

Şekildeki sistem bir kasnak ve pinyon dişliden oluşmaktadır. Pinyonun çapı 60 mm ve kasnağın çapı 120 mm'dir. Kasnak ve pinyon üzerine etki eden kuvvetler şekilde verilmiştir. Ayrıca kasnağın ağırlığı 120 kg'dir. Sistem için kesme ve moment diyagramlarını çizerek en fazla zorlanan noktayı belirleyiniz. Güvenlik katsayısı $n=2$ alarak, (malzemenin akma gerilmesi 310 MPa)

- Maksimum normal gerilme teoremine ($\sigma_{\max} = \frac{S_y}{n}$)
- Maksimum kayma gerilmesi teoremine ($\sigma_1 - \sigma_3 = \frac{S_y}{n}$)
- Şekil değiştirme enerjisi teoremine göre ($\sigma' = \frac{S_y}{n}$)

Milin d çapını belirleyiniz.

Kullanılacak eşitlikler:

$$\sigma' = \sqrt{\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2}}$$

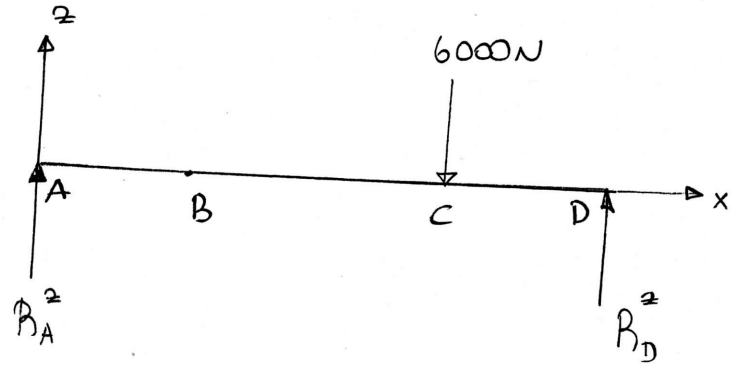
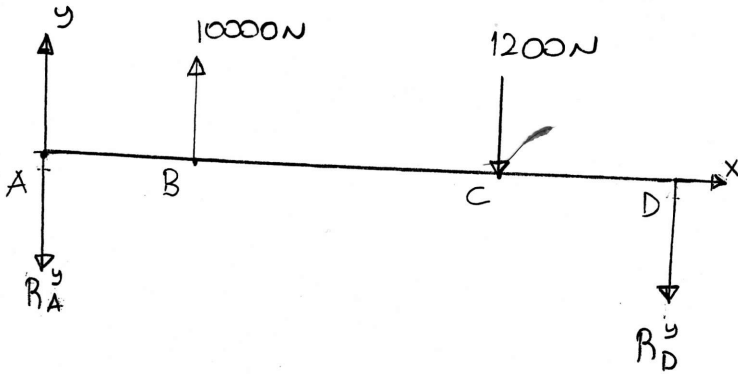
$$\sigma_{1,3} = \frac{\sigma_x}{2} \pm \left[\left(\frac{\sigma_x}{2} \right)^2 + \tau_{xy}^2 \right]^{1/2} \quad (\text{asal gerilmeler})$$

Gözlem

①

XY - düzleminde S.C.D.

XZ - düzleminde S.C.D.



$\sum M_A = 0$

$R_D^y(900) + 1200(675) - 10000(275) = 0$

$R_D^y = 2188,889 \text{ N}$

$\sum F_y = 0$

$10000 - 1200 - R_A^y - R_D^y = 0$

$R_A^y = 6611,111 \text{ N}$

$\sum M_A = 0$

$6000(675) - R_D^z(900) = 0$

$R_D^z = 4333,333 \text{ N}$

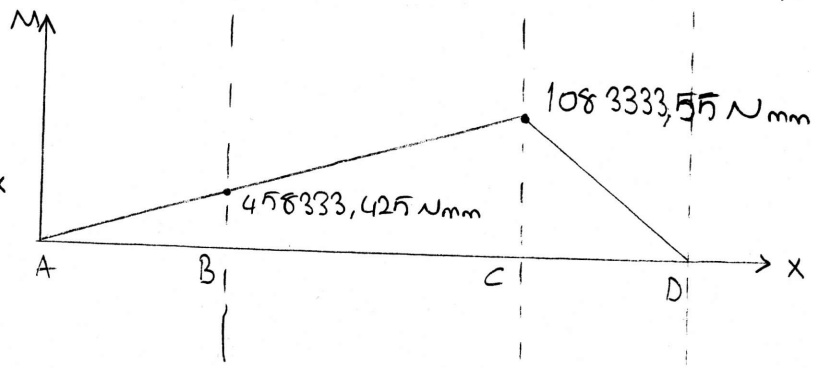
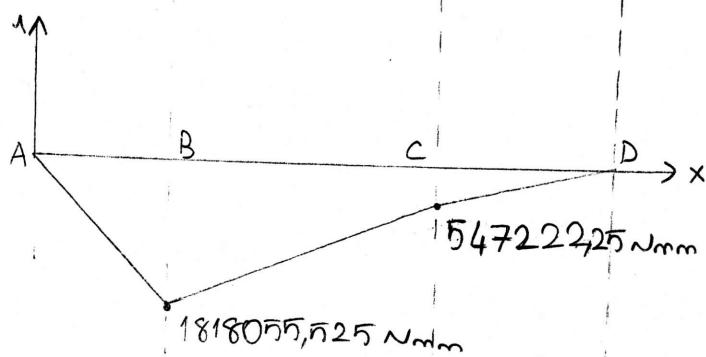
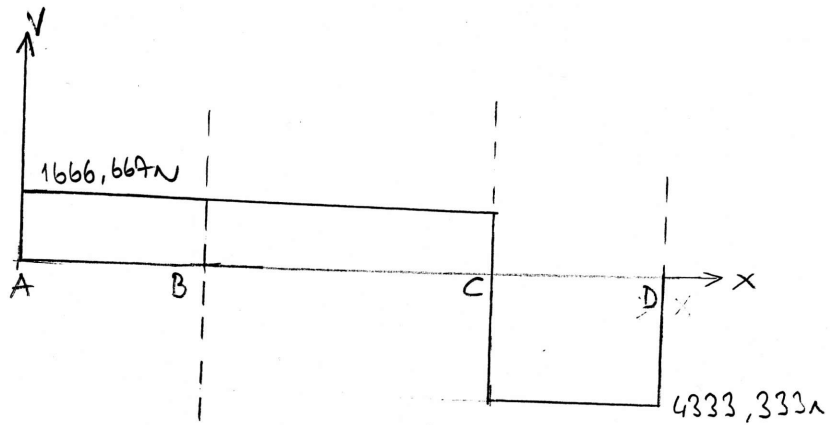
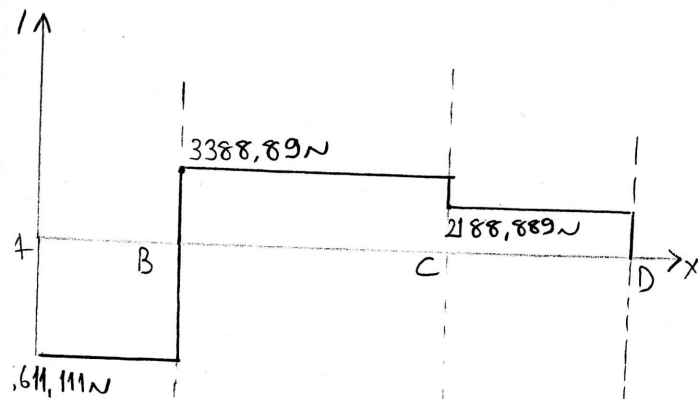
$\sum F_z = 0$

$R_A^z + R_D^z - 6000 = 0$

$R_A^z = 1666,667 \text{ N}$

Kesme ve moment diyagramı

Kesme ve moment diyagramı



B noktasındaki moment

C noktasındaki moment

$$M_B = \sqrt{(1818057,725)^2 + (478333,425)^2}$$

$$M_C = \sqrt{(1083333,57)^2 + (547222,25)^2}$$

$$M_B = 1874938,778 \text{ Nmm}$$

$$M_C = 1213698,118 \text{ Nmm}$$

B noktasındaki tork

C noktasındaki tork

$$T_B = (9000 - 1000)(30) = 240000 \text{ Nmm}$$

$$T_C = (5000 - 1000)(60) = 240000 \text{ Nmm}$$

* Sonuç olarak en fazla zorlanan nokta B noktasıdır.

$$\sigma_x^B = \frac{M_{BC}}{I} = \frac{(1874938,778) \left(\frac{d}{2}\right)}{\frac{\pi d^4}{64}} = 19097969,57 d^{-3} \text{ MPa}$$

$$\tau_{xz}^B = \frac{T_{BC}}{J} = \frac{(240000) \left(\frac{d}{2}\right)}{\frac{\pi d^4}{32}} = 1222309,963 d^{-3} \text{ MPa}$$

* Asal gerilmeler

$$\sigma_{1,3} = \frac{\sigma_x^B}{2} \pm \left(\left(\frac{\sigma_x^B}{2} \right)^2 + \tau_{xz}^B \right)^{1/2}$$

$$\sigma_1 = 19175882,11 d^{-3} \text{ MPa} \quad , \quad \sigma_3 = -77916,53812 d^{-3} \text{ MPa}$$

$$\sigma_1 > \sigma_2 > \sigma_3 \Rightarrow \sigma_1 = 19175882,11 d^{-3} \text{ MPa}$$

$$\sigma_2 = 0 \text{ MPa}$$

$$\sigma_3 = -77912,53812 d^{-3} \text{ MPa}$$

a) Maksimum normal gerilme teorisi,

$$\sigma_{\max} = \frac{S_y}{n} \Rightarrow 19175882,11d^{-3} = \frac{310}{2}$$

$$d = 49,83 \text{ mm}$$

b) Maksimum kayma gerilmesi teorisi,

$$\sigma_1 - \sigma_3 = \frac{S_y}{n} \rightarrow 19175882,11d^{-3} - (-77912,53812d^{-3}) = \frac{310}{2}$$

$$d = 49,89 \text{ mm}$$

$$c) \sigma' = \sqrt{\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2}} \quad (\sigma_2 = 0)$$

$$\sigma' = \sqrt{\sigma_1^2 - \sigma_1\sigma_3 + \sigma_3^2}$$

$$\sigma' = \left[(19175882,11d^{-3})^2 - (19175882,11d^{-3})(-77912,53812d^{-3}) + (-77912,53812d^{-3})^2 \right]^{1/2}$$

$$\sigma' = 19214956,85d^{-3} \text{ MPa}$$

şekil değiştirme enerjisi teorisi,

$$\sigma' = \frac{S_y}{n} \rightarrow 19214956,85d^{-3} = \frac{310}{2}$$

$$d = 49,86 \text{ mm}$$

$d \approx 50 \text{ mm}$ olup yerine koyulursa,

$$\sigma_x^B = 19097969,57 (50)^{-3} = 152,784 \text{ MPa}$$

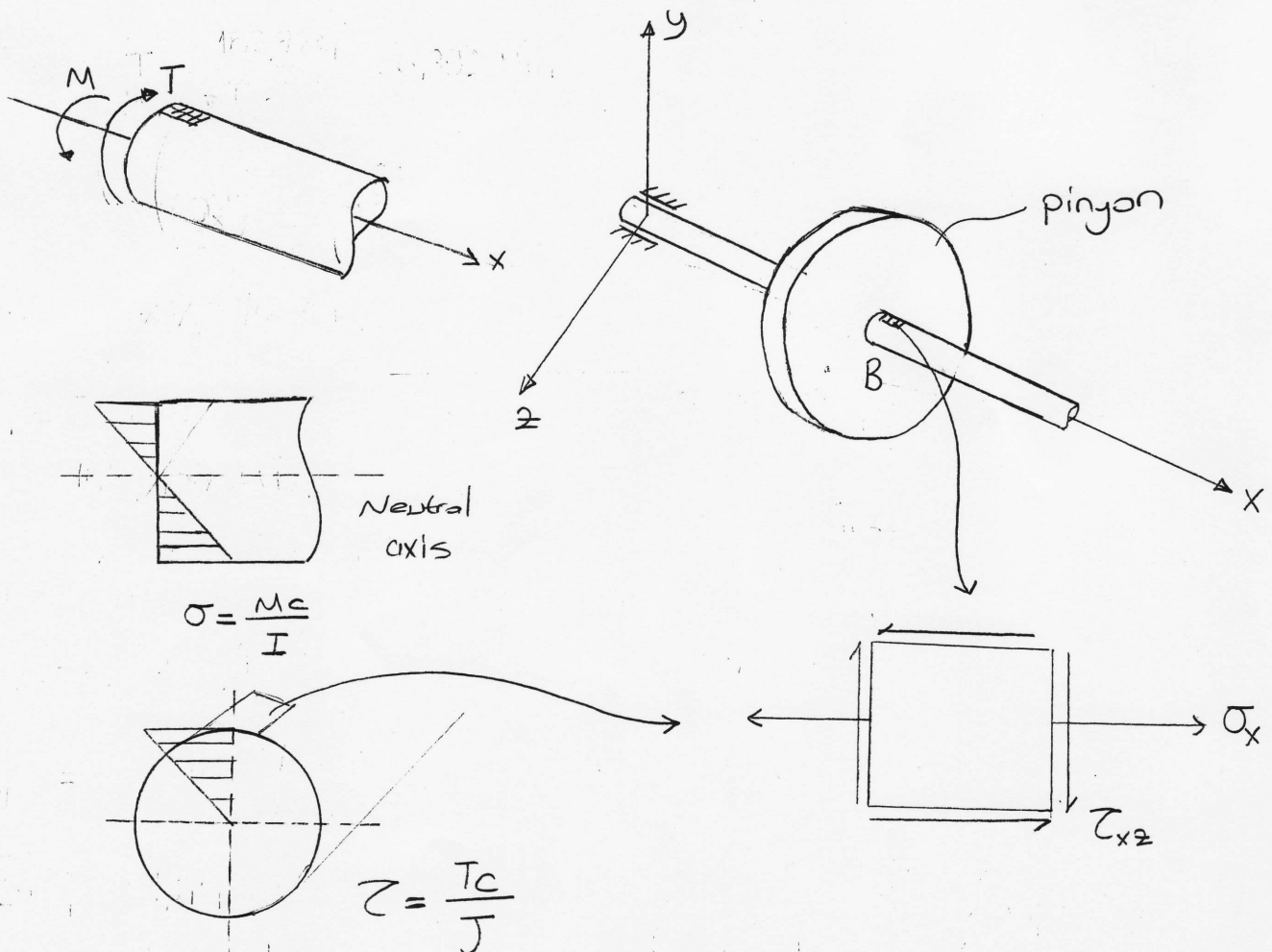
$$\tau_{xz}^B = 1222309,963 (50)^{-3} = +9,778 \text{ MPa}$$

$$\sigma_1 = 19175882,11 (50)^{-3} = 153,407 \text{ MPa}$$

$$\sigma_3 = -77912,53812 (50)^{-3} = -0,623 \text{ MPa}$$

$$\sigma_2 = 0 \text{ MPa}$$

Stress State at point B



Mohr's circle

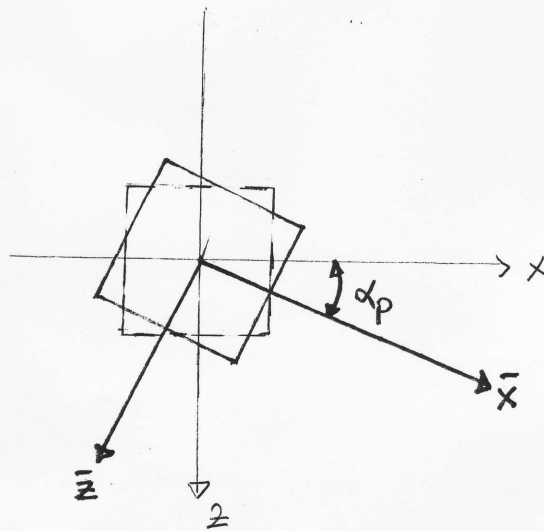
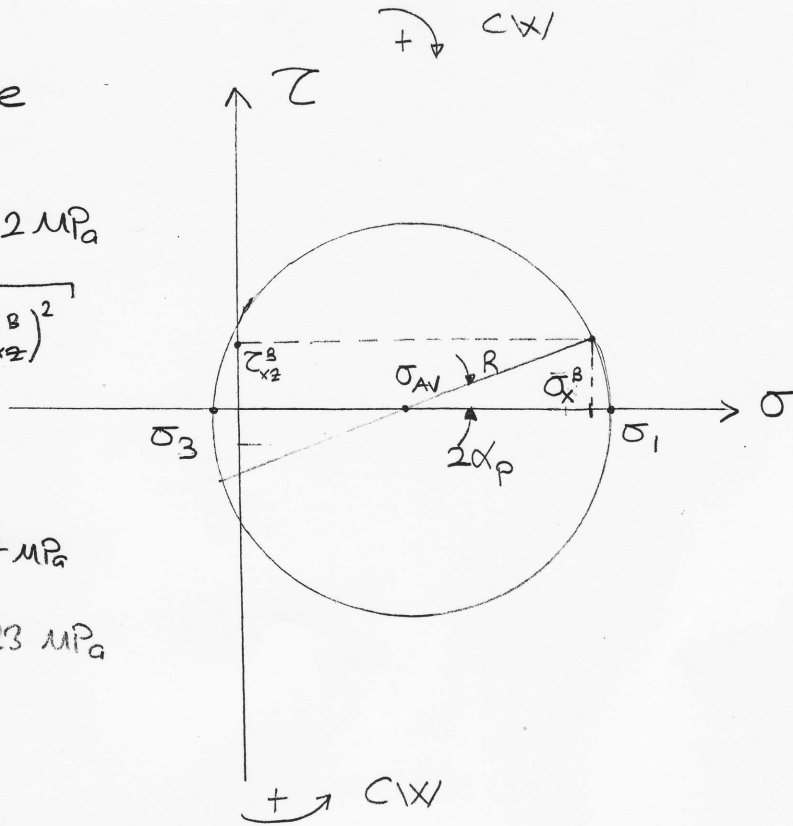
$$\sigma_{AV} = \frac{\sigma_x^B}{2} = 76,392 \text{ MPa}$$

$$r_{max} = R = \sqrt{\left(\frac{\sigma_x^B}{2}\right)^2 + (\tau_{xz}^B)^2}$$

$$r_{max} = 77,017 \text{ MPa}$$

$$\sigma_1 = \sigma_{AV} + R = 153,407 \text{ MPa}$$

$$\sigma_3 = \sigma_{AV} - R = -0,623 \text{ MPa}$$



$$\text{tg}(2\alpha_p) = \frac{\sigma_x^B/2}{\tau_{xz}^B}$$

$$\text{tg}(2\alpha_p) = \frac{76,392}{9,778}$$

$$2\alpha_p = 1,44^\circ$$

$$\alpha_p = 0,72^\circ$$

