Final Exam Problem 5

Friday, December 18, 2020 8:02 AM

Problem 5.

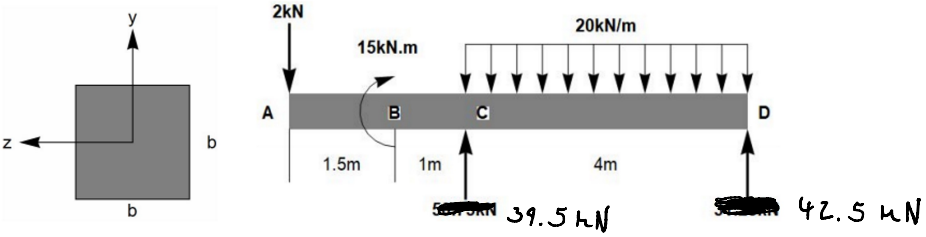
A beam is loaded as shown in the figure.

a. Draw the Shear Force (V) & Bending Moment (M) Diagrams. Verify that V_{max} = –42.5 kN and that $+M_{max}$ = 45.16 kN-m and $-M_{max}$ = –3 kN-m. Clearly identify the location of any points in either diagram where V or M = 0. **Clearly show all calculations for full credit.**

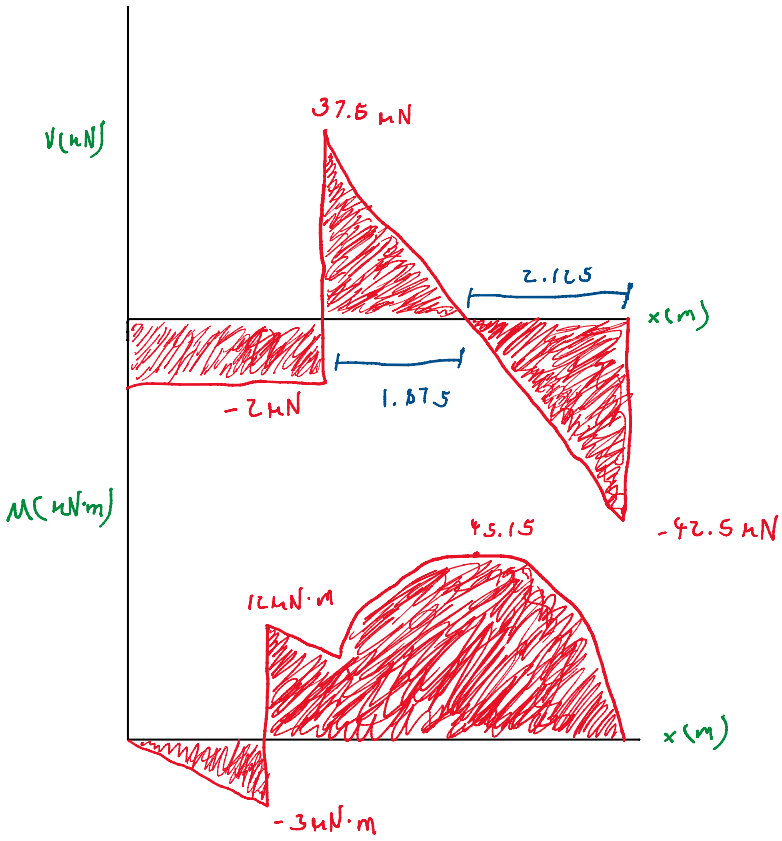
b. Design the minimum dimensions for a solid square cross section (h=b) based on Mmax = 45.16 kN-m. The material has an Allowable Normal Stress = 9 MPa.

c. Verify that the beam does not exceed an Allowable Shear Stress = 1.1 MPa using Vmax = –42.5 kN.

$2(1.5) = 3$ kN·m



A.)



$V_{max} = -42.5$ kN

$M_{max} = 45.15$ kN·m

$M_{min} = -3$ kN·m

B.)

$$\sigma = \frac{-My}{I} \qquad I = \frac{1}{12}h(b)^3 \qquad h = b$$

$$9\times10^6 = \frac{-45.16\left(\frac{b}{2}\right)\times10^3 = \frac{1}{12}b^4}{\frac{1}{12}b^4} \qquad y = \frac{b}{2}$$

$$b^3 = -45.16(6)\times10^3$$

$$\frac{\frac{1}{12}b^4}{y = \frac{b}{2}}$$

$$b^3 = \frac{-45.16(6)\times 10^3}{9\times 10^6}$$

$$b = -.311 \text{ m.}$$

c.) $\tau = \frac{VQ}{It}$ $\quad Q = \bar{y}'A' = \frac{1}{4}b\left(\frac{1}{2}(b^2)\right) = .00376 \text{ m.}$

$t = -6.3$

$$\tau = \frac{-42.5(.00376)}{(7.805\times 10^{-4})(-6.3)}$$

$I = \frac{b^4}{12} = 7.805\times 10^{-4}$

$\tau = 32.5$ Does not exceed 1.1 MPa