MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR

Model Solutions of Mid Term Exam

B. tech- 7th semester (Civil Engineering Department)

Subject:- Foundation Engineering

SECTION –A (Multiple Choice Questions)

Q.1) b Q.2) c Q.3) d Q.4) b Q.5) a Q.6) b Q.7) b Q.8) a

SECTION – B

Ans 1:-

Site investigations are generally done to obtain the information that is useful for one or more of the following purposes:-

1) To select the depth and type of foundation for a given structure.
2) To determine the Bearing Capacity of soil.
3) To estimate the probable maximum and differential settlements.
4) To establish the ground water level and to determine the properties of water.
5) To predict the lateral earth pressure against retaining walls and abutments.
6) To select suitable construction techniques.
7) To predict and to solve potential foundation problems.
8) To ascertain the suitability of soil as a construction material.
9) To investigate the safety of the existing structures and to suggest remedial measures.

STAGES IN SOIL INVESTIGATION:-

Stage 1 – Reconaissance

It includes visit to the site to study the map and relevant records. It helps in deciding future programme of site investigations, scope of work, methods of exploration to be adopted, types of samples to be taken, lab testing and in-situ testing.

Stage 2 – Preliminary Exploration

Aim of this stage is to determine the depth, thickness, extent and composition of each soil stratum at the site. Depth of bed rock and ground water table is also determined.

Stage 3 – Detailed Exploration

Purpose of this stage is to determine the engineering properties of the soil in different strata. It includes extensive boring, sampling and testing of samples in laboratory. Field Tests such as vane shear test, plate load test, permeability test are done to determine the properties of the soil in natural state. For complex projects involving heavy structures such as bridges, dams, multi-storey buildings, it is essential to have detailed explorations.

Ans 2

→ The SPT value so noted at various depths are corrected for:

(a) Overburden
(b) Dialatancy

Overburden Corrⁿ :-

→ SPT value at shallow depth is actually under estimated & that at greater depth is over estimated as compared to the 'N' value which represents the actual B.C. of the soil.

→ After overburden corrⁿ,

SPT value

$$\boxed{N_1 = N_0\left(\frac{350}{\bar{\sigma}+70}\right) \qquad \bar{\sigma} \not> 280\ kN/m^2}$$

N_0 → observed SPTₙ 'N' value at particular depth

$\bar{\sigma}$ → eff. stress at level of test

→ If $\bar{\sigma} > 280\ kN/m^2$, overburden corrⁿ not appld.

Dilatancy Corrⁿ :—

→ Dilatancy Corrⁿ is appld. ~~after~~ to the SPT value already corrected for over burden.

→ Dilatancy Corrⁿ is appld. in case of dense sand below water Table. Because due to impact loading un-drained condⁿ may develop below water table in dense sand which will increase the eff. stress because of -ve excess pore pressure generation. Thus, the SPT 'N' value would be over-estimated.

→ we need to reduce the over-estimated value.

→ Dilatancy Corrⁿ is appld. only when $N_1 > 15$

($N_1 > 15$ represents Dense Sand)

$$N_2 = 15 + \frac{1}{2}(N_1 - 15)$$

final SPT 'N' value at a particular depth

→ Avg. SPT 'N' value is ~~obtained by taking~~ the taken for SPT value b/w depth D_f to $[D_f + (1.5 \text{ to } 2) B]$

→ Any individual SPT 'N' value should not be more than 50% of the avg.

Ans 3

Ques. Differentiate between General shear & local shear failure?

Ans.

General shear failure (G.S.F.)	Local shear failure (L.S.F.)
→ In this, there develops continuous failure surfaces b/w edge of footing & ground surface.	→ In this, there is significant compression of soil under footing & only partial development of state of plastic equilibrium.
→ When pressure approaches q_f, state of plastic equ^m is reached initially in the soil around the edges of footing & then it gradually spreads downwards & outwards.	→ Due to this reason, failure surfaces do not reach the ground surface & only slight heaving occurs.
→ Ultimately, state of plastic equ^m is fully developed throughout the soil above the failure surfaces.	→ In such a failure, tilting of foundation is not expected.
→ failure is accompanied by appearance of failure surfaces & by considerable bulging of sheared mass of soil.	→ failure is not sudden & is characterized by occurence of relatively large settlements which would not be acceptable in practice.
→ However, final slip movement would occur only on one side, accompanied by tilting of footing.	→ Also, q_f in this failure is not well defined.

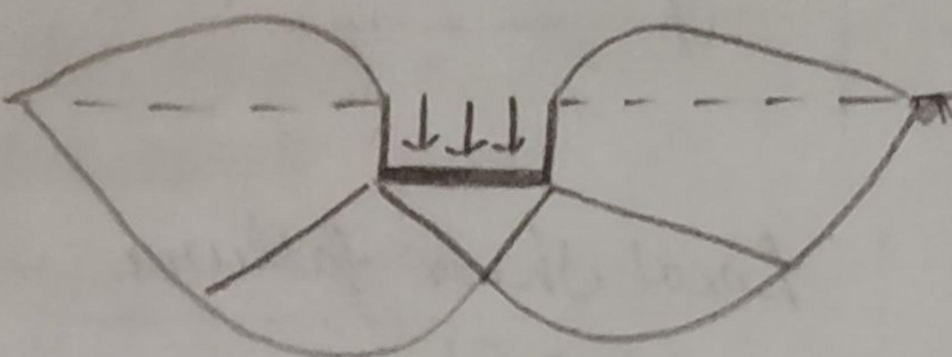


fig general shear failure

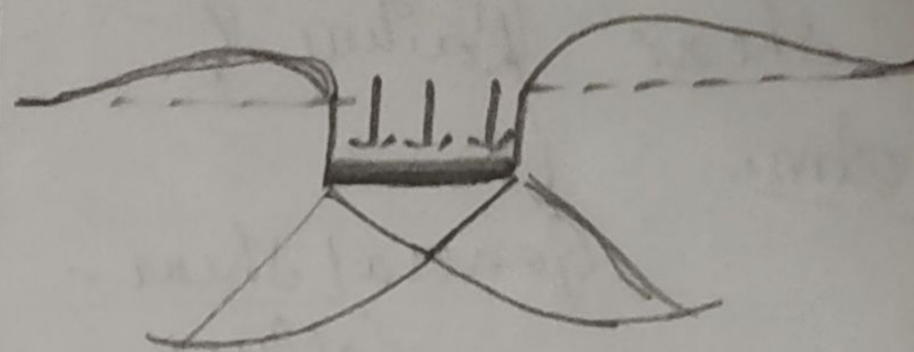


fig. local shear failure

→ It has well-defined failure surfaces, reaching upto ground surfaces.	→ failure pattern is clearly defined only immediately below the footing.
→ $\exists$ considerable bulging of sheared mass of soil adjacent to footing.	→ failure surfaces do not reach the ground surface → $\exists$ only slight bulging of soil around footing.
→ Failure is accompanied by tilting of footing.	→ failure is not sudden & $\nexists$ any tilting of footing.
→ failure is sudden with pronounced peak resistance.	→ Instead failure is defined by large settlements
→ ult. B.C. is well defined.	→ ult. B.C. not well defined.

Ans 4 (Numerical)

Given, strip footing

General shear failure

width of footing $(B) = 1.5 m$

Depth of footing $(D_f) = 1.0 m$

$C = 15 \ KN/m^2$ ~~γ = 18 KN/m³~~ $\gamma = 18 \ KN/m^3$

$\phi = 30^\circ$ $N_c = 37.2$, $N_q = 22.5$, $N_\gamma = 19.7$

As per Terzaghi's

$ult. B.C. = cN_c + \gamma D_f N_q + 0.5 B \gamma N_\gamma$ —— for strip footing

$= (15)(37.2) + (18)(1)(22.5) + 0.5(1.5)(18)(19.7)$

$= 558 + 405 + 265.95$

$\boxed{ult. B.C. = 1228.95 \ KN/m^2}$

Ans-4

TERZAGHI'S ANALYSIS

An analysis of condⁿ of complete bearing capacity failure, usually termed general shear failure, can be ~~assu~~ made by assuming that the soil behaves like an ideally plastic material.

Assumptions in Terzaghi's analysis :-

→(1.) Soil is homogeneous & isotropic & its shear strength is represented by Coulomb's eqn.

→(2.) Strip footing has a rough base, & the problem is essentially 2 dimensional.

→(3.) The elastic zone has straight boundaries inclined at $\psi = \phi$ to the horizontal, & the plastic zones fully develop.

→(4.) P_p consists of 3 components which can be calculated separately & added, although the critical surface for these components are not identical.

→(5.) failure zones do not extend above the horizontal plane through the base of the footing i.e., the shear resistance of soil above the base is neglected & the effect of soil around the footing is considered equivalent to a surcharge $\sigma = \gamma D$.

Note :- Assumption (2)

Base of footing is rough so that it prevents lateral movement of the soil in contact with it & confines the soil as if it were a part of foundation itself

Ans 5

Given, Square footing ($B \times B$) where B is width of footing

Depth of footing (D_f) $= 1.3m$

safe load $= 800\,KN$

Factor of safety $= 3$

$N_c = 37.2$, $N_q = 22.5$, $N_\gamma = 19.7$, $C = 8\,KN/m^2$, $\phi = 30^\circ$

Soil Properties:- $e = 0.55$

$S = 50\%$

$G = 2.67$

We know, $\gamma_t = \left(\dfrac{G + Se}{1+e}\right)\gamma_w = \left(\dfrac{2.67 + 0.5 * 0.55}{1 + 0.55}\right)(10)$

Assuming $\gamma_w = 10\,KN/m^3$

$\Rightarrow \gamma_t = \left(\dfrac{2.945}{1.55}\right)(10) = 19\,KN/m^3$

$\Rightarrow \boxed{\gamma_t = 19\,KN/m^3}$

From Terzaghi's B.C. theory

ult. B.C. $= cN_c + \gamma D_f N_q + 0.5 B \gamma N_\gamma$

$= (8)(37.2) + (19)(1.3)(22.5) + (0.5)(B)(19)(19.7)$

$= 297.6 + 555.75 + (187.15)B$

ult B.C. $= 853.35 + (187.15)B$ ——— (i)

We know,

safe B.C. $= \left[\dfrac{\text{ult. B.C.} - \gamma D_f}{FOS}\right] + \gamma D_f$

On substituting, we get

safe B.C. $= 300.92 + (62.383)B$ ——— (ii)

Now, safe B.C. $= \dfrac{\text{safe load}}{\text{footing area}}$

$\Rightarrow 317.383 + (62.383)B = \dfrac{800}{B \times B}$ $\Rightarrow B = 1.43$

Adopt $B \approx 1.5m$

footing size $= 1.5m \times 1.5m$

Ans-5

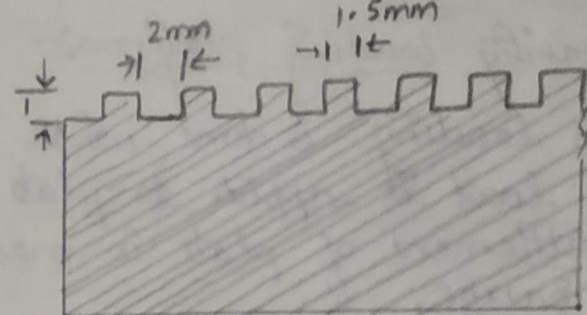
PLATE LOAD TEST

→ Its a field test, conducted from purpose of determining ult. B.C. of soil (q_f) & probable settlement under given loading.

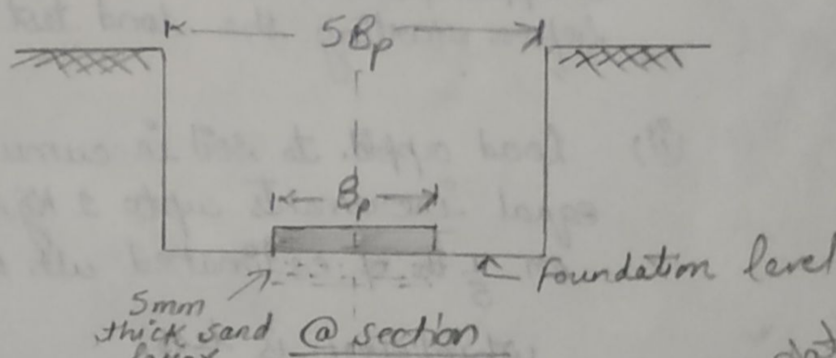
→ Test consists in loading a (rigid) plate at foundation level & determining settlements (corrs to each load increment.)

→ ult. B.C. (q_f) is then taken as load at which plate starts sinking at rapid rate.

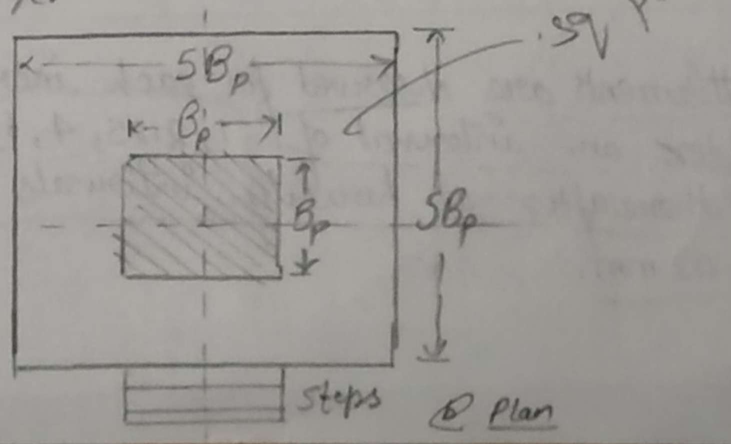
Plate - Circular/Square
thickness (t) ≮ 25mm
Size 300-750mm
Grooved bottom



Test pit — at foundation level
width = $5B_p$



@ section



@ Plan

Loading:- Loading of test plate may be appld. with help of hydraulic jack.

→ I.S. Code (IS : 1888-1982) recommends that the loading of plate should invariably be borne either → by gravity loading platform
or → by reactn truss method

→ Use of reaction truss method is more popular (as it is simple, easy & less clumsy). No support (of loading platform) should be located within distance of 3.5 times the size of test plate from its centre.

→ Gravity loading platform:-
This loading is done with the help of sand bags. When load is appld. to plate, it sinks or settles. The settlement of plate is measured with help of dial gauge.

Loading:-
(i) Minm seating pressure = $70 g/cm^2$ ($0.7 t/m^2$) is appld. & removed before starting the load test.

(ii) Load appld. to soil in cumulative equal increments upto 1 Kg/cm^2 ($10 t/m^2$) or $\frac{1}{5}$th of estimated ult. B.C., whichever is less.

→ Settlements are observed for each increment of load after an interval of 1, 2.25, 4, 6.25, 9, 16, 25 mins & thereafter at hourly intervals to the nearest 0.02 mm.

→ Load-Settlement curve is plotted out to scale. from this load settlement curve, zero correction is determined & subtracted from settlement readings to allow for perfect seating of bearing plate.

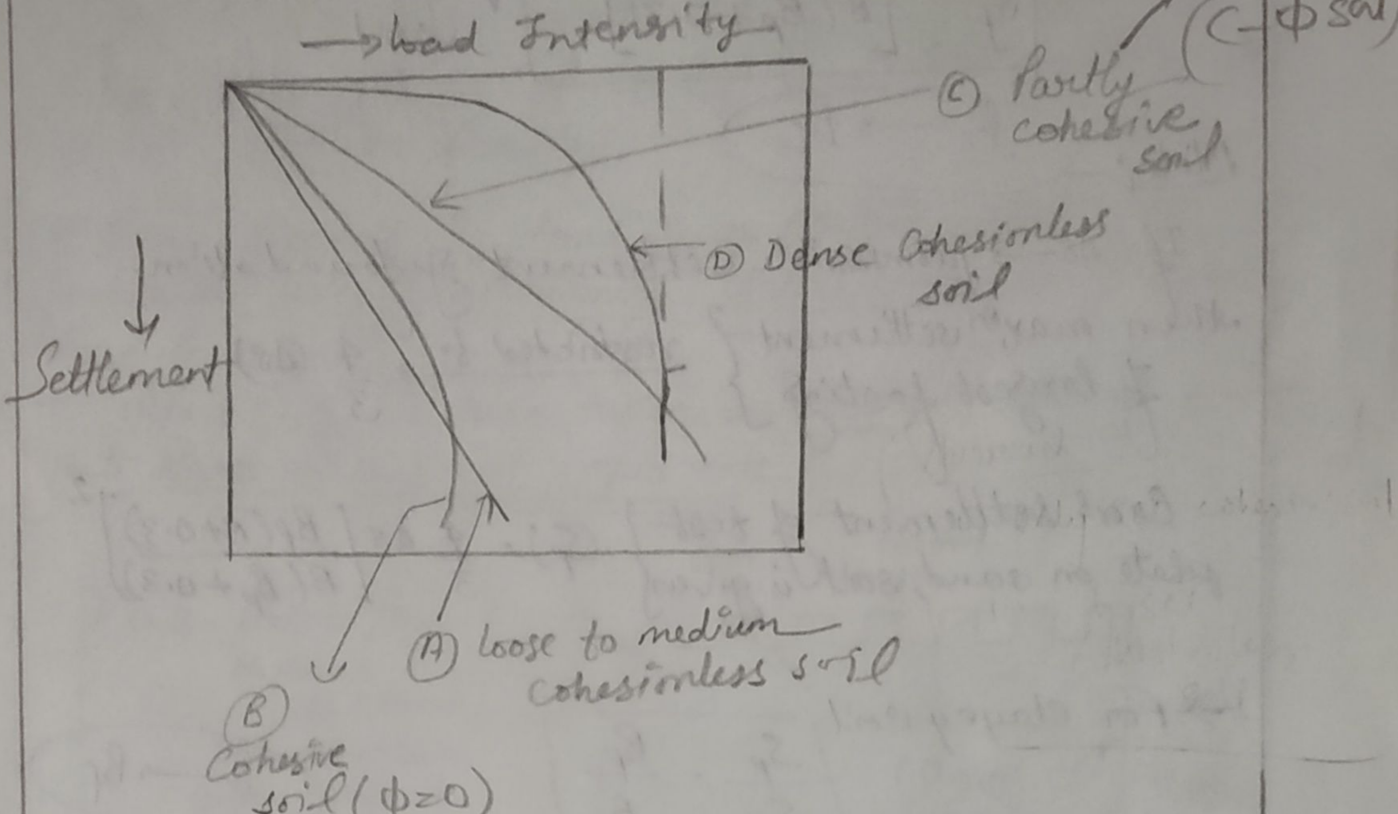


fig:- Load-Settlement Curve

Limitations of PLT:-

→(1) Test reflects only character of soil within $D < 2B_p$.

→(2) It is essentially a short-duration test & hence test doesn't gives ultimate settlement; particularly in case of cohesive soil.

→(3) Effect of size of foundation.

For C-Φ soil

$$\boxed{Q = Aq + Ps}$$

where Q → total load or bearing area
q → bearing pressure beneath area A
P → perimeter of footing
s → perimeter shear