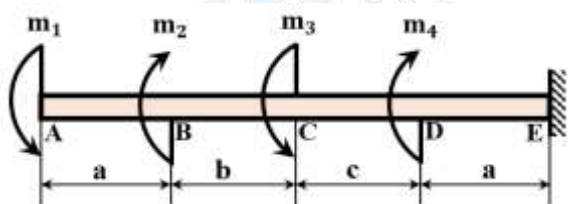## BURALISH DEFORMATSIYASI

B.B. Xasanov

TDTU OF "Mashinasozlik texnologiyasi" kafedrasi assistenti

Masalaning berilgan qiymatlarini va topishimiz mumkin bo'lgan qiymatlarni jadval ko'rinishida yozib olamiz.

a (m)	b (m)	c (m)	m_1 kN·m	m_2 kN·m	m_3 kN·m	m_4 kN·m	G GPa	R_c MPa	Θ °/m	M_K kN·m	τ MPa	φ	θ
0,8	0,5	1,6	13	10	22	7	80	130	3,0	–	–	–	–

Yechish:

AB uchastka uchun:

$$M_{K_{AB}} = -m_1 = -13 \text{ kN} \cdot \text{m}$$

BC uchastka uchun:

$$M_{K_{BC}} = -m_1 + m_2 = -13 + 10 = -3 \text{ kN} \cdot \text{m}$$

CD uchastka uchun:

$$M_{K_{CD}} = -m_1 + m_2 - m_3 = -13 + 10 - 22 = -25 \text{ kN} \cdot \text{m}$$

DE uchastka uchun:

$$M_{K_{DE}} = -m_1 + m_2 - m_3 - m_4 = -13 + 10 - 22 - 7 = -32 \text{ kN} \cdot \text{m}$$

$$\boxed{M_{K_{max}} = 32 \text{ kN} \cdot \text{m}}$$

1). $\tau_{max} = \dfrac{M_{K_{max}}}{W_\rho} \leq [\tau] -$ buralishda mustahkamlik sharti

$$\tau_{max} = \frac{M_{K_{max}}}{W_\rho} = \frac{16 \cdot M_{K_{max}}}{\pi \cdot d^3} \leq R_c$$

$$W_\rho = \frac{\pi \cdot d^3}{16} - \text{val kesimining qutb qarshilik momenti}$$

Valning mustahkamlik shartini qanoatlantiruvchi zaruriy diametrini aniqlaymiz:

$$d_\tau \geq \sqrt[3]{\frac{16 \cdot M_{K_{max}}}{\pi \cdot R_c}} = \sqrt[3]{\frac{16 \cdot 32 \cdot 10^3}{3{,}14 \cdot 130 \cdot 10^6}} = 0{,}108 \, m = 10{,}8 \, sm$$

$$2). \qquad \theta = \frac{M_{K_{max}}}{G \cdot I_\rho} \leq [\theta] - \text{buralishda bikirlik sharti}$$

$$I_\rho = \frac{\pi d^4}{32}$$

$$\theta = \frac{32 \cdot M_{K_{max}}}{G \cdot \pi \cdot d^4} \leq [\theta],$$

$$[\theta] = 3{,}0 \, {}^\circ/m \cdot \frac{\pi}{180^0} = 0{.}0523 \, rad/m$$

Valning **b**ikirlik shartini qanoatlantiruvchi zaruriy diametrini aniqlaymiz:

$$d_\theta \geq \sqrt[4]{\frac{32 \cdot M_{K_{max}}}{G \cdot \pi \cdot [\theta]}} = \sqrt[4]{\frac{32 \cdot 32 \cdot 10^3}{80 \cdot 10^9 \cdot 3{,}14 \cdot 0{.}0523}} = 0{,}0369 \, m = 3{,}69 \, sm$$

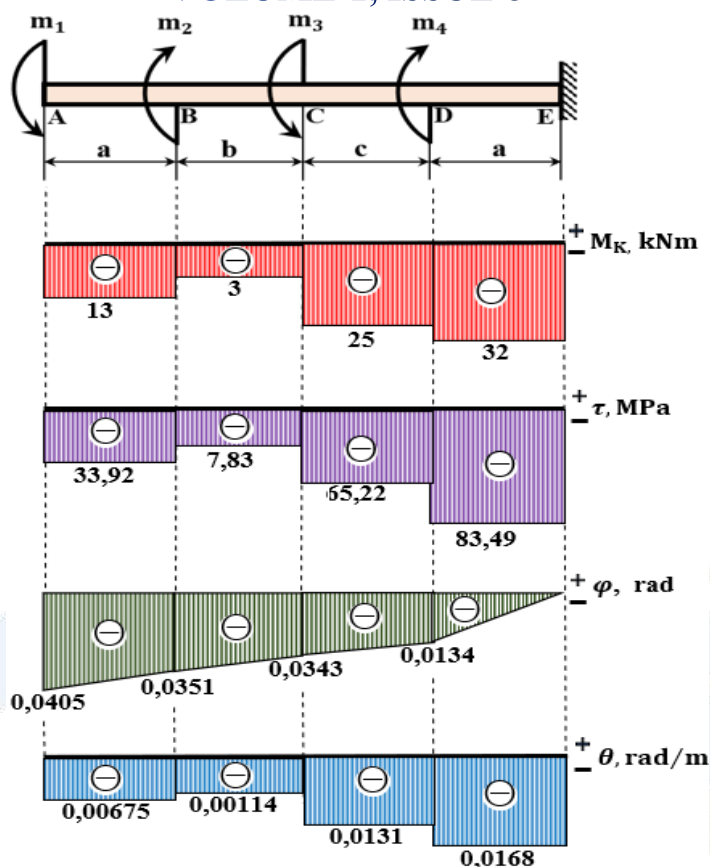Yaxlitlangan $d \approx 12{,}5 \, sm = 125 \, mm$ deb qabul qilamiz

$$\boxed{d \approx 12{,}5 \, sm = 125 \, mm}$$

Doiraviy kesimli srerjenni qutb qarshilik momentini aniqlaymiz

$$W_\rho = \frac{\pi \cdot d^3}{16} = \frac{3{,}14 \cdot 12{,}5^3}{16} = 383{,}301 \, sm^3 = 383{,}301 \cdot 10^{-6} \, m^3$$

Sterjen kesimining qutb inersiya momentini aniqlaymiz

$$I_\rho = \frac{\pi \cdot d^4}{32} = \frac{3{,}14 \cdot 12{,}5^4}{32} = 2395{,}63 \, sm^4 = 2395{,}63 \cdot 10^{-8} \, m^4$$

Har bir oraliqdagi sterjenning urinma kuchlanishlarini aniqlaymiz

$$\tau_{AB} = \frac{M_{K_{AB}}}{W_\rho} = \frac{-13 \cdot 10^3}{383{,}301 \cdot 10^{-6}} = -33{,}92 \text{ MPa}$$

$$\tau_{BC} = \frac{M_{K_{BC}}}{W_\rho} = \frac{-3 \cdot 10^3}{383{,}301 \cdot 10^{-6}} = -7.83 \text{ MPa}$$

$$\tau_{CD} = \frac{M_{K_{CD}}}{W_\rho} = \frac{-25 \cdot 10^3}{383{,}301 \cdot 10^{-6}} = -65.22 \text{ MPa}$$

$$\tau_{DE} = \frac{M_{K_{DE}}}{W_\rho} = \frac{-32 \cdot 10^3}{383{,}301 \cdot 10^{-6}} = -83.49 \text{ MPa}$$

Har bir oraliqdagi buralish burchagini Guk qonunidan foydalanib aniqlaymiz

$$\boxed{\varphi = \frac{M_K \cdot \ell}{G \cdot I_\rho}}$$

$$I_\rho = \frac{\pi \cdot d^4}{32} = \frac{3{,}14 \cdot 12{,}5^4}{32} = 2395{,}63 \ \text{sm}^4 = 2395{,}63 \cdot 10^{-8} \ \text{m}^4$$

$$\varphi_{DE} = \frac{M_{K_{DE}} \cdot a}{G \cdot I_\rho} = \frac{-32 \cdot 10^3 \cdot 0{,}8}{80 \cdot 10^9 \cdot 2395{,}63 \cdot 10^{-8} \ \text{m}^4} = -0{,}0134 \ rad$$

$$\varphi_{CD} = \frac{M_{K_{CD}} \cdot c}{G \cdot I_\rho} = \frac{-25 \cdot 10^3 \cdot 1{,}6}{80 \cdot 10^9 \cdot 2395{,}63 \cdot 10^{-8} \text{ m}^4} = -0{,}0209 \; rad$$

$$\varphi_{BC} = \frac{M_{K_{BC}} \cdot b}{G \cdot I_\rho} = \frac{-3 \cdot 10^3 \cdot 0{,}5}{80 \cdot 10^9 \cdot 2395{,}63 \cdot 10^{-8} \text{ m}^4} = -0{,}0008 \; rad$$

$$\varphi_{AB} = \frac{M_{K_{AB}} \cdot a}{G \cdot I_\rho} = \frac{-13 \cdot 10^3 \cdot 0{,}8}{80 \cdot 10^9 \cdot 2395{,}63 \cdot 10^{-8} \text{ m}^4} = -0{,}0054 \; rad$$

Valni o'ng uchining buralish burchagi nolga teng ekanligi ma'lum.

$$\varphi_E = 0$$

$$\varphi_D = \varphi_E + \varphi_{DE} = -0{,}0134 \; rad$$

$$\varphi_C = \varphi_D + \varphi_{CD} = -0{,}0134 - 0{,}0209 = -0{,}0343 \; rad$$

$$\varphi_B = \varphi_C + \varphi_{BC} = -0{,}0343 - 0{,}0008 = -0{,}0351 \; rad$$

$$\varphi_A = \varphi_B + \varphi_{AB} = -0{,}0351 - 0{,}0054 = -0{,}0405 \; rad$$

Nisbiy buralish burchagi quyidagicha topiladi

$$\boxed{\theta = \frac{\varphi}{\ell}}$$

$$\theta_{AB} = \frac{\varphi_{AB}}{a} = \frac{-0{,}0054}{0{,}8} = -0{,}00675 \; rad$$

$$\theta_{BC} = \frac{\varphi_{BC}}{b} = \frac{-0{,}0008}{0{,}7} = -0{,}00114 \; rad$$

$$\theta_{CD} = \frac{\varphi_{CD}}{c} = \frac{-0{,}0209}{1{,}6} = -0{,}0131 \; rad$$

$$\theta_{DE} = \frac{\varphi_{DE}}{a} = \frac{-0{,}0134}{0{,}8} = -0{,}0168 \; rad$$

Buralishda mustahkamlik sharti bajarildi

$$\tau_{max} = 83.49 \text{ MPa} < R_C = 130 \text{MPa}$$

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