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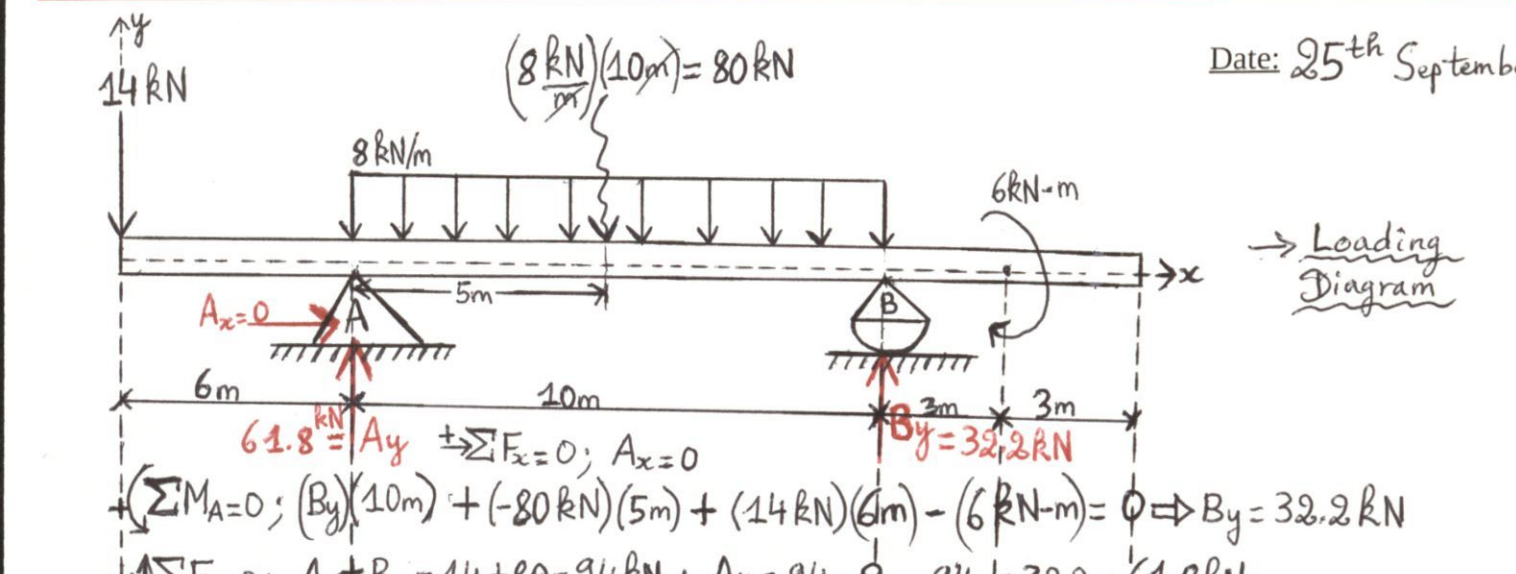
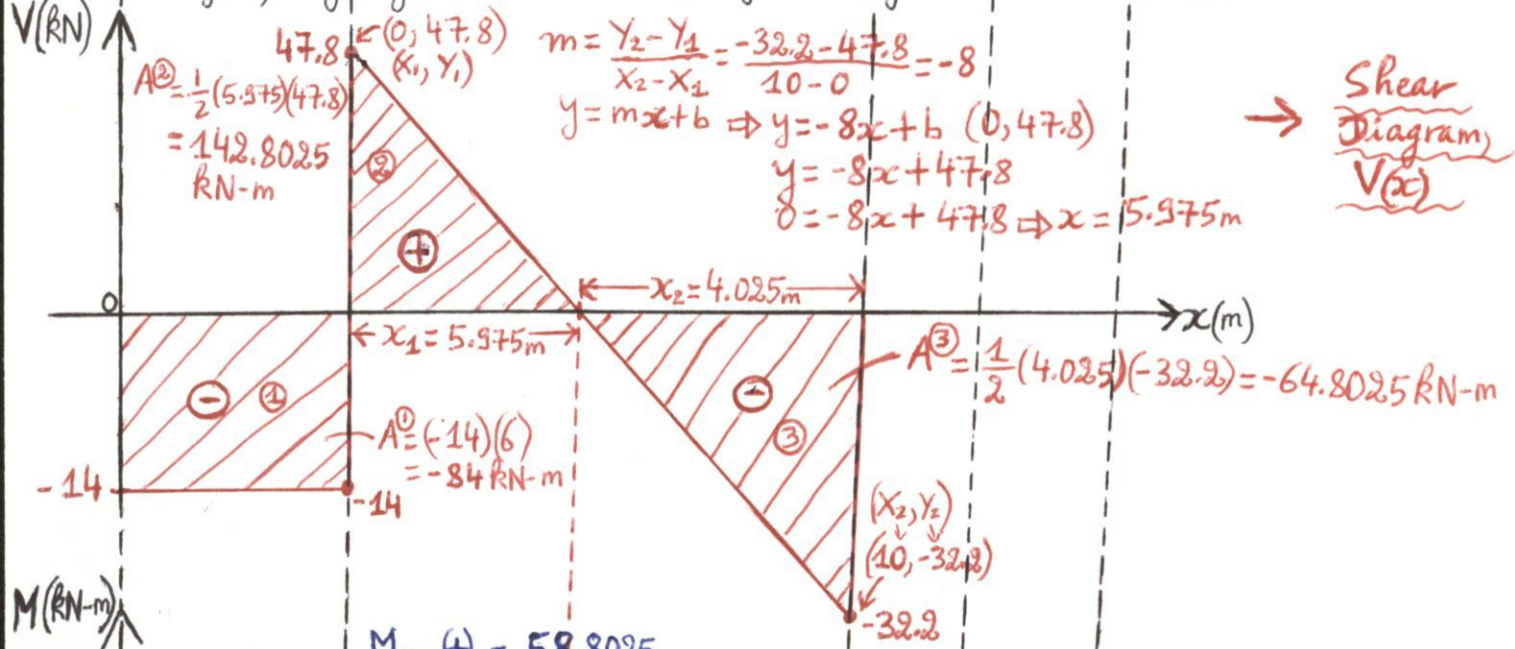
Date: 25th September 2019



$\pm\Sigma F_x = 0;\ A_x = 0$

$+\circlearrowleft \Sigma M_A = 0;\ (B_y)(10m) + (-80\,kN)(5m) + (14\,kN)(6m) - (6\,kN\text{-}m) = 0 \Rightarrow B_y = 32.2\,kN$

$+\uparrow \Sigma F_y = 0;\ A_y + B_y = 14 + 80 = 94\,kN;\ A_y = 94 - B_y = 94 - 32.2 = 61.8\,kN$



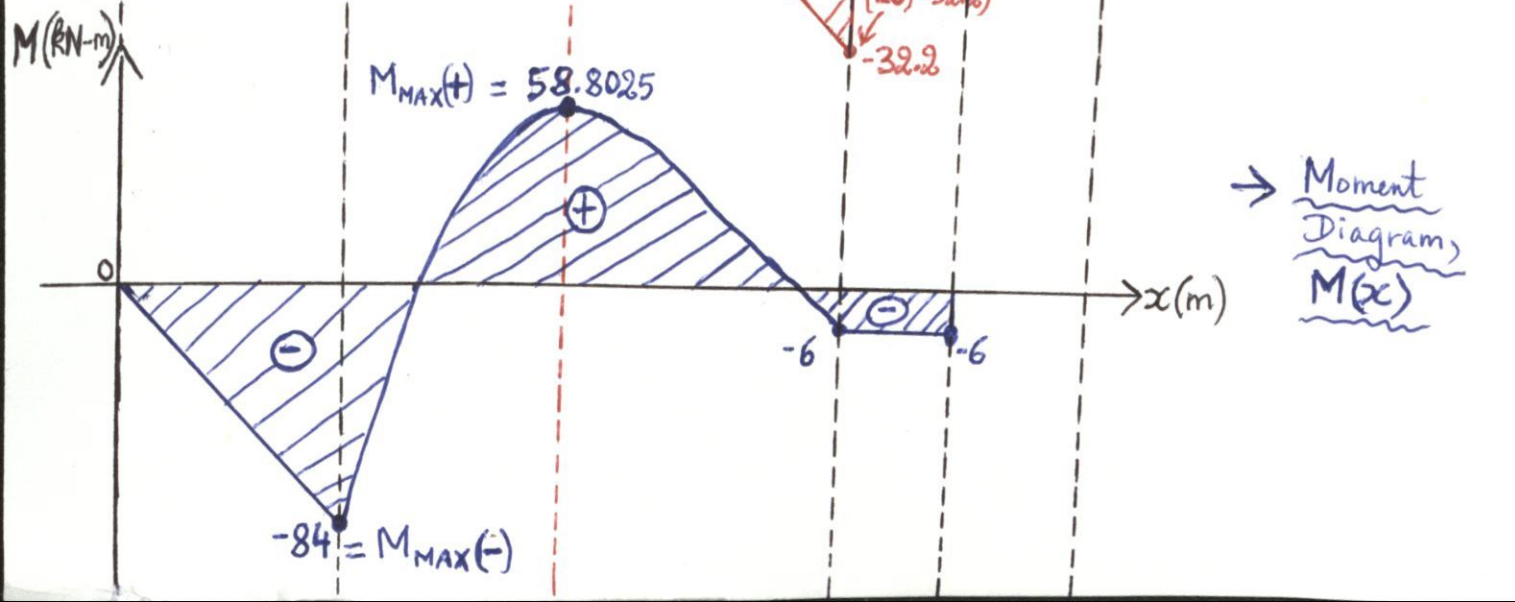
$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-32.2 - 47.8}{10 - 0} = -8$

$y = mx + b \Rightarrow y = -8x + b\ (0, 47.8)$

$y = -8x + 47.8$

$0 = -8x + 47.8 \Rightarrow x = 5.975m$

→ Shear Diagram, V(x)



→ Moment Diagram, M(x)

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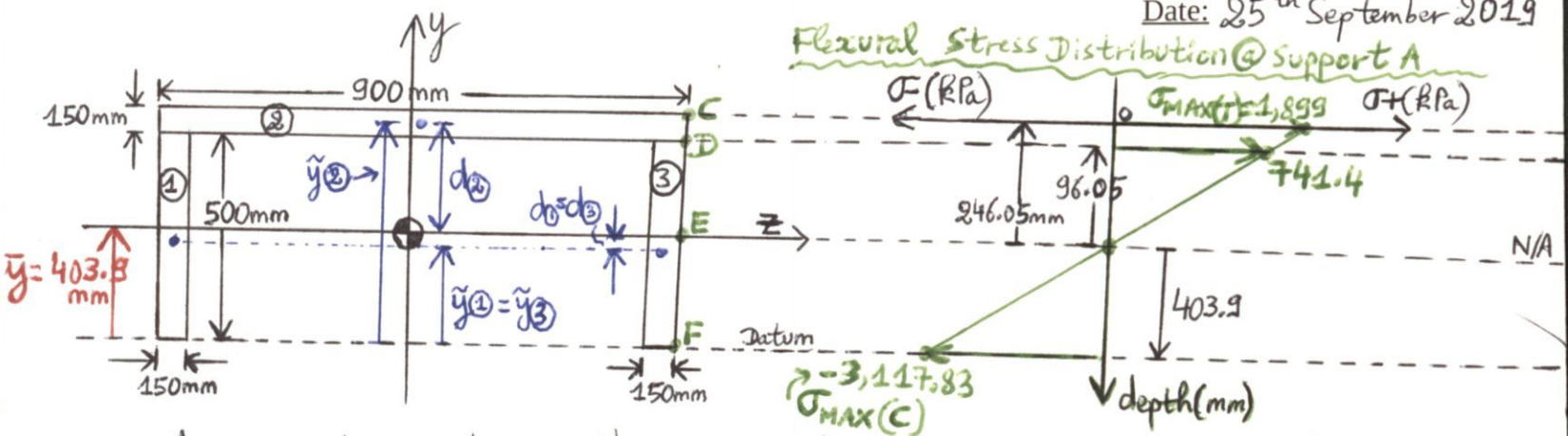

Section	b(mm)	h(mm)	$\tilde{y}$(mm)	A(mm²)	$\tilde{y}A$(mm³)	d(mm) = $\lvert\bar{y} - \tilde{y}\rvert$
①	150	500	250	(150)(500) = 75,000	1.875×10^7	153.9473684
②	900	150	575	(150)(900) = 135,000	7.7625×10^7	171.0526316
③	150	500	250	(150)(500) = 75,000	1.875×10^7	153.9473684
				$\Sigma A = 285{,}000$	$\Sigma \tilde{y}A = 11.5125 \times 10^7$	

$$\bar{y} = \frac{\Sigma \tilde{y}A}{\Sigma A} = \frac{11.5125 \times 10^7 \text{ mm}^3}{285{,}000 \text{ mm}^2} = 403.9473684 \text{ mm}$$

$$I_① = I_③ = \frac{bh^3}{12} + Ad^2 = \frac{(150)(500)^3}{12} + (75{,}000)(153.9473684)^2 = 3339984418 \text{ mm}^4$$

$$I_② = \frac{b_② h_②^3}{12} + A_②(d_②)^2 = \frac{(900)(150)^3}{12} + (135{,}000)(171.0526316)^2 = 4203090375 \text{ mm}^4$$

$$I_{Tot} = I_① + I_② + I_③ = (3339984418) + (4203090375) + (3339984418) = 1.088305921 \times 10^{10} \text{ mm}^4$$

$$I_{Tot} = 1.088305921 \times 10^{10} \text{ mm}^4 \left(\frac{1 \times 10^{-12} \text{ m}^4}{1 \text{ mm}^4}\right) = 0.01088305921 \text{ m}^4$$

$$\sigma_C = -\frac{M_C y_C}{I_{Tot}} = -\frac{(-84 \text{ kN-m})(0.2460526316 \text{m})}{0.01088305921 \text{ m}^4} = 1{,}899.137058 \text{ kPa}$$ → Flexural stresses at support A

$$\sigma_① = -\frac{M_① y_①}{I_{Tot}} = -\frac{(-84 \text{ kN-m})(0.0960526316 \text{m})}{0.01088305921 \text{ m}^4} = 741.3743598 \text{ kPa}$$

$$\sigma_E = 0$$

$$\sigma_F = -\frac{M_F y_F}{I_{Tot}} = -\frac{(-84 \text{kN-m})(-0.4039 \text{m})}{0.01088305921 \text{ m}^4} = -3{,}117.834636 \text{ kPa}$$

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(c)

Maximum flexural stresses at Support A

$\sigma_{MAX(T)} = 1,899 \text{ kPa}$

$\sigma_{MAX(C)} = -3,117.83 \text{ kPa} = -3,118 \text{ kPa}$

→ Maximum tensile and compressive stresses at support A.

(d) Maximum flexural stresses occurring throughout the entire span of the beam

Using $M_{MAX(+)} = 58.8025 \text{ kN-m}$

$$\sigma_C = -\frac{M y_C}{I_{Tot}} = -\frac{(58.8025)(0.246)}{0.01088305921} = -1,329.452463 \text{ kPa}$$

$$\sigma_F = -\frac{M y_F}{I_{Tot}} = -\frac{(58.8025)(-0.4039)}{0.01088305921} = 2,182.577038 \text{ kPa}$$

$\sigma_{MAX(T)} = \sigma_F = 2,183 \text{ kPa}$

$\sigma_{MAX(C)}$ = same as part(c) $= -3,118 \text{ kPa}$

→ Maximum tensile and compressive stresses throughout the entire span of the beam.