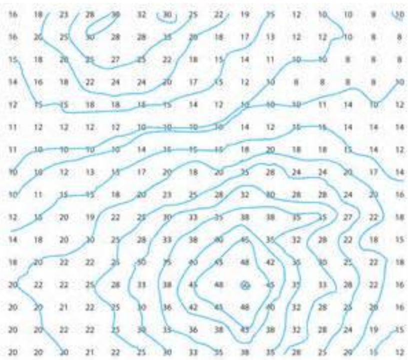

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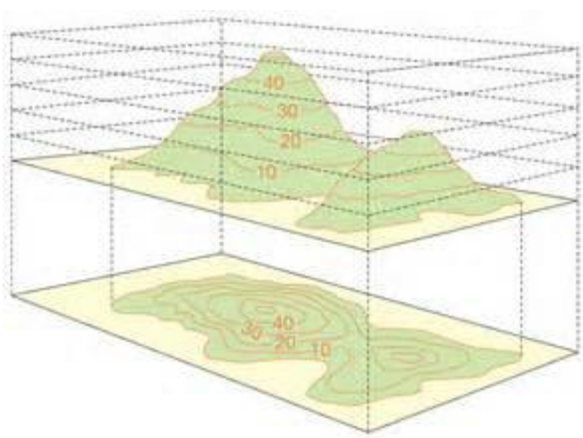

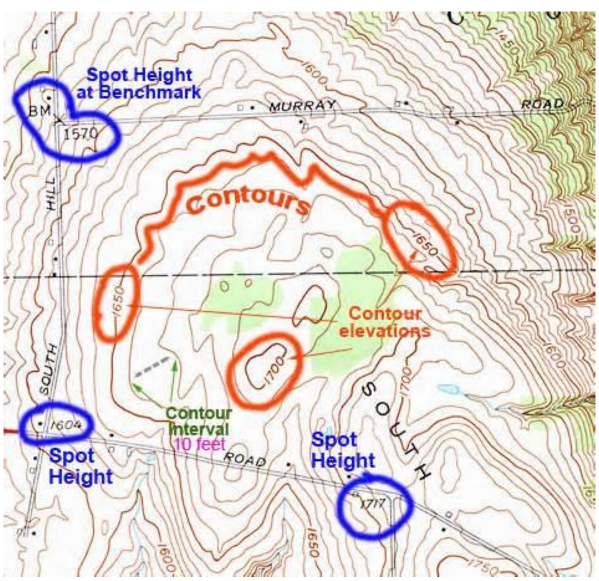

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CE 371

Chapter 2 Tacheometry

2.1 Introduction

Tacheomety or (Stadia survey) is an indirect method of measuring horizontal distance and difference in elevation by using the telescope horizontal hairs and a level rod.

- Stadia is the term used in USA, however, in Europe this method is called "Tacheometry"
- Stadia readings can be taken with theodolites or levels having stadia hairs. These are the upper hair (u), middle hair (r), and lower hair (l). The upper and lower hairs are equidistance from the middle hair. Figure 2.1
- Stadia method is usually associated with topographic surveys where the accuracy is not very critical.

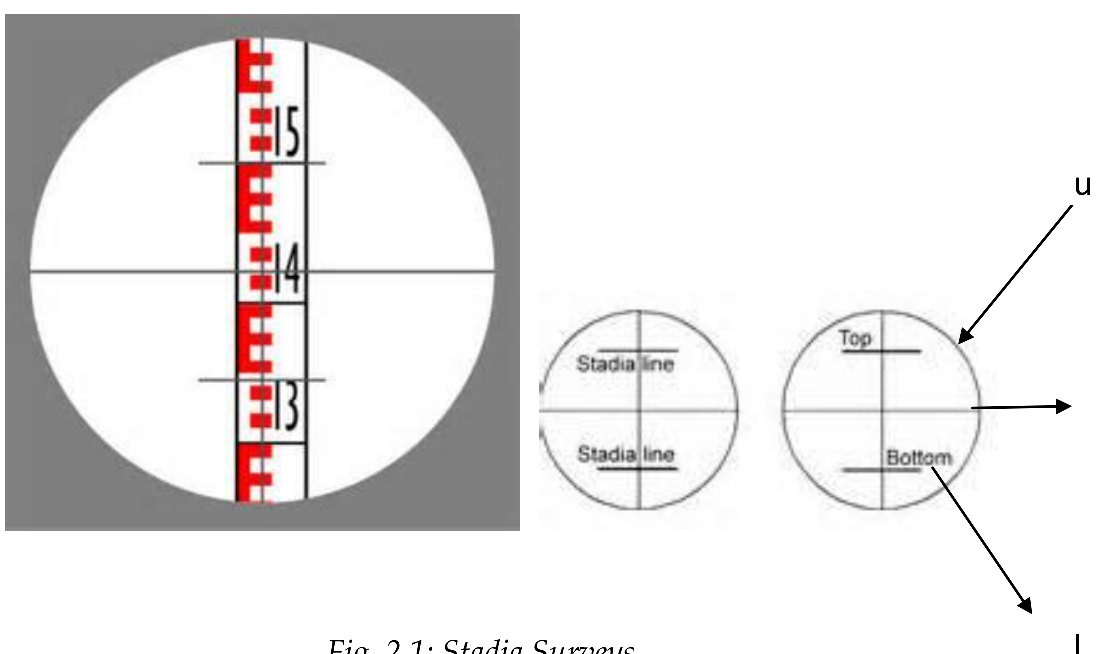


Fig. 2.1: Stadia Surveys

2.2 Stadia Measurements for Horizontal Sights

In stadia surveys, the following terms are used:

i the spacing between stadia hairs which is a constant

R the stadia interval ***(u-l)*** or rod intercept, where ***u*** is the upper hair reading and ***l*** is the lower hair reading.

f/i The stadia interval factor ***K*** which is a constant equal to the focal length ***f*** divided by ***i.***

c the distance from the instrument centre to the objective lens centre.

d the distance from the focal point of the object lens to the level rod.

From similarity of triangles:

$$\frac{d}{f} = \frac{R}{i} \quad \text{or} \quad d = \left(\frac{f}{i}\right).R = K\ R$$

Thus

$$H = K\ R + e$$

Because of signs of f and c the distance *e* becomes negligible, thus;

Horizontal distance $H_{AB} = K\ R$ (horizontal telescope)

$Elev_B = Elev_A + hi_A - (u+l)/2$ (horizontal telescope)

Example 2.1:

It is required to determine the horizontal distance between points *A* and *B* by stadia method. A theodolite at *A* is used to sight a level rod at *B* while the telescope is horizontal. The rod readings are u = 1.88m, l = 0.48 m, If the stadia interval factor K = 100, what is the horizontal distance H_{AB}? If elevation of point *A* is 10.0 m, hi_A = 1.6 m, Compute elevation of *B*.

Solution:

Horizontal distance $H_{AB} = K R$

Horizontal distance $H_{AB} = K (u-l) = 100 (1.88-0.48) = 140$ m

$Elev_B = Elev_A + hi_A - (u+l)/2$

$= 10.0 + 1.6 - (1.88+0.48)/2 = 10.42$ m

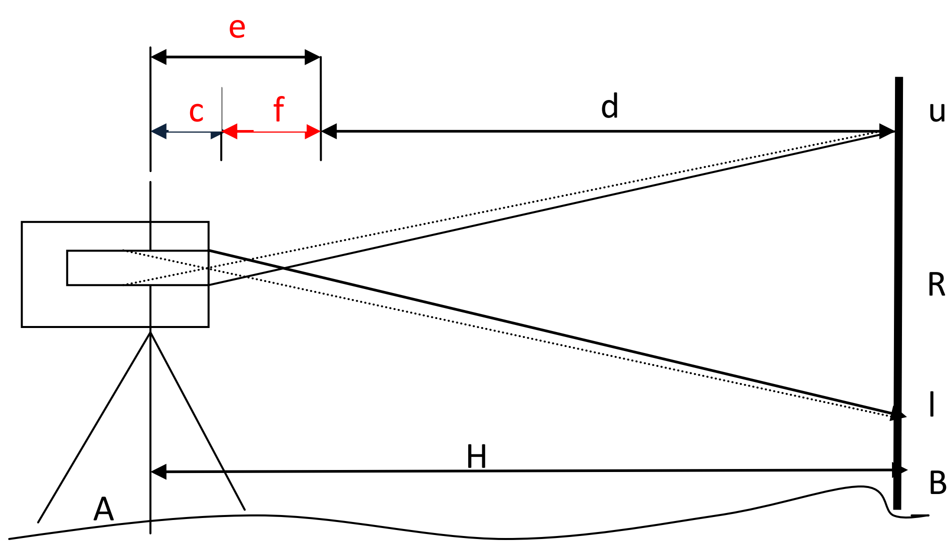


Fig. 2.2: Stadia measurements

l

2.3 Stadia Measurements for Inclined Sights

Due to varying topography, most stadia readings are taken with inclined line of sight.

H = S cos (a) ……………………………………………… (1)

V = S sin (a) ………………………………………………(2)

- Slope distance ***S*** is found from

S = K R′ = K (u′ – l′) …………………………(3)

But R′ is related to R (stadia interval) by:

R′ = R cos (a) ……………………………………………(4)

From (4) into (3)

Slope distance ***S = K R cos (a) + e*** **where** ***e*** = additional constant

Using the above formula into (1) and (2), horizontal and vertical distances are:

Horizontal distance $H_{AB} = K\,R\cos^2(a) + e.\cos(a) = \mathbf{K\,R\,(\sin(z))^2}$

Vertical distance $V = K\,R\cos(a)\sin(a) = \mathbf{0.5\,K\,R\sin(2z)}$ ***or***

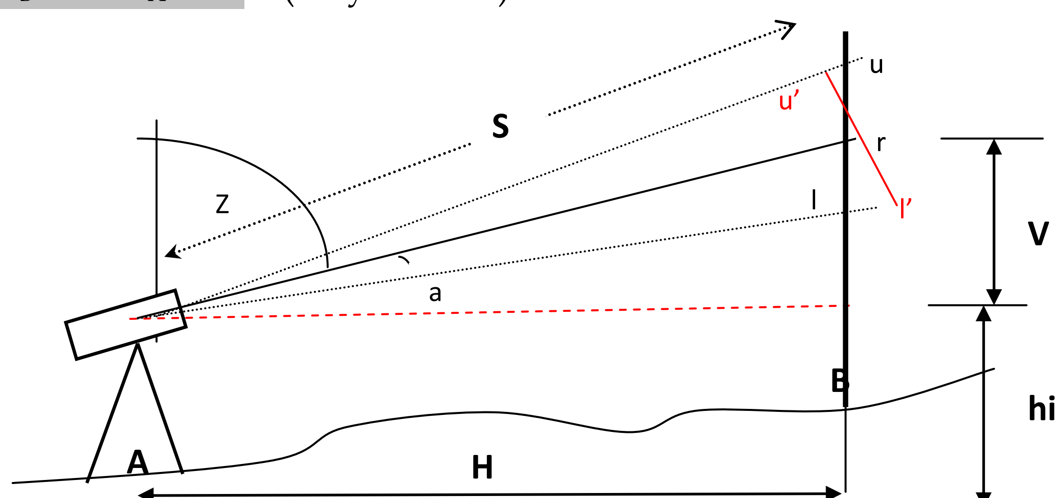
$= H\tan(a)$

- Elevation of B is computed from:

$Elev_B = Elev_A + hi_A + V - r$

If middle hair reading ***r*** = height of instrument ***hi***, then:

$Elev_B = Elev_A + V$ (only if ***r = hi***)



Example 2.2:

A theodolite is used to determine the horizontal distance H_{AB} and the elevation $Elev_B$ of point B. the following stadia readings were taken: Zenith angle $z = 82^o$, $u = 1.92$m, $r = 1.12$ m, $l = 0.32$m. If $K = 100$, $Elev_A = 500$ m, telescope height $hi_A = 1.60$m, compute the horizontal distance H_{AB} and Elevation of point B.

Solution

Stadia interval $R = u - l = 1.92 - 0.32 = 1.60$ m

Horizontal distance $H_{AB} = K\, R\, (sin\, (z))^2$

$$= 100\ (1.60)\ (\sin 82^o)^2 = 156.90 \text{ m}$$

Vertical distance $V = 0.5\, K\, R\, sin\, (2z) = 0.5\ (100)\ (1.60)\ \sin\ (2 \times 82^o) = 22.05$ **m**

$Elev_B = Elev_A + hi_A + V - r = 500 + 1.60 + 22.05 - 1.12 = 522.53$ m

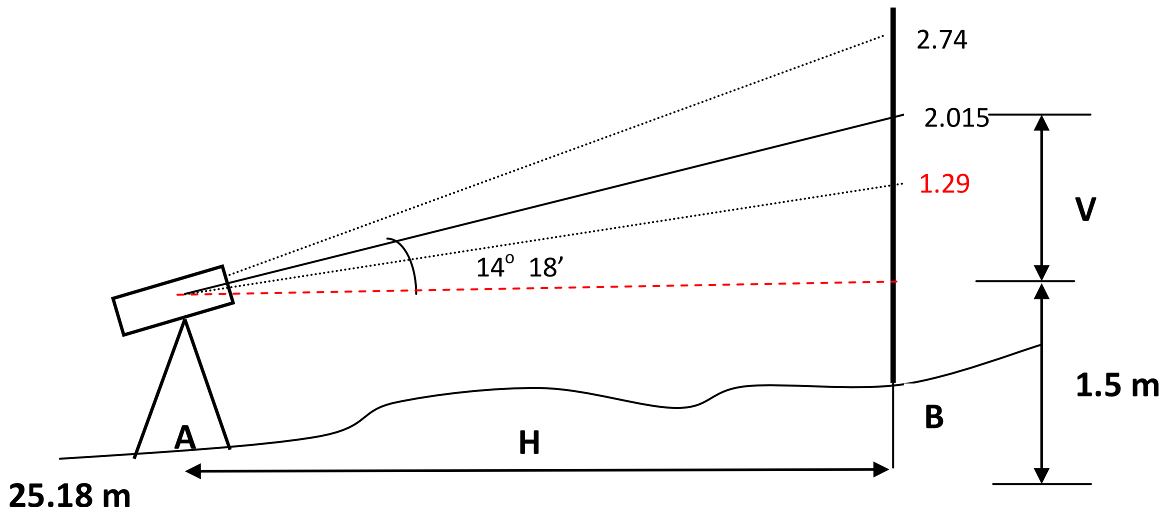
2.4 Precision of Stadia Measurements

- Stadia survey is not suitable for precise horizontal distance measurements or difference in elevations.
- Error ratio can be as low as 1/300 to 1/500 which makes it suitable for rough measurements such as in topographic surveys.
- For long distances, half the stadia interval R can be used to intercept the level rod.

Example 2.3:

A theodolite provided with stadia hairs is used to determine the horizontal distance H_{AB} and the elevation $Elev_B$ of point B. the following stadia readings were taken2.74, 2.015, 1.29 m on a vertical rod. If the vertical angle is $14^o\ 18'$, find the horizontal distance H_{AB} between the instrument and the rod. Find also the elevation of the point where the rod is positioned, if the elevation at the instrument station is 25.18 m. Known that K = 100 and e = 41 cm and hi = 1.5 m.

Solution



K = 100 , e = 41 cm

R = (r-u) = 2.74 – 1.29 = 1.45

Horizontal distance $H_{AB} = K\ R\ cos^2\ (a) + e.\ cos\ (a) = \mathbf{K\ R\ (sin\ (z))^2}$

Given here is the vertical angle (a)

Horizontal distance $H_{AB} = K\ R\ cos^2\ (a) + e.\ cos\ (a)$

Horizontal distance $H_{AB} = 100 \times 1.45\ cos^2\ (14^o\ 18') + 0.41 \times cos\ (14^o\ 18')$

Horizontal distance $H_{AB} = 100 \times 1.45 \times (0.9690)^2 + 0.41 \times (0.9609)$

Horizontal distance $H_{AB} = 136.15 + 0.394 = \underline{\mathbf{136.544}}\ m$

Vertical distance $V = H\ tan\ (a)$

Vertical distance $V = 136.544 \times tan\ (14^o\ 18')$

Vertical distance $V = 136.544 \times 0.2549 = \underline{\mathbf{34.805\ m}}$

$Elev_B = Elev_A + hi_A + V - r$

$Elev_B = 25.18 + 1.5 + 34.805 - 2.015 = \underline{\mathbf{59.47\ m}}$