

2004年硕士研究生入学考试 材料力学试题解答

一. 问答题.

1. AB, DC 等为弯曲变形, BC 等为压弯组合变形

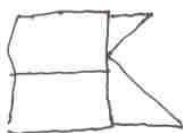
E 截面的内力是剪力 P

2. BC 等为圆形曲线. 曲率半径为 $\rho = \frac{EI}{Pa}$

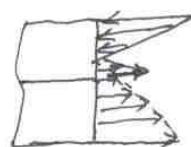
3. (a) 二次静不定. (b) 二次静不定. (c) 一次静不定

4. B 点的应力为 $\sigma_{0.2}$

5. 应力分布图



应力分布图



二. 计算题.

1. 解: BD 等应变为 ε . BD 等应力 $\sigma = E\varepsilon$
BD 等变形 $\Delta l_{BD} = 2a\varepsilon$.

AB 等内力为 BD 等内力的 2 倍, 应变为 2 倍,

$$\text{故有 } \Delta l_{AB} = a \cdot 2\varepsilon$$

$$\text{故有 } \delta = \Delta l_{AB} + \Delta l_{BD} = 4a\varepsilon$$

2. 解: 使甲的材料得到充分利用时, 梁内的最大正弯矩
等于最大负弯矩.

$$\text{最大负弯矩 } M_{\text{负}} = \frac{1}{2}qa^2$$

$$\begin{aligned} \text{最大正弯矩 } M_{\text{正}} &= N_A \cdot \frac{b}{2} - \frac{1}{2}q\left(a + \frac{b}{2}\right)^2 \\ &= \frac{(2a+b)q}{2} \cdot \frac{b}{2} - \frac{1}{2}q\left(a + \frac{b}{2}\right)^2 \end{aligned}$$

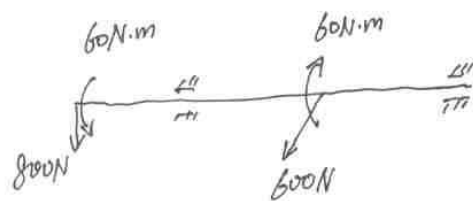
$$\text{由 } M_{\text{负}} = M_{\text{正}} \quad a^2 = (2a+b)\frac{b}{2} - a^2 - ab - \frac{b^2}{4}$$

$$\text{解得 } a = \frac{b}{2\sqrt{2}} \quad \textcircled{1}$$

3. 解: 对轴线的平衡方程 $\sum M_x = 0$

$$P_1 \cdot \frac{D_2}{2} - P_2 \cdot \frac{D_2}{2} = P \cdot \frac{D_1}{2}$$

$$400 \times \frac{300}{2} = P \cdot \frac{150}{2} \Rightarrow P = 800 \text{ N}$$



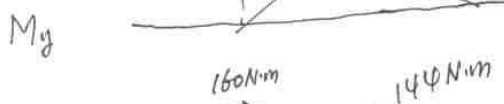
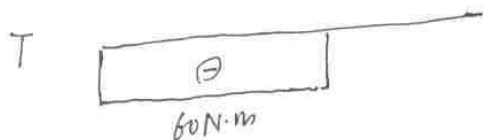
$$M_{\max} = 160 \text{ N}\cdot\text{m}$$

$$T = 60 \text{ N}\cdot\text{m}$$

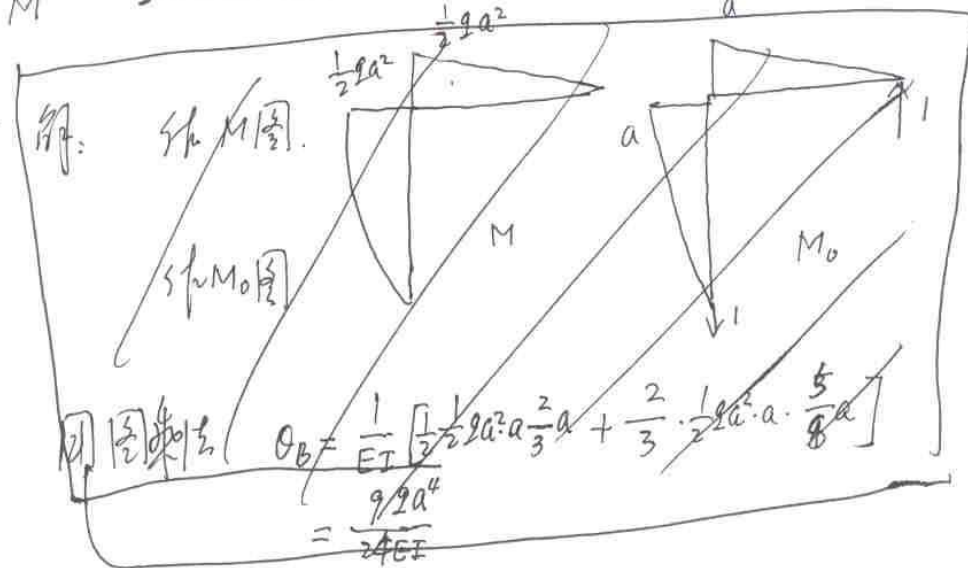
$$\sigma_{\max} = \frac{\sqrt{M^2 + T^2}}{W_z} \leq [\sigma]$$

$$d^3 \geq \frac{32 \sqrt{M^2 + T^2}}{\pi [\sigma]}$$

$$d \geq 26 \text{ mm}$$

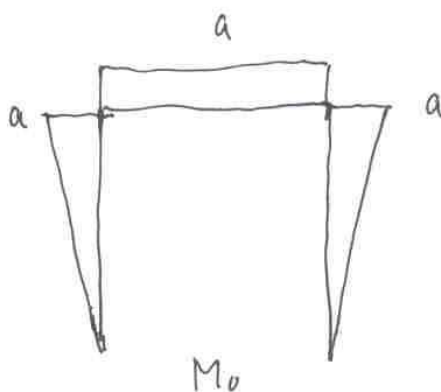
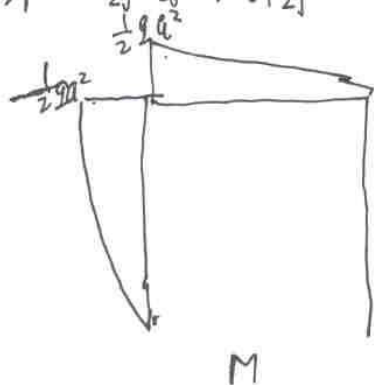


4. 解: 用 M 法



(2)

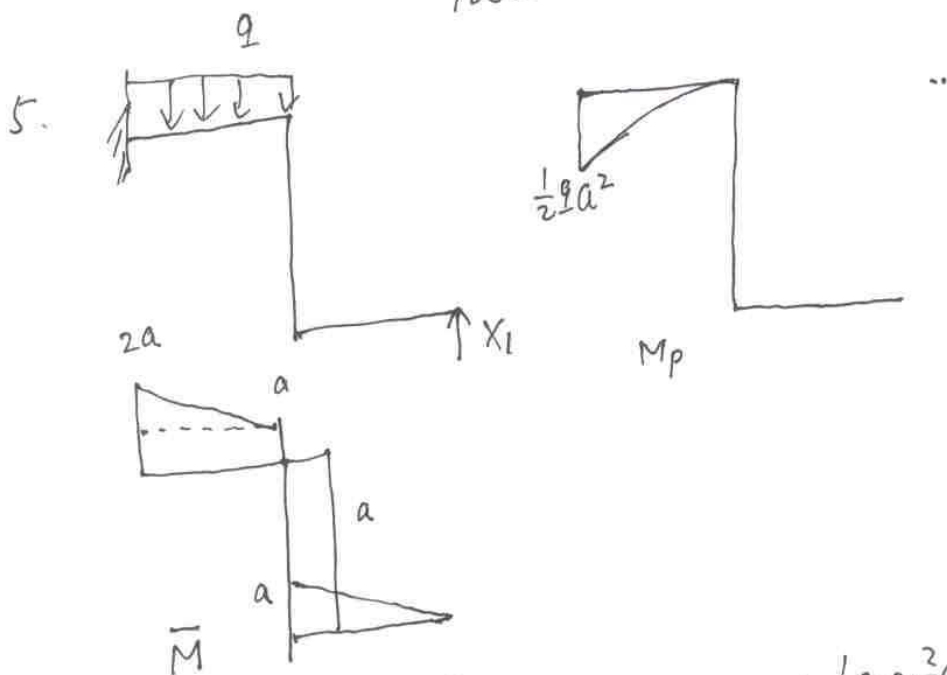
4. $\frac{1}{2} M \left(\frac{2}{3} \right)$ $\frac{1}{8} M_0 \left(\frac{5}{2} \right)$



用图乘法

$$\delta_B = \frac{1}{EI} \left[\frac{2}{3} \times \frac{1}{2} qa^2 \cdot a \times \frac{5}{8} a + \frac{1}{2} \frac{1}{2} qa^2 \cdot a \cdot a \right]$$

$$= \frac{9qa^4}{16EI}$$



$$\delta_{11} = \frac{1}{EI} \left[\frac{1}{2} a \cdot a \cdot \frac{2}{3} a + a \cdot a \cdot a + a \cdot a \cdot a + \frac{1}{2} a \cdot a \cdot \frac{2}{3} a \right]$$

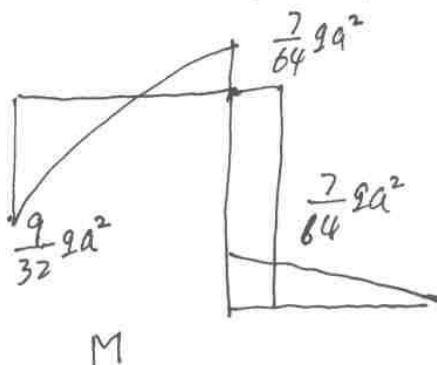
$$= \frac{8a^3}{3EI}$$

$$\Delta_{1P} = -\frac{1}{EI} \left\{ \frac{1}{3} \frac{1}{2} qa^2 \cdot a \left[a + \frac{3}{4} a \right] \right\} = -\frac{7qa^4}{24EI}$$

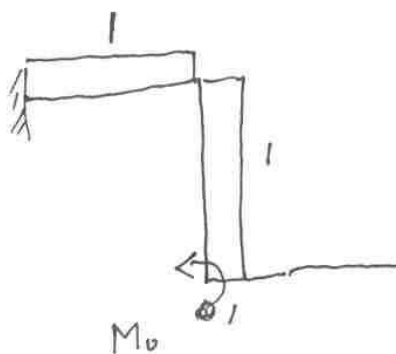
③

由正则方程 $\delta_{11} X_1 + \Delta_{1P} = 0$ $X_1 = -\frac{\Delta_{1P}}{\delta_{11}} = \frac{7}{64} qa$

弯矩图为:



求 C 截面转角, 作 M_0 图



$$\theta_C = \frac{1}{EI} \left[\frac{7qa^2}{64} \cdot a \cdot 1 + \frac{7qa^2}{64} \cdot a \cdot 1 - \frac{1}{3} \cdot \frac{1}{2} qa^2 \cdot a \cdot 1 \right] = \frac{5qa^3}{96EI}$$



6. 取 CD 为研究对象. $\sum M_C(F) = 0$ $N_A = 53.33 \text{ kN}$

$$\lambda = \frac{\mu l}{i} = \frac{1 \times 1500 \times \cos 30^\circ}{\sqrt{\frac{I}{A}}} = \frac{1 \times 1500 \times \cos 30^\circ}{\frac{D}{4} \sqrt{H \alpha^2}} = \frac{108.2}{2.15}$$

$$\lambda_p = \sqrt{\frac{\pi^2 E}{\sigma_p}} \approx 100$$

所以 AB 杆为大柔度杆

$$n = \frac{N_{A1}}{N_A} = 6.14 > n_{st} = 2$$



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