4.4 Capacity from insitu tests:

1. **Standard Penetration Test (SPT)**

2. **Cone Penetration Test (CPT)**

3. **Pile load test**

1.Standard Penetration Test (SPT): The load carrying capacity of a pile can be estimated from the SPT value(N)

i)For Driven pile:

$$q_p = 40N \left(\frac{D}{B}\right) \leq 400N - - - -(1)$$

Where,

q_p=Point resistance(KN/m^2)

D=Length of pile

B=width of pile

The value of q_p is usually limited to 400N

The average unit frictional resistance (f_s) is related to the average value of the blow count $\bar{N}$

For High displacement piles,

$$f_s = 2\bar{N} KN/m^2$$

For low displacement piles,

$$f_s = 1\bar{N} KN/m^2$$

Where $\bar{N}$ is the average uncorrected value

ii)For bored pile in sand:

$$q_p = 14N \left(\frac{D_b}{B}\right) KN/m^2 - - - -(2)$$

D_b=actual penetration into the granular soil

For bored piles in sand,

$$f_s = 0.67\bar{N} KN/m^2$$

2) Dutch cone test:

Meyerhof (1965) relates the unit point resistance (q_p) and the unit skin traction(f_s) of driven pile to cone point resistance (q_c)

Point resistance, $q_p = \frac{q_c}{10} \left(\frac{D_b}{B} \right) - - - (3)$

Unit skin friction:

a) f_s (dense sand) = $q_c/200$ ----- (4)

b) f_s (loose sand) = $q_c/400$ ------ (5)

c) f_s (silt) = $q_c/150$ ----- (6)

3. Pile Load test:

➢ The Pile Load Test is the most reliable method of determining the load carrying of a pile. This test can be performed either on a working pile that forms the foundation of the structure or on a test pile.

➢ Loads Acting on Piles

Following are the loads which are to be taken into account while designing a pile.

➢ Direct vertical load coming from the superstructure.

➢ Impact stresses developed during the process of pile driving.

➢ Stresses developed during handling operations.

➢ Bending stress developed due to the curvature of a pile.

➢ Bending stresses developed due to the eccentricity of loads coming on the pile.

➢ Lateral forces due to the wind, waves, currents of water, etc.

➢ Impact forces due to the ice sheets or bergs.

➢ Impact forces due to ships, in case of marine structures.

➢ Force due to the uplift pressure.
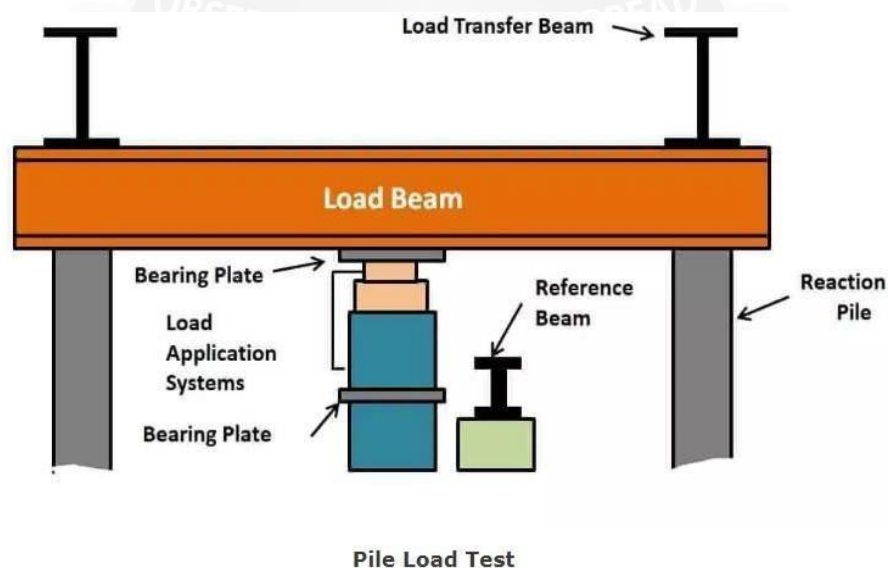
➢ Earthquake forces.

Pile Load Test

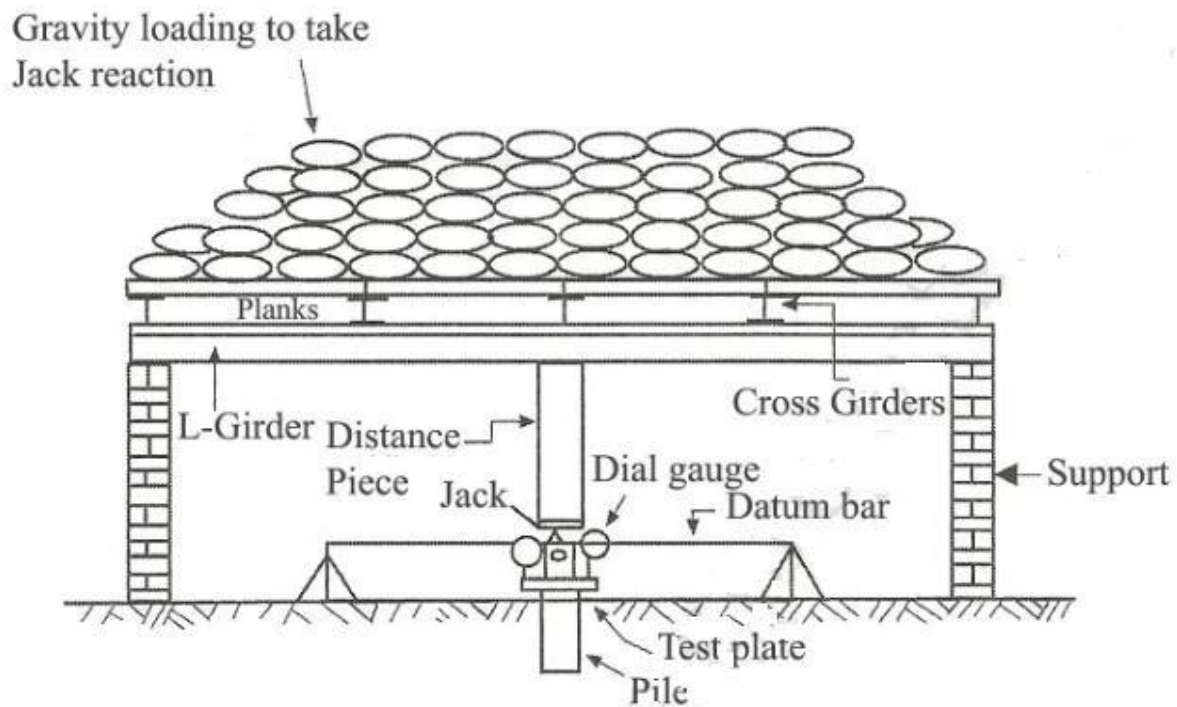Fig1 Pile Load Test

[Fig1 https://civiconcepts.com/blog/pile-load-test]

Fig 2 Jack Loading reaction by loading platform

[Fig 2https://bestengineeringprojects.com/pile-load-test/]
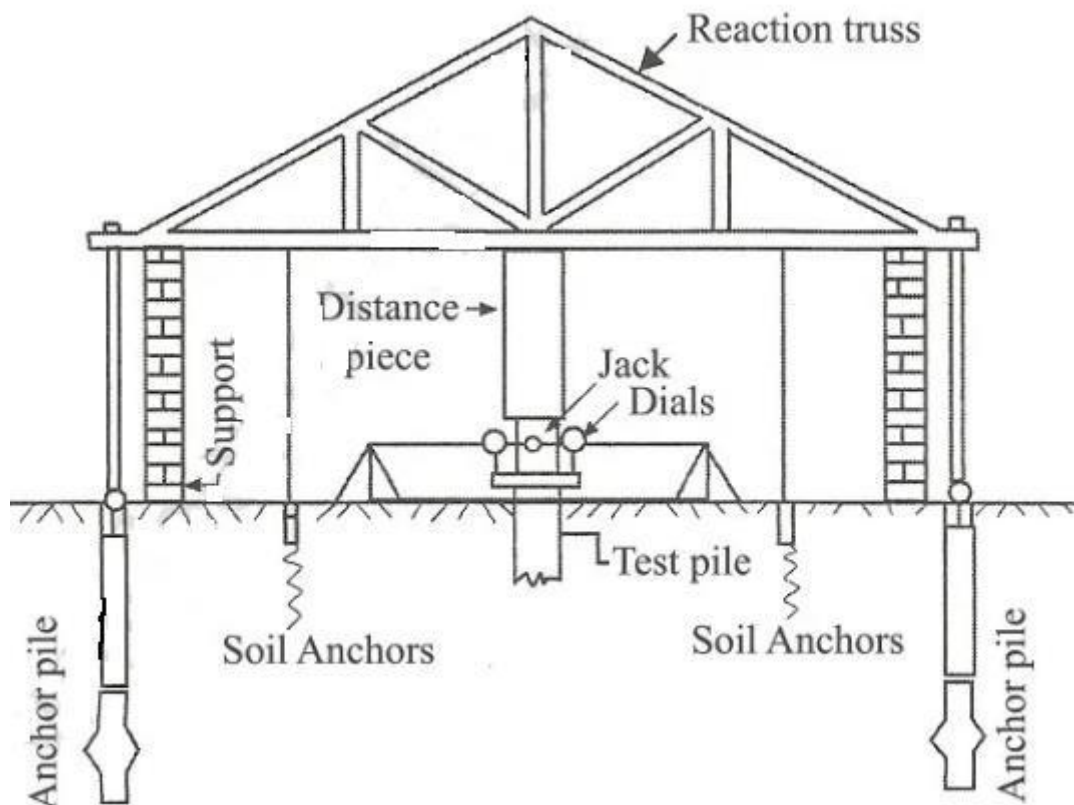
Fig 3 Jack Loading reaction by anchor

[Fig 3 https://bestengineeringprojects.com/pile-load-test/]

The following the procedure of pile load test,

- ➢ The sets up for the load test on a pile consist of two anchor piles providedwith an anchor girder or a reaction girder at their top as shown in Figure above.

- ➢ The test pile is generally installed between two anchor piles in such amanner in which the foundation piles are to be installed.

- ➢ The test pit should be at least 3B or 2.5 m clear from the anchor piles.

- ➢ The load is applied through a hydraulic jack resting on the reaction girder. The measurements of the settlement of the pile are recorded with the help of three dial gauges, with respect to a fixed reference mark.

- ➢ The test is conducted after a period of 3 days after installation of the test pile in sandy soils, and after a period of one month after the installation of the test pile in silts and soft days.

- ➢ This is because by driving the test pile the soil properties are altered andwith the passage of time much of the original properties are restored.

- ➢ The load is generally applied in an equal amount of increment and that is about one fifth of the allowable load. Settlements should be recorded with three dial gauges.

- ➢ Each load increment is kept for sufficient time till the rate of settlement of the becomes less than 0.02 mm per hour.

- ➢ Each load increment is maintained till the rate of movement of the pile is not more than 0.1 mm per hour in sandy soils and 0.02 mm per hour in layer soils ora maximum of two hours (IS: 2911 — 1979).

- ➢ For each load inclement settlements are observed at 0.5, 1, 2, 4, 8, 12, 16,20, 60 minutes.

- ➢ The test pile is loaded until ultimate load is reached.

- ➢ The test load is increased to a value 2.5 times the estimated allowable loador to a load whichever failure occur earlier.

- ➢ The load is removed in the same decrements at 1hour interval and the final rebound is recorded after 24 hours after the entire load has been removed.

➤ The measured values of the settlement are plotted against the corresponding values of Load to obtain the load settlement curve. Fig. shows a typical load settlement curve (firm line) for loading as well as unloading obtained from apile load test.
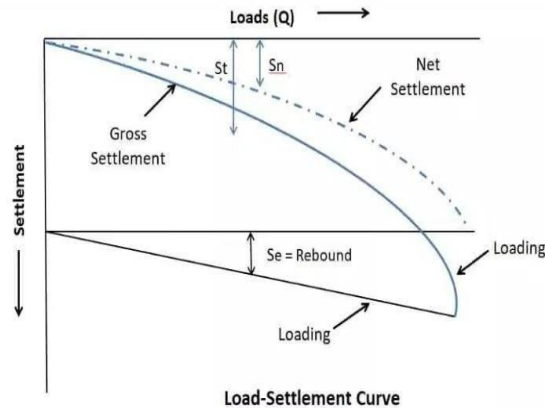

Fig 4 Load Settlement curve

[Fig4 https://civiconcepts.com/blog/pile-load-test]

➤ The ultimate load is clearly indicated by the load settlement curve approaching vertical.

➤ If the ultimate load cannot be obtained from the settlement curve the allowable load is taken as follows,

➤ one-half to one third the final load which cause settlement equal to 10% of the pile diameter.

➤ Two third of the final load which cause a total settlement of 12mm.

➤ Two third of final load which causes a net settlement (residual settlement after the removal of load) of 6mm.

For given load, the net settlement (Sn) is given by,$S_n = S_t - S_e$

Where, S_n = Net Settlement

S_t = Total Settlement or Gross Settlement

S_e = Elastic Settlement (rebound)

➤ Fig. shows two loads-settlement curves obtained from a pile load tests on two different soils. The ultimate load Qu may be determined as the abscissa of the pointwhere the load settlement curve changes to a steep straight line.

➢ Alternatively, the ultimate load Qu is the abscissa of the point of intersection of initial and final tangents of the load settlement curve. The allowable load is usually taken as one-half of the ultimate load.
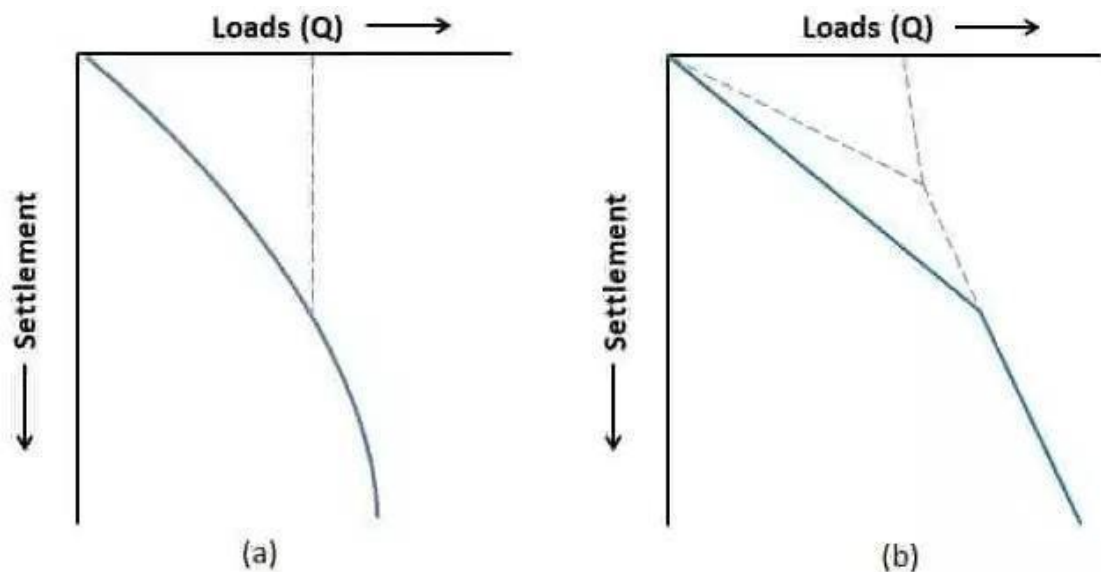
Determination of Ultimate Load from Load Settlement Curve for Pile

Fig5 Settlement curve for pile

[Fig5 https://civiconcepts.com/blog/pile-load-test]

Causes of Failure of Piles:

Following are the most common causes of failure of piles:

➢ Absence of statistical data regarding the nature of soil strata through whichthe pile is to be driven.

➢ The actual load coming on the pile is more than the design load.

➢ Bad workmanship in case of cast-in-situ cements concrete piles.

➢ Attack by insert etc. on wooden piles.

➢ Breakage due to over especially in case of the timber piles.

➢ Buckling of piles due to removal of side support, inadequate lateral support,etc.

➢ Lateral forces (wind, waves, currents, etc.)

➢ Damage due to abrasion resulting from the absence of suitable protective covering.

➢ Improper choice of types of piles.

➢ Improper choice of the method of driving the pile.

- Improper classification.

- Insufficient reinforcement or misplacement in the case of the R. C. C. piles.

- The pressure of soft strata just below the tips of piles.

- Misinterpretation of the results obtained during the pile load test.

- Wrongful use of pile formula for determining its load-bearing capacity.