USN | | | | | | | | | | |

CMRIT — CMR INSTITUTE OF TECHNOLOGY, BENGALURU. ACCREDITED WITH A+ GRADE BY NAAC

Internal Assessment Test 1 – Mar. 2018

Sub:	Ground improvement Techniques (PE)				Sub Code:	15CV654	Branch:	CIVIL
Date:	14/3/2018	Duration:	90 mins	Max Marks:	50	Sem / Sec:	6A & 6B	OBE

<u>Answer any **FIVE FULL** Questions OUT OF SIX</u>

		MARKS	CO	RBT
1 (a)	What is metamorphism? What causes it?	[04]	CO1	L2

Metamorphism is the transformation of existing rock (Protolith) causing profound **physical or chemical change** when subjected to **heat and pressure**.

The causes of metamorphism are:

- They may be formed simply by being **deep** beneath the Earth's surface, subjected to **high temperatures and the great pressure** of the rock layers above it.
- They can form from **tectonic processes** such as continental collisions, which cause horizontal pressure, friction and distortion.
- They are also formed when rock is heated by the **intrusion of hot molten** rock called magma from the Earth's interior. Some examples of metamorphic rocks are **gneiss, slate, marble, schist, and quartzite.**

		MARKS	CO	RBT
(b)	Explain the types of sedimentary rocks with examples.	[06]	CO1	L4

Sedimentary rocks are types of rock that are formed by the **deposition** and subsequent **cementation** of **sediments** either on earth‟s surface or underwater. Sediments are formed by **weathering and erosion of rocks**, **organic dead** remains or precipitates by chemical activity. Sediments are **transported** to the place of deposition **by water, wind, ice, mass movement or glaciers**, which are called **agents of denudation**.

Types of sedimentary rocks-

Clastic sedimentary rocks are formed from the buildup of **clasts**: small pieces of fragmented rocks deposited as a result of mechanical weathering then **lithified** (transform sediments to a stone) by **compaction and cementation**.

Examples of Clastic sedimentary rocks include **sandstone, shale, siltstone, and breccias.**

Chemical sedimentary rocks are formed when the **solution evaporate**, leaving dissolved minerals behind. Sedimentary rocks of these kinds are very common in **arid** lands such as the deposits of salts and gypsum. Examples include **rock salt, dolomites, flint, iron ore, chert.**

Organic sedimentary rocks are formed from the accumulation of any **animal or plant debris such as shells and bones**. These plant and animal debris have **calcium** minerals in them that pile on the sea floor over time to form organic sedimentary rocks . Examples include rocks such as **coal, some limestone, and some dolomites.**

2 (a) Describe the various soil horizons. [06] CO1 L2

A soil horizon is a layer of soil whose characteristics are different from the top an the bottom layers. There are 6 major horizons.

O – HORIZON

Layers dominated by **organic material, undecomposed or partially decompose** litter (such as leaves, needles, twigs, moss, and lichens).

A – HORIZON

It is the part of top soil in which the organic matter is mixed with mineral matte This layer is depleted of (**eluviated of) iron, clay, aluminum, organic matter an other soluble constituents**. It is **dark** in colour due to the presence of **organi matter**.

E – HORIZON

This zone is **lighter in colour because of lack of organic matter** compared to A Horizon. The zone is **heavily leached of iron, clay, aluminum, organic matte** Note both A and E horizons are under leaching but it is more pre-dominant in the horizon. That is E zone will contain **mainly sand and silt** as Quartz is resistant t leaching. E zone is **the most intense zone of leaching** because it is just above th zone of illuviation (dry zone) which create a larger potential difference causing mor movement of water.

B – HORIZON: It is subsurface layer reflecting chemical or physical alteration o parent material. This layer **accumulates all the leached minerals from A and**

horizon. Thus **iron, clay, aluminum and organic compounds accumulate in thi** **horizon [illuviation** (opposite of eluviation)]. **Enriched with calcium carbonat** precipitated from downward moving water or due to capillary action.

C – HORIZON: It is a layer of large unbroken rocks (Weathered parent material).

R – HORIZON: R horizons largely comprise continuous masses of hard rock.

(b)	Explain briefly weathering by exfoliation and frost action.	[04]	CO1	L4

Frost action

Stage 1: Water collects in pre-existing cracks.

Stage 2: When temperature drops water freezes in the crack causing expansi Expansion causes widening of cracks.

Stage 3: When temperature increases ice thaws causing contraction. This causes wa to flow into the widened crack.

Stage 4: Repeated freeze thaw finally splits the rock

Exfoliation

During **day time** the **outer layer is at higher temperature than inner layers.** **night** time the **outer layer is at lower temperature than inner layers**. The **relat** **temperature difference** between inner and outer layers of rock cause the **outer p** **to peel off** as **temperature difference weakens the bond between the inner a** **outer layer.**

3 (a)	Define ground improvement. List the various geotechnical processes involved.	[04]	CO2	L1

Improvement of ground properties to the desired engineering performance using geotechnical processes is known as ground improvement. It includes increase **of shear strength, decrease of compressibility and decrease of permeability.** The following are some of the geotechnical processes:

- **Compaction**
- Drainage
- Chemical stabilization

- Mechanical stabilization
- Geosythetics
- Vibrations
- Grouting and Injections

(b) Describe hazardous ground conditions. [06] CO1 L2

SEISMIC ZONE

Earth quake occurs when there is sudden slip on a fault. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up and the rocks slips suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that we feel during an earthquake. **Sites near faults in seismic zone are classified as hazardous.**

Sites having saturated loose to medium fine sand in seismic zone are prone to liquefaction making it a hazardous zone. Liquefaction is **reduction of shear strength to zero** due to **vibrations.**

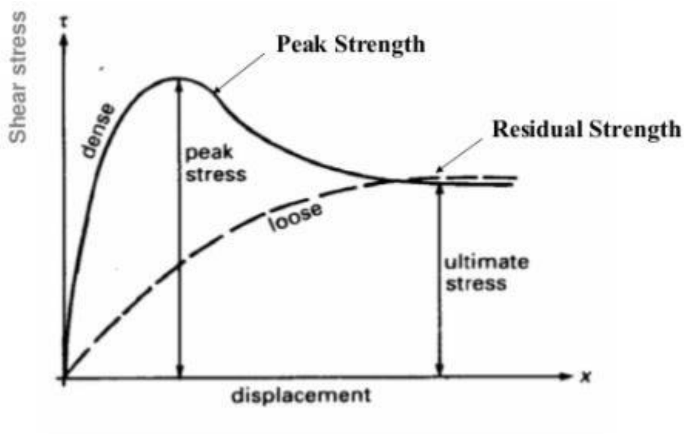
COLLAPSE LOCATIONS

Due to flow of **ground water limestones get dissolved** and carried away forming caverns. It is common in **humid climates**. When the **cave roof collapses sink holes** are formed. Regions where sink holes are expected must at all times be avoided. Similarly the regions above active mines are also a hazardous zone.

HAZARDOUS SLOPES

Clayey slopes at places of high infiltration are a hazardous zone. The infiltration results in raising of water table which will reduce the shear strength.

Sediments deposited into lakes that have come from glaciers are called glaciolacustrine deposits. **Colluvium and glaciolacustrine** have low residual strength which is necessary to resist a slope failure as it is the resisting factor at larger displacements.



Shale is a fine grained sedimentary rock formed from clays compacted together by pressure. The main engineering behaviors of shale is that it is very hard, however, once it is exposed to sunrays, air, and water within a relatively short time it will become soft clays (mud).

4 (a)	Explain briefly how compaction is specified on field.	[04]	CO1	L4

Compaction specification means specifying the compaction requirements of compacted fill (the extend to which compaction should be done). This can be done in two ways:

1. Perfomance type specification
2. Work type specification

Perfomance type specification

The compaction requirement is stated in terms of physical properties of the compacted layer as:

1. Relative compaction
2. Void ratio
3. Relative density
4. Percentage of air voids

Relative compaction = $\frac{(\gamma d)\text{max obtained at field}}{(\gamma d)\text{max obtained in laboratory}}$

Generally 95 % maximum dry density obtained in lab should be attained on field.

The contractor is given the wide scope of in selecting the equipment, lift thickness, moisture content, number of passes to obtain the required density. In the field, compaction is done in successive horizontal layers. After each layer has been compacted, the water content and the in-situ density are determined at several random locations. These are then compared with the laboratory OMC and MDD using either of these two methods: the sand replacement method, or the core cutter method. This method is used in highway and airfield pavements.

Work type specification

The type of equipment, the lift thickness, the moisture content and the number of passes to obtain the necessary dry density are specified. This type is used in the construction of embankments and dams.

(b) Describe the properties of fine grained compacted soil bringing out the differences on the dry of optimum and wet of optimum. [06] CO1 L2

SOIL STRUCTURE

Soils compacted at **dry of optimum** have **flocculated structure** while soils compacted at wet of optimum is of **dispersed structure**. At lower water contents **force of attraction dominates** while on the wet of optimum **the force of repulsion dominates** due to the presence of **adsorbed water layer.**

2. PERMEABILITY

Permeability depends on the size of voids. On the dry side of optimum an increase of water content result in **decrease of permeability.** There is an improved orientation resulting in lesser voids and lesser permeability. The minimum permeability **occurs slightly above OMC** therafter permeability slightly increases but remain **always less than that of dry side of optimum**.

3.SWELLING

A **soil compacted at the dry of optimum** has got high water deficiency than a soil compacted at wet of optimum and hence imbibes more water **and swells more**.

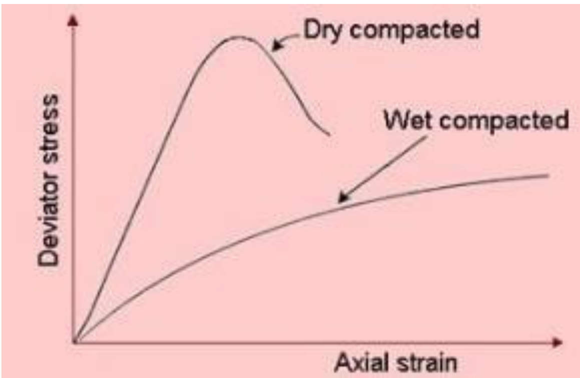
4.SHRINKAGE

Soils **compacted on the dry of optimum shrinks less when dried** than the soils compacted on the wet of optimum. This is because when soils compacted on the **wet of optimum when dried** they pack more efficiently due to the parallel orientation and hence **shrinks.**

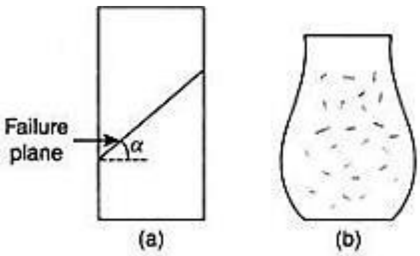
6.COMPRESSIBILITY

Soils compacted at the **dry of optimum** offers **greater resistance** to compression due to its **flocculated structure** and are **less compressible than soils** compacted at the wet of optimum.

7.SHEAR STRAIN RELATIONSHIP



Soils compacted at **dry of optimum have steeper stress strain** curve with a **higher modulus of elasticity.** Failure **is a brittle** in nature. Soils compacted at wet of optimum have **flatter stress strain curve** with a **lower modulus of elasticity**. Failure is plastic in nature as failure occurs at **large strain. (Platic**



igure 13.39 Soil specimen in UCC test: (a) Brittle failure and (b) plastic

6. SHEAR STRENGTH

Flocculated structures have more shear strength than a dispersed structure at low strains. At large strains flocculated structures become dispersed resulting in not much difference in the shear strength.

Soils compacted **at dry of optimum** when **soaked** show **greater shear strength than** soaked shear strength of soil compacted on **the wet of optimum**, but the **difference is low** compared to the unsoaked case

5 (a)	Explain a surface compactor used for compacting cohesive subgrades.	[6]	CO1	L4

SHEEP FOOT ROLLERS

Studs are of different shapes. The **kneading action** of the studs **increases the stability**. The **steel drums** in front can be either be **filled with water or sand to increase the load**. The load acts **through the studs** thus i**ncreasing** the **pressure as the contact area reduces.**

When a loose layer is initially rolled the **studs sinks in** and compacts the bottom most layer. In the next passes the **compaction zone will be higher than the previous zone**. Hence in the consequent passes the **steel drum rises.** The total rising of the steel drum should be **25 to 50 mm in** the last few passes for an efficient compaction. This is known as a **"walk out**" by the compactor. **Failure to "walk out**" is because of high water content or a shear failure of the soil.

The rollers are available in diameters ranging from **100 cm to 180 cm** with loaded mass per drum ranging from **2950 kg to 13600 kg.**

A**dvantage**s of sheep foot rollers over other rollers are:

- **More suitable for cohesive soils** because of the kneading effect which blends the soil well.
- Effective in breaking down larger pieces of soft rock Disadvantages
- The **operation is slower**
- The top layer is **fluffed up** when the studs come out of soil resulting in **entrapped air** and **lower density** in the top layers.

(b)	What are the factors which influences compaction on field?	[4]	CO1	L2

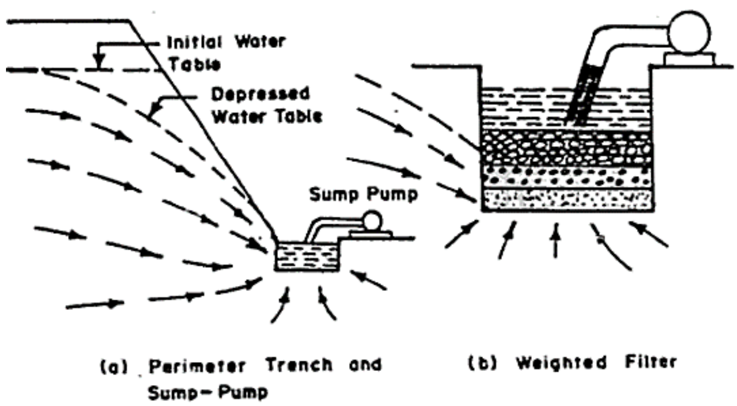
Factors on which compaction depends on:

- **Contact pressure**: Compaction **increases with increase in contact pressure**.
- **Number of passes**: the **compaction of a soil increases with increase in number of passes**. However beyond a certain limit the increase is not appreciable. The number of passes are generally limited to a reasonable number of 5 to 15.
- **Layer thickness:** The **compaction increases with decrease in layer thickness**. Generally the thickness is kept less than 15 cm.
- **Speed of roller:** The speed should be adjusted such that the **maximum compaction** is achieved.
- **Type of soil** and **field conditions**.

6	Explain dewatering by open sump and well point system.	[10]	CO2	L4

Open sumps and ditches

Sump is the name given for the shallow pits that are dug at corner of excavation. Along the periphery of the excavation there are ditches to collect water. This water flows from ditches to sumps. The flow of water is by gravity. Water is pumped out from the sumps.



This is a simple method used for dewatering **shallow** excavations that have **coarse** grained soils or the soils that have permeability that is **greater than 10^{-3} cm/sec.** Significant amount of seepage can result in **formations of holes** and depressions of the lower part of slope. This is due to the washing away of soil into the sump. The slump bottom may also be subjected to **piping**. This problems can be solved by the use of **inverted filter** that is of many layers. These have coarser material in successive layers from the bottom of the sump pit to the upward direction.

If the construction demands for lowering the water table or the ground water head of the area to a depth greater than 0.3 m, the method of sumps and ditches is not suitable. If sumps and ditches are employed for greater depth lowering, seepage will be prominent that will result in the instability of the excavation slopes.

The **Advantages** of Sumps and Ditches are:

The method is widely used. It is appropriate **for small depth lowering**.

This method is found to be most **economical** one among dewatering systems while considering the installation and the maintenance procedures.

The site is mostly recommended where boulders or massive obstructions are met within the ground.

The **Disadvantages** of Open Sump and Ditches
In areas where there is **high heads or steep slopes**, the method is not demanded. This method will bring **collapse of the slopes** and cause dangerous problems

The use of sumps and ditches in open or timbered excavation will bring risk in the stability of the base.

WELL POINT SYSTEM

Filter wells are small well screens of diameter and length of 0.3 m to 1 m**.**
Wellpoint dewatering involves installing a **closely spaced** line of **small diameter** wells alongside an excavation or a ring of wells around an excavation. Each well is known as a '**wellpoint**' and is designed to be low in cost and robust in design and materials.
Typically each wellpoint is approximately 6 m deep and around 50 to 80 mm in diameter. The horizontal spacing between wellpoints is usually between 1 m and 3 m. **The well points are made of brass or stainless steel screens or plastic.** The lower section of each wellpoint has a **perforated screen** with **unperforated liner** in the shallower section above the screen and the top of each well is connected to the header pipe. A wellpoint pump, capable of pumping both air and water, is connected to the header main. The pump creates a **partial vacuum** in the header main, which acts to draw water through the wellpoint screen, up the wellpoint riser,

through the header pipe and to the pump from where it is discharged. In this way a single wellpoint pump can act on many wellpoints simultaneously and can potentially **lower groundwater levels over a wide area.**

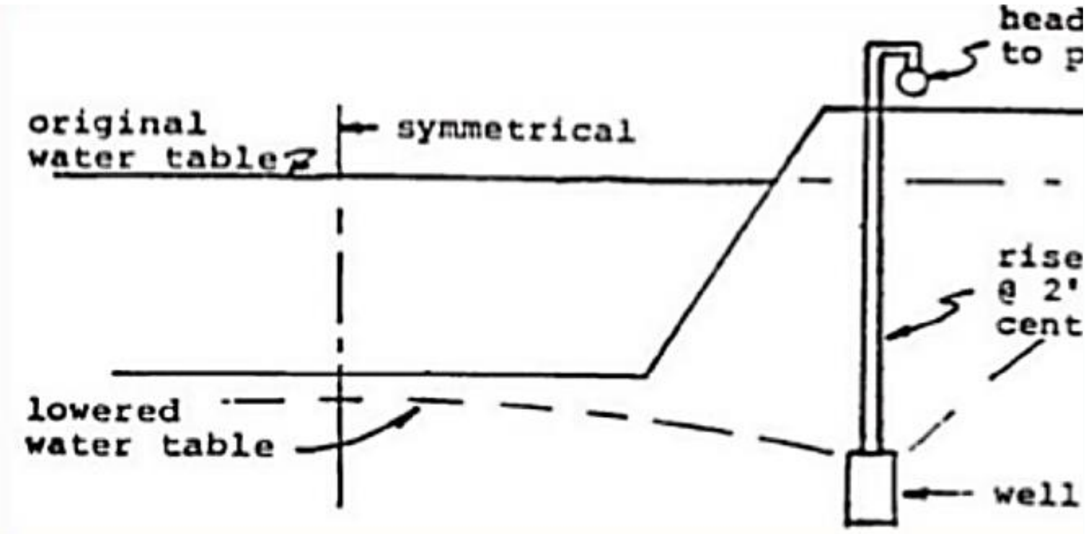
Well points are installed by jetting them in to the ground. Spacing of well points depends on the permeability of the soil. In fine to coarse sands or sandy gravels a spacing of 0.75 m to 1 m is satisfactory. In silty sands (Low permeability) a spacing of 1.5 m is necessary. In highly permeable coarse gravels the spacing is as close as 0.3 m. the spacing between the well points reduces with increase of permeability of soil as more discharge is required to be removed.

This method is not preferred in low permeable soil since the applied vacuum may not produce the required drawdown. This method is not preferred in highly permeable gravels because it becomes uneconomical due to small spacing. Hence well point system is most preferred in soils of moderate permeability (sands and sandy gravels).

The water is drawn away from the excavation hence the side slopes of excavation as well as base remains stable. The water taken in is filtered and contains no fines hence the danger of subsidence due to washing away of silts is not there. The water is lifted up by suction and the lowering of water table up to 6 m is possible.

There are two types of well point systems:

Single stage well point installation (Lowering up to 6 m)



Multistage well point installation (Lowering > 6 m)