



1. Centroid and Moment of Inertia

The centroid is the point where the total area/volume of a body is assumed concentrated.

Moment of inertia measures a section's resistance to bending. For a hollow circular section: $I = (\pi/64)(D^4 - d^4)$. The centroid of a semicircle of radius r from its base is $4r/3\pi$.

2. Stress, Strain, and Elastic Constants

- **Volumetric strain:** $e_v = (P/AE)(1 - 2/\mu)$, where $1/\mu$ is Poisson's ratio
- **Relation between E, K (bulk modulus), μ (Poisson's ratio):** $E = 3K(1 - 2\mu)$
- If modulus of rigidity = bulk modulus, Poisson's ratio = $1/4$
- **Principal planes** are where the resultant stress is purely **normal stress** (no shear)

3. Torsion of Shafts

Torsion formula: $\tau = 16T/(\pi d^3)$. Polar modulus = ratio of polar moment of inertia to distance from center (radius). The ratio of average to maximum shear stress in a solid circular section is $2/3$.

4. Columns and Buckling

Euler's crippling load depends on end conditions. For one end fixed, one end hinged: $P_{cr} = \pi^2 EI / (2L^2)$ (using effective length = $L/\sqrt{2}$).

5. Beams — Shear Force, Bending Moment, Fixed & Continuous Beams

- Shear force = algebraic sum of transverse forces on one side of a section



- A three-hinged arch is **statically determinate**
- Fixed beam with UDL: max hogging BM = $wl^2/12$
- The **three-moment equation** applies only when there's no discontinuity (like hinges) within the span

6. Soil Classification and Index Properties

- Silt particles (IS: 1498) are smaller than **75 microns**
- China clay = **Kaolinite** mineral
- Black cotton soil's swelling nature is due to **montmorillonite**

7. Permeability, Seepage, and Consolidation

- Seepage quantity $\propto$ coefficient of permeability $\times$ head loss
- **Uniformity coefficient** = D_{60}/D_{10} (from the given data $\approx 0.06/0.0005 = 120$... check values)
- **Compression index** = decrease in void ratio per increase in effective stress (log scale)
- Degree of consolidation = ratio of settlement at any time to final settlement

8. Shear Strength of Soil and Bearing Capacity

- For saturated clay shear strength testing: **unconfined compression test** or **triaxial test**
- Relative density formula relates natural, max, and min void ratios
- Bearing capacity relations link safe, net, and ultimate values using factor of safety



9. Open Channel Hydraulics

- **Most economical rectangular channel:** hydraulic mean depth = half the depth of flow
- Normal depth corresponds to **uniform flow**
- Most economical section = maximum discharge for given area, or minimum wetted perimeter
- Hydraulic radius = area of flow / wetted perimeter

10. Surveying — Curves, Contours, and Bearings

- Relation between curve radius and degree of curve: **$R = 1718.9/D$** (for chord definition) or **$R = 1146/D$**
- Contour lines join points of equal elevation
- True bearing = Magnetic bearing $\pm$ declination (West declination is subtracted... actually added when West: True = Magnetic + Declination for West)
- Transition curves gradually introduce superelevation/curvature
- Whole circle bearing ranges from **0° to 360°**