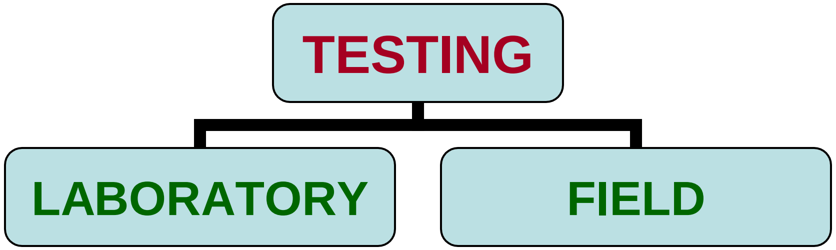
TESTING

# SOIL EXPLORATION

**Dr. Supia Khatun**
***Asst.Prof. Dept. of Civil Engineering***
***Aliah University***
***Newtown Campus, Kolkata-700156***

***er.sk1980@gmail.com***

# TESTING



# FIELD TESTING

# FIELD TESTS

Standard Penetration Test

Dynamic Cone Penetration Test

Static Cone Penetration Test

Field Vane shear Test

# FIELD TESTS

## Standard Penetration Test

The split spoon sampler is connected to a string of drill rods and is lowered into the bottom of the bore hole which was drilled and cleaned in advance.

The test consists of driving a standard split spoon, 50.8 mm outside diameter and 35 mm inside diameter, into soil under the blows of a drop weight (hammer) of 65 kg falling freely through 75 cm.

The weight is guided to fall along a guide rod. The weight is raised and allowed to fall by means of a manila rope, one end tied to the weight and the other end passing over a pulley on to a hand operated winch or a motor.

## FIELD TESTS

## Standard Penetration Test

The number of blows required to penetrate each of the successive 15 cm depths is counted to produce a total penetration of 45 cm.

To avoid seating errors, the blows required for the first 15 cm of penetration are not taken into account; those required to increase the penetration from 15cm to 45 cm constitute the *N*-value.

## The Validity of SPT

### Factors affect the reproducibility of SPT

Variation of the height of free fall of drop weight during the test

Interference of the free fall of drop weight by the guide rod which may be Out of plumb during test

Diameter and condition of drum of the hand operated winch

The number of turns  of rope around the drum

The actual condition of the rope used in the test

Use of badly damaged drive shoe

Improper seating of sampler on the bottom of the hole

## The Validity of SPT

### Factors affect the reproducibility of SPT

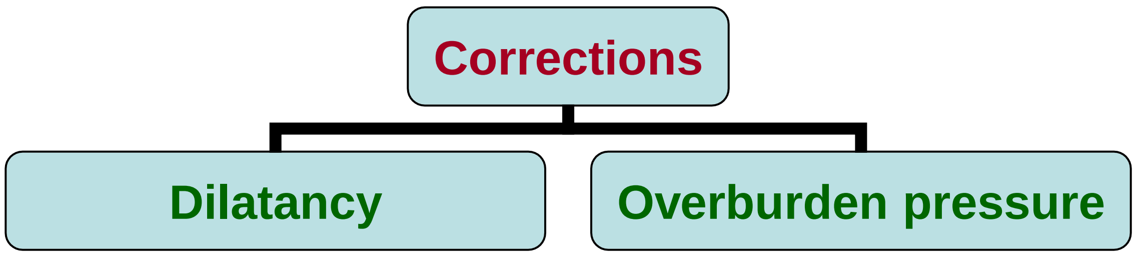
Effect of isolated stones met during driving

Effect of overburden pressure

Carelessness in conducting the test

Length and diameter of drill rod.

## Corrections to observed SPT



## Dilatancy Correction

**This correction is applied when SPT is conducted in fine or silty, saturated sand and when the recorded blow count is greater than 15.**

**This correction as recommended by Terzaghi and Peak(1967) is as follows:**

$$N = 15 + \tfrac{1}{2}(N' - 15)$$

**Where , N and N' are corrected and actual blow counts respectively.**

## Over burden pressure correction

**This correction is applied only to cohesionless soils( dry, moist or wet). The correction as suggested by Gibbs and Holtz (1957) and as widely adopted is as follows.**

$$N = \frac{35 N'}{\bar{\sigma}_0 + 7} \qquad \bar{\sigma}_0 \leq 28 \text{ t/m}^2$$

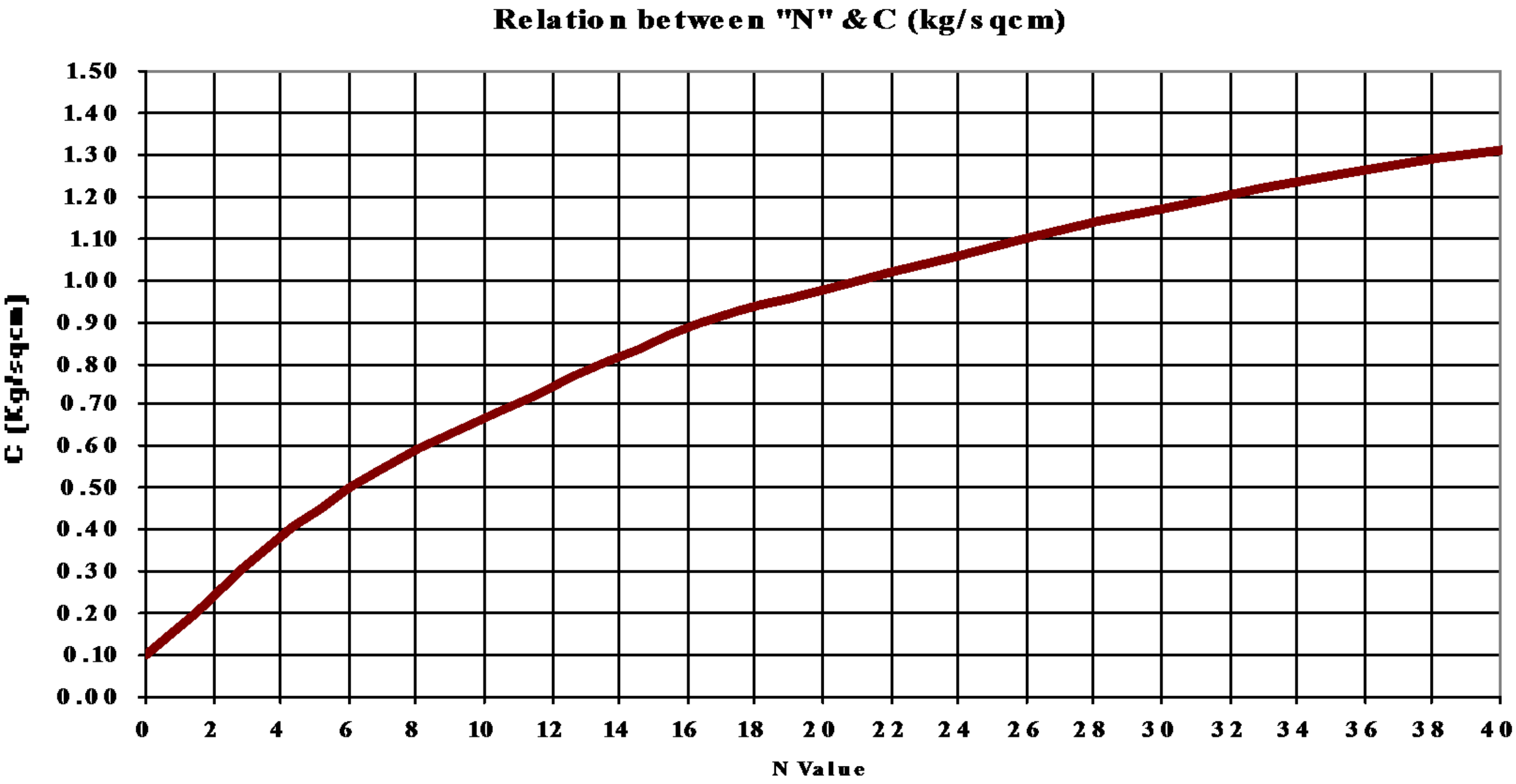
## Over burden pressure correction

$$N = \frac{35 N'}{\bar{\sigma}_0 + 7} \qquad \bar{\sigma}_0 \leq 28\ t/m^2$$

**Where N and N' are corrected and measured blow counts respectively .**

**It is considered advisable to place an upper limit of 2 for overburden correction.**

# Correlation, SPT



# Correlation, SPT

| Sand | | Clay | |
|---|---|---|---|
| N | Density | N | Consistency |
| < 4 | Very Loose | < 2 | Very soft |
| 4-10 | Loose | 2-4 | Soft |
| 10-30 | Normal | 4-8 | Normal |
| 30-50 | Dense | 8-15 | Stiff |
| > 50 | Very dense | 15-30 | Very stiff |
| | | >30 | Hard |

able 3-4: Interpretation of SPT according to Terzaghi &Peck.

## Dynamic Cone Penetration Test

In this method a cone is driven into the ground in the same way as the SPT spoon is driven.

But unlike in SPT, there is no preboring involved.

There exists many varieties of penetrometers. Indian standard Institution recommended 50mm dia and 65 mm dia cones with apex angle of 60°.

But very limited studies conducted to date indicate that 65mm cones is preferable as it yields more consistent relationship with SPT values(Mohan et al 1970).

DCPT test can be used with or without bentonite (mud) slurry.

But when depth of investigation is more than 6 m, use of bentonite or mud slurry is recommended as otherwise friction on the rods would be tremendous. Data from DCPT is plotted as a curve of penetration resistance, Nc number of blows per 30 cm of penetration, versus depth.

## Dynamic Cone Penetration Test

Nc values from dynamic cone penetration tests needed to be corrected for overburden pressure in cohesionless soil like N-values of SPT.

To judge the consistency of soils from Nc values, the general practice often used is to convert Nc into N values of SPT. The relationship commonly used is.

$$Nc = N/C$$

Where , Nc and N are blow count values from dynamic cone and SPT for corresponding depths in the same subsoil,
And C = a constant (found generally to lie between 0.8 to 1.2 when bentonite is used with 65 mm dynamic cone test). It is always advisable that c value be fixed for each other SPT and cone tests nearby each other when bentonite is not used with the test, following equation may be used for preliminary analysis:
Nc= 1.5 N , for depths up to 3 m.
And Nc = 1.75 N , for depths between 3 and 6 m

# Dynamic Cone Penetration Test

## Advantages of DCPT over Boring and SPT

DCPT is faster and more economical.

The penetrometer is primarily useful in mapping of soil strata during the early stages of explorations when the number of borings is normally limited.

During detailed investigation some geotechnical engineers may prefer to substitute a single bore hole by a number of dynamic cone tests and still maintain the cost and obtain more relevant information between the borings

It gives continuous penetration of strata penetrated.

It often the presence of strata which are not recorded or observed in sampling operations.

# Dynamic Cone Penetration Test

## Disadvantages of DCPT

The major limitations of the dynamic cone penetration test is that either no samples or only wash samples are obtained from it, therefore strata cannot be definitely be identified by soundings alone.

Presence of gravels/boulders within the soil strata can give misleading results. Consequently interpretation of results obtained from dynamic cone penetration test requires considerable experience, particularly in those areas in which correlations between the penetration resistance and engineering properties of soils penetrated are to be developed.

# Static Cone Penetration Test

The equipment consists essentially of a steel cone with an apex angel 60° and over all base diameter of 35.7 mm giving a cross sectional area of 10 sq. cm. the cone is attached to rod which is in turn connected to other rods as necessary.

These rods are protected by sleeves known as mantle tubes.

Immediately above the cone a friction jacket, of outside diameter greater than mantle tube, is fitted.

The cone and the friction jacket in combination or separately are pushed into the ground by hydraulic cylinder of a capacities presently varying from 2 tonnes to 10 tonnes.

# Static Cone Penetration Test

**The necessary reaction is obtained by anchors and some time by surcharge loading.**

**By pushing the cone alone and along with friction jacket values of cone resistance and skin friction are obtained at interval of 0.5 m and graphs of cone resistance and skin friction are plotted against depth. The tests are usually conducted to refusal.**

**The results of static cone tests are correlated directly with bearing capacity and settlement of shallow foundations and piles.**

# Static Cone Penetration Test

## Advantages of static cone penetration test over boring and SPT

Static cone penetration test is faster and much cheaper.

In cohesionless soils, particularly below the ground water table, SPT may yield misleading values as a result of loosening, sand blowing etc. In such strata cone penetration test is very beneficial.

Static cone penetration test gives practically a continuous resistance record of strata, which is generally not the case with boring.

Static cone penetration test gives values of skin friction with depth which is useful in estimating skin friction for piles.

# Static Cone Penetration Test

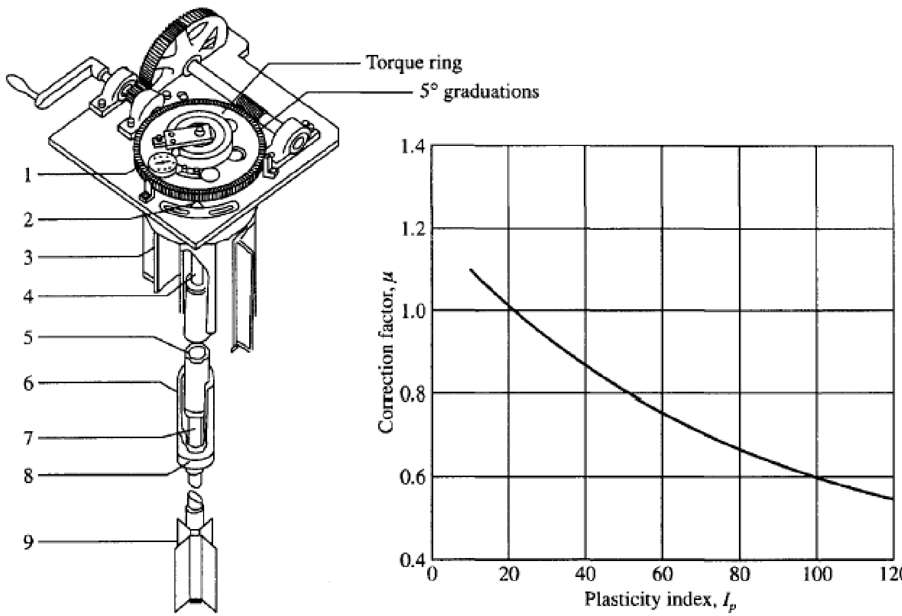
## Limitations of Static Cone Penetration Test

Test is unsuitable for gravelly soils.

Test does not reveal types of soils encountered at various depths. Disturbed or undisturbed samples can not be obtained with his test.

Test depth is limited generally to 15-20 m. Often depth penetrated would be less if smaller capacity machines are used or harder strata is obtained at shallow depths , or enough anchorage is not available at shallow depths.

# Field Vane Shear Test




1. Straingauge for reading torque
2. Rotation indicator
3. 8-in casing with side fins for anchoring torque assembly
4. Torque rod
5. A-rod for applying torque to vane. Made up in 5-ft lengths
6. BX casing for housing torque rod and A rod
7. Vane rod
8. BX-casing-point containing bearing and water seals for vane rod
9. Vane varying sizes
   2 in dia by 4 in
   3 in dia by 6 in
   4 in dia by 8 in

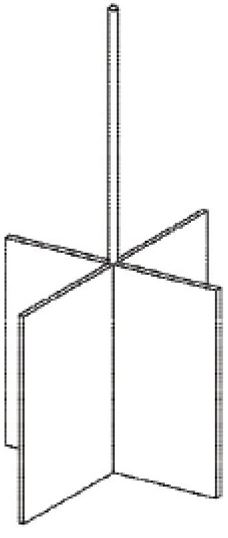
(a) (b)

**Figure 8.32** Vane shear test (a) diagrammatic sketch of a field vane, (b) correction factor $\mu$ (Bjerrum, 1973)

# Field Vane Shear Test

This method is used for soft sensitive clay when other methods can not be applied

Undrained shear strength is obtained in this method.



# Water Table

Ground water affect many important phase of foundation design and construction and must be determined in each job with reasonable accuracy.

The method of determining the ground water level in a bore hole varies with the permeability of the soil.

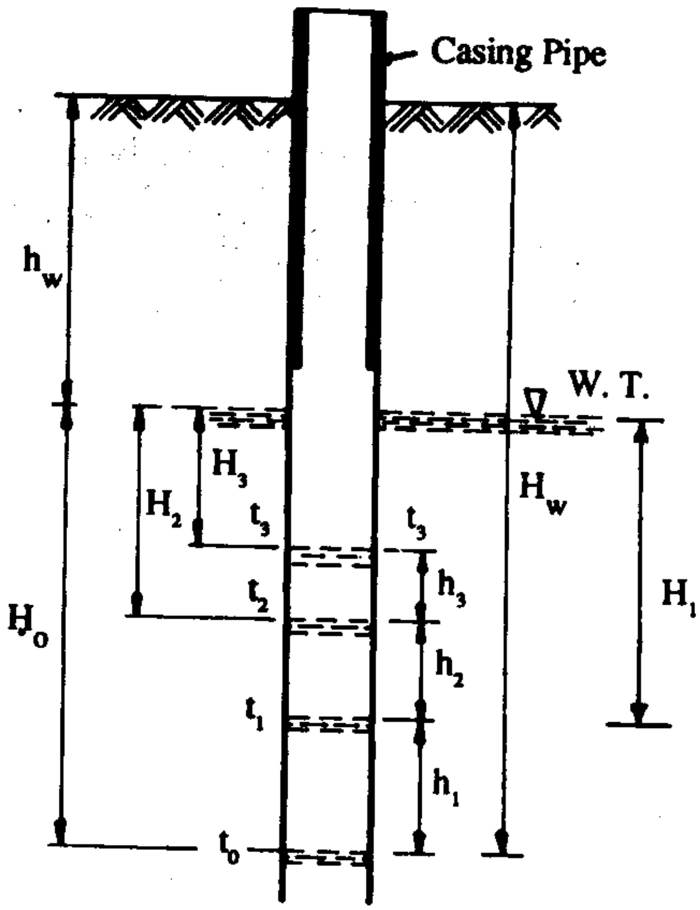
In permeable sand or gravel, the water level will seek to final level in a matter of minute. The depth of ground water may be measured by means of chalked tape, a tape with a floater an electric water level indicator.

## Water Table

In silt or silty soil, the time required for the ground water to come to a final level may be a few days. In such case, water is bailed out to an estimated level and water levels are measured at consecutive equal time interval. The final water level may be estimated by the following method:

# Rising Water Level Method

# FIELD TESTS




$H_0 = h_1^2 \ / (h_1 - h_2)$

$H_2 = h_2^2 \ / (h_1 - h_2)$

$H_3 = h_3^2 \ / (h_2 - h_3)$

Let the corresponding depth of water level below ground surface be $h_{w1}$, $h_{w2}$ and $h_{w3}$

$h_{w1} = H_w - H_0$

$h_{w2} = H_w - (h_1 + h_2) - H_2$

$h_{w3} = H_w - (h_1 + h_2 + h_3) - H_3$

Where, Hw is the depth of water level in the casing from the ground surface at the start of the test.

Normally $h_{w1} = h_{w2} = h_{w3} = h_w$;

If not an average value gives $h_w$ .