SURVEYING I

GE 233

PRACTICAL SHEETS

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ROLL NO. 22 (Twenty two)

BE Civil, SEM III

SUBJECT TEACHER

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OBJECT-1 | TO FIND THE HORIZONTAL DISTANCE BETWEEN TWO POINTS BY RANGING

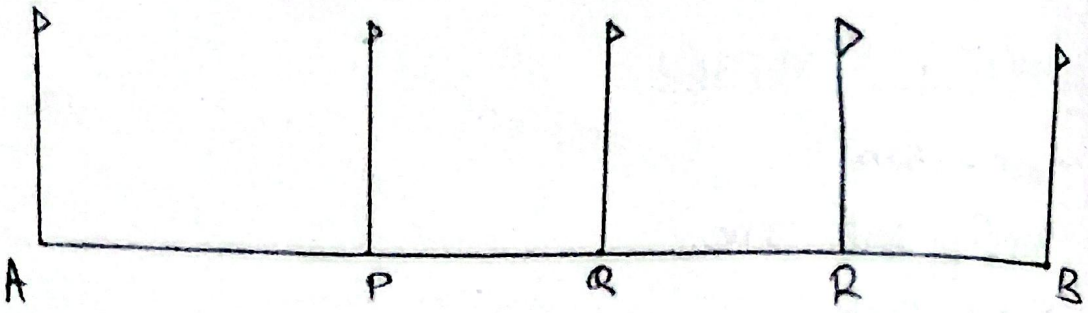
INSTRUMENTS REQUIRED:

Tape - 50m
Ranging rod - 3 pcs.
Peg :- 2 No.
Hammer :- 1 No.

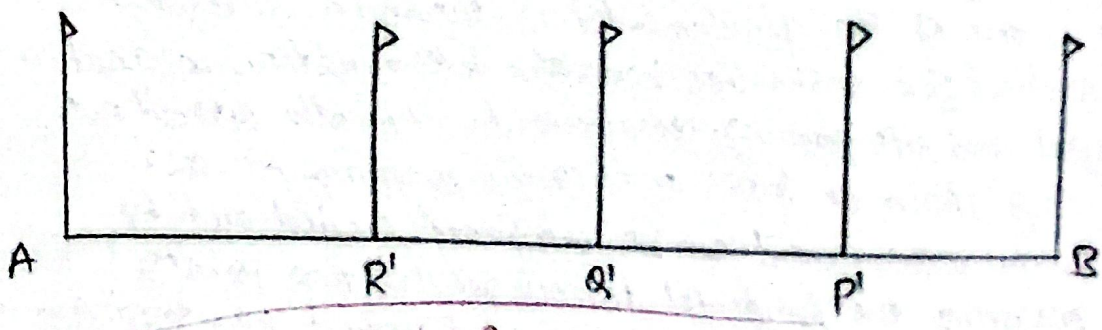
THEORY :

Linear measurement refers to the process of determining the horizontal distance between two points. It is one of the fundamental methods in surveying, essential for tasks like boundary determination, construction layout and site planning. Measurement is typically carried out using chain or tapes or electronic measuring devices. Linear measurement can be ~~categorized~~ carried out by measuring the horizontal distance between two points, stretching the chain or tape straight without any sagging or touching ground. If the distance between the terminal points exceeds the tape or chain length, then intermediate points are established ~~along the~~ in between the terminal points. Then this process of measuring the horizontal disfance is known as Ranging.

Direct Ranging :- This technique is used to measure the distances when the two points are visible to each other. In this method, ranging rods are placed at two end points & intermediate points along the straight line. This method is commonly employed on flat ground where the line of sight is unobstructed, ensuring accuracy & efficiency in measurement



Forward measurement



Backward measurement

PROCEDURE

Here, A & B are two terminal points, whereas P, Q, P', Q' are intermediate points. The distance between A & B exceeds the tape length. So, direct ranging was carried out to measure the distance betn them as follows:

(1) First and foremost, two points, A & B were marked by two pegs which were driven into ground with the help of hammer.

(2) Two ranging rods were erected at the points A & B & held by two surveyors.

(3) An assitant was given a third ranging rod and third point P was established in such a way that the ranging rods at P & B points coincided when watched from point A with the directions given by two surveyors at A & B. The point P was selected such that it didn't exceed 20 meters.

(4) By similar process, the intermediate point Q & R were also marked. As in above figure, P, Q, R are intermediate points.

(5) Now, the segments AP, PQ, QR and RB were measured using tape & noted under the section forward measurment.

(6) Similarly, backward measurement was taken with intermediate points P', Q' & R'.

OBSERVATION

	Forward Measurement		Backward Measurement.
AP	19.036 m	BP'	15.894 m
PQ	18.734 m	P'Q'	17.124 m
QR	14.258 m	Q'R'	15.824 m
RB	14.784 m	R'A	17.950 m
	66.812 m		66.792 m

CALCULATION

$$\text{Discrepancy} = |FM - BM|$$

$$= |66.812 - 66.792|$$

$$= 0.02\,m$$

$$\text{Average value} = \frac{F.M. + B.M}{2} = \frac{66.812 + 66.792}{2} = 66.802\,m$$

$$\text{Precision} = \frac{1}{\frac{\text{Avg. value}}{\text{Discrepancy}}} = \frac{1}{66.802/0.02} = 1:3340.1$$

RESULTS

The horizontal distance between two points A & B was found to be 66.802 m by ranging method.

OBJECT-2 | TO DETERMINE PACE VALUE & DISTANCE BETWEEN TWO POINTS ~~usi~~ ~~USING~~ BY PACING

INSTRUMENT REQUIRED

Tape :- 50 m (1 No.)

Ranging rods :- 2 No.

THEORY :

A 'pace' refers to a ~~double~~ step, measured from ~~one~~ the heel of one foot to the another.

Pace value is the average length of one pace, usually measured in meters. To determine the pace value of an individual, the distance over a known length is paced. & total number of paces is divided by length of measured stretch.

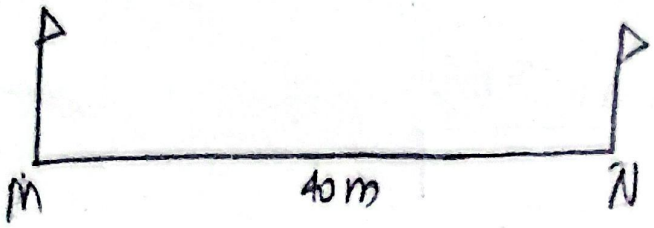
Pacing is a method of measuring horizontal distances by counting the number of paces taken between two points. This method is widely used in surveying due to its simplicity, practicality & convenience in rough or uneven terrain where direct measurements with chain may not be feasible.

PROCEDURE | [To find pace value /factor]

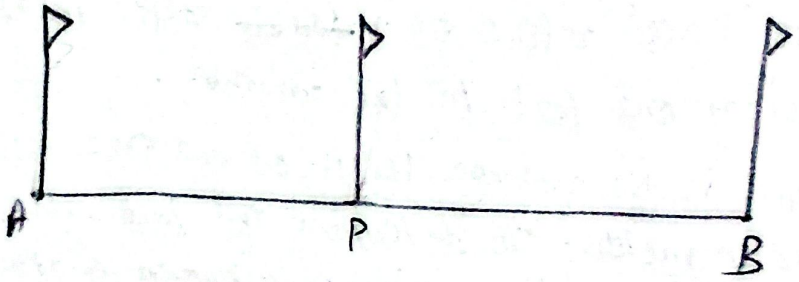
(i) Two ranging rods were placed in points M & N such that MN = 40m

(ii) The distance was paced from one end (M) to another end (N) back and forth for few times & no. of paces were noted each time.

(iii) The average number of paces was calculated and pace factor was calculated.



(i) Determining Pace factor



(ii) Determining distance betⁿ A & B by Pacing

OBSERVATION & CALCULATION [for pace factor]

No. of paces from A to B	No. of paces from B to A
(i) 57	(i) 59
(ii) 58	(ii) 58
(iii) 57	

Average no. of paces $= \frac{57+58+57+59+58}{5}$

$= 57.8$

Pace factor (P.F.) $= \frac{\text{known distance}}{\text{No. of paces}}$

$= \frac{40}{57.8}$

$= 0.692$

PROCEDURE FOR HORIZONTAL DISTANCE MEASUREMENT

(i) Two ranging rods were fixed at two terminal points whose horizontal distance is to be measured.

(ii) The intermediate ranging rod was established to maintain straight line during pacing.

(iii) The distance between two terminal point was paced back and forth.

(iv) The average no. of paces was calculated & then by the help of pace factor, the unknown distance was determined.

OBSERVATION & CALCULATION:

No. of paces between points A & B = 96

No. of paces between points B & A = 98

Average No. of paces = $\frac{96+98}{2}$ = 97

From object-II,

True length between A & B = 66.802 m

By pacing,

Total distance = Pace factor × Avg. no. of pace

= 0.692 × 97

= 67.124 m

Error = measured length - true length

= 67.124 - 66.802

= 0.322

Accuracy = $\frac{1}{\frac{\text{True length}}{\text{error}}} = \frac{1}{\frac{66.802}{0.322}}$ = 1 : 207.95

RESULT:

The horizontal distance between two points A & B was found to be 67.124m by pacing.

OBJECT-3 | CHAINING ON SLOPING GROUND BY DIRECT METHOD.

INSTRUMENTS REQUIRED:

For Measuring Tape –
Ranging Rods –
Pegs –
Hammer

THEORY

For Plotting works, horizontal distance betn two points ais required. Thus there're two methods for getting horizontal distance ~~between~~ on sloping ground betn two points: Direct & indirect method.

Direct method:

In the direct method or stepping method, the distance is measured in small horizontal steps. If we have to measure distance (horizontal) between points A & B as shown in fig (3.1), then follower holds the zero end of tape at A & the leader selects any suitable length l such that the slope doesn't reach ~~the~~ over chest height. The follower directs the leader for ranging from A with reference to another ranging rod at end point B. The leader pulls the tape tight, makes it horizontal & with judgement & swinging the tape up or down, the perpendicular horizontal distance is measured & process is repeated backward & forward.

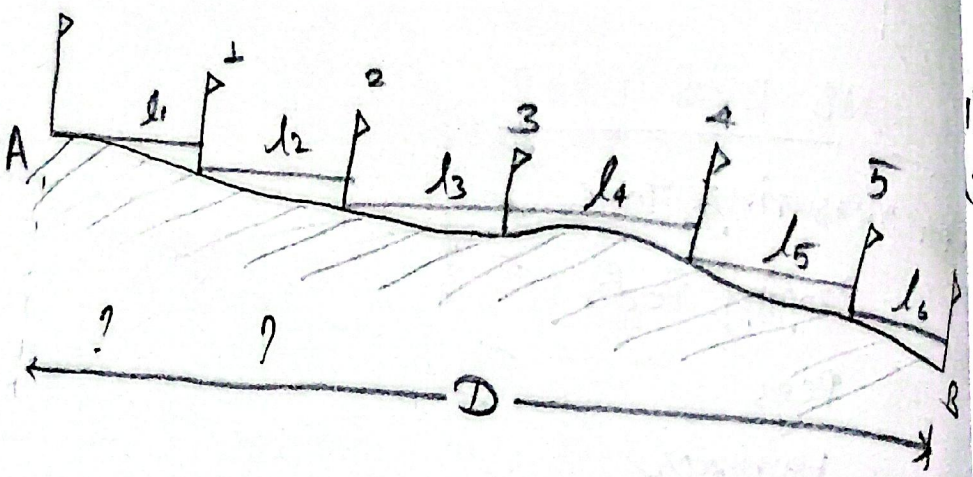


fig. 3.1 Method of stepping

PROCEDURE :

(I) Select points A & B to measure distance between them

(II) With the help of ranging rods at A & B, ~~select~~ the intermediate points of length l_1, l_2, l_3, etc ~~are~~ were selected.

(III) The length l_1 was measured by placing zero of the tape in the bottom of ranging rod A & was pulled perpendicular to ranging rod at ⊥ by judgement & the measurement was checked by swinging tape up & down & shortest ~~dist~~ length was noted as horizontal distance.

(IV) The ~~procedure~~ procedure was repeated till point B was reached.

(V) Again ~~with~~ starting from B, with similar fashion as previous, the distance was measured.

(VI) The average distance by forward & backward measurement was taken to be the horizontal distance on sloping ground between points A & B.

OBSERVATION | CALCULATION :

Forward measurement		Backward measurement
→ l_1 = 1.108 m	→	l_1' = 3.844 m
→ l_2 = 1.194 m	→	l_2' = 2.190 m
→ l_3 = 1.114 m	→	l_3' = 3.016 m
→ l_4 = 1.982 m	→	l_4' = 2.062 m
→ l_5 = 3.588 m	→	l_5' = 1.420 m
→ l_6 = 5.530 m	→	l_6' = 1.976 m
Total = 14.516 m		Total = 14.508 m

$$\text{Average distance} = \frac{14.516 - 14.508}{2}$$

$$= 14.512 \text{ m}$$

Discrepancy = |FM - BM|

= |14.516 - 14.508|

= 0.008 m

$$\text{Precision} = \frac{1}{\frac{\text{Avg. value}}{\text{discrepancy}}} = \frac{1}{\frac{14.512}{0.008}} = 1 : 1814$$

RESULTS:

The horizontal distance on sloping ground between points A & B was found to be 14.512m.

OBJECT - 4 (DETERMINATN)

MEASUREMENT OF HORIZONTAL DISTANCE ON SLOPING GROUND BY INDIRECT METHOD USING ABNEY LEVEL

INSTRUMENT REQUIRED

MEASURING Tape
Abney Level
Ranging rod
Peg
Hammer

Theory

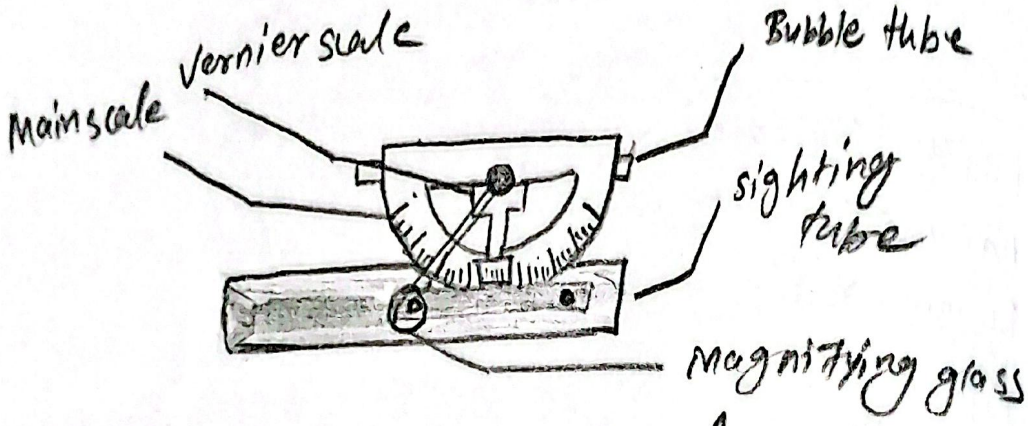
In surveying, horizontal distance on sloping terrain can be calculated using indirect methods when direct methods are impractical. It can be done by measuring sloping distance & the angle of slope. For the measurement of angle, Abney level is commonly used.

Abney level:

The Abney level is a compact, handheld surveying instrument used to measure angle of elevation, depression & slopes. It combines a sighting tube, bubble tube, main scale & a vernier scale allowing surveyors to measure vertical angles and calculate distances using trigonometry.

Working principle:

The working principle of Abney level is simple. The sighting tube is aligned with target and the bubble tube is adjusted until the bubble is centered. When the bubble is centered, the vernier scale moves forward or backward giving depression or elevation respectively.



fig(4.1) Abney level

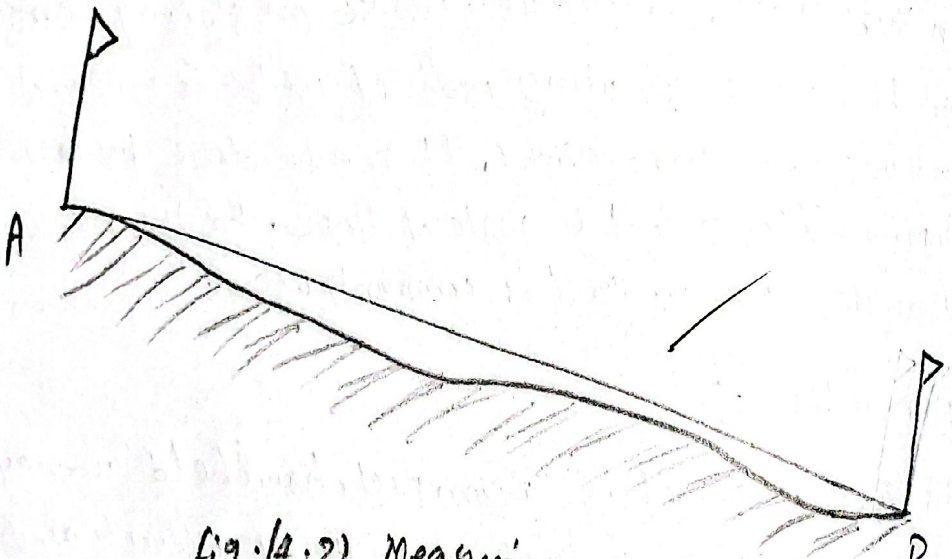


fig.(4.2) Measuring slope distance

3

PROCEDURE

(I) The ranging rods were set at points A & B and the height where Abney level was to be held was marked in both rods.

(II) The Abney level was held at A point & the angle was measured.

(III) The sloping distance was measured between points A & B.

(IV)

OBSERVATION & CALCULATIONS:

Vertical Angle of slope (θ) = ~~16°20'~~ $16°20' = 16.33°$

Sloping distance (D) = 15.080 m

$\therefore$ Horizontal distance (H) = $15.080 * \cos 16.33°$

$= 14.472$ m

Now, true distance(d) = 14.512 m (From previous objective)

Error (e) = $14.512 - 14.472$

$= 0.04$

$$\text{Precision} = \frac{1}{\frac{d}{e}} = \frac{1}{\frac{14.512}{0.04}} = 1:362.8$$

RESULTS:

The horizontal distance by ~~indirect~~ method was measured to be 14.472 m.

OBJECTIVE : 5

CHAIN TRIANGULATION AND RETAILING

INSTRUMENTS REQUIRED:

Chain / Tape : 2 Nos (30m & 50m)

Ranging Rod : 4 Nos

Peg : 4 nos

Hammer : 1 Nos

THEORY :

Chain triangulation is a method of surveying where the area is divided into a series of connected triangles. This method is suitable for relatively small and fairly open areas. We only need chain or tape to conduct this survey. A base line is measured & from it, triangles are formed by measuring the lengths of sides. Chain triangulation is useful when angular measurements aren't required & the ground is relatively flat.

PROCEDURES :

(i) Racce : This involves examining the surveying area, inspection and planning for selection of station points.

(ii) After surveying location was selected, stations were marked.

(iii) The survey stations were mutually visible and one base line was used. Survey line measurement were taken by direct ranging.

(iv) Offsets were taken and ground features were taken in consideration or located.

(v) The data was entered in field book.

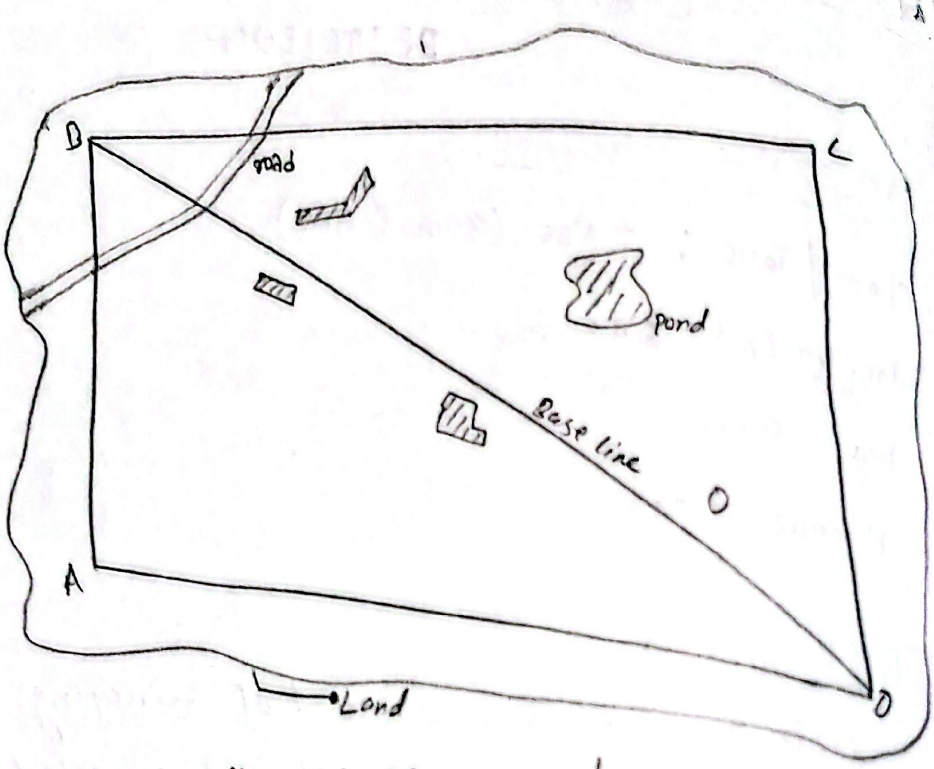
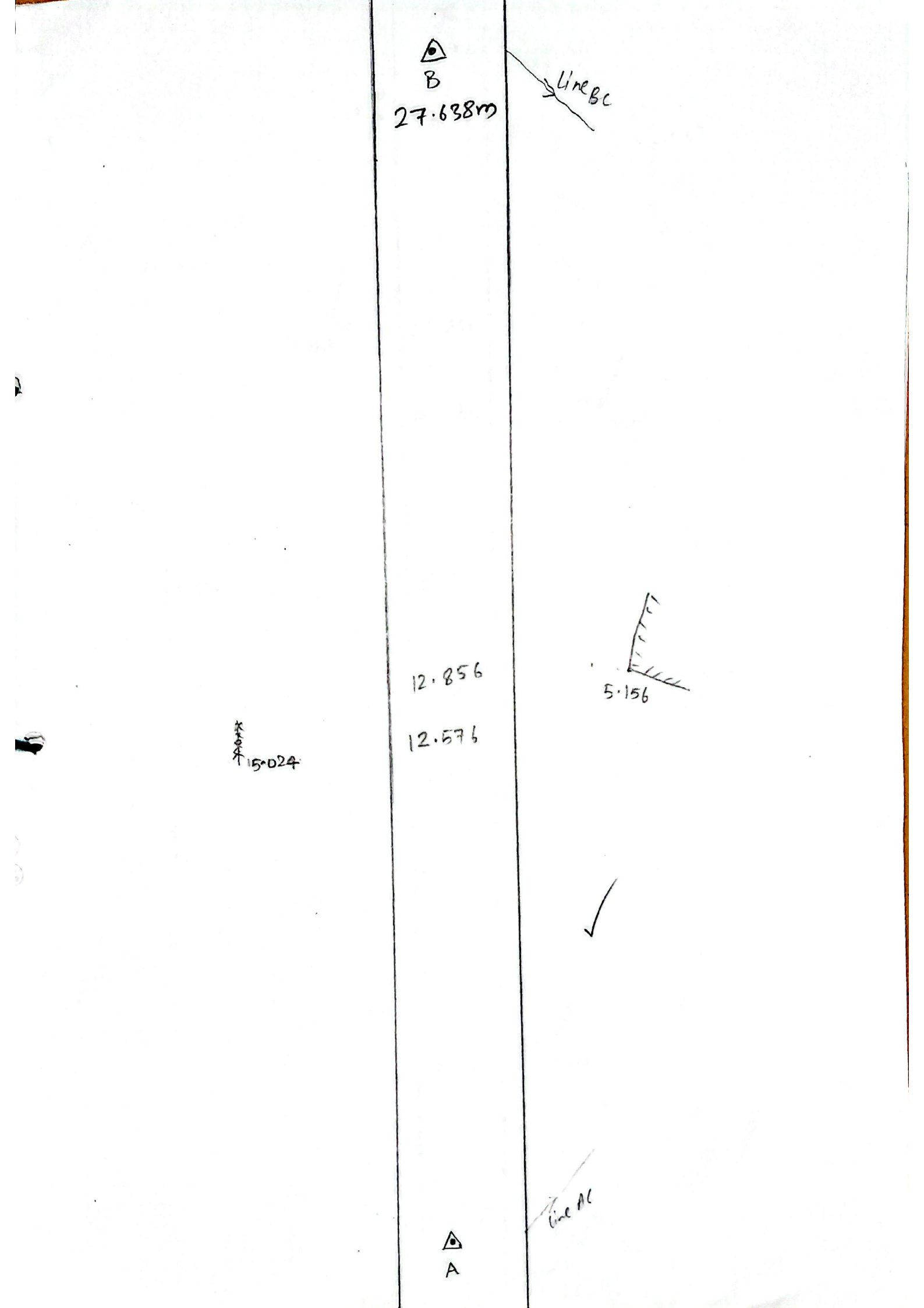
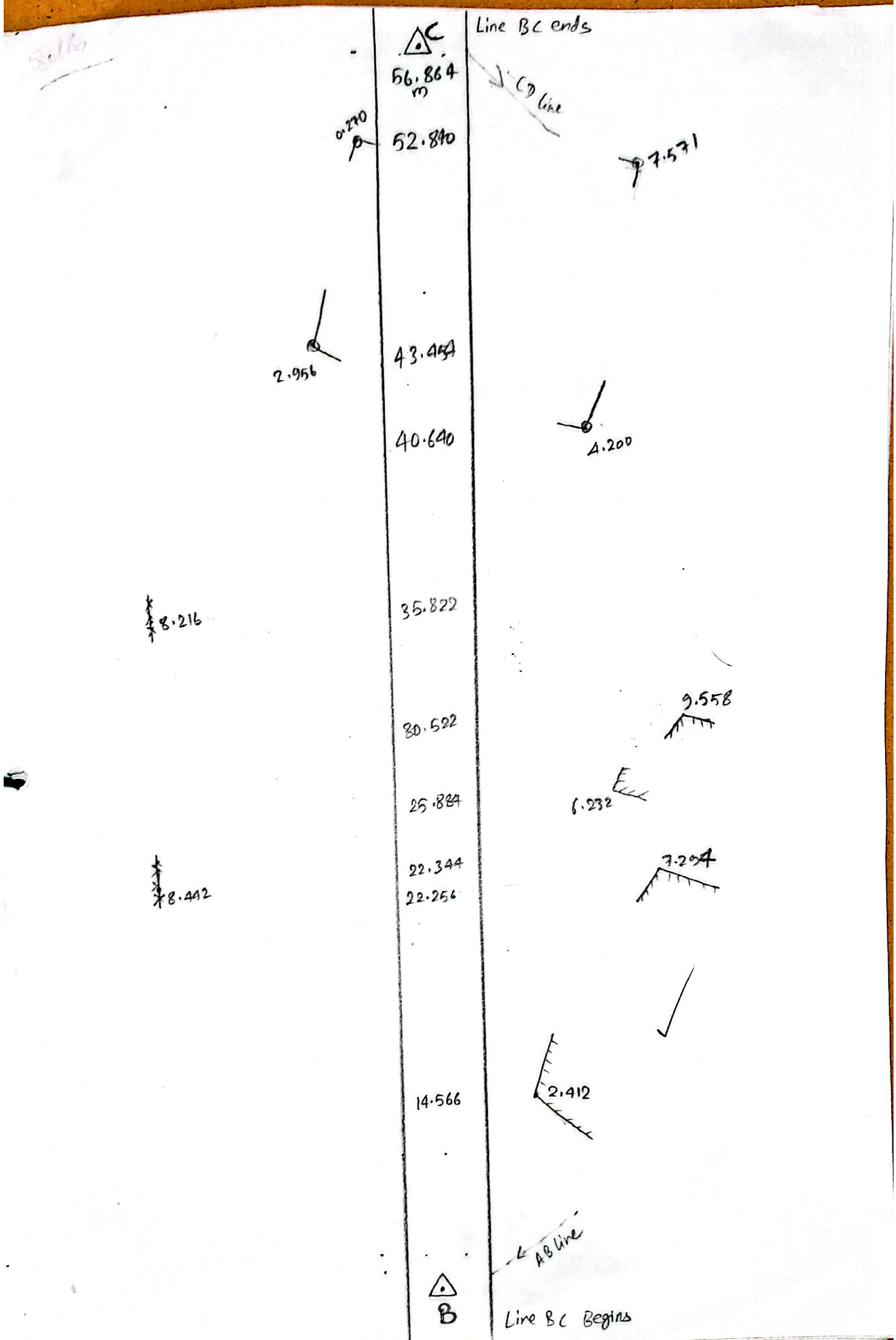
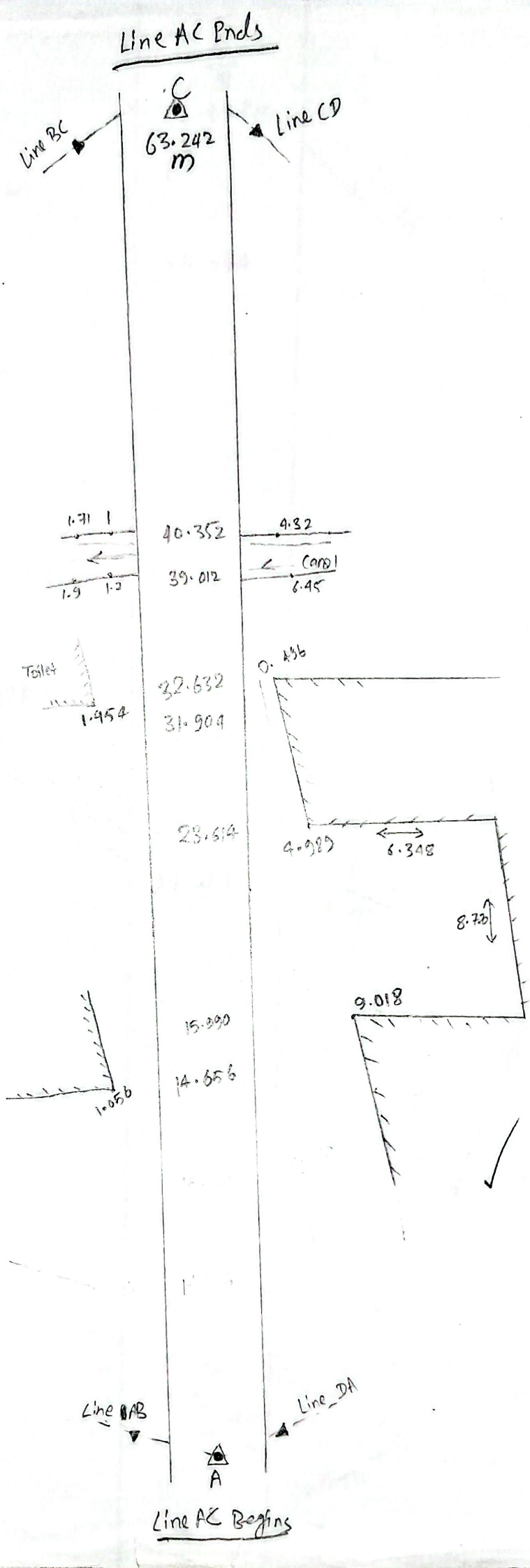
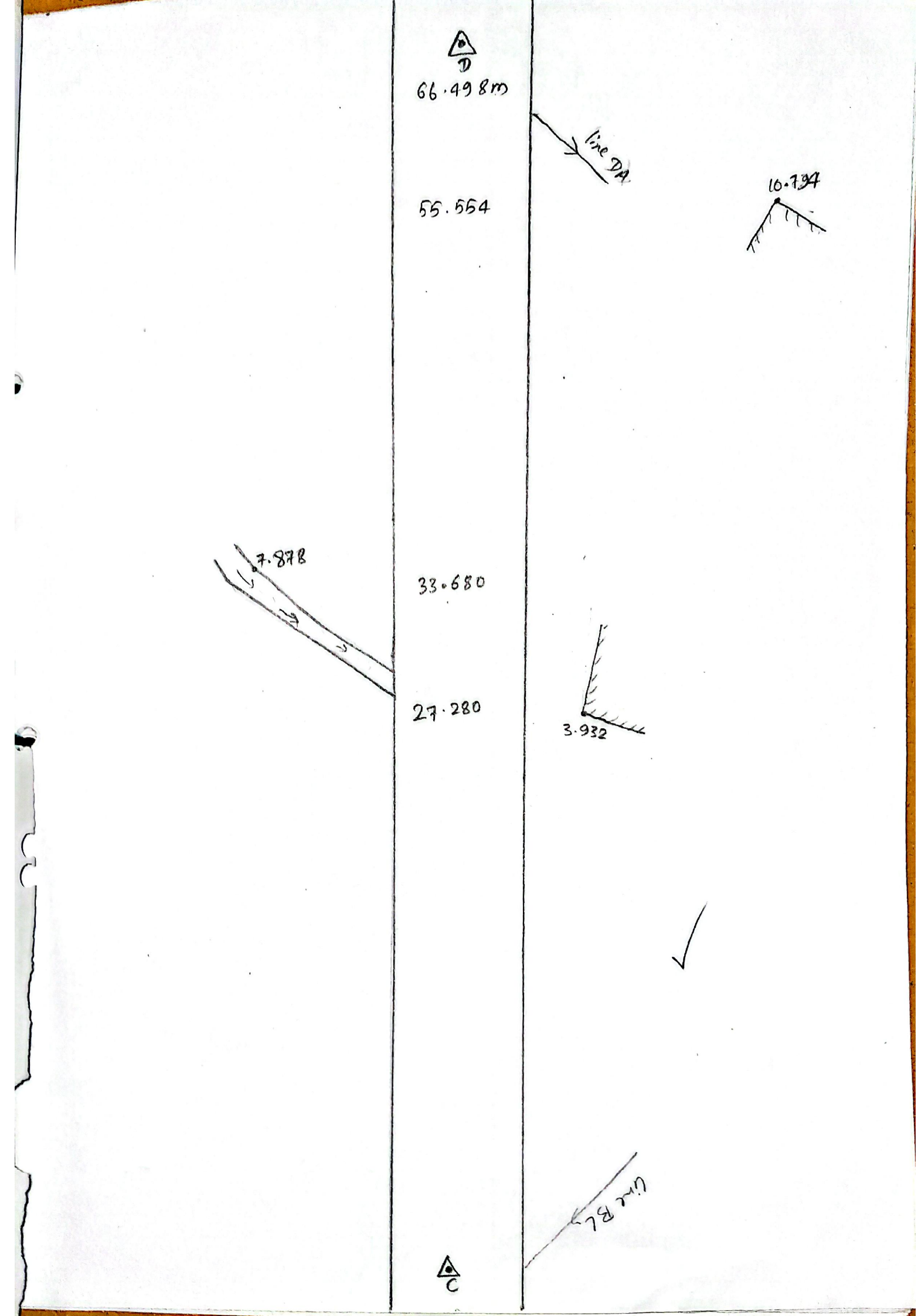


fig. Chain triangulation


B
27.638m
Line BC
12.856
12.576
5.156
15.024
Line AC
A


C
Line BC ends
56.864 m
CD Line
0.270
52.890
7.571
2.956
43.454
40.690
4.200
8.216
35.822
9.558
30.522
6.232
25.884
22.344
7.294
8.442
22.256
14.566
2.412
AB Line
B
Line BC Begins


Line AC Ends
C
63.242 m
Line BC
Line CD
1.71
1
40.352
4.32
Cond
39.012
1.9
1.2
6.45
Toilet
1.954
32.632
31.904
0.456
23.614
4.989
6.348
8.726
9.018
15.990
14.656
1.056
Line AB
Line DA
A
Line AC Begins


D
66.498m
line DA
10.734
55.554
7.878
33.680
27.280
3.932
line BC
C

A

Line DA ends

45.728 m

Line AC

2.308

31.314

5.224m

19.916

14.620

5.542

8200

11.830

Line CD

D

Line DA begins

OBJECTIVE : 6 | COMPASS SURVEY & TRAVERSING

INSTRUMENTS REQUIRED :

Tape → 50m

Ranging rods → 4Pcs

Pegs → 6 Nos

Hammer → 1 Pcs

Compass → 1 Nos

Compass tripod → 1 Nos

THEORY :

Compass survey is a method of surveying in which directions are measured using a magnetic compass. In this practical, a closed traverse was conducted by measuring ~~force~~ fore bearings (FB) & ~~bbb~~ back bearings (BB) of each survey line using a prismatic compass, a type of surveyor's compass commonly used for precise angular measurement. The prismatic compass allows simultaneous sighting & reading of bearings through its prism and graduated ring. The traverse forms a closed polygon, which allows checking for angular errors through the difference between FB & BB. Distances between ~~FB & BB~~ stations were measured using tape. This method is useful for small to medium-sized plots & provides a graphical layout of the area. Error adjustments were applied using appropriate correction techniques to ensure the accuracy of the plotted traverse.

$$|F.B \pm B.B| = 180^\circ$$

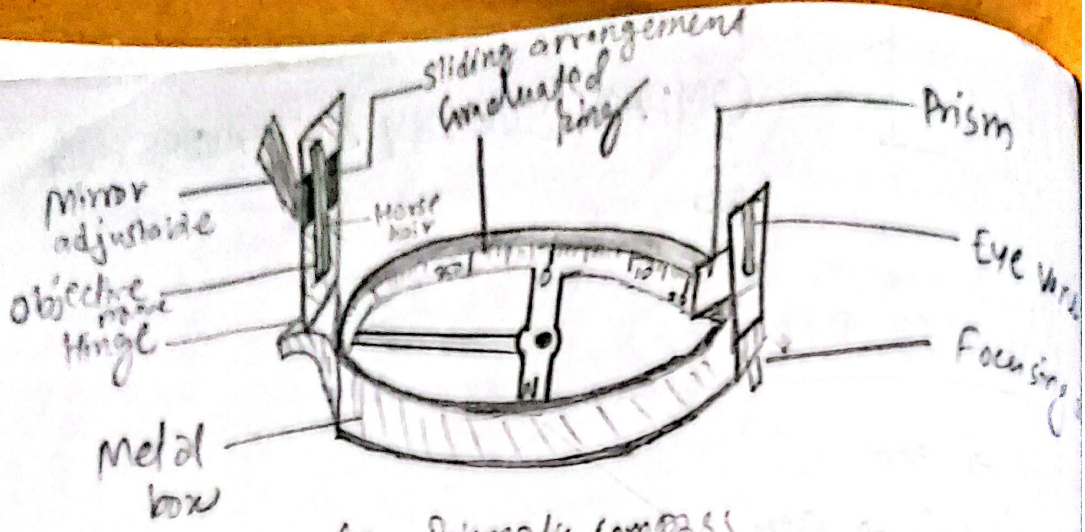


fig. Prismatic compass

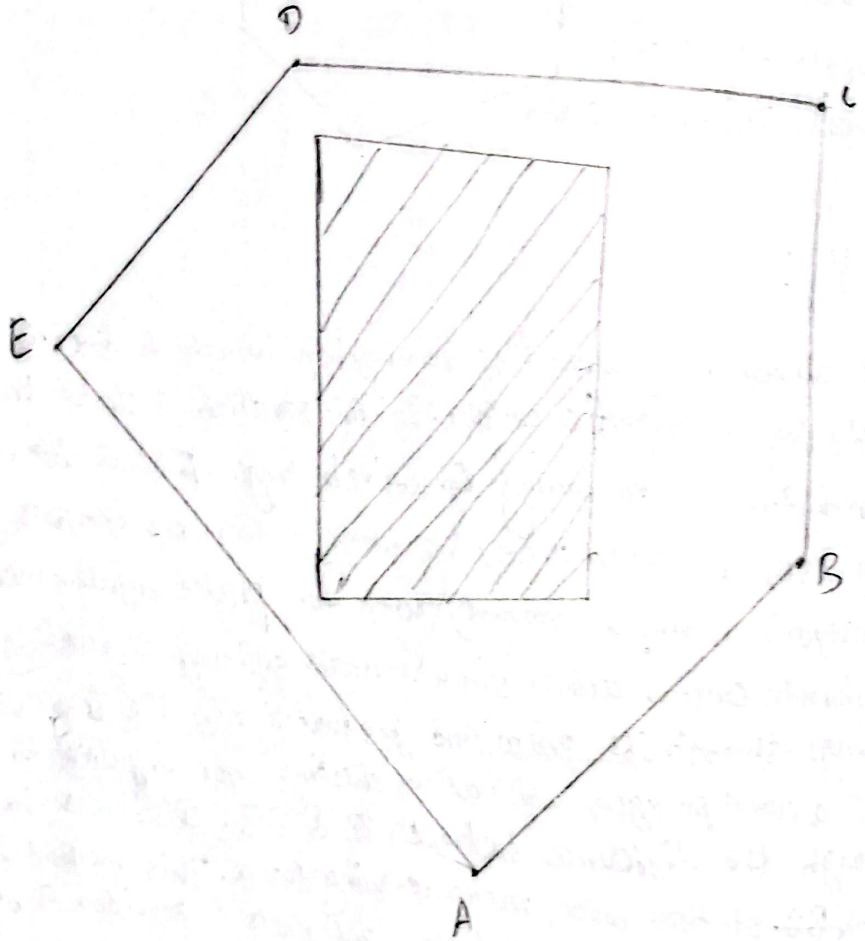


fig. Closed Traverse

PROCEDURES

(i) Raccae was carried out in the field for placing stations & carrying the survey.

(ii) Pegs were used to mark the stations. Five stations were established making a closed anti-clockwise traverse & a building was included inside the traverse

(iii) Suppose the stations be labelled as A, B, C, D & E. The compass was temporarily adjusted at station A.

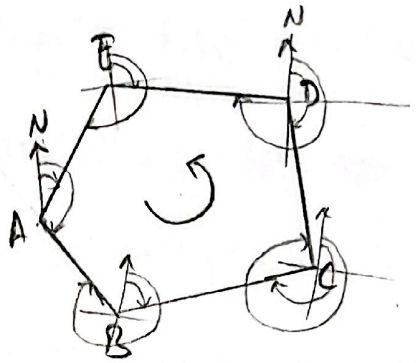
(iv) The fore bearing of line AB ~~was~~ and back bearing of line EA was taken from station A. Similar process was carried out in all stations placing compass and taking the readings as FB & BB.

(v) The offsets were taken simultaneously with the bearing & the distance between two stations was also measured.

OBSERVATION

LINE	FB	BB	DIFFERENCE	Length (m)
AB	158°30'	339°	180° 30'	12.250
BC	62°	242°	180°	17.050
CD	342°	163°	179°	15.500
DE	281°	101°30'	179°30'	11.100
EA	260°30'	80°	180°30'	12.008

CALCULATION for included angles



$\angle A$ = FB. of AB − BB of EA = 158°30′ − 30° = 128°30′

$\angle B$ = 360° − 339° + 62° = 83°

$\angle C$ = 342° − 242° = 100°

$\angle D$ = 281° − 163° = 118°

$\angle E$ = 210°30′ − 101°30′ = 109°

Total sum = 538°30′

Theoretical sum = (2n − 4) × 90°

= 540°

∴ Error = Practical sum − theoretical sum

= 538°30′ − 540°

= −1°30′

& correction in each angle = $\frac{+1°30'}{5}$ = +18′

Hence, corrected angles:

$\angle A$ = 128°48′

$\angle B$ = 83°18′

$\angle C$ = 100°18′

$\angle D$ = 118°18′

$\angle E$ = 109°18′

Calculation for corrected fore bearing

Since there is no local attraction at station B, i.e., $|FB - BB| = 180°$

similarly, $\therefore (BC)_{FB} = 62°$

$(CD)_{FB} = 62° + 100° 18' + 180° = 342° 18'$

$(DE)_{FB} = 342° 18' + 118° 18' - 180° = 280° 36'$

$(EA)_{FB} = 280° 36' + 109° 18' - 180° = 209° 54'$

$(AB)_{FB} = 209° 54' + 128° 48' - 180° = 158° 42'$

$(BC)_{FB} = 158° 42' + 83° 18' - 180° = 62°$ (Check) ✓

Table 2:

Line	corrected FB	Corrected BB	Difference
AB	158°42'	338°42'	180°
BC	62°	242°	180°
CD	342°18'	162°18'	180°
DE	280°36'	100°36'	180°
EA	209°54'	29°54'	180°

✓

OBJECTIVE | 7

TWO PEG TEST FOR DETERMINATION OF LINE OF SIGHT ERROR / COLLIMATION ERROR

INSTRUMENTS REQUIRED:

Auto level → 1 Nos.
Sta Levelling staff → 2 Nos.
Measuring tape → 1 Nos (50 M)
Ranging rods → 3 Nos (optional)
Pegs → 3 Nos
Hammer → 1 Nos
Tripod stand → 1 Nos.

THEORY:

Levelling is a fundamental surveying process used to determine the relative heights of different points on the Earth's surface. It ensures the accuracy in construction & mapping. An autolevel machine maintains a constant horizontal line of sight with the help of an internal compensator. The collimation line is the imaginary horizontal line along which readings are taken through instrument. However, due to mechanical imperfections, the collimation line may deviate from true horizontal, resulting in collimation error.

The Two-Peg test is a practical method used to detect and adjust this error. By comparing readings at fixed distances, the accuracy of the instrument can be checked and corrected.

$$|\Delta h - \Delta h'| = \text{error}$$

$$\text{Precision} = \frac{1}{\frac{\text{horizontal distance}}{\text{error}}}$$

(should be higher than 1 : 10000)

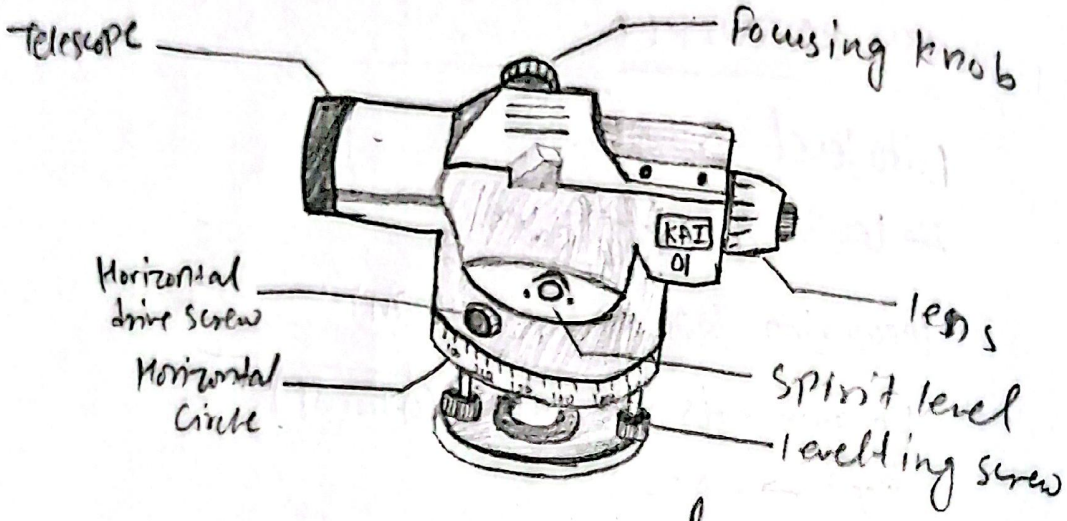


fig. Auto level

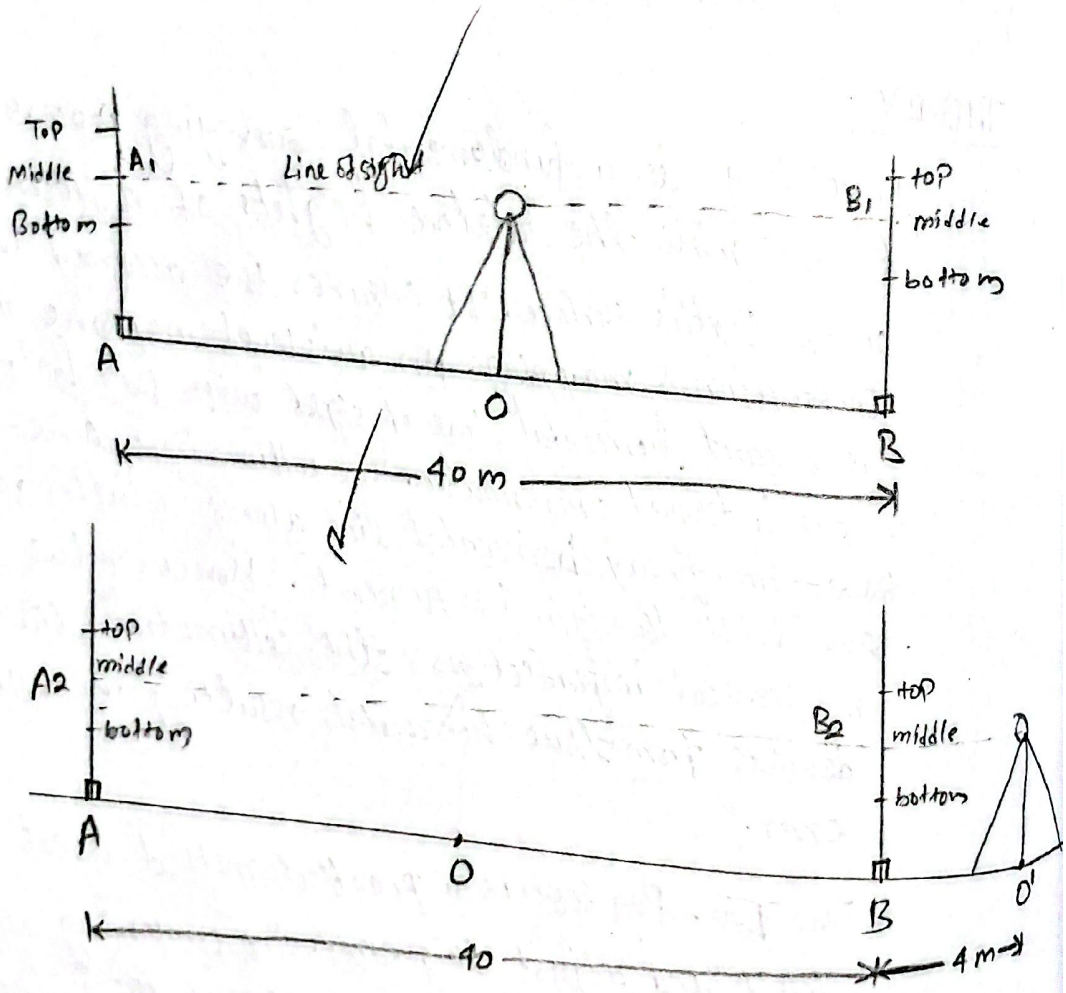


fig. Two-Peg Test

OBSERVATION & CALCULATION

Table 1:

Instrument at	Sighted to	Staff reading			Average (m)
		Top	Middle	Bottom	
O (midway of two pegs A & B)	A	1.375	1.175	1.075	1.175
	B	1.398	1.298	1.200	~~1.299~~ 1.299
O' (4m near B)	A	1.325	1.105	0.885	1.105
	B	1.245	1.226	1.207	1.226

Here, $a = 1.175$, $b = 1.299$, $a' = 1.105$, $b' = 1.226$, $AB = 40$ m

True difference $= \Delta h = |a - b| = 0.124$ m

Apparent difference $= \Delta h' = |a' - b'| = 0.121$ m

Now, error $= |\Delta h - \Delta h'|$

$= 3 \times 10^{-3}$ m

Hence, Precision $= \frac{1}{40/\text{error}} = \frac{1}{40/3\times10^{-3}} = \frac{1}{13333.33} = 1 : 13333.33$

which is higher than $1 : 10000$

RESULT:

The two peg test was carried out & the collimation error was found to be 3×10^{-3} m.

PRECAUTION:

(i) Temporary adjustment of the autolevel should be done properly

(ii) Readings should be taken carefully

02/12

PROCEDURES:

(i) As instructed by our teacher, 40m distance was measured and marked as A & B as end points and marked by pegs.

(ii) The center of the line AB was found i.e. O such that AO = BO = 20m.

(iii) The tripod stand was centered to the peg installed at point O and levelled.

(iv) The autolevel was then installed over it and the bubble in spirit level was levelled.

(v) The staff reading at points A & B was taken & noted.

(vi) The levelling machine was then installed at 4m near point B as shown in figure and staff reading at A & B was taken

(vii) The collimation error was found out.

OBJECTIVE 8 : DETERMINATION OF RL OF A ~~B~~ POINT BY FLY LEVELLING

INSTRUMENT REQUIRED :

→ Auto level Machine : 1 Nos
→ Hammer : 1 Nos
→ Pegs : 2 Nos
→ Staff level : 2 Nos
→ Turning plates : 2 Nos

Theory :

Levelling is the process of determining the relative height (reduced level) of points on Earth's surface using a level instrument like auto level and levelling staff.

There're various types of levelling, profile, fly, check levelling. In fly levelling, rapid measurements are taken to transfer RL from a known benchmark to a new point, often over long distances. Check levelling is performed as a verification step to ensure accuracy & eliminate cumulative errors. The RL of new points is calculated using the rise-and-fall method.

PROCEDURE :

(i) A bench mark was provided & there was another point whose RL was to be found. The backsight was taken with autolevel putting levelling staff right on the RL.

(ii) The almost equal distance was taken (BM to autolevel) and new point was established (marked by turning plate)

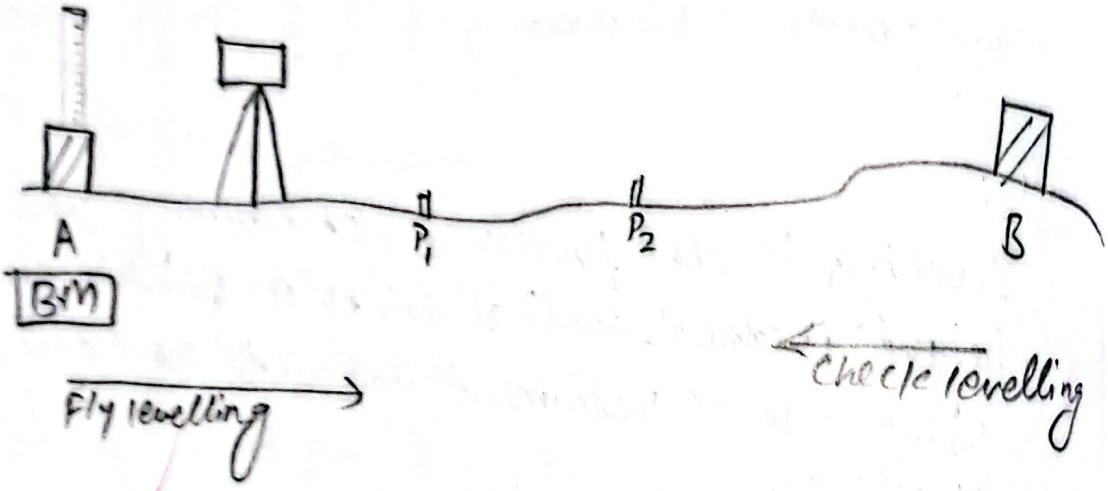


fig. Fly levelling

toward the point whose RL was to be determined. This is taken as Foresight (FS).

(iii) Suppose BM be 'A', another point be 'B' & the points in between 'A' & 'B' be P_1, P_2, ... Then after taking FS, P_2 was established & another machine was in between P_1 & P_2. Now, the reading of P_1 were taken as BS & that of P_2 were FS.

(iv) Similarly, the point B was reached & Fly levelling was completed.

(v) With similar process, check levelling was carried out to ensure the fly levelling was correct & the result of both levelling were compared.

OBSERVATION

Horizontal distance during fly levelling = ~~193.7m~~ 197.8m

Horizontal distance during check levelling = 193.7m

Total distance = 197.8 + 193.7 = 391.5m = 0.3915 km

Now permissible limit $= 24\sqrt{K}$

$= 24\sqrt{0.3915}$

$= 15.016$

True RL = 213.221 m

Observed RL = 213.219m

Error $= |213.219 - 213.221|$

$= 0.002$ m

Fly Levelling

Station Change	BS			Mean BS	S_1 (T-B)	FS			Mean FS	S_2 (T-B)	Rise (+)	Fall (-)	Elevation (m)	$S=S_1+S_2$	Horizontal distance (m) S*100	Remarks
	Top	Mid.	Bot.			Top	Mid.	Bot.								
1.	0.728	0.680	0.632	0.680	0.106								213.221	0.106	10.6	BM
2.	1.142	1.137	1.132	1.137	0.101	1.198	1.144	1.090	1.144	0.108		0.464	212.757	0.209	20.9	
3.	1.415	1.370	1.325	1.370	0.090	1.488	1.434	1.380	1.434	0.108		0.297	212.460	0.198	19.8	
4.	1.513	1.464	1.415	1.464	0.098	1.294	1.249	1.204	1.249	0.090	0.121		212.581	0.188	18.8	
5.	1.611	1.564	1.518	1.564	0.093	1.455	1.405	1.356	1.405	0.099	0.059		212.640	0.192	19.2	
6.	1.602	1.551	1.501	1.551	0.101	1.430	1.381	1.332	1.381	0.099	0.183		212.823	0.200	20	
7.	1.560	1.507	1.455	1.507	0.105	1.436	1.387	1.338	1.387	0.098	0.164		212.987	0.203	20.3	
8.	1.720	1.666	1.612	1.666	0.108	1.420	1.368	1.316	1.368	0.104	0.139		213.126	0.212	21.2	
9.	1.735	1.688	1.640	1.688	0.095	1.065	1.012	0.960	1.012	0.105	0.654		213.780	0.200	20	
10.	1.526	1.483	1.440	1.483	0.086	1.337	1.287	1.236	1.287	0.101	0.401		214.181	0.187	18.7	
11.						1.048	1.006	0.965	1.006	0.083	0.477		214.658	0.083	8.3	
														Total= 1.978	Total= 197.8	

Check Levelling

Station Change	BS			Mean BS	S_1 (T-B)	FS			Mean FS	S_2 (T-B)	Rise (+)	Fall (-)	Elevation (m)	$S=S_1+S_2$	Horizontal distance (m) S*100	Remarks
	Top	Mid.	Bot.			Top	Mid.	Bot.								
1.	1.164	1.074	0.985	1.074	0.179								214.658	0.179	17.9	
2.	0.945	0.858	0.772	0.858	0.173	1.809	1.823	1.738	1.823	0.171		0.749	213.909	0.344	34.4	
3.	1.456	1.373	1.290	1.373	0.166	1.695	1.610	1.525	1.610	0.170		0.752	213.157	0.336	33.6	
4.	1.482	1.402	1.322	1.402	0.160	1.600	1.519	1.438	1.519	0.162		0.146	213.011	0.322	32.2	
5.	1.342	1.256	1.170	1.256	0.172	1.652	1.569	1.487	1.569	0.165		0.167	212.844	0.337	33.7	
6.	1.375	1.313	1.252	1.313	0.123	1.487	1.392	1.302	1.392	0.180		0.136	212.708	0.303	30.3	
7.						0.861	0.802	0.744	0.802	0.116	0.511		213.219	0.116	11.6	
														Total= 1.937	Total= 193.7	

RESULT

The RL of Point B was found to be

PRECAUTIONS:

(i) To avoid personal errors, the readings on auto level should be taken carefully.

(ii) The distance between BS & FS stations from Auto level should be almost equal.

(iii) There should be proper centering of Auto level machine to get accurate readings.

OBJECTIVE 9 | TEMPORARY ADJUSTMENT OF THEODOLITE

INSTRUMENTS REQUIRED :

Theodolite – 1 Nos
Tripod stand – 1 Nos

THEORY

Theodolite is a precision optical instrument used in surveying for measuring horizontal & vertical angles. It plays a crucial role in triangulation, traversing etc. To make it ready for observation, temporary adjustments are necessary to ensure accuracy. These include: centering, levelling and focusing. centering is done by placing theodolite exactly over the station mark. Levelling is achieved by adjusting the instrument so that its vertical axis is truly vertical using the foot screws & spirit level. Focusing is done to remove parallax. Then, finally, theodolite is ready for reliable & precise measurements.

PROCEDURES |

1| Centering :

(i) Set up the tripod firmly over the station point and spread its leg for stability.

(ii) Using plumb bob, it is made sure it is above the Peg (exactly that marks the station).

(iii) Attach the theodolite to the tripod head securely & observe through optical plummet or laser if the vertical axis passes exactly over the station mark.

(iv) Adjust the tripod legs, two at a time laterally, towards or away from the station mark so that the laser beam coincides the middle of peg.

02/17

11 Levelling

(i) The screws of theodolite ~~sh~~ were brought to zero at the start of attachment to tripod.

(ii) Plate level was recommended by teacher and aligned parallel to any two legs of tripod stand and the bubble was centered by raising or lowering one leg at a time. Again the plate level was paralleled to another leg & again bubble was centered.

(iii) The process was continued till the bubble was centered all the time.

(iv) Use the screws to maintain the centering if necessary.

11 Focusing

(i) Eyepiece was focused by pointing telescope towards clear sky until the crosshairs are sharp & black.

(ii) Then, the object was ~~sight~~ sought and focusing knob was adjusted to make the image sharp & parallax free.

PRECAUTIONS

→ The laser beam should point the center of peg.

→ The spirit bubble should be at the centre of plate.

→ During reading, the theodolite should have face left position.