

A PARKING GARAGE SHOPPING CENTER LIFT-SLAB CONSTRUCTION

by

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the Degree of Master in Architecture

ABSTRACT


This parking garage shopping center is related to an urban redevelopment scheme of an eastern Mediterranean city. The great need of parking facilities and the impact of a large structure on the city life are the main concerns of the design. The lift-slab technique construction is used throughout the building for economic reasons and structural simplification.


June 17, 1963

Pietro Belluschi, Dean  
School of Architecture and Planning  
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Dear Dean Belluschi,

In partial fulfillment of the requirement for the  
Degree of Master in Architecture, I hereby submit  
this thesis entitled "A Parking Garage Shopping Center  
Lift-Lab Construction."

Respectfully, 

~~Jean-Michel~~  Haruet

## INTRODUCTION

This complex is situated in the central business district of a redevelopment scheme for an East Mediterranean city. In any growing city, the automobile problem is one of the most important concerns of the planning.

Any city should have an absolutely perfect balance between pedestrian and automobile uses, the overdesign of one or the other creates a definite influence on the city life. Two examples in an illustrative opposition can be easily made:

(1) Brazilia, the city for automobiles, and

(2) Any typical housing redevelopment in the northwest of England.

The first one is designed for speed, and pedestrians are banished or ignored. The second one has a design in which the new road follows an old path from the time of the War of the Roses with great accuracy. This equitable balance in an urban environment is one of my main overall concerns.

A strong differentiation and isolation should be achieved between automobiles and pedestrians; keeping a generous interlocking relationship between the two; another important concern is the readability of the city, or of the building, considered under both aspects: car and man, high speed readability and low speed readability.

The image of Aldo Van Eyck: "the city is a large house," should be analyzed on the understanding of building, of form, and of planning. "The combination of the large and the small, "has to be translated into terms of speed, as well as in terms of dimensions.

The program itself was determined by the enormous needs of parking facilities in the areas adjacent to the redevelopment area.

The redevelopment designed with optimum parking facilities would not be able to handle the surplus of parking needs of the surrounding

zone without being greatly disturbed. This problem was the main motivation to the birth of this program. There is a definite need for parking facilities and these facilities will have a strong impact upon the environment. However, a parking facility is not very well absorbed in an urban environment because of the lack of activity and the lack of life.

By grouping the main commercial zone (the commercials are department store types) with the parking facility, the urban life is then recreated in these buildings which are by themselves only "dead structures," as filing cabinets in an office or storage space in a house.

One of the greatest dangers of large parking units (5000 cars and up) is their function at peak hours, e.g. stadium parking. The danger is avoided here by the fact that these units are situated in a zone of diversified uses. They therefore satisfy different needs at different times. (The redevelopment zone has housing 40%, offices 30%, entertainment, hotel, social, administrative, and community facilities.)

This parking unit, designed to hold 3000 cars, will act as a car harbor theoretically providing parking facilities for any length of time. Three of these parking units are used in such a location that their efficiency will be continuous twenty-four hours a day, mainly because of the variance in peak hours due to the different uses. The most important problem in the establishment of a program (economic) is to avoid the over-design of a building of this importance.

The locations of these units are:

- (1) Near an entertainment and hotel zone;
- (2) In the main business section;
- (3) In a position to serve a complex of administrative buildings.

(See photograph of model)

Their capacity compared to the parking needs of the entire area is three-fifths (3/5) of the total. If the scheme is being implanted in stages, the construction could precede the needs of the next stage.

The main reason for centralizing the commercial area in such a precise position, instead of the typical commercial street, is to avoid the disturbing interference on the normal traffic speed of an automobile concentration in such an area.

The parking unit we will be concerned with in this study is one inserted in a general business spine, (3/4 of a kilometer long) which runs parallel to the sea, the distance is from six hundred and fifteen hundred feet. The blocks of the spine (500 x 500 feet) are limited on the north and south sides by a sunken expressway, widely overpassed by pedestrian bridges. At every block a ramp serves one or the other direction of the north-south traffic. Bus stations and service accesses serve each block from the expressway level. These blocks are surrounded east and west by a one-way road system bridging over the expressway.

A one-way rotary is created around the parking unit.

The two main pedestrian flows are:

- (1) North-south, following the direction of the spine,
- (2) East-west, following the spine perpendicularly at the center of each block towards the sea.

By shifting the one-way road system forty-five degrees ( $45^{\circ}$ ) to the direction of the spine, the pedestrian walks to the sea pass under the roads at their crossing, and by this fact, a strong separation between cars and pedestrians is achieved, keeping them, however, on the same level.

The commercial spine has a low density building floor ratio, none of the buildings being higher than four or five stories.

## DESIGN INTENT

One of the main concerns of the design is to create a building which is integrated in an urban environment. The penalty of a building of large size is the barrier created to the pedestrian impact. The easiest solution "the pilotis" are adopted here because of the sufficient height provided between the structure and the ground level. The two contradictory scales in the design (30' x 30' modular apparant in the facade: "the large") and the interior landscaped area (the small") correspond to the two kinds of city scale:

MAN-low speed                      transportation                      CAR-high speed

The forms of the redevelopment area are strong and unified in the large city scale (mainly constituted by superblocks), but could be very diversified and still maintain their own identity by a different treatment in their human scale.

The parking garage inserted in the spine has the same dimension as the other offices or commercial complexes, the pedestrian approach to it, as well as any building of that spine will be unified by their landscape and will be undistinguishable as far as their atmosphere is concerned. On the contrary, the automobile approach is strongly indicated by the wide ramps detached from the building. The strong differentiation between the pedestrian and the automobile is resolved by using different levels:

- 16 CAR running along the spine; high-speed road 40-50 mph.  
    carrying buses and service access.
- 12 pedestrian in the direction of the sea
- +16 pedestrian parallel to the spine (see diagram)

The level 0 is the level of interaction between car and pedestrian. This is the articulation point between the slow transportation road and deloading and loading passenger areas. The bus stops of the lower level are connected to the ground level by large openings and stairways.



THE SHOPPING AREA USING THE STRUCTURE OF THE PARKING AS AN UMBRELLA is distributed on the street level (-12, +4, +16). The approach to the commercial could be synthesized as one big department store.

The entrance to the parking (from 0' + 32') runs parallel to the main pedestrian crossing (north-south). To avoid any direct interference, the automobile ramps, detached from the main structure, permit a clear reading of the circulation from the automobiles.

The parking is a ninety degree (90) parking system confined in a square plan where two sides are used as ramps to go from one level to the next one with a gentle slope (8%) permitting parking on ramps. These ramps parallel the entrance ramp on the first parking level (32), this creates a space which gets lower toward the center of the building which is most desirable where the pedestrian approach is concerned. The efficiency of the parking is 312 sq. ft. per car. This figure can not be reduced without putting a serious penalty on the internal functions of the ramps during rush hours. The efficiency of a parking garage increases with its dimensions. The recent examples of parking garages with large dimensions follow that rule only theoretically. If the number of cars held is great, the real efficiency of rush hour parking on busy days is considerably affected by the penalty put on the circulation for the optimum number of cars.

Because of the climate, the roof is used as an uncovered parking level. Four batteries of six elevators serve the parking levels. The four cores are:

- (1) Relating the parking levels to the ground floor;
- (2) Providing intercirculation in the commercials themselves.

The treatment of the upper part of the stairways (enclosed in

the parking) differs from the lower part of the stairways (open-air stairways) in the commercials.

The size of the building and the shadow zone created is extended to the building line of the block in order to avoid direct sunshine. This is one of the more important considerations in such a climate. The exhaust of the automobiles is taken care of by the sufficient depth between the floors (10') and the air shaft created by the two interior ramps, and a central well; no solid handrails are used in the interior of the parking levels to accentuate the horizontal draft of air. The ceiling of the commercial area is sealed to keep the automobile fumes from going down. No mechanical ventilation is provided throughout the building because of the large openings around its periphery.

Pedestrians approaching the building to the direction of the sea (south-north) go down from the ground level to level -12' and through the building in its largest space (floor to ceiling height, 44'). This large space is used to create a public square atmosphere extending the urban environment into the structure, pools, benches, palm trees, etc. On this level the shops (two stories high) are internally related to the next level (4'). This level is mainly used as a pedestrian approach to the parking levels.

The last commercial level (+16) takes care of the pedestrian flow running along the spine, this level bridging over the streets is the main access to all the commercial and office facilities of the spine. The parking access level (4') by being between these two flows at an intermediate height provides a differentiation between public and semi-public spaces.

In contrast with the exterior, the internal asymmetry of the commercial floors which defines a symmetric axial penetration through the building is dictated by the need of a visual break of the strong symmetry of the structure.

One of the advantages of the interior ramp system is that the periphery of the building stays horizontal all around, without visual disturbance. The ground floor and the lowest commercial level are not interrupted by any street (the sunken expressway) so that a continuity through the landscape can be preserved.

The treatment of the facade, essentially bumper rails, is in precast concrete for the parking level and is cast in place for the commercial areas. The two different shapes in the design are used to emphasize their two different functions, and to accentuate the segregation between car and pedestrian.

The different treatments of the stairways are intended to control the pedestrian movements through the building. The stairways from 0 to -12 are treated as open space landscaped stairways, in opposition to the three sides (south, west, north) relating the three commercial levels treated as interior fixtures (as an opposition to outdoor fixtures). Finally, the stairways between the elevators used in the parking levels as fire exits (enclosed) are used in the commercial levels as internal circulation in the shopping area itself; the shops are mainly distributed in the corners (75% of the total).

## CHOICE OF THE CONSTRUCTION SYSTEM

The lift slab system was adopted for this building because of its structural and economical advantages.

The floors of a parking garage of this type carrying no heavy mechanical equipment (except electrical conduit) have to be constructed by simple means.

The floors being erected nearly finished the cost of handling and vertical transportation of the material is reduced to its minimum.

The use of post-tensioning or pre-tensioning is limited to its minimum and is used only for the long span section; the post-tensioning is more economical for this span (90°) than a normal reinforced concrete structure because of the penalty created by the dead weight on column connection, etc.

One of the more important components of the cost of reinforced concrete is the construction of the forms themselves. By tremendously reducing their cost, the structure can be built on a very good economical basis.

In common practice, lift slab construction is not as economical as it seems to be, but this fact is related more to the attitude of the contractors or the lift slab firm which, using their patent rights have no interest whatsoever in reducing the cost of the construction. In the future this technique should be improved and used at a more reasonable economical basis.

It seems that the most important advantage of reinforced concrete resides in its structural continuity; cast-in-place concrete used in any system of construction has this advantage compared to any precast concrete system which demands other means to reach the same structural continuity.

The idea of a "moldable stone" used to its extreme gives the image of a building being one "stone," one mold, one pouring operation. In perfect opposition to that the precast systems directly derived from the traditional lumber construction could

possibly survive in a near future because its good economic standing (which nowadays has not been reached, yet, any precast concrete building being most of the time more expensive than a cast in place concrete structure).

The old, constant problems of connections simplified to their extreme by the reinforced concrete technique seem to back up with the precast concrete system.

The most important factor in the reinforced concrete technique is the form, this economic factor which becomes more important than some other structural factors does not seem to be a field of interest of research, however, it seems to me that the economic answer to reinforced concrete techniques has to be found in the forming process, the perfection of connections has been reached already.

LIFT LAB CONSTRUCTION  
(General Information)

The Lifting Equipment:

Because of the little diversity of the equipment available, the lifting operations have a definite effect on the designed components.

The question of whether to brace a lift or to use columns that are adequate for lifting without bracing is largely a matter of economics, regardless of whether bracing is used, some guying will be required to plumb the structure before the top slab is permanently attached to the column. The capacity of the lifting equipment has been increased from the earliest equipment which was rated at 67,000 lbs. per jack to the present which performs at 150,000 per jack. Two jacks can be used by placing them on the end of a horizontal beam on the top of the columns.

The lifting rods connecting jack and slab (two are used for jack, located as close as possible to the center of gravity of the column) are made of 4140 steel, and are threaded one-fourth of an inch ACME 4 per inch. The rods are as large as twenty-four feet (24'), extension rods (couplings) can be added, if needed. The longest column from which the lift has been made to date was about fifty feet (50').

The standard spacing of rods is fifteen inches (15") on center, however, model VI equipment (General Electric) has an additional spacing of 25" c.c. to facilitate working on larger columns.

The anchor nuts which engage in the collar are two and seven-eighths (2 7/8") inches in diameter and are never thicker than two inches (2").

### The Column Size:

Wide flange of any size (although sizes above 10" will require special jack adapter base plate to gain the necessary stability) round columns, through 10" series if equipment is available with rods 25" c.c. up to 20" square can be used.

### Floor Design:

One of the most economical solutions to the floor design is the use of the flat slab with a span between eighteen inches (18") and twenty-four inches (24"), since above this range the slab deadload becomes the major load carried. Canteliver .2 or .4 times the adjacent interior span will reduce the steel of the positive moment required in that slab. Very often the canteliver element can be obtained quite cheaply due to the saving on the steel of the positive moment.

### Type of Columns:

Where possible to use, a pipe column provides a very economical section, rolled sections as a rule are more economical as compared to prefabricated box columns (this seems to be only true for steel columns and the other way around can be noticed for concrete columns). Multiple variations in local prefabrication costs can change this comparison considerably.

### Collar Selection:

The smallest and lightest collar that will permit unit diagonal tension stresses to be contained should be used, often sheer head reinforcing is more economical than the use of the larger collar without stirrups. It is not necessary that collar should be as deep as the slab.

### Planning for Lifting:

On a small project, over-lapping slabs might entail a considerable delay, resulting in handling the equipment more times than required. In multi-story lifting operations, the scheme that

permits the minimum number of moves of the equipment will be the most economical.

Frequently, pour strips can be located as to prevent awkward openings from interrupting structural continuing. In most cases, pour strips should be located after considering structural economy and architectural feasibility.

In general, the lack of long range thinking has been evident in a number of buildings, whereas the individual details have been very well handled (note: normally a lift consists of 12 columns or less, but where equipment is available, lifts up to 36 columns can be made).

#### Collar Selection and Design:

The collar used in lift slab construction performed multiple functions:

- (1) It is initially an anchor for lifting the slab;
- (2) It serves as a guide and a slide for stabilizing the structure during lifting;
- (3) After the lift is complete, it becomes an integral part of the permanent slab to column connection.

Frequently, a simple connection using weld from collar to column both at the top and at the bottom is adequate. A completely rigid connection can be made by extending the collar around the slab for continuous weld from collar to column. For the high moment condition, reinforcing bars are usually welded to the collar to distribute the moment into the slab. The orientation of the collar should be such that the lifting rod will pick up approximately equal loads, for example: near the edge of a slab, the lifting rod should be parallel to the edge.



## CONSTRUCTION OF THE BUILDING

Each floor of the building is formed by nine (9) lift lab elements:

- (1) Four corner slabs symmetrically designed (36 column lifts each)
- (2) Four internal exterior slabs, two being tilted and used as ramps (14 lift columns each)
- (3) The central slab (4 column lift)

The design of these slabs is nearly the same as a cast-in-place floor. The 15' overhang is carried through all the slabs to avoid any eccentricity or asymmetric loading on the columns. This overhang helps to reduce the steel of the positive moment in the slab.

The four corner slabs on the thirty foot (30') span (column to column) have a uniform thickness of seventeen inches (17") + an asphalt topping which carries electrical lines and drainage (between 3" and 5").

A steel pans system was adopted to cut down the deadload of the slab, on a three foot (3') module (3' x 3' pans 14" deep with a 3" structural topping). The same thickness of the slab is carried throughout the building:

- (1) In the four interior slabs where the 90'x 30' bays are constituted by a one-way system using deep girders 46" deep.

These post-tension girders (6 post-tensioning rods jacked at only one of their ends and on the surface of the girder) are spanning in the 30 x 30 pattern 12' x 3' pans being used to span between the girders.

- (2) In the central slab, the same girders are used spanning from column to column with narrower intermediate girders of the same depth to support the same 17" depth pan construction. The central well helps to diminish the load of the bay.

The concrete columns, precast in the plant because of the difficult forming due to the round sections are erected in two parts in order to avoid the buckling, and bracing during the lifting operation. Their sections are respectively for their 30' x 30', 90' x 30', 90' x 90': 18" diameter, 18" x 40" (with round angles and 2 columns of 20" diameter round; this solution was adopted for the 90' x 90' span to avoid the loading, and to simplify the use of a regular equipment of 25" c.c. jack.

The choice of concrete columns was the result of factors in homogeneity with the rest of the structure, fire resistance, low maintenance, height resistance in lateral wind forces.

The lateral dimension of the column cannot be bigger than 18" because of the opening's limitations in the arm of the jack.

After calculations using a live load of 70 lbs. a sq. ft., the reinforcement of the columns is for, respectively 30 x 30, 90 x 30 and 90 x 90 spans: 8-#II bars, 18-#10 bars and for the double column 16-#10 bars.

#### Bearing Blocks and Connection Details:

The zone of the slab around the column constituted by eight (8) solid panels is considered as the bearing block, this heavily reinforced concrete block must be able to withstand the stresses during lifting operations, to transmit the slab's own dead weight together with the vertical load supported and to permit the column slab connection to produce moment continuity.

The bearing pins used in pairs are made of an 8" #I beam (18.4 lb. per ft.) with two lateral 1/4 inch plates welded to the web to provide the required shear capacity. A lead pad is used under the bearing pins to reduce the possibilities of non-uniform bearing on the concrete.

The bearing pin is easy to handle, place, or take away, thereby permitting a rapid landing of the floor, even in parked position. This bearing pin is fire proof after completion of the lifting operations by a mushroom type column cap cast in place pouring the concrete by using the six inch (6") diameter hole

in the collar provided for the lifting rods (a steel form in two sections could be used in regard of the great number of columns of the same type.

The wedges used in pairs are 8" x 6" steel plates, the pair is one inch (1") thick which is the clearance between the column and the bearing block. The wedges produce continuity of the slabs and the column. During lifting operations, the steel wedges also serve to increase the buckling capacity of the slender column by making continuous lines with the parked slabs.

Due to the dimensions of the lift slabs, expansion joints are carried through their edges. An eighteen inch (18") gap is left during casting on the ground operation and straight bars are left sticking out. The bars of one of the slabs are heavily greased or isolated with a plastic conduit and the other ones are left bare during the pouring of a regular expansion material which is used to separate the two slabs, the pour strip being continuous with one and free with the other.

The bumper rails of the parking levels are temporarily fixed to the slabs before lifting to avoid handling with a crane. This handrail is designed to be able to take care of any deflection of the slab, and to be adjusted in order to create a perfect horizontal facade appearance.

When the slab reaches its definitive position, the bumper rails are fixed and welded permanently by using a small lifting machine on wheels.

In the commercial levels, the strip surrounding staircases and elevators are poured in place when the slab has reached its final position. This is to simplify the connection between the vertical elements and the slab.

The exterior automobile ramps are cast in place with removable forms.

PRACTICAL ASPECTS  
(Information Provided by the  
United States Lift Slab Corporation)

### Base Plates

A leveling plate should not be used under a base plate. Base plates that are welded to columns are frequently warped and the use of a base leveling plate results in a ball joint rather than a fixed joint. All base plates should be grounded.

### Moving of Equipment

In order to reduce the time of erection and also to save money, the layout, insofar as possible, should be planned so that the jacks are set only once on each column. All of the lifting should be completed at that time rather than having to tie up the equipment for any length of time, or else having to move off and then return in order to finish lifting.

### Combination Pour Strip and Expansion Joint

If it is desirable to make an expansion joint, one proven method is to extend deformed bars from one slab and smooth dowels. The expansion clearance is provided by a piece of standard rigid expansion joint material.

### Collar Tolerance

As a rule, tolerance should be held to 1/8" all around. However, there are times when this is not possible or desirable. As an example, the column size might reduce in a multi-story lift and a collar that fitted properly at a lower level would be a loose fit further up. A loose fit can endanger the entire structure since it permits the slab to sway. If the tolerance is large, wood wedge or some similar means, should be used to reduce the side play.

### Installing Collars

Collars should be installed on the ground before the columns are erected. Lowering the collars over the columns in place is very expensive. Some method of parking the collars up high on the columns is desirable. A bolt hole through a column works well. The collars on top of the stack can be held with a shore while the bottom collar is lowered.

### Forming

The slabs should be edge formed all at one time with a form which is allowed to run wild on height and crosses all pour strips. The edge of slabs in place can be no better than their accuracy when poured and a continuous form gives the best chance to handle this. When additional forms for each floor are attached to the mounting pile of slabs on the ground, the accuracy of these forms decreases since they will never properly pull up and the cost of forming mounts since the labor is repeated over and over again. Chamfer or grade strips can be tacked to the perimeter forms and worked to more cheaply than individual slab forms can be placed to proper screed grade.

### Contouring Slabs

Since a slab must deflect in order to load up its steel, contouring slabs to compensate for this deflection have been used. By prediction of slab deflection, it is possible to set the screeds so that the slab will be high by this amount and will therefore deflect out flat. Nevertheless, in actual practice this has proven very difficult to do.

### Squareness of Column

It is essential that the top of a column be both square and

flat to allow the jack to be placed free of cocking. The surface finish should be better than torch but need not be elaborately machined. A mill end is generally good enough and the irregularities of torch cutting can be adjusted with welding at a base plate.

#### Column Height

It has proved practical to specify that the column height be about 1" above the final grade of the roof slab. This prevents sloppy cement finishing from getting the slab so thick at a column that it will hit the jack base before arriving at grade. These columns are capped or cut off below roof height. It is best to cap them if adding additional floors is anticipated.

#### Layout Work

Any mark placed over the separating agent will be transferred to the ceilings off it. It is advantageous to do the final layout work of all partitions, doors, etc., after the separating agent is applied and before the bottom steel is laid so that, when in place, the location of top and bottom plates will already be done and will require no vertical locating.

#### Shoring

When a slab must be temporarily parked for extension rod removal, a shore is sometimes used. This is placed, one column at a time, against a column and takes the load of the slab while the lifting rods are free of the load. In areas of tight union control, this can be quite expensive because the iron workers will often claim this operation and must be paid to stand by during a whole change-over. One short cut is to bolt temporary shear plate to the columns for parking since a bolting crew can stay out ahead of a lifting crew on run down, and the bolting



crew can remove the plates at their convenience. Much the best method yet devised is the shop welded connection which requires very little time of the lifting crew and requires no plate removal. The position of temporary parking must be anticipated before construction is undertaken.

#### Welding

Although welded shear blocks are still predominant, their economy should be very thoroughly examined. The lifting equipment will be tied up until the first blocks are ready to receive their load. The hiring of more welders and welding equipment will often break this bottleneck but will run the cost of welding very high due to standby time. The shop welded connection is designed to help this situation.

#### Permanent Bolted Connections

Permanent bolted connections, with high strength bolts or with rib bolts, have been used successfully. From the standpoint of field cost, bolted connections will probably be cheaper than welding on all but round columns where bolting is impractical. The shop welded connection should further reduce the cost of the bolted connection.

#### Swaying a Building

It is virtually impossible to sway or plumb a building after the horizontal or wind bracing welding is completed. The load should be transferred to the shear blocks before the building is swayed. Then the welding is completed. Often it is desirable to install all pour strips before horizontal welding so that any welding strains will not misalign the slabs.

#### Clean Collars

It is imperative that no grout be allowed between collar and column or within a keyhole. The bond between a collar and column is tremendous

and can actually prevent a properly controlled lift. The cost of cleaning such difficult places is worth the small additional attention of careful forming and pouring.

#### Location of Pour Strips

Care should be taken to locate pour strips in conjunction with the architectural concept of a building. For example, if the edge of slab is to show as an architectural horizontal line, the pour strips should, if possible, run parallel to this line so that it will not be broken up by the different color, texture, and possible deficiency. Economy of structural design also influences the location of bracing and guying.

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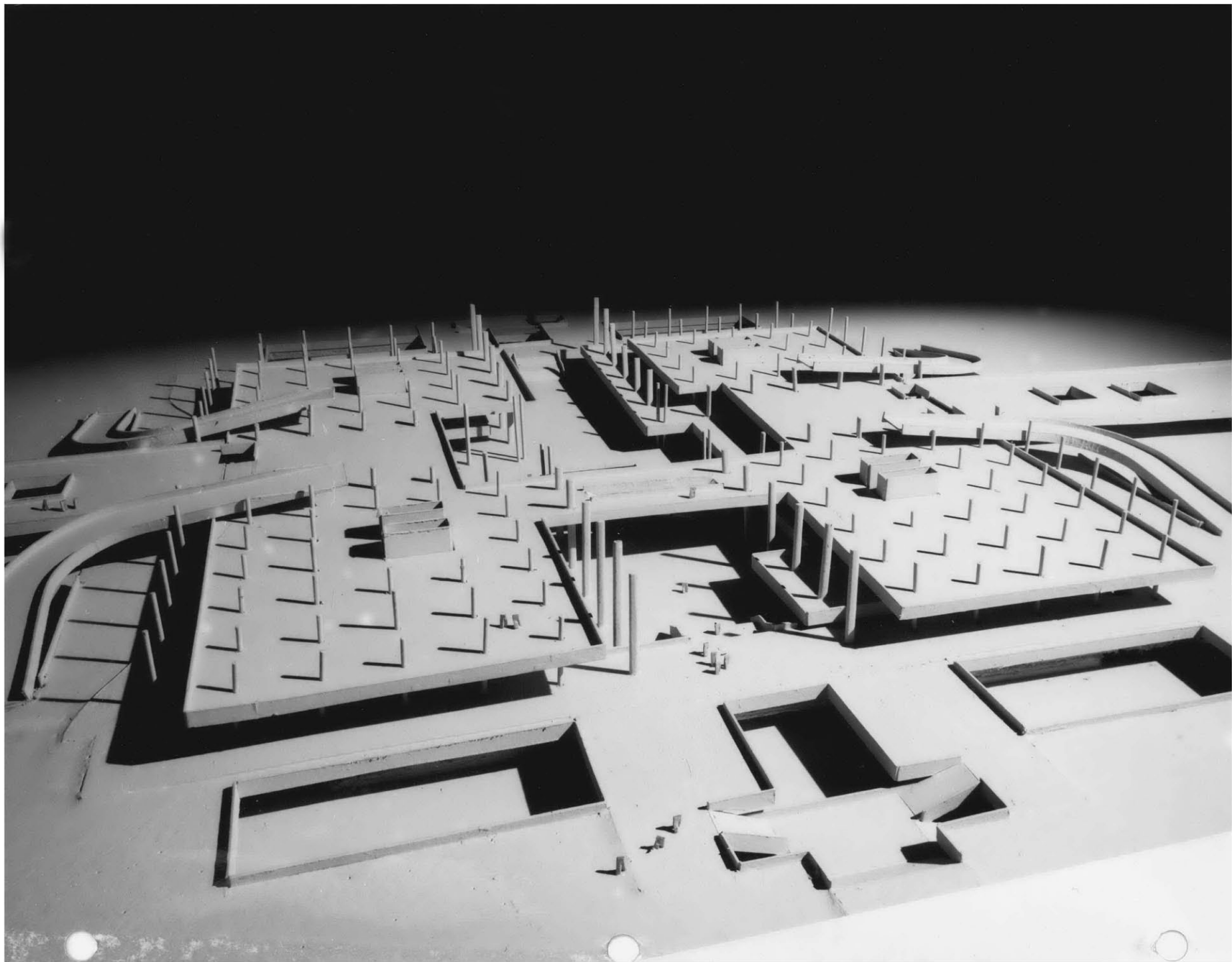
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Hingham, Massachusetts, U.S.A.



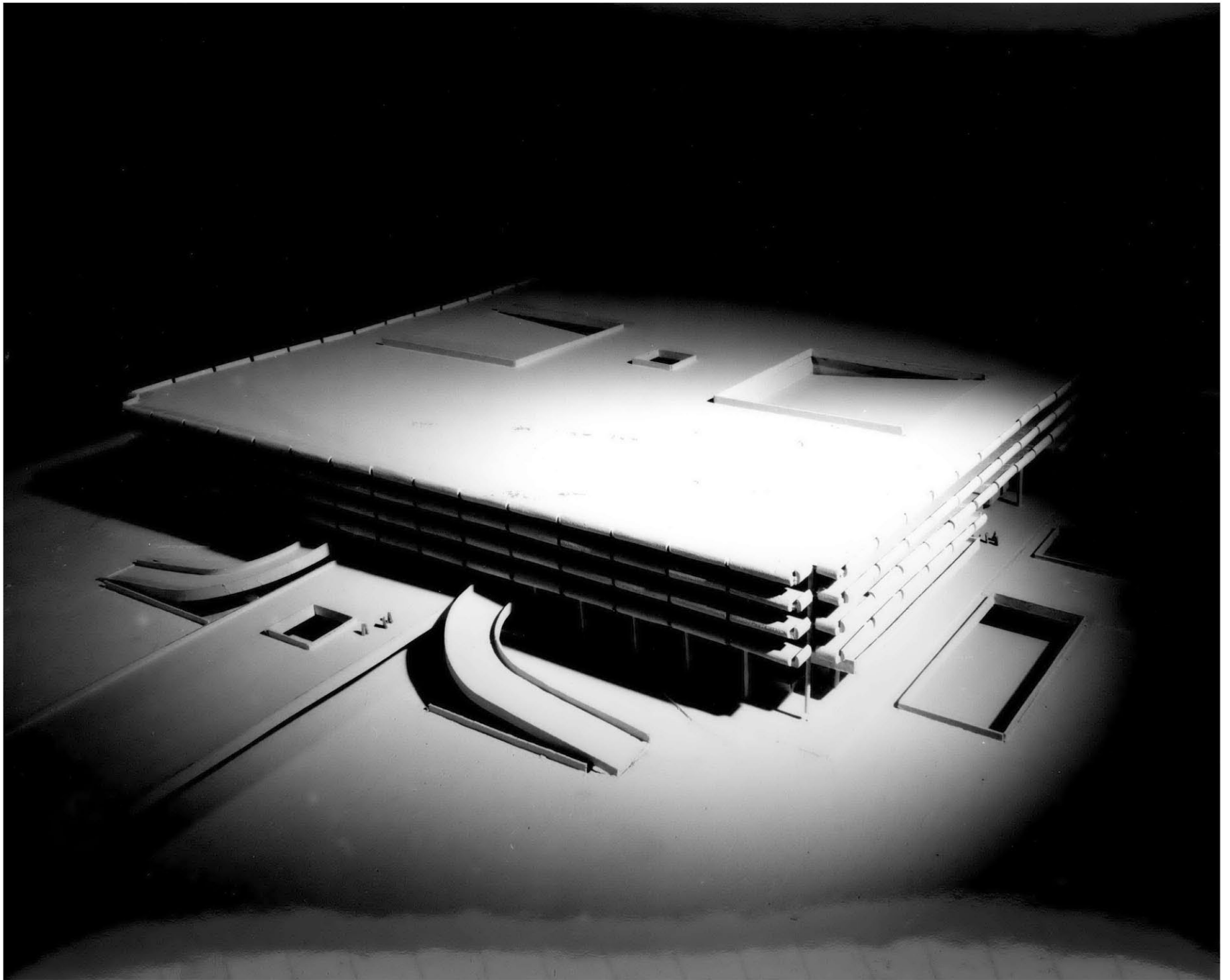






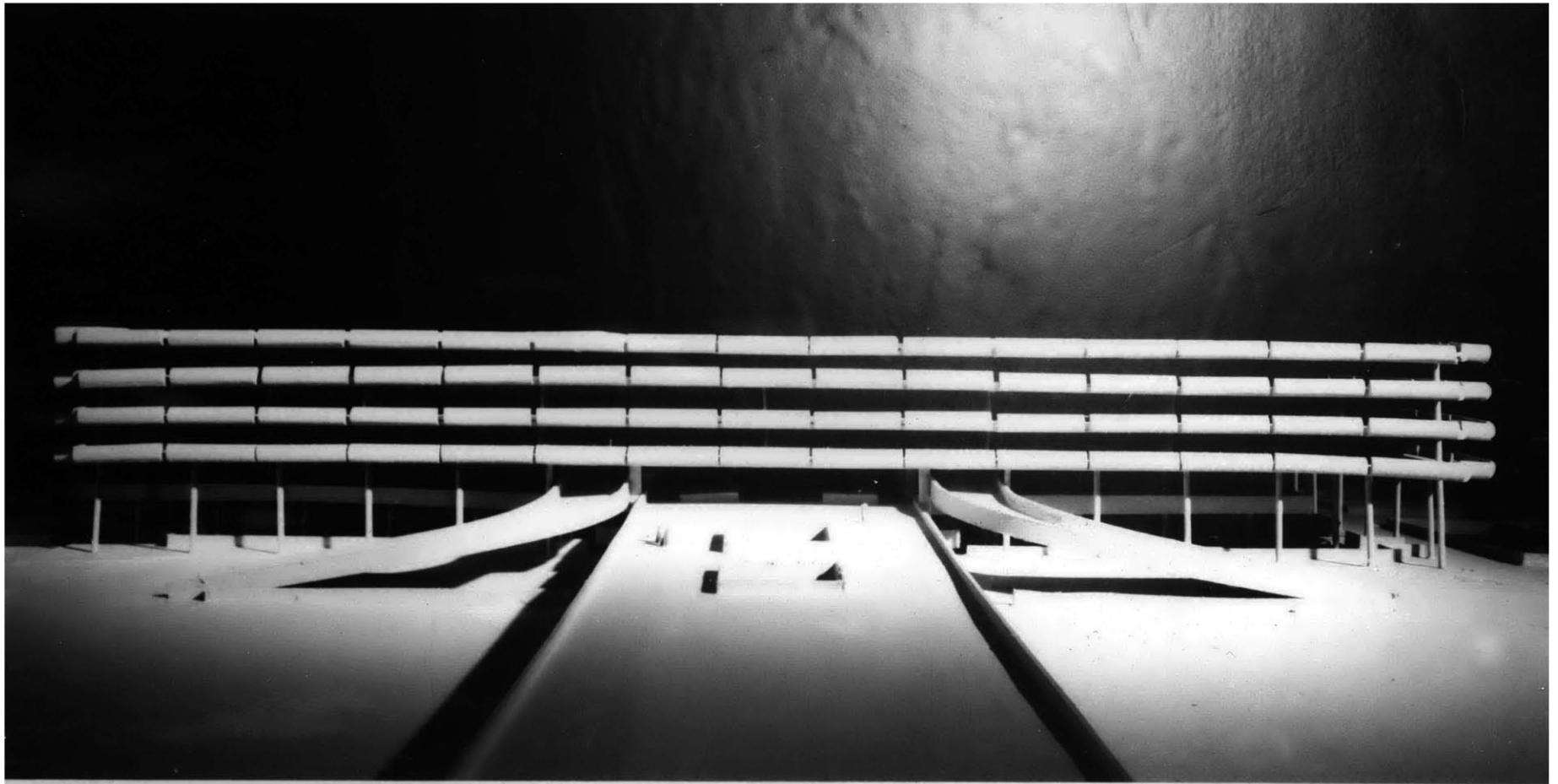








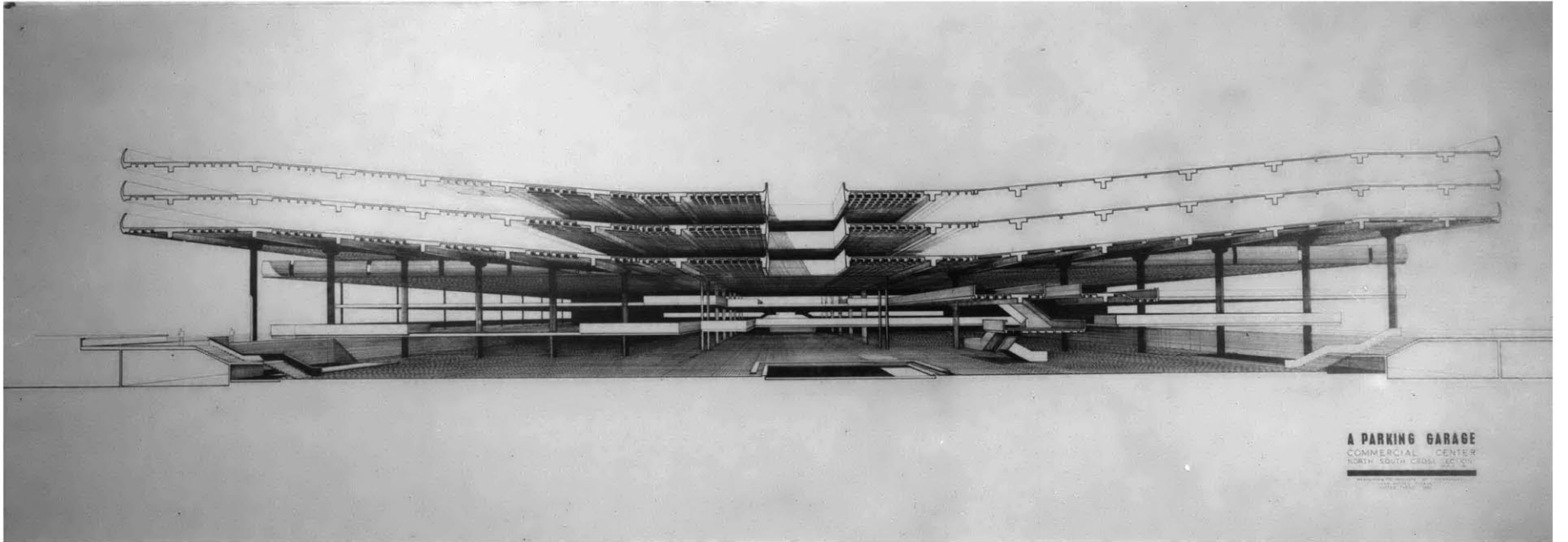




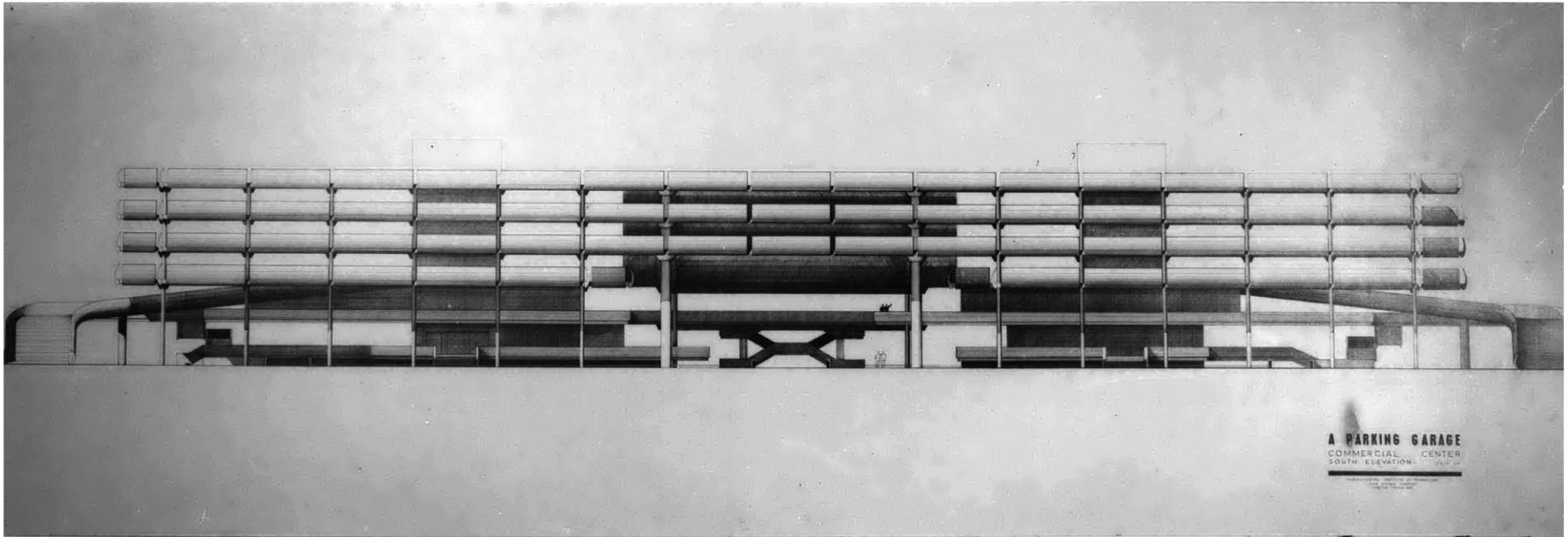
**A PARKING GARAGE  
COMMERCIAL CENTER**

**LIFT SLAB CONSTRUCTION**

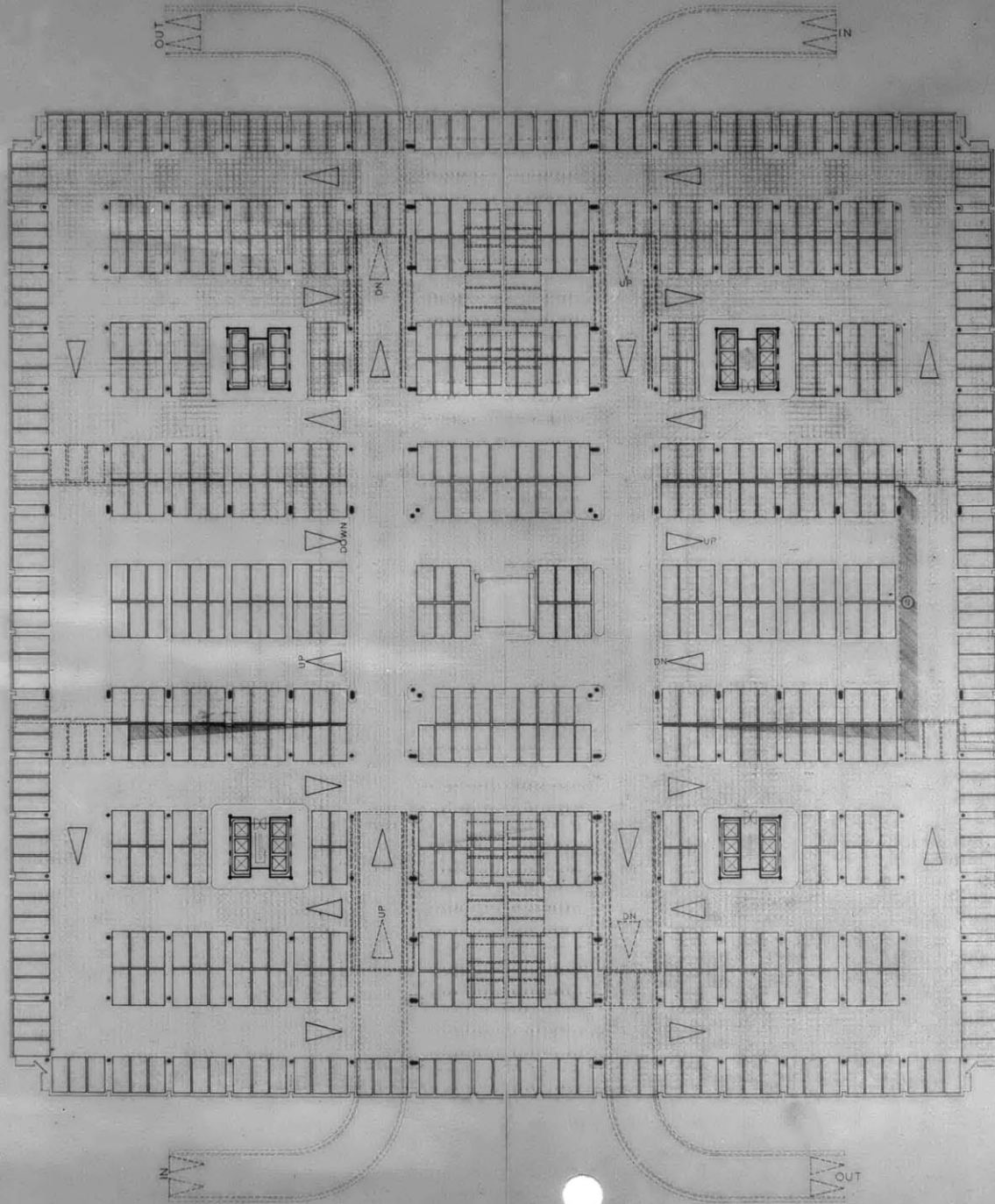
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
MASTER THESIS 1963



**A PARKING GARAGE**  
COMMERCIAL CENTER  
NORTH-SOUTH CROSS SECTION  
1/8" = 1'-0"



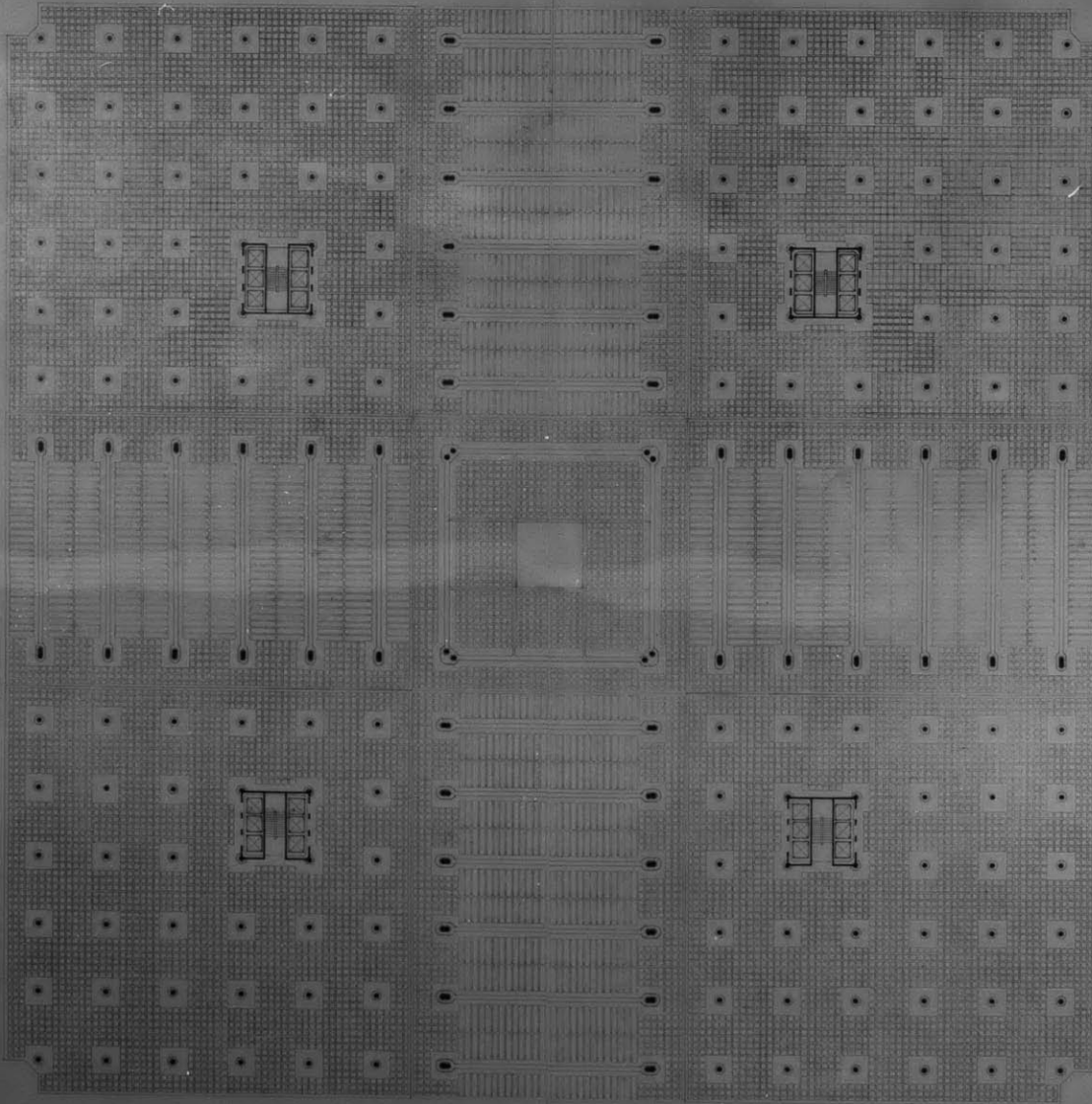
**A PARKING GARAGE**  
COMMERCIAL CENTER  
SOUTH ELEVATION  
SCALE: 1/8" = 1'-0"



SEE THE FIRST FLOOR PLAN FOR DETAILS OF STAIRS, ELEVATORS,  
AND MECHANICAL ROOMS. MARK TO BE EXACTLY AS SHOWN.  
REVISIONS: 1-10-68, 1-11-68, 1-12-68

**A PARKING GARAGE**  
COMMERCIAL CENTER  
TYPICAL PARKING LEVEL PLAN

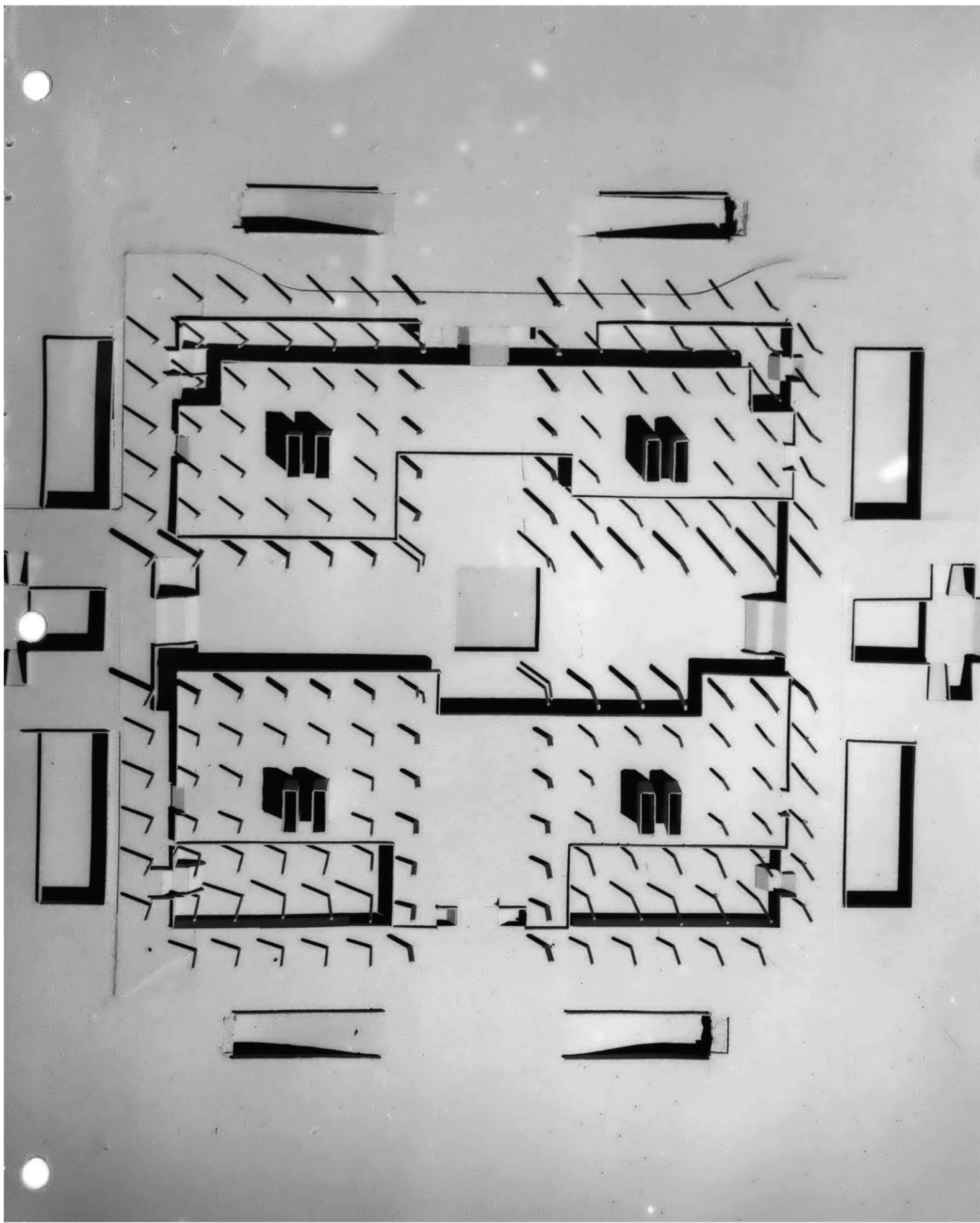
ARCHITECT: [unreadable]  
SCALE: 1/8" = 1'-0"

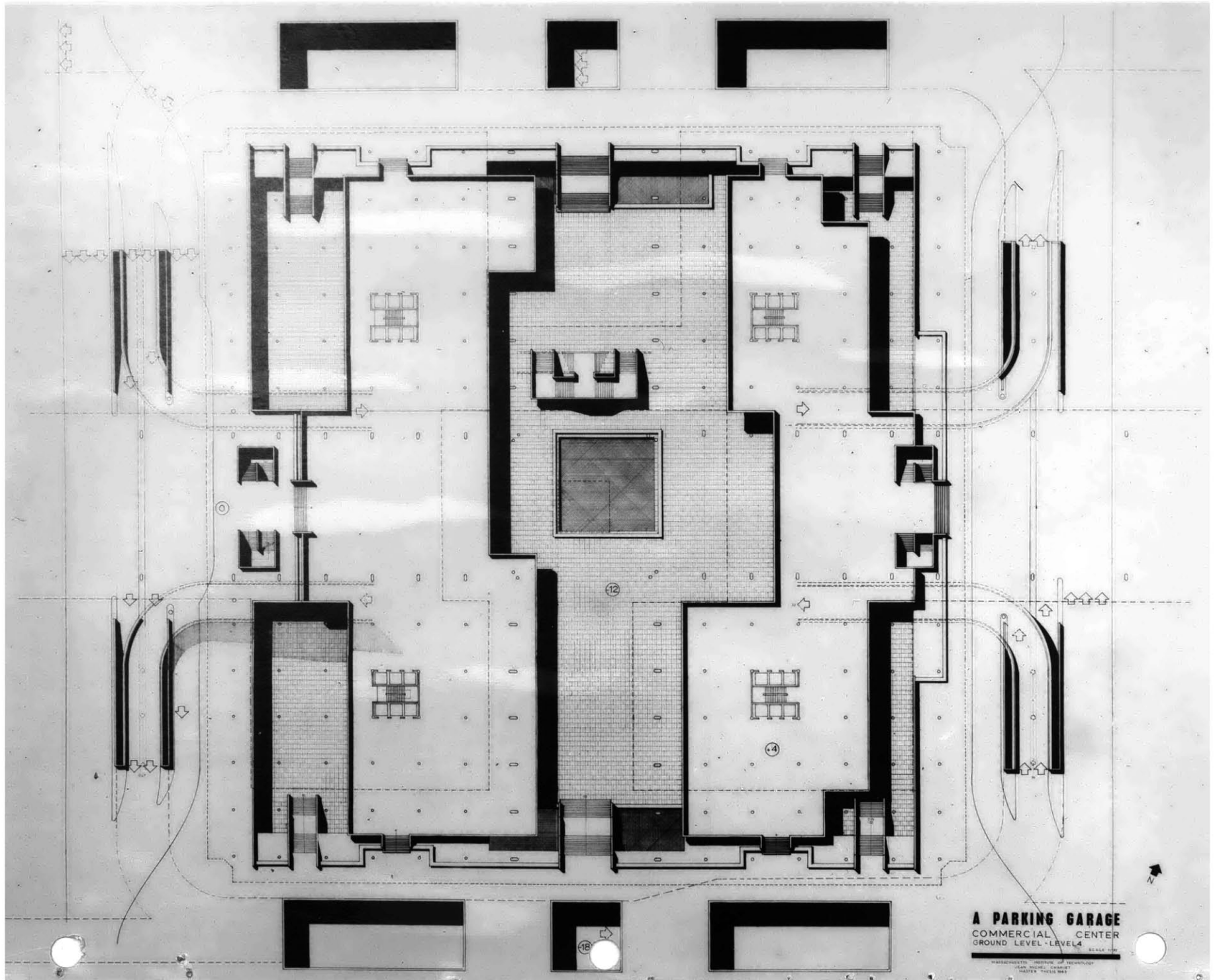


**A PARKING GARAGE**  
COMMERCIAL CENTER  
REFLECTED CEILING PLAN

SCALE: 1/8" = 1'-0"  
DRAWING NUMBER: 100-1000  
DATE: 10-1-54  
PROJECT: 100-1000

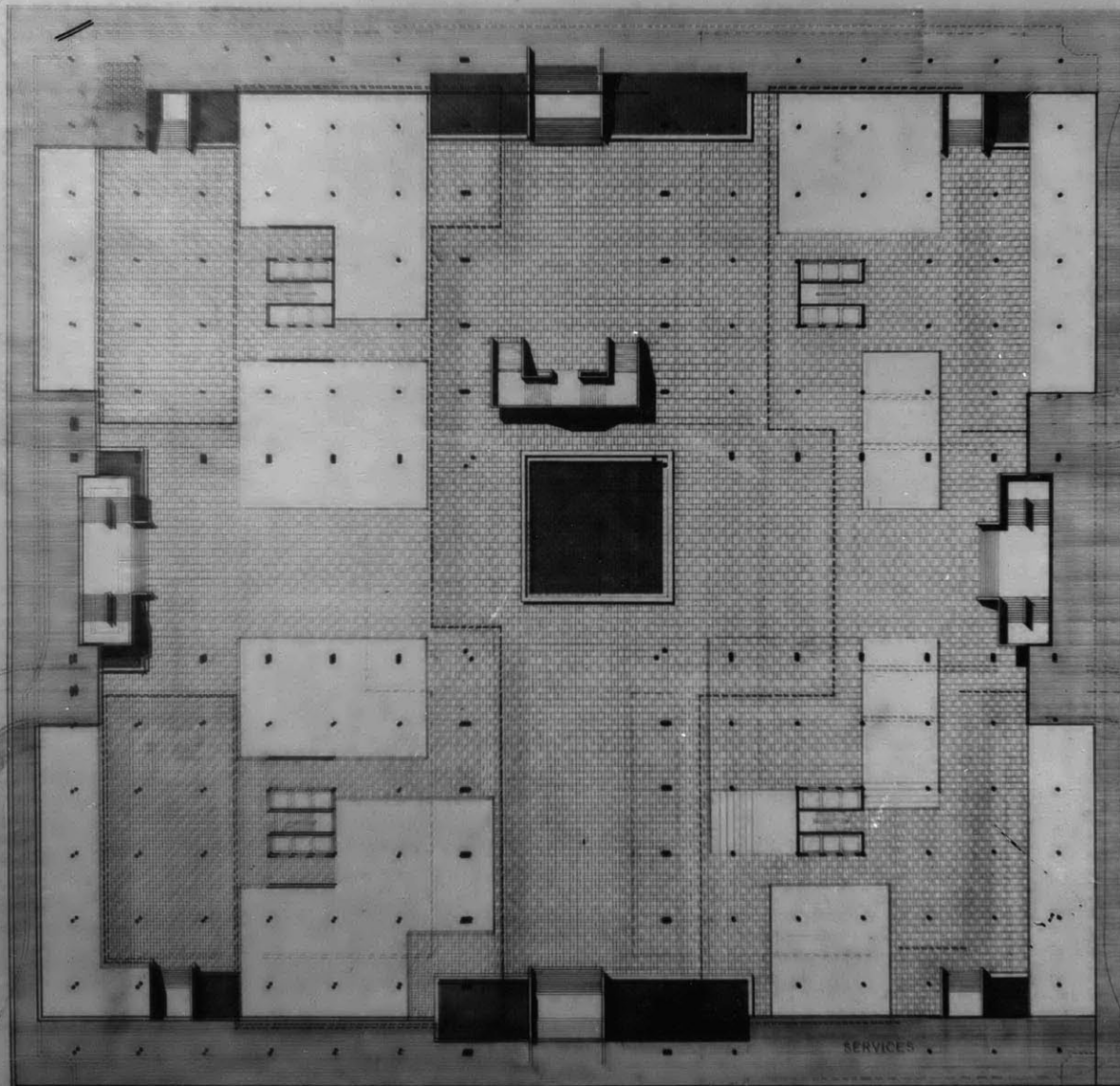






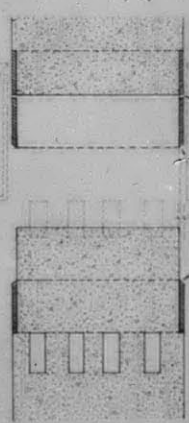
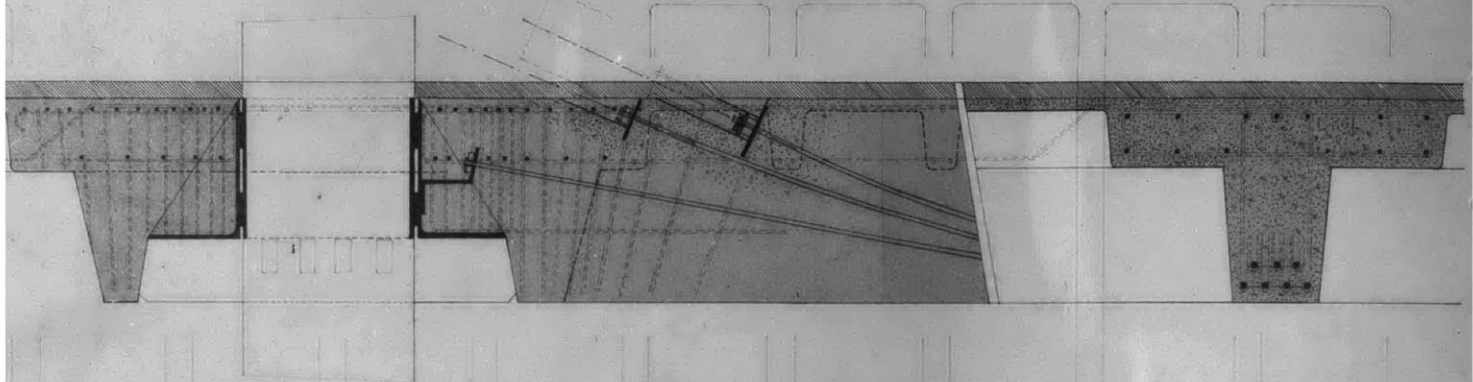
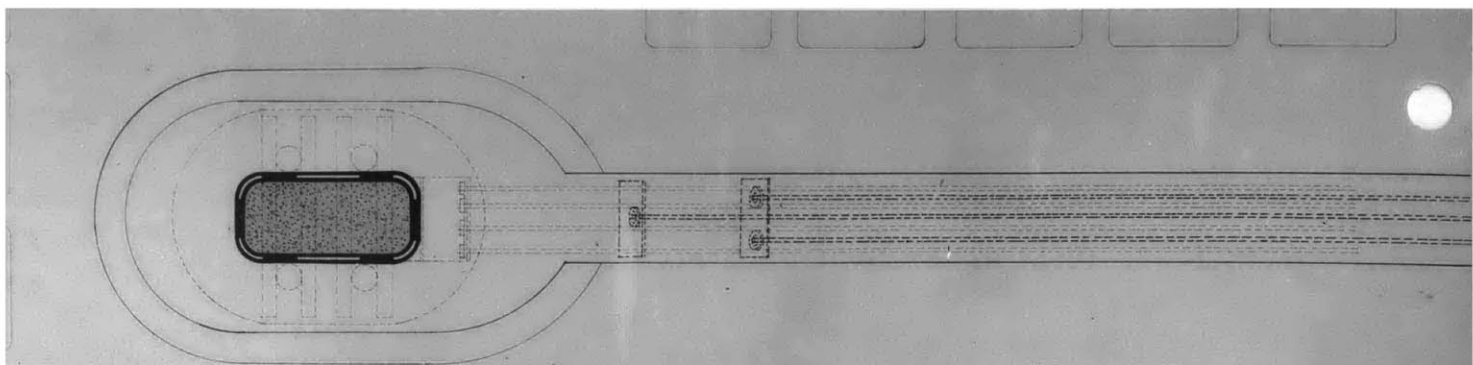
**A PARKING GARAGE**  
COMMERCIAL CENTER  
GROUND LEVEL-LEVEL 4

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
ARCHITECTURAL ARCHIVE  
OFFICE 700A 100

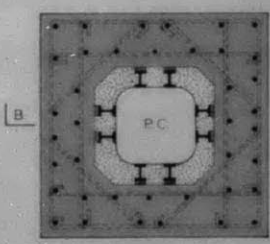


**A PARKING GARAGE**  
COMMERCIAL CENTER  
LEVEL -12 PLAN

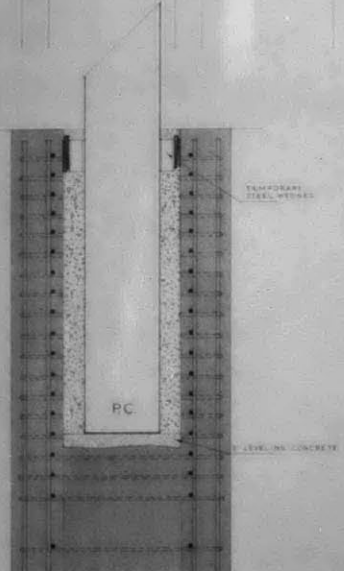
ARCHITECT: [unreadable]  
DATE: [unreadable]



COLUMN CONNECTION  
1/4" = 1'-0"



CONNECTION BETWEEN  
PEDESTAL & PRECAST COLUMN



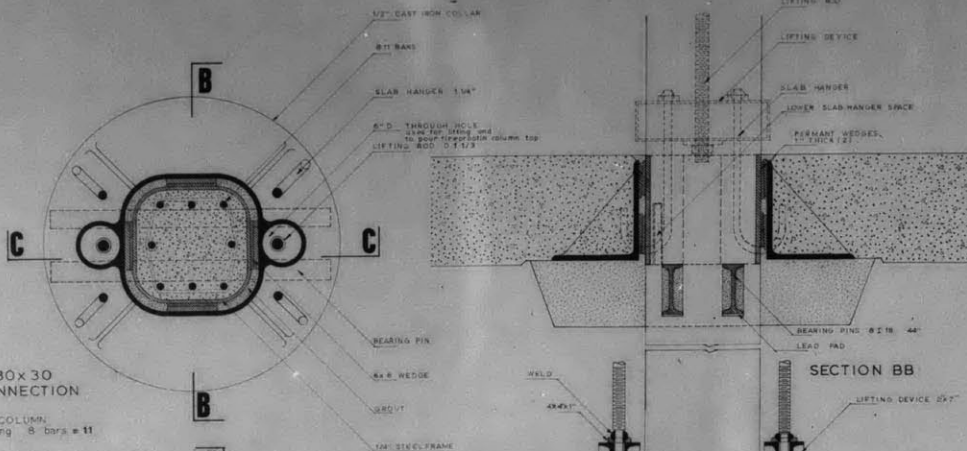
SECTION BB



SECTION CAR RAMP  
CAST IN PLACE CONCRETE  
COLUMN 30" O.C. RC - #8  
DESIGN FOR ECCENTRIC LOADING

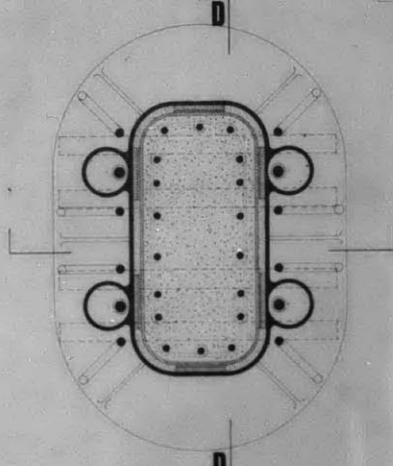
**A PARKING GARAGE**  
COMMERCIAL CENTER  
TYPICAL 90' x 30' - MISC. DETAILS  
SCALE 1/4" = 1'-0"

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FRANK P. BEEL, CHIEF DESIGNER  
HARVEY THURGOOD



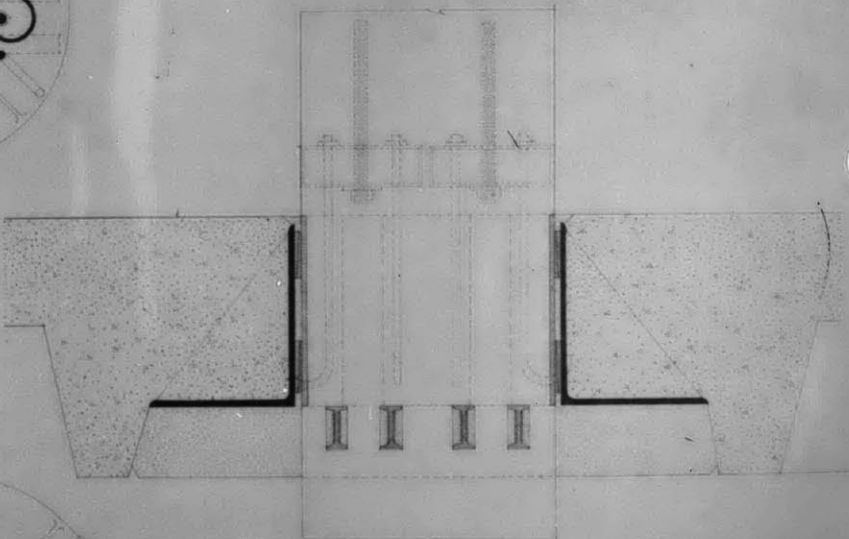
PLAN OF THE 30x30 BAY COLLAR CONNECTION

PRECAST CONCRETE COLUMN  
18" diameter reinforcing 8 bars #11



PLAN OF THE 90x30 BAY COLLAR CONNECTION

18"x18" PRECAST COLUMN  
reinforcing 18 #8 @ 30



PLAN OF THE CENTRE 90x90 BAY COLLAR CONNECTION

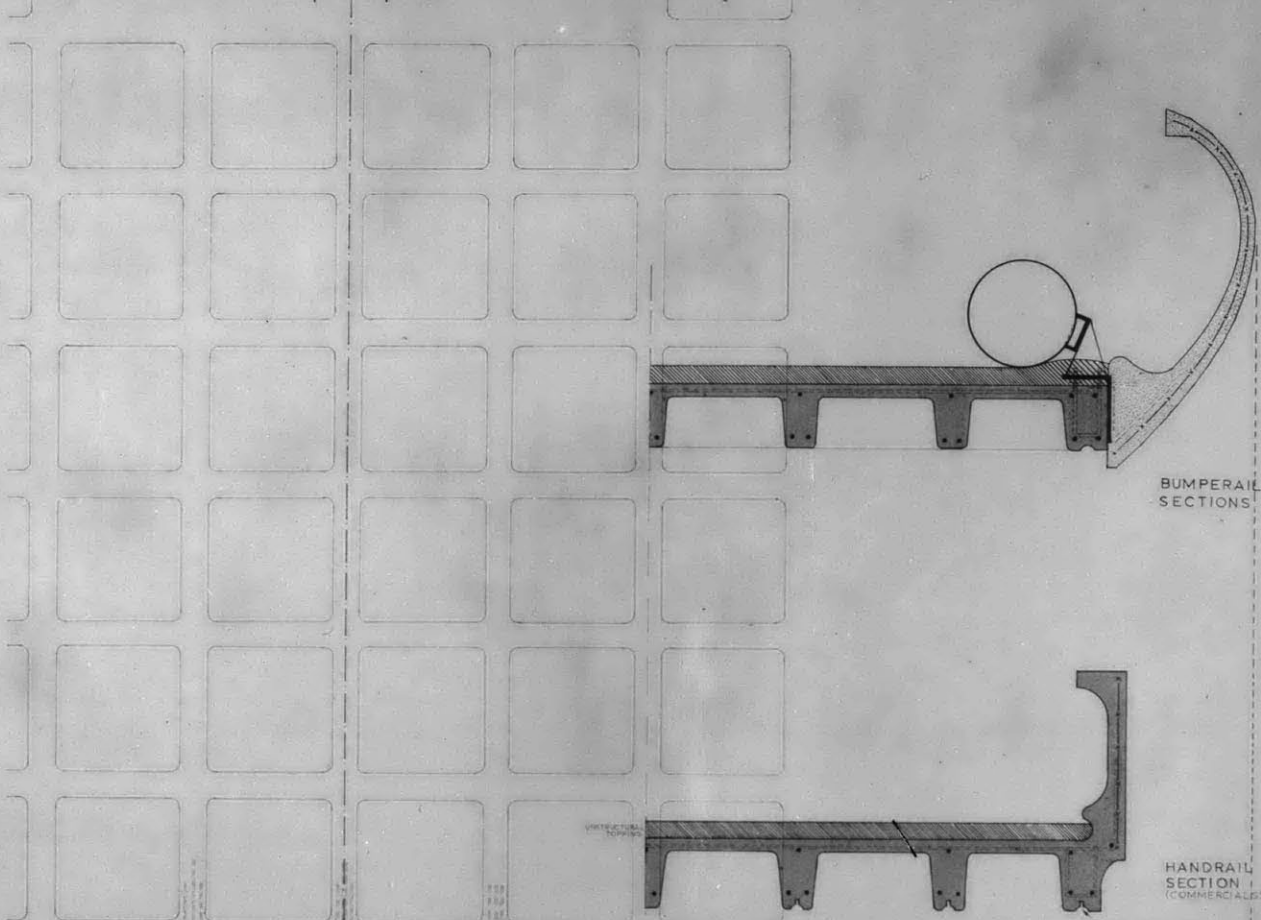
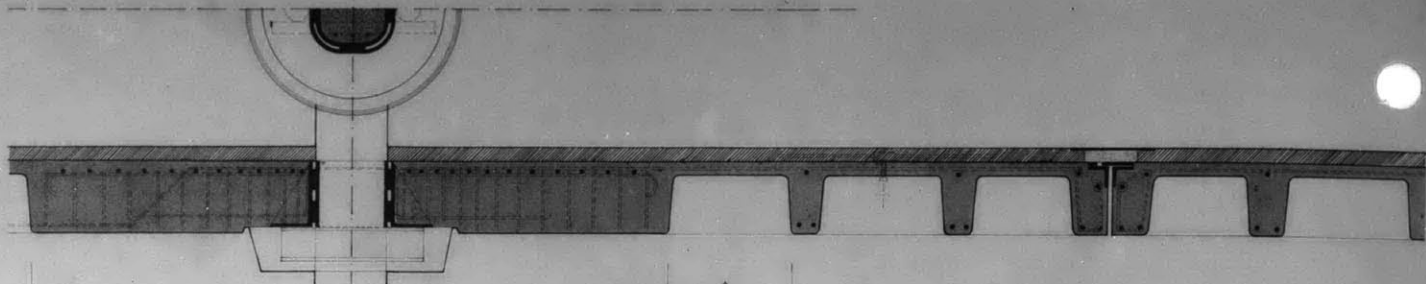
2 - 20" DIAMETER PRECAST COLUMNS  
reinforcing 2 - 10 #11 bars

NOTE: BECAUSE OF THE LIMITATION BETWEEN THE ARMS OF THE JACK, THE ABOVE SOLUTION WAS RECOMMENDED

LIFT SLAB  
3 TYPES OF COLLAR DESIGN  
WITH LIFTING EQUIPMENT DEVICES

**A PARKING GARAGE**  
COMMERCIAL CENTER  
COLUMN-SLAB CONNECTIONS  
SCALE: 1/2"

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
JEAN-PIERRE LEBLANC  
MASTER THESIS  
1988



BUMPERAIL  
SECTIONS

HANDRAIL  
SECTION  
(COMMERCIAL)

3" PLASTIC STRIPS  
GLASS TUBES

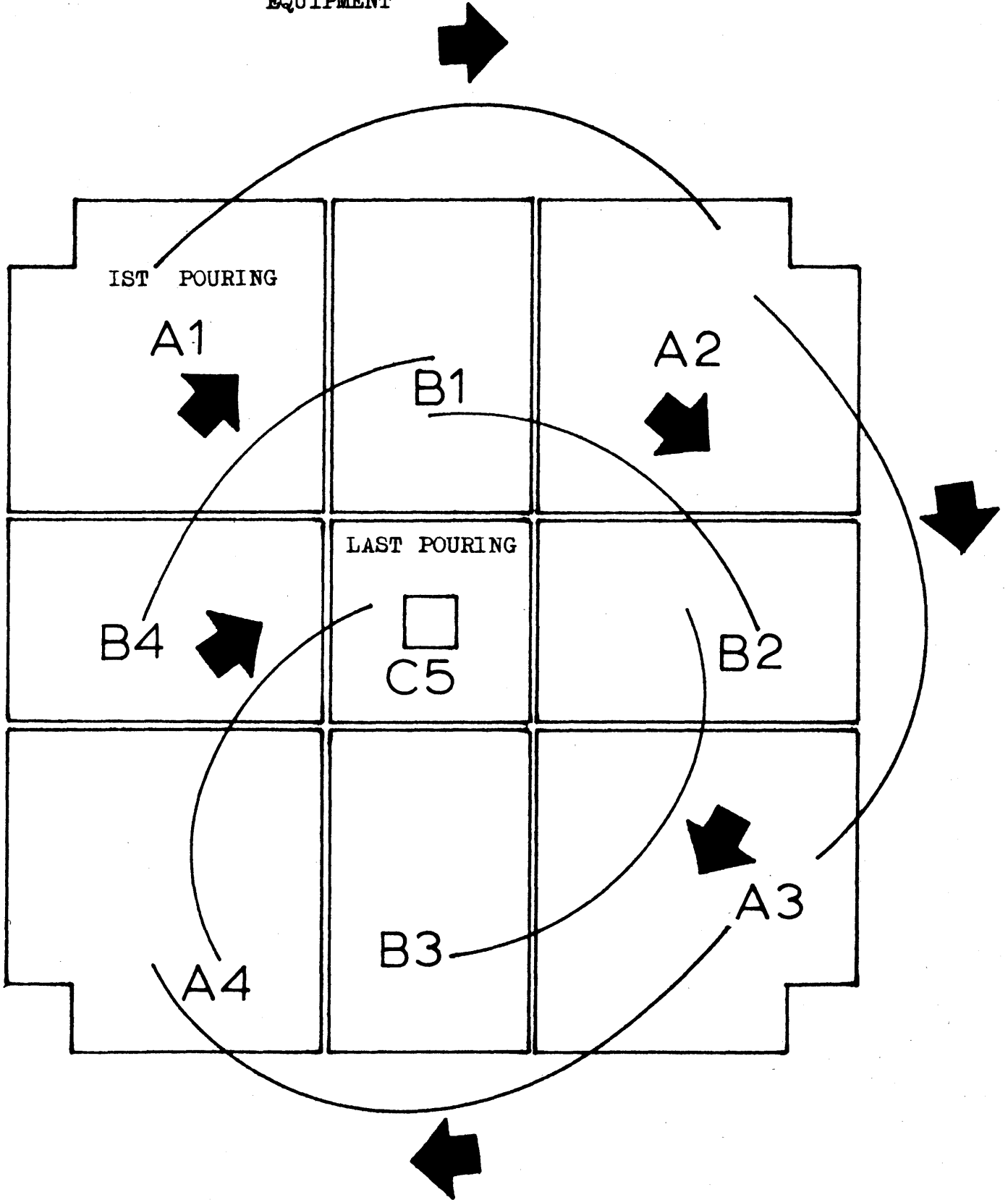
3/8" DOWEL 3' SL.

NOTE: THE CORNER OF THE  
STRUCTURE IS DRAWN IN  
DOTTED LINES TO  
EACH PRECAST BUMPERAIL  
IS 28" LONGER

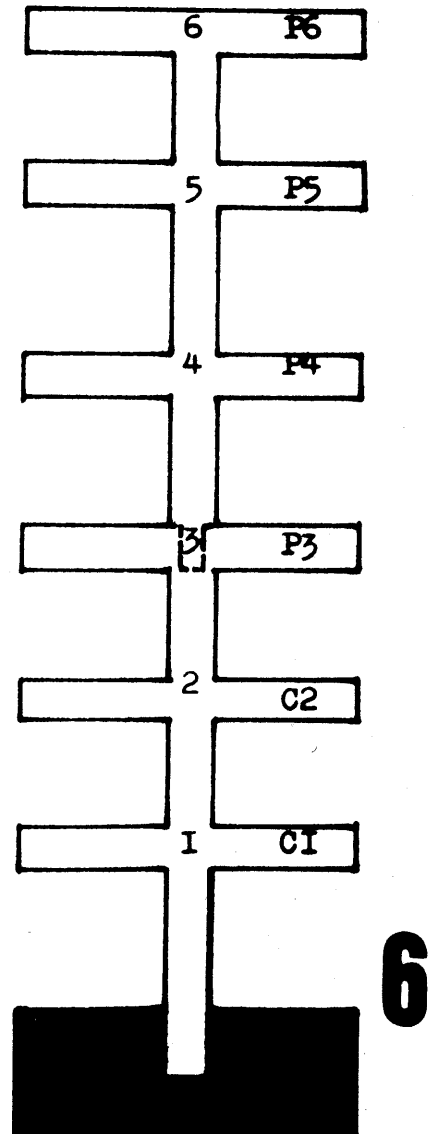
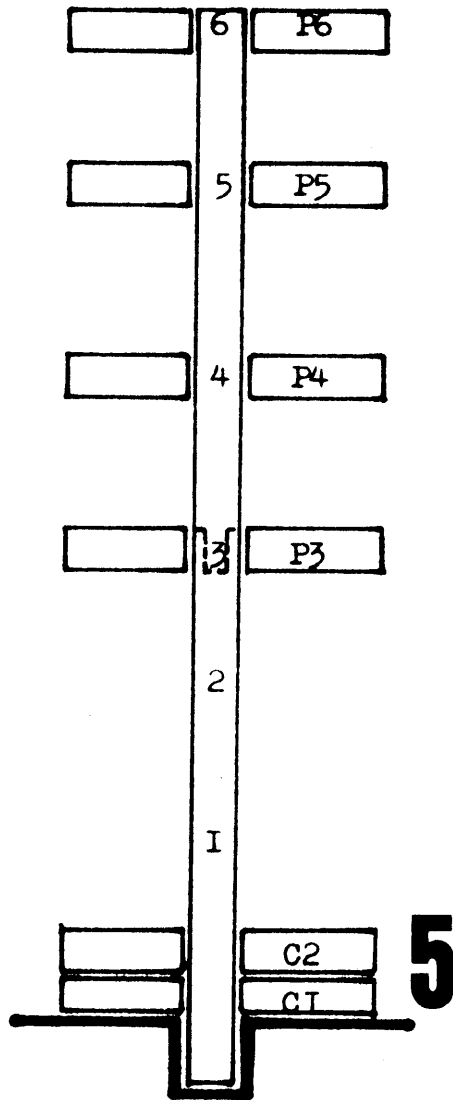
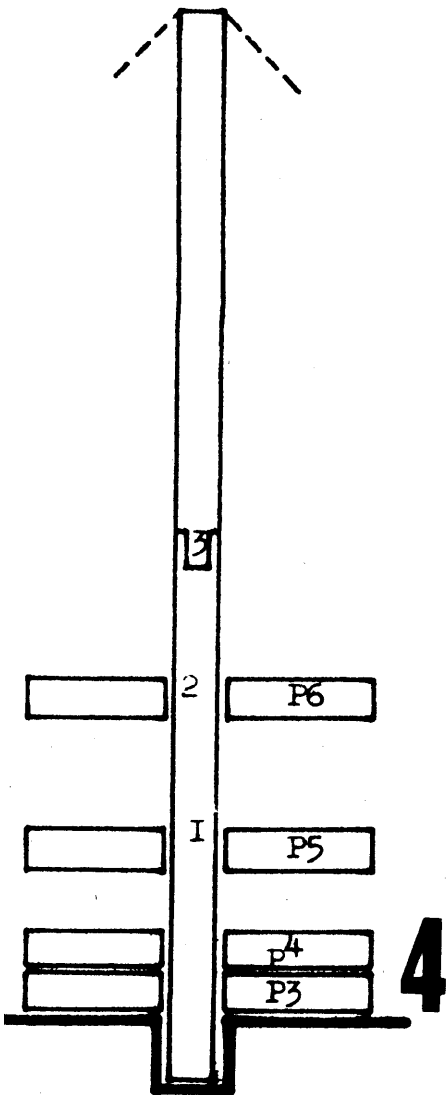
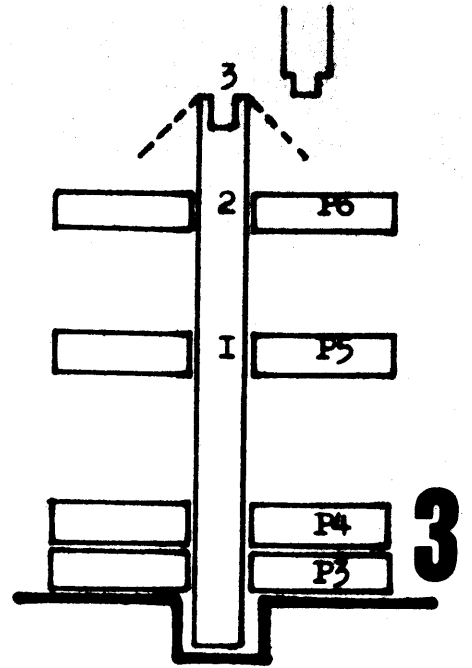
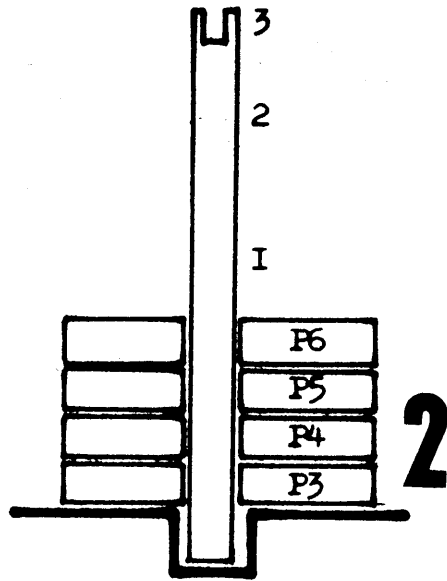
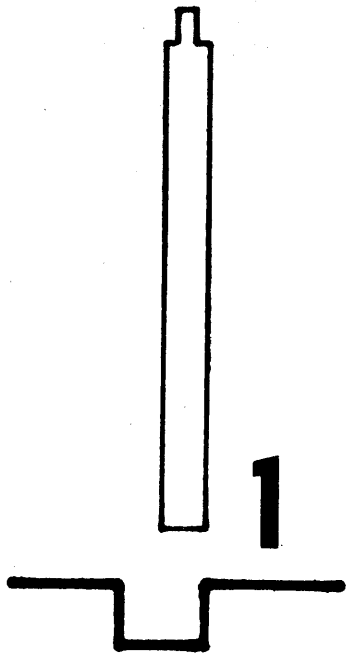
**A PARKING GARAGE**  
COMMERCIAL CENTER  
TYPICAL 30'x30' BAY STRUCTURE  
SCALE 1/4"=1'-0"

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
JEAN MICHEL CHARBET  
MASTER ARCHITECT

EQUIPMENT



SCHEDULE OF POURING (Removal of the pans)  
& ROTATION OF THE LIFTING EQUIPMENT.



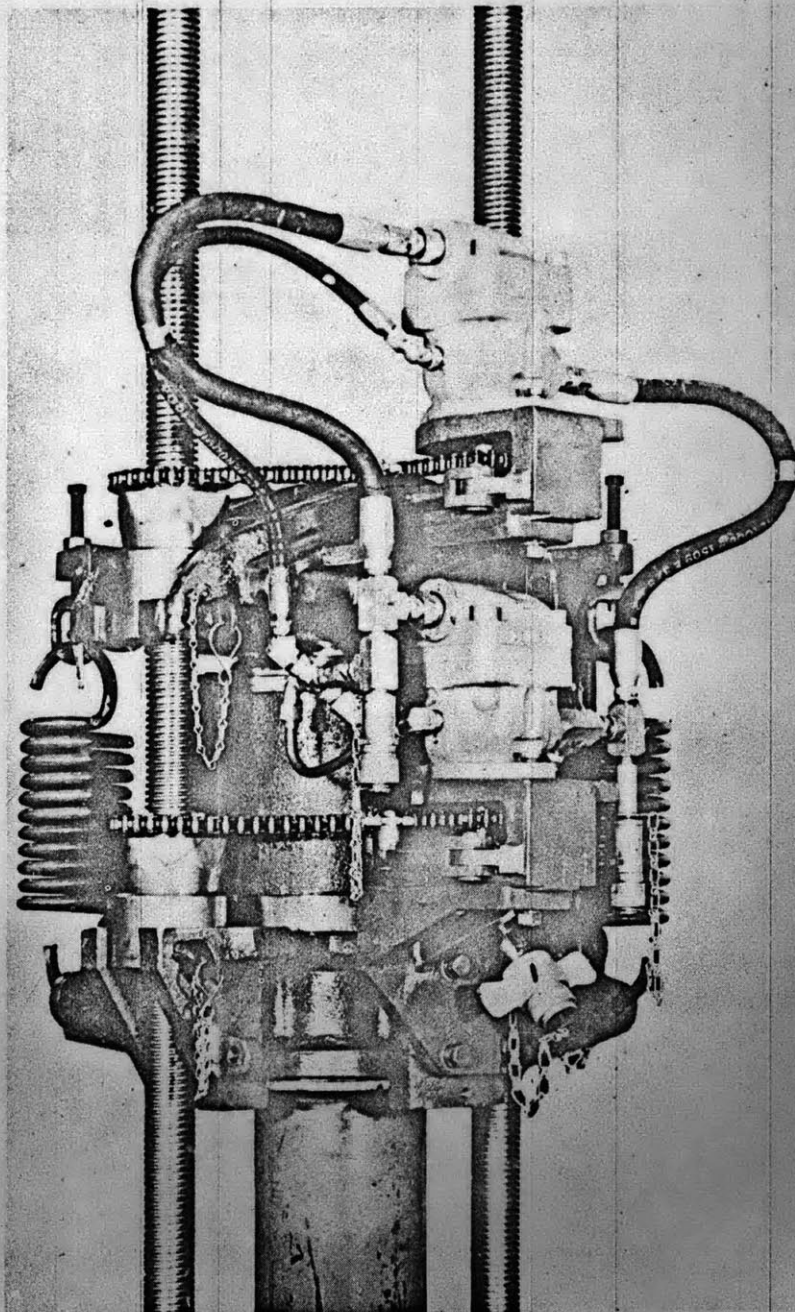
SLAB LIFTING SCHEDULE.



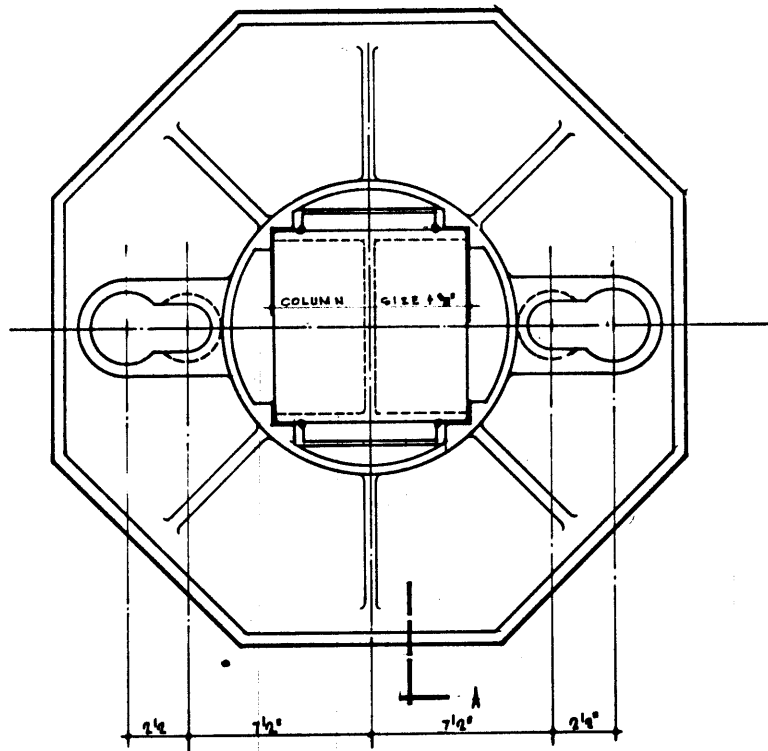
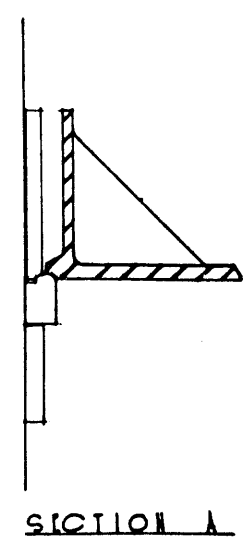
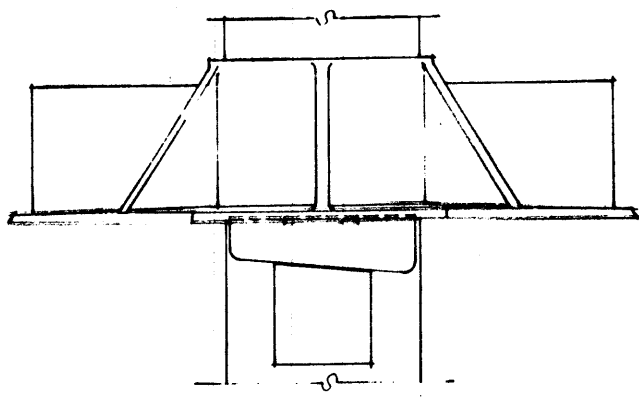
## the lifting equipment

The following information is presented in order to establish the capabilities and limitations of the lifting equipment that have an influence on the architectural layout and engineering design.

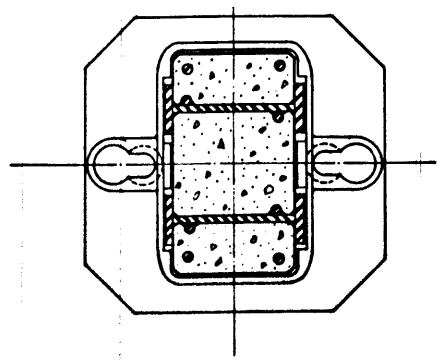
Figure #1 shows a typical lifting head. This equipment is basic and, together with the lifting collar and its component parts, constitutes the portion of the equipment of immediate concern to the designer.



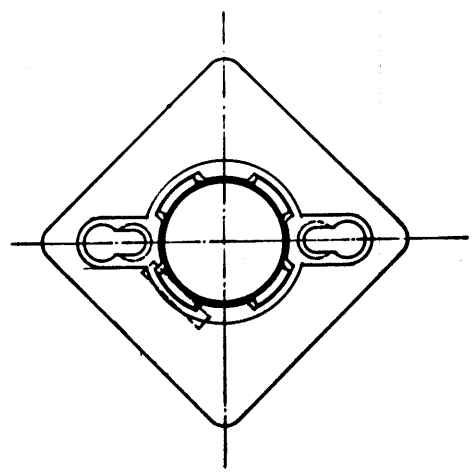
**LIFT**  
THE CONCRETE-SLACK METHOD OF CONSTRUCTION  
**SLAB**



W COLUMN



CONCRETE COLUMN



PIPE COLUMN