UNIT-1

Introduction to Engineering Ground Modification.

The Need for Engineered Ground Improvement: As more and more land becomes subject to urban or industrial development, good construction sites and borrow areas are difficult to find and the soil improvement alternatives becomes the best option, technically and economically.

Where a project encounters difficult foundation conditions, possible alternative solutions are:

1. Avoid the particular site. Relocate a planned highway or development site.

2. Design the planned structure accordingly. Some of the many possible approaches are to:

- Use a raft foundation supported by piles,
- Design a very stiff structure which is not damaged by settlement,
- Or choose a very flexible construction which accommodates differential movement or allows for compensation.

3. Remove and replace unsuitable soils. Removing organic topsoil, which is soft, compressible, and volumetrically unstable.

This is a standard precaution in road or foundation construction.

4. Attempt to modify the existing ground

Objective of Ground Improvement Techniques

The most common traditional objectives include improvement of the soil and ground for use as a foundation or construction material.

The typical Engineering objectives have been:

1) Increasing shear strength, durability, stiffness. And stability:
2) Mitigating undesirable properties (eg. Shrink/ swell potential, compressibility, liquefability
3) Modifying permeability, the rate of fluid to flow through a medium; and
4) Improving efficiency and productivity by using methods that save time and expense,

   The engineer must take a determination on how best to achieve the desired goals required by providing a workable solution for each project encountered. Ground improvement methods have provided adverse choice of approaches to solving these challenges.

Factors affecting choice of improvement method

1. **Soil type** : this is one of the most important parameters that will control what approach or materials will be applicable to only certain types of soil types and grain sizes
2. **Area ,** depth and location of treatment required- many ground improvement methods have depth limitations that render them unsuitable for applications for deeper soil horizons.
3. **Desired/required soil properties-** obviously, different methods are use to achieve different engineering properties, and certain methods will provide various levels of uniformity to improved sites.
4. **Availability of materials-** Depending on the location of the project and materials required for each fesible ground improvements approach.
5. **Availability of skills**, local experience, and local preferences- While the engineer may possess the knowledge and understanding of a preferred method.
6. **Environmental concerns-** With a better understanding and a greater awareness of effects on the natural environment, more attention have been placed on methods that assure less environmental impacts.
7. **Economics-** when all else has been considered, the final decision on choice of improvement method will often come down to the ultimate cost of a proposed method, or cost will be the deciding factor in choosing between two or more otherwise suitable methods.

Identifying your soil type

Soils can be identified in to their general types by the way they feel and respond to handling...

Pick up a handful and squeeze it together. Sand feels gritty and the grains do not stick together when squeezed. Loam feels velvety or flour-like when dry and forms a weak ball shape when wet which crumbles apart when dry. Clay feels sticky, but goes smooth when rubbed. Chalk will have large lumps in it and be hard to mould.

How to work with your soil

The most important thing is to identify your soil type and work with it, remember the golden rule All soil types have their good points and can be improved. Even the best loam soils will benefit from additional organic matter.

Heavy, Clay soil

This holds water, but also bakes dry in the summer. However, clay is very good at holding nutrients and moisture and very fertile as long as you can break it down with the addition of organic matter and grit. This will enable the roots of plants to get through to the nutrients more easily and of course make planting less back breaking for you. Try and avoid walking on the soil too much as this will compact it to a hard pan.

Sandy soil

It loses water very quickly being particularly free-draining. However, you can improve both of these factors with the addition of organic matter and soil improver and of course, many plants thrive in a free-draining soil. It also warms up quickly in the spring.

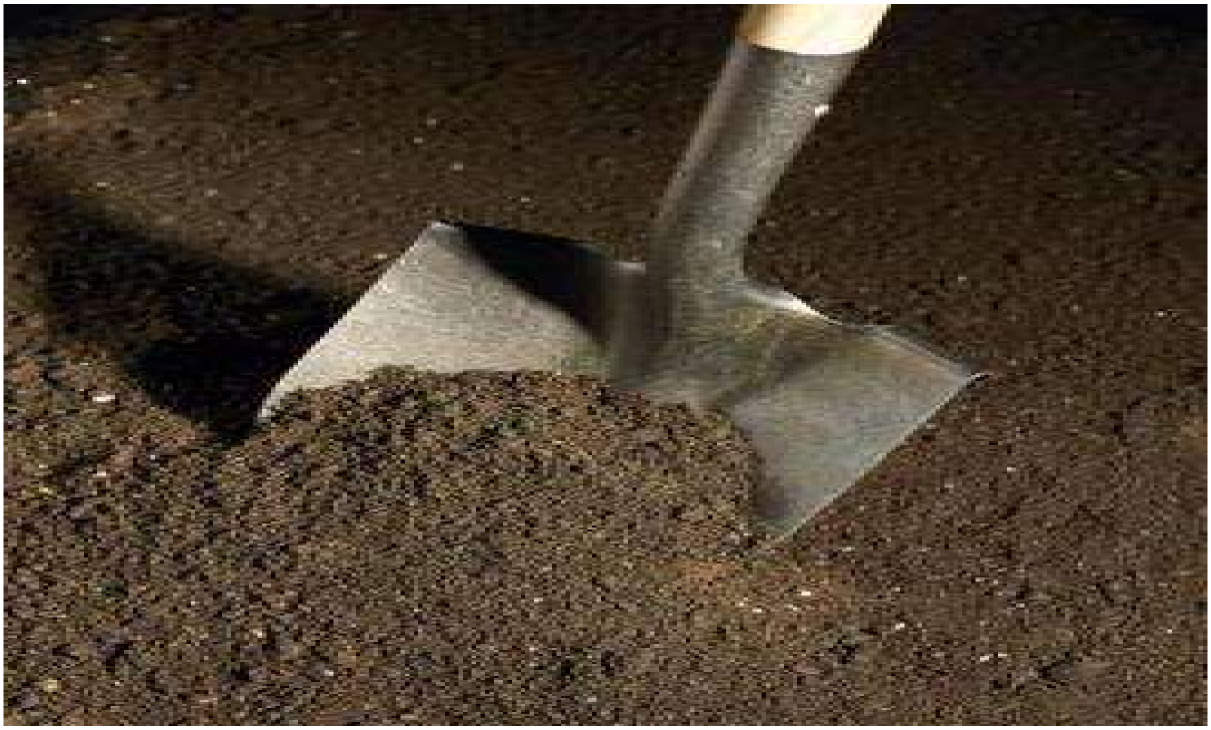
Chalky

This is alkaline so will not suit plants that require ericaceous soil. Some soils contain large clumps of chalk; others are a mixture of chalk and clay. It is normally free draining, but may be low in nutrients so as with the other soils the addition of organic matter will help with both the structure and nutritional content of the soil.

Normal

It retains moisture without impeding drainage, captures nutrients and allows oxygen to circulate. It normally contains equal quantities of sand, clay, silt, and organic matter.

Loam, Sand & Silt Soil Identification



Soil type affects drainage.

Many plants are quite picky about the type of soil in which they live. Therefore, identifying your garden's kind of soil will help you know whether particular plants will do well in your garden without soil amendment or with soil amendment, or if you should just skip using those plants altogether.

Sandy Soil

Most people associate sandy textures with those they feel between their toes at the beach, and the feeling is similar in sandy soil. Its particles are the largest of all the soil particle types, ranging from 0.05 to 0.10 millimeters at the small end and 1 to 2 millimeters at the large end. That factor gives wet or dry sandy soil a grainy texture when you rub it between your fingers, and it makes the soil light and crumbly even when you try to stick it together in your hand. Sandy soil drains very quickly.

Silt Soil

Many people think of loam as the intermediate between sand and clay, but midsized soil particles are referred to as silt. Silt soil is fine and feels almost floury to the touch when dry. When wet, it becomes a smooth mud that you can form easily into balls or other shapes in your hand. When silt soil is very wet, it blends seamlessly with water to form fine, runny puddles of mud. Silt particles are very small, between 0.002 and 0.05 millimeters, which results in their very smooth texture. Silty soil drains well but not as quickly as sand.

Clay Soil

Clay particles are the finest of all the soil particles, measuring fewer than 0.002 millimeters in size. They stick together readily and form a sticky or gluey texture when they are wet or dry. When you gather clay soil into your hand, you can readily shape it into whatever form you want. It will form a ball that doesn‟t break when squeezed, or a thin, flexible ribbon when pressed between your thumb and forefinger.

Loam Soil

Loam is not its own particle type but a designation for soils containing certain combinations of other particles. The way the other particles combine in the soil makes the loam. For instance, a soil that is 30 percent clay, 50 percent sand and 20 percent silt is a sandy clay loam, with the soil types before "loam" listed in the order their particles are most dominant in the loam. The labels “clay loam,” “silt loam” and “sand loam” are used to refer to soils that are composed predominantly of those ingredients.

Insitu laboratory test for problematic Soils

In Situ and Laboratory Testing

ESG’s (Environmental, Social and Governance) geotechnical division offers a wide range of in situ and laboratory-based testing methods for the measurement of soil and rock stiffness parameters. In recent years the importance of soil and rock stiffness parameters in geotechnical engineering design has been increasingly recognized, driven in part by the requirements of EC-7 for calculating serviceability limit state conditions.

Specialist in situ testing

We provide a number of specialist in situ tests for the measurement of soil stiffness, either as a standalone service or part of a wider site investigation, backed up by proven technical and analytical expertise:

- Borehole and surface seismic methods, such as down hole, cross hole, surface refraction and multichannel analysis of surface waves (MASW)
- Seismic cone penetration testing (SCPT), a version of the down hole method where a seismic receiver is incorporated with conventional cone penetration testing (CPT)
- Pressure meter testing using pre-bored high pressure dilatometer (HPD), self-boring pressuremeter (SBP) and driven pressure meter (DPM) to carry out load displacement tests in boreholes

The adoption of EC-7, which advocates the direct measurement of geotechnical parameters by in situ testing techniques, has seen a significant increase in the demand for SBP and HPD testing methods.

Following a major period of investment, ESG"s in situ team now offers combined magnetometer/piezocone resources and upgraded down hole magnetometer analysis, as well as the capability for site clearance with the potential risk of Unexploded Ordnance. In addition, our main cone penetration test rigs have undergone a program of detailed refurbishment to ensure they provide the best possible results.

Advanced laboratory testing

Alongside in situ testing, we also provide extensive sample analysis in our UKAS accredited computer-based laboratories:

- Resonant column and simple shear apparatus, which provide soil stiffness and damping parameters over a range of strain amplitudes
- Triaxial tests with local strain and mid-height pore water pressure measurement to obtain strength and stiffness properties, while significantly reducing the influences of sample

bedding, end effects and allowing a much greater degree of precision of stress and strain measurement, together with automated control of all stages of testing
- Bender elements, either stand-alone or combined with other tests, to measure elastic wave travel times for calculation of wave velocities and stiffness

In situ sampling methods

ESG offers a range of sampling methods to maximize undisturbed sample recovery in a variety of soil and rock ground conditions suitable for advanced testing methods, including:

- Thin-walled open drive tube samples (UT100)
- Thin-walled pushed samples (Shelby) and hydraulically-pushed piston samples
- Block samples
- Wireline rotary cored samples

Various Lab Test on Soil

Soil inspection or say geotechnical inspection is very important in understanding the physical properties of soil and the rocks beneath. This is required to ascertain the type of foundation required for the proposed construction. Various tests are done to explore the sub surface and surface characteristics of soil .Some of these are given below.
Just click on the link to go to the details of that particular test.

1) Water Content – There are two tests which can be done to determine the water content of soil. These are

a) Calcium Carbide Method

Determining Water Content in Soil – Calcium Carbide Method

This test is done to determine the water content in soil by calcium carbide method as per IS: 2720 (Part II) – 1973. It is a method for rapid determination of water content from the gas pressure developed by the reaction of calcium carbide with the free water of the soil. From the calibrated scale of the pressure gauge the percentage of water on total mass of wet soil is obtained and the same is converted to water content on dry mass of soil.

Apparatus required:-

i) Metallic pressure vessel, with a clamp for sealing the cup, alongwith a gauge calibrated in percentage water content
ii) Counterpoised balance, for weighing the sample
iii) Scoop, for measuring the absorbent (Calcium Carbide)
iv) Steel balls – 3 steel balls of about 12.5mm dia. and 1 steel ball of 25mm dia.
v) One bottle of the absorbent (Calcium Carbide)

PREPARATION OF SAMPLE

Sand – No special preparation. Coarse powders may be ground and pulverized. Cohesive and plastic soil – Soil is tested with addition of steel ball in the pressure vessels. The test requires about 6g of sample.

Procedure to determine Water Content in Soil by Calcium Carbide Method

i) Set up the balance, place the sample in the pan till the mark on the balance arm matches with the index mark.
ii) Check that the cup and the body are clean.

iii) Hold the body horizontally and gently deposit the leveled, scoop-full of the absorbent (Calcium Carbide) inside the chamber.

iv) Transfer the weighed soil from the pan to the cup.

V) Hold cup and chamber horizontally, bringing them together without disturbing the sample and the absorbent.

vi) Clamp the cup tightly into place. If the sample is bulky, reverse the above placement, that is, put the sample in the chamber and the absorbent in the cup.

vii) In case of clayey soils, place all the 4 steel balls (3 smaller and 1 bigger) in the body along with the absorbent.

viii) Shake the unit up and down vigorously in this position for about 15 seconds.

ix) Hold the unit horizontally, rotating it for 10 seconds, so that the balls roll around the inner circumference of the body.

x) Rest for 20 seconds.

xi) Repeat the above cycle until the pressure gauge reading is constant and note the reading. Usually it takes 4 to 8 minutes to achieve constant reading. This is the water content (m) obtained on wet mass basis.

xii) Finally, release the pressure slowly by opening the clamp screw and taking the cup out, empty the contents and clean the instrument with a brush.

b) Oven Drying Method

Determining Water Content in Soil – Oven Drying Method

This test is done to determine the water content in soil by oven drying method as per IS: 2720 (Part II) – 1973. The water content (w) of a soil sample is equal to the mass of water divided by the mass of solids.

Apparatus required:-

i) Thermostatically controlled oven maintained at a temperature of 110 ± 5ºC
ii) Weighing balance, with an accuracy of 0.04% of the weight of the soil taken
iii) Air-tight container made of non-corrodible material with lid Tongs

PREPARATION OF SAMPLE

The soil specimen should be representative of the soil mass. The quantity of the specimen taken would depend upon the gradation and the maximum size of particles as under:

Procedure to determine Water Content in Soil By Oven Drying Method

i) Clean the container, dry it and weigh it with the lid (Weight „W_1„).

ii) Take the required quantity of the wet soil specimen in the container and weigh it with the lid (Weight „W_2„).
iii) Place the container, with its lid removed, in the oven till its weight becomes constant (Normally for 24hrs.).

iv) When the soil has dried, remove the container from the oven, using tongs.

v) Find the weight „W_3„of the container with the lid and the dry soil sample.

2) Free Swell Index Of Soil

To determine the free swell index of soil as per IS: 2720 (Part XL) – 1977. Free swell or differential free swell, also termed as free swell index, is the increase in volume of soil without any external constraint when subjected to submergence in water. The apparatus used:

i) IS Sieve of size 425µm?
ii) Oven
iii) Balance, with an accuracy of 0.01g
iv) Graduated glass cylinder- 2 nos., each of 100ml capacity strong>Procedure to determine Free Swell Index of Soil
v) Take two specimens of 10g each of pulverized soil passing through 425µm IS Sieve and oven-dry.ii) Pour each soil specimen into a graduated glass cylinder of 100ml capacity.iii) Pour distilled water in one and kerosene oil in the other cylinder upto 100 ml mark.

iv) Remove entrapped air by gently shaking or stirring with a glass rod.

v) Allow the suspension to attain the state of equilibrium (for not less than 24hours).

vi) Final volume of soil in each of the cylinder should be read out.

3) Plastic Limit of Soil

Determine the Plastic Limit of Soil

This test is done to determine the plastic limit of soil as per IS: 2720 (Part 5) – 1985.The plastic limit of fine-grained soil is the water content of the soil below which it ceases to be plastic. It begins to crumble when rolled into threads of 3mm dia. The apparatus used:

i) Porcelain evaporating dish about 120mm dia.
ii) Spatula
iii) Container to determine moisture content
iv) Balance, with an accuracy of 0.01g
v) Oven
vi) Ground glass plate – 20cm x 15cm
vii) Rod – 3mm dia. and about 10cm long

PREPARATION OF SAMPLE

Take out 30g of air-dried soil from a thoroughly mixed sample of the soil passing through 425μm IS Sieve. Mix the soil with distilled water in an evaporating dish and leave the soil mass for nurturing. This period may be up to 24hrs.

Procedure to determine The Plastic Limit of Soil

i) Take about 8g of the soil and roll it with fingers on a glass plate. The rate of rolling should be between 80 to 90 strokes per minute to form a 3mm dia.

ii) If the dia. of the threads can be reduced to less than 3mm, without any cracks appearing, it means that the water content is more than its plastic limit. Knead the soil to reduce the water content and roll it into a thread again.

iii) Repeat the process of alternate rolling and kneading until the thread crumbles.

iv) Collect and keep the pieces of crumbled soil thread in the container used to determine the moisture content.

v) Repeat the process at least twice more with fresh samples of plastic soil each time.

4) Liquid Limit Of Soil

This test is done to determine the liquid limit of soil as per IS: 2720 (Part 5) – 1985. The liquid limit of fine-grained soil is the water content at which soil behaves practically like a liquid, but has small shear strength. Its flow closes the groove in just 25 blows in Casagrande‟s liquid limit device. The apparatus used :-

i) Casagrande‟s liquid limit device
ii) Grooving tools of both standard and ASTM types

iii) Oven

iv) Evaporating dish

v) Spatula

vi) IS Sieve of size 425µm

vii) Weighing balance, with 0.01g accuracy

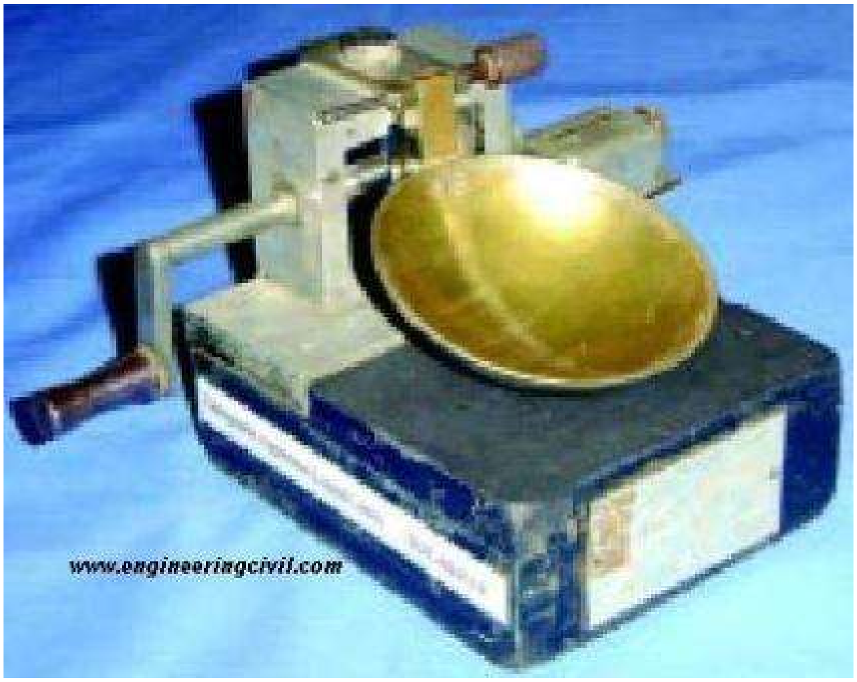
viii) Wash bottle

ix) Air-tight and non-corrodible container for determination of moisture content

PREPARATION OF SAMPLE

i) Air-dry the soil sample and break the clods. Remove the organic matter like tree roots, pieces of bark, etc.

ii) About 100g of the specimen passing through 425µm IS Sieve is mixed thoroughly with distilled water in the evaporating dish and left for 24hrs. for soaking.

6) 

Procedure to Determine The Liquid Limit of Soil

i) Place a portion of the paste in the cup of the liquid limit device.

ii) Level the mix so as to have a maximum depth of 1cm.

iii) Draw the grooving tool through the sample along the symmetrical axis of the cup, holding the tool perpendicular to the cup.

iv) For normal fine grained soil: The Casagrande‟s tool is used to cut a groove 2mm wide at the bottom, 11mm wide at the top and 8mm deep.

v) For sandy soil: The ASTM tool is used to cut a groove 2mm wide at the bottom, 13.6mm wide at the top and 10mm deep.

vi) After the soil pat has been cut by a proper grooving tool, the handle is rotated at the rate of about 2 revolutions per second and the no. of blows counted, till the two parts of the soil sample come into contact for about 10mm length.

vii) Take about 10g of soil near the closed groove and determine its water content

viii) The soil of the cup is transferred to the dish containing the soil paste and mixed thoroughly after adding a little more water. Repeat the test.

ix) By altering the water content of the soil and repeating the foregoing operations, obtain at least 5 readings in the range of 15 to 35 blows. Don‟t mix dry soil to change its consistency.

x) Liquid limit is determined by plotting a „flow curve‟ on a semi-log graph, with no. of blows as abscissa (log scale) and the water content as ordinate and drawing the best straight line through the plotted points.

5) Particle Size Distribution Of Soil

Determine Particle Size Distribution of Soil

This test is done to determine the particle size distribution of soil as per IS: 2720 (Part 4) – 1985.

The appratus required to do this test :-

i) A set of fine IS Sieves of sizes – 2mm, 600µm, 425µm, 212µm and 75µm
ii) A set of coarse IS Sieves of sizes – 20mm, 10mm and 4.75mm
iii) Weighing balance, with an accuracy of 0.1% of the weight of sample
iv) Oven
v) Mechanical shaker
vi) Mortar with rubber pestle Brushes

viii) Trays

PREPARATION OF SAMPLE

i) Soil sample, as received from the field, should be dried in air or in the sun. In wet weather, the drying apparatus may be used in which case the temperature of the sample should not exceed 60^{o}C. The clod may be broken with wooden mallet to hasten drying. Tree roots and pieces of bark should be removed from the sample.

ii) The big clods may be broken with the help of wooden mallet. Care should be taken not to break the individual soil particles.

iii) A representative soil sample of required quantity as given below is taken and dried in the oven at 105 to 120^{o}C.

Maximum size of material present in substantial quantities (mm)	Weight to be taken for test (kg)
75	60
40	25
25	13
19	6.5
12.5	3.5
10	1.5
6.5	0.75
4.75	0.4

Procedure to determine Particle Size Distribution Of Soil

i) The dried sample is taken in a tray, soaked in water and mixed with either 2g of sodium hexametaphosphate or 1g of sodium hydroxide and 1g of sodium carbonate per litre of water, which is added as a dispersive agent. The soaking of soil is continued for 10 to 12hrs.

ii) The sample is washed through 4.75mm IS Sieve with water till substantially clean water comes out. Retained sample on 4.75mm IS Sieve should be oven-dried for 24hrs. This dried sample is sieved through 20mm and 10mm IS Sieves.

iii) The portion passing through 4.75mm IS Sieve should be oven-dried for 24hrs. This oven-dried material is riffled and about 200g taken.

iv) This sample of about 200g is washed through 75µm IS Sieve with half litre distilled water, till substantially clear water comes out.

v) The material retained on 75µm IS Sieve is collected and dried in oven at a temperature of 105 to 120ºC for 24hrs. The dried soil sample is sieved through 2mm, 600µm, 425µm and 212µm IS Sieves. Soil retained on each sieve is weighed.

vi) If the soil passing 75µm is 10% or more, hydrometer method is used to analyse soil particle size.

6) <u>The Specific Gravity Of Soil</u>

Determine the Specific Gravity of Soil

This test is done to determine the specific gravity of fine-grained soil by density bottle method as per IS: 2720 (Part III/Sec 1) – 1980. Specific gravity is the ratio of the weight in air of a given volume
of a material at a standard temperature to the weight in air of an equal volume of distilled water at the same stated temperature.

The apparatus used:

i) Two density bottles of approximately 50ml capacity along with stoppers

ii) Constant temperature water bath (27.0 + 0.2°C)

iii) Vacuum desiccators

iv) Oven, capable of maintaining a temperature of 105 to 110°C

v) Weighing balance, with an accuracy of 0.001g

vi) Spatula

PREPARATION OF SAMPLE

The soil sample (50g) should if necessary be ground to pass through a 2mm IS Sieve. A 5 to 10g sub-sample should be obtained by riffling and oven-dried at a temperature of 105 to 110°C.

Procedure to Determine the Specific Gravity of Fine-Grained Soil

i) The density bottle along with the stopper, should be dried at a temperature of 105 to 110°C, cooled in the desiccators and weighed to the nearest 0.001g (W_1).

ii) The sub-sample, which had been oven-dried should be transferred to the density bottle directly from the desiccators in which it was cooled. The bottles and contents together with the stopper should be weighed to the nearest 0.001g (W_2).

iii) Cover the soil with air-free distilled water from the glass wash bottle and leave for a period of 2 to 3hrs. For soaking. Add water to fill the bottle to about half.

iv) Entrapped air can be removed by heating the density bottle on a water bath or a sand bath.

v) Keep the bottle without the stopper in a vacuum desiccator for about 1 to 2hrs. until there is no further loss of air.

vi) Gently stir the soil in the density bottle with a clean glass rod, carefully wash off the adhering particles from the rod with some drops of distilled water and see that no more soil particles are lost.

vii) Repeat the process till no more air bubbles are observed in the soil-water mixture.

viii) Observe the constant temperature in the bottle and record.

ix) Insert the stopper in the density bottle, wipe and weigh(W_3).

x) Now empty the bottle, clean thoroughly and fill the density bottle with distilled water at the same temperature. Insert the stopper in the bottle, wipe dry from the outside and weigh (W_4).

xi) Take at least two such observations for the same soil.

7) <u>The In-Situ Dry Density Of Soil By Sand Replacement Method</u>

Determine the In-Situ Dry Density of Soil by Sand Replacement Method

This test is done to determine the in-situ dry density of soil by sand replacement method as per IS: 2720 (Part XXVIII) – 1974. The apparatus needed is

i) Sand-pouring cylinder conforming to IS: 2720 (Part XXVIII) -1974

ii) Cylindrical calibrating container conforming to IS: 2720 (Part XXVIII) – 1974

iii) Soil cutting and excavating tools such as a scraper tool, bent spoon

iv) Glass plate – 450mm square and 9mm thick or larger

v) Metal containers to collect excavated soil

vi) Metal tray – 300mm square and 40mm deep with a 100mm hole in the centre

vii) Balance, with an accuracy of 1g

Procedure to Determine The In-Situ Dry Density Of Soil By Sand Replacement Method

A. Calibration of apparatus

a) The method given below should be followed for the determination of the weight of sand in the cone of the pouring cylinder:

b) The pouring cylinder should be filled so that the level of the sand in the cylinder is within about 10 mm of the top. Its total initial weight (W_1) should be maintained constant throughout the tests for which the calibration is used. A volume of sand equivalent to that of the excavated hole in the soil (or equal to that of the calibrating container) should be allowed to runout of the cylinder under gravity. The shutter of the pouring cylinder should then be closed and the cylinder placed on a plain surface, such as a glass plate.

ii) The shutter of the pouring cylinder should be opened and sand allowed to runout. When no further movement of sand takes place in the cylinder, the shutter should be closed and the cylinder removed carefully.

iii) The sand that had filled the cone of the pouring cylinder (that is, the sand that is left on the plain surface) should be collected and weighed to the nearest gram.

iv) These measurements should be repeated at least thrice and the mean weight (W_2) taken.

b) The method described below should be followed for the determination of the bulk density of the sand (Ys):

i) The internal volume (V) in ml of the calibrating container should be determined from the weight of water contained in the container when filled to the brim. The volume may also be calculated from the measured internal dimensions of the container.

ii) The pouring cylinder should be placed concentrically on the top of the calibrating container after being filled to the constant weight (W_1). The shutter of the pouring cylinder should be closed during the operation. The shutter should be opened and sand allowed to runout. When no further movement of sand takes place in the cylinder, the shutter should be closed. The pouring cylinder should be removed and weighed to the nearest gram.

iii) These measurements should be repeated at least thrice and the mean weight (W_3) taken.

B. Measurement of soil density

The following method should be followed for the measurement of soil density:
i) A flat area, approximately 450sq. mm of the soil to be tested should be exposed and trimmed down to a level surface, preferably with the aid of the scraper tool.

ii) The metal tray with a central hole should be laid on the prepared surface of the soil with the hole over the portion of the soil to be tested. The hole in the soil should then be excavated using the hole in the tray as a pattern, to the depth of the layer to be tested upto a maximum of 150mm. The excavated soil should be carefully collected, leaving no loose material in the hole and weighed to the nearest gram(W_w). The metal tray should be removed before the pouring cylinder is placed in position over the excavated hole.

iii) The water content (w) of the excavated soil should be determined as discussed in earlier posts. Alternatively, the whole of the excavated soil should be dried and weighed (W_d).

iv) The pouring cylinder, filled to the constant weight (W_1) should be so placed that the base of the cylinder covers the hole concentrically. The shutter should then be opened and sand allowed to runout into the hole. The pouring cylinder and the surrounding area should not be vibrated during this period. When no further movement of sand takes place, the shutter should be closed. The cylinder should be removed and weighed to the nearest gram (W_4).

8) The In-Situ Dry Density Of Soil By Core Cutter Method

Determine The In-Situ Dry Density Of Soil By Core Cutter Method

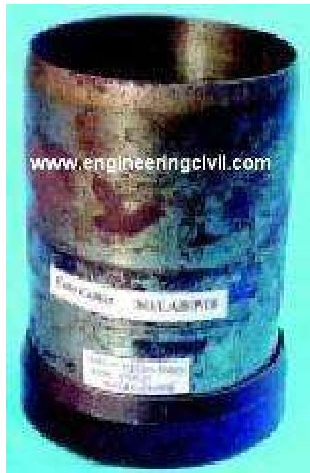
This test is done to determine the in-situ dry density of soil by core cutter method as per IS: 2720 (Part XXIX) – 1975.The apparatus needed for this test is

i) Cylindrical core cutter
ii) Steel dolley
iii) Steel rammer
iv) Balance, with an accuracy of 1g
v) Straightedge
vi) Square metal tray – 300mm x 300mm x 40mm
vii) Trowel

Procedure Determine The In-Situ Dry Density Of Soil By Core Cutter Method

i) The internal volume (V) of the core cutter in cc should be calculated from its dimensions which should be measured to the nearest 0.25mm.

ii) The core cutter should be weighed to the nearest gram (W_1).



iii) A small area, approximately 30cm square of the soil layer to be tested should be exposed and levelled. The steel dolly should be placed on top of the cutter and the latter should be rammed down vertically into the soil layer until only about 15mm of the dolly protrudes above the surface, care being taken not to rock the cutter. The cutter should then be dug out of the surrounding soil, care being taken to allow some soil to project from the lower end of the cutter. The ends of the soil core should then be trimmed flat in level with the ends of the cutter by means of the straightedge.

iv) The cutter containing the soil core should be weighed to the nearest gram (W_2).

v) The soil core should be removed from the cutter and a representative sample should be placed in an air-tight container and its water content (w)

9) The Maximum Dry Density And The Optimum Moisture Content Of Soil

Apart from these some Soil Compaction Tests are also done. See this for details

Determine The Maximum Dry Density And The Optimum Moisture Content Of Soil

This test is done to determine the maximum dry density and the optimum moisture content of soil using heavy compaction as per IS: 2720 (Part 8) – 1983.The apparatus used is

i) Cylindrical metal mould – it should be either of 100mm dia. and 1000cc volume or 150mm dia. and 2250cc volume and should conform to IS: 10074 – 1982.

ii) Balances – one of 10kg capacity, sensitive to 1g and the other of 200g capacity, sensitive to 0.01g

iii) Oven – thermostatically controlled with an interior of noncorroding material to maintain temperature between 105 and 110^{0}C

iv) Steel straightedge – 30cm long

v) IS Sieves of sizes – 4.75mm, 19mm and 37.5mm

PREPARATION OF SAMPLE

A representative portion of air-dried soil material, large enough to provide about 6kg of material passing through a 19mm IS Sieve (for soils not susceptible to crushing during compaction) or about 15kg of material passing through a 19mm IS Sieve (for soils susceptible to crushing during compaction), should be taken. This portion should be sieved through a 19mm IS Sieve and the coarse fraction rejected after its proportion of the total sample has been recorded. Aggregations of particles should be broken down so that if the sample was sieved through a 4.75mm IS Sieve, only separated individual particles would be retained.

Procedure To Determine The Maximum Dry Density And The Optimum Moisture Content Of Soil

A) Soil not susceptible to crushing during compaction –

i) A 5kg sample of air-dried soil passing through the 19mm IS Sieve should be taken. The sample should be mixed thoroughly with a suitable amount of water depending on the soil type (for sandy and gravelly soil – 3 to 5% and for cohesive soil – 12 to 16% below the plastic limit). The soil sample should be stored in a sealed container for a minimum period of 16 hrs.

ii) The mould of 1000cc capacity with base plate attached, should be weighed to the nearest 1g (W1). The mould should be placed on a solid base, such as a concrete floor or plinth and the moist soil should be compacted into the mould, with the extension attached, in five layers of approximately equal mass, each layer being given 25 blows from the 4.9kg rammer dropped from a height of 450mm above the soil. The blows should be distributed uniformly over the surface of each layer. The amount of soil used should be sufficient to fill the mould, leaving not more than about 6mm to be struck off when the extension is removed. The extension should be removed and the compacted soil should be levelled off carefully to the top of the mould by means of the straight edge. The mould and soil should then be weighed to the nearest gram (W2).

iii) The compacted soil specimen should be removed from the mould and placed onto the mixing tray. The water content (w) of a representative sample of the specimen should be determined.

iv) The remaining soil specimen should be broken up, rubbed through 19mm IS Sieve and then mixed with the remaining original sample. Suitable increments of water should be added successively and mixed into the sample, and the above operations i.e. ii) to iv) should be repeated for each increment of water added. The total number of determinations made should be at least five and the moisture contents should be such that the optimum moisture content at which the maximum dry density occurs, lies within that range.

B) Soil susceptible to crushing during compaction –

Five or more 2.5kg samples of air-dried soil passing through the 19mm IS Sieve, should be taken. The samples should each be mixed thoroughly with different amounts of water and stored in a sealed container as mentioned in Part A)

C) Compaction in large size mould –

For compacting soil containing coarse material upto 37.5 mm sizes, the 2250cc mould should be used. A sample weighing about 30kg and passing through the 37.5mm IS Sieve is used for the test. Soil is compacted in five layers, each layer being given 55 blows of the 4.9kg rammer. The rest of the procedure is same as above.

Classification of Ground Modification Techniques

Four groups of ground improvement Techniques are distinguished:

1. Mechanical modification
2. Hydraulic modification

3. Physical and chemical modification

4. Modification by inclusion and Confinement.

1. Mechanical modification

Soil density is increased by the application of
Short-term external mechanical forces, including Compaction of surface layers by:

- Static,
- Vibratory,
- Impact rollers,
- Plate vibrators.

Deep compaction by heavy tamping at the surface
or vibration at depth.

Rollers are the construction equipment used for the compaction of soil, gravel, sand, crushed stone layers, etc. Roller working principle is based on vibration, impact loading, kneading and by applying direct pressure on the respective layer. The four most commonly used rollers are;

Vibratory Roller

Tamping roller/ sheep foot rolle

Smooth wheel rollers

Pneumatic tired roller

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Rollers Jalal Afsar July 3, 2012 Construction Machinery 1 Comment

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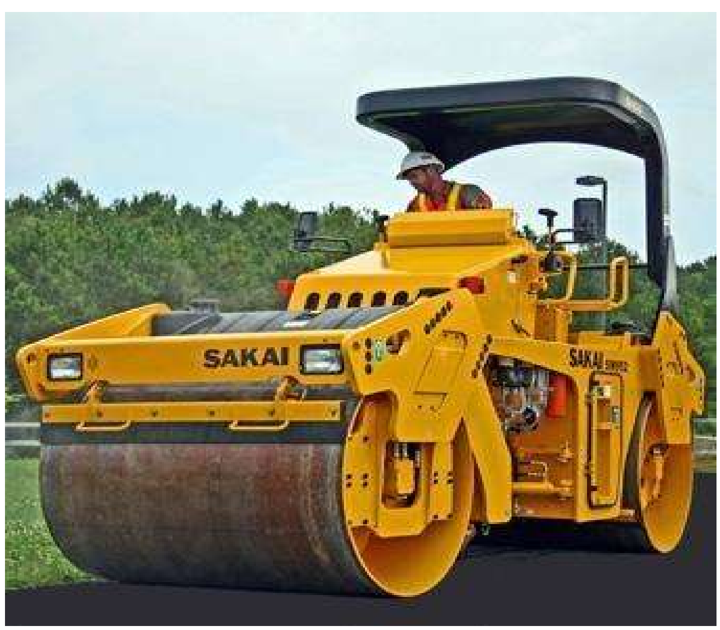
VIBRATORY ROLLER

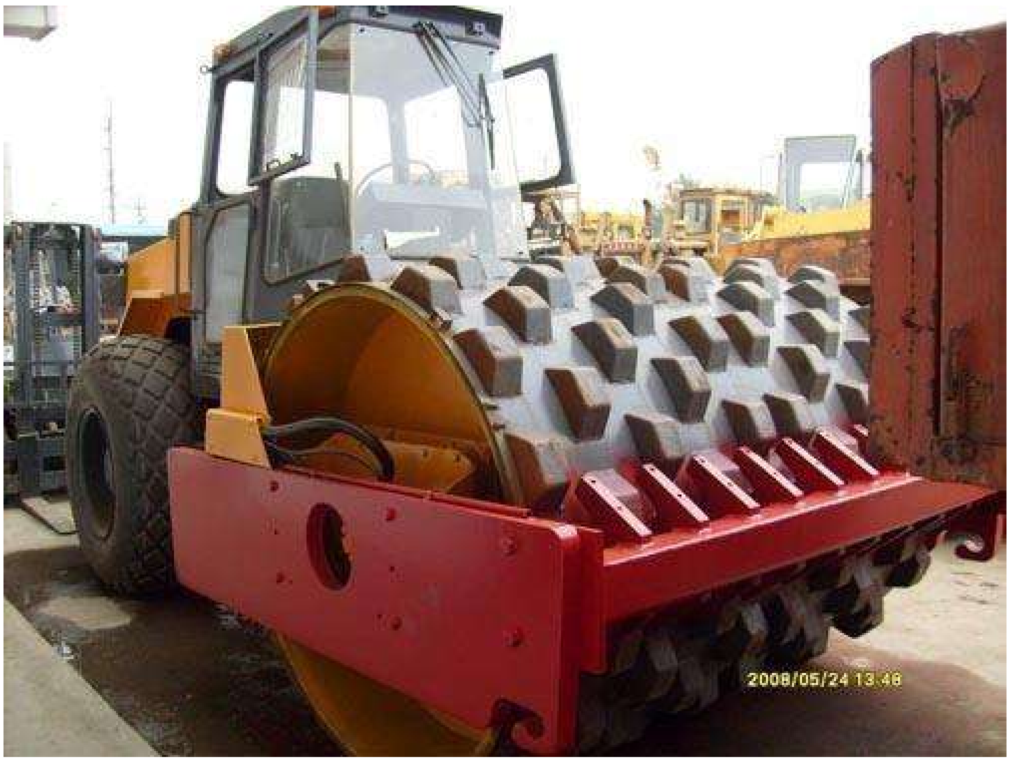
Vibratory type rollers have two smooth wheels/ drums plus the vibrators. One is fixed at the front and the other one is on the rear side of vibratory roller. Both wheels/drums are of the same diameter, length and also of same weight. Vibratory roller covers the full area under wheel. To make vibratory roller more efficient, vibrators are also fixed with smooth wheel rollers. Vibration of vibrators arranges the particles by first disturbing even the arranged ones. On the other hand weight of wheels exerts direct pressure on the layer. Vibrators are turned off during the reversed motion of roller. In that time only static weight directly acts on the soil layer.

Vibration is to reduce the air voids and to cause densification of granular soils. During vibration of soil layer, rearrangement of particles occurs due to deformation of the granular soil because of oscillation of the roller in a cycle.



SHEEP FOOT ROLLER/ TAMPING ROLLER

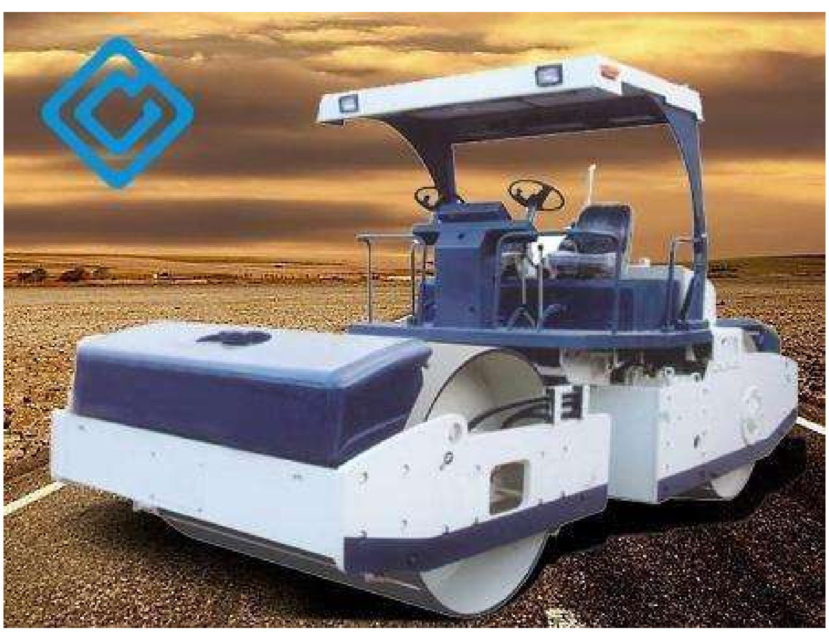
Sheep foot roller also named tamping roller. Front steel drum of sheep foot roller consists of many rectangular shaped boots of equal sizes fixed in a hexagonal pattern. Coverage area of sheep foot roller is less i.e., about 8- 12% because of the boots on drums. Sheep foot roller done compaction by static weight and kneading of respective layer. This makes tamping roller better suited for clay soils. Contact pressure of sheep foot roller varies from 1200- 7000Kpa.



Tamping foot roller consists of four wheels and on each wheel kneading boots/feet are fixed. Tamping roller has more coverage area i.e., about 40- 50%. Contact pressure of tamping roller varies from 1400 – 8500KPa. It is best dedicated for fine grained soils.

SMOOTH WHEEL ROLLER

Smooth wheel roller and vibratory rollers are the same. Both have the same characteristics. Only the difference in both is vibratory equipment. Smooth wheel roller has no vibrator attached with the drum. This makes smooth wheel roller best suited for rolling of weaker aggregates, proof rolling of subgrades and in compacting asphalt pavements. Compaction of clay or sand is not a good choice to done with smooth wheel roller. This is so, because there are many empty voids in clay soil and sand, which cannot be minimized without vibrators.



2. Hydraulic modification

Free –pore water is forced out of the soil via (by means of) drains of wells.

- In coarse grained soils, this is achieved by lowering the ground water level through pumping from boreholes or trenches.
- In fine-grained soils, The long term application of external loads (preloading) or electrical forces (electrokinetic stabilization) is required.

3. Physical and chemical modification

Additives include: - natural soils - industrial by-products or waste materials (fly ash, slag), - Cementations and other chemicals (lime, cement) which react with each other and the ground.

When additives are injected via boreholes under pressure into the voids within the ground or between it and a structure, the process is called GROUTING. Rigs with multiple injectors deliver the stabilizing fluid into the soil. The fluid will prefer to travel into cracks and fissures.

Soil stabilization by heating the ground and by freezing the ground are THERMAL METHODS OF MODIFICATION.

• Heating evaporates water and causes permanent changes in the mineral structure of soils.

• Freezing solidifies part or all of the water and bonds individual particles together.

4. Modification by inclusion and Confinement Reinforcement by:

• Fibers,
• Strips
• Bars,
• Meshes and
• Fabrics.

Insitu reinforcement is achieved by nails and anchors.

Suitability, Feasibility, Desirability

The choice of a method of ground improvement depends on many factors including:

• Type and degree of improvement required

• Type of soil, geological structure,

• Seepage conditions,

Cost (the size of the project may be Decisive),

• Availability of equipment and materials and the quantity of work required,

Construction time available,

• Possible damage to adjacent structures or Pollution of ground water resources,

• Durability of the materials involved,

• Toxicity or corrosively of any chemical

Additives (government regulations may\ Restrict the choice of additives),

Reversibility or irreversibility of the process,

• Reusability of components,

• Reliability of methods of analysis and design,

• Feasibility of construction control and performance measurements.

The feasibility of a particular method is strongly Related to the type of problem in hand:

• a foundation,

• An embankment on soft ground,

• An unstable slope,

• An excavation,

• An earth-retaining structure,

• A leaking dam or reservoir.

Traditional Objectives and Emerging Trends The aim of improving soils as foundation or Construction materials:

1. Increase strength, reduce credibility
2. Reduce distortion under stress (increase Stress-strain modulus)
3. Reduce compressibility
4. Control shrinking and swelling (improve volume stability)
5. Control permeability, reduce water pressure, redirect seepage
6. Prevent detrimental physical or chemical Changes due to environmental conditions

(Freezing/thawing, wetting/drying) \
7. Reduce susceptibility to liquefaction
8. Reduce natural variability of borrow
Materials or foundation soils.

Environmental Geotechnics

Examples of desirable ground modification activities within the framework of environmental geotechnics are:

- Constructive use and if necessary modification of waste materials,
- Prevention of subsidence due to mining
- Preservation of quality and flow patterns of
ground water.

Containment and Constructive use of Waste Materials

• Ground modification techniques are also
increasingly being applied in the rehabilitation of hazardous-waste disposal areas.

• Of increasing concern to environmentally
conscious engineers is the constructive use of high-energy waste materials such as slag and fly ash. Part of this concern arises from the Estimated increase in ash production in the years to come. In the United States, it has been predicted that by next century coal burning will Produce 200 million tons of ash per year. Fly ash could be used as:

- Structural fill on its own or
- In combination with lime or cement
As a stabilizing agent for road bases.

Classification of Ground Improvement Techniques

4 Groups of Ground Improvement techniques:

Mechanical Modification: Soil density is increased by the application of mechanical force, including compaction of surface layers by static vibratory such as compact roller and plate vibrators.

Hydraulic Modification:

1. Free pore water is forced out of soil via drains or wells.
2. Coarse grained soils; it is achieved by lowering the ground water level through pumping from boreholes, or trenches.
3. In fine grained soils the long term application of external loads (preloading) or electrical forces (electro osmetic stabilization)

Physical and chemical modification:

1. Stabilization by physical mixing adhesives with surface layers or columns of soil.
2. Adhesive includes natural soils industrial byproducts or waste. Materials or cementations or other chemicals which react with each other and/or the ground.
3. When adhesives are injected via boreholes under pressure into voids within the ground or between it and a structure the process is called grouting.
4. Soil stabilization by heating and by freezing the ground is considered thermal methods of modifications.

Modification by inclusions and confinement:

1. Reinforcement by fibers, strips bars meshes and fabrics imparts tensile strength to a constructed soil mass.
2. In-situ reinforcement is achieved by nails and anchors. Stable earth retaining structure can also be formed by confining soil with concrete, Steel, or fabric elements