

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Quiz - 2 (Solution)

Date: 03.04.17

Time: 30 mins.

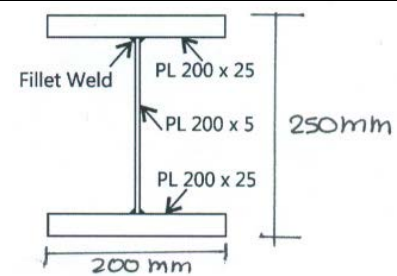
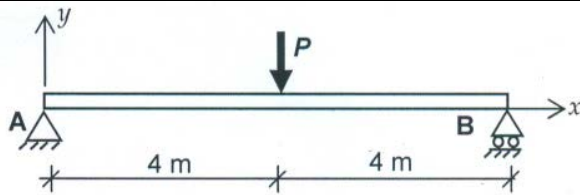
Full Marks: 20

No. of Students: 168

Sub. No.: ESO202A/204

Sub. Name: Mechanics of Solids

2016-17, II Semester



All dimensions are in mm, PL - Plate

SFD & BMD as shown to indicate max. bending moment & shear force. Consider the following three cases of
(a) bending (normal) stress in the section flange
(b) shear stress in the web
(c) shear stress (flow) in the weld.

CASE (a): Max. bending stress in the flange.

$$M_{all}^{max} = \frac{\sigma_{all} I_{zz}}{y_{max}} = \sigma_{all} \left(\frac{4}{2} \right) Nm = (2000mm) \sigma_{all}$$

$$\Rightarrow \sigma_{all} (N) = \frac{M_{all}}{(2000mm)} = \frac{\sigma_{all} I_{zz}}{(2000mm)(y_{max})} = \frac{(165 N/mm^2)(I_{zz})}{(2000mm)(250mm/2)}$$

$$\text{But } I_{zz} = \frac{1}{12} [200 \times 250^3 - 195 \times 200^3] = 1.304 \times 10^8 mm^4$$

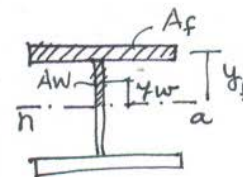
$$\therefore \sigma_{all} = 86.1 kN$$

CASE (b): Web shear max at n.a.

$$Q = A_f y_f + A_w y_w = (25 \times 200)(112.5) + (5 \times 100)(50) = 5.875 \times 10^5 mm^3$$

$$\tau_{all} = \frac{V_{all} Q}{I_b} = \left(\frac{\sigma_{all}}{2} \right) \left(\frac{Q}{I_b} \right)$$

$$\Rightarrow \sigma_{all} = \frac{2 \tau_{all} I_b}{Q} = \frac{2(100 N/mm^2)(1.304 \times 10^8 mm^4)(5mm)}{5.875 \times 10^5 mm^3} = 222 kN$$



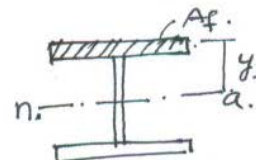
CASE (c): Weld shear below the flange.

$$Q = A_f y_f = (25 \times 200)(112.5) = 5.625 \times 10^5 mm^3$$

$$\text{Shear flow in weld, } q = \frac{VQ}{I_{zz}} = \frac{y_{max} Q}{I_{zz}} = \left(\frac{\sigma_{all}}{2} \right) \frac{Q}{I_{zz}}$$

$$\Rightarrow q_{all} = 2 \left(\frac{200 N}{mm} \right) = \frac{\sigma_{all} (5.625 \times 10^5 mm^3)}{1.304 \times 10^8 mm^4}$$

$$\Rightarrow \sigma_{all} = 185.5 kN$$



$$\therefore \text{Allowable load} = \min [86.1 kN, 222 kN, 185.5 kN] = 86.1 kN \quad \underline{\underline{ANS}}$$

Grading Scheme

Total marks 20

1. BM/SF diagram to identify the location and magnitude of maximum BM and SF - 5 Marks
2. Calculation of I_{zz} - 3 Marks
3. Calculation of allowable P due to bending stresses -- 2 Marks
4. Calculation of Q at the weld -- 3 Marks
5. Calculation of allowable shear stress considering strength at the weld -- 2 Marks
6. Calculation of Q at mid-section -- 3 Marks
7. Calculation of allowable shear stress considering strength of the web -- 2 Marks

Note:

The marks indicated against each item above is the maximum that has been awarded for correctly working out that item. There is uniform deduction of about 25-33% marks for calculation mistakes.