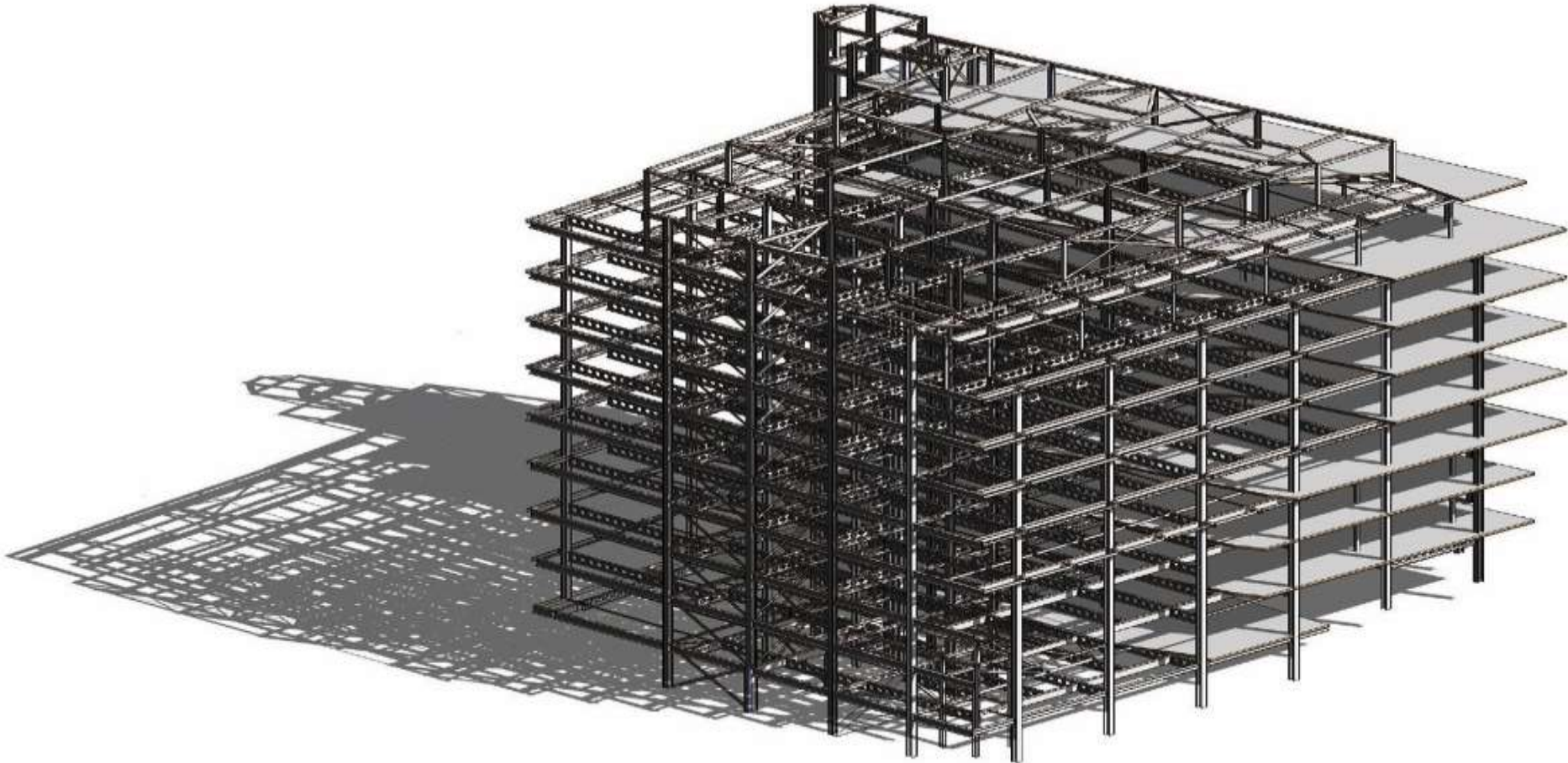


SPACE FRAMES



STEPHEN J M.E.(STRUCTURAL ENGG)

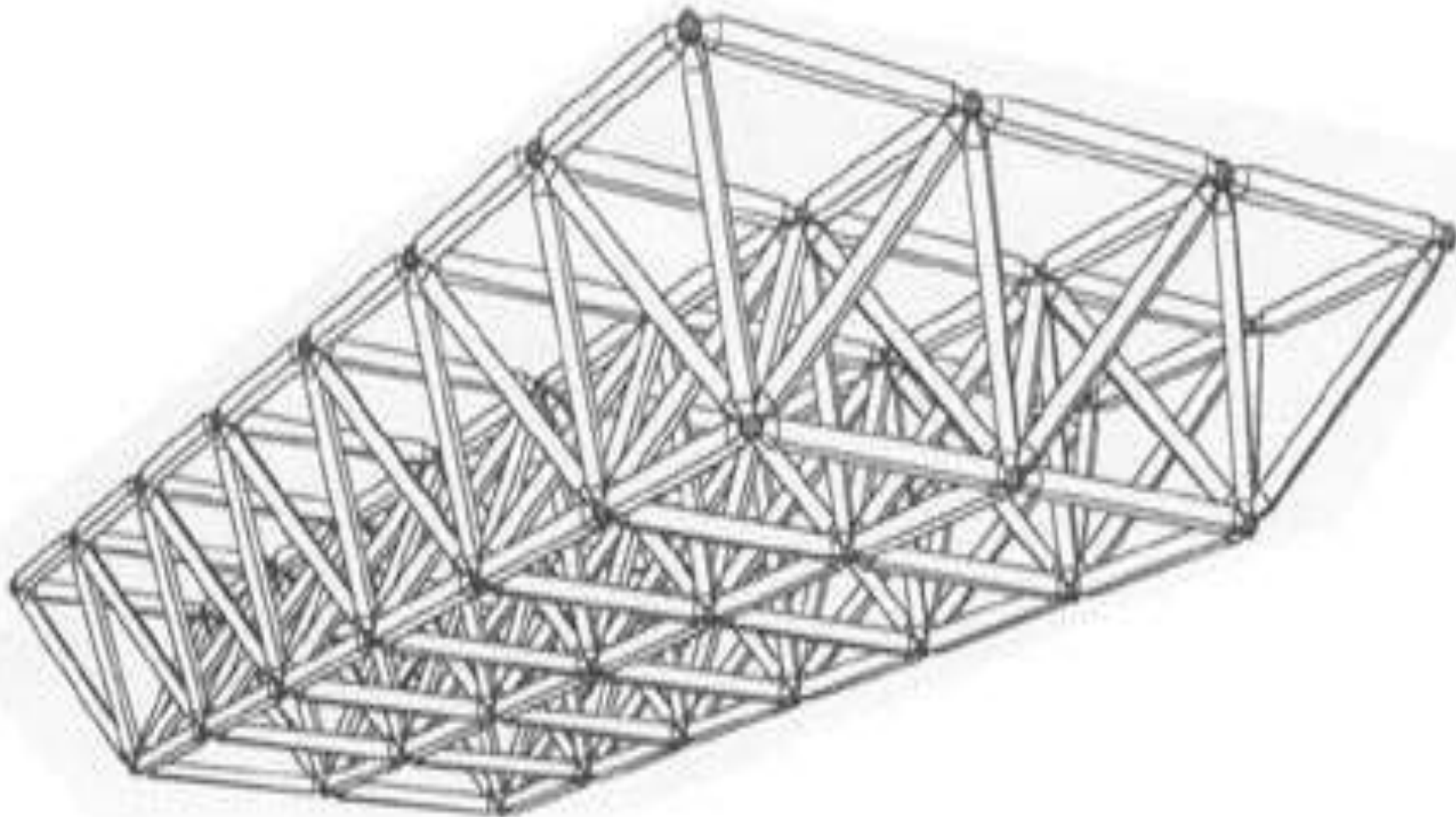
DEPARTMENT OF CIVIL ENGINEERING
KOMBOLCHA INSTITUTE OF TECHNOLOGY



UNIT – II

Space Frames

SPACE FRAME



SPACE FRAMES

A **space frame** is a truss-like, lightweight rigid structure constructed from interlocking struts in a geometric pattern.



SPACE FRAMES

- They derive their strength from the inherent rigidity of the triangular frame; flexing loads (bending moments) are transmitted as **TENSION** and **COMPRESSION** loads along the length of each strut.

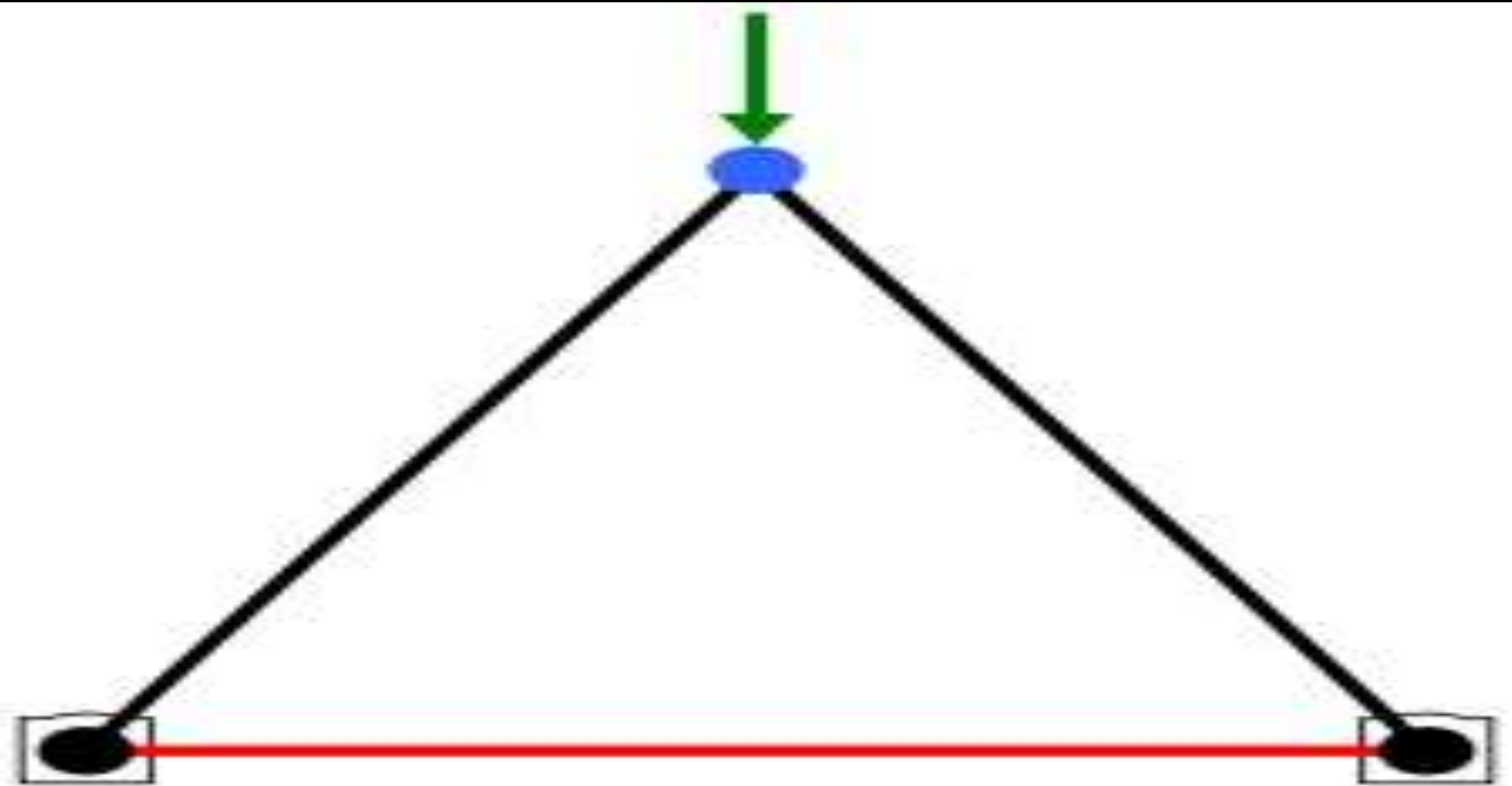




DEFINITION

- A three-dimensional structures.
- The assembled linear elements are arranged to transfer the load.
- Take a form of a flat surface or curve surface.
- Designed with no intermediate columns to create large open area.

LOAD DISTRIBUTION





▶ TYPES OF SPACE FRAME

1) Two and three-way grids

- Characterized as two way or three way

2) Single, Double and Triple Layered

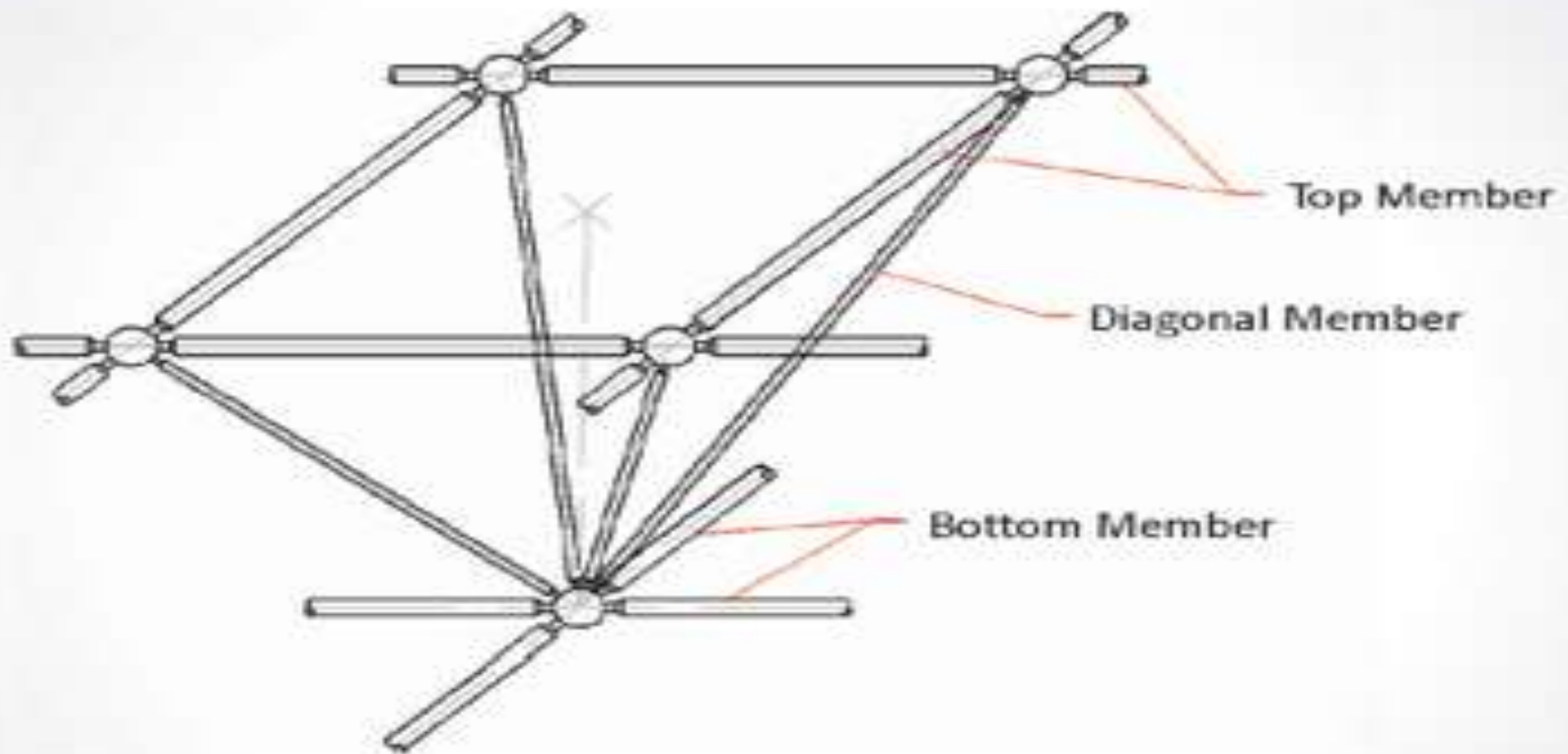
- Single layer frame has to be singly or doubly curved.
- Commonly used space frames are double layered and flat.
- Triple layered is practically used for a large span building.

COMPONENTS OF SPACE FRAME

Consists of axial members : which are **tubes** and **connectors**



MEMBERS OF SPACE FRAME



Typical Detail of one unit of Space Frame

TUBES

1) Circular Hollow Sections



2) Rectangular Hollow Sections



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2

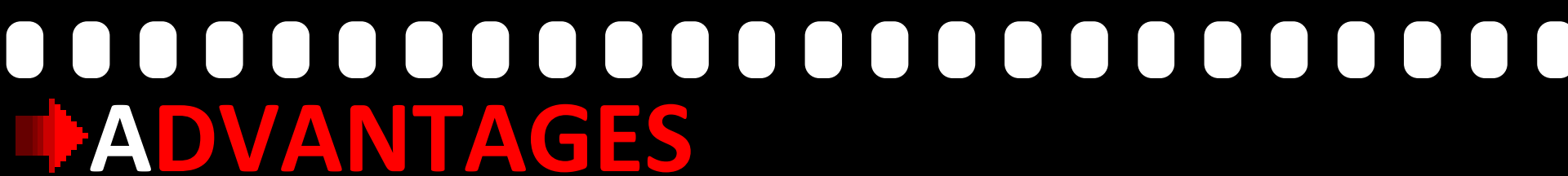
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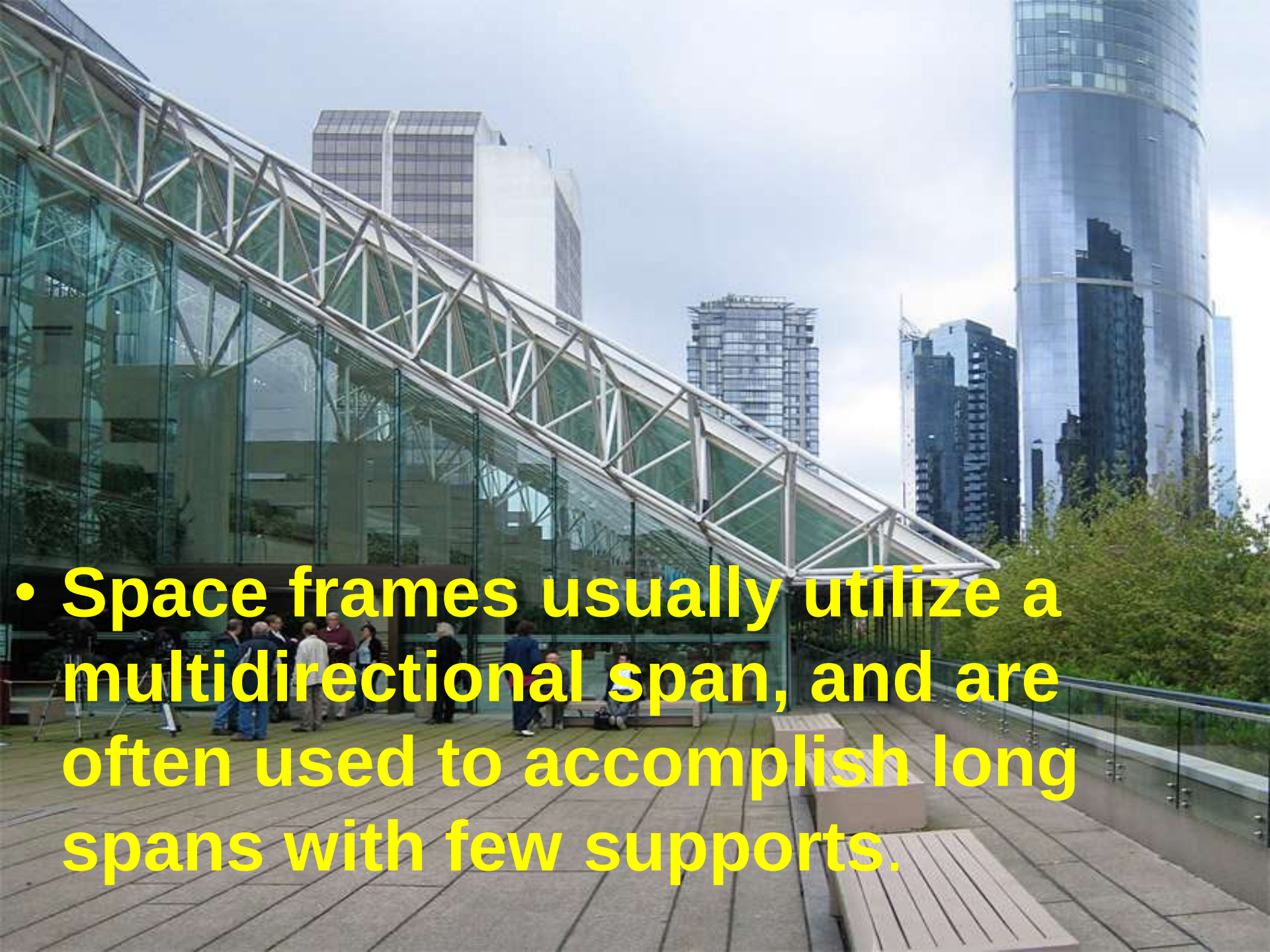
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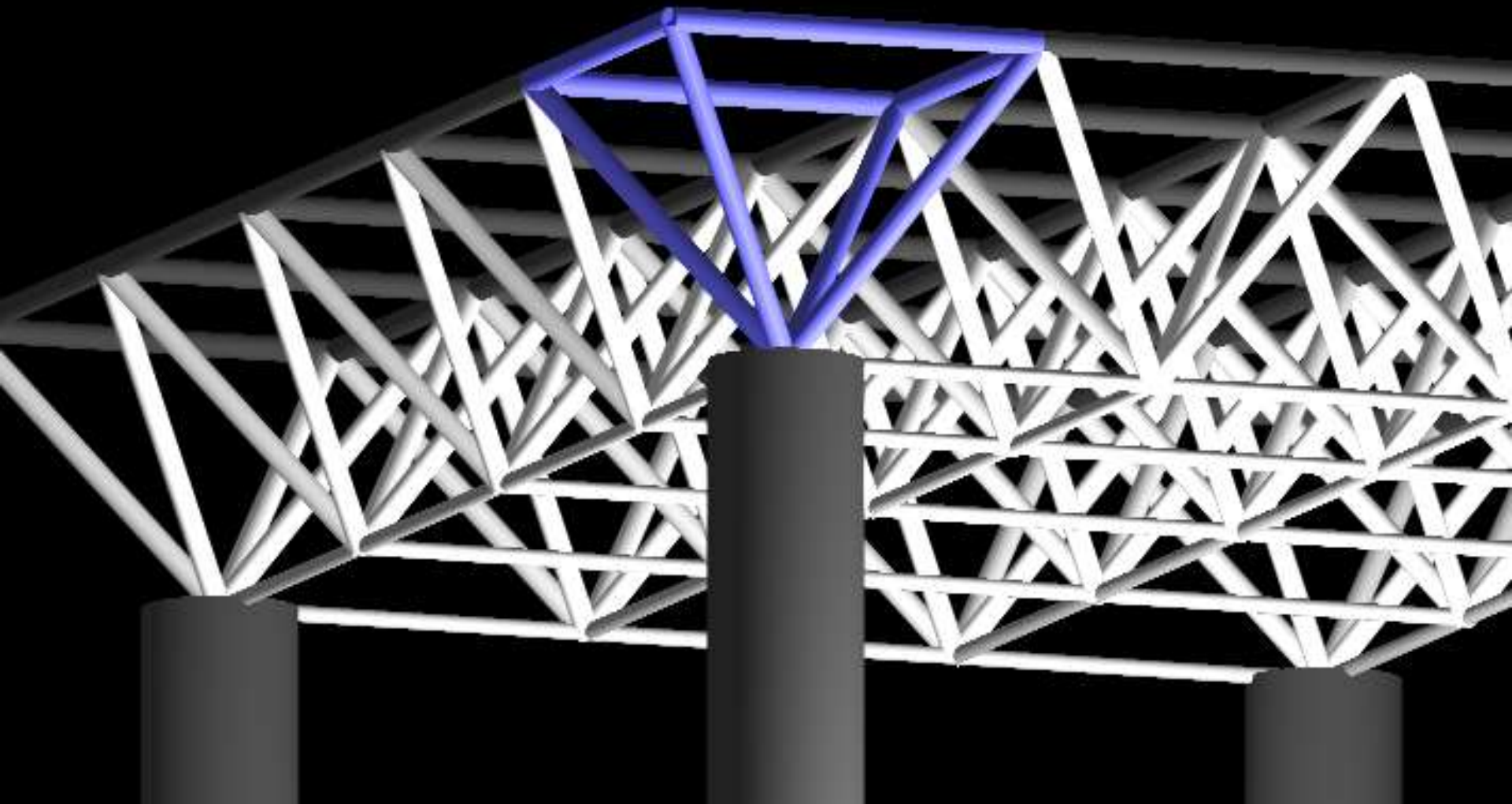


ADVANTAGES

- Light
- Elegant & Economical
- Carry load by three dimensional action
- High Inherent Stiffness
- Easy to construct
- Save Construction Time & Cost
- Services (such as lighting and air conditioning) can be integrated with space frames
- Offer the architect unrestricted freedom in locating supports and planning the subdivision of the covered space.

- 
- Space frames usually utilize a multidirectional span, and are often used to accomplish long spans with few supports.

Simplified space frame roof with the
half-octahedron highlighted in blue





- Space frames are an increasingly common **ARCHITECTURAL** technique especially for large roof spans in modernist commercial and industrial buildings

SOME SPACE FRAME APPLICATIONS

- Hotel/Hospital/commercial building entrances
- Commercial building lobbies/atriums
- Parking canopies

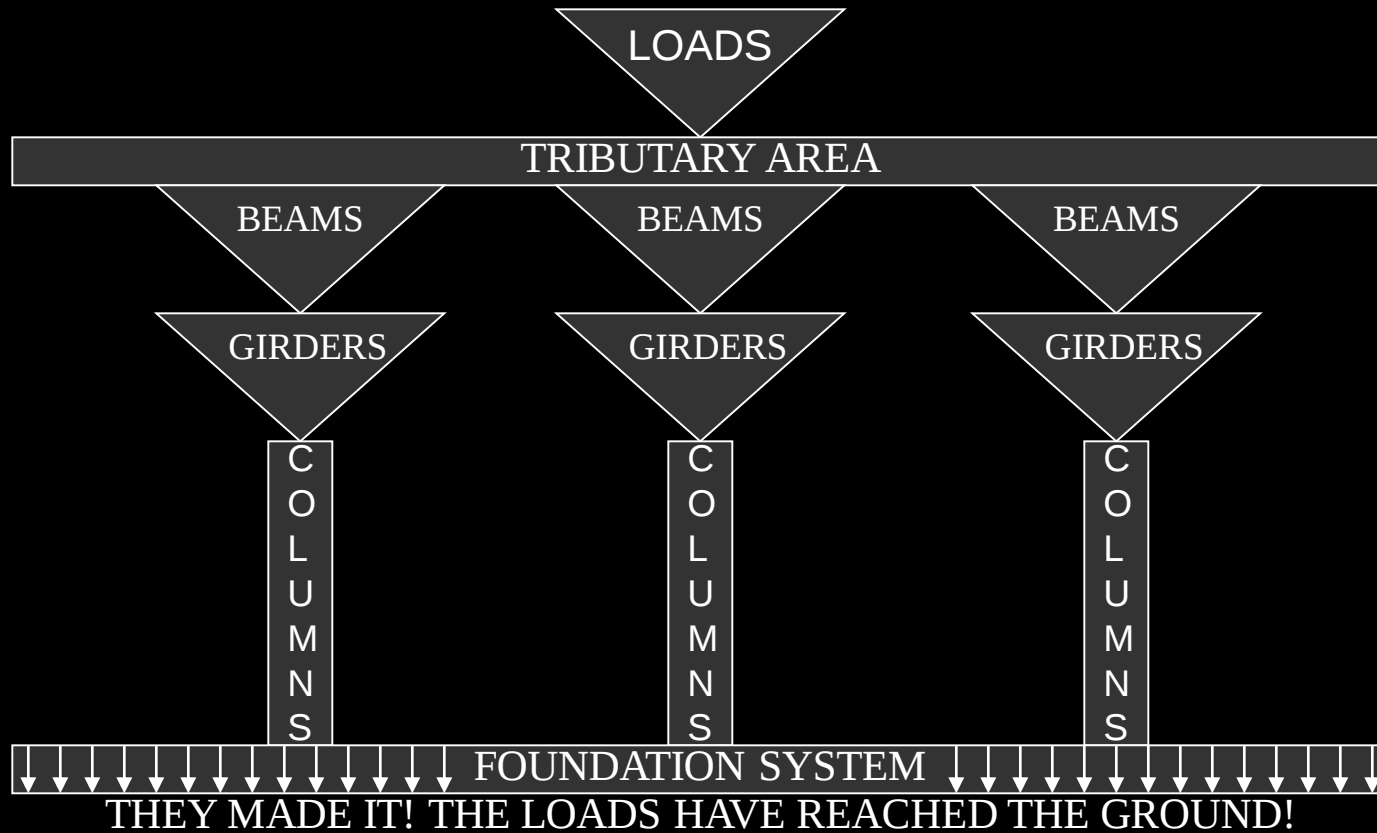


ADVANTAGES OF SPACE FRAME SYSTEMS OVER CONVENTIONAL SYSTEMS

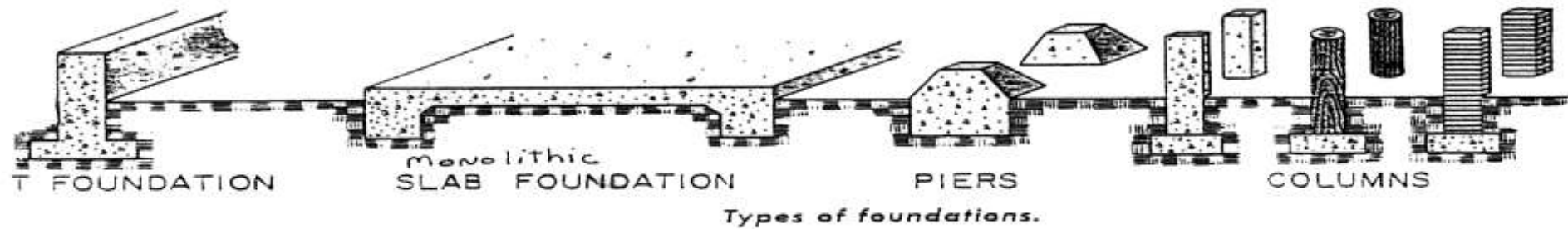
- ✓ Random column placement
- ✓ Column-free spaces
- ✓ Minimal perimeter support
- ✓ Controlled load distribution
- ✓ Design freedom
- ✓ Supports all types of roofing



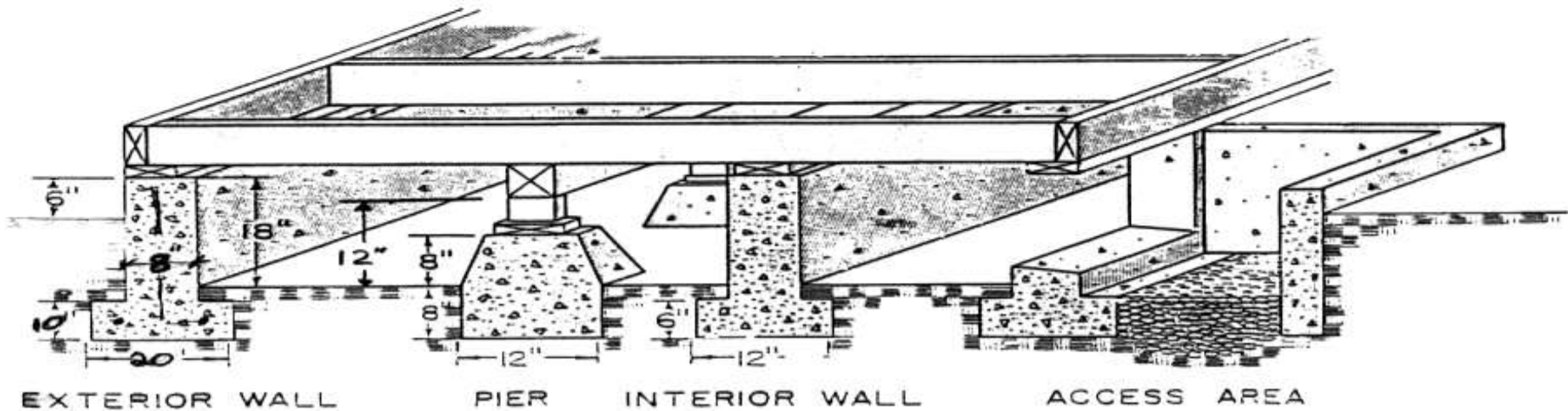
TRANSMISSION OF LOADS



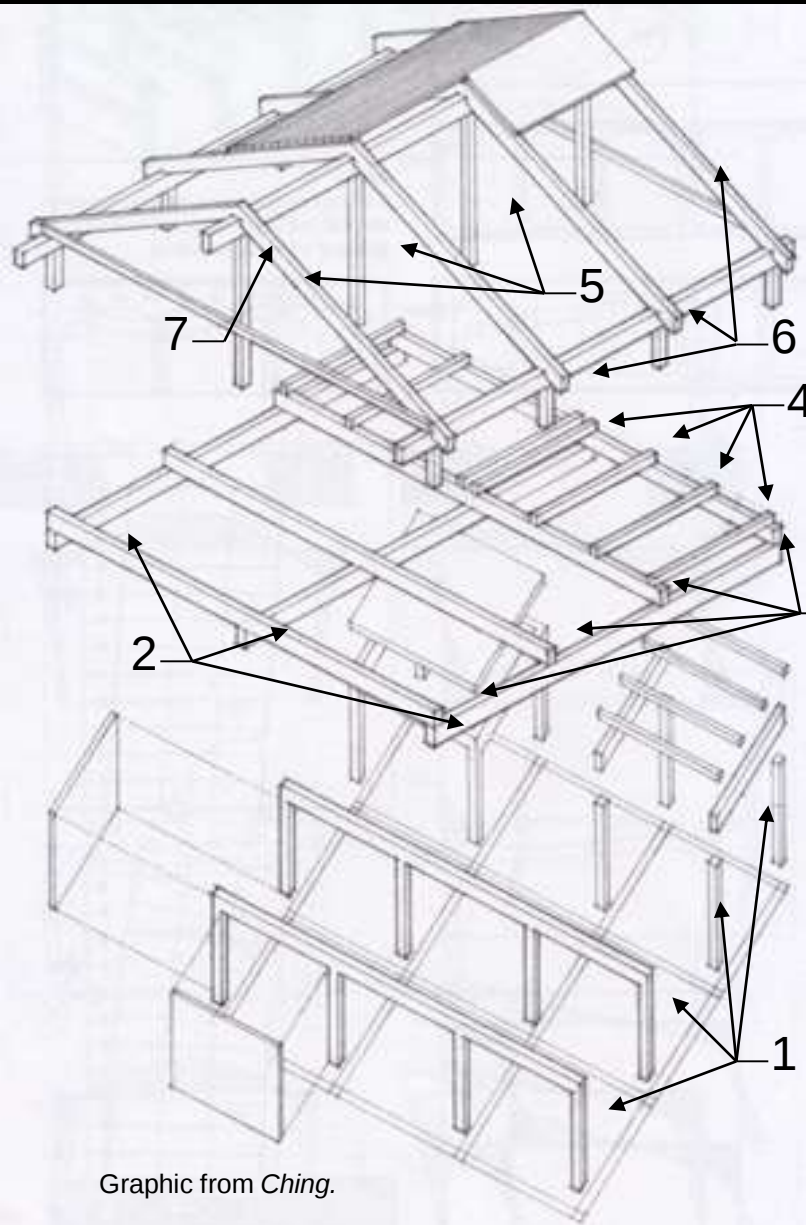
FOUNDATION SYSTEMS



Elements of a T foundation.



TERMS OF THE SYSTEM

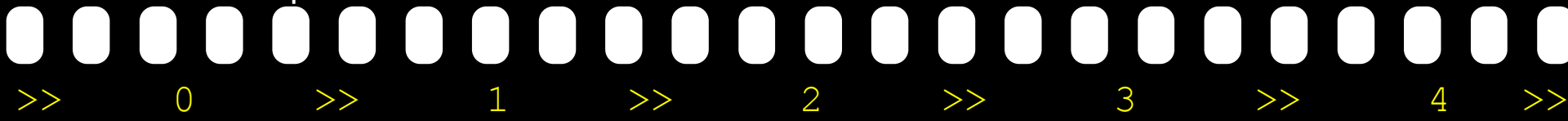


Graphic from Ching.

1. Posts - In timber-framed buildings the main vertical timbers of the walls.
2. Girder - A box girder is of hollow rectangular or other closed cross-section with transverse plates or other diaphragm members at intervals for strengthening.
3. Principal Beam - In the body of a building a main horizontal timber supporting floor or ceiling joists.
4. Joist - Horizontal parallel timbers laid between the walls or the beams of a building to carry the floorboards.
5. King Post - A vertical timber standing centrally on a tie- or a collar-beam and rising to the apex of the roof where it supports the ridge.
6. Rafter - Inclined lateral timbers sloping from wall-top to apex and supporting the roof covering.
7. Ridge Beam - A horizontal, longitudinal timber at the apex of a roof supporting the ends of the rafters.

TYPICAL USES FOR WOOD FRAMING

- Residential Construction
 - This is the most common use
 - Timber can be used to create many aesthetically pleasing irregular shapes
 - Economic/convenient source of building materials
 - Durable for residential use
 - Ease/speed of construction
- Small Commercial Buildings
 - Many small commercial buildings are similar to residential construction
 - Modular quality is advantageous
- Barns (a large farm building used for storing grain, hay, or straw or for housing livestock)
 - Ease/speed of construction
 - Simplicity & Durability of structure
 - Modular benefits
- Camp/Park facilities
 - Aesthetically pleasing/appropriate for location
 - Ease/speed of construction



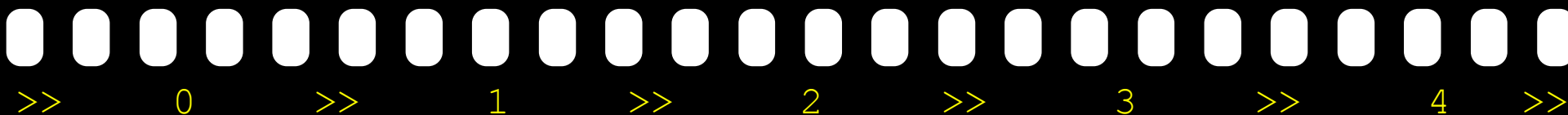
TYPICAL USES AND APPLICATIONS

- Commercial
 - Walkway Canopies
 - Shade Structures
 - Metal Roofing
- Residential
 - Lattice
 - Pool Enclosures
 - Sunrooms
 - Carports



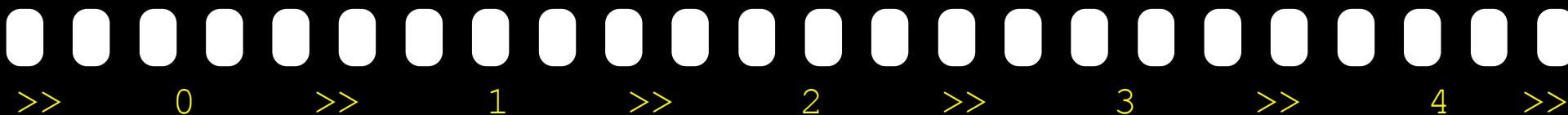
ALUMINUM/FIBERGLASS COLUMNS

- The columns are designed for all types of decorative and load bearing installations and are architecturally correct in their proportions and projections. Fiber-glass columns require very little maintenance, are durable and are ideal for indoor or outdoor applications.
- All components are non-porous, waterproof, and impervious to insect infestation.
- Structural fiberglass columns are load bearing and will typically have some sort of warranty. They can vary in diameters from 5 to 36 inches with a load-bearing capacity from 16,000 to 31,000 lbs., and can be found in lengths ranging from 8 to 30 feet.
- Aluminum's properties give the columns excellent load bearing strength and durability. Since Aluminum is also light weight it aids in the ease of installation. Aluminum and Fiberglass also have a longer usable lifetime than wooden members.



OTHER SPECIFIC USES

- Aluminum is used in architectural skylights which are held using space frames due to its lightweight and strong material properties.
- Aluminum is also used in prefabricated dome structures typically used on religious or institutional buildings.
- Alternative materials are also now used in pedestrian bridges and serve as low maintenance crossways for traffic ranging from horses and pedestrians to golf carts. These bridges are environmentally friendly and meet state and federal codes. These materials are used on a smaller scale presently but show potential use on large scale bridges in the future.
- These alternative construction materials are typically used in the decorative elements of buildings, but are being accepted as load bearing materials due to their weight, strength, cost effective manufacturing, and modular abilities.



The innovative structural system of the John Hancock Center consists of a bearing structure around the perimeter which behaves as a framed and diagonal tube.

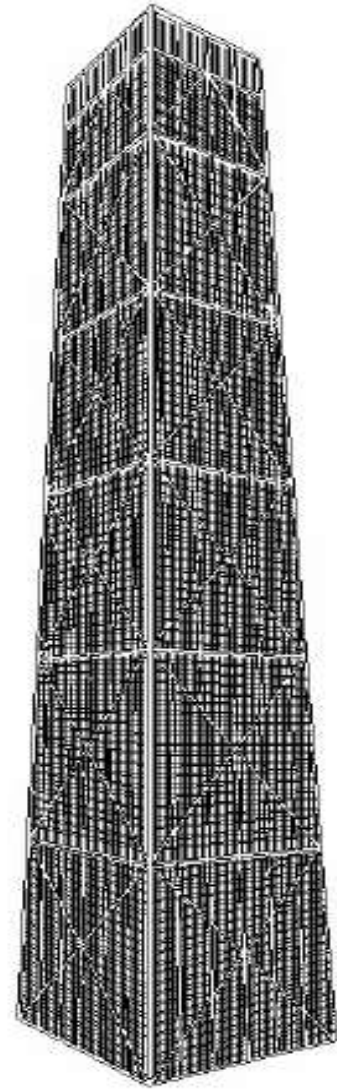
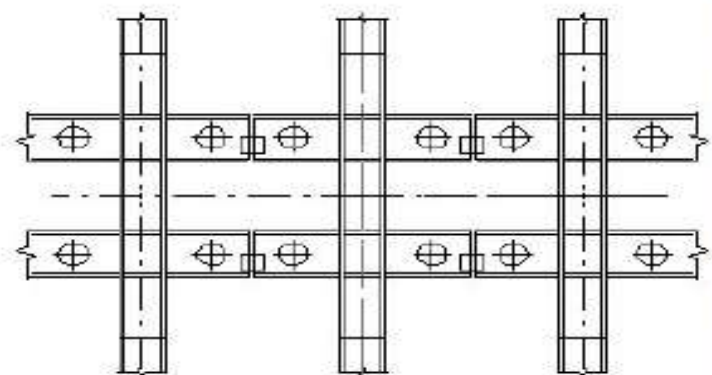
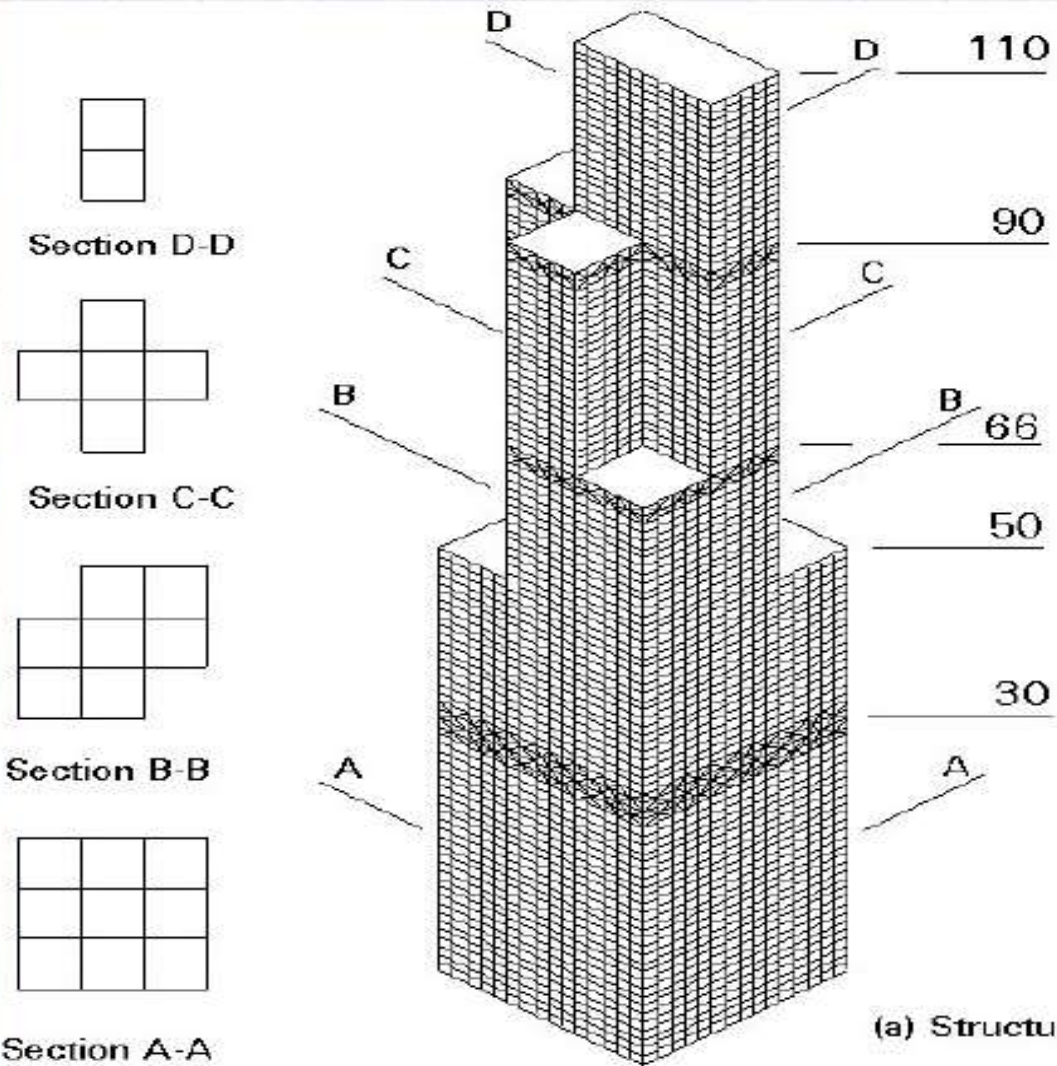


Figure 2 John Hancock Centre, Chicago

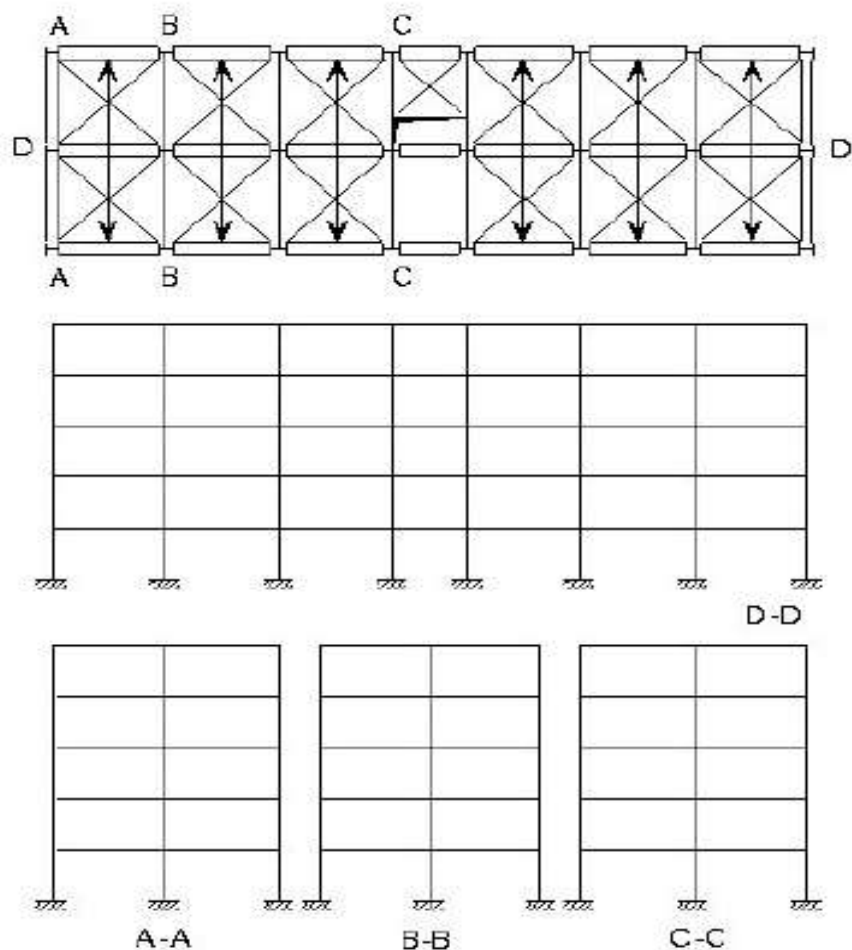


(a) Structural tower

(b) Prefabricated elements of the perimeter bearing structure

Figure 4 Sears Tower

- ① Longitudinal rigid frames
Floors arranged transversely



- ② Longitudinal frames with braced cantilevers
Floors arranged transversely

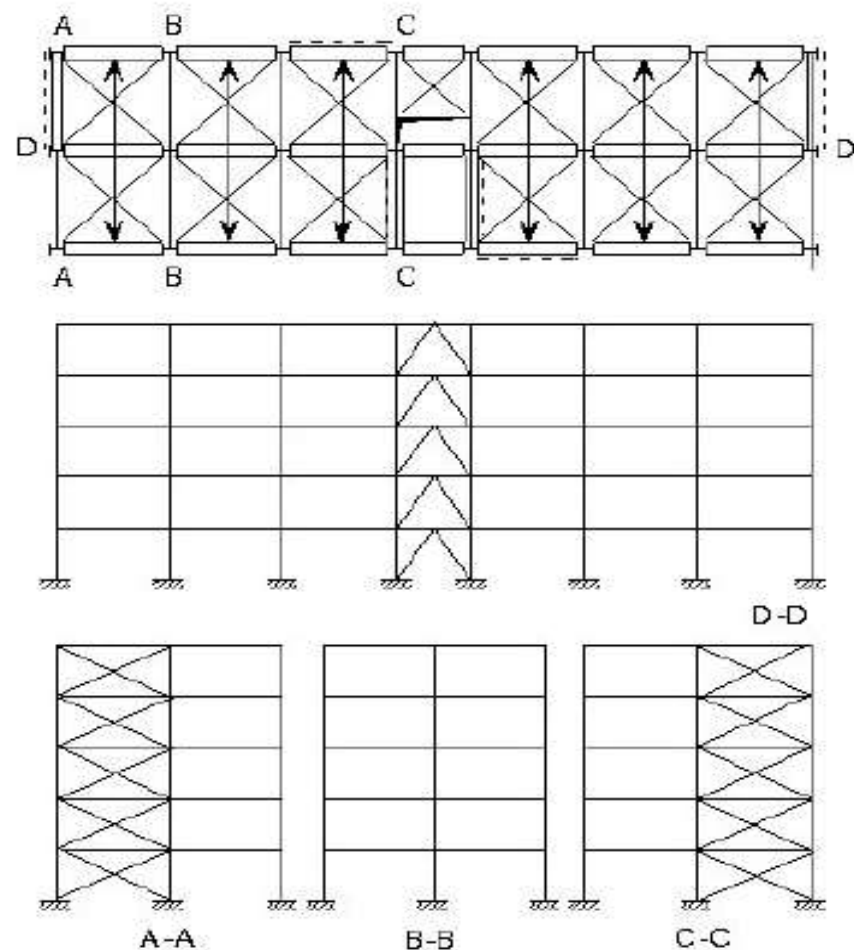
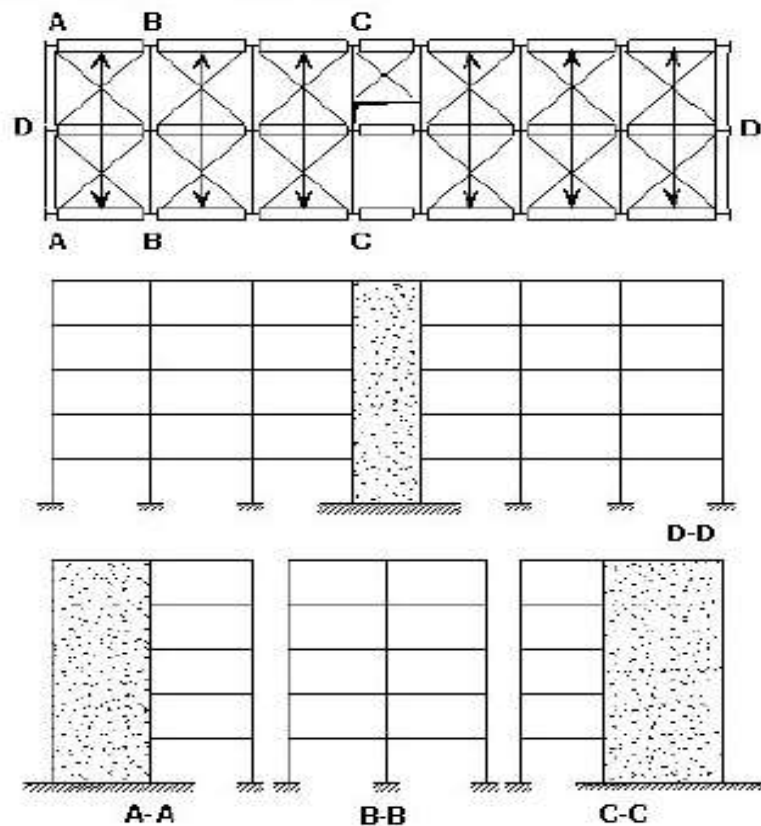


Figure 5 Structural systems for low-rise steel buildings

- ③ Longitudinal frames with concrete walls or core
Floors arranged transversely



- ④ Longitudinal frames with bracing as ① ② & ③
Floors arranged longitudinally

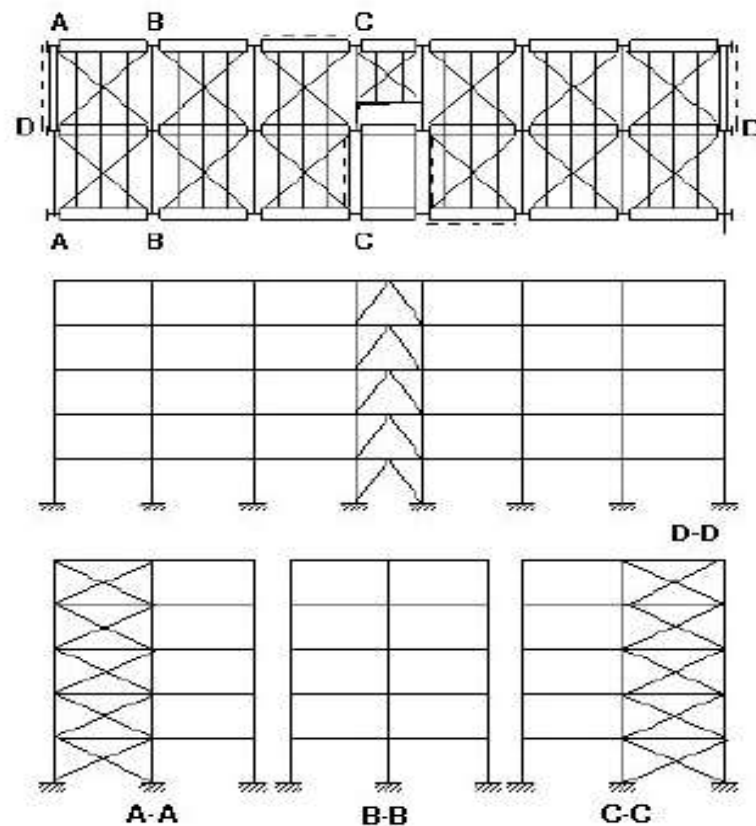
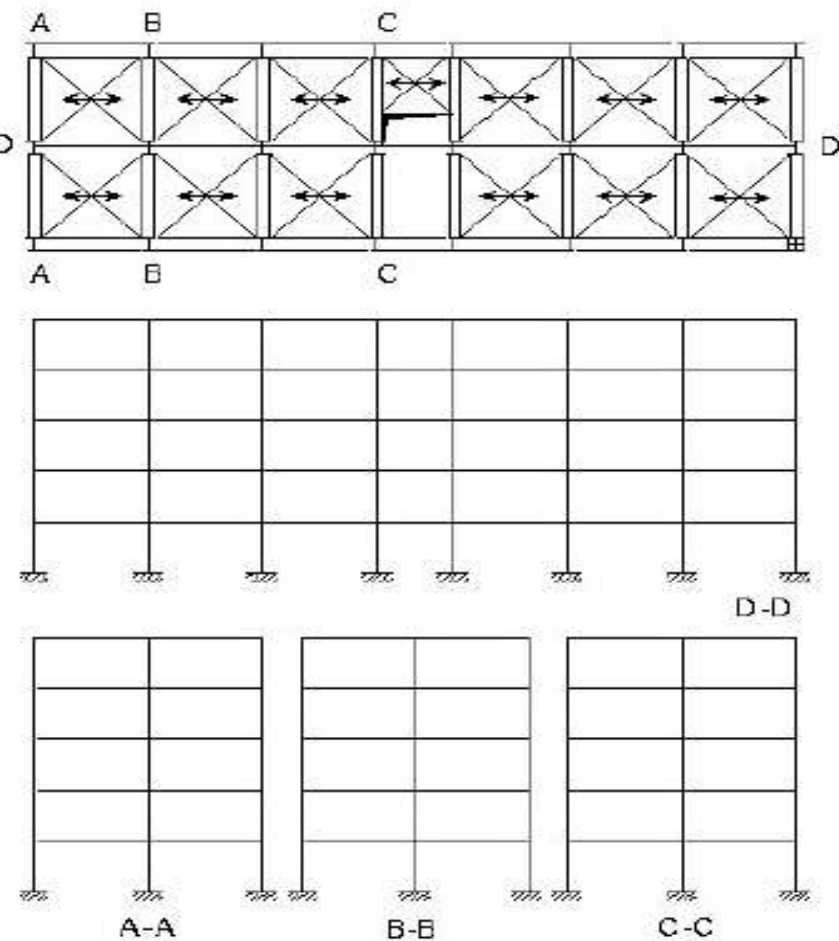


Figure 5 Structural systems for low-rise steel buildings (cont.)

⑤ Transverse rigid frames
Floors arranged longitudinally



⑥ Transverse frames with braced cantilevers
Floors arranged longitudinally

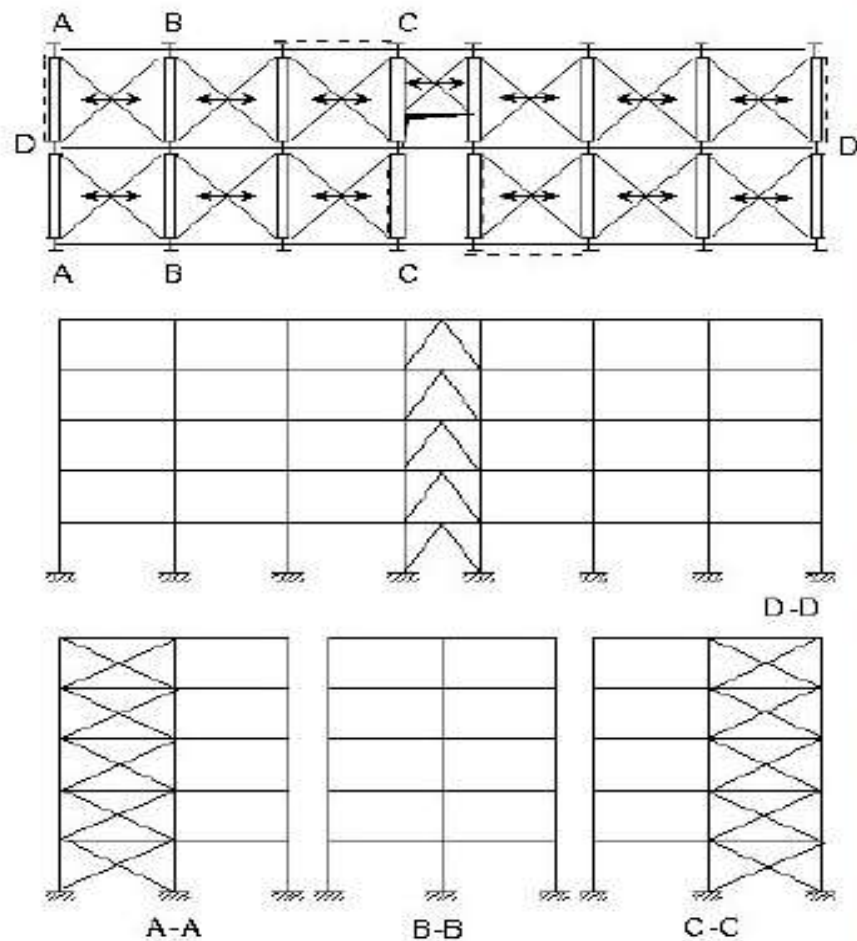


Figure 5 Structural systems for low-rise steel buildings (cont.)

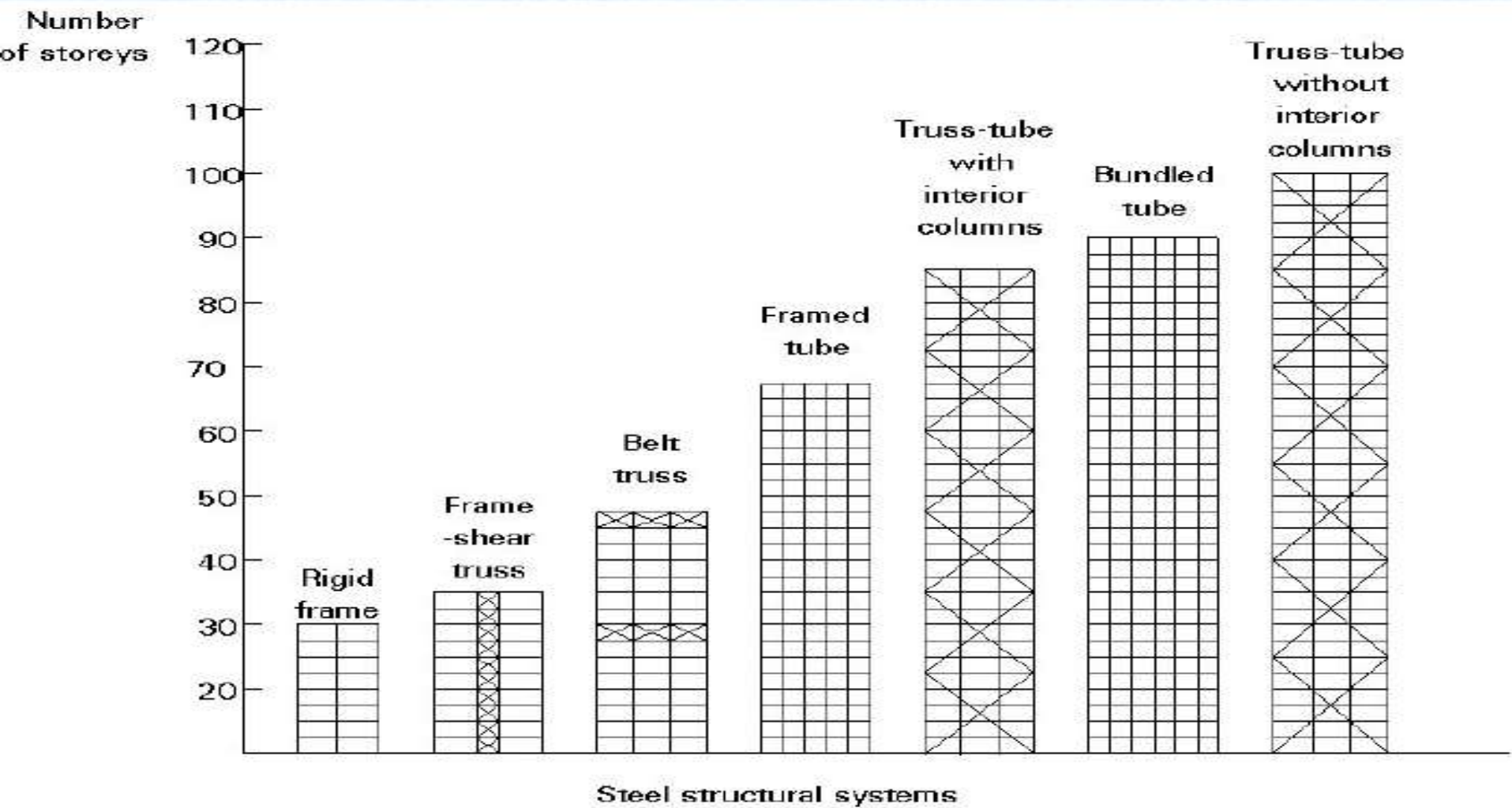


Figure 7 Steel structural systems and the number of storeys

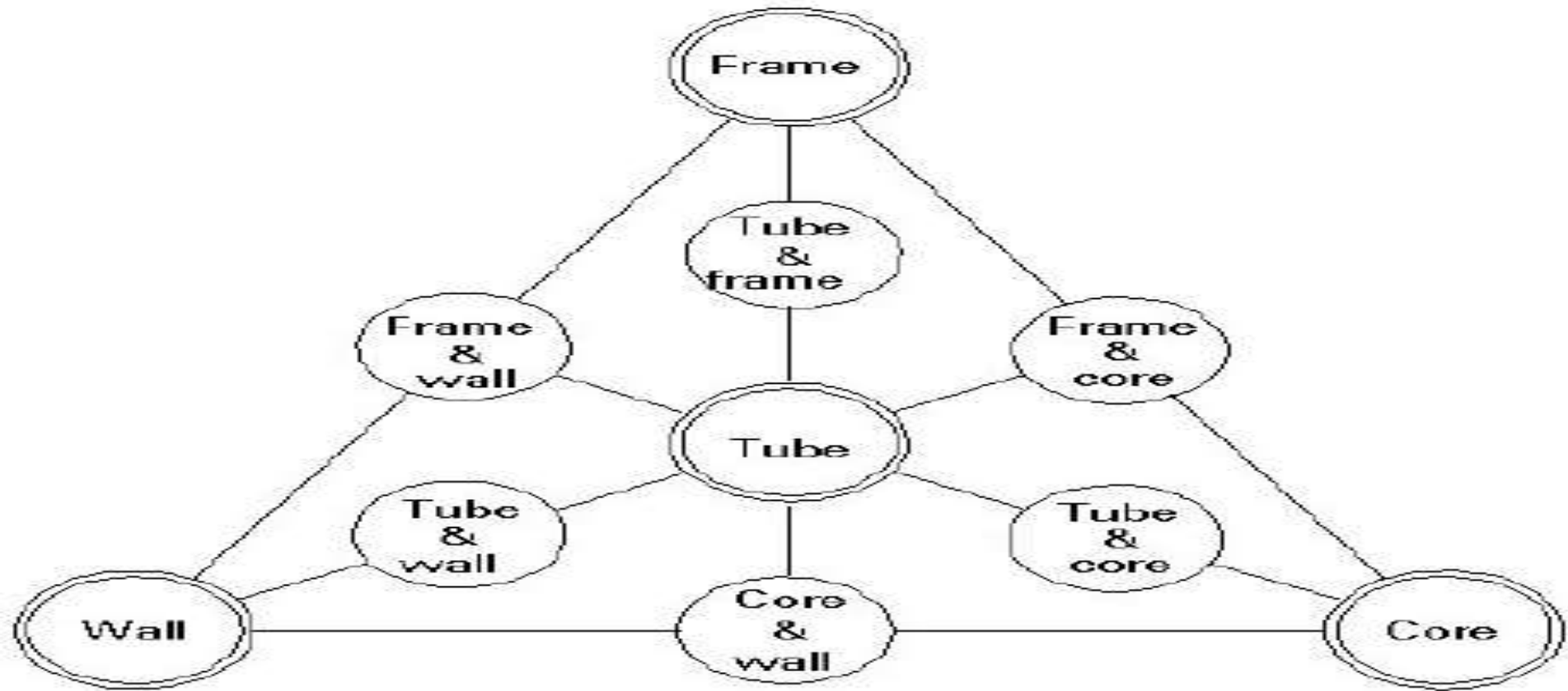


Figure 8 Classification of structural systems of multi-storey buildings [Drosdov, Lishak-1978]

Four overall groupings of structural systems may be identified.

They are:

- a. Bearing wall system
- b. Core system
- c. Frame system
- d. Tube system.

EXAMPLES OF BUILDING



SAN SIRO STADIUM, MILAN



STANSTED AIRPORT, LONDON



ADDIS ABABA AIRPORT, ETHIOPIA





