GLASGOW CALEDONIAN UNIVERSITY

School of Engineering & Built Environment

ENGINEERING DESIGN & ANALYSIS 2 (M2H721926) – Revision: Stress

Tutorial

1. A steel bar 250 mm long, having a rectangular cross-section 50 mm by 25 mm is subjected to an axial tensile force of 60kN. Find the change in the bar dimensions if for steel, $E_S = 210$ GN/m^2 and Poisson's ratio $\nu_s = 0.32$.

2. A press tool is required to pierce slots in steel plate 4mm thick. The slots have semi-circular ends 10.5 mm radius and are 80 mm in overall length. If the shear strength of the plate is 325 MN/m^2, calculate:-
   (a) the force required to pierce 1 slot;
   (b) the compressive stress set up in the punch.

3. A beam 4 m long, simply supported at its ends is to carry a central concentrated load of 10 kN. If the beam is to be of rectangular section, the depth being twice the width, determine its dimensions if the maximum stress in the material is to be 60 MN/m^2.

4. A beam of rectangular section has a depth of 100 mm and a width of 25 mm. If it is subjected to a bending moment of 40 kNm, calculate
   (a) the maximum bending stress set-up in the beam;
   (b) the radius of curvature at the top surface if this surface is placed in a state of tension, taking E = 200 GN/m^2.

5. Calculate the maximum force F which can be applied at mid-span to the simply supported beam shown in Figure Q.5, if the maximum bending stress at this point is not to exceed 200 MN/m^2. The second moment of area about the XX axis is 16 x 10^6 mm^4.

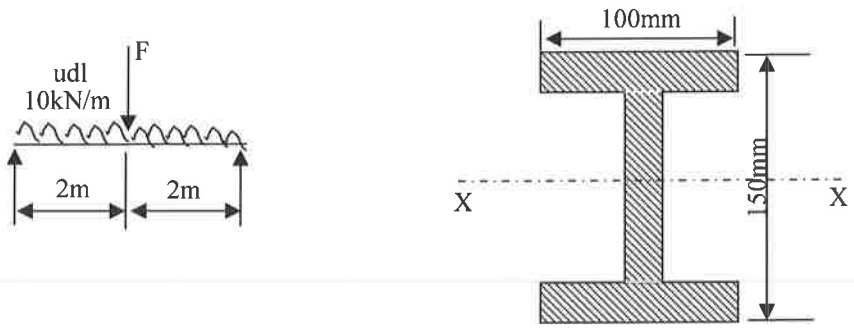

Figure Q.5

6. A bar 2 m long, 30 mm wide and 5 mm thick is supported horizontally on knife edges 1.2 m apart so that the overhand at each end of the bar is 0.4 m. A downward force of 15 N is applied to each end of the bar and the upward deflection midway between the supports is found to be 17mm. Calculate E for the material.

7. A circular steel bar is used as a cantilever beam to carry a transverse force of 20 kN at a point 1.5 m from the support. Calculate the diameter of the bar required to limit the maximum bending stress in the material to 170 MN/m^2.

8. A cast iron pipe is carried over a span of 6 m and may be considered simply supported at each end. The pipe has a 200 mm bore, 10 mm wall thickness and is full of water. Calculate the maximum bending stress in the pipe.
Density of water = 1 Mg/m^3
Density of cast iron = 7.2 Mg/m^3

9. A cantilever of rectangular cross-section 74 mm wide and 110 mm deep carries a concentrated load of 3 kN at its free end. Neglecting the mass of the cantilever, find the maximum length if the greatest permissible stress due to bending is 85 MN/m^2.

10. Find the maximum total uniformly distributed load which can be carried by a timber beam 300 mm deep, 200 mm wide and 3.5 m long which is simply supported at its ends. Neglect the mass of the beam itself and take the maximum stress due to bending to be 8 MN/m^2.

11. A 3 m long cantilever AB carries a vertical load of 10 kN at its free end B, as shown in Figure Q.11. The beam has a square cross-section of 75 mm x 75 mm.
Determine:

(a) the second moment of area of the beam cross-section about its centroidal axis;

(b) the magnitude of the maximum bending moment set up in the beam and where it acts;

(c) the maximum bending stress in the beam material and show the distribution of stress at the cross-section where the maximum moment is acting.

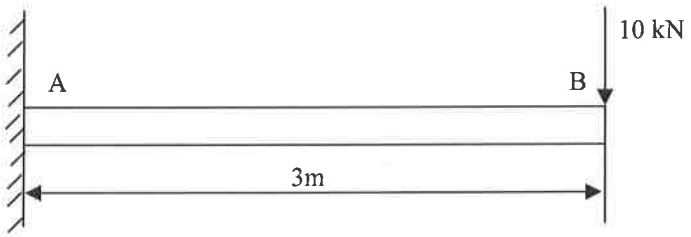

Figure Q.11

y

12. A 5m long simply supported beam carried a 12 kN load, as shown in Figure Q.12(a). The beam material has a maximum allowable stress of 280 MN/m^2.
The beam has a hollow rectangular section as shown in Figure Q.12(b) and bending takes place about the xx-axis. Determine:

(a) the second moment of area of the beam cross-section about the x-x axis;
(b) the magnitude of the maximum bending moment set up in the beam;
(c) the maximum stress set up in the beam material due to bending;
(d) the factor of safety in the loaded beam;
(e) the factor of safety in the loaded beam if the beam is positioned such that bending takes place about the y-y axis.

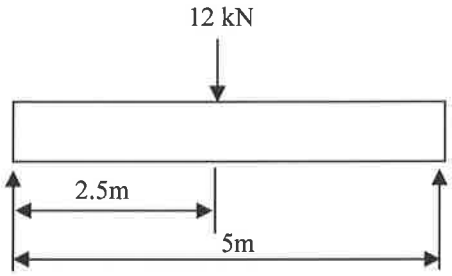

Figure Q.12(a)

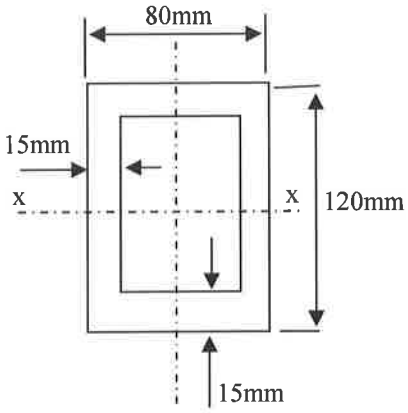

Figure Q.12(b)

ANSWERS

1. δL=0.057mm; δd=-0.00183mm; δb=-0.00366mm
2. (a) 239.2 kN; (b) 150.9 MN/m^2
3. 126mm deep x 63mm wide.
4. (a) 960 MN/m^2; (b) 10.464 m.
5. 22.67kN
6. 326.4 GN/m^2
7. 122 mm
8. 83.75 MN/m^2
11. (a) 2.64 x 10^6 mm^4; (b) 30 kNm at A; (c) 426.7 MN/m^2
12. (a) 8.48 x 10^6 mm^4; (b) 15 kNm at mid-span; (c) 106.13 MN/m^2; (d) 2.64