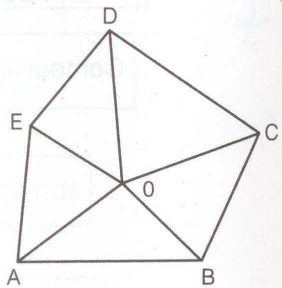
6. CALCULATION OF AREA & VOLUME

GENERAL METHODS OF COMPUTING AREA

(a) By computations based directly on field measurements

By dividing the area into a number of triangles.

Area of $\Delta = \frac{1}{2}bc\sin A = \frac{1}{2}ab\sin C = \frac{1}{2}ca\sin B$



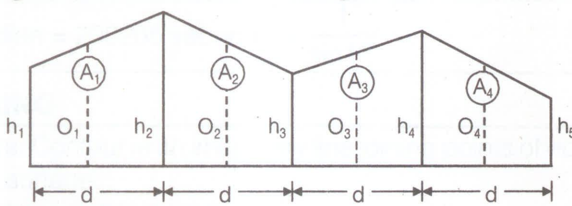
$$\text{Area of } \Delta = \sqrt{s(s-a)(s-b)(s-c)}$$

where s = semi perimeter

$$s = \frac{a+b+c}{2}$$

where a, b and c are length of sides.

(b) Using offsets taken from a staight line



(i) By mid ordinate method

In this case mid ordinates are measured.

$A = d(O_1 + O_2 + O_3 + \ldots O_n)$

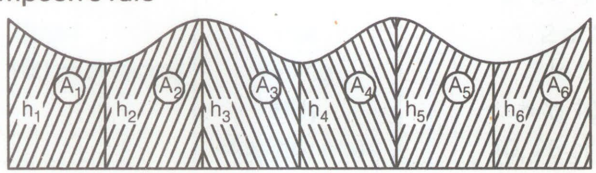
(ii) By Average ordinate method

$$A = (n-1)d\left[\frac{h_1 + h_2 + \ldots h_n}{n}\right]$$

(iii) Trapazoidal rule (End area Method)

$$A = d\left[\frac{h_1 + h_n}{2} + h_2 + h_3 + \ldots h_{n-1}\right]$$

(c) Simpson's rule



$$A = \frac{d}{3}\left[(h_1 + h_n) + 4(h_2 + h_4 + h_6 + \ldots) + 2(h_3 + h_5 + h_7 + \ldots)\right]$$

In this method odd no of offsets are needed. Area should be in pairs.

Note: Simpson's three point formula $A = \frac{d}{3}[h_1 + 4h_2 + h_3]$

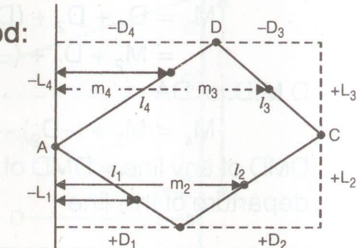
Remember

- This rule is based on the assumptions that the figures are trapezoids.
- The rule is more accurate than previous two rules.
- Simpson's one third rule may be stated as: The area is equal to the sum of the two end ordinates plus four times the sum of even intermediate ordinates plus twice the sum of the odd intermediate ordinates, the whole multiplied by one-third the common interval between them.
- It should be clar that this rule is applicable only when number of divisions of the area is even i.e., the total number of ordinates is odd.

(c) Area by Meridian distance method:

Traverse,

Area of the closed



$$\Delta = \Sigma L \cdot m$$

Or,

$$\Delta = (-L_1 \times m_1) + (L_2 \times m_2) + (L_3 \times m_3) + (-L_4 \times m_4)$$

where 'm' is meridian distance,

$$m_1 = \frac{D_1}{2}$$

$$m_2 = \frac{D_1 + D_1 + D_2}{2} = m_1 + \frac{D_1}{2} + \frac{D_2}{2}$$

$$m_3 = m_2 + \frac{D_2}{2} - \frac{D_3}{2}$$

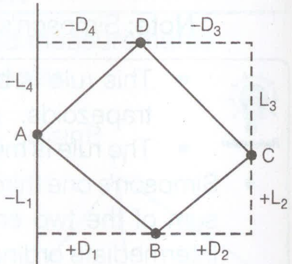
$$m_4 = m_3 - \frac{D_3}{2} - \frac{D_4}{2} = \frac{D_4}{2}$$

MD of any line = MD of previous line + half of departure of previous line + half of departure of this line

Remember

- The distance of mid point of a line w.r.t. a fixed meridian is called meridian distance.
- Here, L_1, L_2, L_3 and L_4 are latitudes line AB, BC, CD and DA. D_1, D_2, D_3 and D_4 are departure.

(d) Area by Double Meridian distance method



Total area, $$\Delta = \frac{1}{2}\Sigma ML$$

$$\Delta = \frac{1}{2}[(-L_1 M_1) + (L_2 M_2) + (L_3 M_3) + (-L_4 M_4)]$$

D.M.D. of AB,

$$M_1 = 0 + D_1 = D_1$$

D.M.D. of BC,

$$M_2 = D_1 + (D_1 + D_2)$$

D.M.D. of CD

$$M_3 = D_1 + D_2 + (D_1 + D_2 - D_3)$$
$$= M_2 + D_2 + (-D_3)$$

D.M.D. of DA

$$M_4 = M_3 + (-D_3) + (-D_4)$$

DMD of any line = DMD of previous line + departure of previous line + departure of this line

VOLUME MEASUREMENT

(a) Trapezoidal formulae:

Volume (V) of earthwork between a number of sections having areas A_1, A_2......A_n spaced at a constant distance d.

$$V = d\left[\frac{A_1 + A_n}{2} + A_2 + A_3 + ... + A_{n-1}\right]$$

(b) Simpson's formulae:

Volume (V) of the earthwork between a number of sections having Area A_1, A_2,..... A_n spaced at a constant distance d apart is

$$V = \frac{d}{3}\left[(A_1 + A_n) + 4(A_2 + A_4 + ... + A_{n-1}) + 2(A_3 + A_5 + ... + A_{n-2})\right]$$

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