UNIVERSITY OF CALIFORNIA, BERKELEY College of Engineering

Mechanics of Materials (CE130) Section I

The Second Mid-term Examination

Problem 1.
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))

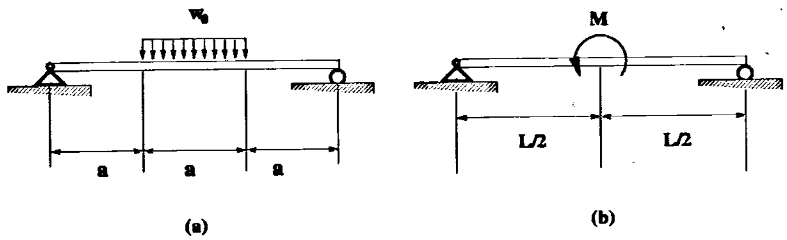

Figure 1: Beams with external loads

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 $V = 5kN$. Find the maximum nail spacing.

$$\begin{aligned}
\tau &= \frac{VQ}{I_z t}, \quad q = \frac{S}{\Delta} = \frac{VQ}{I_z} \\
Q &= \int_A y dA = A\bar{y} \\
I_z &= I_{zc} + d_z^2 A \qquad \text{parallel axis theorem} \\
I_{zc} &= \frac{bh^3}{12} \quad \text{for rectangular cross section.}
\end{aligned} \tag{1}$$

(20 points)

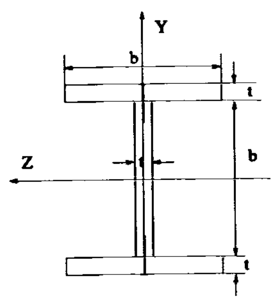

Figure 2: The I-beam.

Problem 3.

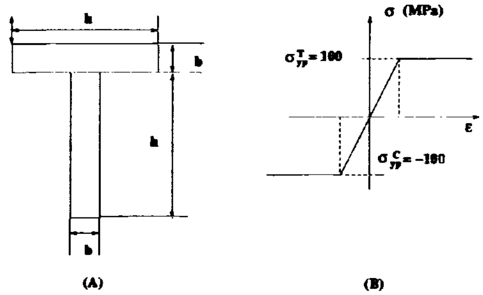

Figure 3: A T beam: (a) the geometry of the cross-section; (b) the stress-strain relation.

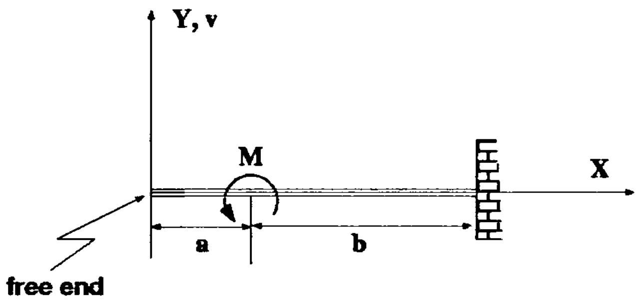

Figure 4: A beam with concentrated moment.

A T-beam shown in Fig. 4 (a) with $b = 20mm$ and $h = 200mm$, which is made of linear elastic-perfectly plastic material (shown in Fig 4 (b)).
Find:

1. The position of the elastic nuetral axis ?
2. Find I_z ?;
3. 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 downward direction. The flexural rigidity of the beam is $EI = const.$. (Recommend using singularity function method).

$$EI\frac{d^4v(x)}{dx^4} = q(x) \tag{2}$$

(20 points)

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

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

(2)

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

UNIVERSITY OF CALIFORNIA, BERKELEY College of Engineering

Mechanics of Materials (CE130) Section II

The Second Mid-term Examination

Problem 1.
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))

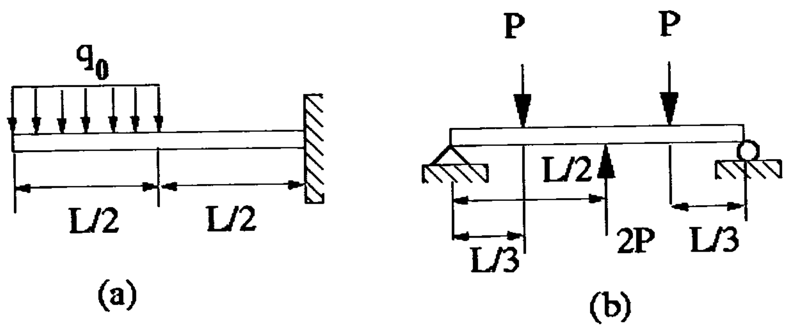

Figure 1: Beams with external loads

Problem 2.
An T-beam shown in Fig. 2 is made of two 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 $V = 5kN$. Find the maximum nail spacing.

$$\begin{aligned}\tau &= \frac{VQ}{I_z t}, \quad q = \frac{S}{\Delta} \\ Q &= \int_A y dA = A\bar{y} \\ I_z &= I_{zc} + d_z^2 A \quad \text{parallel axis theorem} \\ I_{zc} &= \frac{bh^3}{12} \quad \text{for rectangular cross section.}\end{aligned} \tag{1}$$

(20 points)

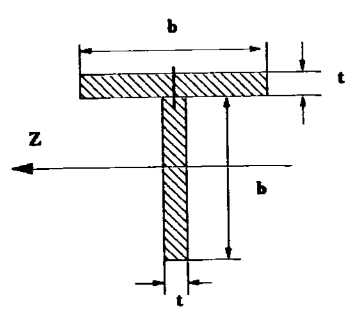

Figure 2: The T-beam.

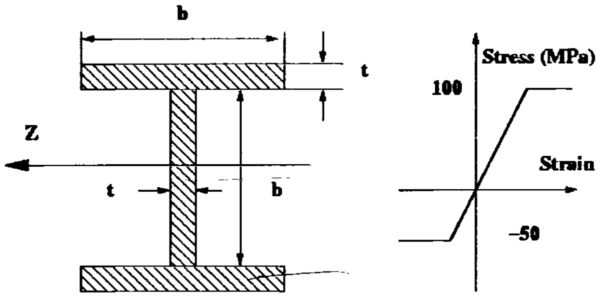

Figure 3: A I beam: (a) the geometry of the cross-section; (b) the stress-strain relation.

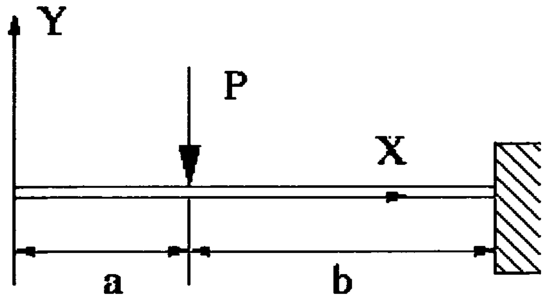

Figure 4: A beam with concentrated force.

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

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