

# Structural Systems in Architecture

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The Basic Principles of Construction

# Architecture

- from Greek *archi* (chief) and *tekton* (worker)
- the art and science of designing and constructing buildings for practical, aesthetic, and symbolic purposes

# Key issues

1. Function
2. Form
3. Structure

# Major Challenges

1. ability of a structure with its parts **to stand without collapsing**
2. to withstand the test of nature and time
3. limitations of available material

# Elements of Architecture

1. skeleton (frame)
2. outer skin
3. vital equipment (plumbing, electrical wiring, lighting, air conditioning, etc.)

## 2 Basic Families of Structural Systems

### **Shell**

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- one building material as both structural support and outside covering

### **Skeleton-and-skin**

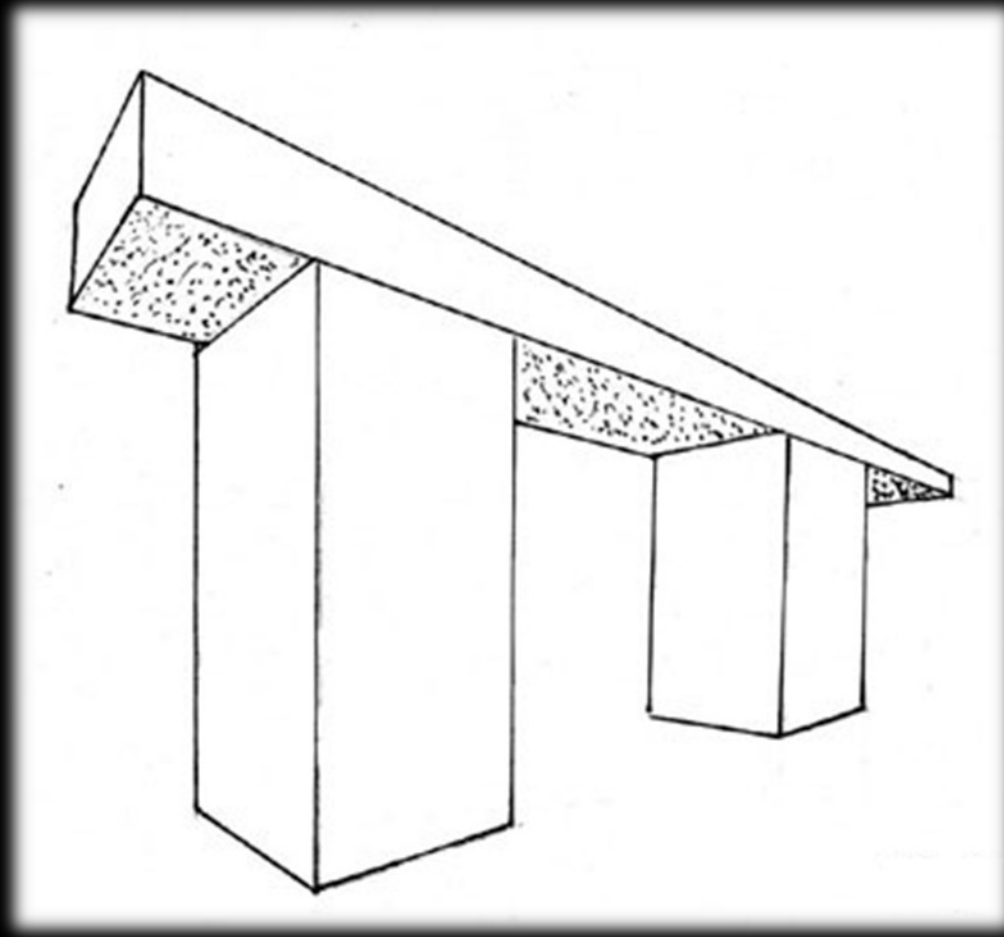
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- has a skeleton as frame and a skin as outside covering

# Basic structural systems

# Post and lintel

- two or more posts supporting a horizontal beam or lintel







Stonehenge (2,500 BC). England.



Colonnade at the courtyard temple of *Amon-Mut-Khonsu*, Luxor, Egypt. Begun c. 1390 BC.

Colonnade – rows of stone columns





Colonnades at the courtyard temple of *Amon-Mut-Khonsu*,  
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The Parthenon in Athens, Greece.

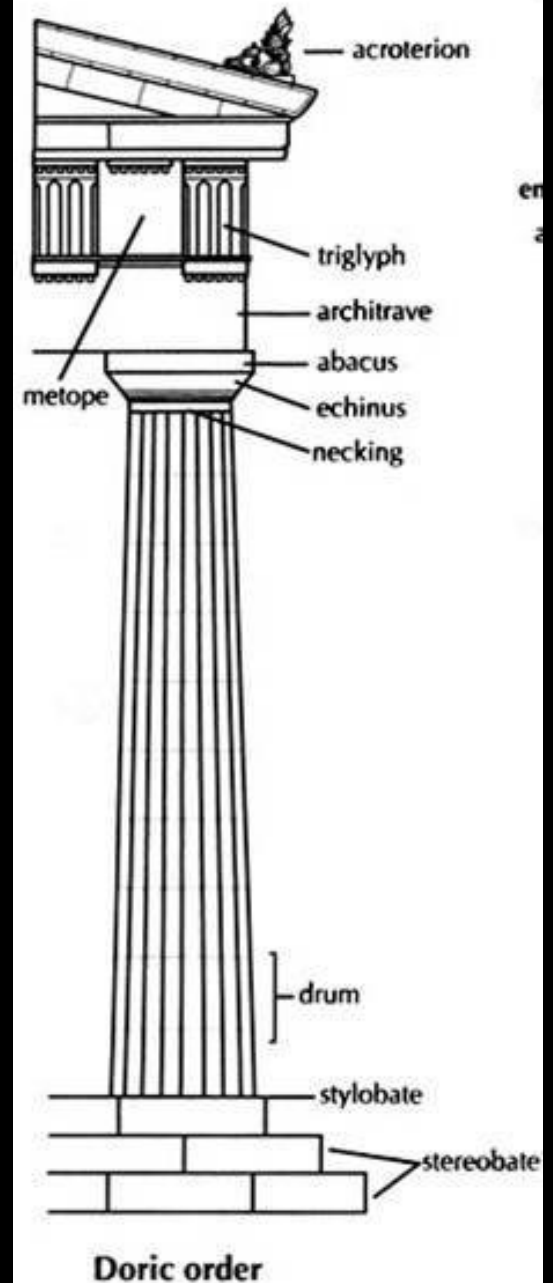




Temple of Athena Nike, Acropolis, Athens. 427-424 BC.

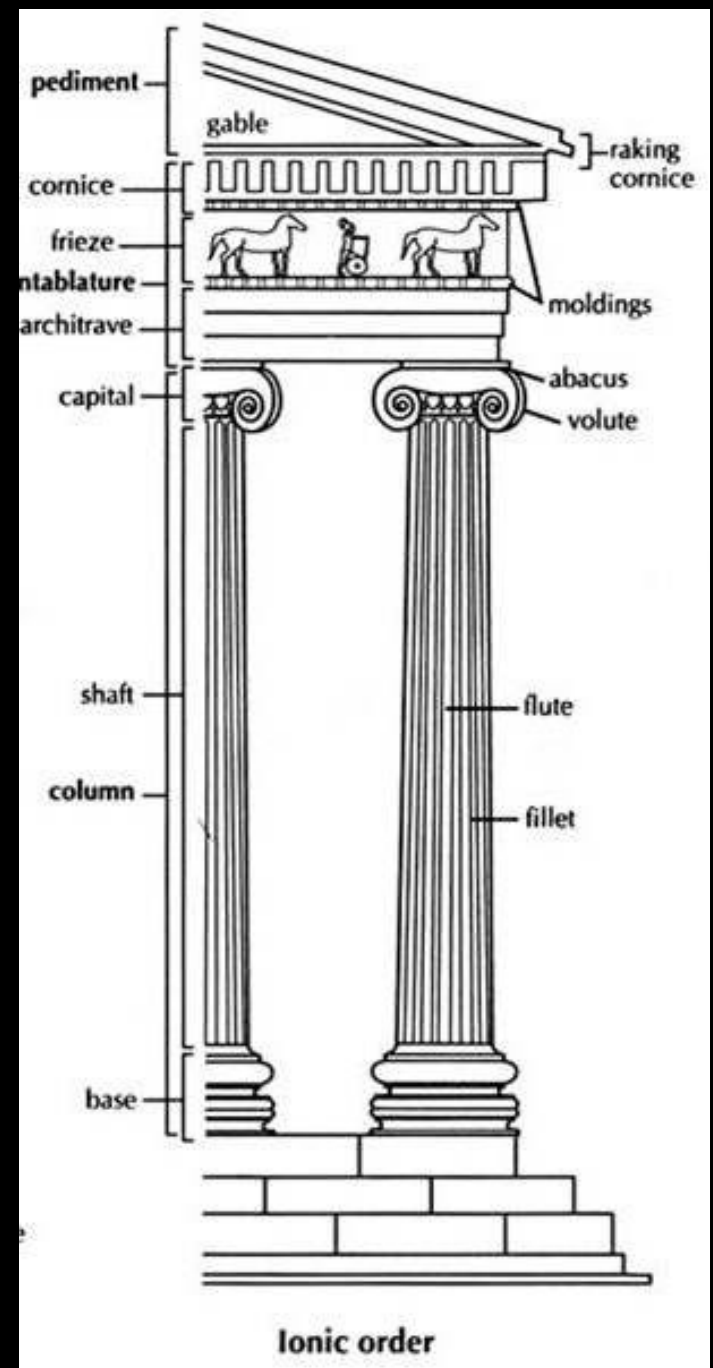
# 3 Greek Orders

1. Doric – no base; capital is just a plain rounded stone slab; geometric



# 3 Greek Orders

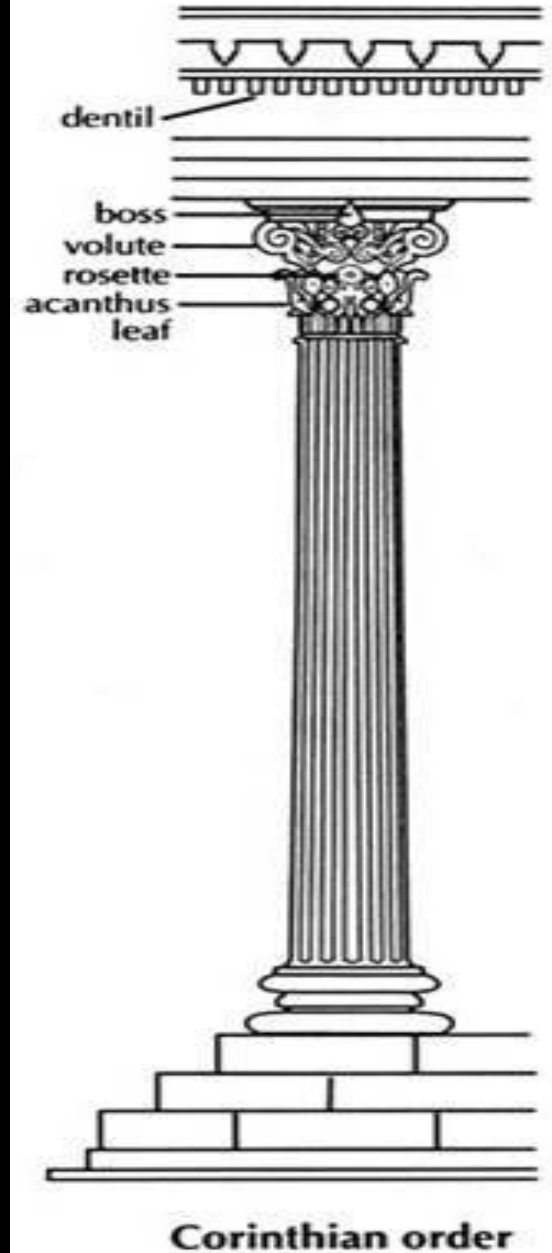
2. Ionic – has stepped base and a carved capital in the form of a scroll called *volute*; taller, more dynamic





# 3 Greek Orders

3. Corinthian – has detailed base and capital adorned with carved acanthus leaves; complex and organic



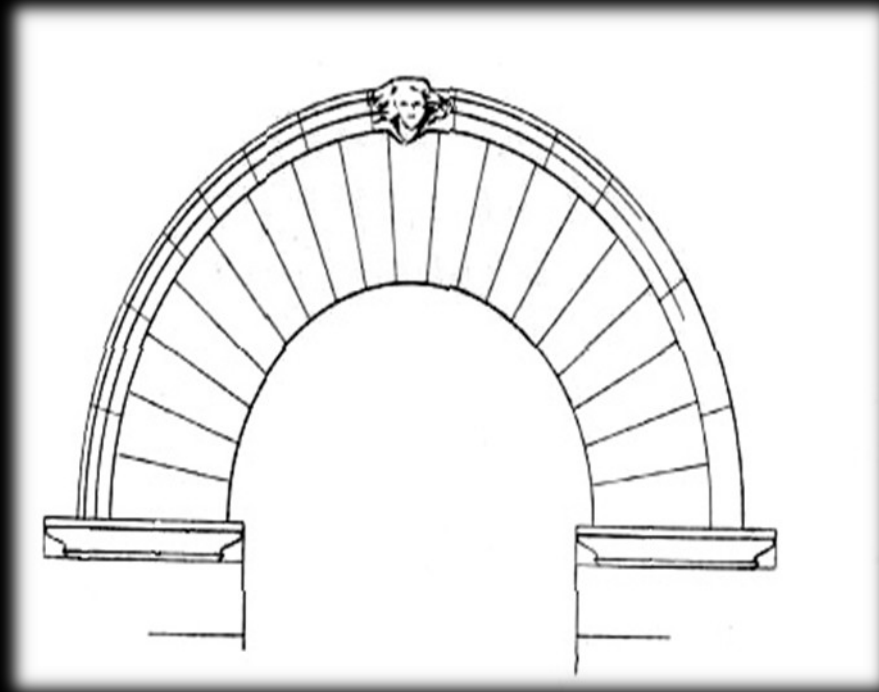


Hoodo (Phoenix Hall), Byodo-in Temple, Uji, Kyoto Prefecture, Japan.  
Heian period, c. 1053.

# Arch and Vault

## Arch

- spans a space and supports structure and weight above it







Arc de Triomphe. Paris, France.

# Arch and Vault

## Arcade

- series of arches supported by columns





Pont du Gard, Nimes, France. Early 1st century AD.

# Arch and Vault

## Vault

- a tunnel-like structure based on the principle of the arch
- barrel vault - an arch extended in depth
- groin vault - two barrel vaults crossed at right angles to each other

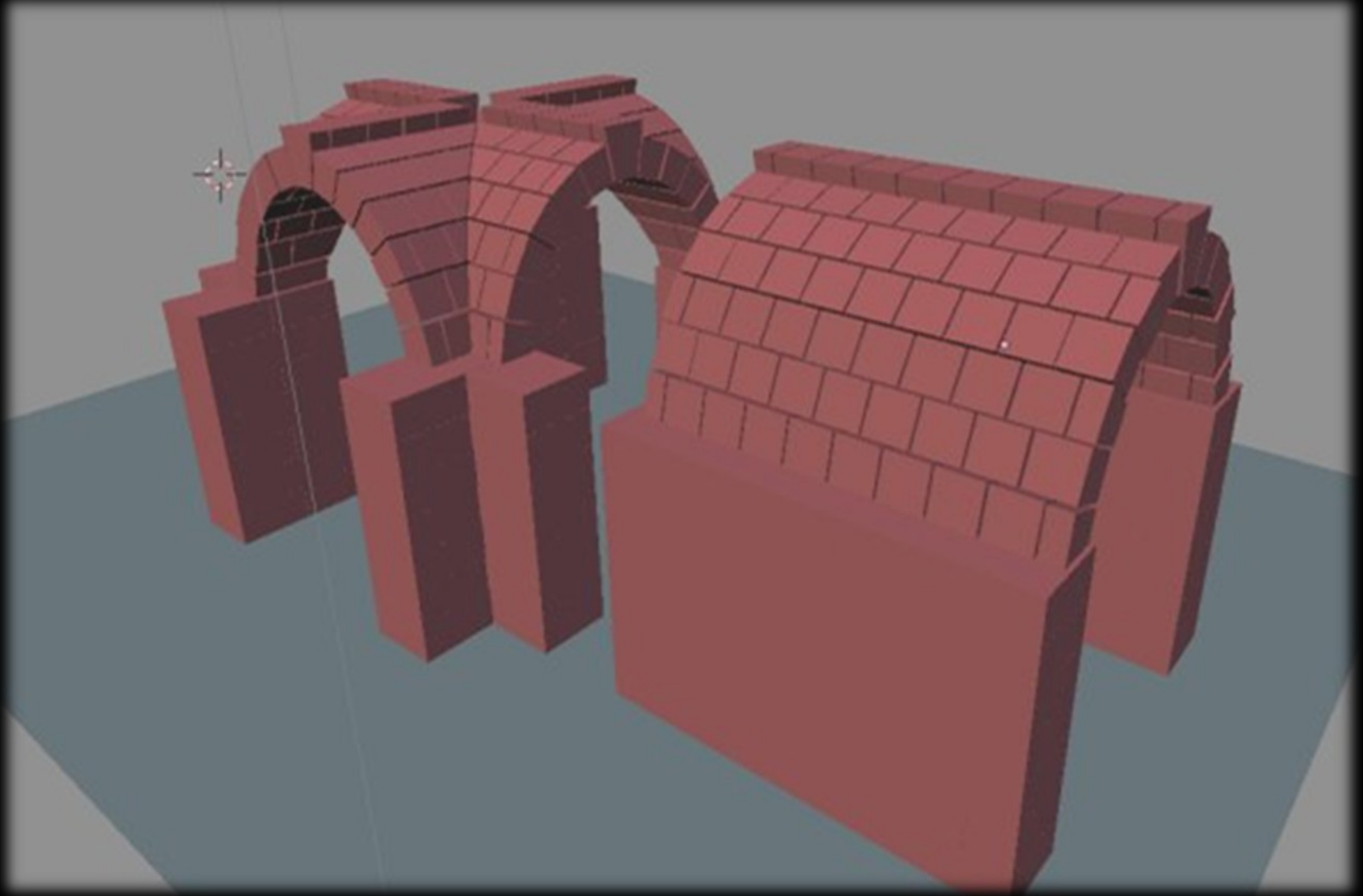


Illustration of groin vault and barrel vault.





Sainte-Foy, Conques, France.  
c. 1050-1120.







Reims Cathedral, France.  
1211- c. 1290.



# Dome

- roof formed by rounded arches or vaults raised on a circular or polygonal base







Pantheon, Rome. 118-124 AD.



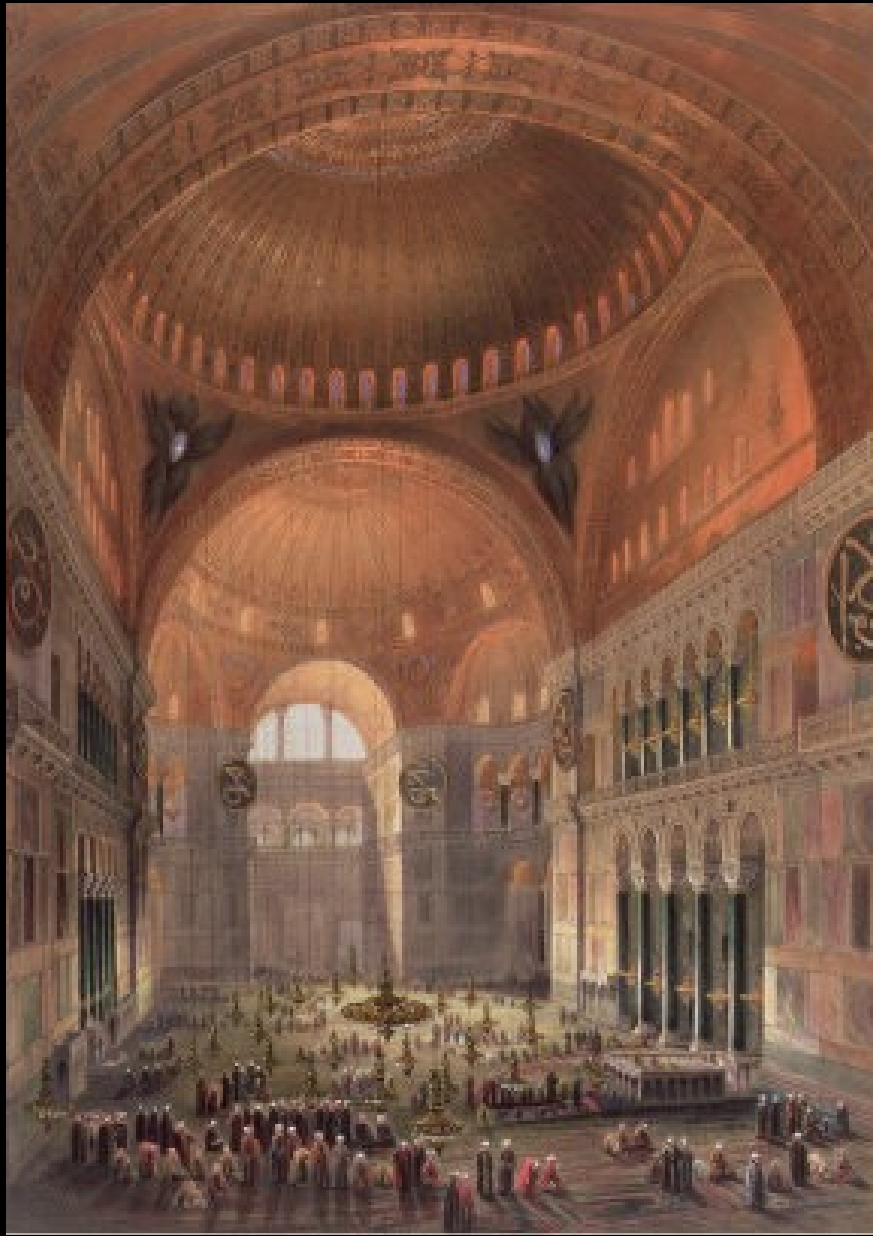


Interior of the Pantheon.



Hagia Sophia, Istanbul. 532-37 AD.







Taj Mahal, Agra, India. 1632-53.



# Frame Construction

➤ is the fitting together of pieces to give a structure support and shape

➤ types:

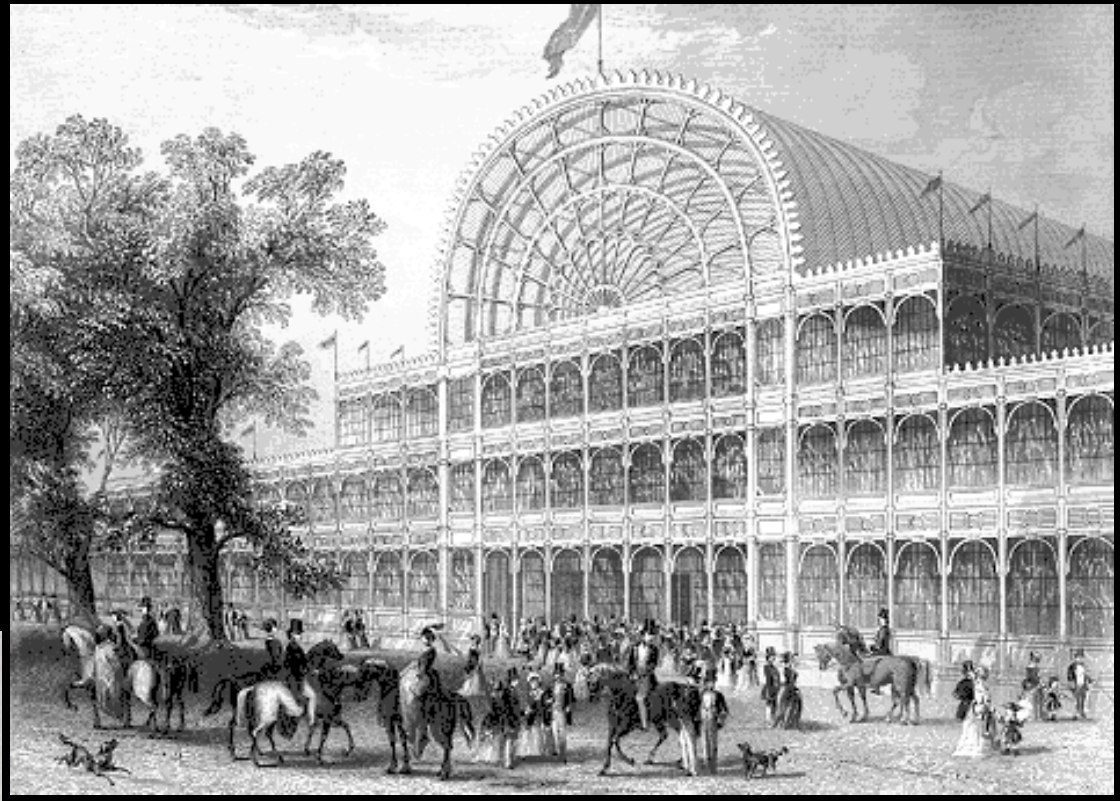
a.cast-iron frame

b.balloon frame

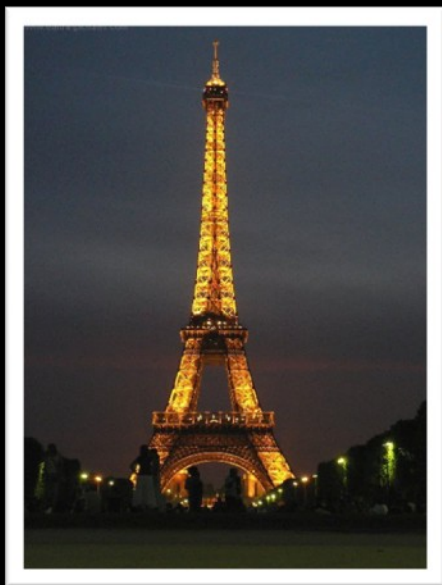
c.steel frame

# Cast iron

Joseph Paxton. *Crystal Palace*,  
Hyde Park, London. 1851,  
destroyed by fire 1936.







Alexandre Gustav Eiffel. *Eiffel Tower*, Paris . 1889.

# Balloon frame



Balloon-frame construction.



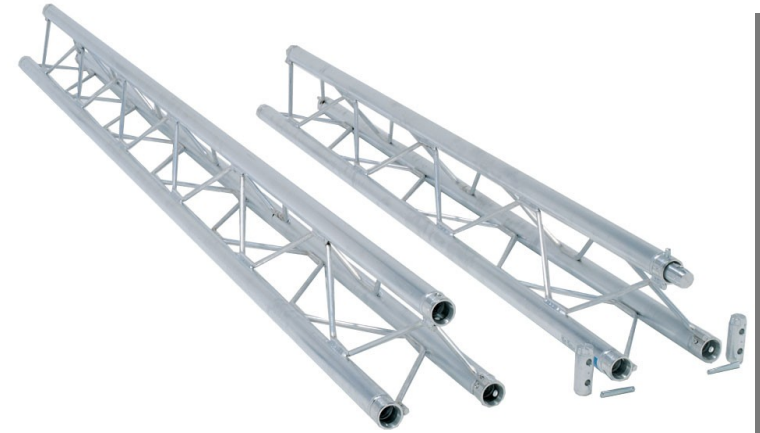
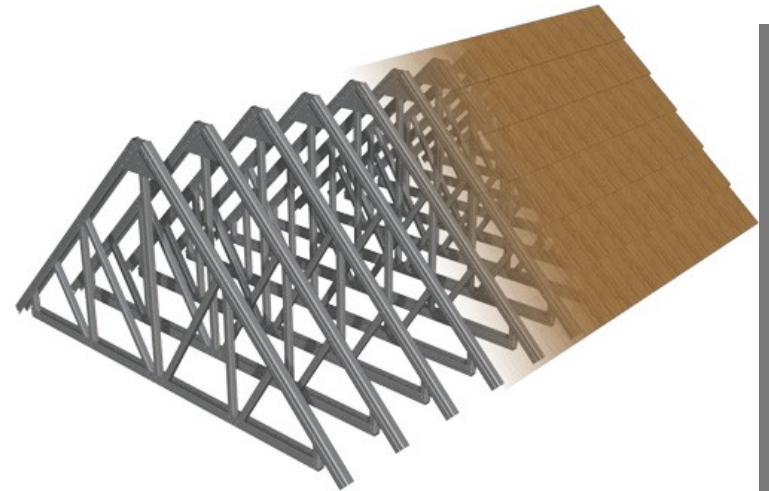
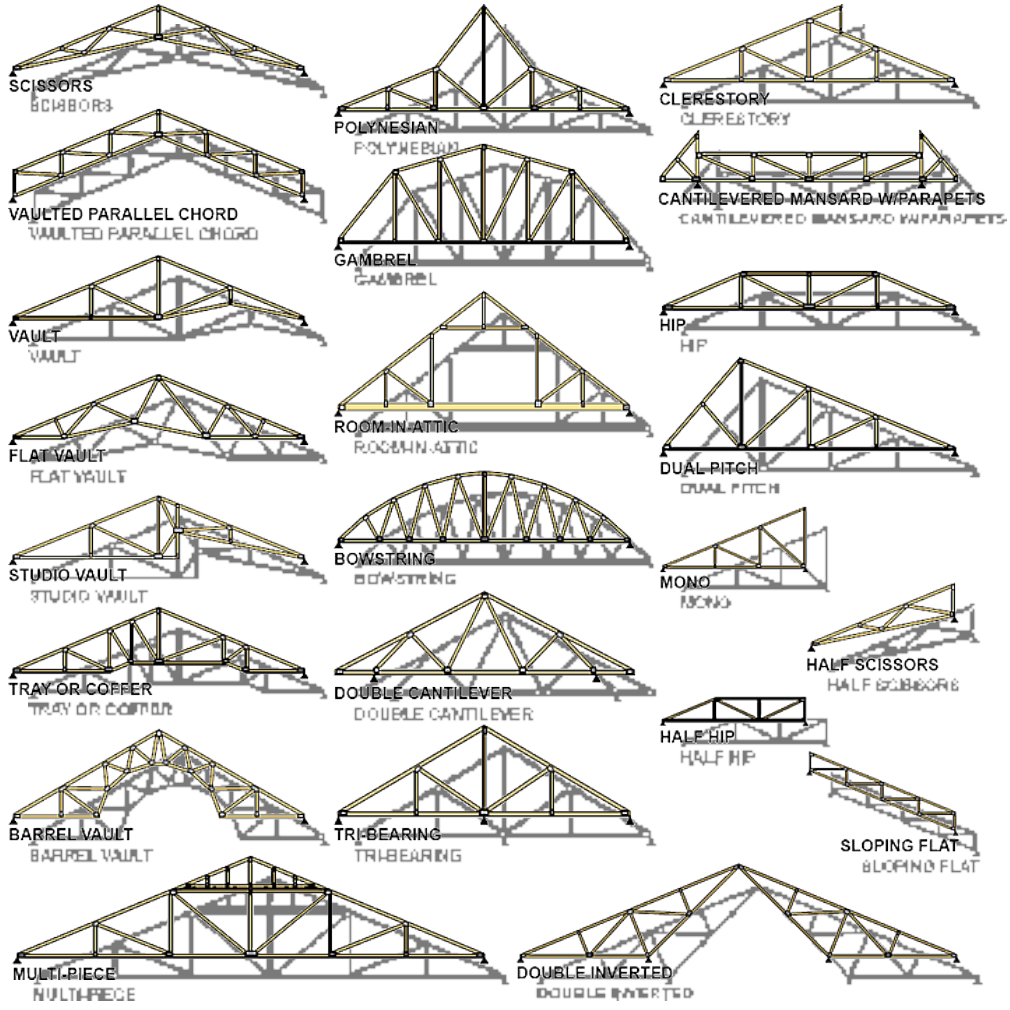
# Steel frame



Steel-frame construction.

# Truss

- **comprising one or more triangular units** constructed with straight slender members whose ends are connected at joints referred to as nodes



# Cantilever

- the overhanging portion of a beam anchored only at one end





Frank Lloyd Wright. *Falling Water*, Bear Run, Pennsylvania.1936.





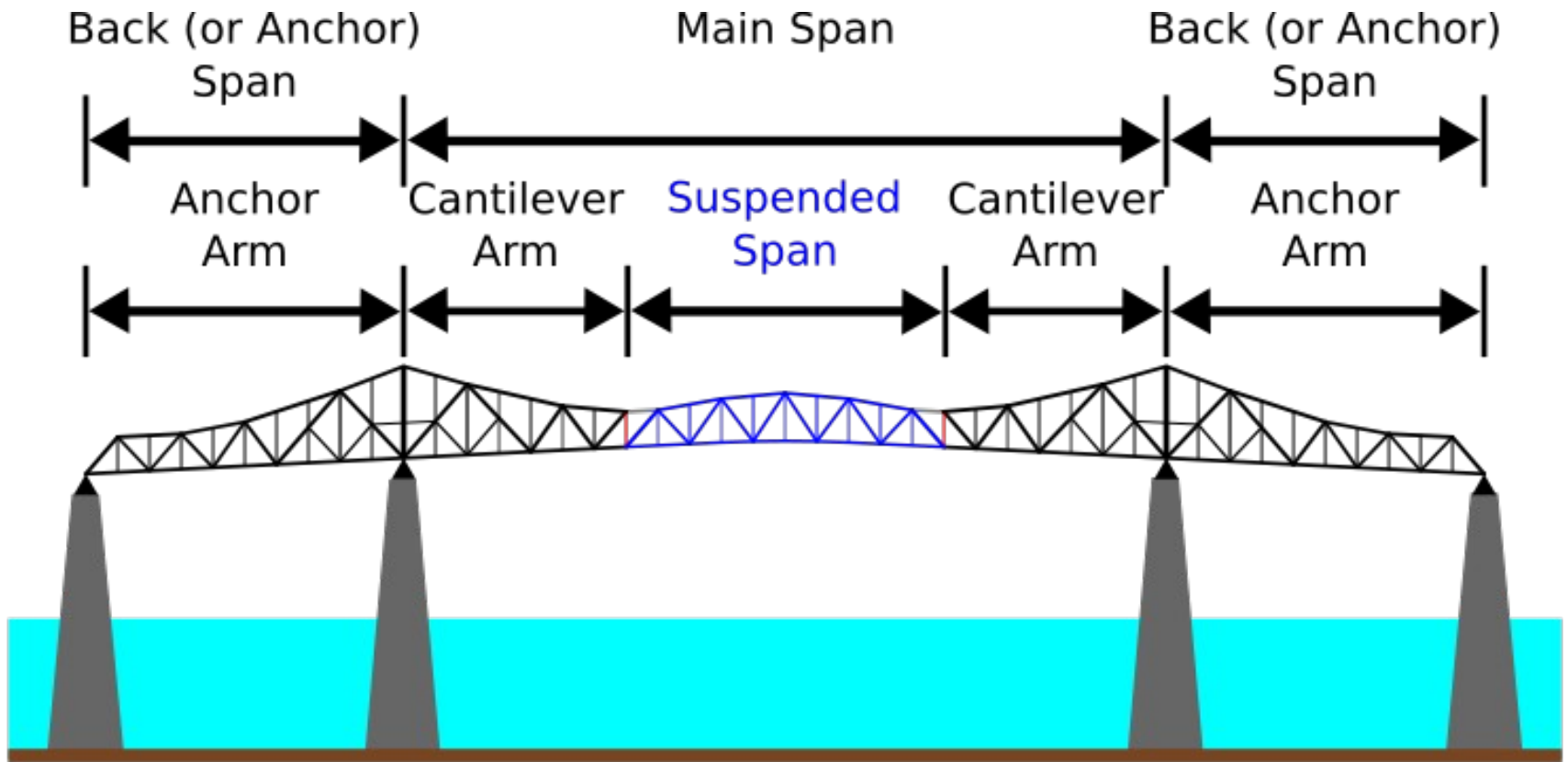
Cottage in the Bahamas. Peter Jefferson.





*Forth Railway Bridge, Scotland. 1890.*





A diagram of the parts of a cantilever bridge.



# Philippine Architecture



# Bahay kubo/payag

- follows the skeleton-and-skin construction
- built with wood, bamboo and nipa or cogon grass



# Bahay-na-bato

- made of coral stone (ground floor), hardwood (second level), *teja* or clay tiles (roof)



## Parts of a bahay-na-bato:

- a. zaguan – where carozzas and carriages are kept
- b. cuadra – for horses
- c. bodega – for agricultural produce
- d. cuartos - bedrooms
- e. caida – small living room
- f. sala – main living room
- g. cucina – where food is prepared
- h. comedor – dining room
- i. azotea - a flat and open terrace
- j. baño – bathroom
- k. comun - restroom



# Simbahan

- not only serves as a house of worship but also a place of refuge during calamities and Moro raids



## Other structures

- a. fuerzas – or forts, to protect the natives from pirate attacks
- b. casa real – town hall
- c. obras publicas – public works which include streets, bridges, markets, and schools