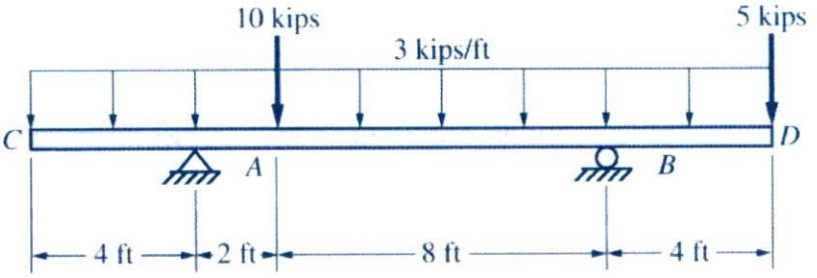
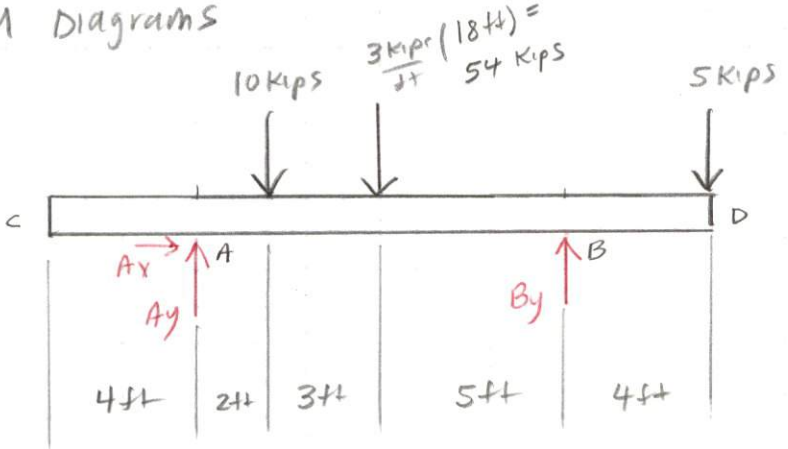
15-9

For each of the beams subjected to the loadings shown, the weight of the beam is already included in the uniform load. Select the lightest wide-flange steel shape using A36 steel. Assume that the beam is supported laterally for its entire length.

Solution.



Solve for the reactions at the supports A & B and draw the V & M Diagrams



FBD- Entire Beam

Equilibrium Equations

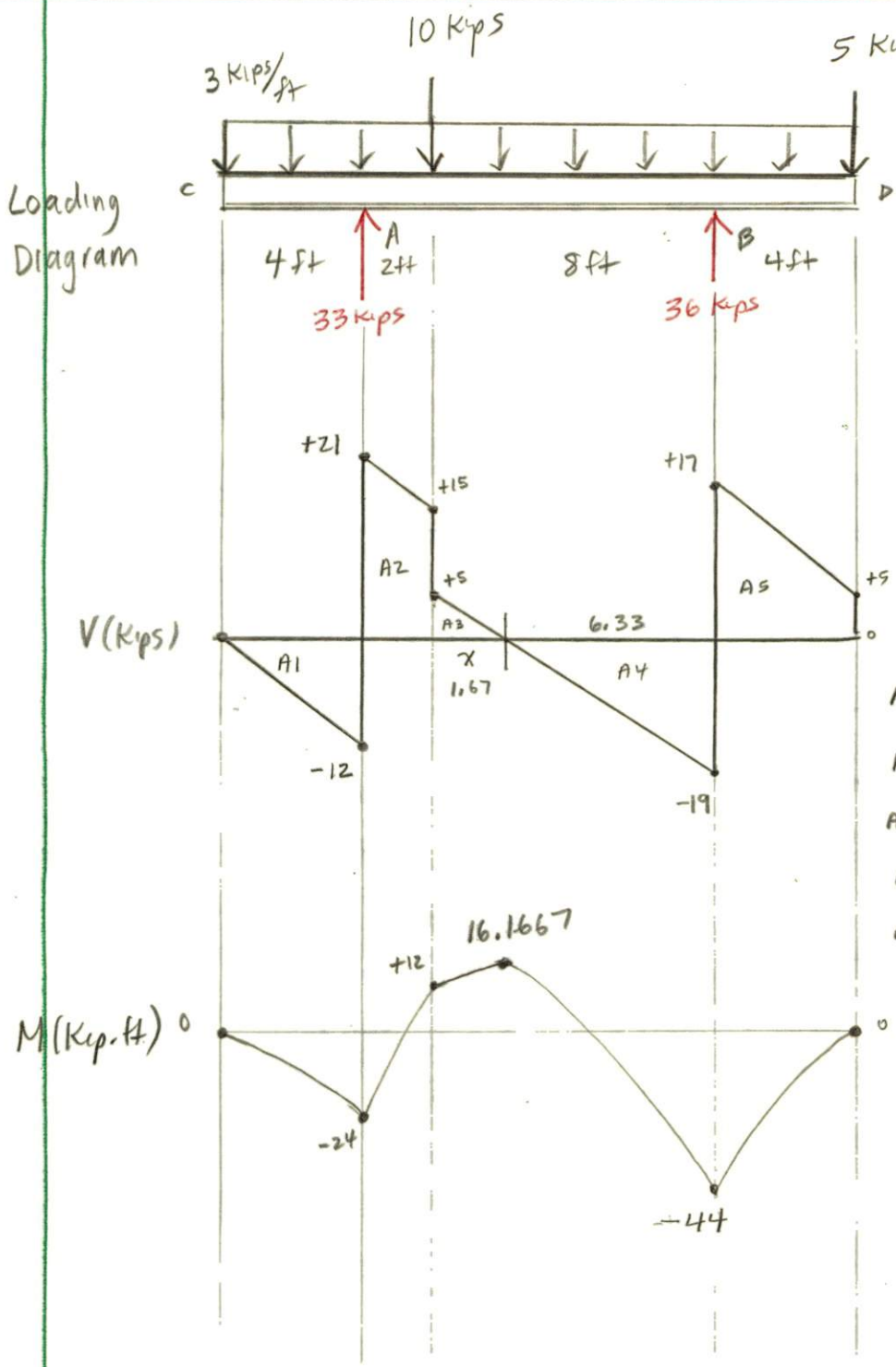
$[\Sigma F_x = 0]$ $A_x = 0$

$+\circlearrowleft [\Sigma M_A = 0]$ $-10\text{ kips}(2\text{ ft}) - 54\text{ kips}(5\text{ ft}) + B_y(10\text{ ft}) - 5\text{ kips}(14\text{ ft}) = 0$

$$B_y = \frac{360\text{ kip}\cdot\text{ft}}{10\text{ ft}} = 36\text{ kips}\uparrow$$

$[\Sigma F_y = 0)$ $A_y - 10\text{ kips} - 54\text{ kips} + B_y - 5\text{ kips} = 0$

$A_y = 69\text{ kips} - 36\text{ kips} = 33\text{ kips}\uparrow$



$\frac{x}{8} = \frac{5}{24} \Rightarrow x = \frac{40}{24} = 1.667$

A1 $\frac{1}{2}(4)(-12) = -24$

A2 $\frac{1}{2}(2)(6) + 2(15) = +36$

A3 $\frac{1}{2}(1.67)(5) = 4.1667$

A4 $\frac{1}{2}(6.33)(-19) = -60.1667$

A5 $\frac{1}{2}(4)(12) + 4(5) = 44$

$V_{MAX} = 21$ Kips

$|M_{MAX}| = 44$ Kip·ft

Step 1. A36 steel

$\sigma_{allow} = 24$ ksi $\qquad \tau_{allow} = 14.5$ ksi

Step 2. $V_{MAX} = 21$ kips

$M_{MAX} = 44$ kip·ft $\left(\frac{12\text{ in}}{\text{ft}}\right) = 528$ kip·in

Step 3. $S_{req} = \frac{M_{MAX}}{\sigma_{allow}} = \frac{528 \text{ kip·in}}{24 \text{ ksi}} = 22 \text{ in.}^3$

Step 4. Table A-1(a)

W 8 x 28	$S = 24.3 \text{ in.}^3$
W 10 x 22	$S = 23.2 \text{ in.}^3$
W 12 x 22	$S = 25.4 \text{ in.}^3$

Select W 12 x 22

$d = 12.31$ in.

$t_w = 0.260$ in.

Step 5. $\tau_{ave} = \frac{V_{MAX}}{d\,t_w} = \frac{21 \text{ kips}}{(12.31 \text{ in})(0.260 \text{ in})} = 6.56 \text{ ksi} < \tau_{allow} = 14.5 \text{ ksi}$ ✓

use, W 12 x 22