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Which of the following scenarios is an example of cohesion?

a) Water molecules stick to one another and form a bead

b) Water molecules stay on the tip of a pine needle because the water is attracted to the surface of the needle

c) Water sticks to the walls of blood vessels

d) Water molecules stick to the surface of a mirror

Answer: A - Cohesion is the ability of water molecules to stick to one another due to hydrogen bonding.

Which of the following describes surface tension in water?

a) Surface tension occurs due to ionic bonding

b) Surface tension is caused by water molecules repelling one another

c) Surface tension allows water to support small objects if they are placed carefully on its surface

d) Surface tension of water is weakened by hydrogen bonding

Answer: C - Surface tension is the tendency of a liquid's surface to resist rupture when placed under tension or stress. If a small object is placed carefully on its surface, the tension created by the hydrogen bonds in the water can often prevent the object from sinking.

How does the interface between air and water behave?

a) Normally behaves like a Newtonian viscous fluid

b) Statically

c) It will always form a convex meniscus near a solid surface

d) Like a membrane in tension, forming a meniscus in close proximity to a solid surface

Answer: D

If the contact angle is lower than 90°, the gauge water pressure, $u_w - u_a$, is therefore?

a) Negative

b) Zero

c) Positive

d) 1

Answer: A


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What is the shape of the pore water pressure profile under hydrostatic conditions in saturated and unsaturated states?

Answer: The shape of the pore pressure profile under hydrostatic condition for saturated and unsaturated states are linear.

What is the soil-water retention curve (SWRC)?

Answer: The relationship between degree of saturation (or water content or volumetric water content or yet water ratio) and (negative) water pressure (or suction).

The concept of contact angle hysteresis can be better explained by considering a drop of water placed on a surface. If the surface is progressively tilted, the contact angles at the leading and trailing edges of the drop will increase and decrease, respectively, to prevent the drop periphery from moving. What will make the drop roll across the surface?

a) These angles become residual angles

b) These angles become the advancing and receding angles, θ_a and θ_r

c) The contact angle of the water drop reaches equilibrium

d) None of the alternatives above

Answer: B

What is the main mechanisms of desaturation?

a) Evaporation only

b) Evaporation from the surface and lowering of the water table

c) Processes of water withdrawal by plants, evaporation and groundwater runoff

d) Evaporation and runoff

Answer: B


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Let us consider a system formed by three capillary tubes, A, B, and C respectively having the same length ($L_A=L_B=L_C$). Let us also assume that the diameters of the tubes are $d_A>d_B>d_C$. Which tube will reach their respective limiting angle, θ_r, first?

a) Tube B

b) Tube C

c) Tube A

d) All of them at the same time

Answer: C - Water will be drained from the largest diameter tube to the smallest, therefore tube A will reach its receding angle first.

Assume that a tube is fully saturated with water, closed at one end and opened at the other. The air–water interface in the tube is flat and the water pressure is zero. What happens if evaporation starts?

a) The water pressure caused by evaporation increase to such an extent that the receding angle θ_r is equal to the advancing angle θ_a

b) The water is not initially removed and the gas–liquid interface of meniscus is displaced

c) Water is initially removed without displacement of the gas–liquid interface of the meniscus

d) The water pressure caused by evaporation increase to such an extent that the contact angle is equal to the advancing angle θ_a

Answer: C

Suppose we have one tube completely filled with water. If evaporation occurs, eventually the water pressure decreases to such an extent that the contact angle is equal to the receding angle θ_r. Which sentence is correct?

a) The negative pressure in the liquid is equal to the maximum negative pressure sustained by surface tension

b) The surface tension force is not important, in this case the air pressure controls the negative water pressure

c) The negative pressure in the liquid is equal to θ_a, when this occurs the water pressure is negative and control the surface tension

d) After this stage, more evaporation occurs, when this happens the water level in the tube increases

Answer: A

Assume that the air–water interface in a tube filled with water is flat and that the water pressure is zero. What happens if the contact angle reaches the receding angle?

a) The water level lowers in the capillary tube, but the receding angle increases while the water pressure is kept stable

b) The water level lowers in the capillary tube, but the receding angle decreases while the water pressure is kept stable

c) The water level lowers in the capillary tube and both the receding angle and water pressure increase

d) The water level lowers in the capillary tube and the receding angle and water pressure remain stable

Answer: D


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Suppose we have one tube completely filled with water and the interface between water and air is initially flat. At the very start of evaporation when the menisci at the surface curves…

a) Negative pressure will be generated in the pore-water but the degree of saturation will remain equal to 1
b) Negative pressure will not be generated in the pore-water and the degree of saturation will remain equal to 1
c) Negative pressure will be generated in the pore-water and the degree of saturation will reduce
d) Negative pressure will not be generated initially in the pore-water and the degree of saturation will be less than 1 but greater than 0.95

Answer: A

How can the suction at air entry value, s_{AE}, of a soil be obtained?

Answer: Suction at air entry value is obtained by intersecting the horizontal line at degree of saturation equal to 1 with the line tangent to the curve at the inflection point.

The SWRC of a soil upon wetting and drying is not equal. Knowing this, one can consider that the relationship between degree of saturation, S_r, and suction, s, is?

Answer: Hysteretic.

Under the assumption of laminar flow, the relationship between the actual flow velocity, v_{act}, and the hydraulic gradient, i, can be determined by solving the Navier–Stokes equations, which variables this equation depends on?

a) The kinematic viscosity and the hydraulic radius
b) The acceleration of gravity, the kinematic viscosity, the unit weight of water and the hydraulic radius
c) the kinematic viscosity, the unit weight of water and the hydraulic radius
d) The acceleration of gravity, the kinematic viscosity and the hydraulic radius

Answer: D


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Considering the intergranular stress between spherical particles, if β, the angle between b and c, the radii of the meniscus in 3D, is equal to 53°, the liquid interface is?

a) Higher than the air pressure

b) Equal than the air pressure

c) Lower than the air pressure

d) None of the above, β does not influence the liquid and air pressures

Answer: B

The soil suction is maximum, when the angle of contact (θ) is _____

a) 0

b) 90

c) 60

d) 45

Answer: A

Rise in temperature _____ soil suction

a) Increases

b) Removes

c) Decreases

d) None of the mentioned

Answer: C

Which of the following facts are not true about matric suction?

a) Capillary mechanisms dominate within medium and high degrees of saturation for all soils

b) Osmotic mechanism is the dominant suction mechanism in granular materials

c) Matric suction is the capacity of unsaturated soil to draw water through the liquid phase

d) Osmotic and electrostatics mechanisms are dominants in low degree of saturation of high clay fraction

Answer: B - Capillarity is the dominant suction mechanism over the majority of the unsaturated water content range for granular materials.


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The osmotic suction can be constant over the entire range of water content if...

a) Concentration of dissolved solutes does not change

b) Concentration of dissolved solutes increases

c) Concentration of dissolved solutes decreases

d) None of the above, osmotic suction is never constant

Answer: A - Osmotic suction will be constant if the concentration of dissolved solutes does not change.

Which of the following statements is incorrect?

a) Total suction is measured through the gas phase

b) Matric suction is measured through the liquid phase

c) Total suction and matric suction can be assumed to be the same in some circumstances

d) All statements above are incorrect

Answer: D - All statements (a to c) are correct, if osmotic suction is negligible then total suction = matric suction. Total suction is measured through the gas phase while matric is measured through the liquid phase.

Why should the shear strength criteria proposed by Fredlund et al. (1978) be avoided?

a) It is over simplistic

b) It does not capture the observed experimental behaviour

c) It is difficult to implement in practice

d) It is too rigorous

Answer: B. Fredlund et al. (1978)'s shear strength criteria assumes that the contribution of suction to shear strength increases linearly with suction and is proportional to tanϕb while experimental results show the contribution of suction to shear strength increases linearly with suction and is proportional to tanϕ'. Beyond the sAE, it is lower than the shear strength that the soil would have exhibited if it had remained saturated at any suction. At high suction, the shear strength envelope tends to level off.

As a first approximation suction at air-entry, s_{AE}, can be determined from an empirical relationship with grain size d_{80}

a) True

b) False

Answer: True.


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Both scenarios, wetting and drying compacted clays, lead to an increase in volume

a) True

b) False

Answer: False. Both scenarios lead to a decrease in volume. Wetting erases the menisci and hence the bonding between particles vanishes. Drying generates menisci at the interface and hence negative pore water pressure / positive effective stress.

Match the term to the correct definition

1 - Residual suction
2 - S_{AE} suction
3 - Water retention behaviour
4 - Residual degree of saturation

a - It is the suction at which the soil desaturates
b - It is the lowest degree of saturation representing immobile water
c - It is the suction beyond which degree of saturation does not change significantly
d - Relationship between the degree of saturation (or water content) and suction

a) 1c, 2a, 3d and 4b
b) 1a, 2c, 3d and 4b
c) 1d, 2b, 3c and 4a
d) 1b, 2c, 3d and 4a

Answer: A

About the compressive intergranular stress generated by the meniscus, which of these sentences is false?

a) The compressive intergranular stress depends on particle size

b) The value of suction within a meniscus water lens has very little effect on the stability of that contact

c) Can be assumed constant whenever the meniscus water lens is present, but it disappears when the surrounding voids are filled with water

d) The contact meniscus influences the compressive stress more than saturated contacts

Answer: D

Typically soils compacted on the dry side of optimum or granular materials prepared by "moist tamping" present an open structure. Which responses may be observed in terms of stress level on these materials?

a) At low stresses, the material will swell, whereas at high stresses, the material will show an initial swelling followed by a significant volume decrease, which is referred to as "volumetric collapse"
b) At low stresses, the material will not change volume, whereas at high stresses, the material will show an initial swelling followed by a significant volume increase, which is referred to as "volumetric collapse"
c) The ratio between shear and normal stress exceeds the interparticle friction angle at high stresses, when this occurs there is an increase in the voids of the particles
d) The effect of the stress level does not change the behaviour of the material, because the compression forces will be helped by the meniscus interparticle contacts

Answer: A


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From the microstructural standpoint, intergranular stresses at the saturated and meniscus contacts can explained by the contribution of suction to shear strength. This contribution is given by:

a) Difference between the shear strength τ and the shear strength at zero suction, $\sigma \tan \phi'$, σ being the total stress

b) The contribution of suction cannot be measured

c) The relationship between intergranular stress and the pore pressure

d) The contribution of suction is not proportional to the intergranular stress and the pore pressure

Answer: A

About the shear stress of unsaturated soils, which of these sentences is correct?

a) As suction decreases beyond the air-entry suction, s_{AE}, the contribution of suction to shear strength $\Delta\tau$ is higher for unsaturated soils than it would have been if it had remained saturated under any suction

b) It is observed that at a value of suction close to the air-entry suction, the shear strength of the unsaturated geomaterial is higher than the shear strength under saturated conditions

c) The meniscus intergranular stress can be lower than saturated intergranular stress at low suction and is higher at high suction

d) The meniscus intergranular stress is lower than saturated intergranular stress at low and high suction

Answer: B

Is this statement true or false?

"Water retention behaviour of unsaturated soils can be characterized by measuring the (negative) pore-water pressure and the degree of saturation / gravimetric water content / volumetric water content on either undisturbed sample in the laboratory or directly in the field with sensors installed in the ground."

a) True

b) False

Answer: True.

Is this statement true or false?

"For preliminary assessment it may be convenient to 'borrow' water retention behaviour from the literature by considering soils that are similar in terms of index properties (grain size distribution, Atterberg limits)."

a) True

b) False

Answer: True.


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Which of the alternatives below relates the list of number with the list of letters correctly?

1 - Gravimetric water content
2 - Water ratio
3 - Volumetric water content
4 - Degree of the saturation

a - Ratio between volume of water and volume of voids
b - Ratio between volume of water and total volume
c - Ratio between volume of water and volume of solids
d - Ratio between mass of water and mass of solids

a) 1a, 2c, 3d and 4b
b) 1d, 2b, 3c and 4a
c) 1b, 2c, 3d and 4a
d) 1d, 2c, 3b and 4a

Answer: D

Is this statement true or false?

"The air-entry suction is associated with the overall grain size, being lower for coarser materials. This is not unexpected as coarse materials are characterised by larger pore size and, hence, lower air-entry suction"

a) True

b) False

Answer: True.

Is this statement true or false?

"The air-entry suction is controlled by the smallest pores in a soil matrix, which can be in turn related to the smaller grain size"

a) True

b) False

Answer: False.

Is this statement true or false?

"Water is essentially immobile at the residual state and the hydraulic conductivity is therefore virtually equal to zero in this state."

a) True

b) False

Answer: True.


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Is this statement true or false?

"When the contact angle is equal to the receding angle θ_r the pressure in the liquid is equal to the maximum pressure sustainable by the meniscus"

a) True

b) False

Answer: True.

Is this statement true or false?

"Water in unsaturated geomaterials exists at the inter-particle contacts around air-filled voids (meniscus water) and in saturated sub-regions of the pore space (bulk water)"

a) True

b) False

Answer: True.

Is this statement true or false?

"Different stable contact angles exist for a given system, i.e., the contact angle exhibits hysteresis"

a) True

b) False

Answer: True.

Is this statement true or false?

"A conventional value for the suction corresponding to the entry of air into the pore space, S_{AE}, is obtained by intersecting the horizontal line at degree of saturation equal to unity with the line tangent to the curve at the inflection point"

a) True

b) False

Answer: True.