LATIHAN SOAL
ILMU UKUR TAMBANG

Oleh:

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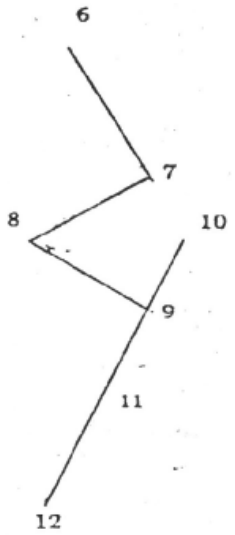
Contoh 1.

Hitunglah bearing dari data pengukuran poligon berikut ini:

BS	IS	Sudut kanan	Jarak datar	Bearing	FS
	6	-	20 m	S 30° E	7
6	7	280°	25 m	?	8
7	8	50°	20 m	?	9
8	9	70°	15 m	?	10
9	10	00°	30 m	?	11
10	11	180°	25 m	?	12



Jawab:

Bearing (Br_{6-7}) = S 30° E → Azimut (α_{6-7}) = 180° – 30° = 150°

Jika sudut ukuran (β) adalah sudut kanan, maka: $\alpha_{2-3} = \alpha_{1-2} + \beta_2 - 180^\circ$

Dengan ketentuan:

Jika α hasil hitungan < 0° maka α hasil hitungan ditambah 360° atau kelipatannya.

Jika α hasil hitungan > 360° maka α hasil hitungan dikurangi 360° atau kelipatannya.

α_{6-7} = 150°

α_{7-8} = $\alpha_{6-7} + \beta_7 - 180^\circ = 150^\circ + 280^\circ - 180^\circ = 250^\circ$ → Br_{7-8} = 250° – 180° = S 70° W

α_{8-9} = $\alpha_{7-8} + \beta_8 - 180^\circ = 250^\circ + 50^\circ - 180^\circ = 120^\circ$ → Br_{8-9} = 180° – 120° = S 60° E

α_{9-10} = $\alpha_{8-9} + \beta_9 - 180^\circ = 120^\circ + 70^\circ - 180^\circ = 10^\circ$ → Br_{9-10} = N 10° E

α_{10-11} = $\alpha_{9-10} + \beta_{10} - 180^\circ = 10^\circ + 00^\circ - 180^\circ = -170^\circ + 360^\circ = 190^\circ$ → Br_{10-11} = 190° – 180° = S 10° W

α_{11-12} = $\alpha_{10-11} + \beta_{11} - 180^\circ = 190^\circ + 180^\circ - 180^\circ = 190^\circ$ → Br_{10-11} = 190° – 180° = S 10° W

Kebenaran hasil hitungan diuji dengan cara dan ketentuan sebagai berikut:

- Jika banyaknya sudut (n) genap, maka: Azimuth akhir = azimuth awal + $\sum\beta_{kanan}$ – (n . 360°)
- Jika banyaknya sudut (n) ganjil, maka: Azimuth akhir = azimuth awal + $\sum\beta_{kanan}$ – (n . 360°) – 180°
- Jika diperoleh hasil hitungan azimut akhir < 0°, maka tambahkan hasil hitungan tersebut dengan 360° atau kelipatannya.
- Jika diperoleh hasil hitungan azimut akhir > 360°, maka kurangilah hasil hitungan tersebut dengan 360° atau kelipatannya.

Pengujian untuk perhitungan di atas:

Banyaknya sudut ukuran (n) = 5 (ganjil), maka:

$Azimuth_{FS} = azimuth_{BS} + \sum\beta_{kanan} - (n \cdot 360^\circ) - 180^\circ$

= 150° + 580° – (5 . 360°) – 180°

= 150° + 580° – 1800° – 180°

= - 1250° (hasil hitungan <0°, maka hasil hitungan ditambah kelipatan 360°)

= - 1250° + (4 x 360°) = - 1250° + 1440°

= 190° (sama dengan azimut 11 ke 12, berarti hasil hitungan di atas benar).

Contoh 2.

Diketahui: koordinat L = N 1.000,00 ; 1.000,00 E
koordinat M = N 406,72 ; 2458,57 E

Hitunglah: jarak datar (HD) dan bearing L ke M.

Jawab:

$HD_{L-M} = \sqrt{(lat_{L-M})^2 + (dep_{L-M})^2}$

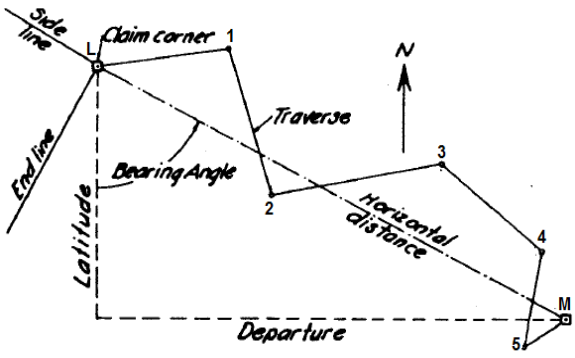
$= \sqrt{(406{,}72 - 1000{,}00)^2 + (2458{,}57 - 1000{,}00)^2}$

$= \sqrt{(-593{,}28)^2 + 1458{,}57^2}$

= 1574,61 ft

$Azimut_{L-M} = \tan^{-1}\frac{dep}{lat} = \frac{1458{,}57}{-593{,}29}$ = 112°08'3" *)

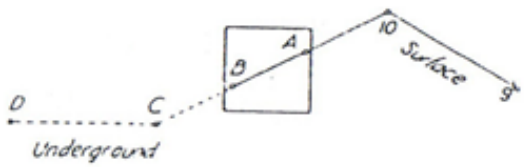
$Bearing_{L-M}$ = 180° – 112°08'3" = S 67°51'57" E **)



*)Ketentuan dalam menentukan letak kuadran azimut:
Jika dep^{+}/lat^{+}, maka azimut (α) terletak di kuadran 1.
Jika dep $^{+}$/ lat $^{-}$, maka azimut (α) terletak di kuadran 2.
Jika dep $^{-}$/ lat $^{-}$, maka azimut (α) terletak di kuadran 3.
Jika dep $^{-}$/ lat $^{+}$, maka azimut (α) terletak di kuadran 4.

**)Ketentuan menentukan kuadran bearing:
Jika 0^{o}<azimut≤90^{o}, maka azimut = bearing N-E
Jika 90^{o}<azimut≤180^{o}, maka (180^{o} - azimut) = bearing S-E
Jika 180^{o}<azimut≤270^{o}, maka (azimut – 180^{o}) = bearing S-W
Jika 270^{o}<azimut≤360^{o}, maka (360^{o} - azimut) = bearing N-W

Contoh 3.
Diketahui data pengukuran Coplaning sebagai berikut:



BS	IS	Sudut Lurus	HD	Bearing	Koordinat		FS
					N	E	
8	9	230”	190,0	N 50^{o} W	6000,00	4000,00	10
9	10	130”	7,0				A
10	A	180”	4,0				B
A	B	180”	6,5				C
B	C	215”	80,0				D

Hitunglah koordinat A, B, C, dan D.
Jawab:
Bearing ($Br_{9\text{-}10}$) = N 50^{o} W → Azimut ($\alpha_{9\text{-}10}$) = 360^{o} – 50^{o} = 310^{o}

$\alpha_{10\text{-}A}$ = $\alpha_{9\text{-}10} + \beta_{10} - 180^{o} = 310^{o} + 130^{o} - 180^{o} = 260^{o}$ → $Br_{10\text{-}A}$ = 260^{o} – 180^{o} = S 80^{o} W
$\alpha_{A\text{-}B}$ = $\alpha_{10\text{-}A} + \beta_{A} - 180^{o} = 260^{o} + 180^{o} - 180^{o} = 260^{o}$ → $Br_{A\text{-}B}$ = 260^{o} – 180^{o} = S 80^{o} W
$\alpha_{B\text{-}C}$ = $\alpha_{A\text{-}B} + \beta_{B} - 180^{o} = 260^{o} + 180^{o} - 180^{o} = 260^{o}$ → $Br_{B\text{-}C}$ = 260^{o} – 180^{o} = S 80^{o}W
$\alpha_{C\text{-}D}$ = $\alpha_{B\text{-}C} + \beta_{C} - 180^{0} = 260^{o} + 215^{o} - 180^{o} = 295^{o}$ → $Br_{C\text{-}D}$ = 360^{o} – 295^{o} = N 65^{o} W

$Latitude_{1\text{-}2} = HD_{1\text{-}2} \cos \alpha_{1\text{-}2}$
$Lat._{10\text{-}A} = HD_{10\text{-}A} \cos \alpha_{10\text{-}A} = 7,0 \cos 260^{o} = -1,21$
$Lat._{A\text{-}B} = HD_{A\text{-}B} \cos \alpha_{A\text{-}B} = 4,0 \cos 260^{o} = -0,69$
$Lat._{B\text{-}C} = HD_{B\text{-}C} \cos \alpha_{B\text{-}C} = 6,5 \cos 260^{o} = -1,13$
$Lat._{C\text{-}D} = HD_{C\text{-}D} \cos \alpha_{C\text{-}D} = 80,0 \cos 295^{o} = 33,81$

$Departure_{1\text{-}2} = HD_{1\text{-}2} \sin \alpha_{1\text{-}2}$
$Dep._{10\text{-}A} = HD_{10\text{-}A} \text{ sins } \alpha_{10\text{-}A} = 7,0 \sin 260^{o} = -6,89$
$Dep._{A\text{-}B} = HD_{A\text{-}B} \sin \alpha_{A\text{-}B} = 4,0 \sin 260^{o} = -3,94$
$Dep._{B\text{-}C} = HD_{B\text{-}C} \sin \alpha_{B\text{-}C} = 6,5 \sin 260^{o} = -6,40$
$Dep._{C\text{-}D} = HD_{C\text{-}D} \sin \alpha_{C\text{-}D} = 80,0 \sin 295^{o} = -72,50$

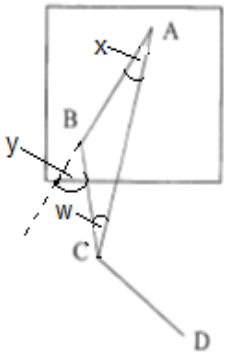
Koordinat $N_2 = N_1 + Lat._{1\text{-}2}$
$N_A = N_{10} + Lat._{10\text{-}A} = 6000,00 - 1,21 = 5998,79$
$N_B = N_A + Lat._{A\text{-}B} = 5998,79 - 0,69 = 5998,10$
$N_C = N_B + Lat._{B\text{-}C} = 5998,1 - 1,13 = 5996,97$
$N_D = N_C + Lat._{C\text{-}D} = 5996,97 + 33,81 = 6030,78$

Koordinat $E_2 = E_1 + Dep._{1\text{-}2}$
$E_A = E_{10} + Dep._{10\text{-}A} = 4000,00 - 6,89 = 3993,11$
$E_B = E_A + Dep._{A\text{-}B} = 3993,11 - 3,94 = 3989,17$
$E_C = E_B + Dep._{B\text{-}C} = 3989,17 - 6,40 = 3982,77$
$E_D = E_C + Dep._{C\text{-}D} = 3982,77 - 72,50 = 3910,27$

Tabulasi hasil hitungan sebagai berikut:

BS	IS	Sudut Lurus	HD	Bearing	Latitude		Departure		Koordinat		FS
					N	S	E	W	N	E	
8	9	230”	190,0	N 50^{o} W					6000,00	4000,00	10
9	10	130”	7,0	S 80^{o} W		1,21		6,89	5998,79	3993,11	A
10	A	180”	4,0	S 80^{o} W		0.69		3,94	5998,10	3989,17	B
A	B	180”	6,5	S 80^{o} W		1,13		6,40	5996,97	3982,77	C
B	C	215”	80,0	N 65^{o} W	33,81			72,51	6030,78	3910,27	D

Contoh 4.



Diketahui data pengukuran triangulasi untuk pembuatan shaft plumbing sebagai berikut:
Bearing AB = S 55°30'30" W
Panjang AB = 1258 mm
Panjang BC = 1545 mm
Panjang AC = 2795 mm
Sudut BCA = 0°15'40"
Sudut ACD = 105°20'40"
Hitunglah bearing CD.
Jawab:
Persamaan sudut pada gambar adalah:
$\angle BAC + \angle ABC + \angle BCA = 180^o$
$\angle ABC + \angle y = 180^o$
$\angle BCA + \angle ACD = \angle BCD = 0^o15'40" + 105^o20'40" = 105^o36'20"$
$\angle BCA (w) = 0^o15'40" = 940"$

$\angle BAC$ (x) dihitung dengan persamaan:

$$\frac{x}{BC} = \frac{w}{AB}$$

$$x = \frac{w}{AB} BC$$

$$x = \frac{940"}{1258} 1545$$

x = 1154" (pembulatan ke detik)

Sudut y dihitung dengan persamaan:

$$\frac{y}{AC} = \frac{w}{AB}$$

$$y = \frac{w}{AB} AC = \frac{940"}{1258} 2795$$

y = 2088" (pembulatan ke detik)

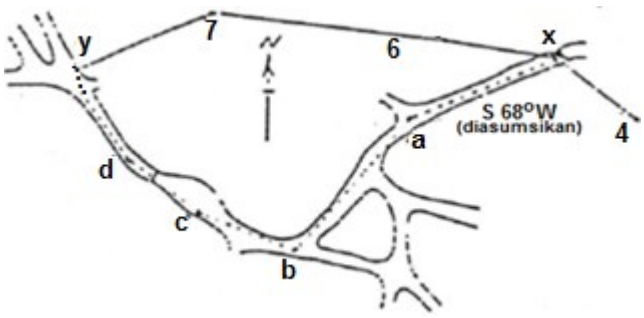
Cek hitungan:
w + x = y → 940" + 1154" = 2094"
y hasil hitungan = 2088"
selisih = 6" → koreksi untuk x dan y masing-masing 3".
Koreksi ini digunakan untuk mengurangi x dan menambah y:
Adj. x = 1154" – 3" = 1151" = 0^o 19' 11"
Adj. y = 2088" + 3" = 2091" = 0^o 34' 51"
Sehingga:
w + x = $0^o15'40" + 0^o$ 19' 11" = 0^o 34' 51" (sama dengan adj.y)

Jadi $\angle ABC = 180^0 - \angle$adj.y = $180^o - 0^o$ 34' 51" = 179^o 25' 9"

Bearing AB = S 55°30'30" W → Azimut (α) AB = $180^o + 55^o30'30" = 235^o30'30"$
$\alpha_{B-C} = \alpha_{A-B} + \beta_{ABC} - 180^o = 235^o30'30" + 179^o25'9" - 180^o = 234^o55'39"$
$Br_{B-C} = 234^o55'39" - 180^o$ = S $54^o55'39"$ W

$\alpha_{C-D} = \alpha_{C-D} + \beta_{BCD} - 180^o = 234^o55'39" + 105^o36'20" - 180^o = 160^o31'59"$
$Br_{8-9} = 180^o - 160^o31'59"$ = S $19^o28'01"$ E

Contoh 5.
Diketahui data pengukuran untuk orientasi dan koneksi melalui dua shaft sebagai berikut:



BS	IS	Angle Right	HD	Bearing	Coordinate		FS
					N	E	
Pengukuran di permukaan tanah:							
2	3	.....	.....	.....	9101,0	10.926,0	4
3	4	.....	100,0	N53°W			*x*
4	*X*	150°00'	45,0				6
x	6	178°30'	90,0				7
6	7	144°30'	60,0				*y*
Pengukuran di bawah tanah:							
...	*X*	.....	62,5	S68°W (asumsi)			*a*
x	*A*	146°30'	70,5				*b*
a	*B*	261°45'	42,0				*c*
b	*C*	191°00'	39,5				*d*
c	*D*	197°15'	33,7				*y*

Hitunglah koordinat titik-titik poligon di permukaan dan di bawah tanah.

Jawab:

Bearing (Br_{4-x}) = N 53° W → Azimut (α_{4-x}) = 360° – 53° = 307°

$\alpha_{x-6} = \alpha_{4-x} + \beta_x - 180^\circ = 307^\circ + 150^\circ00' - 180^\circ = 277^\circ$ → $Br_{x-6} = 360^\circ - 277^\circ = N\ 83^\circ\ W$

$\alpha_{6-7} = \alpha_{x-6} + \beta_6 - 180^\circ = 260^\circ + 178^\circ30' - 180^\circ = 275^\circ30'$ → $Br_{6-7} = 360^\circ - 275^\circ30' = N\ 8^\circ\ W$

$\alpha_{7-y} = \alpha_{6-7} + \beta_7 - 180^\circ = 260^\circ + 144^\circ30' - 180^\circ = 240^\circ$ → $Br_{7-8} = 240^\circ - 180^\circ = S\ 60^\circ\ W$

Bearing (Br_{x-a}) = S 68° W → Azimut (α_{x-a}) = 180° + 68° = 248°

$\alpha_{a-b} = \alpha_{x-a} + \beta_a - 180^\circ = 248^\circ + 146^\circ30' - 180^\circ = 214^\circ30'$ → $Br_{a-b} = 214^\circ - 180^\circ = S\ 34^\circ30'\ W$

$\alpha_{b-c} = \alpha_{a-b} + \beta_b - 180^\circ = 260^\circ + 261^\circ45' - 180^\circ = 296^\circ15'$ → $Br_{b-c} = 360^\circ - 296^\circ15' = N\ 63^\circ45'\ W$

$\alpha_{c-d} = \alpha_{b-c} + \beta_c - 180^\circ = 260^\circ + 191^\circ00' - 180^\circ = 307^\circ15'$ → $Br_{c-d} = 360^\circ - 307^\circ15' = N\ 52^\circ45'\ W$

$\alpha_{d-y} = \alpha_{c-d} + \beta_d - 180^\circ = 260^\circ + 197^\circ15' - 180^\circ = 324^\circ30'$ → $Br_{d-y} = 360^\circ - 324^\circ30' = N\ 35^\circ30'\ W$

$Latitude_{12} = HD_{12} \cos \alpha_{12}$

$Lat._{4-x} = HD_{4-x} \cos \alpha_{4-x} = 100,0 \cos 307^\circ = 60,2$

$Lat._{x-6} = HD_{x-6} \cos \alpha_{x-6} = 45,0 \cos 277^\circ = 5,5$

$Lat._{6-7} = HD_{6-7} \cos \alpha_{6-7} = 90,0 \cos 275^\circ30' = 8,6$

$Lat._{7-y} = HD_{7-y} \cos \alpha_{7-y} = 60,0 \cos 240^\circ = -30,0$

$Lat._{x-a} = HD_{x-a} \cos \alpha_{x-a} = 62,5 \cos 248^\circ = -23,4$

$Lat._{a-b} = HD_{a-b} \cos \alpha_{a-b} = 70,5 \cos 214^\circ30' = -58,1$

$Lat._{b-c} = HD_{b-c} \cos \alpha_{b-c} = 42,0 \cos 296^\circ15' = 18,6$

$Lat._{c-d} = HD_{c-d} \cos \alpha_{c-d} = 39,5 \cos 307^\circ15' = 23,9$

$Lat._{d-y} = HD_{d-y} \cos \alpha_{d-y} = 33,7 \cos 324^\circ30' = 27,4$

$Departure_{12} = HD_{12} \sin \alpha_{12}$

$Dep._{4-x} = HD_{4-x} \sin \alpha_{4-x} = 100,0 \sin 307^\circ = -79,9$

$Dep._{x-6} = HD_{x-6} \sin \alpha_{x-6} = 45,0 \sin 277^\circ = -44,7$

$Dep._{6-7} = HD_{6-7} \sin \alpha_{6-7} = 90,0 \sin 275^\circ30' = -89,6$

$Dep._{7-y} = HD_{7-y} \sin \alpha_{7-y} = 60,0 \sin 240^\circ = -52,0$

$Dep._{x-a} = HD_{x-a} \sin \alpha_{x-a} = 62,5 \sin 248^\circ = -57,9$

$Dep._{a-b} = HD_{a-b} \sin \alpha_{a-b} = 70,5 \sin 214^\circ30' = -39,9$

$Dep._{b-c} = HD_{b-c} \sin \alpha_{b-c} = 42,0 \sin 296^\circ15' = -37,7$

$Dep._{c-d} = HD_{c-d} \sin \alpha_{c-d} = 39,5 \sin 307^\circ15' = -31,4$

$Dep._{d-y} = HD_{d-y} \sin \alpha_{d-y} = 33,7 \sin 324^\circ30' = -19,6$

Koordinat $N_2 = N_1 + Lat._{12}$

$N_x = N_4 + Lat._{4\text{-}x} = 9101{,}0 + 60{,}2 = 9161{,}2$

$N_6 = N_x + Lat._{x\text{-}6} = 9161{,}2 + 5{,}5 = 9166{,}7$

$N_7 = N_6 + Lat._{6\text{-}7} = 9166{,}7 + 8{,}6 = 9175{,}3$

$N_y = N_7 + Lat._{7\text{-}y} = 9175{,}3 - 30{,}0 = 9145{,}3$

$N_a = N_x + Lat._{x\text{-}a} = 9161{,}2 - 23{,}4 = 9137{,}8$

$N_b = N_a + Lat._{a\text{-}b} = 9137{,}8 - 58{,}1 = 9079{,}7$

$N_c = N_b + Lat._{b\text{-}c} = 9079{,}7 + 18{,}6 = 9098{,}2$

$N_d = N_c + Lat._{c\text{-}d} = 9098{,}2 + 23{,}9 = 9122{,}2$

$N_y = N_d + Lat._{d\text{-}y} = 9122{,}2 + 27{,}4 = 9149{,}6$

Koordinat $E_2 = E_1 + Dep._{12}$

$E_x = E_4 + Dep._{4\text{-}x} = 10.926{,}0 - 79{,}9 = 10.846{,}1$

$E_6 = E_x + Dep._{x\text{-}6} = 10.846{,}1 - 44{,}7 = 10.801{,}5$

$E_7 = E_6 + Dep._{6\text{-}7} = 10.801{,}5 - 89{,}6 = 10.711{,}9$

$E_y = E_7 + Dep._{7\text{-}y} = 10.711{,}9 - 52{,}0 = 10.659{,}9$

$E_a = E_x + Dep._{x\text{-}a} = 10.846{,}1 - 57{,}9 = 10.788{,}2$

$E_b = E_a + Dep._{a\text{-}b} = 10.788{,}2 - 39{,}9 = 10.748{,}3$

$E_c = E_b + Dep._{b\text{-}c} = 10.748{,}3 - 37{,}7 = 10.710{,}6$

$E_d = E_c + Dep._{c\text{-}d} = 10.710{,}6 - 31{,}4 = 10.679{,}1$

$E_y = E_d + Dep._{d\text{-}y} = 10.679{,}1 - 19{,}6 = 10.659{,}6$

Tabulasi hasil hitungan sebagai berikut:

BS	IS	Angle Right	HD	Bearing	Latitude		Departure		Coordinate		FS
					N	S	E	W	N	E	
Pengukuran di permukaan tanah:											
2	3	.....	.....	.....					9.101,0	10.926,0	4
3	4	.....	100,00	N 53° W	60,2			79,9	9.161,2	10.846,1	*x*
4	*x*	150°00′	45,00	N 83° W	5,5			44,7	9.166,7	10.801,5	6
x	6	178°30′	90,00	N 84°30′ W	8,6			89,6	9.175,3	10.711,9	7
6	7	144°30′	60,00	S 60° W		30,0		52,0	***9.145,3***	***10.659,9***	***y***
Pengukuran di bawah tanah:											
...	*x*	.....	62,50	S 68°W (asumsi)		23,4		57,9	9.137,8	10.788,2	*a*
x	*a*	146°30′	70,50	S 34°30′ W		58,1		39,9	9.079,7	10.748,3	*b*
a	*b*	261°45′	42,00	N 63°45′ W	18,6			37,7	9.098,2	10.710,6	*c*
b	*c*	191°00′	39,50	N 52°45′ W	23,9			31,4	9.122,2	10.679,1	*d*
c	*d*	197°15′	33,70	N 35°30′ W	27,4			19,6	***9.149,6***	***10.659,6***	***y***

*)Perhatikan terdapat perbedaan nilai koordinat titik y di permukaan dan di bawah tanah, sehingga perlu dilakukan koreksi terhadap bearing x ke a yang diasumsikan.

Pada pengukuran bawah tanah:

$HD_{y\text{-}x} = \sqrt{(lat_{y-x})^2 + (dep_{y-x})^2}$

$= \sqrt{(9161{,}18 - 9149{,}59)^2 + (10.846{,}14 - 10.659{,}58)^2}$

$= \sqrt{11{,}59^2 + 186{,}56^2}$

= 186,92 ft

Azimut yx $= \tan^{-1}\frac{dep}{lat} = \frac{186{,}56}{11{,}59} = 86^\circ 26'39''$ → Bearing yx = N 86°26′39″ E

∠yxa (sudut luar) = $\alpha_{x\text{-}a} - \alpha_{y\text{-}x} + 180^\circ = 248^\circ - 86^\circ 26'39'' + 180^\circ = 341^\circ 33'21''$

Pada pengukuran di permukaan:

$HD_{y\text{-}x} = \sqrt{(lat_{y-x})^2 + (dep_{y-x})^2}$

$= \sqrt{(9161{,}18 - 9145{,}29)^2 + (10.846{,}14 - 10.659{,}92)^2}$

$= \sqrt{15{,}89^2 + 186{,}21^2}$

= 186,89 ft

Azimut yx $= \tan^{-1}\frac{dep}{lat} = \frac{186{,}21}{15{,}89} = 85^\circ 07'22''$ → Bearing yx = N 85°07′22″ E

Selanjutnya dihitung azimut xa yang sebenarnya ($\alpha_{x\text{-}a}'$):

$\alpha_{x\text{-}a}' = \alpha_{y\text{-}x} + \beta_x - 180^\circ = 85^\circ 07'22'' + 341^\circ 33'21'' - 180^\circ = 246^\circ 40'43''$ → Bearing xa terkoreksi = S 66°40′43″ W

Hasil hitungan poligon bawah tanah terkoreksi disajikan dalam tabel berikut:

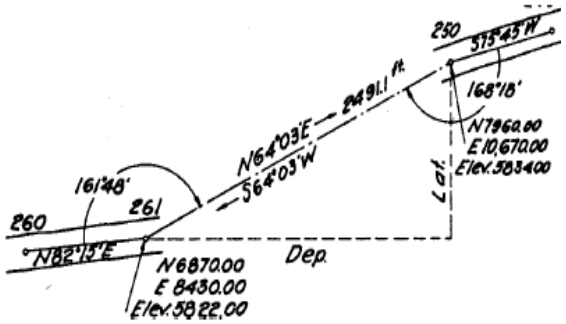
BS	IS	Angle Right	HD	Bearing	Latitude		Departure		Coordinate		FS
					N	S	E	W	N	E	
Pengukuran di permukaan tanah:											
2	3	.....	.....	.....					9.101,0	10.926,0	4
3	4	.....	100,00	N 53^o W	60,2			79,9	9.161,2	10.846,1	*x*
4	*x*	150^{o}00’	45,00	N 83^o W	5,5			44,7	9.166,7	10.801,5	6
x	6	178^{o}30’	90,00	N 84^{o}30’ W	8,6			89,6	9.175,3	10.711,9	7
6	7	144^{o}30’	60,00	S 60^o W		30,0		52,0	***9.145,3***	***10.659,9***	***y***
Pengukuran di bawah tanah:											
...	*x*	.....	62,50	S 66^{o}40’42” W		24,7		57,4	9.136,4	10.788,7	*a*
x	*a*	146^{o}30’	70,50	S 33^{o}10’42” W		59,0		38,6	9.077,4	10.750,2	*b*
a	*b*	261^{o}45’	42,00	N 65^{o}04’18” W	17,7			38,1	9.095,1	10.712,1	*c*
B	*c*	191^{o}00’	39,50	N 54^{o}04’18” W	23,2			32,0	9.118,3	10.680,1	*d*
C	*d*	197^{o}15’	33,70	N 36^{o}49’18” W	27,0			20,0	***9.145,3***	***10.659,9***	***y***

*)Perhatikan setelah dilakukan koreksi terhadap bearing x ke a, maka nilai koordinat titik y di permukaan sama dengan koordinat titik y di bawah tanah.

Contoh 6.

Diketahui data pengukuran untuk menghubungkan dua drift sebagai berikut:

Bearing 260 ke 261 = N 82^{o}15’ E
Bearing 249 ke 250 = S 75^{o}45’ W
Koordinat titik 261 = N 6870,00 ; E 8430,00
Elevasi titik 261 = 5822,00
Koordinat titik 250 = N 7960,00 ; E 10670,00
Elevasi titik 250 = 5834,00
Hitung: jarak, bearing, sudut dan gradenya



Jawab:

$HD_{261k-250} = \sqrt{(lat_{261-250})^2 + (dep_{261-250})^2}$
$= \sqrt{(7960 - 6870)^2 + (10670 - 8430)^2}$
$= \sqrt{1090^2 + 2240^2}$
= 2491,12 ft

Azimut 261 ke 250 = $\tan^{-1} \frac{dep}{lat} = \frac{2240}{1090}$ = 64^{o}03’ → Bearing 261 ke 250 = N 64^{o}03’ E

(hasil hitungan dibulatkan ke menit)

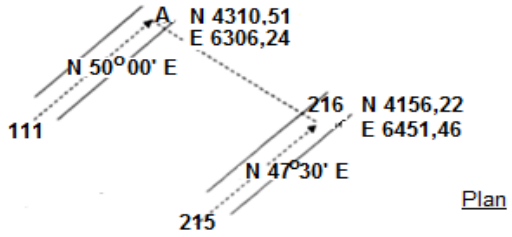
Dari persamaan azimut dengan sudut kanan:
$\alpha_{261\text{-}250} = \alpha_{260\text{-}261} + \beta_{261} - 180^o \rightarrow \beta_{261} = \alpha_{261\text{-}250} - \alpha_{260\text{-}261} + 180^o = 64^o03' - 82^o15' + 180^o = 161^o48'$
$\alpha_{250\text{-}261} = \alpha_{249\text{-}250} + \beta_{250} - 180^o \rightarrow \beta_{250} = \alpha_{250\text{-}261} - \alpha_{249\text{-}250} + 180^o = (64^o03'+180^o) - (180^o+75^o45') + 180^o = 168^o18'$

Grade (berdasarkan VD dan HD):
Perbedaan elevasi = 5.834,00 – 5.822,00 = 12,00 feet
Grade = $\frac{12,00}{2491,12}$ x 100 % = 0,48% , positif dari 261 ke 250.

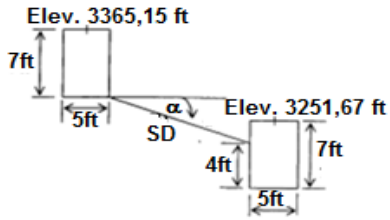
Contoh 7.

Diketahui data pengukuran untuk menghubungkan dua drift dengan satu raise seperti gambar berikut:
Hitunglah:

- bearing A ke 216 dan 216 ke A
- sudut vertikal (α)
- jarak miring (SD)
- sudut kanan 215-216-A dan 111-A-216



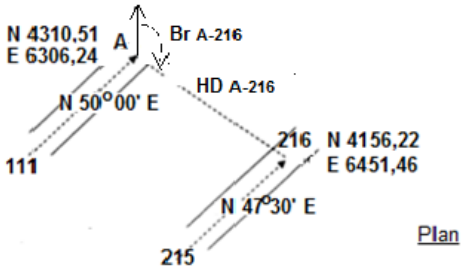
Plan



Section

Jawab:

Perhatikan ilustrasi plan (tampak atas)



Plan

$HD_{A\text{-}261} = \sqrt{(lat_{A-261})^2 + (dep_{A-261})^2}$

$= \sqrt{(4156{,}22 - 4310{,}51)^2 + (6451{,}46 - 6306{,}24)^2}$

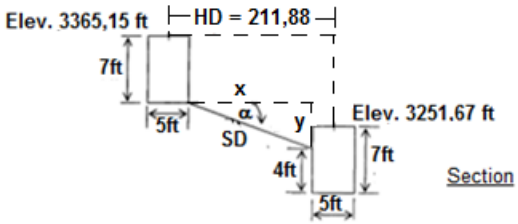
$= \sqrt{(-154{,}29)^2 + 145{,}22^2}$

= 211,88 ft

Azimut A ke 216 $= \tan^{-1} \frac{dep}{lat} = \frac{145{,}22}{-154{,}29} = 136^\circ 44'$

Bearing A ke 216 = 180°-136°44' = S 43°16' E → Bearing 216 ke A = N 43°16' W

Perhatikan ilustrasi section (penampang)



Section

x = $HD_{A\text{-}261}$ – (2x2,5) = 211,88 – 5 = 206,88 ft

y = (Elev. A – 7) – (Elev. 216 – 7 + 4) = (3365,15 – 7) – (3251,67 – 7 + 4) = 109,48 ft

$\alpha = \tan^{-1} \frac{y}{x} = \frac{109{,}48}{206{,}88} = 27°53'$

$\cos \alpha = \frac{x}{SD}$ → $SD = \frac{x}{\cos\alpha} = \frac{206{,}88}{\cos 27°53'} = 234{,}06$ ft

Dari persamaan azimut dengan sudut kanan:

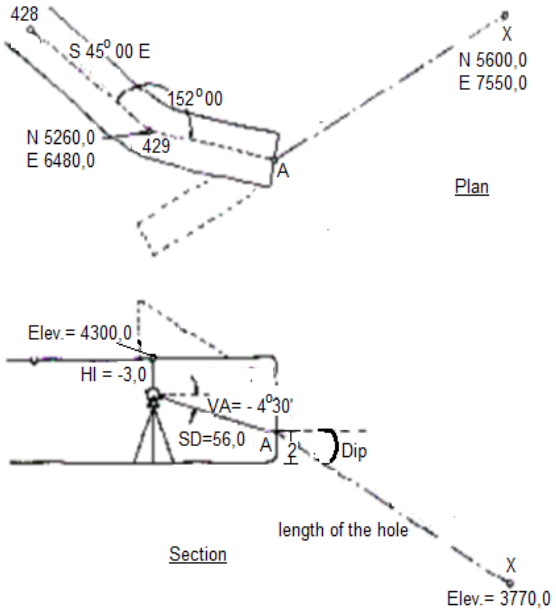
$\alpha_{A\text{-}216} = \alpha_{111\text{-}A} + \beta_A - 180^\circ$ → $\beta_A = \alpha_{A\text{-}216} - \alpha_{111\text{-}A} + 180^\circ = 136^\circ 44' - 50^\circ 00' + 180^\circ = 266^\circ 44'$

$\alpha_{216\text{-}A} = \alpha_{215\text{-}216} + \beta_{216} - 180^\circ$ → $\beta_{216} = \alpha_{216\text{-}A} - \alpha_{215\text{-}216} + 180^\circ = (136^\circ 44' + 180^\circ) - 47^\circ 30' + 180^\circ = 89^\circ 14'$

Contoh 8.

Diketahui data pengukuran untuk menempatkan drill hole pada suatu garis sebagai berikut:

Hitunglah bearing, sudut kanan, dip, dan panjang hole tersebut



Jawab:

Azimut ($\alpha_{429\text{-}A}$) = $(180^\circ - 45^\circ) + 152^\circ 00' - 180^\circ = 107^\circ$

Bearing ($Br_{429\text{-}A}$) = $180^\circ - 107^\circ$ = S 73° E

$HD_{429\text{-}A}$ = 56,0 x cos (-4° 30') = 55,8 ft

$VD_{429\text{-}A}$ = 56,0 x sin (-4° 30') = -4,4 ft

$Latitude_{429\text{-}A}$ = $HD_{429\text{-}A}$ cos $\alpha_{429\text{-}A}$ = 55,9 cos 107° = -16,3

$Departure_{429\text{-}A}$ = $HD_{429\text{-}A}$ sin $\alpha_{429\text{-}A}$ = 55,9 sin 107° = 53,4

Koordinat N_A = N_{429} + $Lat._{429\text{-}A}$ = 5260,0 + (-16,3) = 5243,7

Koordinat E_A = E_{429} + $Dep._{429\text{-}A}$ = 6480,0 + 53,4 = 6533,4

$Elev._A$ = $Elev._{429}$ + HI_{429} + $VD_{429\text{-}A}$ = 4300,0 + (-3,0) + (-4,4) = 4292,6

$$Azimut_{A\text{-}X} = \tan^{-1}\frac{dep_{A-X}}{lat_{A-X}}$$

$$= \tan^{-1}\frac{(7550,0-6533,4)}{(5600,0-524,7)} = \tan^{-1}\frac{1016,6}{356,3} = 70^\circ 41'$$

$Bearing_{A\text{-}X}$ = N 70°41' E

$$HD_{A\text{-}X} = \sqrt{(lat_{A-X})^2 + (dep_{A-X})^2}$$

$$= \sqrt{(5600,0-5243,7)^2 + (7550,0-6533,4)^2} = \sqrt{356,3^2 + 1016,6^2} = 1077,2 \text{ ft}$$

$VD_{A\text{-}X}$ = $Elev._X$ – ($Elev._{429}$ + HI + VD_A)

= 3770,0 – (4300,0 + (-3,0) + (-4,4)) = -522,6

$$Dip_{A\text{-}X} = VA_{A\text{-}X} = \tan^{-1}\frac{VD_{A\text{-}X}}{HD_{A\text{-}X}} = \frac{-523,6}{1077,2} = -25^\circ 53'$$

$$\cos VA_{A\text{-}X} = \frac{HD_{A\text{-}X}}{SD_{A\text{-}X}} \rightarrow SD_{A\text{-}X} = \frac{HD_{A\text{-}X}}{\cos VA_{A\text{-}X}} = \frac{1077,2}{\cos 25°53'} = 1197,8 \text{ ft}$$

Dari persamaan azimut dengan sudut kanan:

$\alpha_{A\text{-}X} = \alpha_{429\text{-}A} + \beta_A - 180^\circ$ → $\beta_A = \alpha_{A\text{-}X} - \alpha_{429\text{-}A} + 180^\circ = 70^\circ 41' - 107^\circ + 180^\circ = 143^\circ 41'$

Tabulasi hasil hitungan sebagai berikut:

HI	BS	IS	Angle to right	Bearing	SD	VA	Coordinate		Elev.	FS
							N	E		
		428		S45°00'E			5260,0	6480,0	4300,0	429
-3,0	428	429	152°00'	S73°00'E	56,0	-4°30'	5243,7	6533,4	4292,6	A
	429	A	143°41'	N70°41'E	1197,8	-25°53'	5600,0	7550,0	3770,0	X

Contoh 9.

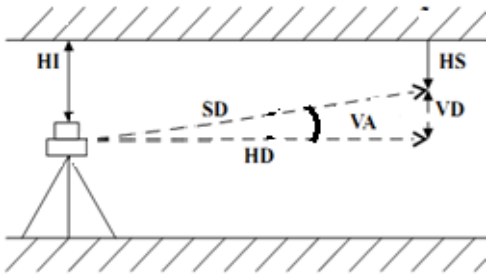
Diketahui hasil pengukuran sebagai berikut:

Tinggi instrument (HI) = 3,45ft dari roof
Tinggi target (HS) = 4,67ft dari roof
Jarak miring (SD) = 94,78ft
Sudut vertikal (VA) = +17°42'

Hitung: jarak horisontal (HD), jarak vertikal (VD), beda tinggi dari A ke B (ΔH_{AB})

Jawab:

HD = SD cos VA
= 94,78 cos 17°42'
= 90,92ft



VD = SD sin VA
= 94,78 sin 17°42'
= 28,82ft

ΔH = VD + HI – HS
= 28,82 + (-3,45) - (-4,67)
= +30,04ft

Catatan: VD bernilai (+) jika arah bidikan ke atas, (-) jika arah bidikan ke bawah.
HI bernilai (-) jika diukur dari roof, (+) jika diukur dari floor.
HS bernilai (-) jika diukur dari roof, (+) jika diukur dari floor.

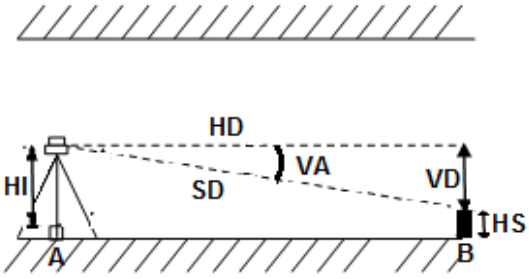
Contoh 10.

Diketahui hasil pengukuran sebagai berikut:

Koordinat titik A = N 176,286 ; E 255,751
Tinggi titik A = 42,623 m
Azimut A-B = 240°25'20"
Tinggi instrument (HI) = 1,565m dari floor
Tinggi target (HS) = 1,690m dari floor
Jarak miring (SD) = 11,682m
Sudut vertikal (VA) = -3°22'30"

Hitung: Koordinat dan tinggi titik B.

Jawab:



HD_{A-B} = SD_{A-B} cos VA_{A-B}
= 11,682 cos (-3°22'30") = 11,662m

Lat_{A-B} = HD_{A-B} cos α_{A-B}
= 11,662 cos 240°25'20"
= -5,756

Dep_{A-B} = HD_{A-B} sin α_{A-B}
= 11,662 sin 240°25'20"
= -10,142

N_B = N_{A-B} + Lat_{A-B}
= 176,286 + (-5,756)
= 170,530

E_B = E_{A-B} + Dep_{A-B}
= 255,751 + (-10,142)
= 245,609

VD_{A-B} = SD_{A-B} sin VA_{A-B}
= 11,682 sin (-3°22'30") = -0,688m

ΔH_{A-B} = VD_{A-B} + HI_A – HS_B
= -0,688 + 1,565 - 1,690 = -0,813m

H_B = H_A + ΔH_{A-B}
= 42,623 + (-0,813)
= 41,810m