NPTEL Course on Ground Improvement

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(Questions)

Module I - Introduction to Ground Improvement

L1: Need for Ground Improvement

1. **What are different types of engineering problems with soils?**
2. **What are the problems with expansive soils?**
3. **What are the problems with collapsible soils?**
4. **What are the problems with soft and sensitive soils?**
5. **How do slope stability problems occur?**
6. **What are the problems due to liquefaction due to earthquakes?**
7. **What are the strategies for ground improvement?**
8. **What are different methods of ground improvement?**
9. **What are different methods that are applicable to different types of soils**
10. **How are different ground improvement techniques classified?**
11. **What are the factors affecting the selection of ground improvement techniques?**
12. **What are the objectives of ground improvement techniques?**
13. **What are the emerging trends?**

L2: Classification of ground modification techniques

1. **What are different methods of modification of soils?**
2. **What are the differences among ground reinforcement, ground improvement and ground treatment?**
3. **What are the factors affecting the selection of ground improvement?**
4. **How does assessment of engineering properties of native soils help in arriving at the choice of ground improvement?**
5. **Why does the expansive soil treatment with lime does not work in the presence of sulphates?**
6. **How does reusability of certain products help in general terms in the reduction of carbon foot print?**
7. **How does recycling of plastics help in ground improvement**
8. **What are the typical engineering properties that need to be improved and give suitable examples**

L3: Emerging trends in ground improvement

1. **What are the benefits of ground improvement?**
2. **Name different types of ground reinforcement techniques**
3. **What are the emerging trends? Explain how i) a dump yard can be stabilized? Ii) how waste materials can be reused iii) how geosynthetics**

help in geotechnical construction iv) what are the uses of biotechnical stabilization

4. **What are the catalysts and accelerators of better use of ground improvement techniques?**
5. **What are the likely trends tomorrow?**

Module II - Ground Modification

L4: Mechanical modification

1. **What are the advantages of compaction?**
2. **What are the strategies for good compaction process?**
3. **How do you do laboratory compaction?**
4. **What is the difference between standard compaction and modified compaction**
5. **What are the fundamental processes in the compaction?**
6. **How the line of optimums is is obtained?**
7. **What are the various equipment used for shallow compaction? What are their characteristics?**
8. **What are the typical ranges of pressure induced in clays and sands due to compaction?**

L5: Compaction Control

1. **What are the requirements t of compaction control tests?**
2. **What are compaction control procedures?**
3. **What are different types of specifications?**
4. **What are different types of tests that are conducted for compactioncontrol?**
5. **What are non-destructive methods in compaction control?**
6. **What are different methods of compaction control?**
7. **How are statistics and probability useful in compaction control?**

L6: Deep compaction

1. **What are the methods of improving soil at deeper strata?**
2. **What are the principles and procedures in dynamic compaction?**
3. **For which types of soils, dynamic compaction is preferable?**
4. **What are different types of dynamic compaction methods?**
5. **How do you evaluate dynamic compaction method ?**
6. **How do you evaluate ground vibrations due to dynamic compaction?**
7. **Specify tolerable limits for peak particle velocity and how do you do monitoring?**

L7: Dynamic compaction

1. **Discuss a design approach to dynamic compaction**
2. **Construct a suitable design example to stabilize loose sand deposit of 10m. Make all the necessary assumptions?**

3. **How do you verify that the area is compacted as per requirement using suitable field testing? Give examples in relation to improvement of liquefaction resistance in a loose sandy deposit?**

Module III - Stone columns

L8: Vibro-compaction methods

1. **What are Vibro-compaction methods?**
2. **How does grain size distribution help in deciding about compatibility?**
3. **What are the applications of stone columns?**
4. **What are the factors that influence stone –column foundation response?**
5. **What are the principles of stone column design?**
6. **Explain IS method of stone column design?**
7. **What are the salient points of Preibe's method?**
8. **What are aggregate piers and what is the difference between stone columns and aggregate piers?**

L9: Case studies in stone columns

1. **What are the different methods of installation of stone columns?**
2. **What are the features of quality control checks?**
3. **What are the applications of stone columns?**
4. **What are the salient features of Paradeep ground improvement project using stone columns?**
5. **What are the salient features of Vallarpadam ground improvement project using stone columns?**
6. **What are the salient features of Piparav Shipyard, Gujarat?**
7. **What are the salient features of Chennai Power Plant project?**
8. **What are the salient features of New Delhi Power Plant Project?**

Module IV - Prefabricated Vertical drains

L10: Prefabricated Vertical Drains (PVDS) – I

1. **What is the principle of preloading?**
2. **Explain the design of PVDs for soft ground improvement?**
3. **What are the advances of PVDs over sand drain?**
4. **What is a trial embankment?**
5. **Explain the installation of PVDs.**
6. **Explain the salient features of Gangavaram port soft ground improvement using PVDs.**
7. **What is the principle of vacuum consolidation?**
8. **What are the advantages of vacuum consolidation?**
9. **Explain the construction sequence of using vacuum consolidation?**

L11: Prefabricated drains (PVDS) – II

1. **What the different layout patterns in sand drains?**
2. **What are the advantages of coir-geotextiles over synthetic geotextiles.**

Module V - Dewatering and Electro kintetics

L12 and L13: Dewatering Part I & Part II

1. **What are the purposes of dewatering?**
2. **What are the common methods of dewatering?**
3. **What are the well point systems?**
4. **Discuss the applicability of dewatering systems in different soils?**
5. **What are the different applications of dewatering?**
6. **What are the most important design input parameters for dewatering?**
7. **Write short notes on different types of tests that need to be conducted for evaluation of permeability?**
8. **What are the difference between fixed wall permeameter and flexible wall permeameter test?**
9. **Evaluate discharge from an aquifer in the case of a) single well b) multi-wells.**

L14: Electro-kinetic stabilization

1. **What are the uses of electro-kinetic stabilization?**
2. **What is electro-osmosis?**
3. **What are the factors influencing electro-osmosis?**
4. **What are the electrode reaches and how does it help in the electro-osmotic process?**
5. **Describe the case-study conducted in U.K.?**
6. **Explain the results obtained in the above case study?**
7. **What are the electro-kinetic geosynthetics? What are the applications?**
8. **Describe a case study on electro-kinetic geosynthetic technology?**

Module VI - Ground Treatment methods

L15 and L16: - Heating and freezing methods, Blasting methods Part I & Part II

1. **What are the properties on which temperature control methods depend on?**
2. **Define thermal conductivity of soil?**
3. **Define heat capacity of the soil?**
4. **Define heat of fusion?**
5. **Define heat of vaporization?**
6. **What are the methods of heating the soil in-situ?**
7. **What is ground freezing?**

8. **What are the principles of ground freezing?**
9. **What are the application areas?**
10. **How does liquid nitrogen vapor freezing technique?**
11. **What is meant by blast densification?**
12. **How do you estimate safe distance in an explosion**
13. **How was blast densification helpful in the case of Highway S04 Bridge over coldwater credo?**

L17 and L18: Ground Treatment with lime Part I & Part II

1. **List the problems associated with expansive soils?**
2. **What are the mechanisms of improvement when soil is mixed with lime?**
3. **What are the factors compiling the characteristics of lime treated clay?**
4. **Comment on the drying-wetting test results on lime-treated expansive soils.**
5. **How is lime added to the soil in the field?**
6. **How are lime columns helpful?**
7. **How are lime columns installed?**
8. **8. How do you design lime column treated foundation?**
9. **How do you estimate strength and stiffness gain in the case of expansive soil treated with lime?**
10. **Discuss the case study of rehabilitation of power station resting on expansive soils?**

L19: Ground treatment with cement

1. **What are the applications of ground treatment with cement?**
2. **What are the factors that influence strength and stiffness improvement of cement treated soils**
3. **What are the chemical reactions that take place and explain their effects.**
4. **How is a soil treatment project using cement is executed?**
5. **Discuss the experimental results obtained from the studies of Bergado et al (1996).**
6. **Write short notes on deep mixing methods?**
7. **How are the procedures adopted for deep mixing in the field?**

L20: Grouting procedures

1. **What is compaction grouting?**
2. **What is jet grouting (using single, double and treble fluid systems?**
3. **What are the advantages of jet grouting?**
4. **What is chemical grouting?**

Module VII - Grouting and Micropiles

L21: Grouting

1. **What are the various types of chemical grouting?**
2. **Comment on the penetrability of various grouting?**
3. **What are the characteristics of chemical grouts?**
4. **Discuss the case study in the construction of street tunnel?**
5. **What are the rheological considerations in grouting?**
6. **Discuss how the water pressure testing is done and explain various pattern of flow rate/pressure diagrams.**
7. **What are geotechnical considerations for use of compaction grouting?**
8. **What are the various steps in compaction grouting?**
9. **What are the applications of compaction grouting?**
10. **What are the advantages of compaction grouting?**
11. **Explain the case study of Mc Clellan pump station?**
12. **What is jet grouting? What are different systems of jet grouting?**

L22: Micropiles

1. **Define a micropile and discuss the classification of different types of micropiles.**
2. **What are different types of applications.**
3. **What are the geotechnical considerations in the design of micropile.**
4. **What are the design steps in micropile design.**
5. **How is the technique useful in excavations in urban areas.**

Module VIII - Geosynthetics

L23: Introduction to Geosytnthetics - I

1. **What are the various types of geosynthetic materials.**
2. **What are the different functions of geosynthetics.**
3. **What are geogrid, geofoam, GCL and geopipe. Give application for each product.**
4. **How are RE walls useful?.**
5. **What are the typical application of geosynthetics in geoenvironmental Engineering.**
6. **What are the typical applications of geosynthetics in transportation engineering?**
7. **How do geosynthetics help in dam engineering and water resources?**

L24: Introduction to Geosytnthetics – II

1. **What are different types of polymers?**
2. **What are typical properties of polymers.**
3. **How geosynthetics are produced in factory.**

L25: Reinforced soil principles and mechanisms

1. **What are externally stabilized and internally stabilized retaining systems.**
2. **What are the concepts of reinforced soil?**
3. **What are the technical and economic benefits of reinforced soil.**
4. **Explain the effect of reinforcement orientation.**
5. **What is strain compatibility of reinforced soil?**

L26: Material properties.

1. **How do you identify polymers used in geosynthetics.**
2. **What are the geometric properties of geosynthetics.**
3. **What are the mechanical properties of geosynthetics.**
4. **What are different types of creep tests on geosynthetics?**
5. **Why creep properties are important**
6. **How are impact and abrasion tests conducted?**
7. **What are hydraulic properties of geosynthetics?**
8. **What are the durability properties of geosynthetics. How they are measured?**

L27: Factors affecting reinforced soil

1. **List the factors that influence the performance of reinforced soil characteristics.**
2. **How do the reinforcement form, distribution affect reinforced soil structure performance.**
3. **How do soil type and state influence the reinforced soil structure performance.**
4. **What are the different construction factors that affect the performance of reinforced soil.**

L 28 and L29: Bearing capacity improvement

1. **What are the modes of failure of reinforced soil foundations.**
2. **What are the assumptions made in Binquet and Lee method.**
3. **What are the steps required to evaluate tensile failure of the reinforced soil foundation.**

4. **What are the steps required to evaluate pullout failure of the reinforced soil foundation.**
5. **How is bond resistance of geogrids helpful in reinforced soil beds.**
6. **What are the various mechanisms by which the bearing capacity of a soil can be improved using geosynthetics.**

L30: Reinforced soil slopes

1. **How is reinforced soil technique helpful in slope stability improvement.**
2. **What are the approaches for the design of reinforced soil slopes.**
3. **What are the various parameters required for design?**
4. **What are the steps involved in the design of reinforced soil slope.**
5. **How do you optimize the geogrid reinforcement quantity in design.**

L31 and L32: Reinforced Soil Walls

1. What are different types of retaining walls.
2. Write short notes on design approaches for RE walls.
3. Explain the difference between tie back wedge method and coherent gravity method.
4. How do you evaluate tensile failure of reinforcement?
5. How do you evaluate pull-out failure of reinforcement?
6. What are the differences between segmental wall and panel wall c constructions.
7. What are the failure modes in segmental wall construction.
8. Explain the construction feature of panel wall construction.
9. Explain the construction features of segmental wall constructions.
10. How do RE walls respond in earthquake conditions.
11. What are the recommended factors of safety for design of RE walls as per FHWA.
12. What are the typical specifications for backfill materials as per FHWA.
13. What are the design guidelines for earthquake resistant design of RE walls.
14. How are vertical and horizontal loads and loads due to sloping terrain are considered in RE wall design.
15. What are the design checks in segmental wall constructions.

L33: Soil Nailing

1.What is soil nailing and how does it help in ground improvement.
2.Explain the principle of soil nailing.
3.What are the favourable/unfavourable conditions for soil nailing.
4.What are the failure modes of soil nail wall.
5.How do you ensure global stability of soil nailed wall. What are the recommended factors of safety?

6.How do you check for soil nail pull out failure. What are the recommended factor of safety.
7.How do you check for tensile strength failure of soil nailed wall. What are the recommended factors of safety.
8.Please explain facing stability and how do you ensure facing stability.
9.Explain the design with reference to a 8m high wall and the native soil properties are $\phi' = 30^o$, c = 3 kPa and γ_b = 18 kN/m^3.Use tor steel as reinforcement.
10.What are the implications of construction sequence in soil nailed wall. Explain with reference to case study of soil nailed wall at IISc.
11.Discuss a case study of soil nailed wall from literature.

L34: Design of embankments on soft soil using geosynthetics.

1.What are the problems with soft soils and now does geosynthetics help in design and construction.
2.What are the typical applications of geosynthetics in embankment on soft soil.
3.What are the failure mechanisms that need to be considered in analysis and design.
4.Illustrate with sketches different failure modes that need to be considered.
5.Explain the design procedure for internal stability assessment of embankment on soft soil.
6.Explain the design procedure external stability assessment of embankment on soft soil.
7.Explain the assessment of deformation in the embankment?

L35. Design of embankments on soft soil using geocells (15 minutes)

1.Explain the uses of geocells in embankment.
2.Explain the concept of geocell reinforcement.
3.Explain the construction of embankment on soft soil using a) geosynthetics b) geocells.

Use of Geosynthetics for filtration and drainage (45 minutes)

1.What are the functions of filter in soil?
2.What are the functions of geosynthetics in geotechnical design.
3.What are the differences between aggregates/sand and geosynthetic filters.
4.Write as many number of applications as you can think of for geosynthetics in filter and drainage design.
5.What are the filtration flow conditions.
6. What are the guidelines.
7.Write short notes on granular filter design criteria.

8.Write short notes on geosynthetic filter criteria.
9.What are the experiments required to evaluate filter criteria.
10.Discuss the durability criteria.
11.Give applications/examples of filter criteria.

L36: Applications in filtration and drainage & erosion control

1.What is erosion control?
2.Why in erosion control required
3.How does geosynthetic help.
4.What are the factors influencing erosion.
5.How do you estimate erosion losses?

L37: Geosynthetics in pavements

1.What are the functions of geosynthetics in highways.
2.What are the mechanisms of improvement when geosynthetics in highways are used.
3.What are the benefits of using the geosynthetics in pavement.
4.What are the subgrade conditions under which geosynthetics are useful.
5.Discuss the application of Giround and Noiray's approach to pavement design.
6.Comment on the contribution of geosynthetic tension on the thickness of pavement.
7.Discuss the applications of geosynthetics in paved roads.
8.How geosynthetics are helpful in pavement overlays.

Module IX - Emerging and innovative topics

L38: Sustainable development and energy geotechnology

1.What is sustainable development? Why is it required?
2.What are the threats to sustainability?
3.What is the current scenario in terms of temperature increase and carbon emissions global stability.
4.What is the basis/strategy for carbon emission reduction?
5.What is energy geotechnology? How does it help?
6.Why is underground space required for energy storage and how it can be done?
7.What is the role of geotechnical engineering in the containment of radioactive solid waste?
8.What is carbon capture and geological sequestration?
9.How does waste re-use help in sustainability?
10.What are the geotechnical consequences of climate change?

11.What are the challenges in geotechnical engineering to build sustainable environment?

L39: Microbial Geotechnology and Ground Improvement

1.What are the applications of microbiology in ground improvement.
2.What are the suitable micro-organisms.
3.Discuss the size effects of bacteria in relations to grain size distribution of soils.
4.What are the factors affecting the application of micro-organism.
5.What is bio-clogging. What are the various mechanisms and applications.
6.What are the limitations and potential problems.
7.What is bio-cementation, what are the mechanisms.
8.How does bio-cementations of sand helps? How does it compare with conventional mechanical compaction or chemical grouting?
9.What are the requirements of bio-cementations?
10.What are different applications of bio-cementations?
11.What are the limitations of bio-cementation process?
12.What bio-safety issues.

L40: Nano-technologies in ground improvement and site remediation.

1. **What is nano-technology, how does it help?**
2. **What are the challenges that geotechnical engineers have in the use of nano-technology.**
3. **What is nano-soil? What are the implications?**
4. **How does nano-technology help in site remediation?**
5. **Discuss a few case studies of remediation using nano-iron?**
6. **What are the limitations of the technology?**
7. **What are the research needs in this area in India?**
8. **What are the implementation strategies in India?**