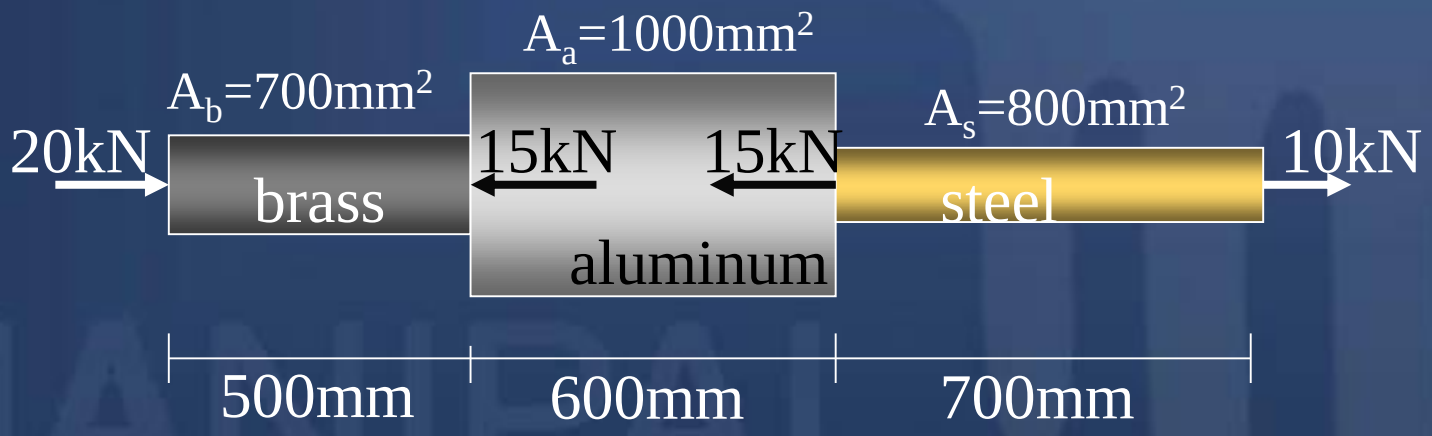
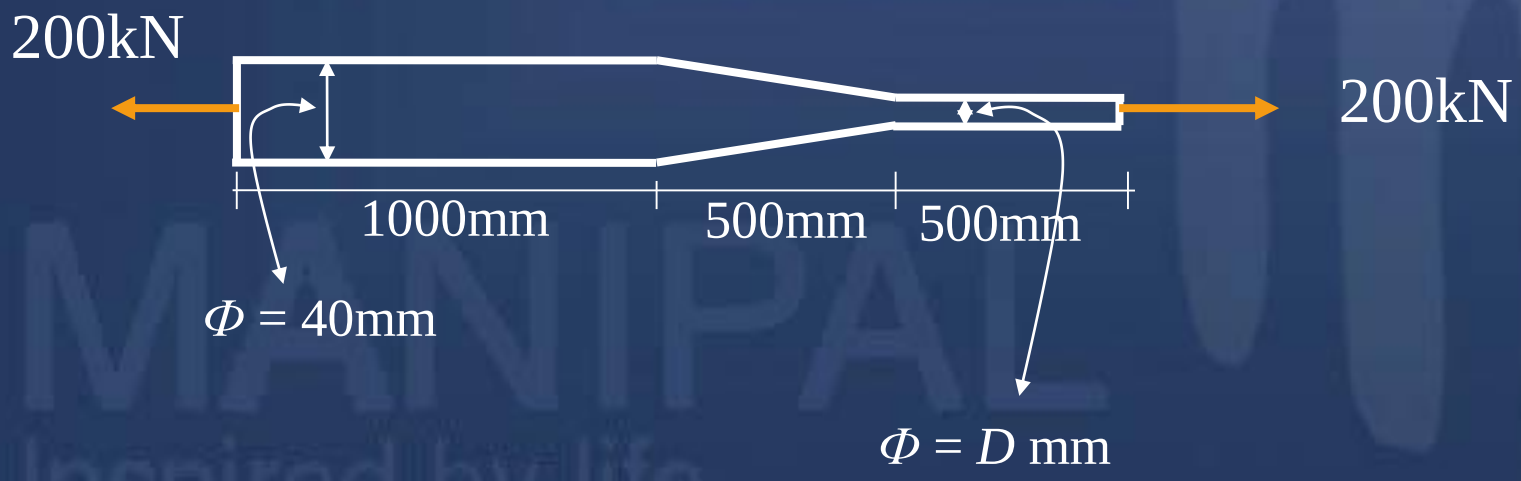
Exercise Problems

Q1. An aluminum tube is rigidly fastened between a brass rod and steel rod. Axial loads are applied as indicated in the figure. Determine the stresses in each material and total deformation. Take E_a=70GPa, E_b=100GPa, E_s=200GPa



Ans: σ_b=28.57MPa, σ_a=5MPa, σ_s=12.5MPa, δl = - 0.142mm

Q2. A 2.4m long steel bar has uniform diameter of 40mm for a length of 1.2m and in the next 0.6m of its length its diameter gradually reduces to '*D*' mm and for remaining 0.6m of its length diameter remains the same as shown in the figure. When a load of 200kN is applied to this bar extension observed is equal to 2.59mm. Determine the diameter '*D*' of the bar. Take E =200GPa



Q3. The diameter of a specimen is found to reduce by 0.004mm when it is subjected to a tensile force of 19kN. The initial diameter of the specimen was 20mm. Taking modulus of rigidity as 40GPa determine the value of E and μ

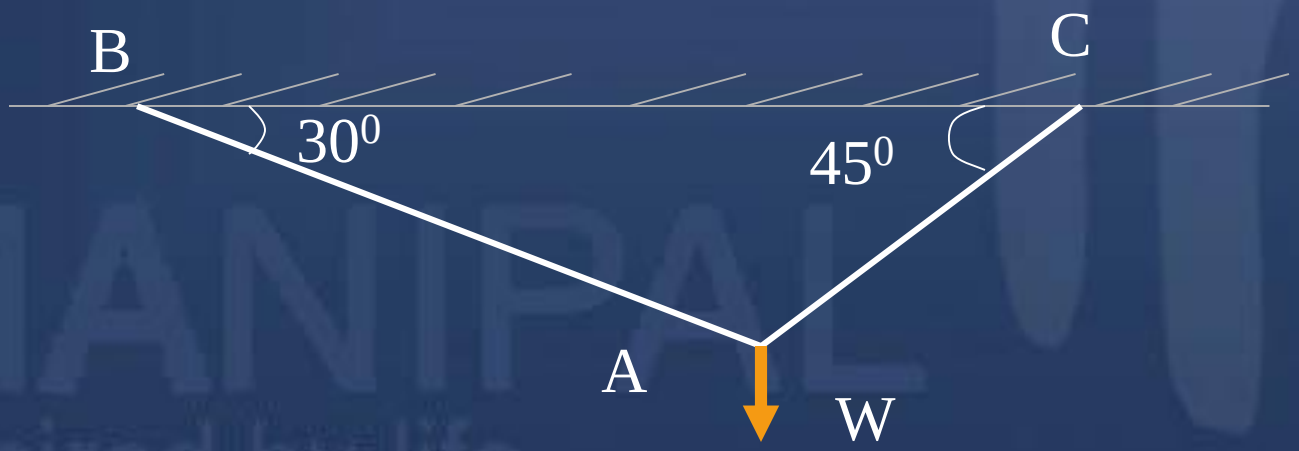
Ans: E=110GPa, μ=0.36

Q4. A circular bar of brass is to be loaded by a shear load of 30kN. Determine the necessary diameter of the bars (a) in single shear (b) in double shear, if the shear stress in material must not exceed 50MPa.

Ans: 27.6, 19.5mm

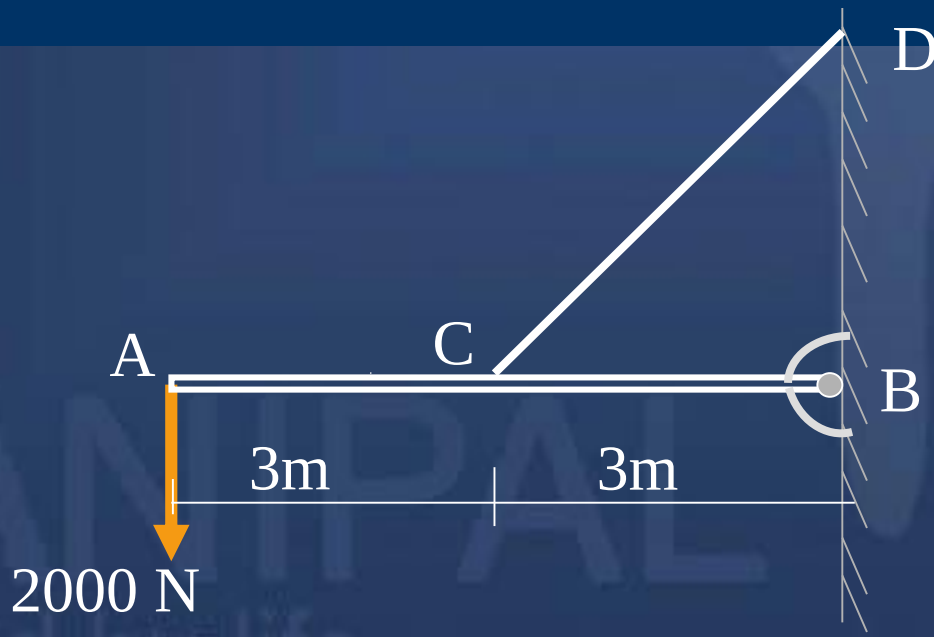
Q5. Determine the largest weight W that can be supported by the two wires shown. Stresses in wires AB and AC are not to exceed 100MPa and 150MPa respectively. The cross sectional areas of the two wires are 400mm^2 for AB and 200mm^2 for AC.

Ans: 33.4kN

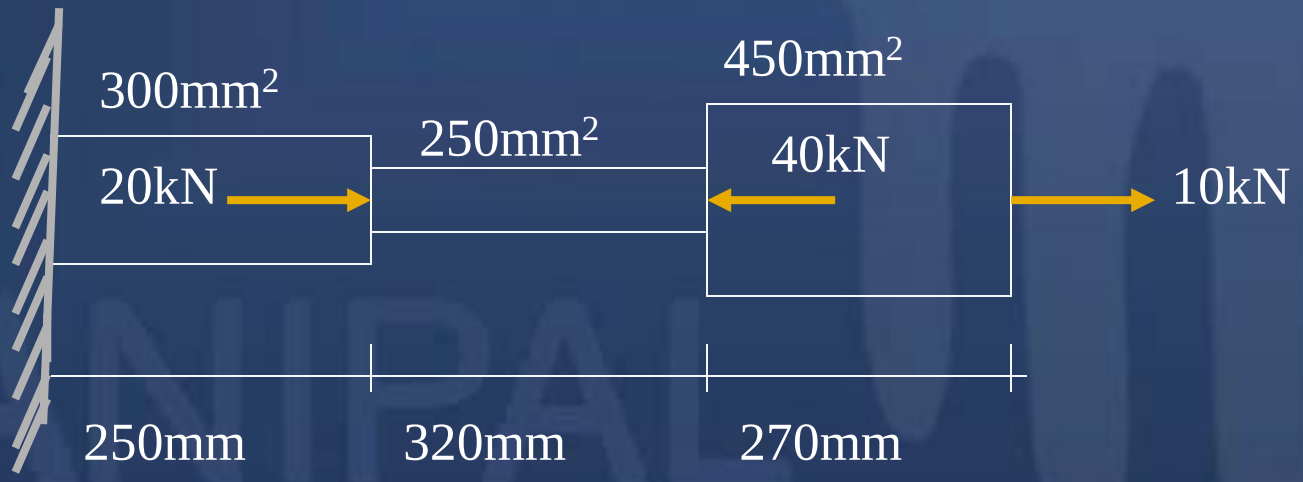


Q6. A homogeneous rigid bar of weight 1500N carries a 2000N load as shown. The bar is supported by a pin at B and a 10mm diameter cable CD. Determine the stress in the cable

Ans: 87.53MPa



Q7. A stepped bar with three different cross-sectional areas, is fixed at one end and loaded as shown in the figure. Determine the stress and deformation in each portions. Also find the net change in the length of the bar. Take E = 200GPa



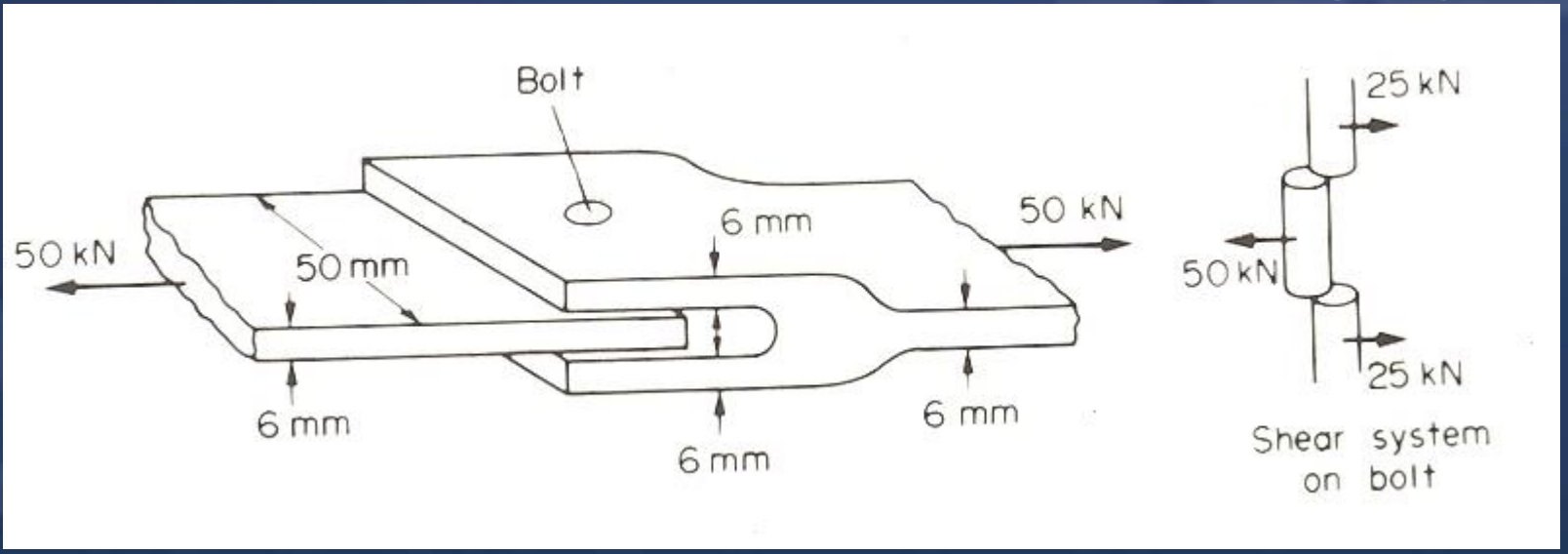
Ans: -33.33, -120, 22.2MPa, -0.042, -0.192, 0.03mm, -0.204mm

Q8. The coupling shown in figure is constructed from steel of rectangular cross-section and is designed to transmit a tensile force of 50kN. If the bolt is of 15mm diameter calculate:

a) The shear stress in the bolt;

b) The direct stress in the plate;

c) The direct stress in the forked end of the coupling.



Ans: a)141.5MPa, b)166.7MPa, c)83.3MPa

Q9. The maximum safe compressive stress in a hardened steel punch is limited to 1000MPa, and the punch is used to pierce circular holes in mild steel plate 20mm thick. If the ultimate shearing stress is 312.5MPa, calculate the smallest diameter of hole that can be pierced.

Ans: 25mm

Q10. A rectangular bar of 250mm long is 75mm wide and 25mm thick. It is loaded with an axial tensile load of 200kN, together with a normal compressive force of 2000kN on face 75mm×250mm and a tensile force 400kN on face 25mm×250mm. Calculate the change in length, breadth, thickness and volume. Take E = 200GPa & μ=0.3

Ans: 0.15,0.024,0.0197mm, $60mm^3$

Q11. A piece of 180mm long by 30mm square is in compression under a load of 90kN as shown in the figure. If the modulus of elasticity of the material is 120GPa and Poisson's ratio is 0.25, find the change in the length if all lateral strain is prevented by the application of uniform lateral external pressure of suitable intensity.

Ans: 0.125mm

Q12. Define the terms: stress, strain, elastic limit, proportionality limit, yield stress, ultimate stress, proof stress, true stress, factor of safety, Young's modulus, modulus of rigidity, bulk modulus, Poisson's ratio,

Q13. Draw a typical stress-strain diagram for mild steel rod under tension and mark the salient points.

Q14 Diameter of a bar of length 'L' varies from D_1 at one end to D_2 at the other end. Find the extension of the bar under the axial load P

Q15. Derive the relationship between Young's modulus and modulus of rigidity.

Q16 Derive the relationship between Young's modulus and Bulk modulus.

Q17 A flat plate of thickness 't' tapers uniformly from a width b_1 at one end to b_2 at the other end, in a length of *L* units. Determine the extension of the plate due to a pull *P.*

Q18 Find the extension of a conical rod due to its own weight when suspended vertically with its base at the top.

Q19. Prove that a material subjected to pure shear in two perpendicular planes has a diagonal tension and compression of same magnitude at 45^o to the planes of shear.

Q20. For a given material $E=1.1\times10^5 N/mm^2$ & $G=0.43\times10^5 N/mm^2$ .Find bulk modulus & lateral contraction of round bar of 40mm diameter & 2.5m length when stretched by 2.5mm. ANS: K=83.33Gpa, Lateral contraction=0.011mm

Q21. The modulus of rigidity of a material is $0.8\times10^5 N/mm^2$, when 6mm×6mm bar of this material subjected to an axial pull of 3600N.It was found that the lateral dimension of the bar is changed to 5.9991mm×5.9991mm. Find μ & E. ANS: μ=0.31, E= 210Gpa.