RSSB-JE | 2020

Rajasthan Staff Selection Board

Combined Junior Engineer Direct Recruitment Examination

Civil Engineering

Surveying and Field Engineering

Well Illustrated **Theory** *with*
Solved Examples and **Practice Questions**

MADE EASY
Publications

Surveying and Field Engineering
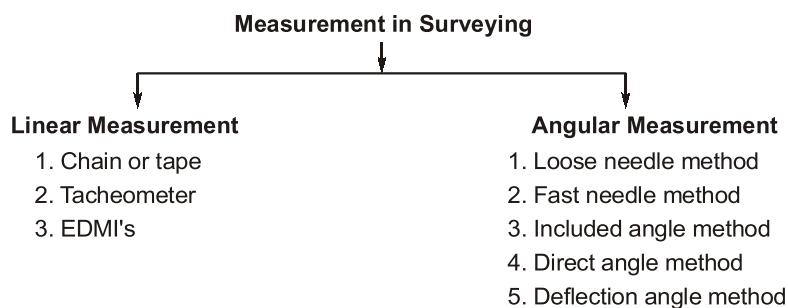
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Traversing

4.1 Introduction

Traverse is a framework consisting of series of straight line connected together forming an open or closed polygon.

4.1.1 Type of Traverse

1. Open traverse
2. Closed traverse

Measurement in Surveying

Linear Measurement	Angular Measurement
1. Chain or tape	1. Loose needle method
2. Tacheometer	2. Fast needle method
3. EDMI's	3. Included angle method
	4. Direct angle method
	5. Deflection angle method

- In traversing linear measurement equipment should be selected such that degree of accuracy is same order of angle measuring equipment.
- If very precise equipments are used for angular measurement then equally precise equipment shall be used for distance measurement.
- If θ is the least count of angle measuring equipment then permissible error in linear measurements equipment should be of the order of $\left(\tan\theta = \dfrac{\delta L}{L} \right)$.

Example - 4.1 If least count of compass is 30′ then determine order of error for linear measurement equipment used in compass survey.

Solution:

$$\tan(30°) = \frac{\delta L}{L}$$

$$\frac{\delta L}{L} = 0.00873$$

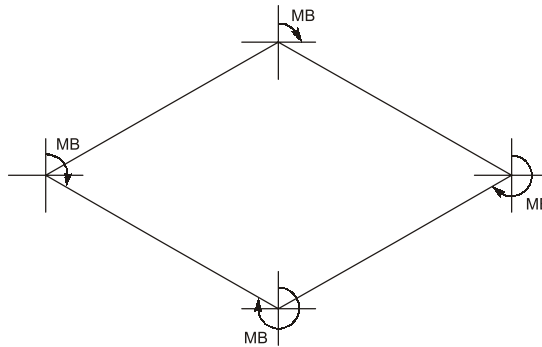For $L = 1\text{m}$

$\delta L = 8.73\,\text{mm}$

Hence, if least count of compass is 30′ then permissible error in chain will be 8.73 mm for 1 m.

4.2 Angular Measurement

(i) **Loose needle/free needle method :** In this method we try to measure magnetic bearing of each traverse line.

(ii) **Fast needle method :** In this method we measure magnetic bearing of any one line generally it is first traverse line and we measure included angle at all the other station.
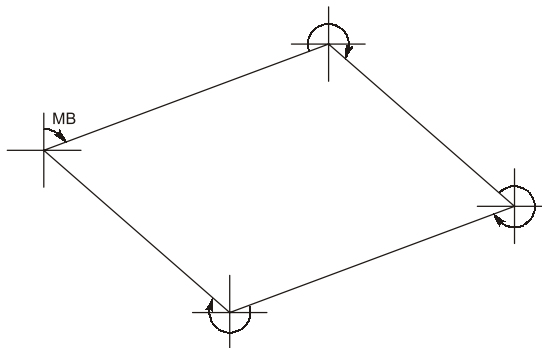

This method is more accurate then loose needle method, and is generally preferred in the field.

(iii) **Included angle method :** In this method we measure magnetic bearing of any one line generally it is first traverse line and we measure included angles at all stations.
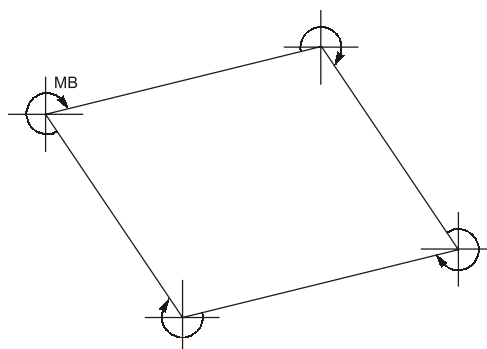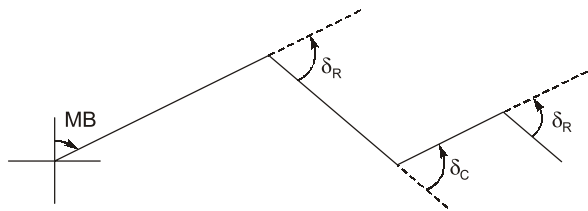

This method is more accurate then previous two method.

(iv) Direct angle method : In this method direct angles i.e., angle towards right direction are measured.
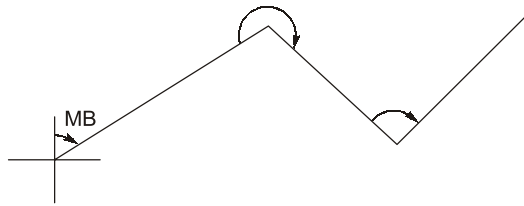
It is used for open traverse.

(v) Deflection angle method : Deflection angle method is used for open traverse, in which traverse line make small deflection like railway, canal and sewer etc.

Deflection angles are the angles which a line makes with the prolongation of the proceeding line.

4.3 Angle of Misclosure

- Before leaving the field, it advisable to determine the angle misclosure in the case of a loop traverse.
- In loop traverse, difference between actual sum and theoretical sum should not exceed by angle of misclosure.

 It's permissible limit is: $E = k\sqrt{N}$

  where, N = No. of angles 'or' no. of sides

  k = A constant, whose value will depends on least count of theodolite, no. of repetitions and accuracy desired.

- Generally for ordinary theodolite survey the value of k is assumed as 20″.

4.4 Latitude and Departure

- Latitude of a line is its orthographic projection on N-S meridian.

  +ve Northing, −ve Southing

- Departure of a line is its orthographical projection on East-West meridian
  +ve Eating, −ve Westing.
  L = latitude = $l \cos \theta$
  D = Departure = $l \sin \theta$
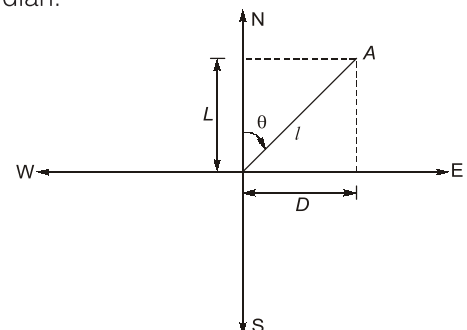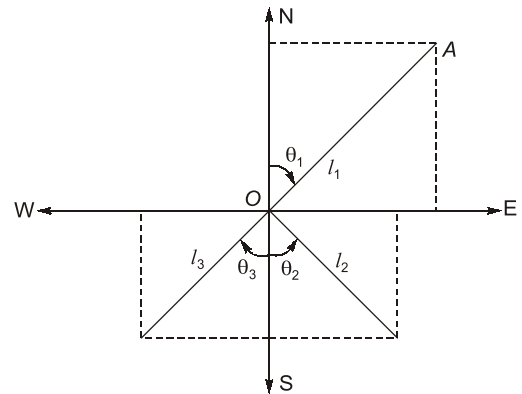
QB System:

$$L_{OA} = l_1 \cos \theta_1$$
$$L_{OB} = -l_2 \cos \theta_2$$
$$D_{OA} = l_1 \sin \theta_1$$
$$D_{OB} = +l_2 \sin \theta_2$$
$$L_{OC} = -l_3 \cos \theta_3$$
$$D_{OC} = -l_3 \sin \theta_3$$

WCB System:

$$L_{OA} = l_1 \cos \theta_1$$
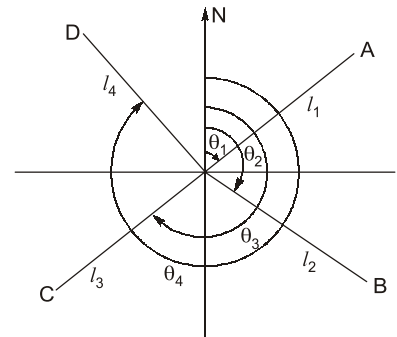$$L_{OB} = l_2 \cos \theta_2$$
$$D_{OA} = l_1 \sin \theta_1$$
$$D_{OB} = l_2 \sin \theta_2$$
$$L_{OC} = l_3 \cos \theta_3$$
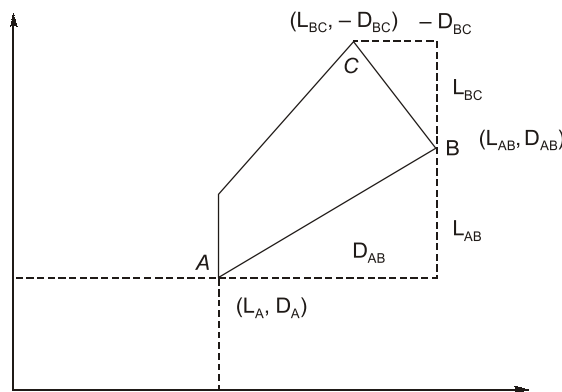$$L_{OD} = l_4 \cos \theta_4$$
$$D_{OC} = l_3 \sin \theta_3$$
$$D_{OD} = l_4 \sin \theta_2$$

• Algebraic sign of latitude and departure are automatically obtained from cos and sine component of WCB.

4.5 Consecutive/Dependent Coordinate System

• If coordinate of end point of a line is defined w.r.t. previous point, it is called as consecutive coordinate system.
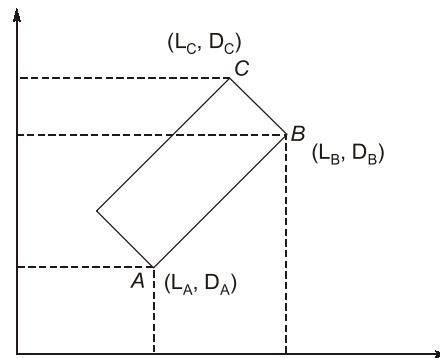

4.6 Independent Coordinate System

• In this type of coordinate system, each point is defined w.r.t. some common origin.
• These are also called as total latitude or total departure upto that point

$$L_C = L_A + L_{AB} + L_{BC}$$
$$D_C = D_A + D_{AB} - D_{BC}$$

- Total latitude or departure at any point is equal to latitude/departure of starting point + algebraic sum of latitude/departure of all the lines upto that point.
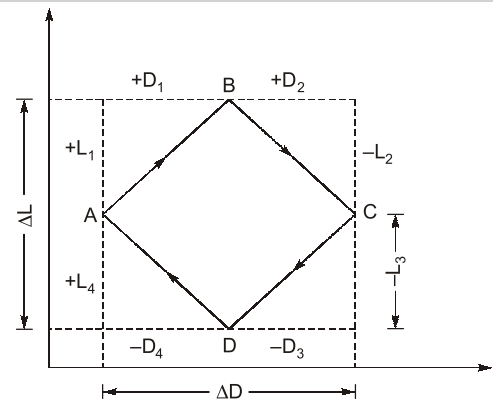
  NOTE: In independent coordinate system error is localized whereas in consecutive coordinate system error gets maximized.
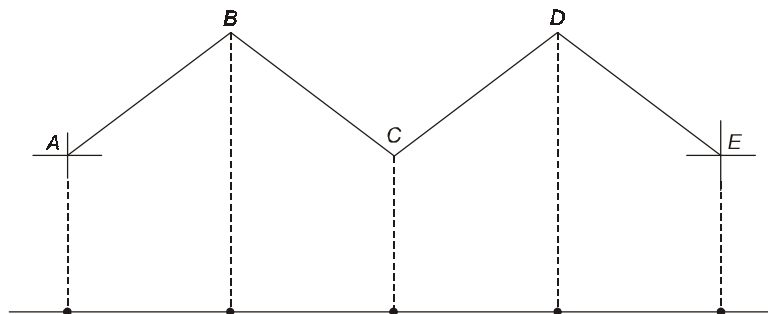
4.7 Check in Closed Traverse

4.7.1 Loop Traverse

$$\Sigma L = L_1 - L_2 - L_3 + L_4$$
$$= \Delta L - \Delta L = 0$$
$$\Sigma D = D_1 + D_2 - D_3 - D_4$$
$$= \Delta D - \Delta D = 0$$

Hence, for a closed traverse $\Sigma L = 0$; $\Sigma D = 0$

4.7.2 Link Traverse

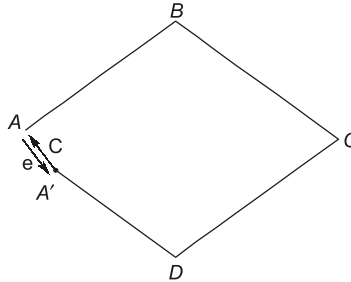$$\Sigma L = \text{Latitude of last point} - \text{Latitude of first point}$$
$$\Sigma D = \text{Departure of last point} - \text{Departure of first point}$$

4.8 Closing Error/error of Closure

If a traverse has an error of closure, it will not close on piece of paper.

4.8.1 Loop Traverse

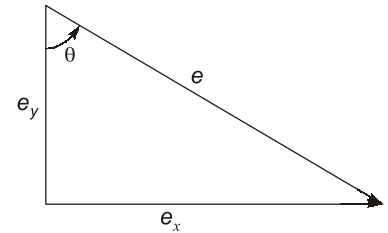Closing error = (AA') i.e., coordinate of A' w.r.t. coordinate of A
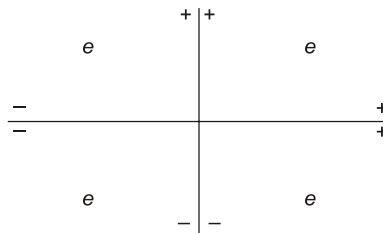
$$e_x = \Sigma D$$
$$e_y = \Sigma L$$
$$e = \sqrt{e_x^2 + e_y^2}$$
$$= \sqrt{(\Sigma \Delta D)^2 + (\Sigma \Delta L)^2}$$
$$\theta = \tan^{-1}\left(\frac{|e_x|}{|e_y|}\right)$$

The quadrant of closing error can be determined with the help of algebraic sign of e_x and e_y.

Correction will have the Same Magnitude but Opposite Direction to that of Closing Error

4.8.2 Link traverse
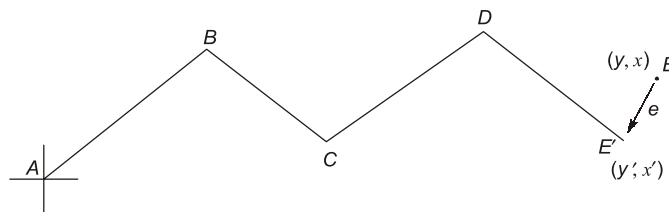
$$e_x = x' - x$$
$$e_y = y' - y$$
$$e = \sqrt{(e_x)^2 + (e_y)^2}$$
$$\theta = \tan^{-1}\left(\frac{|e_x|}{|e_y|}\right)$$

- Quadrant of closing error can be determined with the help of algebraic sign of e_x and e_y.

ANSWER KEY // STUDENT'S ASSIGNMENTS

1. (b)	**2.** (d)	**3.** (c)	**4.** (d)	**5.** (a)
6. (b)	**7.** (d)	**8.** (c)	**9.** (a)	**10.** (a)
11. (b)	**12.** (d)	**13.** (b)	**14.** (b)	**15.** (c)
16. (c)	**17.** (b)	**18.** (c)	**19.** (b)	**20.** (b)

HINTS & SOLUTIONS // STUDENT'S ASSIGNMENTS

2. (d)

$$L = 78 \text{ m} = l \cos \theta$$
$$D = 45.1 \text{ m} = l \sin \theta$$
$$\tan \theta = -\frac{4.51}{78}$$
$$\theta = -30°$$
$$\Rightarrow \text{WCB of AB is } (360° - 30°) = 330°$$

4. (d)

According to Bowditch rule,
Correction for departure of length 'l'
= Total correction in departure

$$\times \frac{\text{Length of line}}{\text{Perimeter of traverse}}$$

$$= \Delta D \times \frac{l}{L}$$

10. (a)

$$\Sigma \Delta L = 1 \text{ m}$$
$$\Sigma \Delta D = 1 \text{ m}$$
$$\text{(Both the in first quadrant)}$$
$$\tan \theta = 1$$
$$\theta = 45°$$
$$\therefore \quad e = \sqrt{\left(\Sigma \Delta D^2\right) + \left(\Sigma \Delta L\right)^2}$$
$$= \sqrt{1^2 + 1^2} = \sqrt{2}$$

∴ Direction of closing error N45°E.

12. (d)

In traversing the precision of angular measurements should be same as the precision of linear measurement.

13. (b)

Bowditch method for balancing the traverse:
It is based on the assumption that the error in linear measurements are proportional to $\sqrt{l}$ and that the errors in angular measurements are inversely proportional to $\sqrt{l}$,
where l = length of the line

$$\therefore \quad C_1 \propto \sqrt{l}, \ C_2 \propto \frac{1}{\sqrt{l}}$$

15. (c)

Latitude and departure coordinate of any point with reference to the preceding point are equal to latitude and departure of the line joining the preceding point to the point under consideration such coordinate are known as 'consecutive coordinate'. Consecutive coordinates are also known as 'dependent coordinates'.
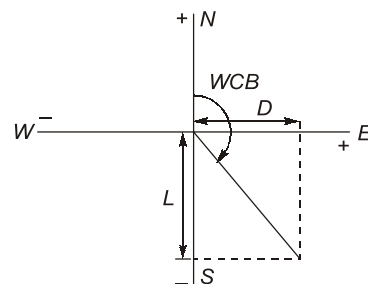Hence option (c) is correct.

16. (c)

Transit rule, conveniently employed where angular measurements are more accurate than the linear measurements.

18. (c)

$$\text{Relative precision} = \frac{\text{Error of closure}}{\text{Perimeter of traverse}}$$
$$= \frac{e}{p}$$
$$= \frac{\sqrt{(0.3)^2 + (0.4)^2}}{1000} = \frac{1}{2000}$$

19. (b)

Latitude is negative
Departure is positive