HIGH RISE STRUCTURAL SYSTEMS

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INTRODUCTION AND DEFINITION

High rise is defined differently by different bodies.

Emporis standards-
"A multi-story structure between 35-100 meters tall, or a building of unknown height from 12-39 floors is termed as high rise.

The International Conference on Fire Safety –
"any structure where the height can have a serious impact on evacuation"

Building code of Hyderabad,India-

A high-rise building is one with four floors or more, or one 15 meters or more in height.

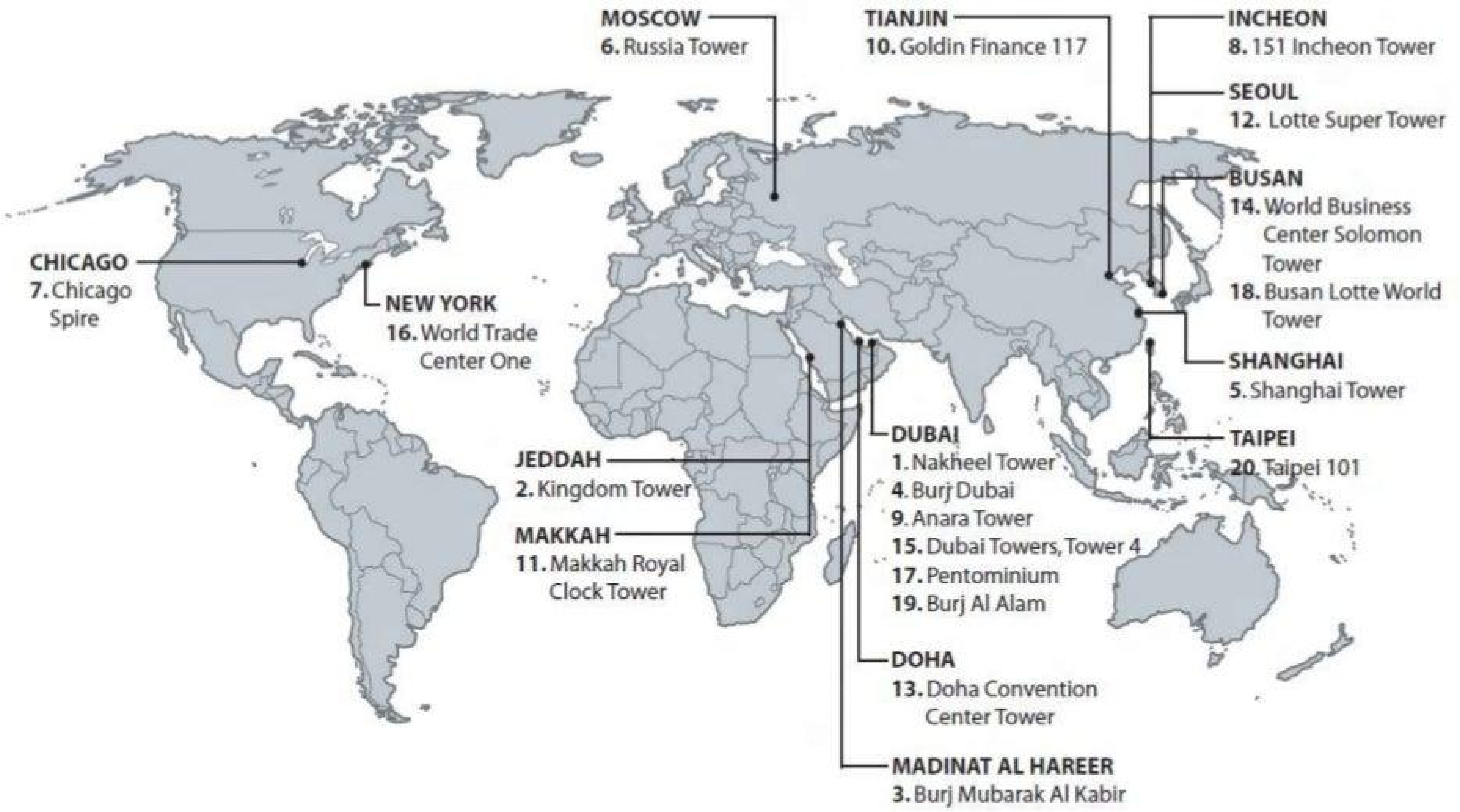
Massachusetts, United States General Laws –
A high-rise is being higher than 70 feet (21 m).

Demand for High-Rise Buildings

- Scarcity of land in urban areas
- Increasing demand for business and residential space
- Economic growth
- Technological advancements
- Innovations in Structural Systems
- Desire for aesthetics in urban settings
- Concept of city skyline
- Cultural significance and prestige
- Human aspiration to build higher

GEOGRAICAL DISTRIBUTION OF HIGHRISE

Locations: The Tallest 20 in 2020



Criteria: The Tallest 20 in 2020

GEOGRAICAL DISTRIBUTION OF HIGHRISE

Skyscrapers in Regions			
#	Continent	Buildings	Percent
1	Asia	24,302	33.16 %
2	North America	22,863	31.20 %
3	Europe	13,114	17.89 %
4	South America	9,903	13.51 %
5	Oceania	2,244	3.06 %
6	Africa	859	1.17 %

(Tables source: Emporis Corporation April 2004)

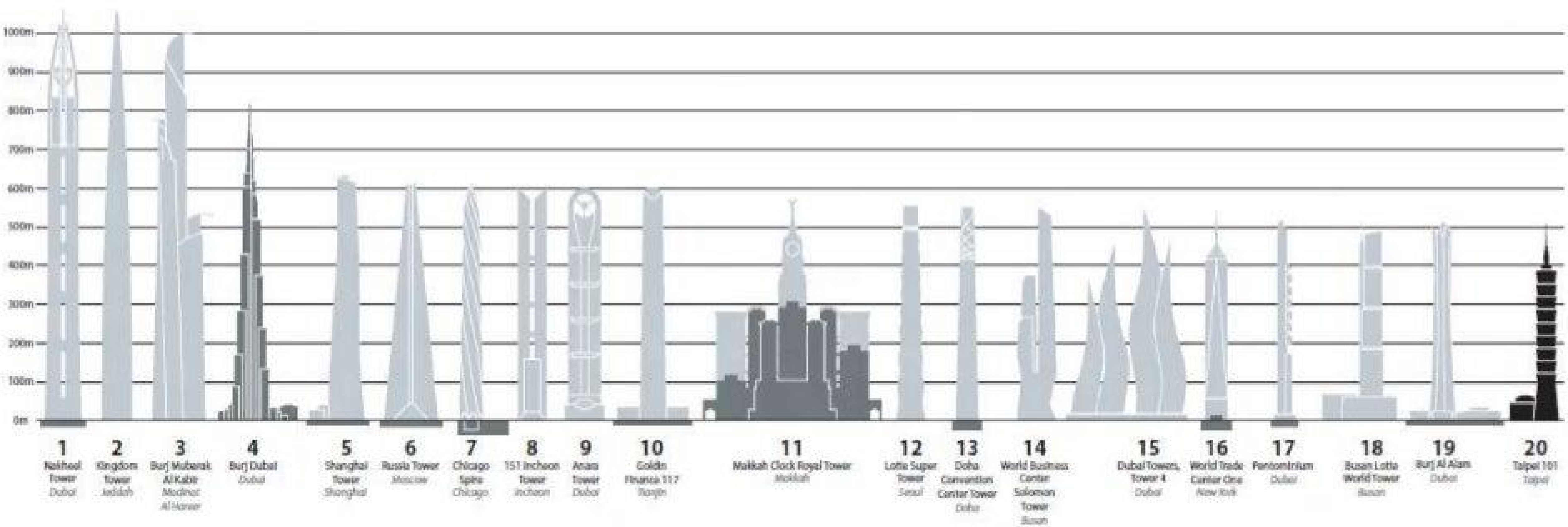
Most Skyscrapers		
#	City	Buildings
1.	Hong Kong	7,254
2.	New York City	5,317
3.	Singapore	3,489
4.	Istanbul	2,090
5.	São Paulo	2,043
6.	Rio de Janeiro	1,854
7.	Toronto	1,582
8.	Tokyo	1,466
9.	Buenos Aires	1,410
10.	London	1,277
11.	Chicago	1,024
12.	Bangkok	706
13.	Osaka	685
14.	Sydney	652
15.	Caracas	650
16.	Milan	625
17.	Seoul	589
18.	Shanghai	523
19.	Kuala Lumpur	515
20.	Vancouver	501
21.	Madrid	500
22.	Curitiba	495
23.	Mumbai	476
24.	Honolulu	431
25.	Los Angeles	416

Council on Tall Buildings and Urban Habitat

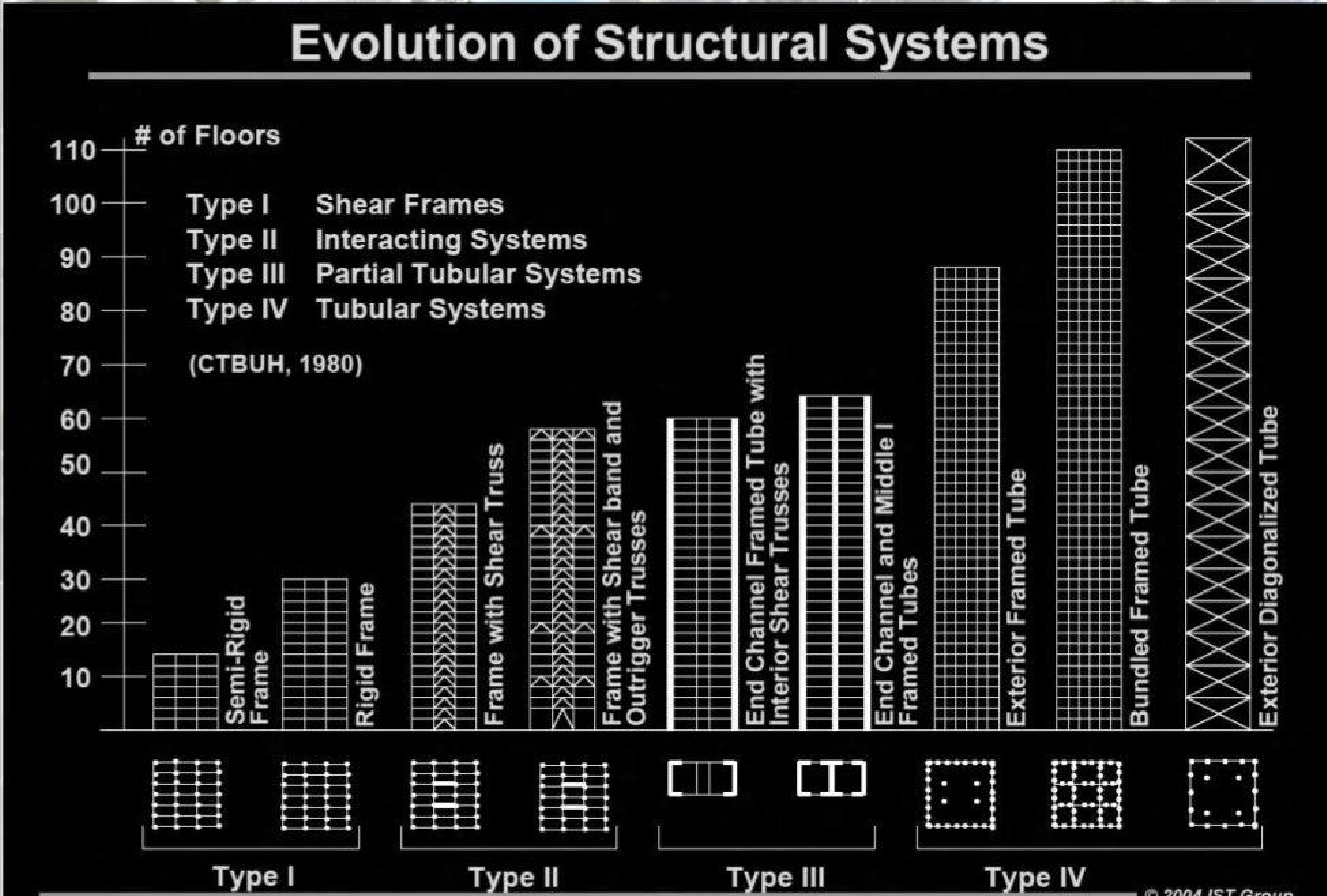
The Tallest 20 in 2020

CTBUH Projection, Second Edition, January 2009

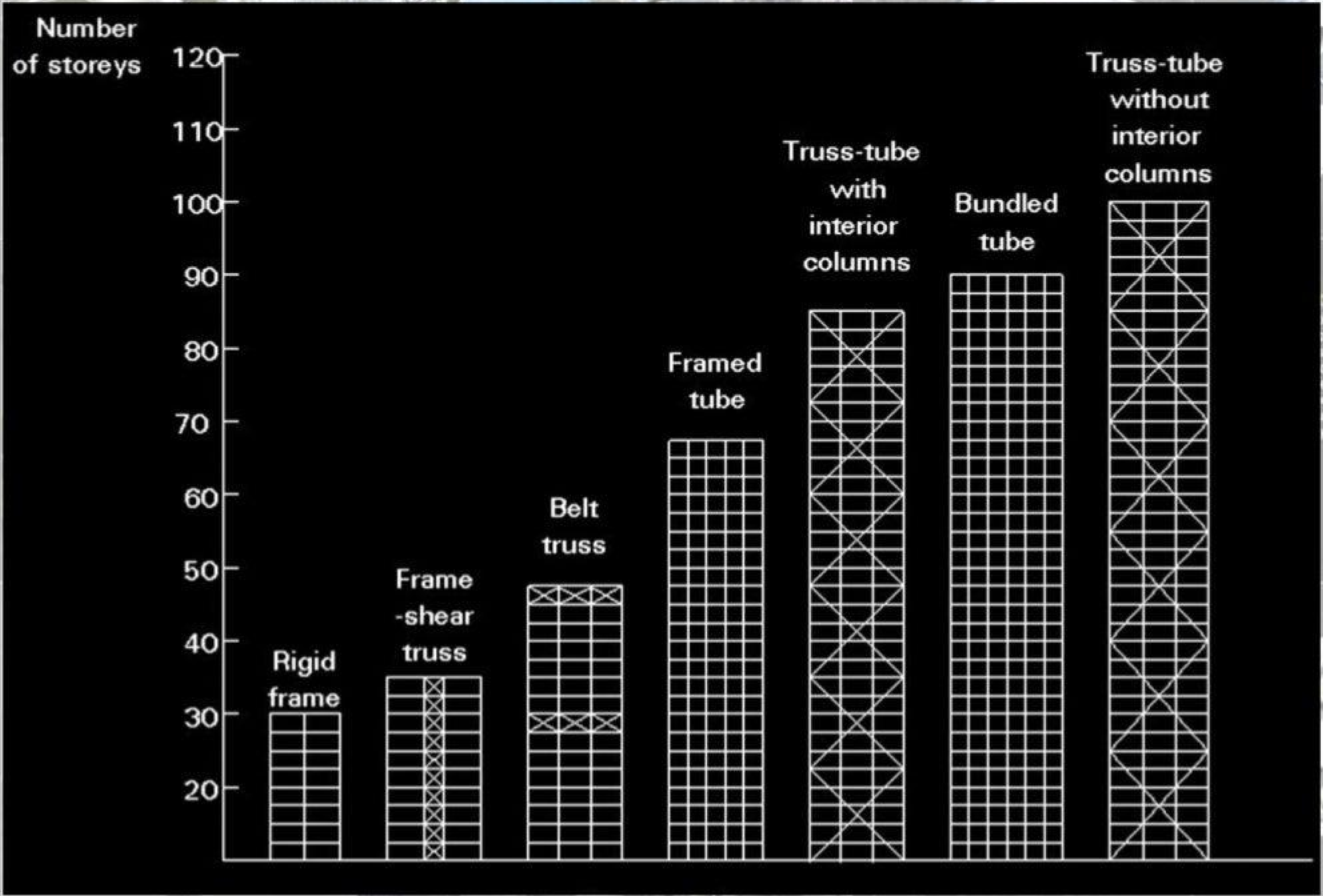
Due to the current economic climate, some buildings on this list may have slowed construction / development pace or have been put 'on hold' recently. The current intention, however, is that all projects on the list will be completed, though that may change in the coming months / years. Only buildings that are fully in the public domain and fulfill all the criteria listed at the end of this document are included in the CTBUH Tallest 20 in 2020 – there may well be other proposed buildings that would make the list, but are for client / project confidentiality reasons not yet publicized. Also, due to the changing nature of early stage designs and client information restrictions, some height data for 'proposed' tall buildings that appears on this list is unconfirmed.



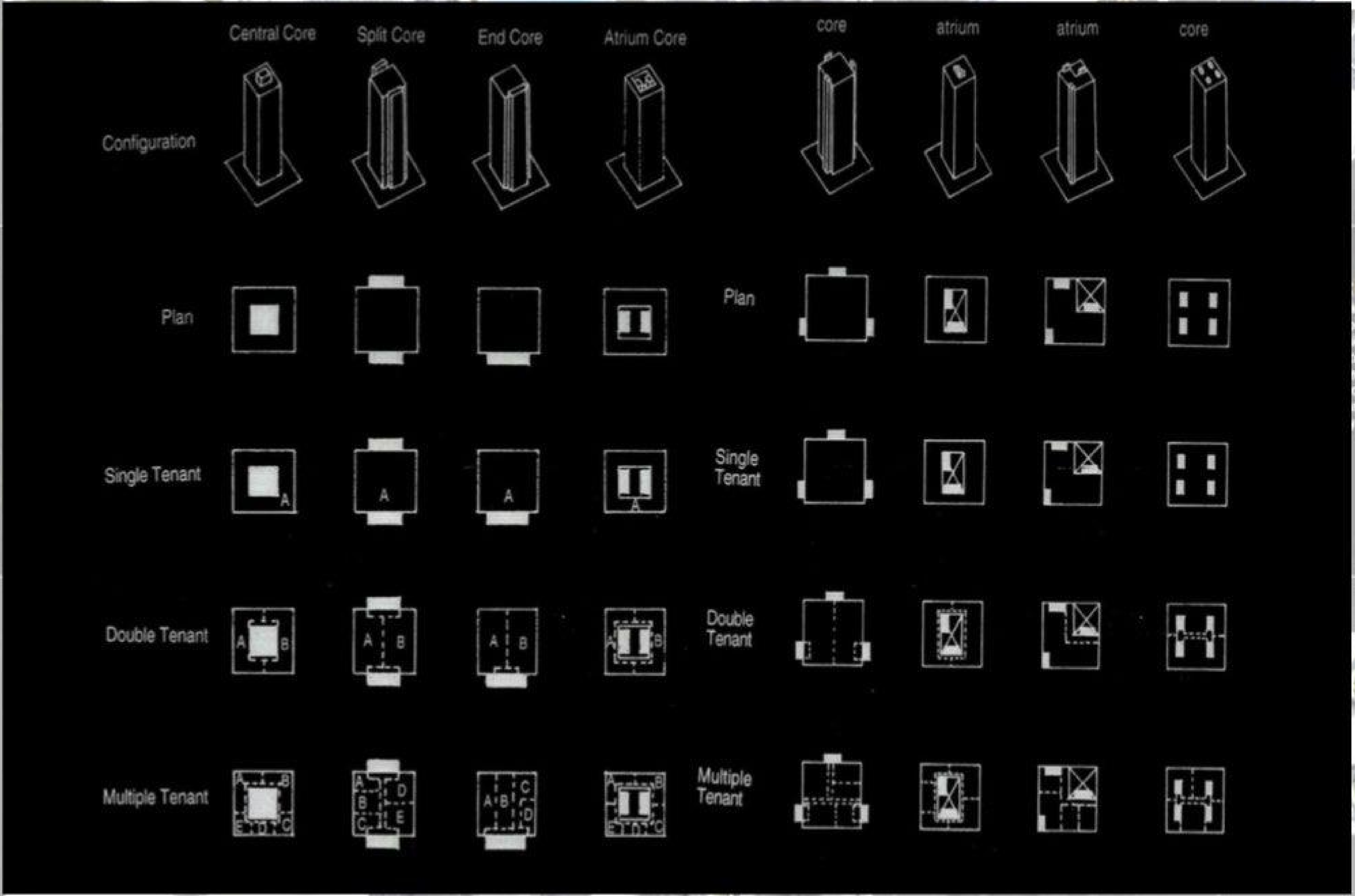
EVOLUTION OF STRUCTURAL SYSTEMS



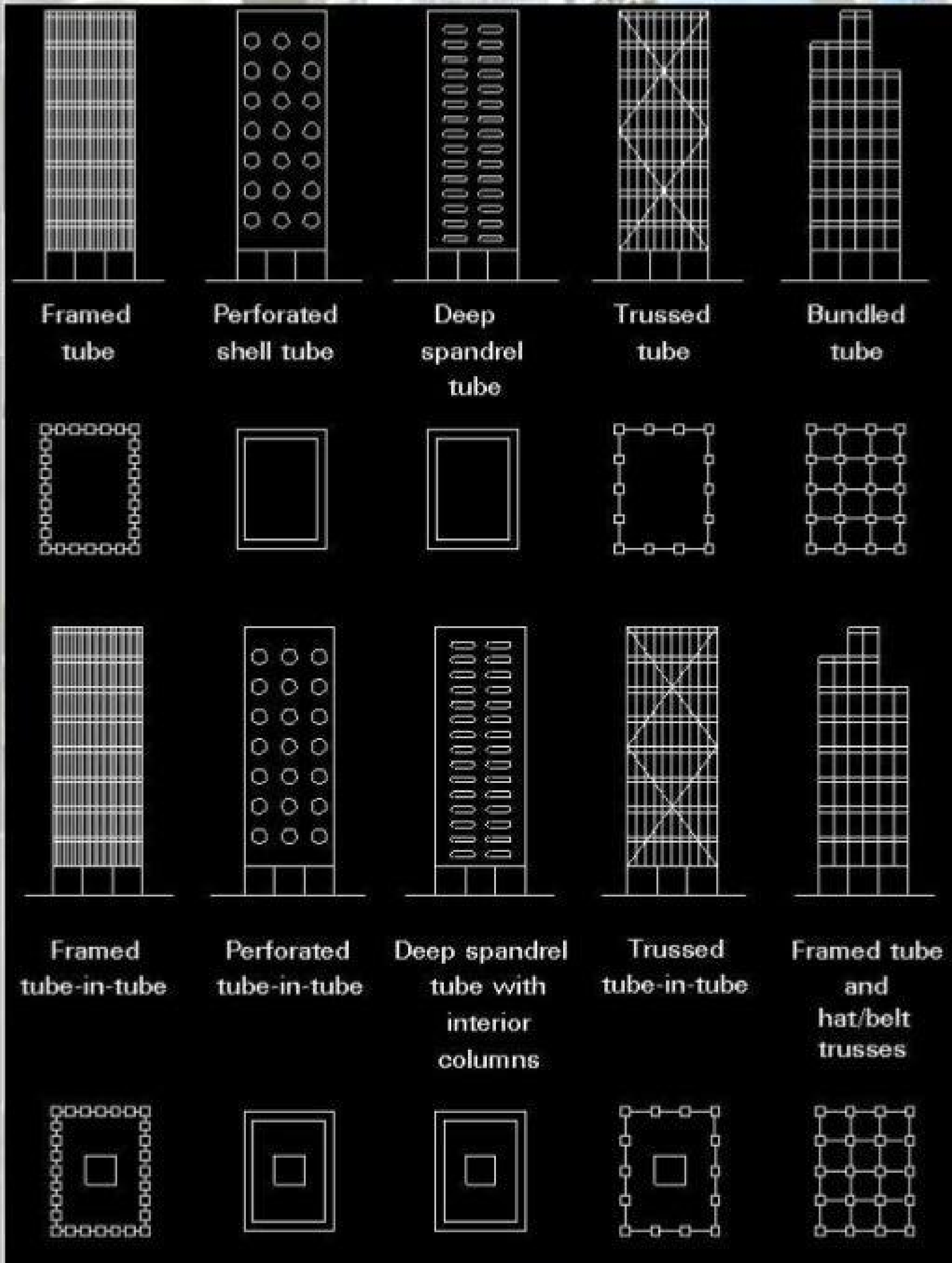
STEEL STRUCTURAL SYSTEMS AND THE NO. OF STOREYS

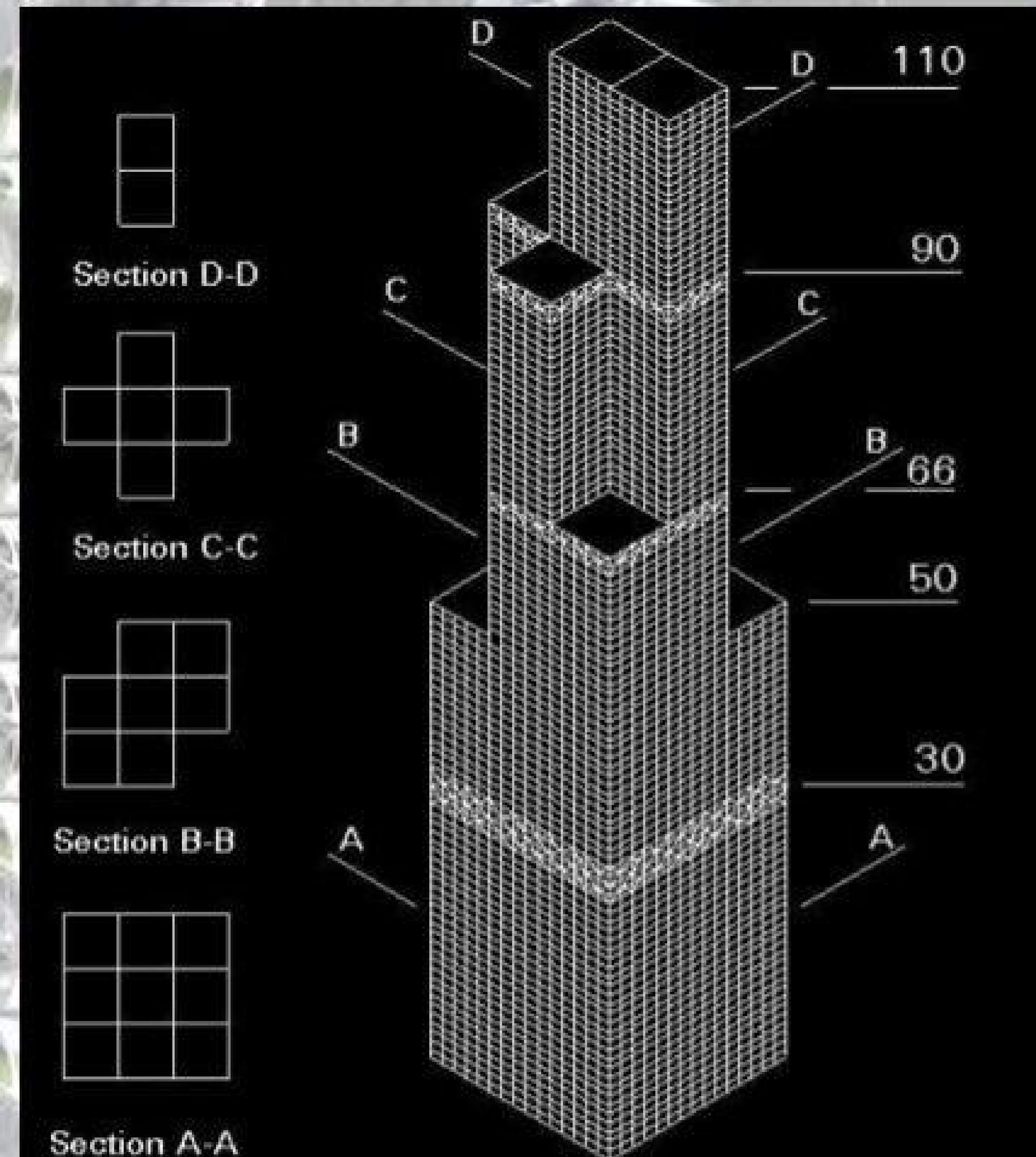


TYPES OF CORE SYSTEMS

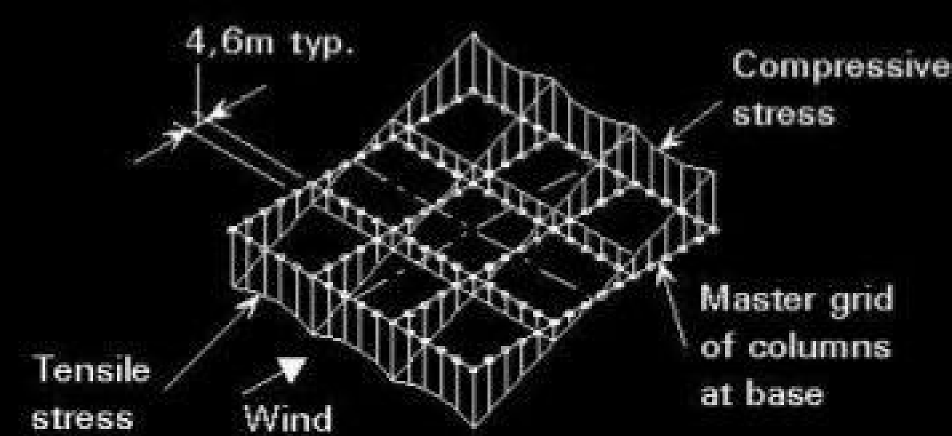


TYPES OF TUBULAR SYSTEMS

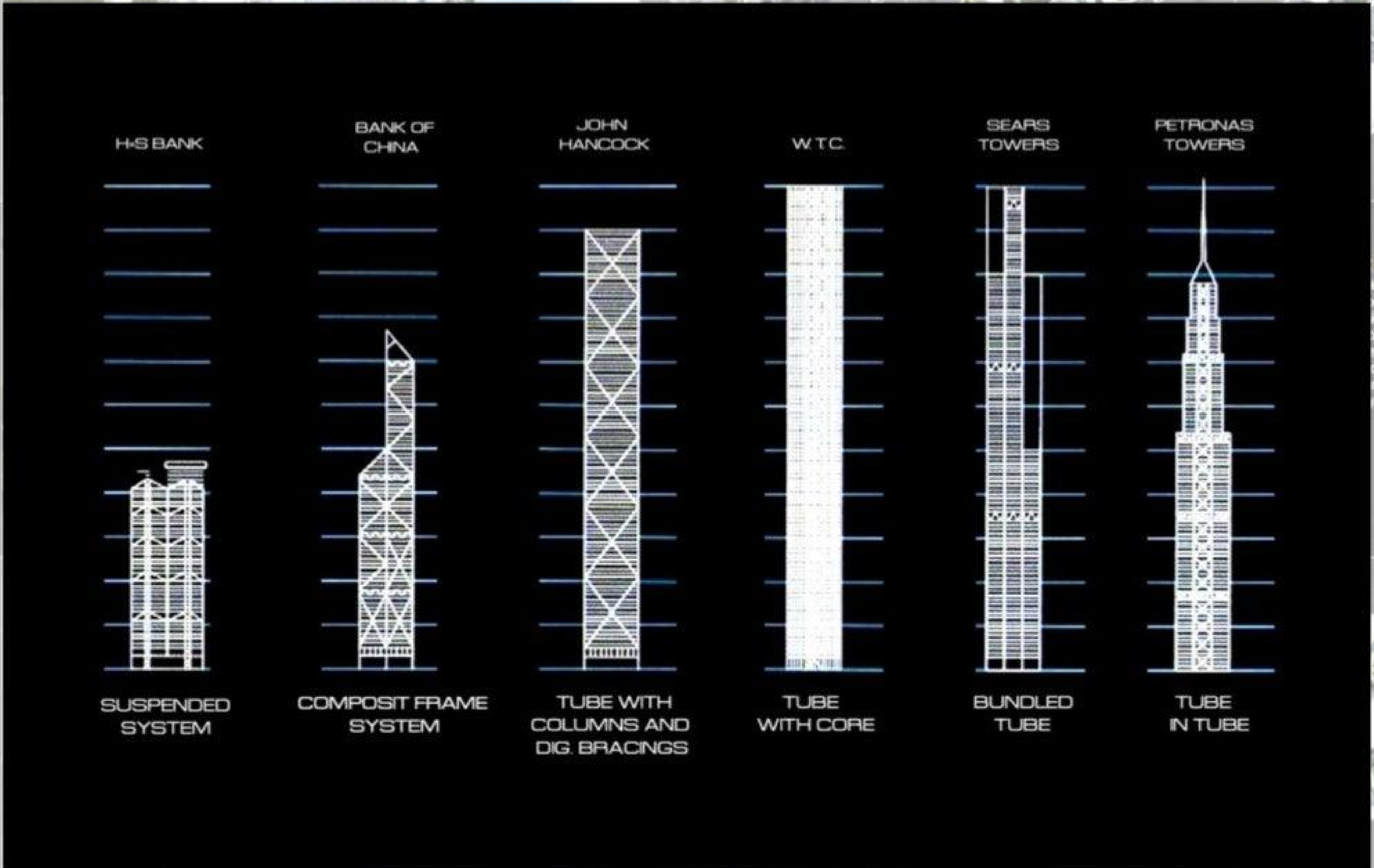




(a) Modular floor configurations

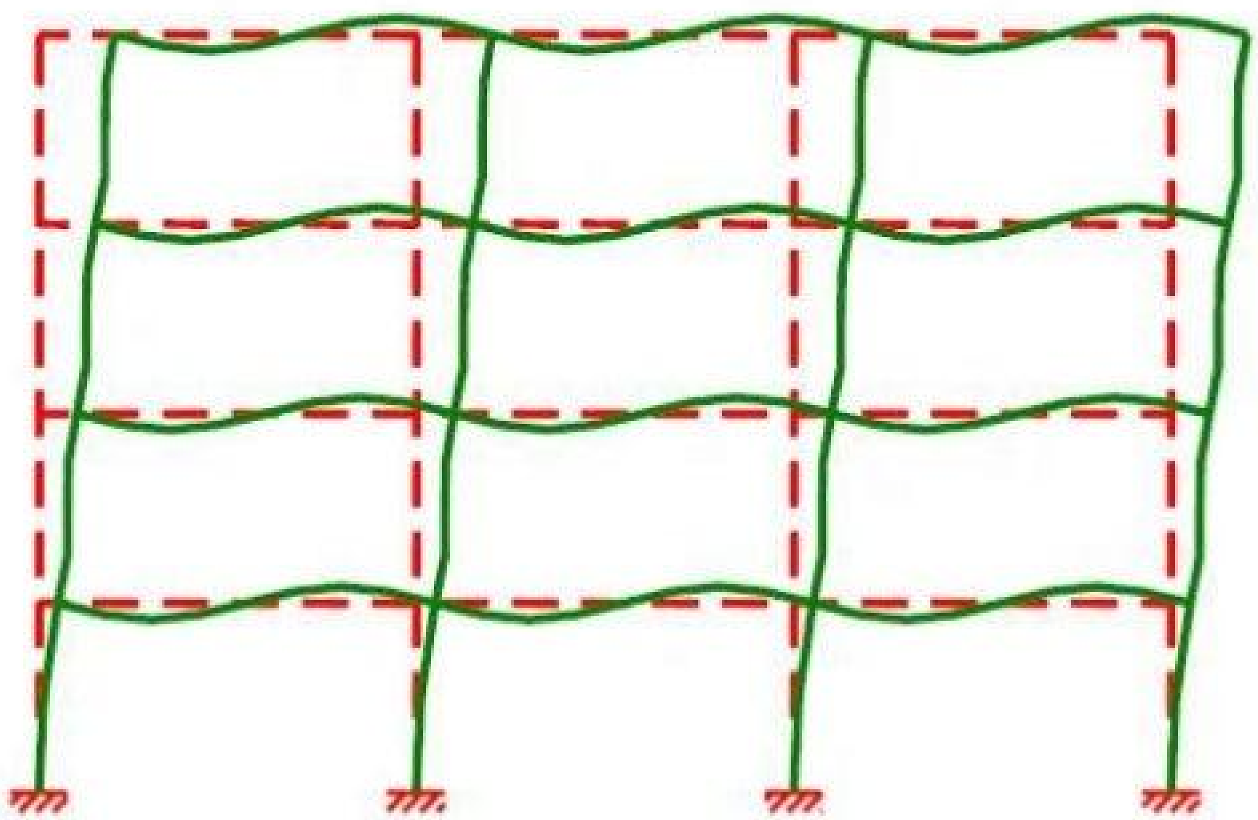


EXAMPLES OF STEEL STRUCTURAL SYSTEMS



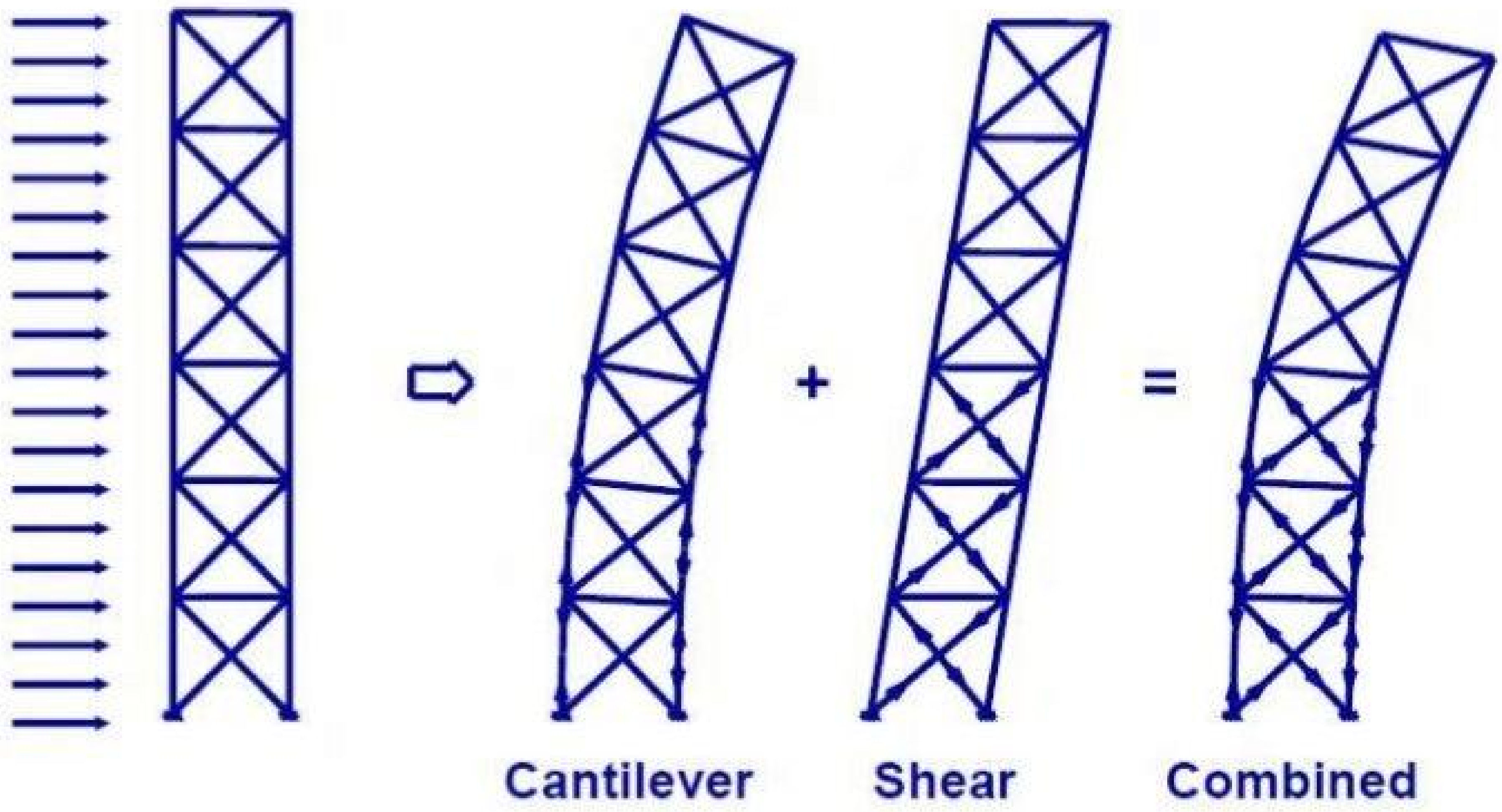
Shear Frame System

- Resists lateral deformation by joint rotation
- Requires high bending stiffness of columns and beams
- Rigid joints are essential for stability
- Not effective for heights over 30 stories



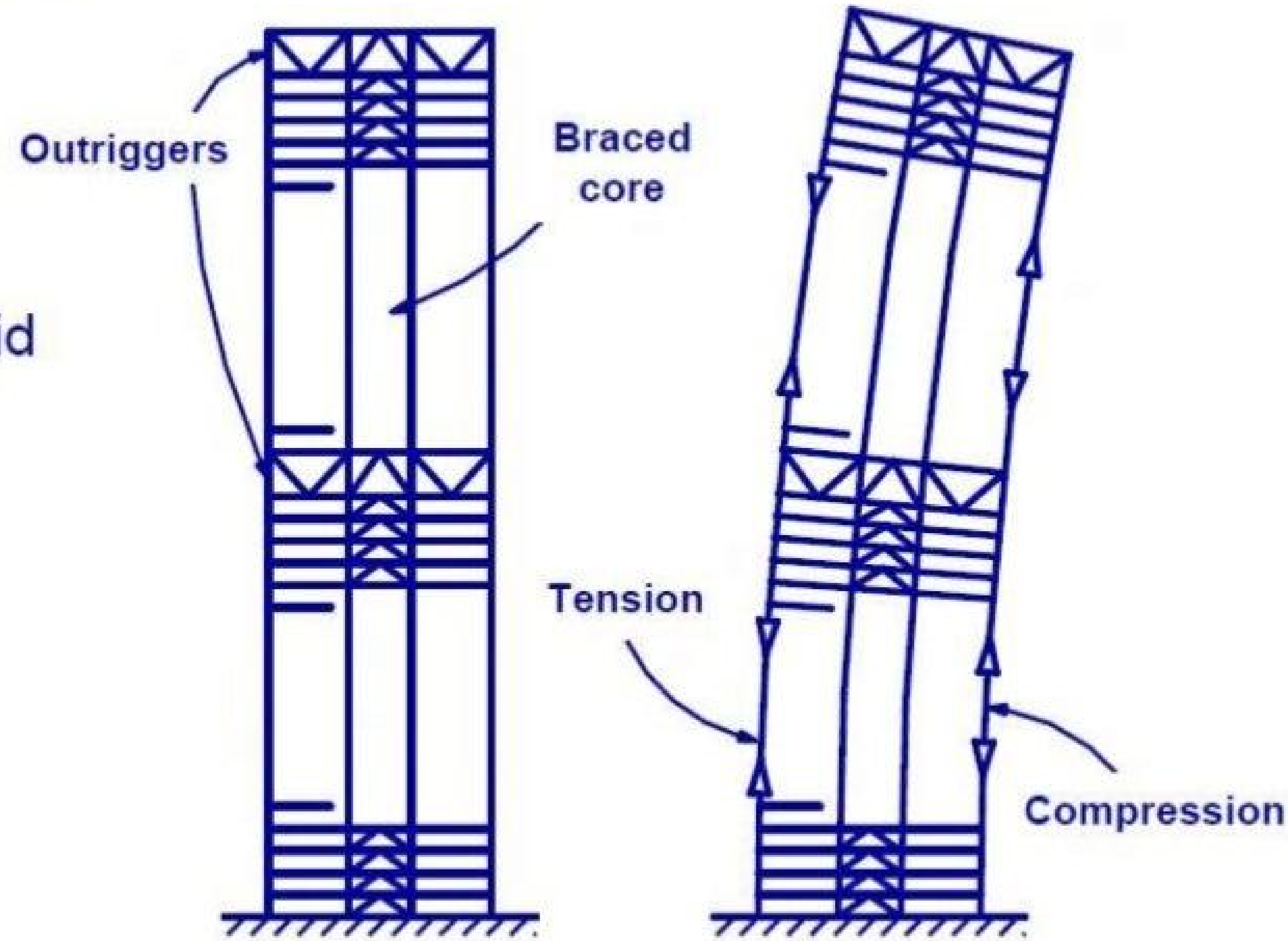
Braced Frame System

- Lateral forces are resisted by axial actions of bracing and columns
- Steel bracing members or filled-in bays
- More efficient than a rigid frame



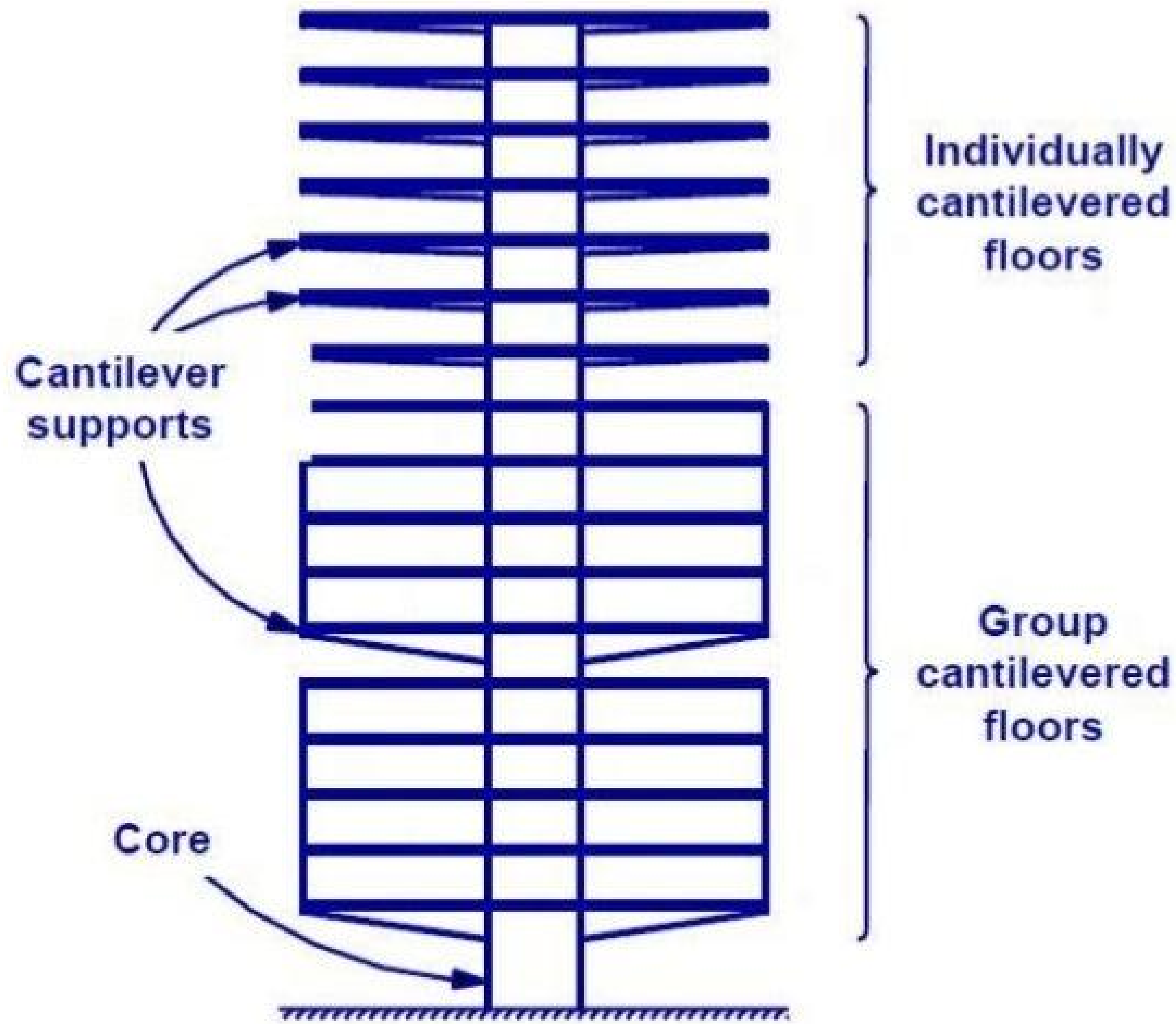
Outrigger Braced Structure System

- 1- or 2-story deep truss connects core to perimeter columns
- Increases the bending rigidity
- Dependent of rigid core for shear resistance



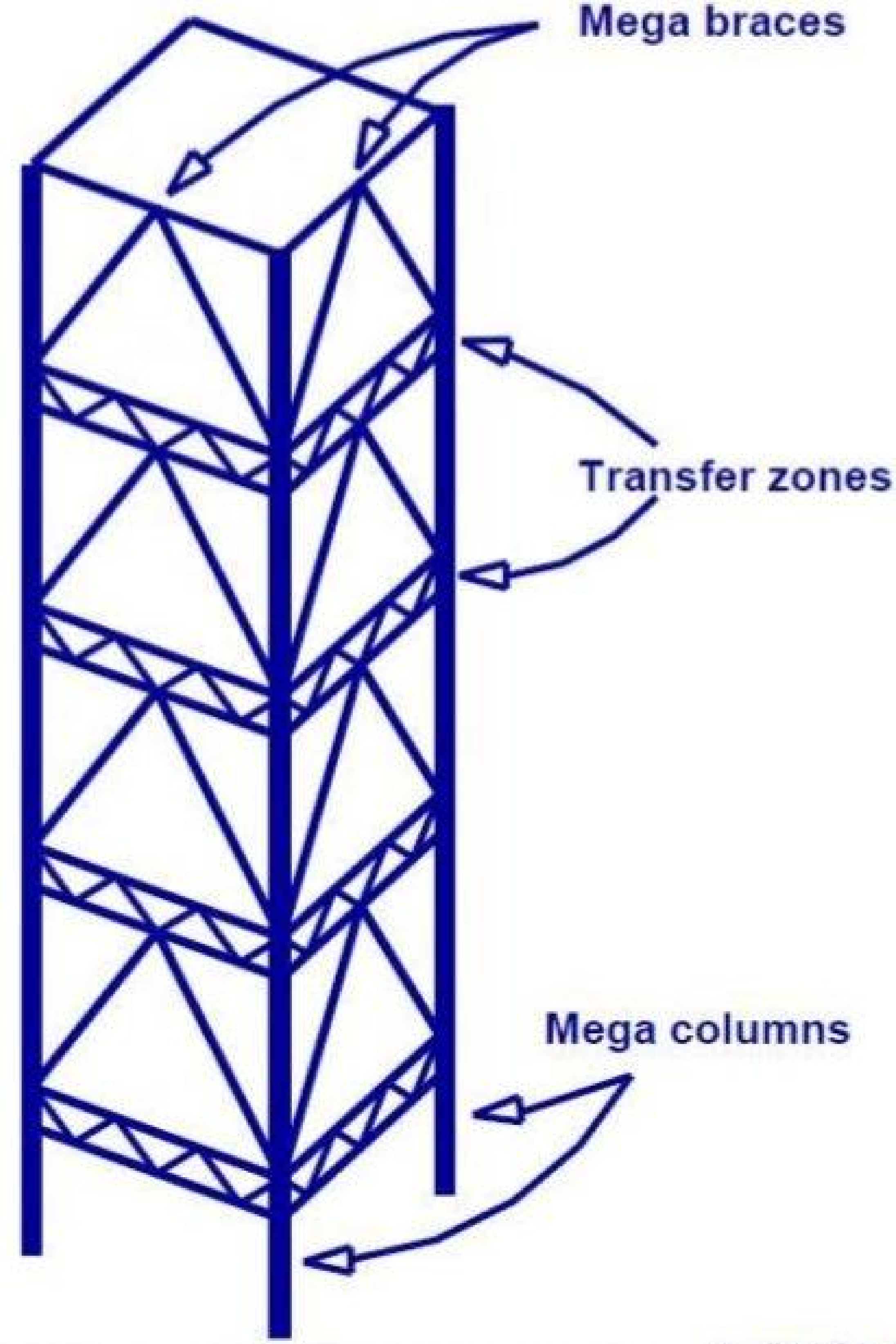
Core Structure System

- Lateral and gravity loads supported by central core
- Eliminates columns and bracing elements
- Core is inefficient because it is not deep in respect to bending
- Moment supported floors are inefficient



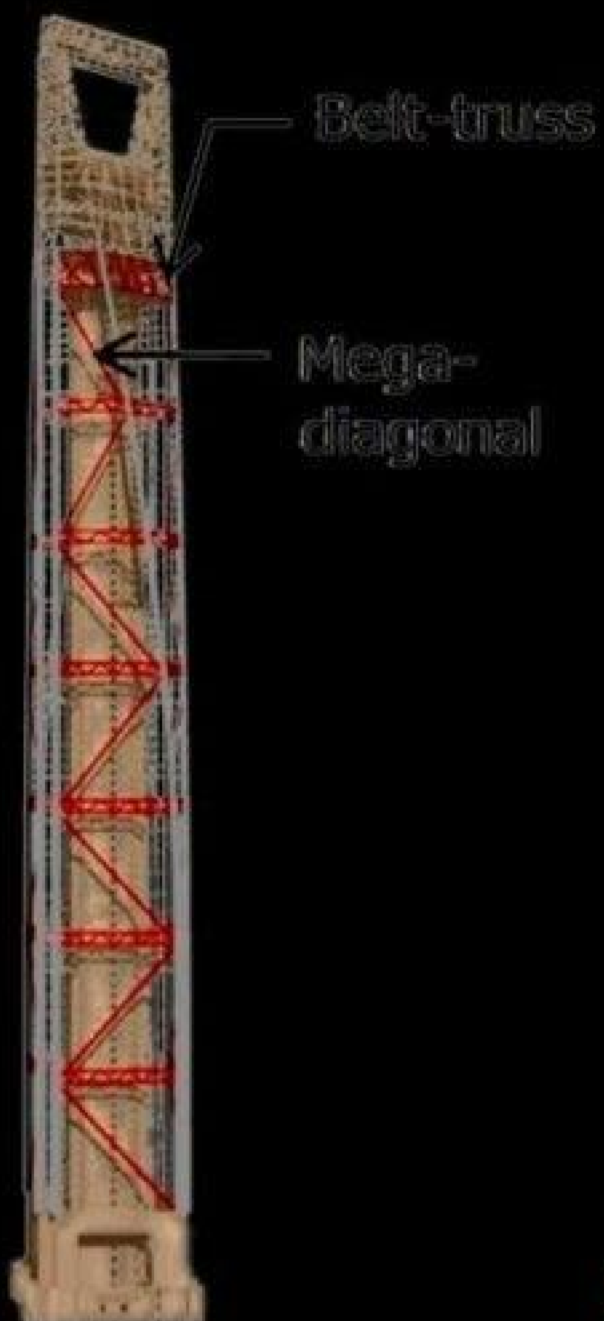
High-Efficiency Mega-Braced Frame System

- Very large columns and bracing
- Small number of columns
- Bracing extends over multiple floors
- Stiff transfer floors allow for internal flexiblity



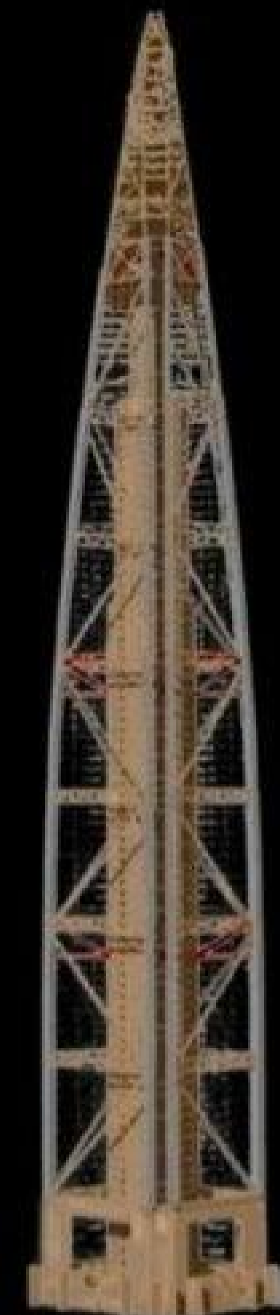
BELT TRUSS SYSTEM

SHANGHAI TOWER

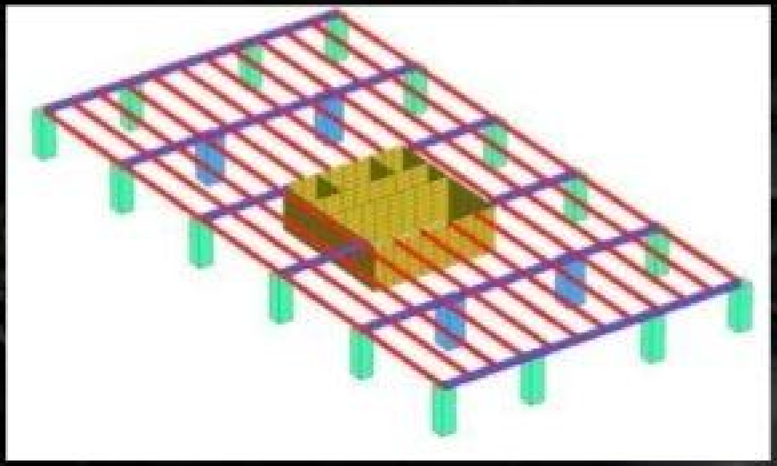


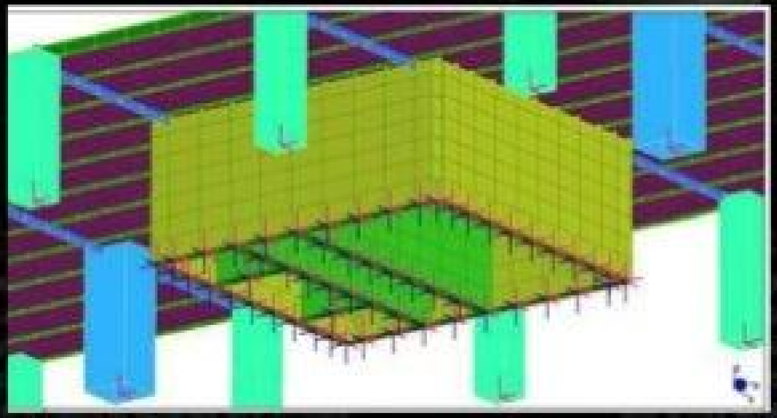
MEGA STUCTURE

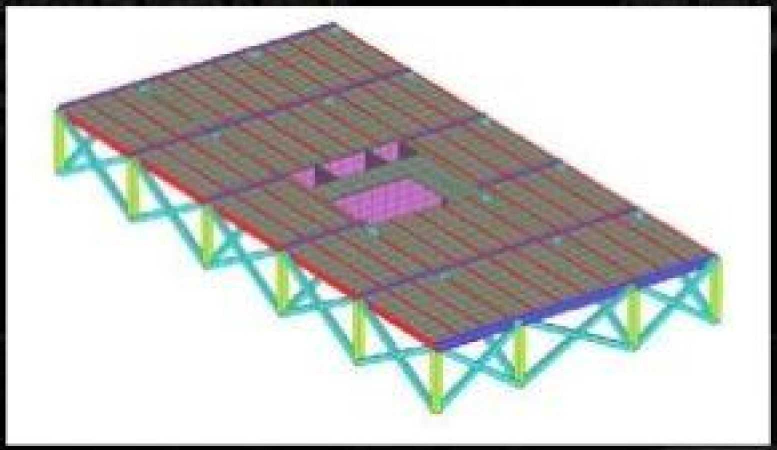
CORE TRUSS

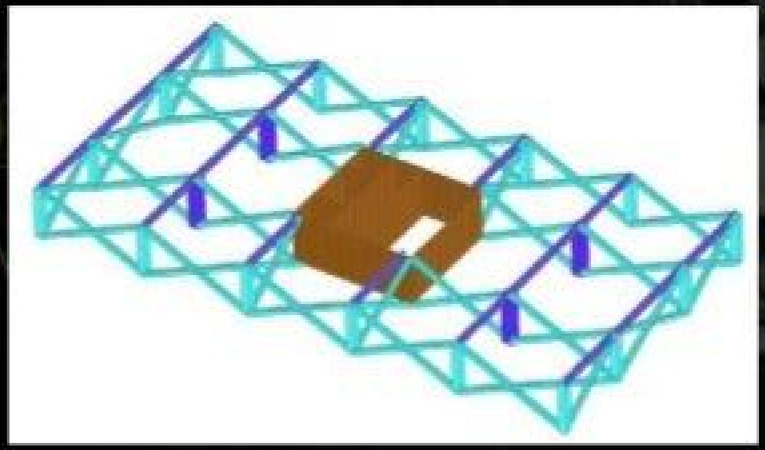


OUT-TRIGGER TRUSS

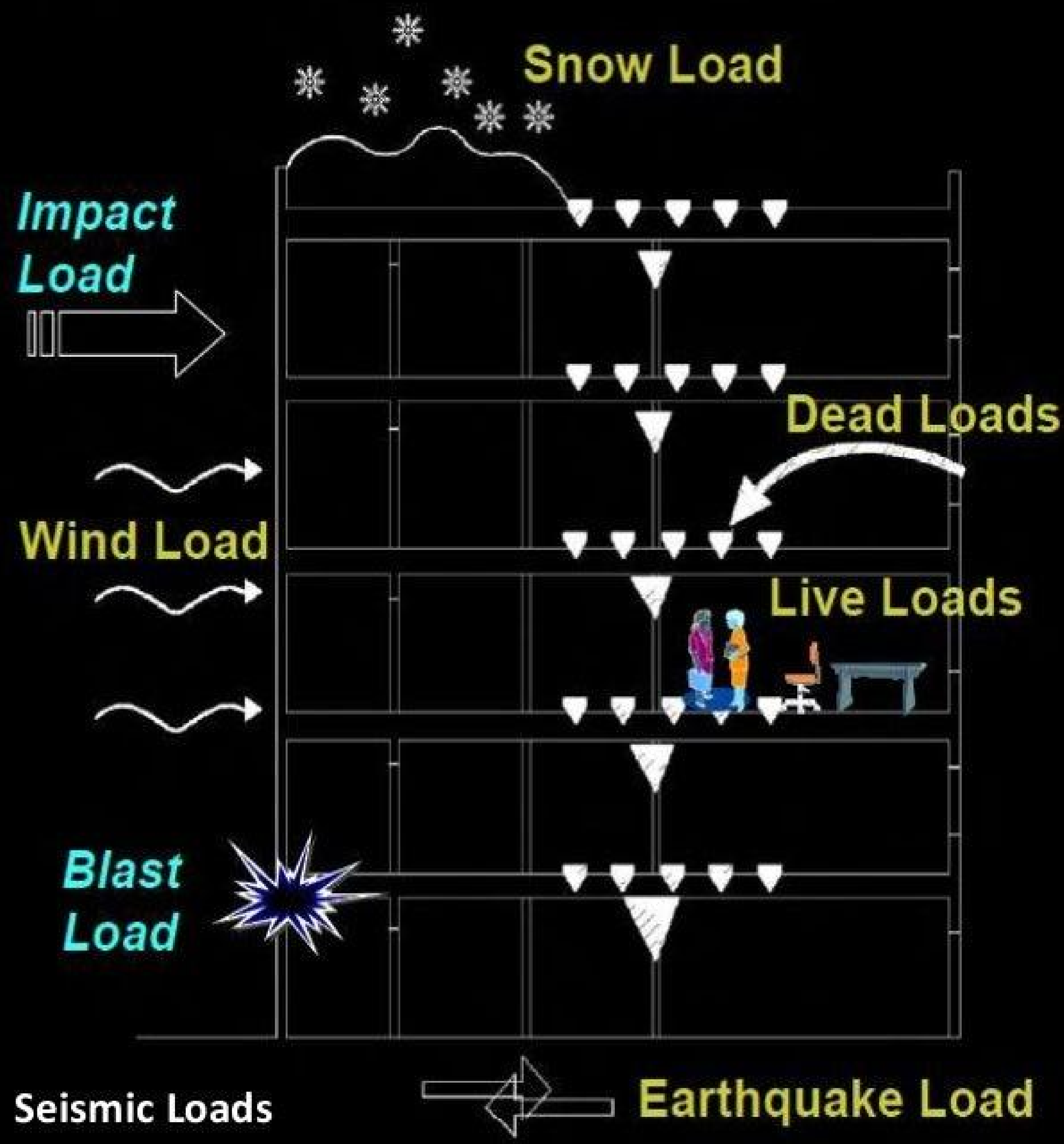




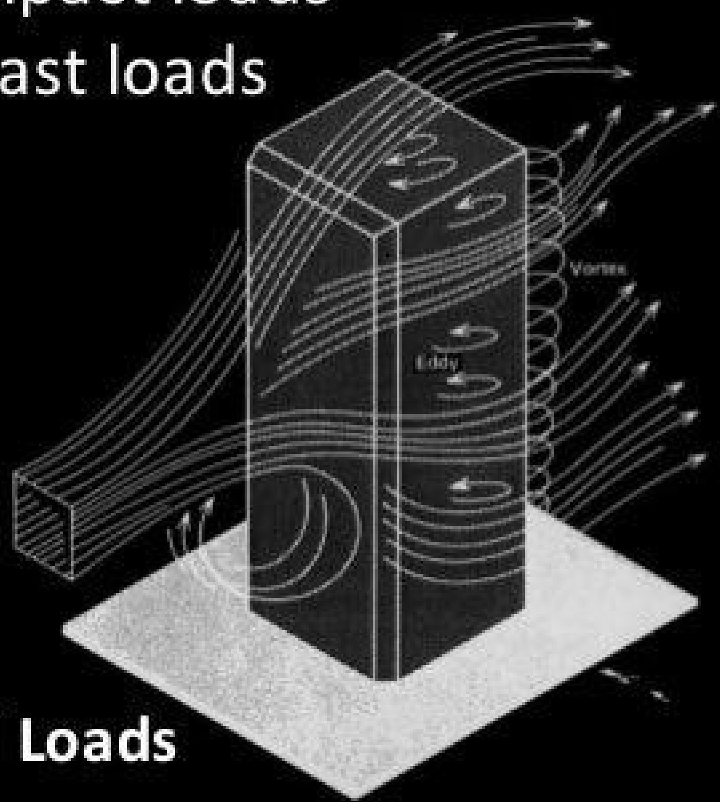




Structural Loads

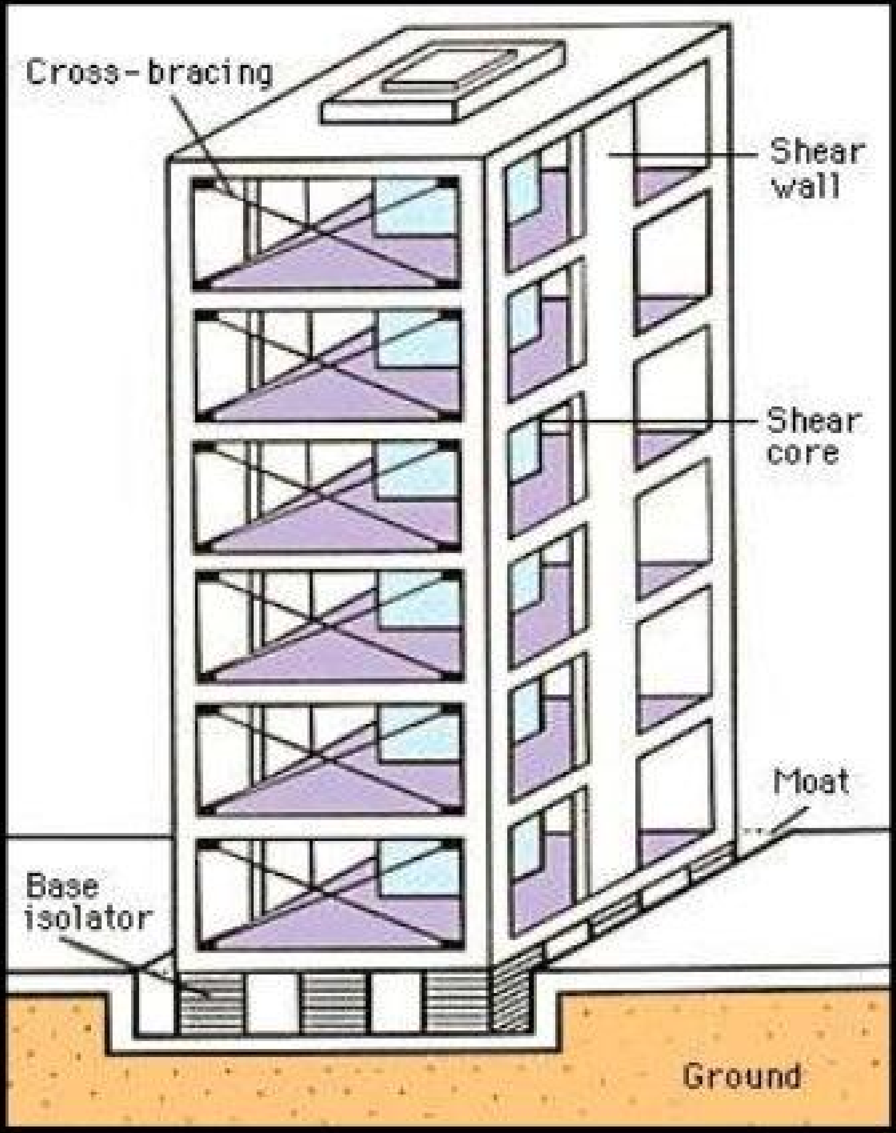


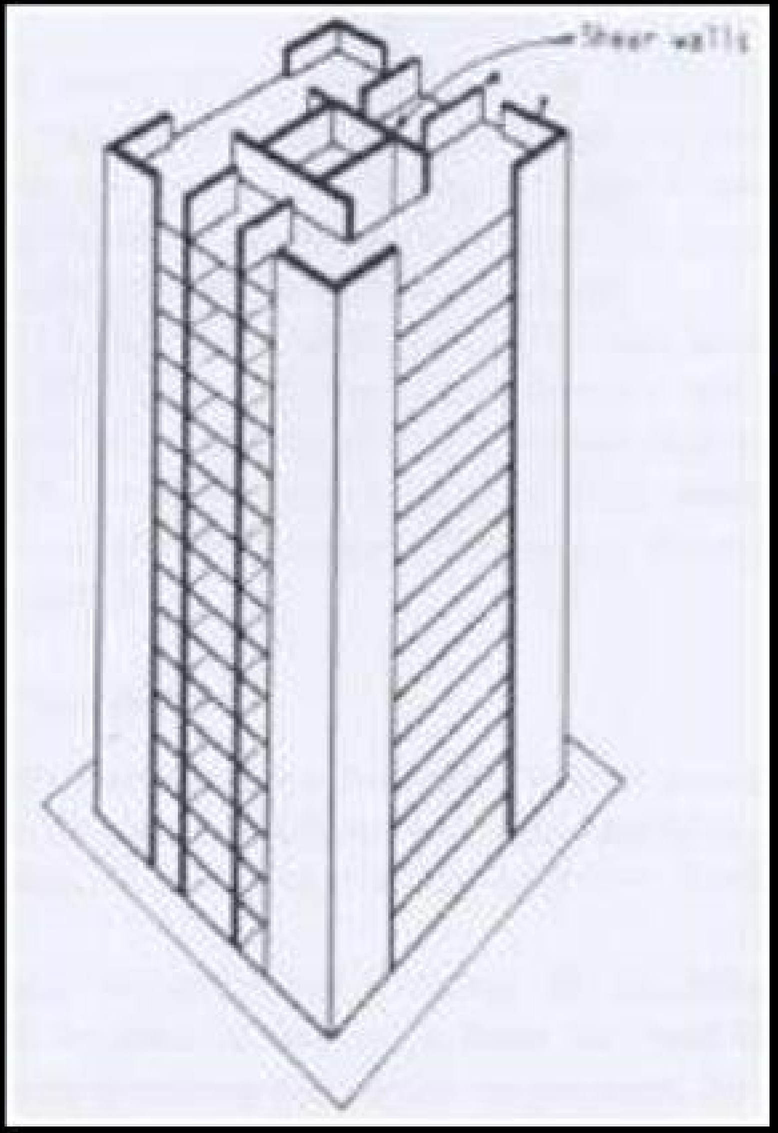
- Gravity loads
  - Dead loads
  - Live loads
  - Snow loads
- Lateral loads
  - Wind loads
  - Seismic loads
- Special load cases
  - Impact loads
  - Blast loads

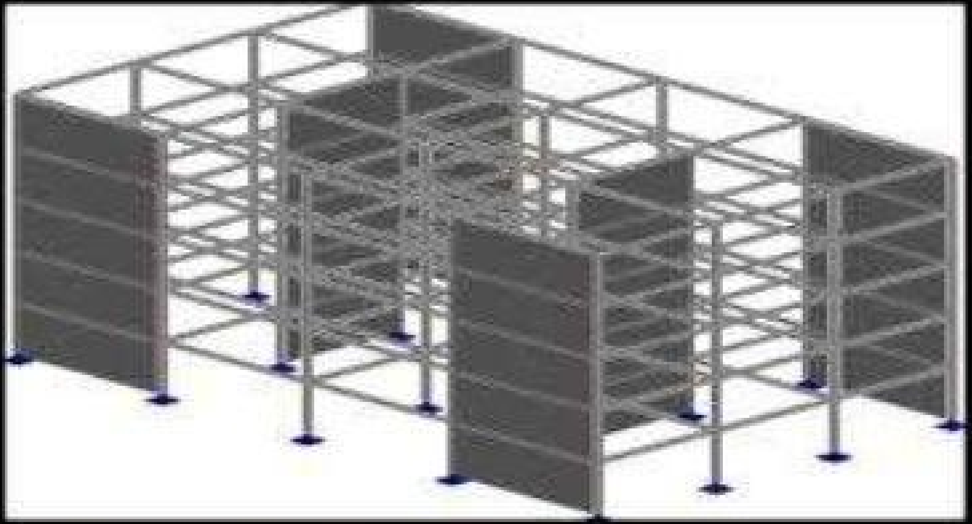


Shear wall system

- A type of rigid frame construction.
- The shear wall is in steel or concrete to provide greater lateral rigidity. It is a wall where the entire material of the wall is employed in the resistance of both horizontal and vertical loads.
- Is composed of braced panels (or shear panels) to counter the effects of lateral load acting on a structure. Wind & earthquake loads are the most common among the loads.
- For skyscrapers, as the size of the structure increases, so does the size of the supporting wall. Shear walls tend to be used only in conjunction with other support systems.







FRAMED-TUBE STRUCTURES]

The lateral resistant of the framed-tube structures is provided by very stiff moment-resistant frames that form a “tube” around the perimeter of the building.

The basic inefficiency of the frame system for reinforced concrete buildings of more than 15 stories resulted in member proportions of prohibitive size and structural material cost premium, and thus such system were economically not viable.

The frames consist of 6-12 ft (2-4m) between centers, joined by deep spandrel girders.

Gravity loading is shared between the tube and interior column or walls.

When lateral loading acts, the perimeter frame aligned in the direction of loading acts as the “webs” of the massive tube of the cantilever, and those normal to the direction of the loading act as the “flanges”.
The tube form was developed originally for building of rectangular plan, and probably it’s most efficient use in that shape.