FINAL-TERM PAPER

SUBJECT: GROUND IMPROVEMENT TECHNICQUES

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Q.NO# 1 (A)

How do we improve soil through excavation and replacement? How & which properties of soil are modified through additives, name a few additives with their functions?

ANS:

Soils are used to support structures, to support pavement for highways, airport and dams. Some types of soils may be used in their natural state, while others may be excavated, processed, and compacted in order to serve their purpose, so the properties, characteristics, and behavior of soil must be known in order to design or construct projects involving the use of soils.
Blending and mixing heterogeneous soils to produce more homogenous soils. They may be mixed the soil during excavation by using equipment such as a power shovel or a deep-cutting belt loader to excavate through several layers in one operation. When such material is placed on a fill, it may be subjected to further blending by several passes with a disk harrow.

There are some properties have a direct effect on the ease or difficulty of handling earth , the selection of equipment, and the production rates of equipment.

Swell and Shrinkage:

When the volume of earth increases because of losing, this increase is defined as swell. It is expressed as a percent of the original undisturbed volume. If the earth removed from a hole having a volume of 1 Cu Yd. is found to have a loose volume of 1.25 Cu Yd. The gain in volume is 0.25 Cu Yd. or 25 percent when earth is placed in a fill and compacted under modern construction methods, it will usually have a smaller volume than in its original condition. This reduction in volume is the result of an increase in the density. This reduction in volume is defined as shrinkage

The plasticity index of soil with high clay content can be reduced by incorporating hydrated lime into the soil using a disk harrow or other stabilizing equipment such as the pulverize. The explanation for this soil improvement lies in a Base Exchange reaction occurring between the lime and clay particles, which cause the clay to agglomerate and become more granular and porous. After compaction a cementing reaction occurs between the lime and free silica and alumina in the clay, resulting in a substantial improvement in the strength and stability of the soil.

Asphalt such as Mc-3 or Rc-3 are mixed with granular soils, in amounts of 5 to 7 percent of the volume of soil. To produce more stable soil. The moisture content of the soil must be low at the time the asphalt is added, also the volatile oils must be allow to evaporate from the bitumen before finishing and rolling the material. Soil treated in this manner may be used as finished surface for low traffic density secondary roads or as base courses for high-type pavement.

This method is economical and convenient where the soil is clay or silt and native deposits of gravel or rock are scarce. The ratio of cement to soil is from 5 to 7 percent by weight.

QNO #1 Part B:

What are the various dewatering techniques which are generally used for ground improvement discuses briefly?

Dewatering is a process in which groundwater contained within the site’s soil is extracted, ensuring a stable foundation.
There are four methods which are generally used for dewatering to improve ground soil.

1. Open dewatering:
   It enables one to lower the groundwater table adequately in cohesive and low permeable soils. Water pumped off directly from sumps (ditches) along the toes fo the slope of the excavation work. The section hose with strainer is merely placed in the sump and the collected water primed and discharged. This makes to install and simple to operate the open dewatering system utilize.
   - Self-priming
   - Vacuum assisted centrifugal pumps.
2. Well point dewatering system:
   - Well point dewatering system enables one to lower the groundwater table adequately for deep and lager construction sites.
   - It has proven to be a very flexible system. The water form high permeable soils is pumped form well points, installed along the trench of the site.
   - The well point are jetted and spaced to obtain an efficient draw done against lowest capacity.
   - The well points with integral strainers are joined to transparent flexible loses, which are connected by quick release couplers to the ring main header pipeline.
   - Well point dewatering is done either by gravity.

QNO # 2 (A)

What do you understand about soil nailing? Under what condition the soil nailing is preferable?

ANS:

Soil Nailing is a technique to reinforce and strengthen ground adjacent to an excavation by installing closely spaced steel bars called "nails", as construction proceeds from top down. It is an effective and economical method of constructing retaining wall for excavation support, support of hill cuts, bridge abutments and high ways.
The nails are subjected to tension compression, shear and bending moments.

History of Soil Nailing:

Technique came from New Austrian Tunneling Method in 1960.
Stabilization works in underground tunnel in Europe in 1970.
The first recorded use of soil nailing in its
Modern form was in France in 1972.
The United States first used soil nailing in 1976 for the support of a 13.7 m deep foundation excavation in dense salty sands.

FAVOURABLE CONDITION OF NAILING:

Critical excavation depth of soil is about 1-2 m high vertical or nearly vertical cut.
All soil nails within a cross section are located above groundwater table.

FAVOURABLE SOILS:

Stiff to hard fine grained soils, dense to very dense granular soils with some apparent cohesion, weathered rock with no weakness planes and glacial soils etc.

UNFAVOURABLE SOILS:

Dry, poorly graded cohesion less soils, soils with cobbles and boulders, soft to very soft fine grained soils, organic soils.

ADVANTAGES:

- 1 With the right soil and site conditions, a rapid and economical means of constructing earth retention support systems and retaining walls.
- Shorter drill holes.

- Smaller diameter bars at shorter lengths.
- Retaining walls are secured laterally into the soil, eliminating piles and foundation footers.
- Grouting only once is required, saving time and labor.
- The technique is flexible, easily modified

DISADVANTAGES:

- Nail encroachment to retained ground rendering unusable underground space
- Tendency of high ground loss due to drilling technique, particularly at course grained soil
- Less suitable for course grained soil and soft clayey soil, which have short self-support time, and soils prone to creeping
- Suitable only for excavation above groundwater

CONCLUSION:

Since this process is effective in cohesive soil, broken rock, shale, or mixed face conditions it permits flexibility to conform to a variety of geometric shapes to meet specific site needs. Due to its rather straightforward construction method and is relatively maintenance free, the method has gained popularity in India for highway and also hillside development projects. Soil nailing is an economical means of creating shoring systems and retaining walls.

QNO #2: (B)

Discuss the characteristics of a grout where and why grouting is required? What is compaction grouting; discuss the advantages and disadvantages of grouting?

ANS:

Grouting is a construction materials used to embed rebar in masonry wall, connect sections of pre-cast concrete, fill voids, and seal joints. And all of these is used for to improve the ground soil. Grout is generally composed of a mixture of water, cement, sand, often color tint and sometimes fine gravel if needed. Initially, its application confines mainly in void filling, water stopping and consolidation. Nowadays, it extends to alleviate settlement of ground caused by basement and tunnels excavation works, to strengthen ground so that it can be used as a structural member to remaining structure in solve geotechnical problems. There are some types of grouting and all of them are using for one main purpose to improve ground soil to give it stranger and stability against external load.

- Cement based grout:
- pure cement grout:
- Mennonite cement grout:
- Grout with fillers:
- Silicate based grouts:
- Soft gel grout:

Grout injection method:

- Drill Hole Method:
- Drill Tool Method:
- Grout pipe Method:

- Jetting method:

COMPACTION GROUTING:

Compaction grouting involves injecting a very stiff homogeneous grout mix under relatively high-pressures and at low injection rates to subsurface locations in pre-designed patterns in order to displace and compact soils.

The injected grout pushes the soils to the side as it forms a grout column or bulb. The soil becomes increasingly dense as water and/or air are forced out and soil particles are rearranged. Grout injections can be continued until grout forces overcome overburden or containment pressures and heave occurs.

Compaction grouting can improve soft and compactable soils, stabilize or re-level existing structures, stabilize existing underground structures such as pipes and tunnels, reduce water seepage and mitigate settlement.

ADVANTAGES:

- This can be done on almost any ground condition.
- It does not induce vibration and can be controlled to avoid structural damage.
- Improvement in-ground structures can be measured.
- Very useful for limited space and low headroom applications.
- Used for slab jacking that lifts or levels the deformed foundation.
- It can be installed adjacent to existing walls.

DISADVANTAGES:

Truth be told, there are few disadvantages associated with compaction grouting. It is a very effective, affordable, and practical soil stabilization technique, and many satisfied clients throughout the region have been pleased with the success of this method when installed by Engineered Solutions. The one main disadvantage of this technique is that it is a bit messy and may require cleanup. However, when you work with Engineered Solutions, this is never an issue, as our team strives to leave your property looking as it did when we arrived, only with sturdier ground soils underneath.

QNO#3 :(A)

What are the causes for which ground improvement techniquies are under taken?

ANS:

1) prevent excessive settlements of the surface of the reclamation area when structures like buildings, roads and other foundations are loaded on it;
2) improve shear strength of the fill and subsoil to ensure sufficient bearing capacity of the foundations and/or sufficient stability of the slopes;
3) Increase the density of the fill mass and/or subsoil to prevent liquefaction; and improve soil permeability in order to increase drainage capacity.
4) improve shear strength of the fill and subsoil to ensure sufficient bearing capacity of the foundations and/or sufficient stability of the slopes; increase the density of the fill mass and/or subsoil to prevent liquefaction ;
5) To form seepage cut-off and environmental control.
6) To increase resistance to liquefaction.

QNO#3 (B)

What are the causes for which ground improvement techniquies are under taken?

Expansive Soil Can Cause Foundation Problems

Expansive soil is distinguished by the presence of swelling clay minerals that can absorb a significant amount of water molecules. When expansive soils obtain moisture, they expand or swell up. Likewise, when expansive soils lose moisture, they begin to shrink.

Since foundation walls are designed to support loads from above rather than lateral (sideways) bearings, expanding soil can cause foundation problems.

Hence, when rain or improperly channeled water enters too quickly and oversaturates your backfill soil, that excess water will exert immense pressure against your foundation walls. This is known as hydrostatic pressure.

The Problem with Hydrostatic Pressure

Water is heavy! And it can build up underneath the floor, pushing upwards against your foundation. This is known as hydrostatic pressure and will enter the home through any weak point it can find.

When that pressure bearing down becomes greater than your below ground basement or crawl space walls can handle, the affected walls will begin to crack, bow, and push inwards. As pressure continues to build over time, what starts as a hairline crack will worsen and can eventually result in extreme wall failure, typically in the form of buckling, shearing, or even complete collapse.

In addition to hydrostatic pressure caused from heavy or steady rains, factors such as expansive clay (which all homes in Georgia reside on) and water thawing too quickly after a winter freeze can also create too much stress on basement walls, causing them to crack, bow, and deteriorate.

COMMON QUESTION ABOUT FOUNDATION PROBLEMS

When you make preparations to build a home, the soil on the property may be the last thing on your mind. However, considering the soil is very important to the structure and future stability of your home. If you live in an area where the soil is primarily clay-based, you should identify

the soil's tendency to expand and contract so that you know what building materials and techniques to use. This will help you avoid certain foundation problems, including:

FOUNDATION HEAVING:

Foundation heaving is one of the most common and serious problems associated with expansive soils. As moisture collects and freezes in the soil, the soil expands. This places upward pressure on some foundations, causing them to inch upward over the years. If you notice any signs or symptoms of foundation shifting, including cracks in the walls of your home, contact a foundation repair specialist immediately.

DIFFERENTIAL SWELLING:

If parts of your foundation are more heavily loaded than others, you may experience differential swelling, which is characterized by non-uniform changes in foundation elevation. Differential swelling is more complex and oftentimes more expensive to repair than uniform swelling. Since light buildings are more likely to be affected by soil heaving and expansion than heavy, large buildings, homeowners generally have to worry more about expansive soils than commercial building owners.

QNO#4 (A)

How stone columns and blasting help soil to stabilize and gain bearing capacity?

ANS:

stone columns method:

Stone columns are extensively used to improve the bearing capacity of poor ground and reduce the settlement of structures built on them. A stone column is one of the soil stabilization methods that is used to increase strength, decrease the compressibility of soft and loose fine graded soils, accelerate a consolidation effect and reduce the liquefaction potential of soils. They are mainly used for stabilization soft soil such as soft clays, silts and silty-sands. It is believed that this method was used first in France in 1830s. This method is in wide range of use especially in Europe since 1950s. The columns consist of compacted gravel or crushed stone arranged by a vibrator. This article presents installation methods, design and failure modes of stone columns.

Stone columns are installed using either top- or bottom-feed systems, either with or without jetted water. The top-feed method is used when a stable hole can be formed by the vibratory probe. With the dry method (top or bottom-feed), the probe is inserted into the ground and penetrates to the target depth under its own weight and compressed air jetting .Most widely used methods for installation of stone columns are:

The construction of stone columns is generally carried out using either a replacement or a displacement method. In the displacement or dry method, native soil is displaced laterally by a vibratory probe using compressed air. This installation method is appropriate where ground water level is low and in situ soil is firm.

Blasting Method:

The settlement control is critical for the safety of road based on high filled embankment. The traditional construction methods have the characteristic with less soil thickness compacted at a time. There are many advantages to compact the gravel soil with blasting. The cavity in soil is formed by blasting and its fillings to form a composite foundation for the embankment.

The field data show this composite foundation can meet the requirement of loading and settlement control with less construction time. In geotechnical blasting, the high temperature due to blasting will swell the material around, so its worthy to do the coupled analysis with thermal mechanics (TM) and blasting compaction in the high filled embankment.

Then, the thermal strains got from the model are used to estimate the displacement of surrounding soil to predict the degree of compaction and optimize the distribution of blast holes in plan.

The dynamic loading due to blasting is a complex process. The blasting load can make the volume of blast hole enlarge and the fracture of soil expanded. The gas pressure and dynamic load will be reduced with volume enlargement. Finally, the explosive gas rapidly overflows and the applied force decays to zero when fractures developed to connect together.

At the beginning of blasting, the dynamic load will increase with time until it reaches the peak intensity of blasting when the detonation gas wave propagates to the bottom of blast hole. Many researches showed that the initial peak blasting load was related to the detonation wave pressure. for decoupled charges, the initial explosion pressure was also related to the ratio of the blast hole diameter and the charge diameter.

QNO#4(B)

Which types of ground improvement would be used in black cotton soil and why?

ANS:

In rainy season black cotton soil absorbs water heavily which results into swelling and softening of soil. In addition to this it also loses its strength and becomes easily compressible.
Stabilization is the process of improving the engineering properties of soil and making it more stable.
Black cotton soils are boon to agriculture but are proved to be serious threat to construction founded on it. These soils have the property of high swelling due to imbibing of water in monsoon and shrinkage due to evaporation of water in summer seasons. This swelling and shrinkage nature is attributed to the presence of mineral montmorillonite. Because of this high swelling and shrinkage nature, the structures constructed on these soils experience cracks, making it unsuitable for foundation. Hence there is a need for improving black cotton soil to suite as foundation material.
Over the past few decades, stabilization is found to be the best technique for reducing the swelling and shrinkage nature of black cotton soil. Various researchers had tried stabilizing black cotton soil using lime, cement, fly ash, rich husk ash, etc. Of these, lime stabilization is one of the techniques which is in use for stabilizing black cotton soil from the past few decades. Use of lime reduces the high plasticity of black cotton and makes it workable.