True error = measured value - True value

Residual error = measured value - mean

① $C_T = 0.0000116\ (T_1 - T_0)\ L$ → طول الـ line

coefficient of thermal · temperature in field · calibration temperature

② $C_s = -\frac{w^2\ L^3}{24\ P^2}$, $w = \frac{W_0}{\ell_0}$

وزن · طول الخط · طول الـ tape nominal

(pull, tension) الشد

③ $C_p = \frac{(P_1 - P_0)\ L}{A * E}$ ← line طول الـ

field الشد · calibration الشد

cross section of tape · modulus of elasticity

④ $C_L = (\ell_a - \ell_0) * \frac{L}{\ell_0}$ ← طول المقاس

actual length of tape · nominal

اذا الطول المطلوب

$L' = L\ \frac{\ell_a}{\ell_0}$

$A' = A\ \left(\frac{L_a}{\ell_0}\right)^2$

[illegible] 360°

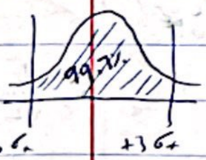
---

mean = $\bar{x} = \frac{\Sigma x_i}{n}$ $S_x = \sqrt{\frac{\Sigma e_i^2}{n-1}}$

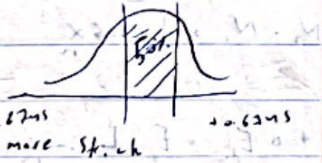
the mean measurement of standard error)

اذا طلب (standard error $\sigma_{\bar{x}} = \frac{\sigma_x}{\sqrt{n}}$

max error



probable error



more flexible

max error $\pm x_i - \bar{x} \le \pm 3\sigma$

p(ple) error = ∓ 0.6745 σ

حساب σ و $\bar{x}$ بالآلة: ١. نضغط mode 2 ثم SD

٢. ندخل الأرقام من ... وبعد كل رقم M+

٣. بعد ما نخلص الأرقام كلها، نضغط AC

٤. نضغط shift 2 ثم نختار الخيار المناسب

← اذا بدنا نعمل حسابة جديدة لازم نلغي الأولى من خلال

shift → mode → 3

Relative precision = 1 / D/e

① $\sigma_y^2 = \left(\frac{\partial y}{\partial x_1}\ \sigma_{x_1}\right)^2 + \frac{\partial y}{\partial x_2}\ \sigma_{x_2}^2$ + ——

checks:

S.P #B.S = # of F.S

$\Sigma B.S - \Sigma F.S$ = last h - first h

→ عدد setup = T.P + 1

Z.P $\sum_{i=1}^{n} HI_i N_i - \Sigma I.S - \Sigma F.S = \sum_{i=2}^{n} h_i$

→ N_i = # of I.S + 1

Profile: max staff reading > min elevation

min staff reading < max elevation

misclosure error (e) = measured elevation - known elevation

Tolerance error ε_m = $c\sqrt{k}$ (mm)

$K_1 = \frac{\Sigma D_{B.S} + \Sigma D_{F.S}}{1000}$

$\varepsilon_{lp_m} = \frac{m}{\text{setup}} \varepsilon$

$D = (r_1 - r_3) \times 100$ ⇐ مسافة الـ BS و FS صيغة نستخدم

---

contour: لما الخطوط بتقرب من بعض بزيد الـ slope

① max min elevation ② uphill downhill ③ degree of slope (sharp, mild, flat constant)

④ shape of the ground (valley ——

Systematic error ← collimation error / curvature and atmospheric ——

$\varepsilon_{A_1} = R_{A_1} - R'_{A_1} = d_{A_1} \tan\alpha$

$R'_i = R_i - d \tan\alpha$

الخطأ عادي

$\Delta h_{AB_1} = R'_{A_1} - R'_{B_1}$ ←

$= R_A - R_B$

$\varepsilon_A = \varepsilon_B$ الأطوال نفس

$\Delta h_{AB} = R'_A - R'_B = R_A - R_B$

$= h_B - h_A$ ← اذا اعطانا B.M

$\tan\alpha = \frac{R_{A_1} - R_{B_1} - (R^*_{A_2} - R_{B_2})}{d_{A_1} - d_{B_1}}$

②

curvature

$\varepsilon_{cr} = \varepsilon_c - \varepsilon_r$

$\varepsilon_c = 0.785\ D^2$

$\varepsilon_r = \frac{\varepsilon_c}{7}$

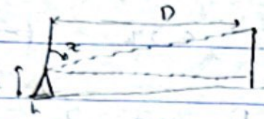
$\varepsilon_{cr} = 0.0675\ D^2$

بالإشارات
انو هو

$R_i' = R_i - d \tan\alpha - \varepsilon_{cr}$

Theodolite → H.A → azimuth (α) (0, 360)
bearing → ϕ [0, 90]
→ V.A → zenith [0, 180]

Zenith angle:



$h_B = h_A + HI + V$, $V = \frac{D}{\tan z}$

Tangential method

measurement $(r_1, z_1)\ (r_2, z_2)$

$$D = \frac{r_1 - r_2}{\frac{1}{\tan z_1} - \frac{1}{\tan z_2}}$$

$V_1 = \frac{D}{\tan z_1}$ $V_2 = \frac{D}{\tan z_2}$

$h_B = h_A + HI + V_1 - r_1$

$h_B = h_A + HI + V_2 - r_2$

Stadia method:

measurement (z, r_1, r_2, r_3)

$D = k r \sin^2 z$, $k = 100$ stadia constant

$V = \frac{1}{2} k r \sin 2z$

$r = r_1 - r_3$

$h_B = h_A + HI + V - r_2$

اذا ما بعرف، بحط زيرو staff
turn عن نقطة م

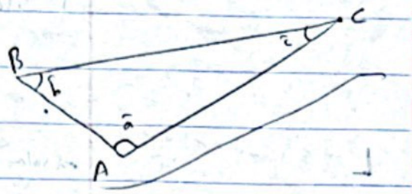
$h_C = h_A + HI + V$, $V = \frac{D_{AC}}{\tan z_{AC}}$

① select A and B

② mea: D_{AB}, h_A, $\hat{a}$, $\hat{b}$ (H.A), Z_{AC} (V.A)

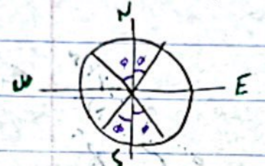
$\hat{c} = 180° - \hat{a} - \hat{b}$

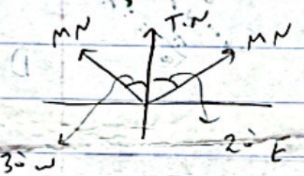
$\frac{D_{AC}}{\sin b} = \frac{D_{AB}}{\sin c} \Rightarrow D_{AC} = ??$



Azimuth, Back azimuth

Reduce Bearing → N φ E , N φ W
S φ E , S φ W





$\Delta E_{AB} = E_B - E_A$ change in departure

$\Delta N_{AB} = N_B - N_A$ change in latitude

$\Delta E_{12} = E_2 - E_1 = L \sin\alpha_{12}$

$\Delta N_{12} = N_2 - N_1 = L \cos\alpha_{12}$

$E_2 = E_1 + \Delta E_{12} = E_1 + L \sin\alpha_{12}$

$N_2 = N_1 + \Delta N_{12} = N_1 + L \cos\alpha_{12}$

Traverse closed loop

angular accuracy:-

بما The sum of interior $= 180°(n-2)$

n عدد اضلاع الـ traverse

Angular misclose $= \sum$ angle $- 180°(n-2)$

Tolerance error $= c\sqrt{n}$

Angular $< c\sqrt{n}$

$$\text{correction for each angle} = \frac{-\text{angular misclose}}{n}$$

corrected angle = angle + correction

---

check in all traverse

$E_{end} - E_{start} = \sum \Delta E$

$N_{end} - N_{start} = \sum \Delta N$

$\delta_E = \sum \Delta E - (E_{end} - E_{start})$

$\delta_N = \sum \Delta N - (N_{end} - N_{start})$

Total closing error

$\delta = \sqrt{\delta E^2 + \delta N^2}$

$$\text{precision} = \frac{1}{\frac{\sum L}{\delta}}$$

---

closed loop

$\delta E = \Delta E$

$\delta N = \sum \Delta N$

adjustment: least square / Bowditch

$C_{\Delta E} = \frac{-\delta E\ L}{\sum L} \rightarrow C_{\Delta E_{AB}} = -\delta E \frac{L_{AB}}{\sum L}$

$\Delta E' = \Delta E + C_{\Delta E}$

$C_{\Delta N} = -\delta N \frac{L}{\sum L} \rightarrow C_{\Delta N_{AB}} = -\delta N \frac{L_{AB}}{\sum L}$

$\Delta N' = \Delta N + C_{\Delta N}$

$E_2 = E_1 + \Delta E'$

$N_2 = N_1 + \Delta N'$

check ① $C_{\Delta E} = -\delta E$ | $C_{\Delta N} = -\delta N$

② $\sum \Delta E' = 0$ $\sum N = 0$

③ $E_{end} = E_1$ $N_{end} = N_{start}$

① نحسب الزوايا وبنطلع آزار azimuth

بنطلع ΔE و ΔN وبنحسب δE و δN و C

آ بنربط ΔE , ΔN آ بنوجد E' و N'

St	length	angle	azimuth	ΔE	ΔN	$C_{\Delta E}$	$C_{\Delta N}$	ΔE'	ΔN'	E	N
A											
B											

Σ δE δN -δE -δN 0 0 أول نقطة

نحسب azimuth أول آز ا azimuth بعد بنطلع ال error بالجدول

$$\varepsilon = \alpha_{FC_E} - \alpha_{FC_m}$$

$$\varepsilon \leq \varepsilon_a = c\sqrt{n} \qquad c = 60, 90$$

$$c = \frac{-\varepsilon}{n}$$ 7 ث

أول azimuth بعدها 7 ثواني 16 وهكذا

ما أصل آز واحد بحسب Σ كلي وضيف بربط ال azimuth

بعدين بحسب E و N سابق

$$E_B = E_A + D\sin\alpha'$$

$$N_B = N_A + D\sin\alpha'$$ —

طرح ما أوصل لآخر نقطة وبقارن إحداثياتها المحسوبة مع المعلومة

$$\delta_E = E_{F_c} - E_{F_m}$$

$$\delta_N = N_{F_c} - N_{F_m}$$

$$C_{E_i} = \frac{-\delta E \; L_i}{\Sigma L_{ij}}$$

$$C_{N_i} = \frac{-\delta N \; L_i}{\Sigma L_{ij}}$$

أ نحسب الإحداثيات الصح

St	length	angle	azimuth	α	E	N	C_E	C_N	E'	N'	
							—	—	—	—	

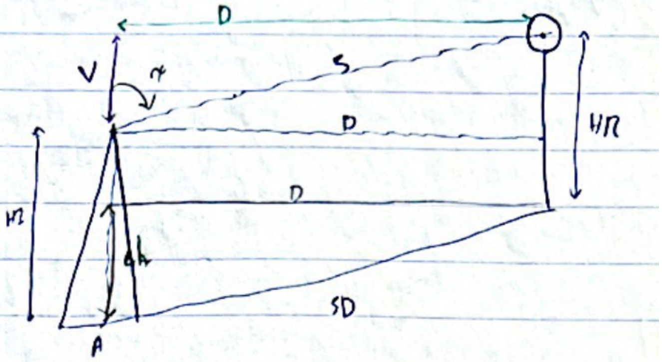
النقطة الأولى ما إلها أي تصحيح

δE

δN

SE

total Station = Theodolite + EDM



SD ما بنطلعها إلا إذا S و HI و HR ثابت وبان

$$V = S\cos Z \qquad D = S\sin Z$$

$$\Delta h_{AB} = h_B - h_A \qquad SD = (HD^2 + \Delta h^2)^{\frac{1}{2}}$$

$$h_B = h_A + HI + V - HR$$

$$L_B = L_{AB}$$

$$L_C = L_{AB} + L_{BC}$$

$$L_D = L_{AB} + L_{BC} + L_{BD}$$

$$\delta E = 0.97 \qquad \delta N = -1.23$$

$$\delta = \sqrt{} = 1.58$$

$$R.P = \frac{1}{\frac{\Sigma L}{\delta}} =$$

import $$\delta \leq \delta_a = 0.0006\,\Sigma L + 0.2a$$

1en $$\delta \leq \delta_c = 0.0009\,\Sigma L + 0.2$$

— — — — —

$$V = \frac{\pi R^2 h}{3}$$

— — — — — — — — — — —

is acceptable to have a standard error of 0.05 m in the length measurement

$$\delta = 0.0005 + \text{ثابت} + 0.03 = \pm.17$$ ok

$$0.05 < 0.17$$

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