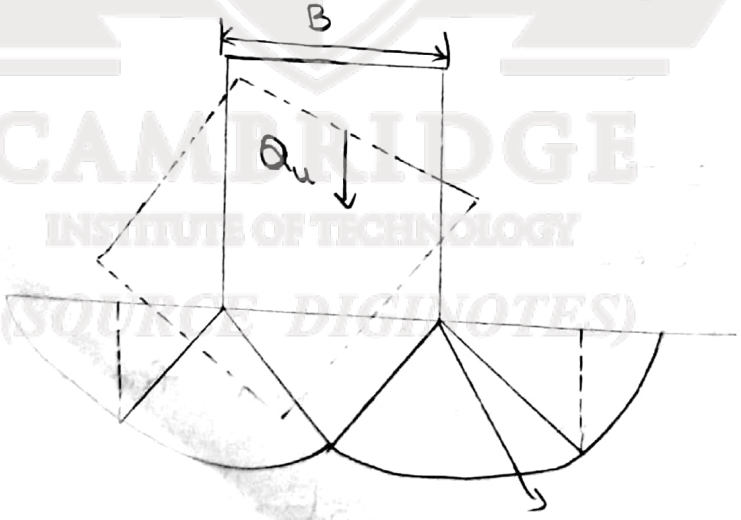
Shear strength of soil

It is the capacity of a material to resist and internal and external resistance which slide pass each other.

Significance of shear strength :-

The nature of shearing resistance to analize soil problems such as slope stability, lateral earth problems.

* Earth retaining structures
* Pavement



Shear failure under foundation load

Components of Shear Strength of Soils

Shear Strength in Soil is due to the following

(1) Resistance due to interlocking of particles

(2) Frictional resistance between the individual soil grains, individual friction which may be Sliding friction

(3) Adhesion

Soil derives its shear strength from two Sources

(1) cohesion between particles [Stress independent component]

(i) cementation between soil grains

(ii) Electrostatic attraction between clay particles

(iii) Frictional resistance and interlocking between particles [stress dependent component]

(iv)

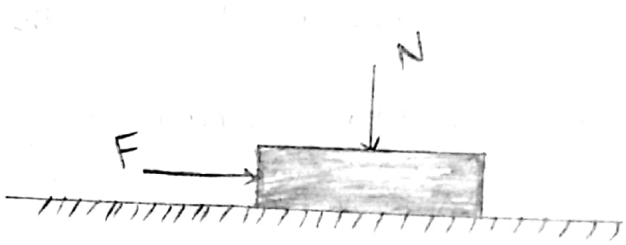
Cohesion :- [C]

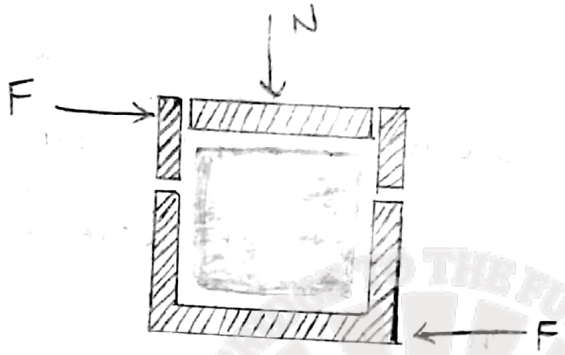
Cohesion is a measure of forces that cement particles of Soils.

Internal friction

Internal friction angle is the measure of the shear strength of Soils due to friction

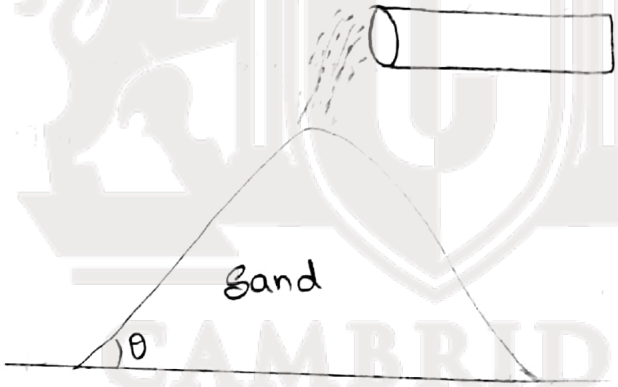
Angle of internal friction :-





Direct Shear test Apparatus

Angle of Repose :-



(i) particle size higher for large particles

(ii) particle shape (higher for angular shape]

(iii) Shear Strengths [Higher for higher Shear Strength]

Stresses :-

Gravity generate stresses [force / unit area] in the ground at different points. Stress on a plane at a given point in terms of two

components

Normal stress (σ) acts normal to the plane and tends to compress soil grain towards each other

Shear stress (τ) :- It acts tangential to the plane and tends to slide grains related to each other (distortion) and ultimately sliding failure)

Factors influencing shear strength :-

① Soil composition :- mineralogy, grain size distribution, shape of particles, pore fluid type and content, ions on grain and in pore fluid

② Initial state :- State can be described in terms such as loose, dense, over consolidated, Normally consolidated, stiff, soft.

③ Structure :- It refers to the arrangement of soil particles with in the soil mass. The manner in which the soil particles are packed are distributed shows the features such as layers, voids, pockets, cementation etc.

Coulomb failure criterion [charles Augustin de coulomb)

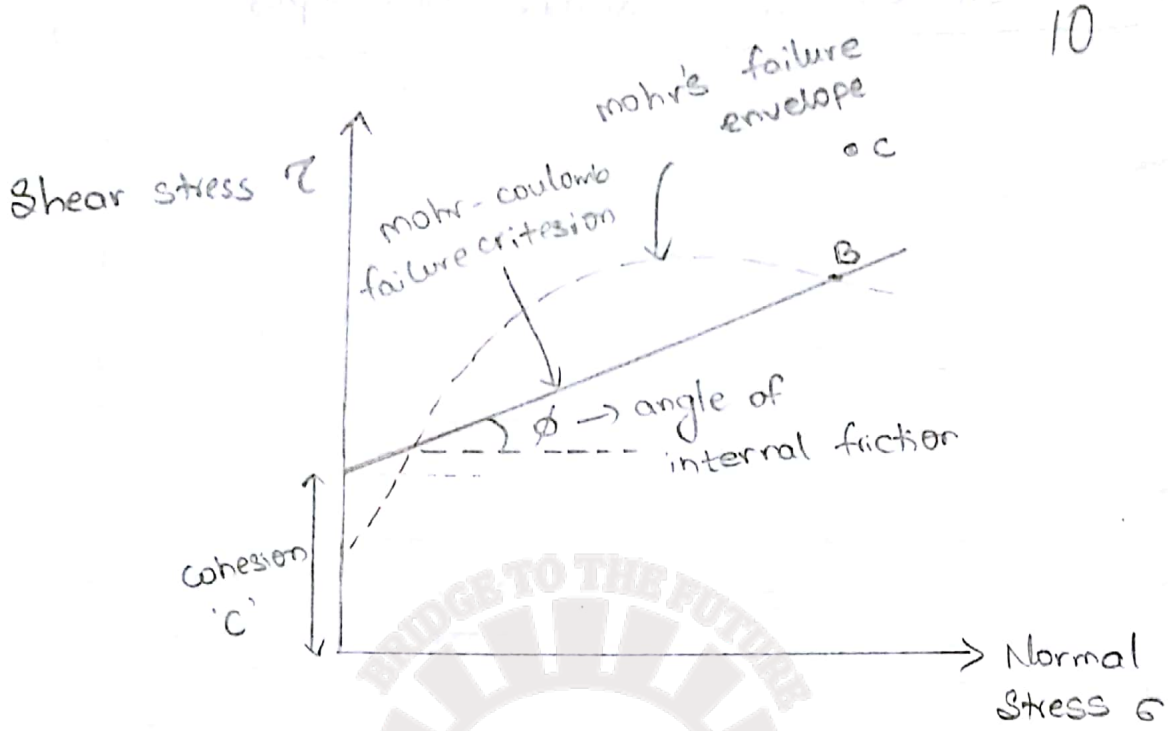
Coulomb stated that the shear stress at failure is a function of normal stress".

$$\tau_f = f(\sigma)$$

The mohr failure criterion :-

mohr presented in 1900 a theory of rupture of material as a result of a , that was the result of a combination of both normal and shear stresses. The shear stress at failure is thus a function of normal stress and the mohr circle is tangential to the functional relationship given by columb.

This theory states that " A material fails because of a critical combination of normal stress and a shear stress and not from either maximum normal or shear stress alone.



Comparison between mohr - coloumb failure critession and mohr's failure envelope.

Although the failure curve is a quadrarthic functions it is represented as linearly. can be

$$\tau_f = c + \sigma \tan\phi$$

$\phi = 0$

τ_f → shear strength

c → cohesion

σ → Normal stress

ϕ → angle of internal friction

This equation is known as mohrs coloumb equation

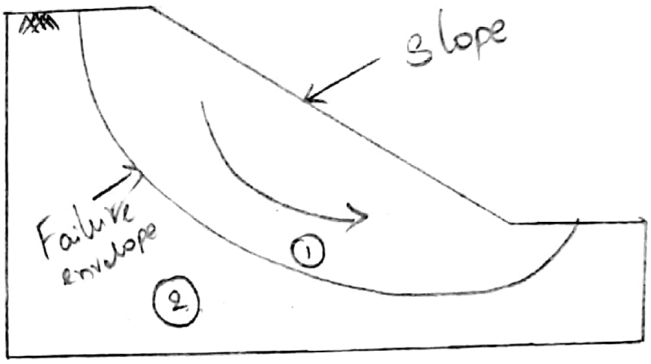
For pure cohesion soils

$c > 0$, $\phi = 0$

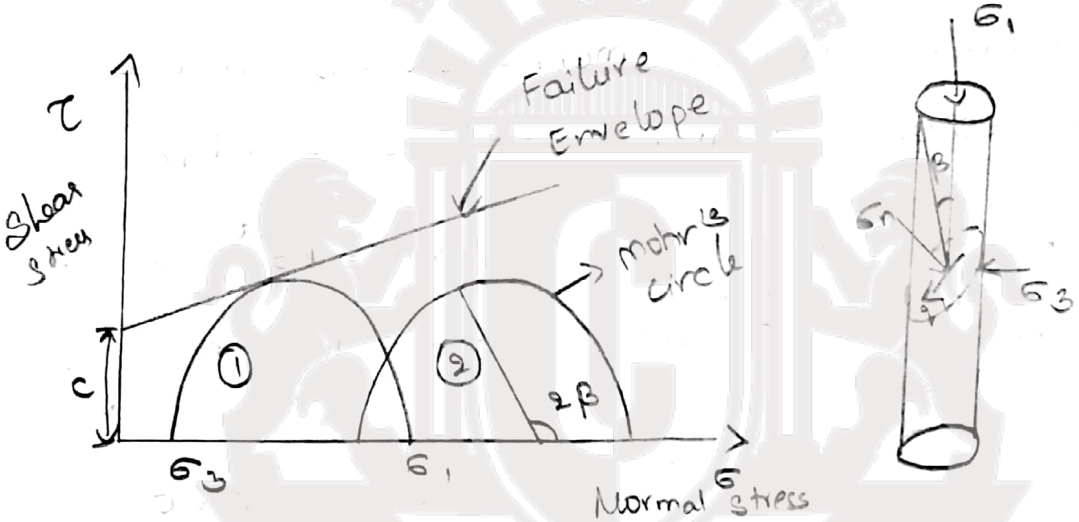
For cohesionless soils

$c = 0$ $\phi > 0$

mohr circles and failure envelopes



soil elements at different locations

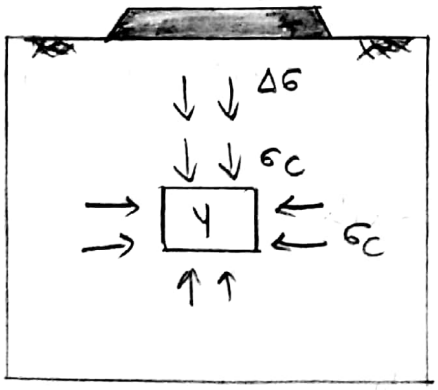


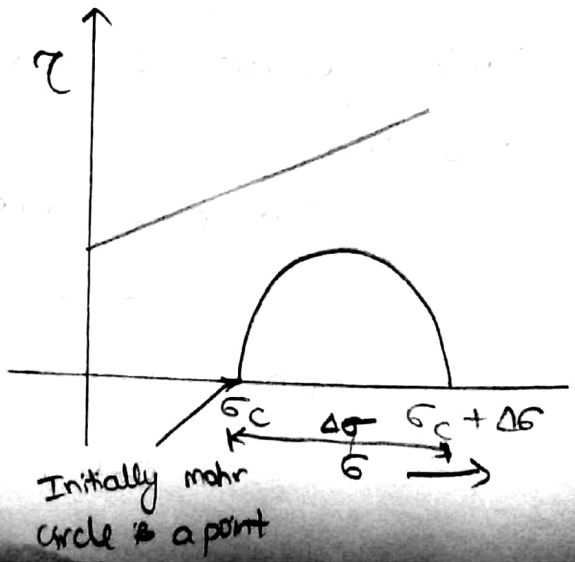
① ⇒ failure

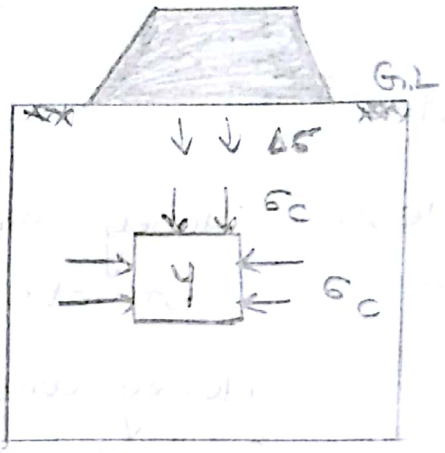
② ⇒ stable

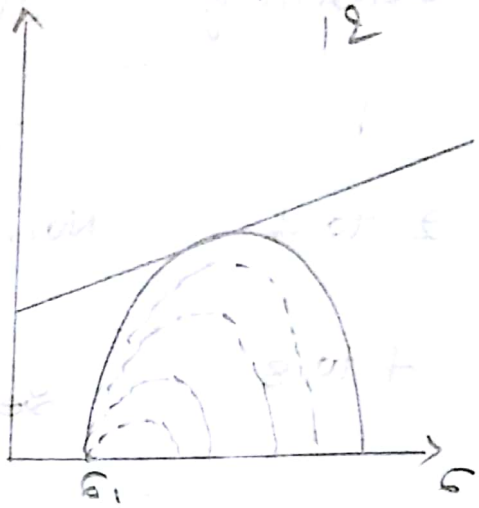
q_u = ultimate load

$$c = \frac{q_u}{2}$$









The consistency of a undisturbed clay is altered, even at the same water content, if it is remoulded. It is because the original structure of clay is altered by reworking or remoulding. Since the strength of a clay soil is related to its structure Remoulding results in decrease of its strength

* The degree of disturbance of undisturbed clay soil due to remoulding is expressed by Sensitivity.

$$\text{Sensitivity} = \frac{q_u \text{ (undisturbed)}}{q_u \text{ (remoulded)}}$$

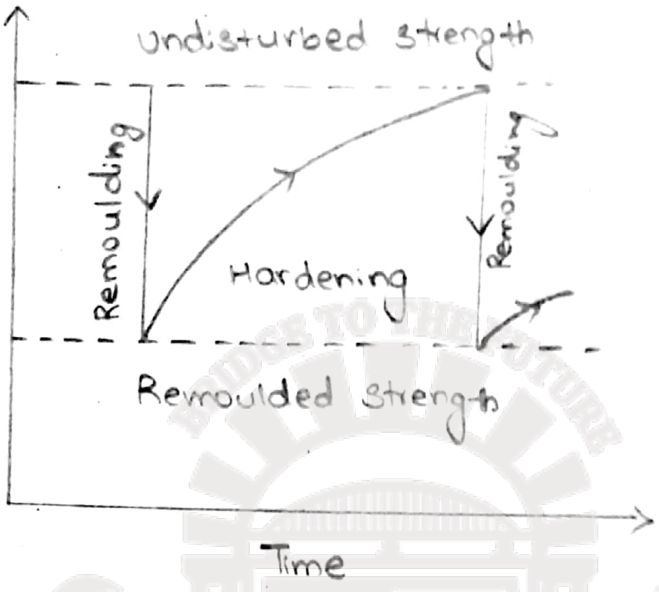
q_u = ultimate bearing capacity

Sensitivity	classification	Structure
1	Insensitive	
2 to 4	Normal to less Sensitive	Honey comb structure
4 to 8	Sensitive	Honey comb or flocculated structure
8 -16	Extra Sensitive	Flocculated structure
>16	Quick	unstable

Quick clays

Sensitivity = 16 - 100

Thixotropy



Consequence of Sensitivity of Soil

(1) marine and lake clays and organic cells with high water content may have no measu-rable remoulded strength.

(2) In any case if disturbance causes a significant strength reduction, great care is required in using the site. Since an un anspated disturbance has the potential of converti the deposit into a viscous fluid.

(3) In norway land mass has flow like flu for a great distance after being triggered by some natural disturbance.

Thixotropy :- It is an isothermal, reversible, time dependent process which occurs under constant composition and volume there by a material softens as a result of remoulding and gradually returns to its original strength when allowed to rest. The larger the sensitivity larger is the thixotropic hardening.

Reasons for loss of strength on remoulding

(1) permanent distruction of the structure due to insitu layers. and

(2) Re-orientation of the molecules in the adsorbed layer.

(3)

Reasons for gain in strength with time

(1) Re-habilitation of the molecular structure of the soil

(2) Due to the thixotropic property.

Applications of thixotropy :-

(1) All clays and other soils containing cementing agents exhibit thixotrophic properties.

(2) Piles driven into soft clay deposit often have very little load carrying capac until a combination of cementation and desipation of excess pore pressure occurs.

(3) However the strength gained from dissipation of pore pressure is not thixotrophy.

Strength tests

1. UCS test [Unconfined compression strength test]
2. Direct shear test
3. Triaxial test
4. Vane shear test