Final Term Exam Paper

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Subject: Ground Improvement Techniques

Specialization: Construction Engineering and Management

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Q1. 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: Soil excavation and reclamation are fundamental steps of infrastructure development. They include the cut and fill of inclined grounds to create usable flat lands, removing soils to install foundations to support buildings and superstructures, filling lowlands to create vertical distance from the sea and river water head and constructing embankments to mitigate flood disaster. In particular for the re-development of urbanized areas, where the use of underground space is unavoidable since finding new land space is usually difficult, few construction works for infrastructure can be possible without excavation. As a result, excavated surplus soils are generated in large quantities. The generation of such soils nationwide was estimated to be about 140 million m^3 in 2012, according to the Japanese Ministry of Land, Infrastructure, Transport and Tourism.

The management of such excavated soils discharged through construction works is therefore an important consideration in geotechnical and geo environmental engineering. Reuse of excavated soils either at the generating sites or at different places has been promoted, because disposal of unusable soils at landfill sites should be minimized due to the limited capacity of landfills. Limitation of available natural resources, as well as land spaces for landfills, has strongly promoted the reuse of materials in Japan. Reuse of materials in construction works has particularly attracted great attention because of the large capacity for application as well as the large generation of by-products including excavated soils.

Stabilization through chemical additives, such as lime, cement, and fly ash, modifies the soil properties, resulting in a stronger foundation-supporting infrastructure.

The most effective additives were sodium carbonate, sodium hydroxide, sodium sulfate, and potassium permanganate. The trace quantities of these additives improved the strength of the soil-cement in excess of 150 percent for the two silts.

Q1. B) **What are the various dewatering techniques which are generally used for ground improvement discuss brief?**

Ans: Various Dewatering techniques:

- Groundwater Control
- Dewatering Techniques
- Well Construction & Drilling
- Pumping Tests
- Well Remediation and Rehabilitation
- Emergency Drinking Water Supply
- Solar Water Pumping
- Geothermal Systems

Dewatering involves controlling groundwater by pumping, to locally lower groundwater levels in the vicinity of the excavation.
The simplest form of dewatering is sump pumping, where groundwater is allowed to enter the excavation where it is then collected in a sump and pumped away by robust solids handling pumps. Sump pumping can be

effective in many circumstances, but seepage into the excavation can create the risk of instability and other construction problems.
To prevent significant groundwater seepage into the excavation and to ensure stability of excavation side slopes and base it may be necessary to lower groundwater levels in advance of excavation. This is known as 'pre-drainage'.

Pre-drainage methods include:

- Deep wells
- WellPoint's
- Educators
- Vacuum wells
- Horizontal wells

Other specialist dewatering techniques are also sometimes used:

- Relief wells
- Artificial recharge
- Siphon drains

The selection of the dewatering technique or techniques at a particular site or country will depend on many factors. Groundwater Engineering's team has decades of experience in dewatering projects around the world, and we provide a complete design and installation service to control your groundwater problems.

Q2. A) **What do you understand about soil nailing? Under what condition the soil nailing is preferable?**

Ans: Soil nailing is a construction remedial measure to treat unstable natural soil slopes or as a construction technique that allows the safe over-steepening of new or existing soil slopes. The technique involves the insertion of relatively slender reinforcing elements into the slope – often general purpose reinforcing bars (rebar) although proprietary solid or hollow-system bars are also available. Solid bars are usually installed into pre-drilled holes and then grouted into place using a separate grout line, whereas hollow bars may be drilled and grouted simultaneously by the use of a sacrificial drill bit and by pumping grout down the hollow bar as drilling progresses. Kinetic methods of firing relatively short bars into soil slopes have also been developed. Bars installed using drilling techniques are usually fully grouted and installed at a slight downward inclination with bars installed at regularly spaced points across the slope face. A rigid facing (often pneumatically applied concrete, otherwise known as shot Crete) or isolated soil nail head plates may be used at the surface. Alternatively a flexible reinforcing mesh may be held against the soil face beneath the head plates. Rabbit proof wire mesh and environmental erosion control fabrics and may be used in conjunction with flexible mesh facing where environmental conditions dictate.

Soil nail components may also be used to stabilize retaining walls or existing fill slopes (embankments and levees); this is normally undertaken as a remedial measure.

Based upon these favorable conditions for soil nailing stiff to hard fine-grained soils which include stiff to hard clays, clayey silts, salty clays, sandy clays, and sandy silts are preferred soils. Sand and gravels which are dense to very dense soils with some apparent cohesion also work well for soil nailing. Weathered rock is also acceptable as long as the rock is weathered evenly throughout (meaning no weakness planes). Finally, glacial soils work well for soil nailing.[4]

A list of unfavorable or difficult soil conditions for soil nailing can include dry, poorly graded cohesion-less soils, soils with a high groundwater table, soils with cobbles and boulders, soft to very soft fine-grained soils, highly corrosive soils, weathered rock with unfavorable weakness planes, and loess. Other difficult conditions include prolonged exposure to freezing temperatures, a climate that has a repeated freeze-and-thaw cycle, and granular soils that are very loose.

Q2. 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: Characteristics of grout:

There are four main characteristics for a grout mixture including bleeding, setting time, strength, and viscosity. In this paper, we try to build some efficient grouting mixtures with different water to cement ratios considering these characteristics.

Grouting refers to all work to be carried out to properly fill the space between concrete surfaces and base plates of equipment, steel structures or concrete prefabricated elements. In concrete foundations (particularly machine foundations) grouting is used to achieve adequate transfer of horizontal and vertical forces. Generally grouts are used for repair works, bonding of concrete surfaces and to act as a medium of force transfer from objects (equipment, machine, superstructure, etc) to the foundation.

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.

Advantages of Grouting:

• 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 of Grouting:

• It is a very effective, affordable, and practical soil stabilization technique.

• Any 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.

Q3. A) **What are the causes for which ground improvement techniquies are under taken?**

Ans: CAUSES FOR GROUND IMPROVEMENT TECHNIQUES:

- To prevent excessive settlements of the surface of the reclamation area when structures like buildings, roads and other foundations are loaded on it;

- To improve shear strength of the fill and subsoil to ensure sufficient bearing capacity of the foundations and/or sufficient stability of the slopes;
- T increase the density of the fill mass and/or subsoil to prevent liquefaction; and
- To improve soil permeability in order to increase drainage capacity.

The specific techniques that can be utilized for ground improvement are:

- preloading or surcharging with sand, either with or without vertical drains;
- various compaction techniques including vibratory methods,
- soil removal and replacement, stone columns, and geotextile encased sand columns; and
- In-situ admixtures like lime cement and fly ash.
- Ground Improvement by Vibration
- Ground Improvement by Adding Load or Increasing Effective Stress Ground Improvement by Structural Reinforcement
- Ground Improvement by Structural Fill

Q3. B) **Identify various geotechnical problem of expansive soil?**

Ans: Expansive soil or clay is considered to be one of the more problematic soils and it causes damage to various civil engineering structures because of its swelling and shrinking potential when it comes into contact with water. Expansive soils behave differently from other normal soils due to their tendency to swell and shrink. Because of this swelling and shrinking behavior, expansive soils may cause the following problems in structures or construction projects:

- Structural damage to lightweight structures such as sidewalks and driveways

- Lifting of buildings, damage to basements, and building settlement
- Cracks in walls and ceilings
- Damage to pipelines and other public utilities
- Lateral movement of foundations and retaining walls due to pressure exerted on vertical walls
- Loss of residual shear strength causing instability of slopes, etc.

Therefore it is essential to check for the presence of expansive soil and a suitable treatment method should be adopted before commencing any construction projects. In some cases post construction treatment of expansive soil may be required if the situation has not been dealt with before construction.

Q4. A) **How stone columns and blasting help soil to stabilize and gain bearing capacity?**

Ans: 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.

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. In this paper, a 3D model is built with FLAC3D to simulate a single hole to predict the range and degree of thermal propagation. 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.

Installation of stone column is a viable, cost effective, and environmentally friendly ground-improvement technique. Columns are made of compacted aggregate and are installed in weak soil as reinforcements to increase the shear resistance of the soil mass and, accordingly, its bearing capacity.

In blasting, the temperature at the center of hole can reach as high as 3000°C, so the temperature influence on surrounding soil cannot be ignored. The temperature is related to the gas pressure. In this paper, based on the analysis of the change of blasting pressure, the volume expansion of the blast hole, the development of fracture in soil, and the motion of blasting gas were analyzed in the accurate mathematical model. The shape of blasting load changing with time was established. Finally, the field monitored data of blasting compaction were used to compare with the results of 3D model considering the TM coupled effect and verified the usefulness of 3D model to predict the settlement of high filled embankment.

Q4. B) **Which types of ground improvement would be used in black cotton soil and why?**

Ans: In dry conditions the black cotton soils have high strength which is almost completely lost when they come in contact with water. These soils are having high degree of expansion which creates a lot of problems during the execution of work and after completion of it. Hence, the stabilization of such soil is prime importance. Attempts have been made to stabilize these soils by using different materials such as lime, cement, asphalt etc. Industrial wastes such as fly ash, furnace slag can also be used for this purpose. In order to improve the engineering and index properties of soil, the experiments have been conducted with industrial

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. The ultimate bearing capacity of the single stone column is influenced by the column's friction angle and the undrained shear strength of the surrounding soil. The effect of modular ratio is small and can be ignored, especially when E_c/E_s is larger than 20. Black cotton soil is a highly clayey soil. They are found in many parts of the world; such kind of soil generally consists of active clay minerals. Geotechnical engineers face various problems while designing foundation, because the black cotton soil possess poor bearing capacity and excessive settlement. To overcome those problems researches concentrated on soil improvement techniques by adding fibers. The main objective of our project is to investigate the use of pili (human hair) and lime in geotechnical applications and to evaluate the effects of pili and lime with black cotton soil. The various percentages of pili (0.5%, 1%, 1.5%, 2%) and lime (3%, 6%, 9%, 12%) are mixed with black cotton soil to enhance the ground improvement. This project includes testing and comparison of Atterberg's limit, Standard Proctor Compaction, Unconfined compressive strength by curing of normal black cotton soil with stabilized black cotton soil and determining optimum dosage of lime and pili to be added to soil.wastes of steel foundry called as furnace slag plus black cotton soil. The results show that 20% addition of slag to black cotton soil is the optimum proportion to improve almost all properties of soil. For 20% addition of slag, the CBR increase from 3–6%. The pavement design and cost analysis of such slag stabilized soil shows reduction in the cost of construction of pavement by 10.58% as compared to pavement construction by only black cotton soil as subgrade.