Q1

(a) $K = 100$

$D_A = 45.9\,m \Rightarrow \theta_{VA} = +5^\circ$

$D_B = 63.6\,m \Rightarrow \theta_{VB} = +6^\circ$

$D_C = 89.4\,m \Rightarrow \theta_{VC} = -5^\circ$

For point (A)

$D_{DA} = K \cdot H \cdot \cos^2\theta$

$45.9 = 100 * H * \cos^2 5$

$H_A = 0.498\,m$

For point (B)

$D_{DB} = K \cdot H \cdot \cos^2\theta$

$63.6 = 100 * H_B \cos^2(6^\circ)$

$H_B = 0.64\,m$

For point (C):

$89.4 = 100 * H_C * \cos^2(5)$

$H_C = 0.89\,m$

difference of elevation between A and B:

$D_A = 45.9\,m$ $\quad Sm = 2.1\,m$ $\quad \theta_V = 5^\circ$

$D_B = 63.6\,m$ $\quad Sm = 2.1\,m$ $\quad \theta_V = 6^\circ$

$D_C = 89.4\,m$ $\quad Sm = 2.1$ $\quad \theta_V = 5^\circ$

$Y_A = D_A \tan\theta = 45.9 \tan 5 = 4\,m$

$RL(A) = RL(D) + hi + y - Sm$

$= RL(D) + hi + 4 - 2.1$

$RL(A) = RL(D) + hi + 1.9 \longrightarrow (1)$

$y_B = D_B \tan\theta = 63.6 * \tan 6 = 6.68m$

$RL(B) = RL(D) + hi + 6.68 - 2.1$

$RL(B) = RL(D) + hi + 4.58 \longrightarrow (2)$

$RL(C) = RL(D) + hi - y - Sm$

$y_C = D_C \tan\theta = 89.4 * \tan 5 = 7.82$

$RL(C) = RL(D) + hi - 7.82 - 2.1$

$RL(C) = RL(D) + hi - 9.92 \longrightarrow (3)$

$\Delta h_{AB} = RL(B) - RL(A) = 2.68m$

$\Delta h_{BC} = RL(C) - RL(B) = -14.5m$

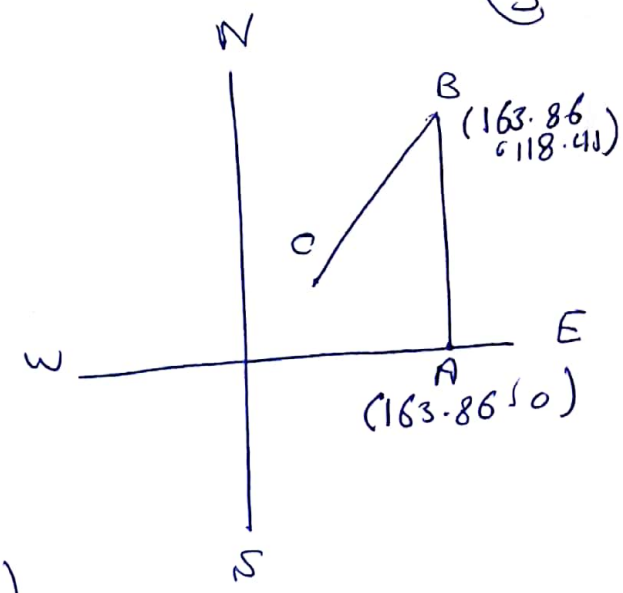
$\Delta h_{AC} = RL(C) - RL(A) = -11.82m$

(3)

$\alpha = H.C.R(C) - H.C.R(A)$

$= 82^\circ 3' - 28^\circ 21$

$= (53^\circ 42')$



$D_{BC} = K.H.\cos^2\theta$

$H = S_u - S_L = 3.42 - 1.14 = 2.28m$

$\theta = 90 - V.C.R = 69^\circ 30'$

$BC = 100 * 2.28 \cos^2(69^\circ 30')$

$(BC = 27.96\ m)$

$\text{Tan}\,\theta_{AB} = \frac{X_B - X_A}{Y_B - Y_A} = \frac{163.86 - 163.86}{118.41 - 0} = \frac{0}{118.41} = 0$

Bearing

$\theta_{AB} = 0$

$\theta_{BC} = \theta_{AB} \pm \alpha \pm 180$

$= 0 + 53^\circ 42' + 180$

$\theta_{BC} = 71^\circ 42' \quad ; \text{Tan}\,\theta_{BC} = 3$

$3 = \frac{X_C - X_B}{Y_C - Y_B} \Rightarrow X_C - X_B = 3(Y_C - 118.41)$

$BC = \sqrt{(x_C - x_B)^2 + (y_C - y_B)^2}$

$27.96 = \sqrt{9(y_C - y_B)^2 + (y_C - 118.41)^2}$

$27.96 = \sqrt{9(y_C - 118.41)^2 + (y_C - 118.41)^2}$

$\Rightarrow (y_C = 108.52 \quad x_C = 134.18)$

$$RL(C) = RL(B) + hi + y - Sm$$

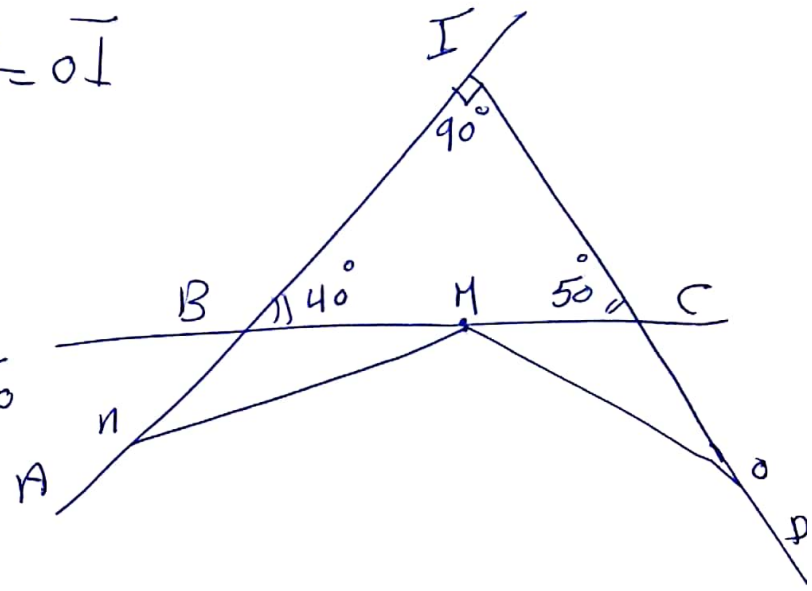
$$RL(C) = 27.3 + 1.35 + 27.96\ Tan(69^\circ 30') - 2.29$$

$$RL(C) = 101.14\ m$$

السؤال الثاني

(a)

Tangent Length $L = n\bar{I} = o\bar{I}$



From Triangle $B\bar{I}C$:

$$\frac{210.5}{Sin90} = \frac{B\bar{I}}{Sin50} = \frac{C\bar{I}}{Sin40}$$

$B\bar{I} = 161.25\ m$

$C\bar{I} = 135.3\ m$

$L = B\bar{I} + Bn$ ($Bn = BM$

$L = B\bar{I} + BM$ ⟶ (1)

$L = C\bar{I} + Co$ ∵ $Co = Cm$

$L = C\bar{I} + Cm$ ⟶ (2)

(2)+(1) نجمع

$L = 253.525\ m$ ← Tangent length

∵ $\theta = 90$

$\therefore L = R\ Tan\frac{\theta}{2}$ ⟹ $R = 253.525\ m$

$L_c = \frac{2\pi R\theta}{360}$ ⟹ $L_c = 398.23\ m$

Long chord $= 2R \sin \frac{\theta}{2} \Rightarrow \overline{Lc} = 358.53\,m$

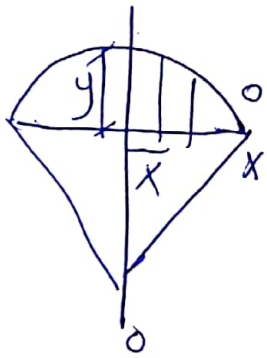
$$y = \sqrt{R^2 - x^2} - \sqrt{R^2 - \frac{u^2}{4}}$$

* تقسيم الأطوال = $\overline{L.c}$ على السريط

$\therefore 358.53 / 30 \Longrightarrow 11,951$

X	30	60	90	$\Longrightarrow$ +	28.53
y					

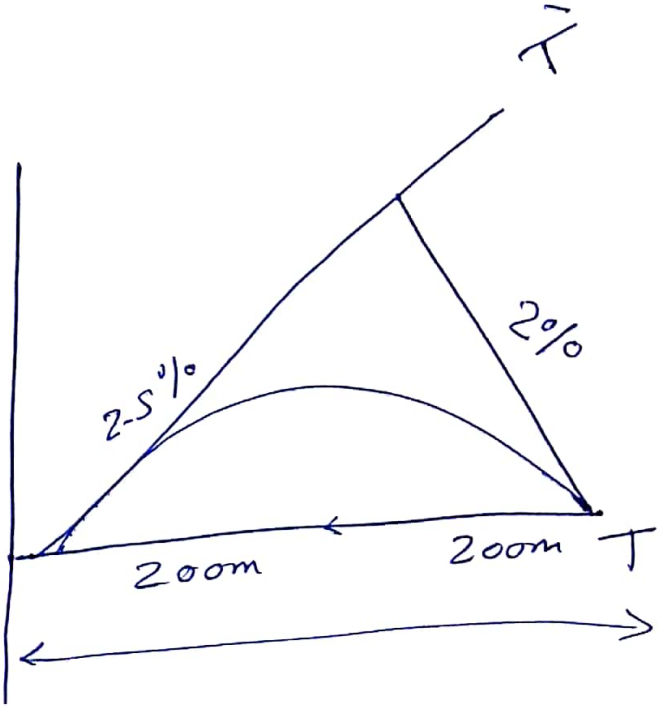
بالتعويض نحصل على y الباقي



السؤال الثاني (6

Type of curve :

⟹ Crest Curve.



$G_1 = 2.5\%$

$G_2 = -2\%$

$L = 400\ m$

$RL_C = 100\ m$

$$RL(I) = RL(C) + \frac{2.5}{100} * \frac{L}{2}$$

$$= 100 + \frac{2.5}{100} * 200$$

$$RL(I) = 105\ m$$

$$RL(T) = RL(I) - \frac{2}{100} * \frac{L}{2}$$

$$= 105 - \frac{2}{100} * 200$$

$$RL(T) = 101\ m$$

$$RL(T') = RL(C) + \frac{2.5}{100} * L \quad = 110\ m$$

$$a = \frac{RL(T) - RL(T')}{L^2} = \frac{101 - 110}{(400)^2} = -5.625 \times 10^{-5}$$

Point	x	Tangent level	$y = 9x^2$	Curve Level
C	0	100	0	100
1	⋮	⋮	⋮	⋮
2	⋮	⋮	⋮	⋮
3	⋮	⋮	⋮	⋮
4	⋮	⋮	⋮	⋮
5	⋮		⋮	
6	⋮		⋮	⋮
7	⋮	⋮	⋮	⋮
T	400	110	-9	101

check

السؤال الثامن (8)

(a)

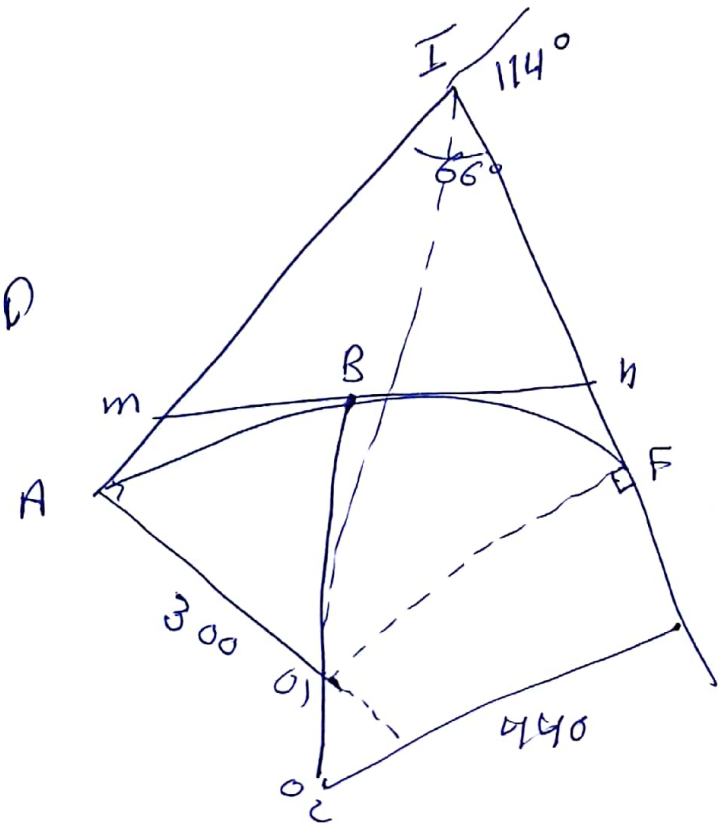
$AI = 520\,m$

$R_1 = 300\,m$

$R_2 = 440\,m$

$I_1 + I_2 = 114^\circ$

$I_2 = 114 - I_1 \longrightarrow (1)$



$mB = R \tan\theta_1$

$mB = 300 \tan\theta_1$

$Bn = R_2 \tan\theta_2$

$= 440 \tan\theta_2$

From Triangle O_1IA

$O_1I = \sqrt{300^2 + 520^2} = 600.33\,m$

$\theta_{O_1IA} = \cos^{-1}\frac{520}{600.33} = 29^\circ\ 58'\ 54''$

$\theta_y = 66 - 29\ 58\ 54 = 36^\circ\ 1'\ 6''$

From Triangle O_1IF:

$O_1F = 600.33 * \sin 36\ 16 = 353\,m$

$IF = 600.33 * \cos(36^\circ\ 1'\ 6'')$

$IF = 485.56\,m$

From Triangle $O_1 O O_2$:

$O_1 O_2 = 440 - 300 = 140\ m$

$O O_2 = 440 - 353 = 87\ m$

$\theta_{O_2} = \cos^{-1} \frac{O_2 O}{O_1 O_2} = \cos^{-1} \frac{87}{140} \Rightarrow \theta_0 = 109.68$

$\therefore I_2 = 51^\circ\ 34'\ 46''$

$I_1 = 114^\circ - 51^\circ\ 34'\ 46'' = 62^\circ\ 25\ 13$

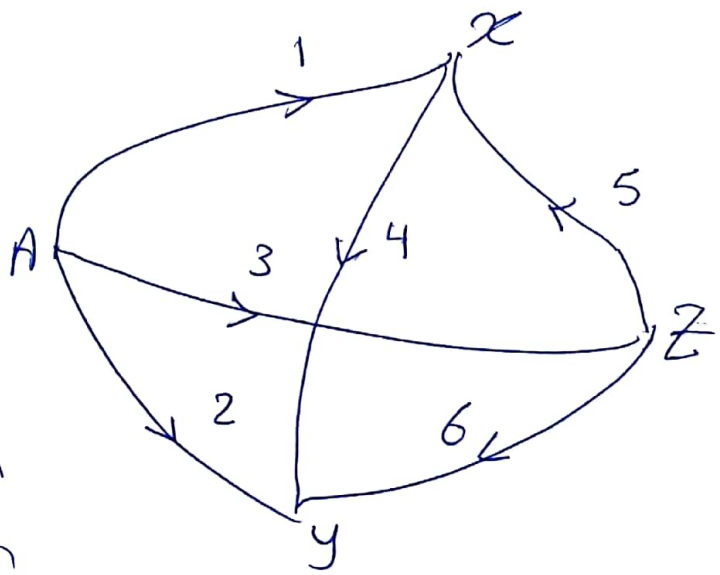
Second Tangent $= Cf + If$

$= 109.68 + 485.56$

$= 595.24\ m$

(a) السؤال الثاني (10)

obs. Eq.



$\Delta h_1 = H_X - H_A \rightarrow ①$

$\Delta h_2 = H_y - H_A \rightarrow ②$

$\Delta h_3 = H_z - H_A \rightarrow ③$

$\Delta h_4 = H_y - H_X \rightarrow ④$

$\Delta h_5 = H_X - H_z \rightarrow ⑤$

$\Delta h_6 = H_y - H_z \rightarrow ⑥$

Approx. value of unk.:-

$\rightarrow ①$ $\therefore 12.483 = H_X - 100 \Rightarrow H_X^\circ = 112.483\,m$

$\rightarrow ②$ $\therefore 48.351 = H_y - 100 \Rightarrow H_y^\circ = 148.351\,m$

$\rightarrow ③$ $\therefore 5.492 = H_z - 100 \Rightarrow H_z^\circ = 105.492\,m$

$$X^\circ = \begin{bmatrix} H_{X_\circ}^\circ \\ H_y \\ H_z^\circ \end{bmatrix} = \begin{bmatrix} 112.485 \\ 148.351 \\ 105.492 \end{bmatrix}$$

$$L^\circ = \begin{bmatrix} \Delta h_1 \\ \Delta h_2 \\ \cdot \\ \cdot \\ \cdot \\ \Delta h_6 \end{bmatrix} = \begin{matrix} 112.483 - 100 \\ 148.351 - 100 \\ 105.498 - 100 \\ 148.351 - 112.483 \\ 112.482 - 105.492 \\ 148.351 - 105.492 \end{matrix} = \begin{bmatrix} 12.483 \\ 48.351 \\ 5.492 \\ 35.868 \\ 6.991 \\ 42.859 \end{bmatrix}$$

$$\therefore \quad w = L - L_\circ = \begin{bmatrix} 0 \\ 0 \\ 0 \\ -0.015 \\ -0.102 \\ 0.098 \end{bmatrix}$$

weight matrix:

$$P = \begin{bmatrix} 1/5 & & & & & \\ & 1/10 & & & & \\ & & 1/7 & & & \\ & & & 1/7 & & \\ & & & & 1/12 & \\ & & & & & 1/9 \end{bmatrix}$$

* Coefficient Matrix

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & 1 & 0 \\ 1 & 0 & -1 \\ 0 & 1 & -1 \end{bmatrix} \quad \therefore A^T = \begin{bmatrix} 1 & 0 & 0 & -1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & -1 & -1 \end{bmatrix}$$

Normal matrix:

$$N = A^T \cdot P \cdot A$$

$$A^T \cdot P = \begin{bmatrix} 0.2 & 0 & 0 & -0.142 & 0.0833 & 0 \\ 0 & 0.1 & 0 & 0.142 & 0 & -0.111 \\ 0 & 0 & 0.142 & 0 & -0.083 & -0.111 \end{bmatrix}$$

$$\underbrace{A^T \cdot P * A}_{= N} = \begin{bmatrix} 0.4258 & -0.142 & -0.0833 \\ -0.142 & 0.353 & -0.111 \\ -0.0833 & -0.111 & 0.336 \end{bmatrix}$$

N^{-1} تكملة حلول المعادلة

$$N^{-1} = \begin{bmatrix} 21.0276 & 3.623 & 89.298 \\ 3.623 & 26.94 & 116.028 \\ 89.298 & 116.028 & 25.7598 \end{bmatrix}$$

$$U = \bar{A}^T * P * W = \begin{bmatrix} -0.00633 \\ -0.0128 \\ -0.0027 \end{bmatrix}$$

$$\hat{x} = N^{-1} * U = \begin{bmatrix} -0.42 \\ -0.68 \\ -2.11 \end{bmatrix}$$

$$x = x^{\circ} - \hat{x} = \begin{bmatrix} 112.065 \\ 147.671 \\ 103.38 \end{bmatrix}$$

d_3 "c" by Condation equation

$$r = n - m$$
$$= 5 - 2 = 3$$

$$\Delta h_3 + v_3 + \Delta h_4 + v_4 - \Delta h_5 - v_5 = 100$$
$$v_3 + v_4 - v_5 = 99.93 \longrightarrow (1)$$
$$\Delta h_5 + v_5 - \Delta h_2 - v_2 - \Delta h_1 - v_1 = 100$$
$$-v_1 - v_2 + v_5 = 99.99 \longrightarrow (2)$$
$$\Delta h_3 + v_3 + \Delta h_4 + v_4 - \Delta h_2 - v_2 - \Delta h_1 - v_1 = 100$$
$$-v_1 - v_2 + v_3 + v_4 = 99.92 \longrightarrow (3)$$

$$\Delta = \begin{bmatrix} 99.93 \\ 99.9 \\ 99.92 \end{bmatrix} - \begin{bmatrix} 100 \\ 100 \\ 100 \end{bmatrix} = \begin{bmatrix} -0.07 \\ -0.1 \\ -0.08 \end{bmatrix}$$

$$B = \begin{bmatrix} 0 & 0 & 1 & 1 & -1 \\ -1 & -1 & 0 & 0 & 1 \\ -1 & -1 & 1 & 1 & 0 \end{bmatrix} \quad \therefore B^T = \begin{bmatrix} 0 & -1 & -1 \\ 0 & -1 & -1 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \\ -1 & 1 & 0 \end{bmatrix}$$

$$W^{-1} = \begin{bmatrix} 3 & 0 & 0 & 0 & 0 \\ 0 & 3 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Q4 (a)

H = 4050 ft

B = 2410 ft

f = 6"

A	B
$x_a = 2.1"$	$x_b = 3.5"$
$y_a = 2"$	$y_b = -1.05"$
$x_{1a} = -2.25"$	$x_{1b} = -1.17"$
$P_a = x_a - x_{1a}$	$P_B = x_b - x_{1b}$
$= 2.1 - (-2.25)$	$= 3.5 - (-1.17)$
$P_a = 4.35"$	$P_b = 4.67"$

$$x_A = \frac{B}{P_a} * x_p \qquad x_B = \frac{B}{P_b} * X_p$$

$$= \frac{2410}{4.35"} * 2.1" = 1163.44 ft \qquad = \frac{2410}{4.67} * 3.5 = 1806.2 ft$$

$$y_A = \frac{B}{P_a} y_p \qquad y_B = \frac{B}{P_b} y_p$$

$$= \frac{2410}{4.35} * 2 = 1108.045 ft \qquad \frac{2410}{4.67} * -1.05 = -541.86 ft$$

$$AB = \sqrt{(x_B - x_A)^2 + (y_B - y_A)^2} = 1770.85 ft$$

$$h_A = H - \frac{B * f}{P_a}$$

$$= 4050 - \frac{2410 * 6}{4.35} = 725.86 \text{ ft}$$

$$h_B = H - \frac{B \cdot f}{P_b} = 4050 - \frac{2410 \cdot 6}{4.67} = 953.64 \text{ ft}$$

Q4 (b)

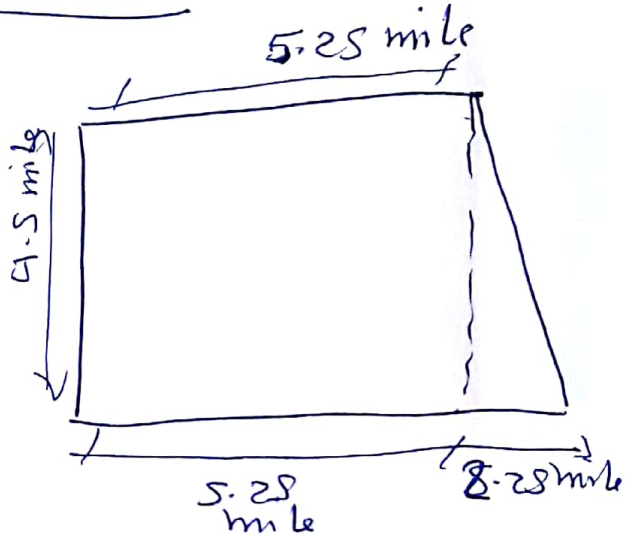
$H = 1500 m$

$f = 6''$

$d_1 = d_2 = a''$

end = 60%

side = 30%



$$B = d_1 * \frac{H'}{f}(1 - \text{end lap})$$

$$= 9 * \frac{1500}{6}(1 - 0.6) \quad \therefore B = 900 m$$

$$w = d_2 * \frac{H'}{f}(1 - \text{side lap})$$

$$= 9 * \frac{1500}{6} * (1 - 0.3) \quad \therefore w = 157.5 m$$

$$\text{a Curr width} = \text{obtained width} + 0.5\, G_2$$

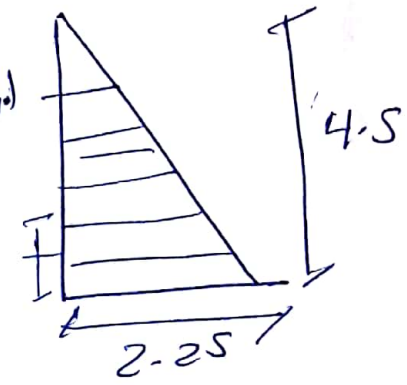
$$= 4.5 * 1609 + 0.5 * 9 * \frac{1500}{6}$$

$$\text{a curd width} = 8365.5 m$$

$$\text{No. of Lines} = \frac{\text{acual width}}{w} = 5.3 = 6 \text{ Lines}$$

$$w' = \frac{\text{obtained width} - 0.5\, G_2}{N - 1} = 1223.1 m$$

$$\therefore \frac{x}{2.25} = \frac{4.5 * 1609 - 0.25 P_2 - (n+1)w}{4.5}$$



$$x = \frac{2.25}{4.5}\left(6678 - (n-1) * 12231\right)$$

$$L = 5.25 * 1609 + x$$

$$= 8447.25 + X$$

B = 900m

Line	$L = L^* + x$	No photo/line $= L/B + 4$
1	11786.25 m	18
2	11174.7 m	17
3	10563.15 m	16
4	9951.6 m	16
5	9340.05 m	15
6	8728.5 m	14

No of all photo = 96 photo