

建筑力学题解集

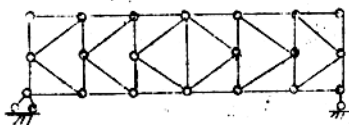
中 册

武汉水利电力学院
建筑力学教研室编

一九八三年八月

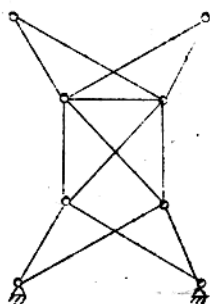
第十一章 静定杆系结构的内力计算

11-1 试对下列结构进行几何组成分析



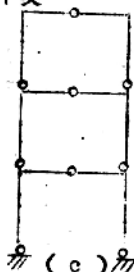
(a)

【解答】 几何不变



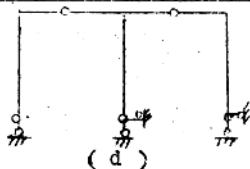
(b)

【解答】 几何不变

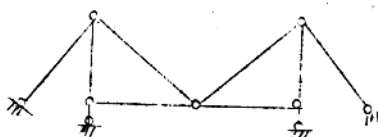


(c)

【解答】 几何不变

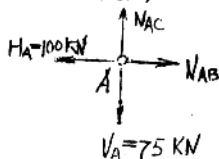
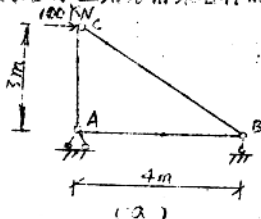


【解答】 几何不变



【解答】 几何不变

11-2 试求图示三角形桁架各杆的轴力。



【解】 1. 计算支反力

$$V_A = 75 \text{ kN} \quad (\downarrow)$$

$$V_B = 75 \text{ kN} \quad (\uparrow)$$

$$H_A = 100 \text{ kN} \quad (\leftarrow)$$

2. 计算各杆内力

A 点:

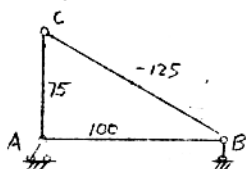
$$\sum X = 0 \quad N_{AB} = 100 \text{ kN}$$

$$\sum Y = 0 \quad N_{AC} = 75 \text{ kN}$$

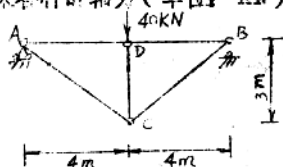
C 点:

$$\sum X = 0 \quad N_{CB} = -125 \text{ kN}$$

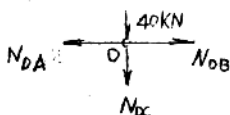
$$\sum Y = 0$$



桁架各杆的轴力 (单位: KN)



(b)



【解】 1. 求支座反力

$$V_A = V_B = 20 \text{ kN} \quad (\uparrow)$$

2. 求各杆内力

取结点 D 为脱离体

$$\sum Y = 0 \quad N_C = -40 \text{ kN}$$

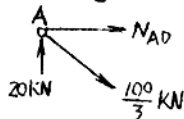
$$\sum X = 0 \quad N_{DA} = N_{DB}$$



取结点 C 为脱离体

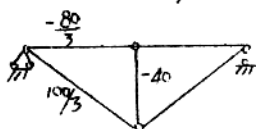
$$\sum X = 0 \quad N_{CA} = N_{CB}$$

$$\sum Y = 0 \quad N_{CA} = \frac{100}{3} \text{ kN}$$



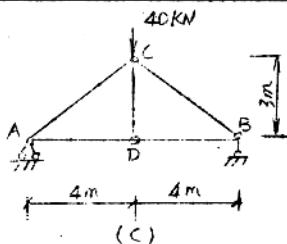
取结点 A 为脱离体

$$\sum X = 0 \quad N_{AD} = -\frac{80}{3} \text{ kN}$$



各杆轴力 (单位: KN)

11-4 第十一章 静定杆系结构的内力计算



【解】 1. 求支座反力

$$V_A = V_B = 20 \text{ kN} \quad (\uparrow)$$

2. 求各杆轴力

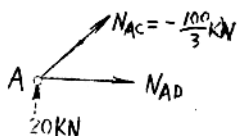
$$N_{DC} = 0$$



取 C 点为脱离体

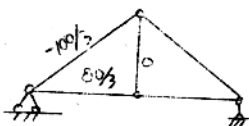
$$\Sigma X = 0 \quad N_{CA} = N_{CB}$$

$$\Sigma Y = 0 \quad N_{CA} = -\frac{100}{3} \text{ kN}$$



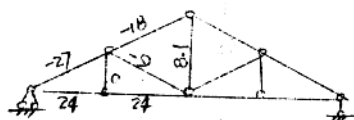
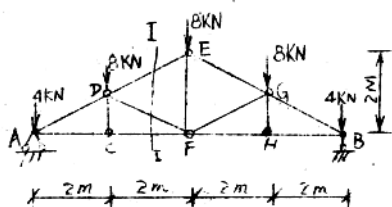
取结点 A 为脱离体

$$\Sigma X = 0 \quad N_{AD} = \frac{80}{3} \text{ kN}$$



各杆轴力 (单位: kN)

11-3 试求图示桁架各杆的轴力



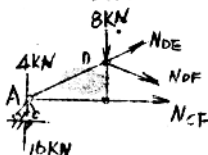
(a)

各杆轴力 (单位: kN)

〔解〕 1. 求支座反力 $V_A = V_B = 16\text{kN}$

2. 计算各杆内力

截面 I—I, 取左部分为脱离体



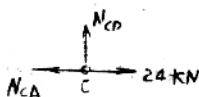
$$\sum M_A = 0$$

$$N_{DF} = -8.944\text{kN}$$

$$\sum M_D = 0$$

$$N_{CF} = 24\text{kN}$$

取结点 C 为脱离体

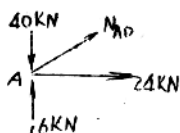


$$\sum Y = 0$$

$$N_{CD} = 0$$

$$\sum X = 0$$

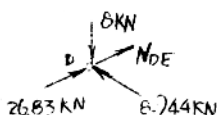
$$N_{CA} = 24\text{kN}$$



取结点 A 为脱离体

$$\sum X = 0$$

$$N_{AD} = -26.83\text{kN}$$

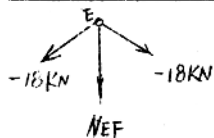


取 D 点为脱离体

$$\sum X = 0$$

$$N_{DE} = -17.886\text{kN}$$

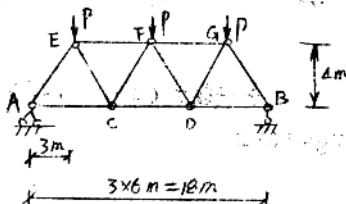
11-6 第十一章静定杆系结构的内力计算



取 E 点为脱离体

$$\sum Y = 0$$

$$N_{EF} = 8.1 \text{ kN}$$



【解】 1. 求支座反力

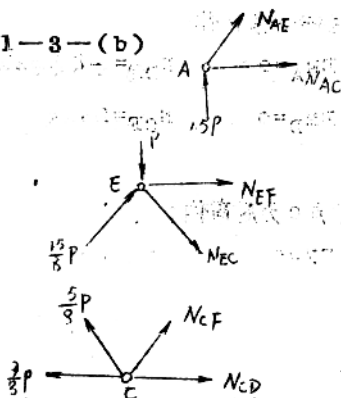
$$V_A = V_B = 1.5P \quad (\uparrow)$$

2. 求各杆内力

取 A 结点为脱离体

$$\sum Y = 0 \quad N_{AE} = \frac{-15P}{8}$$

11-3-(b)



$$\sum X = 0 \quad N_{AC} = \frac{9}{8}P$$

取结点 E 为脱离体

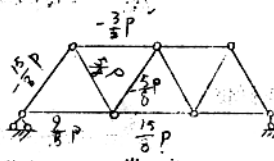
$$\sum Y = 0 \quad N_{EC} = \frac{5}{8}P$$

$$\sum X = 0 \quad N_{EF} = -\frac{3}{2}P$$

取结点 C 为脱离体

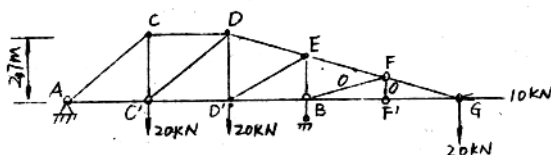
$$\sum Y = 0 \quad N_{CF} = -\frac{5}{8}P$$

$$\sum X = 0 \quad N_{CD} = \frac{15}{8}P$$



桁架各杆轴力

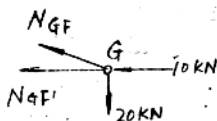
11-3-(C)



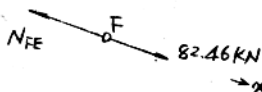
【解】 1. 计算支座反力

$$V_A = \frac{20}{3} \text{ kN} (\uparrow), H_A = 10 \text{ kN} (\rightarrow)$$

$$V_B = \frac{160}{3} \text{ kN} (\uparrow)$$



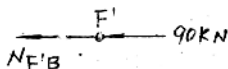
2. 计算各杆内力

 判断 0 杆, $N_{F'F} = 0, N_{FB} = 0$


取结点 G 为脱离体

$$\sum Y = 0 \quad N_{GF} = 82.46 \text{ kN}$$

$$\sum X = 0 \quad N_{GF'} = -90 \text{ kN}$$



取结点 F 为脱离体

$$\sum X' = 0 \quad N_{FE} = 82.46 \text{ kN}$$

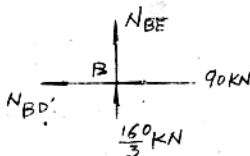
取结点 F' 为脱离体

$$\sum X = 0 \quad N_{F'B} = -90 \text{ kN}$$

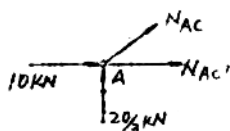
取结点 B 为脱离体

$$\sum X = 0 \quad N_{BF} = -90 \text{ kN}$$

$$\sum Y = 0 \quad N_{BE} = -\frac{160}{3} \text{ kN}$$



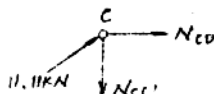
11-8 第十一章静定杆系结构的内力计算



取结点A为脱离体

$$\sum Y=0 \quad N_{AC} = -11.11 \text{ kN}$$

$$\sum X=0 \quad N_{AC'} = -1.11 \text{ kN}$$



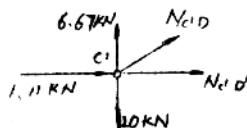
取结点C为脱离体

$$\sum X=0 \quad N_{CD} = -\frac{3.6}{4.5} \times 11.11$$

$$= -8.89 \text{ kN}$$

$$\sum Y=0 \quad N_{CC'} = \frac{2.7}{4.5} \times 11.11$$

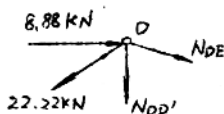
$$= 6.67 \text{ kN}$$



取结点C'为脱离体

$$\sum Y=0 \quad N_{C'D} = 22.22 \text{ kN}$$

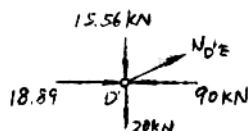
$$\sum X=0 \quad N_{C'D'} = -18.89 \text{ kN}$$



取结点D为脱离体

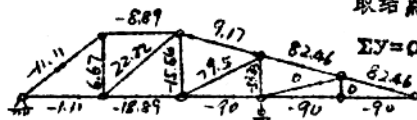
$$\sum X=0 \quad N_{DE} = 9.168 \text{ kN}$$

$$\sum Y=0 \quad N_{DD'} = -15.56 \text{ kN}$$



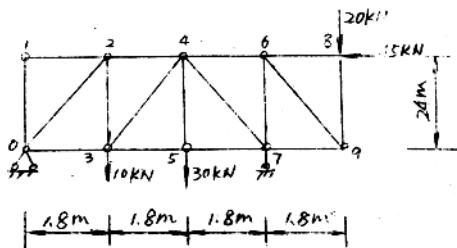
取结点D'为脱离体

$$\sum Y=0 \quad N_{D'E} = 79.5 \text{ kN}$$



(单位: kN)

11-8 (d)



〔解〕 1. 求支反力

$$V_0 = 80 \text{ kN} (\uparrow), H_0 = 45 \text{ kN} (\rightarrow)$$

$$V_7 = 30 \text{ kN} (\uparrow)$$

2. 求各杆的内力

判断零杆: $N_{02} = N_{12} = 0$

取结点 8 为脱离体

$$\sum X = 0 \quad N_{83} = -45 \text{ kN}$$

$$\sum Y = 0 \quad N_{87} = -20 \text{ kN}$$

取结点 3 为研究对象

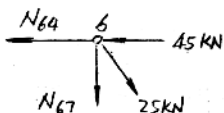
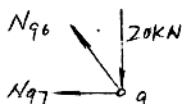
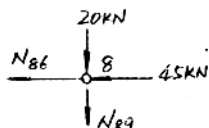
$$\sum Y = 0 \quad N_{03} = 25 \text{ kN}$$

$$\sum X = 0 \quad N_{07} = -15 \text{ kN}$$

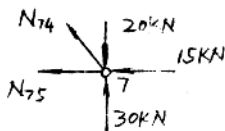
取结点 6 为脱离体

$$\sum Y = 0 \quad N_{67} = -20 \text{ kN}$$

$$\sum X = 0 \quad N_{64} = -30 \text{ kN}$$



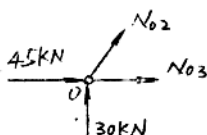
11-10 第十一章 静定杆系结构的内力计算



取结点7为脱离体

$$\sum Y = 0 \quad N_{74} = -12.5 \text{ kN}$$

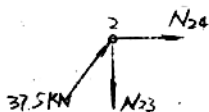
$$\sum X = 0 \quad N_{75} = -7.5 \text{ kN}$$



取结点0为脱离体

$$\sum Y = 0 \quad N_{02} = -37.5 \text{ kN}$$

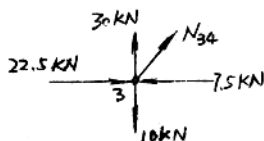
$$\sum X = 0 \quad N_{03} = -22.5 \text{ kN}$$



取结点2为脱离体

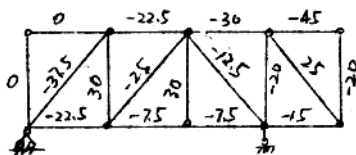
$$\sum X = 0 \quad N_{24} = -22.5 \text{ kN}$$

$$\sum Y = 0 \quad N_{23} = 30 \text{ kN}$$



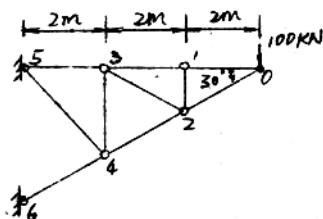
取结点3为脱离体

$$\sum Y = 0 \quad N_{34} = -25 \text{ kN}$$



各杆内力 (单位: kN)

11-8 (e)



【解】 1. 判断 0 杆

$$N_{12} = N_{23} = N_{34} = N_{45} = 0$$

2. 求各杆的内力

取结点 O 为脱离体

$$\sum Y = 0 \quad N_{02} = -200 \text{ kN}$$

$$\sum X = 0 \quad N_{01} = 100\sqrt{3} \text{ kN}$$

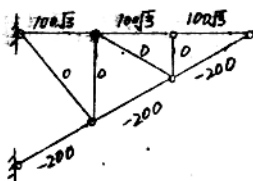
依次根据结点 1, 2, 3, 4 的平衡条件可求出:

$$N_{12} = 100\sqrt{3} \text{ kN}$$

$$N_{24} = -200 \text{ kN}$$

$$N_{23} = 100\sqrt{3} \text{ kN}$$

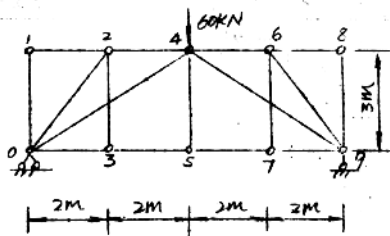
$$N_{45} = -200 \text{ kN}$$



各杆内力 (单位: kN)

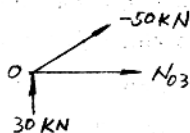
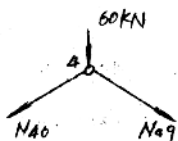
11-12 第十一章静定杆系结构的内力计算

11-3 (f)



【解】 1. 判断 0 杆

$$\begin{aligned} N_{54} &= N_{32} = N_{76} = N_{28} = N_{69} = N_{21} \\ &= N_{68} = N_{10} = N_{19} = N_{24} = N_{46} \\ &= 0 \end{aligned}$$



2. 计算支反力

$$V_0 = V_9 = 30 \text{ kN} (\uparrow)$$

3. 计算各杆内力

取结点 4 为研究对象

$$\Sigma X = 0 \quad N_{40} = N_{49}$$

$$\Sigma Y = 0 \quad N_{40} = -50 \text{ kN}$$

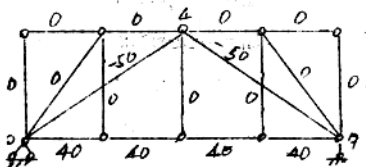
取结点 0 为研究对象

$$\Sigma X = 0 \quad N_{03} = 40 \text{ kN}$$

依次根据结点 3, 5, 7 的

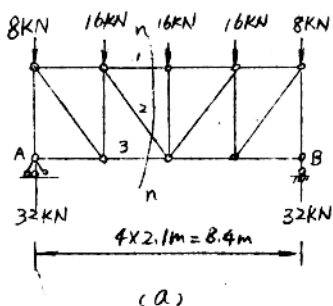
平衡条件可求得:

$$N_{25} = N_{57} = N_{79} = 40 \text{ kN}$$



各杆内力 (单位: kN)

11-4 试求图示桁架中各指定杆的轴力



[解] 1. 求支座反力

$$V_A = V_B = 32 \text{ kN} (\uparrow)$$

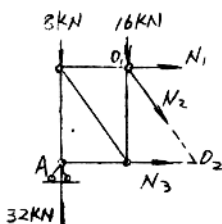
2. 求 1, 2, 3 杆的轴力

 截面 $n \sim n$ 取左边部分
为脱离体

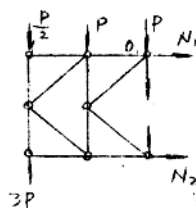
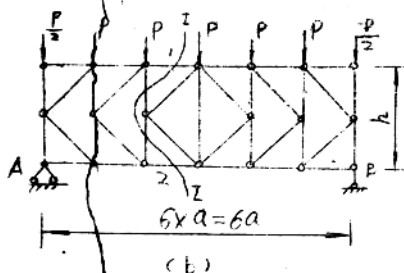
$$\sum M_{O_1} = 0 \quad N_3 = 21 \text{ kN}$$

$$\sum M_{O_2} = 0 \quad N_1 = -20 \text{ kN}$$

$$\sum M_A = 0 \quad N_2 = 10.63 \text{ kN}$$



11-4 (b)



[解] 1. 求支反力

$$V_A = V_B = 3P$$

2. 求 1, 2 杆的内力

11-14 第十一章静定杆系结构的内力计算

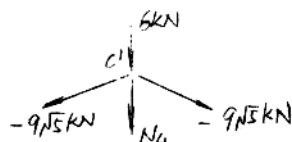
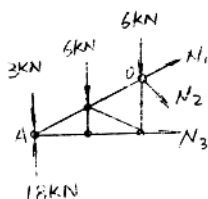
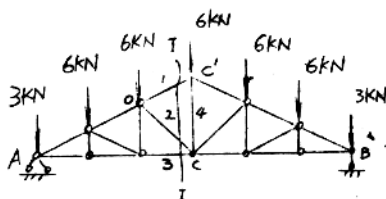
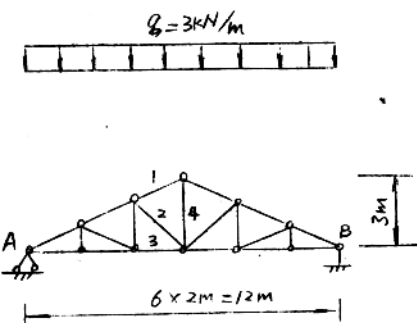
截面 I—I, 取左边部分为脱离体

$$\sum M_{O_2} = 0 \quad N_2 = \frac{4Pa}{h}$$

$$\sum X = 0 \quad N_1 = -N_2 = -\frac{4Pa}{h}$$

[11-4(c) 题解答在 11-5 题后]

11-5 图示一木屋架, 荷载沿水平方向均匀分布, 直接作用于上弦杆试求各指定杆的轴力



[解] 1. 把荷载简化到结点上

(如上图所示)

2. 计算支反力

$$V_A = V_B = 12 \text{ kN}$$

3. 计算 1, 2, 3 杆内力

截面 I—I, 取左边部分为脱离体

$$\sum M_A = 0 \quad N_2 = -6\sqrt{2} \text{ kN}$$

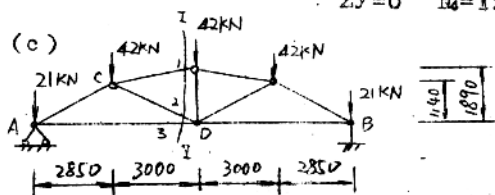
$$\sum M_C = 0 \quad N_3 = -24 \text{ kN}$$

$$\sum Y = 0 \quad N_1 = -9\sqrt{5} \text{ kN}$$

取结点 c' 为脱离体

$$\sum Y = 0 \quad N_4 = 12 \text{ kN}$$

11-4 (c)



(尺寸单位: mm)

(c)

〔解〕 1. 计算支座反力

$$V_A = V_B = 84 \text{ kN}$$

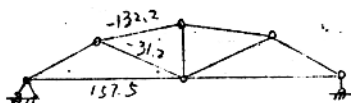
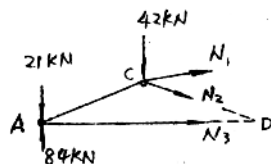
2. 计算 1、2、3 杆的内力

截面 I—I, 取左边部分为脱离体

$$\sum M_C = 0 \quad N_2 = 157.5 \text{ kN}$$

$$\sum M_D = 0 \quad N_1 = -132.2 \text{ kN}$$

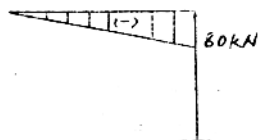
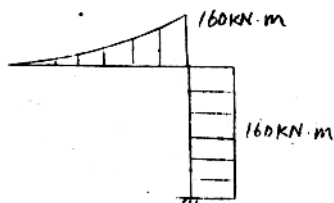
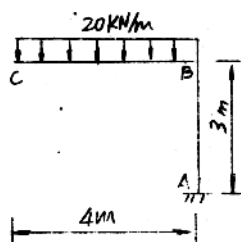
$$\sum Y = 0 \quad N_3 = -81.2 \text{ kN}$$



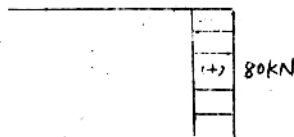
1、2、3 各杆内力〔单位: kN〕

11-8 试作图示各刚架的弯矩图、剪力图和轴力图。

(a)



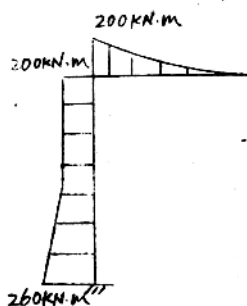
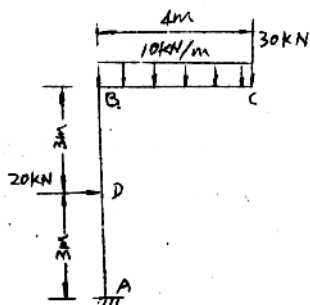
M



Q

Q

11-6 (b)



M