Department of Mechanical, Mechatronics & Manufacturing Engineering,
University City Campus (KSK), UET Lahore.

Subject:	**Mechanics of Materials-I**	**End Term Exam KEY**
Time Allowed: 2 hours	**Max. Marks: 40**	**Session 2008**
Name:_____	**Reg.# 2008-EP-_____**	**Date: 09-01-2010**

Note: Attempt all questions. E = 200 GPa For Steel.

1 (a) Determine moment of Inertia **(I_y)** along Y-Axis for the area shown in **Fig (1a)**.

The X-section can be considered as three composite rectangular areas A, B & D as shown

Rectangle A & D:

$$I_y = \frac{1}{12}(300\text{ mm})(100\text{ mm})^3 + (100\text{ mm})(300\text{ mm})(250\text{ mm})^2$$

$= 1.90 * 10^9$ mm^4

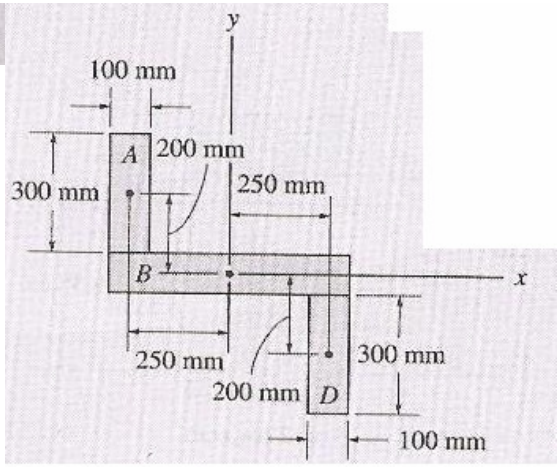
Rectangle B :

$$I_y = \frac{1}{12}(100\text{ mm})(600\text{ mm})^3$$

$= 1.80 * 10^9$ mm^4

so,

$$I_y = 1.90(10^9) + 1.80(10^9) + 1.90(10^9)$$
$$= 5.60(10^9)\text{ mm}^4$$ **Ans.**



1 (b) If the magnitude of the couples required to bend the steel strip is 4.32 * 10 $^{-3}$ N. m into a circle of 20 mm diameter without resulting permanent deformation, then find the width "w" of the strip as shown in **Fig. (1b).**

DATA:

M = 4.32* 10^{-3} N.m

d = 20 mm = 20 * 10^{-3} m OR r = 10 * 10^{-3} m

w =?

h = 0.12 mm OR 0.12 * 10^{-3} m

From Appendix: For steel E = 200 GPa.

Solution:

Flexure formula: M / I = E / r ---------- (1)

Since, I = wh ^{3} / 12

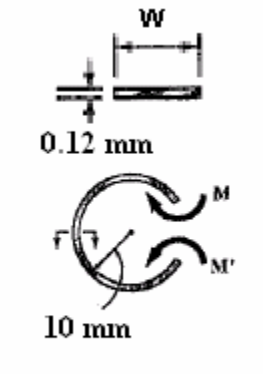


Fig. (1b)

(1) ➔ 12M / wh ^{3} = E / r

➔ 12M r / E h ^{3} = w

➔ w = 12 *4.32* 10^{-3} N.m *10 * 10^{-3} m / 200 GPa * (0.12 * 10^{-3} m) ^{3}

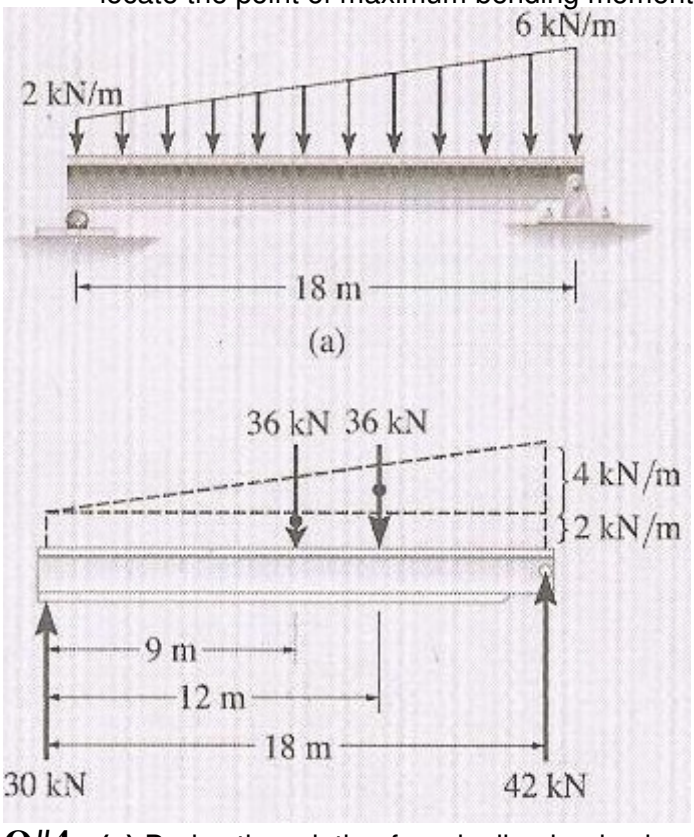
➔ **w = 0.15 m** **Ans.**

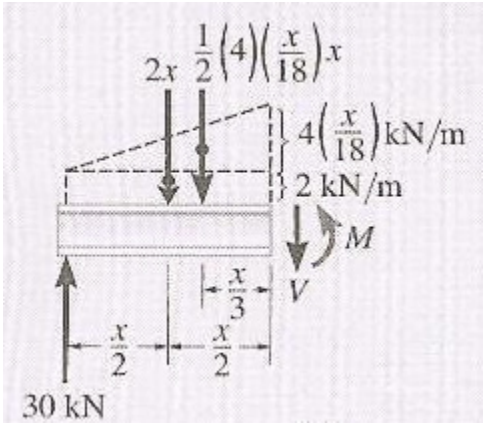
2 (a) from the table in appendix the column's
Area = A= 5890 mm^2, I_X = 45.5 * 10^6 mm^4, I_y = 15.3 * $10^6 mm^4$
By inspection buckling will occur about Y – Axis.
So, $P_{cr} = \pi^2 EI / (ZL)^2$ = 1887.6 KN
Now, $\sigma_{cr} = P_{cr} / A$ = 320.5 MPa.
Since this stress exceeds the yield stress of steel (250 MPa), the load P is determined from simple compression.

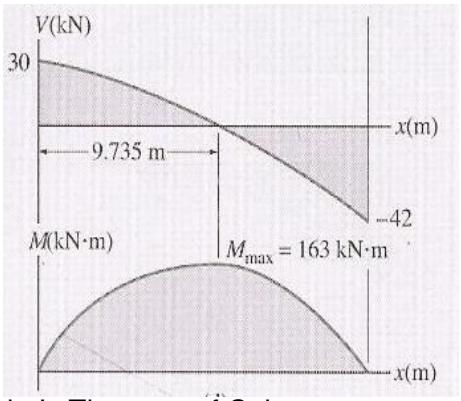
250 MPa = P / 5890 mm^2
➔ **P = 1472.5 KN. Ans.**

2 (b) Flexure Rigidity = E I = 80 * 10^9 N-mm^2 = 80 * 10^9 * $(10^{-3})^2$ N-m^2
$Y = 5 WL^4 / 384 EI = 5 * 2 * 4^4 / 384 * 80 * 10^9 (10^{-3})^2$ = **83.3 *10^{-3} m**
Derivation: **AS in Class**.

Q#3 Draw shear force & bending moment diagrams for the beam shown in **Fig. (3)** & locate the point of maximum bending moment.







Q#4 **(a)** Derive the relation for crippling load using Euler's Theorem of Columns. Assuming that the column is pinned connected at its ends.
(b) Define**:** Perpendicular axis theorem, Bifurcation point, Section modulus & Deflection of beam.

AS IN CLASS LECTURE.