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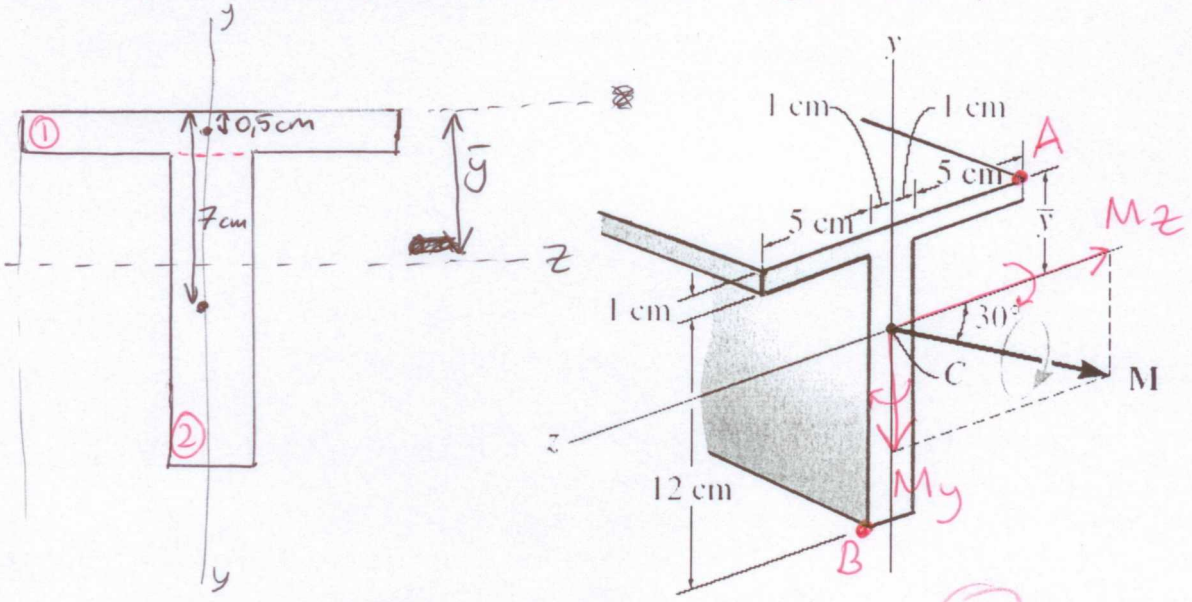
SORU 1

Şekildeki elemanda eğilmeden dolayı oluşan gerilmenin 168 MPa'ı geçmemesi için (a) **M** momentinin en büyük değeri ne olmalıdır. (**M** momenti ağırlık merkezine uygulanmaktadır.)



$$\bar{y} = \frac{\Sigma \bar{y} A}{\Sigma A} = \frac{0{,}5 \times (1\times 12) + 7 \times (12\times 2)}{1\times 12 + 12\times 2} = 4{,}833 \text{ cm} \quad (+2)$$

$$I_z = \left[\frac{1}{12} 12\times 1^3 + 12 \times (\bar{y} - 0{,}5)^2\right] + \left[\frac{1}{12} 2\times 12^3 + (12\times 2)(13 - \bar{y} - 6)^2\right] = 627 \text{ cm}^4 \quad (+2)$$

$$I_y = \frac{1}{12} 12\times 2^3 + \frac{1}{12}\cdot 1\times 12^3 = 152 \text{ cm}^4 \quad (+2)$$

$M_z = M\cos 30$

$M_y = M\sin 30$

Kritik noktalar A ve B noktalarıdır. A noktasında momentin her iki bileşeni de çekme etkisi, B noktasında ise basma etkisi yaratır. Gerilme, bu noktalarda en büyük olabilir.

$$(+8)\quad \sigma_A = \frac{M_z \cdot \bar{y}}{I_z} + \frac{M_y \cdot 6}{I_y} = \frac{M\cos 30 \times 4{,}833}{627} + \frac{M\sin 30 \times 6}{152} = 168 \text{ MPa (çekme)}$$

$$\Rightarrow M = 6{,}36 \text{ kN.m} \quad (+3)$$

$$\sigma_B = \frac{M_z (13 - \bar{y})}{I_z} + \frac{M_y \cdot 1}{I_y} = 168 \text{ MPa (basma)} \quad (+8)$$

$$\Rightarrow M = 11{,}53 \text{ kN.m}$$

küçük olan alınır

M = 6,36 kN.m

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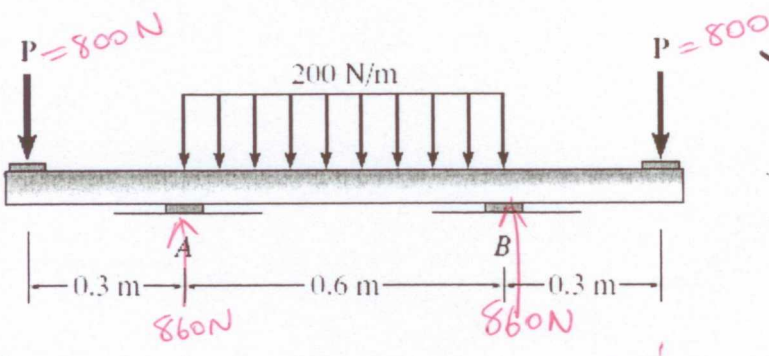
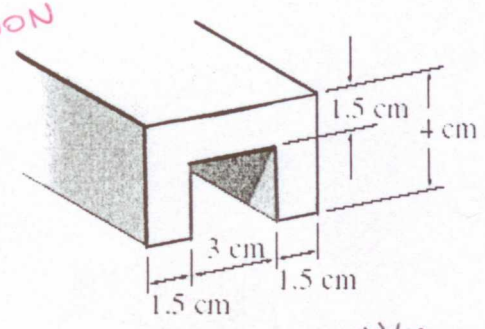
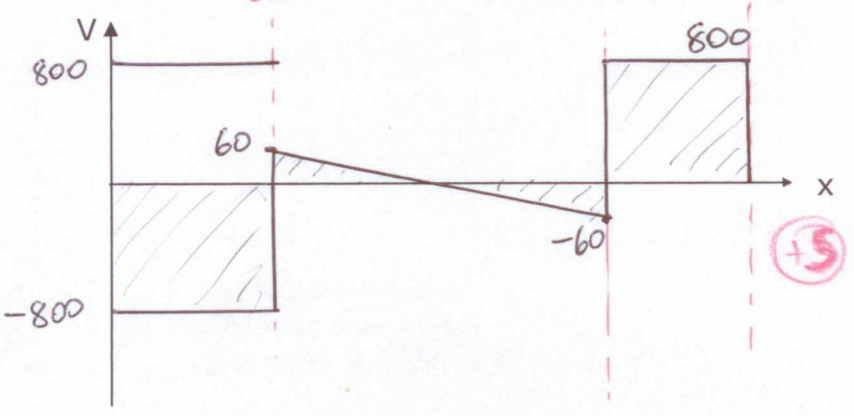
SORU 2

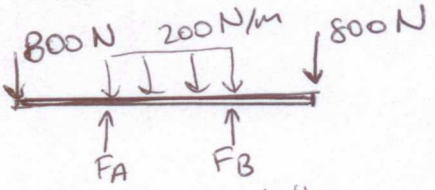
P kuvveti 800 N ise kirişte oluşabilecek en büyük kayma gerilmesini bulunuz. A ve B noktalarındaki destekler sadece düşey eksende kuvvet uygulamaktadırlar. (Önce kesme kuvveti diyagramı çiziniz. Diyagramdan kesme kuvvetinin hangi noktada en büyük olduğunu bulunuz ve o noktadaki en büyük kayma gerilmesini bulunuz.)







+5

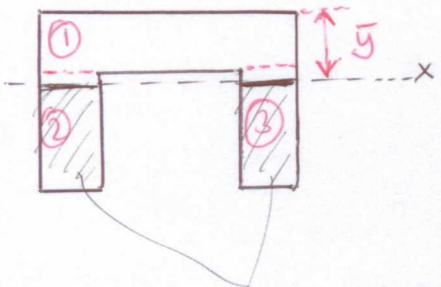


Yükleme simetrik:

$F_A = F_B = \frac{800 \times 2 + 200 \times 0,6}{2}$

$= 860\ N$

$V_{max} = 800\ N$



$\bar{y} = \frac{0,75 \times (1,5 \times 6) + 2 \times [2,75 \times (2,5 \times 1,5)]}{1,5 \times 6 + 2 \times (2,5 \times 1,5)}$

$\bar{y} = 1,6591\ cm$ +5

$I_x = \frac{1}{12} 6 \times 4^3 + (4 \times 6)(\bar{y} - 2)^2 - \left[\frac{1}{12} 3 \times 2,5^3 + (2,5 \times 3)\left(4 - \bar{y} - \frac{2,5}{2}\right)^2\right.$

veya

$I_x = \frac{1}{12} 6 \times 1,5^3 + (1,5 \times 6)(\bar{y} - 0,75)^2$

$+ 2\left[\frac{1}{12} 1,5 \times 2,5^3 + (2,5 \times 1,5)\left(4 - \bar{y} - \frac{2,5}{2}\right)^2\right]$

$I_x = 21,9574\ cm^4$ +5

$Q_{max} = \left[(4 - \bar{y}) \times 1,5 \times 2\right] \times \left(\frac{4 - \bar{y}}{2}\right)$

$= 8,2198\ cm^3$ +5

En büyük kayma gerilmesi tarafsız eksendedir.

+5 $\tau_{max} = \frac{V_{max}\, Q_{max}}{I_x \cdot t} = \frac{800 \times 8,2198}{21,9574 \times (1,5+1,5)} = 99,8\ N/cm^2 \cong 1\ MPa$

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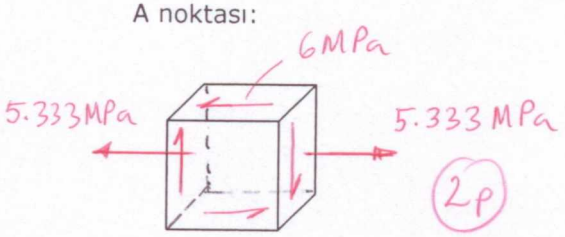
SORU 3

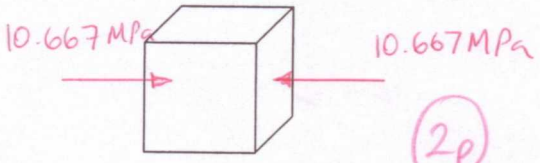
Şekildeki gibi yüklenmiş elemanın *a-a* kesitindeki iç kuvvetleri ve momenti bularak (a) A ve B noktalarındaki bütün gerilmeleri hesaplayınız ve sonsuz küçük kübik eleman üzerinde gösteriniz. (b) a-a kesitindeki normal gerilme dağılımını çiziniz. Elemanın kesiti 0.5 cm x 0.75 cm'dir.

A noktası:

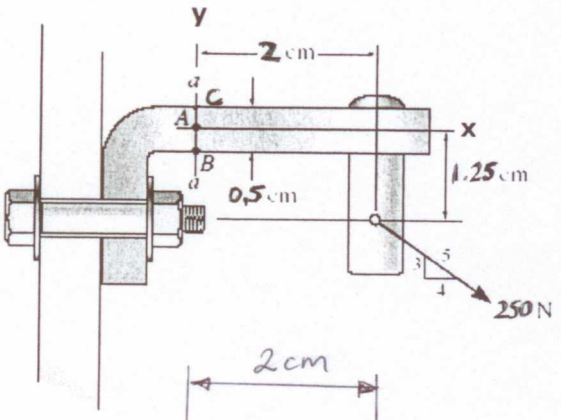


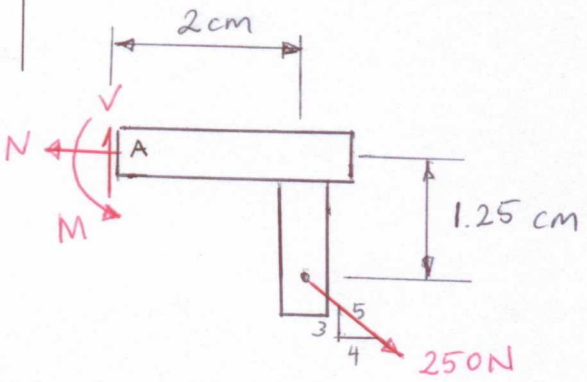
(2p)

B noktası:

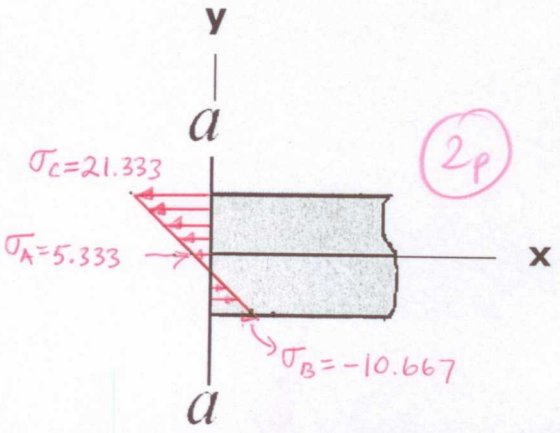


(2p)





Normal gerilme dağılımı:



(2p)

(Normal gerilmenin sıfır olduğu noktayı bulmanız ve en büyük değerlerini göstermeniz gerekmektedir)

$\pm\rightarrow \Sigma F_x = 0$

$-N + 250\left(\frac{4}{5}\right) = 0 \Rightarrow N = 200N$

$+\uparrow \Sigma F_y = 0$

$V - 250\left(\frac{3}{5}\right) = 0 \Rightarrow V = 150\ N$

$\circlearrowleft \Sigma M_A = 0$

$-M - 250\left(\frac{4}{5}\right)(1.25) + 250\left(\frac{3}{5}\right)(2) = 0$

$M = 50\ N.cm = 500\ N.mm$

Normal stress

$$\sigma_{A1} = \frac{N}{A} = \frac{200\ N}{(5)(7.5)\ mm^2} = 5.333\ MPa$$

(2p)

$$\sigma_{A2} = -\frac{My}{I} = \frac{500\ N.mm \cdot 0}{I} = 0\ MPa$$

(2p)

$$\sigma_A = \sigma_{A1} + \sigma_{A2} = 5.333 + 0 = 5.333\ MPa\ (T)$$

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$$\sigma_{B1} = \frac{N}{A} = \frac{200\ N}{(5)(7.5)\,mm^2} = 5.333\ MPa$$ (2p)

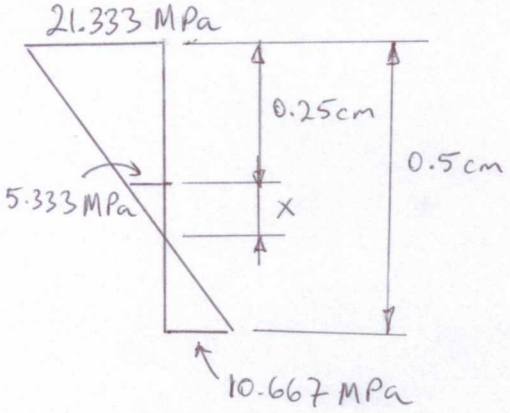
$$\sigma_{B2} = -\frac{My}{I} = -\frac{500\ N.mm \cdot (2.5\ mm)}{\frac{(7.5)(5.0)^3}{12}} = -16\ MPa$$ (2p)

$$\sigma_B = \sigma_{B1} + \sigma_{B2} = 5.333 - 16 = -10.667\ MPa$$

$$\sigma_{C1} = \frac{N}{A} = \frac{200\ N}{(5)(7.5)\,mm^2} = 5.333\ MPa$$

$$\sigma_{C2} = \frac{My}{I} = \frac{500\ N.mm\ (2.5}{\frac{(7.5)(5.0)^3}{12}} = 16\ MPa$$

$$\sigma_C = \sigma_{C1} + \sigma_{C2} = 5.333 + 16 = 21.333\ MPa\ (T)$$



$$\frac{21.333}{0.25+x} = \frac{5.333}{x}$$

$$(21.333 - 5.333)x = (0.25)(5.333)$$

$$x = 0.0833\ cm$$

$$\boxed{x = 0.833\ mm}$$ (3p)

Shear stress

$Q_A = 23.4375\ mm^3$

$$\tau_A = \frac{VQ_A}{It} = \frac{150\ N \cdot (7.5)(2.5)\cdot(1.25)}{\frac{(7.5)(5)^3}{12}(7.5)} = 6\ MPa$$ (4p)

$I = 78.1250\ mm^4$

$$\tau_B = \frac{VQ_B}{It} = \frac{150 \cdot 0}{It} = 0$$ (4p)

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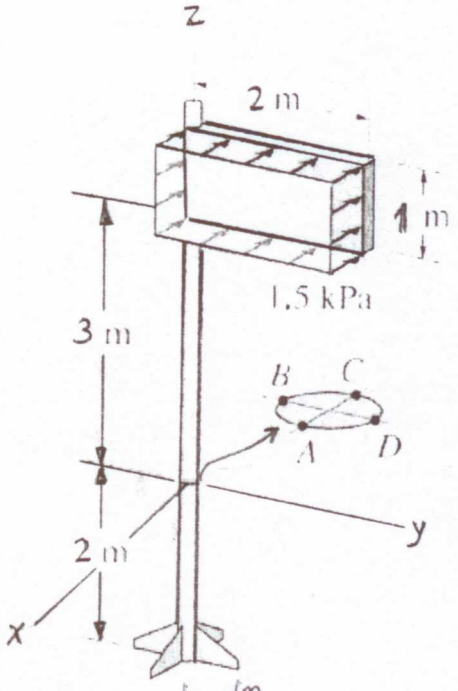
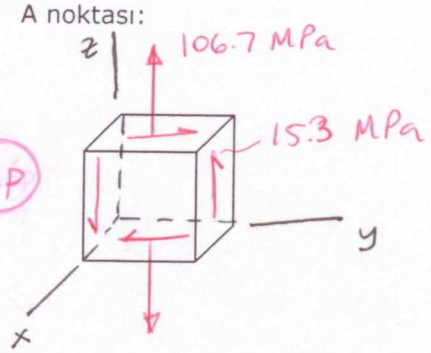
SORU 4

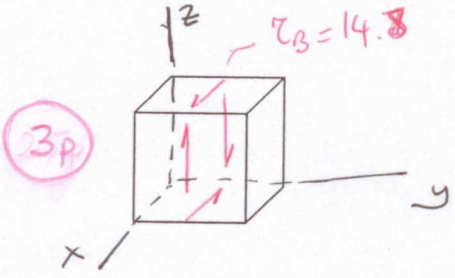
Şekildeki tabela düzgün yayılı rüzgar yüklemesine maruz kalmaktadır. 100 mm çapındaki direğin A ve B noktalarında oluşan gerilmeleri bulunuz ve sonsuz küçük kübik eleman üzerinde gösteriniz.



A noktası:

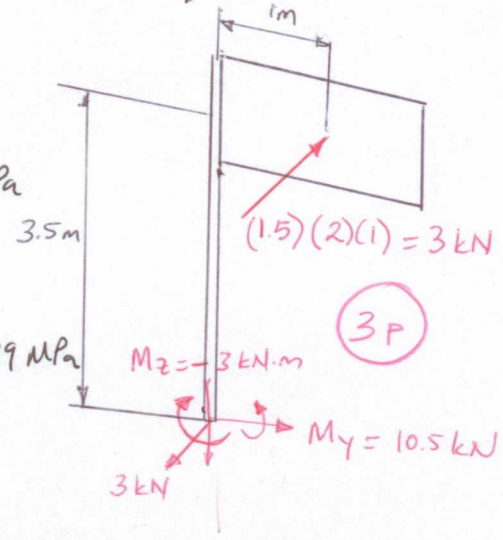


B noktası:



A noktası

(4P) $\sigma_A = \dfrac{M_y \cdot (0.05)}{\frac{\pi}{4}(0.05)^4} = \dfrac{(10.5)10^3}{\frac{\pi}{4}(0.05)^3} = 106.9521$ MPa



(4P) $\tau_A = \dfrac{Tc}{J} = \dfrac{M_z \cdot (0.05)}{\frac{\pi}{2}(0.05)^4} = \dfrac{(3)(10^3)}{\frac{\pi}{2}(0.05)^3} = 15.2789$ MPa

$J = 9.817 \times 10^{-6}\ m^4$

B Noktası

(4P) $\sigma_B = \dfrac{M_y \cdot 0}{I_y} = 0$

(4P) $\tau_B = \dfrac{Tc}{J} - \dfrac{VQ}{It} = (15.2789)10^6 - \dfrac{(3)10^3 \cdot \left(\frac{4(0.05)}{3\pi}\right) \cdot \left(\frac{\pi(0.05)^2}{2}\right)}{\left(\frac{\pi}{4}(0.05)^4\right)(0.100)}$

$\bar{y} \cdot A \rightarrow Q$, $Q = 8.333 \times 10^{-5}\ m^3$

$I = 4.909 \times 10^{-6}\ m^4$

$= 15.2789$ MPa $- 0.5093$ MPa

$= 14.7696$ MPa