



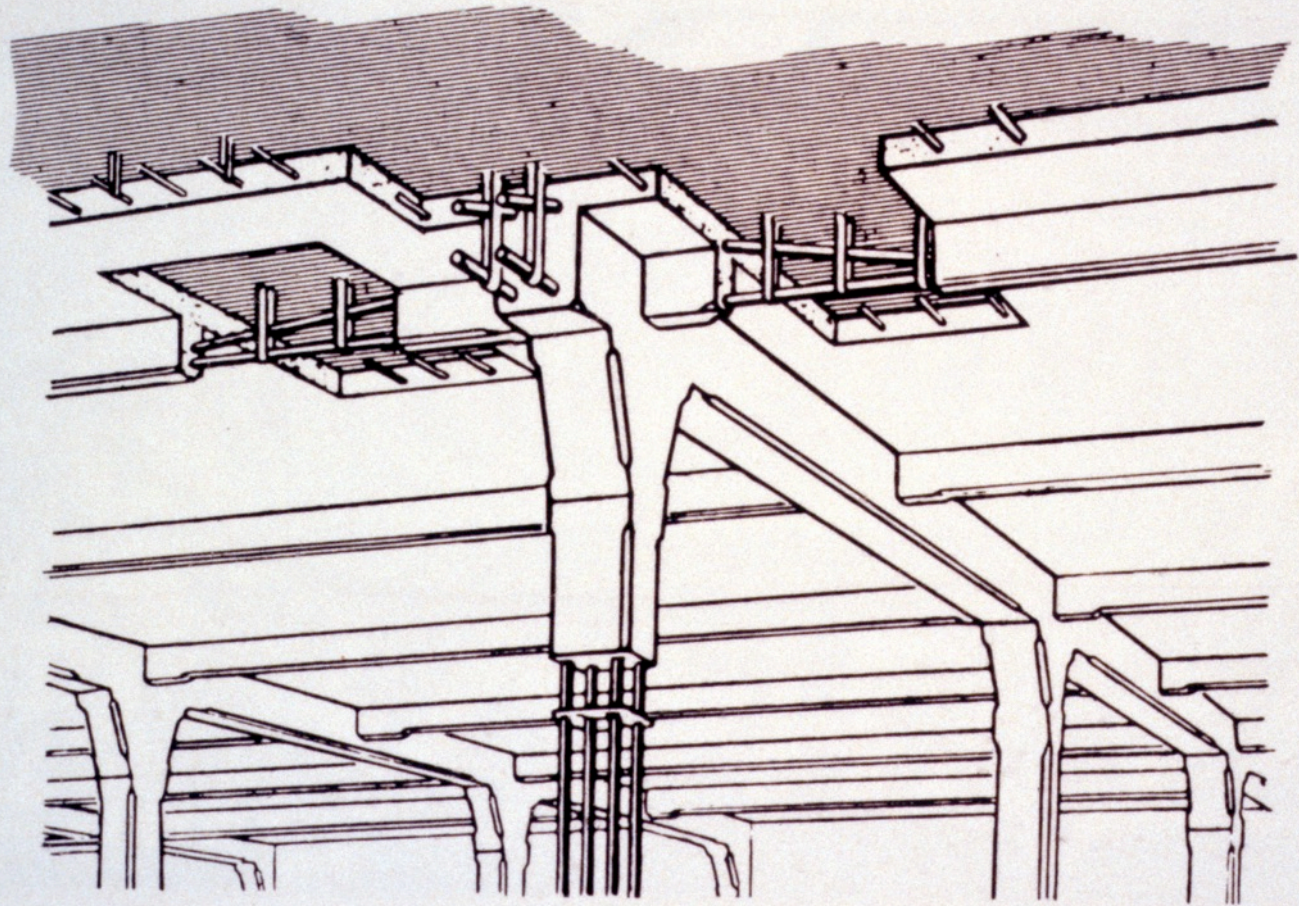
Modern Concrete Construction

Arch 173: Building Construction 2

Winter 2022

Terri Meyer Boake





16 *Hennebique, patent reinforced concrete frame construction, 1892.*















Primary ingredients of concrete:

Large aggregates

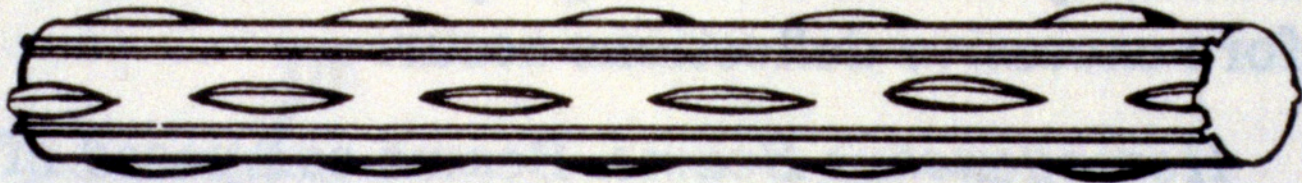
Small aggregates

Cement

Water

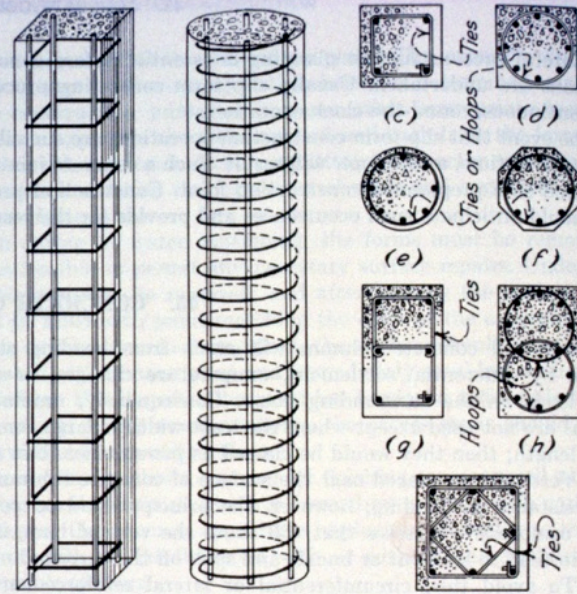


Reinforcing Steel – AKA "rebar"



Steel Reinforcing Bars
Figure 19-2

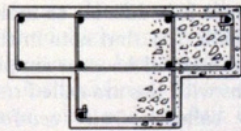
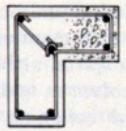
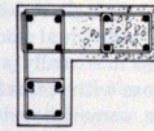




(a) Ties

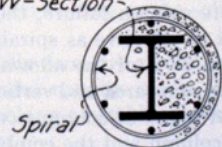
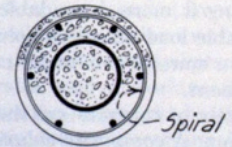
(b) Spiral

(i)



(j) Tied Corner Column

(k) Tied Wall Column
W-Section



(l) Composite Column-Cast-Iron Core (m) Composite Column-Steel Core

FIGURE 7.4 Reinforced concrete columns.

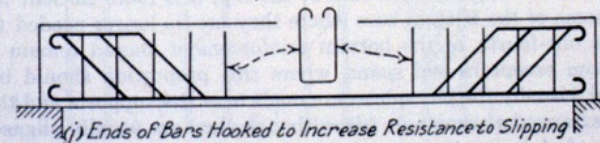
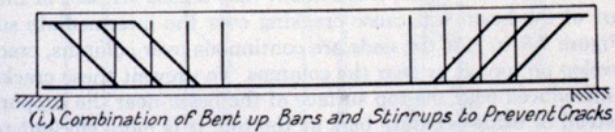
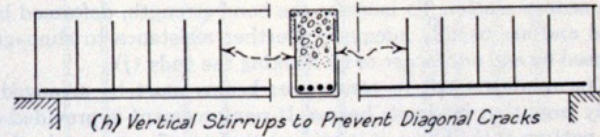
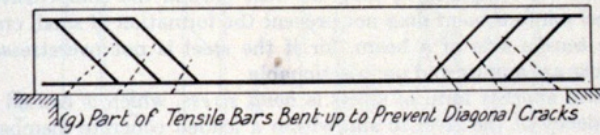
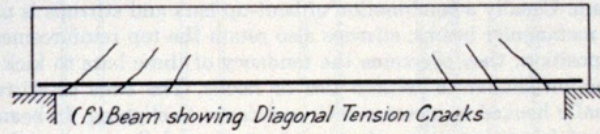
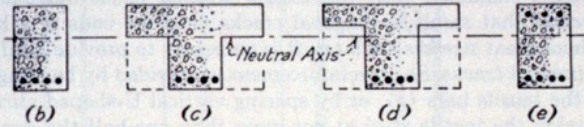
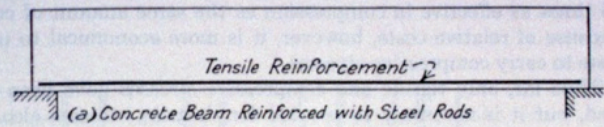


FIGURE 7.5 Simple reinforced concrete beams.

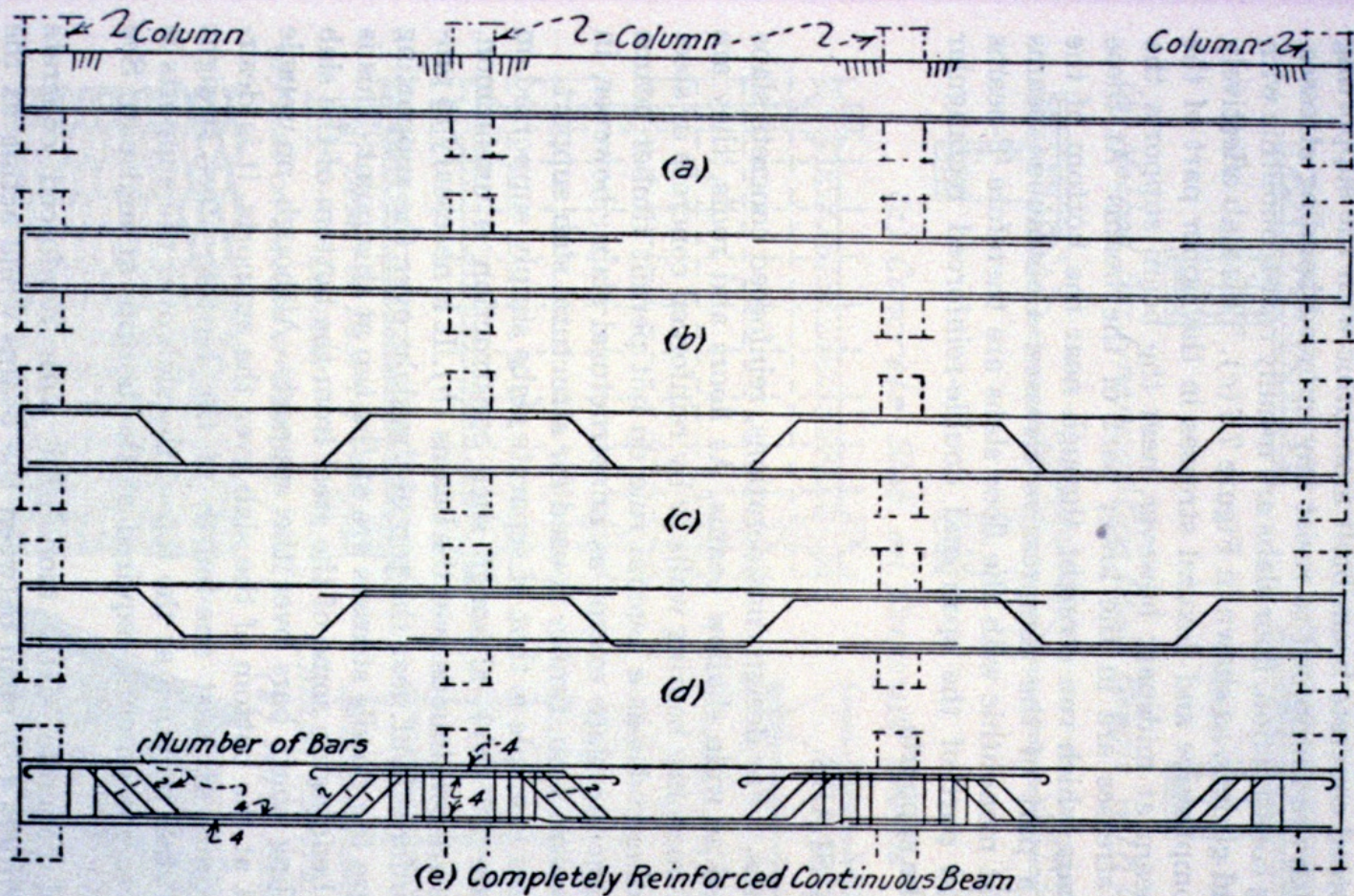
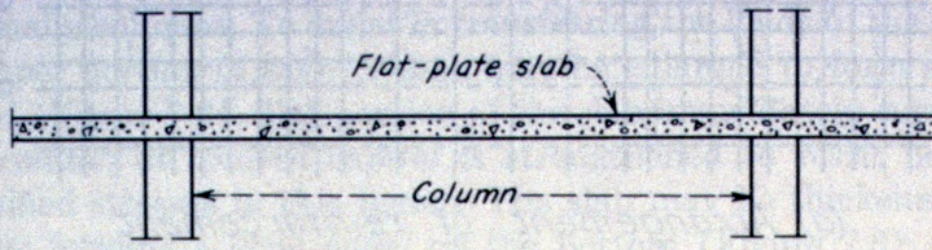
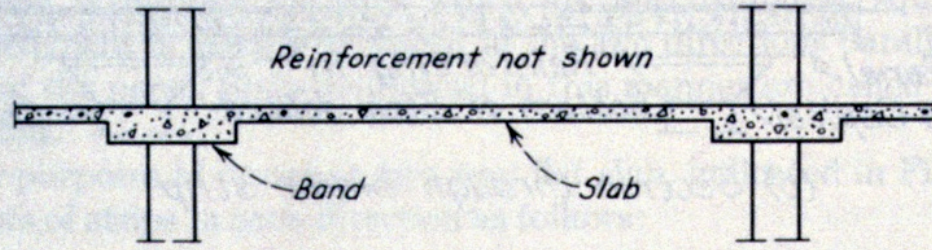


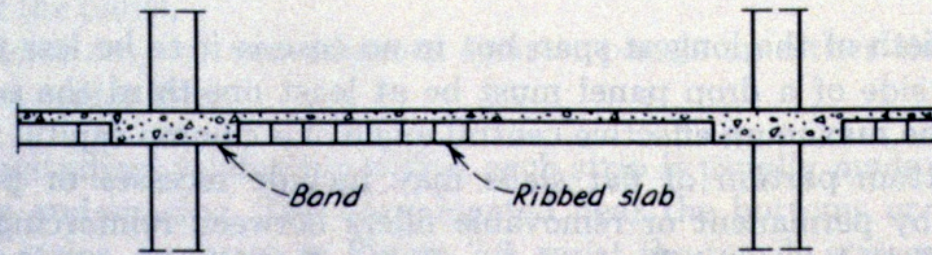
FIGURE 7.6 Continuous reinforced concrete beams.



(a) Flat-plate construction



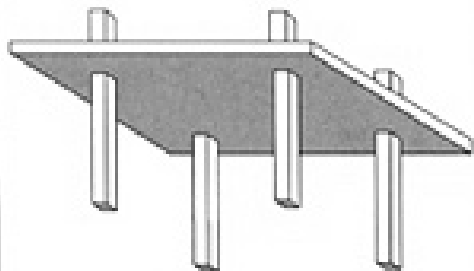
(b) Slab-band construction



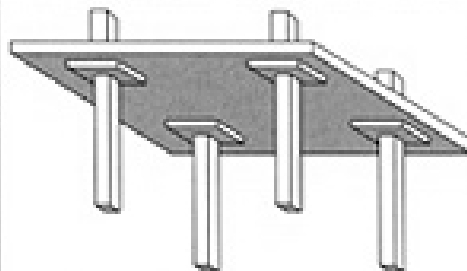
(c) Ribbed slab-band construction

FIGURE 7.9 Flat-plate and slab-band floor construction.

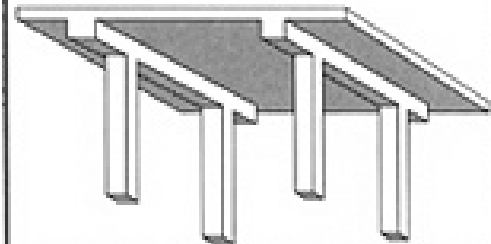
Two-Way Flat Plate



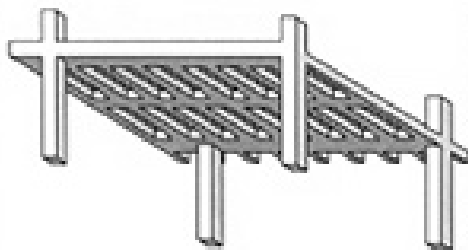
Two-Way Flat Slab with Drop Panels



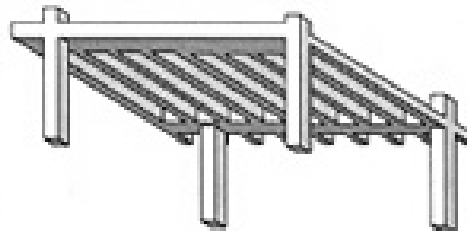
One-Way Beam and Slab



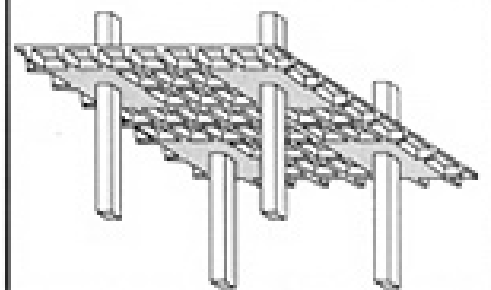
One-Way Joist Slab

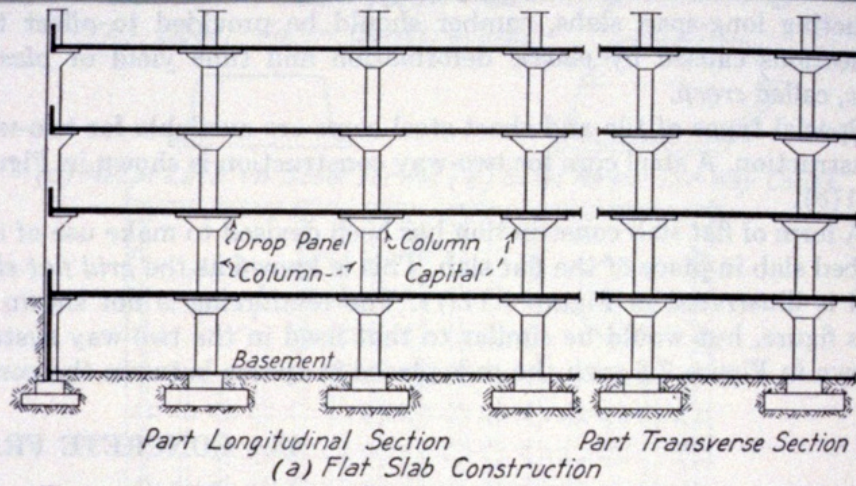


One-Way Wide Module Joist Slab

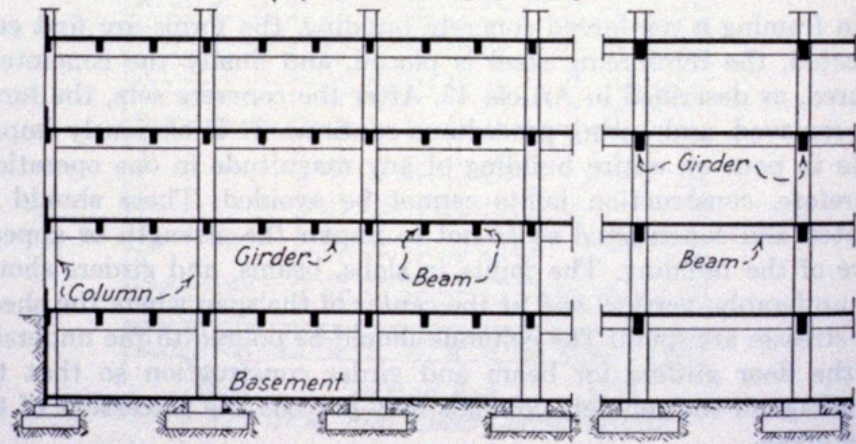


Two-Way Joist Slab (Waffle)





Part Longitudinal Section Part Transverse Section
 (a) Flat Slab Construction



Part Longitudinal Section Part Transverse Section
 (b) Beam and Girder Construction

FIGURE 7.12 Types of reinforced concrete framing.

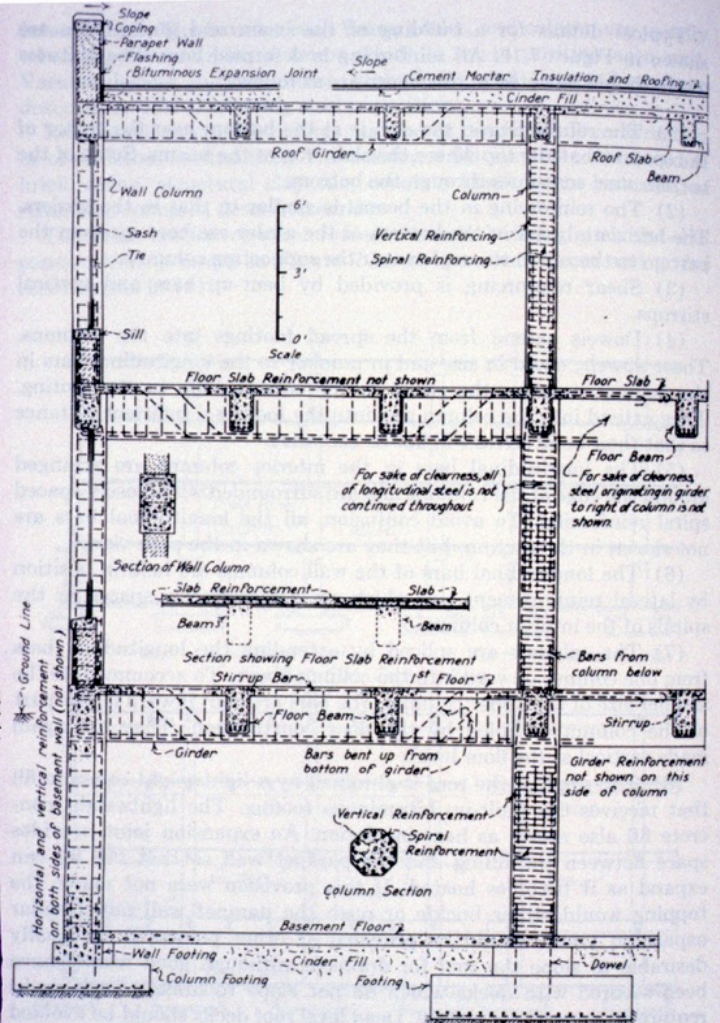


FIGURE 7.13 Beam and girder construction.

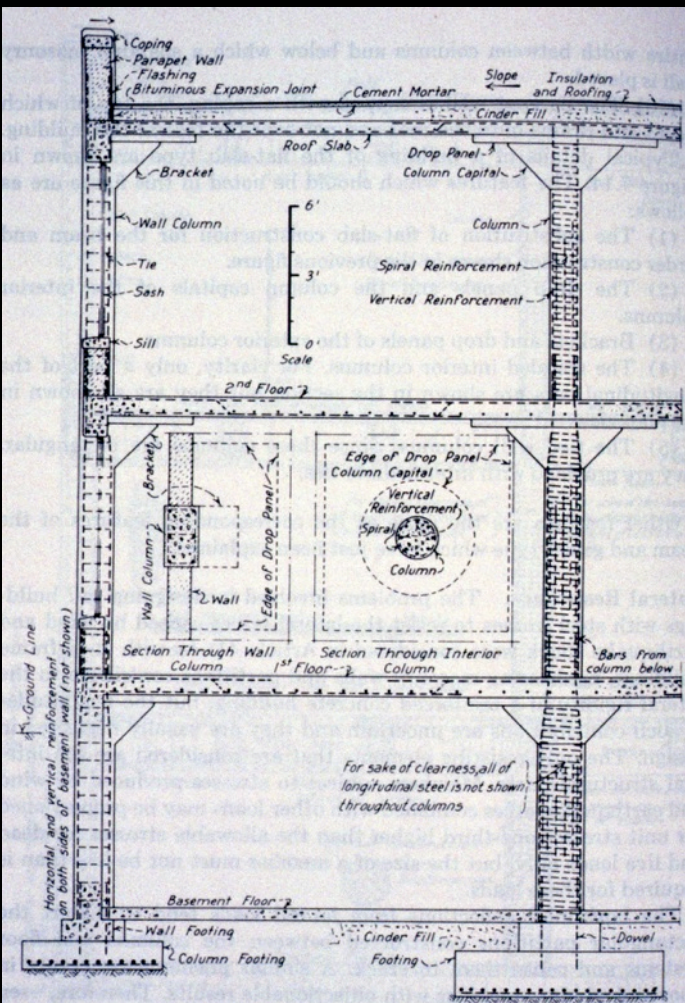
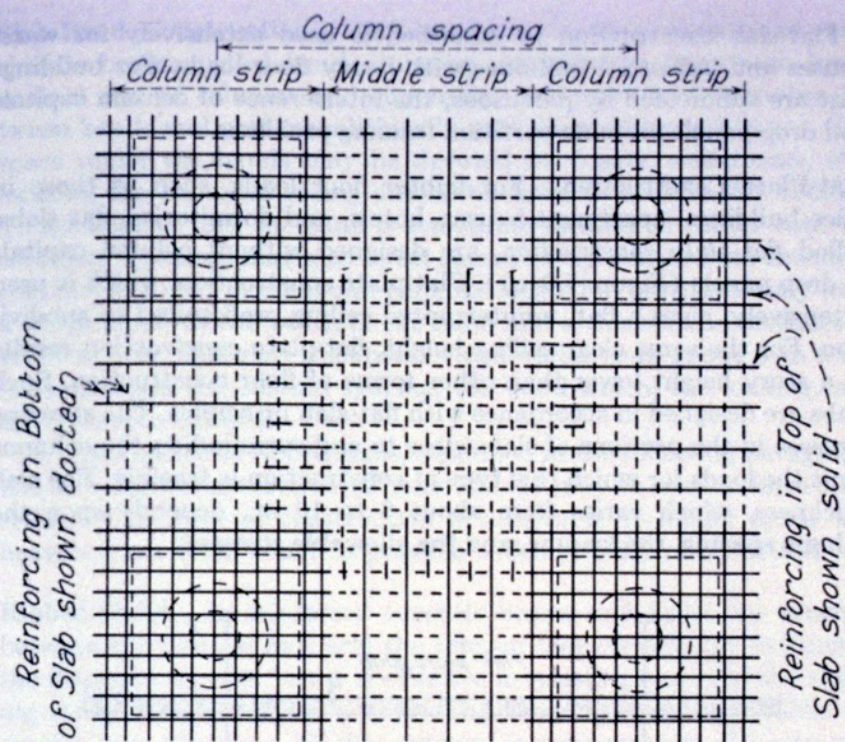
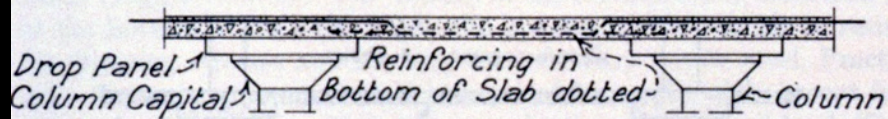


FIGURE 7.14 Flat-slab construction.





(a) Arrangement of reinforcement



(b) Section through middle strip

FIGURE 7.8 Two-way flat-slab construction.









THERMAL-BONDED POLYMER OUTER LAYER

THERMAL-BONDED GALVANIZED INNER LAYER

CONVENTIONAL REINFORCING STEEL

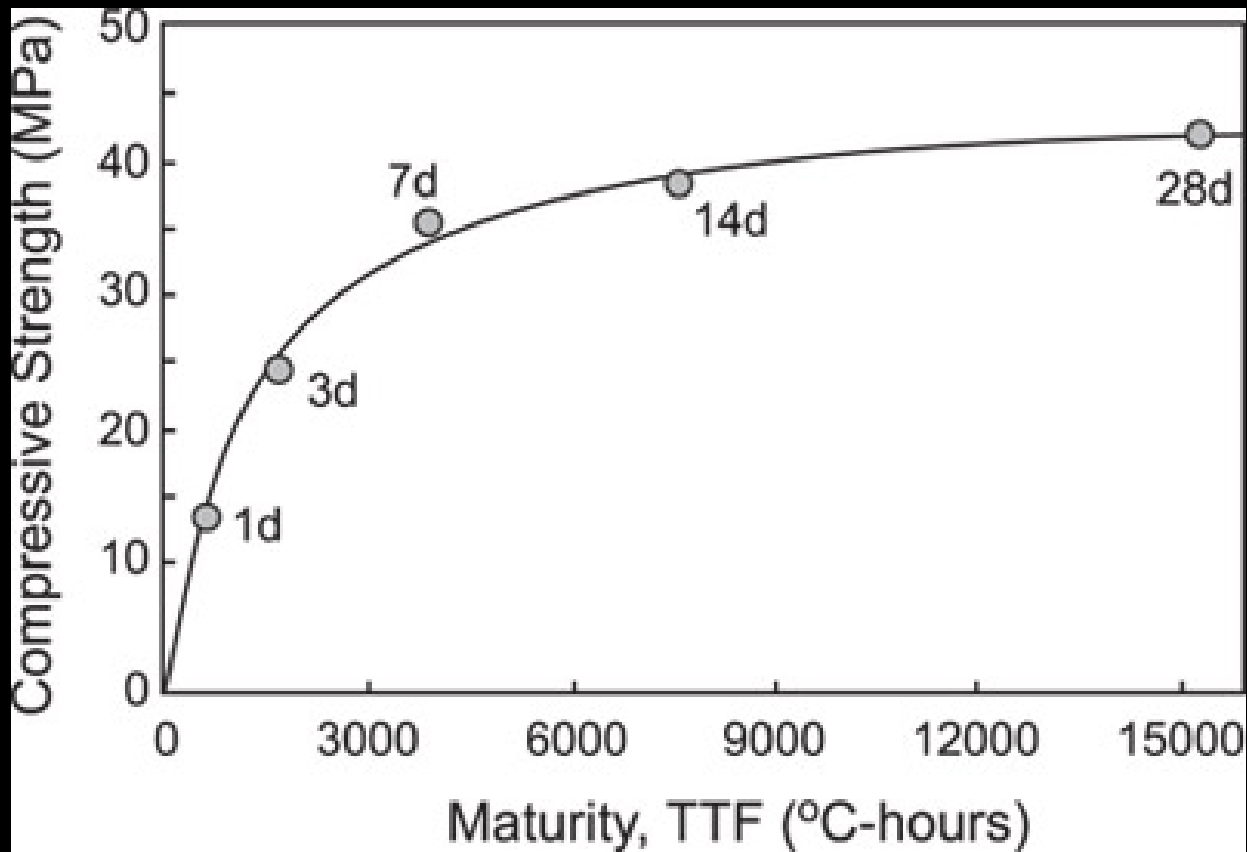
100
YEARS
Lab-Tested
Estimated Life
Expectancy

MEMBER OF
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Admixtures are materials other than cement, aggregate and water, that are added to the concrete to alter its properties:

- Workability
- Air entraining
- Curing temperatures range
- Time set
- Colour



The compressive strength of concrete improves over time



The slump test measures the workability/moisture content of the concrete

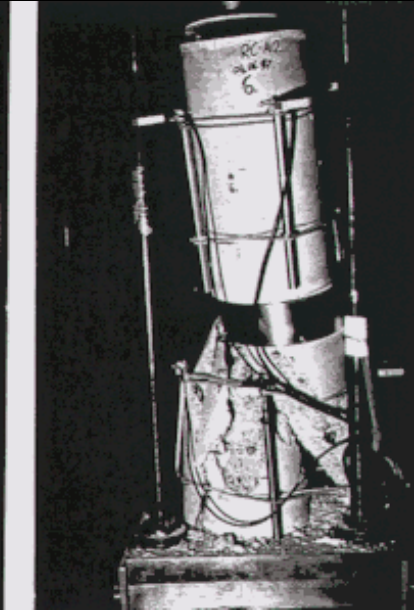
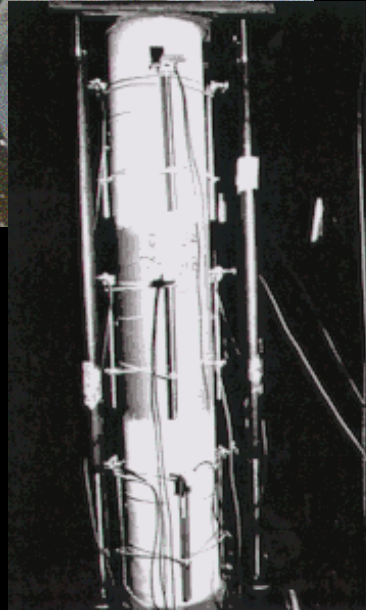


Cylinder Test is done to verify the strength of the concrete – but after it has reached its 28 day full strength.





The hardened cylinder samples are put in a test machine and crushed to the point of breaking



Concrete CREEP

Concrete continues to "cure" forever. Though its strengthening drops off to nil, it continues to SHRINK over time.

This means buildings get shorter over time.

Must detail for differential shrinkage with cladding materials.

The need for and design of
FORMWORK is a unique aspect
of concrete construction.

Impacts the time to construct
and cost of the project.

Form Tie System (Wall Forming Fastener)

FT-07 ϕ 3/8"

Tie Bolt, Nut, Cone-P, Separator, Rubber Washer



FT-07 ϕ 1/2"

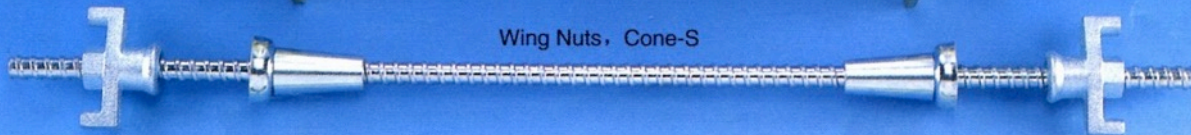
Tie Bolt, Nut, Cone-P, Separator, Rubber Washer



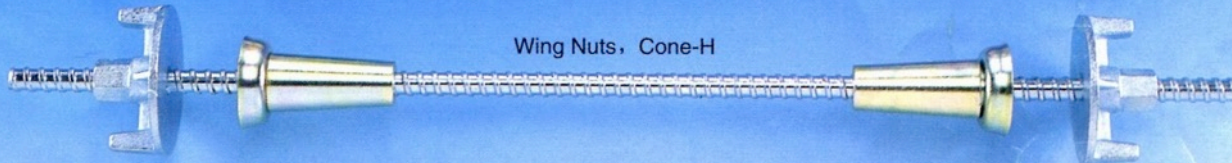
Wing Nuts, Water Stop (WS-68)



Wing Nuts, Cone-S



Wing Nuts, Cone-H

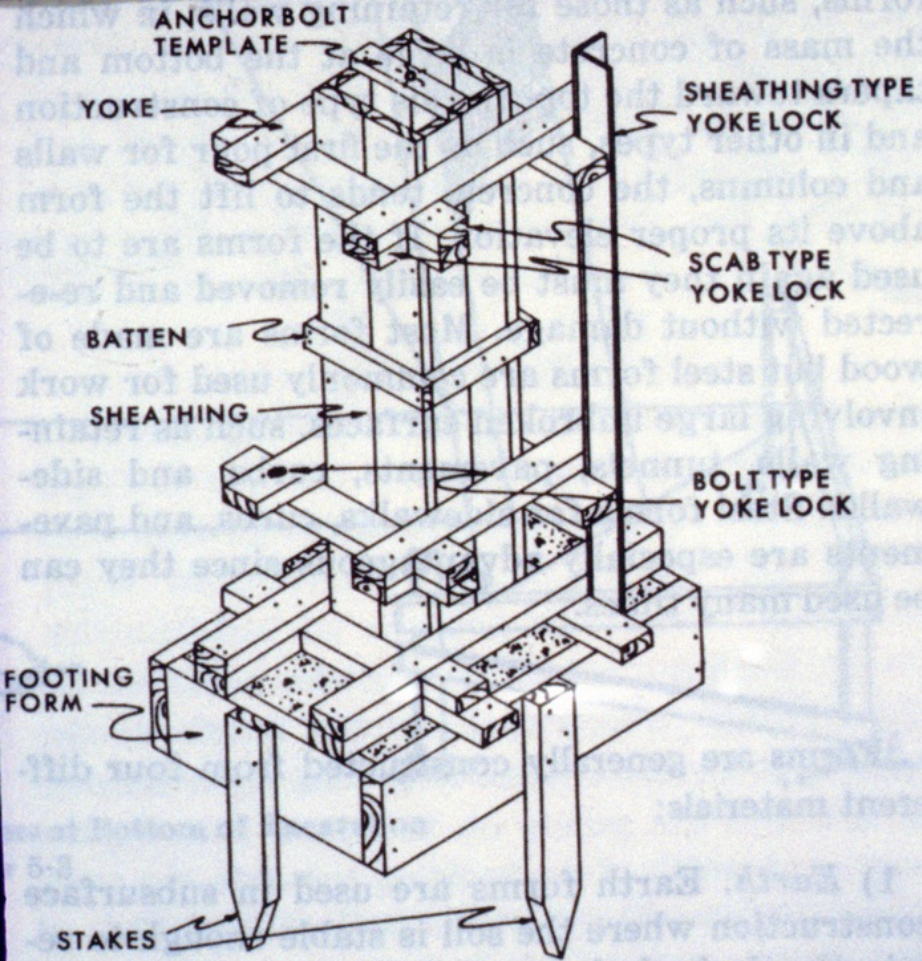




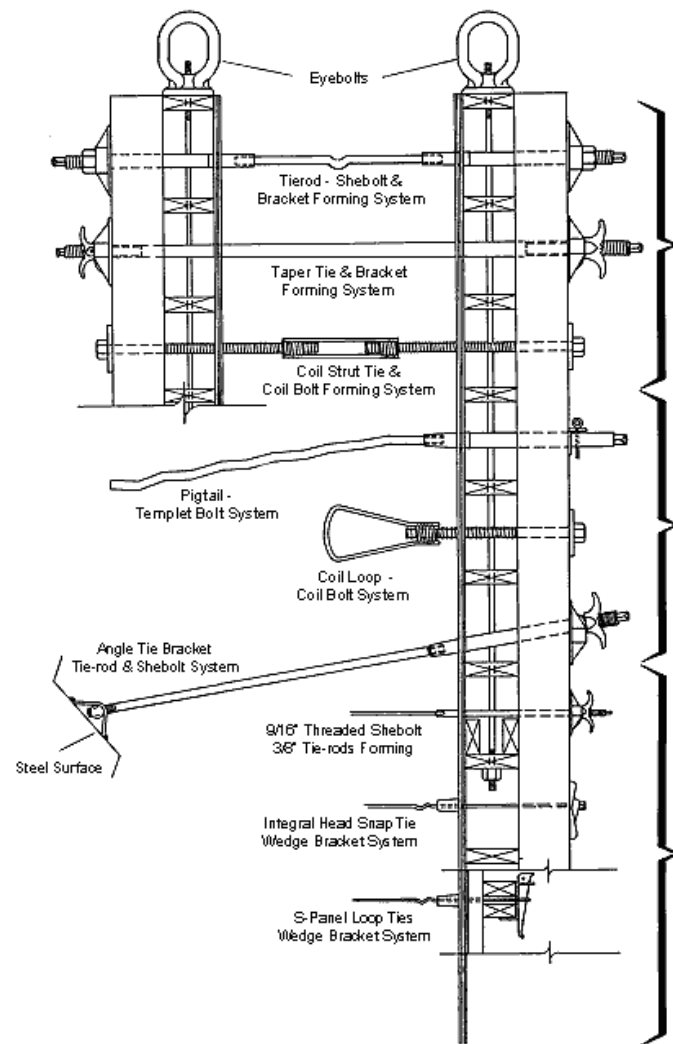


Insulated concrete forms for cold weather pouring at Skydome (Rogers Centre) Toronto

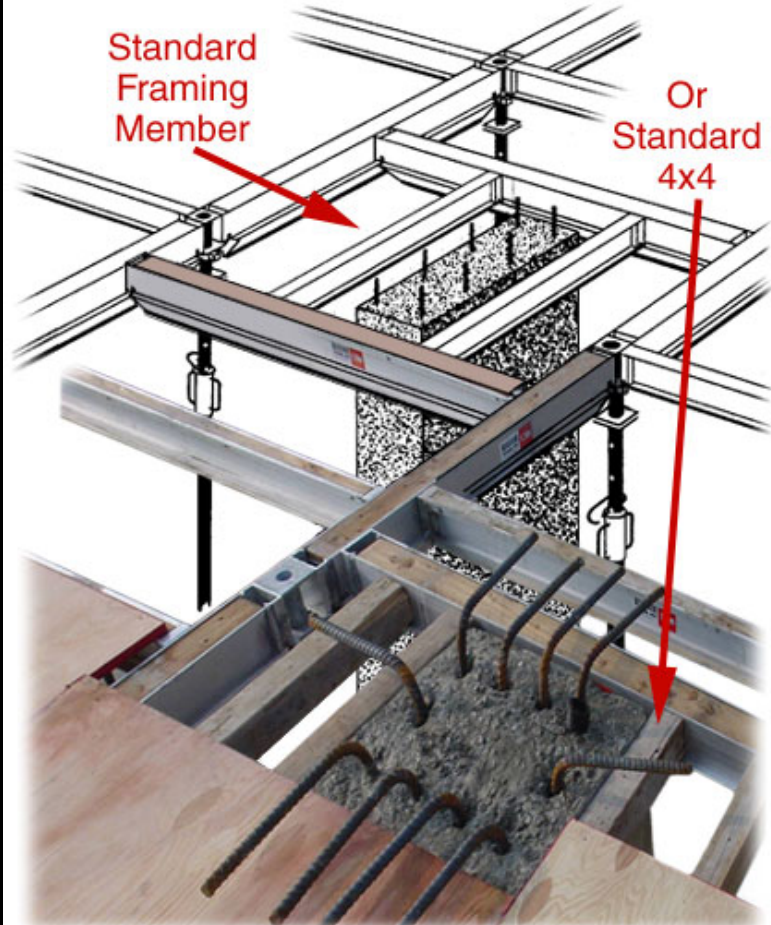




Form for a concrete column
Figure 6-2

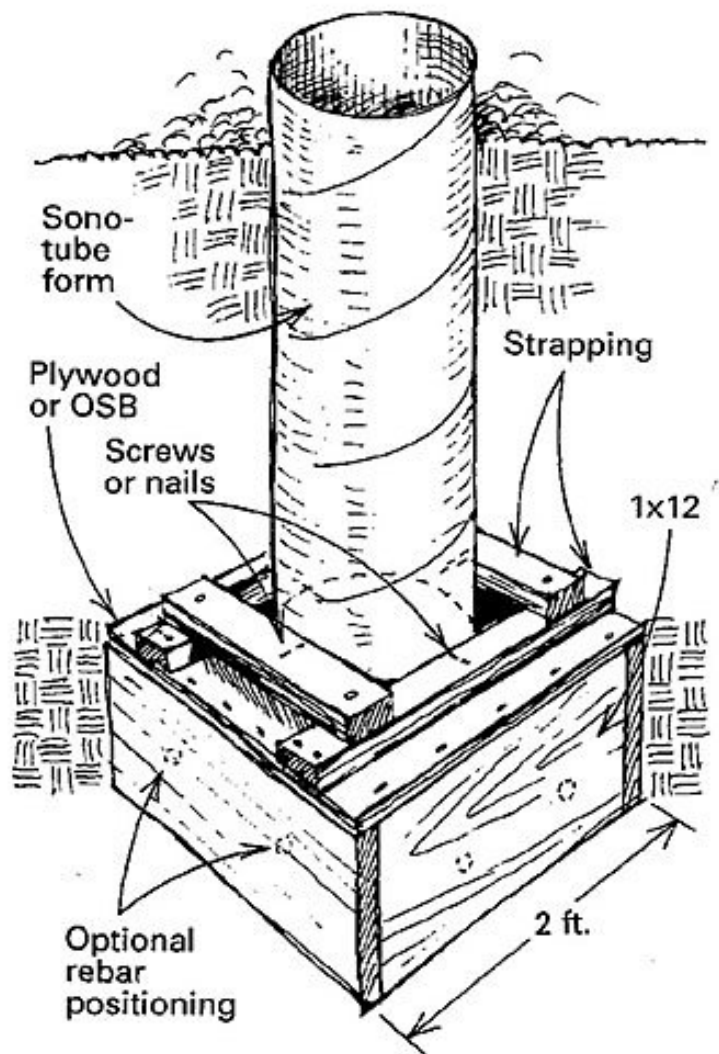


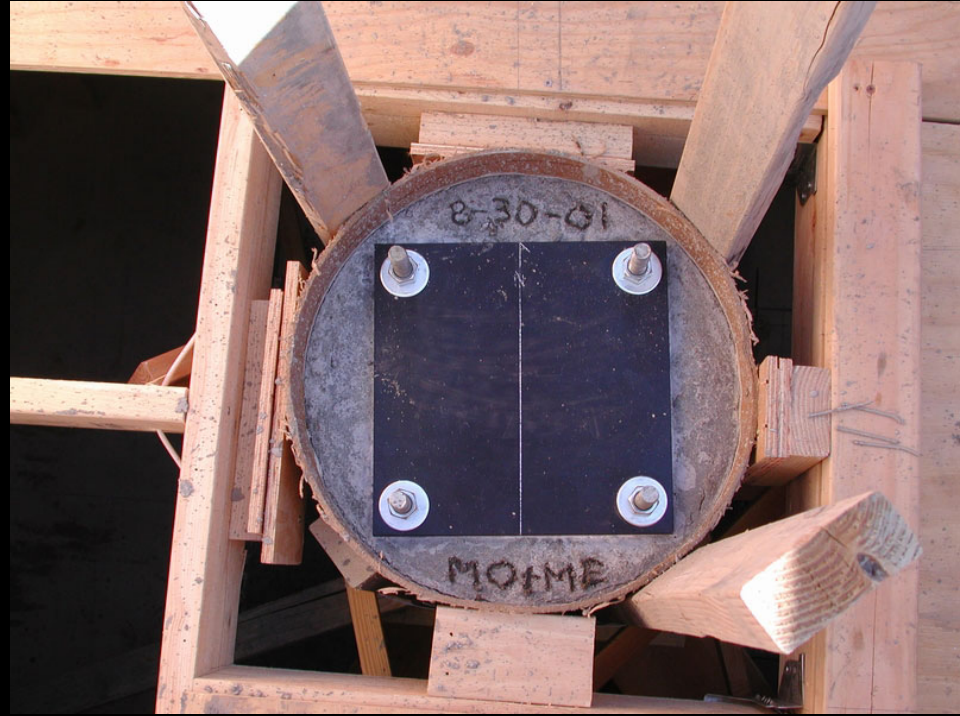
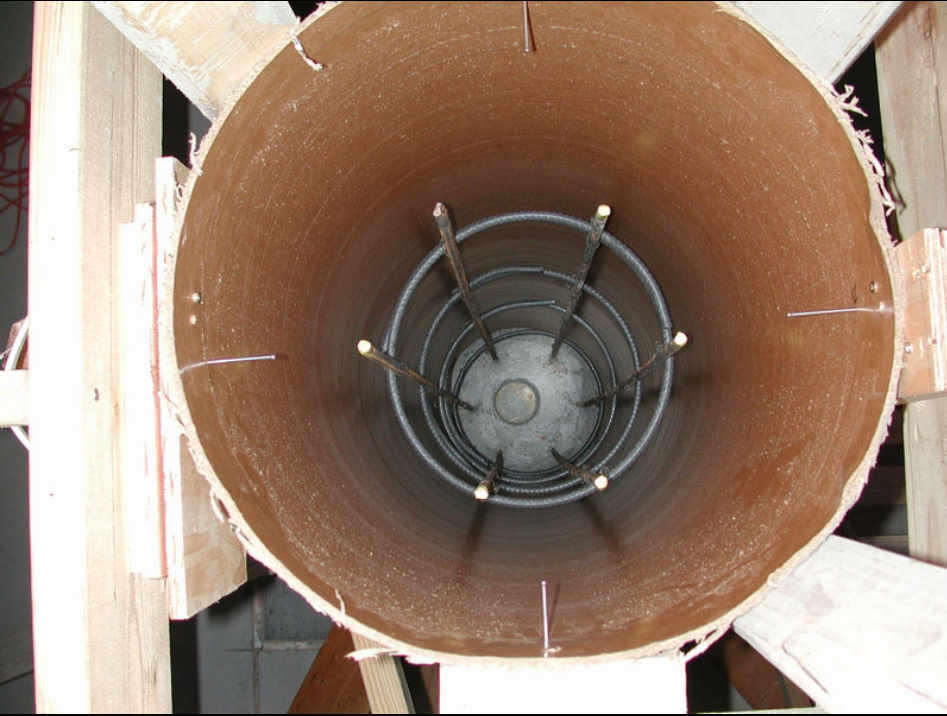
Fast & Simple Framing Around Columns and Walls.

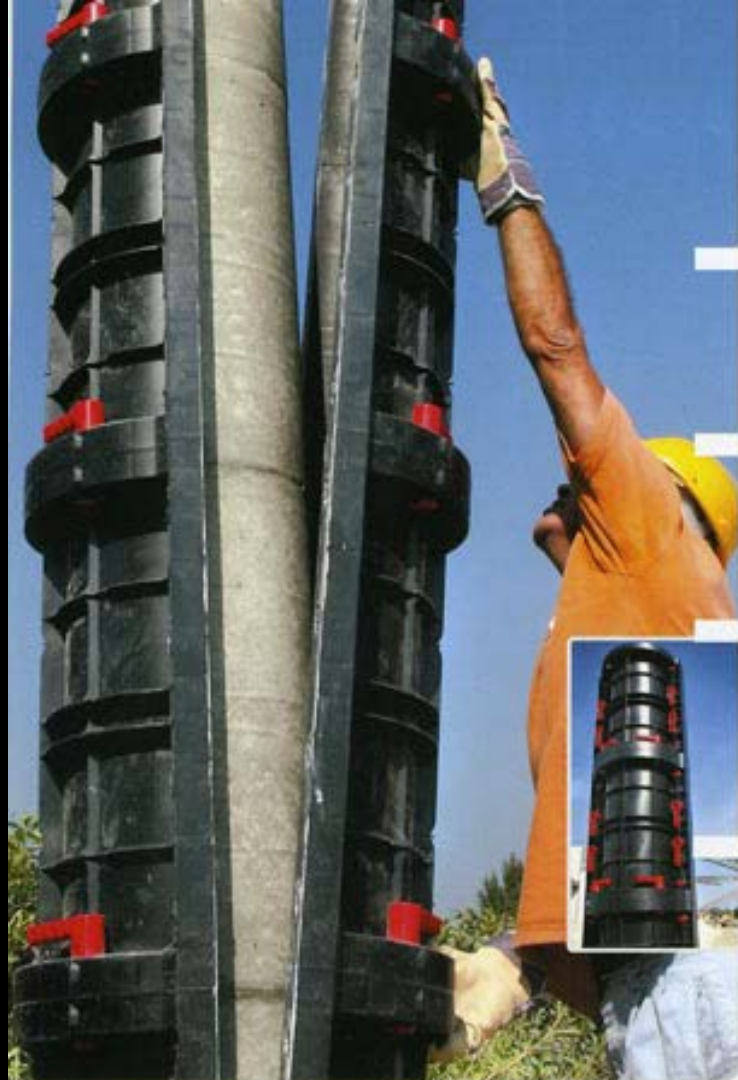


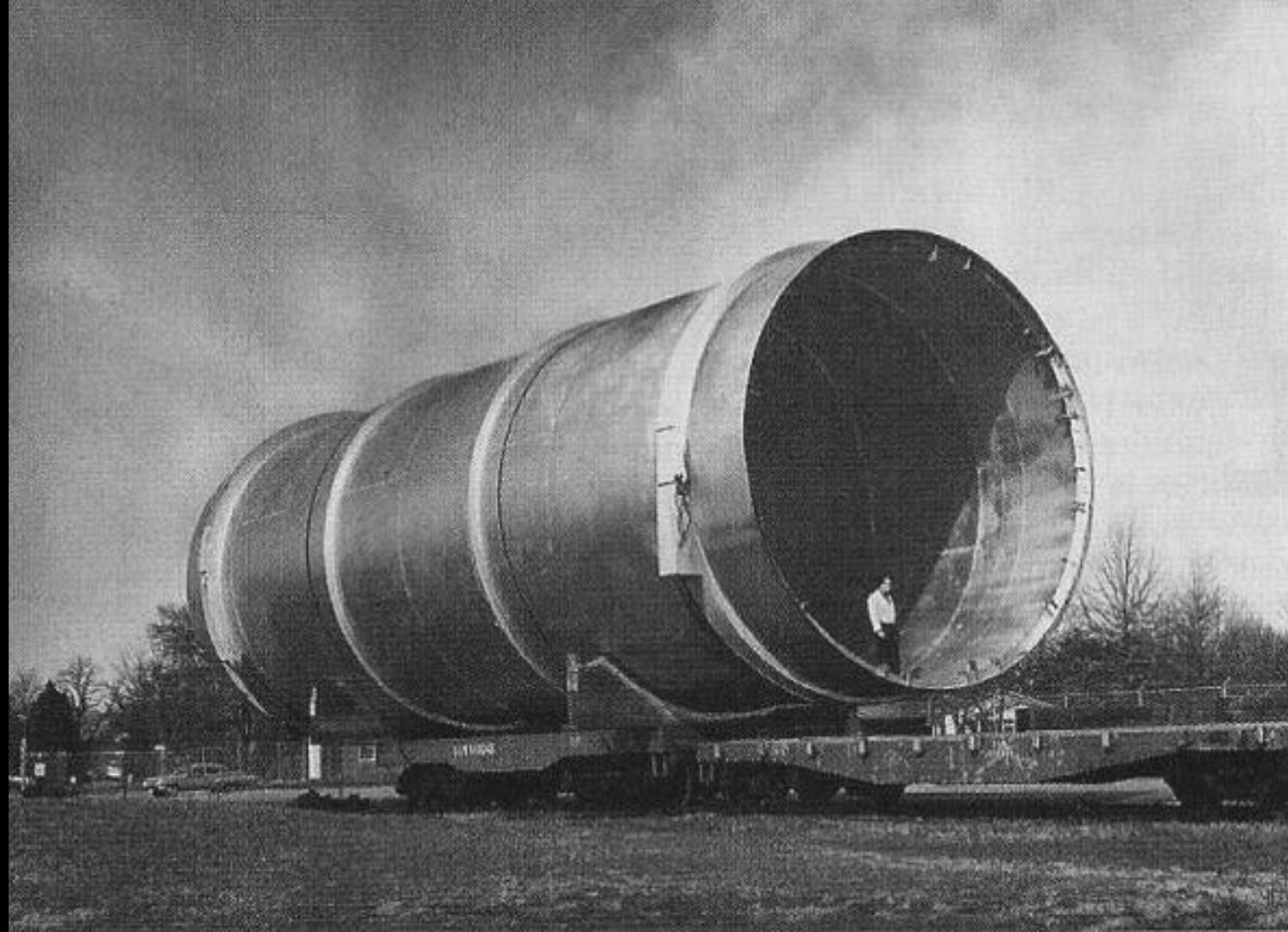
Sonotube forms











Reusable Metal Forms

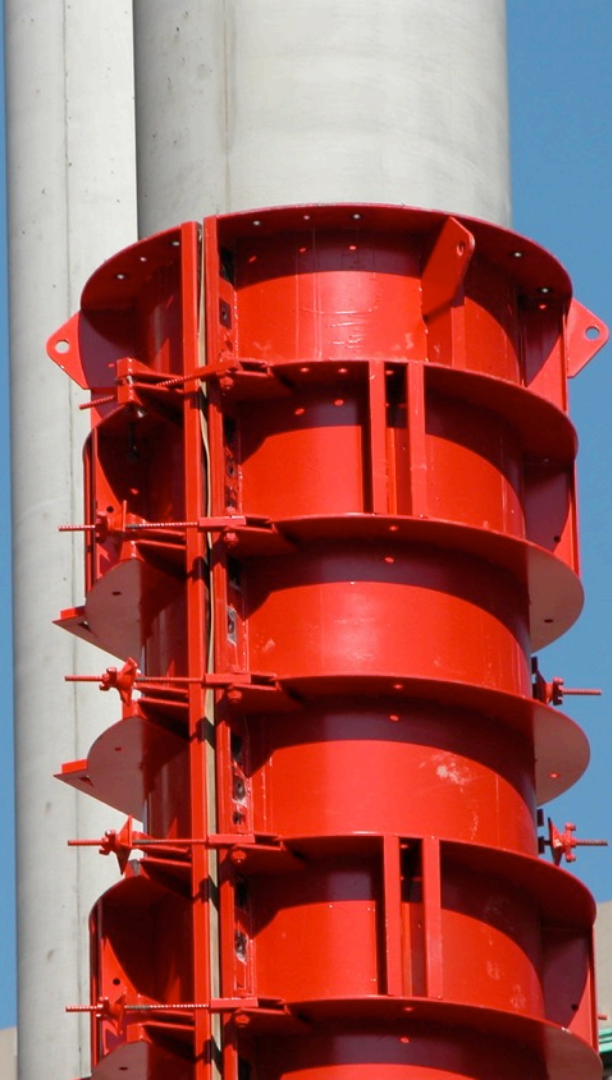
















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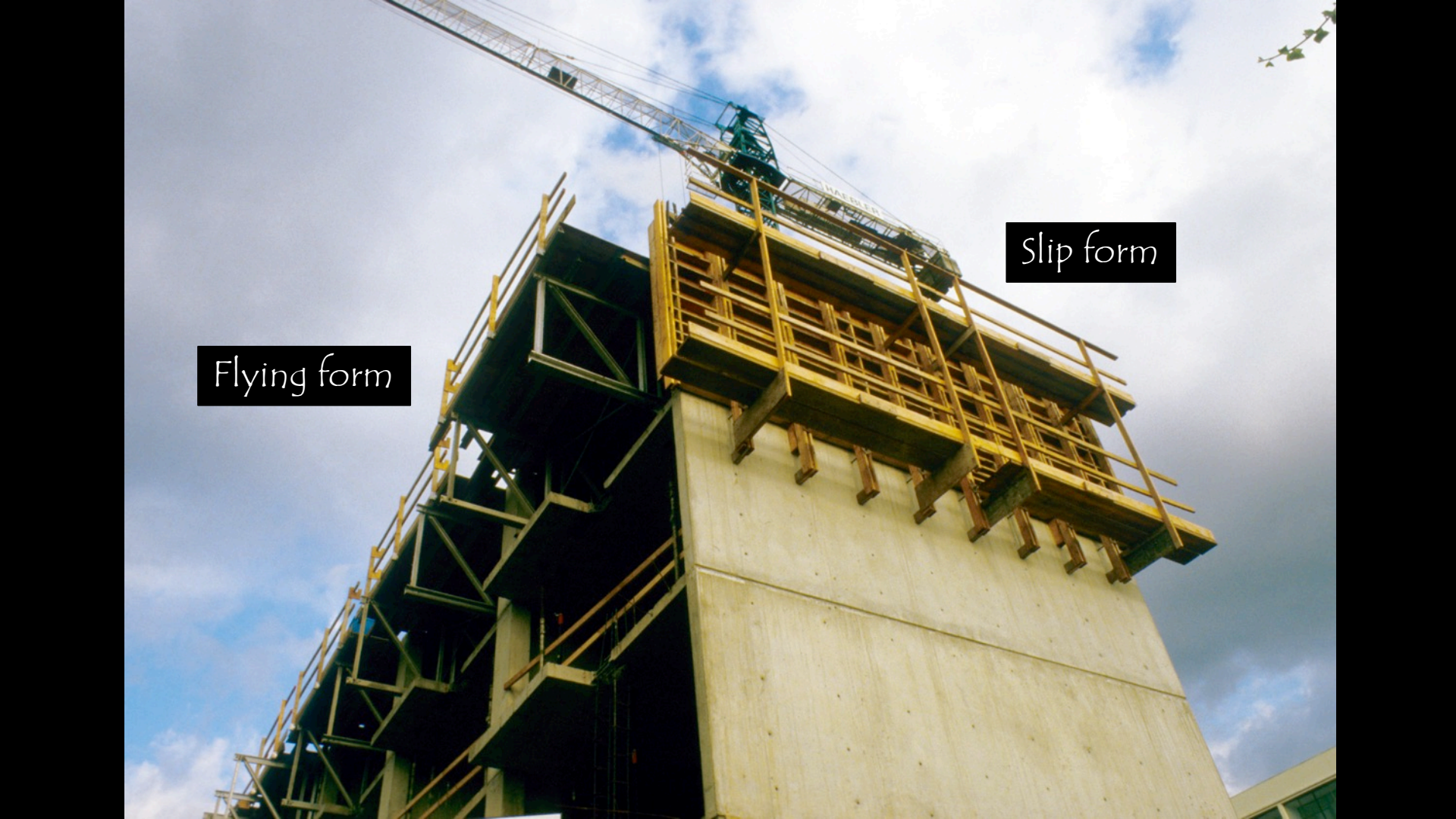
5M2





Slip forms, as this name suggests, is a sliding-form construction method of supporting the pouring of concrete structures. Slip forms are pulled along horizontally or raised vertically as concrete is placed.





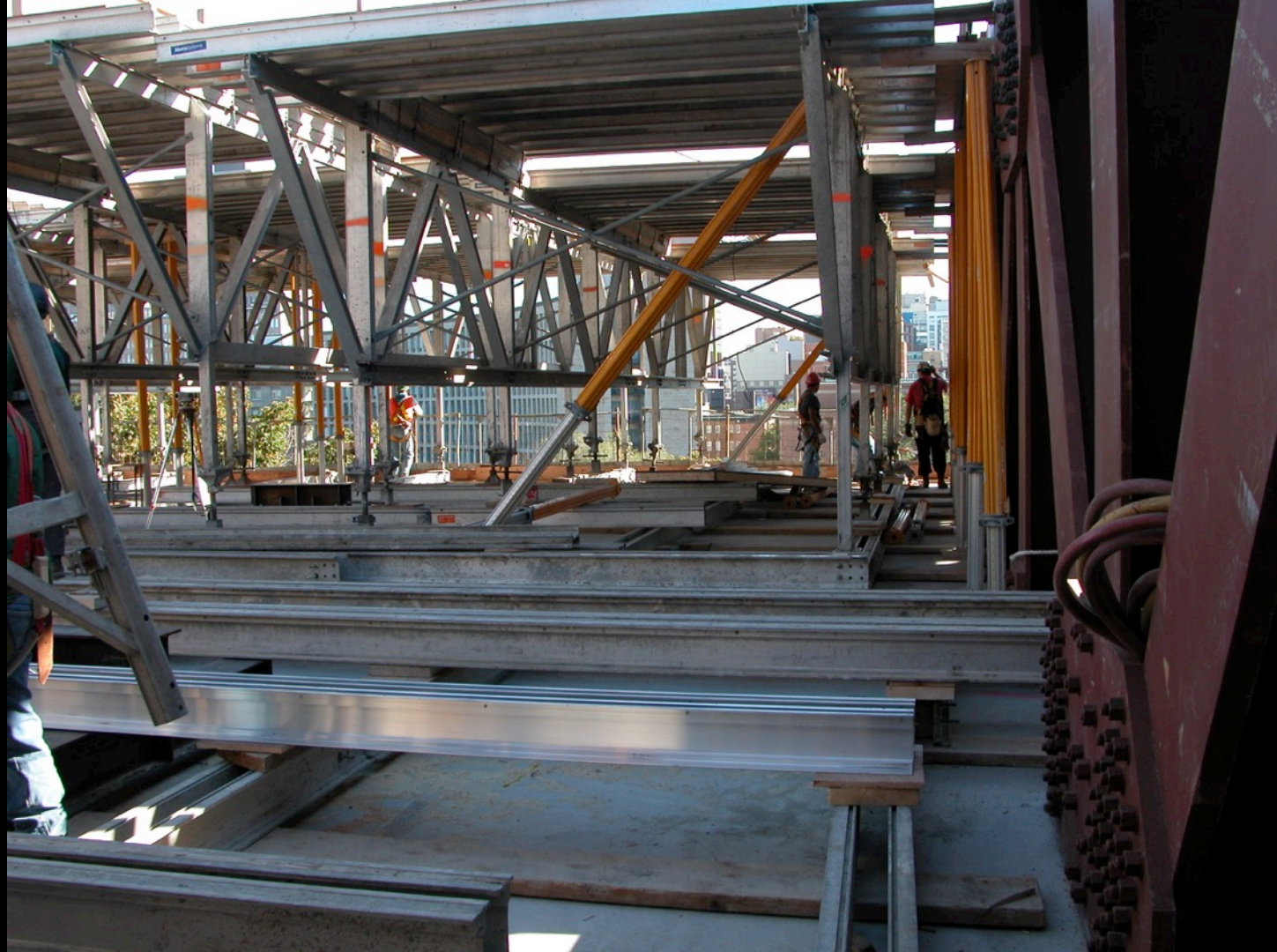
Flying form

Slip form

Flying forms











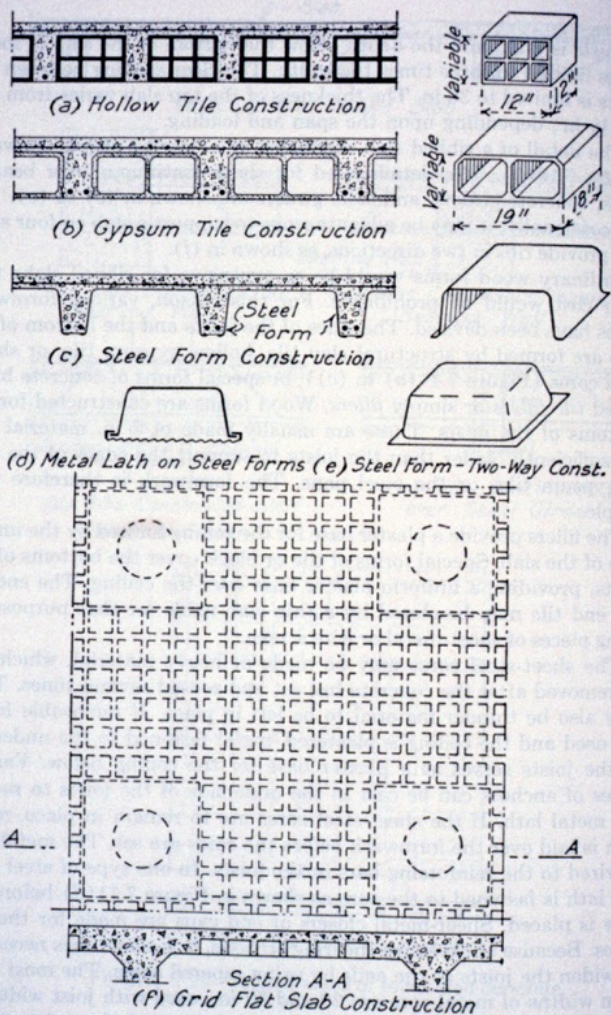


FIGURE 7.11 Cores for ribbed slabs and grid flat-slab construction.

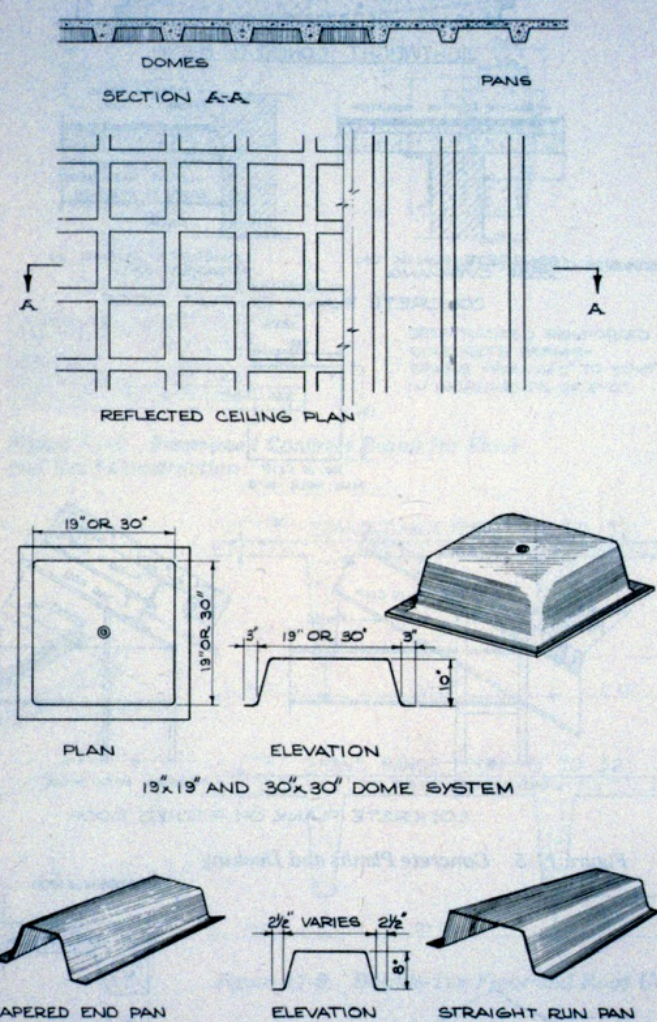
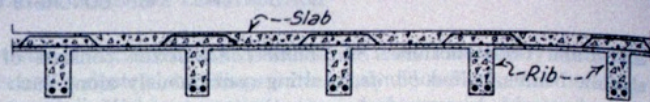
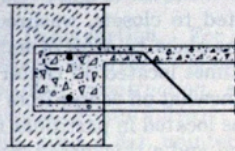


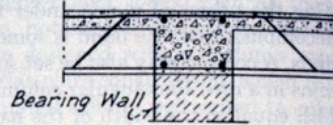
Figure 11-3. Steel Domes and Pans



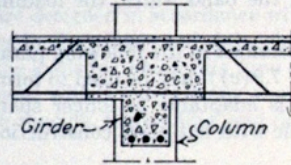
(a) Concrete Ribbed Slab



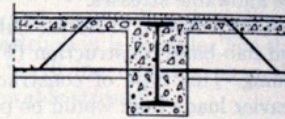
(b) Ribs Supported on Bearing Wall



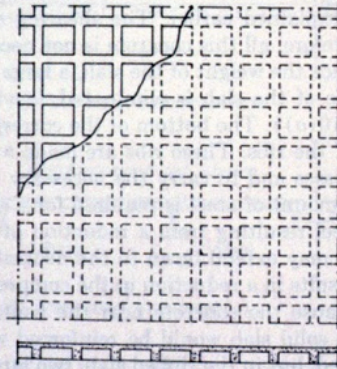
(c) Ribs Continuous over Bearing Wall



(d) Ribs Continuous over Concrete Girder



(e) Ribs Continuous over Steel Girder



(P) Two-Way Rib Construction

FIGURE 7.10 Ribbed slabs of reinforced concrete.







Exit to D



Exits to
Maryland
L'Enfant

THIS EXIT IS CLOSED ON
SATURDAYS AND SUNDAYS.
PLEASE USE THE EXIT AT
7th and MARYLAND AVENUE OR
9th AND D STREETS.





Composite decks use the combined strength of steel decking, reinforcing and the concrete slab

The steel deck acts as a permanent form as well as adding strength

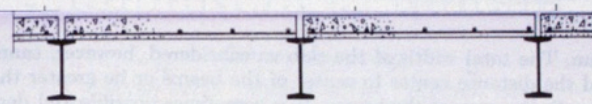




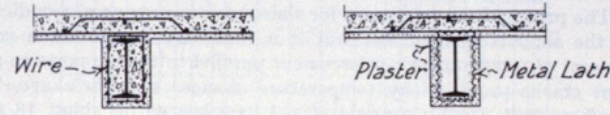




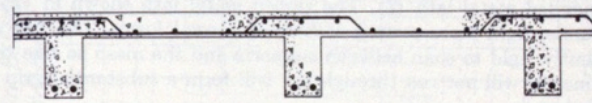




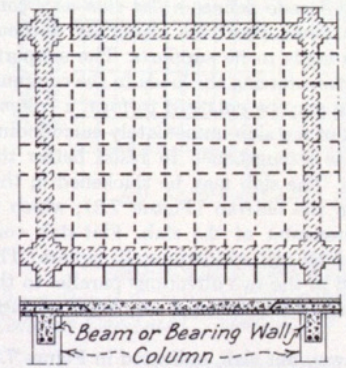
(a) Concrete Slab on Steel Beams



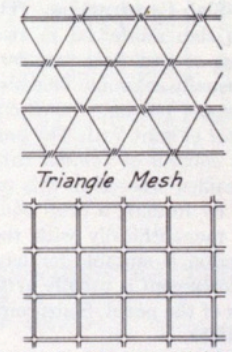
(b) Method for Fireproofing Steel Beams with Concrete



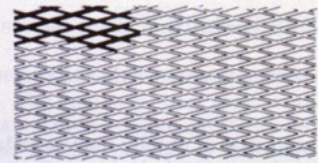
(c) Concrete Slab on Concrete Beams



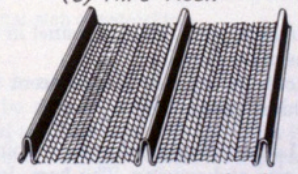
(d) Slab on Beams or Bearing Wall



(e) Wire Mesh



(f) Expanded Metal

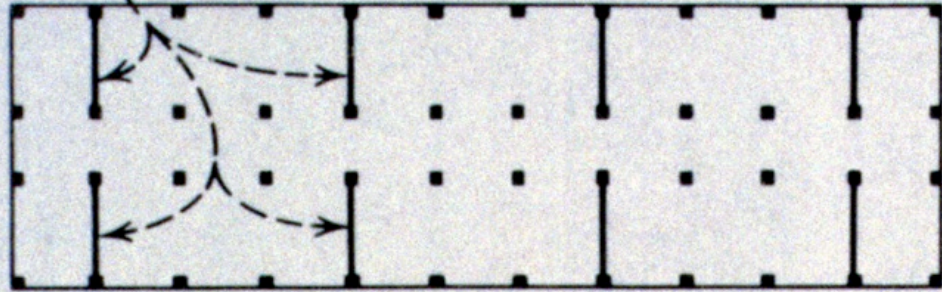


(g) Ribbed Metal Lath

FIGURE 7.7 Reinforced concrete slabs.

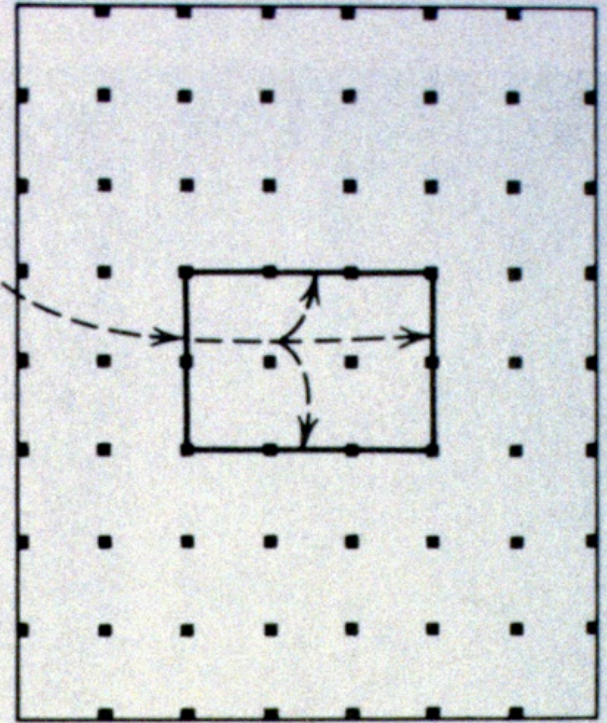
Shear walls are solid concrete walls that are placed perpendicular to the long dimension of the building to make the rectangular form stiffer to resist collapse

*Shear walls continuous to foundation
Openings through walls are required*



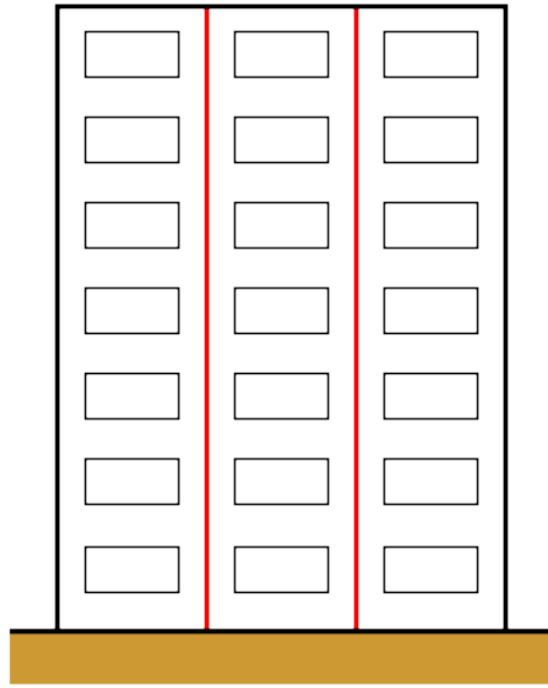
(a) Transverse shear walls

Wind direction

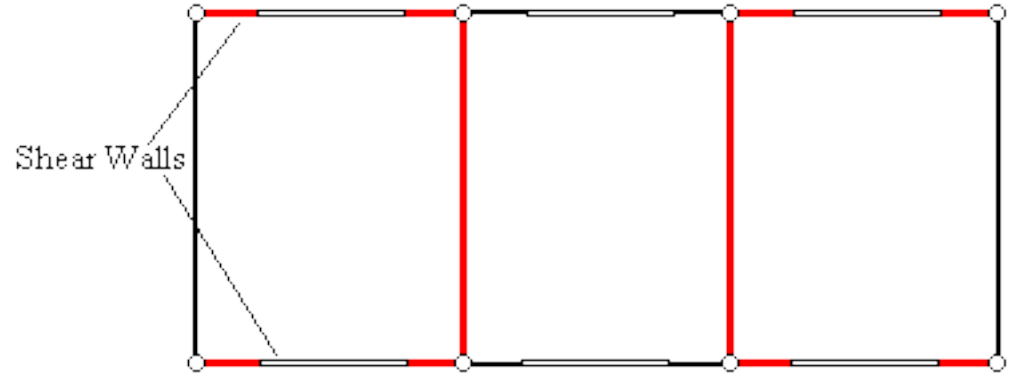


(b) Shear walls around central core

FIGURE 7.16 Shear walls.



Elevation



Plan

Wind direction

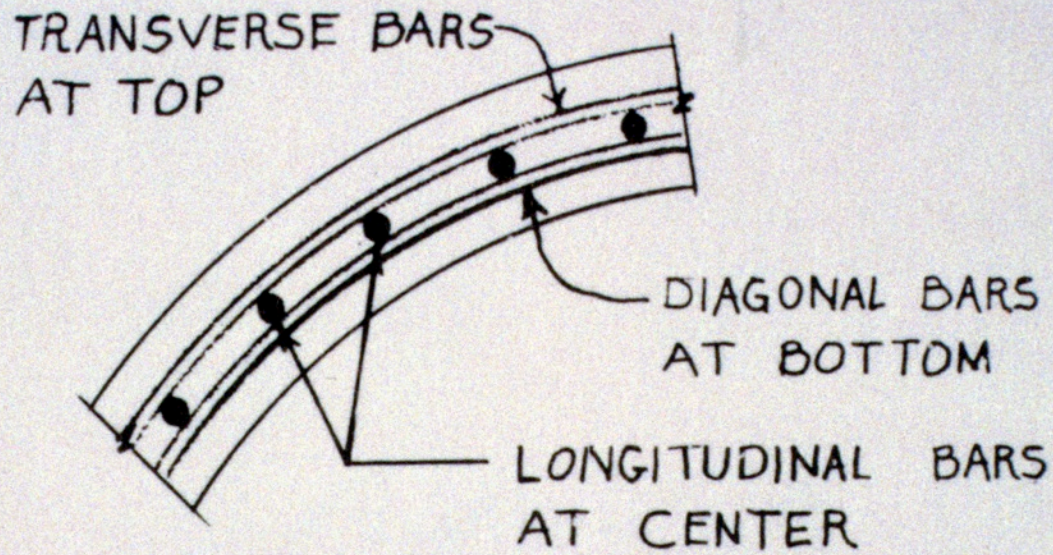


Fig 2. Typical arrangement of shear walls

Thin shell roofs get their strength from the geometry of their shape or cross section

–

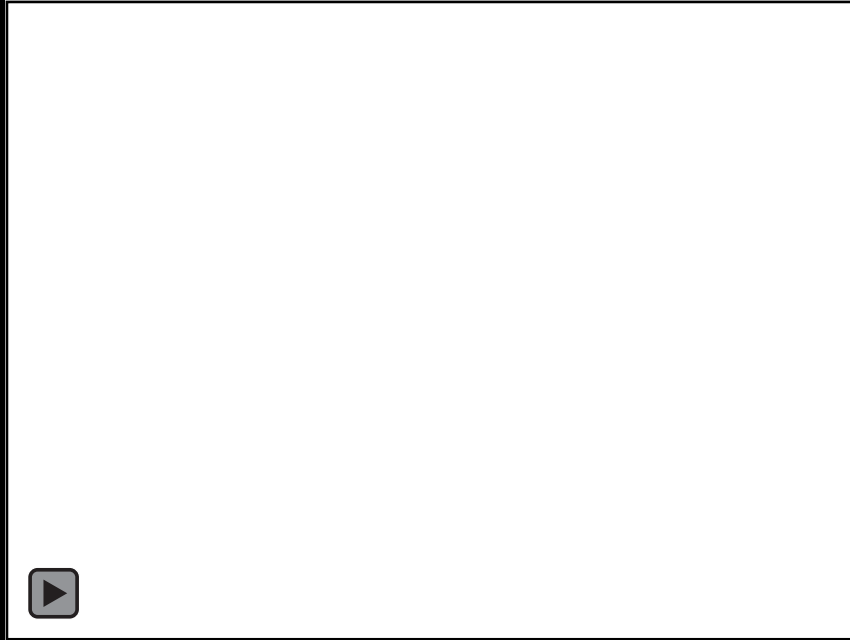
Material is moved away from the centre of gravity of the section



*Figure 11-16. Placement
of Reinforcing Bars in
Thin Shell*







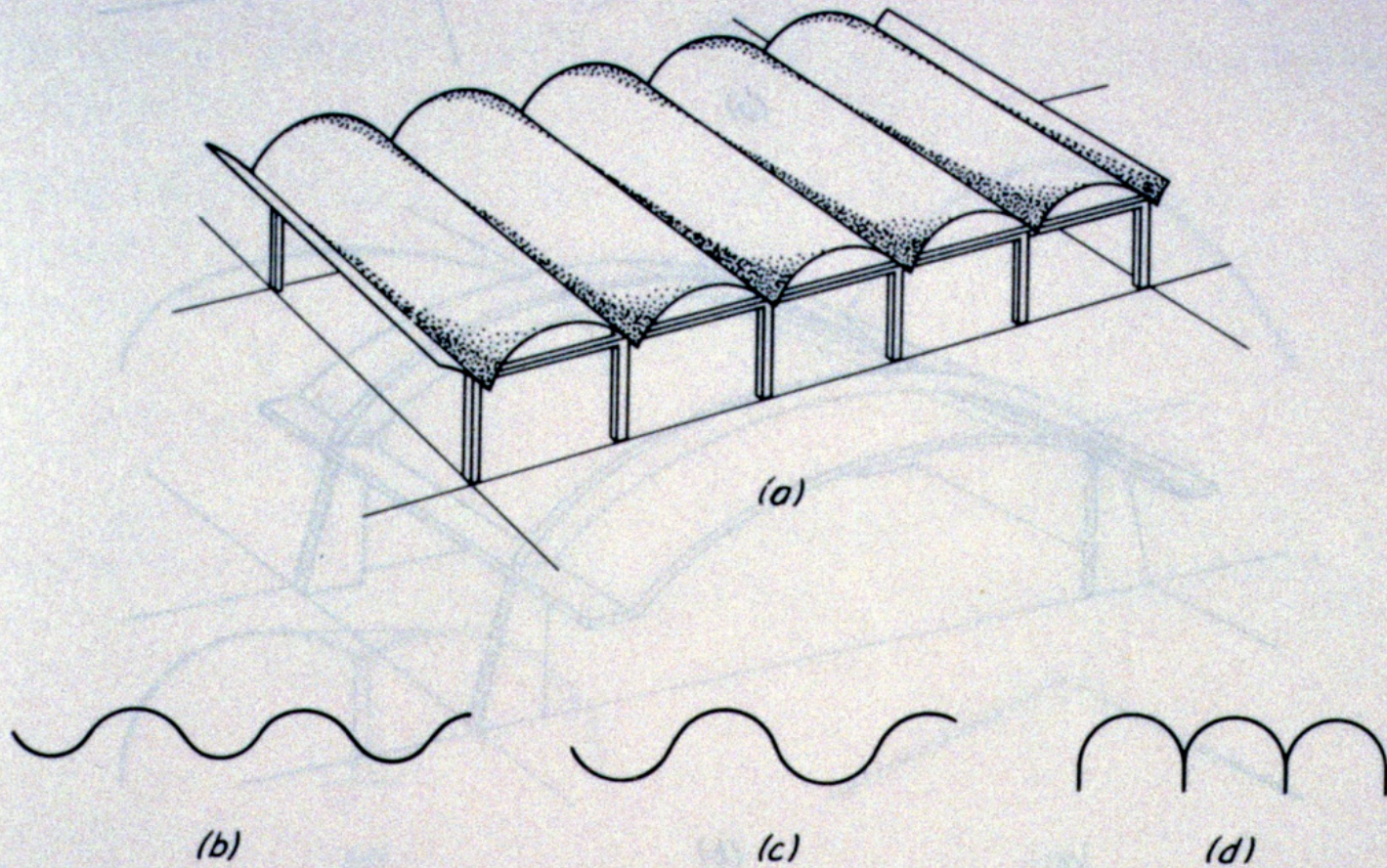
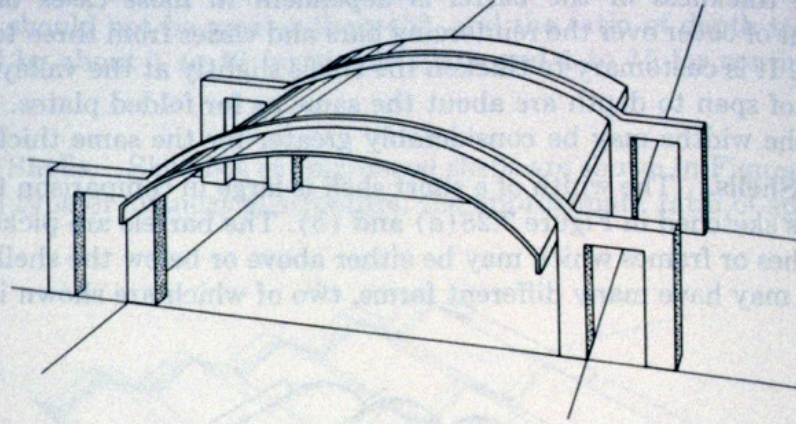
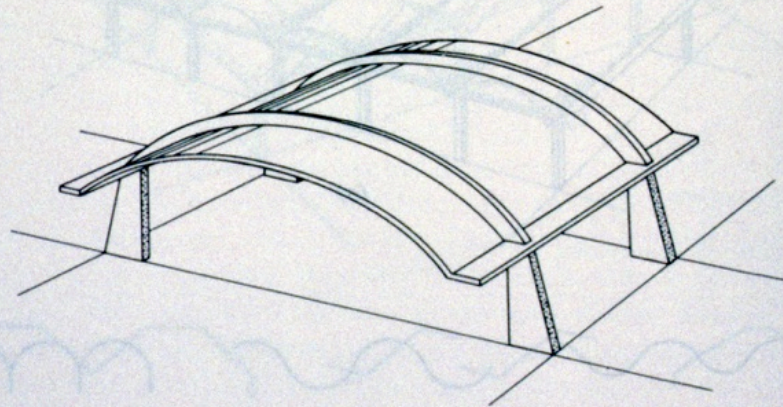


FIGURE 7.25 Long-barrel shell roof.



(a)



(b)

FIGURE 7.26 Short-shell roofs.

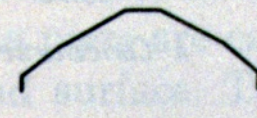
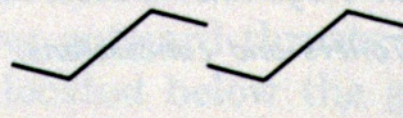
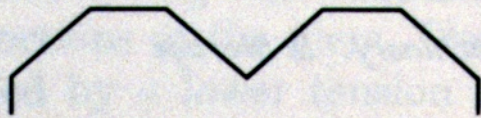
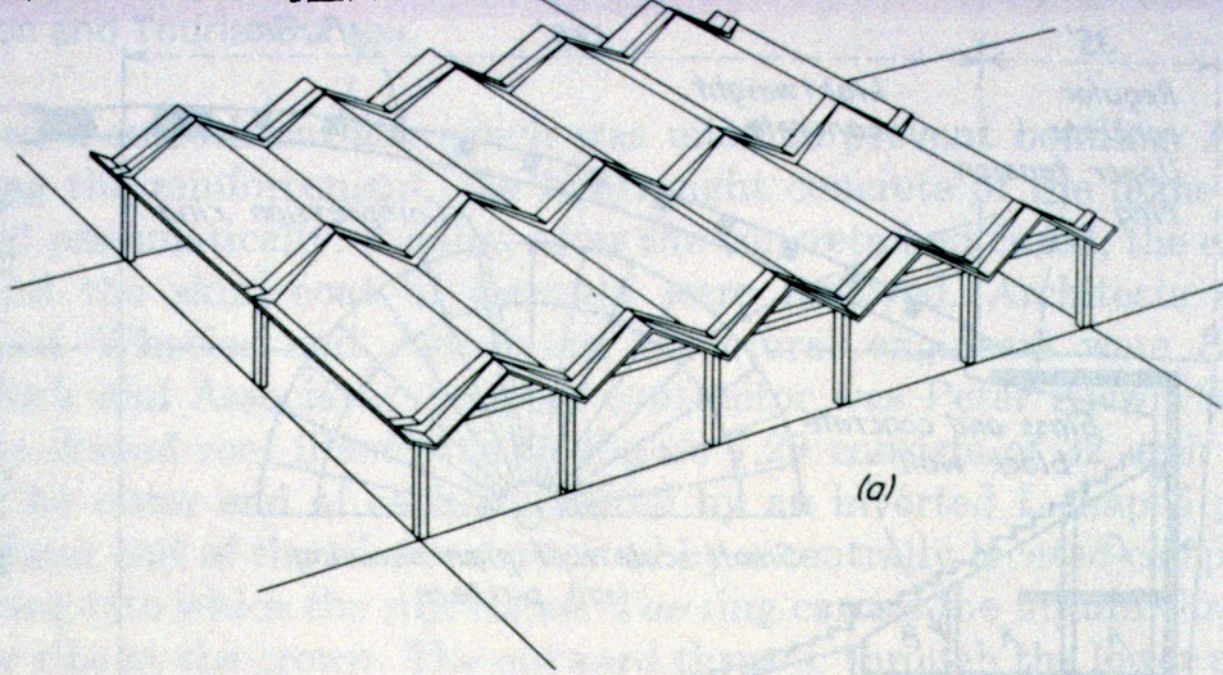
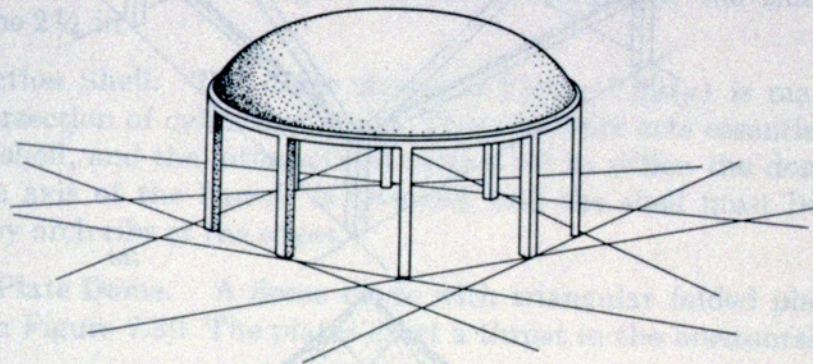


FIGURE 7.24 Folded plate roofs.





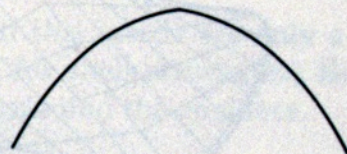




(a)



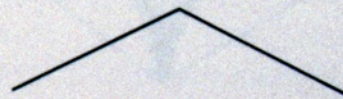
(b)



(c)



(d)



(e)

FIGURE 7.27 Domes of revolution.





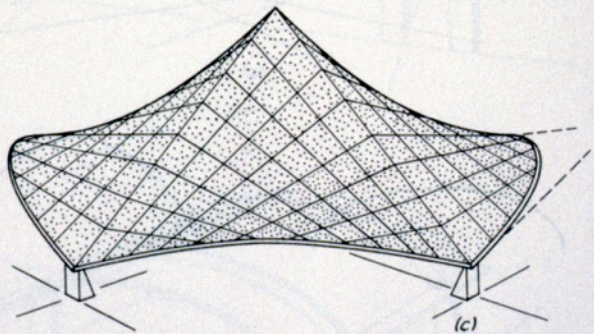
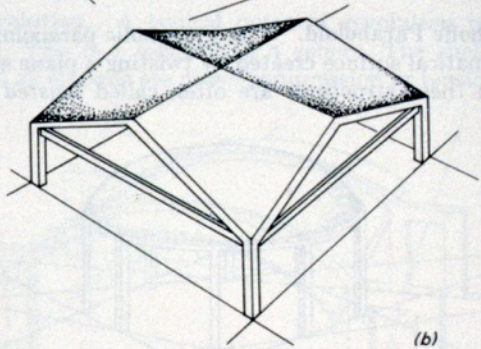
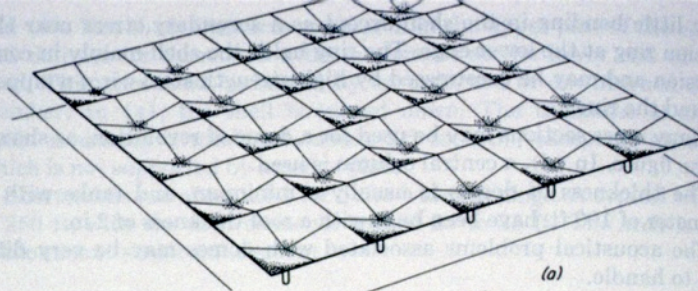
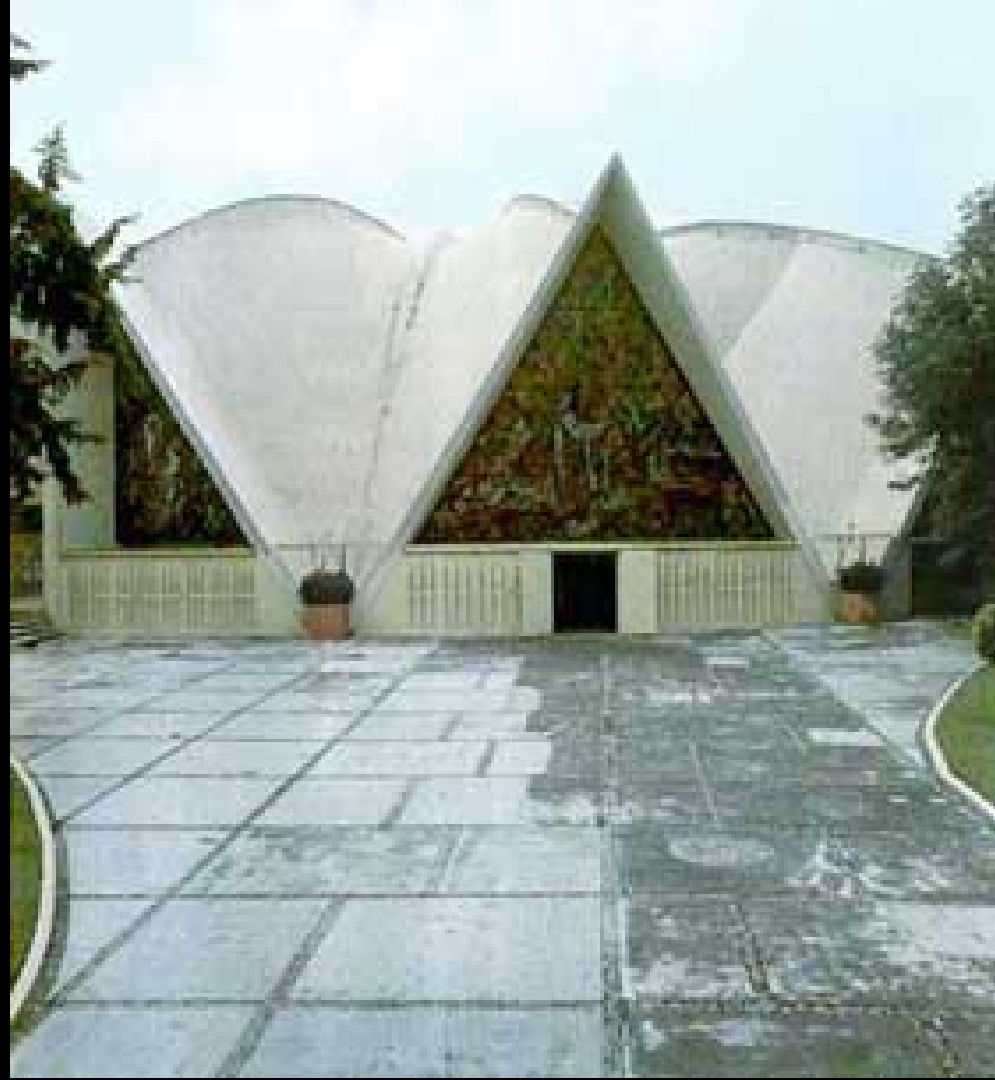


FIGURE 7.28 Hyperbolic paraboloid roofs.





the details of construction practice













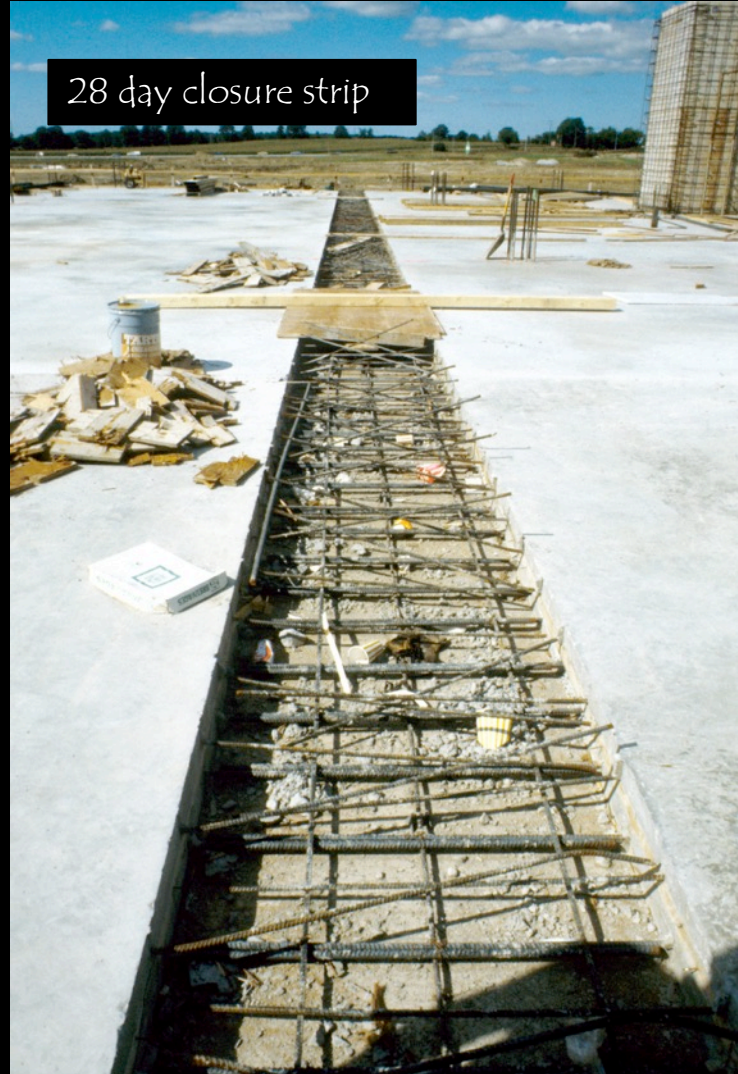




Expansion joint



28 day closure strip

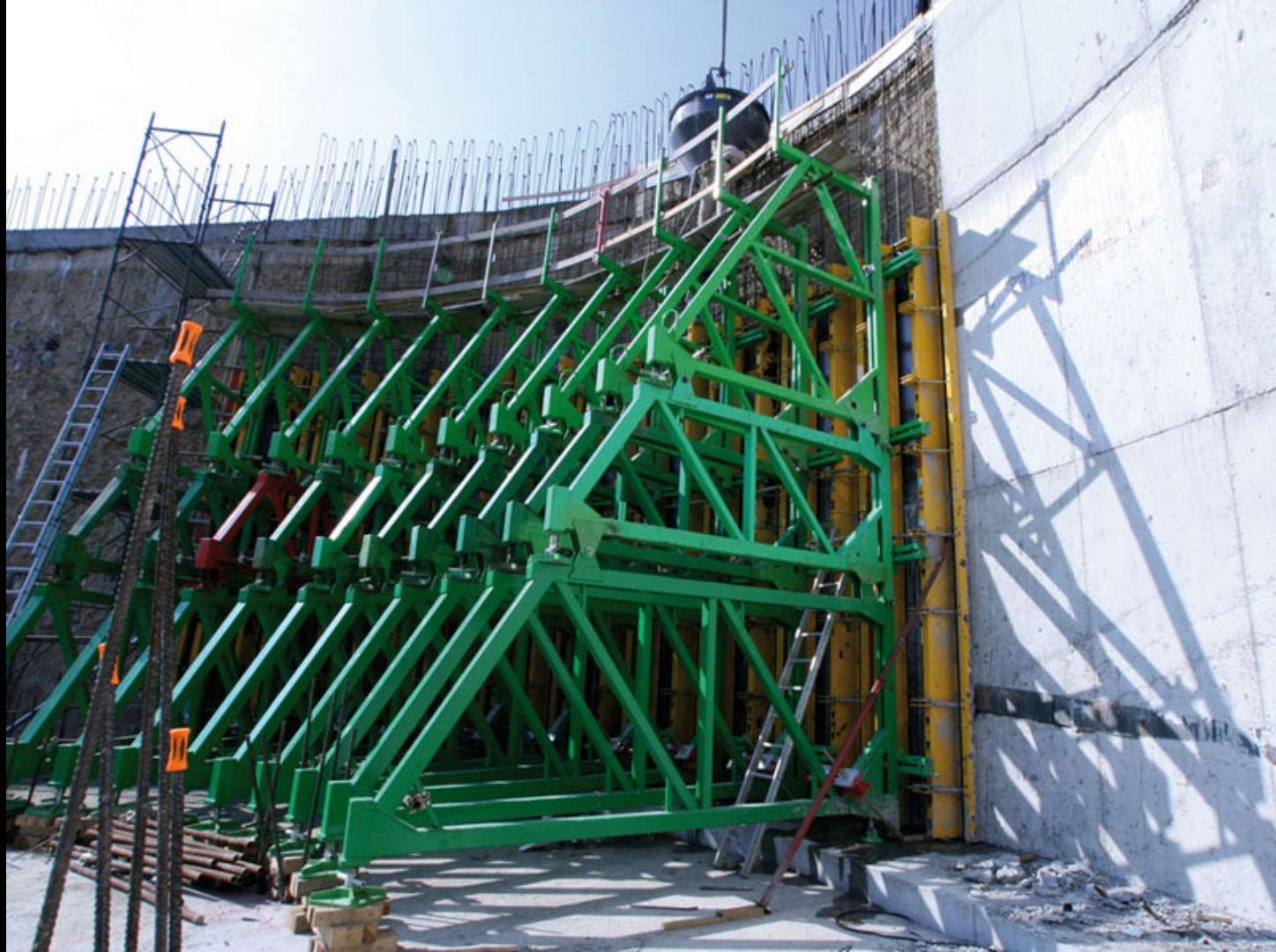


Expansion joint









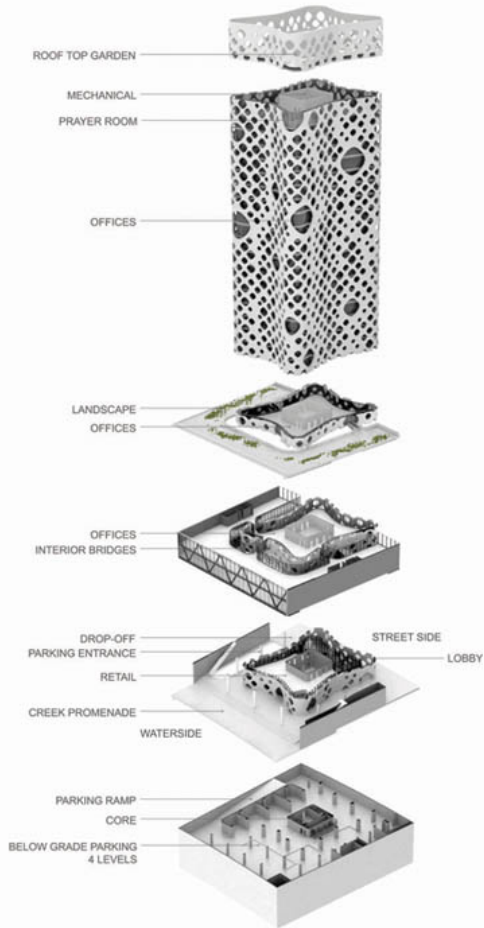




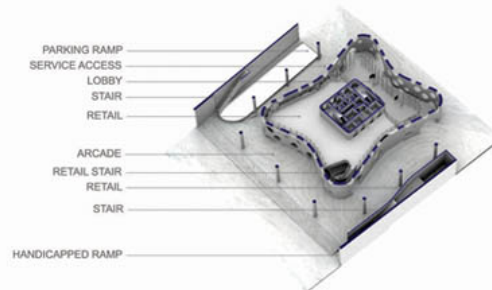
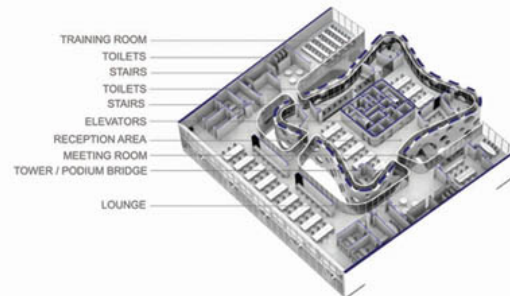
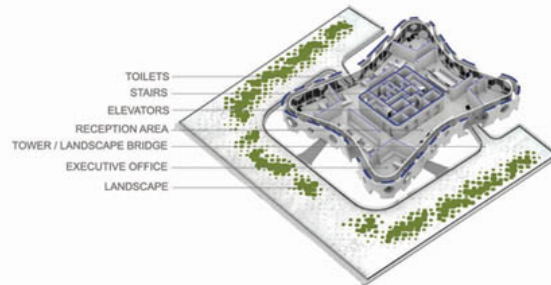


O-14 Tower,
Dubai



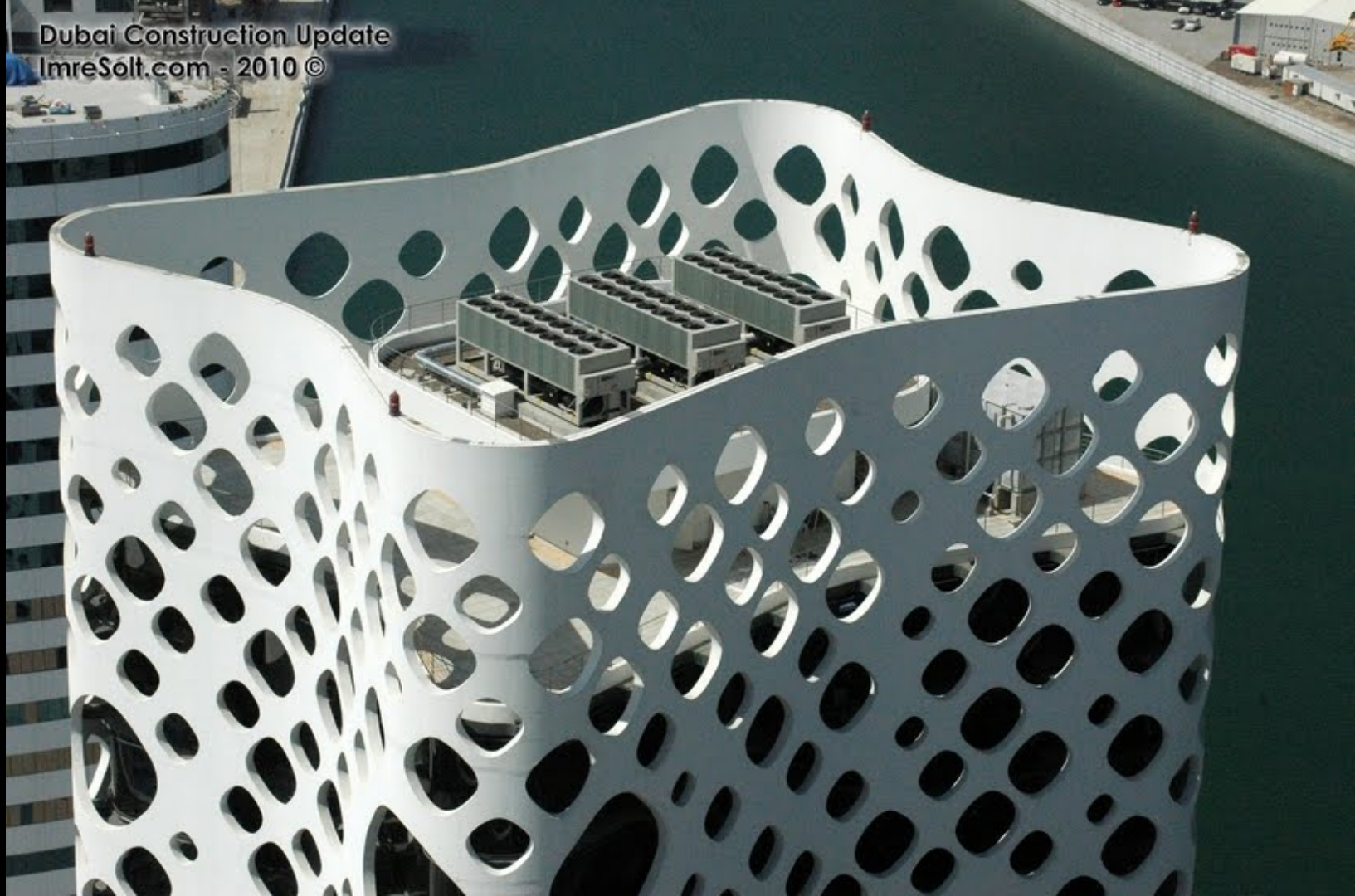


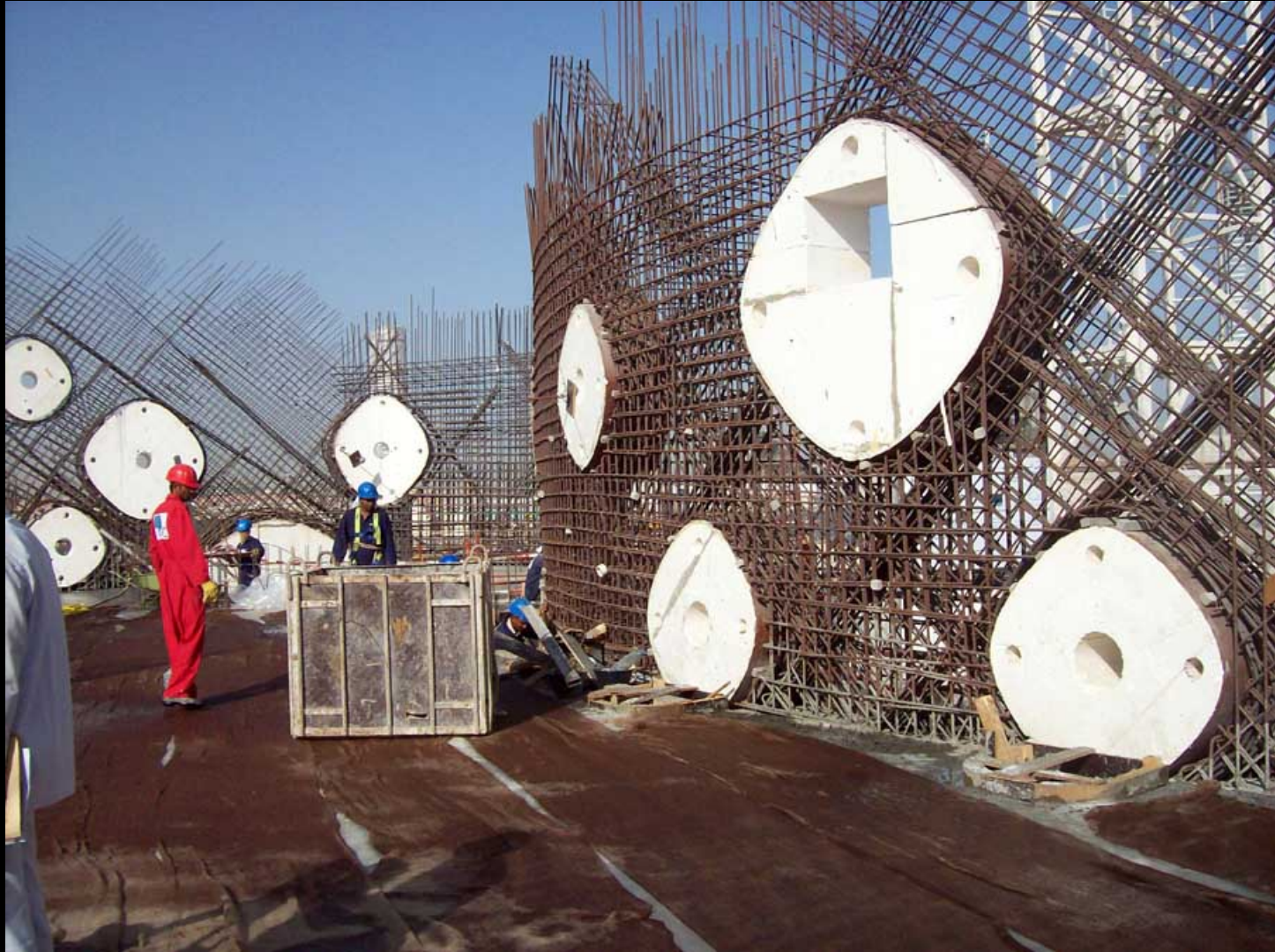
TOWER ISOMETRIC



PODIUM ISOMETRIC

















Makomanai Takino Cemetery
Sapporo, Japan
Tadao Ando
2017









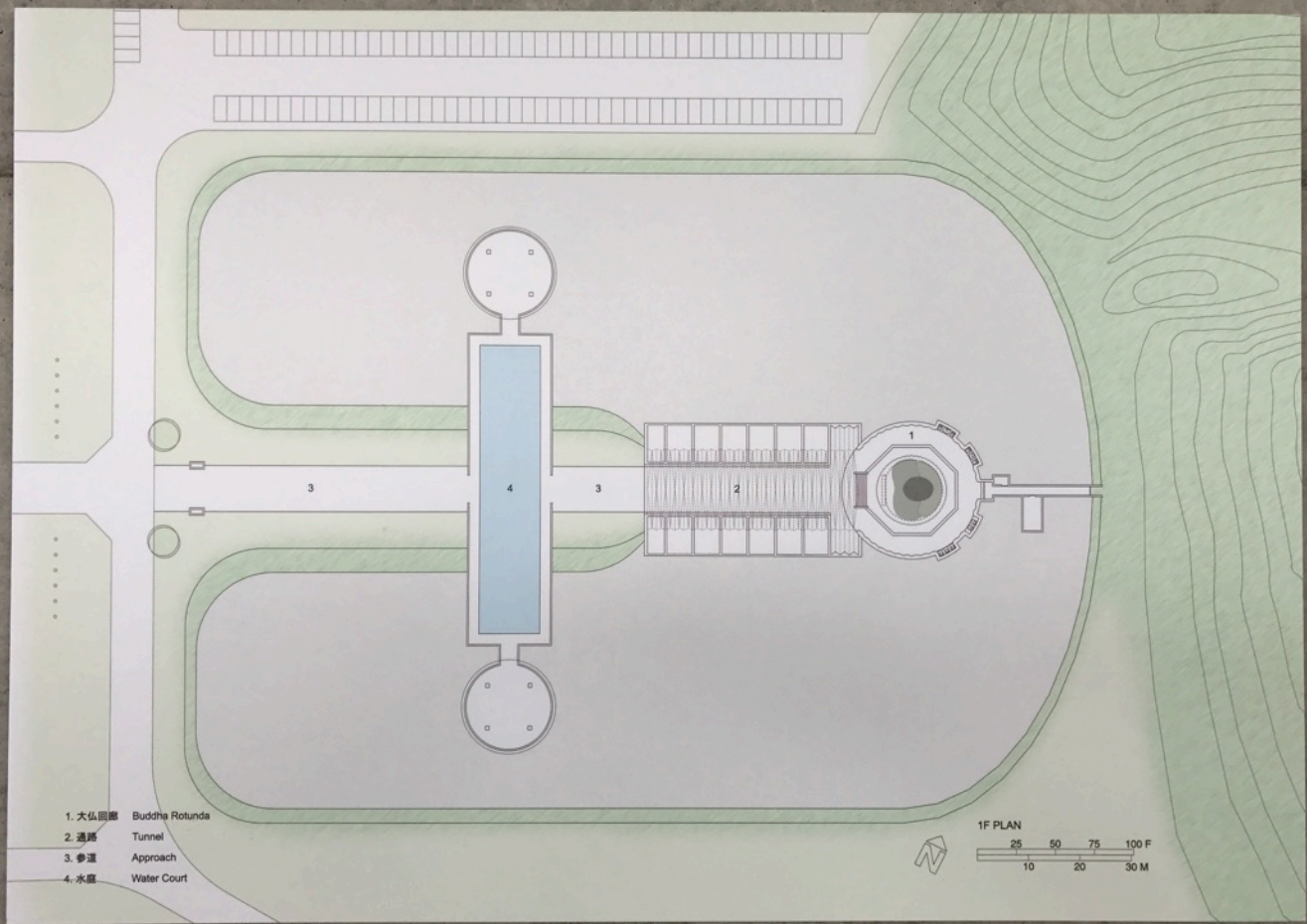
















































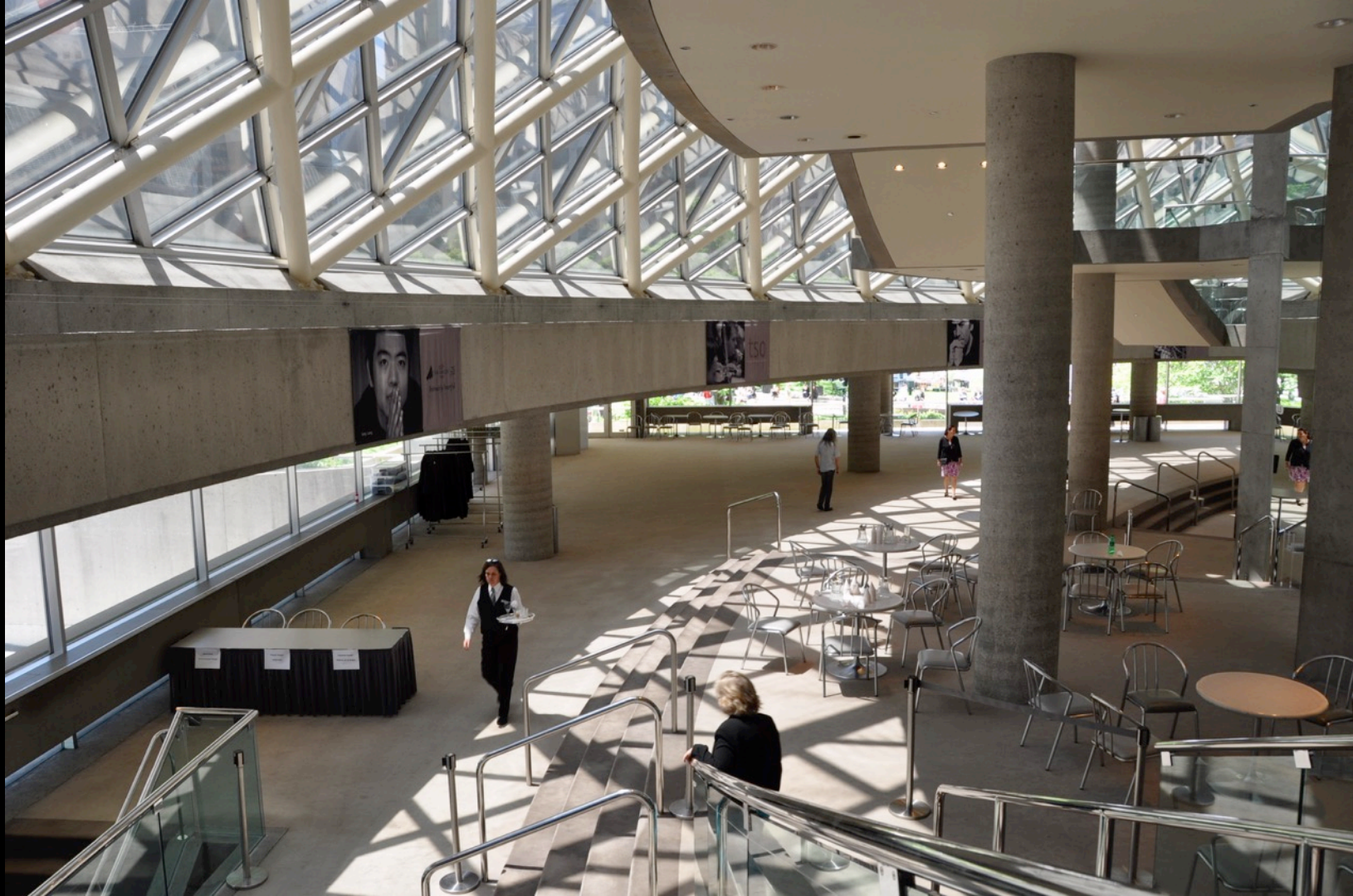






Roy Thomson Hall, Toronto
Arthur Erickson

















University of Lethbridge, Alberta
Arthur Erickson













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Cafe
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STUDY CENTRE





Hyatt Regency Hotel,
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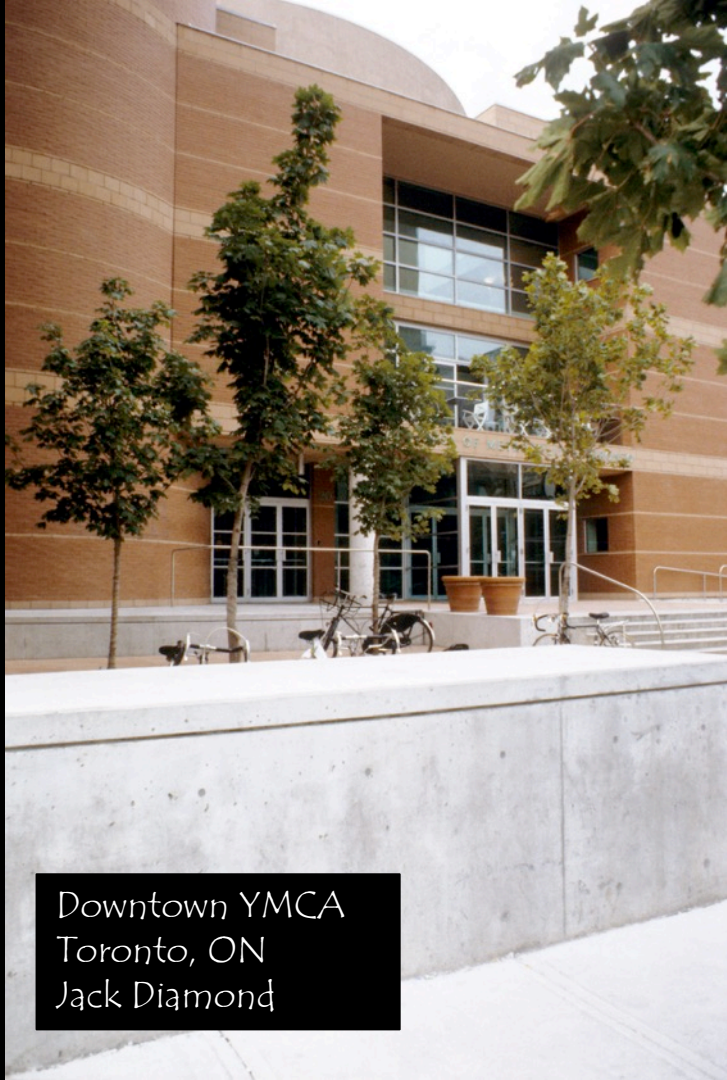












Downtown YMCA
Toronto, ON
Jack Diamond

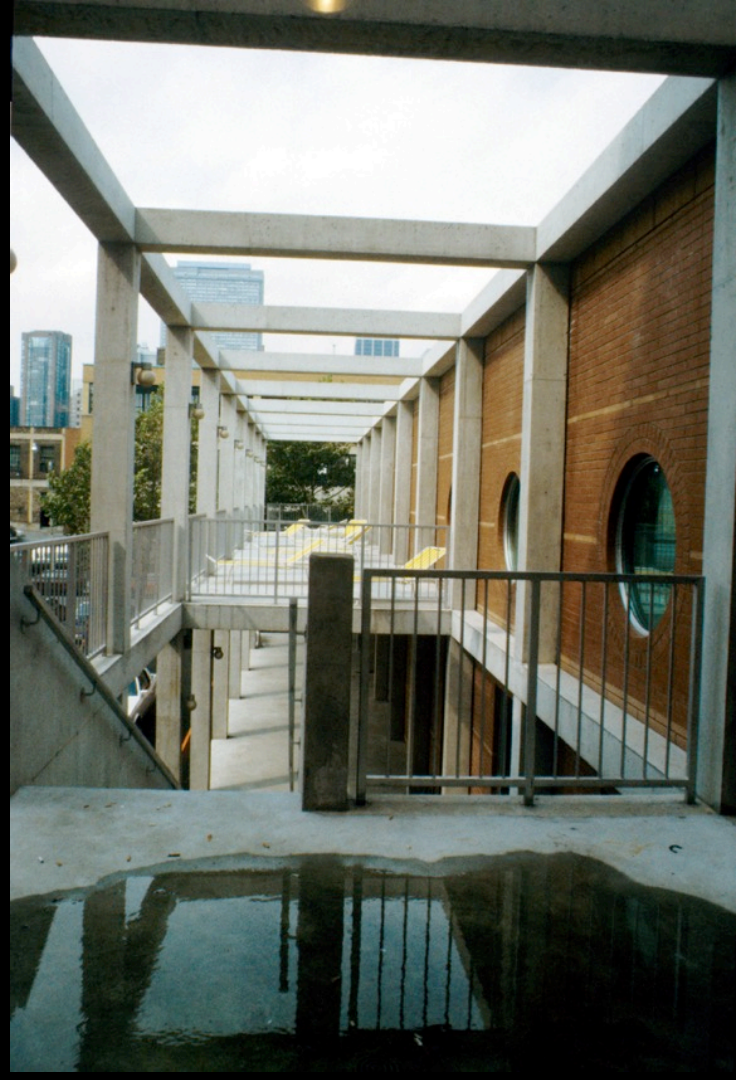














National Gallery
Ottawa, ON
Moshe Safdie

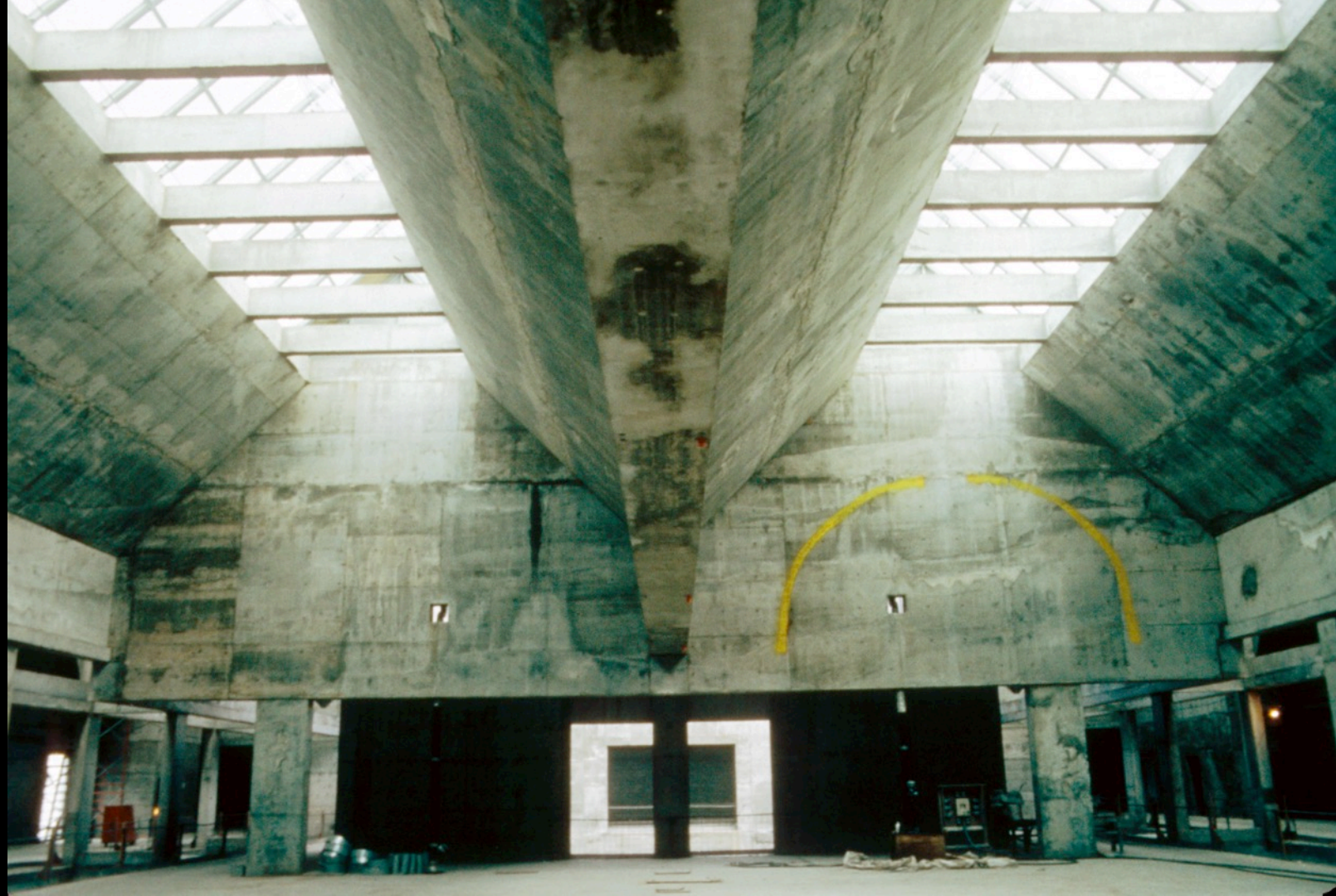






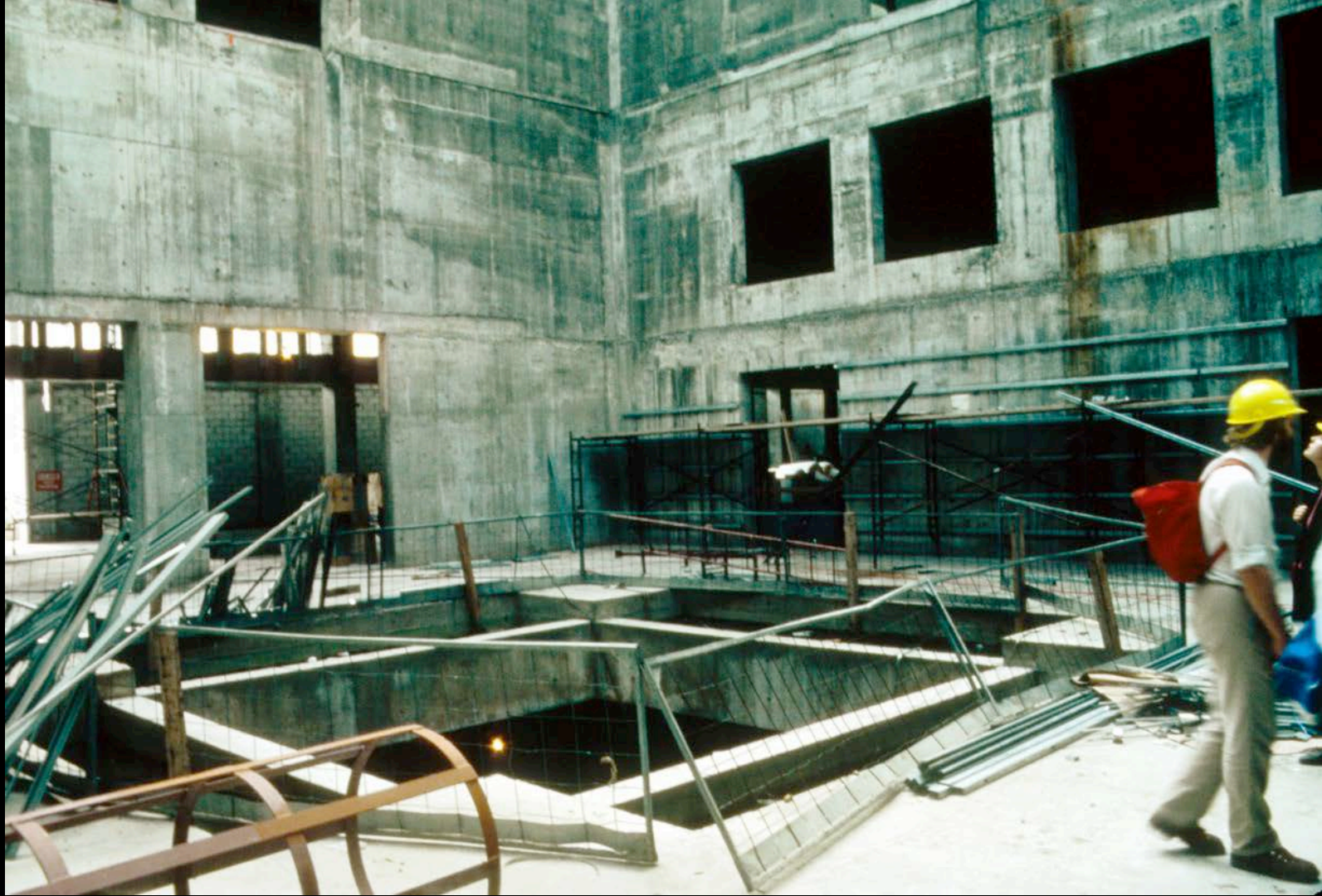


















Brunswick Ave. Toronto



180
CIVIL
CIVIL ENGINEERING













Office Building
Washington, D.C.















Miami Aquarium















Ryerson Student Centre, Toronto
Snohetta

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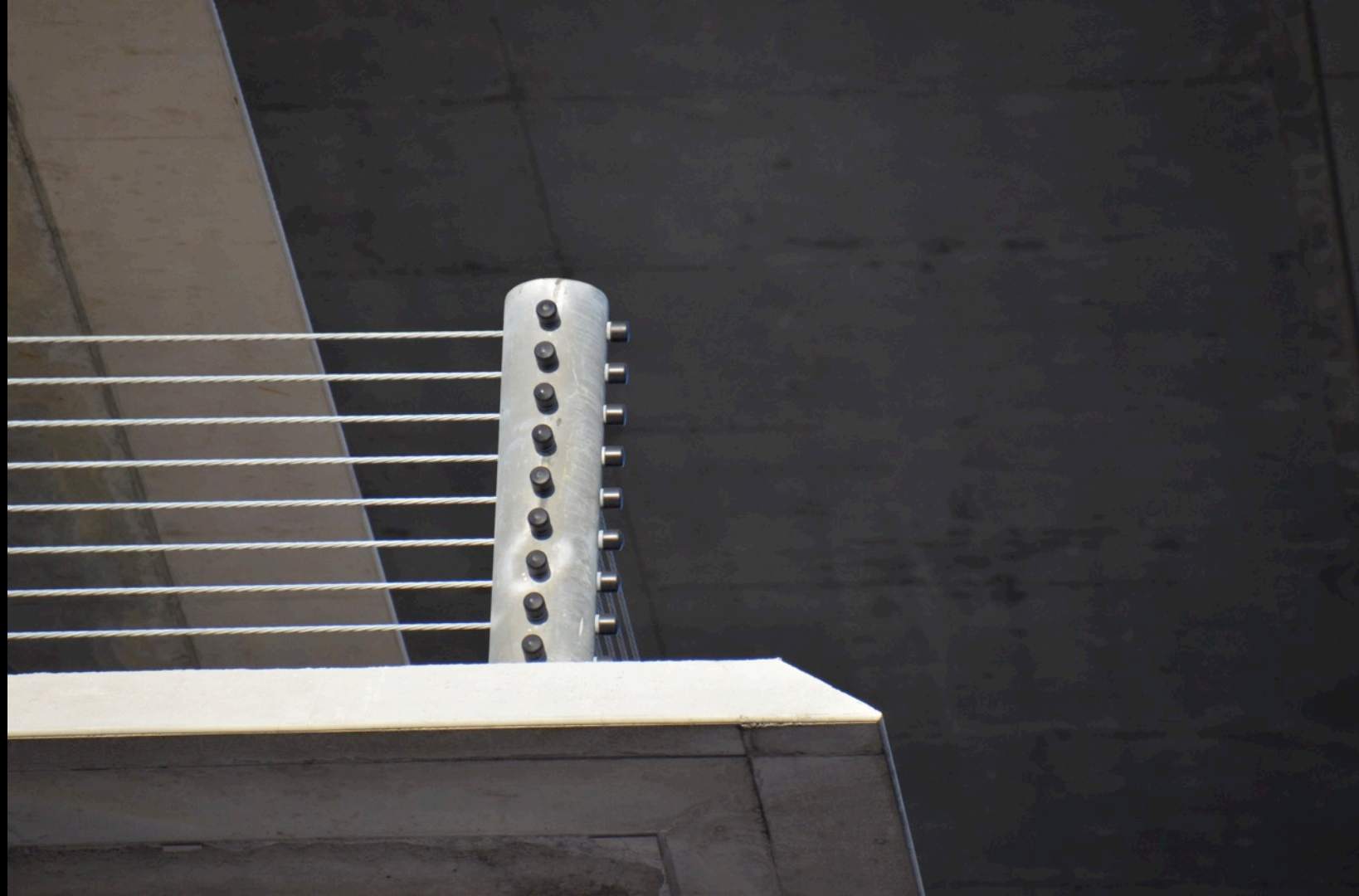






1111 Franklin Road, Miami
Herzog and deMeuron











EXIT







Miami Art Gallery
Herzog and deMeuron









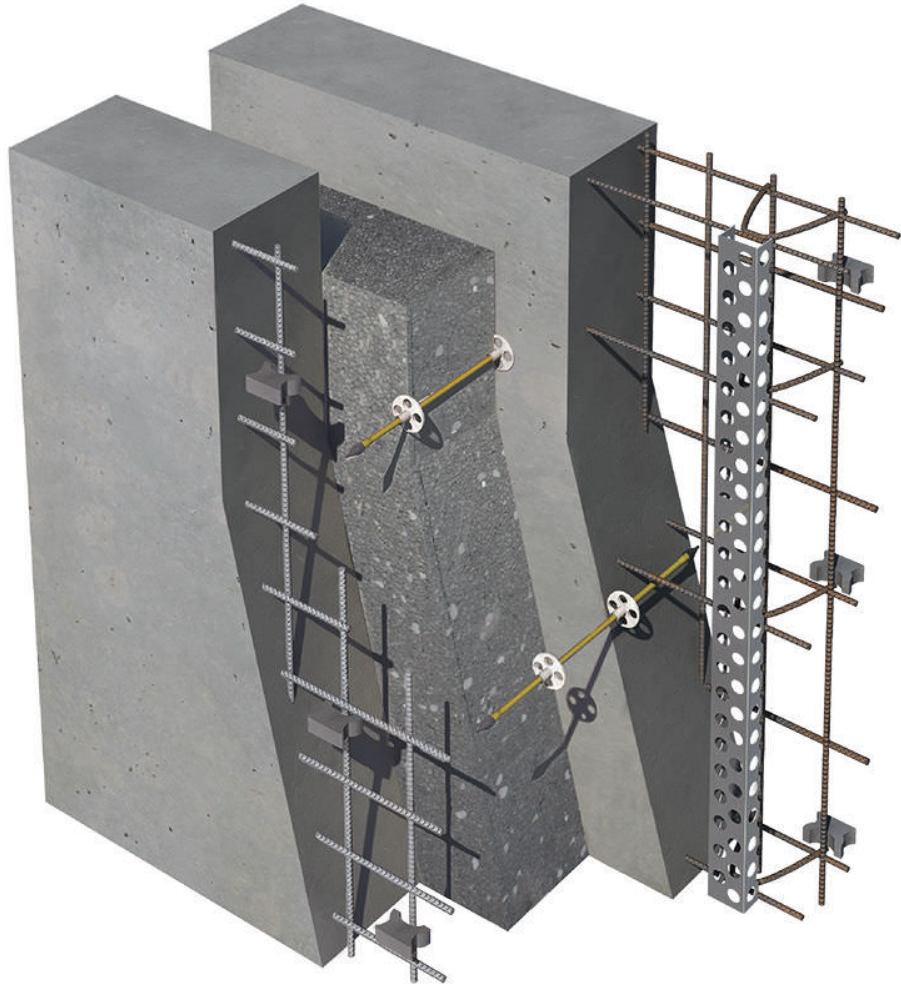
10 Hudson Yards
New York City, USA
KPF Architects
2015
267.7m





Thermal bridges are the CURSE of concrete framing

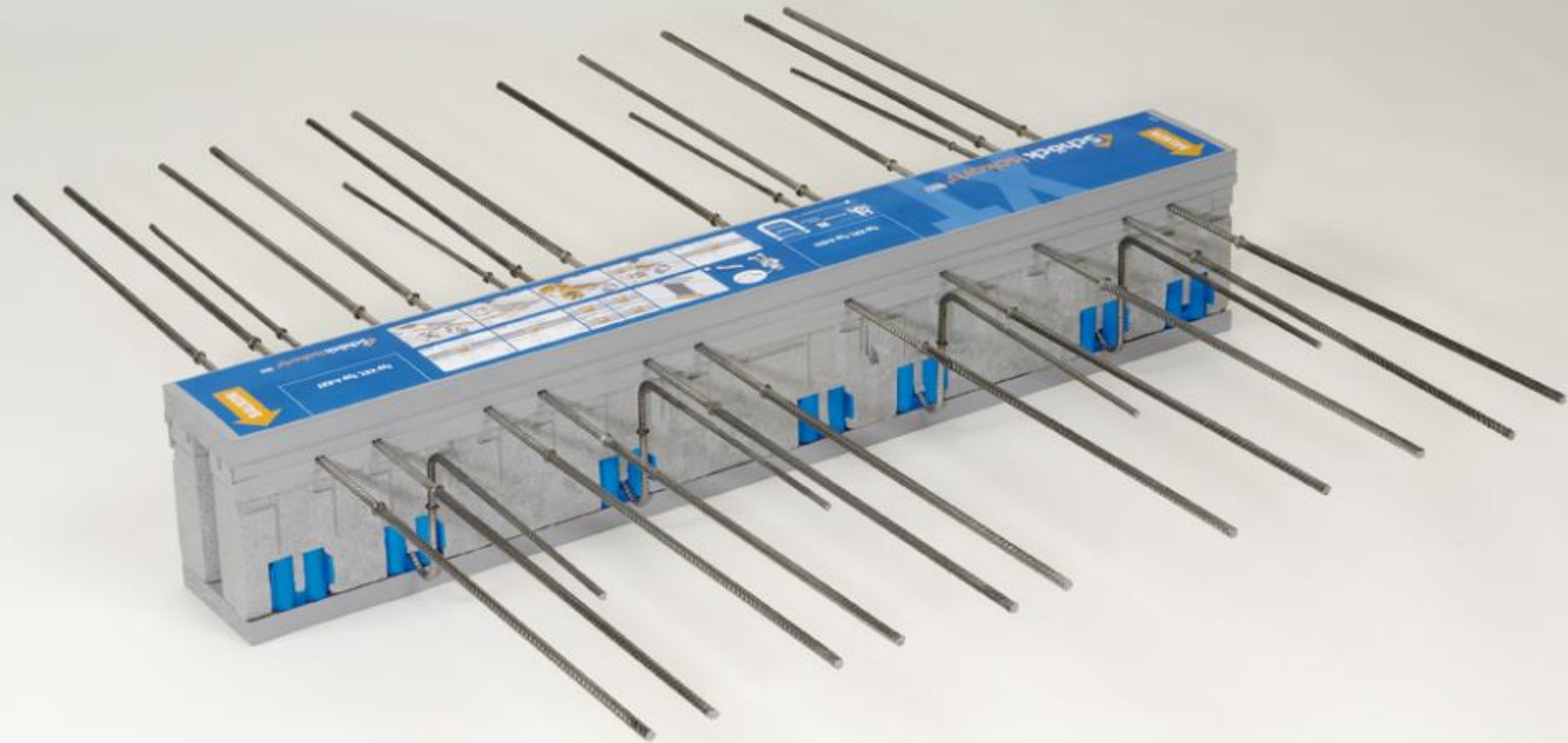
- Details **MUST** be developed to insert a thermal (insulation) break between the exterior and the interior



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













































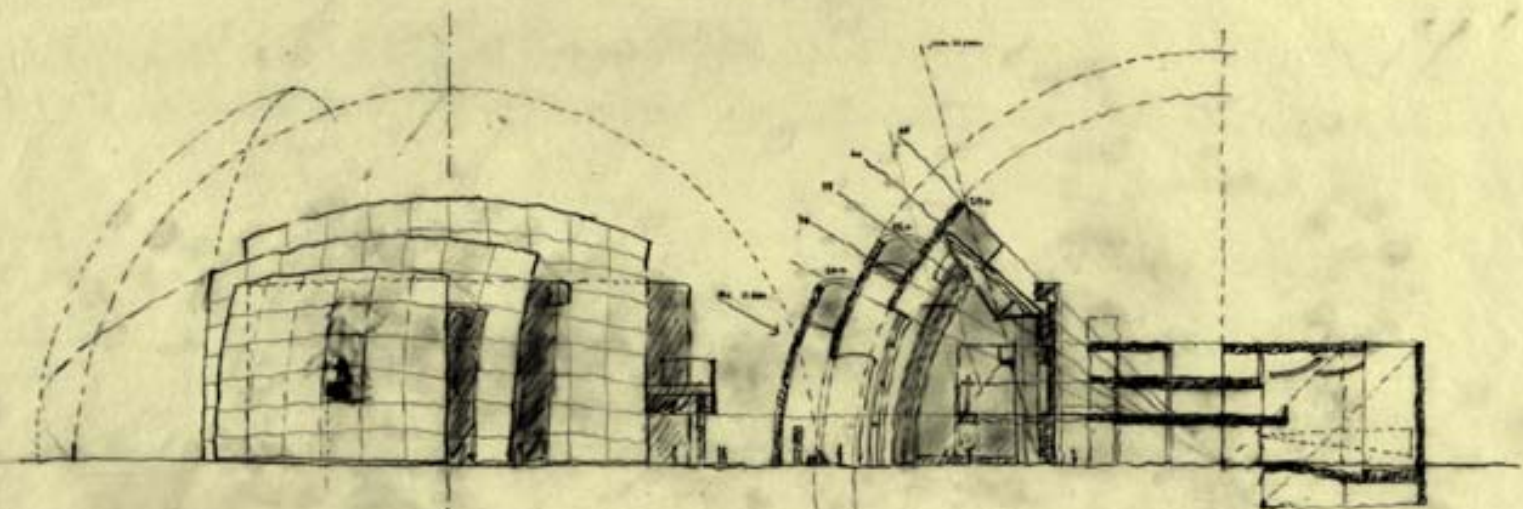




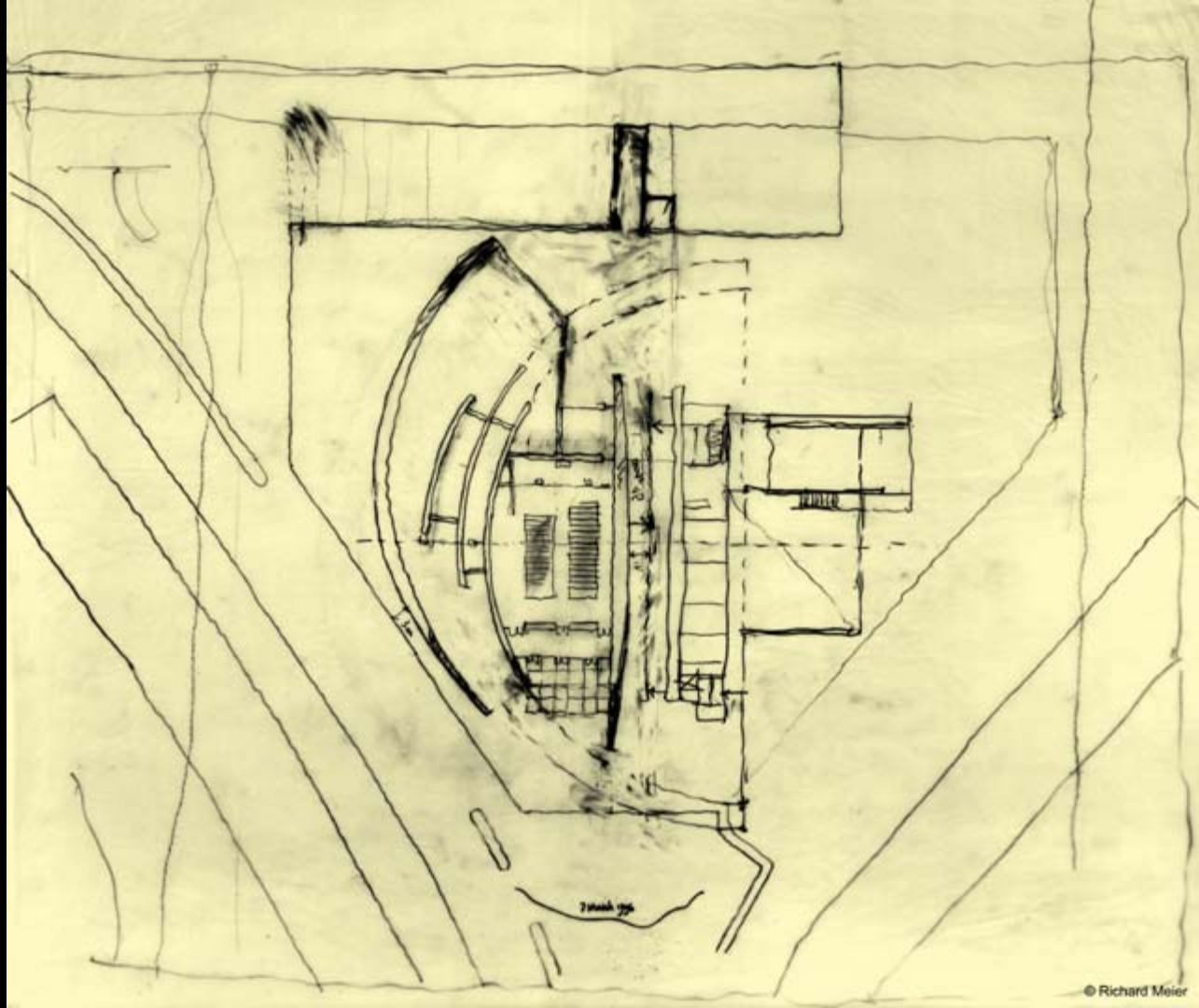


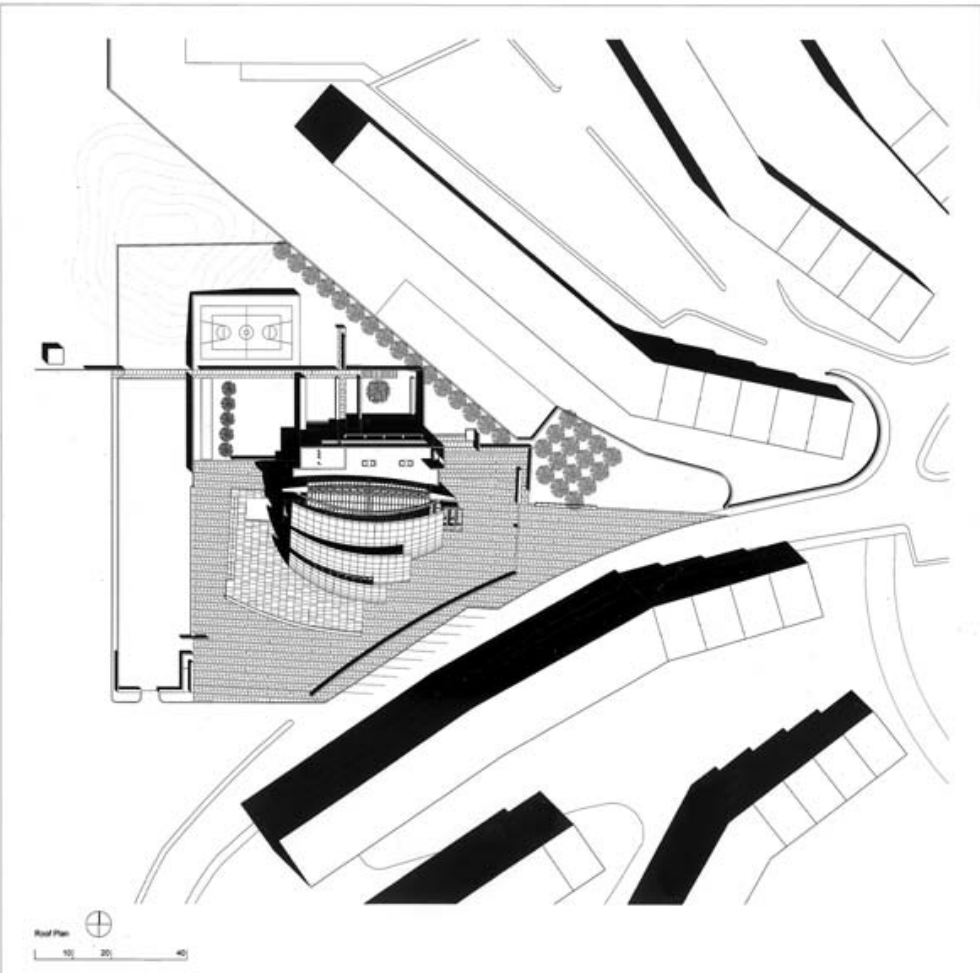


Self cleaning concrete is called photocatalytic concrete
Invented in Italy
Depends on titanium oxide additive to "eat" pollution

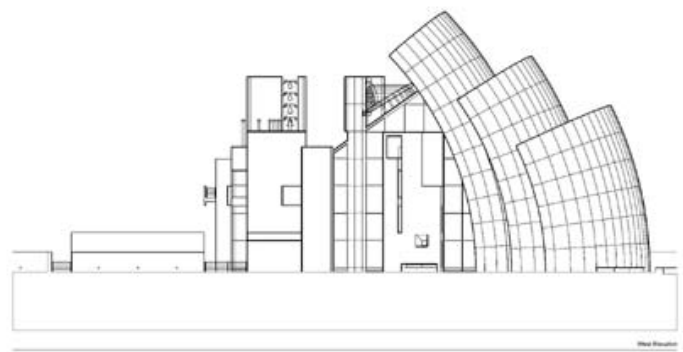
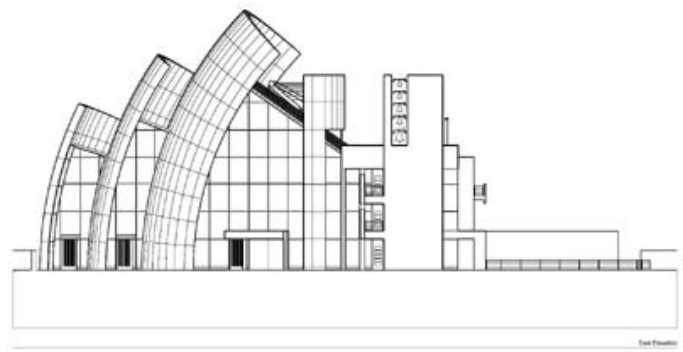


with elevation & longitudinal section
in sketch 1/11

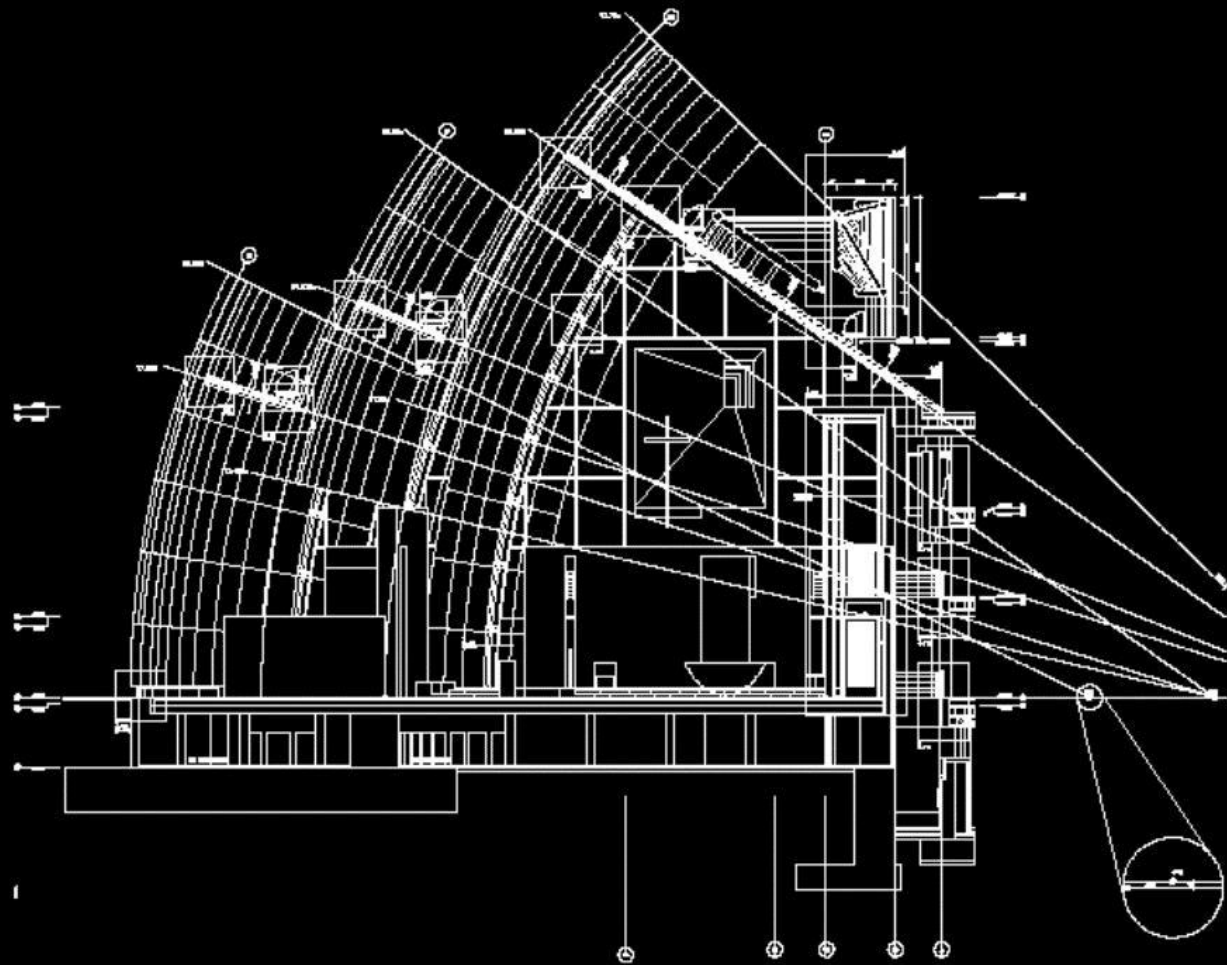




© Richard Meier & Partners, Architects

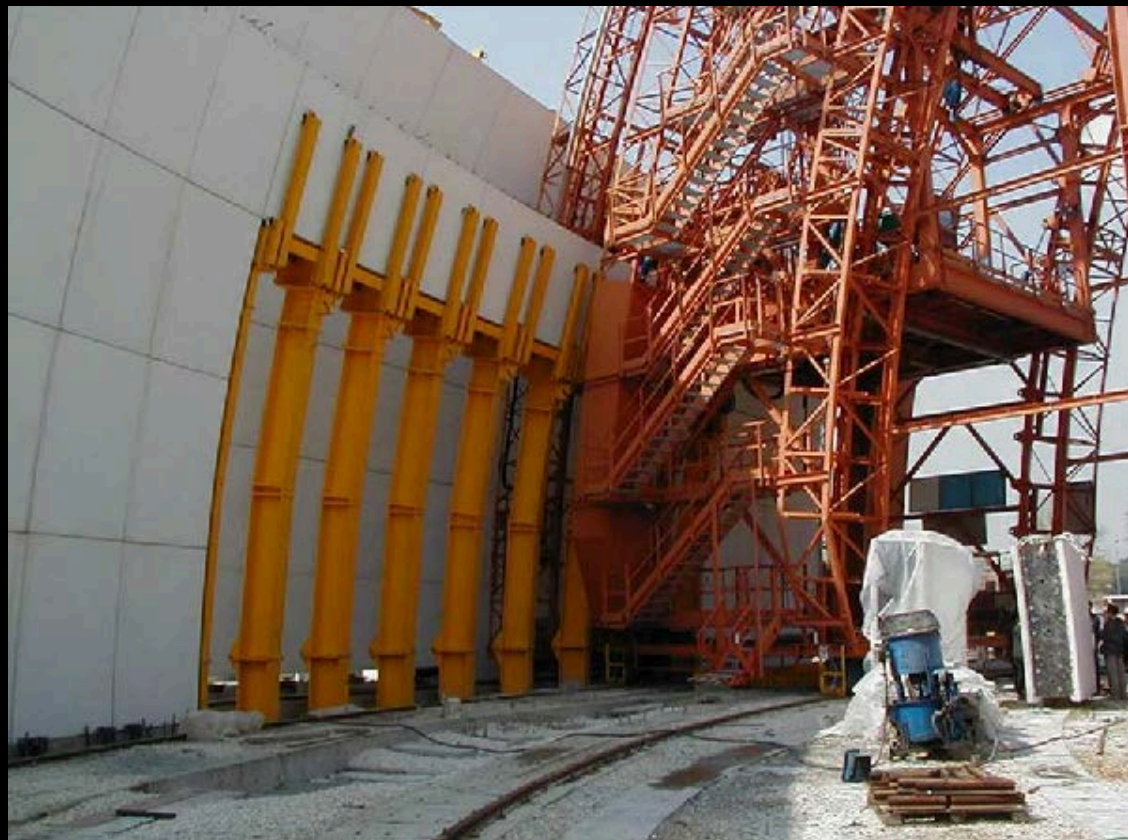


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https://www.researchgate.net/figure/View-of-the-damages-on-the-surface-of-the-self-cleaning-concrete-shells-of-Jubilee-Church_fig29_337427859



Self cleaning concrete
failure... actually premature
ageing