IQRA National University

Civil Engineering Department

MS Water Resources Engineering & Management

Ground improvement techniques

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Part one:

(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?

Answer:

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 constructions 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 m3 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.

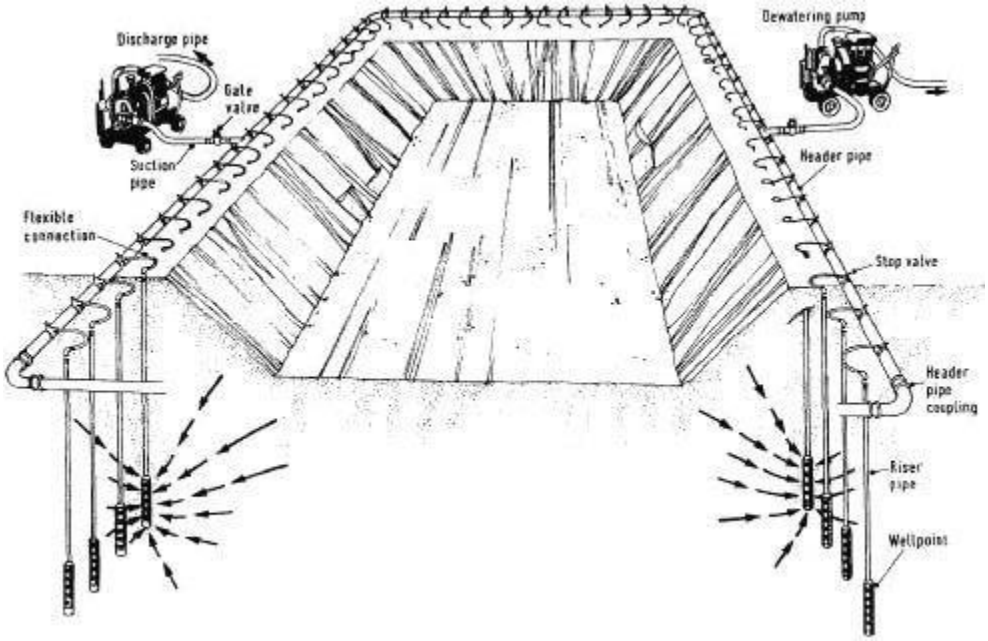
(b) What are the various dewatering techniques which are generally used for ground improvement discuss brief?

Answer:

There are four important dewatering methods one should be aware of:

- Wellpoint method of dewatering,
- Eductor wells,
- Open sump pumping and
- Deep wellpoint method

- **Wellpoint Method of Dewatering Excavations**

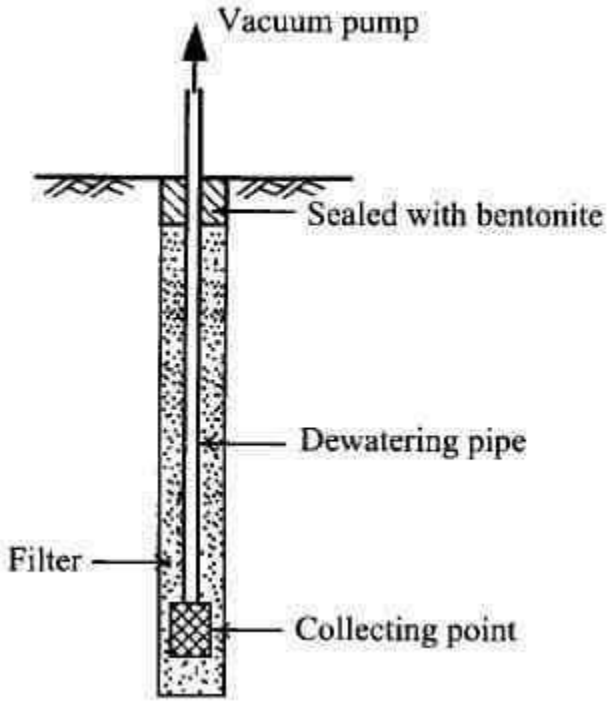


1) A series of wells of required depth are created in the vicinity of the excavated area from where the water has to be pumped out. The wells are arranged either in a line or a rectangular form where the wellpoints are created at a distance of at least 2m from each other.

2) Riser pipes or dewatering pipes are then installed into those closely spaced wells which on the surface are connected to a flexible swing pipe which is ultimately appended to a common header pipe that is responsible for discharging the water away from the site. The purpose of using a flexible swing pipe is just to provide a clear view of what is being pumped and the purpose of header pipe is to create suction as well as discharge the water off the working area.

3) One end of the header pipe is connected to a vacuum pump which draws water through notches in the wellpoint. The water then travels from the wellpoints through the flexible swing pipe into the header pipe to the pump.

4) The drawdown using this method is restricted to around five to six meters below the wellpoint pump level. If a deeper drawdown is required, multiple stages of wellpoints must be used.

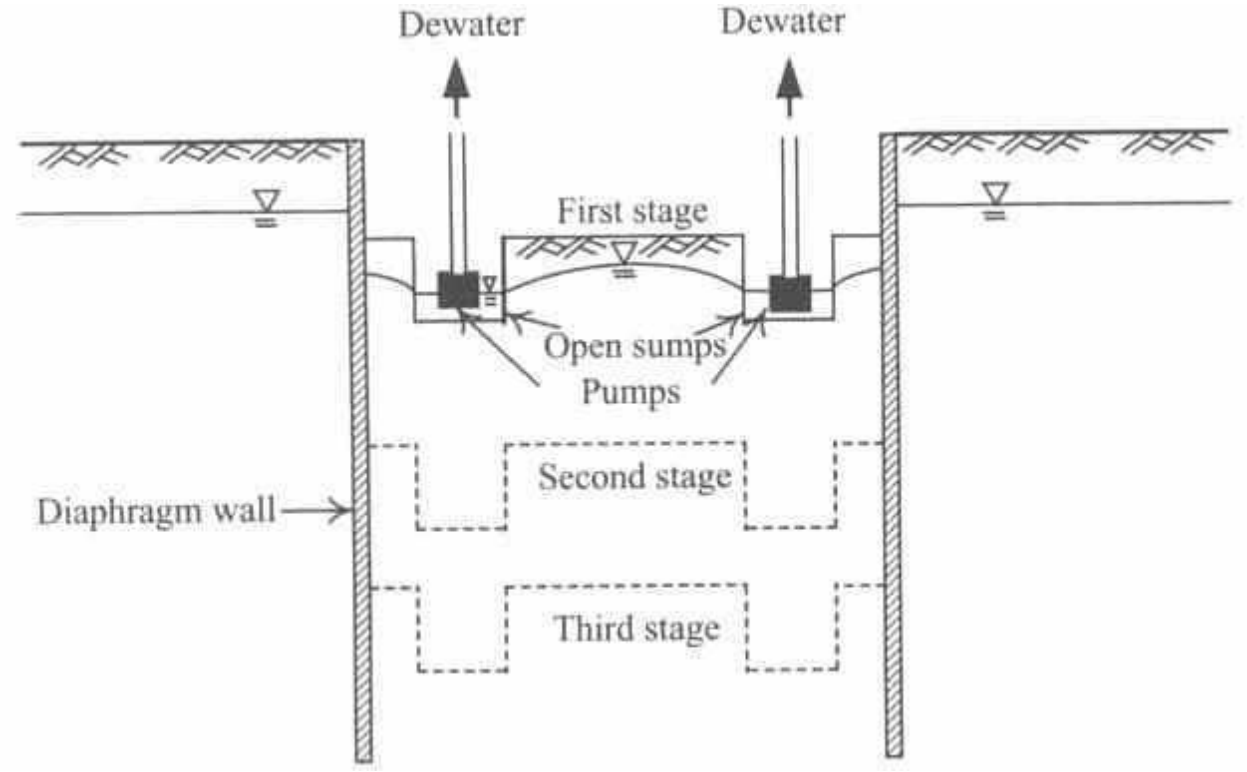


Eductor Wells Method of Dewatering Excavations

The method is very similar to the wellpoint method of dewatering; the only difference lies in the usage of high-pressure water in the riser units instead of vacuum to draw out water from the wellpoints. The method uses the venturi principle which is the reduction in fluid pressure that results when a high-pressure fluid flows through a constricted section of a pipe.

Open Sump Pumping Method of Dewatering Excavations

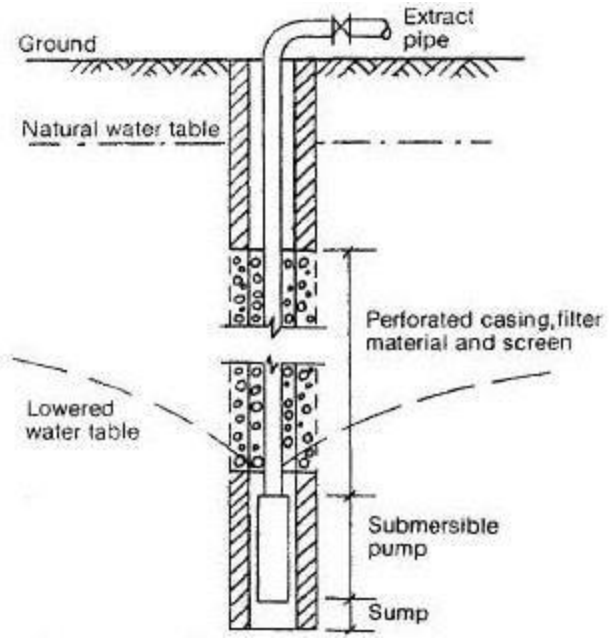
This is the most common and economical method of dewatering as gravity is the main playing force. Sump is created in the excavated area into which the surrounding water converges and accumulates facilitating easy discharge of water through robust solid handling pumps.



Deep Well Method of Dewatering Excavations

Just like the wellpoint method, wells are drilled around the excavated area, but the diameter of wells, in this case, varies between 150-200mm. By creating deep wells around the vicinity, the groundwater is made to fall into them under the influence of gravity.

As a result, the groundwater level in the surroundings would decline. According to the type and arrangement of pumps, the depths of the wells could reach up to 30m. This method is generally adopted when a heavy amount of water from the ground has to be drawn out.



Part Two

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

Answer:

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. Kinetic methods of firing relatively short bars into soil slopes have also been developed.

Based upon these favorable conditions for soil nailing stiff to hard fine-grained soils which include stiff to hard clays, clayey silts, silty 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.

(b) Discuss the characteristics of a grout where and why grouting is required? What is compaction grouting, discuss the advantages and disadvantages of grouting?

Answer:

There are four main characteristics for a grout mixture

1: including bleeding

2: setting time

3: strength

4: viscosity

we try to build some efficient grouting mixtures with different water to cement ratios considering these characteristics. Common uses for grout in the household include filling in tiles of shower floors and kitchen tiles. It is often color tinted when it has to be kept visible and sometimes includes fine gravel when being used to fill large spaces (such as the cores of concrete blocks).

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.

Advantages

- Compaction grouting causes minimal disruption to the landscape, surrounding soils, and nearby structures.
- This technique can be utilized for projects that have limited access and require more delicate installations.
- It is cost-effective and easy to install compared to some other soil stabilization and ground-shoring methods.
- Engineered Solutions has used this versatile technique on a variety of projects, and it has successfully strengthened ground soils in each instance.

Disadvantages

- 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.

Part Three

(a) What are the causes for which ground improvement techniques are under taken?

Answer:

REASONS FOR GROUND IMPROVEMENT: Ground improvement is carried out to prevent excessive settlements of the surface of the reclamation area when structures like buildings, roads and other foundations are loaded on it; 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; and improve soil permeability in order to increase drainage capacity.

(b) Identify various geotechnical problem of expansive soil?

Answer:

is important to identify expansive soils using indirect features before analyzing samples in laboratory. One kind of expansive soil is vertisol, which has characteristic feature landforms in aerial photographs whereas in the field work it is common to observe surface cracks.

Soils are composed of a variety of materials, most of which do not expand in the presence of moisture. However, a number of clay minerals are expansive. These include: smectite, bentonite, montmorillonite, beidellite, vermiculite, attapulgite, nontronite, and chlorite.

Part Four

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

Answer:

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.

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

Answer:

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.