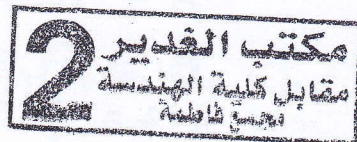


Volumes

①

1. Volumes from cross-sections.
2. Volumes from spot height or spot level.
3. Volumes from contour map.

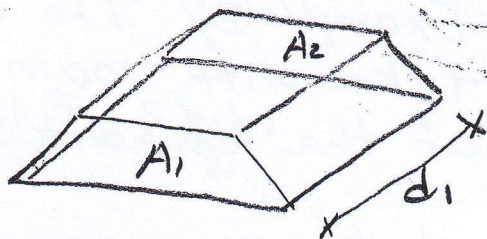
1. Volumes from cross-sections.



(A) End-area (or trapezoidal) method

$$V = \frac{A_1 + A_2}{2} \cdot d_1$$

if N is the number of cross-sections



$$\begin{aligned} \therefore V_{\text{total}} &= V_1 + V_2 + V_3 + \dots + V_n \\ &= \frac{d_1}{2} (A_1 + A_2) + \frac{d_2}{2} (A_2 + A_3) + \frac{d_3}{2} (A_3 + A_4) + \dots + \frac{d_{n-1}}{2} (A_{n-1} + A_n) \end{aligned}$$

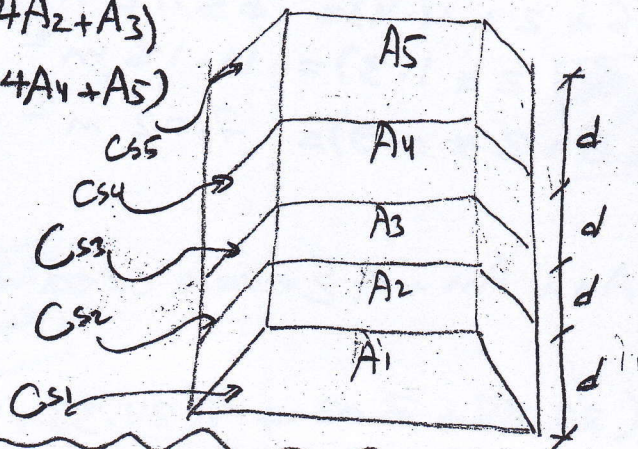
if $d_1 = d_2 = d_3 = \dots = d_{n-1}$

$$V_{\text{total}} = \frac{d}{2} (A_1 + A_n + 2(A_2 + A_3 + \dots + A_{n-1}))$$

(B) prismoïdal method or Simpson's method

$$V_{1-3} = \frac{d}{3} (A_1 + 4A_2 + A_3)$$

$$V_{3-5} = \frac{d}{3} (A_3 + 4A_4 + A_5)$$



$$V_{\text{total}} = \frac{d}{3} (A_1 + A_n + 4 \sum \text{Even area} + 2 \sum \text{Odd area})$$

note: to apply the prismoïdal method must be the number of cross-sections odd.

Example ① Calculate the volume of cut for the cross-section with length of cut 30 m, width of cut 8 m, the depth is 8 m and 5 m, and side slope 1:1. (2)

Sol.

$$A = h(b + sh)$$

$$A_1 = 8(8 + 1 \times 8) = 128 \text{ m}^2$$

$$A_2 = 5(8 + 1 \times 5) = 65 \text{ m}^2$$

$$V = \frac{d}{2} (A_1 + A_2) = \frac{30}{2} (128 + 65) = 2895 \text{ m}^3$$

Example ②/ The elevation of the centre line of road take with 100 m change the depth elevation of the canale is

distance	0	100	200	300	400
Elevation (m)	2.2	2.3	4.4	1.3	0.9

Calculate the volume of cut while the width is 6 m and side slope of canale is 1:2

$$A = h(b + Sh)$$

$$A_1 = 2.2(6 + 2 \times 2.2) = 22.88 \text{ m}^2$$

$$A_2 = 2.3(6 + 2 \times 2.3) = 24.38 \text{ m}^2$$

$$A_3 = 4.4(6 + 2 \times 4.4) = 65.12 \text{ m}^2$$

$$A_4 = 1.3(6 + 2 \times 1.3) = 11.18 \text{ m}^2$$

$$A_5 = 0.9(6 + 2 \times 0.9) = 7.02 \text{ m}^2$$

$$V = \frac{d}{3} (A_1 + A_n + 4 \sum \text{even area} + 2 \sum \text{odd area})$$

$$= \frac{100}{3} (22.88 + 7.02 + 4(24.38 + 11.18) + 2(65.12))$$

$$= 10079.3 \text{ m}^3$$

Prismoidal correction (P.C)

(3)

for one-level section

$$A_1 = h_1(b + Sh_1)$$

$$A_2 = h_2(b + Sh_2)$$

$$V_{\text{end area}} = \frac{d}{2}(A_1 + A_2) = \frac{d}{2}(h_1b + Sh_1^2 + h_2b + Sh_2^2)$$

assuming $h_m = \frac{h_1 + h_2}{2} \Rightarrow A_m = \frac{A_1 + A_2}{2}$

$$A_m = \frac{h_1 + h_2}{2} \left(b + S \frac{h_1 + h_2}{2} \right)$$

$$= \frac{h_1b}{2} + \frac{h_2b}{2} + \frac{Sh_1^2}{4} + \frac{Sh_2^2}{4} + \frac{Sh_1h_2}{2}$$

$$V_{\text{prismoidal}} = \frac{d}{3}(A_1 + 4A_m + A_2)$$

$$= \frac{d}{3} \left[(h_1b + Sh_1^2) + 4 \left(\frac{h_1b}{2} + \frac{h_2b}{2} + \frac{Sh_1^2}{4} + \frac{Sh_2^2}{4} + \frac{Sh_1h_2}{2} \right) + h_2b + Sh_2^2 \right]$$

$$P.C = V_{\text{end area}} - V_{\text{prismoidal}}$$

$$= \frac{d}{6} \cdot S(h_1 - h_2)^2$$

or Dam

(4)

Example/ Calculate the prismatic correction (P.C) for the embankment while length 40m and width formation 6m and side slope 1:1, the height of the section is 6, 7.6, 9.2m and the distance between the section is 20m.

Sol.

$$A = h(b + sh)$$

$$A_1 = 6(6 + 1 \times 6) = 72 \text{ m}^2$$

$$A_2 = 7.6(6 + 1 \times 7.6) = 103.36 \text{ m}^2$$

$$A_3 = 9.2(6 + 1 \times 9.2) = 139.84 \text{ m}^2$$

$$V_1 = \frac{d}{2} (A_1 + A_2)$$

between
 A_1 & A_2

$$= \frac{20}{2} (72 + 103.36) = 1753.6 \text{ m}^3$$

$$\downarrow \text{P.C}_1 = \frac{d}{6} S (h_1 - h_2)^2 = \frac{20}{6} \times 1 (6 - 7.6)^2 = 8.53 \text{ m}^3$$

$$V_2 = \frac{d}{2} (A_2 + A_3)$$

between
 A_2 & A_3

$$= \frac{20}{2} (103.36 + 139.84) = 2432 \text{ m}^3$$

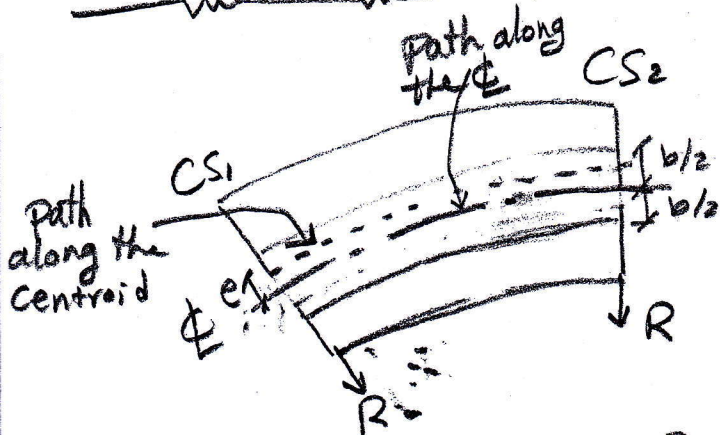
$$\downarrow \text{P.C}_2 = \frac{d}{6} S (h_1 - h_2)^2 = \frac{20}{6} \times 1 (7.6 - 9.2)^2 = 8.53 \text{ m}^3$$

$$\underline{V_{\text{total}}} = 4168.54 \text{ m}^3$$

$$\downarrow (V_1 - \text{P.C}_1) + (V_2 - \text{P.C}_2)$$

Effect of curvature

(5)



$$V_{\text{corrected}} = V_{\text{uncorrected}} \pm C.C$$

$$C.C = \frac{1}{6} (d_1^2 - d_2^2) \left(\frac{b}{2s} + h \right) * \frac{D}{R}$$

Example/ The embankment with width 10m and height 1.5m on centre line, side slope 1:1.5 with earth slope 1:10. Calculate the corrected curvature when the embankment is construction on the circle curve with $R = 1000$ m and 100m long where the natural ground slope to the center of curve.

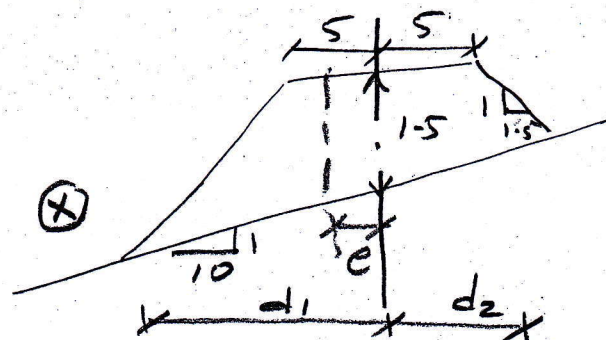
Sol.

$$d_1 = \left(\frac{b}{2} + sh \right) \left(\frac{n}{n-s} \right)$$

$$= \left(\frac{10}{2} + 1.5 * 1.5 \right) \left(\frac{10}{10-1.5} \right)$$

$$= 8.53 \text{ m}$$

(*)



$$d_2 = \left(\frac{b}{2} + sh \right) \left(\frac{n}{n+s} \right)$$

$$= \left(\frac{10}{2} + 1.5 * 1.5 \right) \left(\frac{10}{10+1.5} \right)$$

$$= 6.30 \text{ m}$$

$$A = \frac{1}{2} \left[\frac{b}{2s} + g \right] (d_1 + d_2) - \frac{b^2}{4s}$$

$$= \frac{1}{2} \left[\frac{10}{2+1.5} + 1.5 \right] (8.53 + 6.3) - \frac{10^2}{4 * 1.5}$$

$$= 19.17 \text{ m}^2$$

$$C.C = \frac{1}{6} (d_1^2 - d_2^2) \left(\frac{b}{2s} + h \right) * \frac{D}{R}$$

$$V_{\text{incorr.}} = A * L$$

$$= 19.17 * 100$$

$$= 1917 \text{ m}^3$$

$$= \frac{1}{6} (8.53^2 - 6.3^2) \left(\frac{10}{2 * 1.5} + 1.5 \right) * \frac{100}{1000}$$

$$= 2.66 \text{ m}$$

$$V_{\text{corrected}} = V_{\text{uncorrected}} - C.C = 1917 - 2.67$$

$$= 1914.34 \text{ m}^3$$