GROUND IMPROVEMENT TECHNIQUES.

Pir Ahmad Ali Shah
ID: 13573
MS- Construction Managment.

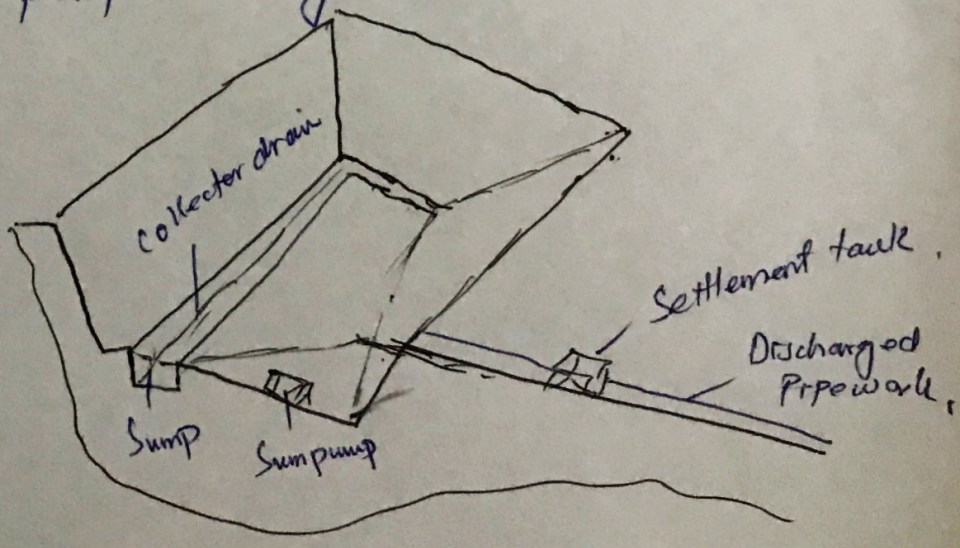
Qu: b) What are various dewatering techniques which are generally used for ground improvement? discuss brief?

Ans The dewatering techniques which are used for ground improvement is as following.

1. Sump Pumping
2. well points
3. Deep Wells.
4. Ejector Wells.

1 Sump Pumping:

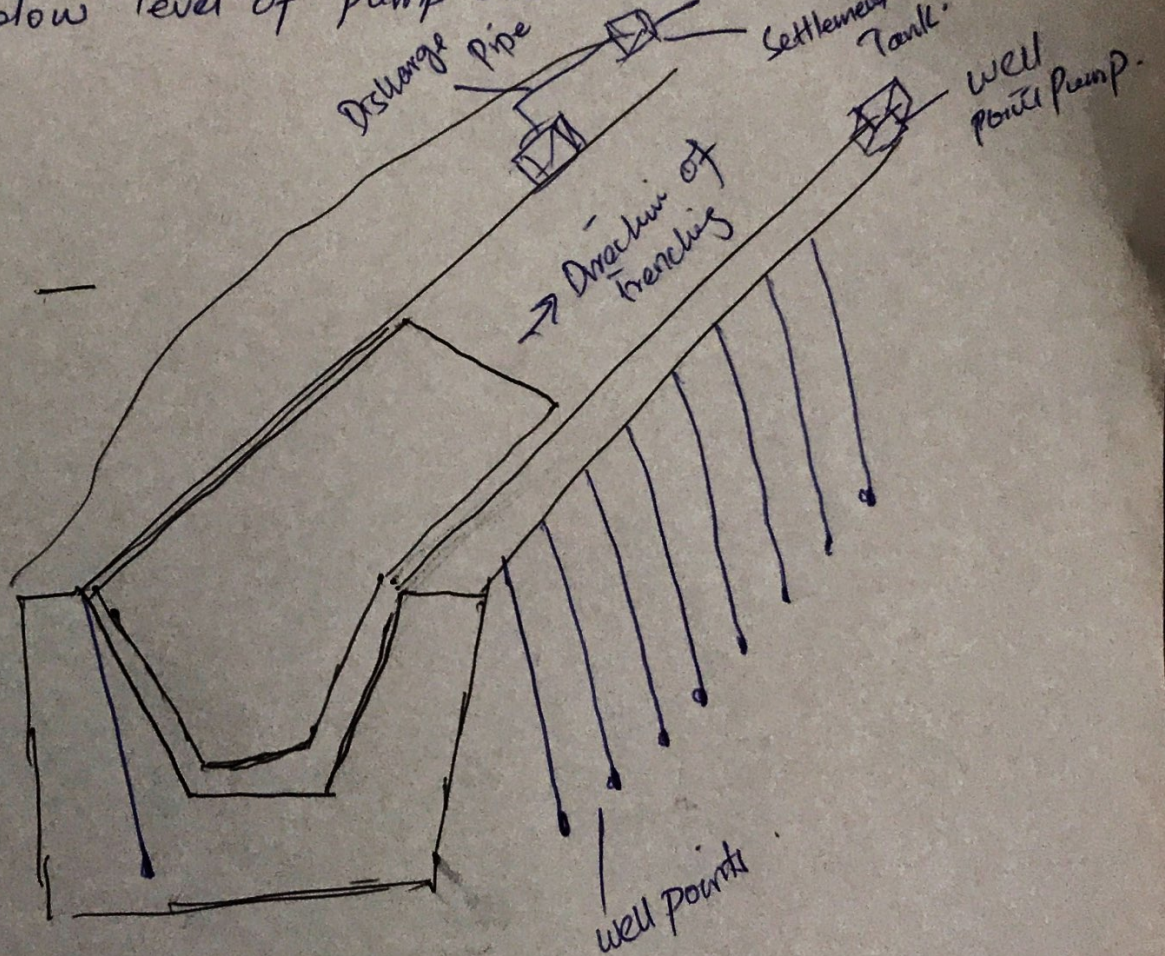
In this method the water of the ground is collected in deeper parts of the excavation which are known as sumps. The sump pumping method is generally used in coarse soils or fissured rock. The sump pumping if carried in grained soils it would result in erosion and would also result in loss of fine particles which ends up in unstability of soil. The ~~pumps~~ water in the excavation is pumped away. It is known as sump pumping



(3) Well Points

A line of small diameter shallow wells which are known as well points. These are installed in close spaces about 1 to 3m around the excavation.

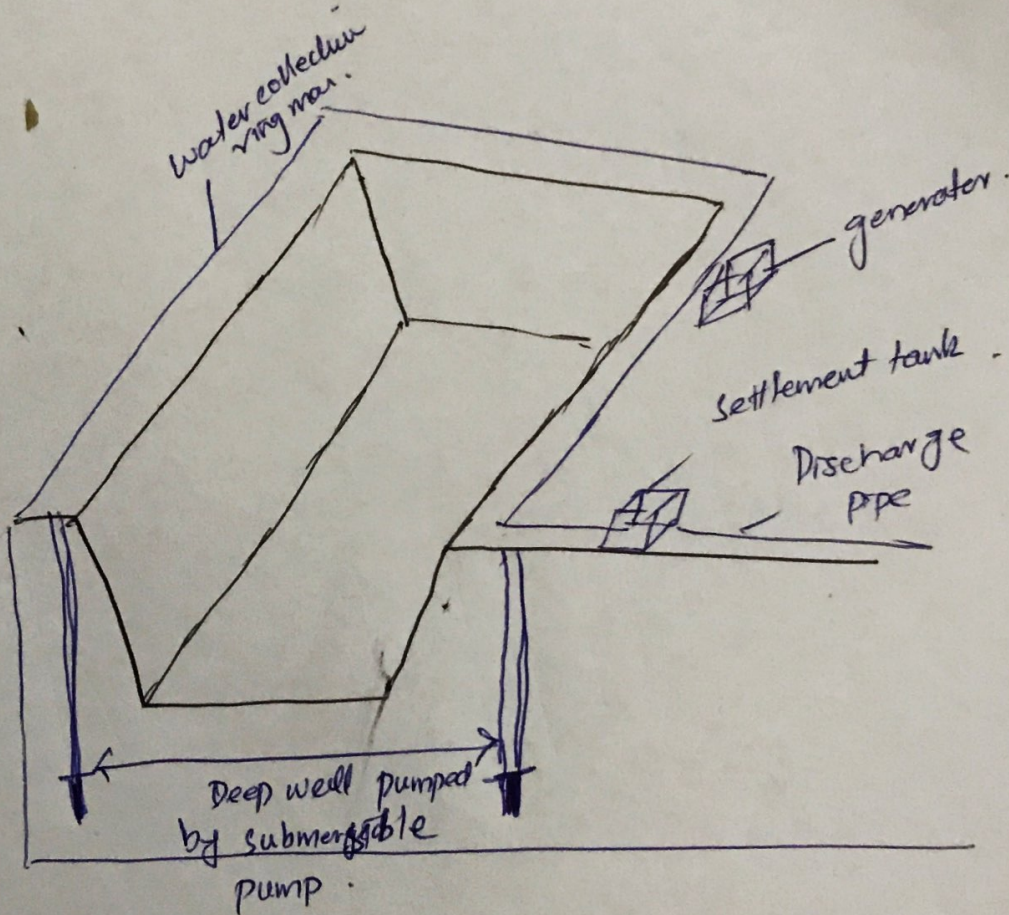
The well points are flexible and effective method of dewatering in sands & gravels. This is used for dewatering of pipeline trenches. Draw down is limited to 5 or 6m below level of pump due to suction.



③ Deep Wells.

In this method ~~deep~~ wells are drilled at the spacing of 10 to 60 m between each well to form a ring around the outside of the excavation. An electric submerged pump is installed in each well. Draw down limited only by well depth and soil stratification.

The method is effective in wide range of ground conditions such as sands, fissured rocks and gravels.

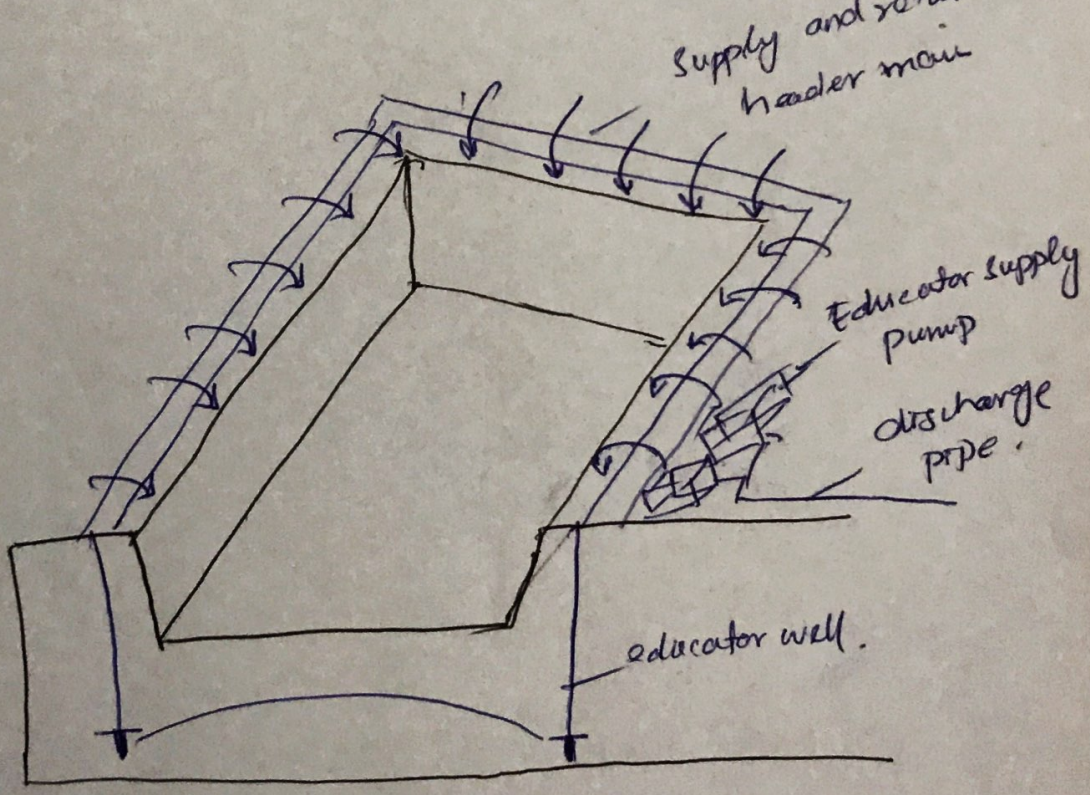


Eductor Well.

~~The~~ eductor well methods well are drilled around or alongside the excavation. The method is only feasable when the well yield is low. The flow capacity limits from 30 – 50 Litres / min per well.

The method is effective in stabilising fine soils like silty sands, silts by reducing the pore water pressure. Drawdown is limited to 25 to 30cm below the pump level.

In low permeability of soils vacuum of 0.95 Bar can be generated in the well.



Q.) (a) Improving of Soil by excavation & replacement (5)

Soil excavation and replacement is one of the oldest and simple method which improve the bearing soil conditions. The foundation condition can be improved by replacing & excavating poor soil (e.g organic soils and medium or soft clay (with more competent materials such as sand, gravel or crushed stone as well nearly any soil can be used in fillings. However, some soils are more difficult to compact then others when used as a replacement layer.

The use of excavation and replacement soil under shallow foundation can reduce consolidation settlement and increase soil bearing capacity. It has some advantages over other techniques and deep foundation as it is more economical and it requires less delay of construction.

~~How it can improve~~ Soil Modification

It is sometimes refered to as mud ~~dying~~ drying. However, soil modification can result in other significant improvement ~~as~~ in soil properties as well. Often subgrade soil are too wet exhibiting poor workability and lacking sufficient strength to support construction equipment. Chemical additives such as lime fly ash and cement can be added to these soils to improve the workability of soil.

It refers to the process of adding ~~to the above~~

and mixing the above chemical agents with the soil to not only dry the soil, improving workability, but also reducing the plasticity Index (PI) and shrink. Swell potential. These improvements often results in slight increase in the shear strength of the soil.

There are two types of soil stabilization

1) Chemical
2) Bituminous.

(*) Few additives to improve soil stabilization using additives

Certain Material such as lime bitumen, fly ash and cement etc are added onto soil at site to improve its characteristics. These may be classified into the following

*) Lime Stabilization

lime can be used to treat soils in order to improve their workability and load bearing characteristics in a no of situations. Quicklime delays the reaction time with soil by about 1.25 times the time taken by slaked lime. Use of lime as a stabilizer enhance the long term permanent strength, stability and stiffness particularly with the action of water and frost.

Once the soil has be cured using lime, important works such as creating embankments or subgrade structures can be done with them, hence avoiding expensive works like excavation and transport. Generally, 2-8% of lime may be required for coarse grained soils.

2) Cement Stabilization

Soil reacts with cement and the hard mixture obtained from the reaction of pulverized soil. Portland cement and water is known as soil-cement. The cementing action is said to be the result of chemical reactions of cement with siliceous soil during hydration reactions. The technique is used in shallow depth stabilization in the case of highways and embankment material and in the stabilization of weak soils at a greater depth such as soft soils and poaty soils

(3) Fly Ash Stabilization

Fly ash being a waste product of thermal power plants is generally used in a variety of operations. Around 65% of the fly ash is utilized in the manufacturing of bricks and cement. Hence despite having lesser cementatious properties than in lime and cement, the abundance of fly ash has made it an increasingly popular & alternative during recent years. The fly ash is used potentially as a subgrade stabilizer and in land reclamation.

(4) Soil Bitumen Additives
- Sand bitumen
- Soil "
- Soil Aggregate
- Spraying bitumen.

(5) Soil Aggregate Mixture.

(6) Sand Clay Mixture.

(7) Sand Gravel Mixture.

(8) Soil - Lime Stabilization

(9) Chloride Stabilization

Q No (8) (a) What do you understand about soil nailing? Under what conditions the soil nailing is preferable. (9)

Soil Nailing

*) Background. This originated from NATM (New Austrian Tunneling Method in 1960). The first use soil nailing was don at France in 1972.

*) Explanation

Soil Nailing is a technique to reinforce and strengthening ground adjacent an excavation by installing closely spaced steel bars known as nails. The construction proceeds from top to bottom. The nails are subjected to tension, compression, shear and bending moments.

Soil Nailing is economical and effective method for retaining soils ~~in~~ after excavation. It also supports hill cuts, bridge abutments and highways.

*) Types of Nails

① Driven Nails
② Grouted Nails
③ jet grouted Nails
④ Launched Nails
⑤ Corrosion Protected Nails.

*) Equipment & Machinery For Soil Nailing

*→ Equipment:

- Compressor → To pump the concrete & To stroke the Nail.
- Grout Mixer → Batching of Concrete.
- Drilling Equipment → To undergo bore in strata.

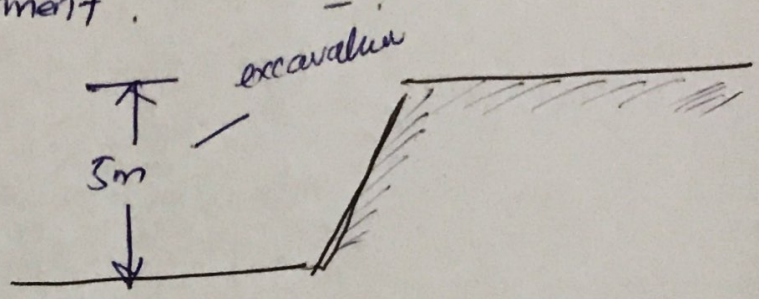
*) Material.

- Concrete
- Shortcrete
- Steel
- Base plate
- Wedge plate
- hooks
- Nails.

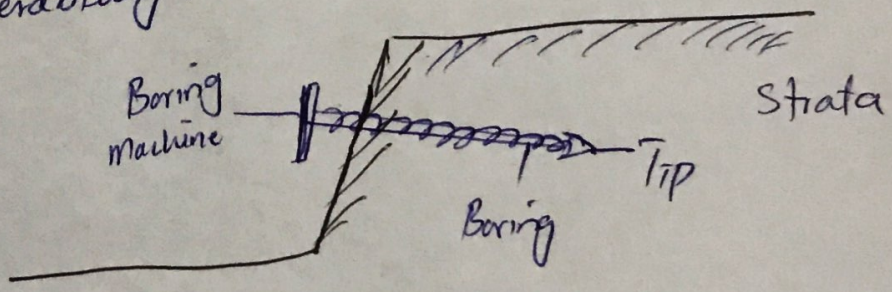
(10)

*) Construction Methoddogy

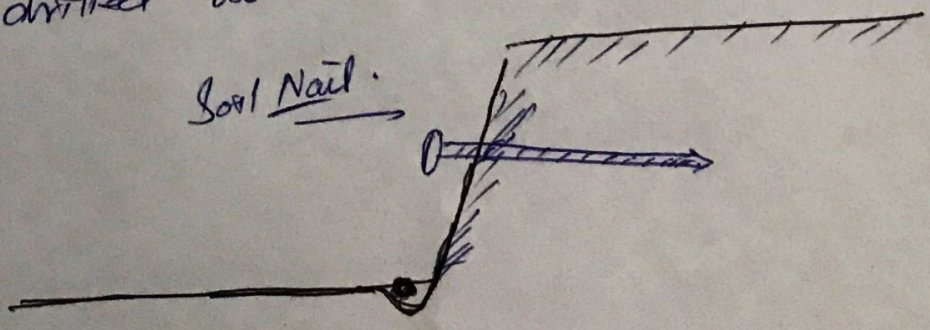
- Step 1 Excavation to be carried out as per construction requirment.



- Step 2. A hole is drilled in the soil strata that is subject to vulnerability.



- Step 3 A nail is installed inside the bore. The bore which is drilled in the vulnerable soil strata.

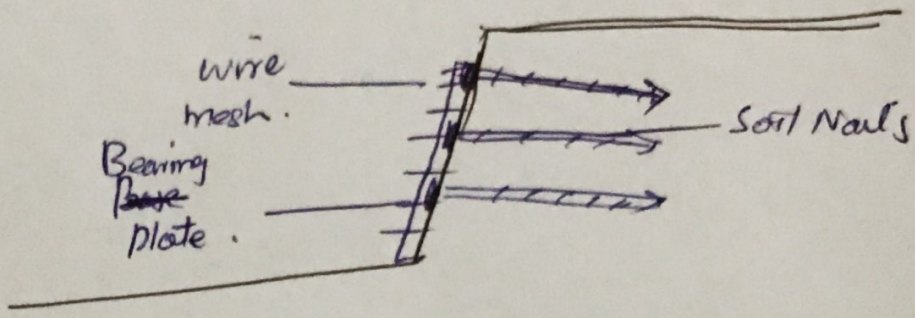


- Step 4.

The nail which is potruded inside the ~~boun~~bore hole is filled with concrete / grout to fix the nail inside the bore. (4)

- Step 5

After the ~~grount~~ grout is carried out a wire mesh is installed along the soil strata, To fix / stabilize the material.



- Step 6. After the wire mesh is installed over the vulnerable strata the shortcreting is carried out with the help of concrete pump. And facing is established.

*) Favorable conditions for Soil Nailing

Soil Nailing can be carried out in the following favorable conditions.

① Soil Nailing used in when soil is dense to very dense granular soils.
② Can be used in weathered rocks with no weak planes.
③ Can be used in ~~clay~~ to ~~very dense~~ Stiff to hard grained soil.
④ Soil Nails ~~st~~ must be above ground water table.
⑤ Can be used in existing concrete / masonry structures.
⑥ On tunnels portals in unstratified and steep slopes.

7) Can Used in retrofitting of girders and abutments of the bridges. (12)

8) ~~Deep~~ Can be used in deep excavations for high rise buildings in case soil is dense or granular.

9) Can be used and favorable for cutting of steep highway slopes.

Q No (8)(B) Discuss characteristics of grout where and why grouting is required? What is compaction grouting. Discuss Advantages and dis advantages. (13)

Sol Grouting

Grouting is the process to inject a slurry or liquid solution ~~into~~ (grout) into a soil or rock formation. Subsequently, it hardens and increases the strength and decreases compressibility and permeability.

*) Characteristics of Grout.

Mainly there are 5 characteristics of grout.

1. Groutability
2. Stability
3. Permanence.
4. Toxicity
5. Setting Time

① Groutability: It is used to obtain satisfactory performance, grain size distribution should be known because it shall show relationship b/w the grout particles size and void dimensions.

Pumping pressure should not be large enough for particles of ~~size~~ soil to be distributed. Grouting pressure is limited to 20 kN/m². Quality of a grout must be sufficiently fluid to enter the soil quickly

The movement should not be too fast. The rate of injection of grout depends upon. (14)

- Viscosity of the grout.
- permeability of soil
- Shear strength of soil

② Stability

Capacity of grout to remain in a fluid state and not seggregate into seperate components.

③ Setting Time

Time required for the grout to set into cemented mass or gel. Early setting causes difficulty in the grout reaching its destination. Late setting causes the grout being washed away if seepage is occuring through soil.

④ Permanence.

Resistance to the grout possesses against being displaced from the soil voids with the time.

⑤ Toxicity

capacity of grouts to contaminate the grout in water

8) Where and why grouting is required.

Grouting is suitable where soil permeability would create a heavy demand on pumping or where ground conditions mean it may be economically insufficient to bore wells. Grout may also be used in the formation of pile foundations, ground anchors, under rimming, under-pinning in road construction, dam construction and other applications.

Different material may be used for grouting depending upon factors such as the soil or rock type and area to be grouted. However, the basic process is the same.

The soil and rock is injected with fluid grout which sets and reduces or act as a sealant on the material's permeability.

Grouting is relatively costly and so wastage must be controlled. This is achieved by the use of additives which improves the gelling properties of the grout and limit its spread through the ground.

*) Compaction Grouting

Compaction grouting is a process that involves injecting of very stiff homogeneous grout mix under relatively high pressures and at low injection rates to sub-surface location in pre-designed patterns in order to displace and compact soils.

*) Advantages of Compaction Grouting

The advantages of Compaction grouting is as follows:

① Compaction grouting causes minimal disruption to the landscape, surrounding soil and nearby structures.

② The technique can be utilized for project that have limited access and require more delicate installations

③ It is cost-effective and easy to install. In comparison to some other soil stabilization and ground shoring methods.

④ Engineering solutions has used this versatile technique on a variety of project and it helps in strengthening of ground soil.

Disadvantages-

1. The main disadvantage of this method that. It is messy.
2. This method requires clean up.
3.

Q No (3) (A) What are the causes for which ground improvement techniques are under taken? (18)

Need of Ground Improvement.

As more and more land become subject to urban or industrial development, good construction sites and borrow areas are difficult to find and the soil improvements alternatives becomes the best option, technically & economically.

where a project encounter difficult foundation condition possible alternative solutions are.

1. Avoid the particular site
2. Relocate a planed highway or developed site.
3. Design the plan structure accordingly.
4. Remove and replace unsuitable soil.
5. Attempt to modify the existing soil.

Causes / Objective of ground improvement

The most common causes include improvement of the soil and ground for use of foundation and construction material

1. To increase shear strength, durability, stiffness and stability
2. To mitigate undesirable properties (eg shrink swell potential, compresibility)
3. To modify permeability, the rate fluid to flow through a medium.

(4) Improving Efficiency productivity by using method by saving time and expenses.

* Major Causes.

- To improve the bearing capacity of soil.
- To control deformation and accelerate consolidation
- To increase resistance liquefaction.
- To provide lateral stability.
- To form seepage cut off and environmental control.

Q3) (b) Identify various geotechnical problem of expansive soil. (20)

Expansive soil is considered to one of the most 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 behaviour, expansive soils may cause the following problems in geotech

(1) It losses the residual shear strength causes instability of slopes.

(2) Expansive soils expand and contract due to change in moisture content of the soil, causing structural problems through differential movement of the foundation. It also results swelling and shrinkage which can result in high shrink swell and also damage various structures constructed on or in these expansive soils.

(2) Expansive soils adds in the additional horizontal pressure applied to foundation walls in basements and crawl spaces.

(3) Also increased water content in the soils adjacent to foundation wall will cause the soils to expand and increase the lateral pressure on foundation wall.

(5) Another effect / geotechnical problem of expansive soil (2)

5) The movement of soils on unstable slopes. Expansive soils found as a layer under a more rigid top layer of soils, become unstable as the morsture content increases, allowing the expansive soil and top layers of soil to move. If the soil is located on a slope the top layer of the soil can creep. Resulting in failure of the structure.

6) Lateral movement of foundations and retaining walls due to pressure exerted on vertical walls.

7) Lifting of building is result of the expansive soils.

8) It can also result in building settlements.

9) Expansion of soils can lead to cracks in wall and ceilings.

Q(4)(A) How stone columns and blasting help soil to stabilize and gain bearing capacity? (22)

→ Stone column act as vertical drain and thus speeding up the process of consolidation, replaces the soft soil by a stronger material and initial compaction of soil during the process of installation. thereby increasing the unit weight. Stone column also mitigate the potential for liquefaction and damage by preventing build up high pore pressure by providing drainage path.

Stone column when using sensitive clays, ~~to~~ stone columns has certain limitations. there is increase in the settlement of bed because of the absence of the lateral resistance. The clay particles get ~~g~~ clogged around the stone column thereby reducing radial drainage. To overcome the limitation and to improve the efficiency of the stone column with respect to the strength or the compressibility, stone columns are incased using geogrids / geocomposite.

→ Blasting principal is that the blasting of explosives in a predetermined pattern cause liquefaction followed by the expulsion of pore water and subsequent densification of the ground.

Blast densification is being utilized for more than 80 years to densify loose sand deposits.

The aim of this ground improvement technique is to densify and improve the engineering characteristics of loose sand deposits and thus prevent or minimize the effects of liquefaction during an earthquake.

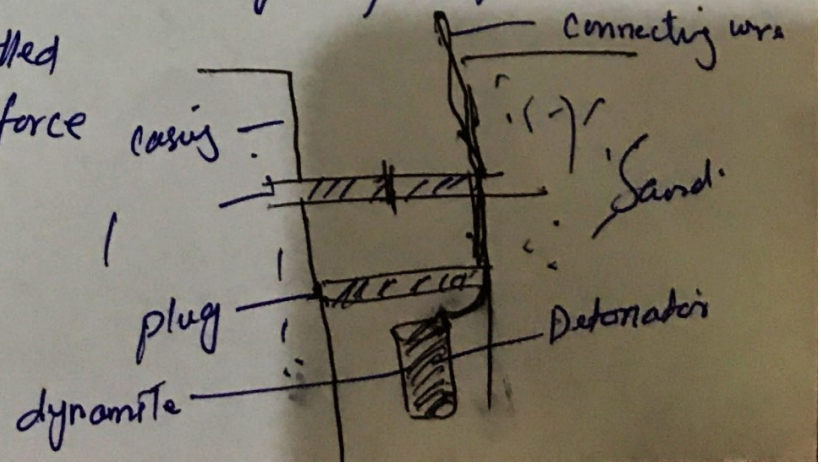
Blasting is more effective in loose sand that contain less than 20% silt and less than 5% clay. In case of partial saturated soil, the capillary action obstructs the densification tendency by preventing soil particles to come close.

How to implement?

A pipe of 7.5 – 10cm is driven to the required depth to the soft strata. The sticks of dynamite and electrical detonator are wrapped in the water proof bundles and lower through the casing.

Casing is withdrawn and a wad of paper or wood is placed against charge of explosives.

– Bore holes are backfilled with sand to obtain full force of blast. The charge is fired in definite patterns.



Q No(4)(B) Which types of ground improvement would be used in black cotton soil & why? (24)

*) Black Cotton Soil.

It is a highly clayed soil. They are formed in many parts of the world. such kind of soil generally consists of active clay minerals. Geotechnical engineer face various problems while designing a foundation because the black cotton soil passes poor bearing capacity and excessive settlement. To overcome this ~~Asap~~ problem researchs ~~on~~ concentrated on soil improvement techniques by adding fibres.

① Removal of black cotton soil and filling with Granular Material.

- the depth at which black cotton soil is existing and its thickness can be ascertained by observation of cracks in the soil. If the depth is shallow ~~that~~ ie within 1200mm, the soil may be excavated and removed.

② Excavating Extra Depth and filling with Sand and Moorum.

- on similar line as above excavation is done after removal of black cotton soil layer an extra depth upto 750mm shall be excavated, The width of the foundation shall be made 75mm wider on either side.

Single brick on edged wall with mud mortar shall be constructed in the extra width. The foundation bed shall be well rimmed by iron rimmer.

(3) Filling Extra Depth by Boulder.

Excavation is done on the similar line as above after removal of black cotton soil layer. The extra depth may be filled with stone boulders. Over which foundation can be layed.

(4) Stabilization with lime

The quality of black cotton soil can be improved by stabilizing it with lime. The soil from the area is collected after removing the hard top soil of depth 70 – 100 mm. The soil collected is then pulverized. Fat lime is spread over the loose soil at the rate of 4% of the dry weight of soil.

(5) Stabilization with fly ash.

The quality of black cotton soil can be improved by stabilizing it with adding blend of fly ash to the existing soil. The soil is collected and layer of fly ash is spread over.