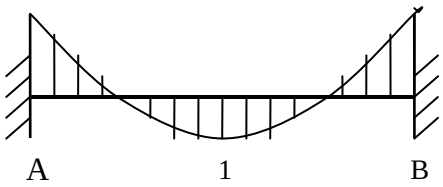
# B 混凝土结构中册习题答案

## 第 11 章

**11．1** 解：1、求支座截面出现塑性铰时的均布荷载 $q_1$

首先计算支座截面极限抗弯承载力 $M_{uA}$：

C20 混凝土查得 $f_c=9.6N/mm^2$， 3 16 $A_s=603mm^2$




$$x=\frac{A_s f_y}{\alpha_1 f_c b}=\frac{603\times 300}{9.6\times 200}=94mm<\xi_b h_0$$

$$M_{uA}=A_s f_y(h_0-\frac{x}{2})=603\times 300(465-\frac{94}{2})=75.6KNm$$

按弹性分析：$M_A=M_{uA}=\frac{ql^2}{12}$，　　$q=\frac{12M_{uA}}{l^2}=\frac{12\times 75.6}{6^2}=25.2k\,N\,n$

$$\therefore q_1=25.2kN/m$$

2、计算跨中极限抗弯承载力 $M_{u1}$：2 16 $As=402mm^2$

$$x=\frac{402\times 300}{9.6\times 200}=63mm,\qquad M_{u1}=402\times 300\left(465-\frac{63}{2}\right)=52.3kNm$$

总弯矩 $M_{总}=M_{uA}+M_{u1}=75.6+52.3=127.9kNm$

由 $M_{总}=\frac{p_u l^2}{8}$ 得 $p_u=\frac{8M_{总}}{l^2}=\frac{8\times 127.9}{6^2}=28.4kN/m$

3、若均布荷载同为 $p_u$,按弹性计算的支座弯矩

$$M_{Ae}=\frac{2}{3}M_{总}=\frac{2}{3}\times 127.9=85.3kNm$$

则调幅系数 $\beta=\frac{M_{Ae}-M_{Au}}{M_{Ae}}=\frac{85.3-75.6}{85.3}=0.114$

**11．2** 解：$A_{s1}=A_{sA}=644mm^2/m$， $f_y=210N/mm^2$， $h_0=120-20=100mm$

$$x=\frac{644\times 210}{9.6\times 1000}=14.1mm<\xi_b h_0$$

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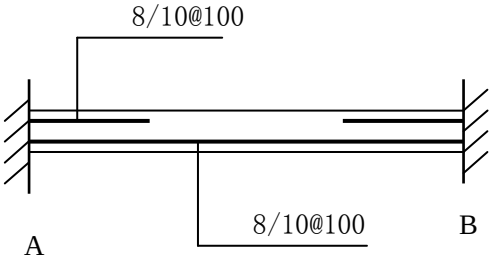
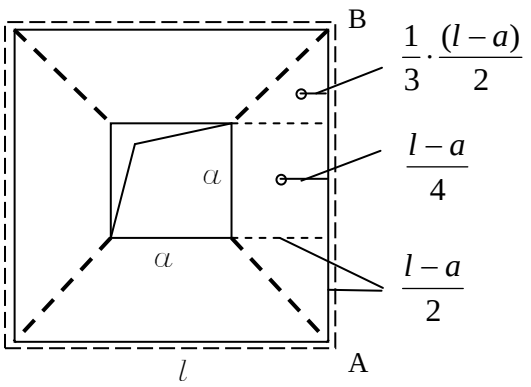



$$M_u=644\times 210(100-\frac{14}{2})=12.58kNm/m$$

$$M_{总}=2M_u=25.2kNm/m$$

$$p_u=\frac{8M_{总}}{l_n^2\times 1}=\frac{8\times 25.2}{4^2\times 1}=12.6kN/m^2$$

**11．3** 解：塑性铰线位置如图所示。




取出一块梯形板块为隔离体，对铰支座 AB 取力矩平衡：

$$m\cdot(l-a)=p_u\left[\left(\frac{l-a}{2}\right)^2\cdot\frac{1}{3}\cdot\frac{(l-a)}{2}+\frac{(l-a)}{2}\cdot a\cdot\frac{(l-a)}{4}\right]$$

$$m=p_u\left[\frac{(l-a)^2}{24}+\frac{a(l-a)}{8}\right]=p_u\cdot\frac{l-a}{8}\left(\frac{l-a}{3}+a\right)=\frac{(l-a)}{24}p_u(l+2a)$$

$$\therefore p_u=\frac{24m}{(l+2a)(l-a)}$$

# 第 12 章

**12．1** 解：

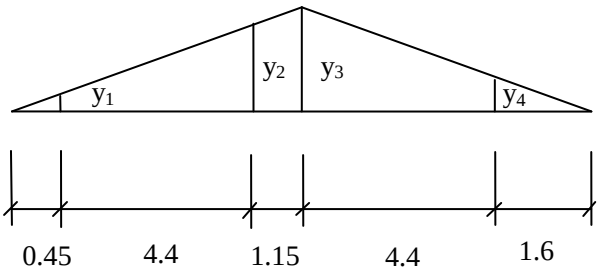
影响线

$$y_3=1$$

$$y_1=\frac{0.45}{6}=0.075$$

$$y_2=\frac{0.45+4.4}{6}=0.808$$

$$y_4=\frac{1.6}{6}=0.267$$




$$\sum y_i=1+0.075+0.808+0.267=2.15$$

$$D_{\max}=0.9P_{\max}\sum y_i=0.9\times2.15\times115=0.9\times247.25=222.5kN$$

$$P_{\min}=\frac{18\times9.8+10\times9.8}{2}-115=22.2kN$$

$$D_{\min}=\frac{P_{\min}}{P_{\max}}\cdot D_{\max}=\frac{22.2}{115}\times222.5=43kN$$

水平荷载系数$\alpha=0.12$

$$T_k=\frac{1}{4}\times0.12(3.94+10)\times9.8=4.098kN$$

$$T_{\max,k}=\frac{4.098}{115}\times222.5=7.93kN$$

**12．2** 解：

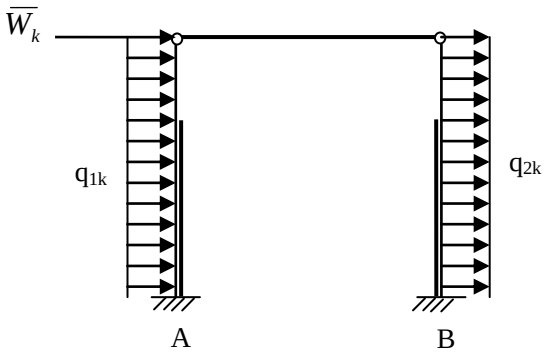
①计算柱顶水平集中力$\overline{W}_k$：柱顶标高处$\mu_z \approx 1.0$，　檐口处$\mu_z \approx 1.07$

$$\overline{W}_k = \overline{W}_{1k} + \overline{W}_{2k} = \left[(0.8+0.5)\times 2.1 + (0.5-0.6)\times 1.2\right]\times 1.07\times 0.45\times 6$$
$$= (1.3\times 2.1 - 0.12)\times 1.07\times 0.45\times 6 = 7.54kN$$

② $q_{1k} = \mu_s \mu_z w_0 B = 0.8\times 1.0\times 0.45\times 6 = 2.16kN/m$

$q_{2k} = -0.5\times 1.0\times 0.45\times 6 = -1.35kN/m$

③ 剪力分配系数计算：




$$n_A = \frac{2.13}{14.38} = 0.148$$
$$n_B = \frac{7.2}{19.5} = 0.369$$
$$\lambda = \frac{10.5-8.4}{10.5} = 0.2;$$

$$C_{0A} = \frac{3}{1+0.2^3\left(\frac{1}{0.148}-1\right)} = \frac{3}{1+0.008(5.757)} = 2.868$$

$$C_{0B} = \frac{3}{1+0.2^3\left(\frac{1}{0.369}-1\right)} = 2.96\left(\text{因只需相对值，故略去}10^9\right)$$

$$\Delta u_A = \frac{H^3}{E_c I_2 C_{0A}} = \frac{H^3}{E_c \times 14.38\times 2.868} = \frac{H^3}{E_c}\cdot\frac{1}{41.24};$$
$$\Delta u_B = \frac{H^3}{E_c}\cdot\frac{1}{19.5\times 2.96} = \frac{H^3}{E_c}\cdot\frac{1}{57.72};$$

$$\frac{1}{\Delta u_A} + \frac{1}{\Delta u_B} = \frac{E_c}{H^3}(41.24+57.72) = 98.96\frac{E_c}{H^3}$$

$$\eta_A = \frac{41.24}{98.96} = 0.417,\qquad \eta_B = \frac{57.72}{98.96} = 0.583$$

④ 计算约束反力$R_A$、$R_B$：

$$C_{11A}=\frac{3\left[1+0.2^4\left(\frac{1}{0.148}-1\right)\right]}{8\left[1+0.2^3\left(\frac{1}{0.148}-1\right)\right]}=\frac{3.028}{98.96}=0.362$$

$$C_{11B}=\frac{3\left[1+0.2^4\left(\frac{1}{0.369}-1\right)\right]}{8\left[1+0.2^3\left(\frac{1}{0.369}-1\right)\right]}=\frac{3.008}{8.11}=0.371$$

$$R_A=q_1HC_{11A}=2.16\times10.5\times0.362=8.21kN(\leftarrow)$$
$$R_B=q_2HC_{11B}=1.35\times10.5\times0.371=5.26kN(\leftarrow)$$

$$\sum R=8.21+5.26=13.47kN$$

⑤ 剪力计算：

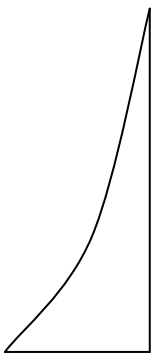
$$\eta_A\left(\sum R+\overline{W_k}\right)=0.417\cdot(13.47+7.54)=0.417\times21.01=8.76kN$$
$$\eta_B\left(\sum R+\overline{W_k}\right)=0.583\cdot(13.47+7.54)=0.583\times21.01=12.25kN$$

A 柱顶剪力 $V_A$=8.76-8.21=0.55Kn (→)

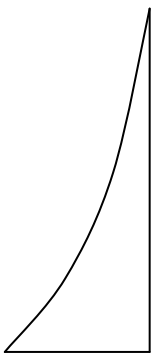
B 柱顶剪力 $V_B$=12.25-5.26=7kN (→)

⑥ 弯矩图：

$$M_{A底}=\frac{1}{2}q_1H^2+V_AH=\frac{1}{2}\times2.16\times10.5^2+0.55\times10.5=124.85kNm$$
$$M_{B底}=\frac{1}{2}\times1.35\times10.5+7\times10.5=147.8kNm$$



$M_A$=124.85kN



$M_B$=147.8kNm

**12．3** 解：从前题知 $n_A$=0.148,　$n_B$=0.369,　$\lambda=\dfrac{3.5}{11}=0.318$

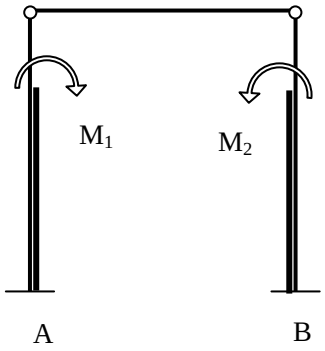
① 计算剪力分配系数：

$$C_{0A}=\frac{3}{1+0.318^3\left(\dfrac{1}{0.148}-1\right)}=2.53 \qquad \Delta u_A\cdot\frac{E_c}{H^3}=\frac{1}{14.38\times 2.53}=\frac{1}{36.38}$$

$$C_{0B}=\frac{3}{1+0.318^3\left(\dfrac{1}{0.369}-1\right)}=2.84 \qquad \Delta u_B\cdot\frac{E_c}{H^3}=\frac{1}{19.5\times 2.84}=\frac{1}{55.38}$$

$$\frac{1}{\Delta u_A}+\frac{1}{\Delta u_B}=(36.38+55.38)\frac{E_c}{H^3}=91.76\frac{E_c}{H^3}$$　（相对值）

$$\eta_A=\frac{36.38}{91.76}=0.4\,,\qquad \eta_B=\frac{55.38}{91.76}=0.6$$




② 计算约束反力 $R_A$、$R_B$：

$$C_{3A}=1.5\cdot\frac{1-0.318^2}{1+0.318^3\left(\dfrac{1}{0.148}-1\right)}=1.5\cdot\frac{0.899}{1.185}=1.138$$

$$C_{3B}=1.5\cdot\frac{1-0.318^2}{1+0.318^3\left(\dfrac{1}{0.369}-1\right)}=1.5\cdot\frac{0.899}{1.055}=1.278$$

$$R_A=\frac{M_1}{H}\cdot C_{3A}=\frac{153.2}{11}\times 1.138=15.85kN(\leftarrow)$$

$$R_B=\frac{M_2}{H}\cdot C_{3B}=\frac{-131}{11}\times 1.278=-15.22kN(\rightarrow)$$

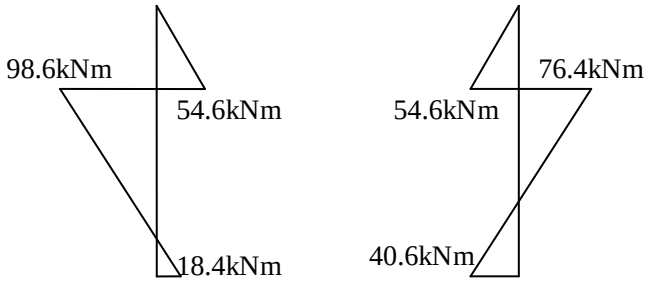
$$\sum R=15.85-15.22=0.63kN(\leftarrow)$$

③ 柱顶剪力：

$$V_A=R_A-\eta_A\sum R=15.85-0.4\times 0.63=15.6kN(\leftarrow)$$

$$V_B=R_B-\eta_B\sum R=-15.22-0.6\times 0.63=-15.6kN(\rightarrow)$$

④ 弯矩图：



**12．4** 解：$f_y$=300 N/mm$^2$, $F_V$=324 kN,　Fh=78 kN,　a=250 mm

$$A_s=\frac{324\times10^3\times250}{0.85\times300\times(800-40)}+1.2\cdot\frac{78\times10^3}{300}=418+312=730mm^2$$

小于最小配筋量 6　12 的面积，故按构造配筋

**12．5** 由于解答不唯一，故从略。

## 第 15 章

**15．1** 解：查得砌体抗压强度设计值 f=1.5 N/㎜$^2$,

$$e=\frac{M}{N}=\frac{8.1\times10^6}{250\times10^3}=32.4mm;\quad \beta=\frac{H_0}{h}=\frac{6800}{620}=10.97;\quad \frac{e}{h}=\frac{32.4}{620}=0.052;$$

$$\varphi_0=\frac{1}{1+\alpha\beta^2}=\frac{1}{1+0.0015\times11^2}=0.846$$

$$\varphi=\frac{1}{1+12\left\{0.052+\sqrt{\frac{1}{12}\left(\frac{1}{0.846}-1\right)}\right\}^2}=0.73$$

$$\varphi fA=0.73\times1.5\times490\times620=332.66kN>N=250kN$$

按轴压计算时 $\beta=\frac{6800}{490}=13.88$

$$\varphi_0=\frac{1}{1+0.0015\times13.88^2}=0.776>\varphi$$　∴承载力应会满足。

**15．2** 解：抗压强度设计值 f=1.19 N/㎜$^2$, 翼墙间距 s=6.8 ㎜,层高 H=3.5 ㎜,

2H>s>H, ∴计算高度 $H_0=0.4s+02H=0.4\times6.8+0.2\times3.5=3.42m$

$$\beta=\frac{3.42\times1.1}{0.19}=19.8,\qquad \alpha=0.0015$$

$$\varphi_0=\frac{1}{1+0.0015\times19.8^2}=0.63$$

底层轴力 N=118+3.36*3.5=129.76Kn

$$\varphi_0 fA=0.63\times1.19\times1000\times190=142.47>129.76$$

**15．3** 解：$N_l=180kN,\quad N_0=50kN,\quad A_0=(250+2\times240)\times240=0.1752m^2$

$$f=1.3N/mm^2,\qquad a_0=10\sqrt{\frac{600}{1.3}}=215mm<240mm$$

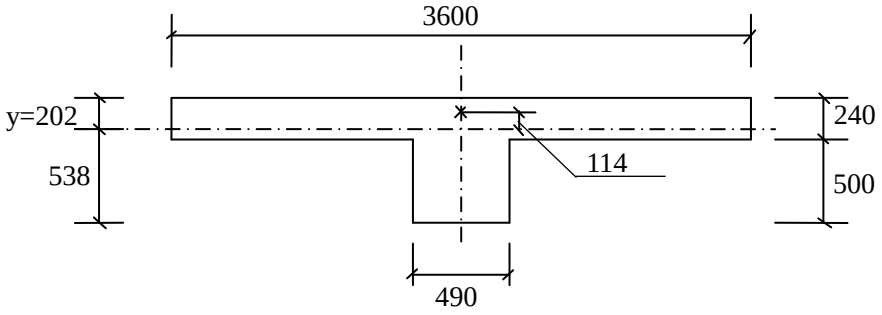
$A_l = a_0 b_b = 215 \times 250 = 53750 mm^2$；　　$\frac{A_0}{A_l} = \frac{175200}{53750} = 3.26 > 3$

$\therefore \psi = 0$　　$\gamma = 1 + 0.35\sqrt{3.26 - 1} = 1.526 < 2$

$\eta\gamma f A_l = 0.7 \times 1.526 \times 1.3 \times 53750 = 74.64 kN < N_l$

局部受压不满足要求。

**15．4** 解：首先计算中和轴位置 y




$$y = \frac{490 \times 740^2 \times 0.5 + (3600 - 490) \times 240^2 \times 0.5}{490 \times 500 + 3600 \times 240} = 202 mm$$

惯性矩 I:

$$I = \frac{490 \times 740^3}{12} + 490 \times 740\left(538 - \frac{740}{2}\right)^2 + \frac{(3600 - 490) \times 240^3}{12} + (3600 - 490)240\left(202 - \frac{240}{2}\right)^2$$

$$= 1.655 \times 10^{10} + 1.0234 \times 10^{10} + 0.3583 \times 10^{10} + 0.5019 \times 10^{10} = 3.5386 \times 10^{10} mm^2$$

$$A = 490 \times 500 + 3600 \times 240 = 1.109 \times 10^6 mm^2$$

回转半径 $i = \sqrt{\frac{I}{A}} = \sqrt{\frac{3.5386 \times 10^{10}}{1.109 \times 10^6}} = 179 mm$

折算厚度 $h_T = 3.5i = 625 mm$，　　高厚比 $\beta = \frac{H_0}{h_T} = \frac{8200}{625} = 13.12$

$e = \frac{M}{N} = \frac{40 \times 10^6}{350 \times 10^3} = 114 mm$，　$\frac{e}{h_T} = \frac{114}{625} = 0.182$，　　$\varphi_0 = \frac{1}{1 + 0.002 \times 13.2^2} = 0.744$

$$\varphi = \frac{1}{1 + 12\left\{0.182 + \sqrt{\frac{1}{12}\left(\frac{1}{0.744} - 1\right)}\right\}^2} = 0.403;$$　　查得 $f = 1.3 N / mm^2$

$\varphi f A = 0.403 \times 1.3 \times 1.109 \times 10^6 = 581 kN > N = 350 kN$

承载力满足要求。

**15．5** 解：f=1.5 N/mm$^2$,

$$a_0 = 10\sqrt{\frac{500}{1.5}} = 183mm < a = 240mm, \qquad A_l = a_0 b_b = 183\times 200 = 36600mm^2$$

$$A_0 = (200 + 2\times 370)\times 370 = 347800mm^2$$

$$\gamma = 1 + 0.35\sqrt{9.5-1} = 2.02 > 2.0 \text{取} \gamma = 2.0$$

$$\eta\gamma f A_l = 0.7\times 2\times 1.5\times 36600 = 76.86kN < 85kN$$

局部承压承载力不满足要求。

**15．6** （条件不足，无法算出灌孔砌体抗压强度设计值。①无标准差，无法得标准值，从而得不到设计值；2 不知 Cb20 混凝土、MU10 砌块、Mb5 砂浆的强度平均值）

**15．7** 解：$f = 2.31N/mm^2$，$e = \frac{M}{N} = \frac{15\times 10^6}{180\times 10^3} = 83.3mm$

$$\rho = \frac{12.6\times(50+50)}{50\times 50\times 250}\times 100 = 0.2016$$

$$f_n = 2.31 + 2\times\left(1 - \frac{2\times 83.3}{245}\right)\times 0.002016\times 430 = 2.86N/mm^2$$

$$\beta = \frac{H_0}{h} = \frac{4.2}{0.49} = 8.57; \qquad \frac{e}{h} = \frac{83.3}{490} = 0.17$$

查得$\varphi = 0.51$

$$\varphi_n f_n A = 0.51\times 2.86\times 490^2 = 350.2kN > N = 180kN$$ 安全

**15．8** 略

**15．9** 解：

（1）屋盖属二类，横墙间距 40m,查表 15-6 可知属于刚弹性方案。

（2）①带壁柱墙验算

形心轴位置：$y_1 = \frac{390^3\times 0.5 + (2400-390)\times 190^2\times 0.5}{390\times 200 + 190\times 2400} = \frac{65.94\times 10^6}{534\times 10^3} = 123.5mm$

$$I = \frac{390^4}{12} + 390^2\left(\frac{390}{2} - 123.5\right)^2 + \frac{(2400-390)190^3}{12} + (2400-390)190\left(123.5 - \frac{190}{2}\right)^2$$

$$= 19.28\times 10^8 + 7.776\times 10^8 + 11.489\times 10^8 + 3.102\times 10^8 = 41.647\times 10^8 mm^4$$

$$i = \sqrt{\frac{I}{A}} = \sqrt{\frac{41.647\times 10^8}{534\times 10^3}} = 88.3mm; \qquad h_T = 3.5i = 309mm$$

s=40 m, H=6.5 m

查表 15-8 得 $H_0 = 1.2H = 1.2 \times 6.5 = 7.8m$

$$\beta = \frac{7.8}{0.309} = 25.24, \quad \mu_1 = 1, \quad \mu_2 = 1 - 0.4 \cdot \frac{1.6}{4} = 0.84, \quad [\beta] = 24$$

$\mu_1\mu_2[\beta] = 1 \times 0.84 \times 24 = 20.16 < \beta$ 不满足要求。

② 壁柱间墙体验算：

s=4 m, H=6.5 m, s<H; $H_0 = 0.6s = 0.6 \times 4 = 2.4m$

$$\beta = \frac{2.4}{0.19} = 12.63 < \mu_1\mu_2[\beta] = 20.16$$ 满足要求。