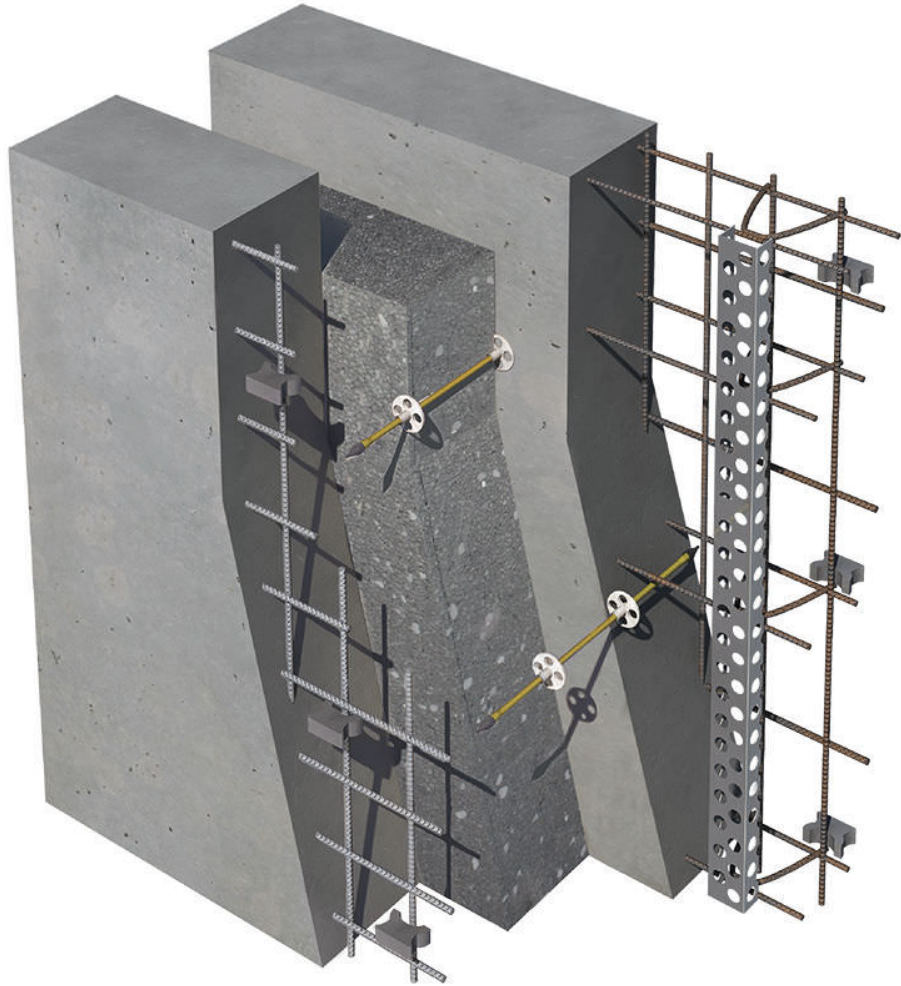


**Thermal bridges** are the CURSE of concrete framing

- Details **MUST** be developed to insert a thermal (insulation) break between the exterior and the interior



Putting insulation  
between layers of cast  
in place concrete for  
that "all concrete" look



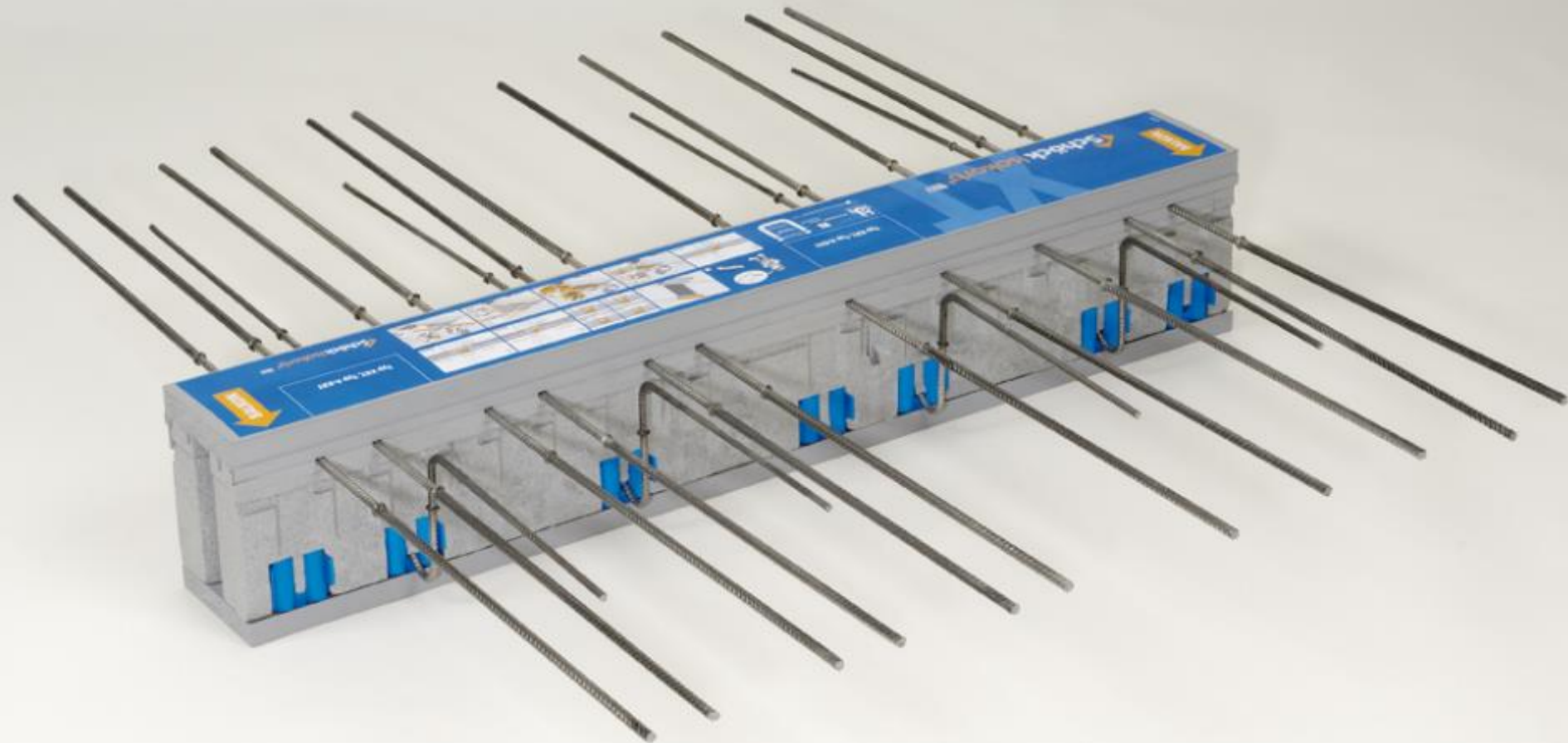
































56 Leonard Street  
New York City, USA  
Herzog & deMeuron  
2016  
250.2m

























































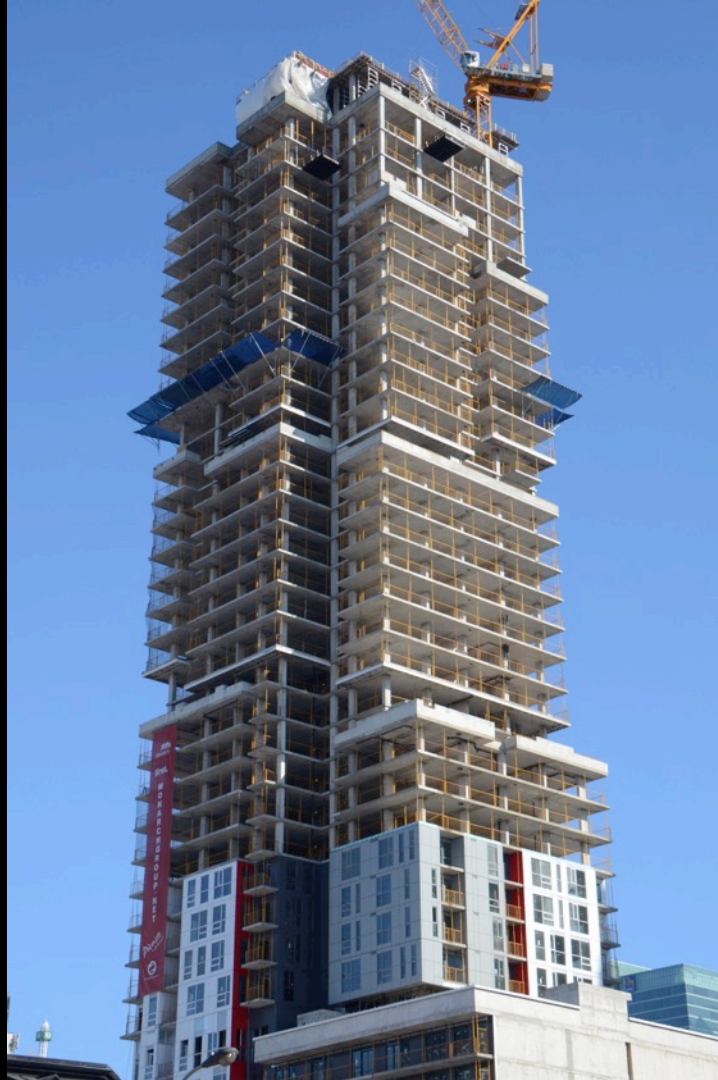




























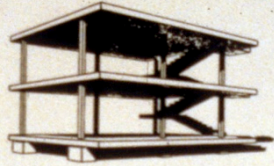




Precast and Prestressed Concrete

Arch 173: Building Construction 2  
Winter 2023





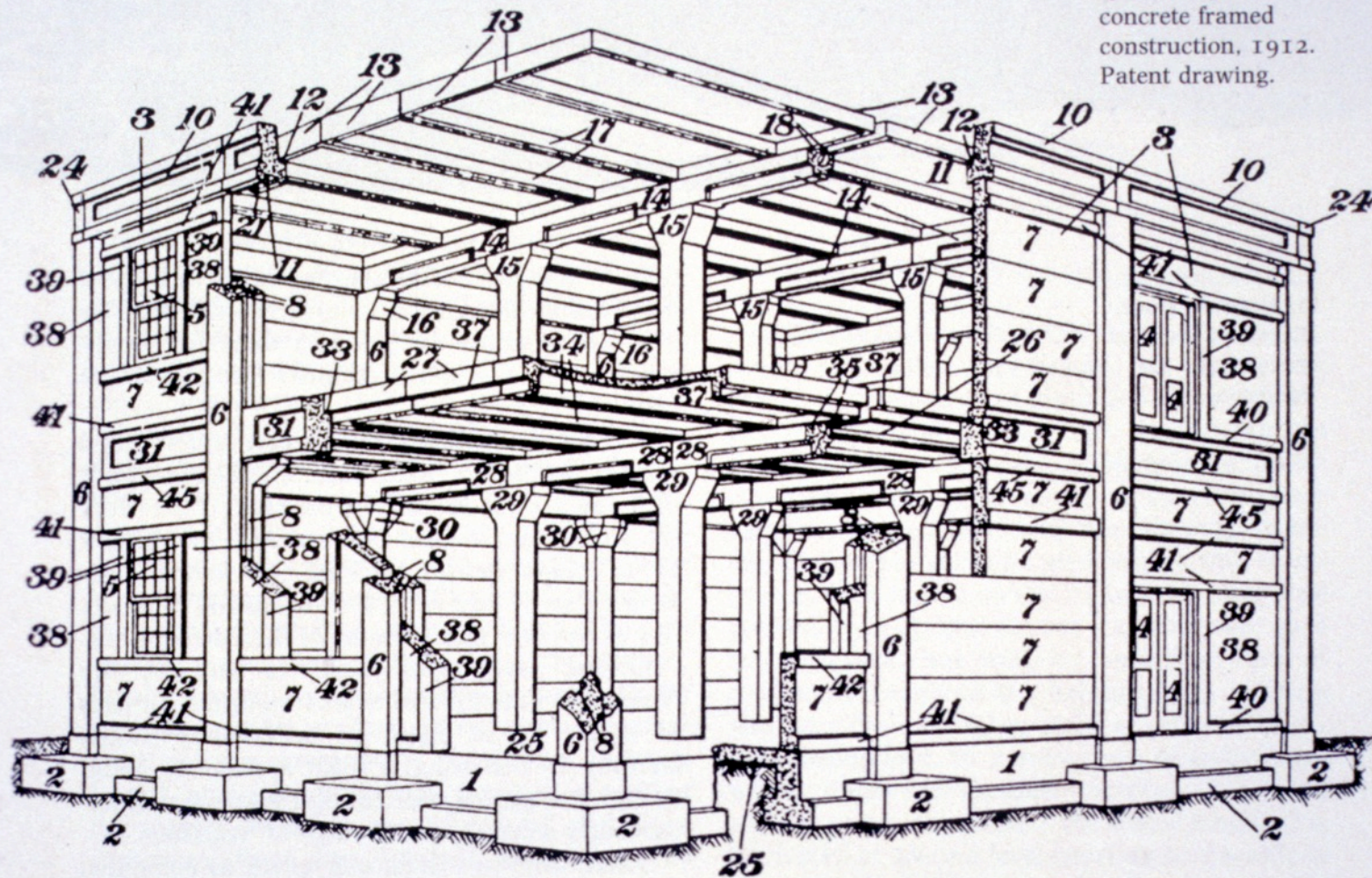
“In the next twenty years, big industry will have co-ordinated its standardized materials . . . technical achievements will have carried . . . methods of rational construction far beyond anything we are acquainted with.”

—Le Corbusier, 1914

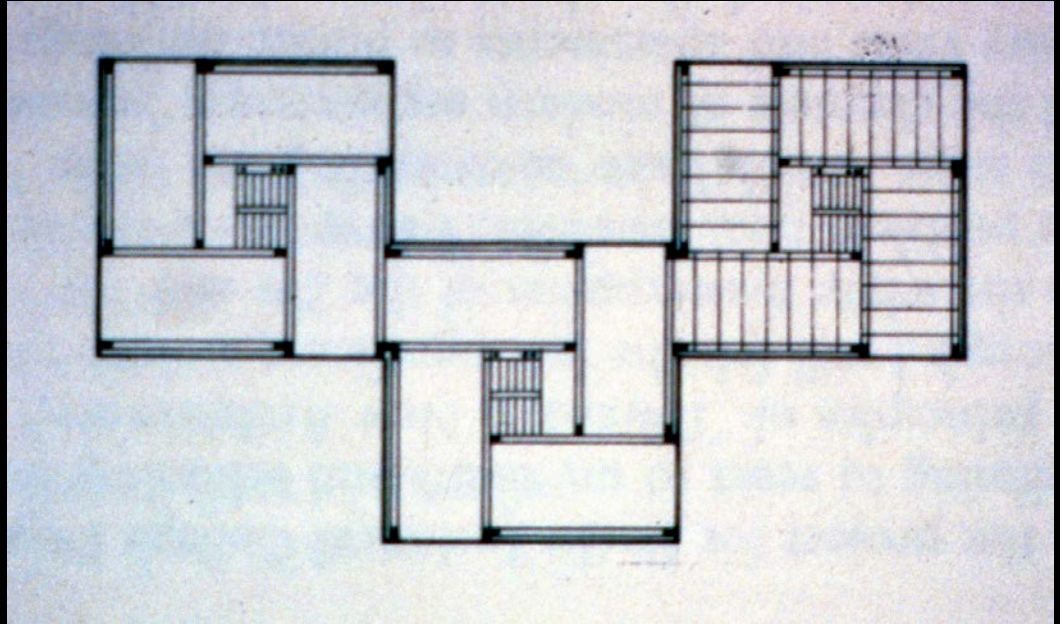
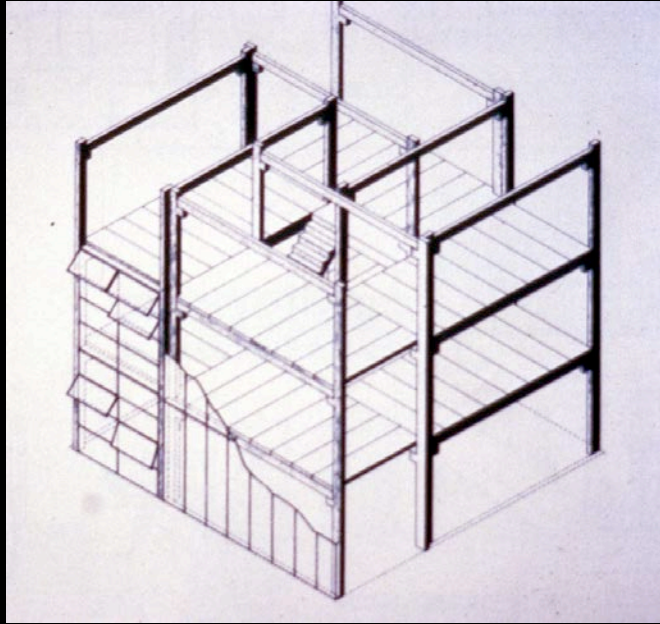
Precast concrete came about in the early 1900s as a response to industrialization.

How could you use concrete but without on site wet processes?

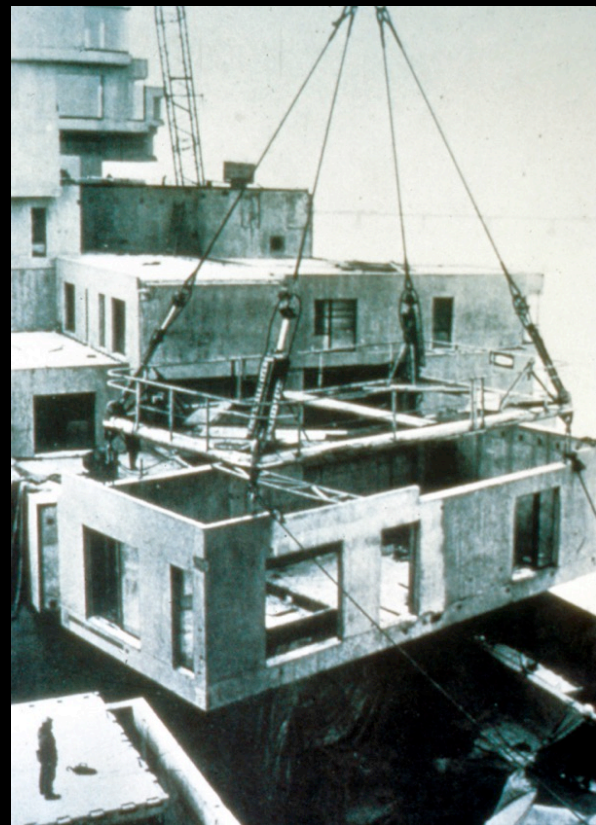
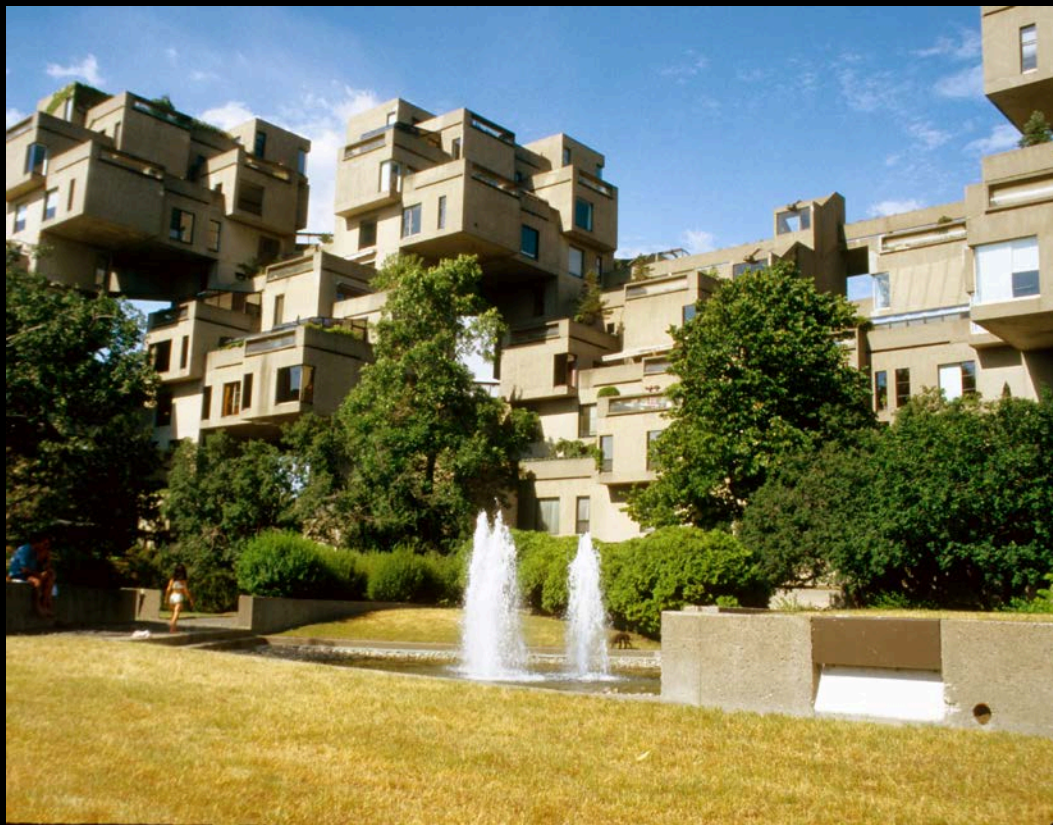
4.10 Conzelman  
system of precast-  
concrete framed  
construction, 1912.  
Patent drawing.







Prototype for a precast concrete house system by James Stirling



Expo 1967, Montreal, Housing  
Moshe Safdie



# Precast Concrete Construction Basics

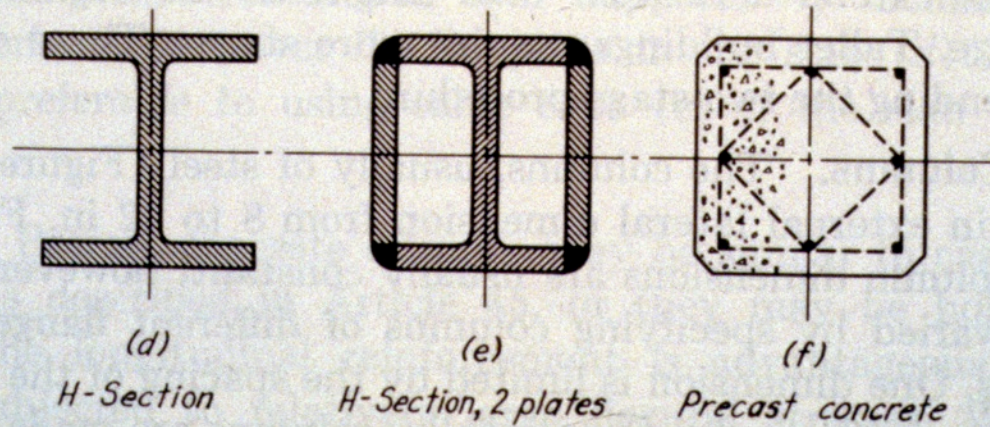
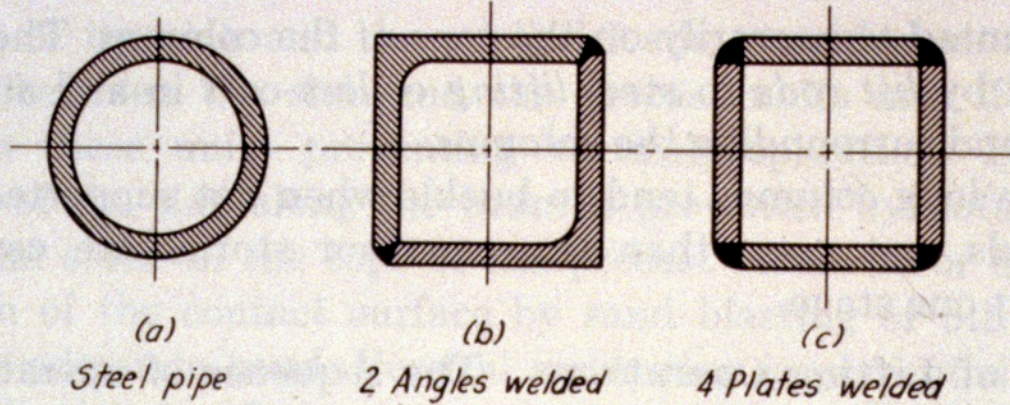
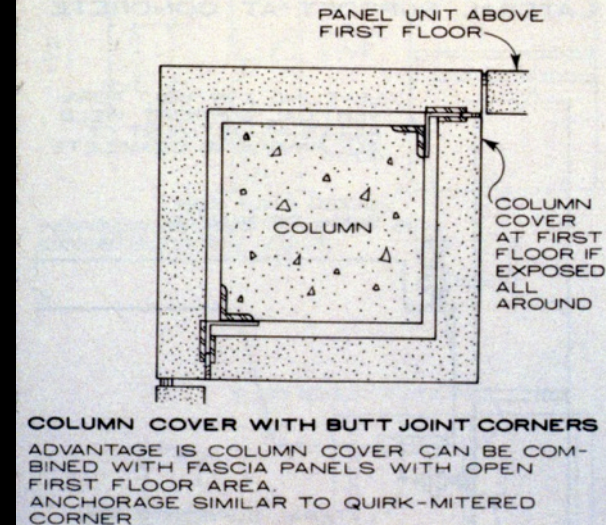
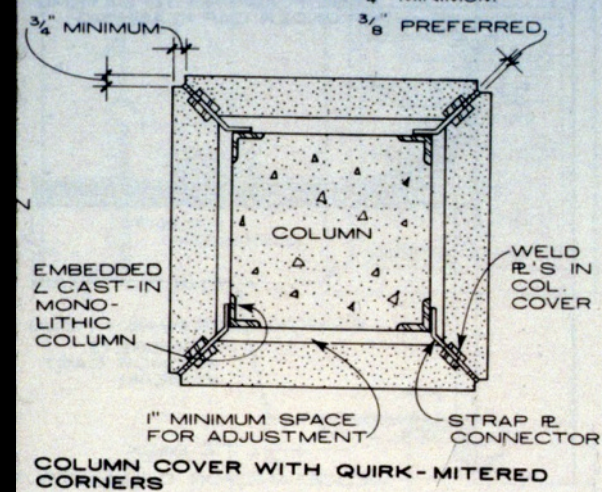
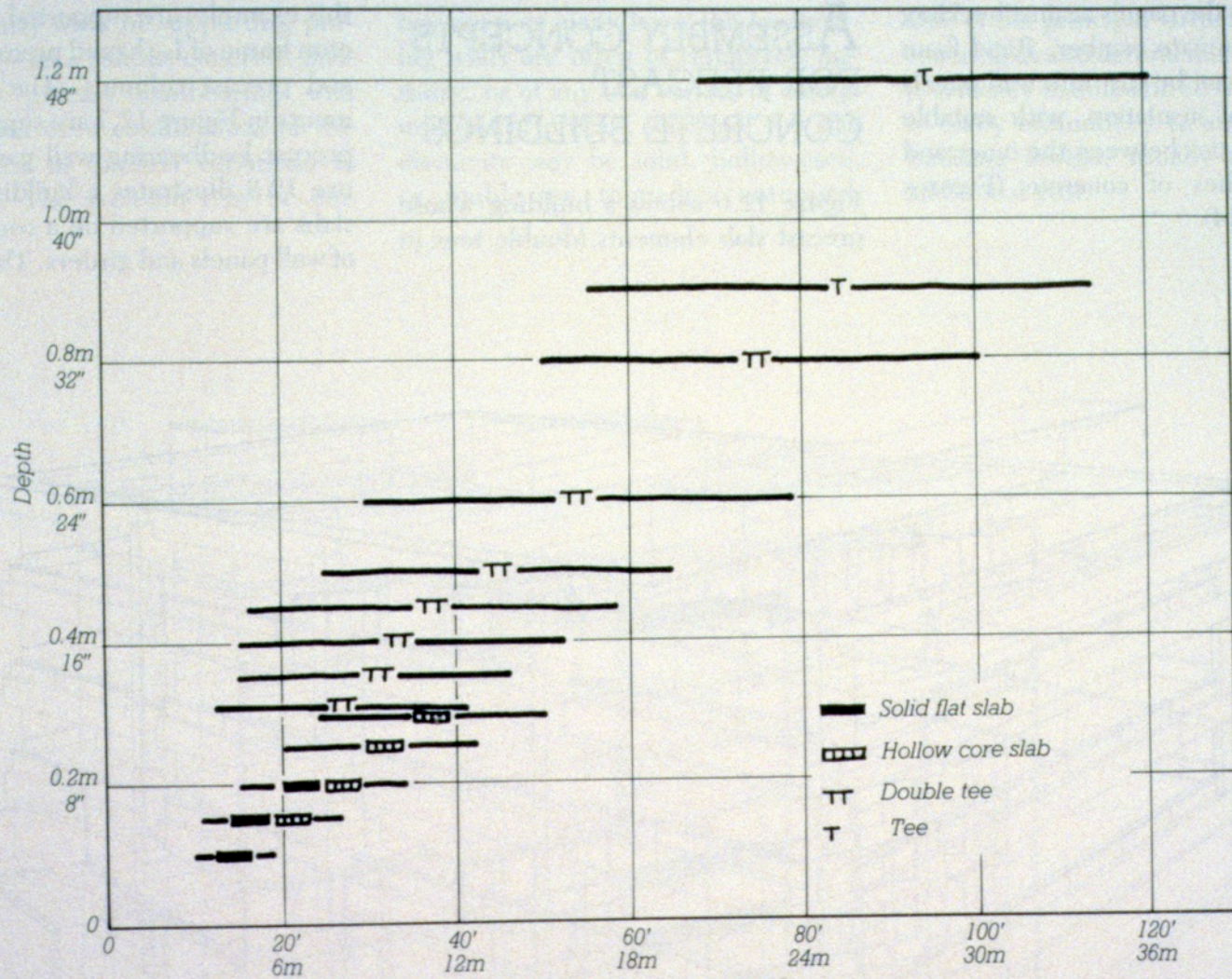


FIGURE 8.9 Types of columns.









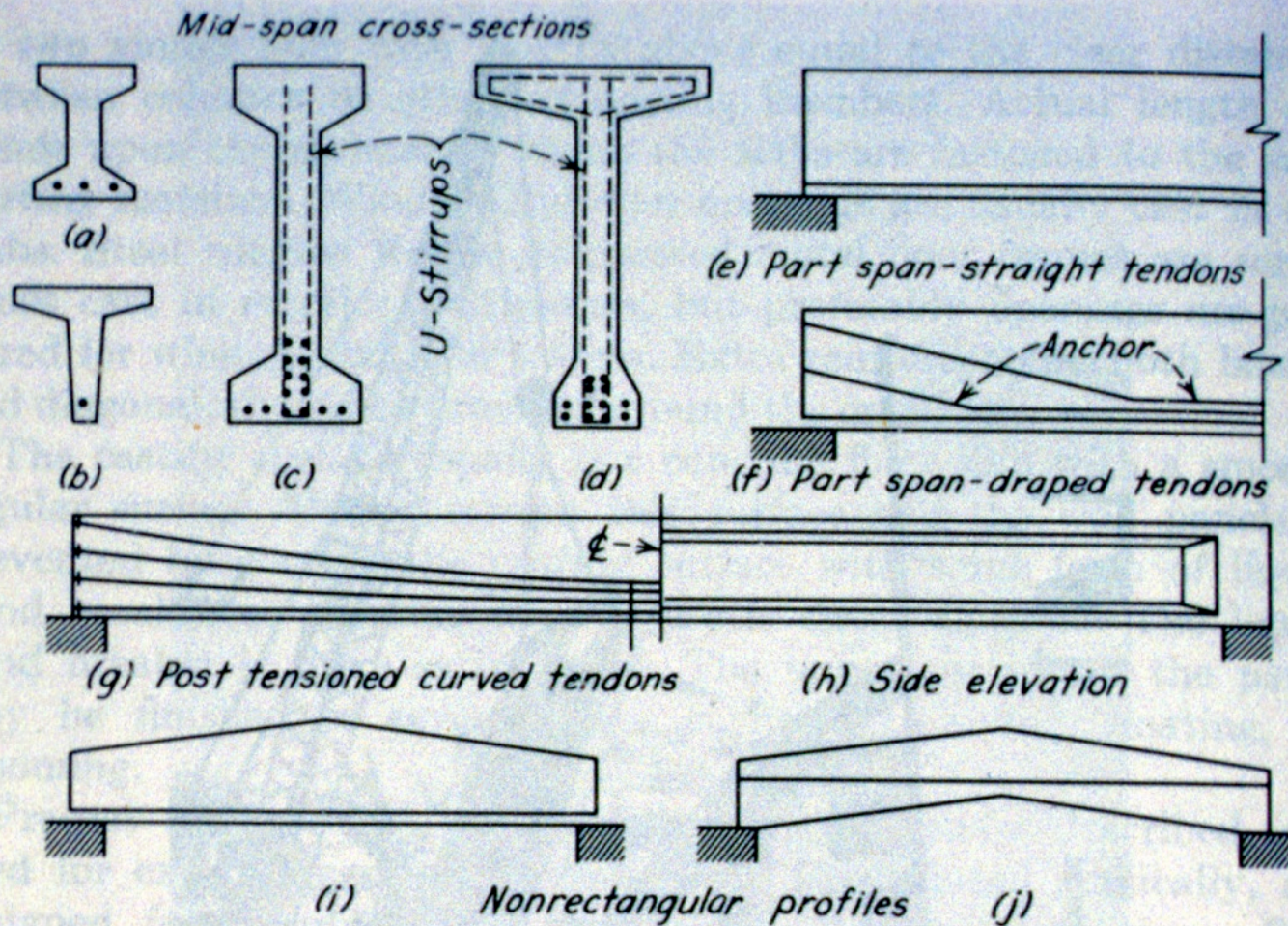
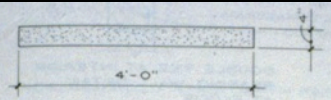
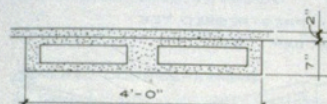


FIGURE 8.6 Precast and prestressed joints, beams, and girders.

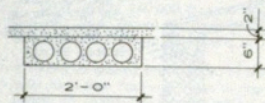




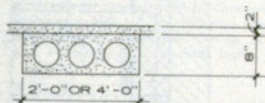
TYPE "A"



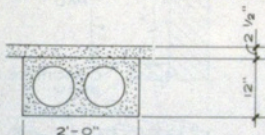
TYPE "B" WITHOUT TOPPING  
TYPE "C" WITH 2" TOPPING



TYPE "D" WITHOUT TOPPING  
TYPE "E" WITH 2" TOPPING



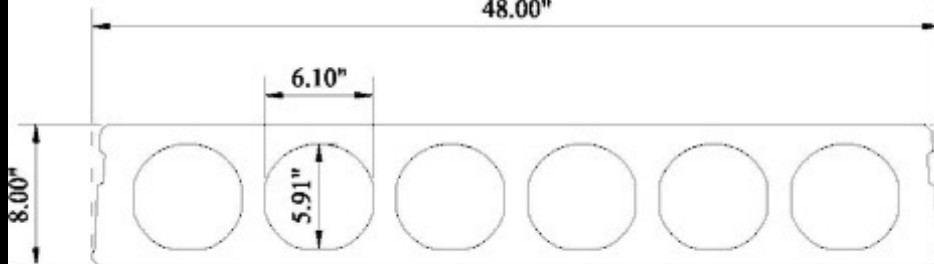
TYPE "F"-WITHOUT TOPPING  
TYPE "G"-WITH 2" TOPPING



TYPE "H"-WITHOUT TOPPING  
TYPE "J"-WITH 2 1/2" TOPPING



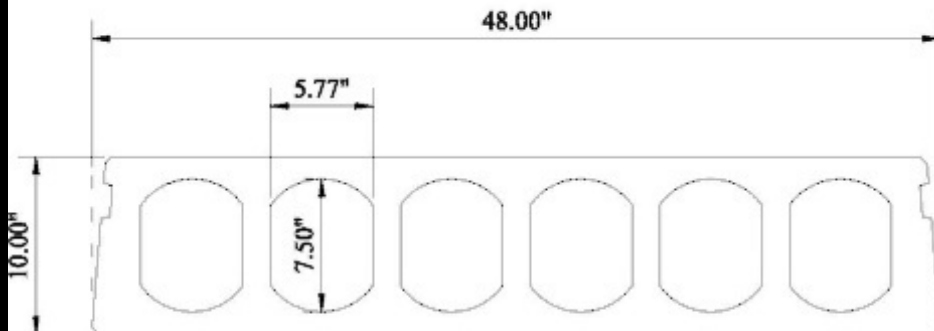
TYPE "K"-WITHOUT TOPPING  
TYPE "L"-WITH 2" TOPPING



8" x 48" PRESTRESSED CONCRETE

HOLLOW CORE SLAB

| PROPERTIES           |                      |                      |           |
|----------------------|----------------------|----------------------|-----------|
| WITHOUT TOPPING      |                      |                      |           |
| A<br>in <sup>4</sup> | y <sub>b</sub><br>in | I<br>in <sup>4</sup> | wt<br>pcf |
| 196                  | 3.97                 | 1580                 | 51        |



10" x 48" PRESTRESSED CONCRETE

HOLLOW CORE SLAB

| PROPERTIES           |                      |                      |           |
|----------------------|----------------------|----------------------|-----------|
| WITHOUT TOPPING      |                      |                      |           |
| A<br>in <sup>4</sup> | y <sub>b</sub><br>in | I<br>in <sup>4</sup> | wt<br>pcf |
| 249                  | 5.00                 | 3108                 | 65        |

## Tee spanning systems

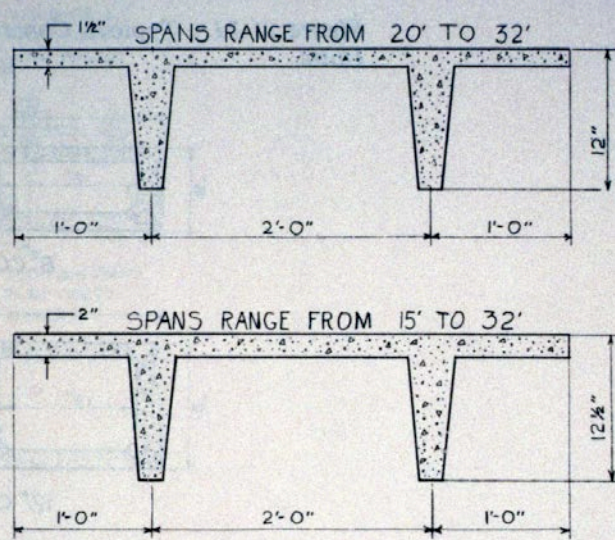
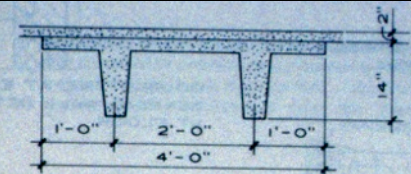
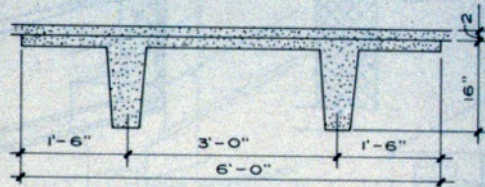


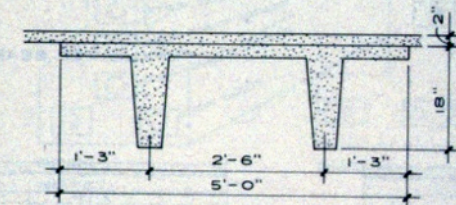
Figure 11-9. Double-Tee Floor and Roof Units



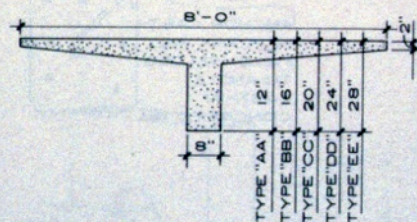
TYPE "M"-WITHOUT TOPPING  
TYPE "N"-WITH 2" TOPPING



TYPE "Q"-WITHOUT TOPPING  
TYPE "R"-WITH 2" TOPPING



TYPE "S"-WITHOUT TOPPING  
TYPE "T"-WITH 2" TOPPING



TYPE "AA" THRU "EE" - AS NOTED

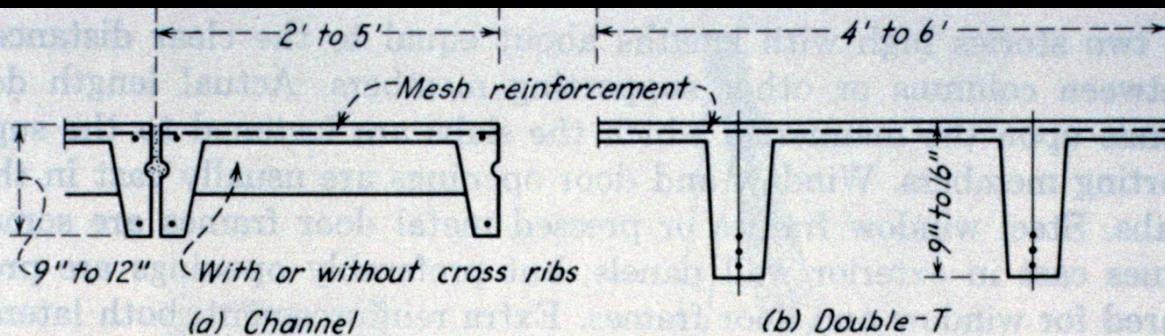


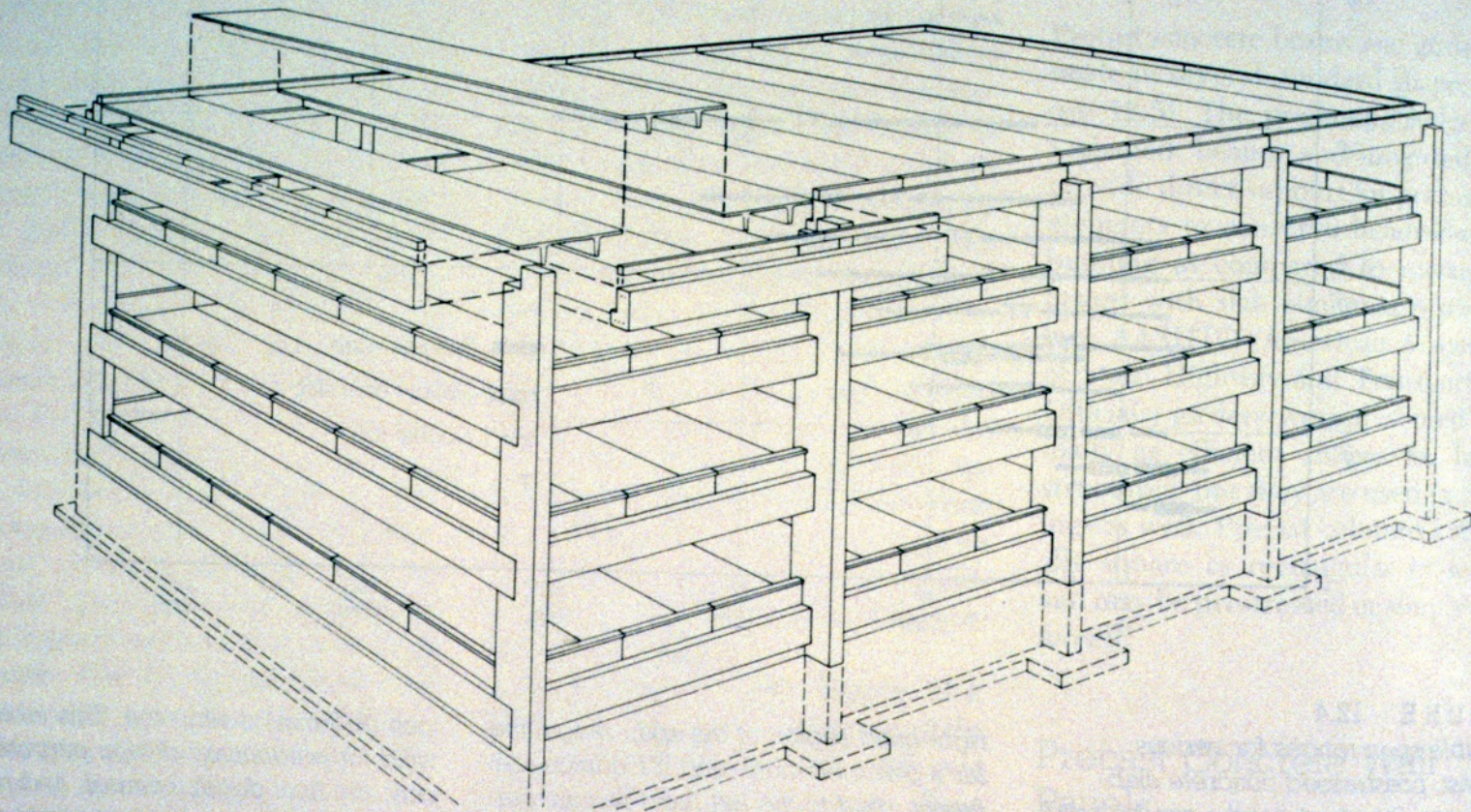
FIGURE 8.4 Channel and double-T decks.





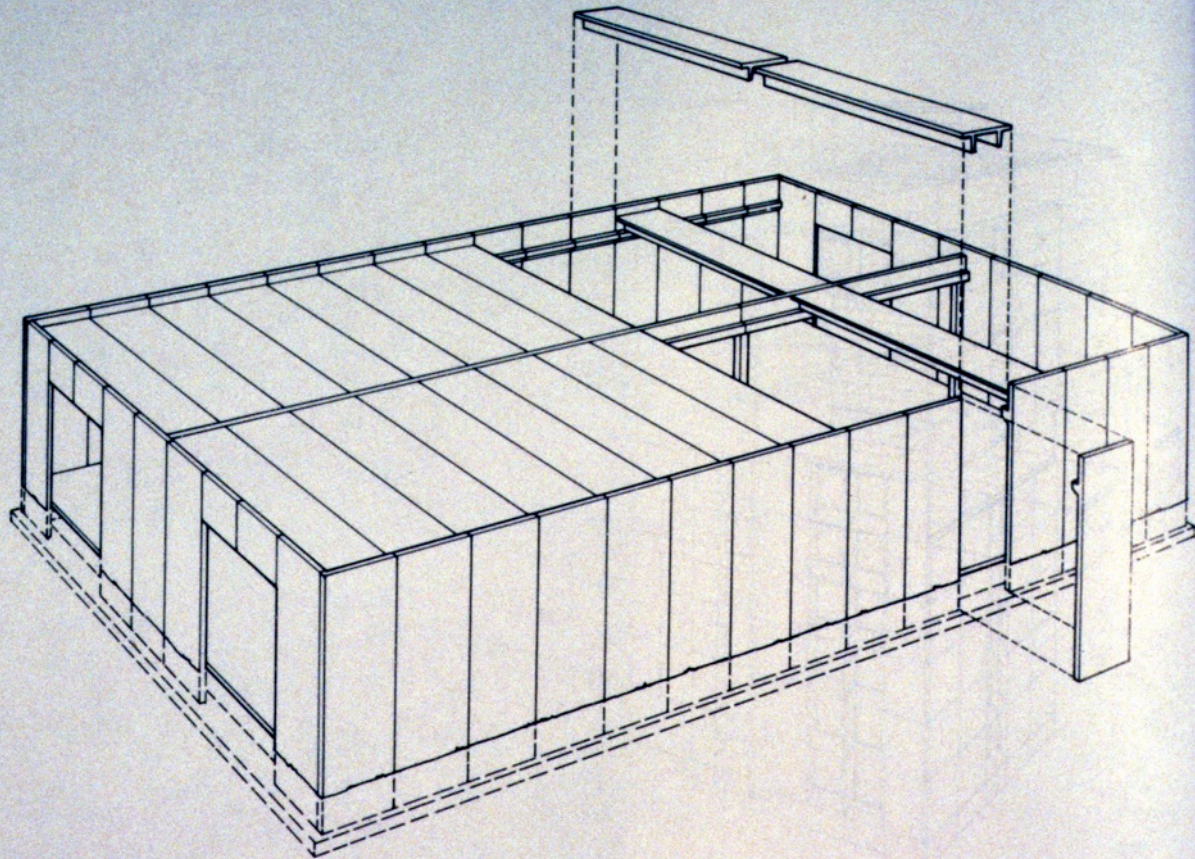
Paul Kane Collection





**FIGURE 12.6**  
*Double-tee slab elements supported on  
a frame of precast columns and L-  
shaped girders. (Courtesy of  
Prestressed Concrete Institute)*

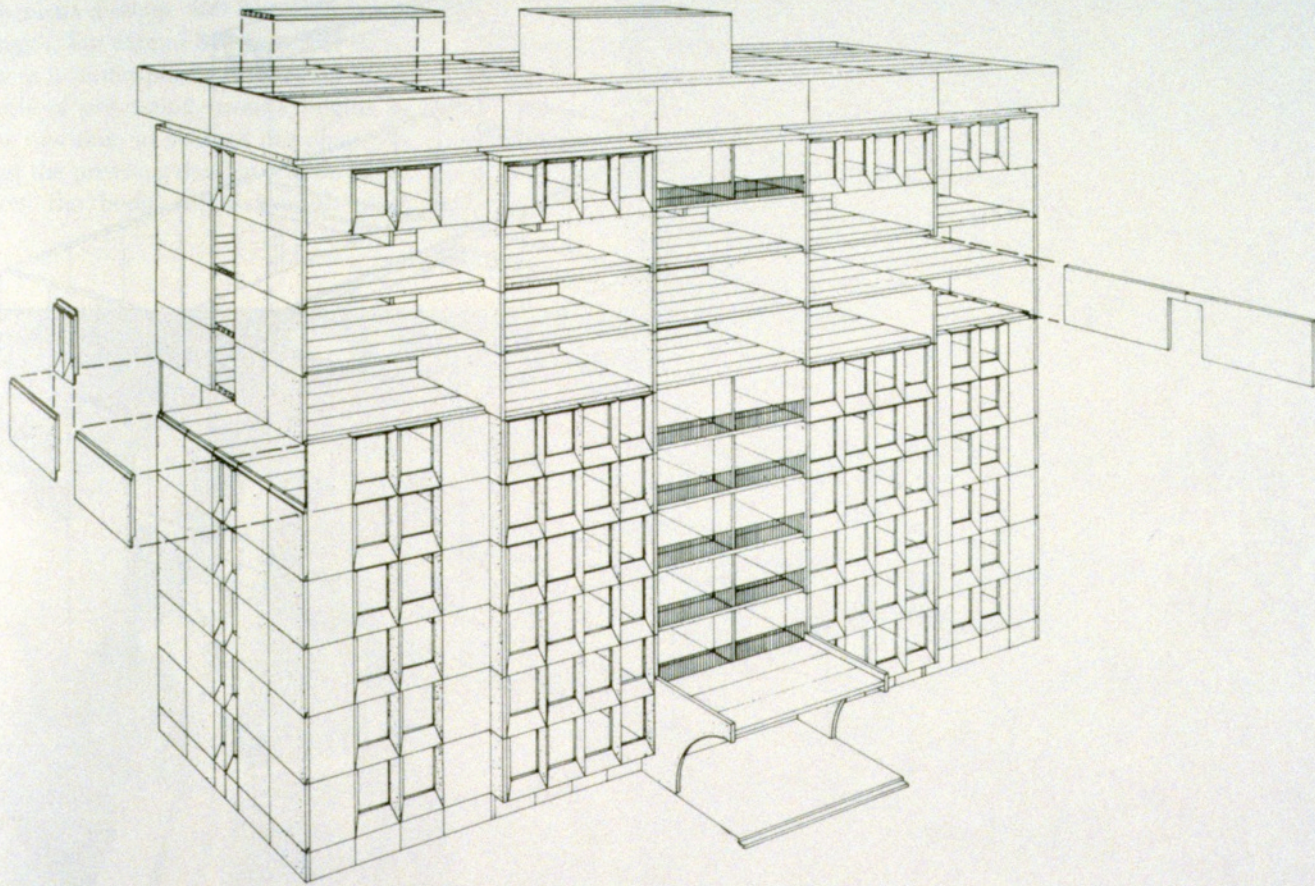




**FIGURE 12.8**

*Double-tee slab elements supported on a perimeter of precast concrete loadbearing wall panels, and an interior structure of precast columns and girders. (Courtesy of Prestressed Concrete Institute)*

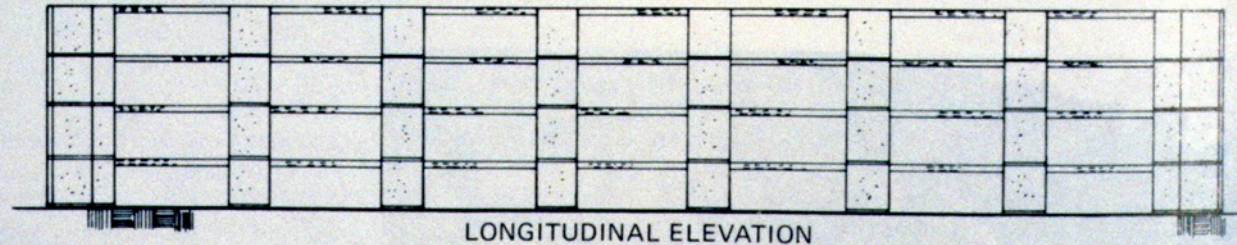
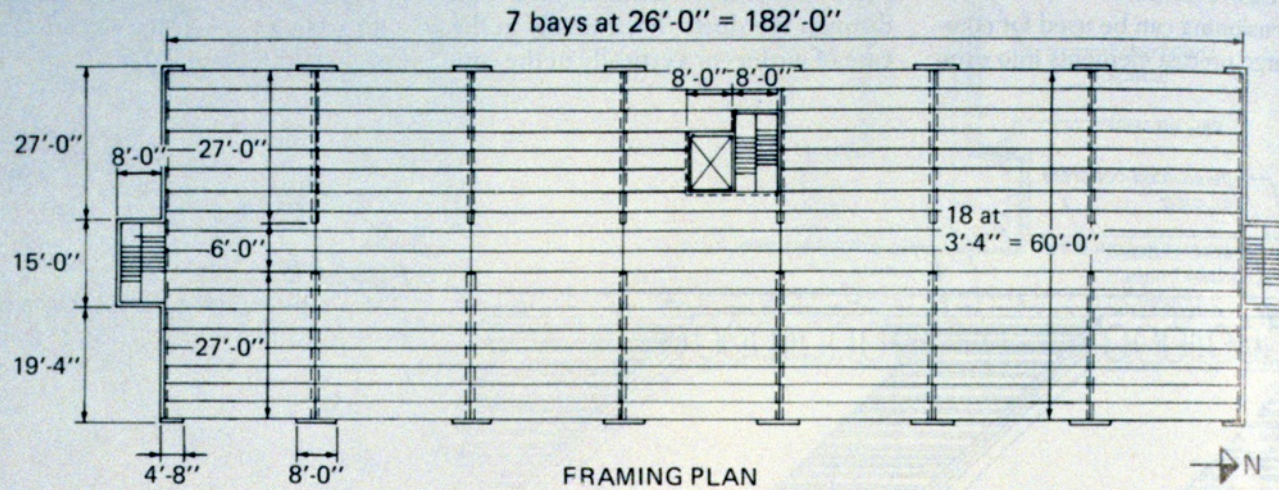




**FIGURE 12.7**

*Hollow-core slab elements supported on precast concrete loadbearing wall panels. (Courtesy of Prestressed*





**FIGURE 12.28**

*A framing plan and elevation of a simple four-story building made of loadbearing precast concrete wall panels and hollow-core slab elements. (Courtesy of Prestressed Concrete Institute)*

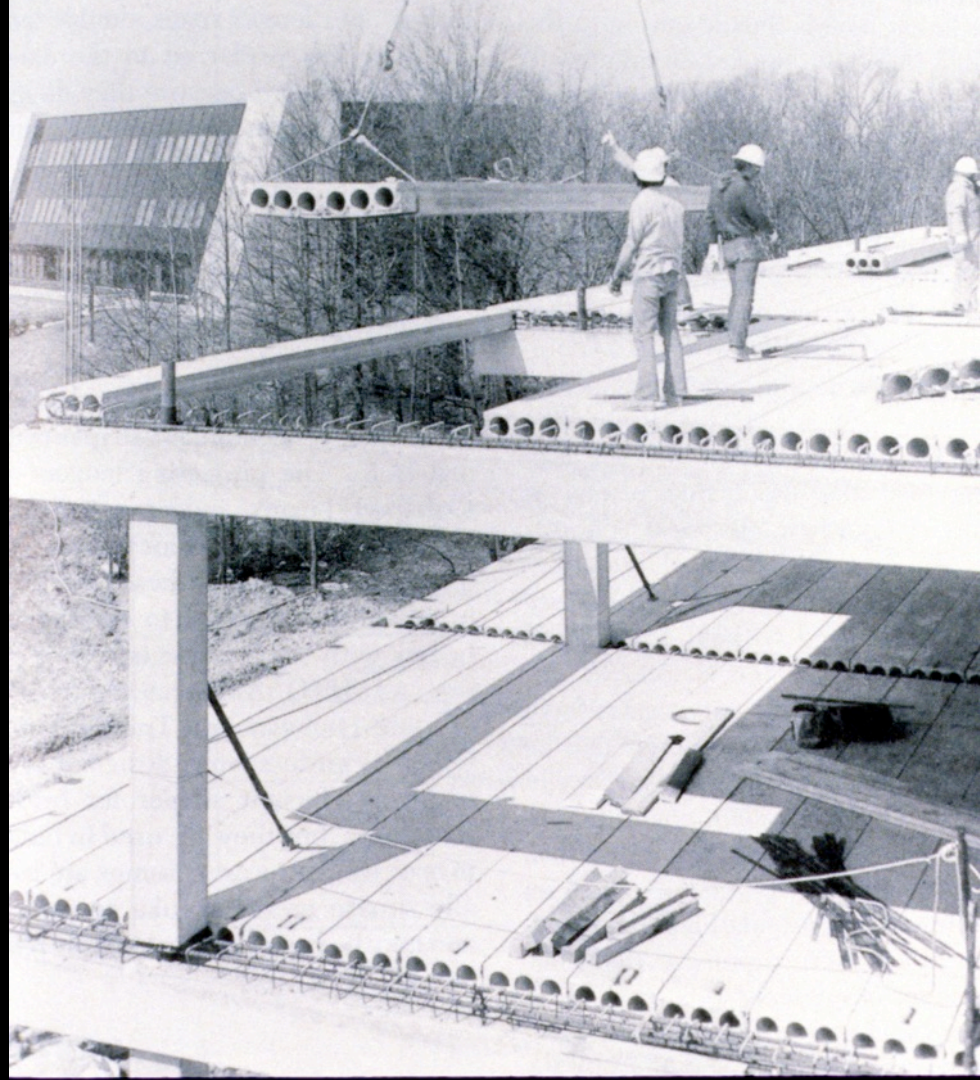




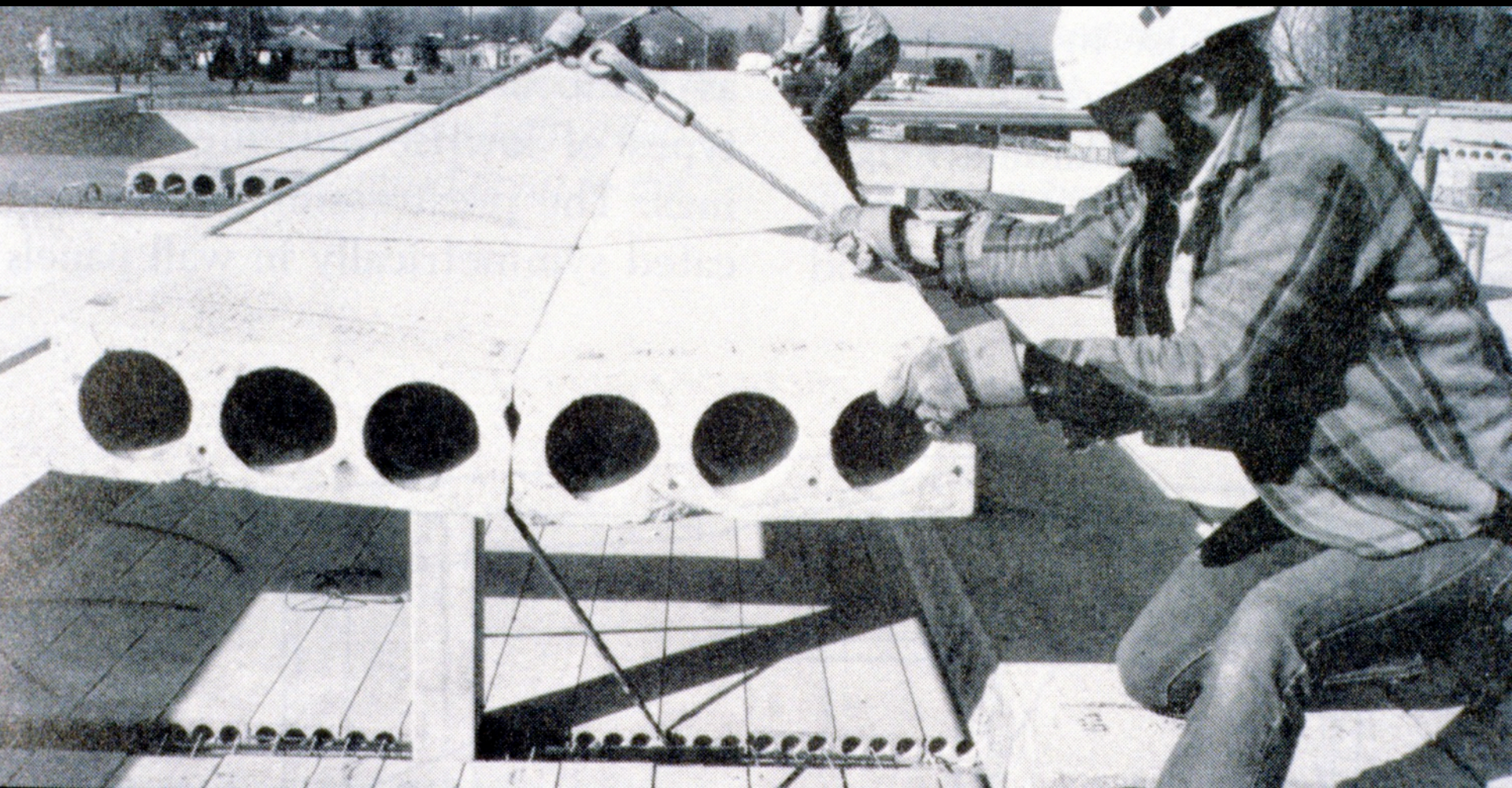






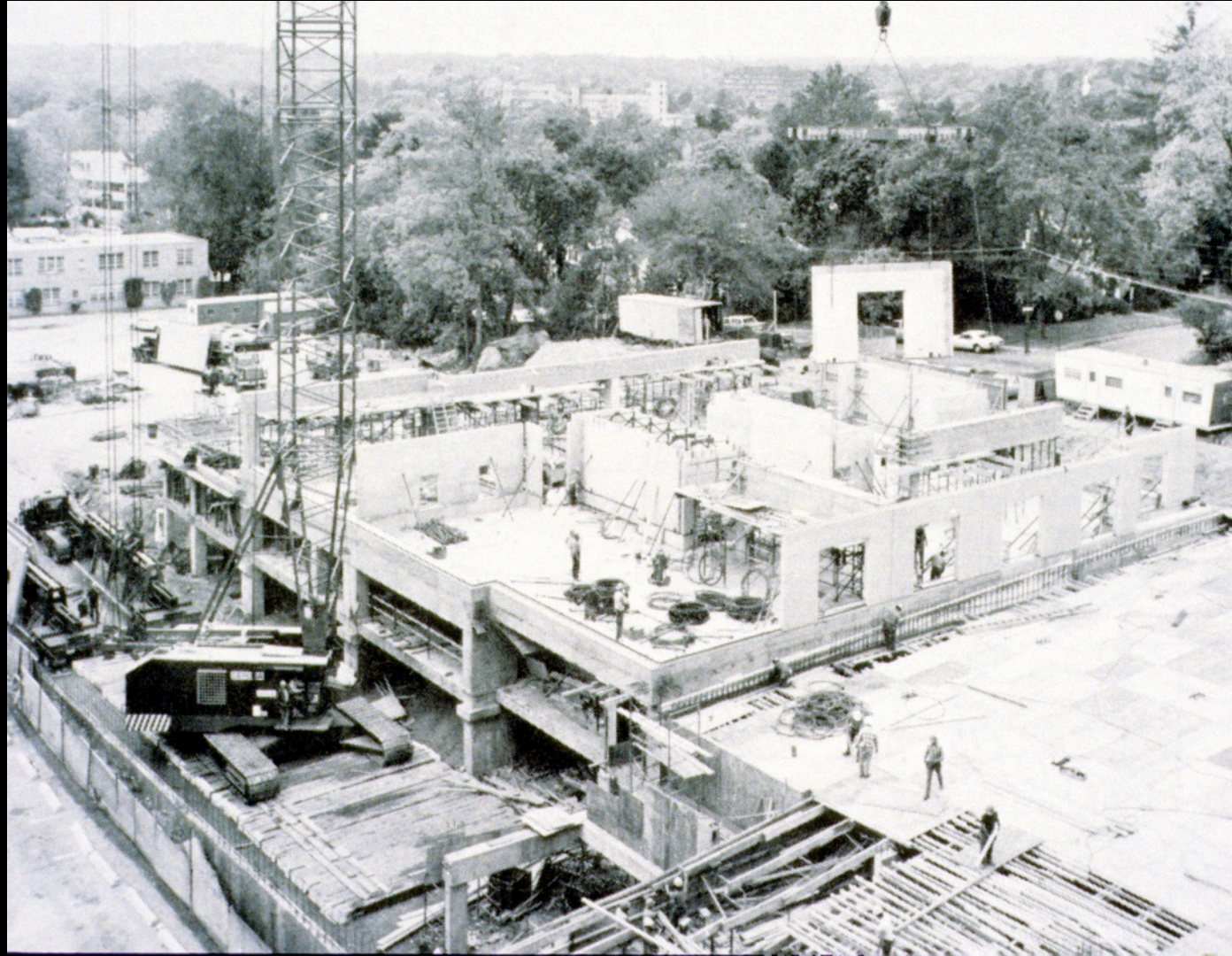








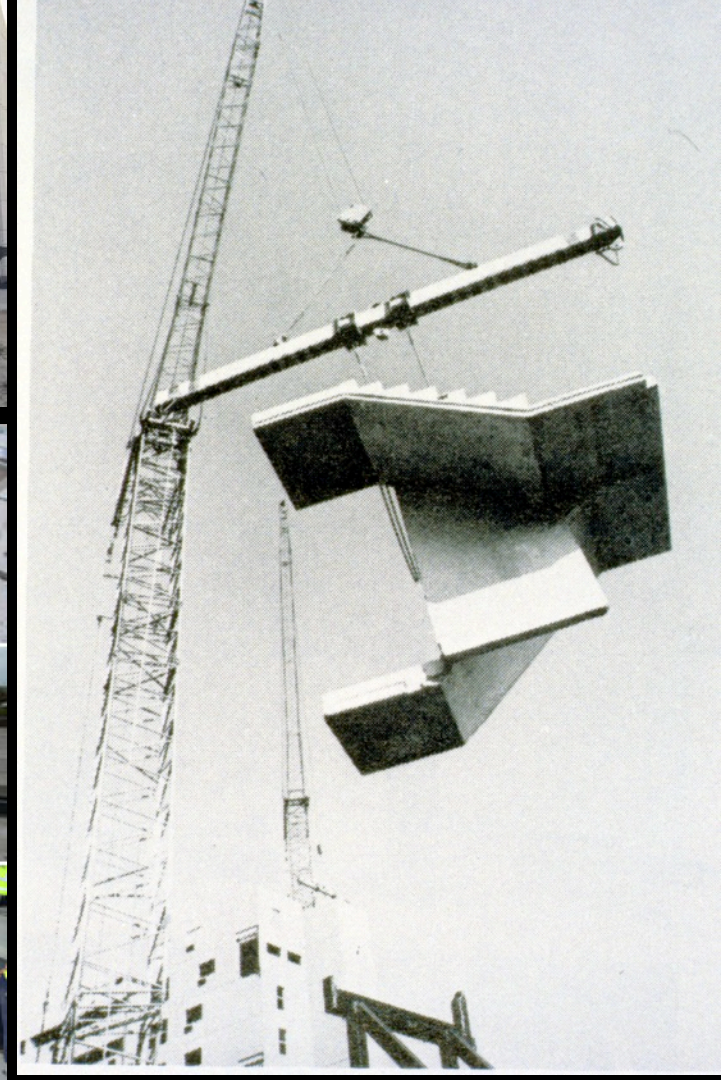




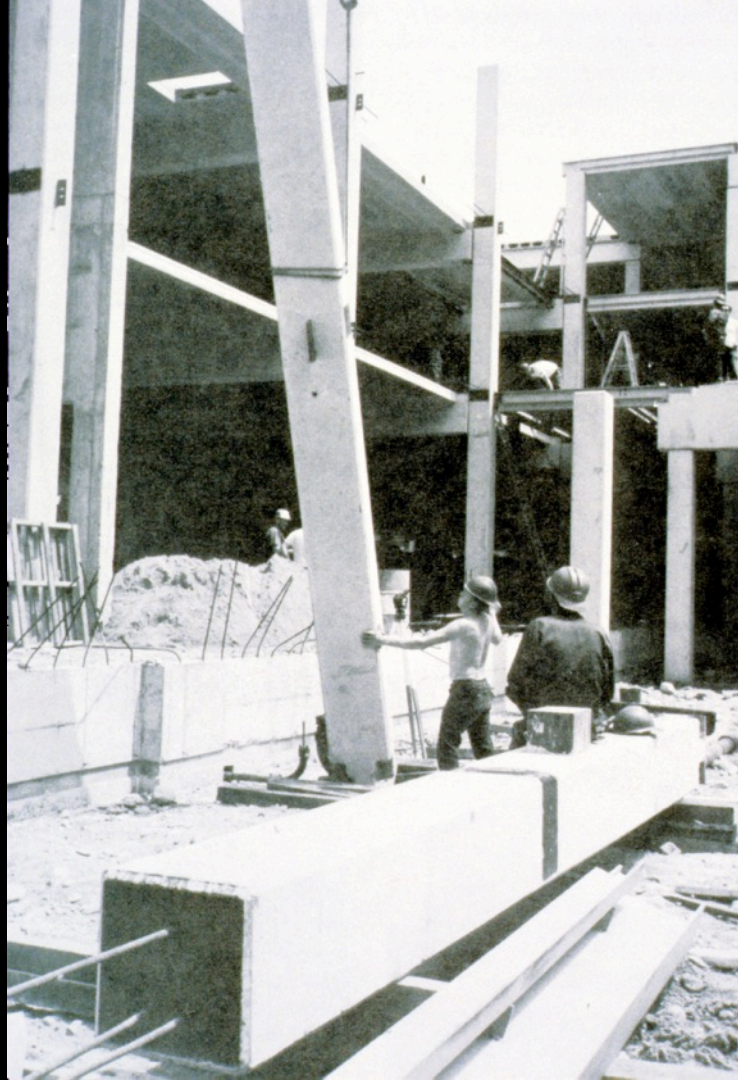


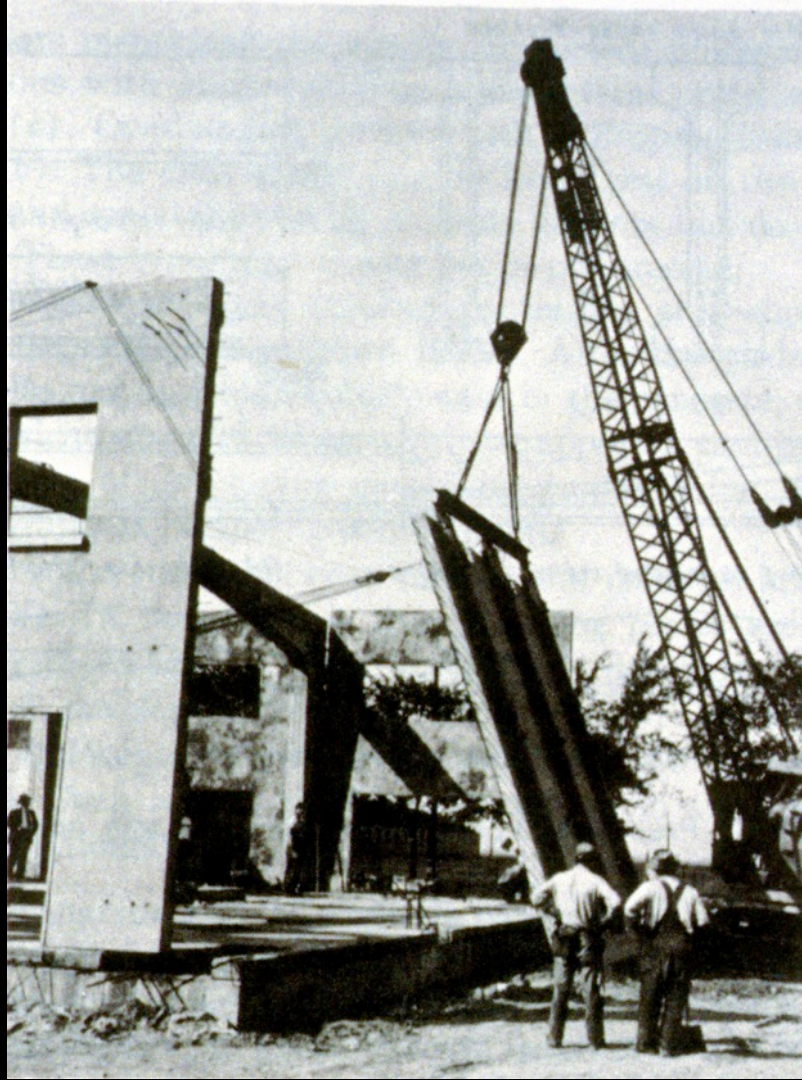




























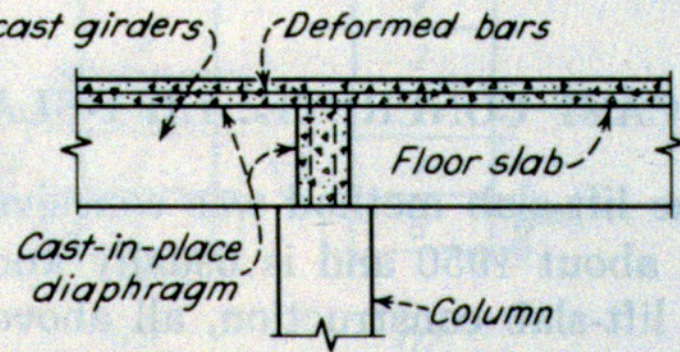
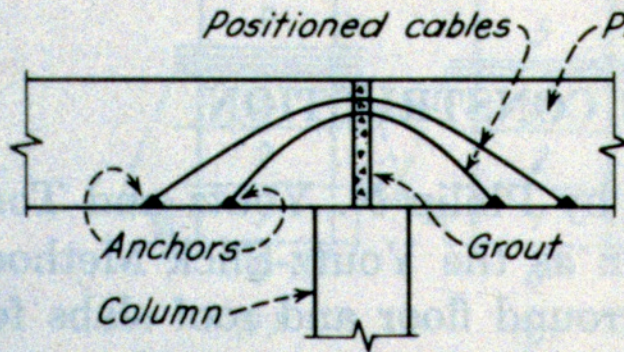
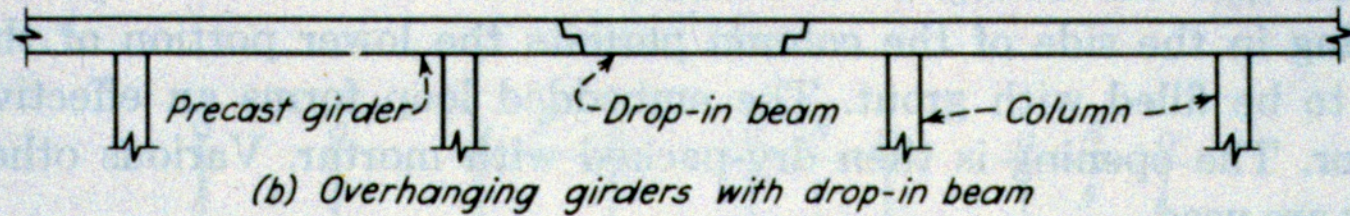
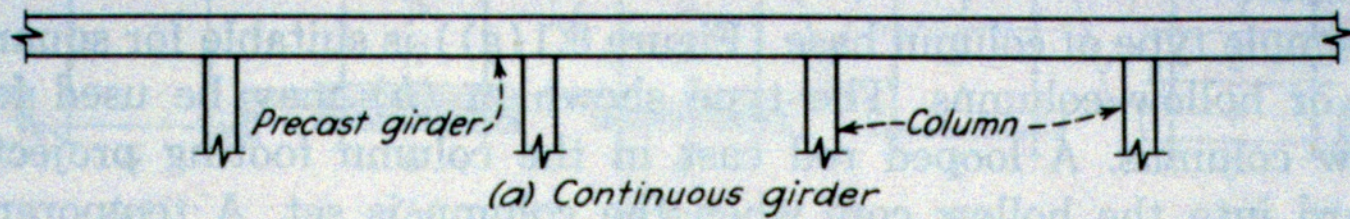
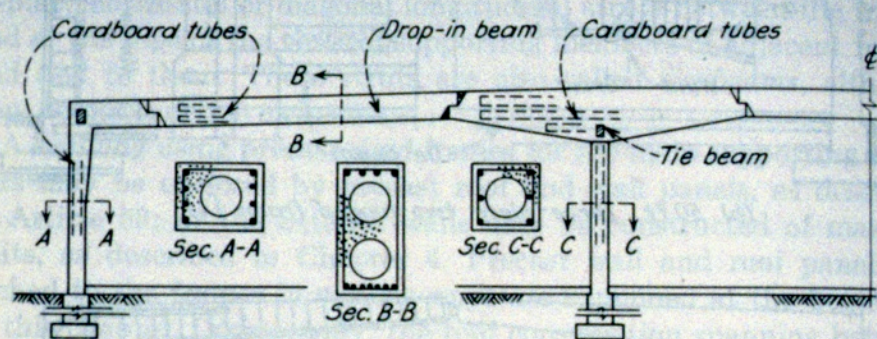
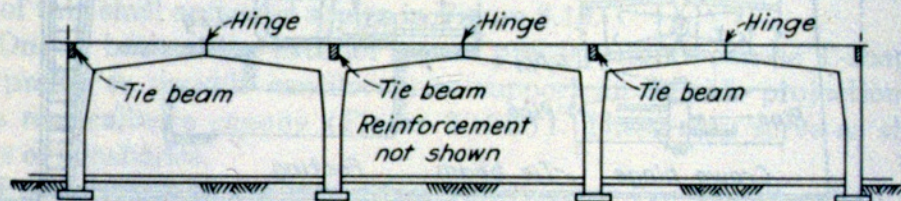


FIGURE 8.7 Overhanging girders and continuity connections.

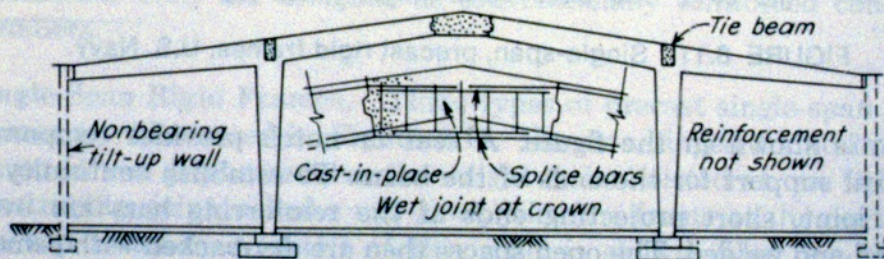




(a) 200 ft. 3-span continuous frame with drop-in beams. U.S. Navy [4].

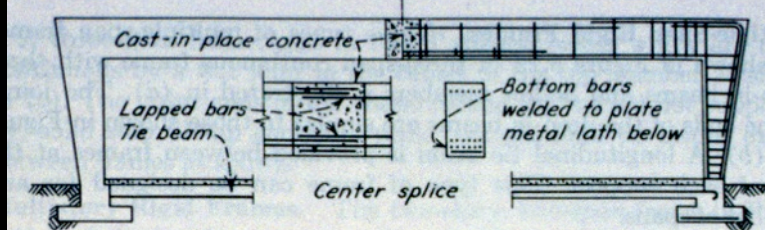


(b) 3-span rigid frame

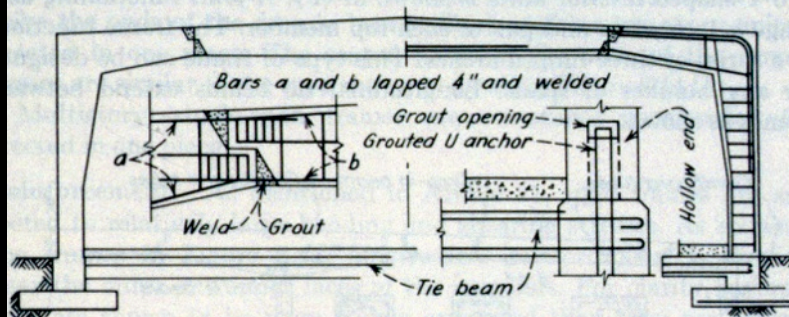


(c) 90 ft. 3-span rigid frame. U.S. Navy [4].

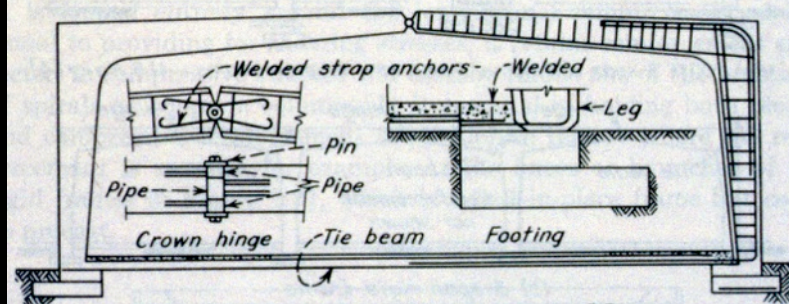
FIGURE 8.12 Three-span rigid frames. U.S. Navy.



(a) 60 ft. Two-piece two-hinged frame [4]



(b) 50 ft. Three-piece two-hinged frame [4]



(c) 64 ft. Two-piece three-hinged frame [5]

FIGURE 8.11 Single-span, precast rigid frames. U.S. Navy.



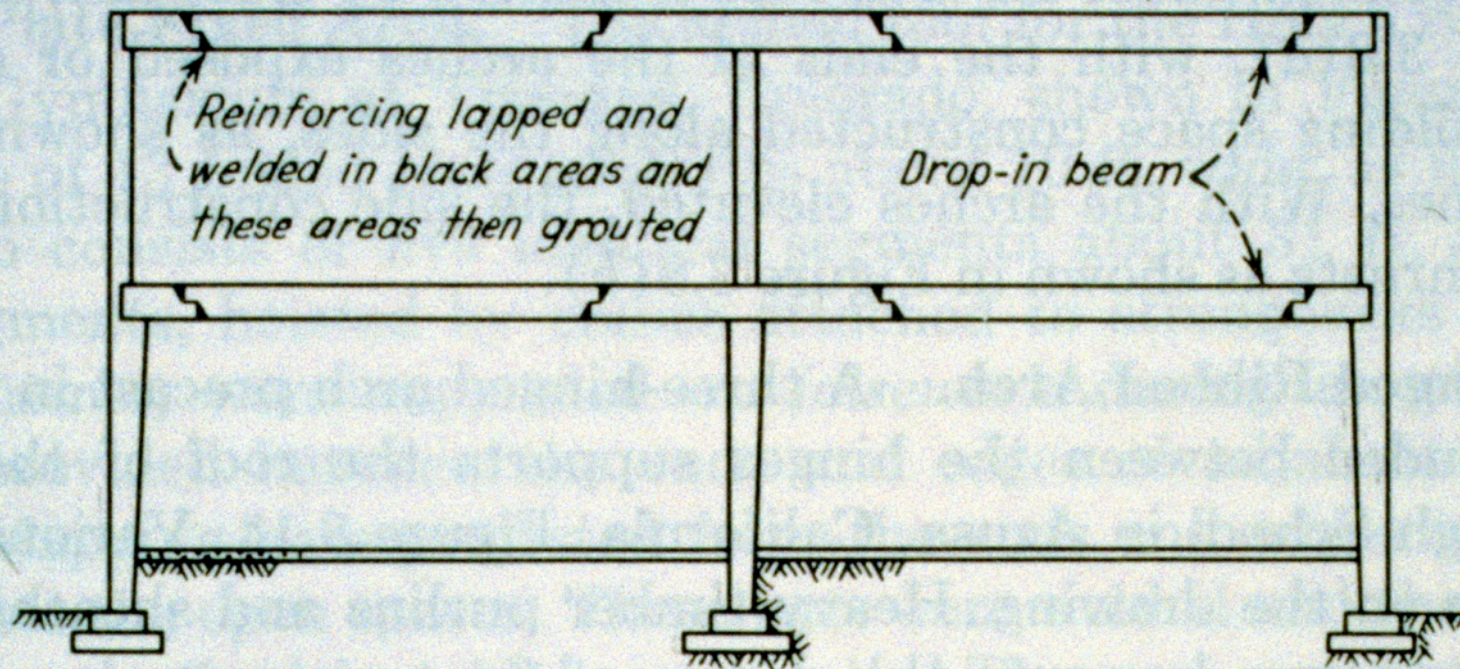
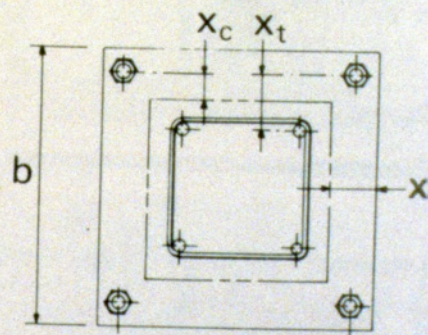
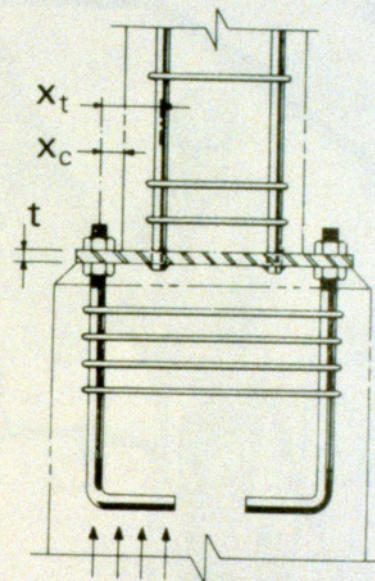
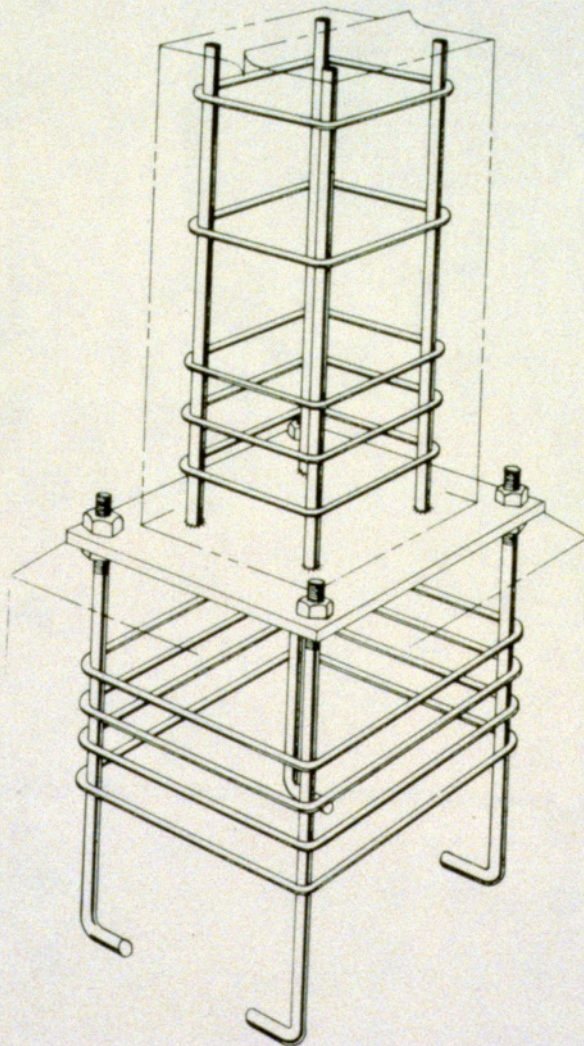
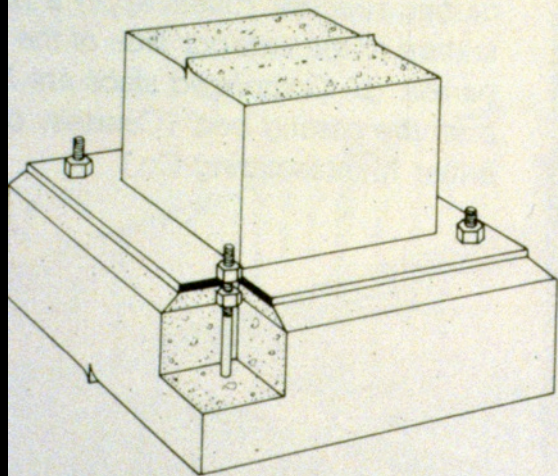
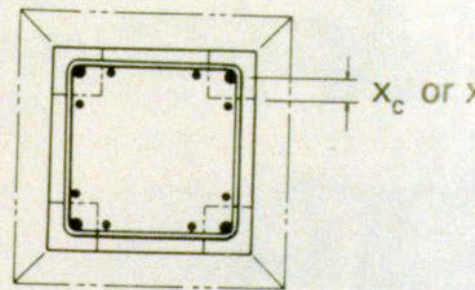
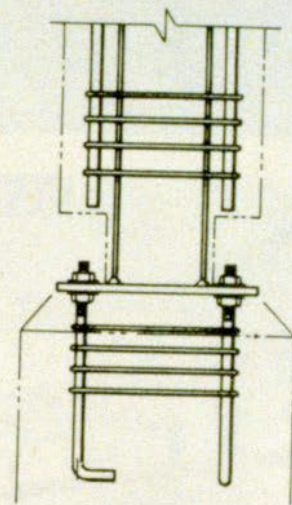
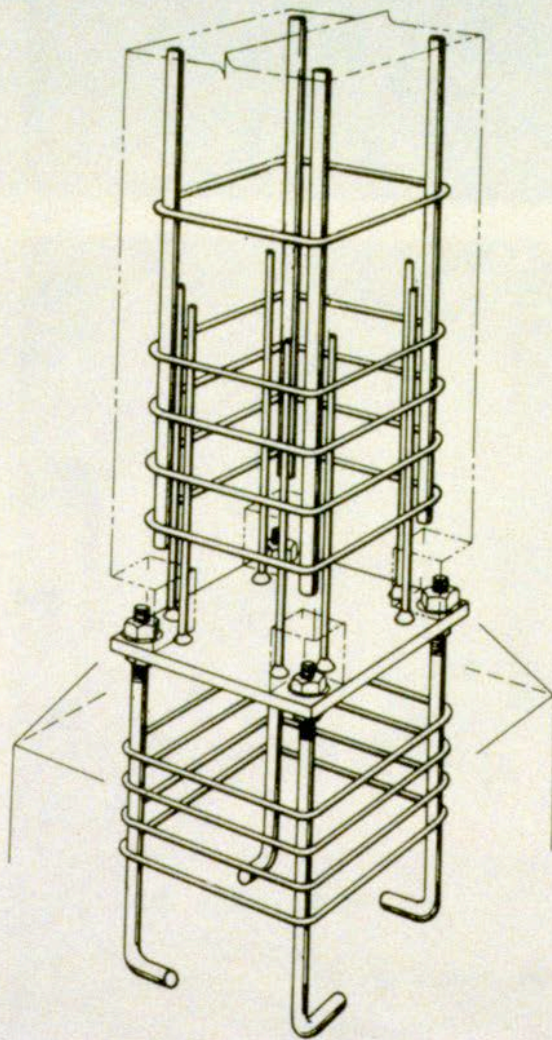
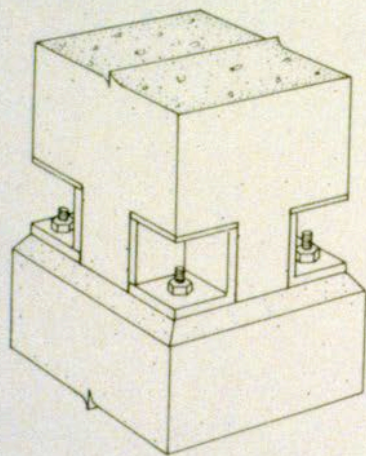


FIGURE 8.13 A 50-ft. two-span, two-story rigid frame with drop-in beam. Designed by Roberts and Schaefer for U.S. Air Force.

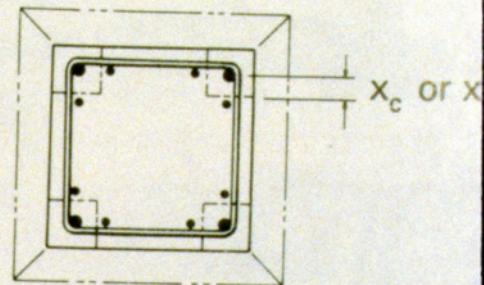
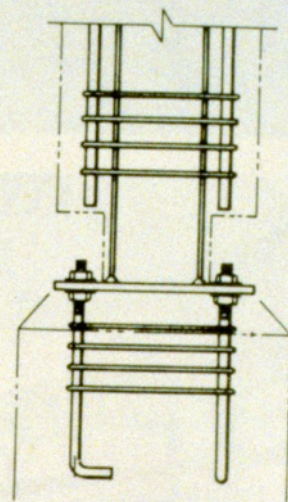
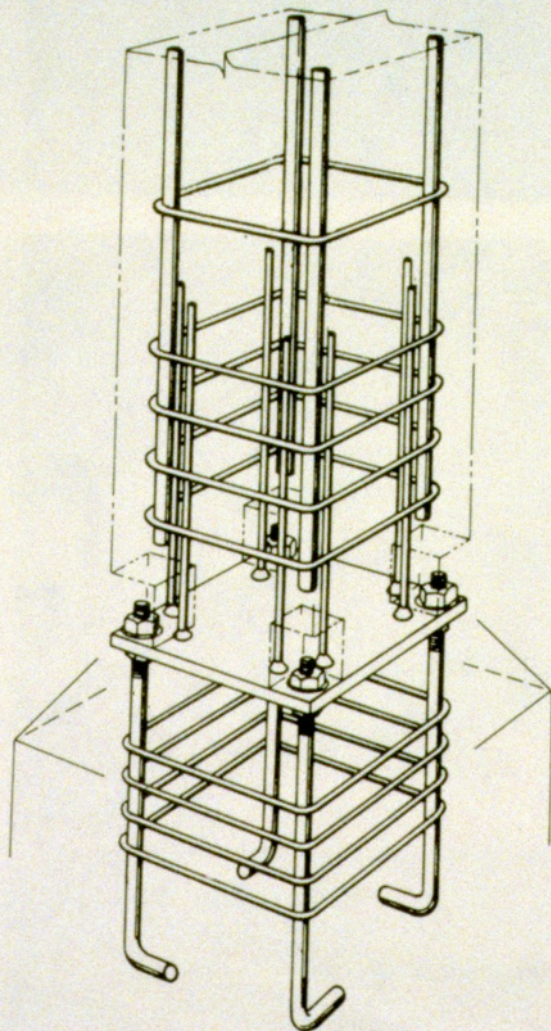
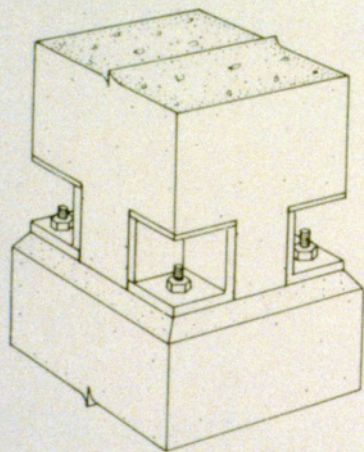








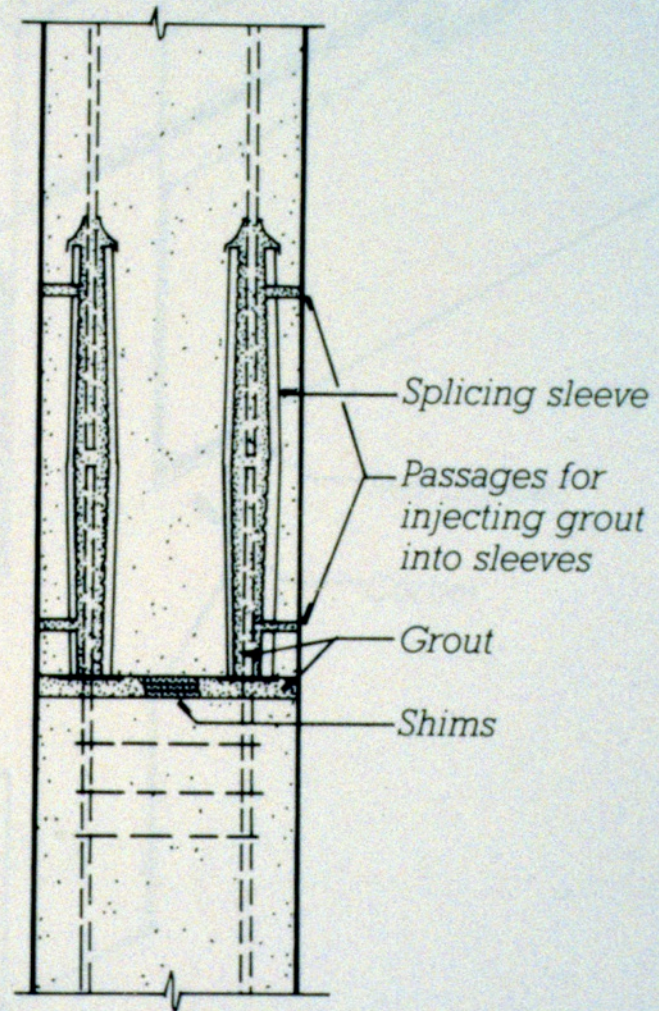




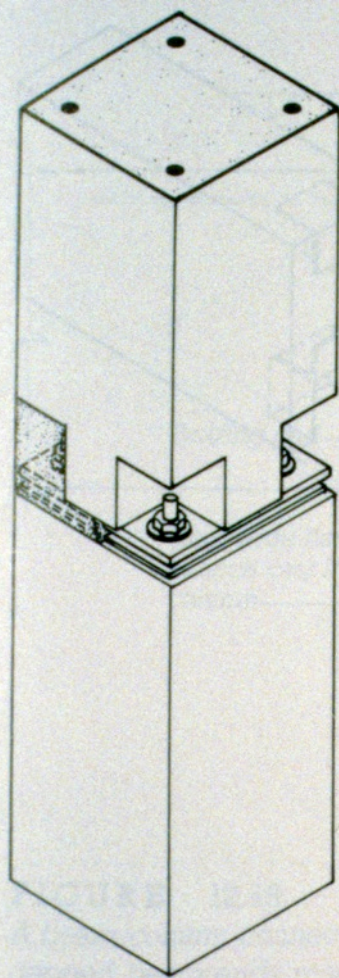


## FIGURE 12.17

*Section through a column-to-column connection using a proprietary sleeve that is cast into the column. Projecting reinforcing bars from the lower column section are inserted in the sleeves, where injected grout makes the connection.*

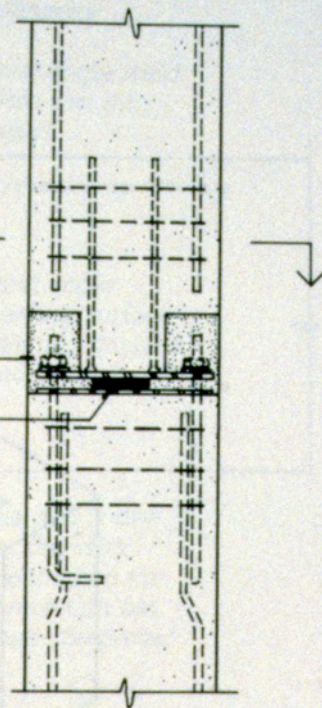




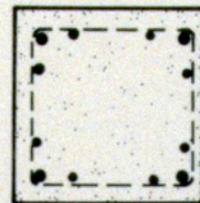


*The entire joint is  
dry-packed with  
grout after  
alignment*

*Shims*

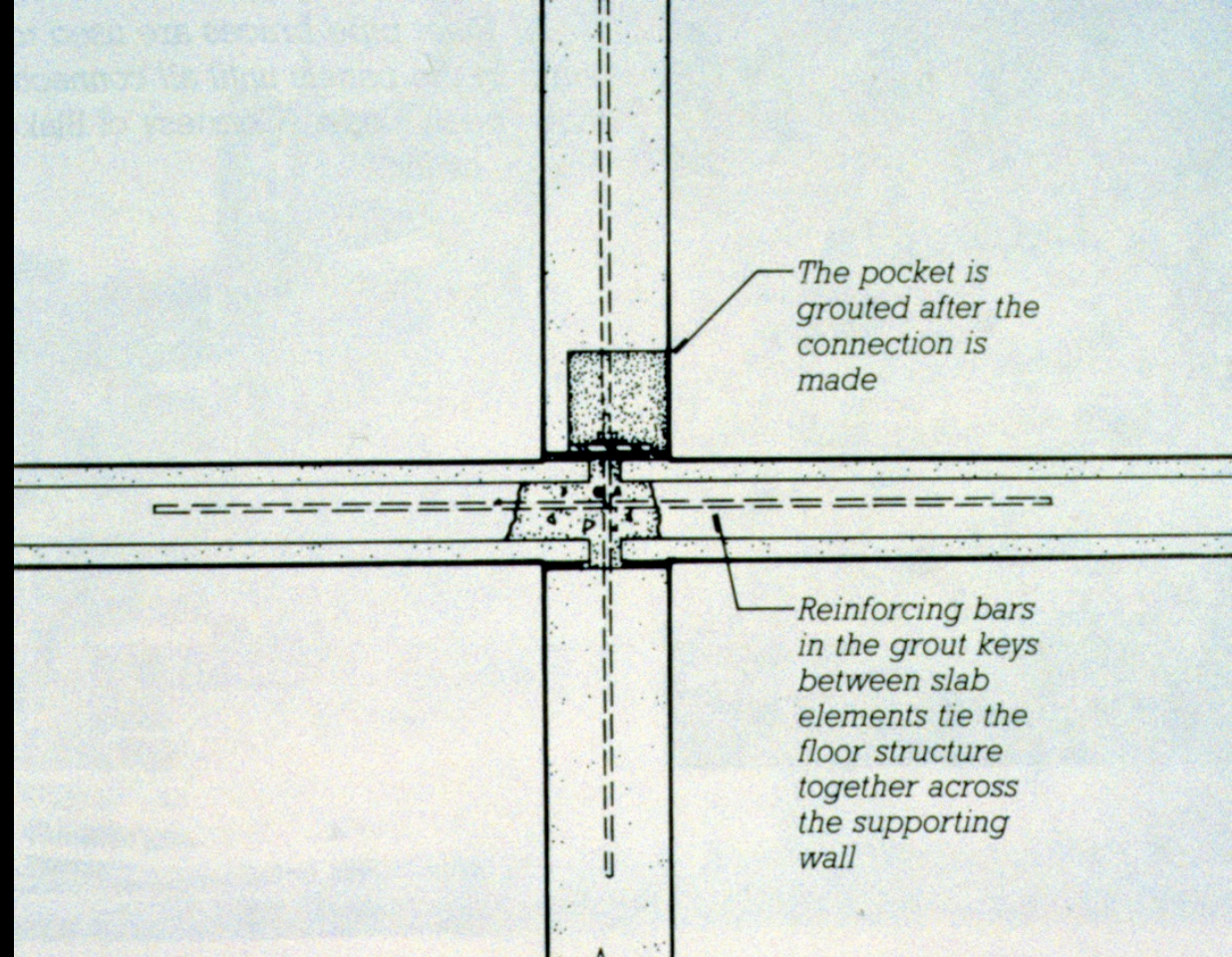
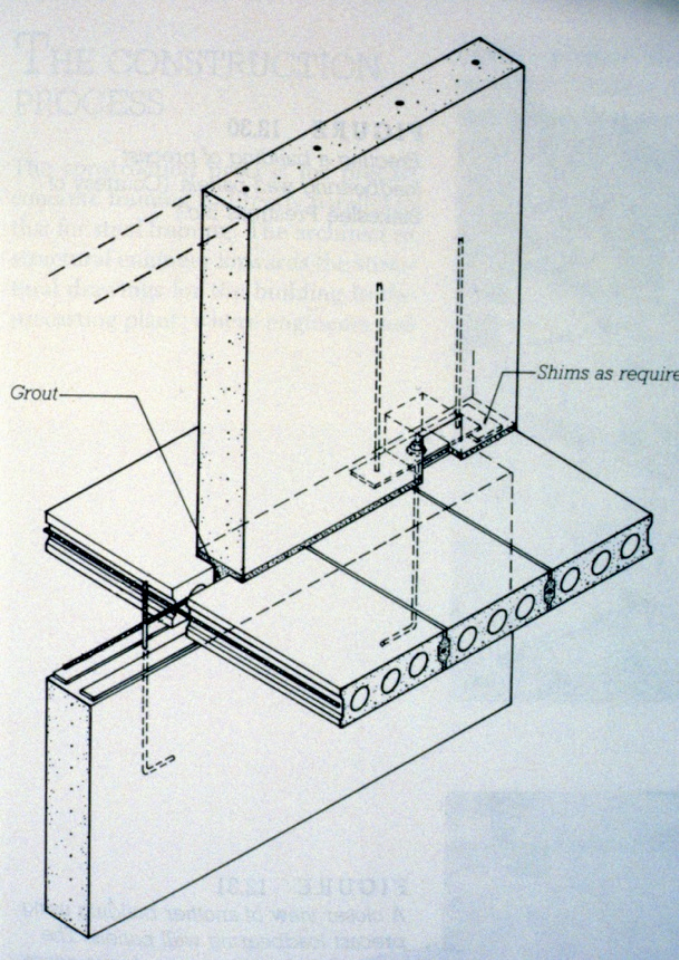


*SECTION*

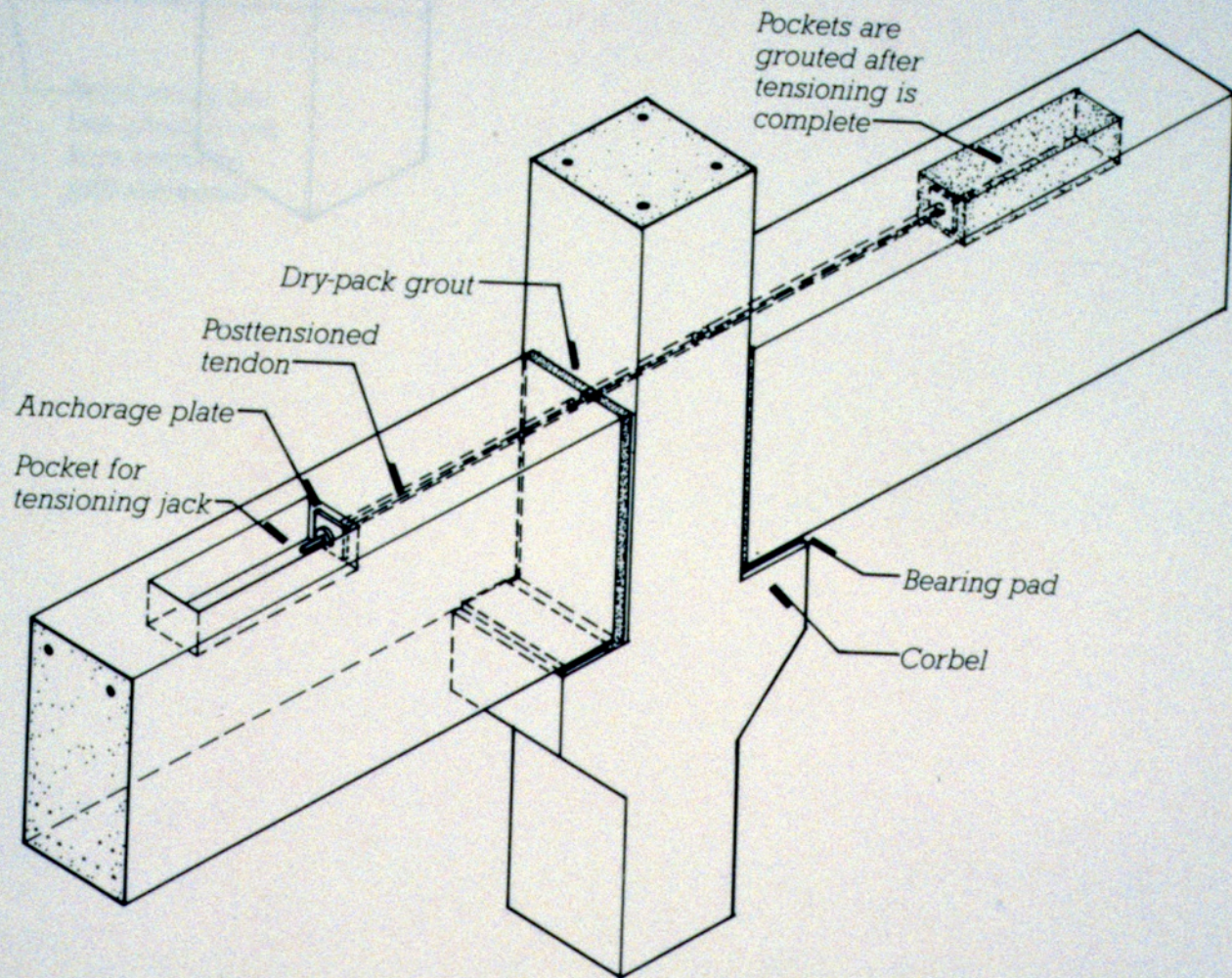


*PLAN*

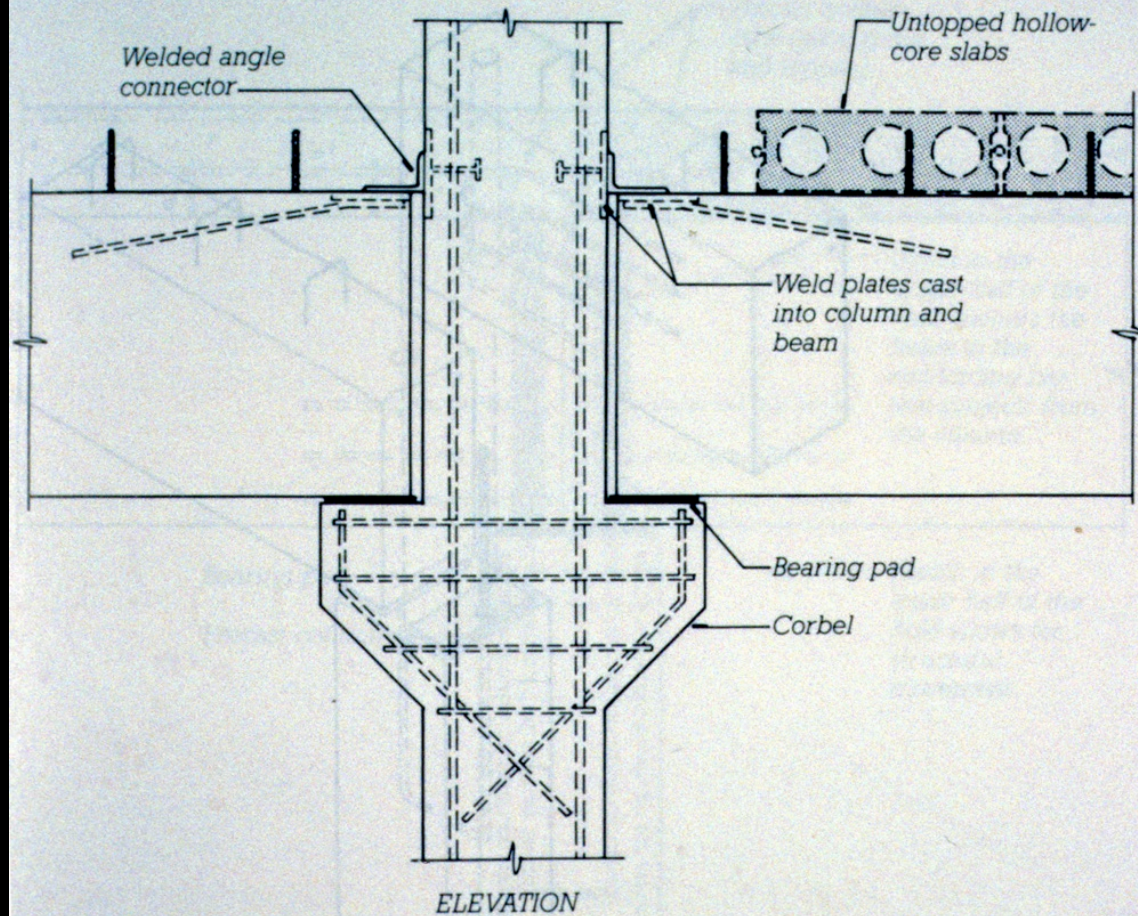
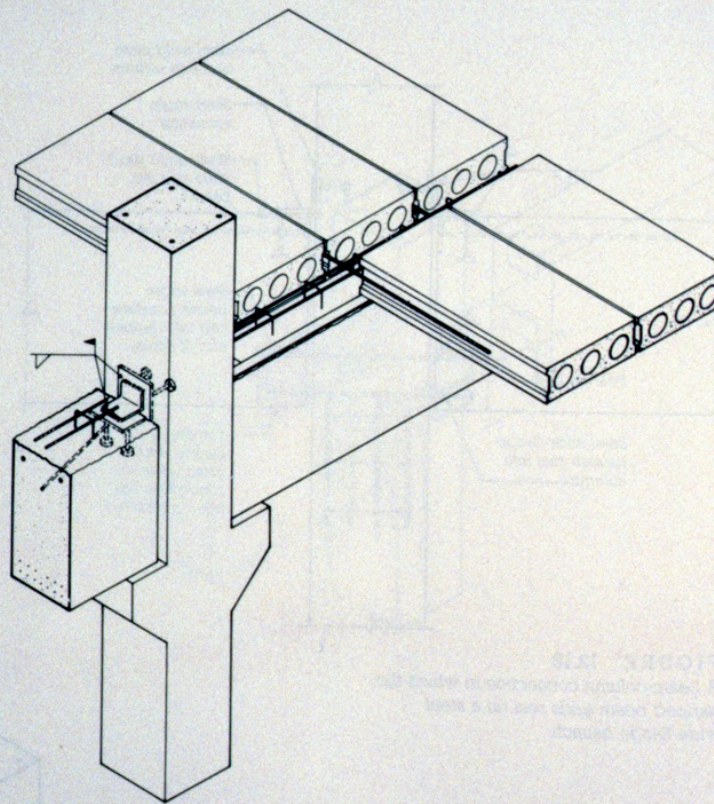




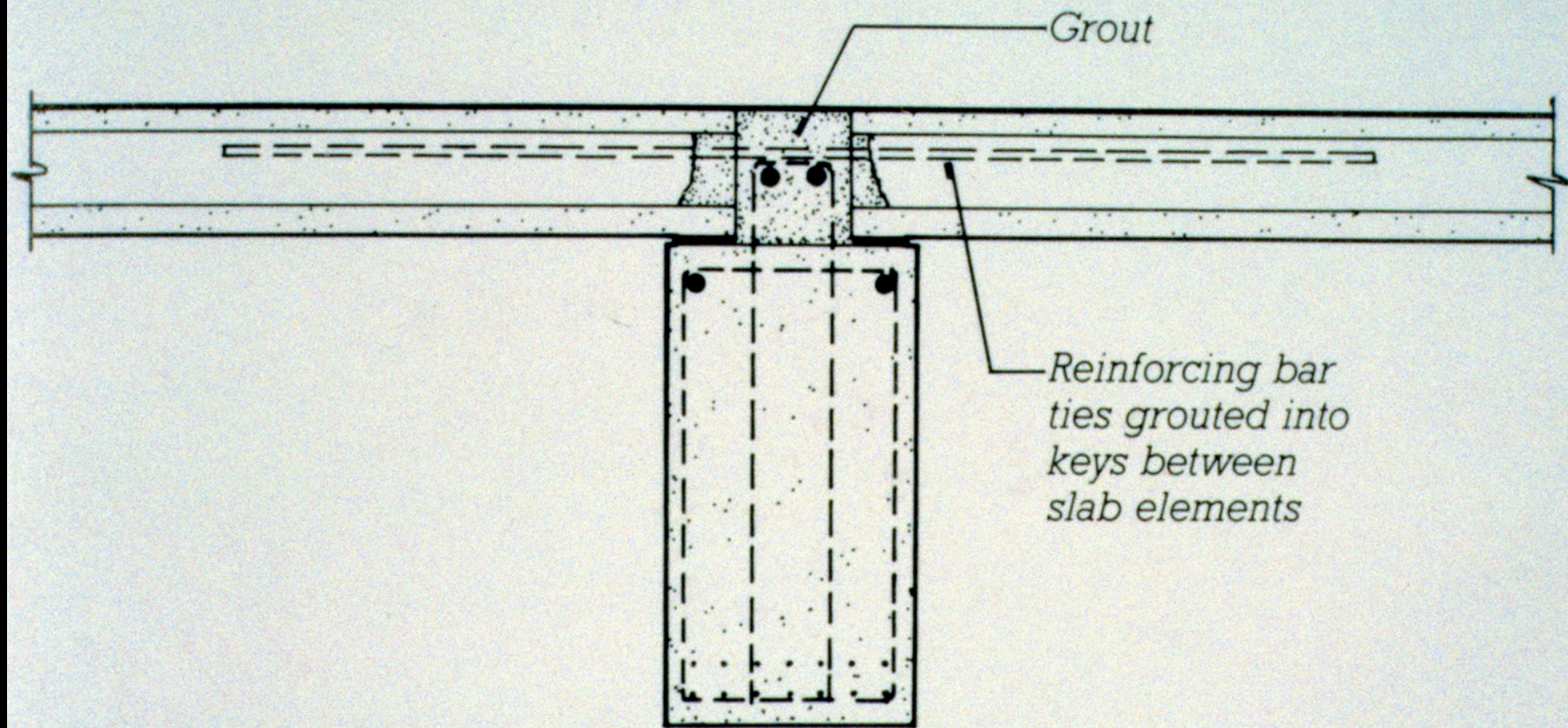




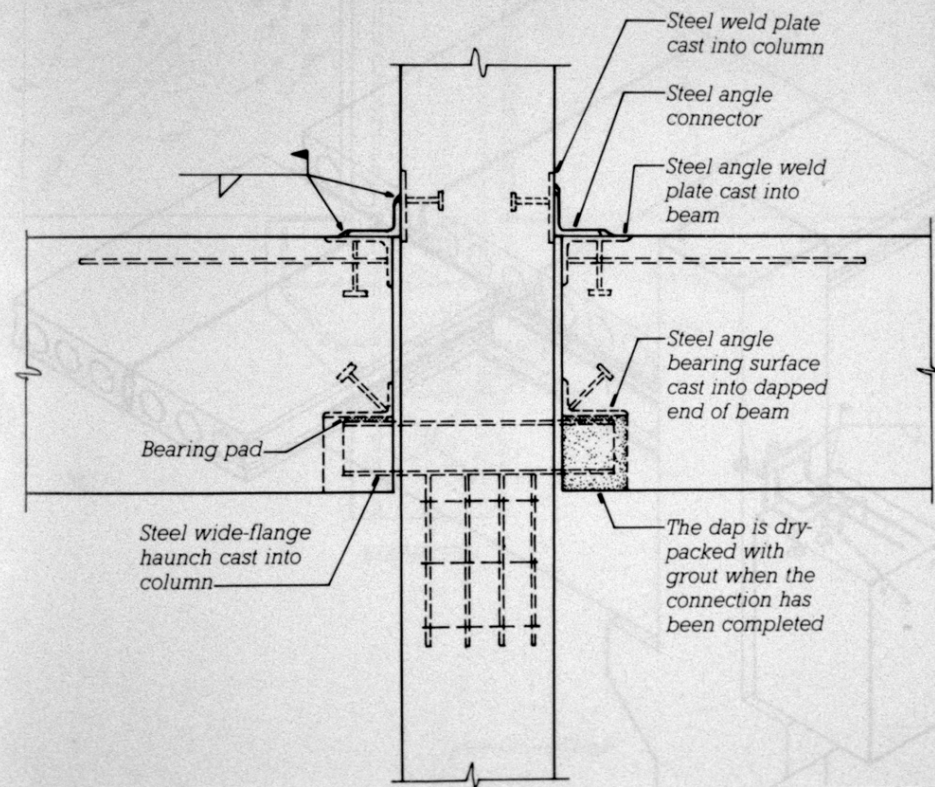
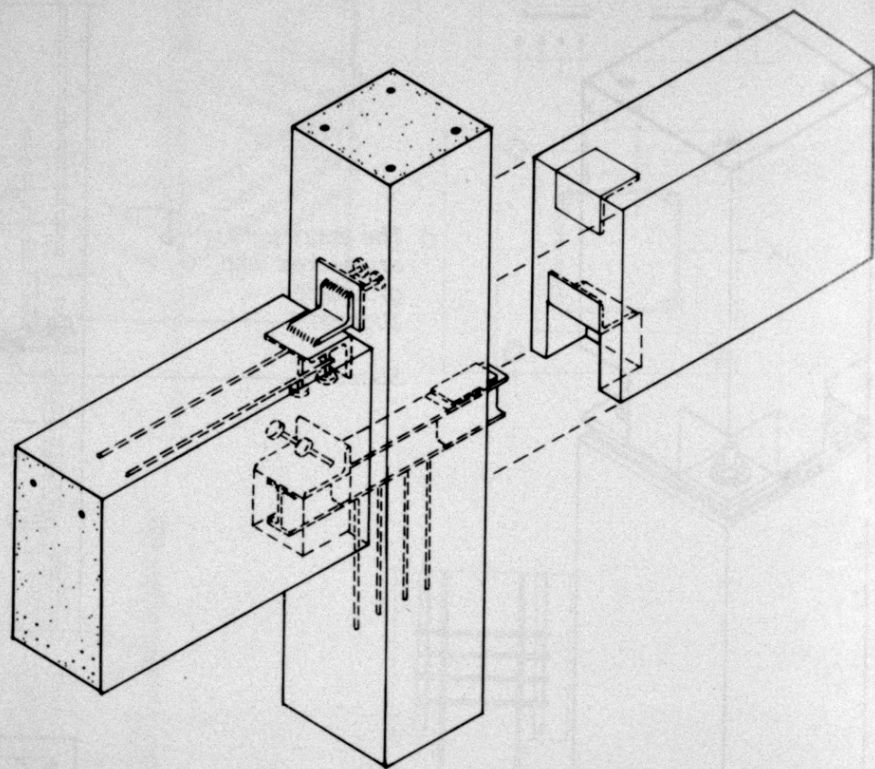




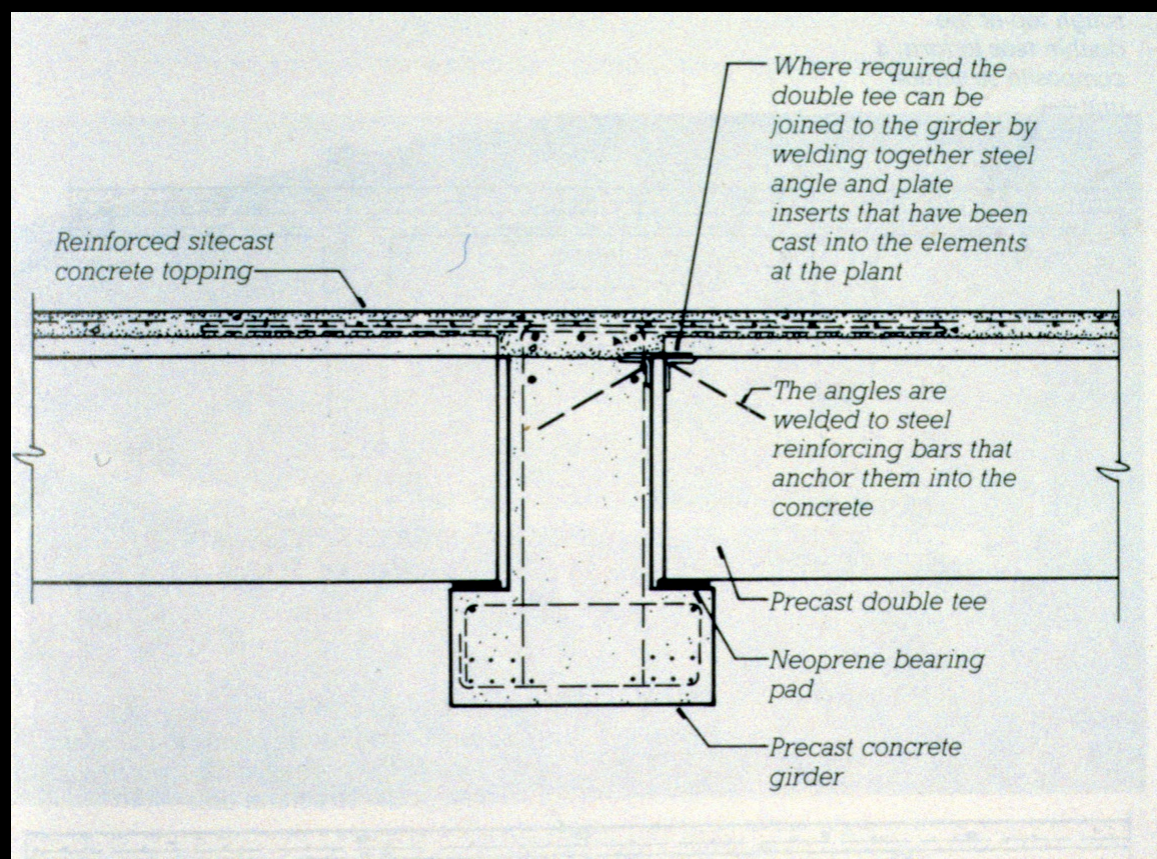
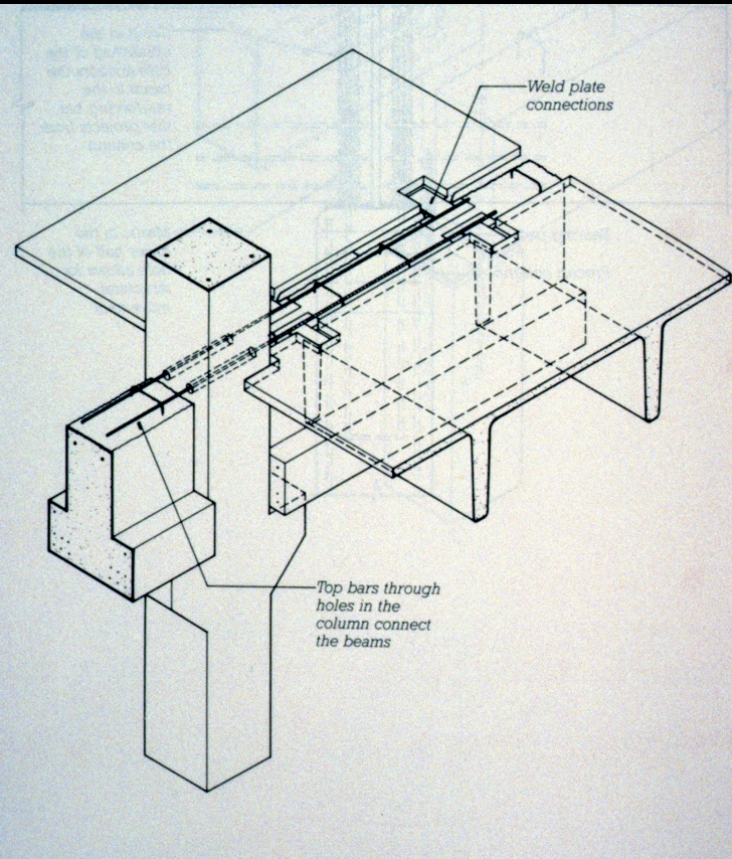




SECTION  
THROUGH BEAM







# Lift Slab Construction



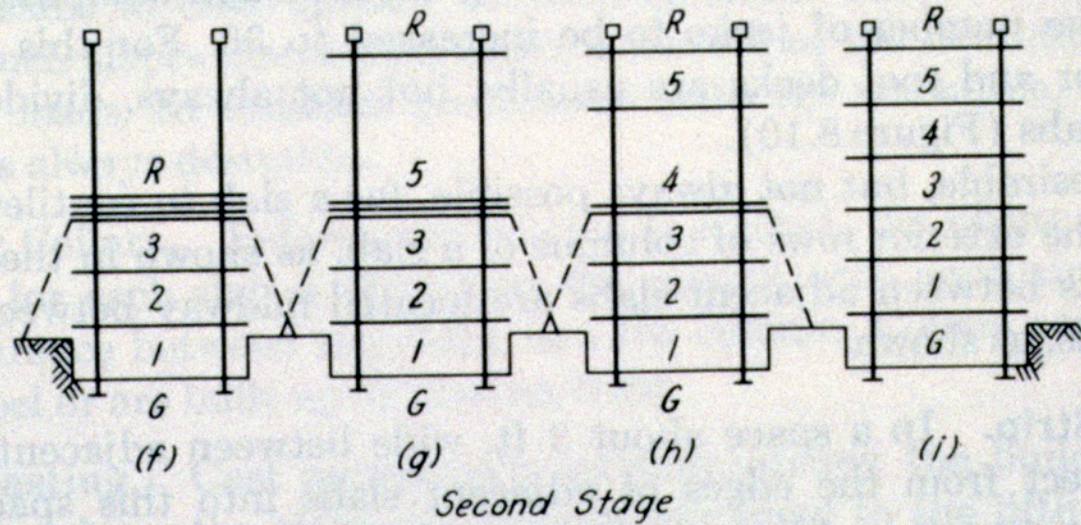
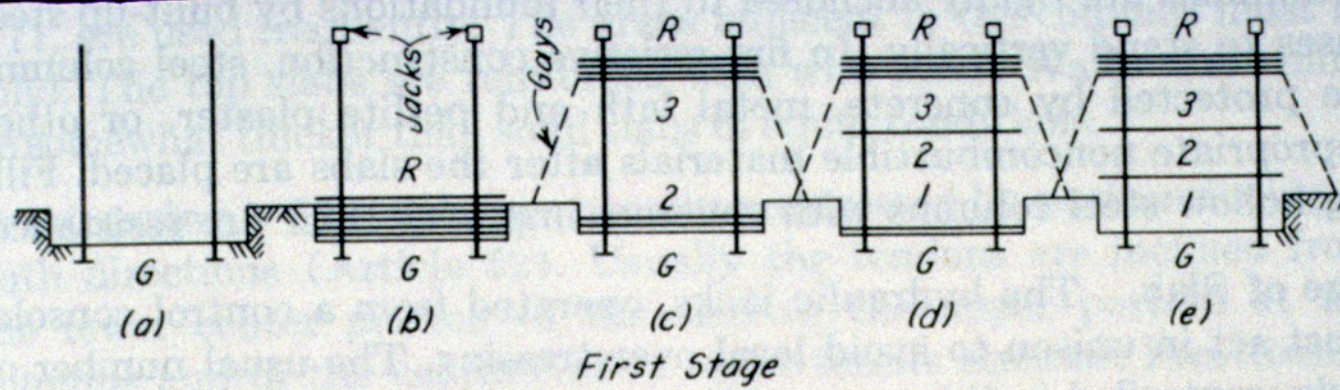
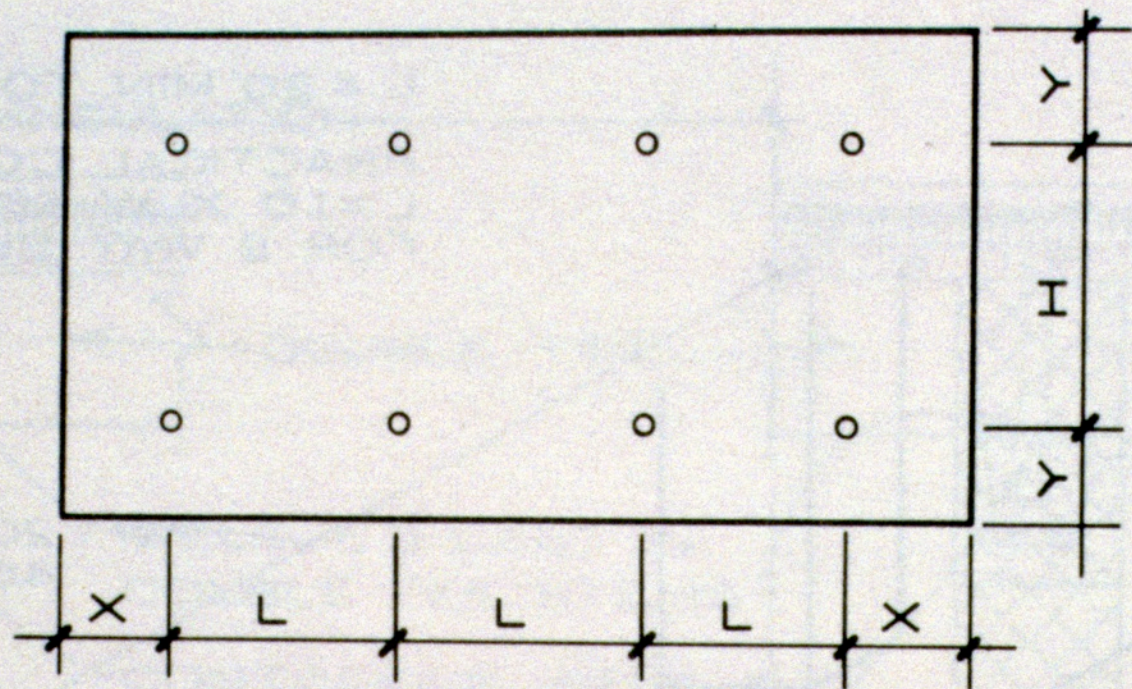


FIGURE 8.8 Sequence of lifting operations.





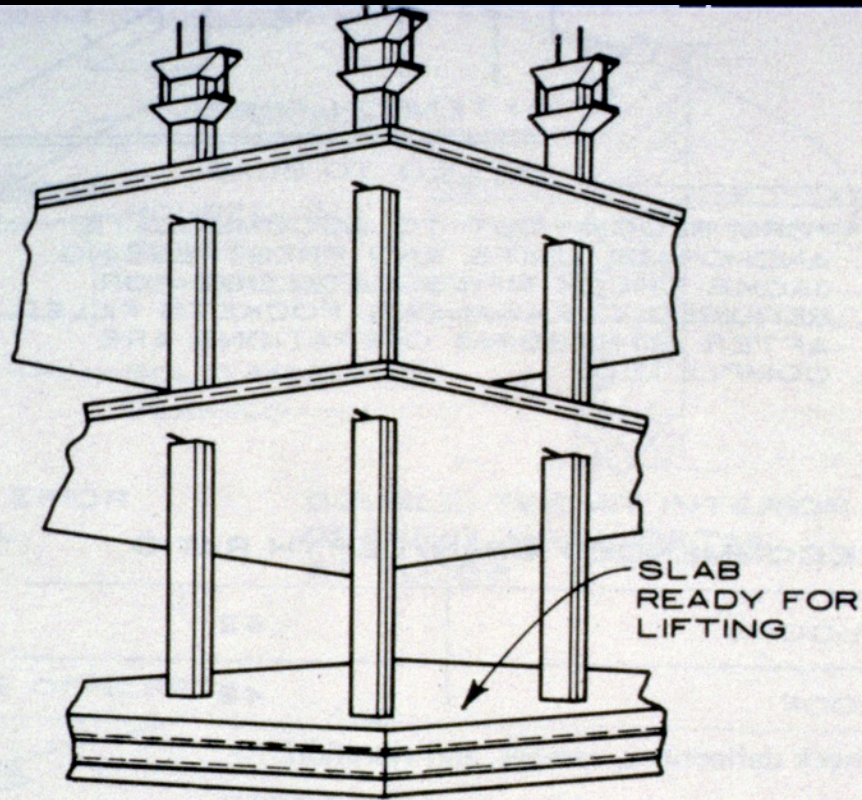
BEST RESULTS OCCUR WHEN  
CANTILEVERS ARE PROPORTIONED  
AS FOLLOWS:

$Y = 25\% \text{ H MIN; } 40\% \text{ H MAX.}$

$X = 25\% \text{ L MIN; } 40\% \text{ L MAX.}$

**PLAN OF LIFT - SLAB**

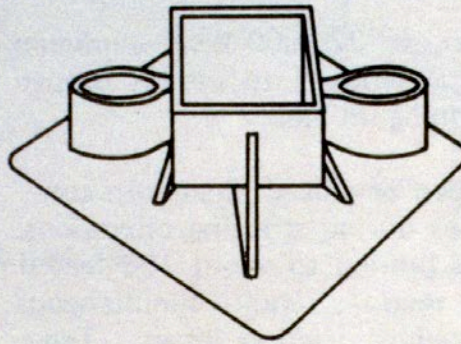




**SCHEMATIC ISOMETRIC OF LIFT-SLAB METHOD**

**NOTE :**

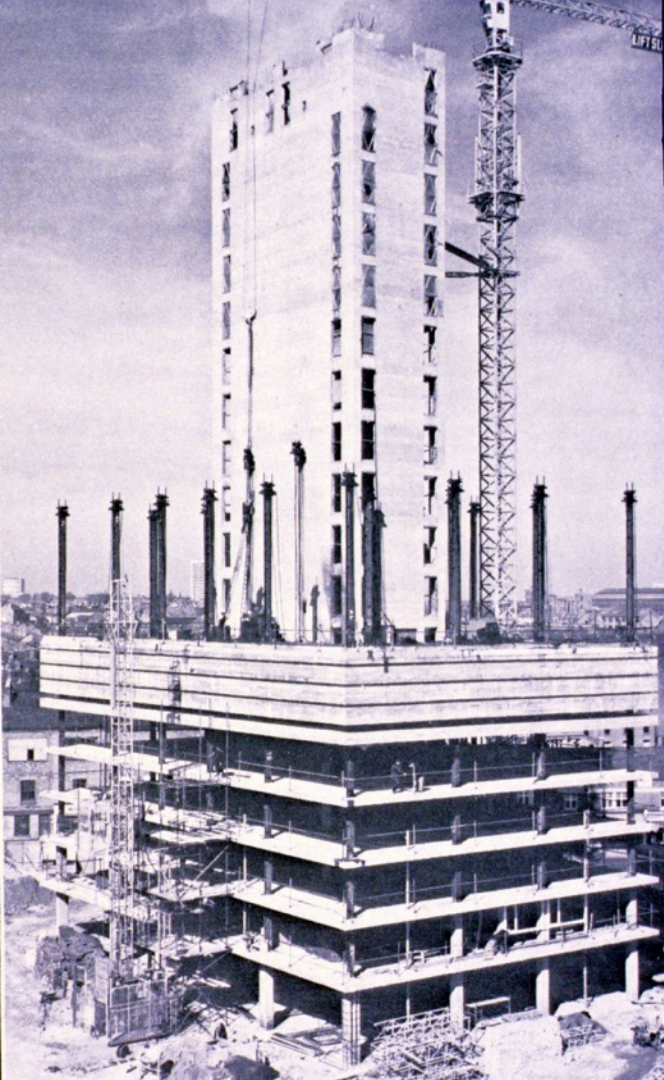
Schematic shows jacks at top of columns, lifting rods, shear bars under slabs. The slabs can be pre-stressed, post-tensioned, or reinforced concrete.



**TYPICAL COLLAR USED IN LIFT - SLAB CONSTRUCTION**

---

**LIFT - SLAB CONSTRUCTION**



<https://www.presconinc.com/prescon-technology/lift-slab/>





The lift slab method was fatefully implemented in the L'Ambiance Plaza development in Bridgeport, Connecticut. What was set to be a 16-storey residential project suddenly collapsed on April 23, 1987, killing 28 construction workers.

# Precast Concrete Cladding Systems





Transamerica Tower, San Francisco



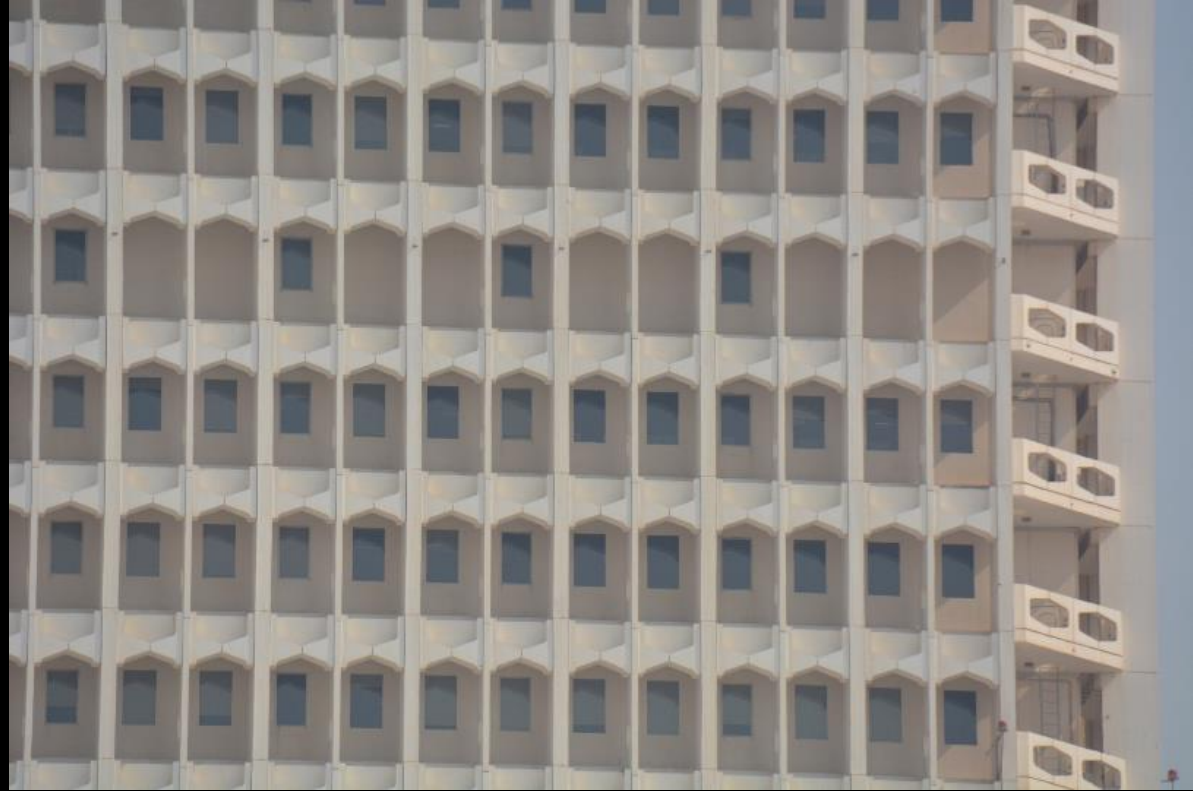












World Trade Center  
Dubai, UAE  
John R. Harris Associates  
1979



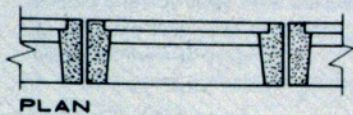




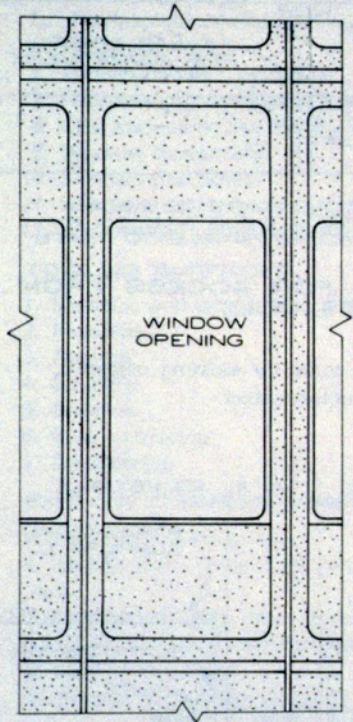
Washington, D.C.







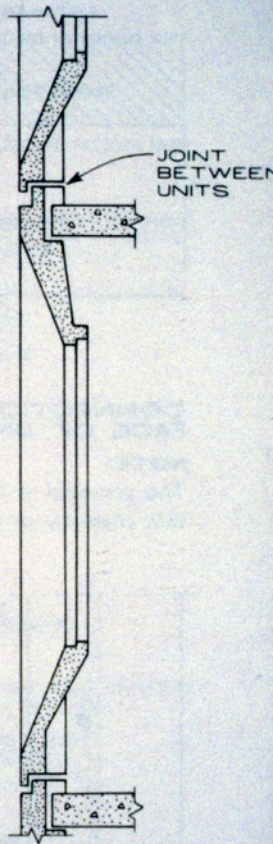
PLAN



ELEVATION

### SINGLE STORY FACING TYPE UNITS

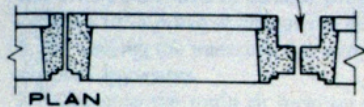
THIS UNIT HAS BOTH STRUCTURAL AND MECHANICAL USES



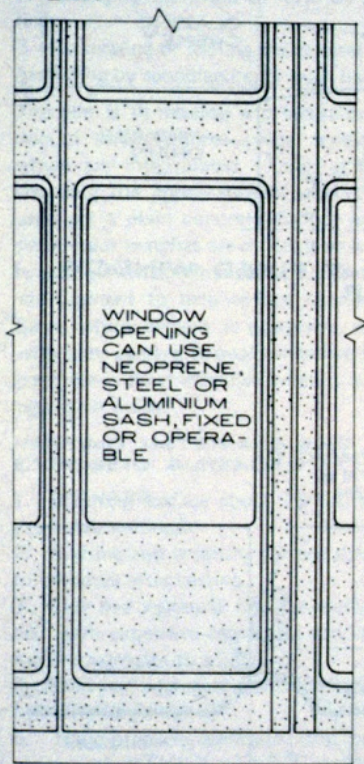
JOINT BETWEEN UNITS

SECTION

MECH. SPACE FOR PIPES, DUCTS, ETC.



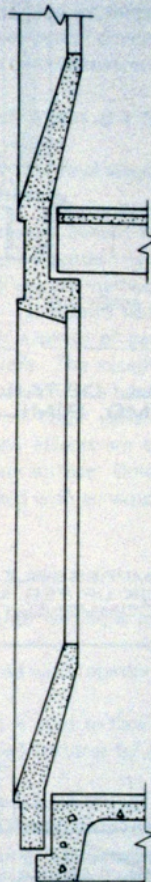
PLAN



ELEVATION

### MULTI-STORY FACING TYPE UNITS

THIS UNIT HAS BOTH STRUCTURAL AND MECHANICAL USES

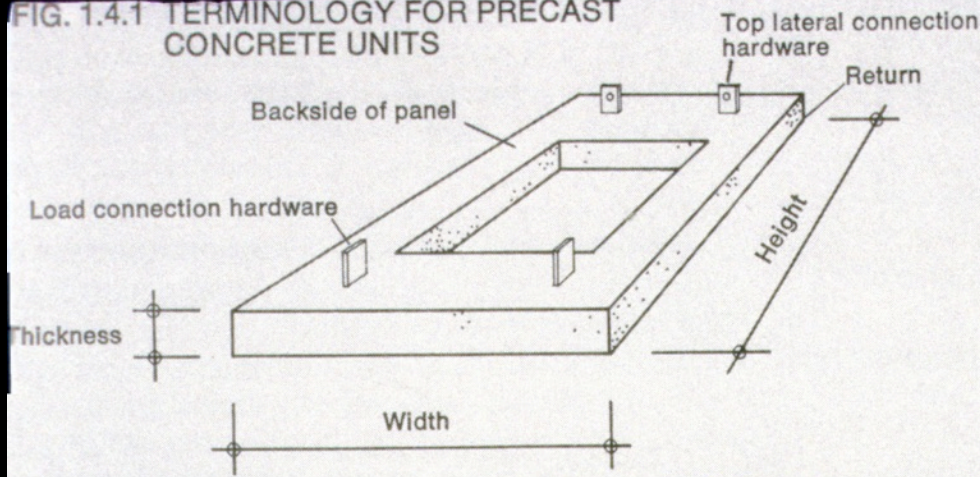


SECTION

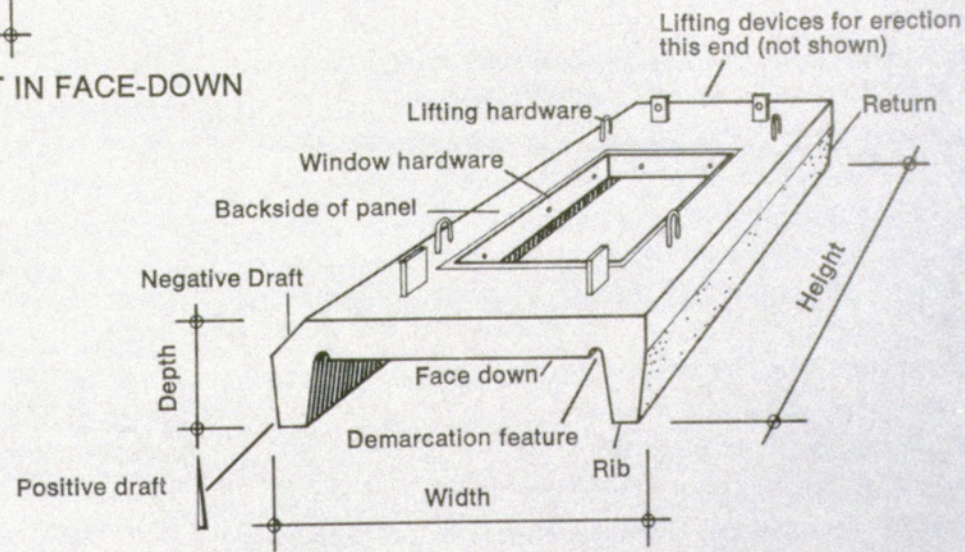




FIG. 1.4.1 TERMINOLOGY FOR PRECAST  
CONCRETE UNITS

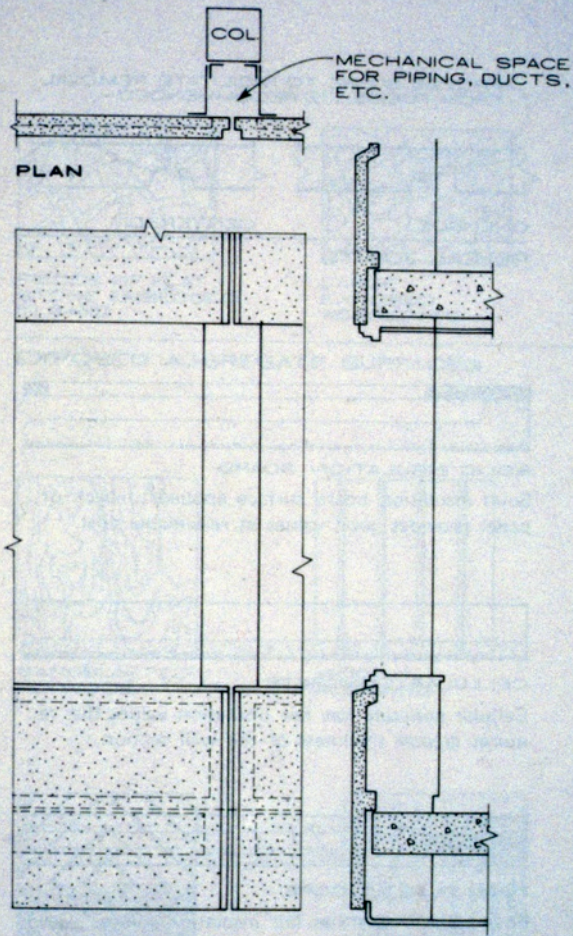


TYPICAL FLAT PANEL AS CAST IN FACE-DOWN  
POSITION

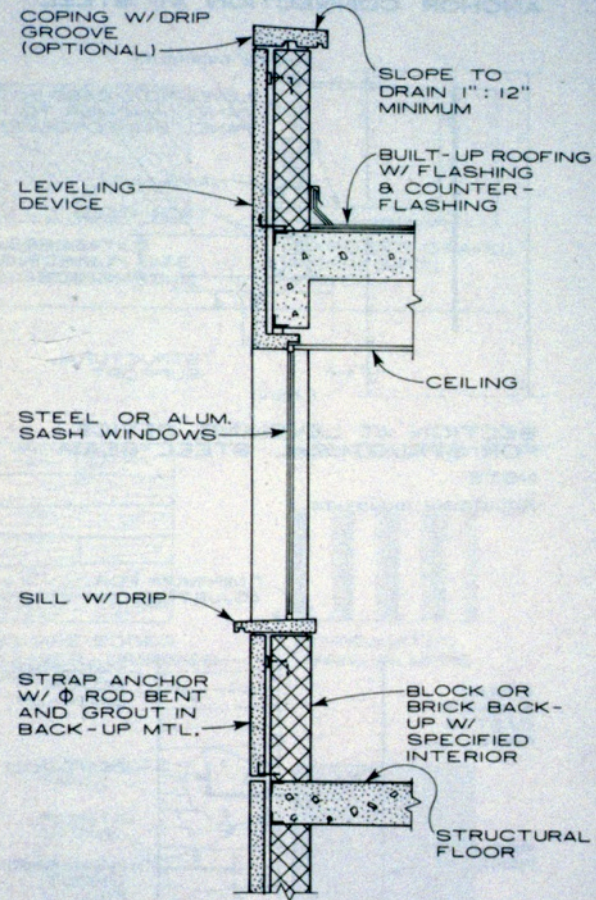


SCULPTURED PANEL AS CAST IN FACE-DOWN  
POSITION





**SPANDREL FACING TYPE UNITS**  
 THESE ARE CANTILEVERED TO ALLOW MECHANICAL SPACE  
**BASIC TYPES**



**SECTION**  
**FLAT FACING UNITS WITH COPING-RETURN AT WINDOW HEAD-WINDOW SILL**















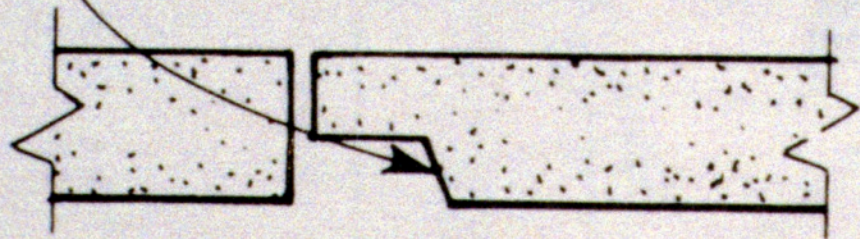




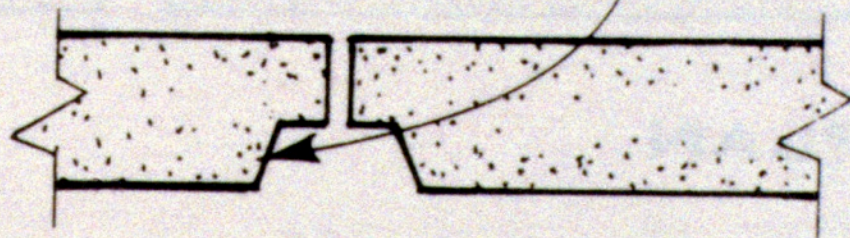




PROVIDE SLOPE TO FACILITATE REMOVAL  
FROM FORMS, 1:12 RECOMMENDED



ONE SIDE



CENTERED

---

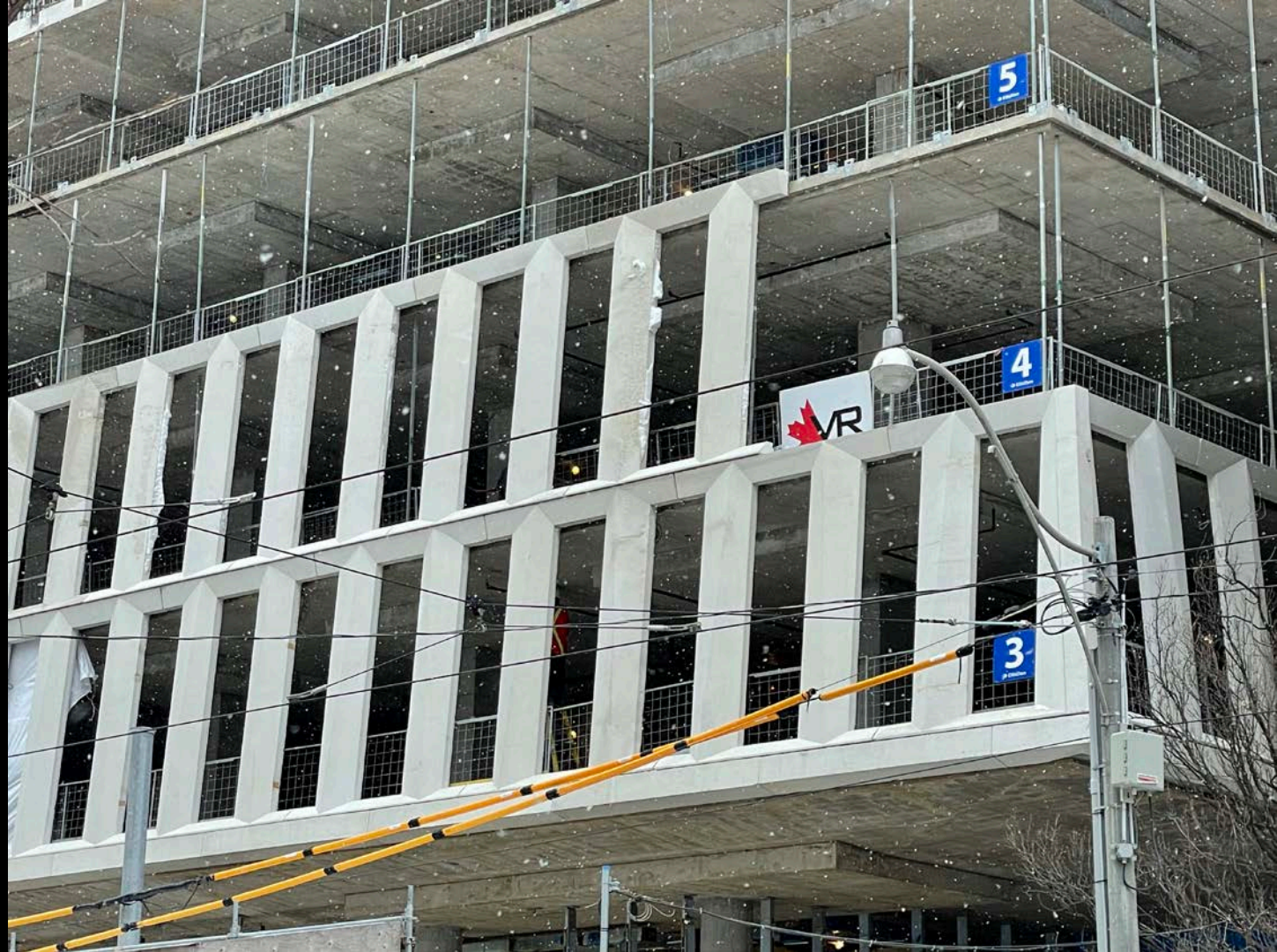
REVEAL JOINTS





College Street, Toronto, 2022









## Precast Concrete Cladding Types:

1. Old style uninsulated panel hung from the floor slabs
  - with steel stud back up and batt insulation (bad)
  - with steel stud back up and impermeable spray foam insulation (better)
  - better if also installed as a rain screen
2. Sandwich panel with impermeable insulation between
  - Best if accompanied by a rain screen drainage behind



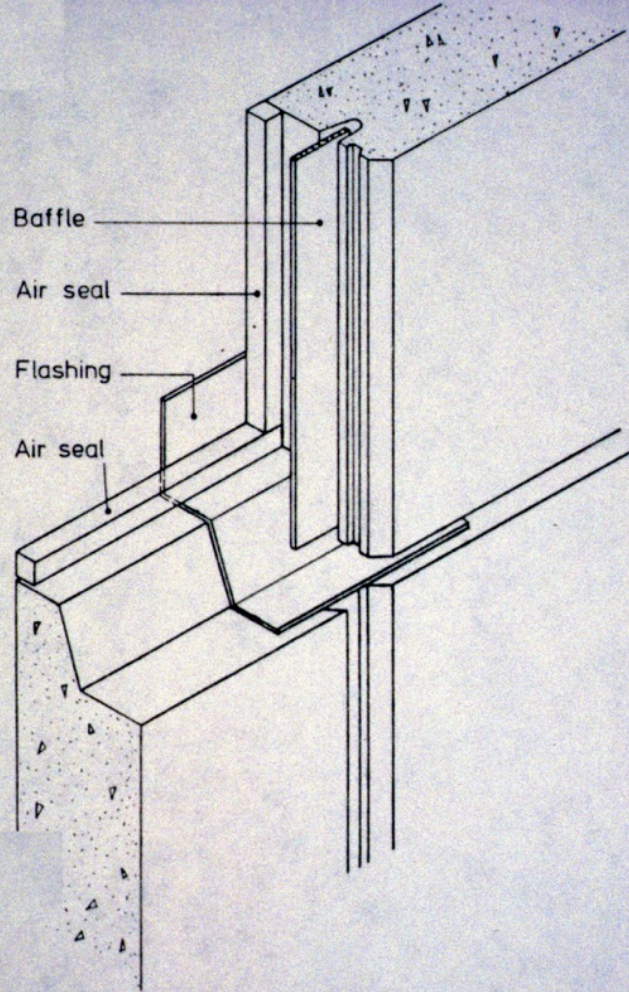
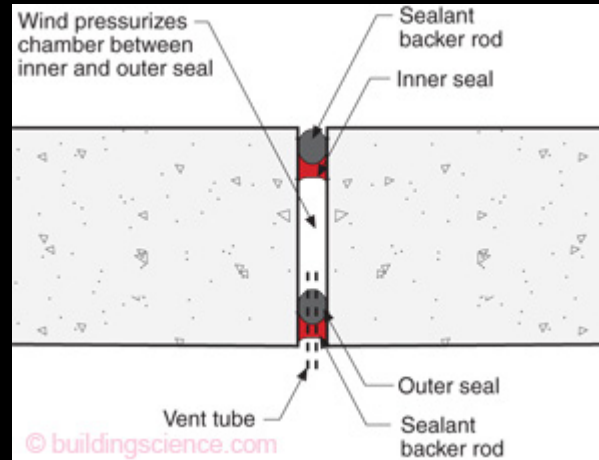
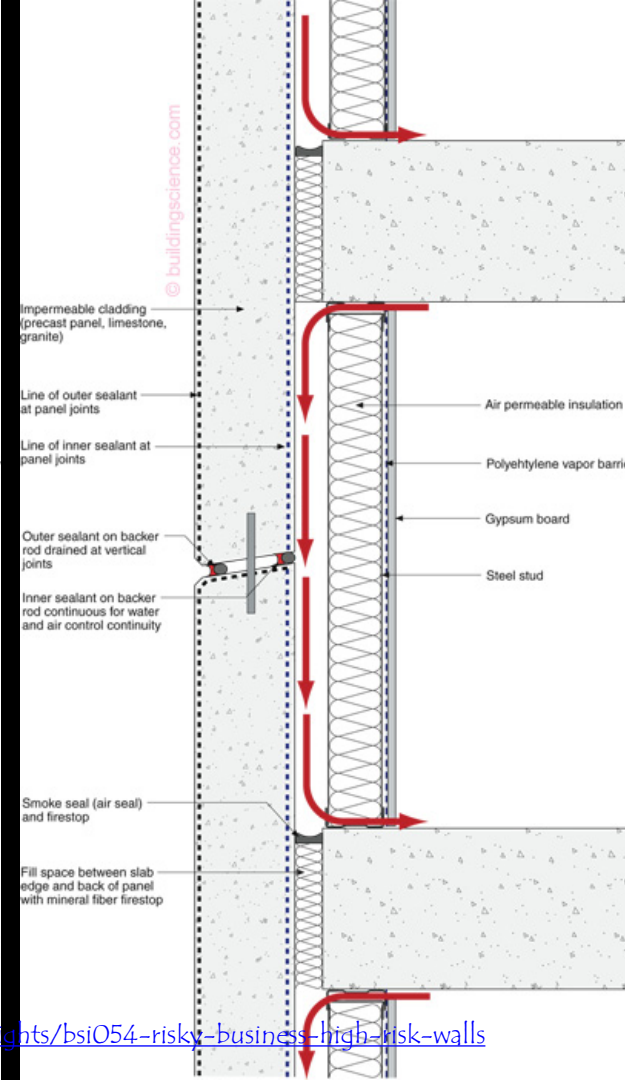
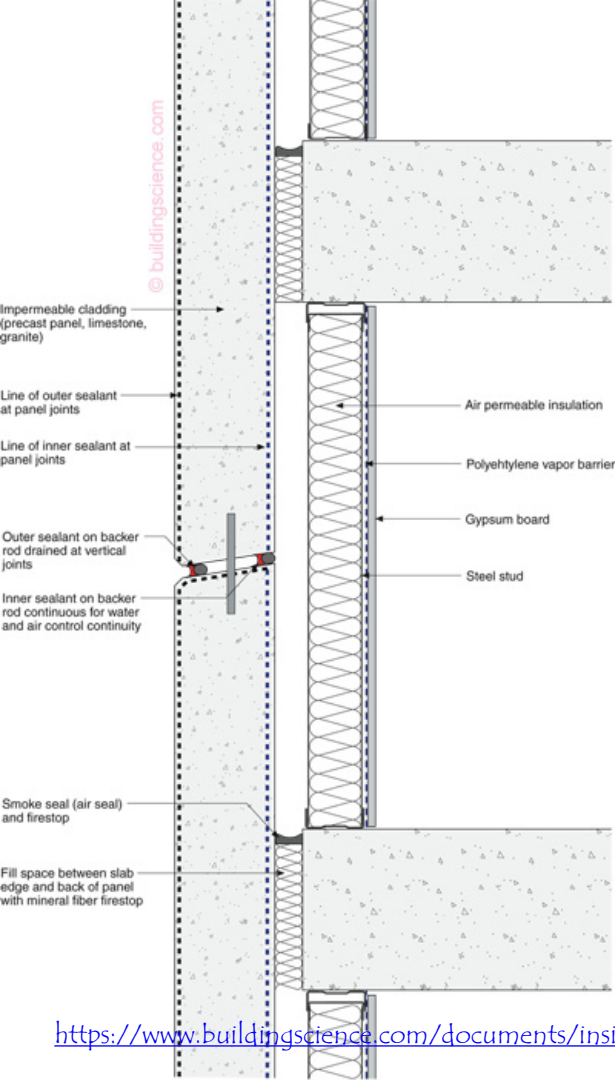


Figure 12. Intersection between horizontal and vertical two-stage joints in an external wall



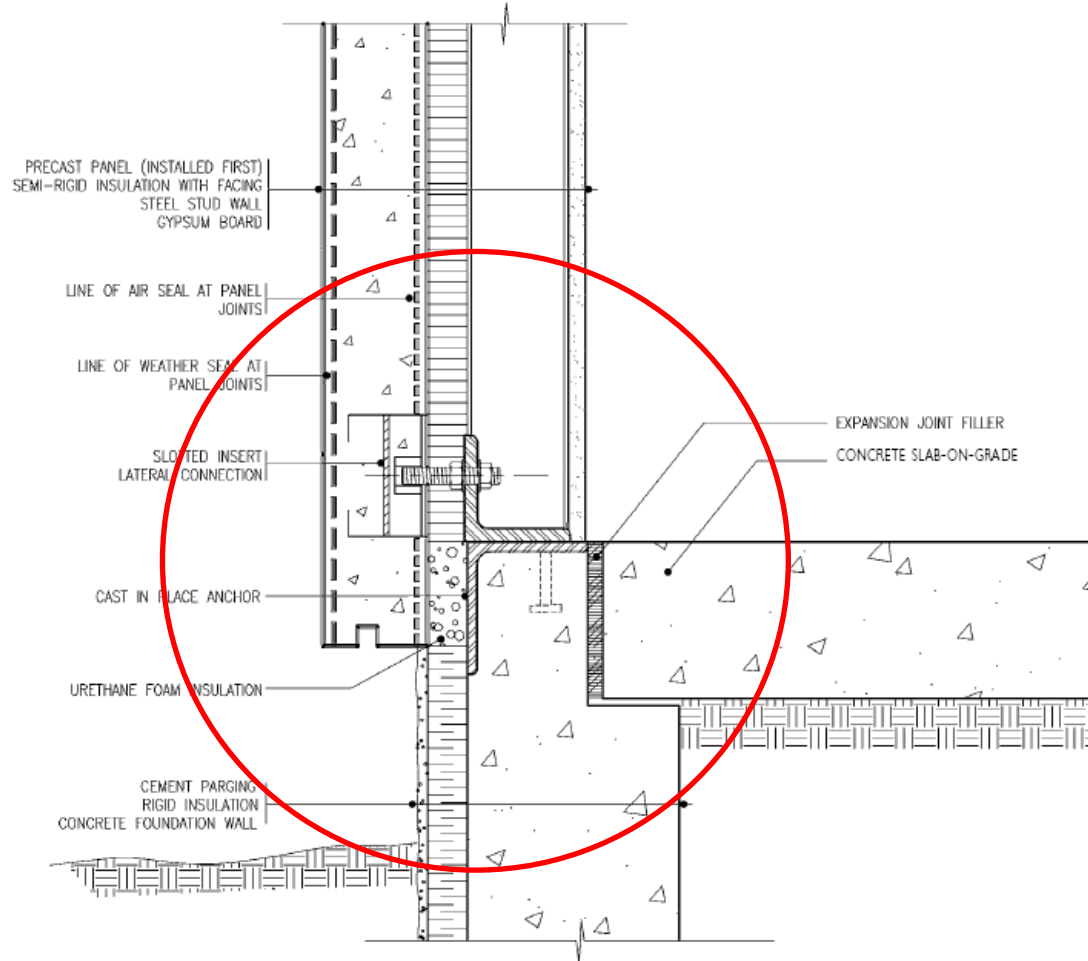
**Two-Stage Joint**—An inner and outer seal provide drainage at joints. The outer seal is exposed to the elements and gets trashed by the UV and heat and water but the assembly still works because of the interior protected seal. This interior seal is installed from the exterior for continuity reasons.



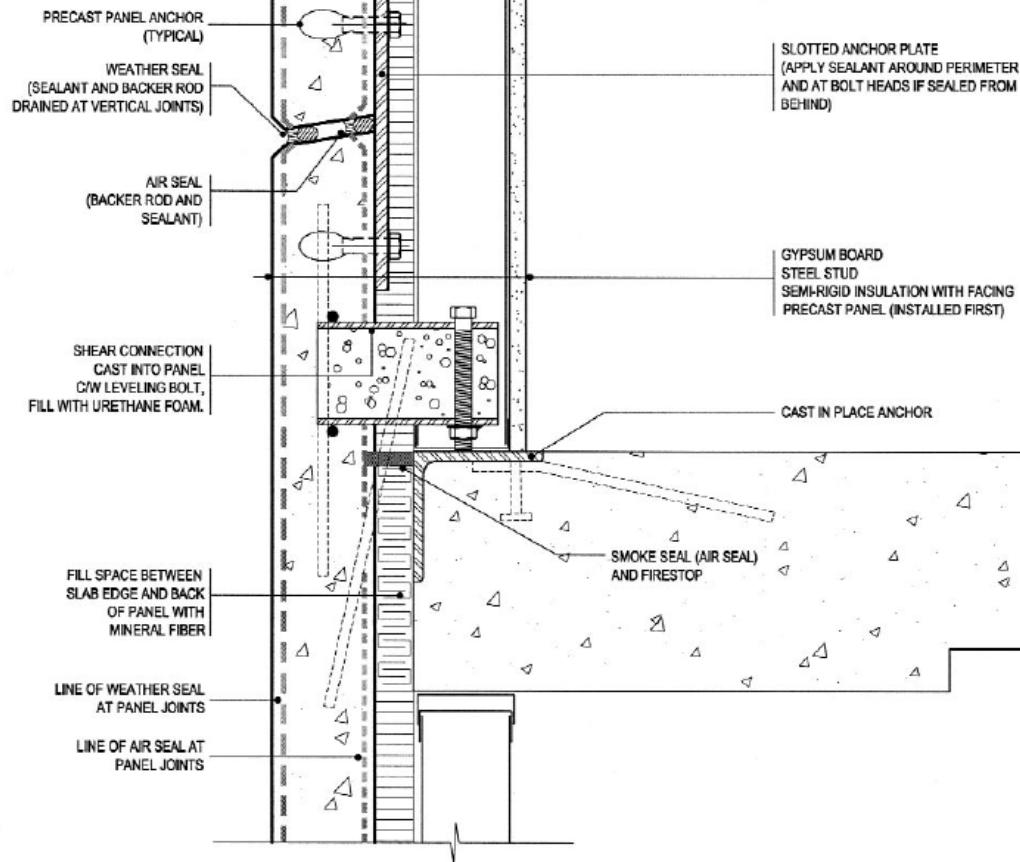
Face-sealed cladding (“perfect barrier”) that is impermeable to water vapor. It is insulated on the interior with air permeable insulation usually held in place between steel studs or impaled on pins protruding from the back of the cladding and covered by a vapor barrier.

BAD DETAIL as the face seal is likely to fail and the cavity is not designed as a rain screen to drain.



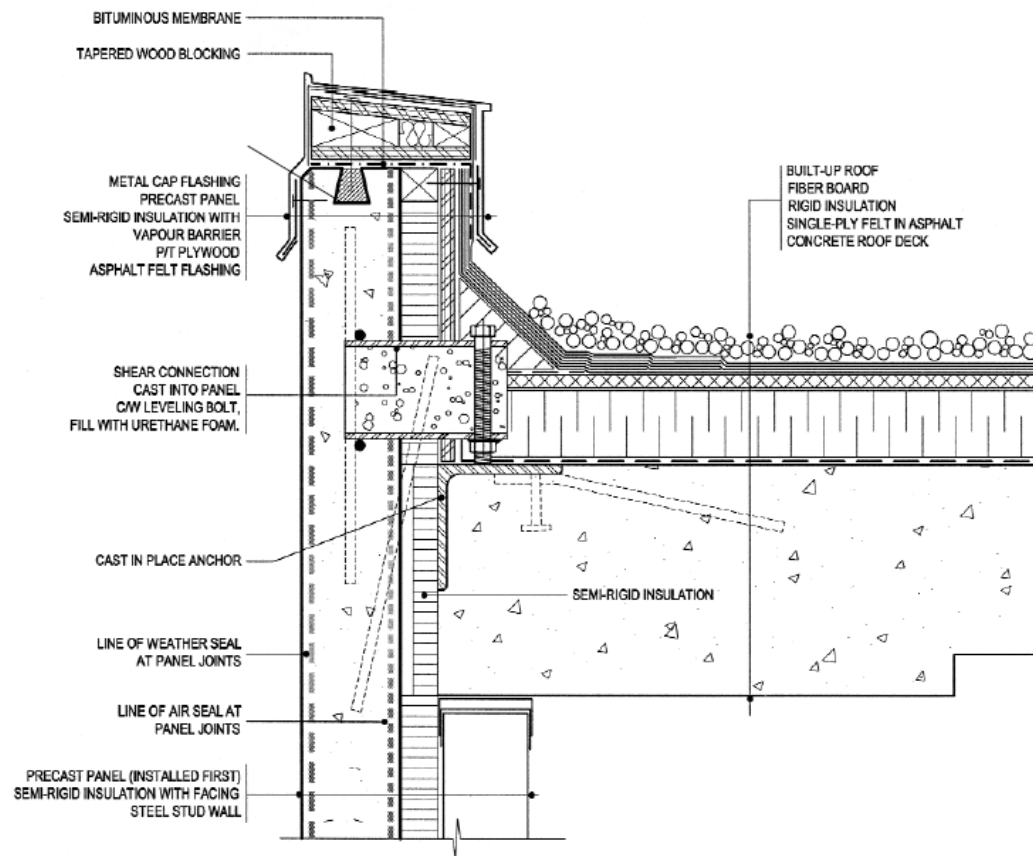


CONVENTIONAL PANEL  
LATERAL FOUNDATION CONNECTION

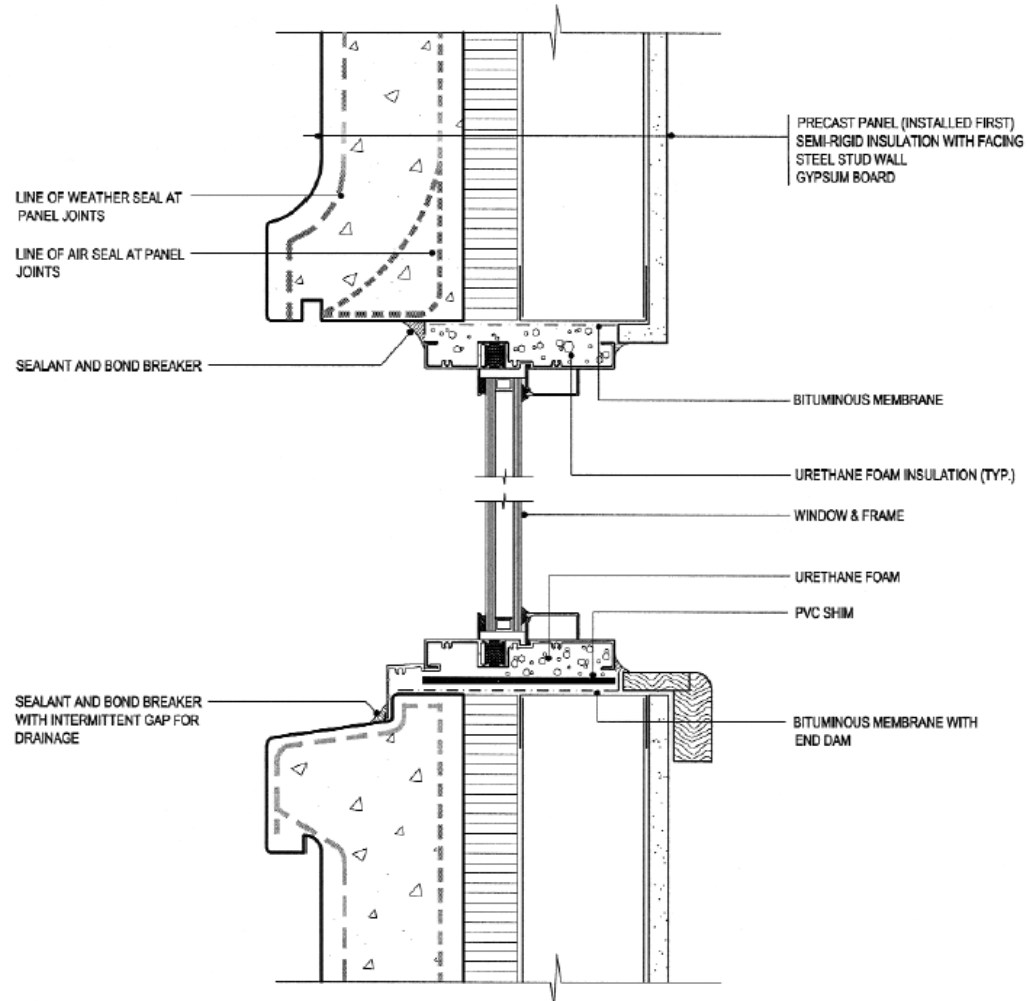


CONVENTIONAL PANEL  
SLAB BEARING CONNECTION



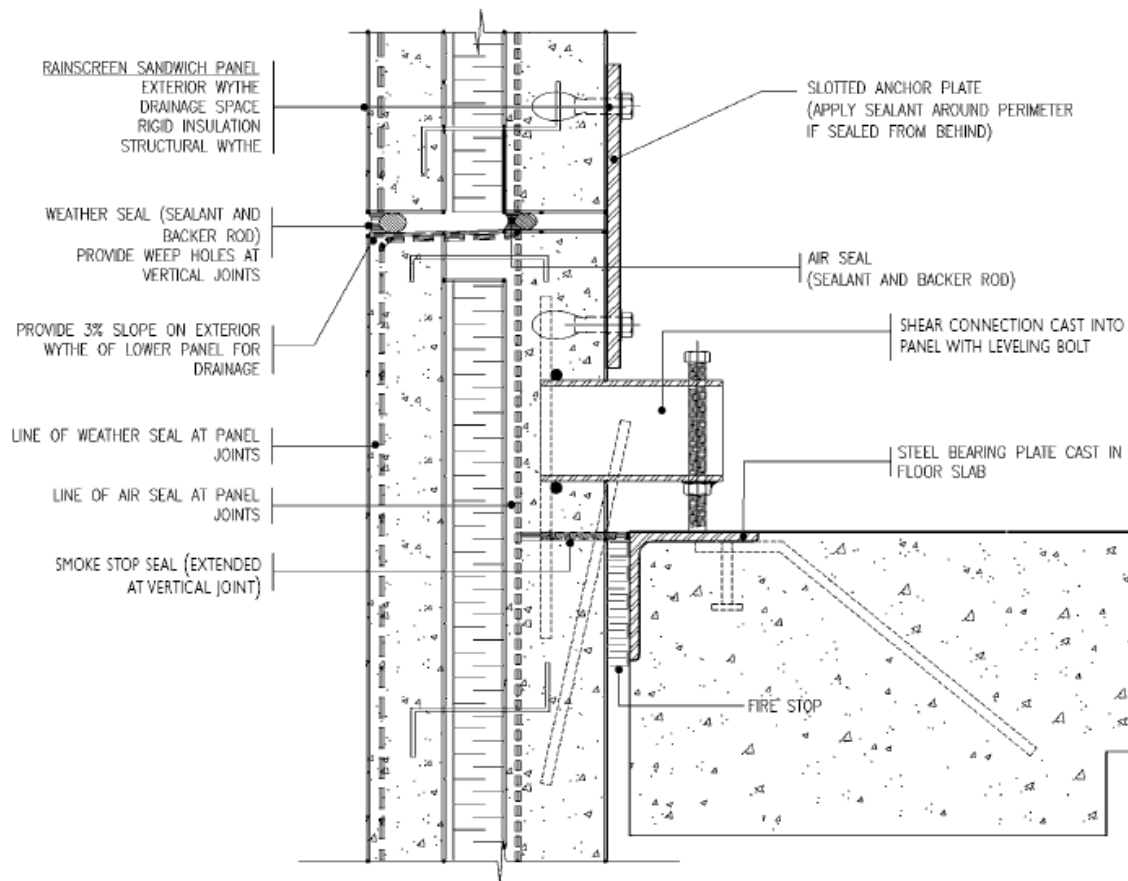


CONVENTIONAL PANEL  
TOP HUNG PARAPET CONNECTION

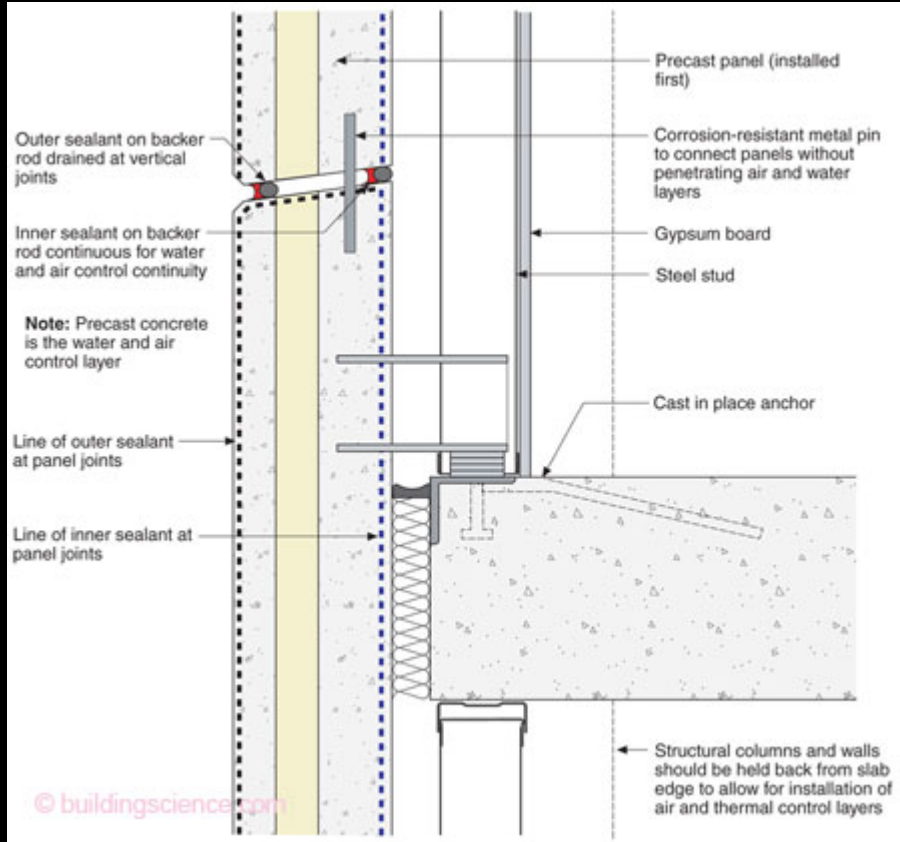


CONVENTIONAL PANEL  
WINDOW HEAD/SILL CONNECTION





SANDWICH PANEL WITH RAINSCREEN  
BEARING CONNECTION TO SLAB EDGE



**Sandwich Panel**—Low risk preinsulated precast panel. Rigid insulation located between two layers of concrete that comprise the panel.





Weathering is a big issue in urban projects.

The rain washes down the building and deposits dirt as it slows down.

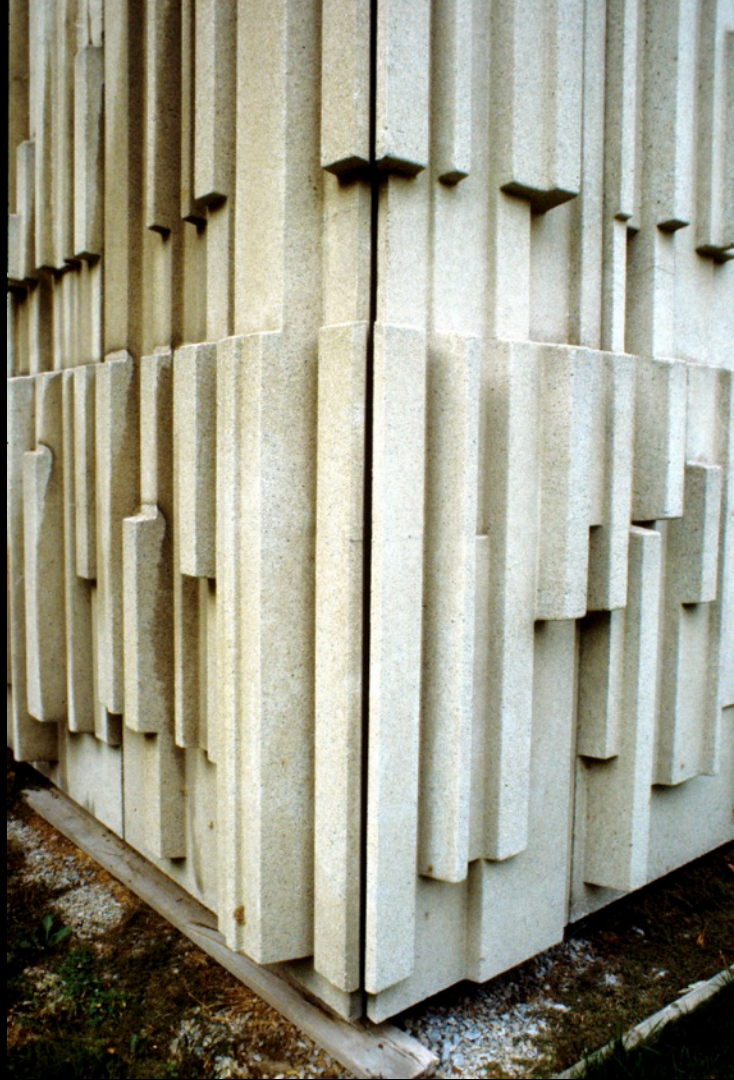
Worse on smooth finished precast.











# Fabricating the Precast Elements

































































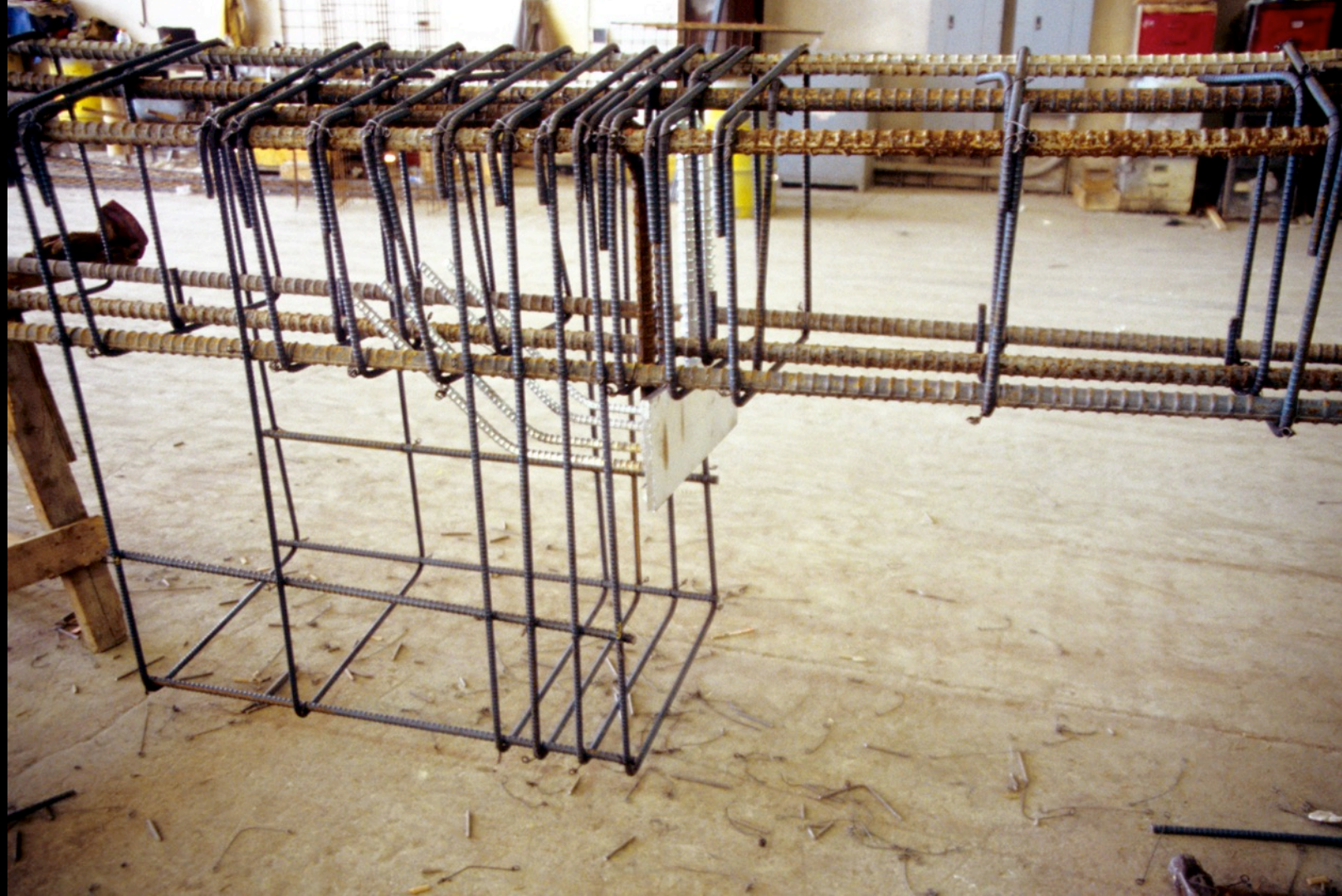








































































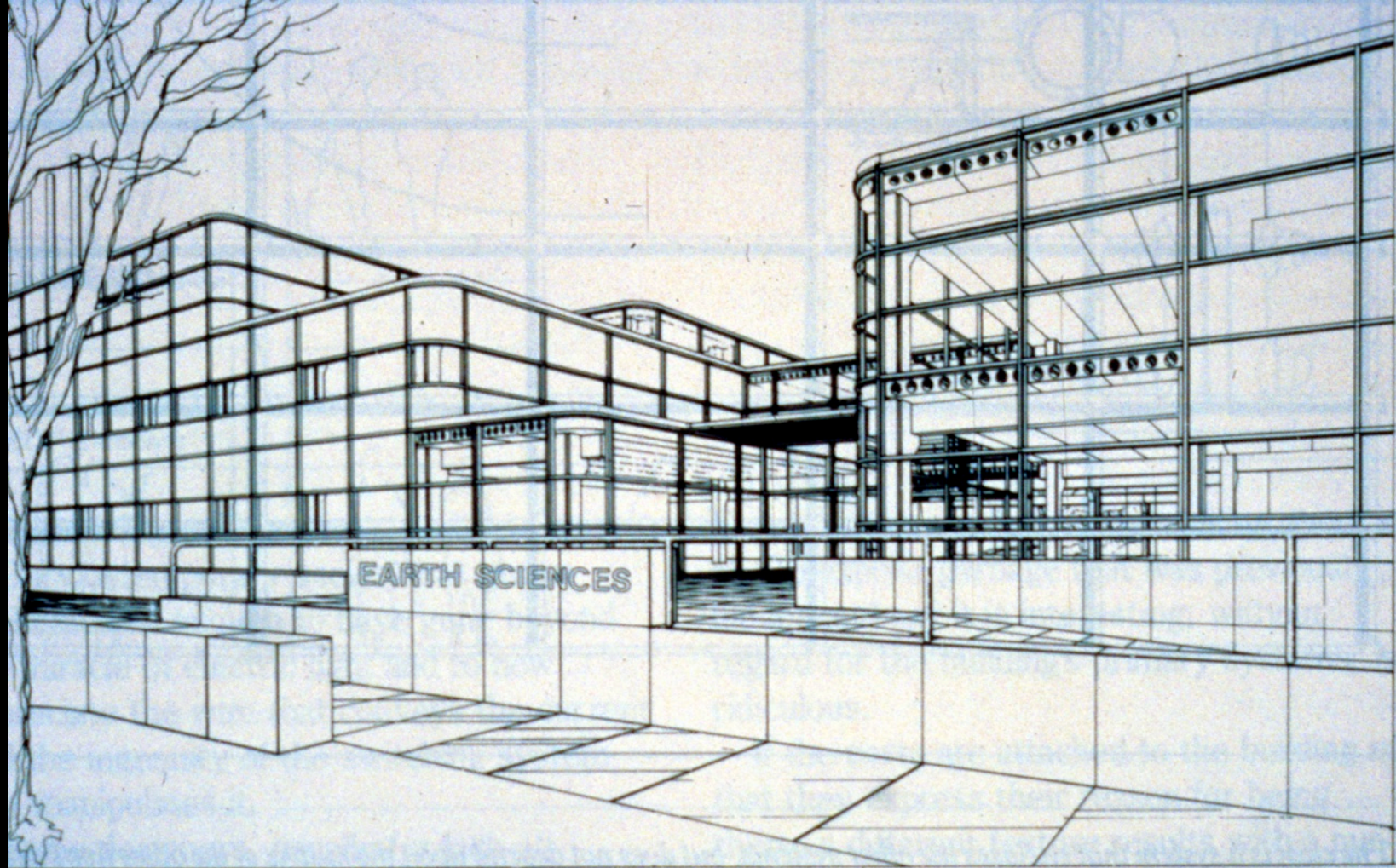








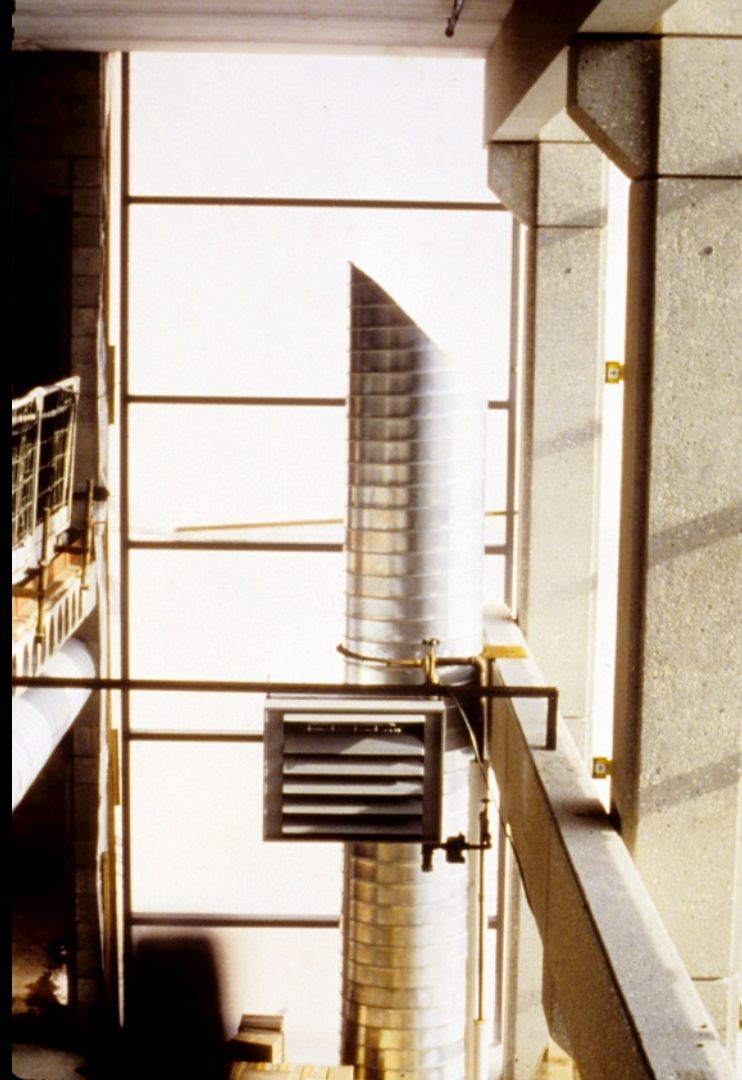
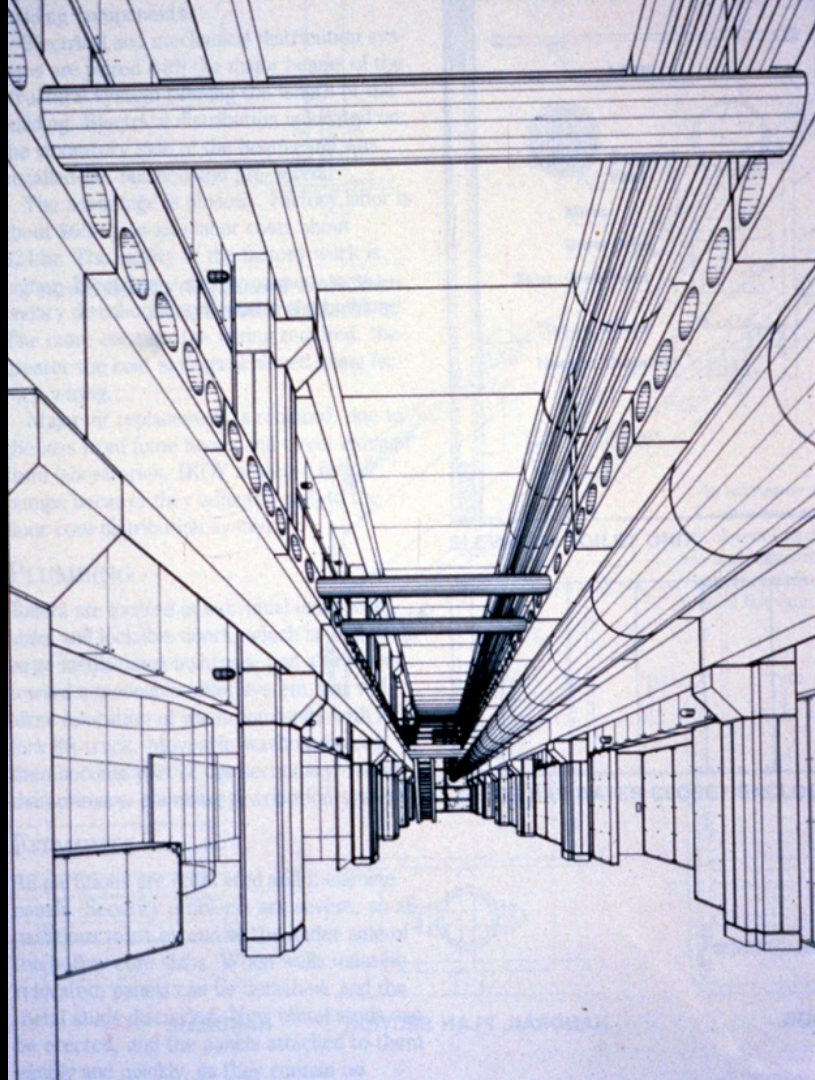






















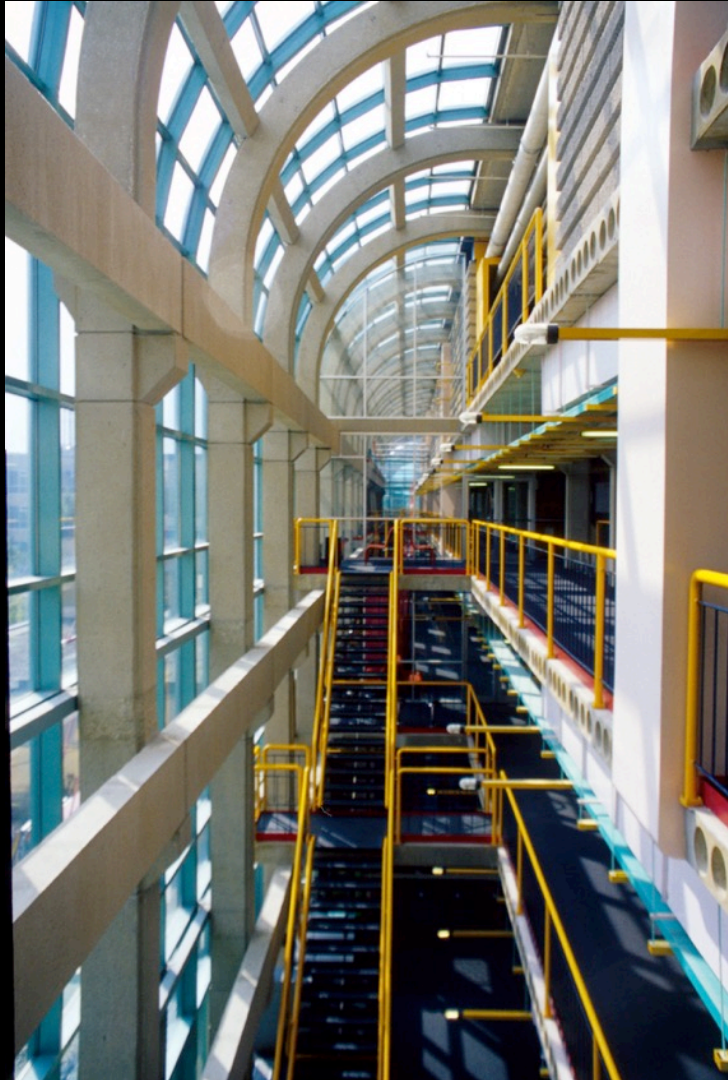






















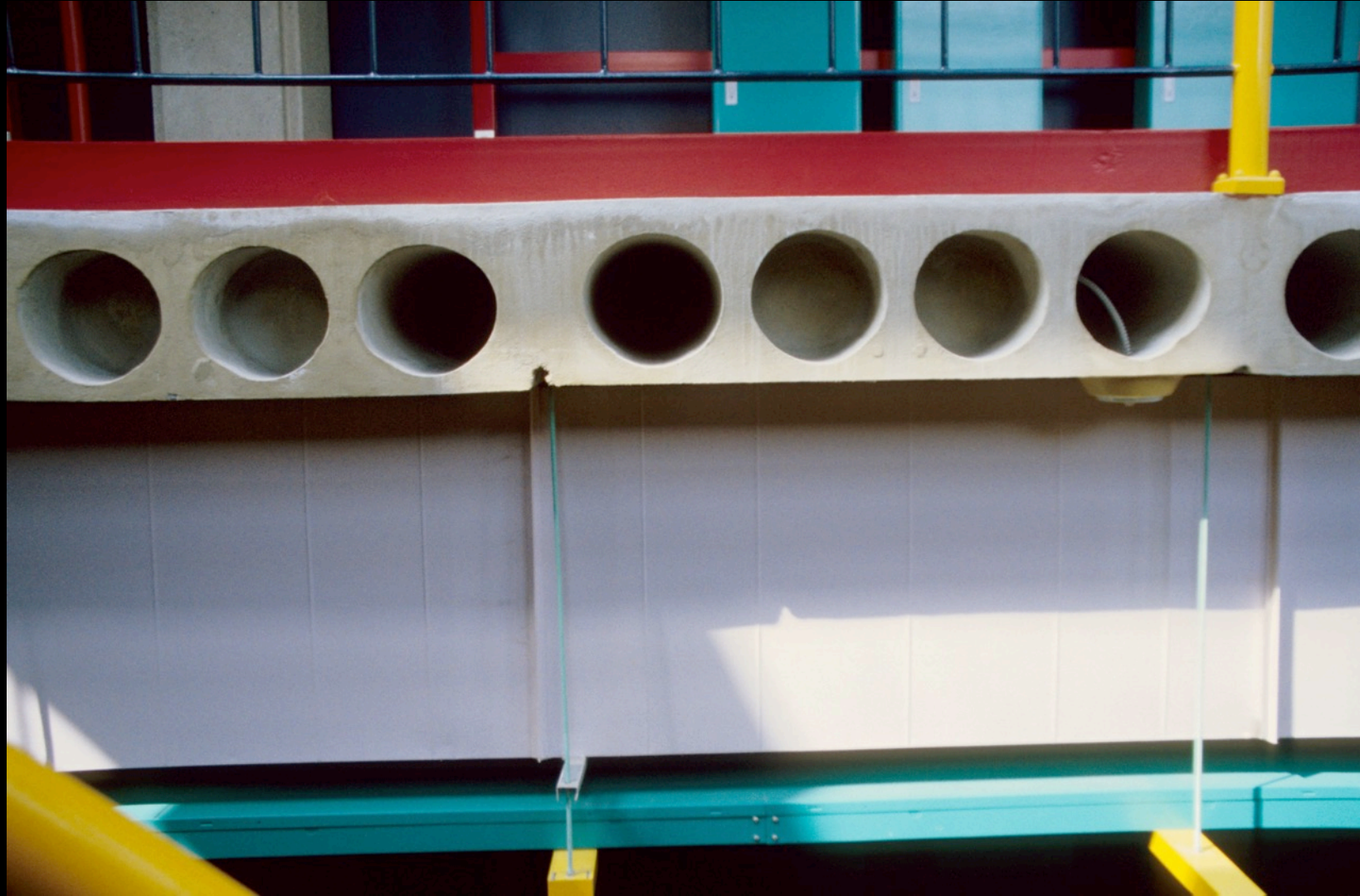
















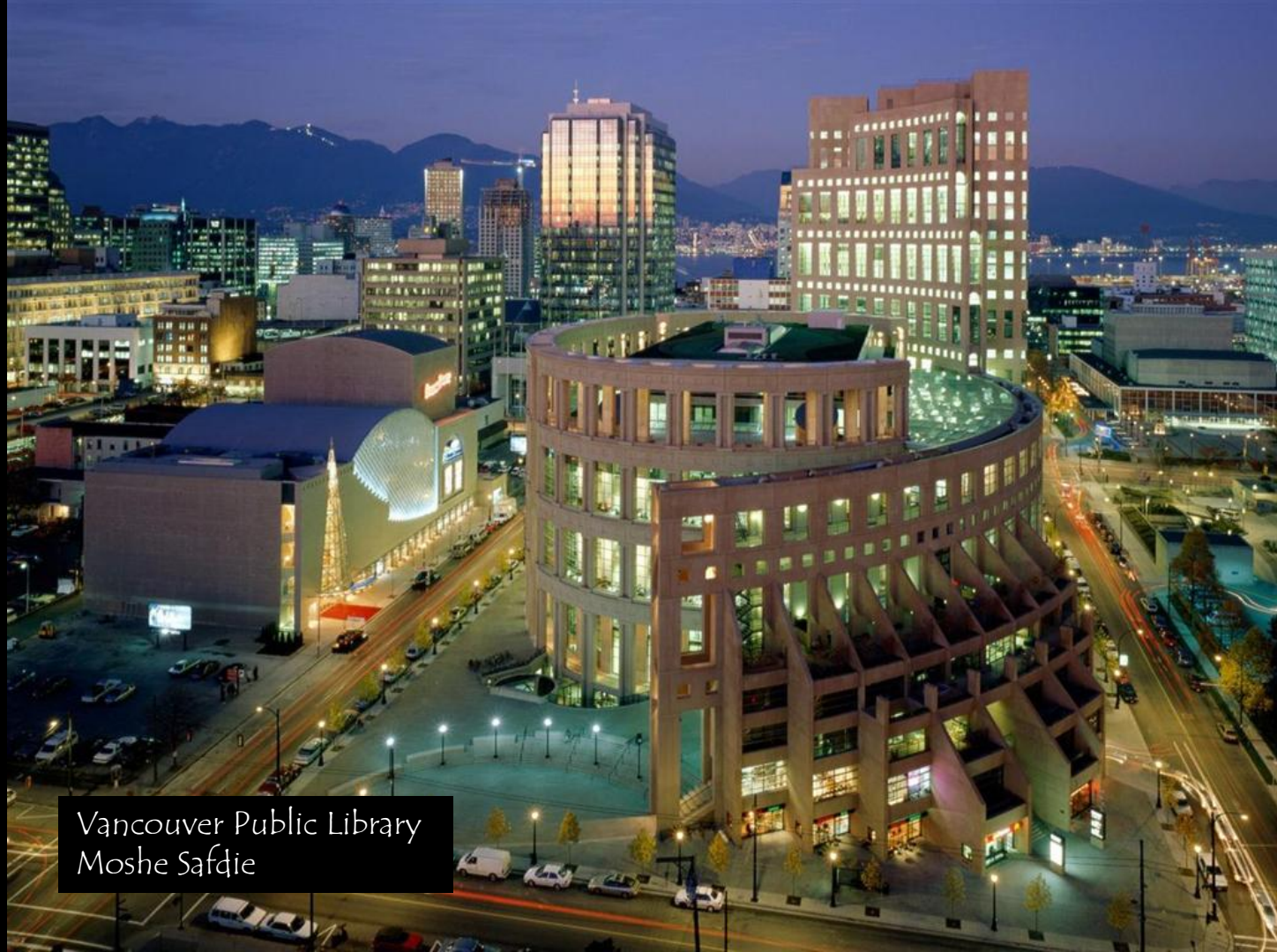












Vancouver Public Library  
Moshe Safdie





























Salt Lake City Public Library  
Moshe Safdie



















Skyscraper  
Medellin, Colombia









# **AURORA MUNICIPAL JUSTICE CENTER**

***Aurora, Colorado***

## **Architects / Engineers:**

**Skidmore, Owings & Merrill, Washington, D.C.**

**Robert P. Holmes, Design Partner**

**Ken Wiseman, Senior Designer**

**Ken Leibowitz, Structural Engineer**

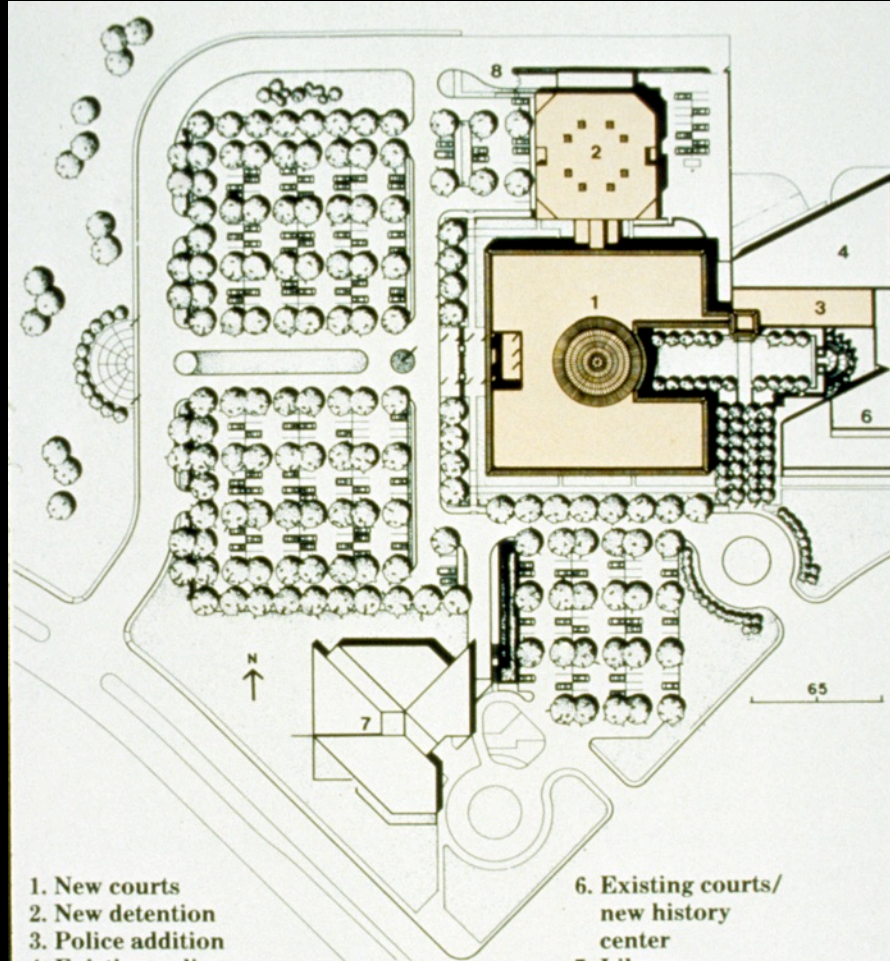
**General Contractor: Weitz-Cohen Construction Co.**

**Precast / Prestressed Concrete Manufacturer:**

**Rocky Mountain Prestress, Inc. Denver, Colorado**







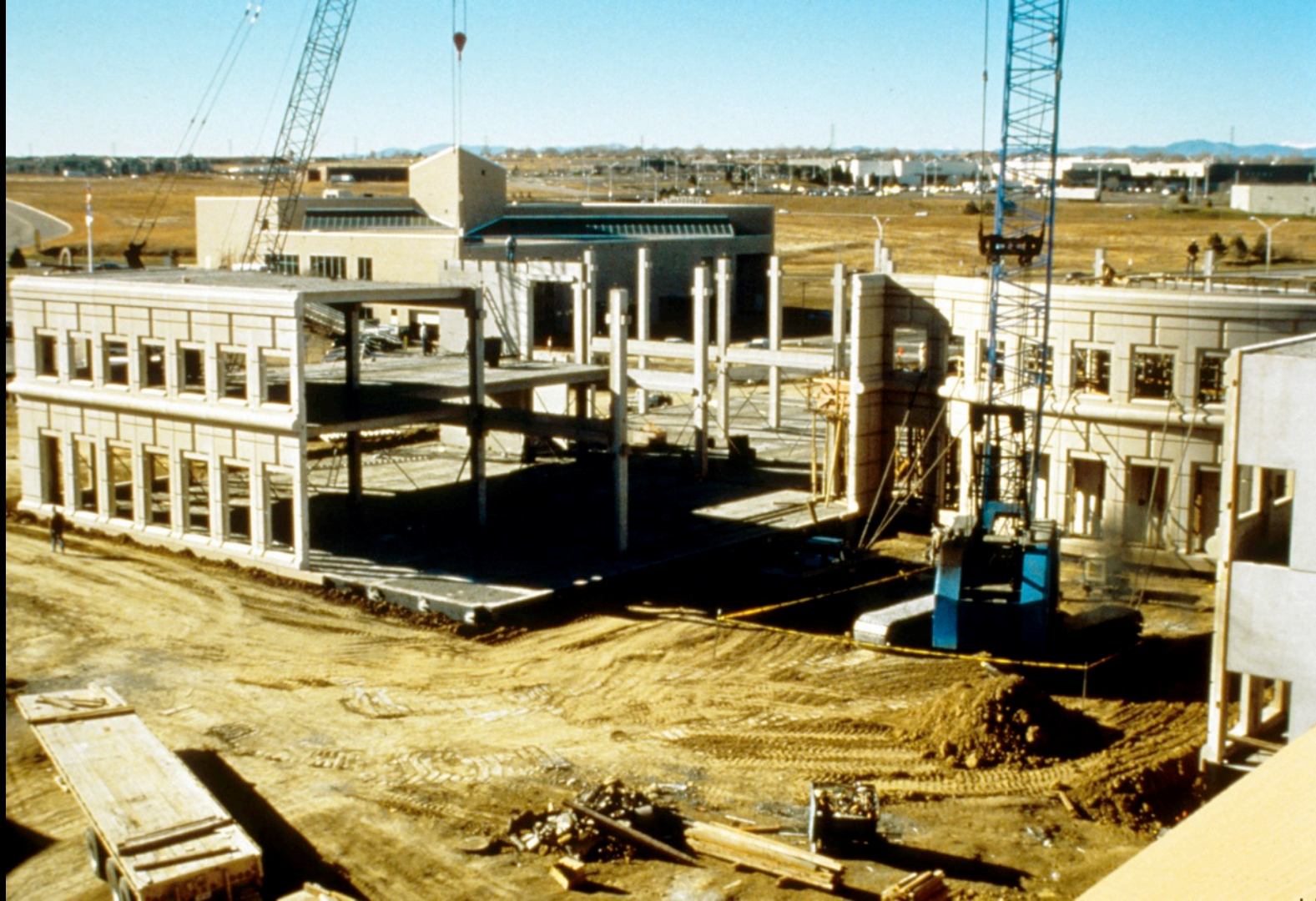
1. New courts
2. New detention
3. Police addition
4. Existing police
5. Existing detention  
(to be removed)

6. Existing courts/  
new history  
center
7. Library
8. Sallyport







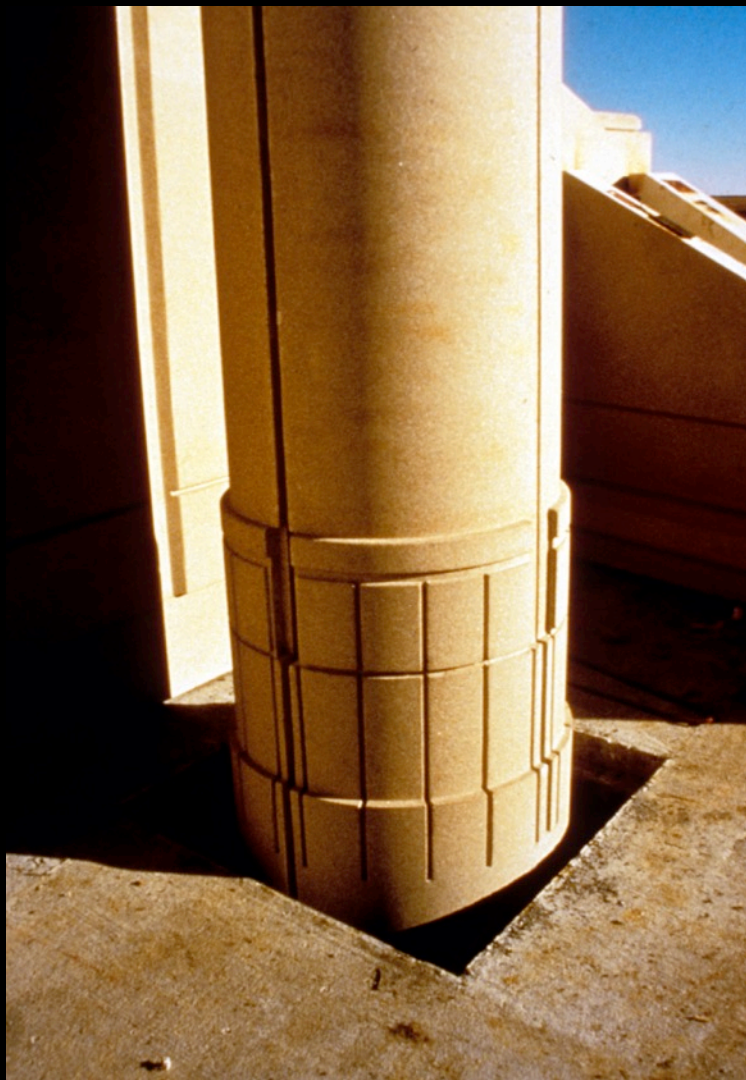










































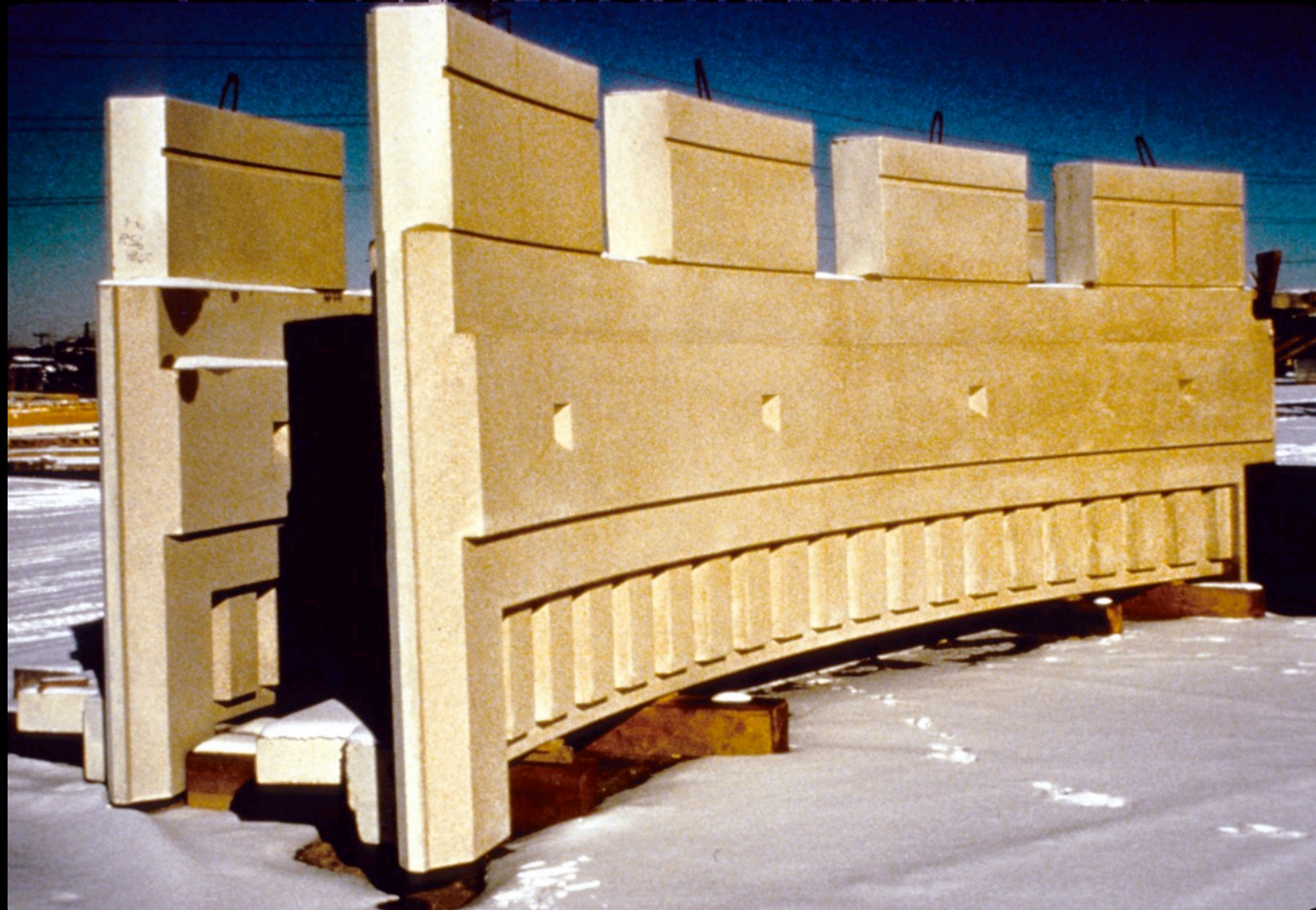
























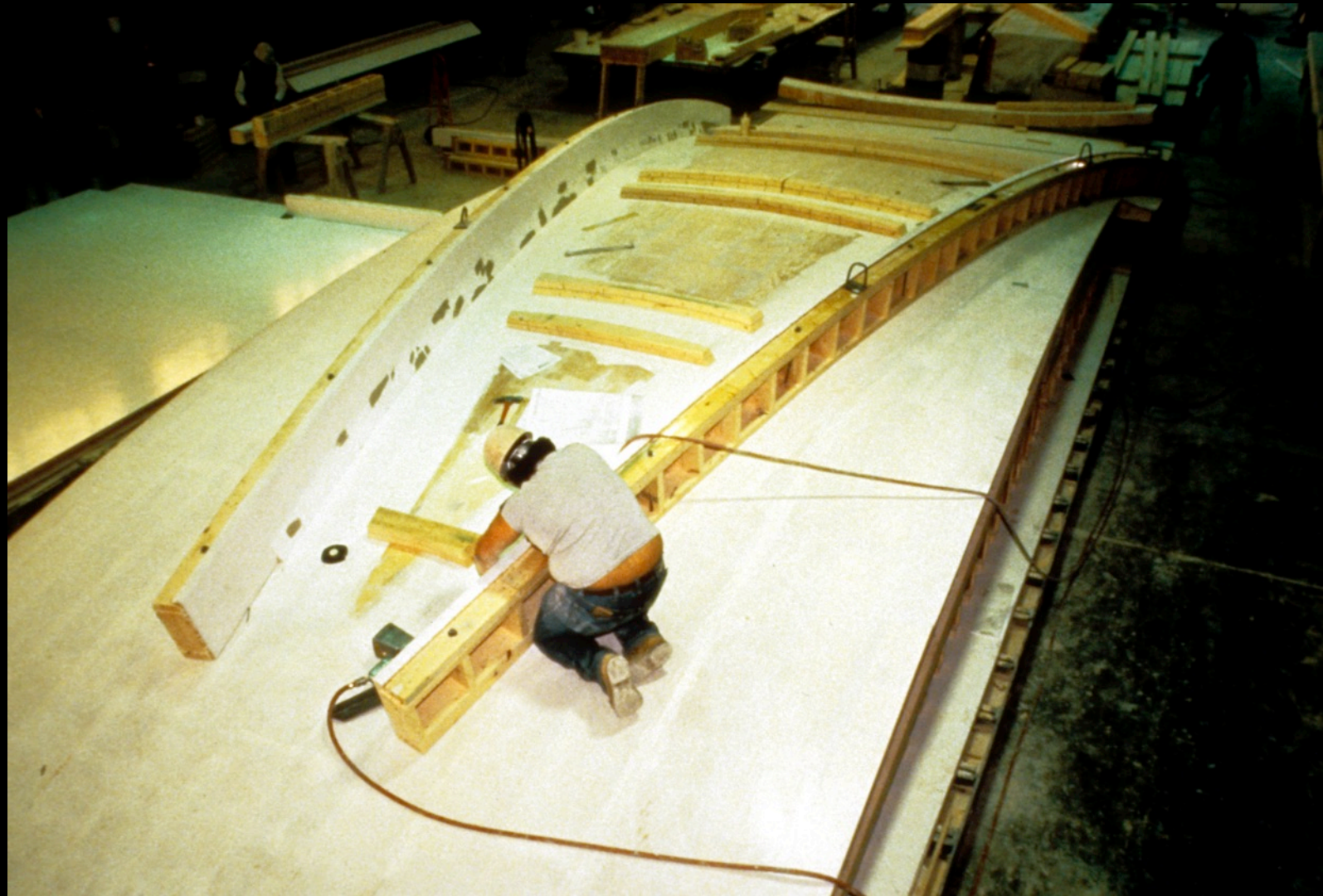














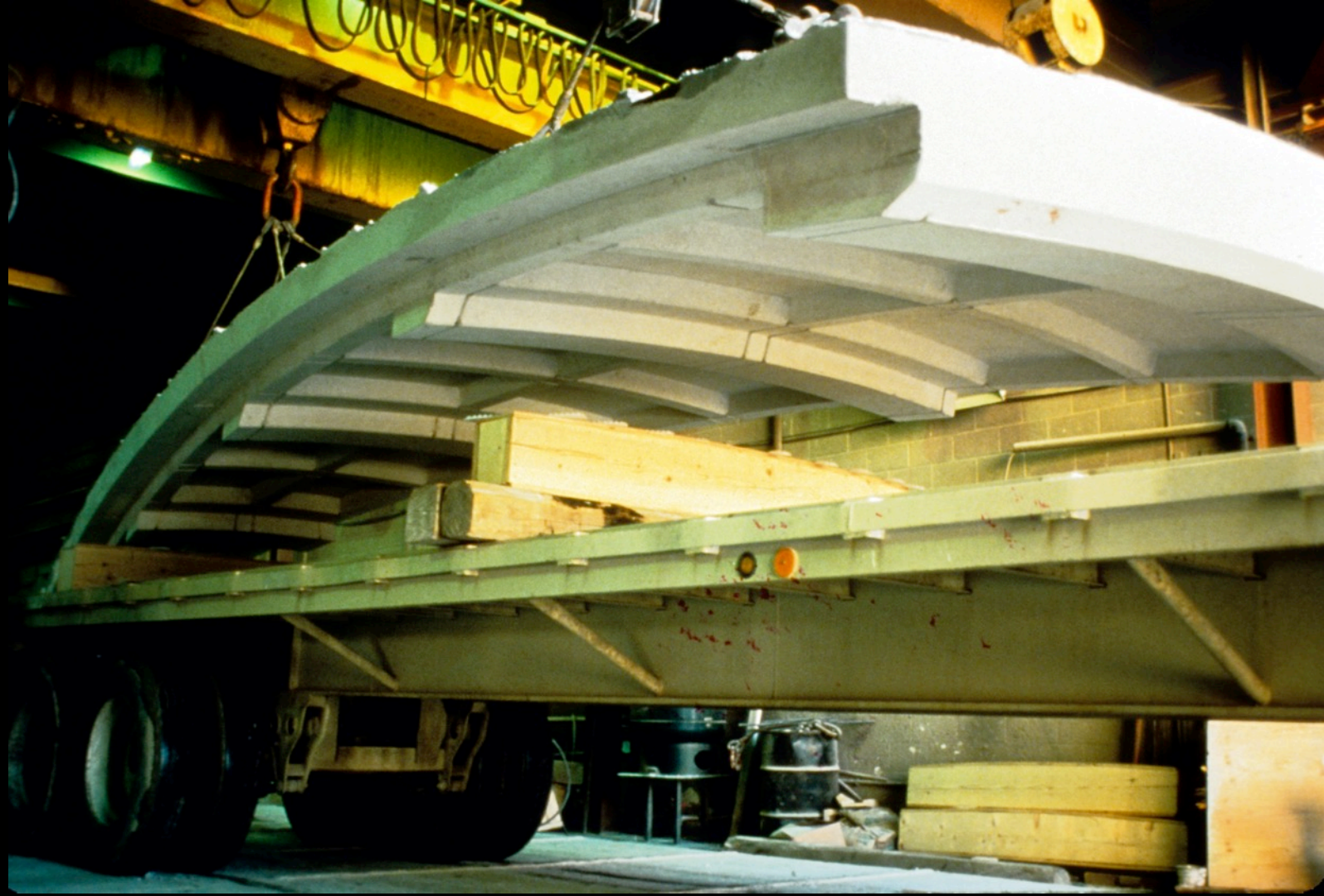


















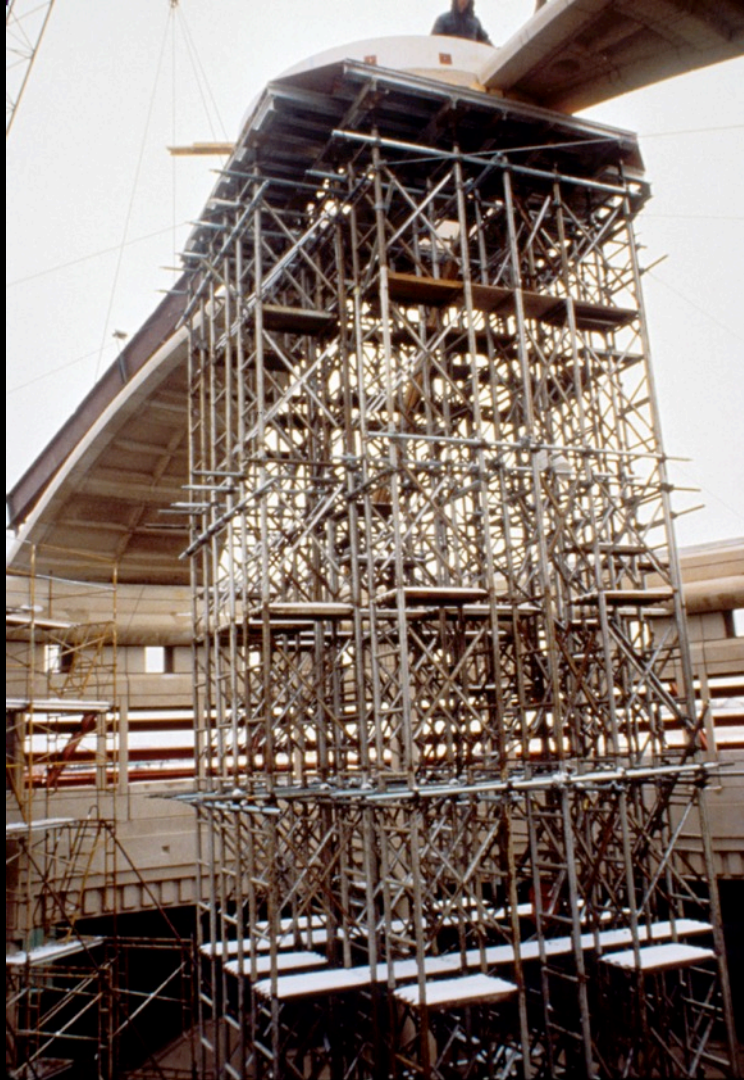












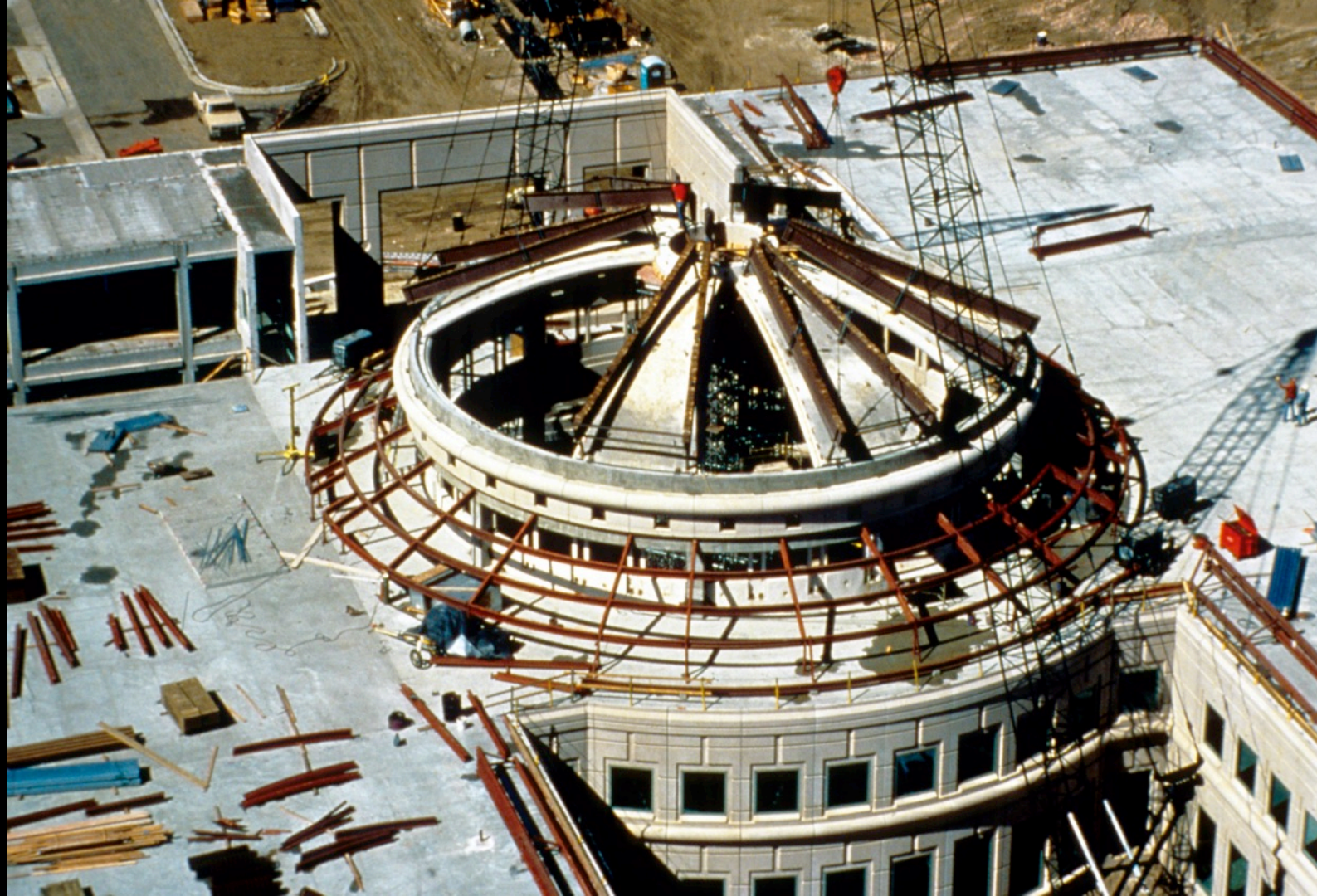




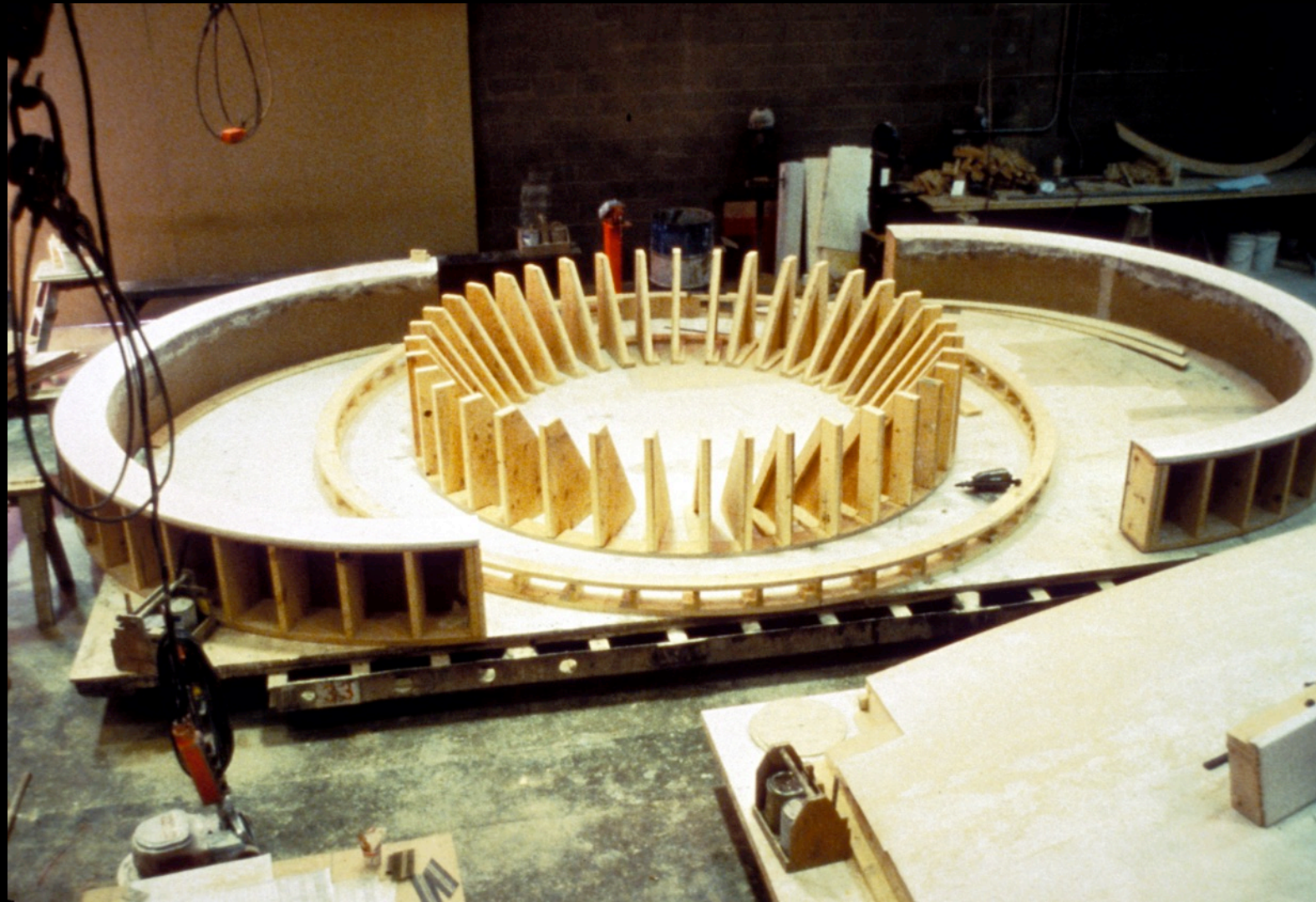








































## Prestressed Concrete:

Prestressed is the general term referring to BOTH pre-tensioned and post-tensioned forms

### Pre-tensioned concrete:

Where the steel tendons are inserted and stretched BEFORE the concrete is placed and has set

### Post-tensioned Concrete:

Normally where conduits are positioned in the concrete forms, concrete is placed around and cured, THEN the steel tendons are inserted and stretched.



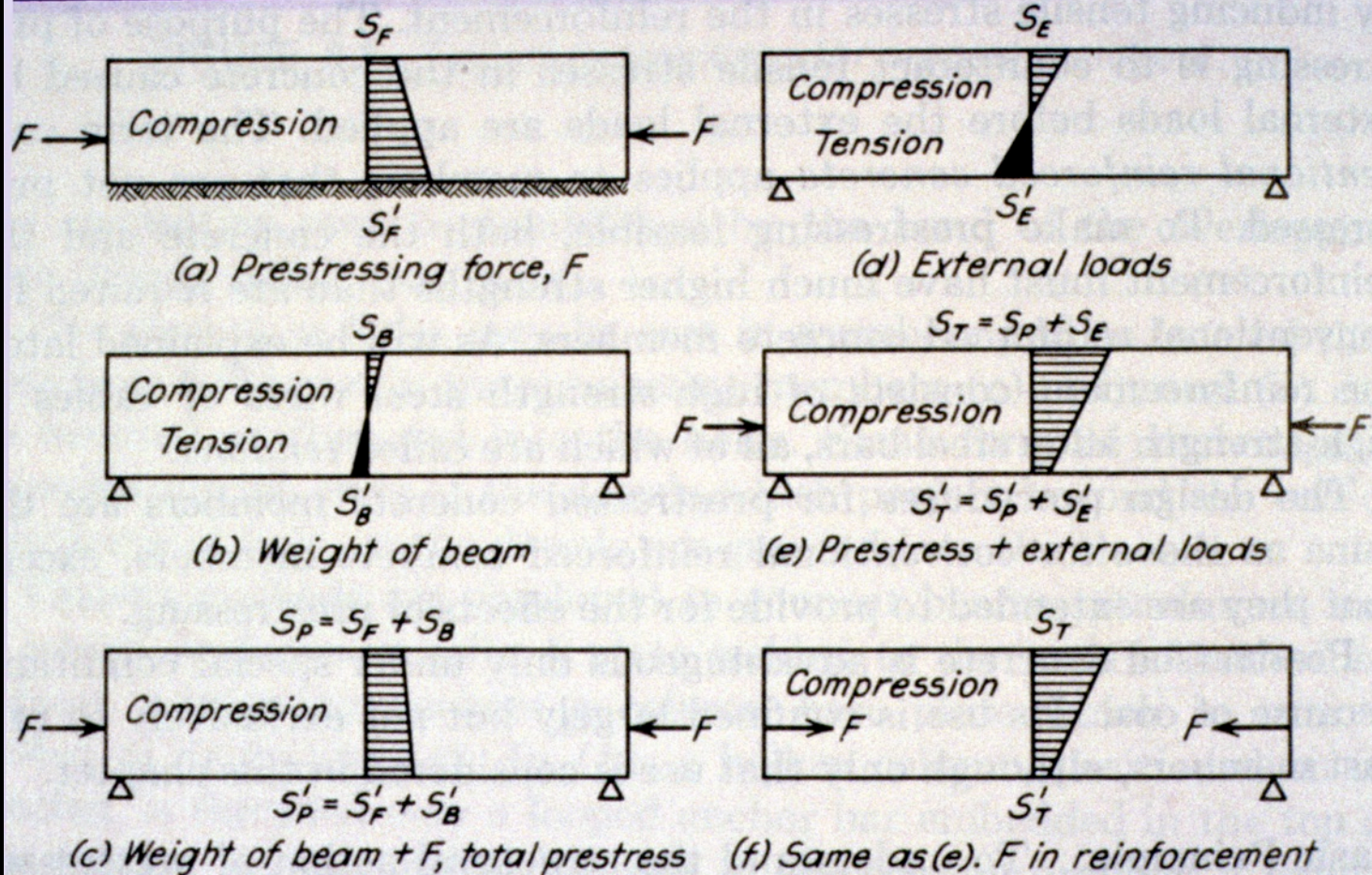
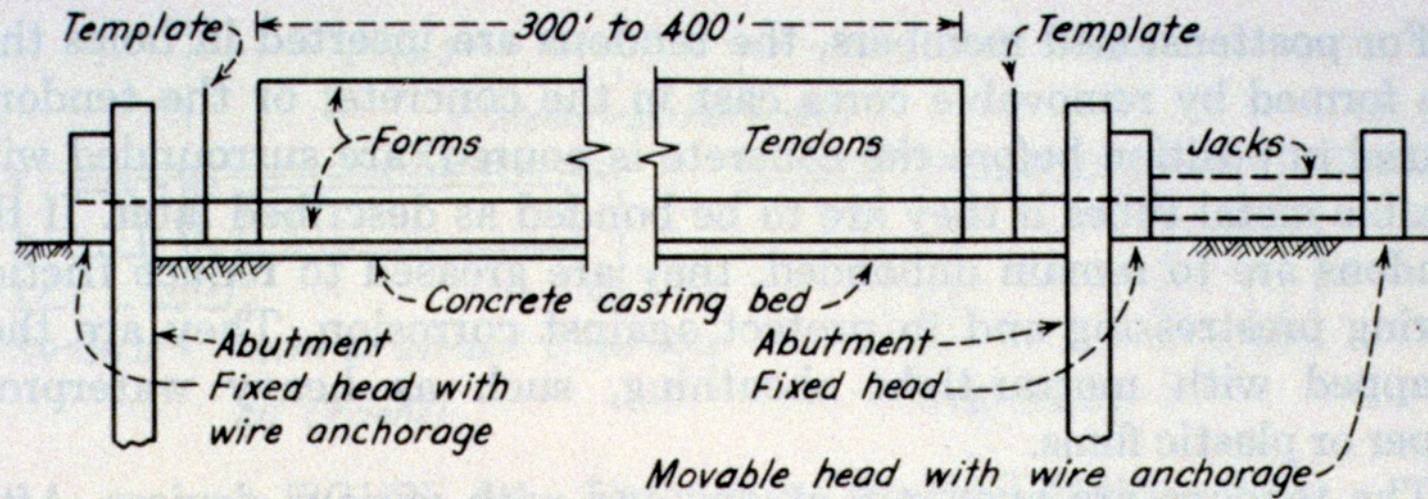
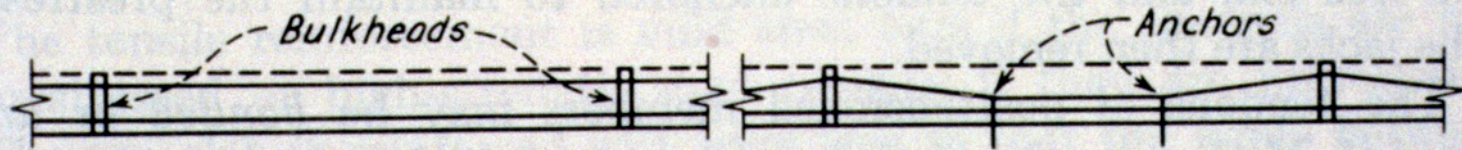


FIGURE 8.2 Fiber stresses caused by various loading conditions.





(a) Pretensioning bed for long-line process  
 Arranged from Portland Cement Ass'n publication



(b) Original position

(c) Draped position

FIGURE 8.3 Pretensioning beds and draping of tendons.





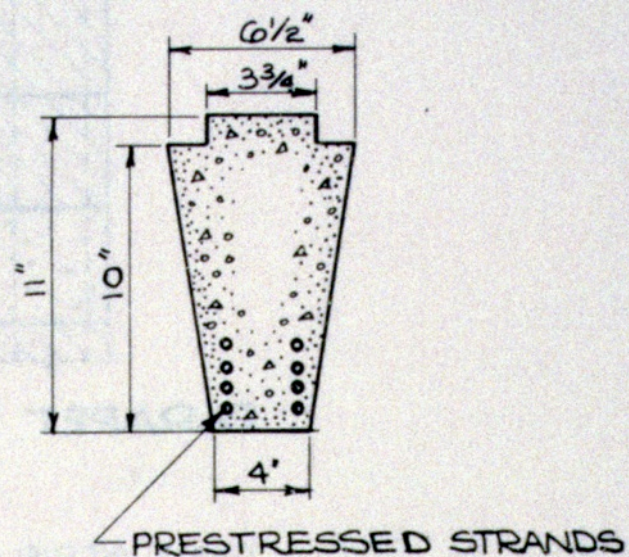
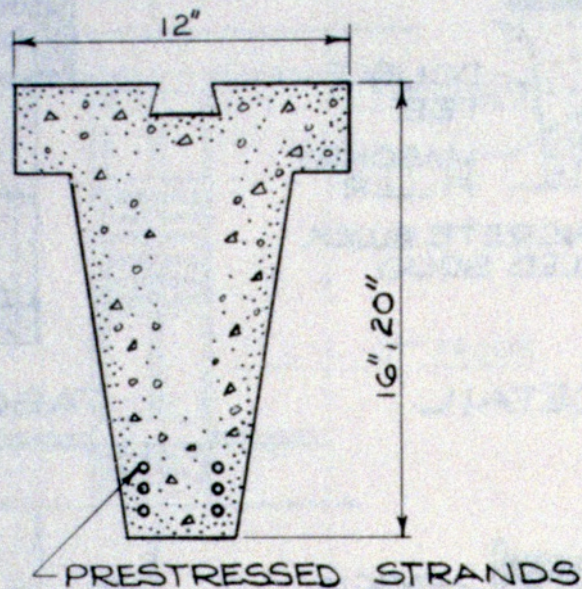










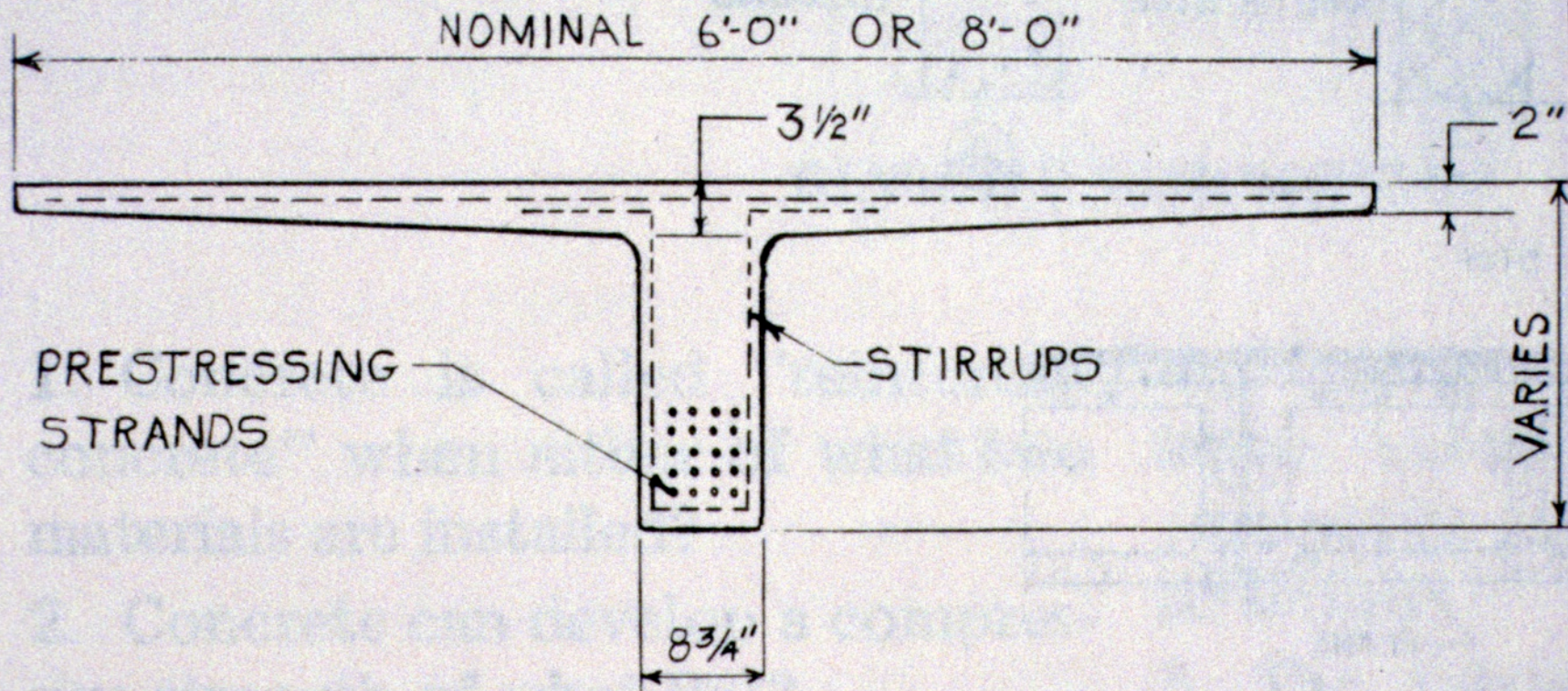


| LOADS PER LINEAR FOOT FOR<br>CONCRETE TEE JOISTS |     |     |    |
|--------------------------------------------------|-----|-----|----|
| SPAN IN FT.                                      | 20  | 45  | 64 |
| LB'S/LIN. FT. 16"                                | 584 | 128 | —  |
| LB'S/LIN. FT. 20"                                | 873 | 293 | 82 |

PRESTRESSED REINFORCED  
CONCRETE BEAMS—  
SPANS FROM 16'-0" TO 32'-0"  
IN INCREMENTS OF 2'-0"

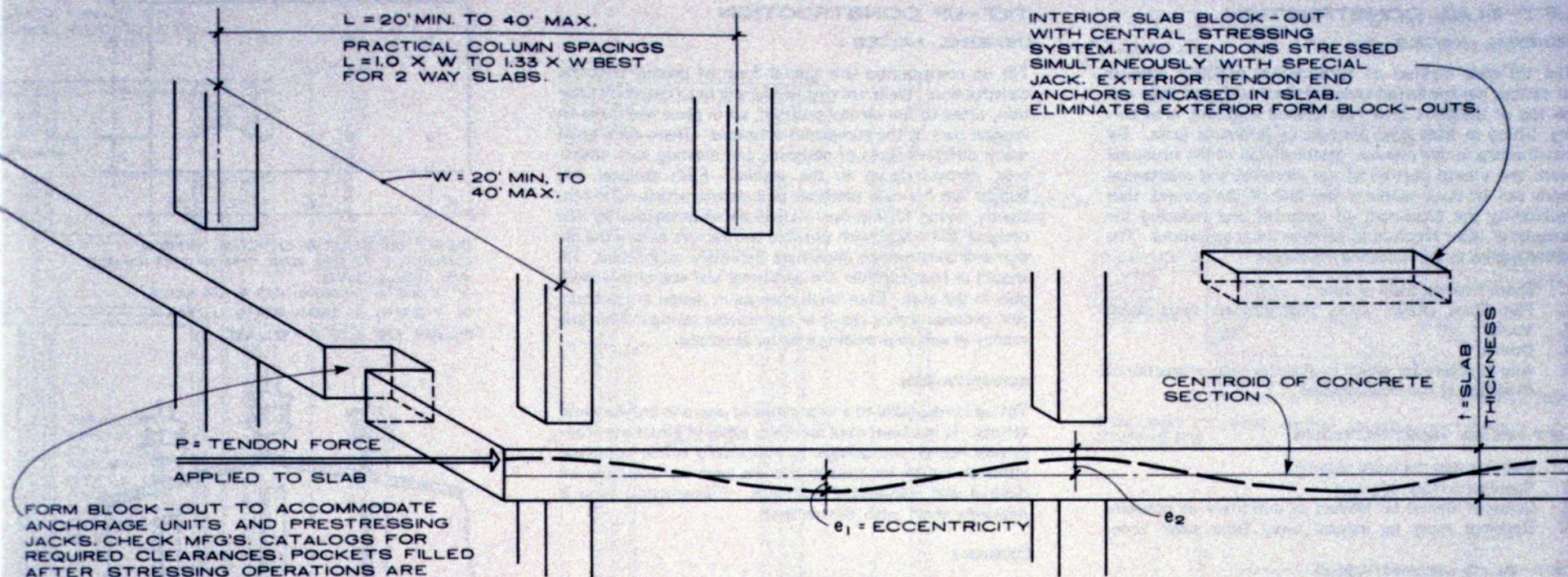
*Figure 11-7. Prestressed Concrete Beams for Floor and Roof Construction*





*Figure 11-10. Typical Prestressed Tee Section*





INTERIOR SLAB BLOCK-OUT WITH CENTRAL STRESSING SYSTEM. TWO TENDONS STRESSED SIMULTANEOUSLY WITH SPECIAL JACK. EXTERIOR TENDON END ANCHORS ENCASED IN SLAB. ELIMINATES EXTERIOR FORM BLOCK-OUTS.

#### RECOMMENDED SPAN/DEPTH RATIO

|        |    |
|--------|----|
| FLOORS | 42 |
| ROOF   | 48 |

Check deflections, camber, and vibration.

Draped post-tension tendons pre-compress concrete to provide resistance to tensile stresses produced by flexural bending due to dead + live loads on floor. Maximum tendon spacing should not exceed 8 times slab thickness ( $t$ ).

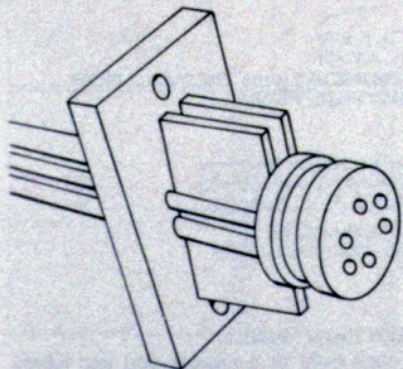
Practical solid slab thickness 6" min. to about 10" max. without drop panels. For long spans cast-in place (not lift slabs) haunched slabs or drop panels may be used. Hollow slabs or waffle slabs can also be used to reduce dead load on long spans.





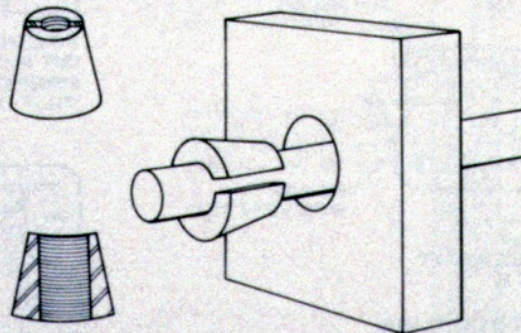




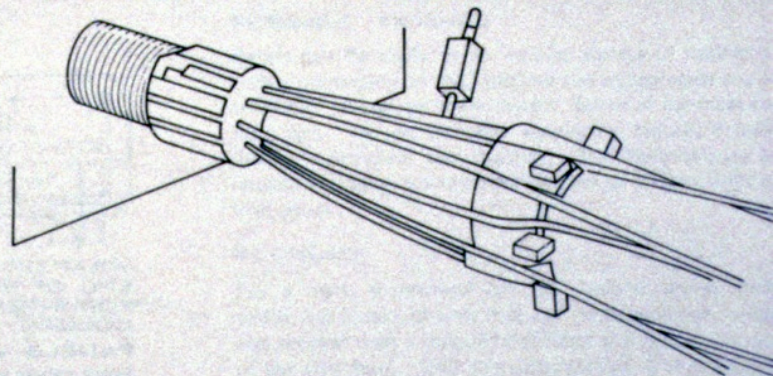


**PRESCON ANCHORAGE**

**NOTE:**



**STRESSTEEL BAR  
ANCHORAGE**



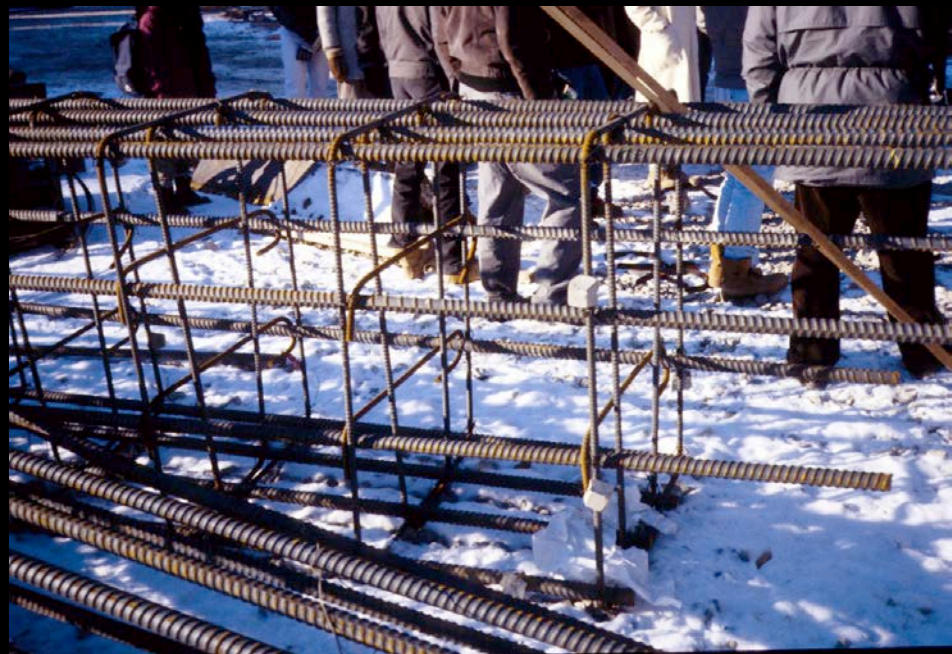
**FREYSSINET WIRE ANCHOR AND JACK**

Two-way post tensioned flat slabs average about 1 lb. of prestressing wire or strand per square foot for 24' to 28' bays. Additionally: at ordinary reinforcing steel runs about 0.5 lbs. per square foot





Construction of SkyDome (Rogers Centre) - 1987















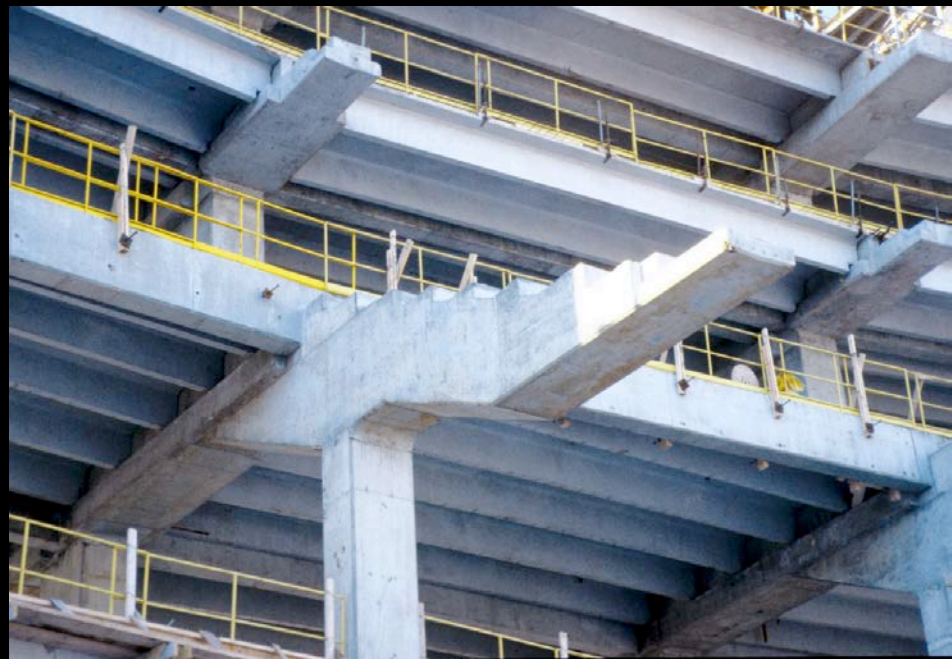
























# ARATA ISOZAKI

***"FOUR DECADES OF ARCHITECTURE"***

**MEMBER, ARCHITECTURAL INSTITUTE OF JAPAN**

**PRINCIPAL; ARATA ISOZAKI & ASSOCIATES**

**TOKYO, JAPAN**

**PRINCIPAL ARCHITECT: COSI— COLUMBUS, OH**



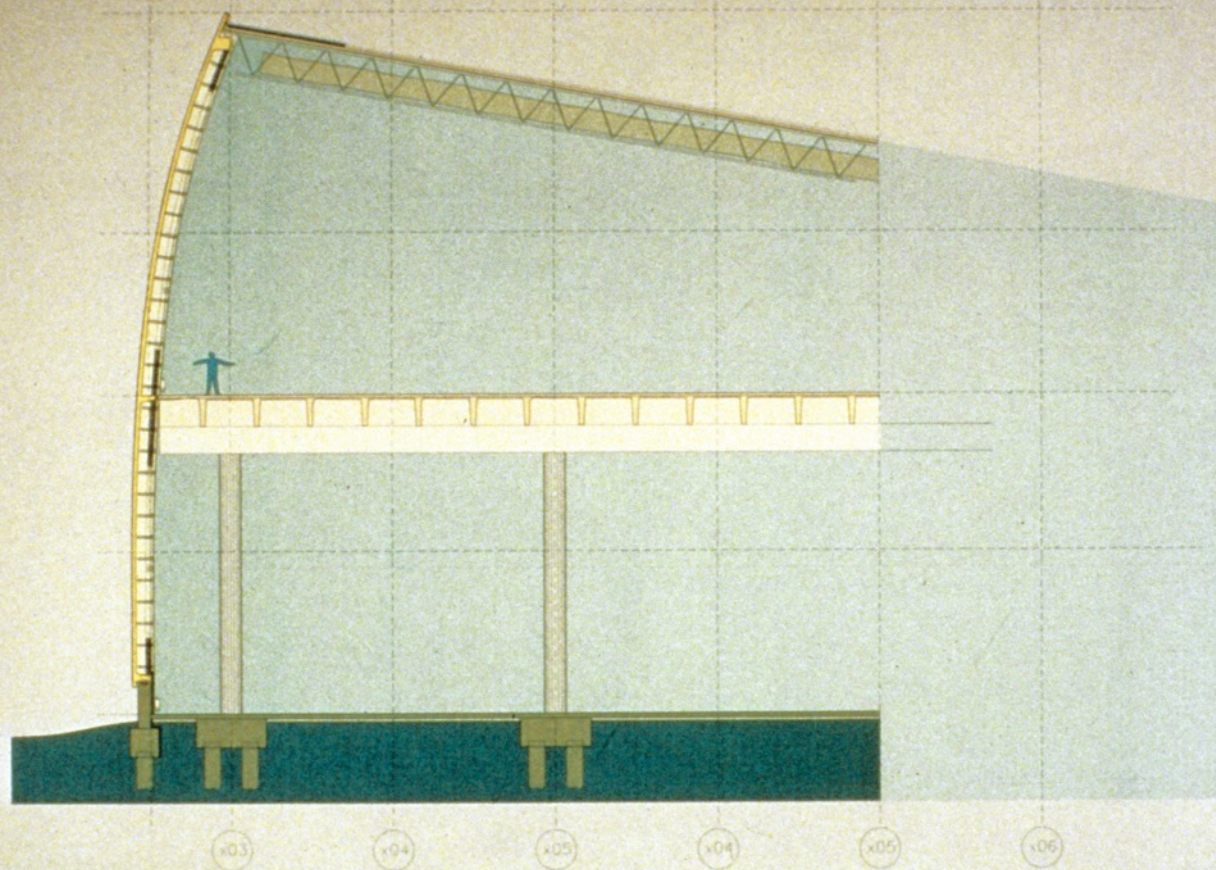












# GREAT WALL SECTION

ARATA ISOZAKI &amp; ASSOCIATES

NBBJ

## Architecture Design Planning

MOODY/NOLAN





















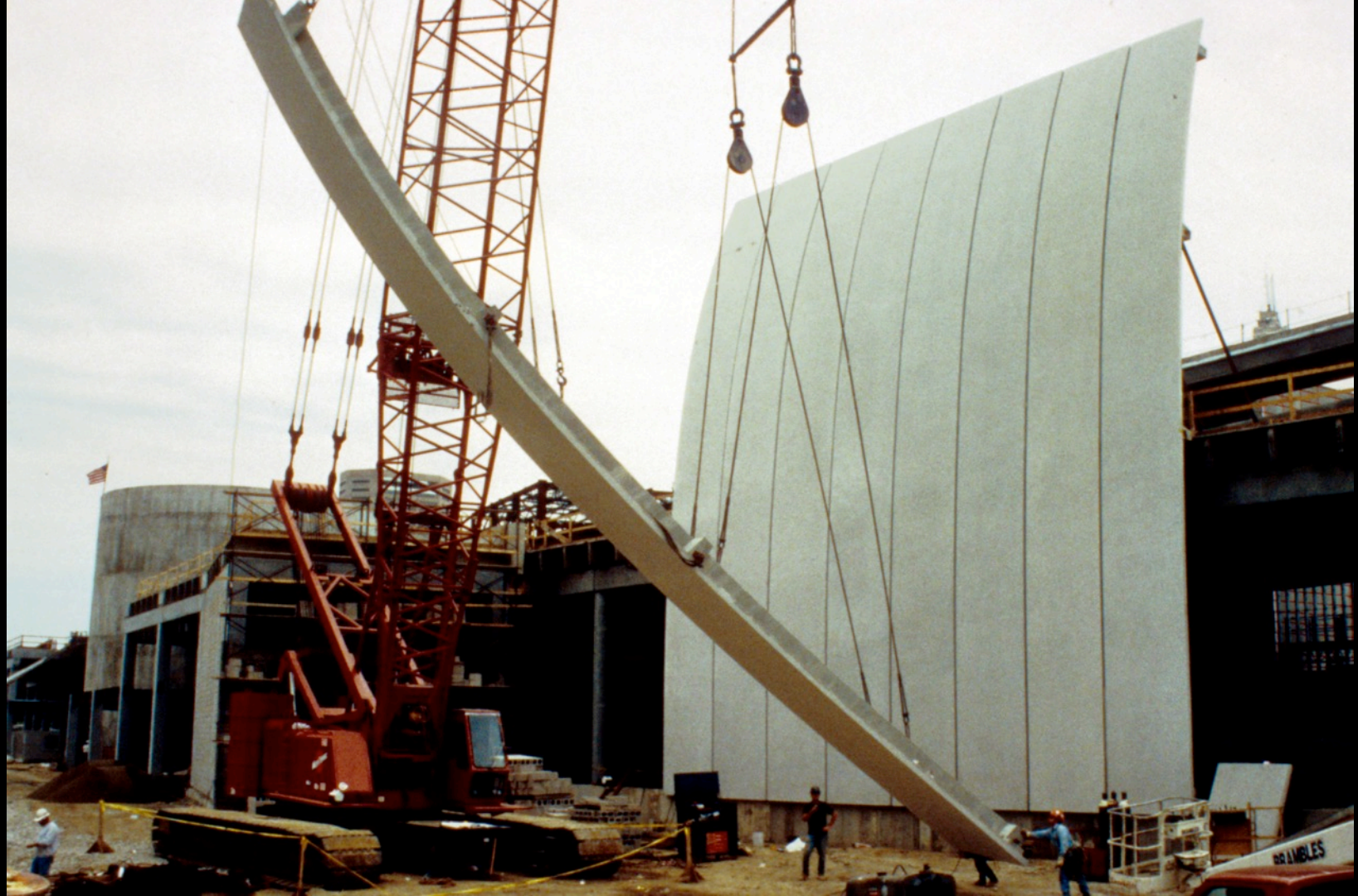








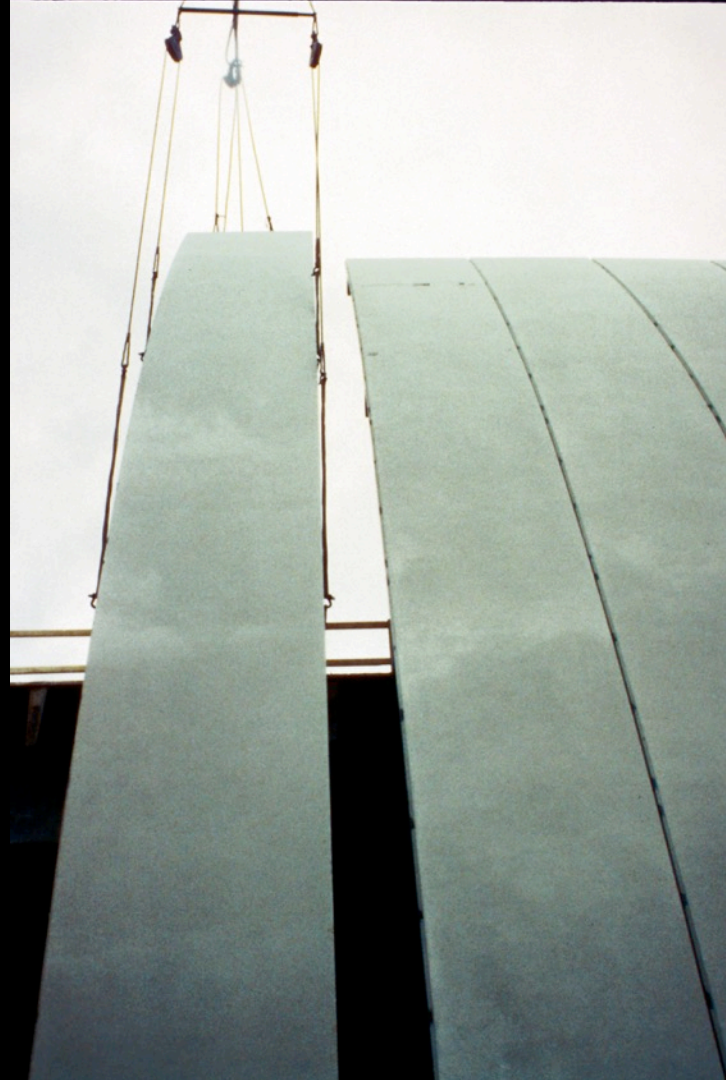




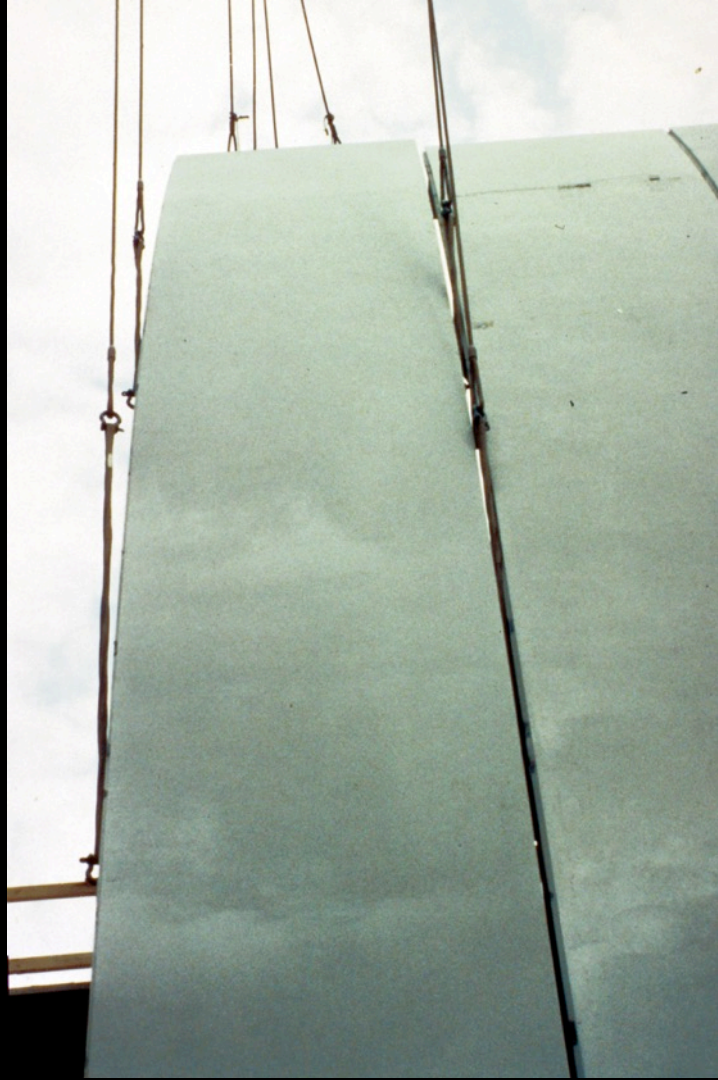


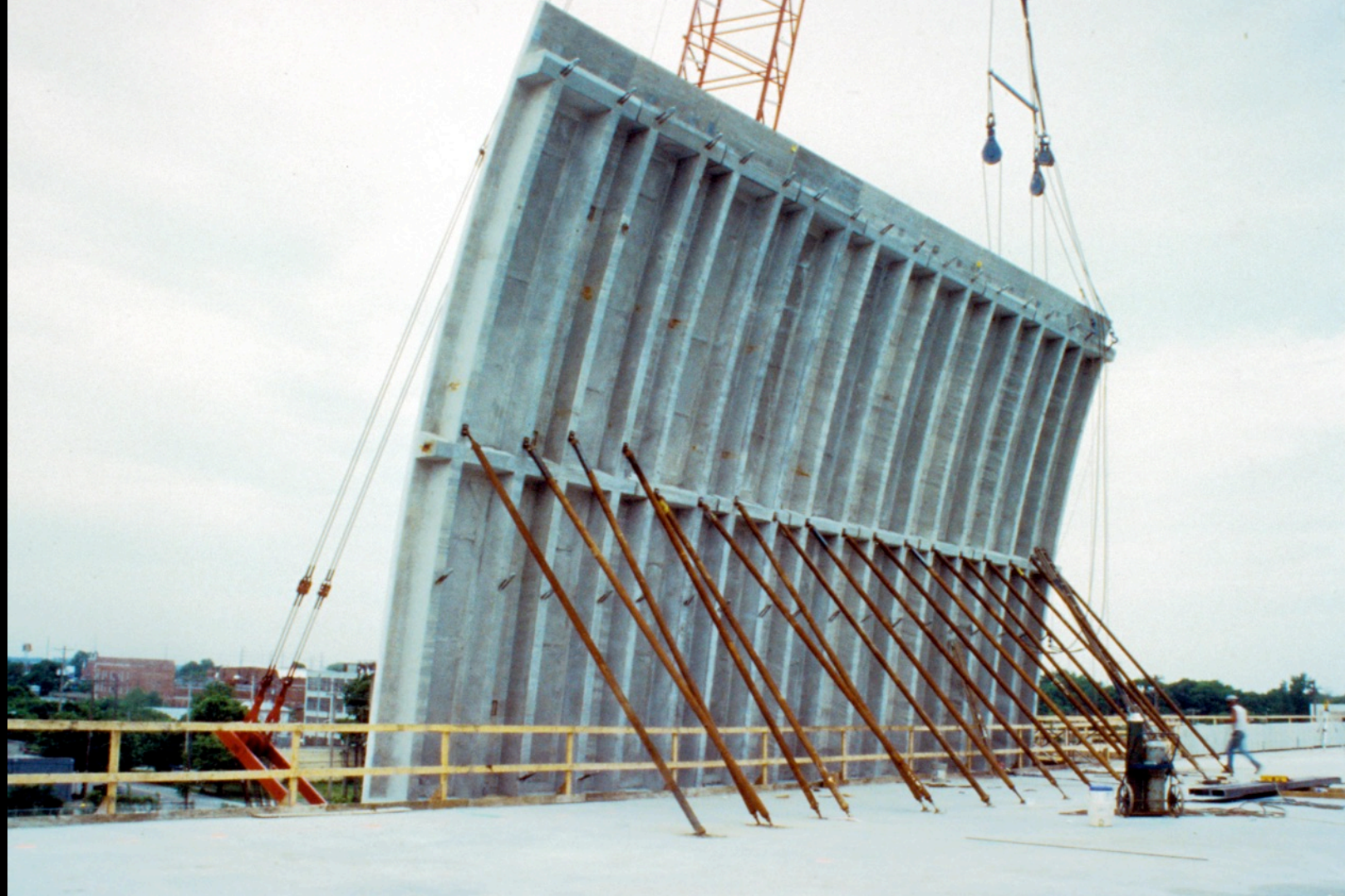




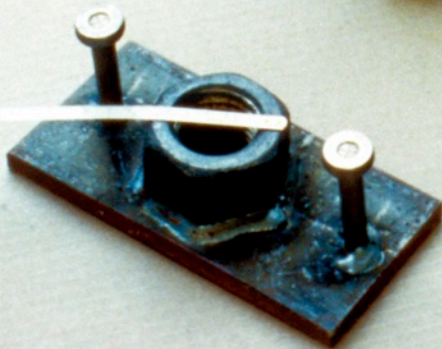
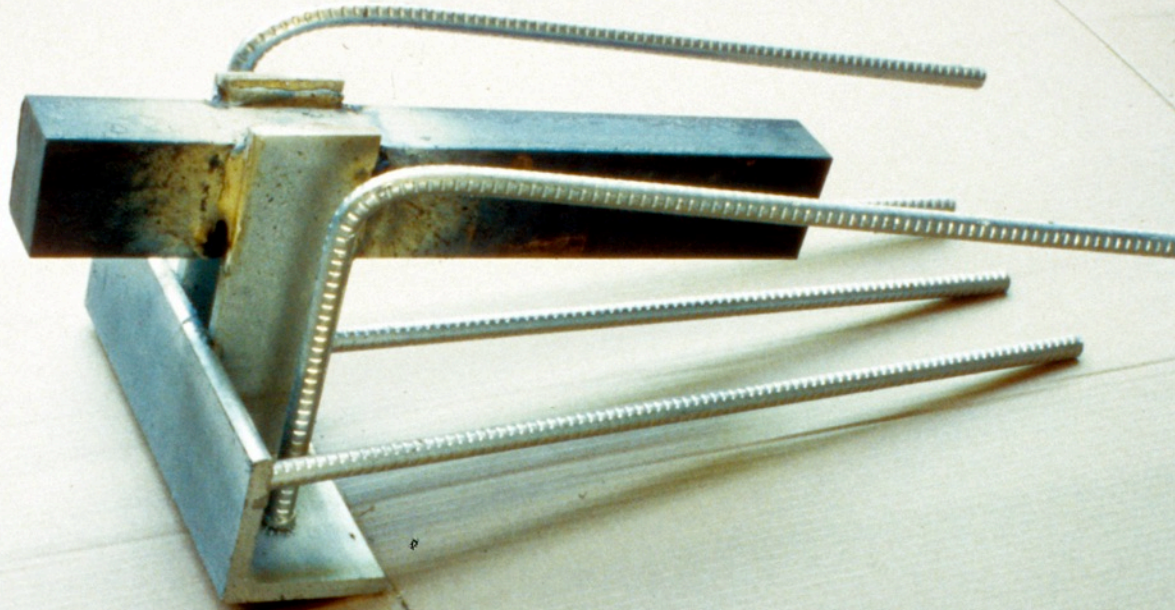


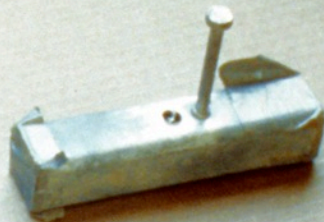
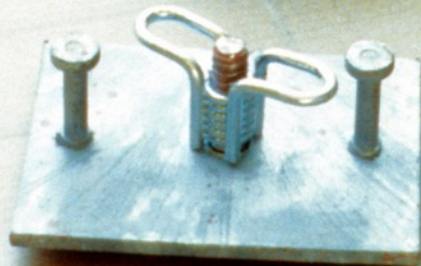
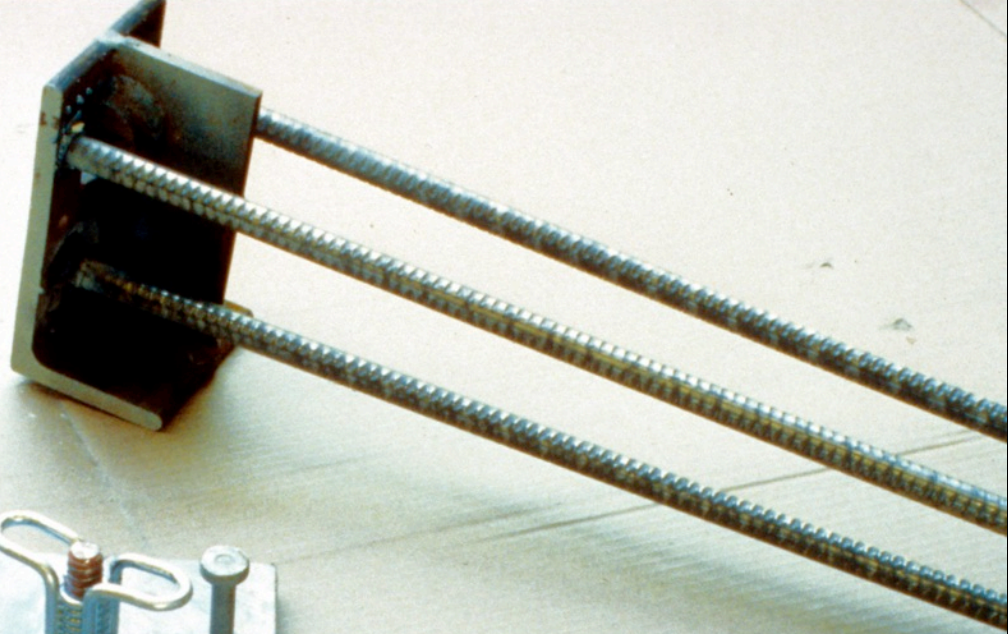


















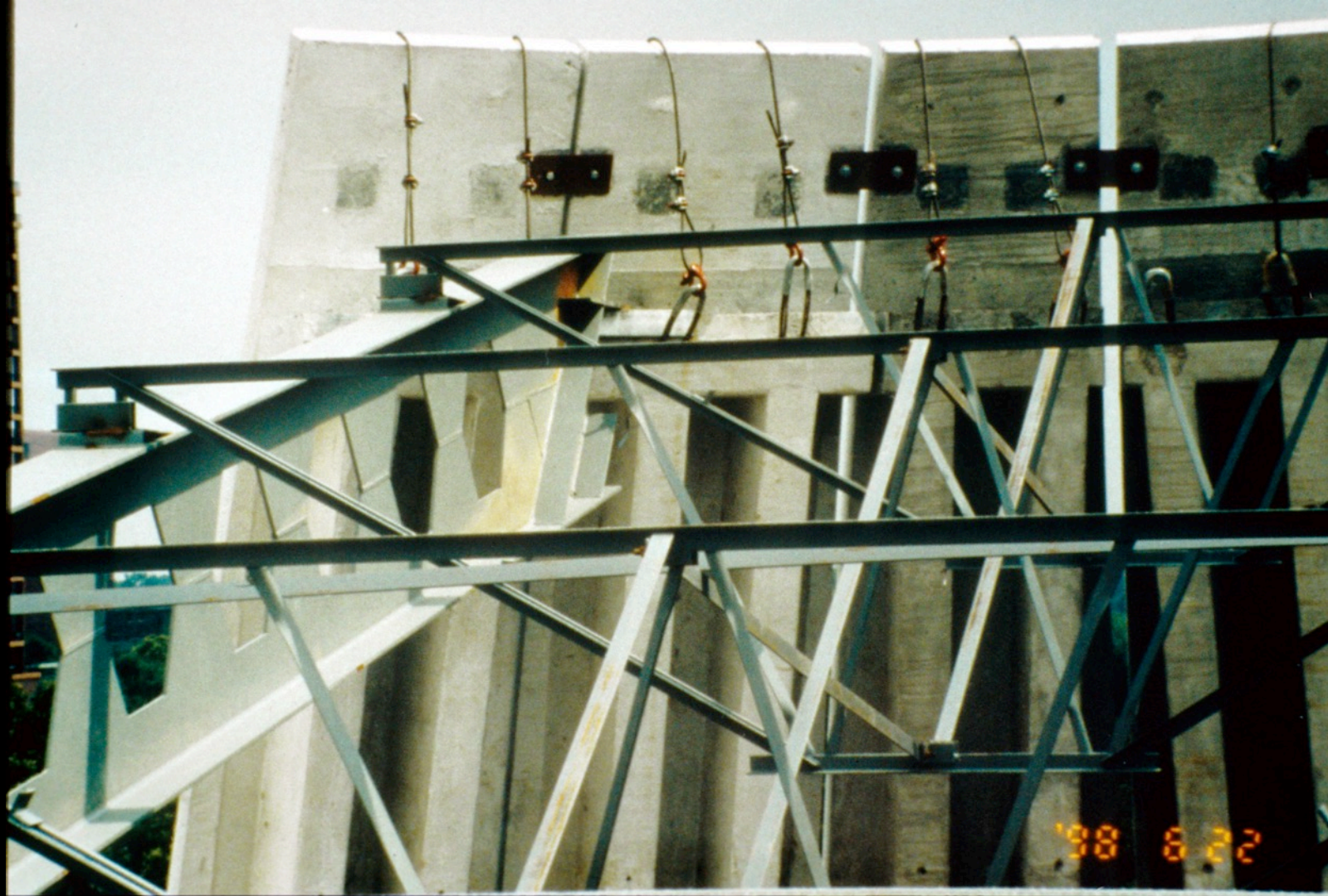




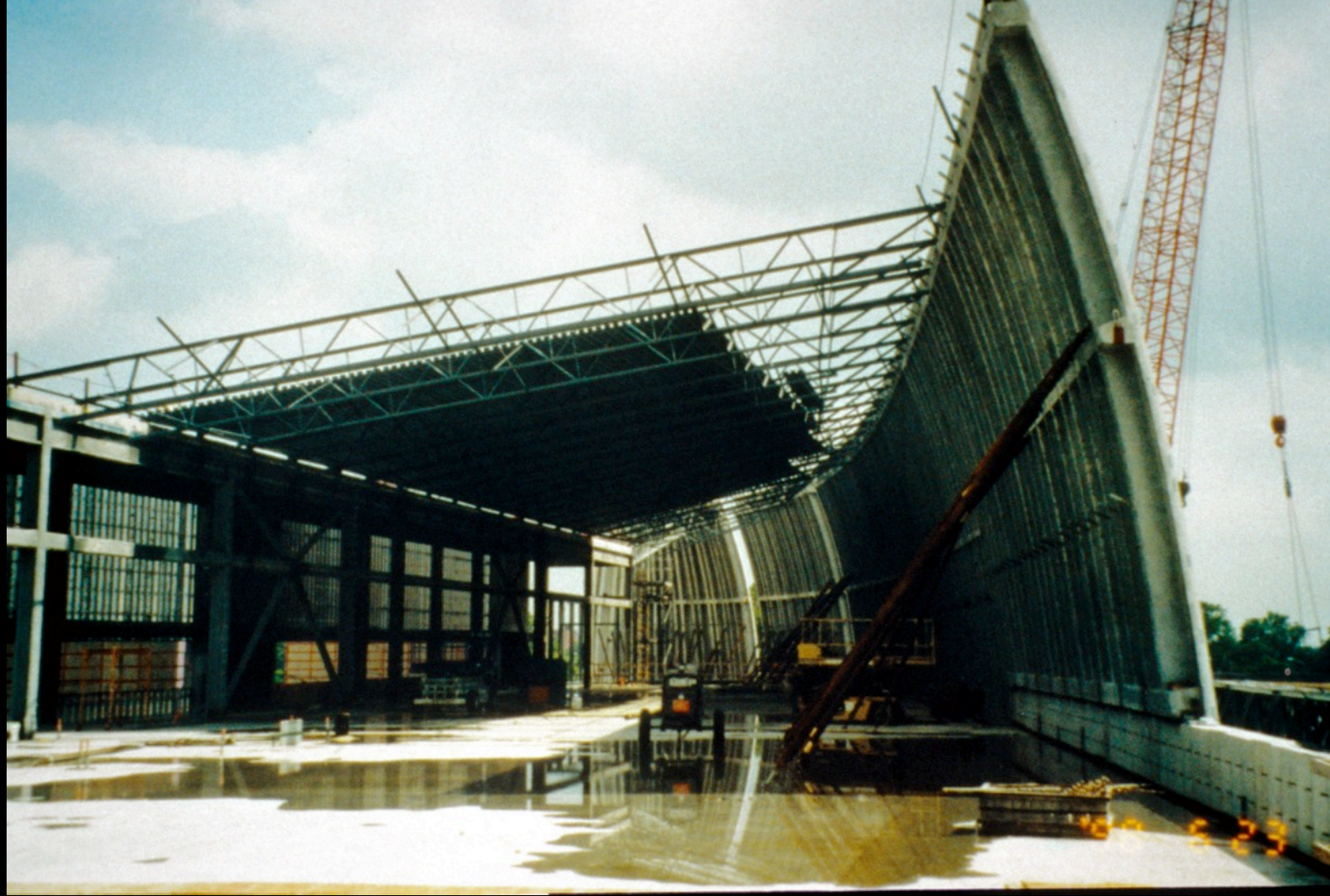
















INSERT FOR TEMPORARY SAFETY RAILING

TERMINATOR BAR

BENT PL. TO  
CHANNEL

PLATE FOR CHANNEL SUPPORT

BENT P  
CHAN

BENT PLATE

CONT. CHANNEL BY OTHERS

CHAN  
TO JO

