


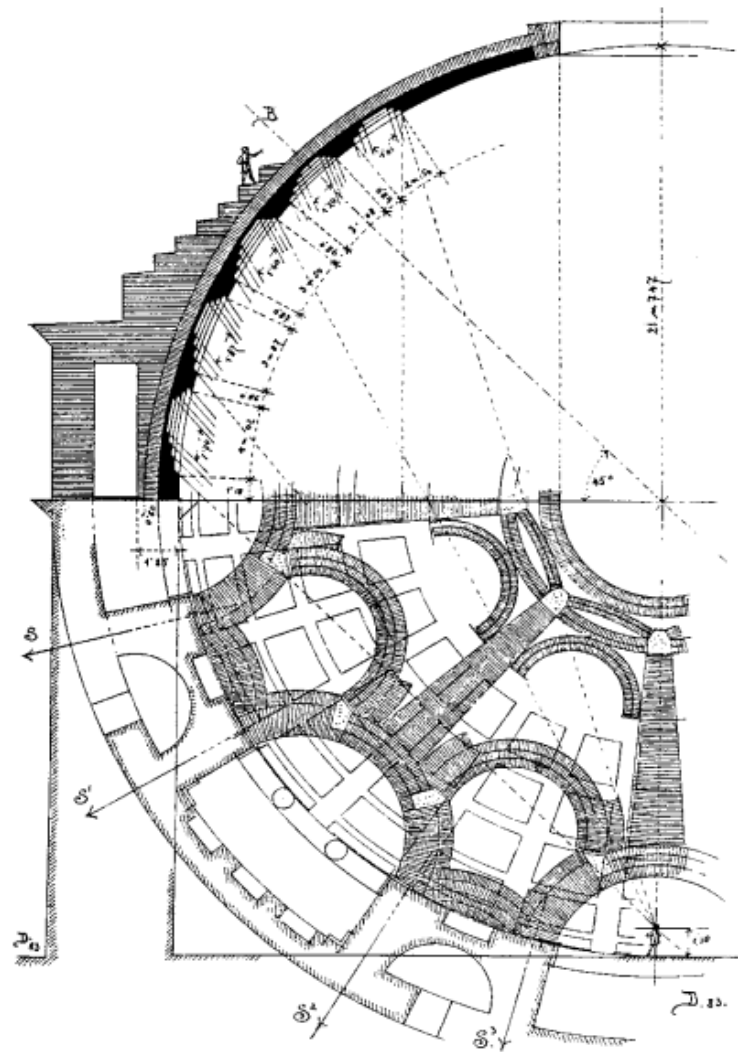
# Developments in Concrete Construction

## Part 1: Origins and Early Development



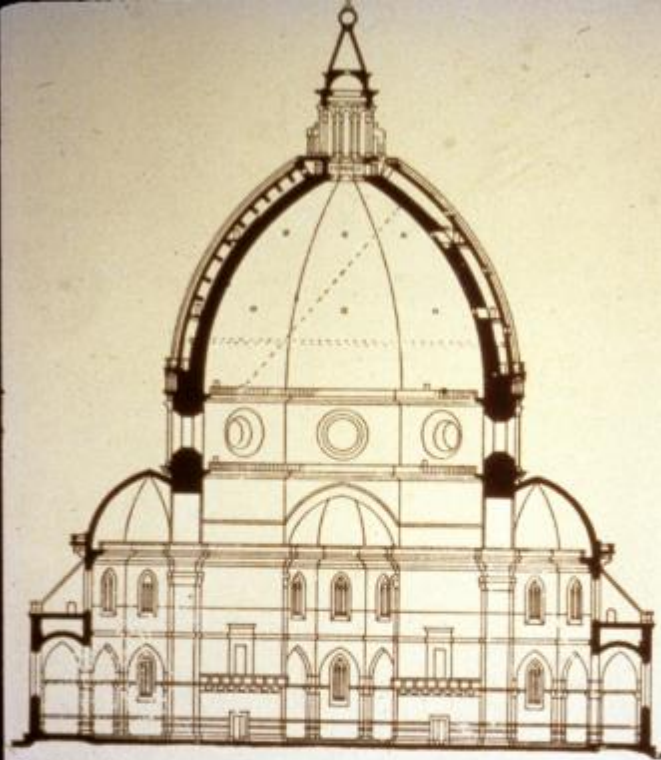
Stone relied on its form to put it into compression, which is the only force that stone can resist.

The Pantheon  
Rome, Italy  
113-125 CD

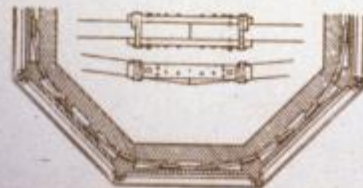


Composite structures

Use multiple materials  
each to their own  
structural advantage



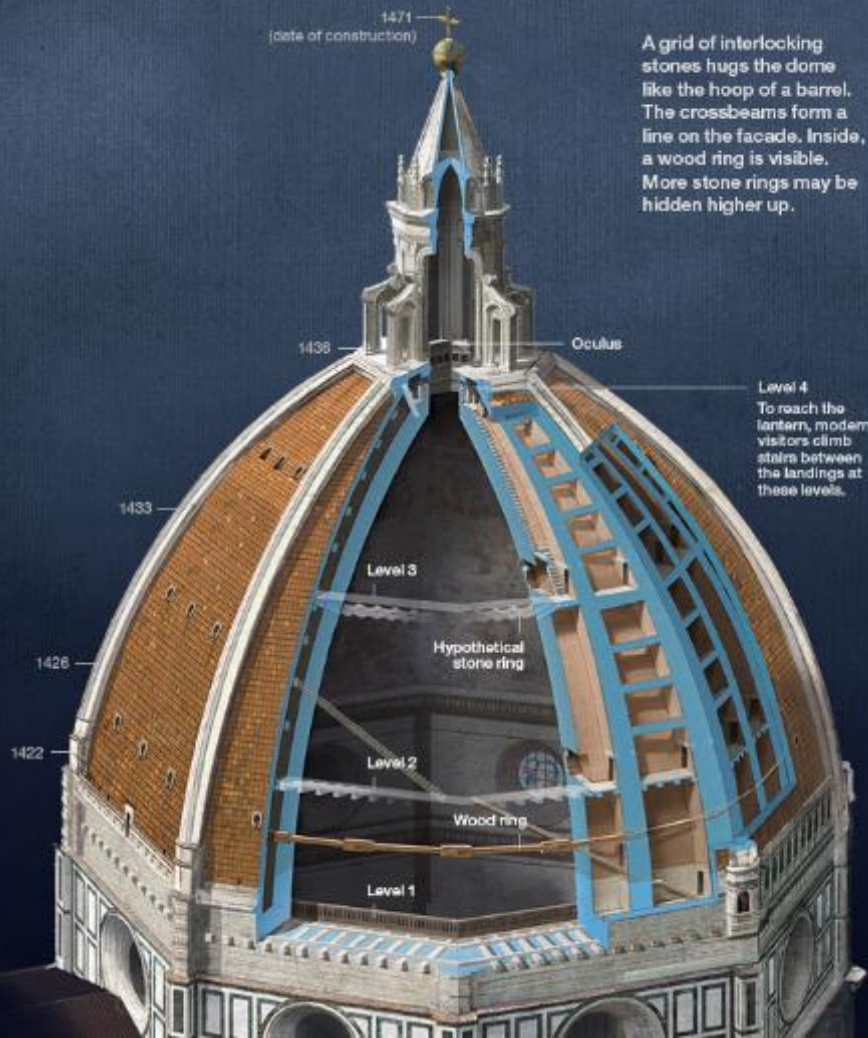
*Section through the Florence Cathedral dome.*



*Half plan of the dome and detail showing the iron chain.*

Santa Maria del  
Fiore  
Florence, Italy  
Filippo Brunelleschi  
1436





1471  
(date of construction)

A grid of interlocking stones hugs the dome like the hoop of a barrel. The crossbeams form a line on the facade. Inside, a wood ring is visible. More stone rings may be hidden higher up.

1438

Oculus

Level 4  
To reach the lantern, modern visitors climb stairs between the landings at these levels.

1433

Level 3

Hypothetical stone ring

1426

Level 2

Wood ring

1422

Level 1

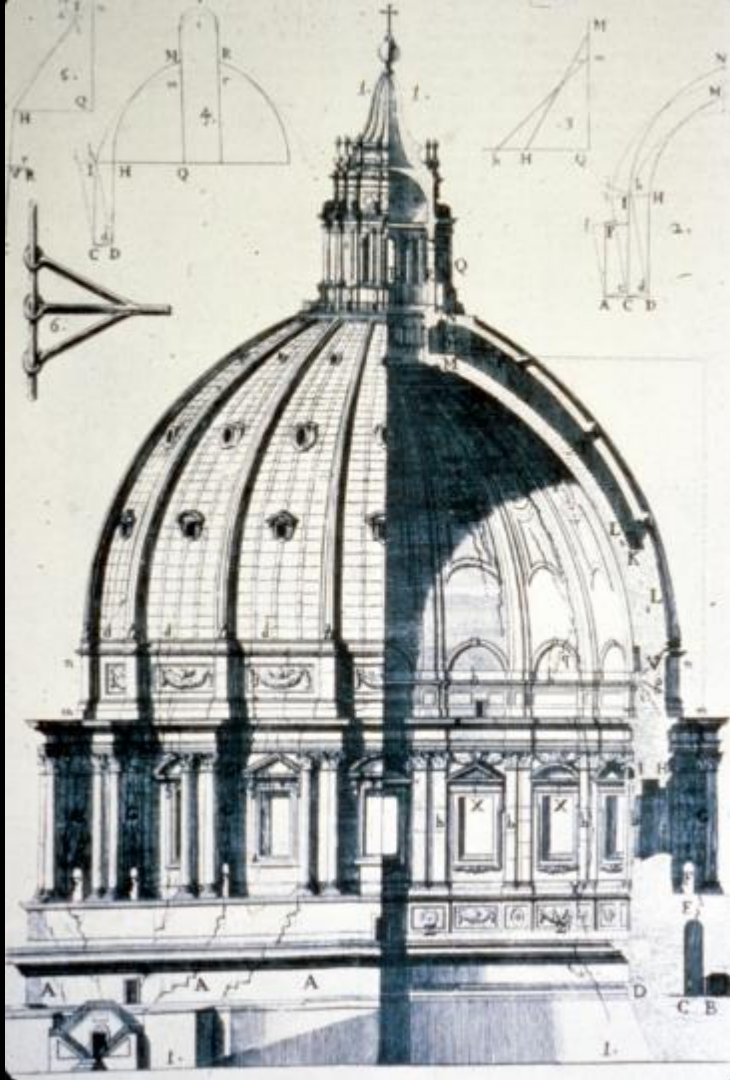


Basilica of St. Peter  
Vatican, Italy  
Various architects  
1506-1626

















Place de la Concorde  
Anges-Jacques Gabriel  
Paris, France  
1755



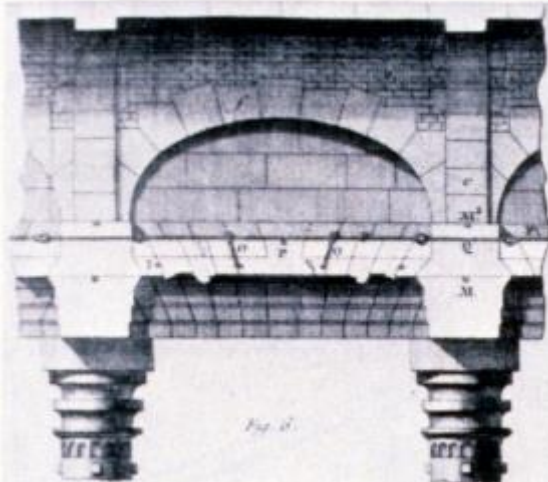


Fig. 1.

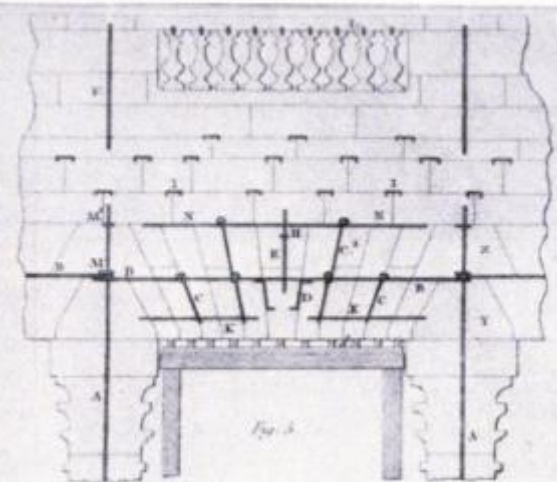


Fig. 3.

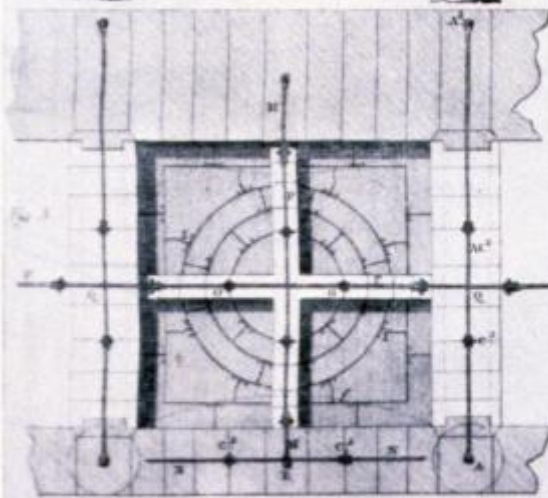


Fig. 4.

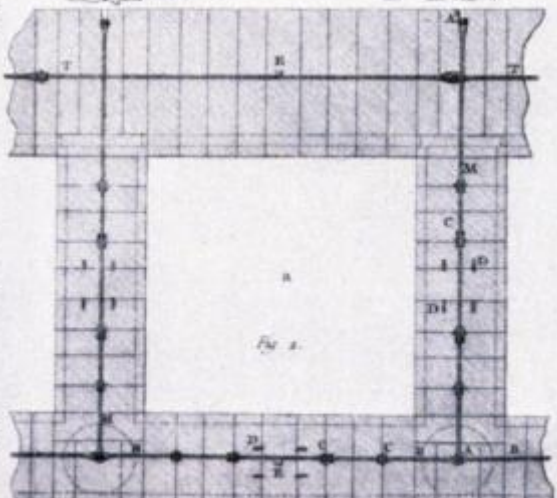
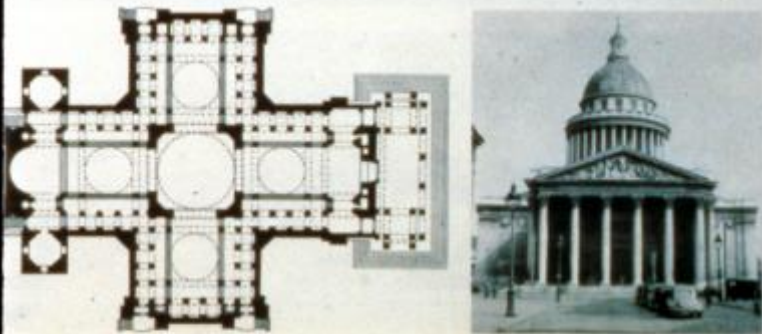
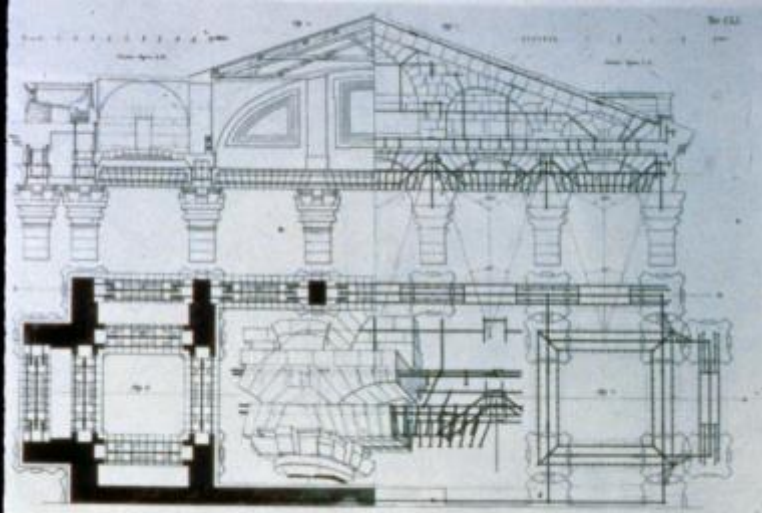


Fig. 2.

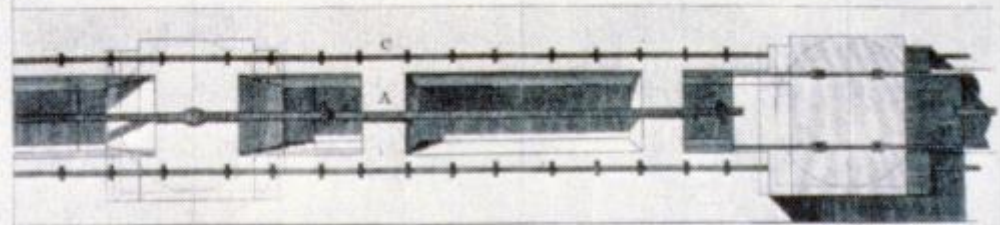
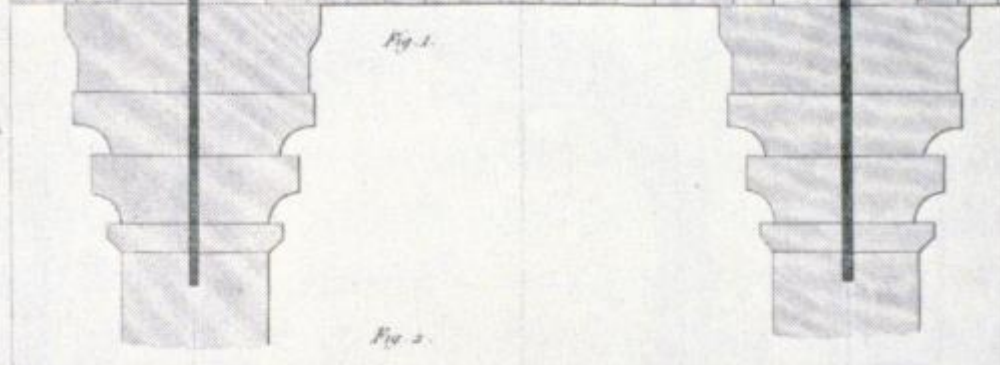
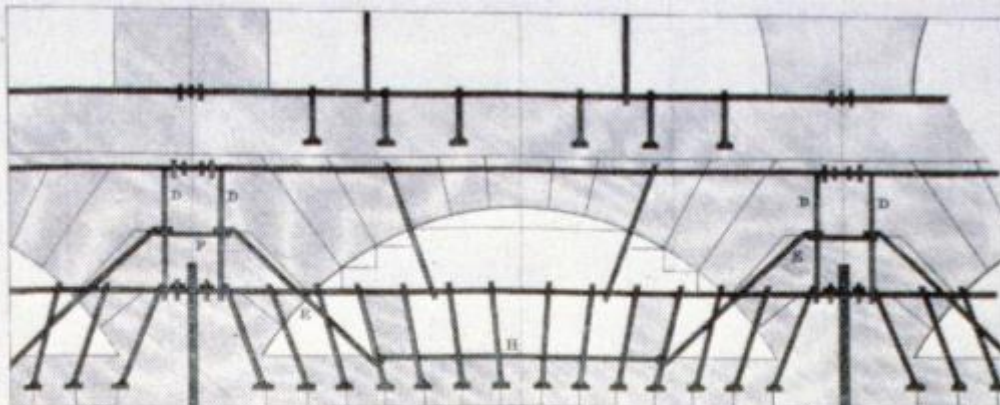
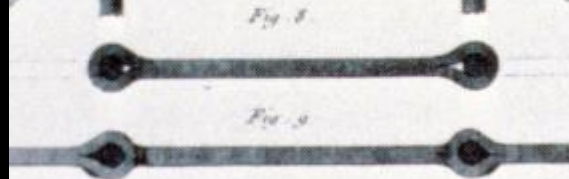
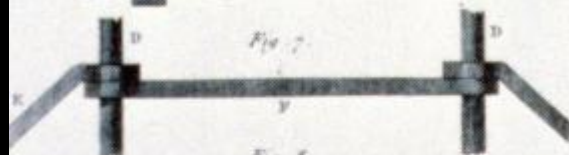
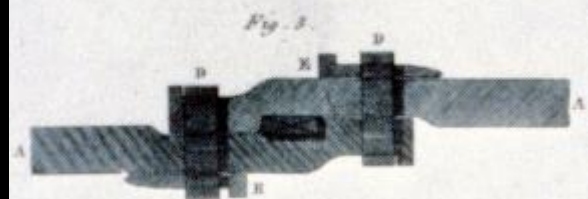
Échelle de 1/200 à Paris  
 construction des Planchettes de la Place de Louis XVI. à Paris.



Church of Ste. Genevieve  
(Pantheon)  
Paris, France  
Jacques-Germain Soufflot  
Jean-Baptiste Rondelet  
1789



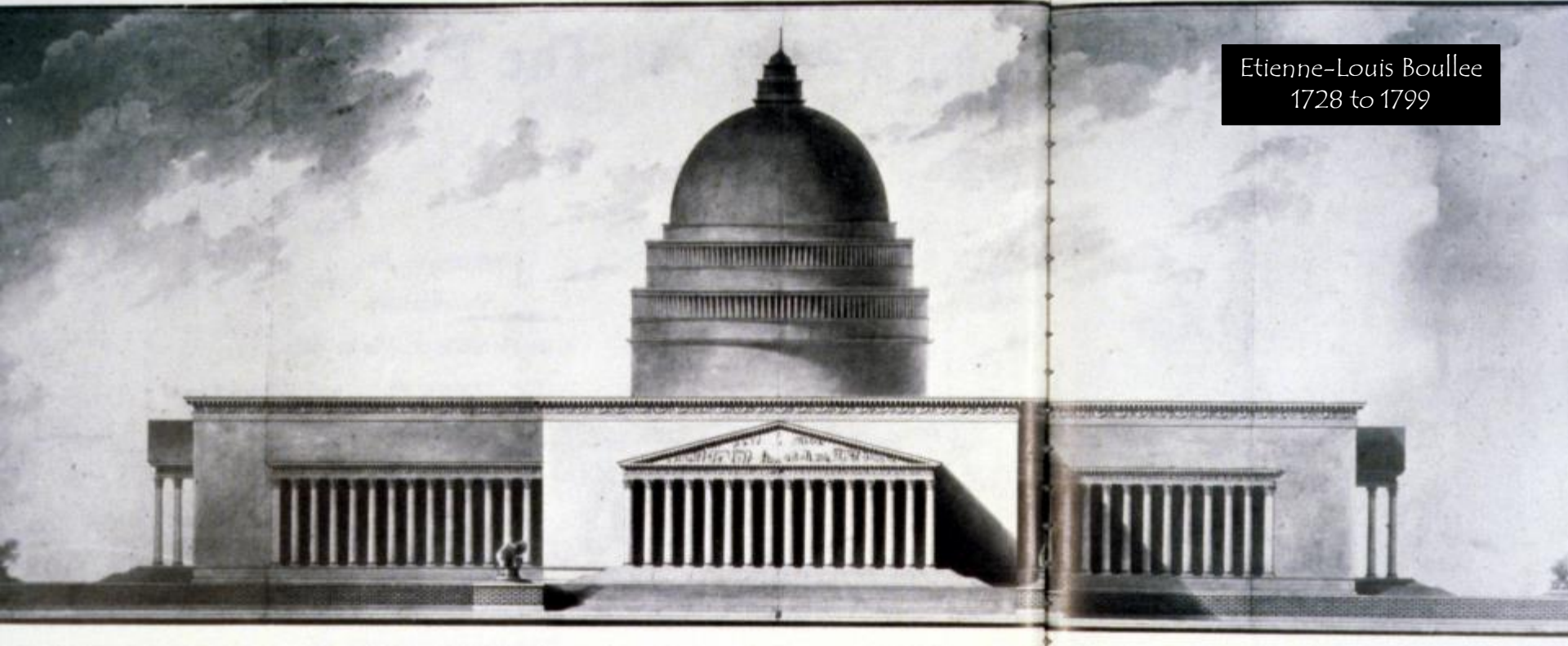
23, 24 Paris, Church of Ste-Genevieve (J. G. Soufflot, 1755): the iron skeleton of the pronaos (from Rondelet, Fig. 151); plan and facade

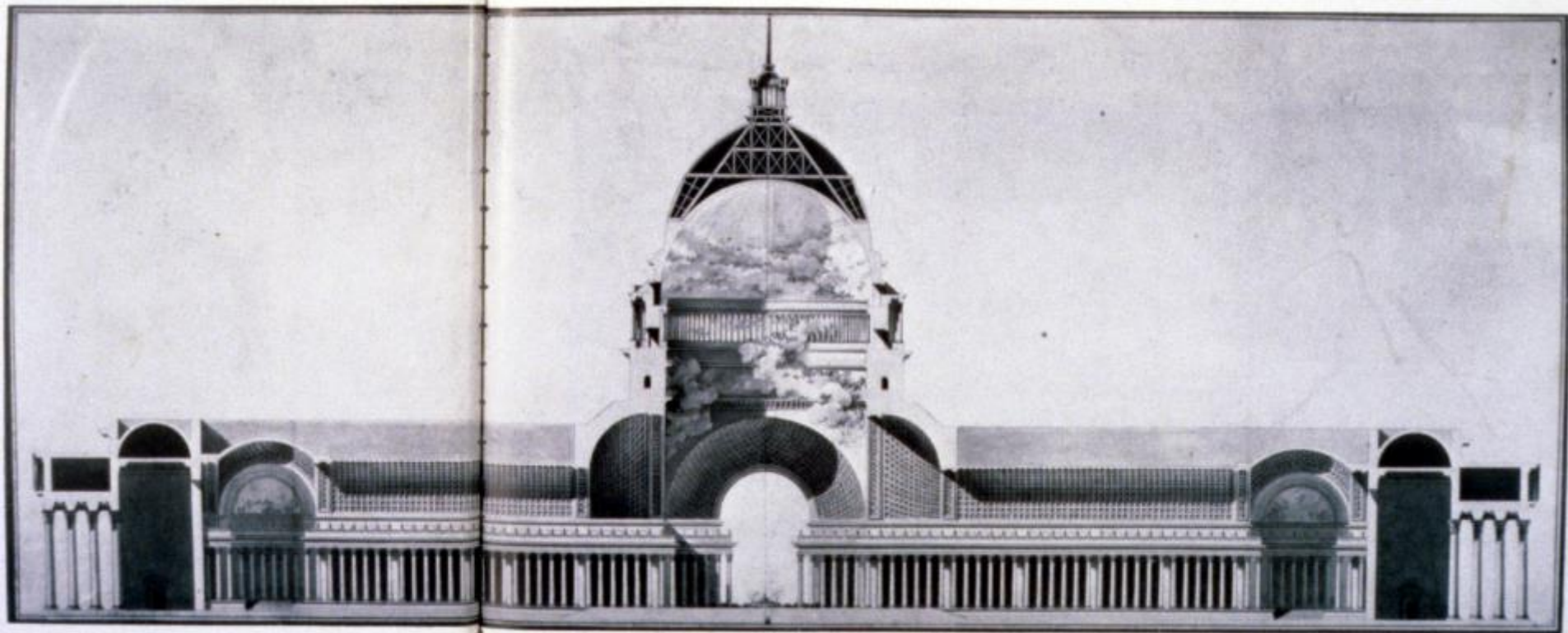


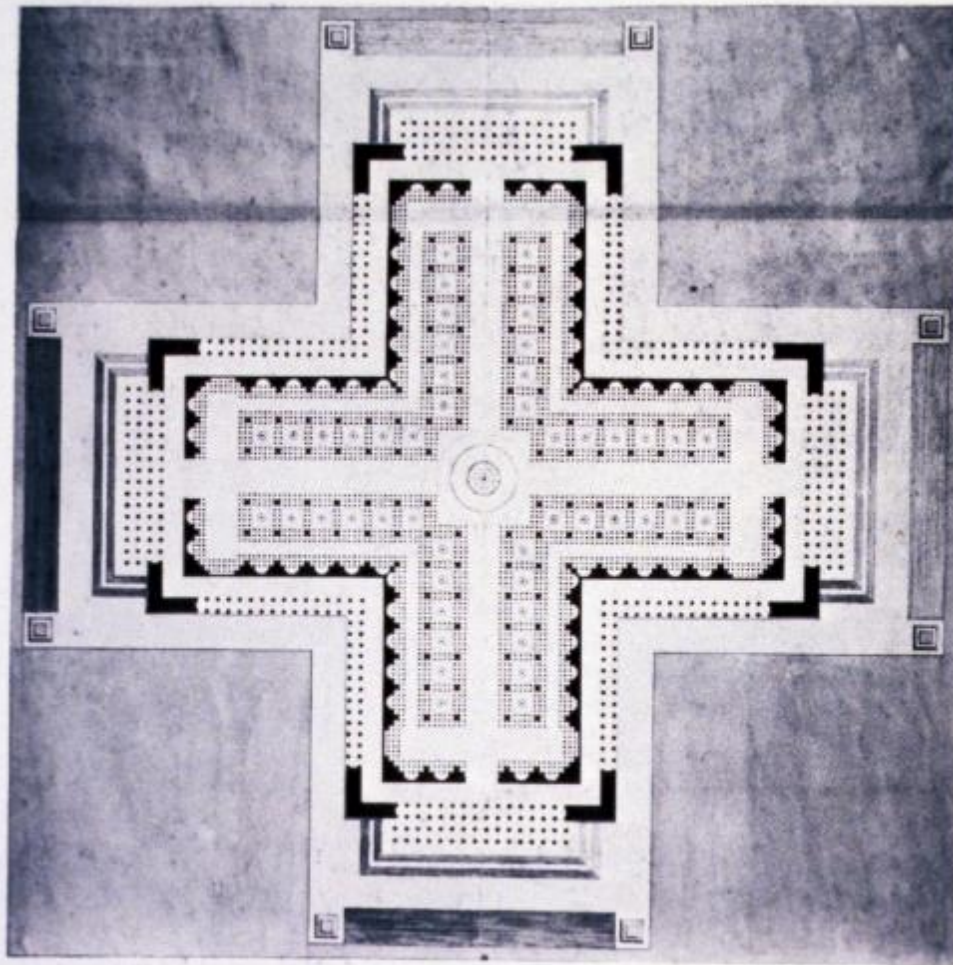
# Visionary Architecture



Etienne-Louis Boullée  
1728 to 1799

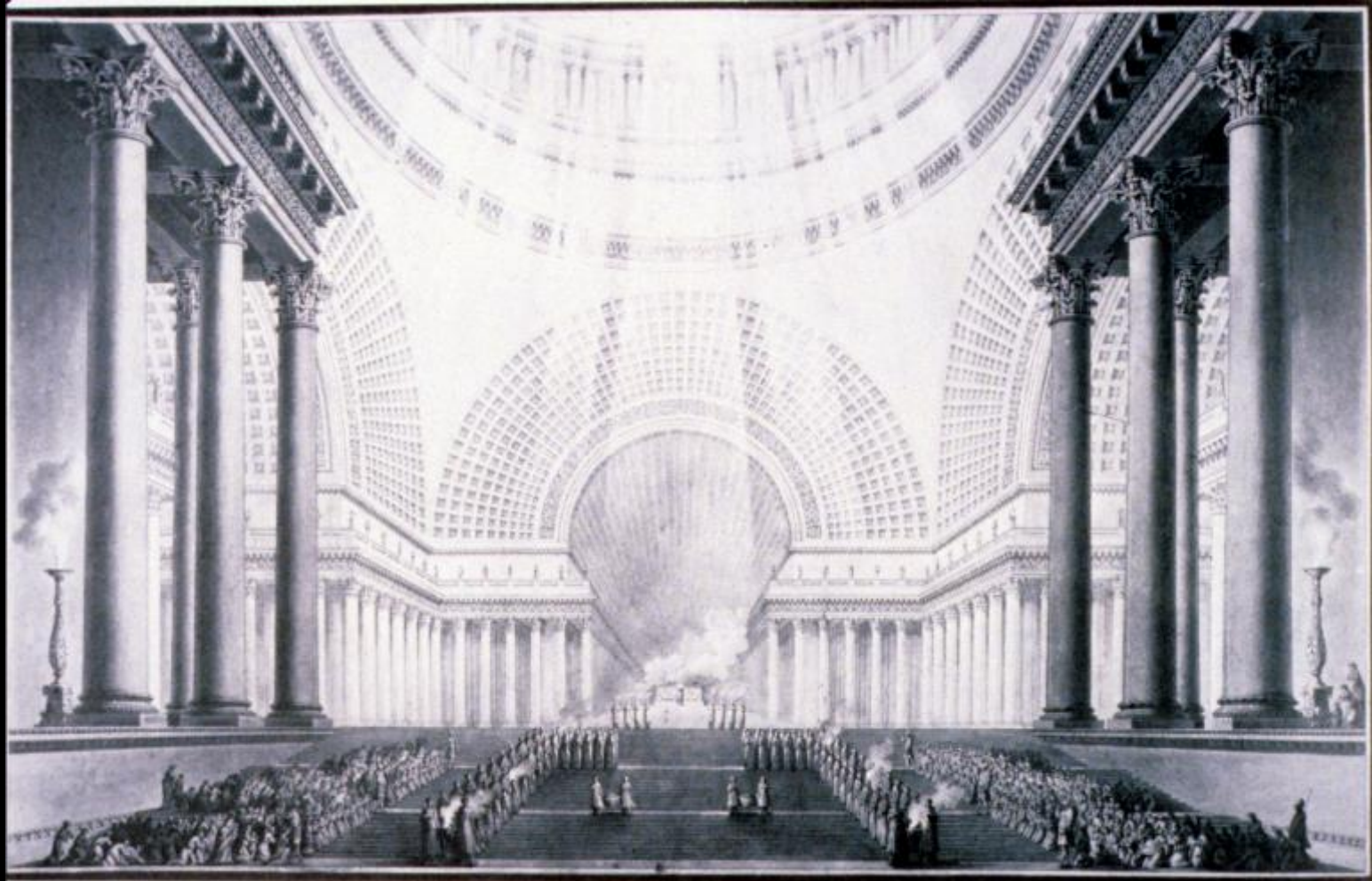






Metropole, ground plan (HA 56, no. 2)

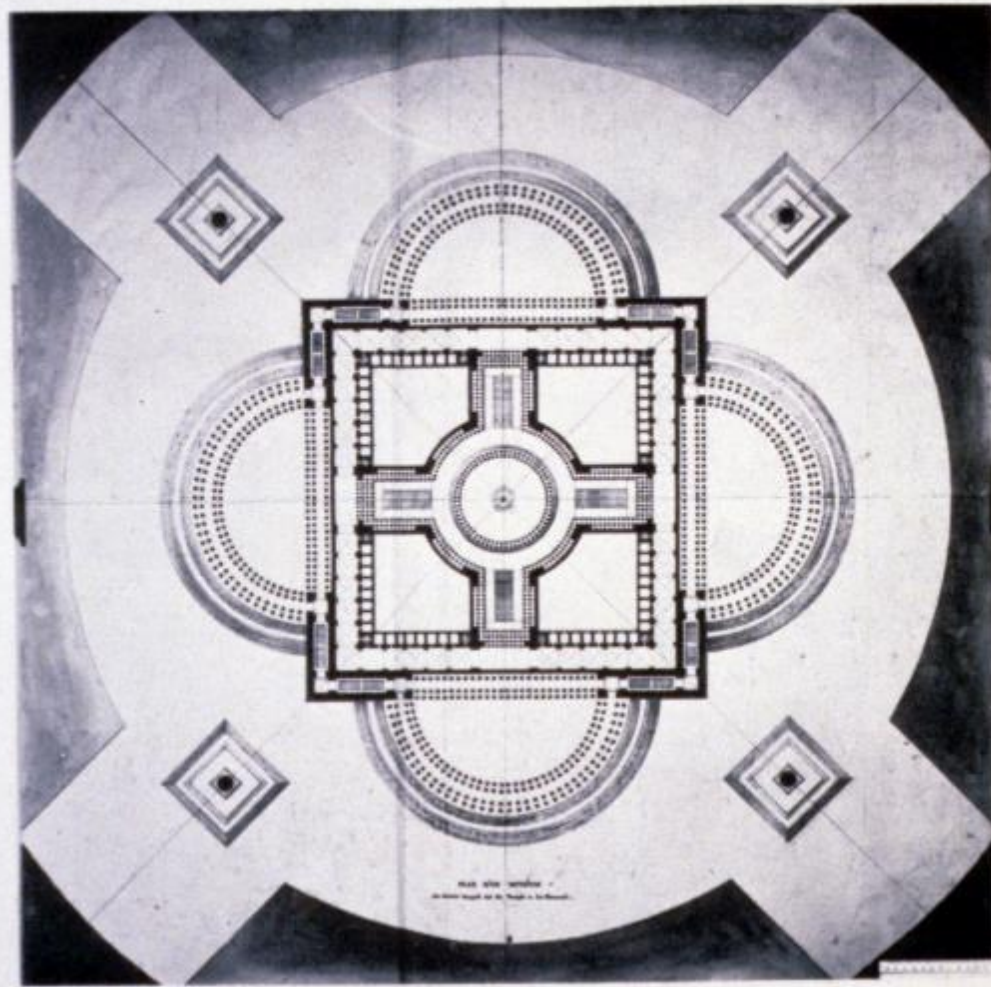


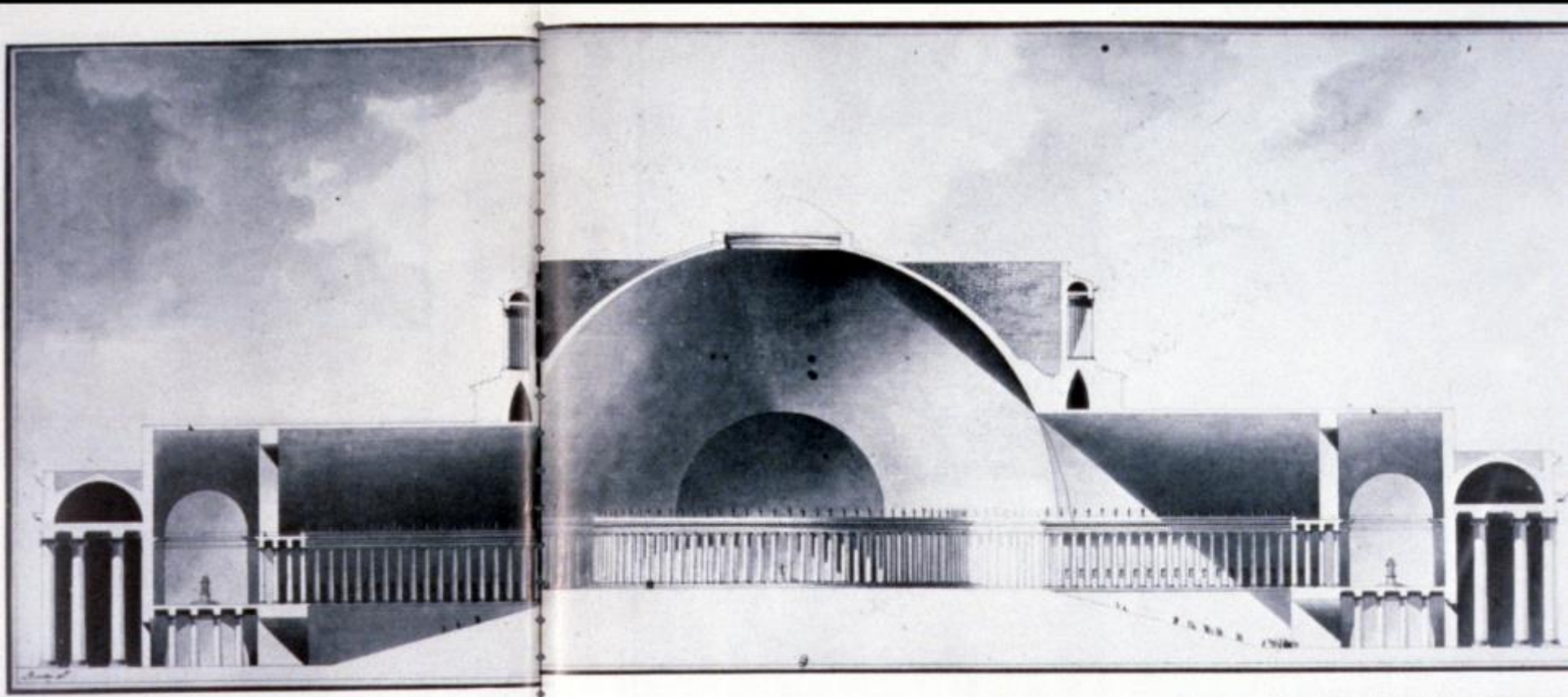


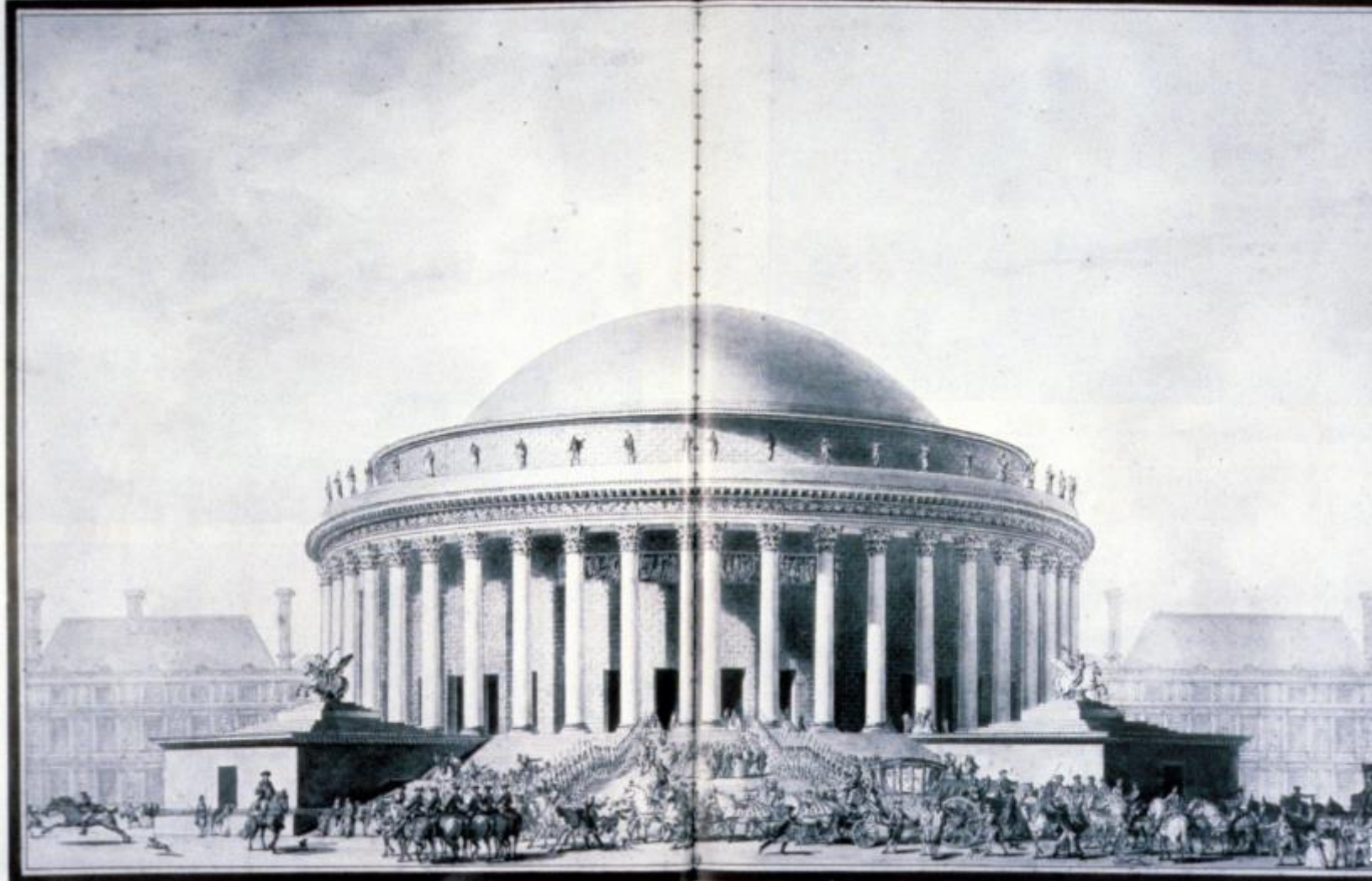
Metropole, interior view at Corpus Christi (HA 56, no. 8)



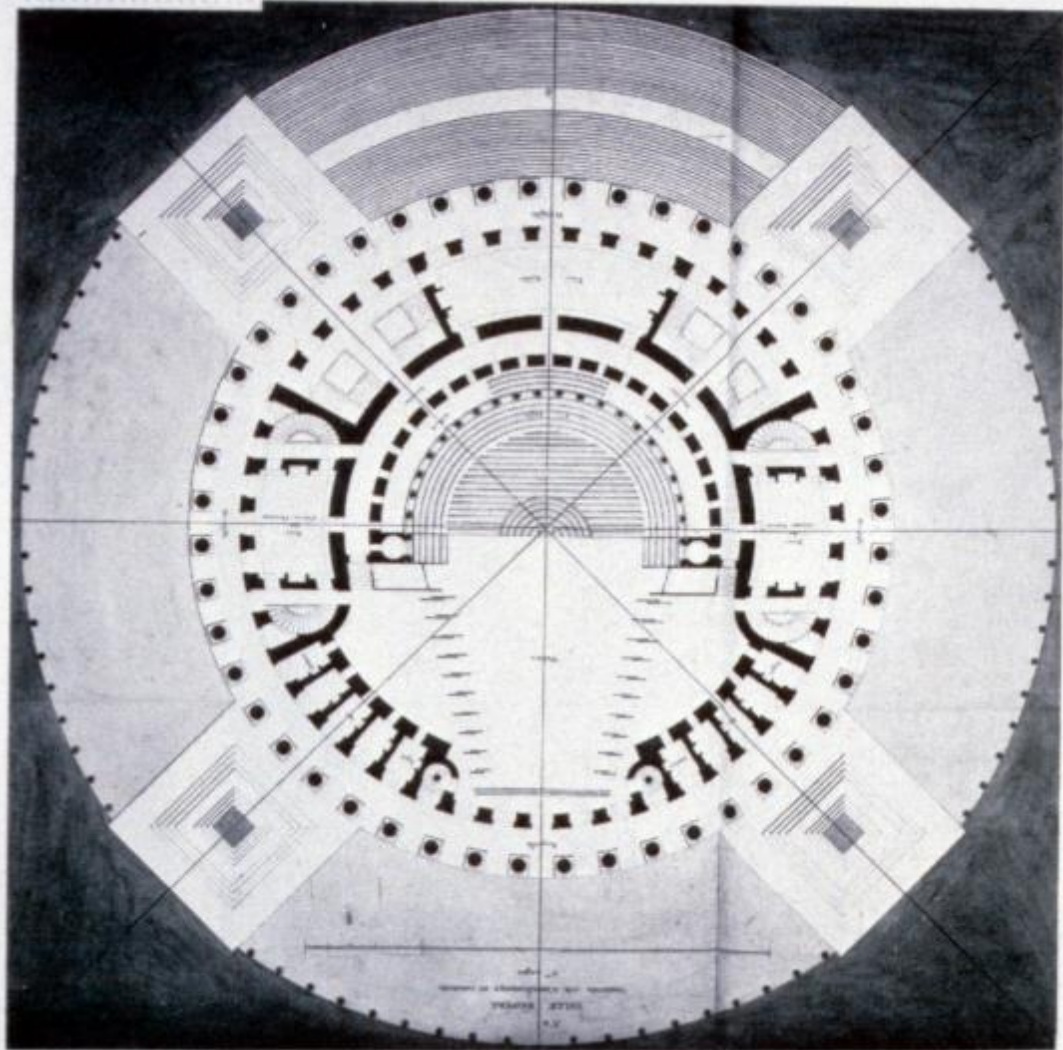
Museum, ground plan (HA 56, no. 26)

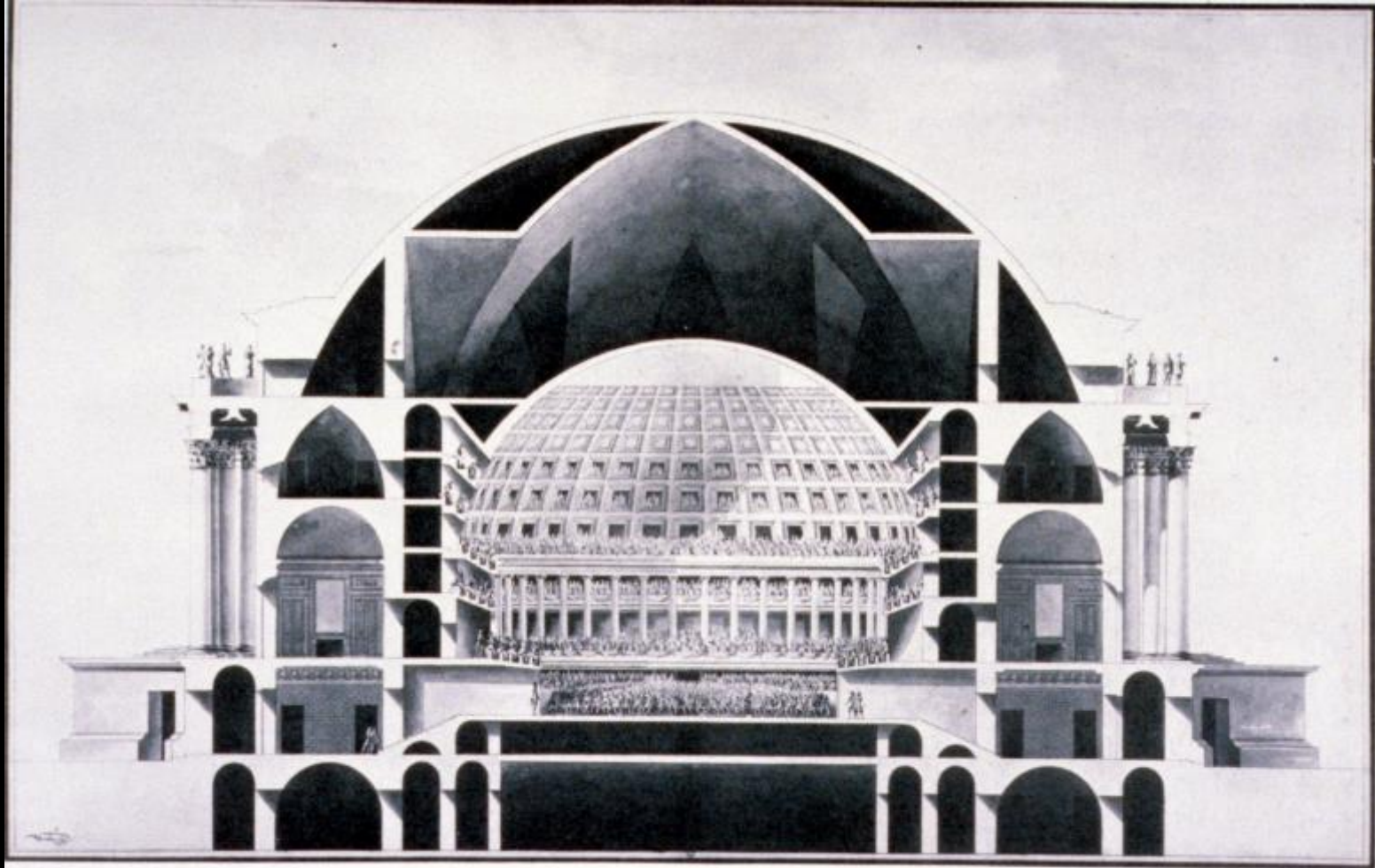




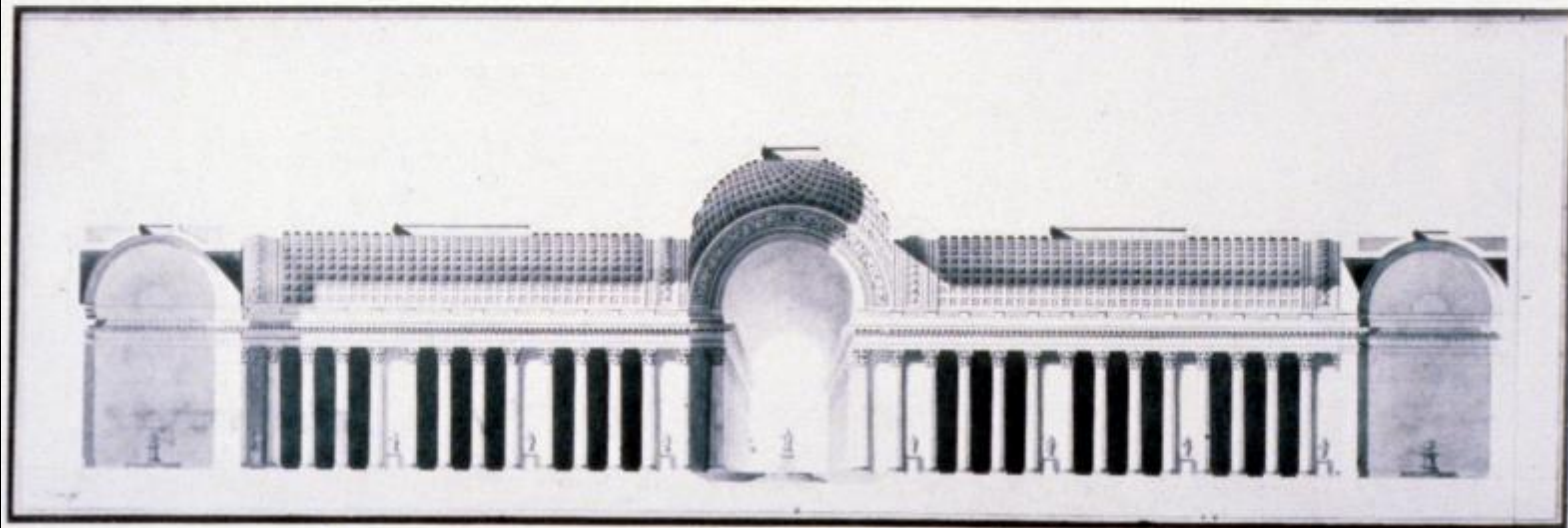
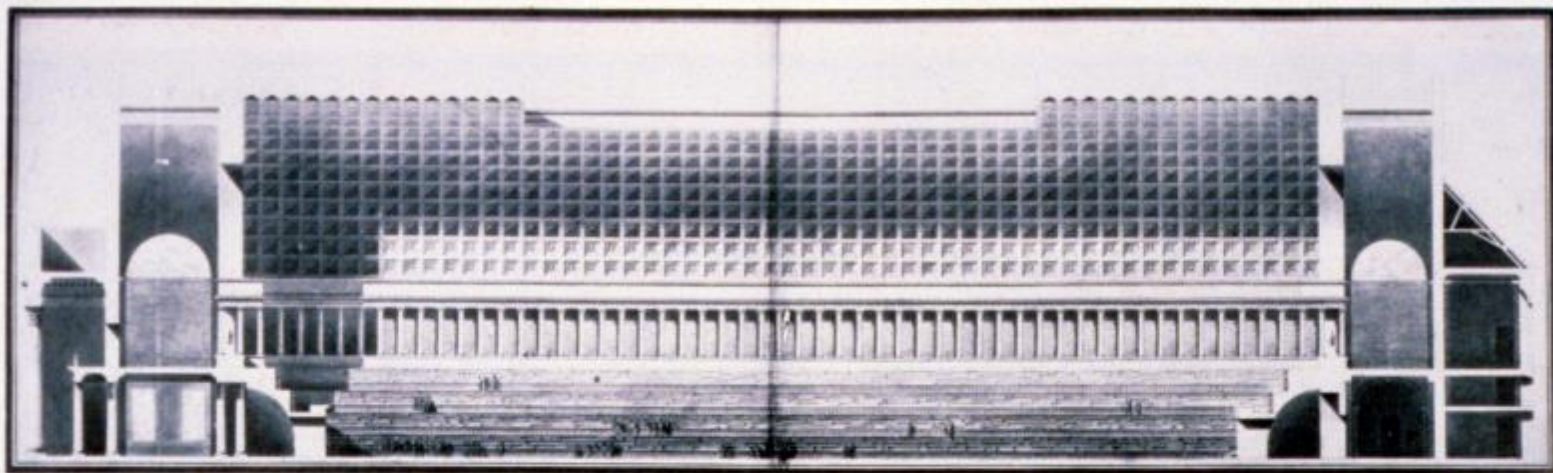








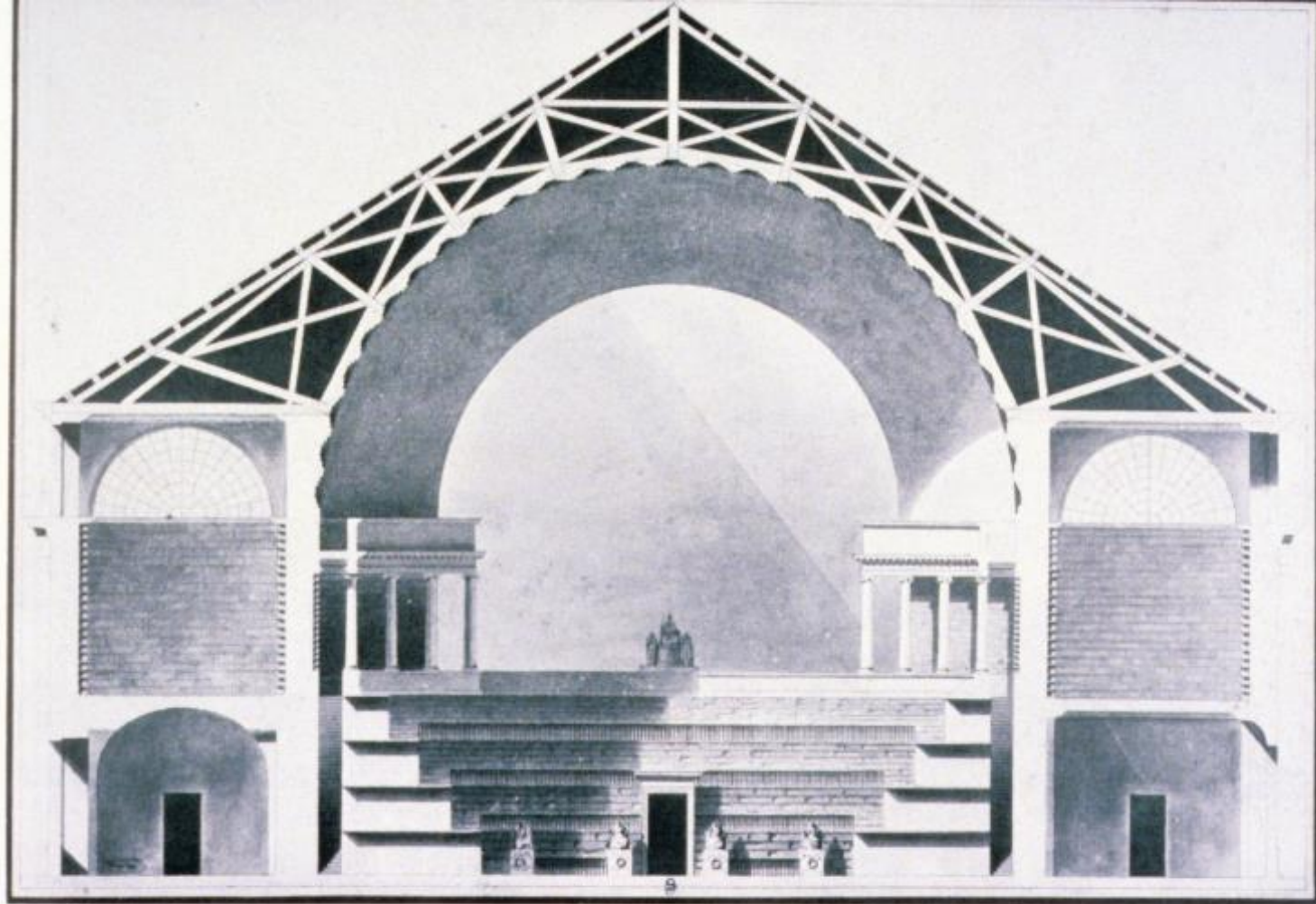
*Above: Opera, section facing the auditorium (HA 55, no. 10) Below: Opera, section facing the stage (HA 55, no. 11)*





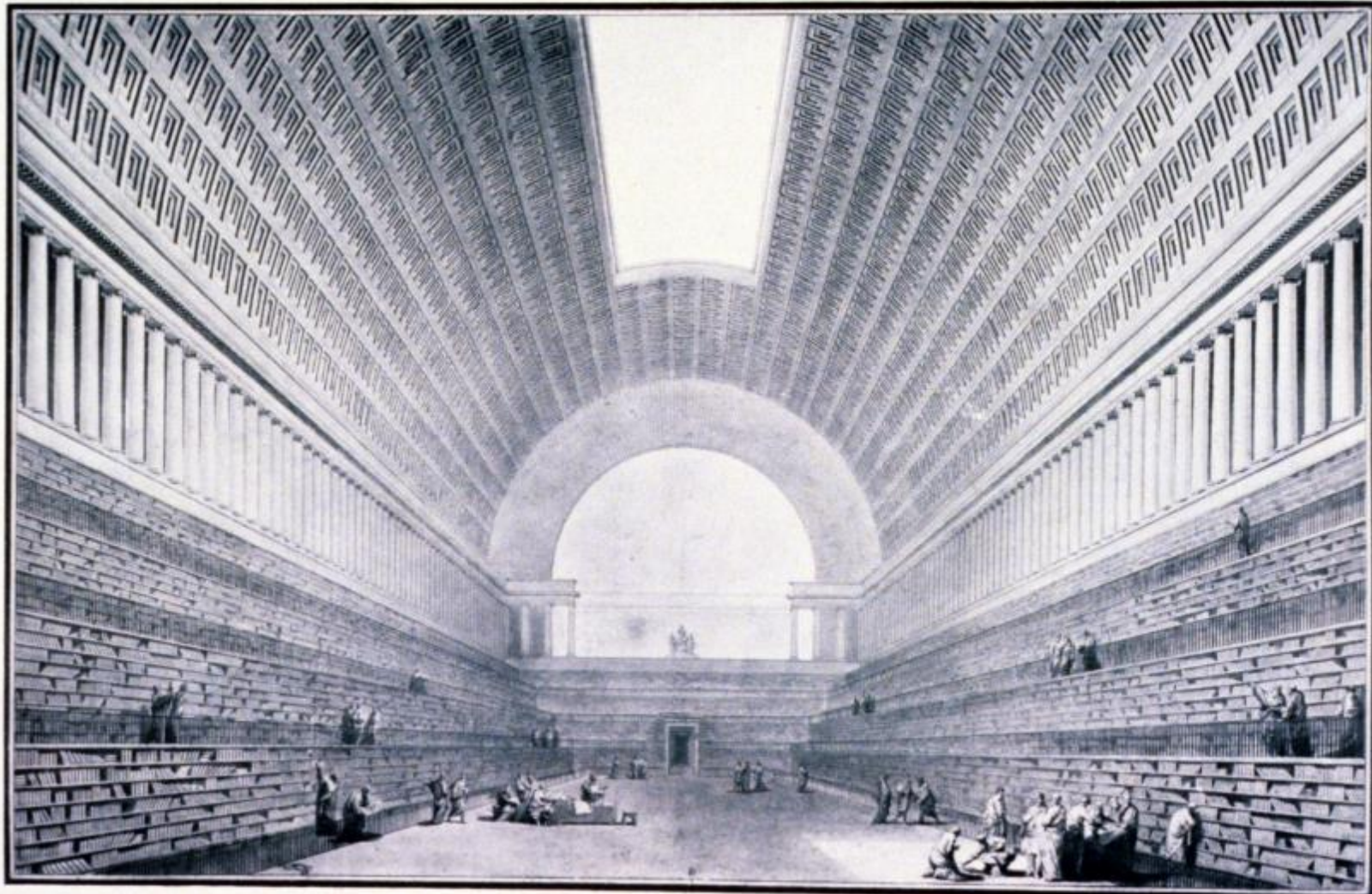


School of Athens  
Rafael

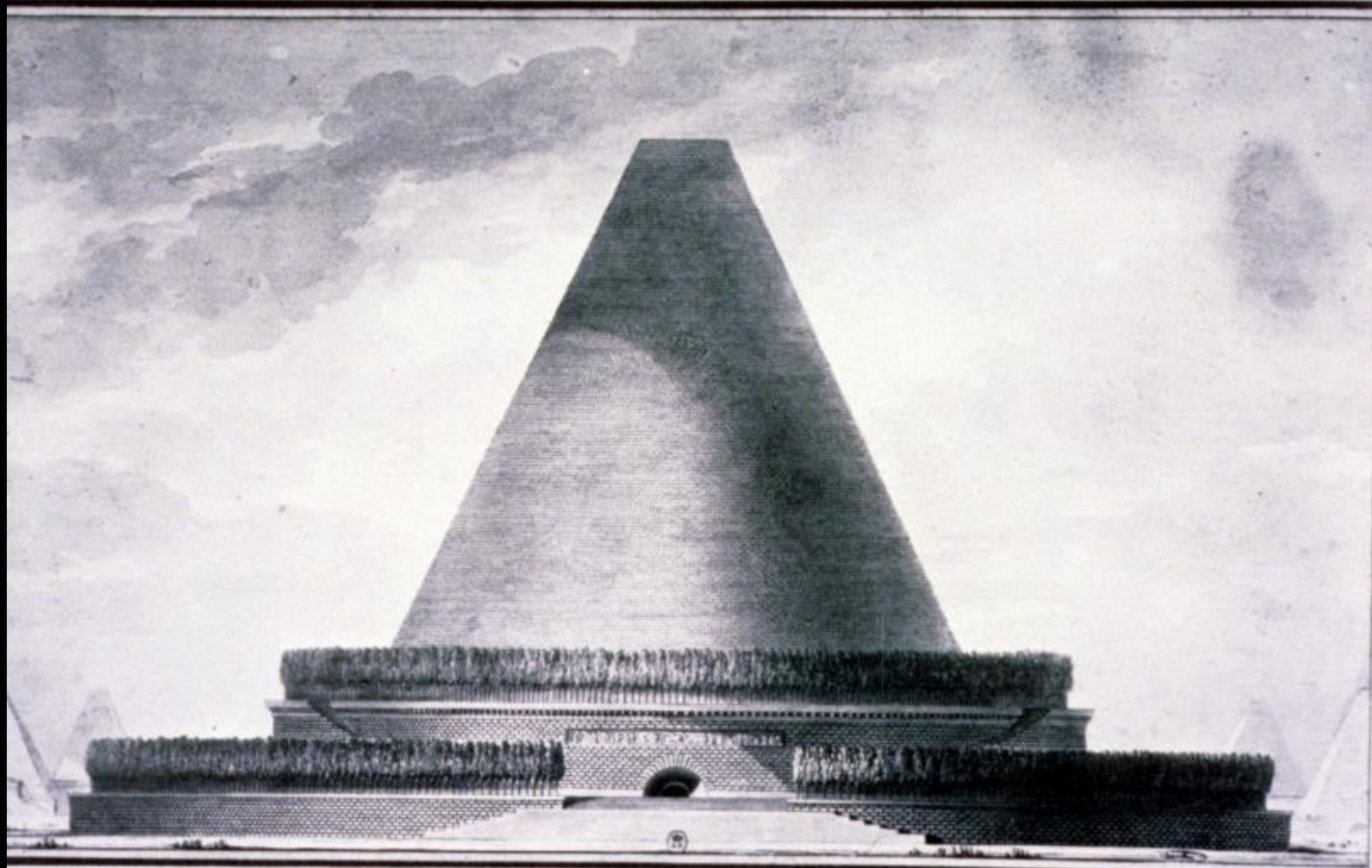


Bibliothèque Nationale, latitudinal section (HA 56, no. 42)





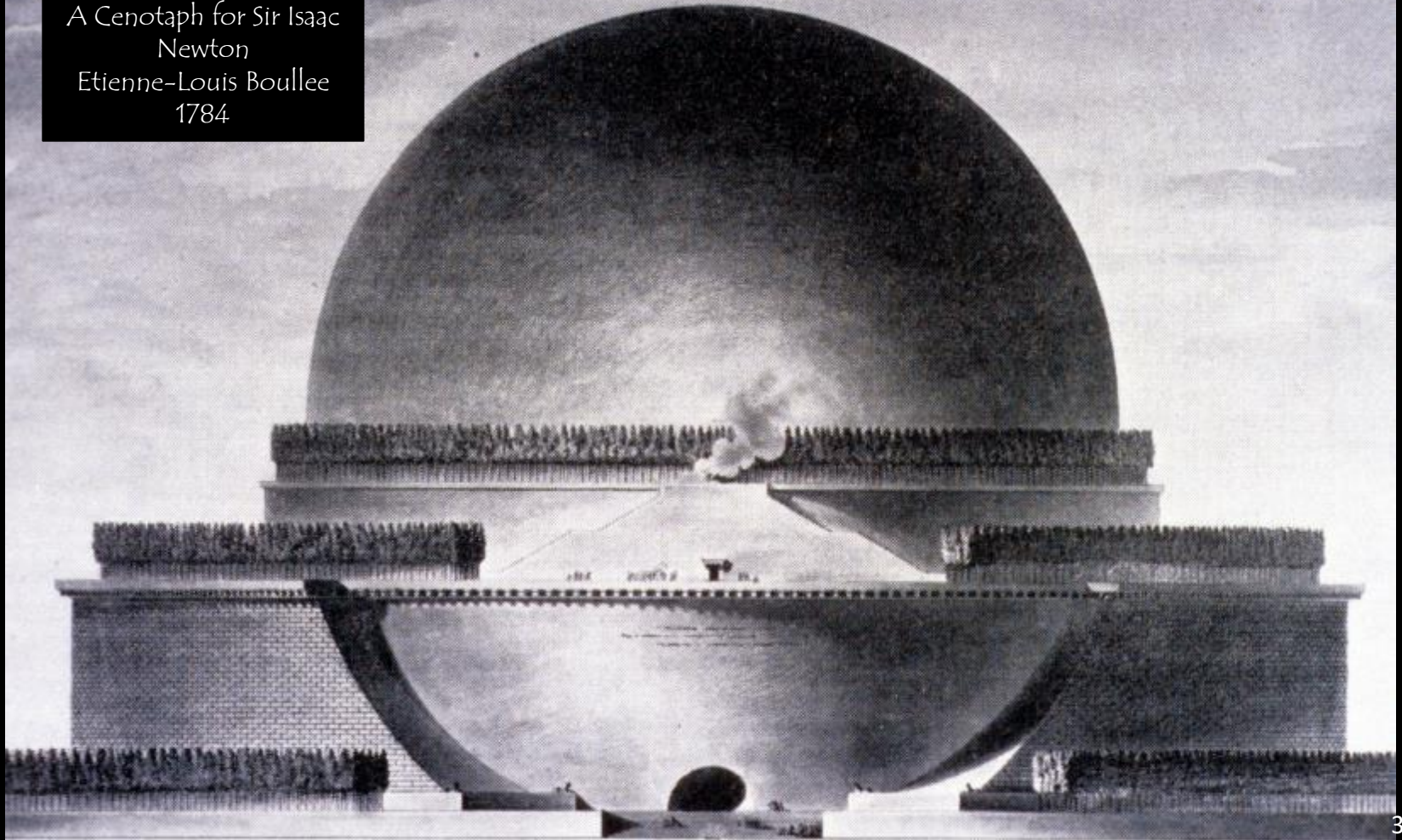




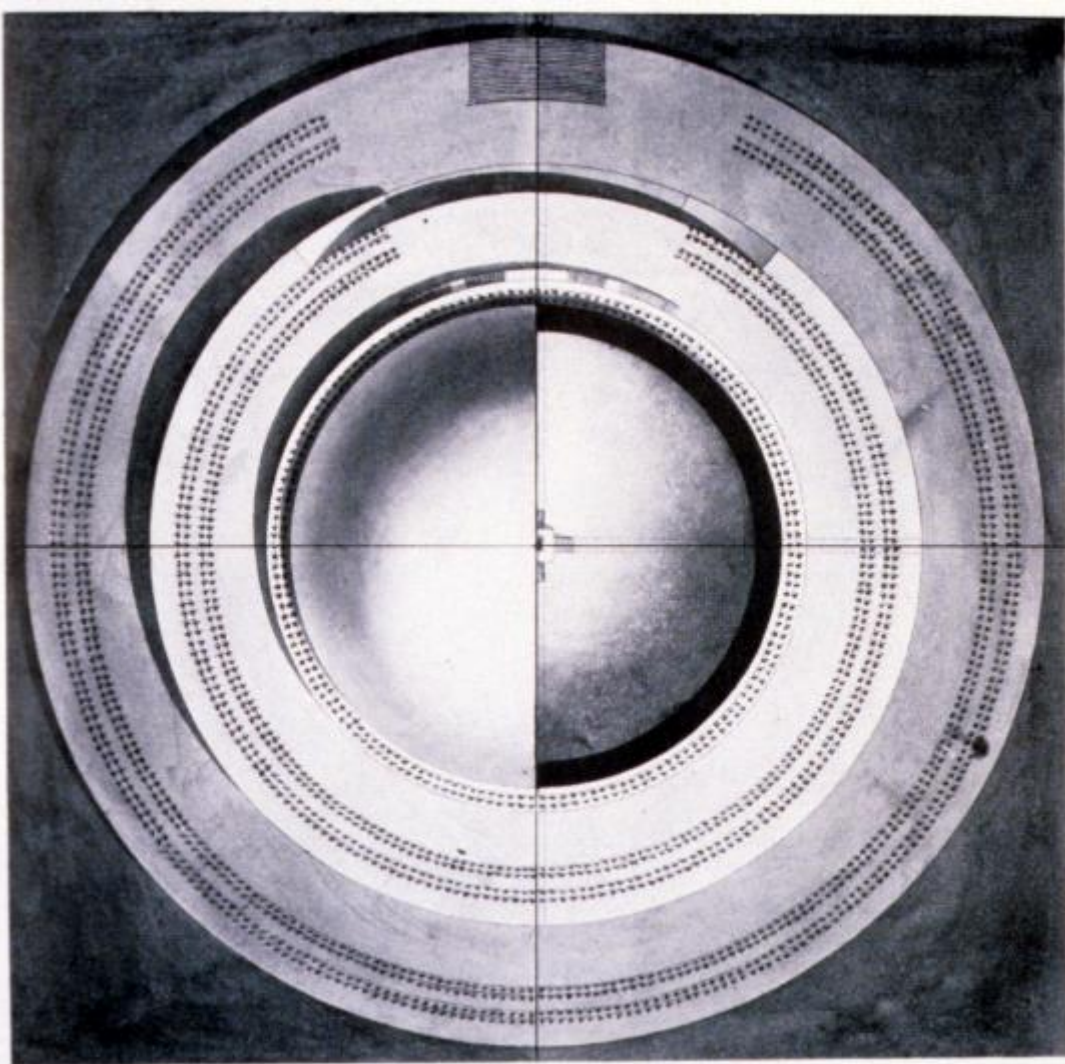


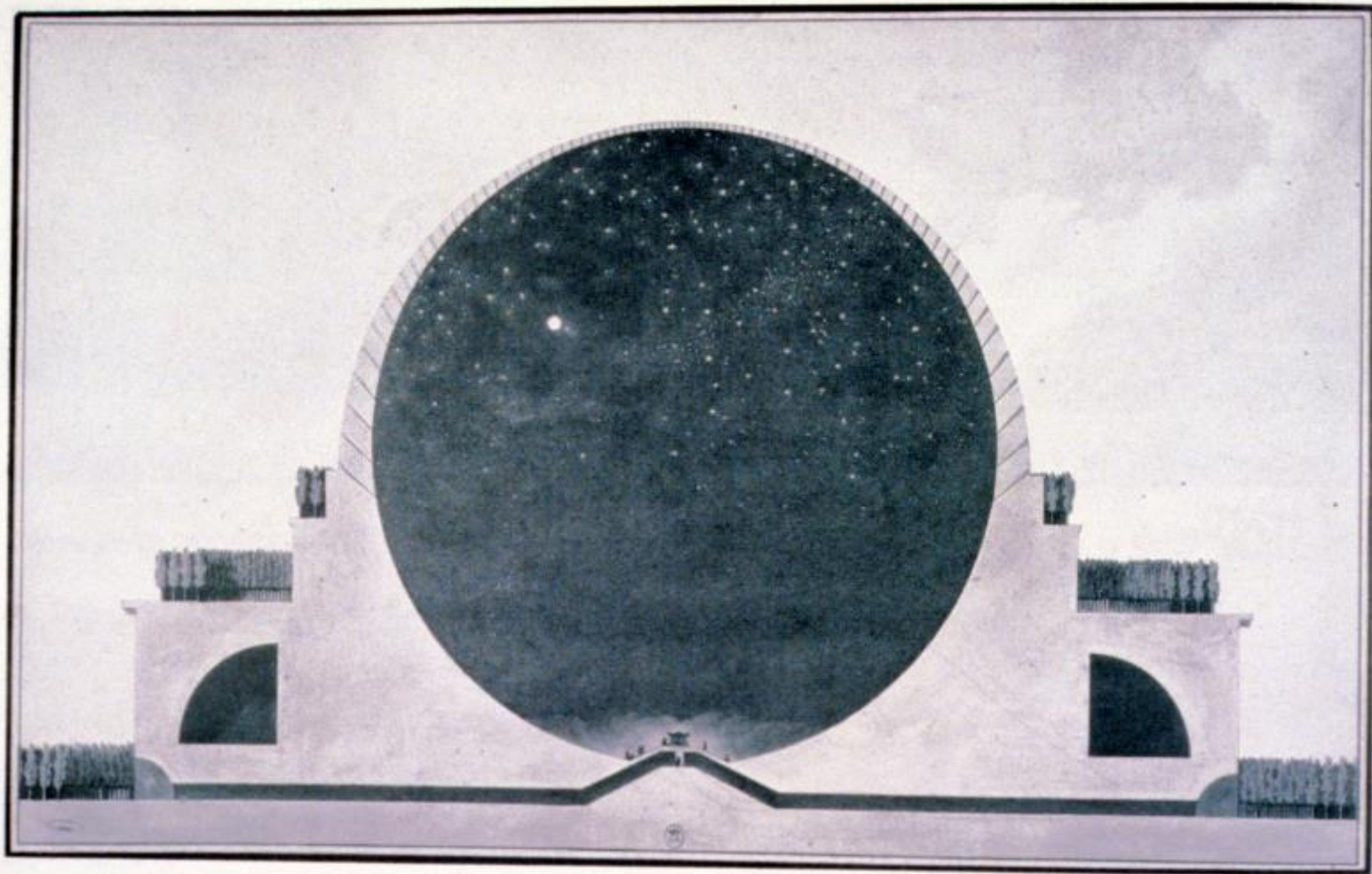


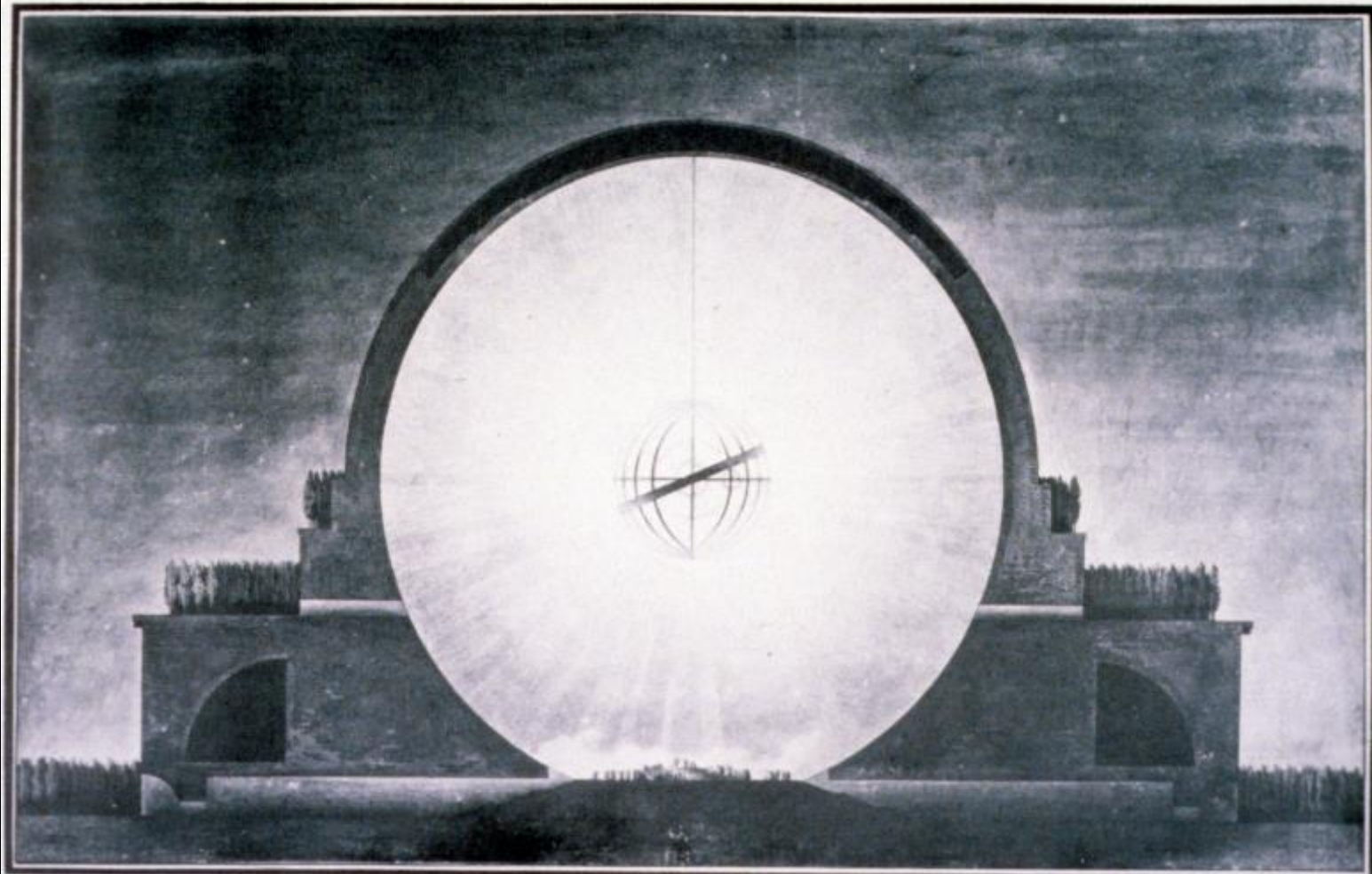
A Cenotaph for Sir Isaac  
Newton  
Etienne-Louis Boullée  
1784













3000 B.C.

Egyptians used mud mixed with straw to bind bricks. They used gypsum and lime mortars in the pyramids.



300 BC- 476 AD

Applian Way, Roman baths, the Colosseum and Pantheon used Pozzallana cement. Animal fat, milk and blood were used as admixtures.



# CONCRETE HISTORICAL TIMELINE

1793

John Smeaton used hydraulic lime to rebuild Eddystone Lighthouse in Cornwall, England



1824

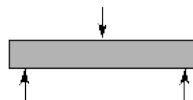
Joseph Aspdin of England invented portland cement by burning ground chalk with finely divided clay in a lime kiln until carbon dioxide is driven off. The product was then ground.



## 3000 B.C.- PRESENT

1836

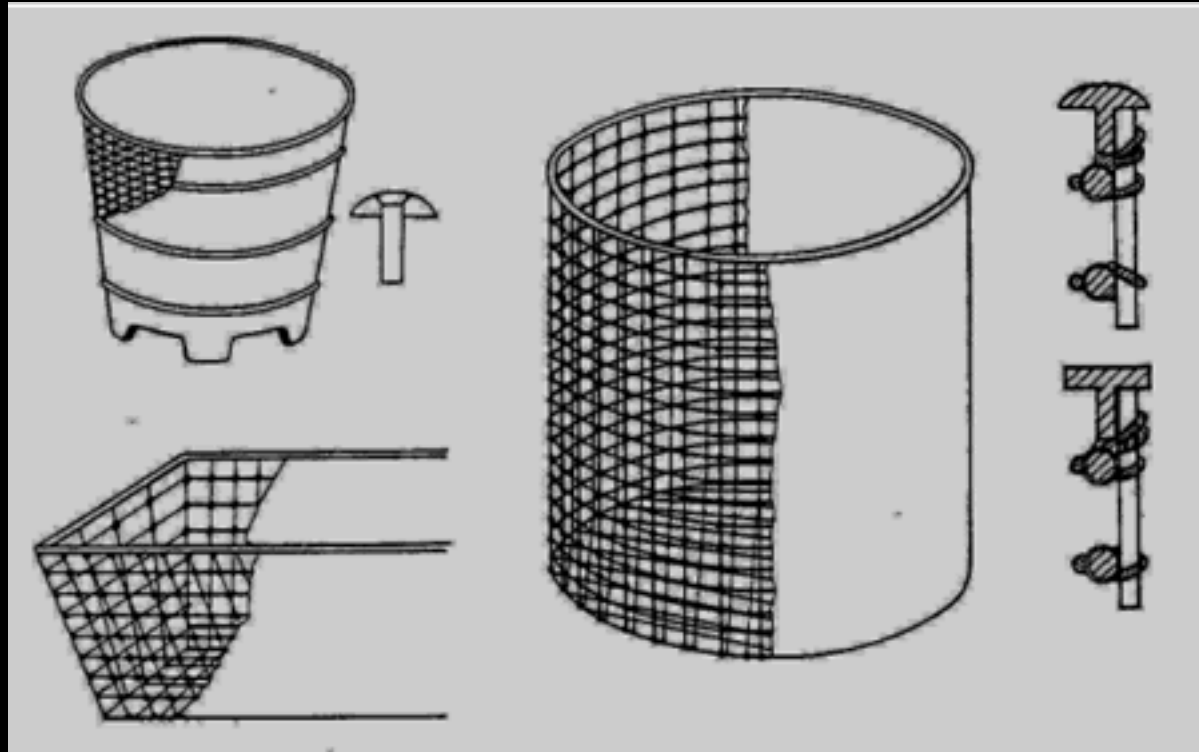
The first systematic test of tensile and compressive strength took place in Germany



1867

Joseph Monier of France reinforced flower pots with wire ushering in the idea of iron reinforcing bars.





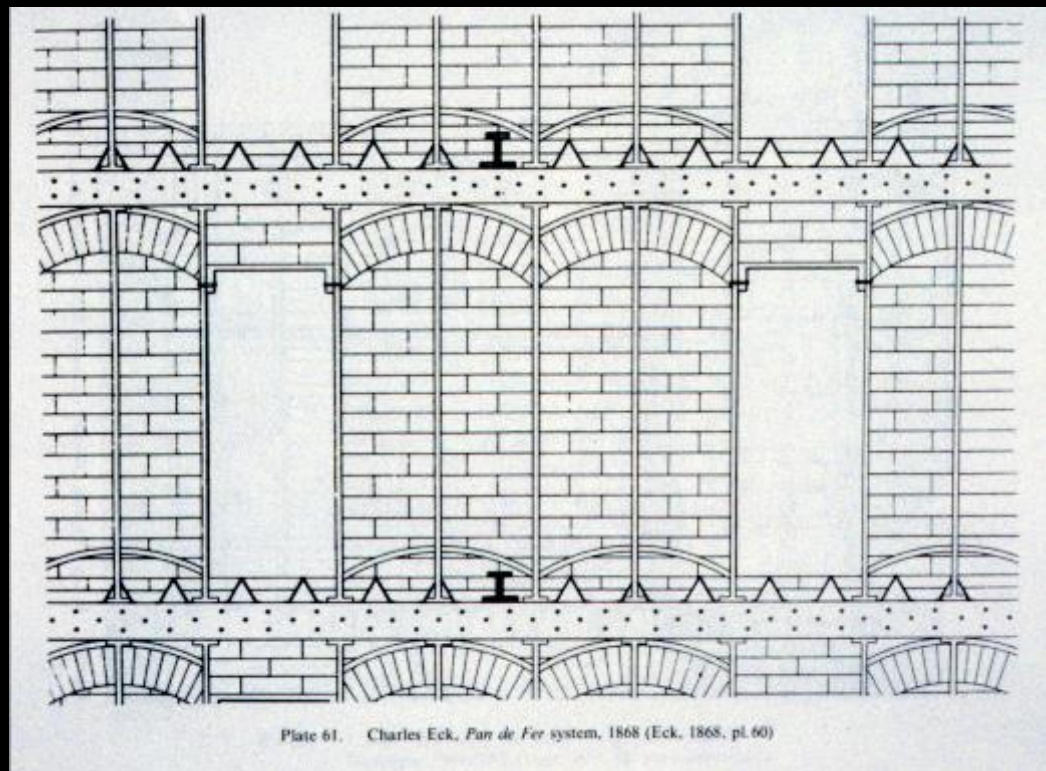


Plate 61. Charles Eck, *Pan de Fer* system, 1868 (Eck, 1868, pl. 60)

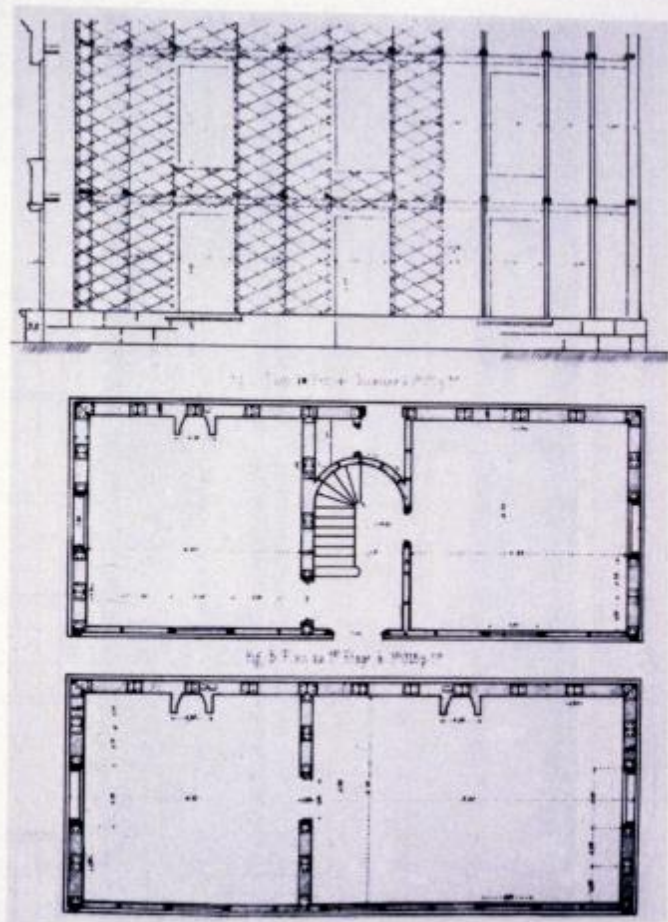


Plate 59. Lacroix system of framing with iron and cement or concrete (*Nouvelle annales de la construction*, X, January, 1864, pl. 7)



1886  
First rotary kiln was introduced in England, which allowed for continuous production of cement.



1889  
First concrete reinforced bridge was built.



1891  
First concrete street in the USA was placed in Bellefontaine, Ohio by George Bartholomew



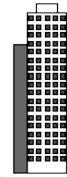
1936  
First major concrete dams, the Hoover Dam and Grand Coulee Dam, were built.

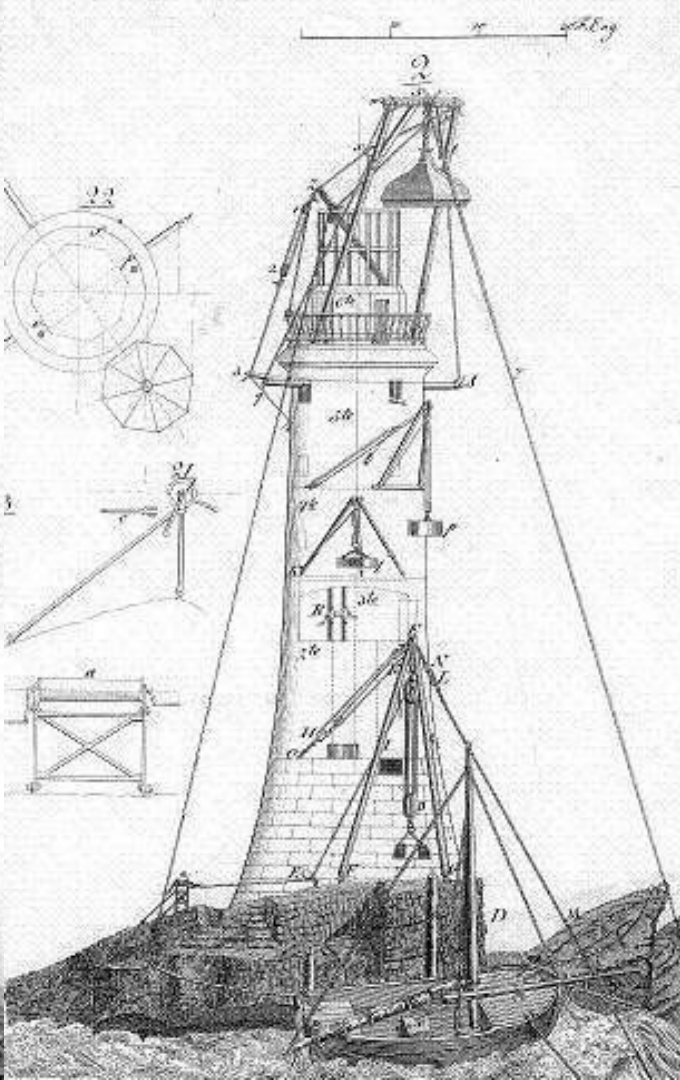
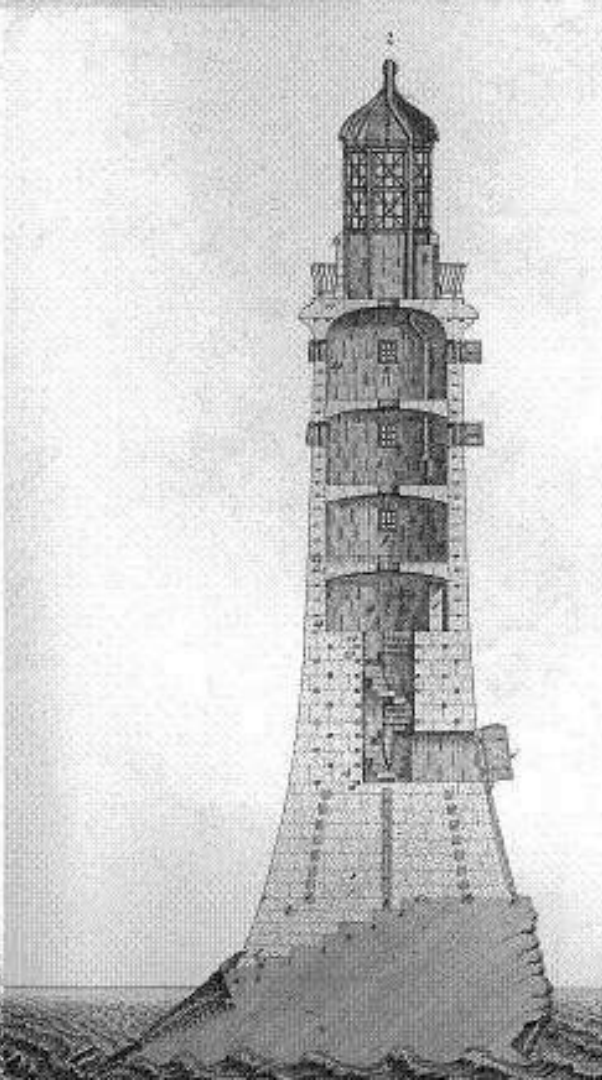
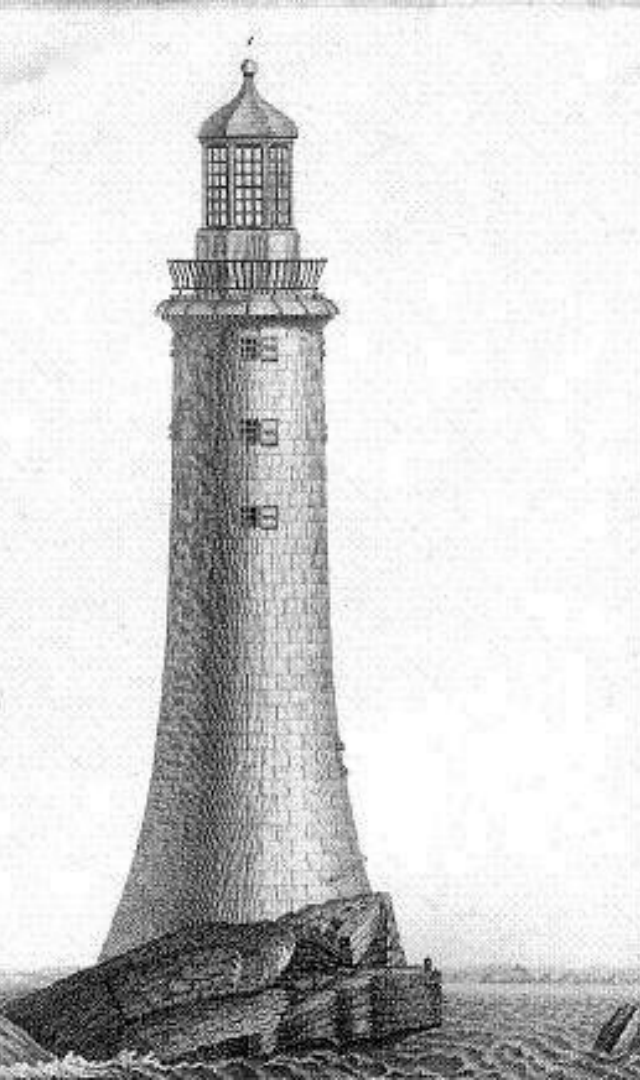


1967  
First concrete dome sport structure constructed at the University of Illinois, Assembly Hall



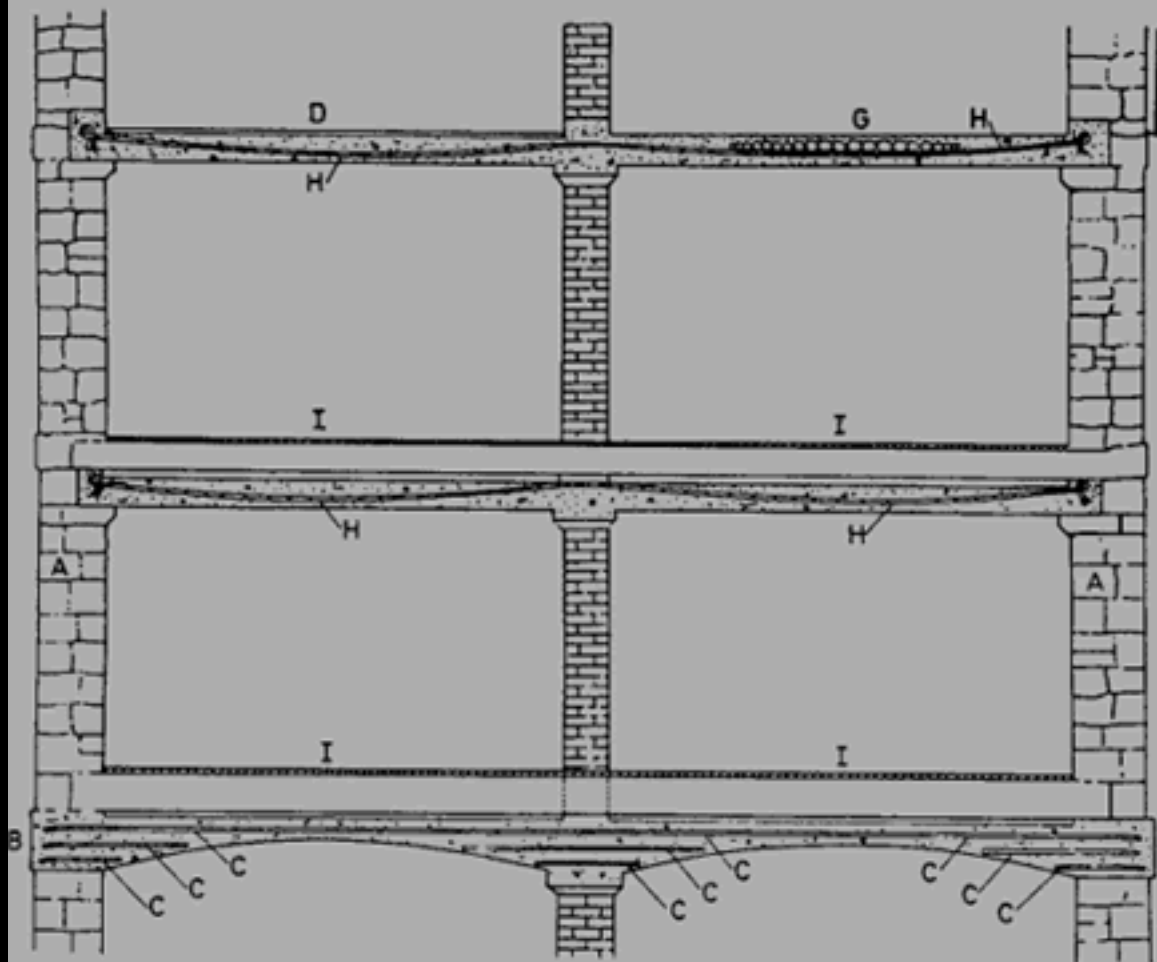
1992  
Tallest reinforced building (946 ft) constructed in Chicago, IL

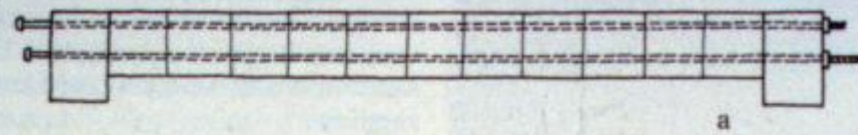




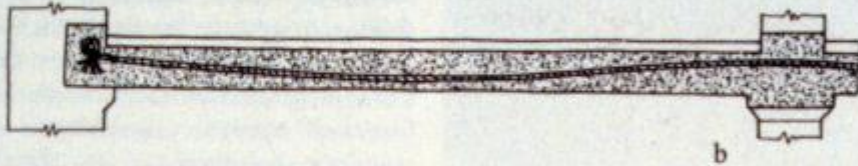
# Concrete as STRUCTURE







a



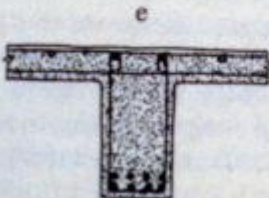
b



c



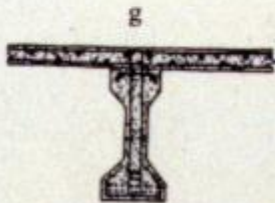
d



e



f



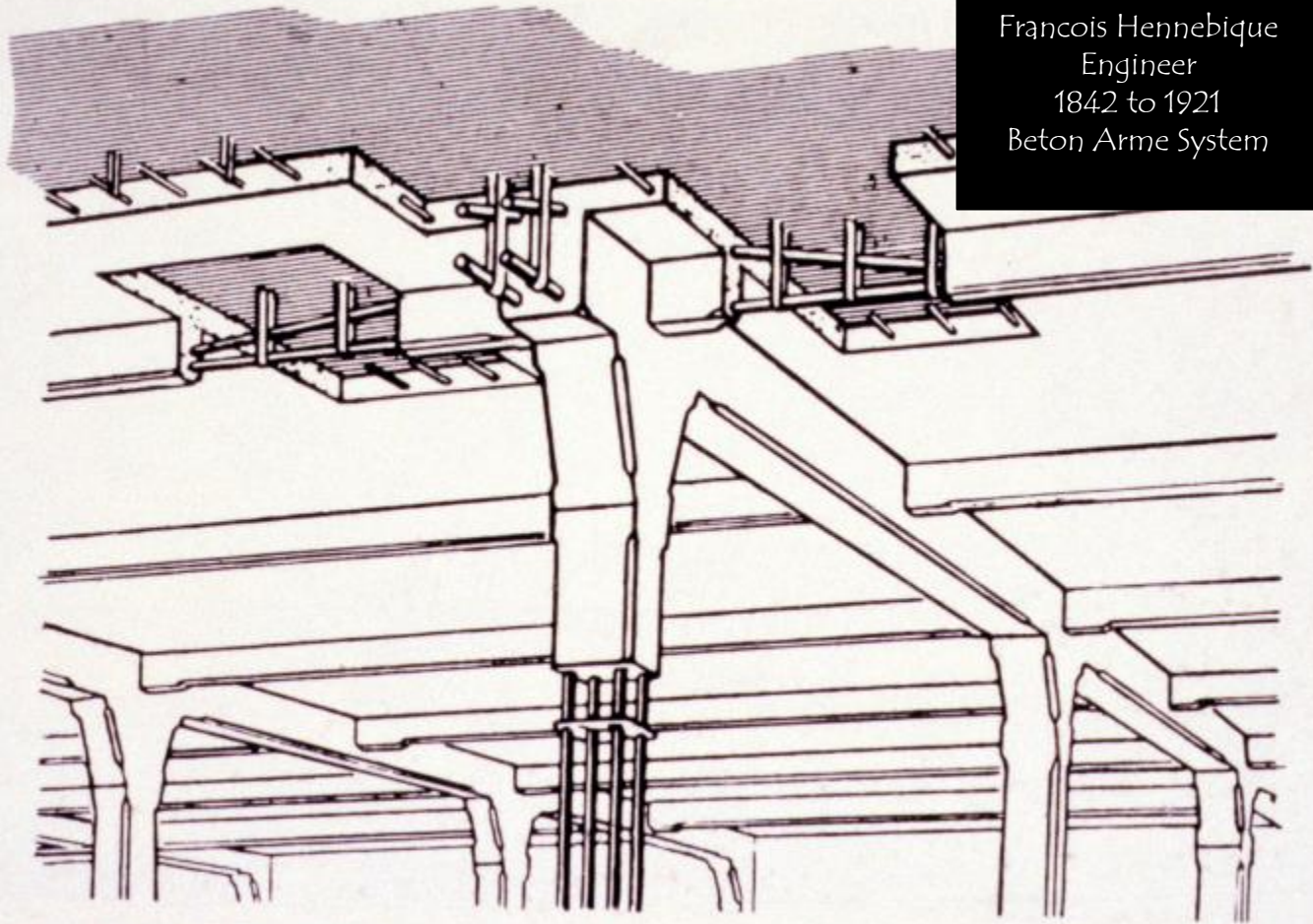
g

8.10 Reinforced-masonry, reinforced-concrete, and prestressed-concrete beams: [a] Pope, 1811; [b] Wilkinson, 1854 patent; [c] Hennebique, 1897 patent; [d, e, f] modern reinforced-concrete; [g] modern prestressed-concrete.

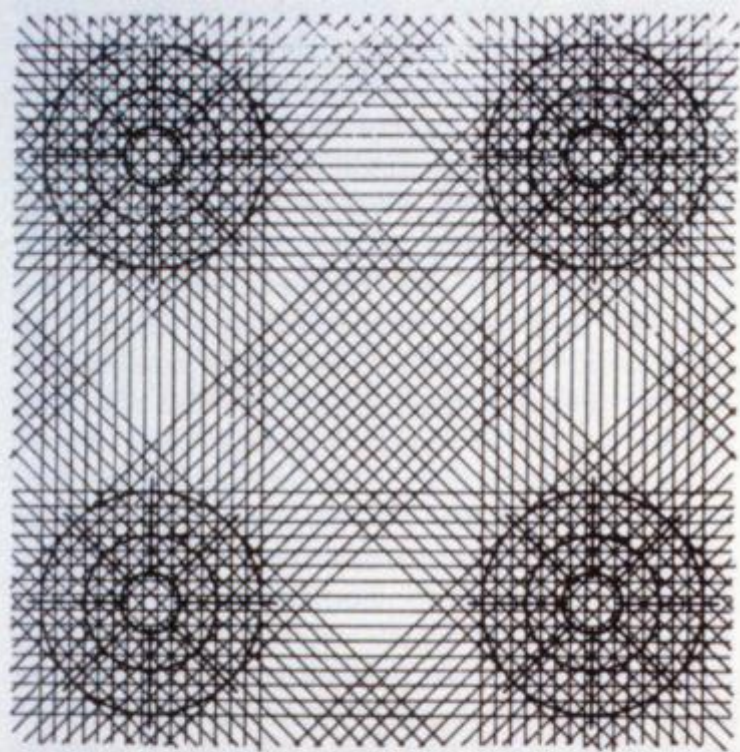




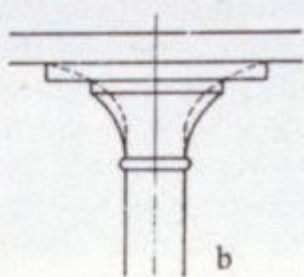
Francois Hennebique  
Engineer  
1842 to 1921  
Beton Arme System



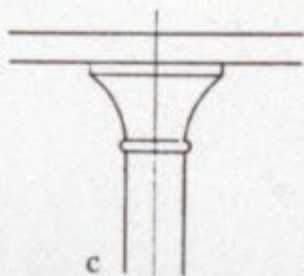
16 Hennebique, patent reinforced concrete frame construction, 1892.



a

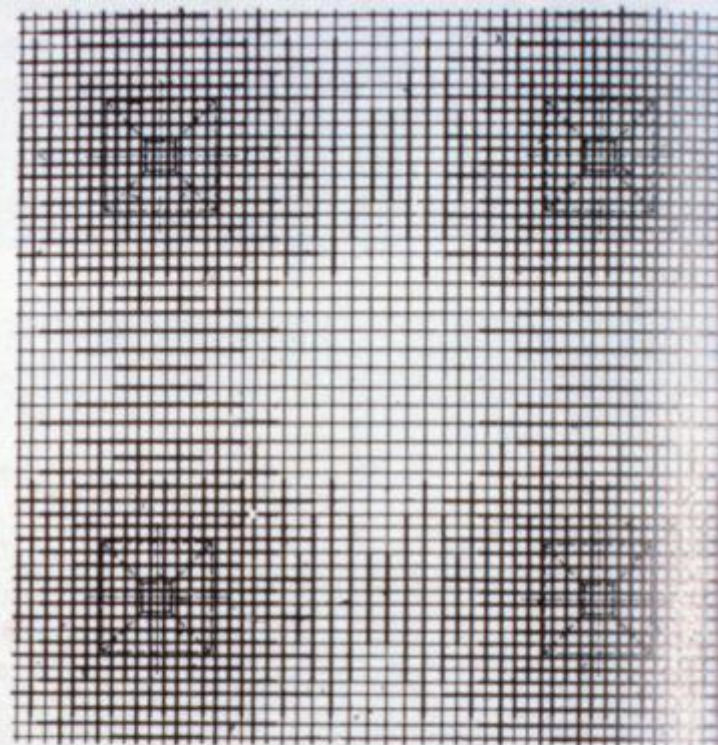


b



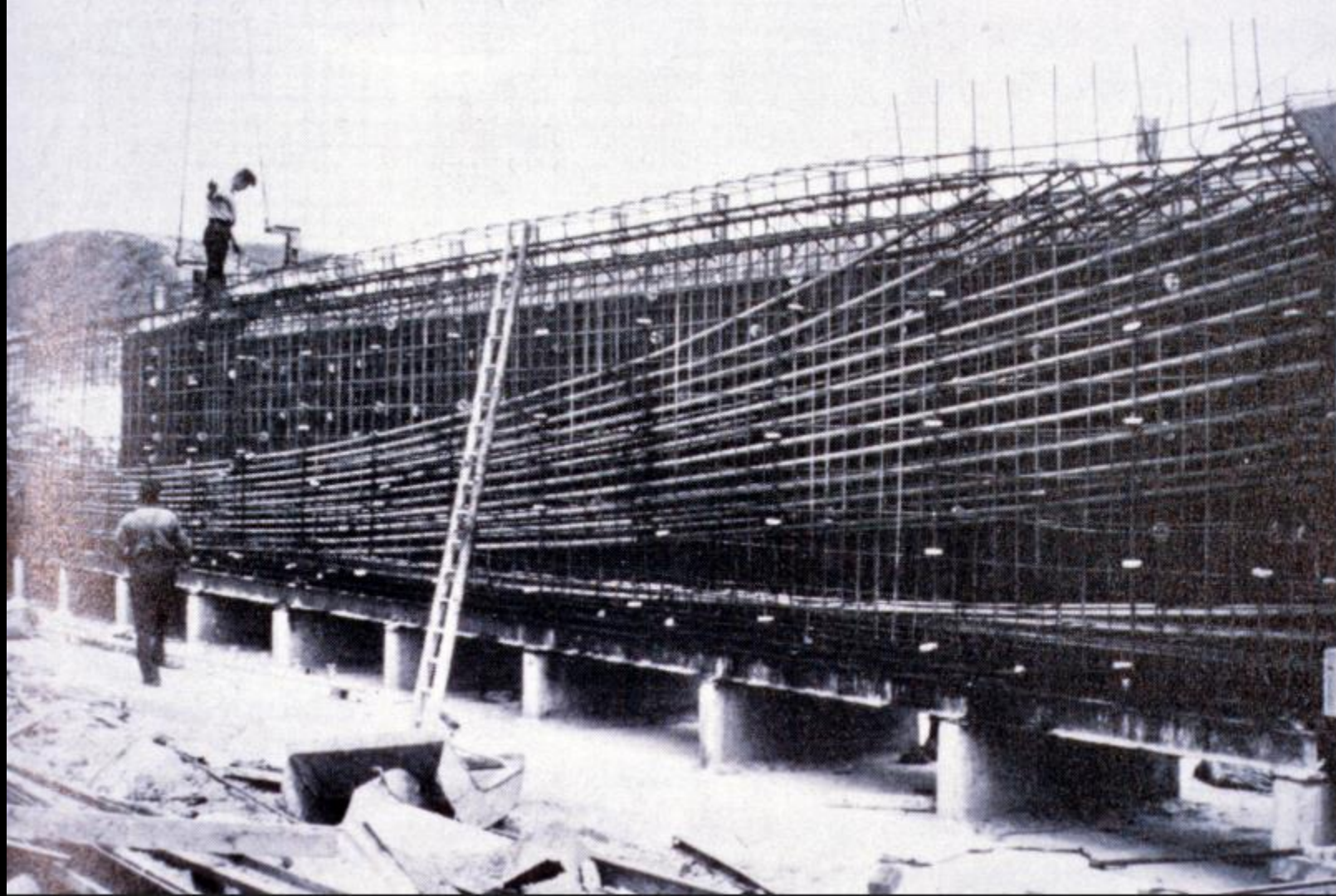
c

d



8.16 Early forms of reinforced-concrete flat slab: (a, b) Turne system; (c, d) Maillart system.









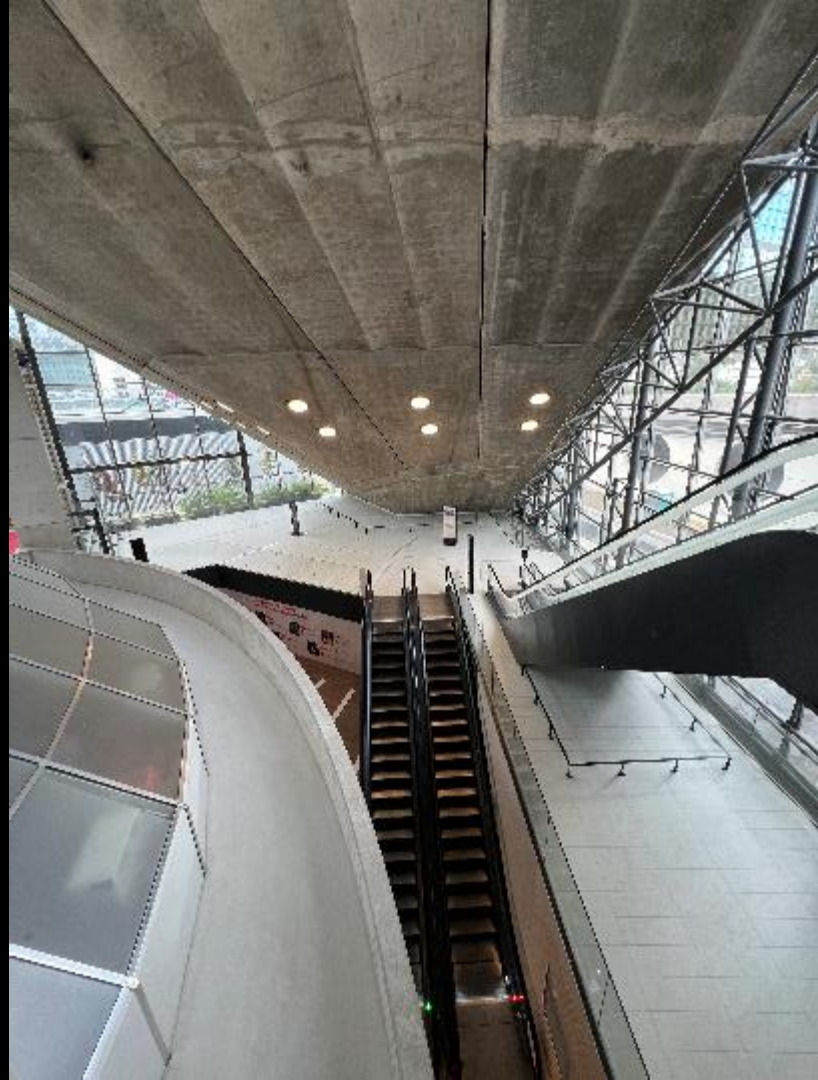


CNIT  
La Défense (Paris)  
Jean Prouve  
1956

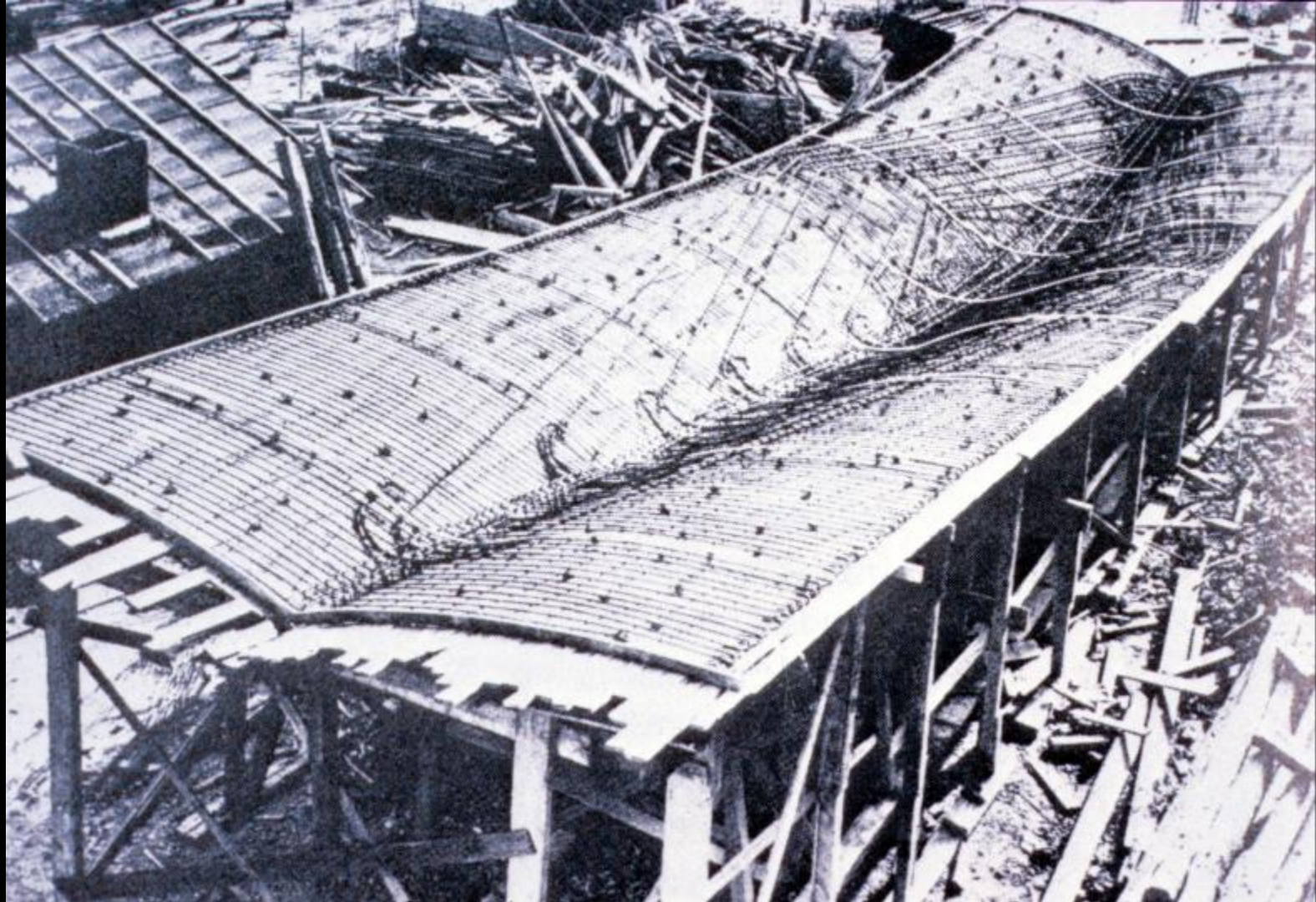














Hoover Dam  
Nevada/Arizona Border  
1931 to 1936















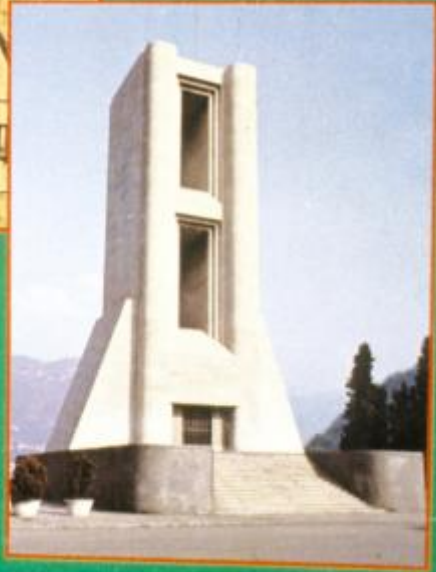


Grand Coulee Dam  
Washington State  
1933 to 1942

# Concrete as STYLE



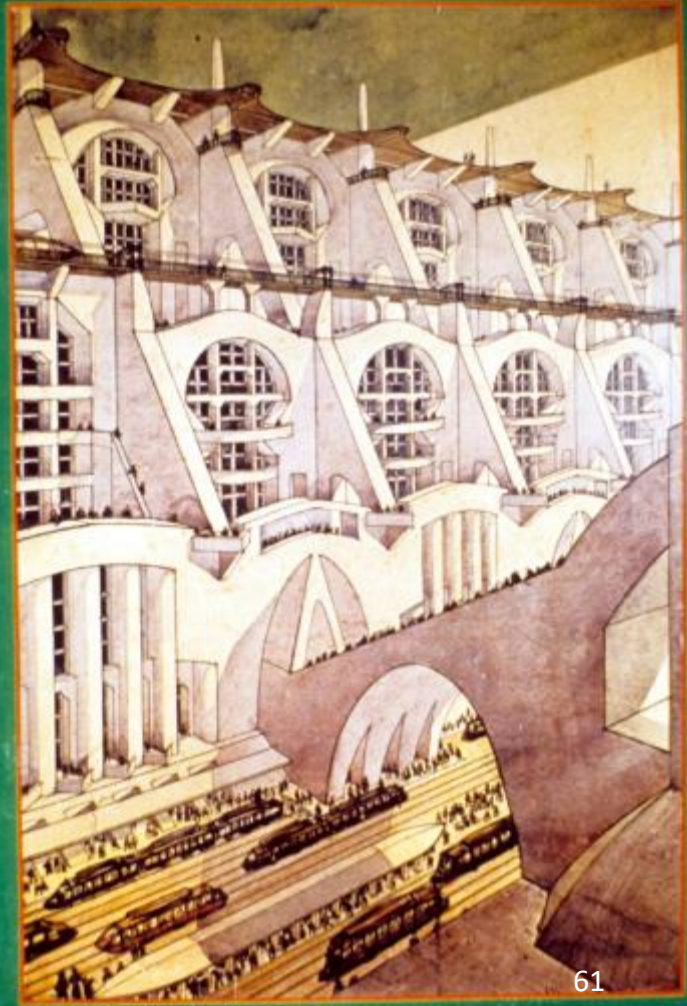
Futurism  
and the beginnings of  
The Modern Movement



From  
**FUTURISM**  
To  
**RATIONALISM**

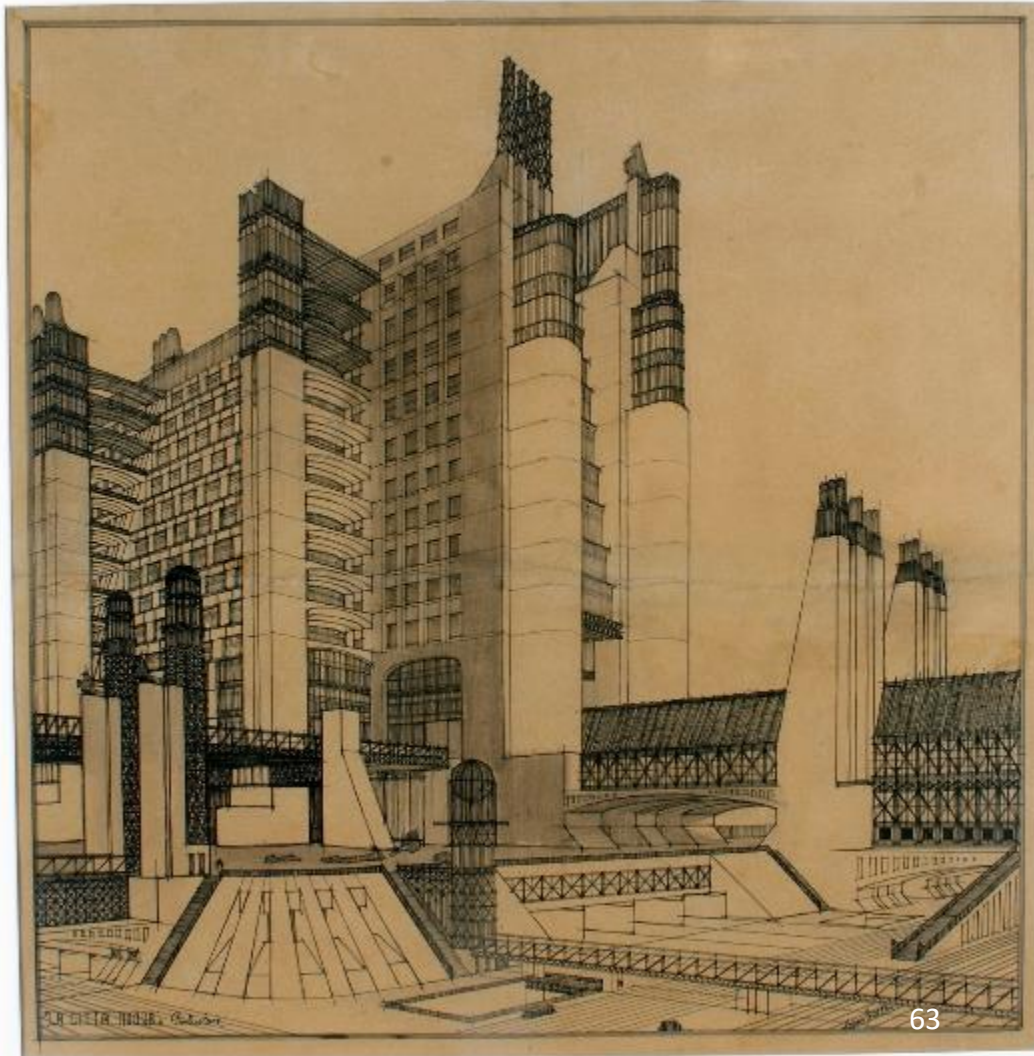
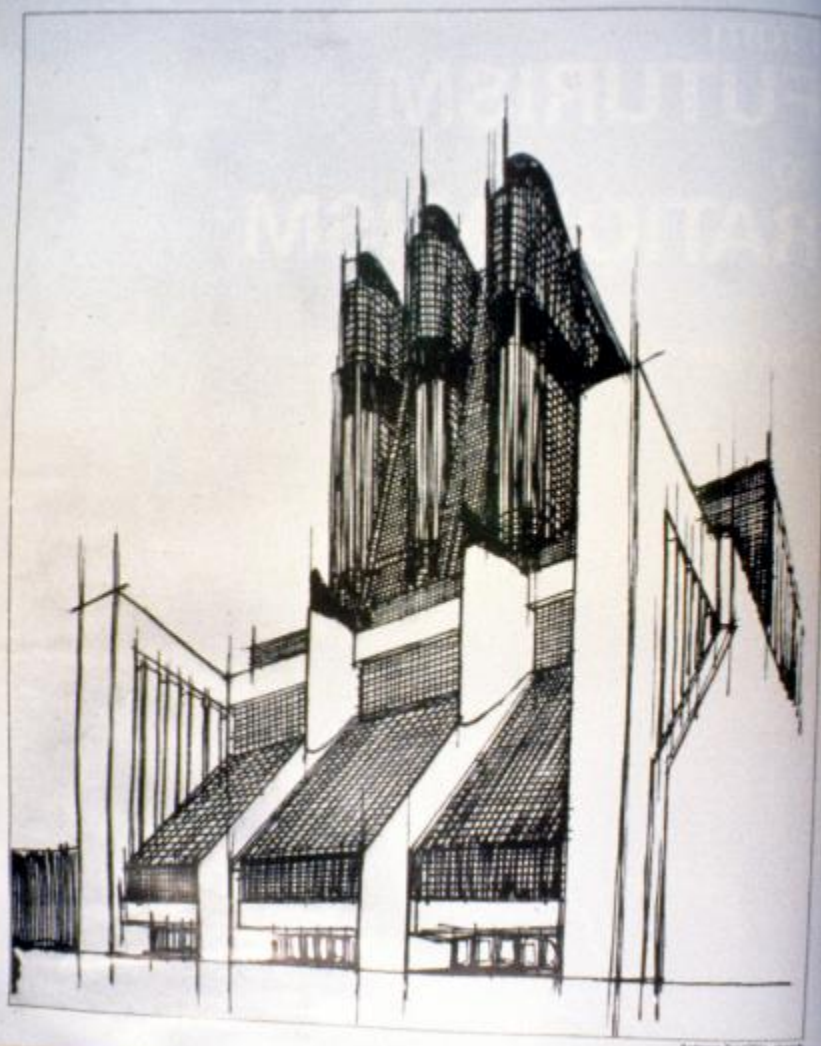
THE ORIGINS OF MODERN ITALIAN ARCHITECTURE  
Ada Louise Huxtable : The Troubled State of Modern Architecture

Antonio Sant'Elia  
Italian Futurist  
Architect  
1888 to 1916









LE CORBUSIER

Towards  
A New Architecture



1923



Grain silo.

THREE REMINDERS TO ARCHITECTS

29



CANADIAN GRAIN STORES AND ELEVATORS

64





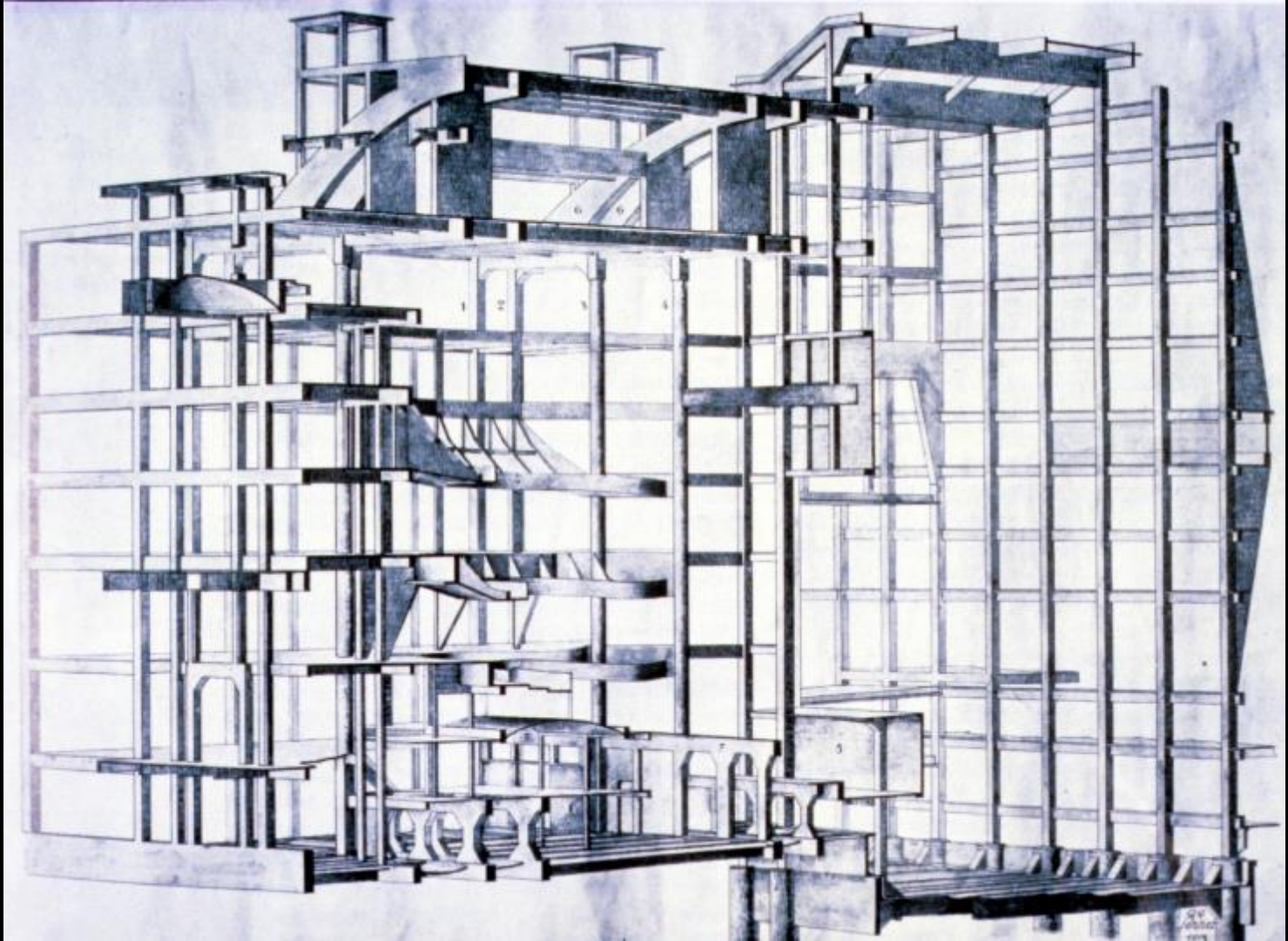
The North American Silo  
Storage System



# The Monolithic Frame



Theatre des Champs-Élysées  
August Perret Architect  
Paris, France  
1911-1913





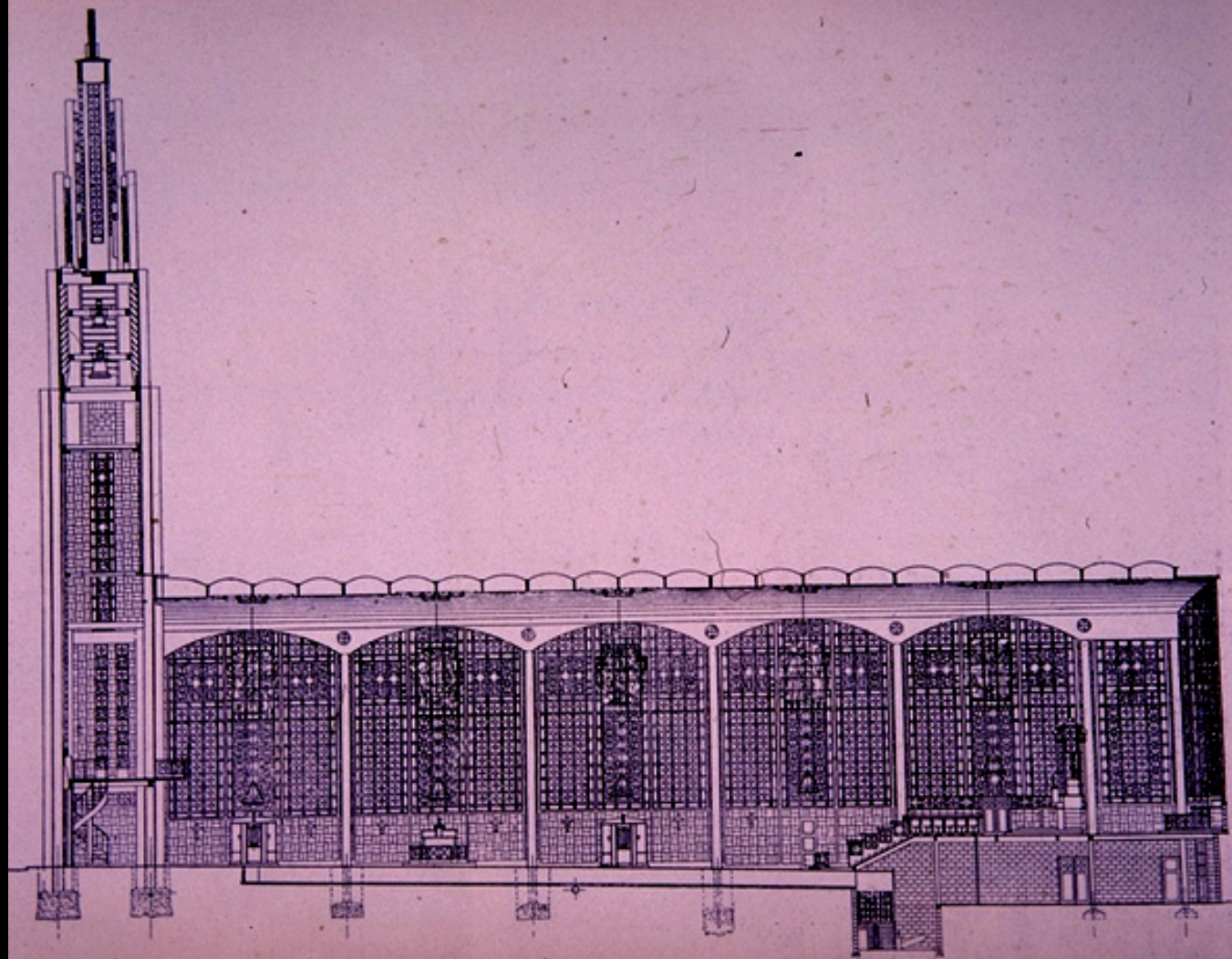




L'église Notre-Dame de la  
Consolation du Raincy  
August Perret Architect  
France  
1922













Long Span  
~  
Bridges







Salginatobel Bridge  
Schiers, Switzerland  
Robert Maillart  
1930





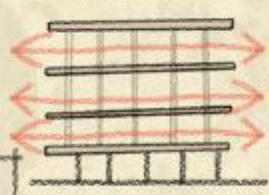


# Le Corbusier's 5 points of Architecture

Le Corbusier  
Swiss/French Architect  
1887 to 1965

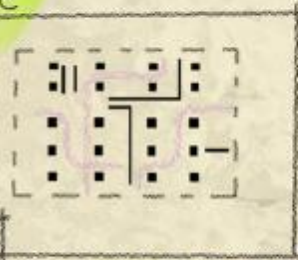
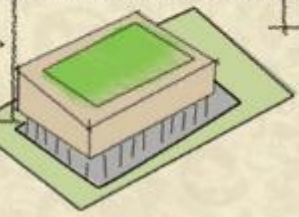
## 2. Free Facade

non-supporting walls that could be designed as the architect wished



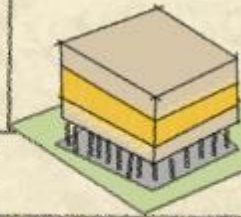
## 4. Roof Terrace

compensate for the green area consumed by the building and replacing it on the roof



## 3. Ribbon Window

allow unobstructed views of the large surrounding

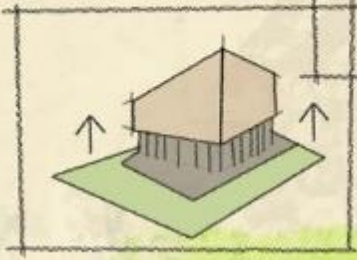


## 5. Open Floor Plan

floor space was free to be configured into rooms without concern for supporting walls.

## 1. Pilotis

provides structural support.

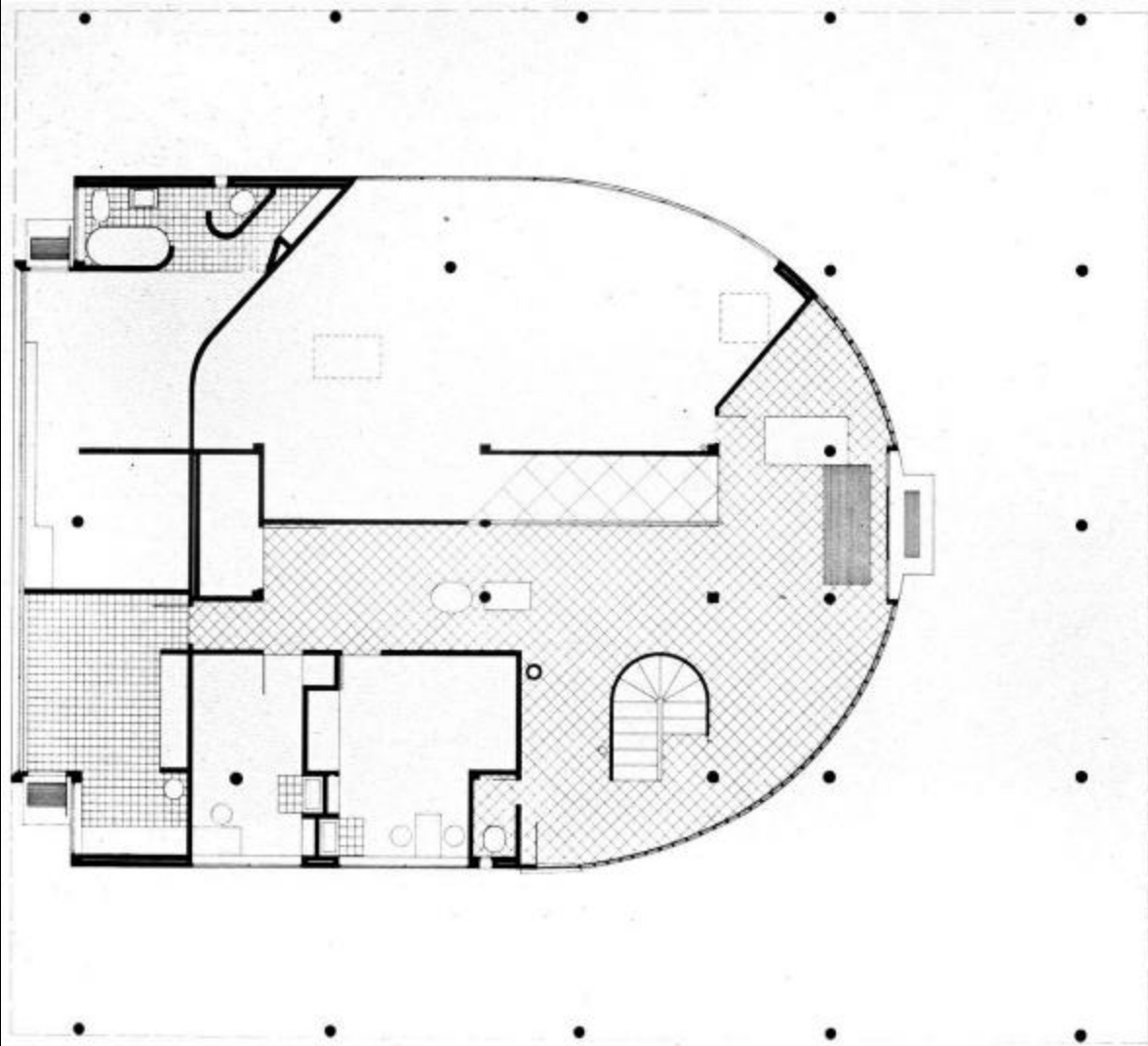




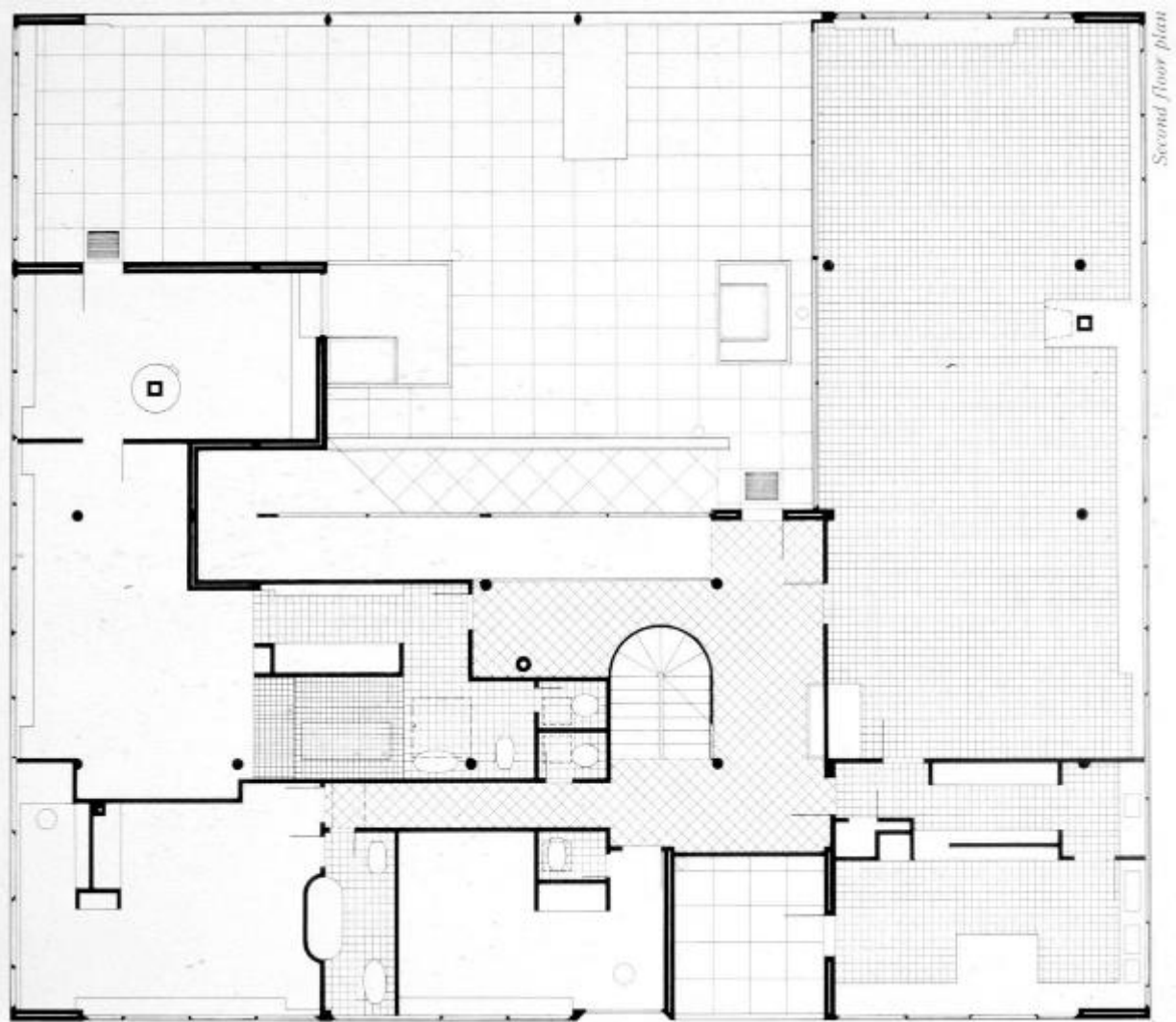


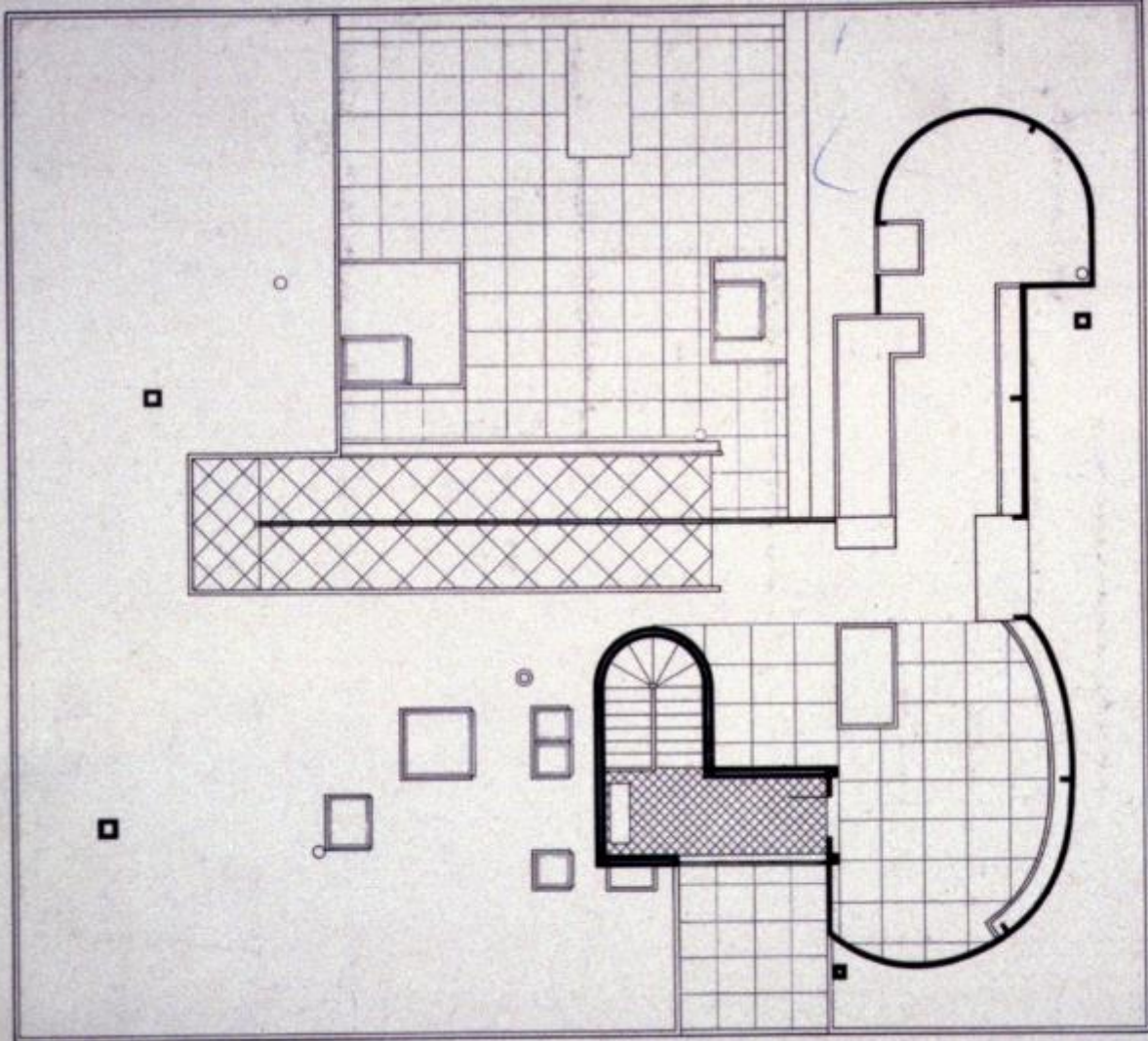
Villa Savoye  
Poissy, France  
Le Corbusier  
1923 to 1925



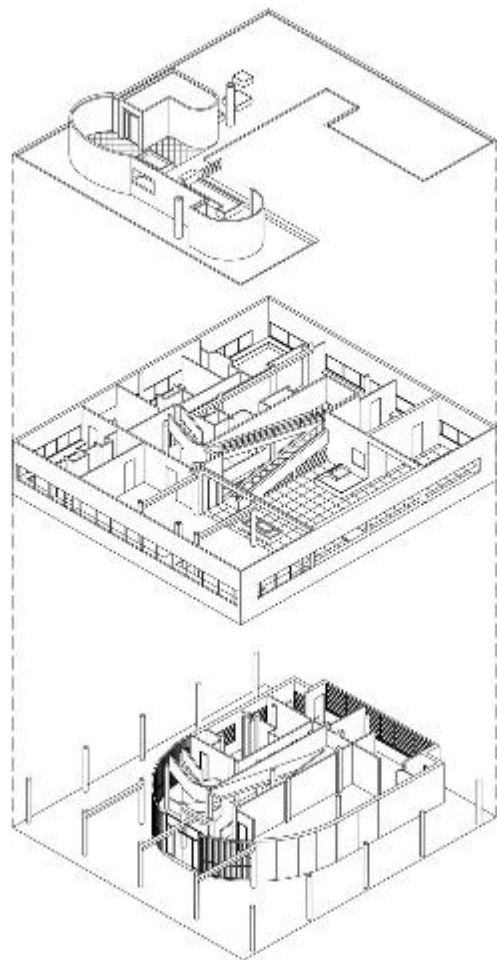


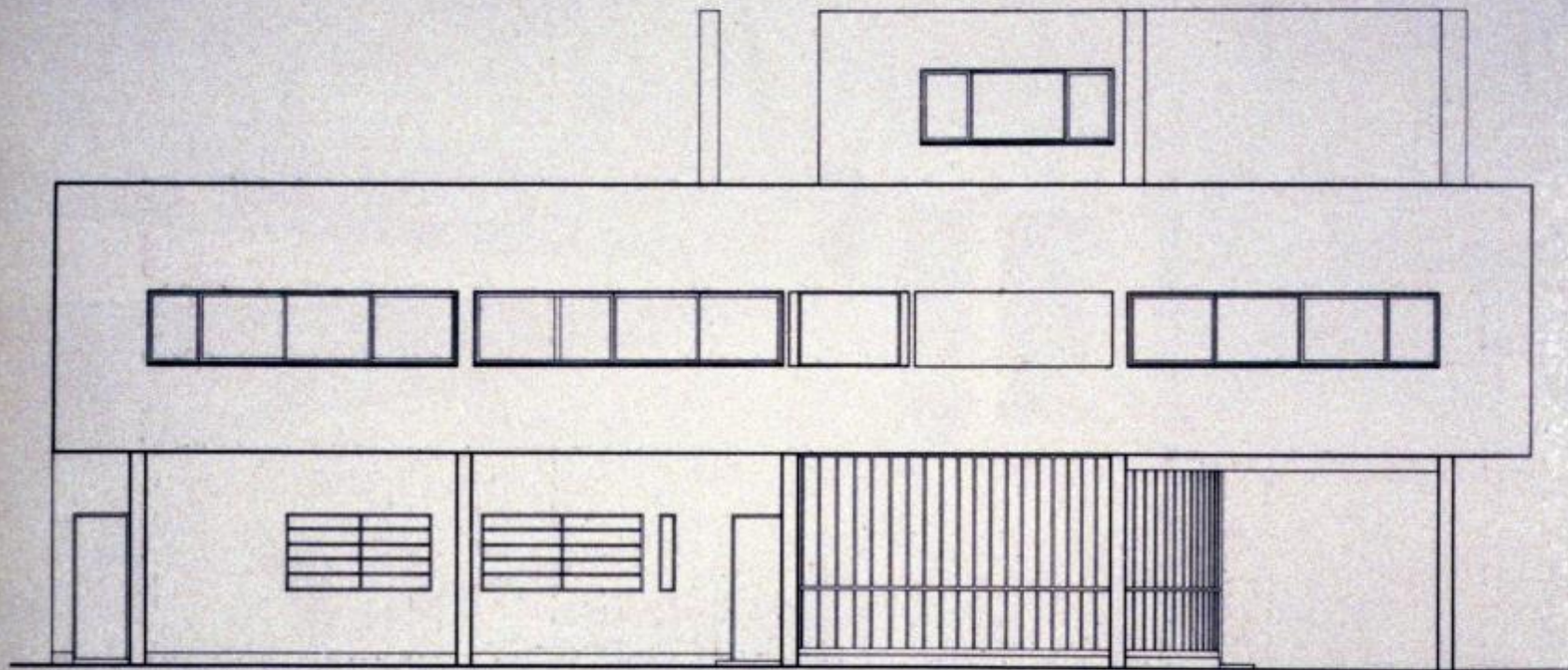
*First floor plan*



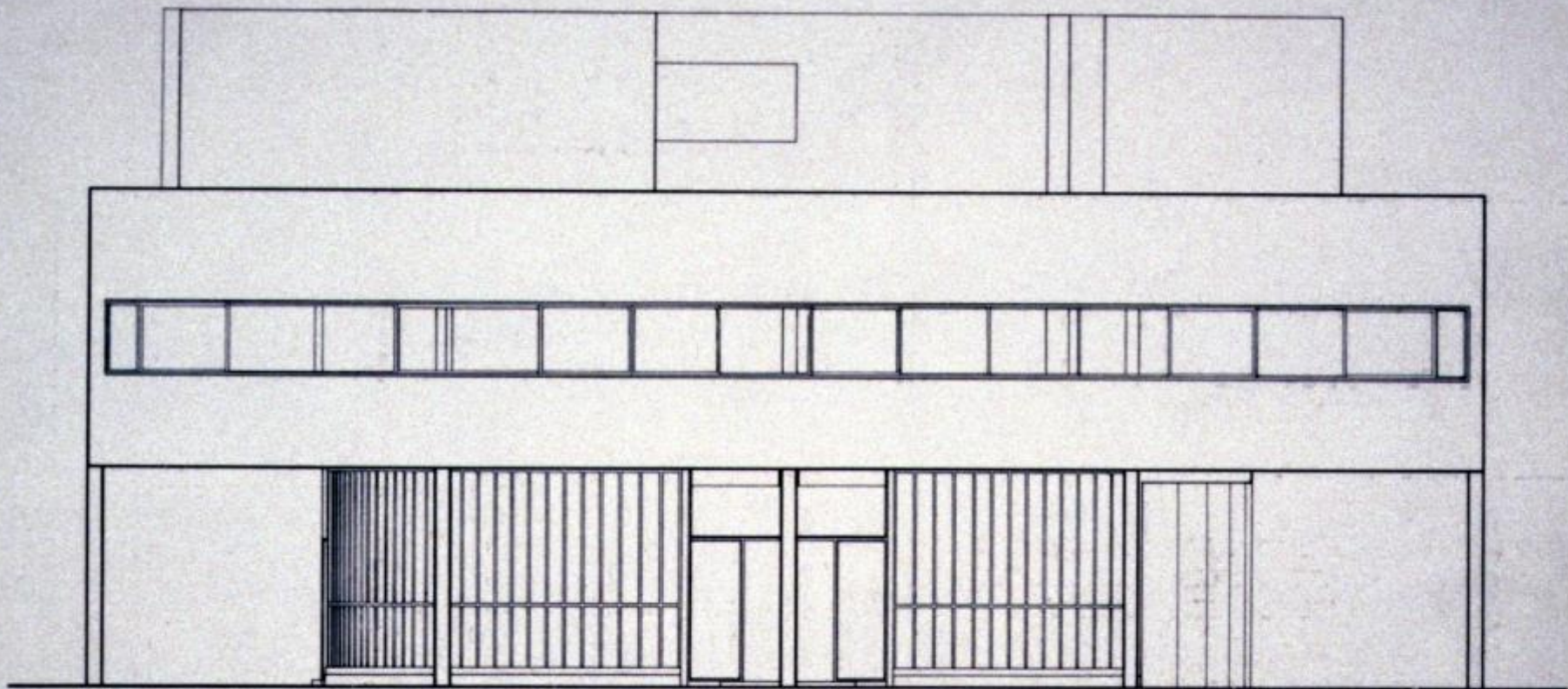








*Elevation west*



*Elevation south*









































Falling Water  
Mill Run, Pennsylvania  
Frank Lloyd Wright  
1939

































































