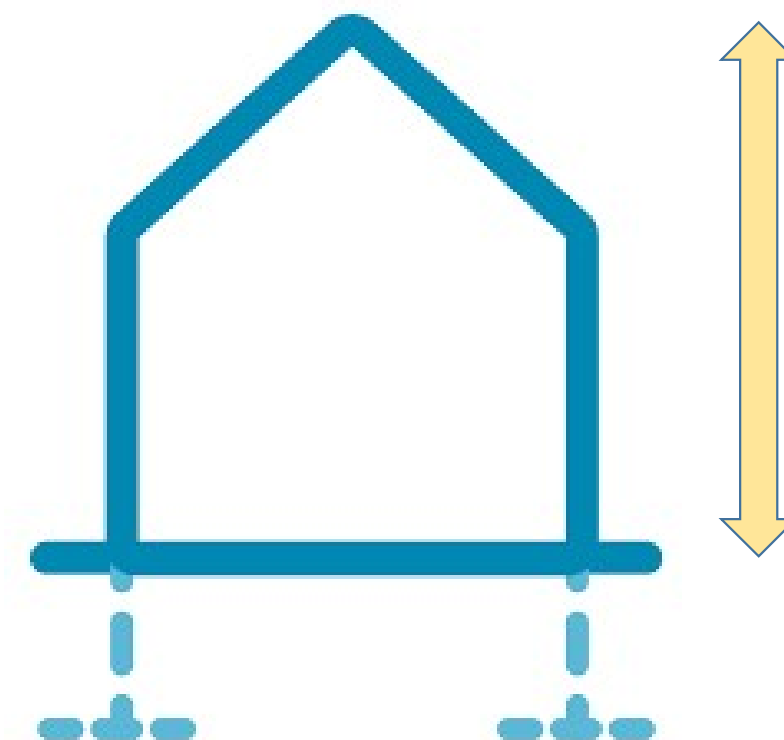


Superstructure : Fundamentals of Construction Technology



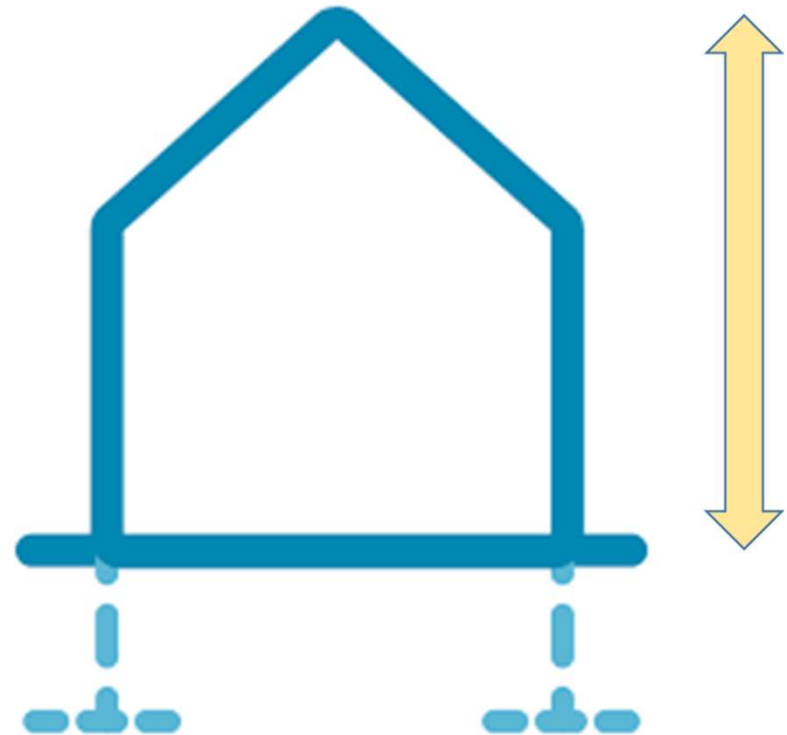
Week 5&6:

Structures

- Forces – Stress – Balance
- Types of structure

Structural Frames

- Timber
- Steel
- Concrete
- Mixed



The use of buildings to house people, equipment and processes have resulted in the development of buildings that can control these internal environments with greater accuracy.

As well as protection and enclosure we can now consider:

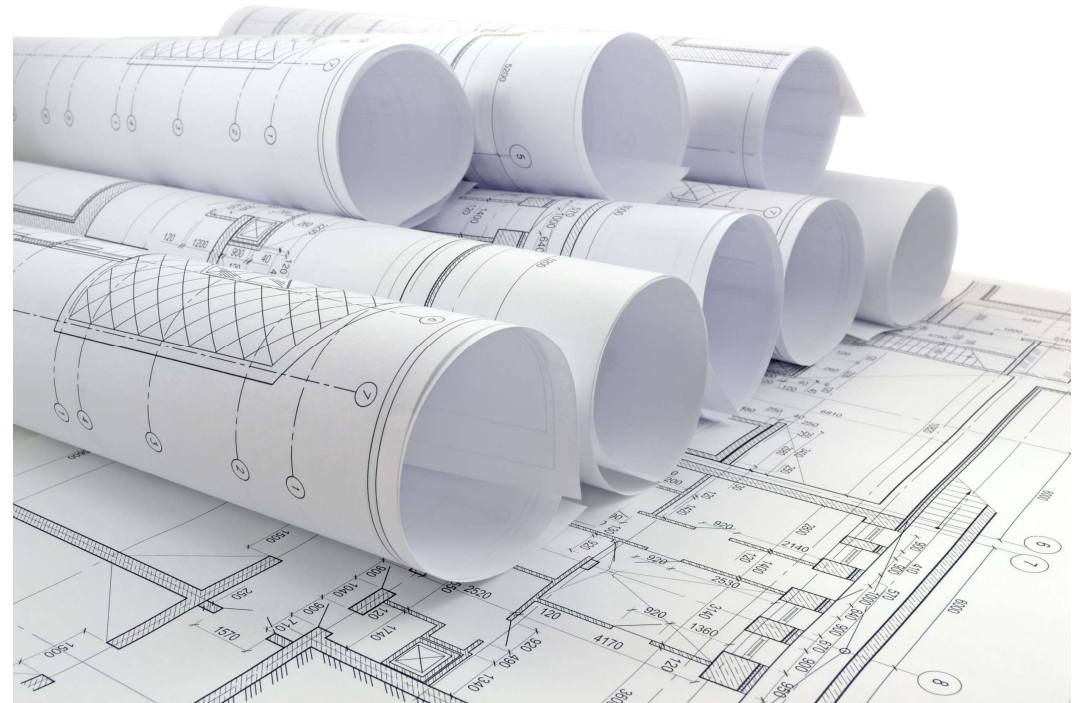
- Thermal Insulation and temperature control
- Acoustic insulation
- Provision of Light (natural and artificial)
- Controls for humidity and ventilation
- Exclusion of contaminants.



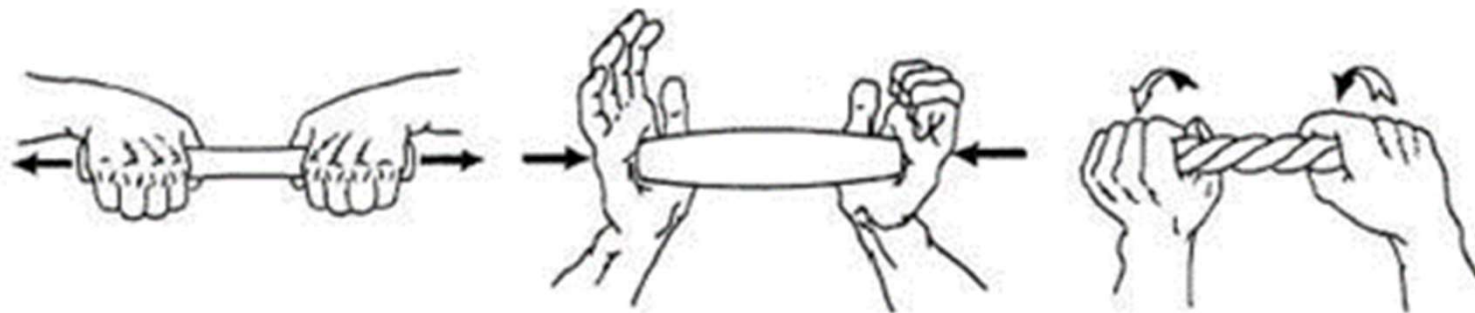
Performance Requirements of the Building Fabric

What are the key drivers in providing a building that is suitable for the need?

- **Structurally Stable**
- Durability
- Thermal insulation
- Protection from weather and exclusion of moisture
- Acoustic performance
- Flexibility to change to changing needs
- Aesthetics
- Buildability
- Sustainability



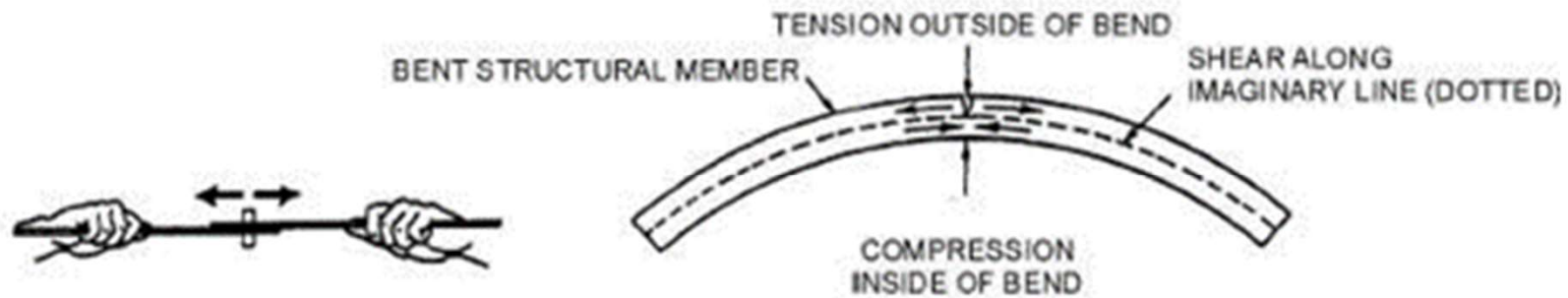
STRUCTURES



(A) TENSION

(B) COMPRESSION

(C) TORSIONAL



(D) SHEAR

(E) BENDING (THE COMBINATION STRESS)

Art0401

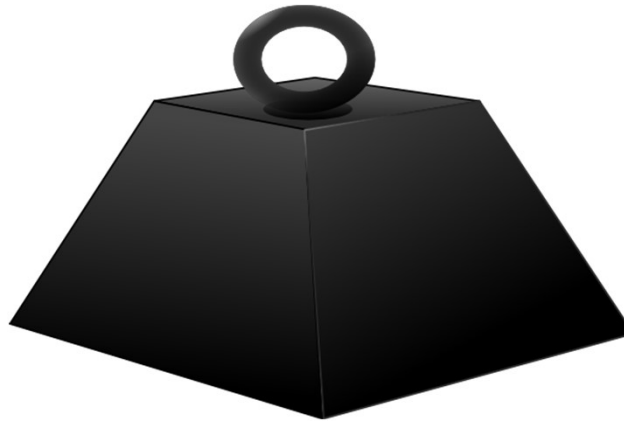
Loads/Forces on Building Frames

Structural loads or **actions** are forces, deformations, or accelerations applied to a structure or its components

Loads cause stresses, deformations, and displacements in structures. Assessment of their effects is carried out by the methods of structural analysis. Excess load or overloading may cause structural failure, and hence such possibility should be either considered in the design or strictly controlled.

Dead load is the load from the self weight of the structure and whatever is permanently attached to it.

Permanent Loads (Eurocodes)



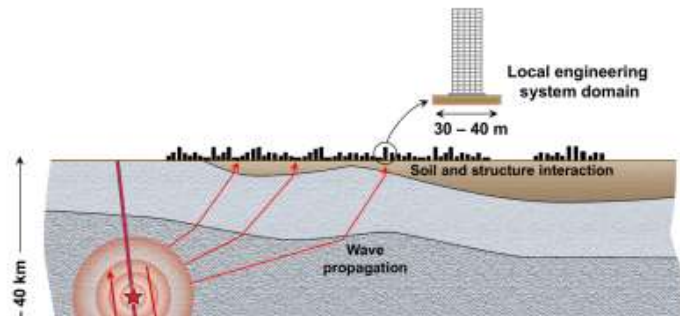
Live loads are loads that may or may not act, fully or partially, and vary with time and exact location on the structure.

Variable Loads (Eurocodes)

Live Loads/Imposed/Transient



Environmental Loads



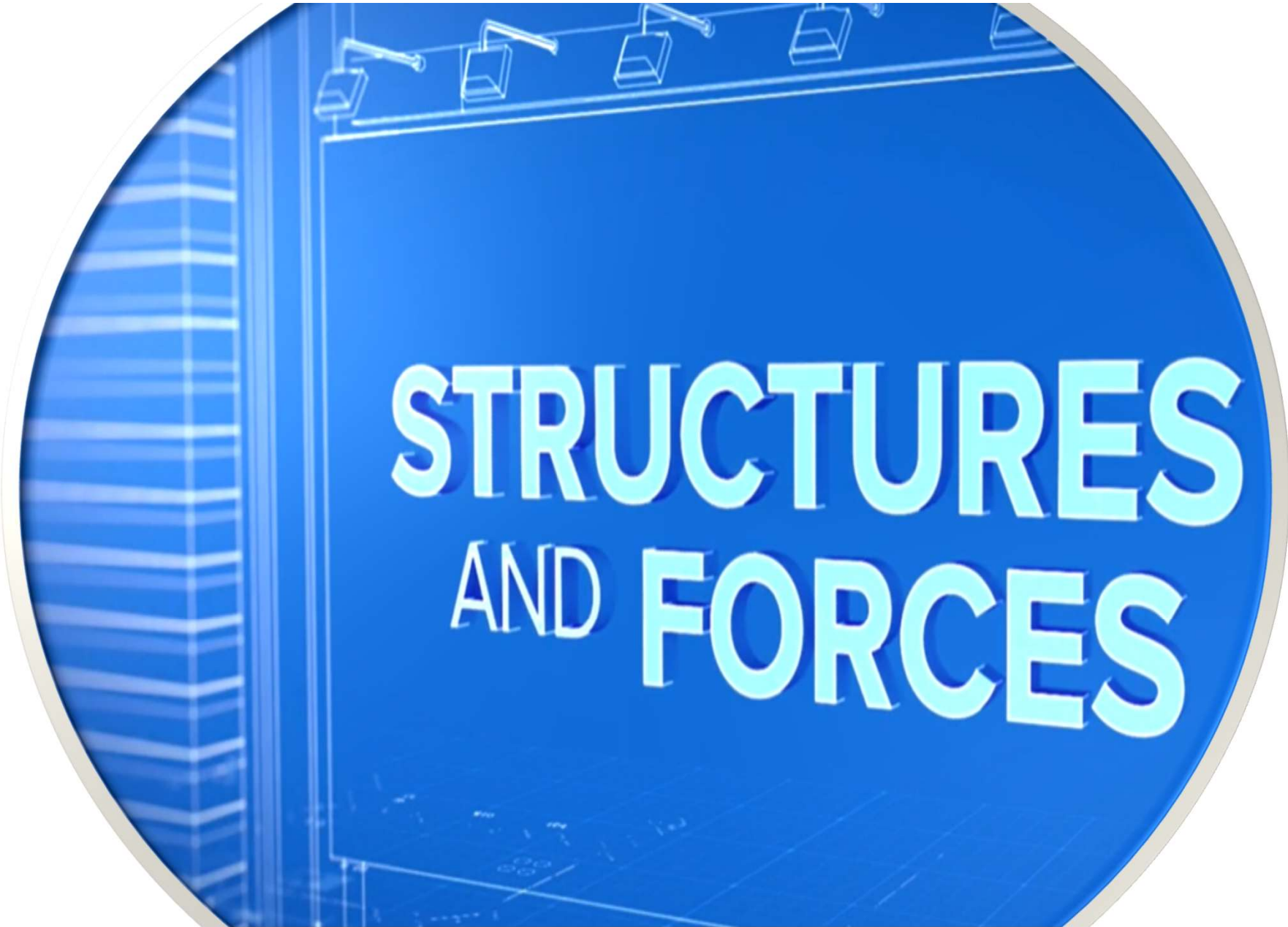
[Types Of Loads On A Structure In Accordance To Eurocode 1 | \(civilsguide.com\)](https://www.civilsguide.com/types-of-loads-on-a-structure-in-accordance-to-eurocode-1/)

Structures: Forces – Stress – Balance

On Teams review the 3 videos

- Structures and Forces
- Structures and Stress
- Structures and Balance

Answer the questions on each
Video saved in the lecture notes
under 'Files'



STRUCTURES AND FORCES

Structures and Forces:

1. Match the types of forces to the statements that best describe them by writing the letter in the corresponding box.

A. Tension

B. Compression

C. Shear

D. Torsion

- ☐ A force pushing a body in a sideways direction.
- ☐ A force stretching a body from end to end.
- ☐ A force squeezing or squashing a body.
- ☐ A force twisting a body.

2. Fill in the missing words in the sentence below.

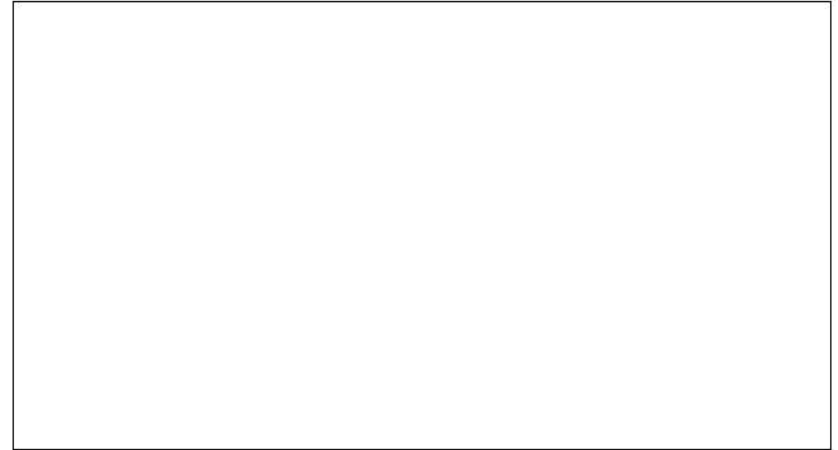
A key part of good design is being able to identify the acting on structures and how to or counteract them.

3. Which of the following are examples of tension at work? Select all that apply.

- ☐ a) Inflating a balloon
- ☐ b) Pulling back an archer's bow
- ☐ c) Wringing out wet clothing
- ☐ d) Erecting a tent

4. Using power lines as an example, explain how a catenary curve is formed.

5. Draw or attach an image of an arched structure that evenly shares four loads between five members. Label each load.



6. In Roman times, arched structures were often built from stone without the need for cement. Explain how compression forces allowed this to happen.

7. If you were to remove half the spokes on a bicycle wheel, explain, in terms of forces, what would happen when the bike is ridden.

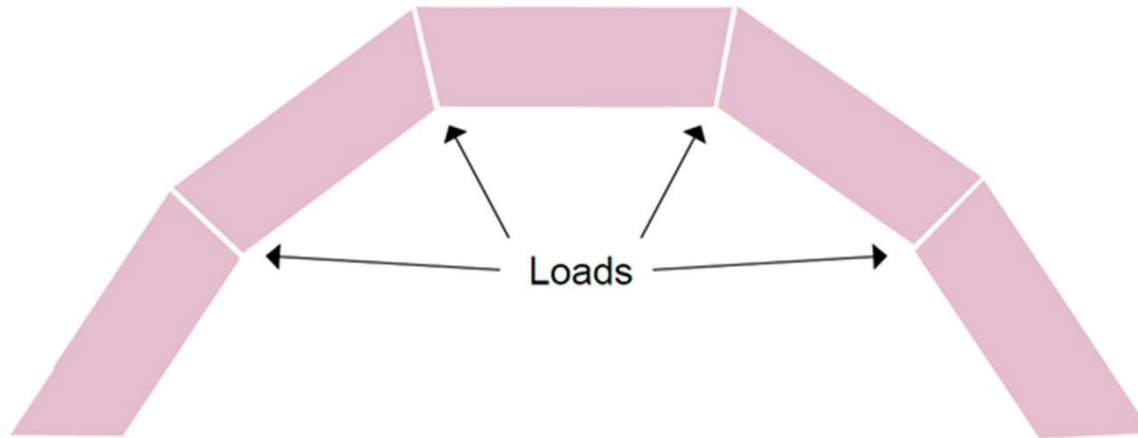
8. Even though our understanding of forces has grown over time, ancient ruins prove that there was a basic understanding of forces thousands of years ago.

☐ True ☐ False

Structures and Forces:

1. ☐ C A force pushing a body in a sideways direction. (*Shear*)
☐ A A force stretching a body from end to end. (*Tension*)
☐ B A force squeezing or squashing a body. (*Compression*)
☐ D A force twisting a body. (*Torsion*)
2. A key part of good design is being able to identify the **forces** acting on structures and how to **balance** or counteract them.
3. a) Inflating a balloon; b) Pulling back an archer's bow; d) Erecting a tent
4. A power line is supported only at its ends by two power poles. There is tension on the cable, as it is stretching from one pole to the other. It doesn't matter how far the poles are apart, gravity will always cause the cable to sag in the middle, creating a catenary curve.

5.



6. Arches form when compression forces are distributed evenly throughout the material. The Romans leaned stones against each other, using compression forces to hold them in place. The heavier the load, the tighter the stones pressed together, creating a stable arch without cement.
7. The weight of the load on a bicycle (i.e. the rider) needs to be counteracted by the tension of the spokes on the wheels. If some spokes are removed, the remaining ones will be put under more compression force by the rider and may fail.
8. True

A blue circular graphic with a white border. The background features faint white line art of a building's roofline with clips at the top and a grid pattern at the bottom. The text "STRUCTURES AND STRESS" is centered in a bold, white, sans-serif font with a slight 3D effect.

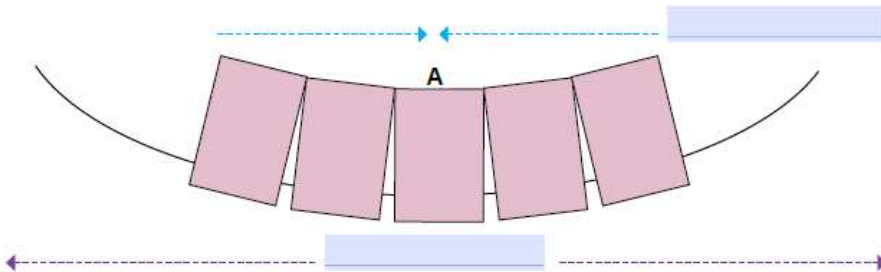
STRUCTURES AND STRESS

Structures and Stress:

1. Fill in the missing words in the sentence below.

Bending occurs when a _____ force is applied to an object along its longitudinal axis, or along its _____ dimension.

2. Label the two forces at play in the diagram below when a perpendicular force is applied at point A.



3. A material often used to reinforce structural beams is:

- ☐ a) rope.
- ☐ b) aluminium.
- ☐ c) rubber.
- ☐ d) steel.

4. There are two ways to strengthen a reinforced structural beam.

- a) Tightening the reinforcements to compress a material, such as concrete, before putting it in place is called _____.
- b) Tightening the reinforcements after a structure has been built is called _____.

5. The bridge shown below has two supports. Select the curve that the steel cables should follow to best reinforce the concrete.



- ☐ a)
- ☐ b)
- ☐ c)
- ☐ d)

6. Justify your answer to Question 5.

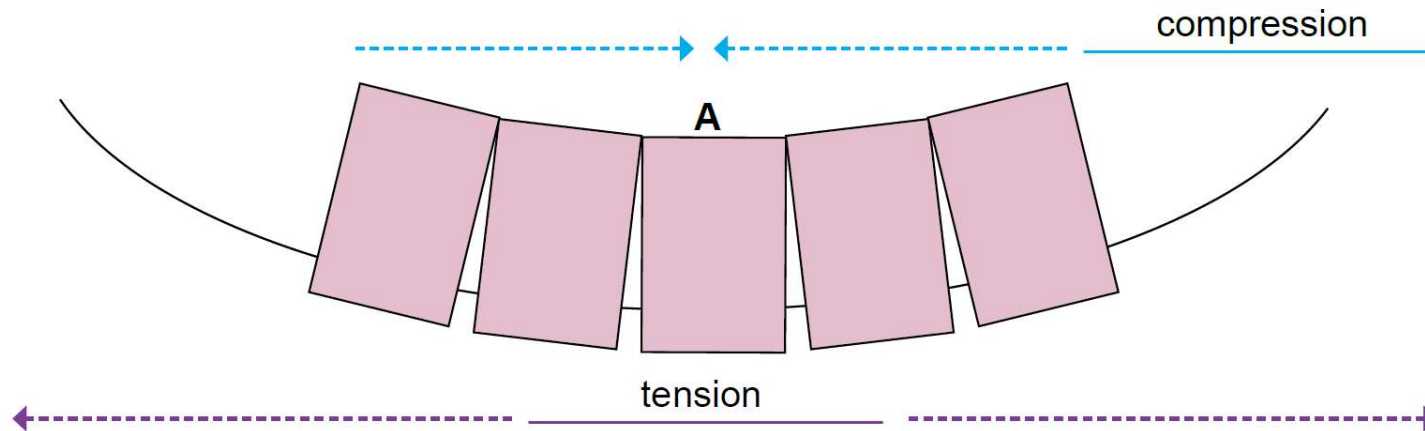
7. Explain what could happen to a poorly structured bridge in high winds, and why.

8. Explain where metal shears got their name, and describe the force that they make use of.

Structures and Stress:

1. Bending occurs when a **perpendicular** force is applied to an object along its longitudinal axis, or along its **longest** dimension.

2.



3. d) steel.
4. a) Tightening the reinforcements to compress a material, such as concrete, before putting it in place is called **pre-stressing/pre-tensioning**.
b) Tightening the reinforcements after a structure has been built is called **post-tensioning**.

5. c)



6. The steel reinforcing cables provide strength where the concrete is weak in tension. For example, the base of the bridge is under tension where it is between two supports, so the reinforcement needs to be along the base.
7. If a bridge is not reinforced for torsion, or a twisting force, it might twist in the wind and ultimately fail.
8. Shear is a pair of sideways forces going in opposite directions. This gives metal shears their name because they cause a material to break as the two blades apply shear force to whatever is in between them.

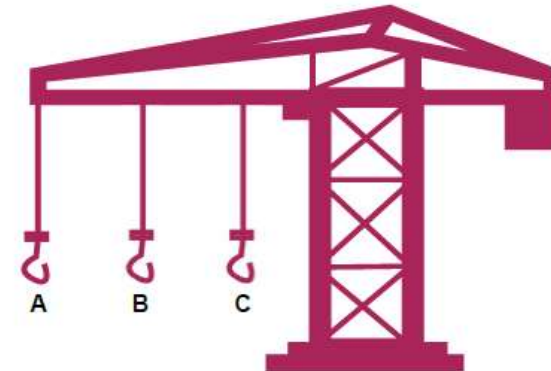
**STRUCTURES
AND BALANCE**

The image is a circular graphic with a blue background. At the top, there is a white line drawing of a series of mechanical components, possibly a conveyor belt or a structural assembly, with several rectangular blocks and connecting arms. The bottom half of the circle features a faint, white grid pattern, resembling a technical drawing or a blueprint. The text 'STRUCTURES AND BALANCE' is prominently displayed in the center in a bold, white, sans-serif font. The word 'STRUCTURES' is on the top line, and 'AND BALANCE' is on the bottom line. The entire graphic is set against a white background.

Structures and Balance:

1. A column is a , which sits on the ground or is partially buried in the foundation.
2. Explain what might happen when a load is added to a column at the top.
3. The more rigid the column:
☐ a) the less guy ropes are required.
☐ b) the more guy ropes are required.
☐ c) has no effect on the number of guy ropes required.
4. A cantilever is a type of with a long beam, or girder, that's fixed at .
5. When a cantilever is horizontal, the top of the beam is in **A** and the bottom is in **B**.
☐ a) **A** = compression **B** = tension
☐ b) **A** = tension **B** = compression
☐ c) **A** = tension **B** = bending force
6. Provide three (3) examples of cantilevers in everyday life.
 -
 -
 -

7. From which line could this crane take the heaviest load?



- ☐ a) A
☐ b) B
☐ c) C
8. Explain your response to Question 7.
 9. Beams are and can take loads along their entire .
 10. Draw or attach an image of the cross-section of an I-beam, and label the three plates.
 11. Explain why I-beams are often preferred in construction over solid steel or timber beams.

Structures and Balance:

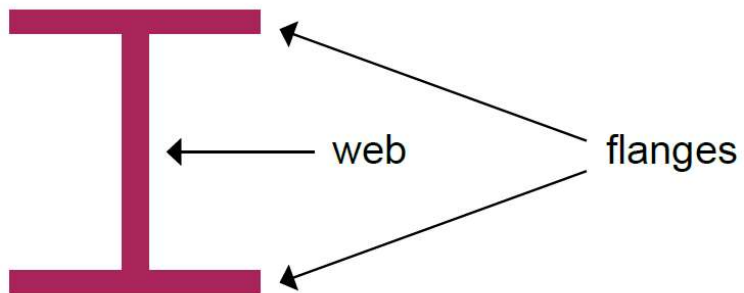
1. A column is a **vertical support**, which sits on the ground or is partially buried in the foundation.
2. When a load is added to the top of a column, it may buckle under the weight of the load if it is not rigid or braced enough using guy ropes.
3. a) the less guy ropes are required.
4. A cantilever is a type of **lever** with a long beam, or girder, that's fixed at **one end**.
5. b) **A** = tension **B** = compression
6. Student responses may vary, however examples mentioned in the video include (human) arms, street lamps, some street signs, cranes, cantilever bridges, aeroplane wings.

7. c) C

8. The very end of a cantilever arm cannot take heavy loads because of the leverage offered by the fulcrum, which is far away. The closer to the crane tower, the heavier the loads the crane can lift because the leverage offered by the fulcrum is less.

9. Beams are **horizontal** and can take loads along their entire **length**.

10.



11. I-beams use less steel or timber than solid beams, so they are lighter (and also therefore cheaper), but just as strong.

Structural Systems

The term **structural system** or **structural frame** in structural engineering refers to the load-resisting sub-system of a structure.

The structural system transfers loads through interconnected structural components or members.



Commonly used structures can be classified into five major categories:

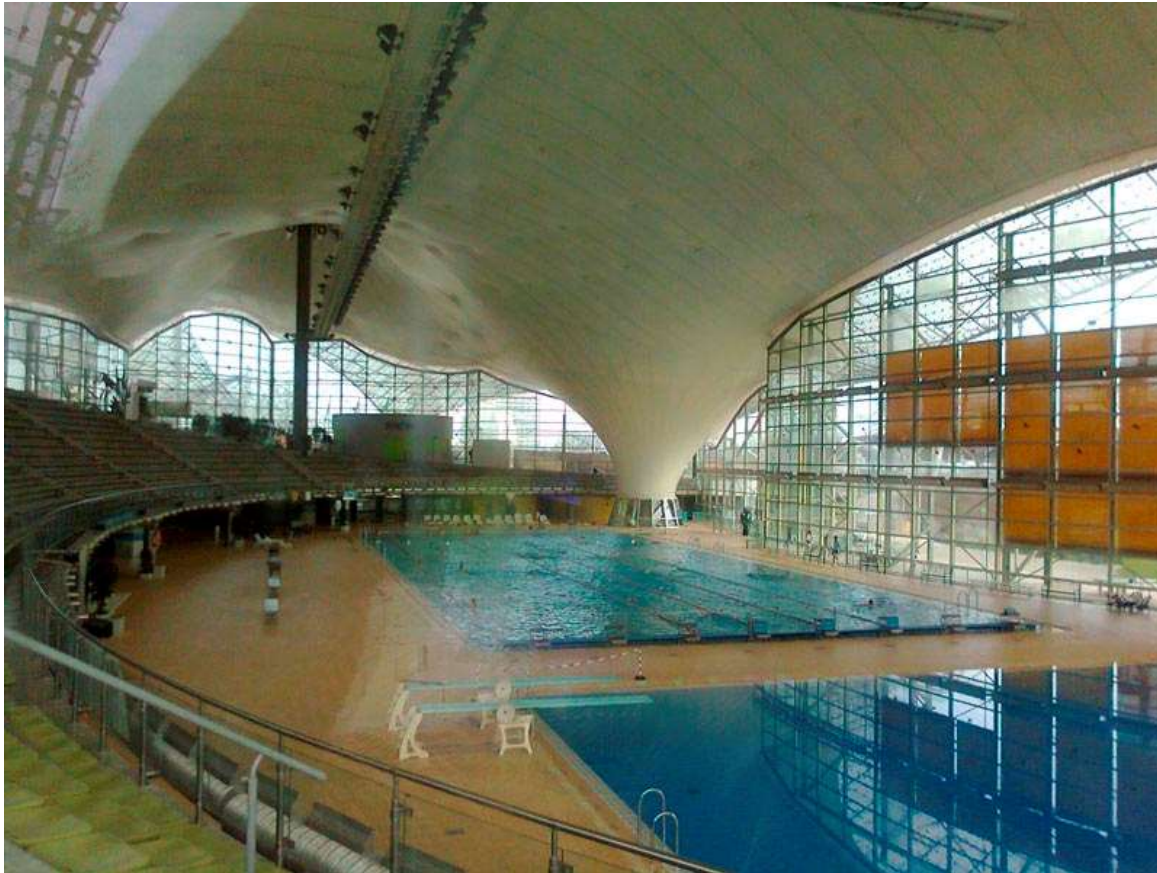
However, any two or more of the basic structural types described in the following may be combined in a single structure, such as a building or a bridge in order to meet the structure's functional requirements.

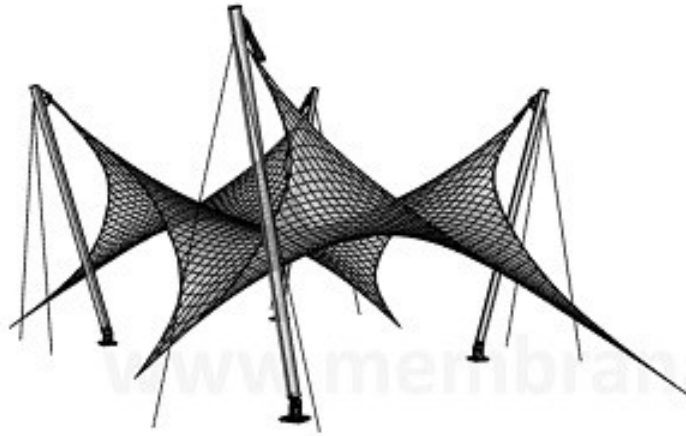
- Tensile structures
- Compressive structures
- Trusses
- Shear structures
- Bending structures

Tensile structures

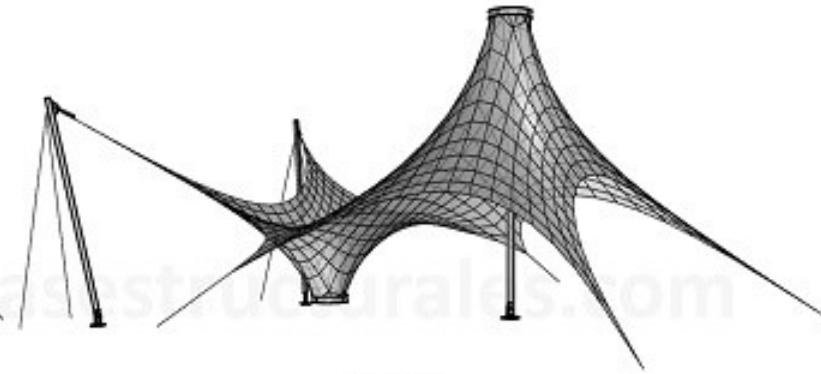
Members of tensile structures are subject to pure tension under the action of external loads. Because the tensile stress is uniformly distributed over the cross-sectional area of members, the material of such a structure is utilized in the most efficient manner.



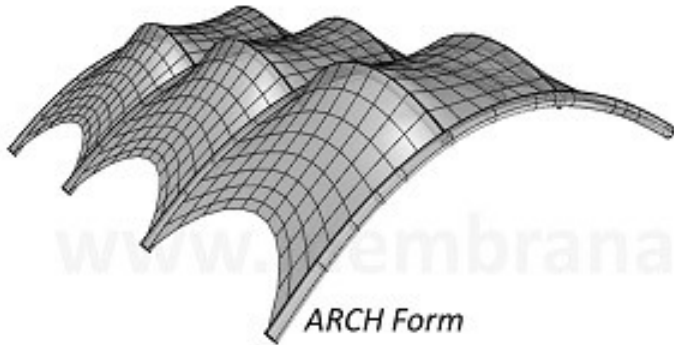




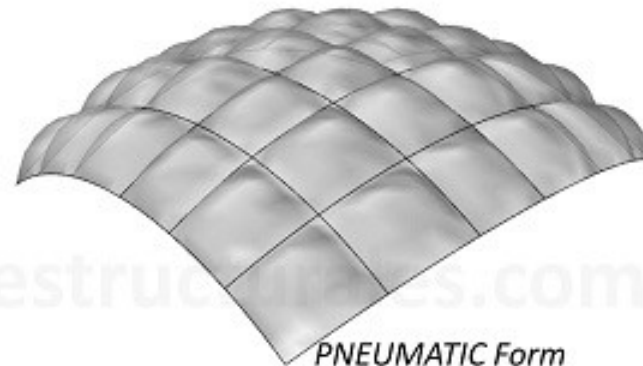
HYPAR Form



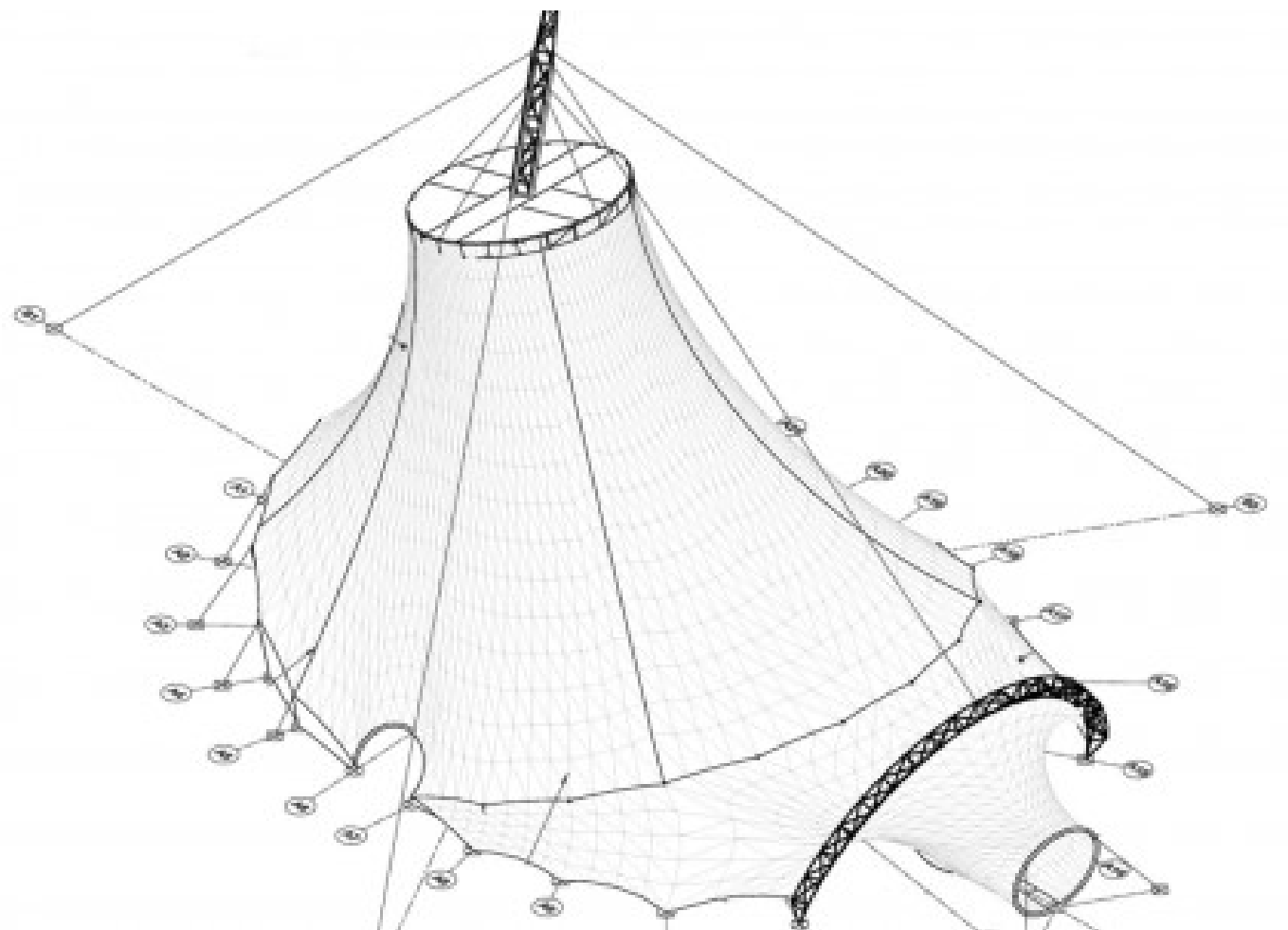
CONIC Form



ARCH Form



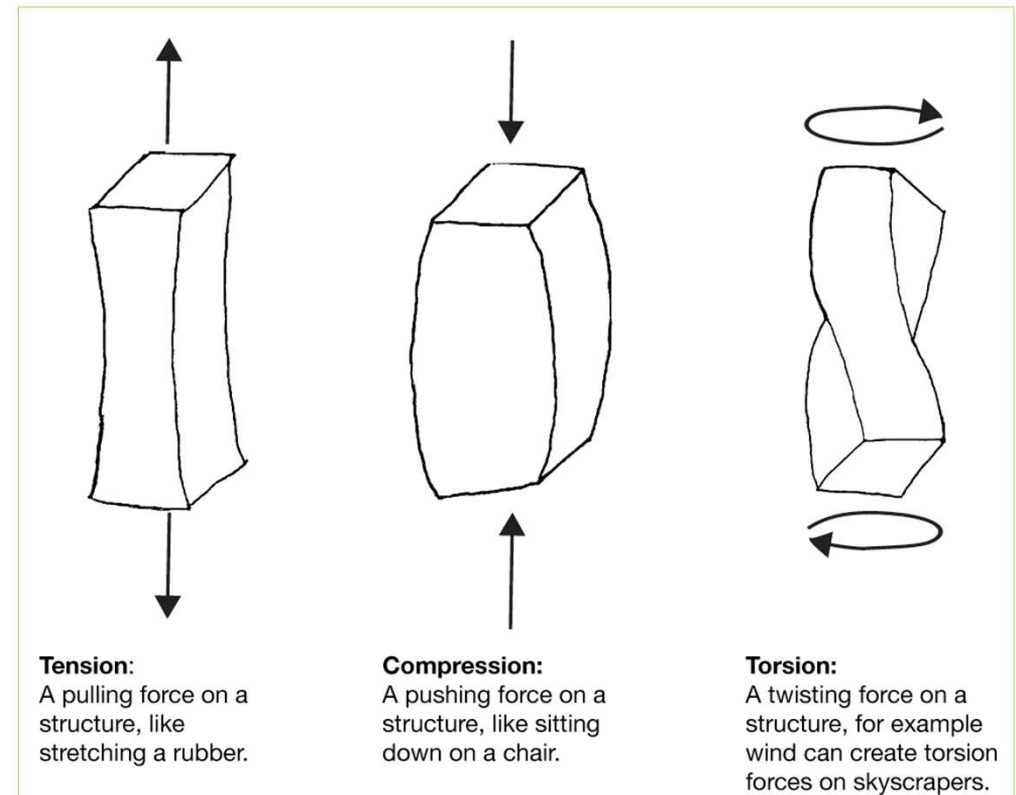
PNEUMATIC Form

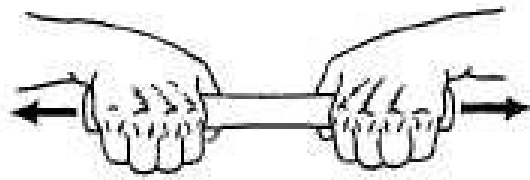




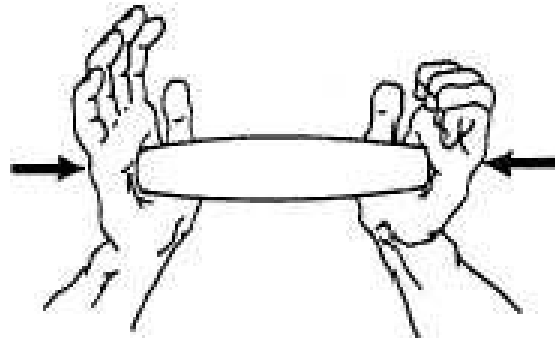
Compressive structures

Compression structures develop mainly compressive stresses under the action of axial loads. Because compressive structures are susceptible to buckling or instability, the possibility of these failures should be considered in their design. If necessary, adequate bracing must be provided to avoid such failures.

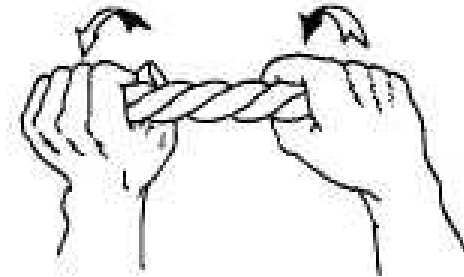




(A) TENSION



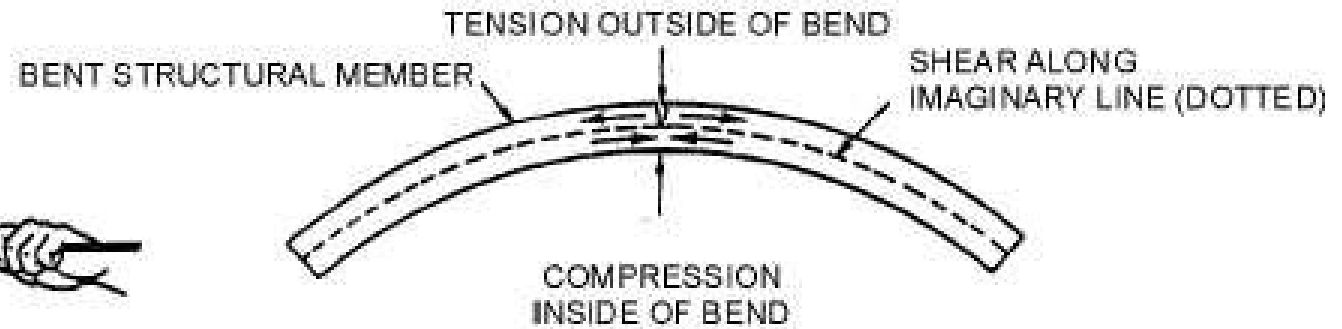
(B) COMPRESSION



(C) TORSIONAL



(D) SHEAR



(E) BENDING (THE COMBINATION STRESS)

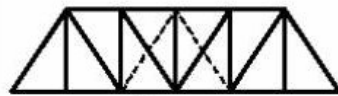


Figure 13 Completed shell and a demonstration of the structural strength



Trusses

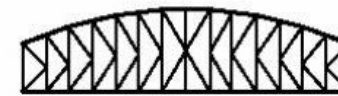
Trusses are composed of straight members connected at their ends by hinged connections to form a stable configuration. Because of their light weight and high strength, they are among the most commonly used types of structure.



Pratt



Parker



K-Truss



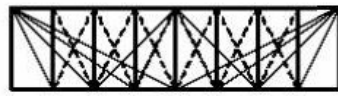
Howe



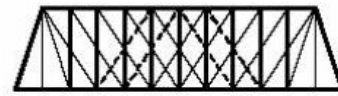
Camelback



Warren



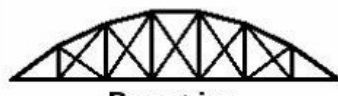
Fink



Double Intersection Pratt



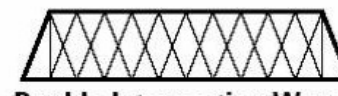
Warren (with Verticals)



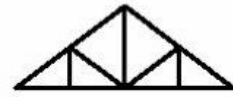
Bowstring



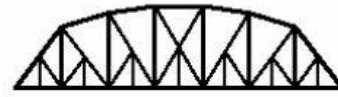
Baltimore



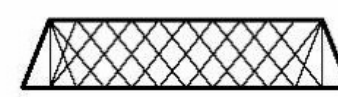
Double Intersection Warren



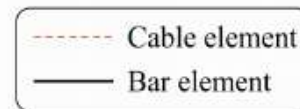
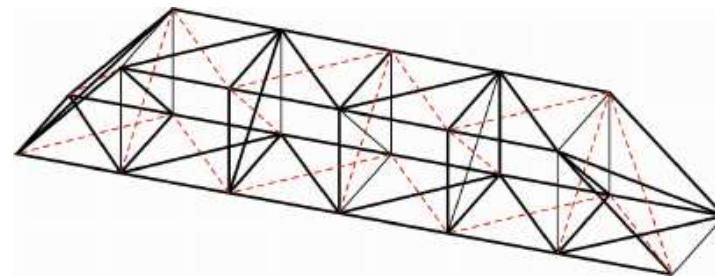
Waddell "A" Truss

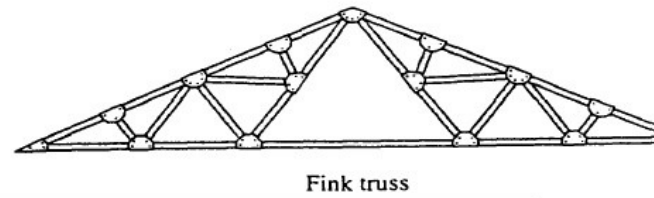
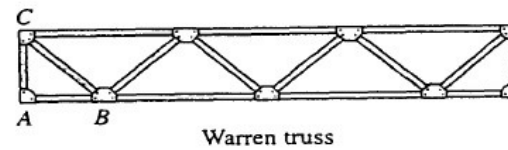
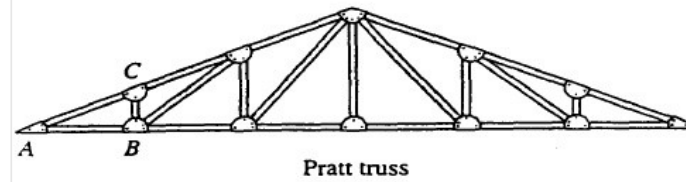
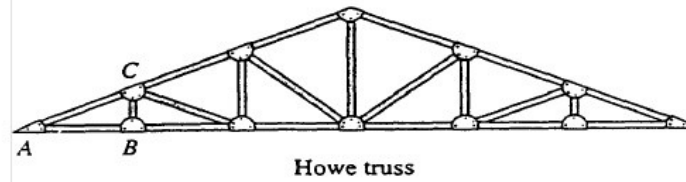
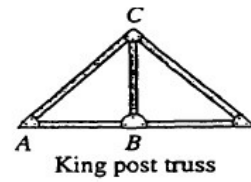


Pennsylvania



Lattice



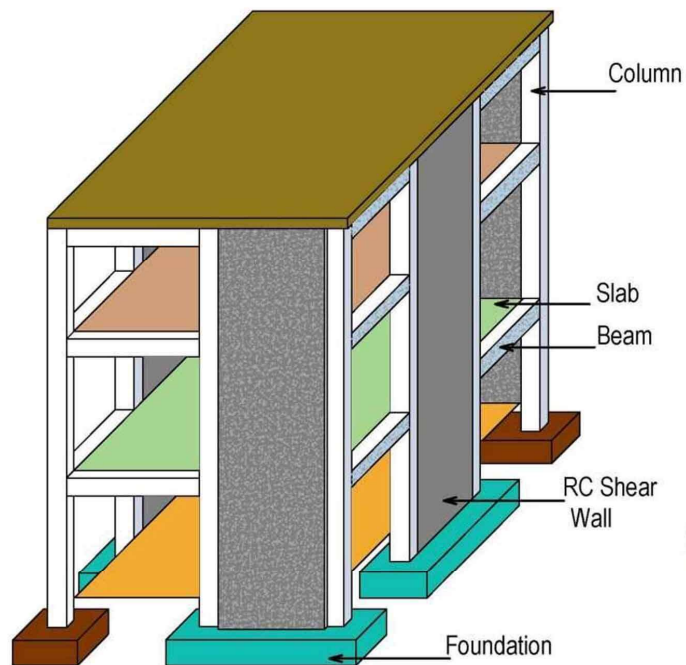


Common Roof Trusses

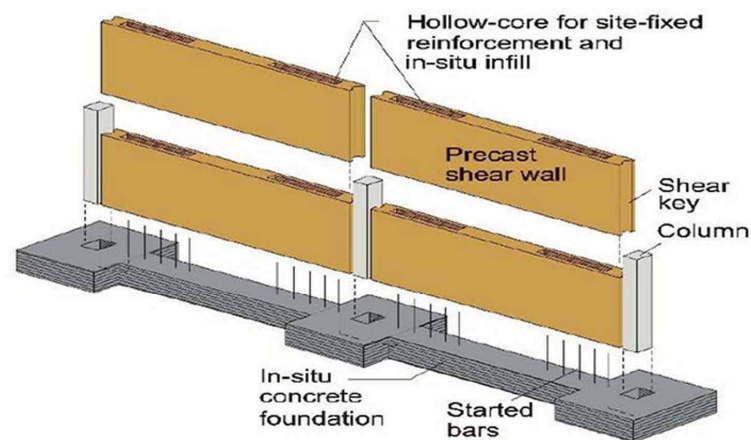


Shear structures

These are structures such as reinforced concrete or wooden shear walls, which are used in multi-story buildings to reduce lateral movements due to wind loads and earthquake excitations. Shear structures develop mainly in-plane shear with relatively small bending stresses under the action of external loads.

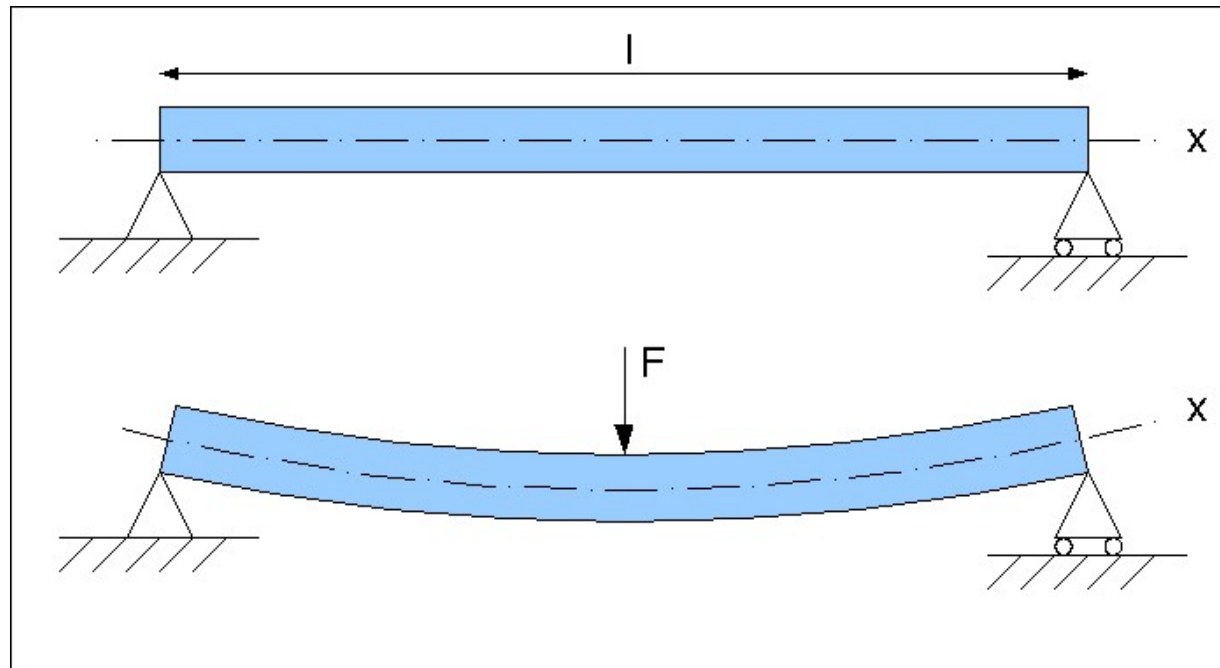


Difference Between Shear Wall And Column

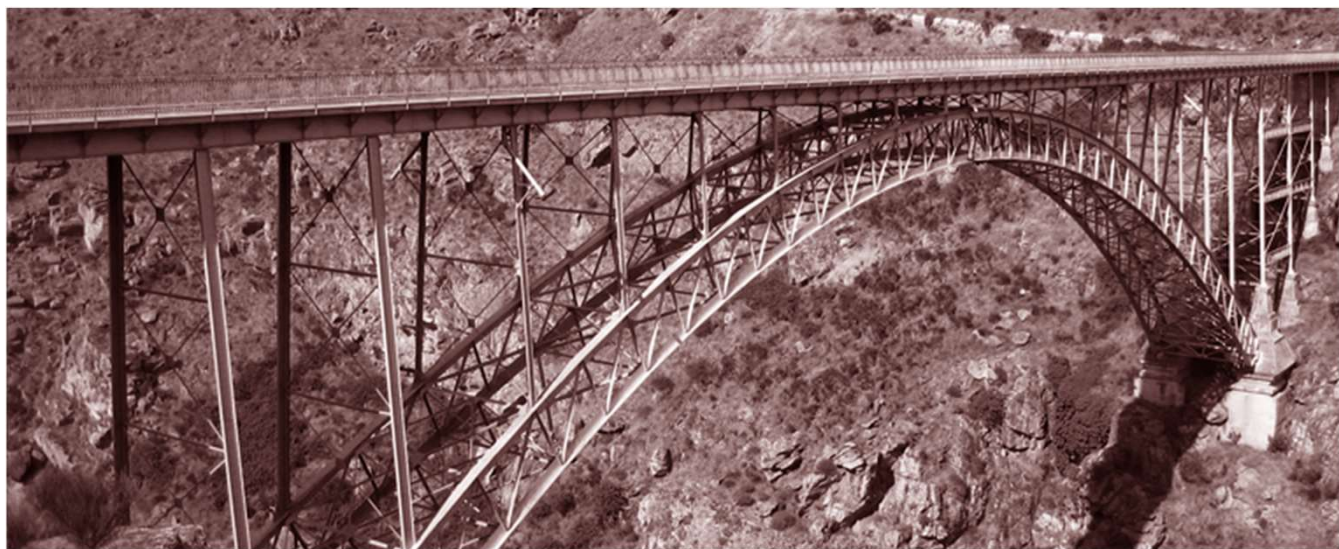


Bending structures

Bending structures develop mainly bending stresses under the action of external loads. The shear stresses associated with the changes in bending moments may also be significant, and should be considered in their design.

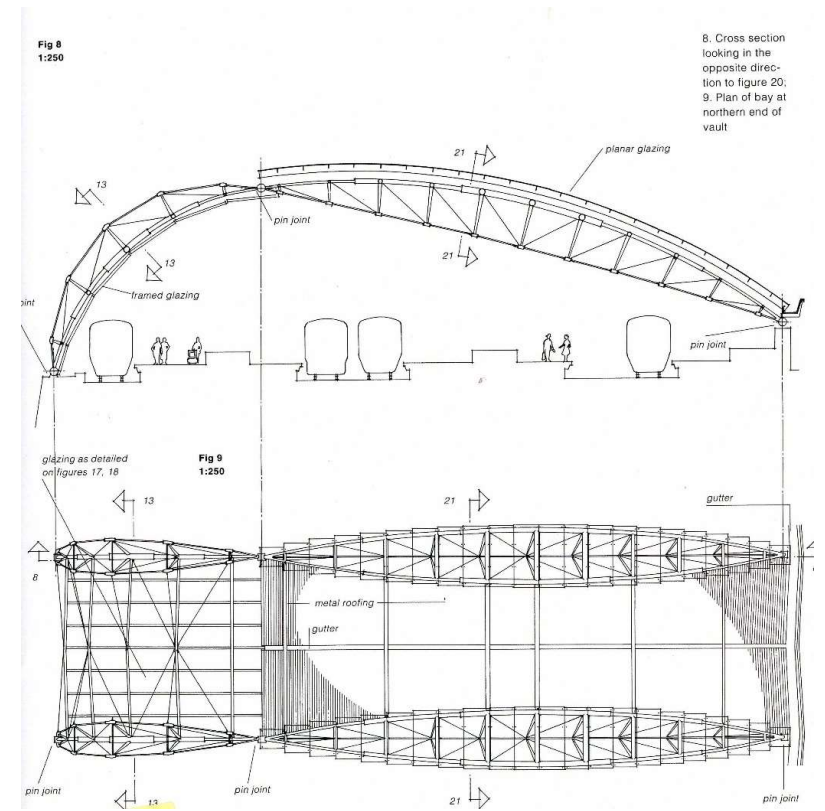








Waterloo Station





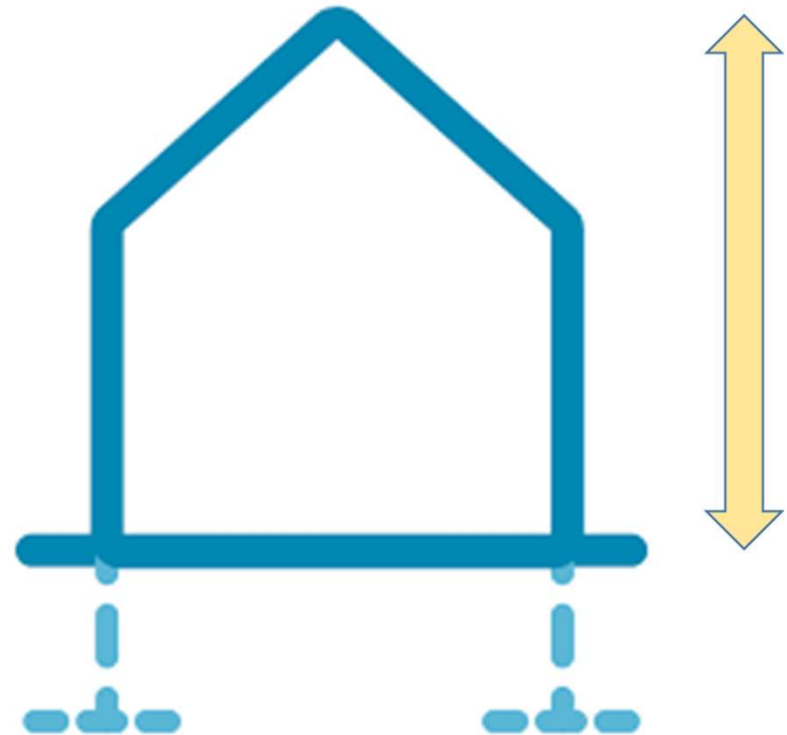
Week 05&06:

Structures

- *Forces – Stress – Balance*
- *Types of structure*

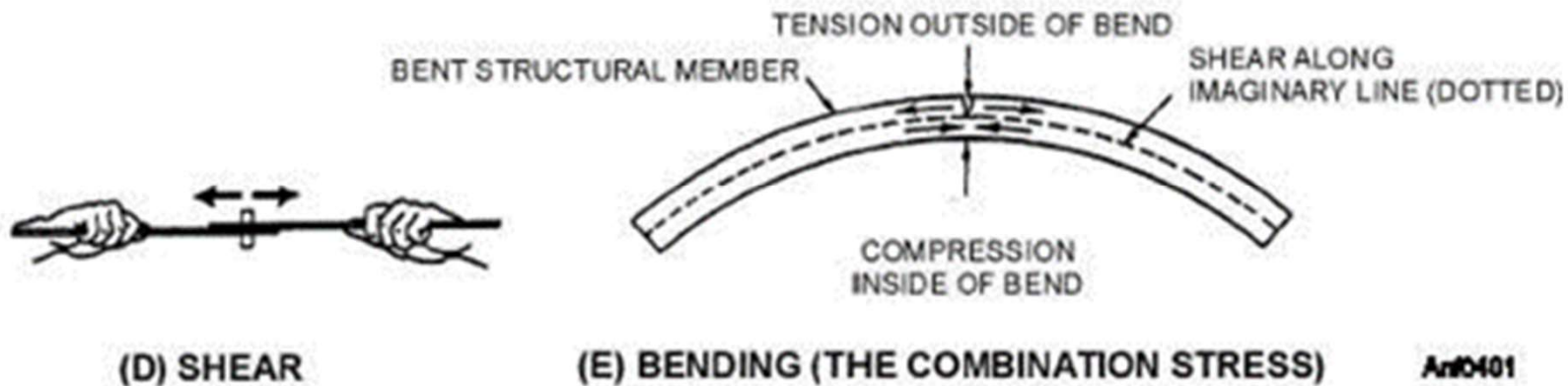
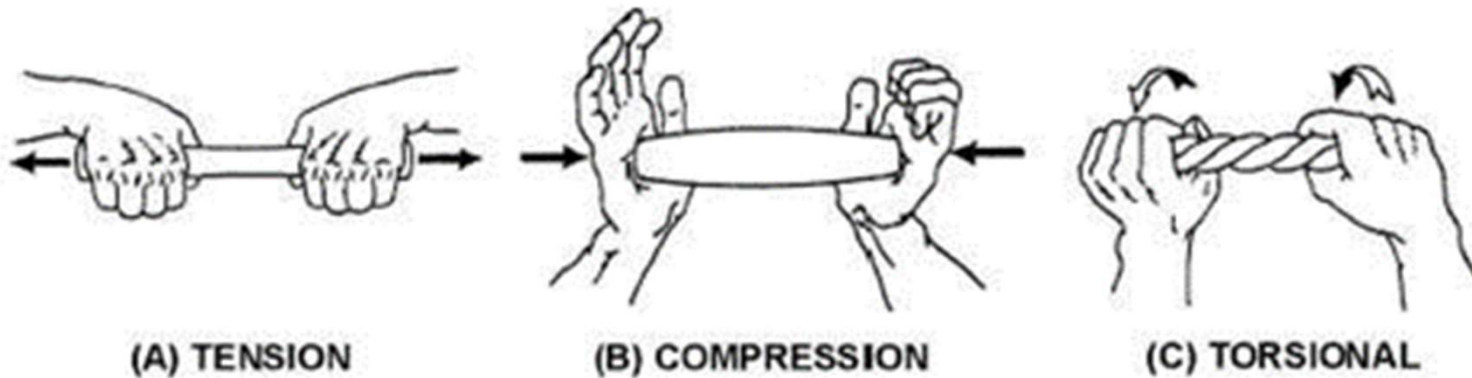
Structural Frames

- Timber
- Steel
- Concrete
- Mixed



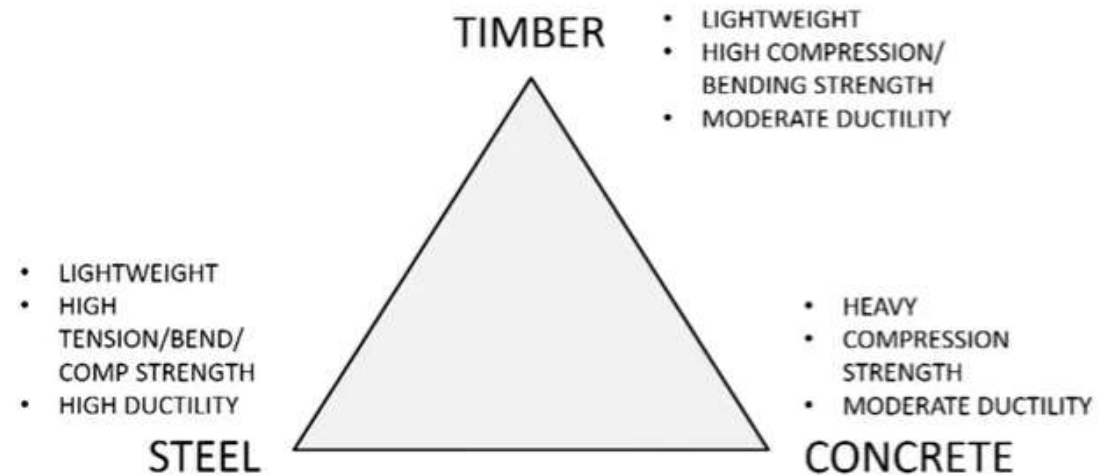
STRUCTURE FRAMES

Introduction



Materials used in structural frames

- Timber
- Steel
 - Standard sections
 - Compound elements
- Concrete
 - Mass concrete
 - Reinforced concrete
 - Precast concrete frames
- Mixed

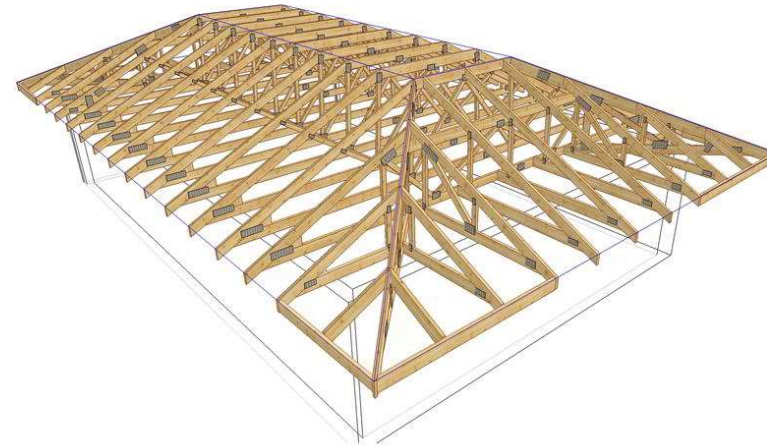


[Timber Tower Research Project – SOM](#)

Timber

Characteristics

- Tensile strength
- Light weight
- Aspect
- Conservation
- Deformation



Use

- Laminated wood
- Building roofs
- Beams
- sheets

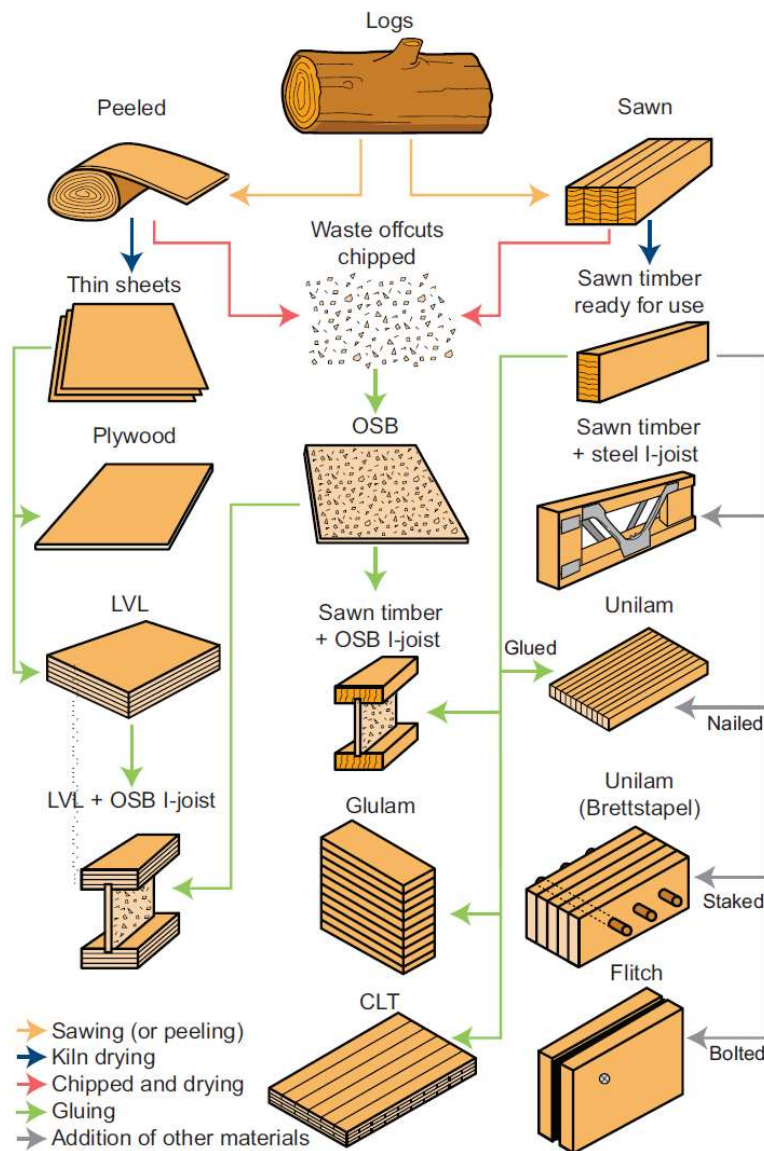


Figure 4.1: Processing from logs to products

4.3 Floor options

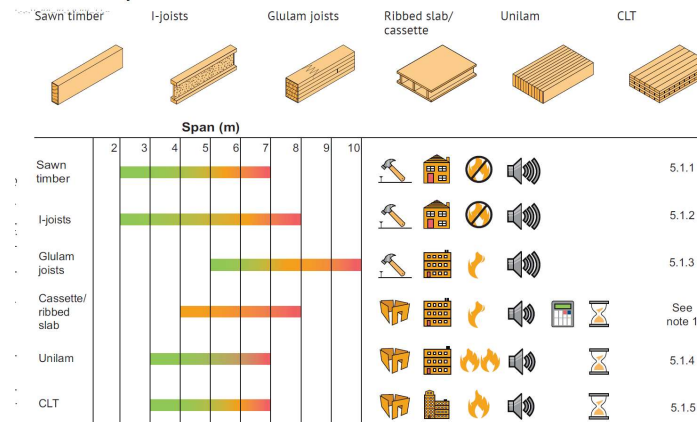


Figure 4.2: Floor options (see notes below)

4.4 Roof options

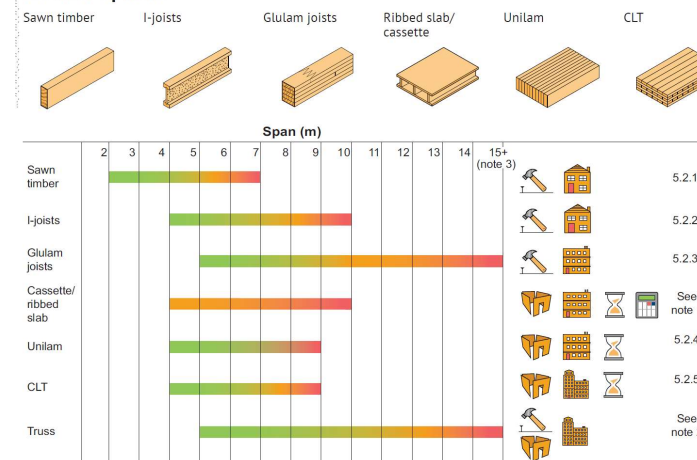
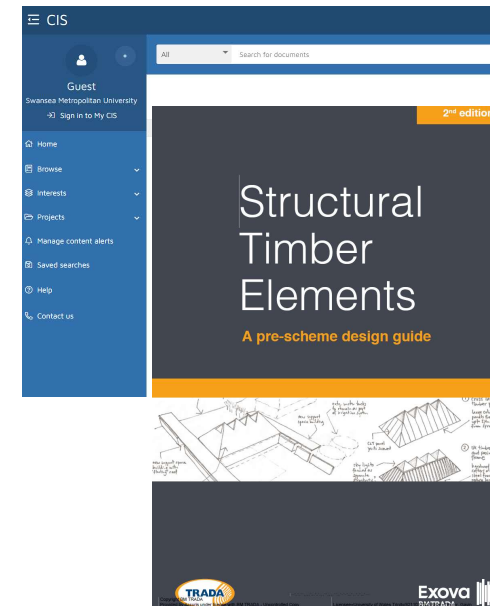


Figure 4.3: Roof options (see notes below)



Available from the library services via 'CIS' database



Timber Frame Construction

Timber frame is very much on the ascendancy as a mainstream construction method for dwellings and medium rise buildings in the UK. Financial and time savings are there to be had providing the method of construction is understood.

Timber frame construction is not a system of building, although there are a number of well-researched systems that use timber frame as a basis.

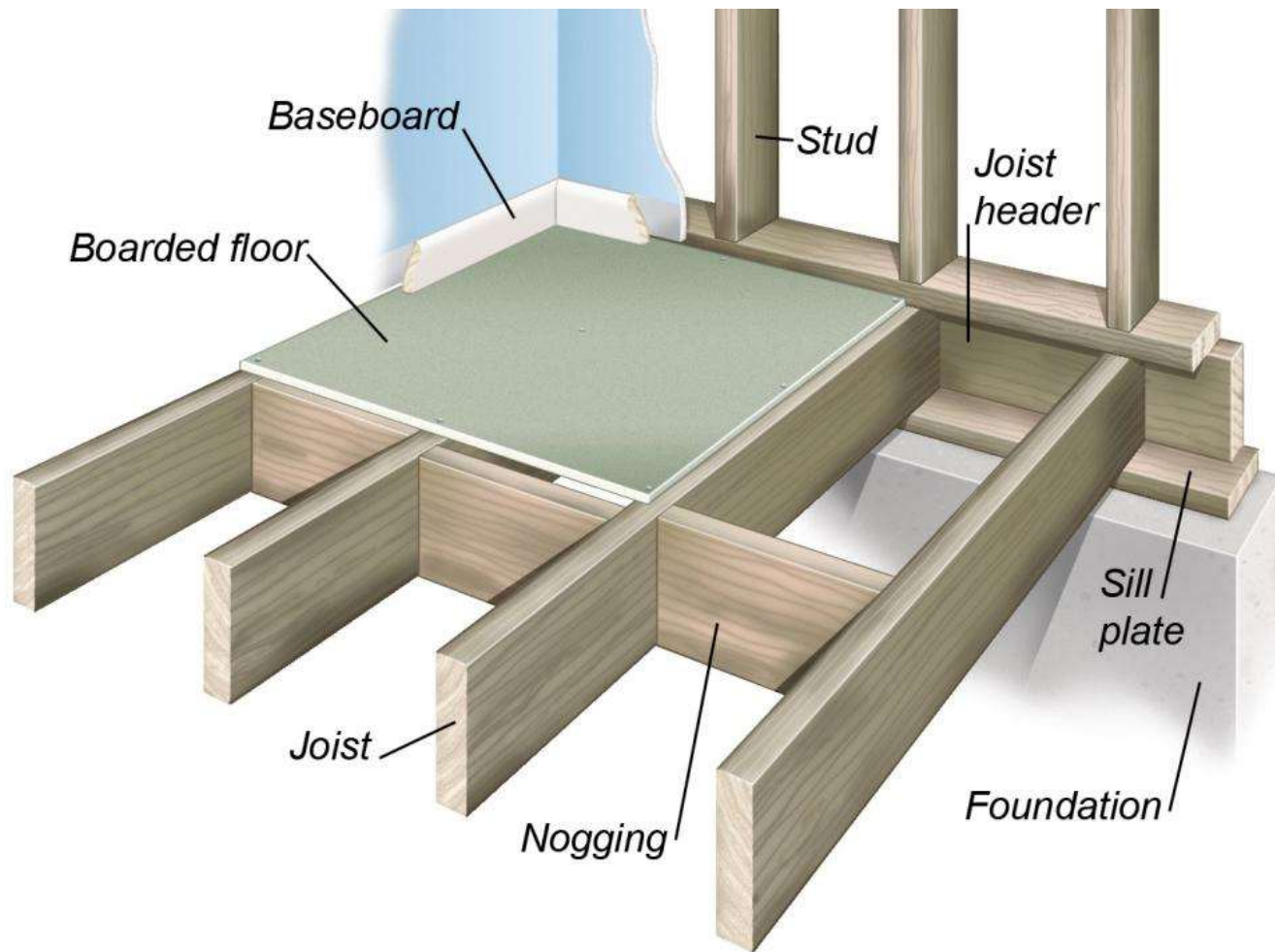
Timber frame construction uses timber studs and rails, together with a structural sheathing board, to form a structural frame that transmits all vertical and horizontal loads to the foundations.

Timber Frame Construction

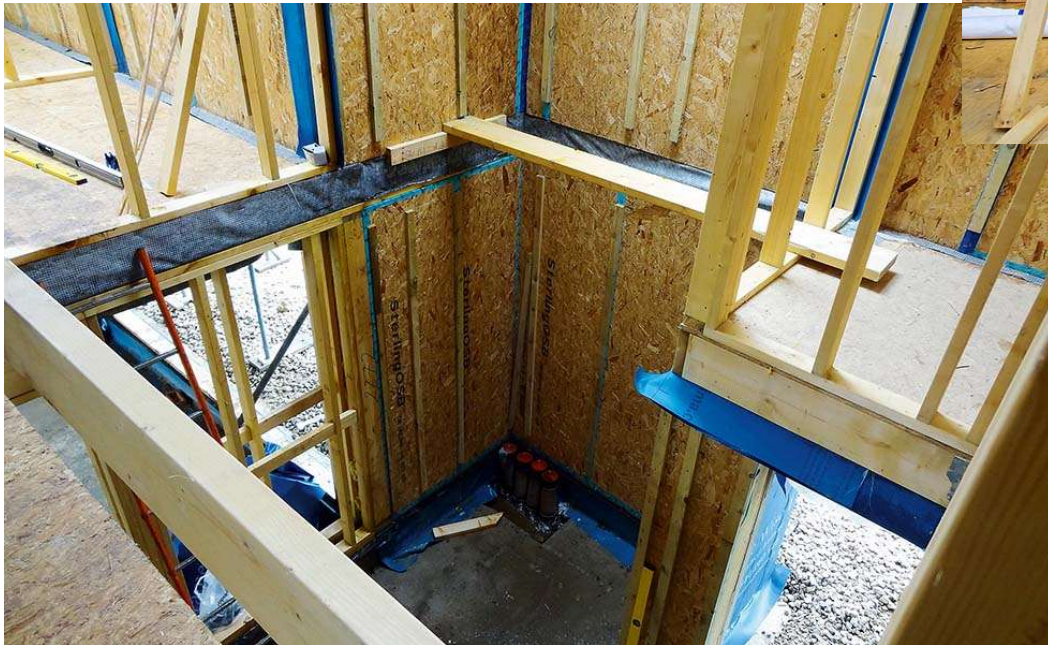
Platform frame is the most commonly used method in the UK. Each storey is framed with floor-to-ceiling height panels and the floor deck of one floor becomes the erection platform of the next.



Timber Frame Construction



Timber Frame Construction



Timber Frame Construction

Other timber building methods include:

SIPs (structural insulated panels) consist of a layer of oriented strand board (OSB) bonded onto each side of an insulating foam core. These composite engineered products can be used as a structural loadbearing element.



[Construction Technology 1 House construction, fourth edition
by Mike Ri \(bloomsburyonlineresources.com\)](http://bloomsburyonlineresources.com)

Timber Frame Construction



Timber Frame Construction

CLT (cross-laminated timber) uses wood panels in which the thickness is made up of a number of narrow widths of timber laid together with each layer at right angles to the previous layer. These panels can be pre-cut in the factory to form wall, roof and floor elements.



Timber Frame Construction



Timber Frame Construction

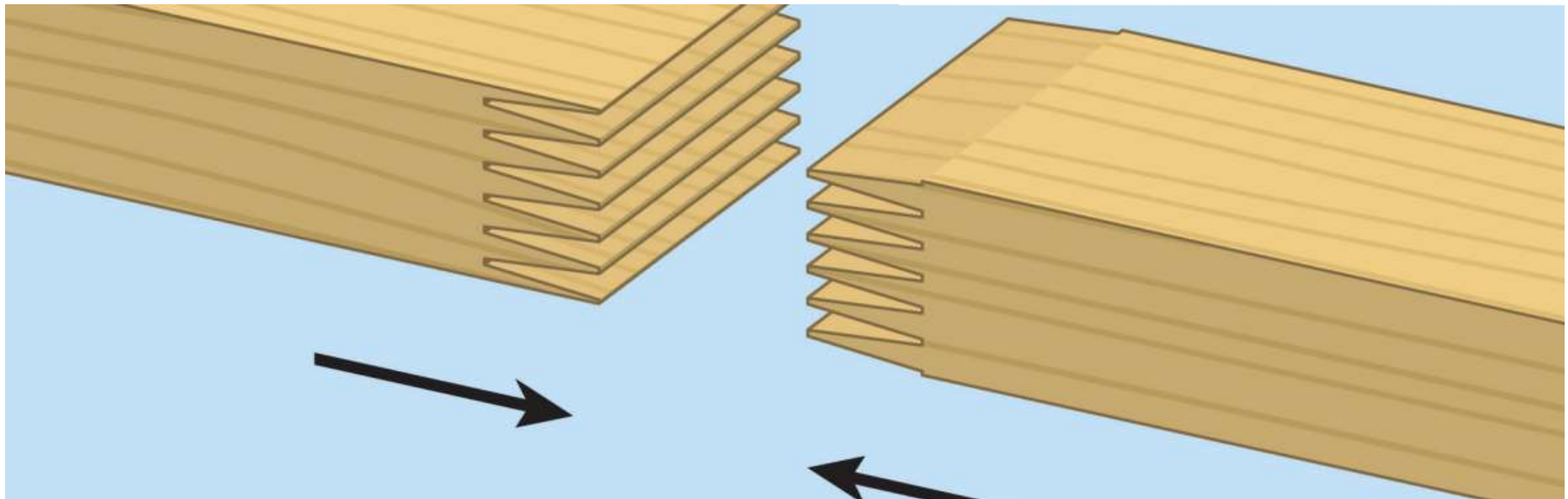
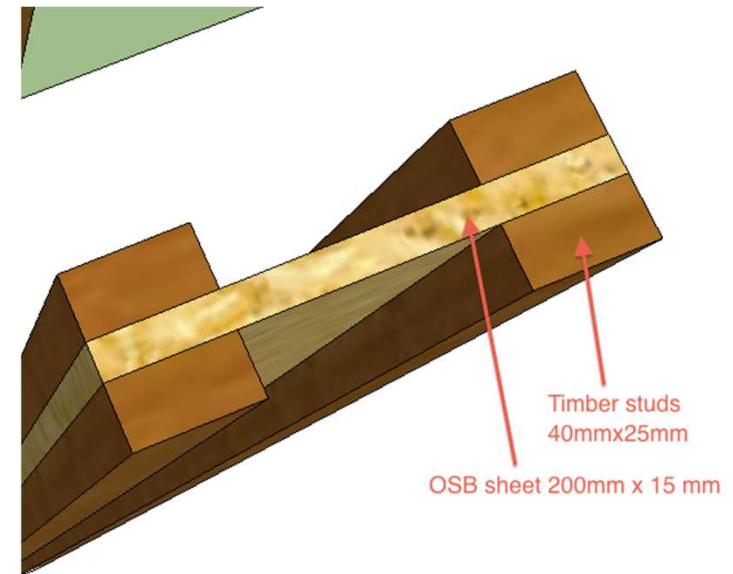


Timber Frame Construction

Engineered stud is a simple way to allow a large depth of insulation to be installed between the loadbearing timber studs used for timber frame wall panels. A number of different types of engineered stud are available, using either I-joist or metal web joist designs.



Timber Frame Construction



Timber Frame Construction



Timber Frame Construction



Timber Frame Construction

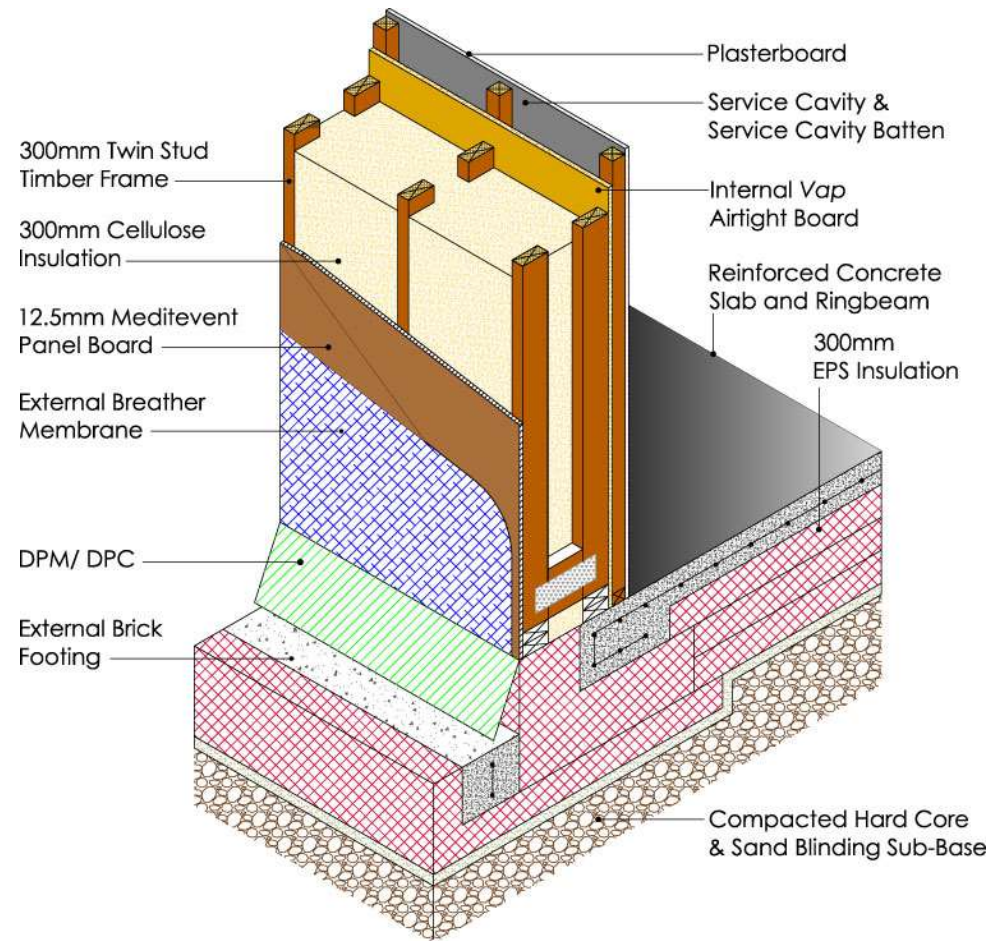


Timber Frame Construction



Timber Frame Construction

Twin stud is two timber frame stud walls in parallel, separated by a cavity, but only one of these carries the vertical load of the building.



Passive Wall & Foundation Junction

Timber Frame Construction



Timber Frame Construction

Current timber frame construction incorporates high levels of insulation within structural elements, but clients are now seeking designs that can deliver improved thermal performance.

This can be achieved by using:

- deeper solid timber studs
- deep engineered timber studs (typically timber I-joists or open web joists)
- additional layers of insulation material (internally or externally)
- novel construction methods such as SIPs

Timber Frame Construction

Options for improving the thermal performance of existing timber frame buildings include:

- improving airtightness
- increasing roof insulation
- upgrading windows
- adding floor insulation
- upgrading wall insulation.

Timber Frame Construction

Fire protection

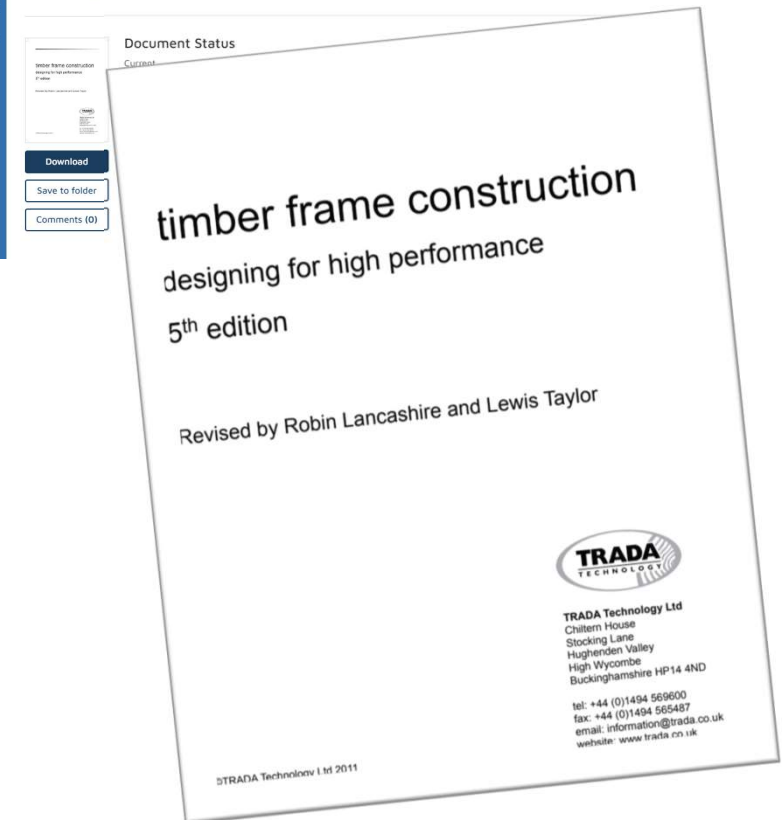
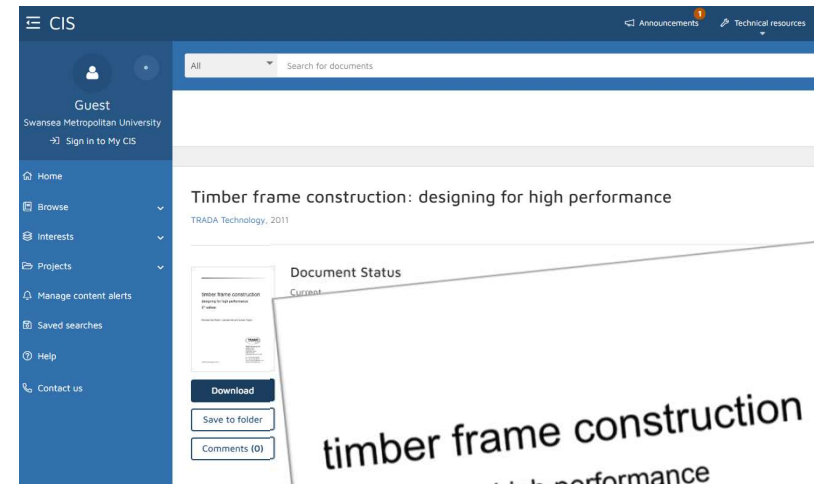
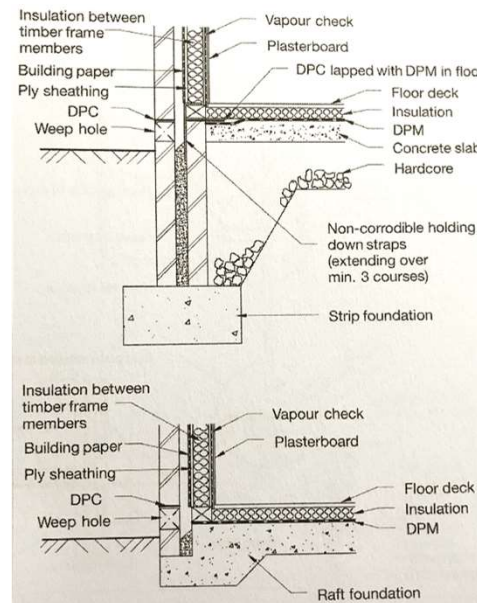
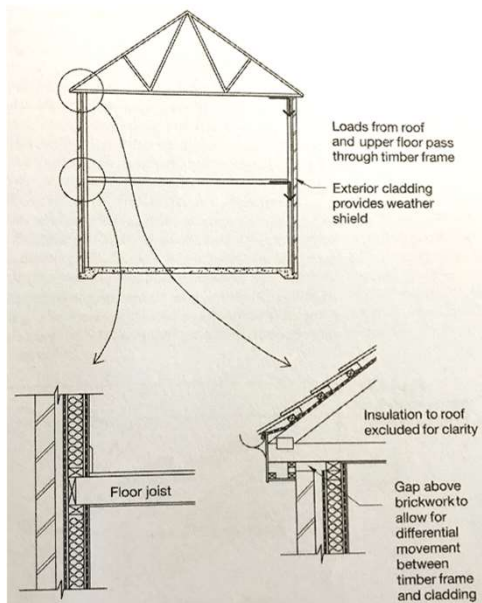
All forms of construction need to comply with the fire performance requirements laid down by national building regulations. Timber frame dwellings have no difficulty in meeting the required levels, given correct design, standards of manufacture and workmanship. The following are important considerations:

- Internal linings, usually plasterboard, limit the potential for a fire to develop and provide the period of fire resistance required by the building regulation.
- Cavity barriers prevent a fire from entering a cavity and prevent a fire from escaping to an adjacent cavity zone. **Their correct installation on a timber frame site is of paramount importance.**

Timber Frame Construction

Sources for Timber construction

[Construction Technology 1 House construction, fourth edition by Mike Ri \(bloomsburyonlineresources.com\)](http://bloomsburyonlineresources.com)



book Construction technology. 1, House construction
Riley, Mike., Cotgrave, Alison., Third edition., Basingstoke, Hampshire : Palgrave Macmillan, 2013., Total Pages vii, 382 pages, 8 pages of unnumbered plates :

Steel

Characteristics

- High compression and tension strength
- Relatively light weight
- Beams and columns
- Wires and cables
- Made before arriving at the site
- Large deformation



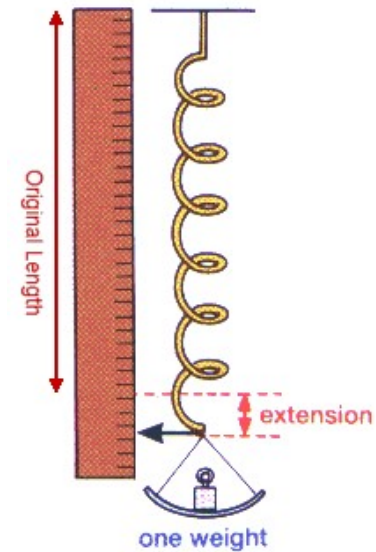
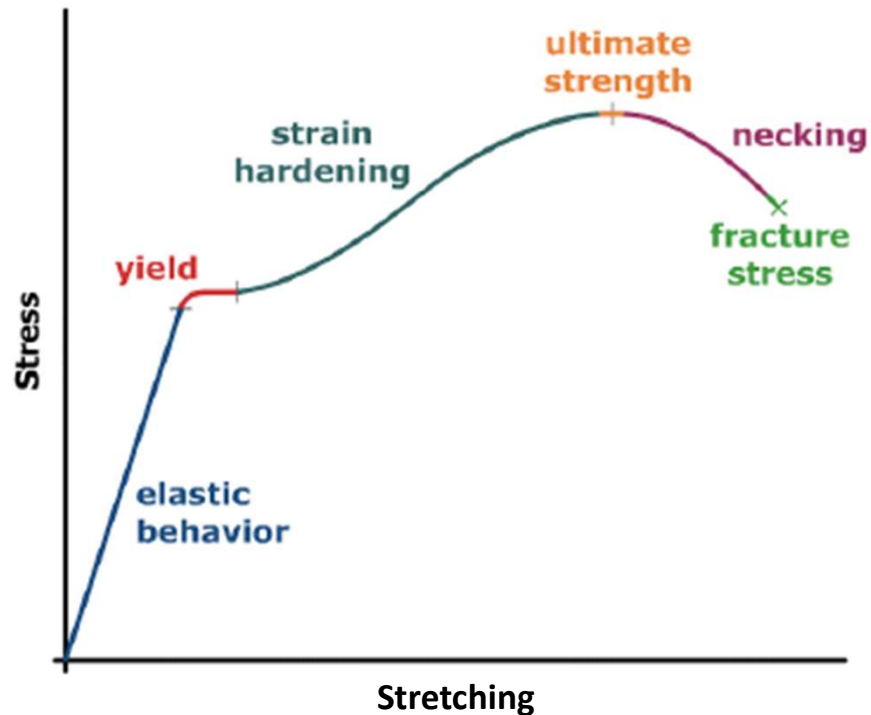
Uses

- Buildings
- Industrial buildings

Steel

This is essential to help engineers determine the safe working load of a structure and to ensure that it will not deform excessively under normal loads.

Hooke's law

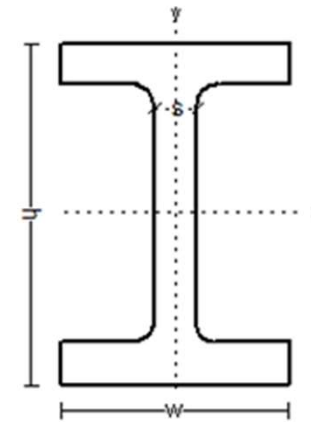
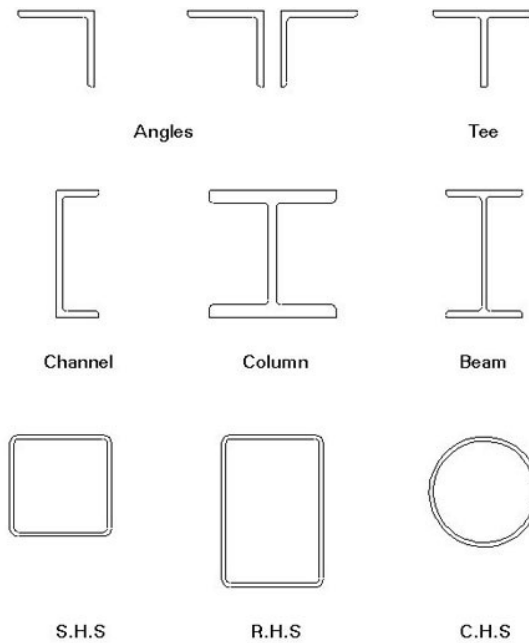


https://youtu.be/kw_kthwCdNY

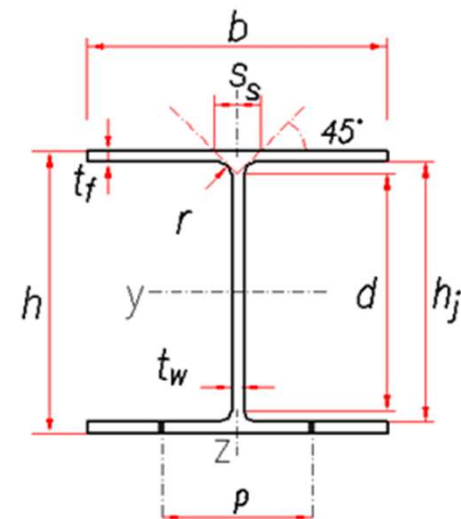
Steel

Types

Universal beams and columns
Channels



UB



UC

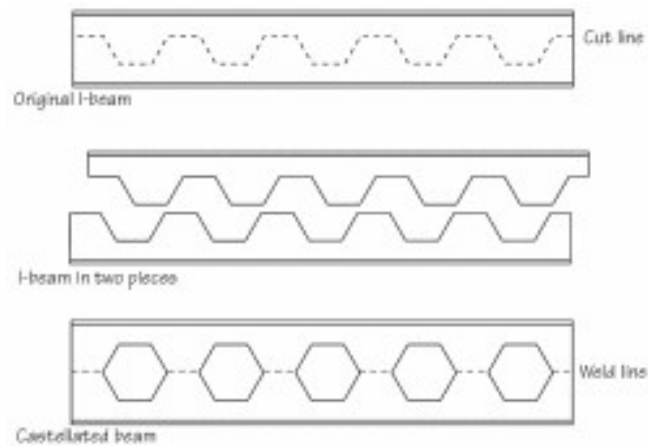
Steel

Types

Universal beams and columns
Channels



Castellated Universal Beam Sections



Steel

Types

Universal beams and columns

Channels



Hot rolled steel sections

Section	Product	Corus size range (mm)*			Typical Uses
	Universal Beams (UB)	1016 x 305 914 x 419 914 x 305 838 x 292 762 x 267 686 x 284 610 x 305 610 x 229 533 x 210	457 x 191 457 x 152 406 x 178 406 x 140 356 x 171 356 x 127 305 x 165 305 x 127 305 x 102	254 x 146 254 x 102 203 x 133 203 x 102 178 x 102 152 x 89 127 x 76	Beams
	Universal Columns (UC)	356 x 406 356 x 368	305 x 305 254 x 254	203 x 203 152 x 152	Columns
	Parallel Flange Channels (PFC)	430 x 100 380 x 100 300 x 100 300 x 90 260 x 90	260 x 75 230 x 90 230 x 75 200 x 90 200 x 75	180 x 90 180 x 75 150 x 90 150 x 75 125 x 65 100 x 50	Channels Edge beams Secondary steelwork
	Equal angles	200 x 200 150 x 150	120 x 120 100 x 100	90 x 90	Truss members Bracing ties Secondary steelwork
	Unequal angles	200 x 150 200 x 100 150 x 90	150 x 75 125 x 75 100 x 75	100 x 65	Truss members Bracing ties Secondary steelwork
	Square Hollow Sections	400 x 400 350 x 350 300 x 300 250 x 250 200 x 200 180 x 180	160 x 160 150 x 150 140 x 140 120 x 120 100 x 100 90 x 90	80 x 80 70 x 70 60 x 60 50 x 50 40 x 40	Columns Trusses Members subject to torsion
	Rectangular Hollow Sections (RHS)	500 x 300 450 x 250 400 x 200 300 x 200 300 x 100 250 x 150 250 x 100	200 x 150 200 x 120 200 x 100 160 x 80 150 x 100 120 x 80 120 x 60	100 x 60 100 x 50 90 x 50 80 x 40 60 x 40 50 x 30	Columns Beams Trusses Members subject to torsion
	Circular Hollow Sections (CHS)	508 457 406.4 355.6 323.9 273 244.5 219.1	193.7 168.3 139.7 114.3 88.9 76.1 60.3 48.3	42.4 26.9	Columns Trusses Members subject to torsion

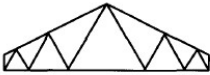
Most of these sections are available in a range of cross-sectional thicknesses (usually termed weights). Refer to Corus section tables. Structural Hollow Sections are also formed by cold rolling. These sections are not interchangeable with hot rolled Structural Hollow Sections as the section properties are different.

Light steel sections (cold formed sections)

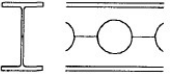
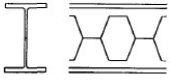
Section	Product	Common UK Size Range*	Typical Uses
	C Section	75 to 300 mm deep	Lipped Structural frames Joists Studs Columns Unlipped Connecting members in panels
	Sigma	130 to 265 mm deep	Sheeting rails Purlins Studs Joists
	Zed	140 to 300 mm deep	Purlins Sheeting Rails

* Cold-formed sections are manufactured by many different companies and size ranges vary. For actual sizes refer to manufacturers' information. Summary information on sizes of channel sections is contained in *Building Design using Cold Formed Steel Sections: An Architect's Guide*, published by The Steel Construction Institute. These sections are typically 1.2 to 3.2 mm thick and are galvanised.

Fabricated light steel lattice trusses

Section	Product	Type size range*	Typical uses
	Lattice Trusses	220 to 3000 mm deep	Floor beams Roof trusses - curved - pitched - parallel chord

Fabricated beams

Section	Product	Type size range*
	Cellular beam	457 to 915 mm deep 1.5 times the depth of the section from which the two halves of the beam are cut.
	Castellated beam	457 to 915 mm deep 1.5 times the depth of the section from which the two halves of the beam are cut.
	Plate girder	Bridge construction, often more than 1m deep (usually without openings) Tapered sections and sections with openings can be used in buildings 400 to 1000 mm deep

* Fabricated structural sections are manufactured by many different companies and size ranges vary. For actual sizes refer to manufacturers' information.

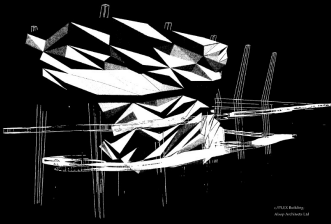
CIS

Guest
Swansea Metropolitan University
Sign in to My CIS

Home
Browse
Interests
Projects
Manage content alerts
Saved searches
Help
Contact us

All
Search for documents

Architectural Teaching Resource
STUDIO GUIDE
Second Edition






Available from the library services via 'IHS Markit' database



Portal frames



Trusses



Steel Frame Construction

Most steel construction is done with a type of steel called *mild steel*. Mild steel is a material that is immensely strong.

Take a circular bar of steel 1 inch / 25mm in diameter. If you were to attach this bar securely to your ceiling, you could hang from it 20,000 Kg (which is 20 tons), or any one of the following:

18 Honda City Cars

2 and a half African Elephants

1 and a half London City Routemaster Double-Decker Buses

Steel Frame Construction



Steel Frame Construction

This immense strength is of great advantage to buildings.

The other important feature of steel framing is its flexibility.

It can bend without cracking, which is another great advantage, as a steel building can flex when it is pushed to one side by say, wind, or an earthquake.

The third characteristic of steel is its plasticity or ductility. This means that when subjected to great force, it will not suddenly crack like glass, but slowly bend out of shape. This property allows steel buildings to bend out of shape, or *deform*, thus giving warning to inhabitants to escape.

Failure in steel frames is not sudden - a steel structure rarely collapses. Steel in most cases performs far better in earthquake than most other materials because of these properties.

Steel Frame Construction



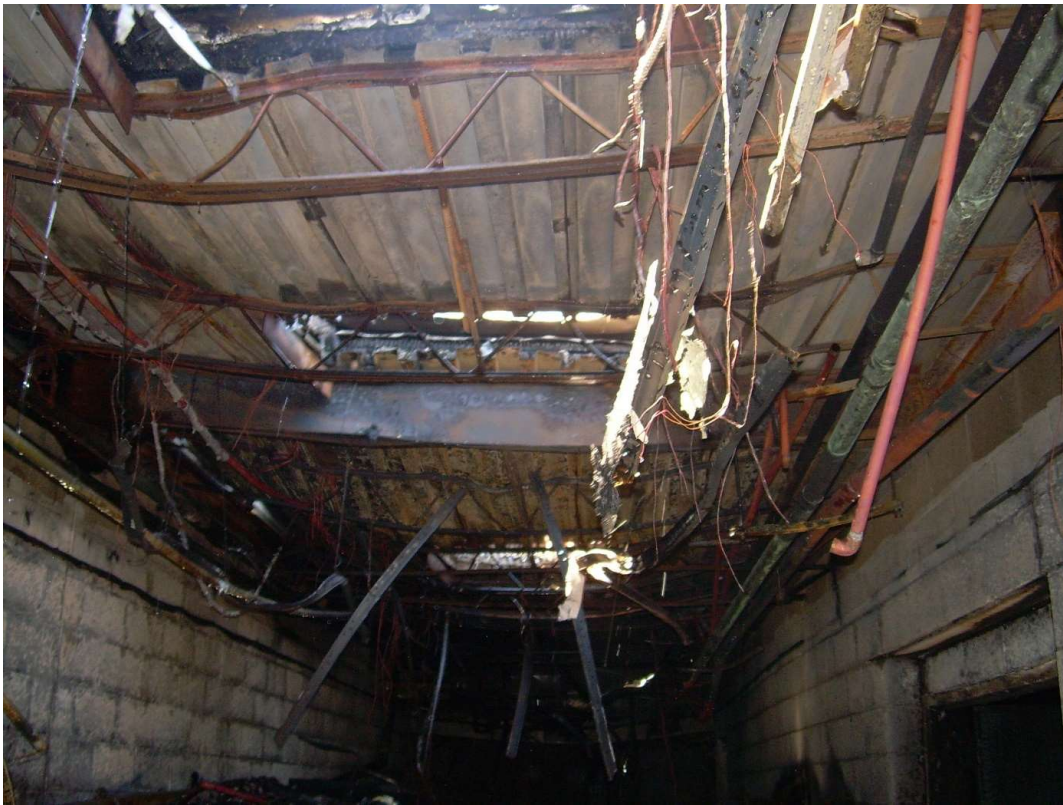
Steel Frame Construction

However one important property of steel is that it quickly loses its strength in a fire.

At 500 degrees celsius (930 degrees F), mild steel can lose almost half its strength. This is what happened at the collapse of the World Trade Towers in 2001.

Therefore, steel in buildings must be protected from fire or high temperature; this is usually done by wrapping it with boards or spray-on material called *fire protection*.

Steel Frame Construction



Steel Frame Construction

Steel construction is most often used in:

High rise buildings because of its strength, low weight, and speed of construction

Industrial buildings because of its ability to create large span spaces at low cost

Warehouse buildings for the same reason

Residential buildings in a technique called *light gauge steel construction*

Temporary Structures as these are quick to set up and remove

Steel Frame Construction – High Rise



Steel Frame Construction – Industrial Buildings



Steel Frame Construction – Warehouse Frames



Steel Frame Construction



Steel Frame Construction – Temp Structures



Steel Frame Construction

Conventional Steel Fabrication

is when teams of steel fabricators cut members of steel to the correct lengths, and then weld them together to make the final structure. This can be done entirely at the construction site, which is labour-intensive, or partially in a workshop, to provide better working conditions and reduce time.



Steel Frame Construction

Bolted Steel Construction occurs when steel fabricators produce finished and painted steel components, which are then shipped to the site and simply bolted in place.

This is the preferred method of steel construction, as the bulk of the fabrication can be done in workshops, with the right machinery, lighting, and work conditions.

The size of the components are governed by the size of the truck or trailer they are shipped in, usually with a max length of 6m (20ft) for normal trucks or 12m (40ft) for long trailers.

Since the only work to be done at site is lifting the steel members into place (with cranes) and bolting, the work at site is tremendously fast.

Pre-engineered buildings are an example of bolted steel construction that is designed, fabricated, shipped and erected by one company to the owner.



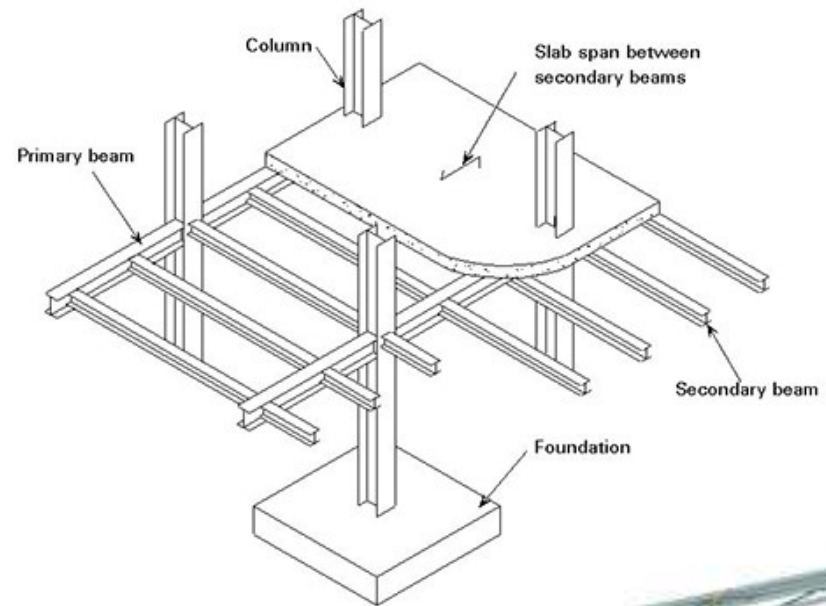
Steel Frame Construction

Light Gauge Steel Construction is a type of construction that is common for residential and small buildings. This is similar to timber framed construction, except that light gauge steel members are used in place of wood two-by-fours.

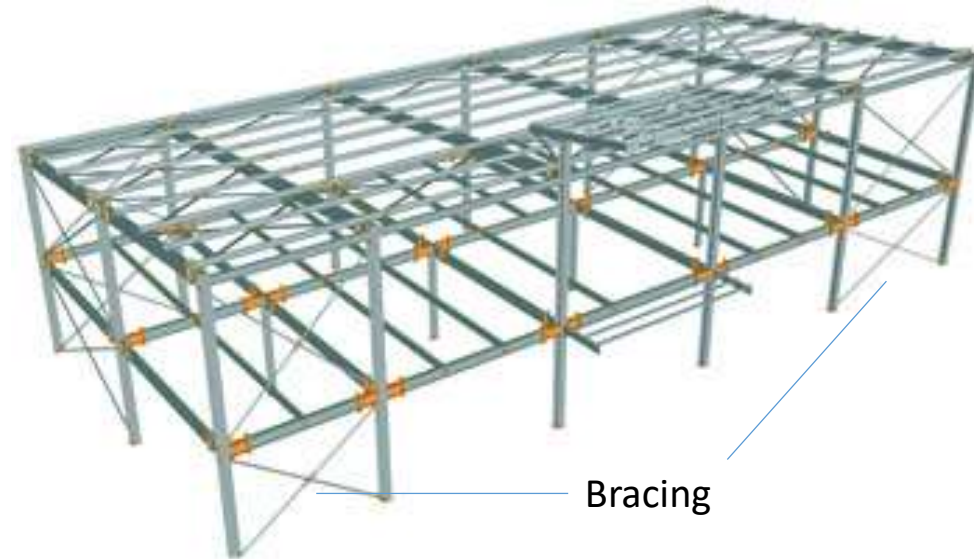
Light gauge steel is steel that is in the form of thin (1-3mm) sheets of steel that have been bent into shape to form C-sections or Z-sections.

Steel Frame Construction



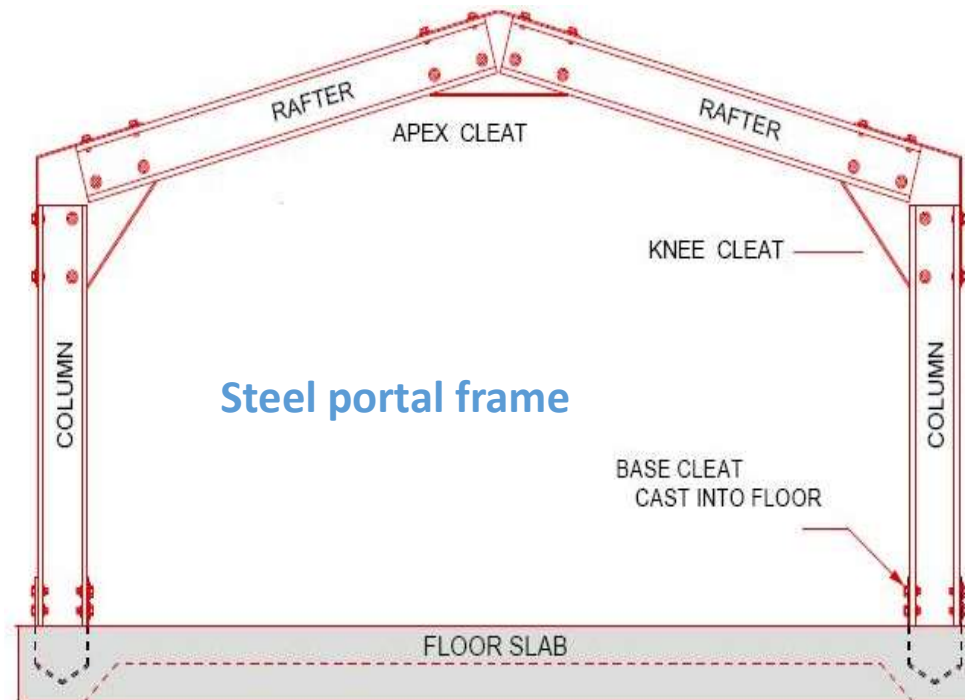


Steel structure performance

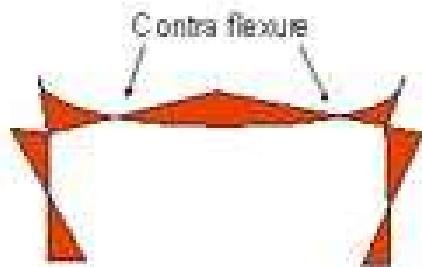
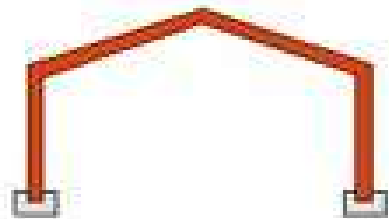


PORTAL FRAMES

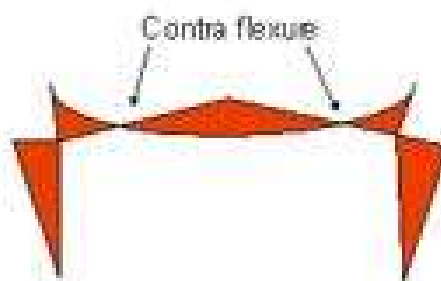
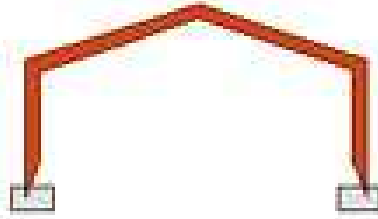
Continuous, rigid frame where all joints are rigid
Connections between columns and rafters are moment-resistant
They transfer bending moments to each other



RIGID BASE



2 PIN



3 PIN



Steel Frame Construction

Steel structures have the following advantages:

They are **super-quick** to build at site, as a lot of work can be pre-fabbed at the factory.

They are **flexible**, which makes them very good at resisting dynamic (changing) forces such as wind or earthquake forces.

A wide range of **ready-made structural sections** are available, such as I, C, and angle sections.

They can be made to take any kind of **shape**, and clad with any type of **material**.

A wide range of **joining methods** is available, such as bolting, welding, and riveting.

Steel Frame Construction

Steel structures have the following disadvantages:

They lose strength at high temperatures, and are susceptible to **fire**.

They are prone to **corrosion** in humid or marine environments.

Steel Frame Construction



Steel Frame Construction



Concrete

Characteristics

- High compression strength
- Cast in site
- Easy to shape
- Monolythical behaviour once hardened
- Heavy
- Very low tension resistance



Use

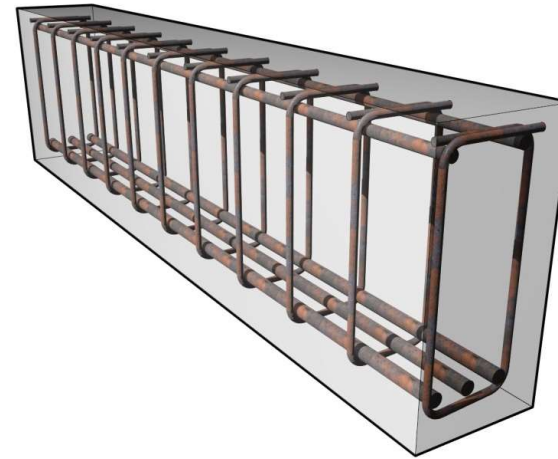
Reinforced
concrete

- Common use in structures
- Reinforced concrete
- Precast concrete

Reinforced concrete

Combination of:

- Compressive strength of concrete
- Tension strength of steel



Reinforced concrete

Analysis of loads

Compressed and tensioned fibres



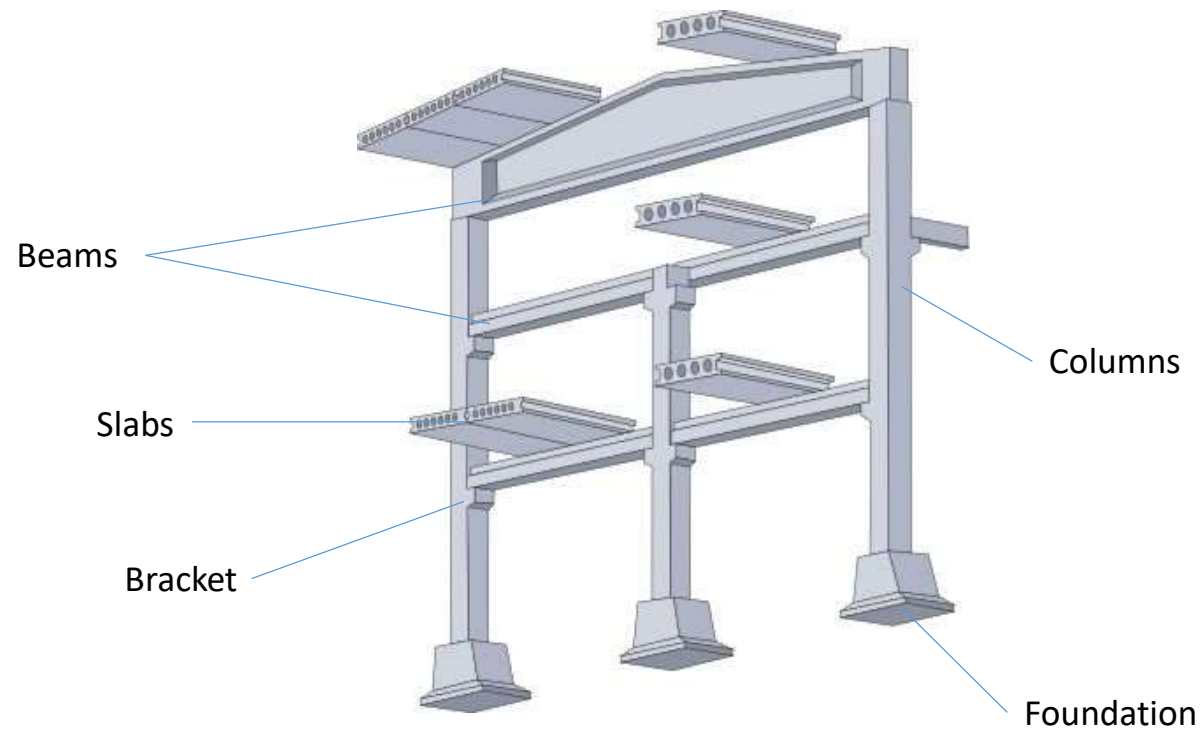
Where should the reinforcement be put? Up or down?







Precast concrete

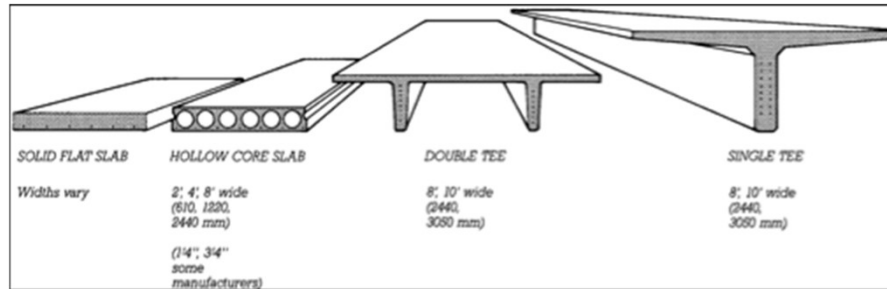




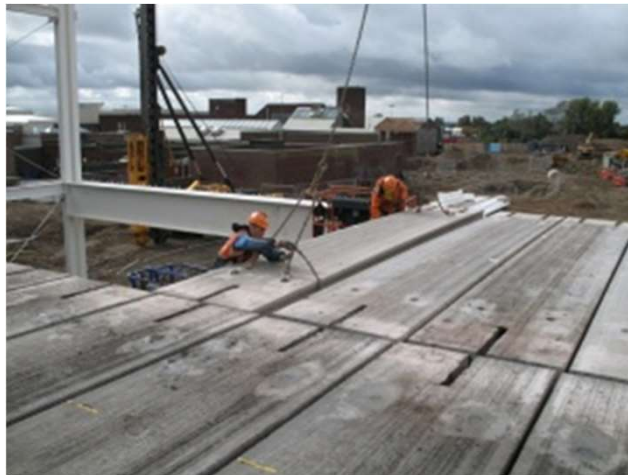
Columns and beams



Slabs

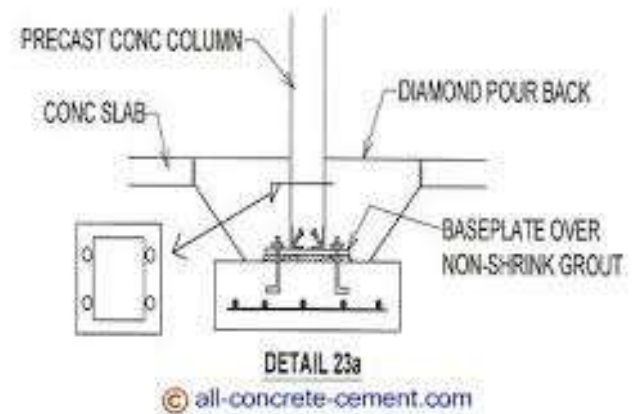


Joints: adhesives or concrete





Foundations



CONCRETE FRAME STRUCTURES

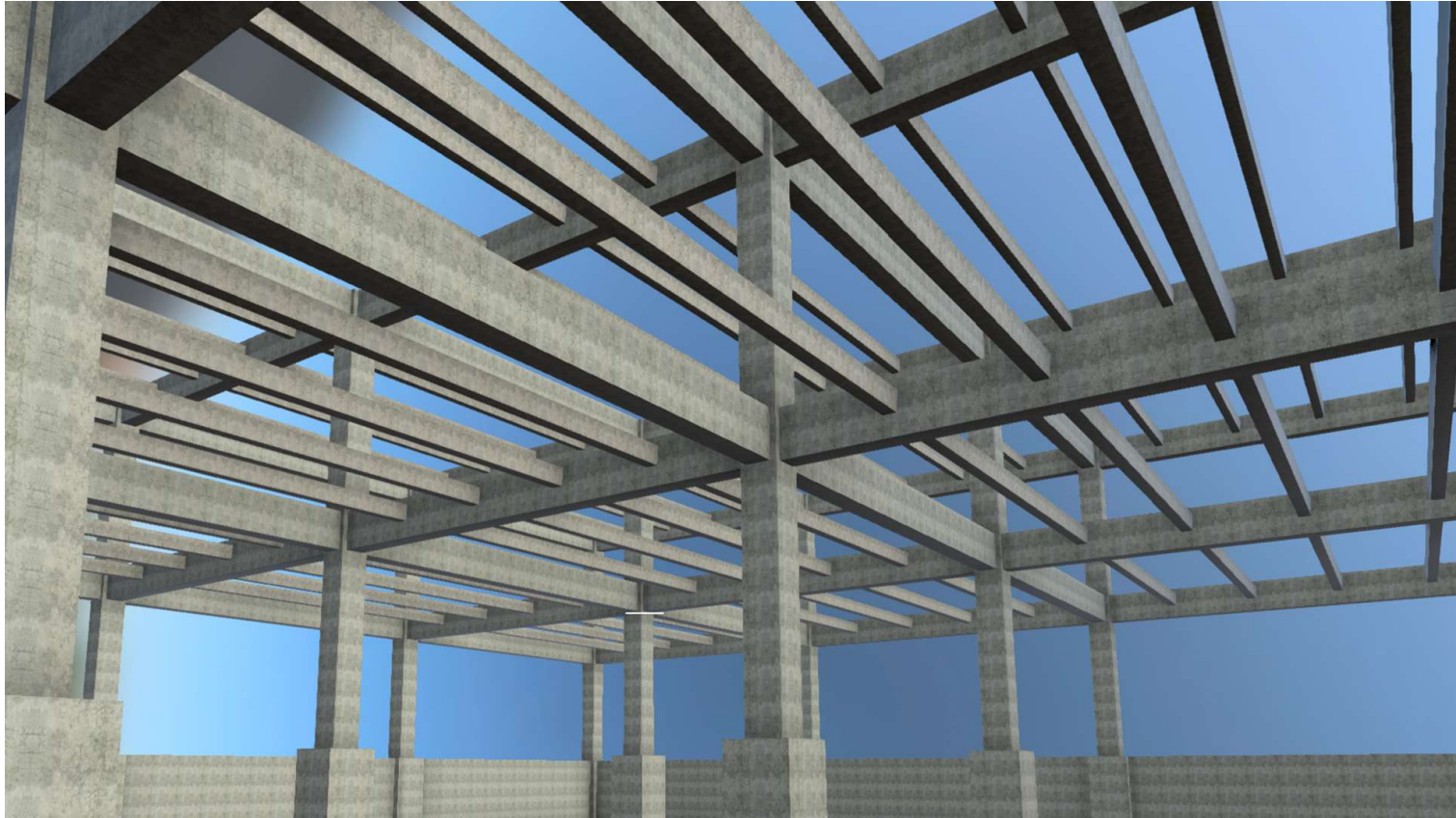
Concrete frame structures are a very common - or perhaps the most common- type of modern building internationally.

As the name suggests, this type of building consists of a frame or skeleton of concrete. Horizontal members of this frame are called *beams*, and vertical members are called *columns*.

CONCRETE FRAME STRUCTURES



CONCRETE FRAME STRUCTURES



CONCRETE FRAME STRUCTURES



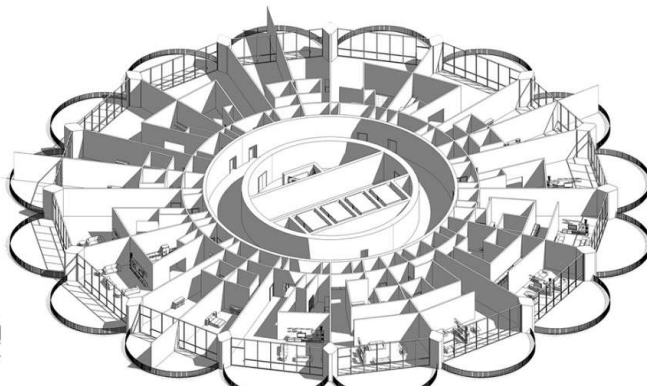
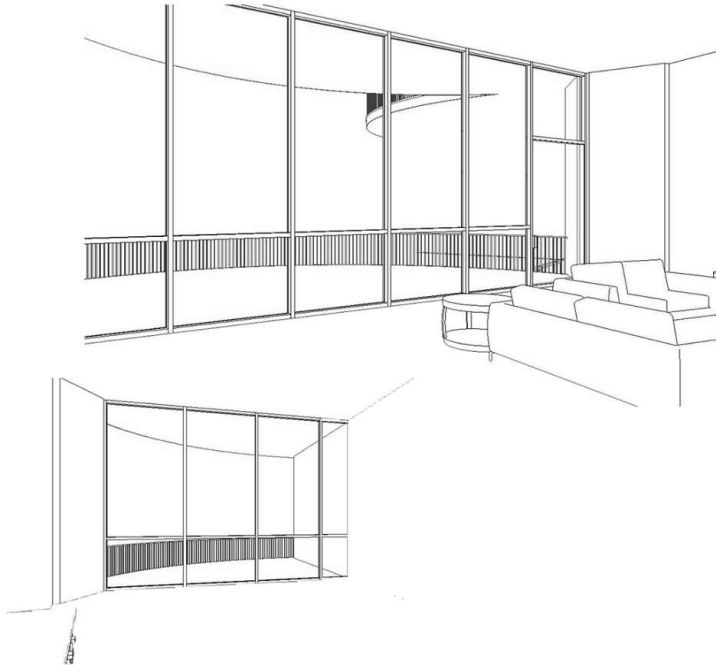
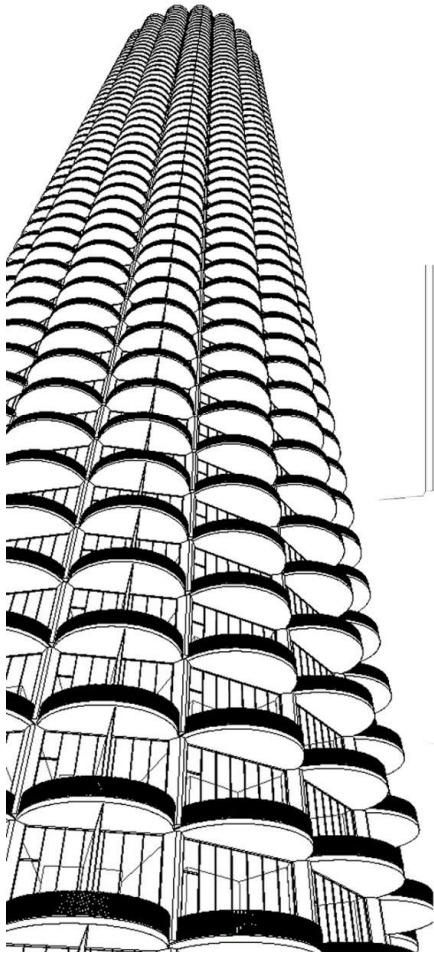
CONCRETE FRAME STRUCTURES



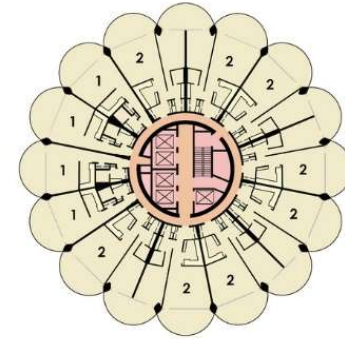
CONCRETE FRAME STRUCTURES



CONCRETE FRAME STRUCTURES

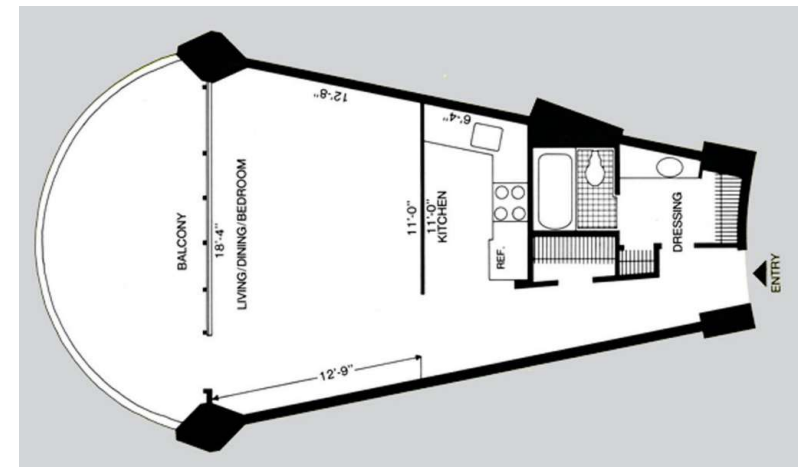


4 Floorplan
Marina City Tower
 Chicago, USA, 1964
 200 North State Street
 G. Goldberg + Associates

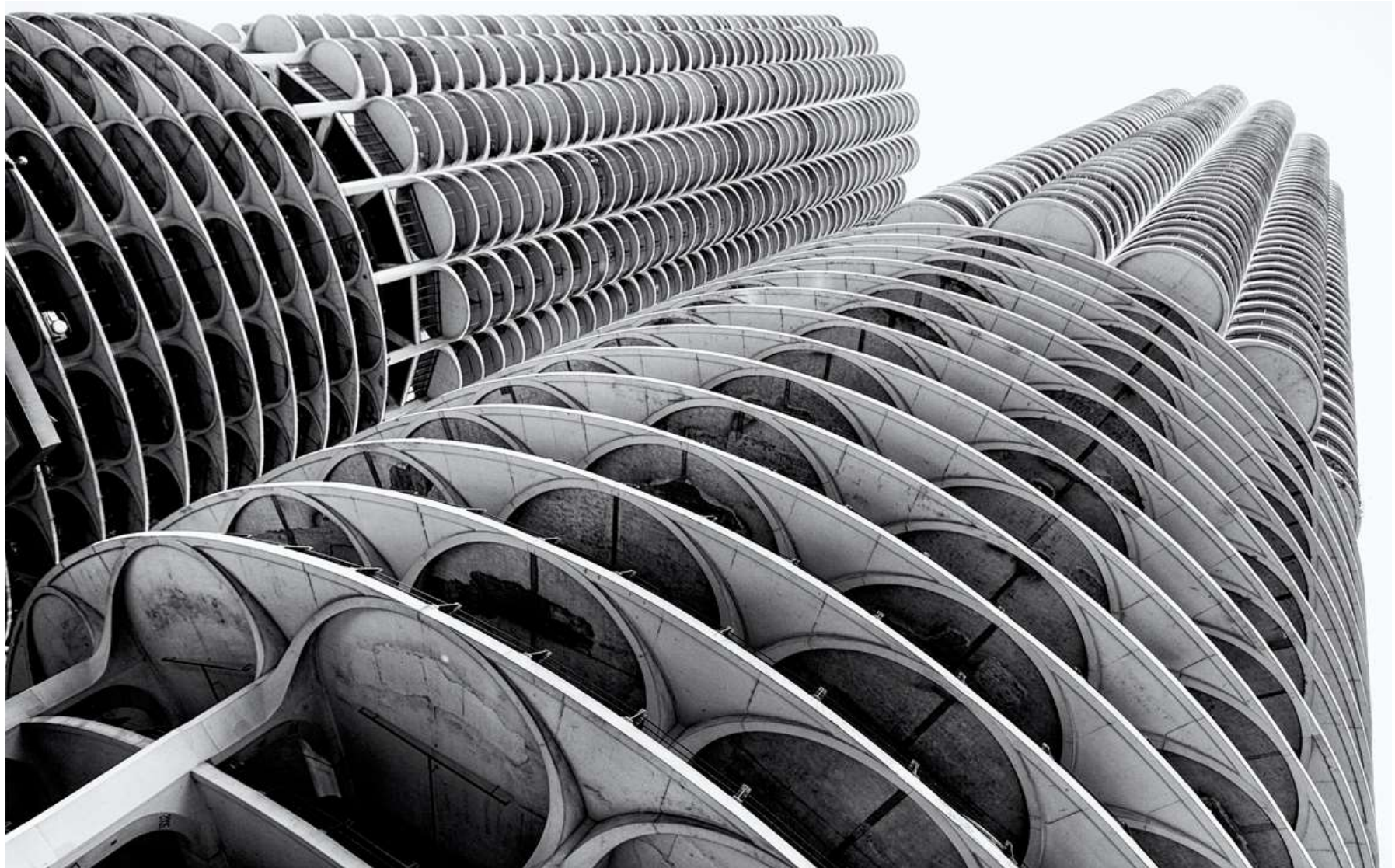


3 Number of Bedrooms — 10pt
 Apartment Entrance
 Apartments
 Horizontal Circulation
 Vertical Circulation
 Communal Areas

0 20 40 80 Feet



CONCRETE FRAME STRUCTURES



CONCRETE FRAME STRUCTURES



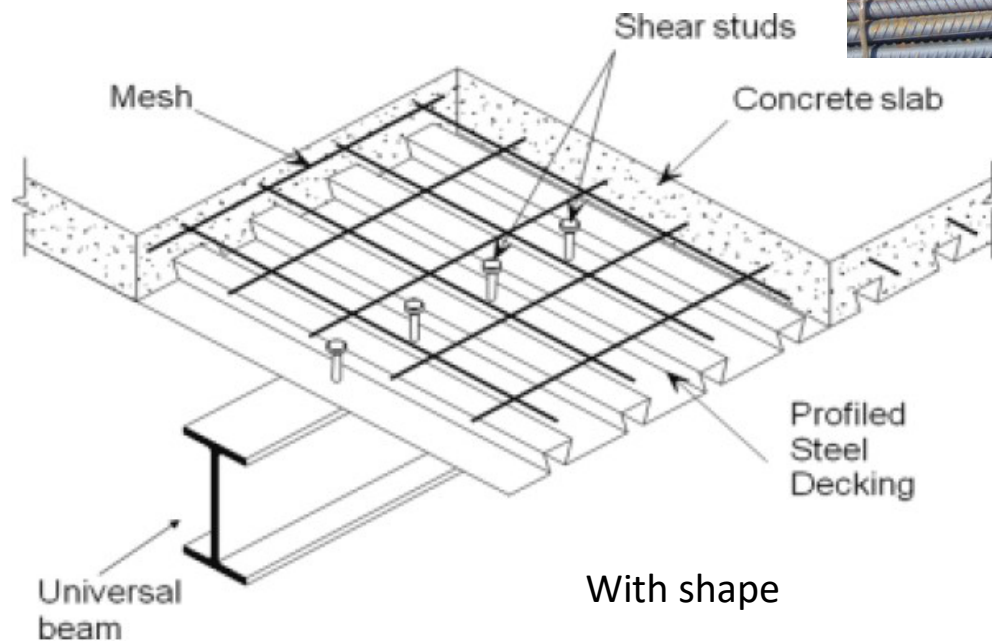
CONCRETE FRAME STRUCTURES



Mixed structures / hybrid

Steel – concrete

Adherence



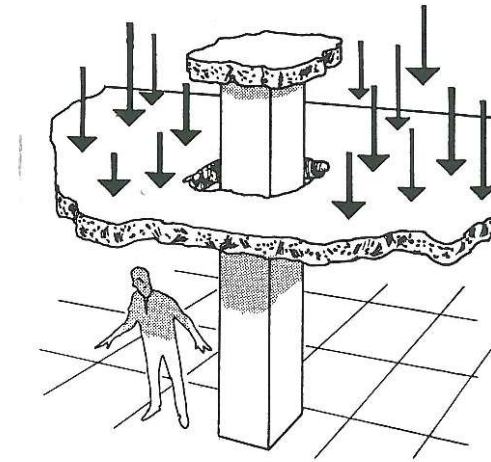
Corrugated

With shape

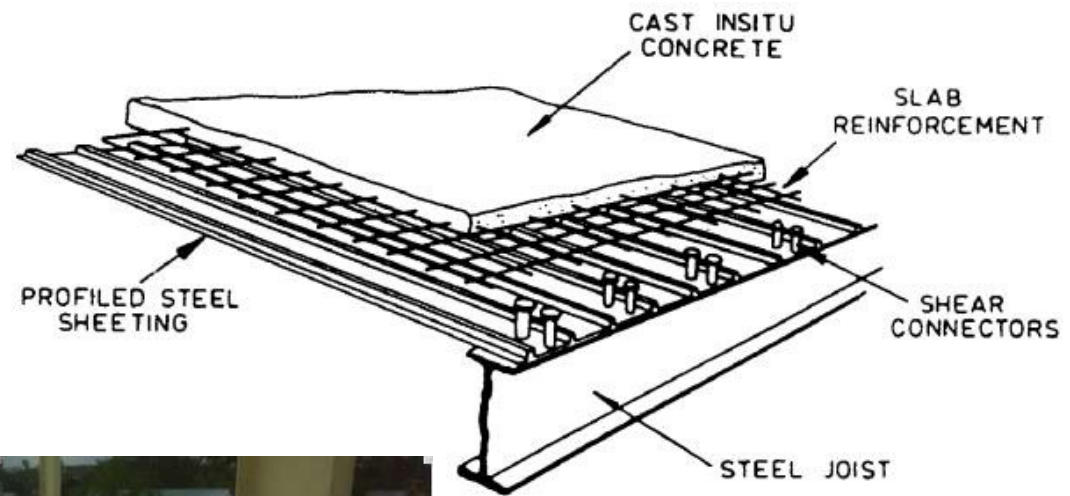
Mixed structures / hybrid

Steel – concrete

Careful with shear stress



Steel – concrete



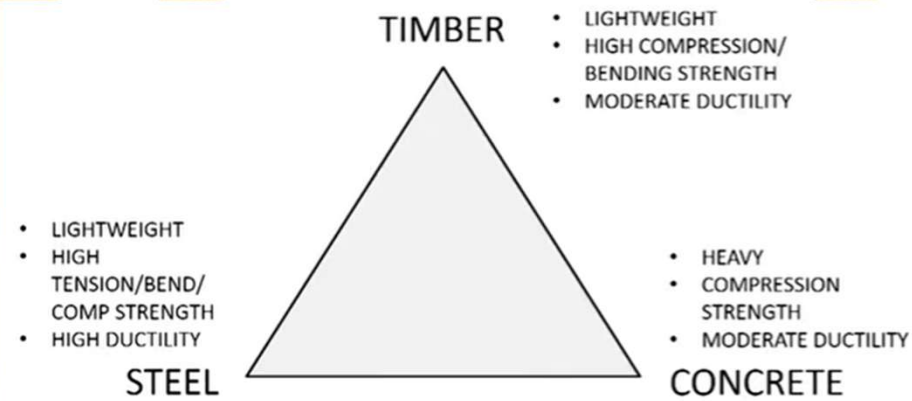
Mixed structures / Hybrid structures

Steel – Concrete - Timber



[Timber Tower Research Project – SOM](#)

<https://youtu.be/Q0njl-6VBBk?si=ShU8OqHJm8xpUcr>



Timber Tower Research Project

Questions

Which material / structures do you think is better for the following situations and why?

High-rise buildings

Fire resistance

Earthquake resistance

Covering an Exhibition Centre

Further Reading:

Building Construction Illustrated

Wiley

Francis D.K. Ching

AJ Handbook of Building Structure

Architectural Press

Allan Hodgkinson

The Construction of Buildings 3 & 4

Blackwell Scientific Publications

R Barry

Summary :

Structures

Structural Frames

