

EXIT EXAM MODEL QUESTIONS

Soil Mechanics I
&
Soil Mechanics II

Soil Mechanics I & Soil Mechanics II

THE ESSENTIAL POINTS ARE:

- 1. Soils are derived from the weathering of rocks and are commonly described by textural terms such as gravels, sands, silts, and clays.**
- 2. Physical weathering causes reduction in size of the parent rock without change in its composition.**
- 3. Chemical weathering causes reduction in size and chemical composition that differs from the parent rock.**
- 4. Clays are composed of three main types of mineral—kaolinite, illite, and montmorillonite.**
- 5. The clay minerals consist of silica and alumina sheets that are combined to form layers. The bonds between layers play a very important role in the mechanical behavior of clays. The bond between the layers in montmorillonite is very weak compared with kaolinite and illite. Water can easily enter between the layers in montmorillonite, causing swelling.**
- 6. A thin layer of water, called adsorbed water, is bonded to the mineral surfaces of soils. This layer significantly influences the physical and mechanical characteristics of fine-grained soils.**

Soil Mechanics I & Soil Mechanics II

THE ESSENTIAL POINTS ARE:

- 1. Fine-grained soils have much larger surface areas than coarse-grained soils and are responsible for the major physical and mechanical differences between coarse-grained and fine-grained soils.**
- 2. The engineering properties of fine-grained soils depend mainly on mineralogical factors.**
- 3. Coarse-grained soils have good load-bearing capacities and good drainage qualities, and their strength and volume-change characteristics are not significantly affected by changes in moisture conditions.**
- 4. Fine-grained soils have poor load-bearing capacities and poor drainage qualities, and their strength and volume-change characteristics are significantly affected by changes in moisture conditions.**

Water content (w) is the ratio of the weight of water to the weight of solids.

Void ratio (e) is the ratio of the volume of void space to the volume of solids.

Porosity (n) is the ratio of the volume of void to the total volume of soil.

Degree of saturation (S) is the ratio of the volume of water to the volume of void.

Bulk unit weight (γ) is the weight density, that is, the weight of a soil per unit volume.

Saturated unit weight (γ_{sat}) is the weight of a saturated soil per unit volume.

Dry unit weight (γ_d) is the weight of a dry soil per unit volume.

Effective unit weight (γ') is the weight of soil solids in a submerged soil per unit volume.

Relative density (D_r) is an index that quantifies the degree of packing between the loosest and densest state of coarse-grained soils.

Swell factor (SF) is the ratio of the volume of excavated material to the volume of in situ material (sometimes called borrow pit material or bank material).

Liquid limit (LL) is the water content at which a soil changes from a plastic state to a liquid state.

Plastic limit (PL) is the water content at which a soil changes from a semisolid to a plastic state.

Shrinkage limit (SL) is the water content at which a soil changes from a solid to a semisolid state without further change in volume.

Soil Mechanics I & Soil Mechanics II

THE *ESSENTIAL POINTS* ARE:

- 1. Fine-grained soils can exist in one of four states: solid, semisolid, plastic, or liquid.**
- 2. Water is the agent that is responsible for changing the states of soils.**
- 3. A soil gets weaker if its water content increases.**
- 4. Three limits are defined based on the water content that causes a change of state. These are the liquid limit—the water content that caused the soil to change from a liquid to a plastic state; the plastic limit—the water content that caused the soil to change from a plastic to a semisolid; and the shrinkage limit—the water content that caused the soil to change from a semisolid to a solid state. All these limiting water contents are found from laboratory tests.**
- 5. The plasticity index defines the range of water content for which the soil behaves like a plastic material.**
- 6. The liquidity index gives a qualitative measure of strength.**
- 7. The soil strength is lowest at the liquid state and highest at the solid state.**

Soil Mechanics I & Soil Mechanics II

THE ESSENTIAL POINTS ARE:

- 1. Compaction is the densification of a soil by the expulsion of air and the rearrangement of soil particles.**
- 2. The Proctor test is used to determine the maximum dry unit weight and the optimum water content and serves as the reference for field specifications of compaction.**
- 3. Higher compactive effort increases the maximum dry unit weight and reduces the optimum water content.**
- 4. Compaction increases strength, lowers compressibility, and reduces the rate of flow water through soils.**

Soil Mechanics I & Soil Mechanics II

1. The ratio of the volume of voids to the total volume of soil is:

(a) Voids ratio

(c) Air Content

(d) Porosity

(b) Degree Of saturation

Solution

(a) Void ratio (e) is the ratio of the volume of void space to the volume of solids. Void ratio is usually expressed as a decimal quantity.

(b) Porosity (n) is the ratio of the volume of voids to the total volume. Porosity is usually expressed as a percentage.

Clay soils can have void ratios greater than 1.

(c) Air content (a_c) Volume of air to volume of void

(d) Degree of saturation (S) is the ratio, often expressed as a percentage, of **the volume of water to the volume of voids**:

Soil Mechanics I & Soil Mechanics II

2. Dry density of soil is equal to the:

- (a) Mass of solids to the volume of solids.
- (b) Mass of solids to the total volume of soil.
- (c) Density of soil in the dried condition.
- (d) None of the above.

Solution

(b) The dry mass density is defined as the mass of solids per unit total volume

As the soil may shrink during drying, the mass density may not be equal to bulk mass density of soil in dry condition.

Express the denseness of soil. High value of density indicates the soil is in compacted state.

Soil Mechanics I & Soil Mechanics II

3.The shrinkage index is equal to

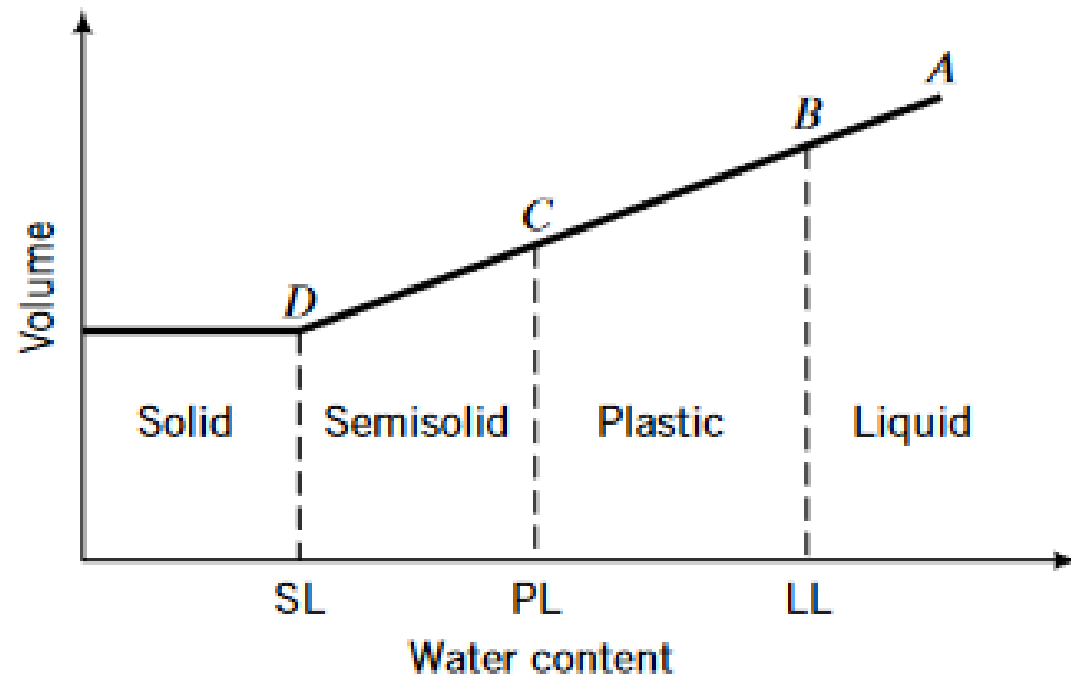
- (a) Liquid limit minus plastic limit.
- (b) Liquid limit minus shrinkage limit.
- (c) Plastic limit minus shrinkage limit.
- (d) None of above.

Solution

(a) The range of water contents over which the soil deforms plastically is known as the plasticity index, PI:

$$PI = LL - PL$$

$$LI = \frac{w - PL}{PI}$$

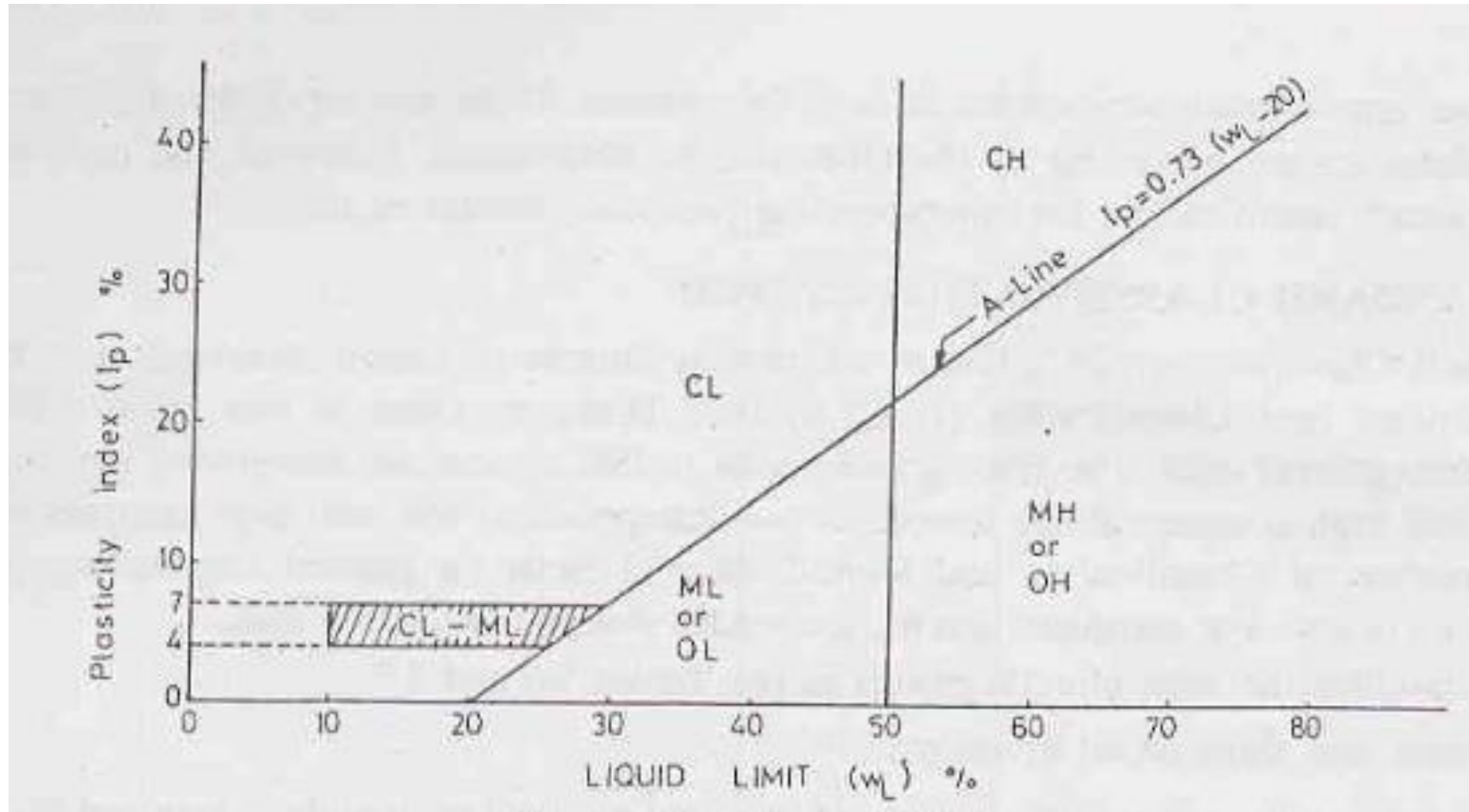


Soil Mechanics I & Soil Mechanics II

4.The soils which plot above the A line in the plasticity chart are

- (a) Clays (b) silts
- (c) Sands (d) organic Soils

Solution



Soil Mechanics I & Soil Mechanics II

5. A constant-head permeameter is used for

- | | |
|--------------------------|-------------------|
| (a) Coarse-grained soils | (b) Silty soils |
| (c) Clayey soils | (d) Organic soils |

Solution

Constant-Head Test:—The constant-head test is used to determine the hydraulic conductivity of coarse-grained soils.

Falling-Head Test:—The falling-head test is used for fine-grained soils because the flow of water through these soils is too slow to get reasonable measurements from the constant-head test.

Soil Mechanics I & Soil Mechanics II

6. The shear strength of cohesion less soil is

- (a) Proportional to the angle of shearing resistance.
- (b) Inversely proportional to the angle of shearing resistance.
- (c) Proportional to the tangent of the angle of shearing resistance
- (d) None of the above

Solution

Shear strength of a soil is the maximum internal resistance to applied shearing forces.

$$\tau_f = c_{cm} + (\sigma'_n)_f \tan (\xi_o)$$

For cemented soils, Coulomb's frictional law is $\tau_f = c_{cm} + (\sigma'_n)_f \tan (\xi_o)$ where c_{cm} is called the cementation strength and ξ_o is the apparent friction angle.

Soil Mechanics I & Soil Mechanics II

7. The effective stress controls the following properties of soils;

(a) Shear strength

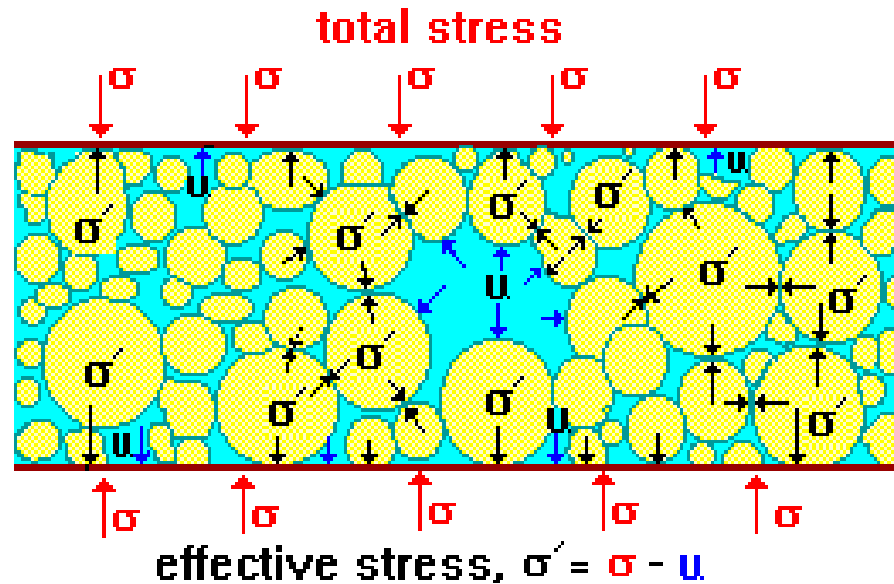
(b) Compressibility

(c) Permeability

(d) All of above

Solution

- The resistance or reaction to σ is provided by a combination of the stresses from the **solids**, called **effective stress** (σ'), and from water in the pores, called **pore water pressure** (u).



Soil Mechanics I & Soil Mechanics II

8. The range of optimum water contents for the standard proctor test for clayey soils is

- | | |
|----------------|---------------|
| (a) 6 to 10 % | (b) 8 to 12 % |
| (b) 12 to 15 % | (d) 14 to 20% |

Soil Mechanics I & Soil Mechanics II

9. The line of optimums generally corresponds to percentage air voids of about

- (a) Zero percent
- (b) 5 percent
- (c) 10 percent
- (d) 20 percent

Soil Mechanics I & Soil Mechanics II

10. Pneumatic-tyred rollers are useful for compacting

- (a) Cohesive soils
- (b) Cohesion less soils
- (c) Both (a) and (b)
- (d) For soils in confined space

Soil Mechanics I & Soil Mechanics II

11. When drainage is permitted throughout the triaxial test, the test is known as

- (a) Quick Test
- (b) Drained Test
- (c) Consolidated Undrained Test
- (d) None of (a), (b) and (C)

Solution

1. UU (unconsolidated undrained) test:

- In this, cell pressure is applied without allowing drainage. Then keeping cell pressure constant, deviator stress is increased to failure without drainage.

2. CU (consolidated undrained) test

In this, drainage is allowed during cell pressure application

- Then without allowing further drainage, deviator stress is increased keeping cell pressure constant.

3. CD (consolidated drained) test

This is similar to CU test except that as deviator stress is increased, drainage is permitted.

Soil Mechanics I & Soil Mechanics II

12. The shear strength of plastic undrained clay depend up on

- A. Internal Friction
- B. Cohesion
- C. Both (a) and (b)
- D. Neither (a) and (b)

Soil Mechanics I & Soil Mechanics II

13. Soil compacted dry of optimum as compared to wet of the optimum

- (a) Has less permeability
- (b) swells less
- (c) Shrink less
- (d) Has less resistance to compression

Soil Mechanics I & Soil Mechanics II

14. Standard Penetration Test is useful to measure

- (a) Shear strength of soft clay
- (b) shear strength of sands
- (c) consistency of clay
- (d) None of the above

Soil Mechanics I & Soil Mechanics II

15. In-situ vane shear Test is used to measure the shear strength of

- (a) Very soft and sensitive clay
- (b) stiff and fissured clay
- (c) Sandy soil
- (d) All of the above

Soil Mechanics I & Soil Mechanics II

16. In wet soil mass air occupies one-sixth of its volume and water occupies one-third of its volume. The void ratio of the soil is

- A. 0.25
- B. 0.50
- C. 1.50
- D. 1.00.

Soil Mechanics I & Soil Mechanics II

17. A soil sample has a specific gravity of 2.60 and a void ratio of 0.78. The water content required to fully saturate the soil at that void ratio will be

- A. 20 %
- B. 30%
- C. 40%
- D. 60%.

Soil Mechanics I & Soil Mechanics II

18. select the correct statement

- A. Relative compaction is the same as relative density
- B. Vibrofloatation is effective in the case of highly cohesive soil
- C. Zero air void line and 100% saturation line are identical

Soil Mechanics I & Soil Mechanics II

16. In the stability analysis the term mobilized shear strength refers

- (a) Shear strength
- (b) Maximum shear stress
- (c) Applied shear stress
- (d) Non of the above

Soil Mechanics I & Soil Mechanics II

17. Bishop's Simplified Method of Slices Satisfies

- (a) Only moment Equilibrium
- (b) only vertical force Equilibrium
- (c) Only horizontal Force Equilibrium
- (d) all of the statics equation, except the horizontal force equilibrium

Soil Mechanics I & Soil Mechanics II

18. Identify the incorrect statement

The stability of slope is decreased by

- (a) Removal of part of slope by excavation
- (b) Shock caused by earthquake
- (c) pore water pressure in soil
- (d) Providing berm at the toe

Soil Mechanics I & Soil Mechanics II

19. The Method of slice for the stability of slop

- (a) can be used for stratified soil
- (b) can be used when seepage occurs and the pore pressure exists within the soil
- (c) gives factor of safety based on the moments and not the force
- (d) All of the above

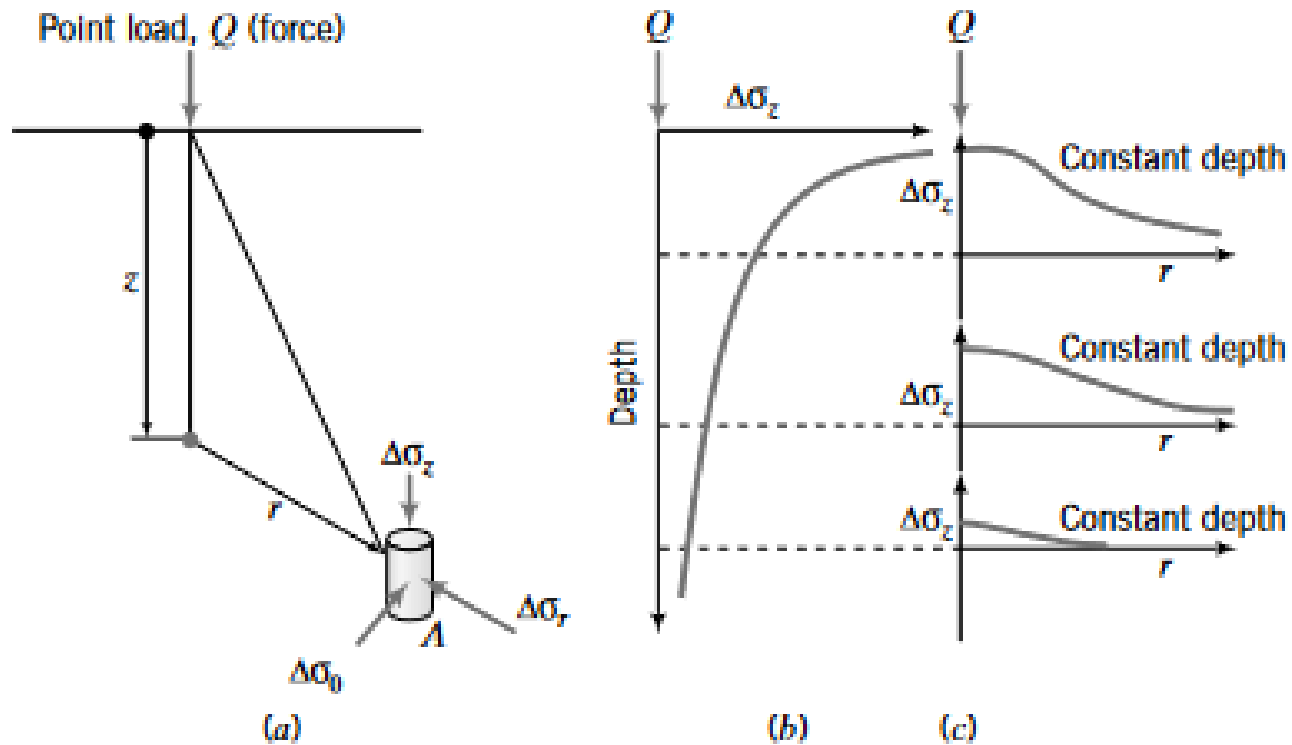
Soil Mechanics I & Soil Mechanics II

20. The stress developed at a point in the soil exactly below a point load at the surface is

- A) Proportional to the depth of point
- B) Proportional to the square of depth of point.
- C) Inversely proportional to the depth of point.
- D) Inversely proportional to the square of the depth of point.

Solution

$$\Delta\sigma_z = \frac{3Q}{2\pi z^2 \left[1 + \left(\frac{r}{z} \right)^2 \right]^{5/2}}$$



Solution

THE *ESSENTIAL POINTS* ARE:

- 1. The increases in stresses below a surface load are found by assuming the soil is an elastic, semi-infinite mass.**
- 2. Various equations are available for the increases in stresses from surface loading.**
- 3. The stress increase at any depth depends on the shape and distribution of the surface load.**
- 4. A stress applied at the surface of a soil mass by a loaded area decreases with depth and lateral distance away from the center of the loaded area.**
- 5. The vertical stress increases are generally less than 10% of the surface stress when the depth-to-width ratio is greater than 2.**

Soil Mechanics I & Soil Mechanics II

21. The permeability of soil varies

- A. Inversely as square of grain size
- B. As square of grain size
- C. As grain size
- D. Inversely as void ratio

$$q_j = v_j A = A k_j i \quad (6.9)$$

The unit of measurement for q_j is m^3/s or cm^3/s . The conservation of flow (law of continuity) stipulates that the volume rate of inflow $(q_j)_{in}$ into a soil element must equal the volume rate of outflow, $(q_j)_{out}$, or, simply, inflow must equal outflow: $(q_j)_{in} = (q_j)_{out}$.

The hydraulic conductivity depends on

1. *Soil type*: Coarse-grained soils have higher hydraulic conductivities than fine-grained soils. The water in the double layer in fine-grained soils significantly reduces the seepage pore space.
2. *Particle size*: Hydraulic conductivity depends on D_{50}^2 (or D_{10}^2) for coarse-grained soils.
3. *Pore fluid properties, particularly viscosity*: $k_1 : k_2 \approx \mu_2 : \mu_1$, where μ is dynamic viscosity (dynamic viscosity of water is $1.12 \times 10^{-3} \text{ N.s/m}^2$ at 15.6°C) and the subscripts 1 and 2 denote two types of pore fluids in a given soil.
4. *Void ratio*: $k_1 : k_2 \approx e_1^2 : e_2^2$, where subscripts 1 and 2 denote two types of soil fabric for coarse-grained soils. This ratio is useful in comparing the hydraulic conductivities of similar soils with different void ratios. However, two soils with the same void ratio can have different hydraulic conductivities.
5. *Pore size*: The greater the interconnected pore space, the higher the hydraulic conductivity. Large pores do not indicate high porosity. The flow of water through soils is related to the square of the pore size, and not the total pore volume.
6. *Homogeneity, layering, and fissuring*: Water tends to seep quickly through loose layers, through fissures, and along the interface of layered soils. Catastrophic failures can occur from such seepage.
7. *Entrapped gases*: Entrapped gases tend to reduce the hydraulic conductivity. It is often very difficult to get gas-free soils. Even soils that are under groundwater level and are assumed to be saturated

Soil Mechanics I & Soil Mechanics II

22.If the entire semi infinite soil mass loaded with load intensity of q at the surface ,the vertical stress at any depth is equal to

- A. q
- B. $0.5q$
- C. Zero
- D. Infinity

Soil Mechanics I & Soil Mechanics II

23. The coefficient of compressibility is

- A. Change in void ratio to change in effective stress
- B. Volumetric strain to change in effective stress.
- C. Change in thickness to change in effective stress
- D. Stress to strain.

Solution

Consolidation is the time-dependent settlement of soils resulting from the expulsion of water from the soil pores.

Primary consolidation is the change in volume of a fine-grained soil caused by the expulsion of water from the voids and the transfer of stress from the excess porewater pressure to the soil particles.

Secondary compression is the change in volume of a fine-grained soil caused by the adjustment of the soil fabric (internal structure) after primary consolidation has been completed.

Excess porewater pressure, Δu , is the porewater pressure in excess of the current equilibrium porewater pressure. For example, if the porewater pressure in a soil is u_o and a load is applied to the soil so that the existing porewater pressure increases to u_1 , then the excess porewater pressure is $\Delta u = u_1 - u_o$.

Drainage path, H_{dr} , is the longest vertical path that a water particle will take to reach the drainage surface.

Past maximum vertical effective stress, σ'_{zc} , is the maximum vertical effective stress that a soil was subjected to in the past.

Normally consolidated soil is one that has never experienced vertical effective stresses greater than its current vertical effective stress ($\sigma'_{zo} = \sigma'_{zc}$).

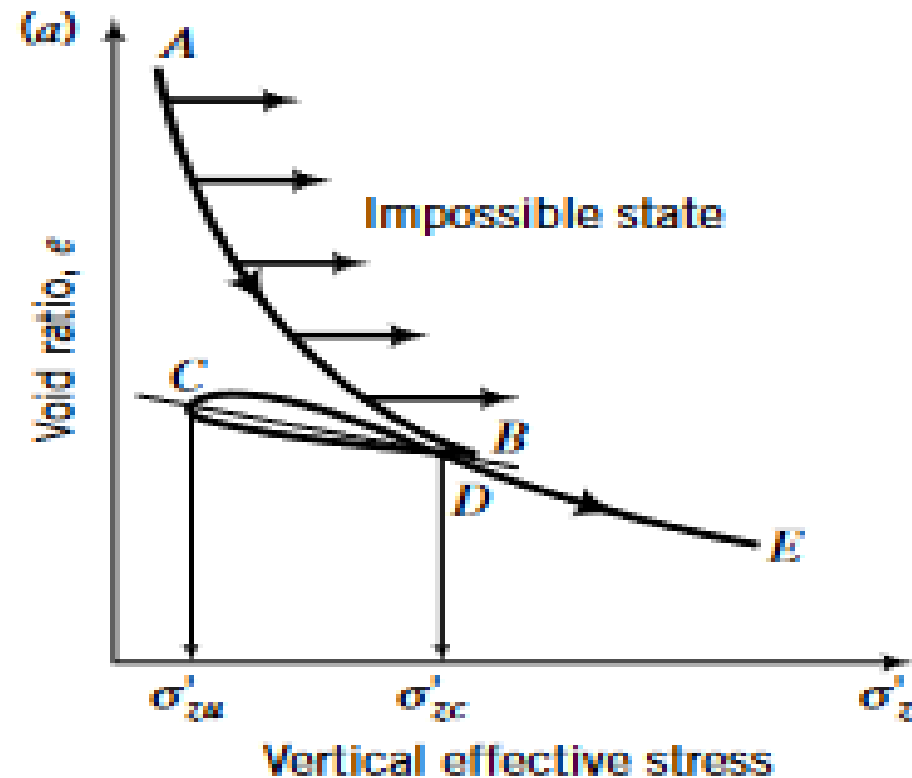
Overconsolidated soil is one that has experienced vertical effective stresses greater than its existing vertical effective stress ($\sigma'_{zo} < \sigma'_{zc}$).

Overconsolidation ratio, OCR, is the ratio by which the current vertical effective stress in the soil was exceeded in the past ($OCR = \sigma'_{zc}/\sigma'_{zo}$).

Compression index, C_c , is the slope of the normal consolidation line in a plot of the logarithm of vertical effective stress versus void ratio.

Unloading/reloading index or **recompression index**, C_r , is the average slope of the unloading/reloading curves in a plot of the logarithm of vertical effective stress versus void ratio.

Modulus of volume compressibility, m_v , is the slope of the curve between two stress points in a plot of vertical effective stress versus vertical strain.



12.8. BASIC DEFINITIONS

The following basic definitions related to consolidation are of paramount importance.

(1) Coefficient of Compressibility. The coefficient of compressibility (a_v) is defined as decrease in void ratio per unit increase in effective stress. It is equal to the slope of the $e - \bar{\sigma}$ curve at the point under consideration [Fig. 12.7 (a)].

$$\text{Thus} \quad a_v = \frac{-de}{d\bar{\sigma}} = \frac{-\Delta e}{\Delta \bar{\sigma}} \quad \dots(12.12)$$

As the effective stress increases, the void ratio decreases, and therefore, the ratio $de/d\bar{\sigma}$ is negative. The minus sign makes a_v positive. For convenience, the coefficient of compressibility a_v is reported as positive.

As the value of a_v is different at various effective stresses, while reporting its value, the effective stress to which that value corresponds must be mentioned. The coefficient of compressibility decreases with an increase in the effective stress. In other words, the soil becomes stiffer (less compressible) as the effective stress is increased and the curve becomes flatter.

The coefficient of compressibility (a_v) has the dimensions of $[L^2/F]$. The units are m^2/kN . It may be noted that the units are inverse of that for pressure.

(2) Coefficient of Volume change. The coefficient of volume change (or volume compressibility) is defined as the volumetric strain per unit increase in effective stress. Thus

$$m_v = \frac{-\Delta V/V_0}{\Delta \bar{\sigma}} \quad \dots(12.13)$$

where m_v = coefficient of volume change, V_0 = initial volume,

ΔV = change in volume, and $\Delta \bar{\sigma}$ = change in effective stress.

The reader should note that the coefficient of volume change is inverse of the bulk modulus used in solid mechanics and fluid mechanics. For most clays, $m_v = 1 \times 10^{-3}$ to $1 \times 10^{-4} \text{m}^2/\text{kN}$.

The volumetric strain ($\Delta V/V_0$) can be expressed in terms of either void ratio or the thickness of the specimen as explained under:

(a) Let e_0 be the initial void ratio. Let the volume of solids be unity. Therefore, the initial volume V_0 is equal to $(1 + e_0)$. If Δe is the change in void ratio due to change in volume ΔV , we have $\Delta V = \Delta e$. Thus

$$\frac{\Delta V}{V_0} = \frac{\Delta e}{1 + e_0}$$

(3) Compression Index. The compression index (C_c) is equal to the slope of the linear portion of the void ratio versus $\log \bar{\sigma}$ plot [Fig. 12.7 (b)]. Thus

$$C_c = \frac{-\Delta e}{\log_{10} (\bar{\sigma}/\bar{\sigma}_0)} \quad \dots(12.17)$$

where $\bar{\sigma}_0$ = initial effective stress, $\bar{\sigma}$ = final effective stress, Δe = change in void ratio

Sometimes, Eq. 12.17 is expressed as

$$C_c = \frac{-\Delta e}{\log_{10} \left(\frac{\bar{\sigma}_0 + \Delta \bar{\sigma}}{\bar{\sigma}_0} \right)} \quad \dots(12.18)$$

where $\Delta \bar{\sigma}$ is the change in effective stress.

The numerical value of C_c can be easily determined from the difference in void ratio corresponding to one log cycle. Thus

$$C_c = \frac{-\Delta e}{1} = -\Delta e \quad \dots(12.19)$$

The compression index is extremely useful for determination of the settlement in the field.

The compression index of a clay is related to its index properties, especially the liquid limit. Terzaghi and Peck gave the following empirical relationship for clays of low to medium sensitivity ($S_t \leq 4$).

$$(a) \text{ For undisturbed soils, } C_c = 0.009 (w_L - 10)$$

$$(b) \text{ For remoulded soils, } C_c = 0.007 (w_L - 10)$$

where w_L = liquid limit (%).

The value of C_c normally varies between 0.30 for highly plastic clays and 0.075 for low plastic clays.

The compression index is also related to the insitu void ratio e_0 or water content (w_0) as under

$$C_c = 0.54 (e_0 - 0.35) \quad \dots(12.21)$$

$$C_c = 0.0054 (2.6w_0 - 35) \quad \dots(12.22)$$

The coefficient of compressibility a_v may be calculated from the compression index as under :

$$a_v = 0.435 \frac{C_c}{\bar{\sigma}_a}$$

(5) Recompression Index. Recompression is the compression of a soil which had already been loaded and unloaded. The load during recompression is less than the load to which the soil has been subjected previously. The slope of the recompression curve obtained during reloading (CFD in Fig. 12.8) when plotted as e -log $\bar{\sigma}$, is equal to the recompression index (C_r). Thus

$$C_r = \frac{-\Delta e}{\log \left(\frac{\bar{\sigma} + \Delta \bar{\sigma}}{\bar{\sigma}} \right)} \quad \dots(12.24)$$

The recompression index is appreciably smaller than the compression index C_c . It is usually in the range of 1/10 to 1/5 of the compression index.

(6) Normally consolidated and Over-consolidated clays. A normally consolidated soil is one which had not been subjected to a pressure greater than the present existing pressure. A soil is said to be over-consolidated if it had been subjected in the past to a pressure in excess of the present pressure.

The portion AB of the curve in Fig. 12.8 represents the soil in normally consolidated condition. The curve in this range is also called the *virgin compression curve*. The soil in the range CD when it is recompressed represents overconsolidated condition, as the soil had been previously subjected to a pressure $\bar{\sigma}_2$ which is greater than the pressure in the range CD .

The maximum pressure to which an over-consolidated soil had been subjected in the past divided by the present pressure is known as the overconsolidation ratio (O.C.R.). For example, the soil indicated by the condition at point C has an over-consolidation ratio of $\bar{\sigma}_2/\bar{\sigma}_1$.

It may be emphasized that normally consolidated soils and overconsolidated soils are not different types of soils but these are conditions in which a soil exists. The same type of soil can behave as normally consolidated in a certain pressure range and an over-consolidated in some other pressure range. For example, in Fig. 12.8, the soil which behaves as overconsolidated in the range CD would again behave as normally consolidated in the range DG .

The liquidity index of a normally consolidated clay is generally between 0.6 and 1.00, whereas that for an over-consolidated clay between 0.0 and 0.60.

As the recompression index (C_r) is very small as compared with the compression index (C_c), the soils in the overconsolidated state have smaller compressibility. The settlements of the structures built on over-consolidated clays are small.

(7) Underconsolidated clays. If the clay deposit has not reached equilibrium under the applied overburden loads, it is said to be underconsolidated. This normally occurs in areas of recent land fill.

24. With an increase in the liquid limit, compression index

- A. Decreases
- B. Increases
- C. remain constant
- D. may increase or decrease

25. The recompression index is about ----- of the compression index

A. 5 times

B. $\frac{1}{2}$

C. $\frac{1}{5}$

D. $\frac{1}{20}$

26. When consolidation of a saturated soil sample occurs, the degree of saturation

- A. Increases
- B. Decreases
- C. remains constant
- D. may increase or decrease

27. Shallow foundation is usually defined as a foundation which has

- A. Depth less than 0.6 m**
- B. Depth less than its width**
- C. Depth less than 1.0 m**
- D. None of the above**

Foundation is a structure that transmits loads to the underlying soils.

Footing is a foundation consisting of a small slab for transmitting the structural load to the underlying soil. Footings can be individual slabs supporting single columns (Figure 12.2a) or combined to support two or more columns (Figure 12.2b), or be a long strip of concrete slab (Figure 12.2c, d; width B to length L ratio is small, i.e., it approaches zero) supporting a load-bearing wall, or a mat (Figure 12.2e).

Embedment depth (D_f) is the depth below the ground surface where the base of the foundation rests.

Shallow foundation is one in which the ratio of the embedment depth to the minimum plan dimension, which is usually the width (B), is $D_f/B \leq 2.5$.

Ultimate bearing capacity is the maximum pressure that the soil can support.

Ultimate net bearing capacity (q_u) is the maximum pressure that the soil can support above its current overburden pressure.

Ultimate gross bearing capacity (q_{ult}) is the sum of the ultimate net bearing capacity and the overburden pressure above the footing base.

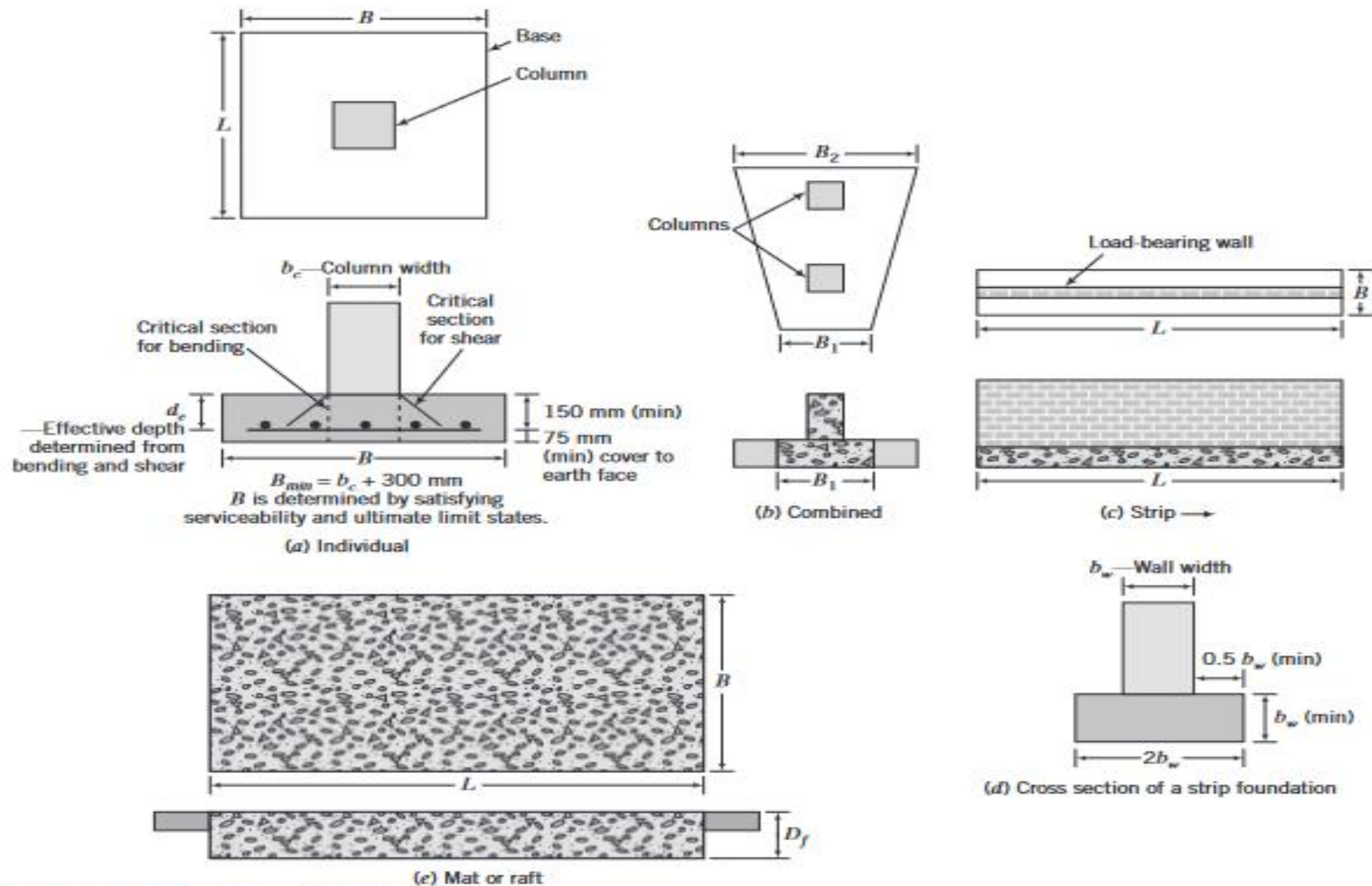


FIGURE 12.2 Type of shallow footing

Allowable bearing capacity or ***safe bearing capacity*** (q_a) is the working pressure that would ensure a margin of safety against collapse of the structure from shear failure. The allowable bearing capacity is usually a fraction of the ultimate net bearing capacity.

Factor of safety or ***safety factor*** (FS) is the ratio of the ultimate net bearing capacity to the allowable net bearing capacity or to the applied maximum net vertical stress. In geotechnical engineering, a factor of safety between 2 and 5 is used to calculate the allowable bearing capacity.

Ultimate limit state defines a limiting stress or force that should not be exceeded by any conceivable or anticipated loading during the design life of a foundation or any geotechnical system.

Serviceability limit state defines a limiting deformation or settlement of a foundation, which, if exceeded, will impair the function of the structure that it supports.

28. The bearing capacity of soil supporting a footing of size 3m x 3m will not be affected by the presence of water table located at a depth below the base of footing of

- A. 1.0 m
- B. 1.5 m
- C. 3 m
- D. 6 m

29.If the gross bearing capacity of a strip footing 1.5 m wide located at a depth of 1 m in clay is 400 kN/m^2 , its net bearing capacity for 20 kN/m^2 is

- A. 370 kN/m^2
- B. 380 kN/m^2
- C. 390 kN/m^2
- D. 360 kN/m^2

30. The method of slices for the stability of slope

- A. Can be used for stratified soils
- B. Can be used when seepage occurs and the pore pressure exists within the soil.
- C. Gives the factor of safety based on moments and not the forces.
- D. All the above.

THE *ESSENTIAL POINTS* ARE:

1. Geological features and environmental conditions (e.g., external loads and natural forces) are responsible for most slope failures.
2. The common modes of slope failure in soils are by translation, rotation, flow, and block movements.

THE *ESSENTIAL POINTS* ARE:

1. The maximum stable slope in a coarse-grained soil, in the absence of seepage, is equal to the friction angle.
2. The maximum stable slope in coarse-grained soils, in the presence of seepage parallel to the slope, is approximately one-half the friction angle.
3. The critical slope angle in fine-grained soils is 45° for an infinite slope failure mechanism.
4. The critical depth is the depth of tension cracks, that is, $2s_u/\gamma$.



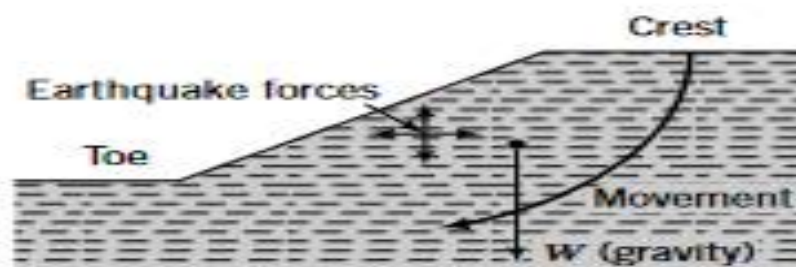
(a) Steepening of slope by erosion



(b) Scour by rivers and streams



(c) Rainfall fills crack and introduces seepage forces in the thin, weak soil layer



(d) Gravity and earthquake forces



(e) Geological feature—soil stratification



(f) Overloading at the crest of the slope



(g) Excavation at toe of the slope

31. In stability analysis, the term mobilized shear strength is referred to as

- A. Shear strength
- B. Maximum shear stress
- C. Applied shear stress
- D. None of the above.

32. Bishop's simplified method of slices satisfies

- A. only the moments equilibrium**
- B. only the vertical forces equilibrium**
- C. only the horizontal forces equilibrium**
- D. All the statics equations, except the horizontal force equilibrium.**

32. The factor of safety of an infinite slope in a sand deposit is 1.732. If the angle of shearing resistance is 30° , the safe slope is

- A. 19.45°
- B. 75.45°
- C. 18.4°
- D. 71.6°

