

Theory of Structure(26454)

5th Semester

Civil Technology

Providan-2022

Presented By

Omit Goss

Junior Instructor (Civil)

Bogura Polytechnic Institute, Bogura

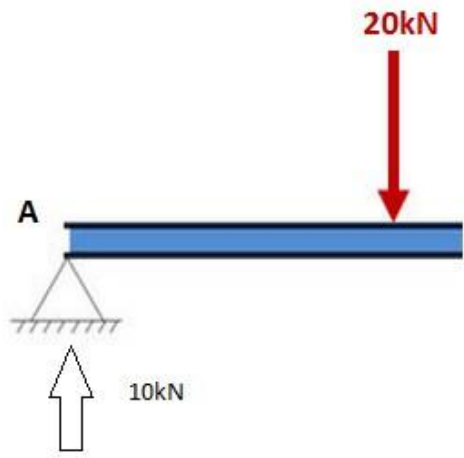
Shear Force And Bending Moment Of Beams

What is shear force Diagram?

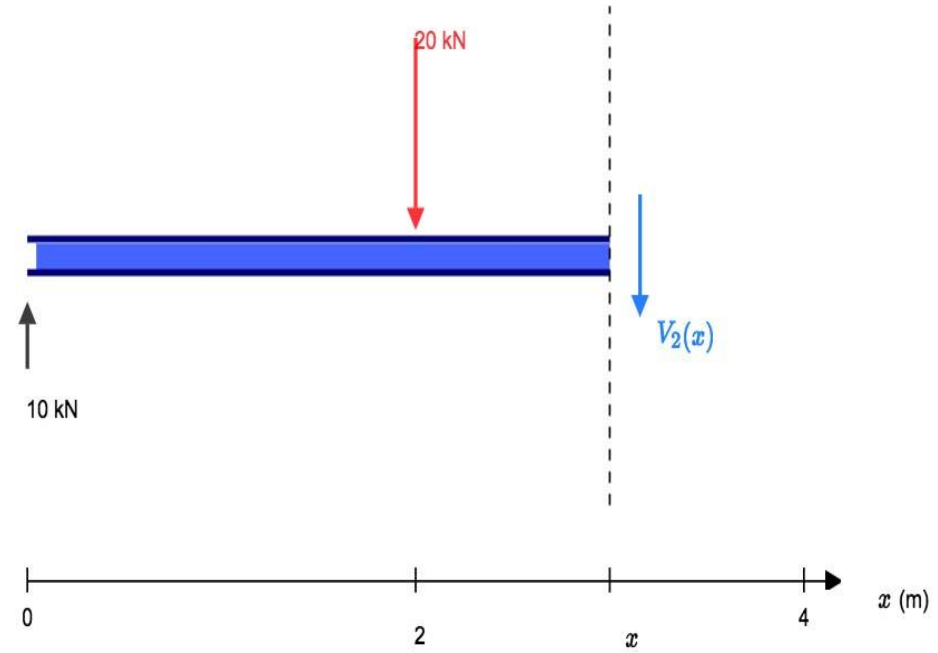
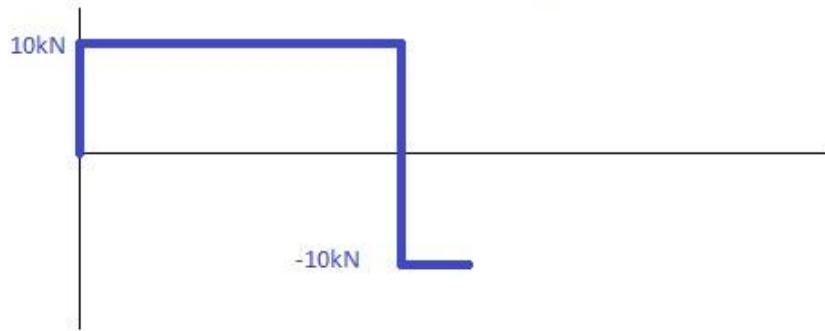
The use of shear force diagram is to calculate the shear force at different sections. In some complicated cases it is difficult to calculate shear force so it is easier to make SFD and calculate shear force.

- ✦ The shear force at a section of a beam is the force that shears off the section and is **obtained** as the algebraic sum of all forces including the reaction forces.
- ✦ The normal convention used in most engineering applications is to label a positive shear force one that spins an element clockwise (up on the left, and down on the right). Likewise the normal convention for a positive bending moment is to warp the beam in a "u" shape manner (Clockwise on the left, and counterclockwise on the right). Another way to remember this is if

the moment is bending the beam into a "smile" then the moment is positive, with compression at the top of the beam and tension on the bottom. o the axis of the beam either to the left or right of the beam.



Shear Force Diagram



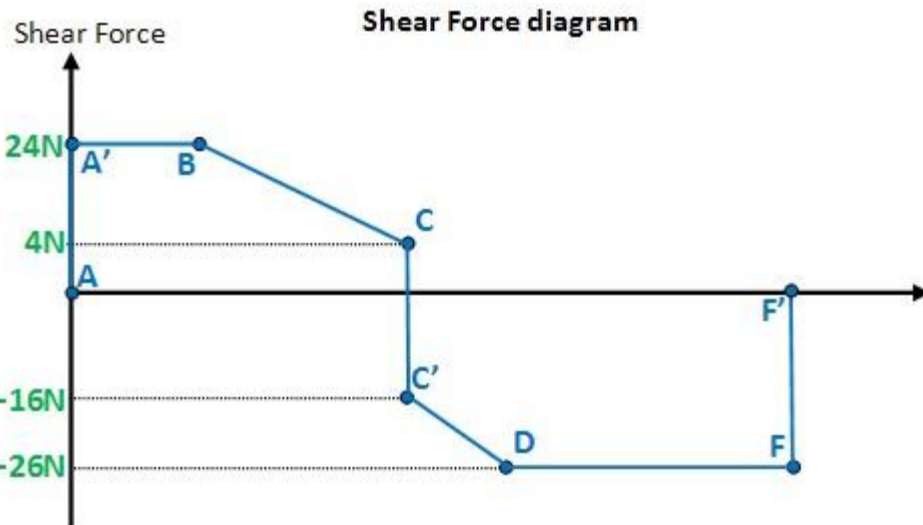
Take a cut for $2 \leq x \leq 4$:

$$+\uparrow \Sigma F_y = 0$$

$$+10 - 20 - V_2(x) = 0$$

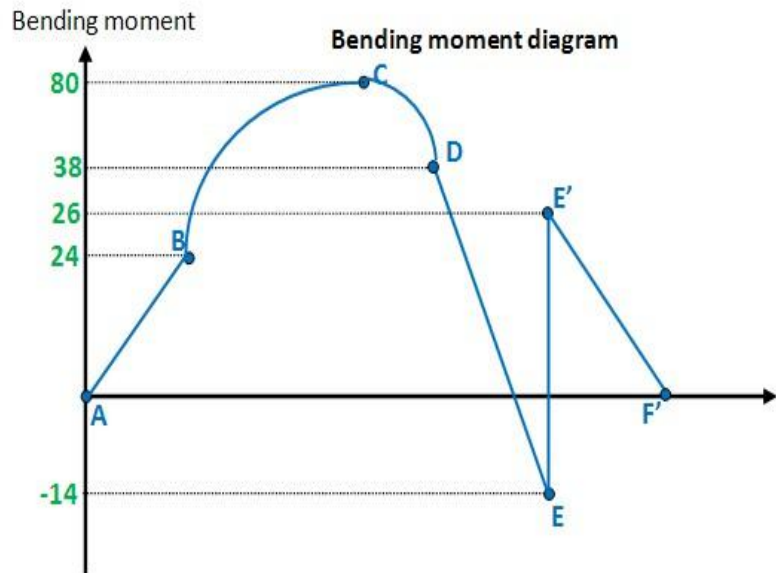
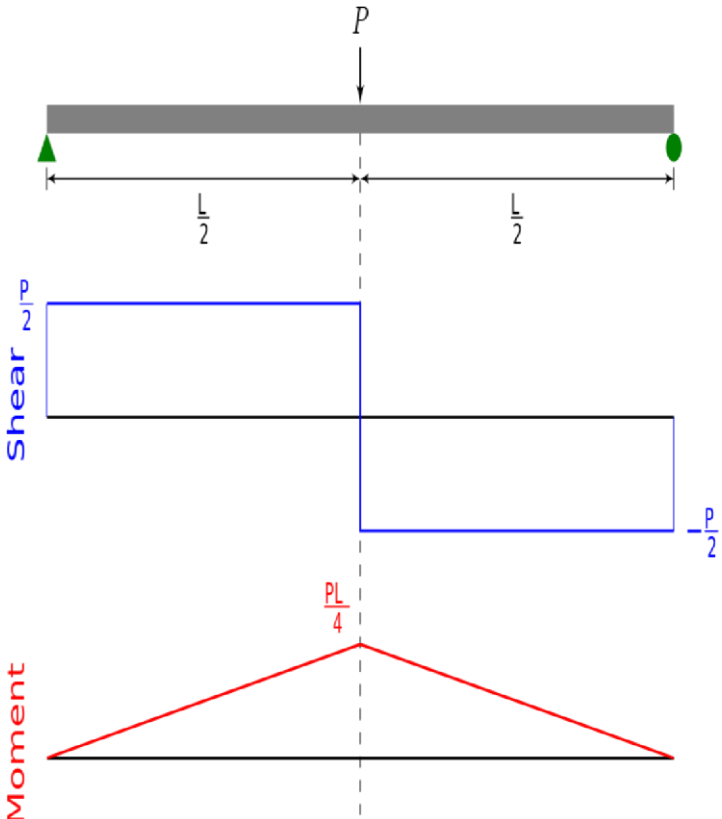
$$V_2(x) = -10$$

$$\therefore V_2(x) = -10 \quad \text{for } 2 \leq x \leq 4$$

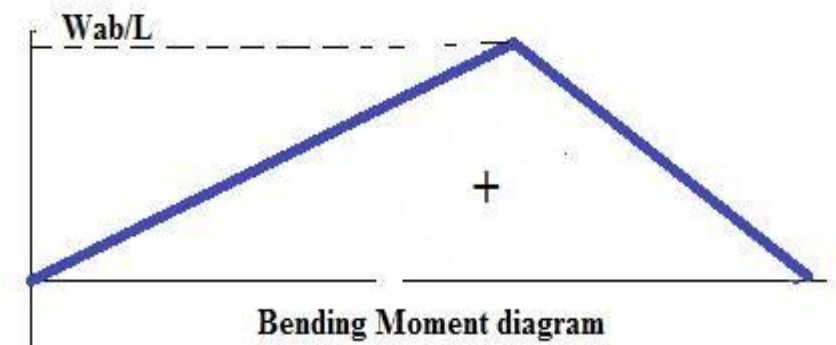
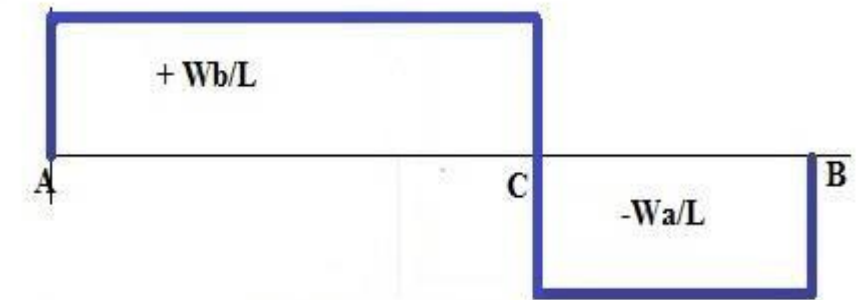
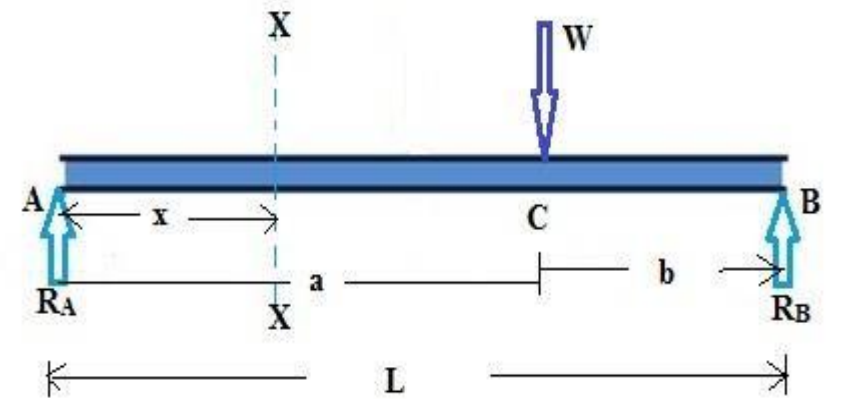
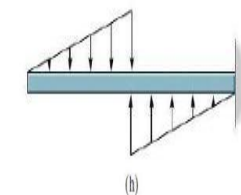
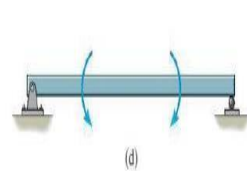
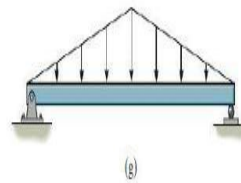
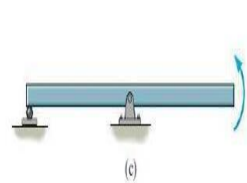
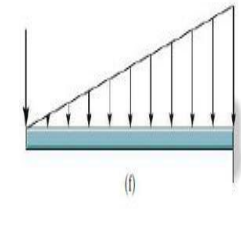
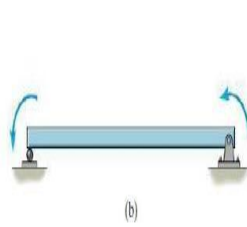
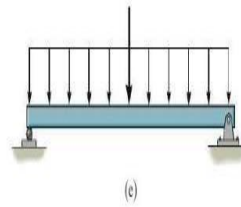
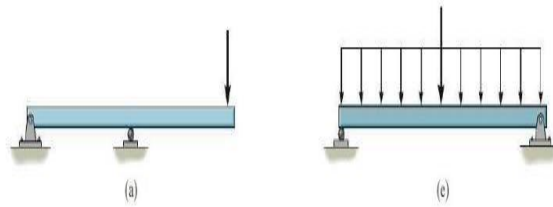


What is Bending Moment Diagram?

A **bending moment** is the reaction induced in a structural element when an external force or **moment** is applied to the element causing the element to **bend**. The most common or simplest structural element subjected to **bending moments** is the beam. The **diagram** shows a beam which is simple. Shear and **bending moment diagrams** are analytical tools used in conjunction with structural analysis to help perform structural design by determining the value of shear force and **bending moment** at a given point of a structural element such as a beam. ply supported at both ends.



1. In each case, the beam is subjected to the loadings shown. Draw the free-body-diagram of the beam, and sketch the general shape of the shear and moment diagrams. The loads and geometry are assumed to be known.



Chapter -2

Bending Stresses In Beams:

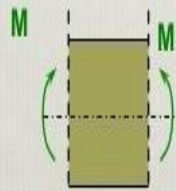
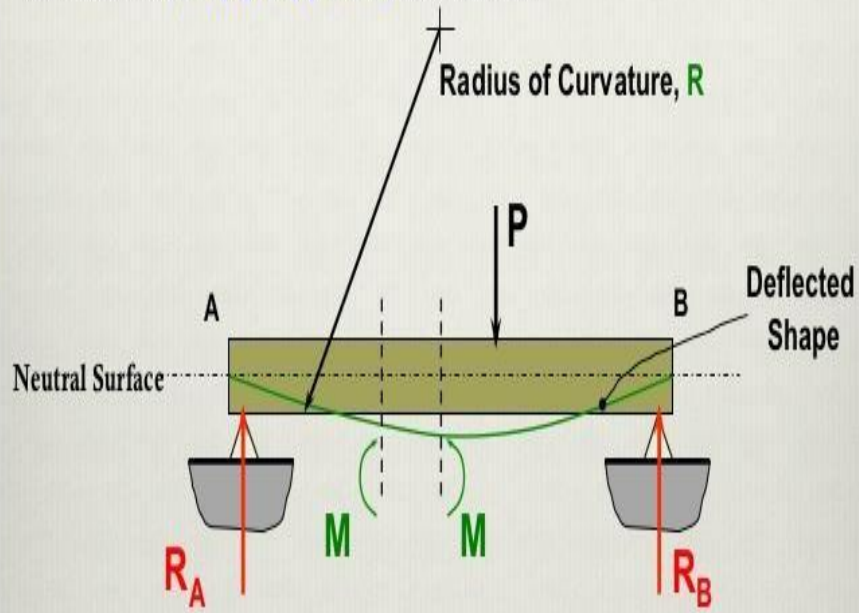
About bending stresses in beams!

- **Bending stress** is the normal **stress** that is induced at a point in a body subjected to loads that cause it to bend. When a load is applied perpendicular to the length of a beam (with two supports on each end), **bending** moments are induced in the beam. ... The bottom fibers **Bending stress** is the normal **stress** that is induced at a

point in a body subjected to loads that cause it to bend. When a load is applied perpendicular to the length of a beam (with two supports on each end), **bending** moments are induced in the beam. If the beam undergoes a normal tensile **stress**.

Bending Stress in beams

Consider the simply supported beam below:



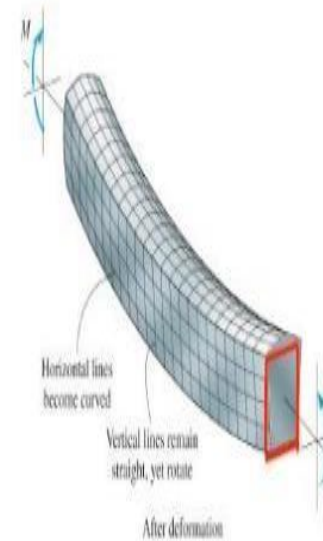
What stresses are generated within, due to bending?

Stresses in Beams – Bending and Shear

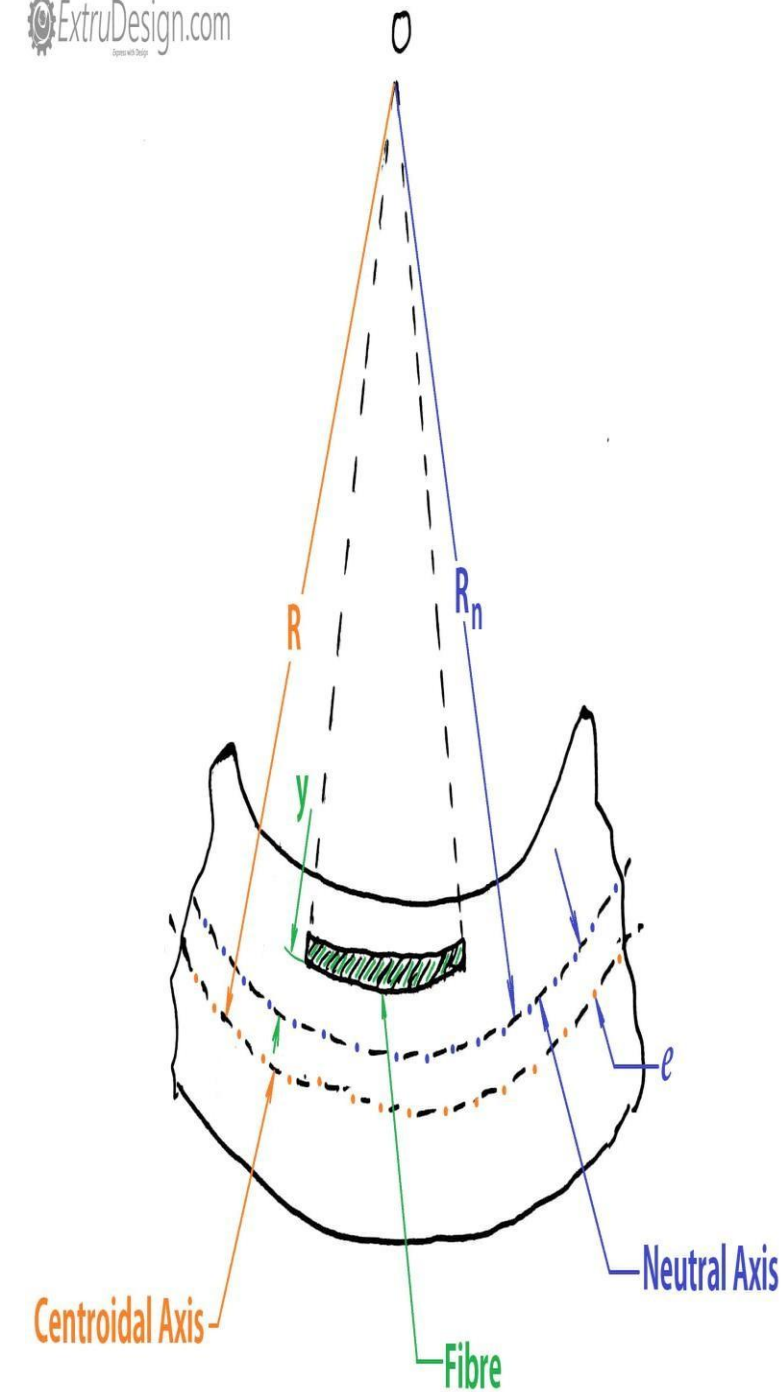
- Internal bending moment causes beam to deform.
- Top fibers in compression, bottom in tension.
- **Neutral surface** – no change in length.
- **Neutral Axis** – Line of intersection of neutral surface with the transverse section.
- All cross-sections remain plane and perpendicular to longitudinal axis.



Before deformation



After deformation



Chapter-3

About shearing stresses in beams!

- The **shearing stress in beam** is defined as the **stress** that occurs due to the internal **shearing** of the **beam** that results from **shear** force subjected to the **beam**. It is denoted by the symbol τ and is expressed in th The **formula** for **shear stress** is $\tau = F / A$, where 'F' is the applied **force** on the member, and The WSS is **calculated** from the **formula**: (a) $\text{WSS} = \text{WSR} \times P$, where WSR is the **wall shear** rate and P is the viscosity (0.01 for PBS). The WSR is **calculated** from the **formula**: (b) $\text{WSR} = 8 \times V_m / D$, where V_m is the fluid mean velocity and D is the diameter of the tube (1.025 mm in case of Drummond glass capillary tubes). 'A' is the cross-sectional area of the member. e unit of psi or N/mm

- When a beam is subjected to a transverse loading, a normal and a shearing stresses result in the beam. The influence of the shearing stress in the beam does not disturb the influence of the bending stress. The shear stress applied on the vertical surface of the beam exerts the same identical stress on the horizontal surfaces of the beam. Generally, the beam subjected to the transverse load exerts the longitudinal shear stress in the beam.
- 2.

1. Shear stresses involved the sliding of one plane against another

2. Shear Stress for a rectangular cross section

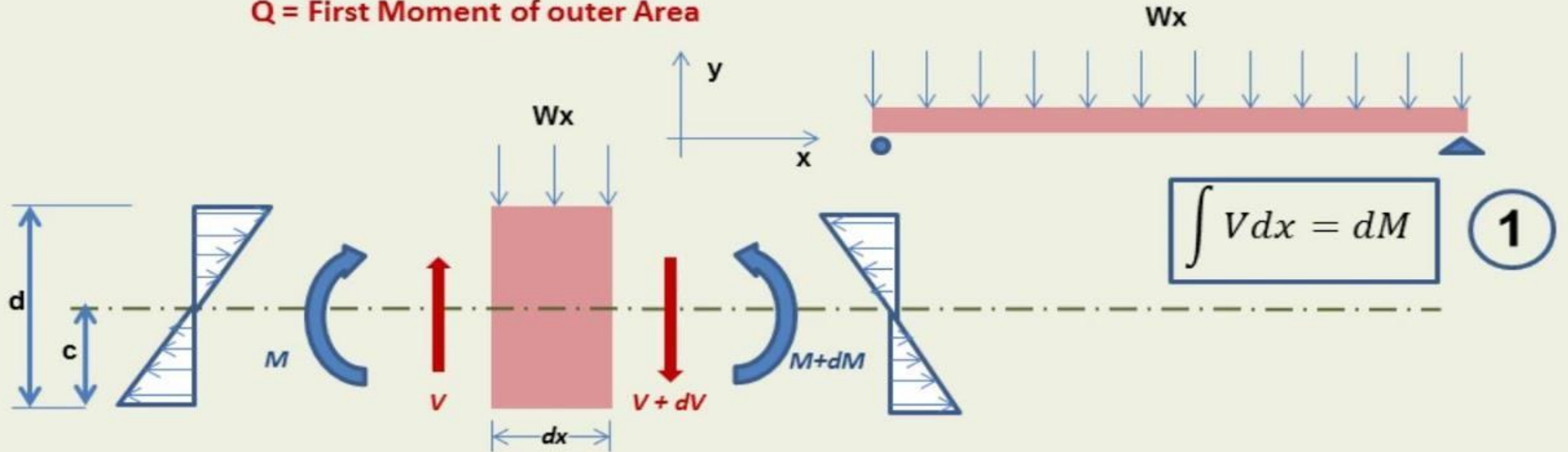
$$= \frac{V Q}{I b}$$

V = Shear force at location where stress is to be determined

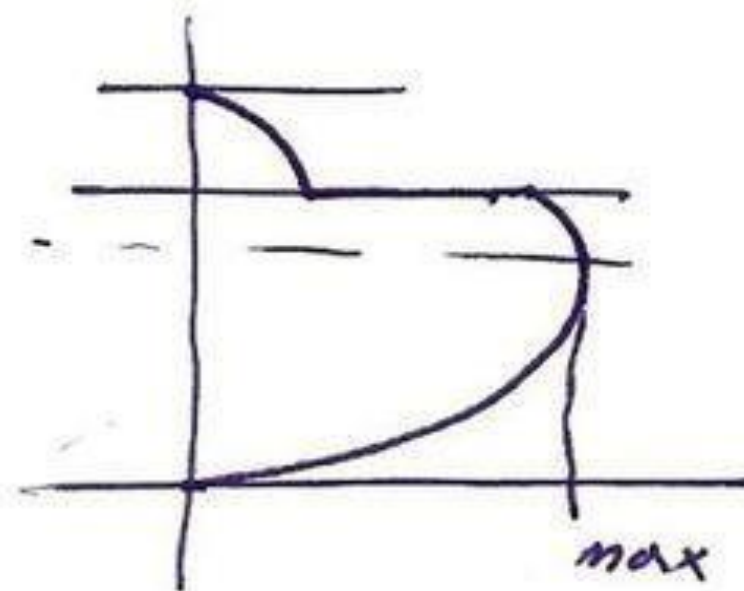
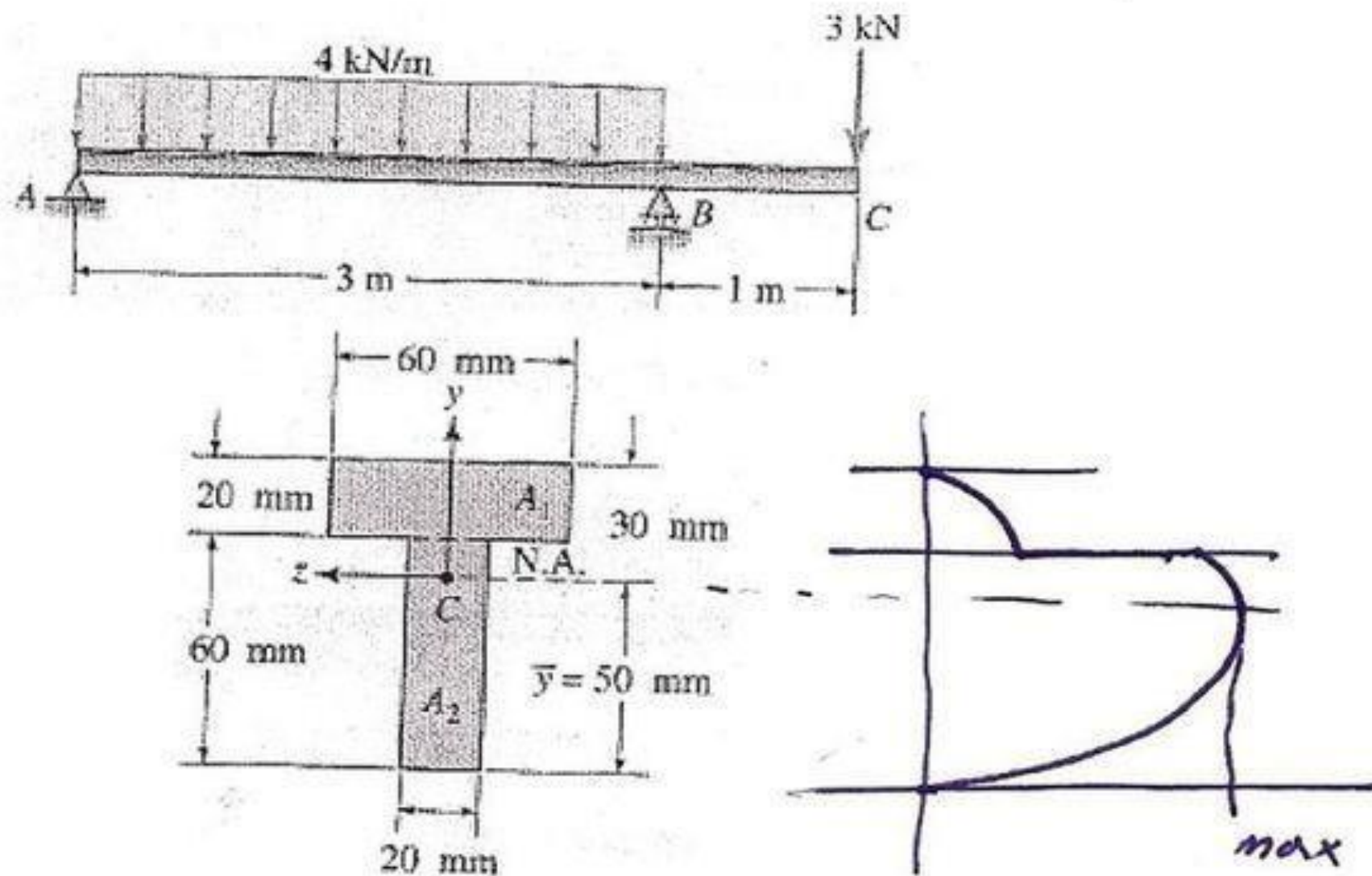
I = Moment of inertia of the beam cross-section

b = Width of beam cross section

Q = First Moment of outer Area

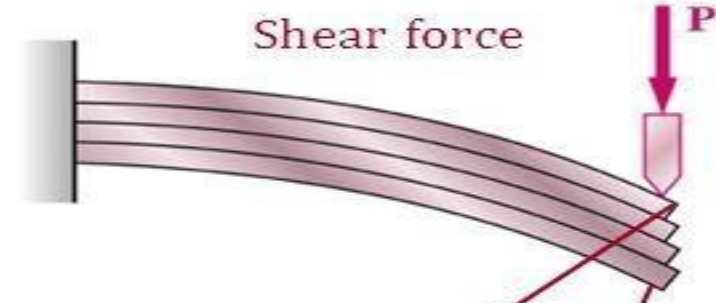
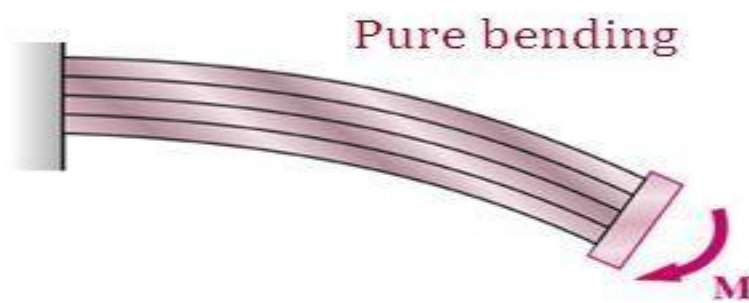


15. A T beam with overhang is supported and loaded as shown in Figure Q15. Calculate the greatest shearing stress.

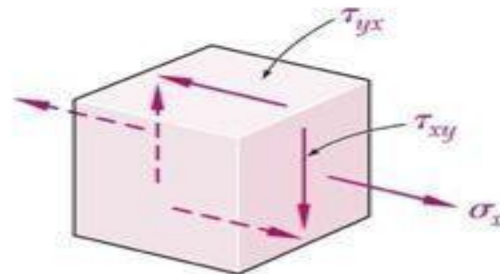


Shear Stress in Beams

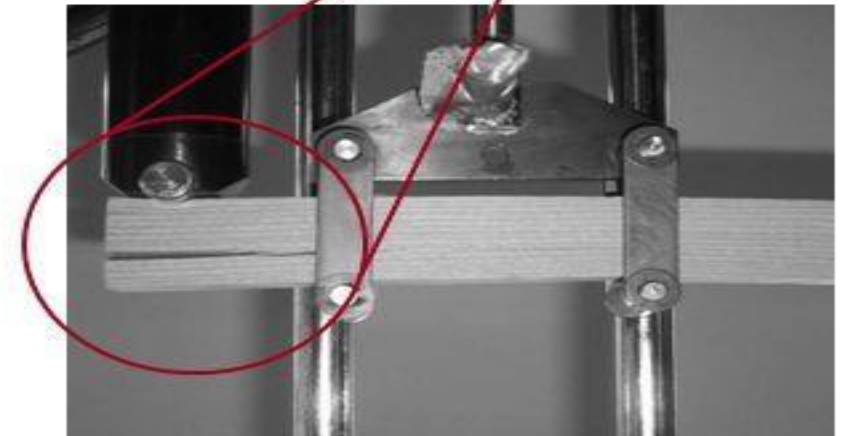
- Consider a cantilever beam composed of separate planks clamped at one end:



- Shear force causes tendency to “slide.”
- Stresses are equal in horizontal and vertical directions.



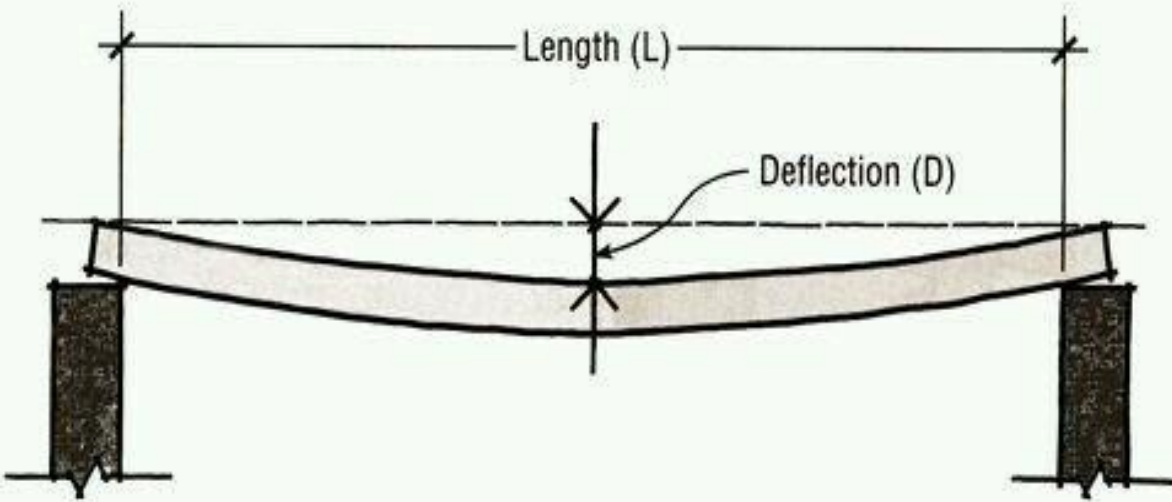
Shear Stress in Beams



About Deflection Of Beams.....

- In engineering, **deflection** is the degree to which a structural element is displaced under a load. ... The **deflection** of **beam** elements is usually calculated on the basis of the Euler–Bernoulli **beam** equation while that of a cantilevered **beams**, the **maximum deflection** will occur when the load is located at the free end of the **beam**, while for simply supported **beams**, **maximum deflection** will occur when the load is located in the center of the **beam** or shell element is calculated using plate or **allowable deflection** is generally expressed as a fraction of the span, in inches. All structural members will **deflect** or flex under load. ... For example, the **allowable deflection** of a 12ft span floor joist with plaster ($L/360$) is 0.4" (12ft divided by 360). Jun 5, 2019ell theory....

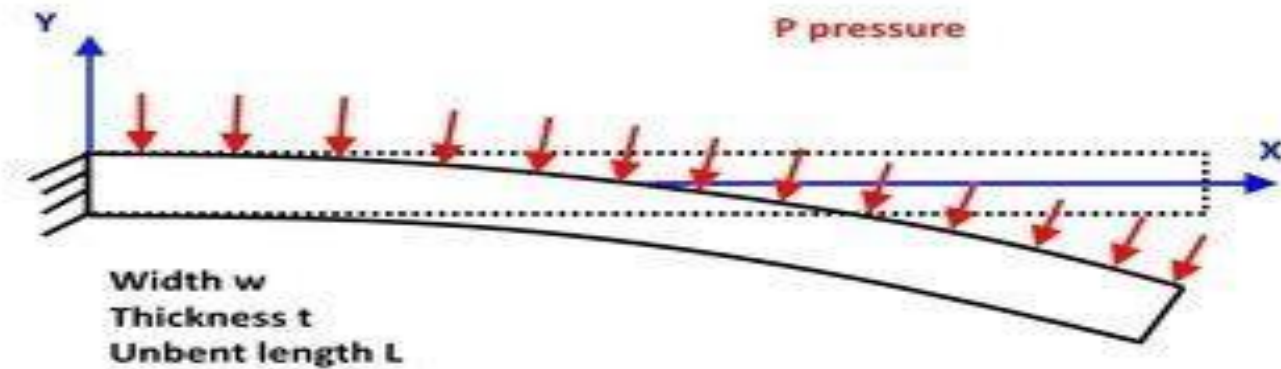
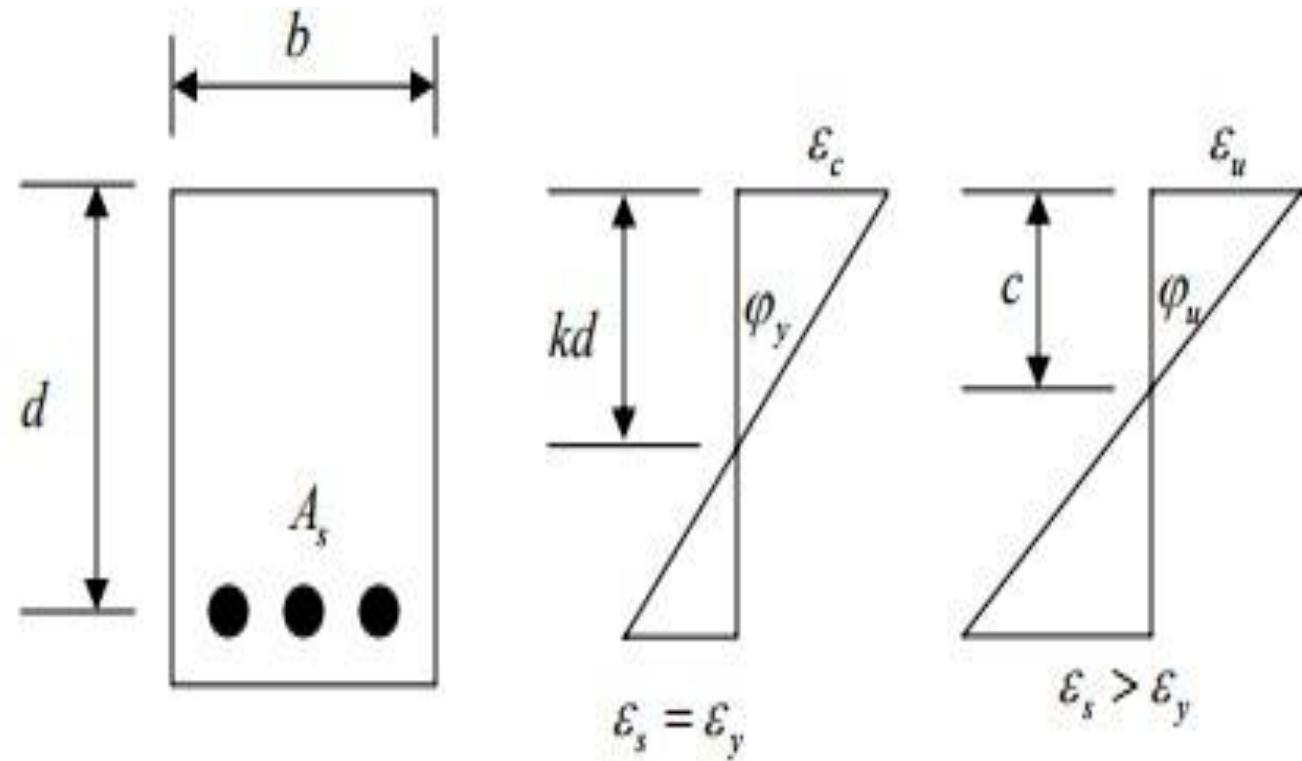
Calculating Deflection



Maximum allowable deflection (D) for joists is equal to $L/360$

For example, if $L = 20'-0''$:

$$\text{Deflection (D)} = \frac{L}{360} = \frac{20' \times 12''}{360} = \frac{240''}{360} = .666'' \approx 5/8''$$



$Y = f(X)$ equation of beam at equilibrium?

- Concept Of Steel Structure And Joints.....

What is steel Structure?

- **Structural steel** is a category of [steel](#) used for making [construction materials](#) in a variety of shapes. Many structural steel [shapes](#) take the form of an elongated beam having a [profile](#) of a specific [cross section](#). Structural steel shapes, sizes, [chemical composition](#), mechanical properties such as strengths, storage practices, etc., are regulated by [standards](#) in most industrialized countries.

A steel building is a metal structure fabricated with steel for the internal support and for exterior cladding, as opposed to steel framed buildings which generally use other materials for floors, walls, and external envelop



BEAM



HSS



CHANNEL



ANGLE



PLATE

What types of Math does a structural engineer use?

- We rely heavily on the mechanics and calculus which Newton developed in the 17th century, together with linear algebra.

Most problems boil down to solving the Euler–Bernoulli beam equation (usually the time-independent one, where inertial forces are disregarded).



Empire
City

Empire
City

- About welded Connections....



About Welded Connection!

5.7.2 **Welding.** **Welded connections** are **connections** whose components are joined together primarily by **welds**. ... Although fillet **welds** are generally weaker than groove **welds**, they are used more

often because they allow for larger tolerances during erection than groove **welds**.



Advantages of Welding

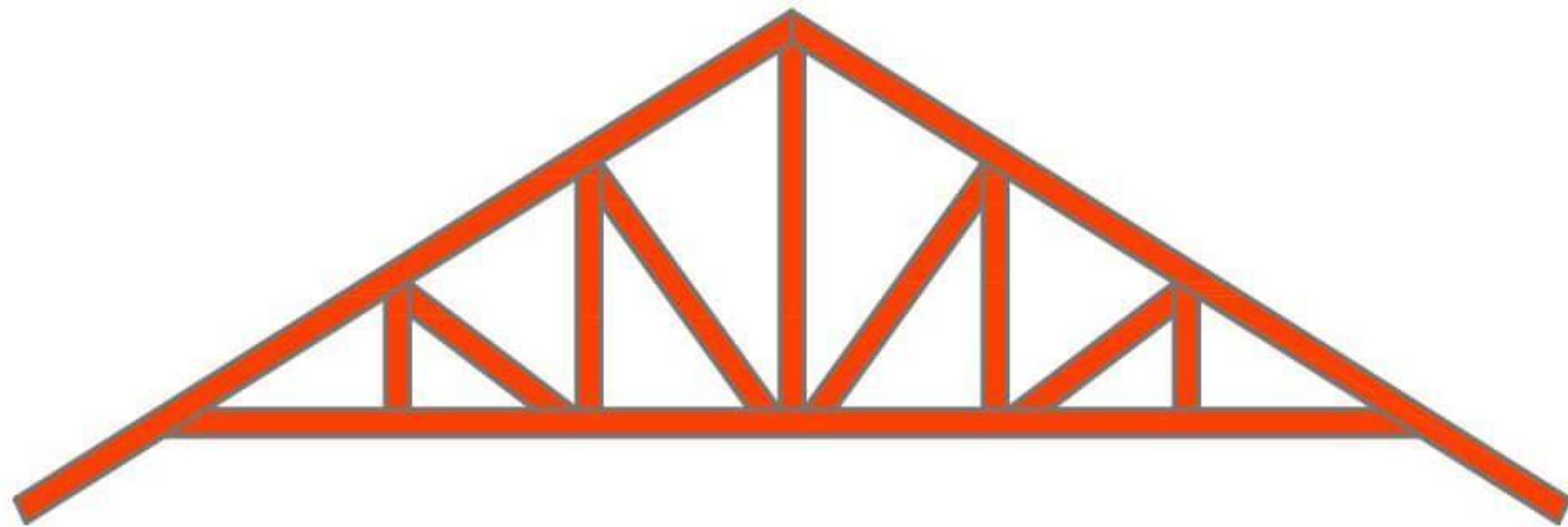
Welded joints are more economical as less labor and less material is required. The efficiency of **welded joint** is more than that of the riveted **joint**. ... The speed of

fabrication is faster in comparison with the riveted joints. Complete rigid joints can be provided with **welding** process.

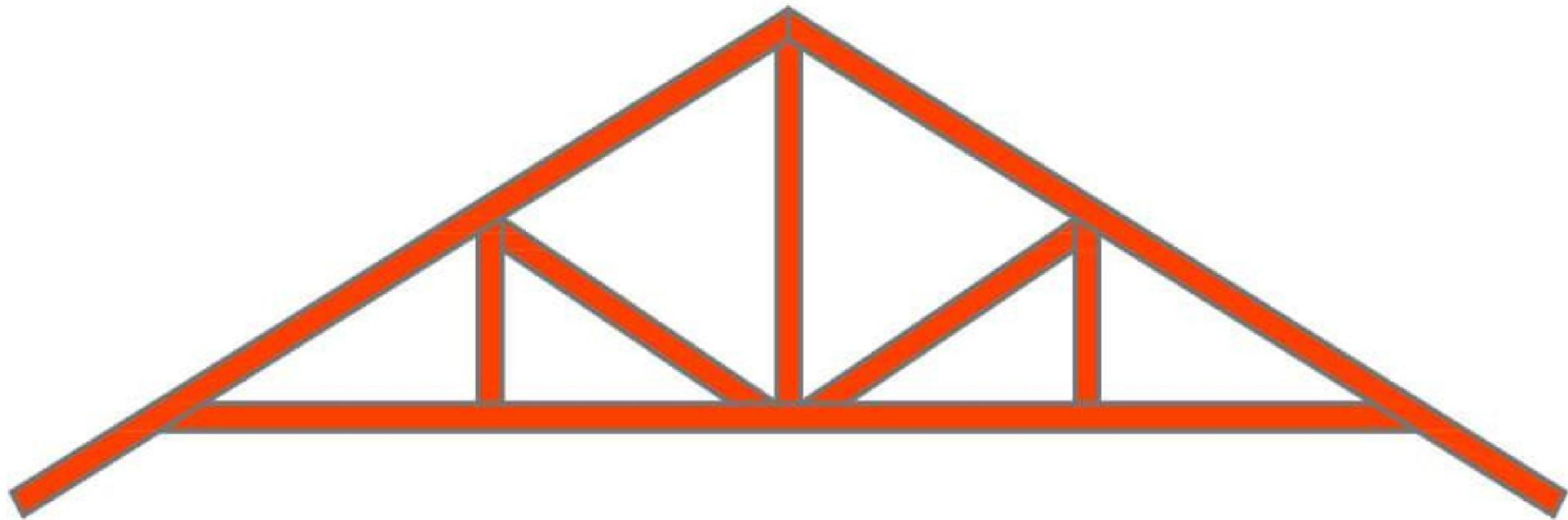
Action offered in frames.....

What is frame in civil engineering?

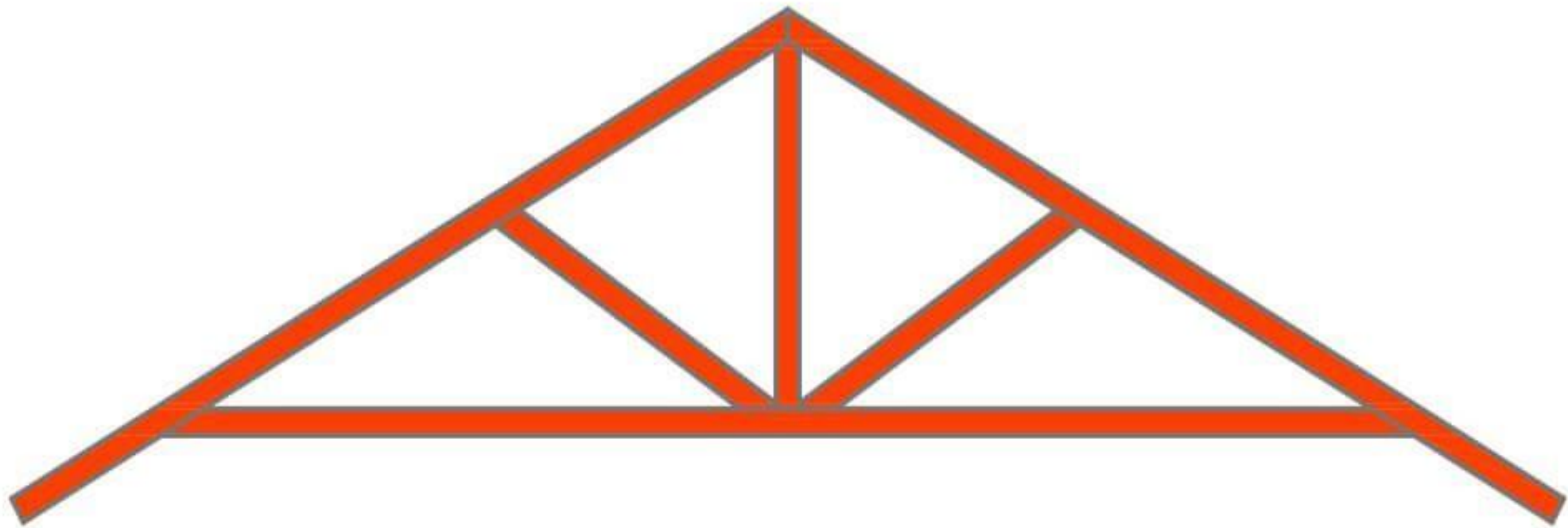
- **Frame** structures are the structures having the combination of beam, column and slab to resist the lateral and gravity loads. These structures are usually used to overcome the large moments developing due to the applied loading.



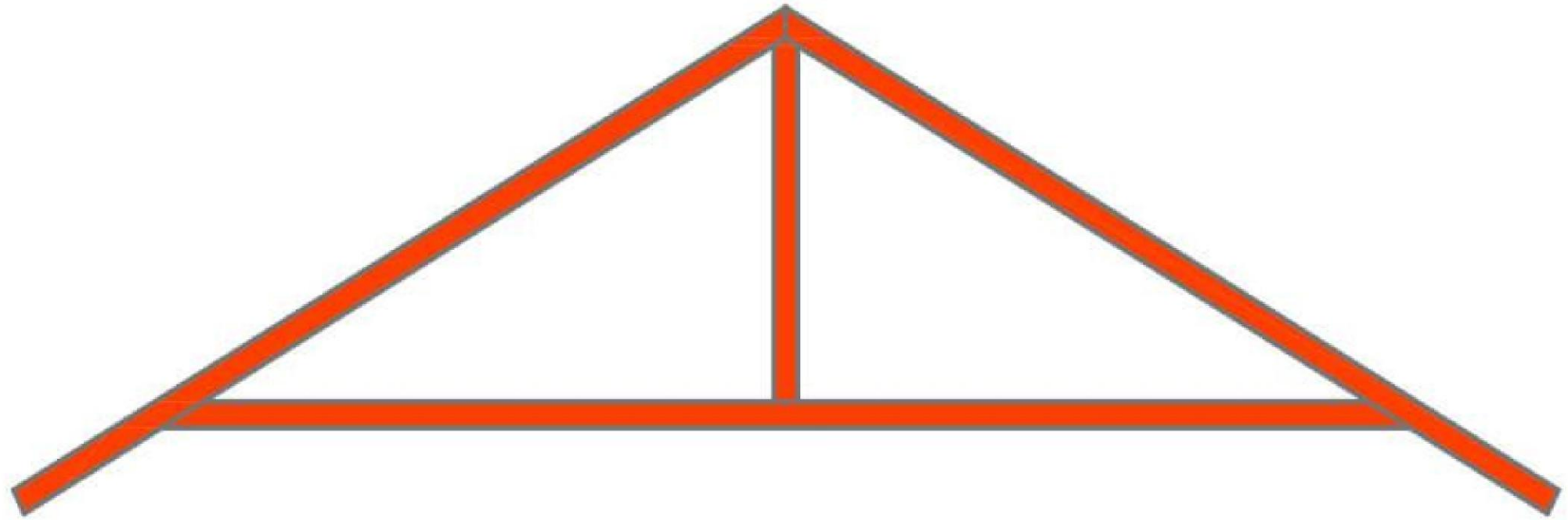
PRATT TRUSS



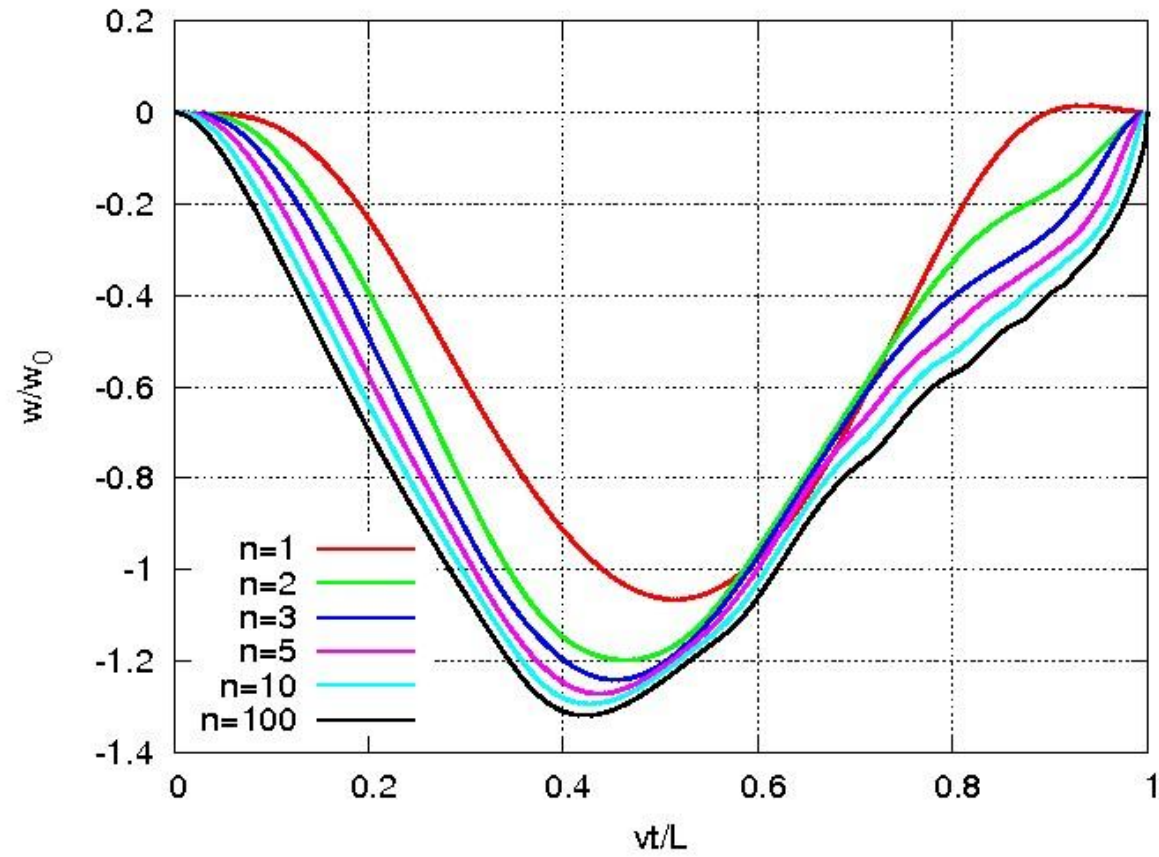
HOWE TRUSS



QUEEN POST TRUSS



KING POST TRUSS



Moving load!!!

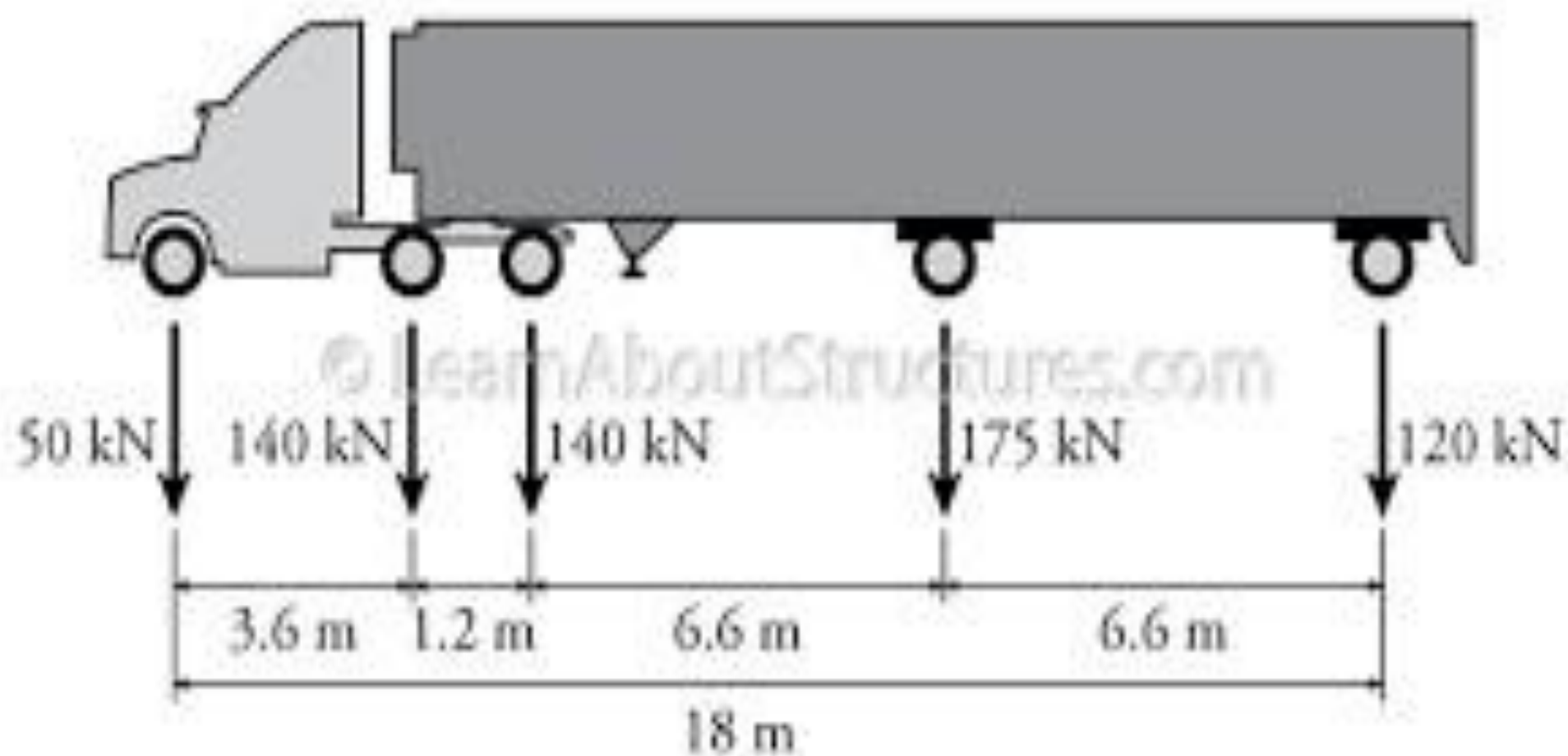
In [structural dynamics](#) this is the load that changes in time the place to which is applied. Examples: vehicles that pass bridges, trains on the track, guideways, etc. In computational models the load is usually applied as:

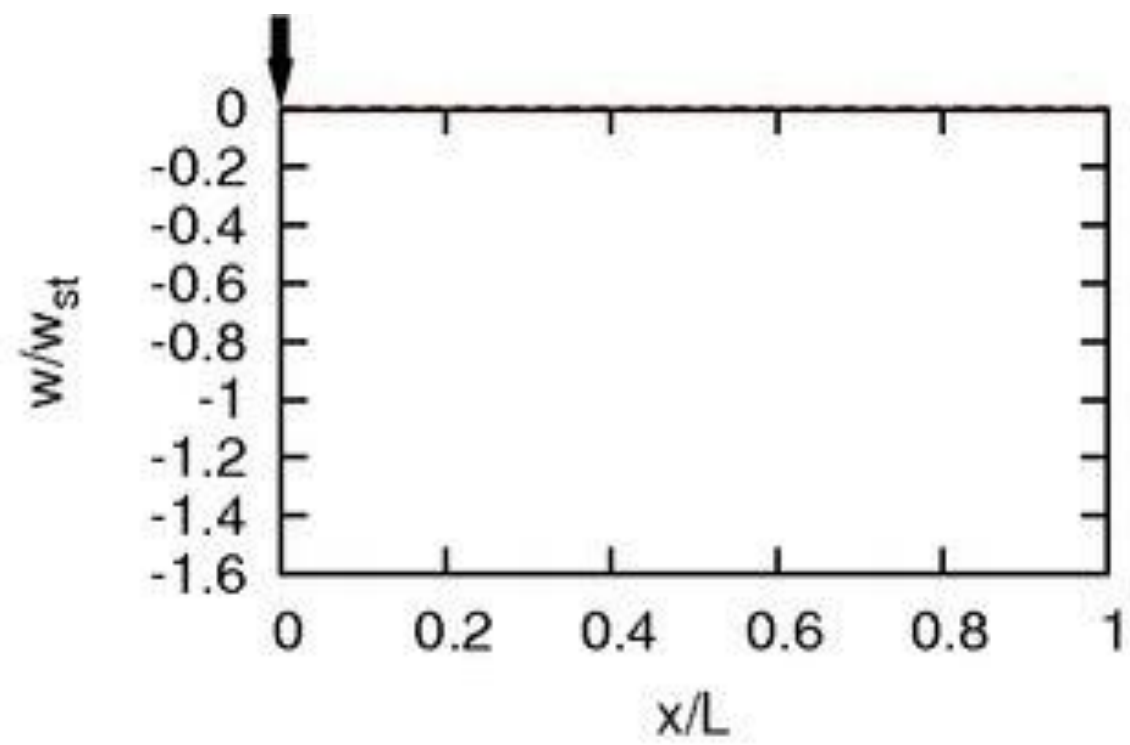
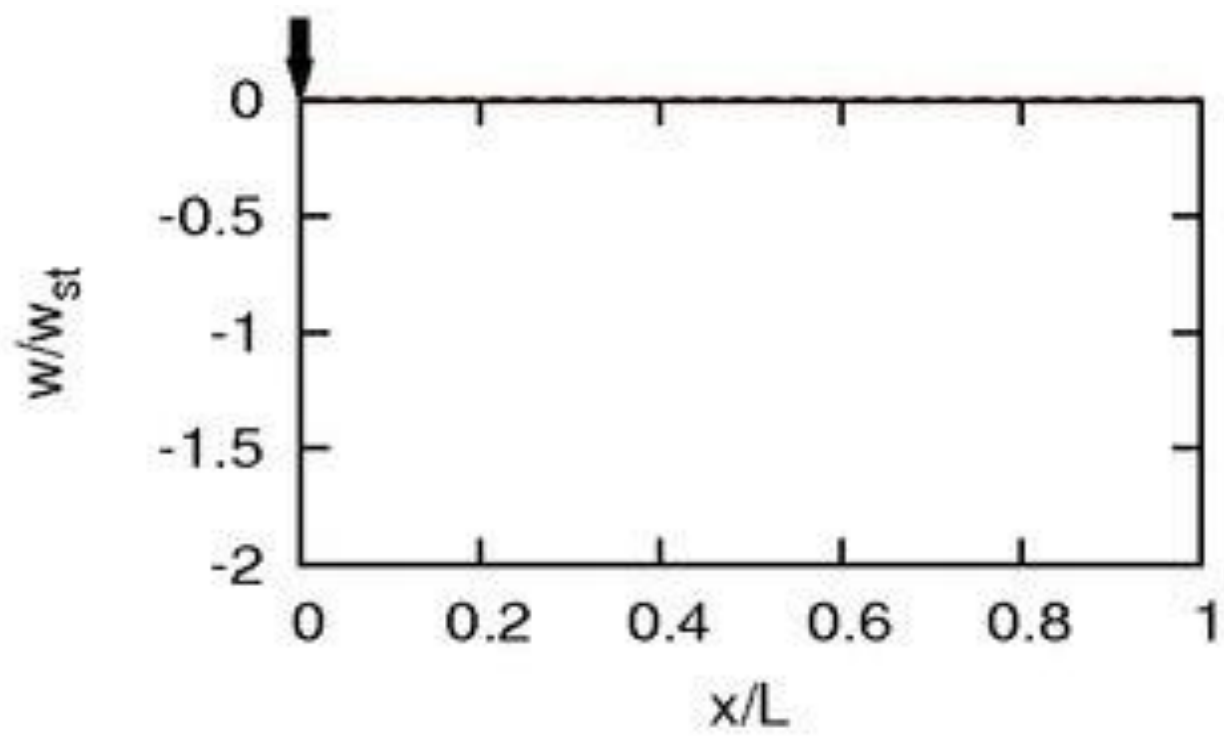
- a simple massless force,
- an oscillator,
- an inertial force (mass and a massless force).

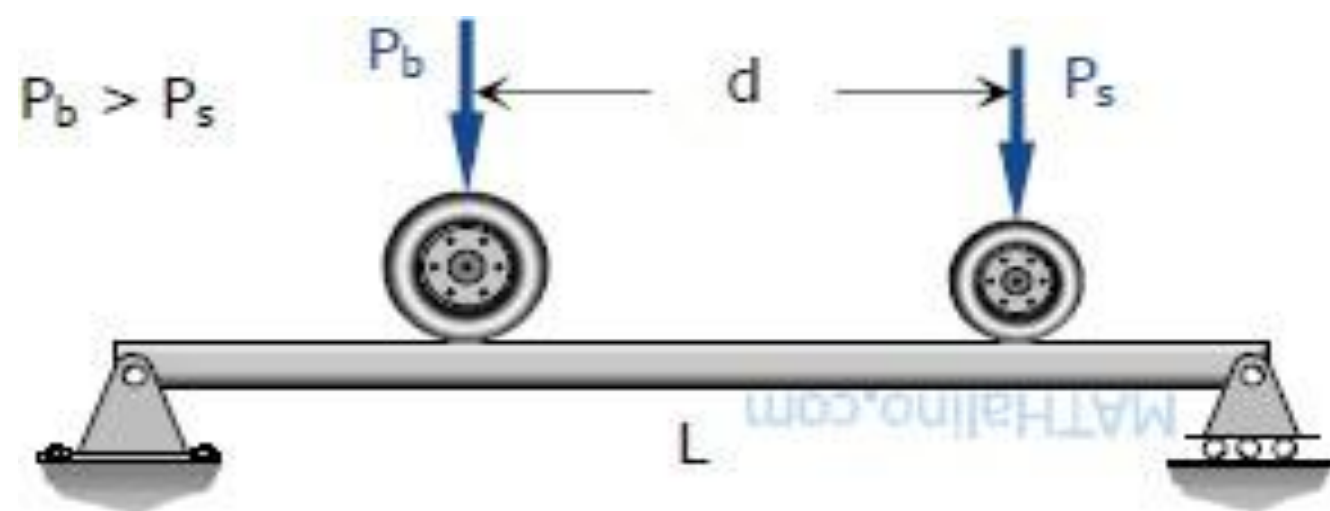
Numerous historical reviews concerning the moving load problem exist (for example, [\[1\]\[2\]](#)). Several publications deal with similar problems. [\[3\]](#)

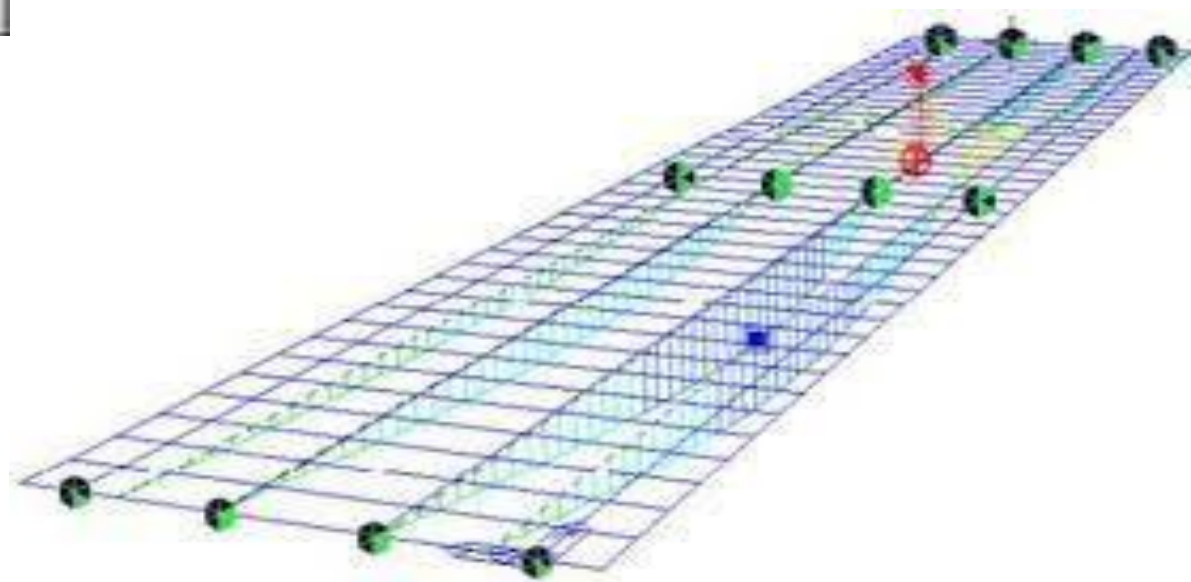
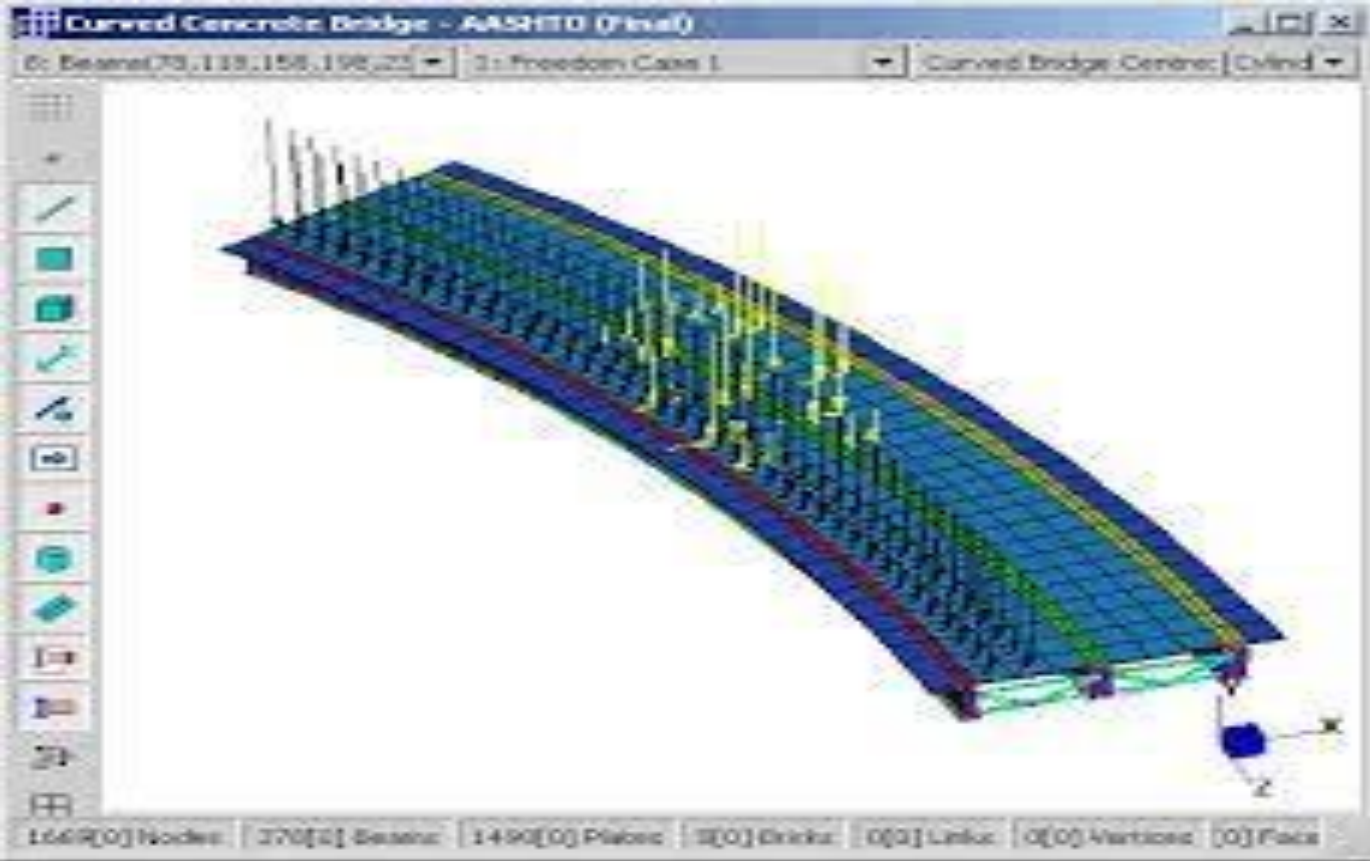
The fundamental monograph is devoted to massless loads. [\[4\]](#) Inertial load in numerical models are described in [\[5\]](#) Unexpected property of differential equations that govern the motion of the mass particle travelling on the string, [Timoshenko](#) beam, and [Mindlin](#) plate is described in. [\[6\]](#) It is the discontinuity of the mass trajectory near the end of the span (well visible in string at the speed $v=0.5c$). The moving load significantly increases displacements. The critical velocity, at which the growth of displacements is the maximum, must be taken into account in engineering projects. Structures that carry moving loads can have finite dimensions or can be infinite and supported periodically or placed on the elastic foundation.

Consider simply supported string of the length l , cross-sectional area A , mass density ρ , tensile force N , subjected to a constant force P moving with constant velocity v . The motion equation of the string under the moving force has a form







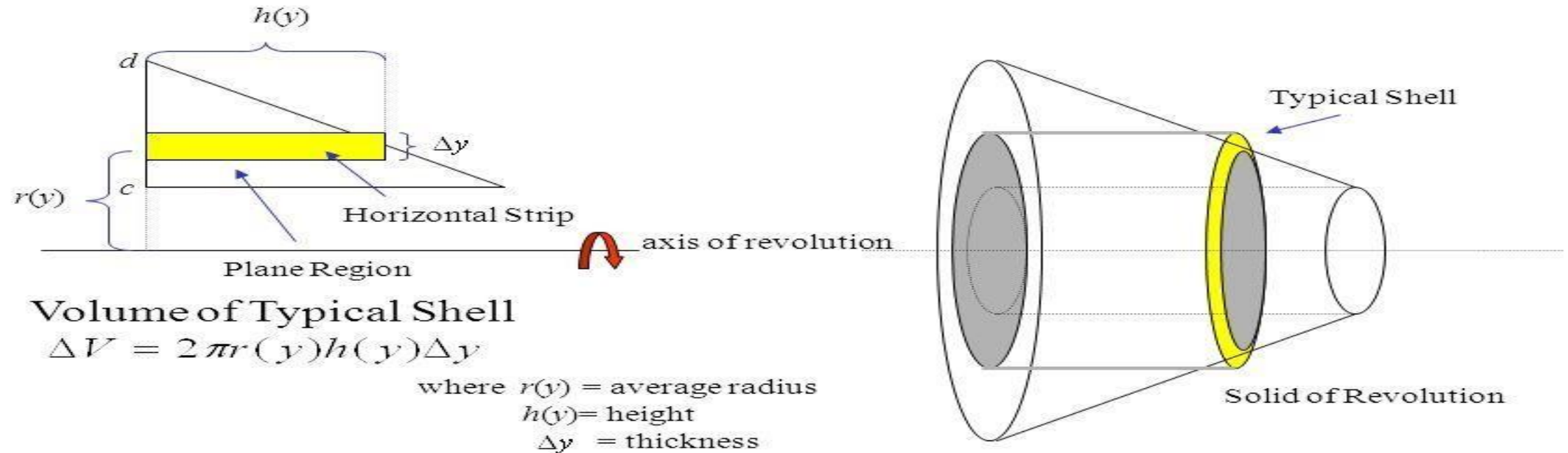


Define cylindrical shells!

- What is cylindrical shell?
- The **cylindrical shell** method. ... The volume of a cylinder of radius r and height h is $V = \pi r^2 h$. The volume of the **shell** between two cylinders, of the same height, one of radius r_1 and the other of radius $r_2 > r_1$ is $V = \pi (r_2^2 - r_1^2) h$, where r is the average radius and dr is the change in radius.
- Understanding the **Formula**
- The **shell method** relies on an easy geometrical **formula**. A very thin cylindrical **shell** can be approximated by a very thin rectangular solid. ... Thus, the volume of the **shell** is approximated by the volume of the prism, which is $L \times W \times H = (2 \pi r) \times h \times dr = 2\pi r h dr$.
- What is the difference between washer and shell method?

- The **disk method** is typically easier when evaluating revolutions around the x-axis, whereas the **shell method** is easier for revolutions around the y-axis---especially for which the final solid will have a hole in it (hence **shell**).

Volume: The Shell Method

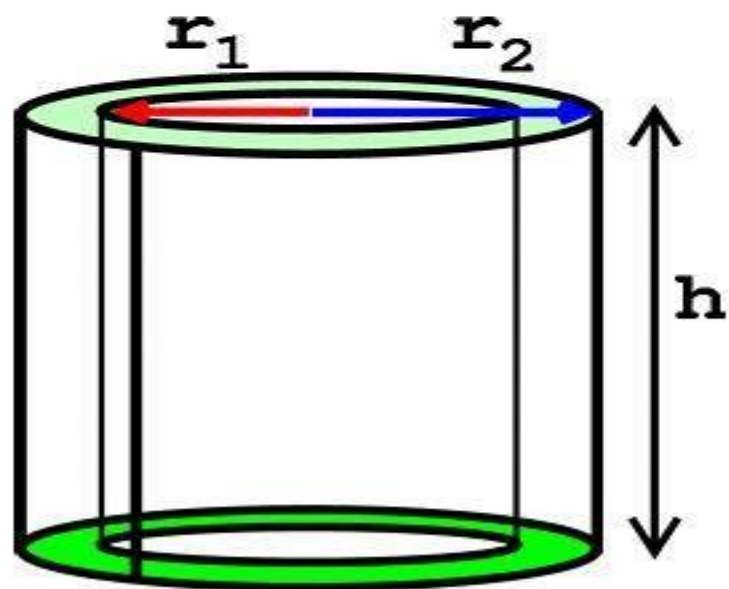


Volume of Solid

$$V = 2\pi \int_c^d r(y)h(y)dy$$

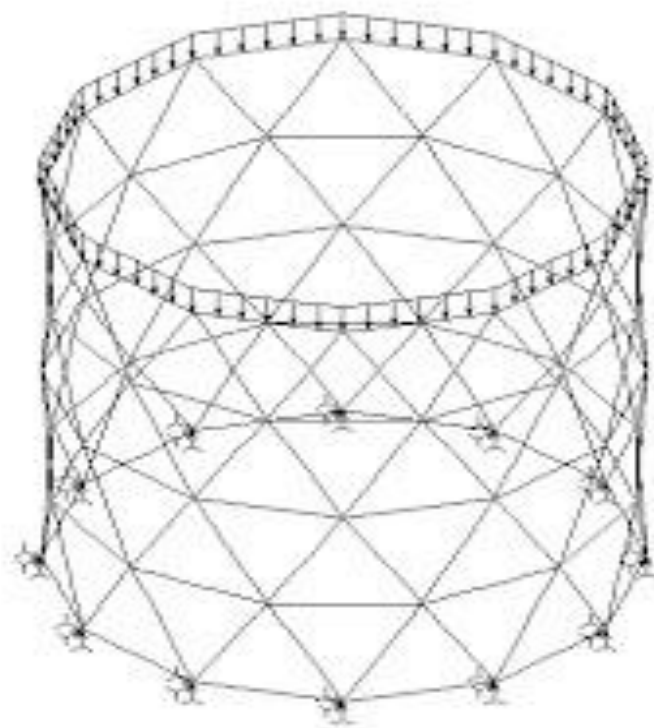
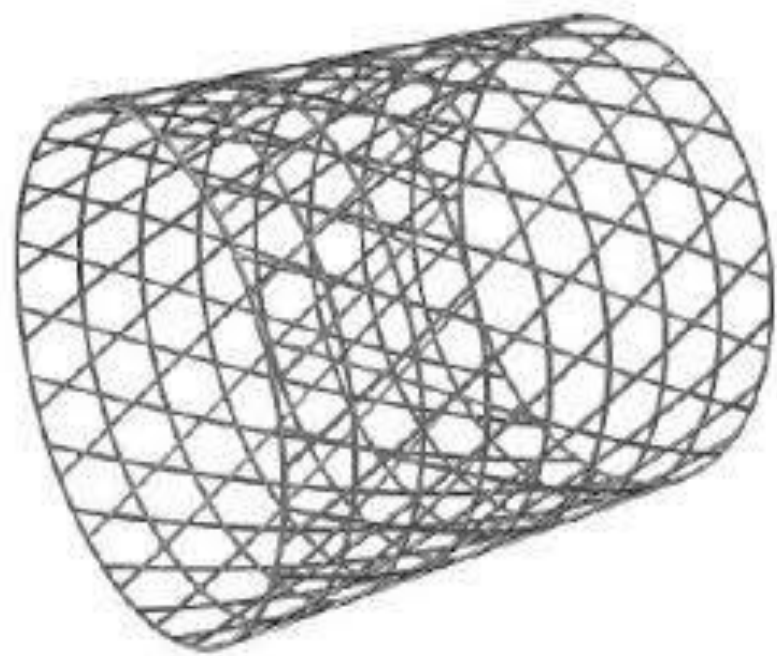
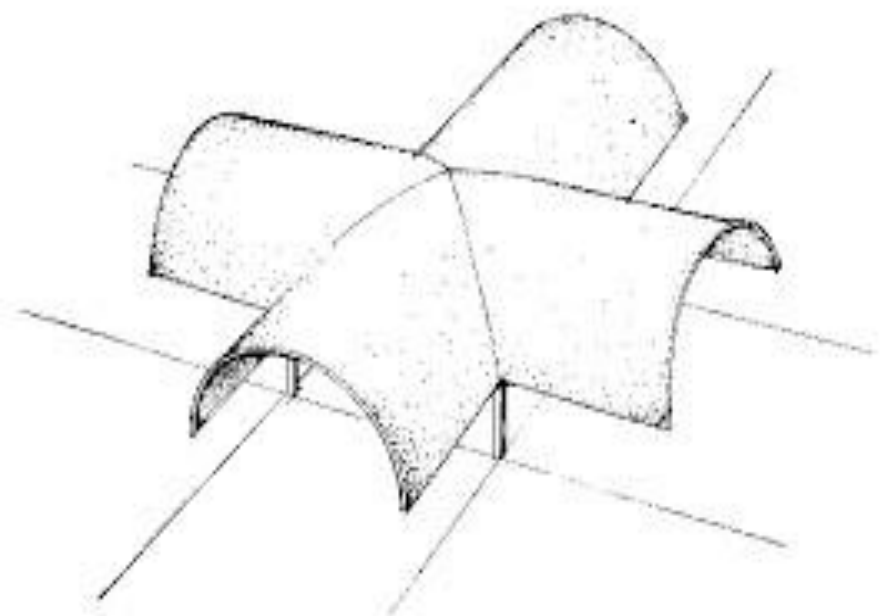
Method of Cylindrical Shells

We let the thickness of the shell be $\Delta r = r_2 - r_1$ and we also have $r = \frac{1}{2}(r_2 + r_1)$ so then the formula for the volume of a sphere is as follows:



$$V = 2\pi r h \Delta r$$

- Definition -Thin Shells
- If the wall thickness of the shell is less than 10% of the diameter of the shell then it can be treated as a thin shell.
- When the shell is subjected to internal Pressure the stresses developed are assumed to be uniform throughout the wall thickness.



Thank you for watching.....