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Layout, control, and sign posting in the design of parking facilities is discussed emphasizing self parking and automated control. Considerations such as site, traffic, function of the facility, city codes, and sizes are related to design considerations. Traffic control factors are related to the direction and placement of cars and the collection of fees. The importance of lighting parameters in the design of traffic control signs is emphasized. The author concludes that design criteria for parking facilities are open to improvement. The appendix includes layouts of parking facilities. (JP)

DESIGN OF PARKING LOTS AND GARAGES

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Acceptance of your invitation to talk on "Design of Parking Lots and Garages" could be interpreted to mean that I believe it is now timely to summarize the twenty or thirty competent manuals and textbooks on this subject and reduce the whole matter to a twenty-minute discussion. A man would be bold indeed, however, not to say foolish, to imply that firm conclusions on this important subject can be stated. Indeed, this is a phase of the art of traffic engineering and architecture which may never be closed.

Almost every major parking structure built in the last five years has some unique feature which constitutes an important improvement in design. The great variety of layouts that have been used in actual construction during that period might be taken to indicate that there is a fertile field for the do-it-yourself garage designer. A more critical review, however, would show that the more successful garages are simply imaginative applications of sound principles, and that in all cases the designers had studied and benefited by all of the work that had gone before.

In the field of mechanical garages, a great deal of inventive talent is being applied, and substantial sums of money are being invested in working models and promotional activities. All this intensive effort in the parking field simply serves to underline the universal need for something better than anything available today. It is widely recognized that fame and financial reward will come to several people in the next few years for successful efforts to bring forth a better parking structure or a better mechanical parking device.

It would be a disservice to anyone faced with the problem of designing a garage or even an important parking lot to over-simplify the knowledge in this field and attempt to reduce it to a few dogmatic principles and tables of basic dimensions. The only advice that can be given conscientiously is that the engineer or architect should review not only the standard manuals and textbooks on the subject when faced with the opportunity to design a garage, but he should also examine critically the more important of the recent structures. This implies a visit to each one to see it in actual operation. Only in this way can a man keep abreast of all of the innovations in this rapidly evolving industry.

This paper will be an introduction to the design of parking facilities, therefore, rather than a masterpiece to close the subject. Layout, signing and control will be mentioned specifically to illustrate the need for practical and up-to-the minute policies on all interrelated features of the design.

Problems connected with parking lots are usually not as complex as those of garages and mechanical parking devices. It is relatively easy to experiment with the layout of a lot, for example, and faulty design can be corrected easily and inexpensively. Most of the discussion which follows, therefore, will refer to garages. The principles are generally applicable, however, to parking lots.

Layout

In preparing to design a specific parking facility, the designer must evaluate a number of fixed conditions. First priority is assigned to the available site. Its shape, topography, relation to surrounding traffic arteries and cost may predetermine the type of facility (ramp or mechanical), the traffic pattern, and the structural system. The size of the garage in number of levels and square feet per floor is usually established by earlier decisions as to the number of spaces required. The availability of money is another obvious criterion in planning a facility. Anticipated parking habits and characteristics of potential patrons also figure prominently in design. A particular garage at a given location must satisfy a combination of specific needs. There is no general formula to apply since other sites, other aims and other demands would call for a totally different design.

Usually, the dimensions of a site are not ideal to park cars in the most efficient manner. Compromises have to be made in developing a scheme which makes best use of the available site. Covering every square foot of land does not necessarily mean best utilization. Often it is better to build on only part of the site, leaving the remainder vacant or developing it for other uses. While such a design may appear to be wasteful of expensive property, an efficient layout may result at the lowest possible total cost per car space. Certain minimum dimensions are required to arrive at an economical layout. In intensely developed downtown areas, the cost of assembling a site large enough for an efficient ramp garage is often prohibitive. In such cases, land requirements can be drastically reduced by selecting one of the many types of mechanical parking facilities, assuming that such a garage satisfies all other needs.

Characteristics of traffic on streets surrounding a proposed garage influence the design, particularly on the street level. The direction and volume of traffic on adjoining streets largely determines the requirements for entrance and exit movements of vehicles and pedestrians as well as interior circulation. Although garages have been designed which are accessible from four surrounding streets, these are the exception. Most facilities must rely on one or two streets to carry traffic to and from them. Careful consideration should be given to such items as one-way streets and prohibited turns to assure that the garage is easily accessible.

Garages of apparently similar type may serve altogether different functions. While one design is particularly adaptable in a location of high turnover, another may be best suited for all-day parking. A garage planned to offer the utmost service to the general public may differ from one designed to produce maximum revenue. For example, customer garages are usually built with a view toward convenience and advertising value, while employee or all-day parking facilities are normally planned to accommodate the maximum number of vehicles in the least possible space. Other special features must be incorporated into the design of garages which provide parking for a particular building, hotel, airport or other public facility. Furthermore, there are many instances in which various sections or levels of a single facility have been designated for separate uses, each requiring different design criteria.

Often the exterior and interior design reflects these various categories of usage. It may be appropriate to recommend a barren steel or concrete structure with little attention to quality of design or execution in order to minimize investment and maximize profits. Municipalities and business firms, aware of their responsibilities in shaping community appearance or corporate image, will attempt to give quality of design to these functional structures. Department stores in urban locations will provide services, conveniences and other design features in an attempt to extend the atmosphere of their retail sales area to the parking structure, as illustrated herewith.

City codes also have their peculiar effect on the design of garages. Requirements vary greatly from city to city in regard to floor load, ventilation, stairs, exits, fire protection, elevators, and many other items. Local codes, therefore, may dictate not only interior planning but the design of the envelope enclosing the structure.

All these various factors require careful consideration before proceeding with final design of a parking facility, regardless of type or location.

Rising labor costs for garage attendants have helped speed the trend toward self-parking. This trend, in turn, has made it desirable to keep ramps reasonably flat and of shorter length than would be acceptable for professional drivers. The result is a tendency to adopt some type of sloping floor design which can vary from the continuous spiral and two-way aisles to a split level design with sloping floors over only a portion of the total area. The latter arrangement, illustrated herewith, is used in conjunction with ramps having only a small difference in elevation between their two ends. It can be seen that in a longer garage

with this same basic scheme, the floors on the two halves of the garage could be at the same level at their centers, eliminating the ramps entirely.

The trend toward self-parking has also increased the use of angular arrangement of stalls. While somewhat wasteful of space, even as great an angle as 70 or 75 degrees with the aisle expedites parking and unparking maneuvers. This is especially important where a large volume of traffic must move past the stalls on the lower floors to reach parking areas above. Parking at 90 degrees to the aisle may still be dictated by high land cost, as in the case of the garage for Midtown Manhattan shown herewith, or by high construction costs as encountered in most underground garages.

One design feature leads to another. Use of angular layout of the parking stalls makes one-way movement in the aisles almost imperative. One-way movement is desirable, furthermore, because it reduces the chances for accidents by the self-parkers. In some designs, however, particularly in connection with the continuous spiral, one-way movement makes an express exit-ramp necessary.

The trend toward clear span design is another instance of the close relation of cause and effect. Clear span design is that in which the parking area is kept free of all columns. The rapidly developing art of prestressed concrete design and construction has made clear spans of 58 or 60 feet economically feasible. With certain foundation conditions, in fact, a clear span building is less expensive than the more conventional framed structure with columns dividing the parking areas into three-car bays.

The obvious advantages of the clear parking floor are the saving in space otherwise occupied by columns and the reduction in opportunities for collision with the columns. Of growing importance, however, is the further advantage of flexibility in layout of the parking area to accommodate cars which now come in a wide range of sizes. Of all the automobiles manufactured in the United States in 1960, 29 percent were of the "compact" variety. If this ratio holds for the next several years--and it may well become even greater--attempts will be made to segregate small cars from standard-sized cars in large garages in order to take advantage of the lower space requirements of the compacts. Even at the present time, odd corners of garages which would formerly have been unrentable are now marked "Small Cars Only" and turned into revenue producing space. At the other end of the scale, some garages have special spaces--and rates--for out-sized behemoths.

Control

Increasing labor costs have influenced not only the layout of parking lots and garages, but also the type of control exercised over entering vehicles and the collection of fees. Rather than employ attendants to pass out tickets to entering vehicles, for example, it is now customary to use automatic ticket dispensers. These are sometimes interlocked with a gate, but more often they are merely wired so as to sound a warning if a driver fails to take his ticket. Since such machines are often some distance from the nearest supervisory employee, they issue tickets only after an entering vehicle has operated a treadle. This prevents dishonest parkers from securing a second ticket thirty minutes before leaving the garage after having parked all day.

The attendant who formerly issued tickets would also sometimes promote the sale of gasoline or announce a special sale in a nearby department store. Even this human "touch", however, can be filled by a public address system giving a recorded message upon actuation of the ticket issuing machine. The sultry voice of Miss Monitor, for example, could probably sell more oil changes than could Grease Pit Joe in a grimy personal appearance.

Inside the garage, the wonders of science take the motorist by the hand and lead him to the nearest parking space. Electronic devices emitting sound, radar or infra-red beams detect the number of vehicles entering and leaving each section of the facility and automatically actuate signs directing drivers to the appropriate section or level. The same counting devices are also used to actuate signs at the street entrances, advising motorists when the garage is full.

Mechanizing the control of vehicles leaving parking facilities is a little more difficult. Fees must be computed and collected, change must be made, and credit must be given and charges allocated under ticket validation programs. However, the gadgeteers--who can send a rocket to the Moon--are not likely to be over-awed by such earthly, everyday problems.

A robot to compute and collect parking fees will undoubtedly make his debut in the very near future. Several machines are known to be under development, and some with limited capabilities are actually on the market. Those now available will accept a ticket on which the time of entry has previously been punched. In one operation, the machine computes the fee for the time that has elapsed and indicates the charge on an illuminated board displayed to both the cashier and the patron.

The fee collected is also stamped on the ticket before it clears the machine, so that auditing of the daily receipts is reasonably easy and protection of the revenue is assured.

It would be a logical further development to combine this device with the coin collection machines which have become familiar objects on toll roads and toll bridges throughout the country. Presumably, these would be used where there was an attendant present to make change and supervise the entire operation. With dollar bill changers and coin changers already on the market, however, the entire fee collecting operation could be completely automated in one or more exiting lanes.

Manufacturers have let it be known that they are working on a device which will do everything a human cashier can do except take coffee breaks. The time a motorist enters the facility will be recorded by magnetic impulses on metallized cards. The impulses will not be subject to alteration by the patron unless he has access to very special devices. Retail stores participating in a validation program will be able to process the cards by a simple machine at each cash register to assume a part of the parking charges of their customers. Upon completion of his errands, the parker will drive his car to the exit of the garage where he will place the metallized card in a machine. The machine will compute his fee, giving credit for all validations, and the net fee to be paid will be shown on a board facing the driver. The machine will then accept any combination of coins, make change and open the exit gate. Other functions of the device, of course, will include the counting of receipts and summarizing the charges to be billed to each store participating in the validation program. The value of such a machine in reducing labor costs and the great number of establishments that would be potential buyers of such devices makes it almost a certainty that a machine performing all of these functions will be marketed in the very near future.

Among the simpler types of control is the coin-operated entrance gate, which is widely used by parking lots charging a flat fee regardless of the length of time parked. The exiting movement is controlled by a gate which is opened either by a second coin or by mere passage of the vehicle over a treadle. In either case, a treadle closes the gate behind the vehicle. Both entrance and exit gates can also be operated by keys or metallized cards to accommodate monthly parkers or other authorized users of a lot.

Parking meters have been used in innumerable off-street parking lots. In most instances, they have been applied where the lots are under the jurisdiction of a municipality with police power. The regulations

imposed by the parking meters are enforceable, therefore, under the laws applying to curbside meters. Usually, however, overtime parking is subject only to the requirement that an envelope bearing the license number of the vehicle and containing the proper additional fee be deposited in a courtesy box.

A variation of this method of fee collection has been used successfully in the municipally-owned Seventh Street garage in Cincinnati. The large number of entrances and exits for this three-level facility on a narrow site made it sifficult to devise a system that could be operated without a prohibitive number of attendants. The installation of meters, however, made it possible to operate a 256-space garage with just one attendant on each shift. The attendant makes hourly rounds in the garage to check the meters, punching time stations on each level. He also makes change for the patrons, and the night attendant performs janitorial services.

The rates are 25 cents for the first hour and then 25 cents for each additional three hours.

An interesting commentary on this operation is that it was found necessary to impose a penalty on the motorist who allowed a red flag to appear on the meter in front of his vehicle. Otherwise, many people parked without inserting any coins in the meter. The patrons reasoned--all too logically--that each would get nine to ten hours parking for $0.75 rather than $1.00 by simply paying one quarter for each mark on the courtesy envelope attached to his car. The imposition of a 50-cent penalty for everyone with a red flag showing removed the sporting chance which so universally intrigued the patrons, and the number of cars tagged on the 9:00 A.M. round dropped from an average of 95 to 100 to a mere three or four.

Signing

With the removal of the attendant at the entrance to a parking garage, it becomes necessary to erect signs to convey a great deal of information to the entering motorist. As a design problem, this is not a matter to be taken casually. In a large cavernous garage, for example, a motorist may turn in from a street on a clear sunny day with the light intensity approaching 20,000 foot-candles and find himself in a garage where the level of illumination is approximately 100 foot-candles. In a matter of seconds, his eyes must not only adjust to this vast change in light intensity, but they must also perceive, and his brain comprehend, the meaning of such an array of signs as STOP--TAKE TICKET;

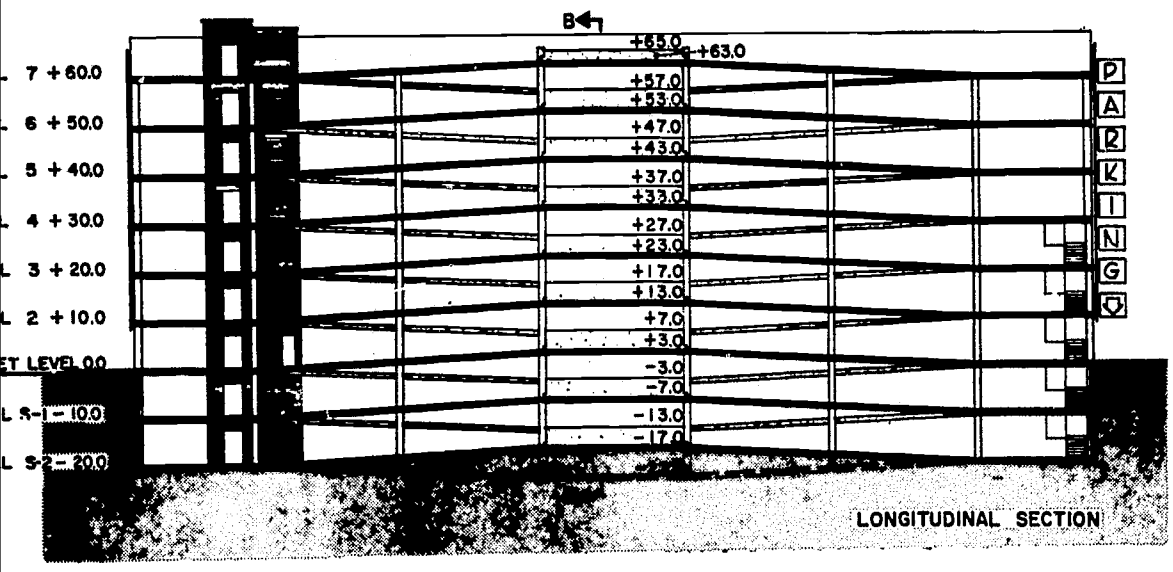
LOWER YOUR ANTENNA; REMOVE YOUR SUN GLASSES; HEADROOM 6' 8"; KEEP TO RIGHT; NO PARKING ON THIS LEVEL, PROCEED UP TO LEVE 2; and perhaps a schedule of fees as well as regulations as to smoking, locking cars and other matters. In addition to all these signs conveying important information, it is not unusual to have an entire wall devoted to such messages as "Thirty minutes free parking for patrons of Benny's Delicatessen."

This problem has led to a good deal of experimentation with various types of signs, including formed neon tubes, enamelled metal, interior lighted plastic, reflectorized sheets and every other type known to the industry. Architects and traffic engineers are still seeking better signs to meet the variety of applications for providing adequate information in parking garages.

We are currently planning the signs for a four-level underground garage and bus terminal with about 1,240 parking spaces. We find that over 300 major signs will be needed with more than 50 different messages.

I have implied that the designers of parking lots and garages are faced with many problems for which they can find no clear-cut answers in the available handbooks. This does not mean that everyone's opinion is as good as everyone else's and that it makes little difference what you do. Rather, it means that the engineer or architect facing the problem of designing a major parking facility should contemplate a substantial period of study and research to develop all of the potentials of the particular site with which he is working.

There is no need for him to fear experimentation and application of new techniques. The substantial progress of the past few years has come about only through a willingness to admit that our design criteria for such structures are still wide open to improvement. He will do well, however, to learn what mistakes have been made, and why. Thus he can avoid incorporating them into his design. At the same time, he should learn from the experience of others what is good and how it can be best applied.



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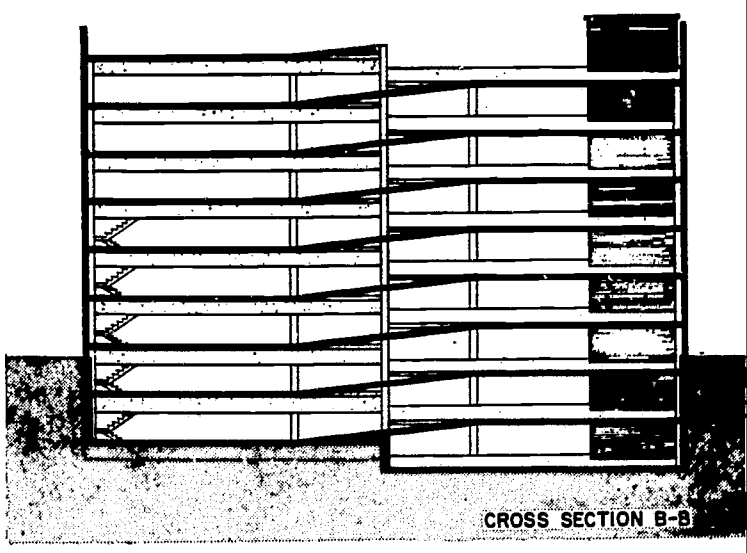

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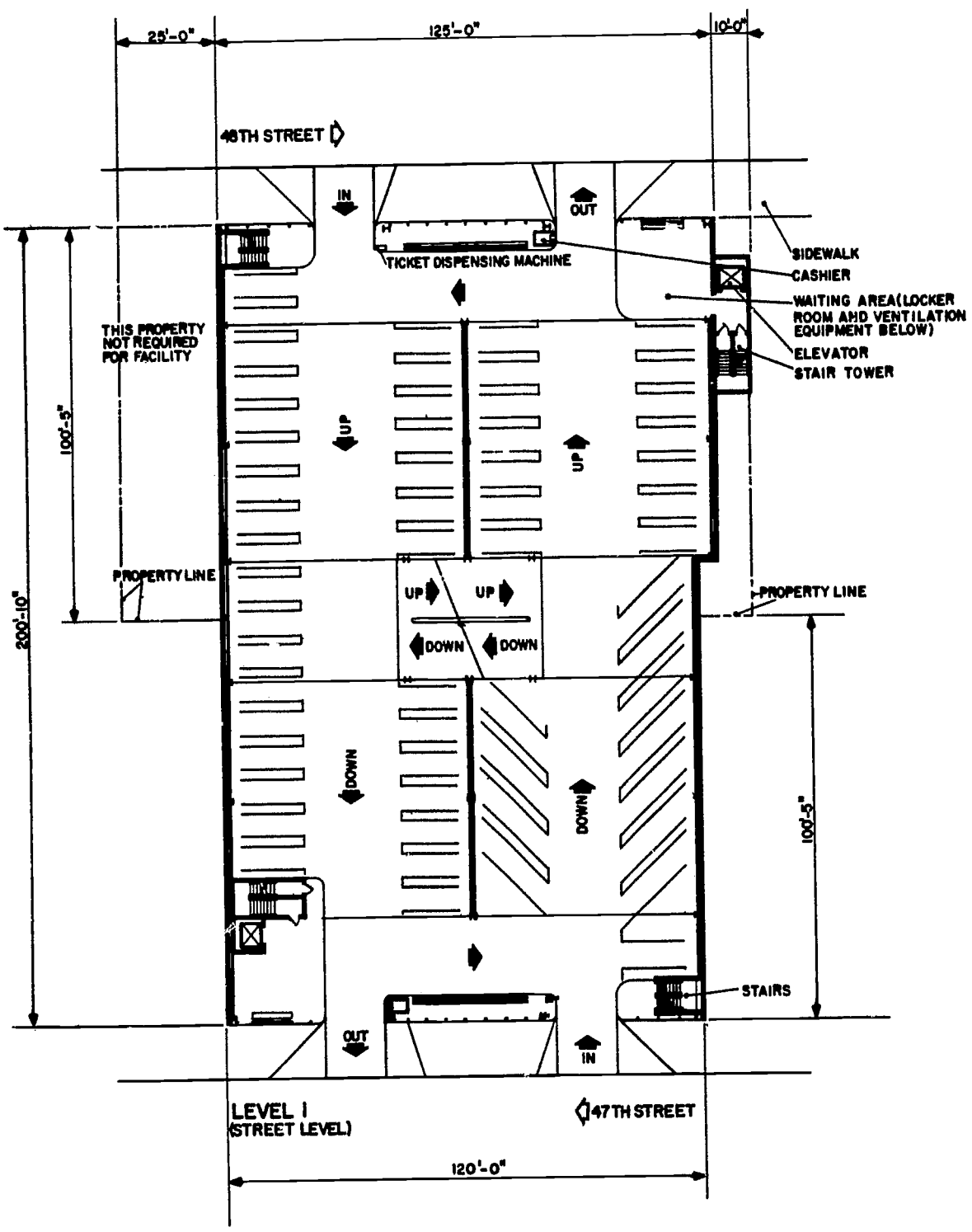
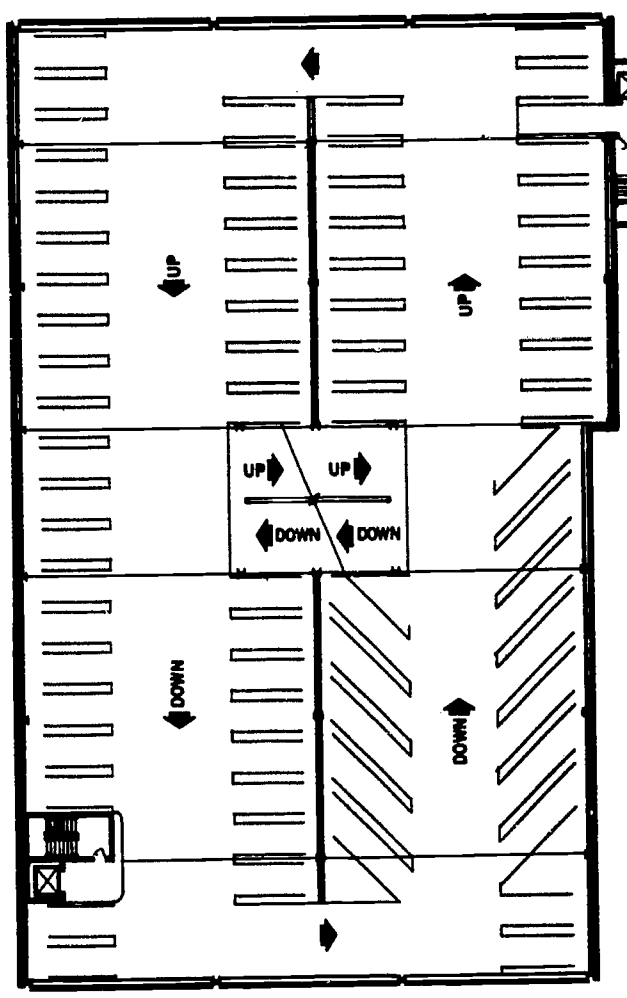




TYPICAL LEVEL

CAPACITY: 600 CARS - 9 LEVELS

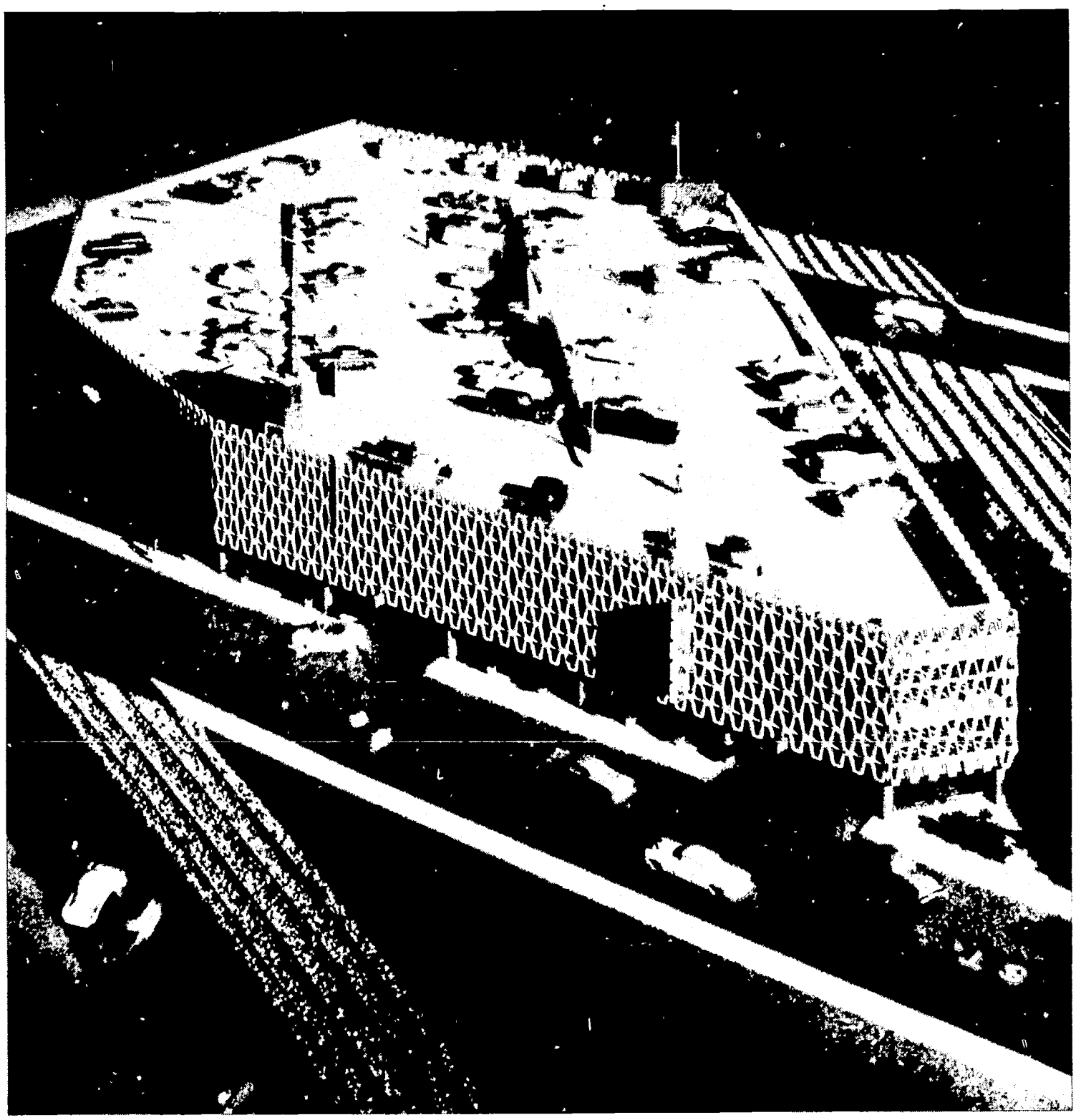
TYPICAL PARKING GARAGE

MIDTOWN MANHATTAN

prepared for

CITY OF NEW YORK - DEPARTMENT OF TRAFFIC

CHARLES E. DE LEUW - CONSULTING ENGINEER



MULTI - LEVEL PARKING DECK

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