Course Number: CE 560
Course Name: Soil Dynamics
Credits: 3-0-0-3
Prerequisites: Geotechnical Engineering I (CE 302), Geotechnical Engineering II (CE 402) or Equivalent course.
Intended for: UG and PG students
Distribution: Discipline Elective

Course Preamble:

In the undergraduate curriculum, the basic course on Geotechnical Engineering introduces students to the fundamentals of the engineering behaviour of soil under static loading. The aim of this course "Soil Dynamics" is to explore, in some detail, the behaviour of soil when it is subjected to time-dependent cyclic loading. Starting with the principle of wave propagation in the soil media, this course takes the student through the estimation of dynamic soil properties by laboratory and in-situ methods of testing. The student will learn the geotechnical site characterisation, site response analysis and the methods for evaluation of liquefaction potential of a site. A part of this course is dedicated to explaining the modes of vibration and design of machine foundation.

Course outcome:

By the end of the course, the students will be familiar with the approaches to understand the dynamic behaviour of soil and determine the strength and stiffness of soil and the application of these properties in practice. It will help in preparing a background for further study and research in the area of geotechnical earthquake engineering and the related fields.

Course modules with lecture hours:

1. **Introduction to soil dynamics:** Importance of soil dynamics, nature and types of dynamic loading, concept of dynamic loading, Simple harmonic motion, degrees of freedom, types of vibration, free and forced vibration, decay of motion, vibration measuring instruments. **(8 hours)**

2. **Wave propagation in elastic half space:** Elastic response of continua, Wave propagation in soil media, Earthquake waves, Seismic travel time curve, Three-circle method of estimation of Earthquake epicentre. (**6 hours**)

3. **Dynamic soil properties:** Stresses in soil element, concept of soil stiffness, damping ratio and plasticity properties of soil, techniques for estimation of dynamic soil properties from field (intrusive and non-intrusive testing) and laboratory testing. Correlation for obtaining various geotechnical parameters. **(6 hours)**

4. **Site response analysis:** Transfer function, homogeneous and layered un-damped and damped soil resting on rigid block, equivalent and non-linear approach of ground response analysis, convolution and deconvolution of the earthquake wave, site classification. **(6 hours)**

5. **Liquefaction and lateral spreading:** Concept of liquefaction (static and cyclic), cyclic mobility, estimation of liquefaction potential of soil from field and laboratory testing data, cyclic stress ratio of soil and its importance, post liquefaction lateral spreading of soil, effect of liquefaction on various geotechnical structures. **(6 hours).**
6. **Design of machine foundations:** Types of machine foundation, Mass-spring dashpot model, concept of vibration isolation, Tschebotarioff's reduced natural frequency method; Elastic half space method; Vertical, sliding, torsional (yawing) and rocking (and pitching) modes of oscillations; Design guidelines as per codes; Typical design problems. **(10 hours).**

Textbooks:

1. Shamsher Prakash "Soil Dynamics", McGraw Hill Book Company (1981).
2. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc (2003).

References:

1. Robert W. Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York. (2002)
2. Kenji Ishihara, "Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA. (1996).
3. G.V. Ramanna and B.M. Das "Principles of Soil Dynamics" CENGAGE Learning, USA. (2011).
4. Richart, F.E., Woods, R.D. and Hall, J.R. Vibrations of soils and foundations. Prentice-Hall, 1970.

Additional Readings

Journal papers in the area of Soil Dynamics.