AN URBAN UNIVERSITY:
AN INTEGRATED SYSTEM OF BUILDING COMPONENTS

by

STANLEY E. PINSKA
Bachelor of Architecture
University of Minnesota
March, 1965

Submitted in partial fulfillment of the requirements
for the degree of Master of Architecture at the
Massachusetts Institute of Technology, Cambridge, Massachusetts
on 19 June 1967

Author: . . . .

Thesis Advisor: . .

Head of the Department: .

I am grateful to Professor Eduardo Catalano and Professor Waclaw Zalewski for their valuable assistance during the development of this project.

Cambridge, Massachusetts 02139
19 June 1967

Dean Lawrence B. Anderson
School of Architecture and Planning
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Dear Dean Anderson:

In partial fulfillment of the requirements for the degree of Master of Architecture I hereby submit this thesis entitled "An Urban University: An Integrated System of Building Components."

Sincerely,

Stanley E. Pinska

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ABSTRACT

Title of Thesis: Phase I - An Integrated Building Component System

Phase II - An Urban University

Author: Stanley E. Pinska

Submitted to the Department of Architecture in partial fulfillment of the requirements for the degree of Master of Architecture.

The objective of Phase I of this thesis is to develop a building system based on modern technology of construction, integration of environmental services with structure and future growth as well as internal change.

Thesis advisor: Eduardo F. Catalano

Title: Professor of Architecture

I. INTRODUCTION

In order that present and future building needs can be met, significant technical advances within the building industry are necessary. The architect, through a collaborative effort with engineers and industry, must develop industrialized construction techniques into a familiar vocabulary. Extensive research into the various disciplines involved in construction will lead to a new creative stimulus.

The master's thesis affords the student the opportunity to study the techniques of industrialized construction and evaluate its inherent aesthetic potential.

Phase I of this thesis deals with research and study. Phase II will serve as an evaluation through application to the design of an urban university campus.

II. OBJECTIVE

The objective of this thesis is to develop and evaluate a building system based on the following principles:

a) Modern technology of prefabrication and assembly

b) Future growth and internal flexibility

c) Integration of environmental services with structure.

Design Criteria

a) Modern technology of prefabrication and assembly

> In the USA the coefficient of cost of automobiles as compared with the period before 1914 is -50. That is because production was organized in such a way as to exploit the miracle of machines. The coefficient of cost of buildings as compared with the pre-war period is +210. That is because no advantage was taken of the methods that might have overcome heavy labor costs in the building trades which are essential to the country. [1]

These words, written by LeCorbusier in 1935, clearly express the then and current basic shortcoming in the building industry. The majority of United States industry is able, through production development, to continually provide more product for less money. However, the building industry, still based primarily on on-site labor, continues to provide less for more. At a time when economic prosperity and increasing population point toward an increased

[1] LeCorbusier, When the Cathedrals were White, New York, McGraw Hill Book Company, 1964, p. 199.

amount as well as rate of building, the industry is sorely in need of more efficient, improved technique in order to produce more for less. Principles common to the product industry, such as standardization and prefabrication, must be employed by the building industry.

The degree to which construction can be "industrialized" depends not only on prefabrication of components, but also on component assembly. No matter how sophisticated the prefabrication and standardization of elements may be, elements will necessarily have to be "assembled" to complete the building statement. Technology of component assembly is at least as critical a consideration as component prefabrication in the design of building elements.

b) Future growth and internal flexibility

In buildings such as office facilities, light industrial facilities, research and especially educational facilities, it is not possible to accurately predict future usage requirements beyond, perhaps, 8-10 years. However, the potential life span of most large-scale buildings today is at least 100-150 years. With these two facts in mind, it is obvious that buildings must allow for continued internal usage change during the life span of the structure. Taking an educational facility as an example, it can be seen that shifting of department location, revision of curriculum and increased enrollments all suggest the need for adaptable and "readaptable" space. "Form follows function" may or may not be a valid principle; in any case, it becomes extremely important to correctly define the function and, as suggested, it appears that one primary function is the ability to allow for change.

In addition to internal change, buildings must be able to grow. As more effort is directed to our urban development problems, the doctrine of orderly growth potential becomes ever more critical. Buildings must not only allow for change within themselves, but must also anticipate growth. The same reasoning applies to growth as to internal change.

c) Integration of environmental services with structure

The necessity for buildings to allow for internal change has been discussed. This necessity implies the need to supplement the structure with environmental services to create a self-sufficient framework.

In addition, through integration, a more efficient use of space required for structure and services is possible so that greater spans (i.e., more column-free area) will be possible within the same depth or less as is now commonly occupied by structure and services (see diagram).

separate

integrated

III. PROPOSAL

a) Selection of material

Basically three structural materials are available and commonly used. They are: steel and reinforced concrete, either cast-in-place or precast. To a certain degree contemporary steel construction is based on the principles of prefabrication and standardization. The various shapes and sizes of steel members are both prefabricated and standard. However, with steel construction the variety of components, although standard, is definitely limited and in most cases fireproofing is necessary.

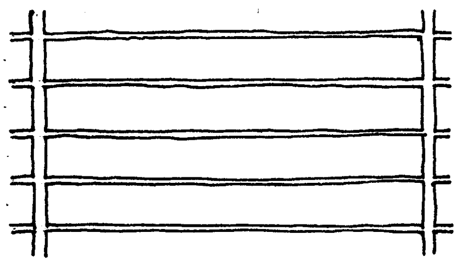
Reinforced concrete offers an unlimited potential for shaping of elements and it is inherently fireproof. In the case of pre-cast concrete practically all the advantages of both concrete and steel construction exist.

However, as with steel, the joinery of components becomes critical. Cast-in-place concrete, although expensive, due to the necessary on-site labor of form erection etc., offers monolithic connection potential. Therefore, by combining precast technique with that of cast-in-place, an extremely logical and efficient solution is possible.

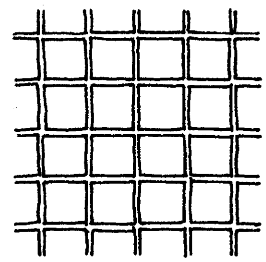
A combination of precast and cast-in-place concrete has been chosen as the structural material for this study.

b) Selection of framing system

The two basic types of framing systems are rectangular (one-way) and square (two-way). See diagram.



rectangular



square

The rectangular framing system has been chosen for this study based on the following three considerations:

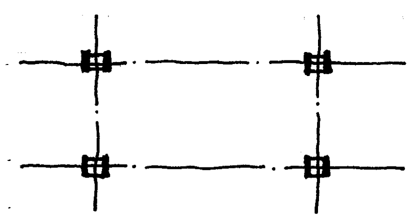
1) The possibility to achieve a greater span, within the same structural depth, than a two-way system. Admittedly this increase in span is only in one direction, but it nevertheless appears to be an advantage.

2) The relatively simple shape of one-directional elements as opposed to the complicated shapes required for two-directional elements.

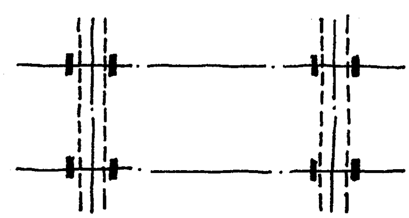
3) The apparent correlation between the primary-secondary nature of the structural framing and the primary-secondary nature of the air distribution pattern.

c) Description

A one-way combination precast cast-in-place system based on a 4.5 foot module is proposed. The solution is based on a structural bay of 31.5' x 63.0', with girder spacing of either 9.0' (Scheme "A") or 15.0' (Scheme "B"). In both Schemes A and B vertical distribution of services is directly related to column location. In Scheme A the entire area between columns is utilized for services while in Scheme B the area is divided by a corridor. See diagram.



Scheme A.



Scheme B.

The two basic structural elements of the system are based on the precast concrete T-beam. The "girder-beam" is a T-beam with two diaphragms cast either 9.0' or 15.0' apart (whether Scheme A or B). The ends of the "girder-beam" are notched. The "infill beam" is a simple T-beam with notched ends and is placed between the "girder-beams." The columns are cast-in-place.

Construction sequence[2]

1) Erect scaffolding and column formwork
2) Pour column to bottom of girder
3) Place "girder-beam" elements on scaffolding
4) Place post-tension cable and sleeve in girder and place girder stirrups
5) Place girder joint forms
6) Cast girder joints
7) Remove girder joint forms
8) Place "infill-beams"
9) Post tension girder cables and remove scaffolding and column formwork.

d) Environmental services

The vertical distribution of services is, as mentioned, accommodated within the space adjacent to the columns. The air distribution is based on each column pair serving one bay in area. The air is supplied vertically at 6000 cfm to a sound attenuator in the plenum. From the attenuator the air travels horizontally at 1200 cfm throughout the bay. The air is returned at 1200 cfm both horizontally and vertically. The system is therefore a "single duct, low velocity, terminal reheat" (electric coils) with potential of reheat coils

[2]Typical floor sequence only.

as needed for individual room control.

The plumbing service required is accommodated with basically the same distribution pattern as the air distribution system.

Electric and telephone circuits are distributed from the cores within the leveling slab.

IV. SUMMARY - EVALUATION

Of the various considerations affecting the solution, two play a dominant role. First, at the outset of the study it was assumed that the structure would be uniform in depth, thereby establishing a flat undersurface to aid standardization of partition height for increased flexibility. Secondly, the beams were designed to be continuous across the girders so that a cantilever condition could be developed. The cantilever allows for variation in the length of the beams and therefore increasing planning flexibility.

Since, in some ways, these considerations are at odds with each other, they tend to complicate the solution. This complication is ultimately concentrated at the connection of beam and girder. For this reason the combination of precast and cast-in-place construction seems to be a logical choice.

PROPOSAL: PHASE II

Although many of the factors considered in the development of the component system are general in nature and applicable to various types of facilities[1] the planning module, on the other hand, is more directly related to the particular function to be accommodated. The planning module of the proposed system is based on increments of 4'-6". Three types of functional requirements determined the 4'-6" dimension: laboratory facilities, office facilities and parking.[2] Increments of 9'-0" are often adopted in laboratory planning.[3] Either 9'-0" or 13'-6" is a satisfactory dimension for the types of offices necessary in a university. Parking spaces of 9'-0" x 18'-0" are a common size and the column spacing of 31'-6" x 72'-0" (27'-0" x 63'-0" clear) allows for rows of parking oriented in either direction within the bay. Facilities such as classrooms, lecture halls, seminar rooms and special functions are somewhat more flexible in terms of exact dimensions and were considered as secondary factors to the determination of planning module.

[1]See Introduction, page 1.

[2]According to Carl Peterson, Director of the Physical Plant of MIT, the Institute has found 9'-0" to be a satisfactory module for laboratory planning.

[3]It is assumed that a large amount of parking will be accommodated below the academic space.

The site selected for this project is in the Washington Park Urban Renewal District of Boston. It is bounded on the west by Washington Street, on the north by Dudley Street, on the east by Warren and Walnut Streets and on the south by Dale Street. The area to the north of the site is the southern limit of a commercial area along Washington Street. A portion of this commercial area extends along Warren Street. The remainder of the surrounding neighborhood is residential in character, composed of one and two family dwellings. There is a small park (Washington Park) to the south of the site across Dale Street. The site is approximately a 1:2 rectangle, being actually somewhat narrower at the northern portion.

Ten MBTA (Massachusetts Bay Transit Authority) rapid transit routes either pass through or terminate at Dudley Street station one block north of the site. The site is basically one large hill with a plateau approximately in the center. The north portion slopes from elevation 35.0' at Dudley Street to the plateau elevation of 125.0'. The remainder of the perimeter slopes up from approximately 65.0' of elevation.

The organization of the university facilities is based on the interdependence of the following elements:

1) categories of space usage

2) horizontal and vertical circulation

3) site shape and accessibility

The categories of space usage are defined as follows: Group spaces (classrooms, lecture halls, seminar rooms, etc.), individual spaces (laboratories, offices, studios, etc.) and special spaces (library, auditorium, student center, theater, etc.).

The organization of the various spaces of the university is directly related to circulation. The critical demands on the circulation system naturally occur during "class-break." This fact suggests that group spaces should be located as close together as possible to minimize the distance the student must travel during class-break. It should be noted that "distance minimized" should be vertical as well as horizontal. Since it is basically impractical to move large numbers of people via elevators (especially at only 6-7 times a day) group spaces should be in areas of only 3-4 stories. Individual spaces do not have the "peak load" type of circulation pattern. For this reason, plus the necessity for low percentage of land use inherent in any urban structure, the individual spaces can easily be "stacked" vertically and served by elevators. In addition, it is not a necessity that individual spaces (of various different departments) be close together.

The shape of the site and the points of access to it, plus the factors discussed earlier, ultimately define the form of the university. The rectilinear shape of the site, the linear structural system, and the need for orderly growth led to a solution based on a linear organization of elements. The university is structured along an open space which runs the length of the site and serves as a "spine." The spaces directly adjacent to the spine are group spaces. The individual spaces are located outside the group spaces toward the site boundary.

In each of the two major elements adjacent to the spine there is a primary circulation artery that serves the length of the complex. The vertical service cores are located regularly along the artery and determine the location of secondary corridors perpendicular to the main arteries. The special functions such as the library, student center, theater and auditorium are located along the spine and coincide with connections across the open space. In this way the special spaces act as "landmarks" in the campus circulation system. The linear nature of the complex allows for orderly growth to the south.

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M. Arch. Section A
Architectural Design
Issued: February 6, 1967
Due: 28 May 1967

AN URBAN UNIVERSITY
(Site Plan and Buildings Design)

A college in the northeast U.S.A. has acquired 65 acres of land near the heart of its capital city, with the purpose of developing a new campus.

The present facilities outside the city are overcrowded; and buildings and site restrictions do not allow further growth. The construction of a new campus closer to the very dense populated areas of the city seems to be the most proper solution to their problem. It brings back the academic life into the heart of the city and allows the organization of a branch institution as a free community, self-directed and new.

Program

Site: Area - 65 acres. Shape of site to be determined by each designer, who is also free to determine street widths, topography, and surroundings.

The site is within an area subject to urban renewal, with buildings four to six stories high of mixed uses for housing and light industry.

It is expected that the construction of the new university will influence the renewal of such areas, which hopefully will become an integrated part of a larger development.

Density: Since land is scarce and expensive, the college has decided to build a very dense group of buildings and adopt a master plan that allows horizontal and vertical growth. For this reason, no outdoor athletic activities, which demand large areas, are included in the college program.

Number of students: A first stage of construction for 5,800 students will satisfy the college needs til 1980. It is contemplated that the college will have an enrollment of 12,000 at the turn of the century.

Section A
February 1967

Design Approach: A program is presented, with indication of the different disciplines or departments and area required for each one. This information is provided with the sole purpose of giving the designer an idea of the elements needed, whether spaces for office work, laboratories, classrooms, libraries, workshops, seminar rooms, or spaces for social, living or eating activities.

The general study of the need required by each function will allow the designer to set the organization of the building system, as related to spans, vertical and horizontal circulation, services, demountability, growth, and floor to ceiling heights.

The designs prepared are not expected to show with precision the location of each room, which could be of a temporary condition. It should however show that the building system is flexible enough to permit within its free envelope the location and number of rooms of different uses at any time in its life span.

Experience has shown that the constant changes in educational systems; growth and the creation of new disciplines demand a flexible system.

It is accepted that within the order created by a unified module of bays there will be spaces that recognize specific needs, such as housing, athletic facilities, theatre-auditorium, etc.

Site Plan: Special importance should be given to the development of the site plan, regarding spatial definition of entrances to site and buildings, interior automobile circulation, design of an underground network of servies (power plant, tunnels with utilities) to connect and serve every building or area of the project and landscape.

Section A
February 1967

It is requested to design a continuous circulation system as to be able to move from place to place, within enclosed spaces.

Design Development: One complete level of the project should be developed with enough detail as to incorporate in it, in a rational planned manner, as many activities as required by the program in order to show that the building system proposed is capable of housing rooms of many sizes and functions.

Requirements:

1. Site plan, with complete indication of roads, landscape.
2. Model of first stage of construction for 5,800 students.
3. First underground level, showing parking and services.
4. Underground connecting network of mechanical and electrical services.
5. Two plans - one should show distribution of functions as explained in "Design Development."
6. Two sections.
7. Two elevations.
8. Plan showing growth.
9. Detailed plan of the most significant open space, showing construction details such as: paving, steps, ramps, parapets, landscape areas, rails, benches, outdoor lighting, and part of the surrounding buildings.
10. Four photographs of model - 8" x 10".
11. Report.

Partial deadlines will be set for each requirement.

Presentation techniques will be unified by determining drafting standards. The material required for this project together with the one prepared for the spring semester, will constitute the required thesis.

Last jury before presentation will be held the 3rd week of May.
Final jury will be held the 15th of June 1967.

Simplified Program

		sq. ft.
Science		
Total Gross Area		507,160
Mathematics Department		
Administration and Staff		
Classrooms and seminar rooms		
Instructional Laboratories		
Research and graduate facilities		
	Totals	17,060
Physics Department		
Administration and staff		29,200
Classrooms and seminar rooms		26,600
Instructional laboratories		40,500
Research and Graduate facilities		30,400
	Totals	126,700
Chemistry Department		
Administration and staff		31,800
Classrooms and seminar rooms		29,000
Instructional laboratories		44,300
Research and graduate facilities		33,200
	Totals	138,300
Geology, Meteorology, Geophysics Department		
Administration and staff		26,800
Classrooms and seminar rooms		24,300
Instructional laboratories		37,000
Research and graduate facilities		27,800
	Totals	115,900
Biology Department		
Administration and staff		25,100
Classrooms and seminar rooms		22,900
Instructional laboratories		35,000
Research and graduate facilities		26,200
	Totals	109,200
Engineering		
Total Gross Area		460,000

		sq. ft.
<u>Electrical Engineering</u> (550 students, 56 staff)		
Administration and staff		11,000
Classrooms and seminars		7,700
Instructional laboratories		28,380
Research laboratories		19,360
	Totals	66,440
<u>Mechanical Engineering</u> (500 students, 56 staff)		
Administration and staff		10,000
Classrooms and seminars		7,000
Instructional laboratories		91,180
Research laboratories		62,080
	Totals	170,260
<u>Metallurgy</u> (200 students, 25 staff)		
Administration and staff		4,000
Classrooms and seminars		2,800
Instructional laboratories		12,600
Research laboratories		8,580
	Totals	27,980
<u>Civil Engineering</u> (270 students, 29 staff)		
Administration and staff		5,400
Classrooms and seminars		3,380
Instructional laboratories		27,666
Research laboratories		18,834
	Totals	55,680
<u>Sanitary Engineering</u> (90 students, 11 staff)		
Administration and staff		1,800
Classrooms and seminars		1,260
Instructional laboratories		9,220
Research laboratories		6,280
	Totals	18,960
<u>Computation Center</u>		
Total Gross Area		45,000

		sq. ft.
Chemical Engineering (40 students, 9 staff)		
Administration and staff		800
Classrooms and seminars		560
Instruction laboratories		2,960
Research laboratories		1,740
	Totals	5,660
Energy and Propulsion (550 students, 56 staff)		
Administration and staff		11,000
Classrooms and seminars		7,700
Instructional laboratories		51,600
Research laboratories		35,200
	Totals	105,500
Library (contains 50,000 books)		
Books		3,750
Administration		3,000
Students Reading Room		3,750
	Totals	10,500
(sq. ft. per student: 208)	Total:	460,980

School of Humanities
(1,150 students)

Total Gross Area		121,194
Library for 70,000 volumes		
Shelving		7,000
Seating		13,800
Sound room (language)		500
General area		1,000
	Total	22,300
Faculty and staff personnel		30,190
20 seminars		7,500
20 classrooms		14,000
Journal laboratories		5,546
Audio classroom		1,260
Circulation, etc.		40,398
	Total	121,194

School of Architecture and Planning
(350 students, 33 faculty, 18 administration)

Total Gross Area 206,650

School of Architecture and Planning (cont.)		sq. ft.
General		
Dean's office		1,400
Conference		600
Library		30,000
Exhibition rooms (2)		12,000
Projection room		1,000
Research (indoors)		12,000
Research (outdoors)		20,000
Seminar rooms (5)		3,000
Lounge		6,000
	Total	86,000
Architecture Department		
Studios (8)		35,900
Model storage		6,000
Faculty		6,160
Administration		1,000
	Total	49,060
City and Regional Planning Department		
Studios (3)		15,000
Maps, reference, etc.		600
Faculty		3,300
Administration		700
	Total	19,600
Construction Department		
Studios (4)		20,000
Workshops (2)		12,000
Sample exhibition		6,000
Faculty		2,600
Administration		600
	Total	41,200
Visual Design Department		
Studios (4)		6,000
Darkrooms (2)		900
Project studio		2,400
Technician		300
Discussion and jury		1,000
Plaster area		200
	Total	206,660

(sq. ft. per student: 590 approx.)

<u>University Library</u>

Total gross area	221,900
Public catalogue	2,000
Bibliography	1,500
Processing departments	4,000
Lobby and display	3,000
Reference	
Humanities	
Sciences	
Recreational reading	
Periodicals	
Open stacks for 500,000 books	
2,000 readers with 35 sq. ft. per reader	120,000
Map room	1,200
Rare books	1,800
Music Lounge	3,000
Listening rooms	1,200
Newspaper reading	1,300
Scanners	600
Microfilm storage	900
Library lounge	1,400
Seminars (8 with 240 sq. ft.)	2,000
Total	143,900
Classrooms (3 with 600 sq. ft.)	1,800
Conference rooms (6 with 240 sq. ft.)	1,500
Miscellaneous offices and workrooms	5,000
Receiving and shipping	1,200
Bookbinding	1,000
Photostating and reproducing	1,500
Staff lounge	1,000
Closed stacks with carrels and study oasis, 500,000 books	50,000
	206,900
Circulation and mechanical	15,000
Total	221,900

<u>Museum</u>

Total gross area 25,650

Just by its function a museum is verry difficult to program. Its functions vary with the kind of collections it can have, in this case collections owned by the museum itself are going to be very small. The following information has to be taken as proportional and not as a definitive number.

Temporary exhibit space	
Permanent exhibit space	
Storage (1/3)	
Total	23,000
6 offices (director, assistant, etc.)	1,350
Auditorium (50 seats)	900
Services	400
Total-annex	2,650

<u>Parking Area</u>

Students	1,500
Staff	400
Employees	550
Visitors	50
	2,500 cars

It is requested to provide at least 250 cars on grade close to the several entrances.

<u>Auditorium</u>

1,400 seats and a theatre with 600 seats

Total gross area	54,070
<u>Large Auditorium</u>	21,900
Front lobbies and offices	5,820
Back stage area	3,980
Auditorium and platform	12,200
<u>The Theatre</u>	32,170
Front lobbies and offices	3,240
Auditorium	4,350
Stage	7,200
Back stage	17,200

<u>Athletic Facilities</u>

<u>Intercollegiate Basketball Arena</u>
(8,000 capacity)

Main floor area	90,000
Service level (including mechanical, storage, varsity locker rooms, training rooms and general maintenance)	45,000

<u>General Athletic Facilities</u>

Total gross area	150,000

	sq. ft.
Administrative facilities	15,000
Athletic director	
Coaching staff	
Intramural offices	
Clerical staff	
Ticket sales	
Miscellaneous	
Lobby (display)	4,000
Special gyms	15,000
Men (3)	
Women (2)	
Tennis courts included	
Swimming pools (2)	8,000
General Locker room facilities	25,000
Game rooms	15,000
Handball courts (10)	
Boxing, etc. (5)	
Apparatus rooms (2)	
Tumbling (1)	
Recreation Rooms	4,000
Men (1)	
Women (1)	
Bowling Alleys (16)	12,000
Main Athletic Equipment Storage	2,000
Laundry	2,000
Mechanical	15,000
Total - net	117,000
Total gross	150,000

Graduate Center
(1,000 students)

Total gross area 400,000

The Graduate student center is formed by 4 units called houses of 250 students each. One of these houses is for women graduate students.

Undergraduate Center
(for 2,000 students)

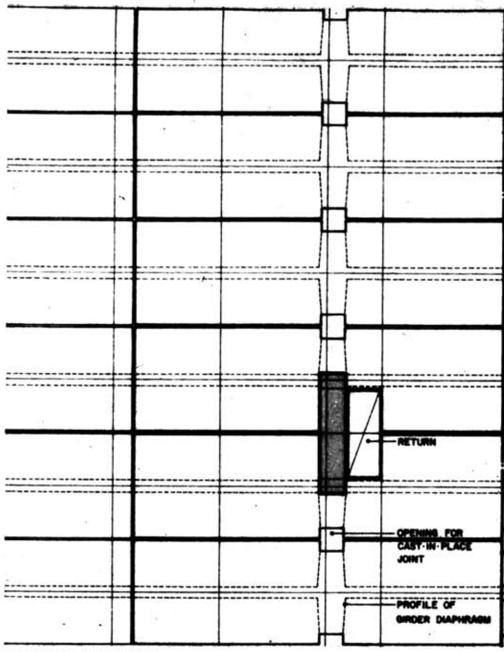
Total gross area (approx.) 867,000

The undergraduate center is formed by 7 units called houses of 285 students each (5 for men and 2 for women).

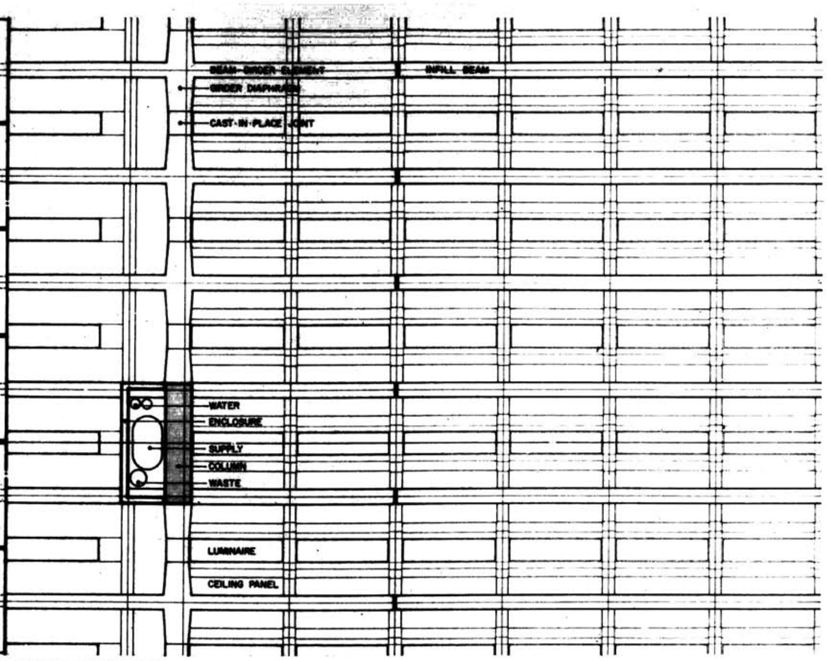
Married Student Housing
(250 units)

Total gross area 220,000

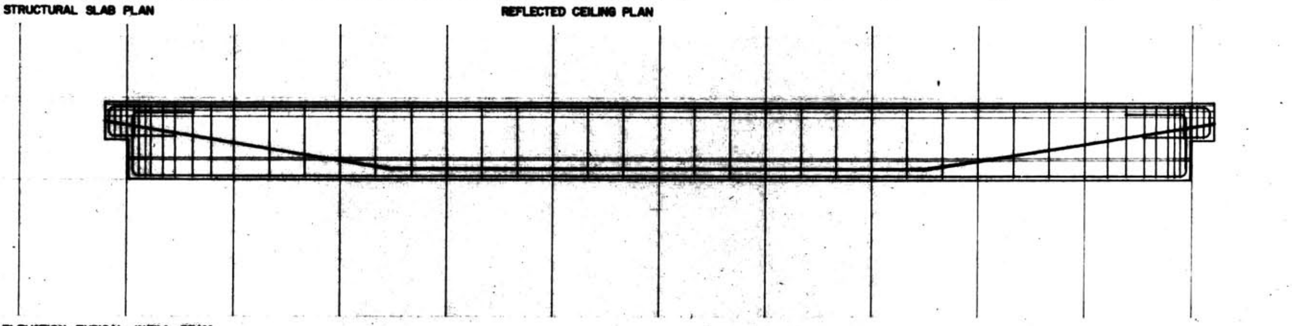
	sq. ft.
Student Center	
Total gross area	170,000
Medical Department: (clinic, infirmary for 100 students)	
Total gross area	100,000
Physical Plant	
Power plant	
Workshops	
Technical office	
Total	100,000



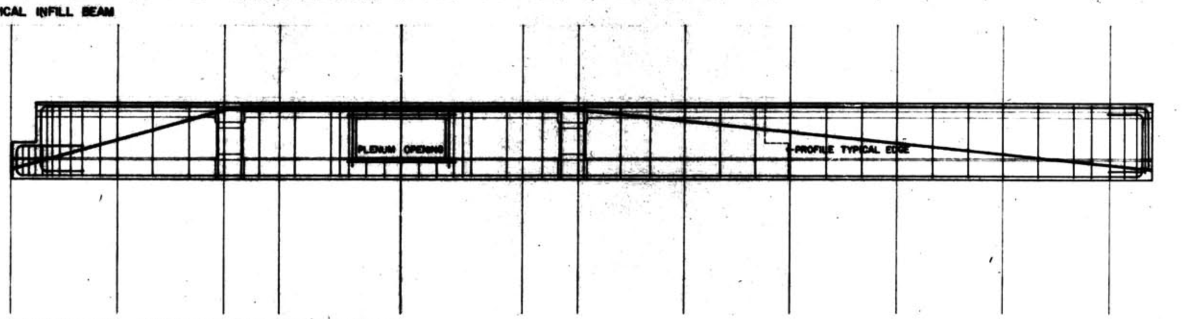
STRUCTURAL SLAB PLAN



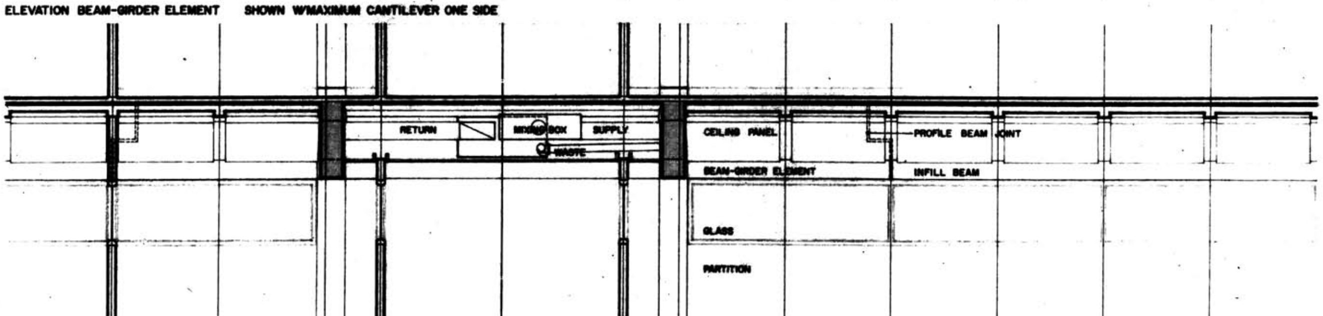
REFLECTED CEILING PLAN



ELEVATION TYPICAL INFILL BEAM



ELEVATION BEAM-GIRDER ELEMENT SHOWN W/MAXIMUM CANTILEVER ONE SIDE



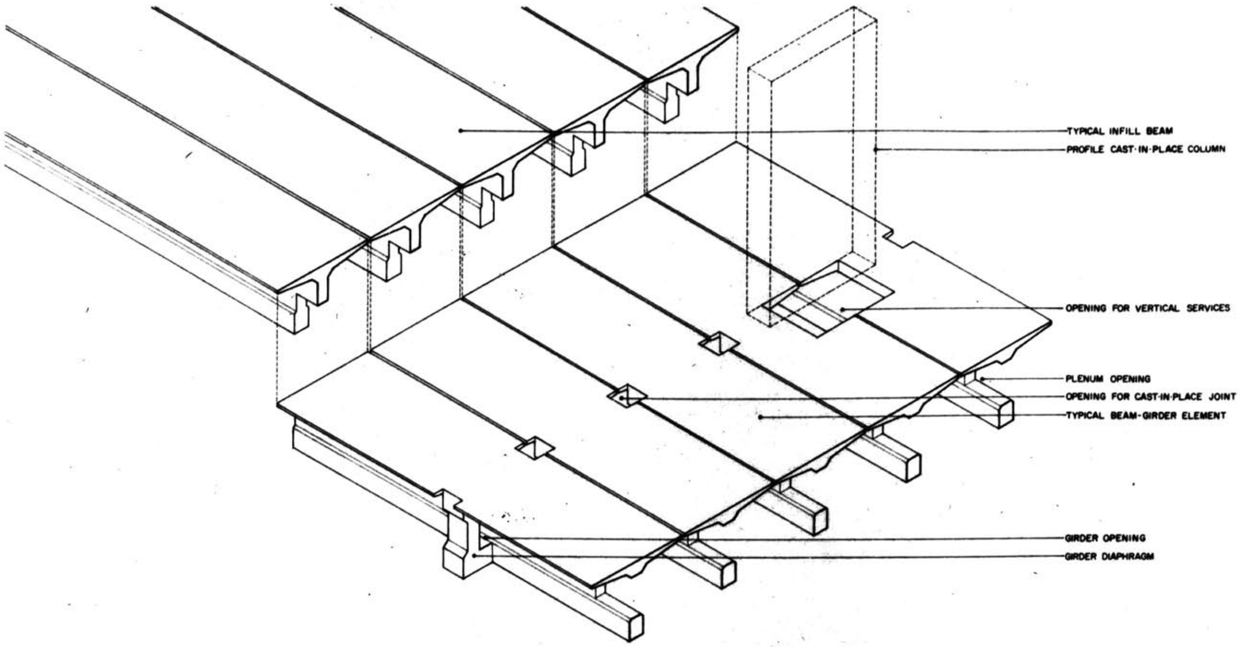
LONGITUDINAL SECTION

SCHEME B

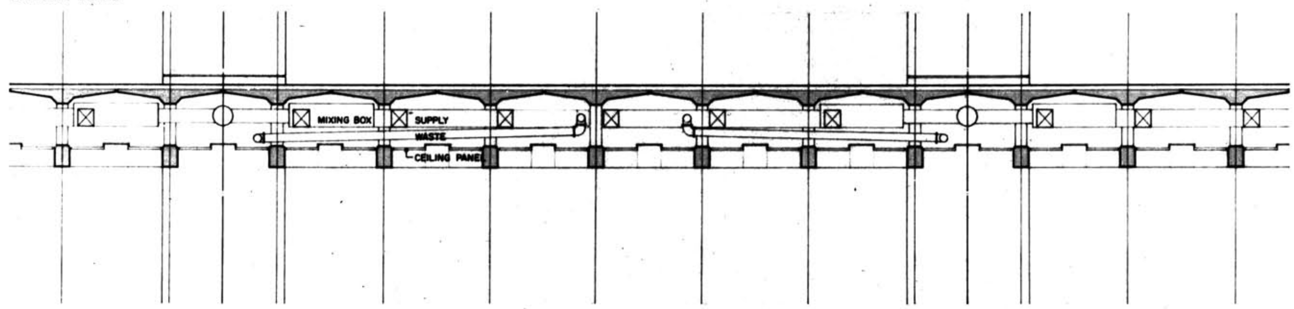
MASTER OF ARCHITECTURE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
STANLEY E. PINSKA FALL 1966-67

0 1 2 4 8 12

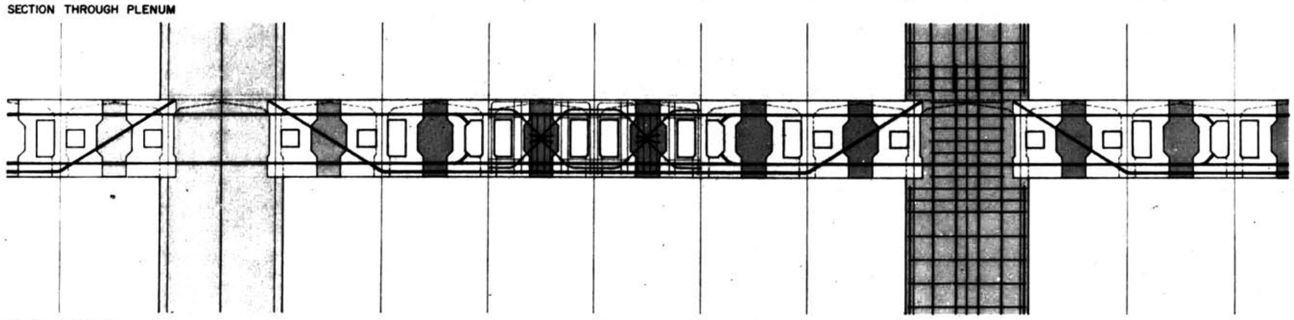
COMPONENT DETAILS



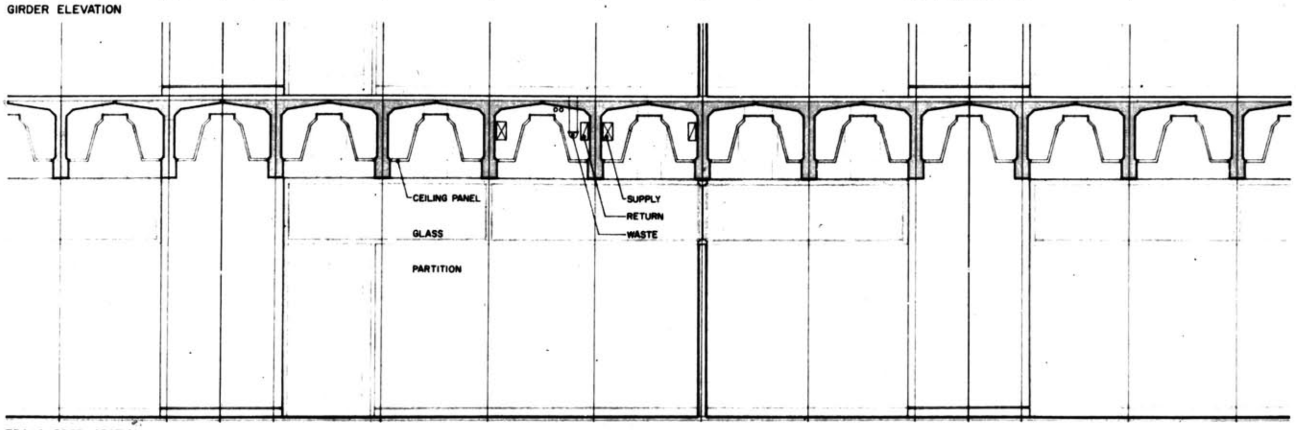
ISOMETRIC DETAIL



SECTION THROUGH PLENUM



GIRDER ELEVATION



TRANSVERSE SECTION

MASTER OF ARCHITECTURE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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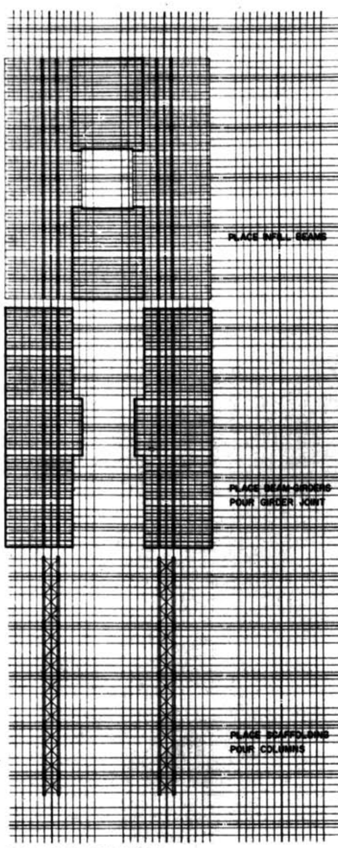
0 1 2 4 8 12

COMPONENT DETAILS



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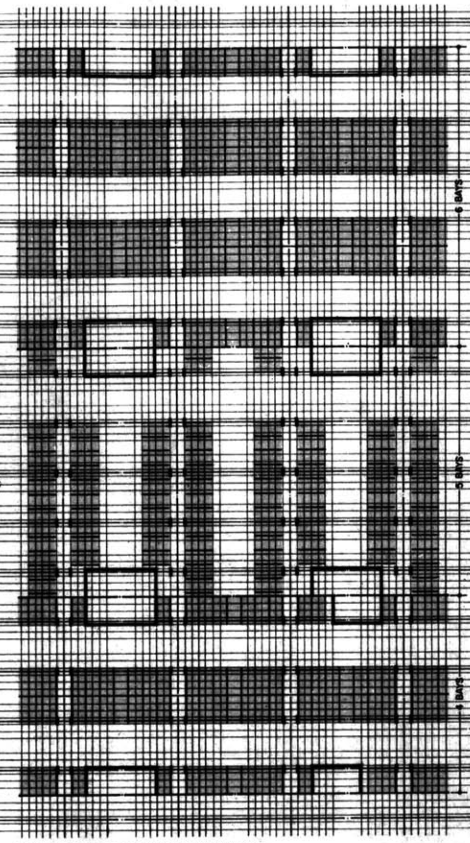
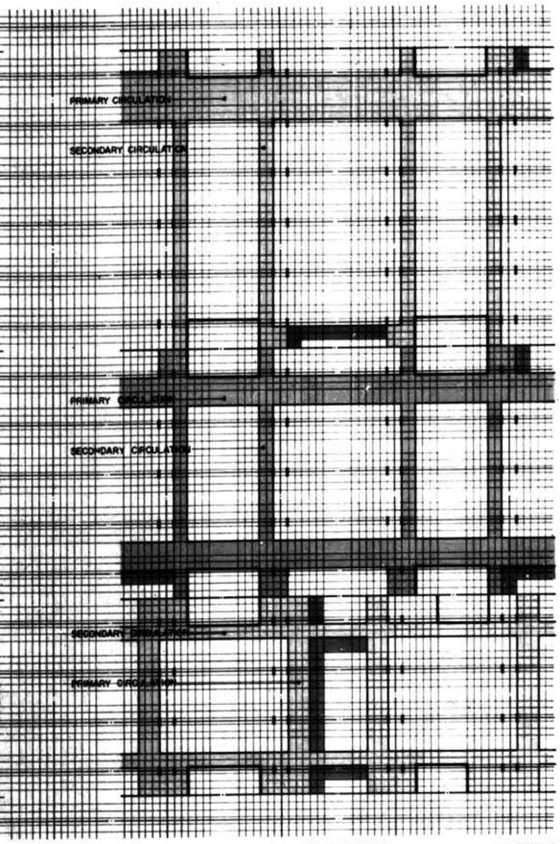
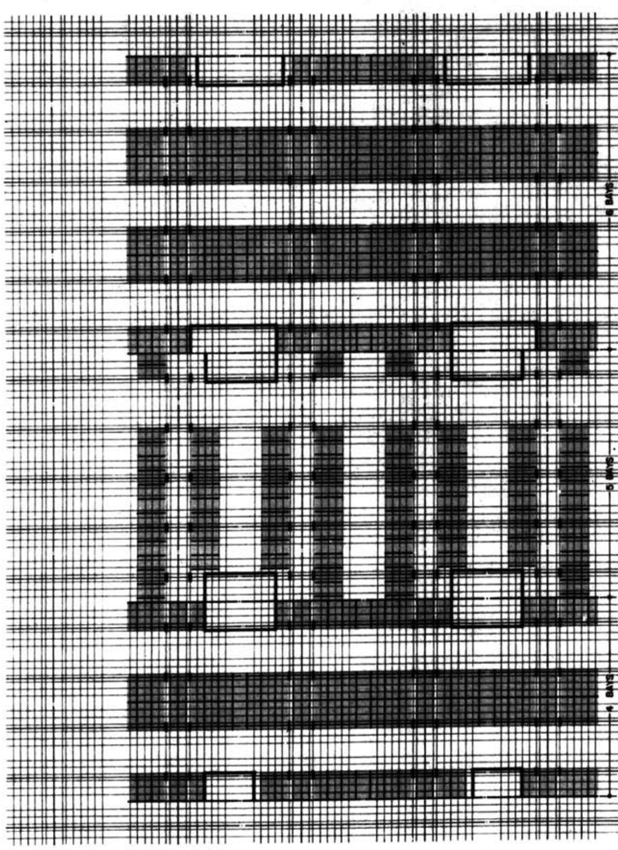


CORE LOCATION-PARKING RELATIONSHIPS



CORE LOCATION-CIRCULATION RELATIONSHIPS

SCHEME A



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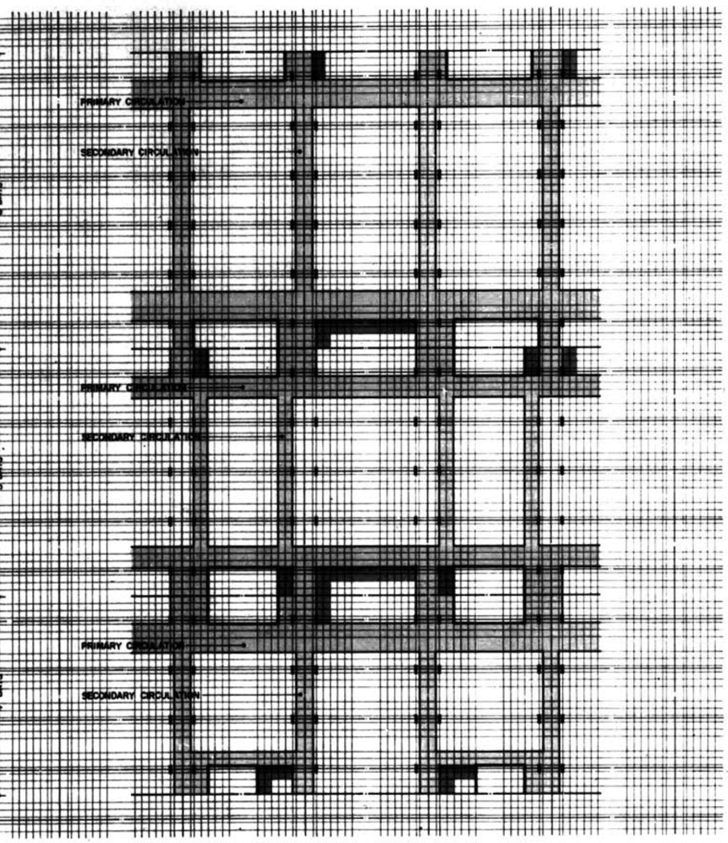

CORE LOCATION-CIRCULATION RELATIONSHIPS

SCHEME B

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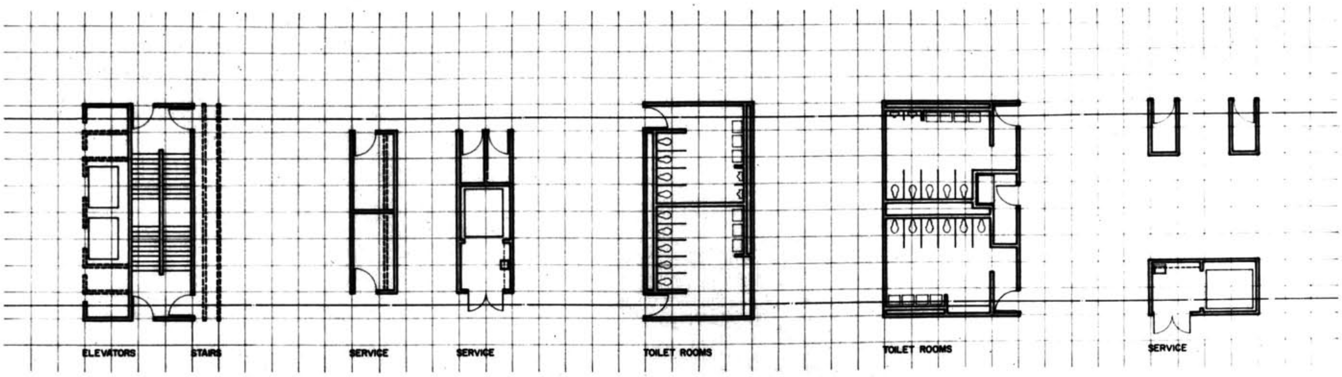
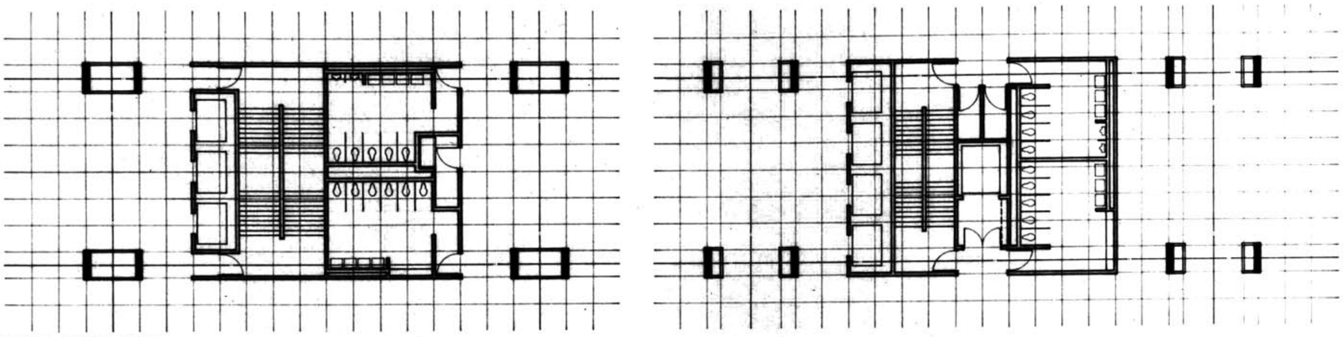
0 15 30 60 120 180

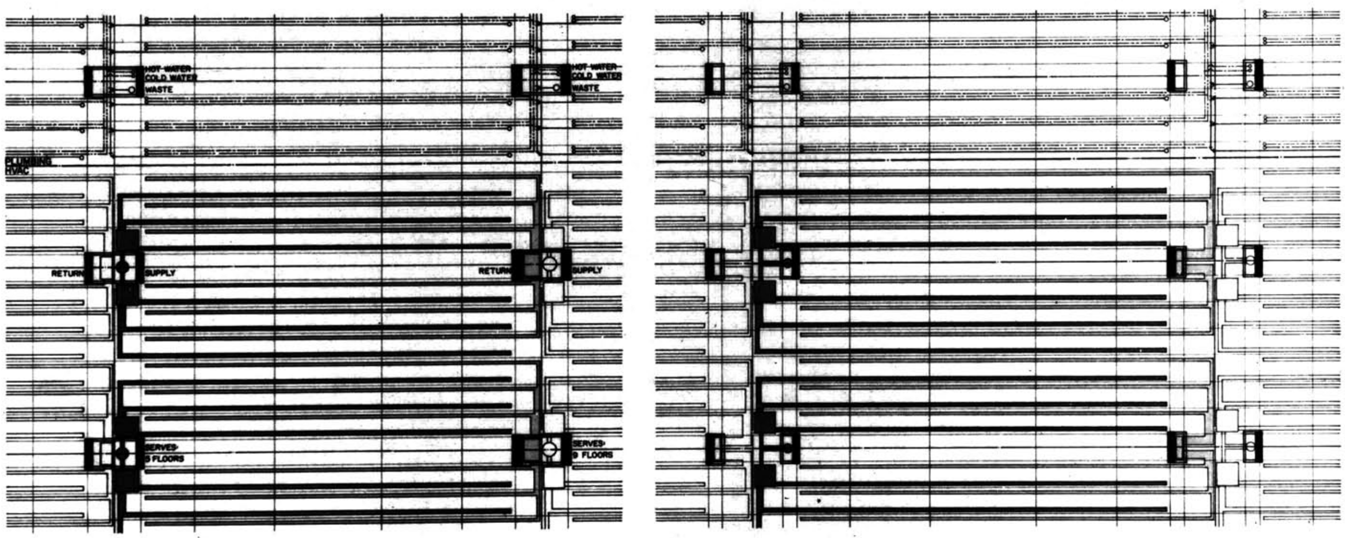
PLANNING SCHEMATICS



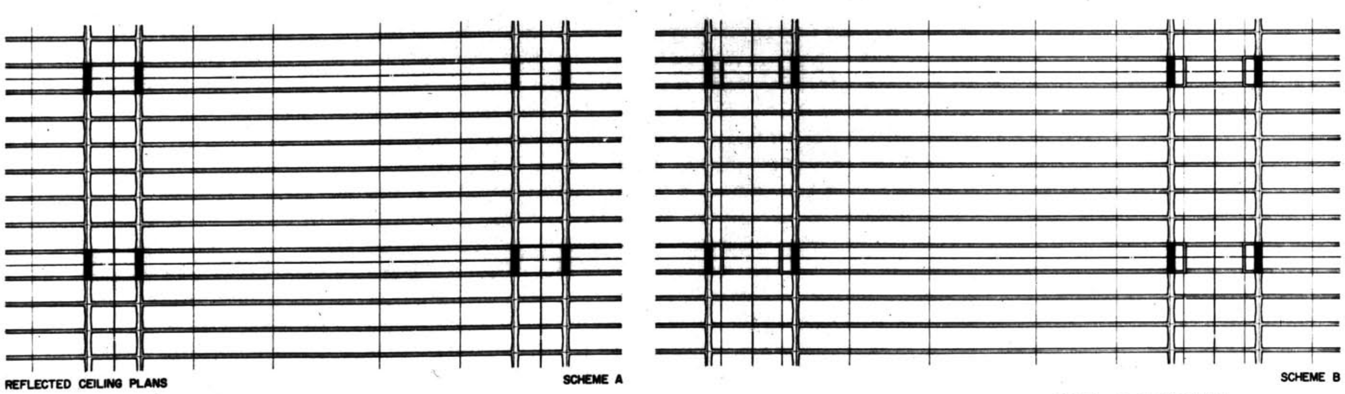
CORE COMPONENTS



TYPICAL CORE VARIATIONS



ENVIRONMENTAL SERVICES DIAGRAMS



REFLECTED CEILING PLANS

SCHEME A

SCHEME B

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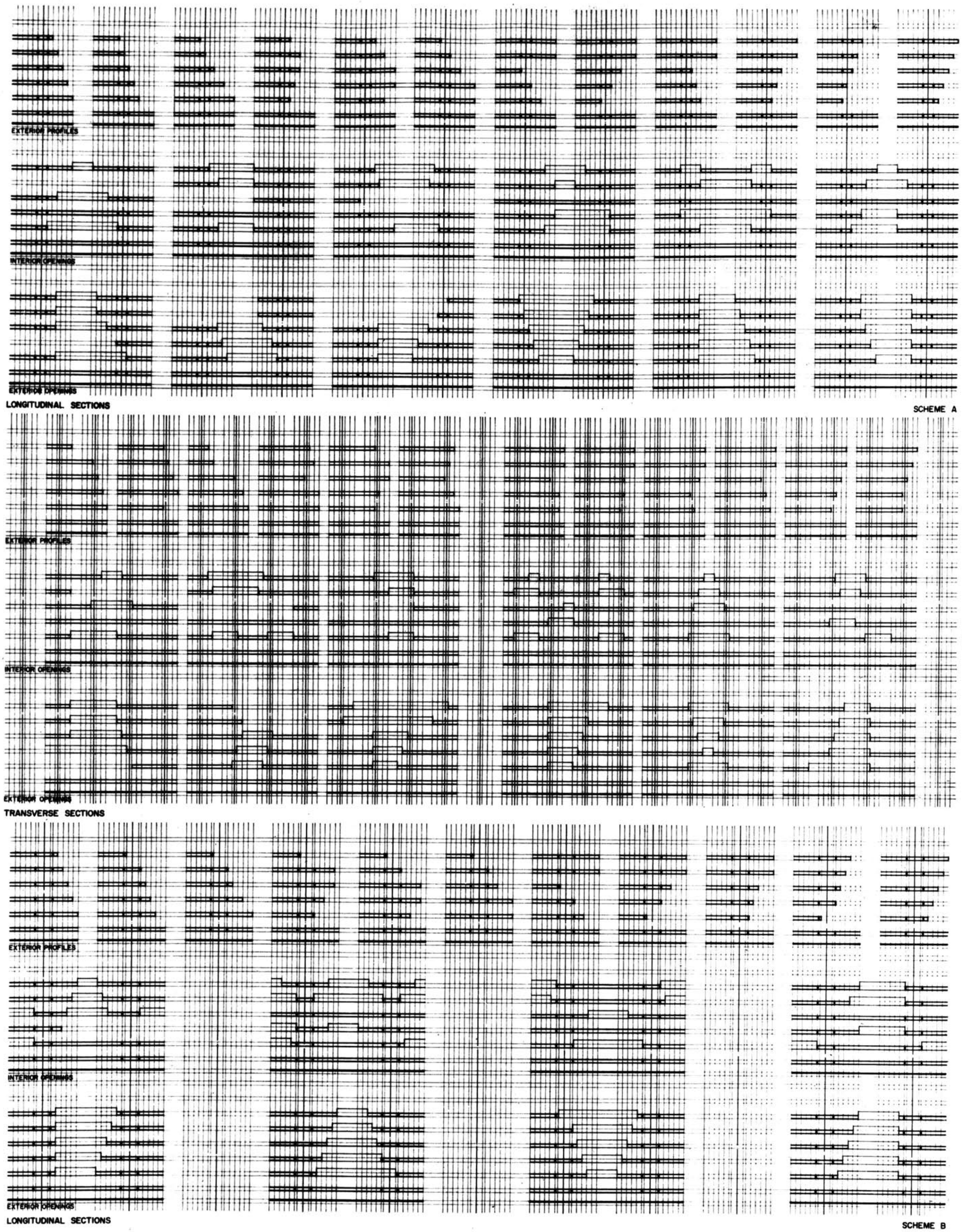
CORE COMPONENTS · ENVIRONMENTAL SERVICES



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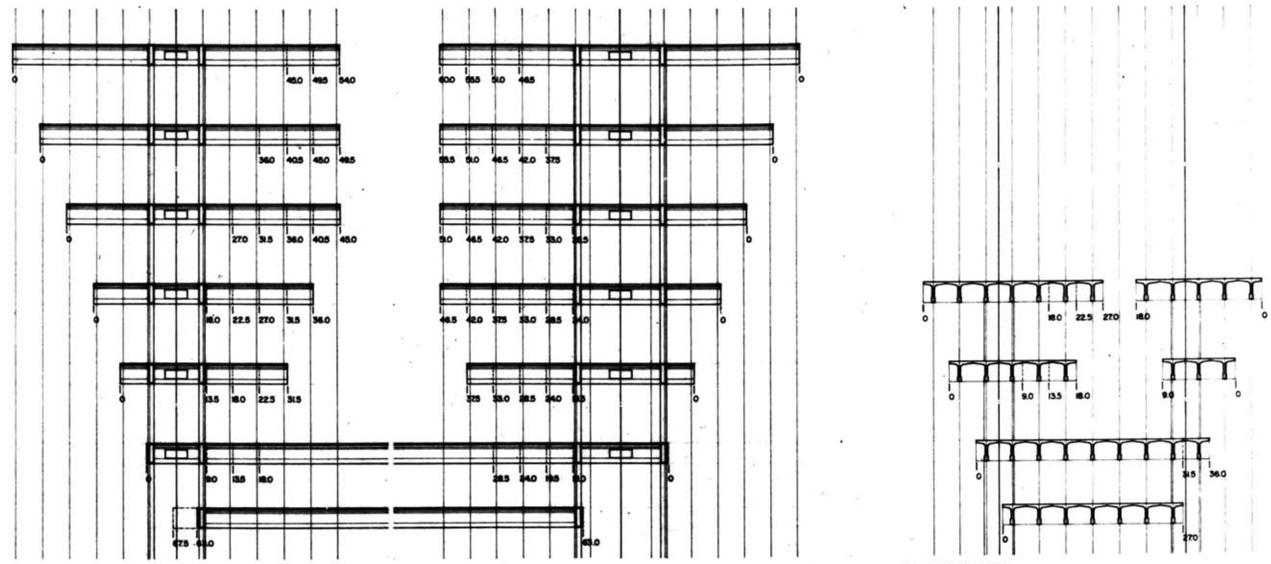
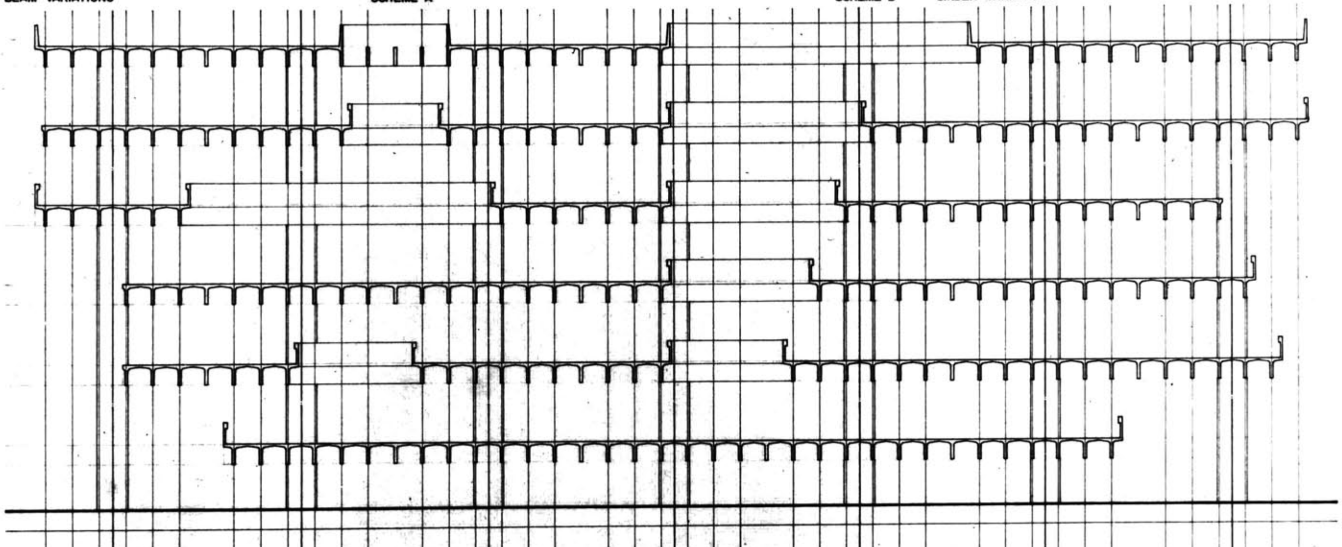
0 15 30 60 120 180

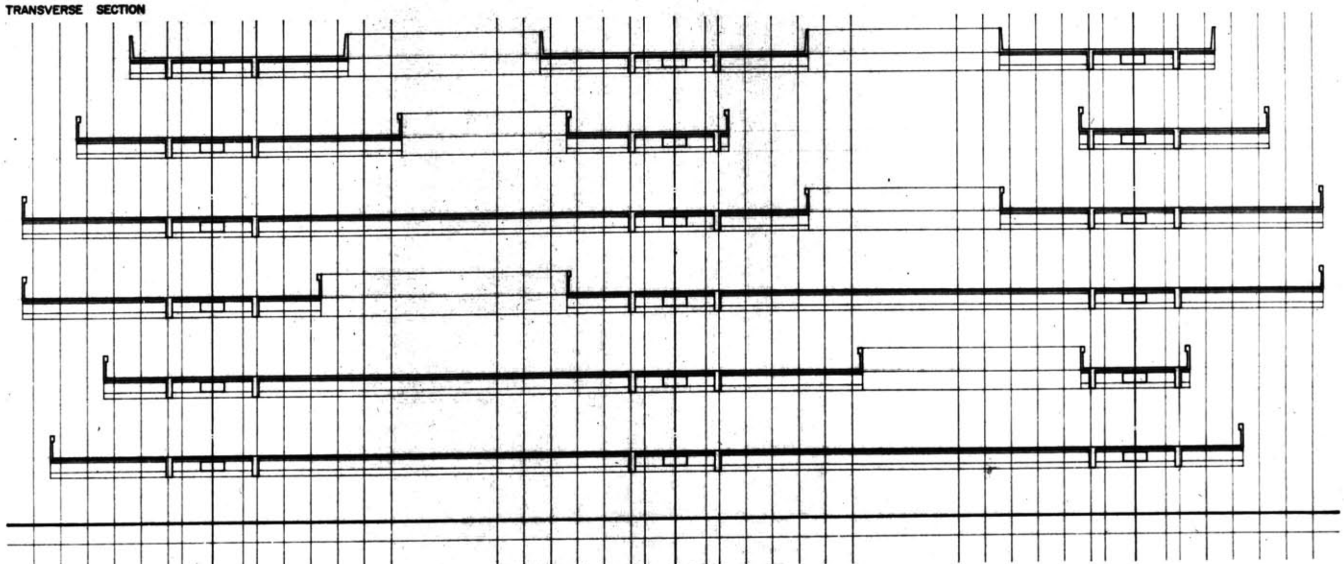
SECTION VARIATIONS



BEAM VARIATIONS SCHEME A SCHEME B GIRDER VARIATIONS



TRANSVERSE SECTION



LONGITUDINAL SECTION

SCHEME B

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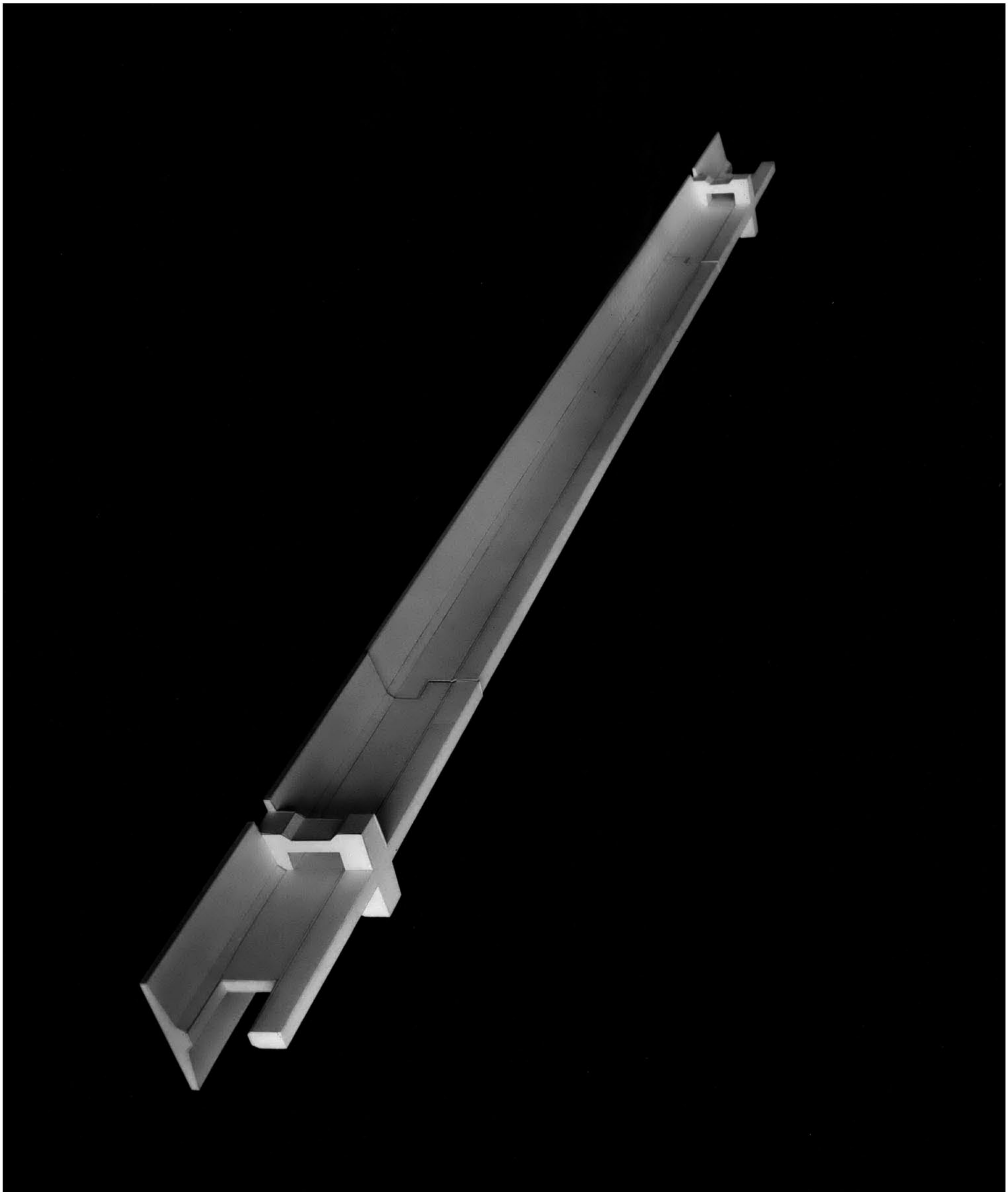
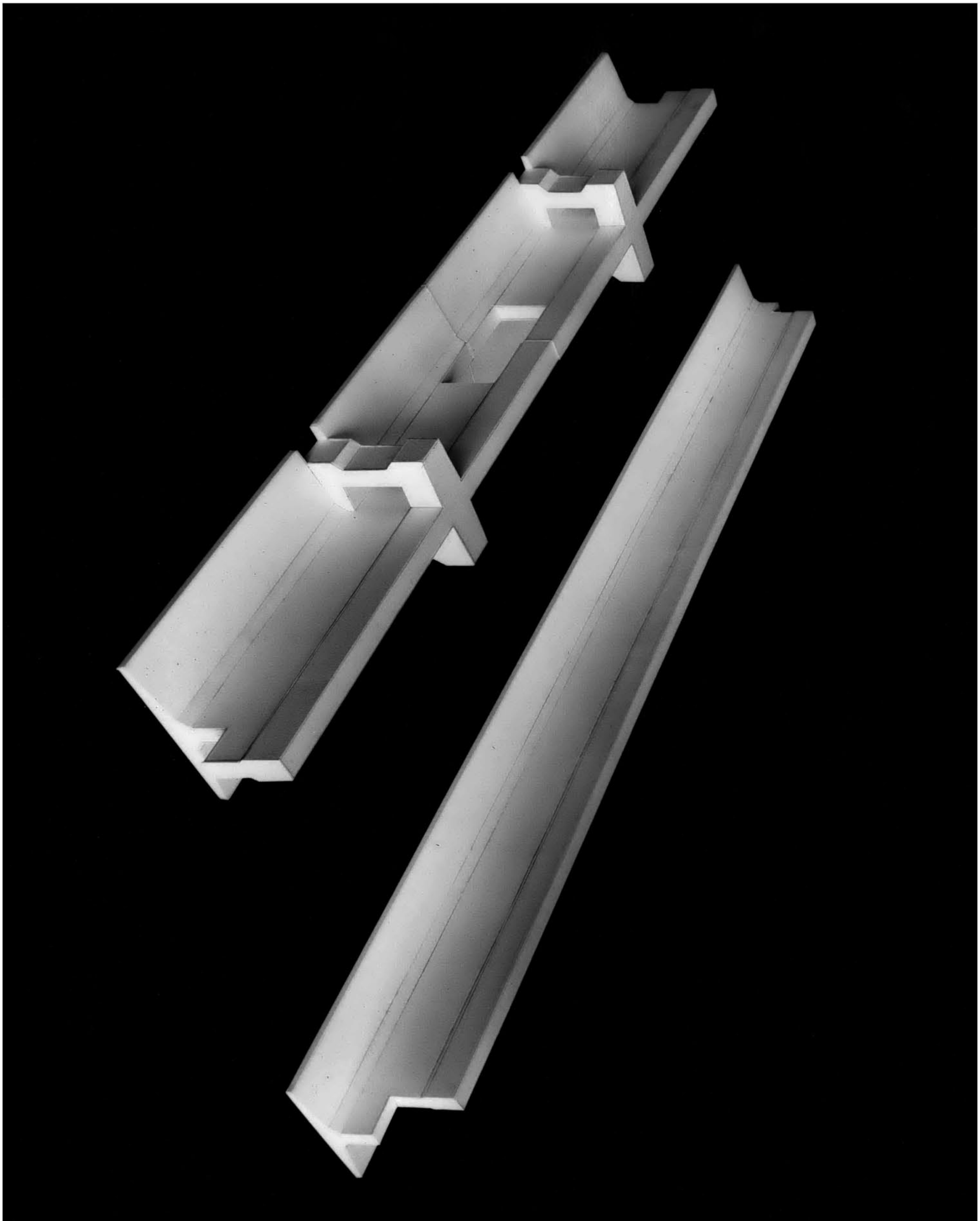
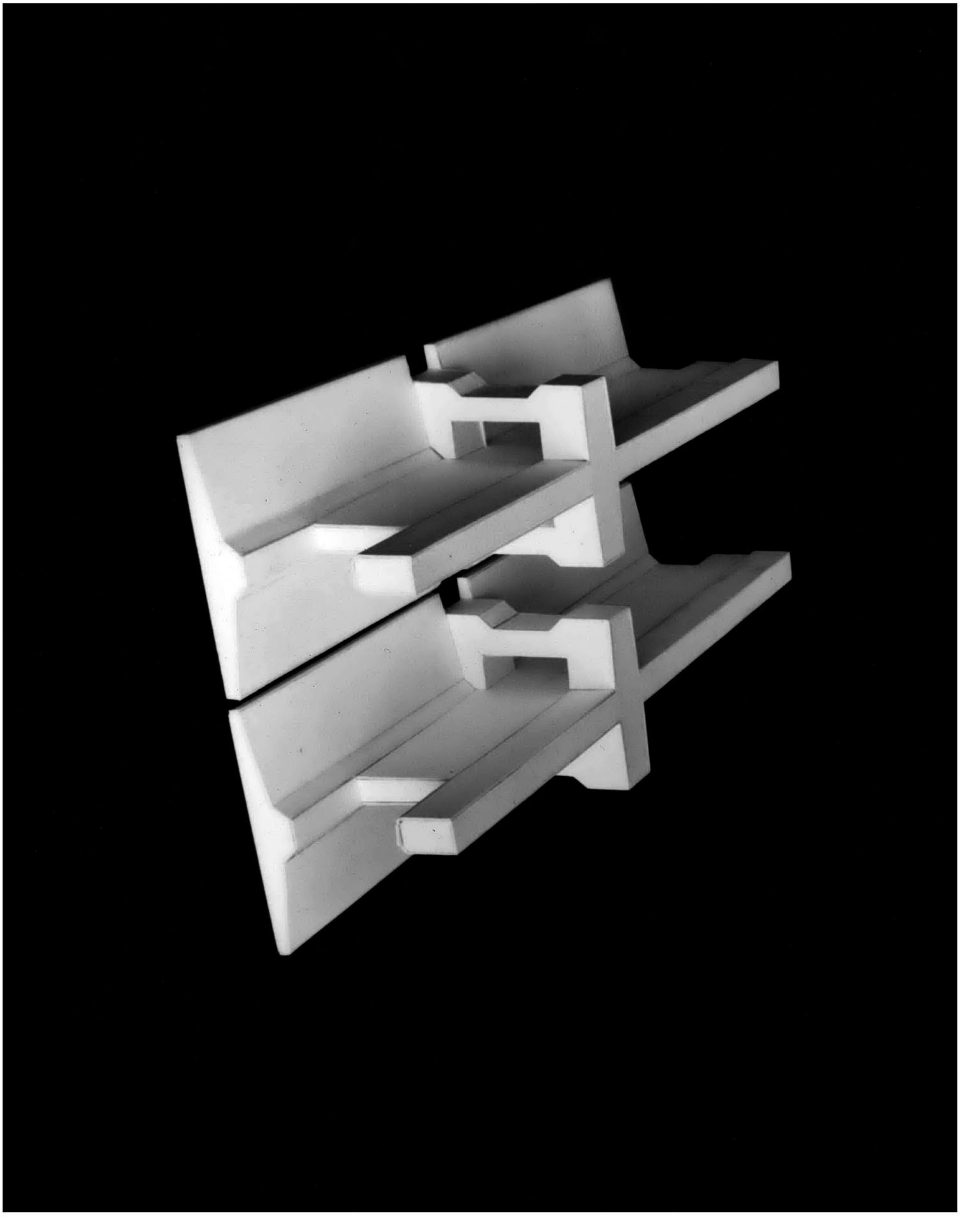
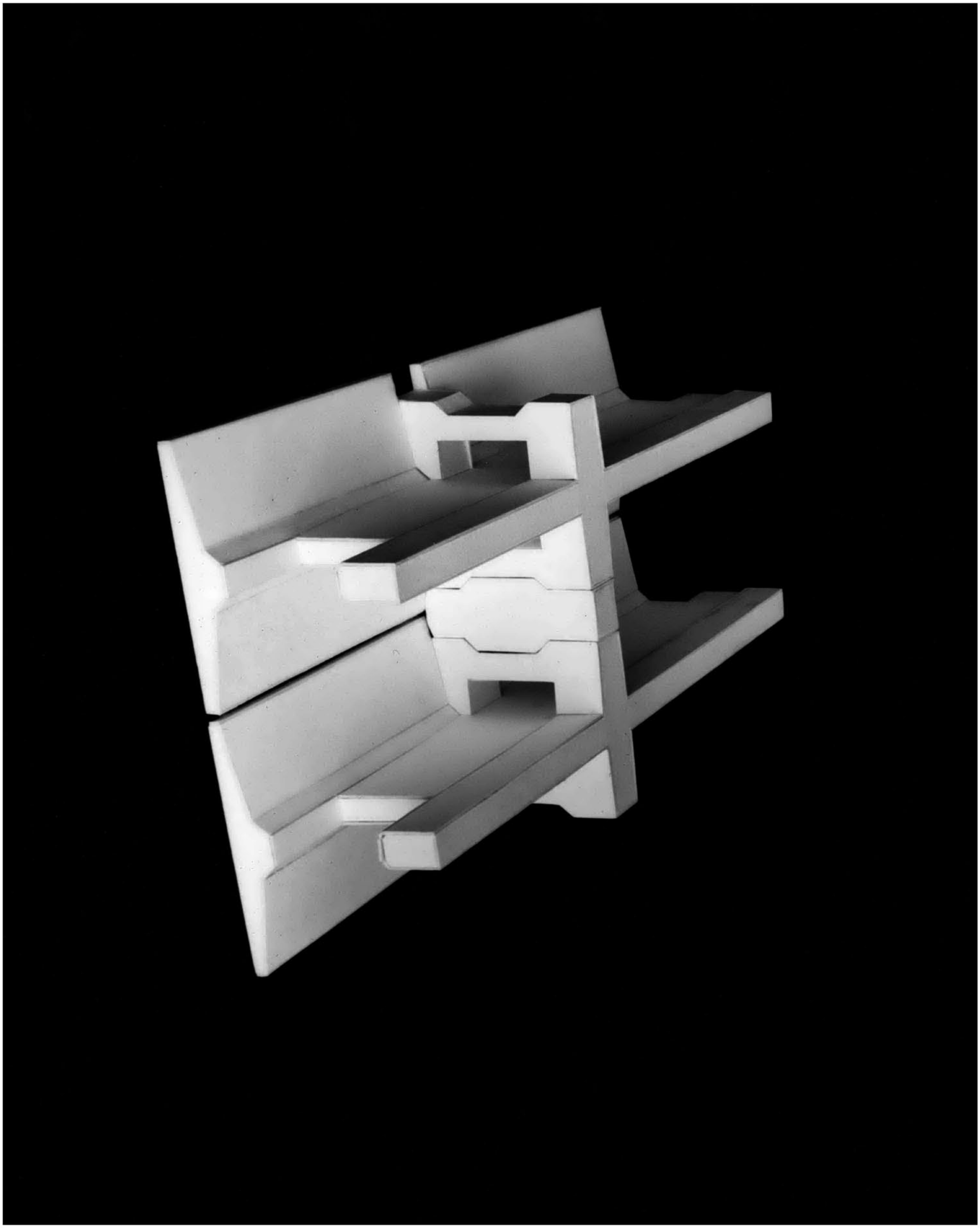
0 4 8 16 32 48

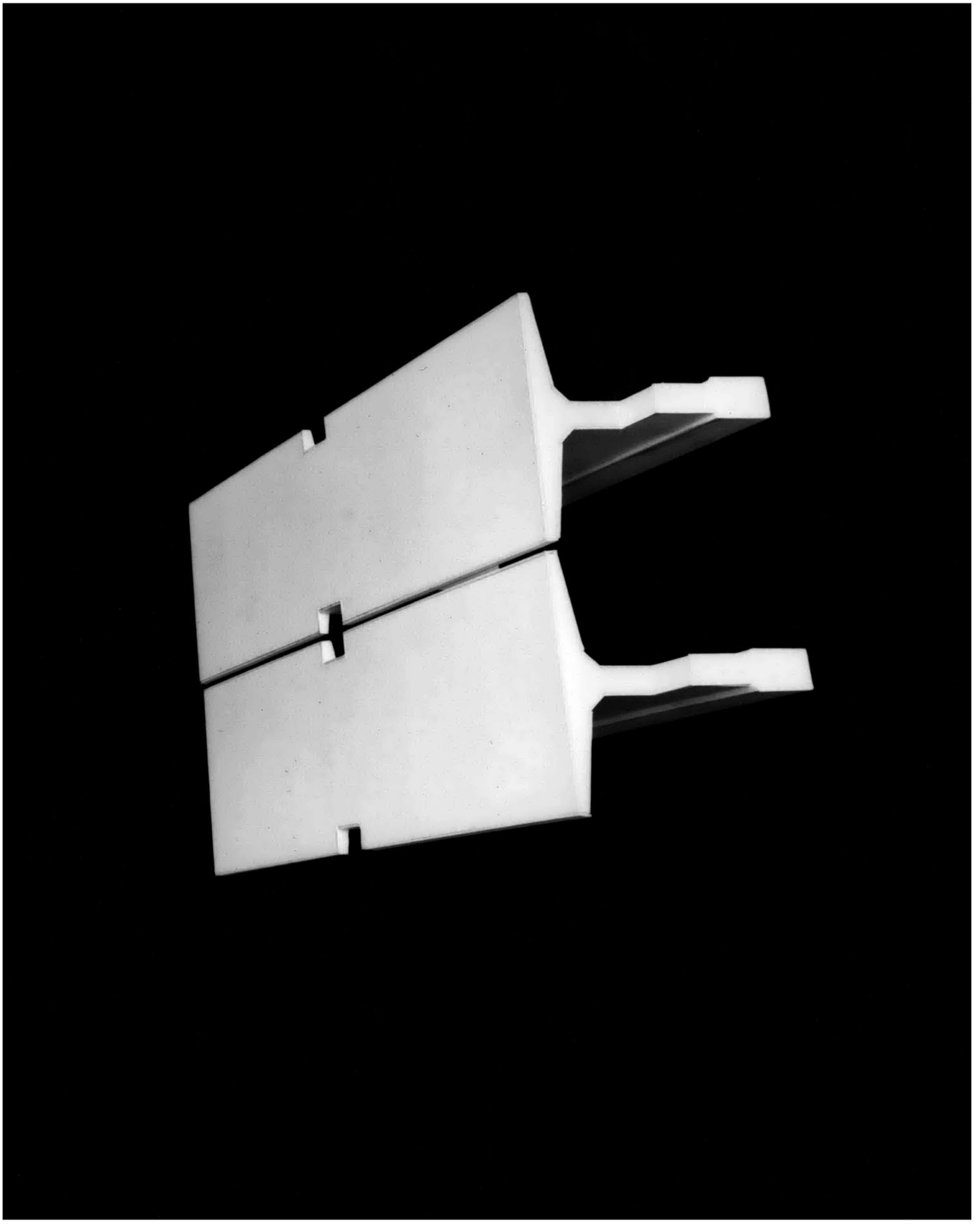
STRUCTURAL VARIATIONS

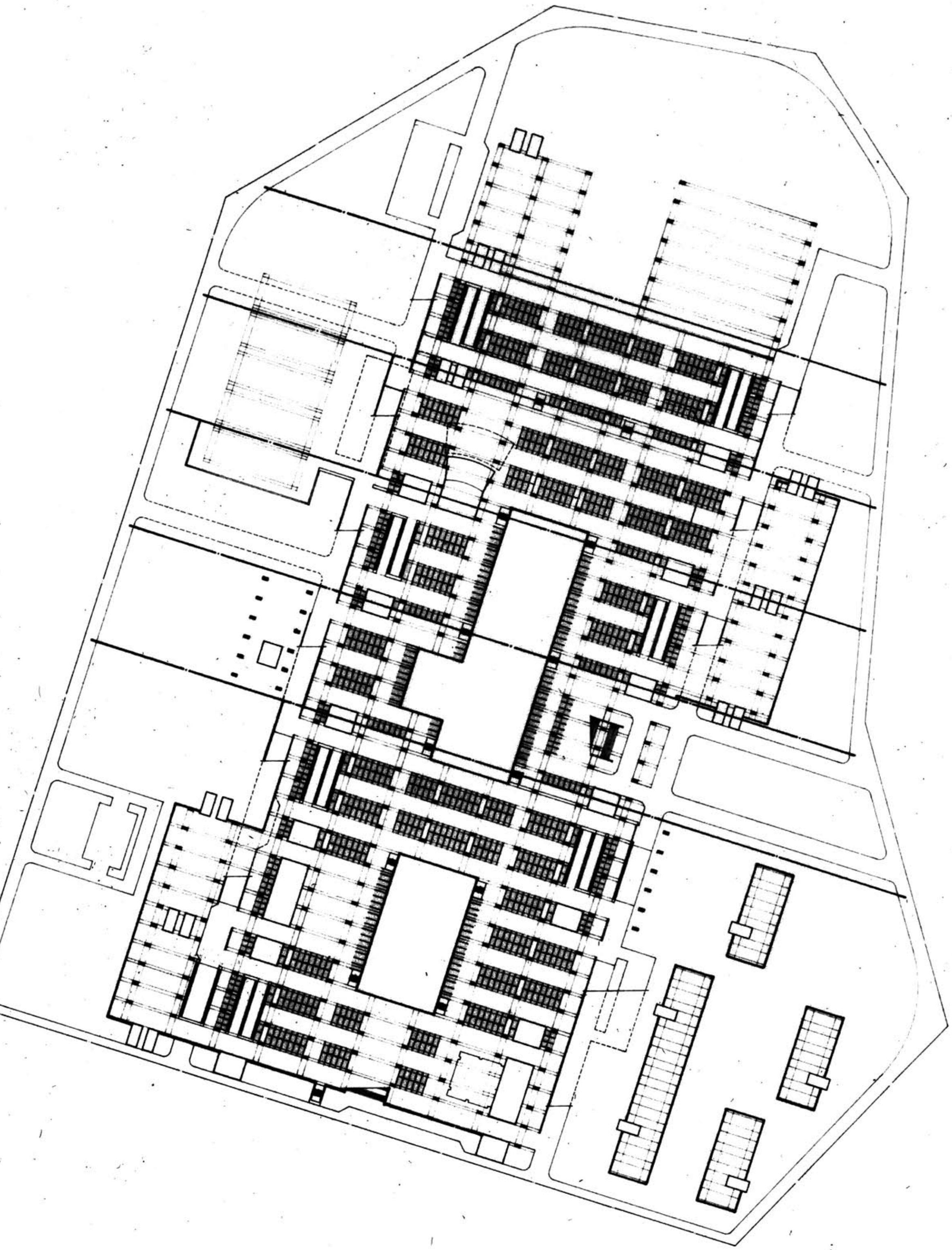












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PARKING LEVEL PLAN

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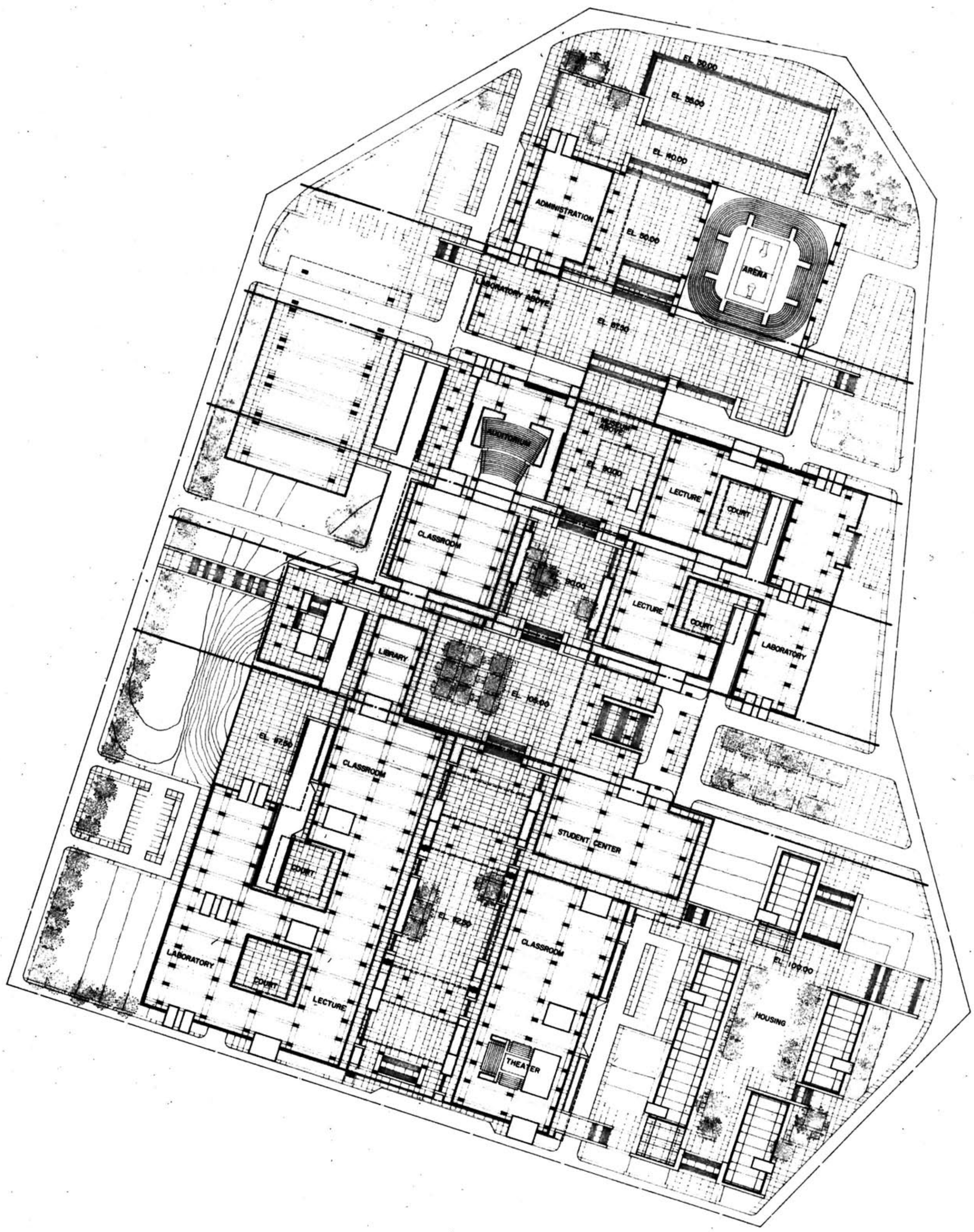
0 30 60 120 240 360



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GROUND LEVEL PLAN

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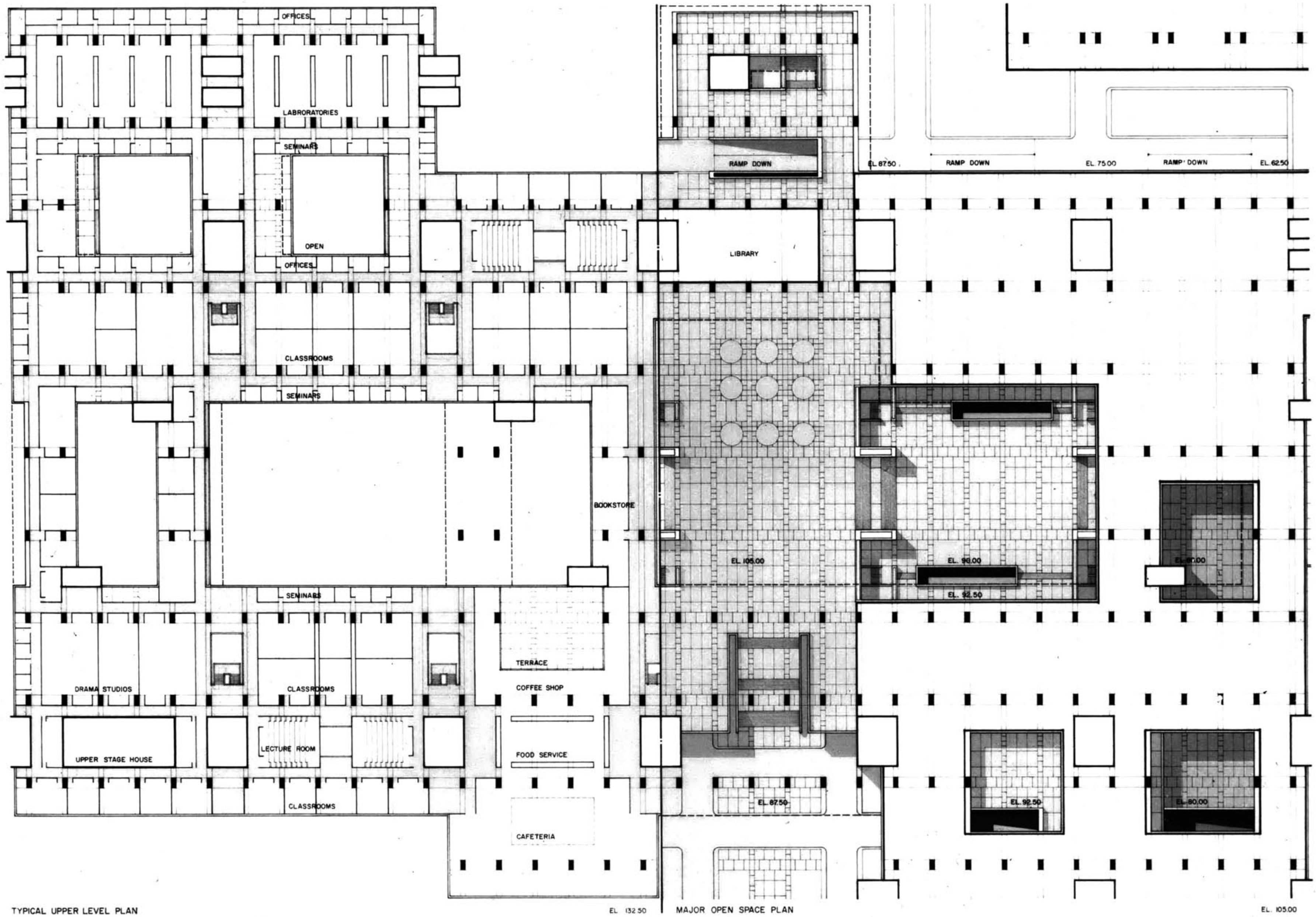
0 30 60 120 240 360



TYPICAL UPPER LEVEL PLAN

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PLANS

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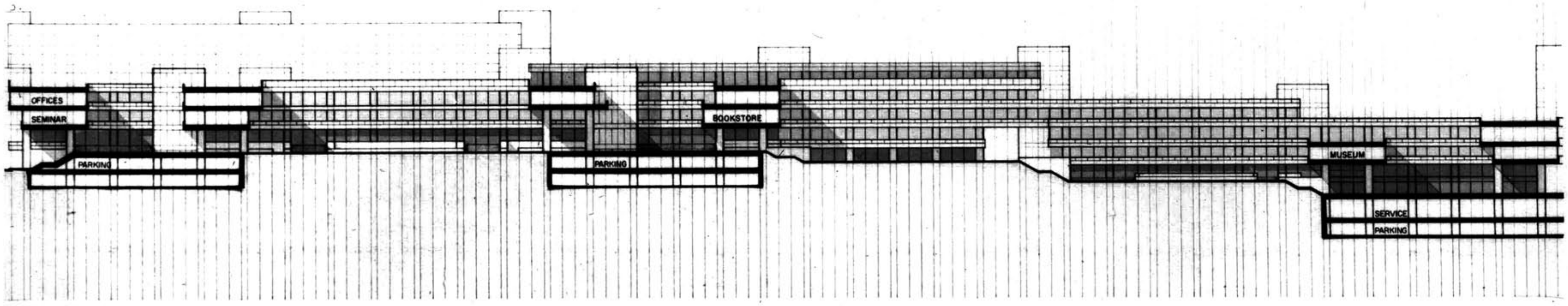
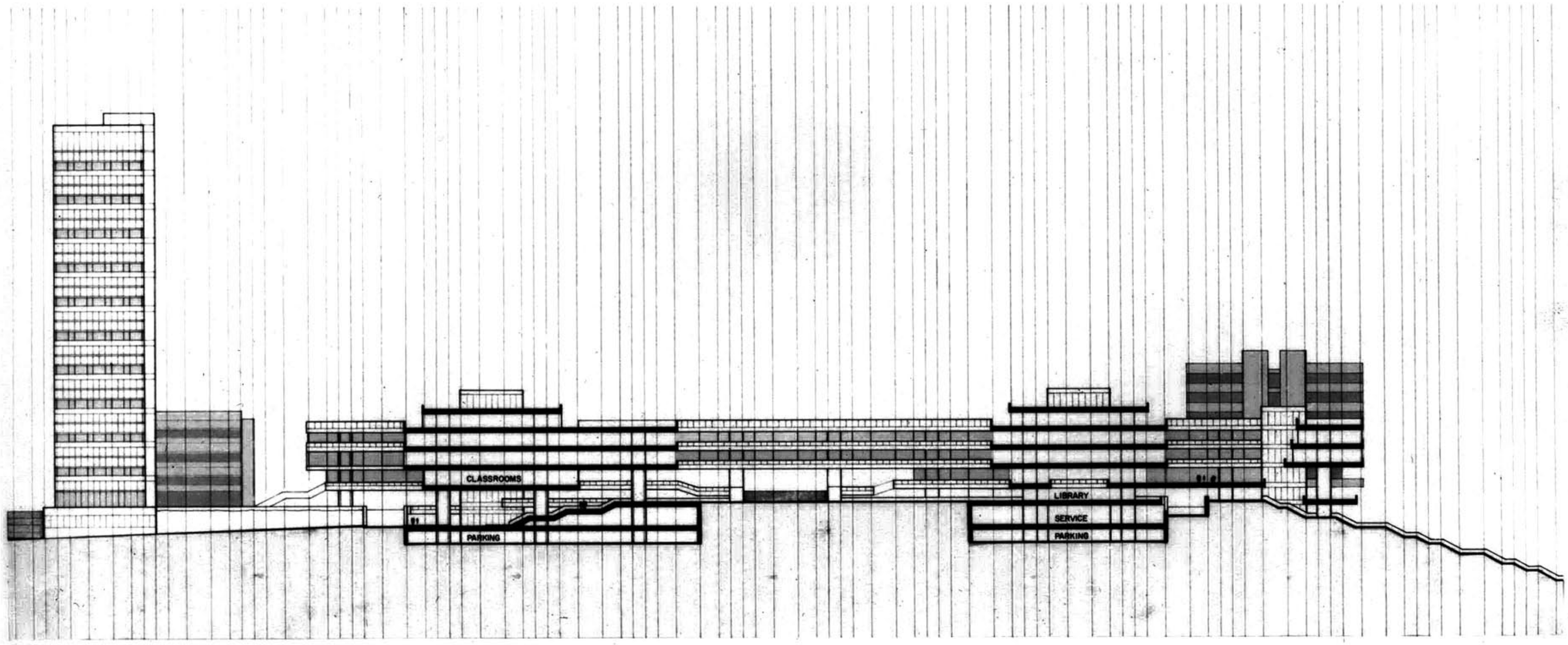
0 15 30 60 120 180



SECTION LOOKING WEST



SECTION·LOOKING SOUTH

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SECTIONS

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0 15 30 60 120 180