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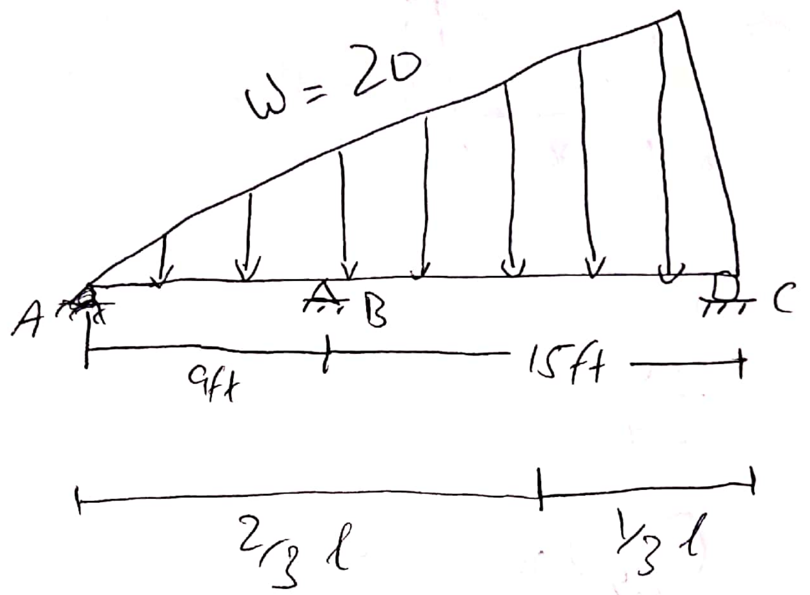
ID # 7820

Section: A

Subject: Structural Analysis-I

ID # 7820

Question No. 1



$\Sigma M_B = 0 \quad \circlearrowleft^{+}$

$\frac{1}{2} \times 20 \times 24 \times \frac{1}{3} \times 24 = R_A \times 15$

$\Rightarrow R_A = \frac{1920}{15}$

$\boxed{R_A = 128 \text{ lb}}$

$\Rightarrow R_B = 1164 - 128$

$\boxed{R_B = 1036 \text{ lbs}}$

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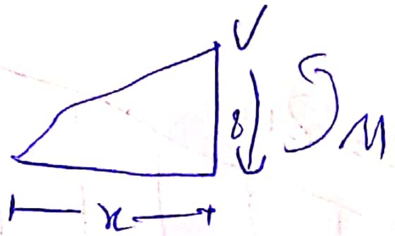
Now Section (1) — (1)



For y

$$\frac{y}{x} = \frac{20}{24}$$

$$y = \left(\frac{20}{24}\right) x$$

So $\Sigma F_y = 0 \uparrow +$

$$\Rightarrow -\frac{1}{2} \times x \times \left(\frac{20}{24}\right) x - V_c = 0$$

$$\Rightarrow V_c = \frac{20x^2}{48}$$

V_c = at $x = 0$

$$V_c = 0$$

at $x = 9$

$$\boxed{V_c = -168.68 \text{ lb}}$$

$\Rightarrow M = -\frac{1}{2} \times x \times \left(\frac{20}{24} x\right) \times \frac{1}{3} x$

$M = \quad -\frac{20x^3}{144}$

at $x = 0$

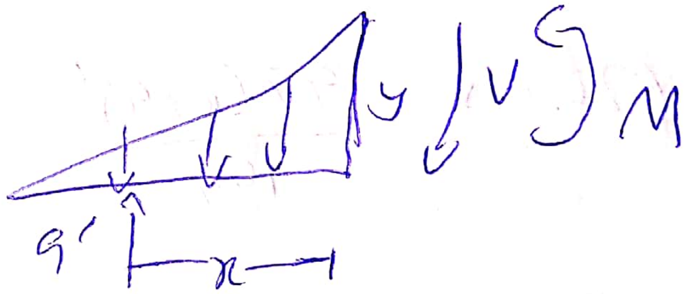
$M = 0$

at $x = 9$

$\boxed{M = -491.06 \text{ lbs-ft}}$

Now for section (2) - (2)

for y



620.8

$\frac{y}{(x+9)} = \frac{20}{24}$

$\Rightarrow y = \frac{20}{24}(x+9)$

So $\Sigma F_y = 0$

$$620.8 - \frac{1}{2} \times (x+9)\left(\frac{20}{24}\right)(x+9) - V_c = 0$$

$$\Rightarrow V_c = 620.8 - \frac{20 \times (x+9)^2}{48}$$

at $x = 0$

$V_c = 457.125$

at $x = 15$

$$\boxed{V_c = -543.2\ k}$$

$$M + \frac{1}{2}(x+9)\left(\frac{20}{24}\right)(x+9) \times \frac{1}{3} \times (x+9) - 620x =$$

$$\Rightarrow M = 620.8\,x - \frac{97(x+9)^3}{144}$$

at $x = 0$

$M = -491.0625$ lb-ft

at $x = 15$

$$\boxed{M = 0}$$

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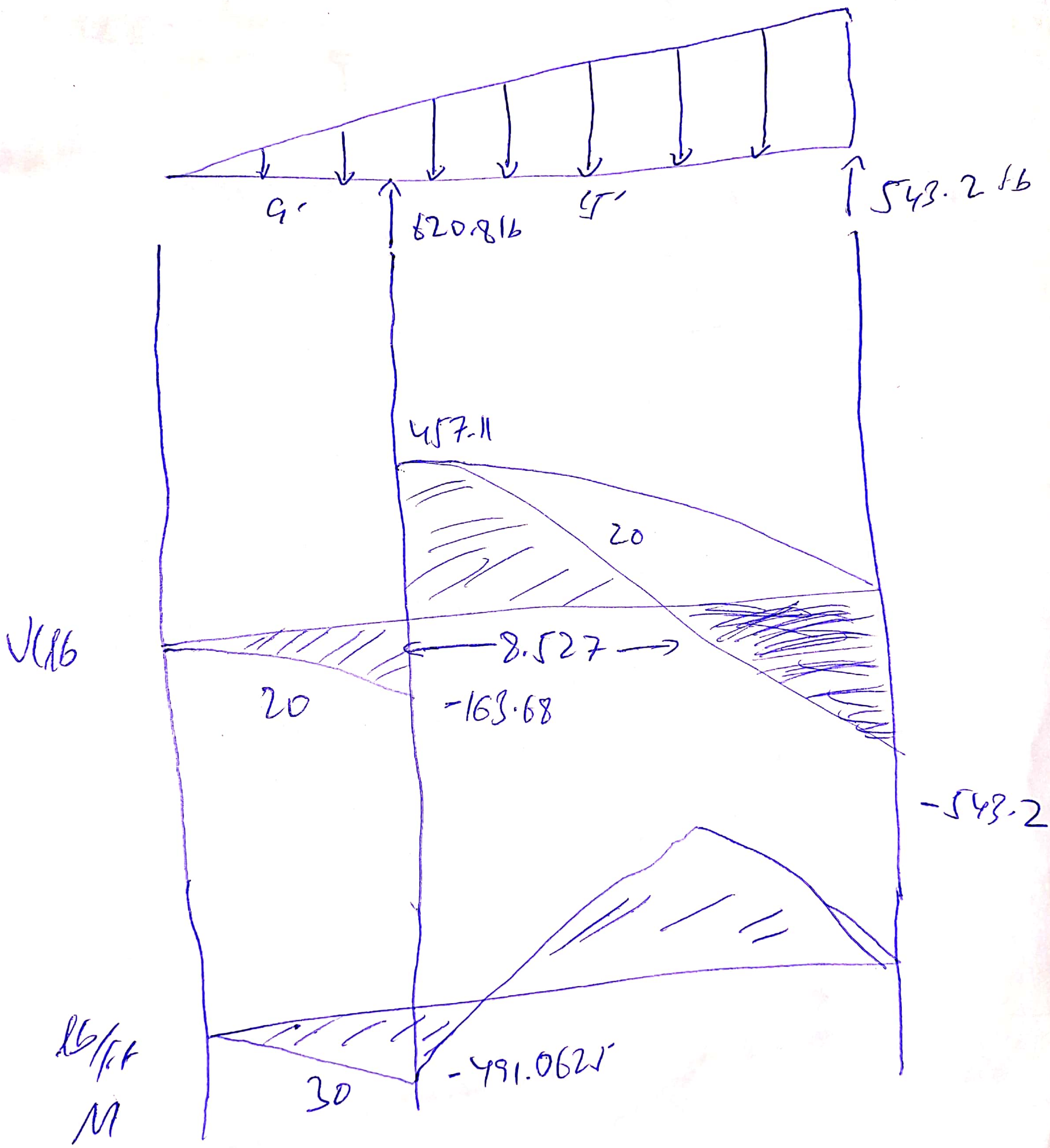

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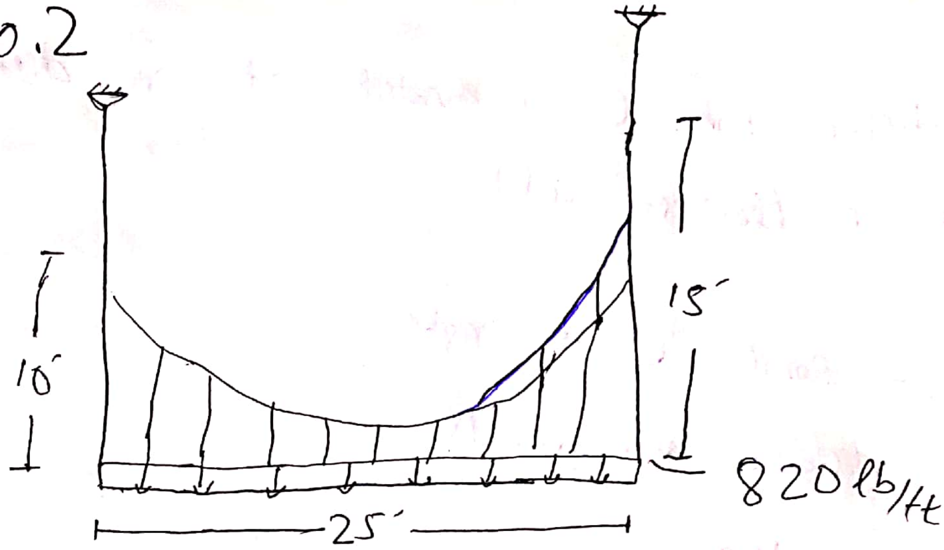
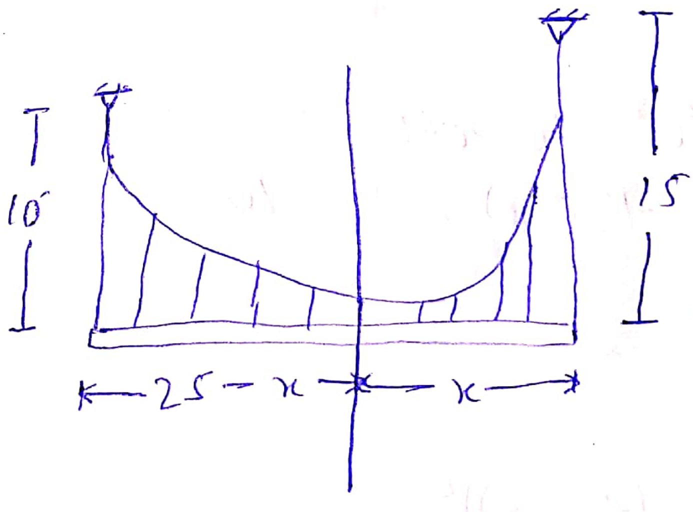
Question No. 2



SOLUTION:-

Let suppose we take a point "O" in the cable which is the lowest point, where slope is zero.



using formula,

$$y = \frac{w_o}{2T_o} \cdot x^2 = \frac{820}{2T_o} x^2$$

$$\boxed{y = \frac{410}{T_o} x^2}$$

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Now,

Assume point C is located at x distance from point "O" (lowest point)

So,

⇒ From point "O" to right

For distance 'x', $y = 15'$

$$\Rightarrow y = \frac{410}{T_0} x^2$$

$$15 = \frac{410}{T_0} x^2 \Rightarrow T_0 = \frac{410}{15} x^2 \quad \text{---(1)}$$

$$\boxed{T_0 = 27.33\, x^2} \quad \text{---(2)}$$

Again,

⇒ From point "O" to left

For distance $-(125-x)$, $y = 10$

$$y = \frac{410}{T_0} x^2$$

$$10 = \frac{410}{T_0} (-(125-x))^2$$

$$\boxed{10 = \frac{410}{T_0} \left(-(125-x)\right)^2} \quad \text{---(3)}$$

Again,

$\Rightarrow$ From point "D" to left

For distance $-(25-x)$, $y=10$

$$\Rightarrow \quad y = \frac{410}{T_0} x^2$$

$$\Rightarrow \quad 10 = \frac{410}{T_0} \left[-(25-x)\right]^2$$

$$\Rightarrow \quad \boxed{T_0 = \frac{410}{10} \left[-(25-x)\right]^2} \quad \text{---- (3)}$$

Comparing eqn (2) & (3)

$$\frac{410}{15} x^2 = \frac{410}{10} \left[-(25-x)\right]^2$$

Interchanging

$$\frac{\cancel{410}}{\cancel{410}} x^2 = \frac{15}{10} (625 - 50x + x^2)$$

$$x^2 = 1.5 (625 - 50x + x^2)$$

$$x^2 = 937.50 - 75x + 1.5x^2$$

$$\Rightarrow 937.5 - 75x + 1.5x^2 - x^2 = 0$$

$$\Rightarrow \quad 0.5x^2 - 75x + 937.5 = 0$$

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Using Quadratic Equation.

$a = 0.5, \quad b = -75, \quad c = 937.5$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-(-75) \pm \sqrt{(-75)^2 - 4(0.5)(937.5)}}{2(0.5)}$$

$$x = \frac{75 \pm \sqrt{5625 - 1875}}{1}$$

$$x = 75 \pm \sqrt{3750}$$

we got

$$\boxed{x = 13.76\ ft} \quad \text{---} (4)$$

Now put eq (4) in (2)

$$T_0 = 27.33\, x^2$$

$$= 27.33\, (13.76)^2$$

$$\boxed{T_0 = 5173.5}$$

Now we have to find the tension at given points.

By using formula,

$$y = \frac{W_o}{2T_o} x^2$$

$$y = \frac{410}{T_o} \cdot x^2$$

Differentiate the above eq. w.r.t 'x'

$$\frac{dy}{dx} = \frac{d}{dx}\left(\frac{410}{T_o} \cdot x^2\right)$$

$$= \frac{410}{T_o} \cdot 2x$$

$$\frac{dy}{dx} = \frac{820}{T_o} x \quad \text{---(a)}$$

Also

$$\frac{dy}{dx} = \tan\theta \quad \text{---(b)}$$

So,

$$\boxed{\tan\theta = \frac{820}{T_o} x}$$

As point a is -11.24 away from "D"

$$\tan\theta_A = \frac{820}{5173.5} (-11.24)$$

$$\theta_A = \tan^{-1}(1.60)$$

$$\boxed{\theta_A = 60.5^\circ}$$

Now, Tension at point A is,

$$T_A = \frac{T_0}{\cos\theta_A} \qquad \because \left(\cos\theta = \frac{T_0}{T_A}\right)$$

$$= \frac{5173.5}{\cos(-60.5)} = \frac{5137.5}{-0.68}$$

$$= 10225 \text{ lbs}$$

$$= 10.2 \text{ kips}$$

Now point B where $x = 13.76$ ft

$$\tan\theta_B = \frac{820}{T_0}(13.76)$$

$$= \frac{820}{5173.5}(13.76)$$

$$\theta_B = \tan^{-1}(2.18)$$

$$\boxed{\theta_B = 65.5^\circ}$$

Now Tension

$$T_C = \frac{T_0}{\cos\theta_B}$$

$$T_C = \frac{5713.5}{\cos(65.5)}$$

$$= 13777.65^\circ \text{ lbs}$$

$$= 13.7 \text{ ki}$$

Question No. 3

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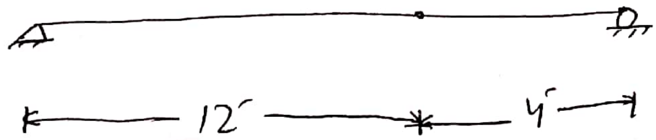
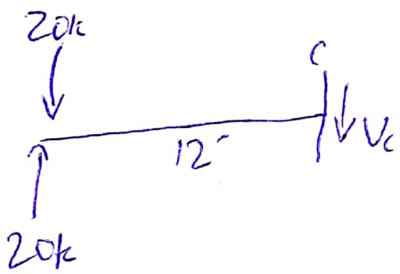


Solution :-

(a) Shear force influence for the beam.

x (ft)	V_c (k)
0	0
2	-12.125
4	-24.5
6	-36.375
8	-48.5
10	-60.625
12	-72.75(L), 27.25(R)
14	12.125
16	0

at $x = 0$



$$-20 + R_A - V_c = 0$$

$$\Rightarrow V_c = 0$$

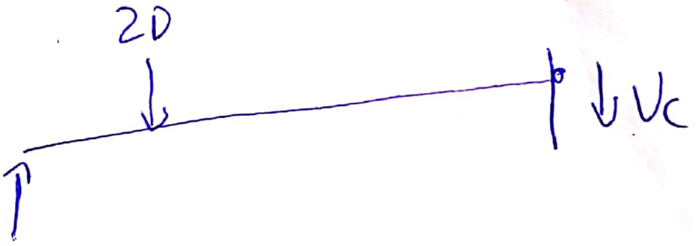
at $x = 2$

$R_A = 84.97$

$-20 + 84.875 - V_c = 0$

$\boxed{V_C = 67.875}$

at $x = 4$

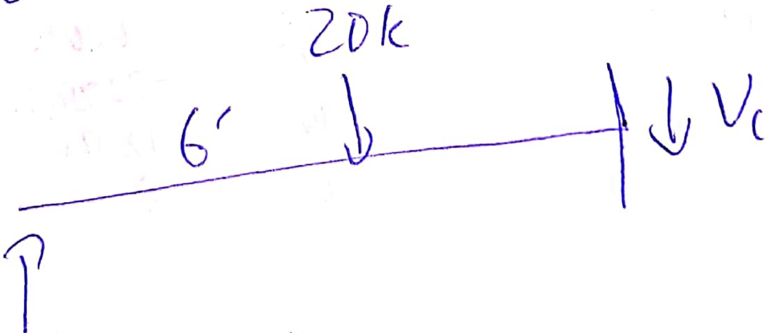


$R_A = 72.5\,k$

$-20 + 72.5 - V_c = 0$

$\boxed{V_c = -52.5}$

at $x = 6'$

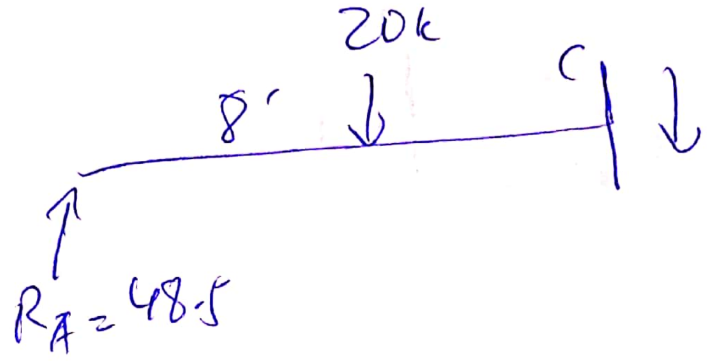


$R_A = 60.625k$

$-20 + 48.5 - V_c = 0$

$V_c = +20.5\,k$

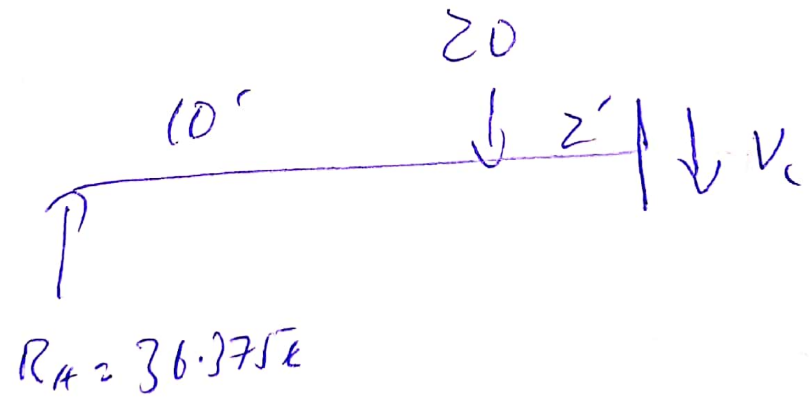
at $x = 8'$



$\Rightarrow \quad -20 + 48.5 - V_c = 0$

$$\boxed{V_c = 28.5\,k}$$

at $x = 10'$



$-20 + 36.375 - V_c = 0$

$$\boxed{V_c = 16.375\,k}$$

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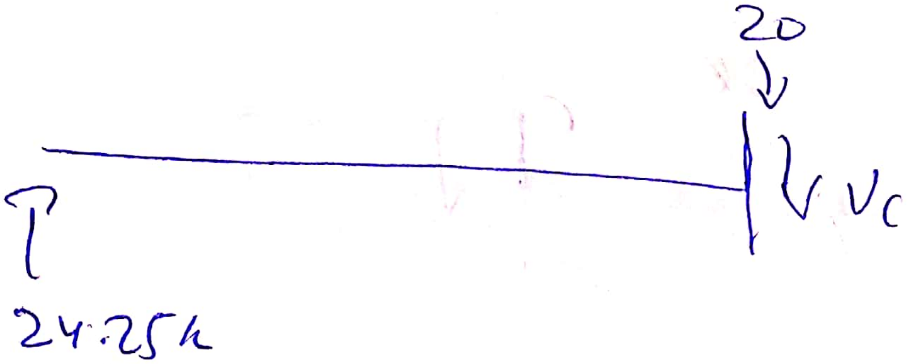
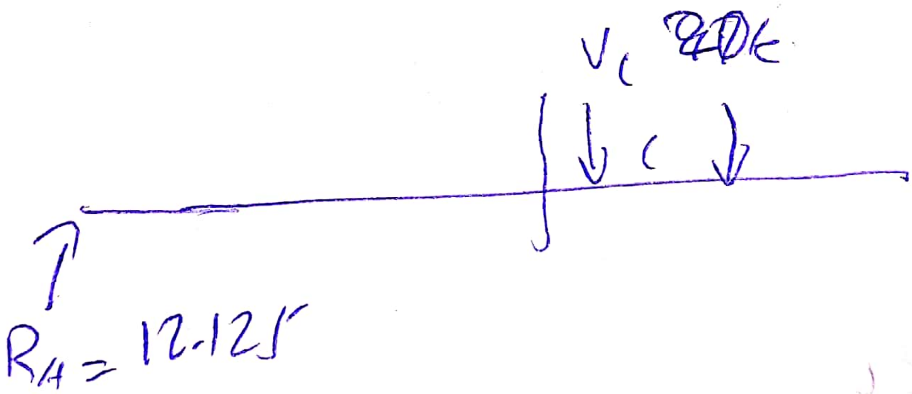
at $x = 12'$ just to Right



$$24.25 - V_c = 0$$

$$\boxed{V_c = 24.25}$$

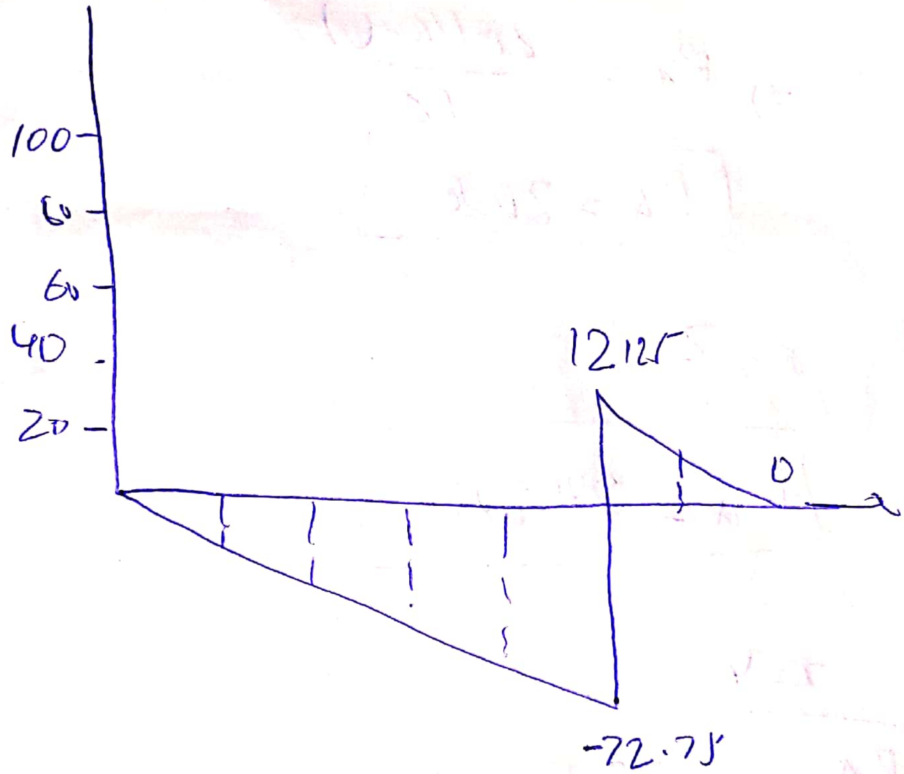
at $x = 14'$.



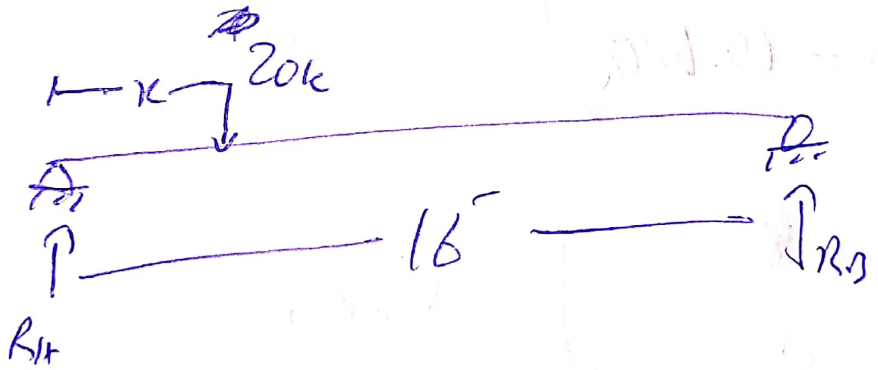
$$V_c = 12.125$$

at $x = 16$

$$V_c = 0$$



b) Now influence line for Reaction at A



$\Sigma M_B = 0$

$\Rightarrow R_A \times 16 - 20(16 - x) = 0$

$\Rightarrow R_A = \dfrac{20(16 - x)}{16}$

$\Rightarrow R_A = \frac{20(16-0)}{16}$

$\boxed{R_A = 20\,k}$

at $x = 2$

$\boxed{R_A = 84.875\,k}$

at $x = 4$

$\boxed{RA = 72.5\,k}$

at $x = 6$

$\boxed{R_A = 60.625\,k}$

x	$R_A (k)$
0	97
2	84.2
4	72.5
6	60.625
8	48.5
10	36.3
12	24.25
14	12.125

(3), (7)