9th nov,
SUNDAY

08. TACHEOMETRIC SURVEYING

- Tacheometer is a theodolite in which a special diaphragm with top central & bottom cross hairs blw eye piece and objective of a telescope

- Accuracy of tacheometer is 1 in 1000.

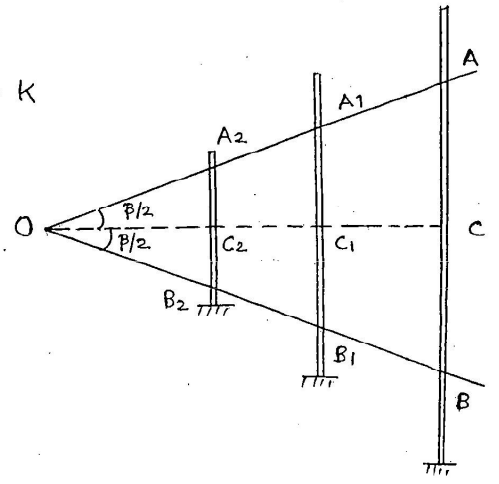
→ Systems of Tacheometric Surveying

1. Stadia-hair System.
   (i) Fixed Stadia Hair.
   (ii) Movable Stadia Hair.
2. Tangential Method.
3. By special instruments.

* Stadia hair method. (Fixed).

Principle: The ratio of perpendicular to the base is constan-

$$\frac{OC}{AB} = \frac{OC_1}{A_1B_1} = \frac{OC_2}{A_2B_2} = \text{const} = K$$



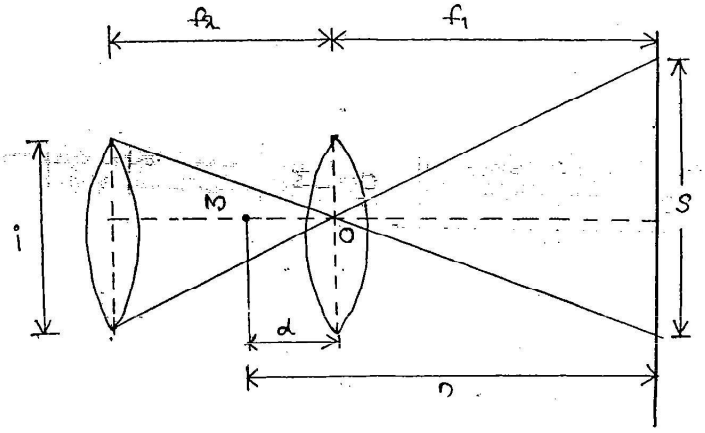
$$\tan\left(\frac{\beta}{2}\right) = \frac{A_2C_2}{OC_2}$$

$$= \frac{\frac{1}{2}A_2B_2}{K A_2B_2}$$

$$\Rightarrow K = \frac{1}{2}\cot\left(\frac{\beta}{2}\right)$$

⊙ If $\beta = 34' 22.64'' \approx 34'22''$, $K = 100$

* Distance formula when LOS is horizontal.



M → centre of instrument

O → optical centre of objective & eyepiece.

S → staff intercept

i → stadia intercept.

d → distance b/w optical centre & centre of instrument

D → horizontal distance b/w object & instrument.

f_1 & f_2 → focal lengths of objective & eyepiece respectively.

$$\frac{f_1}{f_2} = \frac{S}{i} \quad \rightarrow (1) \qquad \{\text{similar } \Delta s\}$$

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

Multiplying with ff_1,

$$f_1 = f + f\left(\frac{f_1}{f_2}\right) = f + f\left(\frac{S}{i}\right)$$

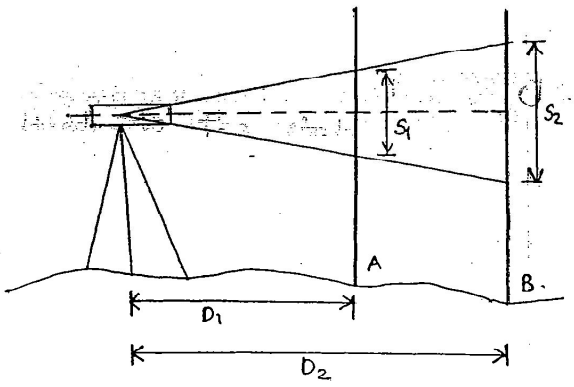
Horizontal distance, $D = f_1 + d$.

$$= f + f\left(\frac{S}{i}\right) + d.$$

$$\boxed{D = KS + C}$$

$$K = \frac{f}{i} \quad \text{(multiplicative const.)}$$

$$C = f + d \quad \text{(additive const.)}$$



→ Distance & Elevation formula.

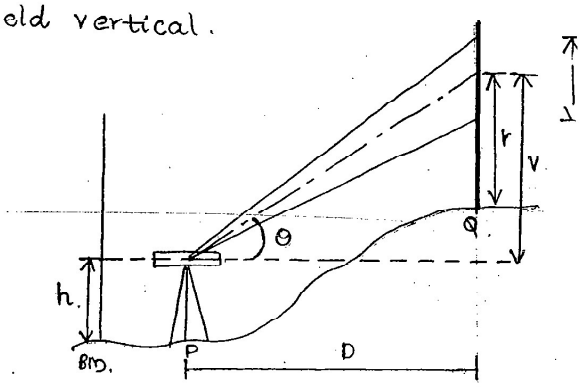
1. LOS inclined & Staff held vertical.

r → central hair reading
or axial hair reading.

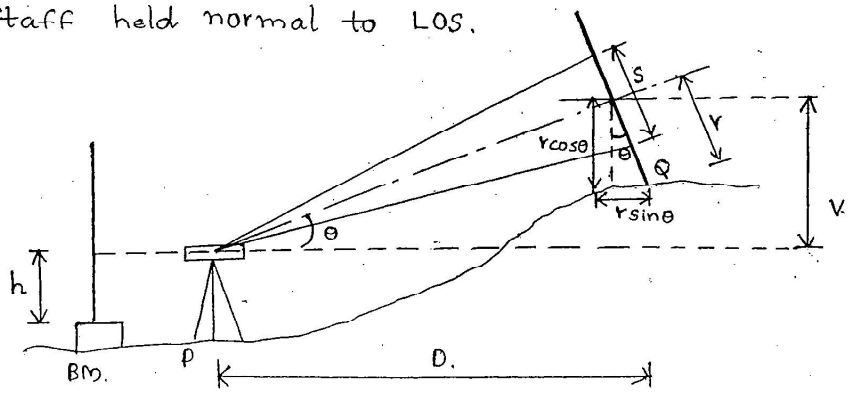
$$D = KS\cos^2\theta + C\cos\theta$$

$$V = \frac{KS}{2}\sin 2\theta + C\sin\theta$$

RL of Q = RL of BM + h + V − r.



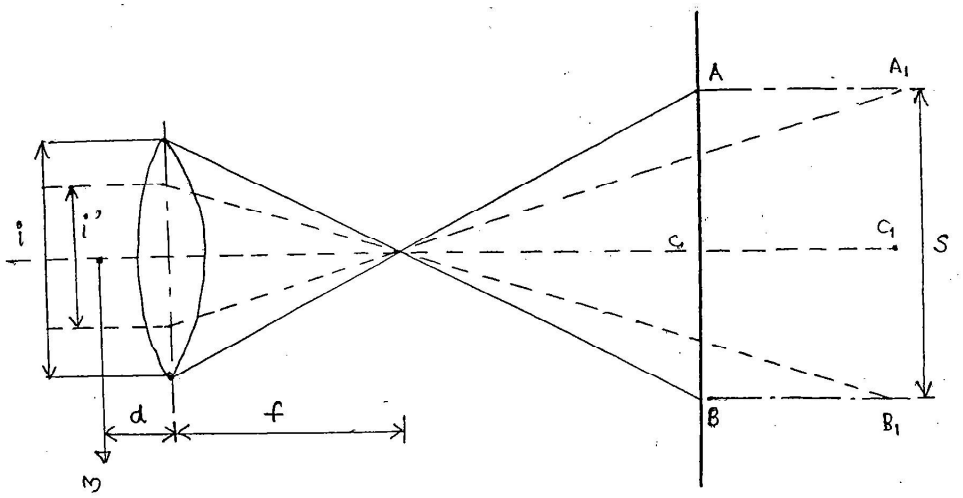
2. Staff held normal to LOS.



$$D = (KS + C)\cos\theta + r\sin\theta$$

$$V = (KS + C)\sin\theta.$$

* Movable Hair Method.



p → pitch of micrometer screw.

m → no. of rotations

$$\boxed{i = mp.}$$

$$D = \frac{f}{i} S + (f+d)$$

$$= \frac{f}{mp} S + f + d.$$

$$= \left(\frac{f}{p}\right)\frac{1}{m} \times S + (f+d).$$

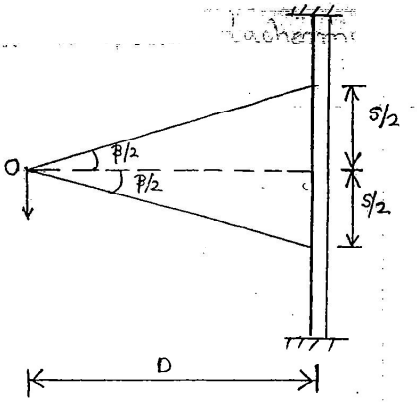
$$\boxed{D = \frac{K}{m} S + C.}$$

- In this method, stadia interval is variable whereas the staff intercept is kept constant.
- Staff intercept is called as base.
- If base is horizontal, method is called as "horizontal subtense bar method"

* Horizontal Subtense Bar Method :

$$\tan\left(\frac{\beta}{2}\right) = \frac{\left(\frac{S}{2}\right)}{D}$$

$$\therefore \boxed{D = \frac{S}{2\tan\left(\frac{\beta}{2}\right)}}$$



when β is taken in $(^\circ, '')$

$$\boxed{D = \frac{S}{2\times\left(\frac{\beta}{2}\right)} = \frac{S}{\beta} \times 206265 \; ; \; \beta \text{ in seconds}}$$

It is used for measurement of distances & elevations on sloping grounds. It is accurate for long sights.

→ Effect of Angular Error

$$D = \frac{S}{\beta}$$

$$\partial D = \frac{-S}{\beta^2} \cdot \partial\beta$$

$$= \frac{-1}{\beta}\left(\frac{S}{\beta}\right)\partial\beta$$

$$\Rightarrow \boxed{\partial D = -D\,\frac{\partial\beta}{\beta}}$$

NOTE :

⊙ Positive error in $\partial\beta$ will produce a negative error in D and vice versa

→ Tangential Method

- In this method readings corresponding to cross hairs are not required.

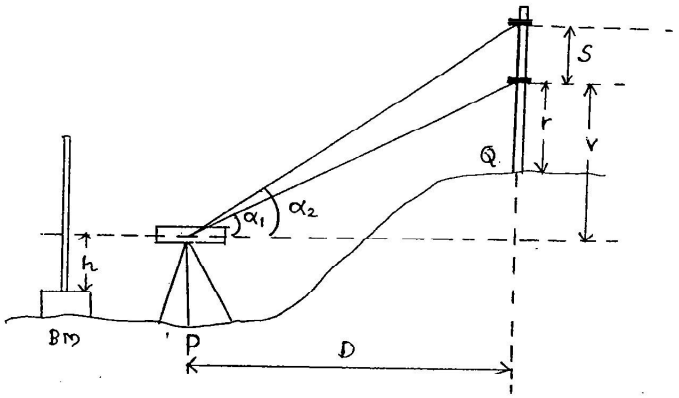
- Target staff is used for taking the vertical angles. On the vanes fixed to the staff.

Case 1: Both are angle of elevation.

$V = D \tan \alpha_1$

$V + S = D \tan \alpha_2$

$$D = \frac{S}{\tan \alpha_2 - \tan \alpha_1}$$



RL of Q = RL of BM + h + V - r.

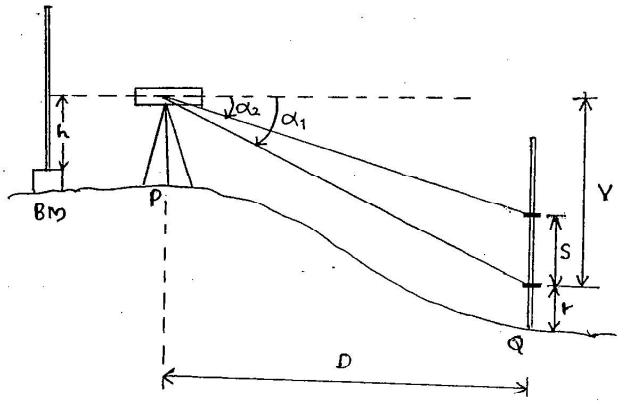
Case 2: Both are angles of depression.

$V = D \tan \alpha_2$

$V - S = D \tan \alpha_1$

$S = D(\tan \alpha_2 - \tan \alpha_1)$

$$D = \frac{S}{\tan \alpha_2 - \tan \alpha_1}$$



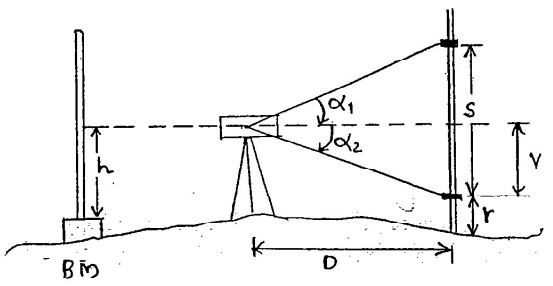
RL of Q = RL of BM + h - V - r

Case 3: One angle of elevation & One angle of depression

$V = D\tan\alpha_2$

$S - V = D\tan\alpha_1$

$S = D(\tan\alpha_1 + \tan\alpha_2)$



$$D = \frac{S}{\tan\alpha_1 + \tan\alpha_2}$$

RL of Q = RL of BM + h − V − r

→ Special Instruments

1. Beamann's Stadia Arc
2. Jeff Cott Direct Reading Tacheometer.

In this instrument, a special diaphragm is fixed with fixed pointer (red colour) and movable pointers (blue and black)

Horizontal distance = (difference in the readings of blue and red pointers) * 100.

Vertical distance = (difference in the readings of black and red pointers) * 100

3. Range finder

It is suitable for inaccessible points blw which the distance can be measured. It is more suitable for targetting the objects at a height of 500 km

4. Gradienter

It is used in setting out grades in tangential method of tacheometry.

5. Omnimeter

It is a special tacheometer invented by Eckathold and used for tangential method of tacheometry.

P-63,

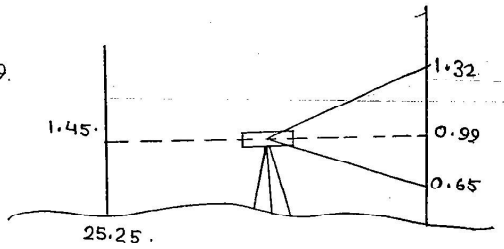
Q.1. $D = \left(\frac{f}{i}\right)S + (f+d)$

$= \frac{200}{4}(3-1) + (200+100)\times 10^{-3}$

$= \underline{\underline{100.3}}$ m

Q.2. RL of SS $= 25.25 + 1.45 - 0.99$

$= \underline{\underline{25.71}}$ m



Q.3 $D = KS\cos^2\theta + C\cos\theta$ { if not given, assume $K = 100$, $C = 0$ }

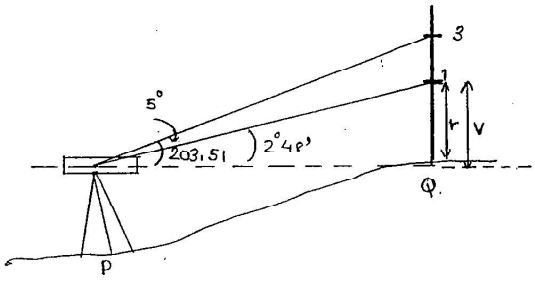
$= 100\,(2.985 - 2.225)\cos^2(7°54') = \underline{\underline{74.564}}$ m

Q.7. $V = D\tan 2°48'$

$V + 2 = D\tan 5°$

$\Rightarrow D = 51.84$ m.

$V = 2.535$ m.



RL of Q $= 203.51 + 2.535 - 1 = \underline{\underline{205.045}}$ m

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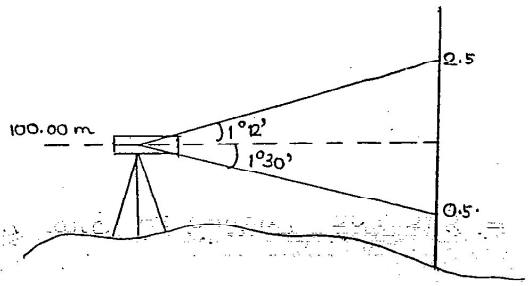
$V = D \tan 1°30'$

$2-V = D \tan 1°12'$

$D = 42.43\ m.$

$V = 1.11\ m.$



RL of $Q = 100 - V - 0.5.$

$= \underline{\underline{98.41\ m}}$

10. $D = 100\,(2.265 - 1.545)\cos^2 4°25'20''$

$= \underline{\underline{71.572\ m}}.$

$V = D \tan 4°25'20'' = 5.535\ m.$

RL of $Q = 123.265 + V - 1.905 + 1.28$

$= \underline{\underline{128.17\ m}}$