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**A REPORT
ON
SURVEYING PRACTICAL
SURVEYING – II (CE – 554)**



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Handwritten signature and date: 2080/12/05

Submitted To:
Survey Instruction Committee
Department Of Civil Engineering
Pulchowk Campus
Pulchowk , Lalitpur

RESECTION

OBJECTIVE:

TO find co-ordinate of the required point with help of known co-ordinate.

INSTRUMENT USED

- (i) Total station
- (ii) Tripod stand
- (iii) Prism, prism pole, prism stand
- (iv) Plumb bob.

THEORY

Resection is the method of co-ordinating the instrument station with the help of known-coordinates by measuring horizontal direction towards known.

We used Tienstra's method of 3-point resection for computation of co-ordinates of our traverse point.

Here, point P is instrument station and S, T, D are known points with coordinates shown.

Then,

Co-ordinate of P is computed as

$$E_P = \frac{k_1 E_A + k_2 E_B + k_3 E_C}{k_1 + k_2 + k_3}$$

$$N_P = \frac{k_1 N_A + k_2 N_B + k_3 N_C}{k_1 + k_2 + k_3}$$

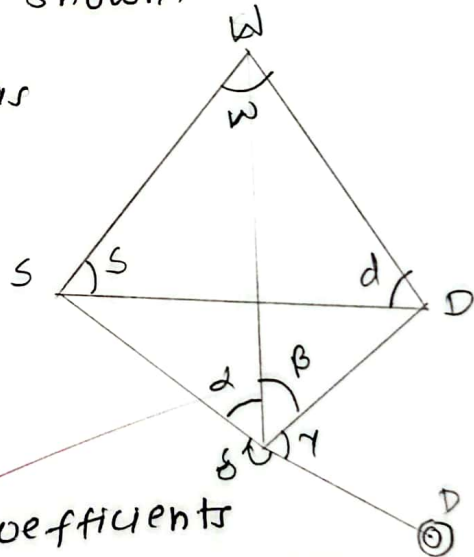
where,

$k_1, k_2, k_3 \rightarrow$ curvature coefficients

$\hookrightarrow$ If ΔABC is outside, $k \rightarrow +ve$

$\hookrightarrow$ If ΔABC inside, $k \rightarrow -ve$

$$k_1 = \frac{1}{\cot A - \cot \theta_1}, \quad k_2 = \frac{1}{\cot B - \cot \theta_2}, \quad k_3 = \frac{1}{\cot C - \cot \theta_3}$$

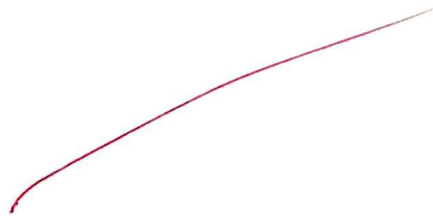


Resection is suitable for detailing or setting out. It is used for joining the map with national grid system. It is used to provide control points in a instrument station.

PROCEDURE

An unknown point P was fixed and the instrument was kept and temporarily adjusted. The point P was such chosen that three known points were visible along with one point along the major traverse. The instrument was adjusted and sighted to first known point and the reading was set to zero. Then sighting was done to second known point and horizontal angles were recorded. A station B, prism was fixed and the angles and two way lengths were taken. Later co-ordinate from P is transferred to the point on major traverse.

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Group No:

Observer:

Recorder:

Instrument:

Resection

Inst. St and Ht. of Inst.	Sighted to	F A C E	Set-I						Set-II						Mean Horizontal Angle {(I+II)/2}			Remarks
			HCR Observation			Horizontal Angle			HCR Observation			Horizontal Angle						
			d	m	s	d	m	s	d	m	s	d	m	s	d	m	s	
O	Syambhu	L	0	0	0				90	0	0							
		R	180	0	1				270	0	13							
	NTC Tower	L	18	13	45	18	13	51	108	13	37	18	13	37	18	13	44	
		R	198	13	58				288	13	49							
	Station C	L	140	25	37	122	11	52	230	25	29	122	11	53	122	11	53	Major Station
		R	320	25	50				50	25	43							
	D-Block	L	177	2	3	36	36	20	267	1	44	36	36	12	36	36	16	
		R	357	2	4				87	1	51							
	Syambhu	L	359	59	58	182	58	3	89	59	53	182	58	10	182	58	7	
		R	180	0	14				270	0	1							

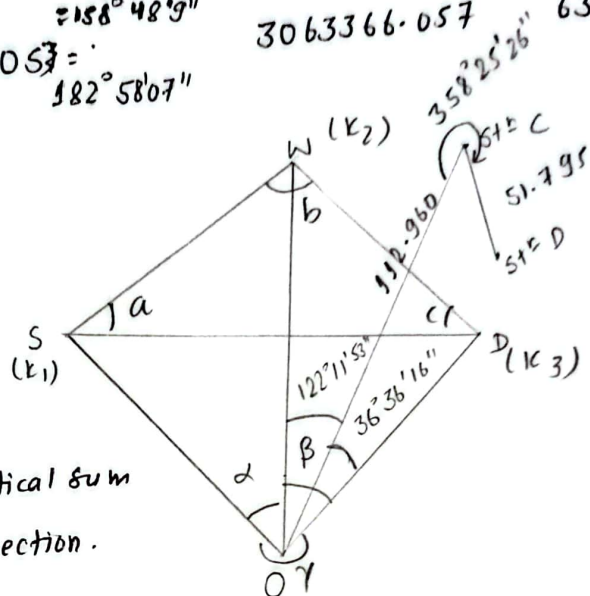
Known station	Horizontal angle	Northing	Easting
(S) Swayambhunath (S)	$\angle SON = 181^{\circ}3'44''$ (α)	3066928.474	627464.718
Wifi-Antenna (W)	$\angle NOD = 122^{\circ}11'53''$ (β) $+36^{\circ}36'16''$ $= 158^{\circ}48'9''$	3063451.150	630353.890
D-block Antenna (D)	$\angle DOS = 182^{\circ}58'07''$ (γ)	3063366.057	630413.780

$$\alpha + \beta < 180^{\circ}$$

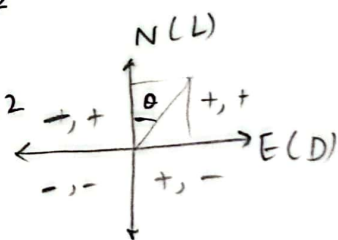
(Outside case)

Observed sum = Theoretical sum

So, no error & correction.



Line	Latitude (L)	Departure (D)
SW	-3477.324	2889.172
WD	-85.093	59.89
DS	3562.417	-2949.062



Bearings

$$\theta_{SW} = \tan^{-1} \left[\frac{D_{SW}}{L_{SW}} \right]$$

$$= S 39^{\circ}43'19'' E$$

$$\theta_{WD} = \tan^{-1} \left[\frac{D_{WD}}{L_{WD}} \right] = S 35^{\circ}8'19'' E$$

$$\theta_{DS} = \tan^{-1} \left[\frac{D_{DS}}{L_{DS}} \right] = N 39^{\circ}37'8'' W$$

Internal angles,

$$a = \theta_{SW} - \theta_{SD} = (S 39^{\circ}43'19'' E - S 39^{\circ}37'8'' E) = 0^{\circ}6'11''$$

$$b = \theta_{WS} - \theta_{WD} = (320^{\circ}16'41'' - 144^{\circ}51'41'') = 175^{\circ}25'0''$$

$$c = |\theta_{DW} - \theta_{DS}| = (324^{\circ}51'41'' - 320^{\circ}22'52'') = 4^{\circ}28'49''$$

$$a + b + c = 180^{\circ}00'00''$$

$$K_1 = \frac{1}{\cot \beta a - \cot \beta} = \frac{1}{\cot (0^{\circ}6'11'') - \cot (158^{\circ}48'9'')} \\ = 0.00179$$

$$K_2 = \frac{1}{\cot b - \cot \gamma} = \frac{1}{\cot (175^{\circ}25'0'') - \cot (182^{\circ}58'6'')} \\ = -0.03149$$

$$K_3 = \frac{1}{\cot c - \cot \alpha} = \frac{1}{\cot (4^{\circ}28'49'') - \cot (18^{\circ}13'44'')} \\ = 0.10282$$

Thus, coordinates of point on F-Block (O) is,

$$E_0 = \frac{K_1 E_S + K_2 E_W + K_3 E_D}{K_1 + K_2 + K_3} \\ = \frac{0.00179 \times 627464.718 + (-0.03149) \times (630353.890) + 0.10282 \times 630413.780}{0.00179 - 0.03149 + 0.10282} \\ = 630367.378 \text{ m E}$$

$$N_0 = \frac{K_1 N_S + K_2 N_W + K_3 N_D}{K_1 + K_2 + K_3} \\ = \frac{0.00179 \times 3066928.474 + (-0.03149) \times 3063451.150 + 0.10282 \times 3063366.057}{K_1 + K_2 + K_3} \\ = 3063416.62 \text{ m N.}$$

Thus, coordinate of O is
O (3063416.62 m N, 630367.378 m E)

$$\text{Bearing of OS} = \tan^{-1} \left[\frac{E_S - E_O}{N_S - N_O} \right]$$

$$= \tan^{-1} \left[\frac{627464.718 - 630367.378}{3066928.474 - 3063416.620} \right]$$

$$= \tan^{-1}(-0.82653) \left(\frac{270}{90} \right)$$

$$= N 39^\circ 34' 30'' W (RB)$$

$$= 320^\circ 25' 30'' (WCB)$$

$$\text{Bearing of OC} = \text{Bearing of OS} + \alpha + \beta + 122^\circ 11' 53''$$

$$(\theta_{OC}) = 320^\circ 25' 30'' + 18^\circ 13' 44'' + 122^\circ 11' 53'' - 180^\circ$$

$$= 220^\circ 51' 7'' (-51' 53'')$$

$$= 82^\circ 51' 7'' (WCB)$$

$$= 100^\circ 51' 7''$$

Thus,

Coordinates of station C,

$$N_C = N_O + OC \cos(\theta_{OC})$$

$$= 3063416.62 + 112.960 \times \cos(100^\circ 51' 7'')$$

$$= 3063395.353 \text{ m}$$

$$E_C = E_O + OC \sin(\theta_{OC})$$

$$= 630367.378 + 112.960 \times \sin(100^\circ 51' 7'')$$

$$= 630478.312 \text{ m}$$

Now,

$$\text{Bearing of CO, } \theta_{CO} = \tan^{-1} \left[\frac{E_O - E_C}{N_O - N_C} \right]$$

$$= \tan^{-1} \left[\frac{630367.378 - 630478.312}{3063416.620 - 3063395.353} \right]$$

$$= 280^\circ 51' 7'' (WCB)$$

$$= N 79^\circ 8' 53'' W (RB)$$

$$\text{Bearing of CD} = \theta_{CO} + 358^\circ 25' 26''$$

$$= 621^\circ 16' 33'' (-540^\circ)$$

$$= 279^\circ 16' 33'' (WCB)$$

TRAVERSING BY TOTAL STATION

OBJECTIVE

- (i) TO learn how to handle, operate and measure with total station.
- (ii) TO measure linear and angular data and find error and correct them.

INSTRUMENT USED

- (i) Total station
- (ii) Tripod
- (iii) Prism poles
- (iv) Prism target
- (v) Prism stand

THEORY:

Traversing is the type of survey in which connected series of lines form the framework where linear and angular measurements are done in field.

Traversing is used to establish control points with high precision for mapping and photogrammetric work. Also, to locate existing boundary line and to ascertain the reference points for the national and international grid system (co-ordinate system).

There are two types of traverse

(1) Closed traverse

- ↳ closed loop closed traverse
- ↳ open loop closed traverse

(2) Open traverse

1.(i) Closed loop closed traverse

(Major traverse)

- ↳ Traverse having same starting and ending points which is the known point
- ↳ Geometrically and mathematically closed

1.(ii) Open loop closed traverse

(Link traverse)

- ↳ Starting and ending points are not same but both are known points
- ↳ Geometrically ~~and~~ open and Mathematically closed.

PROCEDURE

- (i) Reconnaissance survey of the area.
- (ii) Station fixing (such that the stations are intervisible to one another)
- (iii) Referencing.

SPECIFICATIONS FOR MEASUREMENT

(i) Horizontal control specifications

- (i) Two set horizontal angle (0° and 90°)
- (ii) Face left (FL) and Face right (FR) angle difference $180^\circ \pm 2 \times \text{L.C.}$, L.C. $\rightarrow$ Least count
- (iii) Difference between set I and set II angle within $1'$
- (iv) Avoid straight angles.
- (v) Distance measurement two way.

For total station,

Precision: Major traverse $\rightarrow 1$ in 5000

Minor traverse $\rightarrow 1$ in 3000

(vi) Leg Ratio

Major $\rightarrow 1:2$

Minor $\rightarrow 1:3$

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Group No: _____

Observer _____

Recorder _____

Instrument _____

Horizontal Angle And Distance of Major Traverse

Inst. St and Ht. of Inst.	Sighted to	F A C E	Set-I						Set-II						Mean Horizontal Angle {(I+II)/2}			Horizontal Distance(m)	Remarks
			HCR Observation			Horizontal Angle			HCR Observation			Horizontal Angle			d	m	s		
			d	m	s	d	m	s	d	m	s	d	m	s					
A	H	L	0	0	0	62	53	15	9	0	0	62	53	22	62	53	18	47 621	
		R	180	0	12				270	0	6							67 29	
	B	L	62	53	21				152	53	18								
		R	242	53	21				332	53	31								
B	A	L	0	0	0	128	23	3	90	0	0	128	23	17	128	23	10	67 298	
		R	180	0	5				270	0	1								
	C	L	128	23	3				218	23	15							54 244	
		R	308	23	7				38	23	20								
C	B	L	0	0	0	71	51	49	90	0	0	71	51	49	71	51	49	54 234	
		R	180	0	12				270	0	2								
	D	L	71	51	49				161	51	47							51 791	
		R	251	52	1				341	51	53								
D	C	L	0	0	0	216	2	56	90	0	0	216	2	57	216	2	57	51 791	
		R	180	0	10				270	0	11								
	E	L	216	2	58				306	3	1							62 635	
		R	36	3	4				126	3	4								
E	D	L	0	0	0	107	39	7	90	0	0	107	39	7	407	39	7	62 635	
		R	180	0	12				270	0	11								
	F	L	107	39	14				197	39	11							48 219	
		R	287	39	11				17	39	13								
F	E	L	0	0	0	92	14	39	90	0	0	92	17	38	92	14	39	48 225	
		R	180	0	5				269	59	50								
	G	L	92	14	40				182	14	39							46 635	
		R	272	14	43				2	14	26								
G	F	L	0	0	0	120	10	16	90	0	0	120	10	18	120	10	17	46 634	
		R	179	59	57				270	0	3								
	H	L	120	10	2				210	10	18							40 883	
		R	306	10	17				30	10	20								
H	H	L	0	0	0	280	43	39	90	0	0	280	43	35	280	43	37	40 882	
		R	180	0	8				270	0	11								
	A	L	280	43	44				10	43	33							47 628	
		R	100	43	41				190	43	38								

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Minor Traverse by Total Station

Group No:

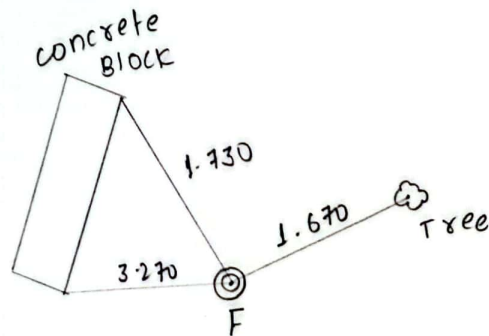
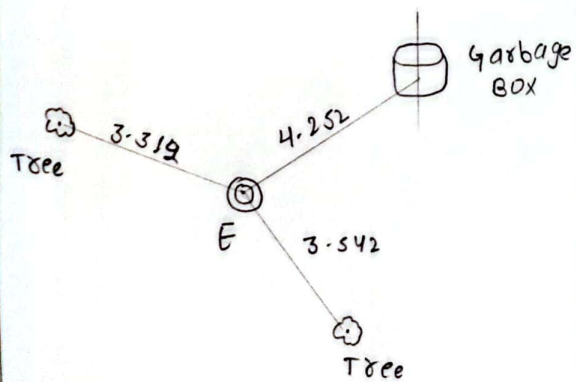
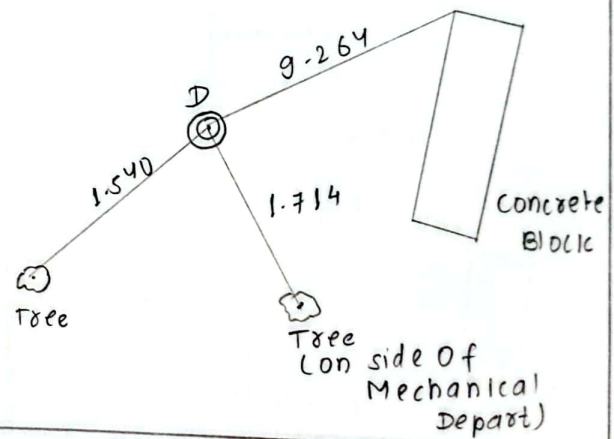
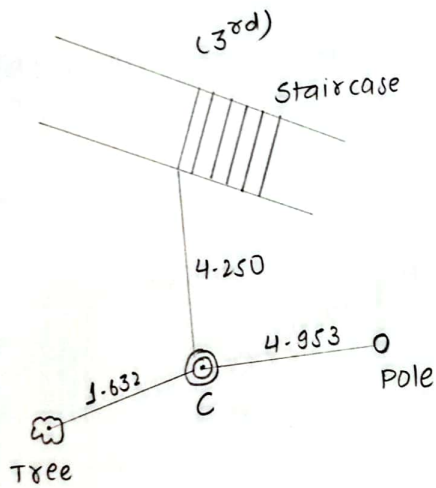
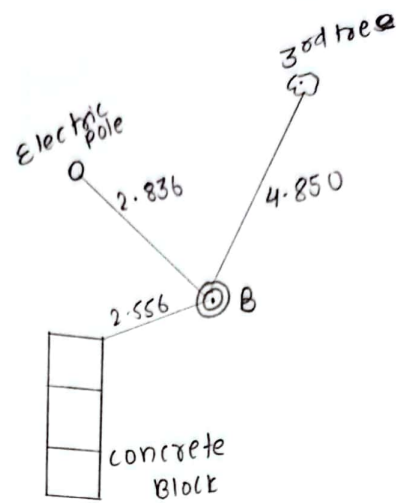
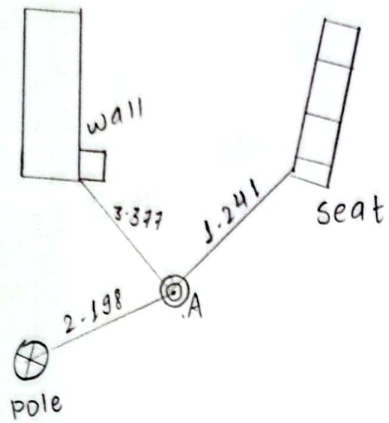
Observer:

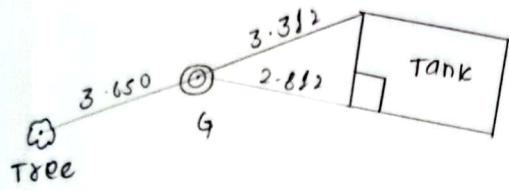
Recorder:

Instrument:

Inst. St and Ht. of Inst.	Sighted to	F A C E	HCR Observation			Mean		Mean Horizontal Angle {(I+II)}/2			Horizontal Distance(m)	Remarks
			d	m	s	m	s	d	m	s		
H	G	L	0	0	0	0	-3	98	35	54	40.878	Major Station
		R	179	59	55							
	a	L	98	35	56	35	51				25.142	
		R	278	35	46							
a	H	L	0	0	0	0	-3	320	20	50	25.142	
		R	179	59	55							
	b	L	320	20	35	20	31				19.286	
		R	140	20	27							
b	a	L	0	0	0	0	-2	62	5	34	19.286	
		R	179	59	57							
	D	L	62	5	56	5	48				20.598	
		R	242	5	41							
D	b	L	0	0	0	0	2	98	48	10	20.619	Major Station
		R	180	0	4							
	E	L	98	48	11	48	12				62.624	
		R	278	48	13							

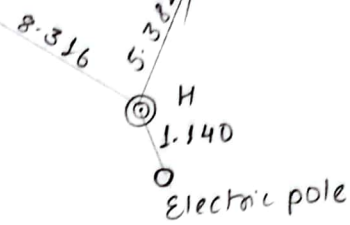
Referencing (Major traverse)



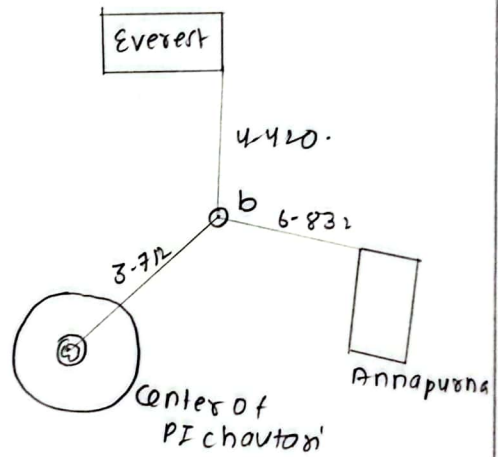
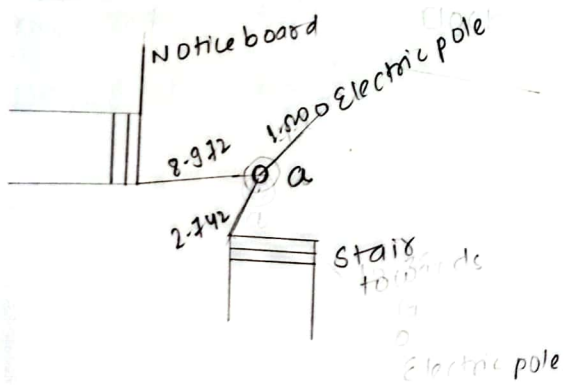


F-Block

way to PI Chautari



Referencing for Minor station



Permissible check:

For major traverse:

$$\text{Angular error (e)} = \text{Observed sum} - \text{Theoretical sum}$$

We have,

$$e = 1079^{\circ}59'1'' - \frac{1080^{\circ}}{(\text{For 8 stations})}$$

$$= 00'59''$$

$$\text{Permissible} = 30''\sqrt{N} = 30''\sqrt{8} = 1^{\circ}25''$$

Error distributed equally.

For minor traverse:

$$\text{Angular error (e)} = \text{calculated bearing} - \text{standard bearing}$$

(shown in Gales table)

Gales Table for Major and Minor traverse showing
Independent coordinates of traverse legs and
Adjusted length and Adjusted Bearing



Horizontal control Traverse Calculation

Co-ordinate Calculation of Control Station Gales Table

Group No: H3

Observer: 078BCE177, 078BCE178, 078BCE180, 078BCE195
Recorder:
Instrument:

Station	Leg	Length (m)	Corrected Horizontal Angle				WCB				Consecutive Co-ordinate		Correction		Corrected		Independent Co-ordinate		Adjusted length	Adjusted Bearing	Adjusted Bearing DMS	Remarks
			deg	min	sec	DD	deg	min	sec	DD	Latitude (Lcosθ)	Depature(Lsinθ)	For latitude	For depature	Latitude	Depature	Northing	Easting				
A	AB	67.29	62	53	26	62.8905556	79	1	53	79.03139	12.80334855	66.06071727	-0.001278799	0.011936626	12.80206975	66.07265389	3063334.387	630387.2544	67.301	79.03439122	79°02'54"	
B	BC	54.239	128	23	18	128.388333	27	25	11	27.41972	48.14562388	24.97735018	-0.001030774	0.009621499	48.14459311	24.98697168	3063347.189	630453.127	54.242	27.42974495	27°25'45"	
C	CD	51.795	71	51	57	71.8658333	279	17	8	279.2856	8.357383601	-51.11630038	-0.000984328	0.009187956	8.356399273	-51.10711242	3063395.334	630478.314	51.785	279.286121	279°17'10"	Known Point
D	DE	62.634	216	3	6	216.051667	315	20	14	315.3372	44.54882612	-44.02749195	-0.001190315	0.011110695	44.5476358	-44.01638125	3063403.69	630427.2069	62.625	315.340867	315°20'37"	
E	EF	48.222	107	39	15	107.654167	242	59	29	242.9914	-21.89878711	-42.96282588	-0.000916425	0.008554139	-21.89970353	-42.95427174	3063448.238	630383.1905	48.214	242.9838023	242°59'09"	
F	FG	46.634	92	14	47	92.2463889	155	14	16	155.2378	-42.34618303	19.53281185	-0.000886247	0.008272442	-42.34706928	19.54108429	3063426.338	630340.2562	46.638	155.2390054	155°13'44"	
G	GH	40.883	120	10	25	120.173611	95	24	41	95.41139	-3.855520493	40.70079423	-0.000776953	0.007252268	-3.856297446	40.70804649	3063383.991	630359.7773	40.89	95.41151438	95°24'41"	
H	HA	47.624	280	43	46	280.729444	196	8	27	196.1408	-45.74672262	-13.239439	-0.000905061	0.008448059	-45.74762768	-13.23099095	3063380.135	630400.4854	47.622	196.1307672	196°07'51"	
A																	3063334.387	630387.2544				
TOTAL		419.321				1080					0.007968903	-0.074383683	-0.007968903	0.074383683	0	0			419.317			

Precision: 1/5605.2

Horizontal control Traverse Calculation
Co-ordinate Calculation of Control Station
Gales Table
Minor Traverse by Total Station

Observer
Recorder
Instrument

Observer Recorder Instrument																															
Station	Leg	Length (m)	Observed HCR			WCB			Correction		Corrected WCB			Consecutive Co-ordinate		Correction		Corrected		Independent Co-ordinate		Adjusted Length	Adjusted Bearing	Adjusted Bearing in DMS	Remarks						
			deg	min	sec	deg	min	sec	deg	sec	deg	min	sec	DD	Latitude (cosθ)	Depature(sinθ)	For latitude	For depature	Latitude	Depature	Northing					Easting					
	G-H	40.876				95	24	41			95	24	41	95.411							3063380.135	630400.4854				Major Station					
H			98	35	54										24.3919	6.0955	-0.00305403	0.011404284	24.3888	6.106904	3063404.524	630406.592	25.14179961	14.0576729	14°07'28"	Minor Station					
	H-a	25.142				14	0	35	1	16	14	1	51	14.031																	
a			320	20	34										-17.392	8.3346	-0.00234269	0.008748032	-17.3943	8.343348	3063387.13	630414.936	19.29182765	154.3748889	154°22'30"	Minor Station					
	a-b	19.286				154	21	9	2	34	154	23	43	154.4																	
b			62	5	50																										
	b-D	20.608				36	26	59	3	49	36	30	48	36.513	16.563	12.2619	-0.00250328	0.009347684	16.5605	12.27125	3063403.69	630427.207	20.61149125	36.53826623	36°32'18"	Major Station					
D			98	48	10																										
	D-E	62.634				315	15	9	5	55	315	20	14	315.34																	
Total															23.5629	26.692			23.555	26.7215											
Total		168.546																													

$\Delta N = 23.555$ $\Sigma L = 23.5629$ $\Delta L = 23.5629 - 23.555$ $\Delta D = 26.692 - 26.7215$
 $\Delta E = 26.7215$ $\Sigma D = 26.6920$ 0.0079 -0.03

$e = 0.031$ Precision = $1 / 5435.95$

LEVELLING

OBJECTIVE:

TO find elevation difference between two points by differential levelling and thus compute RL of the instrument stations.

INSTRUMENTS

- (i) ~~IR~~ Auto-Level
- (ii) Tripod
- (iii) Levelling staff
- (iv) Measuring tape.

THEORY

Levelling is art of determining relative altitude of points above or below the surface of earth. It deals with measurement in vertical plane.

Loop Levelling

↳ Process of level transfer on every station point when distance is known

Specifications

- (i) Only middle wire reading taken
- (ii) Sight balance: $\pm 1m$
- (iii) Staff reading 0.6m to 3m
- (iv) permissible check.

$$e = \pm 24 \sqrt{k} \text{ m}$$

$k \rightarrow$ loop distance in km

'OR'

$$e = \pm 5 \sqrt{N} \text{ mm}$$

$N \rightarrow$ Number of setup of instrument

Calculations:

error = Calculated RL of A - standard RL of A

$$\text{Correction of RL of B} = \frac{l_1}{\sum_{i=1}^n l_i} \times e$$

Tribhuvan University
Institute of Engineering
Pulchowk Campus
Department of Civil Engineering
Survey Instruction Committee

Group No:

Observer:

Recorder:

Instrument:

FLY Levelling for RL of Station A

Sighted To	BS	FS	RISE	FALL	RL	Remarks
BM	0.714				1304.693	TBM
A		1.264		0.55	1304.143	

Sighted To	BS	FS	RISE	FALL	RL	Remarks
A	1.246				1304.143	
BM		0.696	0.55		1304.693	TBM

RL Calculation For Major Stations

Sighted To	BS	FS	RISE	FALL	RL	Corrected RL	Remarks
A	0.647				1304.143		
H	1.246	1.466		0.819	1303.324	1303.325	
G	0.819	1.121	0.125		1303.449	1303.451	
F	1.485	1.46		0.641	1302.808	1302.812	
E	1.218	0.845	0.64		1303.448	1303.453	
D	1.819	1.713		0.495	1302.953	1302.959	
C	1.519	2.087		0.268	1302.685	1302.693	
B	1.928	1.349	0.17		1302.855	1302.864	
PI	1.434	0.984	0.944		1303.799	1303.809	
BM		0.552	0.882		1304.681	1304.693	TBM

TOTAL:	12.115	11.577	2.761	2.223			
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RL Calculation For Minor Stations

Sighted To	BS	FS	RISE	FALL	RL	Corrected RL	Remarks
H	1.516				1303.324		Major Station
a	1.221	1.427	0.089		1303.413	1303.412	
b	0.722	1.136	0.085		1303.498	1303.497	
D		1.266		0.544	1302.954	1302.953	Major Station
TOTAL:	3.459	3.829	0.174	0.544			

DETAILING BY TOTAL STATION

OBJECTIVE:

- ↳ TO find independent co-ordinates of each detailing points. with se.
- ↳ TO draw map of the plot showing various details.
- ↳ TO draw contours of ground points.

INSTRUMENT USED

- TOTAL station
- Tripod
- Prism pole
- Prism stand
- Prism

THEORY:

There are two types of detailing taken

- Hard detailing (Man-made structures)
- Soft detailing (Ground points)

Before taking the detailing of points rough sketch (index sketch) was drawn in A3 sheet of whole plot and cumulative numbering was done

For any point 5 informations must be taken:

- Height of instrument (HI)
- Vertical distance from line of sight (VD)
- Target height
- Horizontal Angle
- Horizontal distance

Computations:

Co-ordinates:

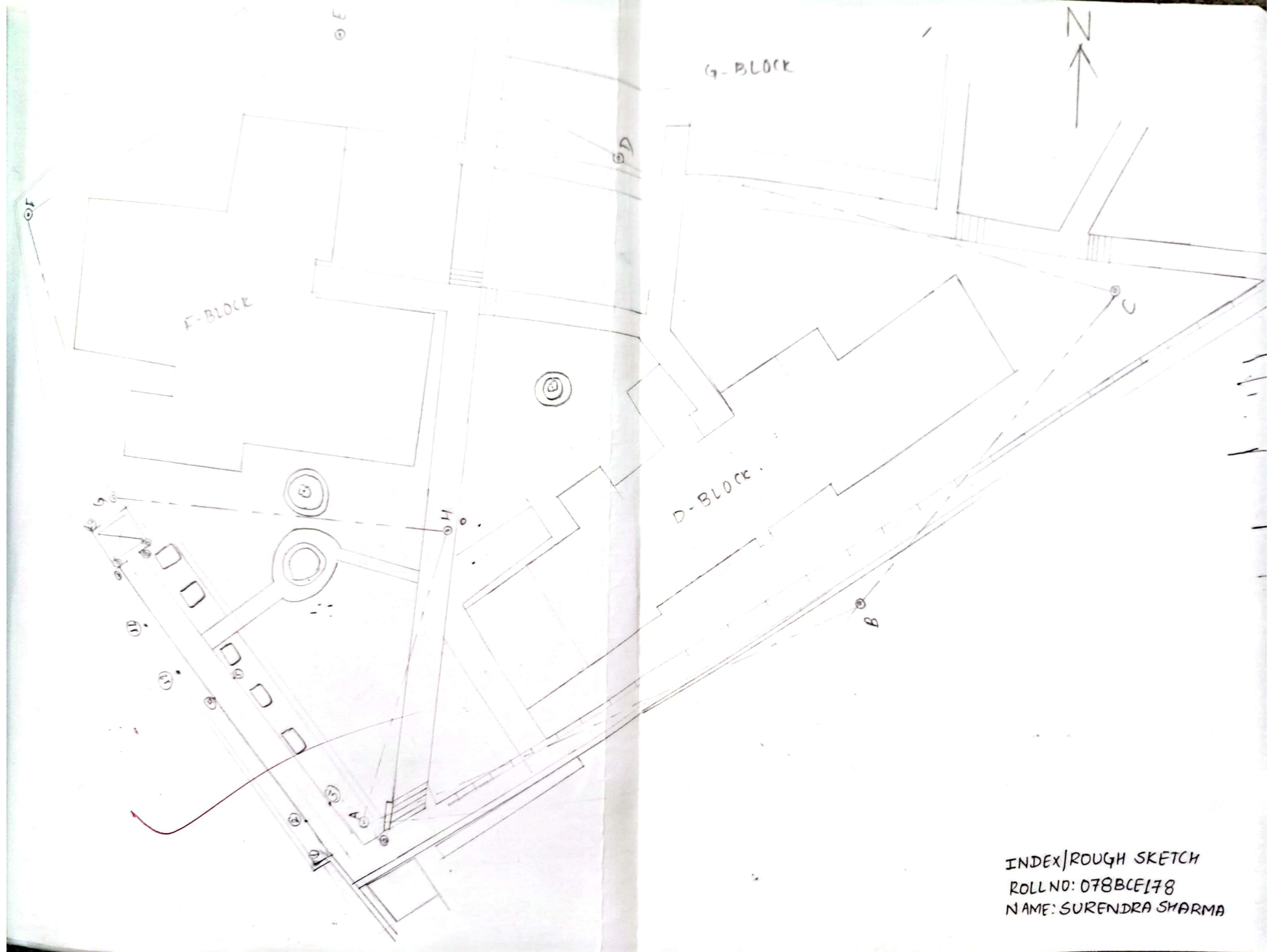
Noting of detailing pt.

$$N_{D.Pt} = N_{Inst.stn} + (H_{Inst.stn \rightarrow D.Pt}) \times \cos(\theta_{I-D})$$

D → D.Pt → Detailing point

I → Inst.stn → Instrument station

θ → Bearing H → Horizontal distance.



INDEX/ROUGH SKETCH
ROLL NO: 078BCE178
NAME: SURENDRA SHARMA

Instrument station and HI	Sighted to	Target Height	Horizontal Angle			Horizontal distance	Vertical distance(±) (m)	Horizontal Angle	Bearing	Northing (N)	Easting(E)	RL of point(m)	Remarks
			degrees(d)	minutes(m)	seconds(s)								
A (HI=1.488)	H	1.38	0	0	0	47.616	-0.923	0	16.130767	3063380.128	630400.4836	1303.328	
	1	1.4	225	12	25	3.41	0.269	225.20694	241.33771	3063332.751	630384.2623	1304.5	Compound wall
	2	1.38	295	25	27	4.816	-0.081	295.42417	311.55493	3063337.582	630383.6505	1304.17	Temple Way
	3	1.38	327	47	5	5.056	-0.078	327.78472	343.91549	3063339.245	630385.8536	1304.173	Temple Way
	4	1.38	309	17	55	28.645	-0.081	309.29861	325.42938	3063357.974	630371.0006	1304.17	Temple Way
	5	1.38	314	53	0	28.613	-0.094	314.88333	331.0141	3063359.416	630373.3887	1304.157	Temple Way
	6	1.4	314	14	32	39.418	-0.116	314.24222	330.37299	3063368.652	630367.768	1304.115	Temple Stair
	7	1.4	310	18	24	39.375	-0.127	310.30667	326.43743	3063367.198	630365.486	1304.104	Temple Stair
	8	1.4	314	11	7	42.611	0.29	314.18528	330.31604	3063371.406	630366.1528	1304.521	Temple wall
	9	1.4	311	7	14	41.688	0.29	311.12056	327.25132	3063369.449	630364.7031	1304.521	Temple wall
	10	1.4	310	2	40	44.957	0.65	310.04444	326.17521	3063371.735	630362.2289	1304.881	Temple wall
	11	1.4	315	49	29	31.31	0.093	315.82472	331.95549	3063362.021	630372.5338	1304.324	Compound wall
	12	1.4	299	51	27	16.438	0.139	299.8575	315.98827	3063346.209	630375.8332	1304.37	Compound wall
	13	2	152	7	39	3.94	0.655	152.1275	168.25827	3063330.529	630388.0562	1304.286	Compound wall
	14	1.4	68	3	18	5.674	0.039	68.055	84.185767	3063334.962	630392.8992	1304.27	Near Pole
	15	1.4	9	0	23	6.557	0.01	9.0063889	25.137156	3063340.323	630390.0397	1304.241	Stair
	16	1.4	347	16	37	6.624	-0.054	347.27694	3.4077114	3063340.999	630387.6481	1304.177	Stair
	17	1.4	336	16	8	3.407	-0.024	336.26889	352.39966	3063337.764	630386.8038	1304.207	Notice board
	18	1.4	5	1	10	7.802	-0.736	5.0194444	21.150211	3063341.663	630390.0695	1303.495	Way to Civil Department
	19	1.4	351	20	7	7.775	-0.832	351.33528	7.4660448	3063342.096	630388.2647	1303.399	Way to Civil Department
	20	1.4	344	44	45	7.459	-0.655	344.74583	0.8766003	3063341.845	630387.3685	1303.576	Way to Civil Department
	21	1.4	1	4	21	24.419	-0.762	1.0725	17.203267	3063357.714	630394.4766	1303.469	Electric Pole
	22	1.4	355	22	19	24.471	-0.764	355.37194	11.502711	3063358.367	630392.1343	1303.467	pole
	23	1.4	354	55	7	27.992	-0.692	354.91861	11.049378	3063361.86	630392.6192	1303.539	PI Chautari way
	24	1.4	355	31	24	29.221	-0.69	355.52333	11.6541	3063363.006	630393.1571	1303.541	PI Chautari way
	25	1.4	357	6	21	44.906	-0.828	357.10583	13.2366	3063378.1	630397.5366	1303.403	Way to Civil Department
	26	1.4	0	16	6	44.889	-0.809	0.2683333	16.3991	3063377.45	630399.9277	1303.422	Electric Pole
	27	1.4	1	42	28	32.247	-0.775	1.7077778	17.838545	3063365.084	630397.1328	1303.456	Way to Mechanical Department
	28	1.4	1	54	30	25.402	-0.741	1.9083333	18.0391	3063358.54	630395.1205	1303.49	Way to Mechanical Department
	29	1.4	10	19	37	2.451	0.328	10.326944	26.457711	3063336.581	630388.3464	1304.559	chautari
	30	1.4	125	11	1	4.854	-0.024	125.18361	141.31438	3063330.598	630390.2884	1304.207	Main way
	31	1.4	81	18	53	7.842	-0.007	81.314722	97.445489	3063333.371	630395.0303	1304.224	Main way
	32	1.42	61	28	59	1	-0.121	61.483056	77.613823	3063334.601	630388.2311	1304.09	Main way
	33	1.4	57	1	31	6.759	-0.005	57.025278	73.156045	3063336.346	630393.7234	1304.226	Helicopter pole
	34	1.4	29	37	28	9.836	-0.075	29.624444	45.755211	3063341.25	630394.3006	1304.156	Helicopter pole
	35	1.4	49	49	42	17.636	-0.001	49.828333	65.9591	3063341.572	630403.3606	1304.23	Helicopter pole
	36	1.4	103	43	40	11.382	0.003	103.72778	119.85854	3063328.72	630397.1255	1304.234	Main way
	37	1.4	91	18	32	15.473	-0.066	91.308889	107.43966	3063329.75	630402.0162	1304.165	Main way
	38	1.4	102	5	27	17.417	0.002	102.09083	118.2216	3063326.151	630402.601	1304.233	Guard house
	39	1.4	135	55	44	14.746	0.135	135.92889	152.05966	3063321.36	630394.1637	1304.366	Guard house
	40	1.4	141	30	38	9.848	0.107	141.51056	157.64132	3063325.279	630391.0006	1304.338	Gate
	41	1.4	67	36	43	28.792	-0.375	67.611944	83.742711	3063337.525	630415.8749	1303.856	Main road pole
	42	1.4	74	7	18	29.59	-0.251	74.121667	90.252434	3063334.257	630416.8441	1303.98	Main road pole
	43	1.4	72	11	1	40.178	-0.641	72.183611	88.314378	3063335.569	630427.415	1303.59	Bike Parking
	44	1.4	69	22	20	39.63	-0.645	69.372222	85.502989	3063337.494	630426.7624	1303.586	Bike Parking
	45	1.4	94	29	22	24.208	-0.371	94.489444	110.62021	3063325.862	630409.9115	1303.86	Bike Parking

Instrument station and HI	Sighted to	Target Height	Horizontal Angle			Horizontal distance(m)	Vertical distance(±)	Horizontal Angle	Bearing	Northing (N),(m)	Easting(E), (m)	RL of point(m)	Remarks
			degrees(d)	minutes(m)	seconds(s)								
H(HI=1.364m)	G	1.3	0	0	0	40.883	0.066	0	275.411389	3063383.991	630359.7846	1303.4551	starting point
	46	1.4	353	52	5	13.759	0.721	353.86806	269.279444	3063379.962	630386.7275	1304.0101	chautari center
	47	1.4	101	40	25	5.346	-0.027	101.67361	17.085	3063385.245	630402.056	1303.2621	pi chautari road point
	48	1.4	100	46	7	6.645	-0.039	100.76861	16.18	3063386.517	630402.3371	1303.2501	pi chautari road point
	49	1.4	89	0	48	12.023	-0.001	89.013333	4.42472222	3063392.122	630401.413	1303.2881	F Block chain gate
	50	1.4	91	27	36	16.036	-0.044	91.46	6.87138889	3063396.056	630402.404	1303.2451	F Block chain gate
	51	1.4	94	24	6	23.757	-0.003	94.401667	9.81305556	3063403.544	630404.5344	1303.2861	F block way
	52	1.4	93	58	24	22.754	-0.014	93.973333	9.38472222	3063402.584	630404.1957	1303.2751	F block way
	53	1.4	94	53	28	26.209	0.119	94.891111	10.3025	3063405.921	630405.1728	1303.4081	F block way
	54	1.4	101	34	24	23.671	0.148	101.57333	16.9847222	3063402.774	630407.4001	1303.4371	Notice board
	55	1.4	101	24	3	27.859	0.134	101.40083	16.8122222	3063406.803	630408.5432	1303.4231	„
	56	1.4	101	42	10	24.811	0.141	101.70278	17.1141667	3063403.847	630407.7867	1303.4301	road
	57	1.4	95	25	26	28.298	0.127	95.423889	10.8352778	3063407.928	630405.805	1303.4161	road
	58	1.4	100	36	41	28.186	0.14	100.61139	16.0227778	3063407.226	630408.2653	1303.4291	G block way
	59	1.4	100	25	54	28.796	-0.425	100.43167	15.8430556	3063407.837	630408.3468	1302.8641	step end
	60	1.4	95	19	20	28.946	-0.446	95.322222	10.7336111	3063408.575	630405.8764	1302.8431	step end
	61	1.4	100	8	11	38.358	-0.419	100.13639	15.5477778	3063417.089	630410.7669	1302.8701	G block way
	62	1.4	100	8	21	41.283	-0.475	100.13917	15.5505556	3063419.907	630411.5529	1302.8141	G block way
	63	1.4	96	42	12	41.459	-0.459	96.703333	12.1147222	3063420.671	630409.1864	1302.8301	F block way
	64	1.4	96	32	20	38.413	-0.466	96.538889	11.9502778	3063417.716	630408.4393	1302.8231	F block way
	65	1.4	100	34	18	60.505	-0.456	100.57167	15.9830556	3063438.301	630417.1456	1302.8331	G block corner
	66	1.4	100	5	46	59.427	-0.486	100.09611	15.5075	3063437.399	630416.3741	1302.8031	G block drainage corner
b(HI=1.267m)	D	1.3	0	0	0	20.612	-0.503	0	36.5383333	3063403.691	630427.2073	1302.961	Major station
	a	1.3	297	54	12	19.29	-0.019	297.90333	334.441667	3063404.532	630406.6134	1303.445	Minor station
	67	1.3	169	31	28	3.603	0.829	169.52444	206.062778	3063383.893	630413.3527	1304.293	Pi Chautari center
	68	1.3	215	10	38	6.042	-0.093	215.17722	251.715556	3063385.234	630409.1988	1303.371	Pi Chautari
	69	1.3	205	8	16	6.806	-0.121	205.13778	241.676111	3063383.901	630408.9445	1303.343	Pi Chautari
	70	1.3	190	4	37	9.973	-0.169	190.07694	226.615278	3063380.28	630407.6877	1303.295	pi chautari bench
	71	1.3	172	49	4	10.254	-0.104	172.81778	209.356111	3063378.193	630409.9088	1303.36	pi chautari bench
	72	1.3	183	26	58	7.841	-0.135	183.44944	219.987778	3063381.122	630409.8969	1303.329	pi chautari bench
	73	1.3	176	12	51	7.991	-0.128	176.21417	212.7525	3063380.409	630410.6125	1303.336	pi chautari bench
	74	1.3	189	23	4	12.471	-0.072	189.38444	225.922778	3063378.455	630405.9765	1303.392	pi chautari bench
	75	1.3	175	31	35	12.739	-0.019	175.52639	212.064722	3063376.334	630408.1729	1303.445	pi chautari bench
	76	1.3	135	2	18	9.102	-0.115	135.03833	171.576667	3063378.126	630416.269	1303.349	pi chautari bench
	77	1.3	115	43	28	7.733	-0.082	115.72444	152.262778	3063380.286	630418.5348	1303.382	pi chautari bench
	78	1.3	73	35	18	8.847	-0.038	73.588333	110.126667	3063384.086	630423.2425	1303.426	D-block tank
	79	1.3	78	53	4	10.016	0.015	78.884444	115.422778	3063382.83	630423.9818	1303.479	D-block tank
	80	1.3	58	5	44	8.956	0.357	58.095556	94.6338889	3063386.406	630423.8624	1303.821	D-block corner
	81	1.3	36	18	30	23.638	0.375	36.308333	72.8466666	3063394.102	630437.5223	1303.839	D-block corner
	82	1.3	82	43	13	10.661	0.027	82.720278	119.258611	3063381.919	630424.2366	1303.491	D-block water tank
	83	1.3	85	44	5	11.733	0.03	85.734722	122.273056	3063380.865	630424.8561	1303.494	D-block water tank
	84	1.3	89	31	59	18.095	0.342	89.533056	126.071389	3063376.476	630429.5616	1303.806	D-block corner
	85	1.3	148	10	46	20.022	0.285	148.17944	184.717778	3063367.176	630413.2889	1303.749	D-block corner
	86	1.3	162	5	3	15.104	0.266	162.08417	198.6225	3063372.817	630410.1125	1303.73	D-block corner
	87	1.3	175	56	47	21.379	-0.083	175.94639	212.484722	3063369.096	630403.4536	1303.381	D-block corner

Instrument station and HI b(HI=1.267m)	Sighted to	Target Height	Horizontal Angle			Horizontal distance	Vertical distance (t) (m)	Horizontal Angle	Bearing	Northing (N)	Easting (E)	RL of point (m)	Remarks
			degrees (d)	minutes (m)	seconds (s)								
	88	1.3	129	47	19	6.344	-0.06	129.78861	166.3269	3063380.966	630416.435	1303.404	pi chautari beanch road
	89	1.3	137	10	3	6.846	-0.073	137.1675	173.7058	3063380.325	630415.686	1303.391	pi chautari beanch road
	90	1.3	1	5	59	2.842	-0.125	1.0997222	37.63806	3063389.381	630416.671	1303.339	pi chautari beanch road
	91	1.3	301	48	2	3.445	-0.125	301.80056	338.3389	3063390.332	630413.664	1303.339	pi chautari beanch road
	92	1.3	279	25	47	6.592	-0.122	279.42972	315.9681	3063391.869	630410.354	1303.342	contour
	93	1.3	200	28	57	11.474	-0.172	200.4825	237.0208	3063380.884	630405.311	1303.292	contour
	94	1.3	145	56	18	12.275	-0.064	145.93833	182.4767	3063374.866	630414.405	1303.4	contour
	95	1.3	24	55	17	8.981	-0.067	24.921389	61.45972	3063391.421	630422.825	1303.397	contour
B/1.333	A	2	0	0	0	67.318	0.951	0	259.0344	3063334.384	630387.238	1303.148	
	96	1.28	24	36	19	9.677	0.004	24.605278	283.6397	3063349.471	630443.923	1302.921	
	97	1.28	25	44	22	7.796	0.174	25.739444	284.7739	3063349.177	630445.789	1303.091	
	98	1.28	74	7	26	5.749	0.18	74.123889	333.1583	3063352.319	630450.731	1303.097	
	99	1.28	14	35	4	7.639	0.038	14.584444	273.6189	3063347.671	630445.703	1302.955	
	100	1.28	352	1	13	5.519	0.094	352.02028	251.0547	3063345.397	630448.107	1303.011	
	101	1.28	307	44	50	3.985	0.156	307.74722	206.7817	3063343.631	630451.531	1303.073	
	102	1.28	297	21	43	2.845	0.065	297.36194	196.3964	3063344.46	630452.524	1302.982	
	103	1.28	236	22	1	7.894	0.201	236.36694	135.4014	3063341.568	630458.87	1303.118	
	104	1.28	235	30	18	25.071	0.325	235.505	134.5394	3063329.604	630471.197	1303.242	
	105	1.28	216	8	37	22.32	0.326	216.14361	115.1781	3063337.693	630473.526	1303.243	
	106	1.28	217	57	33	19.646	0.26	217.95917	116.9936	3063338.272	630470.833	1303.177	
	107	1.28	218	37	41	18.611	0.238	218.62806	117.6625	3063338.549	630469.811	1303.155	
	108	1.28	222	36	37	13.691	0.217	222.61028	121.6447	3063340.006	630464.982	1303.134	
	109	1.28	216	11	32	21.936	0.134	216.19222	115.2267	3063337.84	630473.171	1303.051	road
	110	1.28	212	20	25	22.189	0.471	212.34028	111.3747	3063339.102	630473.99	1303.388	
	111	1.28	180	21	25	20.834	-0.196	180.35694	79.39139	3063351.025	630473.805	1302.721	staircase top
	112	1.28	183	34	56	23.601	-0.383	183.58222	82.61667	3063350.222	630476.732	1302.534	stair next corner bottom
	113	1.28	180	26	31	24.221	-0.978	180.44194	79.47639	3063351.613	630477.141	1301.939	stair next first bottom
	114	1.28	176	45	35	21.615	-1.016	176.75972	75.79417	3063352.493	630474.281	1301.901	stair second corner
	115	1.28	174	41	28	32.182	-1.079	174.69111	73.72556	3063356.208	630484.219	1301.838	D block end
	116	1.28	175	9	44	31.457	-1.185	175.16222	74.19667	3063355.756	630483.595	1301.732	
	117	1.28	169	41	16	30.385	-1.86	169.68778	68.72222	3063358.215	630481.641	1301.057	Road
	118	1.28	167	53	58	26.021	-1.221	167.89944	66.93389	3063357.384	630477.268	1301.696	sitting place
	119	1.28	169	14	58	22.538	-1.195	169.24944	68.28389	3063355.528	630474.265	1301.722	
	120	1.28	173	42	54	21.807	-1.073	173.715	72.74944	3063353.656	630474.153	1301.844	Pole D block
	121	1.28	159	35	15	40.206	-1.145	159.5875	58.62194	3063368.124	630487.653	1301.772	D block First corner
	122	1.28	136	8	33	13.545	-0.83	136.1425	35.17694	3063358.26	630461.13	1302.087	
	123	1.28	73	52	38	5.757	-0.267	73.877222	332.9117	3063352.314	630450.705	1302.65	Chautari
	124	1.28	240	24	57	5.831	0.057	240.41583	139.4503	3063342.758	630457.118	1302.974	Chautari
	125	1.28	270	19	90	3.337	0.097	270.34167	169.3761	3063343.909	630453.942	1303.014	
	126	1.28	283	42	34	10.862	0.137	283.70944	182.7439	3063336.339	630452.807	1303.054	Road (Hydraulic lab side)
	127	1.28	234	49	30	21.661	0.216	234.825	133.8594	3063332.18	630468.945	1303.133	Heavy lab
	128	1.8	298	13	22	13.467	0.89	298.22278	197.2572	3063334.328	630449.332	1303.287	
	129	1.8	304	5	28	18.518	0.388	304.09111	203.1256	3063330.159	630446.054	1302.785	
	130	1.6	289	27	54	28.925	0.457	289.465	188.4994	3063318.582	630449.052	1303.054	
	131	1.5	286	58	10	21.48	0.298	286.96944	186.0039	3063325.827	630451.08	1302.995	
	132	1.5	261	59	51	14.813	0.717	261.9975	161.0319	3063333.18	630458.142	1303.414	
	133	1.28	6	44	34	14.83	0.126	6.7427778	265.7772	3063346.097	630438.537	1303.043	
	134	1.28	333	5	10	17.277	0.161	333.08611	232.1206	3063336.581	630439.69	1303.078	

Instrument station and HI	Sighted to	Target Height	Horizontal Angle			Horizontal distance(m)	Vertical distance(±)(m)	Horizontal Angle	Bearing	Northing (N)	Easting(E)	RL of point(m)	Remarks
			degrees(d)	minutes(m)	seconds(s)								
B/1.333	135	1.28	8	42	11	15.978	0.098	8.7030556	267.7375	3063346.558	630437.3615	1303.015	
	136	1.28	9	6	52	21.377	0.194	9.1144444	268.1489	3063346.498	630431.9612	1303.111	
	137	1.28	6	35	31	19.581	0.144	6.5919444	265.6264	3063345.696	630433.803	1303.061	Drain
	138	1.28	358	50	51	18.744	0.866	358.8475	257.8819	3063343.254	630435.0007	1303.783	
	139	1.28	338	50	30	10.323	0.755	338.84167	237.8761	3063341.7	630444.5844	1303.672	
	140	1.28	41	56	16	11.436	-0.155	41.937778	300.9722	3063353.074	630443.5216	1302.762	
	141	1.28	35	24	49	11.277	-0.096	35.413611	294.4481	3063351.856	630443.0611	1302.821	
	142	1.28	62	0	32	10.103	-0.292	62.008889	321.0433	3063355.045	630446.9749	1302.625	Pole +Road
	143	1.28	128	19	18	18.137	-0.881	128.32167	27.35611	3063363.298	630461.6613	1302.036	
	144	1.28	113	46	55	24.407	-0.977	113.78194	12.81639	3063370.988	630458.7411	1301.94	
	145	1.28	68	39	47	18.046	-0.234	68.663056	327.6975	3063362.442	630443.6834	1302.683	
	146	1.6	56	57	11	27.302	1.153	56.953056	315.9875	3063366.824	630434.3572	1303.75	
	147	2	12	57	20	37.628	1.521	12.955556	271.99	3063348.496	630415.7217	1303.718	
	148	1.28	6	38	9	44.729	0.807	6.6358333	265.6703	3063343.812	630408.7257	1303.724	
	149	1.28	9	45	21	40.273	1.166	9.7558333	268.7903	3063346.339	630413.063	1304.083	
	150	1.28	221	1	32	4.551	-0.152	221.02556	120.06	3063344.909	630457.2659	1302.765	
	151	1.28	210	22	52	12.299	-0.159	210.38111	109.4156	3063343.101	630464.9266	1302.758	
	152	1.28	198	41	47	14.439	-0.348	198.69639	97.73083	3063345.247	630467.6348	1302.569	
	153	1.28	188	4	20	15.047	-0.518	188.07222	87.10667	3063347.949	630468.3548	1302.399	
	154	1.28	178	31	24	15.791	-0.604	178.52333	77.55778	3063350.591	630468.7471	1302.313	
	155	1.28	165	55	16	17.002	-0.752	165.92111	64.95556	3063354.386	630468.7305	1302.165	
	156	1.28	154	42	47	18.532	-0.938	154.71306	53.7475	3063358.148	630468.2716	1301.979	
	157	1.28	146	32	47	19.627	-1.131	146.54639	45.58083	3063360.926	630467.3454	1301.786	
	158	1.28	140	30	16	13.449	-0.861	140.50444	39.53889	3063357.561	630461.8887	1302.056	
	159	1.28	121	7	2	7.985	-0.566	121.11722	20.15167	3063354.685	630456.0779	1302.351	
	160	1.28	168	10	3	19.257	-0.848	168.1675	67.20194	3063354.651	630471.0796	1302.069	
	161	1.28	162	54	51	21.045	-1.153	162.91417	61.94861	3063357.086	630471.8998	1301.764	
	162	1.28	157	13	6	22.946	-1.255	157.21833	56.25278	3063359.936	630472.4065	1301.662	
	163	1.28	151	0	57	21.897	-1.261	151.01583	50.05028	3063361.249	630470.1134	1301.656	
	164	1.28	160	0	25	24.026	-1.256	160.00694	59.04139	3063359.548	630473.9302	1301.661	
	165	1.28	161	38	42	26.671	-1.309	161.645	60.67944	3063360.25	630476.5813	1301.608	
	166	1.28	157	4	19	31.021	-1.586	157.07194	56.10639	3063364.488	630479.0767	1301.331	
	167	1.28	154	7	33	33.954	-1.839	154.12583	53.16028	3063367.547	630480.5009	1301.078	
	168	1.28	158	23	17	34.017	-1.422	158.38806	57.4225	3063365.505	630481.9919	1301.495	
	169	1.28	100	23	56	15.599	-0.59	100.39889	359.4333	3063362.787	630453.1727	1302.327	
	170	1.28	67	9	2	15.98	-0.285	67.150556	326.185	3063360.466	630444.4339	1302.632	
	171	1.28	42	52	9	16.849	-0.034	42.869167	301.9036	3063356.094	630439.0232	1302.883	
	172	1.28	107	25	18	32.487	0.425	107.42167	6.456111	3063379.47	630456.9799	1303.342	
	173	1.28	107	50	28	29.183	0.033	107.84111	6.875556	3063376.162	630456.8206	1302.95	
	174	1.28	106	7	40	24.65	-0.426	106.12778	5.162222	3063371.739	630455.5449	1302.491	
	175	1.28	88	28	45	25.16	0.454	88.479167	347.5136	3063371.754	630447.8872	1303.371	
	176	1.28	68	24	32	26.327	0.638	68.408889	327.4433	3063369.379	630439.1596	1303.555	
	177	2.05	68	58	20	20.654	0.796	68.972222	328.0067	3063364.706	630442.3841	1302.943	
	178	2.05	359	43	51	11.536	0.156	359.73083	258.7653	3063344.941	630442.0121	1302.303	
	179	2.05	239	56	50	12.226	0.313	239.94722	138.9817	3063337.964	630461.3509	1302.46	

Instrument station and HI	Sighted to	Target Height	Horizontal Angle			Horizontal distance	Vertical distance (m)	Horizontal Angle	Bearing	Northing (N)	Easting (E)	RL of point (m)	Remarks
			degrees(d)	minutes(m)	seconds(s)								
a/1.460	H	1.3	0	0	0	25.15	-0.252	0	194.058	3063380.13	630400.483	1303.32	
	180	1.3	83	13	49	26.735	-0.252	83.230278	277.288	3063407.92	630380.073	1303.32	
	181	1.3	100	12	49	22.994	0.176	100.21361	294.271	3063413.98	630385.63	1303.748	
	182	1.3	15	17	36	19.343	-0.445	15.293333	209.351	3063387.66	630397.111	1303.127	
	183	1.506	19	35	46	14.857	-0.198	19.596111	213.654	3063392.16	630398.359	1303.168	
	184	1.506	67	53	36	9.61	-0.433	67.893333	261.951	3063403.18	630397.077	1302.933	
	185	1.506	71	17	3	7.538	-0.435	71.284167	265.342	3063403.91	630399.079	1302.931	
	186	1.506	81	56	32	14.816	-0.159	81.942222	276	3063406.07	630391.857	1303.207	
	187	1.506	273	34	24	8.09	-0.625	273.57333	107.631	3063402.07	630414.302	1302.741	
	188	1.28	253	4	12	8.521	-0.627	253.07	87.1278	3063404.95	630415.102	1302.965	
	189	1.28	216	47	42	3.389	-0.586	216.795	50.8528	3063406.66	630409.22	1303.006	
	190	1.28	271	39	57	31.197	-0.519	271.66583	105.724	3063396.07	630436.622	1303.073	
	191	1.28	287	57	1	32.997	-0.53	287.95028	122.008	3063387.03	630434.573	1303.062	
	192	1.6	266	56	54	30.11	-0.253	266.94833	101.006	3063398.78	630436.148	1303.019	
	193	1.6	271	19	17	34.792	-0.024	271.32139	105.379	3063395.3	630440.138	1303.248	
	194	2.215	270	38	49	45.641	1.23	270.64694	104.705	3063392.94	630450.738	1303.887	
	195	1.28	267	59	5	54.076	1.211	267.98472	102.043	3063393.24	630459.478	1304.803	
	196	2.215	272	5	50	44.509	1.212	272.09722	106.155	3063392.14	630449.343	1303.869	
	197	2.215	271	57	8	35.276	0.962	271.95222	106.01	3063394.79	630440.5	1303.619	
	198	2.215	273	17	36	36.092	0.968	273.29333	107.351	3063393.76	630441.042	1303.625	
	199	1.28	273	42	52	34.286	-0.673	273.71444	107.772	3063394.06	630439.242	1302.919	
	200	1.28	273	30	45	33.55	-0.107	273.5125	107.57	3063394.4	630438.577	1303.485	
	201	1.28	269	25	46	28.742	-0.544	269.42944	103.487	3063397.82	630434.541	1303.048	
	202	1.28	273	21	58	27.333	-0.504	273.36611	107.424	3063396.34	630432.671	1303.088	
	203	1.28	273	12	49	31.387	-0.348	273.21361	107.271	3063395.21	630436.564	1303.244	
	204	1.28	266	55	57	33.755	-0.381	266.9325	100.99	3063398.09	630439.728	1303.211	
	205	1.28	267	37	59	39.684	-0.043	267.63306	101.691	3063396.48	630445.453	1303.549	
	206	1.28	280	14	44	10.646	-0.373	280.24556	114.303	3063400.14	630416.295	1303.219	
	207	1.28	246	25	33	8.965	-0.758	246.42583	80.4836	3063406.01	630415.434	1302.834	
	208	1.28	179	51	30	9.792	-0.652	179.85833	13.9161	3063414.03	630408.947	1302.94	
	209	1.28	92	60	9	10.429	-0.13	93.0025	287.06	3063407.58	630396.622	1303.462	
	210	1.28	40	15	58	9.884	-0.273	40.266111	234.324	3063398.76	630398.563	1303.319	
G/1.316	F	1.28	0	0	0	46.619	-0.671	0	335.218	3063426.32	630340.236	1302.816	
	211	1.28	5	55	48	31.365	-0.66	5.93	341.148	3063413.67	630349.642	1302.827	
	212	1.28	358	34	58	23.288	-0.695	358.58278	333.801	3063404.89	630349.496	1302.792	
	213	1.28	355	28	32	23.377	-0.481	355.47556	330.693	3063404.38	630348.335	1303.006	
	214	1.28	357	27	40	13.047	-0.538	357.46111	332.679	3063395.58	630353.789	1302.949	
	215	1.28	351	20	55	13.456	-0.342	351.34861	326.566	3063395.22	630352.363	1303.145	
	216	1.28	347	32	10	13.379	-0.574	347.53611	322.754	3063394.64	630351.68	1302.913	
	217	1.28	10	33	21	11.457	-0.565	10.555833	345.774	3063395.1	630356.962	1302.922	
	218	1.28	74	37	42	12.016	-0.569	74.628333	49.8461	3063391.74	630368.961	1302.918	
	219	1.28	91	46	37	2.797	-0.104	91.776944	66.9947	3063385.08	630362.352	1303.383	
	220	1.28	119	6	45	3.341	-0.201	119.1125	94.3303	3063383.74	630363.109	1303.286	
	221	1.28	62	48	21	3.023	-0.079	62.805833	38.0236	3063386.37	630361.639	1303.408	
	222	1.28	74	3	19	7.575	0.218	74.055278	49.2731	3063388.93	630365.518	1303.705	
	223	1.28	94	34	43	12.361	-0.293	94.578611	69.7964	3063388.26	630371.378	1303.194	
	224	1.28	90	51	41	11.654	-0.305	90.861389	66.0792	3063388.72	630370.43	1303.182	
	225	1.28	97	10	28	7.565	-0.22	97.174444	72.3922	3063386.28	630366.988	1303.267	

Instrument station and HI	Sighted to	Target Height	Horizontal Angle			Horizontal distance	Vertical distance(±) (m)	Horizontal Angle	Bearing	Northing (N)	Easting(E)	RL of point(m)	Remarks
			degrees(d)	minutes(m)	seconds(s)								
G/L 316	226	1.28	132	45	49	26.719	-0.236	132.7636111	107.9813889	3063375.743	630385.1913	1303.251	
	227	1.28	132	23	28	27.946	-0.215	132.3911111	107.6088889	3063375.537	630386.4139	1303.272	
	228	1.28	143	14	42	27.258	-0.211	143.245	118.4627778	3063371	630383.7405	1303.276	
	229	1.28	142	57	23	28.677	-0.195	142.9563889	118.1741667	3063370.451	630385.0565	1303.292	
	230	1.28	147	43	13	28.377	0.817	147.7202778	122.9380556	3063368.562	630383.5929	1304.304	
	231	1.28	155	9	53	27.689	-0.261	155.1647222	130.3825	3063366.052	630380.869	1303.226	
	232	1.28	160	20	6	28.364	-0.209	160.335	135.5527778	3063363.742	630379.6392	1303.278	
	233	1.28	166	23	6	29.327	-0.197	166.385	141.6027778	3063361.007	630377.9926	1303.29	
	234	1.28	166	32	50	30.85	-0.184	166.5472222	141.765	3063359.759	630378.87	1303.303	
	235	1.28	167	29	49	24.685	-0.195	167.4969444	142.7147222	3063364.351	630374.7311	1303.292	
	236	1.28	172	44	32	24.567	-0.164	172.7422222	147.96	3063363.166	630372.8104	1303.323	
	237	1.28	173	20	35	19.097	-0.151	173.3430556	148.5608334	3063367.698	630369.7382	1303.336	
	238	1.28	173	26	7	18.066	-0.169	173.4352778	148.6530556	3063368.562	630369.1756	1303.318	
	239	1.8	162	38	12	18.498	0.273	162.6366667	137.8544445	3063370.276	630372.1898	1303.24	
	240	1.8	165	44	12	19.387	0.297	165.7366667	140.9544445	3063368.934	630371.9899	1303.264	
	241	1.28	172	52	22	11.872	-0.169	172.8727778	148.0905556	3063373.913	630366.0526	1303.318	
	242	1.28	193	5	11	12.511	0.075	193.0863889	168.3041667	3063371.74	630362.3135	1303.562	
	243	1.28	184	42	30	11.972	-0.142	184.7083333	159.9261111	3063372.746	630363.8865	1303.345	
	244	1.28	201	14	26	9.04	-0.01	201.2405556	176.4583334	3063374.968	630360.3357	1303.477	
	245	1.28	109	9	7	37.552	-0.406	109.1519444	84.36972224	3063387.675	630397.1481	1303.081	
	246	1.28	99	36	6	26.486	-0.462	99.60166667	74.81944447	3063390.927	630385.3391	1303.025	
	247	1.28	187	19	42	13.187	0.88	187.3283333	162.5461111	3063371.411	630363.7326	1304.367	
	248	1.28	177	58	18	12.887	0.887	177.9716667	153.1894445	3063372.489	630365.5899	1304.374	
	249	1.28	157	23	58	12.548	-0.223	157.3994444	132.6172222	3063375.495	630369.0113	1303.264	
	250	1.28	134	31	9	13.737	-0.255	134.5191667	109.7369445	3063379.352	630372.7073	1303.232	
	251	1.28	113	33	1	14.499	-0.322	113.5502778	88.76805558	3063384.303	630374.2729	1303.165	
	252	1.28	51	7	58	5.079	-0.168	51.1327778	26.35055558	3063388.542	630362.0317	1303.319	
C/L 258	D	1.3	0	0	0	51.789	0.312	0	279.2861111	3063403.691	630427.2037	1302.963	
	253	1.3	53	11	49	14.103	0.206	53.19694444	332.4830556	3063407.842	630471.7983	1302.857	
	254	1.3	78	28	47	31.135	0.268	78.47972222	357.7658333	3063426.445	630477.1002	1302.919	
	255	1.3	88	56	35	33.355	0.075	88.94305556	8.229166666	3063428.346	630483.0882	1302.726	
	256	1.3	87	22	40	34.516	0.013	87.37777778	6.663888888	3063429.617	630482.3194	1302.664	
	257	1.3	97	41	54	27.721	-1.43	97.69833333	16.98444444	3063421.846	630486.4116	1301.221	
	258	1.72	135	16	42	19.649	-0.998	135.2783333	54.56444444	3063406.726	630494.3234	1301.233	
	259	1.3	142	42	44	19.374	-1.464	142.7122222	61.99833333	3063404.43	630495.42	1301.187	
	260	1.72	158	37	18	20.978	-1.002	158.6216667	77.90777778	3063399.729	630498.8265	1301.229	
	261	1.3	170	26	45	21.256	-2.053	170.4458333	89.73194444	3063395.433	630499.5698	1300.598	
	262	1.3	145	26	28	8.877	-2.141	145.4411111	64.72722222	3063399.124	630486.3413	1300.51	
	263	1.3	153	41	28	10.824	-2.175	153.6911111	72.97722222	3063398.503	630488.6638	1300.476	
	264	1.3	157	10	37	11.664	-2.287	157.1769444	76.46305555	3063398.064	630489.654	1300.364	
	265	1.3	171	18	26	10.662	-2.337	171.3072222	90.59333333	3063395.224	630488.9754	1300.314	
	266	1.3	133	37	45	7.176	-2.227	133.6291667	52.91527778	3063399.661	630484.0386	1300.424	
	267	1.3	115	5	30	6.097	-0.935	115.0916667	34.37777778	3063400.366	630481.7567	1301.716	
	268	1.3	60	58	30	6.972	-0.894	60.975	340.2611111	3063401.896	630475.9593	1301.757	
	269	1.3	47	6	57	8.638	0.423	47.11583333	326.4019444	3063402.529	630473.534	1303.074	
	270	1.485	28	59	13	7.058	0.578	28.98694444	308.2730556	3063399.706	630472.773	1303.044	
	271	1.3	36	59	20	11.115	0.391	36.98888889	316.275	3063403.366	630470.6313	1303.042	
	272	1.3	73	42	54	16.024	0.249	73.715	353.0011111	3063411.239	630476.3615	1302.9	

Instrument station and HI	Sighted to	Target Height	Horizontal Angle			Horizontal distance	Vertical distance(±) (m)	Horizontal Angle	Bearing	Northing (N)	Easting(E)	RL of point(m)	Remarks
			degrees(d)	minutes(m)	seconds(s)								
C/L 258	273	1.3	78	12	39	15.683	0.147	78.2108333	357.49694	3063411.002	630477.629	1302.798	
	274	1.3	77	5	35	14.5	0.194	77.0930556	356.37917	3063409.805	630477.398	1302.845	
	275	1.3	78	5	59	20.324	0.388	78.0997222	357.38583	3063415.637	630477.387	1303.039	
	276	1.3	79	14	10	22.68	0.154	79.2361111	358.52222	3063418.006	630477.729	1302.805	
	277	1.3	44	13	24	18.946	1.256	44.2233333	323.50944	3063410.566	630467.047	1303.907	
	278	1.3	352	38	21	22.915	0.978	352.639167	271.92528	3063396.104	630455.412	1303.629	contour
	279	1.3	347	2	24	21.887	1.093	347.04	266.32611	3063393.932	630456.472	1303.744	contour
	280	1.3	348	23	3	26.075	1.123	348.384167	267.67028	3063394.274	630452.261	1303.774	contour
	281	1.3	345	46	37	27.69	1.223	345.776944	265.06306	3063392.951	630450.727	1303.874	contour
	282	1.3	348	7	36	37.288	0.962	348.126667	267.41278	3063393.651	630441.064	1303.613	contour
	283	1.3	349	47	18	37.868	0.969	349.788333	269.07444	3063394.722	630440.451	1303.62	contour
	284	1.3	345	41	16	36.617	1.207	345.687778	264.97389	3063392.126	630441.838	1303.858	contour
	285	1.3	353	33	40	39.44	0.37	353.561111	272.84722	3063397.293	630438.923	1303.021	contour
	286	1.3	359	32	36	38.749	0.31	359.543333	278.82944	3063401.282	630440.024	1302.961	contour
	287	1.3	178	27	56	17.577	-2.046	178.465556	97.751667	3063392.963	630495.73	1300.605	contour
	288	1.3	222	43	36	20.873	-2.168	222.726667	142.01278	3063378.883	630491.161	1300.483	
	289	1.3	235	8	52	17.972	-2.483	235.147778	154.43389	3063379.122	630486.07	1300.168	
	290	1.3	240	40	34	23.15	2.332	240.676111	159.96222	3063373.585	630486.246	1304.983	
	291	1.3	247	33	32	23.887	-2.052	247.558889	166.845	3063372.074	630483.75	1300.599	
	292	1.3	239	35	18	25.891	-0.869	239.588333	158.87444	3063371.183	630487.645	1301.782	
	293	1.3	246	11	40	26.483	-0.925	246.194444	165.48056	3063369.697	630484.954	1301.726	
	294	1.3	230	20	48	29.392	-0.358	230.346667	149.63278	3063369.974	630493.173	1302.293	
	295	1.3	223	30	28	33.847	-0.341	223.507778	142.79389	3063368.376	630498.781	1302.31	
	296	1.3	241	37	7	28.844	-0.755	241.618611	160.90472	3063368.077	630487.75	1301.896	
	297	1.3	235	37	30	31.31	-0.756	235.625	154.91111	3063366.978	630491.59	1301.895	
	298	1.3	229	46	17	34.453	-0.341	229.771389	149.0575	3063365.784	630496.029	1302.31	
	299	1.3	229	7	59	34.942	-0.853	229.133056	148.41917	3063365.567	630496.613	1301.798	
	300	1.3	223	34	48	37.14	-1.146	223.58	142.86611	3063365.725	630500.735	1301.505	
	301	1.3	223	33	1	31.24	-1.012	223.550278	142.83639	3063370.438	630497.186	1301.639	
	302	1.3	223	40	53	34.214	-1.01	223.681389	142.9675	3063368.021	630498.92	1301.641	
	303	1.3	221	45	10	34.391	-1.61	221.752778	141.03889	3063368.592	630499.939	1301.041	
	304	1.3	222	26	19	37.301	-1.597	222.438611	141.72472	3063366.051	630501.42	1301.054	
	305	1.3	213	35	17	38.73	-1.687	213.588056	132.87417	3063368.982	630506.697	1300.964	
	306	1.3	212	4	16	39.103	-1.641	212.071111	131.35722	3063369.497	630507.665	1301.01	
	307	1.3	210	0	39	29.223	-2.097	210.010833	129.29694	3063376.826	630500.929	1300.554	
	308	1.3	203	30	2	30.98	-2.128	203.500556	122.78667	3063378.558	630504.359	1300.523	
	309	1.3	208	59	51	32.469	-2.146	208.9975	128.28361	3063375.218	630503.801	1300.505	
	310	1.3	213	42	44	32.969	-1.915	213.712222	132.99833	3063372.85	630502.427	1300.736	
	311	1.3	210	56	21	34.27	-1.861	210.939167	130.22528	3063373.203	630504.48	1300.79	contour
	312	1.3	210	44	2	27.883	-2.096	210.733889	130.02	3063377.404	630499.667	1300.555	contour
	313	1.3	222	42	36	26.114	-1.605	222.71	141.99611	3063374.757	630494.393	1301.046	contour
	314	1.3	229	40	47	27.127	-1.304	229.679722	148.96583	3063372.09	630492.299	1301.347	contour
	315	1.3	230	58	10	24.071	-1.254	230.969444	150.25556	3063374.434	630490.256	1301.397	contour
	316	1.3	202	2	33	30.349	-2.186	202.0425	121.32861	3063379.554	630504.238	1300.465	contour
	317	1.3	202	16	13	16.785	-2.698	202.270278	121.55639	3063386.55	630492.617	1299.953	contour
	318	1.3	212	32	10	19.376	-3.193	212.536111	131.82222	3063382.414	630492.753	1299.458	contour
	319	1.3	225	58	41	14.294	-2.774	225.978056	145.26417	3063383.587	630486.459	1299.877	contour
	320	1.3	215	44	31	12.123	-2.987	215.741944	135.02806	3063386.758	630486.882	1299.664	contour

Instrument station and HI	Sighted	to Target Height	Horizontal Angle degrees(d)	minutes(m)	seconds(s)	Horizontal distance	Vertical distance(±) (m)	Horizontal Angle	Bearing	Northing (N)	Easting(E)	RL of point(m)	Remarks
G/1 258	321	1.3	220	2	33	20.133	-3.064	220.0425	139.3286111	3063380.064	630491.4351	1299.587	contour
	322	1.3	202	31	4	12.052	-2.983	202.5177778	121.8038889	3063388.982	630488.5565	1299.668	contour
	323	1.3	234	37	53	8.907	-2.097	234.6313889	153.9175	3063387.334	630482.2301	1300.554	contour
	324	1.3	225	2	53	6.612	-1.578	225.0480556	144.3341667	3063389.962	630482.1692	1301.073	contour
	325	1.3	269	55	38	6.609	-0.681	269.9272222	189.2133333	3063388.81	630477.2558	1301.97	contour
	326	1.3	320	7	2	7.22	0.255	320.1172222	239.4033333	3063391.659	630472.0992	1302.906	contour
	327	1.3	346	26	46	9.327	0.443	346.4461111	265.7322222	3063394.64	630469.0129	1303.094	contour
	328	1.3	333	20	40	17.229	0.745	333.3444444	252.6305556	3063390.191	630461.8706	1303.396	contour
	329	1.3	332	25	56	19.302	0.802	332.4322222	251.7183333	3063389.279	630459.9863	1303.453	contour
	330	1.3	79	50	6	12.283	0.073	79.835	359.1211111	3063407.616	630478.1256	1302.724	contour
	331	1.3	94	12	29	11.208	-0.411	94.20805556	13.49416667	3063406.233	630480.9293	1302.24	contour
	332	1.3	111	41	41	11.644	-1.375	111.6947222	30.98083333	3063405.317	630484.3078	1301.276	contour
	333	1.3	112	59	10	16.436	-1.786	112.9861111	32.27222222	3063409.231	630487.0899	1300.865	contour
D/1 446	C	1.28	0	0	0	51.783	-0.422	0	99.28611111	3063395.334	630478.3113	1302.697	
	334	1.28	325	44	19	13.075	-0.187	325.7386111	65.02472222	3063409.211	630439.0593	1302.932	Road
	335	1.28	315	57	36	14.934	-0.262	315.96	55.24611111	3063412.203	630439.4768	1302.857	Road
	336	1.28	333	28	43	15.587	-0.169	333.4786111	72.76472222	3063408.308	630442.094	1302.95	Road
	337	1.28	330	3	51	19.345	-0.239	330.0641667	69.35027778	3063410.512	630445.3091	1302.88	Road
	338	1.28	334	36	42	21.866	-0.289	334.6116667	73.89777778	3063409.755	630448.2151	1302.83	Road
	339	1.28	323	25	20	18.502	-0.181	323.4222222	62.70833333	3063412.174	630443.6493	1302.938	Road
	340	1.28	316	21	49	21.017	-0.214	316.3636111	55.64972222	3063415.549	630444.5586	1302.905	chemical corner
	341	1.28	278	35	19	30.614	-0.349	278.5886111	17.87472222	3063432.826	630436.6035	1302.77	
	342	1.28	278	14	28	29.439	-0.443	278.2411111	17.52722222	3063431.762	630436.0727	1302.676	
	343	1.28	254	12	37	33.009	-0.419	254.2102778	353.4963889	3063436.487	630423.4681	1302.7	
	344	1.28	254	22	22	31.808	-0.495	254.3727778	353.6588889	3063435.303	630423.6938	1302.624	
	345	1.28	252	44	28	12.508	-0.299	252.7411111	352.0272222	3063416.077	630425.472	1302.82	Road
	346	1.28	252	8	9	9.265	-0.262	252.1358333	351.4219444	3063412.851	630425.825	1302.857	
	347	1.28	219	56	50	6.492	-0.223	219.9472222	319.2333333	3063408.607	630422.9678	1302.896	
	348	1.28	204	35	31	16.486	-0.34	204.5919444	303.8780556	3063412.88	630413.5198	1302.779	
	349	1.28	203	34	31	17.359	-0.434	203.5752778	302.8613889	3063413.109	630412.6256	1302.685	
	350	1.28	192	15	15	15.8	-0.317	192.2541667	291.5402778	3063409.491	630412.5104	1302.802	
	351	1.28	191	46	13	16.72	-0.425	191.7702778	291.0563889	3063409.697	630411.6033	1302.694	
	352	1.28	328	44	48	9.241	-0.202	328.7466667	68.03277778	3063407.147	630435.777	1302.917	
	353	1.28	331	52	8	10.042	-0.198	331.8688889	71.155	3063406.934	630436.7106	1302.921	
	354	1.28	349	53	23	7.806	-0.21	349.8897222	89.17583333	3063403.802	630435.0121	1302.909	
	355	1.28	352	6	6	8.426	-0.238	352.1016667	91.38777778	3063403.486	630435.6304	1302.881	
	356	1.28	351	36	46	6.013	-0.252	351.6127778	90.89888889	3063403.596	630433.2192	1302.867	
	357	1.28	203	25	50	12.038	-0.333	203.4305556	302.7166667	3063410.196	630417.0787	1302.786	
	358	1.28	237	25	26	22.304	-0.277	237.4238889	336.71	3063424.177	630418.3882	1302.842	contour
	359	1.28	286	37	18	26.067	-0.332	286.6216667	25.90777778	3063427.137	630438.5962	1302.787	contour
	360	1.28	265	10	58	14.175	-0.289	265.1827778	4.468888888	3063417.822	630428.3114	1302.83	contour
E/1 445	D	1.28	0	0	0	62.637	-0.663	0	135.3436111	3063403.682	630427.2151	1302.955	
	361	1.28	100	17	5	33.715	-0.538	100.2847222	235.6283333	3063429.204	630355.3624	1303.08	
	362	1.28	103	5	35	35.533	-0.562	103.0930556	238.4366667	3063429.639	630352.9142	1303.056	
	363	1.28	89	33	58	30.035	-0.385	89.56611111	224.9097222	3063426.967	630361.986	1303.233	
	364	1.28	88	37	35	31.039	-0.382	88.62638889	223.97	3063425.899	630361.6407	1303.236	
	365	1.28	85	57	20	25.579	-0.297	85.95555556	221.2991667	3063429.021	630366.3086	1303.321	
	366	1.28	65	56	9	27.43	-0.361	65.93583333	201.2794444	3063422.678	630373.2357	1303.257	
	367	1.28	60	14	31	26.207	-0.241	60.24194444	195.5855555	3063422.995	630376.1493	1303.377	
	368	1.28	58	18	30	27.279	-0.202	58.30833333	193.6519444	3063421.73	630376.752	1303.416	

Sighted to	Target Height	Horizontal Angle			Horizontal distance	Vertical distance(±) (m)	Horizontal Angle	Bearing	Northing (N)	Easting(E)	RL of point(m)	Remarks
		degrees(d)	minutes(m)	seconds(s)								
67.445	369	1.28	60									
	370	1.28		8	20	21.492	0.236	60.13888889	195.4825	3063427.526	630377.4533	1303.382
	371	1.28	60	10	14	15.098	-0.187	60.17055556	195.5141667	3063433.69	630379.1521	1303.431
	372	1.28	60	6	38	16.118	-0.208	60.11055556	195.4541667	3063432.703	630378.8956	1303.41
	373	1.28	46	41	2	16.462	-0.03	46.68388889	182.0275	3063431.786	630382.6081	1303.588
	374	1.28	46	32	8	18.554	-0.089	46.53555556	181.8791667	3063429.694	630382.5821	1303.529
	375	1.28	24	37	24	19.729	-0.031	24.62333333	159.9669444	3063429.703	630389.9489	1303.587
	376	1.28	20	59	17	19.436	-0.079	20.98805556	156.3316667	3063430.437	630390.9929	1303.539
	377	1.28	330	57	47	35.418	-0.43	330.9630556	106.3066667	3063438.293	630417.1837	1303.188
	378	1.28	331	29	54	32.467	-0.457	331.4983333	106.8419444	3063438.831	630414.2649	1303.161
	379	1.28	298	37	1	38.024	-0.458	298.6169444	73.96055554	3063458.744	630419.7343	1303.16
	380	1.28	288	32	10	31.61	-0.098	288.5361111	63.87972221	3063462.155	630411.5722	1303.52
	381	1.28	280	35	33	31.735	-0.015	280.5925	55.9361111	3063466.013	630409.4802	1303.603
	382	1.28	278	55	52	30.977	-0.053	278.9311111	54.27472221	3063466.325	630408.3384	1303.565
	383	1.28	274	58	34	20.888	-0.036	274.9761111	50.31972221	3063461.575	630399.2663	1303.582
	384	1.28	261	31	5	20.58	-0.405	261.5180556	36.86166666	3063464.704	630395.5361	1303.213
	385	1.28	257	9	38	26.103	-0.242	257.1605556	32.50416666	3063470.252	630397.2172	1303.376
	386	1.28	163	51	48	14.293	-0.325	163.8633333	299.2069444	3063455.212	630370.7147	1303.293
	387	1.28	161	7	48	12.335	-0.556	161.13	296.4736111	3063453.737	630372.149	1303.062
	388	1.28	135	54	25	19.9	-0.123	135.9069444	271.2505555	3063448.672	630363.2952	1303.495
	389	1.28	126	51	32	17.18	-0.473	126.8588889	262.2025	3063445.907	630366.1694	1303.145
	390	1.28	133	33	55	13.283	-0.2	133.5652778	268.9088889	3063447.985	630369.9099	1303.418
	391	1.28	166	20	41	9.1	-0.546	166.3447222	301.6883333	3063453.018	630375.4471	1303.072
	392	1.28	78	13	7	16.19	-0.179	78.21861111	213.5622222	3063434.747	630374.24	1303.439
	393	1.28	97	26	16	24.617	-0.424	97.43777778	232.7813889	3063433.348	630363.5872	1303.194
	394	1.28	6	36	17	12.309	-0.328	6.604722222	141.9483333	3063438.545	630390.7774	1303.29
	395	1.28	314	4	2	9.746	-0.057	314.0672222	89.41083332	3063448.338	630392.936	1303.561
	396	1.28	280	33	13	15.384	-0.304	280.5536111	55.89722221	3063456.863	630395.929	1303.314
		1.28	232	57	50	12.589	-0.195	232.9638889	8.307499989	3063460.695	630385.0094	1303.423
F/L315	E	1.28	0	0	0	48.218	0.61	0	62.9858333	3063448.239	630383.1933	1303.457
	397	1.28	12	5	24	7.055	-0.301	12.09	75.0758333	3063428.155	630347.0532	1302.546
	398	1.28	18	14	3	5.979	-0.257	18.23416667	81.21999997	3063427.251	630346.1451	1302.59
	399	1.28	342	53	40	4.801	-0.524	342.8944444	45.88027774	3063429.68	630343.6828	1302.323
	400	1.28	342	54	23	5.993	-0.366	342.9063889	45.89222219	3063430.509	630344.5394	1302.481
	401	1.28	241	22	33	8.315	-0.337	241.3758333	304.3616666	3063431.031	630333.3722	1302.51
	402	1.28	230	42	52	7.664	-0.396	230.7144444	293.7002777	3063429.419	630333.2186	1302.451
	403	1.28	112	57	59	11.787	0.106	112.9663889	175.9522222	3063414.58	630341.0682	1302.953
	404	1.28	86	17	35	15.697	-0.166	86.29305556	149.2788889	3063412.844	630348.2552	1302.681
	405	1.28	75	20	13	14.871	-0.047	75.33694444	138.3227777	3063415.231	630350.1244	1302.8
	406	1.28	88	50	1	35.439	0.058	88.83361111	151.8194444	3063395.1	630356.9723	1302.905
	407	2	91	39	30	35.631	0.733	91.65833333	154.6441666	3063394.139	630355.4948	1302.86
	408	1.7	94	14	1	18.692	0.504	94.23361111	157.2194444	3063409.104	630347.4738	1302.931
	409	1.28	325	10	41	7.494	-0.197	325.1780556	28.16388886	3063432.945	630343.7733	1302.65
	410	1.28	20	7	13	9.194	-0.154	20.12027778	83.10611108	3063427.442	630349.3637	1302.693
	411	1.6	94	24	25	15.155	0.138	94.40694444	157.3927777	3063412.347	630346.062	1302.665
	412	1.6	94	32	8	21.224	0.345	94.53555556	157.5213889	3063406.727	630348.351	1302.872
	413	1.6	246	14	2	5.879	-0.326	246.2338889	309.2197222	3063430.055	630335.6816	1302.201

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 E630015m
 E630010m
 E630005m
 E630000m



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ROLL NO.: 078BCE178
GROUP: H3

DETAILING BY TACHEOMETRIC METHOD.

OBJECTIVE

TO find details of point on plot by tacheometric method.

THEORY

Tacheometry is the branch of angular surveying in which horizontal and vertical distance of points are obtained by optical means though it has been of less accuracy. It is suitable for steep and broken ground; deep valleys where topography is difficult and taping is not possible.

Different tacheometric measurement system:

- (i) Stadia hair method.
- (ii) Tangential method
- (iii) Intersection method.

(i) Stadia Hair Method:

In field we did fixed hair method.

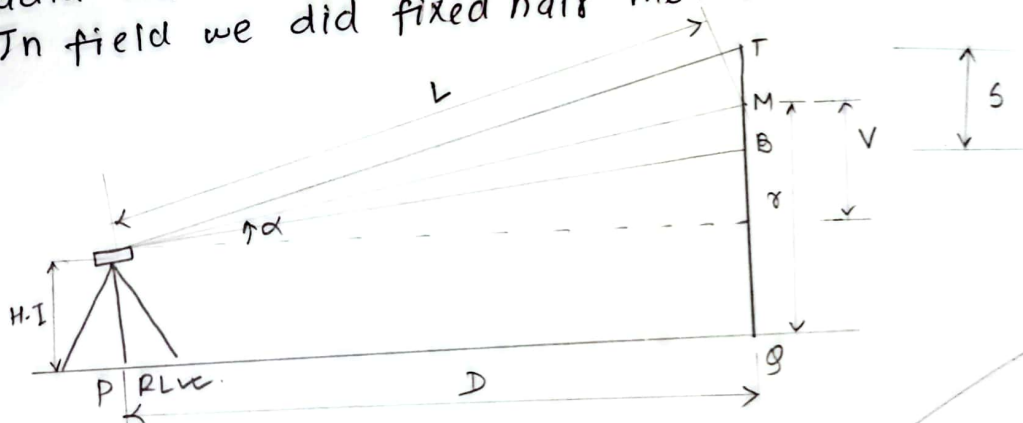


Fig: stadia Method

Procedure

- (i) Theodolite was set at traverse station (centering, levelling, elimination of parallax)
- (ii) Three wire reading T, M, B were taken
- (iii) vertical angle was read.
- (iv) horizontal distance of the point and its RL were calculated.

Calculation:-

$$\text{Inclined distance } (L) = Ks \cos \alpha + C$$

K = multiplying constant of theodolite

$\rightarrow 100$

$C \rightarrow$ additive constant = 0.

S = stadia interval

$$\text{Horizontal distance } (D) = L \cos \alpha$$

$$\text{Vertical distance above line of sight } (V) = L \sin \alpha$$

$$\text{RL of point } Q = \text{RL of Instrument station } (P) + HI + V - x$$

HI = height of instrument

x = central hair reading

Sample calculation,

For point L ,

$$\text{Stadia intercept } (s) = T - B = 1.908 - 1.846 = 0.062 \text{ m}$$

$$\text{Zenithal angle} = 87^\circ 45' 30''$$

$$\begin{aligned} \text{Vertical angle } (\alpha) &= 90^\circ - 87^\circ 45' 30'' \\ &= 2^\circ 14' 30'' \end{aligned}$$

$$\begin{aligned} \text{Inclined distance } (L) &= Ks \cos \alpha \\ &= 100 \times 0.062 \times \cos(2^\circ 14' 30'') \\ &= 6.195 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Horizontal distance } (D) &= L \cos \alpha \\ &= 6.195 \times \cos(2^\circ 14' 30'') \\ &= 6.191 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Vertical distance } (V) &= L \sin \alpha \\ &= 6.195 \times \sin(2^\circ 14' 30'') \\ &= 0.242 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{RL of } L &= \text{RL of } Q + HI + V - x \\ &= 1303.451 + 1.450 + 0.242 - 1.876 \\ &= 1303.267 \text{ m.} \end{aligned}$$

Observer :

RL of G = 1303.451m

Recorder :

Instrument :

TACHEOMETRY SURVEY SHEET

Weather :

Temperature :

Date :

Inst. Stn & Ht of Inst	Sighted to	Hz. Angle			Stadia Reading			Vrt. Angle, Zenithal			Stadia intercept S=T-B	Hz. Dst (m)	V ± (m)	R.L. of points (m)	Remarks
		d	m	s	Top	Mid	Bot	d	m	s					
G															
(1.450)	1				1.908	1.876	1.846	87°	45'	30"	0.062	6.191	0.243	1303.267	
	2				1.336	1.305	1.276	92°	12'	30"	0.06	5.991	-0.231	1303.365	
	3				1.912	1.881	1.852	87°	57'	30"	0.06	5.992	0.214	1303.234	
	4				1.780	1.747	1.712	88°	8'	00"	0.068	6.793	0.221	1303.375	
	5				1.586	1.552	1.523	91°	0'	30"	0.063	6.298	-0.111	1303.238	
	6				1.781	1.751	1.721	86°	03'	00"	0.060	5.972	0.412	1303.562	
	7				1.912	1.872	1.833	87°	31'	24"	0.079	7.885	0.341	1303.370	
	8				1.884	1.826	1.769	89°	15'	06"	0.115	11.498	0.150	1303.225	
	9				1.876	1.812	1.748	89°	15'	36"	0.128	12.798	0.165	1303.254	
	10				1.975	1.890	1.807	88°	40'	06"	0.168	16.791	0.390	1303.401	

Tangential Method.

It is a method of tacheometric surveying in which the vertical angles to the two targets fixed on level staff are taken, then using trigonometric relations, the required distance of the objects is calculated.

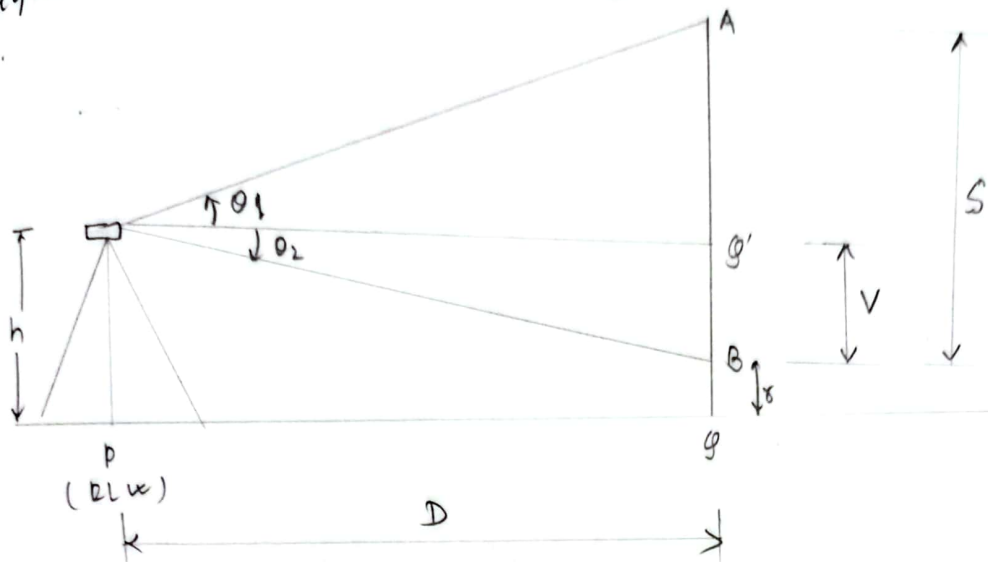


Fig: tangential Method.

When one at elevation and depression

From figure, $s = \text{staff interval}$

$$\text{Horizontal distance (D)} = \frac{s}{\tan \theta_1 + \tan \theta_2}$$

$$\begin{aligned} \text{Vertical distance (V)} &= D \tan \theta_2 \\ &= \frac{s \tan \theta_2}{\tan \theta_1 + \tan \theta_2} \end{aligned}$$

$$\text{RL of Q} = \text{RL of P} + \text{HI} \pm V - \gamma$$

$+$ $\rightarrow$ for elevation
 $-$ $\rightarrow$ for depression.

PROCEDURE:

- (i) Zenithal angle reading was taken at 1m and 2m of the staff.
- (ii) Calculations for horizontal distance and RL of staff station was taken.

Sample calculation

For point II,

Zenithal angle reading on staff

$$\text{At } 2\text{m} = 87^{\circ}22'18''$$

$$\text{At } 1\text{m} = 94^{\circ}37'48''$$

Vertical angle;

$$\begin{aligned}\text{At } 2\text{m}, \theta_1 &= 90^{\circ} - 87^{\circ}22'18'' \\ &= 2^{\circ}37'42'' \text{ (elevation)}\end{aligned}$$

$$\begin{aligned}\text{At } 1\text{m}, \theta_2 &= 94^{\circ}37'48'' - 90^{\circ} \\ &= 4^{\circ}37'48'' \text{ (depression)}\end{aligned}$$

$$\text{Staff intercept (s)} = 2 - 1 = 1\text{m}$$

$$\begin{aligned}\text{Horizontal distance (D)} &= \frac{s}{\tan \theta_1 + \tan \theta_2} \\ &= \frac{1}{\tan(2^{\circ}37'42'') + \tan(4^{\circ}37'48'')} \\ &= 7.881\text{m}\end{aligned}$$

$$\begin{aligned}\text{Vertical distance (V)} &= D \tan \theta_2 \\ &= 7.881 \times \tan(4^{\circ}37'48'') \\ &= 0.638\text{m}\end{aligned}$$

$$\begin{aligned}\text{RL of II} &= \text{RL of G} + \text{HI} \pm V - i \\ &= 1303.451 + 1.450 \pm - 0.638 - 1 \\ &= 1303.263\text{m}.\end{aligned}$$

Tangential Method

RL of G = 1303.451m

Institute of Engineering
Central Campus Pulchowk, Lalitpur, Nepal
DEPARTMENT OF CIVIL ENGINEERING
Survey Instruction Committee

Observer :

Recorder :

Instrument :

TACHEOMETRY SURVEY SHEET

Weather :

Temperature :

Date :

Inst. Stn & Ht of Inst	Sighted to	Hz. Angle			Stadia Reading			Vrt. Angle/Zenithal			Stadia intercept S=T-B	Hz. Dst (m)	V ± (m)	R L of points (m)	Remarks
		d	m	s	Top	Mid	Bot	d	m	s					
G (1.450)	11				2.000			87°	22	18					
							1.000	94	37	48					
											1.000	7.881	0.638	1303.263	
	12				2.000			86°	12'	24"					
							1.000	94°	34'	00"					
											1.000	6.841	0.546	1303.354	
	13.				2.000			86°	56'	18"					
							1.000	95°	39'	36"					
											1.000	6.553	0.649	1303.252	
	14.				2.000			86°	57'	12"					
							1.000	95°	10'	00"					
											1.000	6.962	0.629	1303.271	
	15.				2.000			86°	35'	12"					
							1.000	96°	41'	12"					
											1.000	5.654	0.663	1303.238	

INTERSECTION

OBJECTIVE

To find the co-ordinate of inaccessible point with the help of co-ordinates of known points.

INSTRUMENTS

- (i) ~~Total~~ Theodolite
- (ii) Tripod

THEORY

Intersection is the process of finding the co-ordinates of unknown inaccessible point with the help of ~~two~~ co-ordinates of known accessible point.

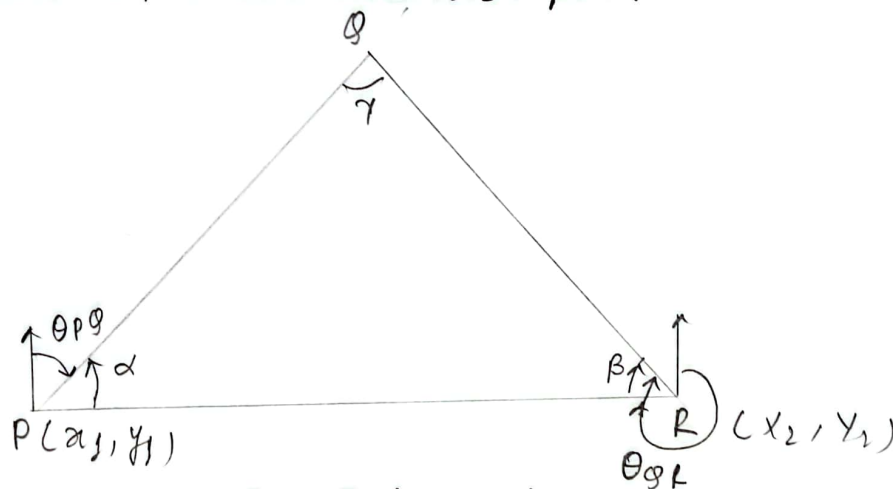


Fig: Intersection.

P and R are known points.

$$PQ = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$\text{Bearing; } \theta_{PQ} = \tan^{-1} \left(\frac{x_2 - x_1}{y_2 - y_1} \right)$$

α , & β angles are read.

$$\gamma = 180^\circ - \alpha - \beta.$$

Using sine rule,

$$\frac{\sin \alpha}{RQ} = \frac{\sin \beta}{PQ} = \frac{\sin \gamma}{PR}$$

$$x_Q = \frac{(x_1 + PQ \sin \theta_{PQ}) + (x_2 + RQ \sin \theta_{RQ})}{2}$$

$$y_Q = \frac{(y_1 + PQ \cos \theta_{PQ}) + (y_2 + RQ \cos \theta_{RQ})}{2}$$

PROCEDURE

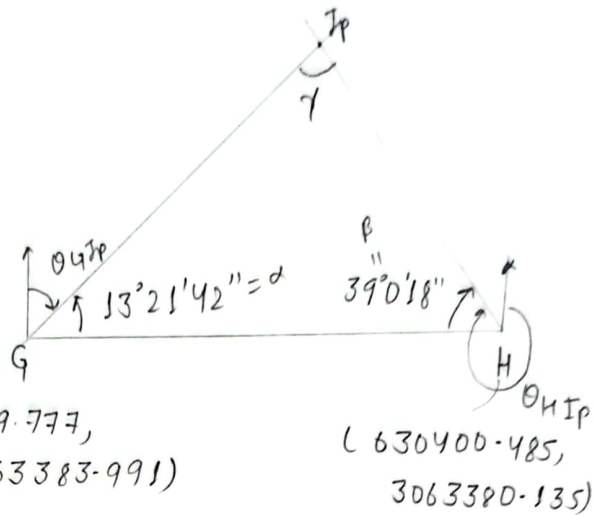
- (i) TS was set at known point
- (ii) setting zero at next known point Horizontal angle was read at unknown point.
- (iii) TS was set at next known point and zero setting at previous known point horizontal angle was read.

OBSERVATION

Bearing of GH

$$\theta_{GH} = \tan^{-1} \left(\frac{x_2 - x_1}{y_2 - y_1} \right)$$

$$= 95^\circ 24' 41''$$



$$\gamma = 180^\circ - \alpha - \beta$$

$$= 127^\circ 38' 0''$$

$$\text{Distance GH} = 40.890 \text{ m}$$

CALCULATIONS

Here,

$$\text{Bearing, } \theta_{GIp} = \theta_{GH} - \alpha$$

$$= 82^\circ 2' 59''$$

$$\theta_{HIp} = \theta_{HG} + \beta$$

$$= 314^\circ 24' 59''$$

Using sine law,

$$\frac{\sin(13^\circ 21' 42'')}{HIp} = \frac{\sin(39^\circ 0' 18'')}{GIp} = \frac{\sin(127^\circ 38' 06'')}{GH}$$

$$\Rightarrow HIp = 11.932 \text{ m}$$

$$GIp = 32.497 \text{ m}$$

Coordinates of intersection point,

$$x_{fp} = \frac{[630359.777 + 32.497 \times \sin(82^\circ 2' 59'')] + [630400.485 + 11.932 \sin(314^\circ 24' 59'')]}{2}$$

$$= 630391.962m$$

$$y_p = \frac{[3063383.991 + 32.497 \times \cos(82^\circ 2' 59'')] + [3063380.135 + 11.932 \cos(314^\circ 24' 59'')]}{2}$$

$$= 3063388.487m$$

RESULT

Hence, co-ordinates of intersection point was
(630391.962m E, 3063388.487m N)

DISCUSSION AND CONCLUSION

Hence, we found co-ordinate of inaccessible point with the help of co-ordinate of known points by intersection method using theodolite.

TRIGONOMETRIC LEVELLING

OBJECTIVE

→ To determine the RL of an elevated point that has base inaccessible in some and different vertical plane by trigonometric levelling.

INSTRUMENT AND ACCESSORIES

- Tripod
- Total station
- Prism, prism pole and prism stand
- Plumb bob
- Measuring tape
- Pegs.

THEORY:

Trigonometric levelling is an indirect method of levelling in which the relative height of various points are determined from the vertical angles measured with theodolite and horizontal distance measured with a help of EDM. It isn't as accurate as direct levelling.

It generally is used in topographic work and in very rough terrain where direct levelling is difficult.

The principle of trigonometric levelling is to find the required RL of any point as the principle of triangle and its properties with the use of trigonometric levelling.

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Case I: When instrument are in same vertical plane at different level.

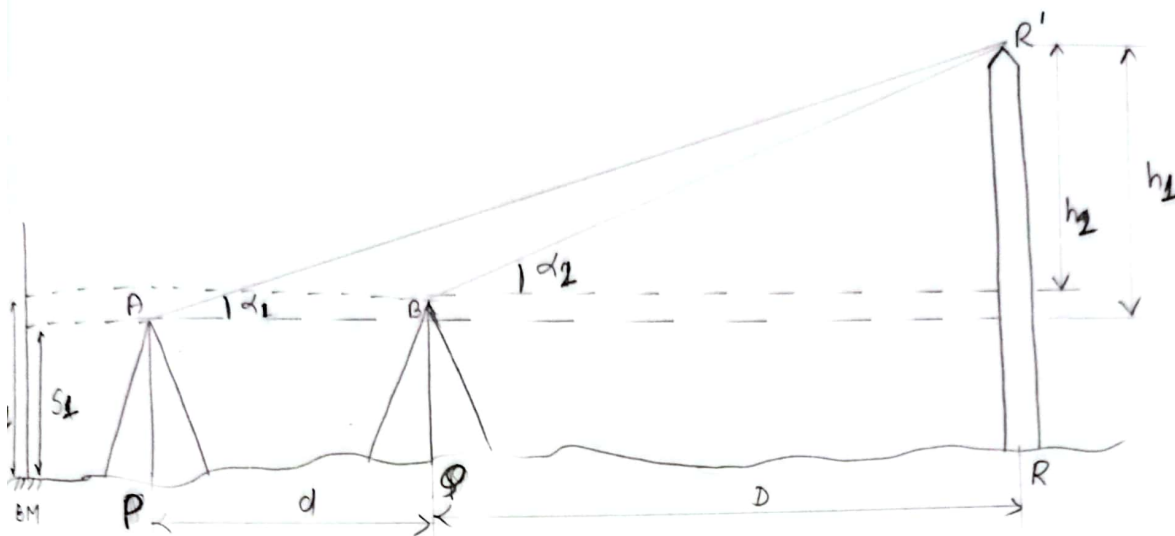


Fig: Instrumental setup for Trigonometric Levelling when instruments and elevated point (Dhazhara) are in same vertical plane.

SN	Instrument station	Zenithal angle		Target pt.	Staff reading on BM	Mean Vertical angle	Remarks
		FL	FR				
1	P	87°43'26"	272°16'21"	Dhazhara	S ₁ = 0.037	2°16'30"	
2	Q	87°43'02"	272°16'42"	Dhazhara	S ₂ = 0.721	2°16'50"	

distance between p and Q, PQ = d = 22.974m.

From figure,

$$h_2 = D \tan \alpha_2 = D \tan (2^\circ 16' 50'') \quad \text{--- (i)}$$

$$h_1 = (D + 22.974) \tan \alpha_1 = (D + 22.974) \tan (2^\circ 16' 30'') \quad \text{--- (ii)}$$

Subtracting (i) from (ii)

$$0.721 - 0.037 = h_1 - h_2 = S_2 - S_1 = (D + 22.974) \tan (2^\circ 16' 30'') - D \tan (2^\circ 16' 50'')$$

$$\text{Solving, } [D = 2354.818\text{m}]$$

Given,

Standard RL of BM = 1290.125m.

Then,

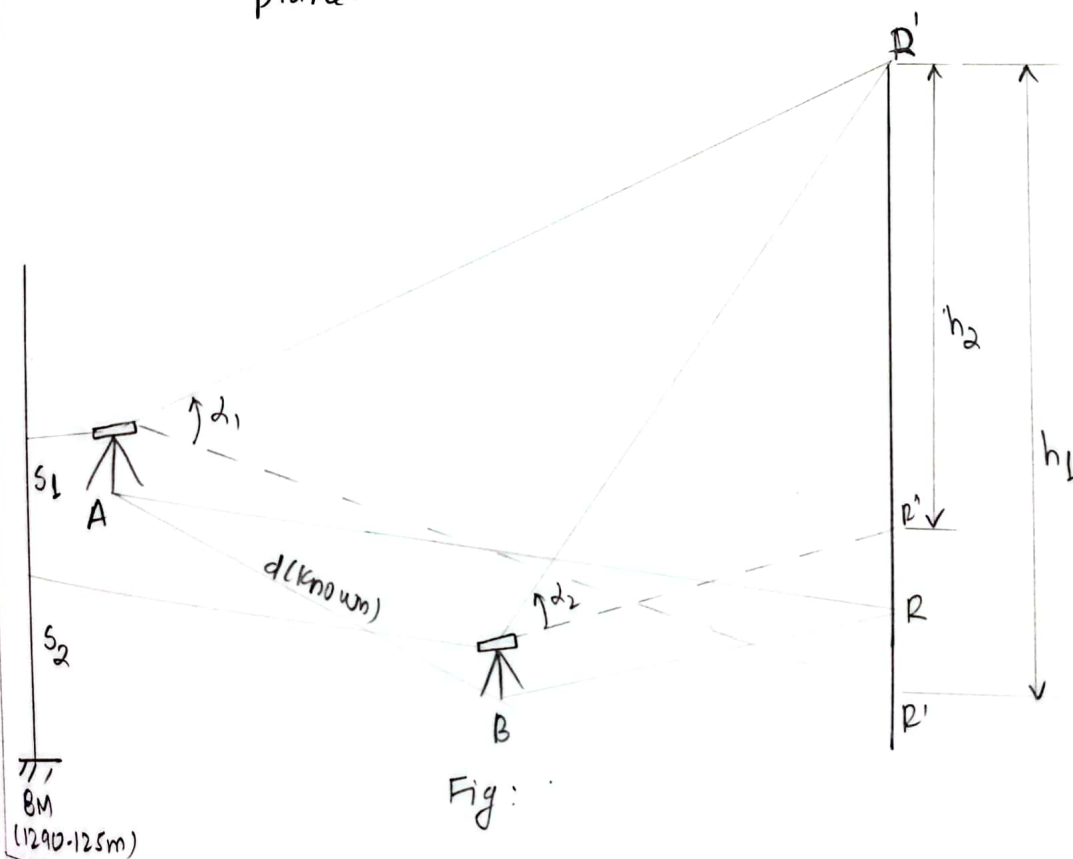
with reference to P,

$$\begin{aligned}\text{RL of } P' &= \text{RL of BM} + S_1 + h_1 \\ (\text{top of Dharahara}) &= 1290.125 + 0.037 + \\ &\quad (2354.818 + 22.974) \\ &\quad \tan(2^\circ 16' 30'') \\ &= 1384.625\text{m}\end{aligned}$$

Similarly with reference to Q,

$$\begin{aligned}\text{RL of } P' &= \text{RL of BM} + S_2 + h_2 \\ &= 1290.125 + 0.721 + 2354.818 \\ &\quad \tan(2^\circ 16' 50'') \\ &= 1384.625\text{m}.\end{aligned}$$

Case II: Base inaccessible and two instrument stations are and target are at very different vertical plane.



OBSERVATIONS:

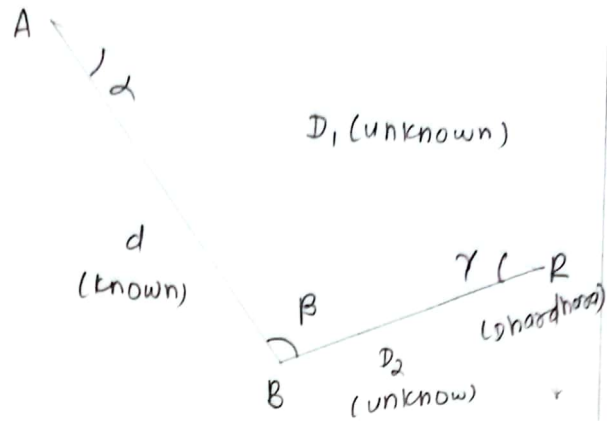


Fig: Plan view

Vertical readings.

Station	Sighted to	Zenithal Angle		Mean Vertical Angle	Remarks
		FL	FR		
A	R'	87°44'38"	272°15'18"	$90^\circ - 87^\circ44'40'' = 2^\circ15'20''$	α_1
B	R'	87°42'40"	272°17'10"	$90^\circ - 87^\circ42'45'' = 2^\circ17'15''$	α_2

Similarly,

Horizontal Angles Readings.

Station	Sighted to	Face	HCR	Mean Horizontal Angle	Remarks
A	R'	L	0° 0' 00"	99° 45' 24"	α
	B	L	260° 45' 15"		
	R'	R	180° 0' 00"		
	B	R	80° 14' 28"		
B	R'	L	0° 0' 00"	78° 41' 56"	β
	A	L	78° 41' 47"		
	R'	R	180° 0' 00"		
	A	R	258° 42' 04"		

Thus,

From triangle ABR,

$$\begin{aligned}
 \gamma &= 180^\circ - \alpha - \beta \\
 &= 180^\circ - 99^\circ45'24'' - 78^\circ41'56'' \\
 &= 1^\circ32'41''
 \end{aligned}$$

From sine law,

$$\frac{AR}{\sin(\beta)} = \frac{AB}{\sin(\gamma)} = \frac{BR}{\sin(\alpha)}$$

We have, $AB = 63.821 \text{ m}$

Thus,

$$AR = 2321.588 \text{ m}$$

$$BR = 2333.249 \text{ m}$$

When instrument at A,

$$\begin{aligned} h_1 &= AR \tan(\alpha_1) \\ &= 2321.588 \tan(2^\circ 15' 20'') \\ &= 91.441 \text{ m} \end{aligned}$$

Thus,

$$\begin{aligned} \text{RL of } R' &= \text{RL of BM} + S_1 + h_1 \\ &= 1290.125 + 1.025 + 91.441 \\ &= 1382.591 \text{ m.} \end{aligned}$$

When instrument at B,

$$\begin{aligned} h_2 &= BR \tan(\alpha_2) \\ &= 2333.249 \tan(2^\circ 17' 15'') \\ &= 93.203 \text{ m} \end{aligned}$$

Thus,

$$\begin{aligned} \text{RL of } R' &= \text{RL of BM} + S_2 + h_2 \\ &= 1290.125 + 0.893 + 93.203 \\ &= 1384.221 \text{ m.} \end{aligned}$$

Thus,

$$\begin{aligned} \text{Average RL of Dhaadha} &= \frac{1384.625 + 1382.591 + 1384.221}{3} \\ &= 1383.812 \text{ m} \end{aligned}$$

DISCUSSION AND CONCLUSION

Hence, we found the RL of top of Dhaadha by trigonometric levelling when instrument were in same vertical plane and when instrument were in different vertical planes.

DESIGN AND LAYOUT OF SIMPLE CIRCULAR CURVE BY LONG CHORD METHOD

OBJECTIVE:

TO set out simple circular curve by measuring only linear distance.

INSTRUMENTS

- (i) ~~Tape~~ Tape (30m)
- (ii) Metallic tape (5m)
- (iii) Peg
- (iv) Arrows.

THEORY:

Simple circular curve is formed by single circular arc of circle in which both ends are tangent to straight.

Designing,

$$\Delta = 52^\circ$$

$$R = 30m$$

Finding elements

$$T = R \tan\left(\frac{\Delta}{2}\right) = 30 \tan\left(\frac{52^\circ}{2}\right) = 14.632m$$

$$\text{curve length } (L) = \frac{\pi R \Delta}{180^\circ} = \frac{\pi \times 30 \times 52^\circ}{180^\circ} = 27.227m$$

$$\text{Long chord } (L) = 2R \sin\left(\frac{\Delta}{2}\right) = 26.302m$$

$$\text{Apex distance } (A) = R \left(\sec \frac{\Delta}{2} - 1 \right) = 3.378m$$

$$\text{Mid-ordinate } (O_0) = R \left(1 - \cos \frac{\Delta}{2} \right) = 3.036m$$

$$\text{Half-length of long chord} = \frac{L}{2} = 13.151m$$

$$\text{ordinate } (O_m) = \sqrt{R^2 - x^2} - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$$

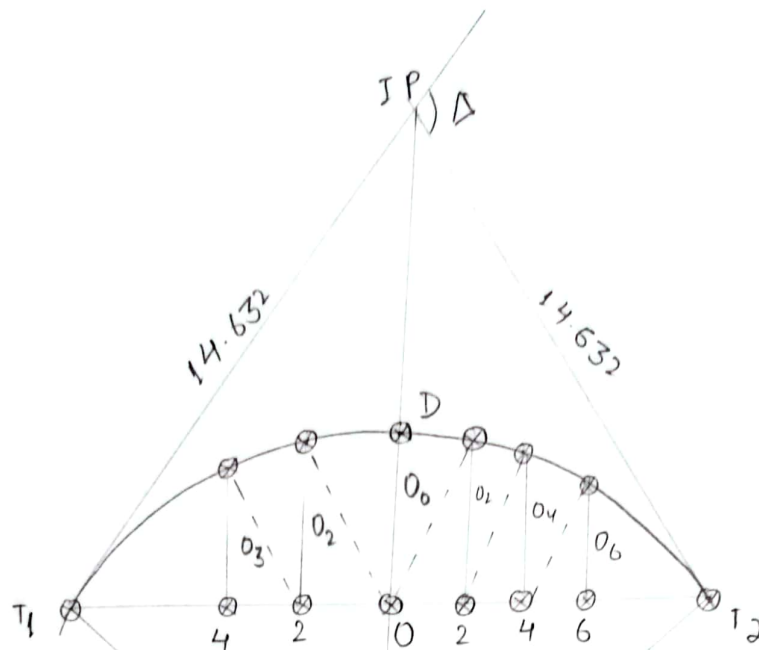


Fig: Simple Circular curve

TABLE

ordinate	Distance from center towards T_1 (m)	ordinate distance (m)	Hypotenuse (m)	Sum, Ordinate + Hypotenuse (m)	Remarks.
O_0	0	3.036		3.036	Mid-ord.
O_2	2	2.969	3.580	6.549	
O_4	4	2.768	3.415	6.183	
O_6	6	2.430	3.147	5.577	
O_8	8	1.950	2.793	4.743	
O_{10}	10	1.320	2.396	3.716	
O_{12}	12	0.532	2.070	2.602	
T_1	13.151	0		0	T_1

FIELD PROCEDURE

- (i) Fix T_1 and measuring distance of long chord fix peg at T_2 .
- (ii) Find IP by intersecting tape from T_1 and T_2 each at tangent distance (14.632)
- (iii) Find mid-point of T_1T_2 at O.
- (iv) Fix peg at D (at distance O_0) from O.
- (v) Fix arrows at 2m intervals in one side of O.
- (vi) With distance of sum (ordinate + hypotenuse) in tape swing tape such that to meet ordinate distance

above .x distance and fix the peg.
(vii) Repeat the procedure till T_1 & again for next side.

OBSERVATIONS:

Apex distance + Mid-ordinate (AO-IP) = 6.400 m

$$\text{Actual, } A + O_0 = 6.414 \text{ m}$$

$$\begin{aligned} \text{Error} &= \left| \frac{6.414 - 6.400}{6.414} \right| \times 100\% \\ &= 0.218\% \end{aligned}$$

Measured curve length (l)

$$\begin{aligned} &= 1.268 + 2.136 + 2.130 + 2.022 + 2.042 + \\ &\quad 1.978 + 2.010 + 1.808 + 2.204 + 2.316 + \\ &\quad 1.784 + 2.108 + 2.124 + 1.278 \\ &= 27.208 \text{ m} \end{aligned}$$

Actual curve length (l') = 27.227 m

$$\begin{aligned} \text{Error} &= \left| \frac{27.227 - 27.208}{27.227} \right| \times 100\% \\ &= 0.07\% \end{aligned}$$

DISCUSSION AND CONCLUSION

Hence, simple circular was set out by long chord method just by use of tape and arrows. and error was calculated.

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DESIGN AND LAYOUT OF THE COMPOSITE CURVE

OBJECTIVE

TO set out composite curve by use of total station.

INSTRUMENTS

- (i) Total Station
- (ii) Tripod
- (iii) Tape
- (iv) ~~Range~~ Ranging Rod
- (v) Peg
- (vi) Arrows

THEORY

When both end of circular curve introduced to transition curve is called composite curve.

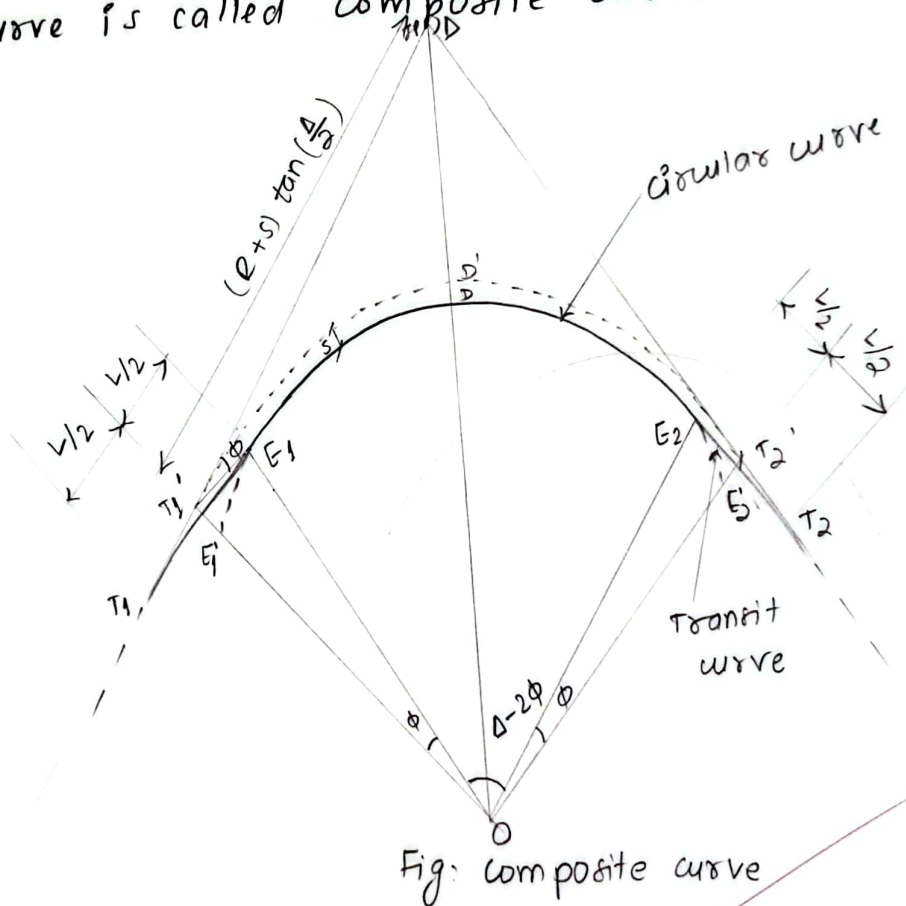


Fig: Composite curve

Designing

$$\Delta = 52^\circ$$

$$\text{Radius } (R) = 60 \text{ m}$$

$$\text{Normal chord length} \rightarrow \text{Circular} = 5 \text{ m}$$

$$\rightarrow \text{Transition} = 3 \text{ m}$$

$$\text{Length of transition curve} = 17.42 \text{ m.}$$

(L)

$$\text{Shift } (s) = \frac{L^2}{24R} = 0.21\text{m}$$

$$\begin{aligned}\text{Total tangent Length} &= \frac{L}{2} + (R+s) \tan\left(\frac{\Delta}{2}\right) \\ &= \frac{17.42}{2} + (60+0.21) \tan(28^\circ) \\ &= 38.08\text{m}\end{aligned}$$

$$\text{Spiral angle } (\phi_s) = \frac{L}{2R} \times \frac{180^\circ}{\pi} = 8^\circ 19' 03''$$

$$\text{Central angle for circular curve} = \Delta - 2\phi = 35^\circ 21' 54''$$

$$\text{Length of circular curve} = \frac{\pi R (\Delta - 2\phi)}{180^\circ} = 37.03\text{m}$$

TABLE

For Left transition curve	For circular curve	For right transition curve
$\alpha = \frac{573 L^2}{RL} \text{ minutes}$ $\alpha_1 = \frac{573 \times (3)^2}{60 \times 17.42} = 0^\circ 4' 56''$ $\alpha_2 = \frac{573 \times 6^2}{60 \times 17.42} = 0^\circ 19' 44''$ $\alpha_3 = 0^\circ 44' 24''$ $\alpha_4 = 1^\circ 18' 57''$ $\alpha_5 \text{ (} l=15\text{m)} = 2^\circ 3' 21''$ $\alpha_6 \text{ (} l=17.42\text{m)} = 2^\circ 46' 22''$ Check $\alpha_6 = \frac{1}{3} \phi$ $= \frac{1}{3} \times (8^\circ 19' 03'')$ $= 2^\circ 46' 22''$	$\delta = 1718.87 \frac{C}{R} \text{ min}$ $C = \text{chord length}$ $\delta_1 = \frac{1718.87}{60} \times \frac{5}{60}$ $= 2^\circ 23' 14''$ $\delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7$ $\delta_8 = \frac{1718.87 \times 2.03}{60 \times 60}$ $= 0^\circ 58' 9''$ $\Delta_1 = \delta_1 = 2^\circ 23' 14''$ $\Delta_2 = \delta_1 + \delta_2 = 4^\circ 46' 28''$ $\Delta_3 = \delta_1 + \delta_2 + \delta_3 = 7^\circ 09' 43''$ $\Delta_4 = 9^\circ 32' 57''$ $\Delta_5 = 11^\circ 56' 11''$ $\Delta_6 = 14^\circ 19' 25''$ $\Delta_7 = 16^\circ 42' 39''$ $\Delta_8 = 17^\circ 40' 48''$ Check, $\Delta_8 = \frac{\Delta - 2\phi}{2} \checkmark$	$360^\circ - \alpha$ $\alpha_1 = 359^\circ 55' 4''$ $\alpha_2 = 359^\circ 40' 16''$ $\alpha_3 = 359^\circ 15' 36''$ $\alpha_4 = 358^\circ 41' 9''$ $\alpha_5 = 357^\circ 56' 39''$ $\alpha_6 = 357^\circ 13' 38''$

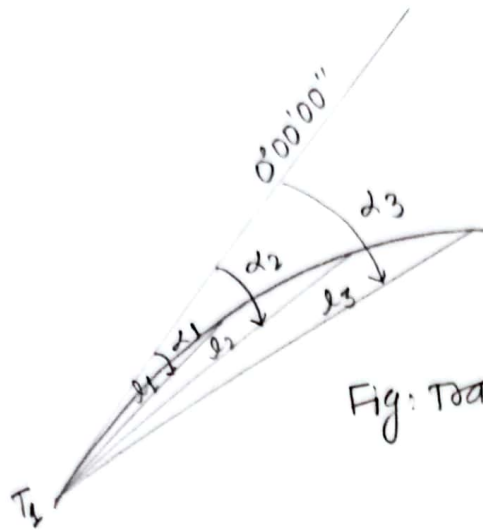


Fig: Transition curve

FIELD PROCEDURE

- ① Total station in IP
- ② Peg fixed at tangent length at T_1
- ③ Zero set at T_1 and transit $\Delta(52^\circ)$ and fix peg at T_2 .
- ④ Total station at T_1
- ⑤ Set transit corner upto beginning of circular curve E_1 by measuring tangential deflection angles.
- ⑥ Now, shift total station to E_1 and back sight to point T_1 . Then, ~~transit the~~ swing the total station by $\frac{2}{3}\phi = 5^\circ 32' 44''$ and transit by 180° then zero set to measure total deflection angles ($\Delta_1, \Delta_2, \dots$) for setting of circular curve by Rankine Method. unless sighted to E_2 .
- ⑦ Then, measure total length of composite curve.

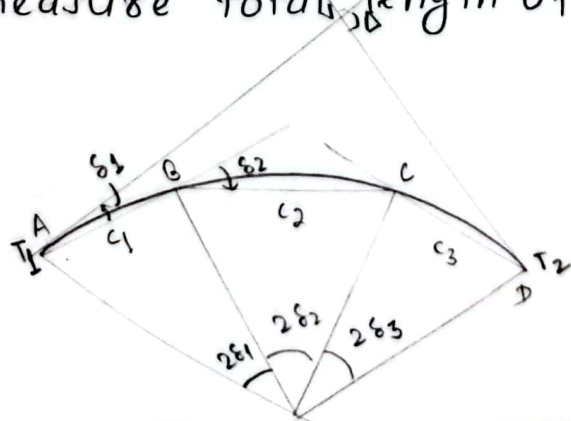


Fig: Setting circular curve by Rankine's method.

OBSERVATIONS

Length of transition curve,

$$\text{From } T_1 \text{ to } E_1 = L_1 = 17.426 \text{ m}$$

$$\text{From } T_2 \text{ to } E_2 = L_2 = 17.431 \text{ m}$$

Length of circular curve

$$\text{From } E_1 \text{ to } E_2, l = 36.982 \text{ m}$$

Final deflection angle measured from

$$E_1 = \Delta_s = 17^\circ 39' 12''$$

$\therefore$ Total curve length

$$= 17.426 + 17.431 + 36.982$$

$$= 71.839 \text{ m}$$

Actual,

total curve length

$$= 17.42 \times 2 + 37.03$$

$$= 71.87 \text{ m.}$$

$$\text{Error in length} = \left| \frac{71.87 - 71.839}{71.87} \right| \times 100\%$$

$$= 0.0431\%$$

Actual final deflection angle; $\Delta_s = 17^\circ 40' 48''$

$$\text{Error in angle} = \left| \frac{17^\circ 40' 48'' - 17^\circ 39' 12''}{17^\circ 40' 48''} \right| \times 100\%$$

$$= 0.151\%$$

DISCUSSION AND CONCLUSION

Hence, setting out of composite curve was done in field with total station and possible errors in length and deflection angles were computed.

CONTOURING

OBJECTIVE

- (i) TO prepare contour map of given area.
- (ii) TO be able to read contour map.

INSTRUMENT AND ACCESSORIES

- (i) Measuring tape
- (ii) total station
- (iii) Tripod stand
- (iv) Plumb bob
- (v) Prism, prism pole, prism stand

THEORY:

A contour is defined as an imaginary line of constant elevation on the ground that is the intersection of level surface with ground surface. A line joining point of equal elevation is contour line.

Index contour is a contour line is shown in distinctive manner for ease of identification with one printed more heavily than other contour lines. The difference in elevation between such contour line on a given map is contour interval and it depends on.

- i. Nature of terrain
- ii. Scale of Map
- iii. Accuracy
- iv. Availability time & fund
- v. Purpose of map.

Horizontal Equivalent

The horizontal distance between two successive contour line for a given slope is horizontal equivalent.

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The process of spacing the contours proportionally between the plotted ground point is interpolation.

Methods of Interpolation:

- (i) Estimation method
- (ii) Arithmetic calculation
- (iii) Mechanical or graphical method.

CONTOURING PROCESS

The grid is plotted to the scale of map and spot levels of grid corners are entered. The contours of desired values are located by spot levels to the salient features of ground such as hill tops, deepest point.

DISCUSSION AND CONCLUSION

Hence, by grid method, contouring was done on scale of 1:100 with contour interval $CT = 0.5m$. Interpolation was done by arithmetic calculation. Various features were obtained in contour map. Hence contour map was plotted.

SCALE 1:100



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