Geotechnical Engg.- II (VIII Sem)

Unit-1

(Part-6 Plate Load Test)

Plate Load Test:

The *Plate load test* is a field test, which is performed to determine the ultimate bearing capacity of the soil and the probable settlement under a given load. This test is very popular for the selection and design of the shallow foundation.

For performing this test, the plate is placed at the desired depth, then the load is applied gradually and the settlement for each increment of the load is recorded. At one point a settlement occurs at a rapid rate, the total load up to that point is calculated and divided by the area of the plate to determine the **ultimate bearing capacity** of soil at that depth. The ultimate bearing capacity is then divided by a safety factor (typically 2.5~3) to determine the **safe bearing capacity**.

Plate load test apparatus and equipment:

The following plate load test apparatus is necessary for performing the test:

1. Test plate
2. Hydraulic jack & pump
3. Reaction beam or reaction truss
4. Dial gauges
5. Pressure gauge
6. Loading columns
7. Necessary equipment for the loading platform.
8. Tripod, Plumb bob, spirit level, etc.

Loading arrangement:

The loading to the test plate may be applied with the help of a hydraulic jack. The reaction of the hydraulic jack may be borne by either of the following:

1. ***Gravity Loading method***
2. ***Reaction Truss method***

1. Gravity loading method:

In the gravity loading method, a platform is constructed over a vertical column resting on the test plate, and the loading is done with the help of sand bags, stones or concrete blocks.

2. Reaction truss method:

The reaction of the jack is borne by a reaction truss. The truss is held to the ground through soil anchors. The reaction truss is made of mild steel section. The guy ropes are used for the lateral stability of the truss.

Test Procedure:

The necessary steps to perform a plate load test is written below-

1. Excavate test pit up to the desired depth. The pit size should be at least 5 times the size of the test plate (B_p).
2. At the centre of the pit, a small hole or depression is created. The size of the hole is the same as the size of the steel plate. The bottom level of the hole should correspond to the level of the actual foundation. The depth of the hole is created such that the ratio of the depth to width of the hole is equal to the ratio of the actual depth to the actual width of the foundation.
3. A mild steel plate is used as a load-bearing plate whose thickness should be at least 25 mm thickness and size may vary from 300 mm to 750 mm. The plate can be square or circular. Generally, a square plate is used for square footing and a circular plate is used for circular footing.
4. A column is placed at the centre of the plate. The load is transferred to the plate through the centrally placed column.
5. The load can be transferred to the column either by gravity loading method or by truss method.
6. For gravity loading method a platform is constructed over the column and load is applied to the platform by means of sandbags or any other dead loads. The hydraulic jack is placed in between column and loading platform for the application of gradual loading. This type of loading is called reaction loading.
7. At least two dial gauges should be placed at diagonal corners of the plate to record the settlement. The gauges are placed on a platform so that it does not settle with the plate.
8. Apply seating load of .7 T/m^2 and release before the actual loading starts.
9. The initial readings are noted.
10. The load is then applied through the hydraulic jack and increased gradually. The increment is generally one-fifth of the expected safe bearing capacity or one-tenth of the ultimate bearing capacity or any other smaller value. The applied load is noted from the pressure gauge.
11. The settlement is observed for each increment and from dial gauge. After increasing the load-settlement should be observed after 1, 4, 10, 20, 40, and 60 minutes and then at hourly intervals until the rate of settlement is less than .02 mm per hour. The readings are noted in tabular form.
12. After completing the collection of data for a particular loading, the next load increment is applied and readings are noted under new load. This increment and data collection is repeated until the maximum load is applied. The maximum load is generally 1.5 times the expected ultimate load or 3 times of the expected allowable bearing pressure.

Calculation of Bearing Capacity from Plate Load Test:

After the collection of field data, the load-settlement curve is drawn. It is a logarithmic graph where the load applied is plotted on X-axis and settlement on Y-axis. From the graph, the ultimate load for the plate is obtained which is the corresponding load for settlement of one-fifth of the plate width.

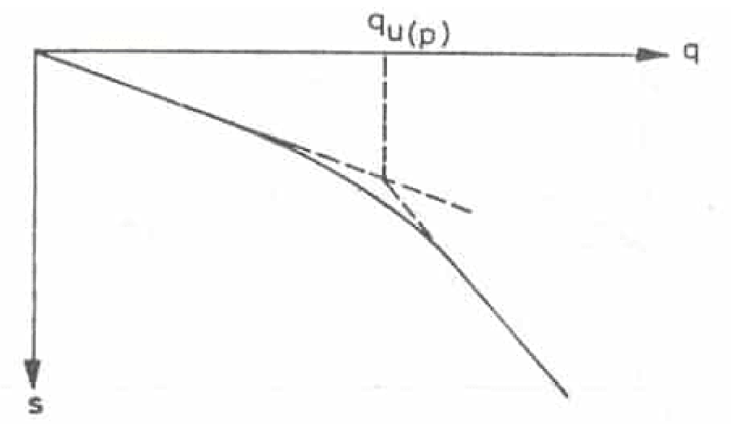


Figure: Load-settlement graph

When the points are plotted on the graph, the curve is broken at one point. The corresponding load to that breakpoint is considered to be the ultimate load on the plate. The ultimate bearing capacity can be calculated from the ultimate load from the plate. The ultimate bearing capacity is then divided by a suitable factor of safety to determine the safe bearing capacity of soil from the foundation.

Bearing Capacity Calculation for Clayey Soils

Ultimate bearing capacity = ultimate load for plate

i.e. $\mathbf{q_u(f) = q_u(p)}$

Bearing Capacity Calculation for Sandy Soils

Ultimate bearing capacity = ultimate load for plate x {Width of pit (B_f) / Size of Plate (B_p)}

$\mathbf{q_u(f) = q_u(p) \times B_f / B_p}$

Finally, safe bearing capacity = ultimate bearing capacity / factor of safety

The factor of safety ranges from 2 to 3.

Calculation of Foundation Settlement from Plate Load Test:

We can also calculate settlement for given load from plate load test as follows

Foundation Settlement Calculation on Clayey Soils

Settlement of foundation (s_f) = s_p x B_f/B_p

Foundation Settlement Calculation on Sandy Soils

Settlement of foundation (s_f) = s_p $[\{B_f(B_p + 0.3)\}/\{B_p(B_f + 0.3)\}]^2$

Where B_f and B_p are widths of foundation and plate.

Advantages of Plate load test:

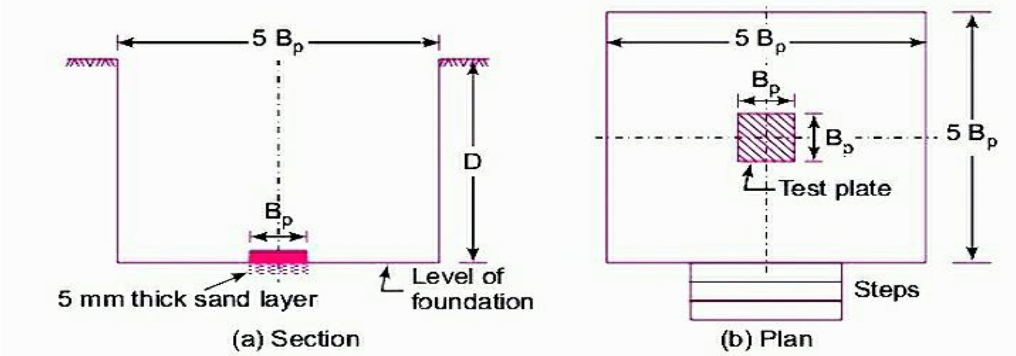
The advantages of Plate Load Test are discussed below:

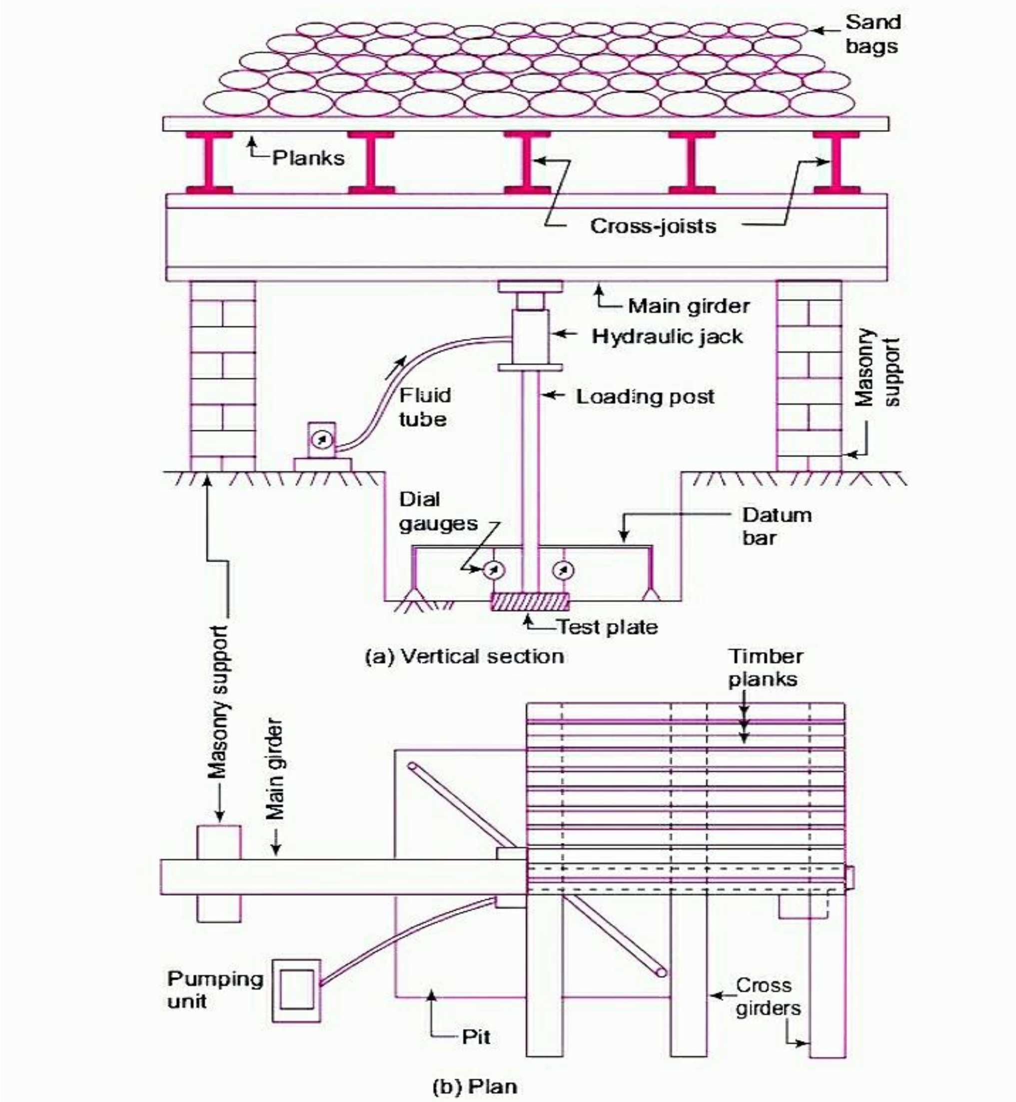
- Being able to understand the foundation behaviour under loading conditions.
- Evaluation of bearing capacity of soil at a certain depth and prediction of settlement for a certain load.
- Shallow foundation can be calculated considering the allowable bearing capacity, which can be predicted from the plate load test.
- Time and cost-efficient.
- Easy to perform.
- Reliable.

Limitations of Plate load test:

It has the following limitations:

- The test predicts the behaviour of soil located at a depth less than twice the depth of the width of the bearing plate. But in practical condition, the influence zone of a foundation is up to a much greater depth.
- The plate load test is performed for a short time period, so it cannot predict the settlement for a longer period, especially for cohesive soil.
- The bearing capacity for clayey soil is almost similar to the bearing capacity obtained from the plate load test, but in the case of dense sandy soil, the plate load test provides a conservative value. The actual capacity obtained for dense sandy soil is higher than the results from the plate load test.
- The settlement for losing sandy soil is usually greater than the settlement indicated by the plate bearing test.


5 B_p
D
B_p
5 mm thick sand layer
Level of foundation
(a) Section
5 B_p
B_p
B_p
5 B_p
Test plate
Steps
(b) Plan


Sand bags
Planks
Cross-joists
Main girder
Hydraulic jack
Masonry support
Fluid tube
Loading post
Dial gauges
Datum bar
Test plate
(a) Vertical section
Masonry support
Main girder
Timber planks
Pumping unit
Pit
Cross girders
(b) Plan

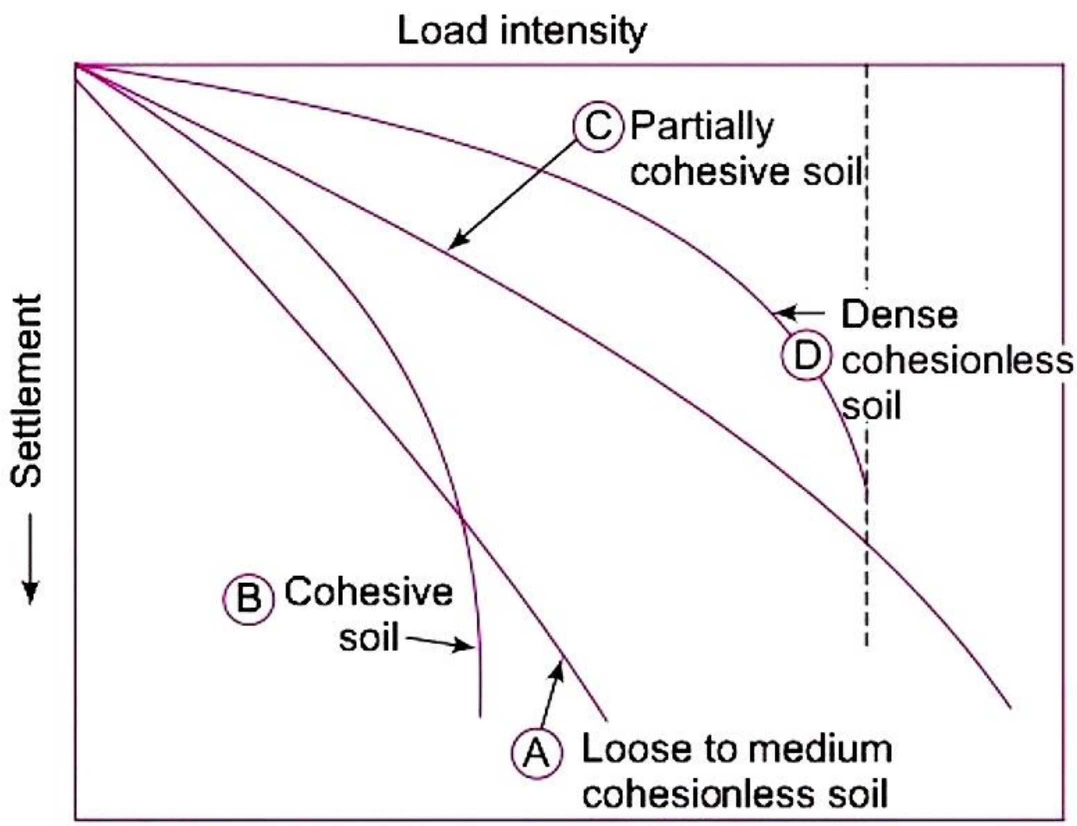


Fig 1. Load Settlement Curve