DESIGN OF AN

UNDERGROUND PARKING STRUCTURE

IN LANSING, MICHIGAN

INTRODUCTION

The necessity of moving traffic without congestion on the roads and highways has become increasingly evident in the last fifteen years. Its seriousness is shown by the attention that safety engineers and traffic engineers have given to the elimination of the causes of congestion.

It is generally agreed that the parking of automobiles along a street does slow down traffic. In addition, parking requires one, two, and sometimes three lanes of the right of way which could otherwise be used for moving vehicles. So, in sections where mobility of traffic is of prime importance, such as in a crowded business district, it can be seen that optimum results can be obtained only if street parking is either partially or completely eliminated. However, if street parking is eliminated, a second and possibly more serious problem arises -- What is to be done with those automobiles which would normally have been parked on the street?

By the application of a comprehensive parking plan utilizing off-street areas throughout the district, these vehicles can be conveniently stored. At certain points, structures of one type or another may be needed to fully utilize the space available, and it is the design of such a structure that constitutes the main body of this thesis.

In addition, three other points closely related to the main topic are considered, making four points in all. The four are discussed in the order shown below:

1. Analysis of present and future parking needs.
2. Location of structure to be designed.
3. Design of structure.
4. Method of financing project.

ANALYSIS OF PRESENT AND FUTURE

PARKING NEEDS

In the central business district of Lansing, Michigan, a problem, similar to that outlined in the introduction, has developed. Although parking has not been forbidden on the streets, still a deficit of parking spaces exits. It is expected that this deficit will increase in the next few years, and bring with it correspondingly greater traffic confusion. Therefore, it was felt that some solution to the problem must be found, and applied immediately.

A plan, which was the result of a lengthy and detailed study by a committee of seven men, has been presented to the city, and it is gradually being put into operation. The plans and statistics evolved from this study are presented below, and except where noted are summarizations of the information published by this committee.

The first step in approaching the problem was to define the central business district, since this was the area directly concerned in the study. The area was considered as that bounded by Genesee Street on the North, Hillsdale Street on the South, the Grand River on the East, and Seymour and Townsend Streets on the West. Also included was the property lying along both sides of Michigan Avenue from the Grand River east to the Michigan Central Railroad. (See Map No.1)

In adopting a plan a design period of five years was used, during which time it is estimated that urban traffic can be expected to increase from 40% to 60%. The lower figure of 40% was used in the committee's estimates.

In order to determine the present and the future deficit of parking space, a table was drawn listing all available information gathered from observations, shopping polls, and traffic counts. A copy of this table is shown on the next page.

PARKING FACILITY ANALYSIS - TABLE NO. 1

Present Facilities

Off Street (25 lots & 3 buildings)		2,264 Vehicles
Street - Metered	930	
Street - Time Limited	968	1,898 "
Total Parking Facilities		4,162 "

People Entering Central Business District and Parking Facilities Required

	Total	By Automobile	Persons Per Car
Labor Force	10,000	6,000	1.4
Shopping Force	15,000	9,000	1.7
Business	1,500	900	1.7
Recreation	500	300	1.7
Total (normal day)	27,000	16,200	1.6

	No. Cars	Parking Turnover	Parking Required
Labor Force	4,200	1.1	3,890
Shopping Force	5,290	5.0	1,058
Business	529	2.0	265
Recreation	176	2.0	88
Total (normal day)	10,275	2.5	5,301
Total - pak day (normal + 15%)			795
			6,096
Anticipated increase of 40%			2,438
Total future requirements			8,534

Assured Future Facilities

Street Parking (25% of present)	475
(25% is an estimate of the amount of street parking to be allowed)	
Off Street Parking (Three buildings)	415
Total future facilities	890
Future Deficiti	7,644

It can be seen from the table that approximately 7,500 parking spaces must be provided to handle the expected increase.

As a start, the committee asked themselves:- "Where should this parking be located?" (1) In one large central building. (2) In several locations around the outer edge of the central business district. (3) At various locations in the district.

It has been agreed upon by leading national architects and planners that the greatest distance people are willing to walk from their cars to shop is between a block, and a block and a half. It can be seen from this that the first two suggestions are impractical since it would be impossible to bring all points in the central business district within a block and a half of parking areas located using these plans.

Therefore, the third suggestion was the one selected, and the overall parking plan was set up using this as a basis.

The next step was to provide the area within the business district where the automobiles could be parked. Three plans were proposed: (1) Parking over the Grand River. (2) Parking under Washington or Michigan Avenue (3) Parking in lots

and buildings within the district. The first two of these plans were rejected because of the expense involved in their construction (it might be noted at this point that much of the cost of the underground parking plan was for moving public utilities, repaving streets, and strengthening footings of existing buildings). Therefore, the third plan was selected as being the most practical.

A survey was made of the entire central business district and thirty-two locations of sufficient size for parking were found. All of these were either vacant or occupied by low cost buildings which were well amortized, marking it economically possible to use them for this purpose.

Ten of these sites were chosen as to location, parking capacity, and traffic distribution. They were so located that practically all property in the district is within one and one half blocks of at least one of them. (See Map No. 2).

The capacity of these areas when fully developed by use of five story parking structures is 7,940 automobiles. Each site has access from two streets, and traffic to and from them would be spread over twenty different points on

thirteen streets. In addition, the cost per parking unit was found to be nearly $2,500 cheaper than the least expensive of the other two plans considered. It is also the most flexible of the three plans, as each unit may be developed as it is needed.

The reasons for the selection of plan number three, the recommendations in the administration of the plan, and the conclusions of the committee can be summed up in the following twelve points. (Point number twelve was added by the author.)

1. It provides adequate parking facilities within easy walking distance of any property in the central business district.
2. It will spread parking traffic throughout the area rather than congest it at a few focal points.
3. It is the most flexible plan. Each of the ten units can be developed separately, and to a degree to satisfy parking demands at this particular location.
4. It is the most economical plan having an estimated unit cost of $620.20 against $3,054.74 for plan number one, and $4,844.17 for plan number two.
5. This plan can be completed without cost to the city. The aquisition of the ten parcels of land, the surfacing, and the installation of meters can be financed by

use of the funds created by parking meters for this purpose, and a loan from the Public Improvement Reserve Pool. This loan is to be repaid from parking earnings.

6. It is the most economical plan to operate.

Recommendations

7. The parking buildings should be built as needed by the sale of revenue bonds to be retired from earnings.

8. Each lot should be equipped with two-hour parking meters that will take one, two or three nickels at a time, making it possible for the customer to park his own car for a period up to six hours. These lots would not require an attendant, only a periodic check by the police department.

9. The parking charge should be five cents for each two hours.

10. The first buildings erected on each location should be three level, one level below grade, one level on grade, and one level above grade. The structures are to be so designed so that two or more levels can be added when needed. These three level buildings should also be metered, allowing personal parking. This would require but one attendant to check available spaces and violations.

11. Each unit could be municipally operated, or leased to private operators. If municipally operated, this plan

would not only be self sustaining, but would provide a net return of $35,000 to $500,000 to the city annually, which might relieve property taxes or make possible an earlier realization of planned public improvements.

12.* All parking on Michigan Avenue from the Grand River to the capitol, on Washington Avenue from Genesee Avenue Hillsdale Street, and on Capitol Avenue from Ottawa Street to Allegan Street is to be eliminated.

* Added by author

DESIGN OF STRUCTURES

In designing the structure the first step was to estimate how many automobiles it should be able to handle so as to best fit into the plan advanced by the parking committee. Since their plan called for ten parking areas to handle a deficit of 7,644 spaces, it was felt that a structure capable of storing about one ninth of this figure or about 850 vehicles would be of the correct size. Rough calculations showed that in order to provide this amount of parking space in the area selected, a two level structure would be needed.

Of the great number of building materials available, one had to be selected which would meet the following requirements:

1. Be fire resistant.
2. Provide maximum head room with minimum depth.
3. Provide high strength with comparatively thin sections.
4. Be easy to transport and place.
5. Be comparatively quiet to erect or place.
6. Have low comparative cost.
7. Require short erection, or placing time.

Of the materials considered, reinforced concrete was the type which possessed most of the above requirements, espec-

ially the first three. Therefore, it was decided to design the structure using reinforced concrete throughout.

Specifications Used

In order to make the structure conform as closely as possible to the most widely used, and the safest set of standards, several codes were examined.

Since the State of Michigan does not have a building code, the Lansing building code was selected first. The section concerning the structural standards of reinforced concrete design had been deleted and reference was made to the code published by the American Concrete Institute. The next code selected for consideration was the one published by the National Board of Fire Underwriters. This too referred to the American Concrete Institute code. Therefore, the 1941 Building Regulations for Reinforced Concrete (A.C.I. code) was adopted as the standard to be used in the design specifications of all the reinforced concrete members.

The next step was the selection of a code which specified the live and dead loads, ventilation requirements, and any other factors not directly involved in the design of the structural members. The building code published by the National Board of Fire Underwriters was compared with the Lansing building codes. In general, it was found that the former provided a greater margin of safety, and most re-

quirements of the Lansing code were also contained in the Underwriters code. Since this was the case it was decided to adopt the National Board of Fire Underwriters building code as the one used in the design of the structure.

Loads on Floor and Roof System

In the selection of floor loads and roof loads, the maximum specified in the National Board of Fire Underwriters code were used.

So as to indicate clearly which part of the structure is referred to certain terms are defined at this point.

1. Roof - Refers to the top of the parking structure and includes that portion of the structure which supports the earth cover.
2. First level - Refers to the first level below the surface of the ground.
3. First level floor - Refers to the floor of the first level which is also the ceiling on the second level.
4. Second level - Refers to the second level below the surface of the ground.
5. Second level floor - Refers to the portion of second level floor, other than column and retaining wall footings, which is directly in contact with the earth.

In order that the park that is in front of the capitol at present may be replaced when the structure is completed, a thin cover of earth must be furnished to allow landscaping. A depth of four feet was designed for, since this would permit the use of shrubs and small trees. Assuming earth to weigh 150 lbs/cu. ft., this would produce a dead load of (4) (150) lb/sq. ft. or 600 lb/sq. ft. An additional live load of 100 lb/sq. ft. was added to this to take care of any group of persons collecting, or any small vehicles such as power lawn mowers being used. The thickness of the roof slab of the structure was initially estimated at 12 inches and later calculation proved this correct. Therefore, taking the weight of reinforced concrete as 150 lb/cu. ft. this gives a load of (1) (150) or 150 lb/sq. ft. Summarizing the roof loads.

Earth load	-	600 lb/sq. ft.
Live load	-	100 lb/sq. ft.
Slab load	-	150 lb/sq. ft.
Total	-	850 lb/sq. ft.

The load on the first level floor was composed of the live load due to vehicles and pedestrians, plus the dead load due to the weight of the floor. From the building code the live load was taken as 175 lb/sq. ft. which is from 25 to 50 lb/sq. ft. above local building codes. The slab thickness was estimated at 8 inches and this also proved to be correct

in later calculations. Summarizing the first level load.

Live load - 175 lb/sq. ft.

Slab load - 100 lb/sq. ft.

Total - 275 lb/sq. ft.

Where the walks are located on each floor an increase in concrete thickness of approximately 6 inches occurs. However, the whole floor is designed for a 175 lb/sq. ft. live load and only that portion used by vehicles is subjected to this load. The sidewalks need only be designed for a live load of 100 lb/sq. ft., and so a 6 inch curbing increasing the load by 75 lb/sq. ft. is permissable.

EXPLANATION OF COLUMNS IN BAR PLACEMENT SCHEDULE

Column 1 - Panel No.

Designates the panel (as A1)

Column 2 - Length

Designates the length (long dimension- L, short dimension- S) in the direction in which steel is being placed.

Column 3 - Bar No.

Designates bar type as shown on "Bar Type Sheet." Letter preceding number indicates whether bar belongs to interior (I), or exterior (E) type. Letter following number indicates position of bar in the strip as shown on "Bar Placement Diagram."

Column 4 - Strip Size

Designates whether a whole (W), or half (H) column strip is receiving the reinforcement designated. If the panel is bounded by a different dimensioned panel (width) on a side parallel to the direction in which the steel runs, only a half column strip (H) is designed for. See sketch below.

Column 5 - Strip Location

The location of the strip is given in this column by writing its location as for example "side adjacent to panel Q1." If the two half column strips in a panel are reinforced in the same manner, a dash (-) is placed in this column. It is not necessary to locate whole column strips since their location can be found by reference to the framing plan.

Column 6 - No. of Bars

Gives the number of bars of that particular type that are used. A cross in this column indicates that the bars of this type, and at this position, have already been placed on another sheet shown by the numbers in the cross.

Column 7 - Spacing

Gives spacing of type of bar indicated only. If other types of bars run parallel to these particular bars, they are spaced separately. For example:

When spacing is given for bars in a half column strip this spacing is obtained by adding the width of the half column strip adjacent and dividing the total number of bars of the particular type used into the total width. This is shown in the sketch below.

Column 8 - Bar End or Center On

This column gives the location of either the center of the bar (not centerline; see sketch below) if an interior type bar, or the end of the bar if an exterior type bar.

In order to locate the bar positions, the panel must first be placed in some particular position. The panel is placed so that, of the two adjacent panels along the length being considered, the one with the smaller length of the two adjacent panels is on the right, and the larger length and any discontinuous edge is on the left. If the two adjacent lengths are equal, the panels adjacent along the width are used, and the panel with the larger width or any discontinuous edge is placed on top.

When the panel has been positioned, the left edge is lettered "L", the centerline "C", and the right edge "R". These are the lines referred to in the next paragraph. Interior type bars are placed so that they are perpendicular to and centered on the line given in Column 6. Exterior type hooked bars are placed so that the hook starts at the line indicated. Exterior type straight bars are placed so that their ends fall two inches beyond the line indicated.

Column 9 - Same as Column 3.

Column 10 - Same as Column 6.

Column 11 - Same as Column 7.

Column 12 - Same as Column 8.

Column 13 -
14 -
15 - Gives dimensions of panels perpendicular to direction bars run. Used to calculate spacings.

Laboratory Visual Inspection

Sample No.

1. P. I. = 4 Yellow, sandy loan. Shear sample soft to plastic. Weakly coherent.

2. Non plastic. Clean, yellow, firm sand. Some very fine sand. Slight trace of silt.

3. Non plastic. Dark, mottled, yellow brown, fine to coarse sand. Slight trace of clay and silt.

4. Non plastic. Wash sample. Clean fine grey sand.

5. Non plastic. Clean grey, fine sand.

6. P. I. = 5. Firm stiff, sandy loam. Trace of small pebbles.

7. P. I. = 40. Stiff, sandy, loam. Trace of pebbles.

8. Non plastic. Wash sample, clean, fine, grey sand.

(Note) The t extural classification used in the remarks column is based on the triaxial chart.

(Note A) No water in uncased boring holes to a depth of 35 feet. Hole caved in at a depth of 35 feet. observation made 30 days later in original boring hole.

Foundation

The first step in selecting the type of foundation to be used was to investigate soil conditions at the location of the structure. As was mentioned previously a record of test borings was obtained from the Michigan State Highway Department. These borings were taken very close to the City Hall in downtown Lansing, and from examination of these it was decided that approximately the same soil conditions prevailed at the site of the parking building. So the test hole on the north-east corner of the Michigan and Capitol intersection was selected since this represented a typical boring close to the required site.

A copy of the field notes and of the results of a laboratory visual inspection are given below.

Foundation

The elevations given in the field notes must be corrected by adding 705.88 feet to them. This is caused by the fact that the elevations taken for the boring were referred to a city bench mark whose elevation is taken as 705.88 feet less than the U. S. Coast and Geodetic survey elevation on the benchmark.

Referring to the "log of borings" it is seen that between an elevation of 849.84 and 828.84 a medium to fine yellow sand was found. The bearing capacity of this sand was estimated at 6,000 lb/sq. in.

LOG OF BORINGS Project - 4501 Lansing No. for Lansing City Hall. Michigan State Highway Department.

Test Hole 1 (Elev. 147.36) Record of samples

Location - 30' N. of N. curb of Michigan and 4' E. of E. curb of Capitol.

0' - 0.4'	Concrete Walk
0.4' - 4'	Firm yellow clay, trace of gravel
4' - 11'	Firm yellow loam, very sandy with some gravel
11' - 20'	Fine yellow sand
20' - 25'	Medium and coarse yellow sand
25' - 32'	Medium and fine yellow sand with small particles of black shaley material.
32' - 46.5'	Hard blue clay, sandy and gravel
46.5' - 49'	Medium and fine grey sand
49' - 51'	Gravel
51' - 59'	Medium and fine grey sand (compact)
59' - 62'	Medium and fine grey sand (loose)
62' - 63'	Medium hard grey sand stone
63' -	Hard grey sand stone

Test Hole #1

Record of Samples

Sample #	Consistency	Sample Depth	Sample Length	Sample Penetration Drive	No. of blows to drive 12" with 140 lb Hammer
1	Firm	6'	12"	15"	11
2	Firm	10'	Failed	15"	8
3	Sand	15'	13"	15"	18
3	Sand	20'	12"	12"	10
4	Sand	25'	Failed	12"	8
4	Sand	25'	Wash sample		
5	Sand	30'	9"	12"	6
6	Hard	35'	7"	12"	36
7	Hard	41'	6"	8"	21
8	Sand	48'	Wash sample		

(Note) Consistency determined by inspection of samples and substantiated by resistance to casing and jet rod.

All Test Holes Sampled Feb. 20, 1947

LOCATION OF STRUCTURE

TO BE DESIGNED

An inspection of map number two, showing the ten selected parking sites and the area they serve, shows that there are still a few sections in the central business district which are not adequately served. One of these is the area at Capitol and Michi gan Avenue. It is in the heart of the business district, and the need for parking facilities here are apparent. There is a large number of retail stores within a block and a half of this intersection, none of which can furnish adequate parking space for their customers. In addition, there is a large labor force to be served which is concentrated in the State Capitol, the Lansing City Hall, the Olds Tower, the Olds Hotel, and the Bank of Lansing building. Indications are at present that the state is planning on extending the capitol buildings to the West in the four blocks directly in the rear of the present capitol building. This will have the effect of increasing traffic concentration at all points near the capitol, and will of course necessitate more parking spaces.

Further inspection of map number two reveals that the only possible location for parking is the large open area directly in front of the State Capitol. Since neither a parking structure built above the ground or parking at ground level would be acceptable because of the appearance, it follows that if the area is to be utilized, parking must be under-

ground. This solution has been applied in many cities, and it could be very easily applied here.

The land is state owned and any attempt to use it for the above purpose would probably meet much resistance in the state legislature. Most of the objections come from the desire on the part of many to retain old landmarks and memorials. However, it is felt by the author that the city containing the state capitol should be a leader in its state in civic improvement. Surely, visitors from other sections of the country cannot be expected to be favorably impressed with a state whose Capitol City provides him with the present limited parking spaces and crowded streets.

The objection that the beauty of the area would be destroyed is an invalid one, since the proposed structure would be covered and landscaped. Thus, a park fully as beautiful as the one existing could be placed on top of the underground parking building.

Traffic to this area comes in from North, South, East, and West, and therefore a parking area here would be easily accessible. Traffic to or from the structure could be moved from or into six streets, Michigan, Capitol, Allegan, Ottawa

Seymore, and Townsend. Therefore, at rush hours, the traffic load could be distributed with little congestion.

It is planned to have three entrances and exits to the structure; one on Capitol leading in from Michigan, one at Allegan and Townsend, and one at Ottawa and Seymore. These entrances and exits are to be designed so that they may discharge and receive their traffic with a minimum of turning and stopping.

One other point which was considered before this area was selected was its location from an engineering standpoint. This consideration included the depth of the water table, the soil conditions, and the proximity of the proposed structure to existing utilities and structures.

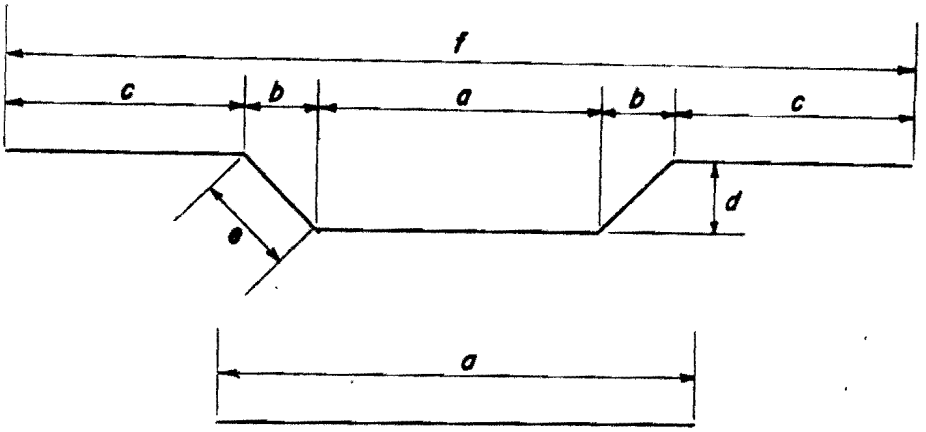
Information concerning soil conditions was taken from a test boring made by the highway department at the NE corner of Capitol and Michigan Avenue. From this boring the conditions existing at the site of the proposed structure were assumed. It was found that at the elevation of the foundation, the soil was a mixture of fine and medium yellow sand with an estimated bearing capacity of 6,000 lbs/sq. ft. for an ordinary spread footing.

The water table was found to be at an elevation of approximately 818.24'. This is far enough below the elevation of the foundation of the parking structure so as to eliminate any danger of frost action or buoyant force tending to lift the structure.

The closest structure, and the only one offering any problem to construction, is the capitol building. This difficulty has been overcome by locating the parking structure retaining walls far enough from the capitol building so that no surcharge need be added in their design. At one point, the entrance steps to the capitol are over the structure, but this weight can be taken by the columns underneath the steps.

From information obtained from the capitol building superintendant, the telephone company, the water and power company, and the city engineer, it was found that no utilities are located so as to be interfered with by any part of the structure except the north ramps. At the intersection of Townsend and Ottawa an electric conduit enters the capitol area. This conduit would be crossed by any ramps from or into the structure at this point. It is located at an average depth of two to three feet below the present ground surface, and would present no difficulty in bypassing during contruction. Steam and water lines also enter the capitol area at this point, but they too can be easily bypassed, and need only be left

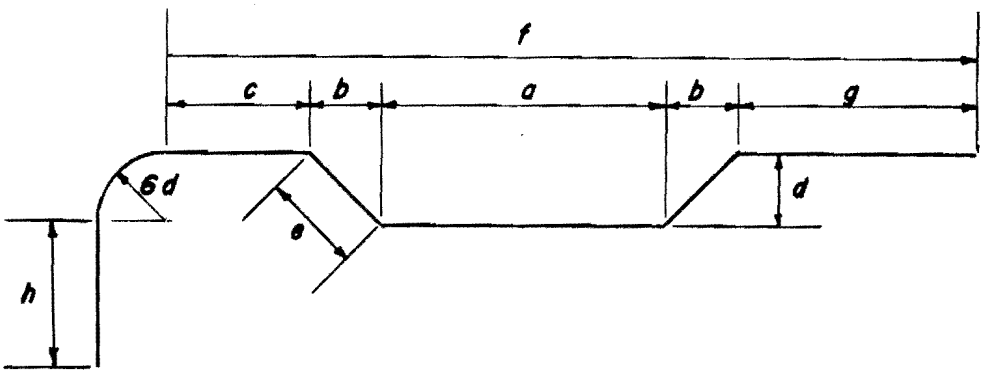
in their temporary position during the construction of the ramps.



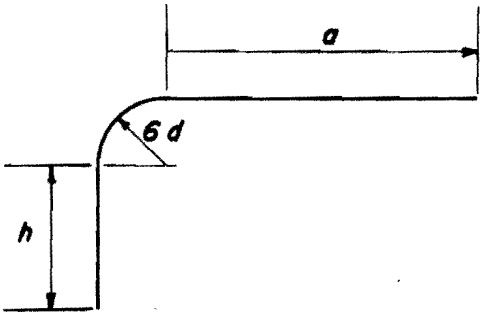
Bar 1

Bar 2

Interior Type Bars



Bar 3



Bar 4

Exterior Type Bars

Plate No. 3
BAR TYPE SHEET (FS)

Scale-None Ralph J. Stephenson

Sheet 1 of 2 Sheets

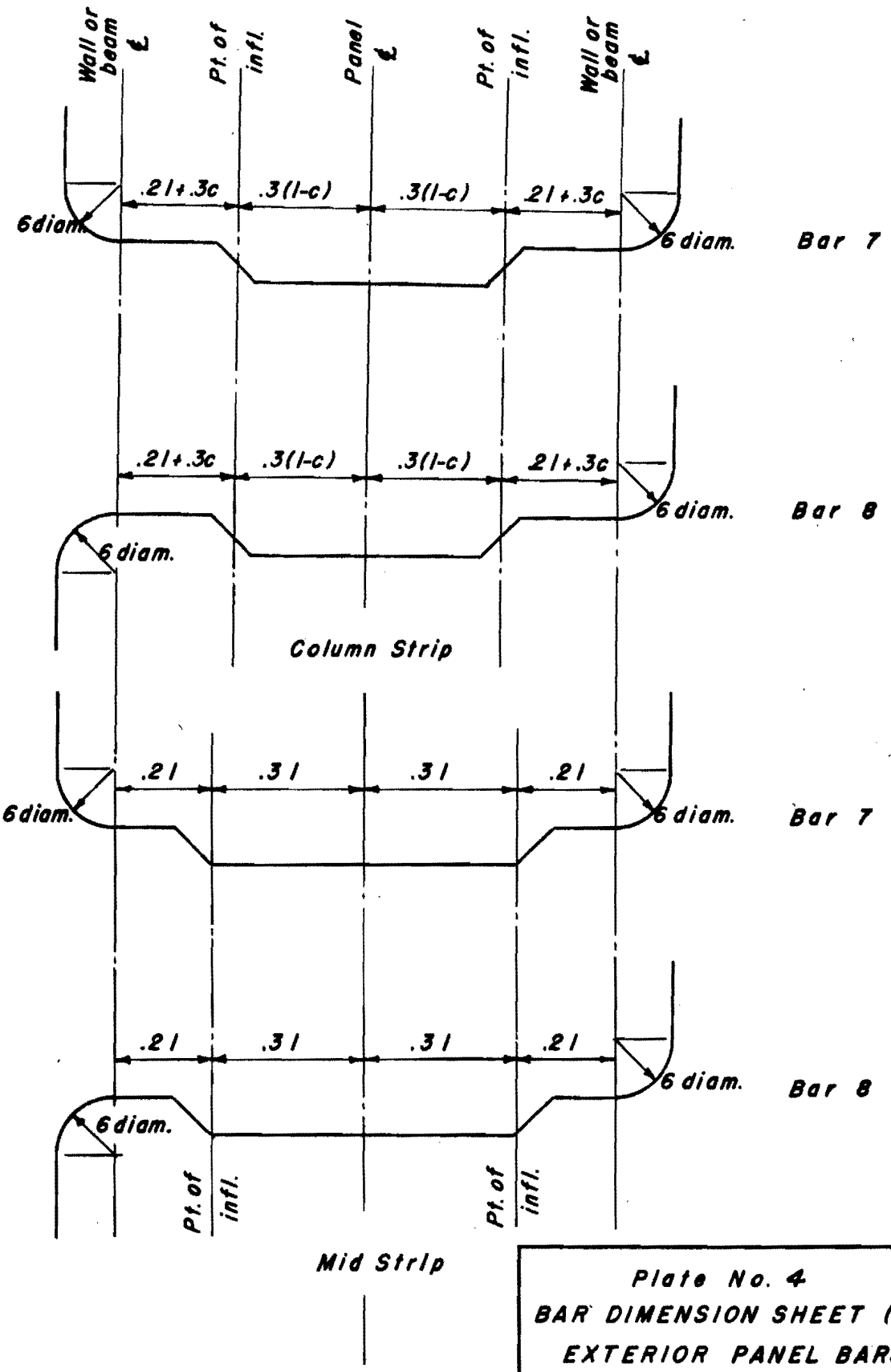


Plate No. 4

BAR DIMENSION SHEET (FS)

EXTERIOR PANEL BARS

Scale - None

Ralph J. Stephenson

Sheet 4 of 4 sheets

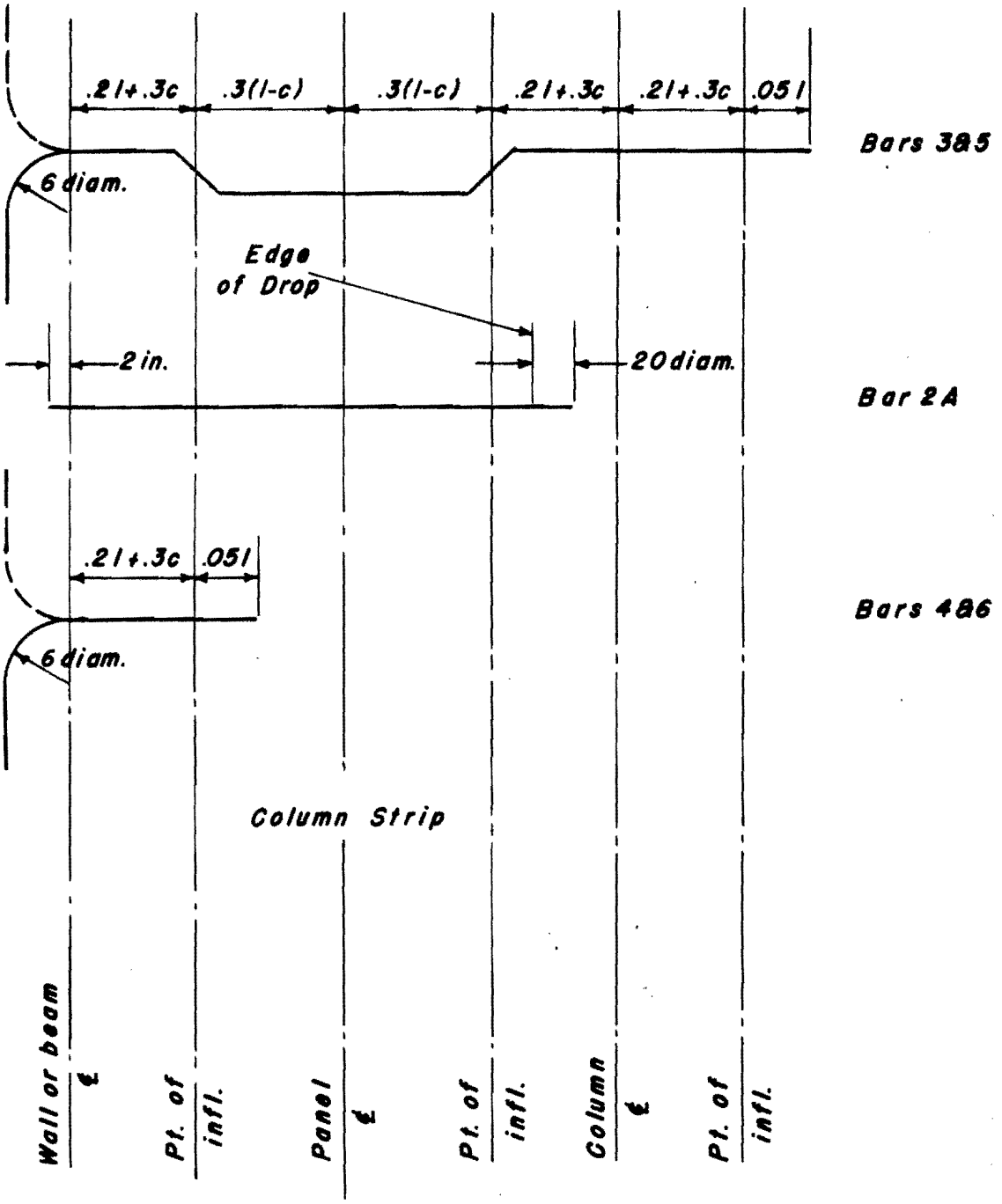


Plate No. 4

BAR DIMENSION SHEET (FS)

EXTERIOR PANEL BARS

Scale - None

Ralph J. Stephenson

Sheet 2 of 4 sheets

(FS)

18'-00" x 21'-00"

Roof

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.
A1	L	C	I1	36'-6"	8'-8 3/4"	0'-8"	12'-11 1/4"	0'-8"	0'-11 1/4"	35'-11 3/8"		
			I2A	16'-4"	16'-4"							
			I2B	14'-11 3/8"	14'-11 3/8"							
		M	I1	33'-3 5/8"	12'-7 1/4"	0'-8"	9'-4 7/8"	0'-8"	0'-11 1/4"	32'-9"		
			I2A	13'-7 3/4"	13'-7 3/4"							
			I2B	11'-9"	11'-9"							
	S	C	I1	30'-8 1/4"	7'-1/4"	0'-7"	11'-1/8"	0'-7"	0'-9 7/8"	30'-2 3/8"		
			I2	13'-4"	13'-4"							
			I2B	12'-2 3/8"	12'-2 3/8"							
		M	I1	27'-5 3/4"	10'-9 5/8"	0'-7"	7'-6 1/4"	0'-7"	0'-9 7/8"	27'-0"		
			I2A	11'-8 3/8"	11'-8 3/8"							
			I2B	9'-0"	9'-0"							
A2	L	C	I1	36'-3"	8'-8 3/4"	0'-8"	12'-9 3/4"	0'-8"	0'-11 1/4"	35'-8 3/8"		
			I2A	16'-4"	16'-4"							
			I2B	14'-8 3/8"	14'-8 3/8"							
		M	I1	33'-5/8"	12'-7 1/4"	0'-8"	9'-3 3/8"	0'-8"	0'-11 1/4"	32'-6"		
			I2A	13'-7 3/4"	13'-7 3/4"							
			I2B	11'-6"	11'-6"							
	S	Same as A1										

A.

18'-00" x 21'-00"

STEEL DESIGN (FS)

Roof 21'-00" Length

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
$M_0 = 5,100,000 =$ 5,100 kip in.	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	1020	2550	765	765	255	637	765	765						
12" / 6" Using 1" ϕ Bars Depth d in. =	10.5	15.5	10.5	9.5	10.5	15.5	10.5	9.5						
$A_s = \frac{M}{(20)(.866)(d)} =$	5.79	9.50	4.20	4.65	1.40	2.37	4.20							
Min. A_s = (.0025)( )(d)					2	2								
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														

1st Level Floor

$M_0 = 1682$ kip in.

Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
$\frac{3}{4}$" / 2 Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)} =$														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

(FS)

20'-00" x 21'-00"

Roof

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.

(FS)

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.

(FS)

18'-00" x 23'-06"

Roof

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.
C1	L	C	I1	39'-3"	10'-2 3/4"	0'-8"	13'-6 3/4"	0'-8"	0'-11 1/4"	38'-8 3/8"		
			I2A	18'-10"	18'-10"							
			I2B	15'-2 3/8"	15'-2 3/8"							
		M	I1	36'-5 5/8"	14'-1 1/4"	0'-8"	10'-3 3/8"	0'-8"	0'-11 1/4"	35'-6"		
			I2A	15'-3 1/4"	15'-3 1/4"							
			I2B	12'-0"	12'-0"							
	S	C	I1	30'-8 1/4"	7'-1/4"	0'-7"	11'-5/8"	0'-7"	0'-9 7/8"	30'-2 3/8"		
			I2A	13'-4"	13'-4"							
			I2B	12'-2 3/8"	12'-2 3/8"							
		M	I1	27'-5 3/4"	10'-9 5/8"	0'-7"	7'-6 1/4"	0'-7"	0'-9 7/8"	27'-0"		
			I2A	11'-8 3/8"	11'-8 3/8"							
			I2B	9'-0"	9'-0"							
C2	L	C	E3	34'-3 3/8"	10'-2 3/4"	0'-8"	5'-11 5/8"	0'-8"	0'-11 1/4"	31'-1 1/4"	13'-6 3/4"	1'-10 1/4"
			E2A	21'-4"	21'-4"							
			E4	10'-1 1/4"	7'-7 5/8"							1'-10 1/4"
			I2B	14'-11 3/8"	14'-11 3/8"							
		M	E3	32'-8 1/4"	14'-1 1/4"	0'-8"	4'-3/8"	0'-8"	0'-11 1/4"	29'-6"	10'-3/8"	1'-10 1/4"
			E2A	19'-6 5/8"	19'-6 5/8"							
			E4	6'-1 7/8"	3'-6 1/4"							1'-10 1/4"
			I2B	11'-9"	11'-9"							

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
M_o=	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s=\frac{M}{(20)(.866)(d)}$=														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s=\frac{M}{(20)(.866)(d)}$=														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
$M_0 = 5290$	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	1059	2650	794	794	265	661	794	794	1322	2910	2380	1005	873	529
12" / 6" Using 1" ϕ Bars Depth d in. =	10.5	14.5	9.5	9.5					10.5	14.5	14.5	9.5	9.5	9.5
$A_s = \frac{M}{(20)(.866)(d)} =$	5.82	10.55	4.83	4.83					7.27	11.58	9.98	6.11	5.30	3.21
Min. A_s = (.0025)(120)(d)	3.15		2.85	2.85					3.15			2.85	2.85	2.85
Min. A_s = (.0025)(96)(d)		3.48								3.48	3.48			
Use A_s sq. in.	5.82	10.55	4.85											
No. of bars														
1st Level Floor $M_0 =$														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)} =$														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

$M_0 = 4,650$	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	930	2325	698	698	233	581	698	698	1162	2560	2090	884	767	465
12" / 6"														
Using 1" ϕ Bars Depth d in. =	10.5	14.5	9.5	9.5	10.5	14.5	9.5	9.5	10.5	14.5	14.5	9.5	9.5	9.5
$A_s = \frac{M}{(20)(.866)(d)} =$	5.11	9.27	4.24	4.24	1.28	2.31	4.24	4.24	6.39	10.2	8.32	5.37	4.66	2.83
Min. A_s = (.0025)(144)(d)	3.99		3.61	3.61	1.89		3.61	3.61	3.99			3.61	3.61	3.61
Min. A_s = (.0025)(96)(d)		3.48				1.74				3.48	3.48			
Use A_s sq. in.	5.11	9.27	4.24	1.89	2.31	4.24	4.24	6.39	10.2	8.32	5.37			
No. of bars														
1st Level Floor M_0 =														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)} =$														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o=	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	1020	2550	765	765	255	637	765	765						
12" / 6" Using 1" ϕ Bars Depth d in. =	10.5	15.5	10.5	9.5	10.5	15.5	10.5	9.5						
$A_s = \frac{M}{(20)(.866)(d)}$ =	5.79	9.50	4.20	4.65	1.40	2.37	4.20	4.65						
Min. A_s = (.0025)(108)(d)	2.83		2.83	2.57	1.42		2.83	2.57						
Min. A_s = (.0025)(96)(d)		3.48				1.74								
Use A_s sq. in.	5.79	9.50	4.20	4.65	1.40	2.37	4.20	4.65						
No. of bars	8	12	6	6	2	3	6	6						
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	337	841	252	252	84	210	252	252						
8" / 4" Using $\frac{3}{4}$" ϕ Bars Depth d in. =	6.62	9.62	6.62	5.62	6.62	9.62	6.62	5.62						
$A_s = \frac{M}{(20)(.866)(d)}$ =	2.94	5.05	2.20	2.59	.73	1.26	2.20	2.59						
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

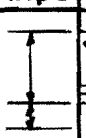
STEEL DESIGN (FS)

Roof

$M_o = 7,380$	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	1476	3690			369	922	1170	1170						
12" / 6" Using 1" ϕ Bars Depth d in. =	10.5	15.5			10.5	15.5	10.5	9.5						
$A_s = \frac{M}{(20)(.866)(d)} =$	8.07	13.72			2.03	3.43	6.43	7.11						
Min. A_s = (.0025)(120)(d)	3.15				1.58		3.15	2.85						
Min. A_s = (.0025)(96)(d)		3.72				1.86								
Use A_s sq. in.	8.07	13.72			2.03	3.43	6.43	7.11						
No. of bars	9	14			3	4	7	8						
1st Level Floor $M_o =$														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)} =$														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o=	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
 Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
 Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
M_o = 7,380	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	1476	3690			369	922	1170	1170						
12" / 6" Using 1" ϕ Bars Depth d in. =	10.5	15.5			10.5	15.5	10.5	9.5						
$A_s = \frac{M}{(20)(.866)(d)}$ =	8.07	13.72			2.03	3.43	6.43	7.11						
Min. A_s = (.0025)(120)(d)	3.15				1.58		3.15	2.85						
Min. A_s = (0025)(96)(d)		3.72				1.86								
Use A_s sq. in.	8.07	13.72			2.03	3.43	6.43	7.11						
No. of bars	9	14			3	4	7	8						
1st Level Floor M_o = 2.420														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	484	1210		121	303	313	121	121						
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =	8.07	13.72												
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o = 7210	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	1442													
Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														

1st Level Floor

M_o =

Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
$M_0 = 7,210$	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	1442	3605	1081	1081					1802	3970	3250	1370	1190	721
12" / 6"														
Using 1" ϕ Bars Depth d in. =	10.5	15.5	10.5	9.5					10.5	15.5	15.5	10.5	9.5	9.5
$A_s = \frac{M}{(20)(.866)(d)} =$	7.93	13.42	5.95	6.57					9.91	14.79	12.09	7.53	7.23	4.
Min. A_s = (.0025)(123)(d)	3.23		3.23	2.92					3.23			3.23	2.92	2.92
Min. A_s = (.0025)(96)(d)		3.72								3.72	3.72			
Use A_s sq. in.	7.93	13.42	5.95	6.57					9.91	14.79	12.09	7.53	7.23	4.38
No. of bars	11	17	8	9					13	19	16	10	10	6
1st Level Floor $M_0 = 2,360$														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips	472	1180	354	354	118	295	354	590	1299	1061	448	389		
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)} =$														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o=	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o=	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
M_o=	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
M_o=	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
M_o=	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s=\frac{M}{(20)(.866)(d)}$=														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s=\frac{M}{(20)(.866)(d)}$=														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o=	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
M_o=	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s = \frac{M}{(20)(.866)(d)}$ =														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
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Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
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Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o=	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s=\frac{M}{(20)(.866)(d)}$=														
Min. A_s = (.0025)( )(d)														
Min. A_s = (.0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
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Use A_s sq. in														
No. of bars														

STEEL DESIGN (FS)

Roof

M_o=	Interior Panel				Exterior Panel, Steel Parallel to disc. edge				Exterior Panel, Steel Perpendicular to disc. edge					
	Column Strip		Mid Strip		Column Strip		Mid Strip		Column Strip			Mid Strip		
	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Int Neg	Ext Neg	Pos	Int Neg	Ext Neg
Moment Coeff.	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using 1" ϕ Bars Depth d in. =														
$A_s=\frac{M}{(20)(.866)(d)}$=														
Min. A_s = (.0025)( )(d)														
Min. A_s = (0025)(96)(d)														
Use A_s sq. in.														
No. of bars														
1st Level Floor M_o=														
Moment Coeff	.20	.50	.15	.15	.05	.125	.15	.15	.25	.55	.45	.19	.165	.10
Moment in. kips														
Using $\frac{3}{4}$" ϕ Bars Depth d in. =														
$A_s=\frac{M}{(20)(.866)(d)}$=														
Min. A_s = (.0025)( )(d)														
Min A_s = (.0025)(96)(d)														
Use A_s sq. in														
No. of bars														

(FS)

20'

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.

(FS)

20'-6" x 23'-6"

Roof

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.
S1	L	C	E4									

(FS)

20'-6" x 23'-00"

Roof

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.
R1	L	C	I1	37'-3"	9'-11 1/4"	0'-8"	12'-8 5/8"	0'-8"	0'-11 1/4"	36'-8 3/8"		
			I2A	18'-4"	18'-4"							
			I2B	14'-8 3/8"	14'-8 3/8"							
		M	I1	34'-5/8"	13'-9 5/8"	0'-8"	9'-2 1/4"	0'-8"	0'-11 1/4"	33'-6"		
			I2A	14'-11 3/8"	14'-11 3/8"							
			I2B	11'-6"	11'-6"							
	S	C	I1	36'-1/4"	8'-10 1/4"	0'-7"	0'-9 7/8"	35'-6 3/8"				
			I2A									
			I2B									

(FS)

23'-00" x 23'-6"

Roof

Panel No.	Length	Strip	Bar No.	Bar Length	a.	b.	c.	d.	e.	f.	g.	h.
K1	L	C	E3	34'-3 3/8"	10'-2 3/4"	0'-8"	5'-11 5/8"	0'-8"	0'-11 1/4"	31'-1 1/4"	13'-6 3/4"	1'-10 1/4"
			E2A	21'-4"	21'-4"							
			E4	10'-1 1/4"	7'-5 5/8"							1'-10 1/4"
			I2B	14'-11 3/8"	14'-11 3/8"							
		M	E3	32'-8 1/4"	14'-1 1/4"	0'-8"	4'-3/8"	0'-8"	0'-11 1/4"	29'-6"	10'-3/8"	1'-10 1/4"
			E2A	19'-6 5/8"	19'-6 5/8"							
			E4									
			I2B	6'-1 7/8"	3'-6 1/4"							

S.S. FILM. B-34283

BAR PLACEMENT SCHEDULE
(FS)

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1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Panel No.	Length	Column Strip - C						Mid Strip - M				Panel Width	1/2 Panel Width	1/4 Panel Width
		Bar No.	Strip Size	Strip Loc.	No. of bars	Spac-ing	Bar e. or c.o	Bar No.	No. of bars	Spac-ing	Bar e. or c.o			