Question 1

(A) improvement of soil through excavation and replacement:

Soil improvement through excavation and replacement includes the removal of unsuitable material like plants, roots, sterms, organic and inorganic wastes etc, removal of slush points and more sandy material with low soil-bonding properties and rocks.

Then the site is replaced by suitable soil with known proctor values and moisture content, compacted and improved.

Additive: Additive can be defined as an alteration or preservation of one or more soil properties to creat an improved soil material possessing the desired engineering properties.

How and which properties of soils are modified through additives?:

Types of soil additive techniques

Mechanical additive
Soil-aggregate mixture
Soil clay mixture - cement
- Sand-gravel mixture
- stabilization of soil with soft aggregates

Chemical additive or stabilization by additives such as - lime
- Sodium Silicate
- calcium chloride
- bituminous material
- resinous material

When the ground is soft (loose-surface), additives are used to stregthen the surface, such as cement or lime.

Additives are used to improve the workability and the durability of the soil. It helps in reducing the soil volume change due to change in temperature or moisture content. Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which is very useful especially in dry and arid weather.

Name a few additives with their function:-

① Cement: Cement is a standard material whose quality is tested and assured. Because of its high flexural strength it has a very high load spreading property. Thus soil-cement is able to spread the load over a wider area and bridge over locally weak spots of the underlying sub-grade or sub-base.

② Lime:

③ Soil Bitumen stabilization

④ Fly Ash

⑤ Blast furnance slag.

Q 1 (B) what are the various dewatering techniques (3) which are generally used for ground improvement discuss brief:-

Answer: Dewatering is a process in which ground water contained within the site's soil is extracted, ensuring a stable foundation.

Dewatering techniques:- Widely used dewatering techniques are given as follows.

① Sump pumping:-

② well points:-

③ Deepwells.

④ Ejector wells.

① Sump Pumping:- * Water is collected in deeper parts of the excavation (called sumps) and pumped away.

* simple and cheap method of dewatering in favourable ground conditions.
* Limited to use in relatively coarse soils or fissured rock - if used in fine grained soils can lead to erosion and loss of fines with the risk of resulting instability.
* the sump takes up space within an excavation.
* Can lead to water pollution problems due to silt-laden water.

(2) well points. ★ A line or ring of small diameter shallow wells (called Wellpoints) installed at closed spacing (1 to 3 m centres) around the excavation.

★ Commonly used for dewatering of pipeline trenches.

★ Can be a very flexible and effective method of dewatering in sands or sands and gravels.

★ Draw down limited to 5 or 6 m below level of pump due to suction lift limits.

★ individual well points may need to be carefully adjusted (trimming).

(3) Deepwells: ★ wells are drilled at wide spacing (10 to 60 m between wells) to form a ring around the outside of the excavation

★ An electric submersible pump is installed in each well. drawdown limited only by well depth and soil stratification.

★ Effective in a wide range of ground conditions / sands, gravels, fissured rocks.

(4) Ejector wells: ★ Effective in stabilising fine soils (silts, silty sands) by reducing pore water pressures.

★ wells are drilled around or alongside the excavation

★ suitable when well yields are low. Flow capacity 30 to 50 litres/min per well

★ Drawdown generally limited to 25 to 30 m below pump level.

★ vacuum of 0.95 Bar can be generated in the well, making this very effective in low permeability soils.

Less commonly used dewatering techniques

- Horizontal well points
- Relief wells
- Artificial recharge
- Groundwater remediation.

Q2 (A) Soil Nailing: * 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 top down.

* It is an effective and economical method of constructing retaining wall for excavation support, support of hill cuts, bridge abudments and high ways.

* The nails are subjected to tension Compression, Shear and bending moments.

Preferable Ground Conditions: * Critical excavation depth of Soil is about 1–2m high vertical or nearly vertical cut.

* All Soil nails within a cross section are located above groundwater table.

* Stiff to hard fine grained soils, dense to very dense granular Soils with some apparent Cohesion, weatheredrock with no weakness Planes and glacidl soils etc.

(B) Characteristics of a grout:- Grout is a Construction material used to embed rebars in masonary walls, Connect sections of Pre-Cast Concrete, fill voids, and Seal joints (like those between tiles). Grout Can also be defined as a solution, an emulsion or suspension in water, which will harden after a certain time interval.

There are four main Charateristics for a grout.

① mixture including bleeding ② setting time

③ Strength ④ viscosity

Grouting:- Grouting is the process to inject grout into the ground. Hence, the volume of the ground ready to accept grout is the primary consideration before any other consideration.

Where and why grouting is required?:- Since grout is a densed fluid that is used to fill gaps or used as reinforcement in existing structures, therefore grouting is required in the repair of cracks, water-stopping in submerged structures such as canals, tunnels etc, fill seams between tiles and for stabilizing soils.

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.

★ 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.

★ improve in-ground structures can be measured.

Disadvantages of Grouting:- ★ Grouting adjacent to unsupported slopes may be ineffective.

★ Not suitable in decomposable materials

★ Danger of filling underground pipes with grout.

★ Effectiviness questionable in saturated clays.

Q(3) (A) What are the Causes for which ground improvement techniques are undertaken.

Answer: Ground improvement refers to a technique that improves the engineering properties of the soil mass treated. usually, the properties that are modified are shear strength, stiffness and permeability. Ground improvement has developed into a sophisticated tool to support foundations for a wide variety of structures.

Need for engineered ground improvements Strategies:

- When a project encounters difficut foundation
- Conditions, possible alternative solutions are
- Avoid the particular site
- Design the planned structure (flexible/rigid) accordingly.
- Removing and replacing unsuitable soils.
- Attempt to modify existing ground.
- Enable cost effective foundation design.
- Reduce the effects of Contaminated soils.
- Ensure Suslainability in construction projects using ground Improvement techniques

Before starting any construction project, contractors need to ensure that they commence construction project on hard ground. if the construction of building is not done on solid ground, then it may lead to repairs and instability later on.

Q 3 (15) Identify various geotechnical problem of expansive soil:-

Answer

★ Expansive soils expand and contract due to change in moisture content of the soil, causing structural problems through differential movement of the structure resulting in severe damage to the foundations, buildings, roads, retaining walls, canal lining etc. the amount by which the ground can swell and/or shrink is determined by the water content in the near-surface zone. However, it may be noted that swelling and shrinkage are not fully reversible processes, and the effects of high shrink-swell potential can cause severe damage to various structures constructed on or in these expansive soils.

★ A second effect of expansive soils is the additional horizontal pressure applied to foundation walls in basement and crawl spaces. Increased water content in the soils adjacent to the foundation walls if the foundation wall does not have sufficient strength,

minor cracking, bowing or movement of the wall may occur. Serious Structural damage or failure of the wall may also occur.

* A third effect associated with Claystone (a type of expansive soils) is the movement of soils on unstable slopes. Expansive Claystone soils found as a layer under a more rigid top layer of soils, become unstable as the moisture content increases, allowing the Claystone and top layers of the soil to move. if the soil is located on a slope, the top layer of soil can creep.

Q(4)

(A) How Stone Columns and blasting help Soil to Stabilize and gain bearing Capacity.

Answer: Stone Columns are a ground improvement techniques to improve the load bearing Capacity of the soil.

The Stone Column Consists of crushed Coarse aggregates of various sizes.

The ratio in which the stones of different sizes will be mixed is decided by design criteria.

Vibro-Replacement Stone Columns extends the range of Soils that can be improved by vibratory techniques to include Cohesive Soils. Densification and/or reinforcement of the Soil with compacted granular Columns or "Stone Columns" is accomplished by either top-feed or the bottom-feed method

The Vibro-Replacement Stone Column process !!

(1) Reduces Shallow foundation settlement.
(2) Increases bearing Capacity, allowing reduction in footing Size.
(3) Mitigates liquefaction potential.
(4) Permits Construction on fills.

(5) Provides Slope Stabilization.

(6) Permits shallow footing Construction.

(7) Prevents earth-quake Indueed lateral Spreading.

Blasting technique to improve and gain bearing Capacity: Blasting is the use of buried explosive to Cause the densification of loose cohesion less ground. The principal is that the blasting of explosives in a Predetermined pattern causes 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, saturated sand deposits.

Procedure of the blasting for ground improvement:

* Series of boreholes are drilled and pipe of 7.5 to 10cm is driven to the required depth.
* The detonator and the dynamic sticks are both enclosed in a water proof bundle and is lowered through casings.
* Casing is withdrawn and a wad of paper or wood is placed against the charge of explosive

Q4 B

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

Answer: Black cotton is very expansive soil found in many parts of india. It contains the montmorillonite mineral, due to this soil has a tendency to swell and shrink excessively with change in moisture content. It has low bearing capacity and high shrinkage and swelling characteristics.

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.