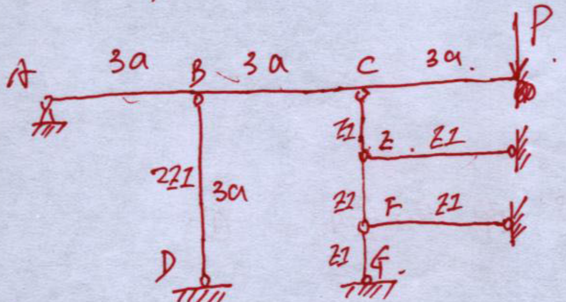
(一). ~~解~~:



解: 由平衡方程. $\Sigma M_A=0$. $P\cdot 9a - N_{BD}\cdot 3a - N_{CE}\cdot 6a = 0$ ---①

由变形协调方程: $\Delta l_{BD} = \frac{1}{2}\Delta l_{CG}$ ---②

物理方程为:
$$\Delta l_{BD} = \frac{N_{BD}\cdot 3a}{2EA}$$
$$\Delta l_{CG} = 3\cdot\frac{N_{CE}\cdot a}{EA}$$

把物理方程代入协调方程有.

$$\frac{N_{BD}\cdot 3a}{2EA} = \frac{1}{2}\cdot\frac{3N_{CE}\cdot a}{EA} \Rightarrow N_{BD}=N_{CE} \quad ---③$$

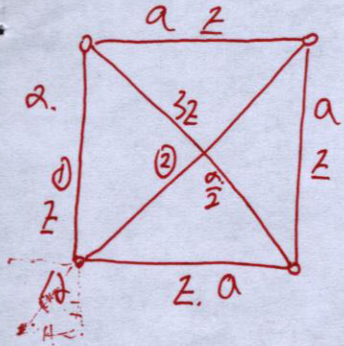
③代入①得.
$$N_{BD}=P$$
$$N_{CE}=P$$

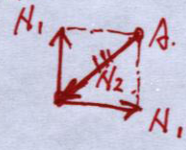
由稳定条件有:
$$P_{cr}^{BD} = \frac{2\pi^2 EI}{(3a)^2}$$
$$P_{cr}^{CE} = \frac{\pi^2 EI}{a^2}$$

即有
$$\left.\begin{aligned}\frac{P_{cr}^{BD}}{N_{BD}} \geq n_w^{BD} \quad P_1 \leq \cdots \\ \frac{P_{cr}^{CE}}{N_{CE}} \geq n_w^{CE} \quad P_2 \leq \cdots\end{aligned}\right\} \Rightarrow P=\max\{P_1, P_2\}$$

因为当杆BD破坏时. 整个构件并未破坏, 当杆CE. EF. FG 破坏时构件破坏. 所以 $P=\max\{P_1, P_2\}$

$\frac{a^4}{12}$ $\frac{5}{2}$





平衡方程: $N_1 = N_2\cos45°$ 即 $N_1=\frac{\sqrt2}{2}N_2$ --- ①

变形协调条件:

$$\alpha t\cdot a-\frac{N_1 a}{EA_1}=\left(\frac{1}{2}\alpha t\cdot\sqrt2 a+\frac{N_2\cdot\sqrt2 a}{3EA}\right)\cdot\frac{\sqrt2}{2}$$

即: $\frac12\alpha t a=\frac{N_1 a}{EA_1}+\frac{N_2 a}{3EA_2}$

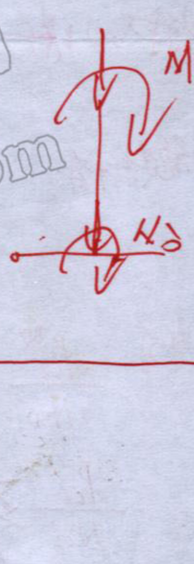
又∵ $\frac{A_1}{A_2}=\frac{20}{1}$

故有 $\frac12\alpha t=\frac{N_1}{E\cdot 20A_2}+\frac{N_2}{3EA_2}$ --- ②

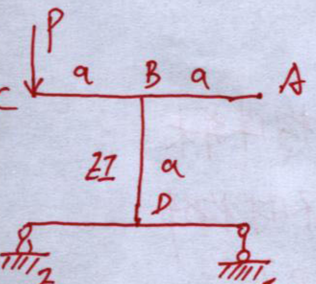
由①②解得.

$$N_2=\frac{\frac12\alpha tEA_2}{\frac{\sqrt2}{40}+\frac{1}{3}}=\frac{60\alpha tEA_2}{3\sqrt2+40}$$

∴ $\sigma_2=\frac{N_2}{A_2}=\frac{60\alpha tE}{3\sqrt2+40}$



(三).



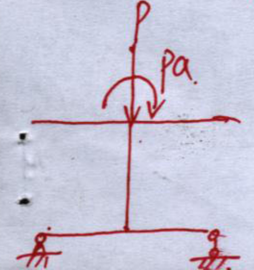
解: $\theta_A=\theta_{A1}+\theta_{A2}$

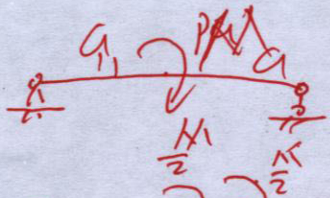
$\theta_{A1}=\frac{(Pa)a}{EI}=\frac{Pa^2}{EI}$

$\theta_2=\frac{\frac{Pa}{2}a}{3EI}=\frac{Pa^2}{6EI}$

∴ $\theta_A=\frac{Pa^2}{EI}+\frac{Pa^2}{6EI}$

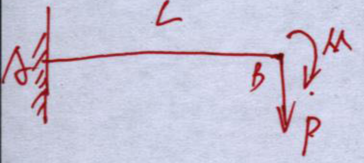
$=\frac{7Pa^2}{6EI}$





$\frac{\frac{M}{2}\cdot a}{3EI} = \frac{\quad}{6EI}$

(三)、



在A,B点去除约束以P和M取代.

由图可知: $\delta_B = \frac{ML^2}{2EI} + \frac{PL^3}{3EI}$

$\theta_B = \frac{PL^2}{2EI} + \frac{ML}{EI}$

而: $\delta_B = \Delta$

$\theta_B = 0$

故有: $\begin{cases} \frac{ML^2}{2EI} + \frac{PL^3}{3EI} = \Delta \\ \frac{PL}{2} + M = 0 \end{cases} \Rightarrow \begin{cases} M = -6\Delta\cdot\frac{EI}{L^2} = -\frac{6\Delta EI}{L^2} \\ P = \frac{12\Delta}{L}\cdot\frac{EI}{L^2} = \frac{12\Delta EI}{L^3} \end{cases}$

故有: $M_A = -P\cdot L = -12\Delta\cdot\frac{EI}{L^2}$

$M_B = -M = 6\Delta\frac{EI}{L^2}$

(四).

$U = \frac{T_A^2 l_A}{2G_A J_A} + \frac{T_B^2 l_B}{2G_B J_B}$

$= \ldots\ldots$

解: 令其扭矩分别为 T_A 和 T_B

φ_A φ_B

则有 $\cancel{\frac{T_A l_A}{GJ_A}}$ $\frac{T_A l_A}{GJ_A} + \frac{T_B l_B}{GJ_B} = \beta. \Leftarrow \varphi_A + \varphi_B = \beta$

即 $T_A = T_B$.

故有: $T_A = T_B = \frac{\beta}{\frac{l_A}{G_A J_A} + \frac{l_B}{G_B J_B}}$

(11). 解：把P分解为P_x P_y. P_z.

$$P_x=P_y=P_z=P/\sqrt{3}$$

故有：轴力 $P_x=\frac{P}{\sqrt{3}}$

弯矩 $M_z=P_y l=\frac{Pl}{\sqrt{3}}$

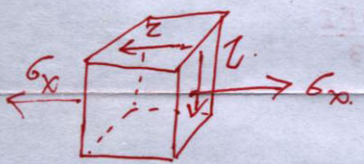
$M_y=P_z l=\frac{Pl}{\sqrt{3}}$

故有 $\delta_x=\frac{P_x \cdot l}{E\cdot A}=\frac{Pl}{3Ea^2}$

$$\delta_y=\frac{P_y\cdot l^3}{3EI}=\frac{\frac{P}{\sqrt{3}}\cdot l^3}{3E\cdot\frac{a^4}{12}}=\frac{4Pl^3}{\sqrt{3}Ea^4}$$

$$\delta_z=\frac{4Pl^3}{\sqrt{3}Ea^4}$$

$$\delta=\sqrt{\delta_x^2+\delta_y^2+\delta_z^2}$$



$$\sigma_x=\frac{P_x}{A}-\frac{M_z}{W}=\frac{P}{\sqrt{3}a^2}-\frac{\frac{Pl}{\sqrt{3}}}{\frac{a^3}{6}}=\frac{P}{\sqrt{3}a^2}-\frac{6Pl}{\sqrt{3}a^3}$$

$$\tau=\frac{3Q}{2A}=\frac{3}{2}\cdot\frac{P}{\sqrt{3}a^2}=\frac{\sqrt{3}P}{2a^2}$$

故有.

$$\sigma_{\substack{max\\min}}=\frac{\sigma_x}{2}\pm\sqrt{\left(\frac{\sigma_x}{2}\right)^2+\tau_x^2}$$

故有 $\sigma_1=$

$\sigma_2=$

$\sigma_3=$

$\int_0 q(x)\,dx$

(七) 由于题可能未写清楚. 此题属于结构力学范围. 但此题应用图乘法解最简单