A CONTEMPORARY RESORT HOTEL OF REINFORCED CONCRETE

Thesis for the Degree of B. S.

MICHIGAN STATE COLLEGE

T. R. Heineman

1949

THESIS

A CONTEMPORARY RESORT HOTEL

OF

REINFORCED CONCRETE

A Thesis Submitted

to

The Faculty of

MICHIGAN STATE COLLEGE

of

Agriculture and Applied Science

by

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Candidate for the Degree

of

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INTRODUCTION

The purpose of a senior thesis is for the student to actually design a structure, or study and analyze a situation. In this way he can apply to an actual condition the theory and engineering know-how he is assumed to have absorbed in the four year engineering curriculum of this institution.

Designing a reinforced concrete resort hotel would be a full time job for several engineers, and would certainly take several months at least. In designing this structure, I shall only compute the size of the concrete portions and the necessary steel and placing of same. There will be an architects conception of the completed structure. The specifications will be only ideas of what I would insist upon should the building ever be constructed.

The plumbing, heating, ventilating, arrangement of rooms, electrical wiring and design, interior decoration, landscaping of the building and grounds, and other detail items will have to be planned later.

Needless to say I have spent many hours planning these extra items necessary to the ultimate function and architectural appeal of the structure. Time, however, does not permit their inclusion in this paper at the present time.

LOCATION

The theoretical location of this resort hotel is on the northwest tip of Charity Island. This island is in the State of Michigan in Saginaw Bay, actually a part of Lake Huron. The approximate position of the island is:

44° 02' North Latitude

83° 26' West Longitude

There are actually two pieces of land above the level of the lake. However, the smaller area (known as Little Charity) is only about one eighth of a square mile. It is directly south of the main island. The larger piece of land is approximately one mile long and one half mile wide, a total area of just one half square mile.

The closest towns are Au Gres, Michigan, nine miles due west, and Caseville, Michigan, nine miles southeast. At present the property is uninhabited. Occasional fishing and siteseeing parties are the only visitors.

At one time the U.S. Government maintained a litehouse for navigational purposes in the Saginaw Bay area. This has been discontinued years ago, but the litehouse and the keeper's home are still standing on the northern tip of the island.

The present owner is a Mr. Robert Gillingham of Caseville, Michigan. Whether the property would be sold, or what the price would be I don't know. This is a theoretical problem designed for an actual location.

CHARACTERISTICS OF THE ISLAND

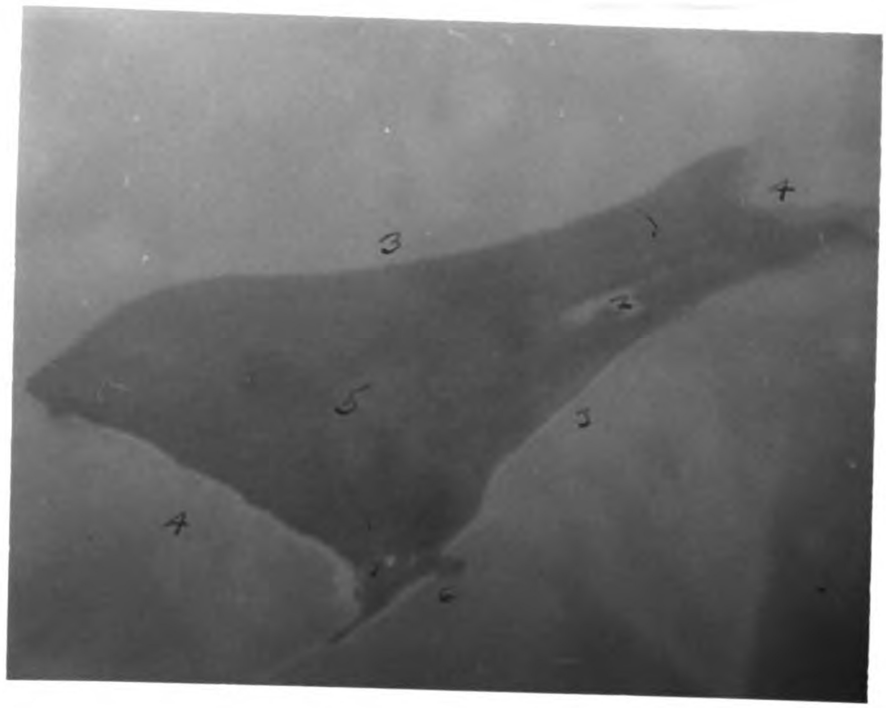
AGGREGATES: Practically an unlimited supply of natural material for concrete work is found on and around the island. The materials would have to be quarried and graded, naturally. There are outcroppings of solid limestone layers of rock. This natural stone can be used instead of bricks and blocks for finished walls and fireplaces.

AREA: To my knowledge, no survey of the island has been made. I would estimate the area to be from one-half to three-quarters of a square mile. A rough description of the general shape would be that of an extremely uneven five pointed star.

ELEVATION: The highest point is less than thirty feet above the level of the lake. The elevations are determined by the formations of gently rising sand dunes. On the southwest side of the island is a very small lake of slightly higher elevation than the surrounding body of water. This fits nicely into the plans for additional improvements for the property. The depth of water surrounding the property varies from six to fifteen feet. There are many large rocks to be avoided, and a large reef one-half mile northeast.

SOIL CONDITIONS: As previously stated, the island is an outcropping of limestone covered with sand dunes, upon which there is an abundance of vegetation; mostly oak and pine trees.

WATER SUPPLY: The water from the surrounding lake could be safely used for drinking and other purposes.



VIEW LOOKING SOUTH

1. LOCATION OF PROPOSED STRUCTURE.
2. INLAND LAKE
3. SANDY BEACHES
4. ROCKY SHORE
5. WOODED AREA
6. BOAT LANDING

VIEW LOOKING NORTH

THE STRUCTURE IS THE ABANDONED LIGHTHOUSE TOWER AND KEEPER'S HOME. THIS IS THE APPROXIMATE POSITION OF THE PROPOSED BUILDING.

ADVANTAGES of the LOCATION

Building a resort on an island previously uninhabited and easily accessable from population centers would insure a maximum of privacy and seclusion. It would also call for an excessive amount of extra development and engineering projects.

In the case of CHARITY ISLAND, transportation would prove to be rather uncomfortable unless the island had an airstrip. A nine mile ride over open water could prove to be quite discouraging to possible clients. With the proper type of boat, the trip by water could be fast, dry, and comfortable. Guests from Detroit and that vicinity could be flown to the island in less than one hour.

The island is ideal for a summer resort. In the clear waters of that area are some of the biggest and scrappiest fish in the Great Lakes. Swimming is wonderful, and there are wide, sandy beaches all around the island. The northwest tip has a small harbor that with some improvement could handle several large yachts. Bridle paths would prove to be scenic and enjoyable.

The hotel would have complete facilities for games such as shuffleboard, billiards, and others. Dancing, lounging, sunbathing areas, and bars are also included in the plans. The entire resort would prove to be an attraction for airmen and yachtsmen passing nearby.

In this particular climate, all resorts tend to be one seasonal. In our case, the season would be from May until October. The only use for the resort during the winter months would be as a rest haven for those who desire seclusion. Ice fishing is becoming more popular every year, and this could prove to be a major factor in an all-season resort.

NOTATIONS on the STRUCTURE

TOWER: The T tower has several purposes other than architectural design. In the upper portion will be a water tank as a part of the water system of the hotel. The square portion also will house an elevator shaft. The longer and narrower portion of the tower will contain the stairways and small rest room on each floor. At the top of the column will be a glassed in observation tower, a beacon, and radio and television antennae. Any excess space will be used as storage.

CONCRETE: Air entrained concrete shall be used for all portions as it has excellent weathering properties. A cement dispersing agent such as Pozzolith shall also be used thruout. Aggregates from the island will be found suitable for all mixes. All bathrooms and borders of other areas shall be of Terrazo. Various architectural designs can be used as the forms are constructed previous to pouring concrete.

OUTER WALLS: Natural stone as found on the island will prove suitable for the first floor, fireplaces, and other parts of walls where the design calls for a masonry wall. However, for the outer wall of the second floor no provision has been made for the load of a masonry wall between columns. Therefore, I have planned on a sheet aluminum insulated wall of a light weight for this part of the structure.

ARRANGEMENT OF ROOMS AND FLOORS: The main floor will contain an open recreational area, aclosed lounging and game room with three sides of glass. The dining area shall also have three glass walls and will overlook the open water. The center portion will contain the lobby, stairway, manager's office, and kitchen. If the water table of the island permits, a utility room will be the only semblance to a basement area.

The second floor shall contain four suites, two at each end of the building. In addition, there will be many rooms, bathrooms, and two dormitories. The manager's suite is deck #5. The remainder of the third floor is to be an open dance floor and sunbathing deck. Movies can be projected on the square portion of the T tower and viewed by guests fron the sundeck area. A bar for drinking takes up deck #3. Deck #2 could be a bridal suite if the ceiling from the bar is completely soundproofed. The elevator ends at the bar deck.

GENERAL DESIGN: This thesis covers only the very basic plans of the total idea. In computing size of members I have allowed for an additional floor to be added later. The columns are oversize, but in the flat slab and cap type of structure has a particularly good resistance to wind and other twisting forces. The overall size is 30' x 150', and the tower is 60' tall. There will be suspended ceilings to allow for plumbing and electrical conduit. Rooms and ceiling shall be soundproofed. A chimney can be run thru the center of "D" columns to accomodate a fireplace and the fumes from the oil heating unit. Heating will be of the radiant floor panel type.

ADDITIONAL PROJECTS

AIR STRIP: An airstrip of 4000' could be easily constructed across the island. It is really a neccessity. It would have to be suitable for aircraft such as the standard small airliners as the DC-3. Prevailing winds would be the factor in its plans.

SWIMMING POOL: For days when lake swimming may be uncomfortable, a pool should be available. It would be located so as to be sheltered from winds, but still be in the sun most of the day.

GAME AND PLAYGROUND FACILITIES: Tennis courts, shuffleboard, bridle paths, beach areas, etc. would be constructed or developed. As this is primarily a resort, these facilities must be fully developed after careful planning.

UTILITIES: An adequate and safe water supply is the number one item. A sewage disposal system is also important. On an island, a method of communication is necessary. Electrical power must be provided, and must be exceptionally reliable.

Water could be obtained from the lake, and with very little treatment be safe for all uses. The best deal for sewage might be to study the water currents near the island, and then pipe the material out from the island far enough so it would be carried out to the open lake and not be swept back to the beaches. A large septic tank would be another solution.

YACHT BASIN AND BOAT DOCK: A protected landing must be provided for the craft that visit the island. The lake that is on the island could be deepened and a channel cut to the open water. The material removed in this process would be used as aggregate for construction of the hotel.

Standards for Reinforced Concrete Design

(:: - equals)

$f'c$ :: 2500 psi, concrete with a 28 day strength of 2500# shall be the standard throughout this problem.

fs :: 20,000 psi, maximum stress for steel

n :: $\frac{Es}{Ec}$ :: 12 , design factor

fc :: 1125 psi :: .45$f'c$ Compressive load

.25$f'c$ :: 625 psi, maximum compressive load for columns

T :: $.026L\sqrt[3]{\frac{2500}{f'c}}$, in this case :: .026L

v :: .03$f'c$ :: 75 psi, maximum shearing stress

d :: $\sqrt{\frac{M}{Kb}}$, effective depth of slab

As :: $\frac{M}{fs\ jd}$, area of steel to be placed in concrete

M :: $k\ w\ S^2$, moment calculations for continuous slabs

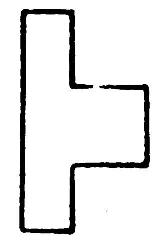
j :: 7/8, design factor

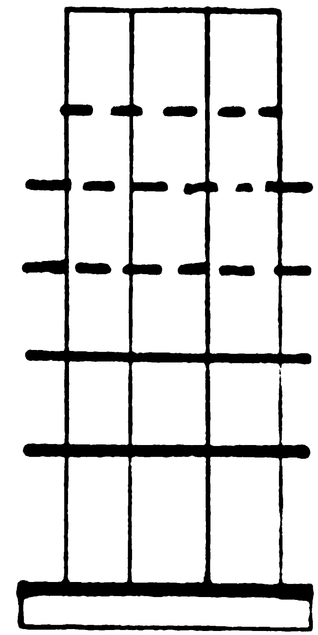
v :: $\frac{V}{bjd}$, computation for unit shearing stress

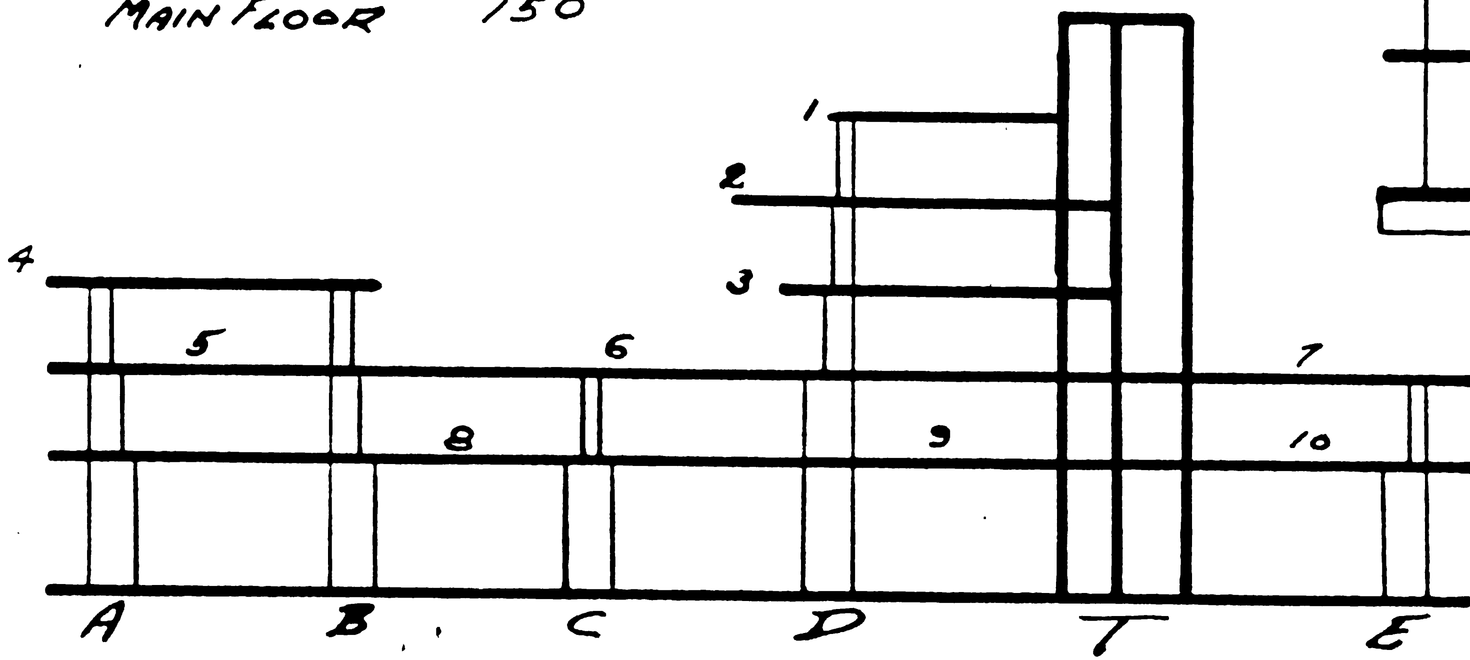
u :: $\frac{V}{\Sigma O\ jd}$, bond stress

Other formulas used were found in Joint Committee Specifications

No.	Loading
1	30 #/FT²
2	40
3	120
4	30
5	40
6	120
7	120
8	40
9	40
10	40
Main Floor	150

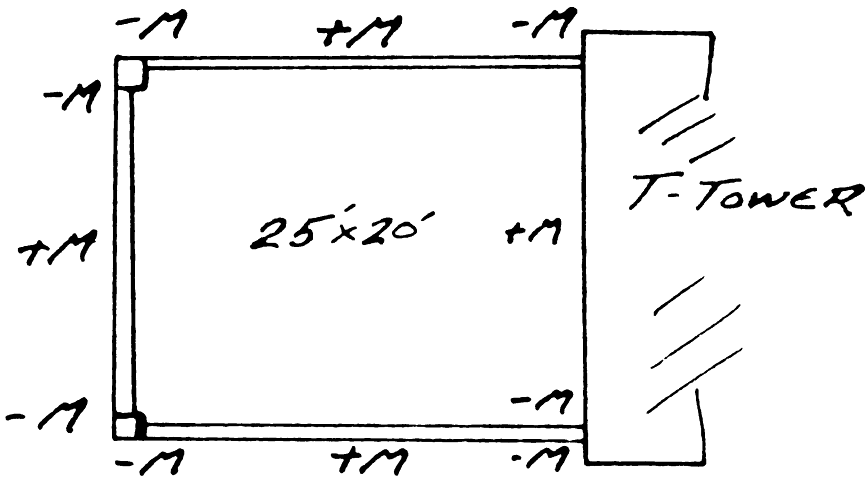






FLOOR LOADINGS

DECK #1
ROOF OF MANAGER'S
SUITE ON 5TH FLOOR



SIZE
25'X20'

THICKNESS
6"

EFFECTIVE DEPTH = 4.5" + COVER = 6"

LOADING   L.L = 30 #/FT²
D.L = 70
100

MOMENTS/LIN. FT

STEEL

SHORT SPAN

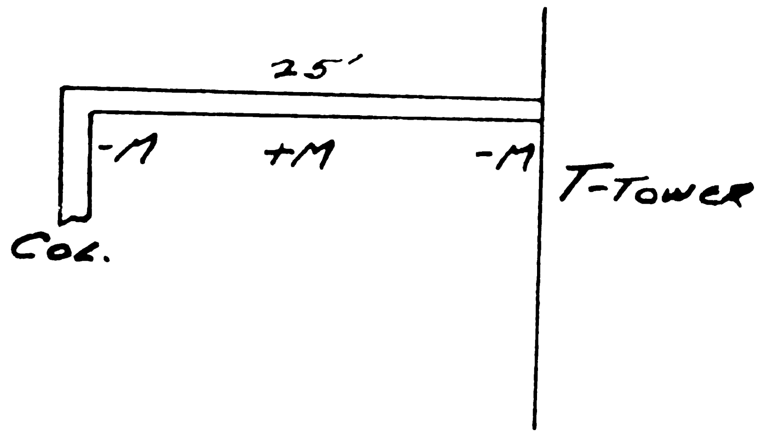
	A_s	
$-M = .074\,w\,S^2 = -29{,}600.$ '# CONTINUOUS EDGE	.42 IN²	3/8 ϕ @ 3"
$+M = .056\,w\,S^2 = +22{,}400.$ MIDSPAN	.32	3/8 ϕ @ 4"
$-M = .037\,w\,S^2 = -14{,}800.$ DISCONTINUOUS EDGE	.22	3/8 ϕ @ 6"

LONG SPAN

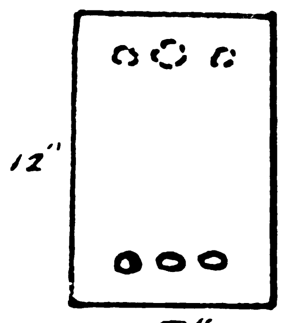
CONT. $-M = .058\,w\,S^2 = -36{,}300.$	.52	1/2 ϕ @ 4"
DISCONT. $-M = .029\,w\,S^2 = -18{,}100.$	.26	3/8 ϕ @ 4"
MIDSPAN $+M = .044\,w\,S^2 = 27{,}500.$	.40	3/8 ϕ @ 3"

$$A_s = \frac{M}{f_s\,j\,d}$$

✓ -M = TOP BARS
✓ +M = BOTTOM BARS
✓ ALLOW AT LEAST 1" COVER



	SIZE
	8"x12"



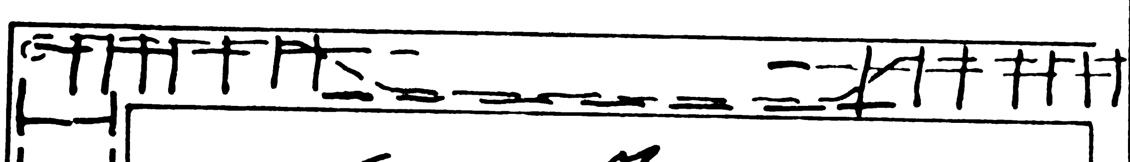
	STEEL
+M	3-7/8 φ 2" C TO C
-M CONTINUOUS	1-7/8 φ 2-3/4 φ
-M DISCONTINUOUS	1-7/8 φ

BEND MID 7/8 φ UP AT EACH END

STIRRUPS

1/4 φ @ 4" FOR 2'

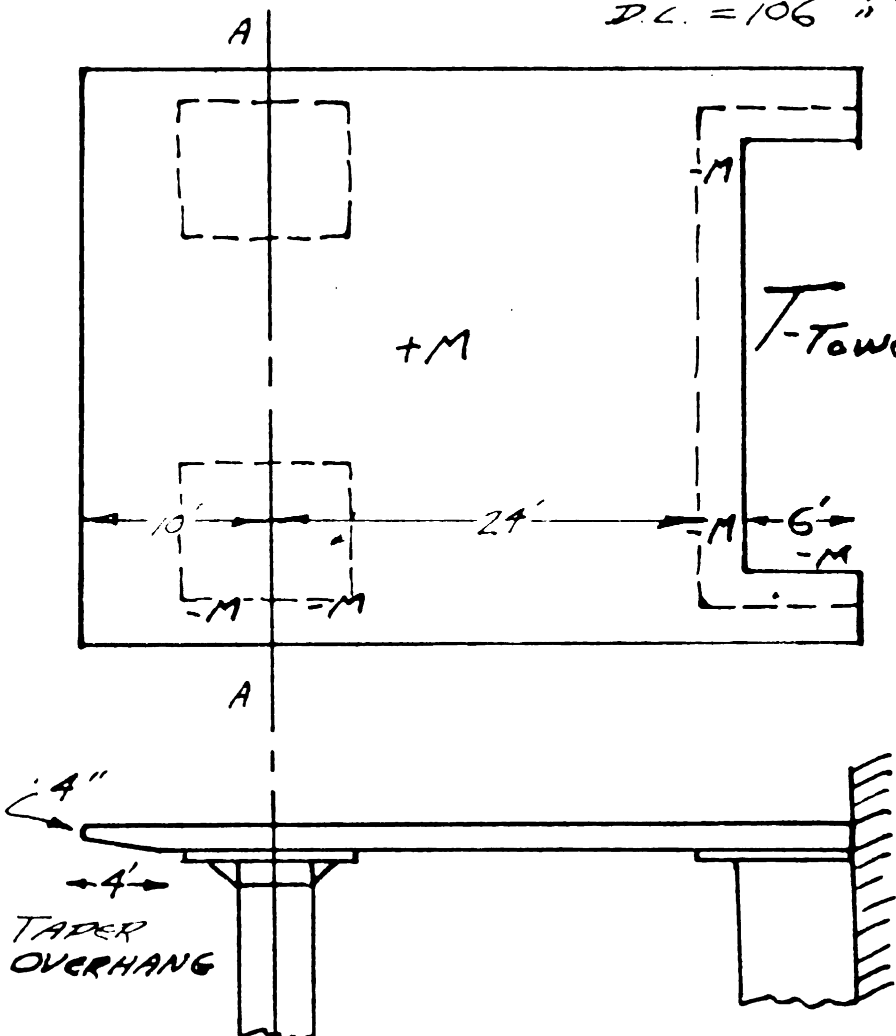
1/4 φ @ 6" FOR 2'

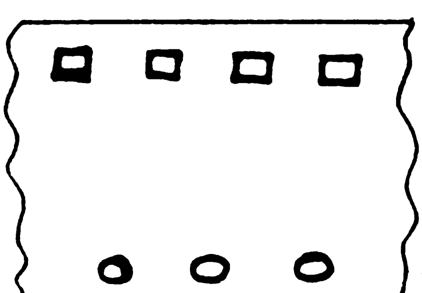


GENERAL METHOD OF PLACING BARS

DECK #2
5TH FLOOR WITH
8' CANTILEVER OVERHANG

LOADING L.L. = 40 #/FT²
D.L. = 106 "





12" SECTION OF A-A

1" COVER MIN. IN ALL CASES

SIZE
34' x 30'

THICKNESS
9"

DROPS
7'x7'x3"

CAPS
5'x5'

STEEL
+M 3/8 φ @ 4"
-M 1/2 φ @ 3"

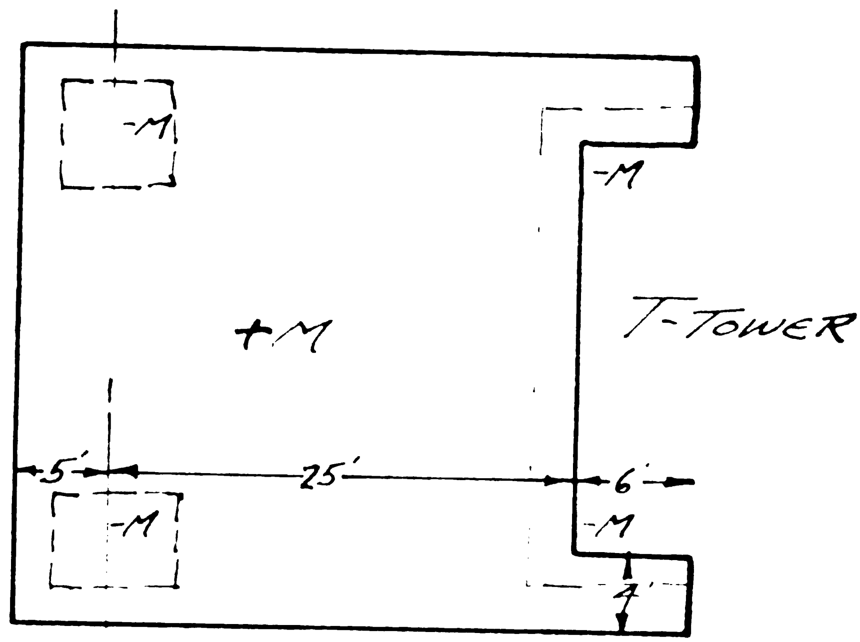
CANTILEVER STEEL
1 1/8 φ @ 3"

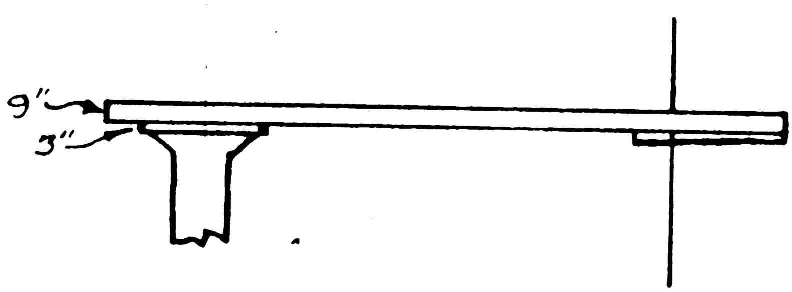
7/8 φ @ 4"

LOADING — L.L. 120 #/FT²

9" THICKNESS — D.L. 106

226 #/FT²





A_s Req'd.

$M_o = 25{,}400$ '#/LIN FT — $-M = 1.05$ □"/LIN FT

$-M_{COL} = .54\,M_o = 13{,}750$ — $-M = .16$

$-M_{MID} = .08\,M_o = 2{,}080$ — $+M = .37$

$+M = .19\,M_o = 4{,}830$

BEND UP ALTERNATE BARS
FOR -M REINFORCEMENT

SIZE
30'x30'

THICKNESS
9"

DROPS
8'x8'x3"

CAPS
6'x6'

STEEL

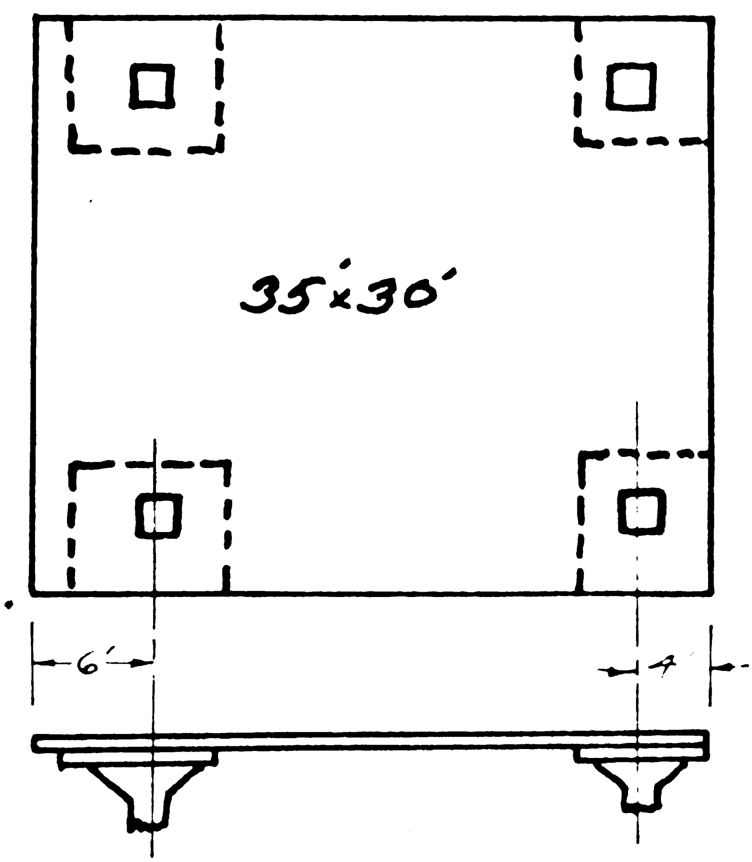
$-M_{COL.}$
3/4φ@4"

$-M_{MID}$
3/8φ@2"

$+M$
3/8@2"

DECK #4
ROOF OF SUITE ON THIRD FLOOR

LOADING — UNIFORM 30#/FT²



4 WAY REINFORCED SLAB

MAX STRESS FOR LONG WAY USED TO DETERMINE SIZE OF MEMBERS & SPACING OF STEEL BARS.

LOCATION OF STEEL FOR THE SHORT DIMENSION SHALL BE THE SAME.

LENGTH OF RODS SHALL EXTEND AT LEAST ONE FOOT BEYOND STRIP LIMITS. BARS FOR -M SHALL EXTEND COMPLETLY OVER COLUMNS & DROPS.

+M — BOTTOM BARS -M = TOP BARS

SIZE
35'X30'

THICKNESS
6"

DROP
8'x8'x3"

CAP
5'X5'

STEEL

COL. STRIP

-M 1/2 Φ
3" SPACING

+M 3/8 Φ
6" SPACING
BEND UP 10
ALT. BARS

MID STRIP

-M 3/8 Φ
8" SPACING

+M
SAME AS
+M COL. STRIP

SAMPLE COMPUTATION
DECK #4

$MIN.\ THICKNESS = .026L\sqrt[3]{\frac{1500}{f'c}} = .026L = 7.2''$

L. LOAD 30#/FT²
D LOAD 94 "
124

$DROPS = \frac{L}{3} = 8' \times 8' \times 3''$

$CAPS = 0.2L = 4.6'$ USE 5'

$M_o = .09\left(L - \frac{2C}{3}\right)^2 \frac{W}{L} = 89{,}000 = \frac{wL^2}{8}$

$K = \frac{M}{bd^2}$ FROM TABLE = 196

$K = \frac{48{,}000}{12 \cdot 6^2} = 111$

COLUMN STRIP

$-M = .54 M_o = 48{,}000'\#$

$+M = .19 M_o = 16{,}900'\#$

MIDDLE STRIP

$-M = .08 M_o = 7{,}130'\#$

$+M = .19 M_o = 16{,}900'\#$

$d = \sqrt{\frac{M}{bK}} = \sqrt{\frac{48{,}000 \cdot 12}{12 \cdot 12 \cdot 196}} = 4.5'' + 1.5\ COVER = 6''$

SAMPLE COMPUTATION
DECK #4

$$A_s = \frac{M}{f_s\, j d} = \frac{48{,}000 \cdot 8 \cdot 12}{20{,}000 \cdot 7 \cdot 6} = 5.5\text{ IN}^2$$

($-M_{COL}$)

USEING ½ φ, 28 NEEDED FOR 7' STRIP
SPACING — 3" APART

($+M_{COL}$)

$$A_s = \frac{16{,}900 \cdot 8}{20{,}000 \cdot 7 \cdot 6} = 1.93\text{ IN}^2$$

USE ⅜ φ, 6" APART
BEND UP 10 ALTERNATE BARS:–

$-M_{MID}$

$$A_s = \frac{7{,}150 \cdot 8}{20{,}000 \cdot 7 \cdot 6} = .8\text{ IN}^2$$

USE ⅜ φ
SPACE 8" APART

$+M_{MID}$ SAME AS $+M_{COL}$ STRIP

USE SAME SIZES & SPACING OF STEEL FOR SHORT SPAN.

ALL STEEL TO HAVE AT LEAST 1" COVER.

SHEAR $= .03 f'_c = 75\ \#/\text{IN}^2$

$6' \times 124\ \#/\text{FT}^2 = 744\ \#/\text{FT}$ LINEAR

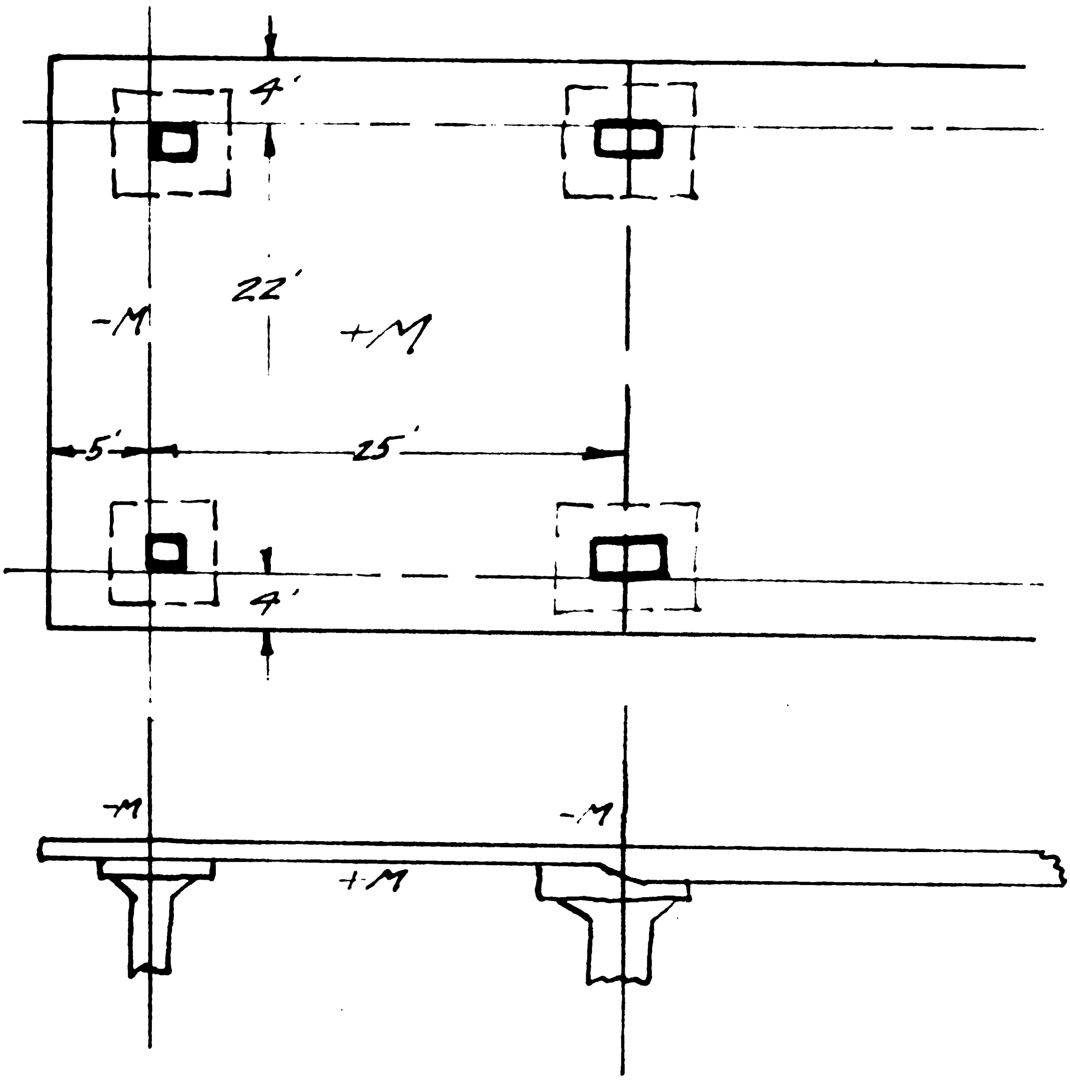
$9" \times 12" = 108\ \square"$ $75\# \times 108" = 810\ \#/\text{LIN FT} > 744\ \#/\text{LIN FT}$

BOND ✓ OK $u = \frac{V}{\Sigma_0\, j d}$

OK

DECK #5
END PORTION OF
3RD FLOOR

LOADING: L.L. 40 #/FT²
D.L. 81
121



SIZE
30'X30'

THICKNESS
6 1/2"

DROPS
8'x8'x3"

CAPS
5'x5'
&
5'x8'

STEEL

-M FOR CANTILEVER OVERHANGS
3/4 φ @ 4"

+M
3/8 φ @ 4"

-M FOR CONTINUOUS SLAB
3/8 φ @ 3"

DECKS #6 & #7
3RD FLOOR – PROPOSED OPEN DANCE AREA, GAME AREA, & SUN DECK

LOADING L.L $120^{\#}/FT^2$
D.L. 106
226

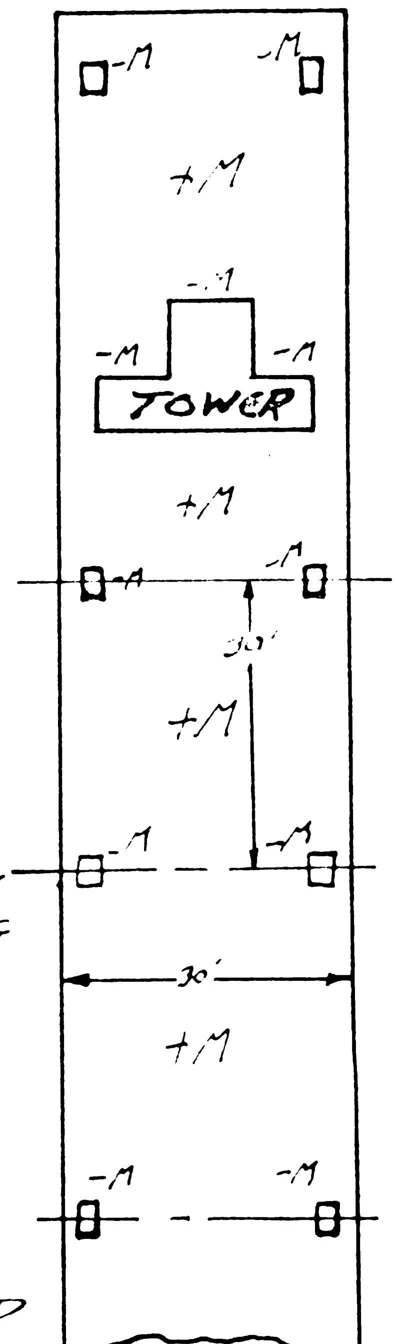
$M_o = \frac{WL^2}{8} = 25{,}400'\#$

$-M$ DISCONTINOUS $= .55 M_o$

$+M = .25 M_o$

$-M_{CONTINUOUS} = .21 M_o$

IN THESE PANELS AS IN ALL OTHERS THE REINFORCEMENT SHALL RUN FOUR WAYS – I.E., HORIZONTALLY & VERTICALLY ACCORDING TO THE DRAWING. THE COLUMN STRIP IS FROM THE EDGE TO THE 1/4 POINT. THE MID STRIP IS THE MIDDLE HALF, AS PER PCA SPECS. THE SLAB SHALL BE TIED INTEGRALLY TO THE T-TOWER, WHICH SERVES AS A UNIT SUPPORTING COLUMN. A 3" DROP SHALL BE FORMED ABOUT THE PERIMETER OF THE TOWER TO A DISTANCE OF 3.



SIZES
MAX = 30'
30' X 30'
30' X 25'

THICKNESS
9"

DROPS
8' X 8' X 3"

CAPS
7' X 7'

STEEL

$-M$ FOR OVERHANG
3/4 φ @ 1"

$+M$
3/8 φ @ 2"

$-M$ FOR CONTINUOUS FLAT SLAB
1/2 φ @ 4"

DECKS #8, 9, & 10

2ND FLOOR - PRIVATE ROOMS, SUITES, & DORMS - INCLUDING BATHROOMS

LOADING

UNIFORM L.L. $= 40\ \#/FT^2$

6" SLAB D.L. $= 75$

115

$M_{o\ MAX\ SPAN} = 13{,}000'\#$

$$A_S = \frac{M \cdot 12}{f_s\ j\ d}$$

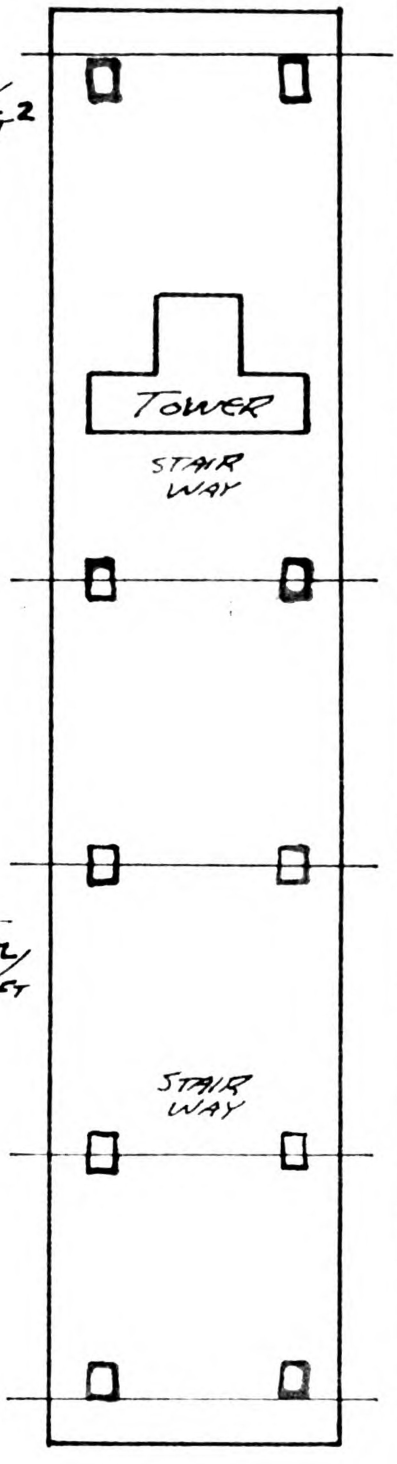
$$= \frac{F\ 13^{000}\ 12 \cdot 8}{20^{000} \cdot 7 \cdot 5}$$

$A_S = 1.2F$

F	A_S
$-M_{DISCONT.} = .55M_o$	.65 IN^2/FT
$+M = .25M_o$	.30
$-M_{CON} = .21M_o$	.25

BOND ✓OK

SHEAR ✓OK



SIZE

MAX SPAN = 30'

PANELS 30' x 30', 30' x 25'

THICKNESS

6"

DROPS

8' x 8' x 3"

CAPS

7' x 7'

MAXIMUM CANTILEVER OVERHANG

5'

3-4' AVG

STEEL

$-M_{CANTILEVER}$

3/4 φ @ 6" - T

$-M_{DISCONTINUOUS}$

1/2 φ @ 3" - T

$+M$

3/8 φ @ 4" - B

$-M_{CONTINUOUS}$

3/8 φ @ 5" - T

MAIN FLOOR

PROPOSED USE: FOR KITCHEN, DINING, LOBBY, RECREATIONAL AREAS

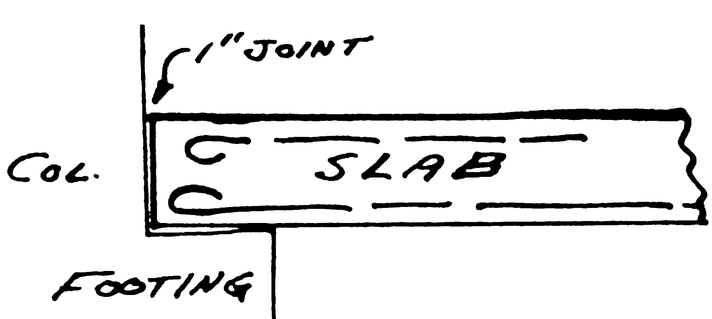
LOADING L.L. 150
9" SLAB D.L. 106
256 #/FT^2

STEEL SHALL BE PLACED 1½" FROM BOTTOM - 4 WAY

SLAB RESTS ON COMPACTED SAND AT LEAST 3' DEEP

BOTTOM 6" OF SLAB SHALL BE ZONOLITE CONCRETE. TOP 3" SHALL CONTAIN RADIANT HEATING PIPES, & BE OF A GOOD WEARING CONCRETE.

AT <u>NO</u> POINT SHALL THE SLAB BE ATTACHED TO COLUMNS, FOOTINGS, OR TOWER. AN ASPHALT JOINT SHALL CONNECT SLAB AT THESE POINTS.



SIZE

150' X 30'

THICKNESS

9"

STEEL

-M
$\frac{3}{8}\phi$ @ 4"

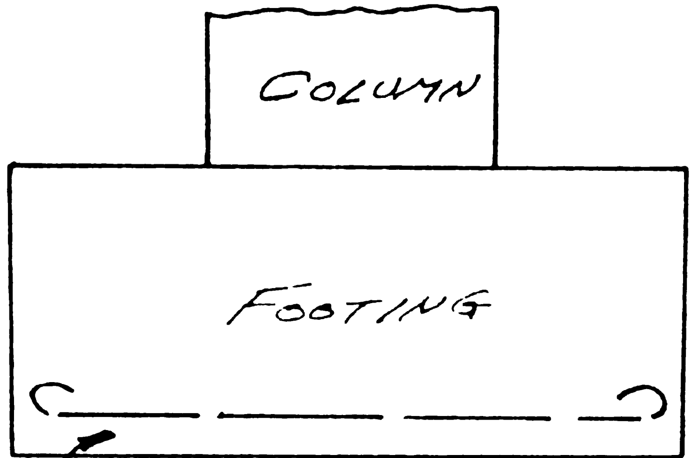
-M
$\frac{7}{8}\phi$ @ 4"

WIRE MESH TO BE LAID DIRECTLY ON SAND BASE.

DETAIL OF COLUMNS

No.	SIZE	SUPPORTING DECKS #-	STEEL	COVER
2	8"x8"	#1	8-3/4φ@3"	1"
4	12"x12"	#4	4-1#@6"	2"
4	15"x15"	#6,7	8-1#@4"	2"
4	18"x18"	#2,5	8-1#@6"	3"
6	24"x24"	#3,5,6	8-1#@7"	3½"
10	36"x36"	#8,9,10	12-1#@7"	6"

FOOTINGS



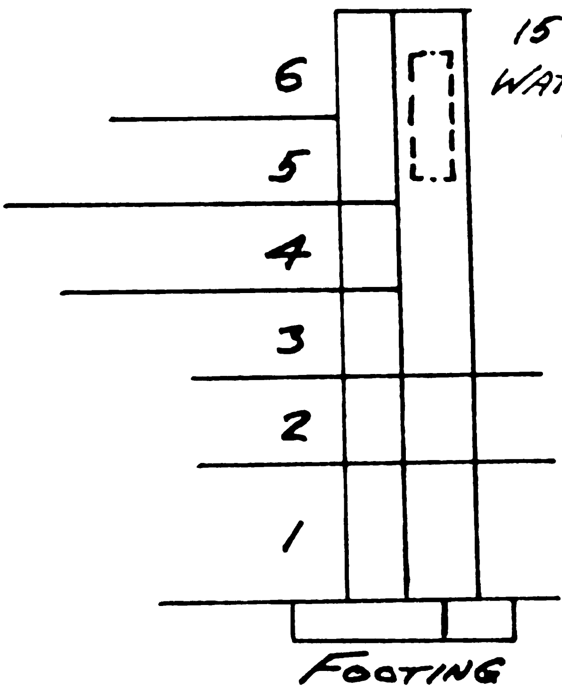
MAINTAIN AT LEAST
6" COVER FOR STEEL

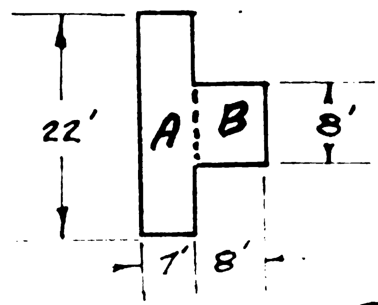
SOIL BEARING PRESSURE
ESTIMATED AT 6000 #/FT²

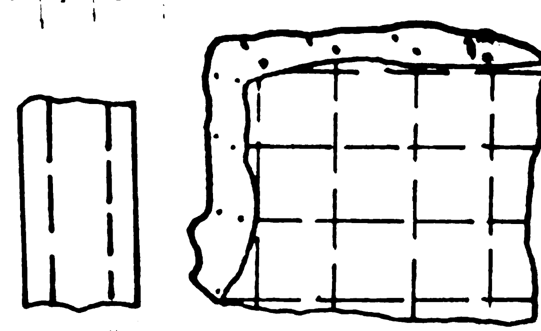
FOOTING	SIZE L. & W.	DEPTH	STEEL 4 WAY
A	7'×7'	3'0"	3/4 φ @ 7"
B	7'×7'	3'0"	3/4 φ @ 7"
C	6'×6'	2'0"	3/4 φ @ 10"
D	7'×7'	3'6"	3/4 φ @ 4"
E	6'×6'	2'0"	3/4 φ @ 10"

T-TOWER

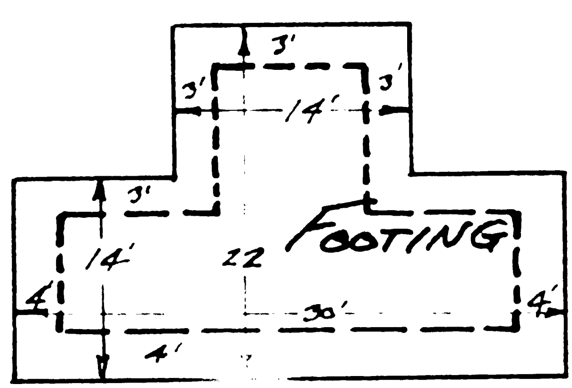
HEIGHT · 60'
WIDTH · 22'
DEPTH · 15'







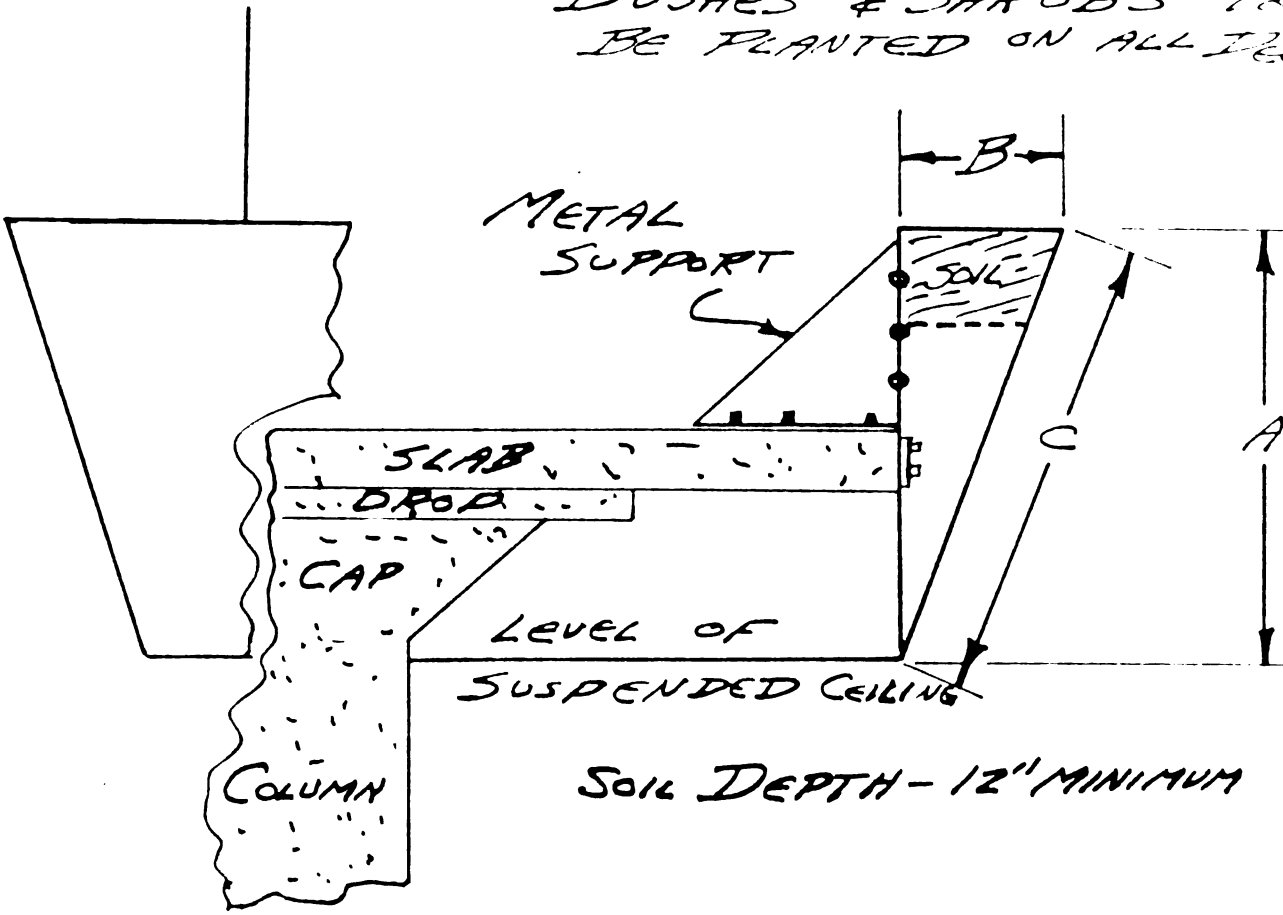
STORY	"A" WALL	STEEL	COVER	"B" WALL	STEEL	COVER
1	15"	3/4 ϕ @ 4"	3"	12	3/4 ϕ @ 4"	3"
2	12"	3/4 ϕ @ 6"	2"	12	3/4 ϕ @ 4"	2"
3	10"	3/4 ϕ @ 8"	2"	10	3/4 ϕ @ 4"	2"
4	8"	1/2 ϕ @ 3"	1 1/2"	8	3/4 ϕ @ 3"	1 1/2
5 & 6	6"	3/8 ϕ @ 3"	1"	8	3/4 ϕ @ 3"	1



DEPTH · 4'
STEEL
1# @ 8"
(4 WAY)

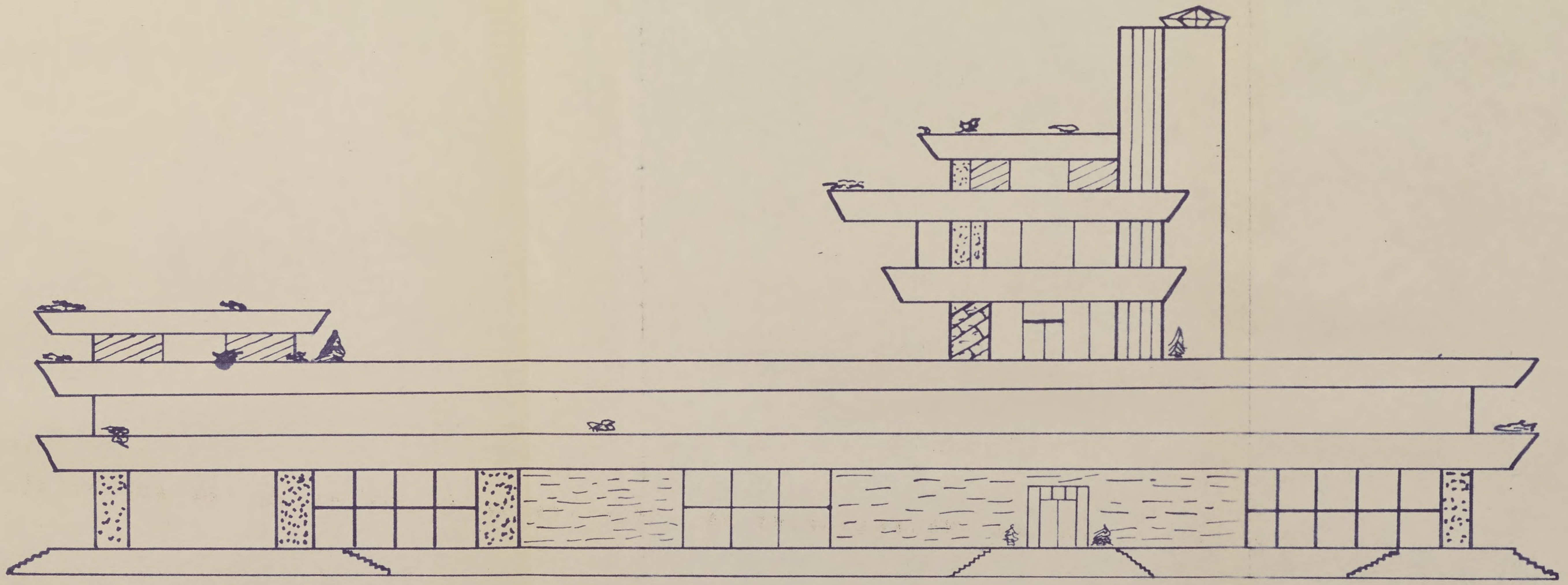
METHOD OF ATTATCHING METAL FLASHING

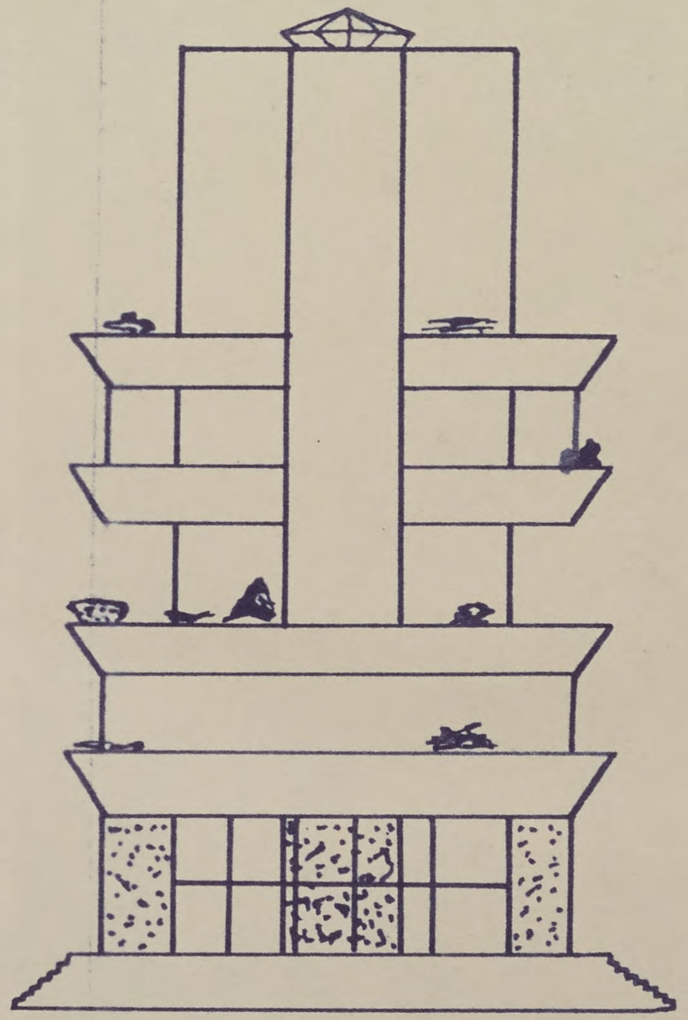
BUSHES & SHRUBS TO BE PLANTED ON ALL 12 DECKS



SOIL DEPTH - 12" MINIMUM

DECK	A	B	C
1	36"	20.8"	41.6"
2	48"	27.7"	55.4"
3	48"	27.7"	55.4"
4	36"	20.8"	41.6"
5	60"	34.7"	69.4"
8	72"	41.6"	83.2"





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