PROTOTYPE STRUCTURE FOR A RESEARCH AND DEVELOPMENT BUILDING

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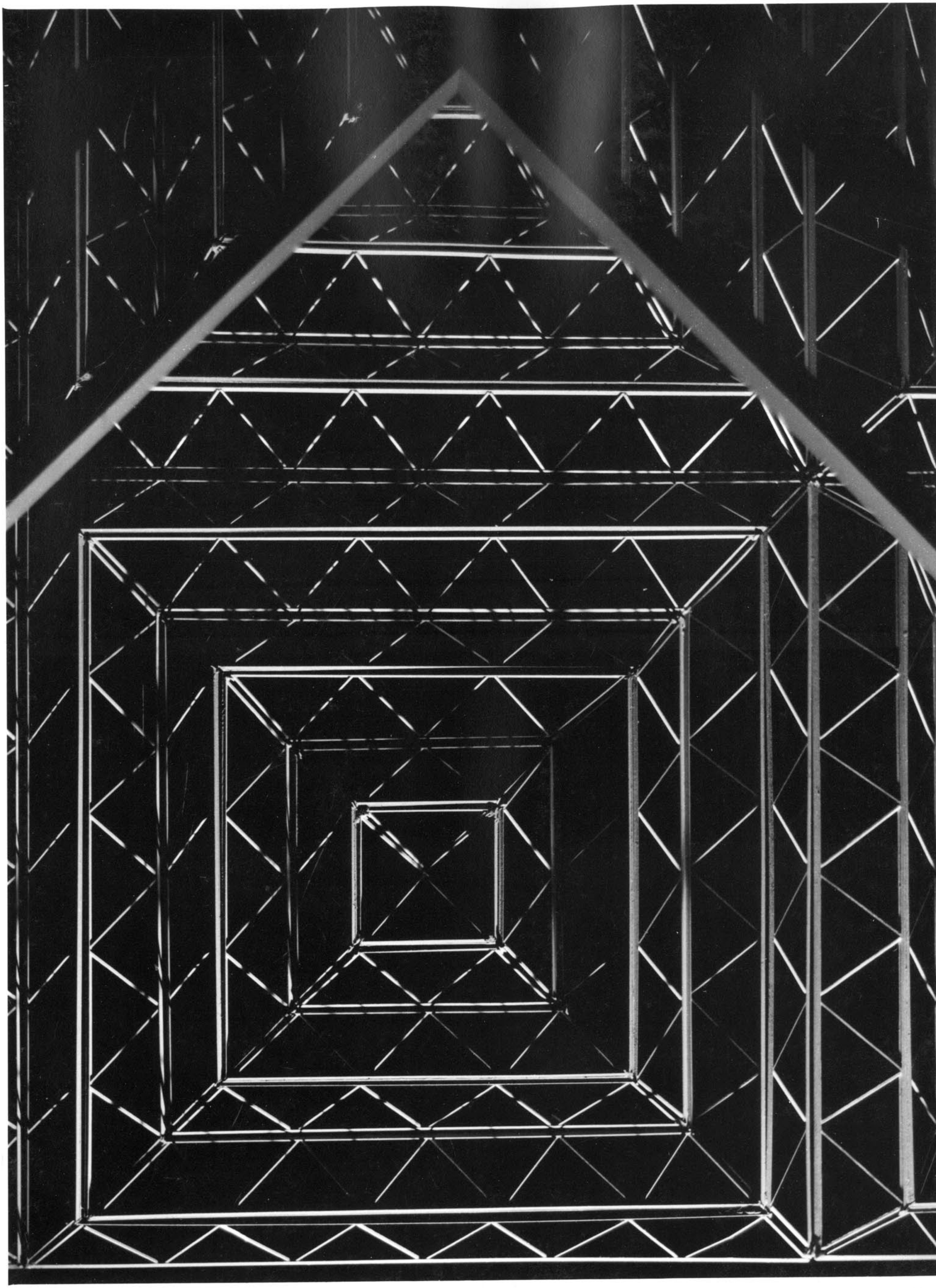

ABSTRACT

A program given to the Masters Class at the Massachusetts Institute of Technology School of Architecture, outlines the general usage for a research and development building. Using this program as a general specification of needs, a demountable, fireproofed steel structural system has been developed as a prototype solution which can be used in many research facilities.

The structure is unique in that it eliminates the bracing members from the bottom cords which are present in conventional metal "space frames" and that though it is fabricated of trusses, it can still be demounted in ever enlarging squares. It combines the advantages of construction by large members and demountability which is consistent with the system's structural behavior. Material exists only where it is needed.

The system has been investigated utilizing models and the IBM 7094 Computer located at the M. I. T. Computation Center. The computer has proved invaluable in varifying the structural theory and in determining the size of the members used in the test bay.

Though the problem is essentially a theoretical one, such a project makes it possible, not only to develop a new prototype structure, but to investigate the implications of the machine and technology.

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ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to Professor Eduardo Catalano, Massachusetts Institute of Technology, and Professor Waclaw Zalewski, University of Caracas and University of Warsaw, for the assistance which they gave me in this research project.

The computations for this structure have been accomplished utilizing the IBM 7094 computer at the Massachusetts Institute of Technology Computation Center, Cambridge, Massachusetts.

INTRODUCTION

Developments in technology and refinements in industrialization during the twentieth century have advanced to a degree of accuracy and precision never before attainable. Computerised production techniques now mean that a machine can produce extremely complex products in a short time with a control of quality that is impossible to achieve with hand labor. Automation has meant that most of the dull repetitive operations of mass production have been eliminated, freeing many men for more creative and interesting work. Today, only 16 men who push buttons produce the nearly two billion light bulbs which are used in America each year.

However, these advances have meant the problems in every field of study have become extremely complex and as a result it is now virtually impossible for one man to master every facet of his chosen profession. The result has been that men have had to specialize, choosing a particular subject within their field and devoting all their time in exploring it. Quite often these subjects have themselves become too complex and have had to be further divided into sub-specialties. As this fracturing process has expanded, it has become increasingly difficult to establish co-ordination or general goals among these heterogeneous experts.

THE BUILDING INDUSTRY

This fracturing process has become so widespread in the field of construction that the specialists are often working at counter purposes, making the dominant characteristic of the building industry one of waste and confusion. Materials manufacturers are constantly developing new products which have unique structural properties and require special installation procedures, quite often with no thought as to their use. Construction and fabrication techniques are constantly changing to adapt to these new materials, often making it necessary for the manufacturers to train their own installation specialists. The trade unions themselves represent groupings of countless specialists within the industry which have become lobbying groups for the "status quo."

Architects are constantly having to refer to specialists such as structural and mechanical engineers, and as a result have retreated into an ivory tower of "design," relegating technical responsibility to their "consultants." As a result, few construction techniques utilizing twentieth century technology have been developed, and each building is being treated as an individual occasion, demanding a completely new structural system and set of details. Such so-called modern buildings arise from a morass of formwork and waste and the city created from this attitude has become a conglomeration of isolated buildings, each fighting with the other for importance.

In recent years, large building offices have been created in an attempt to bring order from this chaotic situation. These concerns which are seeking to co-ordinate the heterogeneous specialities of the building field, and establish goals for the profession to follow, are generally characterized by their great size and scale of operations.

Several architectural offices presently employ hundreds of designers, engineers, and other consultants in the design phase of building. Such firms are the result of an architect merging with his specialists and paying them a fixed fee. However, no attempt is being made by such architects to become involved in building construction beyond the passive position of "observer."

Other solutions are being attempted by speculators, franchises, and state and federal agencies who seek to provide the administrative co-ordination for the design and construction offices.

An effort to involve one office in every phase of building is presently being made by the so-called package dealing firms which consist of contractors, lawyers, and real estate brokers, as well as designers and engineers. They are prepared to turn the keys for a new building over to the client after having selected the site, arranged the financing, designed and constructed the building, and even furnished and landscaped it; all for a fixed cost. Because of the close control of every phase of construction which these firms have, they are able to provide much more accurate cost estimates than are possible by the conventional contractor-owner bidding procedure.

These attempts at a solution have had initial success in co-ordinating the specialties but have had great difficult in establishing goals for the industry to follow. Though they possess the potential for efficient administration, this efficiency is of little use as it is being wasted on an outdated building technology which is based on hand labor and building "trades," a name and approach to construction dating from the middle ages.

THE MACHINE

Great architecture of the past expressed structural systems which were based on the technology of the age. As societies evolved, technology and art developed at equal rates, allowing each to influence the other in harmony. Today, however, a technology based on the machine has grown too rapidly to be assimilated by society.

The machine is neither good nor bad. Its impersonal nature means that a given set of goals can cause it to create a situation where its users become as anonymous as it is. However, this cold, qualitative instrument can be used just as easily to create environments which are a delight to those who use them. Herein lies a great opportunity for the individual architect to assume leadership as an inventor as well as an artist, who can establish the goals to guide the machines. To do so, he must gain a working knowledge of structures, computerization, and the many other technical tools which will be used, the primary one being the machine itself.

Industrialization has meant that it is now possible to achieve a degree of quality control in building with an inherent precision which is not attainable using conventional hand tools. However, the great cost of the individual machine means that it can be justified only in the context of mass production. The advantage implied in mass production of precise, standardized parts can be derived, in turn, if the fabrication process is moved from the building site to the factory where dimensions are controlled by the jig instead of the hand rule.

However, the machine should not be thought of as an enlarged hand tool. It is the result of the careful fabrication by skilled technicians to meet the needs of a given program. Thus the new "craftsmen" of the twentieth century are the machine makers. Their thinking is precise and technically qualitative, and their measuring devices are calipers and micrometers; not hand rules. In this context it is not necessary to think of tradesmen such as steel workers or carpenters, but only of fabrication specialists and erection experts who put the products together on the site. It is unimportant what the finished product is made of, as the machine can accurately fabricate any material. Thus the building process becomes one of assembly as fabrication occurs in the factory.

PROTOTYPE BUILDINGS

In order to establish goals for the machine it is necessary to conduct pure building research. This research, based on a broad program of needs, seeks to integrate a combination of systems into one building form which, in turn, can be adapted to many other situations. Such prototype structures are useful in that they offer a chance not only to develop new construction and structural systems, but also to investigate their implications on building form. Prototype structure investigation thus represents a form of laboratory study, which does not have to be controlled by the pecularities of a given architectural style, site, or even client, as these represent variables which the prototype can later be adapted to meet.

The approach to buildings through systems and their adaption to varying conditions is not particularly new. Many such prototype structures have been developed in the past by different societies. The solutions which were developed in each case were a direct result of the technology of the time.

THE JAPANESE HOUSE

The Japanese spent hundreds of years developing a construction system which utilized available materials and a few repetitive joints. The entire system was based on the way that wood and stone could be joined together and the tools which were used to form them. The result was the classical Japanese house type which was dimensioned by the size of the Tatami mat and used a few repetitive details which were developed to infinite refinement. A Zen philosophy was evolved concerning the art of jointery and these joints were displayed for they were what gave the architecture its character.

Once the system was evolved, the Japanese were able to concentrate on placing the building on its site and developed a ritual for this purpose. The designer would visit the site for many days, sometimes with a mat and tea, and noticing its potentials would be able to create a building which was a natural outgrowth of the site, preserving and accentuating its best features. The system allowed the chance for rich individual expression within the context of modular dimensioning and repetitive joints.

TAOS PUEBLO

The pueblo which has been the dwelling place for the North Tiwa Indians at Taos, New Mexico for nearly 600 years is another example of an evolved structural prototype. In this case, the structural system has been based on the most available materials: adobe clay, stone, and wood. The wooden beams or "vargas" are used over and over, since they are not only scarce but will last almost indefinitely in the dry air. The vargas which are available can span no more than 20 feet with the adobe loads placed on them. This has formed the basis for the dimensioning of the entire pueblo which is constructed of an adobe bearing wall system that runs east and west, giving the pueblo its proper orientation.

Though the system has not been repeated in this particular configuration outside the pueblo, it has been refined over and over until the pueblo has become a prototype building in itself. Variety and changes can occur in the planes which are perpendicular to the bearing walls, producing an extremely rich composition and allowing each family in the pueblo an individual place in the context of the entire community.

THE CRYSTAL PALACE

The classic example of a prototype structure which utilized the potential of the machine was built in London by Joseph Paxton in 1850. Paxton explored the implications of technology at a time when the Victorian style of architecture was dominating Europe and America. The Crystal Palace was thus a building which was 100 years ahead of its time.

Paxton was primarily a designer of greenhouses who had spent 10 years studying the applications of the machine to building before the competition for the large exhibition hall was announced. He was thus able to approach the problem from the point of view of the machine which would produce an accurate system that could be repeated as often as was necessary to produce the final building.

The system he evolved for the Crystal Palace was based on the size of the standard glass panels then available, and on the unique erection procedure. The columns were hollow and of uniform diameter, but varied in thickness depending on the loads which they were to receive, allowing the trusses to be made a constant length. No member weighed more than a ton, so that they could be easily assembled using hand winches. Glass was laid on the roof by means of a special moving platform which the glazers worked from, making it unnecessary to walk on the roof during construction. This platform ran along a patented steel track which served as a structural member and a gutter after the building was completed:

> "The design of the floor members, their cross sections, their geometrical arrangement, reflected the play of force within the structural system and alone determined the character of the building."
> (Konrad Wachtsman, The Turning Point of Building, p. 14).

The erection of this building became merely an assembly process which could be repeated any number of times to produce a building of any size. The resulting hall was 1851 feet long and was completed in less than four months.

These buildings, and many more like them, demonstrate that it is indeed possible to attain individual expression within the context of a given system. However, it is necessary for the designer to engage in intensive study to determine which systems are more promising. Only when technology has been mastered through prototype research can the true value of the designer be realized.

BUILDINGS AS SYSTEMS
A PROTOTYPE STRUCTURE FOR RESEARCH AND DEVELOPMENT

The purpose of this problem is to develop a prototype building of about 600,000 square feet gross floor area, as an integrated system of life, growth, circulation, services, and construction, to be used for the development of scientific and technological ideas for furthering the exploration of space.

Two kinds of space are required for such use: a very simple flexible space, where scientists and administrative personnel work independently or in groups, and a more complex flexible space, for laboratories and workshops which develop components for experimental work. The latter space requires spans of not less than 40 feet and a very flexible system of services, thus providing working conditions that go far beyond the use described above.

The physical relation between both types of space varies with the kind of projects developed and it is difficult to predict at a given time, the necessary areas and locations for each activity. It is possible to determine only the location of the basic plant, such as mechanical rooms, general service rooms, general workshops, and certain permanent activities, but other activities will change from time to time, or unforseen ones may be needed for special projects.

Though the specific needs of such a research facility are difficult to predict, it is possible to form a general program based on building occupancy and use.

General Requirements:

1. Maximum continuity of the divisible space in the building.
2. Easy division of this space based on a 5'-0"x 5'-0" module.
3. Modular supply of services.
4. Simplification and concentration of vertical services through the use of efficient cores.
5. A system of expansion of floor area and services.
6. Ease in attaining variable heights from floor to floor even after the building is completed.
7. Demountability of structural parts.

The construction system of either steel or concrete should be based on the use of prefabrication and standardization of parts.

20 STORY BUILDING
(Core Requirements)
250 people & 30,000 sq. ft. / floor

No.	Facility	Unit Floor Area	Total Floor Area
14	Passenger Elevators	50	700
1	Service Elevator	120	120
1	Service Elevator Loading Area	200	200
2	Fire Stairs	250	500
2	Public Telephone	25	50
2	Drinking Fountains	10	20
1	Janitor's Closet	100	100
1	Electric Closet	100	100
	Men's Toilets		
4	Urinals		
5	Water Closets		
5	Lavatories		500
	Women's Toilets		
5	Water Closets		
5	Lavatories		500

Total floor area not including mechanical space	6780
Percentage of core to floor area	8.5%

15 STORY BUILDING
(Core Requirements)
330 people & 40,000 sq. ft. /floor

No.	Facility	Unit Floor Area	Total Floor Area
12	Passenger Elevators	50	600
1	Service Elevator	120	120
1	Service Elevator Loading Area	200	200
2	Fire Stairs	250	500
4	Public Telephones	25	100
4	Drinking Fountains	10	40
1	Janitor's Closet	100	100
1	Electric Closet	100	100
	Men's Toilets		
5	Urinals		
7	Water Closets		
6	Lavatories		600
	Women's Toilets		
7	Water Closets		
6	Lavatories		600

Total floor area not including mechanical space	2960
Percentage of core to floor area	8%

10 STORY BUILDING
(Core Requirements)
500 people & 60,000 sq. ft. /floor

No.	Facility	Unit Floor Area	Total Floor Area
10	Passenger Elevators	50	500
2	Service Elevators	120	240
2	Service Elevators Loading Areas	200	400
4	Fire Stairs	250	1000
6	Public Telephones	25	150
6	Drinking Fountains	10	60
3	Janitor's Closets	100	300
3	Electric Closets	100	300
	Men's Toilets		
6	Urinals		
9	Water Closets		
7	Lavatories		800
	Women's Toilets		
9	Water Closets		
7	Lavatories		800

Total floor area not including mechanical space	4550
Percentage of core to floor area	7.5%

5 STORY BUILDING
(Core Requirements)
1000 people & 120,000 sq. ft. /floor

No.	Facility	Unit Floor Area	Total Floor Area
8	Passenger Elevators	50	400
5	Service Elevators	120	600
5	Service Elevators Loading Areas	200	1000
4	Fire Stairs	250	1000
10	Public Telephones	25	250
10	Drinking Fountains	10	100
5	Janitor's Closets	100	500
5	Electric Closets	100	500
	Men's Toilets		
10	Urinals		
15	Water Closets		
12	Lavatories		1600
	Women's Toilets		
15	Water Closets		
12	Lavatories		1600

Total floor area not including mechanical space	7550
Percentage of core to floor area	6.7%

ADDITIONAL MECHANICAL REQUIREMENTS

MECHANICAL ROOMS

All mechanical rooms in one or two levels	- 10% gross area of building.
Basic mechanical equipment (no air handling) and electrical, telephone, and pumping equipment	- 4% gross area of building
Total area for air handling units (in zones, independent from basic mechanical equipment)	- 6% gross area of building
Total area for air handling units,	
if divided in 4 rooms	- 7% gross area of building
if divided in 8 rooms	- 7.5% gross area of building
if divided in 16 rooms	- 8% gross area of building
if divided in 32 rooms	- 9% gross area of building

DUCT DIMENSIONING

Velocity of Air

Supply:	low velocity: 1000 CFM high velocity: maximum, 4000CFM advisable, 3000CFM
Return:	1000CFM

Air Supply:

Interior Zones: (low velocity)	1CFM/sq. ft. of floor area Duct at low velocity: 1 sq. ft. / 1000 sq. ft. of floor area
Exterior Zones: (high velocity due to additional loads)	4-5 CFM/sq. ft. of floor area Duct at high velocity: 1-1.2 sq. ft. /100 sq. ft. of floor area

Note:

Exterior zone should not cover a peripheric band wider than 10-15 feet. Leave space for spare ducts, insulation, and a "few inches" to place and support the ducts from the structure.

PIPE DIMENSIONING

Drains, 6" O.D.
Hot Water pipes: 2" O.D. plus 2" insulation = 4" O.D.
Cold Water: 2" O.D.
Ventilation pipes: 2" O.D.
Note:

Place pipes next to each other leaving 2" clear space between them for servicing.

INTERPRETATION OF PROBLEM

The general needs of a research building as outlined in the program represents a specification for the system which would be used in this type of building. For this reason, a prototype structural system has been developed which satisfies these requirements and which can thus be used in any research facility regardless of site, soil, or climate conditions.

SELECTION OF MATERIAL

The flexibility which the building's services requires means that the structural and mechanical systems have to occur within the same structural depth. This indicates that a hollow structure is necessary which allows the mechanical system to run through it. In addition, the structure has to be demountable, even after the building is completed. Thus a system has been developed which consists of fireproofed steel trusses with hinged and bolted connections to take advantage of the inherent lightness, flexibility, and strength of steel.

THE STRUCTURAL SYSTEM

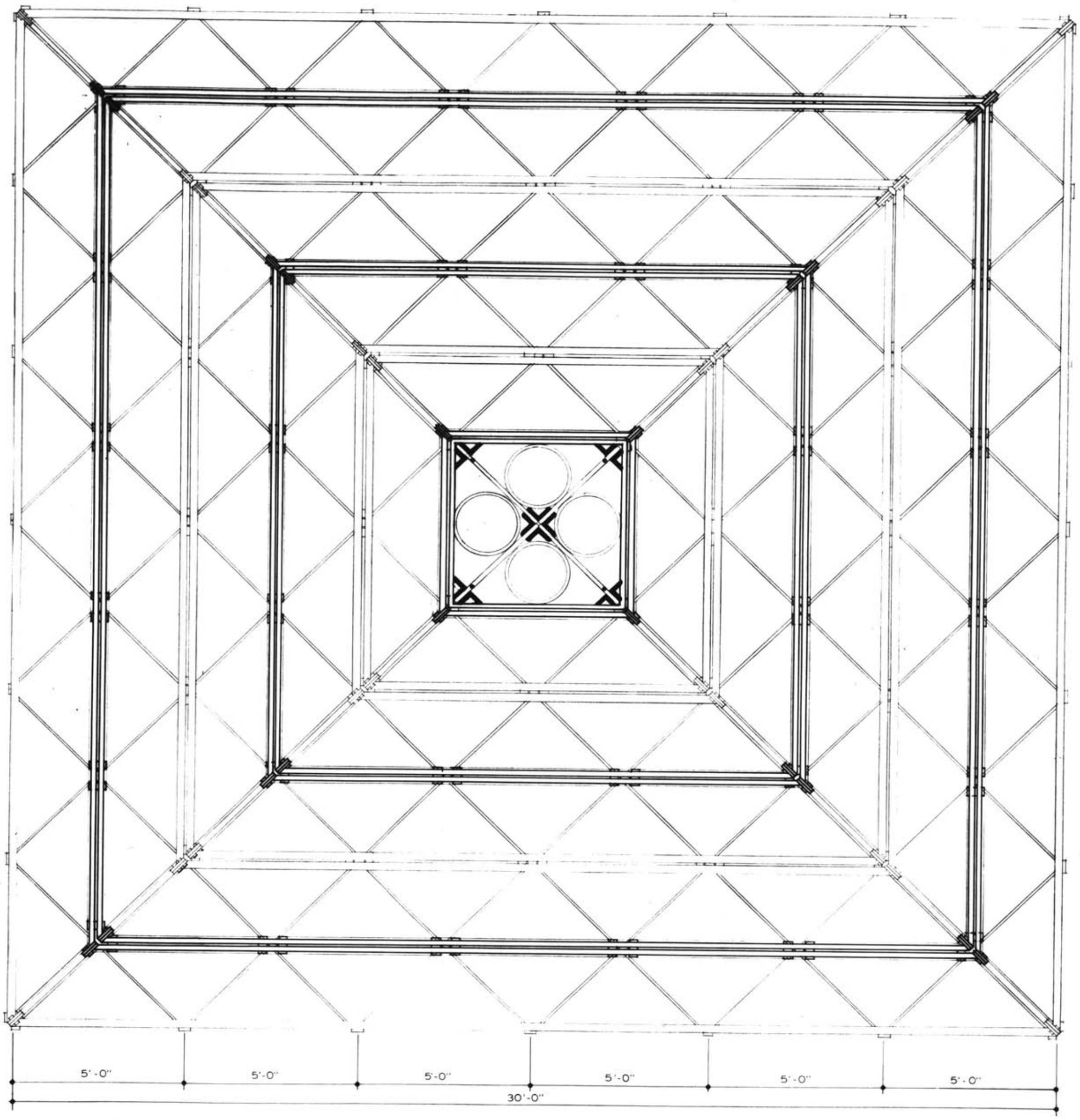
Because steel can be fabricated in linear elements, it is easy to place and join, and its strength means that little material is needed to span large distances. This lightness also means that foundations can be smaller and hence, cheaper.

However, the major problem in any steel structure is the fireproofing. Though steel has great strength at room temperatures, its structural value vanishes in the heat of a normal fire. The structural system thus has to provide for the fireproofing as well as space for utilities within its structural depth. In addition, it has to have the potential of having sections removed which would be small enough to be transported easily and yet not so small that they would be uneconomical to construct.

To meet these needs, a triangulated steel structure has been developed with fireproof coffers inserted in the alternating pyramid.shaped voids, leaving space for the utilities in the other openings. The result is a fireproof structure that provides a ceiling free from the clutter of exposed utilities. However these utilities are easily accessible by the removal of the coffers.

The structural system consist of a series of concentric structural "rings." These rings are composed of two trusses and a floor unit and are closed in section as well as plan. The structural behavior of the rings dictates that they be used in a "two way system" with square bays as this allows for concentric rings to be removed without affecting the behavior of the structure.

The system is unique in that it eliminates the bracing members from the bottom cords which are present in conventional "space frames" and that though it is fabricated of trusses, it can still be demounted in ever enlarging squares. It combines the advantages of construction by large members and demountability which is consistent with the system's structural behavior. Material exists only where it is needed.



PLAN OF BASIC STRUCTURAL UNIT

STRUCTURAL SYSTEM

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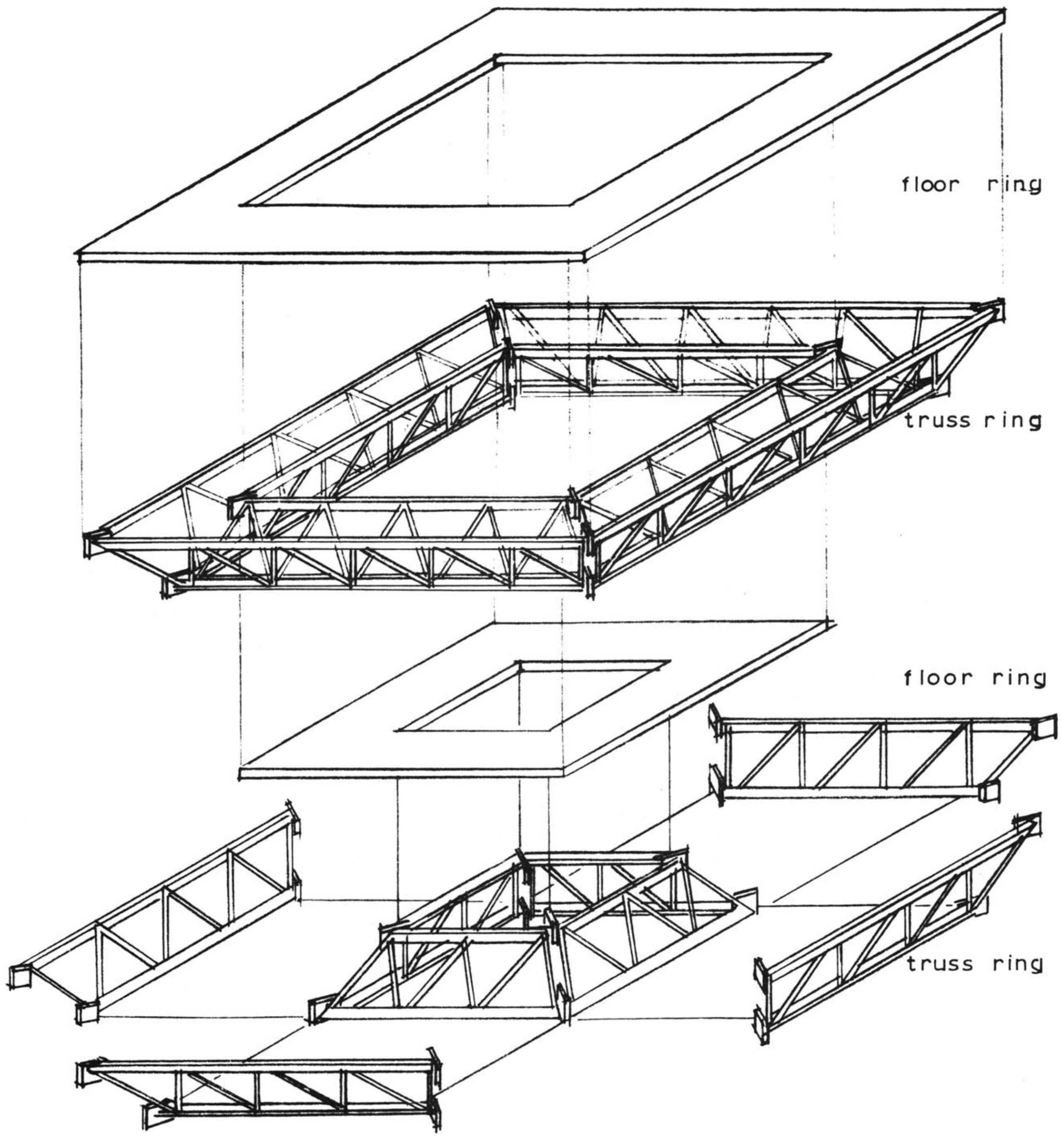
SCALE IN FEET

PROTOTYPE STRUCTURE FOR A RESEARCH AND DEVELOPMENT BUILDING
MASTER IN ARCHITECTURE THESIS
ANTHONY EMMET LAYTON MIT JUNE 1965



EXPLODED ISOMETRIC

STRUCTURAL SYSTEM

SCALE IN FEET

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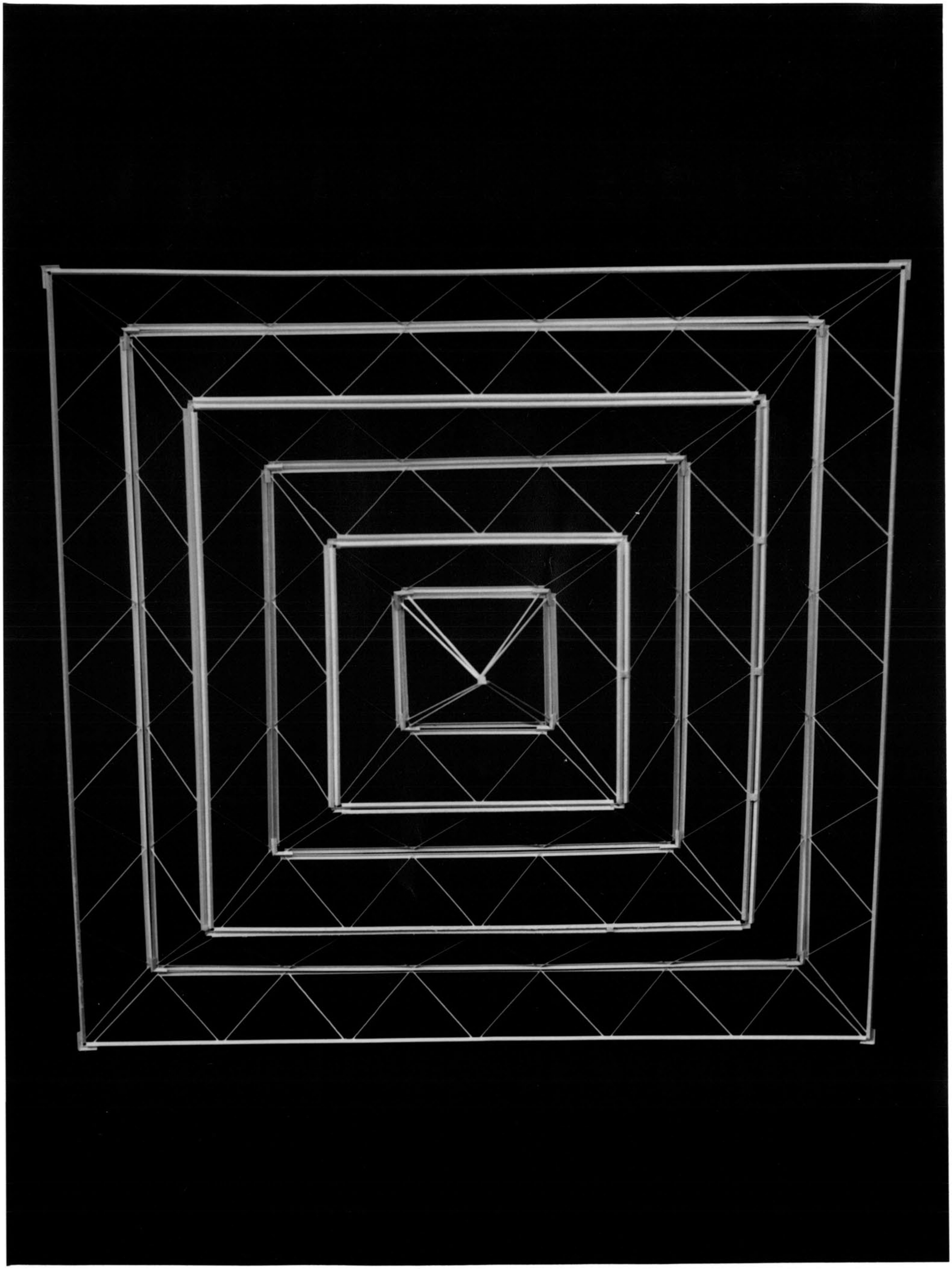


STRUCTURAL THEORY

The structural system is designed to take only tension and compression loads within its members. Thus, as long as the structure is loaded only at the panel points of the trusses, the distribution of forces is identical, whether the system is supported simply or cantilevered. For this reason, the ability of the structure to resist loading has been determined assuming that it is uniformly cantilevered from a central support. Using the concept that any force system can be subdivided, the stress distribution can be investigated when a point load is placed on one of the corners of the structure. This load can be broken into the sum of three other loadings, one being uniform, and the other two being asymmetric.

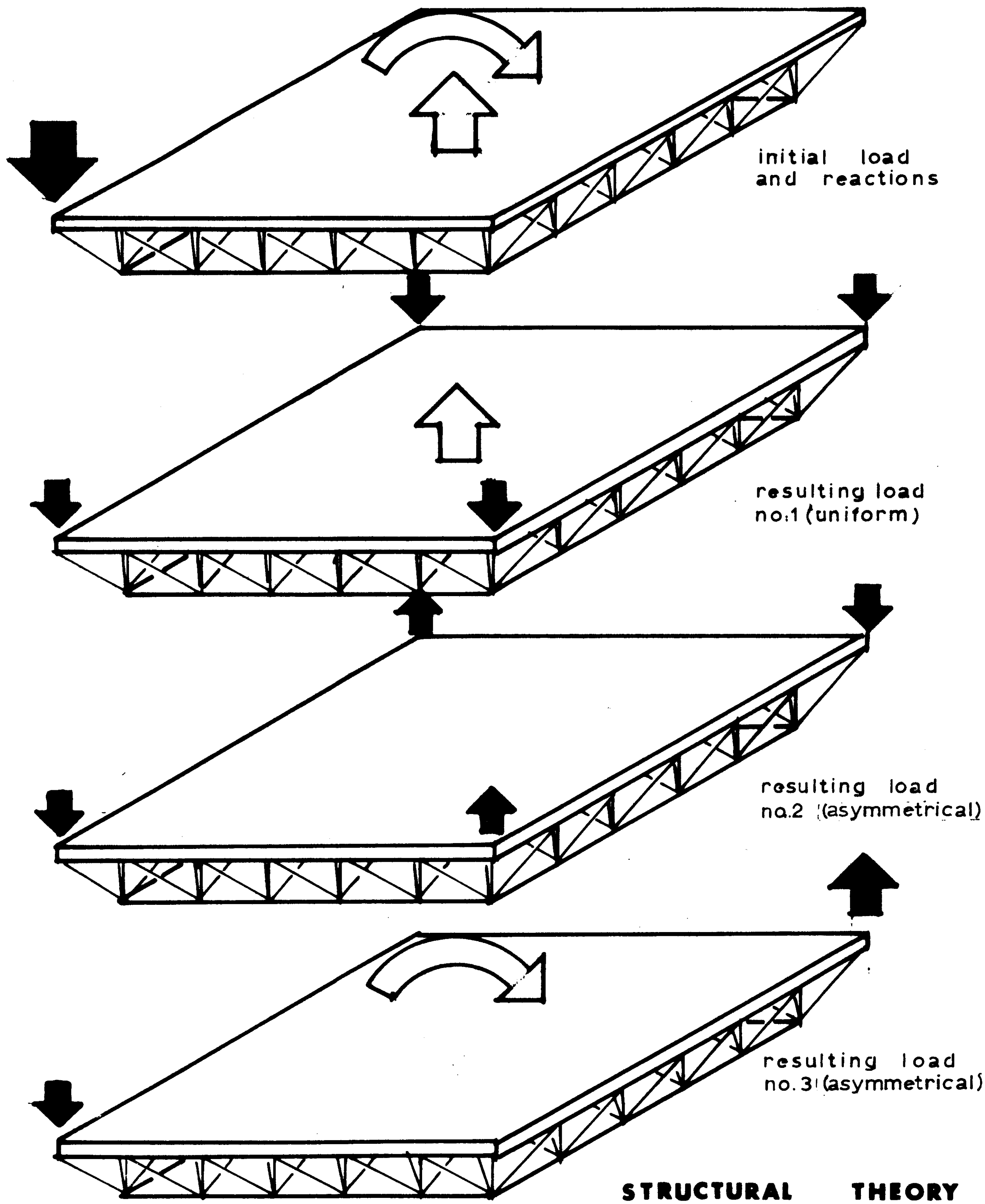
When the forces placed at the four corners of the structure are equal in magnitude and direction, they are transmitted inwards by the series of truss "rings." The top cord of the exterior truss ring is placed in tension and the bottom cord is placed in compression. In turn, these forces are carried to the next ring of trusses at the corner which are loaded as a mirror image of the first and the process continues inwards, along the diagonals of the structural unit to the column. An interesting result of this distribution is that there are no horizontal forces in the structure, eliminating the need for an integral floor slab.

The distribution of forces when the structure is loaded asymmetrically is somewhat more complicated. If each ring is again analyzed, it is found that a couple force is being introduced at each corner, and that this loading is similar throughout the structure. The result is that each ring is in torsion, creating a horizontal force in the structure. In order for the structure to resist this torsion force, it is necessary to use the floor integrally to close the section of the ring. The resulting structure is undergoing torsion by bending which is different from pure torsion.

Pure torsion is a force which is impossible for a structure to resist and occurs when the section of the member undergoing the twisting is not closed. Examples of such sections are: t's, angles, and plates. Their cross sections offer no resistance to torsion as the stresses formed create great shear forces which rapidly lead to the failure of the member. However, the closed symmetrical section allows each side to resist the force as if it were a uniformly loaded beam. When the forces are analyzed, the webs are found to be carrying all the load as the tension and compression forces in the cords cancel each other out. In both cases though, the forces are transferred along the diagonals of the structure.

The floor slab is thus used to distribute the initial loads, to close the section, and to provide added re-enforcement to the corners of the structure where there are stress concentrations.

An interesting result of the behavior of the structure is that the system does not require horizontal tolerances in construction. Any deviation in truss length will cause a vertical displacement to occur which can be handled by the concrete finish floor and the leveling system in the ceiling.



SUMMATION METHOD
FOR A GIVEN LOAD

STRUCTURAL THEORY

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SCALE IN FEET

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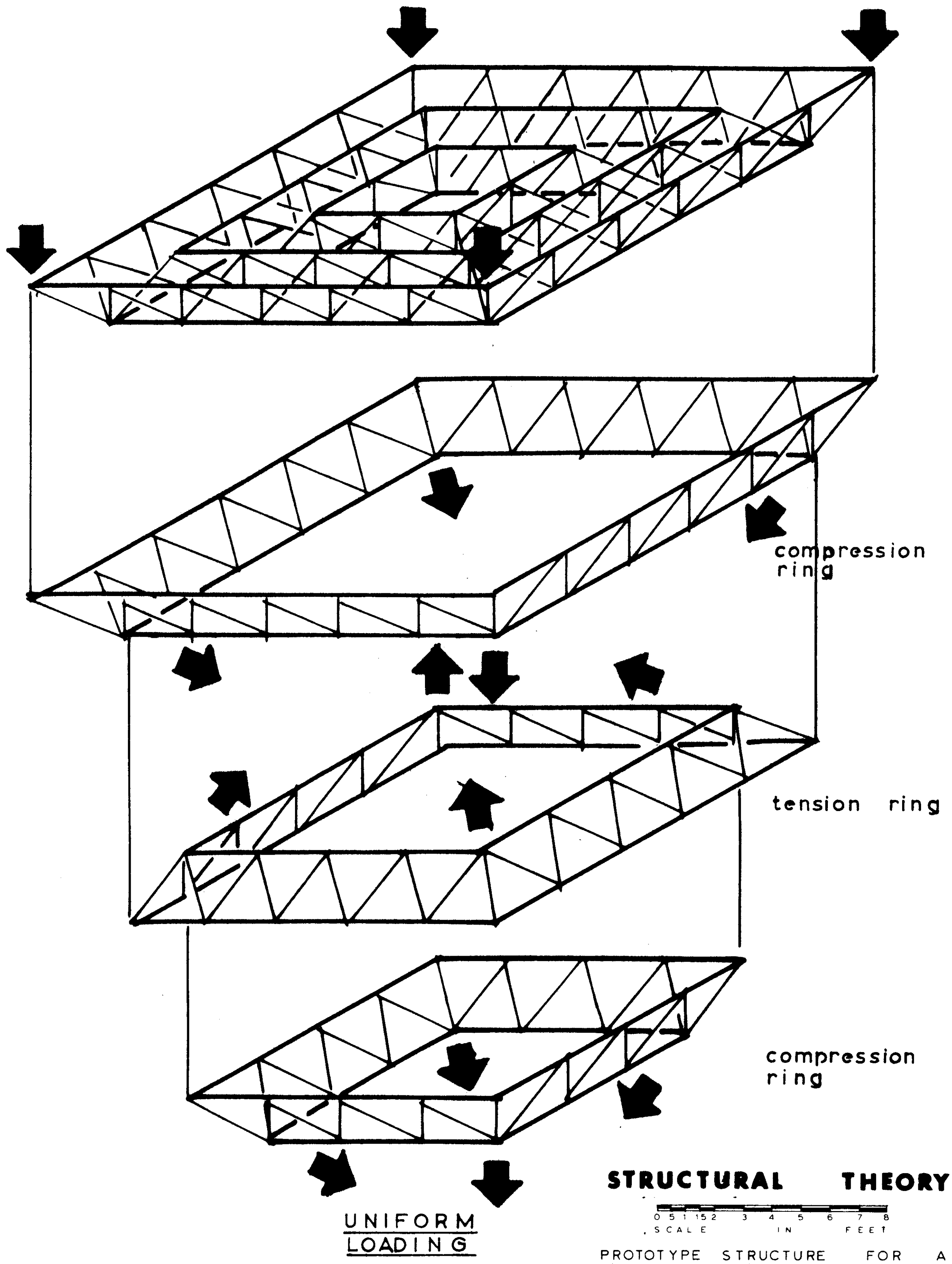

STRUCTURAL THEORY

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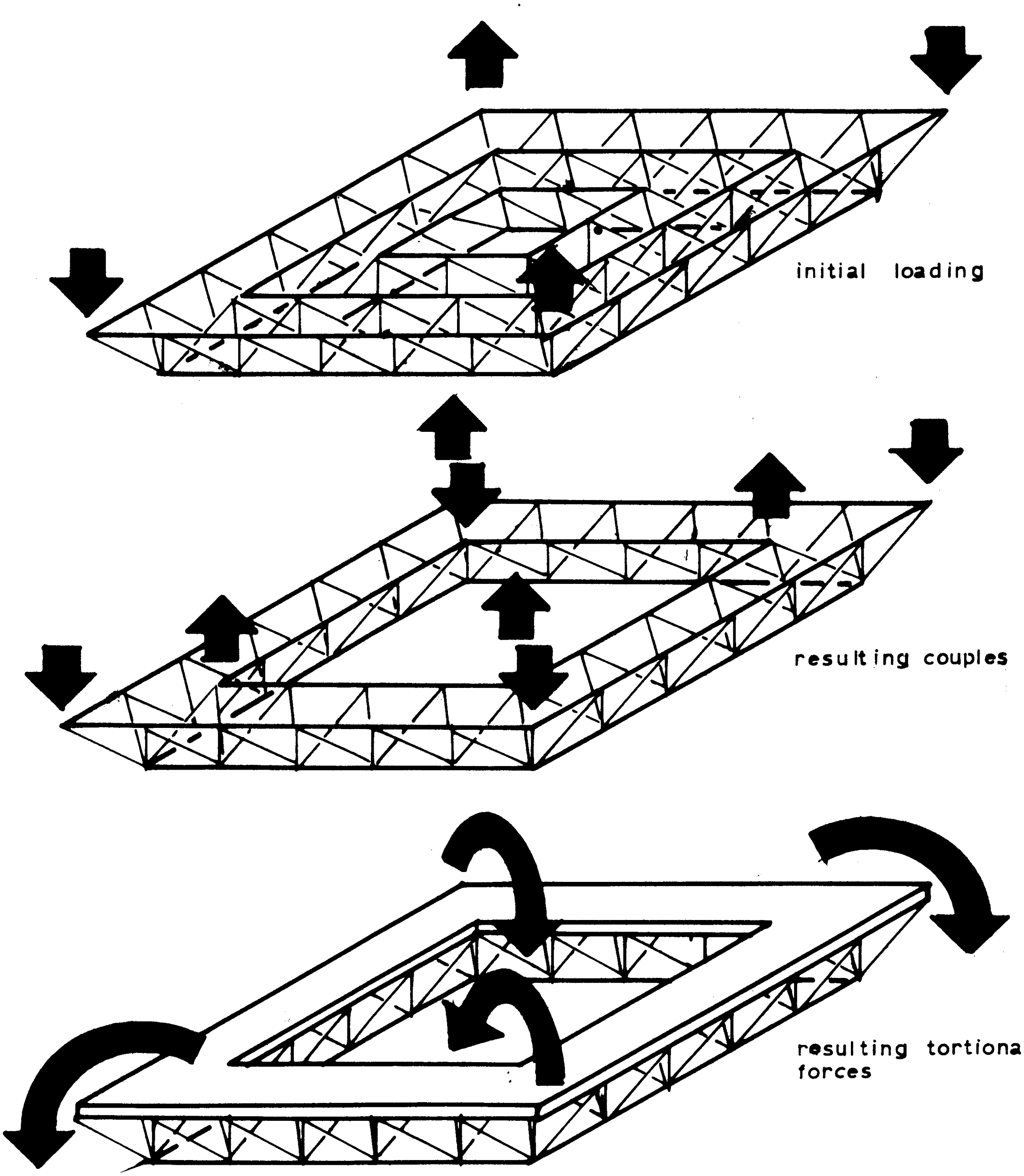

ASYMMETRICAL LOADING

STRUCTURAL THEORY

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SCALE IN FEET

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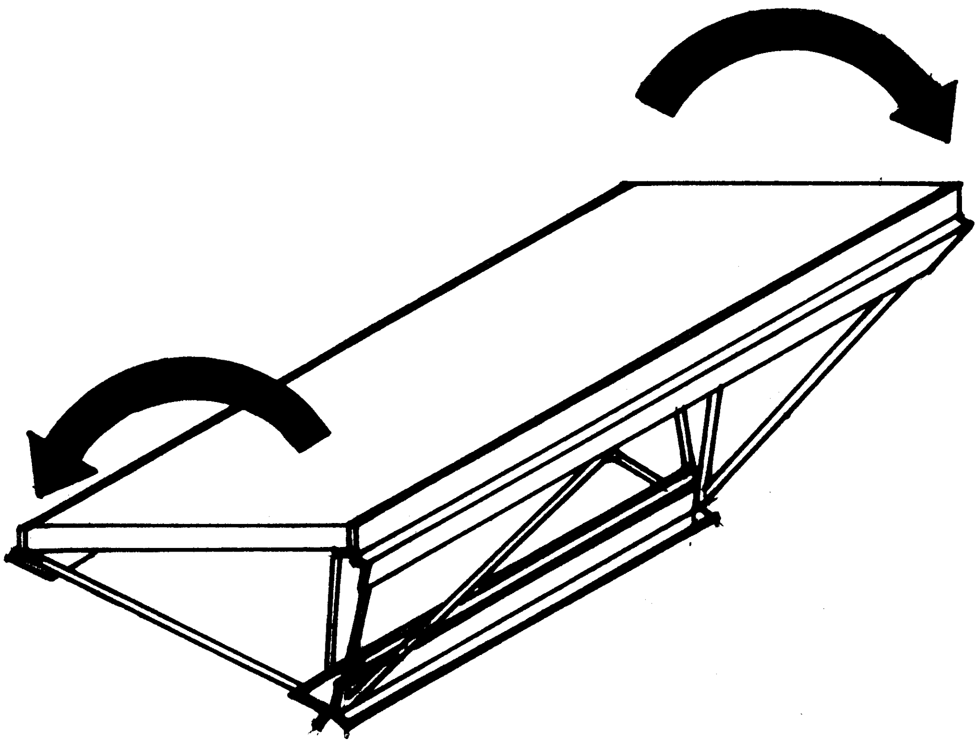
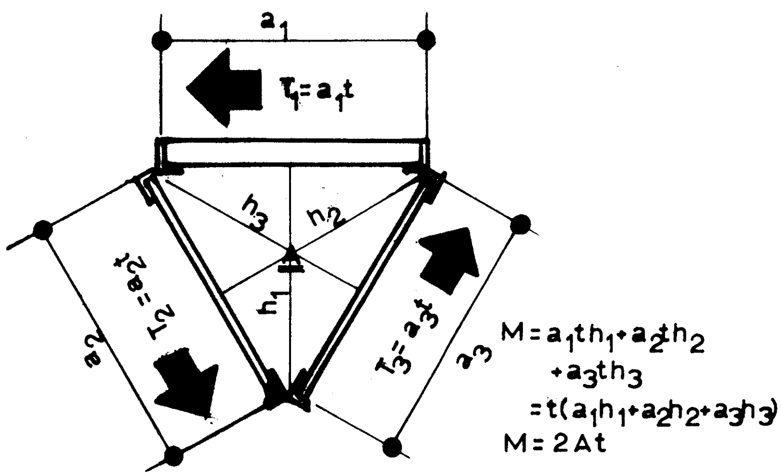
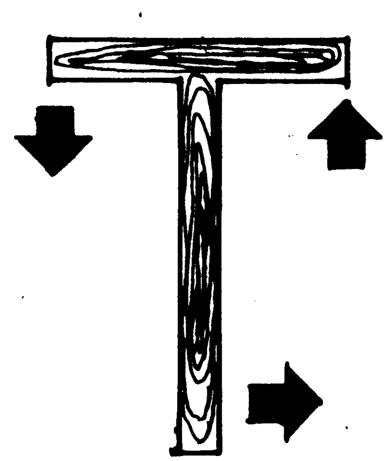




TORSION BY BENDING



PURE TORSION

RESISTANCE TO TORSION FORCES

STRUCTURAL THEORY

0 5 1 15 2 3 4 5 6 7 8
SCALE IN FEET

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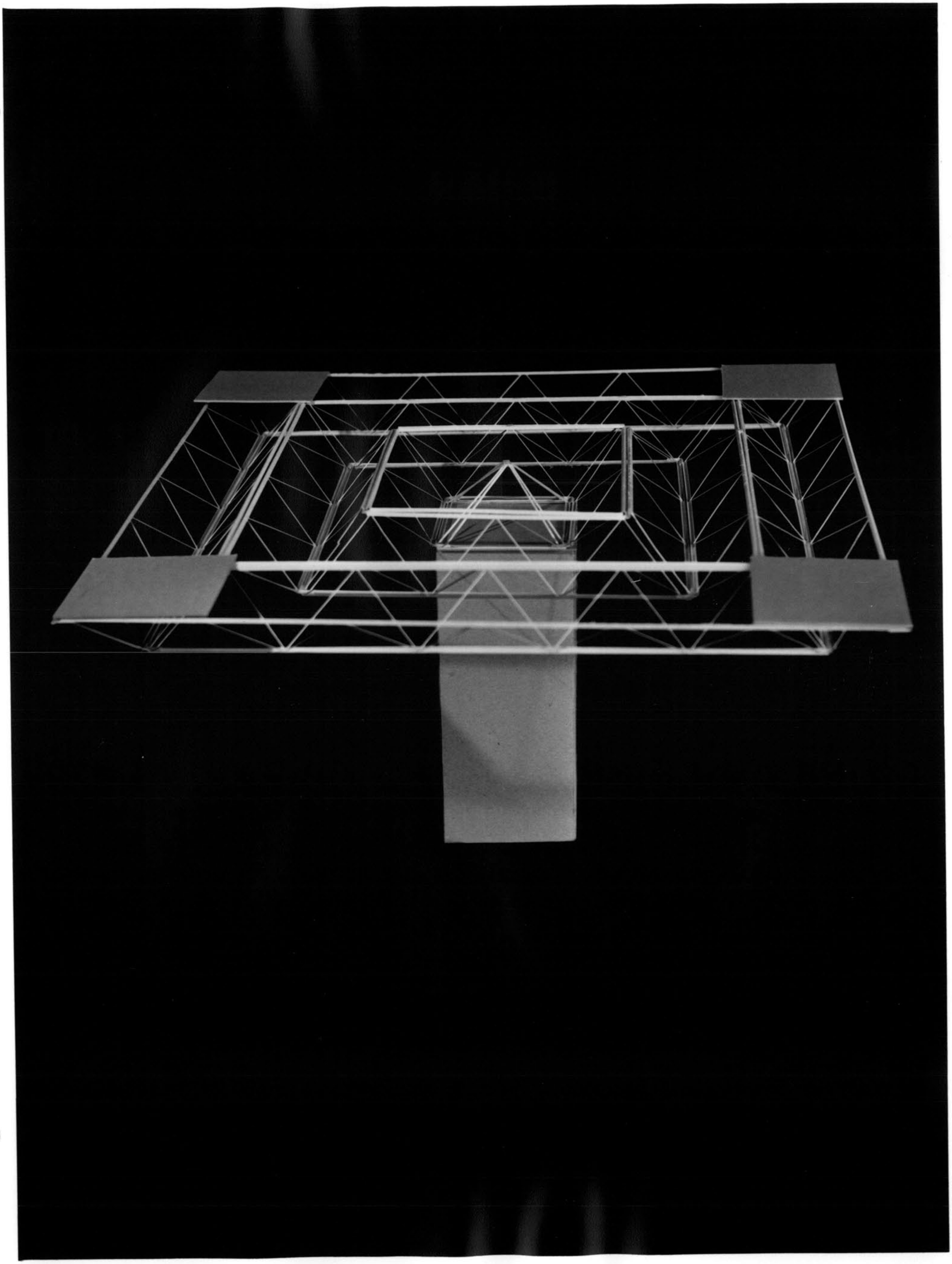
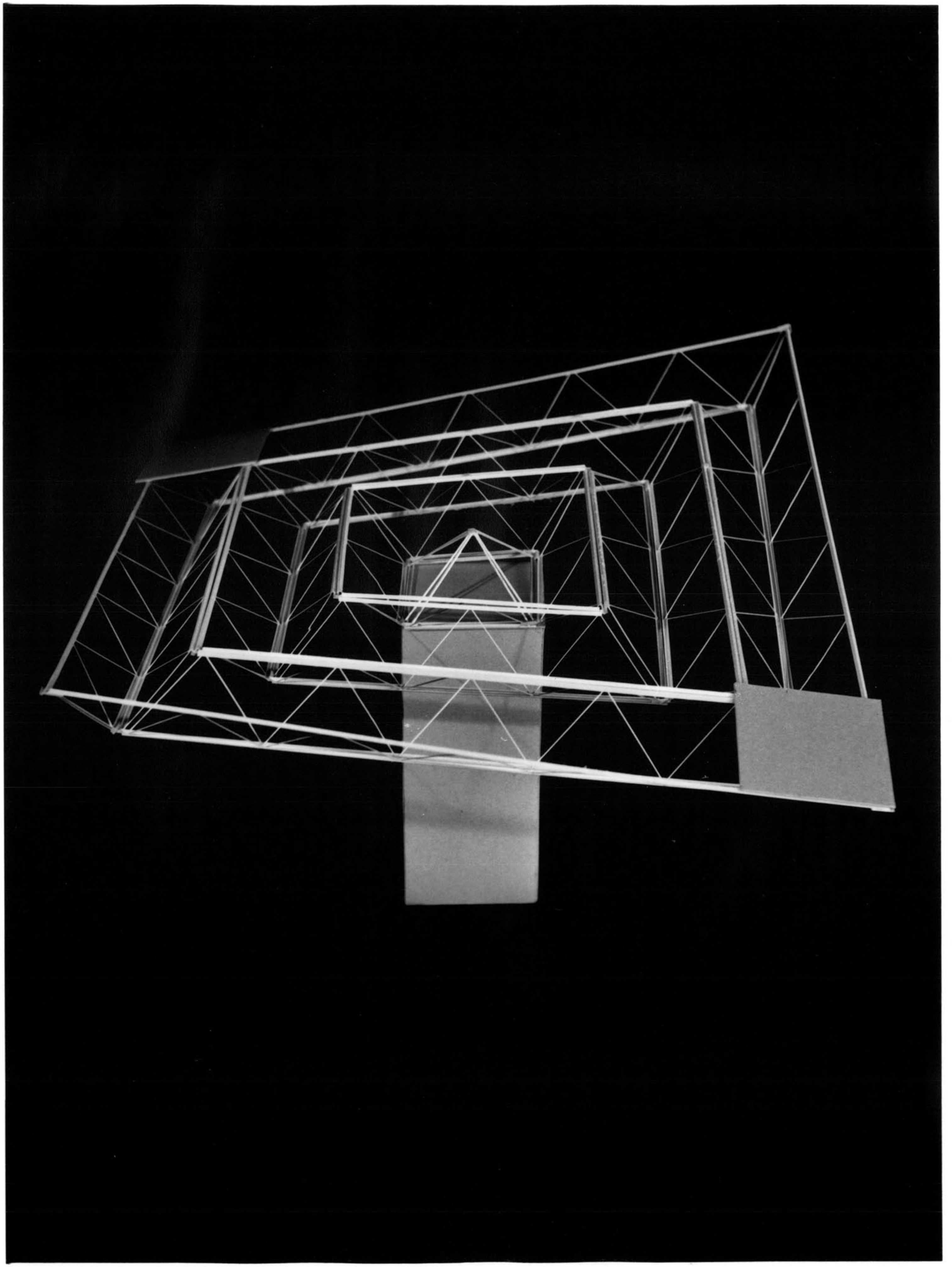
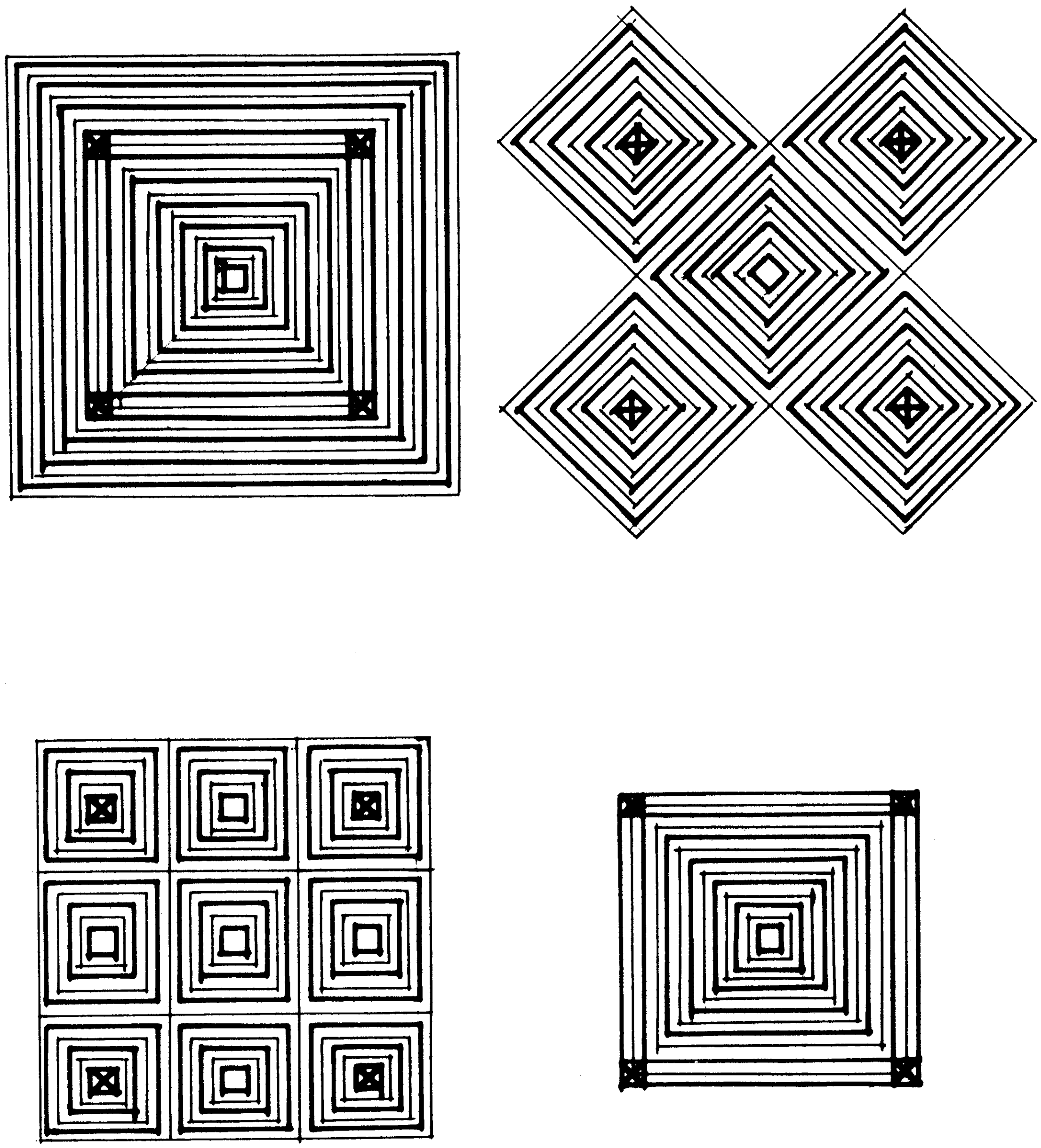




COMBINATION OF UNITS

The ability of the structural system to be either cantilevered or simply supported means that it can be combined in any of four different ways. As it is difficult to predict which of the four spanning methods will be used in any research building, the third combination has been analyzed as being most typical. This system which utilizes 5' structure depths and a 60' by 60' bay contains elements in common with all the others and thus demonstrates the combined potential of the structure.



CEILING PLANS

COMBINATIONS OF UNITS

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SCALE IN FEET

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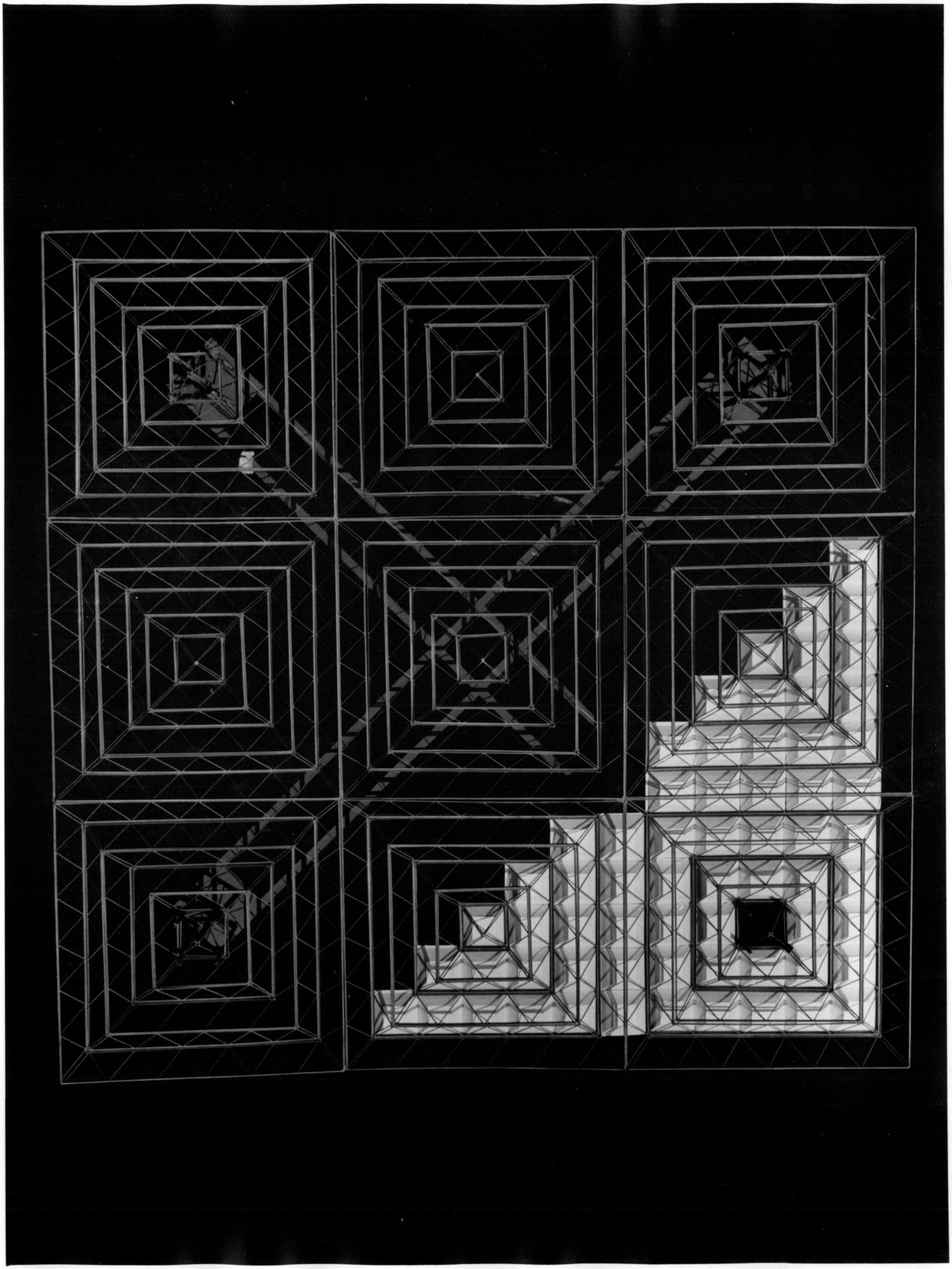
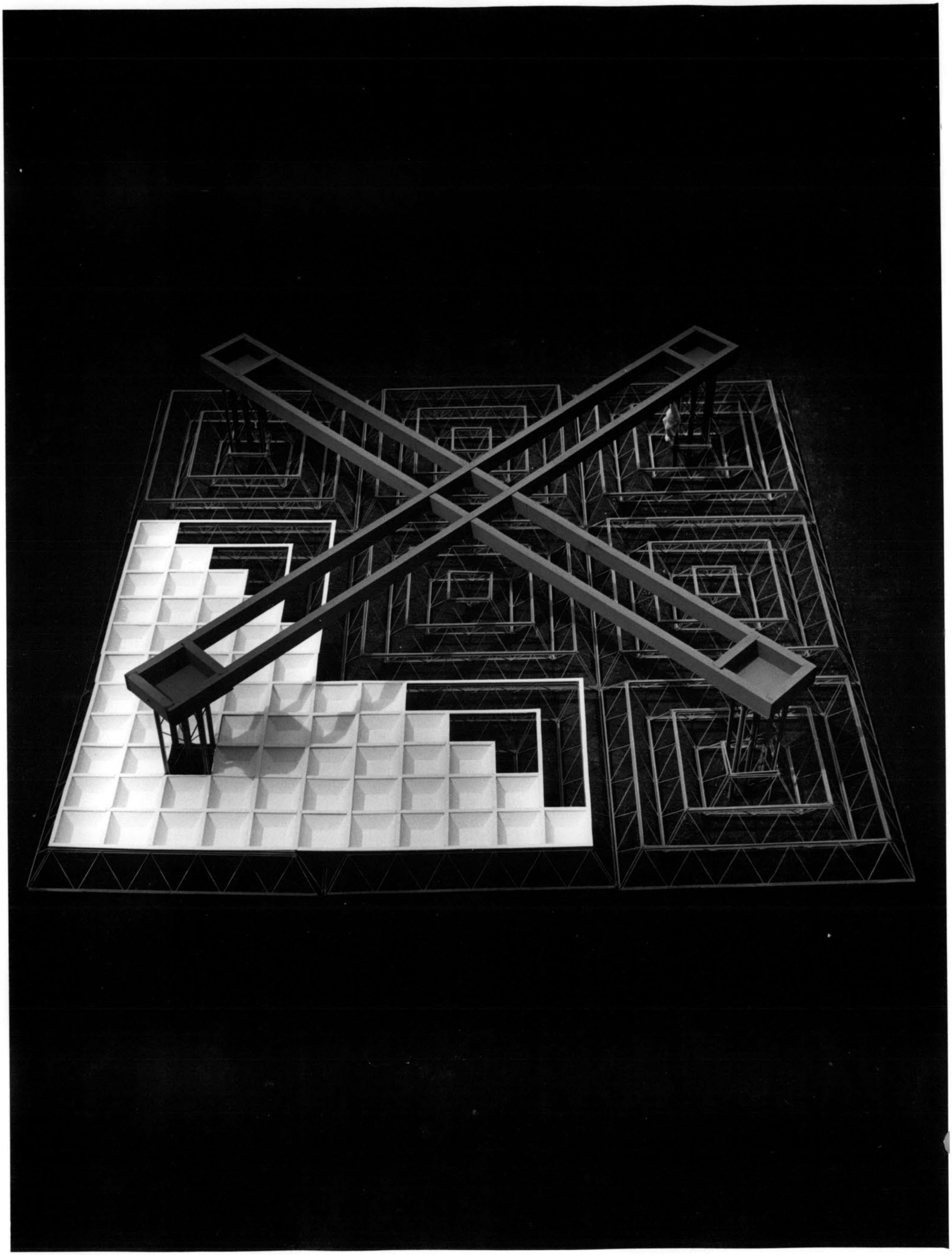
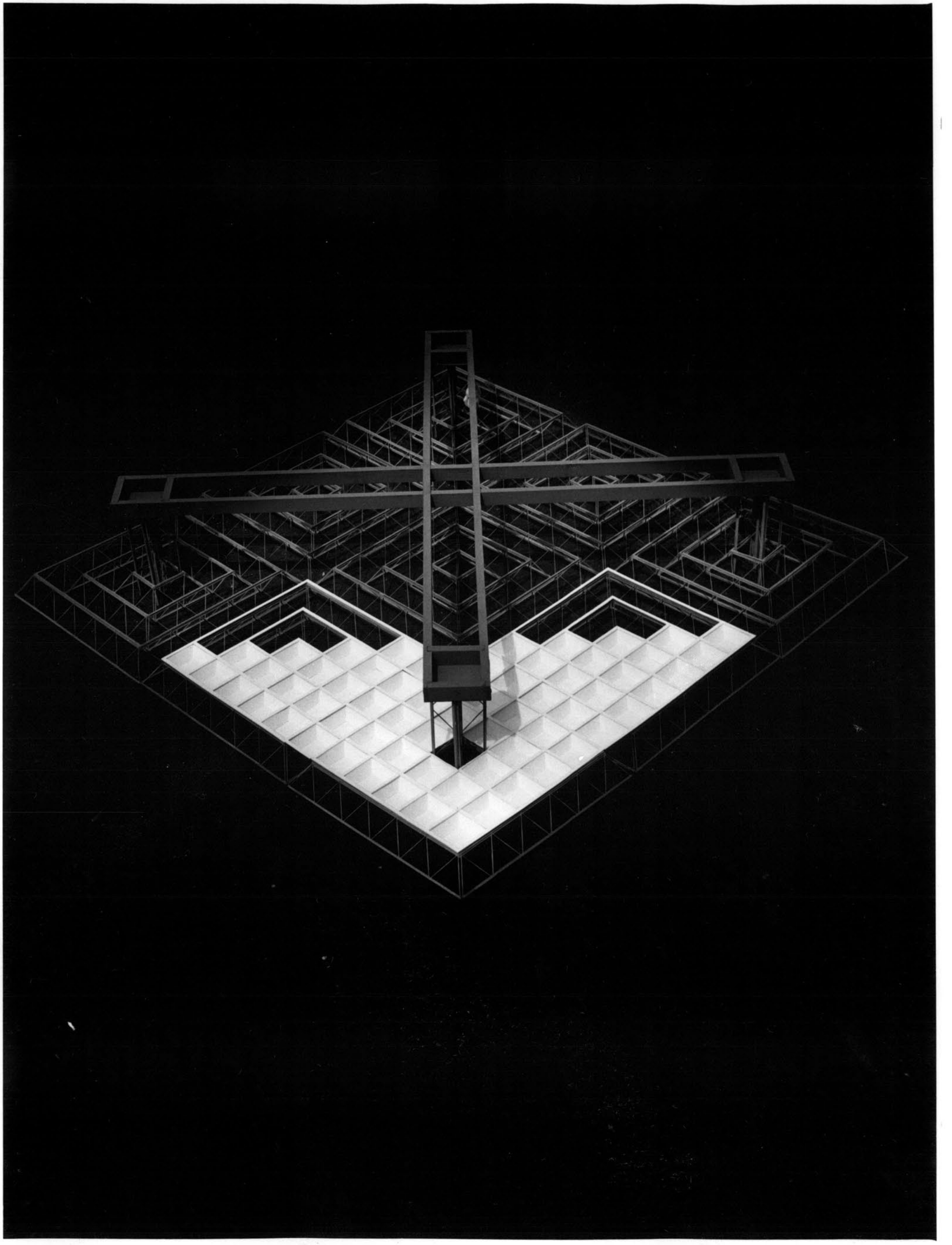
ANTHONY EMMET LAYTON MIT JUNE 1965







"STRESS" PROGRAMMING OF THE STRUCTURE

(See data supplement to this report)

The exact size and shape of the structural members used in this combination of units have been determined by the use of the IBM 7094 computer at the Massachusetts Institute of Technology Computation Center. The method employed is the Structural Engineering Systems Solver or "Stress" system. This programming method, developed in 1963 at M. I. T., makes it unnecessary for the user of the computer to be a programming expert. Rather, it is possible for the designer to specify a structural problem to the computer using engineering language which is then automatically translated into "Fortran" language by the use of a specially prepared tape. "Stress" can analyze a great variety of structures with a minimum of programming effort utilizing a few key words, which are themselves engineering terms, to establish a sequence for the computer to follow. The system can analyze structures of two or three dimensions, with combinations either pinned or of rigid joints, and prismatic or nonprismatic members, which are subjected to concentrated or distributed loadings, support motions, or temperature effects.

Thus the "Stress" system gives the designer the ability to establish member sizing and force concentrations with great accuracy in a short time. Though the system is still in the developmental stage, it is already a powerful tool which the architect or engineer can use on a day to day basis.

The initial problem which has been programmed for the 7094 consists of the basic 30' by 30' structural unit which is centrally supported. The geometry of the structure is established for the computer by locating the joints in space utilizing a global co-ordinate system, and specifying the members which run between the joints. The structure is specified as a "space frame" which automatically assumes that all the joints are rigid, and the hinged connections between the individual trusses indicated by the use of member releases.

Resistance to buckling in the diagonal webs and the top and bottom cords of the structure is crucial as they are subject to axially concentrated compression and tension loadings at the corners. As a result, it was necessary to investigate three trial sections for the top and bottom cords before the final one could be developed which resists buckling equally well in any direction.

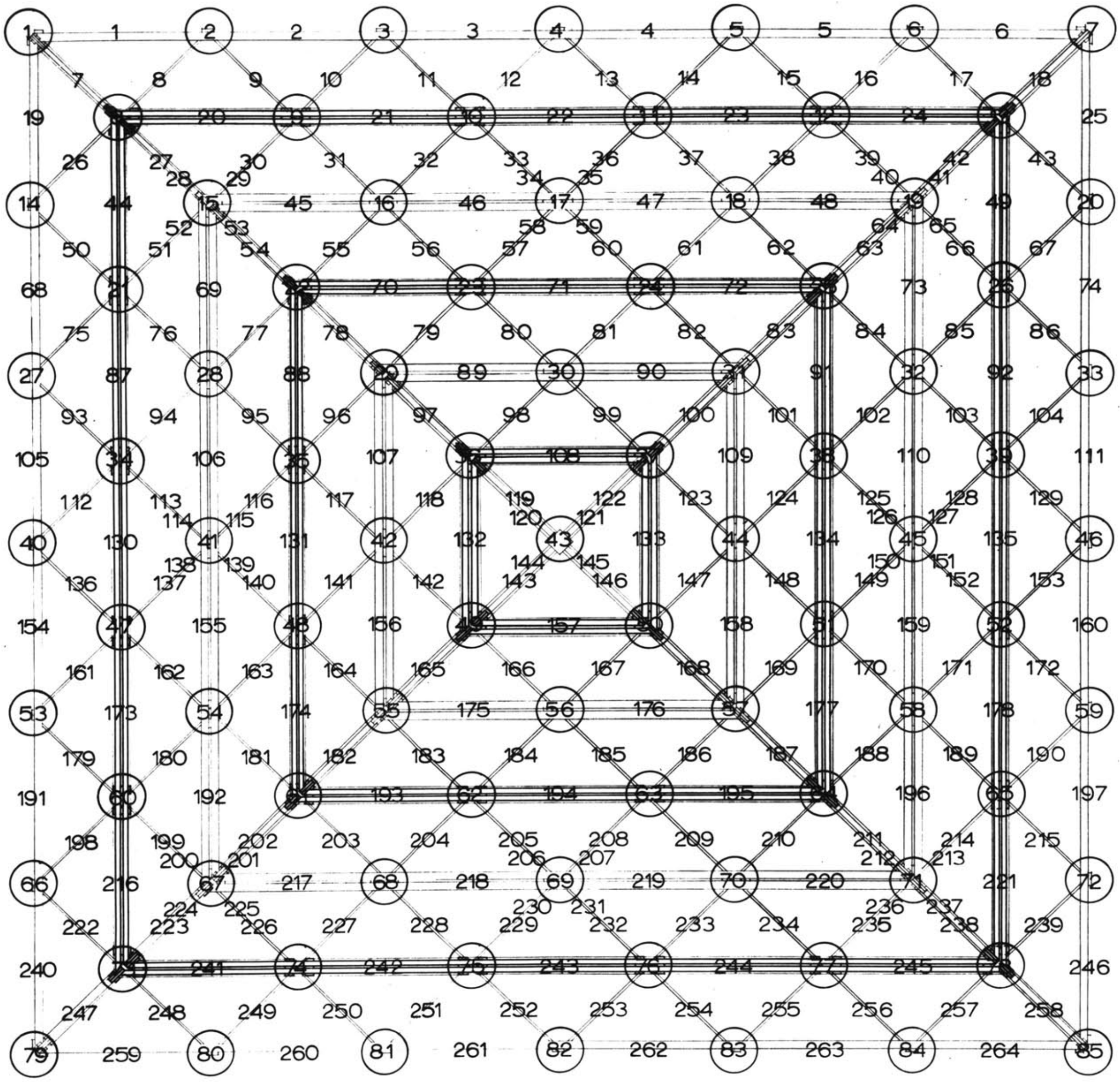
Uniform loadings have been specified on all the top joints of the structure and the initial program fed into the computer, the results analyzed, and section properties of members altered. The problem has then been re-submitted with the addition of 5 modifications representing all the varying conditions which the structure can be subjected to.

The first modification places concentrated loads at all four corners. This condition occurs when the centrally supported element is surrounded on all four sides by other elements. The next modifications place unequal concentrated loadings on three corners, duplicating the conditions when the basic unit occurs at the corner of a building or projects into an opening.

The results indicate that the members chosen are slightly small as the last and most severe loading condition causes a vertical deflection of over 1/240th of the span.

The structure has finally been analysed when acting as a removable filler, uniformly loaded and supported at the four corners, with a number of trusses removed. The results show that the system actually deflects less vertically when a portion is removed, indicating that there is no necessity for the stiffening rings which are used in conventional "space frames."

The "Stress" method of analysis has proven invaluable in determining the correct sizes for the members and also in demonstrating the accuracy of the basic structural theory of the system.



JOINT AND MEMBER LOCATIONS

COMPUTER PROGRAMING

0 .5 1 1.5 2 3 4 5 6 7 8
SCALE IN FEET

PROTOTYPE STRUCTURE FOR A RESEARCH AND DEVELOPMENT BUILDING

MASTER IN ARCHITECTURE THESIS
ANTHONY EMMET LAYTON MIT JUNE 1965

STRUCTURE STRUCTURAL SYSTEM FOR A RESEARCH AND DEVELOPMENT BUILDING

LOADING 1 UNIFORM LOAD,CENTER SUPPORT

JOINT DISPLACEMENTS

JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z DISPLACEMENT	X ROTATION	Y ROTATION	Z ROTATION
		FREE JOINT DISPLACEMENTS				
1	-.0028964	.0122280	-.2622355	-.0002125	.0002866	.0001986
2	.0001125	.1460881	-.3275924	-.0023135	-.0000353	.0003263
3	-.0013624	.0453951	-.2641463	-.0026355	-.0001533	.0001608
4	.0012674	.1652072	-.3303070	-.0033756	-.0000117	-.0000059
5	.0039572	.0441532	-.2624428	-.0026377	.0001184	-.0002001
6	.0026669	.1415324	-.3233843	-.0022905	.0000005	-.0003865
7	.0059670	.0050975	-.2569356	-.0001530	-.0002900	-.0002120
8	.0155797	-.0147896	-.2335929	-.0005395	-.0004831	-.0001554
9	.0119283	-.0537745	-.2082391	-.0020865	-.0004286	-.0007120
10	.0062587	-.0829776	-.1857166	-.0031003	-.0002005	-.0002629
11	-.0031857	-.0838009	-.1847335	-.0031027	.0001679	.0002303
12	-.0090697	-.0564361	-.2053534	-.0020907	.0004035	.0007030
13	-.0131514	-.0186583	-.2298332	-.0005332	.0004802	.0000670
14	-.1158121	.0092056	-.3038343	-.0003054	-.0031975	-.0001852
15	-.0093894	.0163990	-.1908431	-.0007415	-.0010663	.0001877
16	-.0038746	.0500368	-.1264058	-.0017668	-.0010547	.0005767
17	.0006883	.0646903	-.0825699	-.0021668	-.0000111	-.0000201
18	.0050836	.0481911	-.1244723	-.0017504	.0010122	-.0005924
19	.0104869	.0136635	-.1864703	-.0007562	.0010363	-.0002161
20	.1188454	.0017873	-.3038045	-.0002134	.0032890	.0001660
21	.0391830	-.0106958	-.2047320	-.0004361	-.0014145	.0004369
22	.0731319	-.0171542	-.1161274	-.0007456	-.0014639	-.0001706
23	.0682855	-.0583426	-.0344088	-.0006554	-.0013738	-.0007894
24	-.0647971	-.0602316	-.0335097	-.0013693	.0013035	.0008896
25	-.0698667	-.0196994	-.1128640	-.0007574	.0014264	.0001250
26	-.0454332	-.0145024	-.2026516	-.0004074	.0015840	-.0005999
27	-.0205341	.0097521	-.2318495	-.0001470	-.0014417	-.0003079
28	-.0217665	.0127806	-.1560455	-.0004636	-.0015600	-.0001397
29	-.0086206	.0141180	-.0343085	-.0005260	-.0012857	-.0007402
30	-.0000937	-.0334646	.0189881	-.0010398	-.0000179	-.0000141
31	.0083883	.0123588	-.0324507	-.0005190	.0012531	.0007002
32	.0193462	.0096055	-.1499392	-.0004821	.0015613	.0000849
33	.0181253	.0028925	-.2351326	-.0001627	.0015694	.0001143
34	.0453307	-.0082520	-.1826729	-.0003205	-.0016025	-.0000815
35	.0843152	-.0075926	-.0812816	-.0003910	-.0022981	.0001035
38	-.0832280	-.0100636	-.0777945	-.0003888	.0022017	-.0001480
39	-.0599121	-.0119623	-.1819693	-.0002908	.0019887	-.0000135
40	-.1477527	.0098028	-.2879547	-.0002598	-.0042783	-.0001362
41	-.0189003	.0094636	-.1317984	-.0003607	-.0015892	-.0000809
42	-.0258169	.0012003	-.0161805	.0000143	-.0013333	.0001098
43	-.0003287	-.0001060	-.0004436	.0000358	-.0000090	-.0000000
44	.0226464	-.0004738	-.0143128	.0000119	.0012715	-.0001569
45	.0144765	.0054269	-.1261201	-.0003357	.0016195	.0000550
46	.1311748	.0041991	-.2862726	-.0003041	.0041458	-.0000276
47	.0469188	-.0053272	-.1636188	-.0003220	-.0019422	.0000504
48	.0622838	.0004245	-.0706600	.0000304	-.0018497	-.0008434
51	-.0647253	-.0018770	-.0675686	.0000413	.0017865	.0007818
52	-.0603659	-.0092769	-.1638219	-.0003155	.0020520	-.0000009
53	-.0208278	.0103143	-.1933204	-.0007470	-.0013816	.0008550
54	-.0296806	.0051500	-.1141956	-.0001350	-.0012834	.0000615
55	-.0142649	-.0101741	-.0346828	.0004785	-.0005306	-.0000396
56	-.0030390	-.0220564	-.0168596	.0006615	-.0000150	-.0000166
57	.0085688	-.0122258	-.0329353	.0004888	.0004935	-.0000025
58	.0238587	.0006632	-.1108092	-.0000957	.0013090	-.0000798
59	.0152646	.0053586	-.1977814	-.0004756	.0015435	-.0001406
60	.0351298	-.0026870	-.1480026	-.0001901	-.0013426	-.0005632
61	.0129547	.0100737	-.0820874	.0003094	-.0005930	-.0001655
62	.0018939	.0386969	-.0548480	.0008233	-.0002492	.0004941
63	-.0077133	.0381982	-.0541702	.0008349	.0002296	-.0005103
64	-.0188343	.0079486	-.0804759	.0003597	.0005782	.0001128
65	-.0463777	-.0067448	-.1486398	-.0001758	.0016820	.0006158
66	-.0762862	.0108520	-.2011027	-.0003845	-.0020706	.0001644
67	-.0156535	-.0017331	-.1175978	.0002100	-.0005420	-.0000359
68	-.0092012	-.0196745	-.0921945	.0008046	-.0002471	-.0001495
69	-.0037796	-.0148002	-.0867376	.0012013	-.0000039	-.0000205
70	.0016726	-.0220440	-.0916551	.0008308	.0002390	.0001122
71	.0082384	-.0063429	-.1168408	.0002685	.0005490	-.0000065
72	.1150282	.0060963	-.2305707	-.0003841	.0032004	-.0001911
73	.0032229	.0014186	-.1407444	-.0000167	-.0002581	.0000394
74	-.0007370	.0342970	-.1296076	.0011687	-.0001419	.0005242
75	-.0031065	.0477322	-.1260613	.0016377	.0000077	.0000620
76	-.0056649	.0470277	-.1260647	.0016369	-.0000051	-.0000840
77	-.0081613	.0321744	-.1297281	.0011533	.0001371	-.0005562
78	-.0123671	-.0026027	-.1417681	-.0000220	.0003288	-.0000579
79	-.0071365	.0070753	-.1453796	.0000096	.0007319	-.0008731
80	-.0034544	-.1331256	-.2244681	.0016206	-.0000104	-.0000495
81	-.0042899	-.0123735	-.1604674	.0013043	.0000106	.0000797
82	-.0046615	-.1281773	-.2302117	.0020603	.0000193	-.0000539
83	-.0050047	-.0144565	-.1608802	.0012885	-.0000675	.0000357
84	-.0056362	-.1234348	-.2174645	.0013627	-.0000502	.0001767
85	-.0017071	.0021584	-.1471186	-.0004568	-.0003669	.0000901

STRUCTURE STRUCTURAL SYSTEM FOR A RESEARCH AND DEVELOPMENT BUILDING

LOADING 2 EQUAL POINT LOADS ON ALL CORNERS,CENTER SUPPORT

JOINT DISPLACEMENTS

JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z DISPLACEMENT	X ROTATION	Y ROTATION	Z ROTATION
		FREE JOINT DISPLACEMENTS				
1	-.0719159	.0932554	-1.1816952	-.0041845	-.0032940	.0004084
2	-.0488583	.2367072	-1.0418022	-.0067541	-.0026917	.0003535
3	-.0301165	.1309961	-.8575517	-.0081442	-.0018507	.0000275
4	.0022704	.2460226	-.8757699	-.0084436	-.0000175	-.0000218
5	.0347225	.1282789	-.8553603	-.0081423	.0018150	-.0000768
6	.0536629	.2305118	-1.0373950	-.0067579	.0026555	-.0004245
7	.0770347	.0815028	-1.1748584	-.0041723	.0032422	-.0005274
8	.1022721	-.1045740	-.9216970	-.0038646	-.0035455	-.0002649
9	.0729400	-.1968174	-.7200317	-.0066644	-.0029350	-.0017901
10	.0307265	-.2736287	-.5853063	-.0091709	-.0011988	-.0006908
11	-.0259955	-.2751507	-.5841011	-.0091718	.0011586	.0006344
12	-.0684189	-.2015444	-.7164978	-.0066665	.0029036	.0017612
13	-.0981738	-.1118936	-.9168680	-.0038445	.0035343	.0001415
14	-.1686182	.0701867	-.9846033	-.0037557	-.0061700	.0002342
15	-.0514188	.0750208	-.6772542	-.0034916	-.0046373	.0007269
16	-.0247243	.1669506	-.4042735	-.0062851	-.0042810	.0016939
17	.0009545	.2197086	-.2319772	-.0069941	-.0000081	-.0000358
18	.0264984	.1637233	-.4019070	-.0062324	.0042273	-.0017306
19	.0531209	.0693759	-.6721305	-.0035168	.0045969	-.0007795
20	.1660411	.0581180	-.9799040	-.0036777	.0061266	-.0003447
21	.1588497	-.0746630	-.7097882	-.0029718	-.0044226	.0009863
22	.2589574	-.0654593	-.3855474	-.0028596	-.0053130	-.0006870
23	.2426167	-.1881816	-.0853669	-.0023501	-.0050300	-.0022812
24	-.2390649	-.1907069	-.0842272	-.0045236	.0048951	.0025587
25	-.2556623	-.0699095	-.3817964	-.0028825	.0052920	.0005666
26	-.1651002	-.0819172	-.7070188	-.0029318	.0045047	-.0011580
27	-.0375809	.0502044	-.7553657	-.0021965	-.0040294	.0004173
28	-.0619660	.0540045	-.5003965	-.0023415	-.0054157	-.0000861
29	-.0274934	.0447297	-.1031006	-.0017179	-.0044356	-.0026437
30	-.0003809	-.1406088	.0827280	-.0033500	-.0000319	-.0000246
31	.0266677	.0420230	-.1004778	-.0017125	.0044033	.0025879
32	.0584891	.0479139	-.4938986	-.0023505	.0054683	-.0000044
33	.0341760	.0386493	-.7581000	-.0020524	.0042380	-.0002828
34	.1726978	-.0446834	-.5755103	-.0016020	-.0048181	-.0002129
35	.2695319	-.0318333	-.2487120	-.0015338	-.0071025	-.0000555
38	-.2708440	-.0362178	-.2447655	-.0015263	.0070133	-.0000214
39	-.1890376	-.0518341	-.5745204	-.0015927	.0048216	.0000076
40	-.1253605	.0309513	-.7077927	-.0012315	-.0059265	.0002051
41	-.0494367	.0299383	-.3943359	-.0012775	-.0050930	-.0002819
42	-.0717219	.0023060	-.0432358	.0000495	-.0039854	.0004640
43	-.0005738	-.0003889	-.0004330	.0001285	-.0000154	-.0000000
44	.0664309	-.0005125	-.0401234	.0000433	.0039107	-.0005432
45	.0419378	.0230233	-.3884847	-.0012485	.0051933	.0002317
46	.1349790	.0206045	-.7233010	-.0011382	.0065719	-.0000669
47	.1705731	-.0126705	-.5061932	-.0007037	-.0047437	.0000148
48	.1932262	-.0014010	-.2102217	.0002250	-.0055134	-.0024938
51	-.2001367	-.0056067	-.2066436	.0002234	.0054644	.0024109
52	-.1885498	-.0199904	-.5066219	-.0006755	.0050502	.0000107
53	-.0401527	.0115613	-.6139529	.0001018	-.0040431	-.0014123
54	-.0894341	.0034577	-.3514287	.0001417	-.0044431	-.0001512
55	-.0418638	-.0349557	-.1041775	.0015418	-.0017309	-.0001501
56	-.0052832	-.0663723	-.0447829	.0019658	-.0000236	-.0000287
57	.0318862	-.0386271	-.1014863	.0015616	.0016775	.0000700
58	.0788561	-.0040400	-.3480068	.0001862	.0045302	.0000955
59	.0279215	.0020017	-.6183984	-.0003319	.0041414	.0002605
60	.1438425	.0174717	-.5033764	.0007471	-.0050884	-.0013040
61	.0504474	.0322105	-.2611063	.0012351	-.0022147	-.0005501
62	.0120571	.1056594	-.1560628	.0024549	-.0009671	.0013080
63	-.0235097	.1049004	-.1551752	.0024860	.0009448	-.0013350
64	-.0621355	.0282651	-.2595006	.0013590	.0022063	.0004419
65	-.1620992	.0100742	-.5049313	.0007491	.0048608	.0012910
66	-.2443809	-.0099557	-.7426693	.0014779	-.0072971	-.0003626
67	-.0674444	-.0284542	-.4117377	.0015999	-.0028012	-.0001054
68	-.0368269	-.0620090	-.2756454	.0028680	-.0014281	-.0001256
69	-.0070762	-.0409455	-.2394612	.0035060	-.0000039	-.0000356
70	.0226521	-.0660828	-.2753438	.0028845	.0014256	.0000629
71	.0533293	-.0362789	-.4115100	.0016811	.0028101	.0000341
72	.1607199	-.0188917	-.7060783	.0014411	.0058066	.0003197
73	.0673336	.0474352	-.5849636	.0017307	-.0030159	.0000579
74	.0374342	.1203538	-.4324592	.0031695	-.0018786	.0011279
75	.0074634	.1436631	-.3635033	.0038875	-.0004997	.0000285
76	-.0242517	.1423410	-.3637707	.0039071	.0005052	-.0000693
77	-.0543827	.1163548	-.4333511	.0032383	.0019153	-.0011931
78	-.0846112	.0400246	-.5873007	.0017657	.0029663	-.0000516
79	-.0778236	-.0355516	-.7603397	.0011585	-.0034672	.0009952
80	-.0521059	-.1278007	-.6261190	.0028974	-.0023296	.0000444
81	-.0307607	-.0143210	-.4771444	.0031854	-.0008945	-.0000432
82	-.0088382	-.1293024	-.5161251	.0037533	-.0000107	.0000161
83	.0130805	-.0184289	-.4785364	.0032455	.0010075	-.0002321
84	.0345064	-.1545072	-.6399847	.0033177	.0024485	-.0003052
85	.0603014	-.0446911	-.7635333	.0018688	.0029680	.0000962

STRUCTURE STRUCTURAL SYSTEM FOR A RESEARCH AND DEVELOPMENT BUILDING

LOADING 3 UNEQUAL POINT LOADS ON 2 CORNERS, CENTER SUPPORT

JOINT DISPLACEMENTS

JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z DISPLACEMENT	X ROTATION	Y ROTATION	Z ROTATION
			FREE JOINT DISPLACEMENTS			
1	-.1003979	.1736531	-1.7486351	-.0072978	-.0049974	.0003954
2	-.0852679	.3036572	-1.4966858	-.0090855	-.0049095	.0000182
3	-.0725888	.1784076	-1.1634331	-.0094383	-.0042773	-.0002665
4	-.0544137	.2766845	-1.0063885	-.0089311	-.0032575	-.0003211
5	-.0342262	.1380088	-.7702180	-.0074595	-.0020535	-.0005043
6	-.0288937	.2146063	-.6981993	-.0057037	-.0019338	-.0007681
7	-.0171550	.0587940	-.5367378	-.0024802	-.0017164	-.0003909
8	.1670643	-.1882918	-1.3503343	-.0069699	-.0053446	-.0001818
9	.1454714	-.2446907	-1.0404713	-.0086309	-.0048262	-.0010020
10	.1167013	-.2780334	-.7821672	-.0097290	-.0035884	-.0000657
11	.0790750	-.2491568	-.6138703	-.0087247	-.0020132	.0010022
12	.0538429	-.1619825	-.5334153	-.0058479	-.0010395	.0018383
13	.0393531	-.0724678	-.4777820	-.0026297	-.0008743	.0001687
14	-.1874784	.1585108	-1.3640608	-.0070416	-.0075842	.0004045
15	-.0850321	.1563706	-.9639908	-.0063886	-.0058301	.0005053
16	-.0630507	.2108907	-.6257176	-.0077877	-.0053581	.0008310
17	-.0450764	.2206287	-.3681963	-.0077115	-.0022258	-.0004836
18	-.0291219	.1565808	-.3538116	-.0060083	.0006779	-.0016893
19	-.0139104	.0669609	-.3996170	-.0028060	.0006843	-.0006618
20	.0921635	.0470474	-.4520821	-.0021029	.0019596	.0001449
21	.2013079	-.1679772	-.9491642	-.0062563	-.0058398	.0004756
22	.2483944	-.1301365	-.5704829	-.0055476	-.0059176	-.0006495
23	.2291016	-.2239398	-.2341884	-.0052605	-.0055806	-.0014953
24	-.1228074	-.1812707	-.1385074	-.0047240	.0017419	.0025587
25	-.1308200	-.0621469	-.2446363	-.0027476	.0019775	.0005111
26	-.0216388	-.0587277	-.3331397	-.0021530	.0004450	-.0010907
27	-.0591466	.1483135	-.9225238	-.0058157	-.0051190	.0000333
28	-.0834539	.1385647	-.6083182	-.0053911	-.0058623	.0002445
29	-.0674430	.1192159	-.1899590	-.0035297	-.0047331	-.0017239
30	-.0357529	-.0291323	.0168448	-.0042520	-.0009222	-.0005796
31	-.0165932	.0665619	-.0695731	-.0018164	.0022364	.0013942
32	-.0002795	.0588109	-.2537066	-.0021345	.0016740	.0002355
33	-.0087210	.0431197	-.2915525	-.0015678	.0006842	.0001375
34	.1880531	-.1520342	-.6027955	-.0054416	-.0056725	-.0006490
35	.2316386	-.0986581	-.2817421	-.0038770	-.0064755	-.0009615
38	-.1465554	-.0420472	-.1094754	-.0016782	.0032761	.0000831
39	-.0494416	-.0492868	-.2201201	-.0017040	.0011788	-.0001772
40	-.1771796	.1475053	-.6383083	-.0059477	-.0069012	-.0000442
41	-.0468478	.1226827	-.3143228	-.0045300	-.0042400	.0003620
42	-.0704139	.0794279	-.0423578	-.0015015	-.0033510	.0008536
43	-.0078798	.0194588	-.0004368	-.0003975	-.0002070	-.0000000
44	-.0007633	.0427093	-.0003337	-.0006019	.0011278	-.0001863
45	-.0080200	.0519653	-.1374717	-.0017709	.0015842	-.0000525
46	.1077040	.0404384	-.2664586	-.0014647	.0036423	.0000542
47	.1292176	-.1396981	-.2827630	-.0051794	-.0040776	-.0010765
48	.1056140	-.0810585	-.0924909	-.0028788	-.0031629	-.0025610
51	-.0905731	-.0312879	-.0338852	-.0011182	.0020028	.0012207
52	-.0635786	-.0424649	-.1203556	-.0016286	.0016152	-.0002023
53	-.0307971	.1435711	-.2036751	-.0062356	-.0024877	.0015481
54	-.0416813	.1114248	-.0538267	-.0040550	-.0020284	.0002570
55	-.0193822	.0688449	.0281308	-.0014660	-.0001906	.0004065
56	-.0160829	.0630798	.0259823	-.0012415	.0000289	-.0004333
57	-.0124290	.0354713	.0269041	-.0006643	.0001074	-.0003161
58	.0008309	.0470318	-.0355278	-.0015727	.0011234	.0000820
59	-.0014978	.0410801	-.1111473	-.0016360	.0013713	-.0000106
60	.0510960	-.1315698	.0166972	-.0048928	-.0016917	-.0017151
61	-.0107698	-.0729519	.0871942	-.0030910	-.0001620	-.0005320
62	-.0210450	-.0400728	.0901618	-.0022080	.0001252	.0007012
63	-.0291642	-.0261935	.0718861	-.0016656	.0004462	-.0000723
64	-.0367780	-.0265497	.0379113	-.0012447	.0006364	.0003306
65	-.0637659	-.0386526	-.0271790	-.0014974	.0017200	.0002162
66	-.0441766	.1448059	.1330438	-.0057011	-.0010756	.0002346
67	-.0182220	.1019256	.1774196	-.0038329	.0000713	-.0000672
68	-.0131868	.0673097	.1634739	-.0027639	.0003974	-.0005418
69	-.0099047	.0534080	.1326533	-.0019935	.0005699	-.0001776
70	-.0071485	.0413383	.0960120	-.0016179	.0006715	-.0000957
71	-.0040028	.0413865	.0510928	-.0013566	.0008264	-.0000715
72	.1066277	.0409099	-.0802693	-.0014862	.0036402	-.0000542
73	-.0394242	-.1259220	.3087161	-.0048005	.0006085	-.0003128
74	-.0452829	-.0798361	.2683872	-.0029269	.0007408	.0008498
75	-.0479441	-.0555296	.2172774	-.0018976	.0009062	.0002614
76	-.0491773	-.0380468	.1653891	-.0012498	.0008104	.0002507
77	-.0501130	-.0291516	.1159124	-.0010479	.0008614	-.0000134
78	-.0525763	-.0360320	.0622567	-.0014586	.0010022	-.0000414
79	-.0109622	.1379724	.4788224	-.0046286	.0019448	-.0016349
80	-.0042868	-.0337989	.3292651	-.0025635	.0011193	-.0003945
81	-.0050680	.0717364	.3236977	-.0025147	.0010677	-.0001464
82	-.0034606	-.0584070	.1832292	-.0011327	.0011727	-.0003106
83	-.0048575	.0404407	.1825562	-.0012991	.0009659	-.0002075
84	-.0050078	-.0811083	.0596269	-.0005879	.0009486	.0000053
85	-.0035474	.0394377	.0759338	-.0018045	.0004048	.0001163

STRUCTURE STRUCTURAL SYSTEM FOR A RESEARCH AND DEVELOPMENT BUILDING

LOADING 4 UNEQUAL POINT LOADS ON 3 CORNERS,CENTER SUPPORT

JOINT DISPLACEMENTS

FREE JOINT DISPLACEMENTS

JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z DISPLACEMENT	X ROTATION	Y ROTATION	Z ROTATION
1	.0318606	-.0231167	-.1597651	-.0019506	.0042414	.0008856
2	.0435475	.1665786	-.4739599	-.0055966	.0044783	.0013655
3	.0488471	.1235650	-.6967012	-.0078094	.0044592	.0009963
4	.0733996	.2886053	-1.0859711	-.0096842	.0059165	.0007425
5	.0959371	.2179479	-1.4100695	-.0107209	.0071855	.0007975
6	.1143619	.3782029	-1.9290053	-.0105057	.0082170	.0005683
7	.1352192	.2788680	-2.3923559	-.0089998	.0085419	.0000264
8	-.1360623	-.1146885	-.1914776	-.0020554	.0032230	.0002072
9	-.1505566	-.1932586	-.3845102	-.0058329	.0032755	-.0017896
10	-.1792184	-.2802836	-.5980513	-.0093770	.0043239	-.0009794
11	-.2237104	-.3038672	-.9136602	-.0108753	.0061937	.0002212
12	-.2595325	-.2560502	-1.3380175	-.0099836	.0077919	.0013585
13	-.2883196	-.1732378	-1.8361175	-.0085076	.0085702	.0006307
14	-.0519207	-.0348115	-.1120562	-.0014212	.0004107	.0002239
15	.0482603	.0141884	-.1966460	-.0024089	.0013380	.0011949
16	.0615325	.1342989	-.2652172	-.0062344	.0011074	.0023397
17	.0787377	.2439197	-.3886225	-.0084182	.0043277	.0012204
18	.1017297	.2674655	-.7938821	-.0089286	.0081117	-.0005254
19	.1317563	.2251679	-1.3084641	-.0076475	.0088978	-.0001760
20	.2424568	.2579973	-1.8995554	-.0087637	.0107687	-.0001605
21	-.0375139	-.1021195	-.0777227	-.0016927	.0016901	.0018687
22	.0884298	-.0836381	-.1119089	-.0023631	-.0003551	-.0003766
23	.0855040	-.1954675	-.0964743	-.0028021	-.0003296	-.0021596
24	-.3189409	-.2458878	-.2892161	-.0076565	.0080688	.0024880
25	-.3464500	-.1228577	-.7813130	-.0065387	.0086891	.0008706
26	-.2918360	-.1443295	-1.3501601	-.0074646	.0087455	.0001316
27	.0649242	-.0363720	.0070321	-.0009652	.0011964	-.0000091
28	.0654395	.0088066	-.0723984	-.0018409	.0004091	.0001527
29	.0687779	.0389895	-.0034920	-.0014166	-.0010911	-.0010643
30	.0828139	-.0455184	.0265802	-.0045892	.0020466	.0010630
31	.1246924	.1555641	-.2754776	-.0042710	.0068052	.0026900
32	.1605782	.1997884	-.8908509	-.0062050	.0090910	.0001399
33	.1208037	.2392463	-1.3691736	-.0070194	.0077281	-.0000665
34	.0306534	-.0940303	.0104686	-.0013313	.0002601	.0005192
35	.1190125	-.0677108	.0049436	-.0014862	-.0012963	.0002970
38	-.3149554	-.0804511	-.4447254	-.0044099	.0099044	.0014022
39	-.2375438	-.1191382	-.9456560	-.0062151	.0077075	.0013282
40	-.0464179	-.0355327	-.0061510	-.0010445	-.0023028	.0001523
41	.0902357	.0030923	.0298226	-.0015582	.0003036	.0003654
42	.0885736	.0214515	.0513300	-.0005597	.0010383	.0008354
43	.0284669	.0194137	-.0004318	-.0004113	.0007513	.0000000
44	.1699045	.1009143	-.1011893	-.0015331	.0063438	-.0006806
45	.1380406	.1772035	-.5588160	-.0050124	.0070898	-.0000031
46	.2364612	.2287278	-1.0178546	-.0066400	.0087387	.0001946
47	.0702221	-.0894479	.0917180	-.0013768	-.0001149	.0006553
48	.0939326	-.0596441	.0741135	-.0010365	-.0000730	-.0006046
51	-.1420601	-.0537515	-.2404537	-.0028939	.0059434	.0036559
52	-.1538879	-.0960397	-.5919220	-.0055458	.0063066	.0014257
53	.1045237	-.0320108	.1431934	-.0017857	.0003065	.0014508
54	.1038446	-.0004248	.1200880	-.0014110	.0005104	.0002825
55	.1148258	.0155917	.0841084	-.0007672	.0005028	-.0001910
56	.1198663	-.0089364	.0619197	-.0015771	.0009971	.0007154
57	.1291478	.0814482	-.0480344	-.0010923	.0024487	.0006323
58	.1632305	.1583766	-.2779139	-.0041746	.0045868	.0001658
59	.1388727	.2158145	-.5752753	-.0059201	.0048411	.0002709
60	.0970732	-.0870832	.1725236	-.0013322	.0001645	.0002375
61	.0742307	-.0570433	.1432014	-.0012920	.0008035	.0000752
62	.0678474	-.0336262	.0963452	-.0011735	.0008039	.0006190
63	.0558442	-.0128905	.0381453	-.0014540	.0013716	-.0004164
64	.0363927	-.0366446	-.0687247	-.0028531	.0020537	.0010374
65	-.0473956	-.0784719	-.2833513	-.0047954	.0045624	.0023519
66	.0843270	-.0309101	.1992956	-.0014165	-.0002759	.0004313
67	.1286392	-.0048956	.1998319	-.0012826	.0006460	.0004367
68	.1314919	.0202299	.1592790	-.0014426	.0007377	.0004864
69	.1363435	.0497140	.1113694	-.0015177	.0008782	.0003629
70	.1445122	.0762464	.0486871	-.0023059	.0013543	.0009308
71	.1567629	.1405121	-.0546963	-.0034880	.0020329	.0004207
72	.2657400	.2092950	-.2896348	-.0053469	.0051803	.0002745
73	.1111507	-.0851213	.2518674	-.0012647	.0005479	.0004023
74	.1082783	-.0557939	.2176888	-.0008144	.0005758	.0004265
75	.1050822	-.0377032	.1794856	-.0009762	.0007061	.0001977
76	.0997152	-.0288443	.1365548	-.0015575	.0007556	.0001913
77	.0915039	-.0293164	.0812455	-.0026001	.0011951	-.0006106
78	.0787292	-.0647268	-.0064844	-.0044984	.0017140	.0006462
79	.1514663	-.0321044	.3049124	-.0009003	.0016228	-.0008156
80	.1525291	-.1482704	.1882138	-.0000099	.0004263	.0006034
81	.1532483	.0161414	.2345894	-.0010937	.0004452	.0008203
82	.1543819	-.0583746	.1432004	-.0009142	.0004905	.0006162
83	.1598059	.0954533	.1826534	-.0022340	.0006136	.0007329
84	.1644096	.0293220	.0843868	-.0026937	.0009515	.0009090
85	.1776970	.1959980	.0754710	-.0050135	.0011333	.0006722

PART 1 CF PROBLEM COMPLETED.

STRUCTURE STRUCTURAL SYSTEM FOR A RESEARCH AND DEVELOPMENT BUILDING

LOADING 1 UNIFORM LOAD,CORNER SUPPORTS

JOINT DISPLACEMENTS

JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z DISPLACEMENT	X ROTATION	Y ROTATION	Z ROTATION
		FREE JOINT DISPLACEMENTS				
2	.0020891	.0343418	-.0867078	.0000954	.0011788	-.0000091
3	.0018834	.0033884	-.1095101	.0007766	.0005559	.0002820
4	-.0000753	.0568998	-.1545147	.0002677	-.0000004	-.0000026
5	-.0020253	.0031434	-.1094839	.0007796	-.0005554	-.0002838
6	-.0021696	.0341639	-.0867470	.0000991	-.0011785	.0000125
8	-.0325009	.0289982	-.0552633	.0009205	.0009523	.0000276
9	-.0228039	.0388767	-.1099524	.0006289	.0007450	.0002052
10	-.0085329	.0474266	-.1427570	.0007755	.0002972	.0000676
11	.0082003	.0475195	-.1428661	.0007775	-.0002935	-.0000628
12	.0225789	.0392014	-.1102607	.0006306	-.0007456	-.0002106
13	.0324922	.0289827	-.0552989	.0009181	-.0009584	-.0000162
14	-.0348683	-.0020367	-.0836364	.0011747	-.0003558	-.0000279
15	.0079371	-.0075360	-.1112566	.0005116	.0008814	-.0001089
16	.0043984	-.0071332	-.1609791	.0006501	.0007348	-.0000580
17	-.0003499	-.0135337	-.1897017	.0005467	.0000033	-.0000002
18	-.0050310	-.0072428	-.1614046	.0006684	-.0007269	.0000512
19	-.0085374	-.0079329	-.1121589	.0005566	-.0008762	.0001151
20	.0376459	-.0018681	-.0846484	.0011794	.0003965	.0000709
21	-.0354969	.0190648	-.1030869	.0006132	.0005814	-.0000126
22	-.0344956	.0027201	-.1463655	.0001956	.0006940	.0000988
23	-.0333993	.0076124	-.1874468	.0001619	.0006860	.0000484
24	.0316088	.0082645	-.1879074	.0001277	-.0006780	-.0000686
25	.0328978	.0033594	-.1475250	.0002058	-.0006779	-.0000960
26	.0376876	.0190365	-.1030868	.0006100	-.0005998	.0000609
27	-.0128214	-.0015405	-.1084666	.0006514	.0002377	-.0005499
28	-.0038184	-.0048648	-.1376318	.0003204	.0005807	-.0001521
29	.0004995	-.0006029	-.1718054	-.0000461	.0005134	.0003476
30	-.0006530	.0302947	-.1941951	.0001023	.0000101	.0000070
31	-.0016893	-.0001589	-.1729949	-.0000236	-.0004929	-.0003567
32	.0033395	-.0050310	-.1398046	.0003298	-.0006306	.0001554
33	.0121805	-.0013851	-.1061463	.0005096	-.0003619	.0003341
34	-.0333211	.0063616	-.1270153	.0001899	.0004094	.0000092
35	-.0247366	-.0007939	-.1553445	.0000545	.0004505	.0001814
36	-.0019527	-.0065909	-.1712661	-.0001889	.0000221	.0000089
37	-.0012509	-.0046151	-.1722798	-.0001566	.0000134	.0000199
38	.0231478	-.0002166	-.1571895	.0000653	-.0004216	-.0001790
39	.0375719	.0063294	-.1269975	.0002032	-.0003543	-.0000065
40	-.0840858	-.0002102	-.1620208	.0000888	-.0013721	-.0001672
41	-.0065044	-.0005758	-.1475273	.0000119	.0003833	.0000254
42	-.0006247	.0022685	-.1662176	-.0001784	.0002155	-.0000860
43	-.0002791	.0025269	-.1677029	-.0001788	.0000259	.0000208
44	-.0016420	.0030121	-.1686959	-.0001628	-.0002294	.0000691
45	.0059985	-.0003792	-.1501261	.0000134	-.0004612	-.0000360
46	.0665709	-.0002099	-.1492856	.0000030	.0008578	.0000034
47	-.0334503	-.0070819	-.1270011	-.0001951	.0001778	-.0000037
48	-.0145663	-.0048075	-.1507522	-.0001997	.0002169	.0001497
49	-.0020662	-.0074545	-.1603769	-.0001915	.0000452	.0000172
50	-.0012282	-.0051227	-.1633810	-.0001563	.0000437	.0000192
51	.0130927	-.0043671	-.1529145	-.0002030	-.0002070	-.0001564
52	.0371953	-.0070386	-.1268843	-.0002064	-.0003847	-.0000069
53	-.0104212	.0011343	-.1074287	-.0010875	.0003427	.0013854
54	-.0010819	.0038824	-.1386885	-.0003244	.0004366	.0001814
55	.0007873	.0043771	-.1512831	-.0002618	.0001692	.0000449
56	-.0014119	.0057397	-.1588727	-.0002356	.0000247	.0000138
57	-.0035341	.0055922	-.1540741	-.0002669	-.0001441	-.0000424
58	.0000042	.0045912	-.1409065	-.0003476	-.0005004	-.0001783
59	.0124733	.0010112	-.1065046	-.0005045	-.0003470	-.0003346
60	-.0333408	-.0198447	-.1031589	-.0006298	.0009129	.0000678
61	-.0074302	-.0081220	-.1345121	-.0002899	.0002639	.0000709
62	-.0035115	-.0063169	-.1490252	-.0001642	.0001497	.0000026
63	.0011854	-.0066799	-.1498166	-.0001792	-.0001300	-.0000040
64	.0054412	-.0079229	-.1359015	-.0003100	-.0002581	-.0000680
65	.0363007	-.0197166	-.1025497	-.0006228	-.0006442	-.0000887
66	.0231108	.0020025	-.0516341	-.0010585	.0008778	-.0001987
67	.0087967	.0077861	-.1092218	-.0006220	.0006217	.0000088
68	.0047816	-.0009320	-.1401401	-.0005215	.0003506	-.0001537
69	-.0004340	-.0044779	-.1506072	-.0003553	.0000063	.0000070
70	-.0056507	-.0001221	-.1408079	-.0005229	-.0003412	.0001683
71	-.0097174	.0089689	-.1101504	-.0006182	-.0006266	-.0000204
72	.0376991	.0016392	-.0849466	-.0011848	.0004507	-.0000741
73	-.0289650	-.0299838	-.0540784	-.0009312	.0009155	-.0000290
74	-.0192779	-.0365831	-.1022884	-.0004526	.0005999	-.0000937
75	-.0067573	-.0373139	-.1265629	-.0003256	.0002091	.0000226
76	.0064937	-.0373960	-.1266171	-.0003330	-.0002056	-.0000281
77	.0191419	-.0367933	-.1023732	-.0004689	-.0006148	.0001097
78	.0290875	-.0296064	-.0535868	-.0009442	-.0008805	-.0000088
80	.0017674	-.0384515	-.0850939	.0000625	.0011473	-.0000902
81	.0012428	-.0127021	-.1061835	-.0003778	.0005158	-.0003460
82	-.0000701	-.0680594	-.1497872	.0000991	-.0000033	.0000063
83	-.0013721	-.0121485	-.1058800	-.0003954	-.0005174	.0003483
84	-.0018442	-.0381737	-.0848532	.0000671	-.0011436	.0000827

PART 1 OF PROBLEM COMPLETED.

STRUCTURE STRUCTURAL SYSTEM FOR A RESEARCH AND DEVELOPMENT BUILDING

MODIFICATION OF LAST PART SMALL HOLE IN CENTER,CORNER SUPPORTS

LOADING 1 UNIFORM LOAD,CORNER SUPPORTS

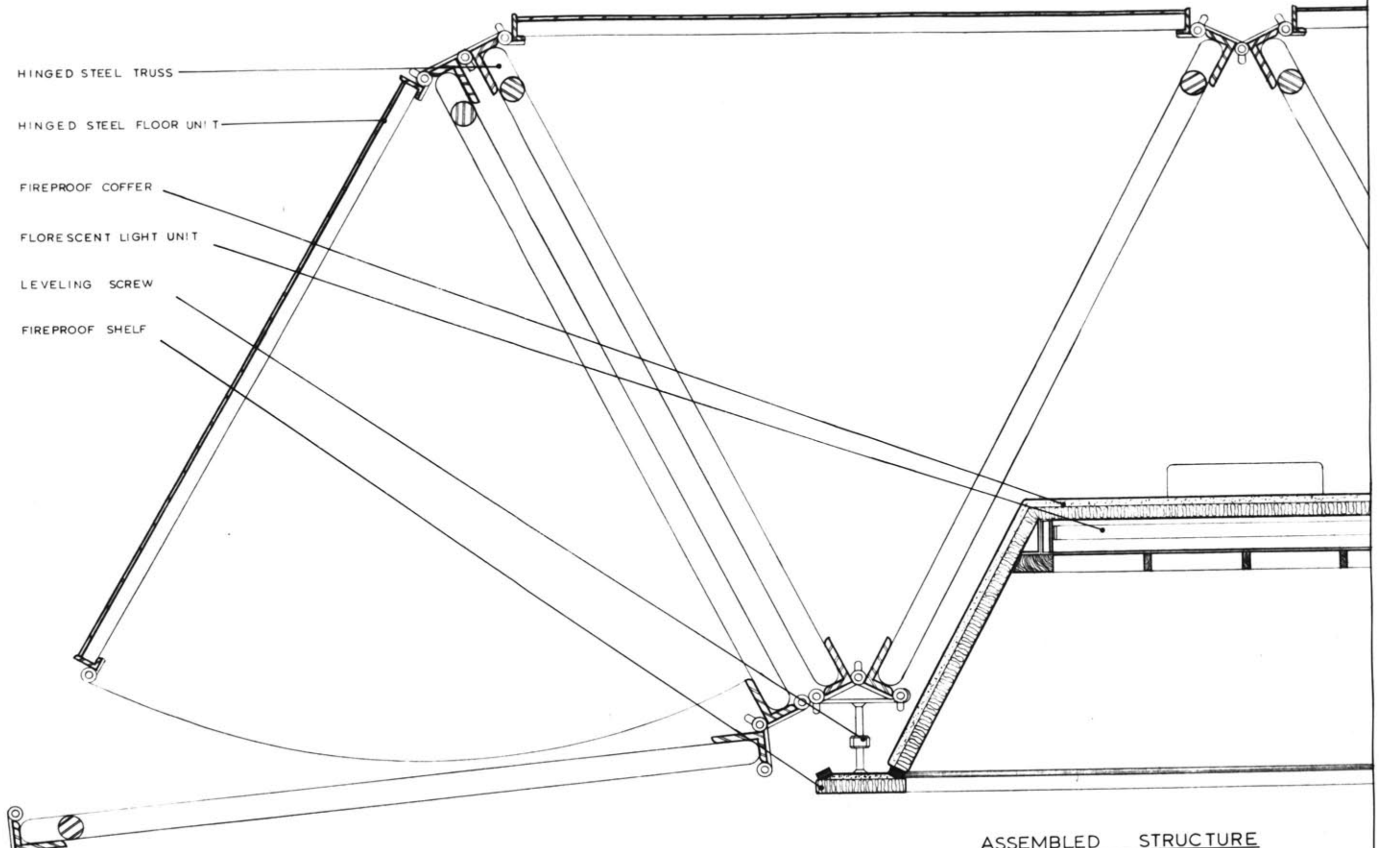
JOINT DISPLACEMENTS

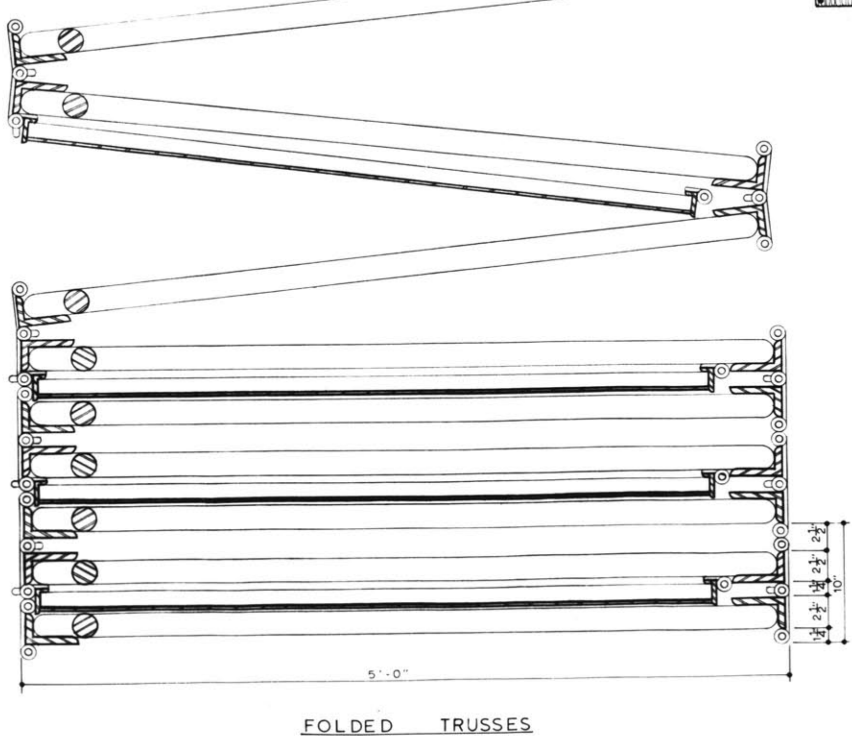
JOINT	X DISPLACEMENT	Y DISPLACEMENT	Z DISPLACEMENT	X ROTATION	Y ROTATION	Z ROTATION
		FREE JOINT DISPLACEMENTS				
2	.0021499	.0344174	-.0856505	.0000838	.0011596	-.0000138
3	.0019963	.0028223	-.1077627	.0007551	.0005487	.0002716
4	-.0000009	.0560359	-.1525262	.0002528	-.0000005	-.0000028
5	-.0019986	.0025611	-.1077351	.0007568	-.0005480	-.0002736
6	-.0021513	.0342215	-.0857016	.0000870	-.0011593	.0000175
8	-.0318895	.0284804	-.0541484	.0009021	.0009348	.0000228
9	-.0224120	.0378655	-.1080824	.0006107	.0007380	.0001998
10	-.0083354	.0463862	-.1407091	.0007649	.0002961	.0000685
11	.0082323	.0464147	-.1407878	.0007664	-.0002934	-.0000664
12	.0223771	.0379827	-.1083004	.0006116	-.0007380	-.0002042
13	.0319926	.0283615	-.0541828	.0008989	-.0009410	-.0000148
14	-.0382411	-.0019033	-.0842452	.0011774	-.0004399	-.0000782
15	.0077992	-.0071594	-.1088267	.0004939	.0008583	-.0001118
16	.0044344	-.0073211	-.1584664	.0006463	.0007456	-.0000760
17	-.0001446	-.0147051	-.1877957	.0006232	.0000009	.0000007
18	-.0046880	-.0074788	-.1587673	.0006471	-.0007381	.0000668
19	-.0080476	-.0076481	-.1094902	.0005285	-.0008548	.0001212
20	.0381757	-.0018323	-.0837387	.0011639	.0004192	.0000789
21	-.0349935	.0188549	-.1009679	.0006015	.0005420	-.0000188
22	-.0352261	.0033173	-.1439028	.0001474	.0006772	.0000897
23	-.0343966	.0094995	-.1867162	.0004376	.0007756	.0000930
24	.0333367	.0098319	-.1869390	.0007489	-.0007588	-.0001320
25	.0342755	.0032296	-.1445419	.0001545	-.0006701	-.0000846
26	.0366732	.0187092	-.1010313	.0005997	-.0005665	.0000542
27	-.0126171	-.0013531	-.1060497	.0005124	.0002499	-.0003243
28	-.0041698	-.0045264	-.1349536	.0003236	.0005403	-.0001526
29	.0013712	-.0017363	-.1709087	.0005920	.0012523	.0000175
30	-.0002807	-.1155935	-.2820466	.0019489	.0000144	-.0000027
31	-.0019725	-.0020224	-.1715657	.0005947	-.0012493	-.0000177
32	.0043262	-.0048463	-.1363510	.0003245	-.0005785	.0001586
33	.0128501	-.0013197	-.1048326	.0005070	-.0003282	.0003347
34	-.0334550	.0064500	-.1245916	.0001900	.0004704	.0000033
35	-.0278836	.0000973	-.1544900	.0001157	.0008976	.0001880
38	.0270473	-.0000502	-.1553781	.0001165	-.0008701	-.0001858
39	.0366115	.0062751	-.1246408	.0002016	-.0003207	-.0000033
40	-.0666732	-.0000630	-.1490499	-.0000004	-.0009781	-.0000057
41	-.0068147	-.0002347	-.1451709	.0000163	.0003888	.0000334
42	.1141289	.0038157	-.2355691	-.0001902	.0032183	.0000134
44	-.1143457	.0035926	-.2361448	-.0001932	-.0032157	-.0000044
45	.0070378	-.0002853	-.1466011	.0000147	-.0004189	-.0000366
46	.0673118	-.0001669	-.1478567	.0000033	.0008899	.0000039
47	-.0340481	-.0067433	-.1245278	-.0002005	.0003255	-.0000115
48	-.0171780	-.0039763	-.1501706	-.0002489	.0007043	.0001658
51	.0166329	-.0041783	-.1509597	-.0002520	-.0006817	-.0001589
52	.0362855	-.0068460	-.1245550	-.0002039	-.0003531	-.0000084
53	-.0129105	.0011754	-.1060343	-.0005090	.0002831	.0003285
54	-.0008159	.0045097	-.1366328	-.0003242	.0004271	.0001828
55	.0042535	.0081021	-.1521268	-.0007411	.0007614	.0000864
56	.0001031	.1278209	-.2313244	-.0014930	.0000020	-.0000026
57	-.0040553	.0079468	-.1524557	-.0007463	-.0007534	-.0000835
58	.0009821	.0046089	-.1375633	-.0003408	-.0004404	-.0001806
59	.0131901	.0010262	-.1052174	-.0005016	-.0003142	-.0003350
60	-.0342361	-.0192091	-.1005144	-.0006145	.0005936	.0000638
61	-.0064315	-.0072373	-.1322857	-.0002735	.0002588	.0000859
62	-.0024738	-.0081725	-.1481424	-.0007385	.0001835	-.0000505
63	.0023573	-.0082573	-.1483065	-.0007414	-.0001782	.0000465
64	.0063152	-.0074631	-.1327703	-.0002827	-.0002529	-.0000809
65	.0354172	-.0192684	-.1005607	-.0006127	-.0006146	-.0000821
66	-.0382084	.0017692	-.0843613	-.0011779	-.0004849	.0000806
67	.0092960	.0087615	-.1072619	-.0006089	.0006049	.0000127
68	.0052721	-.0000122	-.1377707	-.0005110	.0003457	-.0001563
69	.0000592	-.0036827	-.1479894	-.0004285	.0000015	-.0000001
70	-.0051471	.0000662	-.1379604	-.0005063	-.0003423	.0001613
71	-.0091743	.0089153	-.1076167	-.0005919	-.0006044	-.0000254
72	.0382566	.0016493	-.0840526	-.0011697	.0004726	-.0000826
73	-.0284551	-.0288551	-.0523984	-.0009243	.0008602	.0000035
74	-.0188557	-.0354261	-.1002365	-.0004440	.0006059	-.0001009
75	-.0064821	-.0360762	-.1242954	-.0003122	.0002047	.0000256
76	.0065689	-.0360997	-.1243523	-.0003138	-.0002028	-.0000270
77	.0189734	-.0355095	-.1003903	-.0004468	-.0006053	.0001027
78	.0286358	-.0288994	-.0524876	-.0009261	-.0008632	-.0000112
80	.0018349	-.0383951	-.0838476	.0000866	.0011253	-.0000814
81	.0013596	-.0118281	-.1041693	-.0003594	.0005083	-.0003361
82	.0000444	-.0671215	-.1476564	.0001161	.0000002	.0000008
83	-.0012776	-.0117509	-.1042072	-.0003650	-.0005073	.0003367
84	-.0017875	-.0383281	-.0839101	.0000829	-.0011260	.0000803

PART 2 OF PROBLEM COMPLETED.

ASSEMBLY PROCEDURE

The trusses are jointed together by a system of hinges and bolted connections which allow them to be assembled or disassembled in several ways. The method to be used in the initial assembly process involves folding a set of trusses into a compact accordion-like package. These can then be shipped to the site, with the steel floor system sandwiched between them, unfolded, bolted together at the ends, and lifted into place. The procedure used to demount portions of the structure once the building is erected is to disengage each closed section of the ring at the hinges, and to lower them to the floor below separately for further disassembly. Still another method can involve fitting the hinged portion of each truss separately to the supporting structure and then swinging them into the ring position and bolting the four corners.





ASSEMBLY PROCEDURE

0 3 6 9 12 24
SCALE IN INCHES

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MASTER IN ARCHITECTURE THESIS

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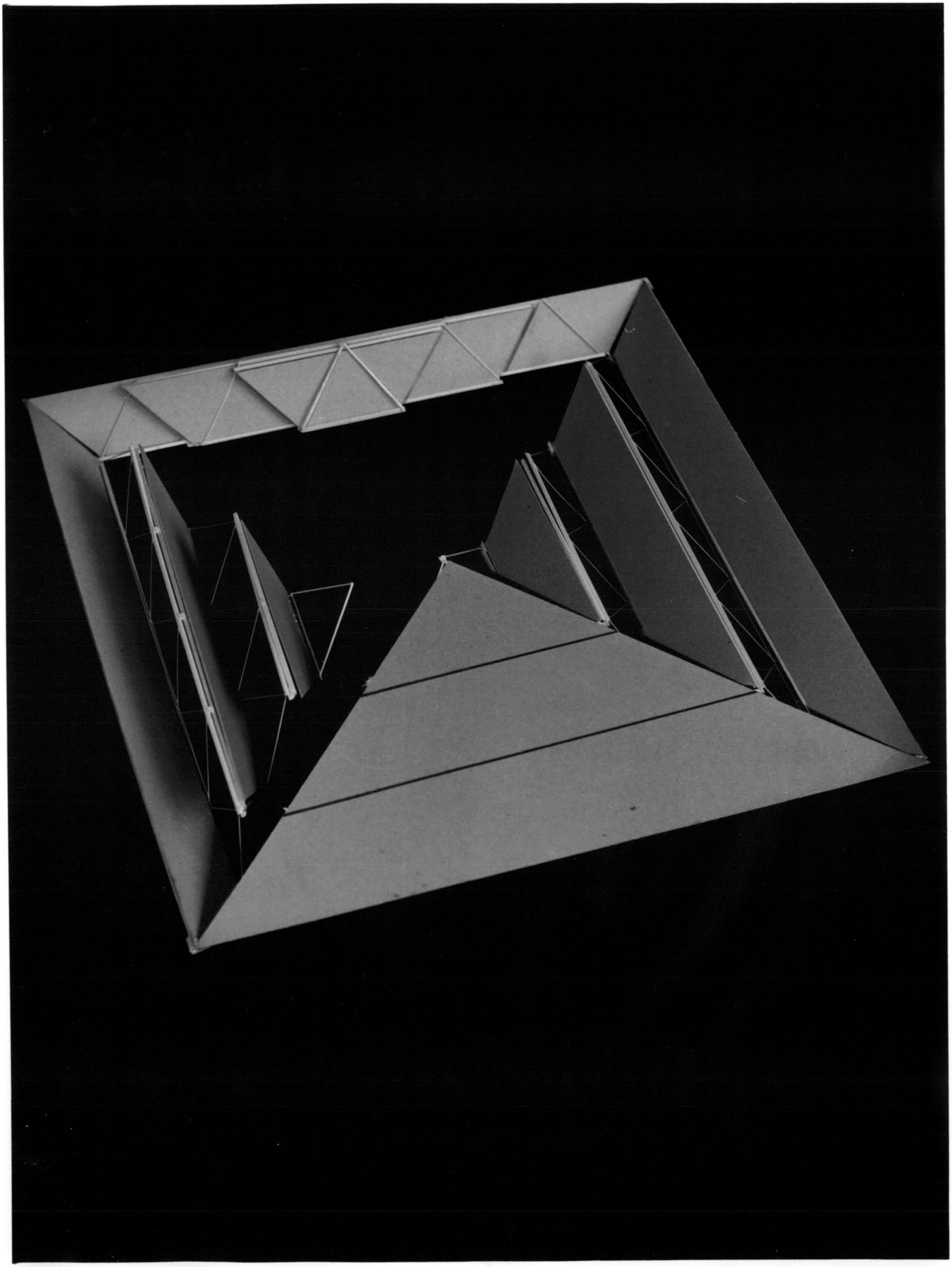


MECHANICAL SYSTEM

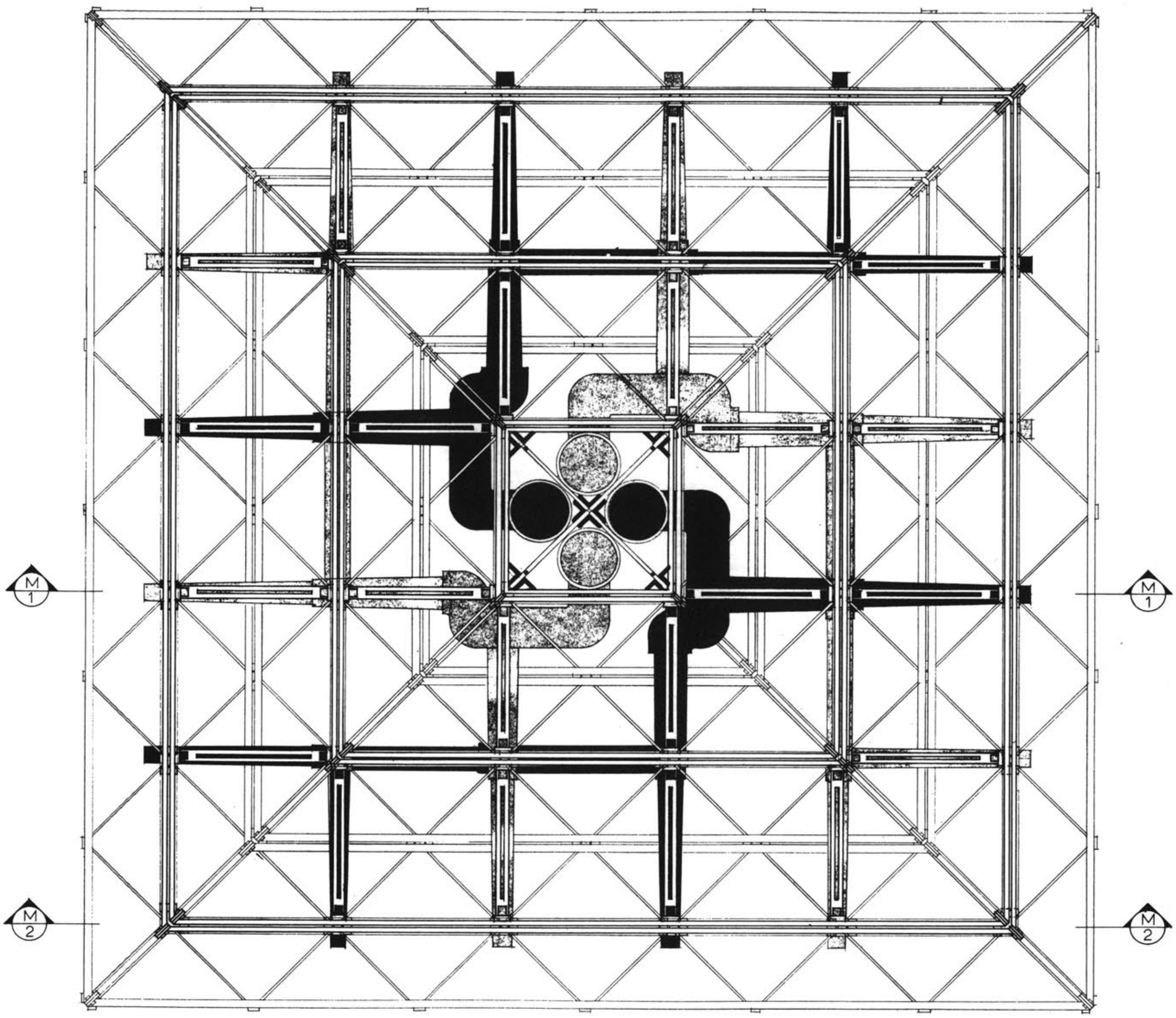
Mechanical services can be supplied to the structural system either through the columns or by means of cores. Supplying the services through the cores allows for a more efficient placement of mechanical rooms as the utilities are concentrated into one area. The result is that the columns are small as they have to only support the structure. However, a more even mechanical distribution can be obtained by supplying the services through the columns eliminating the need for long horizontal mechanical runs, and allowing the cores to become smaller, though this means that the columns become larger.

It is difficult to predict which supply system will be used in a particular research building and, as the prototype structure will work equally well in either case, a mechanical system has been developed assuming that the utilities would be supplied through the columns.

The program calls for a general supply and return of air at the rate of 50 cubic feet per minute. To accomplish this, a high velocity air handling system is used which can bring filtered air at a temperature of 68 degrees to the diffusers where it can then be slowed down, tempered, and introduced at the required velocity.

The basic diffuser units are placed 5' on the center perpendicular to the bottom cords of the trusses. The unit contains fireproofing and a mechanically operated fire damper which can seal the duct off if the temperature inside the diffuser rises to a level which is damaging to the structure. The tempering coil can be attached to any diffuser unit allowing for the degree of temperature control desired. Thus, the same diffuser can be used to supply as well as return the air.

The supply branches from the column consist of telescoping insulated tubes which can be delivered to the site as a compact 5' long package.



PLAN OF AIR DISTRIBUTION

LEGEND:

diffuser units

high velocity supply duct

high velocity return duct

MECHANICAL SYSTEM

0 .5 1 1.5 2 3 4 5 6 7 8
SCALE IN FEET

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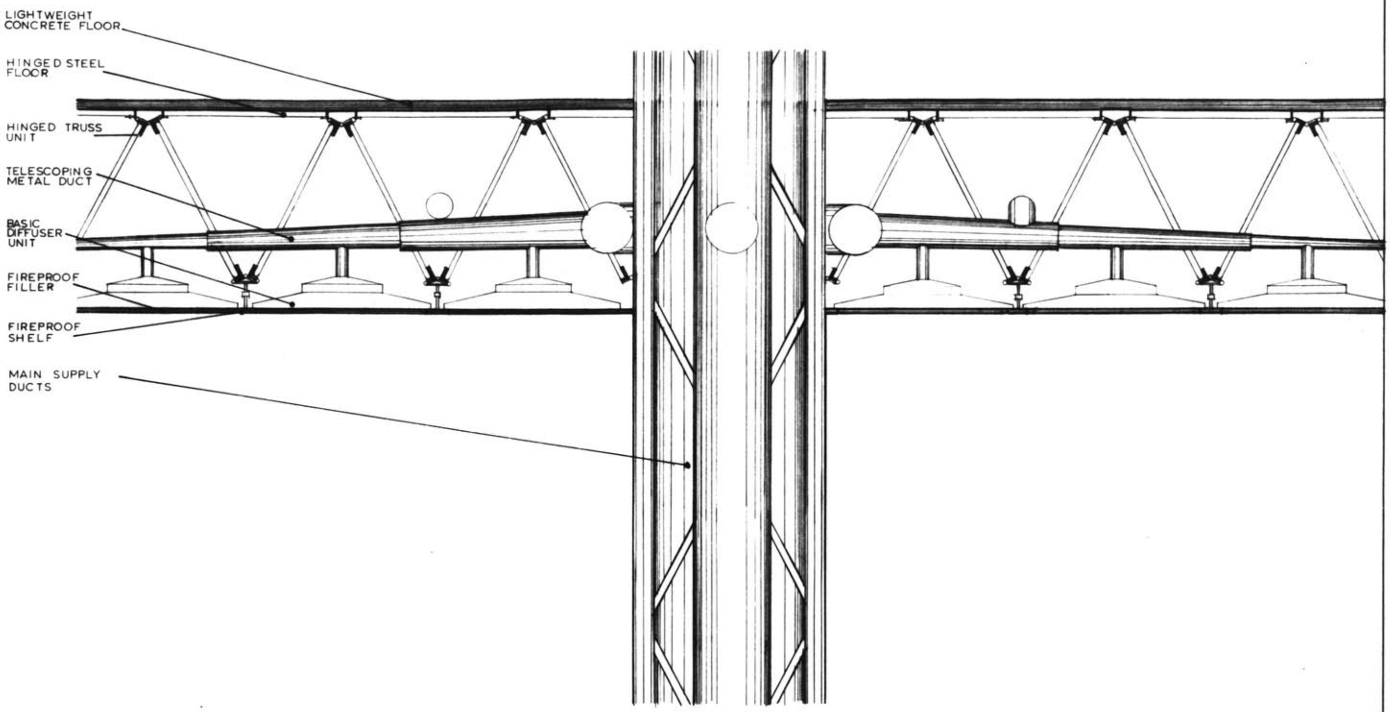
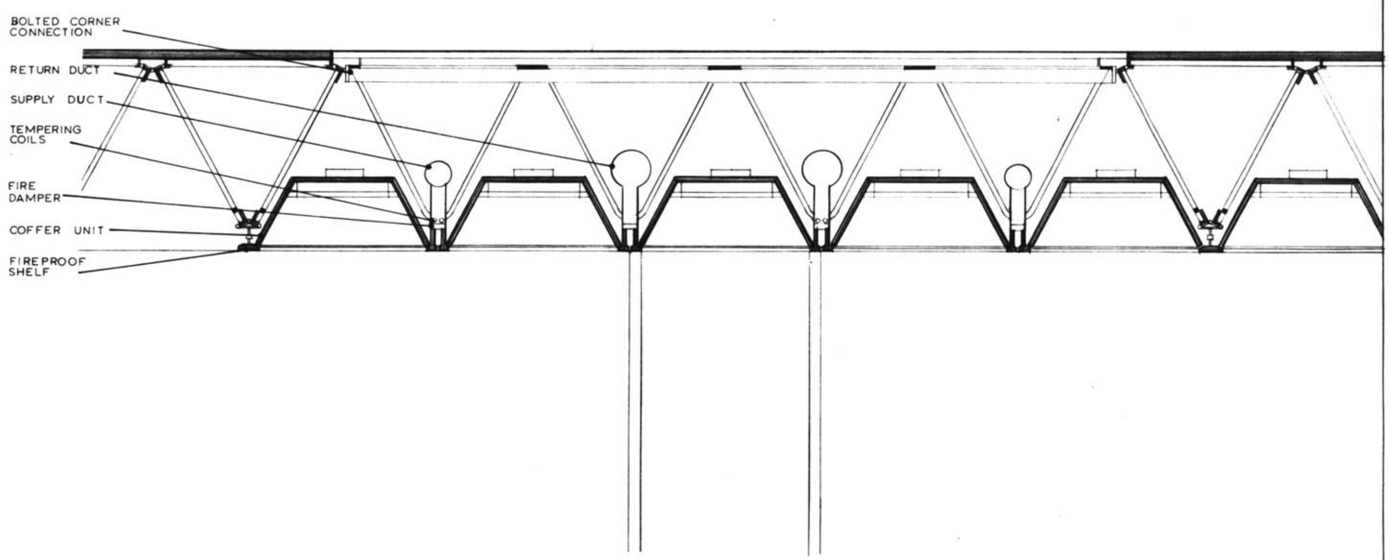


M 1 SECTION THROUGH COLUMN



M 2 SECTION THROUGH END TRUSS

MECHANICAL SYSTEM

0 .5 1 1.5 2 3 4 5 6 7 8
SCALE IN FEET

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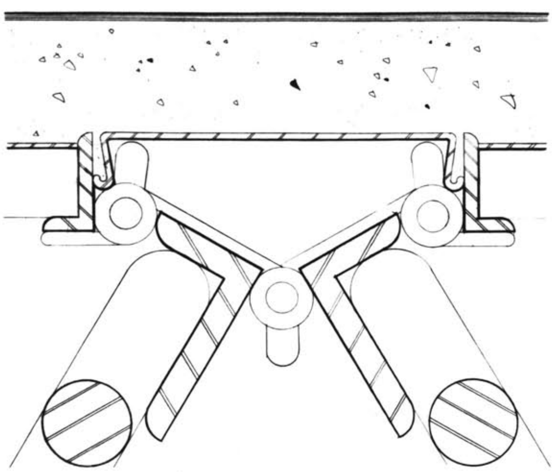
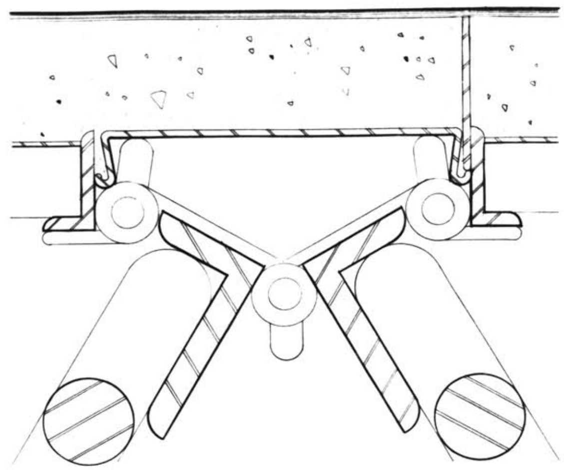
FLOOR SYSTEM

The joint between the trusses in the floor system also has to satisfy a variety of demands. All the incidental utilities such as water pipes, gas lines, and electrical and communication lines are to be introduced through the floor system. In parts of the building, where such demands for utilities do not exist, the floor slab is used merely as a permanent supporting surface.

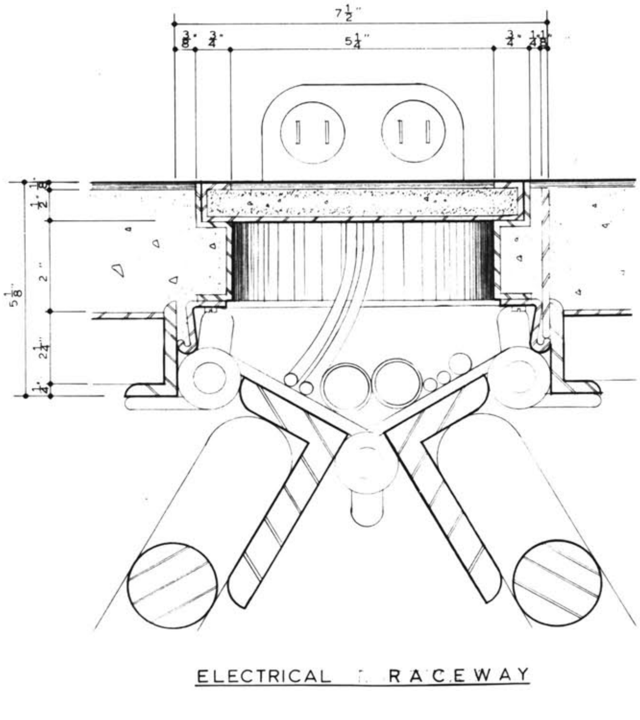
Four possible typical solutions for the joint have been developed. Where no service requirements are present, the floor can be treated as a permanent flat slab, with a blank filler clipped into the joint. This filler allows for the introduction of an expansion joint, which can be attached to one side of the concrete slab by means of tack welded rods. This joint also serves as a place where the floor can be broken for demounting. If a section of the structure has to be removed, the trusses can be unpinned at these points and the assembly can be dropped to the floor below, leaving the expansion joint on the portion of the floor which remains. The other raceway developed, used for piping, is continuously accessible by the removal of a fireproof steel cover plate. All these mechanical services can be connected to the supply either by means of a raceway embedded in the concrete floor or through the gap between the floor system and the top cord of the trusses.



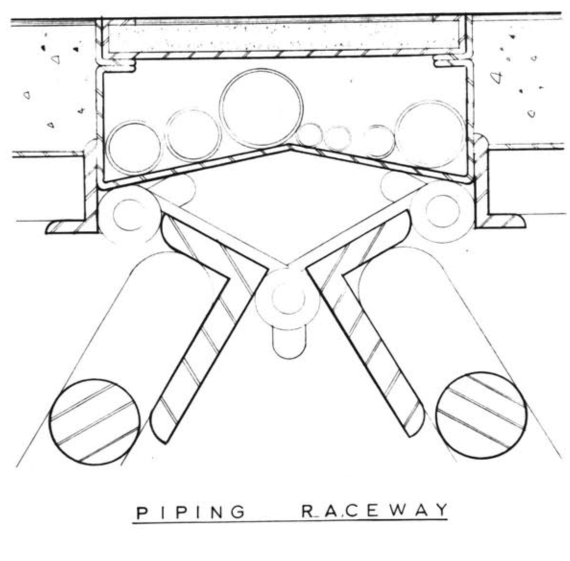
PERMANENT FLOOR SLAB



EXPANSION JOINT



ELECTRICAL RACEWAY



PIPING RACEWAY

FLOOR SYSTEM

0 .5 1 1.5 2 3 4 5 6
SCALE IN INCHES

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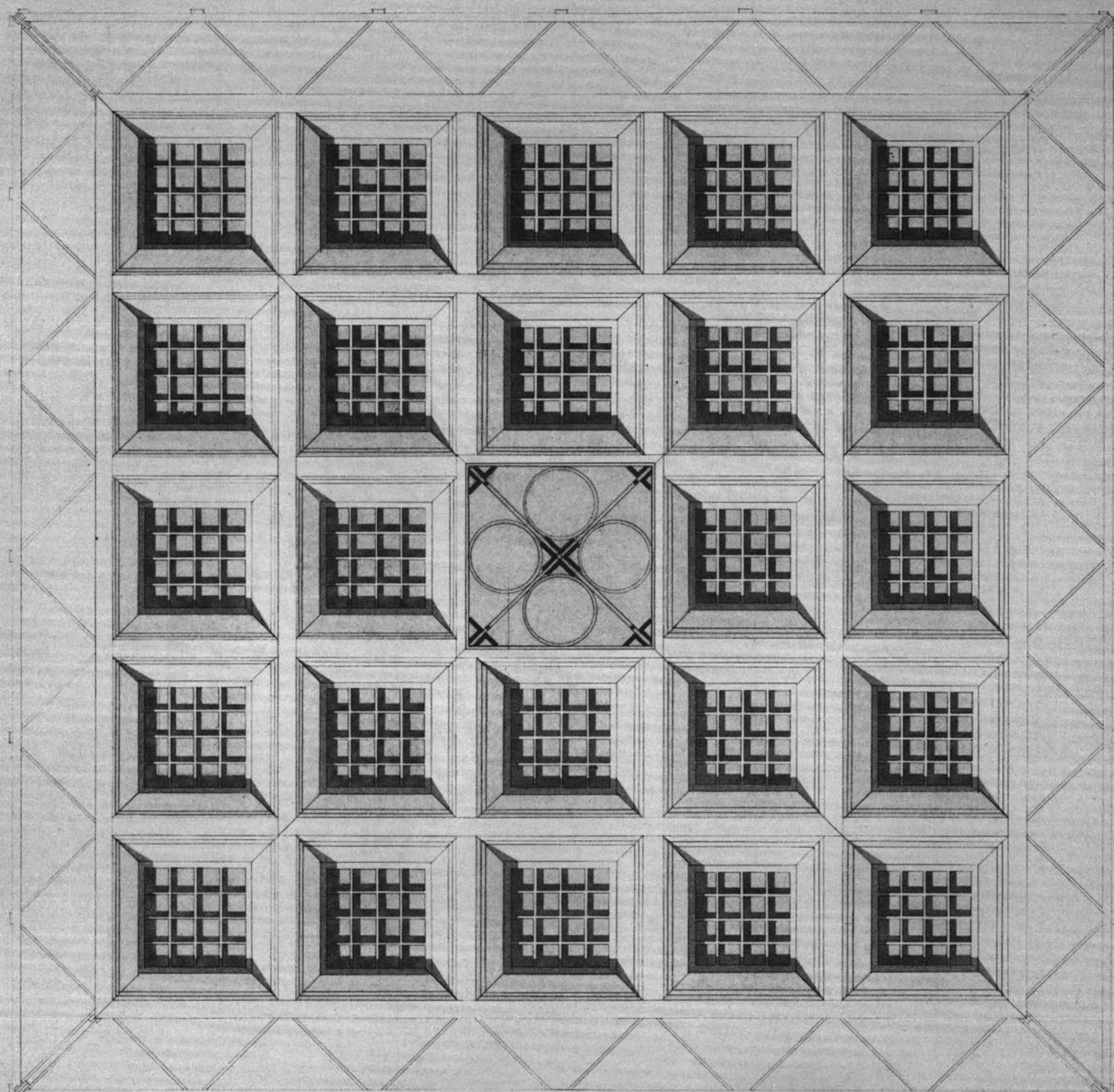
COFFER SYSTEM

Fire protection is a great problem in any building, especially in a research facility. The great investment which is made in equipment for research means that the building must have a 3-4 hour fire rating. Such a fireproof coffer system has been developed which is suspended from the structure and is easily removable for servicing or demounting of the system. These coffers consists of a steel form onto which a one half inch thick layer of fireproof gypsum plaster is sprayed. The form has short steel rods tack welded to it to provide the bond between the plaster and steel. A one inch thick layer of fiberglass is laminated to the plaster and covered with a protective perforated metal sheet. This insulation provides added fire protection and when combined with the reflective surface of the fireproofing provides an accoustical insulation which eliminates the problems of isolation which are inherent in conventional hung ceilings.

The lighting fixtures within the coffers utilize a series of 30" fluourescent tubes which are attached to an electric raceway. This raceway allows for variation of the lighting intensity by the alteration of the number of fluorescent tubes. The fixture is covered with a diffuser consisting of a wooden grill supporting a translucent plastic sheet. As the scale of the five foot coffer will be overpowering in a small office, it is possible to further subdivide the coffer by the addition of a hung ceiling which can be screwed into the perforated metal covering.

The coffer units are placed on a steel shelf which is fireproofed in a similar manner. This shelf is hung parallel to the bottom cord of the trusses and leveled by means of bolts which are attached to hangers. The hangers themselves are placed at the truss panel points and utilized the same hinge connections as the floor system does. To keep the joint from becoming rigid, one side of the hanger is a sliding connection.

The diffuser units are also set on this fireproofed shelf and all the joints are sealed with a flexible asbestos pad which can be replaced when necessary. The system is completed by a fireproof filler panel which clips over the diffuser. This panel has a hollow space in the insulation which allows for the introduction of air through the perforations in the steel covering and at the same time conceals the diffuser itself.



REFLECTED CEILING PLAN

COFFER SYSTEM

0 .5 1 1.5 2 3 4 5 6 7 8
SCALE IN FEET

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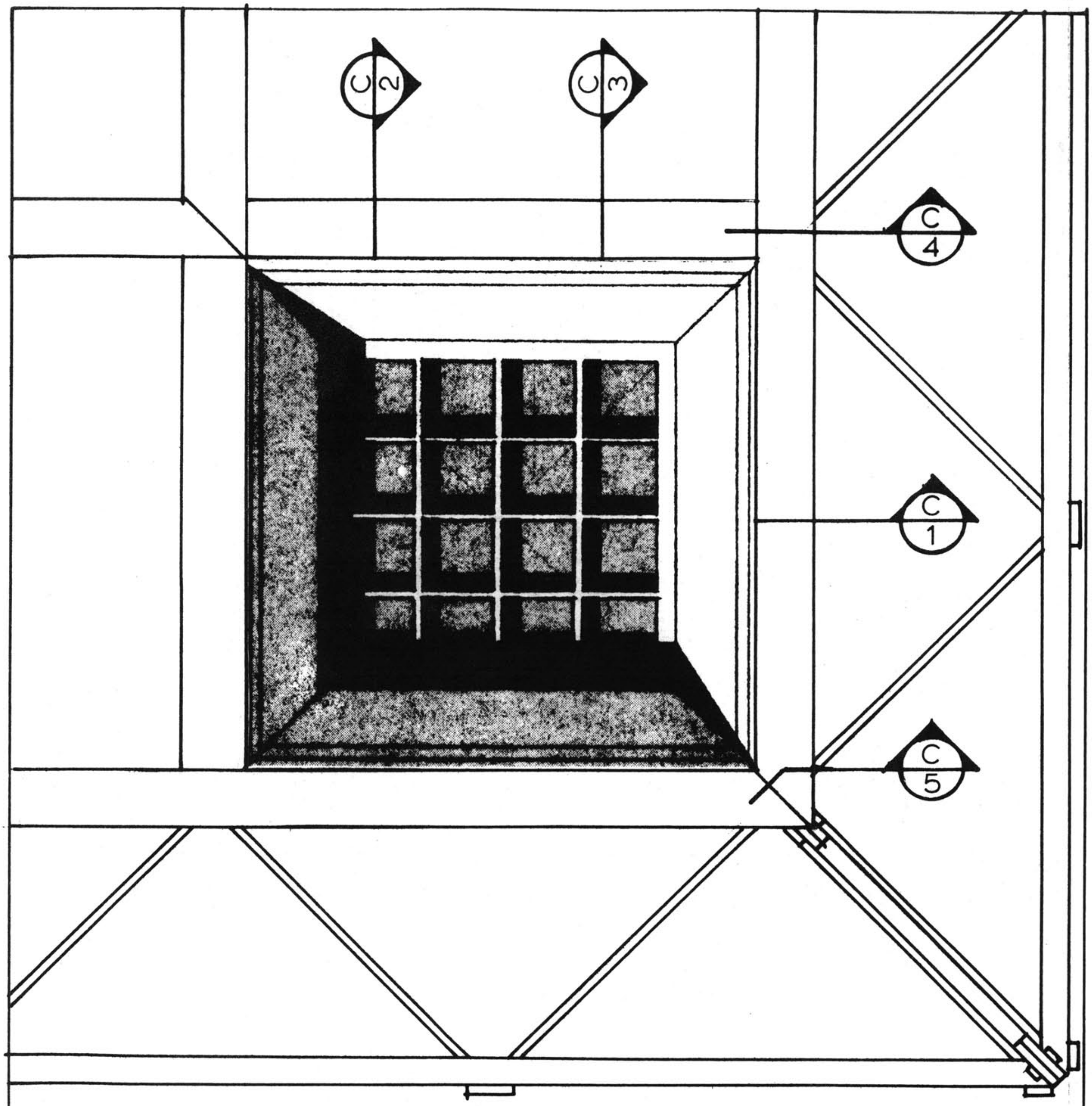

LOCATION OF SECTIONS

COFFER SYSTEM

0 .5 1 1.5 2 3 4 5 6 7 8
SCALE IN FEET

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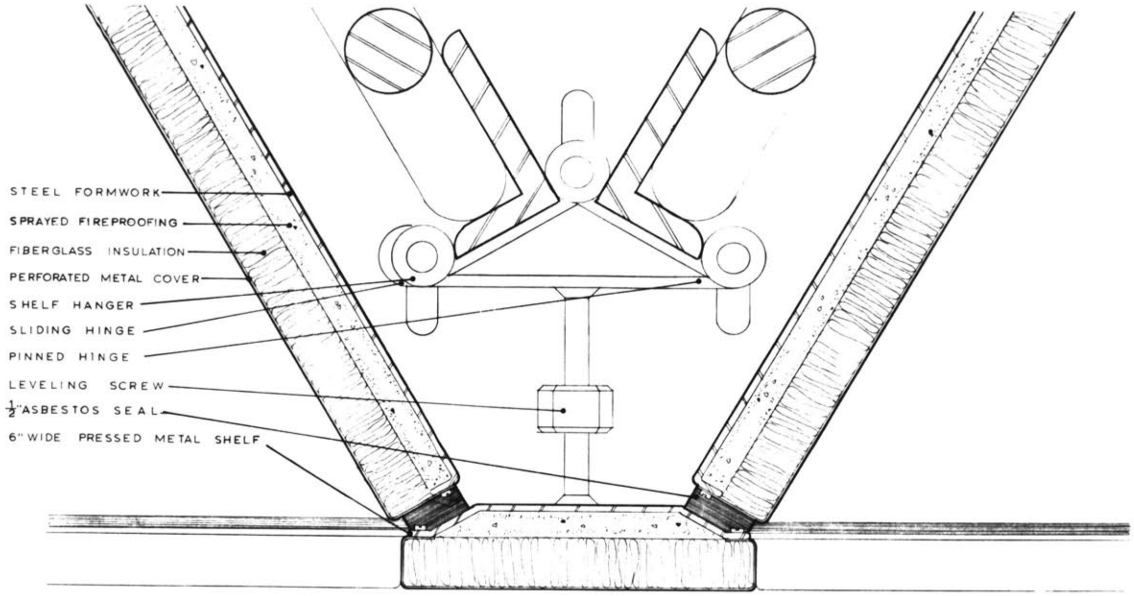
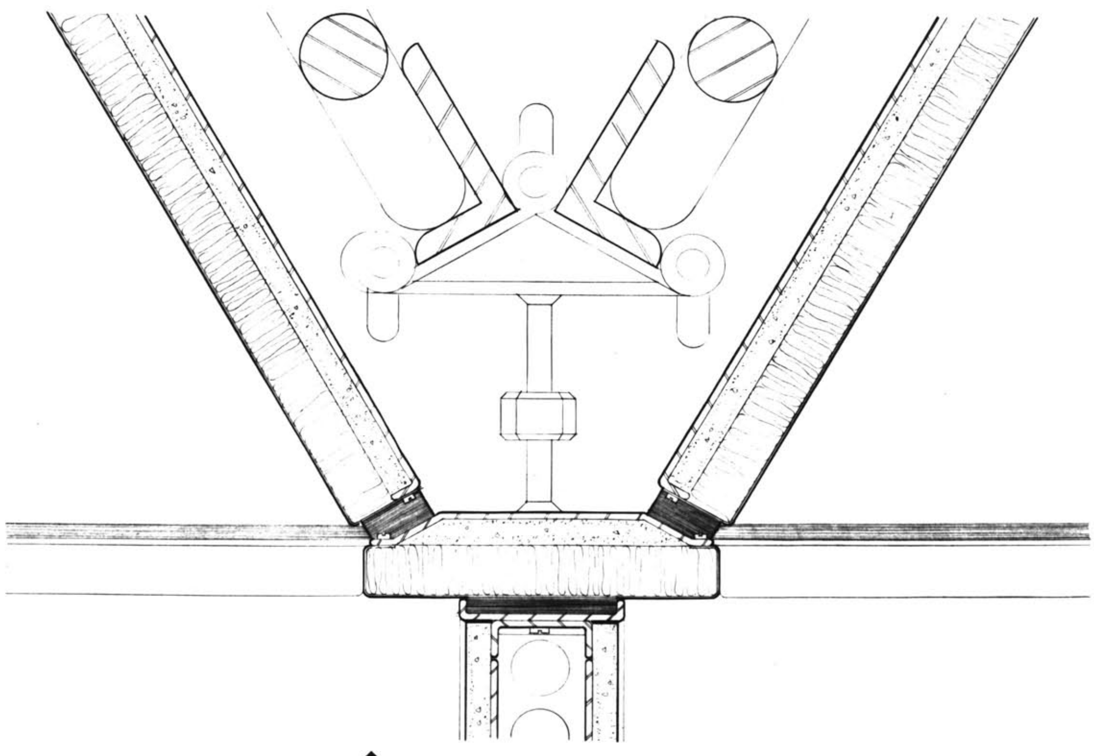


C/1 TYPICAL SHELF



C/1 STANDARD PARTITION CONNECTION

COFFER SYSTEM

0 .5 1 1.5 2 3 4 5 6
SCALE IN INCHES

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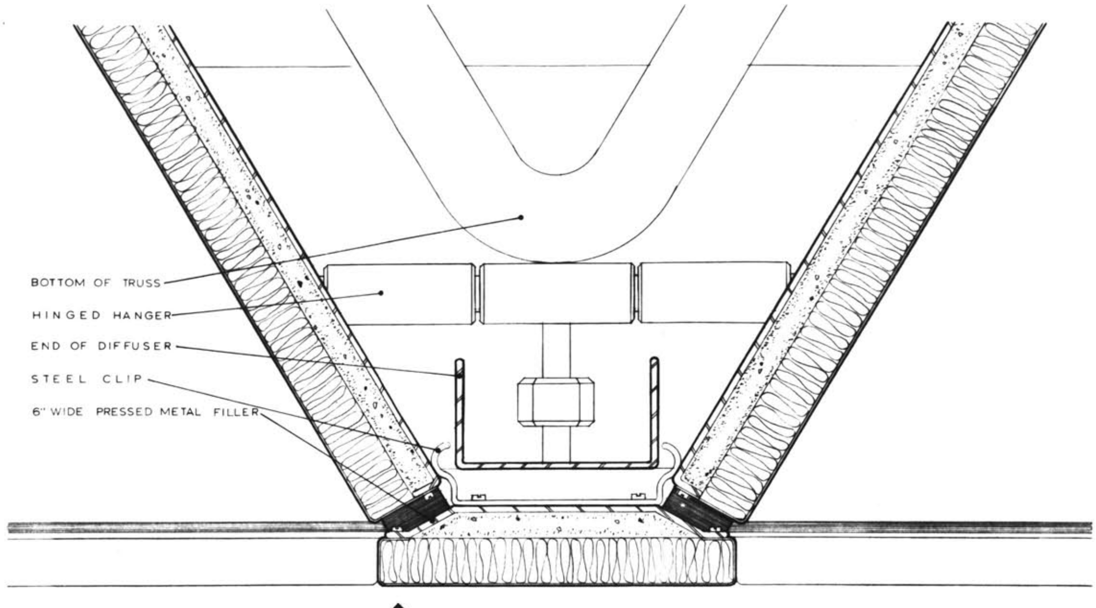
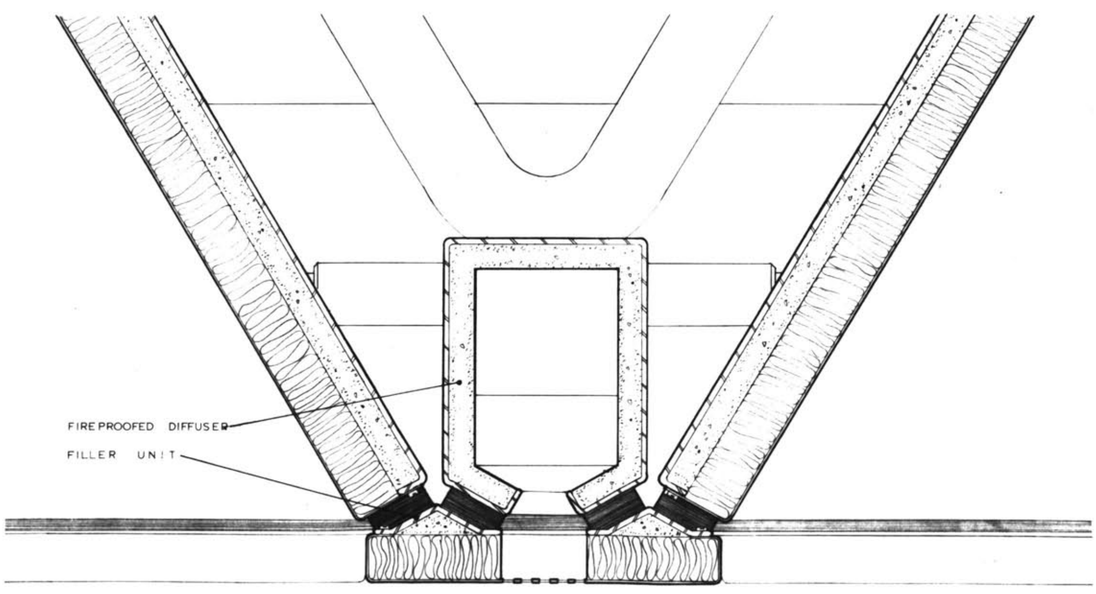


C/2 END OF FILLER



C/3 DIFFUSER AND FILLER UNIT

COFFER SYSTEM

0 .5 1 1.5 2 3 4 5 6
SCALE IN INCHES

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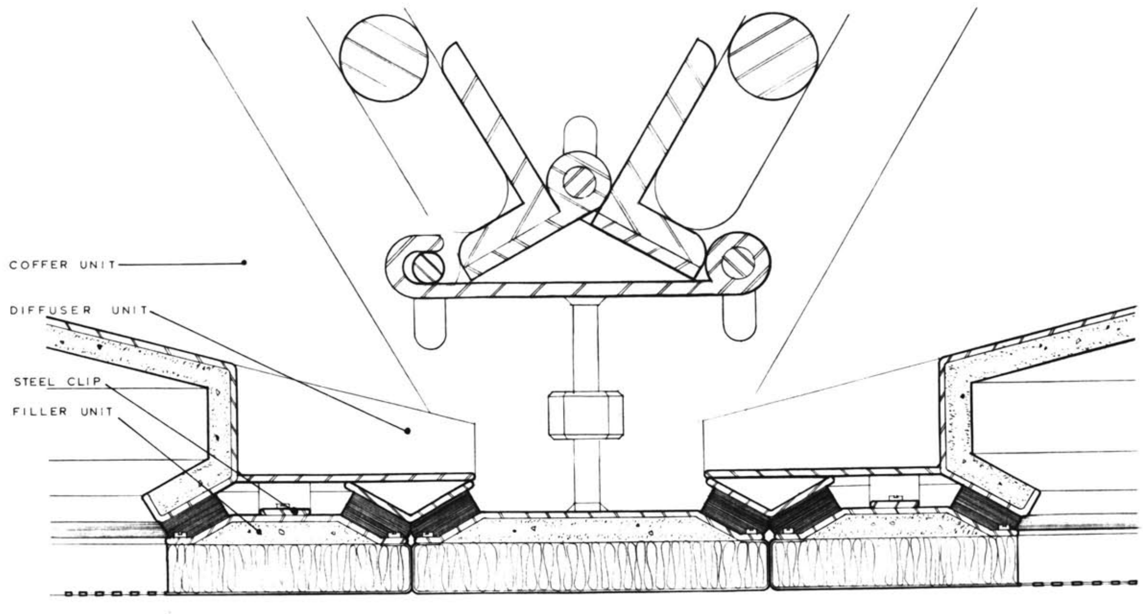
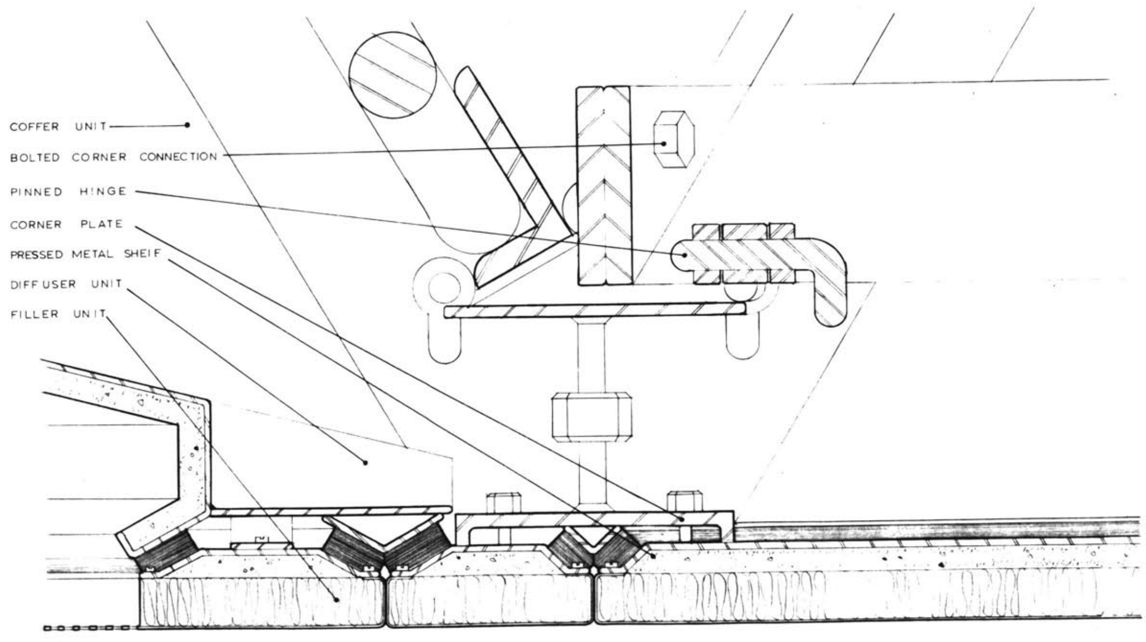


C 4 INTERSECTION OF SHELF AND FILLER UNITS



C 5 CORNER DETAIL

COFFER SYSTEM

0 .5 1 1.5 2 3 4 5 6
SCALE IN INCHES

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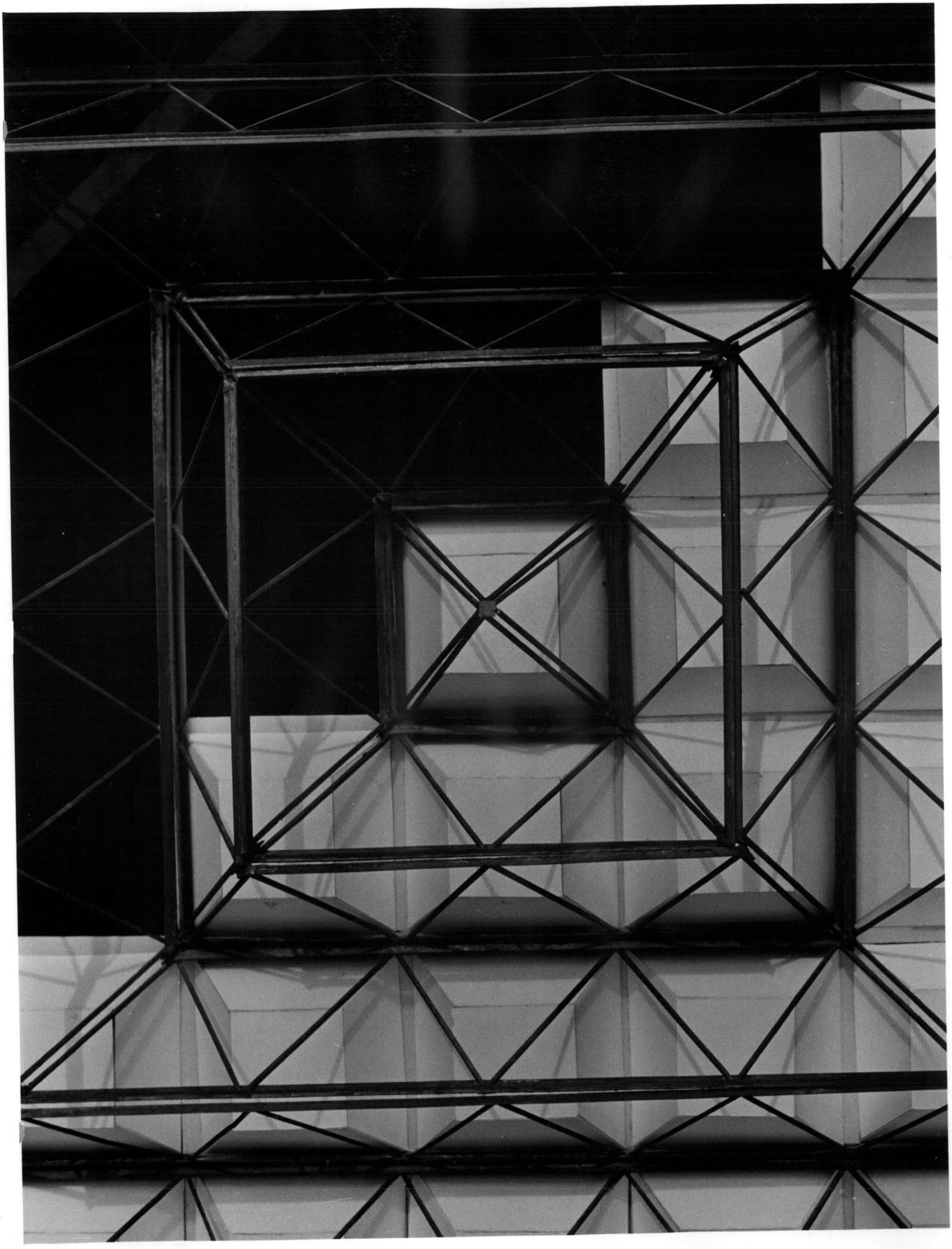

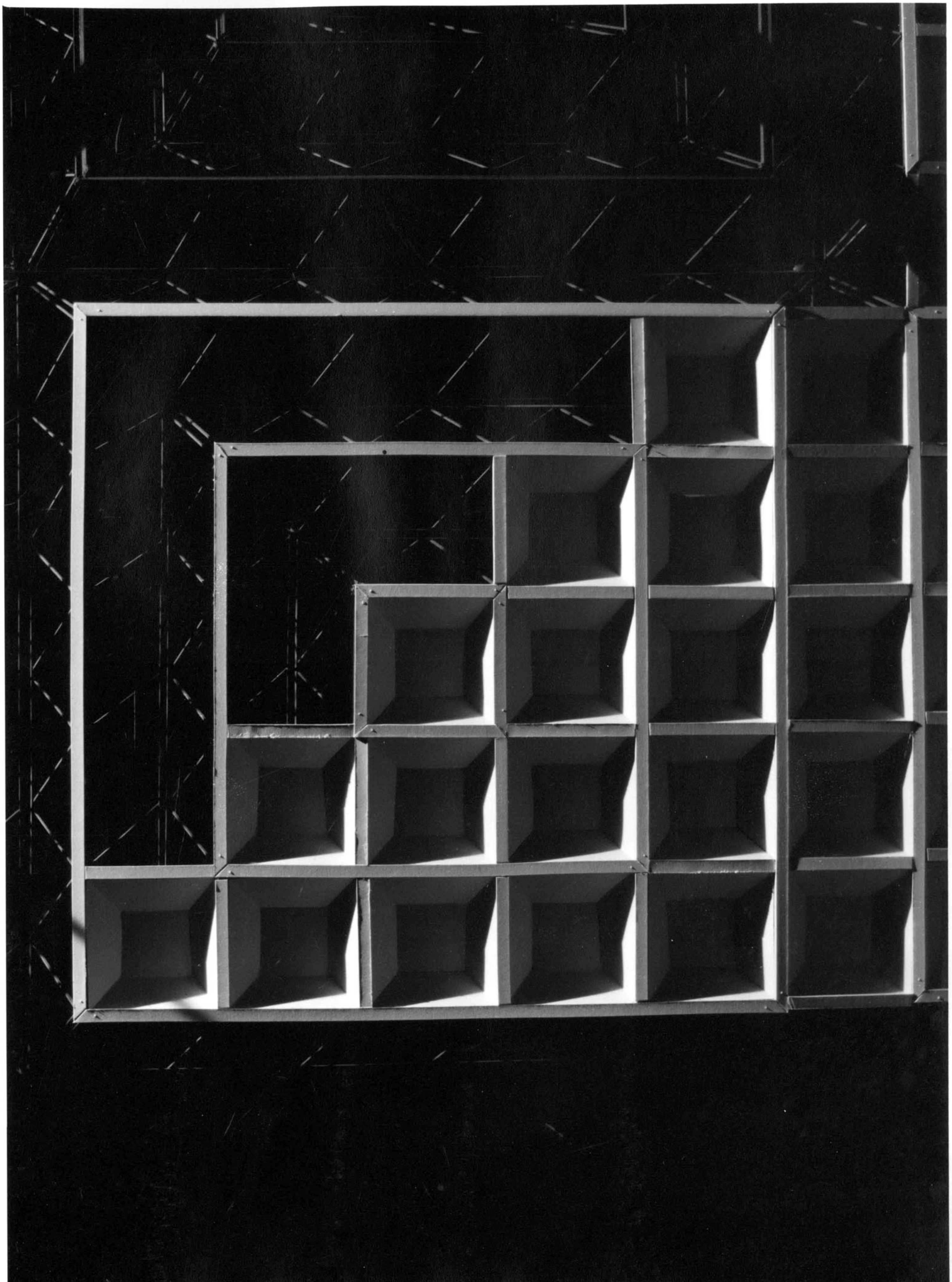

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