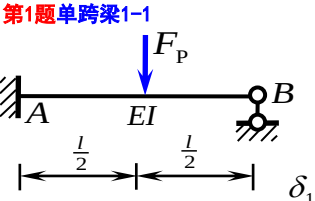
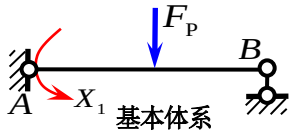
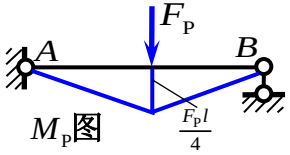
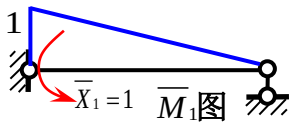
载常数、形常数

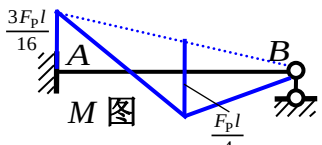
第1题单跨梁1-1





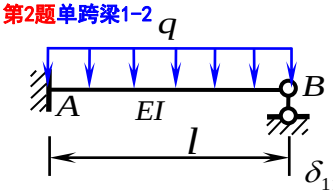


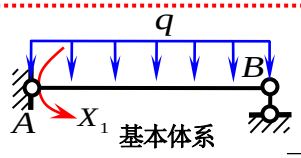


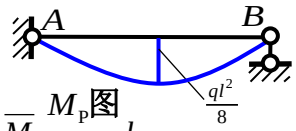


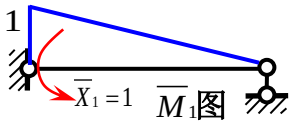
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-F_Pl^2}{16EI} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{3F_Pl}{16} \quad M=\overline{M}_1X_1+M_P$$

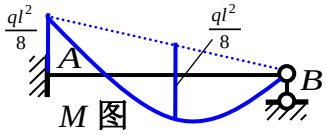
第2题单跨梁1-2





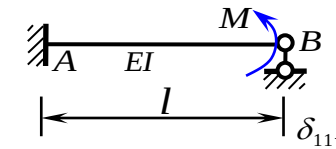


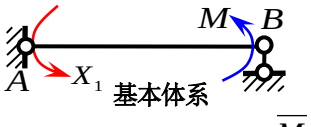


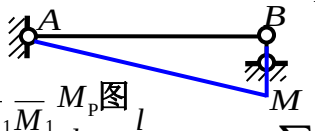


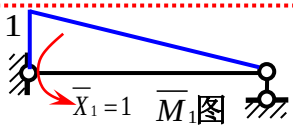
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^3}{24EI} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{ql^2}{8} \quad M=\overline{M}_1X_1+M_P$$

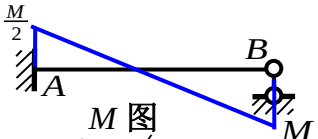
第3题单跨梁1-3





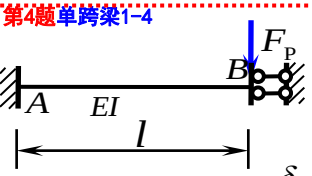


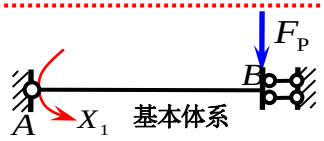


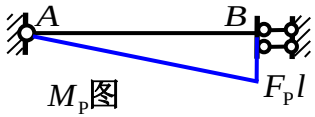


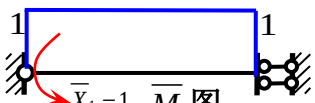
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-Ml}{6EI} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{M}{2} \quad M=\overline{M}_1X_1+M_P$$

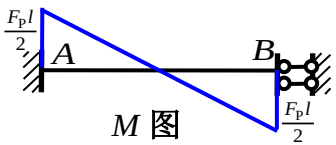
第4题单跨梁1-4





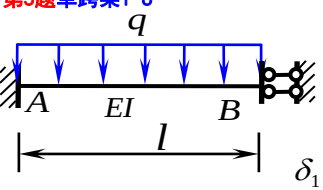


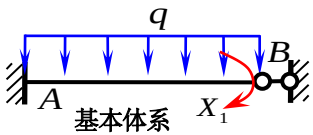


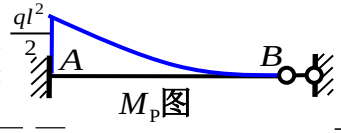


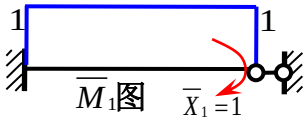
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-F_Pl^2}{2EI} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{F_Pl}{2} \quad M=\overline{M}_1X_1+M_P$$

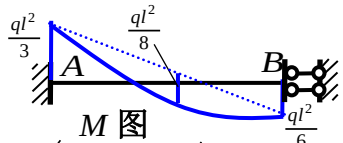
第5题单跨梁1-6





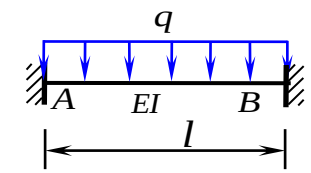


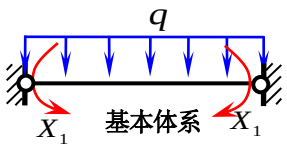


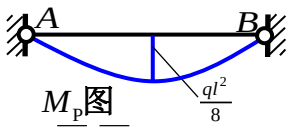


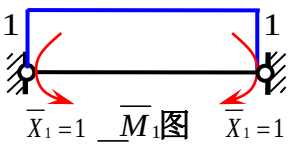
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^3}{6EI} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{-ql^2}{6} \quad M=\overline{M}_1X_1+M_P$$

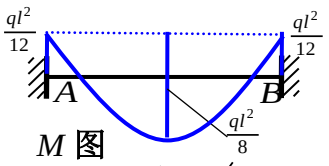
第6题单跨梁1-7





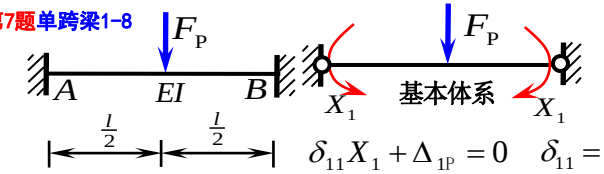


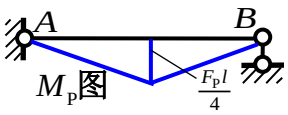


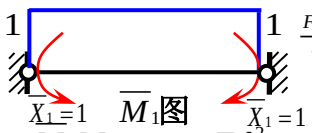


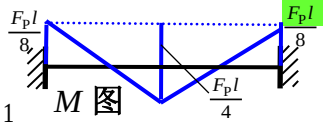
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^3}{12EI} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{ql^2}{12} \quad M=\overline{M}_1X_1+M_P$$

第7题单跨梁1-8



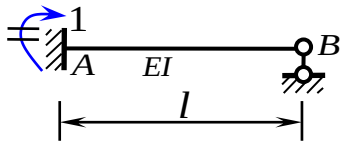


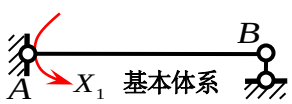


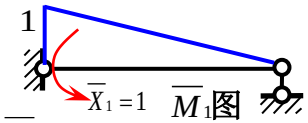


$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-F_P l^2}{8EI} \quad X_1=-\Delta_{1P}/\delta_{11}=F_P l/8 \quad M=\overline{M}_1X_1+M_P$

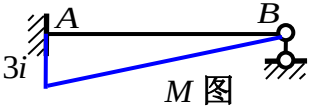
第8题单跨梁1-13







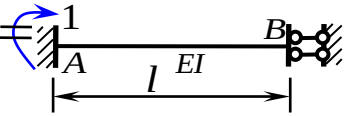
M_P图=0

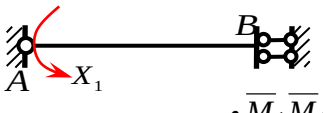


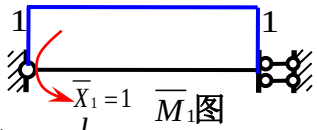
令：线刚度 $i=EI/l$

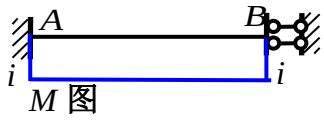
$\delta_{11}X_1=-1 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \quad X_1=-3EI/l=-3i \quad M=\overline{M}_1X_1$

第9题单跨梁1-14





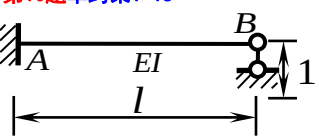


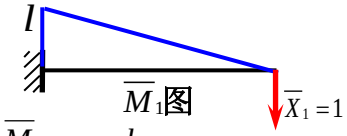


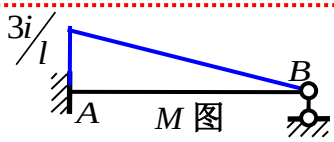
令：线刚度 $i=EI/l$

$\delta_{11}X_1=-1 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI} \quad X_1=-EI/l=-i \quad M=\overline{M}_1X_1$

第10题单跨梁1-15



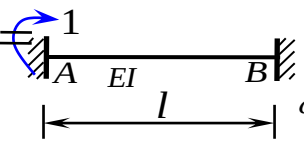


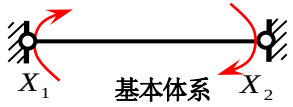


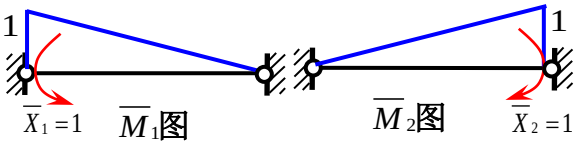
令：线刚度 $i=EI/l$

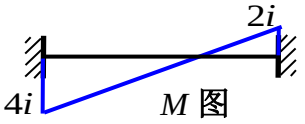
$\delta_{11}X_1=1 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \quad X_1=-3EI/l^3=3i/l^2 \quad M=\overline{M}_1X_1$

第11题单跨梁1-17









$X_1=4i \quad X_2=2i$

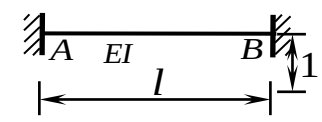
$M=\overline{M}_1X_1+\overline{M}_2X_2$

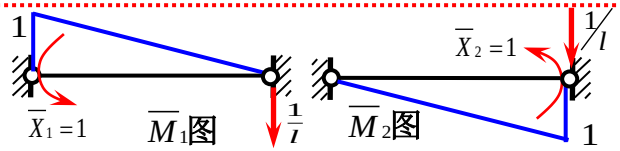
$\delta_{11}X_1+\delta_{12}X_2=1$

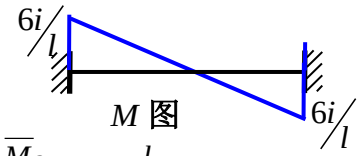
$\delta_{21}X_1+\delta_{22}X_2=0$

$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \quad \delta_{22}=\sum\int\frac{\overline{M}_2\overline{M}_2}{EI}ds=\frac{l}{3EI} \quad \delta_{21}=\delta_{12}=\sum\int\frac{\overline{M}_1\overline{M}_2}{EI}ds=\frac{-l}{6EI}$

第12题单跨梁1-18







$\delta_{11}X_1+\delta_{12}X_2+\Delta_{1C}=0$

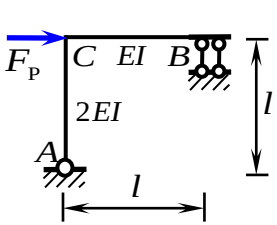
$\delta_{21}X_1+\delta_{22}X_2+\Delta_{2C}=0$

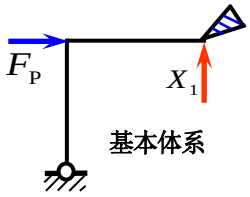
$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \quad \delta_{22}=\sum\int\frac{\overline{M}_2\overline{M}_2}{EI}ds=\frac{l}{3EI} \quad \delta_{21}=\delta_{12}=\sum\int\frac{\overline{M}_1\overline{M}_2}{EI}ds=\frac{-l}{6EI}$

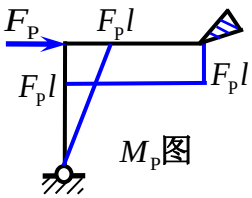
$\Delta_{1C}=-\sum\overline{F}_{R1,\,i}c_i=\frac{-1}{l}\times1=\frac{-1}{l} \quad \Delta_{2C}=-\sum\overline{F}_{R2,\,i}c_i=\frac{-1}{l}\times1=\frac{-1}{l} \quad X_1=6i/l \quad X_2=6i/l$

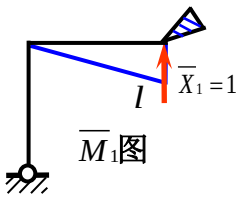
$M=\overline{M}_1X_1+\overline{M}_2X_2$

【例题13】用力法作弯矩图。（1次1-6）两种基本体系





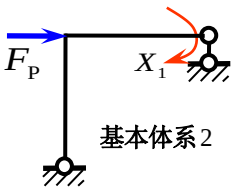


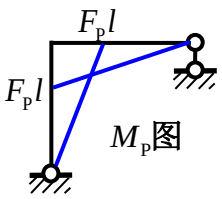


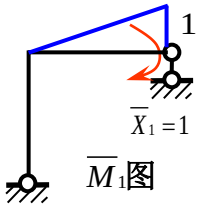
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l^3}{3EI}$$

$$\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{F_Pl^3}{2EI}$$

$$X_1=-\Delta_{1P}/\delta_{11}=-3F_P/2 \qquad M=X_1\overline{M}_1+M_P$$

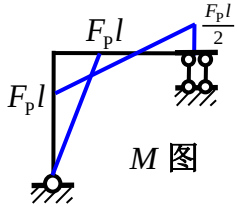




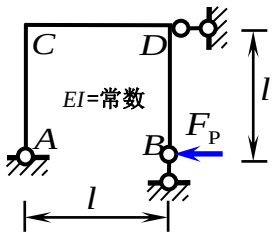


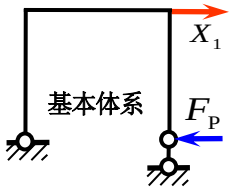
$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI}$$

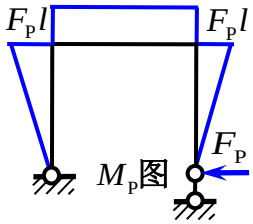
$$\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-F_Pl^3}{6EI} \qquad X_1=\frac{F_Pl}{2}$$

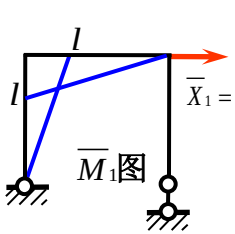


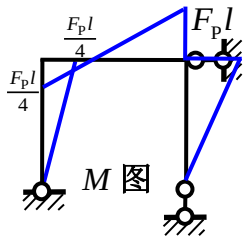
【例题14】用力法作弯矩图。（1次1-8）









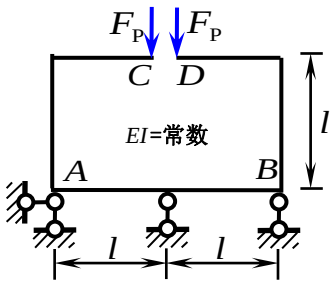


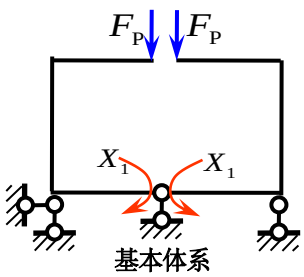
$$\delta_{11}X_1+\Delta_{1P}=0$$

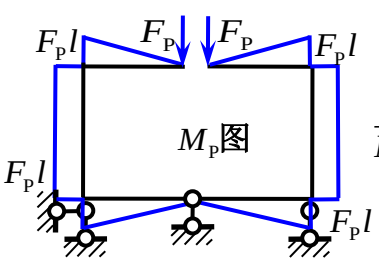
$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{2l^3}{3EI}$$

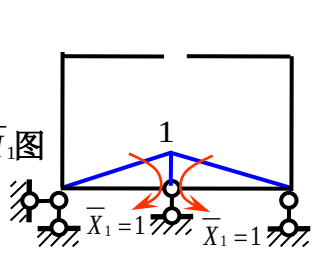
$$\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-5F_Pl^3}{6EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=5F_P/4 \qquad M=X_1\overline{M}_1+M_P$$

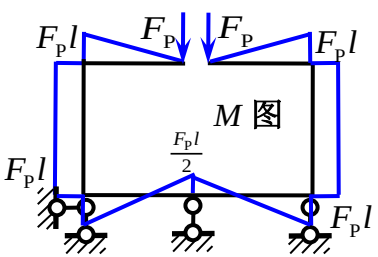
【例题15】用力法作弯矩图。（1次1-9）







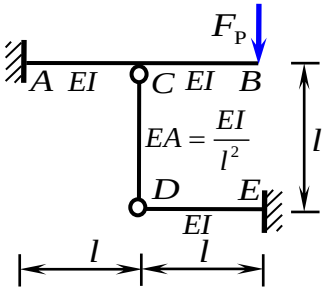


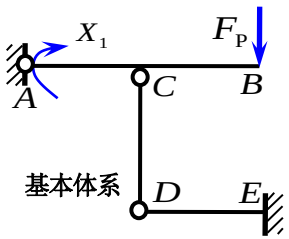


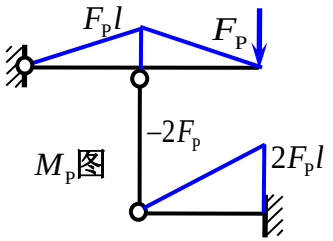
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{2l^3}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-F_Pl^2}{3EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=F_Pl/2$$

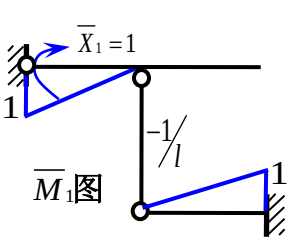
$$M=X_1\overline{M}_1+M_P$$

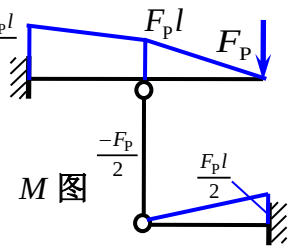
【例题16】用力法作弯矩图。（1次1-17）









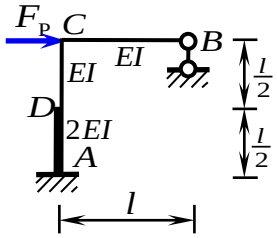


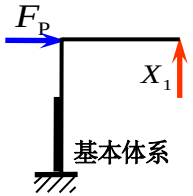
$$\delta_{11}X_1+\Delta_{1P}=0$$

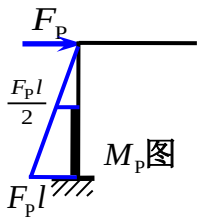
$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds+\sum\frac{\overline{F}_{N1}\overline{F}_{N1}l}{EA}=\frac{2l}{3EI}+\frac{l}{EAl^2}=\frac{5l}{3EI}\qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds+\sum\frac{\overline{F}_{N1}F_{NP}l}{EI}=\frac{F_Pl^2}{2EI}+\frac{2F_P}{EA}=\frac{5F_Pl^2}{2EI}$$

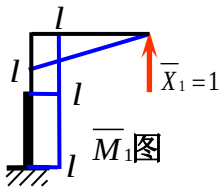
$$X_1=-\Delta_{1P}/\delta_{11}=-3F_P l/2\qquad M=X_1\overline{M}_1+M_P$$

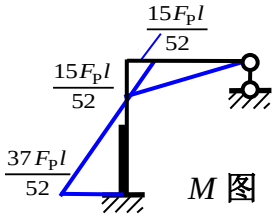
【例题17】用力法作弯矩图。（1次1-30）







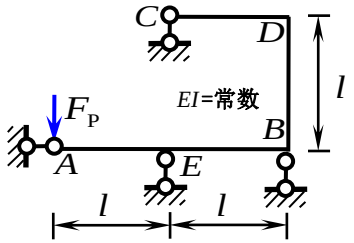


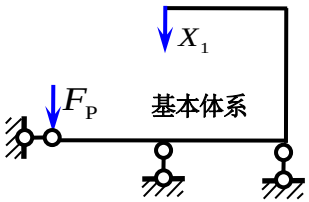


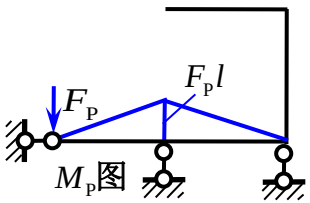
$$\delta_{11}X_1+\Delta_{1P}=0\qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{13l^3}{12EI}\qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-5F_Pl^3}{16EI}$$

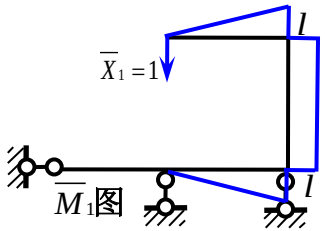
$$X_1=-\Delta_{1P}/\delta_{11}=15F_P/52\qquad M=X_1\overline{M}_1+M_P$$

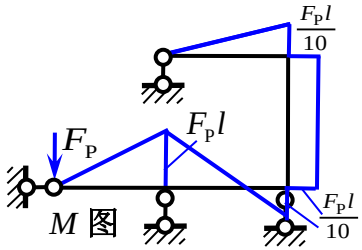
【例题18】用力法作弯矩图。（1次1-34）







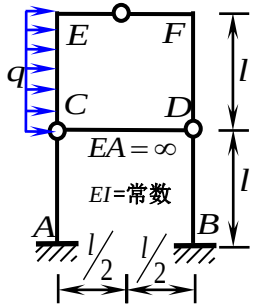


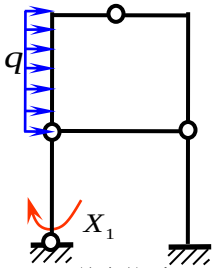


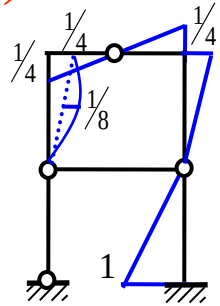
$$\delta_{11}X_1+\Delta_{1P}=0\qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5l^3}{3EI}\qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-F_Pl^3}{6EI}$$

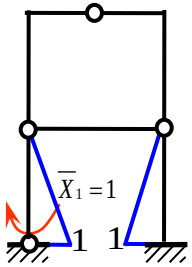
$$X_1=-\Delta_{1P}/\delta_{11}=F_P/10\qquad M=X_1\overline{M}_1+M_P$$

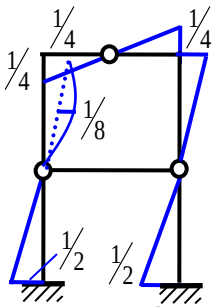
【例题19】用力法作弯矩图。（1次2-13）











$$\delta_{11}X_1+\Delta_{1P}=0$$

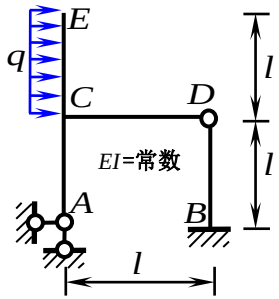
$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{2l}{3EI}$$

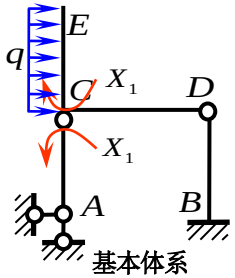
$$\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^3}{3EI}$$

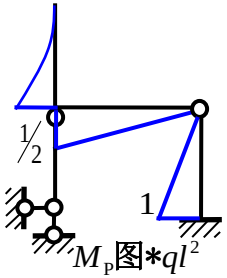
$$X_1=-\Delta_{1P}/\delta_{11}=-ql^2/2$$

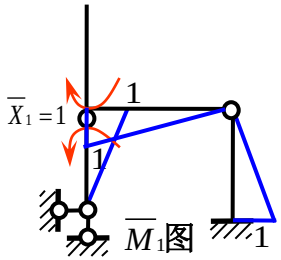
$$M=X_1\overline{M}_1+M_P$$

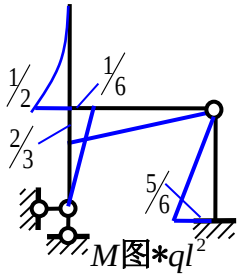
【例题20】用力法作弯矩图。（1次2-14）





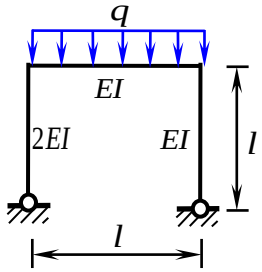


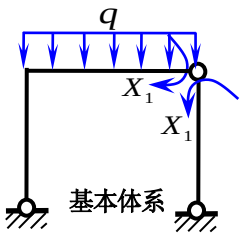


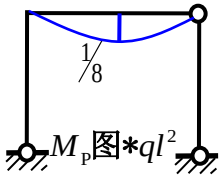


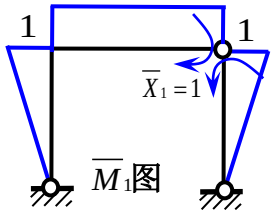
$$\delta_{11}X_1+\Delta_{1P}=0\quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI}\quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^3}{6EI}\quad X_1=-\Delta_{1P}/\delta_{11}=ql^2/6\quad M=X_1\overline{M}_1+M_P$$

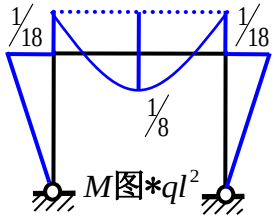
【例题21】用力法作弯矩图。（1次2-16）





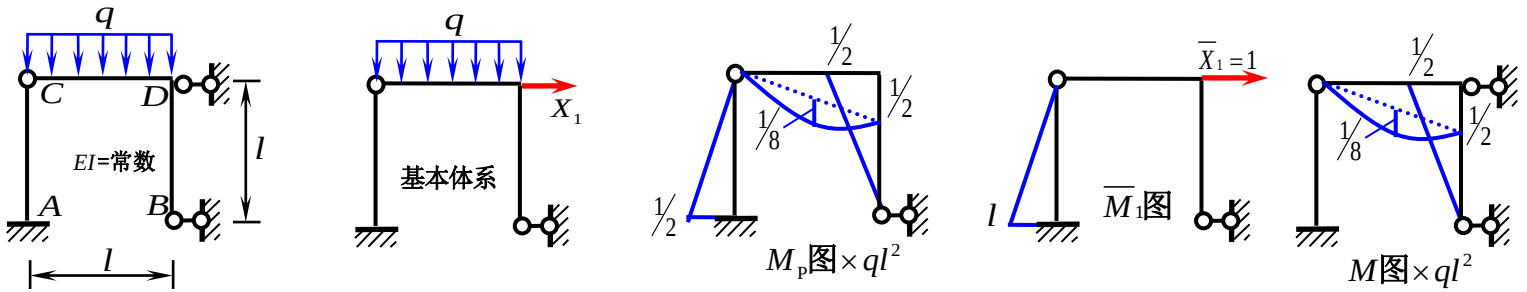






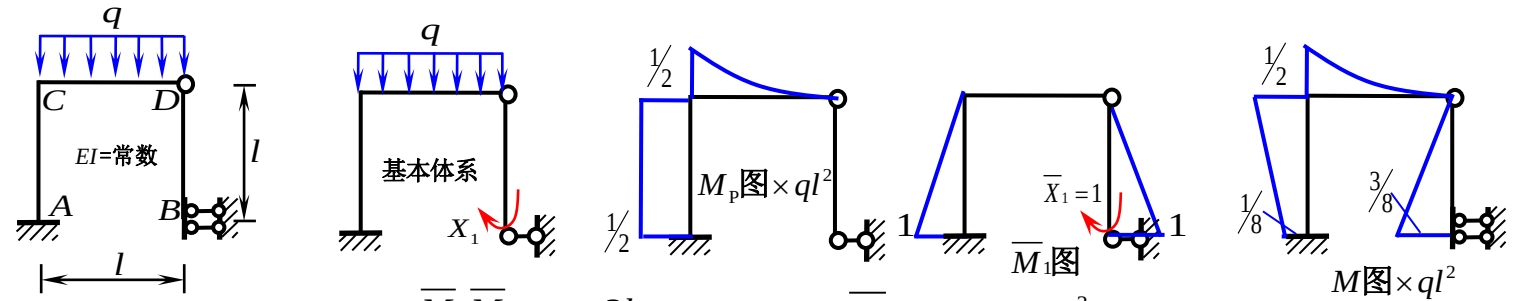
$$\delta_{11}X_1+\Delta_{1P}=0\quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{3l}{2EI}\quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^3}{12EI}\quad X_1=-\Delta_{1P}/\delta_{11}=ql^2/18\quad M=X_1\overline{M}_1+M_P$$

【例题22】用力法作弯矩图。（1次3-28）



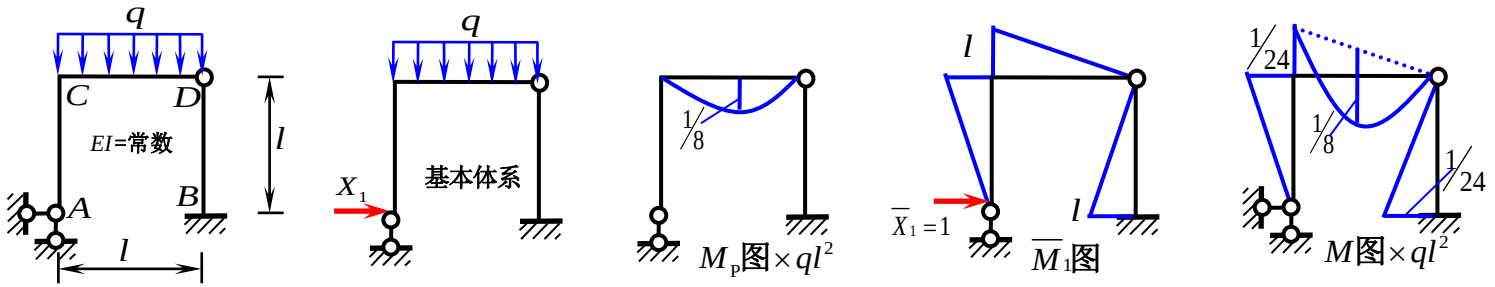
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l^3}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^4}{6EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=-ql/2 \qquad M=X_1\overline{M}_1+M_P$$

【例题23】用力法作弯矩图。（1次3-29）



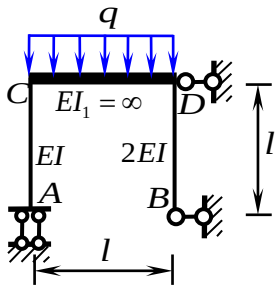
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{2l}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^3}{4EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=-3ql^2/8 \qquad M=X_1\overline{M}_1+M_P$$

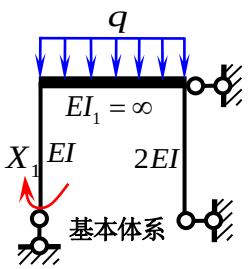
【例题24】用力法作弯矩图。（1次3-32）

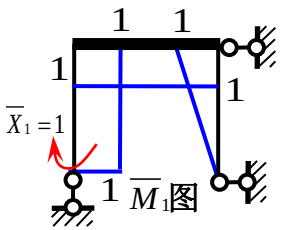


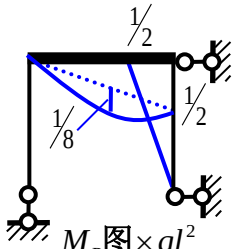
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l^3}{EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^4}{24EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=ql/24 \qquad M=X_1\overline{M}_1+M_P$$

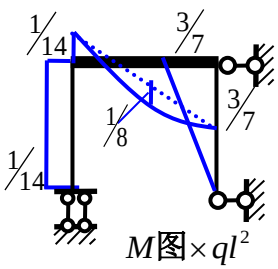
【例题25】用力法作弯矩图。（1次3-36）





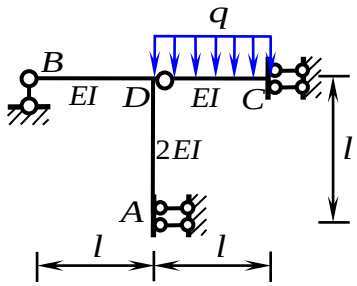


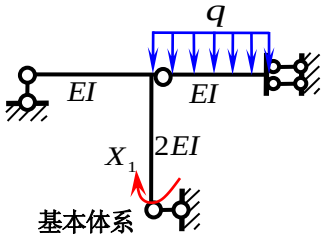


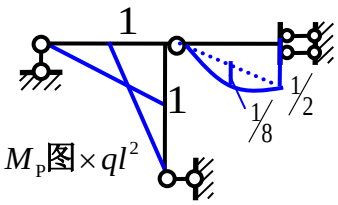


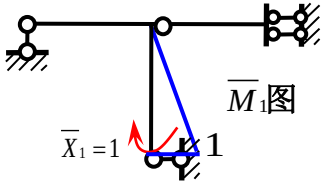
$\delta_{11}X_1+\Delta_{1P}=0$ $\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{7l}{6EI}$ $\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^3}{12EI}$ $X_1=-\Delta_{1P}/\delta_{11}=-ql^2/14$ $M=X_1\overline{M}_1+M_P$

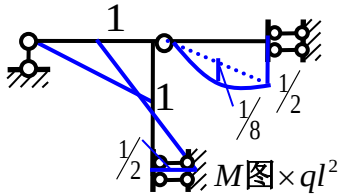
【例题26】用力法作弯矩图。（1次3-37）





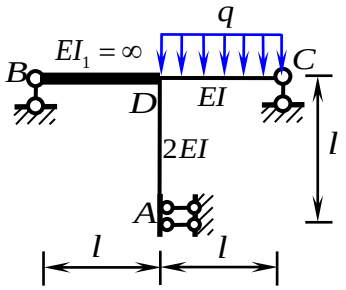


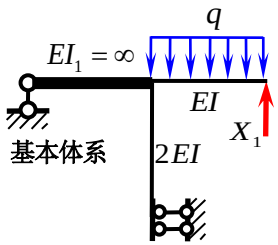


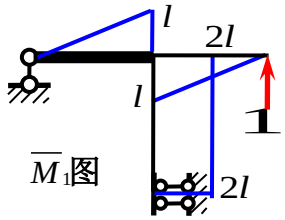


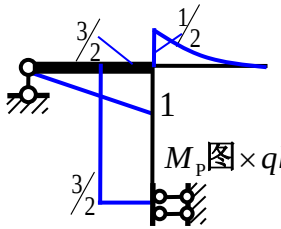
$\delta_{11}X_1+\Delta_{1P}=0$ $\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{6EI}$ $\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^3}{12EI}$ $X_1=-\Delta_{1P}/\delta_{11}=ql^2/2$ $M=X_1\overline{M}_1+M_P$

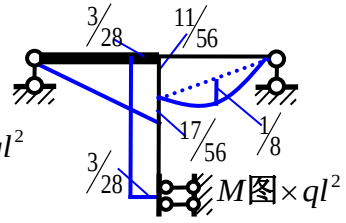
【例题27】用力法作弯矩图。（1次3-39）





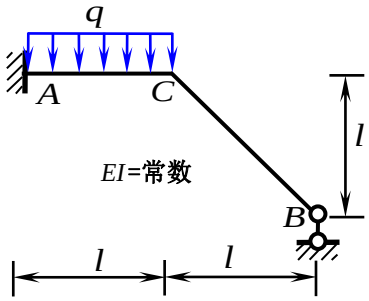


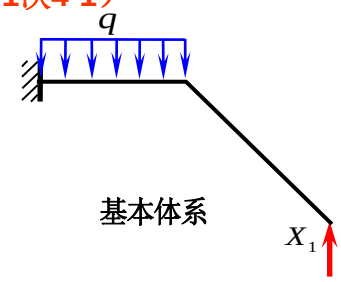


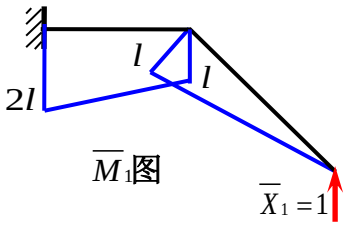


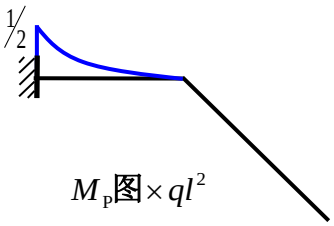
$\delta_{11}X_1+\Delta_{1P}=0$ $\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{7l^3}{3EI}$ $\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-13ql^4}{8EI}$ $X_1=-\Delta_{1P}/\delta_{11}=39ql/56$ $M=X_1\overline{M}_1+M_P$

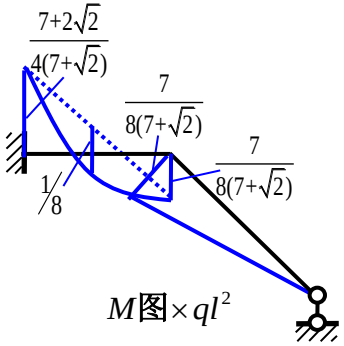
【例题28】用力法作弯矩图。（1次4-1）





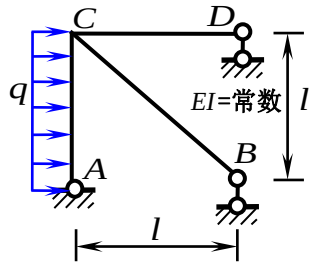


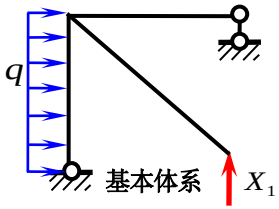


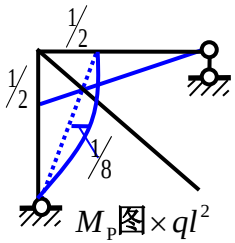


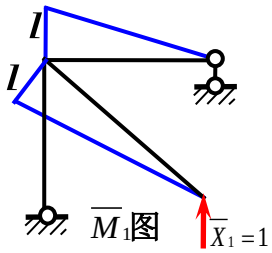
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{\left(7+\sqrt{2}\right)l^3}{3EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-7ql^4}{24EI} \quad X_1=-\Delta_{1P}/\delta_{11}=7ql/8\left(7+\sqrt{2}\right) \quad M=X_1\overline{M}_1+M_P$$

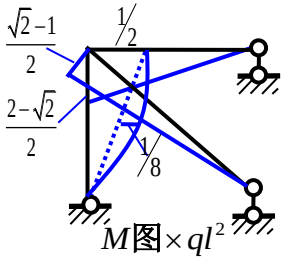
【例题29】用力法作弯矩图。（1次4-22）





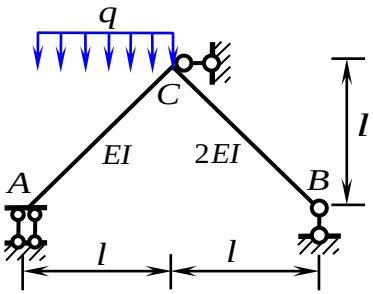


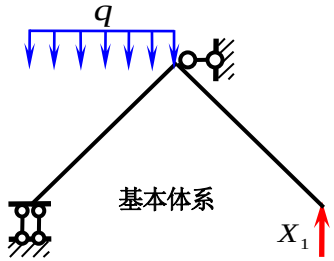


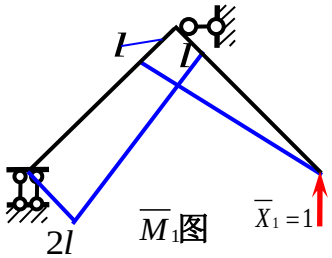


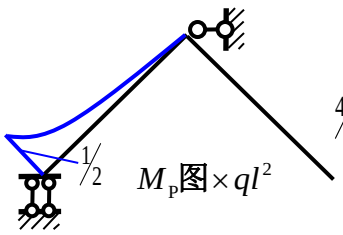
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{\left(1+\sqrt{2}\right)l^3}{3EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^4}{6EI} \quad X_1=\frac{\left(\sqrt{2}-1\right)ql}{2} \quad M=X_1\overline{M}_1+M_P$$

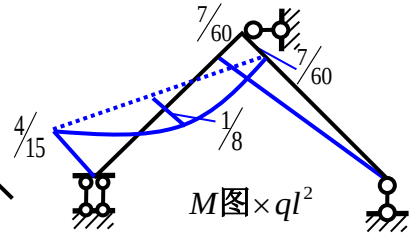
【例题30】用力法作弯矩图。（1次4-40）





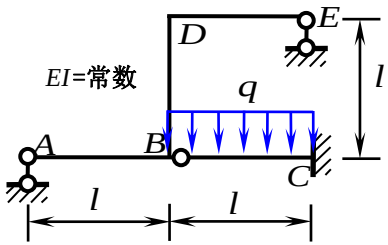


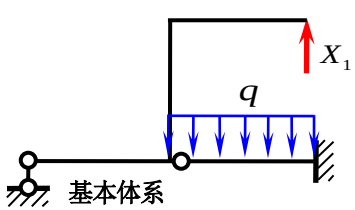


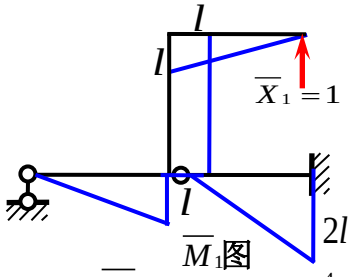


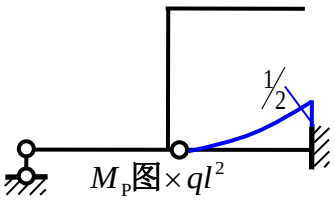
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5\sqrt{2}l^3}{2EI} \quad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-7\sqrt{2}ql^4}{24EI} \quad X_1=-\Delta_{1P}/\delta_{11}=7ql/60 \quad M=X_1\overline{M}_1+M_P$$

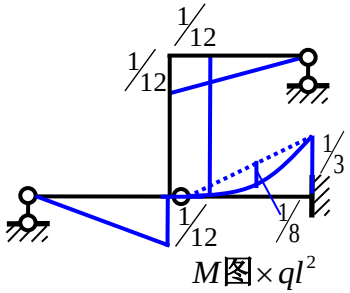
【例题31】用力法作弯矩图。（1次7-1）





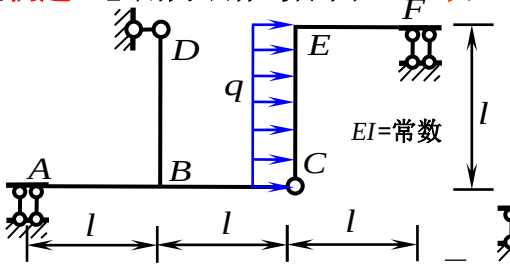


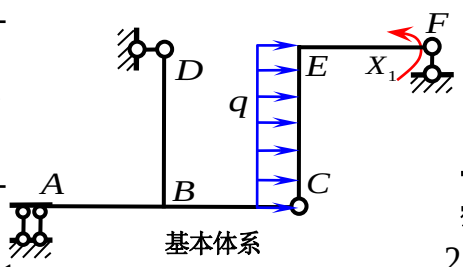


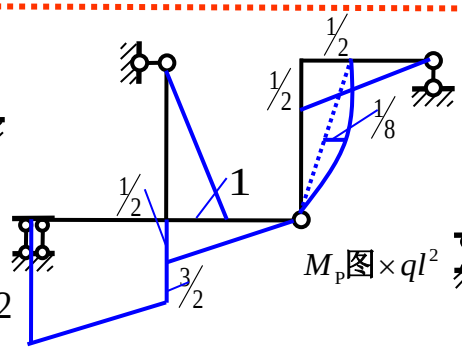


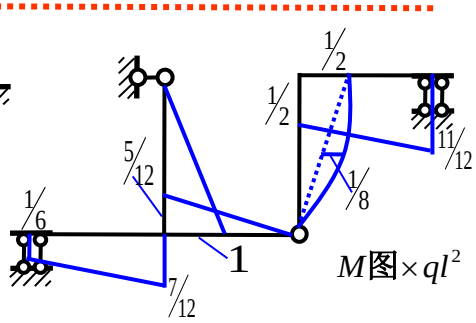
$\delta_{11}X_1+\Delta_{1P}=0$ $\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{3l^3}{EI}$ $\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^4}{4EI}$ $X_1=-\Delta_{1P}/\delta_{11}=ql/12$ $M=X_1\overline{M}_1+M_P$

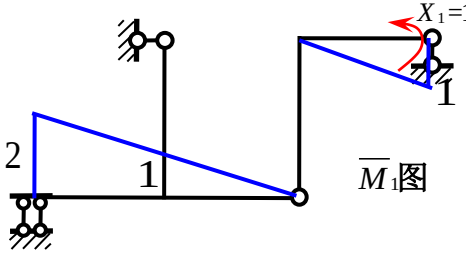
【例题32】用力法作弯矩图。（1次15-1）





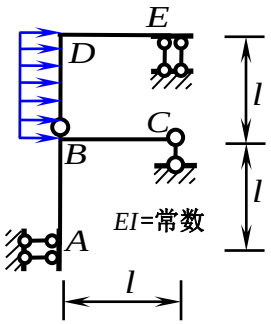


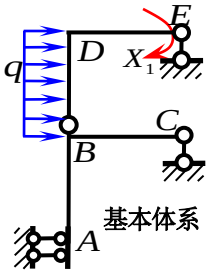


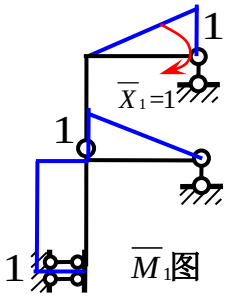


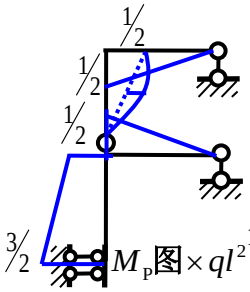
$\delta_{11}X_1+\Delta_{1P}=0$ $\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{3l^3}{EI}$ $\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-11ql^3}{4EI}$ $X_1=-\Delta_{1P}/\delta_{11}=11ql^2/12$ $M=X_1\overline{M}_1+M_P$

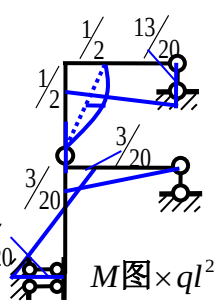
【例题33】用力法作弯矩图。（1次15-17）











$\delta_{11}X_1+\Delta_{1P}=0$

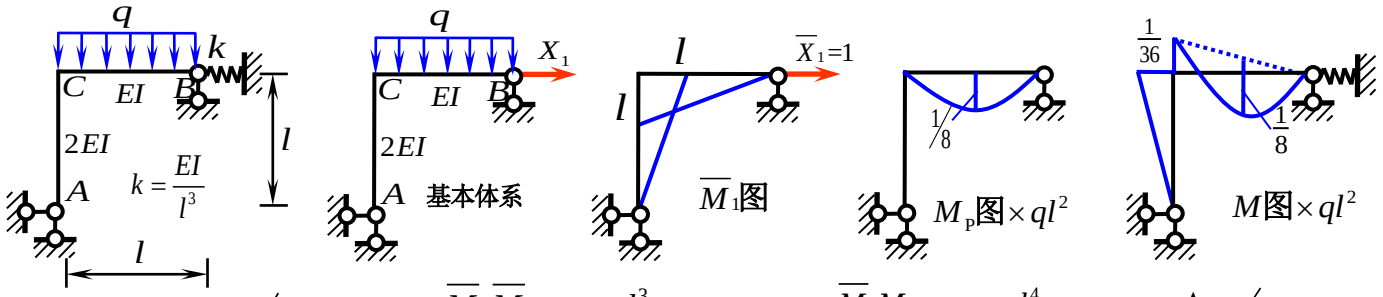
$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5l}{3EI}$

$\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{13ql^3}{12EI}$

$X_1=-\Delta_{1P}/\delta_{11}=-13ql^2/20$

$M=X_1\overline{M}_1+M_P$

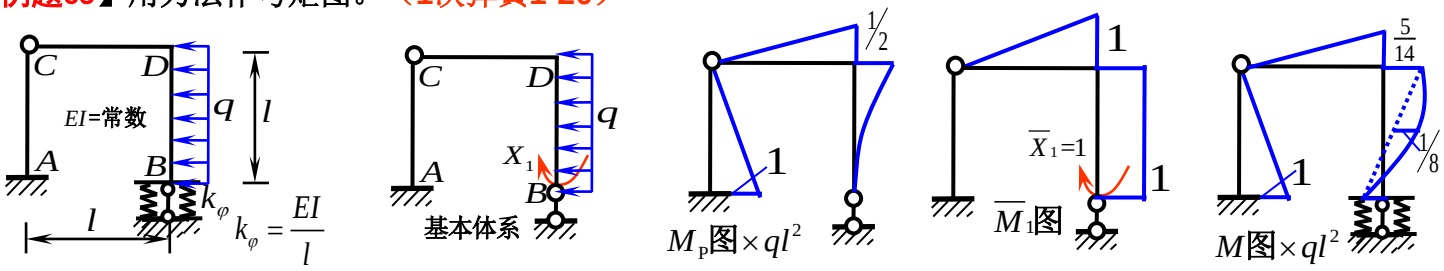
【例题34】用力法作弯矩图。（1次弹簧1-1）



$$\delta_{11}X_1+\Delta_{1P}=-X_1/k \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l^3}{2EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^4}{24EI}$$

$$X_1=-\Delta_{1P}\Big/\left(\delta_{11}+\frac{1}{k}\right)=-ql/36 \qquad M=X_1\overline{M}_1+M_P$$

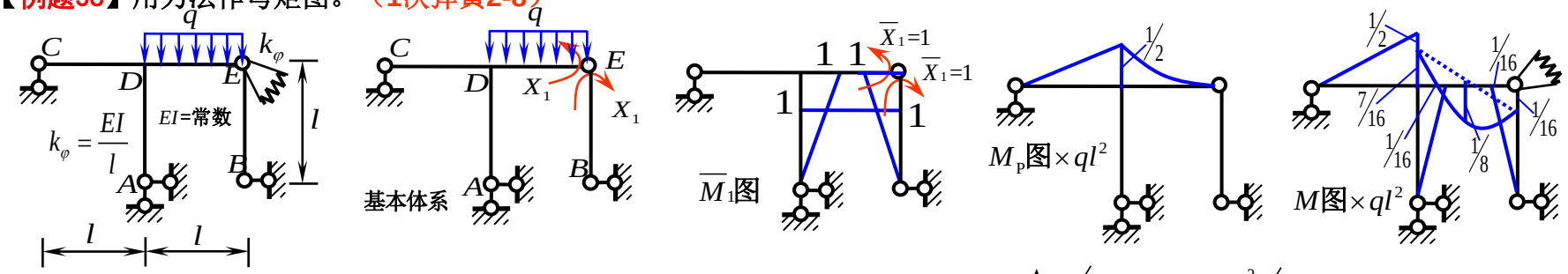
【例题35】用力法作弯矩图。（1次弹簧1-20）



$$\delta_{11}X_1+\Delta_{1P}=-X_1/k_\varphi \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{4l}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^3}{3EI}$$

$$X_1=-\Delta_{1P}\Big/\left(\delta_{11}+\frac{1}{k}\right)=-ql^2/7 \qquad M=X_1\overline{M}_1+M_P$$

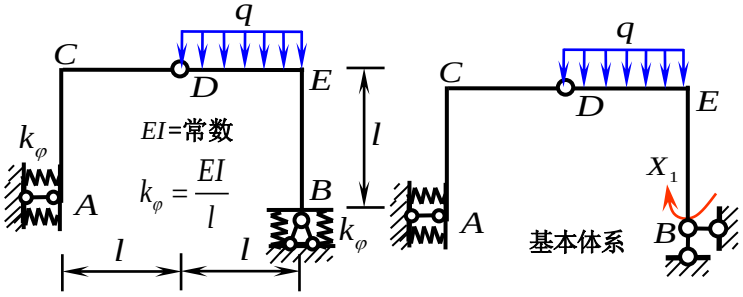
【例题36】用力法作弯矩图。（1次弹簧2-8）

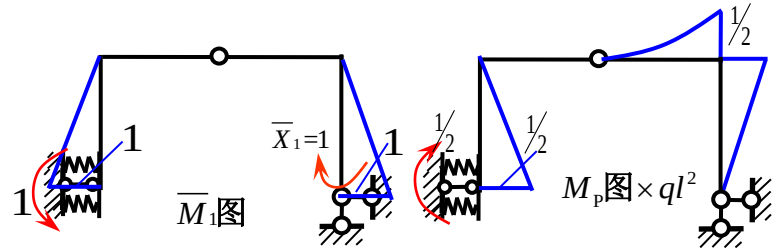


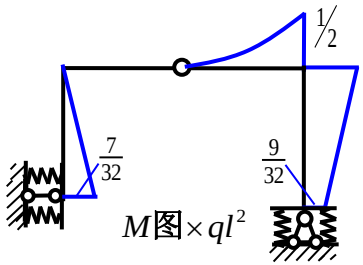
$$\delta_{11}X_1+\Delta_{1P}=-X_1/k_\varphi \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5l}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^3}{6EI}$$

$$X_1=-\Delta_{1P}\Big/\left(\delta_{11}+\frac{1}{k_\varphi}\right)=ql^2/16 \qquad M=X_1\overline{M}_1+M_P$$

【例题37】用力法作弯矩图。（1次弹簧2-14）



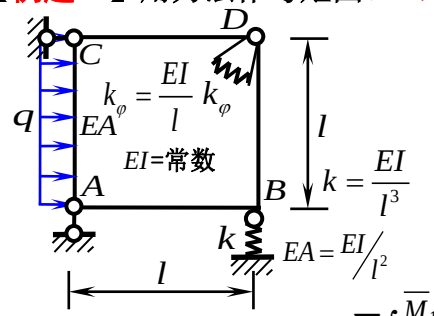


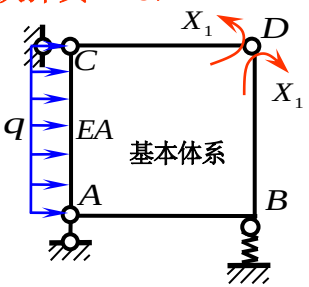


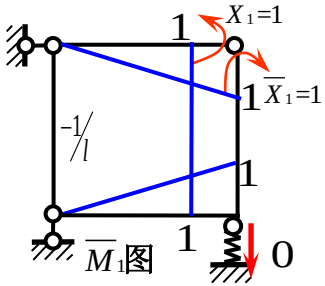
$$\delta_{11}X_1+\Delta_{1P}=-X_1/k_\varphi \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds+\sum\frac{\overline{F}_k\overline{F}_k}{k}=\frac{5l}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds+\sum\frac{\overline{F}_kF_{kP}}{k}=\frac{-3ql^3}{4EI}$$

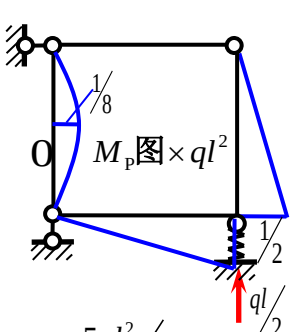
$$X_1=\frac{-\Delta_{1P}}{\left(\delta_{11}+\frac{1}{k_\varphi}\right)}=9ql^2/32 \qquad M=X_1\overline{M}_1+M_P$$

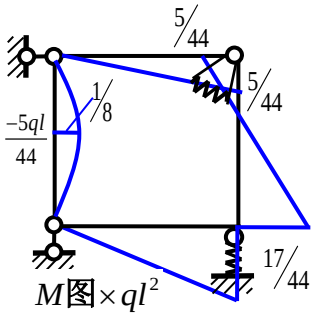
【例题38】用力法作弯矩图。（1次弹簧2-19）









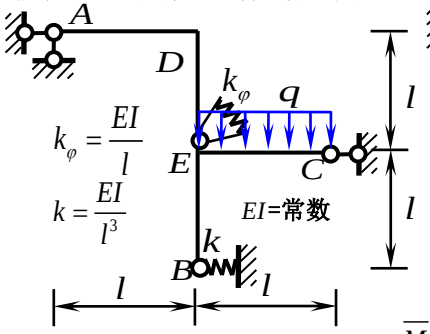


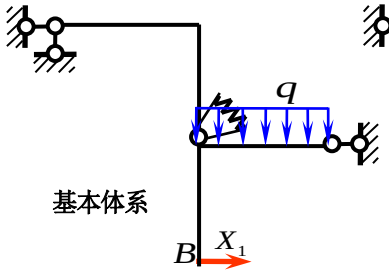
$$\delta_{11}X_1+\Delta_{1P}=-X_1/k_\varphi \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds+\sum\frac{\overline{F}_{N1}\overline{F}_{N1}l}{EA}+\sum\frac{\overline{F}_k\overline{F}_k}{k}=\frac{8l}{3EI}$$

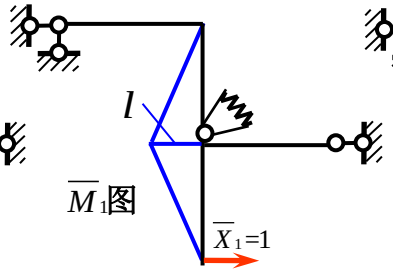
$$\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds+\sum\frac{\overline{F}_kF_{kP}}{k}=\frac{-5ql^3}{12EI}$$

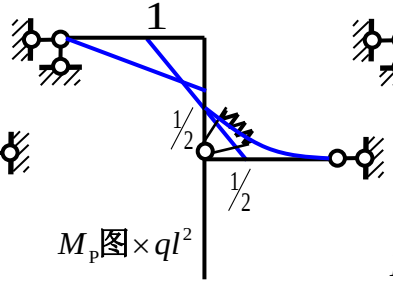
$$X_1=\frac{-\Delta_{1P}}{\left(\delta_{11}+\frac{1}{k_\varphi}\right)}=5ql^2/44 \qquad M=X_1\overline{M}_1+M_P$$

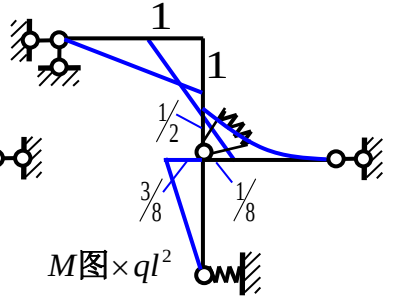
【例题39】用力法作弯矩图。（1次弹簧2-33）







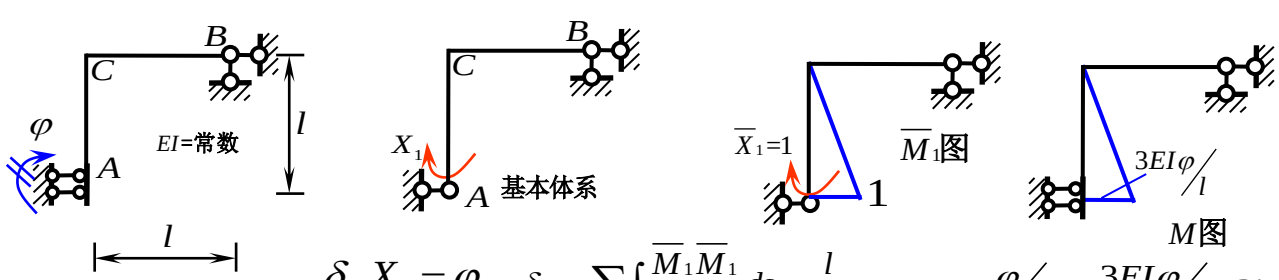




$$\delta_{11}X_1+\Delta_{1P}=-X_1/k \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds+\sum\frac{\overline{F}_k\overline{F}_k}{k}=\frac{5l^3}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds+\sum\frac{\overline{F}_kF_{kP}}{k}=\frac{-ql^4}{EI}$$

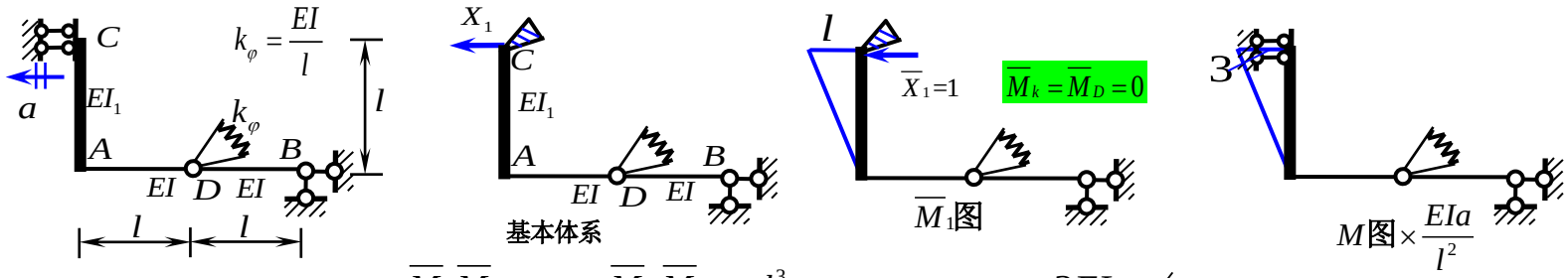
$$X_1=\frac{-\Delta_{1P}}{\left(\delta_{11}+\frac{1}{k}\right)}=3ql/8 \qquad M=X_1\overline{M}_1+M_P$$

【例题40】用力法作弯矩图。（1次支座位移1-2）



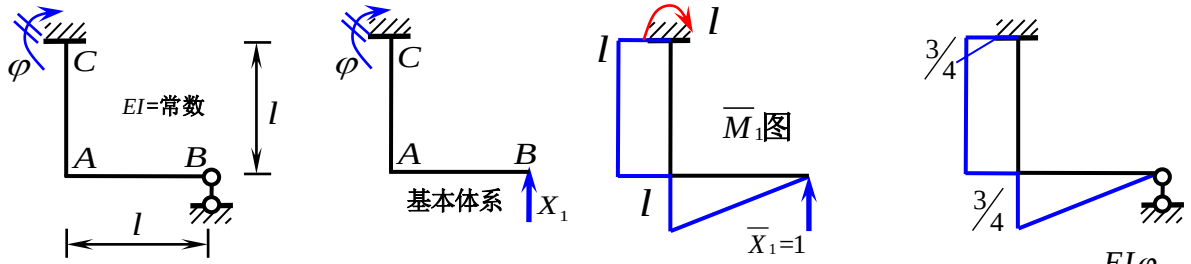
$$\delta_{11}X_1=\varphi \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{3EI} \qquad X_1=\varphi/\delta_{11}=3EI\varphi/l=3i\varphi \qquad M=X_1\overline{M}_1$$

【例题41】用力法作弯矩图。（1次支座位移1-16）



$$\delta_{11}X_1=a \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds+\sum\frac{\overline{M}_k\overline{M}_k}{k_\varphi}=\frac{l^3}{3EI_1} \qquad X_1=a/\delta_{11}=3EI_1a/l^3 \qquad M=X_1\overline{M}_1$$

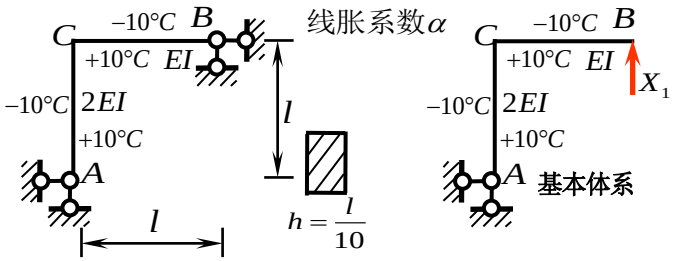
【例题42】用力法作弯矩图。（1次支座位移1-9）

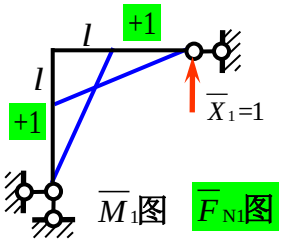


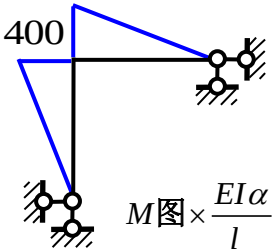
$$\delta_{11}X_1+\Delta_{1C}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{4l^3}{3EI}$$

$$\Delta_{1C}=-\sum\overline{F}_{Ri}c_i=-l\times\varphi=-l\varphi \qquad X_1=-\Delta_{1C}/\delta_{11}=3EI\varphi/4l^2 \qquad M=X_1\overline{M}_1$$

【例题43】用力法作弯矩图。（1次温度1-1）







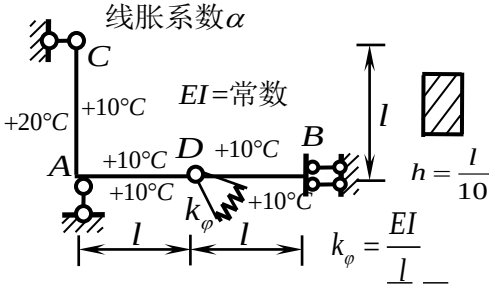
$t_{0AC}=0°C$　$t_{0BC}=0°C$

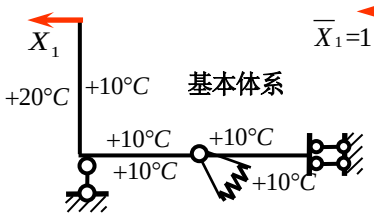
$\Delta t_{AC}=20°C$　$\Delta t_{BC}=20°C$

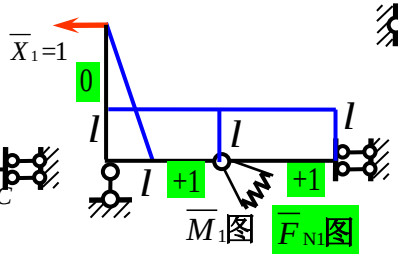
$A_{AC}=\frac{l^2}{2}$　$A_{BC}=\frac{l^2}{2}$

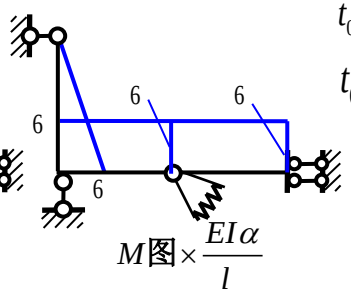
$\delta_{11}X_1+\Delta_{1t}=0$　$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l^3}{2EI}$　$\Delta_{1t}=\sum\overline{F}_N\alpha t_0 l+\sum(\pm)A_{\overline{M}}\frac{\alpha\Delta t}{h}=200\alpha l$　$X_1=-\Delta_{1t}/\delta_{11}=-400EI\alpha/l^2$　$M=X_1\overline{M}_1$

【例题44】用力法作弯矩图。（1次温度1-8）









$t_{0AC}=15°C$　$t_{0AD}=10°C$

$t_{0BD}=10°C$　$\Delta t_{AC}=10°C$

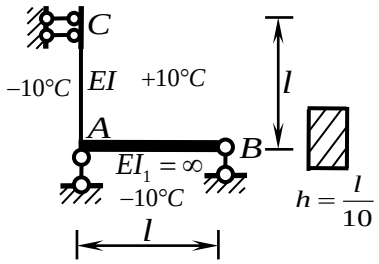
$\Delta t_{AD}=0°C$　$\Delta t_{BD}=0°C$

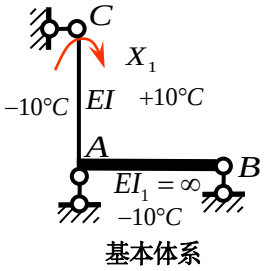
$A_{AC}=\frac{l^2}{2}$　$A_{AD}=l^2$

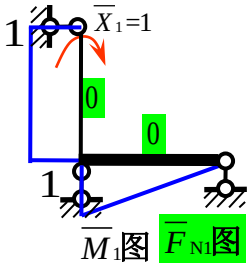
$A_{BD}=l^2$

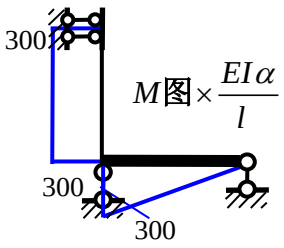
$\delta_{11}X_1+\Delta_{1t}=0$　$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds+\sum\frac{\overline{F}_k\overline{F}_k}{k}=\frac{10l^3}{3EI}$　$\Delta_{1t}=\sum\overline{F}_N\alpha t_0 l+\sum(\pm)A_{\overline{M}}\frac{\alpha\Delta t}{h}=-30\alpha l$　$X_1=-\Delta_{1t}/\delta_{11}=6EI\alpha/l^2$　$M=X_1\overline{M}_1$

【例题45】用力法作弯矩图。（1次温度1-18）









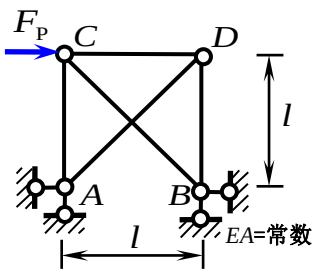
$t_{0AC}=0°C$　$t_{0BA}=0°C$

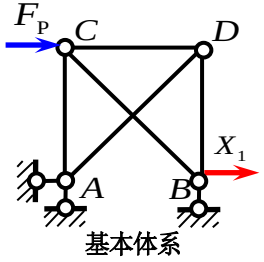
$\Delta t_{AC}=20°C$　$\Delta t_{BA}=20°C$

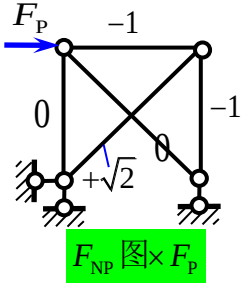
$A_{AC}=l$　$A_{BA}=\frac{l}{2}$

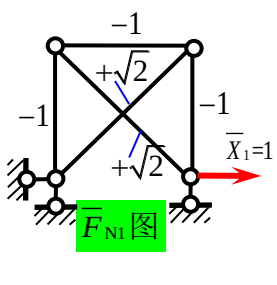
$\delta_{11}X_1+\Delta_{1t}=0$　$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI}$　$\Delta_{1t}=\sum\overline{F}_N\alpha t_0 l+\sum(\pm)A_{\overline{M}}\frac{\alpha\Delta t}{h}=-300\alpha$　$X_1=-\Delta_{1t}/\delta_{11}=300EI\alpha/l$　$M=X_1\overline{M}_1$

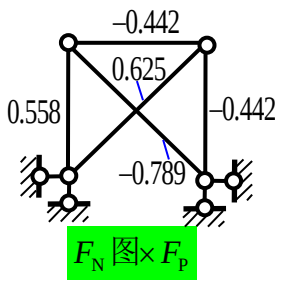
【例题46】用力法作弯矩图。（1次桁架1-1）







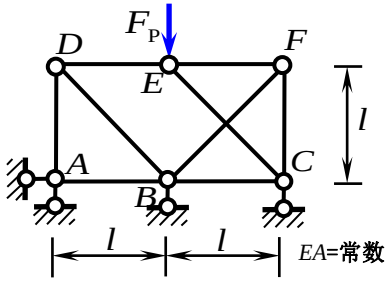


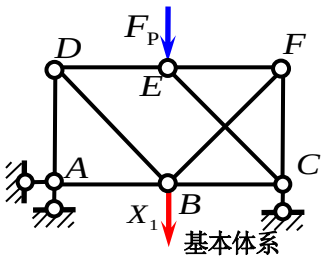


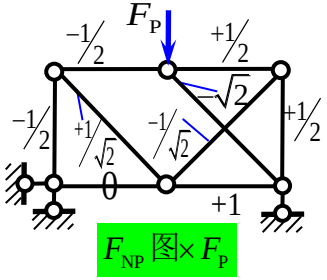
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\frac{\overline{F}_{N1}^2 l}{EA}=\frac{(3+4\sqrt{2})l}{EA} \quad \Delta_{1P}=\sum\frac{\overline{F}_{N1}F_{NP}l}{EA}=\frac{(2+2\sqrt{2})F_P l}{EA} \quad X_1=-\Delta_{1P}/\delta_{11}=\frac{-(10+2\sqrt{2})\ F_P}{23}=-0.558F_P$$

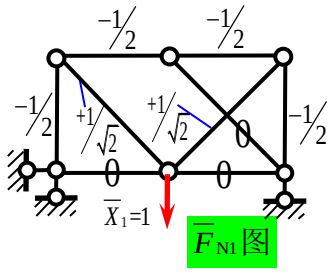
$$F_N=X_1\overline{F}_{N1}+F_{NP}$$

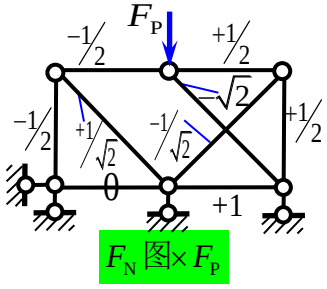
【例题47】用力法作弯矩图。（1次桁架1-7）





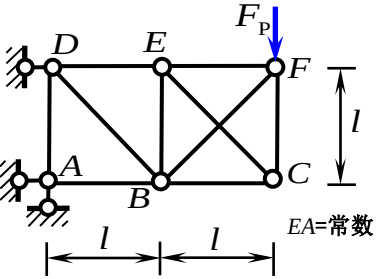


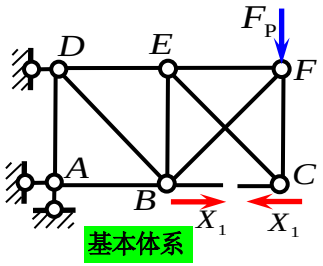


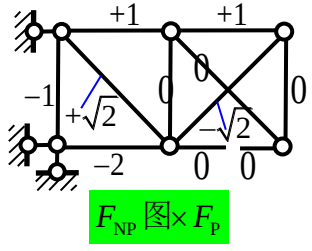


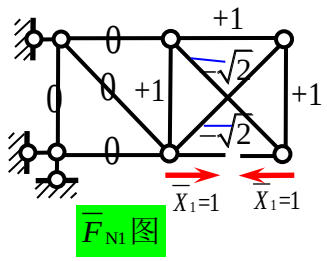
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\frac{\overline{F}_{N1}^2 l}{EA}=\frac{(1+\sqrt{2})l}{EA} \quad \Delta_{1P}=\sum\frac{\overline{F}_{N1}F_{NP}l}{EA}=0 \quad X_1=-\Delta_{1P}/\delta_{11}=0 \quad F_N=X_1\overline{F}_{N1}+F_{NP}$$

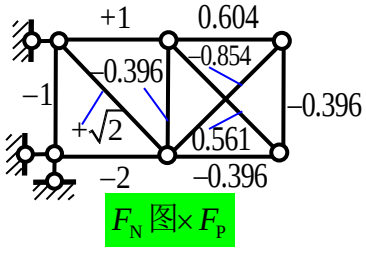
【例题48】用力法作弯矩图。（1次桁架2-4）







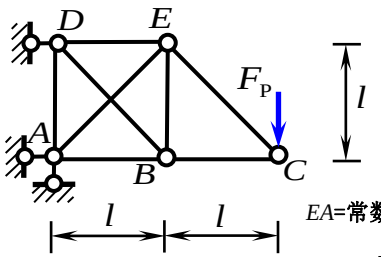


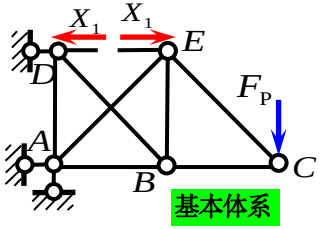


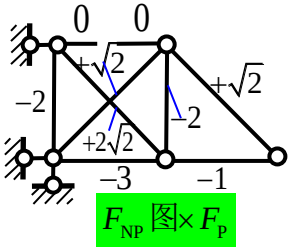
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\frac{\overline{F}_{N1}^2 l}{EA}=\frac{(4+4\sqrt{2})l}{EA} \quad \Delta_{1P}=\sum\frac{\overline{F}_{N1}F_{NP}l}{EA}=\frac{(1+2\sqrt{2})F_P l}{EA} \quad X_1=-\Delta_{1P}/\delta_{11}=\frac{(3-\sqrt{2})\ F_P}{4}=-0.396F_P$$

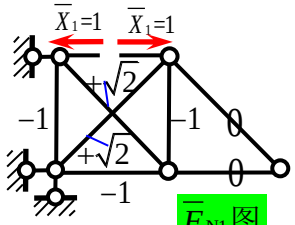
$$F_N=X_1\overline{F}_{N1}+F_{NP}$$

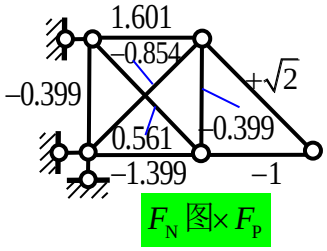
【例题49】用力法作弯矩图。（1次桁架2-5）





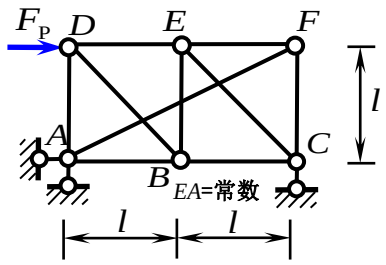


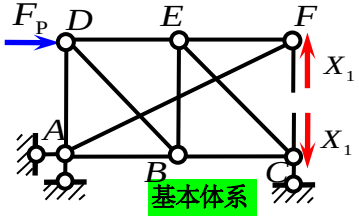


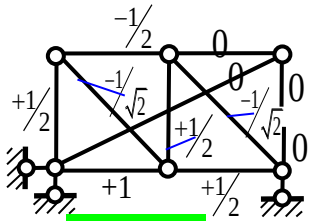


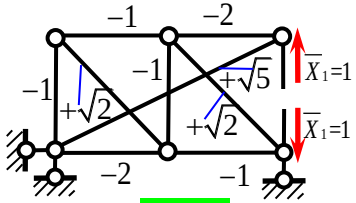
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\frac{\overline{F}_{N1}^2 l}{EA}=\frac{(4+4\sqrt{2})l}{EA} \quad \Delta_{1P}=\sum\frac{\overline{F}_{N1}F_{NP}l}{EA}=\frac{(7+6\sqrt{2})F_P l}{EA} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{-(5+\sqrt{2})\ F_P}{4}=-1.601F_P \quad F_N=X_1\overline{F}_{N1}+F_{NP}$$

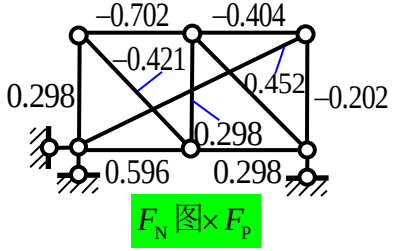
【例题50】用力法作弯矩图。（1次桁架2-6）





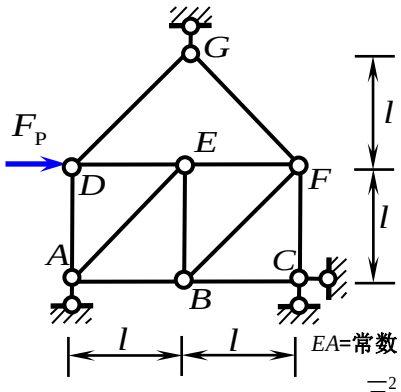


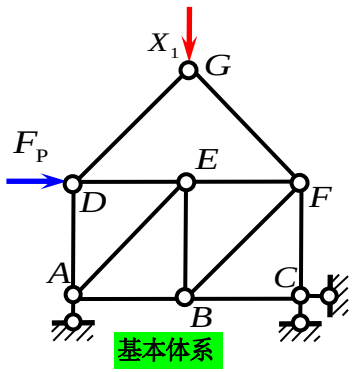


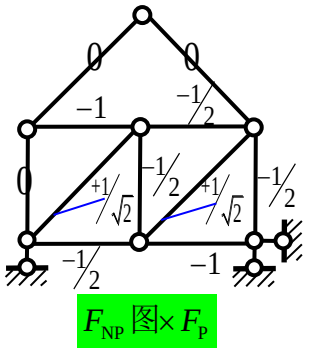


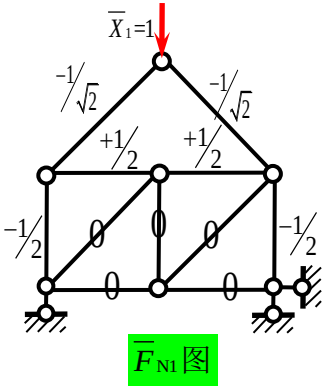
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\frac{\overline{F}_{N1}^2 l}{EA}=\frac{(12+4\sqrt{2}+5\sqrt{5})l}{EA} \quad \Delta_{1P}=\sum\frac{\overline{F}_{N1}F_{NP}l}{EA}=\frac{-(3+2\sqrt{2})F_P l}{EA} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=0.202F_P \quad F_N=X_1\overline{F}_{N1}+F_{NP}$$

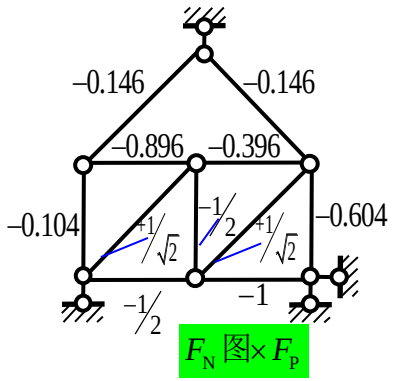
【例题51】用力法作弯矩图。（1次桁架2-18）





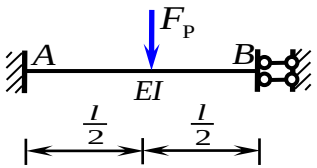


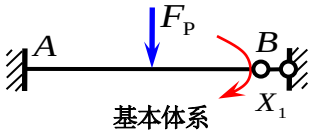


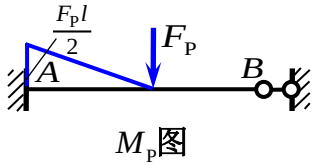


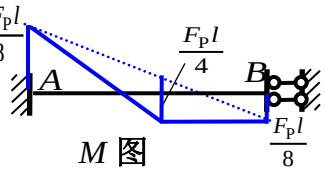
$$\delta_{11}X_1+\Delta_{1P}=0 \quad \delta_{11}=\sum\frac{\overline{F}_{N1}^2 l}{EA}=\frac{(1+\sqrt{2})l}{EA} \quad \Delta_{1P}=\sum\frac{\overline{F}_{N1}F_{NP}l}{EA}=\frac{-F_P l}{2EA} \quad X_1=\frac{-\Delta_{1P}}{\delta_{11}}=\frac{(\sqrt{2}-1)\ F_P}{2}=0.207F_P \quad F_N=X_1\overline{F}_{N1}+F_{NP}$$

【例题52】用力法作弯矩图。（梁1-5）

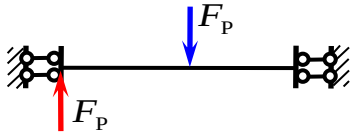


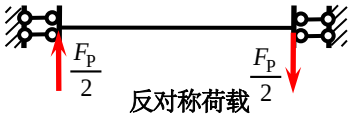


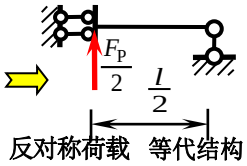


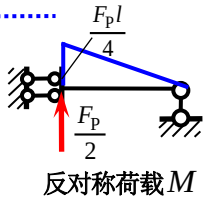


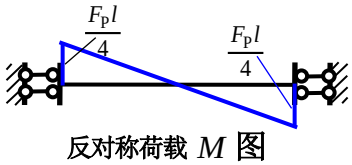
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{F_P l^2}{8EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=-F_P l/8 \qquad M=X_1\overline{M}_1+M_P$$

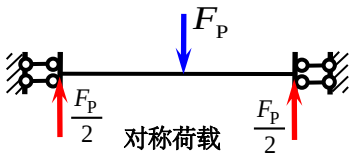


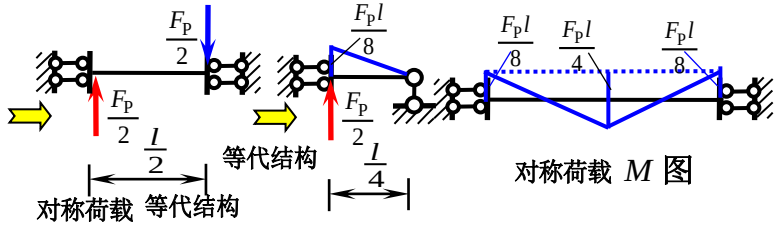




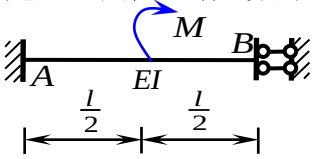


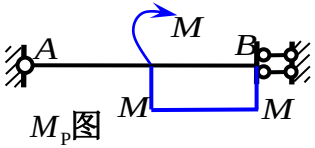


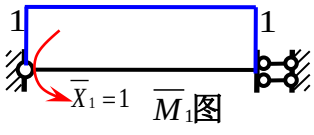


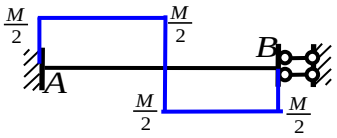


【例题53】用力法作弯矩图。（1梁1-10）





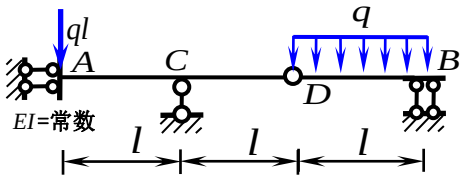


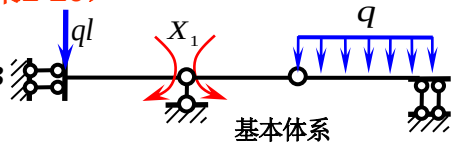


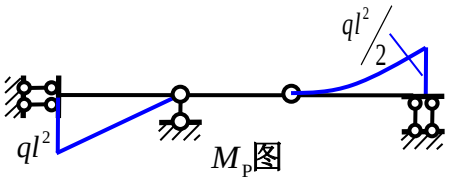
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l}{EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-M\,l}{2EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=M/\quad \qquad M=X_1\overline{M}_1+M_P$$

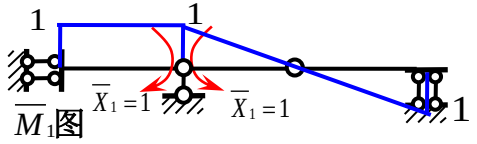
【思考？】可否用对称性？

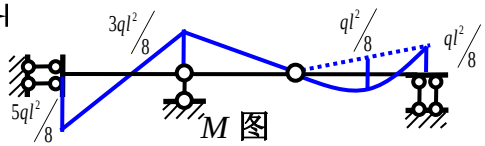
【例题54】用力法作弯矩图。（1梁1-20）







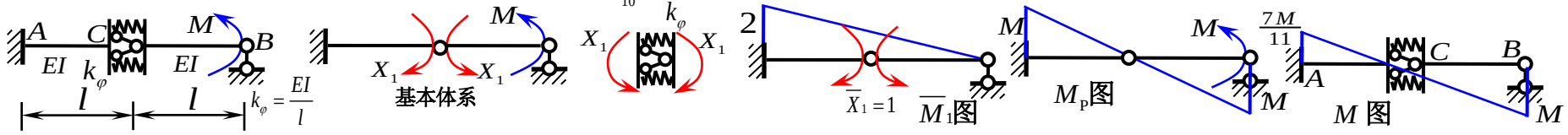




$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5l}{3EI} \qquad M=X_1\overline{M}_1+M_P$$

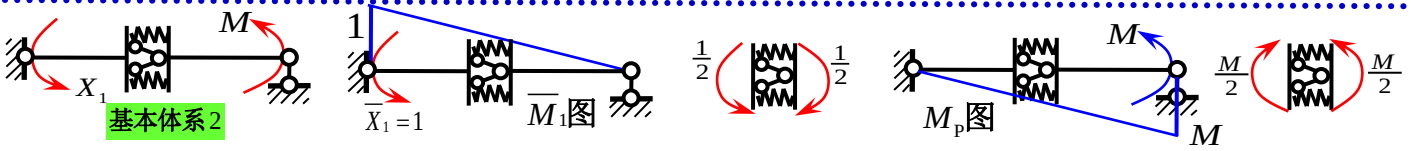
$$\Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-5ql^3}{8EI} \qquad X_1=-\Delta_{1P}/\delta_{11}=3ql^2/8$$

【例题55】用力法作弯矩图。（1梁1-26）



$$\delta_{11}X_1 + \Delta_{1P} = -\frac{X_1}{k_\varphi} \qquad \delta_{11} = \sum\int \frac{\overline{M}_1\overline{M}_1}{EI}ds = \frac{8l}{3EI} \qquad \Delta_{1P} = \sum\int \frac{\overline{M}_1 M_P}{EI}ds = \frac{2Ml}{3EI}$$

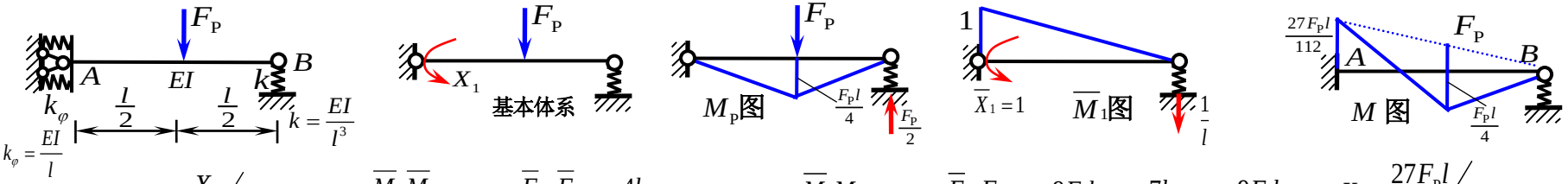
$$\frac{11l}{3EI}X_1 + \frac{2Ml}{3EI} = 0 \qquad X_1 = -2M/11 \qquad M = X_1\overline{M}_1 + M_P$$



$$\delta_{11}X_1 + \Delta_{1P} = 0 \qquad \delta_{11} = \sum\int \frac{\overline{M}_1\overline{M}_1}{EI}ds + \sum\frac{\overline{F}_{k1}\overline{F}_{k1}}{k} = \frac{11l}{12EI} \qquad \Delta_{1P} = \sum\int \frac{\overline{M}_1 M_P}{EI}ds + \sum\frac{\overline{F}_{k1}F_{kP}}{k} = \frac{-7Ml}{12EI}$$

$$X_1 = -\Delta_{1P}/\delta_{11} = 7M/11$$

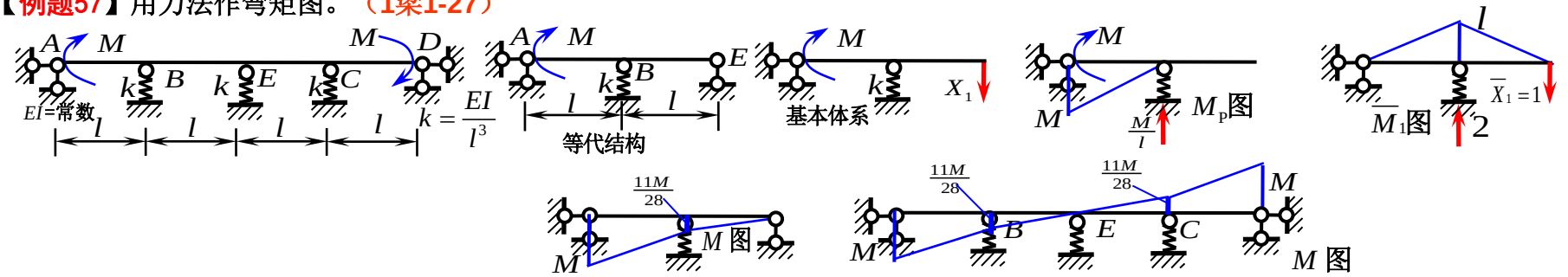
【例题56】用力法作弯矩图。（1梁1-32）



$$\delta_{11}X_1 + \Delta_{1P} = -\frac{X_1}{k_\varphi} \qquad \delta_{11} = \sum\int \frac{\overline{M}_1\overline{M}_1}{EI}ds + \sum\frac{\overline{F}_{k1}\overline{F}_{k1}}{k} = \frac{4l}{3EI} \qquad \Delta_{1P} = \sum\int \frac{\overline{M}_1 M_P}{EI}ds + \sum\frac{\overline{F}_{k1}F_{kP}}{k} = \frac{-9F_P l}{16EI}$$

$$\frac{7l}{3EI}X_1 - \frac{9F_P l}{16EI} = 0 \qquad X_1 = 27F_P l/112 \qquad M = X_1\overline{M}_1 + M_P$$

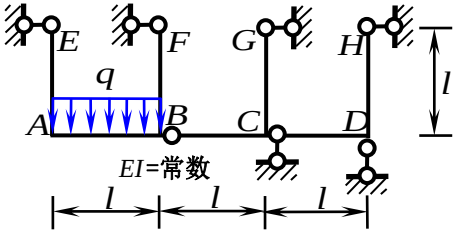
【例题57】用力法作弯矩图。（1梁1-27）

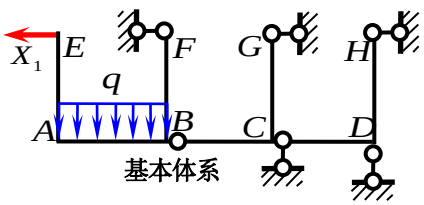


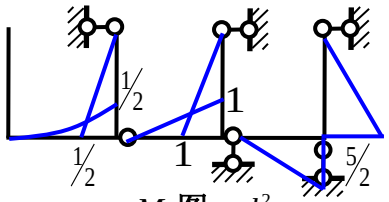
$$\delta_{11}X_1 + \Delta_{1P} = 0 \qquad \delta_{11} = \sum\int \frac{\overline{M}_1\overline{M}_1}{EI}ds + \sum\frac{\overline{F}_{k1}\overline{F}_{k1}}{k} = \frac{14l^3}{3EI} \qquad \Delta_{1P} = \sum\int \frac{\overline{M}_1 M_P}{EI}ds + \sum\frac{\overline{F}_{k1}F_{kP}}{k} = \frac{11Ml^2}{6EI}$$

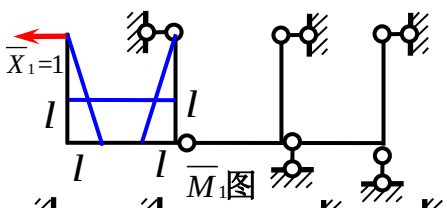
$$X_1 = -\Delta_{1P}/\delta_{11} = -11M/28l \qquad M = X_1\overline{M}_1 + M_P$$

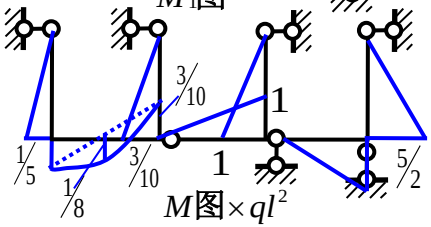
【例题58】用力法作弯矩图。（1次16-2）







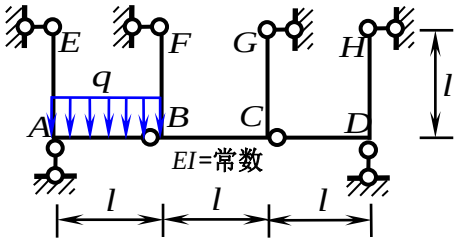


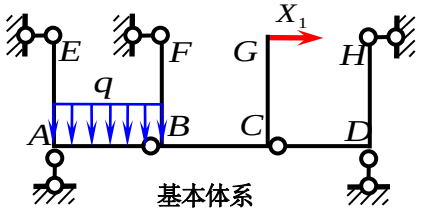


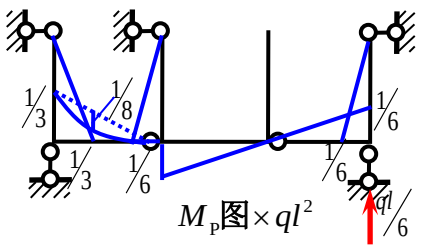
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5l^3}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^4}{3EI}$$

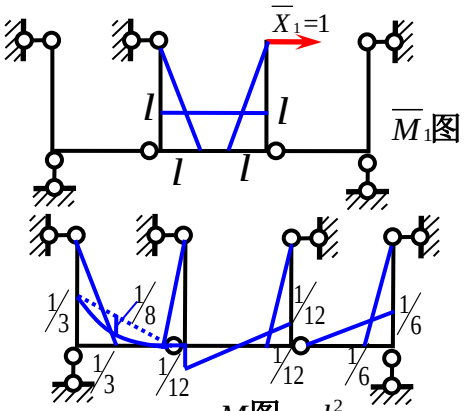
$$X_1=-\Delta_{1P}/\delta_{11}=-ql/5 \qquad M=X_1\overline{M}_1+M_P$$

【例题59】用力法作弯矩图。（1次16-4）





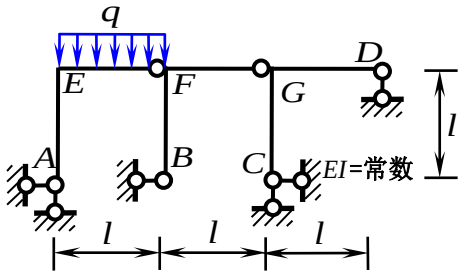


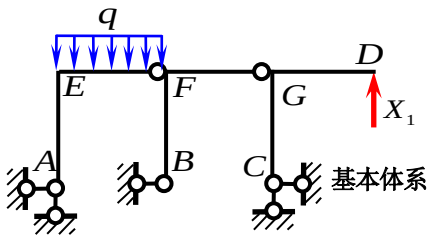


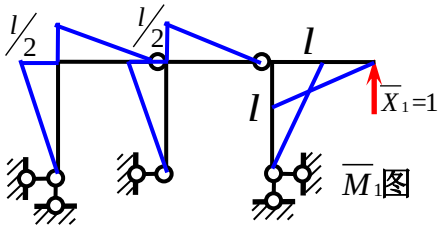
$$\delta_{11}X_1+\Delta_{1P}=0 \qquad \delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5l^3}{3EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-5ql^4}{36EI}$$

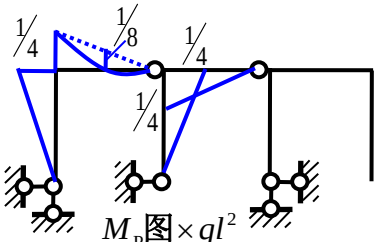
$$X_1=-\Delta_{1P}/\delta_{11}=ql/12 \qquad M=X_1\overline{M}_1+M_P$$

【例题60】用力法作弯矩图。（1次1-8）



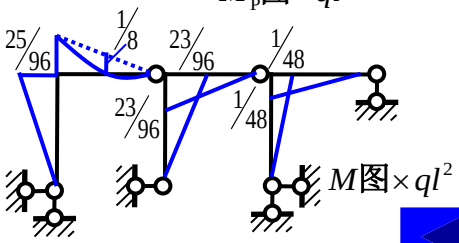




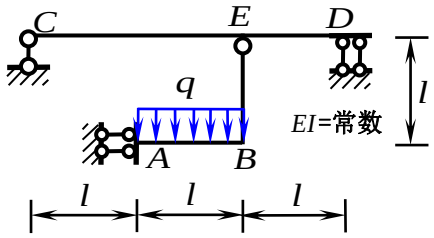


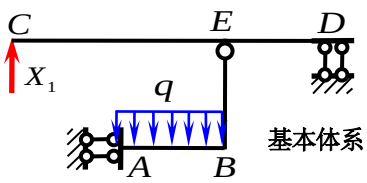
$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{l^3}{EI} \qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-ql^4}{48EI}$$

$$\delta_{11}X_1+\Delta_{1P}=0 \qquad X_1=-\Delta_{1P}/\delta_{11}=ql/48 \qquad M=X_1\overline{M}_1+M_P$$

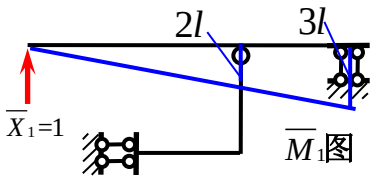


【例题61】用力法作弯矩图。（1次16-20）

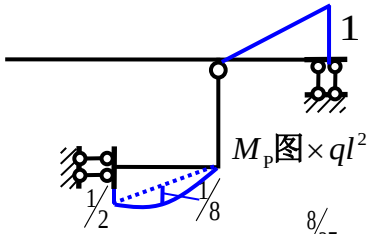




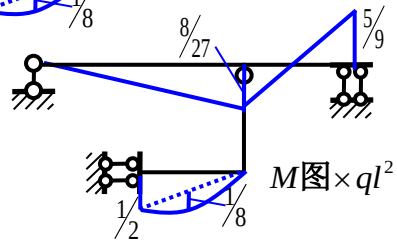
基本体系



$\overline{M}_1$图



M_P图$\times ql^2$



M图$\times ql^2$

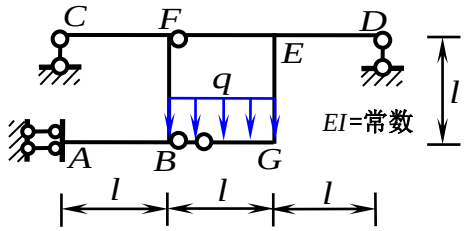
$$\delta_{11}X_1+\Delta_{1P}=0$$

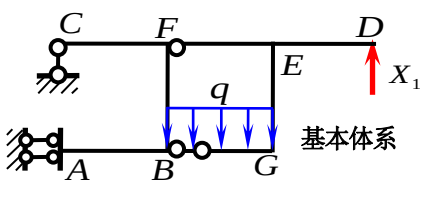
$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{9l^3}{EI}\qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-4ql^4}{3EI}$$

$$X_1=-\Delta_{1P}/\delta_{11}=4ql/27$$

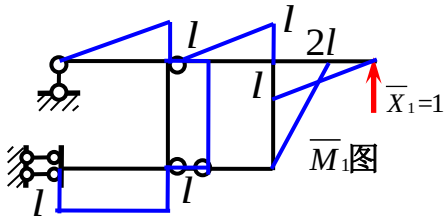
$$M=X_1\overline{M}_1+M_P$$

【例题62】用力法作弯矩图。（1次16-22）

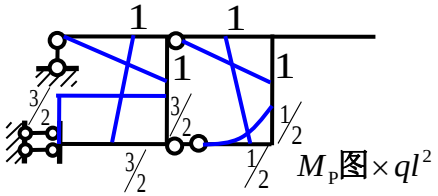




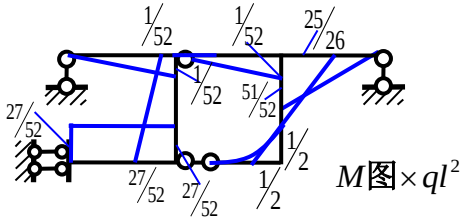
基本体系



$\overline{M}_1$图



M_P图$\times ql^2$



M图$\times ql^2$

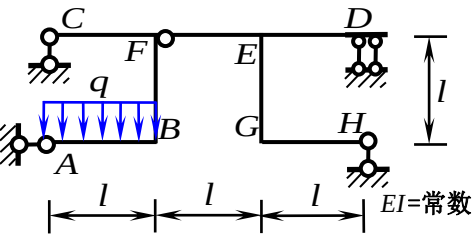
$$\delta_{11}X_1+\Delta_{1P}=0$$

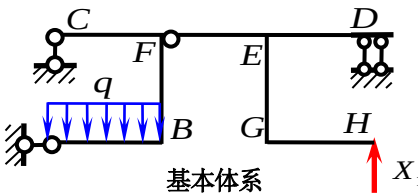
$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{13l^3}{3EI}\qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{-17ql^4}{4EI}$$

$$X_1=-\Delta_{1P}/\delta_{11}=51ql/52$$

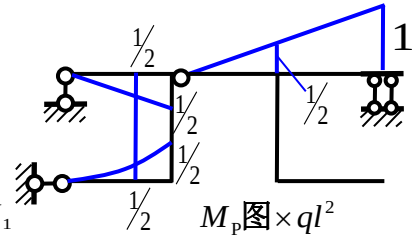
$$M=X_1\overline{M}_1+M_P$$

【例题63】用力法作弯矩图。（1次16-1）

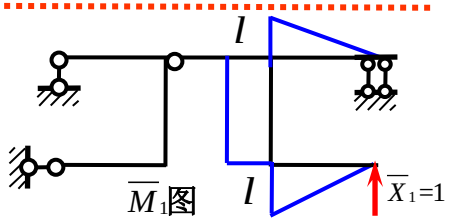




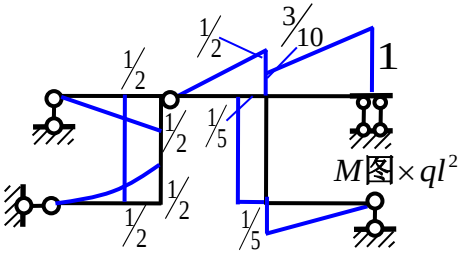
基本体系



M_P图$\times ql^2$



$\overline{M}_1$图



M图$\times ql^2$

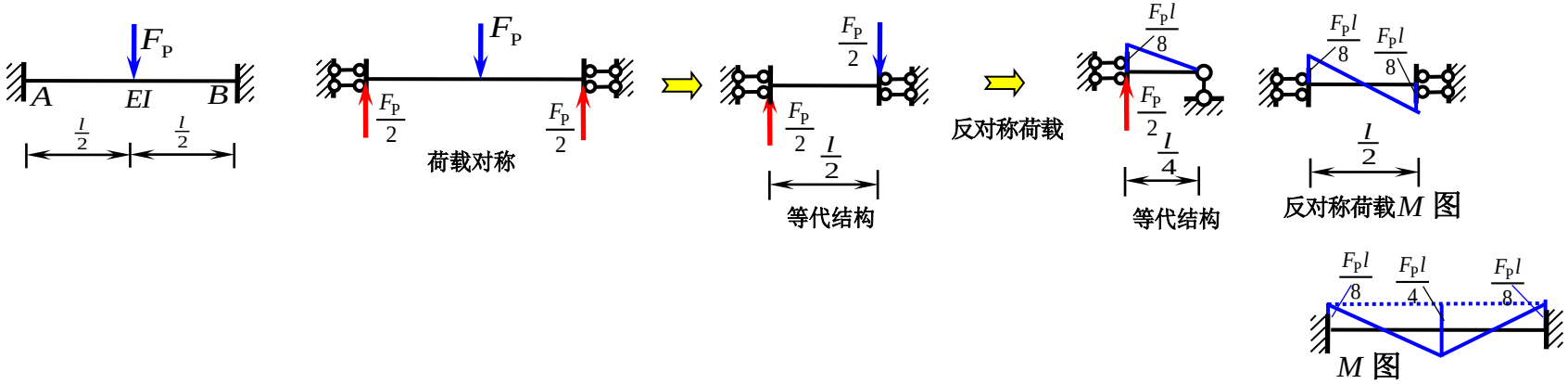
$$\delta_{11}X_1+\Delta_{1P}=0$$

$$\delta_{11}=\sum\int\frac{\overline{M}_1\overline{M}_1}{EI}ds=\frac{5l^3}{3EI}\qquad \Delta_{1P}=\sum\int\frac{\overline{M}_1M_P}{EI}ds=\frac{ql^4}{3EI}$$

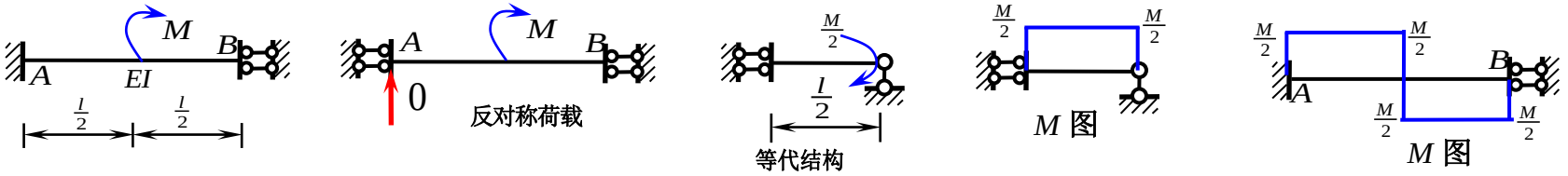
$$X_1=-\Delta_{1P}/\delta_{11}=-ql/5$$

$$M=X_1\overline{M}_1+M_P$$

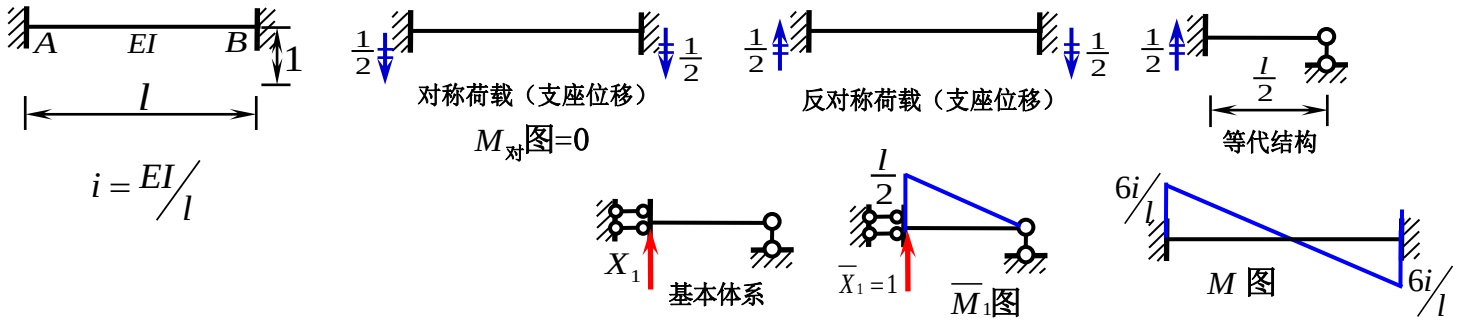
【例题64】用力法作弯矩图。（梁1-8）



【例题65】用力法作弯矩图。（梁1-10）



【例题66】用力法作弯矩图。（梁1-18）



$$\delta_{11}X_1 = \frac{1}{2} \qquad \delta_{11} = \sum\int \frac{\overline{M}_1\overline{M}_1}{EI}ds = \frac{l^3}{24EI} \qquad X_1 = -12EI/l^3 = 12i/l^2 \qquad M = X_1\overline{M}_1$$