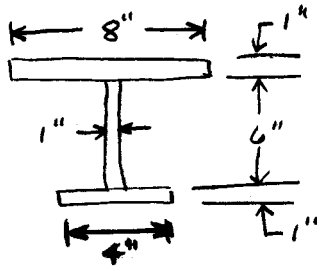
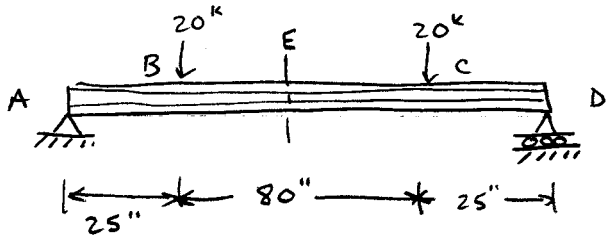
PURE BENDING EXAMPLE PROBLEM

Beam Cross Section



Given:



Required: Determine maximum tensile & compressive stresses in beam.

Assumptions: None

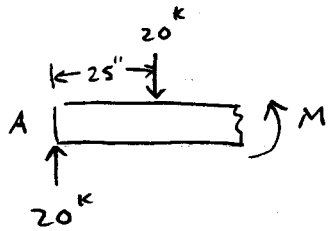
Solution: Could draw shear & moment diagrams to determine maximum M - not necessary in this case.

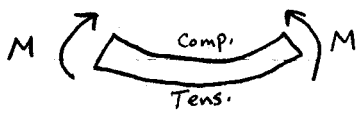
(a) Determine maximum M in beam.

From symmetry: $R_A = R_D = 20^k$

maximum moment occurs in portion BC.

FBD of Portion to the left of E:



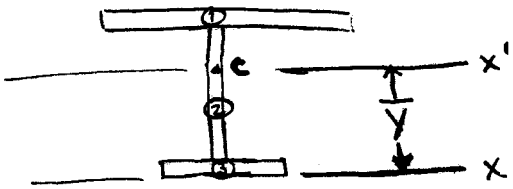


Bending moment is positive

$\curvearrowleft +$

$$\Sigma M_A = M - (25)(20) = 0 \Rightarrow M = +500 \text{ in-k}$$

(b) Locate centroid (∴ N.A.) and calculate $I_{x'}$.



Section	Area (in^2)	$\bar{y}$ (in)	$\bar{y}A$ (in^3)
1	8	7.5	60
2	6	4	24
3	4	0.5	2
	$\Sigma A = 18 in^2$		$\Sigma \bar{y} A = 86 in^3$

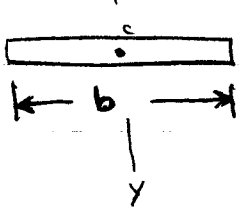
$$\bar{Y} = \frac{\Sigma \bar{y} A}{\Sigma A} = \frac{86 in^3}{18 in^2} = 4.778"$$

$I = \bar{I} + Ad^2$ } parallel axis theorem

Section	$\bar{I}$ (in^4)	A (in^2)	d (in)	Ad^2 (in^4)	I (in^4)
1	$0.\bar{6}$	8	$7.5 - 4.778 = 2.722$	59.28	59.95
2	18	6	$4 - 4.778 = -0.778$	3.63	21.63
3	$0.\bar{3}$	4	$0.5 - 4.778 = -4.278$	73.20	73.53

$\Sigma I = 155.11\ in^4$

Note: For a rectangle:



$\bar{I}_{xx} = \frac{bh^3}{12}$

$\bar{I}_{yy} = \frac{hb^3}{12}$

(c) Calculate maximum stresses

(1) Max. tensile stress – at bottom of beam; $c = 4.778"$

$$\sigma_m = \frac{Mc}{I} = \frac{(500\ in\text{-}k)(4.778")}{155.11\ in^4} = +15.4\ ksi$$

(2) Max. Compressive stress - at top of beam; $c = 3.222"$

$$\sigma_m = \frac{(500)(3.222)}{155.11} = -10.4\ ksi$$

Summary of Answers

σ_m (tensile) = +15.4 ksi

σ_m (compressive) = −10.4 ksi