GUJARAT TECHNOLOGICAL UNIVERSITY

SUBJECT NAME: GROUND IMPROVEMENT TECHNIQUES
SUBJECT CODE: 3714310
M.E. Semester-I

Type of course: Program Elective I

Prerequisite: Knowledge of Geotechnical Engineering

Rationale: This subject is introduced with a view that student can identify and explore various problematic soils based on sub soil exploration report. Understanding each ground improvement technique based on its mechanics and its effectiveness under particular regional conditions. Learning various design parameters for particular method based on both field experience and international standards. Suggesting suitable ground improvement technique based on available technology, need of construction industry and cost analysis.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction** Concepts of soil type and its physical and mechanical relevance on engineering properties of soil including soil structure changes, Engineering properties of soft, weak and compressible deposits and problems associated with these deposits**.**	5	15
2	**Mechanical modification** dynamic compaction, impact loading, compaction by blasting, vibro-compaction; pre-compression, stone columns; Hydraulic modification: dewatering systems, preloading and vertical drains, electro-kinetic dewatering, compaction piles heavy tamping, deep mixing, vibro-replacement, granular columns, micro piles, ground freezing and thawing, heat treatment, its concept and application, geothermal piles	17	35
3	**Chemical modification and Stabilization** Modification by admixtures (lime, cement, lime-fly ash, hydroxides, carbonates etc., inorganic stabilizers), stabilization using industrial Wastes,. Lime columns, bituminous stabilization.	8	20
4	**Grouting** Classification, Grout materials, physical and chemical properties, strength, Rheological aspects of coarse and fine grouts, penetrability and	6	15

	performance aspect of coarse and fine grouts, Various application of grouting		
5	**Soil Reinforcement and its Application:** Type of soil reinforcement, selection of stabilization/improvement of ground using Geotextiles, Goegrid, geomembranes, geocells, shallow foundations on reinforced earth, analysis and design of shallow foundations using geosynthetic reinforcements, road designs with geosynthetics	6	15

Reference Books:

1. Proceedings of the Conference on Soil Stabilization, Massachusetts Institute of Technology, June 18-30, 1959.
2. A.C. Houlsby, Grouting Manual, Water Resources Commission, Australia-1977.
3. R.H. Karol, Chemical Grouting, Applied Science Publishers-1986.
4. A.V. Shroff & D.L. Shah, Grouting technology for dam construction and tunneling, Oxford & IBH Publishers, 2nd addition, 1999
5. Koerner R M, "Construction and Geotechnical Methods in Foundation Engineering",
6. McGraw Hill Publishing Co. Ltd., 1984
7. Hausmann M.R. „Engineering Principles of Ground Modification" McGraw Hill
8. Publishing Company, New York - 1990.
9. Zeevart L, "Foundation Engineering for Difficult Subsoil Conditions"
10. Bell F G, "Foundation Engineering in Difficult Ground", Butterworth, 1978.
11. Van Impe W.F, "Soil Improvement technique and their evaluation"
12. Rao V.V S, "Ground Improvement techniques

Course Outcome: After learning the course the students should be able to:

1. The course would help the students in reinforcing their knowledge for determination of engineering properties of different soils and interpreting the results.
2. The course would provide insight into identifying various engineering problems associated with soft and compressible soil deposits.
3. The course would impart knowledge about design and implementation of various soil improvement techniques.
4. The course would develop the understanding for selection of appropriate soil improvement technique based on the soil type and application.
5. The course would cover details related to determination of various properties of different grouts, which is a necessary knowledge for grouting design for various engineering applications in the field.
6. The course would cover various engineering applications of grouting, the awareness of which would help in the field to decide the suitability of grouting for solving an engineering problem.

List of Experiments:

1. Determination of various index properties of problematic soil (specific gravity, liquid limit, plastic limit, shrinkage limit, relative density, soil classification)
2. Determination of various engineering properties of soil (permeability, shear strength, compaction, swell pressure)
3. Determination of various physical and chemical properties of grout (fluidity, bleeding potential, gelation, gel strength, specific gravity, Ph, colour change, water retentivity, syneresis)

4. Chemical analysis of soil

Major Equipment:

1. Complete tri-axial system with pore pressure measurements,
2. unconfined compression system,
3. automated soil compactor,
4. California bearing ratio (CBR) machine,
5. permeameter (Flexiwall & Blaine's),
6. pH and Electrical conductivity probes/meters,
7. Viscometers

List of Open Source Software/learning website:

- NPTEL lecture series
- MIT open source material