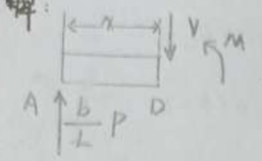
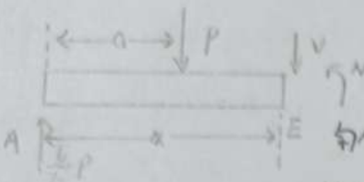
P.5.1

解:



$+\uparrow \Sigma F_y=0: \frac{b}{L}P - V = 0$, $V=\frac{b}{L}P$

$\circlearrowleft \Sigma M_D=0: -\frac{bP}{L}x + M = 0$, $M=\frac{bP}{L}x$



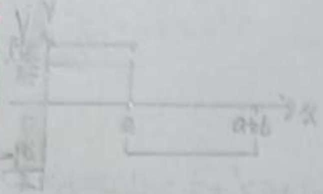
$\frac{bP}{L} - P - V = 0$, $V=\frac{-a}{L}P$

$\circlearrowleft M_E=0$

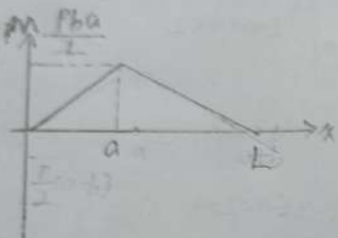
$M + P(x-a) - \frac{bP}{L}x = 0$

$M = -\frac{bP}{L}x + Pa$

$= \frac{Pa}{L}(L-x)$



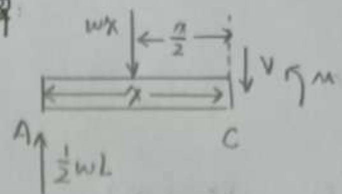
$$V=\begin{cases} \frac{Pb}{L} & 0<x\le a \\ \frac{-Pa}{L} & a<x<L \end{cases}$$



$$M=\begin{cases} \frac{Pbx}{L} & 0<x\le a \\ \frac{Pa(L-x)}{L} & a<x<L \end{cases}$$

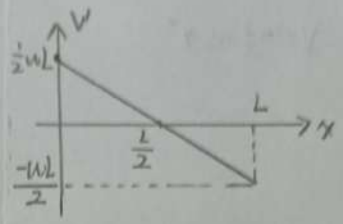
P.5.2

解:

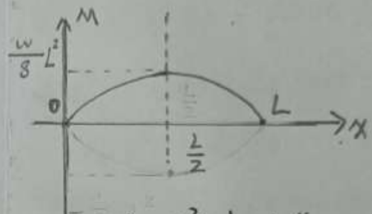


$+\uparrow \Sigma F_y=0: +\frac{1}{2}wL - wx - V = 0$, $V=\frac{1}{2}wL - wx$

$\circlearrowleft \Sigma M_C=0: M + wx\cdot\frac{x}{2} - \frac{1}{2}wL\cdot x = 0$, $M=\frac{-1}{2}wx^2+\frac{1}{2}wL\cdot x$



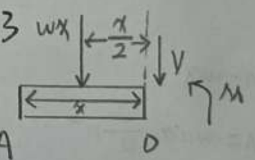
$V = -wx + \frac{1}{2}wL$



$M = -\frac{1}{2}wx^2 + \frac{1}{2}wLx$

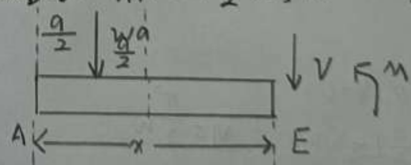
P.5.3

解:



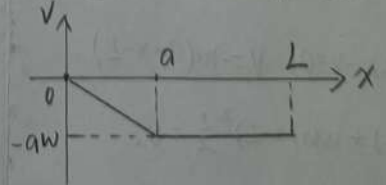
$+\uparrow \Sigma F_y=0: -wx - V = 0$, $V=-wx$

$\circlearrowleft \Sigma M_D=0: M + wx\cdot\frac{x}{2}=0$, $M=-w\cdot\frac{x^2}{2}$

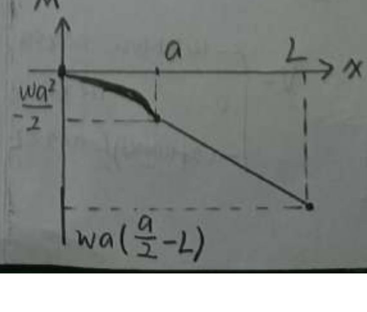


$+\uparrow \Sigma F_y=0: -wa - V=0$, $V=-wa$

$\circlearrowleft \Sigma M_E=0: M + wa(x-\frac{a}{2})=0$, $M=+\frac{w}{2}a^2 - wax$



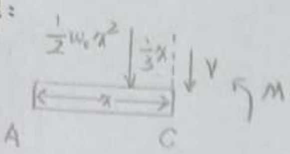
$$V=\begin{cases} -wx & 0<x\le a \\ -wa & a<x<L \end{cases}$$



$$M=\begin{cases} -w\frac{x^2}{2}, & 0<x\le a \\ -wax+\frac{wa^2}{2}, & a<x<L \end{cases}$$

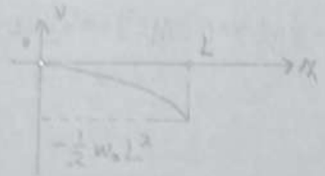
P.5.4

解：

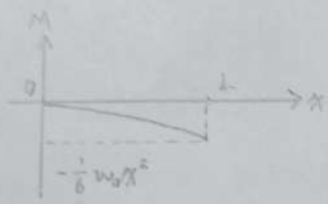


$+\uparrow \Sigma F_y=0: \ -V-\frac{1}{2}w_0x^2=0, \quad V=-\frac{1}{2}w_0x^2$

$\circlearrowleft^+ \Sigma M_C=0: \ M+\frac{1}{3}x\cdot\frac{1}{2}w_0x^2=0, \quad M=-\frac{1}{6}w_0x^2$

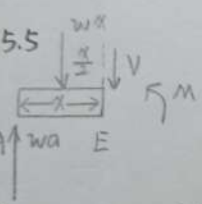


$V=-\frac{1}{2}w_0x^2$



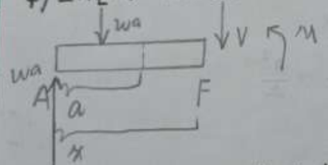
$M=-\frac{1}{6}w_0x^2$

P.5.5



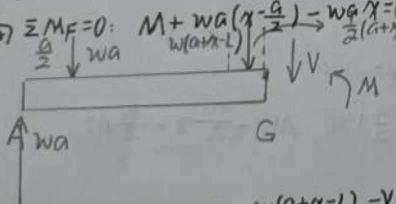
$+\uparrow \Sigma F_y=0: \ wa-wx-V=0, \ \underline{V=wa-wx}$

$\circlearrowleft^+ \Sigma M_E=0: \ M+\frac{w}{2}x^2-wa\cdot x=0, \ M=wax-\frac{w}{2}x^2$



$+\uparrow \Sigma F_y=0: \ wa-wa-V=0, \ \underline{V=0}$

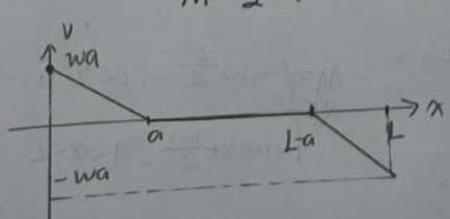
$\circlearrowleft^+ \Sigma M_F=0: \ M+wa(x-\frac{a}{2})-wa\cdot x=0, \ M=\frac{a^2}{2}w$



$+\uparrow \Sigma F_y=0: \ wa-wa-w(a+x-L)-V=0, \ \underline{V=-w(a+x-L)}$

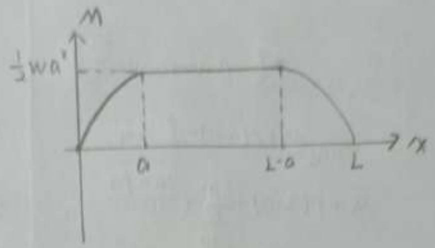
$\circlearrowleft^+ \Sigma M_G=0: \ M-wax+wa\cdot(x-\frac{a}{2})+w(a+x-L)^2\cdot\frac{1}{2}=0,$

$$M=\frac{-1}{2}w(a+x-L)^2+\frac{w}{2}a^2$$



$$V=\begin{cases}-wx+wa & 0<x\le a\\ 0 & a<x\le L-a\\ -wx+w(L-a) & L-a<x<L\end{cases}$$

$$M=\begin{cases}-\frac{w}{2}x^2+wa\cdot x & 0<x\le a\\ \frac{1}{2}a^2w & a<x\le L-a\\ -\frac{1}{2}w(a+x-L)^2+\frac{w}{2}a^2 & L-a<x<L\end{cases}$$



P.5.6

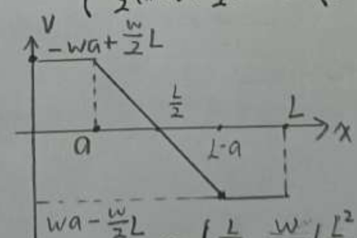
解：$V=-w\langle x-a\rangle^1+w\langle x-L+a\rangle^1+\frac{1}{2}w(L-2a)\langle x-0\rangle^0$

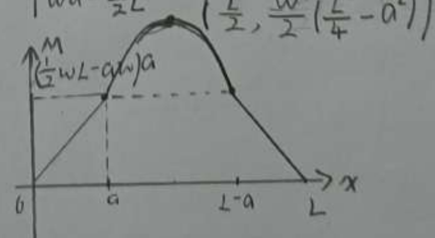
$$V=\begin{cases}\frac{w}{2}(L-2a) & 0<x<a\\ \frac{w}{2}(L-2a)-w(x-a) & a\le x<L-a\\ \frac{w}{2}(L-2a)+w(x-L+a+a-x) & L-a\le x<L\end{cases}$$

$$V=\begin{cases}-wa+\frac{w}{2}L & 0<x<a\\ -wx+\frac{w}{2}L & a\le x<L-a\\ wa-\frac{w}{2}L & L-a\le x<L\end{cases}$$

$$M=-\frac{w}{2}\langle x-a\rangle^2+\frac{w}{2}\langle x-L+a\rangle^2+(\frac{1}{2}wL-aw)\langle x-0\rangle$$

$$M=\begin{cases}(\frac{1}{2}wL-aw)x & 0<x<a\\ -\frac{w}{2}(x-a)^2+(\frac{1}{2}wL-aw)x & a\le x<L-a\\ -\frac{w}{2}(x-a)^2+\frac{w}{2}(x-L+a)^2+(\frac{1}{2}wL-aw)x & L-a\le x<L\end{cases}$$





Homework-VI

Problem 2

and 5.20 For the beam and loading shown, determine the maximum normal stress due to bending on a transverse section at C.

σ

解:

$+\uparrow \Sigma F_y = 0$: $N_A + N_B - 90\times2.4 - 150 - 150 = 0$

$\circlearrowleft \Sigma M_A = 0$: $-90\times2.4\times1.2 - 150\times3.2 - 150\times4 + N_B\times4.8 = 0$

$N_B = 279\ kN$

$N_A = 237\ kN$

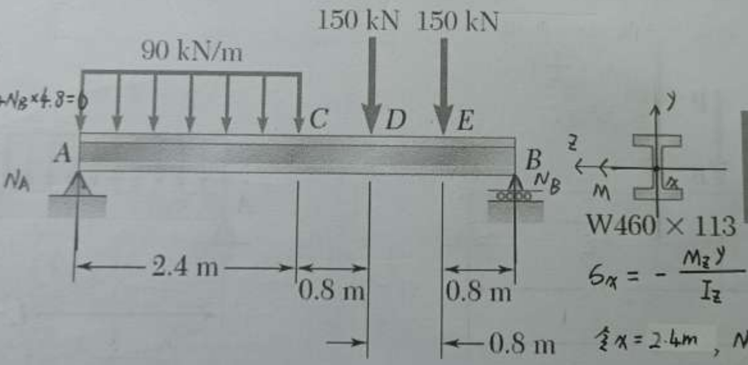
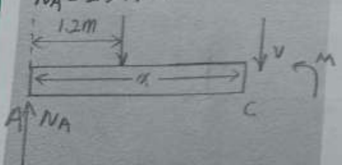


Fig. P5.20



$+\uparrow \Sigma F_y = 0$: $N_A - 90\times2.4 - V = 0$

$\circlearrowleft \Sigma M_C = 0$: $M + (x-1.2)\times90\times2.4 - N_A x = 0$

$\Rightarrow M = 21x + 259.2\ kN\cdot m$

$$\sigma_x = -\frac{M_z y}{I_z} = +\frac{(21x+259.2)\times\frac{1}{2}\times462\times10^{-3}}{554\times10^{6}\times(10^{-3})^4}$$

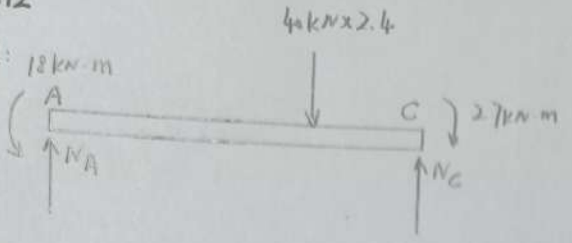
令 $x = 2.4m$, $M_C = 309.6\ kN\cdot m$, $S = 2390\times10^{-6}\ m^3$

$$\sigma_x = \frac{(309.6)}{2390\times10^{-6}} = 129540\ kPa$$

$= 129.5\ MPa$

5.112

解:

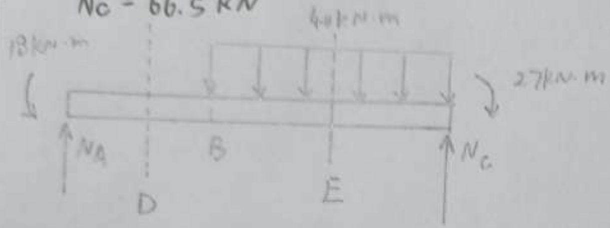


$+\uparrow \Sigma F_y = 0: \quad N_A + N_C - 40\times2.4 = 0$

$\circlearrowleft M_A = 0: \quad +18 - 27 + N_C\times3.6 - 40\times2.4\times2.4 = 0$

$\Rightarrow N_A = 29.5$ kN

$N_C = 66.5$ kN



$V_D = N_A\langle x-0\rangle^0$

$V_E = +N_A\langle x-0\rangle^0 - 40\langle x-1.2\rangle^1$

$M_D = N_A\langle x-0\rangle^1 - 18\langle x-0\rangle^0$

$M_E = N_A\langle x-0\rangle^1 - 20\langle x-1.2\rangle^2 - 18\langle x-0\rangle^0$

$$M = \begin{cases} 29.5x - 18 & 0<x<1.2 \\ -20x^2 + 77.5x - 46.8 & 1.2<x<3.6 \end{cases}$$

$M_1 = 29.5\times1.2 - 18 = 17.4$ kN·m

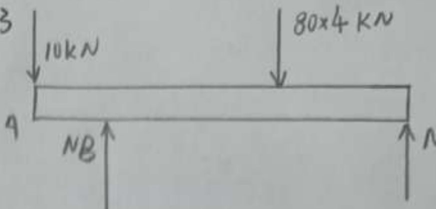
$x = \frac{77.5}{40} = 1.9375$ m

$M_2 = 28.28$ kN·m $\boxed{max}$

$\sigma_{max} = \frac{M_z}{S} = \frac{28.28}{624\times10^{-6}} = 45.32$ MPa

5.113

解:

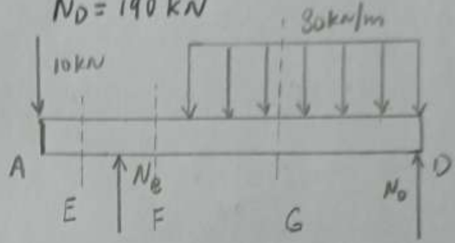


$+\uparrow \Sigma F_y = 0: \quad N_B + N_D - 10 - 80\times4 = 0$

$\circlearrowleft \Sigma M_A = 0: \quad N_B\cdot1 - 80\times4\times4 + N_D\times6 = 0$

$\Rightarrow N_B = 140$ kN

$N_D = 190$ kN



$V_E = -10\langle x-0\rangle^0$

$V_F = -10\langle x-0\rangle^0 + 140\langle x-1\rangle^0$

$V_G = -10\langle x-0\rangle^0 + 140\langle x-1\rangle^0 - 80\langle x-2\rangle^1$

$\Rightarrow M_E = -10\langle x-0\rangle^1$

$M_F = -10\langle x-0\rangle^1 + 140\langle x-1\rangle^1$

$M_G = -10\langle x-0\rangle^1 + 140\langle x-1\rangle^1 - 40\langle x-2\rangle^2$

$$M = \begin{cases} -10x & 0<x<1 \\ 130x - 140 & 1\le x<2 \\ -40x^2 + 290x - 300 & 2\le x<6 \end{cases}$$

$M_{max} = -40\times\left(\frac{29}{8}\right)^2 + 290\times\frac{29}{8} - 300 = 225.625$ kN·m

$x = \frac{29}{8} = 3.625$ m $\boxed{max}$

$\sigma_{max} = \frac{M_z}{S} = \frac{225.625}{3720\times10^{-6}} = 60.65$ MPa