EARTHWORK

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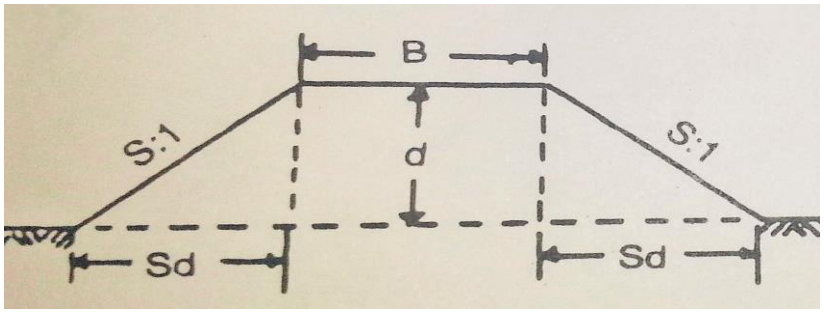
EARTHWORK

- Cross section of earthwork of road in banking or in cutting is usually in the form of trapezium.
- The quantity of earthwork in the form of trapezium calculated by the following formula.

Quantity or Volume = Sectional Area x Length



- Sectional Area = Area of central portion + Area of two side triangular portion
- Sectional Area = Bd + 2 ($\frac{1}{2}$ sd x d) = **Bd + Sd²**
- S : 1 is the ratio of sides slopes as horizontal : vertical.
- For "1" vertical, horizontal is "s", for "d" vertical, horizontal is "sd".
- So , **Quantity = Bd + Sd² X L**

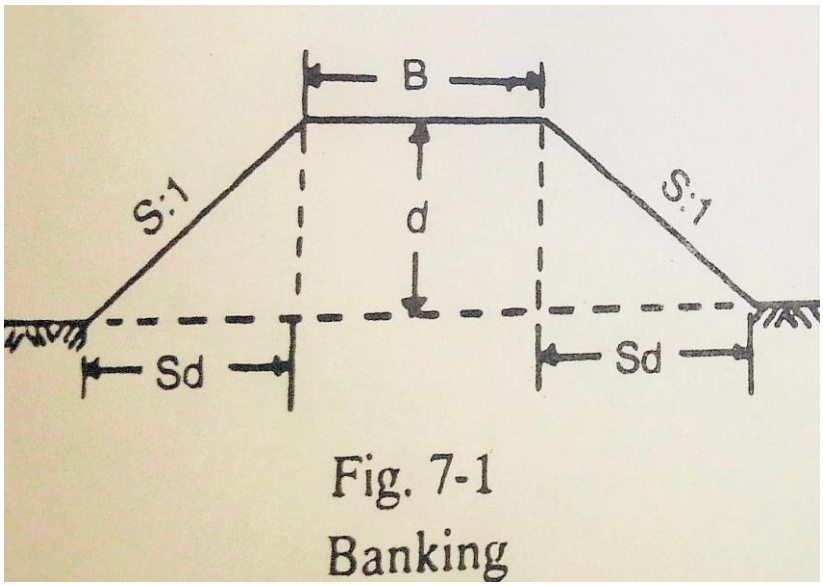


Fig. 7-1
Banking

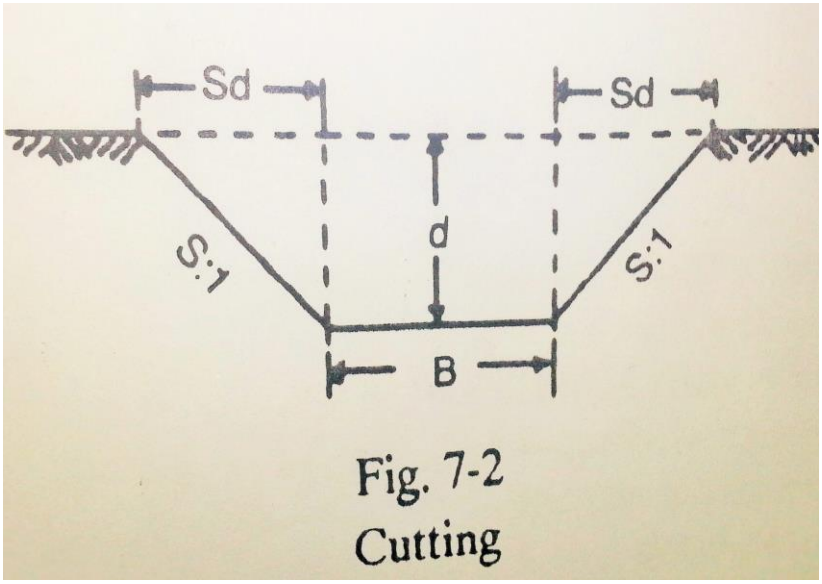
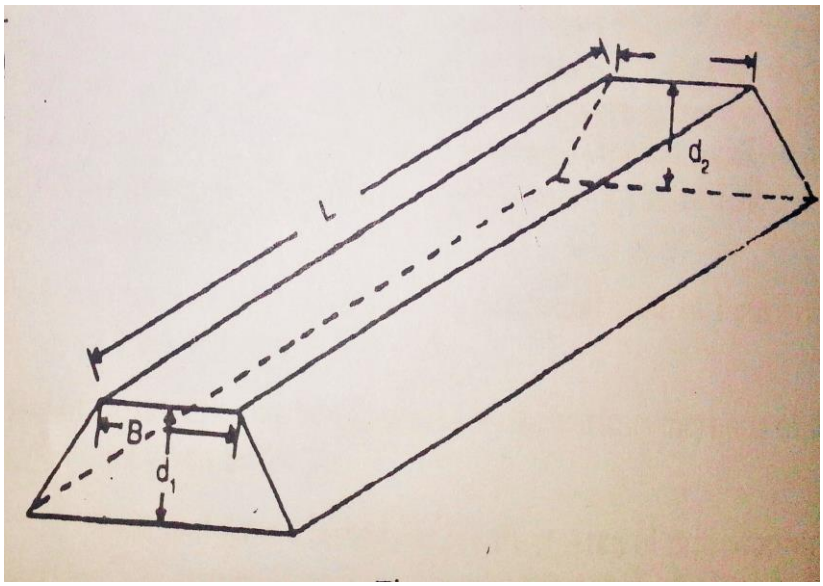


Fig. 7-2
Cutting

EARTHWORK

- When the ground is in a longitudinal slope, the height of bank or depth of cutting will be different at two ends of the section.
- So mean height or depth may be taken for "d".

$$\textbf{Mean height} = \frac{d1+d2}{2}$$



LEAD AND LIFT

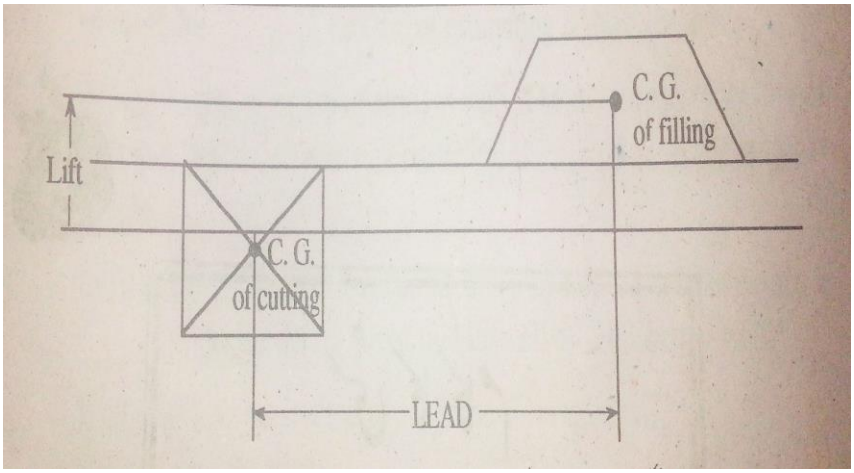
LEAD

Horizontal distance traveled by the earth to be moved for banking or dumping.

LIFT

Vertical distance travelled by earthwork after excavating.

LEAD AND LIFT



LEAD AND LIFT

- Normally earthwork is estimated for 30 m lead for distance and 1.5 m lift for height or depth.
- Normal rate for earthwork is for 30 m lead and for 1.5 m lift.
- For greater lead or lift the rates will be different (higher) for every unit of 30 m lead and every unit of 1.5 m lift.
- Therefore, the earthwork is estimated separately for every 30 m lead and for every 1.5 m lift.

METHODS OF EARTHWORK

The quantity of earthwork may be calculated by the various methods of mensuration. Out of which we will discuss following three methods.

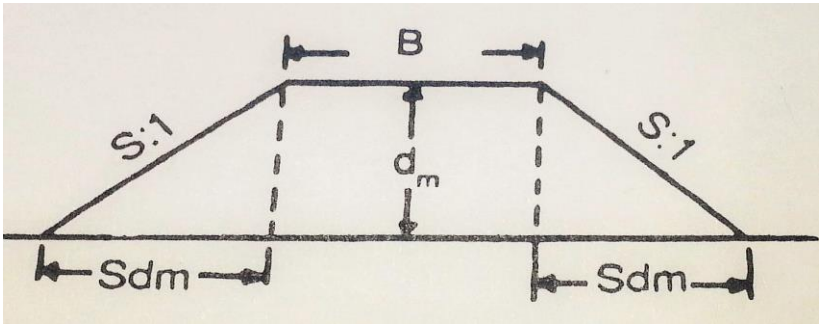
1. **Mid-sectional Area Method**
2. **Mean Sectional Area Method**
3. **Prismoidal Formula Method**

1. Mid-sectional Area Method

- In this method we calculate the quantity of earthwork by following formula:

  Quantity = Area of Mid Section x Length

- Let d1 and d2 be the height of bank at two ends portion of embankment($d_m = \frac{d1+d2}{2}$), L the length of the section, B the formation width and S:1 (horizontal : vertical) the sides slope then, (count…..)



- Area of mid section = Area of rectangular portion + Area of two triangular portion
- Area of mid section = $Bd_m + \frac{1}{2} Sd_m^2 + \frac{1}{2} Sd_m^2$ = **$Bd_m + Sd_m^2$**
- Quantity of earth work = **$(Bd_m + Sd_m^2) \times L$**
- **$Q = (Bd + Sd^2) \times L$** (where d stands for mean height or depth)

1. Mid-sectional Area Method

- The quantities of earthwork may be calculated in a tabular form as given below:

Station Or Chainage	Depth Or Height	Mean depth or height "d"	Area of central portion Bd	Area of sides Sd^2	Total sectional area $Bd+Sd^2$	Length between stations L	Quantity $(Bd+Sd^2) \times L$	
							filling	cutting

2. Mean-sectional Area Method

In this method we use following formula to calculate quantity of earthwork.

Quantity = Mean sectional Area x Length

- Sectional area at one end A1= Bd1 + Sd1^{2,}
- Sectional area at other end A2= Bd2 + Sd2^{2,}
- d1 and d2 are the heights or depth at two ends.
- The mean sectional area A= $\frac{A1+A2}{2}$

$$\textbf{Quantity} = \frac{A1+A2}{2} \textbf{ X Length}$$

2. Mean-sectional Area Method

The quantities of earthwork may be calculated in a tabular form as given below:

Station Or Chainage	Depth Or Height "d"	Area of central portion Bd	Area of sides Sd²	Total sectional area Bd+Sd²	Mean sectional area	Length between stations L	Quantity (Bd +Sd²) x L	
							filling	cutting

3. Prismoidal Formula Method

In this method we use following formula to calculate earth work quantity.

$$\textbf{Quantity or Volume} = \frac{L}{6}(A1+A2+4Am)$$

- Where A1 and A2 are the cross-sectional areas at two ends of a portion of embankment of a road length L. And Am is the mid sectional area.
- Let d1 and d2 be the heights of banks at two ends, and dm be the mean height at the mid section, B be the formation width and S:1 be the side slope.

3. Prismoidal Formula Method

- Cross sectional area at one end

  $A_1 = Bd_1 + Sd_1^2$

- Cross sectional area at other end

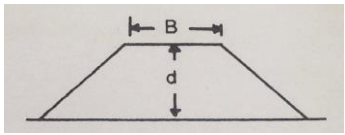
  $A_2 = Bd_2 + Sd_2^2$

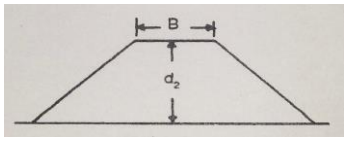
- Cross section at middle

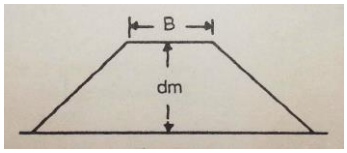
  $dm = \frac{d1+d2}{2}$

➢ **$Am = Bdm + Sdm^2$**

$$\textbf{Quantity} = \frac{L}{6}(A_1+A_2+4Am)$$







Example

- Calculate the quantity of earthwork for 200 meter length for a portion of a road in an uniform ground the heights of banks at the two ends being 1.00m and 1.60m. The formation width is 10 meter and side slopes 2:1 (Horizontal : Vertical). Assume that there is no transverse slope.

➢ Solution of this problem is calculated by three methods as next slides. (count…)

By Method 1
Mid-sectional Area Method

Quantity = $(Bd + Sd^2) \times$ Length

B = 10 m, S = 2, L = 200m

d = mean depth $= \frac{1.00+1.60}{2} = 1.30$m

Q = $(10 \times 1.3 + 2 \times 1.3^2) \times 200 (13+3.38) \times 200 = 16.38 \times 200$

Q = 3276 cum

By Method 2
Mean Sectional Area Method

A1 = sec. area at one end = $Bd_1 + Sd_1^2$

A1 = 10 x 1 + 2 x 1^2 =12 sq. m

A2 = sec. area at other end = $Bd_2 + Sd_2^2$

A2 = 10 x 1.60 + 2 x 1.60^2 =21.12 sq. m

Mean section area = $\frac{A1+A2}{2} = \frac{12+21.12}{2}$ =16.56 sq. m

Quantity = mean sec. area x length = 16.56 x200

Q = 3312 cu m

By Method 3
Prismoidal Formula Method

Quantity = $\frac{L}{6}$ (A1+A2+4A_m)

A1 = sec. area at one end = $Bd_1 + Sd_1^2$

A1 = 10 x 1 + 2 x 1^2 =12 sq. m

A2 = sec. area at other end = $Bd_2 + Sd_2^2$

A2 = 10 x 1.60 + 2 x 1.60^2 =21.12 sq. m

A_m = mid section area = $Bd_m + Sd_m^2$

By Method 3
Prismoidal Formula Method

$A_m = Bd_m + Sd_m^2$

Where, $d_m = \frac{d1+d2}{2} = \frac{1.00+1.60}{2} = 1.30m$

So, $A_m = 10 \times 1.30 + 2 \times 1.30^2 = 16.38$ sq. m

$Q = \frac{200}{6}(12 + 21.12 + 4 \times 16.38) = \frac{200}{6} \times 98.64 = \frac{19728}{6}$

Q = 3288 cum

THANKS

Any Questions??