Unit-X: LATERAL EARTH PRESSURE

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Unit-X: Earth Pressure

- Introduction, earth pressure at rest, Rankine`s active & passive states of plastic equilibrium, Rankine`s earth pressure theory, Coulomb`s earth pressure theory, Culmann`s graphical construction, Rebhann`s construction.

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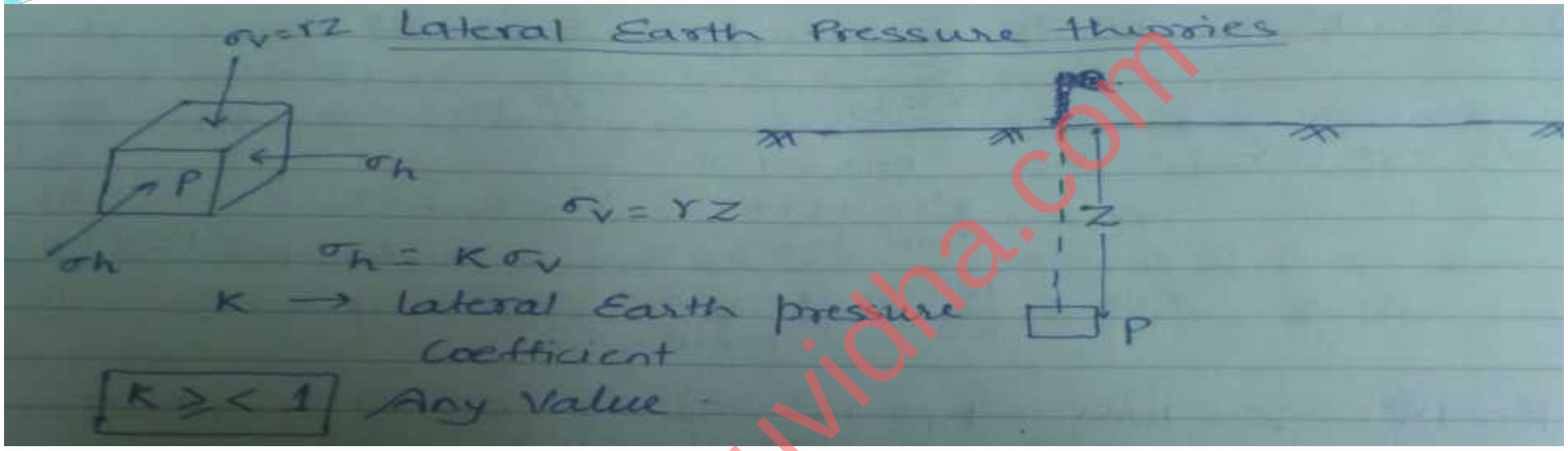
LATERAL EARTH PRESSURE



- There are three states of Lateral Earth Pressure
  - Active State
    - Wall moves away from fill ($K = K_a$)
  - At rest state
    - Wall is stationary ($K=K_o$)
  - Passive State
    - Wall pushed against the soil/towards soil ($K = K_p$)

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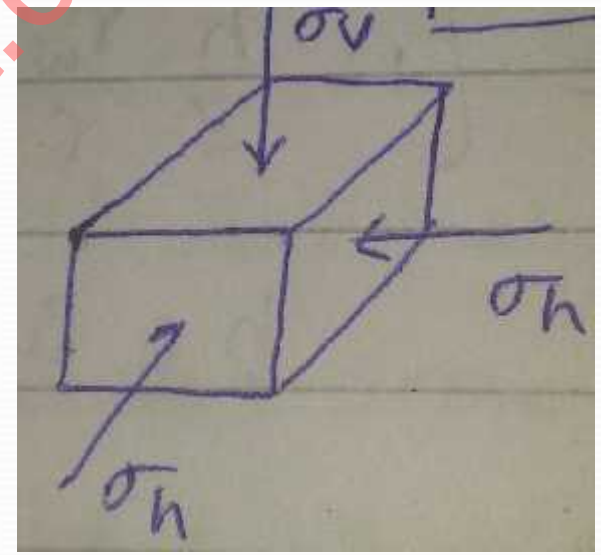
LATERAL EARTH PRESSURE

- Earth pressure at rest
  - If the wall is stationary then lateral earth pressure at any depth z is $\pm_h = p_o = k_o ¥ z$
  - If lateral strain is zero $\epsilon_h = 0$



$$-\frac{\pm_h}{E} + «\frac{\pm_v}{E} + «\frac{\pm_h}{E} = 0$$

$$\pm_h = \frac{«}{(« - 1)} \pm_v$$

$$\pm_h = k_o \pm_v$$

  - If friction angle of soil ϕ is then K_o is given by

$$k_o = 1 - \sin ¤$$

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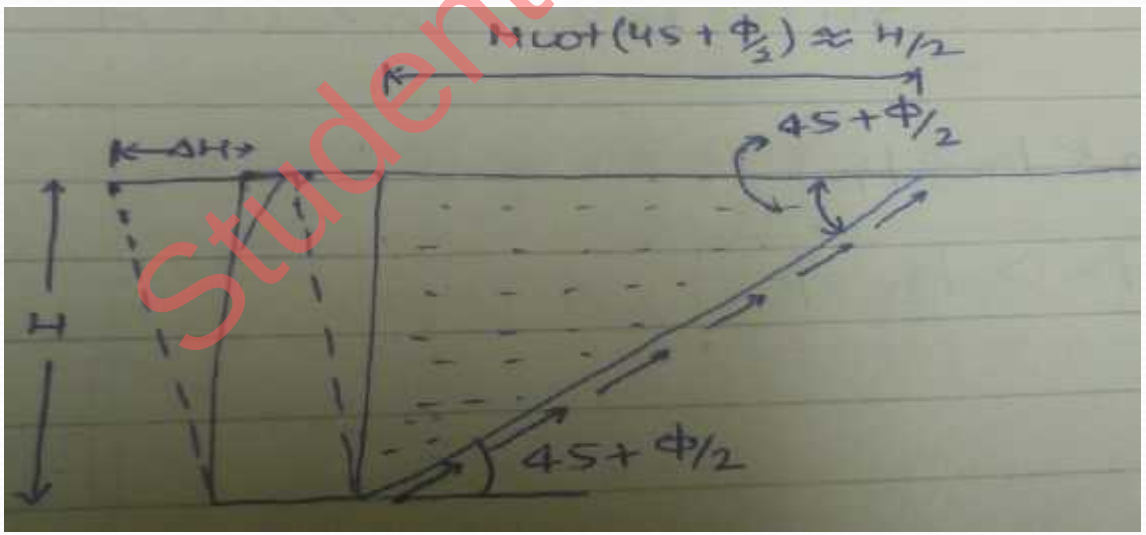
LATERAL EARTH PRESSURE

- Active earth Pressure
  - In active state, earth pressure is less than earth pressure at rest because when wall moves away from backfill then mobilization of internal resistance in the soil occur
  - At any depth z from ground level active earth pressure

$$p_a = k_a ¥ z$$

  - Where K_a is active earth pressure coefficient



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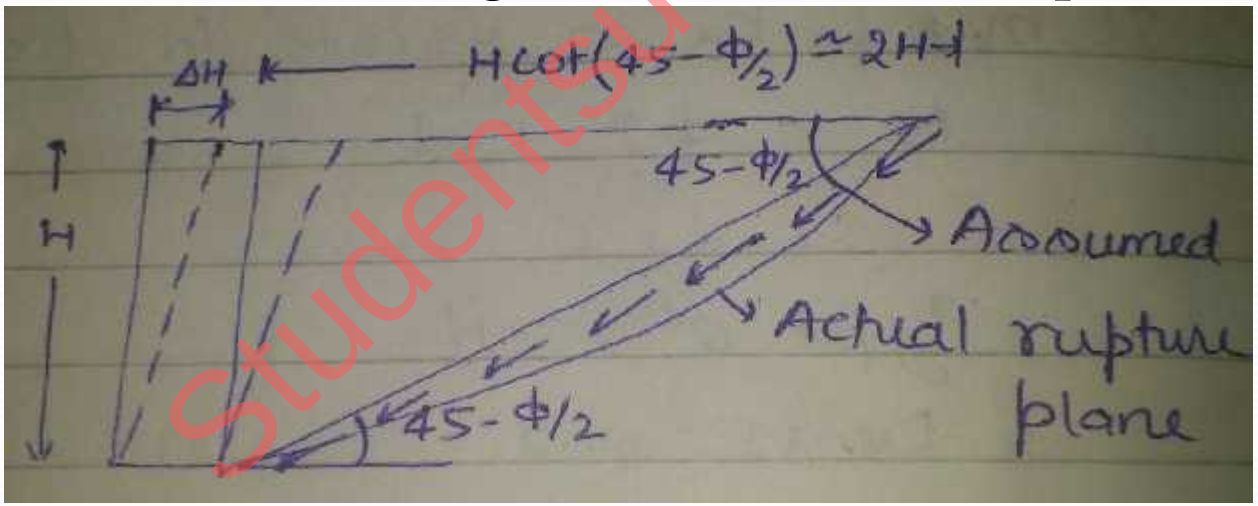
LATERAL EARTH PRESSURE

- Passive earth pressure
  - In passive state, the wall is pushed against the backfill of soil
  - The passive earth pressure is greater than the earth pressure at rest because when wall is pushed against the backfill the shearing resistance is built up in the soil



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LATERAL EARTH PRESSURE THEORIES

- Though Coulomb's theory was given first and rankine's theory was improvement over coulomb's theory but Rankine's theory is more versatile due to its simplicity
- Coulomb's considered inclined and rough wall whereas Rankine considered vertical and smooth wall
- Coulomb's considered wedge failure whereas Rankine considered element failure
- In coulomb's theory, The position and direction of resultant thrust is known
- Both theories considered, the soil mass to be dry, cohesionless, homogeneous, isotropic and elastic
- For RCC and masonary walls coulomb's theory is more practical whereas metallic surface Rankine theory is better
- In case of passive earth pressure, coulomb's theory is less accurate because in passive state, failure surface is curved & coulomb's approximated to the plane surface

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RANKINE THEORY

- Assumptions
  - Soil mass is semi-infinite, homogeneous, dry and cohesionless
  - The ground surface of backfill soil is plane which may be horizontal or inclined
  - The face of the wall in contact with the backfill is vertical and smooth
  - The wall yields about the base sufficiently to mobilise full active and passive state
  - The stresses in the soil are considered when failure occurs at rupture surface and at the time of failure soil reaches in plastic state
  - Rankine considered element failure. He made analysis by considering equilibrium of an element

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RANKINE THEORY

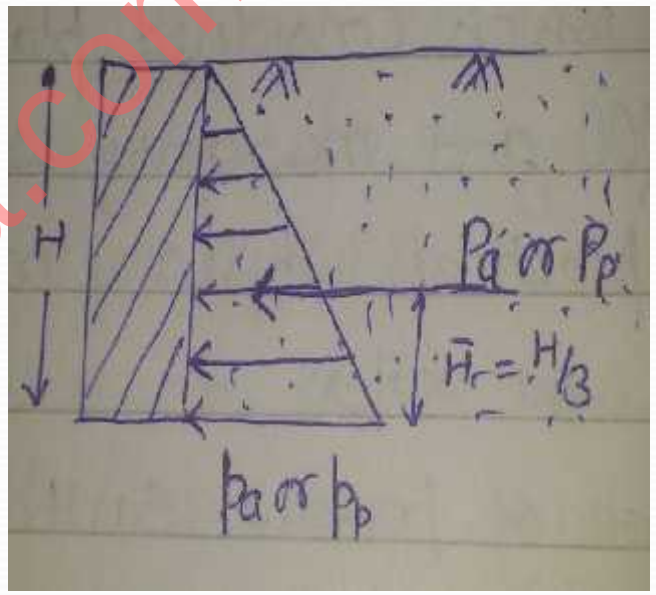
$$p_a = k_a ¥ H$$

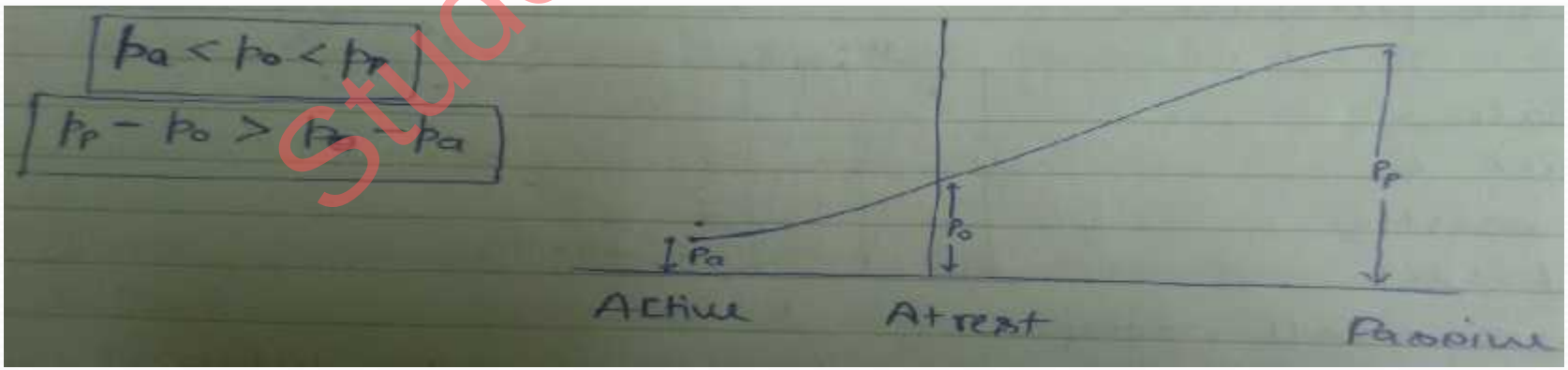
$$p_p = k_p ¥ H$$

$$K_a = \frac{(1-\sin ¤)}{(1+\sin ¤)} = \tan^2(45-\frac{¤}{2})$$

$$K_p = \frac{(1+\sin ¤)}{(1-\sin ¤)} = \tan^2(45+\frac{¤}{2})$$

$$K_a < K_o < K_p \qquad K_a = \frac{1}{K_p}$$





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