

ARCHITECTURE
INTRODUCTION TO STRUCTURES
M4X01974 TECH AND ENV 1



PURPOSE

Transmit loads to the foundations

What loads?

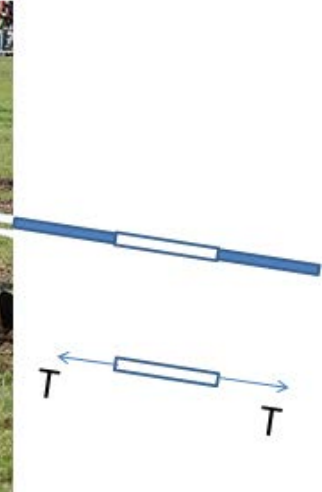
What elements can we use?

What materials?



TYPES OF LOADS

TENSION



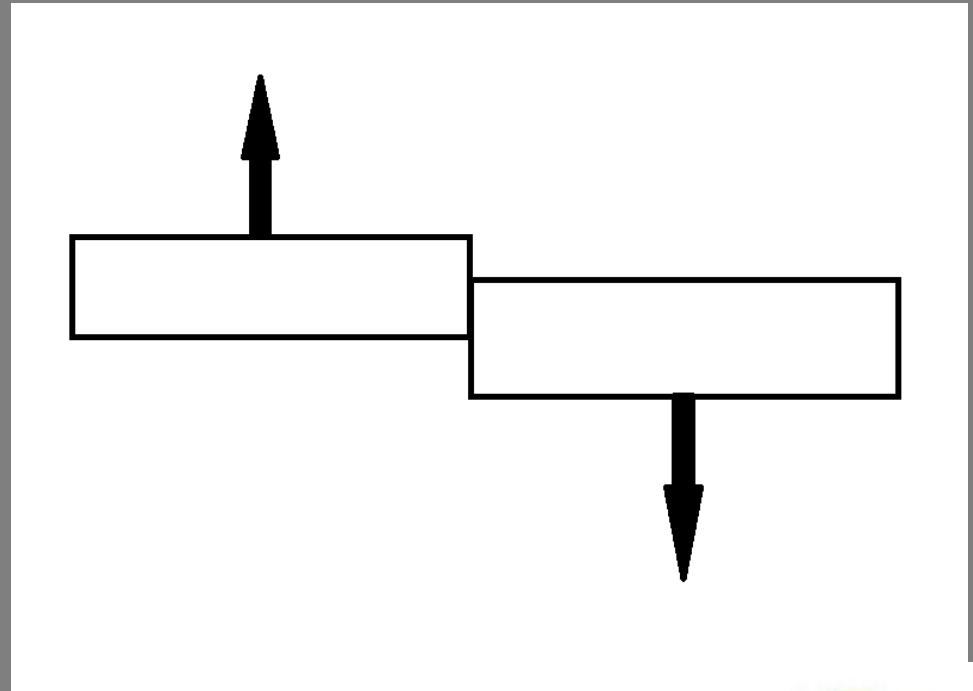
COMPRESSION



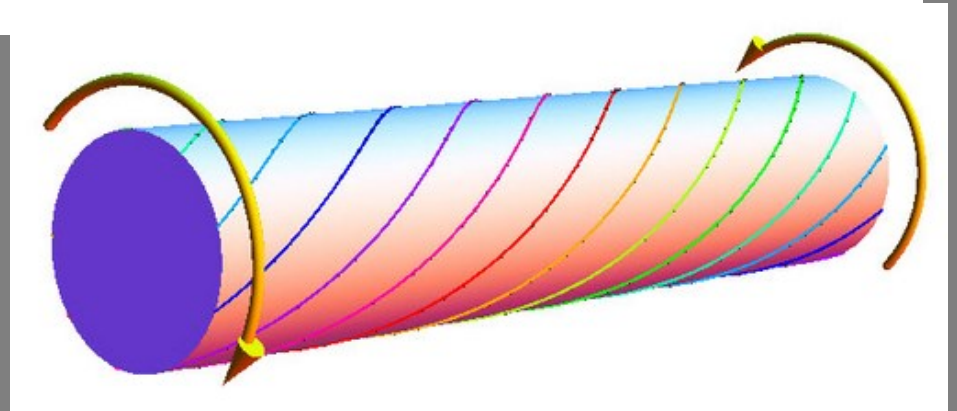


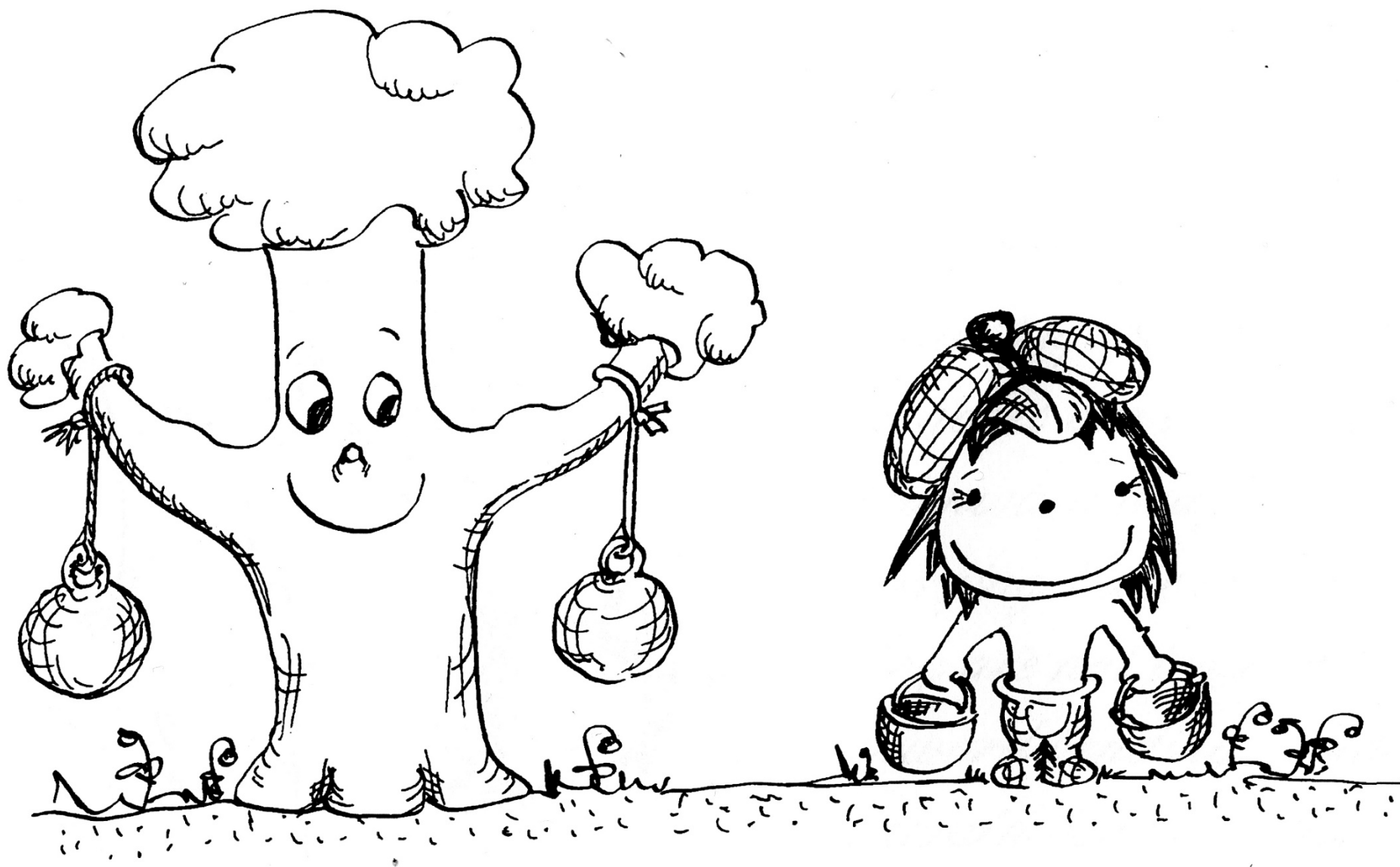
TYPES OF LOADS

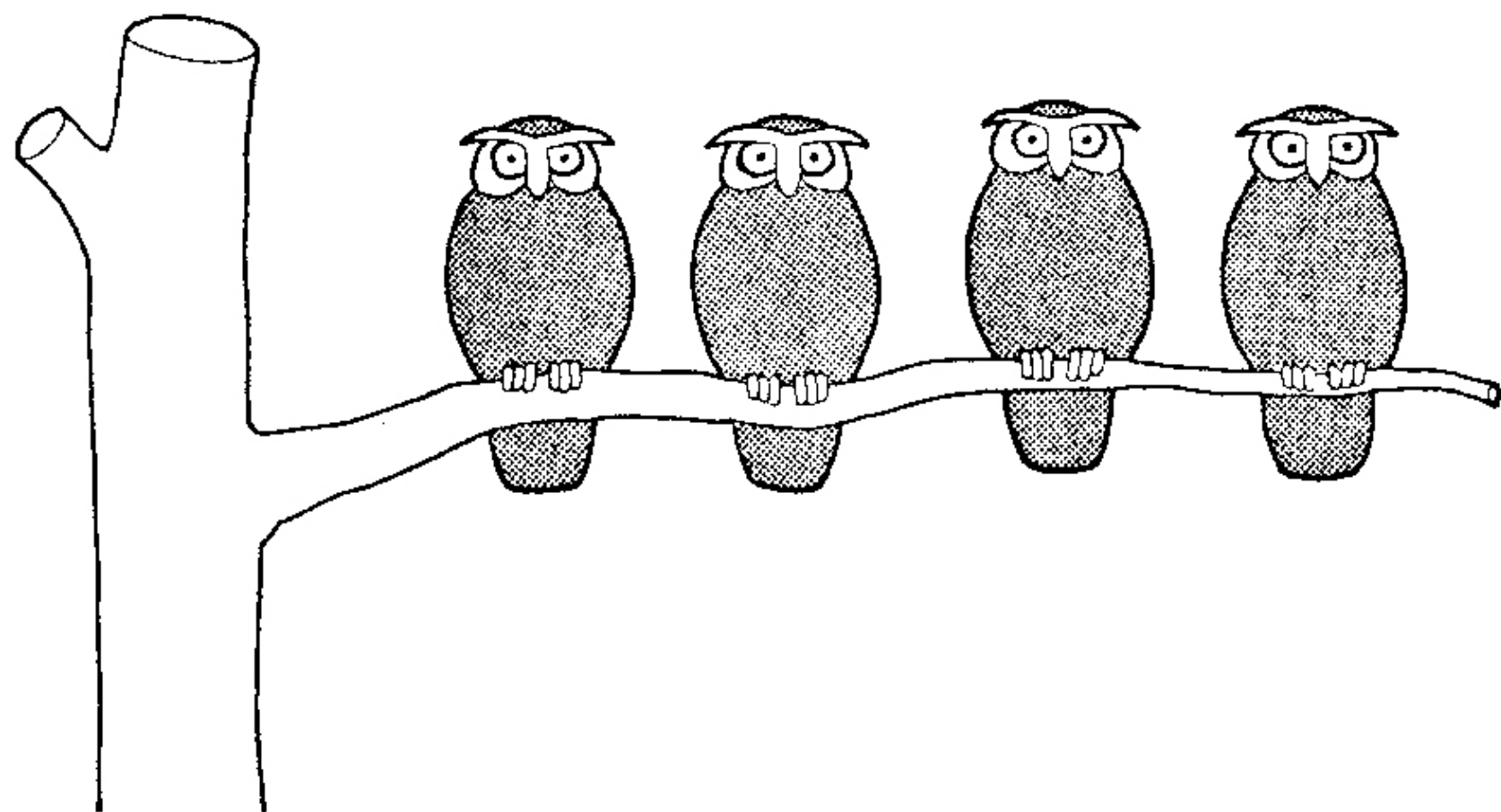
SHEAR FORCE



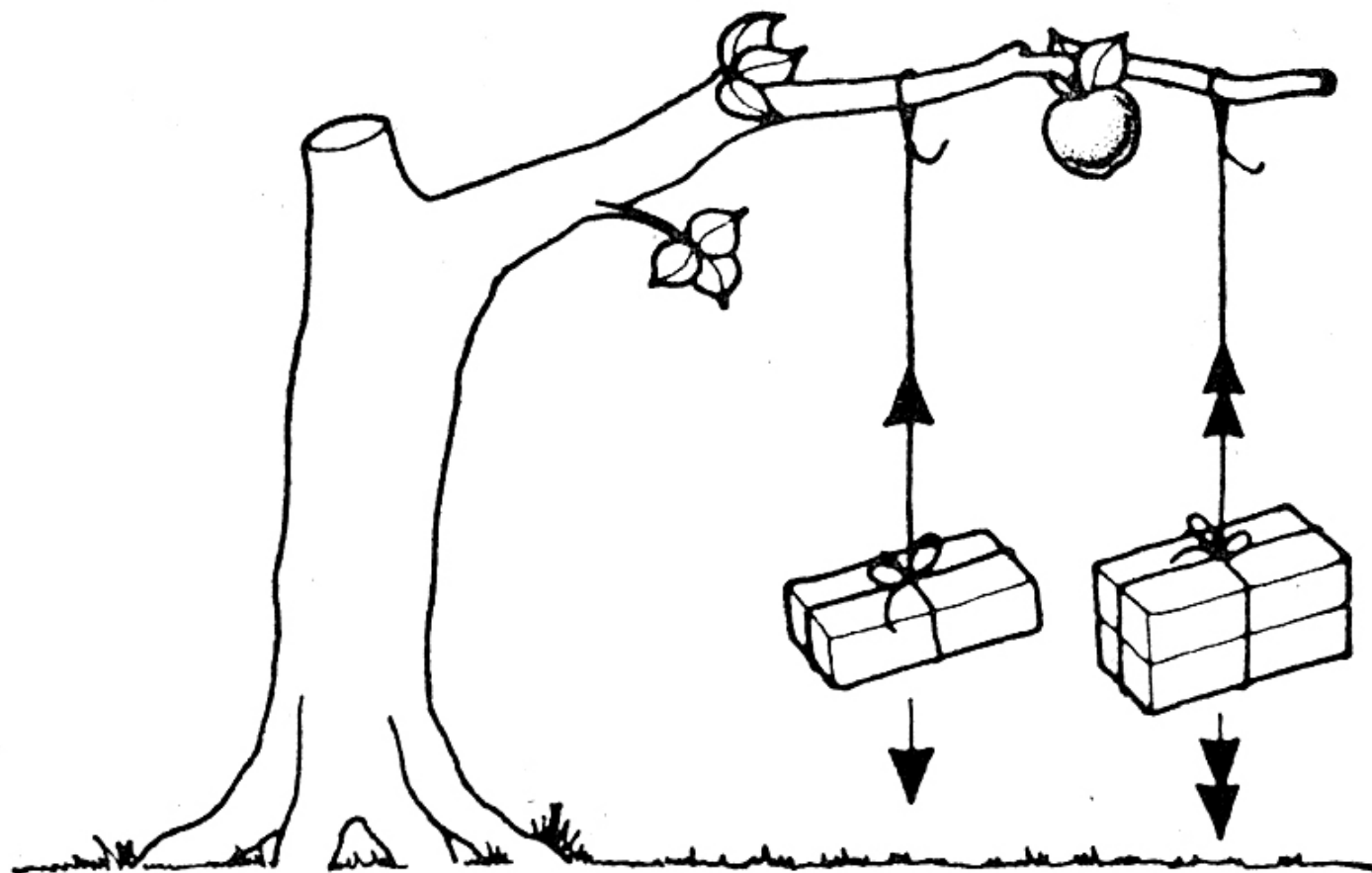
TORSION







A cantilever beam with distributed load.

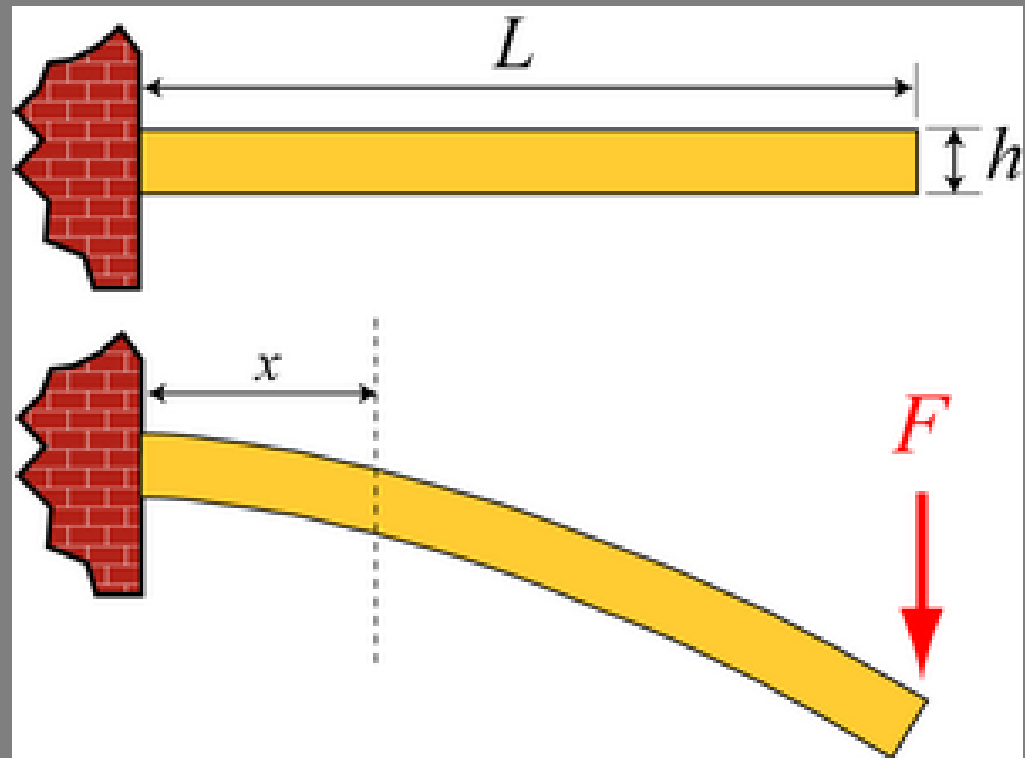


The weight of the brick, acting downwards, must be supported by an equal and opposite upward pull or tension in the string.

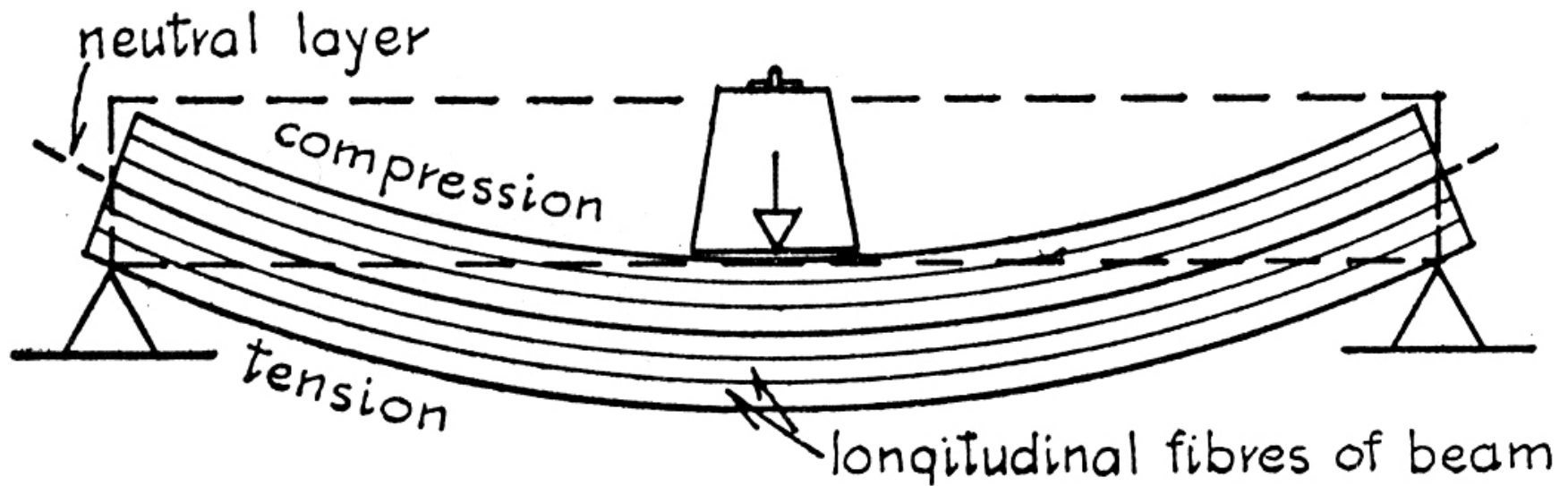


TYPES OF LOADS

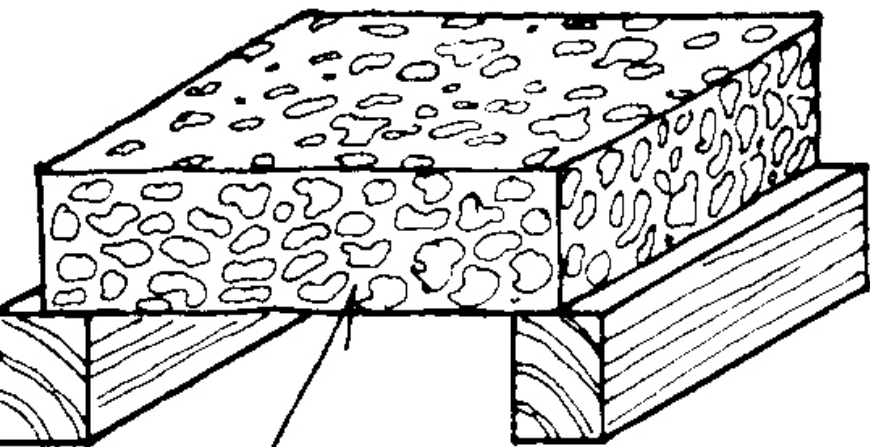
BENDING MOMENT



SIMPLY SUPPORTED BEAM

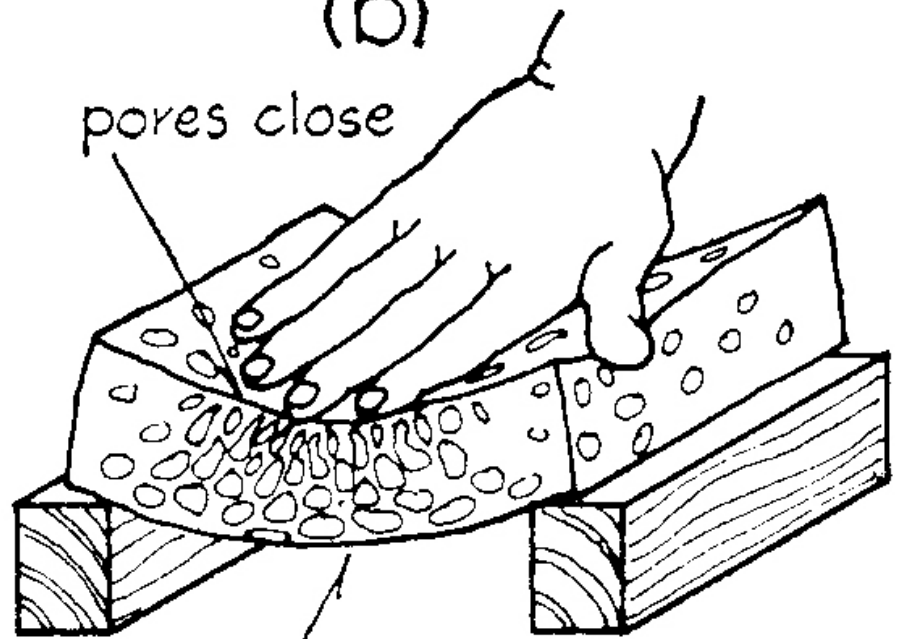


(a)



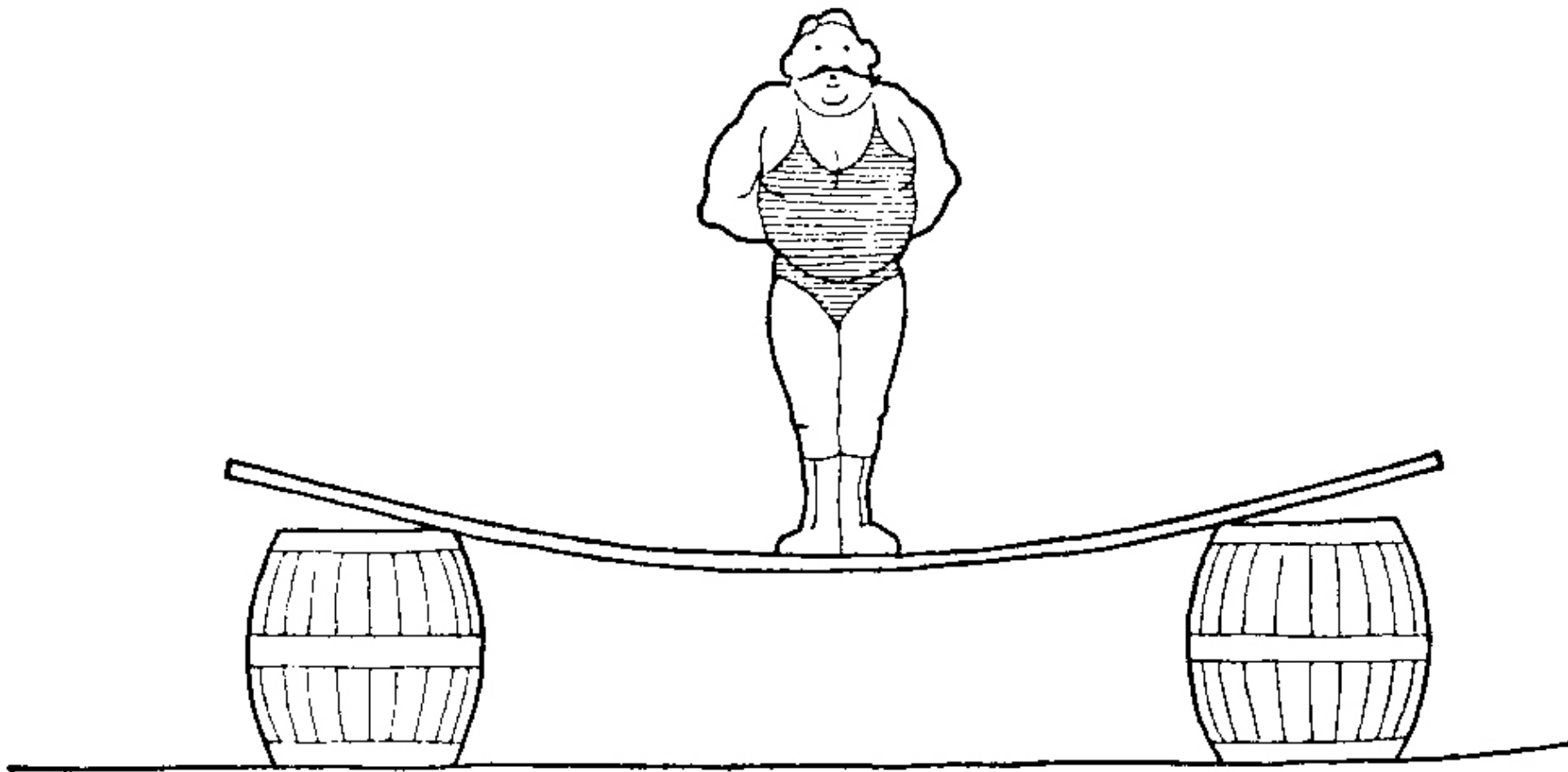
pores of sponge

(b)



pores close

pores open wider

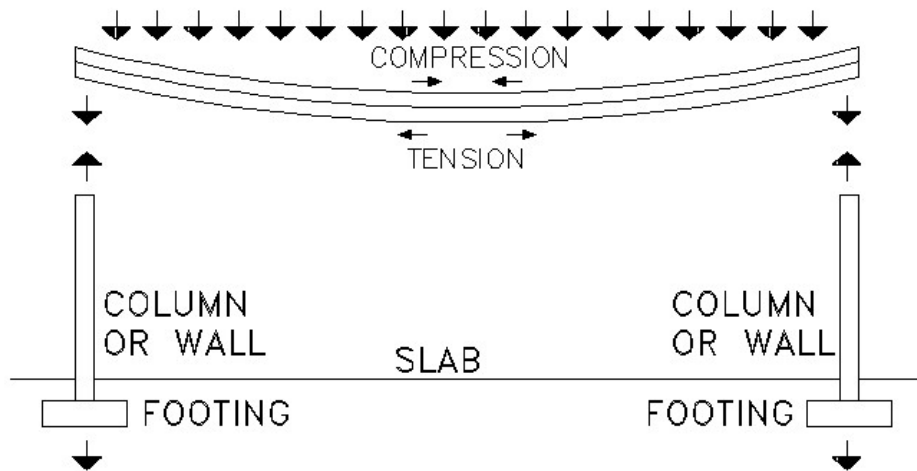


Simply supported beam.



Structural elements

Beam and columns



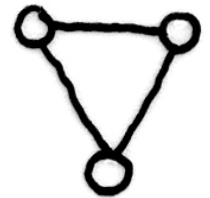
BEAMS

- BEAMS USED IN BUILDINGS MAY VARY IN CROSS SECTIONAL AREA. SOME MAY BE SOLID OR HOLLOW
- BEAM SHAPES
 - BOX
 - I SECTION
 - L SECTION
 - TUBE
 - TRIANGULAR
 - RECTANGULAR
- SOLID BEAMS ARE HEAVIER THAN HOLLOW BEAMS
- THEY HAVE A SPECIAL CROSS SECTION FOR STRENGTH AND RIGIDITY
- THEY MAY BE AS STRONG AS SOLID BEAM BUT MUCH LIGHTER
- THEY CAN BE DESCRIBED AS HAVING A GOOD STRENGTH TO WEIGHT RATIO

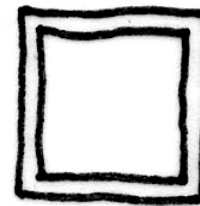
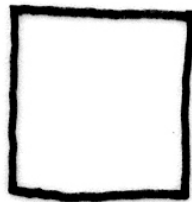
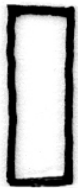
Efficiency

← LEAST

→ GREATEST



BEAMS

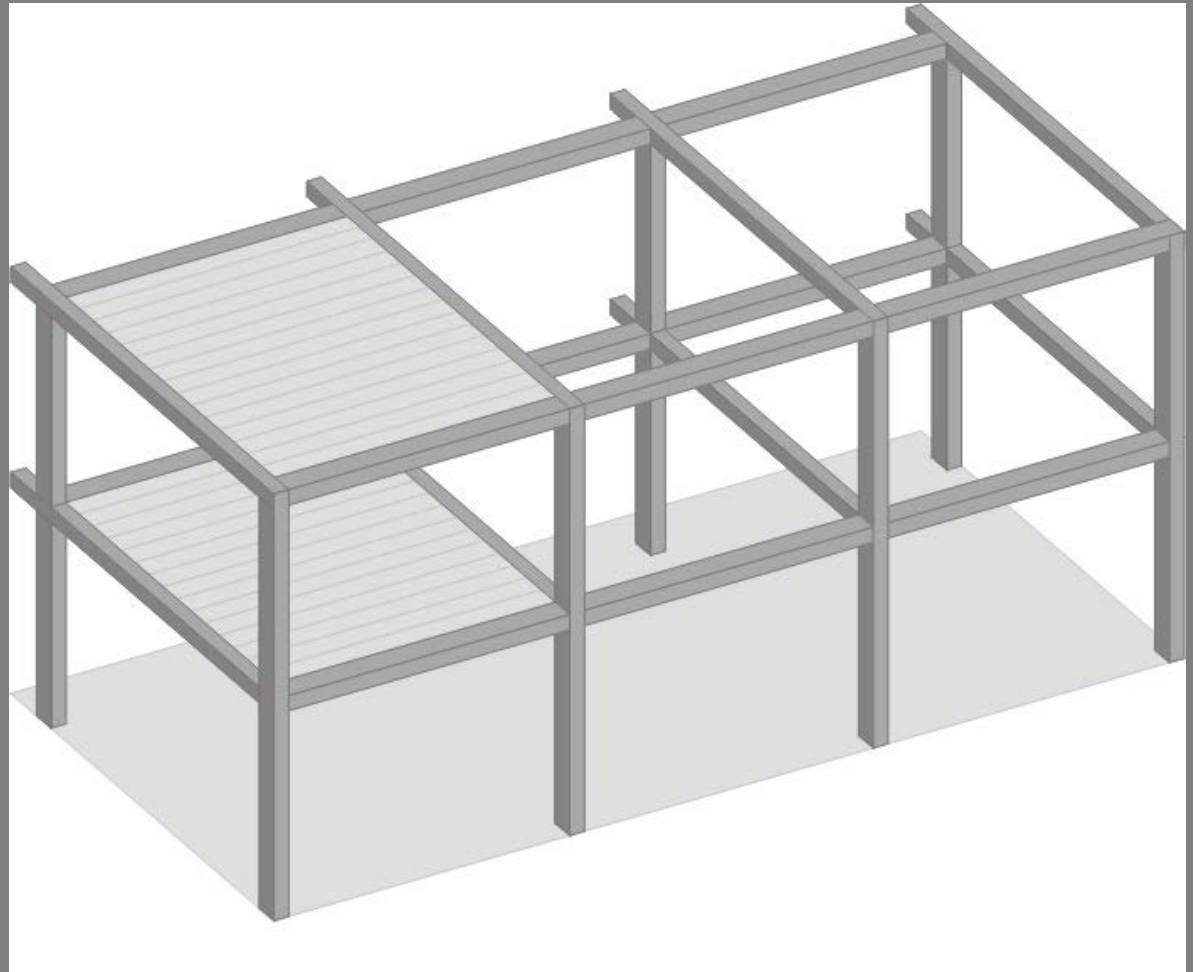


COLUMNS



Structural Typologies

- Skeletal
- Solid
- Surface





Structural Typologies

- Skeletal
- Solid
- Surface





Structural Typologies

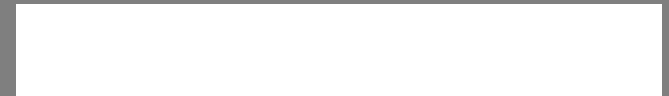
- Skeletal
- Solid
- Surface





Structural Typologies

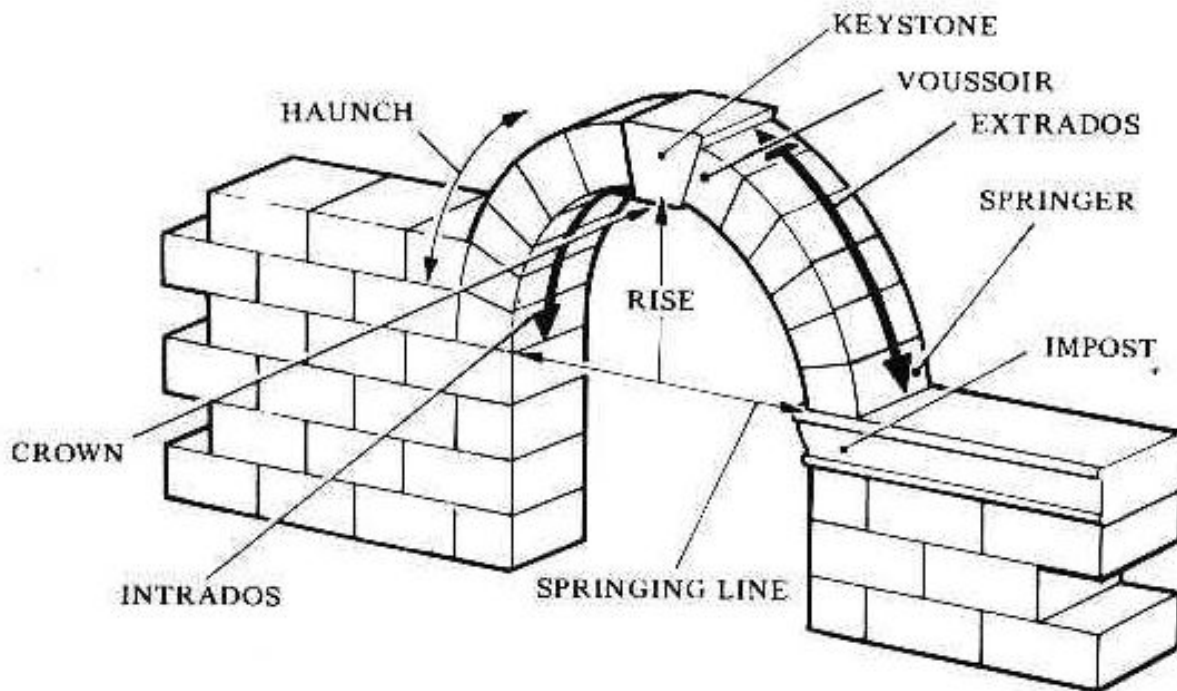
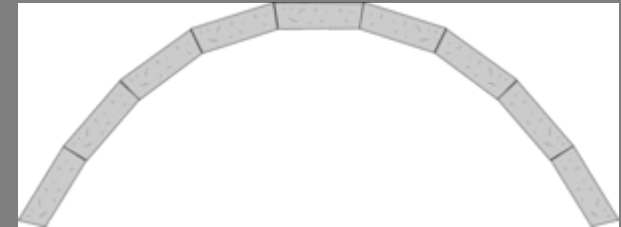
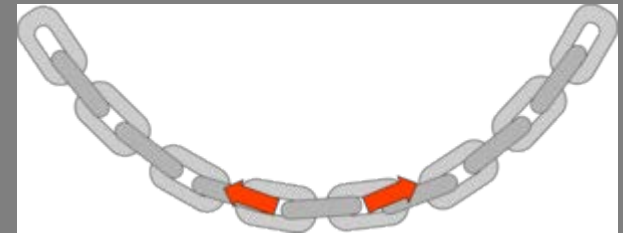
- Skeletal **How are loads transmitted in each case?**
- Solid **What elements are used?**
- Surface **Does the shape affect the bearing capacity?**

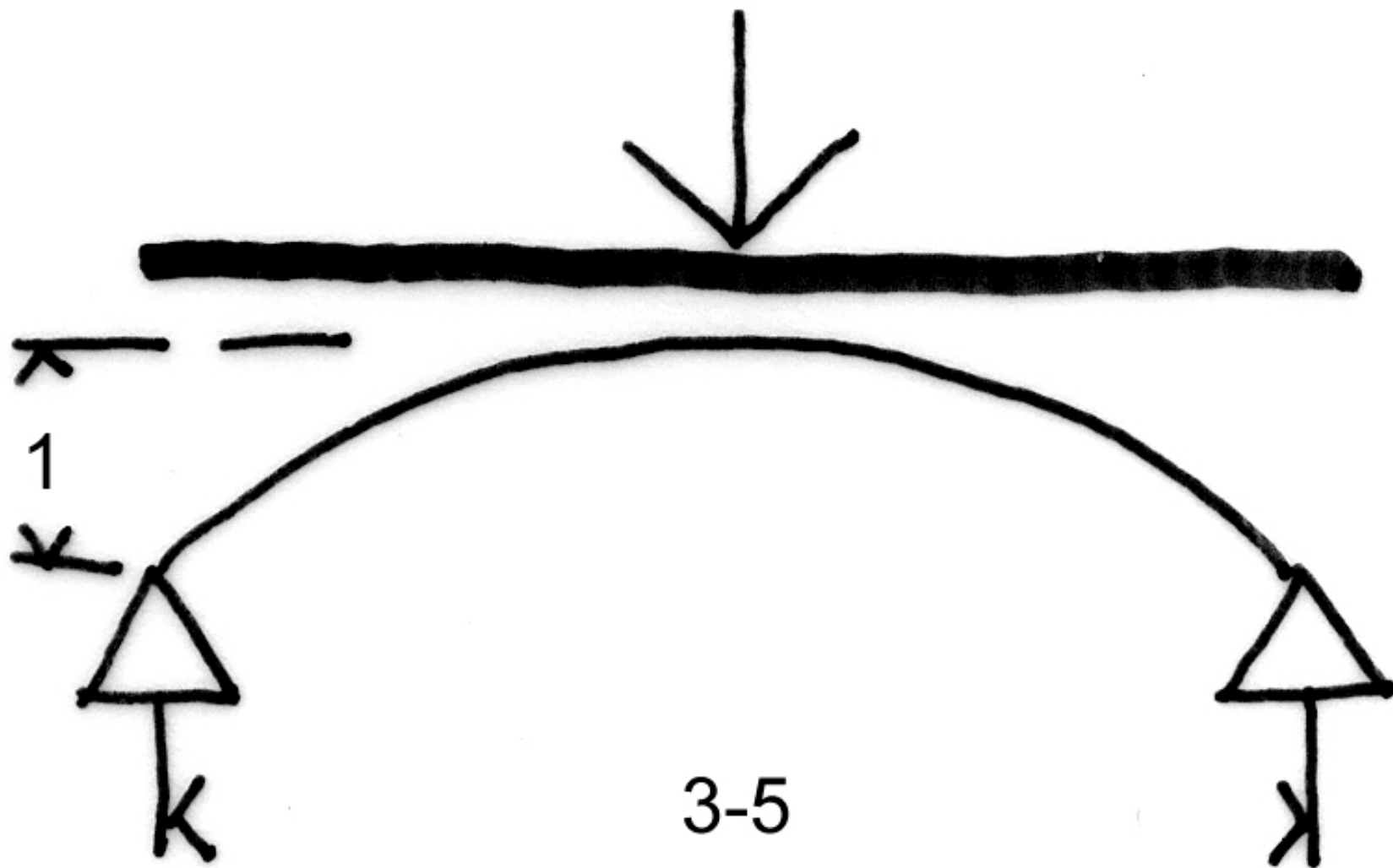




Structural elements

Arch shape

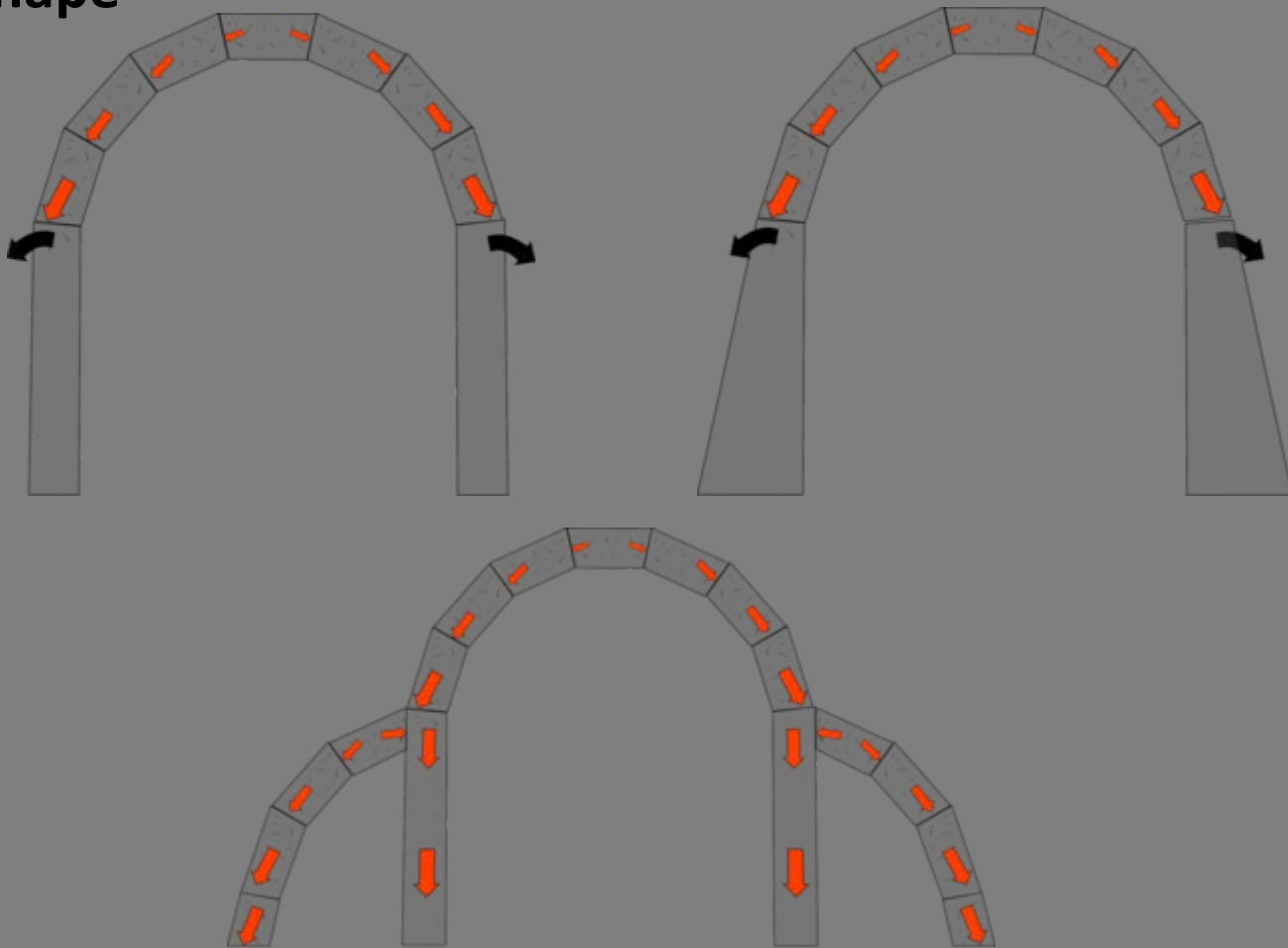






Structural elements

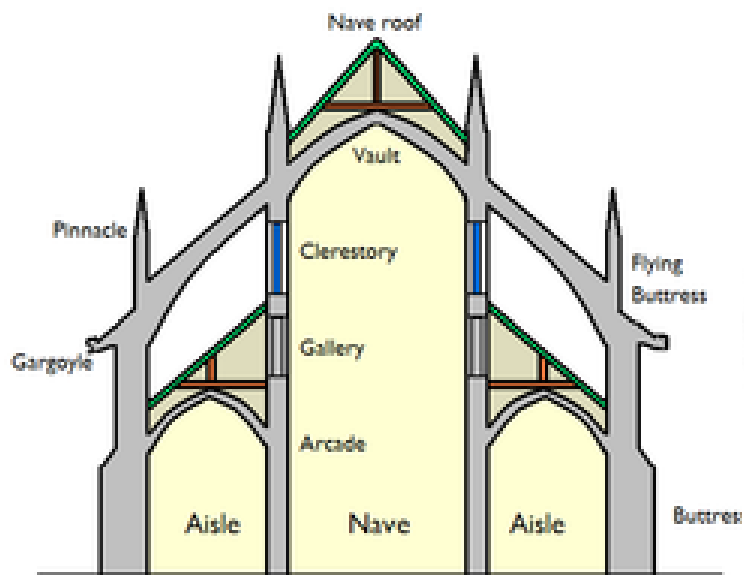
Arch shape





Structural elements

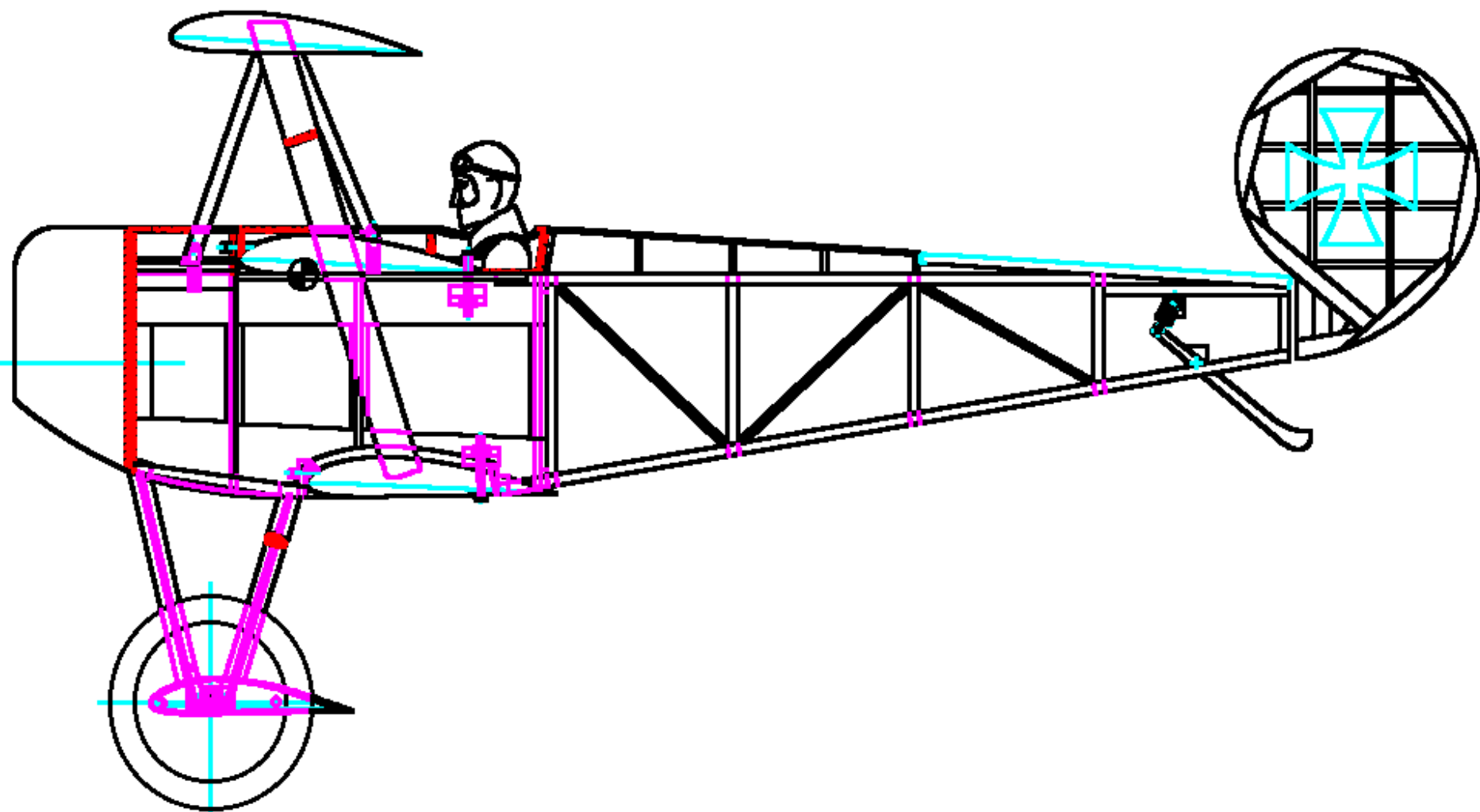
Gothic Architecture

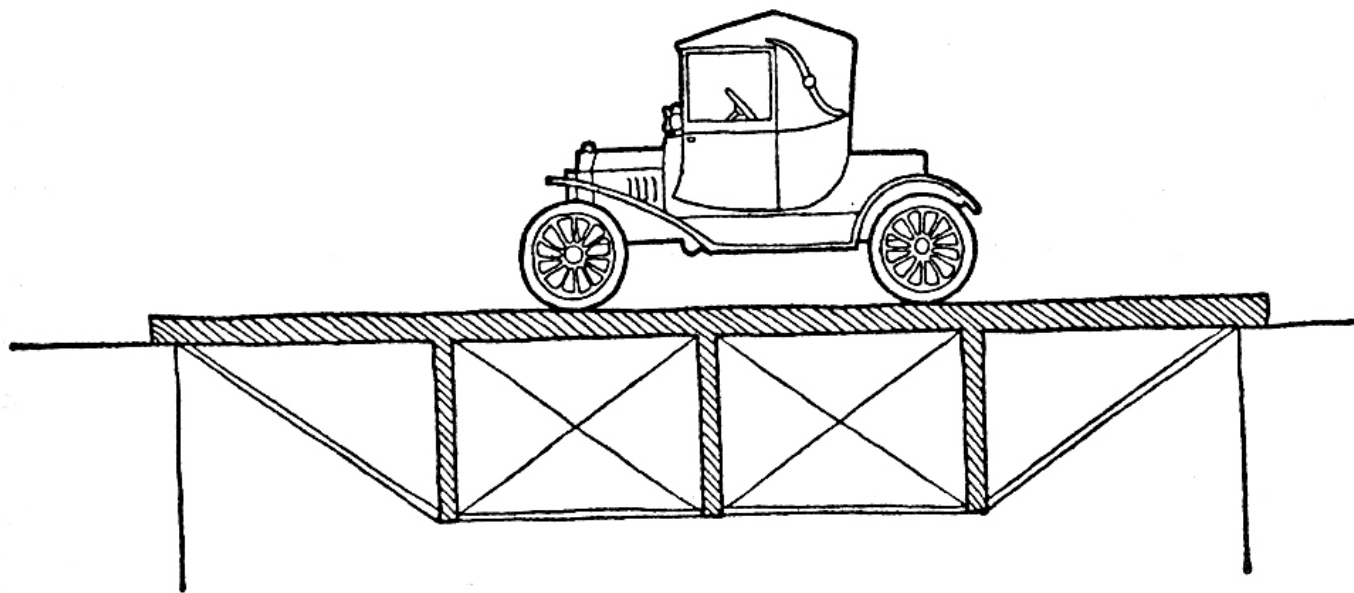


Triangulation

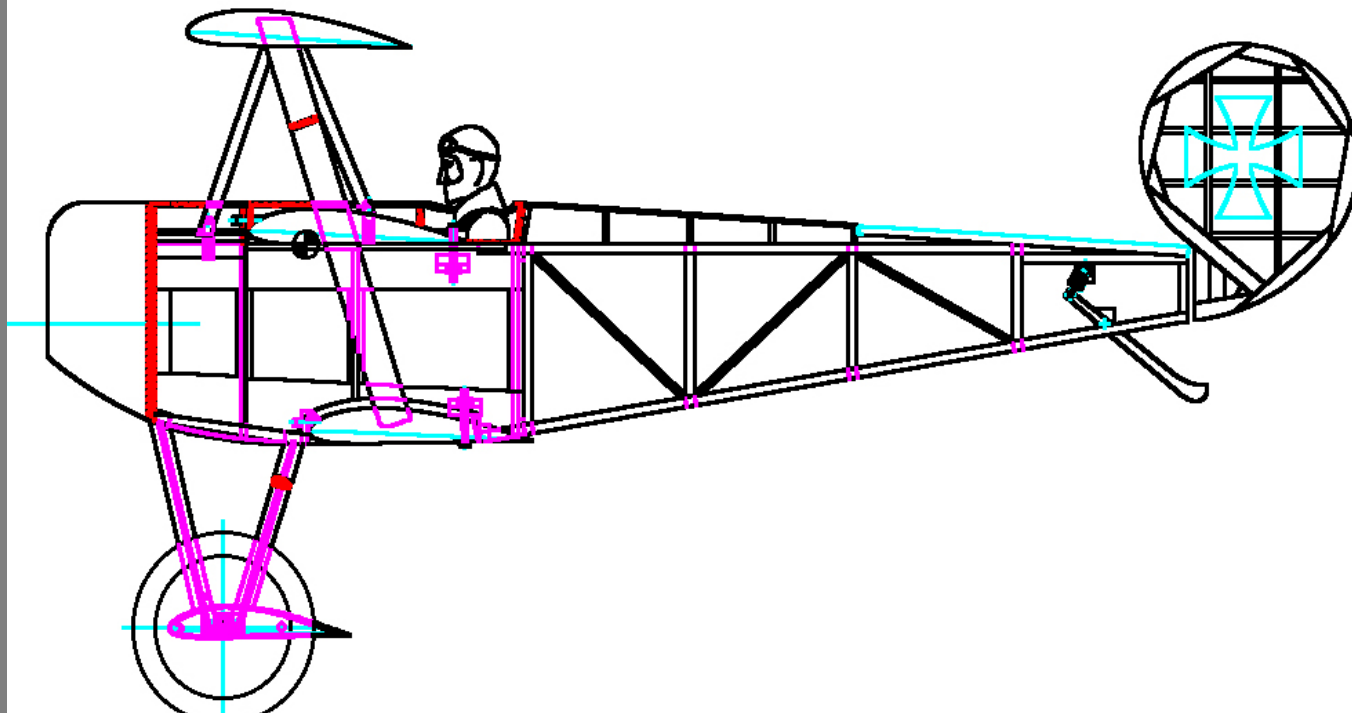
- Triangulation
- This law, is sometimes a better way of dealing with three forces that meet at one point.
- Loads that are applied to structures can be transferred through the structure, into smaller members, cancelling out the loads.

Bi planes





Pratt or Howe truss.



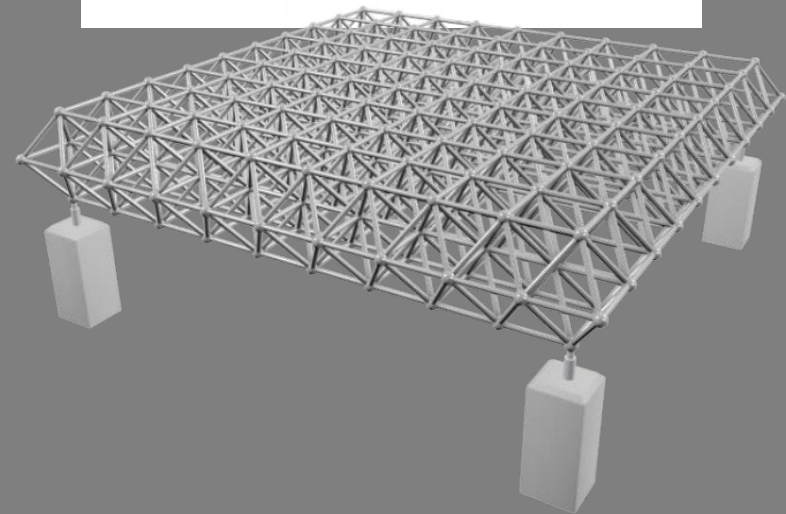
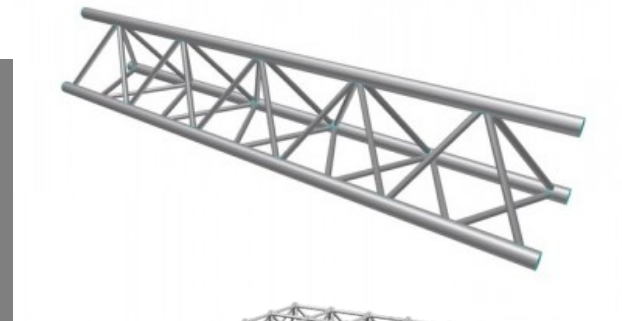
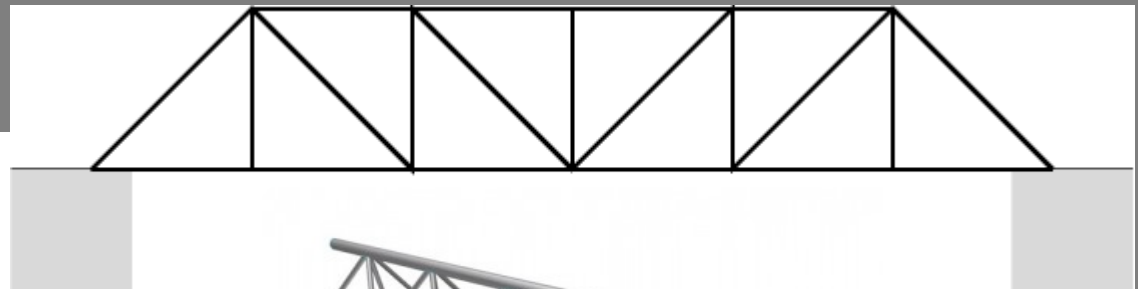
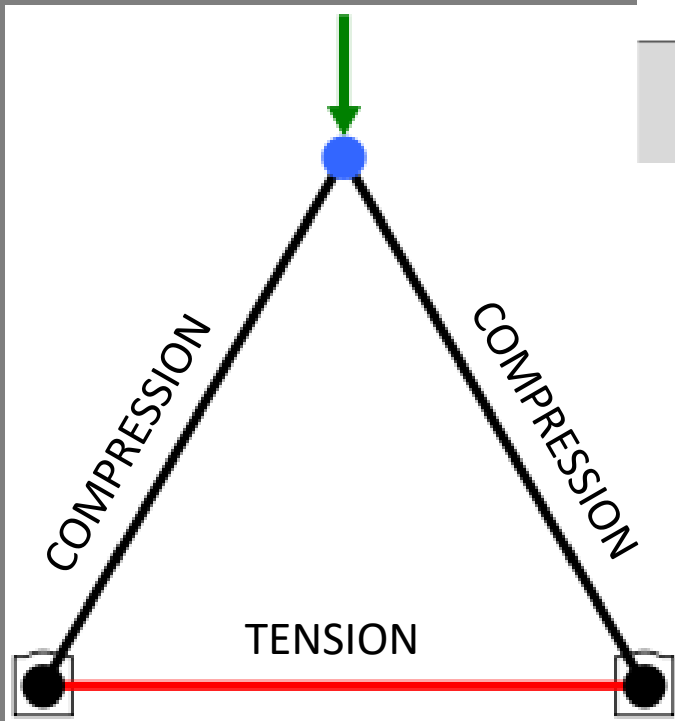
Bi planes





Structural elements

Triangular structures





Structural elements

Triangular structures

Purlins

Trusses

Base plate





Materials used

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





Exercise 1

Analyse every material and think about its characteristics and possibilities for construction structures

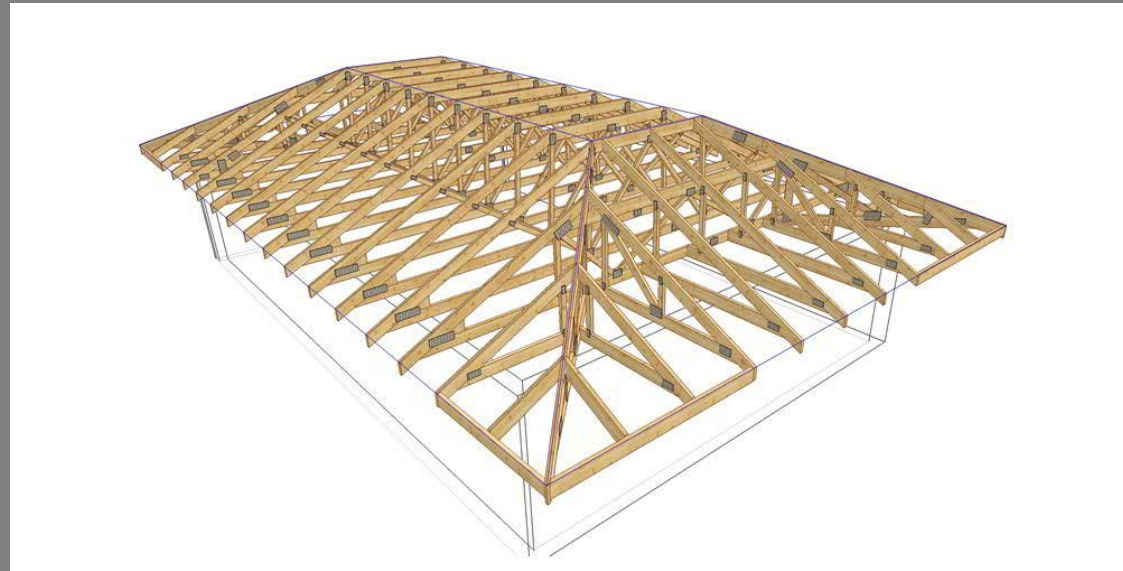
- Timber
- Concrete
 - Reinforced concrete
 - Precast concrete frames
- Steel
 - Standard sections
 - Compound elements
- Mixed



Timber

Characteristics

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



Use

- Laminated wood
- Building roofs
- Beams
- sheets

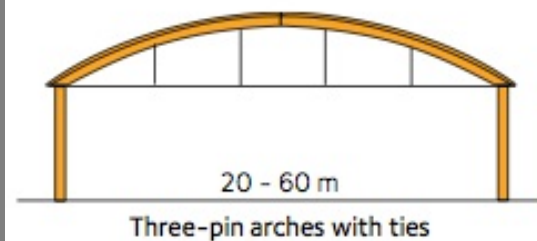
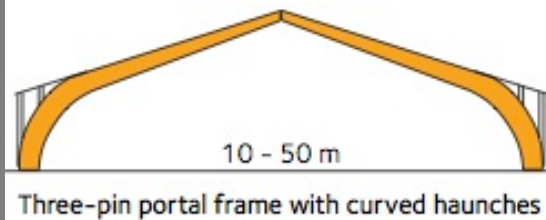
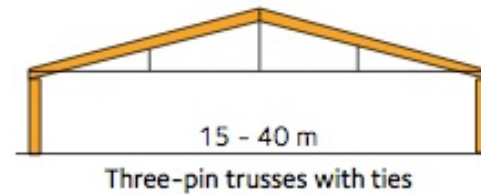
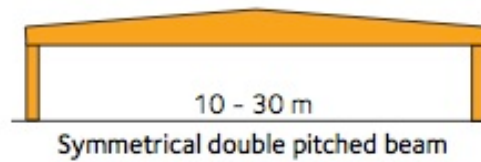
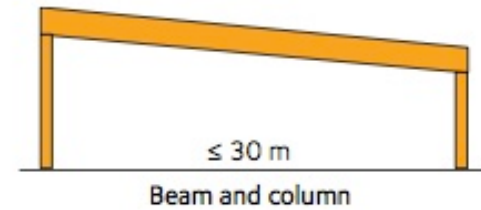
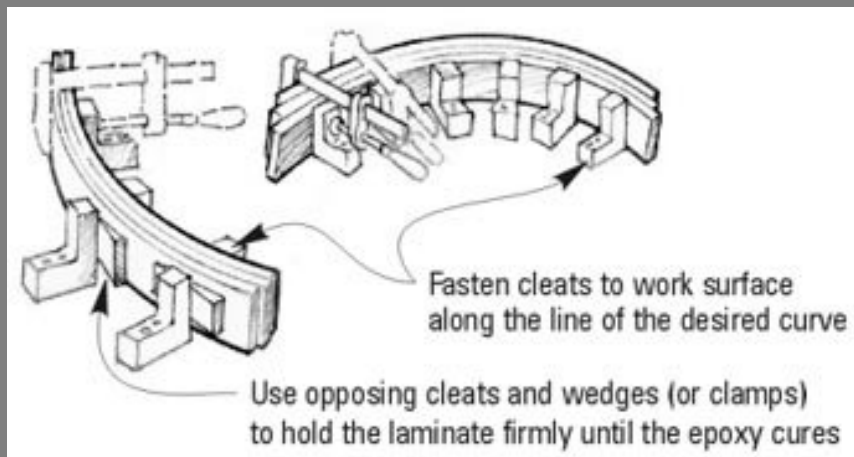
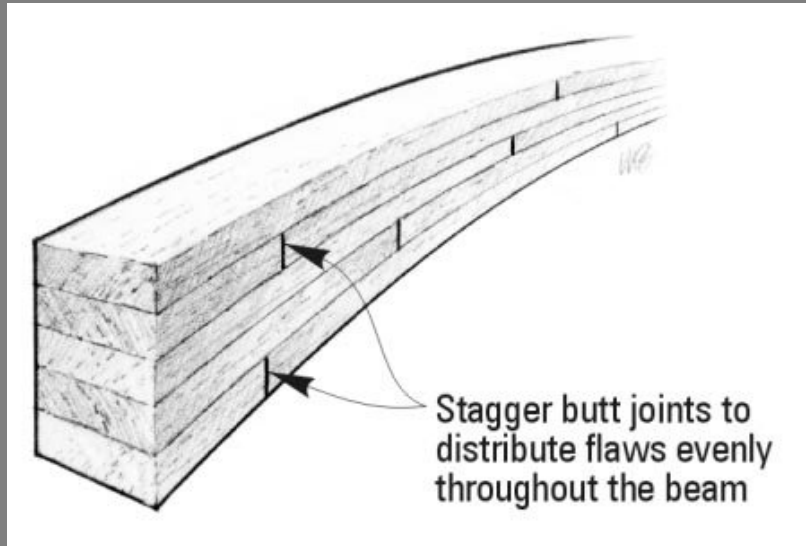


INTRODUCTION TO STRUCTURES





Laminated wood











Steel

Characteristics

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



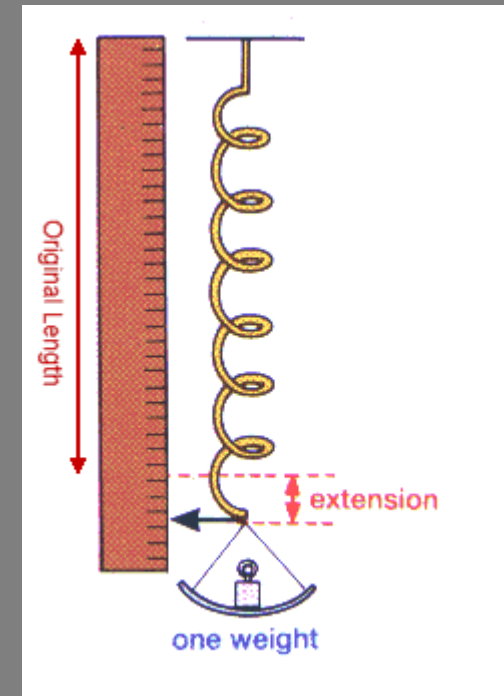
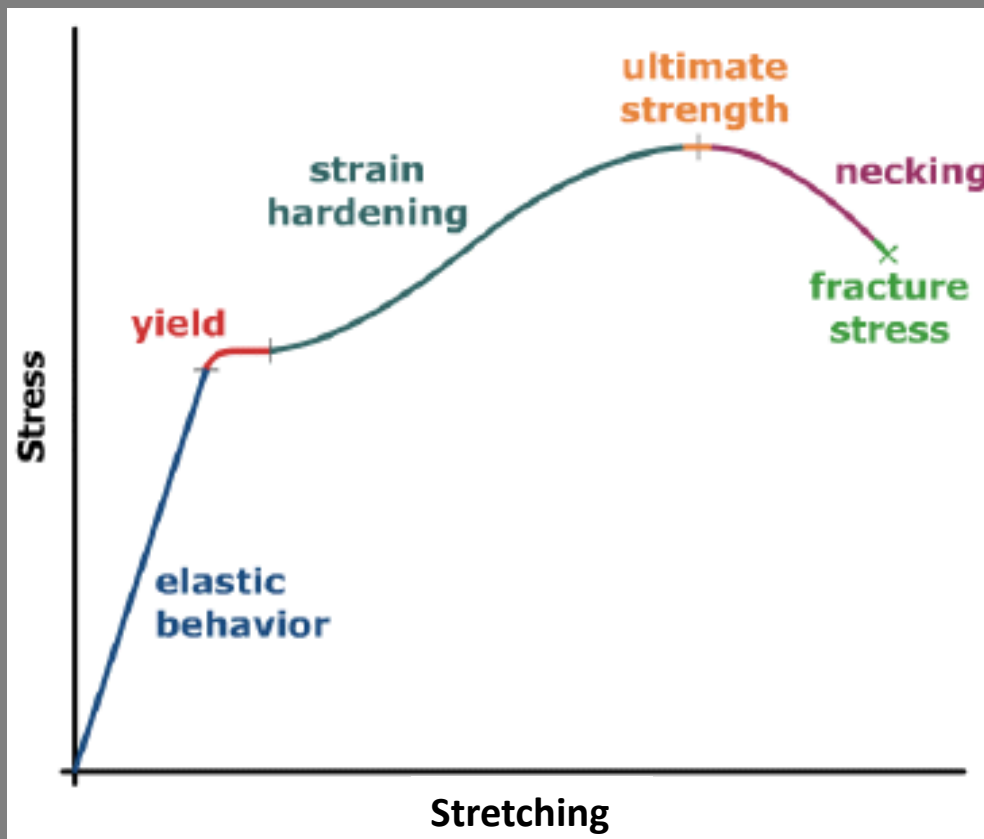
Uses

- Buildings
- Industrial buildings
- Bridges



Steel

Hooke's law



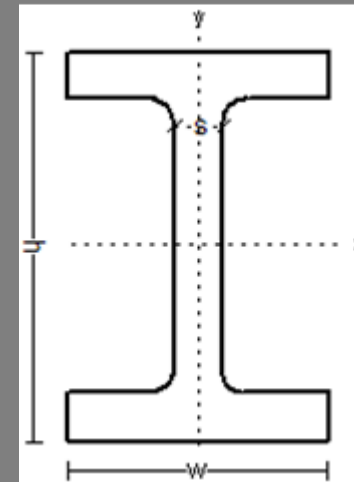
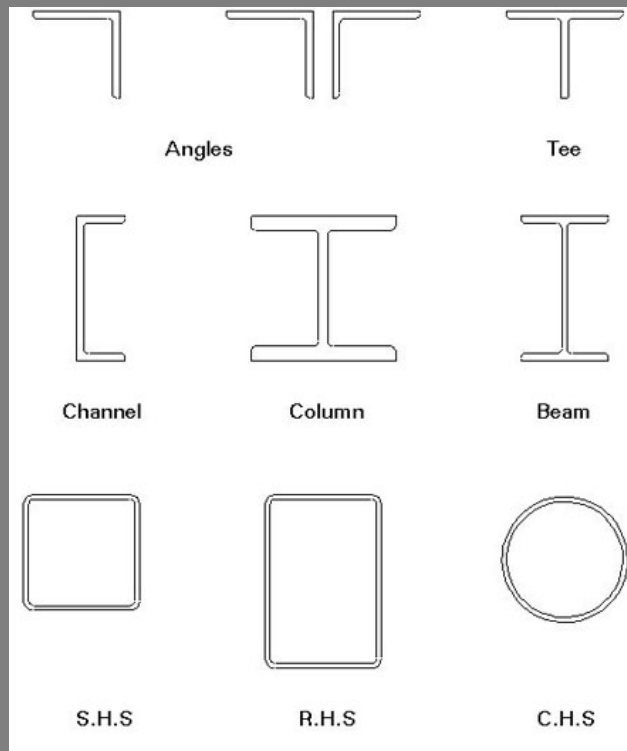


Steel

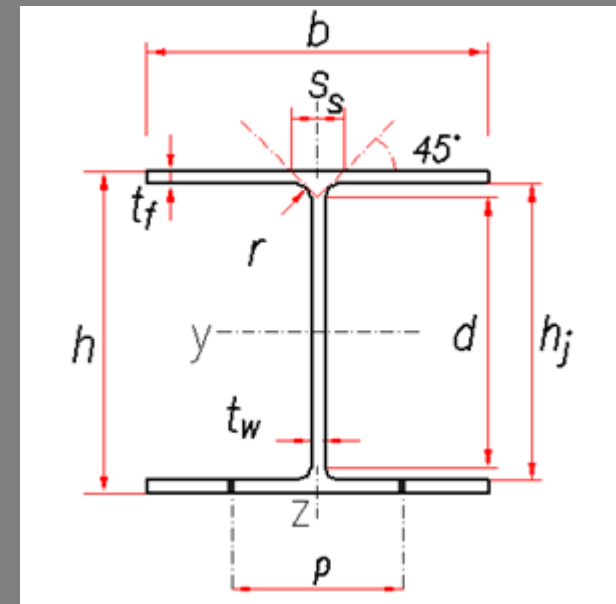
Types

Universal beams and columns

Channels



UB



UC



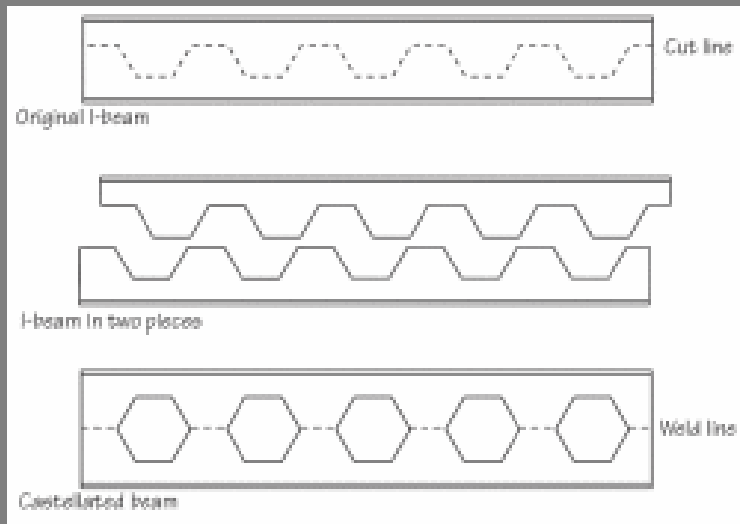
Steel

Types

Universal beams and columns
Channels



Castellated Universal Beam Sections





Steel

Types

Universal beams and columns

Channels





Steel

Connections

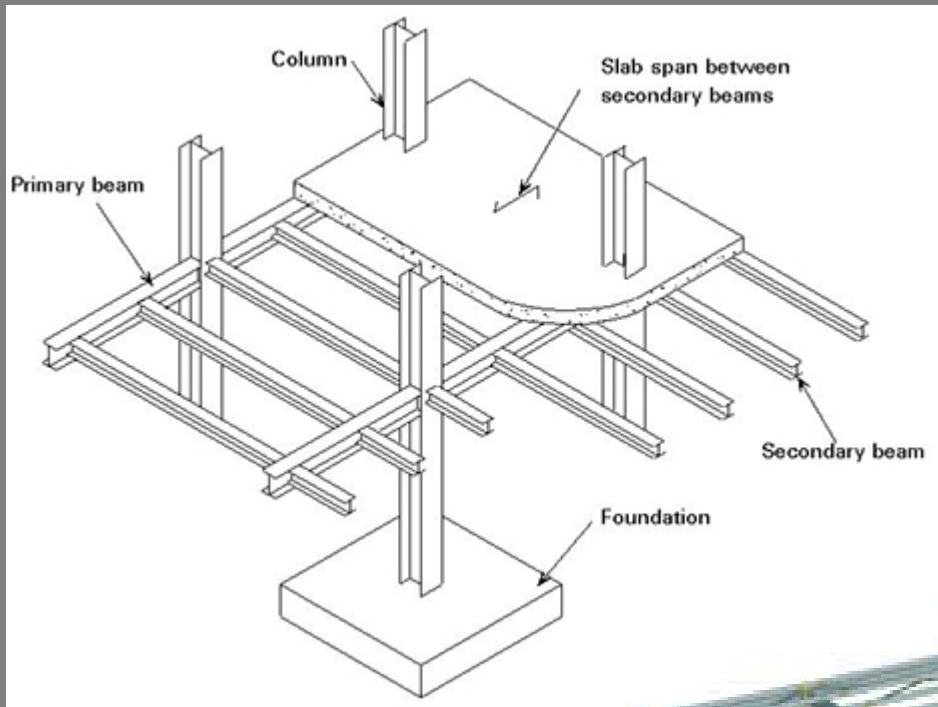
Bolted
Welded

Isostatic
Statically indeterminate

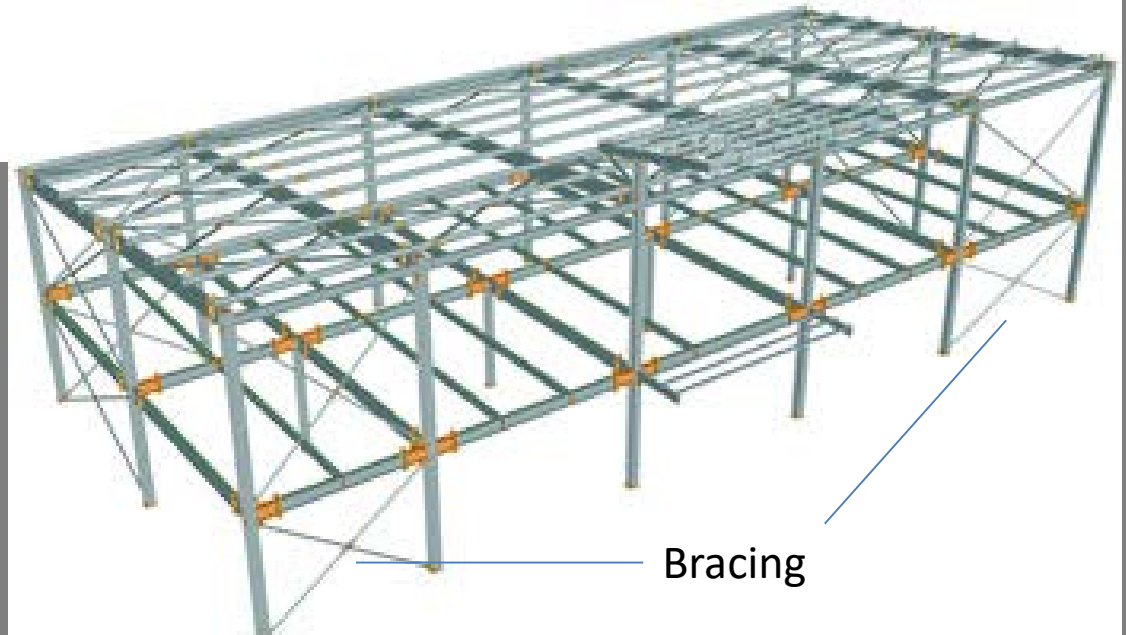




Steel structure performance



Isostatic structure





INTRODUCTION TO STRUCTURES





Portal frames





Trusses







Wires and cables

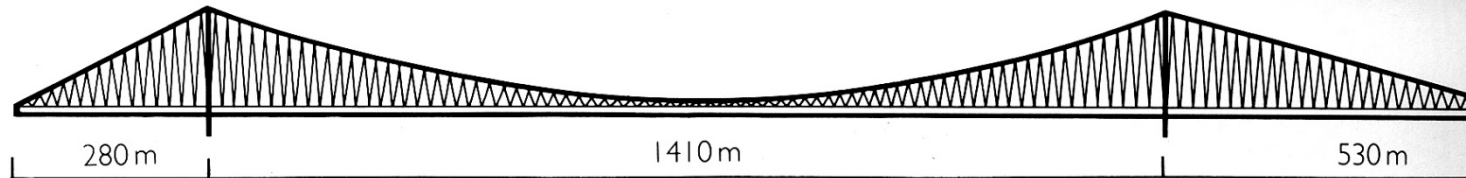


SUSPENSION BRIDGES

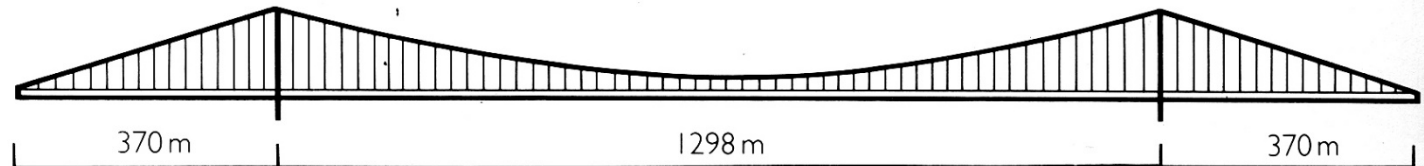
- SUSPENSION BRIDGES IN THEIR SIMPLEST FORM WERE ORIGINALLY MADE FROM ROPE AND WOOD
- MODERN SUSPENSION BRIDGES USE A BOX SECTION ROADWAY SUPPORTED BY HIGH TENSILE STEEL CABLES
- TODAY CABLES ARE MADE FROM THOUSANDS OF INDIVIDUAL STEEL WIRE BOUND TIGHTLY TOGETHER.
- STEEL IS VERY STRONG IN TENSION IS AN IDEAL MATERIAL FOR CABLES
- A STEEL WIRE ONLY 5MM THICK CAN EASILY SUPPORT OVER HALF A TON WITHOUT BREAKING.
- LIGHT AND STRONG SUSPENSION BRIDGES CAN SPAN LONG DISTANCES

Suspension Bridges

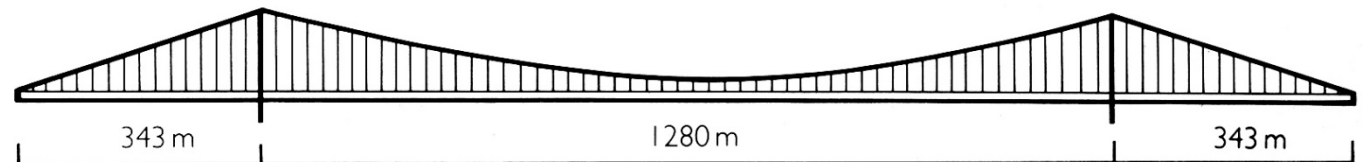
The Humber Bridge differs from its near rivals in several ways. Topography and geology prevented the usual near symmetry of the side span measurements, though the bridge's length masks the asymmetry. The use of reinforced concrete rather than steel for the towers had been confined to bridges with spans less than half the size.



Humber Bridge



Verrazano Narrows Bridge



Golden Gate Bridge

Suspension Bridges



Beam Bridge



Arch Bridge



Arch Bridge





Concrete

Characteristics

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



Reinforced concrete

Use

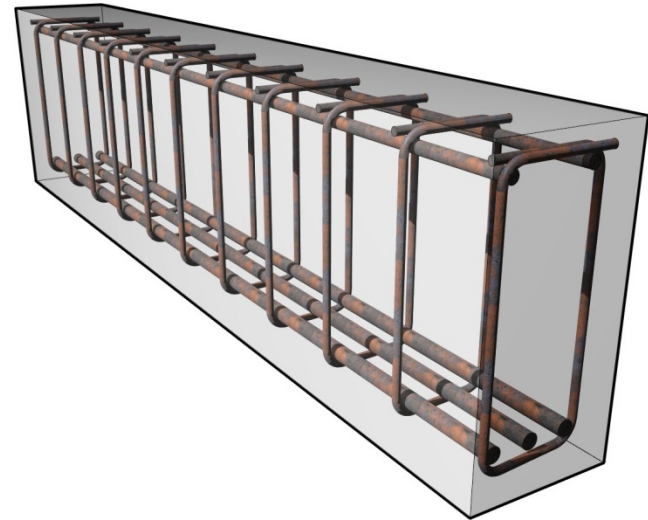
- Common use in structures
- Reinforced concrete
- Precast concrete



Reinforced concrete

Combination of:

- Compressive strength of concrete
- Tension strength of steel

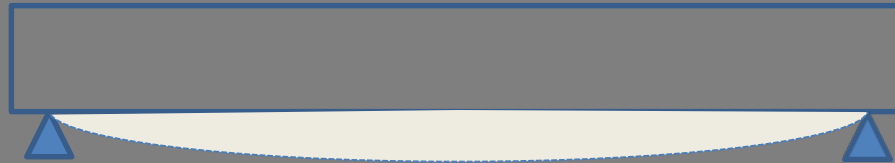




Reinforced concrete

Analysis of loads

Compressed and tensioned fibres



Where should the reinforcement be put? Up or down?

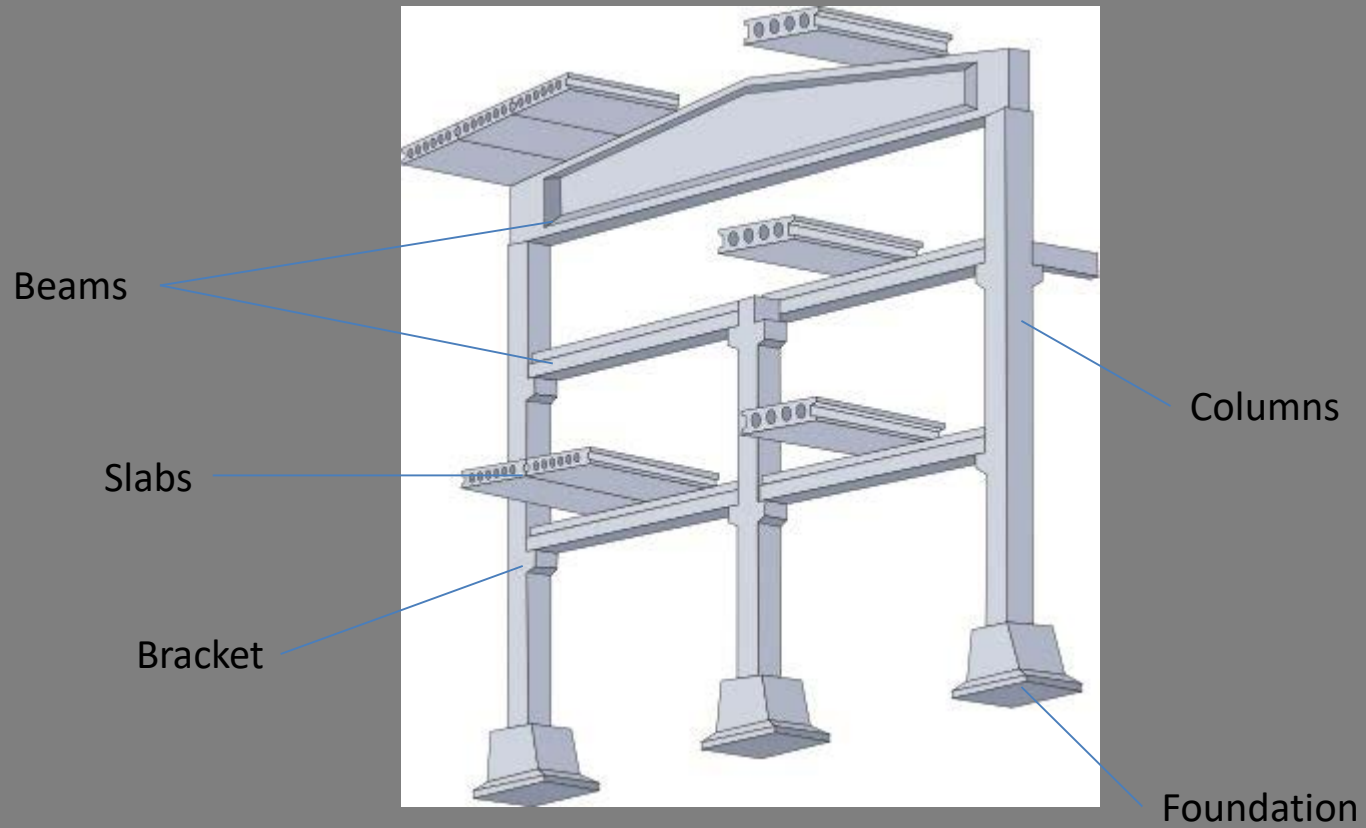


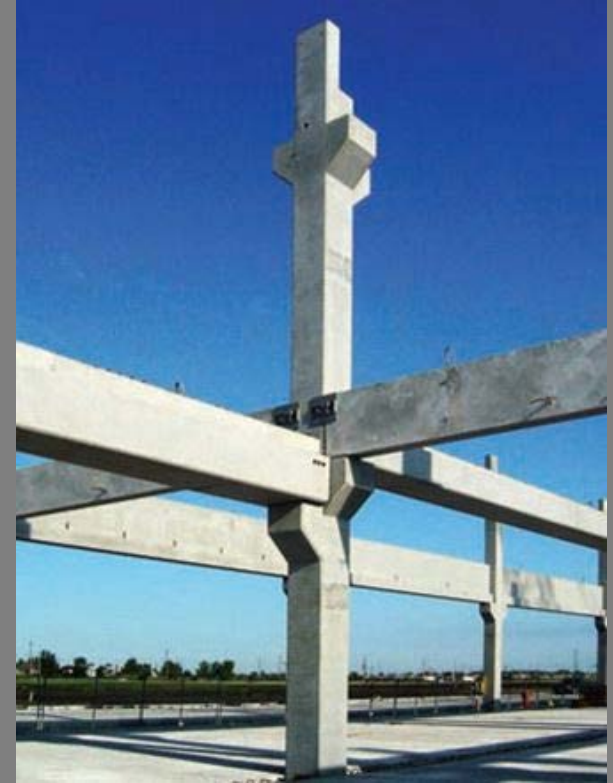






Precast concrete



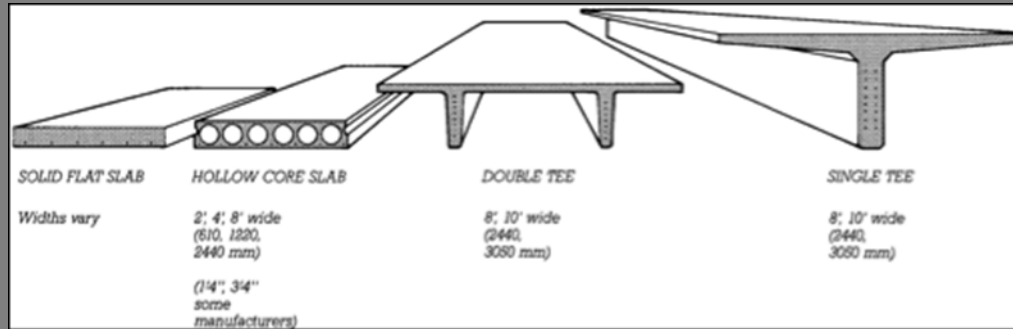


Columns and beams

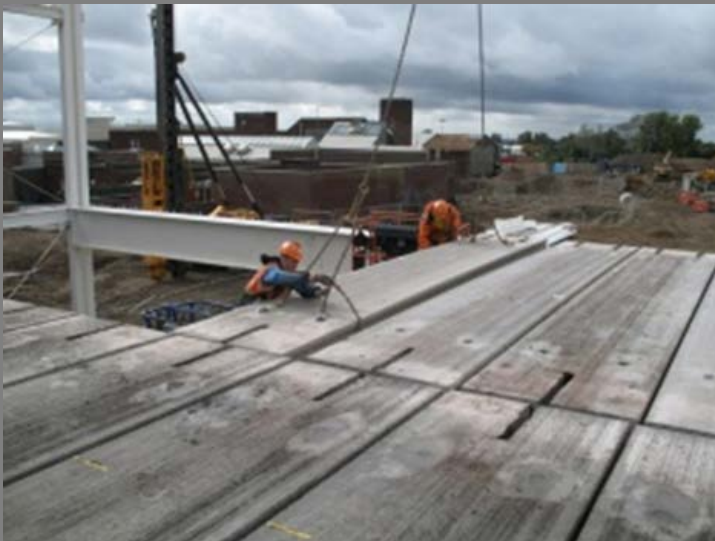




Slabs

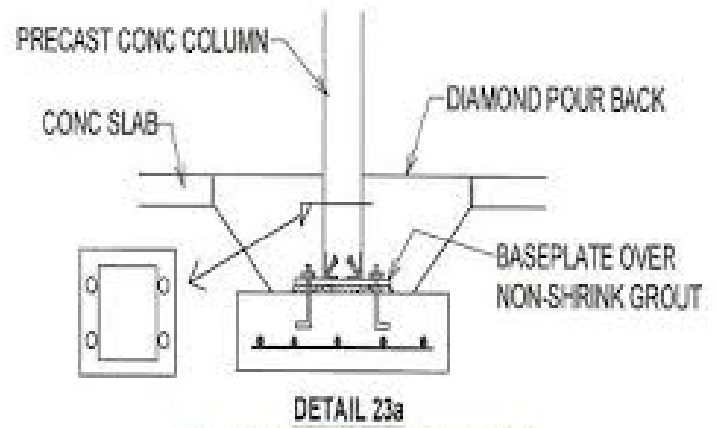


Joints: adhesives or concrete





Foundations



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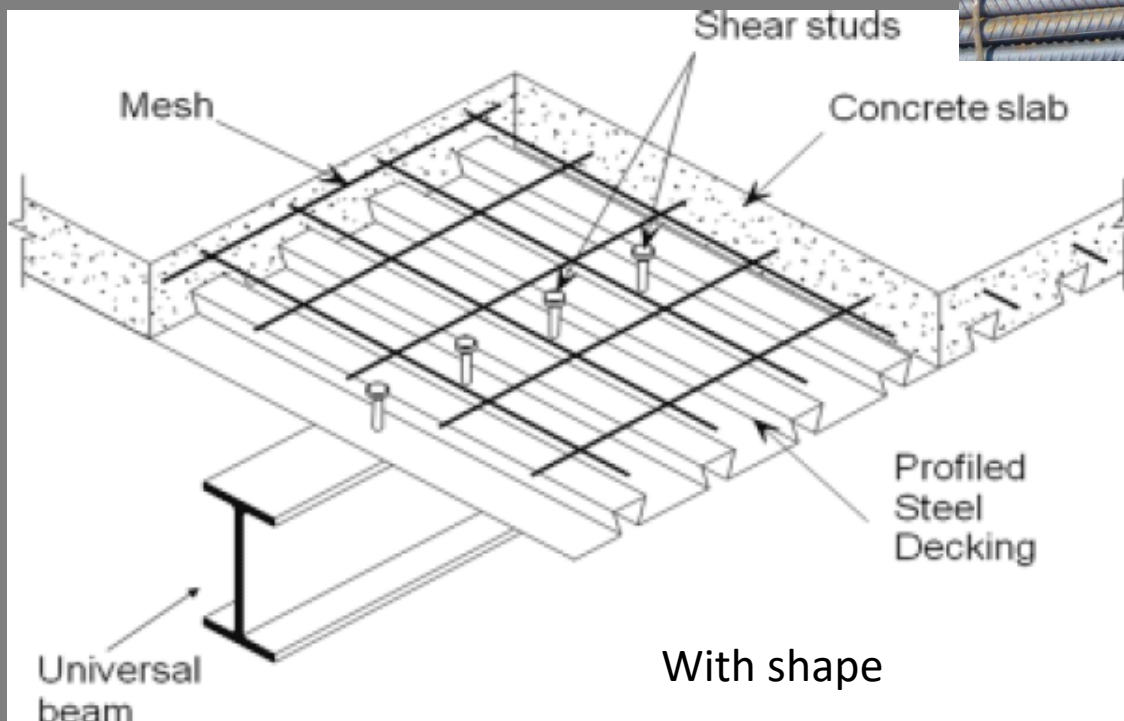
Mixed structures

Steel – concrete

Adherence



Corrugated



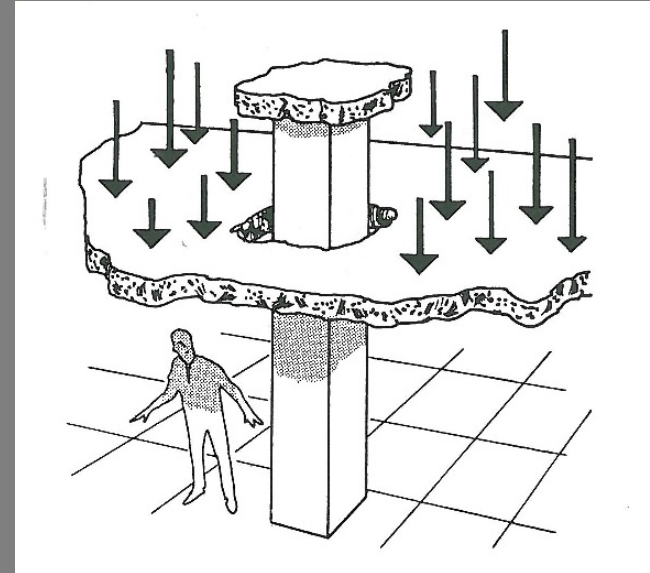
With shape



Mixed structures

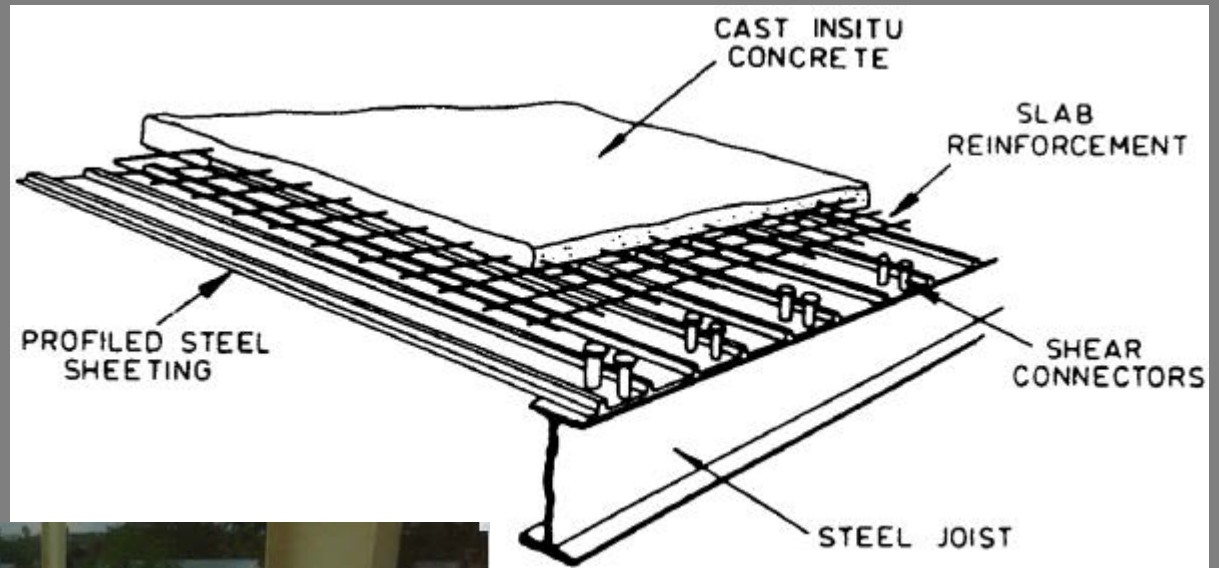
Steel – concrete

Careful with shear stress





Steel – concrete





Questions

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

High-rise buildings

Fire resistance

Earthquake resistance

Covering an Exhibition Centre

EXERCISE

The Chair

