THE DESIGN OF A REINFORCED CONCRETE PARKING GARAGE FOR LANSING

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Billy Joe Shell

1949

This is to certify that the

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THE DESIGN OF A REINFORCED CONCRETE PARKING GARAGE
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OF

A REINFORCED CONCRETE PARKING GARAGE

FOR

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By

BILLY JOE SHELL

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May 1949 Billy J. Shell

East Lansing, Michigan

I N T R O D U C T I O N

INTRODUCTION

This thesis is concerned with one of the biggest problems facing all large size cities in the United States, namely, the parking problem in the central business districts. No city will commit itself to any statement claiming complete solution of their parking problem. Many noteworthy strides have been made toward solutions of this problem in various cities throughout the country. San Franciscos' underground parking garage is a fine example of a solution in high priced, heavily congested business districts. Detroit will soon begin construction on an underground parking garage on Washington Boulevard. And so it goes in all sections of the country, new solutions arise to fit particular needs.

As an insight into the problem as it exists today, the author addressed letters to the city engineers of various cities throughout the country. The cities selected for this survey were; Detroit, Michigan -- Chicago, Illinois -- Seattle, Washington -- San Francisco, California -- Houston, Texas -- New York City, New York -- Cleveland, Ohio -- and Buffalo, New York. Some of their replies can be found at the end of this thesis. The suggestions they made helped immeasurably in writing this thesis. The greatest aid was the material furnished by the Eno Foundation For Highway Traffic Control.

To design a parking garage that will help solve the parking demand, many factors must be given consideration. A parking garages success, unlike other buildings, depends on the whims and wishes of many people who have no share in the ownership of the building. The services offered by the building should be attractive enough to encourage the continual usage by its customers. To achieve this situation it must be well located and efficient in operation.

The first part of this thesis has attempted to set forth the following things; cause of parking problems, the affects of a parking deficiency, and the possible solutions of parking problems. Care was taken not to be sidetracked into too elaborate discussions of the finer points of the problem. Many books and articles have been written about various aspects of the parking problem, and the author referes the reader to these, for a more complete treatment than that which is included in this thesis.

The second part of this thesis presents a definite problem being faced by the city of Lansing, Michigan. Most of the information about Lansing's situation was taken from their Off Street Parking Study of 1946.

The final part of this thesis discusses the steps taken to design an open deck reinforced concrete parking garage, for Lansing. Computations are included of the various members used in construction of the garage. An actual site was selected and the design worked out to meet the needs of that location.

Unfortunately the available plot faces only one street, and both entrances and exits must open on the same street. This is not the ideal situation, but the design was worked out to fit these conditions.

The author wishes to call the readers' attention to the method used for referring to selected works. Each work included in the bibliography has been assigned a number, and this number, where found in the thesis, refers to the work so numbered in the listed bibliography.

May 1949 Billy J. Shell

East Lansing, Michigan

P A R T O N E

THE PARKING PROBLEM

CAUSE - EFFECTS - SOLUTIONS

***

PARKING PROBLEM

Primarily when speaking of a parking problem, we are referring to parking in the central district of a city. The central business district is that section of the city wherein lies the greatest concentration of business establishments. This district is characterized by high land values, congestion, and maximum use of all available space. In most cities the central business district provides the city with about 25 per cent of its tax revenue.[1] Considering the amount of space the business district occupies, 25 per cent is a high ratio. Therefore, the major objective of any parking improvement plan should be to protect the economic health of the central business district.[1]

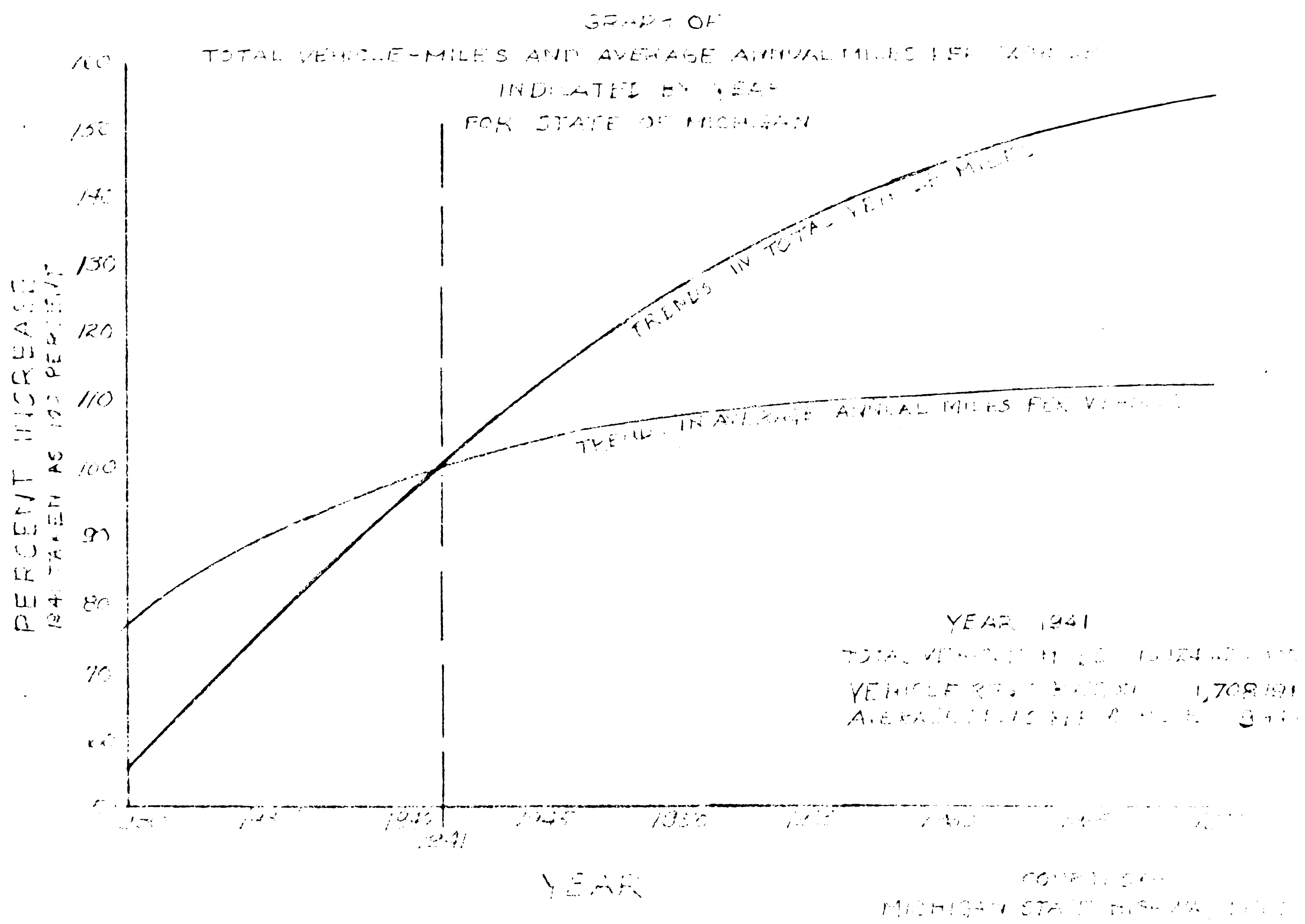
In the early days of our cities, the chief mode of overland transportation was the horse and buggy. Trails into town were satisfactory as they were cheap and generally 'passable'. Our city at that time was merely 'a general store'. As the population increased new businesses began to appear beside the general store. In time we had buildings on both sides of the trail. Where homes had once stood businesses now began to take their place. City engineers, seeing the complexities that continued increases in population were forcing on their communities, devised general plans for future developement. Few were farsighted enough to realize the value of wide streets. As a result merchants built as close to the street as possible and to this day many cities because of high land values find it

impossible to widen their streets. This is especially true in the Northeastern part of our country. Narrow streets mean congestion and a complete lack of curb parking facilities.

When the early settler came to town he tied his horse to the hitching rack in front of the general store. This act gave birth to "angle parking"as the animal was headed up to the rack.[2] As a parrallel to the early settler the modern day parker hopes when driving to the city that he can park his car at the curb in front of the business with which he desires a transaction. This is the ideal in parking, and if this condition was possible, there would be no such thing as a parking problem. It is toward this ideal that we work in attempting a solution to the parking problem.

With the passing of time the automobile began to appear on the 'horse and buggy' city streets. Blacksmith shops became filling stations, and barns and wagon sheds became garages. Small town stores began to grow and expand. Unfortunately many city planners felt the automobile was a passing fancy and refused to adjust their cities to the needs of the 'horseless carriage'. Merchants realized the closer they were to the street the greater their opportunity for business. So businesses were expanded and new ones were born always with the idea that the closer they were to the street the greater the chance of success.[2]

The rapid acceptance of the automobile completely disrupted



TOTAL VEHICLE-MILES AND AVERAGE ANNUAL MILES
INDICATED BY YEAR
FOR STATE OF MICHIGAN
TRENDS IN TOTAL
TREND IN AVERAGE ANNUAL MILES PER
YEAR 1941
1,708,191
PERCENT INCREASE
1941 TAKEN AS 100 PERCENT
YEAR
130
120
110
100
90
80
70
1941

normalcy of the cities. Congestion was commonplace. Land values soared to the sky. Every available lot in the central business district was sold as a site for a new business. Very few cities had foresight enough to reserve sections in and around the business district for the use of the municipality. Those few cities that did, found that it greatly reduced their parking demand to use these areas for off street parking.

Parking affects many groups and interests. Merchants in downtown districts strongly protest when any change is made in regulations on curb parking. They feel that the success of their business depends on the availability of curb parking in front of their shops. This idea has been disproved by surveys and observations.[1] When referring to curb parking it is well to remember that highways and streets were designed to carry moving traffic. Any parking that is allowed on these thoroughfares infringes on the rights of the moving traffic. Eventually, it is felt by leading traffic and highway engineers that parking will be completely abolished on all the main streets in the central business destricts of every city.[1] The continued growth in the number of automobiles on the road makes this a necessity. Hence, the parking problem is growing and will not be solved until we can provide adequate terminal facilities for all automobiles coming into our central business districts.

Motorists too are affected by the parking problem. The average motorist wants[3] the greatest possible convenience with a maximum of safety, a minimum of delay, and the least possible expense, when parking his car. These are the things a traffic engineer must keep in mind when attempting a solution of the parking problem. For any solution not attractive to the average motorist will die a slow death because of disuse. Of course it will be impossible to satisfy all the desires of motorists, but the closer the solution comes to the above mentioned ideal the greater its chance for success. To overlook the desires of the motorist is folly, for in the final analysis it is the motorist who determines the success or failure of any parking program.

Other agencies affected by parking such as taxis, commercial fleets, property owners, emergency vehicles, and mass transportaion require special consideration in a parking program. All with the possible exception of commercial fleets can be settled with curb allotments.[2] A careful analysis of curb space available will be necessary before setting aside special spaces reserved for the above named agencies. Commercial fleet parking, while doing business, can be provided for at terminals or in some cases from the curb in loading zones.

With a realization of the existance of a parking problem and a knowledge of those affected by the problem, we can begin our solution. It is safe to say that everyone in a community has a stake in parking. So our solution must be a community affair. Basically there are eight major steps for a parking improvement program. They are as follows:[1]

1. Get organized to do the job
2. Get the facts -- and analyze them carefully
3. Get decisions on broad policy questions
4. Institute a curb parking improvement program
5. Develop off-street parking plans and facilities
6. Develop program for loading facilities
7. Institute a public education program
8. Coordinate parking and loading improvements with related municipal problems.

This thesis will present a discussion of the first four steps of the above stated program. A more complete analysis will be made of the fifth step and it is to this phase that the work in this thesis is directed. The last three steps in this program are beyond the scope of this thesis and will not be discussed.

In getting organized to do the job, a meeting[1] with all the city officials, downtown property owners, and civic group representatives, is generally effective in getting the program underway. Present the problem to this group pointing out the fact that the job will require money and effort. A definite assignment of responsibilities to certain individuals will keep the program from lagging.

After receiving the support of the above named groups, it is necessary to assemble all the facts pertaining to the problem. No two cities will have the same problem, so it is necessary to make an original investigation. There are many different methods used in making parking surveys. Some of the important things to determine are:[1]

1. Who uses the curb and how long

2. How many off street facilities exist, how extensively are they used and by whom

3. What fees are charged and is the rate schedule attractive

4. Where people who drive into the business district live and what their major destinations are

5. How far do various classes of parkers walk from parking places to destinations.

For a complete discussion of the aims and methods of parking surveys, see the American Automobile Association Parking Manual.

To better orient the program it is necessary to get decisions on broad policy questions. Included in this category are such problems as:

1. Are new parking facilities to be publicly or privately owned

2. Where will the community get the money for public owned facilities

3. Will there be strict enforcement of curb regulations with no "fixing" in the Mayor's office

4. Should there be more emphasis downtown on short time parkers

5. Should there be fees charged at the curb and in facilities.

These are a few of the questions on which policy must be determined early in the life of the program. "Fixing" of tickets breeds a disrespect for regulations, and flagrant violations. If the regulations are not strictly enforced and adherred to, the complete value of the parking survey is lost.

CURB PARKING

One of the first steps toward solution of any parking problem is to institute a curb parking improvement program with continuing enforcement. A careful study of the present curb parking conditions may present an obvious solution. As previously mentioned any move to change the habits of curb parkers can be expected to meet with heavy opposition.

There are many evils connected with curb parking. Street capacity is greatly reduced with moving traffic being delayed by vehicles maneuvering into and out of parking spaces. Curb parking is also a very uneconomical use of space as only a fraction of the total number of street users are accommodated.[2] Then too, this space costs as much as the space used by the flowing traffic. Owing to the small number of street users that can be accommodated at the curb this setup serves to penalize the majority to give convenience to a very small minority. Curb parking also figures as a major factor in accidents.[8] Cars maneuvering to park and unpark present a continual hazard. Fire hazards,[2] decentralization, and increased cost of commerce, can be traced to the congestion caused by curb parking.

Though its evils are many, curb parking is extremely difficult to eliminate. However, by a gradual process corrections and improvements can be made which will in time condition the motorist to an absense of curb parking facilities.[1]

To analyze the parking demand it is necessary to measure the characteristics of curb parking with engineering surveys. Such surveys are generally aimed at determining the following things:

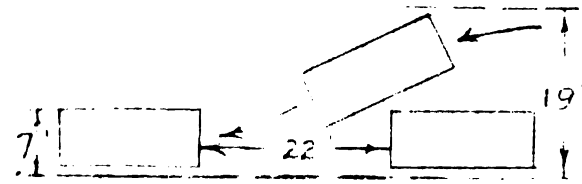
1. Total demand for curb space
2. Fluctuations in the demands at different periods of the day
3. Durations of parking
4. Types of vehicles using curb spaces
5. Concentrations in different areas.

A complete analysis of surveys with methods used can be found in "Parking" by Charles LeCraw and the American Automobile Association Parking Manual.

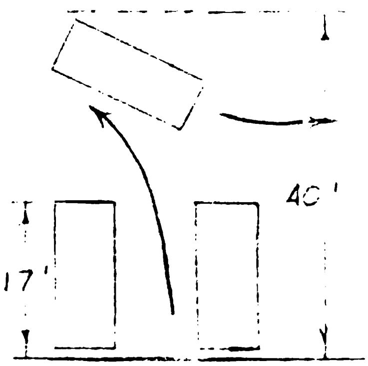
After the survey is made and a complete picture of the parking demand is available, work begins on an allottment of curb spaces. Such questions as, should there be angle parking or parrallel parking, must be decided upon. Angle parking is usually eliminated wherever it is possible to do so. The space requirements for angle parking are enormous when compared to the average availability afforded by most city streets. Most provisions for curb parking are provided for under Act V of the Uniform Motor Vehicle Code.[14] This act gives the minimum distance that a vehicle may be parked from various objects, conditions, and structures. Most states have adopted this act as their legal code.

[15] A Model Traffic Ordinance as prepared by the National Conference on Street and Highway Safety offers a good guide for setting up a curb parking plan. It recognizes regulations

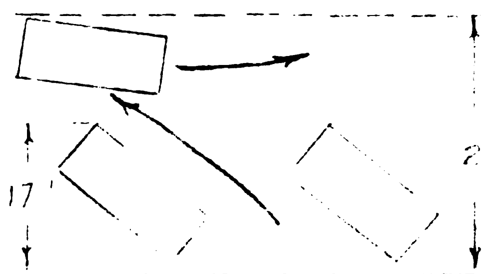
STREET SPACE USED FOR VARIOUS PARKING POSITIONS **



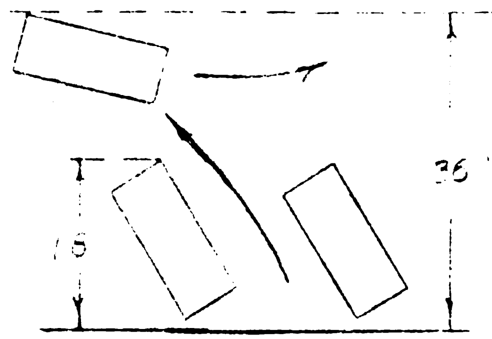
PARALLEL PARKING



RIGHT ANGLE PARKING



45° ANGLE PARKING



60° ANGLE PARKING

Position at Curb	Width of Street Used When Parked	Width Req'd for Parking Plus Maneuvering	Length of Curb Per Car*	Cars Parked per 100 feet
Parallel	7	19	20.0	5.0
45 degrees	17	29	11.3	8.8
60 degrees	19	36	9.2	10.8
90 degrees	17	40	8.0	12.5

*Based on angle parking in stalls 8 feet wide including lines, and on 3 feet between cars parked parallel

** Courtesy-AAA Parking Manual

of the Uniform Motor Vehicle Code and also provides regulation of Parking as to place, time, and circumstance.

Parking meters have become quite prominant as a means of controlling curb parking. Practically overnight they became commonplace in most fair sized cities. However, it must be remembered that parking meters do not add any additional curb space, but merely create a much greater turnover in curb usage. Many cities have employed the revenue received from these meters to provide additional parking facilities off the streets.[2] This is the method Lansing is using to finance its off street parking program. Care must be taken in using meters not to forsake safety by metering closer to intersections and prohibited parking zones merely to increase revenue. Meters are only effective too where proper enforcement is exercised.

To improve curb parking conditions the following requirements must be met:[1]

1. All regulations must be reasonable and warranted

2. Regulations must be clearly and simply set forth on signs and these must be properly maintained

3. All leaders of government - legislative, executive, and judicial - must support the regulations, and there must be no "fixing" of parking tickets; all violators must be substantially and (for the same violation) uniformly punished

4. The public must be kept fully informed so that there is widespread understanding of the reasons and need for the regulations and of the need for compliance by everyone

5. There must be enough police for this enforcement work so that a year round program of daily impartial enforcement is carried on "without lapses."

With curb parking it is necessary to maintain rigid control. Eventually all curb parking on the main streets in business districts will be eliminated, but as long as curb parking exists careful supervision is necessary.[2] To allow reckless use of available space only encourages accidents, congestion, and loss of business to that element of a town it is so necessary to keep economically healthy. Many would be customers prefer to drive extra miles to an outlying business district rather than brave the congested streets of the central business district. Decentralization results in a lowering of land values in the central business district. This in turn lowers the amount of revenue the city receives in taxes. This reduction must be offset by an increase in the amount of tax paid by the land owners in the community. So it becomes quite apparent that all the citizens of a community have a very definite interest in the health of their business district.

OFF STREET PARKING

The solution of the parking problem of a central business district can never be solved with curb parking. Additional facilities must be provided off the streets. At the present time off street parking facilities are far from being adequate in most business districts. This is not necessarily due to the absense of the facilities, but in many instances is due to their locations, or high costs to motorists. Inefficiency in their operation also makes them less desirable to the motorist who is 'in a hurry'. The presense of these facilities has often hampered the developement of needed parking facilities, by giving city officials a perverted view of their space demands. Unless a parking space is used by the public, it cannot rightly be considered in the solution of a parking problem.

Motorists who park their automobiles may be divided into two groups: the short time parker, and the all day parker. Each group has definite characteristics and present entirely different problems. The short time parker rushes down town, stops at one store for fifteen minutes to two hours, and then departs for home. He demands a parking place close to the business with which he desires a transaction. A place at the curb is ideal, for he is not willing to walk very far due to the short time required for his transaction. Then too a small fee is all he will pay due to his brief stay. Thus, the problem connected with a short time parker is to have a place where he can park and unpark in a hurry at a low fee, and still be close to the heart of the business district.

An all day parker is willing to walk much further from his parking place to his destination. Thus he is not so concerned with the speed of parking and unparking, although he does demand a low fee. Parking places for this type of parker are generally located on the fringe of the central business district.

One solution will not solve both problems, as the cost of land varies greatly from the fringe area to the heart of a business district. Neither parker is willing to pay a large fee, so a rapid turnover is the only means of increasing revenue. This restricts the parking facility in the heart of the business district to the use of the short time parker.

When determining parking requirements, it is necessary to determine the businesses to be served. This is not apt to be too accurate however as most shoppers visit many stores while parked in one lot. However it does serve as a guide and the results from using this method have been fairly satisfactory.[1] The table following, shows the parking requirements generally insisted upon by most zoning regulations.[1]

Types of Buildings	ONE Parking Space Required for each		No. of Cities Represented
	Average	Range of Middle 2/3	
Theaters, auditoriums,	7 seats	4-10 seats	24
Retail Business	400 sq.ft.	300-500 sq.ft.*	8
Office Buildings	460 sq.ft.	400 sq.ft.** 500 sq.ft. 500 sq.ft.	3
Restaurants	(See notes)	50 sq.ft.*** 100 sq.ft. 5 seats	3
Hotels	4 guest rooms	3-4 guest rooms	14
Industrial Buildings	3 employees 750 sq.ft.	2-4 employees**** 400-800 sq.ft.	5 4
Single Dwellings	1 unit	1 unit	11
Multiple Dwellings*****	$1\frac{1}{2}$ units	1-3 units	33

NOTES:

* Usually square feet of space devoted to sales.

** Represents all three having such requirements.

*** One per 50 square feet devoted to patron use; one per 100 square feet of total floor area.

**** Parking requirements based on number of employees and on gross floor area shown separately.

***** Represents grouping of all areas where multiple dwellings are permitted. Usually more parking space per dwelling areas than in comparatively low grade areas.

Proper coordination of off street parking facilities with major traffic arteries is a must. Facilities must be designed and operated to prevent the tieup of traffic around the exits and entrances. Flow characteristics of traffic past a garage should be studied. Off street parking areas should be accessible to vehicles arriving in the business district on major streets. Careful design of entrances and exits for facilities abutting on major streets must be carried out to prevent the interruption of traffic on those routes. Generally it is better to locate a parking garage or lot on a side street.

Most communities have found it necessary to subsidize off street parking facilities. Just how far a community can go in this direction seems to vary with different communities.[1] Some believe that off street parking facilities should be provided solely by individual enterprize. They have the idea that a municipality shouldn't compete with an individual. Others feel that community projects would involve use of public money to benefit a very few. Many objections have been raised, but the experience has been that private enterprize doesn't provide enough parking facilities to meet the demand. Therefore cities have, of necessity, assumed control of curb parking and public parking lots.

What has really brought this issue to the public eye, is the loss of business to outlying positions. Merchants have demanded the cities do something to protect their investments. Therefore, community controlled parking projects have become the order of the day, and will greatly increase in the future.

A strong argument for public control of parking facilities, is the theory that facilities for parking automobiles may eventually be looked upon as extensions of the highway and street systems.[2] This would distribute the cost of parking facilities much as the cost of highways are borne. Communities also can operate facilities without such a demand for profit. This would result in lower fees and greater usage. Community control maintains the health of the business district by insuring the adequacy of parking facilities. The people of Detroit showed their feelings about community control by approving, by popular vote, the issue of revenue bonds for the construction of an underground parking garage beneath Washington Boulevard.

Municipal control of parking facilities eliminates many "eyesores" in the business district. Parking lots in particular are generally poorly maintained and improperly cleaned. Their general appearance detracts from the beauty of the city. Then too, municipal control assures permanence. Parking lots are oft times sold as building sites, creating an even larger parking demand. Many cities have worked out zoning laws which demand all new businesses to provide parking spaces; the number being determined by the area of their building floors. This serves to maintain the value of the parking program as one new business opening in the heart of a business district could completely disrupt the parking situation. With these arguments facing them, communities seem destined to control off street parking irregardless of their feelings.

As important as the parking facility itself is the matter of its location. Most lots that exist now came into being because the buildings that occupied them, became so unproductive that owners razed them and used the land for parking. Hence there was no particular planning for a parking lot - - merely a last resort as a source of possible revenue. This haphazard manner of locating lots, didn't offer much as a solution to the parking problem.

One method of locating lots is to make use of block interiors. It has been found quite useful in heavily congested cities. A rather complete study of this method of location has been worked out by Charles S. LeCraw in his thesis entitled, "An Economic Study of Interior Block Parking Facilities". The principle that makes this type of solution possible is the fact that generally there is a large space left between buildings in the center of the block. This wasted space can be utilized to help fill parking needs. Mr LeCraw discusses many ways of appraising the value of these interior spaces. One way is the Somers Depth Curve which establishes a mathematical relationship between any two parts or sites, affected by a single street influence, and makes possible the systematic treatment of varying depths for purposes of valuation.[4]

Making use of block interiors has made possible solutions for many heavily congested cities whose high land values make the purchase of lots for parking facilities a very unwise financial venture. Lansing, however, has many sites that are vacant or occupied by low cost buildings, so this approach is not necessary.

One of the biggest problems that generally stops a parking study, is the high price of land suitable for use of parking facilities in the downtown area. In sharp contrast the land on the edge or "fringe" of the business district is relatively cheap.[1] However, the initial investment should not be the governing factor. All too often fringe areas have been developed only to find they were too poorly located to be used. Along this line "fringe" parking with public transportation downtown has proved quite satisfactory in some cases. However, this plan has been tried and abandoned in many cases due to a lack of patronage. In some instances the community owns land already which is quite well suited to parking. Proper use of this often eliminates much of the parking deficiencies. The approach, therefore, becomes a problem of location as well as design.

TYPES OF PARKING FACILITIES AND THEIR RELATIVE COSTS

The most common method of providing off street parking space is the parking lot. These lots get about 78 per cent of off street parking business.

Parking lots may be generally attributed to the depression.[2] Owners wishing to get a little revenue from their investments turned the land into parking space. Most lots were started as a temporary situation, and an attractive offer for the property generally resulted in a sale as a building site. This situation created additional parking demand. Hence, private owned lots can not be relied upon as being permanent. Parking lots are not too lucrative a business, therefore, supply and demand does not solve this problem. Generally, the first opportunity to use the land for another purpose results in the loss of a parking lot. As an insight into the cost of investment and operation of a parking lot, see the following table. No cost is made for improvements as there are generally no improvements, depreciation, or obscolescence.[1]

PARKING LOT OPERATING COSTS

Typical lot valued at $400 per car space of 170 feet
(which includes lanes for movement)

Item of expense	Annual cost per car space	Per cent of Total
Taxes	$10.00	15.4
Wages	23.00	35.4
Maintenance and Misc.	8.00	12.3
6% return on value	24.00	36.9
	$65.00	100.0

For 300 full days operation per year each space must take in 21¢ daily.

To make parking lots permanent it is necessary to make their appearance blend with surrounding properties. Operating standards should be such as to encourage their usuage.

Lots should be graded and surfaced to keep down dust. Fences or barriers should surround the lot. These will greatly add to their beauty. Entrances and exits should be well marked to prevent confusion. Signs with prices marked should be displayed prominently. Stalls should be marked to provide an orderly parking and maximum use of the space. Adequate reservoir space should be provided to prevent congestion on the street. Lot owners should be made responsible for loss or damage to cars. Careless handling of automobiles has done much to drive business away from lots. Operators should be bonded to insure making good their losses.

Claim checks should be issued at the parking lots. The more important features that should appear on the check are; license number of the car, the date, and time the car was accepted and removed. More elaborate checks are often used, but generally the above mentioned have been found most satisfactory by both customer and owner.

Operating licenses should be required. This provides a means of keeping the owners under control.

There are many different ways to lay out a lot for parking purposes. Where motorists park their own cars, 45, 60, and 90 degree parking may be used. Where attendants park the cars, only 90 degree parking is used, as this offers the most effective utilization of the available space. Some of the possible layouts are illustrated on an included plate.

Odd shaped lots may determine the setup to be used. Where possible 90 degree parking is advocated, though for average motorists it is too difficult for him to guide his car into the narrow confines of a 90 degree stall.

As long as lots can satisfy the demand they should be used due to their low initial cost and maintenance.

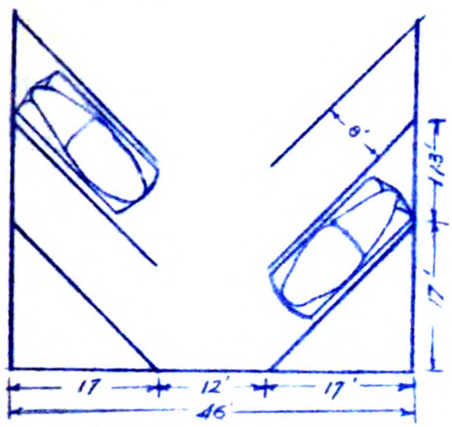
When speaking of off street parking facilities, the question always arises whether to use attendant or customer parking. The arguments are fairly strong on both sides. The problem seems to vary with each new parking facility.

With the use of attendant parking in parking garages, the motorist merely drives into and out of the building. About all he normally sees is the cashiers office, waiting room, and reservoir. Attendants park cars and have complete control of all movements within the garage. This speeds the operations as attendants become quite adept at handling cars in limited spaces. Then too, they use a minimum amount of space and allow parking of more vehicles over a given area. Some of the disadvantages are an increase in operating costs; and often in busy periods attendants are unable to deliver cars as fast as customers call for them.

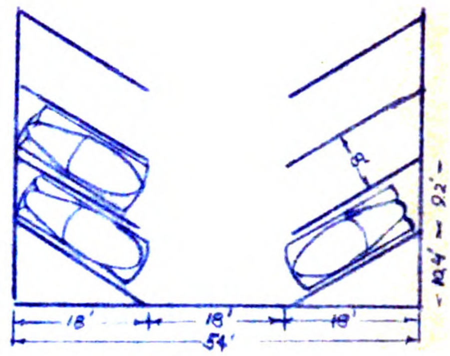
In customer parking the motorist drives his own car to the parking stall. He drives up and down ramps and completes all the movements necessary for parking. The advantages of

Parking Lot Layouts*

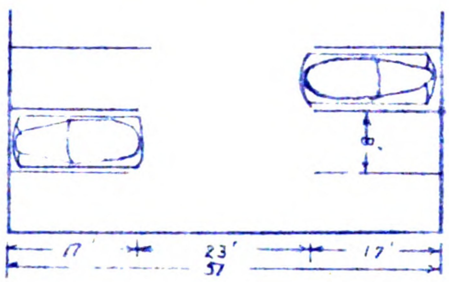
Two Rows of Cars - 45 Degrees
Self Parking - 280 sq. ft. per Car +



Two Rows of Cars - 60 Degrees
Self Parking - 270 sq. ft. per Car



Two Rows of Cars - 90 Degrees
Self Parking - 224 sq. ft. per Car



+ includes aisles & waste space

* Courtesy AAA Manual

Remarks:

1- 45° stalls - easiest to get in and out of

2- 60° stalls - used on lots too narrow for 90°
used when turnover too high for 90°

3- 90° stalls - less waste space - used almost exclusively in parking garages this method are the saving of attendants wages, and customers handling their own cars and locking them. Some of the disadvantages are more space required for each car parked, congestion around parking stalls, and the refusal of some drivers to drive on ramps.

An analysis of both methods is necessary to determine the one to fit any special project. In any garage over three floors high, attendant parking is a must. Attendant parking will be used in the Lansing garage.

PARKING GARAGES

Where parking lots will not satisfy the parking demand, parking garages are used. Parking garages are distinguished from lots by;[3] giving more stalls in a given area, permanency, and a larger investment. These features emphasize the importance of good design especially in providing for the rapid handling of cars, and the adaptability to future changes of car design.

There are two general classes of garages; namely, the enclosed garage, and the open deck type of structure. The enclosed garage is as the name implies. It may be one or more floors connected by ramps or elevators which convey the automobiles to their stalls. Lighting, heating and ventilation, must be provided for. The enclosed garage is a product of the days when open touring cars were in fashion. Many quite elaborate structures have been built and many of them have become white elephants due to their complete abandon by the parking public. Because of their high initial cost and maintenance charges, the fees charged are quite prohibitive to all except the "carriage trade" who are seemingly quite willing to pay for added services. Unfortunately, for many owners, the business afforded by the "carriage trade" isn't enough to meet all expenses and realize any profit. This type of garage has fallen into disuse, And no recent garages of this type have been built.

The type of garage enjoying wide acceptance in this country today is the open deck type garage. Due to the simplicity of design, and ease of construction, it is possible to build this type of structure for about one quarter to one third the cost of an enclosed garage. The open deck garage is a building of two or more floors connected by ramps. Parapet walls are used to act as barriers to prevent cars from being driven over edges. Cars are parked on each floor. No provision is made for heating or ventilation. With the entrance of waterproof steel bodies for automobiles, weatherproof storage facilities are no longer necessary.

As the construction economy of parking garages is the primary concern of most communities, the open deck type garage is the one generally decided upon. The enclosed garage just can't compete; so hereinafter, the discussion will be entirely of open deck type parking structures. Many cities have employed underground parking facilities but only where on other space is available. It is interesting in observing the Lansing report to note the different possibilities offered toward a solution.

OPEN DECK PARKING STRUCTURES

The physical characteristics of a parking garage consist of a main floor, and several storage floors connected by ramps. Some garages are blessed with features of terrain that allow entrances and exits on each floor, eliminating the need for ramps. Such a case exists in the new garage being constructed in Ann Arbor, Michigan. In such a garage each floor is treated the same as an individual lot.

The main floor of a parking garage contains exits, entrances, reservoir space, cashiers cage, and other facilities depending on the design. The reservoir space is that space between the ramps and the entrances and exits, in which cars in excess of the rate of parking by attendants are absorbed. This space is most important to the success or failure of a garage.[3] Failure to recognize this importance when designing, adds a definite liability to the garage. Insufficient space means congestion in the bordering street, and a loss of customers. A general requirement[1] that has been found satisfactory is some garages, is allowing seven to ten spaces for each hundred car capacity. However, this requirement must be adjusted to meet the particular need of each garage. To be on the safe side, it is a good rule to make the reservoir space as large as the size and shape of the garage will allow. Open reservoir space can usually be readily converted to other uses where necessary, but it is seldom possible to convert unplanned space into reservoir use.

Many garages provide rest rooms and check rooms for the convenience of customers. However, inclusion of these facilities merely increases operating expenses. Generally too, there is not too great a demand for these services. It is necessary to provide rest room facilities for employees. Cashiers usually can handle all required checking in small garages.

A waiting room should be designed with the idea of providing comfort while waiting for the delivery of an automobile. They should be clean and orderly with chairs facing the direction where cars are to be picked up. Careful design will eliminate the necessity of the attendant running through the waiting room looking for a customer.

Many garages find it advantageous to lease out the first floor to private businesses as a means of lowering costs. Service facilities are added to provide a profit margin in many garages. Greasing, washing, and general repair of automobiles, are some of the services that have been received favorably. The idea of having these services rendered, while normally parking, pleases many motorists. These added features, when well managed, attract new business and increased usage.

Communication systems have varied from loud speakers to telephones, telautographs, and pneumatic tubes.[3] Some thought has been given to installing electric eyes opposite each parking space with a control board in the office. Where parking meters are used in customer parking garages the electric eye would indicate any automobile illegally parked. While quite expensive at the present time, they might find favor in future years. With this means of operation, one or two attendants could efficiently operate an entire garage.

Storage floors of a parking garage are generally all the same with the exception of the roof which has no columns. The layout of the various floors is determined by aisles and parking stalls. Many old garages have lost their value as they were not designed flexible enough to fit the needs of the present day automobile. Built under erroneous assumptions concerning future car trends, they have lost much of their efficiency. Flexibility and adaptability to changes in car dimensions, are necessities of good design.

It is very difficult to predict the future trends in automotive design. However, analysis of present day models with models of a few years back, show no great changes in demensions. It should be safe to assume that automobiles will not change very much in the future in length and width. Some off size cars will be handled in the garage, but they can usually be accommodated at the ends of aisles.

Many experiments have been made to determine necessary stall widths.[1] For a model automobile of eighteen feet in length, with a width of six feet-four inches, a stall of eight feet for attendant parking, and eight foot-six inches for customer parking, has been found satisfactory. This width is for "back-in stalls" at right angles to the aisles. Eighteen feet is allowed for the length. These dimensions are open to a lot of controversy as many recommend smaller and larger spaces. The author has found these to be about average.

The three car bay is the unit most frequently used. Two and four car bays are used only to suit certain layouts. Aisles are generally accepted as being 22 feet in width. Various layouts can be worked out depending on the type of construction selected. Spacing of columns is the biggest factor in floor layouts.

P A R T   T W O

THE PARKING PROBLEM

- OF THE -

CITY OF LANSING, MICHIGAN

***

LANSING'S PARKING PROBLEM

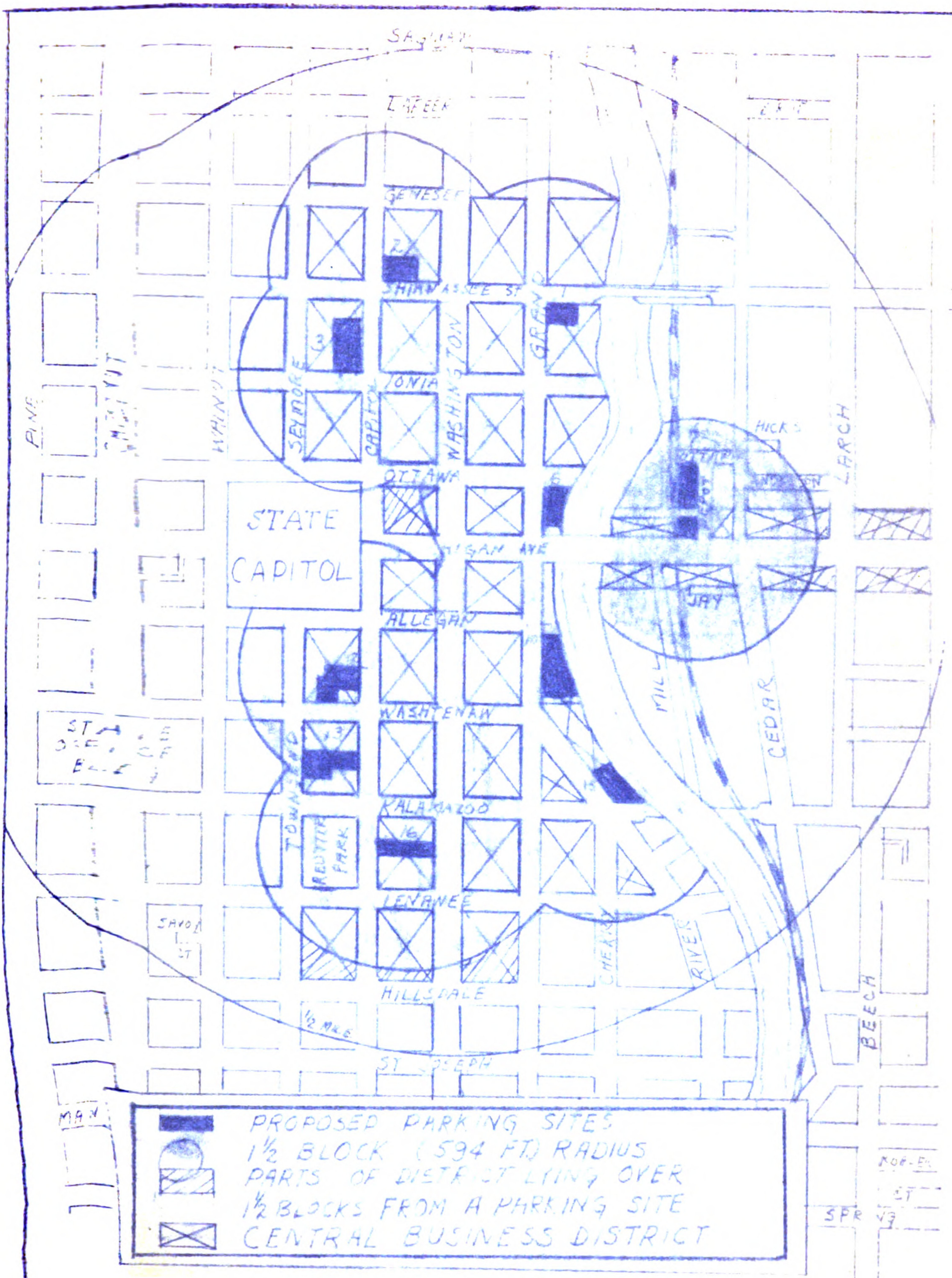
The city of Lansing, Michigan became aware of their parking problem early in 1946. The city planning engineer, C. M. Dwight Wood, felt that, and I quote, "Plans for adequate off street parking in the central business district of Lansing should be made as soon as possible and these plans immediately processed to assure the future prosperity of the City and discourage costly decentralization of our Major Business District".

At Mr. Woods request a Parking study committee was formed to make a study of off street parking needs and recommend a Parking plan for the central business district. Included on the committee was:

Lucius D. Mills, Planning Commissioner
C. M. Dwight Wood, Planning Engineer
Charles E. Ecker, Traffic Commissioner
Sidney Anger, Traffic Engineer

George Arbaugh, Member H. B. Thompson, Member Ralph Toaz, Secretary Mgr.	Merchant Division Lansing Chamber of Commerce

This committee set forth to analyse the parking needs based on the demand of twenty-five years later. They felt that the streets were dedicated as routes over which to travel. Any parking that was allowed was a privelege, and one they must forego in the future. Hence, the need for developing adequate off street parking became a must.



GENESEE
SHIAWASSEE ST
IONIA
OTTAWA
ALLEGAN
WASHTENAW
KALAMAZOO
LENAWEE
HILLSDALE
PINE
WALNUT
SEYMORE
CAPITOL
WASHINGTON
GRAND
STATE CAPITOL
TOWNSEND
REUTTER PARK
MILL
CEDAR
LARCH
JAY
BEECH
1/2 MILE
PROPOSED PARKING SITES
1½ BLOCK (594 FT) RADIUS
PARTS OF DISTRICT LYING OVER 1½ BLOCKS FROM A PARKING SITE
CENTRAL BUSINESS DISTRICT

This committee filled the first major step of our parking program. They were organized to do the job.

After the committee was formed, step number two was put into practice. The committee set out to get the facts and analyse them carefully. They first analysed the number of off street parking facilities available as to present and future needs. Boundaries were set defining the limits of the central business district. Letters with reply cards were sent to a cross section of the population soliciting their suggestions on parking facilities. Also, information was requested concerning personal parking habits which might affect parking demand. Included amoung these were such questions as;

1. What time do you arrive downtown and when do you leave for home

2. What streets do you drive on

3. Where do you park

The result of step number two is given on the following
16
page.

PARKING FACILITY ANALYSIS

Present Facilities

Off Street (25 Lots and 3 Buildings) - - -		2,264
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 Auto-mobile	Persons Per Car	No, of Cars	Parkg Turn-over	Parkg Requir-ed
Labor Force	10,000	6,000	1.4	4,200	1.1	3,890
Shopping Force	15,000	9,000	1.7	5,290	5.0	1,058
Business	1,500	900	1.7	529	2.0	265
Recreation	500	300	1.7	176	2.0	88
Total Normal Day	27,000	16,200	1.6	10,275	2.5	5,301

Peak Day - Plus 15% of Normal - - - - - - - - - - - -		795
Total Peak Day - - - - - - - - - - - - - - - - - - -		6,096
Anticipated Increase of 40% - - - - - - - - - - - - -		2,438
Total Future Requirements - - - - - - - - - - - - -		8,534
Assured Future Facilities		
Street Parking (Not over 25% of Present)	475	
Off Street Parking (3 Buildings)- - - -	415	
Total Future Facilities - - - - - - - - - - - - - - -		890
Future Deficit - - - - - - - - - - - - - - - - - - -		7,644

From the analysis shown, it becomes obvious that there is a need for providing off street parking facilities for over 7500 cars in the near future. As discussed previously in this thesis, these facilities must be established on public land to insure permanent use as parking facilities. How will this parking demand be filled?

As previously discussed, the distance motorists are willing to walk, depends on the time required for their transactions. One central building will not satisfy this requirement. Off street parking facilities must be strategically placed within the heart of the business district in efficiently designed facilities which provide rapid acceptance and delivery of automobiles. Outlying districts and large cumbersome buildings are ruled out as means of satisfying the needs of a shopping public.

Three plans were decided upon for study by the parking committee. The first plan involved parking over Grand River. This plan called for bridging the river and using this space for parking purposes. The cost per parking unit of such a venture would be $3,054.74. Most popular retail stores and offices would be over 1100 feet from this parking area.

The second plan involved use of underground parking facilities. Such heavily congested cities as San Francisco and Detroit, have found this method their only solution. Underground parking is very expensive, but where no other space

ECONOMIC ANALYSIS OF

				ONE LEVEL			SELF PARKING	
[illegible] NUMBER	ASSESSED VALUATION	TAX ★ RETURN	PURCHASE ESTIMATE	SURFACING COST †	METER COST ⊙	TOTAL COST	CAR CAPACITY	ANNUAL GROSS
1	$ [illegible]	[illegible]	[illegible]	5,443.20	6,1[illegible]	76,603.20	112	8,400
2	[illegible]	4[illegible]	56,500	5,589.00	6,325	[illegible]	115	[illegible]
3	[illegible]	425.00	50,000	6,[illegible]	7,[illegible]	64,[illegible]	138	10,350
6	49,000	[illegible]	[illegible]	4,[illegible]	5,[illegible]	10[illegible]	[illegible]	[illegible]
7	31,000	527.00	3[illegible],000 ✓	11,421.00	17,92[illegible]	[illegible]	230	17,225
10	83,000	1,013.00	50,000 ✓	5,532.00	[illegible]	62,432.00	120	[illegible]
12	60,000	1,020.00	120,000	2,[illegible] 40	6,[illegible]	13[illegible]	123	[illegible]
15	35,000	[illegible]	76,000	[illegible] 40	7,035	[illegible]	124	[illegible]
[illegible]	15,000	285.00	[illegible]	[illegible]	8,600	42,[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	4,[illegible]	4,[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	4[illegible],750	7,[illegible]	[illegible]	[illegible]	75,[illegible]	[illegible]	1,[illegible]	[illegible]

★ Tax Rate — $19.00 ⊙ $55.00 per Unit

† Black Top — $1.75 sq. yd. ✓ [illegible]

OFF-STREET PARKING PLAN NO. 3 *

THREE LEVEL		SELF PARKING		FIVE LEVEL		ATTENDANT PARKING		
BLDG & [illegible]	TOTAL COST	CAR CAPACITY	ANNUAL GROSS	BUILDING COST	TOTAL COST	CAR CAPACITY	ANNUAL GROSS	
242,450	307,450	[illegible]	25,200	383,300	448,300	750	52,500	1
249,575	305,575	345	25,875	383,400	43[illegible],300	705	52,[illegible]	2
295,770	345,770	414	31,050	460,000	510,000	910	63,[illegible]	3
266,000	3[illegible]	300	22,500	332,690	4[illegible]	625	45,[illegible]	6
[illegible] 775	[illegible]	705	52,875	783,330	814,330	1,455	10[illegible]	7
2[illegible]	30[illegible]	360	27,[illegible]	4[illegible]	4[illegible]	950	56,[illegible]	10
[illegible]	396,460	372	27,900	41[illegible]	[illegible]	[illegible]	[illegible]	12
279,285	344,285	387	29,025	[illegible]	[illegible]	[illegible]	[illegible]	13
253,200	[illegible]	[illegible]	27,000	4[illegible]	430,[illegible]	[illegible]	[illegible]	1[illegible]
186,190	[illegible]	[illegible]	[illegible]	[illegible]	384,[illegible]	[illegible]	4[illegible]	[illegible]
2,766,[illegible]25	3,4[illegible]	3,5[illegible]	2[illegible]	4,273,730	4,94[illegible]	7,[illegible]	5[illegible]	
			8.4 %				12 %	

ATTENDANT PARKING

3,183,330 4,796 35[illegible]

* [illegible] Parking Study

is available it has been employed successfully. Lansing, however, has no park located well enough to be adapted to this use. The front lawn of the Capitol building would be the only "park like" location available which would be centrally located. Permission to use this area would be very difficult to obtain, as it is owned by the state. The only other possibility would be to provide parking under streets. This would necessitate reinforcing neighboring building foundations. Cost per parking unit for this type of construction was estimated at $4,844.17.

The third plan discussed was the use of parking lots and buildings within the business district. Thirty-two locations were found available for this type of usage. All were either vacant, of supported low cost buildings. Ten of these sights were selected for location, parking capacity, and traffic distribution. Selection of these sites brought practically all the property in the business district within one and one-half blocks of at least one of them. (Note map). When fully developed with parking buildings they will have a potential capacity of 7,940 cars.

The cost of any parking garage space is dependent primarily on the cost of the land, and the cost of construction. These features cause the price to vary greatly from city to city. Lansing figured its price per parking unit at $620.20. This is about the average cost throughout the country. A comparison of prices of the parking units for the three plans, quite naturally leads to the selection of plan number three. Various sketches have been included for a visual inspection fo the proposed solution.

After selection of plan number three the committee drew[16] the following conclusions;

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 10 units can be developed separately and to such degree as parking demands require at this particular location.

   It may be found that a surfaced lot with meters will be adequate at one location for several years while another location may need a full capacity building now.

4. It is the most economical plan to build.

5. It has an estimated parking unit cost of $620.20 against $3,054.74 for Plan No. 1 and $4,844.17 for Plan No. 2.

6. This plan can be completed without cost to the City.

   The acquisition of the 10 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 to be repaid from parking earnings.

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

8. It is the most economical plan to operate.

9. Each lot should be equipped with two hour meters that will take three nickels, making it possible for the customer to park his own car for a period up to 6 hours. These lots would not require an attendant, only a periodic check by the Police Dept..

10. The parking charge would be 5 cents for each 2 hours.

11. The first buildings erected on each location should be three level (one level below grad, one level at grade and one level above grade) structures so designed that two or more levels can be added when needed.

    These three level buildings should also be metered allowing personal parking and would require but one attendant to check available space and violations.

12. 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 $85,000.00 to $500,000.00 to the City annually which might relieve property taxes or make possible an earlier realization of planned public improvements.

The committee recommended that the city adopt Plan No. 3. As soon as locations 1, 2, 3, 7, 12 and 15 were acquired, they should be equipped with meters and put into service. When Lots 6, 10 and 13 were acquired, three level buildings should be put on these sites.

This plan will eventually be put into operation in Lansing. Progress up to now has been very slow as the city is very hesitant about going into debt. An attempt is being made to complete the project as much as possible from the revenue derived from parking meters. The hesitancy of cities to commit themselves is a strong argument for private developement.

P A R T T H R E E

LOCATION AND DESIGN

- OF AN -

OPEN DECK PARKING GARAGE

- FOR -

LANSING, MICHIGAN

***

LOCATION OF THE STRUCTURE

A complete study of the Lansing parking plan emphasized the immediate need for parking space in location number 10. (See Map). This location is on South Grand Avenue with the back of the lot facing the river. Proposed plans call for buying four lots of 66 foot width and varying depth. The depth varies due to the meandering of Grand River.

The possibilities of developement of this site were discussed at great lengths with the city planning commissioner. About all the city had accomplished was selection of the site. The four lots selected lay within the center of a block. This necessitates the presense of the exit and entrance on the same street.

Lots 2, 3, 4 and 5 are to be used for the parking structure. Lot number one is occupied by the Pontiac showroom and garage. There is a limited amount of space behind this garage on which an entrance could be designed by means of a connecting road to Washtenaw Street. This however, offers certain disadvantages. Some civic minded councilman has suggested the future developement of a drive all along the Grand River. Such a plan if put into effect would disrupt the operation of any back entrance to the garage.

It is felt in the planning division of Lansing that eventually there will be a program of one way streets. There has been much agitation on this idea, and some measure will probably be taken in the not too distant future. If such a plan is put into effect, Grand Avenue would be made a one way street. For the purposes of a parking garage this would greatly simplify the entrances and exits. More room and less interference would be offered to arriving and departing traffic in the one way street. This idea was kept in mind while laying out the entrances and exits.

This area as it exists today contain three buildings and a parking lot. All of the buildings will have to be moved or razed to complete the construction. The ground itself is level and well graded. Evidences of a heavy foundation in the rear of lot four suggests the presense of some large building at one time. The depth of the lots varies from approximately 190 feet to approximately 145 feet. There will be no need for fill and possibly some of the excavated material can be dumped over the edges next to the river to help straighten out the bank.

There are no underground facilities present that would interfere with this construction. After clearing off the existing buildings, work can begin on the foundation.

The shape of the ground parcel on which the garage is to be constructed, is irregular and offers the possibility of many different designs. For ease of construction and operation the author selected a rectangular building of dimensions, 264 feet by 145 feet. This allows maximum rectangular space still allowing some distance from the edge of the river. There are many advantages to a rectangular building. Among these, are the facts that; it makes maximum use of all available land, layout of parking bays is more uniform, and in general there is much less wasted space.

Flat Slab - Interior Bay

Drop Panels

[illegible]

Use ACI 1941

[illegible]

[illegible]

Design [illegible]
Use [illegible]

[illegible]

General Data

$f'_c = 2500$ psi $f_s = 20000$ psi $n = 12$

$K = 196$ $j = .867$

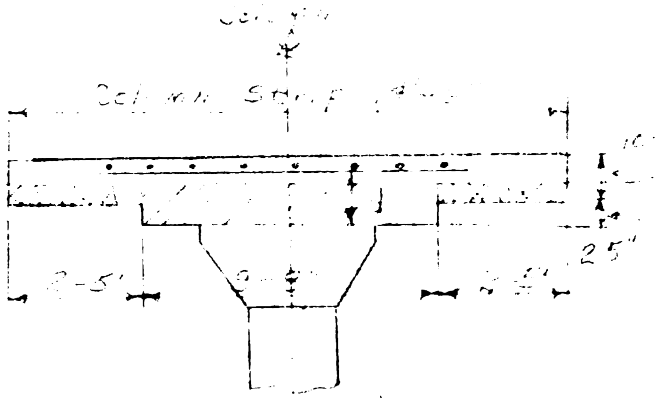
$f_s j = 17340$ psi

Capital dia $= 5'$-$10''$

Drop $- 9'$-$3''$ square

Live load $= 100$ psf*
$10.5''$ slab $= 132$ psf

Total $= 232$ psf



+ No scale

* Buildings Code [illegible]

min t = .026 L [illegible] = [illegible] = 9.25"

[illegible] panel = .05 × 29 × [illegible] = 10.4'

[illegible] 16.5 in.

ACI 1956 [illegible] increase

[illegible] with the [illegible]

[illegible]

$\frac{57-25}{4}$ = 10.5 + 5.75 = 16.25"   [illegible] t = 13"

W = 21 × 2[illegible] × [illegible] = 175,[illegible] lb in

Drop 9.67 × 9.67 × [illegible] = [illegible] lb in

Total [illegible] lb in

M_0 = .09 (29 − .93 c)^2 [illegible]

= .09 ([illegible]) 12 × [illegible] = 4,160,000 [illegible]

This moment is divided between positive

and negative moments

Column Strip

+M = .2 M_0 = 832,000 lb in

R = $\frac{832{,}000}{14.5 \times 12 (9 \ldots)^2}$ = 9[illegible] < 196 ∴ OK

d = $\sqrt{\frac{832{,}000}{196 \times 14.5 \times 12 \times .75}}$ = 7.95"

t = 7.95 + 1.5 + .75 [illegible]

$-M = .50 M_o = 4,3[illegible]$ in#

$t_1 = .02\sqrt{\frac{[illegible]}{116\times116}} + 1\frac{1}{2} = 12.85 < 13"$ ∴ Use 13" Drop

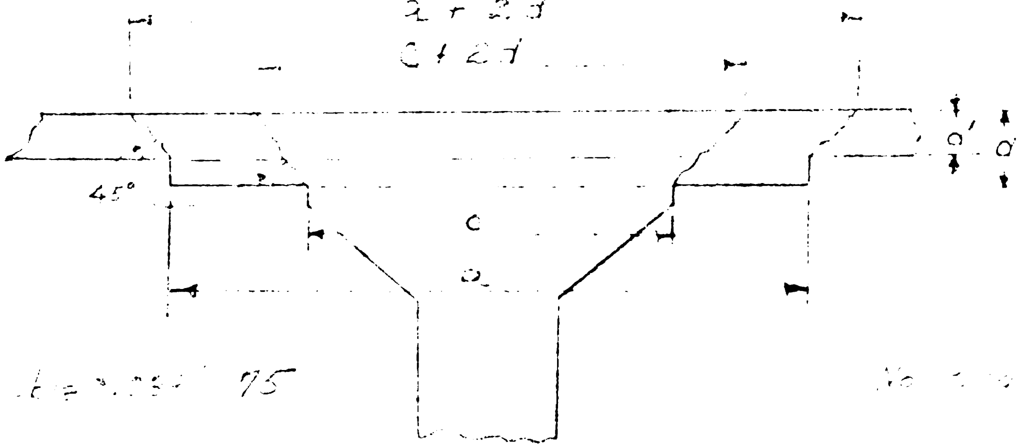
$R = \frac{2125000}{116\times(11.5)^2} = 143 < 196$ ∴ OK

Middle Strip $+M = .15 M_o = 625000$ in#

$R = \frac{625000}{116\times(9)^2} = 67 < 196$ ∴ OK

$-M = .15 M_o = 625000$ in# R OK

Diagonal tension & Shear



Allow. $v = .03 f'_c = 75$

No scale

$a = 9'-9"$ $d = 13"$

$c = 5'-10"$ $d' = 10.5"$

$V_2 = 175000$ # $- \pi \overline{[illegible]}^2 \times 232 = 163,900$ #

$v_2 = \frac{163900}{\pi\, 96 \times .875 \times 10.5} = 55$ psi < 75 ∴ OK

$V_1 = 175000 - \overline{\pi 42}^2 \times 232 = 144500$

$v_1 = \frac{144500}{4\times 34 \times .875 \times 9} = 34 < 75$ ∴ OK

STEEL DESIGN

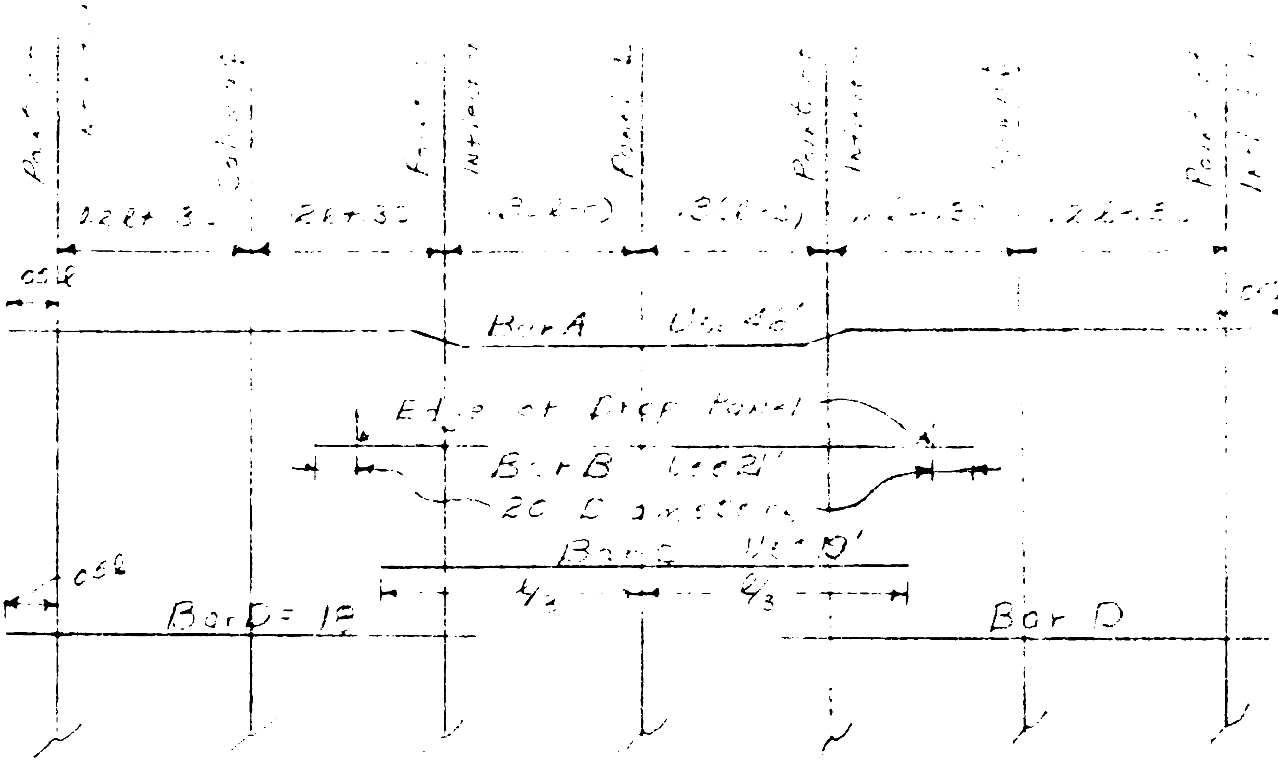
	Interior [illegible]				[illegible]				Exterior Panel [illegible]				
	Column Strip		Mid Strip		Column Strip		Mid [illegible]		Column Strip			[illegible] Strip	
M_2 = 4 [illegible]	P	N	P	N	P	N	P	N	[illegible]	[illegible]	[illegible]	P	[illegible]
Moment Coeff	[illegible]	.50	.14	.15	[illegible]	[illegible]	.15	.15	.25	.55	.45	.15	[illegible]
Moment in. Kips	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]
[illegible]													
Using 3/4 in round bars Depth in.	[illegible]	11.2	5.25	[illegible]	5.62	11.37	[illegible]	9.00	3.62	11.17	[illegible]	[illegible]	[illegible]
$A_s = \frac{M}{20 \cdot .57 (d)}$	5.6	[illegible]	4.4	4.05	[illegible]*	[illegible]*	4.24	4.04	7.00	12.3	[illegible]	[illegible]	[illegible]
Min. A_s .0025 (74) d	3.76		3.59	[illegible]	3.76*		3.76	3.92	3.76			3.76	[illegible]
Min. A_s = (.0025)(1/16)(d		3.24				3.44*				3.24	3.24		
Use A_s sq in.	5.60	10.5	4.4	4.0	[illegible]	3.44	4.24	4.0	7.0	12.3	[illegible]	[illegible]	[illegible]
No. of Bars	13	25	10	10	9*	9*	10	10	16	29	[illegible]	9	[illegible]

* For Half Strip

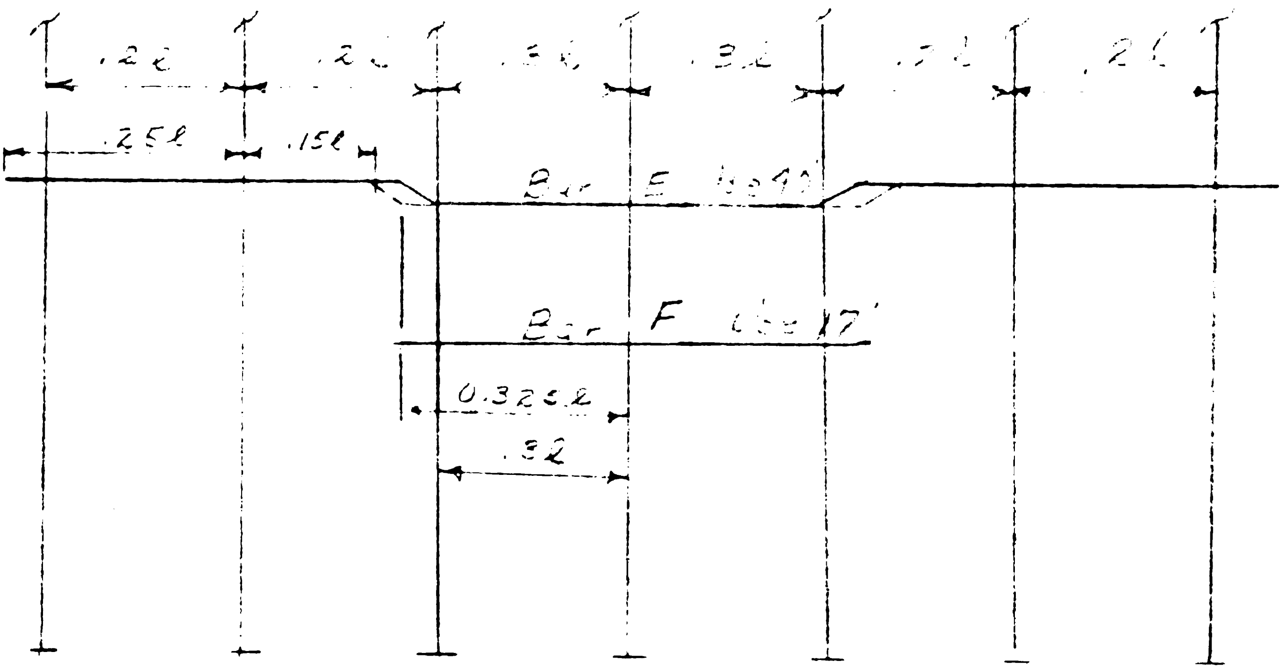
Above Table shows computations for Flat Slab Steel

Steel was design for the 27' length with provisions for use of same [illegible] of steel in 26' length.

All the panels are the same for all [illegible]

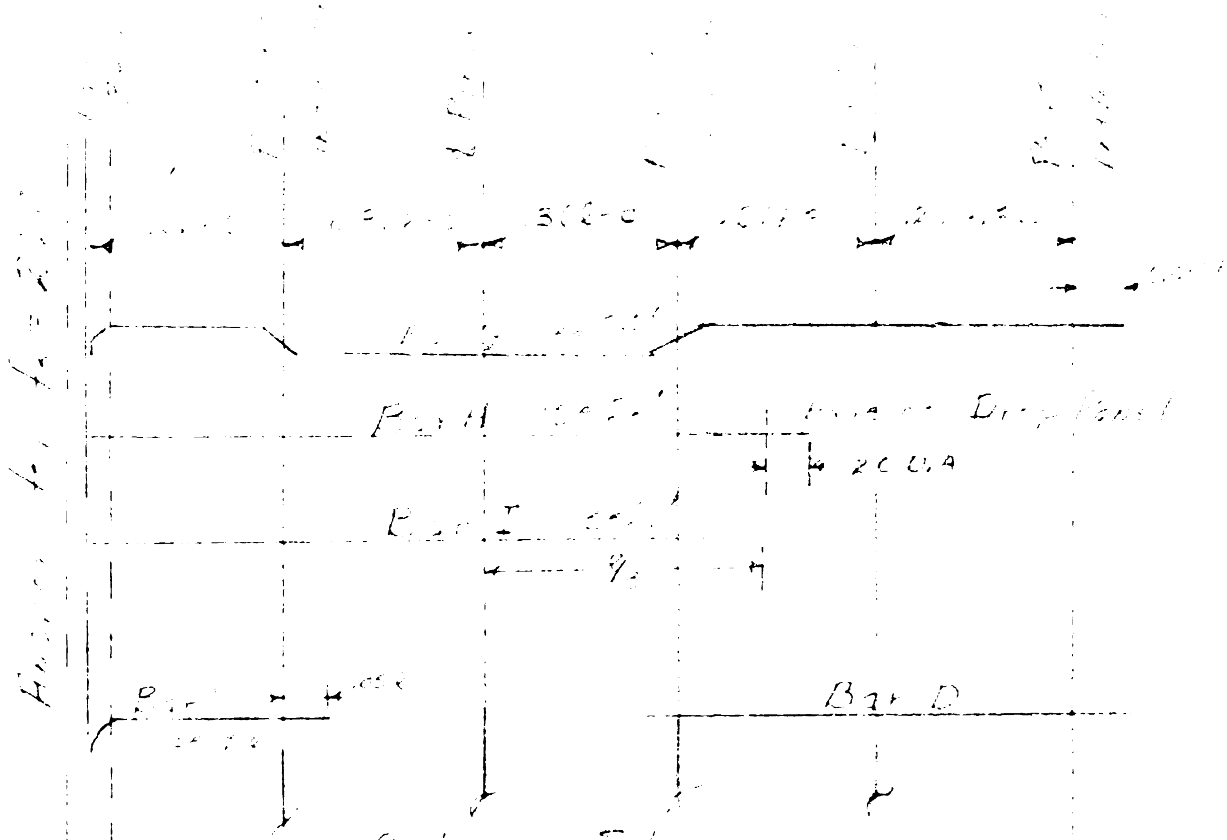


Column Strip

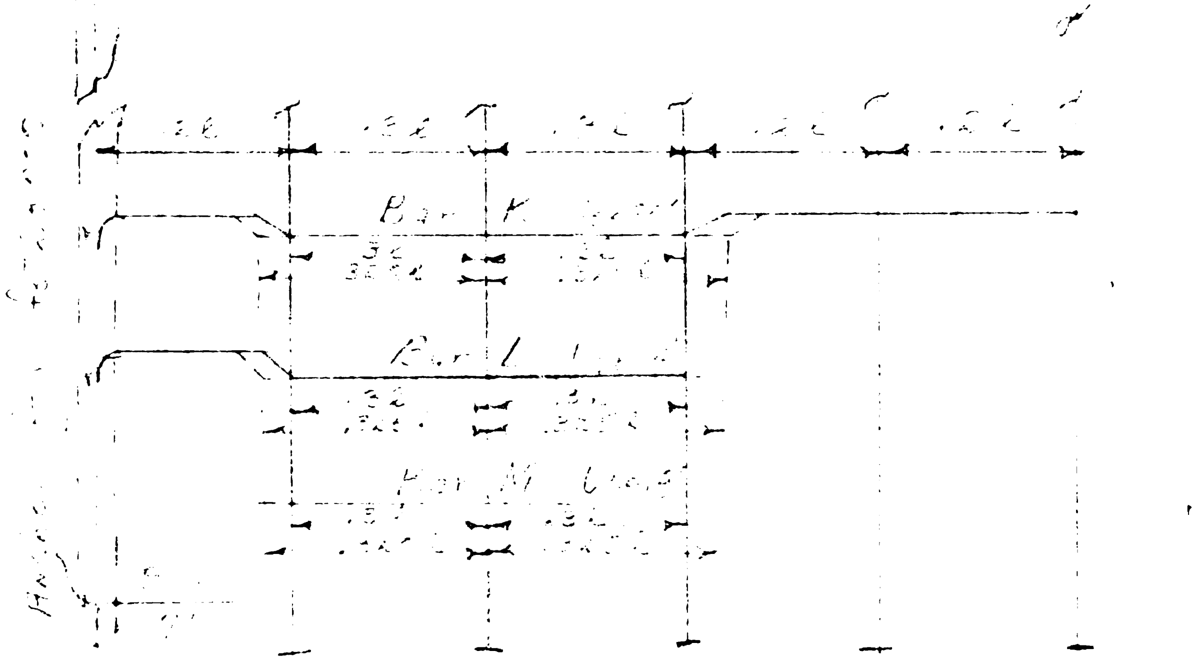


Mid Strip

MINIMUM BAR LENGTHS - INTERIOR PANEL



Column Strip

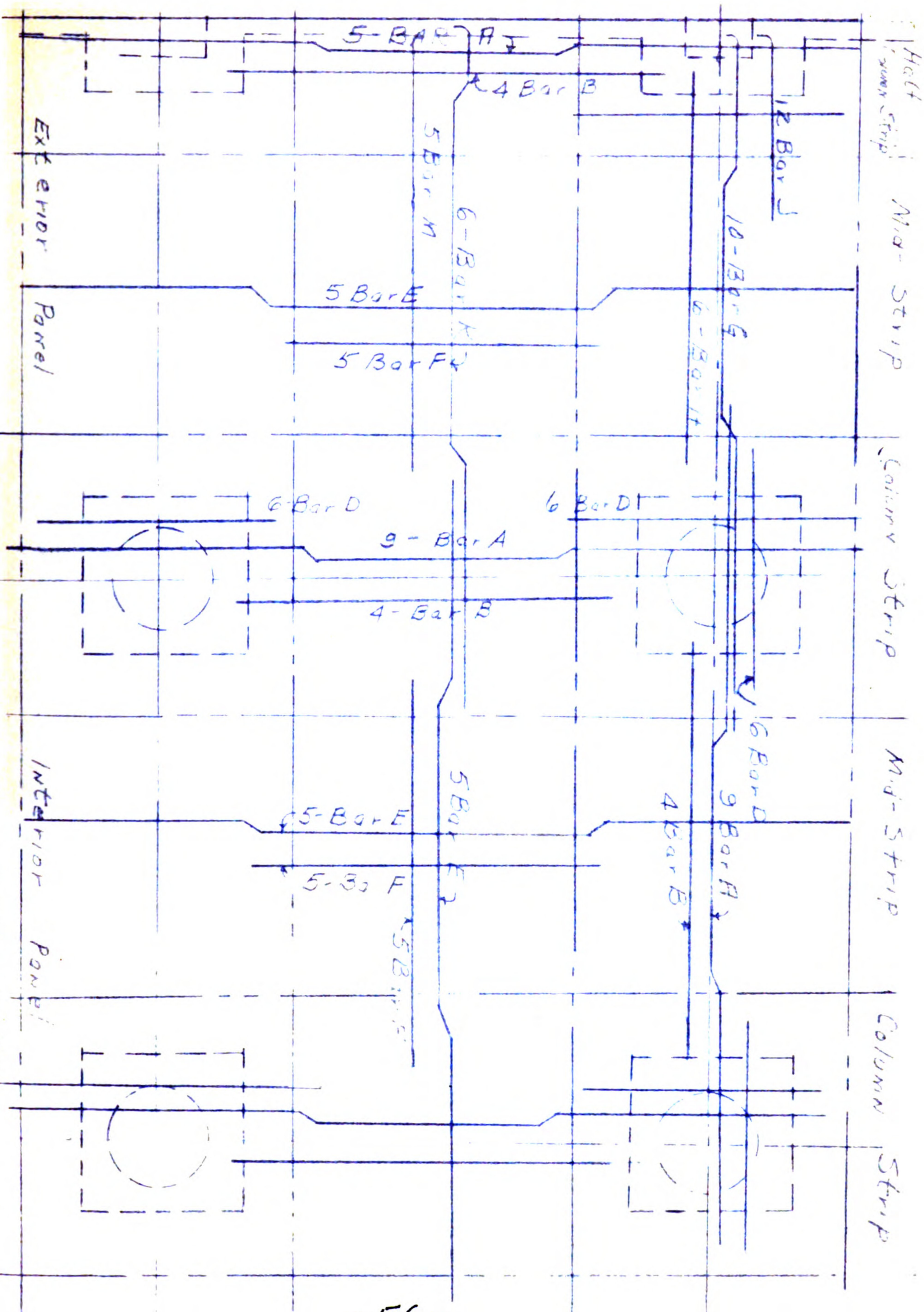


Middle Strip

Minimum Bar length [illegible] Panel

Note – Minimum lengths will be used so that [illegible] 26' length as was designed for the [illegible].

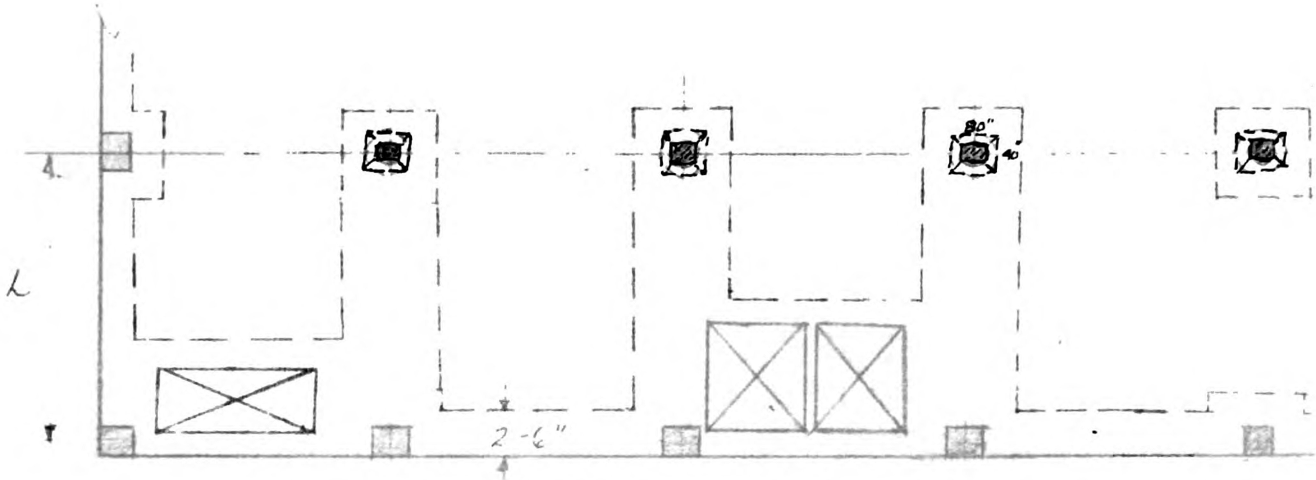
STEEL REINFORCEMENT



Flat Slab - Exterior Panel

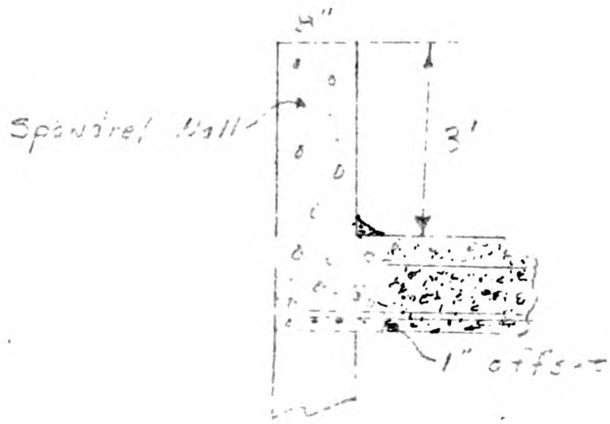
Use 10.5" slab

No walls used - Use a beam around the outer edge - same depth as the drop thickness. This will provide support for the openings caused by ramps - beam - 2'-6" wide



Flat Slab Framing Plan

Use a 3' Spandrel Wall



Section showing layout for
The Spandrel Wall

Interior Column

W = [illegible] = 4,140,000 − [illegible] = [illegible]

slab [illegible] [illegible]

$M_o = .09 ([illegible]) 12 \times \frac{[illegible]}{24}$ = 4,140,000 in-#

Column Strip ⊥ to wall

+M = 1.15 × .20 × 4,140,000 = 952,000 in-#

d = [illegible]

−M int = 1.15 × .50 × 4,140,000 = 2,380,000

d = 11.5" [illegible] $R = \frac{[illegible]}{116 \times 11.5^2}$ = 15[illegible]

−M ext = .5 × .50 × 4,140,000 = 1,1[illegible]5,000

d = 11.5" [illegible] R = ✓

Middle Strip ⊥ to wall

+M = 1.30 × .15 × 4,140,000 = 812,000 in-#

d = 9 in R = ✓

−M int = 1.3 × .15 × 4,140,000 = 812,000 in-#

d = 9 in R = ✓

M ext = .8 × .15 × 4,140,000 = 500,000 in-#

d = 9 in R = ✓

Shear and Diagonal Tension OK

SOIL BORINGS -- FOUNDATION

For actual construction it would be advisable to have soil borings made to determine the exact nature of the underlying strata. Due to the nearness of the river this is an especially good idea. The presense of undesirable soil could cause the complete failure of the structure if not properly taken into account.

For the authors design a record of test borings was obtained from the Michigan State Highway Department. These borings were taken near the city hall in Lansing, and offer some insight as to the composition of soil strata in this area. One of the test holes was selected for this design. A copy of the field notes and the result of a laboratory visual inspection are shown on the following pages.

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
2	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.

Laboratory Visual Inspection

Sample No.

1. P. I. 4 Yellow, sandy loam. 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 pevvles.

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

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

(Note) The textural 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.

The information drawn from this boring chart, shows a medium of fine yellow sand between elevation 849.24 and 828.24. It is in this layer that the seat of settlement of the building, is assumed to take place. This sand has a bearing capacity estimated at 6,000 pounds per square inch. This figure will be used when designing the building foundation.

When determining a design for soil pressure, it is advisable to secure charts of all borings that have been completed in the surrounding area. Interpretation of the results of these borings gives a good picture of the underlying strata. However, soil strata changes with each succeeding section in many localities, and the only real guarantee that is possible when determining soil pressure, is to make soil borings on the exact site.

THE STRUCTURE

A reinforced concrete building of five floors height, will be erected on the site. There will be no floors below grade, as it is cheaper to build up then to use two sets of ramps on the first floor. Also due to the nearness of the river, in times of high water a floor underground could be flooded. There will be no walls used, only three foot parapets. This leaves an open space of about four feet. This area can be covered with pre-cast concrete grills to produce an attractive building.

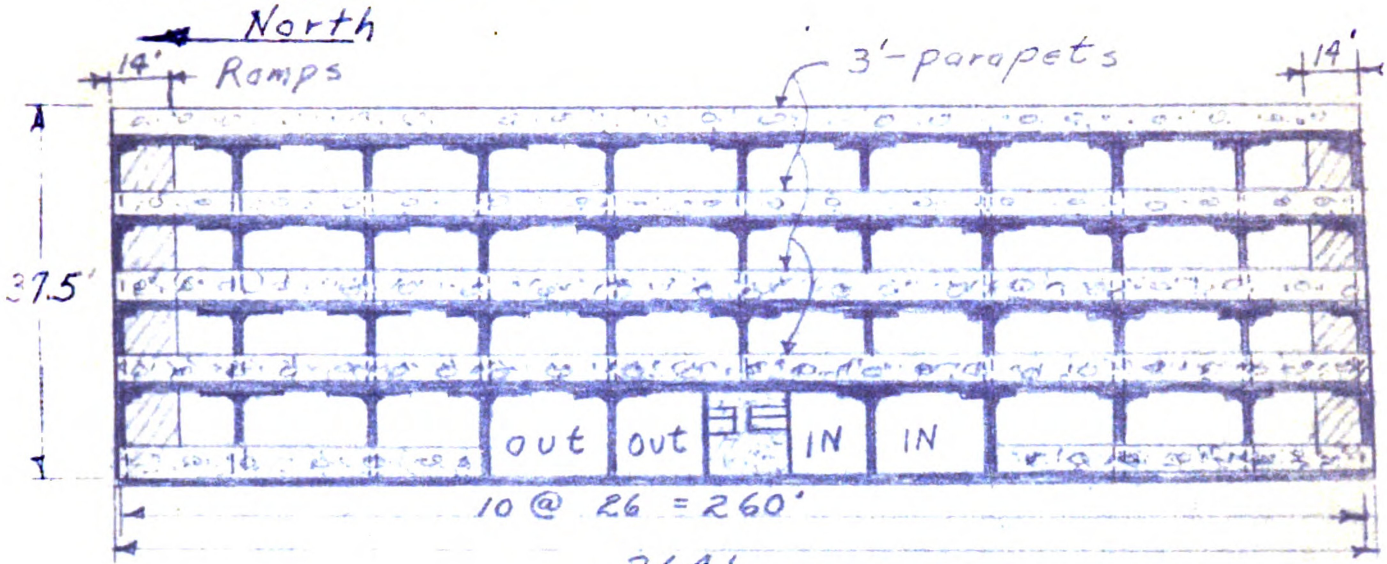
In determining the type of construction to be used in the garage, the author selected a flat slab floor system with drop panels. Some of the advantages for this type of construction are;[11]

1. Shorter story heights for a given clear height
2. Better fire protection with a flat ceiling and a better play for a sprinkling system
3. Economical form design covering flat surfaces
4. Uniform surface for ceiling
5. Favorable costs compared to beam and girder

Clear distance between all floors will be seven and one half feet with the exception of the first floor. The first floor has a clear distance of nine feet to allow parking of trucks.

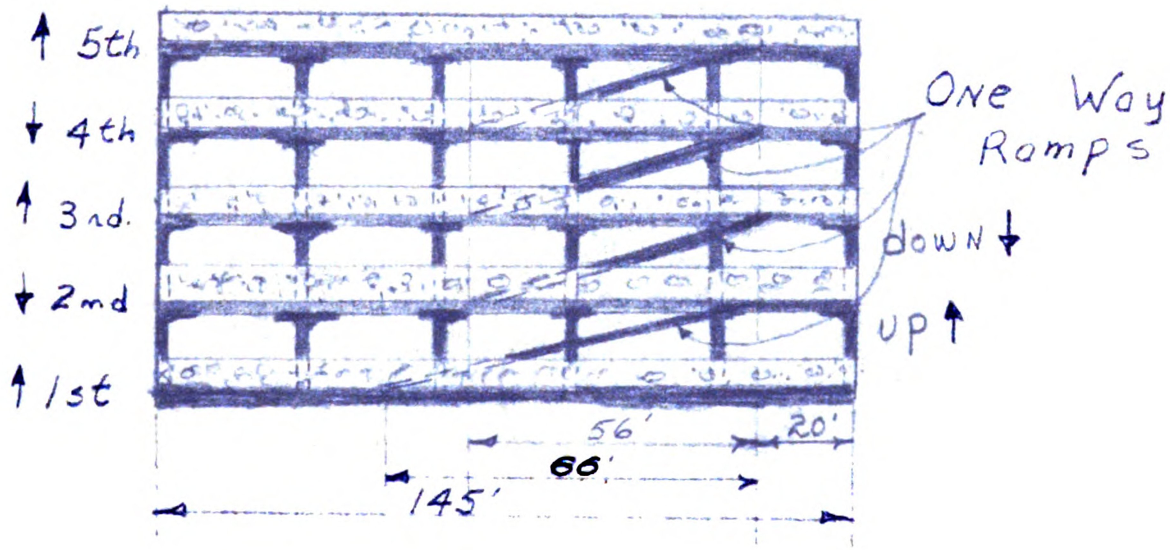
The roof will be used for parking. A greater number of cars can be parked on the roof due to the absense of columns.

Building Layout:



Elevation

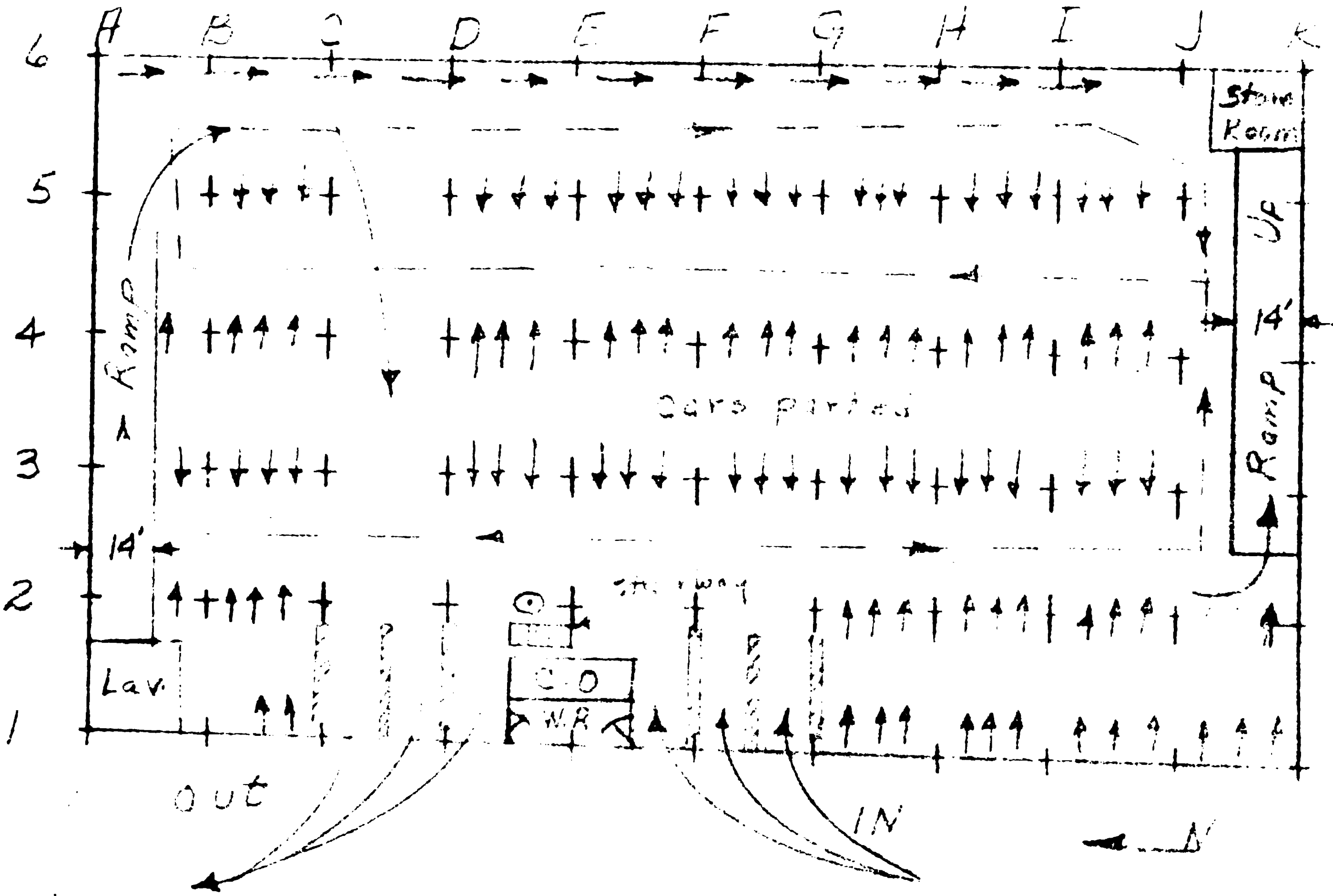
* 1st floor 9'-high – allow parking of trucks
2nd-3rd-4th floors – 7.5'



End View South End *

* North End is same with direction of travel opposite.

Floor Layouts



* Long axis of columns run East and West

↑↑↑ – parked cars 3 in a stall

—→— Direction cars move

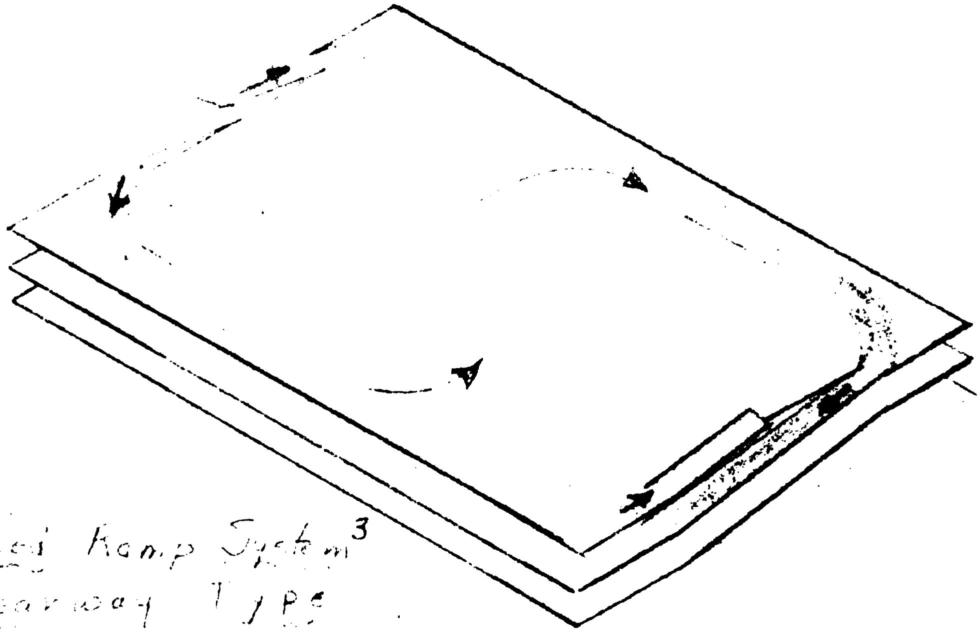
Park – 105 cars

1st Floor Lay out

Cashier Office & check room – 26'x 10'
Waiting room – 26 x 10
Lavatory – 5'x8'
Store room – 14'x 20'

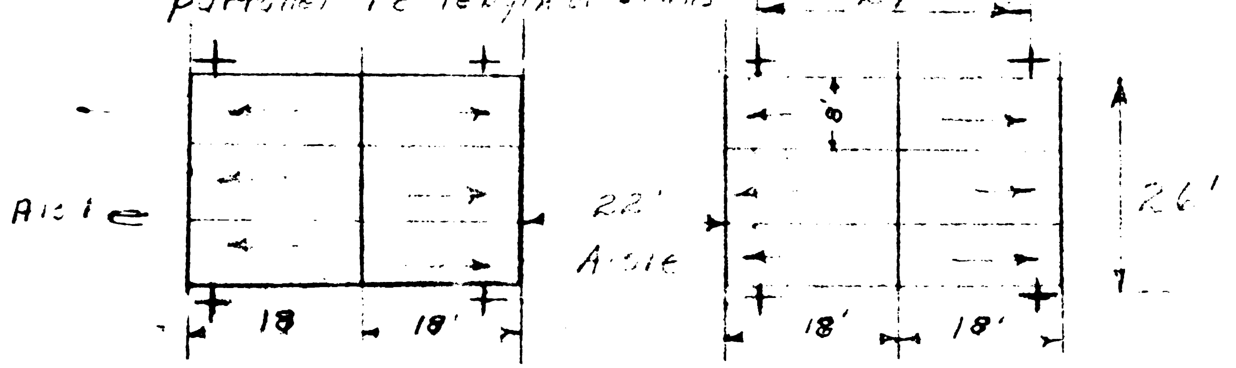
\+ Succeeding floors have same general pattern – with no space left out for rooms – Parallel parking along exterior.

Layout



Opposed Ramp System[3]
Clearway Type

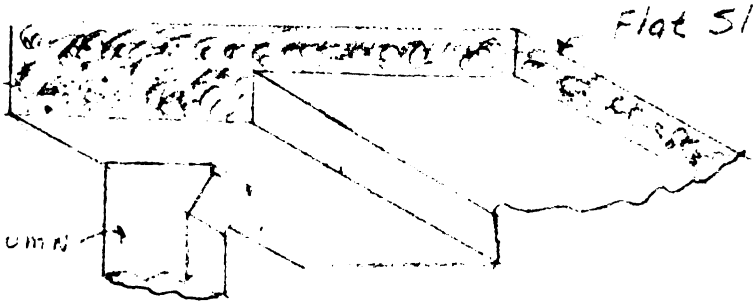
Long dimension of column
parallel to length of stalls



Layout of Parking Units

Spandrel
Beam,
Uniform
Width

Flat Slab



Exterior Spandrel

DESIGN OF COLUMNS

In designing interior columns the author set eighteen inches as a maximum width. This was done to prevent the columns from infringing on the space allotted to parking stalls. In order to keep a width of eighteen inches it was necessary to use rectangular columns. The long axis of the column runs parallel to the long axis of the parking stall. Provision is made that all ends are to be rounded. A metal plate, the height of the average car bumper, will be placed at the base of the column.

Exterior columns are designed as being square. The outer edge of the building has a beam the depth of the drop panel, one foot-six inches wide.

Columns

Spacing - 29 x 26' ℄ columns

In order to keep the parking bays uniform throughout the building - rectangular columns will be used with the provision that their ends must be rounded. Maximum column width is 1'-6"

$f'_c = 3000$ $f_s = 16000$ Use "Reinforced Concrete Design Handbook" - American Concrete Institute

4 th Floor

	Interior	Exterior
Use tied columns - Load -	183.85	100
Load by conc.	106	78
" " steel	77.85	22

Use Column 14" x 14"
8 - 1" ◻ Bars
Use ½" ties @ 12 in. centers

Use 12" x 12"
4 - ⅞" ◻ Bars
¼" ties @ 12 in centers

3rd Floor

Use no reduction of live load as the building will often be at full capacity

Int.

Load = 368 Kips
Concrete · 233
Steel = 125 Kips

Column 18" x 24"
Use 10 - 1" ◻ Bars
½" ties @ 12 in centers

Ext.

Load = 200 Kips
Concrete 106
Steel 94 Kips

Column 14" x 14"
Use 8 - 1" ◻ Bars
½" ties @ 12 in centers

2nd Floor

Load = 556 K
Concrete = 291
Steel = 265

Column 18" x 30"
22 - 1" □ Bars
1/2" ties @ 12 in

exterior

Load = 300 K
Concrete = 175
Steel = 125 K

Column 18" x 18"
10 - 1" □ bars
1/2" ties @ 12 in.

1st Floor

Load = 743
Concrete = 393
Steel 350

Column 18" x 30"
22 - 1 1/8" □ bars
5/8" ties @ 12 in

exterior

Load = 400
Concrete = 214
steel 186

Column 18" x 22"
Use 12 - 1 1/8" □ bars
5/8" ties @ 12 in

To figure the load acting on a column on the fourth floor a summation is made of the slab load, the drop panel and the live loads. On the third floor the columns support the fourth floor load plus the third floor roof plus the fourth floor columns. The above design allows for future floors to be added if so desired.

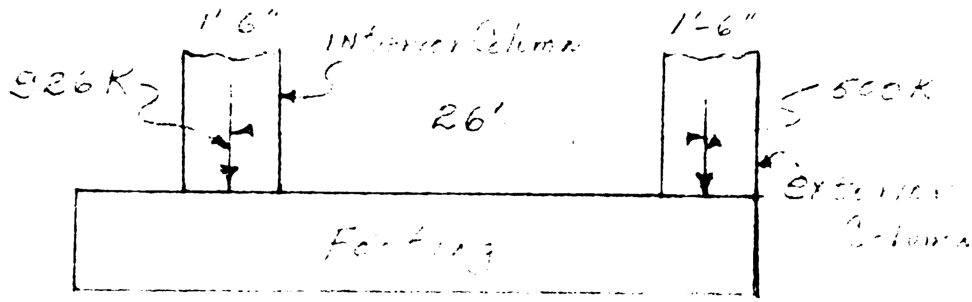
COLUMN FOOTINGS

Column footings are designed for a soil with a resistant force of 6,000 pounds per square inche. Computations of a simple and combined footing are shown.

The combined footing is necessary because the building is built right up to the edge of the property line. The method used for solution is the one recommended by Sutherland and Reese.[13]

The simple footing is designed with use of Peabody as a reference.[11] Observation of the computations should prove self explanatory.

Computation for Combined Footing – North-South ends



Soil pressure = 6000 psf $\qquad f_s$ = 18000 psi

f'_c = 2000 psi $\qquad f_c$ = 900

Assume wt. of footing = .12(926+500) = 171 Kips

m = 15 $\qquad$ J = .857 $\qquad$ R = .857

Reference: Sutherland and Reese – "Reinforced Concrete Design"

The two columns are to be supported on one rectangular footing, one end of which cannot extend beyond the outer face of the exterior column

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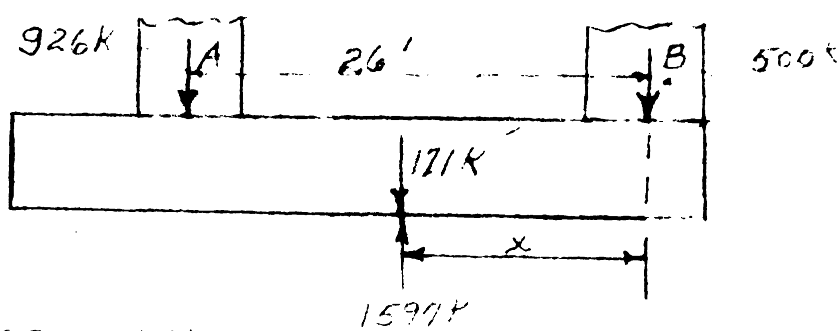
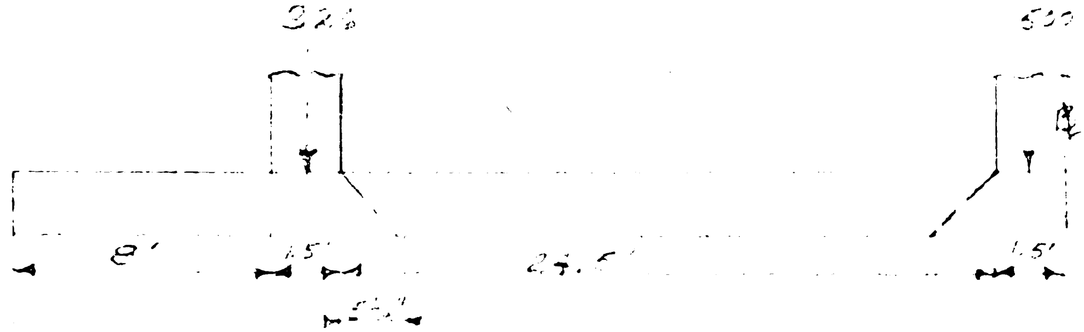


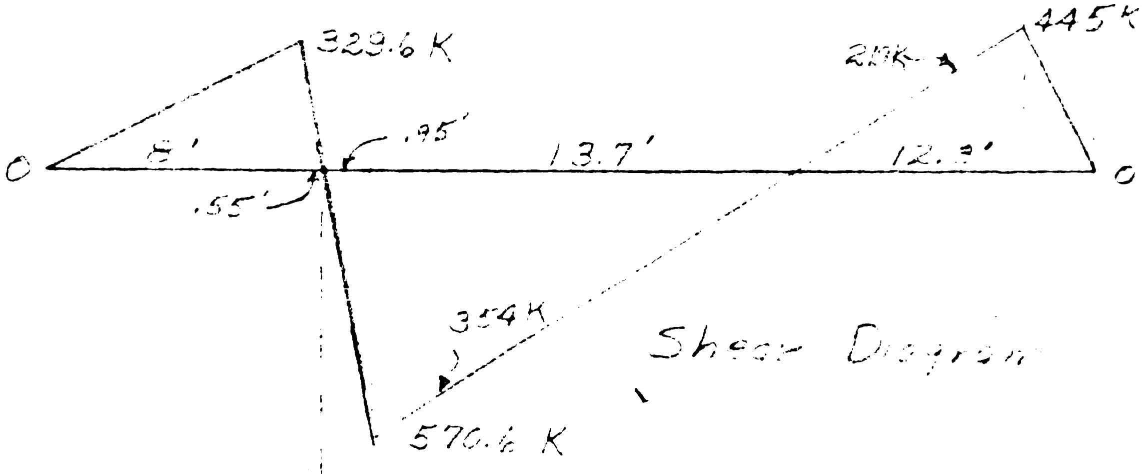
$\Sigma M_B = 26 \times 926 + 171x = 1597x$

$X = 17.0' + .75 = 17.75'$

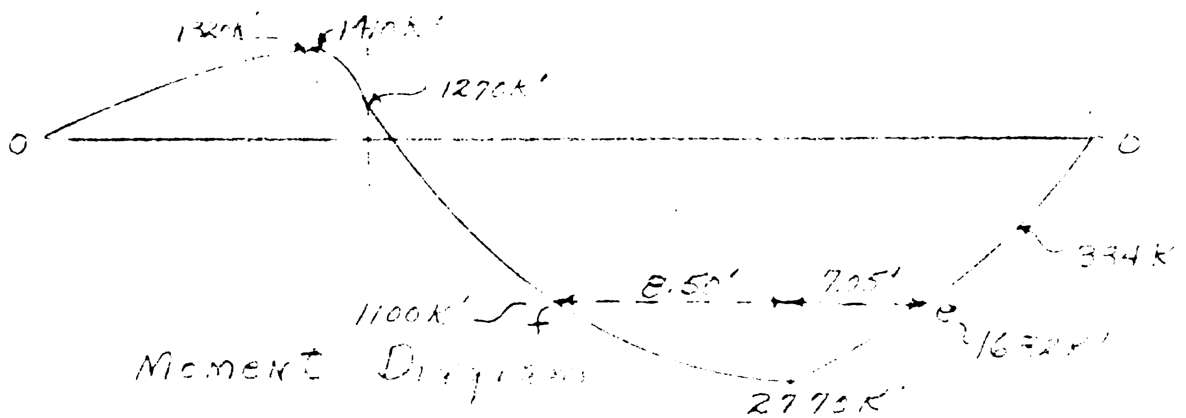
Length of footing = $\underline{35.5'}$

$\frac{1597{,}000}{6000} = 266\ \square'$ base Area Req'd $\therefore \frac{266}{35.5} = \underline{7.5' \text{ width}}$





Shear Diagram



Moment Diagram

Calculations:

7.5 x 6000 = 45000   45000 - $\frac{171}{355}$ = 41,2

Unit pressure = 41.2

8 x 41.2 = 329.6

926 - 329.6 - 1.5 x 41.2 = 570.6

$\frac{570.6}{41.8}$ = 13.7'

$\frac{329.6}{x} = \frac{570.6}{1.5-x}$ x = .55   1.5 - x = .95

26 - 13.7 = 12.3

10.5 x 41.2 = 445 k

Moments were calculated by figuring Area of shear diagram

Shear: $v = \dfrac{V}{bjd}$ $\qquad J = .857$

Allowable $v = .06 f'_c = 120$ p.s.i.

$d = \dfrac{570{,}600}{90 \times .857 \times 120} = 62''$ $\qquad R = 165$

Bending $R = \dfrac{M}{bd^2} \therefore d = \sqrt{\dfrac{2772000}{165 \times 7.5}} = 46.5''$

Use $d = 62'' + 4''$ cover $= 66''$

Weight $= 7.5 \times 35.5 \times 55 \times 150 = \underline{220{,}000}$ #

$u = 150$ (J.C.1940) $\quad \Sigma_o = \dfrac{V}{ujd} = \dfrac{570{,}600}{150 \times .857 \times 62} = \underline{72''}$

$A_s = \dfrac{2772000 \times 12}{18000 \times .857 \times 62} = \underline{34.80''}$

$\dfrac{72}{5} = 15$

Top Steel-

$\dfrac{34.8}{1.56} = \underline{23 - 1\frac{1}{4}''\square} = 35.70''$

Use: 16 straight
7 Bent

$1\frac{1}{4}''\square$ Bars $\quad$ Area $= 1.56 \quad \Sigma_o = 5$ inches

$v = \dfrac{V}{bjd} = \dfrac{570{,}600}{90 \times .857 \times 62} = 120 = 12.0 \therefore$ OK

$v_1 = \dfrac{354{,}000}{90 \times .857 \times 62} = 74 > 60 \quad \therefore$ Use Stirrups

$.03 f'_c$ = Diagonal tension carried by Concrete -

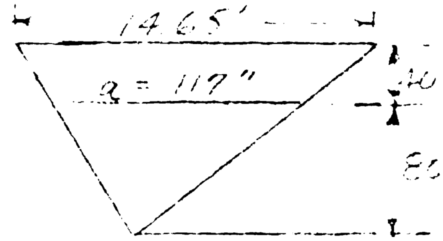
Bottom Steel: $\qquad A_s = \dfrac{1410000 \times 12}{18000 \times .857 \times 62} = \underline{17.6} \square''$

$\dfrac{17.6}{1.56} = 12$ Bars $\qquad$ Use $12 - 1\frac{1}{4}''\square$ Bars

$u = \dfrac{329{,}600}{60 \times .857 \times 62} = 103 < 150$ $\underline{\text{OK}}$

Int Column to Right

V = 120 psi   Use 40 psi for stirrups



$a = \frac{80}{120} \times 14.65 \times 12 = 117 \text{ in}$

$A_v = \frac{117 \times 90 \times 80}{2 \times 16000} = 26.4 \square'$

Max dia stirrups $= \frac{4 \times 150 \times 232}{16000} = .857''$

$d = \frac{4uL}{f_v}$

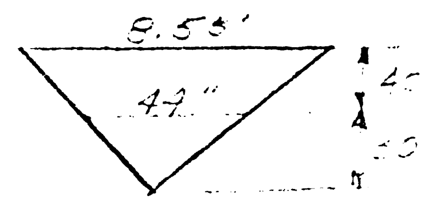
Use 3/4" φ ⊔⊓⊔⊓ = Area 2.640"

$\frac{26.4}{2.64} = 10$ Use 10 - 3/4" φ ⊔⊔⊔

Int col to left.

$V = \frac{329{,}600}{90 \times .857 \times 62} = 68.5760$ ∴ Use stirrups

$\frac{3}{7} \times 8.55 \times 12 = 44''$



$A_v = \frac{44 \times 90 \times 80}{32000} = 10.3 \square''$

$\frac{10}{2.64} = 4.$ Use 4 - 3/4" φ ⊔⊓⊔

Ext Column

$V = \frac{219{,}000}{90 \times .857 \times 62} = 45.5 < 60$ ∴

No stirrups req'd.

Right of zero shear — assume Parabola: $e = 12.3\sqrt{\frac{7}{23}} =$

$M_d = \frac{(5.50)^2}{2} \times 41.2 - 500 \times 4.75 - 1344 < \frac{16}{23} 2770$ $e = 6.80'$

∴ OK

Bend down 12.3' - 6.80' 5.50' from ℄

Left of Zero Shear – Assume Parabola

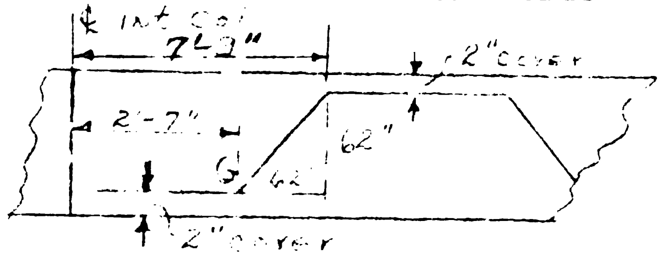
$$f = 14.65\sqrt{\frac{7}{23}} = 8.05'$$

Try 19' from ℄

$$M_F = \frac{(19.0)^2}{2}\,41.2 - 500\,(18.25) = 675 < \frac{16}{23}\,8770$$

Bend 19'-0" from ℄

Bend Up at Int Col



26'-9" − 19'-0" = 7'-9"
− 5'-2"
2'-7"

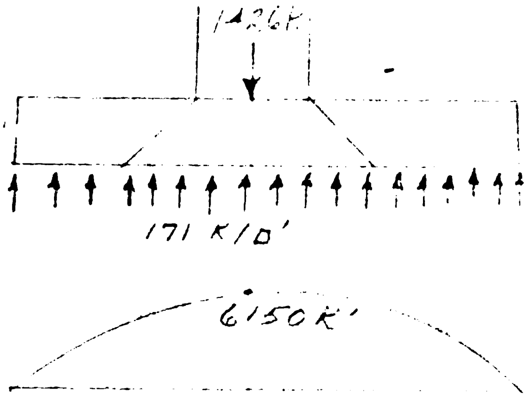
$$M_G = \frac{\left[5+1.5+(2'\text{-}7"-9")\right]^2 41.2}{2} - 926\,(2'\text{-}7") =$$

$$M_G = -30000 < 0 \therefore OK$$

Critical Section Shear

$3.75 - .75 - 5.16 = \;<0$

Falls outside only @ exterior & interior columns ∴ shear is OK



$$\frac{1426}{7.5} = 171\ K/□'$$

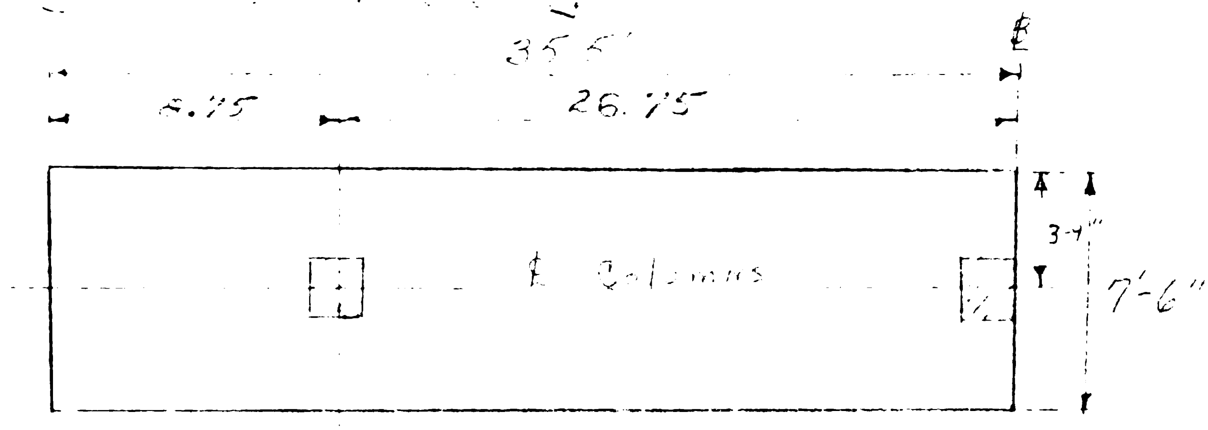
$$A = \frac{6150{,}000}{18000 \times .857 \times 62}$$

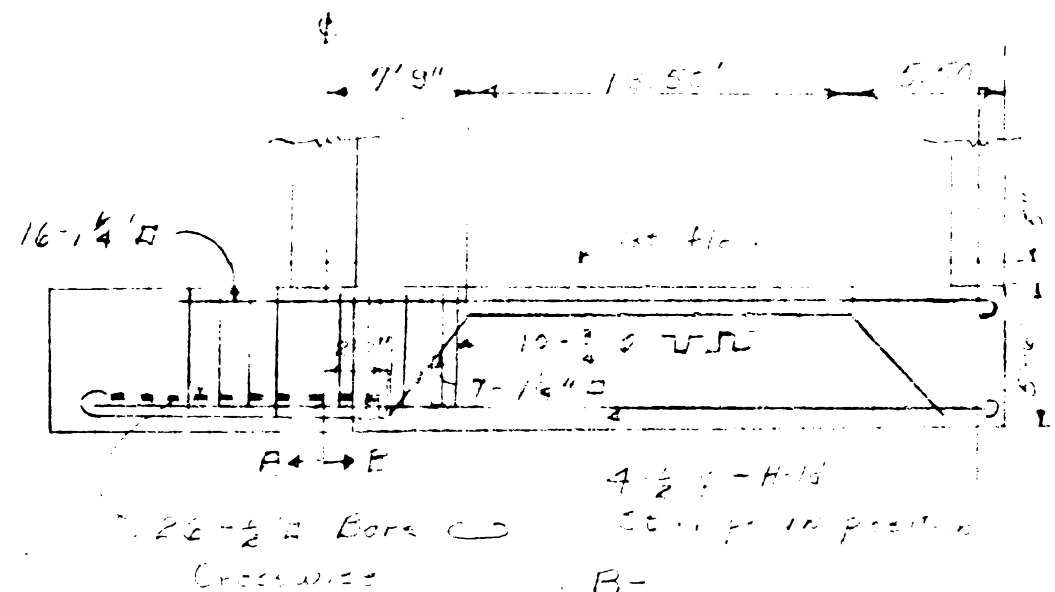
$$M = 171 \times \frac{\left(\frac{7.5}{2}\right)\left(\frac{7.5}{2}\right)}{2} = 6150K'$$

As = 6.35 □"

$$\frac{6.35}{.25} = 26 - \tfrac{1}{2}"\ \text{Bars}$$

Combined Footing





A

Spacing to left

4 @ 8"

B-

Spacing 3/4" (To Right from ℄ of Column)

- 4 @ 5"
- 3 @ 8"
- 3 @ 12"

Total - 10

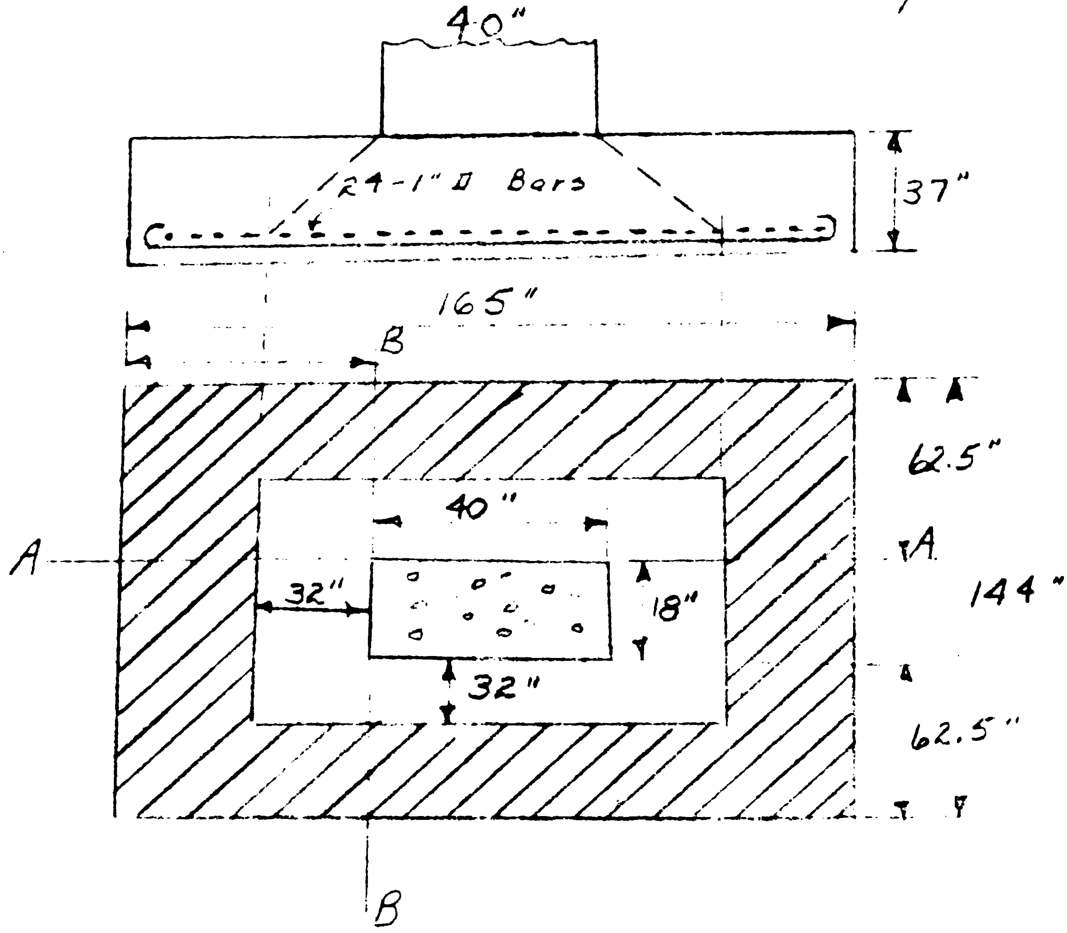
Design of an Interior Column Footing

soil = 6000 psf
$N = 926{,}000$ #

Column 18" x 40"
22 - 1 1/8" ⌀ Bars

$f'_c = 2000$ psi

$f_c = 900$ $f_s = 20000$ $n = 15$
$J = .857$
Use hooks at end of deformed bars
$v = .03 \times 20 = 60$ psi



Column load =	926,000 #	
Wt of footing	55,560 #	(6 %)
Total =	981,560 #	

$$\text{Area base} = \frac{981{,}560}{6000} = \underline{\underline{164\ \square'}}$$

$$Area = 164 = \frac{(19+2c)(40+2c)}{144}$$

$$c = 62.5''$$

Use $\ell_1 = 144''$ $\ell_2 = 165''$ Area = $165\,\square'$

Diagonal Tension - Depth

$$\text{Net pressure} = \frac{981.56K}{164} = 5980\ \#/\square'$$

$$v = 60 = \frac{V}{bjd} = \frac{5980\left[164 - \frac{(18+2d)(40+2d)}{144}\right]}{2\left[(18+2d)+40+2d\right]\times .857d}$$

$$d = 31.7'' \quad \text{Use } 32''$$

$$h = d + 5 = 37''$$

$$\text{Weight} = 74{,}000\ \#$$

Bending Moment - depth

$$M_A = \frac{w\ell^2}{2} = 5980\ \frac{(165)(62.5)^2}{2\times 144} = 13{,}400{,}000\ \text{in}\#$$

$$M_B = \frac{w\ell^2}{2} = 5980\ \left(\frac{(144)(62.5)^2}{2\times 144}\right) = 11{,}700{,}000\ \text{in}\#$$

$$d = \frac{M}{Kb} = \sqrt{\frac{13{,}400{,}000}{165\times 165}} = \sqrt{\frac{11{,}700{,}000}{165\times 144}} = \underline{22.4''}$$

$\therefore$ Use $d = 32$ in $h = 37$

Steel

$$A_s = \frac{M}{f_s jd} = \frac{13{,}400{,}000}{20{,}000\times .857\times 32.5} = \frac{11{,}700{,}000}{20{,}000\times .857\times 32.5} = \underline{\underline{24\,\square''}}$$

$$\Sigma o = \frac{V}{ujd} \quad \frac{5980\times\frac{165\times 62.5}{144}}{150\times .857\times 32.5} = 104\ \text{in}$$

Each Direction: Use 24 - 1"$\square$ bars.

INTERFLOOR TRAVEL

The question of whether to use ramps or elevators usually arises in all new parking garages. The biggest difference between the two is the rate of handling vehicles. Ramps have continuous capacity with cars moving bumper to bumper. Ramps are permanent with no chance of breakdown. True, they require more room, but their ease and economy of handling usually offsets this disadvantage.

Elevators are much more costly to install and require greater maintenance. They do allow parking of more cars in a given area as the space required for ramps can be used for parking. In purely mechanical garages the cars are put in place with no space necessary for maneuvering. For the open deck garage, ramps are invariably used.

An opposed straight ramp system has been selected as the type to use in this garage. This gives one way ramps with a continual circular drive around the garage. One way ramps means that traffic flows only in one direction, either up or down. All turning operations are completed on the floors so the ramps are not superelevated.

Ramps are all designed as flat slabs. Six inch curbs are raised above the slabs on each edge. Fourteen feet is the set width. Where the ramps pass an exterior column, an interior column is placed at the inner edge of the ramp, and a beam is run to the exterior column the same depth as the drop panel. Where the ramp joins each floor, a beam is placed underneath the floor, the same thickness of the drop panel.

The ramps connecting the first and second floors are 60 feet long. All other ramps are 50 feet long. The slope of all the ramps is 15%. Clearance has been kept to a minimum of seven and one half feet. The ramp has been designed as a flat slab with the same thickness and steel as the interior panel. This allows for a maximum load when cars are placed bumper to bumper.

Stairways will be of reinforced concrete construction. With the short story height it will not be necessary to have any landings. Firepoles will be placed opposite the stairs to save time and energy in coming down to the main floor. These poles will be staggered on each floor. All stairways are equipped with prefabricated steel handrails which are connected to the stairs with bolts cast in the concrete.

MISCELLANEOUS

Width of entrance and exit lanes is twelve feet.

Three lanes are reserved for inbound traffic and three lanes are reserved for outbound traffic. Width of these lanes is twelve feet.

Use back-in parking stalls at right angles to access aisles. Length of the stall is eighteen feet with a width of eight feet.

A loud speaker system will be installed throughout the building.

All the floors will be sloped gently toward the center to allow drainage.

BIBLIOGRAPHY

Each selected bibliography has been assigned a number. This number where found in the thesis refers to the work mentioned herein.

1. Parking Manual..........American Automobile Association
2. Parking............Smith & LeCraw........Eno Foundation
3. The Traffic Design of Parking Garages......E. R. Ricker
4. An Economic Study of Interior Block Parking Facilities ....Charles S. LeCraw
5. The Legal Responsibilities of Traffic Agencies ....C. H. Belser
6. Zoning Applied to Parking...............LeCraw & Smith
7. The Prohibition of Curb Parking..........LeCraw & Smith
8. Influence of Parking on Accidents..........Wilbur Smith
9. Simplified Design of Concrete Floor Systems .....Portland Cement Association
10. Reinforced Concrete Construction..................Hool
11. Reinforced Concrete Structures..................Peabody
12. Determining Parking Requirements by Study of Parking Habits...Hitchcock & Willier..Highway Research Board'44
13. Reinforced Concrete Design...........Sutherland & Reese
14. Act V - Uniform Act Regulating Traffic on Highway ......U.S. Gov't Printing Office '45
15. Articles XIII & XIV - Model Traffic Ordinance ......U.S. Gov't Printing Office '46

ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL, INC.

SAUGATUCK, CONNECTICUT

Founded by William Phelps Eno in 1921
Affiliated with Yale University

President: Robert C. F. Goetz, Col. U. S. A. Ret.
Westport 2-4852

November 1, 1948

Mr. B.J.Snell
Civil Engineering Department
Michigan State College
East Lansing, Michigan

Dear Mr. Snell:

In view of your request of October 26, I am sending you a number of our publications. Included is a copy of the October 1948 TRAFFIC QUARTERLY which contains an article on BILLBOARDS AND ZONING. This article was prepared from a thesis by the author, Mr. Thompson.

I should be interested in seeing your thesis with the idea in mind of publishing it in a later edition of the TRAFFIC QUARTERLY if you feel that you would like to have it published.

You do not say when you expect your Master's Degree, but I assume at the end of the present college year. If the thesis lends itself to an article of this type, I'd be very much interested in seeing a copy of it.

Thanking you for your kindness, I remain,

Sincerely yours,

Robert C. F. Goetz

ROBERT C.F.GOETZ
Colonel, U.S.A.Ret.
President

RCFG:CKM

City of Cleveland

DEPARTMENT OF PUBLIC SAFETY
230 CITY HALL
CLEVELAND 14, OHIO

WILLIAM F. SMITH
DIRECTOR

ALVIN J. SUTTON, JR.
ASSISTANT DIRECTOR

DIVISIONS OF
POLICE
FIRE
BUILDINGS

November 11th, 1948

Mr. B. J. Shell
Civil Engineering Department
Michigan State College
East Lansing, Michigan

Dear Sir:

The shortage of parking spaces near where persons want to go not only causes personal inconvenience and loss of business but greatly adds to our traffic movement problem. The shortage of spaces results in an undue amount of cruising which adds to the traffic volume on the streets.

In the high activity section of our central business district there are about 4700 parking lot spaces, 5000 parking garage spaces and 1000 curb parking spaces. It is our opinion that an additional 2000 spaces are necessary in this section to reasonably satisfy the demand without causing too great a loss to the existing parking operators. We have suggested the erection of five garages at the lowest possible cost located in high demand areas to distribute the traffic load as widely as possible.

To accommodate long time parkers we have provided a parking lot adjacent to a freeway, some distance and north from the central district. This large lot accommodating about 1500 cars has loop buses and attracts many drivers who would ordinarily congest the downtown streets. Two similar long time parking lots have been proposed just outside and south of the business district. There are two privately operated lots of the same type in the easterly direction.

To satisfy the need for parking spaces in secondary business districts which are generally ribbon street developments, we have proposed alleys behind the street frontages which would incorporate 90° angle parking. In addition we are requesting the merchants to acquire additional off street parking lot spaces.

We refer you to the following publications for additional information:

The Traffic Design of Parking Garages by Edmund R. Ricker, Eno Foundation.
Parking Manual by Traffic Engineering & Safety Dept., American Automobile Association
Parking by Wilbur S. Smith and Charles S. LeCraw of The Eno Foundation for Highway Traffic Control, Inc., Saugatuck, Conn.

Very truly yours,

V. L. Johnson

V. L. JOHNSON, TRAFFIC ENGINEER

VLJ:MO

CITY AND COUNTY OF SAN FRANCISCO

DEPARTMENT OF PUBLIC WORKS

BUREAU OF ENGINEERING

ADDRESS ALL COMMUNICATIONS TO THE
CITY ENGINEER
ROOM 351 CITY HALL

IN YOUR REPLY, REFER TO FILE:

October 25, 1948

Parking Problems
San Francisco

Mr. B. J. Shell
Civil Engineering Department
Michigan State College
East Lansing, Michigan

Dear Sir:

San Francisco, like practically all major cities, has a major parking problem and I would hesitate to say that we have arrived at any definite solution.

For your information I am enclosing a pamphlet which describes the Union Square Garage, which has been in operation for a number of years and has been very successful from a financial standpoint.

I am also enclosing a quotation from a general report prepared in March 1947, on the subject "Traffic, Transit and Thoroughfare Improvements for San Francisco." The material quoted contains a summary of the recommendations which were made at that time with reference to Off-Street parking.

Very truly yours,

Ralph G. Wadsworth

Ralph G. Wadsworth
City Engineer

Encs.

EXTRACTS FROM REPORT ON

TRAFFIC, TRANSIT AND THOROUGHFARE IMPROVEMENTS FOR SAN FRANCISCO

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Summary of Off-Street Parking Recommendations

1. That local transit facilities be improved and extended so as to reduce the amount of space required for all-day parking of workers' automobiles.

2. That curb parking space be so regulated as to provide for the maximum of short-time customer-client-visitor uses consistent with the requirements of moving traffic.

3. That in all future building construction, appropriate provision for off-street parking should be mandatory.

4. That the construction of parking garages by private capital should be encouraged, particularly by the use of public powers to make suitable sites available.

5. That bonds be issued in the amount of $5,000,000 for the purpose of acquiring land to be used for parking facilities.

6. That the construction of underground facilities beneath certain public parks be approved, and that other unused public property be made available for parking, where appropriate.

7. That the proposal for an elevated terminal parking loop, as outlined, be studied and actively forwarded to a point where action can be taken.

8. That new State legislation be sought to enable the City to establish a Municipal Parking Authority, with power to regulate all off-street parking, to acquire and operate or contract for the operation of parking facilities.

9. That sites be purchased from the proceeds of the bond issue subject to approval in each case by the Planning Commission as to conformity with the Master Plan.

****

Proposal for an Elevated Parking Terminal Loop

Preliminary studies have been made as to the possibility of developing a multiple-purpose project to utilize the space between Minna and Natoma Streets, along the southerly edge of the Central Business District. The basic idea underlying this proposal is to provide access to and through the area by an elevated structure, connected at the west end to the Bayshore Freeway and at the east end to the Bay Bridge. On adjacent property, a continuous series of multi-story garage structures with an eventual capacity for upwards of 20,000 vehicles could then be constructed by private capital. Automobiles entering or leaving the

EXTRACTS FROM REPORT ON

PARKING, TRANSIT AND THOROUGHFARE IMPROVEMENTS FOR SAN FRANCISCO

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Proposal for an Elevated Parking Terminal Loop

Preliminary studies have been made as to the possibility of developing a multiple-purpose project to utilize the space between Mission and Folsom Streets, along the southerly edge of the Central Business District. The basic idea underlying this proposal is to provide access to and through the area by an elevated structure, connected at the west end to the Bayshore Freeway and at the east end to the Bay Bridge. On adjacent property, a continuous series of multi-story garage structures with an eventual capacity for upwards of 20,000 vehicles could then be constructed by private capital. Automobiles entering or leaving the

Proposal for an Elevated Parking Terminal Loop Cont'd

upper floors would pass directly from or to the elevated loop, thus reaching the two major highways without using the City streets. The structure would also serve to provide additional outlets to the down-town area, and as a loop terminal route for an extended system of inter-urban bus lines. It might also provide space for other terminal purposes, such as a future central airlines terminal and various bus depots. It would bring users of the parking facilities close to Market Street.

Proposal for an Elevated Parking Terminal Loop Cont'd

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THE CITY OF SEATTLE

DEPARTMENT OF ENGINEERING

R. W. FINKE, CITY ENGINEER

MEMBER, BOARD OF PUBLIC WORKS

IN RE:

October 26, 1948

Mr. B. J. Shell
Civil Engineering Department
Michigan State College
East Lansing, Michigan

Dear Sir:

We have your request of October 19th for information and data concerning automobile parking problems and their possible solution in this City.

Under separate cover, we mailing to you a copy of the study made of Seattle's parking problem: "A Look into Seattle's Parking Needs."

Yours very truly,

R. W. FINKE
City Engineer

By J W A Bollong
J. W. A. Bollong
Traffic Engineer

BOARD OF SAFETY

City of Buffalo

NEW YORK

October 29, 1948

Mr. B. J. Shell
Civil Engineering Department
Michigan State College
East Lansing, Michigan

Dear Mr. Shell:

I'm very happy to hear that you are studying automobile parking problems. I only wish that we could take the time to assemble some of the local fact and give you an idea of what is going on nationally on this subject but time does not permit.

Locally, we are just in the analysis stage of our problem - no tangible evidence at the moment.

I might suggest that you write to Don McNeill, Traffic Engineer, Pittsburg, Pennsylvania; the Toledo Planning Commission for their recent parking study; and Theodore Matson at the Yale Bureau of Highway Traffic for a bibliography on this subject.

Sorry we can't be more helpful but time just won't permit.

Very truly yours
BOARD OF SAFETY

Henry W. Osborne

Henry W. Osborne
Traffic Advisor

HWO:ms

M 11-46 445 NGS

CHICAGO STREET TRAFFIC COMMISSION

CITY HALL

CHICAGO

October 26, 1948

Mr. B. J. Shell
Civil Engineering Department
Michigan State College
East Lansing, Michigan

Dear Mr. Shell:

With reference to your letter of October 19th with reference to information concerning automobile parking problems in our City, we wish to advise that a comprehensive study on the parking situation has been made by an engineering firm employed by the Chicago Association of Commerce and Industry and the State Street Council.

The report has not been released as yet, but if you will write to the Chicago Association of Commerce and Industry,they might be able to give you some of the information contained in the study.

Very truly yours,

E. Owens

E. Owens
Secretary to Mr. Sorenson

POLICE DEPARTMENT
CITY OF NEW YORK
NEW YORK 13, N. Y.

October 25, 1948.

Mr. B.J. Shell,
Civil Engineering Department,
Michigan State College,
East Lansing, Michigan.

Dear Sir:

Police Commissioner Arthur W. Wallander directs me to acknowledge the receipt of your communication of recent date, and to inform you that, due to exigencies of the service, requests such as yours are being disapproved at this time.

Regretting that we have not a more favorable reply to give you, I am,

Very truly yours,

Mary E. Kennedy

Mary E. Kennedy,
Acting Secretary to
Police Commissioner.

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