



A STEEL STRUCTURAL SYSTEM FOR A
LABORATORY RESEARCH CENTRE

by

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Dip.Arch., Welsh School of Architecture
Cardiff, Great Britain.
(1964)

SUBMITTED IN PARTIAL FULFILLMENT
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TECHNOLOGY

June 1965

Signature of Author
Department of Architecture, June 15, 1965

Certified by

Accepted by

88, Bay State Road,

Boston,

Massachusetts.

June 15th. 1965.

Pietro Belluschi,

The Dean,

The School of Architecture and

City Planning,

Massachusetts Institute of Technology,

Cambridge, Massachusetts.

Dear Dean Belluschi,

I hereby submit my thesis, "A Steel
Structural System for a Laboratory Research Centre", in
partial fulfillment of the requirements for the degree of
Master of Architecture.

Yours sincerely,



David Kenneth Davies.

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I would like to acknowledge the fact that I have been fortunate enough to study in the Graduate year and glean so much that will be of great use to me during my career as a practicing architect.

I would like to thank the following members of the faculty of architecture for their help during my thesis preparation.

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Mr. Waclaw Zalewski.

Professor Grossier.

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OBJECTS OF THE THESIS :

The object of the thesis has been to investigate the requirements necessary to design a large laboratory research centre. The following requirements were found to be the most important and this report and the accompanying drawings are testament as to how successfully this has been achieved.

The most important part of any modern building is its organic framework of structure and servicing. No building can possibly function in a logical manner unless a clarity of structure, construction and servicing has been aimed for and achieved by the designer. In my design I have aimed at creating a simple steel structure in terms of its components and erection, with freedom within its whole to allow the utilities to be positioned and maintained with the least difficulty.

Once the designer has adopted his modular grid and structural type, a logical way of grouping these elements into a self-sufficient unit must be found. The important part of this unit is the core, which contains all the necessary toilet facilities, main ducts and vertical circulation. These self-sufficient units can be adopted as an element of growth and pieced together to form a complex, or fashioned into a part of a specially designed building. However, whether as in the case of this thesis where a building has been designed,

the building should contain a recognizable growth element within its framework and be able to grow using these elements when expansion becomes necessary.

Whatever approach the designer takes in fashioning the clients requirements one thing remains of prior importance. The building is to satisfy a need, the need will require a logical volume and the volume will require proper technical consideration so that its users can function correctly and so satisfy the original need.

BUILDINGS AS SYSTEMS :

Throughout the history of civilized man there is clear evidence to show that when man attempts to create anything of importance, be this a form of government or a method of construction, a logical system is followed. Many examples are to be found in the highest and lowest civilizations of an attempt to organize and provide systems of building, engineering and production that are governed by the available technology, materials and manpower.

Celtic settlements on the Northern coasts of Britain show evidence of a growth system which in principle is very near to the animal world. Just as a colony of seals will huddle on a beach for protection, so the individual units of these settlements form a large cluster. Expansion was taken care of simply by adding on another unit to the mass. The system has its logic, because such an organic mass gave each unit and its pedestrian links protection from the sea storms and with the help of earth insulation was warmer to live in than a conventional settlement of isolated units.

The Minoan civilization in Crete developed systems of building, civil and structural engineering, which in terms of flexibility and servicing remained unsurpassed for many centuries after this civilization collapsed. The Palace of Minos at Knossos, like many other Cretan buildings, was much

altered and extended throughout its history and excavations have shown that many parts of the complex were designed to have vertical and horizontal flexibility. This not only allowed the building to alter over the centuries but also produced a very free and rich massing.

Many civilizations display similar examples of an anti-formalist approach to building but all are governed in their attempt to further their systems by the lack of a developed technology. Until the 19th. century and the advent of the machine and the development of the new structural materials of iron, steel and reinforced concrete, the scope of building had been restricted by the size of its components, its erection techniques and the cost of its construction in time of erection and production of its elements. With the advent of steam and the turbine, the constructor became less dependent on the simple laws of mechanics and manpower to lift large components. The new factories could manufacture a much larger range of prefabricated components, which led to the attempt of bolder and more imaginative buildings. The first evidence of the new technique of prefabrication is to be seen in the work of James Bogardus, who designed many schemes in cast iron. His notable creation was a design for the New York Worlds Fair of 1853, which consisted of numerous cast iron panels which he claimed could be used for a housing scheme when the fair buildings were dismantled. Prefabrication is the attempt of modern building

technology to increase productivity and to bring rationalization to the building site. Since the days of Bogardus, men like Walter Gropius, Jean Prouve and many architects in Great Britain, the U.S.A., the U.S.S.R., France and Scandinavia have achieved buildings completely prefabricated in the factory from raw materials to final assembly.

With the introduction of prefabrication and the aim of industrial manufacture, the demands on the building industry have risen. The traditional methods of architectural thought and design are no longer sufficient, it is essential today to transfer the methods of applied science and systems and industrial engineering to architecture. Not only must the architect retain his hereditary title of artist and designer, he must assume the position of co-ordinator in the industry and assimilate the knowledge and techniques that our modern technology can offer. However, his task must not be the passive acceptance and application of the modern technology, he must educate himself and then lead and even dictate industry into producing the most logical solutions for the new Systems of Building. As heralded by the Industrial Revolution and the coming of the machine, our industry must be geared to satisfy the demands of our civilization. Our civilization needs a logical solution to its demands and this can only come from an attitude which looks for the basic answers to problems and not merely for contrived custom made solutions.

SYSTEM DESIGN IN BUILDING :

Modern architecture appears to be a collection of artistically unassimilated technology. To make technology responsible for this situation is just as wrong as denying its importance, or still worse humanizing it by applying decoration. All these responses are futile except the desire to get at the true technology, without pursuing too many abstract investigations.

The modern architect must have the understanding of technical form as this presupposes technical knowledge -" Mere intuition is not enough " However, structural forms cannot simply be computed, they must be designed, as the relationships between structure and form are too complex for the result to be expressible in numbers alone. The decay of structural form is not necessarily always accompanied by technical dishonesty, it can also result from frivolous modifications. The architect of today and of the future must realise the significance of technology, its pre-eminent position as a form-determining element, uncorrupted and without concessions in the direction of formalism.

Architecture of today, like systems engineering, must use known techniques and principals but must be capable of controlling the entire range of scientific, engineering and business specialities to plan and design systems.

A SYSTEM is a set of objects with relationships between the objects and between their attributes. Objects are the parts or components of a system. Relationships can be casual, logical or random and tie the system together. The decision as to which relationships are important is up to the designer. An organized creative technology refers to unified procedures that lie between basic research and the operations of manufacture and construction. Most of these procedures are understood, however, the least known element is that of SYSTEMS ENGINEERING.

Building technology consists of five functions :

1. Research.
2. Systems Engineering.
3. Development.
4. Manufacture.
5. Construction.

Systems Engineering considers new knowledge, plans and participates in projects and programmes them to their final application. It also provides management with information needed to guide and control the over-all programme and thus acts as the link between research and business.

Increasing complexity in systems can be sensed from the growing number of interactions between the members of our expanding society, the use of machines over manual labour

consequently resulting in a rise in productivity, and the increasing speed and volume of communications and transportation. Increasing complexity is perhaps the cause, or the effect of man's effort to cope with his expanding environment. However, large and complex systems tie our society together and it is the architects responsibility to be aware of them and able to use them correctly.

These systems have increased the need for planning and also for long-range development. Today the combined Building Industry of architects, contractors and managers is attempting to train a type of systems personnel by associating together in teams. However, achieving a good mixture of available talent is no solution and a larger supply of individuals with a better blend of qualities is needed. Also required is research on the best types and amounts of talent to blend for the different kinds of work to be done. This task must be taken up by the Institutes of Advanced Technology, who must offer a kind of training which creates keen and active minds.

The new architecture will be not only concerned with the components that make up a system but with the concept of the system as a whole, its internal relationships and its behavior in the given environment.

THE BUILDING AS A SYSTEM :

A contemporary building contains many systems to allow it to function efficiently and satisfy the purpose for which it was designed. However, the buildings of today and the future, though they must be designed for a particular need, must also be designed so that they can be adapted to meet other requirements should the original need become obsolete. To fulfill this adaptability a building must contain a definite blue-print of systems, with some of these being more important than others.

Building Systems :

1. Space flexibility system.
2. Structure.
3. Circulation.
4. Electrical.
5. Communications.
6. Air Conditioning.
7. Artificial lighting.
8. Utilities.

These are divided into two categories :

1. Permanent.
2. Temporary.

1. The Permanent systems are those which are required in any contemporary building regardless of the

specific function.

2. The Temporary systems are those which are required to meet specific requirements. In this thesis the laboratory accommodation and its special utility requirements should not be permanent. This will probably be reorganized and added to many times during the life of the building and eventually may be replaced by a completely different type of accommodation. The temporary systems consist of the following utility supplies needed for any research activity :

1. Direct air and exhaust.
2. Special temperature control.
3. Piped gasses.
4. Additional electric power.
5. Space for new utilities to meet new requirements.

The utility systems must be easily accessible without interference to the structure. Horizontal utilities in the floor must not interfere with partitions and are therefore confined to the structural depth. Partitions must be able to be moved with no interference. Wet utilities will need short runs of straight pipe, especially the drains from laboratory sinks, to overcome maintenance problems. The Structural grid that I have adopted is a 50 foot module between column centres. Using this grid pipes need not be more than 25 feet long from the centre of the structural bay to the column supply duct. All the drain, rain water and laboratory

utility pipes are in the columns, which rise from a sub-basement system of service tunnels. The columns extend to the roof for exhaust purposes.

Space flexibility system :

1. The basic module of 5 ft. has been adopted.
2. The smallest unit using this module is a 10 ft. by 10 ft. space and is the minimum desirable space for this type of dual laboratory and office activity. All corridors are 10 ft. wide.
3. Using the 5 ft. module any room size is obtainable to suit the requirements of the known function.

Circulation :

The circulation of any building can be one of the following two systems :

1. Lineal.
2. Multidirectional.

Although there are many arguments in favour of creating a lineal spine system, I have adopted a multidirectional system. This design would form the first stage of a large laboratory complex, therefore it deserves some identity as the central point from which future circulation patterns can grow. The building form is a large square with a central court. At the four corners of the inner boundary, adjacent to the court, are the personnel cores containing all vertical

circulation. Personnel entering the building, from the car parking level or the pedestrian level, would first pass through a police check point and then take the elevators to their respective floors. At each floor a main corridor extends around the inner boundry of the building, adjoining minor corridors and the main accommodation.

THE CORE UNIT :

Throughout the structural layout continuity and bracing is provided by the beam and column system. The core units have not been considered as contributing elements towards the structural system, however, their presence will give a certain amount of stability. The core units have been designed within the dimensions of the removable lattice infill area in each bay . They are of two types :

1. Personnel Core Type :

Each floor in the building is approximately 200,000 sq. ft. for the use of 750 people. Four personnel cores each serve an area of 50,000 sq. ft. and provide facilities for 200 people. They contain the following accommodation :

2 passenger elevators - 5 ft. by 7 ft.

1 fire stair.

Mens toilet : 3 urinals.

4 w.c's.

3 lavs.

Womans toilet : 4 w.c's.

3 lavs.

Ducts, with maintenance access area, for ventilation, electric and telephone services.

A janitor's room is provided in one of the duct areas.

2. Service Core Type :

Two service cores serve each floor and contain the following accommodation :

1. freight elevator - 8 ft. by 12 ft.

1. fire stair.

1. freight and maintenance room.

1. janitors room.

Ducts, with maintenance access area, for ventilation, electric and telephone services.

The twocore types contain all the permanent systems and accommodation required for this building to function in an efficient manner. No matter what might happen in the future, even if the building is completely gutted, all the necessary main utility ducts and personnel facilities remain intact.

During the preliminary stages of design I decided to divide the utilities into two categories and distribute these between the core ducts and the columns. The permanent utilities were placed in the core :

1. Ventilation.

2. Electrical.

3. Communications.

The temporary utilities, or those that might be repositioned or replaced many times during the life of the building were placed in the columns :

1. Sink waste pipes.

2. Utility pipes for gases and liquids.

3. Space for new utilities.

THE MECHANICAL SYSTEM :

The building has been considered as a completely sealed volume relying on mechanically introduced air for health and heating and cooling purposes. Opening windows have not been provided for every day use, however, certain casements would be provided for emergency use only.

The Mechanical System :

The system is divided into two parts :

1. The interior of the building is served by a Low Velocity system.

2. The exterior of the building is served by a High Velocity Induction system. This high velocity air system consists of an under cill unit which has heating and cooling elements to condition the air to the required temperature.

Temperature Zones :

1. Considering the building vertically, with its maximum height of 5 floors. No division into vertical zones has been made.

2. Considering the building at each floor. The six core units each contain two duct areas. Each personnel core has two duct areas which contain supply and return low velocity ducts and one area has a high velocity duct for the induction system. Each service core has two duct areas which contain supply and return low velocity ducts and high velocity ducts for the induction system.

Each floor has been divided into 5 zones :

1. The interior of the building as a whole is served by a uniformly controlled low velocity system from the main core ducts.

2. The exterior of the building is divided into 4 zones and is served by a high velocity induction system which is controlled to compensate the climatic conditions at each facade. The service cores, each with its two high velocity ducts, serves one facade and two personnel cores, each with its one high velocity duct, serves one facade.

Supply and Return Air Ratios :

1. Low Velocity system for the interior zone :

Total area served : 182,000 sq. ft.

12 ducts, each serves area of : 15,000 sq. ft.

Duct size for supply and

return at each floor : 30 sq. ft.

Max. duct to serve 5 floors : 150 sq. ft.

Each main supply and return duct is 20 ft by 7 ft. 6 in at each floor.

2. High Velocity system for the exterior zone :

Total area served : 18,000 sq. ft.

8 ducts, each serves area of : 2,250 sq. ft.

Duct size for supply at each

floor : 2.25 sq. ft.

Max. duct to serve 5 floors : 11.25 sq. ft.

Each supply duct is 3 ft. 9 ins. by 3 ft. at each floor.

THREE DIMENSIONAL SYSTEMS :

Apart from certain exceptions, such as the domes of the Middle East and the Mediteranean, architectural history up to recent times contains no examples of buildings in which three-dimensional rigidity has been made the essence of the design. This is what is both new and typical about modern space structures, the internal order and form are essentially the result of their three-dimensional action.

The plane truss is not much used by modern architects, however, Mies van der Rohe's design for a theater in Mannheim is one of the few examples exploiting the truss as an element in an architectural design. Parallel truss systems are more commonly used in steel design to cover large halls, and lighter versions of this system called open web joists are used to span small distances for roofs and floor structures. Much research and development has been carried on by many County Councils and the Education Authority in Britain to achieve low cost, easilly erected prefabricated school buildings. However, here as in many other examples the truss system is either exposed externally, or restricted internally to two storey buildings and therefore simplifies the fireproofing problems which bedevils these systems. It is for this reason that the system is confined to low buildings, the structure being boxed in with a fireproof floor and cieling system as it is aesthetically unpleasing and expensive

to attempt to fireproof the members by any existing applied method.

During the 19th. century, the beginning of the structural steel era, much use was made of truss and parallel truss systems by such men as Eiffel, Paxton and Jenney. In the twenties German engineers designed a number of cylindrical steel lamellar frames which supported the falsework for reinforced concrete shells. Nervi has also employed similar systems. Fuller anticipated that space frames could be used to span large areas with a structure of minimum weight.

During the second quarter of the 20th. century many space truss systems have been devised :

(1) The Mannesman System of tubular scaffolding is based on the use of arbitrary lengths of tubing of standard diameter, connected at any angle by means of clamps. There is no limit to the number of pieces that can be effectively clamped together, it is thus possible to develop very organic structures with this system.

(2) The Mero System has a limited number of members which screw into spherical connectors. The resulting structural forms are characterised by a severe geometric regularity.

(3) The Unistrut System uses prefabricated light bent plate parts and has been developed for permanent rather than temporary construction. The connectors are specially

formed plates and all joints are bolted. Pyramidical broadening of the column heads is typical of this class of structure due to the difficulty of concentrating the forces at the supports.

(4) Konrad Wachsmann developed an easily erected prefabricated, tubular system for building cantilevered hangers of enormous size. The structure was to be easily dismantled for re-erection at another site. In the direction of the main span the top and bottom chords are continuous tubes to which the diagonals are joined by means of ring connectors.

OBJECTS OF THE STRUCTURAL THESIS :

The objects of the structural thesis have been to design a flexible steel system, with the aim of achieving simplicity in structural components and erection techniques. A structural solution has been designed using the following criteria :

1. Provision of a solution using a minimum of component types.
2. Provision of vertical flexibility within the structural bay, yet retaining continuity throughout the structural layout.
3. Easy erection.
4. Provision of freedom within the structural depth for utilities to run unobstructed.

The above criteria have been satisfied by :

(1). Components :

The structural bay consists of three main units :

1. The column, square in plan, is made up of four 12 inch square braced box stanchions spaced 3ft. 6 inches face to face. This column unit would be assembled in the factory, welded complete with all its braces, beam supports and then delivered to the site in one-storey sections. The lower end of each 12 inch square box stanchion would be cut precisely and given an inner sleeve. When the column unit is placed on

the previously positioned unit, the sleeve effects a union between stanchions which is then site welded to form a joint.

2. The structural bay is defined by four prismatic lattice beam units which run from column to column. These units together with the columns form the continuous structure. Each beam unit is made up of two inclined lattice components which are bolted together on site. The lower chords of the unit are welded to the column and the top chords of the four beam units at all columns are welded together to give continuity.

3. The bay infill area is formed of a removable two-way lattice system. During erection linear inclined lattice trusses are first laid between beam units and then chorded to form a two-way system.

(2) Expansion :

Vertical flexibility is provided at any point in the system by the removal of the two-way infill area in each bay. The core units are located within these removable areas. It has been assumed that vertical expansion, for the installation of equipment and laboratory testing, is a part of the design brief.

(3) Erection :

Erection is in five main stages :

1. The column units are positioned and welded.
2. The lattice prismatic beam units are located

and welded to the columns. When each column has its complement of four beam units, the top chords are welded together with a splice member to give continuity to the structure.

3. Inclined lattice trusses are laid between two beam units, adjusted for tolerance and then site bolted. Where their top and bottom chords ajoin the beam units, these connections are site welded.

4. This linear lattice infill is then bottom chorded with a continuous channel member and top chorded with a metal folded plate membrane, to convert it into a two-way space truss system. The channel and folded plate components are welded to the lattice truss units.

5. A concrete slab is then cast on top of the metal folded plate.

(4) Utilities :

When erection has been completed the system in section resembles a space truss. Into each down facing pyramidical volume is placed a fireproof ceiling sheel which incorporates the lighting and ventilation fixtures.

Similar pyramidical volumes are formed in the floor slab face of the system which run in a grid pattern and are unobstructed throughout the structural layout. Into these grid duct areas are placed the main vetilation ducts, drainage and supply pipes. There is also a space left above each fireproof ceiling shell to allow minor ducts to run to

difusers and for supply pipes and conduits to run to outlets and light fixtures.

The structural depth I have adopted is 4 ft. 0 ins. and the horizontal grid is 5 ft. 0 ins. on centre. This depth allows a main ventilation duct 2 ft. 5 ins. by 1 ft. 5 ins. which serves 4,000 sq. ft., to run freely through the structure and gives adequate allowance for other ducts and pipes to pass between it and the top surface of the fireproof ceiling shells.

THE BEHAVIOUR OF THE STRUCTURE :

Types of behaviour :

1. When longitudinal elements of relatively small cross section act as separate members, without any unifying connections, their rigidity and carrying capacity is very small.

2. When two longitudinal elements, in different levels, are joined together by a web to form a truss, the carrying capacity of such a system increases multifold. The transmission of the loads occurs in the direction of the span of these trusses. The planes of the trusses may be vertical or inclined.

3. When vertical trusses are joined together by means of diagonal chords, perpendicular to the truss, a two-way system is obtained.

4. When the trusses are joined together in an inclined manner, as in my design solution, they form a folded plate system. A more homogenous structure is then obtained by adding a perpendicular system of lower and upper chords, thus forming a two-way system.

5. In this case the structure behaves like a homogenous slab due to the perpendicular direction of the chords and also the two additional diagonal directions of the webs.

The structure that I have developed is a three dimensional " Truss - Flat Slab " system giving a two-way load dispersal. During the first stage of erection linear inclined truss units are laid between prismatic truss beams. The second stage consists of the linear trusses being rigidly connected by a metal folded plate top chord and a continuous channel bottom chord.

FIREPROOFING :

The type of structure that I have designed by the nature of its material, steel, though more economic to construct and erect than concrete, has not the built in fireproofing of a concrete system. It is therefore a rather discouraging fact that once the structure has been engineered it must be covered up by a fireproof membrane. However, I have attempted to do this by means of coffered panels which retain the feeling of the pyramidal two-way structure.

These panels consist of a two process casting. The first casting is a rigid asbestos profile onto which is placed a second casting of a fireproofing and acoustically absorbant material. The two layers are rigidly bonded together. This fireproof ceiling shell contains the lighting units and the air diffusers and extracts, these are concealed behind a translucent panel.

The construction problems in fireproofing this type of structure are governed by the following building requirements :

1. The maximum height of the structure .
2. The type of occupation or process.

The higher a building goes and the more hazardous its occupancy becomes, the more fire resistant a structure must become to fulfill the stipulations of the Building Codes.

The problem is to satisfy these requirements without losing

the economic advantages that this type of structure has over its non-combustible competitor, concrete. A steel structure of this type can be less than half the cost of a similar concrete system, to fulfill the same purpose.

To attempt to fireproof this type of system by applying a fireproofing material to the structural members is costly and difficult. If this approach is considered, then it would be more efficient to go over to reinforced concrete. This decision would have to be made if the structure exceeds five storeys, or is classified as having hazardous occupancy.

To try to overcome the difficulty of applying fireproofing, by enclosing the structure between a thick floor slab and homogenous hung ceiling, is again denying the structure its economic advantage and its expression. Again in this instance the adoption of a concrete system would be more efficient from the point of view of construction and would allow the utility area to be maintained without damaging the system.

The simplest solution, in terms of design, cost and access to the utility area, is the adoption of ceiling panels. This type of fireproofing realizes the fact that the structure will be limited in its height and only allows a possible 3 hours fire resistance. However, using this type of fireproof membrane the cost of the entire system is kept on a competitive basis with concrete, the construction problems are minimised

and easy access to the utility area is maintained.

The panel system that I have adopted is positioned by means of screws, to plates fastened onto the underside of the structural bottom chord. Before the panels are positioned a continuous asbestos channel member is secured to the fixing plates. The panels lip into this member and thus a closed joint is effected.

CONCLUSIONS :

" There can be no architecture without a technology to translate architectural concepts into physical reality". 1.

" Technology has always influenced building forms and architects of every age have derived inspiration from the technical mastery of materials. The Parthenon and the Gothic Cathedral are both essentially ultimate refinements of a particular technique ". 1.

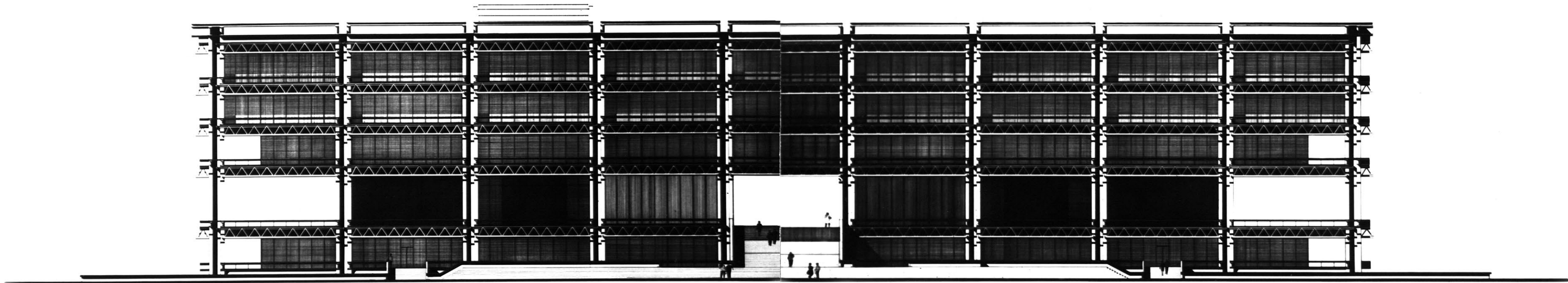
"Design is the essential purpose of engineering. It begins with the recognition of an need and the conception of an idea to meet the need. It proceeds with the definition of the problem, continues through a programme of directed research and development and leads to the construction and evaluation of a prototype. It concludes with the effective multiplication and distribution of a product or system so that the original need may be met wherever it exists ". 2.

Curt Siegle. 1.

Morris Asimow. 2.

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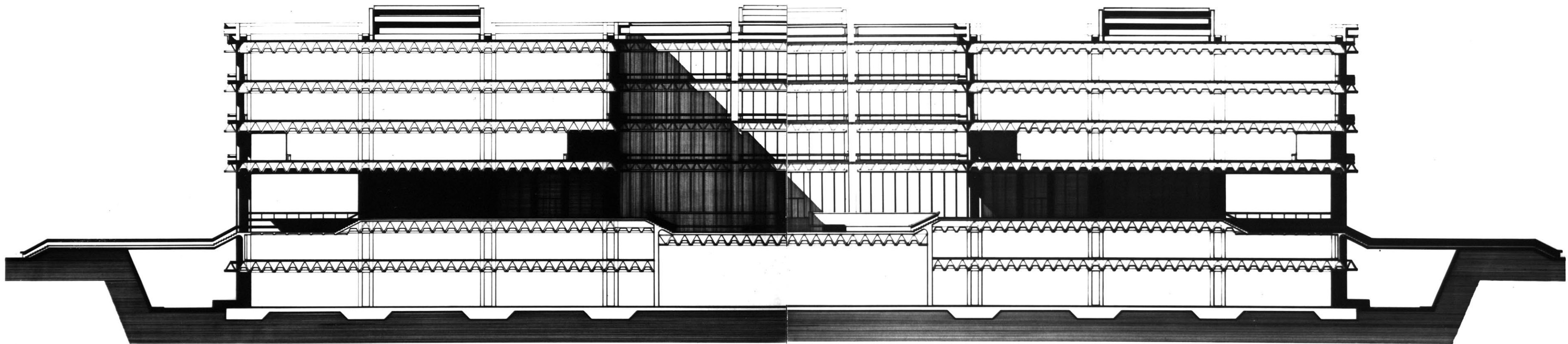
TYPICAL MAIN ELEVATION

NO. 20102 - 20101

scale: 8ft. to 1ins.

LABORATORY RESEARCH CENTRE

DESIGNED BY ARTHUR LOOS
CONSTRUCTED FOR THE UNIVERSITY OF CALIFORNIA - BERKELEY



MAIN SECTION

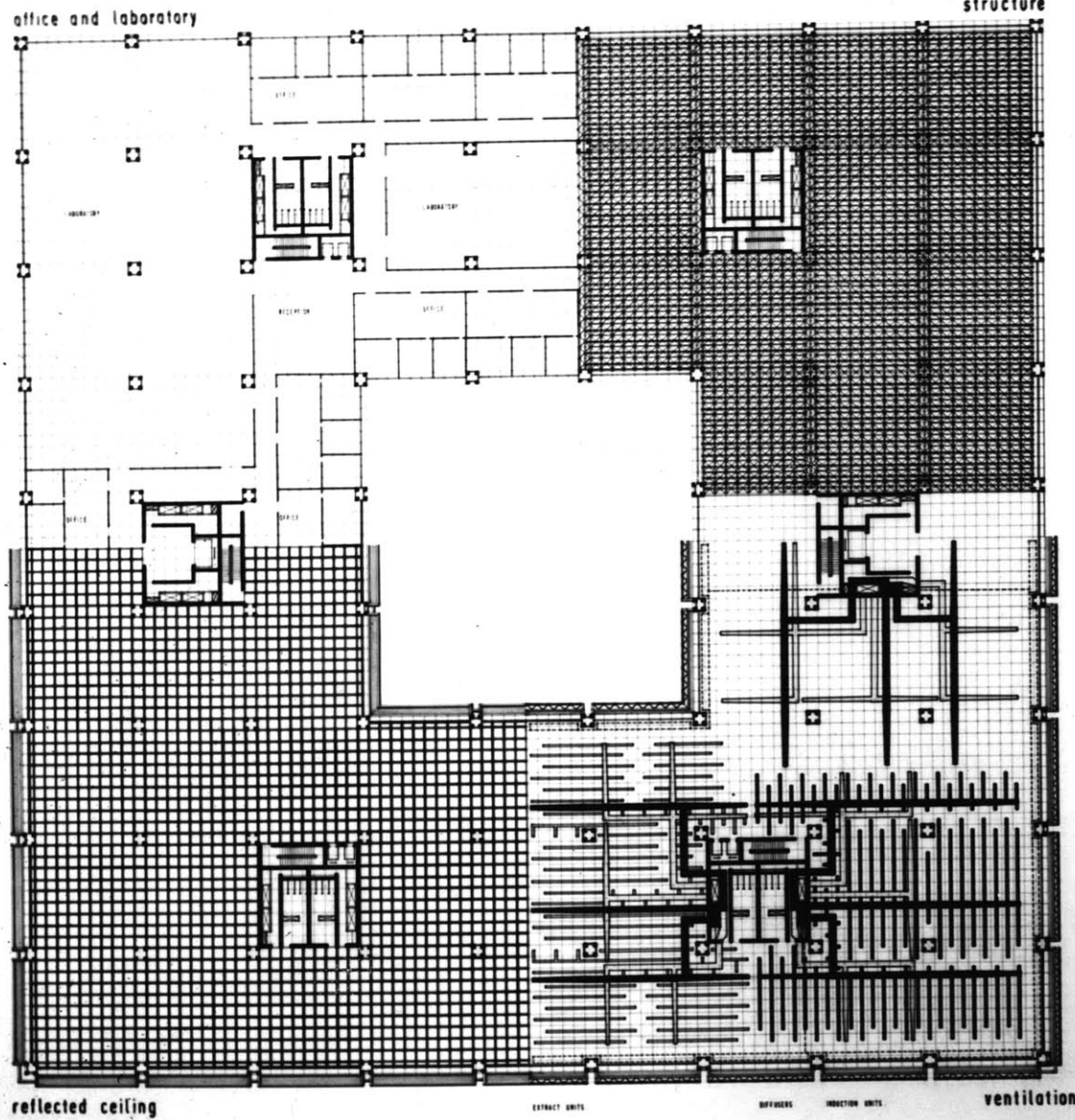
63.20000.00.000

scale - 8ft. to 1 in.



LABORATORY RESEARCH CENTRE

8.4.00000.00.000
SUBMITTED FOR THE RECORDS OF ARCHITECTURE - JUNE 1963



office and laboratory

structure

reflected ceiling

EXTRACT UNITS

DIFFUSERS

INJECTION UNITS

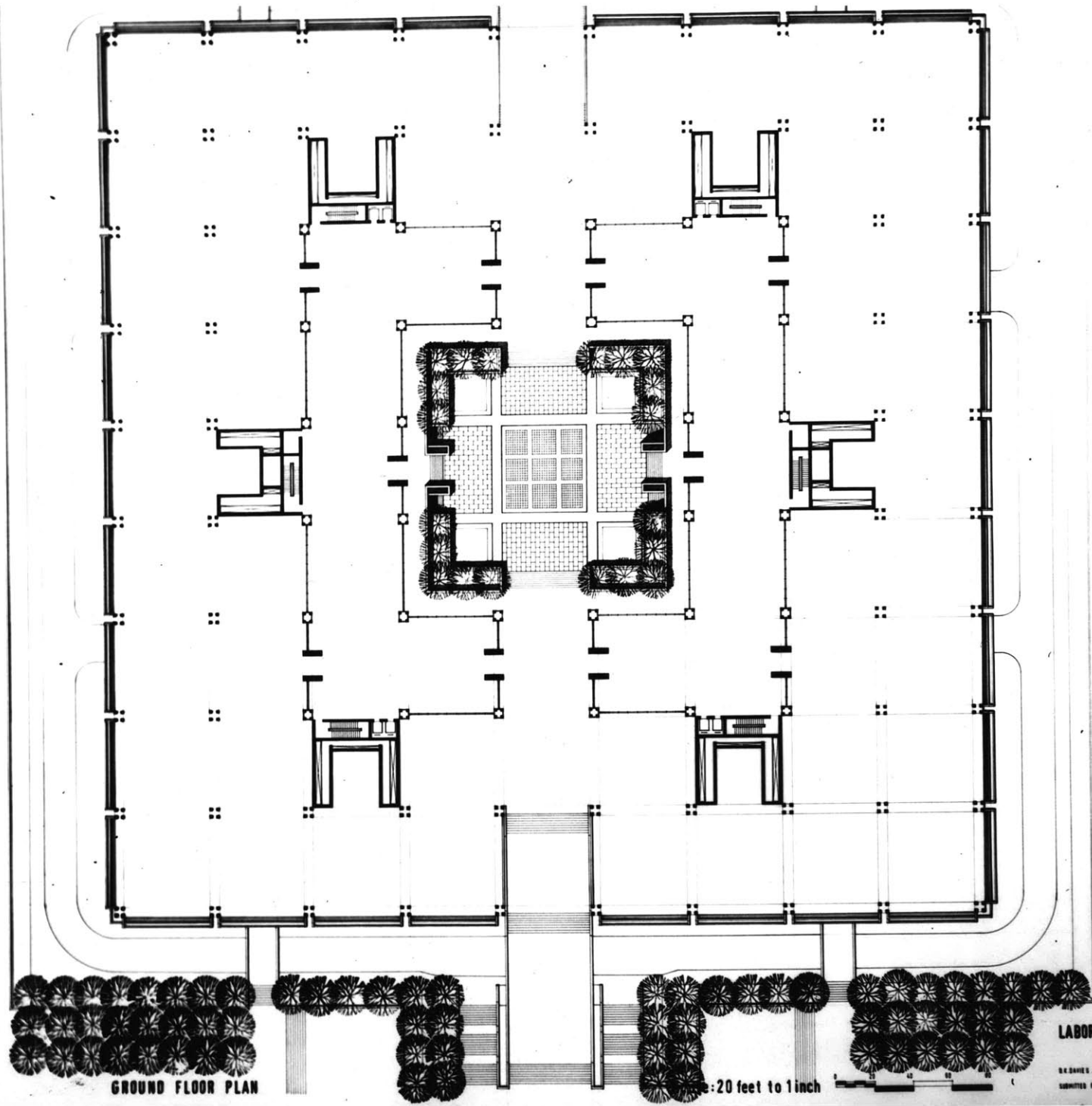
ventilation

TYPICAL FLOOR PLAN

scale: 20 feet to 1 inch

LABORATORY RESEARCH CENTRE

S. S. DUFFY, SVP, ARCH.
 SUBMITTED FOR THE BOARD OF TRUSTEES BY ARCHITECTS - 1950

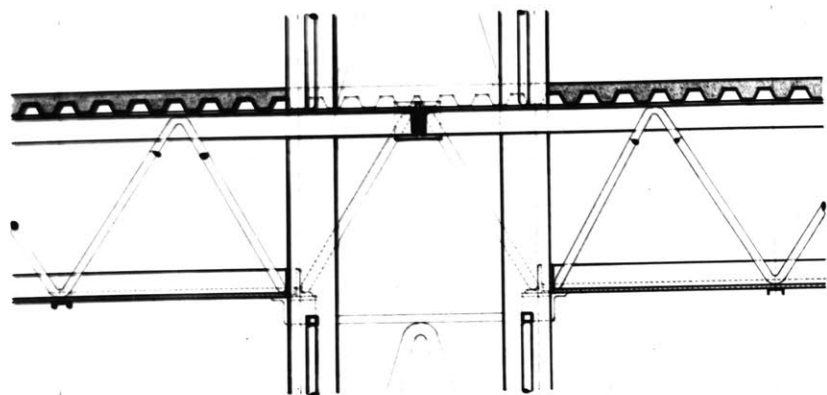


GROUND FLOOR PLAN

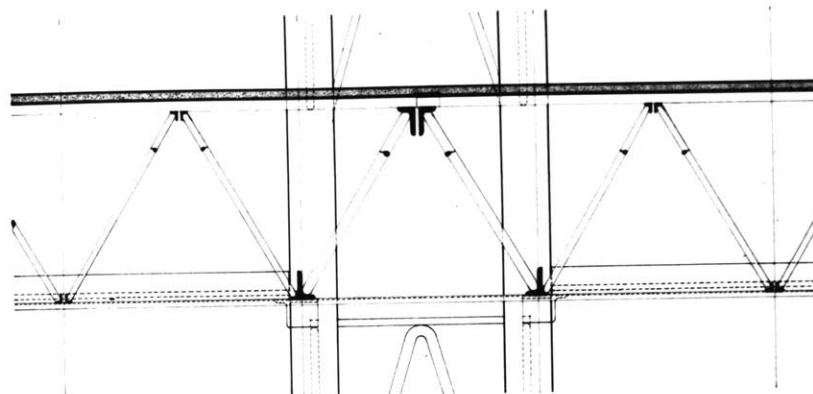
:20 feet to 1 inch

LABORATORY RESEARCH CENTRE

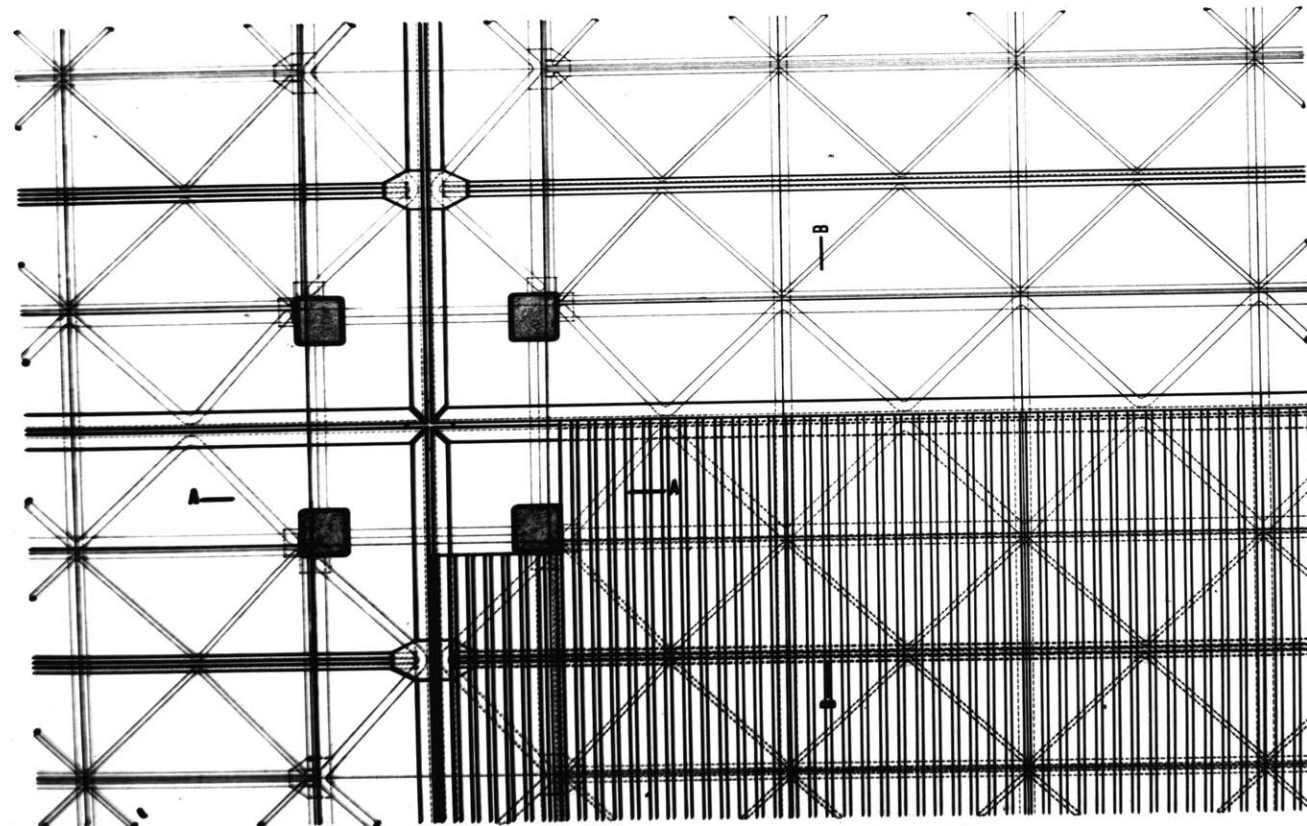
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section through column - A



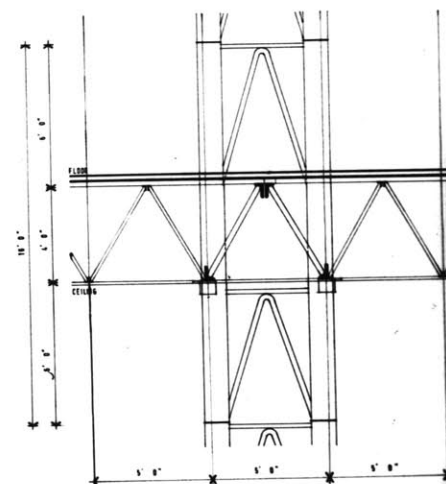
section through beam - B



STRUCTURE - plan of column, beam and infill units.

folded plate.

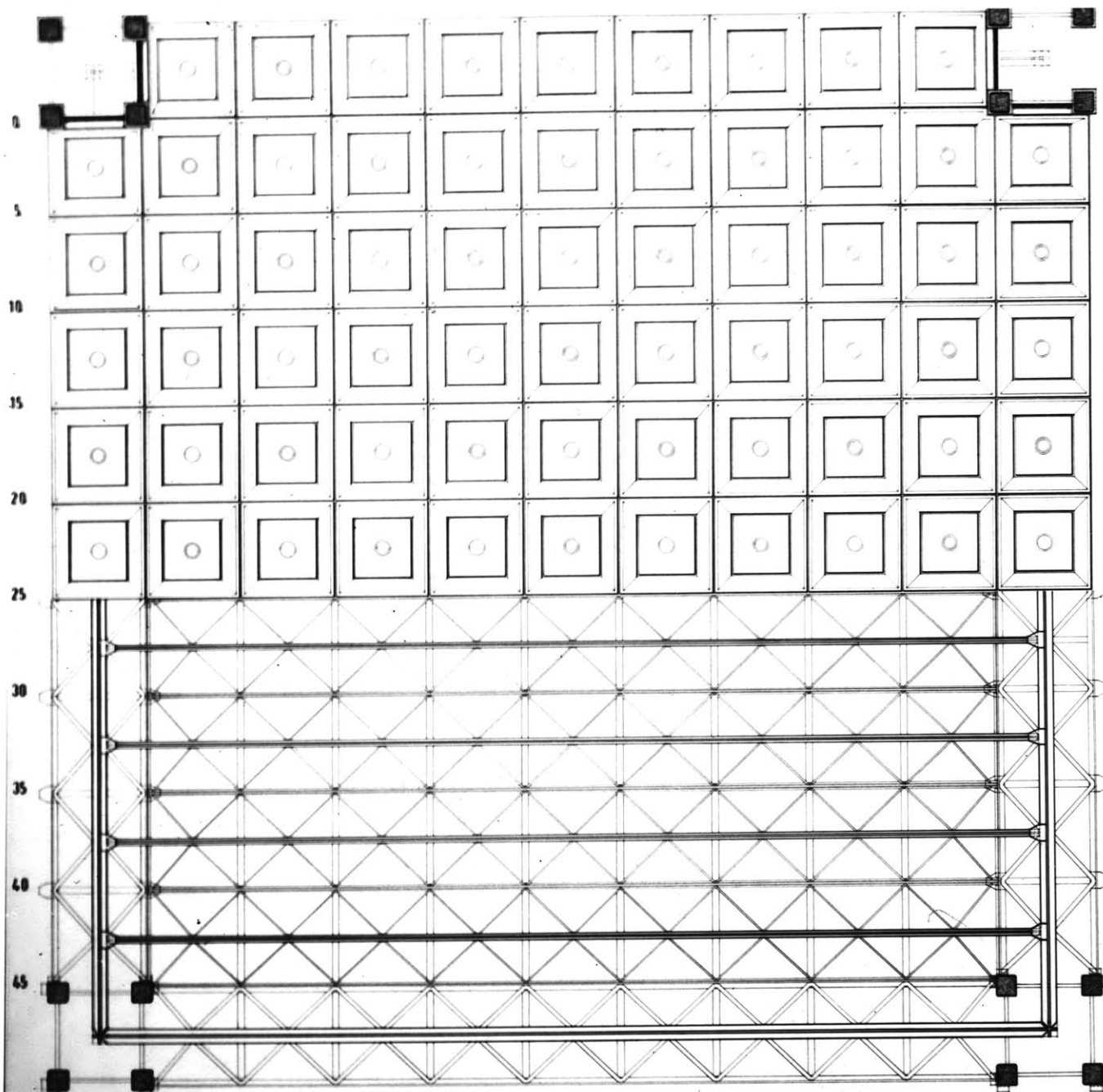
scale: 1ft. to 1ins.



typical column run SCALE: 2 FEET TO 1 INCH

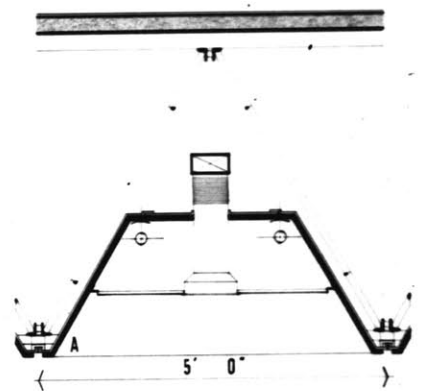
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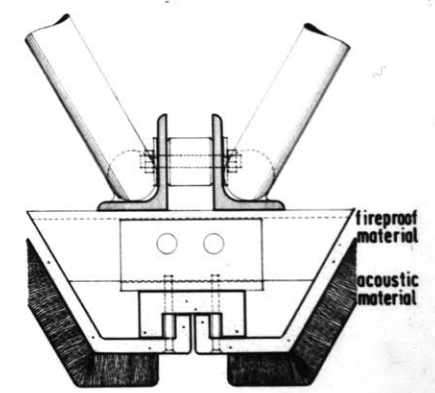


STRUCTURAL BAY - column, beam and infill units - part reflected ceiling plan

scale: 2ft. to 1ins.



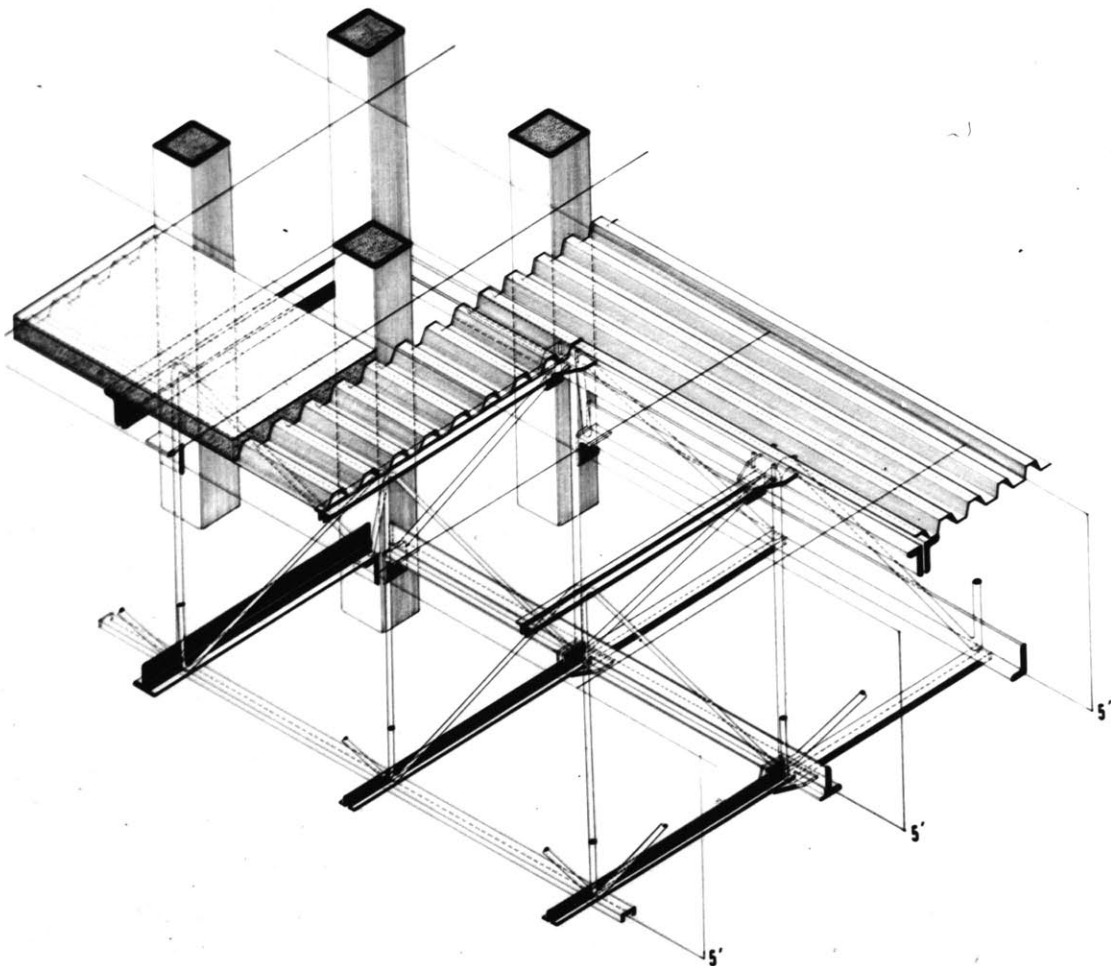
detail of ceiling panel : 1 1/2" to 1"



full size detail at -A

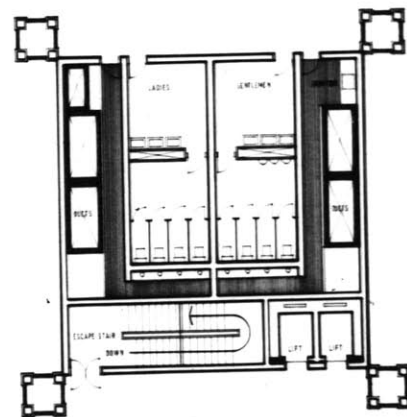
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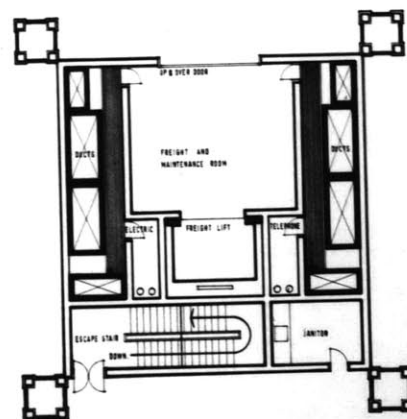


AXONOMETRIC OF COLUMN CONSTRUCTION

scale: 1ft. to 1 in.



personnel core

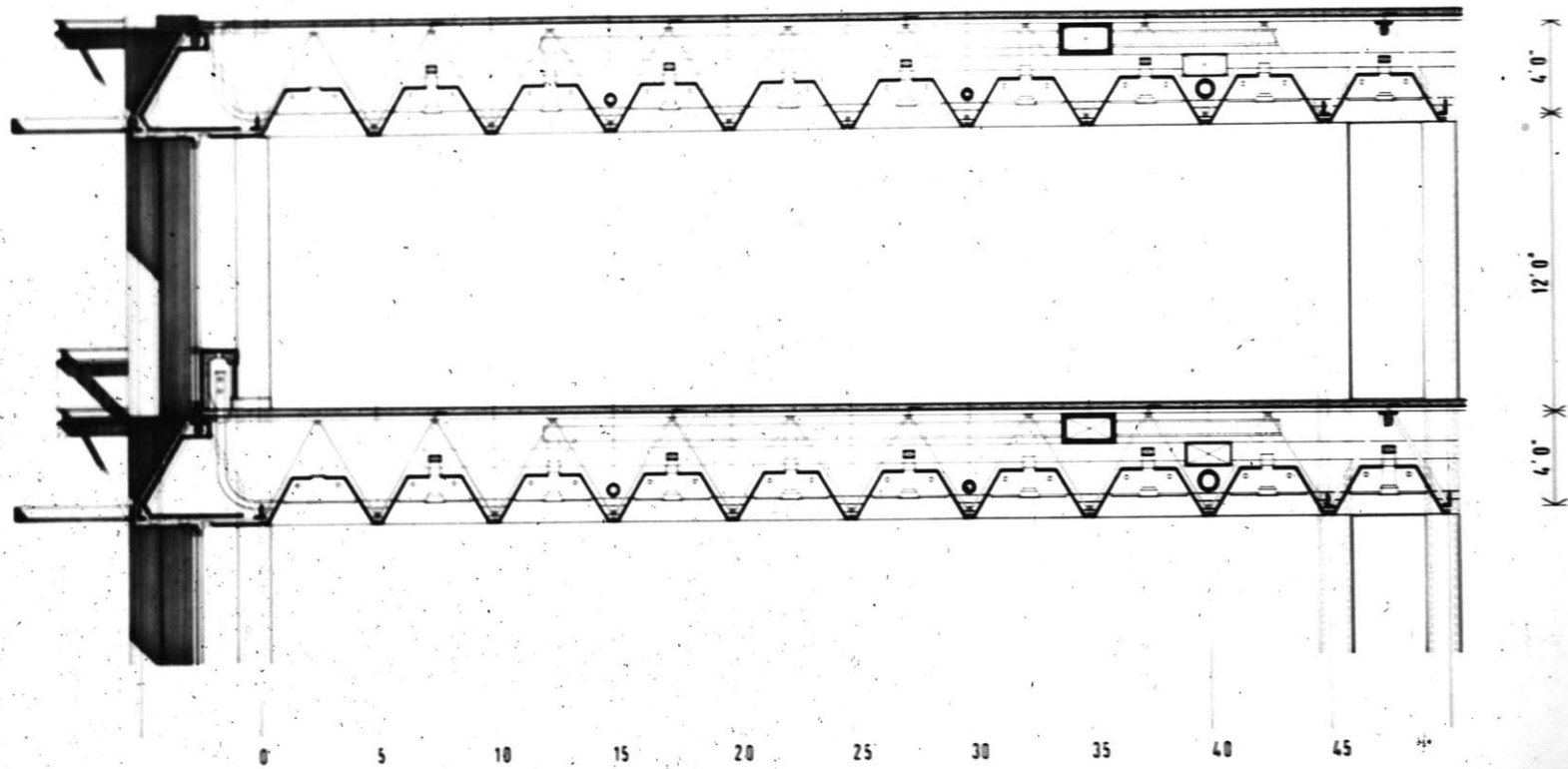


service core

scale: 10 ft. to 1 1/2 ins.

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SECTION OF TYPICAL EDGE BAY

scale - 2ft. to 1ins.



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DESIGNED BY AEC
 DRAWING FOR THE RECORD BY MAYER OF ARCHITECTS - 1961