


Surveying - Traverse




Group Example Problem 2

Balance the latitudes and departures for the following traverse.

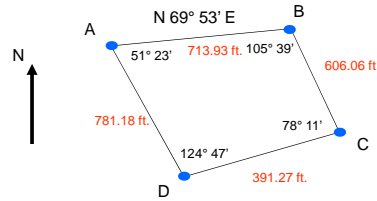
Length (ft)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
600.0	450.00	339.00				
450.0	-285.00	259.50				
750.0	-164.46	-599.22				
1800.0	0.54	-0.72				

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Group Example Problem 3

In the survey of your assign site in Project #3, you will have to balance data collected in the following form:



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Group Example Problem 3


In the survey of your assign site in Project #3, you will have to balance data collected in the following form:

Side	Bearing degree minutes	Length (ft.)	Latitude	Departure	Corrections		Balanced	
					Latitude	Departure	Latitude	Departure
AB	N 69 53 E	713.93						
BC		606.06						
CD		391.27						
DA		781.18						

Enclosure = ft.

Precision =


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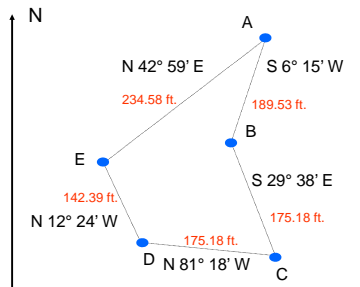
Calculating Traverse Area

- The best-known procedure for calculating land areas is the **double meridian distance (DMD)** method
- The **meridian distance** of a line is the east-west distance from the midpoint of the line to the reference meridian
- The **meridian distance** is positive (+) to the east and negative (-) to the west


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Calculating Traverse Area



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Calculating Traverse Area

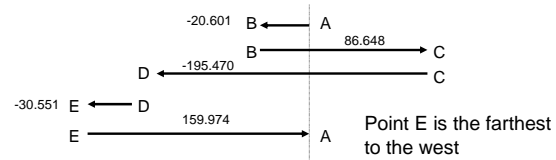
- The most westerly and easterly points of a traverse may be found using the departures of the traverse
- Begin by establishing an arbitrary reference line and using the departure values of each point in the traverse to determine the far westerly point

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Calculating Traverse Area




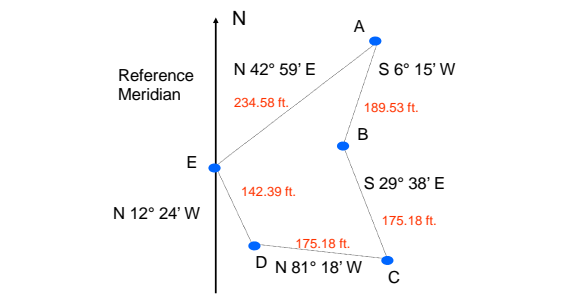
Length (ft.)	Latitude	Departure	Corrections		Balanced	
			Latitude	Departure	Latitude	Departure
189.53	-188.403	-20.634	0.016	0.033	-188.388	-20.601
175.18	-152.268	86.617	0.015	0.030	-152.253	86.648
197.78	29.916	-195.504	0.017	0.034	29.933	-195.470
142.39	139.868	-30.576	0.012	0.025	139.900	-30.551
234.58	171.607	159.933	0.020	0.041	171.627	159.974
939.46	-0.079	-0.163			0.000	0.000



Point E is the farthest to the west


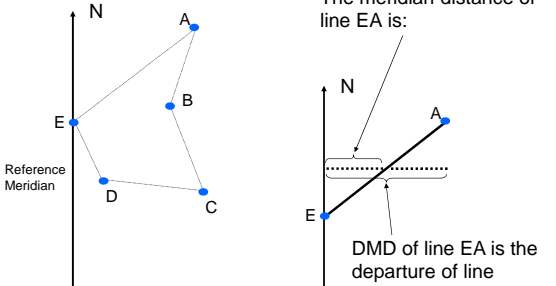
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Calculating Traverse Area

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DMD Calculations


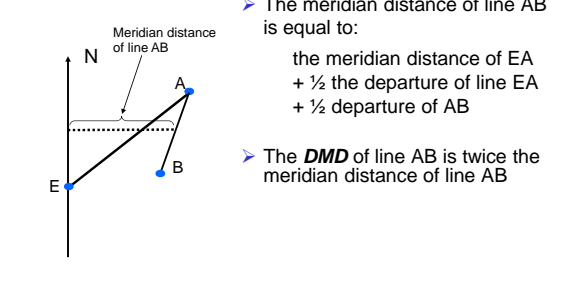



The meridian distance of line EA is:

DMD of line EA is the departure of line

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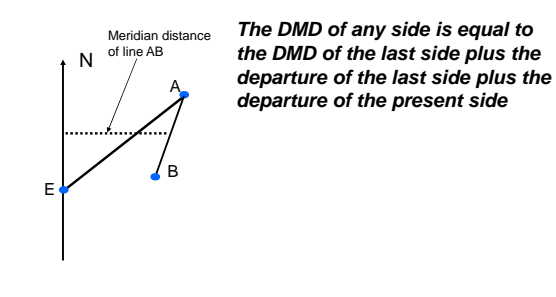
DMD Calculations

- The meridian distance of line AB is equal to:
 - the meridian distance of line EA
 - + 1/2 the departure of line EA
 - + 1/2 departure of AB
- The **DMD** of line AB is twice the meridian distance of line AB

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DMD Calculations

The **DMD** of any side is equal to the **DMD** of the last side plus the departure of the last side plus the departure of the present side

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DMD Calculations



Side	Balanced		DMD
	Latitude	Departure	
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	
CD	29.933	-195.470	
DE	139.080	-30.551	
EA	171.627	159.974	

The **DMD** of line AB is departure of line AB

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DMD Calculations

Side	Balanced		DMD
	Latitude	Departure	
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	45.447
CD	29.933	-195.470	
DE	139.080	-30.551	
EA	171.627	159.974	

The **DMD** of line BC is DMD of line AB + departure of line AB + the departure of line BC

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DMD Calculations

Side	Balanced		DMD
	Latitude	Departure	
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	45.447
CD	29.933	-195.470	-63.375
DE	139.080	-30.551	
EA	171.627	159.974	

The **DMD** of line CD is DMD of line BC + departure of line BC + the departure of line CD

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DMD Calculations

Side	Balanced		DMD
	Latitude	Departure	
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	45.447
CD	29.933	-195.470	-63.375
DE	139.080	-30.551	-289.397
EA	171.627	159.974	

The **DMD** of line DE is DMD of line CD + departure of line CD + the departure of line DE

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DMD Calculations

Side	Balanced		DMD
	Latitude	Departure	
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	45.447
CD	29.933	-195.470	-63.375
DE	139.080	-30.551	-289.397
EA	171.627	159.974	-159.974

The **DMD** of line EA is DMD of line DE + departure of line DE + the departure of line EA

Surveying - Traverse

DMD Calculations

Side	Balanced		DMD
	Latitude	Departure	
AB	-188.388	-20.601	-20.601
BC	-152.253	86.648	45.447
CD	29.933	-195.470	-63.375
DE	139.080	-30.551	-289.397
EA	171.627	159.974	-159.974

Notice that the DMD values can be positive or negative

Surveying - Traverse

Traverse Area - Double Area

➤ The sum of the products of each points DMD and latitude equal twice the area, or the **double area**

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	
CD	29.933	-195.470	-63.375	
DE	139.080	-30.551	-289.397	
EA	171.627	159.974	-159.974	

➤ The double area for line AB equals DMD of line AB times the latitude of line AB

Surveying - Traverse

Traverse Area - Double Area

➤ The sum of the products of each points DMD and latitude equal twice the area, or the double area

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456

➤ The double area for line BC equals DMD of line BC times the latitude of line BC

Surveying - Traverse

Traverse Area - Double Area

➤ The sum of the products of each points DMD and latitude equal twice the area, or the double area

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456

➤ The double area for line CD equals DMD of line CD times the latitude of line CD

Surveying - Traverse

Traverse Area - Double Area

➤ The sum of the products of each points DMD and latitude equal twice the area, or the double area

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456

➤ The double area for line DE equals DMD of line DE times the latitude of line DE

Surveying - Traverse

Traverse Area - Double Area

➤ The sum of the products of each points DMD and latitude equal twice the area, or the double area

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456

➤ The double area for line EA equals DMD of line EA times the latitude of line EA

Surveying - Traverse

Traverse Area - Double Area

➤ The sum of the products of each points DMD and latitude equal twice the area, or the double area

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456

1 acre = 43,560 ft.²


Surveying - Traverse

Traverse Area - Double Area

➤ The sum of the products of each points DMD and latitude equal twice the area, or the double area

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	-188.388	-20.601	-20.601	3,881
BC	-152.253	86.648	45.447	-6,919
CD	29.933	-195.470	-63.375	-1,897
DE	139.080	-30.551	-289.397	-40,249
EA	171.627	159.974	-159.974	-27,456
2 Area =				-72,641
1 acre = 43,560 ft. ²				Area = 0.834 acre


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Traverse Area - Double Area

- The word "acre" is derived from Old English *æcer* (originally meaning "open field", cognate to Swedish "åker", German *acker*, Latin *ager* and Greek *αγρος* (*agros*)).
- The acre was selected as approximately the amount of land tillable by one man behind an ox in one day.
- This explains one definition as the area of a rectangle with sides of length one chain (66 ft.) and one furlong (ten chains or 660 ft.).


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Traverse Area - Double Area

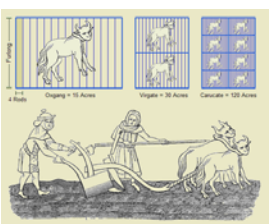
- The word "acre" is derived from Old English *æcer* (originally meaning "open field", cognate to Swedish "åker", German *acker*, Latin *ager* and Greek *αγρος* (*agros*)).
- A long narrow strip of land is more efficient to plough than a square plot, since the plough does not have to be turned so often.
- The word "furlong" itself derives from the fact that it is *one furrow long*.

Surveying - Traverse




Traverse Area - Double Area

- The word "acre" is derived from Old English *æcer* (originally meaning "open field", cognate to Swedish "åker", German *acker*, Latin *ager* and Greek *αγρος* (*agros*)).



Surveying - Traverse



Traverse Area – Example 4


- Find the area enclosed by the following traverse

Side	Balanced		DMD	Double Areas
	Latitude	Departure		
AB	600.0	200.0		
BC	100.0	400.0		
CD	0.0	100.0		
DE	-400.0	-300.0		
EA	-300.0	-400.0		

2 Area = ft.²

1 acre = 43,560 ft.² Area = acre


Surveying - Traverse



DPD Calculations

- The same procedure used for DMD can be used the **double parallel distances (DPD)** are multiplied by the balanced departures
- The **parallel distance** of a line is the distance from the midpoint of the line to the reference parallel or east–west line

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Rectangular Coordinates

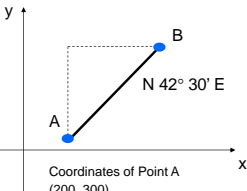
- Rectangular coordinates are the convenient method available for describing the horizontal position of survey points
- With the application of computers, rectangular coordinates are used frequently in engineering projects
- In the US, the **x-axis** corresponds to the east–west direction and the **y-axis** to the north–south direction

Surveying - Traverse

Rectangular Coordinates Example



In this example, the length of AB is 300 ft. and bearing is shown in the figure below. Determine the coordinates of point B




$\text{Latitude}_{AB} = 300 \text{ ft.} \cos(42^\circ 30')$
 $= 221.183 \text{ ft.}$

$\text{Departure}_{AB} = 300 \text{ ft.} \sin(42^\circ 30')$
 $= 202.667 \text{ ft.}$

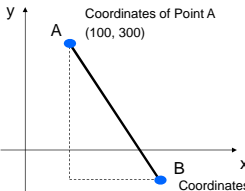
$x_B = 200 + 202.667 = 402.667 \text{ ft.}$
 $y_B = 300 + 221.183 = 521.183 \text{ ft.}$

Surveying - Traverse

Rectangular Coordinates Example



In this example, it is assumed that the coordinates of points A and B are known and we want to calculate the latitude and departure for line AB




$\text{Latitude}_{AB} = y_B - y_A$
 $\text{Latitude}_{AB} = -400 \text{ ft.}$

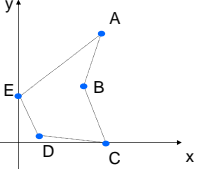
$\text{Departure}_{AB} = x_B - x_A$
 $\text{Departure}_{AB} = 220 \text{ ft.}$

Surveying - Traverse

Rectangular Coordinates Example




Consider our previous example, determine the x and y coordinates of all the points



Side	Balanced	
	Latitude	Departure
AB	-188.388	-20.601
BC	-152.253	86.648
CD	29.933	-195.470
DE	139.080	-30.551
EA	171.627	159.974

Surveying - Traverse

Rectangular Coordinates Example



$\text{Latitude}_{AB} = y_B - y_A$
 $\text{Latitude}_{AB} = -400 \text{ ft.}$

$\text{Departure}_{AB} = x_B - x_A$
 $\text{Departure}_{AB} = 220 \text{ ft.}$

$\text{Latitude}_{BC} = y_C - y_B$
 $\text{Latitude}_{BC} = 152.253$

$\text{Departure}_{BC} = x_C - x_B$
 $\text{Departure}_{BC} = 86.648$

$\text{Latitude}_{CD} = y_D - y_C$
 $\text{Latitude}_{CD} = -195.470$

$\text{Departure}_{CD} = x_D - x_C$
 $\text{Departure}_{CD} = -195.470$

$\text{Latitude}_{DE} = y_E - y_D$
 $\text{Latitude}_{DE} = 139.080$

$\text{Departure}_{DE} = x_E - x_D$
 $\text{Departure}_{DE} = -30.551$

$\text{Latitude}_{EA} = y_A - y_E$
 $\text{Latitude}_{EA} = 171.627$


$\text{Departure}_{EA} = x_A - x_E$
 $\text{Departure}_{EA} = 159.974$

$x_C = 0$
 $A = E + 159.974 = 159.974 \text{ ft.}$
 $B = A - 20.601 = 139.373 \text{ ft.}$
 $C = B + 86.648 = 226.021 \text{ ft.}$
 $D = C - 195.470 = 30.551 \text{ ft.}$
 $E = D - 30.551 = 0 \text{ ft.}$

Side	Balanced	
	Latitude	Departure
AB	-188.388	-20.601
BC	-152.253	86.648
CD	29.933	-195.470
DE	139.080	-30.551
EA	171.627	159.974

Surveying - Traverse

Rectangular Coordinates Example



$\text{Latitude}_{DE} = y_E - y_D$
 $\text{Latitude}_{DE} = 139.080$

$\text{Departure}_{DE} = x_E - x_D$
 $\text{Departure}_{DE} = -30.551$

$\text{Latitude}_{EA} = y_A - y_E$
 $\text{Latitude}_{EA} = 171.627$


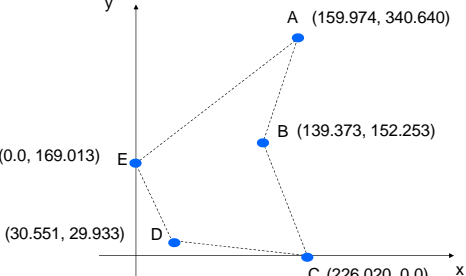
$\text{Departure}_{EA} = x_A - x_E$
 $\text{Departure}_{EA} = 159.974$

$y_C = 0$
 $D = C + 29.933$
 $E = D + 139.080 = 169.013 \text{ ft.}$
 $A = E + 171.627 = 340.640 \text{ ft.}$
 $B = A - 188.388 = 152.252 \text{ ft.}$
 $C = B - 152.252 = 0 \text{ ft.}$

Side	Balanced	
	Latitude	Departure
AB	-188.388	-20.601
BC	-152.253	86.648
CD	29.933	-195.470
DE	139.080	-30.551
EA	171.627	159.974


Surveying - Traverse

Rectangular Coordinates Example

$(0.0, 169.013)$ E
 $(30.551, 29.933)$ D
 $(226.020, 0.0)$ C
 $(139.373, 152.253)$ B
 $(159.974, 340.640)$ A

Surveying - Traverse




Group Example Problem 5

Compute the x and y coordinates from the following balanced.

Side	Bearing degree minutes	Length (ft)	Latitude		Departure		Points	Coordinates	
			Latitude	Departure	Latitude	Departure		x	y
AB	S 6 15 W	189.53	-188.403	-20.634	-188.388	-20.601	A	100.000	100.000
BC	S 29 38 E	175.18	-152.268	86.617	-152.253	86.646	B		
CD	N 81 18 W	197.78	29.916	-195.504	29.933	-195.470	C		
DE	N 12 24 W	142.39	139.068	-30.576	139.080	-30.551	D		
EA	N 42 59 E	234.58	171.607	159.353	171.627	159.374	E		
			939.46	-0.079	-0.163	0.000			

Surveying - Traverse




Area Computed by Coordinates

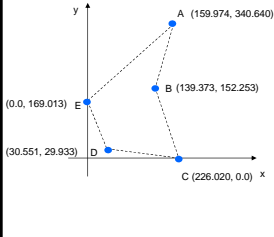
The area of a traverse can be computed by taking each y coordinate multiplied by the difference in the two adjacent x coordinates

(using a sign convention of + for next side and - for last side)

Surveying - Traverse



Area Computed by Coordinates



Twice the area equals:

$$= 340.640(139.373 - 0.0)$$

$$+ 152.253(226.020 - 159.974)$$

$$+ 0.0(30.551 - 139.373)$$


$$+ 29.933(0.0 - 226.020)$$

$$+ 169.013(159.974 - 30.551)$$

$$= 72,640.433 \text{ ft.}^2$$

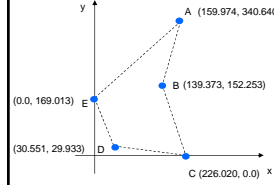
Area = 0.853 acre Area = 36,320.2 ft.²

Surveying - Traverse



Area Computed by Coordinates

There is a simple variation of the coordinate method for area computation




Twice the area equals:

$$= X_1Y_2 + X_2Y_3 + X_3Y_4 + X_4Y_5 + X_5Y_1$$

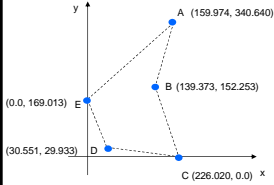
$$- X_2Y_1 - X_3Y_2 - X_4Y_3 - X_5Y_4 - X_1Y_5$$

Surveying - Traverse



Area Computed by Coordinates

There is a simple variation of the coordinate method for area computation



Twice the area equals:

$$159.974(152.253) + 139.373(0.0) + 226.020(29.933) + 30.551(169.013) + 0.0(340.640)$$


$$- 340.640(139.373) - 152.253(226.020)$$

$$- 0.0(30.551) - 29.933(0.0) - 169.013(159.974)$$

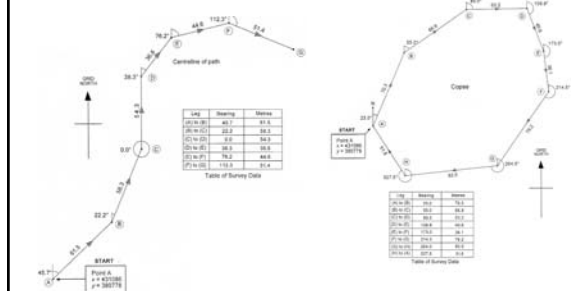
$$= -72,640 \text{ ft.}^2$$

Area = 36,320 ft.²

End of Surveying - Traverse



Any Questions?



Side	Bearing	Distance
AB	S 6 15 W	189.53
BC	S 29 38 E	175.18
CD	N 81 18 W	197.78
DE	N 12 24 W	142.39
EA	N 42 59 E	234.58