A MASTER PLAN AND SYSTEMS DESIGN FOR AN URBAN UNIVERSITY

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MASTER OF ARCHITECTURE

at the

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June, 1967

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Lawrence B. Anderson

ABSTRACT

A systematic technology is essential to the ordering of large building complexes, and to the accomodation of ever more demanding building services. This two part study is a development of this thesis.

The first part is the design of an integrated structural-mechanical system for educational buildings of five to ten stories. The second part is the application of this system to the design of an urban university.

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PART I

SYSTEMS DESIGN FOR AN URBAN UNIVERSITY

CONCEPT

Integration of the building construction, structure, and mechanical systems into one coherent whole is considered a reasonable first step in a systematic architectural development. This binding together of the technological aspects of an extensive project, even before close site or program evaluation, is pertinent to the solution of several prime architectural and educational problems:

ADAPTABILITY What is built today must serve new needs tomorrow.

EXPANSION There are no finished universities.

FIRST COST Dollar economy is a measure of human resources.

VISUAL ECONOMY There must be a fitness of material to form.

ORDER Unity in vast complexes is elusive.

This concern for technological adaptation is not at all a derogation of the architect's responsibilities as artist. Fitness to function and the ordering influence of a systematic technology are positive values. It is rather a delimiting of the endless possibilities at the disposal of the designer, and insurance that the mechanical necessities of good architecture will be met.

A more specific conceptual overlay is a demand for economy. It is distressing to watch the labored form building and intricate preparation for casting on-site concrete. This is especially so in winter. Despite the many obviously fine buildings built in this manner, the American economy can ill afford this waste of human resources. The building industry persists in going about its business as if the Romans were the last of the innovators.

In an attempt at cutting both first costs and building maintenance costs, precast prestressed concrete is designated as the basic structural and architectural material for the building system. An overriding requirement for minimal on-site connection, casting, and alignment labor will rule the structural design for the total building system. Maximum use of protected factory production of basic structural and mechanical elements is a primary goal. The resultant building system must be so simple that the component parts can be easily assembled in an obviously sequential manner.

PROGRAM

FUNCTION The building system must house offices, classrooms, laboratories, seminar rooms, and lounges. Housing, auditoria, gymnasia, and other special activities involving large areas or special physical requirements may or may not be housed within the system.

CONVERTABILITY Modular partitioning must be related to structure and mechanical services such that rearrangement of partitions does not involve major expense, or relocation of other systems. Vertical space changes involving floor section demolition or addition should be feasible. Provision must be made for the accomodation of major building service additions.

EXPANDABILITY The total building system must satisfy the impossible task of accommodating expansion, yet present at all times a finished project face.

PLANNING Basic structural arrangements must admit a variety of core, void, and circulation patterns. Structural bay dimensions must allow the possibility of parking at basement and sub-basement levels.

STRUCTURE First cost must be as low as possible consistent with integration and systems quality. It is assumed that economy is best served with precasting and minimal on-site labor.

AIR DISTRIBUTION Conditioned air must be available to any minimum occupied space. Means for reasonable zone temperature control must be incorporated. The system must be such that it does not require limited partitioning patterns, and is not broken by partition rearrangement.

SERVICES Electrical and communications circuits must be incorporated within the modular field for access in any given minimum occupied space. Reasonable access to hot and cold water, vent and waste lines must be provided. It is assumed that exposed pipes in the president's office are unacceptable. They must be concealed in office areas. Laboratory services may be exposed for immediate access.

LIGHTING A minimum of sixty footcandles throughout is established with a provision for special incandescent and heavy flourescent illumination as required.

ACOUSTICS Reverberation and sound transmission control must be effective, whatever the means.

SOLUTION

CONSTRUCTION Various one and two way precast approaches were evaluated with ease of connection and assembly the primary critical point. With this view, the largest possible components are obviously desirable. It is, however, extremely difficult to gain in the project stage an accurate relationship between total production-transportation-erection cost, and component size and weight. All of the cost inputs are highly variable with location factor, precast plant proximity, crane availability, and mechanical experience. Somewhat blindly, the assumption was made that structural elements fitting within an 8' x 10' x 60' envelope weighing not more than sixty kips were feasible. On-site precasting was rejected as uneconomical for the degree of quality control required for architectural concrete. It is disappointing that a more precise measure of total erection cost is unobtainable. Judgment as to fitness of various construction systems was reduced to an evaluation of element and connection simplicity, and the strength of the sequential order of erection.

With these considerations, and for the large bays required by program, one way systems were deemed superior. Final design involves, very simply, columns, girders, and beams. Columns continuous the height of the building are erected first and temporarily supported. Girders and girder infills are then lifted onto simple pin and grout connections. Beams are placed on girder pin seats. The rough slab is formed integrally with the structure by the flange of the tee beams and the extended flange of the girders. Scaffolding and formwork is anticipated only for core and special end condition construction.

STRUCTURE The columns define a 37' - 4" x 63' - 0" bay. Paired girders forming a channel void for primary mechanical services frame the short side of the bay. Girders are either simple span between columns, continuous across the column lugs with alternate bay girder infills, or continuous across the column lugs to an edge or void cantilever condition. The simple span maximum positive moment is taken as the design condition for the girder concrete section. All beams are simple span between the girders with a clear span of 54' - 0". The bases of the girders are flush with the bases of the beams for ease in partitioning. Floor structure depth is 3'-6" plus a 2" finish concrete topping. Lighting, air distribution, and plumbing are all within this depth. Maximum element dimensions are columns 60'-0" x 1'-6" x 10'-4" at 57.2 kips; beams 54'0" x 3'-6" x 4'-8" at 21.6 kips; and girders 56'0" x 5'-2" x 3'-6" at 47.0 kips.

PLANNING The partitioning module is 4' - 8" x 7' - 0". This is a compromise rectangle derived from partitioning flexibility requirements, structural and mechanical efficiency, basic bay subdivision orders, a desire for lighting each module, laboratory service dimensions, and basement parking dimensions. There is no perfect module. 4' - 8" x 7' - 0" defines a module that meshes with a minimum 9' - 4" laboratory service spacing, that allows efficient 90° parking, that is somewhat small for structural, mechanical, and lighting efficiency, and that is somewhat large for partitioning flexibility. With a structural bay of eight by eight modules, planning does not seem overly difficult.

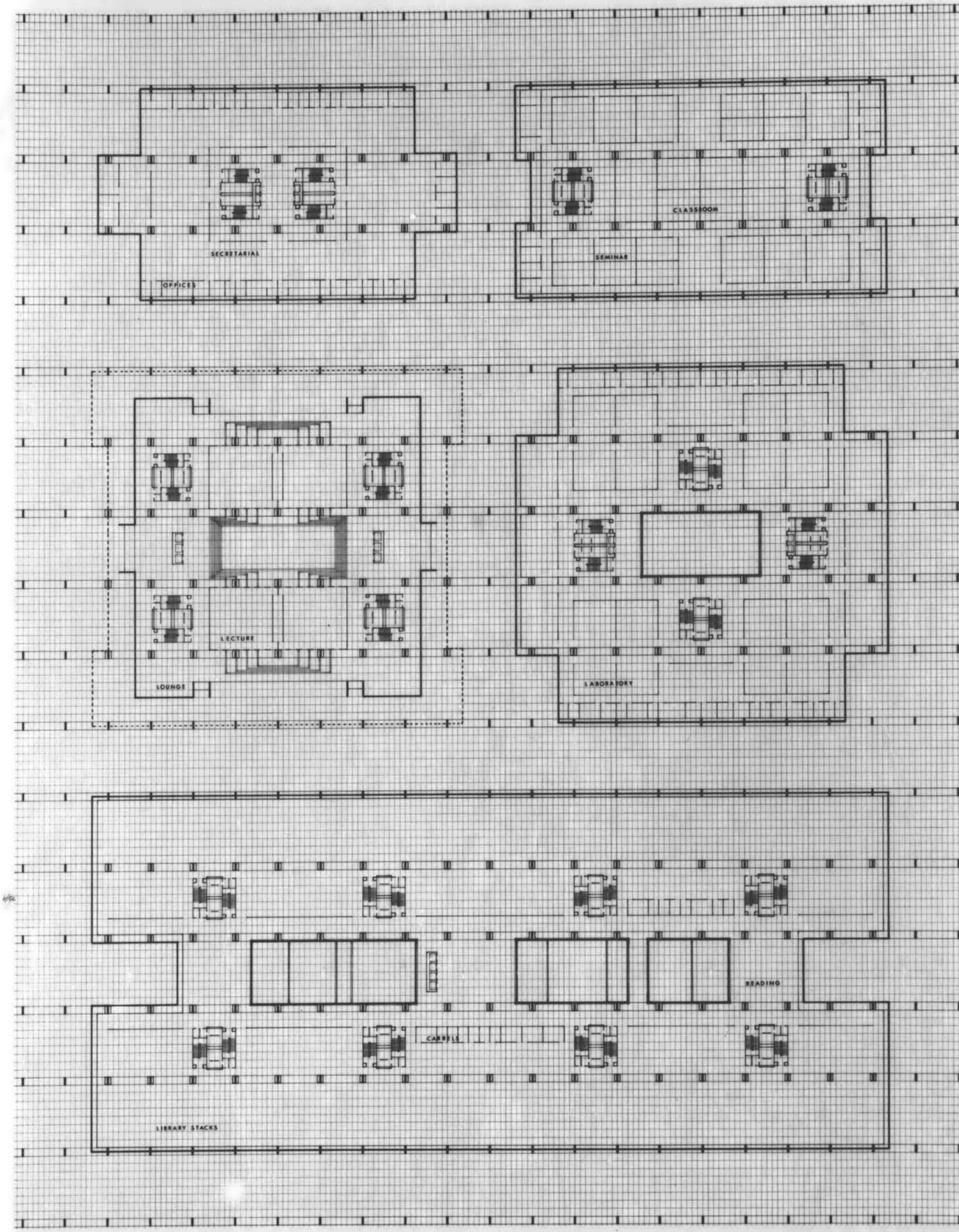
AIR DISTRIBUTION High velocity air for both interior and exterior zones is fed from basement air handling equipment through vertical ducts at each column. Initial horizontal run-out is between the paired girders at high velocity. After tempering and control, air is distributed at low velocity through holes in the girders and between the tee beam stems. The air system to the reduction control point may be dual duct, single duct with reheat, or single duct with variable volume control. In any case, distribution is similar with all tempering, control, and velocity reduction accomplished between the girders, under normal conditions. Control zones may vary from full bay 23500 square feet to the minimum occupied space area of 130 square feet. Additional temperature control at exterior zones is possible with induction units, fan-coil units, or fin tube radiation. Return air is the mirror image of supply. Pick-up is between the tees, through holes in the girders into a primary collection duct, then back to the basement through vertical chases at each column. Duct runs are initially planned as alternate supply and return between the tees, giving a 9' - 4" lateral spacing between supply diffusers. Longitudinal spacing will be determined by partition planning. Both supply and return diffusers may be continuous, integral with the duct; integral with the lighting fixture; or designed as part of the modular cross rib in office ceilings.

PLUMBING SUPPLY AND WASTE Vertical supply waste and vent risers can be located at each column. Horizontal distribution is down the girders channel from the column riser, through the holes in the girders and between the tee beam stems. Pipes typically are exposed in laboratory and classroom spaces, and are concealed with coffer panels in office areas. The vertical chase closets at either side of the columns may be easily expanded to accommodate heavy laboratory services and exhaust. Closure between floors is accomplished with the topping slab continuous across the vertical chase hole in the structural floor. Pipes are sleeved through this topping slab. The chase enclosure is thus free of fire rating restrictions, and horizontal branches may be taken off without closure interference.

ELECTRICAL AND COMMUNICATION A one-way in-topping conduit system is planned at alternate modules, 9' - 4" centers. This supplies power and communications services to any minimum occupied space. Electrical and telephone collection points are at the service cores.

LIGHTING The planning module of 4' - 8" x 7' - 0" is somewhat small for a fixture in each module. This is, however, a highly desirable architectural feature. For spaces other than office zones, diaphragms are specified only at partitions. In such spaces, 8' - 0" flourescent lamps and fixtures give highly economical lighting patterns. Special incandescent lamps and heavy flourescent lighting for high illumination can easily be adapted to the basic structural system.

ACOUSTICS The demand for reverberation-noise control is doubly insistent in an exposed concrete building. Floor carpeting and soft furnishings wherever possible are, of course, highly desirable. Wall carpeting as well is considered completely feasible. Ceiling absorbency is accomplished typically in classrooms and labs with exposed fiberglas duct with perforated metal covers. Office ceilings typically are acoustically transparent lenses with absorbent coffer panel back-up. Sound transmission security is obtained with partitions tight to the tee beam stems in the longitudinal direction. In the transverse direction, sound is stopped by tight diaphragms between the tees at partitions. In office areas, sound is stopped at the infill panel ceiling; the space between the tees is maintained as a free mechanical void.



BUILDING PLAN VARIATIONS

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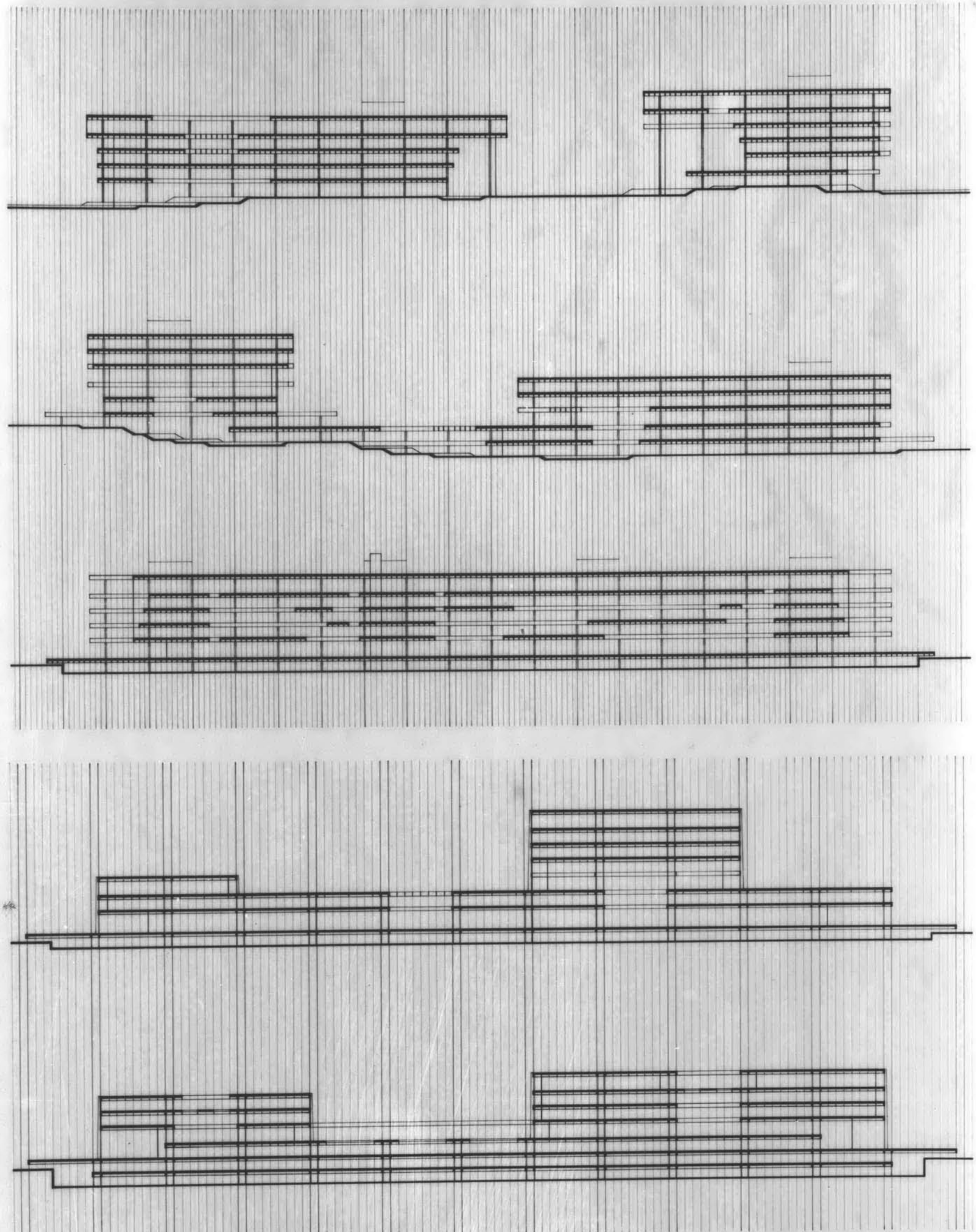

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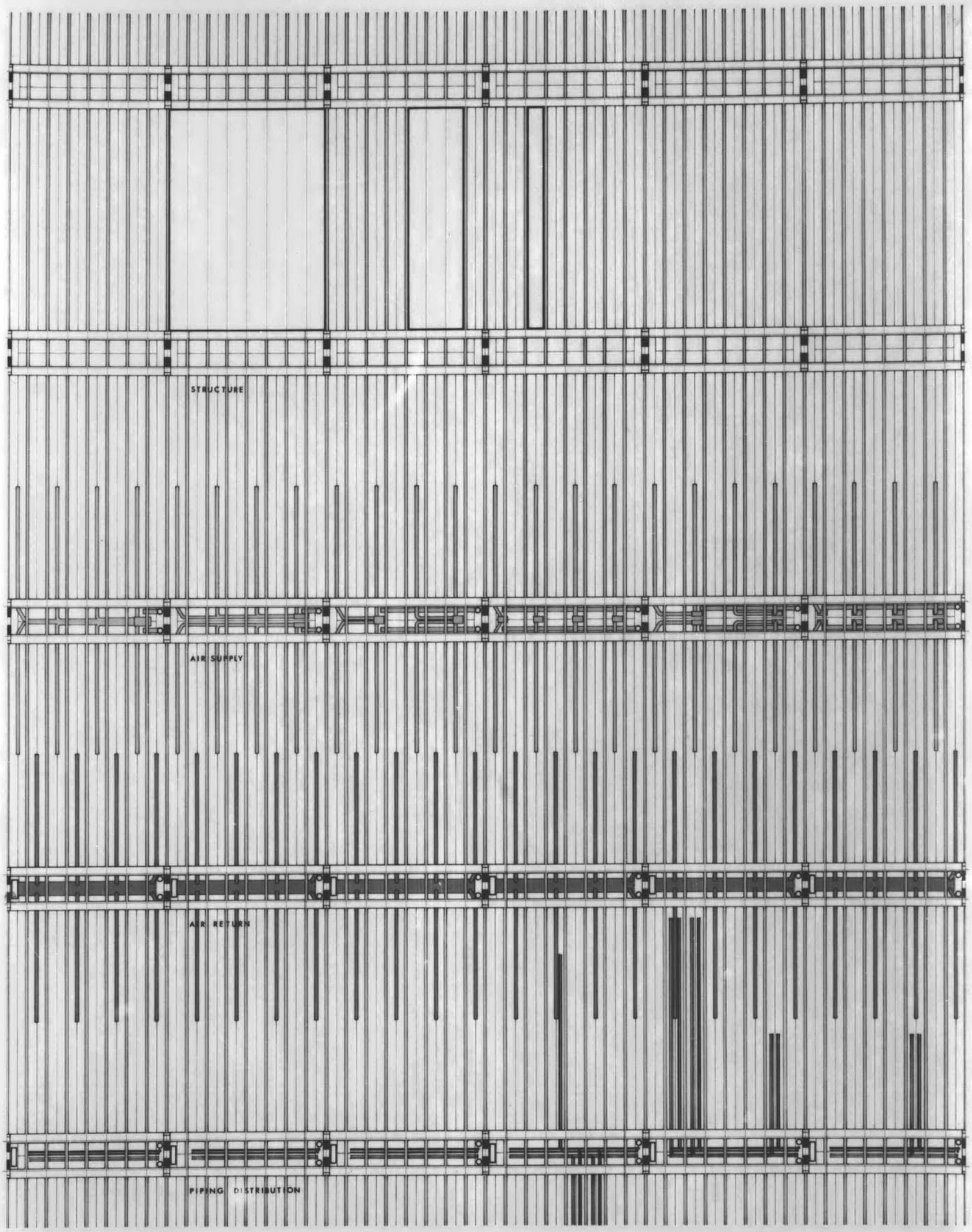

COMPONENT BUILDING SYSTEMS

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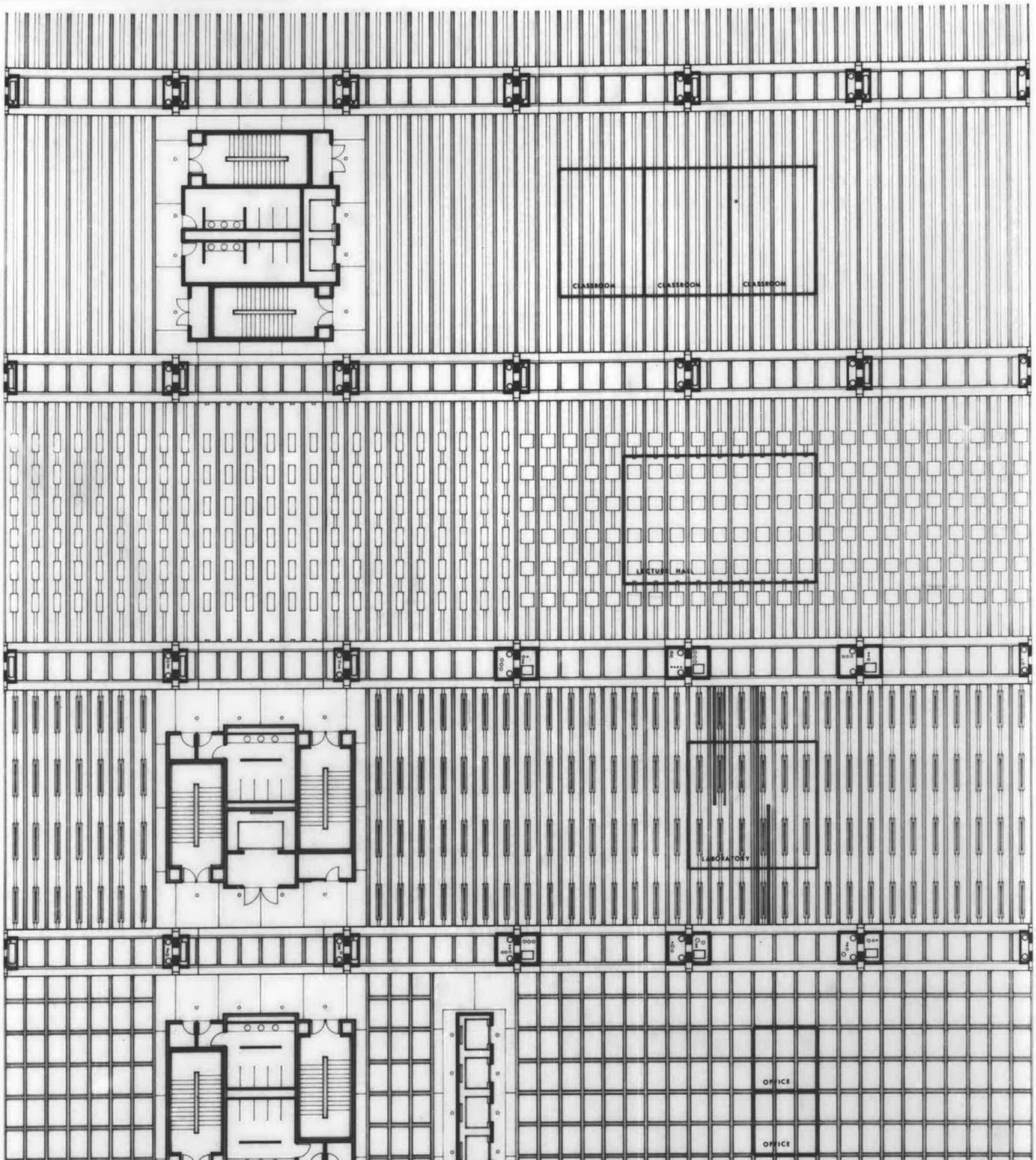

REFLECTED CEILING PLAN VARIATIONS

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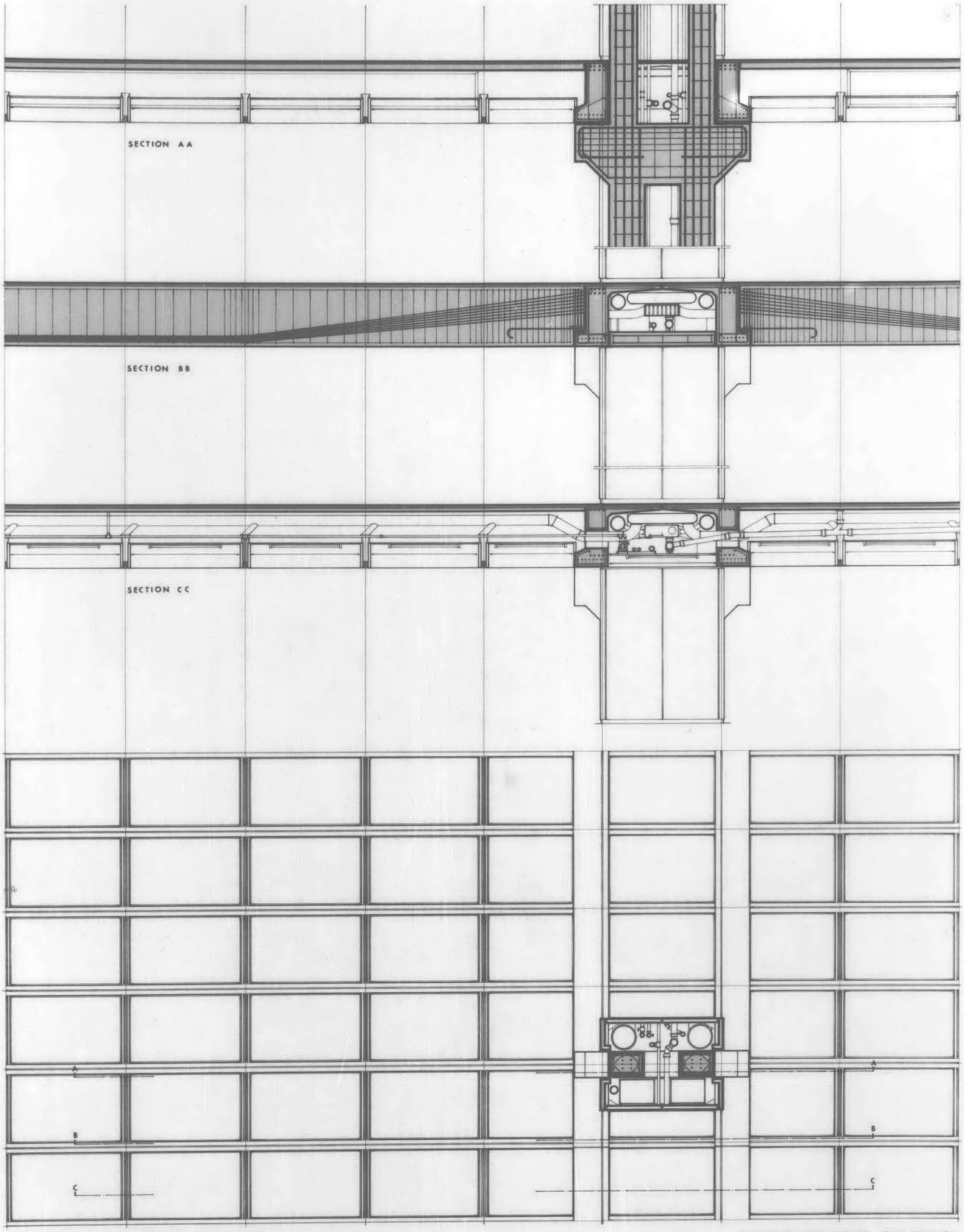

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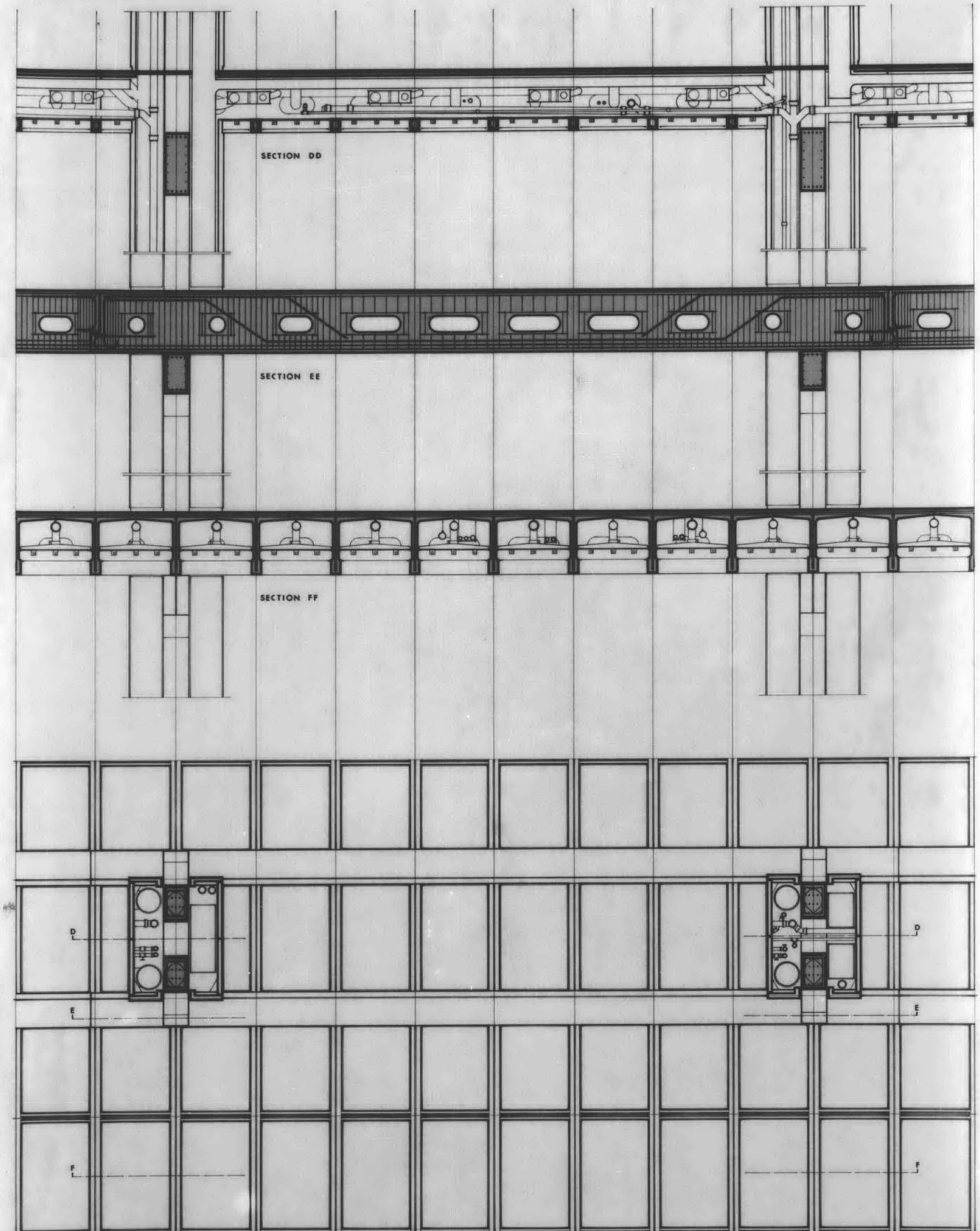

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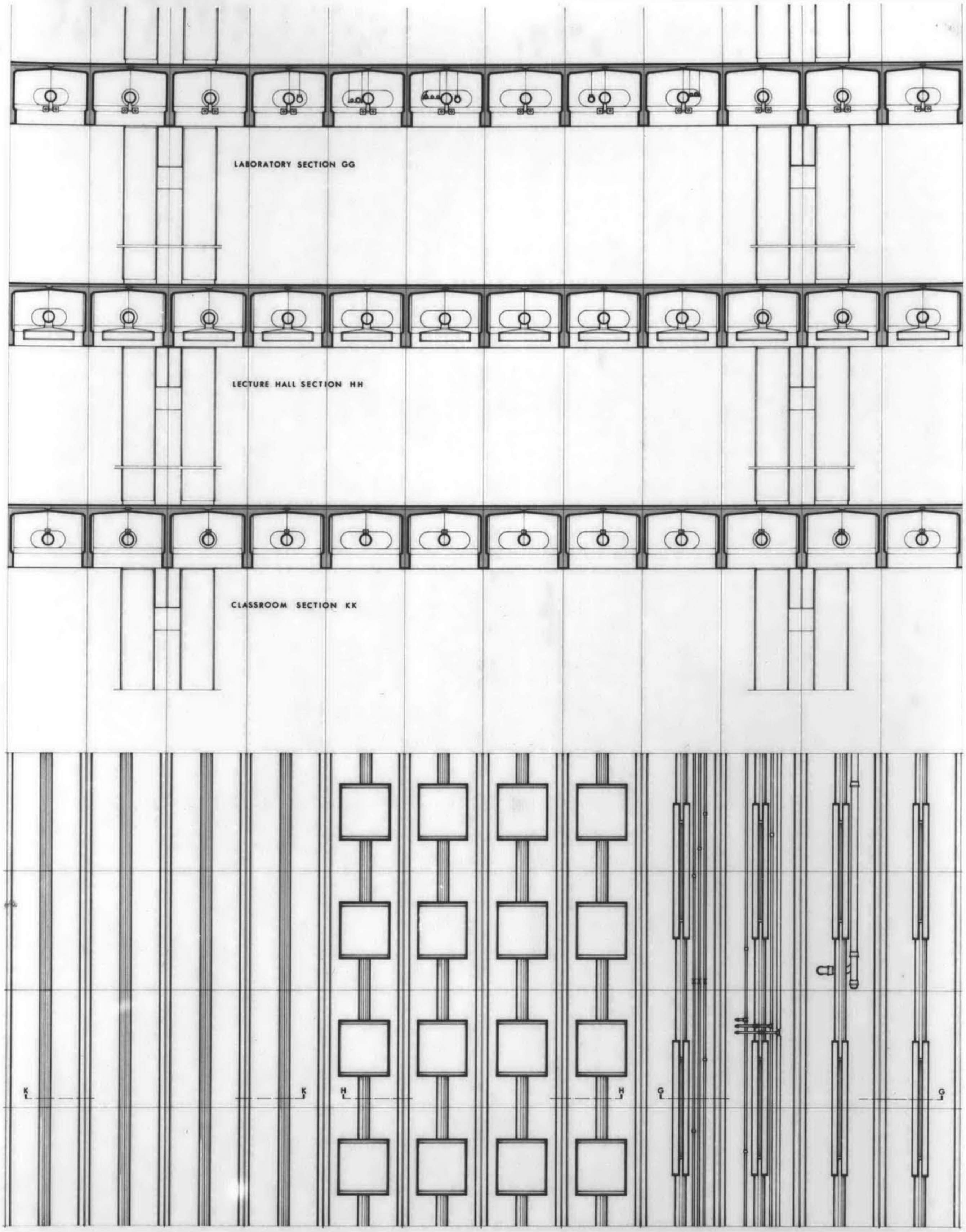

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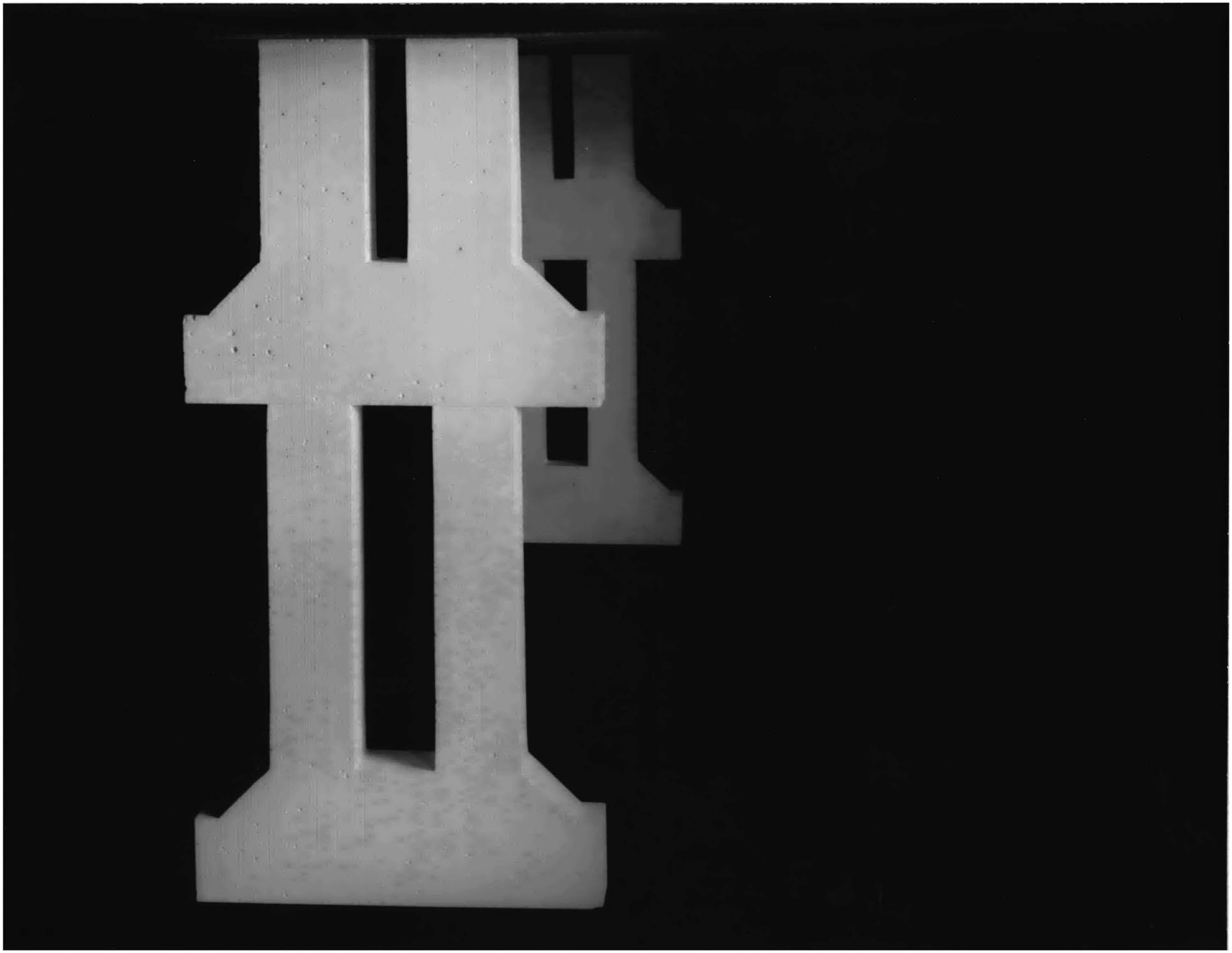
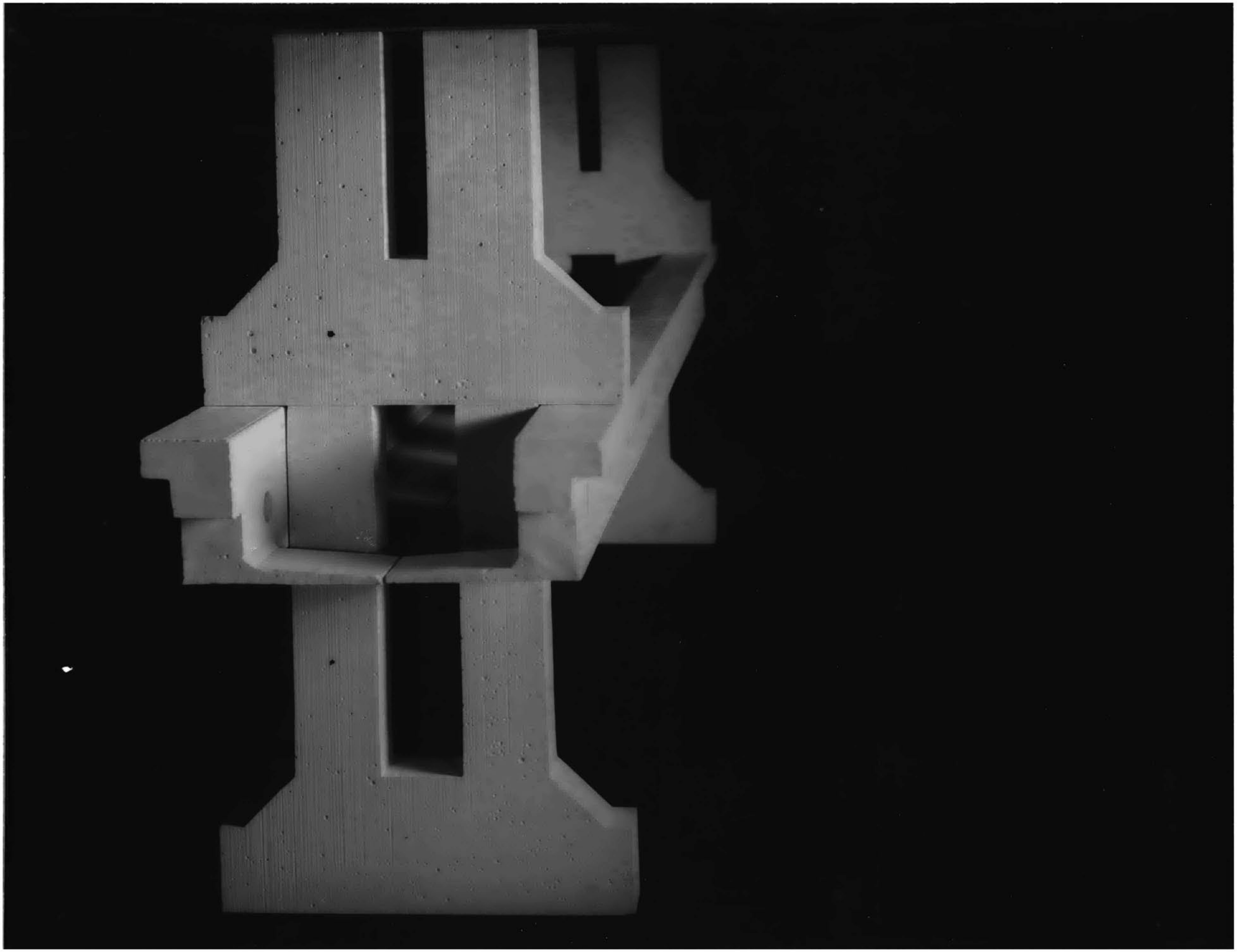
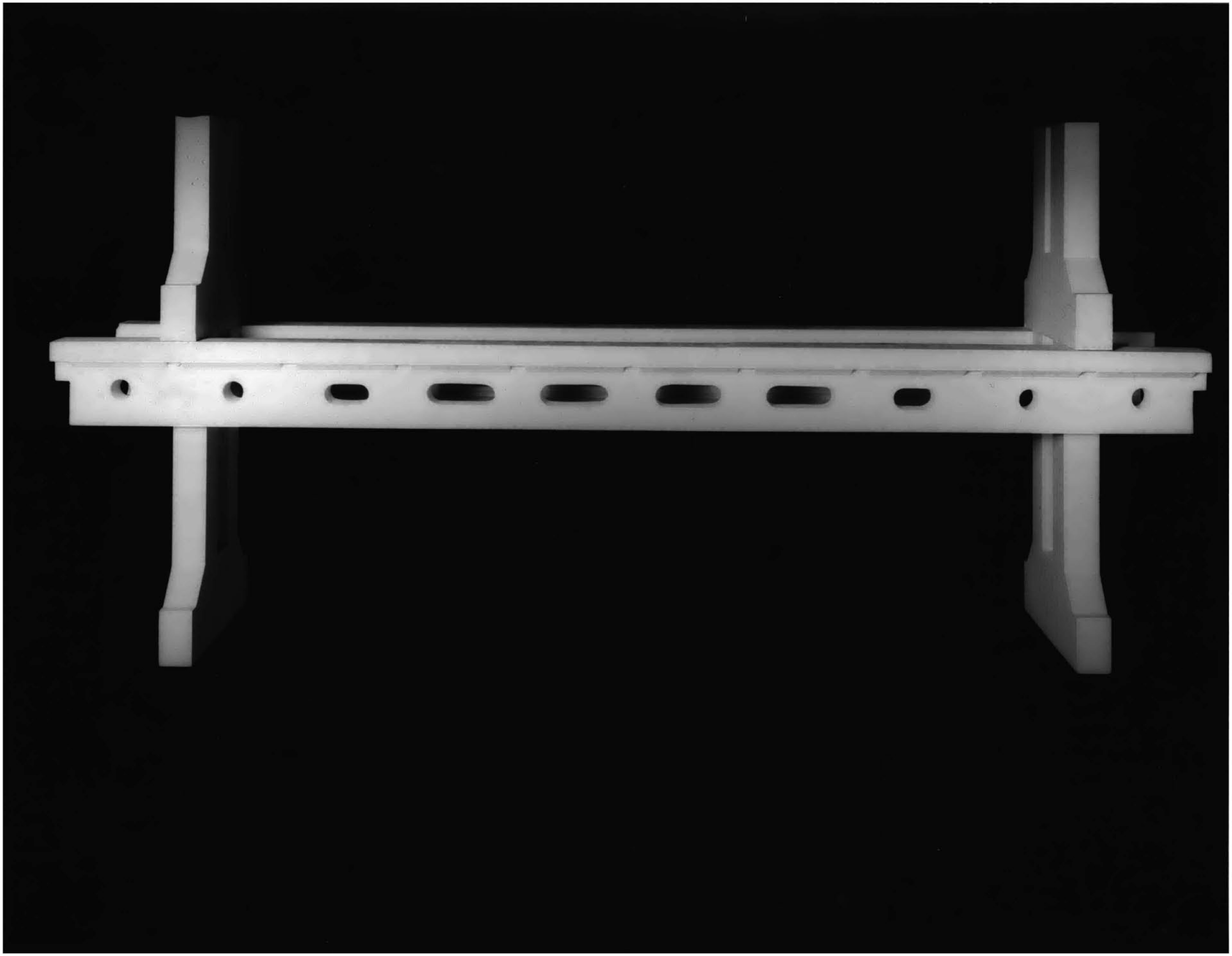
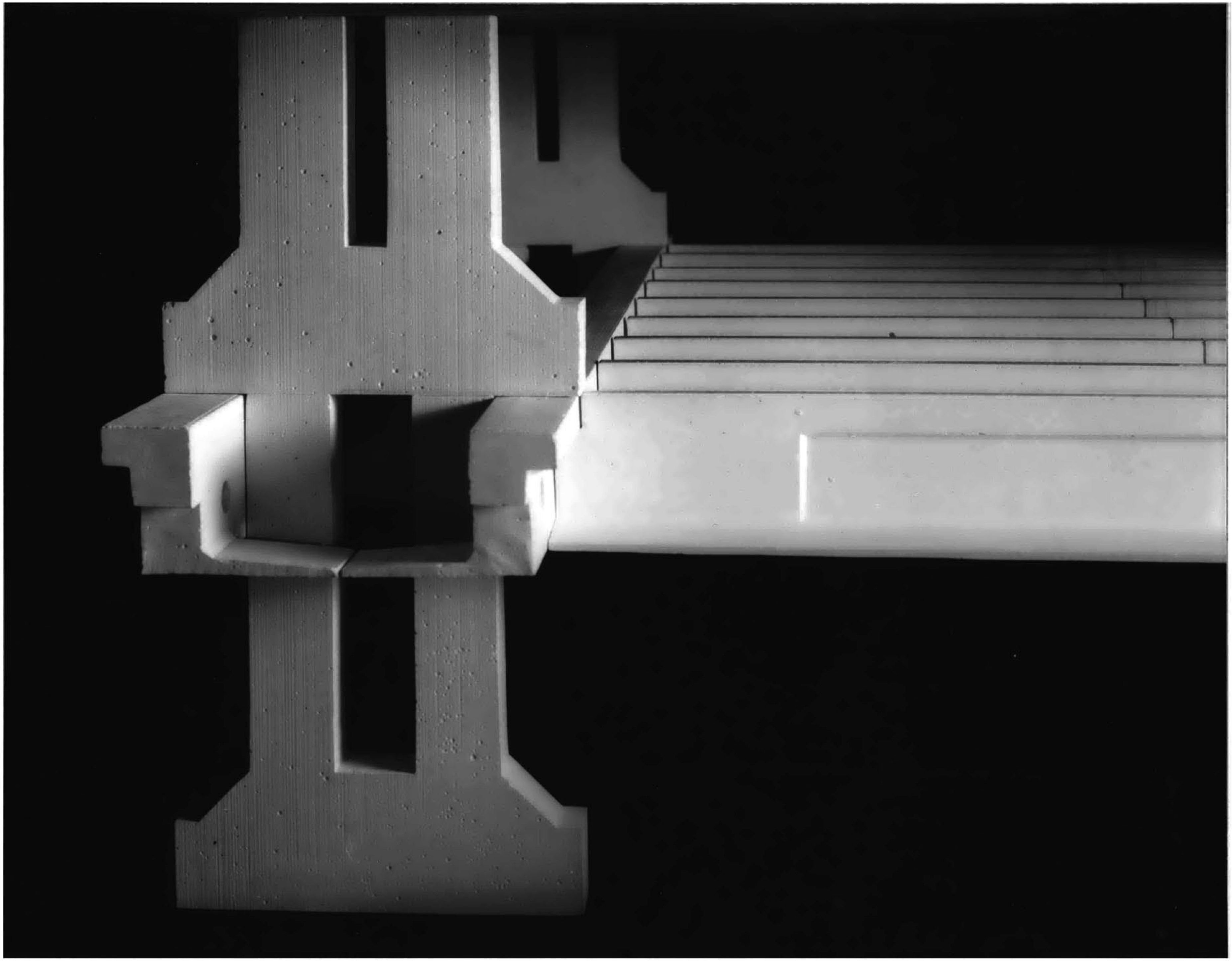








PART II

MASTER PLAN FOR AN URBAN UNIVERSITY

CONCEPT

THE PROBLEM HOST

Problems inherent in dropping an institution of this scale into any urban environment, healthy or otherwise, are mammoth. Where urban renewal is involved, elements of this scale have a way of stubbornly refusing to renew anything. The problems of revitalization, of land economics, of proper land use mix and density, of social relationships, of growth and retreat patterns; all of these in some way affect the design of the university. None can be safely ignored.

But the immediate problem is one of technological application of building systems to a new building scale. This is problem enough. For this reason, the more important relationships of university to community have been generalized, and fixed as design criteria. These involve land utilization, urban form, community involvement, and community revitalization. Prejudice may or may not be evident in these generalizations. They are of course by program related to a hypothetical urban renewal site in any Northeastern city, USA.

SITE UTILIZATION If the renewal area has any residual quality (and if it is near the city core it undoubtedly will) there will be residual worth to the land as well. Program acquisition of sixty-five contiguous acres under these conditions is most unlikely. Of the sixty-five acres, perhaps thirty will be required for first stage construction. Of the remaining acreage held for expansion it is essential that its use be maintained until the university is ready to build. Vacant lots help no one. A primary assumption in each of these generalizations is that activity and density are essential ingredients to community vitality. Assuming one hundred per cent expansion into the full sixty-five acre site, Floor Area Ratio stands at 3.2; density is no problem. Expansion beyond the year 2000 will undoubtedly take place in the same skip-block fashion.

URBAN FORM Density itself is here a dictator. It would be difficult to retreat to grass malls and hallowed walls of ivy. There is room for the ivy, but not for the grass. But beyond density, there is the question of appropriateness of form. Since generalizations have been ruled fair, it would seem that good urban form is that form which functions first as public space container. It bounds a narrow street, it fronts an open plaza. It capitalizes on spatial juxtaposition -- high to low, open to closed. Urban form is negative; the space it helps to contain is positive.

A university that respects the street and its vitality, and for the city creates plazas as meeting ground is commendable. The space held for the community should be the positive form, not the negative remains.

COMMUNITY INVOLVEMENT This is more a matter of spirit than of physical reality, but as a matter of spirit, it is crucial. The university must belong to the community.

Even with a piecemeal site, the university will inevitably operate on an institutional scale much larger than the local public library. It will probably close a few streets to cross traffic. It must give back to the community pedestrian streets through the university. If these ways are open, hospitable, and keyed to the public oriented activities of the university, they will do much to tie the university to the community. If the university is a continuation of the urban skein of pedestrian traffic -- complete with shops, shoe stores, and outdoor cafes -- it will be even finer. The university form, in as much as it is able to do so, must embrace the community, not turn in on itself. Site density is a benefit; there is little possibility of retreating behind a two-hundred foot grass barrier.

COMMUNITY REVITALIZATION The fact that the university site is a series of broken blocks is a blessing to revitalization, only lightly disguised. Whatever the disruption to university communications, a piecemeal site will stretch more easily the neighborhood web of streets and walkways without breaking it. That the web not be broken is essential. The critical dimension that breaks the web is open to debate, but there can be no argument for an institution that stops a neighborhood as a boundary. If it is to allow the web to function as a transmitter of life, the university must ride above it.

In a more positive sense, the university will undoubtedly assist revitalization simply by inducing more activity and mixed use in the area. Five thousand students will require housing and commercial services. If the university can as well be more than an eight-hour-a-day teaching laboratory, if with housing, shops, and dining it can sustain a steady cycle of activity at the pedestrian street level, it will be a rich focus for renewal.

PROGRAM

ABSTRACT

A hypothetical university in the North East United States has acquired title to sixty-five acres of urban renewal land near the heart of a major city. On this land it will build a new urban branch campus.

STUDENT LOAD

Facilities must be constructed immediately for the education of five thousand eight hundred students. The university anticipates an enrollment of twelve thousand by the year 2000.

EDUCATIONAL PROGRAM

The educational system is strongly oriented to science and technology. Methods of teaching are not atypical, but there is realistic recognition of the inevitability of change. For this reason there is no requirement for building definition of the individual departments. It is assumed that in the course of growth some departments will expand into adjacent space, while others will move to new quarters in later construction. The various academic departments are supported by a central library, student center services, a fifteen hundred seat auditorium, a six hundred seat theater, an eight thousand seat arena, athletic facilities, and administrative offices.

STAGING

The first stage detailed program will be financed and constructed as a single project. Planned expansion is set at one hundred per cent of the first stage, and is assumed incremental as need and financing dictate. The master plan must accommodate this expansion within the sixty-five acres now owned by the university.

SITE

The new university will be in a designated urban renewal area of mixed housing, commercial, and light industry. Land use density is high, with buildings averaging four to six stories. The site is essentially flat. The university has not been able to put together sixty-five contiguous acres. Most of the land is, however, on adjacent blocks. The city has approved the closing of a few streets within the gridiron system to ease planning for the first phase. Land marked for expansion will retain its original use until it is needed.

ABBREVIATED SPACE ALLOCATION

School of Science	507,000 square feet
School of Engineering	460,000
School of Humanities	121,000
School of Architecture and Planning	207,000
Central Library	222,000
University Museum	26,000
Auditorium	22,000
Theater	32,000
Arena	135,000
Athletic Facilities	150,000
Housing	1,487,000
Student Center	170,000
Administration	100,000
Covered Parking, 2400 Cars	750,000
Total Gross Area	4,589,000 square feet

SOLUTION

PROJECT DESCRIPTION Density is paramount. The first stage site is rectangular, about twenty-five acres, and bounded on all four sides by city streets. First stage construction on this site is 3.5 million square feet of educational, housing, and parking space, with an additional million square feet of housing on nearby blocks. All four street facades are regular and continue the space corridors formed by the surrounding four to six story buildings. The ground level and basement levels are given to parking and service. Construction with the building systems previously described goes to seven levels above grade. One large interior plaza steps up from ground level in the center of the site to the fifth level at either end. On the long sides, two more floors rise to the seventh level. Two dormitory towers of twenty-five and thirty-five stories stand free within this plaza. At either end of the site are open portal spaces around the theater and auditorium. All levels through the fifth are landscaped and open to outside circulation. Interior secondary spaces between elevator cores accent and give orientation to the loft space on either side of the plaza.

USE DISTRIBUTION The library, the arena, the auditorium, and the theater punctuate the ring of academic space on each side of the rectangle. They are by nature fixed elements oriented to the anchor plaza. The first stage academic departments -- science, engineering, architecture, and humanities -- are distributed about the ring through all levels. Physical education is adjacent to the arena. Both the student center and museum are decentralized, the student center to centers of activity generally at the lower levels, the museum to primary circulation points with displays related to adjacent disciplines. Administration is assigned upper level office space, and is not considered a fixed element. As mentioned before, twin dormitory towers stand free in the plaza. Other housing is provided in the community on nearby blocks. Shops leased and operated by the community are at ground level at entries and at the central plaza. Only the arena, the auditorium, the theater, and the towers use other than the basic structural-mechanical system.

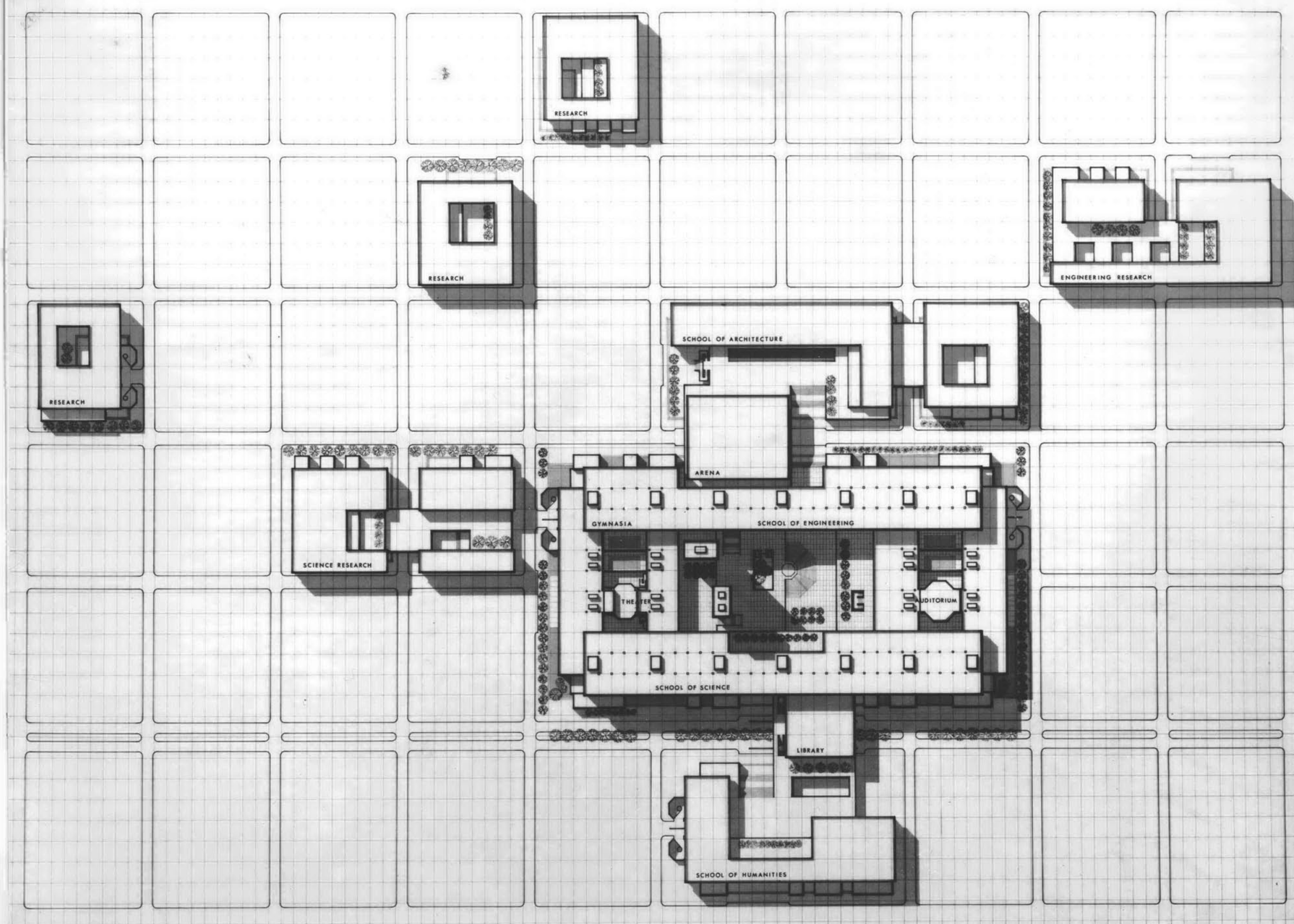
EXPANSION As a heart or anchor to the urban campus, the largest block has been put together for the first stage by closing several streets in the gridiron system. Later stages will occur on lesser block combinations, or on individual blocks. A radiating pattern from the first stage anchor is envisioned with skip block development. Bridges across roads are anticipated where blocks are adjacent.

Interior rearrangement of spaces and minor circulation is relatively simple. Only vertical circulation core walls are permanent. Though far more difficult, floor demolition for the creation of local voids is feasible. As the university grows, some departments will expand into neighboring space, others will move to new construction. The long span loft construction should ease these growing pains. With loft space of this nature which can be manipulated, however, it is essential that the university maintain a planning office to order the change.

VEHICULAR CIRCULATION A through service road runs the length of the building at ground level, and services both parking levels as well as shipping and receiving. Parking for approximately eight hundred cars, vehicle and building maintenance, central storage, and central kitchen are on the ground level. All mechanical equipment and an additional parking for sixteen hundred cars are on the basement level. Parking access to this lower level is by ramps at the service road at either end of the site. Light wells across either end of the site light both parking areas. There is in addition a light court in the central plaza allowing access direct to the lower parking. Since both the central plaza and the upper parking are at ground level, access is also direct. Passenger drop-off zones and street parking are provided on all four sides of the site.

PEDESTRIAN APPROACHES Pedestrian approaches are on each of the four sides. All are open into the central plaza. Each approach is defined by a primary public activity -- the primary approach by the library, secondary approaches around the arena, the theater, and the auditorium. Access from both parking levels is open to the central plaza. Normal circulation from parking, however, would be direct by elevator to working level. Pedestrian approach to the arena is from either the central plaza or the street on that side. Both the theater and the auditorium are oriented to the central plaza, but are easily accessible from the streets on their respective sides. All three can be approached by elevator from both parking levels.

CIRCULATORY SYSTEMS Primary circulation streets at each level are continuous single loaded rings open to the central plaza. Secondary corridors are oriented to vertical circulation cores. Vertical cores are placed at regular intervals. Primary elevators are ranged along either side at each core and serve all floors. Paired elevators at either end of the campus serve the auditorium and the theater. Primary orientation is always to the central plaza, with secondary orientation to interior two story spaces between elevator cores. High traffic cafeterias, lecture halls, and large classrooms are generally at the first level with lower usage offices, seminar rooms and laboratories at upper levels.



UNIVERSITY MASTER PLAN YEAR 2000

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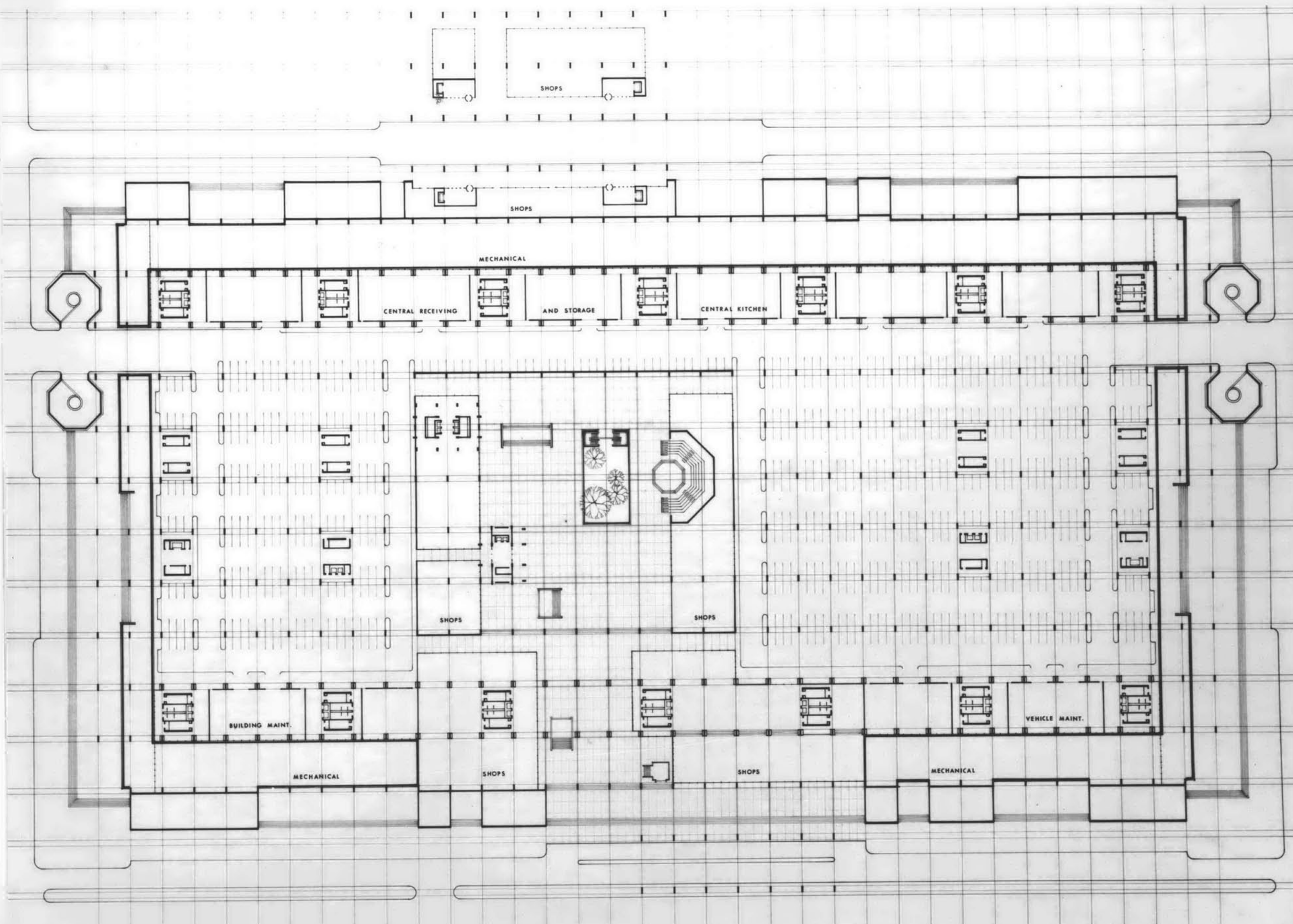

FIRST PHASE GROUND LEVEL PLAN

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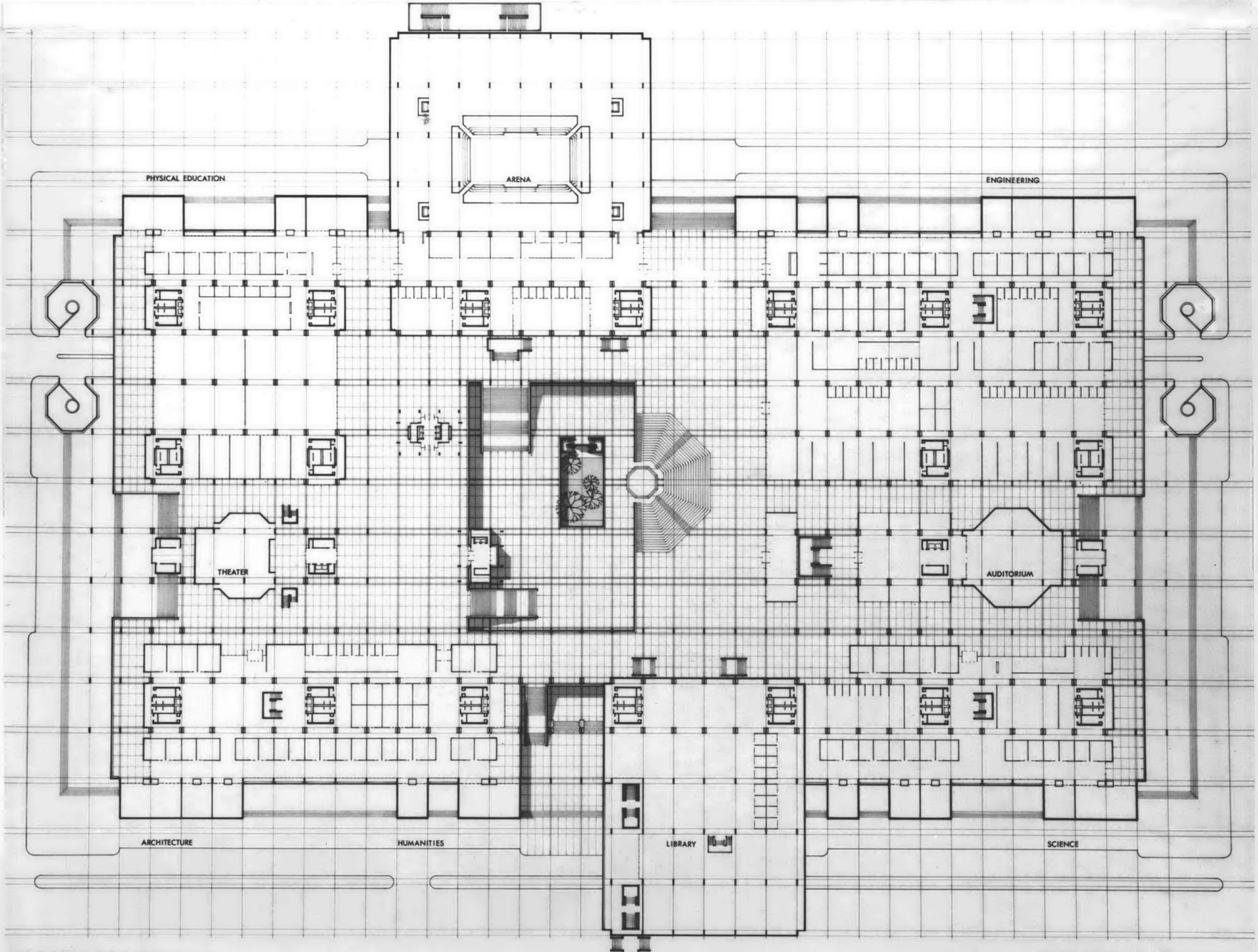

FIRST PHASE FIRST LEVEL PLAN

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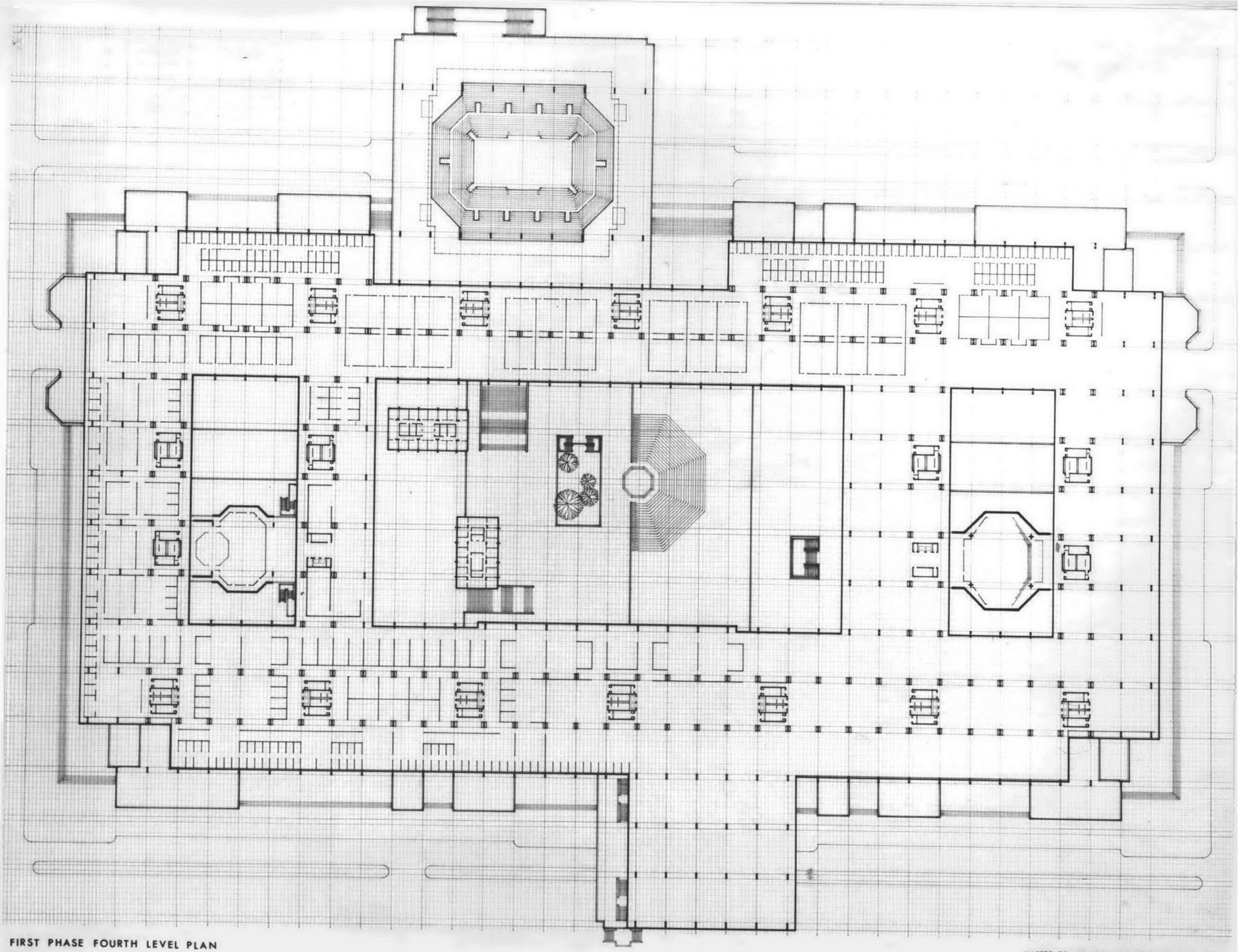

FIRST PHASE FOURTH LEVEL PLAN

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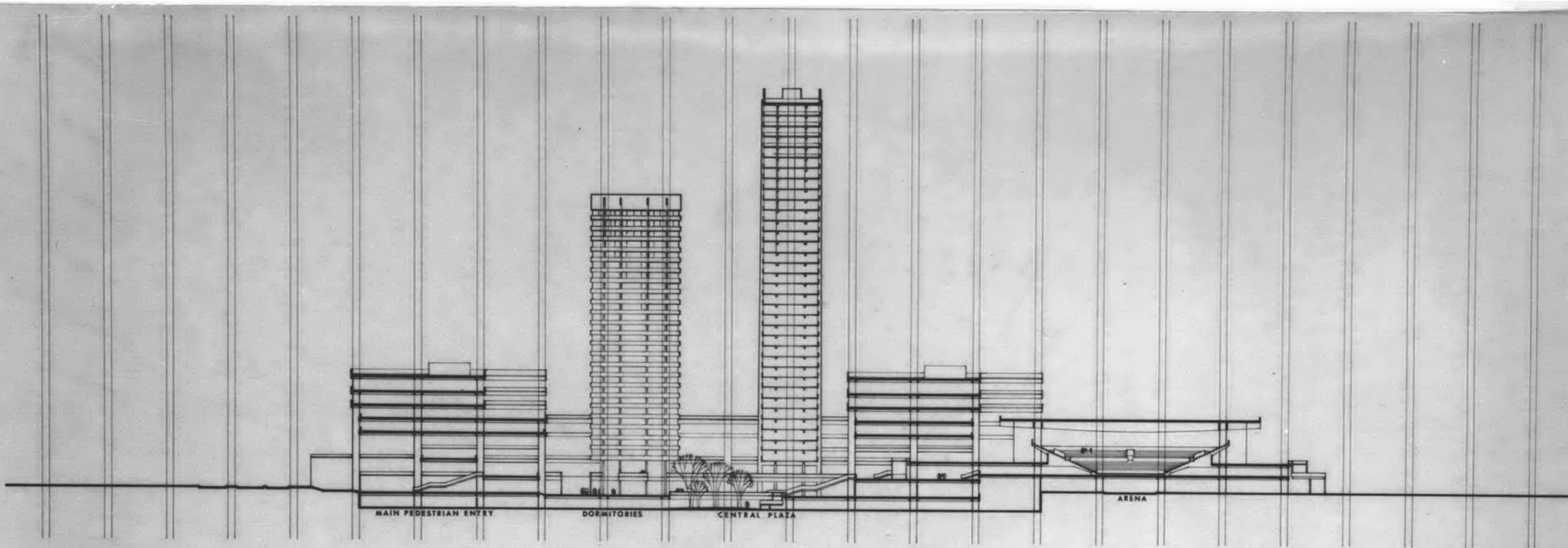

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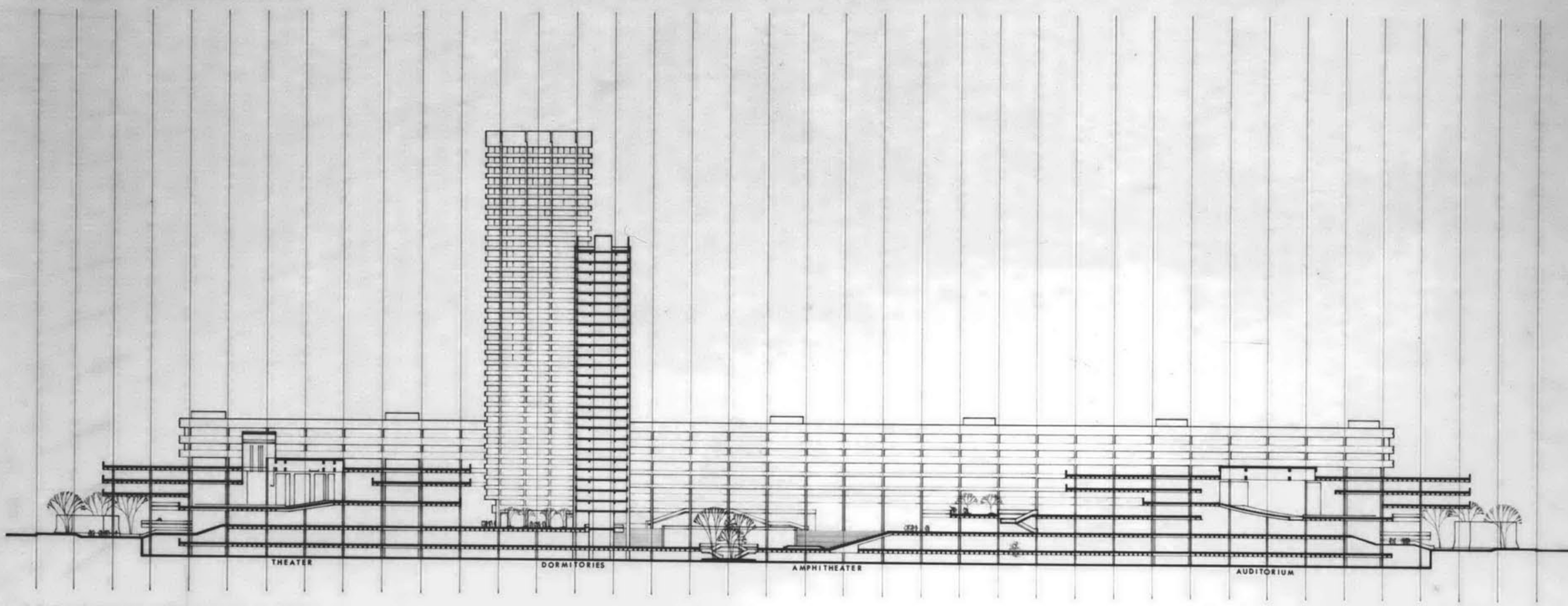

FIRST PHASE LONGTITUDINAL SECTION

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