ASHUR UNIVERSITY

Chapter – 1

Part - 2

Introduction

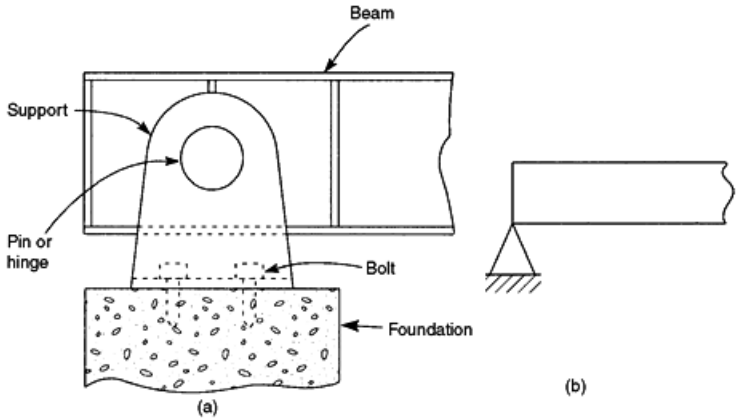
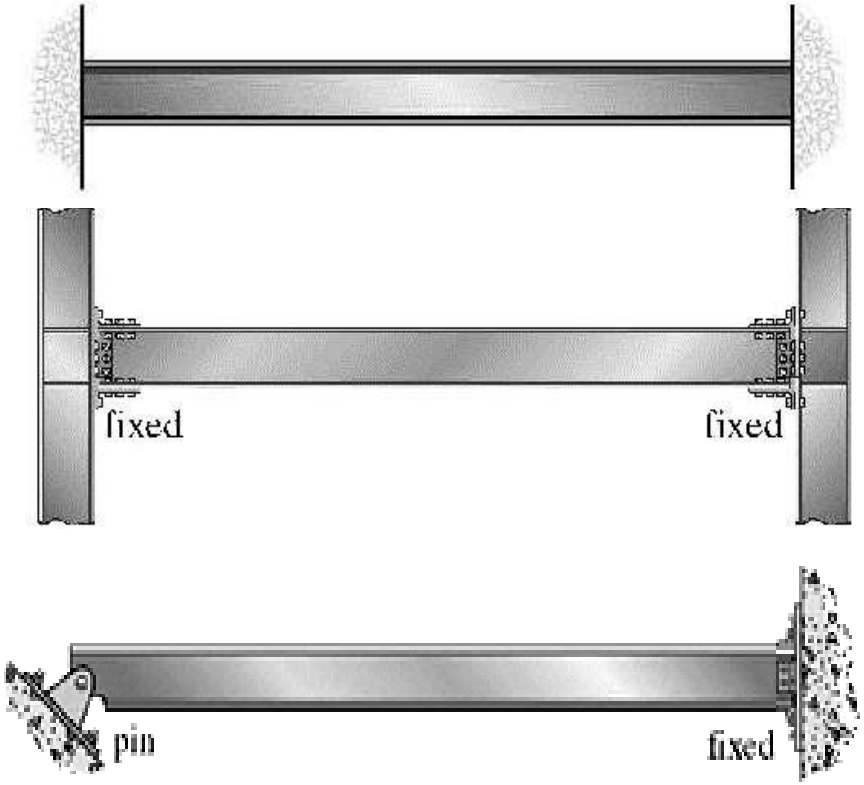


FIGURE 4 Idealization of a pinned support



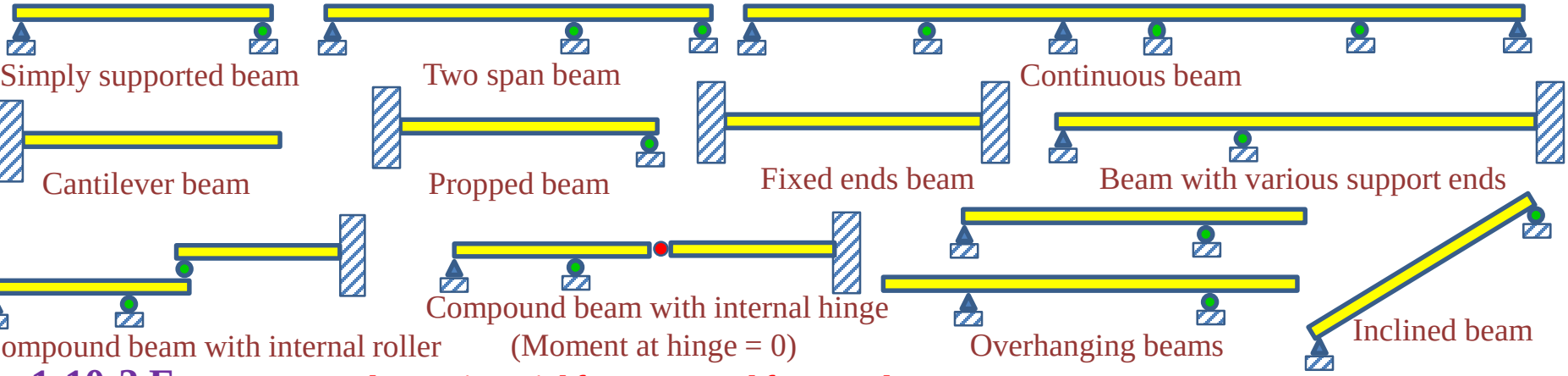




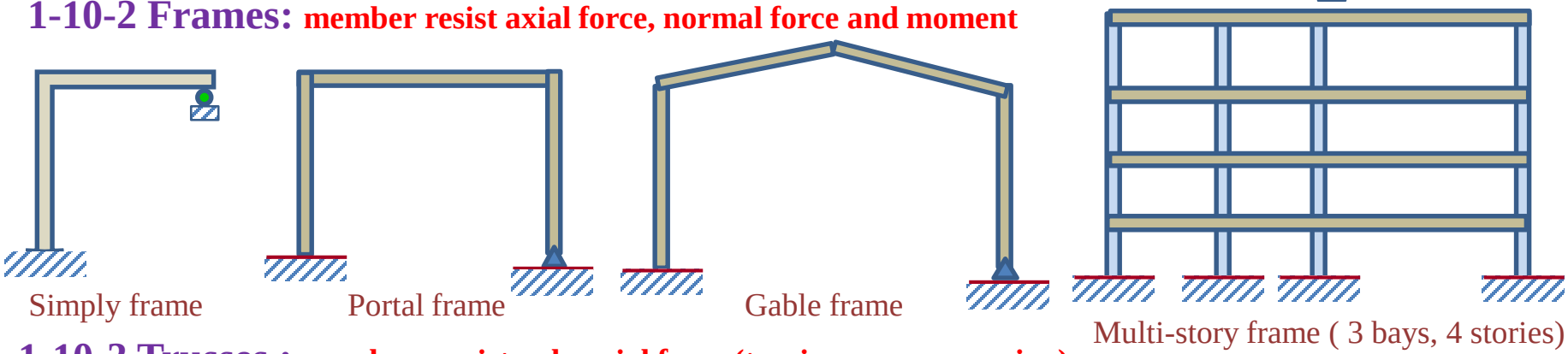

fixed
fixed
pin
fixed

1-10 Classification of Structures:

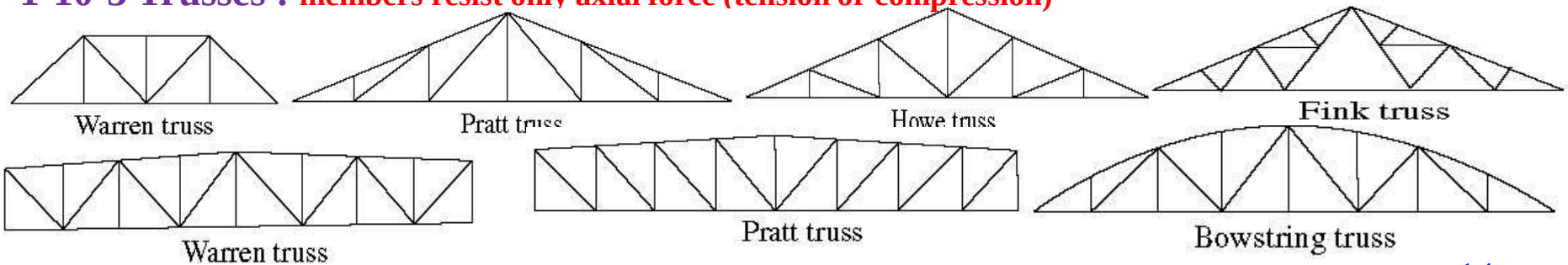
1-10-1 Beams : member resist axial force, normal force and moment



1-10-2 Frames: member resist axial force, normal force and moment

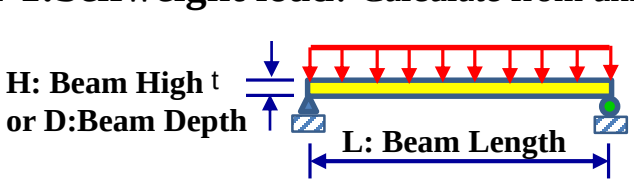


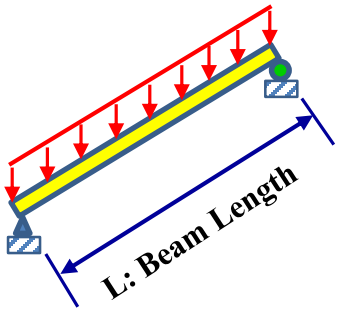
1-10-3 Trusses : members resist only axial force (tension or compression)

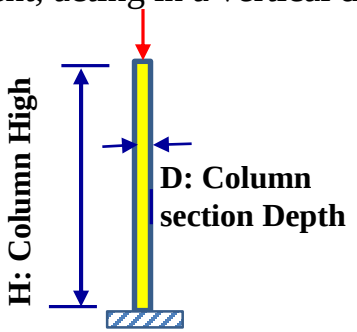


1-11 Types of Loadings:

1-11-1:Selfweight load: Calculate from unit mass of material and volume of element, acting in a vertical direction.







Example-1-1: Calculate the selfweight of a reinforced concrete beam of breadth 300 mm, depth 600 mm and length 6000mm. unit mass of reinforced concrete is 2400 kg/ m^3. Assuming that the gravitational constant is 10 m/ sec^2 (strictly 9.807 m/ sec^2), the unit weight of reinforced concrete, ρ, is

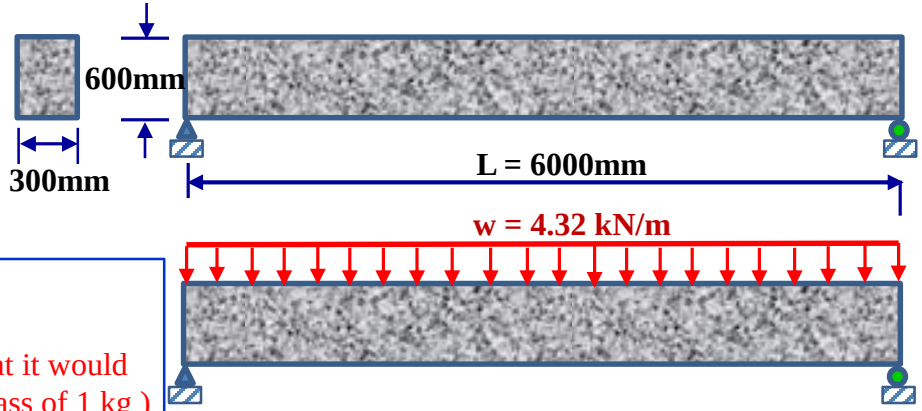
$\rho = 2400 \times 10 = 24\,000\ N/m^3 = 24\ kN/m^3$

Hence,

the selfweight of beam = volume × unit weight

$= (0.3 \times 0.6 \times 6)24 = 25.920\ kN$

selfweight per unit length of beam = 25.92 / 6 = 4.320 kN/m



Hint: force(weight) = mass × acceleration (Newton's Second Law)
For mass = 1 kg, Gravity acceleration= 9.807 m/ sec^2
So force(weight) = 1 × 9.807 = 9.807 ≈ 10 or 1kg = 10N (which means that it would require a force of 9.807N to produce an acceleration of 9.8071m/s^2 in a mass of 1 kg)

Example-1-2: Calculate the selfweight of a reinforced concrete column of circular section with 350 mm radius, and height 3000mm, the unit weight (density) of reinforced concrete, ρ, is

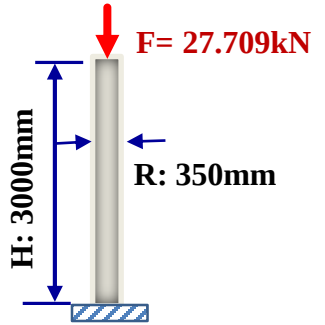
$\rho = 2400 \times 10 = 24\,000\ N/m^3 = 24\ kN/m^3$

Hence,

the selfweight of column= volume × unit weight

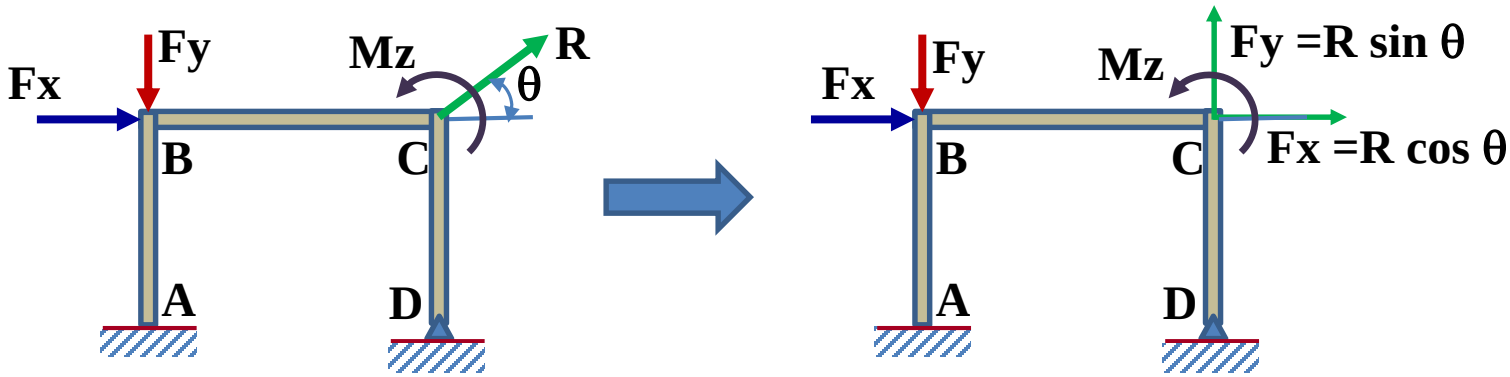
$= ([\pi * 0.35^2] \times 3)24 = 27.709\ kN$

Where $\pi = 3.1415926$

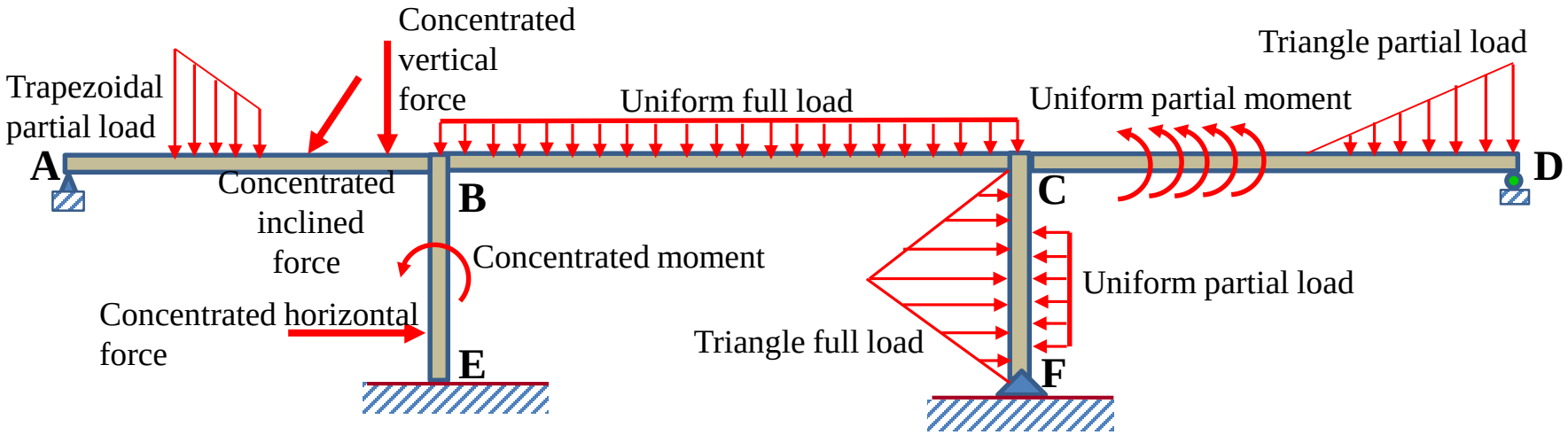


1-11-2 External Loads:

1-11-2-1: **Joint load**: (**Force or Moment), a**cting at the joint only, vertical, horizontal or inclined direction.



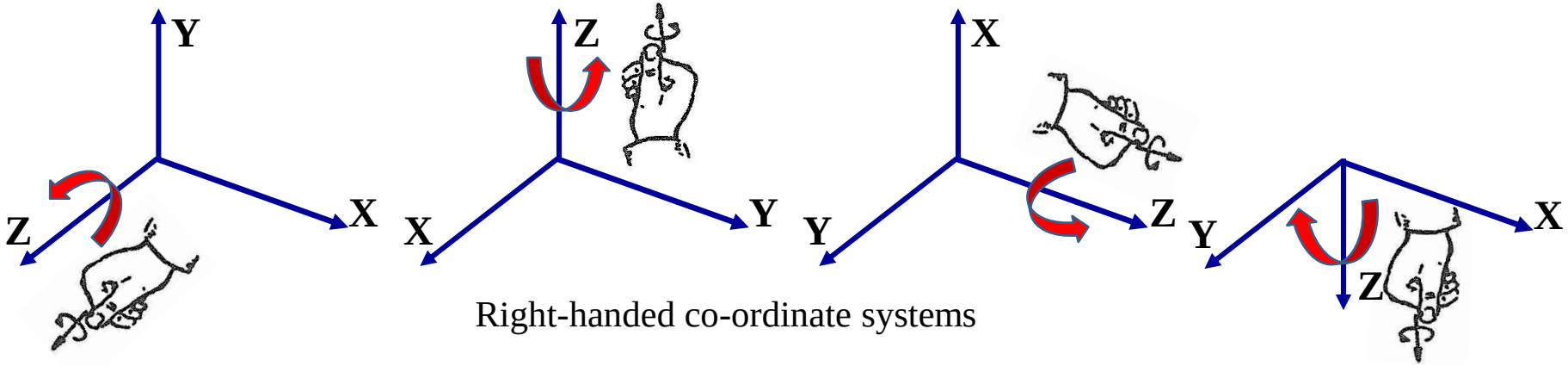
1-11-2-2: **Member load**: (**Load means Force or Moment**) Acting along member, vertical, horizontal or inclined direction.



1-12 Sign Conventions:

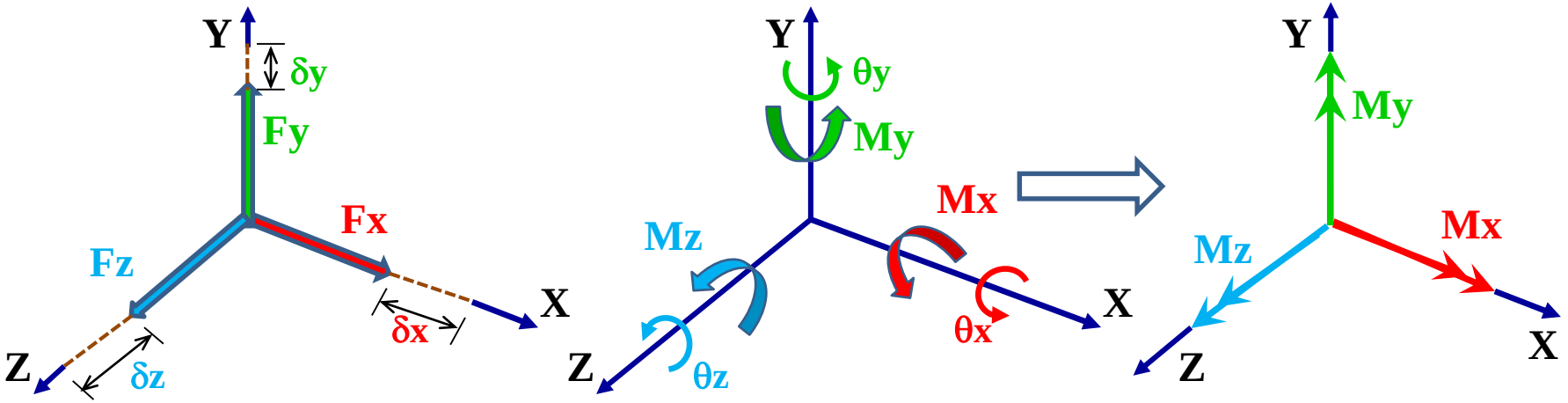
1-12-1 Axes:

Throughout this subject we will use the Cartesian co-ordinate system of three mutually perpendicular axes. Only right-handed systems will be used, which means the following:



Right-handed co-ordinate systems

1-12-2 Forces and Moments: (force produce displacements δ, Moment produce rotation θ)

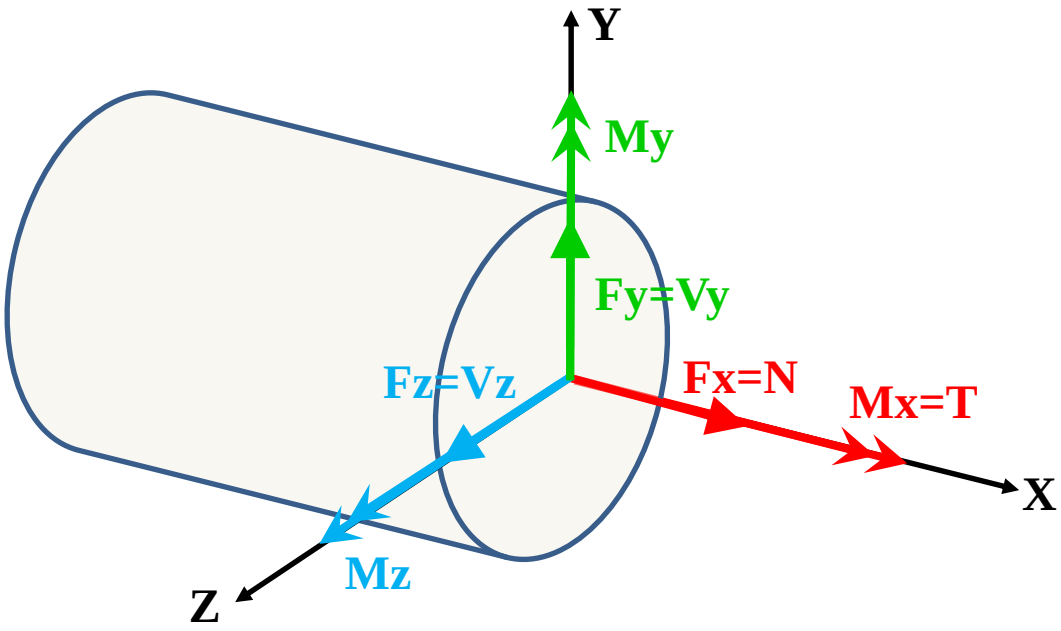


3Forces and 3displacements system

3Moments and 3rotations system

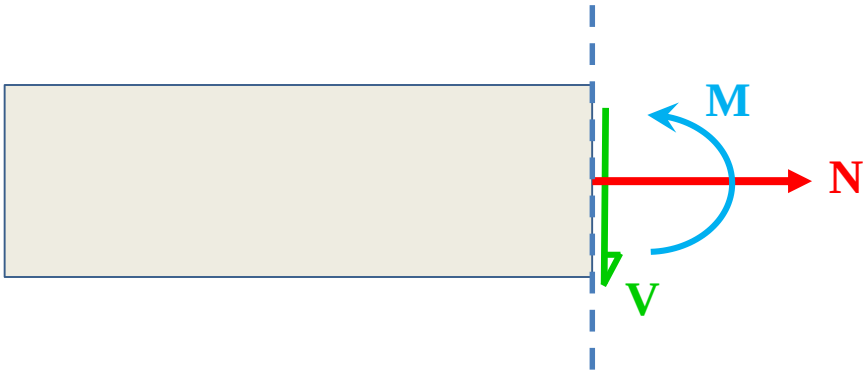
\+ Positive direction of forces and moments system

In general, for a three dimensional problem, there are six loads on any cross section (3 Forces & 3 Moments)



N = Normal Force
V = Shear Force
T = Torque
M = Bending Moment

For two dimensional problems, this can be reduced to three loads (2 forces & 1 moment).



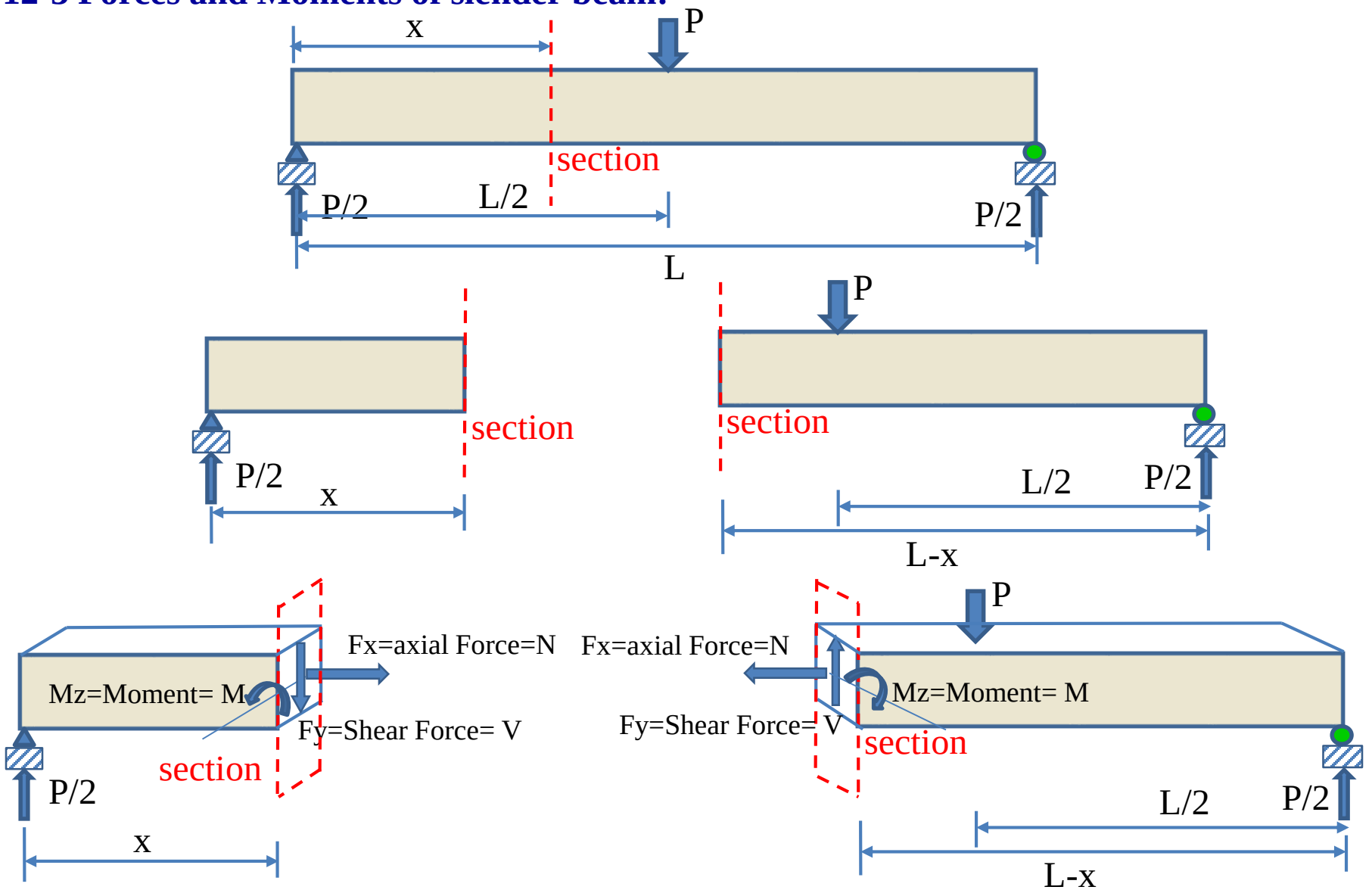
Positive Sign Conventions:

Tension axial force on the section

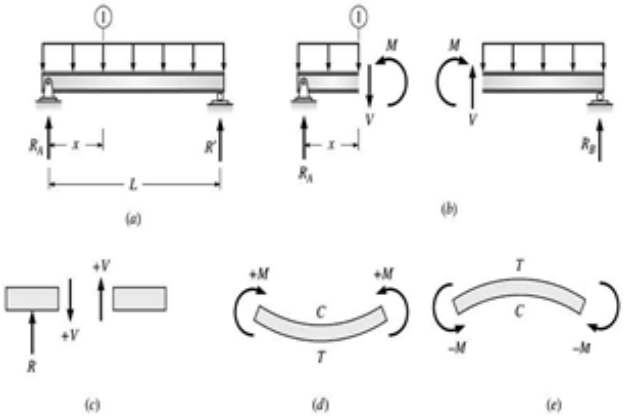
Shears that produces clockwise moments

Bending moments that produce compression in the top fibers and tension in the bottom fibers of the beam

1-12-3 Forces and Moments of slender beam:



+ Positive direction of axial force, shear force and moments at beam section for equilibrium system

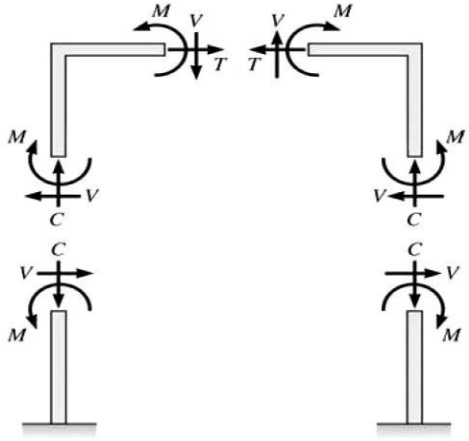


Beam Sign Convention for Shear and Moment

Following our positive beam sign convention, a positive bending moment bends a beam concave upward (or toward the positive y direction), whereas a negative bending moment bends a beam concave downward (or towards the negative y direction).

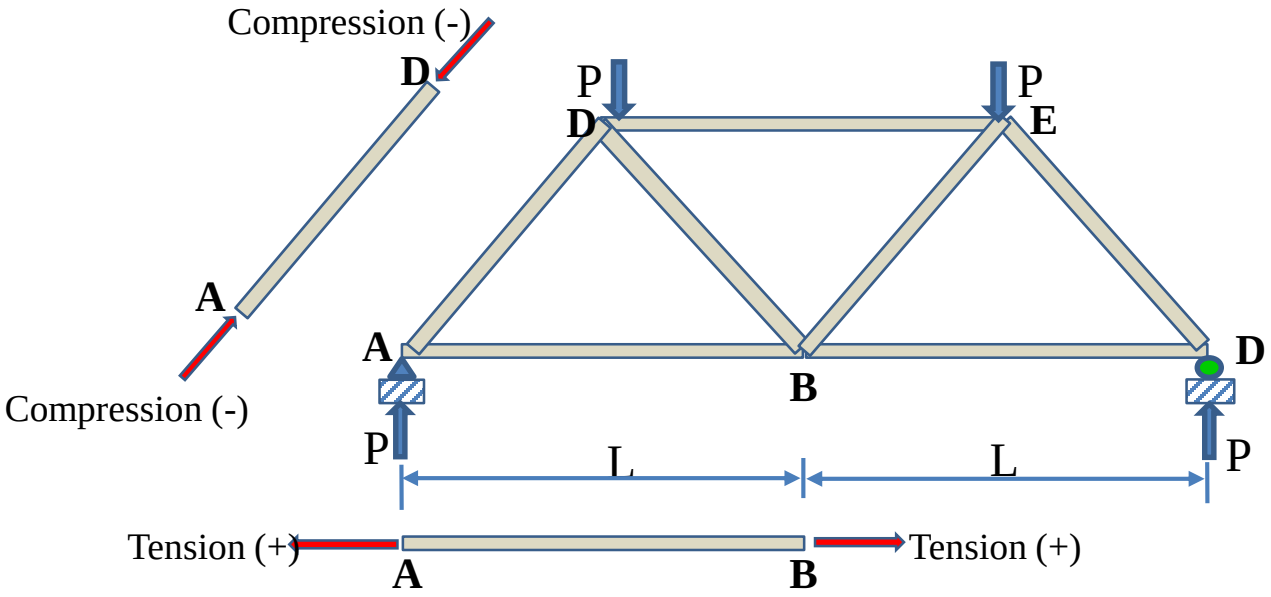
Positive Bending

Negative Bending



Positive Internal Forces Acting on a Portal Frame

1-12-4 Forces truss bar element: resist axial force only, tension or compression



1-13 Review: Statics:

Equations of Equilibrium: In three dimensions, when presented in rectangular Cartesian coordinates, the two conditions (equations of statics) can also be expressed in scalar form as

$$\Sigma F_x = 0 \qquad \Sigma F_y = 0 \qquad \Sigma F_z = 0$$

$$\Sigma M_x = 0 \qquad \Sigma M_y = 0 \qquad \Sigma M_z = 0$$

where the moment summations are taken about each axis at any point in space. For a statically determinate system, these equations will be sufficient to find the restraint forces and internal forces, where number of equations of equilibrium = number of unknowns

Equilibrium in Two Dimensions: The term "two dimensional" is used to describe problems in which the forces under consideration are contained in a plane (say the *xy*-plane). In scalar form, these conditions can be expressed as

$$\Sigma F_x = 0 \qquad \Sigma F_y = 0 \qquad \Sigma M_z = 0$$