5.3 CULMANN'S GRAPHICAL METHOD FOR ACTIVE PRESSURE:

Culmann's (1866) also gave a graphical solution to evaluate the active pressure and can be conveniently used for ground surface of any shape, for various types of surcharging loads, and for a layered backfill of different densities.

PROCEDURE:

1. Draw the ground line φ line and the ψ line as usual
2. Take a slip plane BC1.calculate the weight of the wedge $ABC_1$and plot it as BE_1 to some scale on the φ line.
3. Through E_1, draw E_1, F_1 parallel to the line ψ, to cut the slip plane BC_2 in F_1.
4. Similarly take another slip plane BC_2, calculate the weight of wedge ABC_2 and plot it as BE_2 on the line. Draw E_2F_2 parallel to the line cut the slip plane BC_2 in F_2
5. Take number of such slip planes BC_3, BC4. Plot the weight of the corresponding wedge s on the ψ line and obtain point's F3, F4.
6. Draw a smooth curve through points B, F_1, F_2, F_3, F_4 etc. This curve is known as the Culmann's line.
7. Draw a tangent to the Culmann's line parallel to the φ line. The maximum value of the earth pressure is represented by the intercept EF, on the adopted scale. EF being drawn through the points of tangency parallel to the line ψ line. BFC represents the critical slip plane.
8. To locate the points of application of the resultant pressure, draw a line parallel to the critical slip plane BC, through the center of gravity of the sliding wedge ABC and obtain its intersection on the back AB.

When the ground line is a plane, the weights of the wedges ABC_1, AC_1 =L3, etc. since the height of soil wedge is constant being equal to H_1. Hence the weights of these wedges are plotted as their base lengths L_1, L_2, L_3, etc. on the φ line.

$$P_a=1/2\gamma H_1(EF)$$

If the backfill also carries a surcharge of intensity q, γ

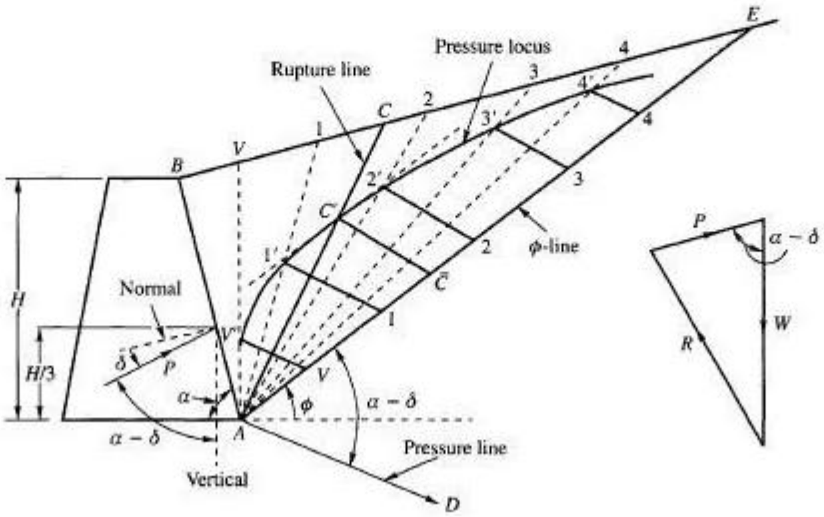

Fig 1 Active Earth Pressure by Graphical Method

[Fig1 https://civilengineeringx.com/foundation/active-pressure-by-culmanns-method-for-cohesionless-soils/]

EFFECT OF LINE LOAD:

Culmann's graphical method can also be used to take into account the running parallel to the retaining wall. A line load of intensity q per unit length, acting at a point C1, distant from the top of the wall. BEF1, F_n shows the Culmann's line and BC is the failure plane in absence of the line load. Let w1 be the weight of the wedge ABC1 which is plotted as BE1on the line ℂ and point F1 is obtained if there were no line load. However, when the line load is there the weight of the wedge ABC1 increases by q. thus BE^I represents and a point change in the Culmann's line the change being proportional to q. for all other failure wedges to the right, the weight q is added to the weight of the wedge and then plotted on the ℂ line. The modified Culmann's line is thus represents by BFF$_1$FF$_n$. when the slip plane is BC the pressure on the wall is represented by EF and when the slip plane is BC1, the pressure is represented by E, aF. if E^{I}F^I < EF slip occurs along BC^I and the pressure on the wall is increased

The Culmann's line BFF$_2$ is plotted by ignoring the line load. The modified Culmann's line BF^{I}F^I is then plotted by taking into account the line load, when the load q is added to the weight of each soil wedge considered. By drawing tangents to two Culmann's lines parallel to ℂ line, intercepts FE and F^{I}E^I are obtained. The intercept E^{I}F gives the greatest value of pressure due to backfill acted upon by q, whereas FE gives the maximumpressure in the absence of the line load. If the tangent at F is prolonged to meet the modified Culmann's line in F_2^I the intercept E_2^I F_2^I equals to FE. This means that if the line is placed beyond $C_{2,}$ there is no effect of the line load on the pressure for the other plotted. it will be seen that is maximum when the load is just at face of the wall, it remains constant with the position of q up to point c1 and then decreases gradually to zero at C_2.

For load positions beyond C_2 the pressure on the wall is not due to q. This method is very much used in locating the position of the railway line or the footing of building on the backfill at such a safe distance that the earth pressure on the (existing) wall does not increase.