DDA JE 2023

ENGINEERS

Soil Mechanics

COMPLETE REVISION

PART 1

CIVIL ENGINEERING

LIVE@5:00PM

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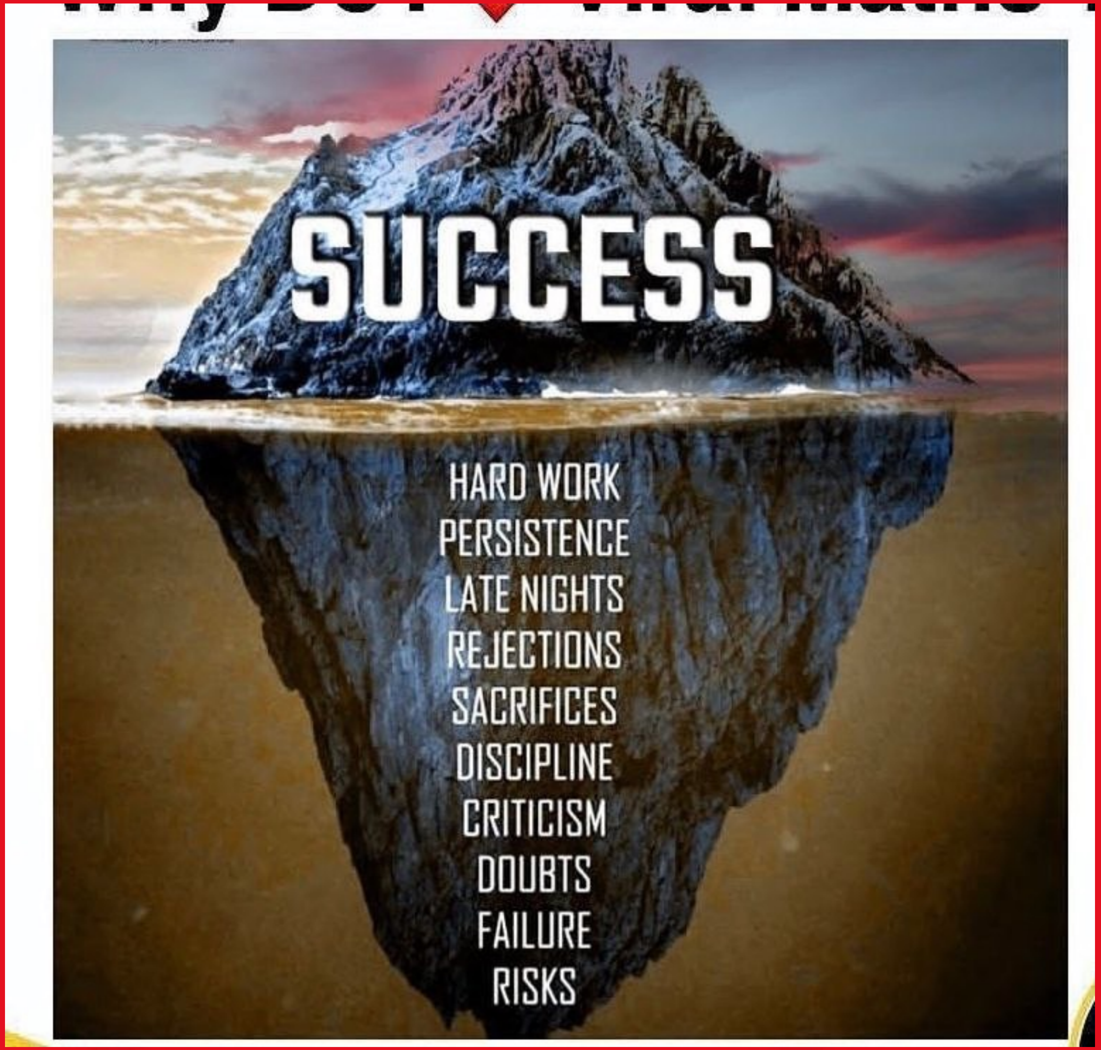


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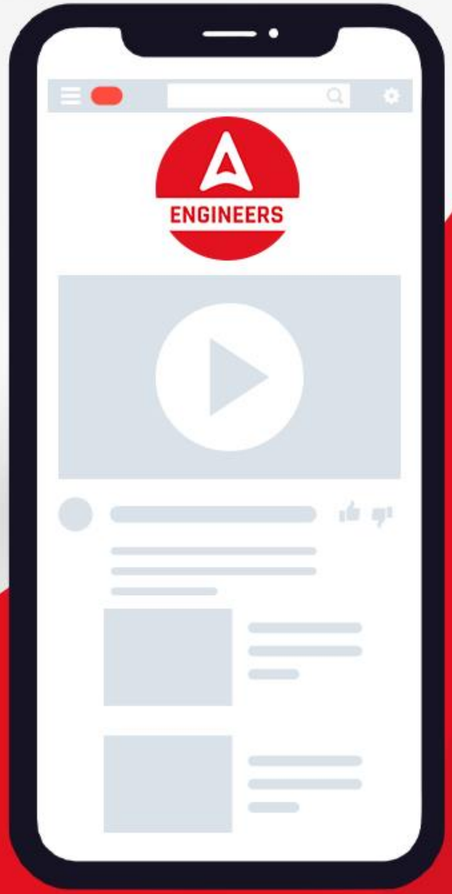

ENGINEERS

Maximum size of silt size particles as per I.S. classification is

(a) 0.425 mm

(b) 2 mm

(c) 0.75 mm

(d) 0.075 mm

Soil Group	Type of Soil	Sub - Group	Size Range
Very Coarse Soils	Boulder		> 300 mm
	Cobble		80 – 300 mm
Coarse Soils	Gravel	Coarse	20 – 80 mm
		Fine	4.75 – 20 mm
	Sand	Coarse	2- 4.75 mm
		Medium	0.425- 2 mm
		Fine	0.075 – 0.425 mm
Fine Soils	**Silt**		**0.002 – 0.075 mm**
	Clay		< 0.002 mm

. classification is

The type of footing in which the load bearing structures share the common rectangular or trapezoidal footing is called:

(a) Eccentric footing

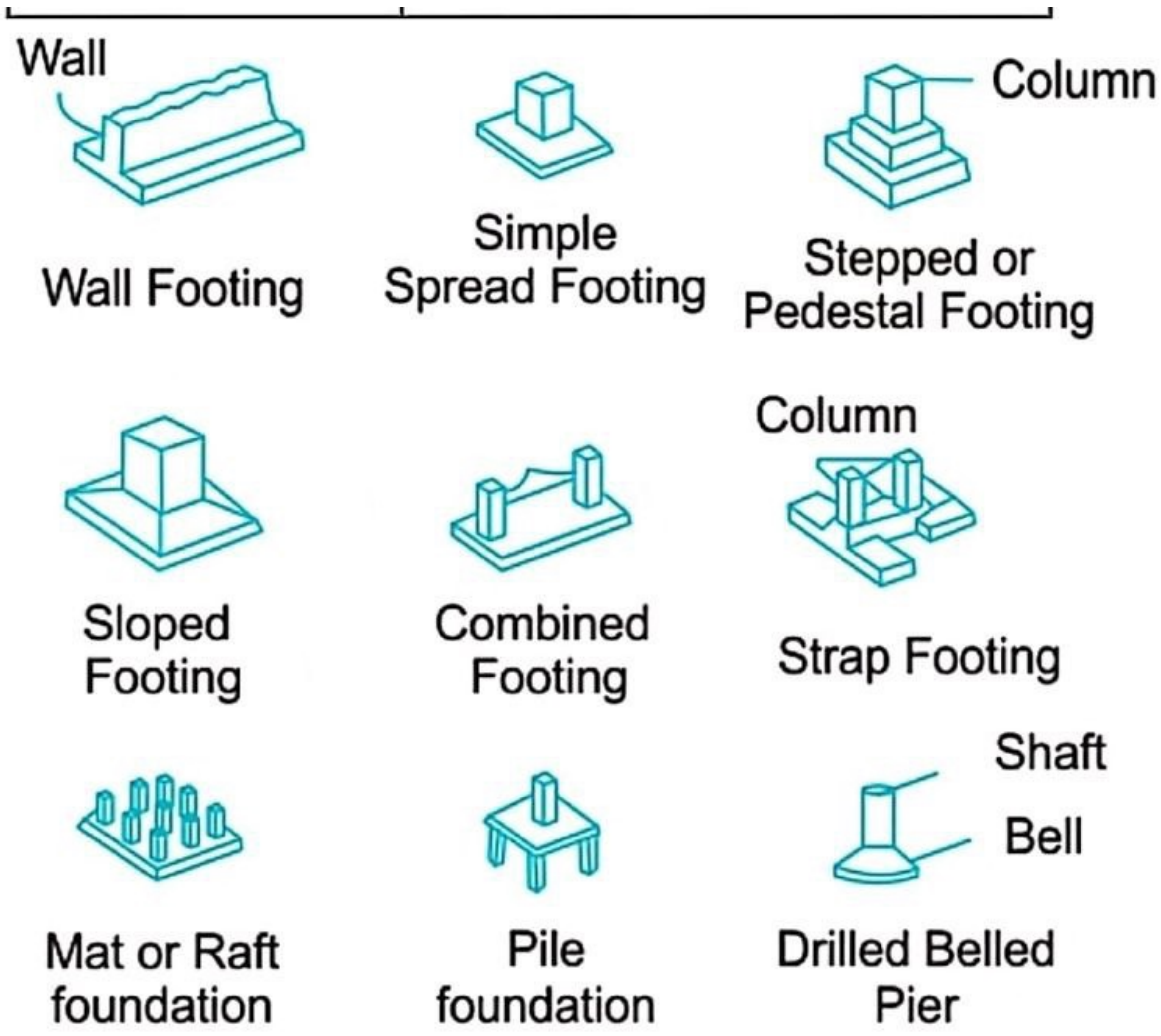
(b) Stepped footing

(c) Combined footing

(d) Isolated footing

Types of footings and their characteristics:

Types of footings	Characteristics
a. Combined footing	I. **For two or more columns** • If the loads are equal then it is constructed in a rectangular shape. • For unequal loading its constructed in a trapezoidal shape.
b. Mat foundation	**II. For supporting all columns of the structure.** • When the allowable bearing pressure is very low, then this is adopted. • **Raft is also used to reduce settlement** is highly compressible soil by making the wt. of the structure and raft approximately equal to the soil excavated.



What is the LIQUEFACTION phenomenon about soil failure?

(a) Sand loses its shear strength due to oscillatory motion.

(b) Failure of soil under Liquid retaining hydraulic structures.

(c) Failure of soil slopes.

(d) Bearing failure of sand under heavy loads.

Liquefaction:

- The phenomenon in which the **shear strength and stiffness of soil are reduced by an earthquake or another rapid loading, causing it to behave like a 'liquid' is** called **soil Liquefaction.**
- It occurs in saturated soils, that is, soils in which the space between individual particles is completely filled with water.
- The sudden water pressure leads to soil losing its cohesive strength. Once the soil loses its cohesion, it gets softened, weak, and loses its solid properties that are converted to liquid properties.

Effects of Liquefaction:

1. When liquefaction occurs, the strength of the soil decreases, and, the ability of a soil deposit to support foundations for buildings is reduced.
2. Liquefied soil also exerts higher pressure on retaining walls, which can cause them to tilt or slide. This movement can cause settlement of the retained soil.
3. Increased water pressure can also trigger landslides and cause the collapse of dams.
4. Pile foundations are embedded deep into the ground because of the soil support. But if the soil is not strong, the foundation's

ut soil failure?

latory motion.

raulic structures.

s.

A direct shear test was conducted on a cohesionless soil (c = 0) specimen under a normal stress of 100 kPa. The specimen failed at a shear stress of 100 kPa. The angle of internal friction of the soil is ____________

(a) 45°

(b) 15°

(c) 30°

(d) 60°

The critical gradient for all soils is normally

(a) 0.5

(b) 1.0

(c) 1.5

(d) 2.5

Which of the below indirect method for calculating coefficient of permeability satisfies the expression $K = C \times D^2_{10}$

(a) Composite test data

(b) Allen hazen's formula

(c) Kozeny-carman equation

(d) Loudon's formula

Root time method is used to determine _______

(a) T, time factor

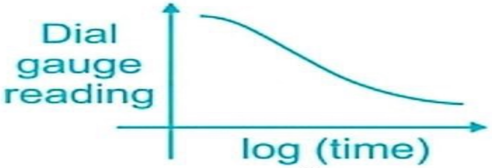
(b) C_V, Coefficient of Consolidation

(c) a_V, Coefficient of compressibility.

(d) m_V, Coefficient of volume compressibility

The logarithm of time fitting method:

- Time for 50% consolidation is noted.

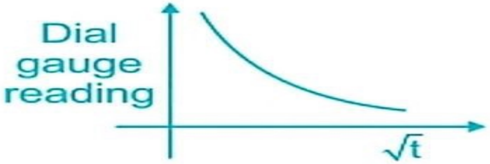


$C_V = \frac{T_{50}\ H^2}{t_{50}}$ Where,

T_{50} = 0.196

square root of time fitting method:

- Time for 90 % Consolidation is noted.



$C_V = \frac{T_{90}\ H^2}{t_{90}}$ Where,

T_{90}= 0.848

Note:

- Taylor curve is suitable because the curve gets plotted as time progresses, and as soon as 90% settlement point is obtained.
- The point is obtained ,next increment of loading is applied, thus time to rest reduces

Consolidation of soil deposit can be divided into:

(a) initial, primary, secondary

(b) initial, primary, final

(c) primary, secondary, final

(d) initial, secondary, final

Let E_2 and E_1 represent compaction energy deployed for compacting the soil as per modified compaction test and standard test, as per IS.

Choose from the following correct ratio $\frac{E_2}{E_1}$:

(a) 4.5 times

(b) 3.5 times

(c) 2 times

(d) None of the above

nergy deployed for
tion test and standard

Type of compaction test:

Properties	Standard proctor test(SPT)	Modified pro test(MPT
Volume of mold	944 cc	944 cc
Number of layers	3	5
Number of blows	25	25
Height of free fall	12 inches	18 inches
Compactive effort(KJ/m^3)	**594.29**	**2703.88 (4.5×Compactiv of SPT)**
Weight of hammer	2.5 kg	4.54 kg

Compactive effort (E) = $\frac{N \times n \times W \times h}{V}$

Where N = Number of blow per layer,n = Number of layers, W = Weight of hammer, h = Heeight of fall, V = Volume of mould

For the SPT test, Compactive energy = E_1, For MPT compactive energy = E_2

Hence, from the above table

$$\frac{E_2}{E_1} = \frac{N_2 \times n_2 \times W_2 \times h_2}{N_1 \times n_1 \times W_1 \times h_1} = \frac{25 \times 5 \times 18 \times 4.54}{25 \times 3 \times 12 \times 2.5} = \mathbf{4.54}$$

What is the size of colloidal particle?

(a) $10^{-3} - 10^{-6}$ mm

(b) $> 10^{-8}$

(c) $10^{-6} - 10^{-8}$ mm

(d) $10^{-1} - 10^{-3}$ mm

Colloidal particle:

- A colloid is a mixture in which one of the substances is split into very minute particles which are dispersed throughout a second substance.
- The substance which is dispersed is called a dispersed phase whereas the one in which the first substance is distributed is called a dispersion medium.
- **The size of colloid particles generally ranges between, 1 to 1000 nanometres i.e. 10^{-5} to 10^{-7} cm.**

Hence, the size of the colloidal particle is 10^{-3} - 10^{-6}mm.

10^{-5} - 10^{-}

A soil sample has liquid limit as 45%, plastic limit as 25% and shrinkage limit as 14% for a natural water content 30%, the liquidity index of the soil is -

(a) 75%

(b) 80%

(c) 25%

(d) 40%

The group index value of soil subgrade in pavement construction is 8. the subgrade soil is rated as:

(a) Poor

(b) Fair

(c) Very poor

(d) Good

Higher the value of group index, poorer is the soil as subgrade material.

n pavement construction

Type of subgrade soil	Group index range of subgrade
Good	0 – 1
Fair	2 – 4
Poor	**5 – 9**
Very poor	10 – 20

Additional Information

Group index of a soil is given by

G.I = 0.2 a + 0.005 ac + 0.01 bd

a = It is the portion of % passing through 75 μ sieve greater than 35 but not exceeding 75 expressed as whole number in between [0-40].

b = It is the portion of % passing through 75 μ sieve greater than 15 but not exceeding 55 expressed as whole number in between [0-40].

c = It is the portion of the numerical liquid limit greater than 40 but not exceeding 60 expressed as whole number in between [0-20].

d = It is the portion of the numerical plasticity index greater than to 10 but not exceeding 30

Alcohol method is used to find which type of soil property?

(a) Bulk density

(b) Specific gravity

(c) Dry density

(d) Water content

Methods used for finding water content:

Method	Properties
Oven drying method	Most accurate method and is a standard laboratory method
Pycnometer method	More suitable for cohesionless soil as removal of entrapped air from cohesive soil difficult.
Sand bath method	It is a rapid method, hence not very accurate
Torsion balance method	Drying and weighing done simultaneously, hence one of the accurate methods
Calcium carbide method	Takes just 5-7 minutes and used as a field test
Alcohol test	It is a quick field test and not used for soils containing calcium or organic compound
Radiation method	Gives water content in an in-situ condition

perty?

The property of a soil due to which the loss in shear strength caused by remoulding can be regained with the time is known as:-

(a) Activity

(b) Sensitivity

(c) Thixotropy

(d) Consistency re-gain

Sensitivity: Degree of disturbance achieved upon remoulding a soil is called Sensitivity. Mathematically, sensitivity is defined as ratio of unconfined compressive strength in un-disturb state to disturb (remoulded) state. Its values ranging from 1 (insensitive soil) > 16 (quick or unstable soil).

Thixotropy: property of soil by which it re-gains a part of its lost strength due to re-orientation of water molecules at constant water content.

Tips:

Activity is not desired in engineering application of soil

Sensitivity is also not desired in engineering application of soil.

ıear strength
ıs known as:-

In comparison to Atterberg limits of normal soil, the expansive soils have which of the following properties.

(i) More liquid limit

(ii) Less plastic limit

(iii) Less shrinkage limit

(iv) More volumetric shrinkage

Select the correct answers using the codes given below.

(a) (i), (ii), (iii) and (iv)

(b) (i), (iii) and (iv)

(c) (ii), (iii) and (iv)

(d) (i), (ii) and (iv)

Plate load test is used to determine:

(a) Depth of foundation

(b) Building dampness

(c) Thickness of pavement layer

(d) The bearing capacity of the soil

Plate load test is a field test to determine the ultimate bearing capacity of soil, and the probable settlement under a given loading.

Bearing plate:

The bearing plate is either circular or square, made of mild steel of **not less than 25mm** in thickness and varying in size from **300 to 750 mm** with chequered or grooved bottom.

The plate is provided with handles for convenient setting and centre marked. As an alternative, cast in situ or precast concrete blocks may be used with depth not less than two thirds the width.

Test Pit-

The test pit is usually at the foundation level, having in general normally of width equal to five times the test plate or block, shall have a carefully levelled and cleaned bottom at the foundation level, protected against disturbances or changes in natural formation.

The test pit should preferably have steps to conveniently go in the pit for setting and for taking observations.

The void ratios at the densest, loosest, and natural states of a sand deposit are 0.2, 0.6, and 0.4, respectively. The relative density of the deposit is:

(a) 100%

(b) 75%

(c) 50%

(d) 25%

In standard proctor compaction test, as per IS specification the mass of the rammer and height of fall is __________ respectively

(a) 4.89 kg and 310 mm

(b) 2.6 kg and 310 mm

(c) 2.6 kg and 450 mm

(d) 4.89 kg and 450 mm

Property	IS light compaction test	IS Heavy Modified compaction test
Weight of hammer	2.6 kg	4.9 kg
Number of Layers	3	5
Number of blows	25	25
Hight of fall	310 mm	450 mm
Volume of mould	1000 cc	1000 cc

er IS specification the _____ respectively

A saturated clay layer with double drainage taken 5 years to attain 90% degree of consolidation under a structure. If the same layer were to be single drained, what would be time (in years) required to attain the same consolidation under the same loading conditions?

(a) 10

(b) 15

(c) 20

(d) 25

Which of the following methods is not used for measuring the in-situ density of compacted soils?

(a) Nuclear density gauge method

(b) water replacement method

(c) Sand replacement method

(d) Cassagrande's method

Methods used for finding water content:

Method	Properties
Oven drying method	Most accurate method and is a standard laboratory method
Pycnometer method	More suitable for cohesionless soil as removal of entrapped air from cohesive soil difficult.
Sand bath method	It is a rapid method, hence not very accurate
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d for measuring the in-

The minimum number of observation wells required, to determine the permeability of a stratum in the field by a pumping test is:

(a) 1

(b) 2

(c) 3

(d) 4

Select the sequence of clay minerals in decreasing order with respect to the plasticity index is

(a) Kaolinite > Illite > Montmorillonite

(b) Montmorillonite > Illite > Kaolinite

(c) Illite > Kaolinite > Montmorillionite

(d) Montmorillonite > Kaolinite > Illite

1. With reference to grain size:

Kaolinite > Illite > Montmorillonite

2. With reference to swelling and shrinkage behavior

Montmorillonite > Illite > Kaolinite

3. With reference to Plasticity Index

Montmorillonite > Illite > Kaolinite

The soil is having unit weight of 20 kN/m^2 and depth of foundation is equal to 1.2 m, if the net bearing capacity of soil is 2532 kN/m^2, then the safe bearing capacity for facto of safety 3 is equal to ___________.

(a) 282 kN/m^2

(b) 1140 kN/m^2

(c) 874 kN/m^2

(d) 173 kN/m^2

Which statement is not true regarding specific gravity?

(a) 50 ml density bottle is useful for all types of soil

(b) Kerosene is used in density bottles

(c) 500 ml flask is used only for fine grained soils

(d) Pycnometer is used only for coarse-grained soil

Specific Gravity:

Specific gravity can be defined as the ratio of the weight of a given volume of soil solids at a given temperature to the weight of the equal volume of distilled water at that temperature. It can be written as $G = \frac{\gamma_s}{\gamma_w}$

gravity?

soil

1. Density bottle method:

- The specific gravity of solid particles can be determined in a laboratory using a density bottle fitted with a stopper having a hole.
- The density bottle of **50 ml capacity is generally used** [IS:2720 (part III) 1980].

ls

soil

2. Pycnometer method:

- **Pycnometer method** is used to determine **specific gravity and water content both**.
- This method is **suitable for cohesionless soils.**
- A pycnometer is a glass jar of 1-liter capacity that is fitted at its top by a conical cap made of brass.
- It has a screw-type cover and there is a small hole at its apex of 6 mm in diameter

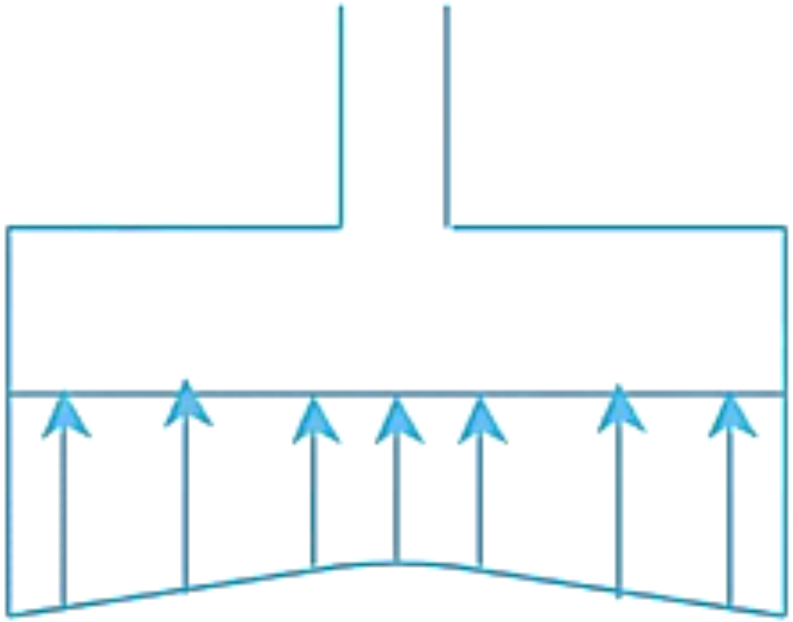
Fig. shows stress distribution below footing:

(a) Rigid footing on clayey soil

(b) Rigid footing on sandy soil

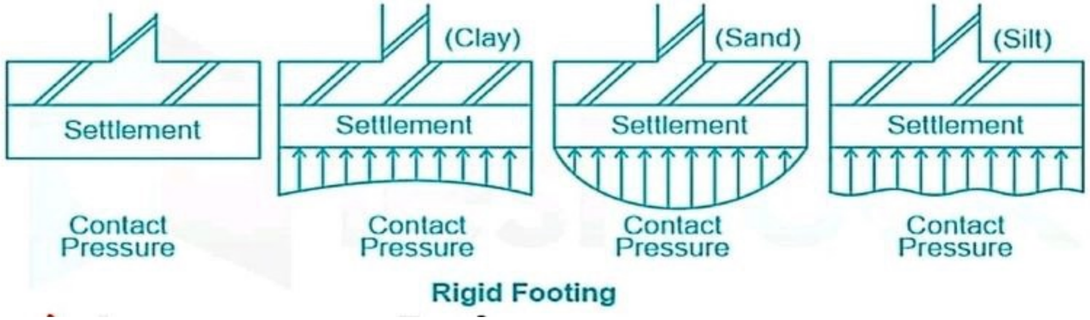
(c) Flexible footing on clayey soil

(d) Flexible footing on sandy soil



The pressure distribution below the footing depends upon the flexural rigidity of the footing and the elastic properties of the soil subgrade. For a rigid footing pressure distribution varies according to the soil subgrade.

1. When cohesionless soil is present beneath the soil, the pressure distribution is parabolic having intensity 0 at the edges and maximum at the center.
2. If **cohesive soil** is present **under the rigid footing** then the pressure distribution is also **parabolic** with the **least intensity at the middle and maximum intensity at the edges**.



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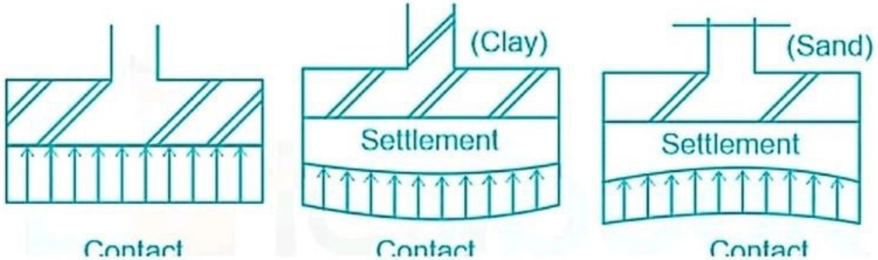
1. When cohesionless soil is present beneath the soil, the pressure distribution is parabolic having intensity 0 at the edges and maximum at the center.
2. If **cohesive soil** is present **under the rigid footing** then the pressure distribution is also **parabolic** with the **least intensity at the middle and maximum intensity at the edges**.

Important Points

- If the footing is **flexible** then the pressure distribution beneath it is **uniform,** irrespective of the type of soil subgrade.



The equation for the determination of compression index for the remoulded soil (For distributed low to medium sensitive soil) is given by:

(a) $C_C = 0.007\ (W_L - 10\%)$

(b) $C_C = 0.007\ (W_L - 20\%)$

(c) $C_C = 0.009\ (W_L - 10\%)$

(d) $C_C = 0.007\ (W_L - 30\%)$

The coefficient of compression or compression index:

- The compression index (Cc) is **the slope of the linear portion of the pressure–void ratio curve on a semi-log plot, with pressure on the log scale** (IS: 8009 – Part 1, 1976).
- This is a dimensionless parameter.

For undisturbed low to medium sensitivity soils, (Terzaghi and Peck empirical index)

→ $C_c = 0.009 \times (W_L - 10\%)$

For disturbed(remolded) low to medium sensitive soil (Skempton's empirical index)

→ $C_c = 0.007 \times (W_L - 10\%)$

Toughness index of a soil is the ratio of -

(a) Flow index to shrinkage flow index

(b) Plasticity index to flow index

(c) Flow index to consistency index

(d) Liquidity index to the flow index

The example of soil transported/formed by wind

(a) Marl

(b) Drift

(c) Loess

(d) Talus

The geostatic stress on the soil is due to the ___________ of the soil.

(a) Explosion

(b) Self weight

(c) Vibration

(d) Excavation

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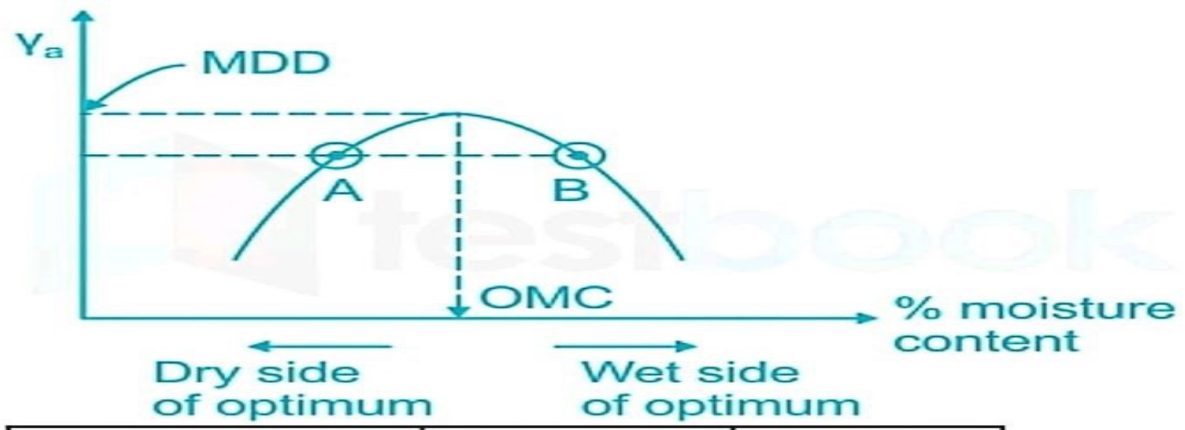

Property	Dry side of optimum (A)	Wet side of optimum (B)
Swelling potential	More	Less
Shrinkage potential	Less	More
Soil Structure	Flocculated	Dispersed
Permeability	More	Less
Compressibility	Less	More

Hence,
The soil at 'A' will have more swelling potential and less shrinking upon moisture variation, compared to 'B'.

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