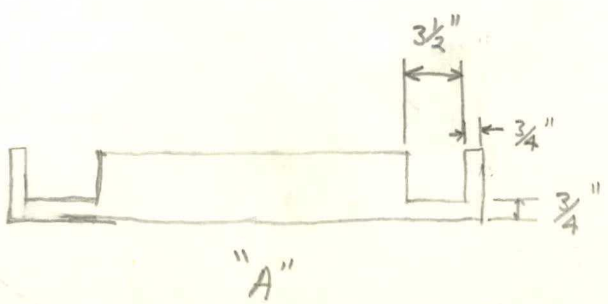
All window boundaries are formed of 1"x material set against the foam and chicken wire on the outside of the building, and shot from the inside presumably at the time of shooting the interior of the building.



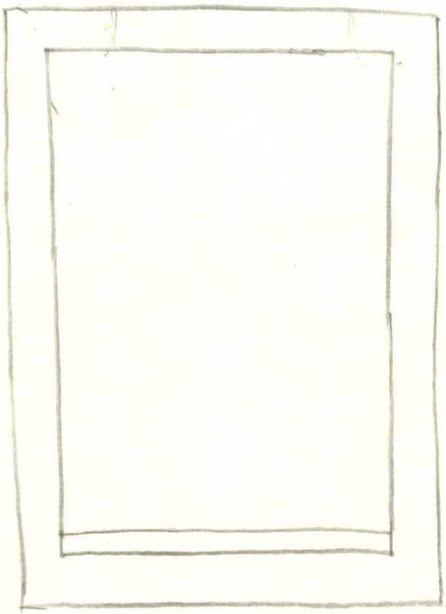
The simplest window boundary is shown on the preceeding page. The result would be a boundary 3/4" out from the plane of the wall and 2 3/4" wide on the top and sides, and 4 3/4" on the bottom. A slightly more compicated version but still within the bounds of the project is shown below. This type results in a boundary which has a sill 3/4" out from the plane of the rest of the boundary and 3/4" reveal on each end.



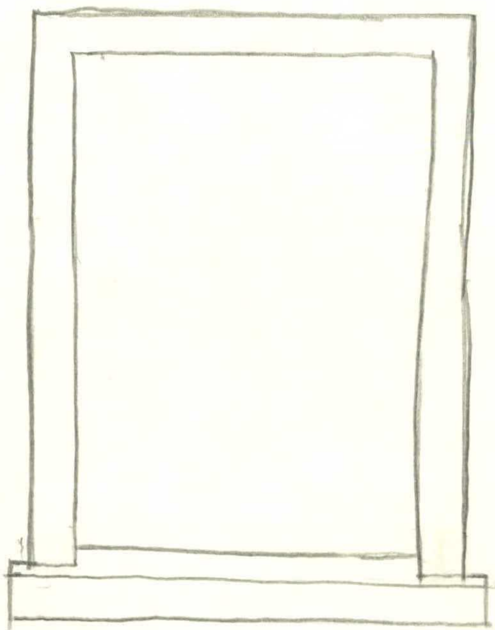




"A"

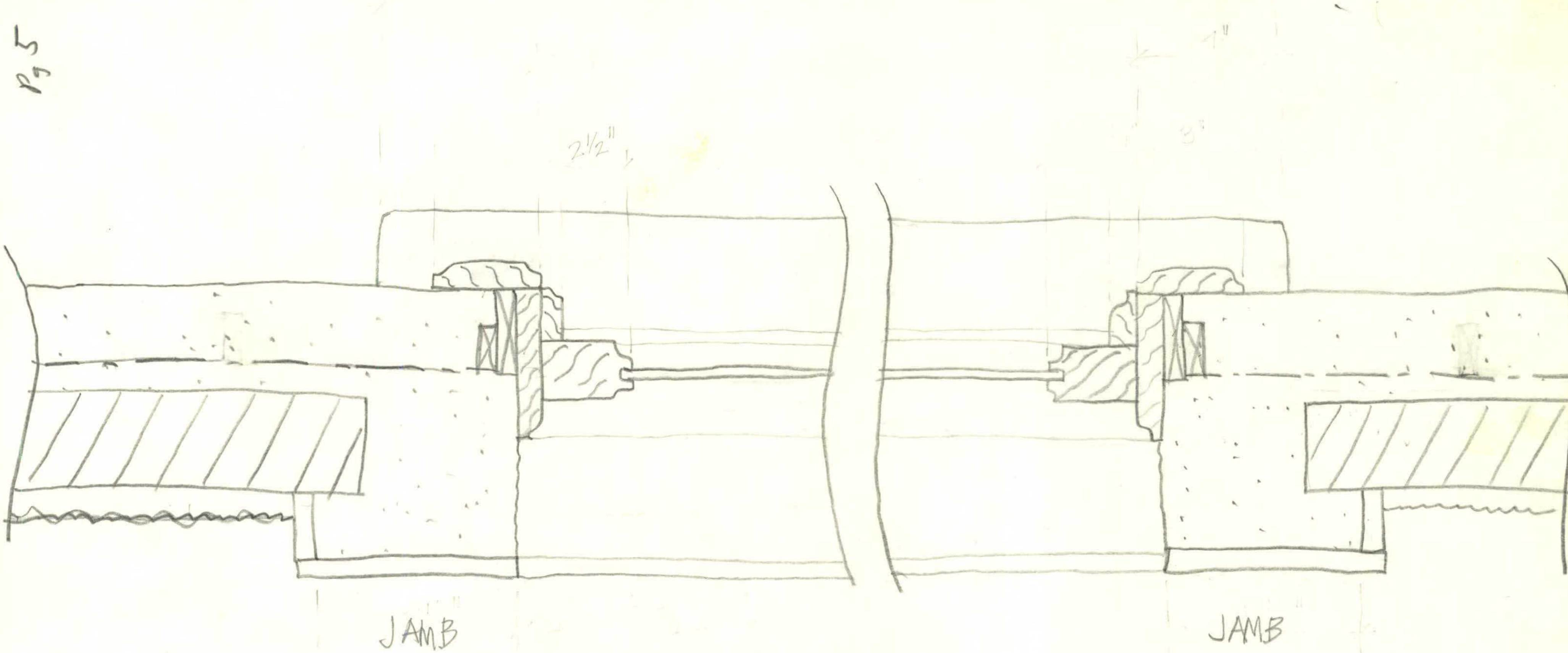


Simple box Type

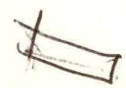


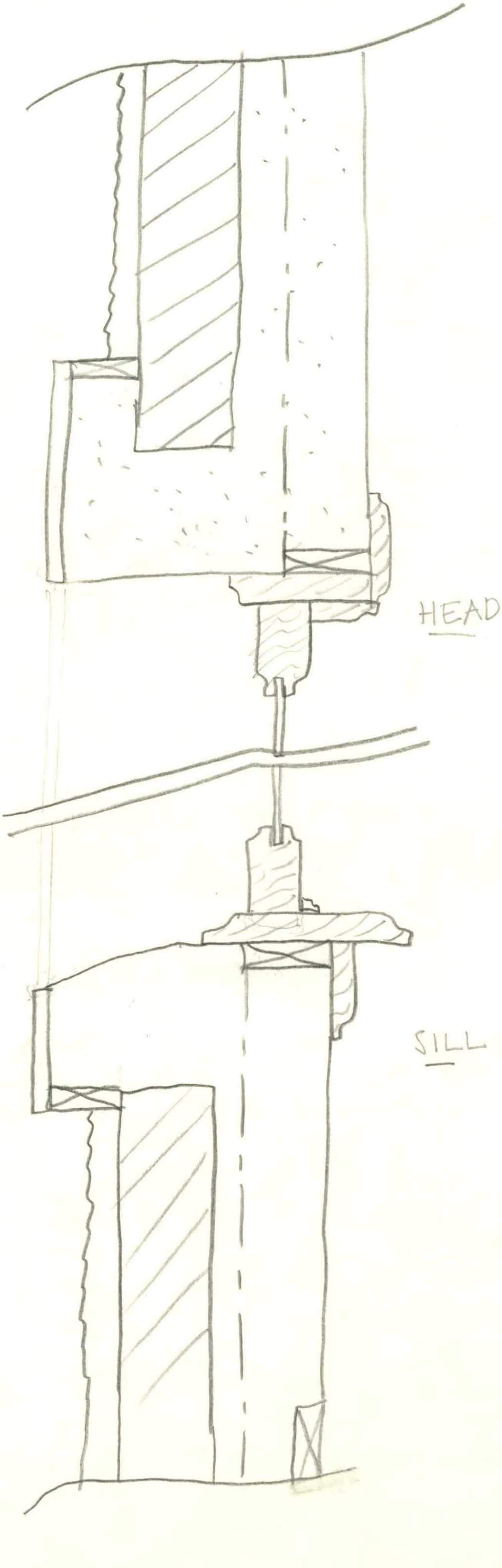
More complicated Sill Type

ELEVATIONS

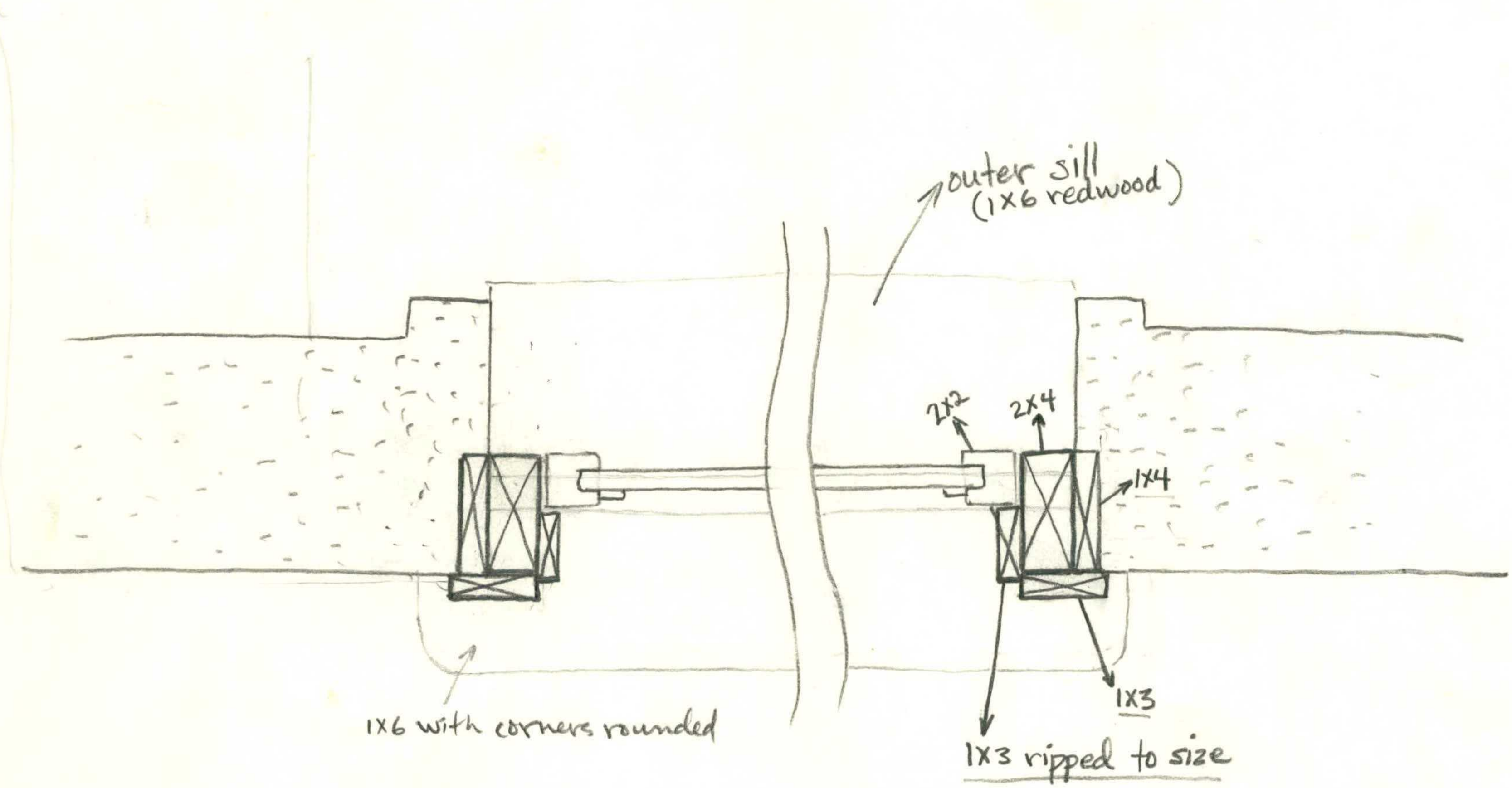


Window Plan





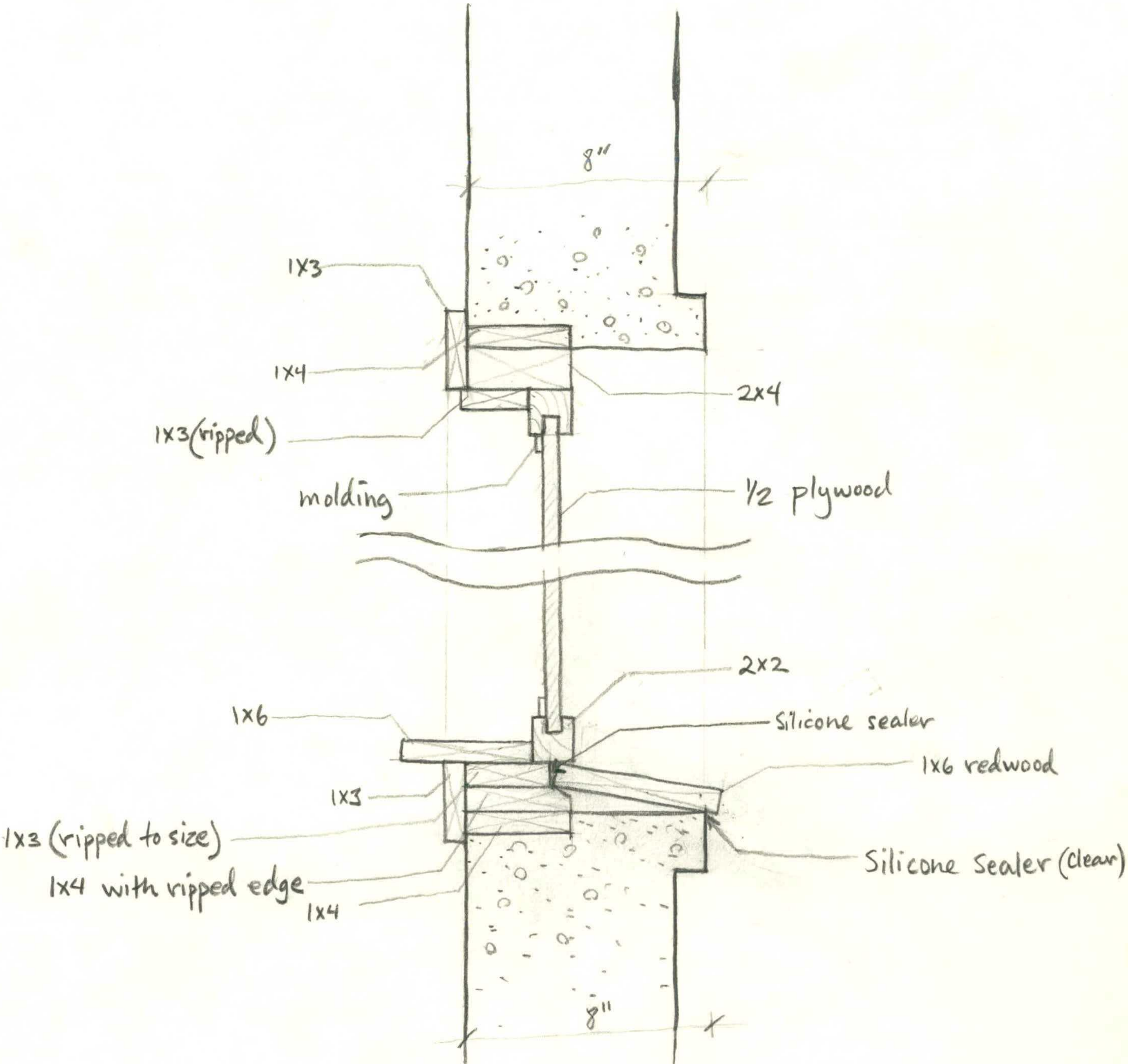
Window Section
1/4" = 1"



WINDOW PLAN

(As built in the tool shed)

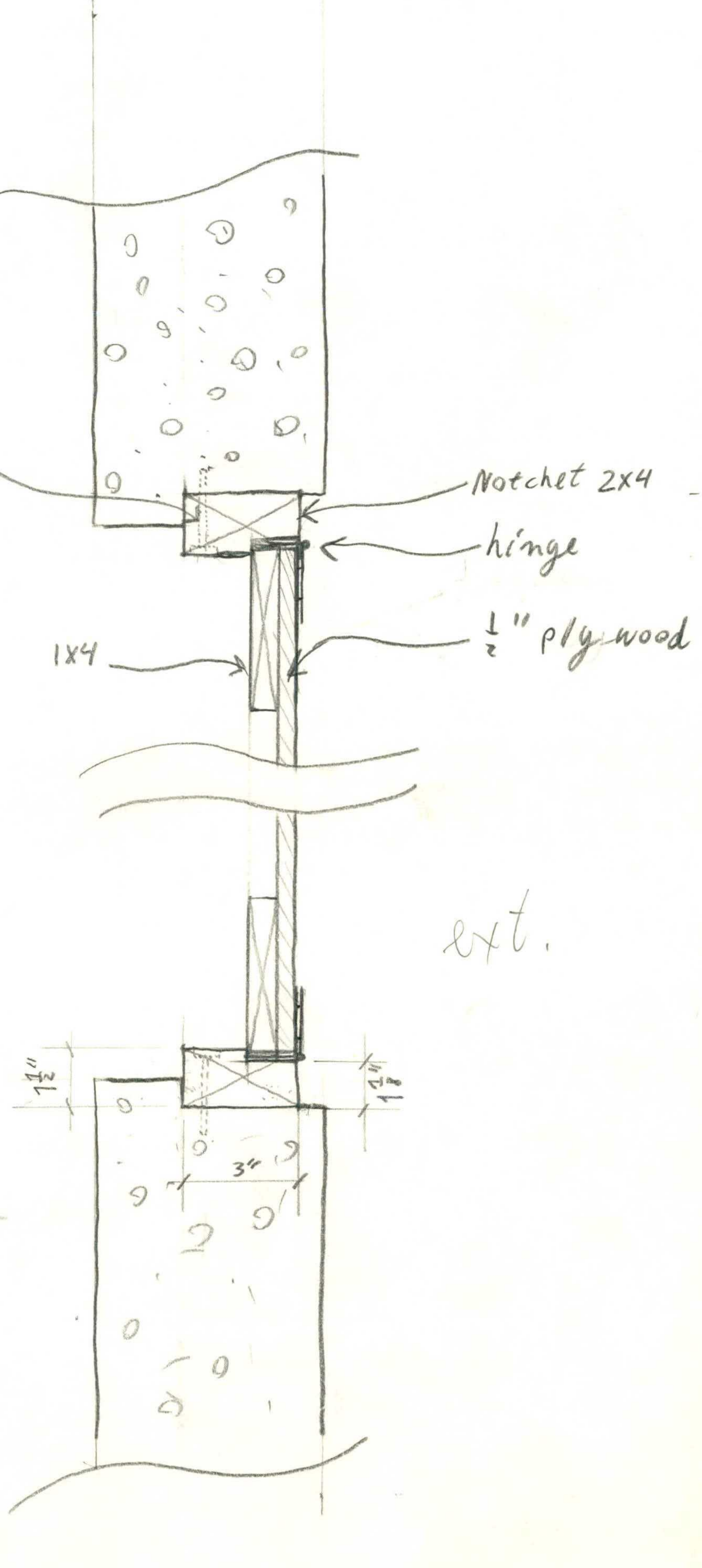
scale $\frac{1}{5}$" = 1"



WINDOW SECTION

(As built in the tool shed)

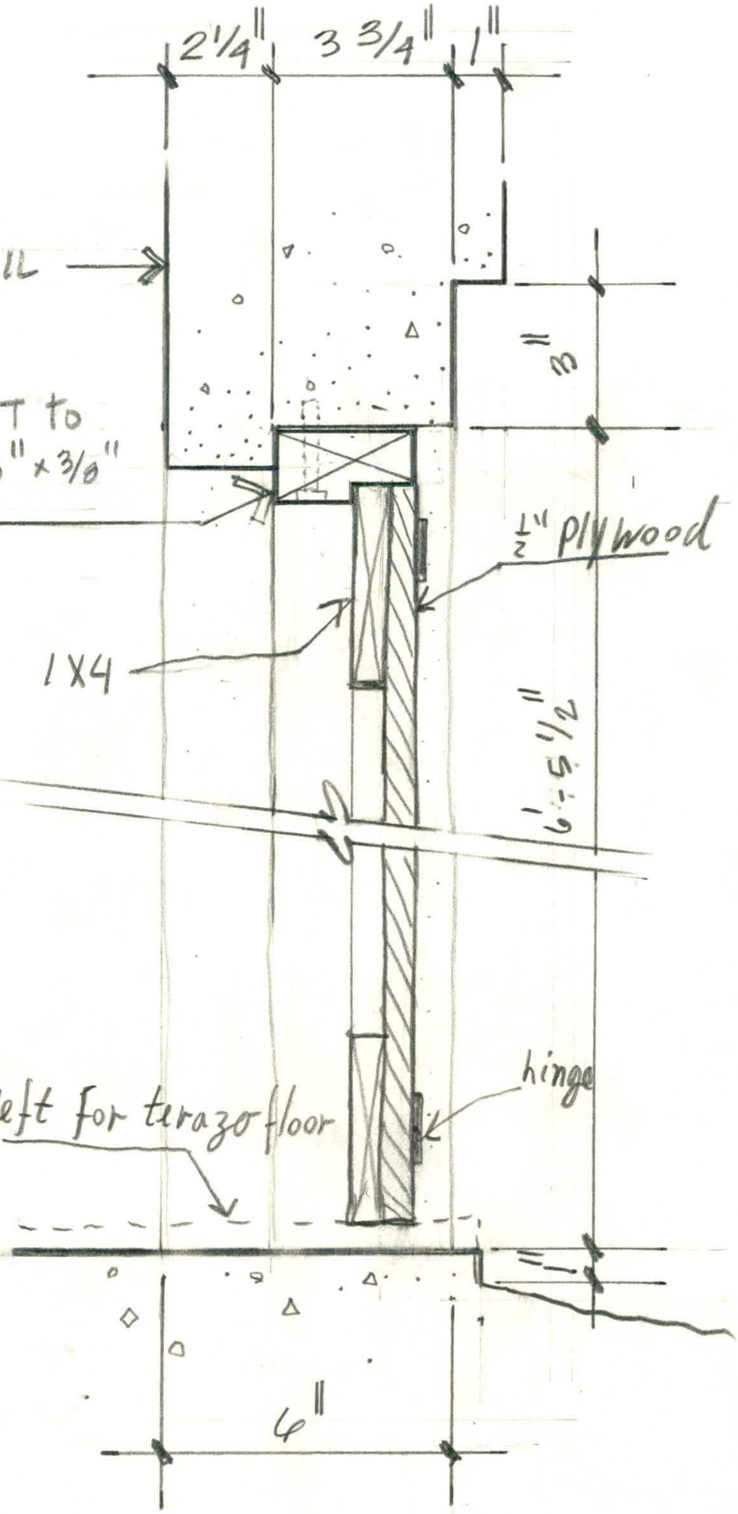
scale 1/5" = 1"

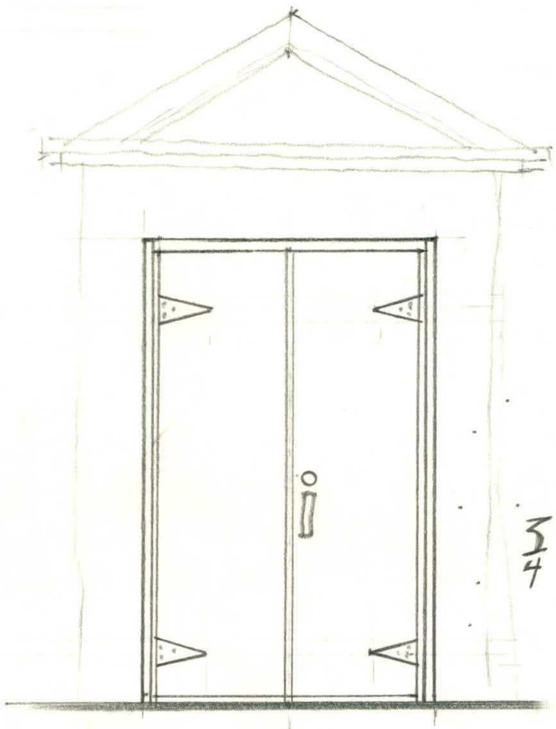


DOOR SECTION

Scale 1":5"

as done in toolshed





ELEVATION
TOOL SHED DOOR
3/8" = 1'-0"

SECTION @ TOOL SHED DOOR
SCALE 3" = 1'-0"

This method of making the window boundaries offers some opportunities to do something nice. For example a base molding could be nailed into the face of the vertical 1"x4" leaving a scalloping in the concrete after the forms are removed.

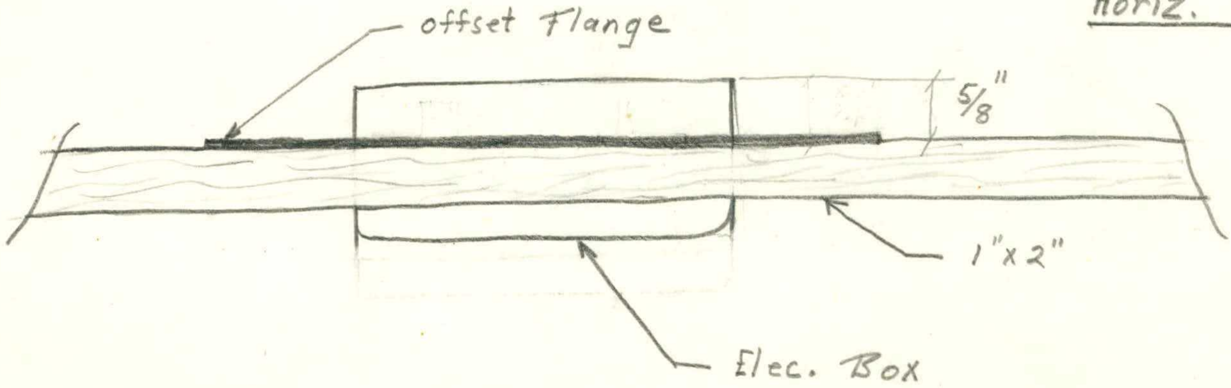
Still unanswered is the question about what happens at the top. Will the gunite stick in a vertical under hanging position? If not then a 1"x8" board will most likely need to be used in place of the screeding operation now planned for.

ELECTRICAL

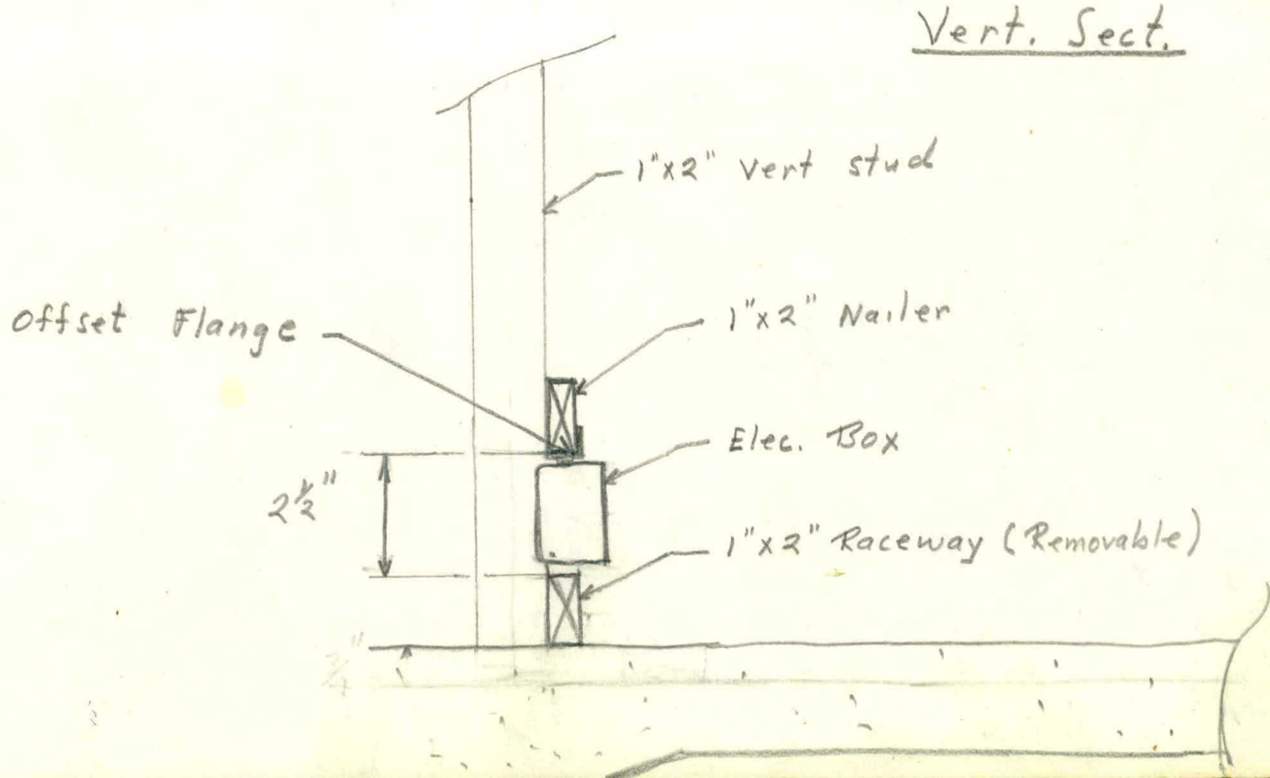
The electrical phase of the construction will take place in two separate operations. The first is to set the boxes prior to gunnite, and the second involves the actual wiring and hook-up.

For the first operation we assume that the light weight wood frame for the walls are in place. The boxes with offset flanges are then nailed in place at the level of the 1"x2" raceway.

Horiz. Sect.

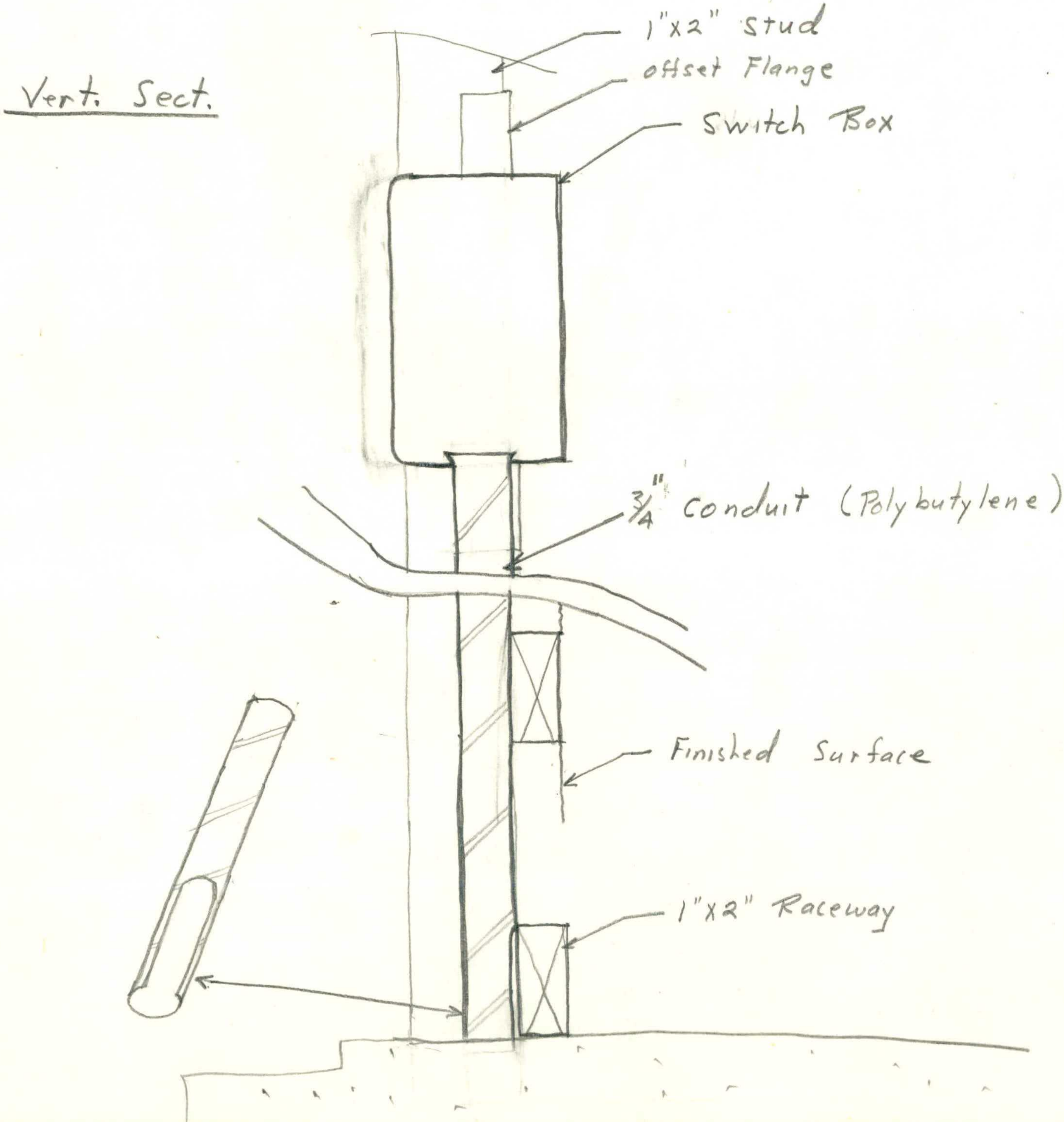


Vert. Sect.



ELECTRICAL

The placement of switches is a slightly different matter. They would occur at ~~openings~~ door openings and be at aheight of approximately 4'-6" from the floor. The switches will be nailed to the 1"x2" vertical stud and wired through a piece of conduit.

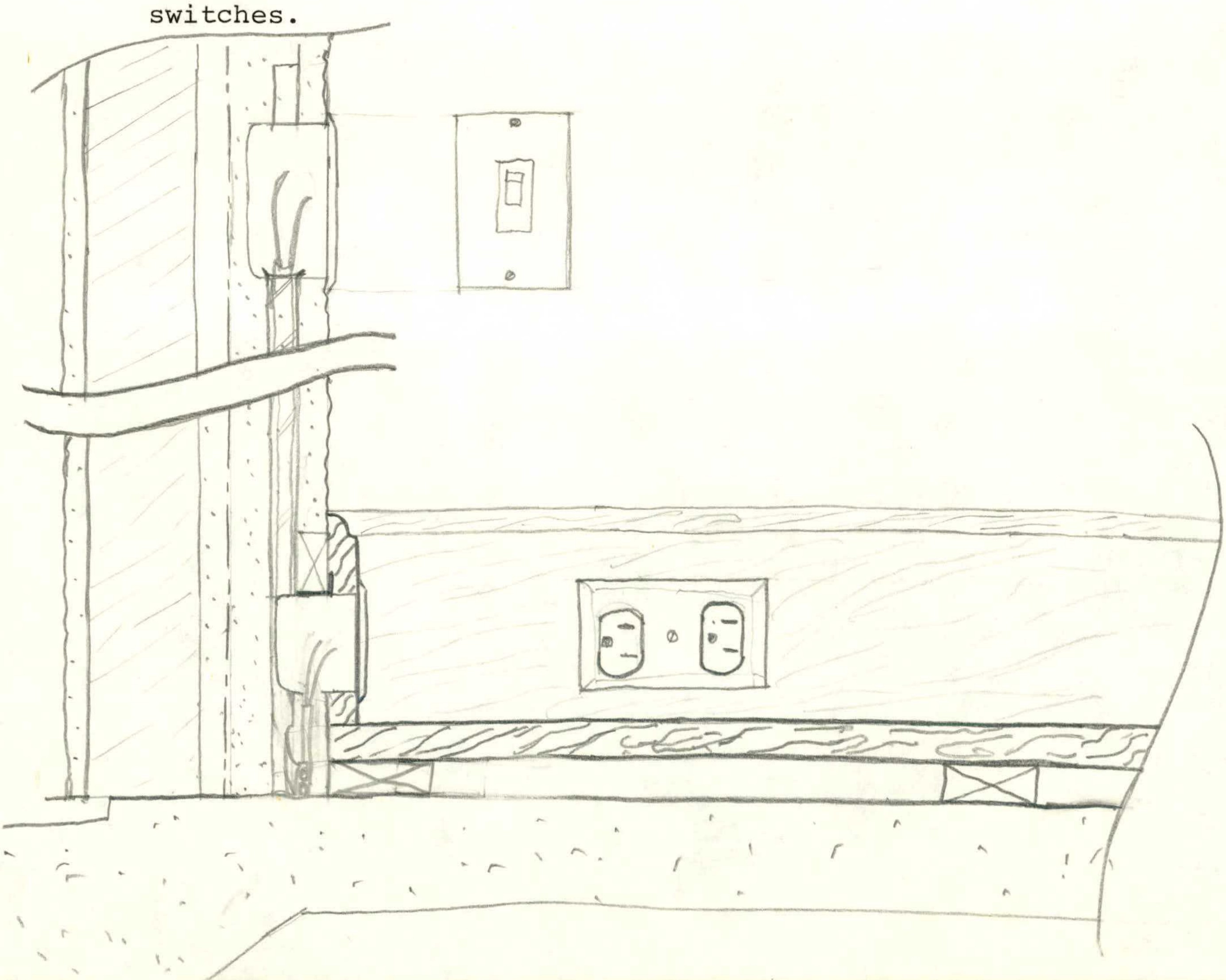


ELECTRICAL

Following placement of all the boxes (outlets and switches) the wall would be shot with gunnite.

After the concrete has set, the 1"x2" raceway would be removed. The wire would then be ~~laid in~~ layed in the void and the boxes wired. The outlets would be wired through knock outs in the underside of the box, and the switches will be wired through the conduit raceway.

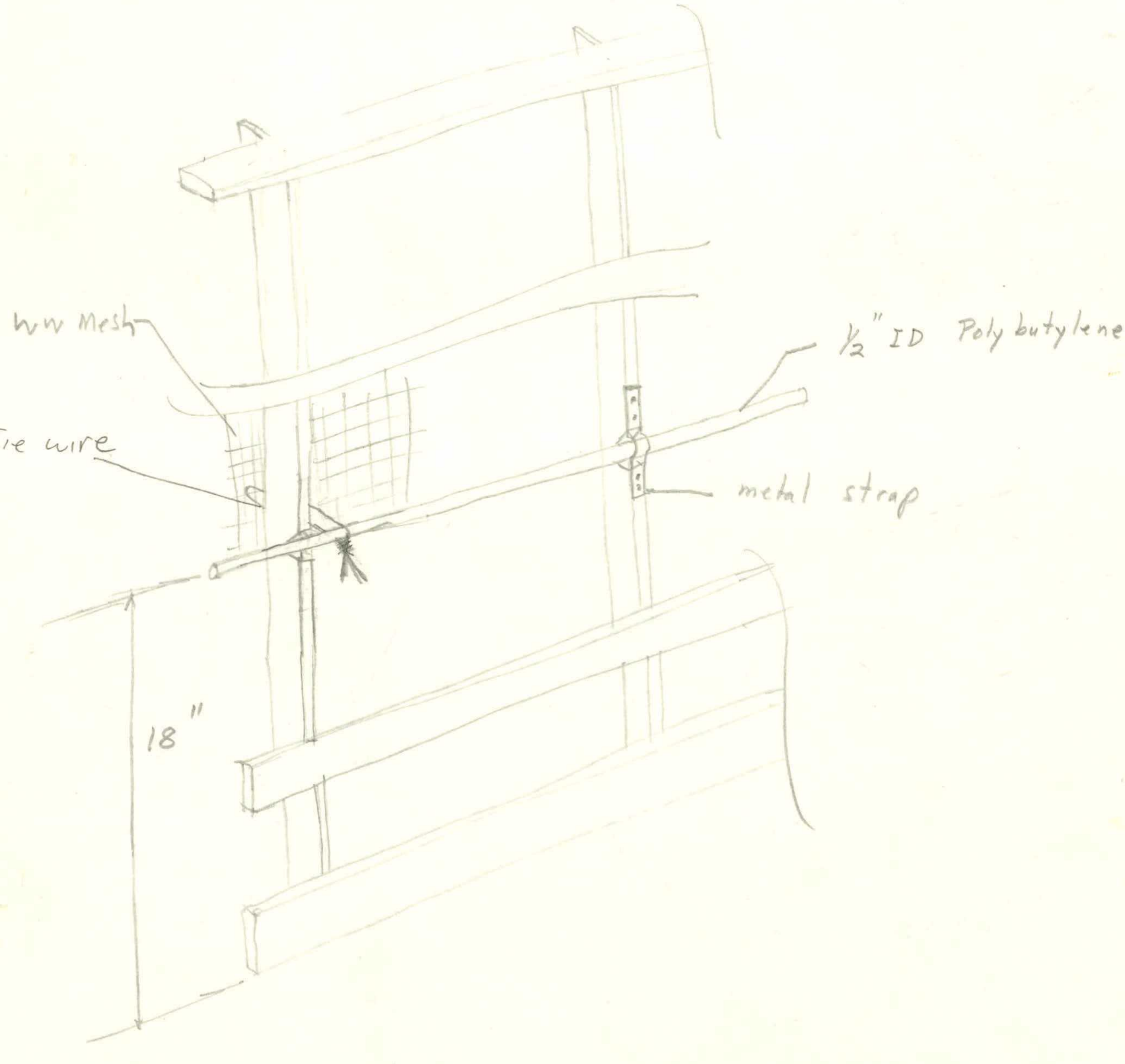
The final phase will be to place the baseboard and cover plates on the outlets and the cover plates on the switches.



RADIANT HEATING (walls)

The radiant heating as currently designed will consist of two systems, one to be located in the wall and one in the ceiling.

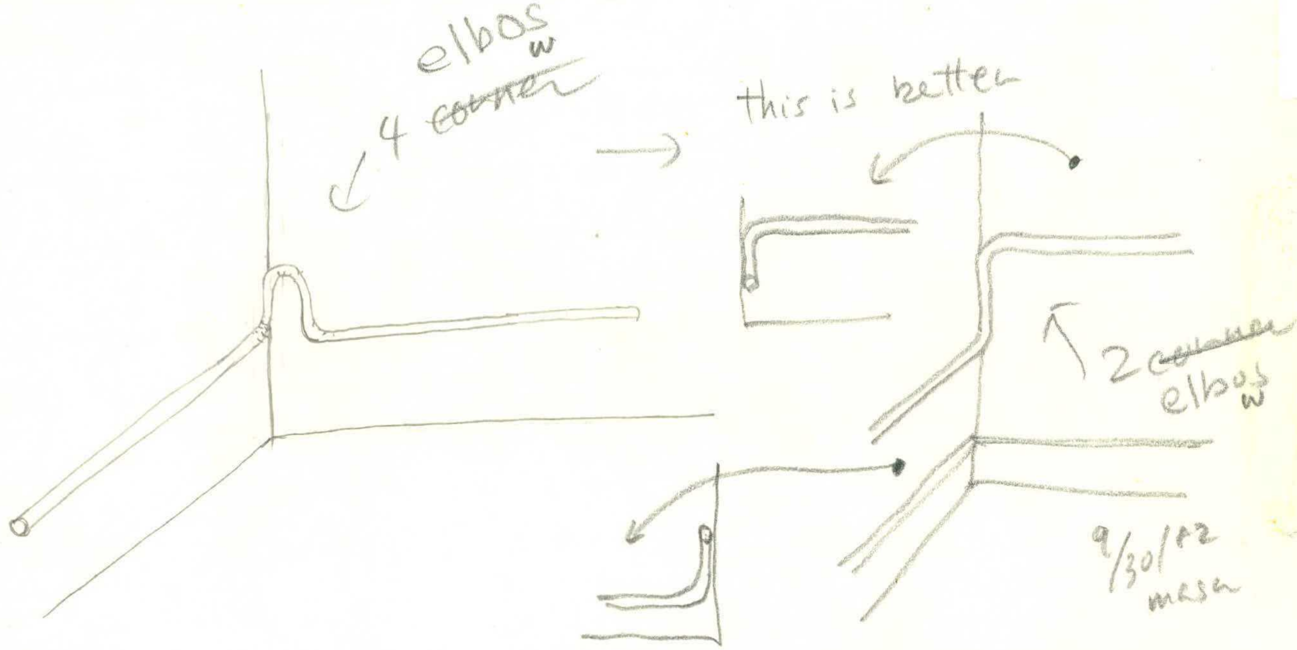
The pipe for the wall system will be laid just prior to shooting and will be located about 18" above the finished floor surface. In order to insure adequate concrete coverage the 1"x2" studs will be notched and the pipe held in place by a strap, or a piece of tie wire attached to the ww mesh.



OK as of 9/5/80 . 2

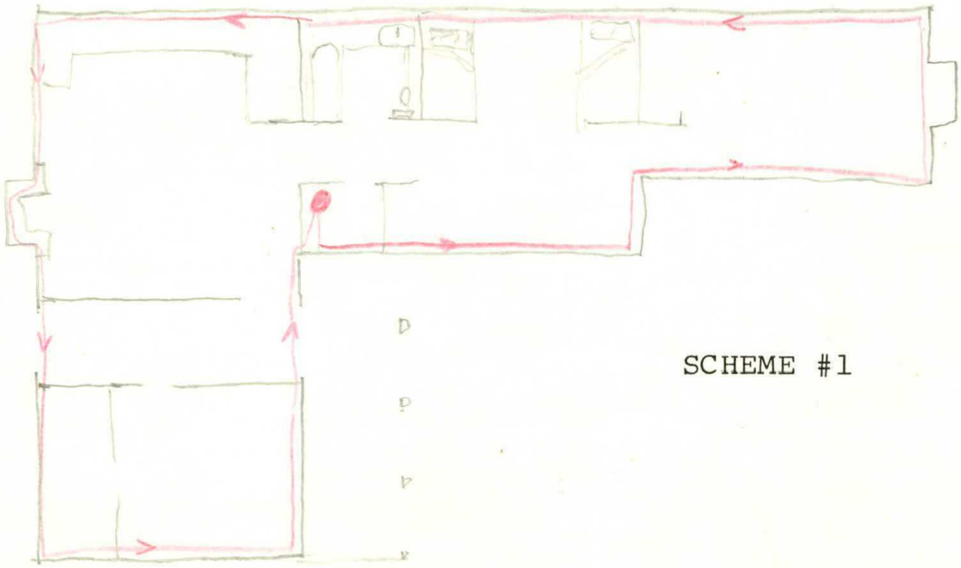
RADIANT HEATING (walls)

Corner bends are made by bending the pipe into the plane of the other wall and then bending again.



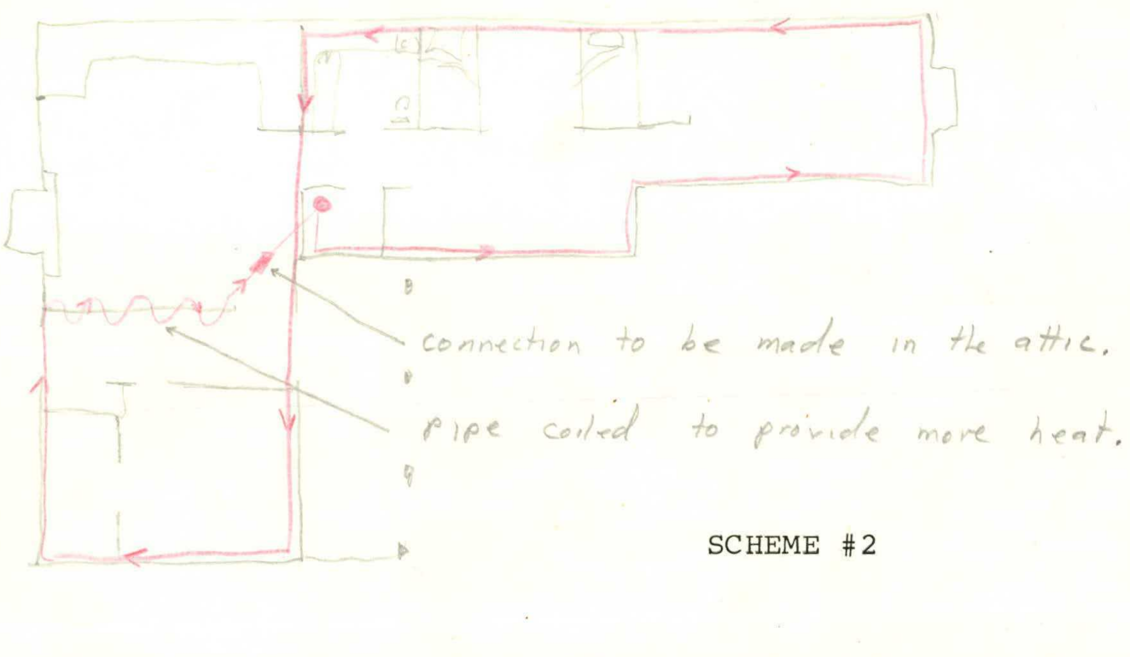
Once the pipe is in place, and befor the concrete is shot the system must be checked for leaks. This is accomplished by pressuizing the system to 100 psi for 30 minutes.

The wall system, consisting of one loop on the outside walls will provide 43% of the total heat requirement. Any other system lay-outs will provide something different than the 43%.



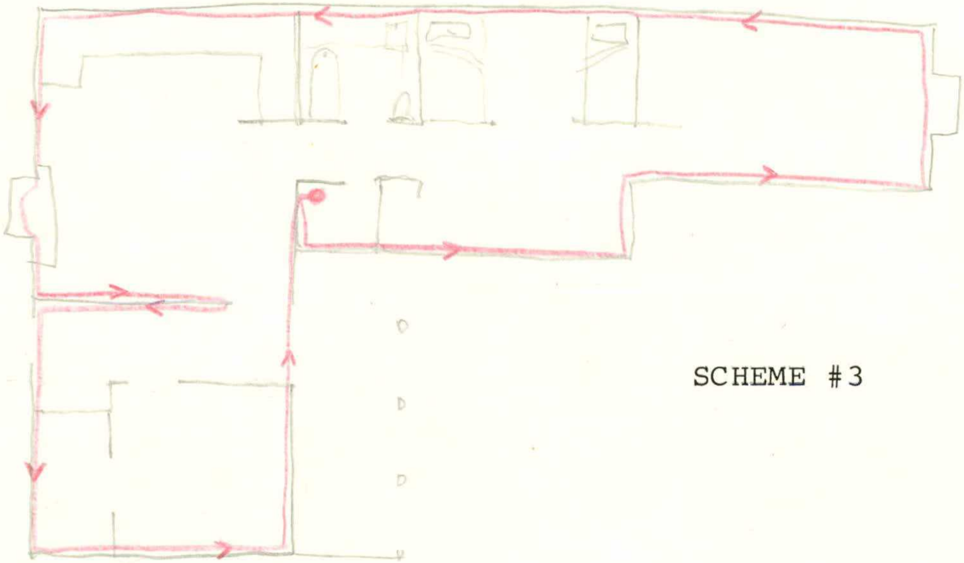
SCHEME #1

The above scheme has some problems associated with it... several feet of line occurs behind the kitchen cabinets and is not very efficient in providing heat to the room. Also the entry hall receives very little heat.



SCHEME #2

Scheme #2 eliminates the problems of #1 but has one dissadvantage, that being that the pipe must be stubbed out from the dinning room partition and connected later in the attic.



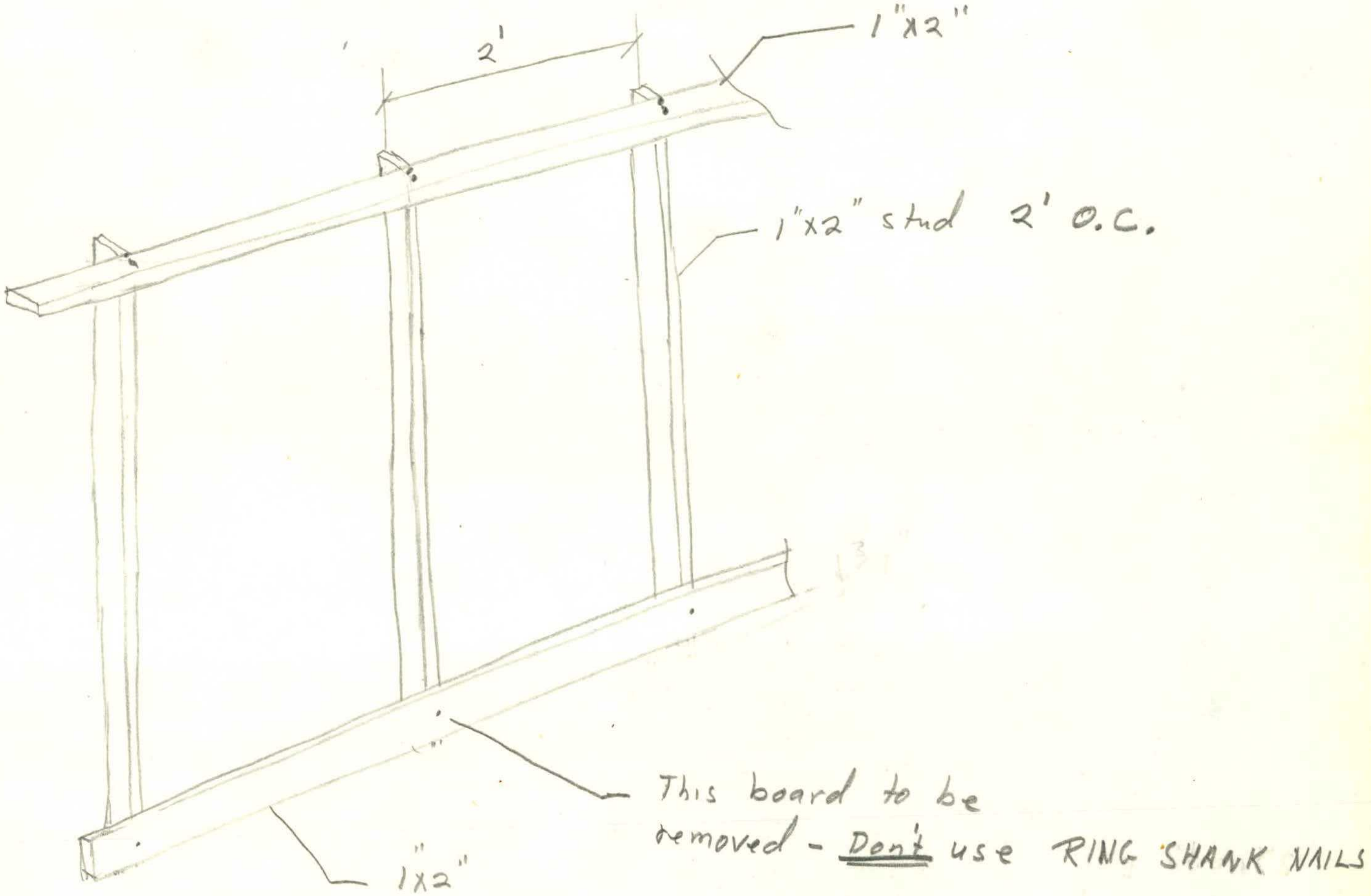
SCHEME #3

Scheme #3 I believe offers the best solution, it accepts a small heat loss behind the kitchen cabinets and adds it back in the interior partition between the entry hall and dinning room.

INTERIOR WALLS

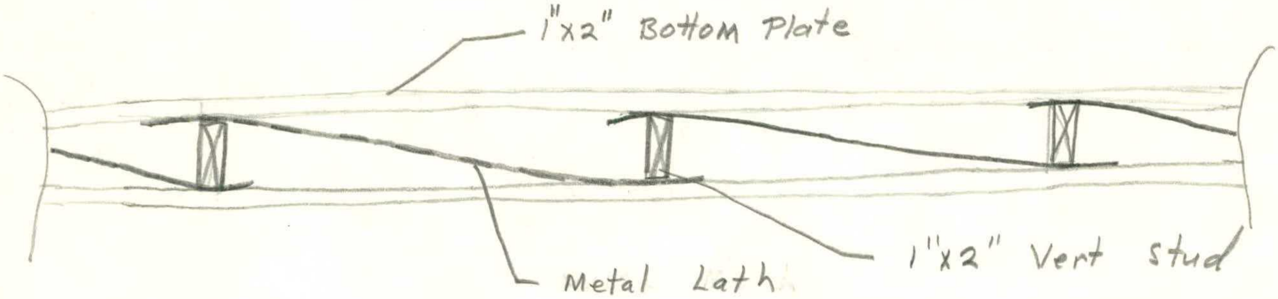
The interior walls are similar to the exterior walls on the level of the wood frame. The only major difference is that the screed boards must be placed on both sides, and the verticals run on 2' centers.

Proceedurely, one begins by building a frame of 1"x2"s... verticals on 2' centers with a TOP and BOTTOM plate ONLY.

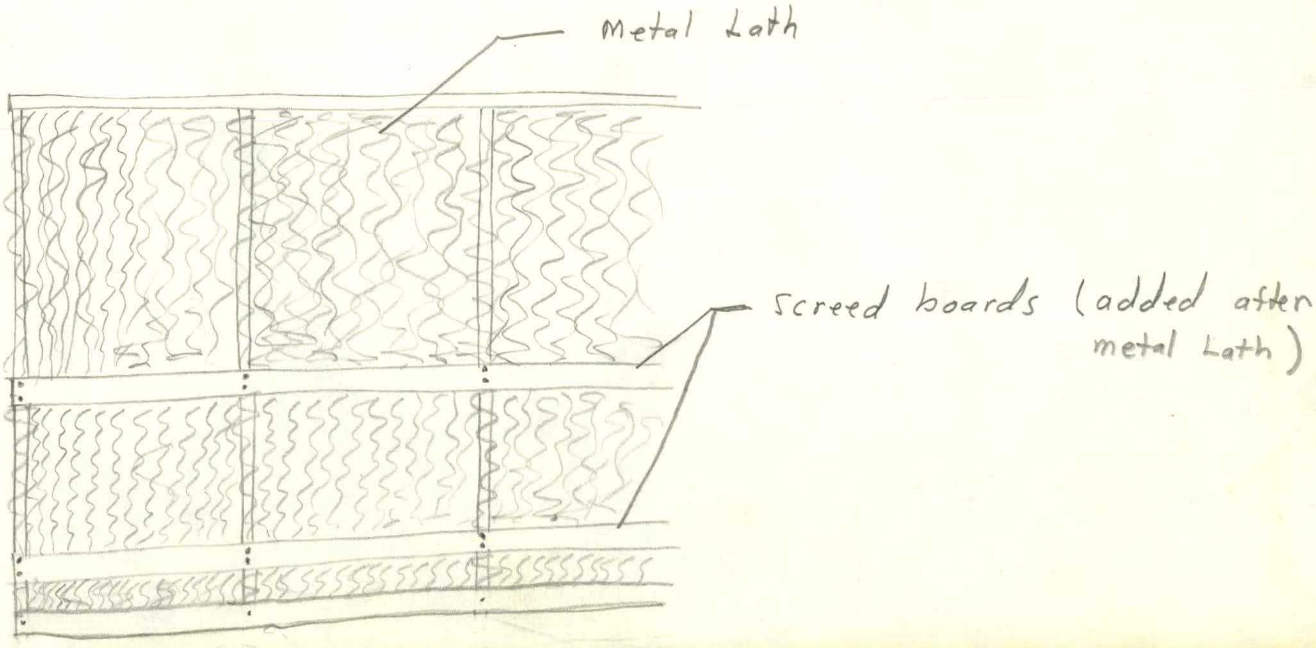


~~EXTERIOR~~ INTERIOR WALLS

Next we put on the wire. Whether it is gun-lath, or expanded metal lath, or something else the proceedure is the same. The metal is stapled to the vertical studs on alternating sides. If expanded metal lath is used it has a bias and they must all be laid the same way.

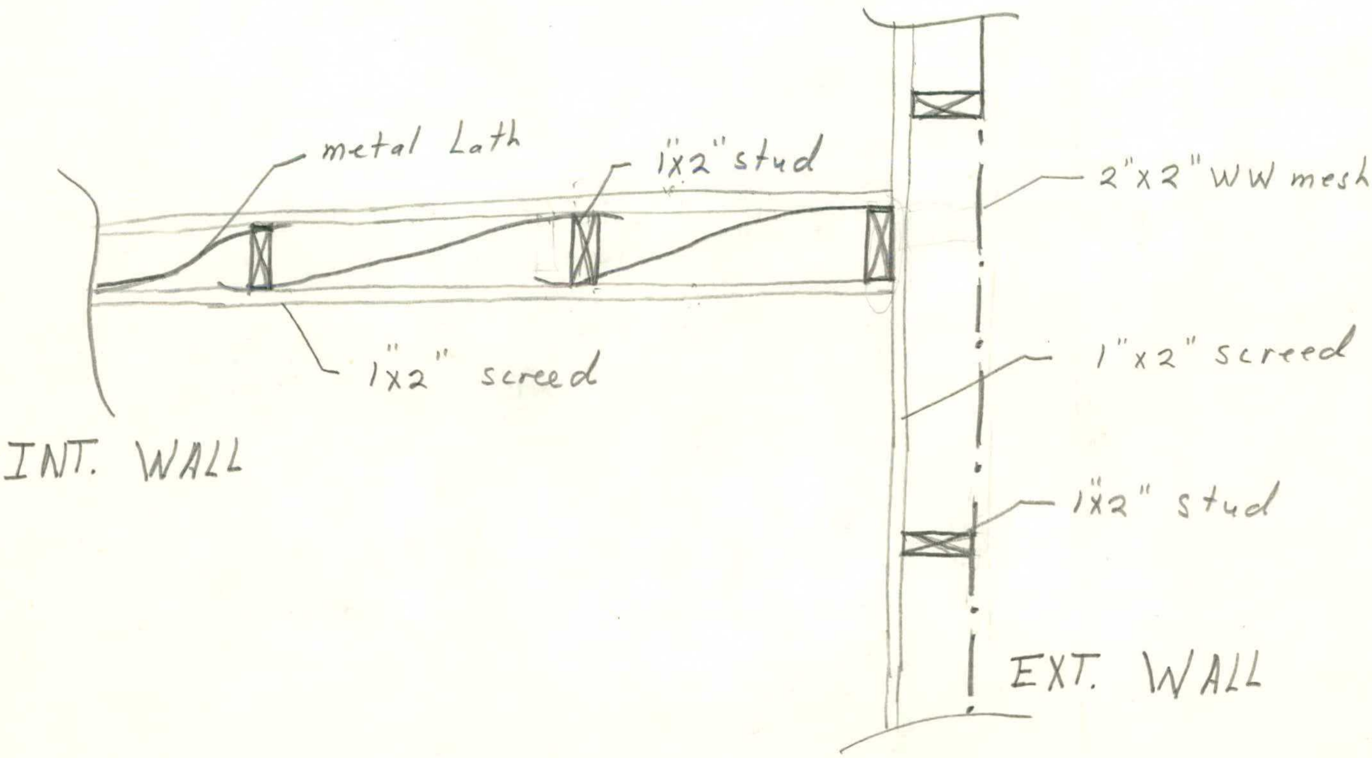


At this point the screed boards can be attached...both sides.



INTERIOR WALLS

The next phase is to erect the interior walls and connect them to the exterior walls.



Since the interior walls are capable of providing considerable lateral support for the exterior walls, they should be erected together.

The final step now is to attatch the wall terminus (see JAMB COL'S).

BEFORE SHOOTING

1. Make sure that all walls and columns and wall ends are tied together with rebar and mesh.

2. Make sure that the electrical outlets and switches are in place.

3. Make sure that the radiant heating lines are in place.

Int. walls

Materials   10'x8' wall

128 Lin ft. 1"x2"	$12.80
36 Lin ft. # 3 rebar	$3.96
5 sheets X-lath @ $2.82/sheet	$14.08
15 cu ft conc. @ $60/cu yd =	$33.33
	64.17

$.80/sq. ft.

Labor

Same as exterior wall based on:

More finishing,
less spraying,
No insulation

$1.13/sq. ft.

Total $1.93/sq. ft.

THIN WALL WITHOUT XMXMXMXMXMXMXmxmxmxmxm INSULATION

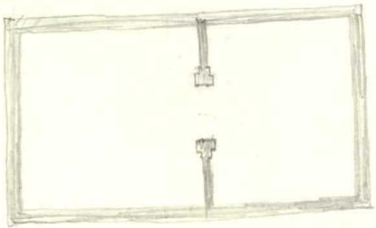
This is a structural wall, 2.5 inches thick, whxchmxmetxmxcodem which fails the insultation code, and can only be used for garages, sheds, stxmxagxm storagem.xThere is a version of the wall with sheetrock covering which can be used for summer buildings that do not require insulation, and a two sides version which can be used for interior walls.

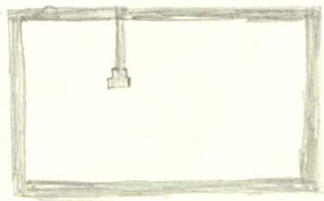
The wall is sprayed from both sides, over 4x2, 10/10 mxsh paper backed mesh. The exterior face is left with the surface as it comes from the gun (a round, pebbled surface). The interior surface (one or two), has vertical flat wood battens (1x4) whichnprovidenprovide anbuildebforntheconcretem set into the concrete, with the concrete surface brought within .25 - .5 inch from the outer surface of the batten. This allows bxx building paper (15# felt) to be stapled to the battens, with sheetrock over, and leaves an airspace between the concrete and the building paper, to provide give additional moisture prtection.

In certain cases the wall may be built with a thicker base, a kind of concrete wainscot, where the base is 4-5" thick, perhaps some two feet high, and provides a continuous splash base around the base of the wall. It also increases the structural strength of the wall, by reducing its effective span between supports, from 6'8" to 4xx 4'8".

WAll Terminus

It is not uncommon to have a situation in a home or other building for that matter, where two spaces need some kind of a partial separation. This can be achieved in a variety of ways, with the most common approach to be the formation of a large opening without doors. Often the large opening is not a real opening at all, but rather is formed where a wall ends in a room.





To pay attention to the opening, to give it substance, is something which is hardley ever done. This section discribes a way to end a wall, and to form an opening.

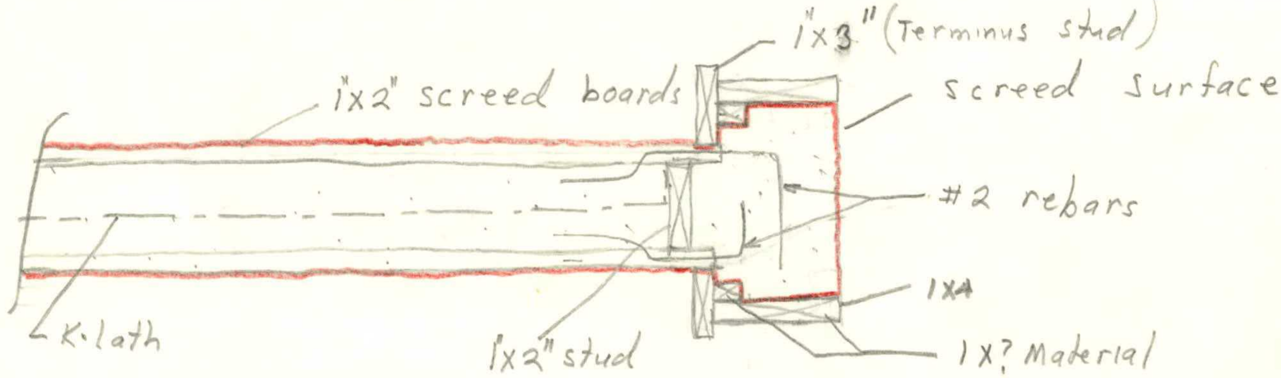
A wall terminus will be formed as part of the interior wall operation. It could be built as part of the wall frame on the ground, but to allow the exact proportioning of the terminus it is imagined that it will be built separately from the wall and attached prior to gunnite.

As mentioned above, two conditions of wall termini occur- those on the end of a fin wall and those which form a doorless opening. The system, therefore, is designed to be flexible, allowing changes in the geometry whenever needed.

WALL TERMINUS

Three cases will be described, the first being the most general configuration and the other two being special modifications of the first.

In the first case we consider a wall terminus to a fin wall.



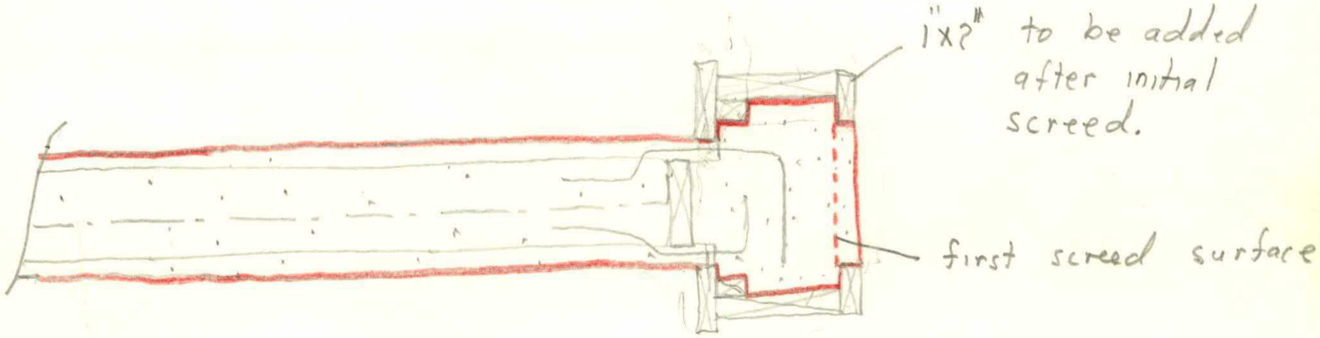
Section Plan of Int Wall

The screed boards are allowed to extend beyond the last vertical wall stud. These serve as the point of attachment of the terminus. In shooting the system with gunnite the wall would be filled with concrete first, sealing the gap between the 1"x3" terminus stud and the plane of the wall. The terminus itself would be shot from the open end and the surface screeded off.

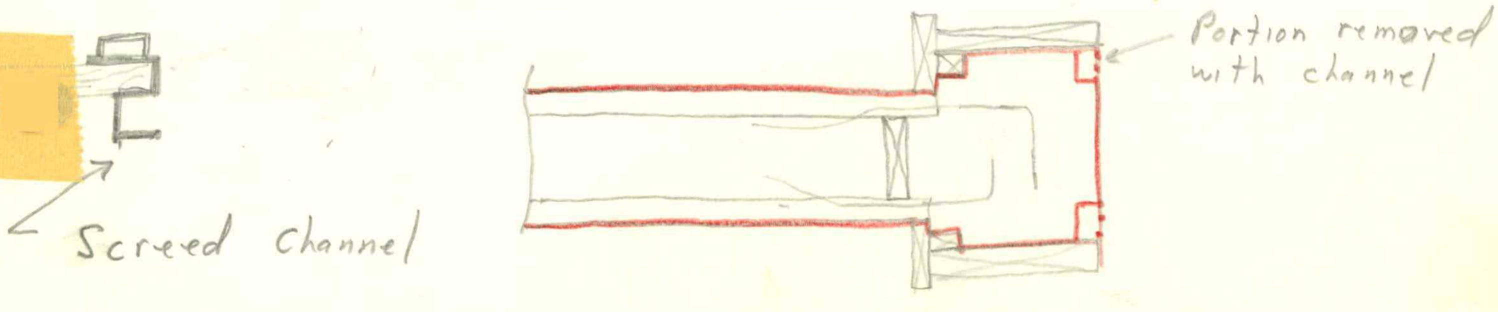
WALL TERMINUS

The next case is a slightly more compicated version of the general case. This version would occur perhaps only one, or at most, two times in the house and is reserved for special openings. In the martinez house considered here this type of terminus would occur at the opening between the entry hall and living room, and in this case would probably continue across the top of the opening in the form of a lowered beam.

The steps described in the general case are identical to those followed in this version, with the point of departure occuring during the gunniting phase.

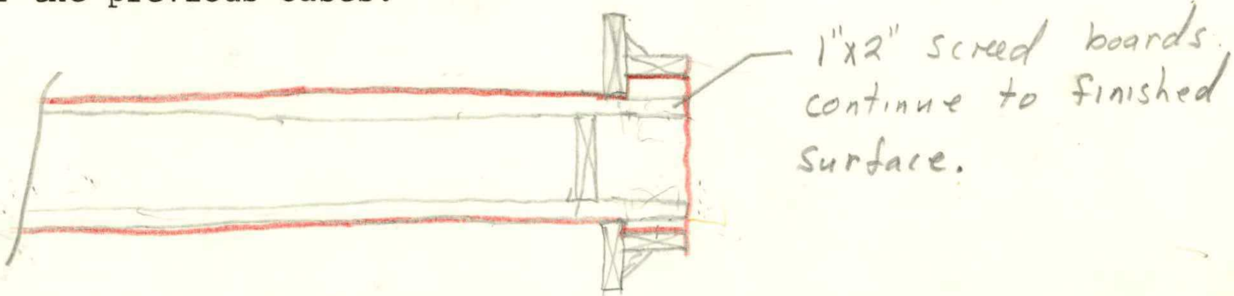


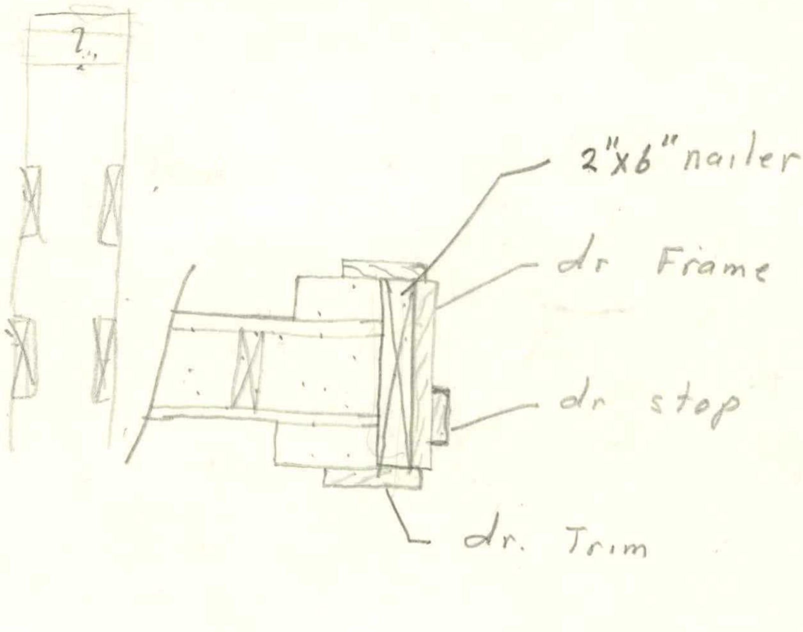
After the wall terminus has been shot, as described in the general case, and screeded, two 1"x2" boards are added to the inside surface of the opening. The gunnite then proceedes to be sprayed in the opening created by the new boards. When filled the surface is once again screeded. The final section is shown in red above.
Another idea for forming the terminus is shown below. This design is identical to the general case, but the edges are scraped out after screeding, with a U shaped channel.



WALL TERMINUS

The last case to be considered is the one which occurs at an opening that has a door. Since the frame for the door and the attendent trim will add considerable detail to the opening it is believed that the concrete detailing should be modest. In essence the proceedure of layout and shooting would be identical to that described for the general case, and the only ~~real~~ differences~~isxthexplanx profilexofxthexterminusxformxwork~~ are that the screed boards for the wall continue to the inside surface of the opening to provide a nailer for the wood door frame and trim, and the resulting concrete profile being simpler than any of the previous cases.





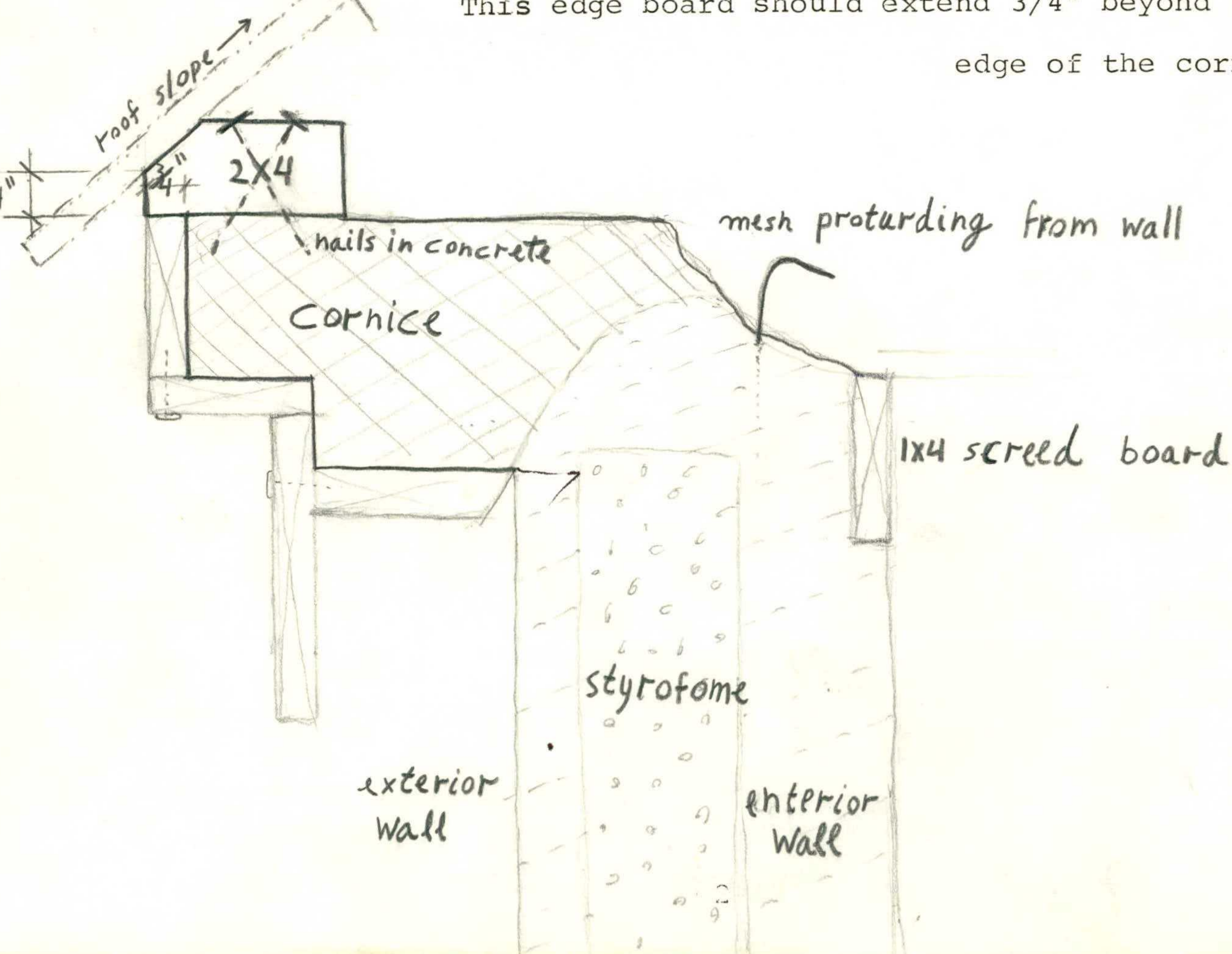
Finished Profile

Cornice Construction

(New Method)

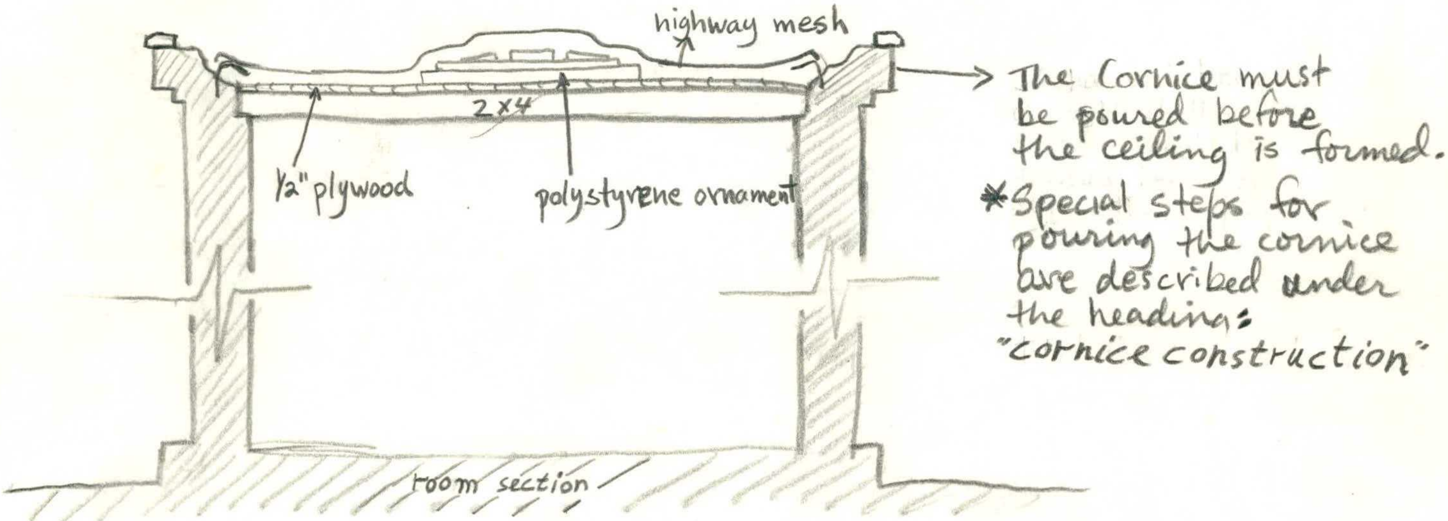
The cornice should be poured before the ceiling operations begin. Details for the cornice can be found in the chapter about the cornice. As the cornice is poured, care should be taken to form a flat, level surface. While the concrete is still wet, a pressure treated 2x4 (perhaps 2x6) is possitioned on the cornice. Nails should be driven into the board boforehand so that as the concrete cures the board will be held in place. This board should run the length of the cornice, from gable to gable. It should end slightly before the face of the gable (see detail under "Gable Framework and Reinforcement"). The outer edge of the 2x4 must be ripped at the same angle as the roof slope.

This edge board should extend 3/4" beyond the edge of the cornice.



<u>Flat ceiling</u>-Framework
(New method)

The 1"x4" screed plates are removed from the top of each wall to create niches for the ceiling form boards.
2"x4" joists are then cut to fit snugly into the place in these niches.they can either be cut slightly long and tapped into place (perhaps from above),or cut losely and put into place with wooden wedges.
The joists will support a 1/2" thick plywood formboard.



The joists should be roughly perpandicular to the walls,so that wherever two sheets of plywood meet, a joist will be able to run directly under the joint and support both pieces of plywood.
The joists will probably work best at 16" centers.At the end wall joists should support the end of the plywood near the wall.
Before laying the plywood marks should be made on the top of the wall wherever the joist meets the wall.
The plywood is then cut to size and layed in place.Keep in mind that the plywood must be removed from below later on.* (see remark in end of chapter)
Now that the plywood is in place it <u>should not</u> be walked on for the rest of the operations..It will probably be necessary

to build a"bridge" which can be easily moved around,with the ends suppotted by the concrete walls.A ladder may work in many cases. Now use a chalk line to maxk mark th e plywood wherever there is a joist below.Use the marks you made on the top of the walls for this purpose,The plywood will be nailed to the joists along these chalk lines from above.

Nailing will be done with very fine fininshing nails[1].There are two reasons for this.1.It will not leave a poor surface for the concrete and 2. the nails must be able to be broken off when the joists are pounded out of the place from below after it is shot. Polystyrine may be cut and glued[2] to the top of the plywood asx an ornament.Wire reinforcement mesh is then layed in place and tied to the mesh protruding from the top of the walls.'

1. we used 1" length.

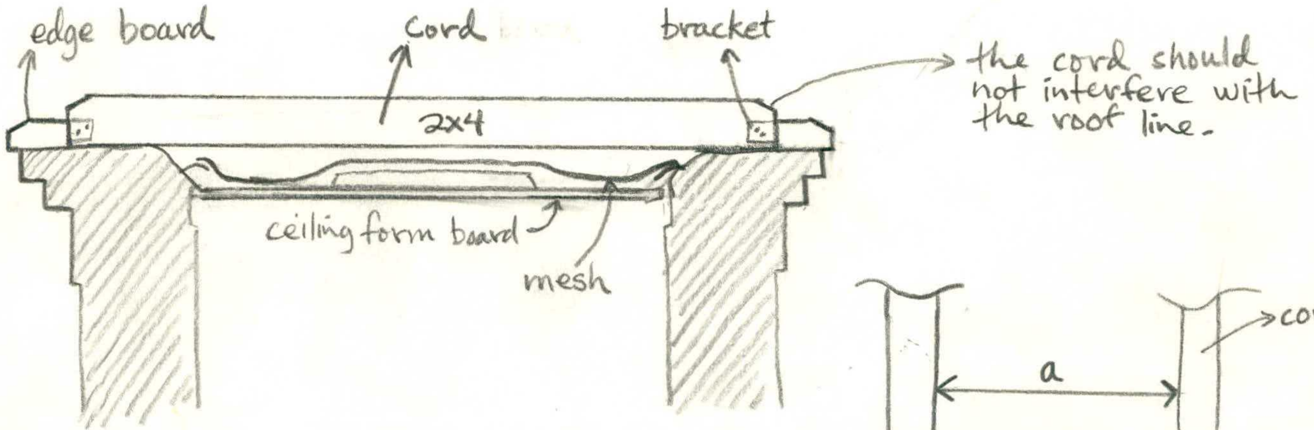
2. we used - PL 200. glue

*The plywood should always be placed with care that the strong side (the fibres' direction) is parallel to the longer span.

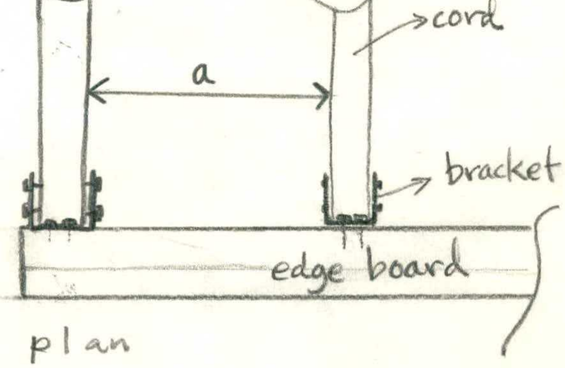
Flat Ceiling- Reinforcement

(New Method)

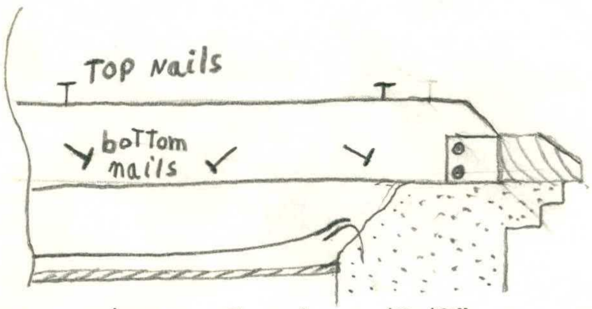
Over the ceiling forms, mesh is layed (highway mesh was used for the 5 1/2 foot span of the tool shed). It is actually quite easy to work with a heavy gauge mesh, since after it is possitioned it stays in place very well. First this mesh should be wired to the mesh protruding from the walls. The mesh should be bent so that later when it is suspended in place it will lie slightly above the surface of the form. The mesh can be left an inch or two longer at the ends wherever a gable will be formed, so it can be connected with the gable reinforcement. In order to shoot the ribs for the ceiling, 2x4 cords must be strung between the two edge boards. These cords will act as form boards (for the ribs), as well as provide a place to nail the rafters And form part of the trusses at the gable ends later on. Some sort of brackets should be used to hold the cords securely to the edge boards. Once these cords are in place the final reinforcement of the ceiling and ribs can be done.

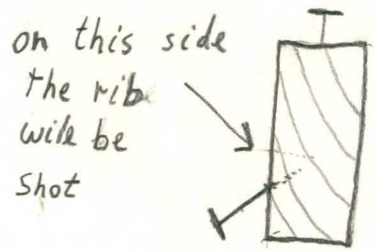


On the tool shed, the cords were placed at 24" centers

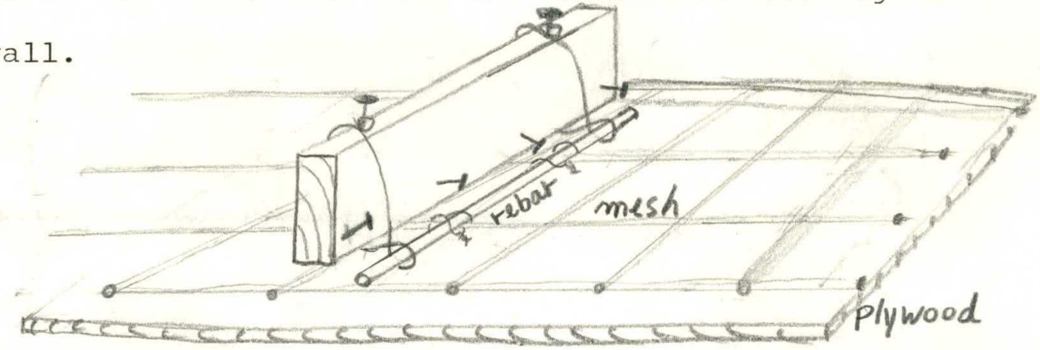


Before placing the rib reinforcement, nails should be driven into the top of the cords at about 2 foot intervals. Half an inch of the nail should be left exposed. Long nails should be driven into one side of the cord (on whichever side the rib will be). These nails should be spaced about one foot apart and driven in at various angles with 2" or 3" left exposed. This will keep the cord rigidly in place after the concrete rib has cured.



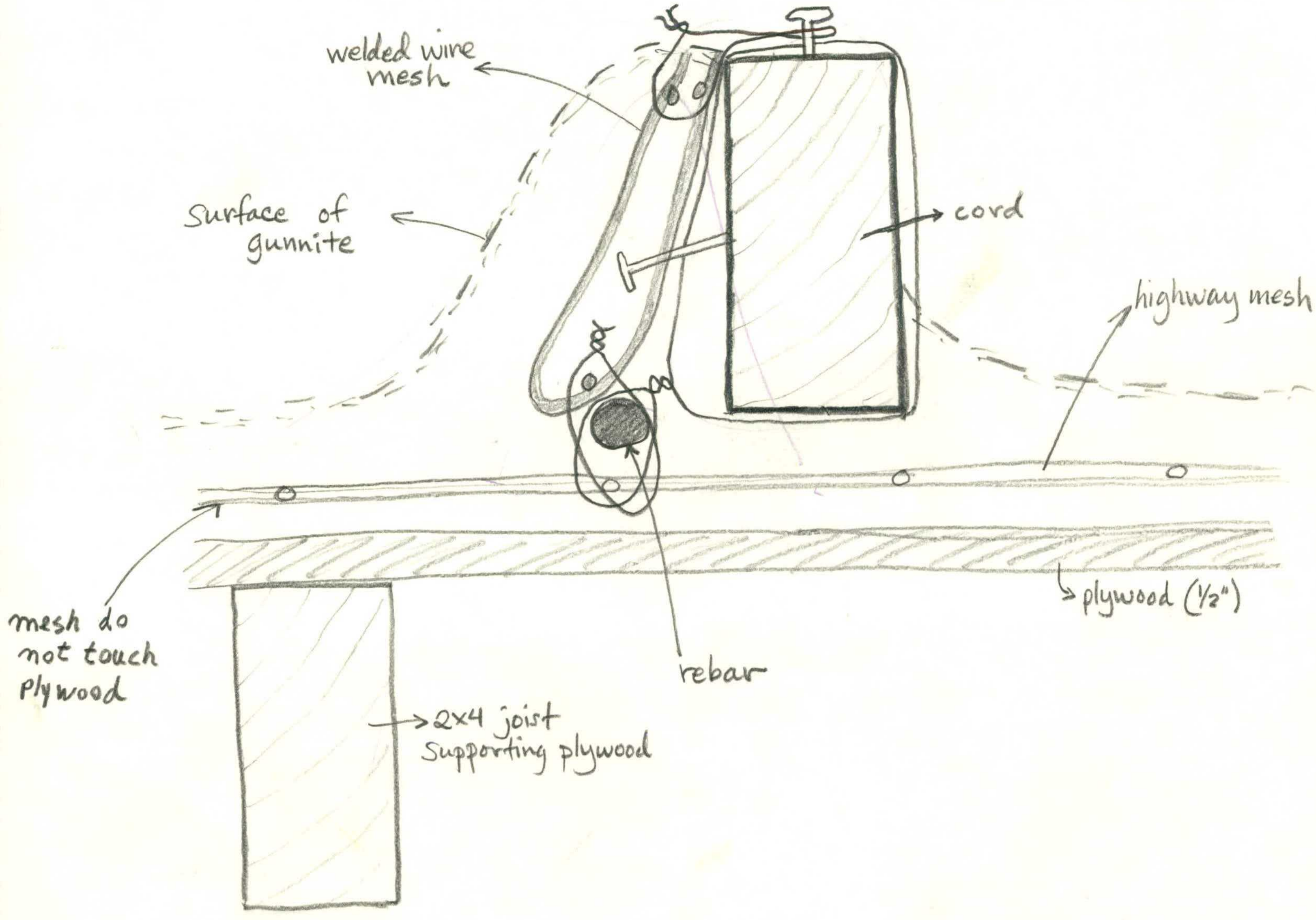


Now a piece of rebar (3/8" was used in the shed) is cut so that it can lay next to the cord with each end of the bar resting on the top of a wall.



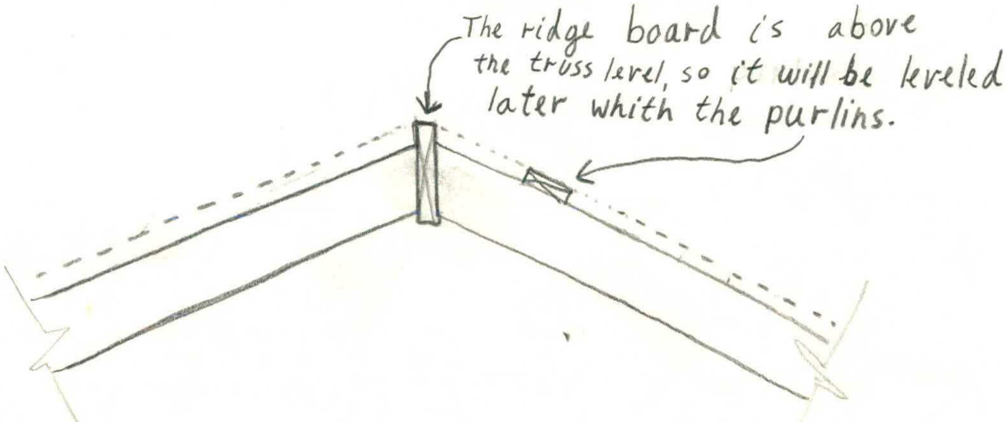
The bar is then suspended from the cord with wire. It is important that the bar is off to the side of the cord, so that it will be directly under the <u>rib</u>. At this point, the highway mesh can be wired to the rebar so that it is supported at the right hight above the ceiling form boards.

The last operation of the ceiling reinforcement is to put in place the rib's wire mesh. (2"x4" welded wire mesh- 15 gauge was used in the tool shed) The mesh is to be cut to 12" strips and then bent down the middle and placed as two 6" layers next to the cord. Then, the top of this mesh can be wired to the nails on the top of the cord, and the bottom can be wired to the rebar and highway mesh.



All of the reinforcement should now be wired together ~~with~~ and supported about 3/4" above the plywood form boards.

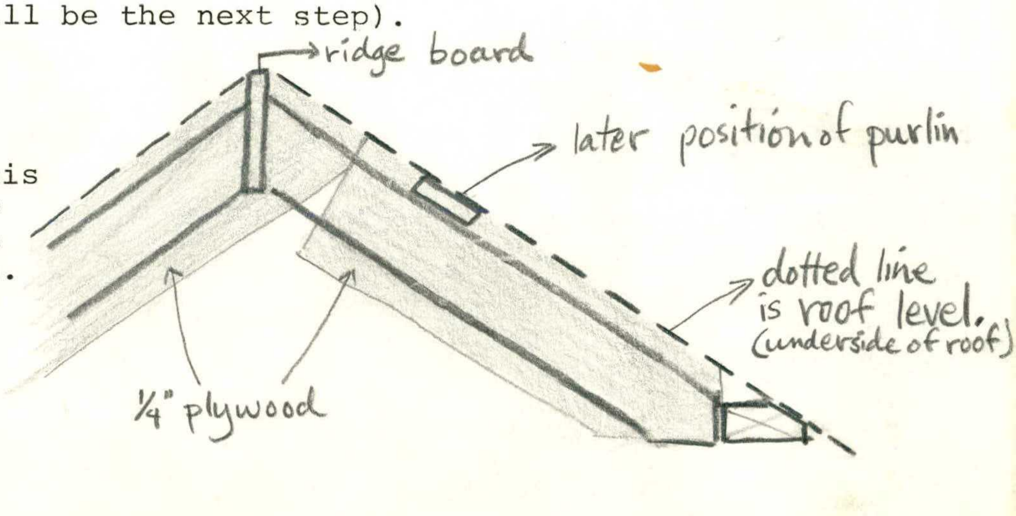
ridge board should be at roof level and should be nailed into place shightly above the truss level.



After construction, the ridge board should be level and all of the truss angles should be correct. Since this is the structure of the roof any errors will directly affect the final product.

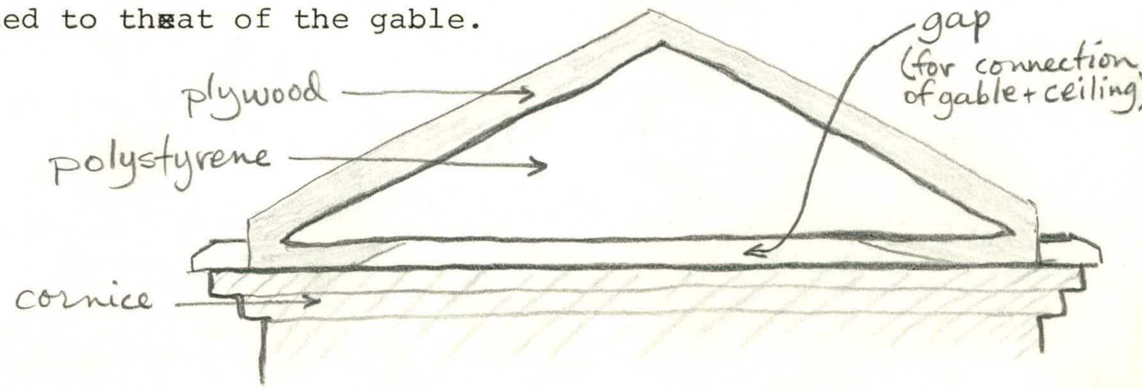
In the tool shed, 2x4s were used for the trusses and a consruction grade 1x6 for the ridge board.

After the pediment is shot it will be level with the underside of the roof. This means it will be level with the ridge board, but not the trusses. A strip of 1/4" plywood must be nailed to the outer side of the truss to act as a form for this pediment beam. The plywood need not cover the whole gable area, but it should be wide enough to glue on the polystyrene (which will be the next step).

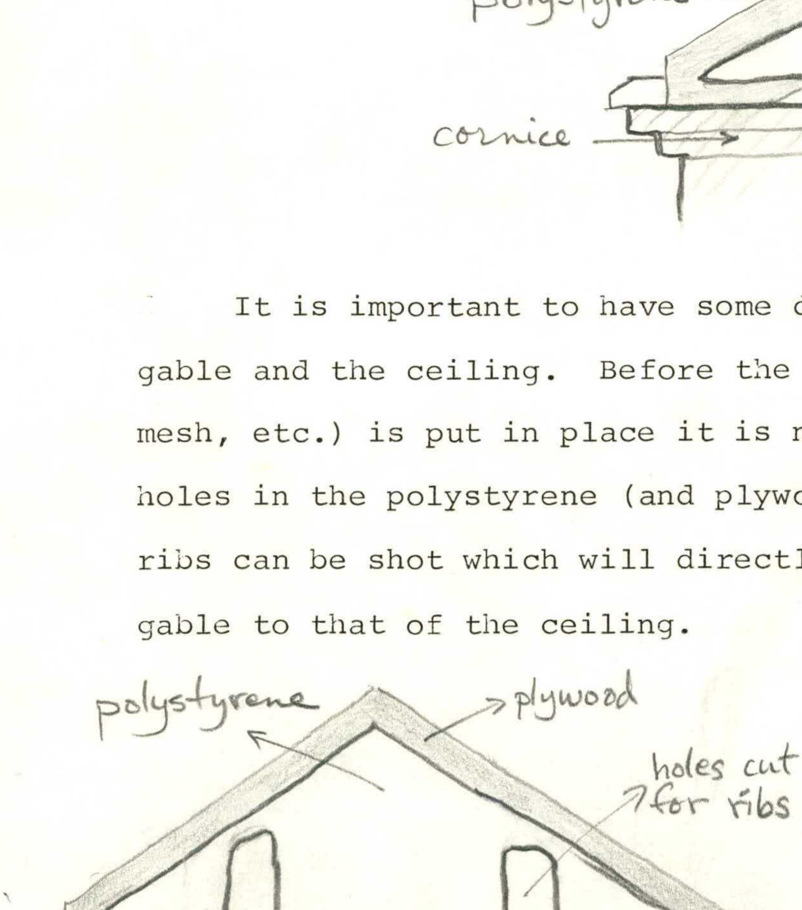


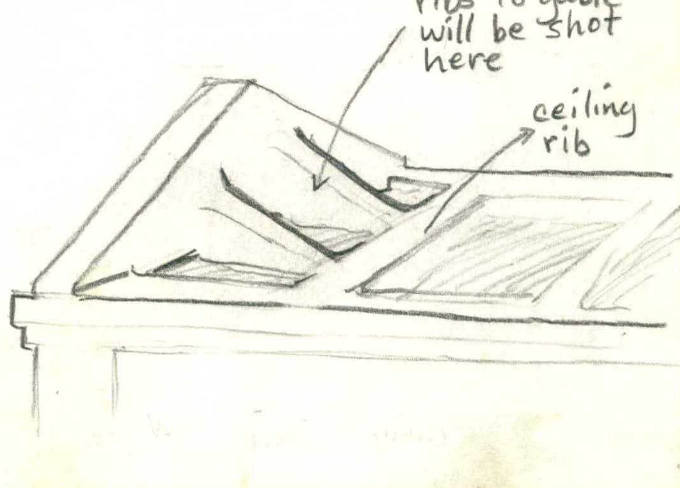
The shaded area in this sketch shows were the plywood was placed on the tool shed trusses.

The next step is to cut a triangular piece of polystyrene which will be glued to the plywood on the front of the truss. The position of the gable on the cornice will be determined by the thickness of this polystyrene. The edge of the pediment should be about 2" from the edge of the cornice. The final adjustment can be made at this time. The polystyrene should act as a filler, moving the gable out to the proper spot and providing a surface to shoot against. The top of the polystyrene should be about 2" below the top of the plywood. There should also be a gap at the bottom so that the concrete of the ceiling can be connected to that of the gable.



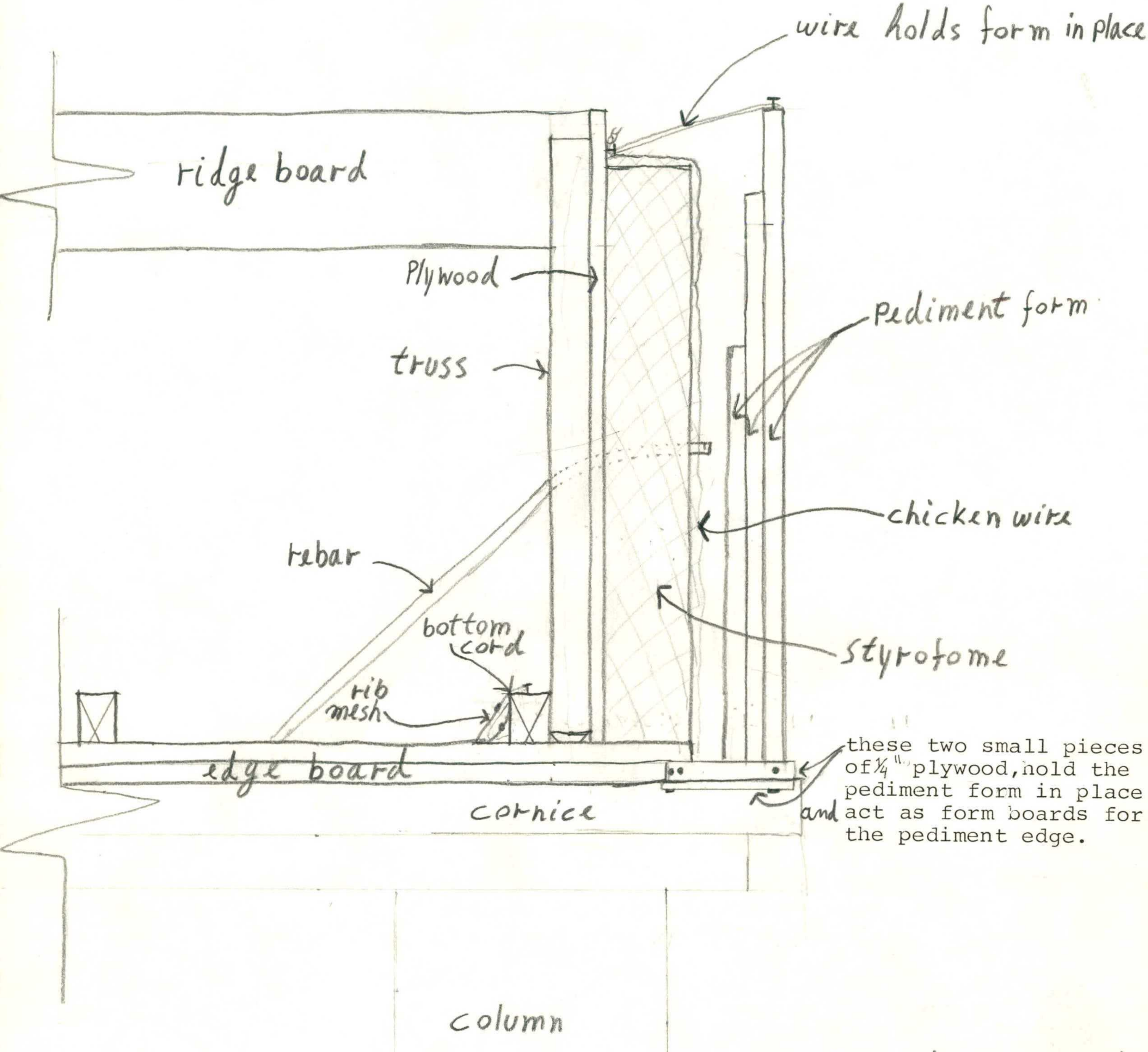
It is important to have some diagonal support between the gable and the ceiling. Before the gable reinforcement (chicken mesh, etc.) is put in place it is necessary to cut a couple of holes in the polystyrene (and plywood) so that a couple of diagonal ribs can be shot which will directly connect the concrete of the gable to that of the ceiling.





At this point the chicken wire can be placed on the front of the polystyrene. Thin strips of wood may be glued to the polystyrene (with Goodrich PL200 glue), thus providing a place to staple the mesh. At the bottom,the mesh should be connected with the ceiling reinforcement. Some extra mesh should be left at the top where the pediment beam will be shot. The diagonal rib should be reinforced with a piece of rebar ~~xjxxj~~ which is connected with the chicken mesh at the top end and with one of the ceiling ribs at the other.

Construct the pediment form to suit the design of the building. It can be connected to the truss at the top with wire (galvanized would be best). At the bottom it should be connected to the edge board (on the cornice) with small pieces of plywood, which will also serve as the forms for the pediment where it meets the cornice.



Gable End-Form Work

Side View

Scale - 1":5"

Shooting of Ceiling and Gable

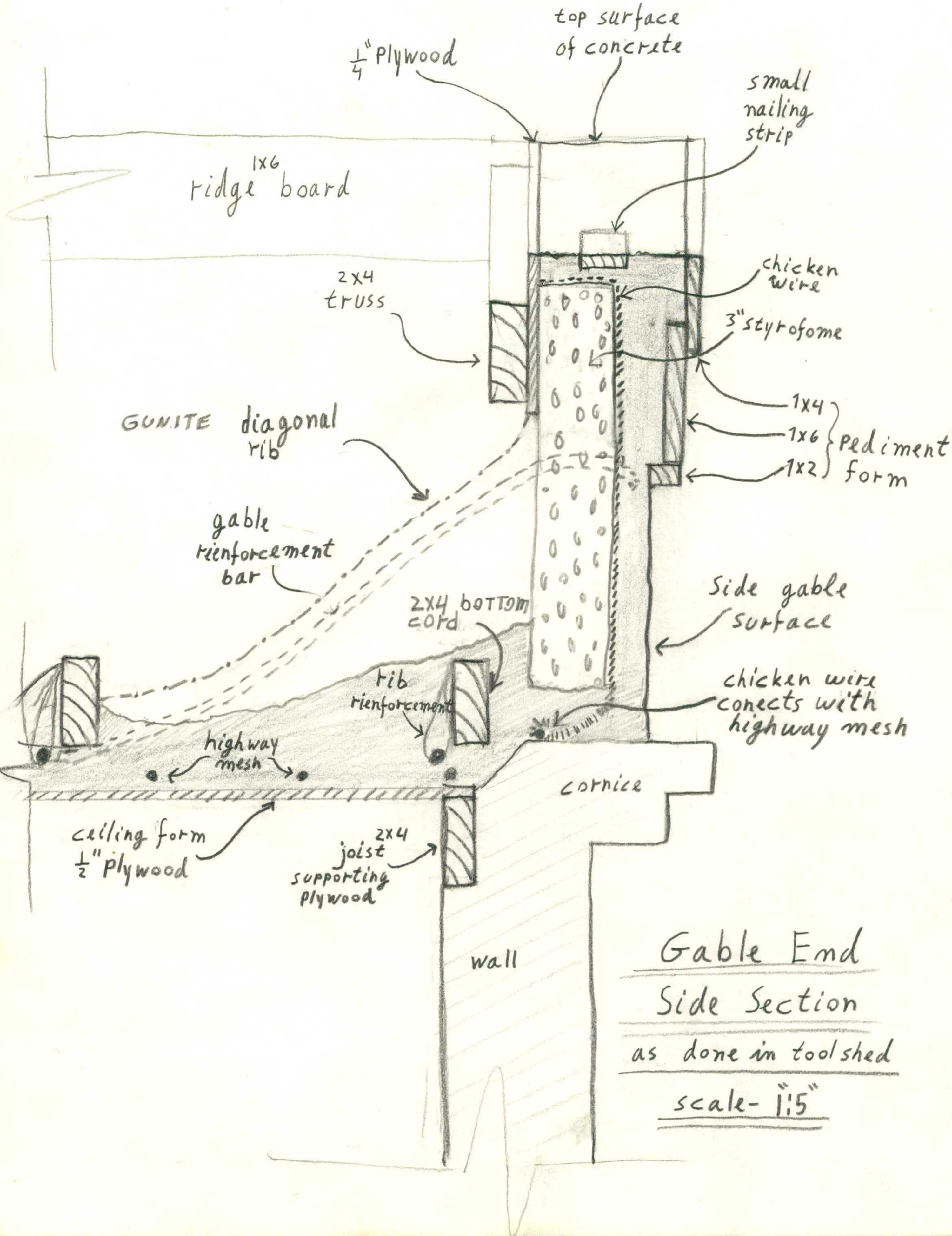
(New Method)

The Ceiling and Ceiling ribs are shot first. Care must be taken that all loose material is removed first.
The form release is spread on forms before starting

The diagonal ribs which connect the gable with the ceiling are shot next. While shooting,the hole in the polystyrene is temporarily covered from the outside.

Next, the gable is shot from the outside.

Finally, the pediment is shot, small nailing strips (Approx. 1"x3"x4") are imbedded in the concrete,and it is carefully screeded to a smooth, flat, even surface.



Gable End

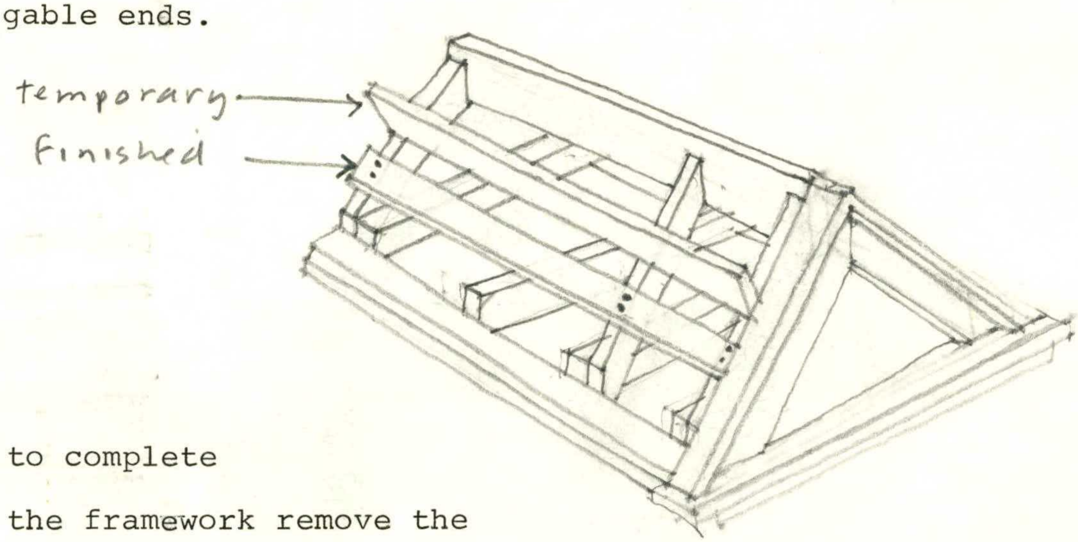
Side Section

as done in toolshed

scale- 1:5"

Framework for Wooden Roof

This framework is assembled after the shooting of the ceiling and the gable ends. The frameworrk of the roof is made of rafters and purlins. First the rafters are nailed to the ridge board above and the 2"x4" bottom cords (the rib forms) below. When shooting the ceiling care must be taken that one side of each bottom cord is left free of gunite in order to nail the rafters later. The rafters are construction grade 2"x's (2"x4"'s were used on the tool shed). Opposing rafters should be nailed at the same time to prevent the ridge board from bending. To make the rafters level with the gable ends, temporarily nail a purlin between the gable ends.



to complete the framework remove the temporary purlins and nail them face down to the rafters with the spacing determined at the site. For the tool shed 2 1"x4" purlins were used on each side.

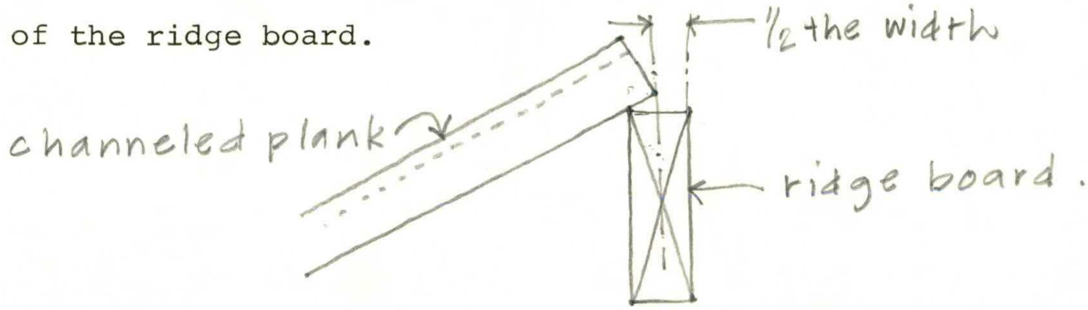
Nailing the Wooden Roof

This is a Russian style wooden roof. It is made from 2 layers of notched planks which extend from the ridge to the eave. The top layer is displaced over the bottom layer by 1/2 the width of a plank. Each plank has two channels for water drainage. The bottom layer is nailed to the purlins and the top layer is nailed to the bottom layer. The ridge is capped.

The first step is to cover the entire framework with building paper. The paper is laid in strips parallel to the ridge line. The first layer is at the eave and each succeeding layer overlaps the previous one by at least one foot. The last layer should cap the ridge. The building paper is stapled in such a way that it is stretched slightly across the framework. This process is done on both sides.

The planks used for the tool shed were Douglas Fir construction grade 1"x8"'s. Each plank has two channels on one face. Each channel is 1" away from the edge, 3/8" deep and approximately 1" wide. The shape of the channel depends on the shape of the shaper's or router's blade. It can be either square, rectangular, round or triangular in section.

The first layer is nailed to the purlins, the ridge board and the edge board with #8 galvanized box nails. The first plank is nailed with roofing nails to the nailing strips which are embedded in the gable truss. This board ~~overlaps~~ extends the face of the pediment by approximately 1 1/2". It is laid on top of the ridge boards and extends 3" past the edge board. The rest of the planks on this layer are cut to approximately the same size, and nailed tightly one next to the other. Care must be taken that all planks are leveled on top, thus they cover 1/2 the top of the ridge board.

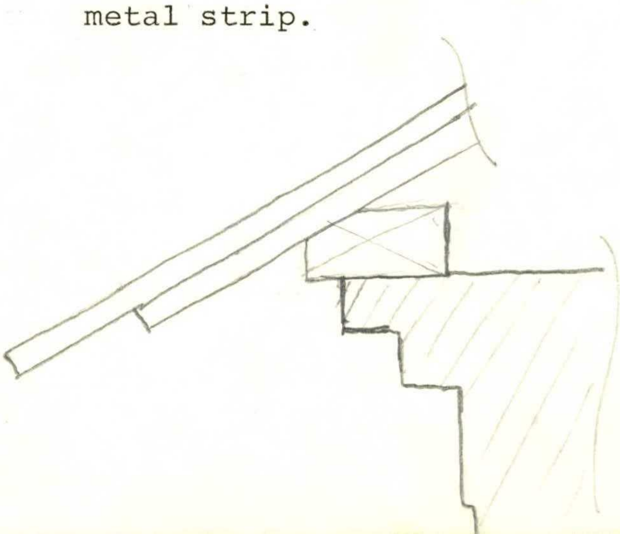


The last plank is nailed (like the first) with roofing nails to the nailing strips. This plank might extend more than 1.5" from the face of the pediment. In this case cut it to fit.

In order to get a straight finish cut at the eave, first mark the finish line with a chalk-line and then saw it. In this way ther is no need for accuracy in nailing the boards to the purlines. It is easy to saw a straight edge at the desired place and to get an accurate line at the eave.

Both sides of the roof are covered in this way. Now cover the ridge with a metal strip, nailing it with roofing nails. (6" Aluminum strip was used in tool-shed).

A second layer is naild and cut exactly as the first layer was. It can extend beyond the first layer at the eave, level with it, or made shorter. Again the ridge is covered with a metal strip.



In the toll-shed the second layer extend the first layer at the eave.

If while nailing the first layer,ther are noticeable cracks at the joints between the roof planks, they mast be sealed with a clear silicone rubber sealer.However,the first layer must be perfectly seald,because the clear sealer still leaves marks that we do not want to show on the finished surface.

Two 1"x's are then naild at the ridge and covers the metal strip. The size of this boards can change due to the proportions of the roof. (1"x3" were used on tool-shed).

Small ornaments can cover the gable sides,and a moulding strip can be set on top of the ridge.

Flat Ceiling And Wooden Roof (new method)

- Inadequate construction details -

Ceiling - 1/2" plywood on 16" centers 2"x4"joists,bowed under the concrete weight.

-The ceiling sould be higher then the cornice for drainag reasons.

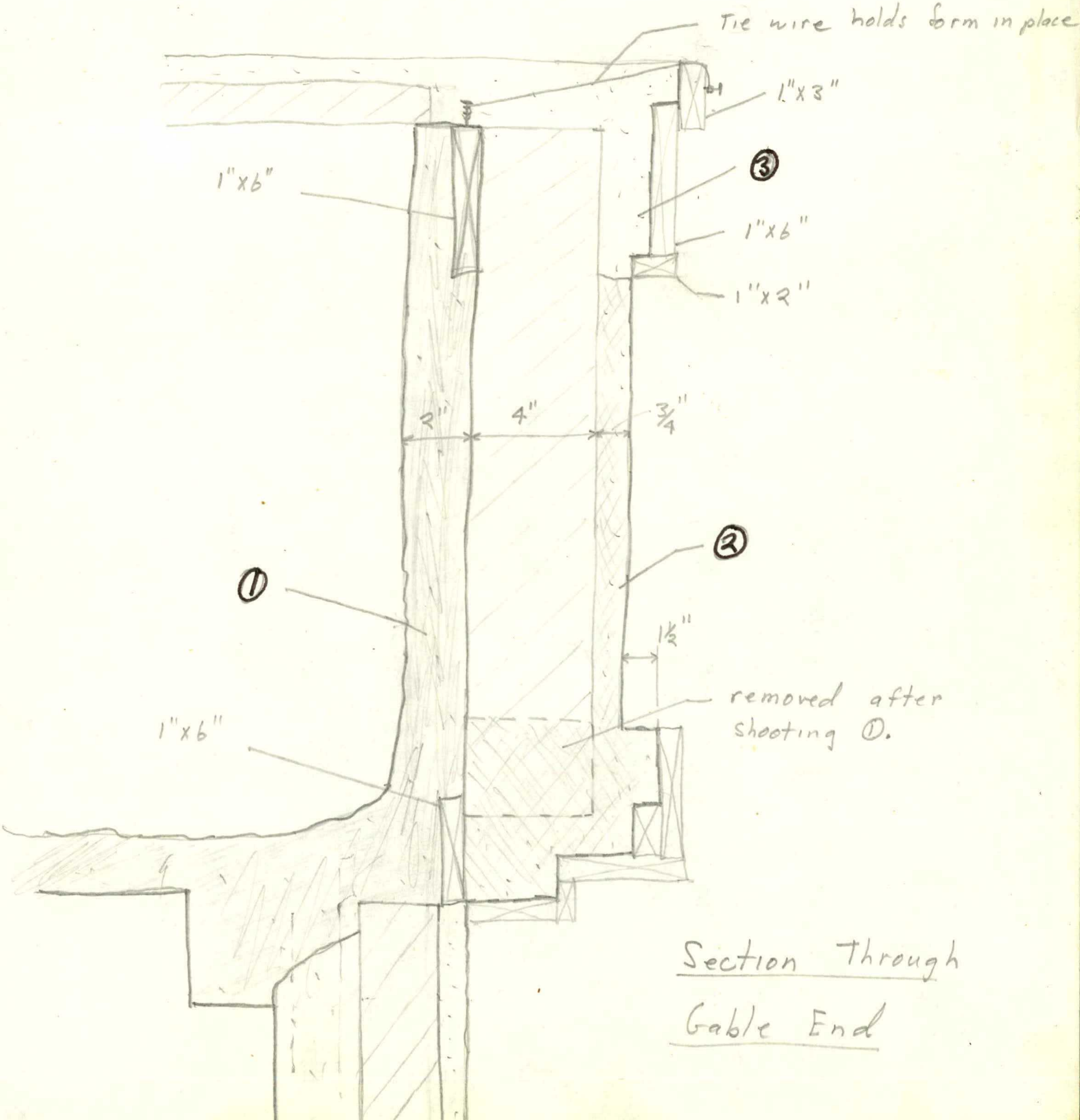
Pediment -The pediment edges should be reinforced with more chicken wire,thus they do not crack.

-The nailing strips imbedded in the pediment dose not work very good,and the roof's edge planks are therfor not rigid enough.

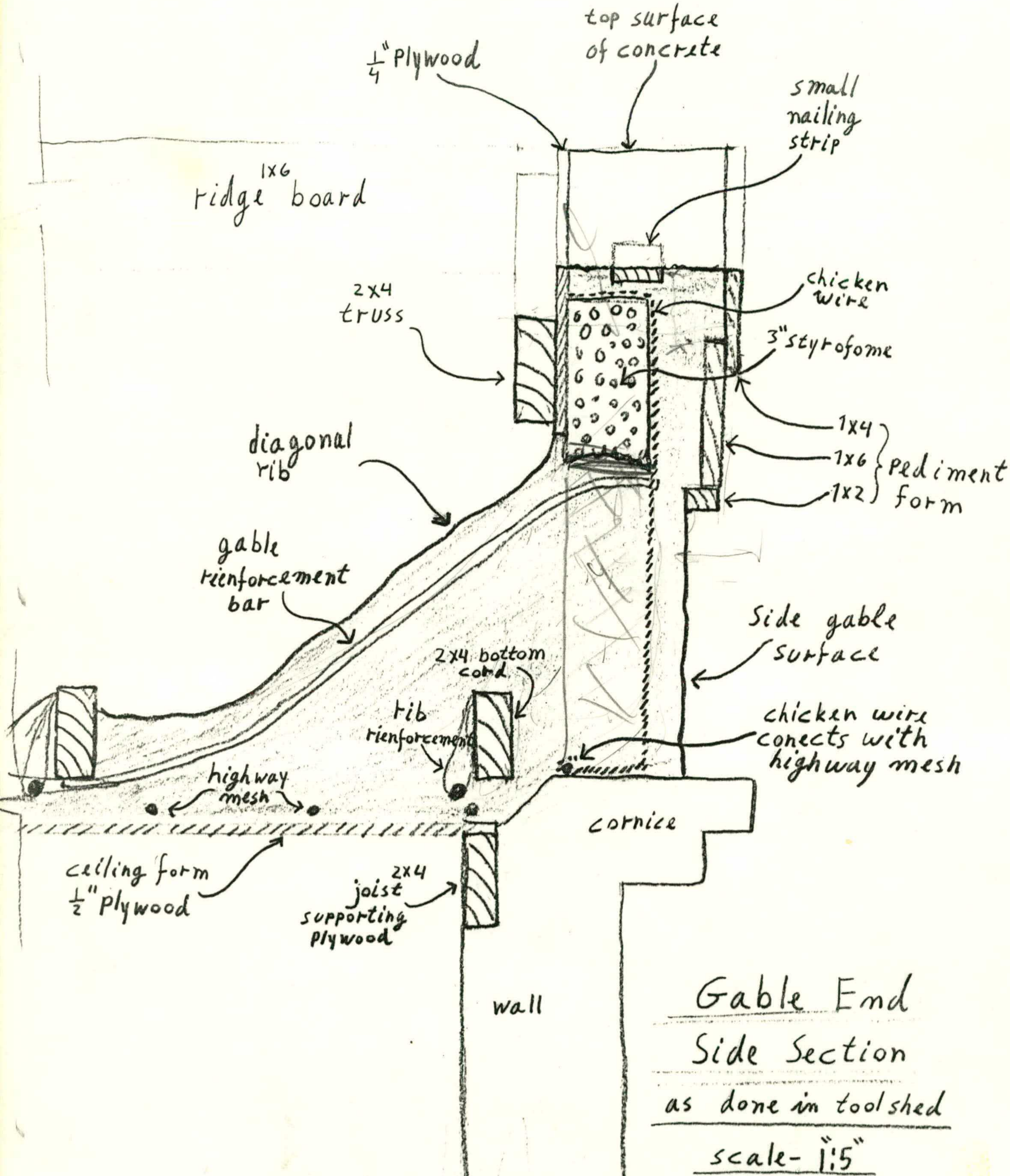
OK 9/9/80
not OK 11/26/80
calculate cantilever steel

GABLE END

The gable end is to be built similarly to the other trusses with two important differences. Both sides are to be shot, and 4" styrofoam is to be substituted for the building paper.



Section Through Gable End



Gable End

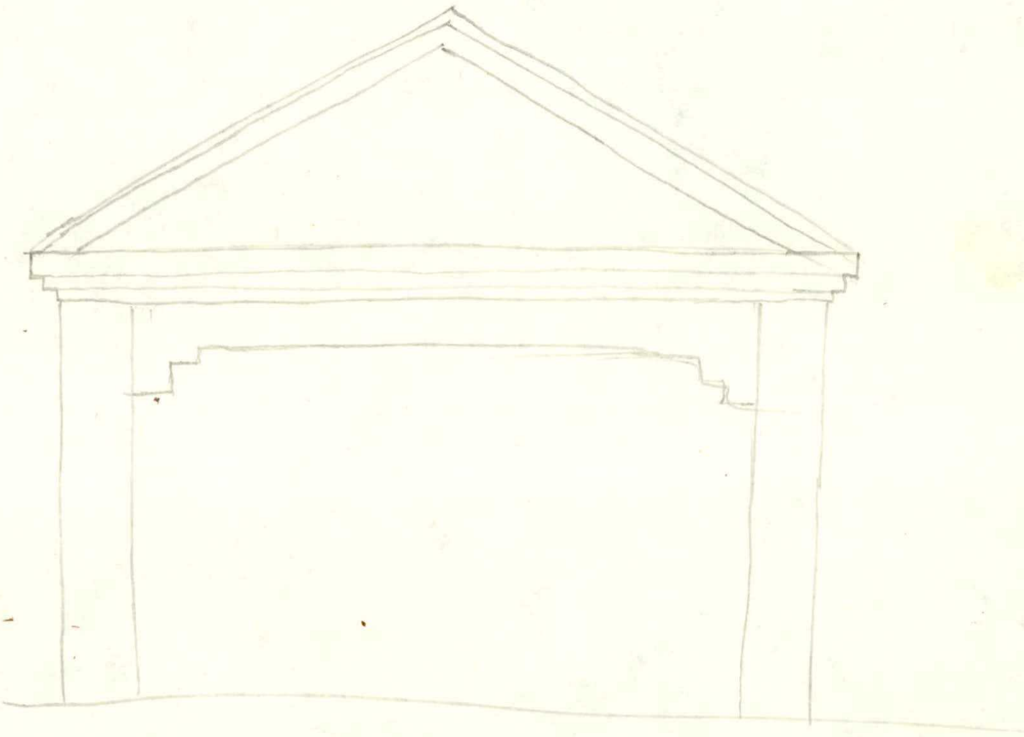
Side Section

as done in toolshed

scale- 1:5"

GABLE END

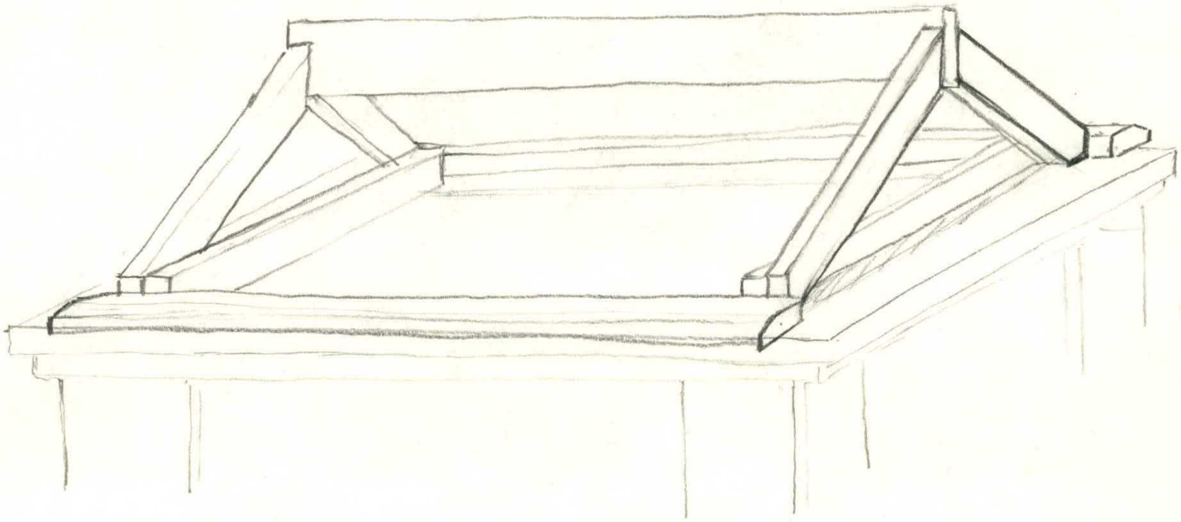
The first shooting ① is to be done at the time of the ceiling and other trusses. Shooting ② and ③ is done at the time of doing the roof and cornice, with ② preceeding ③. Prior to the second shooting a 3" strip of styrofoam is to be removed to allow room for shooting the cornice.



Gable Formwork and Reinforcement

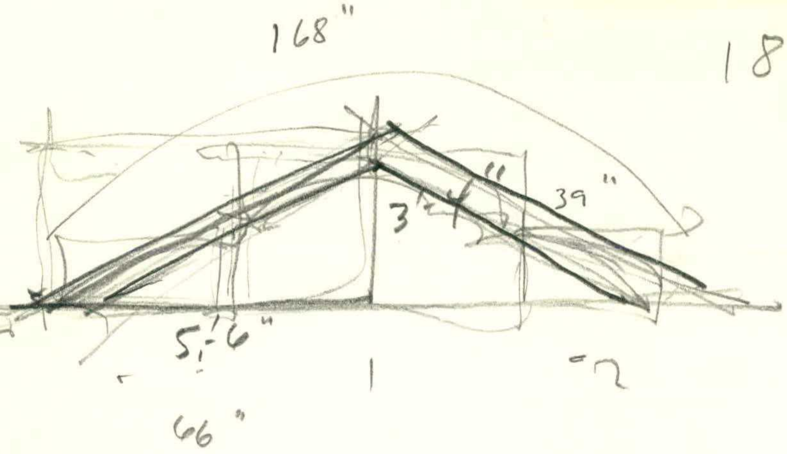
(New Method)

The first step in the gable formwork is to build a wooden truss at each end of the roof with a ridge board connecting them. The bases of the trusses will be formed by nailing the truss boards to the cord boards at each end of the ceiling.



These truss boards should be nailed to the outer side of the cords. After looking over the whole gable construction method, it will be necessary to decide on the correct positioning of the final gable end in relation to the cornice and corner columns. The front of the gable should be somewhat back from the edge of the cornice and the bulk of the gable should rest on the columns. This ~~dxkxxmx~~ will determine the position of the last cord and the truss structure. Once proper set-back distance from the edge has been found, the slope of the roof must be determined and the ridge board possitioned at the correct hight to achieve this angle. The ridge board whould lie directly between the two truss boards and be held tightly in place by them. Before the final roof is built, purlins will be laid on top of the truss boards, so that the truss boards will actually be below roof level. However, the

180'

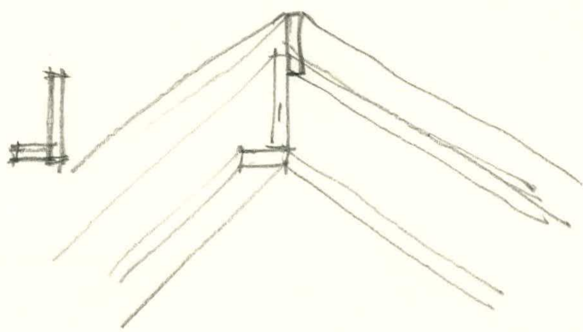


2574.[illegible]"
2688
6435 CU. IN.
46,656 CU. IN. = 1 YD
.19 CU. YDS.

3)22 7

masonite 2 sheets

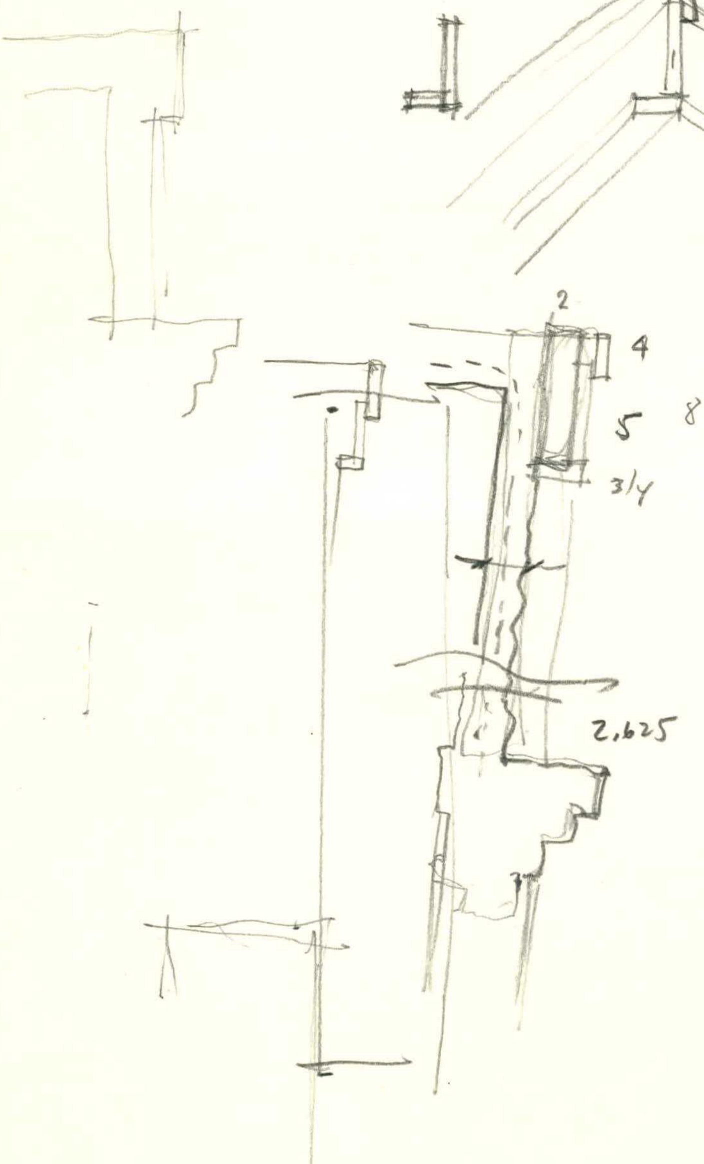
180"



3)33 11

3/8 = 1'-0"

14x



18[illegible]' x 2½"

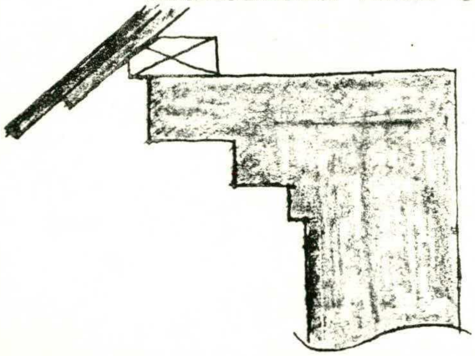
2 8' bds.

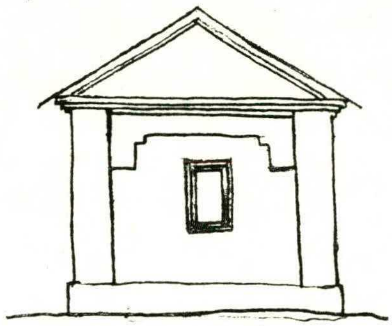
2.625	2	1x4's	@ 8'	.35	50¢
	2	1x6's	@ 8"	.41	
	2	1x2's	@ 8		16 x 10

	2
	2
1.60	2
	6

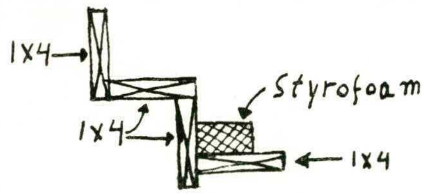
THE CORNICE FORMS

Once the columns forms are erected and braced, the cornice forms are built and put in place. The finished cornice acts as a beam spanning between the tops of the columns and provides a visual transition from the plan of the walls to the overhanging roof.

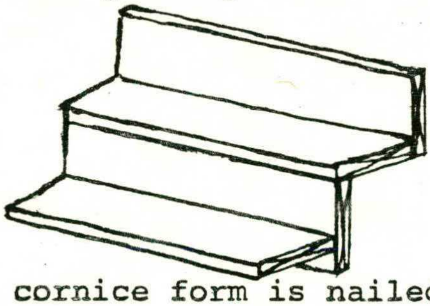


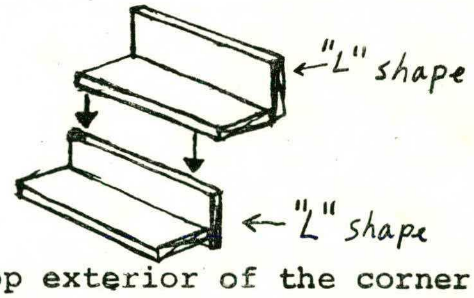


The cornice forms are made of 4(1x4's)" connected on their flats and edges and styrofoam (rectangular section) glued in later.

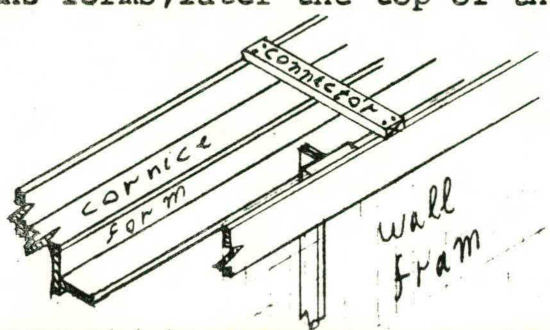


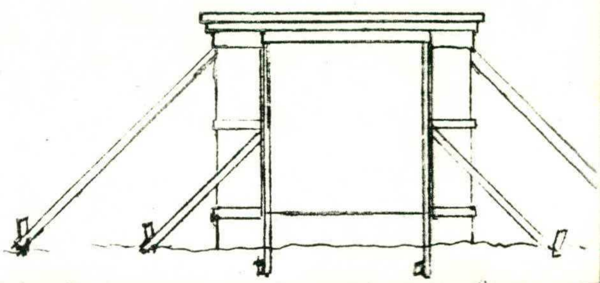
The wooden form is made in two operations. Nailing separately two "L" shapes and joining them. Later the rectangular styrofoam is glued in place.





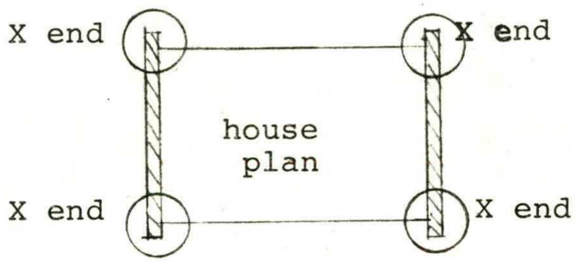
The cornice form is nailed to the top exterior of the corner columns forms, later the top of the wall frame is braced to it.



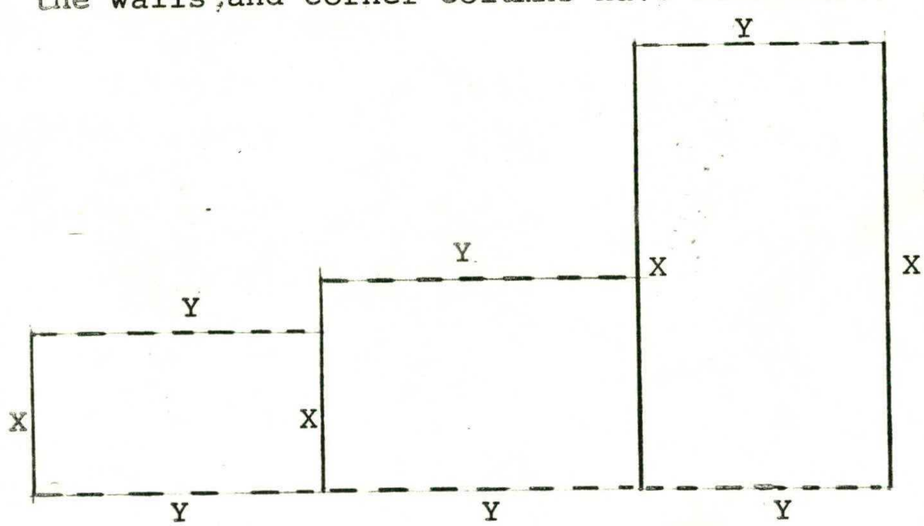


It is essential that the horizontal lines that the cornice forms makes are clean and straight, so that no curved lines will disturb the eye by making the building look unsound. The nature of edge to flat connections of the 1x4's, provides a lot of strength in the spanning ability. However vertical props support the cornice while pouring the concrete, in order to keep it from bowing down.

The most difficult parts in building the cornice forms are the connections between the adjacent forms. The first cornice form to be built on each level of the house will have an identical end on each side. We will call this type an "X" end.



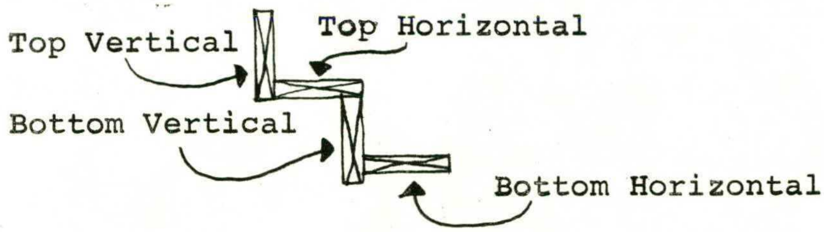
Later, after this cornice forms with two "X" ends are in place, the adjoining cornice form with "Y" ends is measured to fit with the existing "X" to form the joint at the corner. The "Y" cornice form's dimensions are obtained by measuring between the existing "X" connections for each 1x4. The cornice is poured once the walls, and corner columns have been shot.



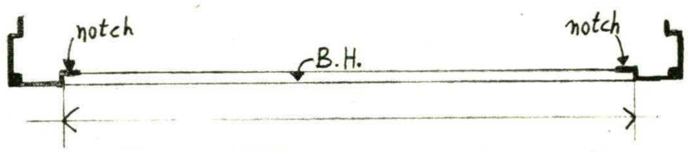
This scheme describes the way the cornices join in the Martines layout.

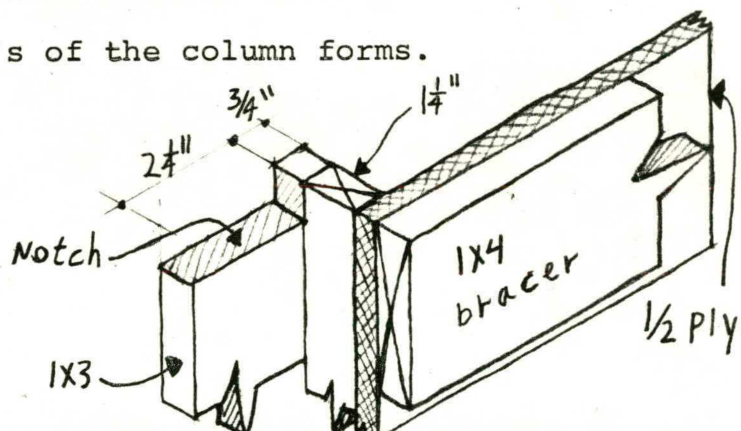
MEASURING THE CORNICE FORMS

The first thing to do is to get accurate measurements. The parts of the cornice are as follows:

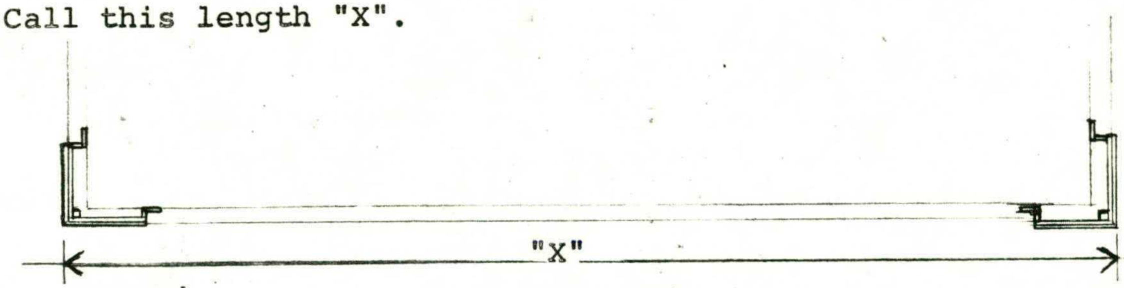


To get the length of the bottom horizontal (B.H.), measure between the inside edges of thecolumn forms that will support the cornice. The bottom horizontal will rest in the notches previuosly cut in the vertical 1x3's of the column forms.





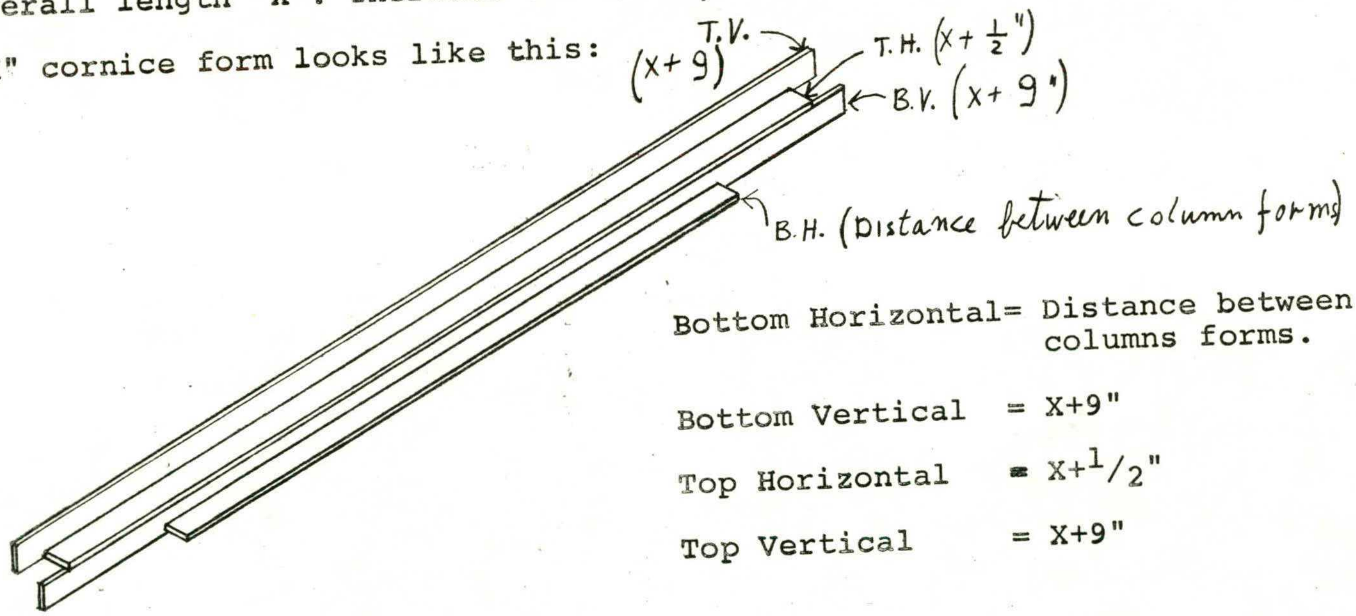
To get the lengths of the rest of the cornice 1x4's, measure the overall length from column form bracer to column form bracer. Call this length "X".



Now that we have the overall length "X", the length of each boardis determined by the geometry of the two corner joints added to this overall length "X".

MEASURING THE "X" ENDED CORNICE FORMS

The bottom vertical (B.V.) extends 4 1/2" on either side of the column forms. So the length of the B.V. is obtained by adding 9" (2x[4-1/2"]), to the overall length "X",(this B.V. will support the T.H. of the "Y" end). The top horizontal extends 1/4" beyond the column form on either side and therefore its length is 1/2", (2x1/4") plus the overall length "X",(this is to accommodate a 1/4" plywood spacer mentioned in pg.9.)The top vertical is the same length as the bottom vertical, thatis , 9" added to the overall length "X". Therfore the overall configuration of the "X" cornice form looks like this:



Bottom Horizontal= Distance between columns forms.

Bottom Vertical = X+9"

Top Horizontal = X+1/2"

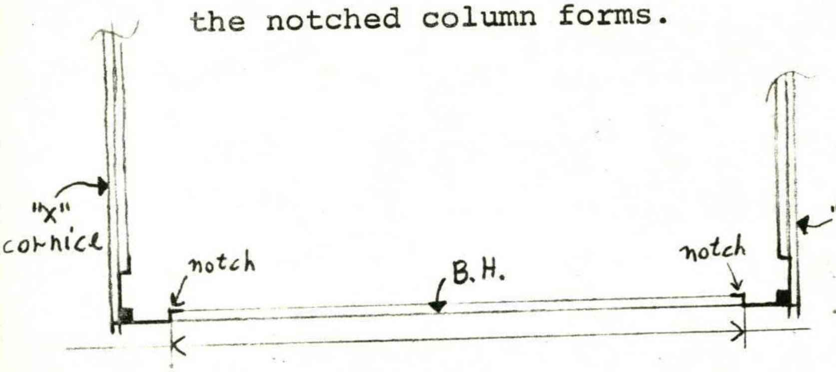
Top Vertical = X+9"

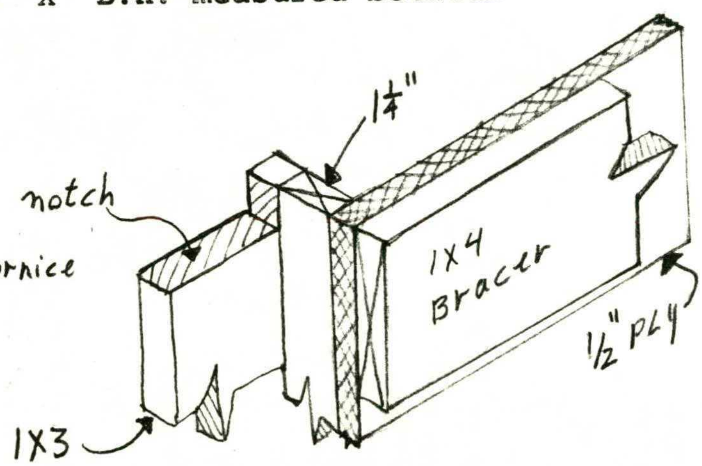
MEASURING THE "Y" ENDED CORNICE FORM

In practice the sequence of operations is to first measure the "X" ended cornice forms, build them and fix them to the column forms.

Only then comes the measuring, ,building and fixing of the "Y" ended cornice forms. For an Orderd Presentation, the measuring is described now.

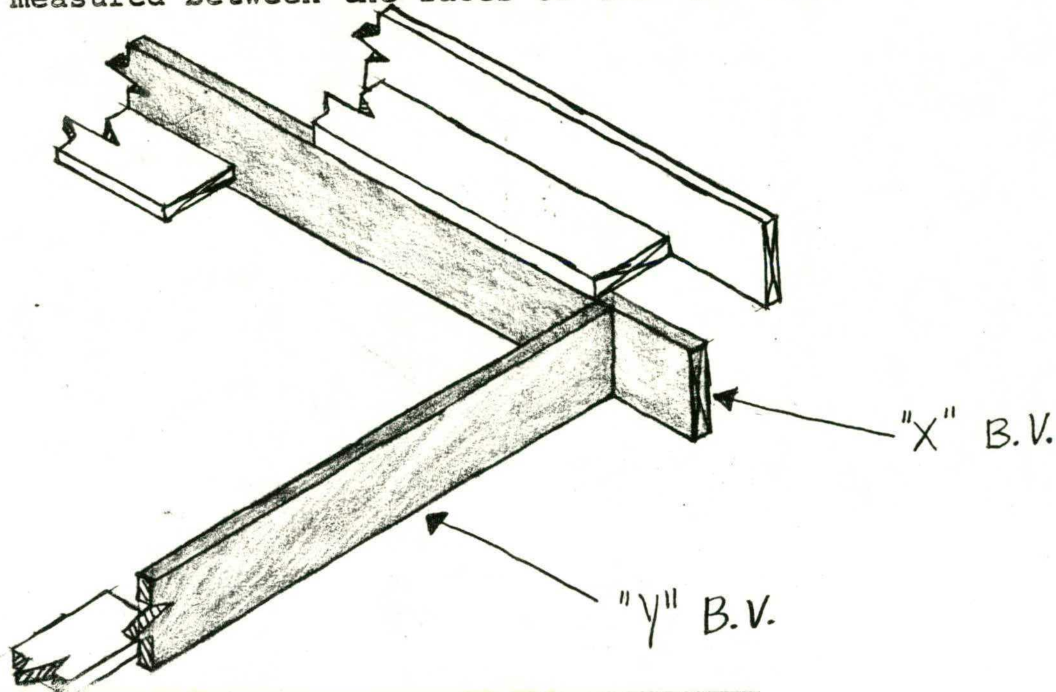
Once the "X" ended cornice form has been secured in position, the adjoining "Y" cornice form is measured. In general the "Y"B.H. measuring process is the same as the "X" B.H.-measured between the notched column forms.



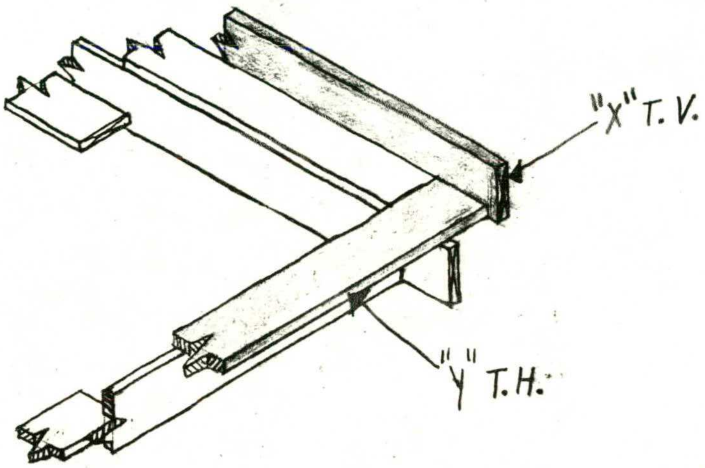


The rest of the 1x4"s for a "Y" ended cornice form are measured between the "X" ended cornice forms already in position, fixed to the column forms:

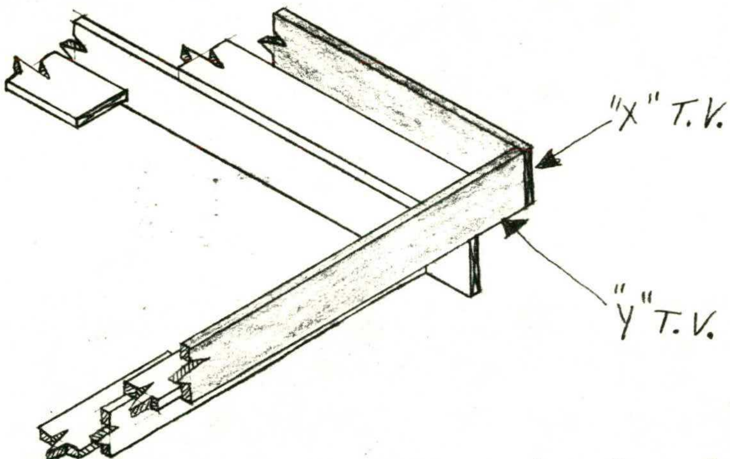
The end of the "Y" bottom vertical connects to the face of the "X" bottom vertical . Therefor the "Y" cornice form has a B.V. measured between the faces of the "X" B.V. s .



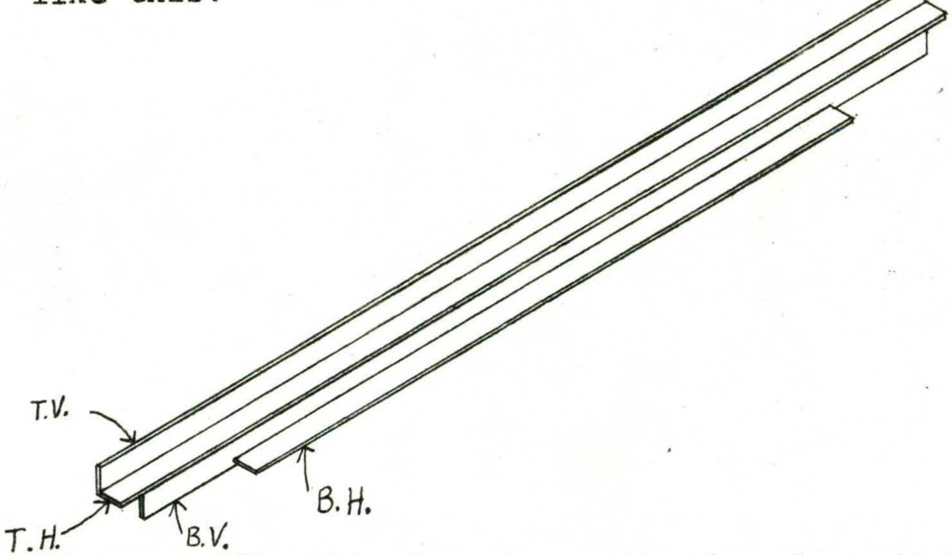
The "Y" T.H. runs into the bottom of the face of the "X"T.V. and over the "X" B.V. Therefore the "Y" cornice has a Y.H. measured between the faces of the "X" T.V.s.



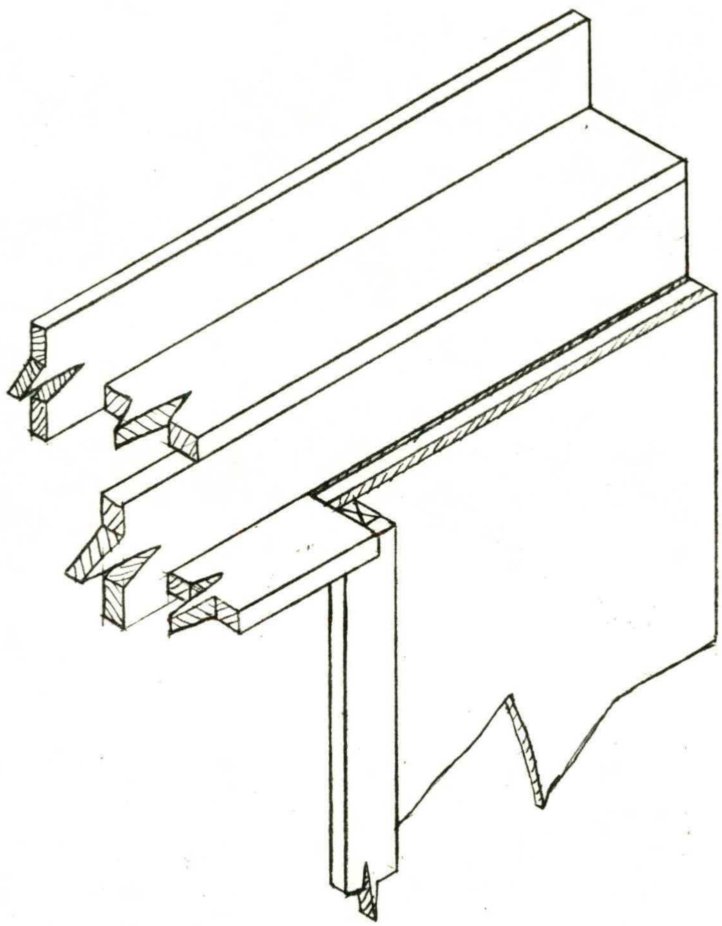
The end of the"Y" T.V. connects to the face of the "X" T.V. Therefor the "Y" cornice has a T.V. measured between the face of the "X" T.V.s.



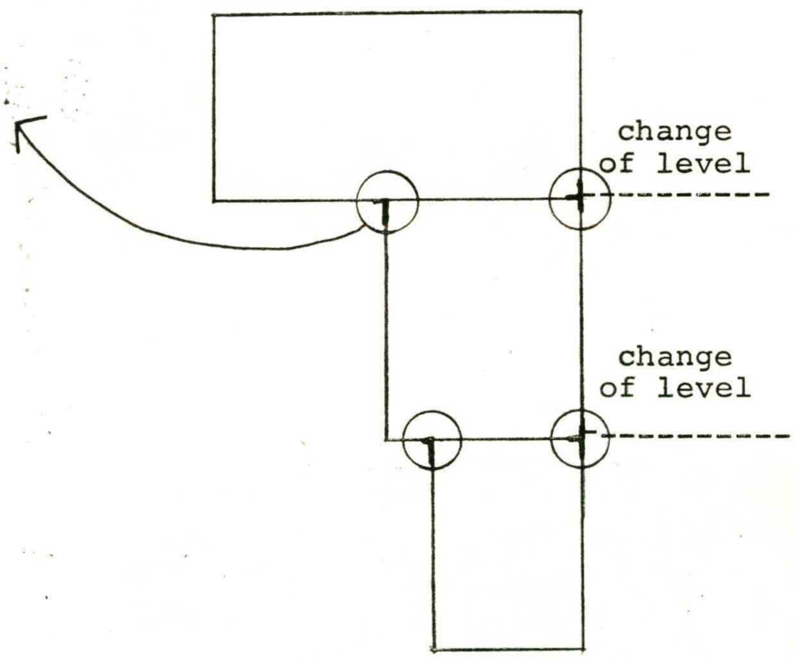
The overall configuration of the "Y" cornice form looks like this:



Sometimes a "Y" or "X" cornice form ends (at one end) in a wall and dose not connect to another cornice form. In that case all the 1x4"s are flush with each ather and the exterior face of the wall-flush with the outside of the wall insulation.

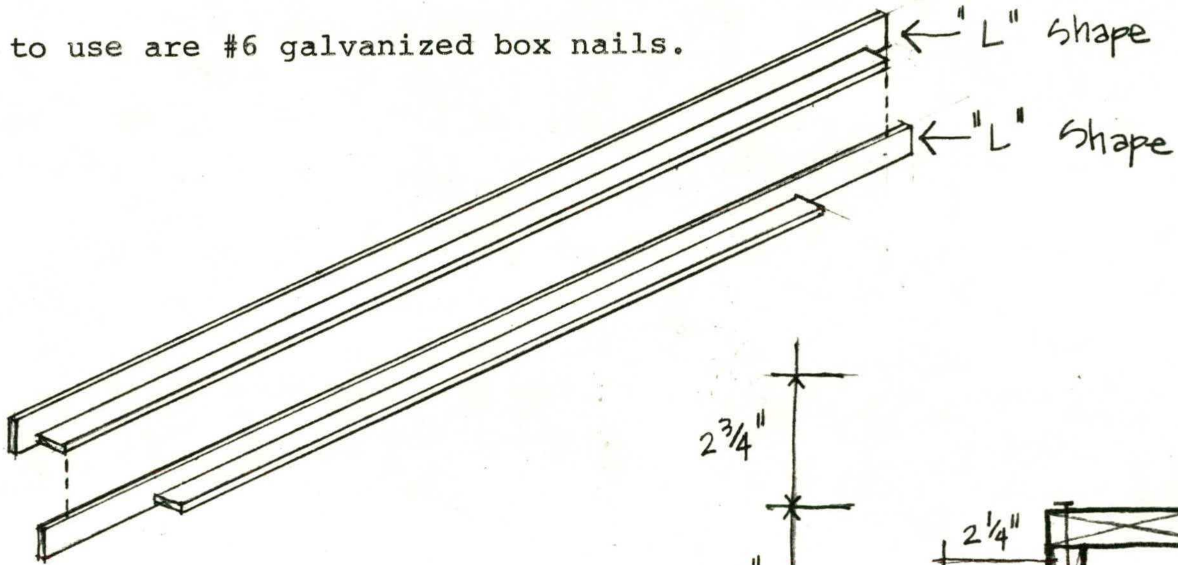


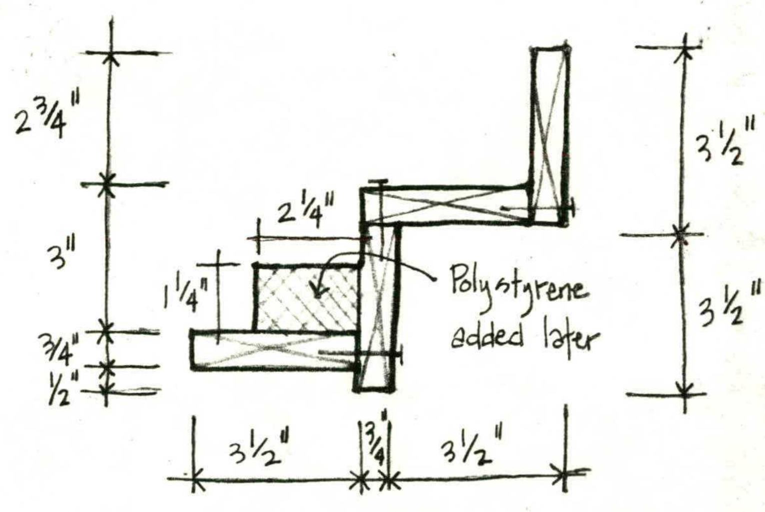
In the Martinez house there are four places were such a cornice end is built. In those places there is a change in the house level.



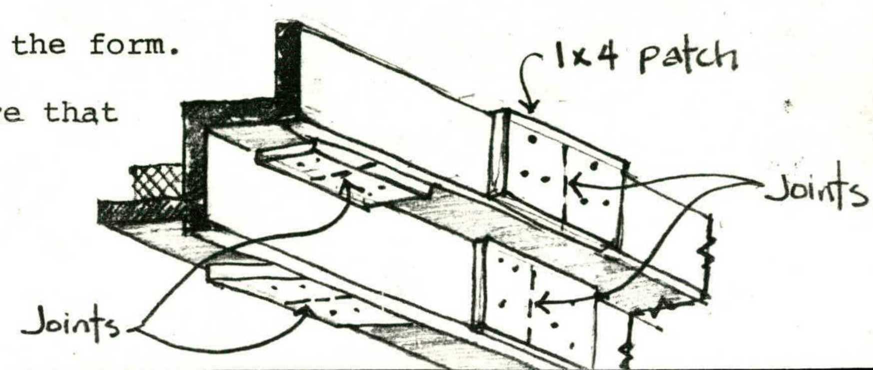
BUILDING THE CORNICE FORMS

As mentioned above, the cornice form is made by first making two "L" shapes, each out of two 1x4's by nailing them together. These we then nail together to form the whole cornice form. The nails to use are #6 galvanized box nails.



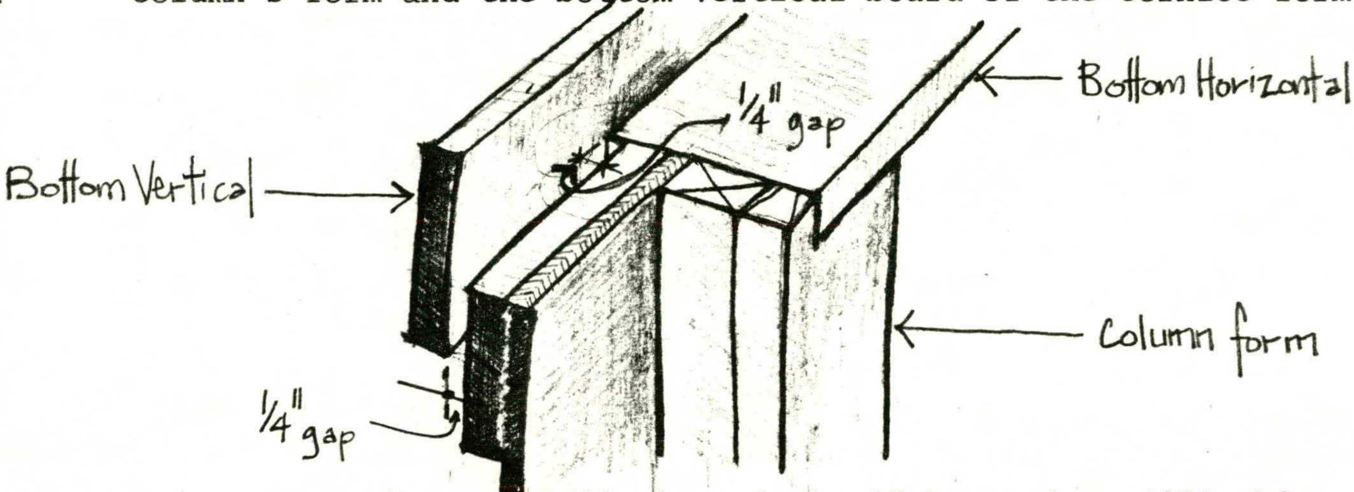


If the cornice is exeptionally long it will be necessary to splice two 1x4's together to get the required length of the cornice members. The splicing is accomplished by placing the two 1x4's end to end and patching the joint with a 1x4 scrap.Make sure that the joint is tight so it won't leave a mark. Also remember to place the 1x4 scrap on the <u>outside</u> of the form. To insure rigidity, make sure that the joints do not align.

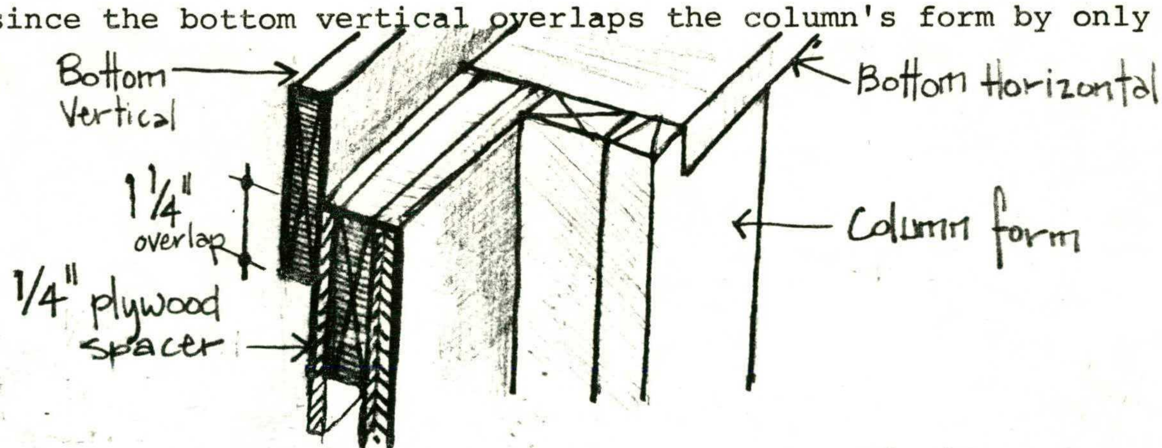


Fixing the cornice form to the column form.

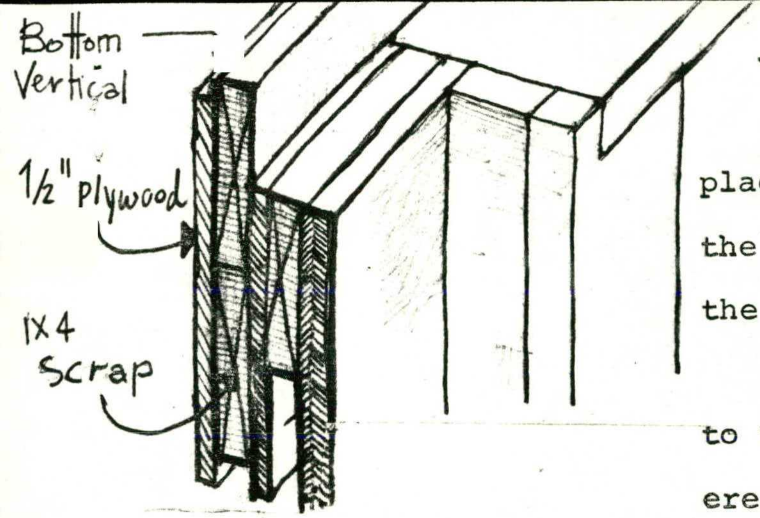
Now that the cornice form has been constructed a special connection to the column's form is necessary. The top of the column's form continues the line of the bottom horizontal of the cornice's form. There is a 1/4" gap between the 1x4 brace at the top of the column's form and the bottom vertical board of the cornice form.



A piece of 1/4" plywood should be used to fill this gap, placed such that the top edge is flash with the top of the 1x4 bracing of the column's form. The 1/4" plywood spacer is also used to strengthen the connection of the cornice's form to the column's form, since the bottom vertical overlaps the column's form by only 1 1/4".

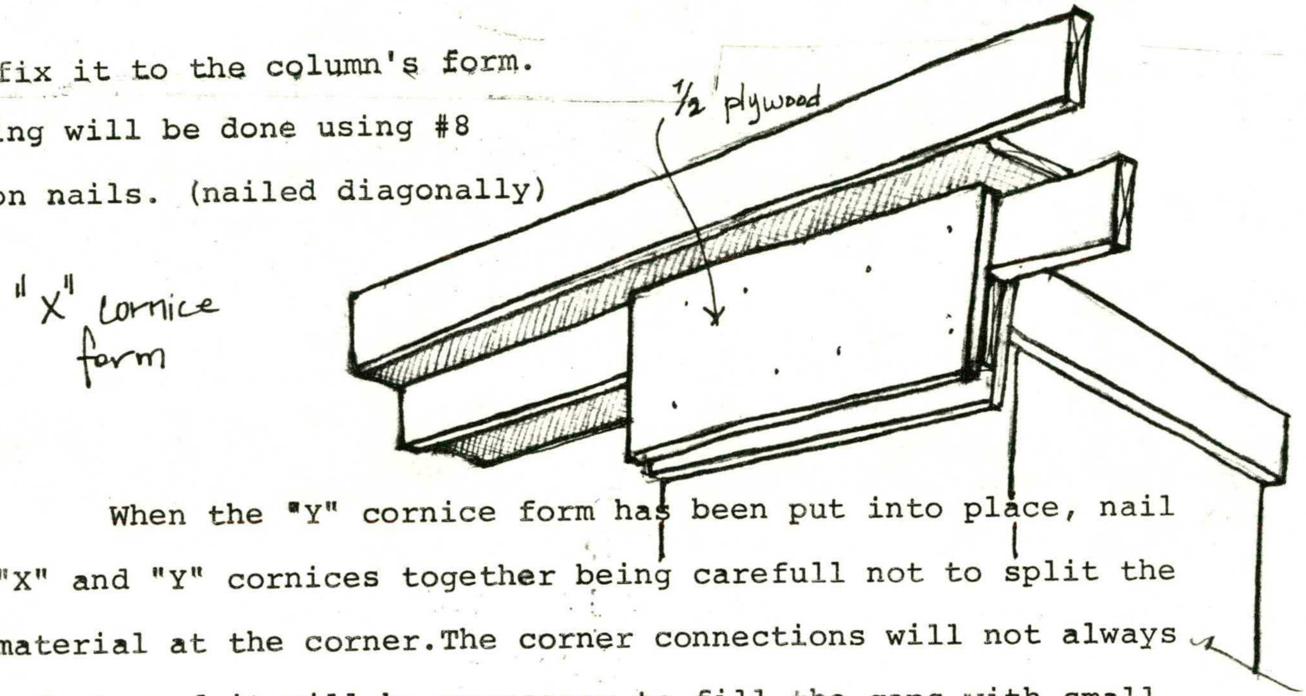


The 1/4" plywood spacer should be about 6" wide and as long as the column's form is wide. Once the 1/4" plywood is nailed into place, nail 1x4 scrap to the 1/4" plywood so that the 1x4 is batting against the bottom vertical.

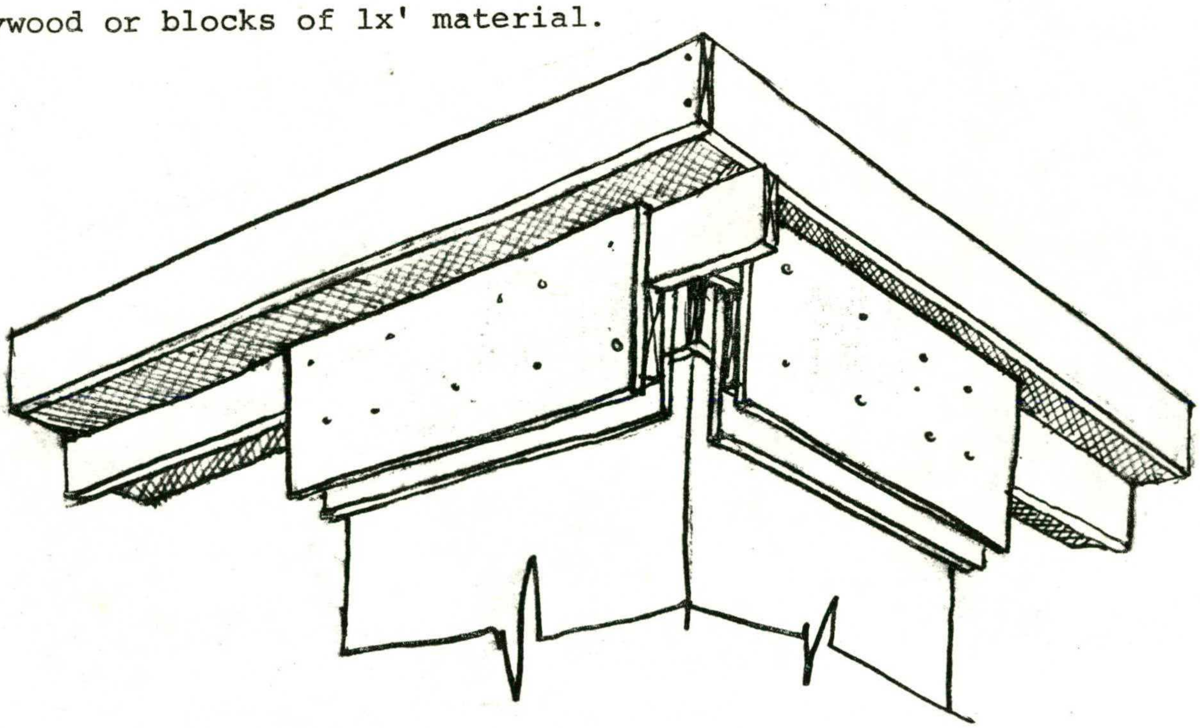


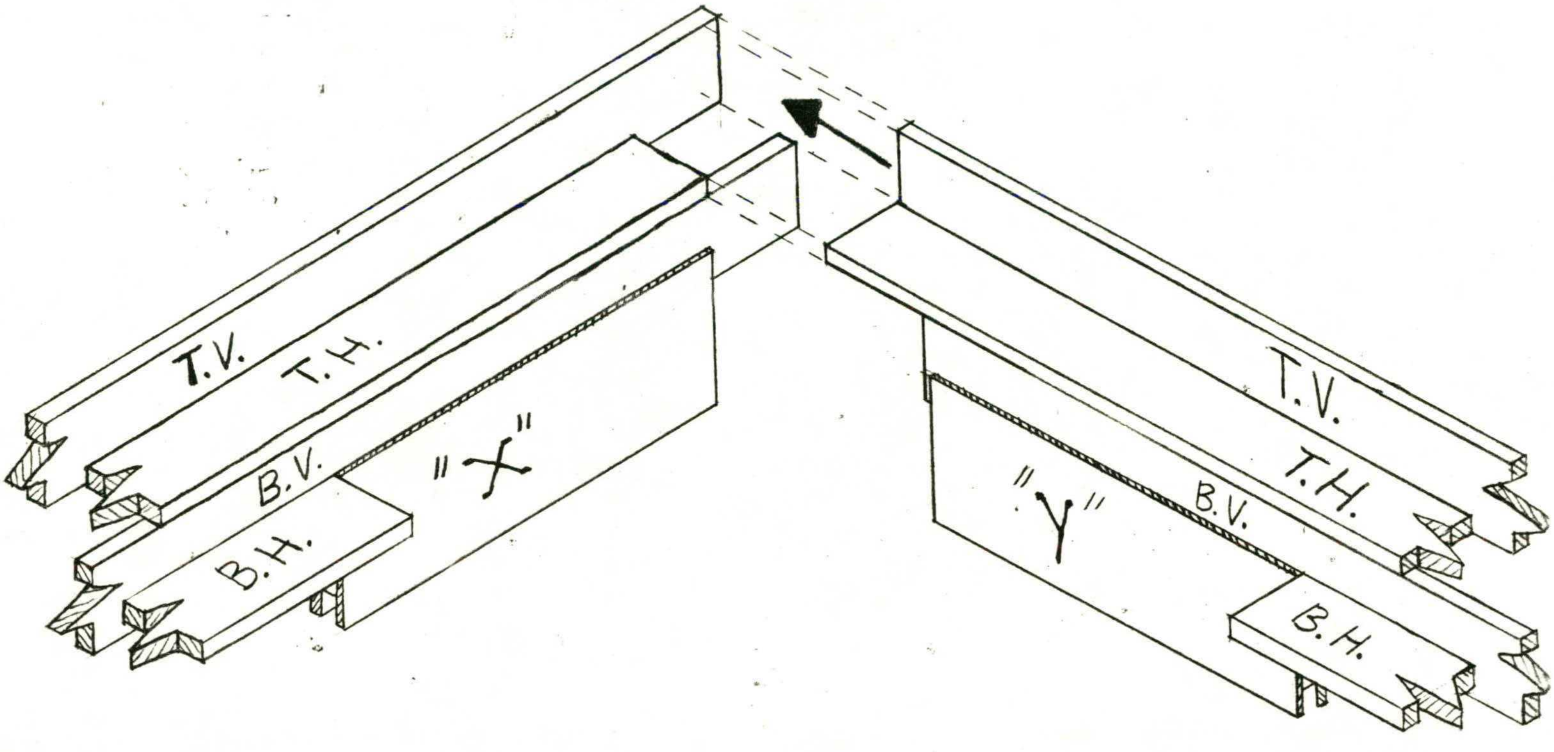
To complete the stiffening of this connectio place a piece of 1/2" plywood on the out side of the bottom vertical and the 1x4" scrap to cover the seam between them.

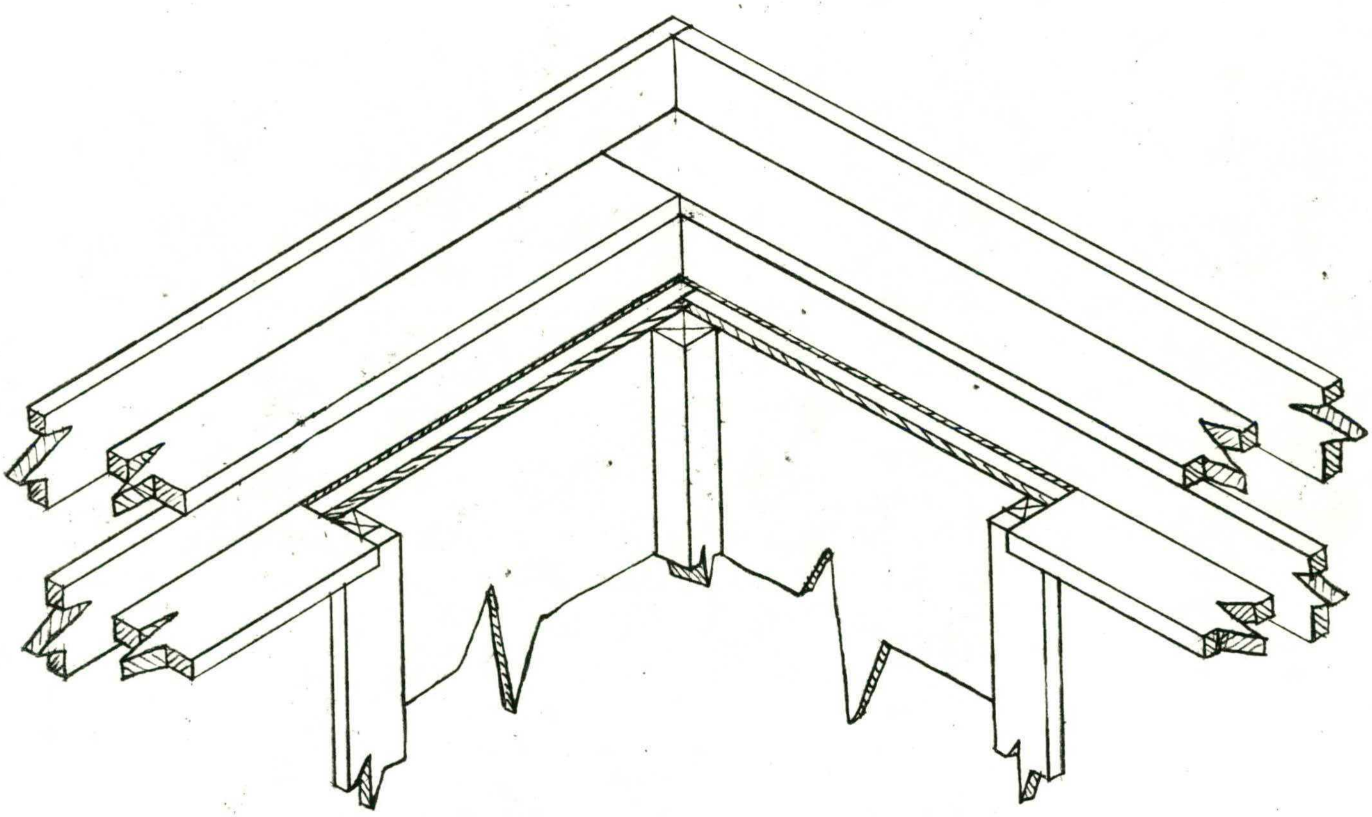
In practice this whole assembly is nailed to the cornice ~~bottom~~ vertical befor it is erected, only then erect it and fix it to the column's form. Nailing will be done using #8 common nails. (nailed diagonally)



When the "Y" cornice form has been put into place, nail the "X" and "Y" cornices together being carefull not to split the 1x' material at the corner. The corner connections will not always be perfect, and it will be necessary to fill the gaps with small bits of plywood or blocks of 1x' material.



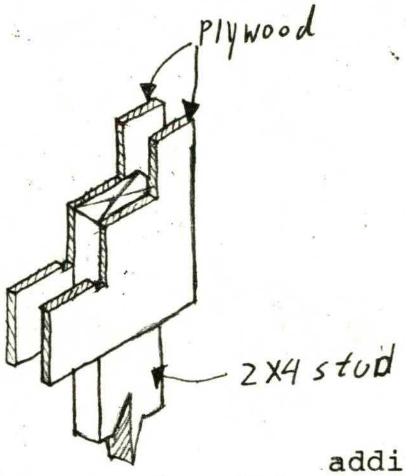

T.V.
T.H.
B.V.
"X"
B.H.
T.V.
T.H.
B.V.
"Y"
B.H.

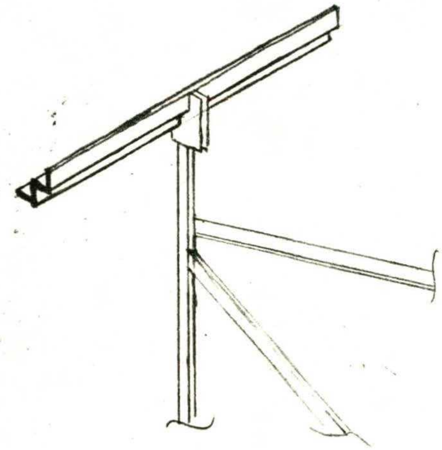


PROPPING

Usually the cornice form can carry its own weight without bending . However, sometimes it is necessary to reduce the span by props underneath the forms.

These props are made of 2x4" studs braced to the ground with diagonals. Two pieces of plywood are nailed at the top of the stud for sufficient connection with the cornice 1x4's form.





As mentioned in pg.2 additional vertical props support the cornice while pouring the concrete. These props are erected just before the pouring, thus they will not interrupt with other building operations.

OPERATION CORNICE WOODEN FORMS

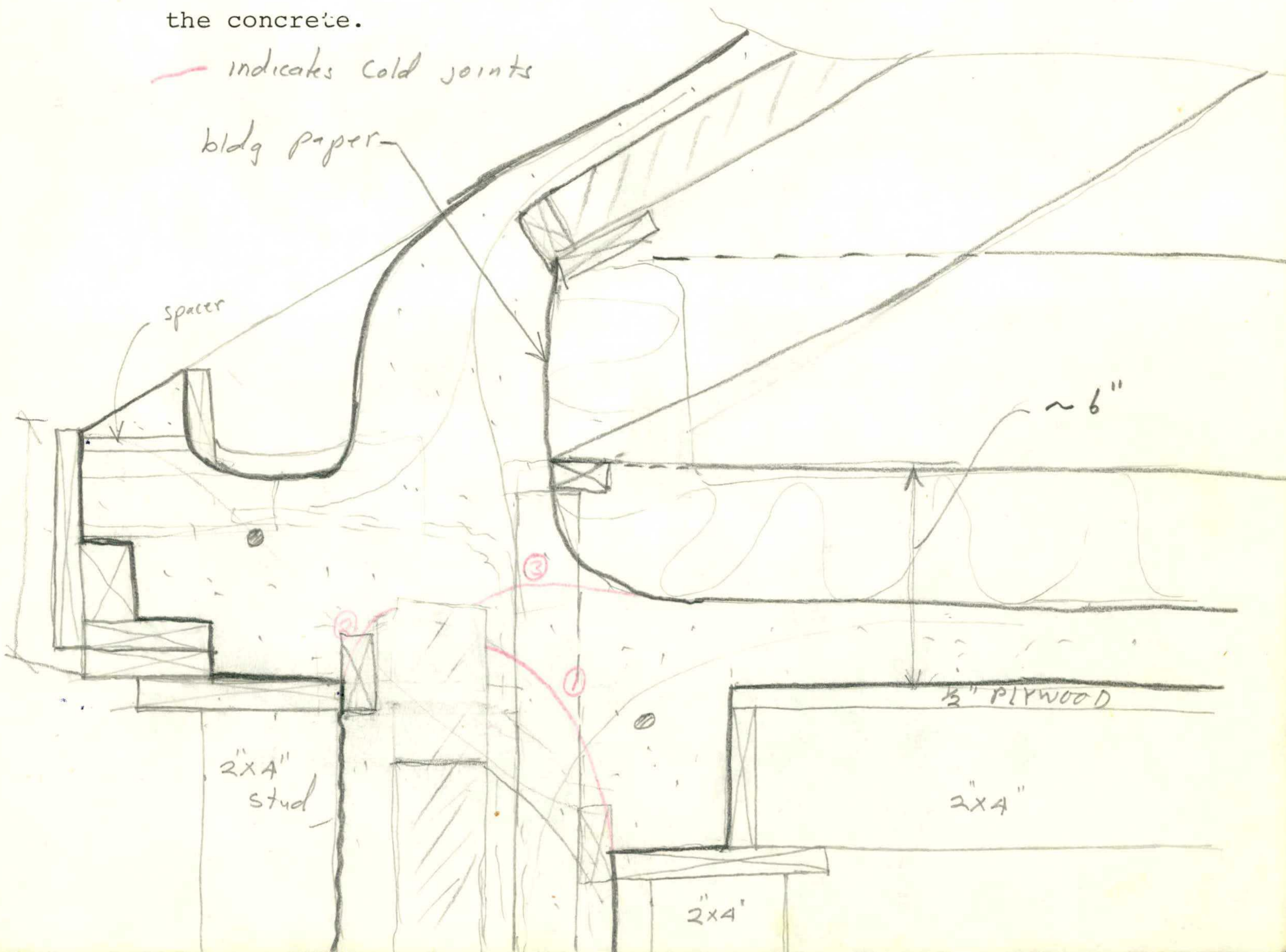
MATERIALS		
DESCRIPTION	COST	REMARKS
For each 1' length		
(1x4)"-[4'] form	0.56 $	given with discount
sub total for 214'	119.84 $	tax not included
TAX- 6.5%	7.79 $	
CONSUMABLES- 5%	6.38 $	
TOTAL	134 $	

LABOR		
DATE	MEN	HOURS
DEC.16,81	2	4.5
DEC.17,81	2	8
DEC.30,81	3	4
DEC.31,81	3	3
JAN. 6,82	3	6.5
JAN.12,82	2	6.5
JAN.13,82	2	5
JAN.18,82	2	4
TOTAL		96.5 m.h.

CORNICE & GUTTER

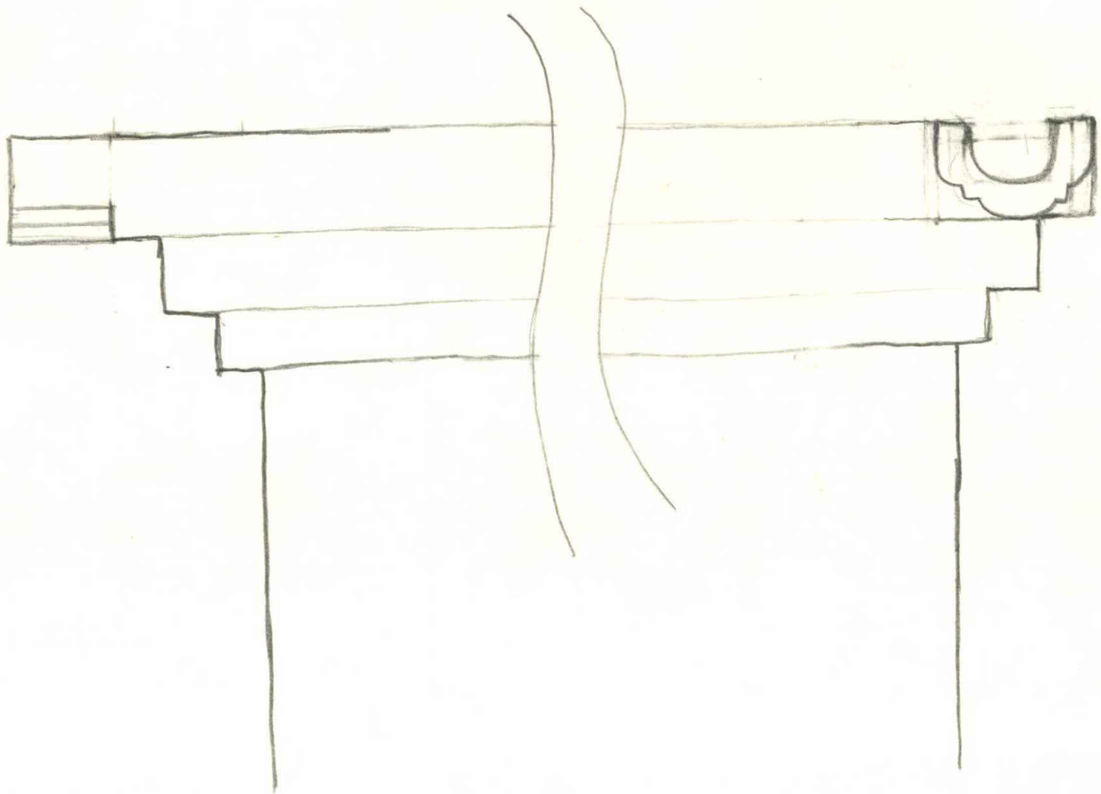
The 1"x3" tapered board is to be tapered along its bottom edge at the ratio of 1" in 20'. When the gunite is shot into the form this edge serves as a screed surface for the bottom of the gutter to provide the correct fall for water drainage.

Following construction of the form the cornice would be raised into place and supported underneath with 2"x4" along its length. It will also be necessary to use some diagonal braces to prevent the form from twisting when loaded with the concrete.



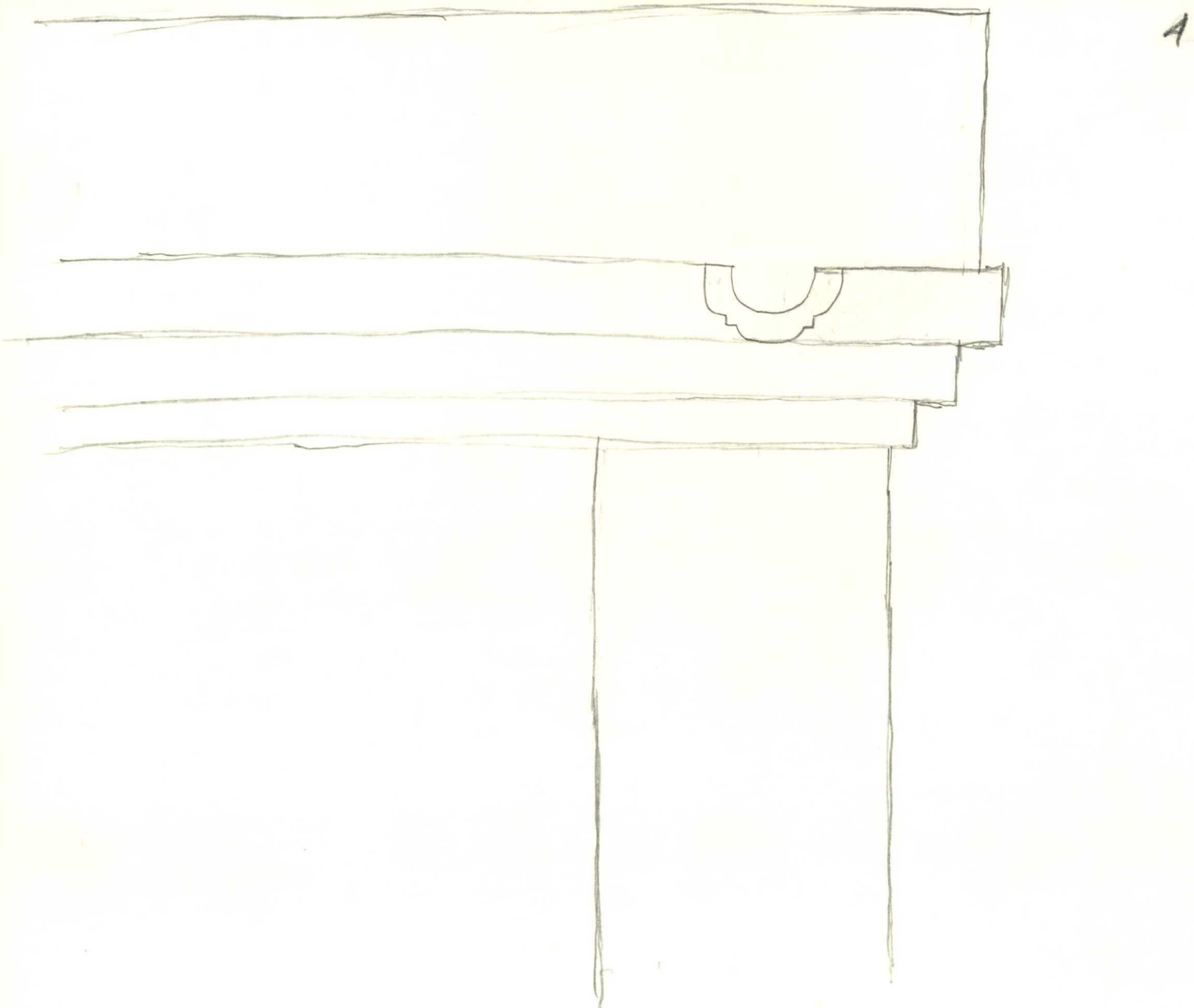
CORNICE

The last thing to consider is the question of down spouts. The present feeling is simply to extend the concrete gutter out beyond the edge of the cornice and allow the water to fall to a splash block on the ground below.



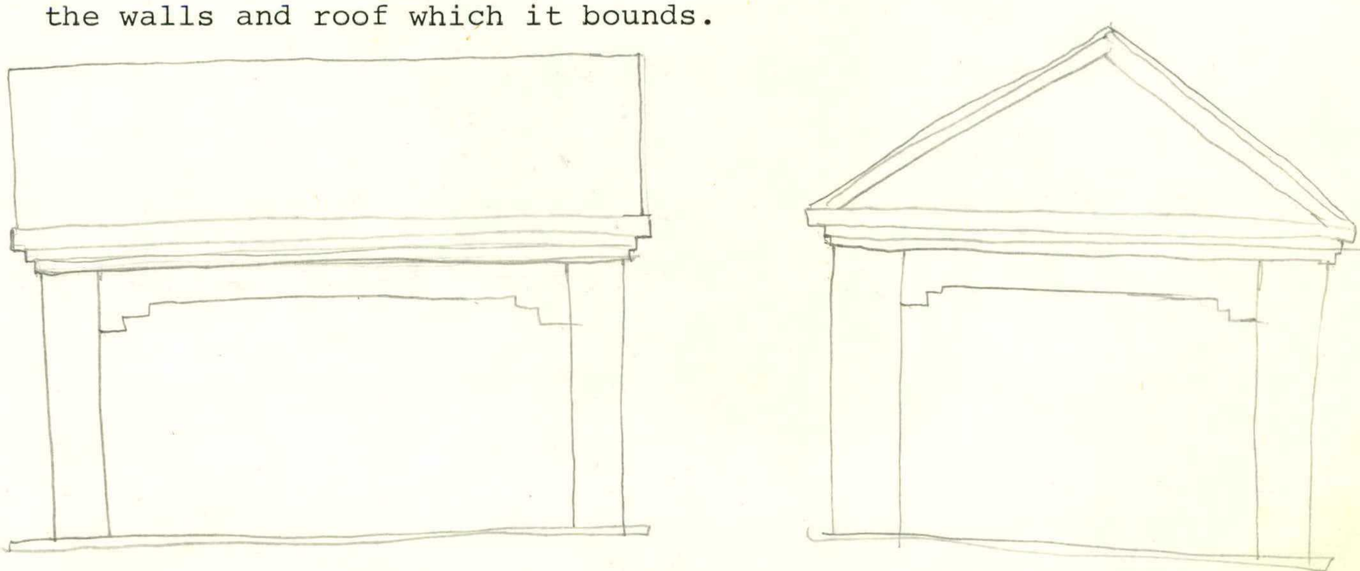
The left side of the fig is the gutter in profile, and the right side is the view when looking at the gable end.

In looking at the above drawings it is felt that the downspout in the present location is not right. It should be moved slightly away from the corner.


A

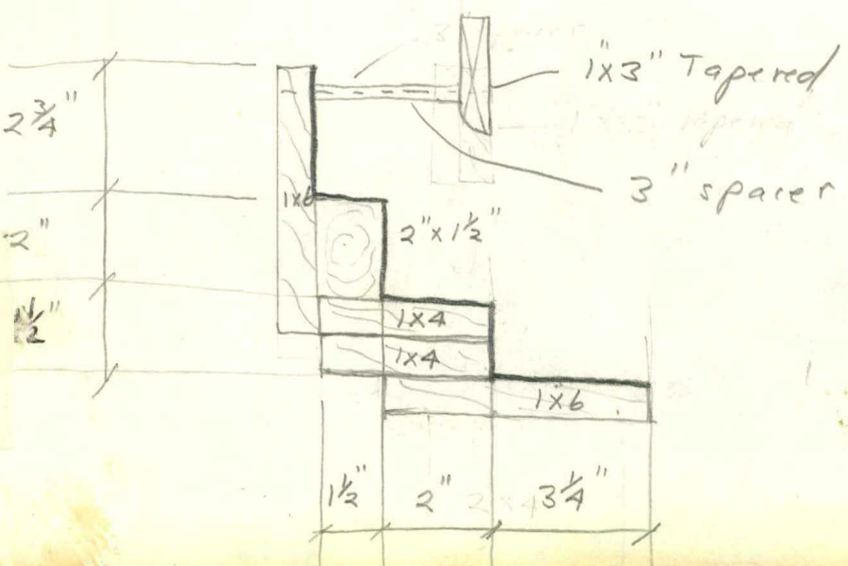
CORNICE & GUTTER

This is an element of the larger building in which the cornice is erected and shot integral with the roof, but where the cornice is visible in the final building standing out from the walls and roof which it bounds.



WE assume that the slab, walls, and ceiling with integral trusses have been built.

The cornice itself is made up of 1"x material which is to include an integral gutter and is to be erected against the exterior wall on a 2"x4" stud wall.



CEILINGS

The ceiling is an essential entity. xk It is this, perhaps more than any other single thing, which defines the space p of an individual room: it is this, above all, which establishes the room as a center.

Thisbdoes This does not mean that the ceiling has to be some kind of fantastic thing, wk with a strong shape or ornament. Obviously, some of the most beautiful ceilings ever made, are simple flat white planes. But even if the ceiling is as simple as this, there is a world of different between a plane which enters the room, shearing across it at 8 feet above the ground, just because panels and sheetrock happen to be 8 feet high - and a flat ceiling, which is anxtnxmm a center, a well defined thing in its own right, created just to create the larger center of the room itself.

Whether the ceiling is a vault, or a flat plane, chamfered at the edge, or a cross shaped mouldedxm moulded ceiling, or a set of vaulted waffles, or a beam ceiling, still , in all these cases, the ceiling must above all, be felt as an entity which unifiedbm unifies the room, and makes it one. And, this means that we do not feel the room, until its ceiling forms it, as a center - and that the ceiling must be made to do this, carefully, andmxm intently.

Flat Ceiling

(New Method)

Introduction

In this method the ceiling structure supports itself and the roof is built mainly with wood construction. Most of the building of these two structures is done during one set of operations. In this set of operations the framework for the ceiling is built and reinforcement is put in place. The ceiling and gable are compl eted in one shooting. Then the final wood roof is built.

First set of operations:

-ceiling formwork (cornice must be poured first)

-ceiling reinforcement

-gable formwork and reinforcement

-sooting of ceiling and gables

Final set of operations:

-framework for roof

-nailing of wooden roof

assume 10'x20' room with slab and walls in place

FLAT CEILINGS

1. Erect perimeter 2"x4" stud wall.

lay chalk line around perimeter of wall at 8'-0" from slab.

cut 2"x4" studs to length (7'-10.5"), enough, for their to be a stud at 2' o.c. around perimeter of room, this will be about 30 studs.

cut 1"x6" top and bottom plates to length (2 @ 20'-0", and 2 @ 9'-1").

nail plates to studs (layout on floor) and lift each wall section up into place and lean against wall, when all are up, nail blocking at corners to fix wall sections together.

level wall sections using shims driven under bottom plate around perimeter so that inside edge of top plate corresponds to level chalk line on wall.

2. Set-up scaffolding tower.

place floor jacks in center of room where corners of tower will be (approximately 5'x10').

set frames over jacks across 5' ends (5'x6' high) and add top jacks at corner posts.

attach diagonal cross braces across 10' sides from frame to frame.

adjust jacks on top and bottom so that craddle of top jack is about 7'-4" off slab at each corner of tower.

cut 4"x8" beams (2) to length so that their ends are within about 1'-6" of end walls (10' wall), this will make each beam about 17' long.

place each beam across jack craddles at corner of tower, center beams along 20' walls, and toenail to craddle.

3. Lay joist/plywood form box.

lay chalk line on top plate of perimeter wall at 3.75" from wall face on long walls and 3" from face on short walls.

cut 2"x4" joists to length (9'-4.5"), enough, for their to be a joist at 2' o.c. along length of room (20' wall), this will be about 11 joists.

place joists on two short walls on 1"x6" top plate along chalk line out 3" from wall face.

place remaining joists at 2' intervals along 20' wall, they will span from top plate to 4"x8" beams to top plate and the ends of the joists should lie on chalk line 3.75" from wall face.

cut 1"x4" end plate to length (2 @ 19'-6") and nail to end of joists, toenail to top plate from rear- lining inside face of 1"x4" with chalk line on top plate.

toenail joists to both 4"x8" beam (or use metal straps).

cut 4'x8'x3/8" plywood to size of 'second ceiling plane' and nail to joists.

cut frame pieces for 'third ceiling plane' and toenail to plywood deck of 'second ceiling plane'.

cut 4'x8'x3/8" plywood to size of 'third ceiling plane' and nail to frame.

cut ornament shape from 1" stock and moldings and nail to 'third ceiling plane' plywood deck.

spray entire assembly with Burke Release form release from spray gun/pump (Hudson sprayer).

insert A →

These four steps complete the ceiling form, the next steps outline the installation of reinforcing steel and shooting the gunnite.

Lay 2"x2" welded wire reinforcing mesh.

roll out lengths of steel mesh about 10' long, cut and lift onto form deck. (could be cut in 20' direction) lap mesh approximately 4" (two cells) and tie with tie wires at about 1' intervals.

shape mesh at perimeter to curve into form trough around edge of room.

bend excess wall mesh down to intersect with ceiling mesh at perimeter trough and lap and tie as above.

Insert B →

Shoot gunnite.

set-up gun and hoses, hoses will extend up over exterior wall and lay on mesh of ceiling form.

start compressor and blow out loose material from f

start water flow into nozzle and blow water film across entire form surface.

begin delivery of dry material into hopper from waiting concrete truck.

begin delivery of material through hose as a test to get proper delivery levels, this should be performed at perimeter trough.

begin shooting gunnite ceiling starting at troughs along ~~short~~ long wall and making sweeps of the gunnite from left to right along length of ~~room~~ ceiling between ribs backing up across form as you go.

at troughs, fill up to the top of the insulation foam, at ceiling fill gunnite to approximately 1.5", at changes of level in ceiling (places where ceiling goes from one plane to another) shoot extra knuckle of material to reinforce the corner.

- at far end of ceiling, step off form onto ladder or scaffolding and finish shooting final trough from outside the room.
- begin next ceiling piece (between ribs) and proceed as before until complete
- check for low spots and fill in where necessary .

Insert C

blow out hose and remove excess material from hopper.

shut down water and compressor.

clean-up excess gunnite from area.

insert A

4. Erect triangle ribs.

Cut 1"x6" rib frame pieces to length (approximately 6'), there will be 4 pairs of frame pieces or 8 pieces.

Mark roof angle on pieces and nail pairs together using gusset plates at apex of triangle.

naxxxframesxtoxtemporaryxbottomxcord

cut 4 bottom cords (2"x4") andxnail approximately 12' long and attach frame pairs to the cords.(temporary).

span triangle from wall to wall with bottom cord resting on foam (may be set up on blocks depending on size of breaks in ceiling planes.

x place nail temporary ridge board and edge board along length of wall (20') to brace triangles together at proper spacing.

hang building paper/felt on triangle and staple into place on frame, leaving hole in center of triangle large enough for a man to crawl through.

insert B

cut welded wire mesh to size of triangle and attach to frame attaching lapped edge to ceiling mesh with tie wire.

cut and and attach steel reinforcing bars to triangle with tie wires.

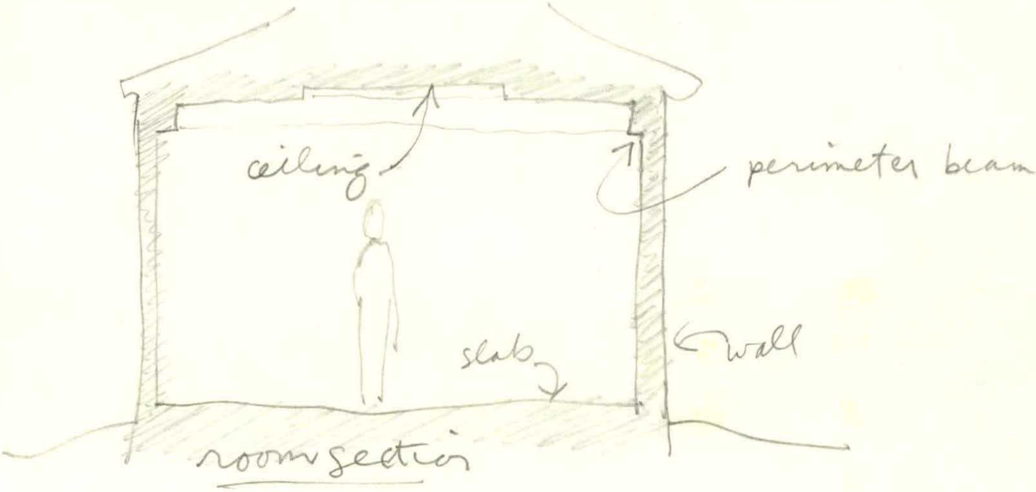
insert C

en at triangles, shoot gunnite onto frame so that it extends smoothly from ceiling gunnite up onto rib frame.(gable ends may need to be shot from outside only.

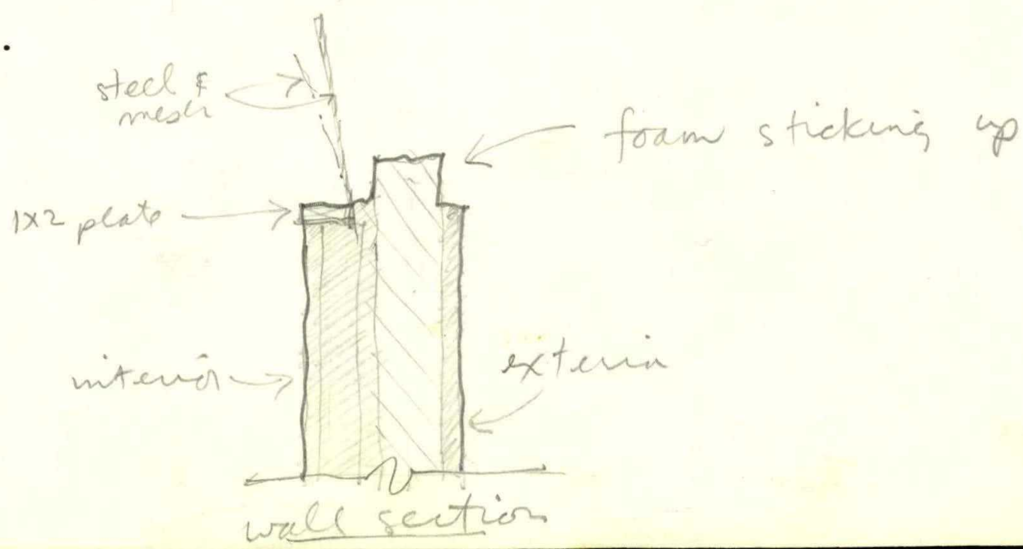
Revised 9/12/80

FLAT CEILINGS

This element of the building completes the envelope of a room. The ceiling is essentially flat with the possibility of steps in the ceiling to provide ornament to the room. The ceiling rests visually on a ~~xxxx~~ small ~~xxxxxxxxx~~ beam which is visible at the top of the wall around the perimeter of the room.



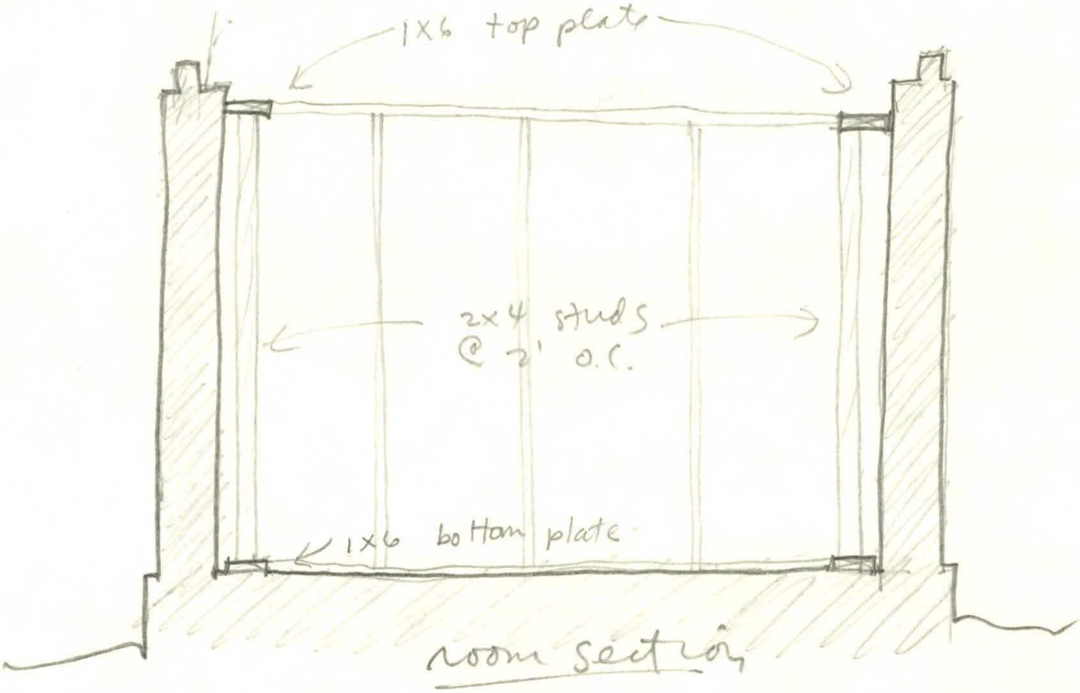
This operation comes after the slab is finished and all the interior and exterior walls are completed, but before the roof is built. So we begin the operation with a surround of concrete walls which have steel reinforcing and mesh stubbed out at the top and foam insulation sticking out above the top of the concrete a few inches.



The form is essentially a plywood skin on wood joists which are supported by a tower of scaffolding at the center and by a stud wall at the edges of the room.

The first step is to build the perimeter stud frame wall support. This consists of 2x4's at 2' on center with top and bottom plates of 1x6's.* These are built on the lab and then tilted into position squared, nailed together, and finally leveled with shims.

* Foot Note Next Page

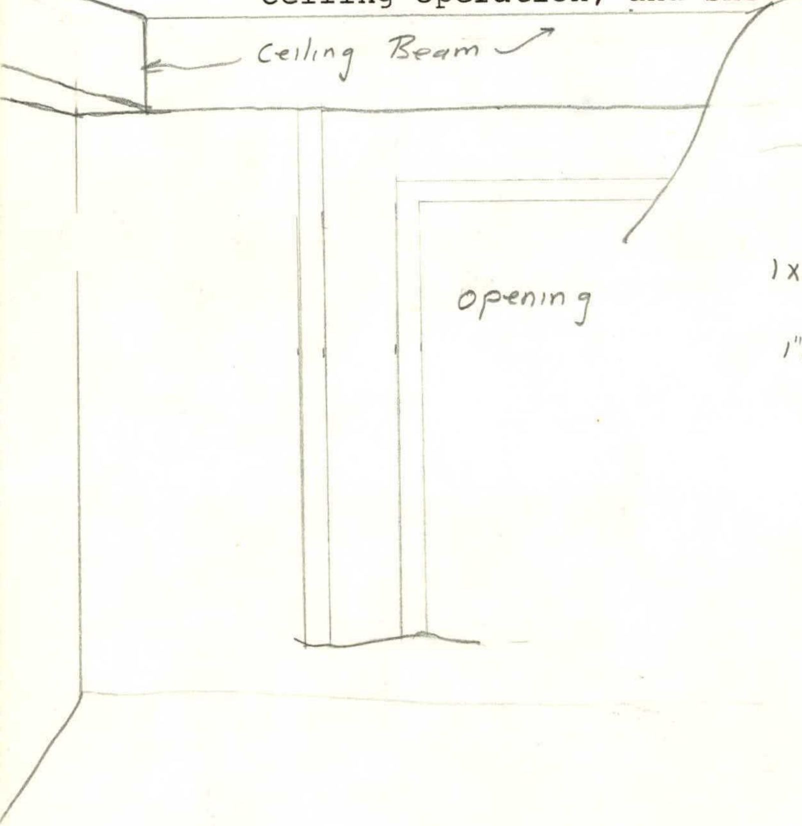


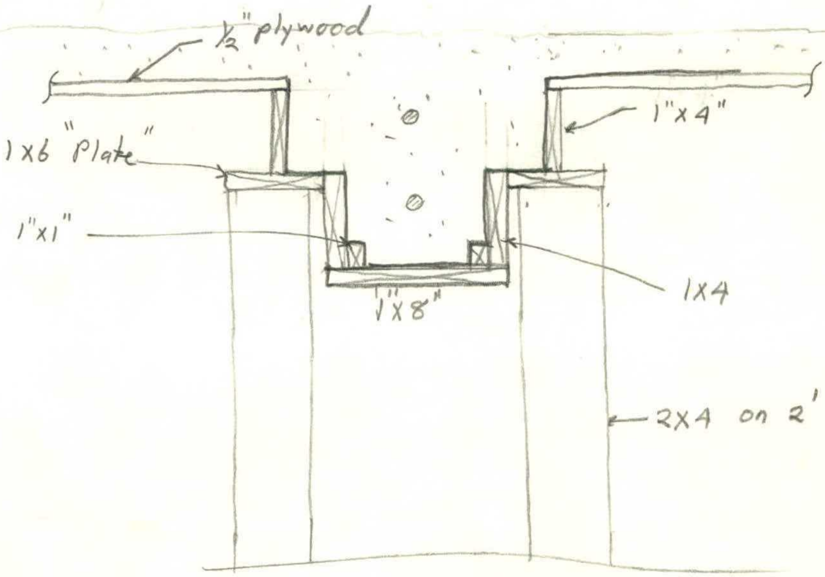
Second step is the assembly of a scaffolding tower in the center of the room. The size of the tower is dependent on the room dimensions, and the height of the tower is dependent on the ceiling height. The tower for a 10'x20' room would be made of a pair of frames tied together with cross braces and sitting on adjustable jacks. The frames would be about 6' high and 5' wide, and the complete tower would be 5'x10'. The jacks enable you to adjust the height of the tower to the exact need of the ceiling.

* foot note

Due to the concrete frame of the door jams (see jamb col's) it may be necessary in some instances to continue the frame over the top of the opening. A definite location for such a condition is the opening into the living room.

This prvents the ~~ceiling~~ form for the ceiling beam from being run around the perimeter of a room in an undisterbed line. Furthermore, from investigating the problem it appears that the ~~over head beam~~ lintel should be formed as part of the ceiling operation, and shot at the same time as the ceiling.

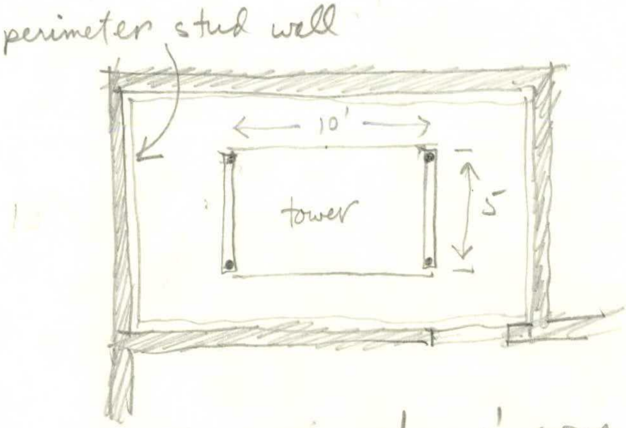




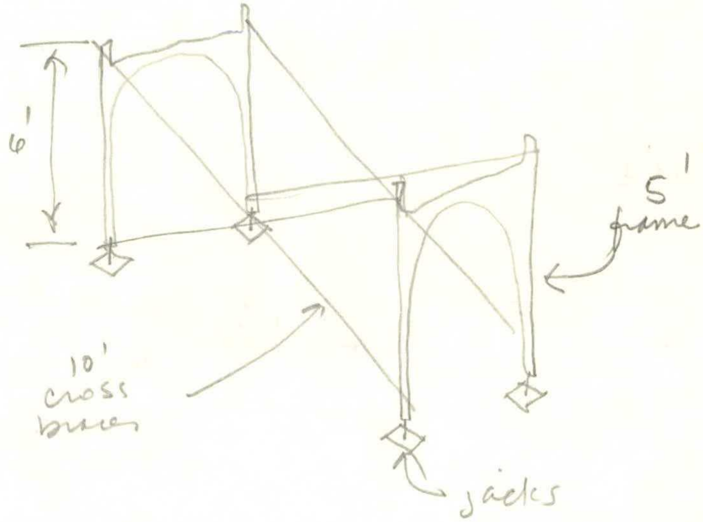
Section Through Lintel of opening into L.R.

Any other openings would be similar except that the section would be simpler.

The tower sits in the middle of the room.

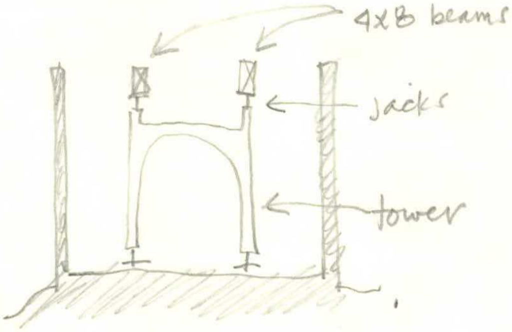


plan of 10'x20' room

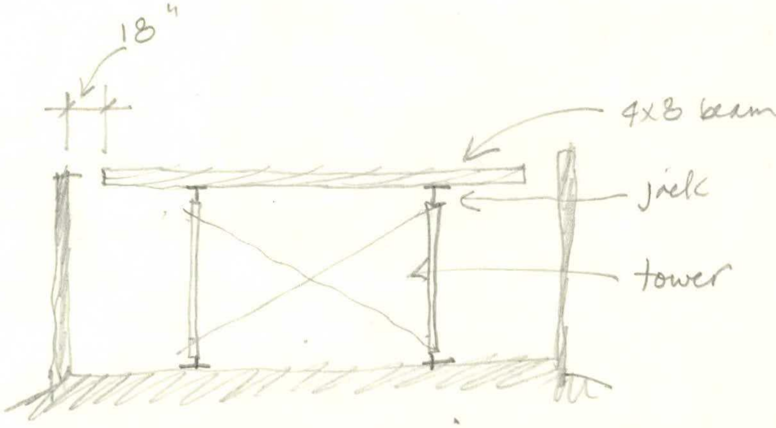


perspective

Adjustable jacks are placed on top of the tower and 2 4x8" beams are placed across these jacks along the length of the room. The beams extend to within about 18" of the end walls.



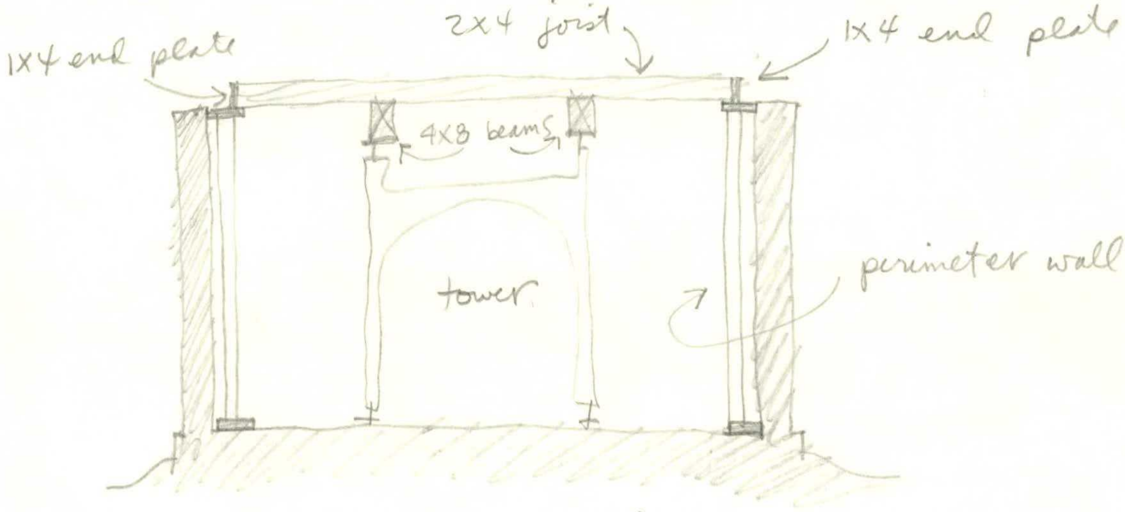
short section



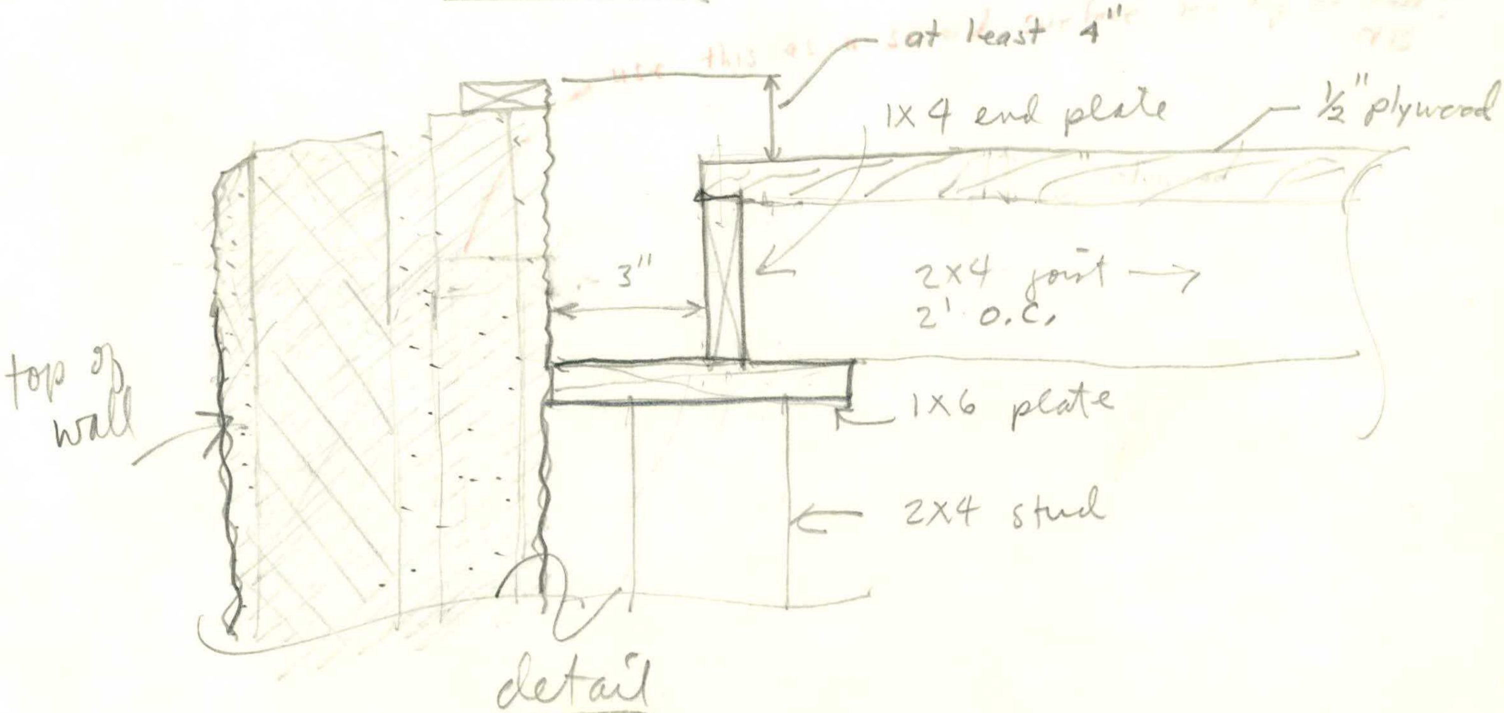
long section

Once the perimeter stud wall and the tower are in place, the ceiling form box is constructed on top of them.

The box consists of 2x4 joists at 2' on center which span from the perimeter wall across the 2 4x8 beams to the opposite p. wall. The joists are fastened together by a 1x4 which is endnailed to each joist.

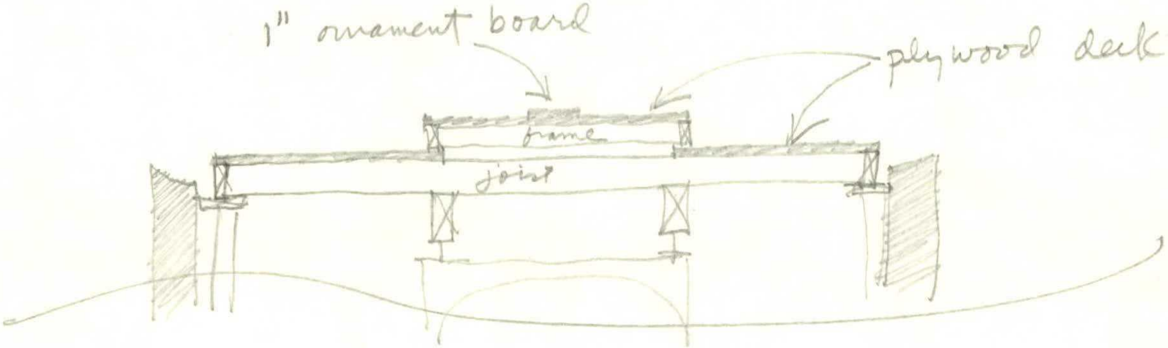


short section



detail

A 3/8th" plywood deck is nailed over the joists. This deck can have different levels to achieve some relief or ornament in the finished concrete. The change in level is made by adding a secondary frame over the deck of the main framebox, and adding a plywood deck over it. This can even have a final level of ornament by adding a small carved piece of 1" wood to the center of the second deck. This will form a void in the concrete of the ceiling.



form section

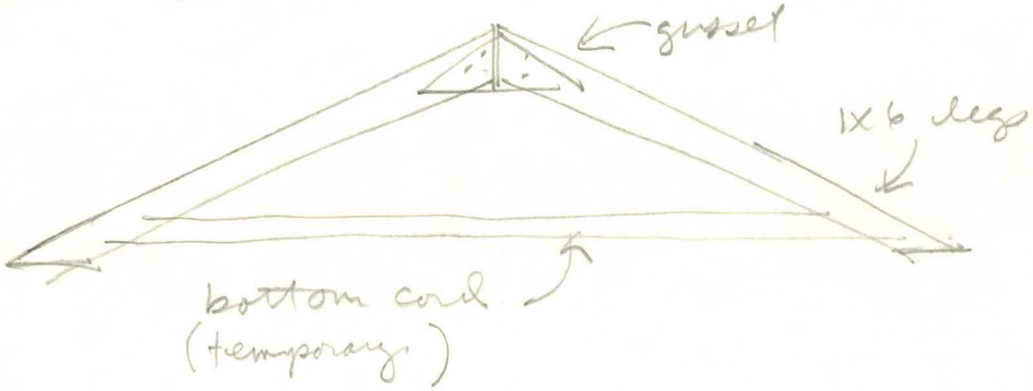
The form for the ceiling is now complete. It must be sprayed with form release.

Since the ceiling is supported ~~of~~ on triangular ribs which in turn support the ~~roof~~ roof, these triangular ribs are built as part of the ceiling operation.

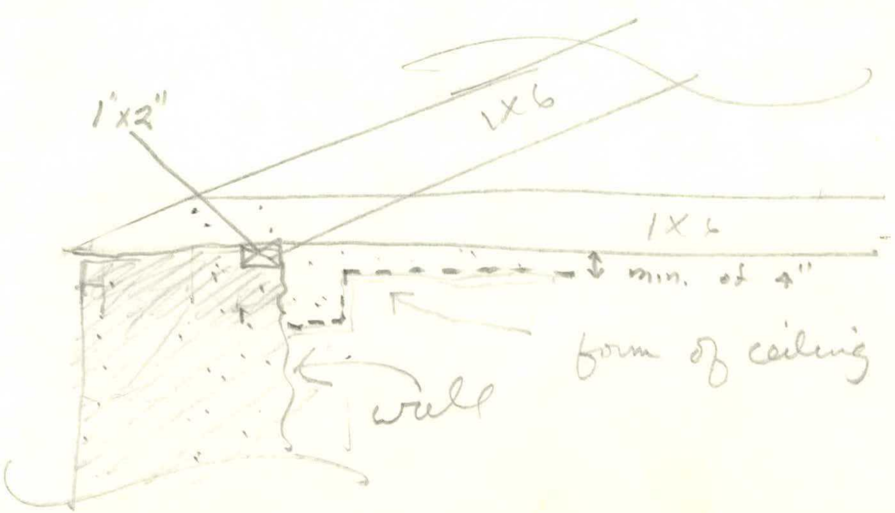
The next part of the form is the construction of these triangular ribs.

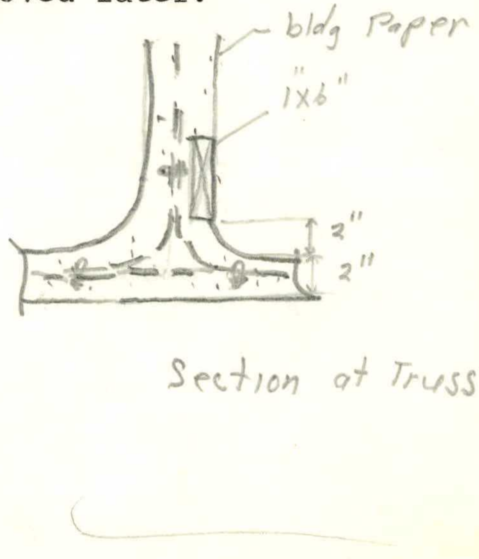
The ribs span from wall to wall and the ceiling is effectively hung from them. The ribs must occur at a maximum spacing of 7'. Since our room had a length of 20' we will build 2 ribs about in from the end walls. The triangles at the ends are built as part of the ceiling operation on interior walls and as part of a 'gable' operation if the end wall is also an exterior wall.

The rib form consists of 2 1x6's andgled at the proper roof slope. They are nailed together with a gusset at the apex of the triangle.



The legs of the triangle are nailed to a temporary bottom cord made of a 1x6, which will span across the wall insulation foam sticking up from the wall (could span from the top screed plate of the 1x2 wall). This bottom cord will be removed later.

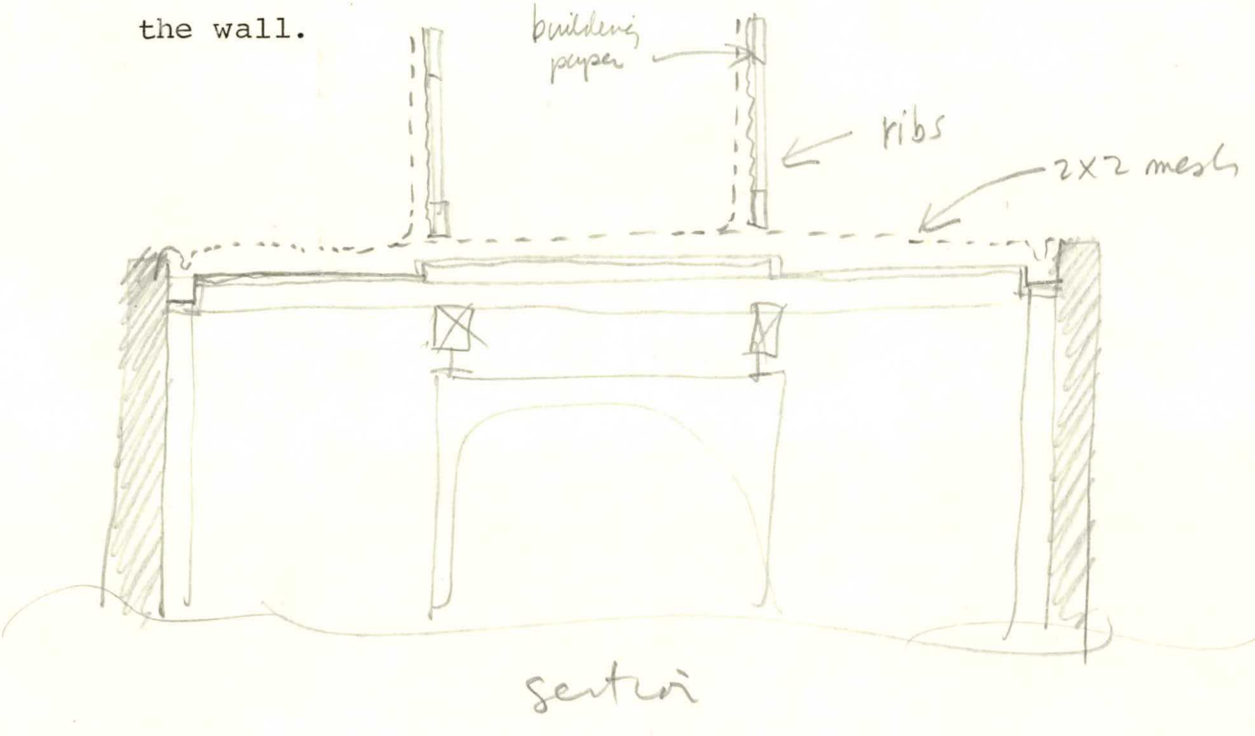




Each triangle is placed on the ceiling form and then braced together with boards at the ridge and edges.

Building paper is stapled to the 1x6 frame to act as a backing for the gunnite.

The ceiling and rib forms are then covered with 2x2 welded wire mesh. The rib mesh laps down onto the ceiling mesh, and the ceiling mesh laps over at the perimeter to meet the stubbed out mesh of the wall.



A hole is left in the building paper and mesh at the center of each rib to enable a man to crawl through, and for ventilation of the attic space.

The entire form is now complete. The reed gun is now setup and gunnite is ~~xkxx~~ shot over the entire ceiling approximately 1.5" thick. It is shot up onto the ribs approximately 2" thick.

The gunnite is shot a little thicker wherever there is a change in the plane of the ceiling, or at the ornament. This is to reinforce the ceiling at these points so the corner will not crack. The gunnite is shot over to the foam sticking up out of the top of the wall.

<u>insert</u>:

Rebars are placed across the bottom cord of the triangle and tied into the stubbed out rebar from the wall. The rebar is hung from tie wire attached to the 2x2 w.w.mesh.

OPERATION SCHEDULE (time in man hours)

Perimeter stud wall		5 m/h
Scaffolding tower		2 m/h
Joists and plywood box		8 m/h
Triangle ribs (2)		2
Reinforcing steel and mesh		4 m/h
Apply form release		1/2 m/h
Shoot gunnite	(three men 1 ceiling per day)	
		24 m/h
Remove forms		12 m/h
	Total labor	57.5 m/h

MATERIALS LIST/COST

2x4 studs ~~and joists~~

2x4 joists

1x6 plates

1x6 triangle legs

1x4 end boards

ornament boards

3/8" plywood decks

2x2 w.w.mesh

Rebars #3 bars

Gunnite (average 2" over ~~xxx~~ 200 s.f. plus 2 ribs at about 15 s.f. each = 230 s.f. x 2" plus 20% rebound factor

Total materials - - - - - -

over

VAULTED CEILING WITH ~~MMMMMMM~~ PITCHED ROOF

This is a double roof, a combination of the vaulted ceiling ~~and~~ on ~~the~~ inside, with the pitched roof on the outside. The vault is built up as usual, but once the freeze coat is on, ~~the ribs are placed which connect~~ ribs of mesh are hung from the rafters, and ~~the~~ this mesh sprayed also, to form ribs which connect the two to form a single structure.

This is an expensive roof, but it solves the problem of Structure follows social spaces, by leaving each vault integral to its room, and also allowingthe roof to be integral to the building as a whole, not merely an aggregate of ~~individual~~ separate vaults.

RADIANT HEATING

Radiant heating tends to be a good selection for a house which utilizes concrete mass(walls, ceilings, and floors) as a thermal storage--- Robert sonderagger LBL.

Radiant heating in the ceiling is the catillac of heating systems--- Jack Golden, heating contractor.

Of primary interest in the selection of a heating system is that of comfort for the occupants. The comfort criteria takes two forms,however. On the one hand is the question of which type of heat(radiant, forced air, electric) feels the best, and on the other is that of responsiveness of the system to the occupants wishes. If a system requires a long lag time to perform then regardless of the quality of the heat the occupants may feel uncomfortable.

All things considered, the decision is made to experiment with radiant heating located in two different locations, with the opption two add a self contained baseboard heater should the above fail. The first location is in the ceiling. The design is based on the assumption that the required capacity is 1/2 that xxqxxxxdx which would normally be required, if one neglected the thermal properties of the building. The scheme as presently conceived consits of two independent loops, one for the upper wing and one in the childrens area and master bed room. In addition, the drawings indicate optional extra footage of piping. Should this be included the incurred cost is expeted to be an additional $30.

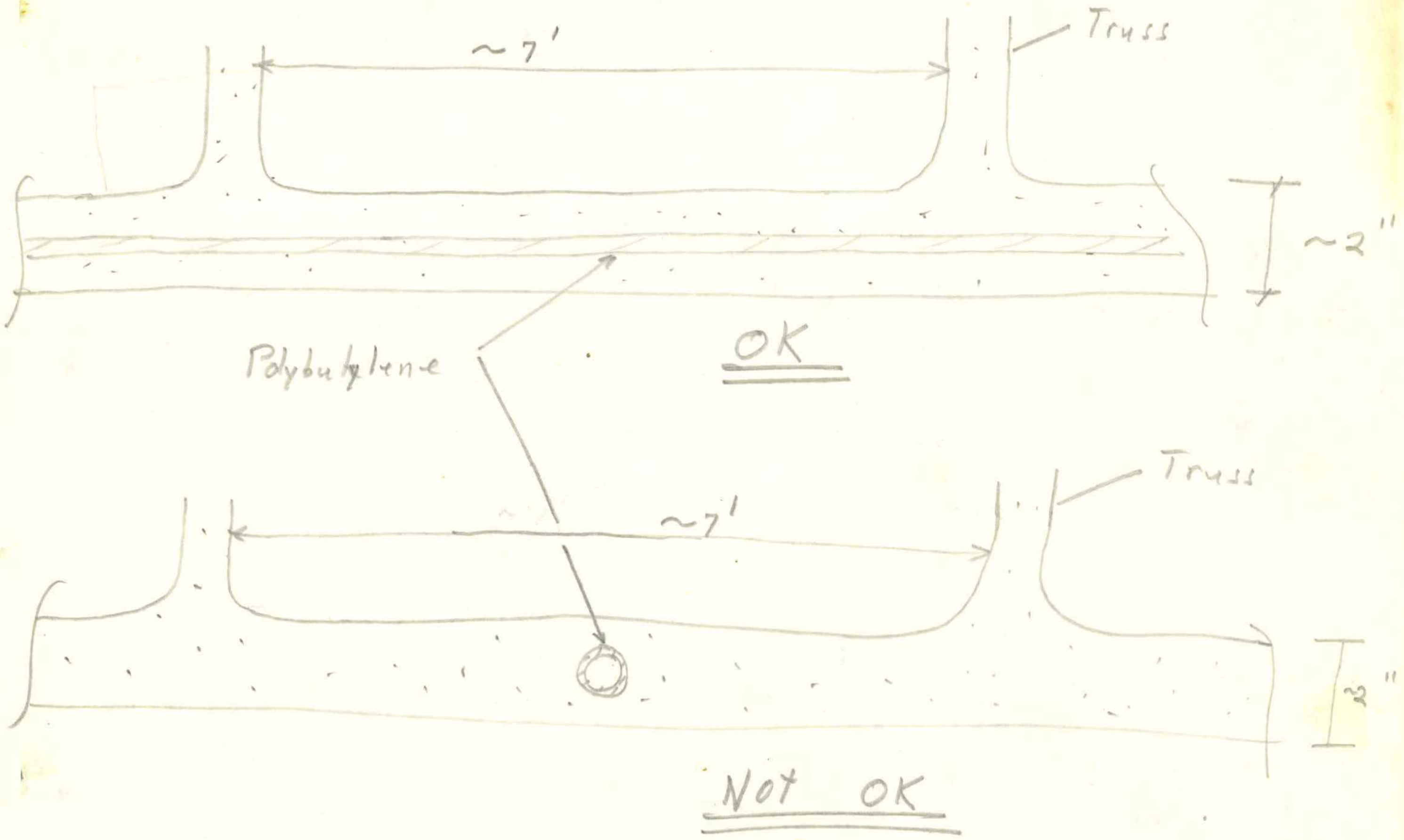
The apparent advantages of the ceiling location are: 1) the response time of the system should be lower than other locations because the mass of concrete in the ceiling is lxx less than in other areas, 2) the quality of the heat is better than that produced in other locations because the heat is of a true radiant nature and does not include convection. This last item has been compared to the type of heat experienced on a clear, cool spring day where the air is crisp and one is warmed by the sun.

OK 9/12/80

RADIANT HEATING (ceiling)

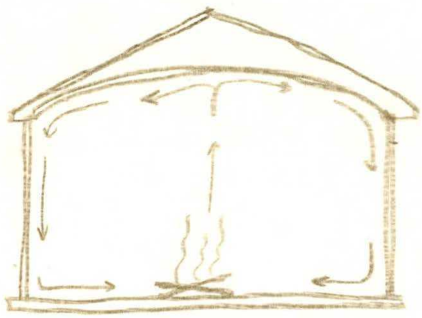
The radiant heating in the ceiling as presently designed is to provide about 57% of the heating requirements of the house, a figure which translates into about 250 linear ft. To get adequate coverage, however the length will probably be greater than 250 ft.

Structural calculations indicate that with regards to shear the pipe can be placed anywhere in the slab without effecting the structural stability of the ceiling. As far as moment is concerned however, the pipe must not be allowed to occur in elevation at areas of critical moment.



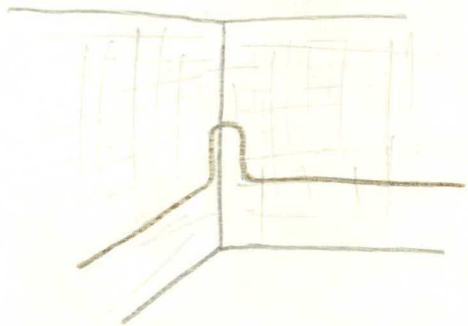
The other location is in the lower half of the exterior walls.

If one imagines a heat source somewhere in the middle of a room the following occurs. The heat rises and moves toward the exterior of the building, where the air is cooler due to the fact that the exterior wall is in contact with the outside. At this point the air cools and sinks down the surface of the wall. The overall effect is to produce a draft as shown below.



Additionally if one places the heat source low in the room, then the possibility of heating through convection as well as radiation is increased.

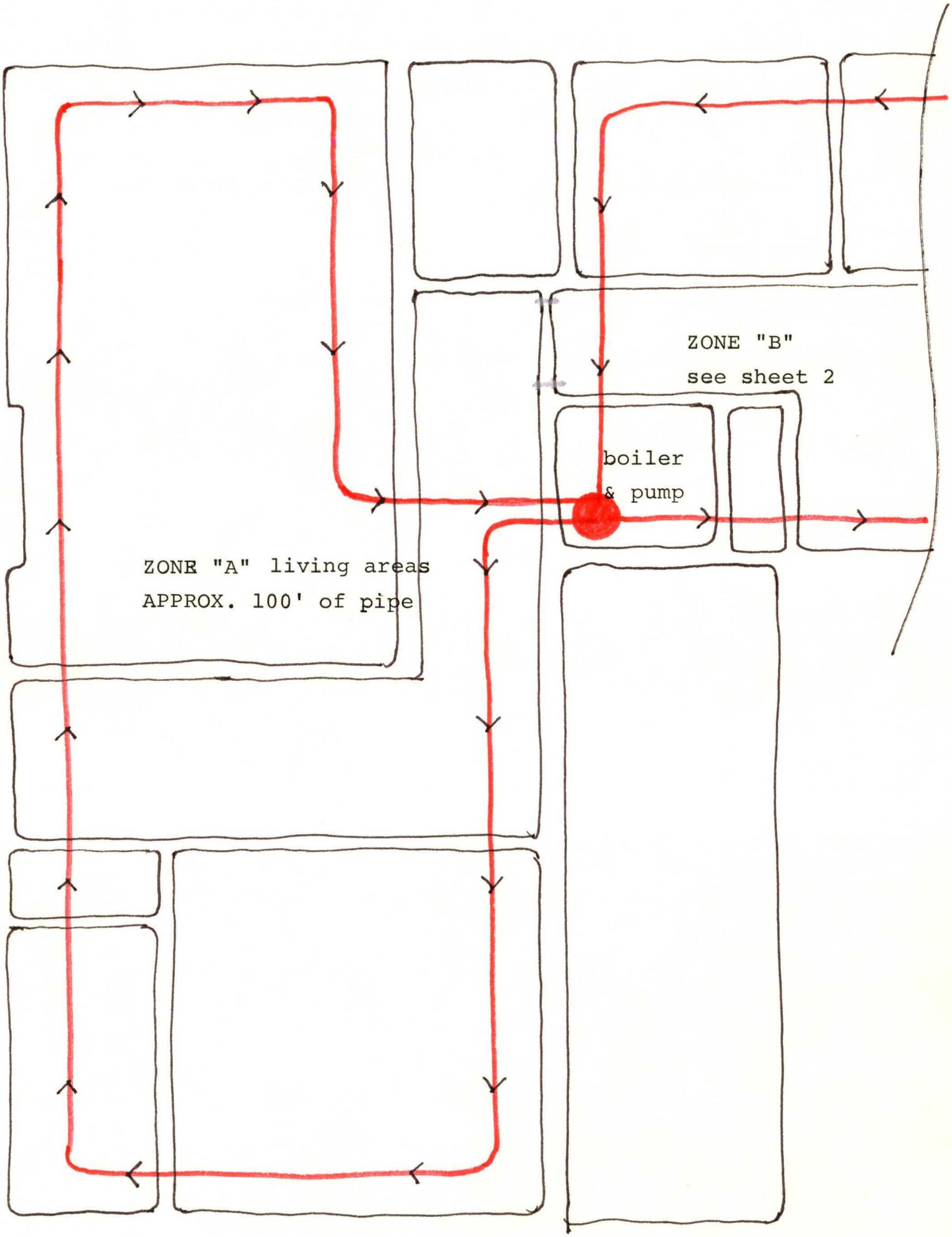
Therefore the wall scheme consists of running one pipe, either 1/2" or 3/4" around the perimeter of the building on the exterior walls approximately 1' above the floor. To avoid imbedding any joints in the concrete, the corners will be made by making a double bend.



The single band of pipe is believed to be able to provide all of the heat required by the martinez house, and supplies 1/2 of the number of Btu's as required by the building code.

The pipeing will be installed on the wall frames after erection and prior to gunnite. They will be attached with u flanges following notching of the studs. A pressure check may be necessary prior to concrete.

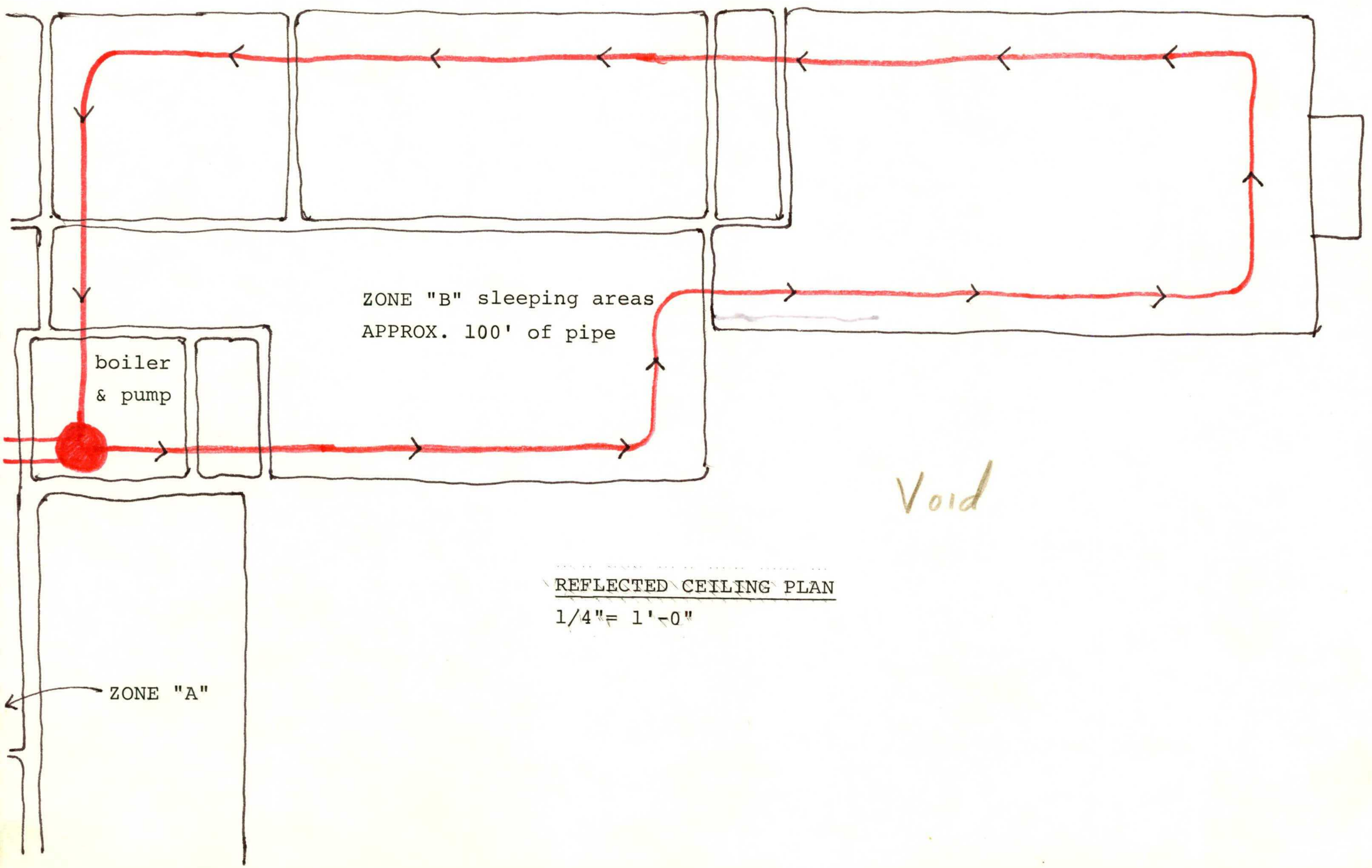
Both schemes are based on the assumption that we can get 60 BTU per square foot of wall and that one 1/2" pipe will heat 9" on either side of itself. In other words one can derive 90BTU per linear foot of pipe. Therefore to supply 1/2 of the xxqxixx Btu as required by code we need approximately 156' of tubing. These figures are for copper pipe imbedded in plaster and must be confirmed for poly butylene imbedded in concrete.



REFLECTED CEILING PLAN

1/4"= 1'-0"

Void


ZONE "B" sleeping areas
APPROX. 100' of pipe
boiler
& pump
Void
REFLECTED CEILING PLAN
1/4"= 1'-0"
ZONE "A"

CEILING DESIGN STRUCTURAL

There are several approaches which can be taken to the structural design of the flat ceilings.

One approach, and the most typical, is to design the section so that the concrete is working to its maximum ~~sxx~~ allowable stress and supply the steel necessary to achieve that. This scheme ~~is~~ results in the most efficient use of material and is generally the cheapest.

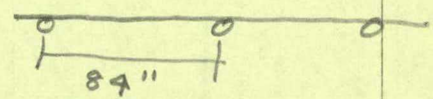
The ceilings of the martinez house pose some interesting problems...which cannot be solved by the generally accepted design approach. Firstly, The above scheme results in a section which is very thin (less than one inch) and consequently has large long term deflections (1-1/2") ~~a~~ associated with it. Secondly, The above approach assumes that the concrete on the tension side of the slab is cracked. Normally this is not a problem, but in the martinez house the underside of the slab is the finished surface. Tension cracking, although structurally sound, in conjuction with large displacements would create a maintainance problem of ~~patching~~ periodically having to patch un-sightly cracks.

An alternate design is therefore proposed. The section is proportioned so that tension cracks are not allowed to form in the concrete. The advantages are: 1. the ceiling wont show any cracks, ~~and~~ 2. the section will have a large moment of inertia which will greatly reduce deflections, and 3. ~~In addition~~ the field work ~~can~~ (location of steel) can be ~~less~~ of a slightly cruder nature, since the section isn't dependent upon the steel for its moment resisting capacity.

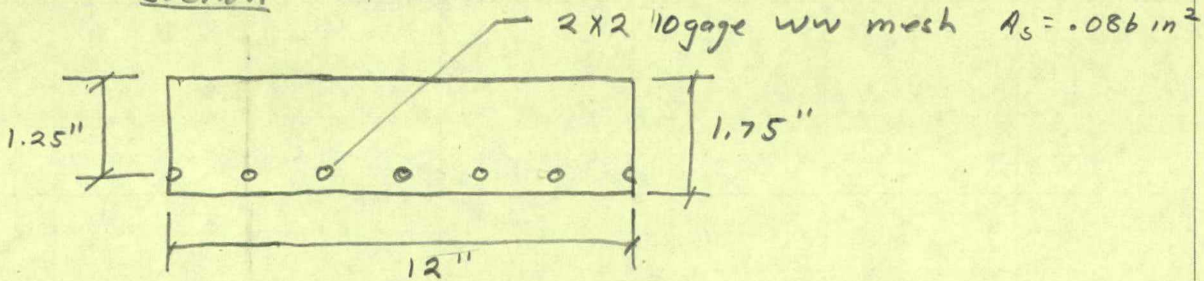
Ceiling Design Structural WSD

Geometry

Span Length = 7' = 84"



Section



$DL = \frac{1.75}{12} f \times 1f \times 150\ Lb/f^3 = 22\ Lb/Lin\ f$

$LL = 20\ Lb/f^2 = 20\ Lb/Lin\ f$

Total Load $42\ Lb/Lin\ f$

Material

$f'_c = 4000$ psi
$f_y = 56000$ psi
$\Rightarrow n = 8$

$f_r = 7.5\sqrt{4000} = 475$ psi

Design Moment

Worst pos. moment $= \frac{1}{11} w l_n^2 = \frac{1}{11} \times 42 \times 7^2 = 187$ f-Lb

$= \underline{\underline{2245 \text{ in-Lb}}}$

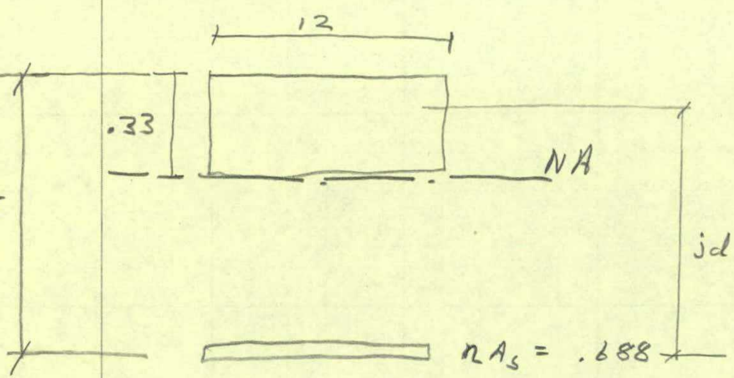
Worst neg. moment $= \frac{1}{10} w l_n^2 = \frac{1}{10} \times 42 \times 7^2 = 205$ f-Lb

$= \underline{\underline{2470 \text{ in-Lb}}}$

Assume uncracked Section

$$\sigma = \frac{Mc}{I} = \frac{(2470)(.875)}{5.36} = 403 \text{ psi} < 475$$ ✓

Assume Cracked Section



$.33 \times 12 \times \frac{.33}{2} = .653$

$.688 \times .920 = .633$ ✓

$$f_s = \frac{M}{A_s jd} = \frac{2470}{(.086)(1.14)} = 25000 \text{ psi} < 28000 \text{ psi ok}$$ ✓

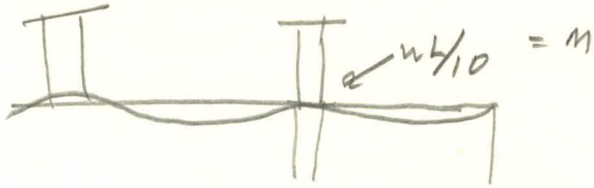
$$f_c = \frac{M}{\frac{1}{2} b k d\, jd} = \frac{2470(2)}{(12)(.33)(1.14)} = 1100 \text{ psi} < 1800 \text{ psi ok}$$ ✓

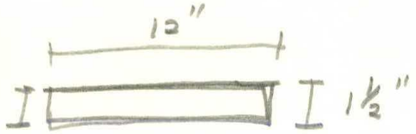
Ameron

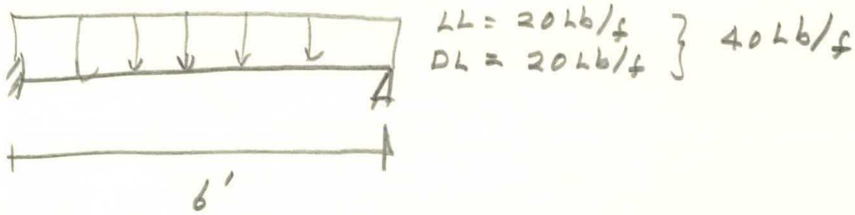
David Fey — 568-7174

A-185 56KSi

Fy	Gage	Diameter	Area/wire	Spacing	Area/ft
	10	.135	.014	2x2	.086
	12	.1055			
					.052
	~14				







$1\frac{1}{2}f \times .13f \times 150 \, Lb/f^2 =$

$$M = \frac{40 \times 6^2}{10} = 144 \text{ Lb-f} = 1728 \text{ in-Lb}$$

For balanced design

$F_c = 900$ psi

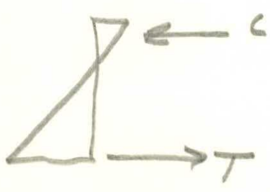
$F_s = 18{,}000$ psi

$K = 165$

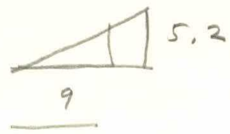
$j = .86$

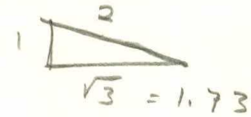
$$bd^2 = M/K = \frac{1728 \text{ in-Lb} - in^2}{165 \text{ Lb}} = 10.47$$

$$d^2 = \frac{10.47}{12} = .87$$

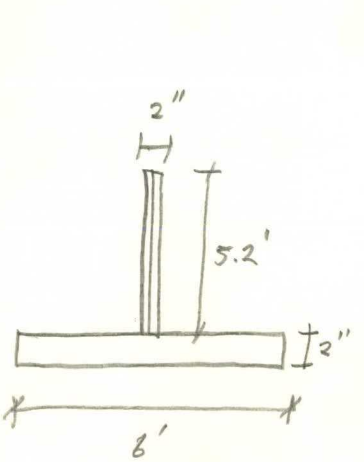


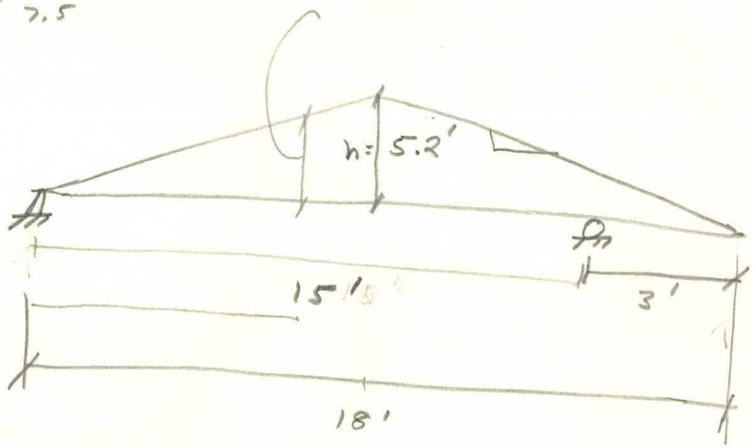
.channel calculations



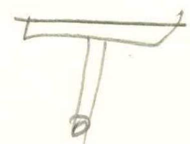


$\frac{5.2}{9} = \frac{x}{7.5} \Rightarrow x = 4.33'$

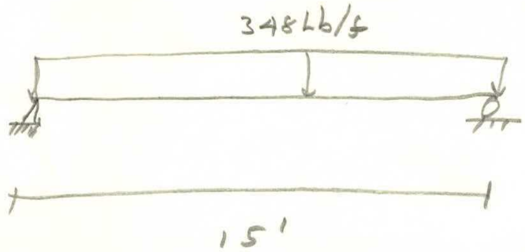




$A_\Delta = \frac{1}{2}\, 18 \times 5.2 = 47 f^2$



7.83 f



LL = 120 Lb/f

DL = 3425/15 = 228 Lb/f

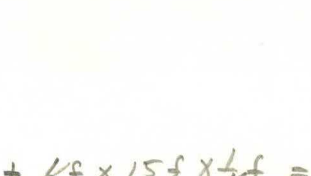
TL = 228 + 120 = 348 Lb/f

$DL = 47 f^2 \times \frac{1}{6} f + 6f \times 15f \times \frac{1}{6} f = 22.8 f^3 \times 150\, Lb/f^3 = 3425\, Lb$

$LL = 20\, Lb/f \times 6f = 120\, Lb$

$M_{max} = wL^2/8 = \frac{348 \times 15^2}{8} = 9788\ f\text{-}Lb = \underline{118000\ in\text{-}Lb}$

$f'_c\ allow = 450\, Lb/in^2$

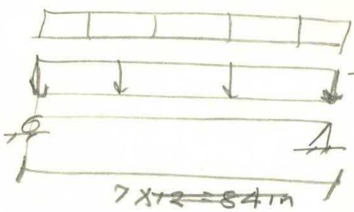


Slab

$LL = 20 Lb/f^2$

$150 L_{/f}^3$

$E_s = 30,000 ksi$



assume Pin-Pin

$M = wL^2/8 = \frac{45 Lb/f (7 f)^2}{8} = 276 Lb\text{-}f$

.0020

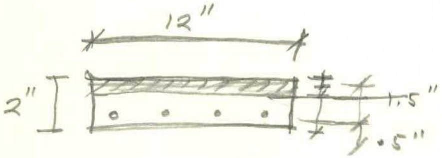
$E_c = ~~3,000,000~~$

$E_c = 57,000\sqrt{f_c}$ $\frac{M}{} = wL/8 = \frac{45 Lb/f \times 7 f}{8} = 40 Lb\text{-}f =$

480 in-Lb

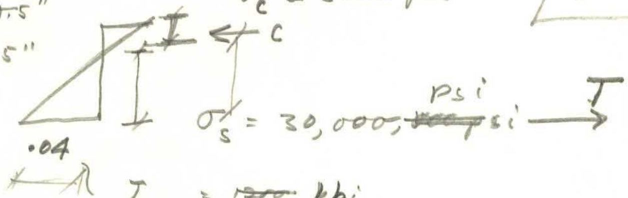
$E = \frac{\sigma}{\varepsilon}$

$\varepsilon = \sigma \times E$



As = .04 in²

$A_c =$



$\sigma_c = 3000 psi$

500 Lb/in²

$\sigma_s = 30,000 psi$

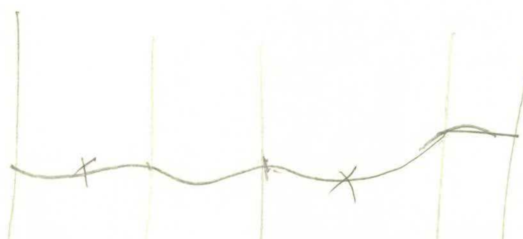
$T_{max} = ~~1200~~ kbi = 120 Lb$

$\varepsilon_s = 30,000,000 X$

$E = \frac{\sigma}{\varepsilon}$ 30,000,000 Lb/in²

30,000 A_1 = 450

$\sigma_c = \frac{Mc}{I}$



1200

480 in-Lb

$T_{max} = ~~1200~~$ 120 Lb

$\varepsilon \times L \ast \frac{1}{2}L$

$\frac{1}{2}L^2$

$\frac{45 \times 7 \times 12}{2} = ~~1890 Lb~~$ 3

160 Lb

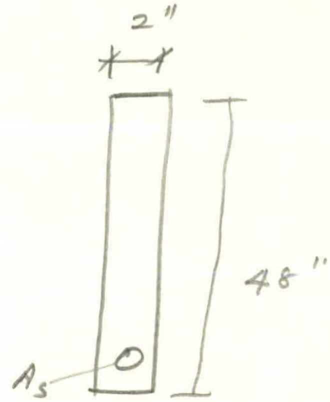
$\sigma_c = \frac{1}{12} bh^3$

$\sigma_c =$

$V_{allow} = 20 lb/in^2$ OK ✓

$\frac{1}{12} bh^3 = \frac{1}{12} \cdot 12 \times 2^3 = 8 in^4$

$F_c = .33 \times 3000 = \underline{\underline{900 \text{ psi}}}$



$F_s = \underline{\underline{1800 \text{ psi}}}$

$n = 15^*$

$K = 165$

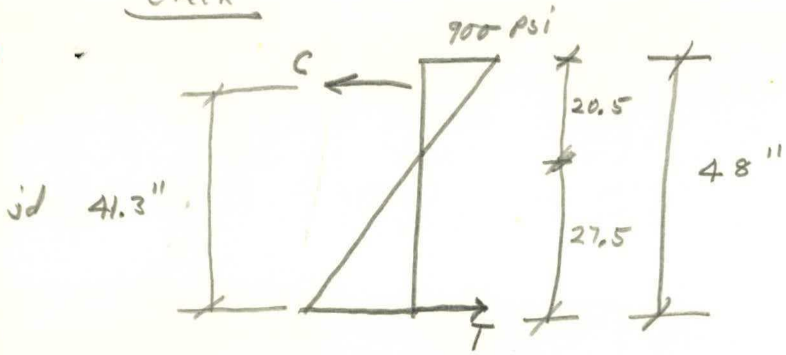
$j = .86$

$bd^2 = M/K = \dfrac{118000 \text{ in-lb} \quad \text{in}^2}{165 \text{ lb}} = 715$

$d = 48" \Rightarrow b = .31$

$A_s = M/F_s jd = \dfrac{118000 \text{ in-lb}}{18{,}000 \text{ lb} (.86)(48 \text{ in})} =$ ~~1.60 in²~~ $\underline{\underline{.16 \text{ in}^2}}$

check



$C = 9225$

$A_s =$

$C = 900 \times 2 \times \frac{1}{2} (kd)$

$jd = d - \frac{1}{3} kd$

$C \cdot jd = M$

Ceiling (Materials)

10'x20'

Form work

- 2"x4" @ 2' centers ⇒
  11 @ 11' = 121' @ .17/lin.' = $20.57 ✓

- Perimeter
  Plywood (Form release)
  7 sheets of 3/8" @ = $55.65 ✓

- 4x8 Beams (2-2"x8") 2 @ 20' @ $1.14/lin.' = $45.60 ✓

- 2x4's @ 4' o.c. perimeter
  12 @ 8' = 16.32 ✓

- 1x6's 2 @ 20
  2 @ 10 = $8.40 ✓

- 1x4's 2 @ 20'
  2 @ 16'
  (2@4, 2@12) = $5.51 –

- Tower Rental = $15/mo
  1 5'x10' tower
  8 adjustable jacks
  & beam seats.

Trusses (4)
48 Lin' x $.14/Lin' = $6.72

173.77 *

173.77 - $91.23 = $82

Ceiling (Materials) & Truss

Concrete

$A = 12\square' / \text{truss} \times 4 = 48\square'$

$48\square' \times .17' / 27 = .30 \text{ cu yd} \times \$60/\text{cu yd} = \$18$ —

$10' \times 20' \times .15' = 30 \text{ cu ft}/27 = 1.11 \text{ cu yd} = \$66.60$

Steel (mesh) $48\square' \times \$.12/\square'$ = $5.76

#3 @ 1½' center = $13.33

(mesh) $10' \times 20' \times \$.12/\square'$ = $24.00

Building Paper @ $.12/□' = $5.76

$133.45

Total = 133.45 + 82 = $205.45

Roof (Materials)

Conc

$12 \times 20 \times .06 / 27 \times \$60$ = $31.80

Foam insul.

$20 \times 12 \times \$.60/\text{SF}$ = $144.00

steel

100' #3 = x .11 = $11.00

chicken wire

$12 \times 20 \times .08$ — $19.20

SUB TOTAL 206.00

?* **Ridge cap**

2 - 20' 1"x2" @ .10/lin' = $4.00

conc. — 6.00

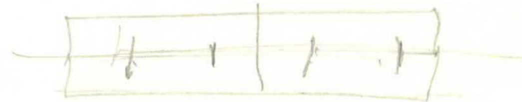
$10.00

sub Total $216.00

Purlins 2-1x4" & 1-1"x8" - 26.40

Total 242.40

Ceiling (Labor)



Form work

erect tower & level beam — 3 man hrs

assemble perimeter cage — 4 man hrs

1 man hrs

5 man hrs.

erect perimeter cage

Form work + mesh + rebar (Ceiling) — 4 man days

Form work + mesh (Trusses) — 2 man days

Gunite — 4 man days

10 man days

Roof (Labor)

Form work	2 man days
Gunite	2 man days
	4 man days
	$360

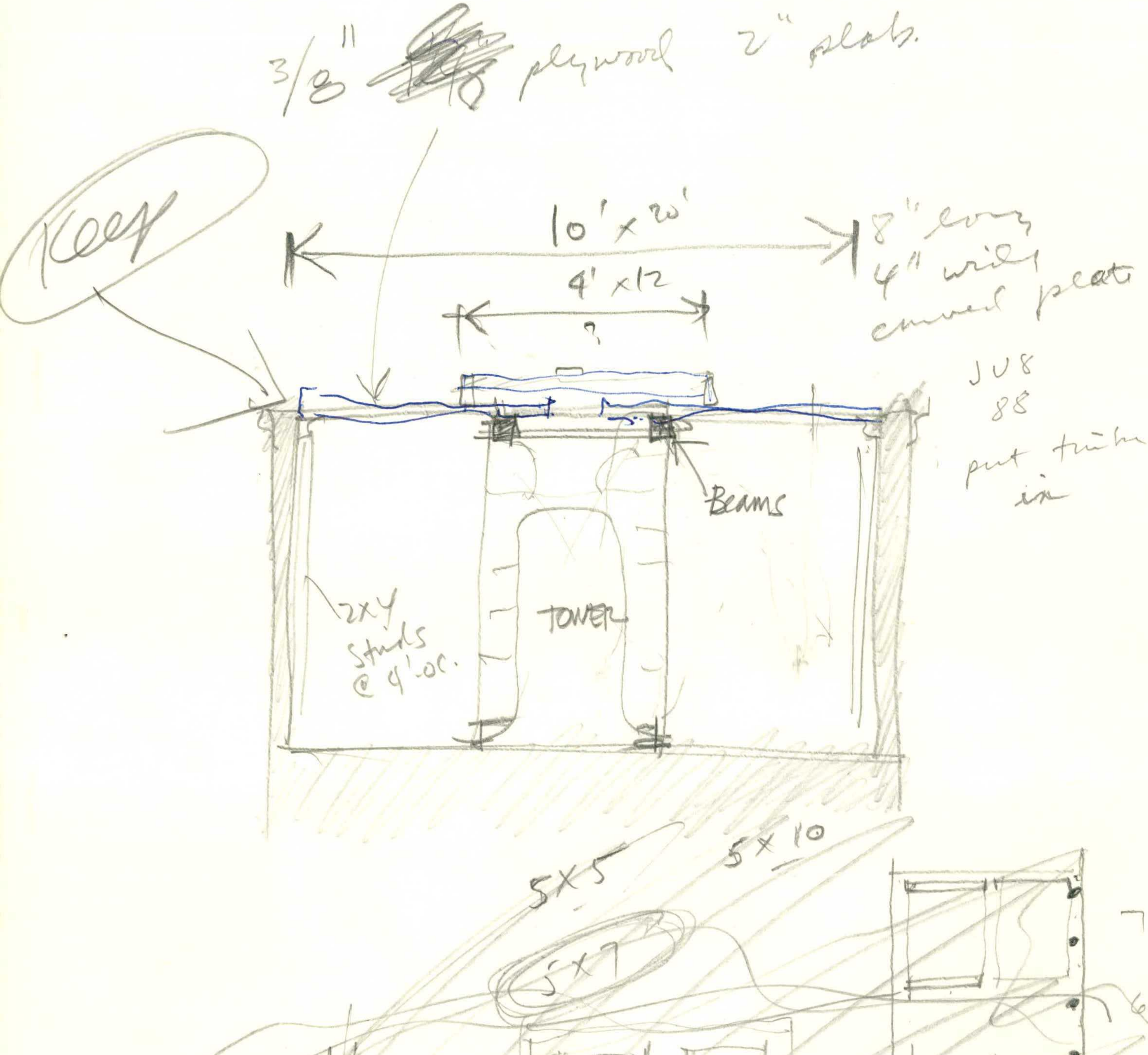
Column matls.

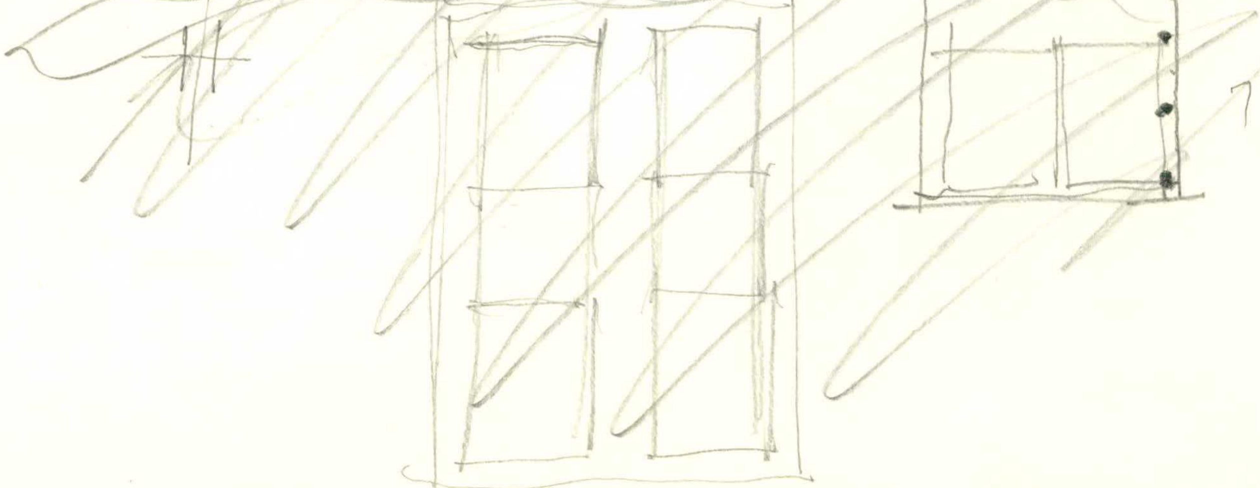
Conc.	$27.00
steel.	$11.00

Form work

2"x2"	$10.00
plywood	$32.00
	$80.00

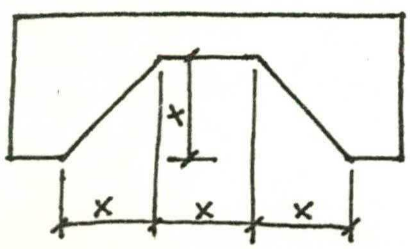
SKETCHES / DESIGNS



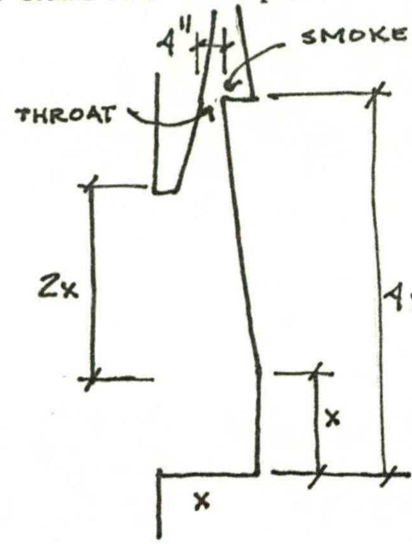


FIREPLACE CONSTRUCTION

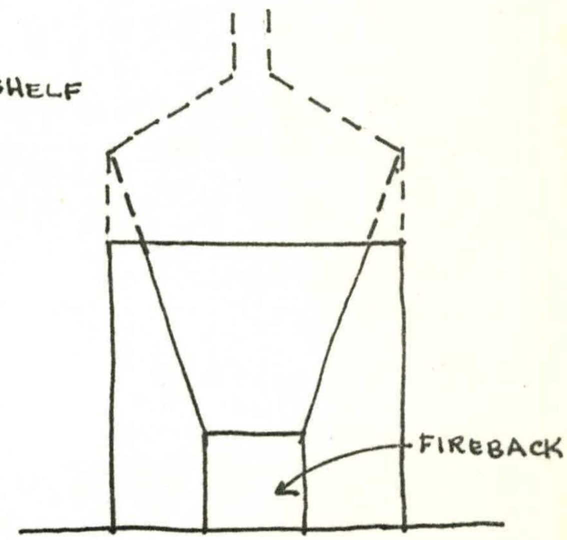
Initially the size and shape of the fireplace is layed out on the site. A sketch is made. The shape is based on a version of the Count Rumford fireplace, which is known for its greater efficiency. Below is a sketch showing basic geometric relations of the Count Rumford fireplace.



PLAN



SECTION

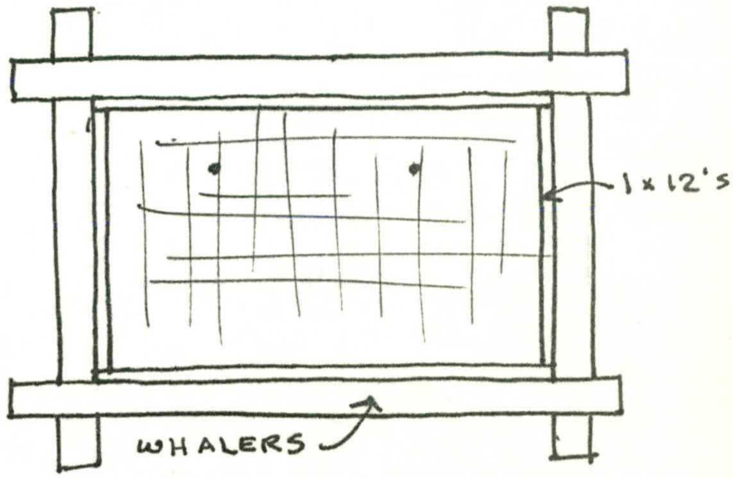


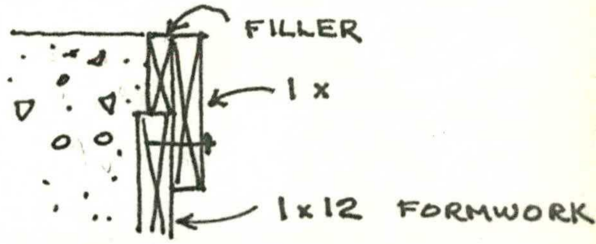
ELEVATION OF OPENING

The sides are at a 45° angle or close to it to increase radiation. The narrow throat increases the draw capacity of the smoke.

The fireplace is made of gunite with a 2-3 inch layer of high temperature refractory material around the firebox. To do this, a form is made to pour the refractory material into. A plywood box in the shape of the firebox is made for the inner side of the form, and the outer wall is made of styrofoam. Chicken wire is used for reinforcing.

A slab is made for the hearth of the fireplace if it is to be raised above floor level. The form is made from 1 x 12's carefully selected for straightness nailed together and braced with 2 x 4's nailed in whalers skirting the form. Vertical #3 re-bars are placed to each side of the fireplace opening. Welded wire mesh is lain in, 2" x 4" openings and is raised by pebbles. A lip is made on the bench area of the hearth by nailing another 1 x to the outside of the 1 x 12's with a filler to the height of the top of slab so that it can be used to screed against.[1] The formwork is oiled on the inside with motor oil. Just before pouring the slab is wetted as well as formwork and concrete adhesive is applyed to the top of the floor slab where the new slab is to be poured. The slab is now poured. The surface is screeded, floated and covered with plastic after setting.

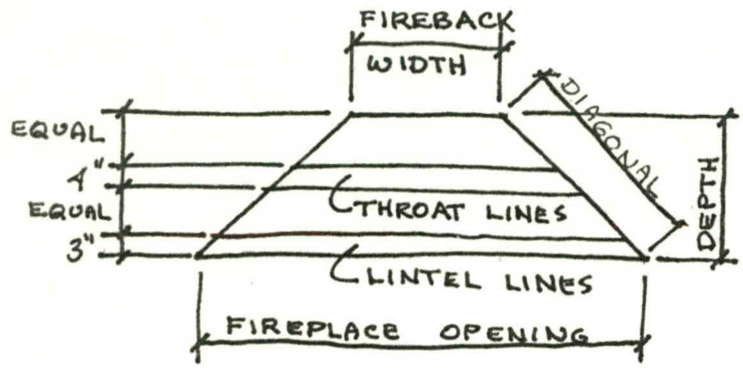




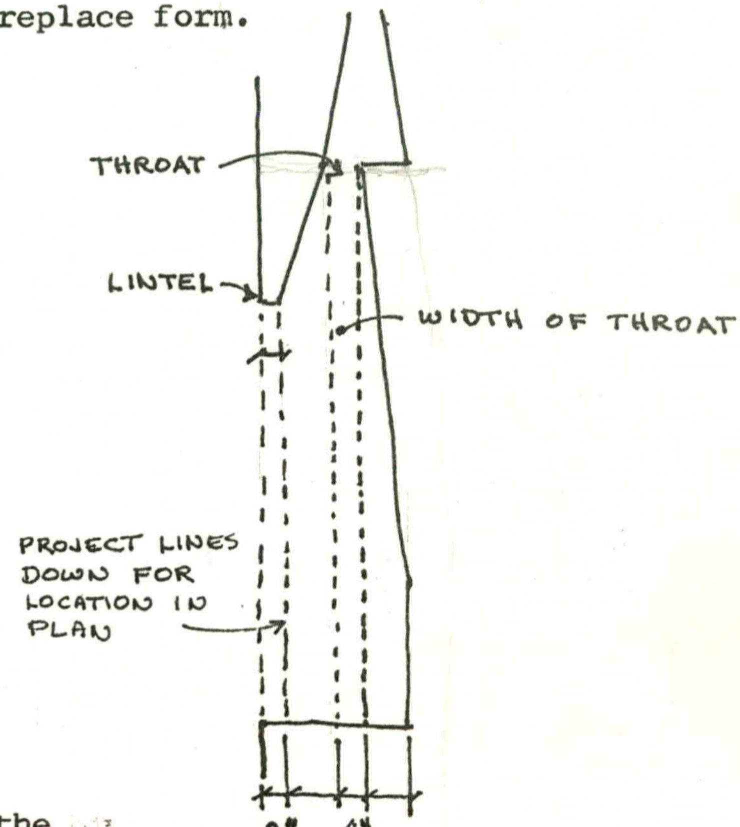
Once the sketch is made and the overall dimensions of the opening, depth , fireback, mantle height, and outside width are known, they are then transfered into a cutting diagram for the plywood box.

1. Without a filler, the top cracked off. Suggest a filler, or deeper, or include chicken wire.

Draw to scale the base of the fireplace opening. Project the location of the throat and lintel into this drawing of the base. This is the "Plan Diagram" and is used as a source for scaling dimensions for the panels of the fireplace form.

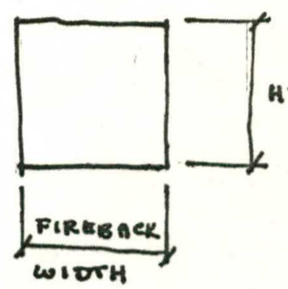


PLAN DIAGRAM



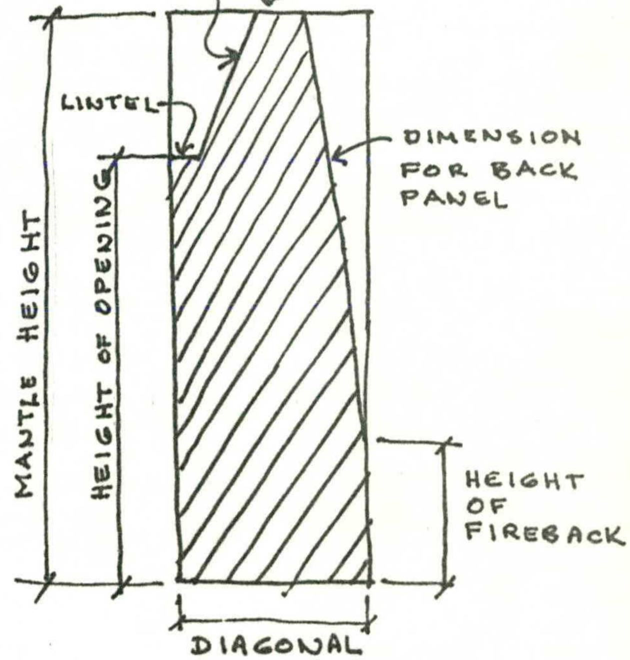
SECTION

The lower back panel is known from the original overall dimensions of the fireback. To find the size of the side panel, measure the diagonal of the projected plan diagram. The measurement along this diagonal to the intersection of the projected lintel and throat lines become the horizontal dimensions for the side panels. To draw the side panel, first draw a rectangle, the base being the measured diagonal, the height that



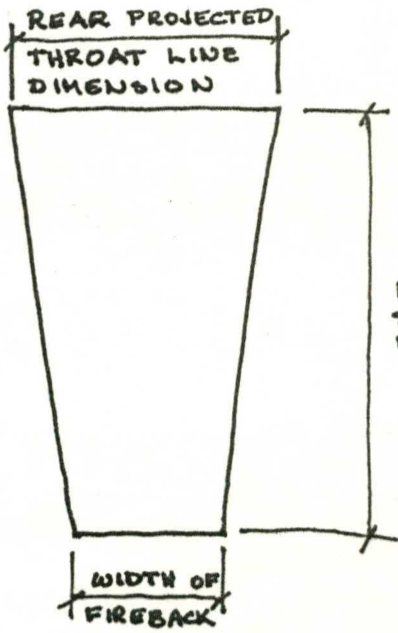
LOWER BACK PANEL (CUT 1)

of the mantle. On one side mark off the height of the opening and on the other side, the height of the fireback. At the top of the rectangle tick off horizontal dimensions taken from the diagonal for the location of the throat. And at the side with the height of the opening marked, measure in to the horizontal dimension of the lintel at the opening height. Now connect all ticks to get the shape of the side panel.



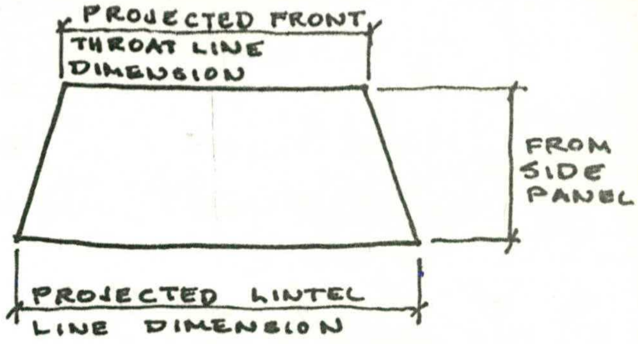
SIDE PANEL (CUT 2)

Next piece is the upper back panel. The measurement of the bottom of it is the width of the fireback. The length of it, perpendicular to the bottom, is taken from the drawing of the side panel by measuring the back. The width at the top is found by measuring the length of the projected rear throat line from the plan diagram.



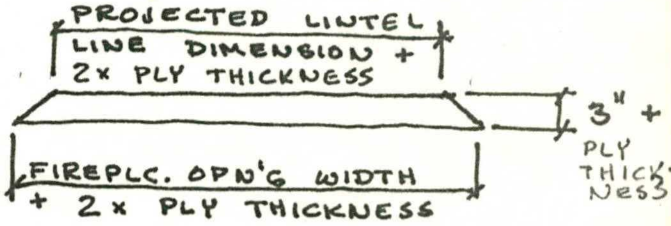
UPPER BACK PANEL (CUT 1)

The front panel is sized in a similar fashion. The bottom of it is taken from measuring the projected lintel line from the plan diagram. The height is measured from the drawing of the side panel, along the front. The width of the top comes from measuring the projected front throat line from the plan diagram.

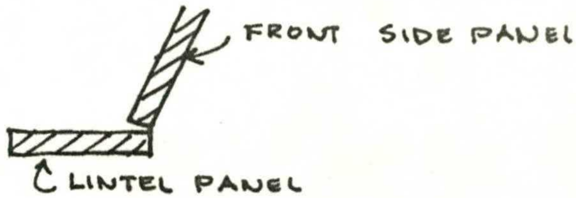


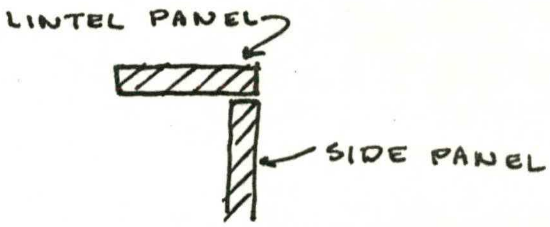
FRONT PANEL (CUT 1)

Lastly the lintel panel is drawn. The front of it is the width of the fireplace opening plus twice the plywood thickness so that it rests on the side panels. Its width is the 3" + the thickness of the plywood. This is so that the lintel panel helps support the front panel piece in construction. The rear length is found by measuring the projected lintel line from the plan diagram plus twice the plywood thickness.[1]

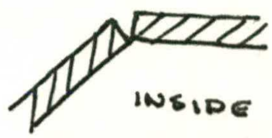


LINTEL PANEL (CUT 1)





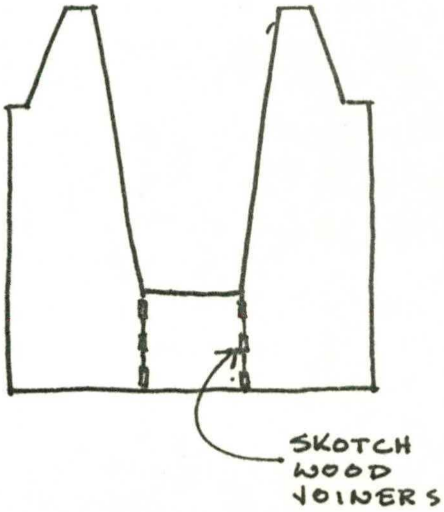
Using 1/2" plywood,[2] the patterns are cut all at once from the sheet; base, lower back, upper back, side panels, front panel, and lintel panel. Be sure to use the finish side of the ply for the side the material will be poured against. The connections at the corners are made with the inside corners butting flush, so no allowances are made for



1. Lintel panel was not cut with added thickness for butt connections. It required adding blocking to inside wall of side panels for support.

2. 3/8" ply was found to be too flexible.

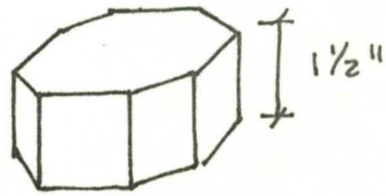
lapping corners with the exeption of the lintel panel connecting to the front and side panels. Taking the lower back panel and the two side panels layed horizontally, connect them with skotch wood joiners, on the inside, 3 on each side used vertically. Next connect the upper back panel to the lower back panel with 3 skotch nails used horizontally. Stand up frame vertically around the base and staple the upper back to the side panels with a staple gun,[1] keeping the upper back panel slightly to the inside of the side panels. At this point, take a good look at the fireplace, mocking up particular parts of it. If it doesn't seem right, modify it now. The rest of the pieces are connected using duct tape, running along the joints on the inside as well as the outside, being as neat as possible. Any remaining outside joints are also covered by duct tape. Light bracing is nailed across the front and top to stabilize the form, being careful not to put anything in the way of the pouring surfaces.

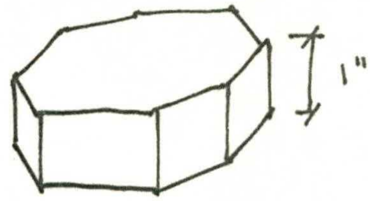


An estimation of the amount of refractory material is made. Estimate a 3" thickness on the plywood pieces, realizing that the material actually will be the thickness 11/2" outside the form, so compensate for this.

1. Staples are abit flimsy.

Onto the outside of this plywood firebox are glued a series of styrofoam spacing blocks, chicken wire, and then styrofoam. There are two sizes of blocks to be cut. They are octagonal in shape and one is cut from 2" square rectangles x 1" thick, the other is cut from 2" square rectangles x $1\frac{1}{2}$" thick.[1] These are cut from 4 x 8 sheets with a power saw. The 1" and $1\frac{1}{2}$" dimensions need to be uniform. Roughly 25-30 of each size are needed. The thicker blocks are the spacers towards the plywood, and the thinner blocks are towards the styrofoam. Next, the thicker blocks are glued tothe plywood panels of the form carefully spacing them to form a decorative pattern. They are kept away from all the edges and corners by about 2". Roughly 3 bands around the sides and back and 2 around the front will do it. The point is to make it so that it will securely support chicken wire and the outer styrofoam skin of the form while concrete is poured in it. They are glued with Great Gripper.[2] The spacers are placed with the 2" side against the ply. These should be allowed to set for 1/2 hour before working with the chicken wire. These blocks of styrofoam will eventually be burned out with the plywood form and patched with refractory material from the inside. While the glue is setting, the outside of the plywood form is oiled with motor oil, keeping the oil away from the styrofoam.



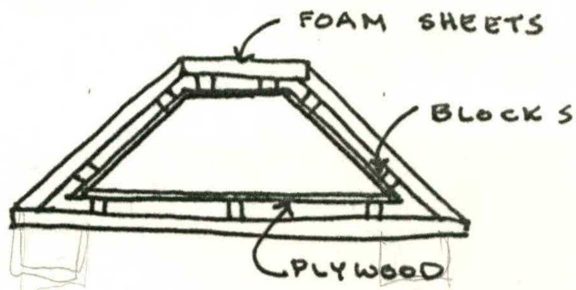


1. Blocks were cut in rectangles $2\frac{1}{2}$" x 3" x 1 & $1\frac{1}{2}$" thick. They were slightly large and their shape impeded the flow of concrete around them.
2. PL200 glue was used in a caulking gun. It requires 24 hours to achieve full strength.

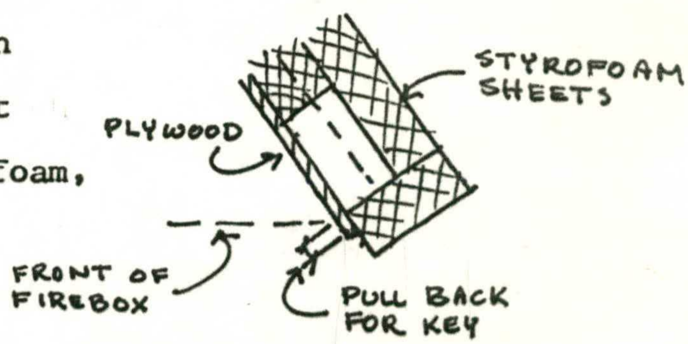
Taking chicken wire with the basic $1^1/2$" cell size,[1] wrap the plywood form with it. Form the chicken wire as closely around the foam blocks by adjusting bags in the wire with crimping or cutting and wiring as necessary. The whole thing should be a continuous fabric around the form. Be sure to keep wires away from plywood. Clip it back abit from the front edge, so that it doesn't come through the front surface.

The outer layer of blocks goes on now. Using the same glue, glue the thinner blocks right over the 1st layer, sandwiching the chicken wire between. Use small pieces of duct tape to tape the blocks to each other where necessary until the glue dries.

Styrofoam sheets, $2^1/2$" thick are now cut to form the wall of the form. Putting the foam right up against the blocks, start by cutting the lower back panel using a keyhole saw. Consideration should be made as to which surfaces lap on which. Each piece is cut and placed, one at a time. The upper back piece is cut next, then sides, and front. When cutting the side pieces, pull back the front edge so that a key will be provided for the finish material on the inside. Begin gluing the foam sheets on starting at the back. Shim gaps with blocks of foam, gluing them in.



PLAN



1. 1" cell chicken wire was used and proved to be on the small size for allowing refractory material to fill in both sides.

Taking duct tape, make a series of straps around the whole fireplace assembly to provide pressure to the glue to bond. Let this assembly sit for 24 hours to allow glue to achieve strength.[1]

The location of the firebox form is now marked on the slab. Make sure the surface is clean. Apply a coat of contact cement to the concrete and bottom of the plywood form. Allow it to dry the specified 15 minutes. Wet the area under the form opening and apply cement adhesive. Then mount the form in place, keeping re-bars to the outside.

Now begin mixing a sack of the refractory material with water to a relatively thin mix; just thin enough so that it can be handled between the two walls of the form. Taking a bucket of the material, pour it evenly around the sides of the form using hands where necessary to direct it down between the chicken wire and the plywood wall. Keep moving around the form as it is filled, maintaining a constant level all around. Light taping on the plywood can help break up air pockets as well as rodding. Always pour to the plywood side of the chicken wire. The rodding will cause it to fill in the other side of the wire. Continue with the sacks of refractory material, 1 sack at a time until the top is reached. Level the top with a float and cover the entire construction with plastic until cured.

1. Check manufacturer's suggestion on strength timetable for Great Gripper.

Center for Environmental Structure

BUILDING OPERATION

FIREPLACE

Unit of measure #

Price/unit: Materials $ ____________

Labor ____________ hours

Project developed for Martinez, Card house

Date 1981

SUMMARY OF OPERATION

Operation Fireplace

Unit of measure #

Step in Operation	Materials				Labor
	Material	Quantity per unit	Price per unit quantity	Price per unit	Hours per unit

Roof and Purlins

After the ceiling has been shot the form for the cornice can be built, and erected into place. This will take several days and will allow time for the ceiling to dry to the point where one can walk on it to do the roof and purlins.

The first step is to build the purlins...which can be done on the ground. ~~The next step is to lift them into place and secure them to the trusses~~

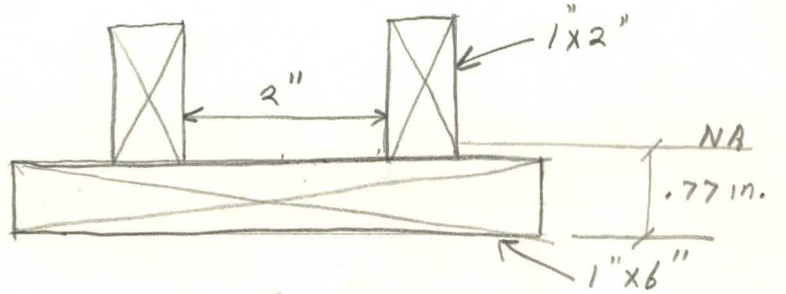
For Wood Calculations

$I = 2.47 \text{ in}^4$

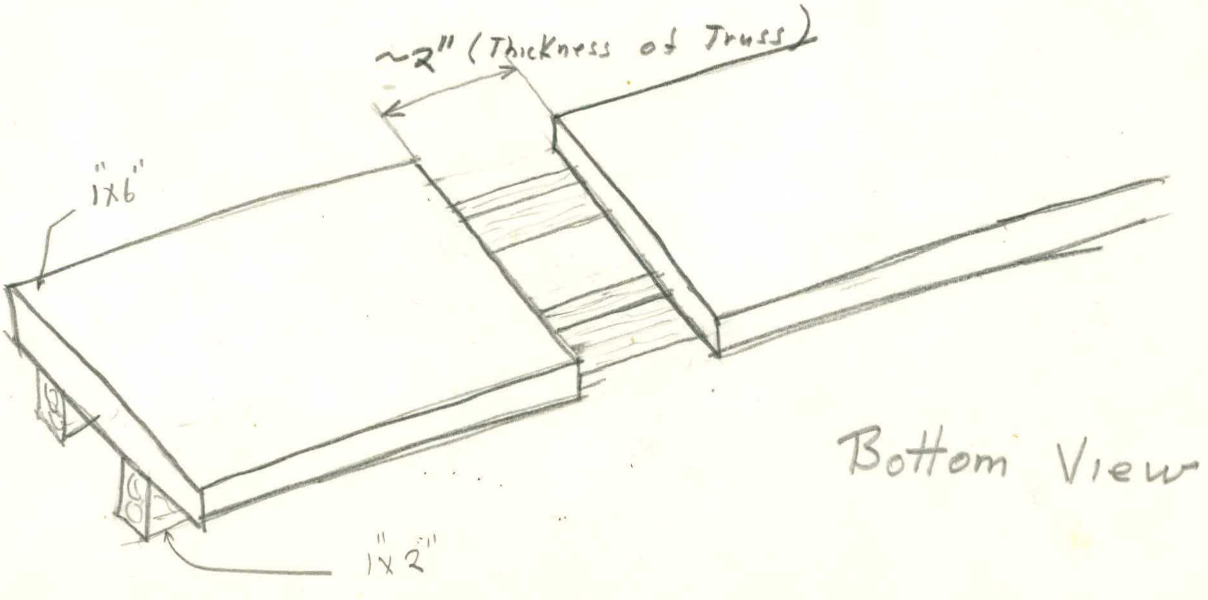
$E \sim 1 \times 10^6$

$\sigma_{max} = 975$ psi

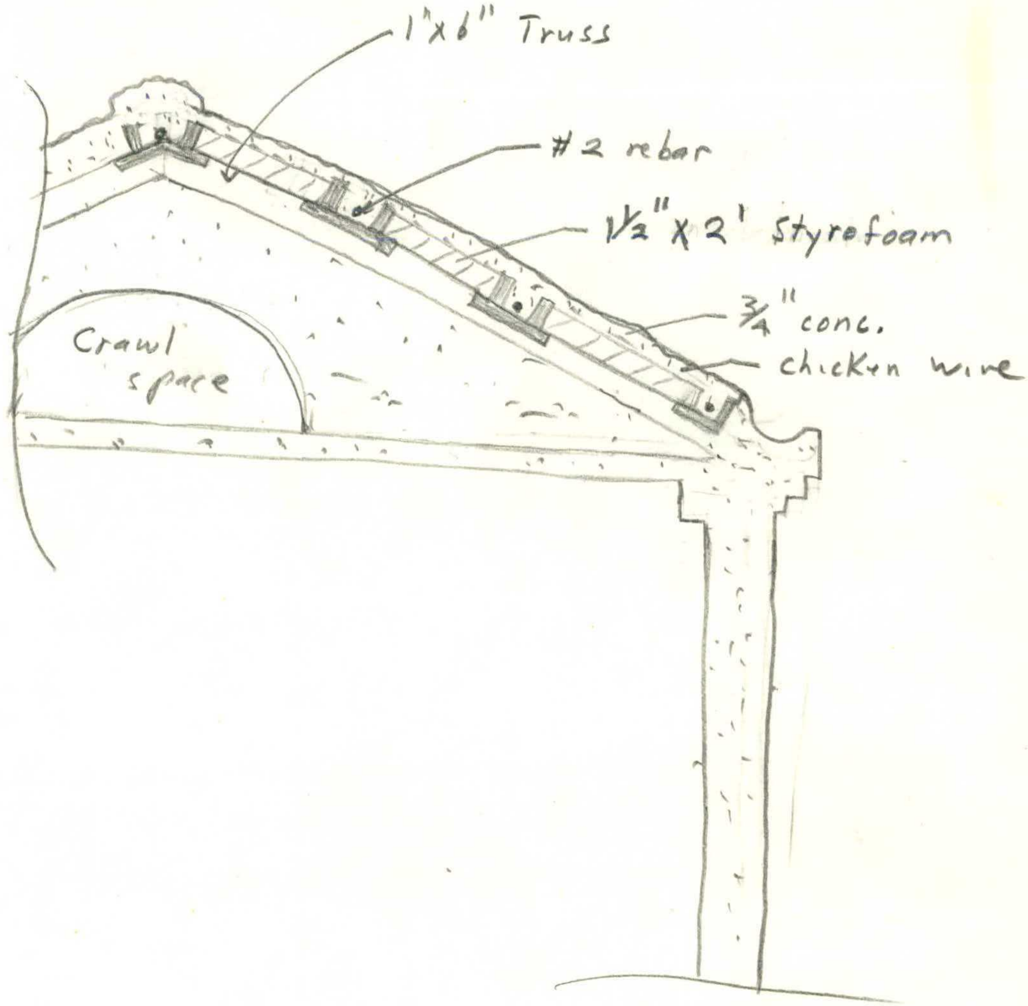
$\Delta_{max} = 0.20$ in.



The next step is to lift them into place and secure them to the trusses. In order to get a bond with the concrete of the truss the 1"x6" is to be cut out at that location.



ROOF AND PURLINS



The final step is to lay in the foam which is pre-cut into 2' widths, put in the #2 rebar, apply chicken wire, and spray with gunite.

ROOF AND PURLINS

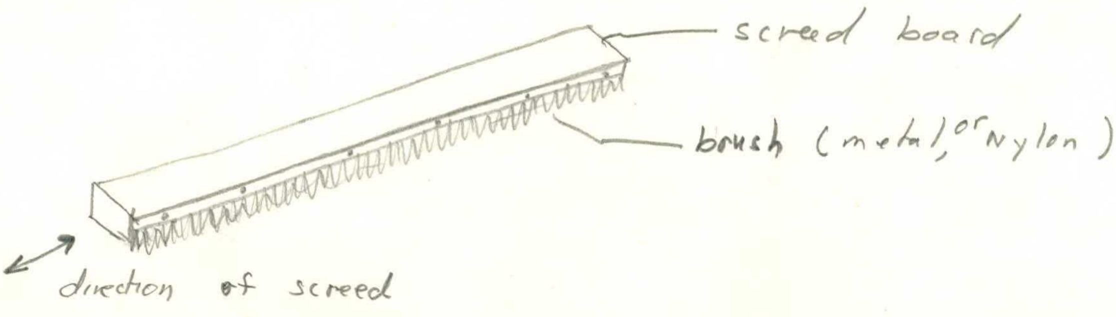
Over the past several months comments have been made regarding the finishes of the building, and in particular the final finish of the roof.

To adequately describe the finish one must think about it in two different ways. First there is texture, which says how rough a surface is to the touch. A coarse grade of sand paper has a rough texture, a piece of glass, a smooth one. Secondly there is out-of-plane roughness. This occurs in concrete when the surface is not screeded. The ocean, with it's many undulations is an example of out-of-plane roughness.

Finally, a finish can be described in terms of it's levels of scale. Typical roofs are made up of small pieces (relative to the size of the roof itself) like tiles, shingles , or even metal with corrugations.

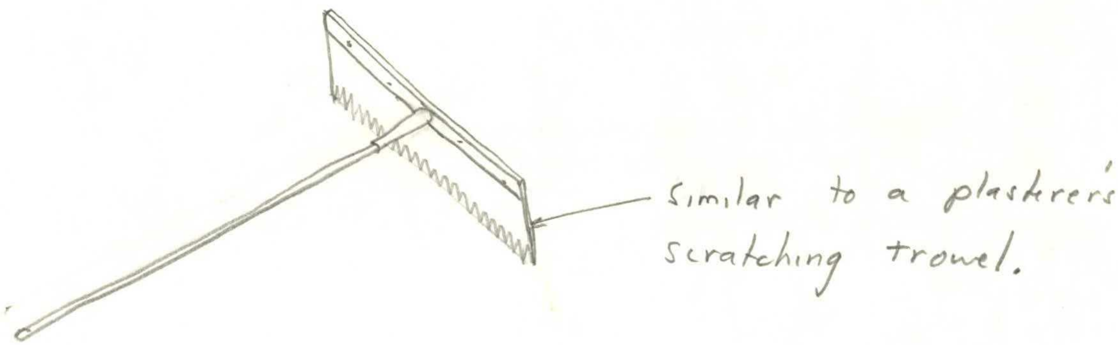
The scheme for the roof finish on the house solves the first two problems, but does not necessarily take of the levels of scale. The whole roof will still be fairly monolithiic.

one idea is to screed and brush the surface simultaneously.



ROOF AND PURLINS

Another idea is to rake the surface with a hoe like thing where the ~~bx~~ blade edge is serrated. It is not clear whether or not the surface would need to be screeded first.



Structural Calculations

Conc

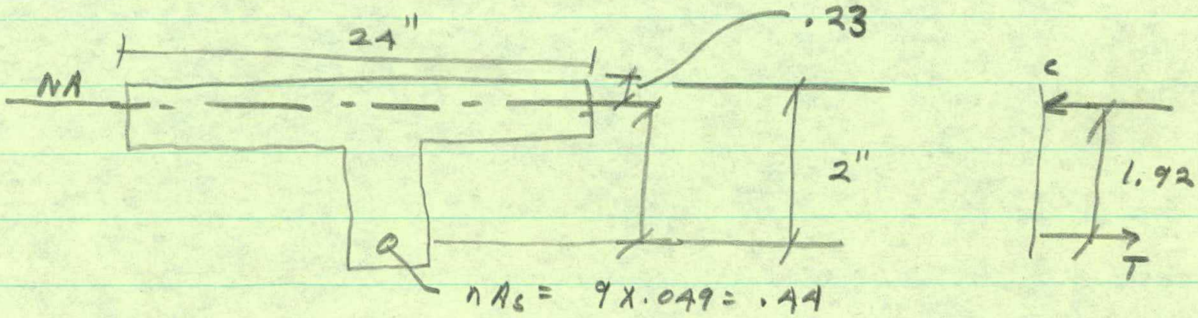
Roof Purlins

$M_{max} = 2116$ in-lb

$\frac{1}{10} w l_n^2$

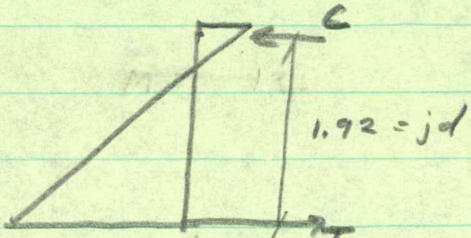
$A_s = .049 \text{ in}^2$

$F_s = .049 \times 30{,}000 = 1470$



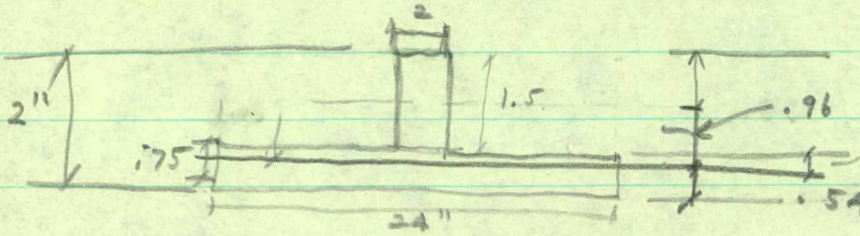
$.23 \times 24 \times .23/2 = .63$ ✓

$(2 - .23)\,.44 = .60$



$M = c\,jd = \left(.23)(24)\left(\frac{1350}{2}\right) \times 1.92\right. = 7153$

$M = T\,jd = A_s f_s\,jd = (.049)(30{,}000)\,1.92 = 2822$ ✓



$\sigma_c = \frac{Mc}{I} = \frac{(2116)(1.46)}{4.65}$

$= 664 < 1350$ ✓ ok ✓

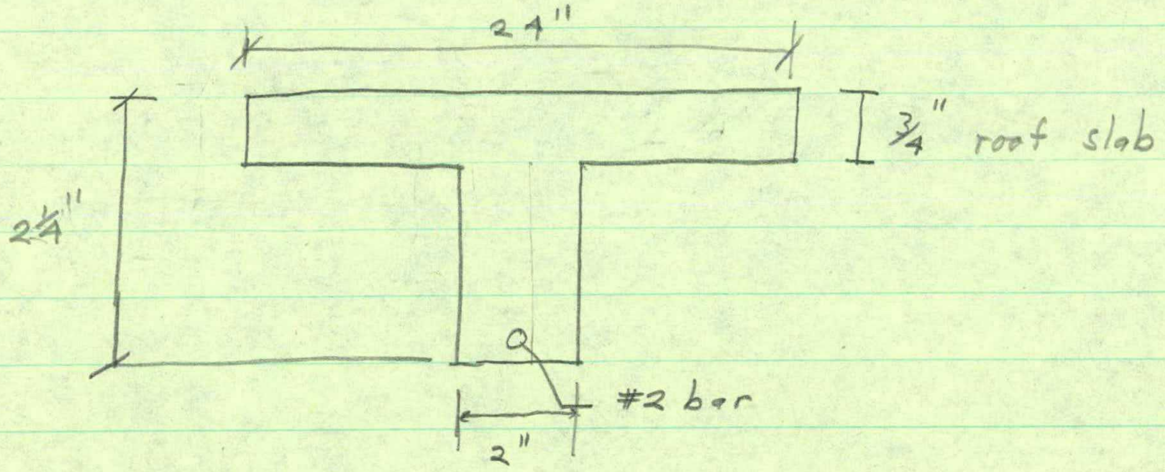
$\bar{y} = \dfrac{.75 \times 24 \times .75/2 + 1.5 \times 2 \times 1.5}{.75 \times 24 + 1.5 \times 2} = .54$

$I = \frac{1}{3}(24)(.54)^3 + \frac{1}{3}(24)(.21)^3 + 3(.96)^2 + \frac{1}{12}\,2(1.5)^3 = \underline{4.65}$

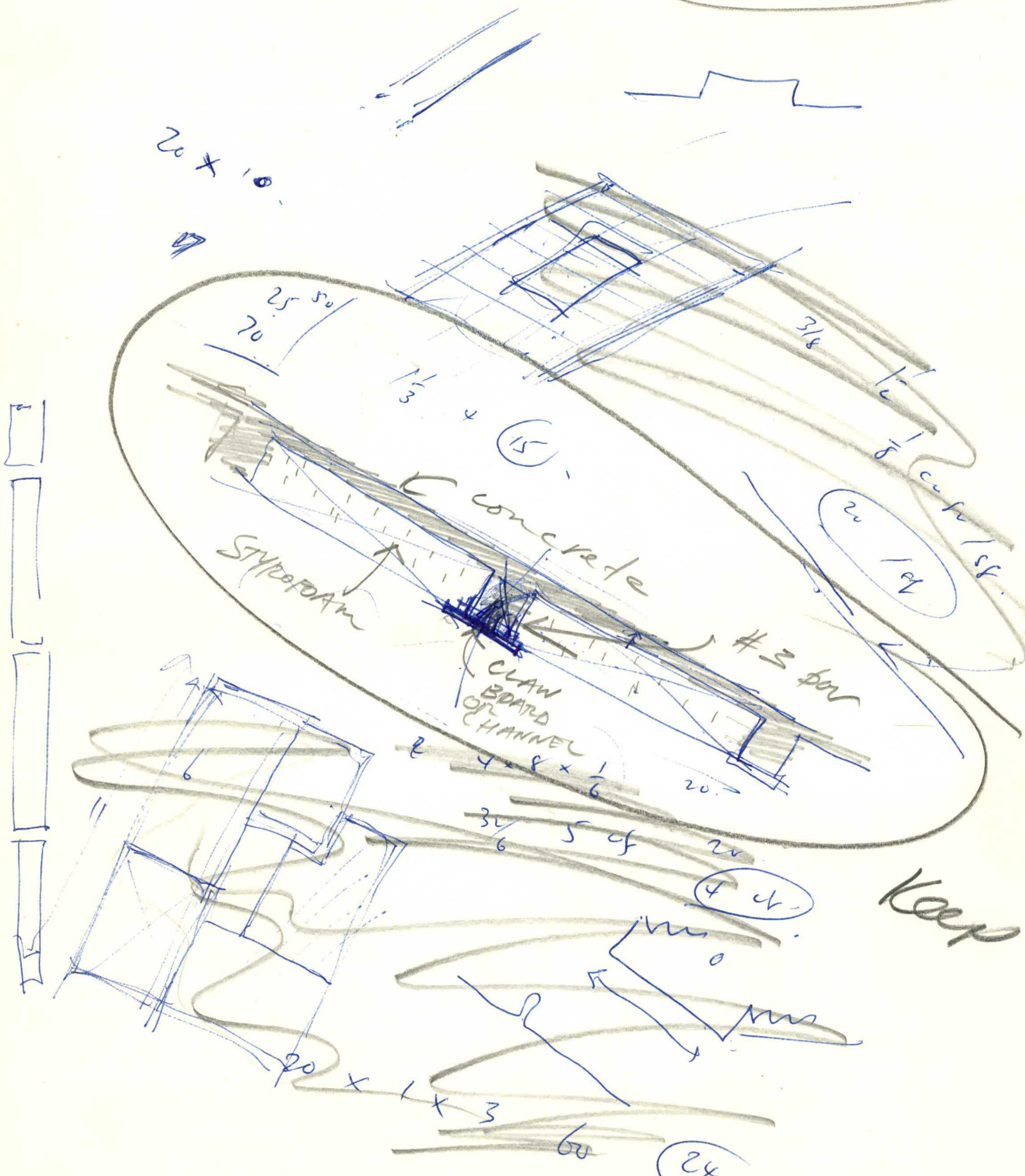
(1.26, .07, 2.76, .56)

$\sigma_T = \frac{Mc}{I} = \frac{(2116)(.54)}{4.65} = 246$ psi ✓ < 411 ok ✓

Purlin Design



PURLINS



Keep

PURLINS

uninsulated
10 x 20 room
no windows or doors

	M	L @ 900 DAY
Cols.	80.00	180
Cornice	56.00	360.00
Ceil	206.00	900.00
Roof	243.00	360.00
Walls	731.00	540.00
	$1316.00	$2340.00
	36%	64%

3656.00 / 23

15.90

1279.00

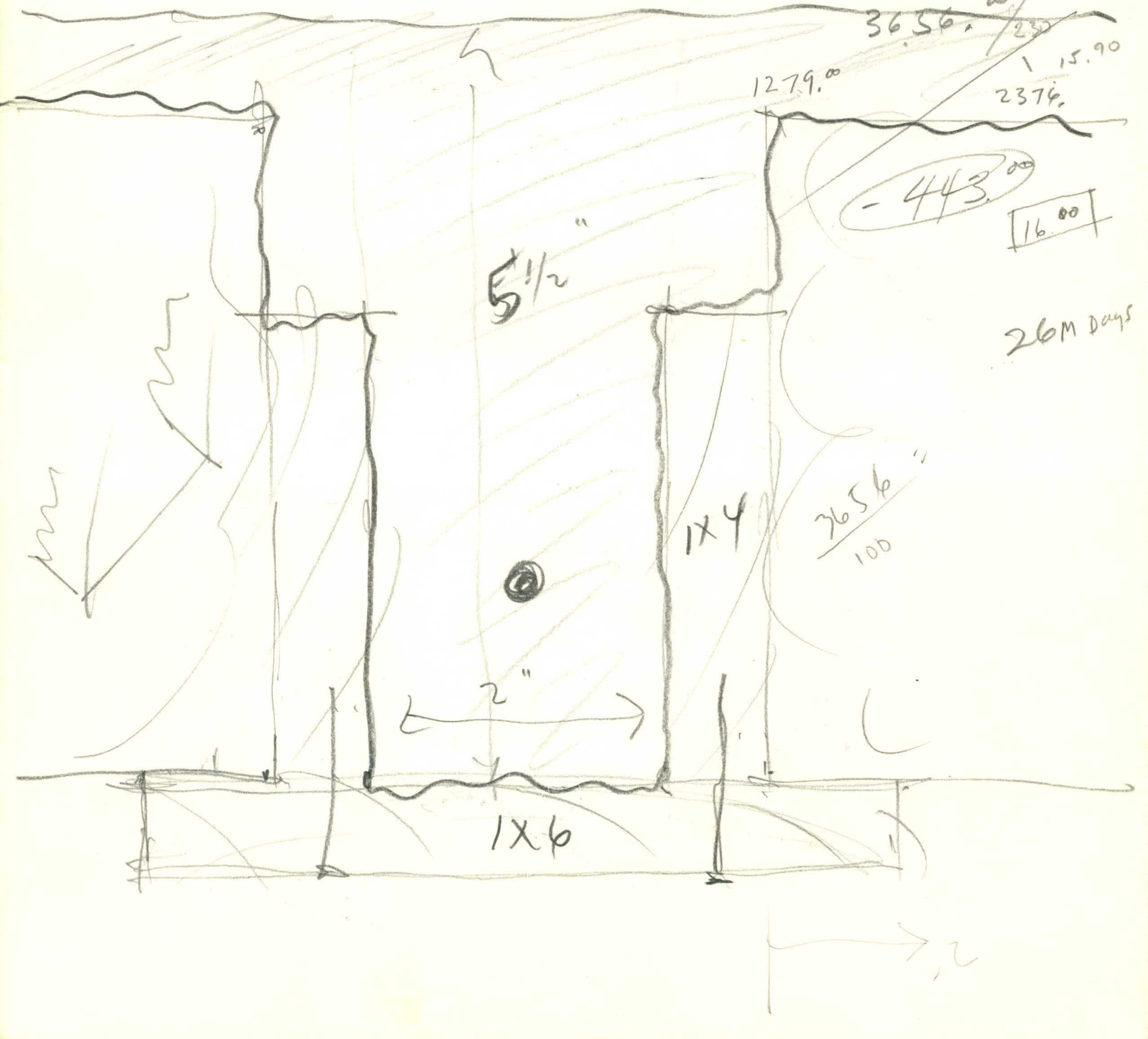
2376.

-443.00

16.00

26M days

3656 / 100

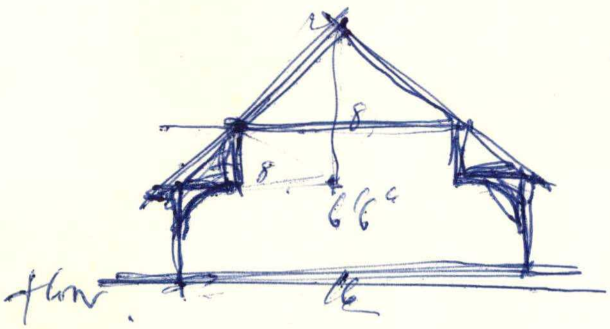


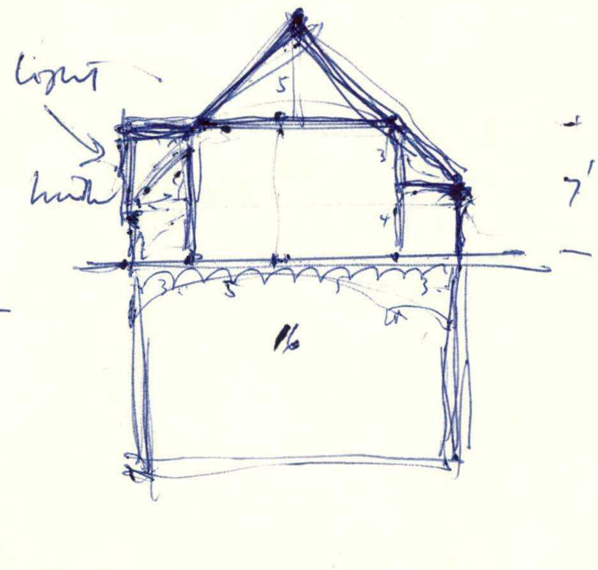
THE ROOF

In order to work properly, the roof, as a structural conception, must come very early in the design. This means the roof cannot simply be stuck on top of the vaults, but must be there as a dominating force, from the beginning.

Suppose we have, then, a fairly steeply pitched roof (say 35 degrees). In addition, we must have something happening in the roof. That means the roof is an inhabited space, a kind of attic, which covers the width of the building, has windows (light), and has headroom. Then it IS something. A workshop, place to play, storage, study, etc.

This tells us something about the roof, both structurally, and in its shape. It must have headroom; therefore tension members must be at least 6'6" feet off floor. It may have a kind of hammerbeam form. It must have possibility of dormers.





RIBBED ~~BARREL VAULTED~~ RAFTER ~~CEILING~~ ROOF

This is a thin, ~~xhex~~ cheap form of roof, or ceiling, which uses a minimum of materials. The rafters are 2' on center, each one is formed by a 1x4, so the edge of the rafter is 3/4 inch thick, the total thickness of the roof is 5", and at its thinnest point it is 1.5" thick.

FORMWORK

The formwork is made by 1x4's on edge, spanning the span, at 2' centers, with two play corrugated cardboard forming small barrel vaults between the rafters. The outer layer of cardboard is better sprayed with waterproofing (or waxed). The cardboard is stapled to the flat side of the 1x4.

STEEL.

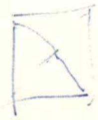
~~A~~ One #4 bar lying over each ~~fa~~ rafter. A layer of 2x4, 10/10 mesh, lying 1 inch below top surface of the roof.

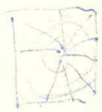
CONCRETE. ~~xhebconcbetemustbbe~~

The first layer of concrete must be put on very thin, 1/4 inch maximum, as the cardboard easily becomes weak, and cannot support more. This first layer of concrete must be put on very evenly, so as not to distort the curves of the cardboard - uneven loading creates flats and bumps and hollows in curve.

VAULTED ROOF - SMALL SPAN. RECTANGLE

A two inch concrete shell, sparyed over a burlap or nylon cloth, stretched over #2 rebar basket. This can take any form with diameters up to about 15 feet.





FORMWORK.

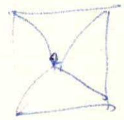
The basket consists of tied 1/4 inch rebars, at about 1 foot centers. The basket grid is a diamond grid, set out at equal intervals on an approximately recntagnular frame. The edge of the vault is shaped especially, to leave no ugly marks when forms are removed. Burlap or nylon is stretched over basket, and sewn. We believe it can be attached to wire with hog ring stapler. Sewing is timeconsuming. Burlap leaves rougher surface, with less wrinkles. Nylon is smooth, but tends to have wrinkles.

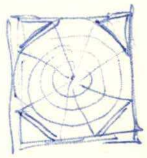
STEEL. Light wire mesh overall, Since each part of this basket is almost perfectly singly curved (i.e. barrel-like, not doubly curved like a dome), it is possible to use mesh on each portion, without distortion.

CONCRETE. Must start with very light freeze coat - no more than about 1/4 inch, finished to 2", finished on outside with XYPEX

CIRCULAR DOME

This is a circular dome, made eactly like the vault, except that the basket which makes the formwork is wovexn differently.





FORMWORK. The formwork is also made of 1/4 rebars, joined in the middle of the dome, forming the vertical ribs (meridians), and braced by interwoven bars running horizontally round the dome in rings. In this case the cloth form must be burlap, since nylon cannot take the double curvature of the dome.

STEEL. The wire mesh has to be patched in in sections, after the freeze coat, since large areas of mesh will not take the double curvature.

CONCRETE. The concrete is two inches thick. It looks best when it is capped by some kind of center at the top. The simplest version, in Mexicali, is the single column block. A more elaborate structure can be sprayed.

STRUCTURAL CALCULATIONS.

The first calculations, suggest that this kind of roof can support the code required 20 lbs/s.f., at up to 10 foot spans. Greater spans will probably require larger rebars, or greater depth in the rafter portion.

The mesh can lie 3/4 of an inch below the surface, because according to the code, when there is a code approved roofing material, the specification for interior surfaces applies to the steel cover.

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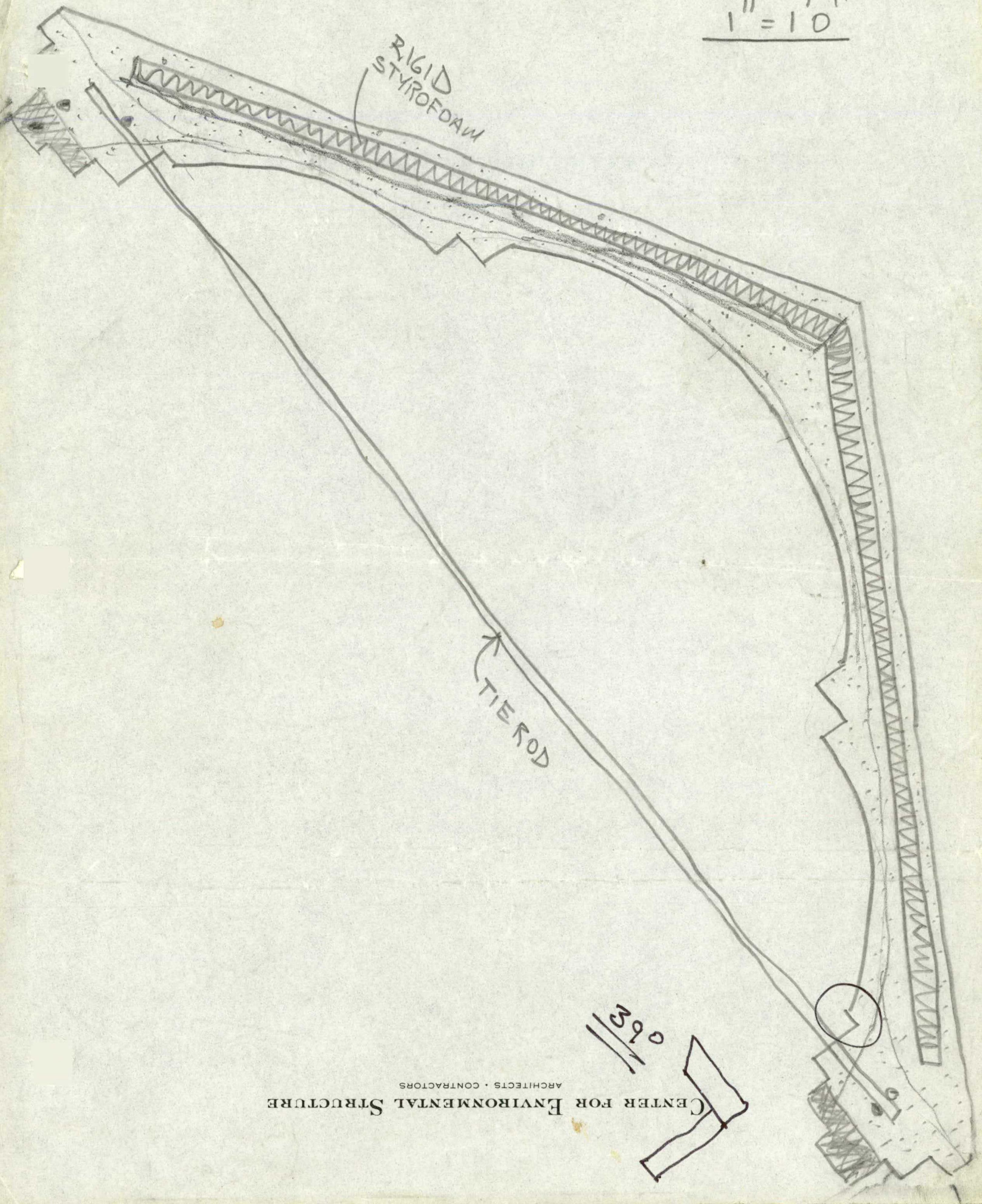

CENTER FOR ENVIRONMENTAL STRUCTURE
ARCHITECTS • CONTRACTORS

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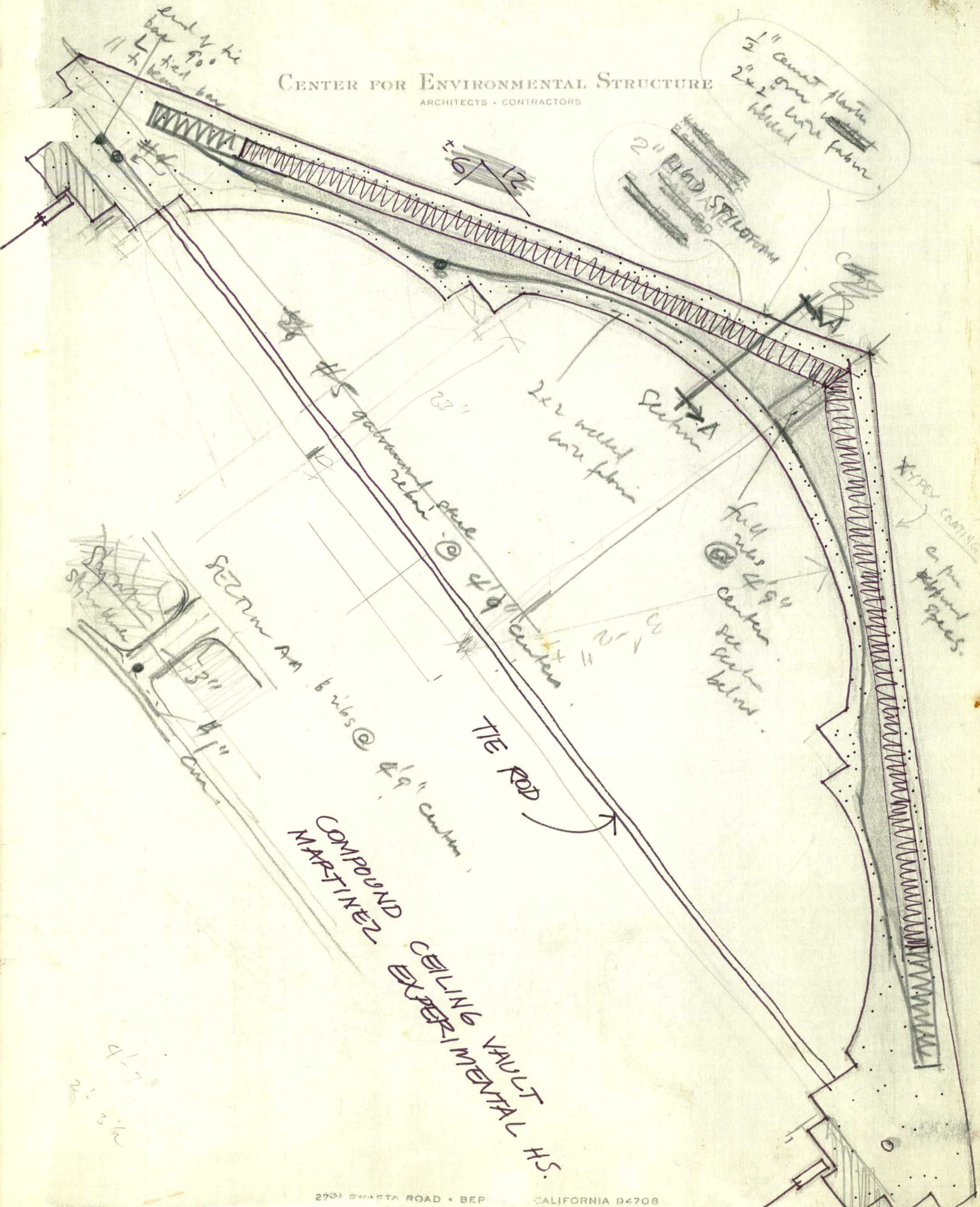

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LUMBER COST

cage

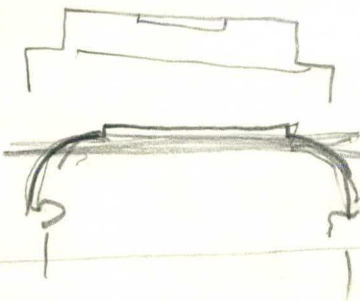
12 2x4's @ 10' ea. = 5.25 □" × 10 × 12 × 12 = 7560 / 144 = 52.50 B.F.

.40 / BF — 21.00 — $ 21.00

1x6's @ = 4.125 □" × 232 × 12 = 11484 / 144 = 79.75 B.F.

48
32
72
80
272'

.41 / BF — 32.69 — $ 32.69



$ 53.69

"Z" section

$ 6.00

2 1x3's @ 20' = 40 lin ft. @ .15 = 6.00

2 1x6's @ 20' = 4.125 □" × 40 × 12 = 1980 / 144 = 13.75 BF × .41 = 5.63 — 4.00

2 1x2's @ 20 = 40 lin ft. × .10 = 4.00 — 4.00

1x4's @ 45 = 1417.5 / 144 = 9.8438 × .35 — 4.00

$ 20.00

terminus

2 1x6's @ 20 = 40 × 12 × 4.125 ÷ 144 = 13.75 BF × .41 = 6.00

2 1x4's @ 20 = 40 × 12 × 2.625 ÷ 144 = 8.75 BF × .35 — 3.00

1x6's 12 × 4.125 × 12 ÷ 144 = 4.125 × .41 — 2.00

$ 11.00

masonite

5 sheets @ 5.75

$ 28.75
29.00

concrete

2'-4 + 3 = 2'-7"

2'-7" + 22" + 5'

12' × 20' = 240 □' = 34,560 □" × 1" THICK* = 34560 CU. IN. / 46656 CU. IN. = .75

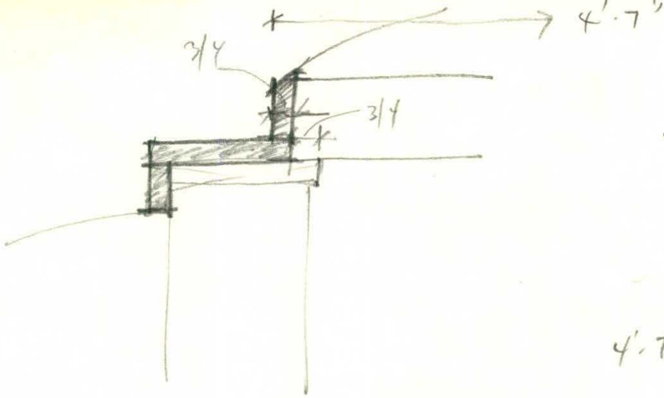
* (AVG. OF 3/4" OVER MASONITE AND THICKER AT TERMINUS)

37920
.81
3360

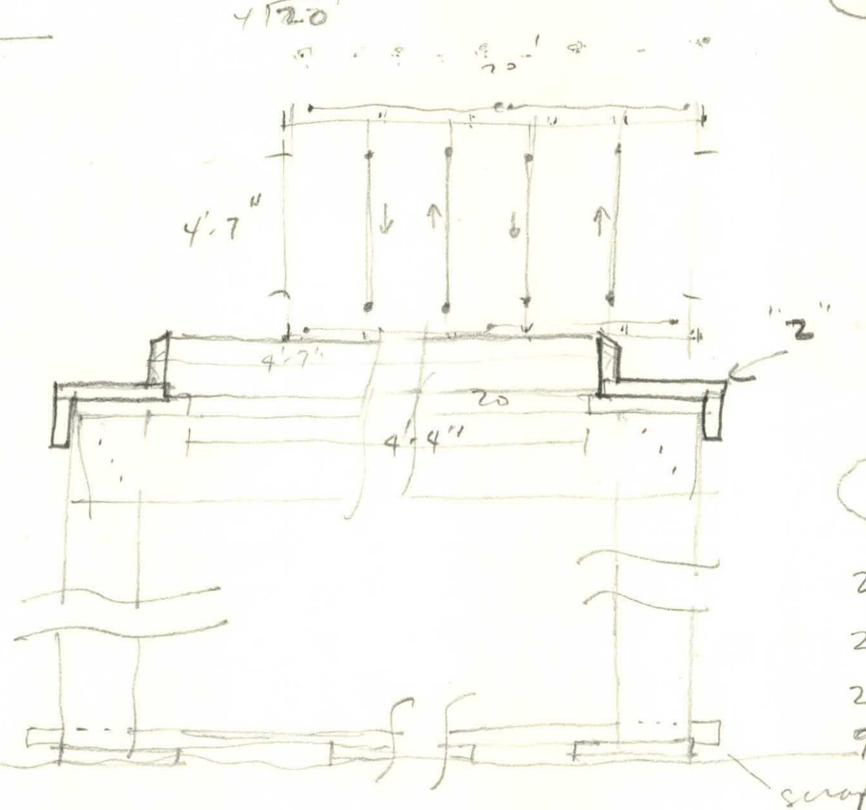
3340 C. IN.

3/4 CU. YD.
45.00 / YD.

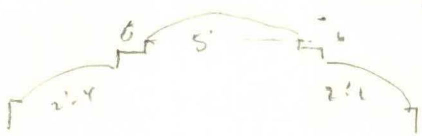
$ 33.00

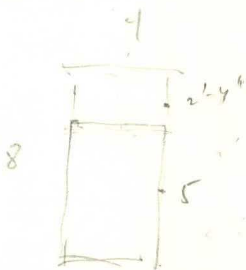


4'-7"
3
4'-4"
1'
4'-1½
5'3



20' / 4' = 5 sheets





cage (mostly scrap)

12 - 2x4's @ 9'-3" (10') studs
4 - 1x6's @ 20'-0"± (20) runners
12 - 1x6's @ 5'-3" (6) cross pieces
4 - 1x6's @ 7'-0"± (8) cross braces lat
4 - 1x6's @ 12'-0" (12) diag braces long

"Z" section all new

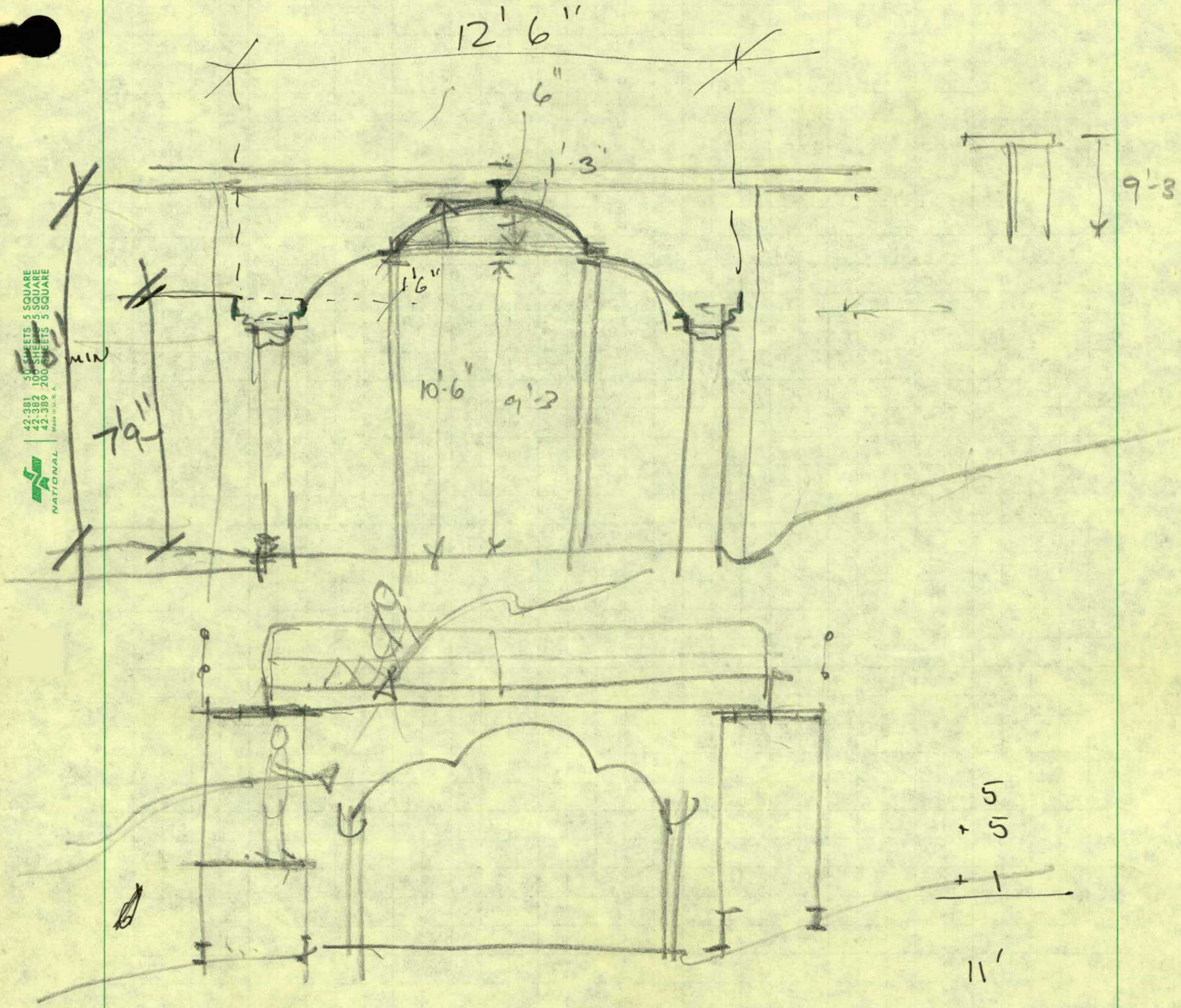
2 - 1x3 @ 20' (20)
2 - 1x6 @ 20' (20)
2 - 1x2 @ 20' (20)
9 1x4 @ 4'-6" (5)

ceiling framing all new

2 - 1x6 @ 20' (20)
2 - 1x4 @ 20' (20)
6 - 1x6 @ 2' (2)

masonite new

5 sheets @ 4' x 2'-4" } 5 sheets
5 sheets @ 4' x 5'


12' 6"
6"
1'-3"
9'-3"
1'6"
MIN
7'9"
10'-6"
9'-3
5
+ 5
+ 1
11'

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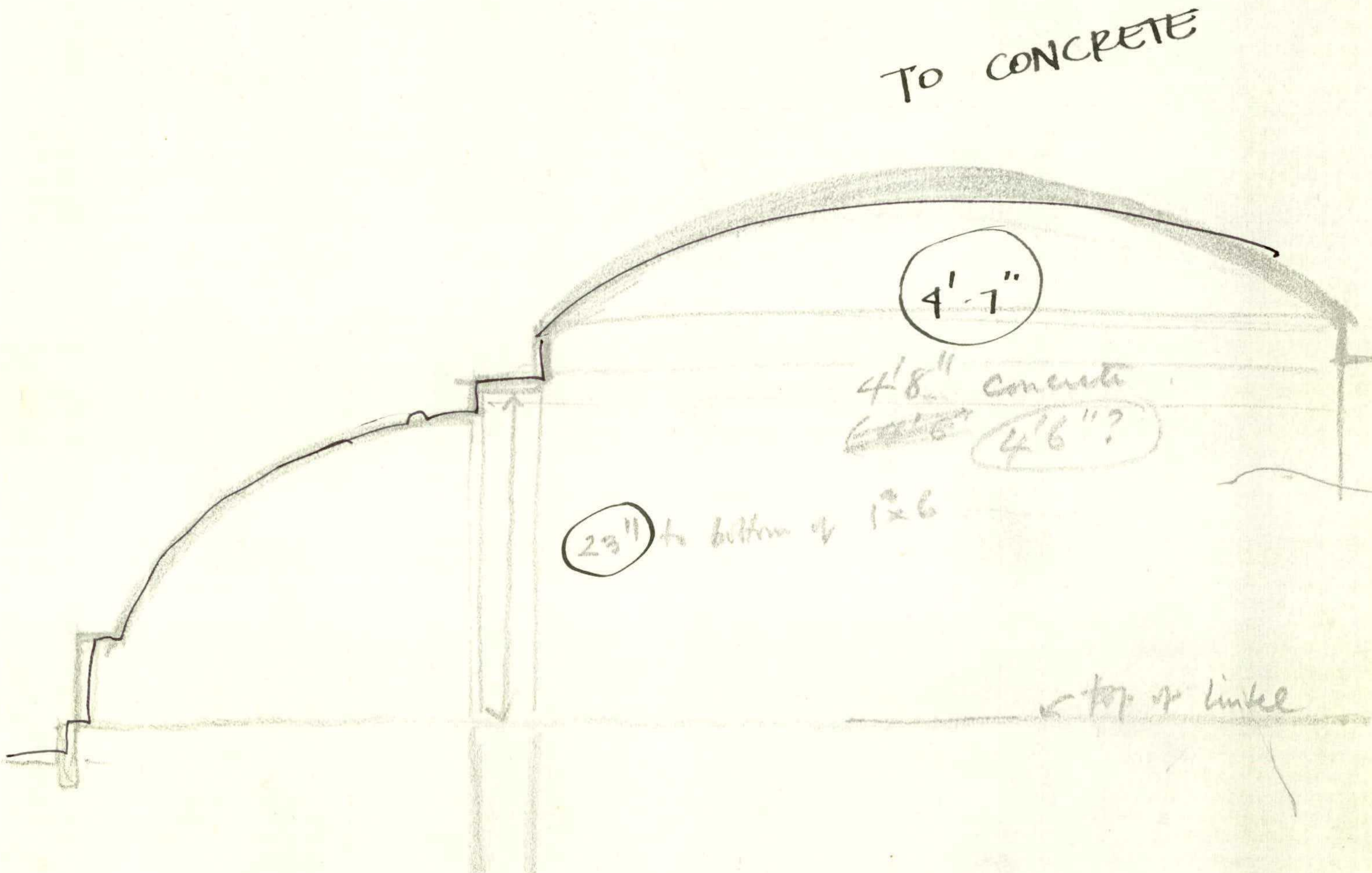

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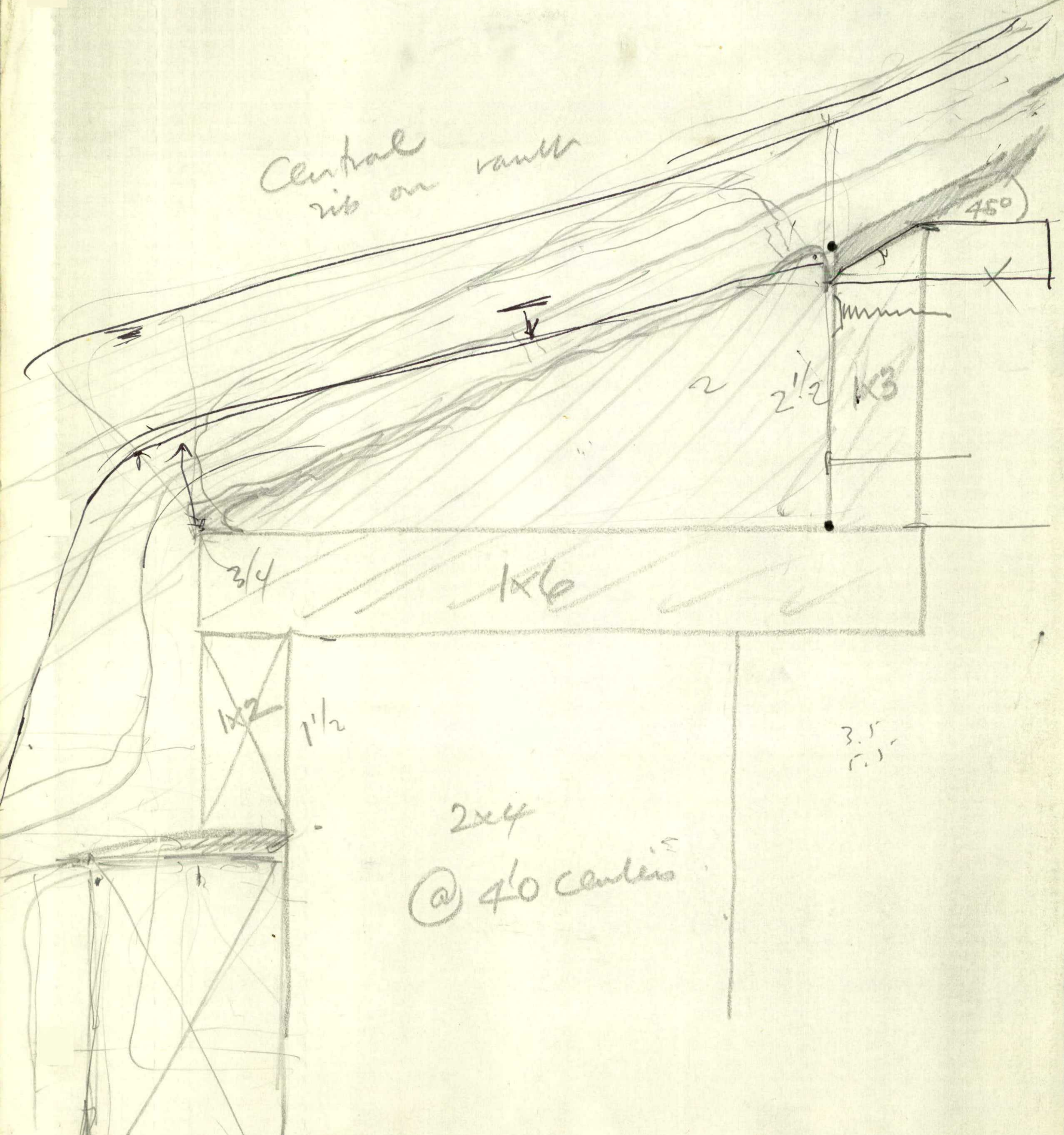

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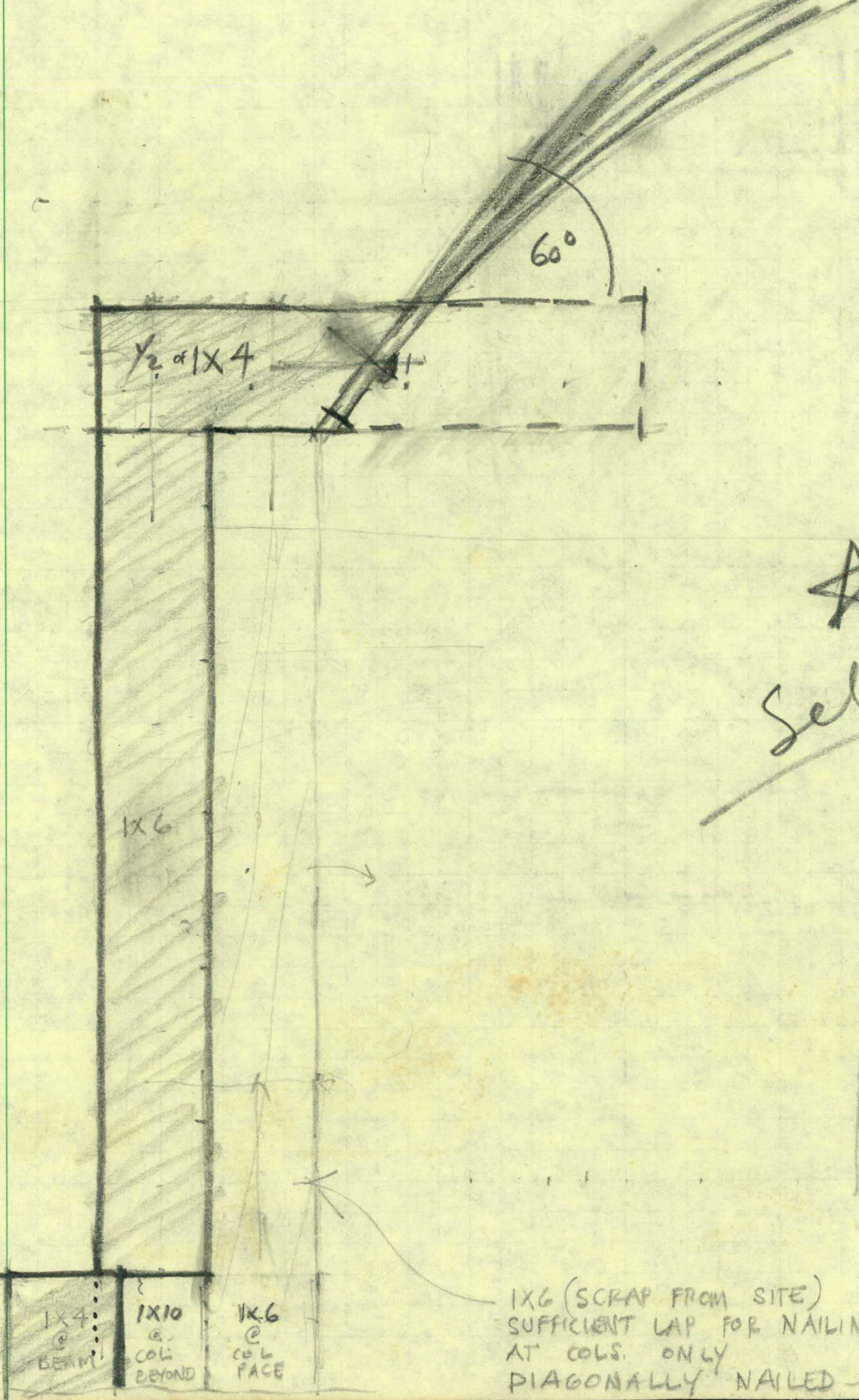
April 5, 79 11:15 – 11:45

CEILING TERMINUS

2.90
6.40
1.50



☆ ✓ Selected

1X6 (SCRAP FROM SITE)
SUFFICIENT LAP FOR NAILING (TO END OF 1X10)
AT COLS. ONLY
DIAGONALLY NAILED

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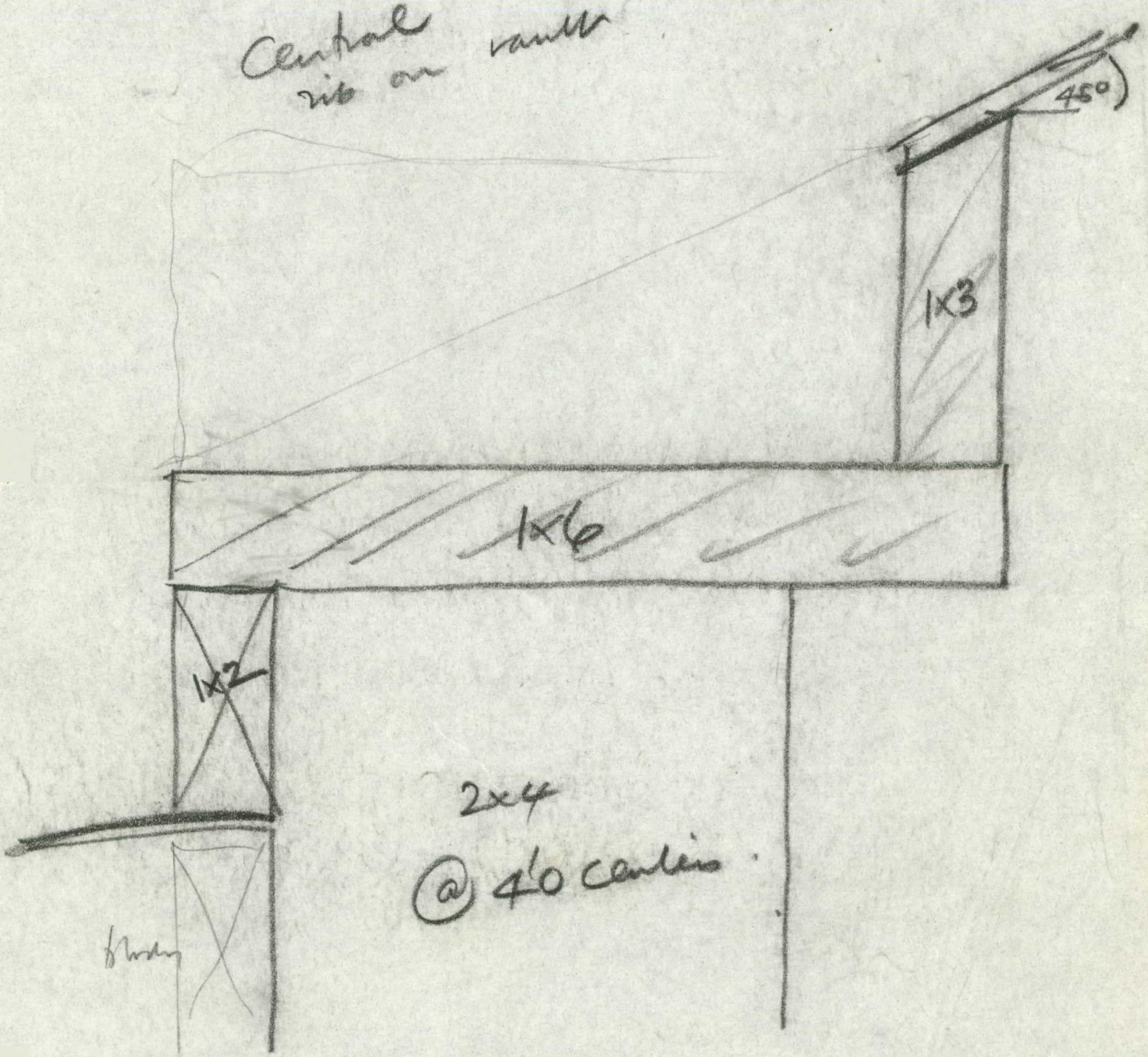

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BUILDING FINISHES TO DATE 2/25/77...

The interior is painted, thw shells, beams and columns, all painted the same, perhaps all white. The gyp board walls are taped and caulked where they intersect the columns, but theyremain smooth, and are painted also, perhaps with some subtle colors.

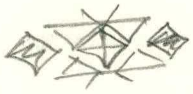
Thw floors are dark oak parquet tiles, prefinished. They do not quite touch the base of the columns, with the intervening space filled with some very dark grout, mastic, or caulking.;

There is a wood base of at least 6" tall stretching between each column, but not wrapping the columns. There is also a cornice molding of less than 4" running between the column capitals. The section of the molding tapers toward the bottom, and is chosen so that the 1x4 trim around the windows stands out clearly along the top. This may require that the top trim be slightly thicker than the others. The window trim is finished, not painted. Door trim is similar.

The exterior walls are colored with a fairly intense pale yellow. Hopefully this color will be integral with the final Gascon surface.

The exterior columns are.....

The exterior beam and spandrel surfaces are......



OILED CEMENT COLOR.

This technique was invented, or at least first recorded, by Gill, ~~atxthexbegx~~ in the late nineteenth century.

INTEGRAL COLOR CEMENT WASH.

In order to provide a low cost color which is integral with the building, not merely a paint, and to waterproof the exterior wall and columns surfaces, it is possible to make up a simple cement slurry, of the consistency of paint, add ~~whatever~~ oxides or other ~~xxxx~~ integral colors, and waterproofing additive, ~~and water~~ and paint on with brush, ~~x~~ roller, or spray. The color must be cured, by wetting down once a day for three days, and will then be solidly integral with the building.

Mixes for cement wash:

By volume:

~~C~~ Grey portland cement

Oxide or other color

Additive

Water

To make colors more brilliant, or to make white~~wash~~, it is possible to use white cement. This is more than twice the price of ~~grey~~ grey cement: in our experience the colors harmonise better, with ~~greys~~ greys of unpainted concrete, when the grey cement is used.

	PIGMENT	WATER	XYPEX	
1	1 green (chromium RJ)	4 water	6 Xypex	too grass green, rich, bright, etc.
2	1 green (CRJ)	6	9 ↓ seems slightly less obtrusive than 4-6	seems nicest of 1, 2, & 3
3 greens as powder seem very similar	1 green (21 dowman) ↑ after drying this seems more yellow than Chromium	4 NOTE: easier to paint when pre-spray is fresh	6	nicer than # 1 not as good as 2
4	1/2 green 1/2 blue (CRJ)	6	9	~~[illegible]~~ very nice grey feeling not blue or green calm, nice to approach
5	3/4 green 1/4 blue *	6	9	too much green still felt, need more blue, nile green
6	~~2/3 green 1/3 blue *~~	~~6~~	~~9~~	decided to make more for greater accuracy
	* accuracy of measuring difficult			
6	1 green 1/2 blue	9	13 1/2	
7 ATTEMPT TO DUPLICATE # 4 AT HIGHER VOLUME	1 green 1 blue	12	18	seems still not as shiny as # 4 and maybe more green

Trying Large Experiment on Building

left half	1/2 green (−) 1/2 blue (+)	6	11
window	1/4 green (−) 1/4 blue (+)	3 2/3	5 1/2

XYPEX — San Rafael, Ca Spaul

472-3184

Concrete Pigment Formula

Blue Green

1 blue #71 from ace Hardware
2 green (Chromium Rhodes Jamison)
15 white portland cement
↑
UNITS

1 UNIT = 1/2 CUP

"WATER TO TASTE"

CONSISTENCY OF HALF & HALF

XYPEX INTEGRAL ROOFING COMPOUND.

This is a material which provides a waterproof roof surface, integral with the concrete. It is a substance, which looks a bit like cement, is painted on withbrush or mopped on, in a thick creamy consistency. After application, the material forms crystals deep in the structure of the concrete surface, and the resulting composite, is completely impervious to water. After application, the surface must be kept moist at all times (under gunny sacks, or wet paper) for three days straight.

Small cracks in the concrete repair themselves, by continued crystal growth. Large cracks must be repaired by application of new Xypex along the crack.

This roofing material is extremely cheap, and ahs been approved by code officials in Northern California, as equivalent to a five year roof.

Within a concrete structure, this vastly simplifies the roofing problem, since it is time consuming, and unsatisfactory to put a built-up roof over a concrete surface. However, other compoundsand waterproof paints, deteriorate, and fail after two or three years.

CABINETS.

Custom Woodcraft. – Berkeley.

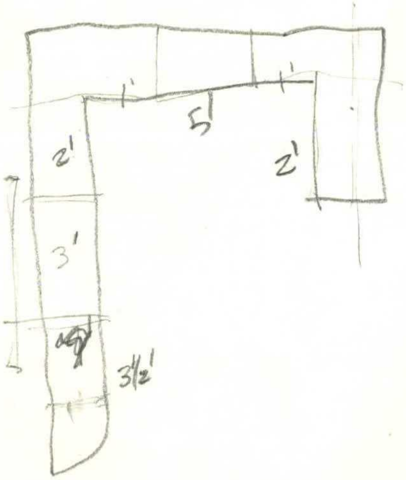
3/4" wood, birch plywood surface.

7'-0" base cabinets 60% } $500.00

5'-0" wall cabinets 40% }

no hardware or countertop.

Cabinets



6 lf.	DOOR & 1 SHELF @ 42.50	255.00
3 lf.	SINK UNIT. @ 37.75	113.25
2 lf.	DRAWERS. @ 67.95	135.90
1 lf.	OPEN.	34.30
14 ft.	COUNTER TOP. @ 14.40.	201.60
4 ft	WALL CABINETS. @ 31.90.	$ 127.60.
	TOTAL.	867.65.

Estimate Berkeley.

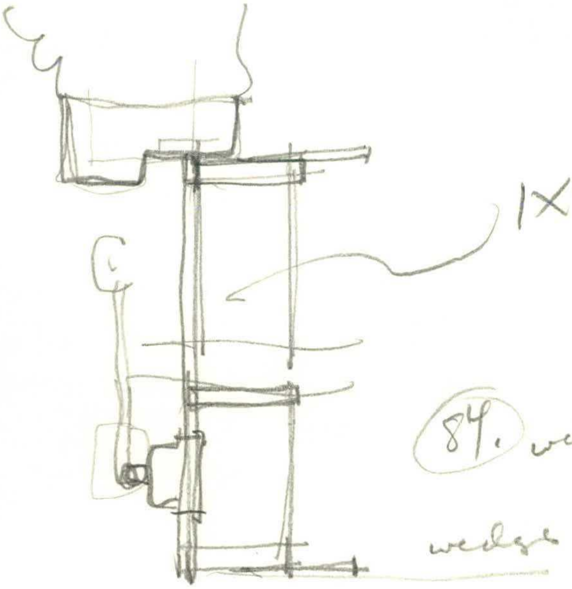
Base 42.86/lf.

Wall 40.00.

no hardware or countertops.

Rear Wall

7 × 10   70 □' rear wall.

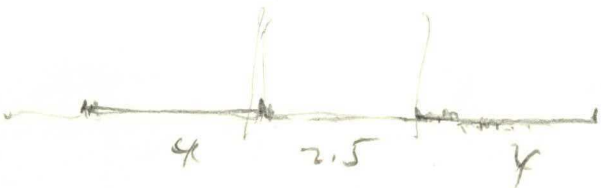


1×4's @ 4.00
17.75
3.00
4.00
28.25

6 1×4's @ 7'
42' lin ft.
12
504 lin in.
7.18 BF
.35

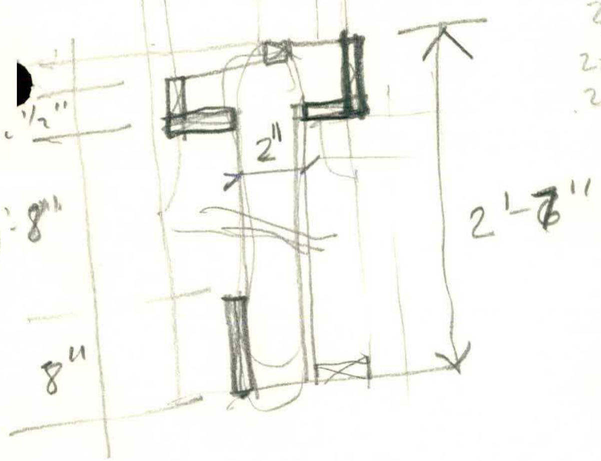
70
1
360

3 @ 5.75

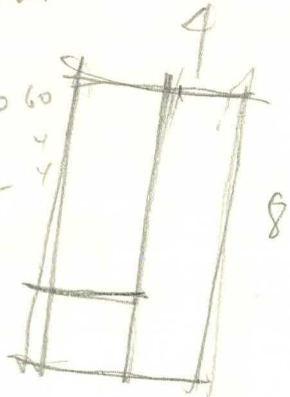


432 lin in.

check lumber
cost @ vault.
waste factor



2x3 0 60
2x 2 4
2x 2 4



29376 cu. in.

.64 cu. yds conc.
.32
.94

8 sheets masonite @ 5.75 ea.

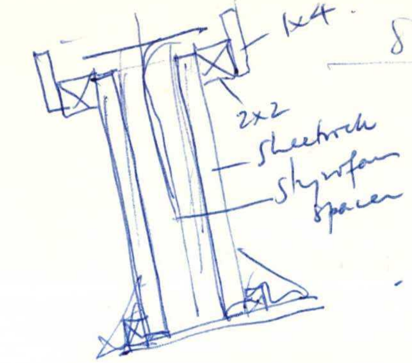
1X2
1X3

4'-6"
8

4 10' pounds

4	1X2's	@ 10'	40'	4.00	
8	1X4's	@ 10	80 lft.	7.00	960 in
8	1X3's	@ 10'	80'	12.00	
4	1X8's	@ 10'		5.00	
~~8~~ 4	1X1	@ ~~10'~~ 13'		~~2.00~~ 3.00	

8.5 (10)



BALUSTRADES

Wherever there are terraces, ~~x~~ either upstairs on a flat roof, or at ground ~~mmmn~~ level, on terraces in the hillside, they need a parapet: and this parapet is best when it is open, like a balustrade ~~x~~.

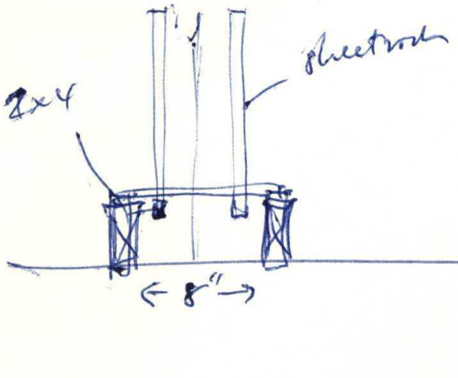
In order to make this balustrade nice, we want ~~x~~ it to be half open, not too ornate, and preferebly made of ~~stone~~ masonry: wooden ones dont last long enough.

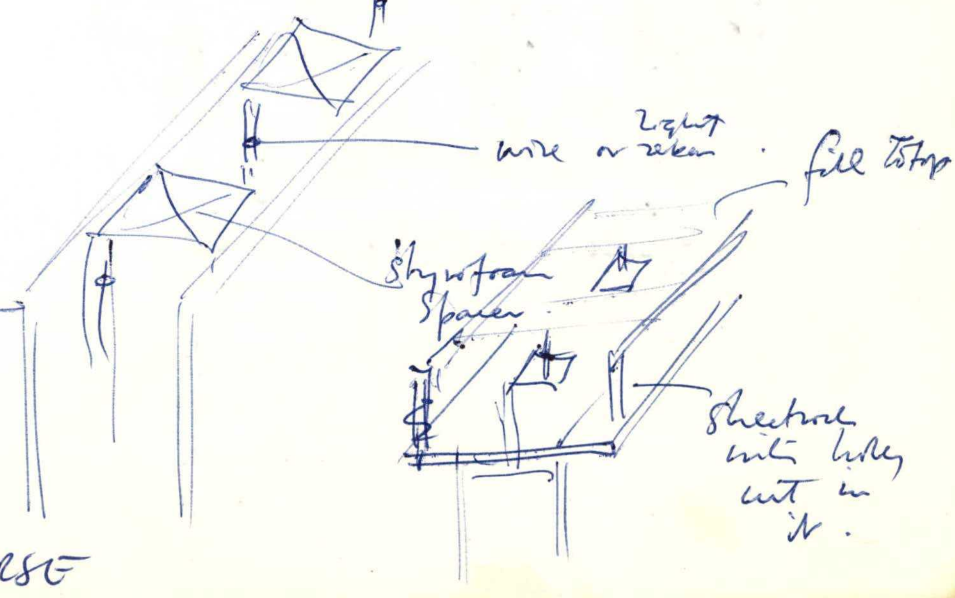
Balustrade needs a top, wide enough to sit on, comfortably.

~~It needs openings~~

On a hillside, it needs no more than about 15" of height, for comfortable sitting. On the edge of a roof~~x xxxx~~ terrace, it needs 40" by code, so becomes ~~x~~ a railing.

Build it up, from sheetrock formwork. Cheap. Easy to work. Bits of styrofoam for spacing between posts.



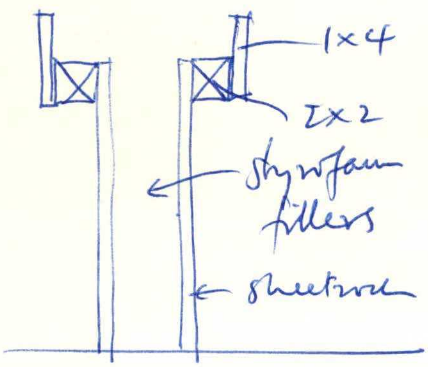


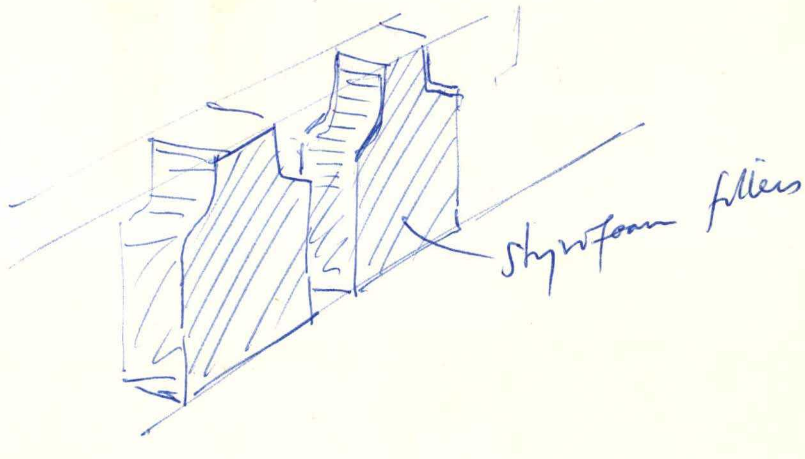
* SEE REVERSE

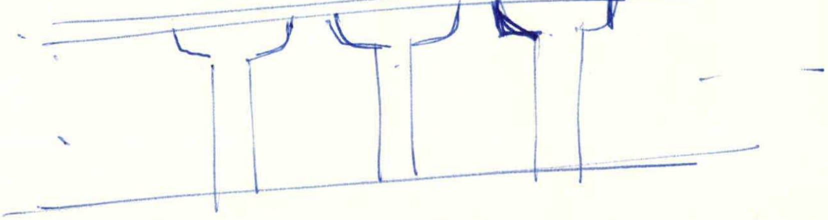
BALUSTRADE.

A simple balustrade, poured in one piece, with a top that is 7 inches wide, and 2 inches high, ~~the~~.

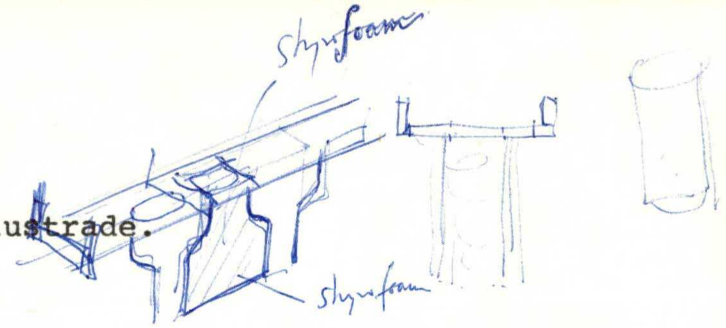
FORMWORK. The balusters are formed by styrfoam pieces, 3" thick, and shaped to form the voids between balusters. ~~On the~~ These styrfoam fillers are glued between two pieces of sheetrock. At the top outer edge of the sheetrock there is a 2x2, with a 1x4 nailed to it to form the outside of the channel that is the top of the baluster.







BALUSTRADES

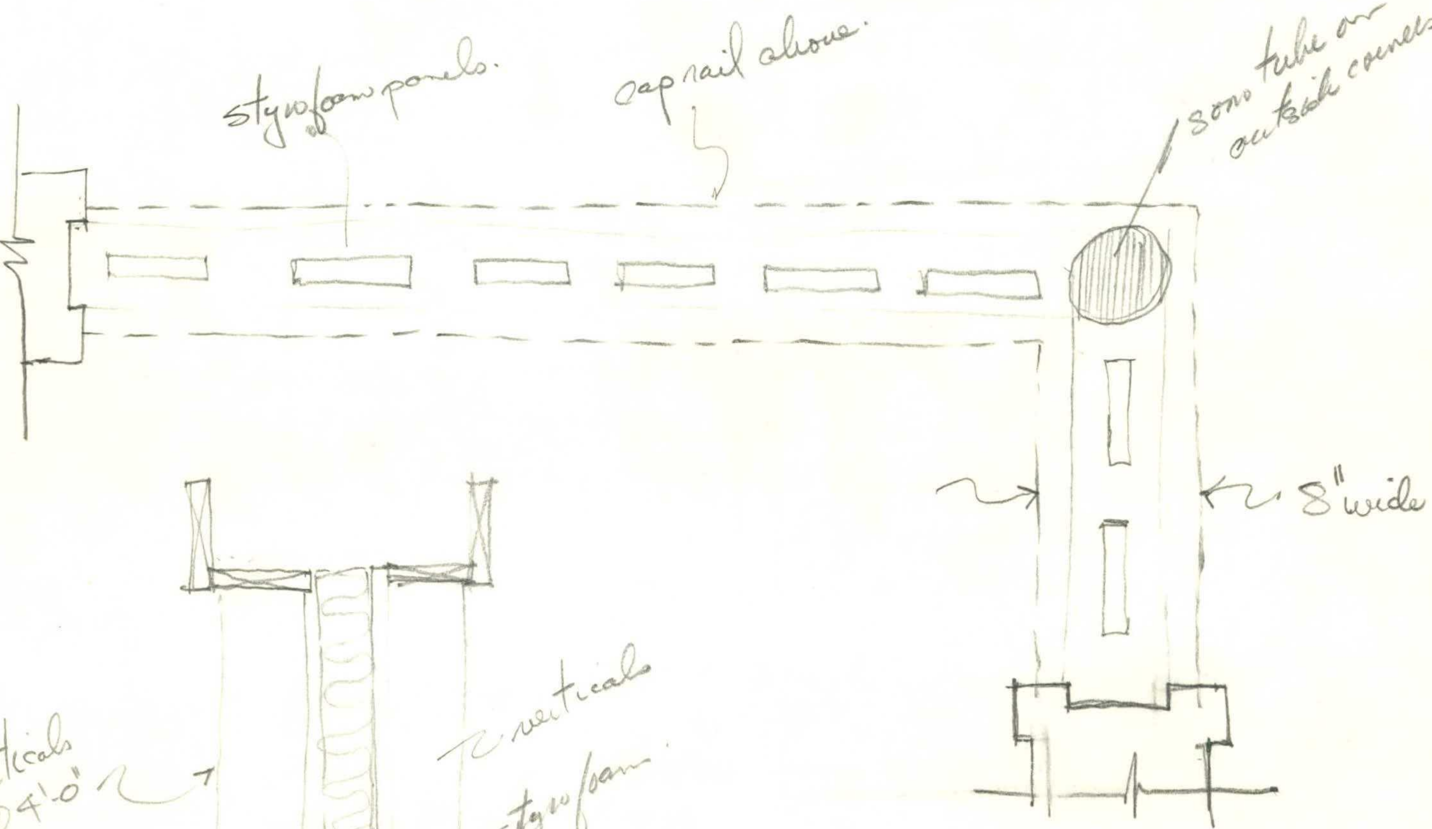


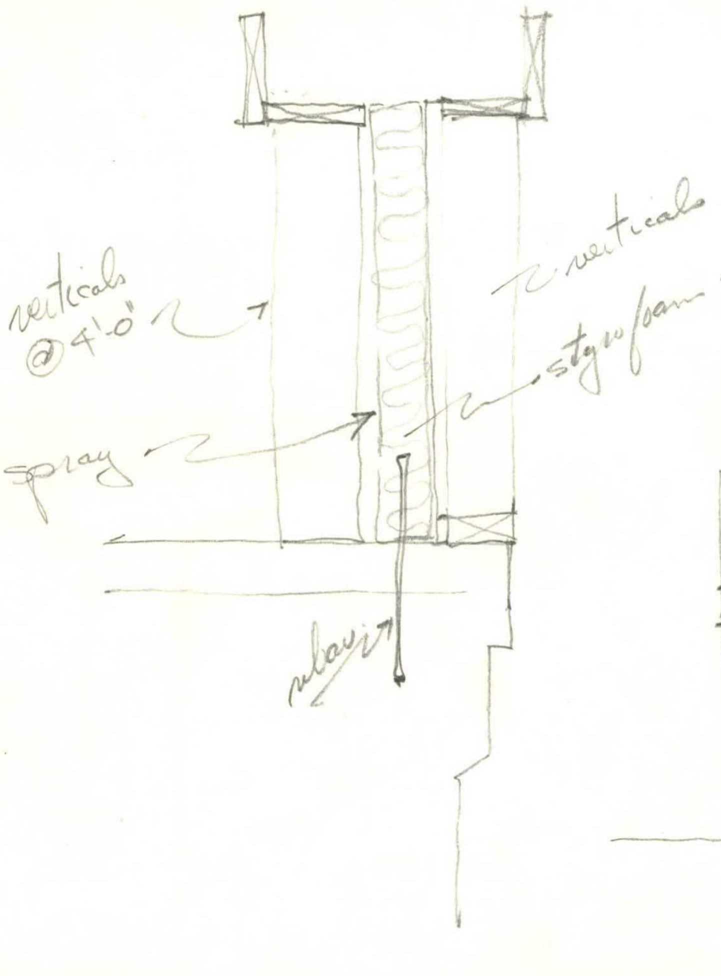
Costs per square foot of balustrade.

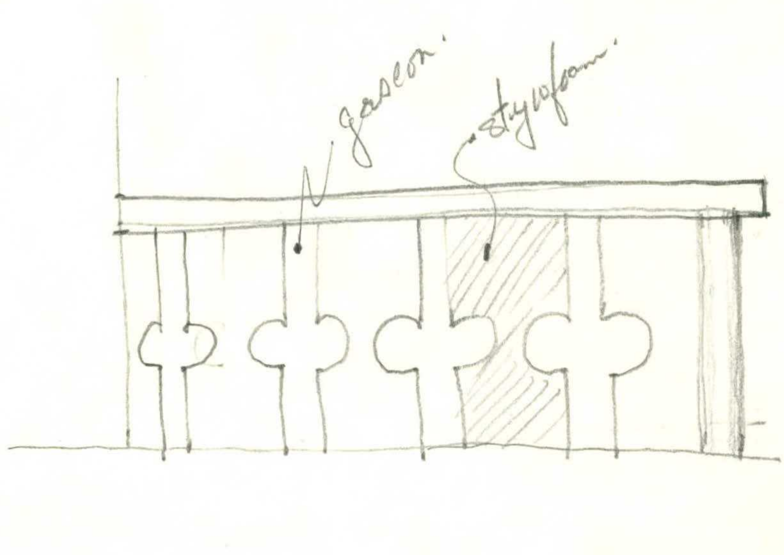
styrofoam	.20
sheetrock	.20
wood (1x4)	
3.4 lf.	.30
gascon	.40
labor	2.22
steel	.20
total	3.40

(five longitudinal pieces/3.5 feet high. and two studs at 3.5' centers.)

(labor assumes 8x16 balustrade, 84 ftsq., set up in one day 160.00, and one hour to strip forms after conc.)







BALUSTRADES

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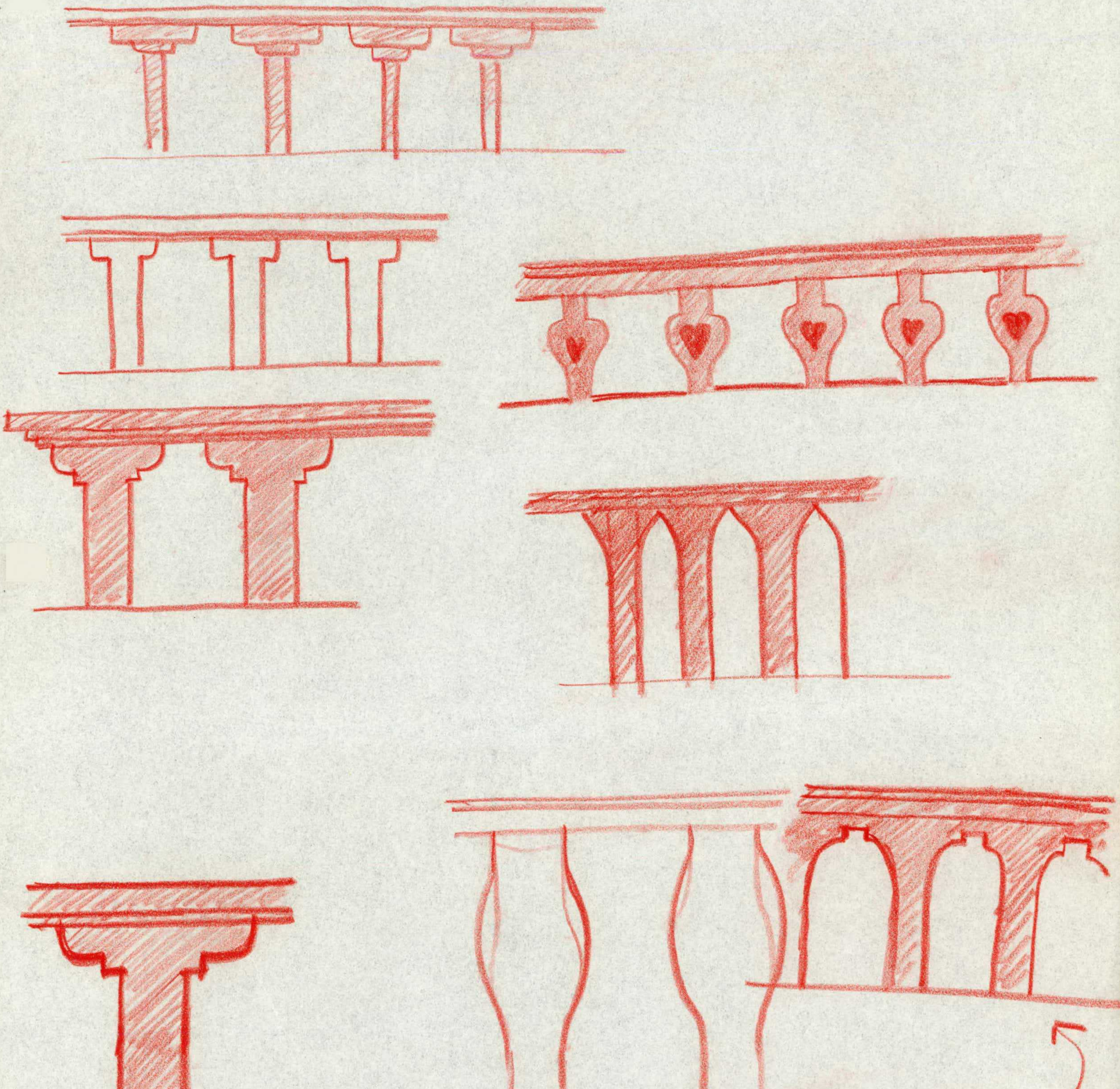

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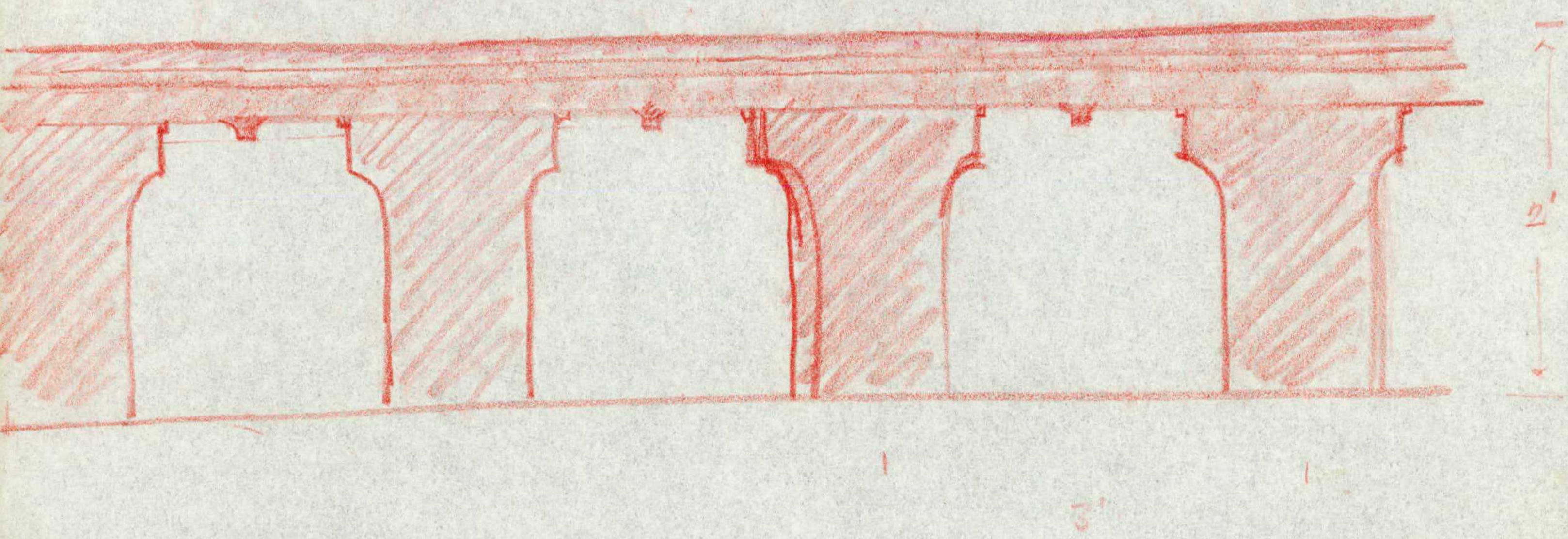

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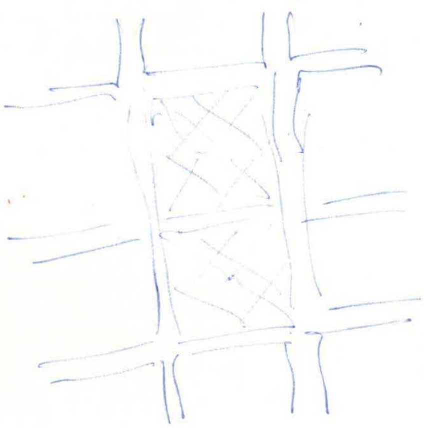
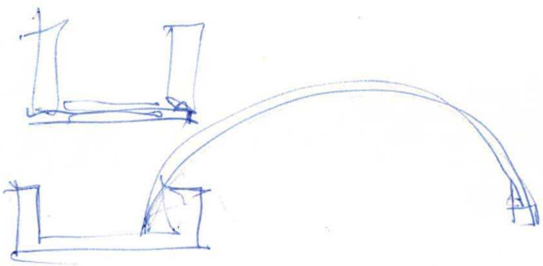
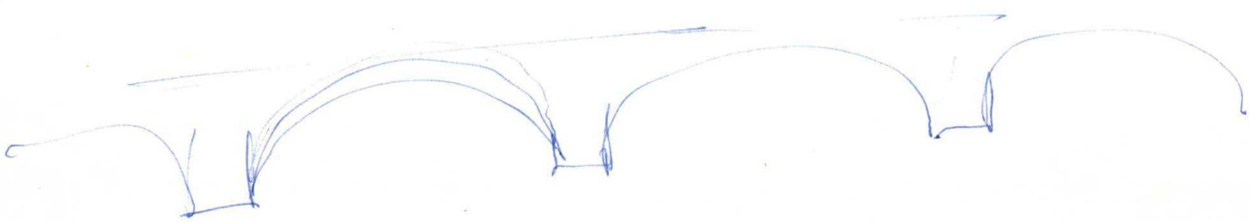
FLOORS

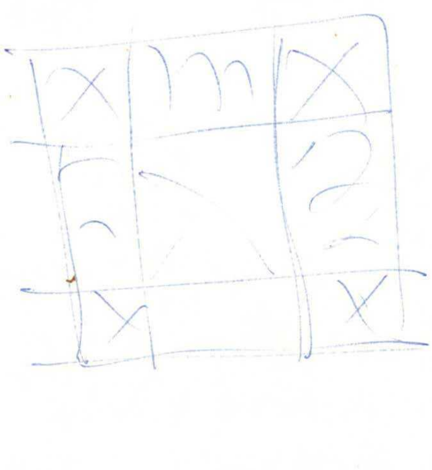
There are the following possibilities:

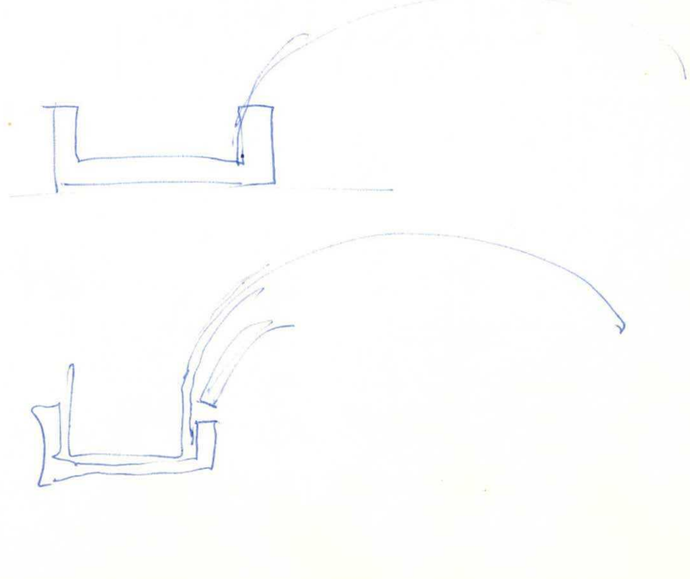
1. Vaults (two way) *with ribs + floor.*
2. Barrel vaults. *with ribs + floor*
3. Ribs, with minibarrels between them.
4. Beams in grid(waffle), with mini vaults between.











FLOORS(ANALYSIS OF TYPES).

What is hard to know, is which is the most beautiful, most satisfying ceiling, to complete a room. Vaults are beautiful, waffles are beautiful, joists or parallel beams arebeautif u l. Which makes sense, feels most right, in any given circumstance.

First: a room with a vault seems lower, more intimate. A room with a high ceiling, high windows, naturally needs a flat ceiling. Perhaps it would be natural to use flatter types on lower floors, and vaults upstairs.
In addition, the vaults make more sense under the roof, where shape corresponds to roof shape. The Flat type makes more sense if there is a floor above it - except perhaps in those cases where column loads or wall loads come down in the middle of the floor, where possibly the vault has more capacity to resist thrust.

In this case, the ceiling vault of the roof, would be a special shape, that corresponds to the real roof shape (more pyramidal), and less flat, less cylidrical).

FLOORS SURFACES

Floors are to be tongue and grooved planks, nailed over 3/4" thick battens, set in top surface of concrete.

We can, if nec, use softwood for floors (as is common in Europe).

Hardwood must cost at least $1/sf. Perhaps with softwood we can reduce this.

We can also use plastic tiles, set in mastic, over concrete, for baths and kitchens.

FLOOR TILES IN CONCRETE

This is a technique where we have a simple die, or stamp, and we press it repeatedly into a floor of wet concrete, making a tile like impression. When the top surface is then colored, green, or red, it makes a beautiful surface, with the design brought out in relief as dust and wax accumulate in the depressions.

See green tile floor in Architecture in Wood, p. 212

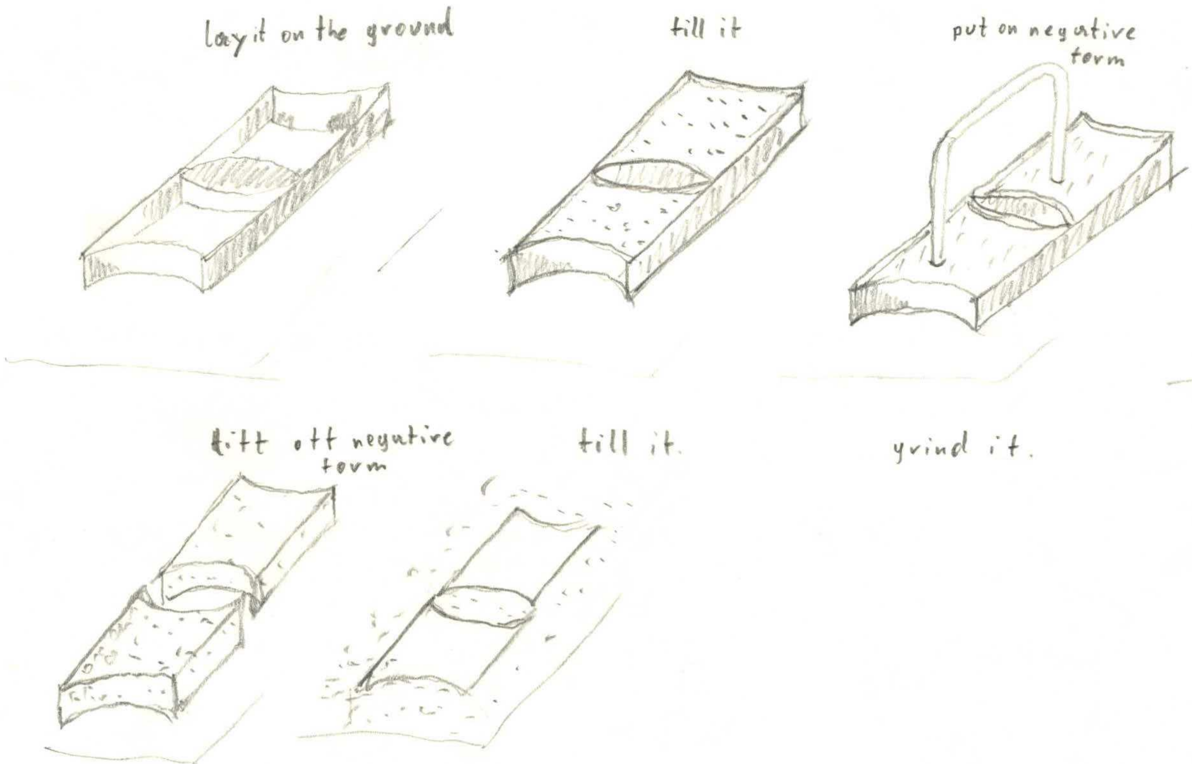
After the impress has been made, the whole must be brushed over with oil, or a light surface coat of cement wash, to make it smooth, and get rid of rough spots.

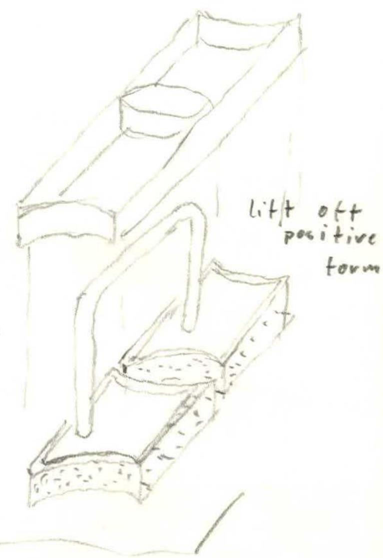
Mould is painted with silicon paint to make it completely slick, and prevent it sticking as mould is raised up from wet concrete.

CONTENTS

The basic idea

In principle you lay a form (lets call it the positive form) on ~~the~~ a concrete slab, fill it with with a marble-cement-water mix, take another form (the negative form), lift the positive form while the negative one presses the mix to the slab and at the end you take off the negative one. A couple of days later you fill the space in between the set up patterns with another mix (different colour). ~~When~~/ Again you wait for a couple of days, then you grind the floor and seal it. ~~This~~/ this simplified description of the process is shown in the fo-lowing drawings.



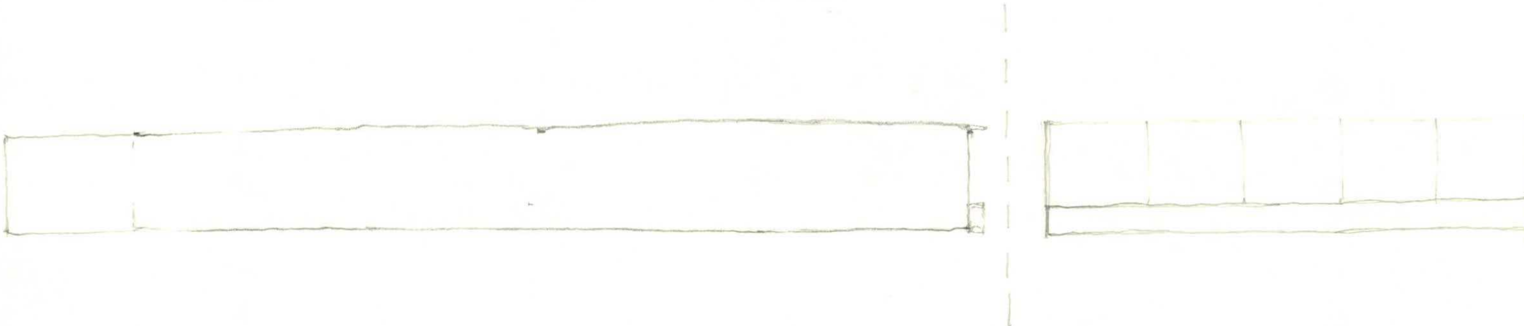


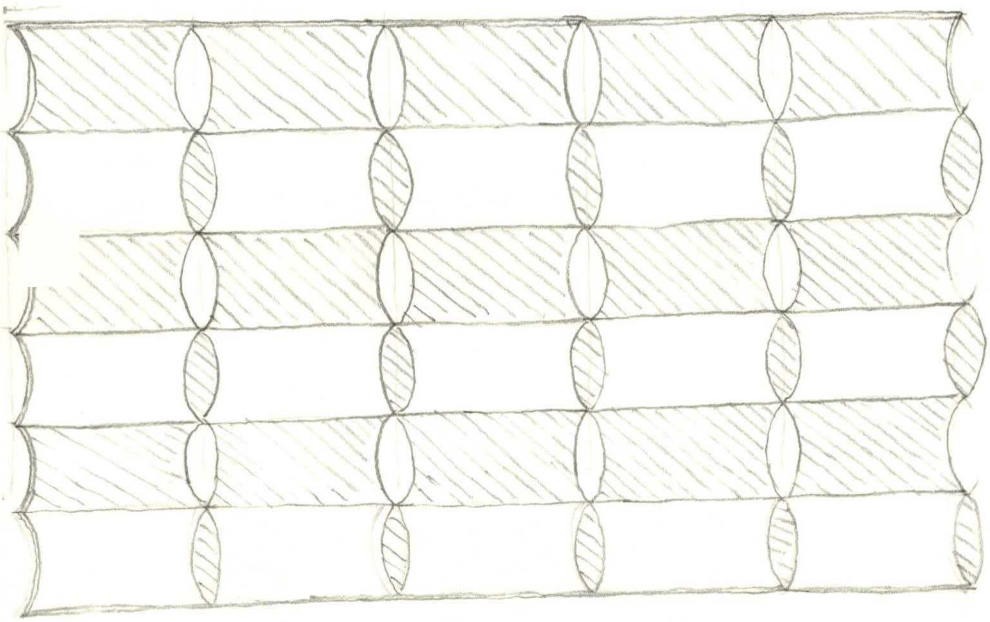
As you allready can see there are three main features involved in this process: the posive form, the negative form and the mix In the following pages I will deal with ~~e~~ the materials you need, with the production of these features and with the actual detailed process of producing a/~~marbel-ce~~/ patterned marbel-cement floor.

The positive form

The actual positive form includes, ~~because of~~ not only one but 30 patterns. (to speed up the production)

The final dimensions are 15"x~~8~~ 7 $^{1/2}$".





Materials you need to make the positive form

The form is made of sheetmetal. ~~This~~ the kind of sheetmetal we used ~~s~~ is available in every ~~heating~~ factory which makes cooling and heating systems. Its the "light galvaniced sheetmetal".

Most of these places ~~can~~ cut the various lengths you need.

..... 25 Linearfeet half inch wide light galvaniced sheetmetal

.... 4 Linearfeet 1 $^{1/2}$ inch wide light galvaniced sheetmetal

.... 5 Linerfeet 1 $^{1/2}$ --"--

Tools you need to make the positive Form

..... 1 gastorch its important to use a gastorch, because its flame is hot enough. DON'T even try to use an electric one.

..... 1 small bottle of liquid acid. DON'T use solderpaste.

..... one round wooden stick with a diameter of two inches.

..... 1 wooden board 2x12/36

..... 2" finish nails

.... Hammer

..... sheetmetal scissors

.... a lot of patients

Desciptions of the production of the form.

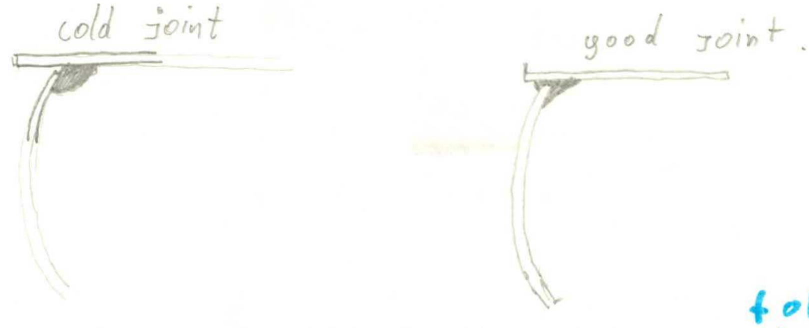
...... cut five strips of sheetmetal 15" long and 1/2 wide
cut two strips of sheetmetal 15" long and 1" wide

...... take some strips of the halfinch sheetmetal and cut them into 5" strips. Take these strips and bend them to a curve.
for bending you use the wooden stick with its two inch diameter.
You just take one of the five inch strips and bend it , by pressing it against the wooden stick.

.... you take two of the 15"x1/2" sheetmetalstrips and fix them by using nails to the wooden board. The distance between these two strips is 1 1/2". Under these two pieces you place a drawing of the finished form.. take one of the curfed pieces and mark the exact length. cut the curfed piece and fix it with nails on the wooden board at its exact place. (The place and the curve is identical as on the drawing which is already placed under the two metal strips. (How the nails should be placed to make the fixture stable is shown in the following drawing.)

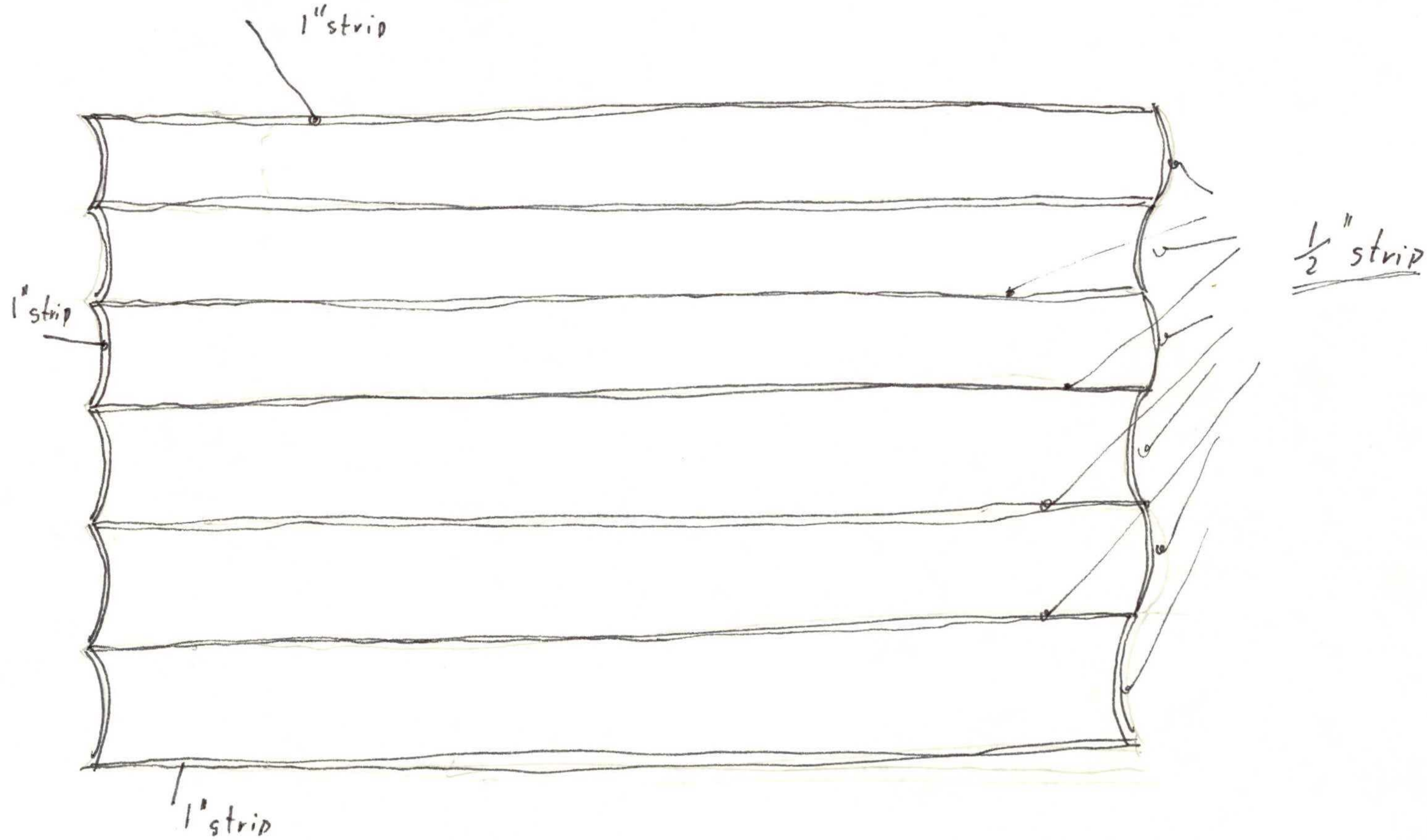
...... Now you start the first <u>solder process</u>. (It is important to take off the top piece of the ~~solder~~ torch, that means its much easier to work accuratly if you have an open flame.)

First you put some acid on the pieces you want to join togather. than you heat it up with the torch. This is the most important phase of the whole soldering operation, as only if your pieces are hot enough you can provide a hot joint. Its rather easy to ~~recognize~~ distinguish an cold joint (which is bad) and a good joint during the operation. ~~In a~~ If your pieces are not hot enouh the soldermaterial will tend to form small bubbles and its difficult to bring it into the right position, in a ~~oo~~ good joint however ~~you~~ the solder-material will start to get very liquid and stay even liquid, when you turn the flame away. The material tends to flow by itself into the right ~~o~~ position and make a solid joint.



..... After you made this first joint you ~~make~~ follow the same process on the other side, and make the exact same thing on the other end of the two sheetmetalstrips.

.....You have a piece of the following shape. 
Using the same nailingtechniqe as well as the soldering... you go on until you hace all the bounderies of the form fixed.
Its important to pay attention, that only on one side of the bounderies you use half inch strips,



...... In the next operation you fill in the rest of the curved pieces.

..... Now you have all thecurved pieces in and the ~~rough~~ fame is ready.

..... you lay the frame on the ~~piece~~ sheetmetalsheet and mark all the wholes which will be covered.Give every one of them a number and cut them. Probably the pieces will woarp during the process of cutting them. Its easy to bend them back, by lauing them on a flat surface and hammer on them until they are flat again.

..... Take the frame. fixx it with nails and put one piece into the whole you want to cover up. Solder it. At this operatoin you have to be very careful not to destroy the old solderjoints. Having covered up allthe holes you only have to solder the handles on and the form is finished

photgraph.

THE NEGATIVE FORM

Because of problems we had with our Prototipe of the negativeform I will not describe how to build the negative form in the way we did it, however I will give you a discription of a form which will solve the problems we had. The mainproblems were the followings cohesion, the expansion of the materials we used and the lack of durability

.....Buy ~~one square~~ half a square foot of 3/4" thick plastic

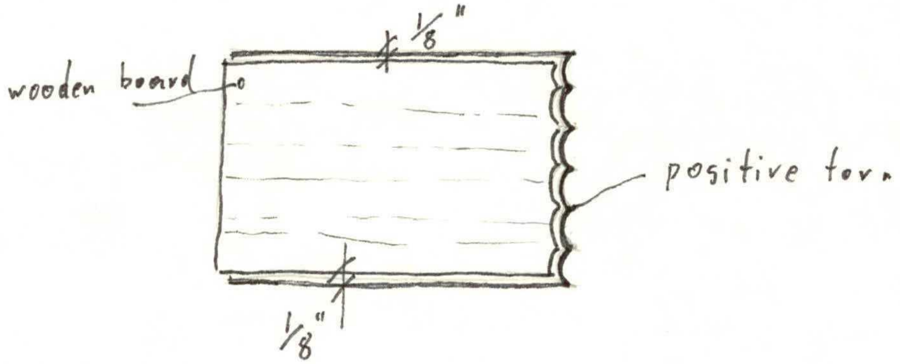
you can get it at................

..... Another possibility is to make this piece by yourself using glasfibres and liquid plastic You get this in......

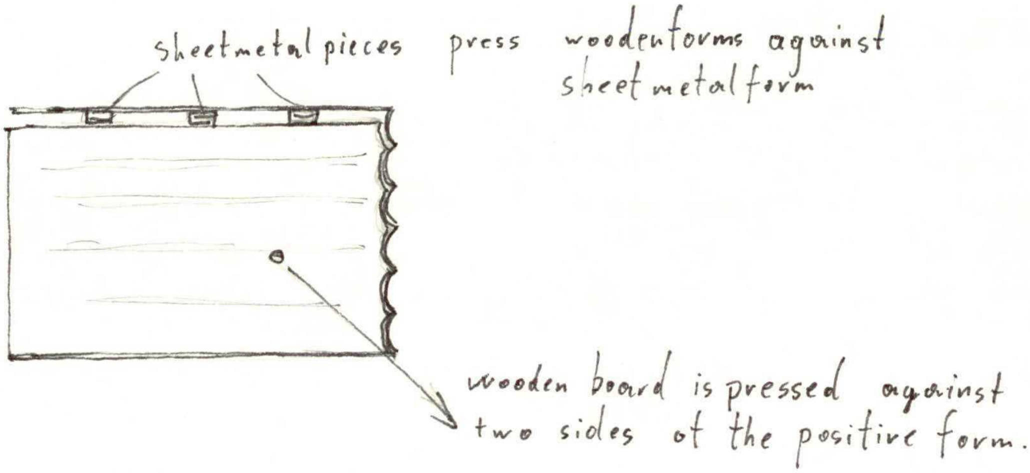
......Lay the positive form on this piece of Plastic and mark these holes which are not covered with sheetmetal. Mark them in a way that your marks are about one sixteens of an inch on the inside of the bounderies of the hole in the positiveform.

.... Cut these pieces with a tshigsaw.

.... Take a ~~piece of woo~~ wooden board 1"x8"/2' and cut it, so that it fits on top of the positive form.There should be a gap of 1/8" between the boundery of the positive form and the wooden board.



.... Lay the two forms down, so that the positive form is laying on top of the wodden board. The wooden board should be fixed in a way, that there is øn/twø/sidøs no space in between the board and the positive form.



.....Now flip thiș flip the ŧ the two forms over. Take care, that none of the sheetmetalstrips gets lose. Another thing you have to take care of is; in this upside down position its very impotant that the flat side of the woodn form presses against the sheetmetalform. In order to do so its the best to put some short woodn pieces under the woonдn form to block it.

DRAWING

.....As shown in the drawing above what you have at this stage in front of you is the upside down sheetmetalform-whørø/yøu /////cạn/sęę/thę with its pattern. Half of the pattern are open and you see the wood , the other half is closed with sheetmetal. ~~At this stage you leave the two forms and go on working on with the~~ plastic.

..... Náow you take the plastic pieces, you already cut

at the beginning of this operation. first try to fit them all in the flipped over forms. Make sure theat there is about one ~~sixtent~~ sixteens to one eights of an inch play between the sheetmetalform and the plastic pieces.

..... If neccercary cut the pieces which are to big , mark the pices and take them out.

......Use ~~so~~ the best available glue for plastic-wood connections (..........) and glue all the pieces to the woodn part of the negative form.

..... ~~Take another~~

In this operation its very important that the plastic pieces are gliued oin in there right position.(seedrawing)

to make sure that there is enough prsuree during the glue dries you can put some books or other heavy objects on the plastic pieses.

...... after everything is glued together, you take a small drill (1/16") and drill a couple of holes throug ~~each p~~ every plastic piece. (to prevent cohesion)

...... put some handles on the negative form. the best way to do this is to buy two of these handles you can screw into th- w-od.

The mix

T.he.mix is one of the most cruicial part using this techniqe
If it is too wet it stiks to the negative form ~~and/≠/~~ or loses its shape. If it is too dry its very hard to work, to get it into the form.

......Cement for white and light colourmixes :white portland cement
for black and dark colours regular grey portland --"--

.......=~~The-materials-you-use~~ marbledust prferable with an sive#8

For couloring the cement use regular cement colours
All this idoms specified above you get in a concret material suppy shop as Rhodes Jamason in Berkeley.

The bets formula for the mix is 1:2:3.5) (water :cement:marbledust)

Colouring Its nearly impossible to tell any colour from the wet mix. Therefore I suggest, that whenever you are ~~worki/~~ trying to find the right colour for your terrazzo make some little samples write down the amount of the different colours you ~~nd~~ added into the different sam ples and let it dry for some time.

The operation

In our case the first thing we did was to pour a regular concret slab. We waited until this slab was completely dry.

1) Before you lay down the ~~negative/~~ positve form its necessary to wet the slab. after this is done you take a little bit of ~~cemrn/~~ cement and take it on the ~~moist/~~ slightly wet slab. Its important that the slab is not too wet, otherwise the black mix would get to wet ~~and/not/stay/in~~

2) you lay down the positive form

3) fill it with the black mix. to fill the edges its often ~~neccer~~ necerssary to use your fingers.

4) T-y to clean the form from the leftover mix as good as possible. at this stage you should have the form where all corners are filled and wher the edge of the black mix ~~is~~ has roughly ~~in~~ the same level as the form.

5) than take the negative form,and press it on the the mix as hard as possible, try to make the mix as dense as possible. Befor you take off the positive form, its very important to lift the negative one for a short time, to minimice cohesion.

6) while pressing down the negative form lift ~~oo~~off the positive. This is the most tricky part of the whole operation,becaus on the one side you must not press the negative one down too hard, because of the resulting cohesion, on the other hand its very important to press hrd enough, , because otherwise you would lift up all the ptterns.

7) repeat all this six steps untill the entire slab is finished

2 days

8) Wait for about ~~30 hours~~ befor you start pouring the white mix in between the black patterns. the white mix should cover the black patterns slighly.

2 day

9) Wait again for ~~30 hour~~- . Grind the terazzo until all the patterns appear in their proper form.

1)) seal the terazzo with at least two layers of Terazzo sealer.

~~Note for the materials we used in this~~ process.

Mixes as described above

Grinder Rockwell which one we used for small areas.

Terazzosealer Universal protecting cotings

Acrtl IC Seall

UK-1206

~~Notes concerning thProcess of grinding~~

~~In our experiment we used the Rockwell~~
~~It is important to know that it is an extremly unpleasant work if its done in the usual way, that means, that you are grinding on a dry surface. To overcome this unpleasant work it is possible to drop some water on the surface~~
~~ATTENTION if you are adding water to the surface take care that you don't get an electric shock.~~
~~In the futre it would be necerssary to work with a grinder wich is also used to grind woodn floors.~~

Grinding

For our little Experiment we used a Rockwell...

Its very good for small areas, for large areas however

a big concrete grinder if possible with side guides is reccommended.

Gribding usually is an extremly unpleasant work. you can over come ~~this/prob/~~ the problem of dust, by dripping water on the floor. Attention. It solves the dust problem, but ~~creates/~~ it might create electrical ones.

Sealing

We used a regular Terazzosealer, avaliable in Paintstores

(Universal protectingcoatings Acrtl IC Seal UK-1206)

.... Be very careful that the surface of the terrazzo is absolutly clean and dry.

.... The shine and durability of the floor depends on how many coats you use. The best result are with 3 coats buts its already o.k. after two.

.... If the sealer leaves funny bubbles or is very unregular after the first coat its neccerssary to sand it just a little bit.

.... After two days the sealer should be completley dry and the floor is ready to use.

Process of dessicionmaking

Before you start making your terrazzofloor, you have to become clear what kind of pattern, or which combination of patterns you want to have on your floor, Is it only a simple boundary near the edge of the room witkh some kind of ornament in it, is the whole floor covered with patterns,is there only a boundary with some kind of ornament in the middle of the room, or is it a combination of patterns ~~bounda-~~ boundaries ornamentslike a persian prayer rug, and wht colours should you use

the decicions about all these questions can be quite difficult in various cases.

The follwing is a description of a decicion making process, which should help you to find the right solution

Which technique to use

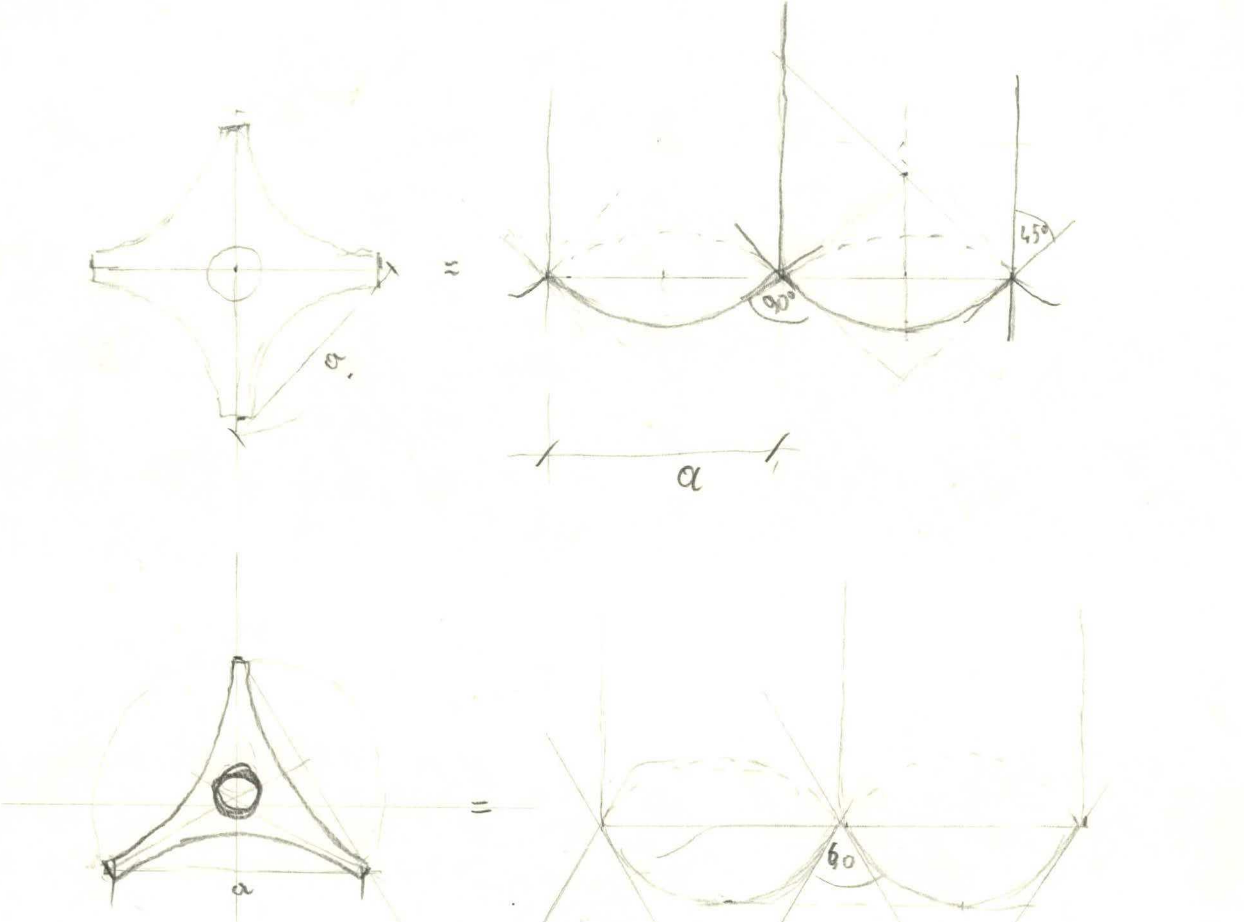
The ~~technique~~ which technique you want to use is the first decission step in determining which kind of pattern youcan have. Thats because the potential ability of the two different techniques is quite different. (The same is true for their deeper quality) To make this easier to understand what kind of decission you actually are making by choosing between these two different techniques a description of their potential abilities and of ~~the/qualities~~ their potential qualities.

The foam technique.

For patterns with straight lines its very fast and easy to make. This is valid for little as well as for large floor areas.

For patterns with simple curves for a large floor area. Obviously the difficulty with ~~simple~~ curve- is how can you cut a huge amount of foampatterns in a time, compareable with the straight lined patterns. Sometimes its possible to invent a little machine wich allows you tou cut a large number in a comparable time as the straightlined patterns. The following is an outline how , and with which kind of little machine you could produce a ~~li~~ floor with simple curved patterns.

360 : 3 = 120



The basic Idea

The basic Idea of this method is: You glue starafoam to the slab, then you fill the space between the glued pieces, wait until the mix is cured, take the foam out (in one way or other, and fill the space in between the already existent concrete patterns, wait until its cured grind and seal it.

The foam patterns

With this technique its very convinient to make pattern, where only straigt lines occure.You can produce a high number of ~~pa~~ pieces in a very short amount of time. If you have a tablesaw availablethats the best, if your skillsaw hasthe capacity of being fixable to a little table, and the floor area is qouite large you should screw it to the table (as shown below)

still its easy and fast enouh to use a skillsa in the regular way.

~~After-you-have~~

After you have made up your mind about the patterns, and you have a large number of similr pieces (squares, triangulars, diamonds.....) draw this patterns on one of ~~y~~ the insulationsheets.

put this piece on top of a couple of other sheets and saw them into strips first and then into the pieces. At this operation a table saw or a fixed skillsaw is very convinient, because you can use a tshigg, ((

Materials

...... either, starafoam or polyeturen insulation material sheets. (half inch)
(
(allthoug starafoam works better if you have a large area, its easier to ~~reme~~ remove it, you should try to get the cheapest available insulation material which is usually polyathuren-Porozell)

...... Glue. you can use any kind of glue as long as ~~its not a~~ it does not eat the insulation . regular white glue.....

.... Cement. for light colours and white use white portland cement for dark colours and black you can use the cheaper regular portlandcement

.........Marbledust. The marbledust shoul have a sive betweeen an 8 and a sixteenth ~~sive~~.(divisions per inch.

.........Colours Use regular ~~e~~ concret colours. ~~Ayy~~- Attention: the colour of the wet mix is not neccerssarly the same as of the cured concrete.

.... Tools If you have a large area~~e~~ (over 50 squarefeet you should have a mixer otherwise its quite possible to mix it in a large pocket.)

a trowel medium size, a large puddiknive, a grinder(size depends on the area, but you always should have a little one, we used the Rockwell.....)

a brush, a Sander(~~i~~ for a small area a drill or even regular sandpaper is enough) Sandpaper #,

~~Sealer~~-

.... Sealer we used an acrylsealer Universal rotecting coatings Actrl IC seal Uk-1206

.... a Saw. prefereable a skillsaw with a fine blade

.... for difficult patterns you can use a tshiggsaw or even a pair of sissors.

Now you have enouh pieces to start. If its an easy pattern just take piece by piece and ~~lay-it-on-the-ground-~~ put some glue on one side of the piece and ~~pu lay-it-on-the-floor,-~~ glue it on the floor.

After the whole floor is finished, wait until the pieces really stick to the floor as soon as that happens, you can start filling the spae in between the foampieces. ~~Always-u-~~

You really should be careful to fo fill these spaces completely, and not higher than the ~~star~~ foampieces. The best way to do this is totake some of the mix put it into the hole and dense it with your puddiknif, eesspecially on the edges and in tight corners. After you have done this for about one square fot take a piece of wood (with a straight edge and screed it to the level of the foam.

Beffore you start filling it , lay a piece of plywood on the floor , to make sure that you dont damage the foampieces.

After the whole slab is finished let it cure for about two days. during the curing process, you shoul make sure that the slab is always wet , to help the curing process

After two days yo take the foampieces out, either by hand, with the puddiknife and the pieces which stick too good to the concret you can just burn out with a gas t torch.

Immedeatly after this you can fiil the space in between the existing patterns with the mix which has the lighter colour. Again use ~~a~~ some sheets of plywood or some woodn boards to move around not to destroy the pattrens. You fill it in the same ~~carf~~ careful way as you did in the first time, and screed it to the level of the existig pattern.

After two days curing you grind ito a smooth surface. For a large area use a heafy ~~du~~ duty concret grinder, for the small ones the Rockwell.....

Clean it, if possible vacume it ad put two coats of sealer on it.

S66

~~Finishing steps or~~

Paterned Terrazzo steps and similar ca es

Build you form of the steps and ~~put~~ [place] the reenforcement

Make your terrazzomix and put it on the edges of the form

W

Wait for abou ~~two-hours~~ half an hour an fill the steps with regolar concretleve about one inch at the top Again after about half an houryou fill this leftover inch with Terrazzomix.

Immideatly after you did this you work strips of foam into the terazzo, and put some weight on it , that i does not start to float.

After two days you can start with the same percidure as described in the previous chapter.

To make the pattern shown on the drawing below you need

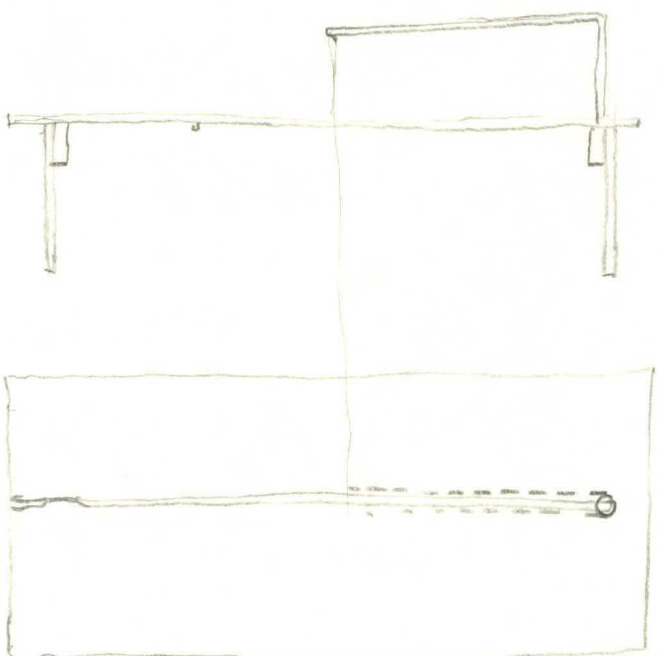
a...... hot wire foamcutter

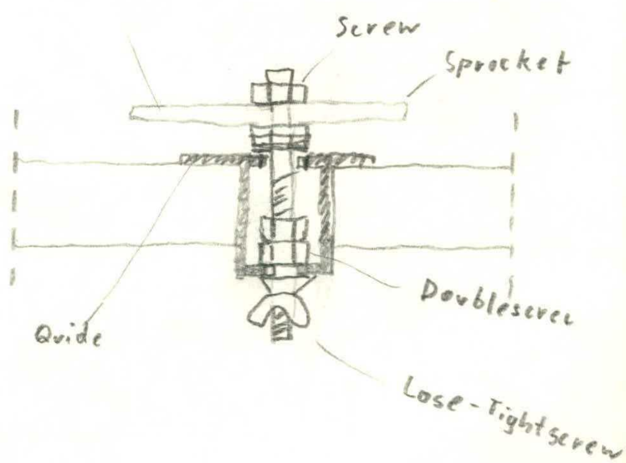
.... sprocket

...... attachment ~~of the~~ for the sprocket on the plate of
the hot wire cutter

The sprocket itself is the critical part in ~~speciffing the--~~ defining the radius of the curve and in defining the angle in which the curve meets the straigt edge of the piece

The attachment ~~has~~ has to be flexible and in a right angle to the direction in which the foam is moved in order to be cut. One Idea how that could be done is shown below.





You mo fix the sprocket in position].take about Jo sheets of foam. put a stick on each end throug them (to hold them together,) and cut them. You should be very carefully, that the sprocket i is always turning in the rightway, so that you get an absolut(?) regular line.

Then tou fix the sprocket in position 2 and make/the cut it again and so on. The only thing you really have to take care of is the line up of the different cuts

Now you have different strips and already all the littlepieces, the strips you cut with either again the hot wire,or ,what is faster with a powersa (fixed skill or thiggsaw,tablesaw...)

SITE EARTHWORK (includes: terrace, below terrace, & above building)

	Mat.	Labor
1. Design grading.		10 hrs.
2. Backhoe rough earth moving.	gilley	5 hrs @ 35.00
3. Finish work (pick and shovel).		16 hrs.
		260
		175

$435.00

DRAINAGE PIPES

	Mat.	Labor.
1. Design ~~dxadx~~ drains.		35.00
2. Dig trenches. *Rough & Finish*		3 hr.
3. Cut PVC drain pipes and lay in trenches.	80' pipe 56.00	4 hr. (items 3–4)
4. Attach pipes at joints and seal.	4.00	
5. Level pipes according to drain fall.		3 hr. (items 5–6)
6. Pack earth around pipes to secure the position and levels.		
7. Backfill trenches with gravel.	15.00	8 hr.
	75.00	215.

8. ??????? *(not sure if correct method)*

290.00