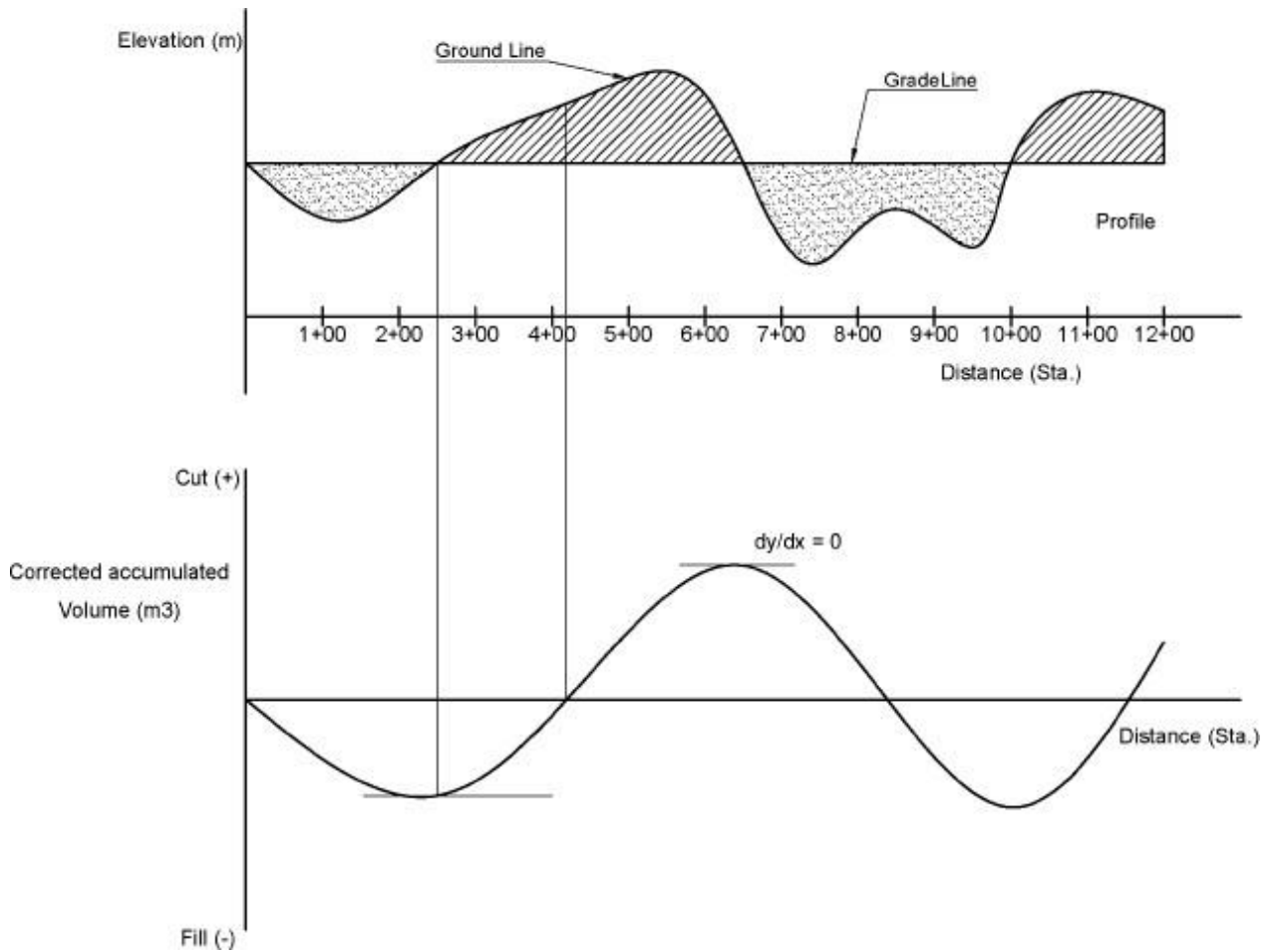# LECTURE 4

EARTHWORKS AND MASS-HAUL DIAGRAM

Mass-haul diagram:

Continuous curve showing the relationship between the accumulated algebraic sums of corrected earthwork volume and distance for the purpose of minimizing the cost of excavating hauling & damping the materials (Soil).

- Rising = Cut

- Falling = Fill

- Steep slope = High cut or fill

- Zero slope = Change from cut to fill or vice versa.

- Zero value = Balance between cut and fill

Haul (النقل) = Volume (m³) * Distance (sta.)

Haul distance: The distance of moving the masses of soil from one place to another, in the process of earthwork.

Free haul distance (F.H.D.): The distance within which there is a fixed price for excavating, hauling, and damping the materials regardless of the distance moved.

$$Free\ Haul\ charge = \frac{I.D}{m^3}$$

Over haul distance (O.H.D.): The distance beyond (F. H. D.) for which there is an additional price for each (m³.sta.)

$$Over\ Haul\ charge = \frac{I.D}{m^3.sta.}$$

Limit of economical haul distance (L.E.H.D.): The distance beyond which it is more economical to waste and borrow rather than to pay for the cost of over hauling.

$$\textbf{L.E.H.D.} = \textbf{F.H.D.} + \textbf{max. O.H.D.} = \textbf{F.H.D.} + \frac{Borrow\ cost\ \frac{I.D}{m^3}}{Over\ haul\ distance\ cost\ \frac{I.D}{m^3.sta.}}$$
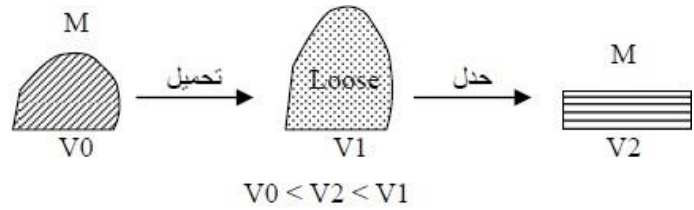
A-B = F. H. D.

C-D = F. H. V.

E-F = L. E. H. D.

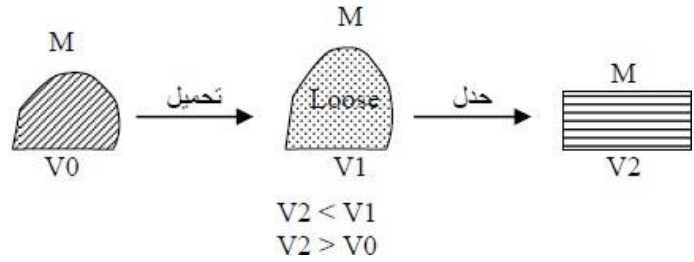G-H = O. H. V.

E-K = West (W)

F-P = Borrow (B)
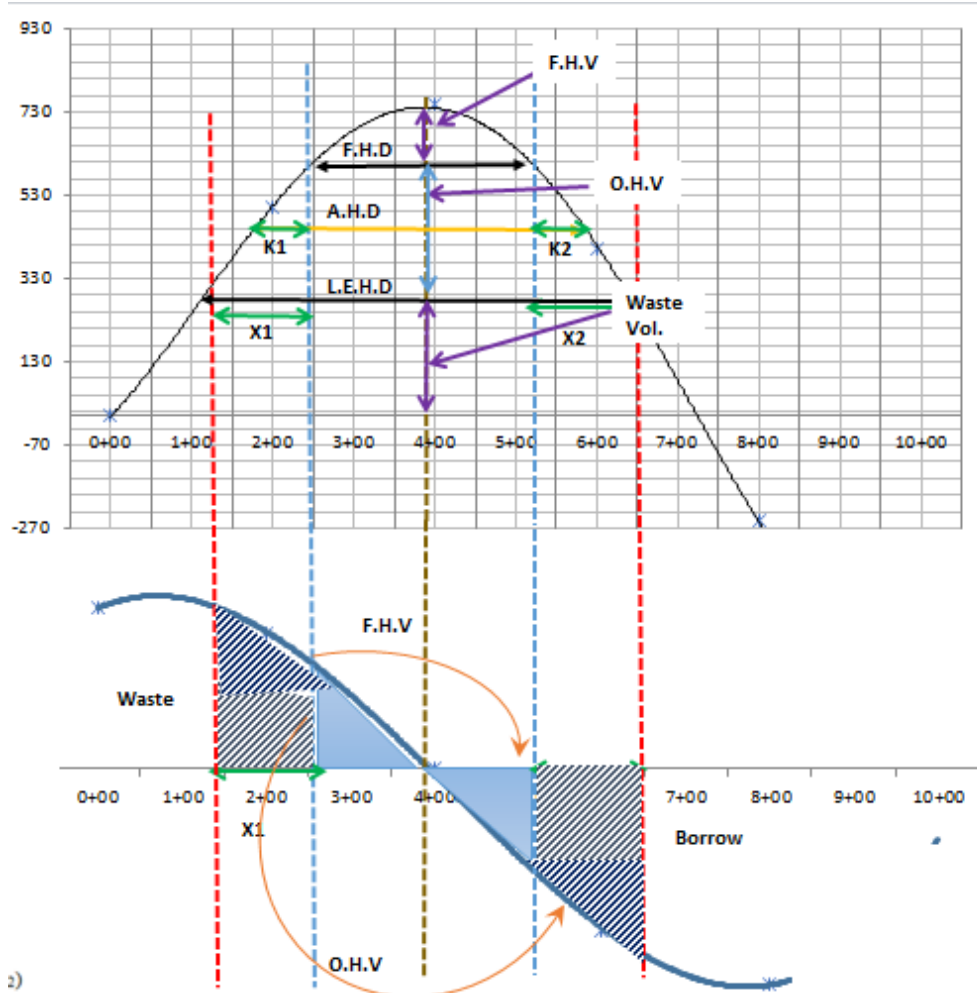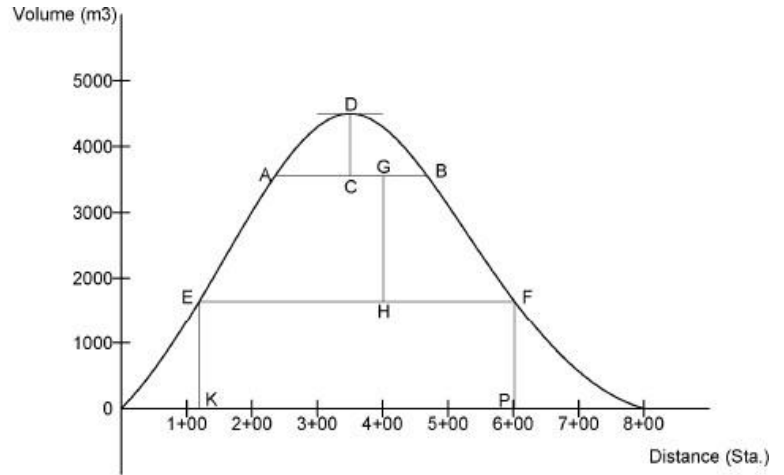
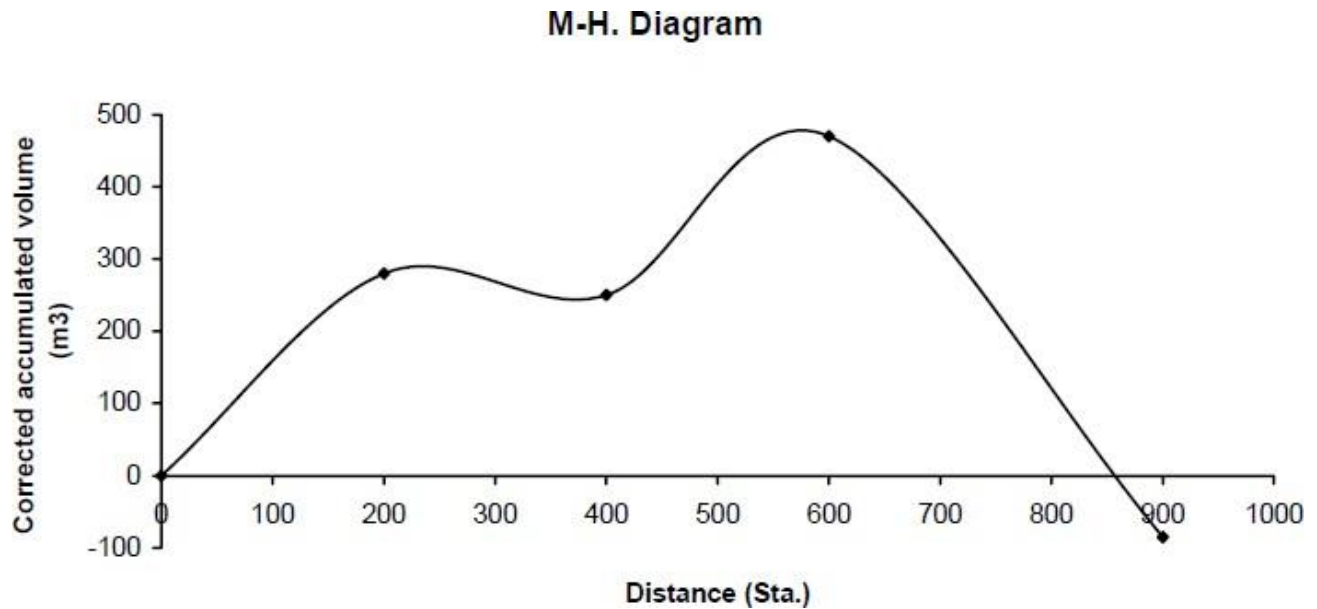## Correction:

* Sandy, Silty clay

    Shrinkage: 5 – 15 % ≈ 10%

$V0 < V2 < V1$

* Lime stone, Sand stone

    Bulking: 25 – 35 % ≈ 30%

$V2 < V1$
$V2 > V0$

Ex.:

Sta.	End Area (m²)		Cut + (m³)	(-) Shrinkage 10% (m³)	Corrected Cut + (m³)	Fill – (m³)	Balance Vol. (m³) (Cut-Fill)	Accu. Vol. (m³)
	Cut	Fill						
0+00	4.0	2.6						0
			0.5*(4+2)*200 =600	600*0.1 =60	600-60 =540	0.5*(2.6+0)*200 =260	+280	
2+00	2	0						+280
			0.5*(2+1)*200 =300	300*0.1 =30	300-30 =270	0.5*(0+3)*200 =300	-30	
4+00	1.0	3						+250
			0.5*(1+7)*200 =800	800*0.1 =80	800-80 =720	0.5*(3+2)*200 =500	+220	
6+00	7	2						+470
			0.5*(7+0)*300 =1050	1050*0.1 =105	1050-105 =945	0.5*(2+8)*300 =1500	-555	
9+00	0	8						-85

M-H. Diagram

Example 1:

F.H.D= 700m =7 st

Over haul cost = 1500 ID/m^3.st

Waste cost = free haul distance = 4500 ID/m^3

Borrow cost = 6000 ID/m^3

Find cost for each m3, L= 5st, 9, 13 and 15st.

Solution:

F.H.D =7 st

1) L= 5st < 7st

Cost = free haul cost = 4500 ID/m^3

2) L= 9st> 7st

L.E.H =F.H.D + Borrow cost (ID/m^3)/Over haul distance cost $(ID/m^3.st)$

=7+ 6000/1500=11 st > 9 st

Cost = 4500 + 2*1500=7500 ID/m^3

3) L = 13st > L.E.H

Cost = waste cost + borrow cost

=4500+6000=10500 ID/m^3

4) L= 15 st > L.E.H

Cost = 4500 + 6000 = 10500 ID/m^3