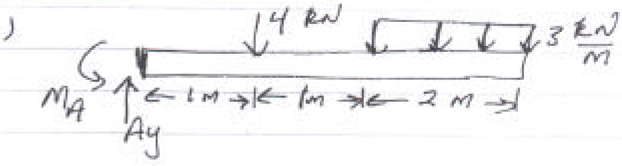
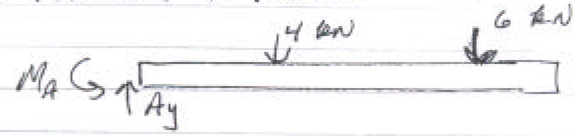
Solutions to Problem Set #12, 24-26, Fall 2001

1 (4.3-2)



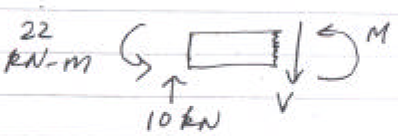
Replace distribution with concentrated load since FBD is complete + we are about to sum moments + forces



$\Sigma F_y = A_y - 4 - 6 = 0 \Rightarrow A_y = 10\ kN$

$\Sigma M|_{A_z} = M_A - 4(1) - 6(3) = 0 \Rightarrow M_A = 22\ kN\text{-}m$

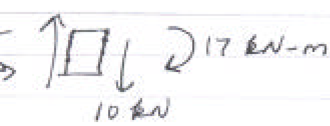
to find V & M at $x = 0.5$, isolate from 0 to 0.



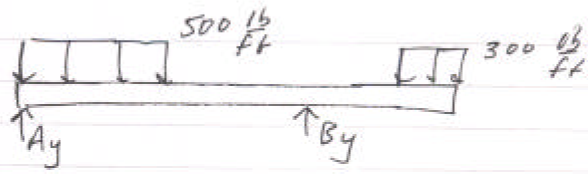
draw V & M as positive by convention

$\Sigma F_y = -10 + V = 0 \Rightarrow \boxed{V = 10\ kN}$

$\Sigma M|_{cut_x} = 22 - 10(0.5) + M = 0 \Rightarrow \boxed{M = -17\ kN\text{-}m}$

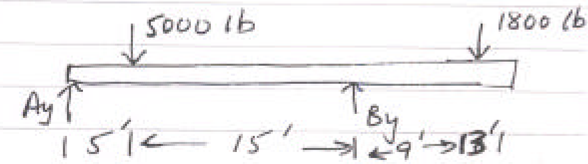


2 (4.3-5)



About to sum forces + moments to find A_y, B_y

replace distributions

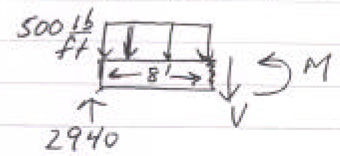


$$\sum M|_{A_z} = B_y(20) - 5000(5) - 1800(29) = 0$$

$$\Rightarrow B_y = 3860 \text{ lb}$$

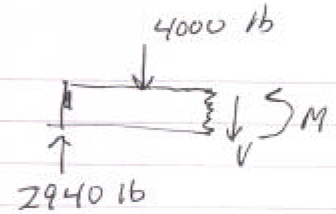
$$\sum F_y = A_y + B_y - 5000 - 1800 = 0 \Rightarrow A_y = 2940 \text{ lb}$$

To find V & M at $x = 8'$, isolate from 0 to 8



Note: original distribution appea[rs], must include actual loads acting on $0 < x < 8$

about to sum forces + moments ⇒ replace distribution by a force of $(500)(8) = 4000$ lb at midpoint $x = 4'$

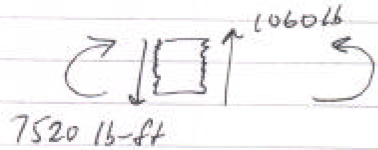


$$\Sigma F_y = 2940 - 4000 - V = 0$$

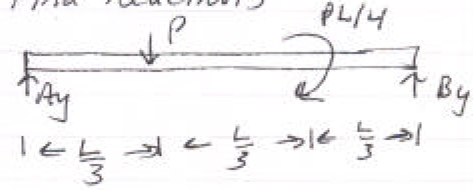
$$\boxed{V = -1060\ lb}$$

$$\Sigma m|_{cut_z} = -2940(8) + 4000(4) + M = 0$$

$$\boxed{M = 7520\ lb\text{-}ft}$$

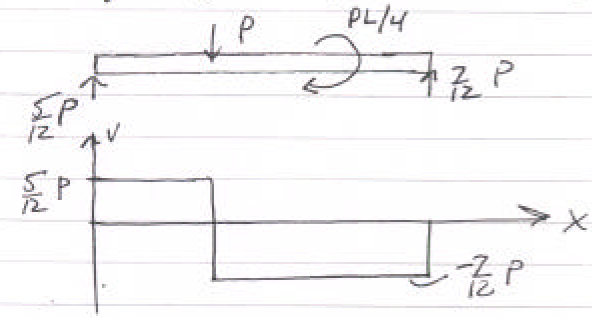


3 (4.5-5) Find reactions

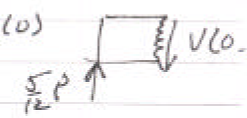


$$\Sigma M|_{A_z} = B_y(L) - P\left(\frac{L}{3}\right) - \frac{PL}{4} = 0 \Rightarrow B_y = \frac{7}{12}P$$

$$\Sigma F_y = A_y - P + \frac{7}{12}P = 0 \Rightarrow A_y = \frac{5}{12}P$$



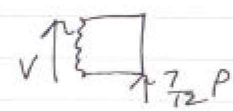
Because reaction of $\frac{5}{12}P$ balances $V(0)$

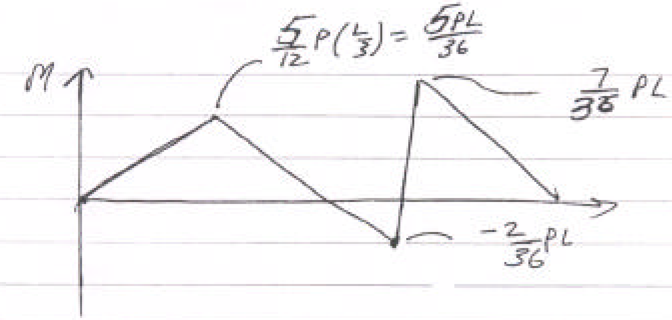


- V is constant in $0 < x < \frac{L}{3}$
- V takes a jump of P at $x = \frac{L}{3}$
- V is constant in $\frac{L}{3} < x < L$
- Value $V = -\frac{7}{12}P$ is consistent with

reaction at right end

$V = -\frac{7}{12}P$





Because $M(0)=0$

- V is constant in $0 < x < \frac{L}{3} \Rightarrow$ slope of M is constant, equal to $\frac{5}{12}P$.

  Value at $x = L/3$ is $\left(\frac{5}{12}P\right)\left(\frac{L}{3}\right)$

- M is linear in $\frac{L}{3} < x < \frac{2L}{3}$, with slope $-\frac{7}{12}P$

  Value just to the left of $x = \frac{2L}{3}$ is

  $$\frac{5PL}{36} - \frac{7}{12}P\left(\frac{L}{3}\right) = -\frac{2PL}{36}$$

- M takes a jump at $x = \frac{2L}{3}$ across moment

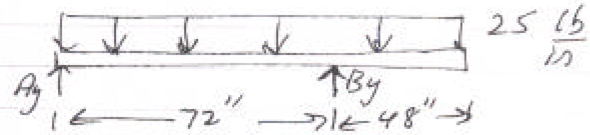
  $\frac{2PL}{36}$ $\frac{PL}{4}$ M

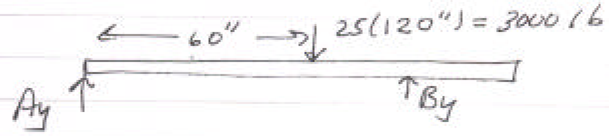
  $$\Sigma M_z = \frac{2PL}{36} - \frac{PL}{4} + M = 0$$

  $$M = \frac{9-2}{36}PL = \frac{7}{36}PL$$

- M varies linearly with slope $-\frac{7}{12}PL$ from $\frac{2L}{3}$ to $L \Rightarrow \frac{7}{36}PL - \left(\frac{7}{12}P\right)\left(\frac{L}{3}\right) = 0$

4 (4.5-15)

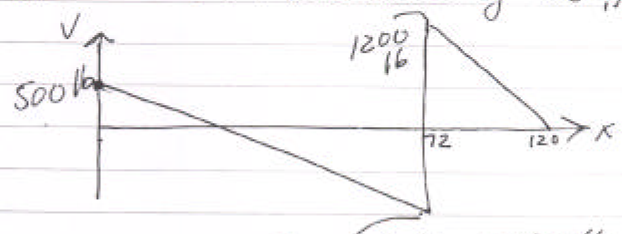




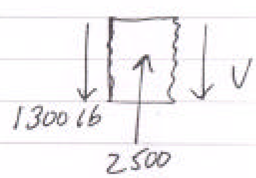
$$\Sigma m/_{A_z} = B_y(72) - 3000(60) = 0 \Rightarrow B_y = 2500$$

$$\Sigma F_y = A_y + B_y - 3000 = 0 \Rightarrow A_y = 500 \text{ lb}$$

V will vary linearly with position x under distribution. Decreases by 25 lb/in



$500 - 25(72) = -1300$ lb



V = 1200 lb just to right of B

decreases by $25(48) = 1200$ lb

to zero at right end

$V_{min} = -1300$ lb, $V_{max} = 1200$ lb

To find M, use fact that slope of M is equal to V. Also change in M is area under V vs. X curve

At $X=0$, $M=0$, since there is no reaction moment

V varies linearly from 500 to -1300 in $0<x<72'$

$V=0$ at $500-25X=0 \Rightarrow X=20$

from 0 to 20 area under V vs. X is $500(20)(\frac{1}{2})=500$ lb

so M reaches a max of 5000 at $x=20$

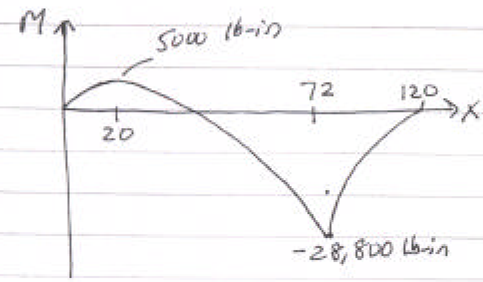
From $x=20$ to 72, area under V is $(-1300)(52)\frac{1}{2} = -33{,}800$ lb-in

so change at $x=72$, $M=5000-33{,}800=-28{,}800$ lb-in

change in M from $x=72$ to 120 is $(1200)(48)(\frac{1}{2})$
$= 28{,}800$

so M at $x=120$ is $-28{,}800+28{,}800=0$

M must be 0 at $x=120$, because there is no moment reaction



$M_{max} = 5000$ lb-in

$M_{min} = -28{,}800$ lb-in