

Computation of the Closed Line Traverse

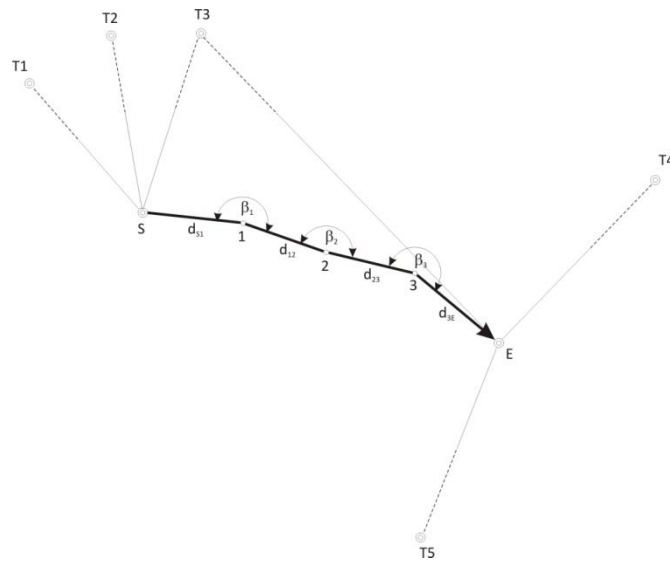


Figure 1.00000

0000000000
 00000000/00
 0000000000
 000000

0000000000
 0000000
 000000000

0	0	0	00	0	00	00
0	0	0	0	0		
0	0	0	0	0		
00	0	0	0	0		
00	0	0	0	0		
00	0	0	0	0		
00	0	0	0	0		
00	0	0	0	0		

Table 1.000000000

Computation of Closed Line Traverse

Station	Distance	Bearing	Latitude	Departure	Latitude	Departure	Latitude	Departure	Latitude	Departure	Latitude	Departure
1	100	S 45° E	70.71	70.71								
2	100	S 45° W	70.71	-70.71								
3	100	N 45° W	70.71	-70.71								
4	100	N 45° E	70.71	70.71								
5	100	S 45° E	70.71	70.71								
6	100	S 45° W	70.71	-70.71								
7	100	N 45° W	70.71	-70.71								
8	100	N 45° E	70.71	70.71								
9	100	S 45° E	70.71	70.71								
10	100	S 45° W	70.71	-70.71								
11	100	N 45° W	70.71	-70.71								
12	100	N 45° E	70.71	70.71								
13	100	S 45° E	70.71	70.71								
14	100	S 45° W	70.71	-70.71								
15	100	N 45° W	70.71	-70.71								
16	100	N 45° E	70.71	70.71								
17	100	S 45° E	70.71	70.71								
18	100	S 45° W	70.71	-70.71								
19	100	N 45° W	70.71	-70.71								
20	100	N 45° E	70.71	70.71								
21	100	S 45° E	70.71	70.71								
22	100	S 45° W	70.71	-70.71								
23	100	N 45° W	70.71	-70.71								
24	100	N 45° E	70.71	70.71								
25	100	S 45° E	70.71	70.71								
26	100	S 45° W	70.71	-70.71								
27	100	N 45° W	70.71	-70.71								
28	100	N 45° E	70.71	70.71								
29	100	S 45° E	70.71	70.71								
30	100	S 45° W	70.71	-70.71								
31	100	N 45° W	70.71	-70.71								
32	100	N 45° E	70.71	70.71								
33	100	S 45° E	70.71	70.71								
34	100	S 45° W	70.71	-70.71								
35	100	N 45° W	70.71	-70.71								
36	100	N 45° E	70.71	70.71								
37	100	S 45° E	70.71	70.71								
38	100	S 45° W	70.71	-70.71								
39	100	N 45° W	70.71	-70.71								
40	100	N 45° E	70.71	70.71								
41	100	S 45° E	70.71	70.71								
42	100	S 45° W	70.71	-70.71								
43	100	N 45° W	70.71	-70.71								
44	100	N 45° E	70.71	70.71								
45	100	S 45° E	70.71	70.71								
46	100	S 45° W	70.71	-70.71								
47	100	N 45° W	70.71	-70.71								
48	100	N 45° E	70.71	70.71								
49	100	S 45° E	70.71	70.71								
50	100	S 45° W	70.71	-70.71								
51	100	N 45° W	70.71	-70.71								
52	100	N 45° E	70.71	70.71								
53	100	S 45° E	70.71	70.71								
54	100	S 45° W	70.71	-70.71								
55	100	N 45° W	70.71	-70.71								
56	100	N 45° E	70.71	70.71								
57	100	S 45° E	70.71	70.71								
58	100	S 45° W	70.71	-70.71								
59	100	N 45° W	70.71	-70.71								
60	100	N 45° E	70.71	70.71								
61	100	S 45° E	70.71	70.71								
62	100	S 45° W	70.71	-70.71								
63	100	N 45° W	70.71	-70.71								
64	100	N 45° E	70.71	70.71								
65	100	S 45° E	70.71	70.71								
66	100	S 45° W	70.71	-70.71								
67	100	N 45° W	70.71	-70.71								
68	100	N 45° E	70.71	70.71								
69	100	S 45° E	70.71	70.71								
70	100	S 45° W	70.71	-70.71								
71	100	N 45° W	70.71	-70.71								
72	100	N 45° E	70.71	70.71								
73	100	S 45° E	70.71	70.71								
74	100	S 45° W	70.71	-70.71								
75	100	N 45° W	70.71	-70.71								
76	100	N 45° E	70.71	70.71								
77	100	S 45° E	70.71	70.71								
78	100	S 45° W	70.71	-70.71								
79	100	N 45° W	70.71	-70.71								
80	100	N 45° E	70.71	70.71								
81	100	S 45° E	70.71	70.71								
82	100	S 45° W	70.71	-70.71								
83	100	N 45° W	70.71	-70.71								
84	100	N 45° E	70.71	70.71								
85	100	S 45° E	70.71	70.71								
86	100	S 45° W	70.71	-70.71								
87	100	N 45° W	70.71	-70.71								
88	100	N 45° E	70.71	70.71								
89	100	S 45° E	70.71	70.71								
90	100	S 45° W	70.71	-70.71								
91	100	N 45° W	70.71	-70.71								
92	100	N 45° E	70.71	70.71								
93	100	S 45° E	70.71	70.71								
94	100	S 45° W	70.71	-70.71								
95	100	N 45° W	70.71	-70.71								
96	100	N 45° E	70.71	70.71								
97	100	S 45° E	70.71	70.71								
98	100	S 45° W	70.71	-70.71								
99	100	N 45° W	70.71	-70.71								
100	100	N 45° E	70.71	70.71								

Table 2.10

Computing the Whole Circle Bearing (WCB) of the S-1 and E-3 directions

$\text{WCB} = \text{Bearing} + \text{Angle}$
 $\text{WCB} = \text{Bearing} + \text{Angle}$
 $\text{WCB} = \text{Bearing} + \text{Angle}$

Computation of Closed Line Traverse

Order	Station	Distance (m)	Bearing	Latitude (m)	Departure (m)	Latitude Error (m)	Departure Error (m)	Angle Error (seconds)
1	S							
2	1	d_{s1}	WCB_{s1}					
3	0	MD_{s1}	WCB_{s1}					
4	T	MD_{s1}	WCB_{s1}					
5	S							

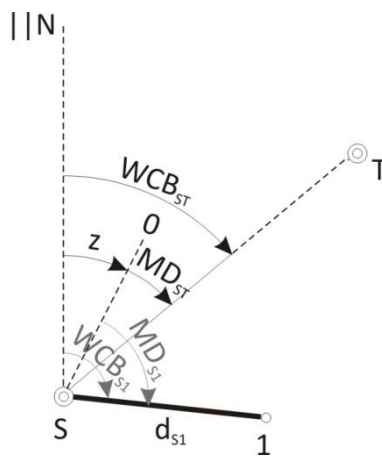


Figure 2.10

$\Delta E = E_T - E_S$
 $\Delta N = N_T - N_S$
 $\alpha = \text{atan} \frac{\Delta E}{\Delta N}$

$\Delta E = -144.67$
 $\Delta N = 141.26$

$$\Delta \quad - \quad \Delta \beta$$

Please note that the coordinate differences are always computed as the difference between the target and the stations coordinates! $\Delta E = E_{\text{Target}} - E_{\text{Station}}$.

$\alpha = \text{atan} \frac{\Delta E}{\Delta N}$

$$\alpha = \text{atan} \frac{\Delta E}{\Delta N} = \text{atan} \frac{-144.67}{141.26} = -45^\circ 41' 00''$$

Computation of Closed Line Traverse

Table 3.1

Table 3.1

Table 3.1

α

	Δ	$\Delta\beta$	
		-	
	-	-	
	-		
α			

Table 3.1

Table 3.1

Δ

$\Delta\beta$

α

$$d_{S-T1} = \sqrt{(\Delta E)^2 + (\Delta N)^2} = 202.197m$$

$$z_{S-T1} = WCB_{S-T1} - MD_{S-T1} = 6^{\circ}36'06''.$$

Computation of Closed Line Traverse

Station	Angle	Sightings			Distances			Coordinates			Station
1	62°	2	3	4	2	3					202 197
	62°	2	3	4	2	3	4				23 227
	72°	2	3	4							125 20
	62°	2	3	4	2	3	4				253 1 2

$\bar{z} = \frac{z_{S-T1}d_{S-T1} + z_{S-T2}d_{S-T2} + z_{S-T3}d_{S-T3}}{d_{S-T1} + d_{S-T2} + d_{S-T3}}$

$$\bar{z} = \frac{z_{S-T1}d_{S-T1} + z_{S-T2}d_{S-T2} + z_{S-T3}d_{S-T3}}{d_{S-T1} + d_{S-T2} + d_{S-T3}} = 6^{\circ}35'37''$$

$$WCB_{S1} = \bar{z} + M D_{S1} = 115^{\circ}30'28''$$

											202 197
											23 227
					6	35	37	115	30	28	125 20
		1	1	57		5	17	2	07	1	253 1 2

Computation of Closed Line Traverse

Station 1

Station 2

Station 3

Station	Angle	Sightings			Angles			Distances			Area
1	2	3	4	5	6	7	8	9	10	11	12
		36	2	6					3		3 622
		9	9	32				2 6		2	2 2 696
	3	33			11	00	58	348	58	58	

Remarks:

1. Please note that the orientation angles should be sufficiently close to each other. Usually the maximal difference is less than 1'. When you experience larger differences, please check your computations.

2. Another useful check: the mean orientation angle must be between the smallest and the largest orientation angles.

3. The mean orientation angles can be computed according to the following method, too:

Subtract the smallest orientation angle cut to a full degree and minute value from all of the orientation angles (in our case, subtract 6°35'00" from all of the orientation angles at the station S). Compute the weighted mean of the residual values:

$$\bar{r} = \frac{66'' \cdot 202.2 + 39'' \cdot 234.23 + 17'' \cdot 253.14}{689.57} = 37''$$

Finally add the subtracted value to this mean to get the mean orientation angle:

$$\bar{z} = 6^\circ 35' 00'' + 39'' = 6^\circ 35' 37''$$

Computing the deflection angles:

Station 1

Station 2

Station 3

Station 4

$$\beta_1 = (225^\circ 30' 07'') - (25^\circ 39' 31'') = 199^\circ 50' 36''$$

Computation of Closed Line Traverse

Hint: It is always a good idea to draw a sketch of the traverse line, because the order of the observations in the field book might differ from the order of the traverse points.

XXXXXXXXXXXX

Stn	Bearing	Sine			Cosine			Distance			Total
		S	E	N	S	E	N	ft	m	in	
1	S 75° E	0.25	0.75	0.00	0.00	0.00	0.00	115	30	28	125 20
2	N 15° E	0.15	0.00	0.00	0.00	0.00	0.00	2	07	1	253 1 2
3	S 25° E	0.25	0.00	0.00	0.00	0.00	0.00	0	00	0	100 8
4	N 75° E	0.25	0.00	0.00	0.00	0.00	0.00	21	2	2	1 2 5
5	S 15° E	0.15	0.00	0.00	0.00	0.00	0.00	11	00	55	592 83
6	N 15° E	0.15	0.00	0.00	0.00	0.00	0.00	7	0	51	3 622
7	S 75° E	0.25	0.00	0.00	0.00	0.00	0.00	20	00	27	2 2 696
8	N 75° E	0.25	0.00	0.00	0.00	0.00	0.00	348	58	58	

197

Table 4. XXXXXXXXXXXX

XXXXXXXXXXXX

XXXX

Computing the deflection angles of the first (S) and the last station (E)

XXXXXX

XXXXXX

XXXXXXXXXX

$$\beta_S = WCB_{S1} \quad \beta_E = 360^\circ - WCB_{E3}$$

Computation of Closed Line Traverse

Station	Angle	Interior Angle			∠	Δβ	Δ	Δβ
		β						
		Σβ						
		115	30	28				
	Σβ							
	-							
	Δβ							

Table 5. Computation of Closed Line Traverse

Table 5. Computation of Closed Line Traverse

Table 5. Computation of Closed Line Traverse

Table 5. Computation of Closed Line Traverse

Table 5. Computation of Closed Line Traverse

$$\Sigma \beta = (n - 1)180$$

Computation of Closed Line Traverse

$n = 10$

$n = 10$

$\sum \beta = 720^\circ 00' 09''$

$\Sigma \beta$

$$\sum \beta = 720^\circ 00' 09''$$

$\Sigma \beta$

$\Delta \beta$

$$\Delta \beta = -9''$$

β

$$v\beta = \frac{\Delta \beta}{n} = -2''$$

Hints:

Please note that the sum of the deflection angles should be equal to $(n-1)180^\circ (+360^\circ)$. The extra 360° should be added when the traverse line goes from the east to the west.

Please note that the sum of the corrections must be equal to the angular misclosure as well. Therefore some of the $v\beta$ correction should be rounded upward, and some should be rounded downward. For example when the angular misclosure is $11''$ and $n=5$ then the $v\beta$ correction should be $2.2''$. Since this value should be rounded to 1 arcsecond, therefore some $v\beta$ values should be rounded to $2''$ and some should be rounded to $3''$. Since the sum of the corrections must be equal to the angular misclosure ($11''$) and $n=5$ therefore the corrections will be $2''$ in four cases and $3''$ in a single case.

Please also note that the maximal values of the accepted angular misclosures are prescribed in the Hungarian regulations. Depending on the purpose of the traverse line, the maximal acceptable value of the angular misclosure is ranging between $50''$ and $105''$. When the computed angular misclosure is larger than the acceptable value, then a part, or even all of the observations must be repeated. When larger angular misclosures are experienced, then one should try to locate the blunder in the deflection angles. It can be done by computing the closed line traverse as a free traverse line from the starting as well as from the terminating station. Comparing the coordinates of the two solutions (two free traverse solutions), the blunder is present, where the coordinates are close to each other in both of the free traverse solutions.

WCB_{S-1}

$\beta_S + v\beta_S$

$WCB_{S-1} = \beta_S + v\beta_S$

$$WCB_{S-1} = \beta_S + v\beta_S$$

Computation of Closed Line Traverse

☰☱☲☳☴☵☶☷

☰☱☲☳☴☵☶☷

β

☰☱☲☳☴☵☶☷

β

$$WCB_{1-2} = WCB_{S-1} + \beta_1 + v\beta_1 - 180^\circ$$

Hint: After the computation of the WCB of the last traverse leg, one should also add the β_E and $v\beta_E$ to this value and subtract 180° from the sum. When all the corrections and the computations are right, then the result should be exactly 0° :

$$WCB_{3-E} + \beta_E + v\beta_E - 180^\circ = 0^\circ$$

This is a check for the computation of the WCBs.

Computing the preliminary coordinate differences

☰☱☲☳☴☵☶☷

☰☱☲☳☴☵☶☷

☰☱☲☳☴☵☶☷

$$(\Delta E) = d \cdot \sin(WCB)$$

$$(\Delta N) = d \cdot \cos(WCB)$$

$$\sum (\Delta E) = E_E - E_S$$

$$\sum (\Delta N) = N_E - N_S$$

$$\sum (\Delta E) = +276.836m$$

$$\sum (\Delta N) = -332.554m$$

$$\Delta E_{S-E} = +276.770m$$

$$\Delta N_{S-E} = -332.500m$$

$$\Delta \Delta E = \Delta E_{S-E} - \sum (\Delta E) = -0.066m$$

$$\Delta \Delta N = \Delta N_{S-E} - \sum (\Delta N) = +0.054m$$

