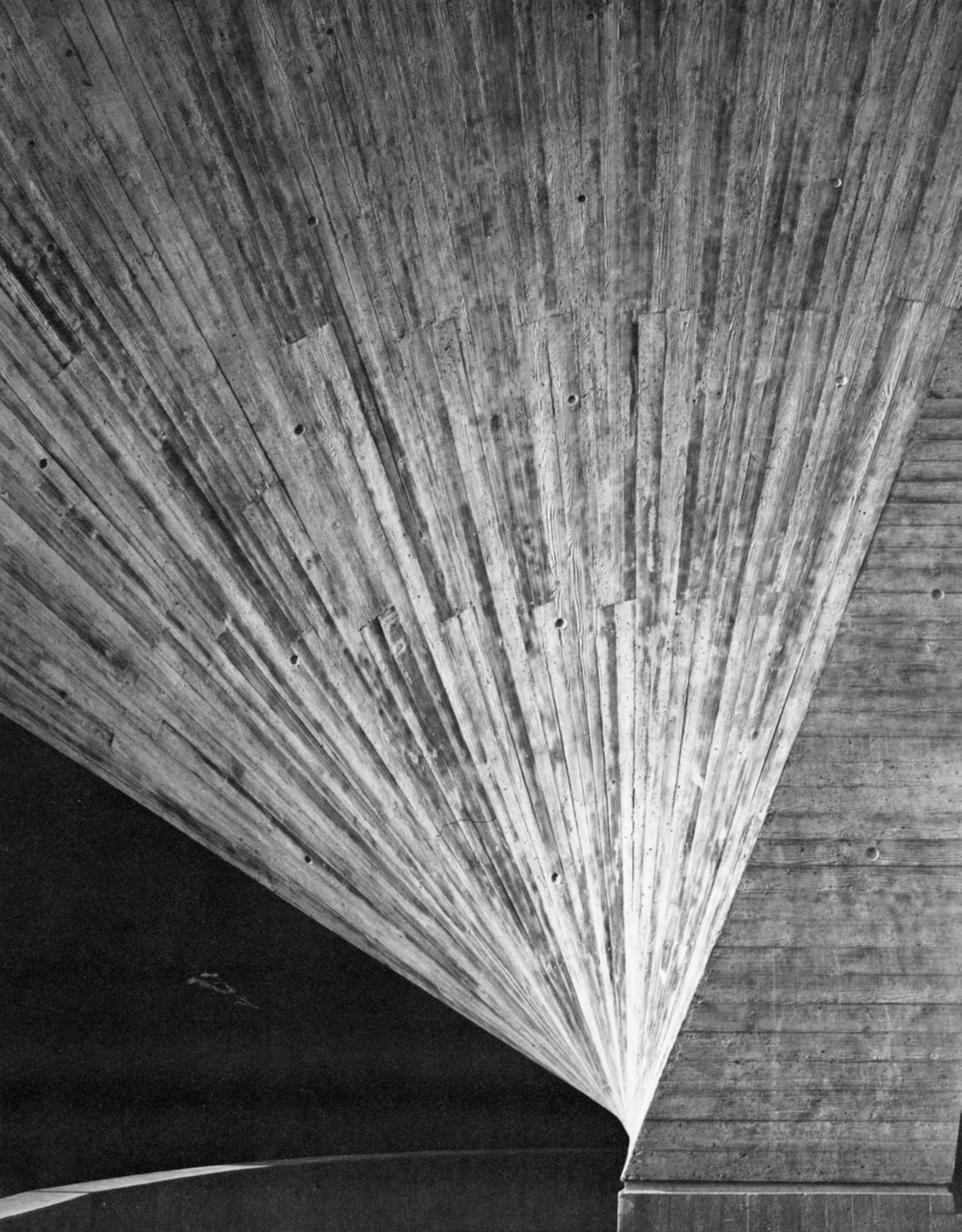


Aside from convictions on the inevitable aesthetic aims in our time—brought into the consciousness of the designer by the systematic study of and experimentation in visual phenomena—convictions about the clear social aims to be achieved in the built environment must be allied with equally clear attitudes about the need to push forward the frontiers of technology as an integral part of all architectural thought. It is the lack of that aspect of the design process which is responsible for so much failure in modern architecture as a convincing, worthy product of our time. By contrast architecture should be expected to embody assurances not only of physical but also of aesthetic longevity.

While Western society, in spite of its desperate physical building needs and shortcomings, can still occasionally support willful, capricious, and wasteful buildings, these are becoming increasingly recognized as irrelevant and, by implication, asocial and amoral pursuits. What could possibly remain valid in building highly labor intensive, almost medievally hand-wrought structures produced at outrageously high quantity and expenditure in material that upon completion demand perpetually operating, vast energy-consuming devices to keep them barely fit for human use?

More and more they are being recognized as a hollow victory indeed, efforts leading toward a dead end in a world hungry for universally applicable devices to cope with the failing man-made environment. Even if there are still ample Texas millionaires and other instrumentalities of much wealth bent on self-aggrandisement, the once great appetite for the occasionally brilliant, purely visual results of their commissions is rapidly cloying. It is the questioning of their relevance today that by implication makes them in fact become ugly.

Above all, there must be an awareness of the realities of the day and the inevitable way these are pointing to the future. In the West in the next century, there will be no armies of unskilled labor to perform the tasks now taken for granted as an inherent aspect of architectural design. In locations such as India or Mexico it may remain valid for longer to demand high labor intensivity, but in Europe, America, Canada, Australia, and other developed areas, this is already highly questionable, and its products are increasingly rejected.

Design concept and constructional means must be an integral, married part of each other. If they are divorced, lead separate lives, or point in different directions, they become invalid and are supportable only by artificial means.

The scale of the work is a major pace-setter in the design and construction relationship. Whereas it may be entirely reasonable in a small, one-of-a-kind structure to expect a substantial amount of hand labor to be expended, the ratio in a large structure must be on an entirely different basis. The balance between labor intensivity and plausibility of a high-technology concept is one of scale.

Much modern architecture and some of today's most celebrated is utterly deceitful in this respect—and much of it is an outright lie. It pretends to be born of and based on a system which in truth is nothing but a tortuous procedure requiring vast amounts of medieval-style hand labor to bring it into existence. Tasks requiring acrobatic feats performed by literally armies of laborers on scaffolds are, when completed, clothed in an envelope that pretends to be stamped out by machine, utterly belying the fact of its great handmade confusion inside.

Let us think simply and realistically of the tasks.

The cardinal imperative for the designer is to find solutions which in addition to all *architectural* considerations can be produced *naturally* in a given socioeconomic climate.

In countries with high labor costs this will increasingly eliminate on-site labor, especially if it is dirty and must be performed on scaffolds.

It will eliminate structures that must be made fireproof by labor-intensive tasks.

It will force architects to devise and maximize systems of mechanization appropriate to and in tune with the particular task. These must not only include considerations of structure and cladding (as is so often the limit of prevailing thought), but encompass simultaneously integral solutions to the problems posed by all services (without the usual nightmarish afterthoughts that complicate most modern buildings).

It will make them pursue with purity and directness the problems of connections and detail which reoccur wherever identical situations generate them (in contrast with ad hoc traditional detailing which contributes so much to the high cost of building).

Architects must strive towards the exquisite understatement inherent in integrated systems which reinforce each other to take the place of today's fashionable devotion to ostentatious complexity.

Systematic solutions and their components, however, should invite variation. The more parts of a system are assembled, the more interesting and visually enticing the totality should become, rather than duller and more soul destroying as is the present-day norm.

In the shaping of elements, free reign must be

The single 800-foot (240-meter) Mutual Life and Citizens Tower occupies only 20 percent of its site. The octagonal shape resulted from the need to avoid the railway tunnels which traverse the site.

given to the expression of the laws of nature—not what is imagined to be so by many structurally naive architects, but the unassailable physical truth of statics. Great richness of expression can result from such a search, which will have that irreplaceable quality of longevity—of remaining valid—being born of the immutable and irrevocable truth of nature.

In the three buildings that will be discussed in detail here, I have attempted to recall some of the high principles and clear moral consequentiality in the work of the great formgivers who demanded a basic integrity and an intrinsic honesty of approach. Considerations of aesthetics, social use, and technology are happily married. In each, the concrete construction is systematized; it takes the best advantage of the available labor and skills; it expresses the flow of structural forces; and it is attractive enough not to need to be pasted over with finishes.

Mutual Life and Citizens Tower

To create as large a landscaped public plaza as possible, all the programmed office space in the Mutual Life and Citizens Tower in Sidney was put into a single octagonally shaped tower. The structure of the 68-story concrete building would have been conventionally solved as a "tube in tube," but this solution with its attendant closely spaced perimeter columns was considered inappropriate here because of its lack of lateral stability. Instead, only eight heavily loaded exterior columns were chosen to give maximum stiffness. The structure that finally evolved was based on a concept called the "progressive strength" concrete system.

That system of construction consists of welded self-supporting, open-web reinforcing bars for primary and secondary beams strong enough to support removable plastic form trays for pouring concrete progressively as the tower rises. First, the main beams are poured; then, the secondary ones; and finally, the slab, which is several floors below the progress of the main beams and slipformed core above.

The system is based on the fact that the reinforcement in a beam can be adapted to provide the initial support needed to start the cycle by prefabricating it in a truss form. As the concrete develops strength, the function of the trusses changes progressively from a means of supporting the concrete to a means of reinforcing it. In this manner, the floors of the tallest concrete building in the world (808 feet, or 242.4 meters) were

Opposite page: Building according to the progressive strength concept depends on sequencing the construction so that the concrete gains enough strength to support its load. Construction begins at the Mutual Life and Citizens Tower with the core which is two levels ahead of perimeter construction and one and a half levels ahead of floor construction.

Left: After the sequence is in progress, the first day of a cycle includes work on all three elements. Here on the topmost level the trussed beams and joists are being constructed prior to pouring the floor.

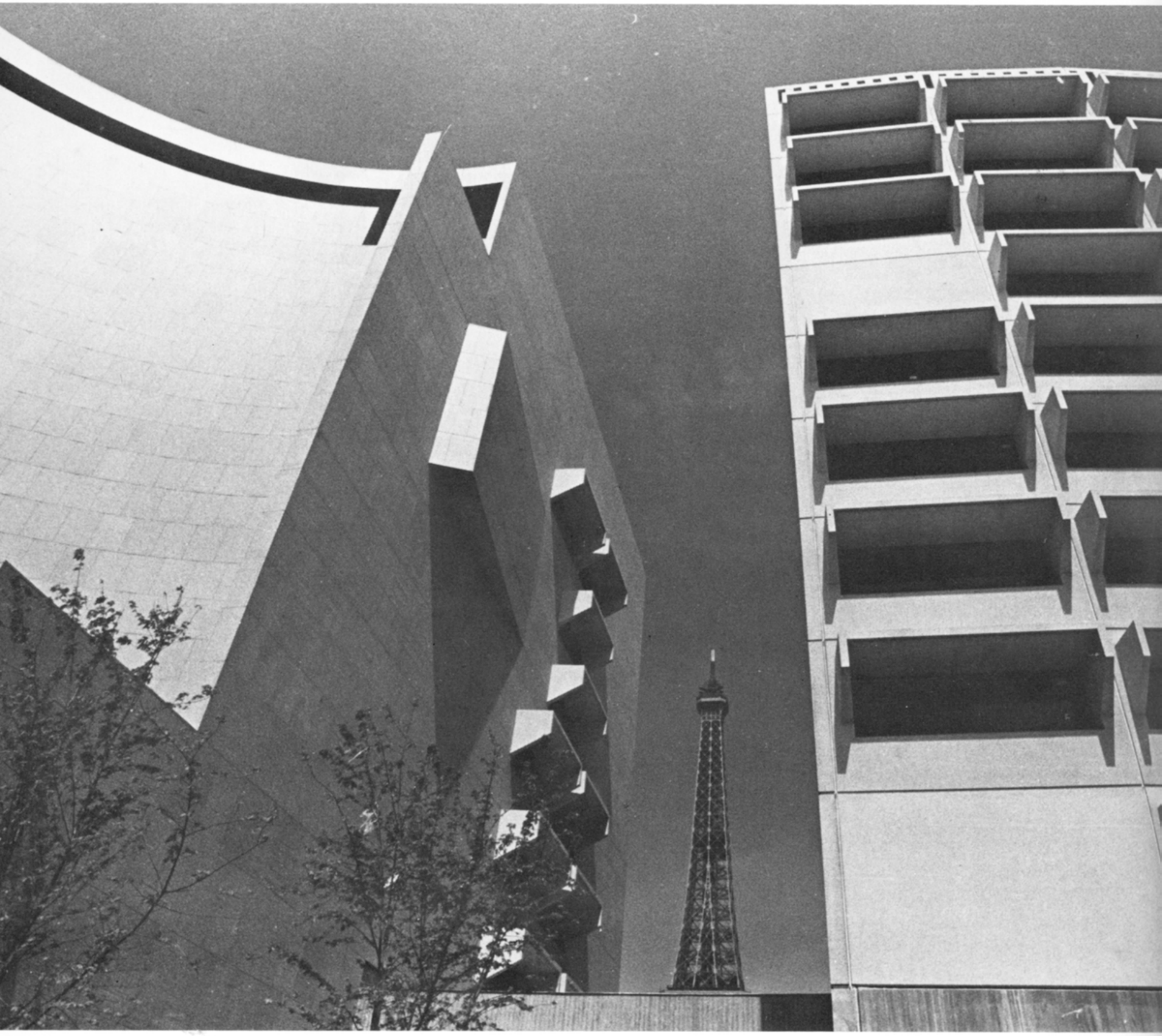
erected without formwork at the rate of one completed floor (facade and all) every four days.

The long span facade beams and columns are fabricated of precast facing units simultaneously with the floors. The 6-foot (1.8-meter) deep spandrel beams alternately span 35 feet (11 meters) and 60 feet (18 meters) around the perimeter; their I-shape resulted from a desire to recess the windows for protection from the sun. The twisted shape of the exterior columns expresses the cantilever action of all tall towers, with the greatest moment-of-inertia resistance at the base where the columns are turned outward and are flush with the building form at the top where no moment occurs. Near the base of the tower the columns are tied together and to the core by curved beams which are exposed in the main entrance. Both the columns and the spandrels are constructed of precast concrete panels as the formwork into which concrete is poured.

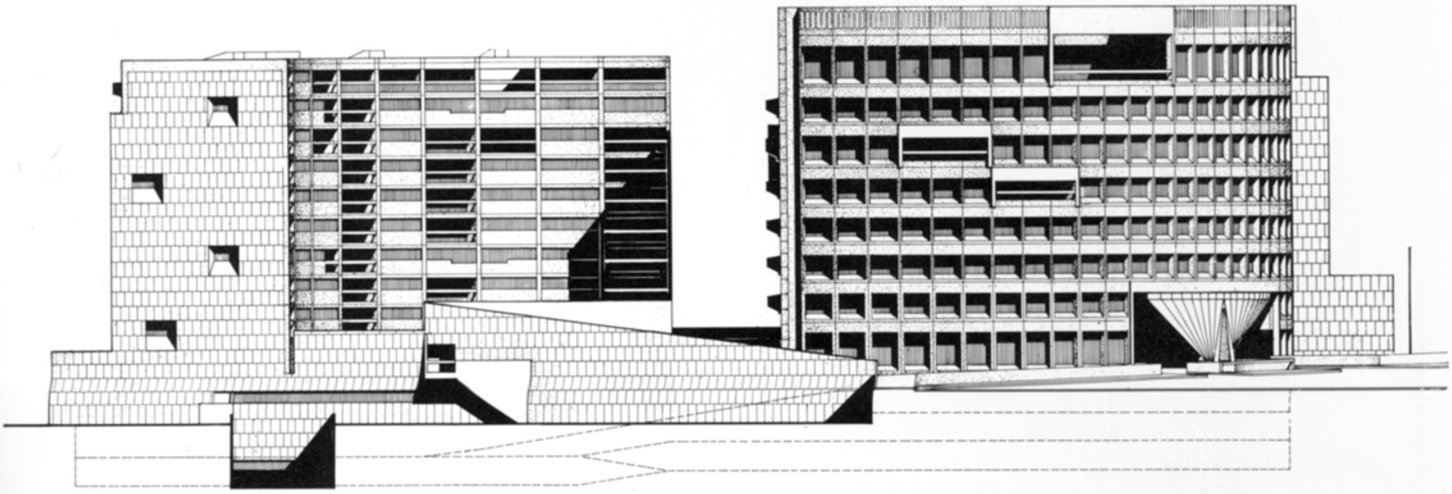
This structural system has many advantages. Not only does it make use of the inherent load-bearing capacity of the forms, but it takes advantage of the progressive gain in strength characteristic of concrete. Its highly industrialized nature transfers the bulk of the work to the factory where there is high quality control and virtually no jointing or tolerance problems. This halves the amount of on-site labor and more efficiently uses the remaining manpower, since the cycle for production of a story is spread over several levels. It also shortens the erection process by more than two days per floor, a five-month saving over the entire building.

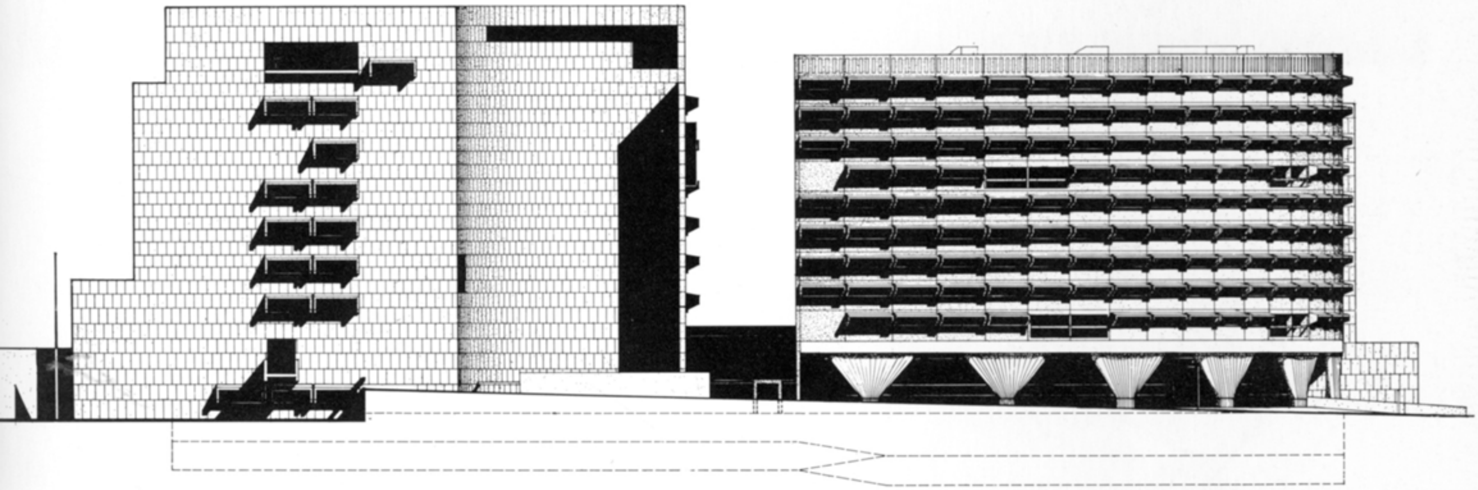
A Mixed-Use Building: Australian Embassy

The program for the Australian Embassy in Paris was split into two quadrant-shaped structures: an office building with precast facade and floors and an apartment building with precast facade and Predalle floors (this system was developed in France and will be discussed below). A combination of factory and on-site prefabrication was developed. Long, identical, tapered T-beams forming the office quadrant were supported by precast, quartz-faced, structural window units and a core built by a rising-form system. Great speed of erection resulted. The precast structural facade was interrupted at the two-story high entrance and carried by a treelike, poured-in-place support which was shaped to reflect its structural effort: to bring down the loads of the curved facade and resolve them (with straight boarded formwork)

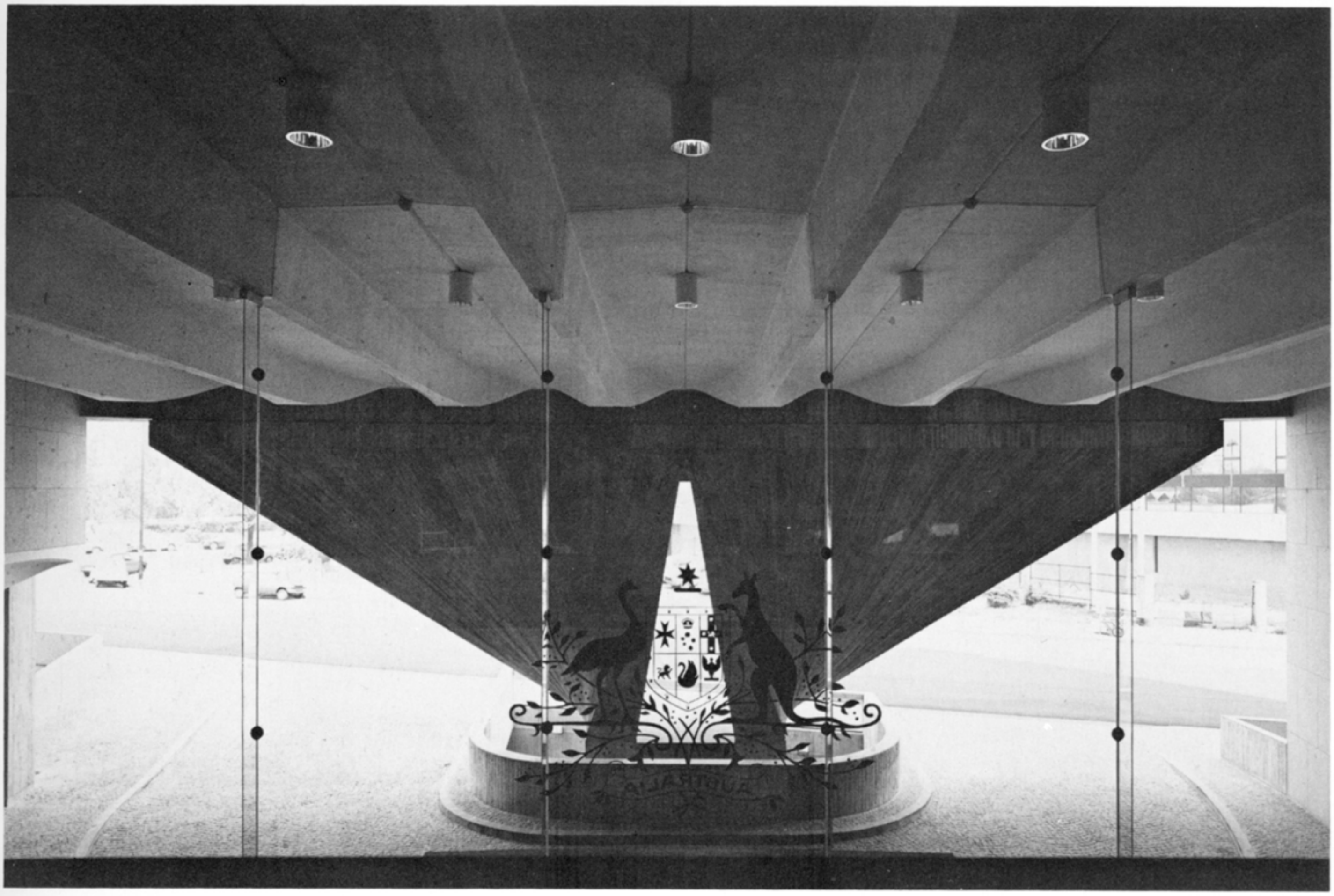


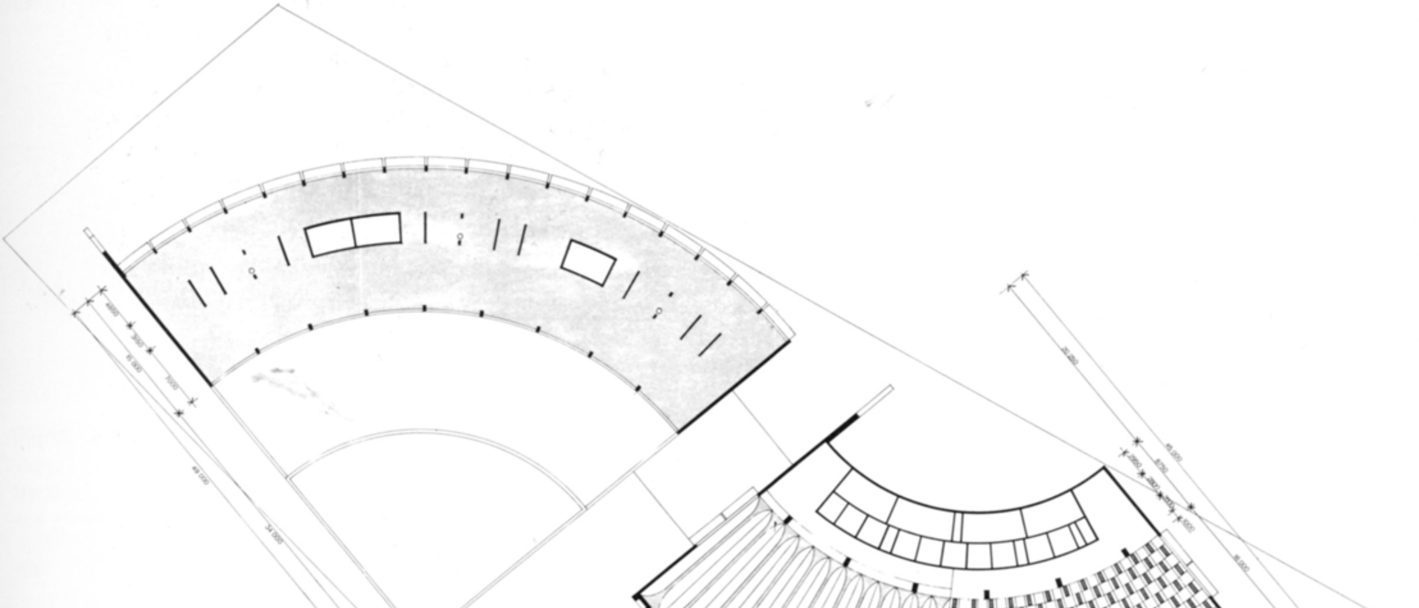
The Australian Embassy in Paris is split into two quadrant-shaped structures, one containing an office building and the other housing.



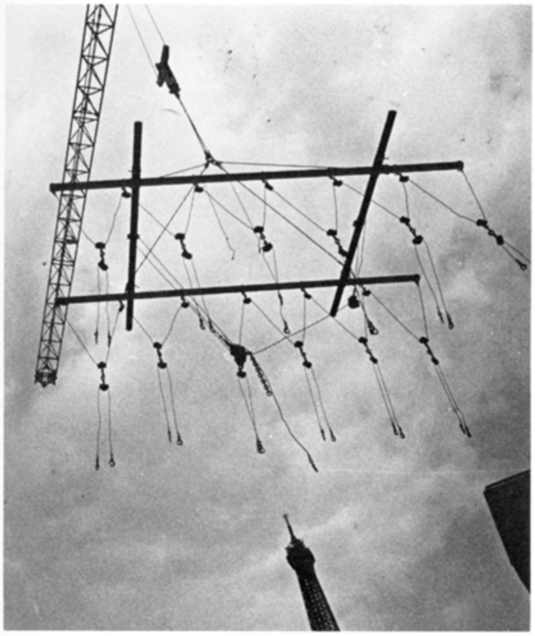


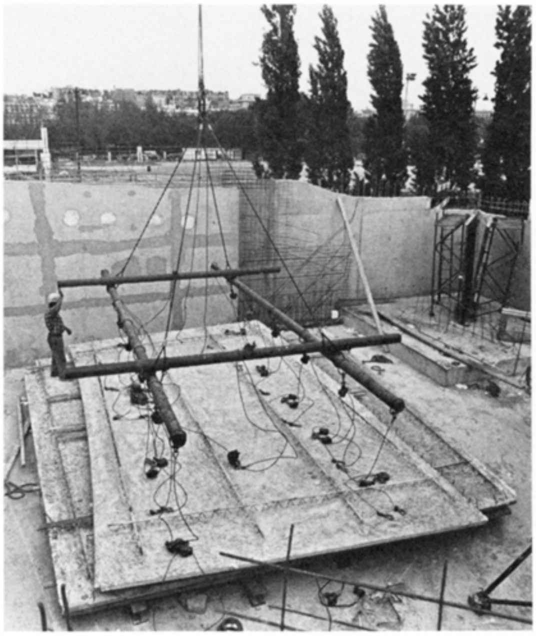
Elevations of the embassy.





STRUCTURE FAUX PLAFOND ET ECLAIRAGE





Opposite page, top: Detail of the lobby shows the precast T beams of the ceiling supported outside by a two-story treelike column.

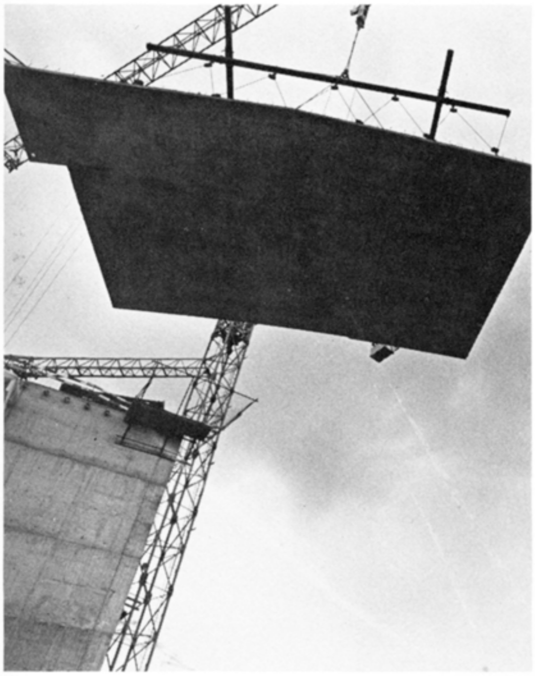
Opposite page, bottom: Reflected ceiling plans of the Australian Embassy show the predalle structure of the apartment building and the T beams of the office block with and without the lighting.

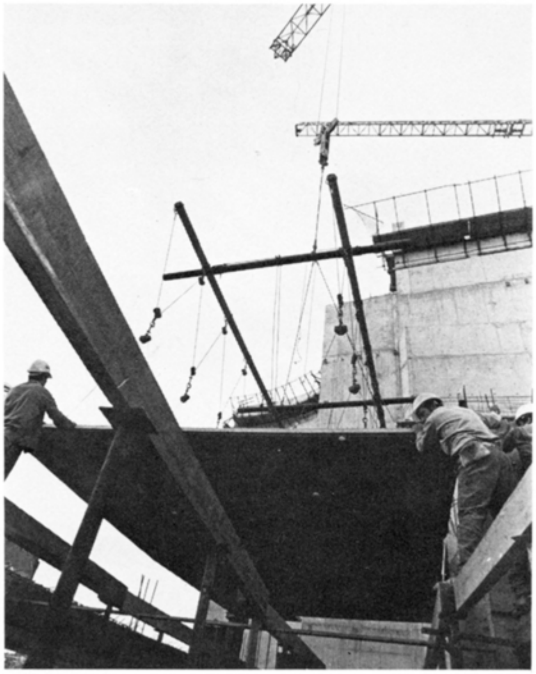
Top, left: A crane is equipped with a special hook system for lifting the 500-square-foot (47-square-meter) panels.

Top, right: The crane is then hooked to the reinforcing trusses.

Bottom, left: The slab is picked up.

Bottom, right: The slab is then moved into place and attached. After this the balance of the slab is poured in place.





into two columns turned at right angles to the facade to give lateral stability. P.L. Nervi served as the consultant.

The apartment building was constructed from a partial system of site prefabrication of its segmental floors. The Predalle system consists of precasting the lower part of the flat slab floors on a steel platform at ground level. The upper surface is left very rough, and the concrete is steam-cured overnight. These panels, up to 500 square feet (47 square meters) in area, are then picked up by a crane and deposited on minimal formwork supported by precast facade and interior columns. The balance of the slab is then poured in place, leaving a smooth, paintable surface below, which eliminated the need for plastering. All conventional, labor-intensive concrete formwork was thus avoided.

Trade Group Offices

The program for the Trade Group Offices in Canberra included the accommodation of three interrelated federal government departments for a total office population of 3,250. Through the design we aimed to achieve an architecture of strength, simplicity, and considering its location adjacent to Australia's Seat of Federal Government, an appropriate level of formality. Any suggestion of short-lived capriciousness and fashionable intricately molded facades and sections was avoided in favor of a simple, strong silhouette. In fact, every hope of aesthetic longevity was projected. The program itself, requiring completely flexible office space, suggested a systematized approach, expressed mainly by the long-span, structural design and the implied means of construction.

The solution adopted consisted of a system of connected wings joined by vertical access cores and creating open courtyards between them. This met the aims of flexibility. Office areas for various departments are spanned from the cores in two directions; they meet, but connect only in cases where communication is required. Each half-wing is served from a core, which cuts down on complete through corridors. Other than providing the specified total occupiable floor space, there is no initial need to define the boundaries of each department.

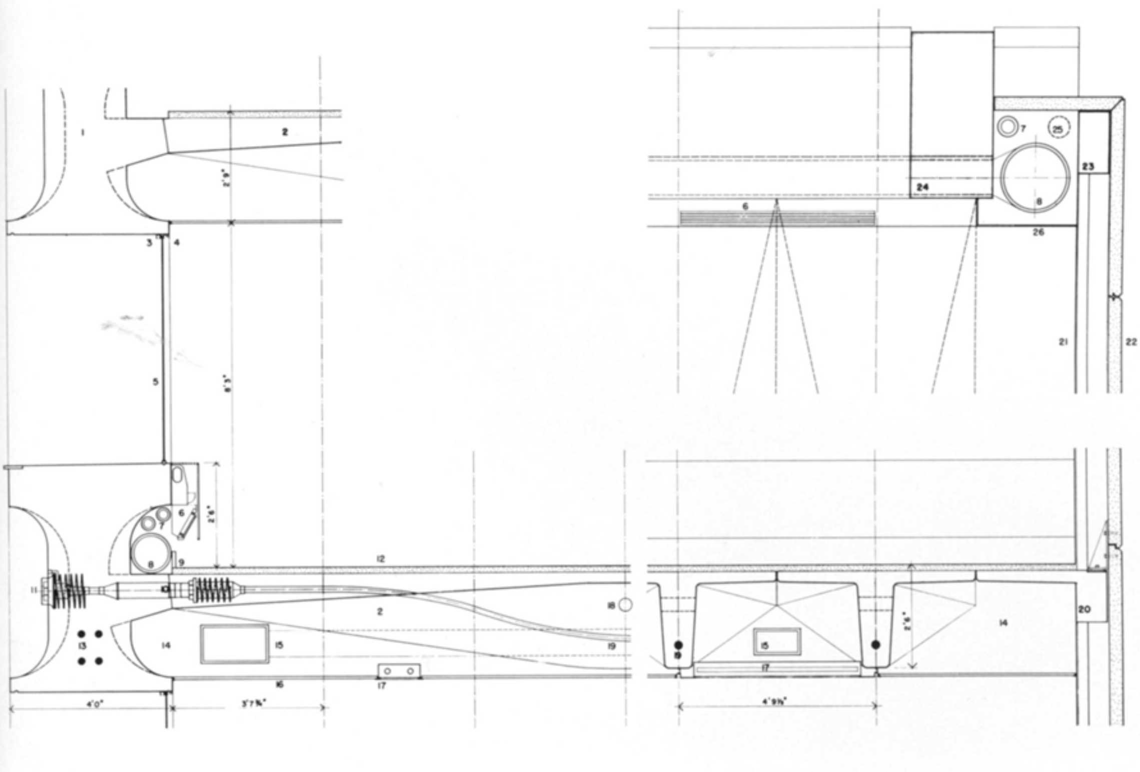
The configuration of the scheme lent itself to a systematized structural solution which consisted of post-tensioned, precast, mass-produced concrete elements. Only one floor element, one exterior wall, and one column element needed to be produced—a basic approach which took into account the fact that the scheme had to be built in a short time.

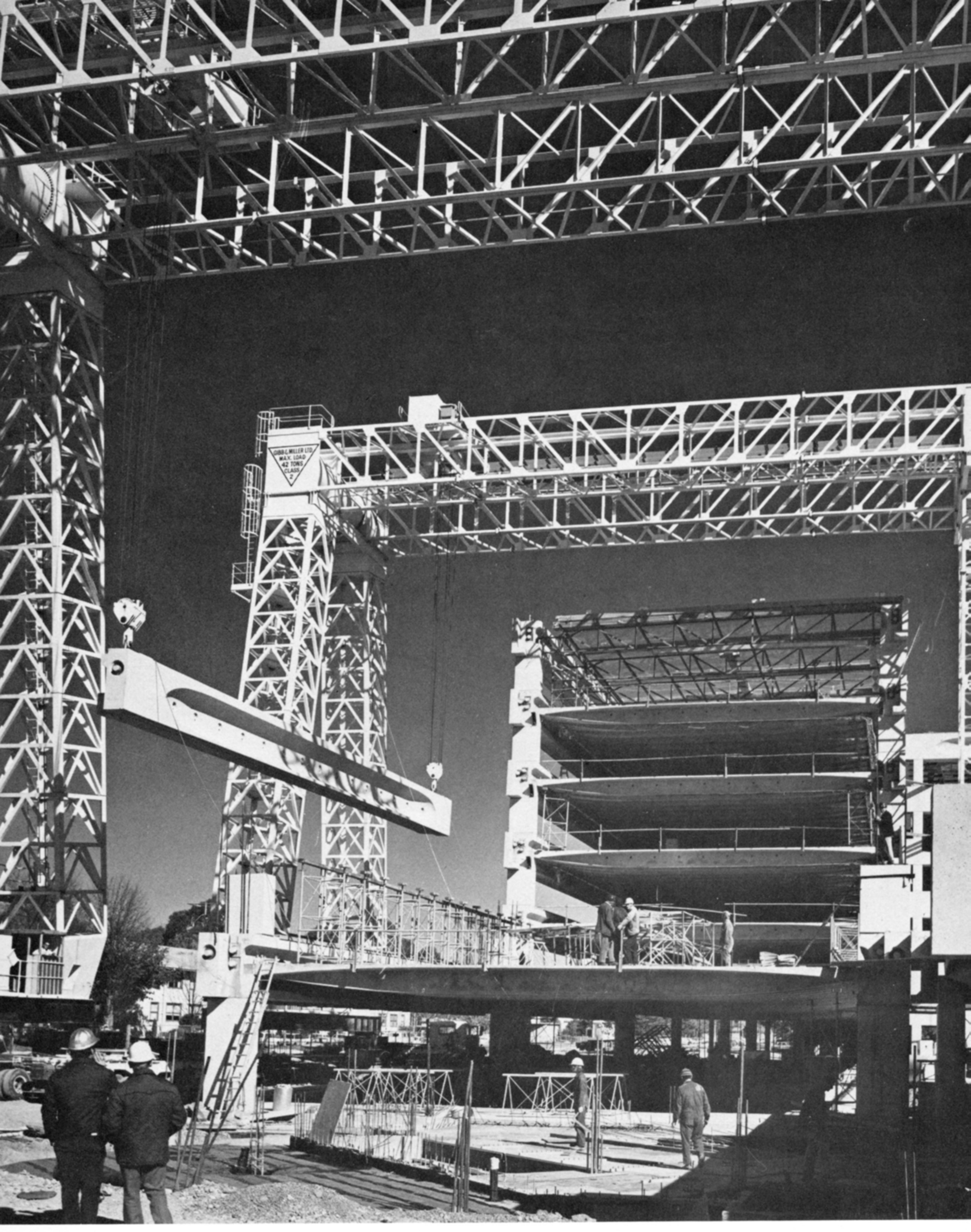
The 50-foot (15-meter) wide, column-free wings were spanned by identical prestressed T-beam planks, 4 feet 9½ inches (146.1 centimeters) wide. The prefabricated floor planks organi-

Opposite page: A typical facade of the Trade Group Offices shows the long-span precast facade girders acting as bris soleil. The knobs visible on the beams support the precast T beams spanning the depth of the office space inside.

Below: Key:

1. *Spandrel I beam*
2. *Modular floor plank T beam*
3. *Window cleaning safety track*
4. *Curtain track*
5. *Heat-absorbing glass and neoprene gasket*
6. *Induction units*
7. *Secondary chilled water supply and return*
8. *High-pressure air supply*
9. *Skirting*
10. *Prestressing anchorage and cover*
11. *Prestressing tendon coupler*
12. *Topping and vinyl tiles*
13. *Prestressing tendons to I beams*
14. *Plenum return air*
15. *Inner zone air supply*
16. *Suspended modular ceiling*
17. *Recessed fluorescent light fixtures*
18. *Beam penetrations for services*
19. *Prestressing tendons to T beams*
20. *Cast-in-place concrete beam and slab*
21. *Brick infill*
22. *Precast concrete facing panels*
23. *Cast-in-place concrete column*
24. *Precast concrete column*
25. *Provisional stack*
26. *Duct casing*

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cally change form from a rectangular support to a T in the center. Two structural facts dictated this design: the T is the most efficient concrete unit for resisting deflection in a 50-foot span and the most efficient concrete unit to be supported is a slab-on-line support. Their shape allowed for the passage of longitudinal service ducts near the supports. All units were post-tensioned individually and to each other.

The program required facades with integral exterior protection from the sun. Upon examination of the most essential shading need, the outline of a sufficient profile that spans 80 feet (24 meters) was developed. The shape expressed the parabolic change from solid at the ends to resist shear to an I in the center to resist bending. They were produced on the site and lifted by moving gantries. The longitudinal exterior walls of the office wings consisted of spandrel beams, with two and three such spans respectively on the short and long sides of the courtyards and with glass between their inner edges forming the office windows.

Columns were also precast and arranged in pairs to provide structurally desirable simple supports for the spandrel beams and to facilitate exit points to the fire stairs attached to each long wing. The space between the paired columns also contained provisional plumbing stacks and condensation lines from induction units.

Not only do the profiles of both floor planks and spandrel beams follow their logical structural outlines, but they provide for the appropriate horizontal service arteries. The installation of the air conditioning consisted of a low-pressure air system serving the inner zone of office space and a high-pressure system serving the induction units under the windows.

The interior zone system requiring little flexibility was chosen because people and lighting loads are relatively constant. Not much air is needed to supply the two zones on each wing; for this, a simple all-air system was most economical.

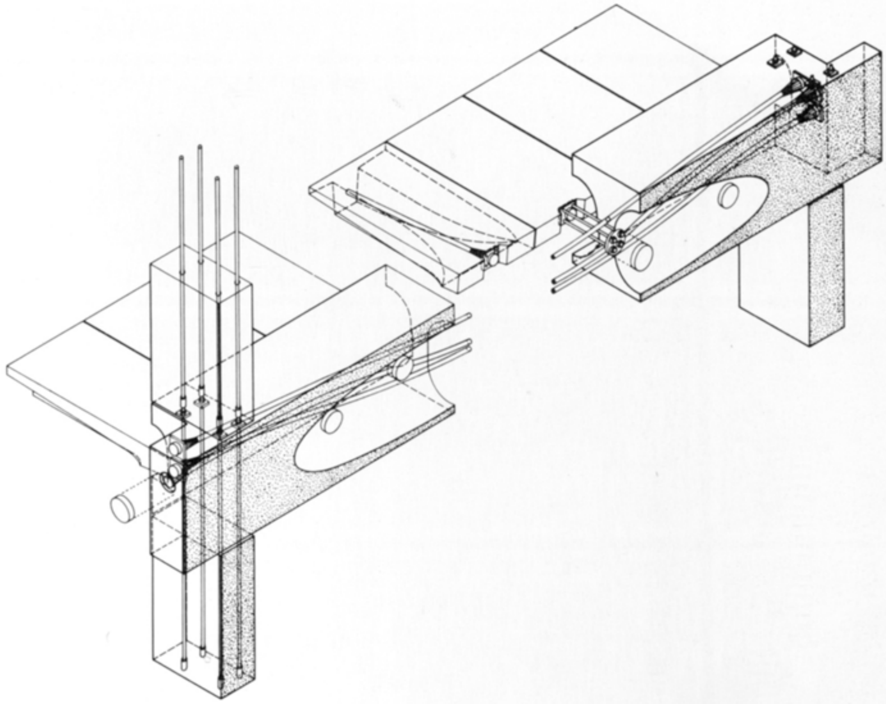
At the perimeter, however, the situation was different. Much flexibility was needed to cater to the variation in interior loads of people and lights and the variation in the load due to the sun's changing orientation. To eliminate downdrafts from the windows in cold weather, an under-window air supply system was preferable. In addition, the savings in mechanical room space led to the choice of an induction unit system.

Flexibility was achieved by the use of separate units for each basement area, which allowed economic off-hours operation of any system. This meant that the office block system could be operated independently to permit a quarter, half, or three-quarters of the building to be air conditioned at any one time.

Air is returned through a ceiling plenum. This decision reduces the quantities of supply air required to condition the space, which reduces the size of the air handling unit. It also provides efficient smoke exhaust from the office space, board rooms, and other areas of heavy smoking. It eliminates the use of door grills in partitions and improves the efficiency and life of light fixtures.

The foregoing examples constitute one designer's efforts to solve problems consequentially, following a clear methodology of approach. The fusing of structure/construction/economy with clear aesthetic aims and practical demands of building users is the essence of mainstream modern architecture's philosophy.

The countless recent buildings throughout the world based on the prevalent out-of-balance, one-sided, capricious approach are threatening to divert the inevitable direction of architectural development. The general public's understandable disenchantment with new building and the environment has been the result. By stressing the need for the integrated approach demonstrated here, we hope to stimulate a desirable reorientation.



Above: Axonometric of the precast concrete assembly showing the post-tensioning rods.

Opposite page: At the Trade Group Offices the construction of precast facade beams (each weighing 80 tons) and floor elements (each weighing 11 tons) is by means of three-legged steel gantries traveling on rails and designed to rotate at the corners.