UNIVERSITY OF CALIFORNIA, BERKELEY College of Engineering

Mechanics of Materials (CE130) Section I

The Second Mid-term Examination

Problem 1.

(a) Find the reaction forces at both ends;

(b) Draw shear & moment diagrams for the following beams (see: Fig. 1 (a)(b)) and label the peak values for the corresponding maximum shear and maximum moment. (30 points (15 each))

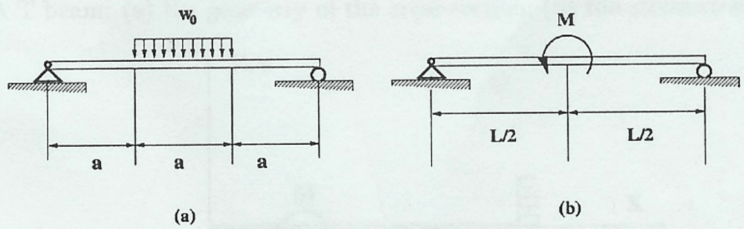

Figure 1: Beams with external loads

Problem 2.

An I-beam shown in Fig. 2 is made of three planks, which are connected by nails. Suppose that each nail can sustain a shear force $1000N$. Let $t = 50mm$ and $b = 500mm$. Suppose that the beam cross section is subjected to a shear force $V = 10kN$. Find the maximum nail spacing.

$$\tau = \frac{VQ}{I_z t}, \quad q = \frac{S}{\Delta} = \frac{VQ}{I_z}$$

$$Q = \int_A y dA = A\bar{y}$$

$$I_z = I_{zc} + d_z^2 A \quad \text{parallel axis theorem}$$

$$I_{zc} = \frac{bh^3}{12} \quad \text{for rectangular cross section.} \tag{1}$$

(20 points)

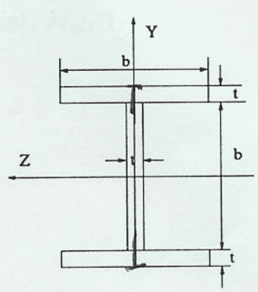

Figure 2: The I-beam.

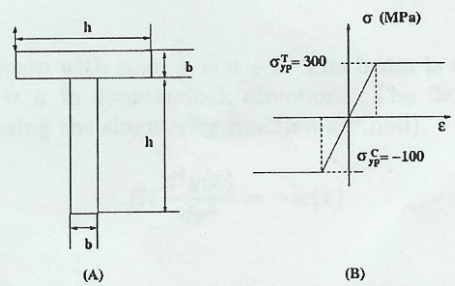

Figure 3: A T beam: (a) the geometry of the cross-section; (b) the stress-strain relation.

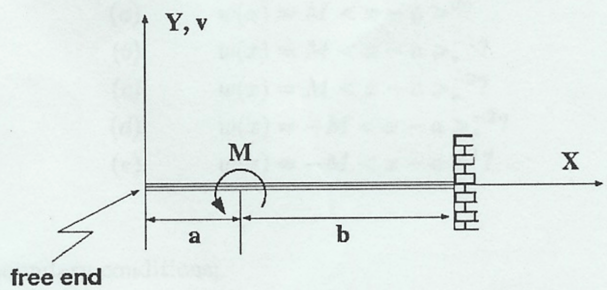

Figure 4: A beam with a concentrated moment.

Problem 3.

A T-beam shown in Fig. 3 (a) with $b = 50mm$ and $h = 200mm$, which is made of linear elastic-perfectly plastic material with $\sigma_y^T = |\sigma_y^C| = 100\ MP_a$ (shown in Fig 4 (b)).

Find:

$\sigma_Y^T = 300\ MP_a$

1. The position of the elastic bending neutral axis, or the centroidal axis ?
2. Find I_z ?;
3. Which surface yields first ? and Find the yield moment, M_Y ?
4. Find the neutral axis position for plastic bending (no elastic core) ?
5. Find the ultimate bending moment, M_{ult} ?

(30 points)

Problem 4.

Consider the cantilever beam with span $L = a + b$. The beam is subjected with a concentrated moment at the position $x = a$ in counterclock direction. The flexural rigidity of the beam is $EI = const.$. (Recommend using the singularity function method).

$$EI\frac{d^4y(x)}{dx^4} = -w(x) \quad (2)$$

(20 points)

(1) What is the $w(x)$?

(a)	$w(x) = M < x - a >^0$?
(b)	$w(x) = M < x - a >_*^{-1}$?
(c)	$w(x) = M < x - a >_*^{-2}$?
(d)	$w(x) = -M < x - a >_*^{-2}$?
(e)	$w(x) = -M < x - a >^1$?

(2)

1. State the four boundary conditions;
2. Find the beam deflection $y(x)$;
3. Find the beam deflection at $x = 0$, i.e. $y(0)$.

(3)

Draw moment and shear diagrams .