

Chapter 13: Architecture

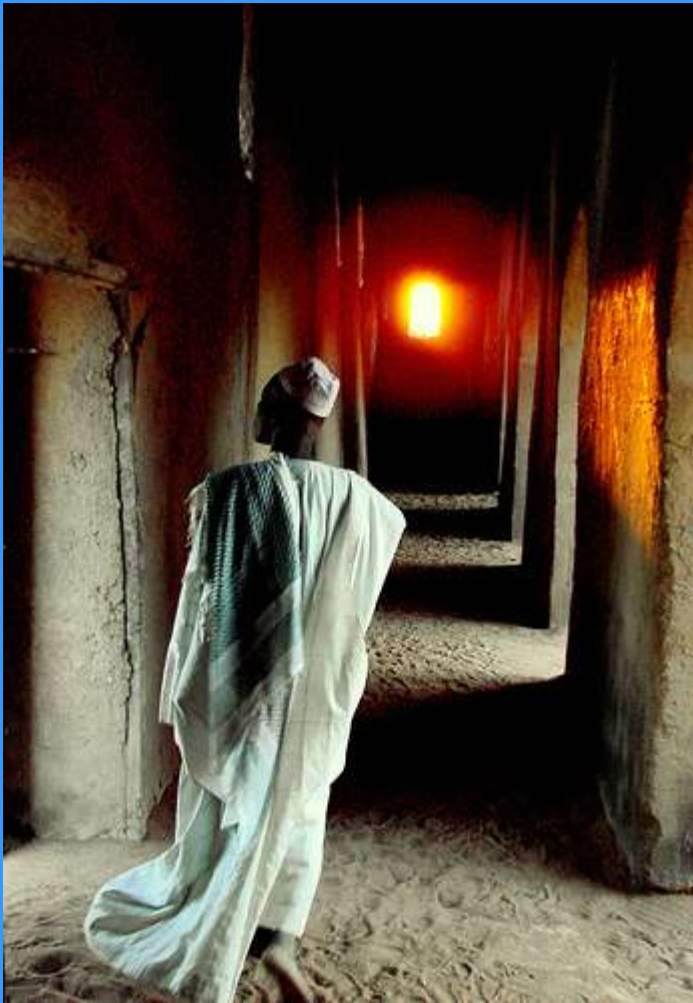
Load Bearing Construction (or “Stacking and Piling”)

Construction in which the builder constructs the walls by piling layer upon layer, stacking one brick or stone on top of another; each brick or stone carries (or bears) the load from those above. Structures tend to have few and small openings in the wall.



Great Friday Mosque, Djenne, Mali. Rebuilt 1907 in the style of a 13th c. original. It is the largest mud brick or adobe building in the world.

<https://youtu.be/XiHOqxo5tpc> 0:35



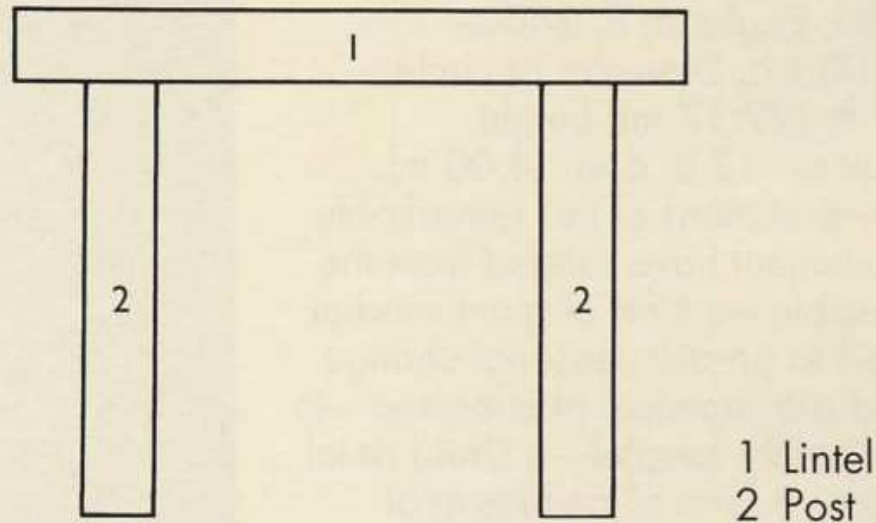
Interior and Exterior Views



The protruding wooden poles serve the workers who restore the mosque's smooth coating of mud plaster every few years.

Post-and-Lintel Construction

In this system of construction, vertical uprights (posts) support a horizontal element (the lintel). Figure **1.24** is a diagram of the most basic single post-and-lintel form, called a **trilithon**. In later eras, this simple system was elaborated into highly complex structures.



1.24 Post-and-lintel construction.



Aerial view of Stonehenge, Salisbury Plain, Wiltshire, England, ca. 2550–1600 BCE.
Circle is 97' in diameter; approx. 24' high.



Heel Stone

Astronomers have determined that the sun appeared to rise over the “heel stone” at the midsummer solstice when one stood in the center of the circle in front of the altar.



Major trilithon (three stones construction.) Stonehenge



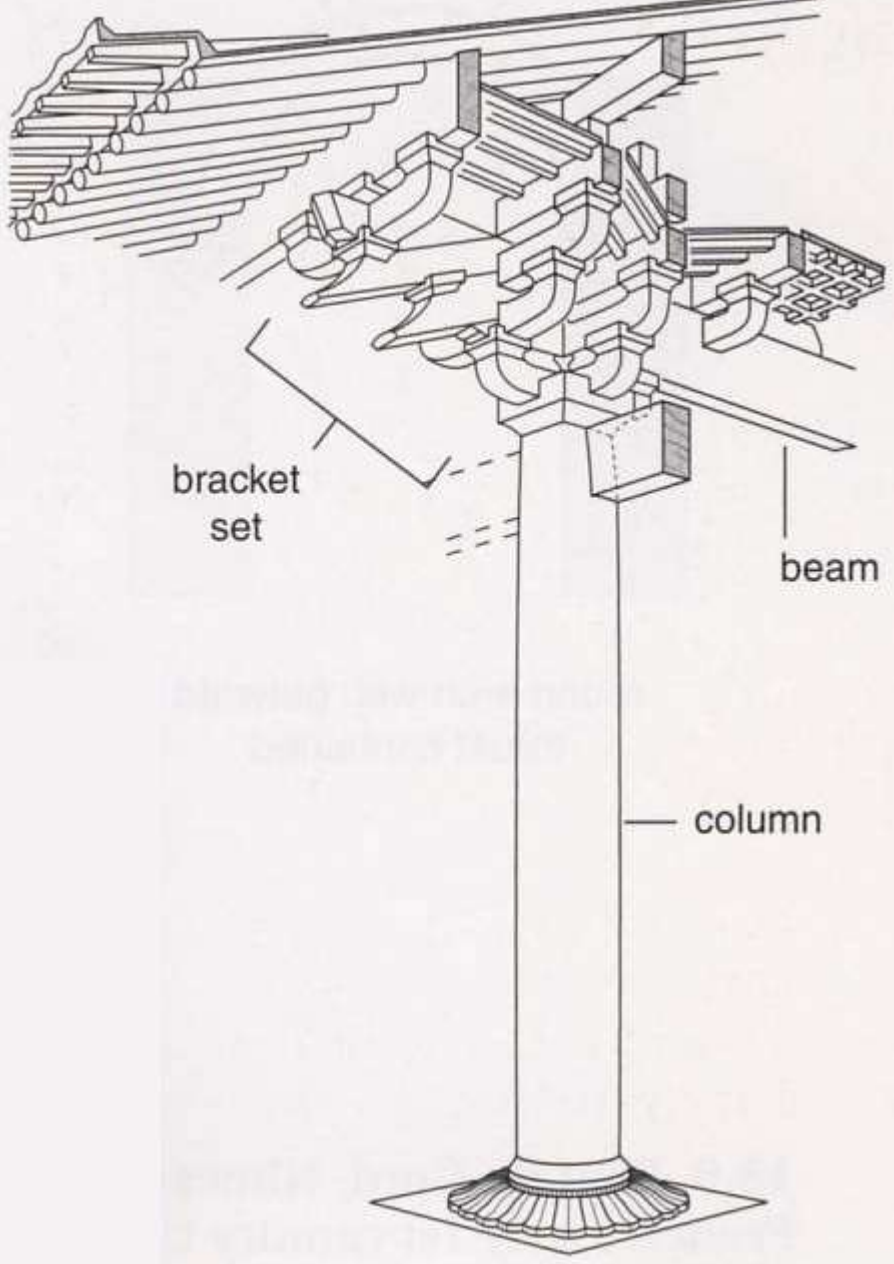
IKTINOS and KALLIKRATES, Parthenon, the Temple of Athena Parthenos Acropolis, Athens, Greece, 447–438 BCE.



Hoodo (Phoenix Hall), Byodo-in Temple, Uji, Kyoto Prefecture, Japan. Heian period, c. 1053.



Hoodo (Phoenix Hall), Byodo-in Temple, Uji, Kyoto Prefecture, Japan. Heian period, c. 1053.



Bracket system



Reconstruction of Chinese Temple Bracket

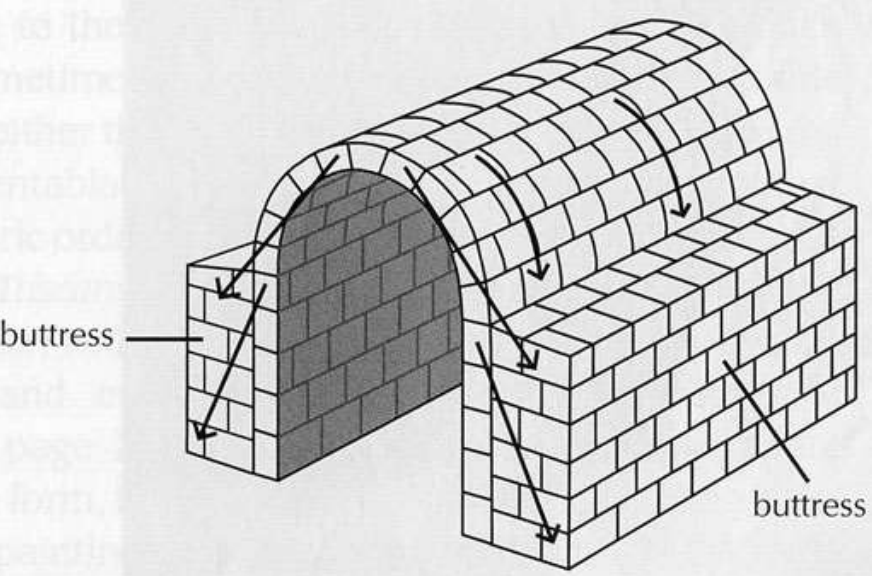


Jōchō, *Amida* (c. 1053)

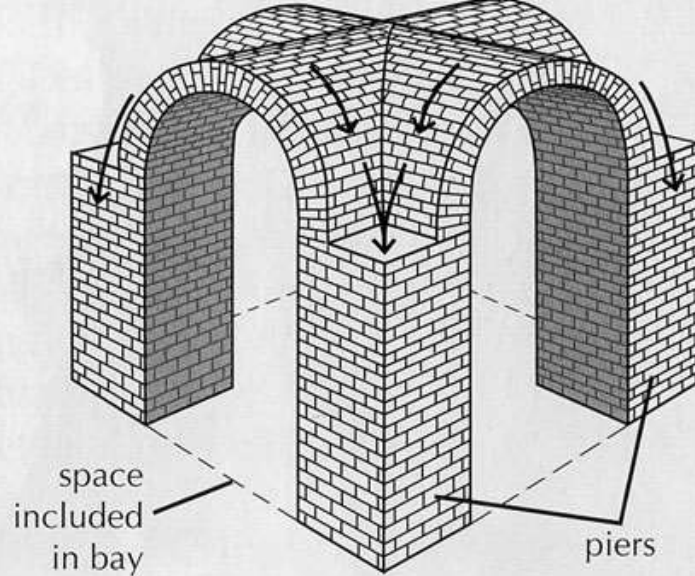
The Amida sculpture is made of Japanese cypress and is covered with gold leaf.

Round Arch and Vault

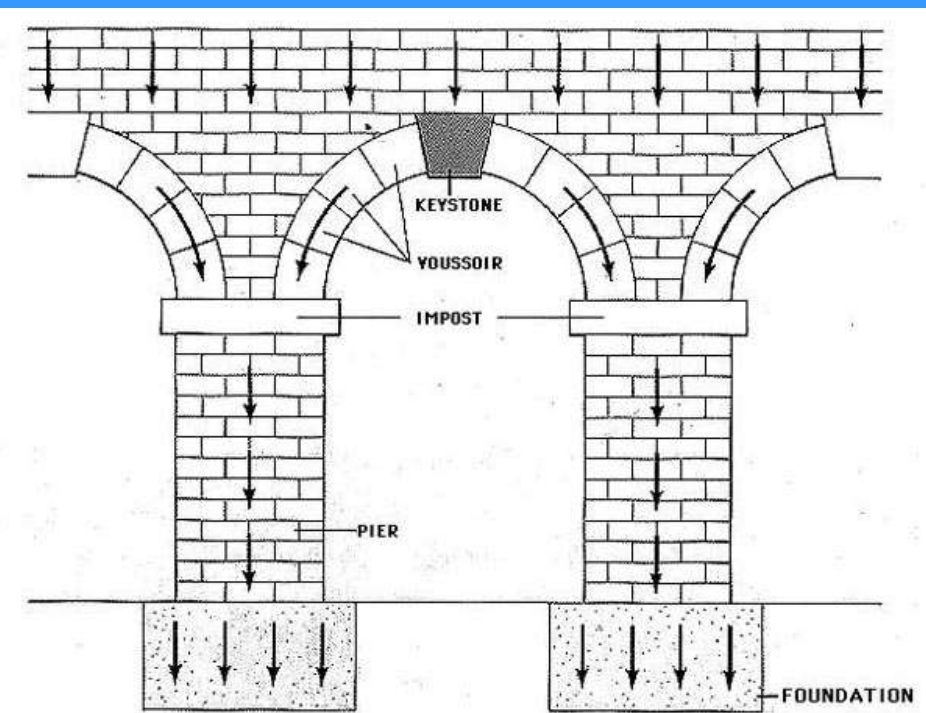
Arch - a typically curved structural member spanning an opening and serving as a support



barrel vault

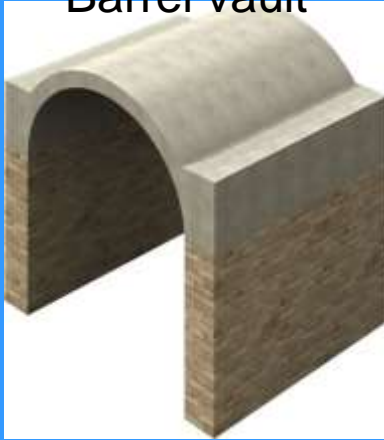


groin vault

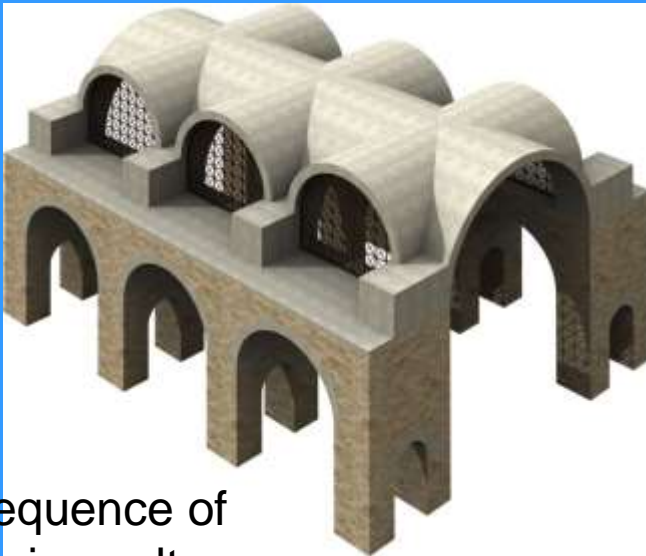


round arch

Barrel vault



Groin vault



Sequence of groin vaults

<https://vimeo.com/16968328>
5:08

Roman concrete construction

Aqueduct

A channel for supplying water; often underground, but treated architecturally on high arches when crossing valleys or low ground.



Pont-du-Gard, Nîmes, France, ca. 16 BCE.

Approximately 900' long and 160' high. The aqueduct provided about 100 gallons of water a day per person, from a source some 30 miles away from Nimes.

Pont-du-Gard, Detail

Each large arch spans some 82'
and is constructed of blocks
weighing up to two tons each.



Dome

Hemispherical
dome with
oculus.

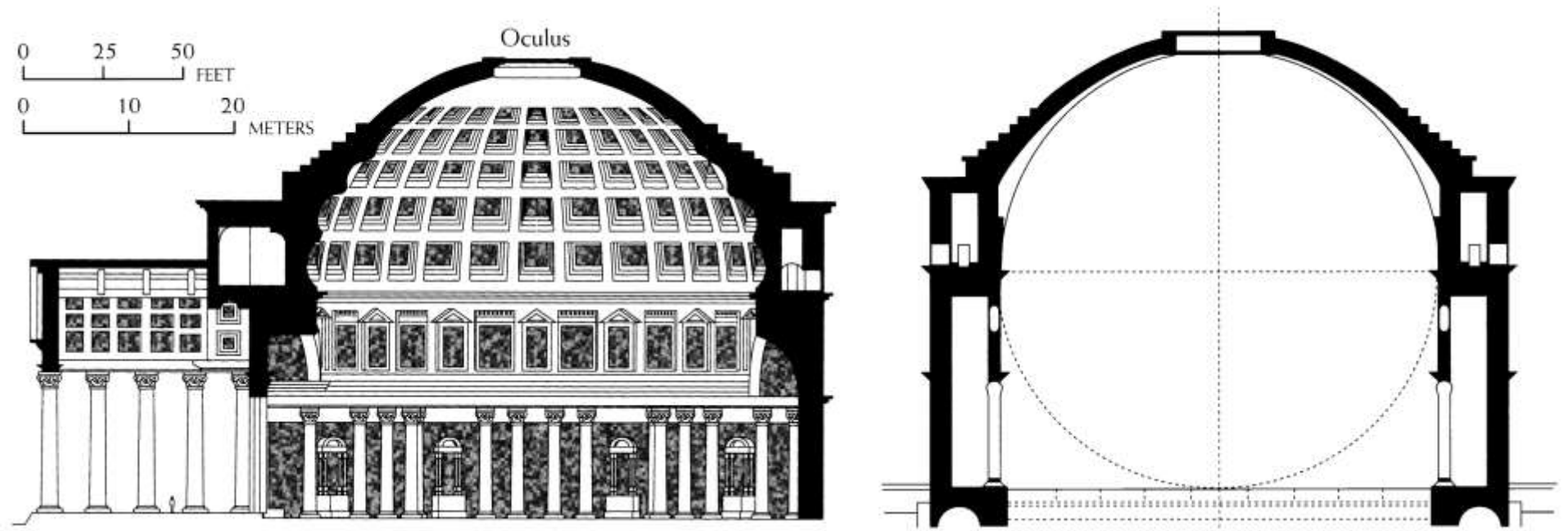




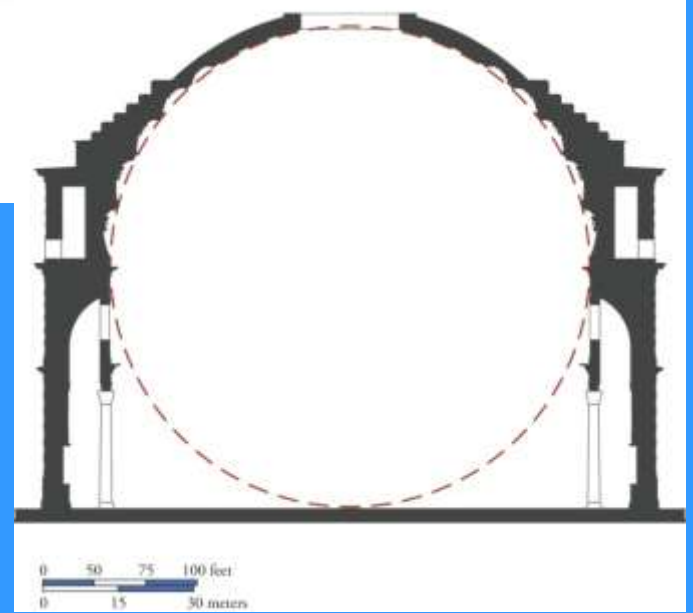
Pantheon ("Temple of all the Gods"), Rome, Italy, 118–125 CE.

Interior of the Pantheon, Rome, Italy,
118–125 CE. 142' high. Built by
Hadrian.





Longitudinal and lateral sections of the Pantheon, Rome, Italy, 118–125 CE.



Restored cutaway view (*left*) and lateral section (*right*) of the Pantheon, Rome, Italy, 118–125 CE.



Aerial view of the Pantheon ("Temple of all the Gods"), Rome, Italy, 118–125 CE.

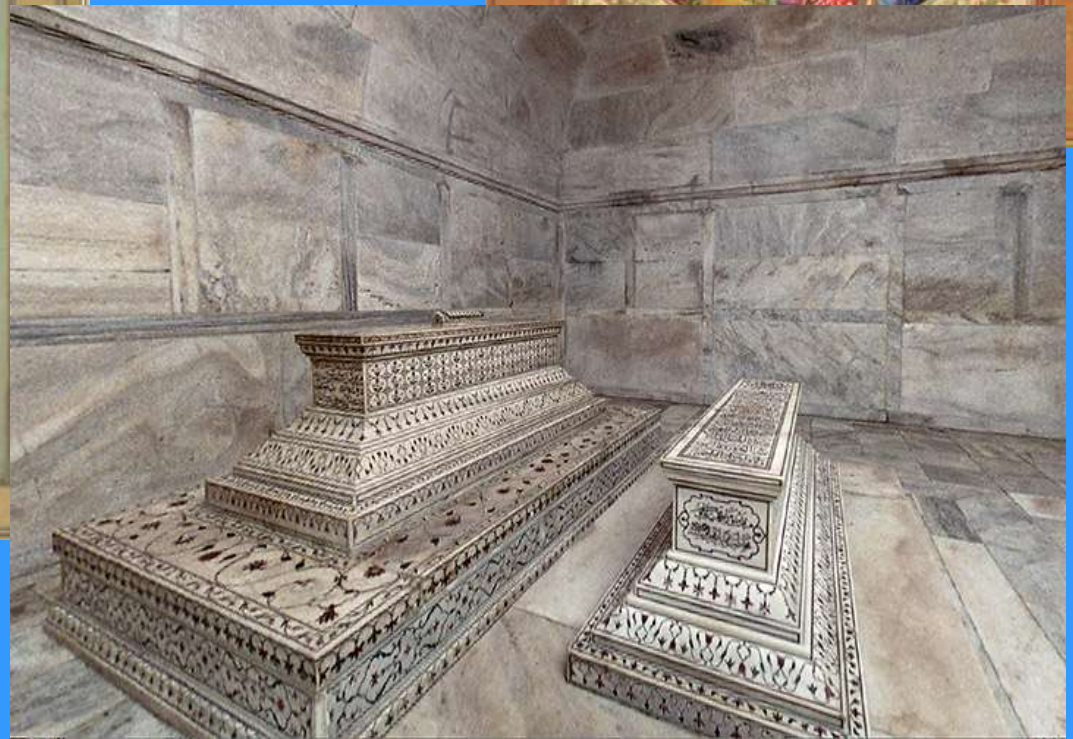


Interior detail: Wall decoration with pediments over niches



Taj Mahal, Agra, India, 1632-53. Constructed of pure white marble

Shah Jahan commissioned the *Taj Mahal* as a monument and tomb for his beloved wife, *Mumtaz Mahal*, who died in 1631



Tombs of Shah Jahan and Mumtaz Mahal

Industrialization and the new building materials

Cast Iron Construction

Gustave Eiffel (1832-1923)

- French engineer. A noted constructor of bridges, he also designed the Eiffel Tower and the internal structure of the Statue of Liberty.
- He was initially charged with corruption in the 1888 scandal of the failed Panama Canal project, but was cleared of all wrongdoing by a French appeals court. Nonetheless, he withdrew from commercial life and spent the rest of his years studying aerodynamics.



When built it was the highest bridge in the world

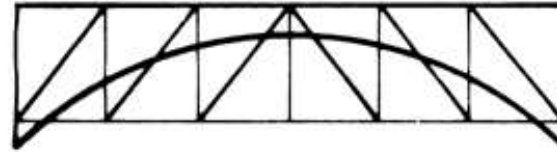


Gustave Eiffel. *Garabit viaduct.* France 1880- 1884. Wrought iron
It is a railway arch bridge spanning the Truyere river. It is 565 m (1,854 ft)
in length and has a principal arch of 165 m (541 ft) span

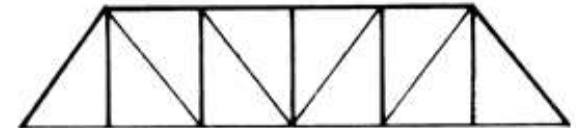
Nineteenth-century patented truss designs.

Truss: truss is a structure comprising one or more triangular units.

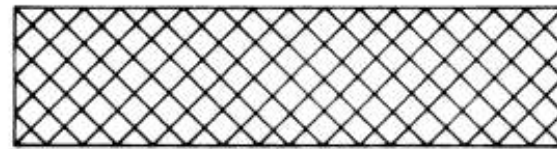
Trusses are used for large spans and heavy loads, especially in bridges and roofs.



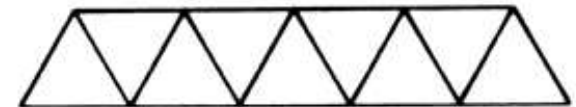
Burr Arch-Truss 1804



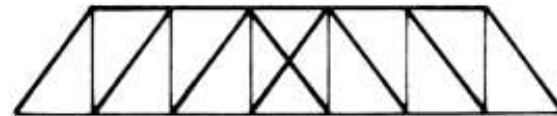
Pratt Truss 1844



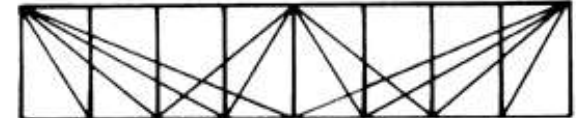
Town Lattice Truss 1820



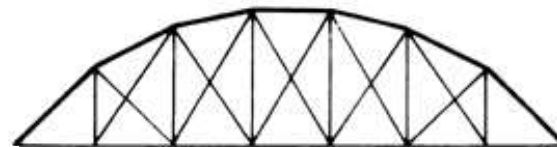
Warren Truss 1848



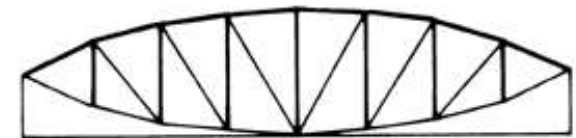
Howe Truss 1840



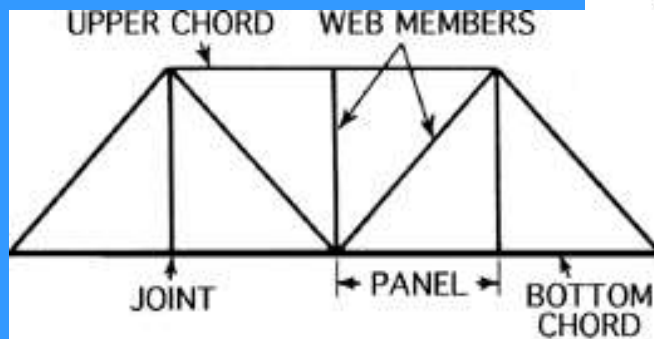
Fink Truss 1851



Whipple Bowstring 1840



Lenticular Truss 1878



Truss Types

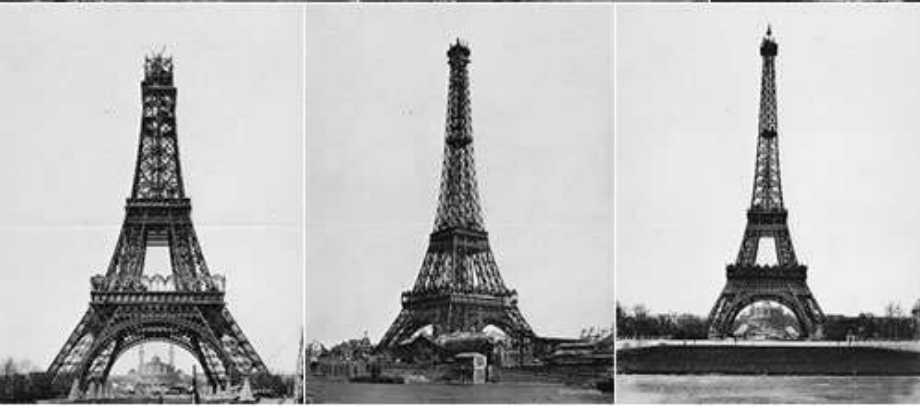
The *Eiffel Tower* was built for the entrance to the International Exposition of 1889, which celebrated the 100th anniversary of the French Revolution..

It was the world's tallest tower from 1889-1931

More than 200,000,000 people visited it since its construction

Gustave Eiffel, *Eiffel Tower*, Paris, France. 1889. 984-foot (300-meter), Iron.





The pieces of the tower were prefabricated and it was assembled at the site in 17 months by only 150 workers.



The curvature of the uprights is mathematically determined to offer the most efficient wind resistance possible.



Balloon framing (begun 1830)

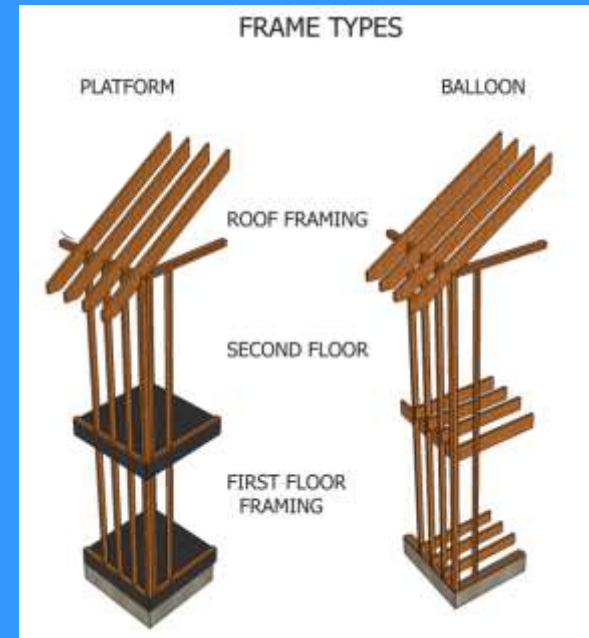
Factory cut studs are mass produced and assembled at the site using thousand of factory produced metal nails.

All vertical structural elements of the exterior bearing walls and partitions consist of single studs which extend the full height of the frame, from the top of the sole-plate to the roof plate.

Eventually evolved into platform framing, in which the studs are only one story high.

<https://youtu.be/Q1ZPw2cbxtc>

Domestic Architecture: Balloon and Platform Framing





Steel Frame Construction: Skyscrapers

Steel is a strong metal of iron alloyed with carbon and other materials.

From 1875 onward steel began to replace iron because its compressive and tensile strengths exceeded those of iron. It is also more rust and fire resistant.

Chicago School / The Commercial Style

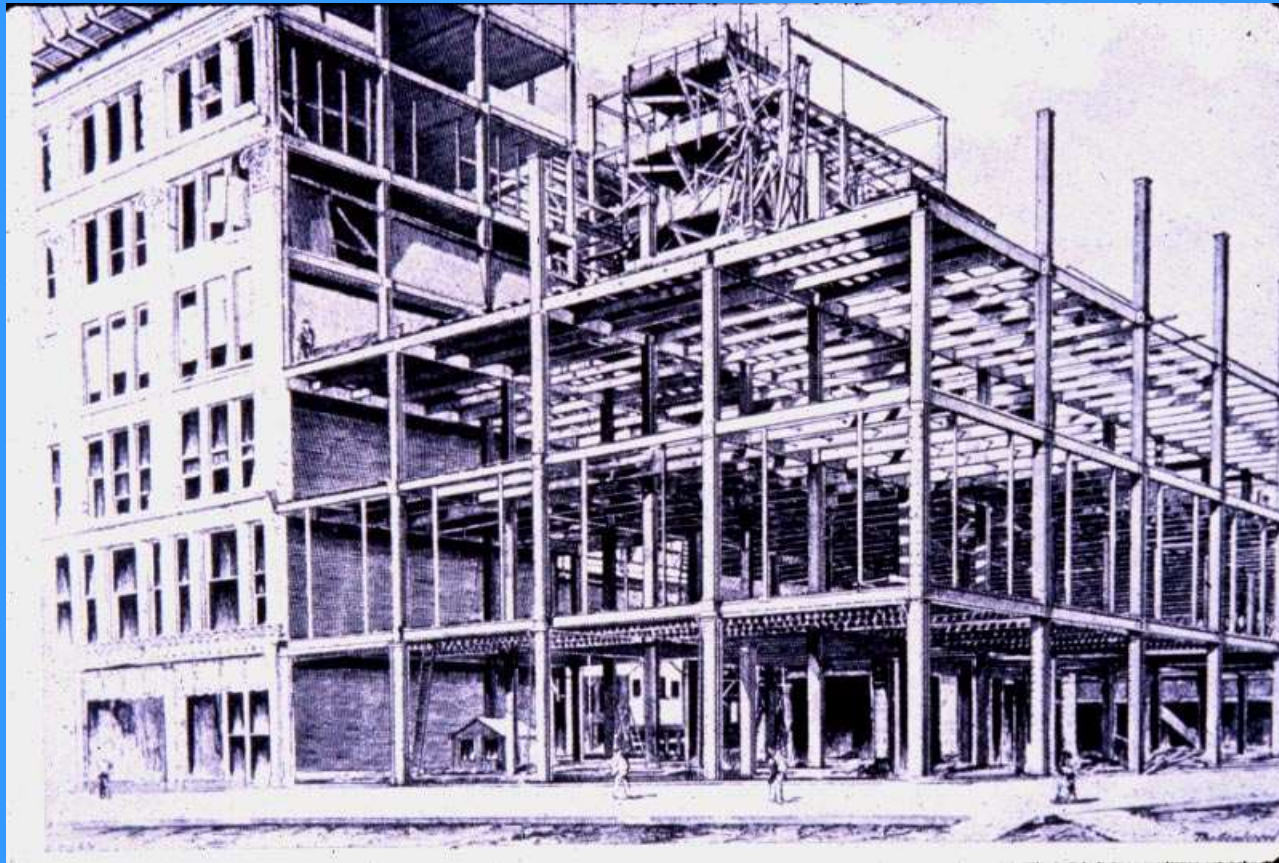
A group of U.S. architects of the late 19th to early 20th century, noted for their utilitarian designs and their use of steel framing as a skeleton for multistory buildings.

- Use of steel-frame buildings with masonry cladding (usually terra cotta).
- Large plate-glass window areas.
- Limiting the amount of exterior ornamentation.

William Le Baron Jenney, *Home Insurance Building*, Chicago, 1884-85, demolished 1929. It had 10 stories and rose to a height of 42 m (138 feet). In 1890, two additional floors were added.

- Considered the world's first skyscraper due to its unique architecture, but was never the tallest in the world.
- The internal metal skeleton carried the weight of the external masonry shell. This invention, together with the invention of the elevator (1853) permitted buildings to rise to great heights.





Jenney's method of Steel frame construction

It was the first building to use steel in its frame, but the majority of its structure was composed of iron.

Louis Sullivan, *Guaranty (Prudential)
Building*, Buffalo, NY, 1894-1896.



Charles Garnier, *The Opera House*, Paris. 1861-74

“Less is more.”

-Mies van der Rohe



Ludwig Mies van der Rohe and Philip Johnson. *Seagram Building.*, NY, 1954-8

Suspension Bridge

A bridge having the roadway suspended from cables that are anchored at either end and usually supported at intervals by towers.



John A and Washington A. Roebling. *The Brooklyn Bridge.*

NY. 1600'. 1869-83

It was the longest suspension bridge in the world from its opening until 1903

<http://youtu.be/Tsi95z1Nmhg>

- This is the first steel-cable suspension bridge. Here each cable contains over 5000 strands of wire.
- Steel cable is flexible, allowing the roadway to sway in response to weather conditions.



**John A and Washington A. Roebling. *The Brooklyn Bridge.*
NY. 1600'. 1869-83**



Golden Gate Bridge, SF, CA, 1937

Reinforced concrete/ferroconcrete

Concrete in which steel is embedded in such a manner that the two materials act together in resisting forces.

Advantages:

- The steel rods increase the tensile strength of concrete (Tensile strength: the material resists a force that tends to pull it or stretch it).
- Concrete prevents the steel from rusting.
- Can span greater distance than stone.
- supports more weight than steel.
- Capacity to take on natural curved shapes that would be unthinkable in steel or concrete alone.



Cantor Center for Visual Arts. Stanford University. 1894

- **One of the first entirely reinforced concrete structures on the West Coast.**



Jørn Utzon, *Sydney Opera House*, Sydney harbor, Australia, 1973



EERO SAARINEN, Trans World Airlines terminal (terminal 5), John F. Kennedy International Airport, New York, 1956-1962. TWA Hotel is scheduled to open in May 2019



EERO SAARINEN, Trans World Airlines terminal (terminal 5), John F. Kennedy International Airport, New York, 1956-1962. TWA Hotel is scheduled to open in May 2019

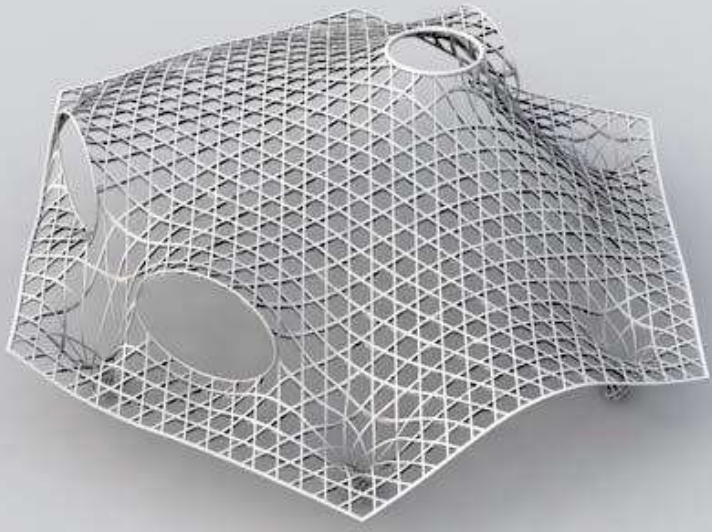


Digital Design and Fabrication

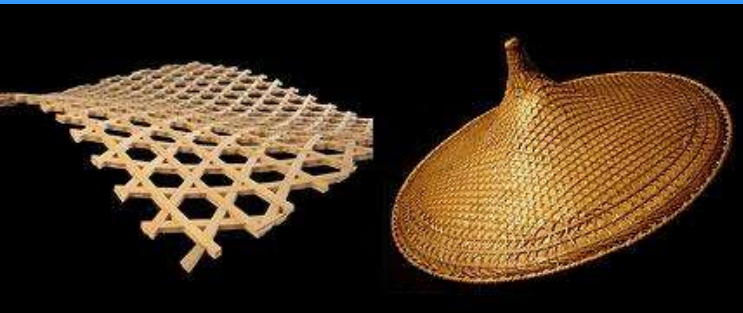
Digital technology is used to help design an object, then the data is fed to computer driven machinery (CNC machines) which automatically fabricates the object.



Shigeru Ban, *Centre Pompidou*, Metz, France
1800 segments of wood were individually fabricated.



The entire wooden structure is covered with teflon coated fiberglass fabric which is stain resistant, self cleaning and translucent, allowing daylight to filter into the interior.





Zaha Hadid Architects
Burnham Pavilion

A temporary pavilion, erected in Chicago's Millennium Park in 2009
Made of fabric over framework of aluminum and steel tubing.



Zaha Hadid

(b. 1950, Baghdad – d. 2016, Miami, Florida, U.S.)

Iraqi-born British architect and designer known for her radical sleek and futuristic designs.

During the 80s and most of the 90s she was considered a “paper- architect” but in 2004 she became the first woman to be awarded the Pritzker Architecture Prize.





Thomas Heatherwick. *Vessel*. Hudson Yards Redevelopment Project in Manhattan, New York City. 16 stories, 154 flights of stairs and 80 landings

Intro To LEED Certification <http://youtu.be/DTIZBFeF2Nc>

Green or Sustainable Architecture

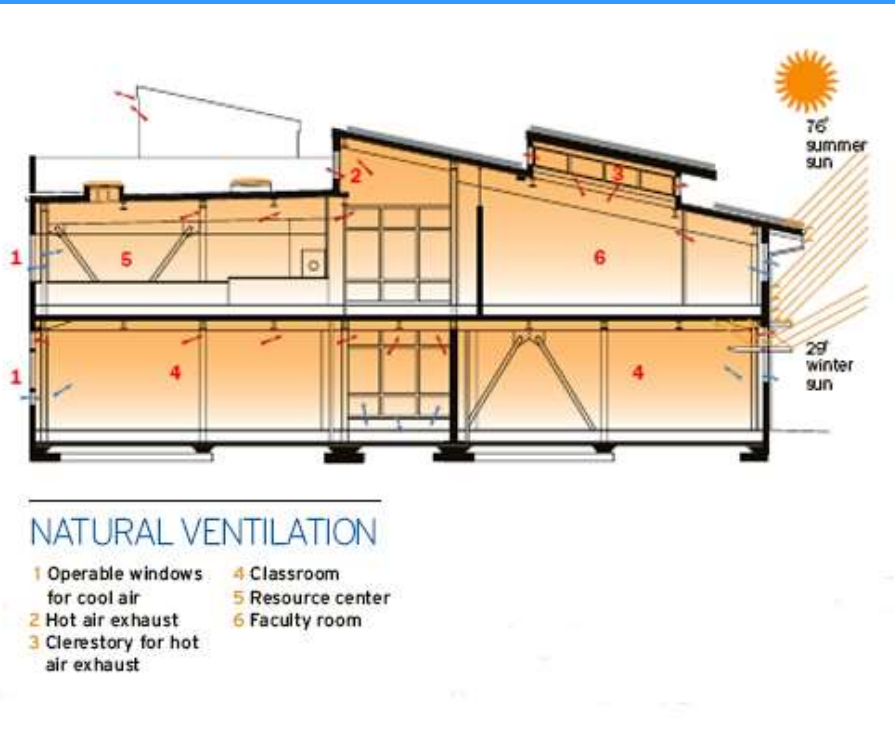
Architecture that seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space.



**VBN Architects, *Kirsch
Center for Environmental
Studies***, De Anza College,
Cupertino, CA. 2005

The first LEED Platinum
community college building in
the United States.





The Kirsch Center reached a total score of 52 points out of a possible 69

- Solar panel roof
- Advanced natural ventilation (West Wing)
- Raised floor for gentle air distribution and flexibility (East Wing)
- Natural daylighting
- Orientation and layout for energy efficiency and passive solar benefits
- Water conservation and water runoff control
- Radiant heating and cooling (West Wing)
- Native species landscaping

