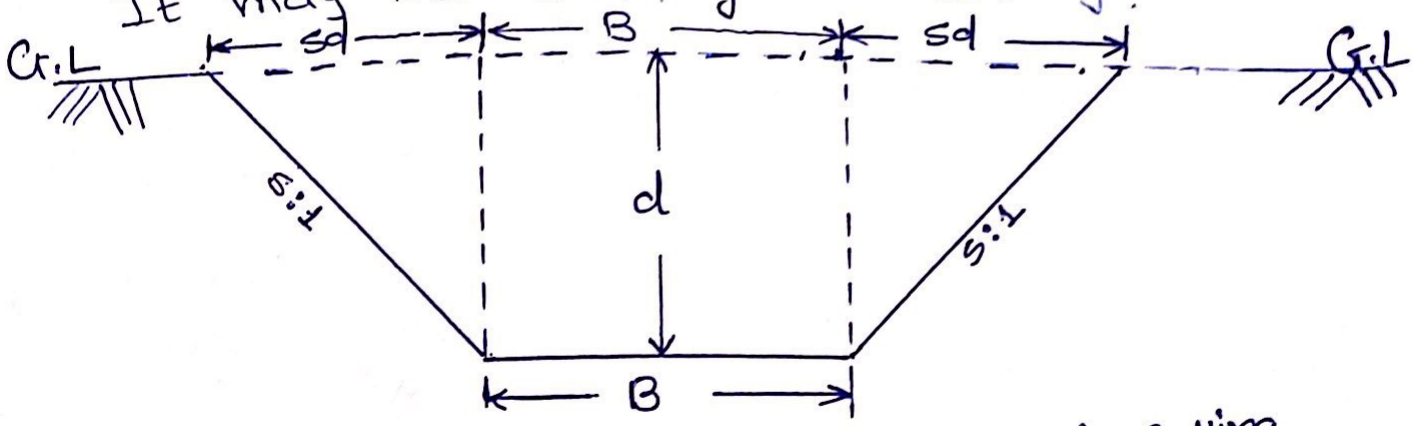
QUANTITY OF EARTHWORK FOR ROAD OR CANAL

The cross section of road is trepezoidal.

It may be Banking or Cutting.



The above diagram shows road is in cutting.

Sectional Area = Area of Rectangal + Area of two side triangular Portion.

$$= B \times d + 2\left[\frac{1}{2} \times sd \times d\right]$$

$$A = Bd + sd^2$$

Now Q+y = Area of cutting x Length

$$Q+y = \underline{\underline{[Bd + sd^2] \times L}}$$

METHODS OF CACULATING QTY. OF EARTHWORK

1. Mid-sectional Area Method.
2. Mean-Sectional Area Method.
3. Prismoidal formula Method.

[1] MID SECTIONAL AREA METHOD

$$Q+y = [Bdm + sdm^2] \times L$$ Where

dm = depth at mid section

$\therefore dm = \frac{d_1+d_2}{2}$

B = width of canal

S = side slope of Canal.

IN THIS METHOD, height of cutting or filling is calculated from the difference of Ground Level and Formation Level. Average depth $(\frac{d_1+d_2}{2})$ between two successive cross-section is taken in to account to calculate the area. Q+y of Earthwork is worked out in tabular form as below.

TABLE-A

CHAINAGE (m)	DEPTH (m)	AVERAGE DEPTH dm (m)	AREA OF MID PORTION Bd (m^2)	AREA OF SIDE PART sd^2 (m^2)	TOTAL Area $(Bd+sd^2)$ (m^2)	DISTANCE BETWEEN TWO POINTS L (m)	Quantity $(Bd+sd^2)\times L$	
							FILLING (m^3)	CUTTING (m^3)

[2] MEAN SECTIONAL AREA METHOD.

In this Method instead of using average depth dm $(dm = \frac{d_1+d_2}{2})$, Average area $Am = (\frac{A1+A2}{2})$ is used for calculation of volume.

TABLE-B

CHAINAGE (M)	DEPTH d (m)	AREA OF MID PORTION Bd (m^2)	AREA OF SIDE PART sd^2 (m^2)	TOTAL AREA $(Bd+sd^2)$ (M^2)	MEAN AREA Am (m^2)	DISTANCE BETWEEN TWO POINTS L (m)	QUANTITY = mean Area x L	
							FILLING (m^3)	CUTTING (m^3)

[3] PRISMOIDAL FORMULA

This Method is based on the volume of Prismoids formed between Successive cross sections.

As Per this formula,

Quantity of earthwork

$$Q = \frac{L}{6}\left[A_1 + 4Am + A_2\right]$$

Where $A_1 = Bd_1 + sd_1^2$

$A_2 = Bd_2 + sd_2^2$

$Am = Bdm + sdm^2$ where $dm = \frac{d_1 + d_2}{2}$

L = distance between two successive cross-sections.

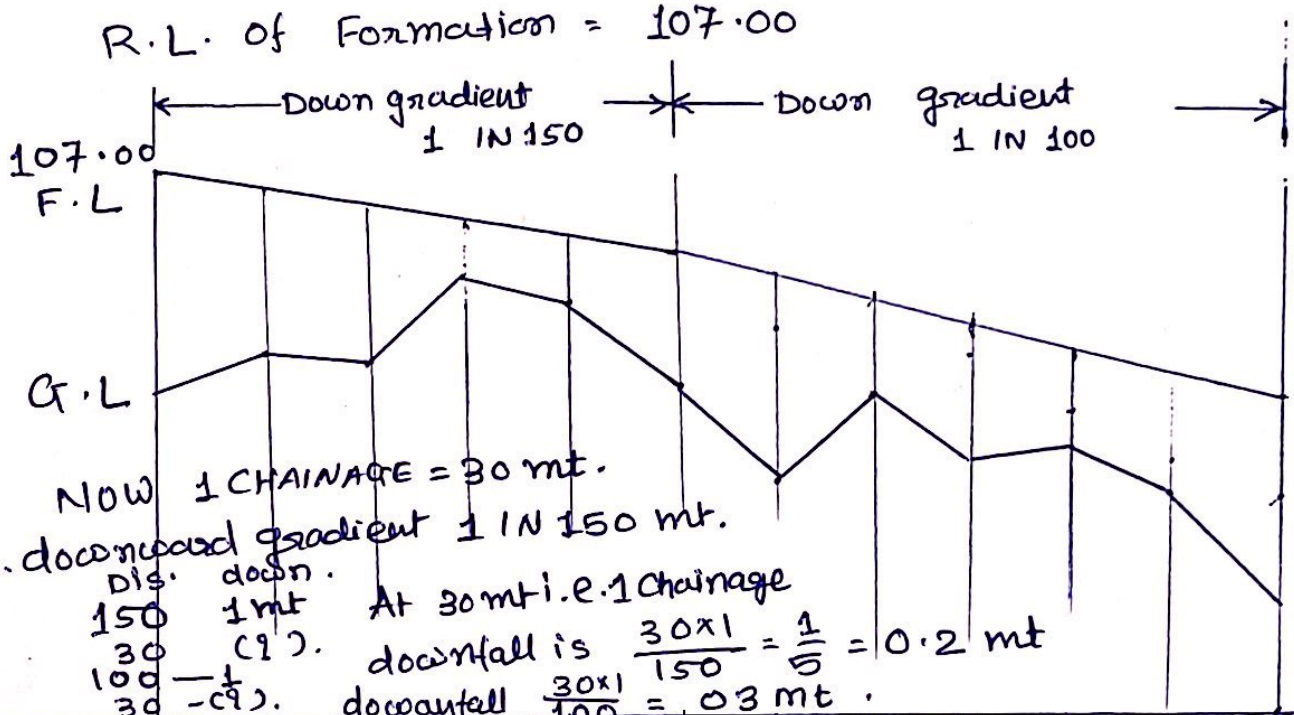
EXAMPLE ON EART-WORK.

EX-1 Reduced level (R.L) of ground along the Centre line of a Proposed road from chainage 10 to chainage 20 are given below. The formation level at the 10th chainage is 107 mt and the road is in downward gradient of 1 IN 150 up to the chainage 14 and then the gradient change to 1 IN 100 downward. Formation width of road is 10 mt and side slopes of banking are (H:V) i.e. 2:1. Length of chain is 30mt. Draw L.S. of the road and typical C.S. and Prepare an Estimate of Earthwork. Data of R.L. of Ground level is given below.

GIVEN DATA →

CHAINAGE	10	11	12	13	14	15	16	17	18	19	20
R.L. OF. GROUND	105.00	105.6	105.44	105.9	105.42	104.30	105.00	104.10	104.62	104.00	103.30

R.L. of Formation = 107.00



NOW 1 CHAINAGE = 30 mt.

∴ downward gradient 1 IN 150 mt.

Dis. down.
150 — 1 mt
30 — (?).

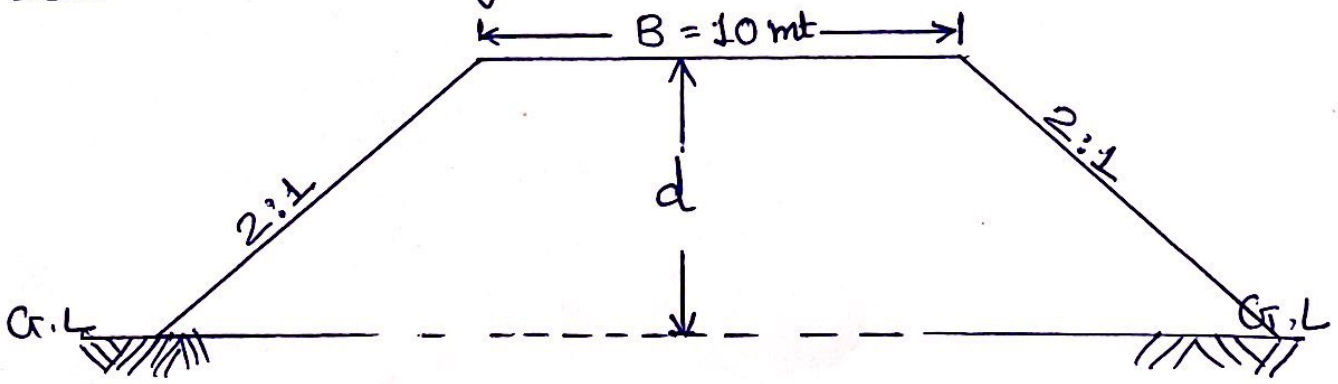
At 30 mt i.e. 1 chainage downfall is $\frac{30\times1}{150} = \frac{1}{5} = 0.2$ mt

Dis. down.
100 — 1
30 — (?).

downfall $\frac{30\times1}{100} = 0.3$ mt.

F.L FORMATION LEVEL	107	106.8	106.6	106.40	106.2	105.9	105.6	105.3	105.0	104.7	104.4
DIFF OF F.L & G.L. F.L − G.L	2.0	1.2	1.16	0.5	0.78	1.6	0.6	1.2	0.38	0.70	1.10

As Formation level is highen than G.L so Road Section is in Banking.



MID SECTIONAL AREA METHOD.

CALCULATION OF QUANTITY OF EARTHWORK

CHAINAGE	LENGTH	Ht. OR Depth. Diff of G.L and F.L	MEAN HEIGHT	CENTRAL AREA Bd	SIDE AREA sd^2	TOTAL AREA $Bd+sd^2$	LENGTH BETWEEN STATION L	QUANTITY $(Bd+sd^2)\frac{L}{2}$ BANKING
10	300	2.07	-	-	-	-	-	-
11	330	1.2	1.6	16	5.12	21.12	30	633.6
12	360	1.16	1.18	11.8	2.78	14.58	30	437.4
13	390	0.5	0.83	8.3	1.38	9.68	30	290.4
14	420	0.78	0.64	6.4	0.82	7.22	30	216.6
15	450	1.60	1.19	11.90	2.83	14.73	30	441.9
16	480	0.60	1.10	11.0	2.42	13.42	30	402.6
17	510	1.20	0.90	9.0	1.62	10.62	30	318.6
18	540	0.38	0.79	7.9	1.25	9.15	30	274.5
19	570	0.70	0.54	5.4	0.58	5.98	30	179.4
20	600	1.10	0.90	9.0	1.62	10.62	30	318.6
							TOTAL=	3513.6 M^3

BY PRISMOIDAL FORMULAE QUANTITY OF EARTHWORK

$$\text{Vol.} = \frac{D}{3}\left[\text{First Area} + \text{Last Area} + 4\Sigma \text{ odd Areas} \cdots \cdots + 2\Sigma \text{ even Areas}\right]$$

$$= \frac{30}{3}\left[21.12 + 10.62 + 4(9.68 + 14.73 + 10.62 + 5.98) + 2(14.58 + 7.22 + 13.42 + 9.15)\right]$$

Total Qty = 2845.20 M^3.

ESTIMATE THE QUANTITY OF EARTHWORK

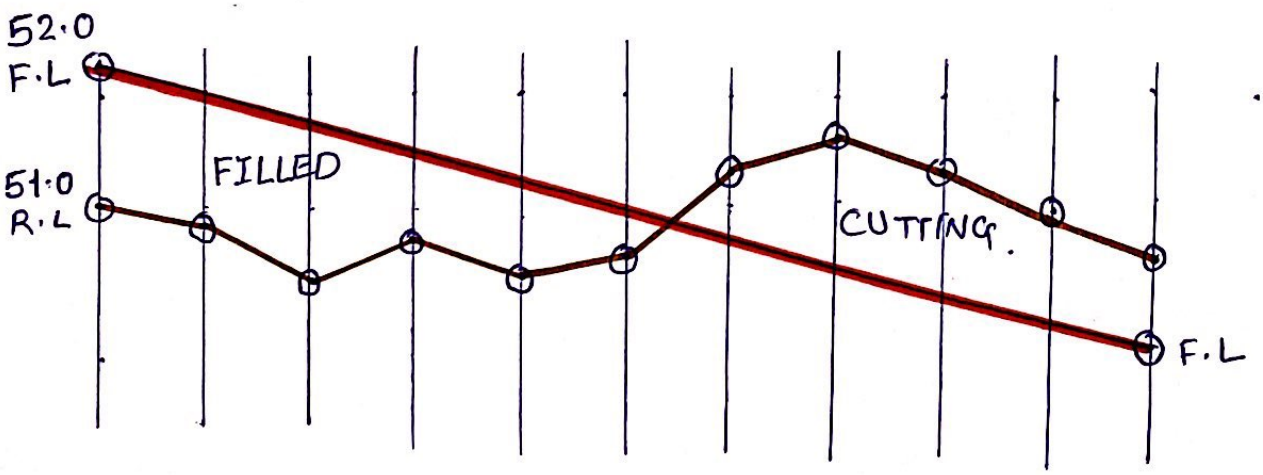
EX-2. Estimate the earthwork for a portion of road for 400 mt length from following Data.
Formation width of road is 10 mt
Side slopes are 2:1 in banking and $1\frac{1}{2}$:1 in Cutting.

STATION	DISTANCE IN MT.	R.L of Gr. L	R.L. OF FORMATION	CALCULATED F.L
25	1000	51.0	52.00	52.00
26	1040	50.90	!	51.80
27	1080	50.50	!	51.60
28	1120	50.80	!	51.40
29	1160	50.60	Dowandoard	51.20
30 →	1200	50.70	Gradient of	51.00
31	1240	51.20	1 IN 200	50.80
32	1280	51.40	!	50.60
33	1320	51.30	!	50.40
34	1360	51.00	!	50.20
35	1400	50.60	!	50.00

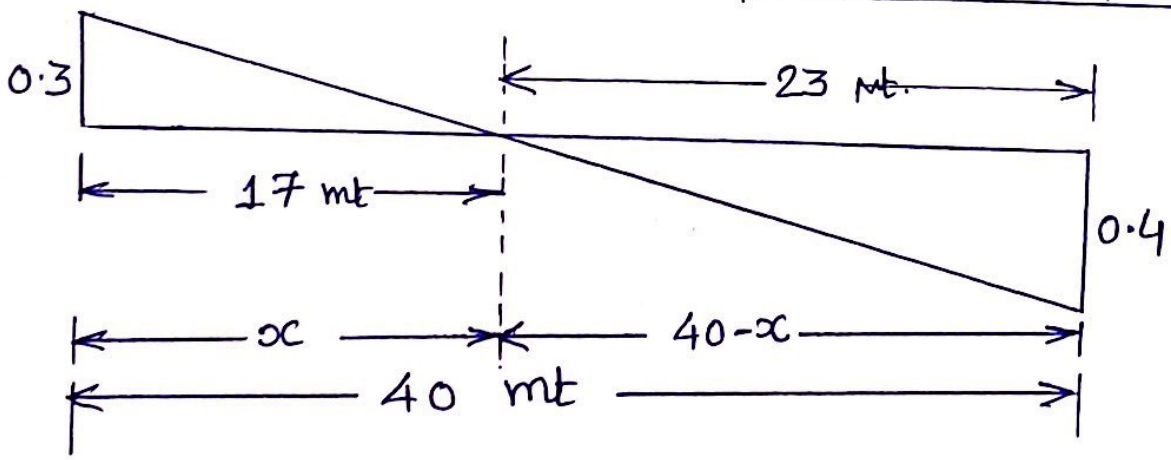
AS Gradient is 1 IN 200 dowandoard gradient.
1040 − 1000 = 40 mt so,

DIS.	fall
200	1
40	(?)

$$\frac{1 \times 40}{200} = \frac{1}{5} = 0.2$$



Sr.	R.L of G.L.	F.L	F.L − R.L Banking d_b	F.L − R.L Cutting d_c	Mean depth d_m	Central Area Bd	Area of sides sd^2	Total Area $Bd+sd^2$	Dist. between L	Quantity $(Bd+sd^2)\times L$ Banking	Quantity $(Bd+sd^2)\times L$ Cutting
25	51.0	52.0	1.0		—	-	-	-	-	-	-
26	50.90	51.8	0.9		0.95	9.5	1.81	11.31	40	452.4	-
27	50.50	51.6	1.1		1.0	10.0	2.0	12.00	40	480.0	-
28	50.80	51.4	0.6		0.85	8.5	1.45	9.95	40	398.0	-
29	50.60	51.2	0.6		0.60	6.0	0.72	6.72	40	268.8	-
30	50.70	51.0	0.3 0.0		0.45 0.15	4.5 1.5	0.41 0.05	4.91 1.55	40 17	196.4 26.35	-
31	51.20	50.8		0.4	−0.20	2.0	0.06	2.06	23	—	47.38
32	51.40	50.6		0.8	−0.60	6.0	0.54	6.54	40	-	261.60
33	51.30	50.4		0.9	−0.85	8.5	1.08	9.58	40	-	383.20
34	51.00	50.2		0.8	−0.85	8.5	1.08	9.58	40	-	383.20
35	50.60	50.0		0.6	−0.70	7.0	0.74	7.74	40	-	309.60
									TOTAL =	1821.95	1384.98



$$\frac{x}{0.3} = \frac{40-x}{0.4}$$

$$0.4x = 12 - 0.3x$$
$$0.7x = 12$$
$$\therefore x = 17.14 \text{ mt} \cong 17 \text{ mt}.$$