# Active Limit State Fundamentals

When soil interacts with a retaining wall which is allowed to move away from the soil slightly, the soil pressure on the wall reduces from the so called at-rest value to a minimum value, the active limit value.

The main features the mechanical interaction between a dry granular cohesionless soil mass with horizontal upper surface and a retaining wall with a vertical and smooth back, are illustrated in Figure 1 where it is assumed that the wall, pushed by the soil, has moved slightly forward so that the conditions of active limit equilibrium have been reached, with the soil pressure decreasing from the at-rest value to a minimum.

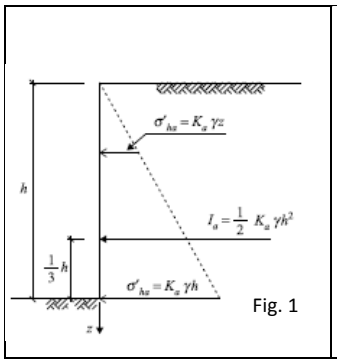

Fig. 1

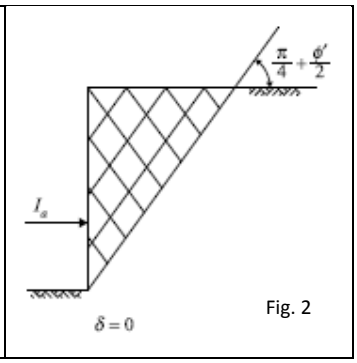

Fig. 2

According to Rankine's theory [1], in a soil with unit weight $\gamma$, the horizontal effective stress $\sigma'_{ha}$ increases linearly with depth, from zero at the top surface to a value of $K_a \gamma h$ at depth $h$, where $K_a$, the coefficient of active earth pressure, is given by $(1 - sin\phi') \,/\, (1 + sin\phi')$ , with $\phi'$ being the soil angle of shearing resistance. The resultant of the lateral pressure diagram is $I_a = K_a \, \gamma h^2/2$, with $I_a$ being the so called total active thrust.

Laboratory experiments conducted by Terzaghi [2] with a vertical wall hinged at the base have shown that a horizontal top displacement of 0.1 to 0.2% of the wall height are sufficient for mobilizing the active limit state in the granular soil, the corresponding triangular soil wedge that follows the wall motion being bounded by a plane, at an angle $\alpha = \pi \,/\, 4 + \phi'/2$ from the horizontal, which separates it from the remaining elastic soil, as depicted in Fig. 2.

[1] I. Smith, Smith's Elements of Soil Mechanics; 8th ed., Oxford: Blackwell Publishing, 2006.

[2] K. Terzaghi, "Large Retaining-Wall Tests: I-Pressure of Dry Sand", Engineering News-Record, vol. 112, no. 5, 136-140, 1934.