TOBB EKONOMİ VE TEKNOLOJİ ÜNİVERSİTESİ

MAK 312 Makina Elemanları Yaz Dönemi, 2011

Kısa Sınav 1

20 Mayıs 2011
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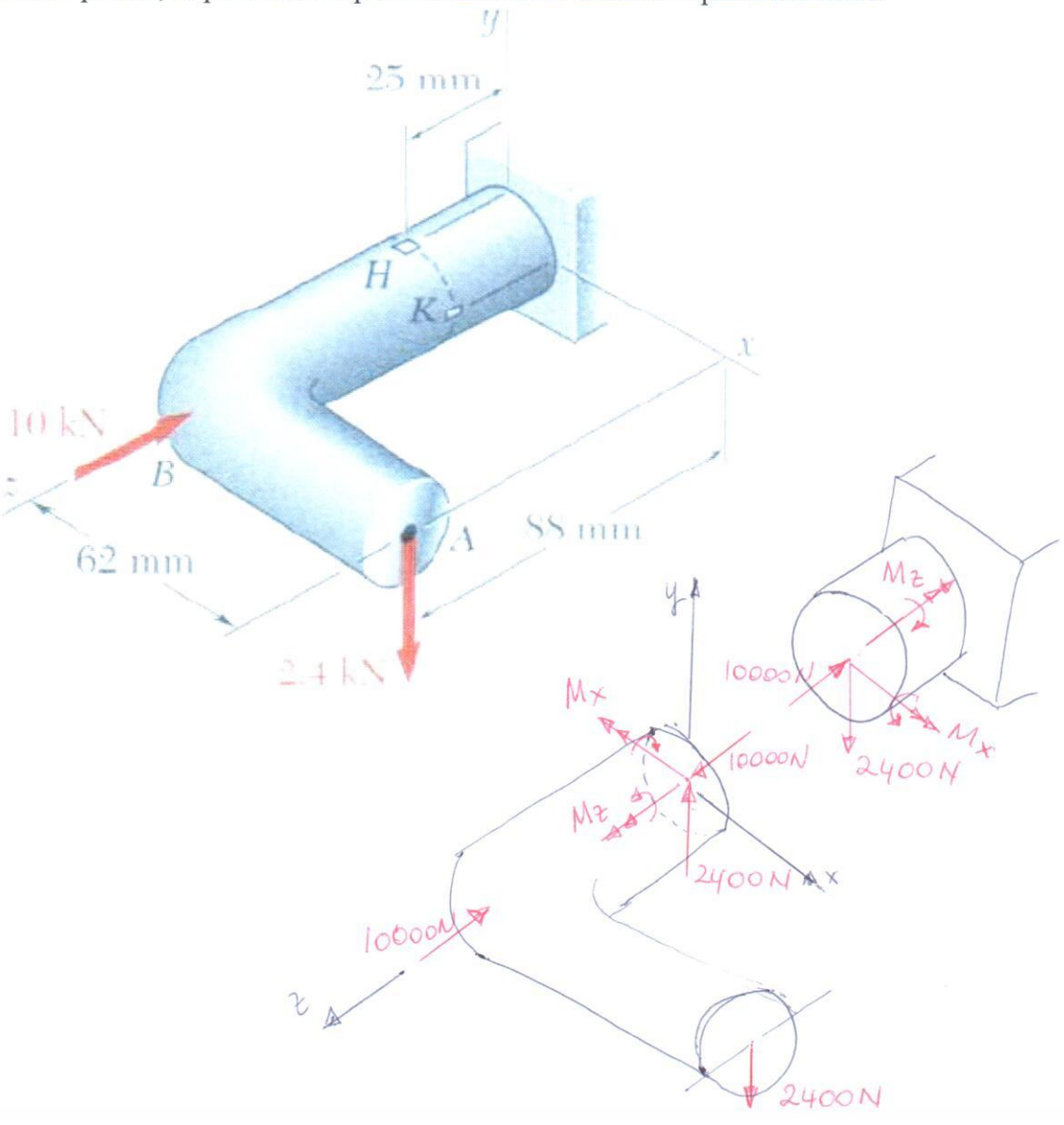
Öğrenci No. _____

Soru: Şekilde geometrik ölçüleri verilen dökme demirden yapılmış 20 mm çapındaki içi dolu brakete A ve B noktalarından sırasıyla 2.4 kN ve 10 kN'luk yükler etki etmektedir. Bu yükleme durumu için H ve K'de oluşan gerilme durumunu (kayma ve normal gerilme) belirleyiniz. H ve K'de oluşan gerilme durumunu kare şeklindeki eleman üzerinde gösteriniz ve Mohr çemberini çiziniz. H ve K'de oluşan asal gerilmeleri ve maksimum kayma gerilmesini bulunuz. Bulduğunuz asal gerilmeleri ve kayma gerilmesini kare elemanlar üzerinde gösteriniz. Asal gerilme ve maksimum kayma gerilmesini bulmak için elemanlar hangi yönde (saat yönü yada saatin tersi yönde) kaç derece döndürülmelidir? (Aşağıdaki şekilde verilen koordinat sisteminin dikkate alarak, tüm çizimlerinizde koordinat sistemini gösteriniz)

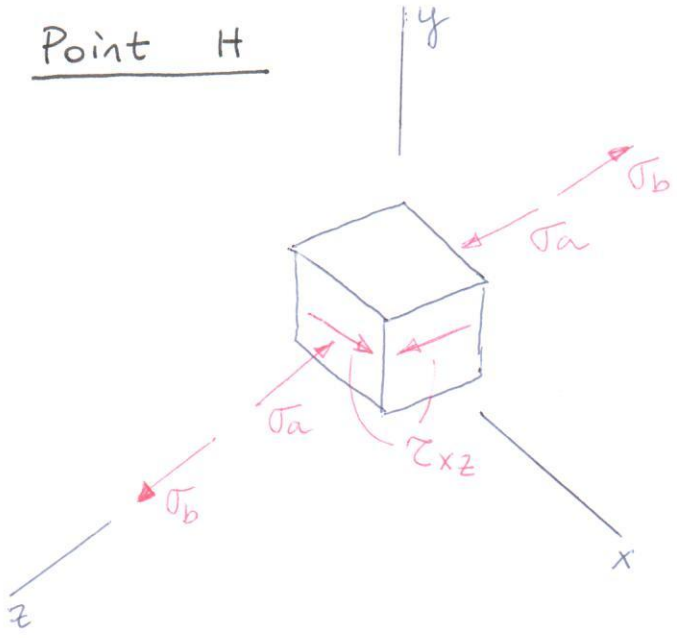
Forces are applied at points A and B to the solid cast iron as shown in figure. Knowing that the bracket has a diameter of 20 mm, determine the stress state (normal and shear stresses) and show the stress state at point H and K on a square element. Then draw the Mohr's circle for these points. Determine the principal stresses and maximum shearing stress and their planes, at point H and point K and show them on square elements.



$\oplus \Sigma M_x = 0 \;:\; M_x - (2400)(88-25) = 0 \Rightarrow M_x = 151200\ N.mm$

$\oplus \Sigma M_z = 0 \;:\; (2400)(62) - M_z = 0 \Rightarrow M_z = 148800\ N.mm$

Point H



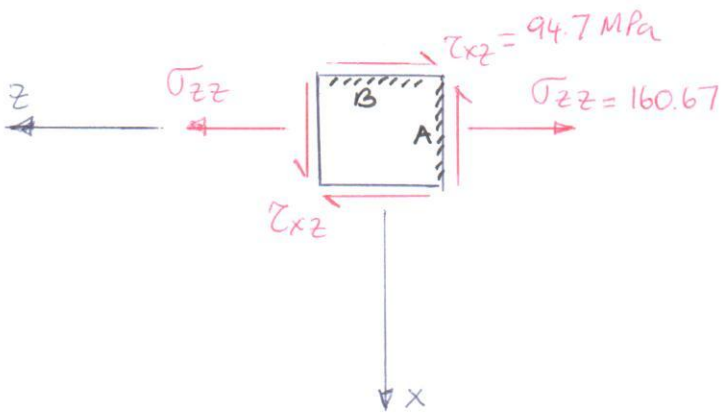
$$\sigma_a = \frac{10000}{A} = \frac{10000}{\frac{\pi(20)^2}{4}} = 31.83\ MPa$$

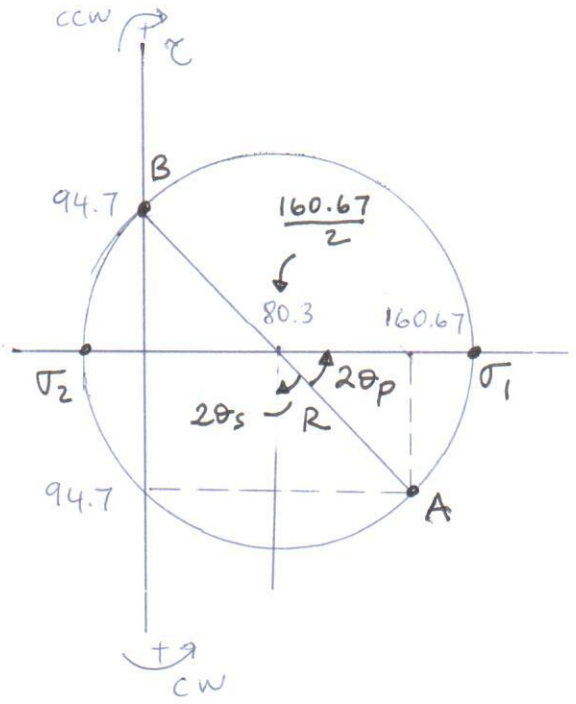
$$\sigma_b = \frac{M_x . r}{I} = \frac{(151200)(10)}{\frac{\pi(20)^4}{64}} = 192.5\ MPa$$

$$\tau_{xz} = \frac{M_z . r}{J} = \frac{(148800)(10)}{\frac{\pi(20)^4}{32}} = 94.7\ MPa$$

$$\sigma_{zz} = \sigma_b - \sigma_a = 192.5 - 31.83 = 160.67$$

$\sigma_{zz} = 160.67\ MPa$





$$R = \sqrt{\left(\frac{160.67}{2}\right)^2 + 94.7^2} = 124.18$$

$\tau_{max} = 124.18\ MPa$

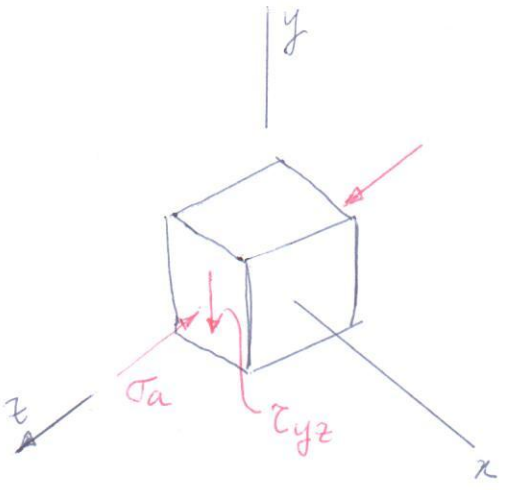
$\sigma_1 = \frac{160.67}{2} + R = 204.515\ MPa$

$\sigma_2 = \frac{160.67}{2} - R = -43.8\ MPa$

$2\theta_p = \tan^{-1}\frac{94.7}{80.33} \Rightarrow \theta_p = 24.8°$

$2\theta_s = \tan^{-1}\frac{80.33}{94.7} \Rightarrow \theta_s = 20.15°$

Point K



$\sigma_a = 31.83$ MPa

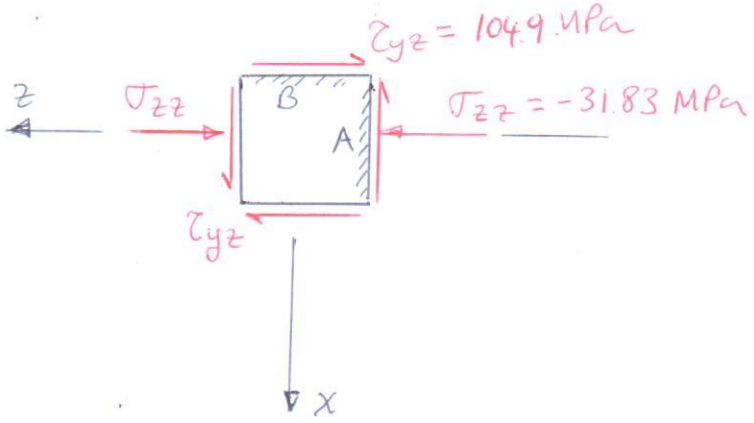
$$\tau' = \frac{M_z \cdot r}{J} = 94.7 \text{ MPa}$$

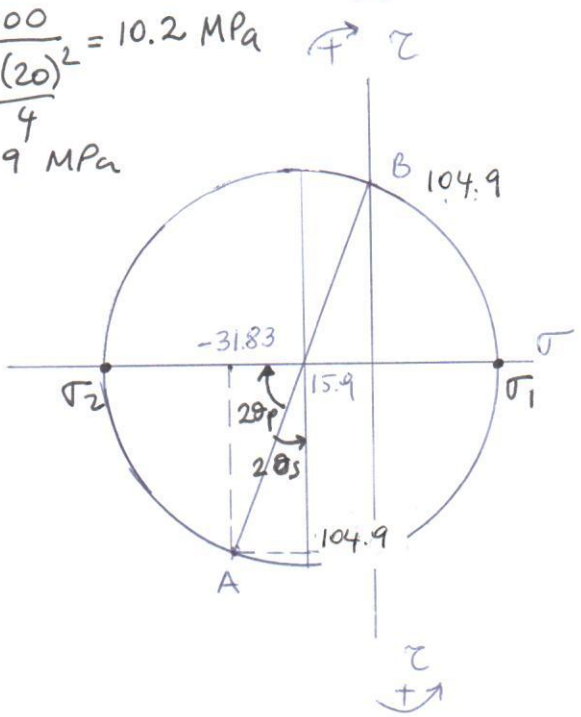
$\therefore \sigma_{zz} = -31.83$ MPa

$$\tau'' = \frac{VQ}{It} = \frac{V \cdot A \cdot \bar{y}}{\frac{\pi d^4}{64} \cdot d} = \frac{V \cdot \frac{\pi d^2}{8} \cdot \frac{2d}{3\pi}}{\frac{\pi d^4}{64} \cdot d} = \frac{V \cdot \frac{d^3}{12}}{\frac{\pi d^2}{4} \cdot \frac{d^3}{16}}$$

$$\tau'' = \frac{4}{3}\frac{V}{A} = \frac{4}{3}\frac{2400}{\frac{\pi (20)^2}{4}} = 10.2 \text{ MPa}$$

$$\tau_{yz} = \tau' + \tau'' = 104.9 \text{ MPa}$$





$$R = \sqrt{\left(\frac{31.83}{2}\right)^2 + 104.9^2} = 106.1 \text{ MPa}$$

$\tau_{max} = 106.1$ MPa

$$\sigma_1 = -\frac{31.83}{2} + R = 90.2 \text{ MPa}$$

$$\sigma_2 = -\frac{31.83}{2} - R = -122. \text{ MPa}$$

$$2\theta_p = \tan^{-1}\frac{104.9}{15.9} = 81.4^\circ \Rightarrow \theta_p = 40.7^\circ$$

$$2\theta_s = \tan^{-1}\frac{15.9}{104.9} = 8.6 \Rightarrow \theta_s = 4.3^\circ$$