

NORTHEASTERN UNIVERSITY
Department of Civil and Environmental Engineering

SOIL & FOUNDATION DYNAMICS
(CIVG311)

Instructor: Dr. M. K. Yegian
Tel: (617)-373-2448 (office)
(781)-910-6680 (cell)
E-mail:myegian@neu.edu

Text: Class Notes

Reference Books:

Das, B.M. “Fundamentals of *Soil Dynamics*” Elsevier.
Dowding, C. H. “Blast Vibration Monitoring and Control”, Prentice-Hall, Inc.
Dowding, C. H. “Construction Vibrations”, Prentice-Hall, Inc.
Kramer, S.L. “*Geotechnical Earthquake Engineering*” Prentice-Hall, Inc.
Prakash, S. “*Soil Dynamics*” McGraw-Hill, Inc.
Prakash, S. and Puri, V. “*Foundations for Machines: Analysis and Design*”, J. Wiley & Sons.
Richart, F., Hall, J. and Woods, R. “*Vibrations of Soils and Foundations*, Prentice-Hall, Inc.

TOPICS:

1. DYNAMIC LOADS
2. VIBRATION MEASUREMENT
3. BLAST VIBRATIONS AND CONTROL
4. TOLERABLE VIBRATIONS
5. VIBRATION ATTENUATION
6. FOUNDATION DYNAMICS (1-Degree-Of-Freedom System)
7. FOUNDATION DYNAMICS (Multi-Degree-Of-Freedom System)
8. GUIDELINES FOR MACHINE FOUNDATION DESIGN AND ANALYSIS
9. SOIL-STRUCTURE INTERACTION (SSI)
10. WAVE PROPAGATION
11. DYNAMIC SOIL PROPERTIES

12. SHEAR STRENGTH DURING REPEATED LOADING (LIQUEFACTION)
13. EARTHQUAKE-INDUCED PERMANENT DEFORMATIONS /
DISPLACEMENTS
14. EARTHQUAKE-INDUCED DEFORMATIONS OF SLOPES AND EARTH
DAMS
15. SEISMIC DESIGN OF EARTH RETAINING STRUCTURES

Northeastern University
Department of Civil and Environmental Engineering

SOIL & FOUNDATION DYNAMICS
(CIVG311)

CLASS NOTES

Table of Contents

TOPIC

1. DYNAMIC LOADS

- 1.1 Problems That Involve Soil & Foundation Dynamics
- 1.2 Sources of Dynamic Loads
- 1.3 Dynamic Versus Static Loads
- 1.4 Systems of Units
- 1.5 Nature of Dynamic Loads
 - 1.5.1 Types of Applied Loads
- 1.6 Characteristics of Dynamic Forces
 - 1.6.1 Machine-Induced Forces
 - 1.6.2 Construction-Induced Forces
 - 1.6.3 Earthquake-Induced Energy
- 1.7 Examples

2. VIBRATION MEASUREMENT

- 2.1 Measurement Instruments (Transducers)
- 2.2 Data Acquisition
- 2.3 General Information and Guidelines

3. BLAST VIBRATIONS AND CONTROL

- 3.1 Introduction to Blasting
- 3.2 Criteria for Control of Blasting
- 3.3 Mass. Building Code
- 3.4 Blast Vibration Measurement Instruments
- 3.5 Examples

4. TOLERABLE VIBRATIONS

- 4.1 Human Tolerance

- 4.2 Structural Tolerance
- 4.3 Machine Tolerance
- 4.4 Examples
- 5. VIBRATION ATTENUATION
 - 5.1 Definitions
 - 5.2 Energy Attenuation Relationships
 - 5.3 Examples
- 6. FOUNDATION DYNAMICS (1-Degree-Of-Freedom System)
 - 6.1 Problems Involving Foundation Dynamics
 - 6.2 Dynamic Analysis of 1-DOF System
 - 6.2.1 Free Vibration of Undamped 1-DOF System
 - 6.2.2 Forced Vibration of Undamped 1-DOF System
 - 6.2.3 Damping for Energy Loss
 - 6.2.4 Free Vibration of Damped 1-DOF System
 - 6.2.5 Forced Vibration of Damped 1-DOF System
 - 6.2.6 Transmitted Dynamic Forces
 - 6.3 Examples
- 7. FOUNDATION DYNAMICS (Multi-Degree-Of-Freedom System)
 - 7.1 Uncoupled and Coupled Systems
 - 7.1.1 Definitions
 - 7.1.2 Uncoupled Foundation Dynamic Responses
 - 7.1.3 Coupled Foundations
 - 7.2 Free Vibrations of a 2-DOF Coupled System
 - 7.2.1 Undamped System
 - 7.2.2 Damped System
 - 7.3 Forced Vibration of Undamped 2-DOF Coupled System
 - 7.4 Center of Rotation, (C.R.)
 - 7.5 Forced Vibration of Damped 2-DOF Coupled System
 - 7.6 Examples
- 8. GUIDELINES FOR MACHINE FOUNDATION DESIGN AND ANALYSIS
 - 8.1 General Guidelines
 - 8.2 Vibration Control
- 9. SOIL-STRUCTURE INTERACTION (SSI)
 - 9.1 Problems Involving SSI
 - 9.2 Introduction to SSI
 - 9.2.1 What is SSI?

- 9.2.2 Analysis Approach
- 9.3 Theory of Vibration of Shallow Foundations
 - 9.3.1. Vertical Excitation of Foundation on Elastic, Homogenous Halfspace
 - 9.3.2 Calculation of k and c , (Foundation Impedances)
 - 9.3.3 Solving for u and θ , (Foundation Dynamic Response)
- 9.4 Dynamic Pile Response
 - 9.4.1 Procedure for Stiffness Calculation
- 9.5 Examples

10. SITE EFFECT AND WAVE PROPAGATION

- 10.1 One-Dimensional Wave Propagation
- 10.2 Uniform Stratum Subjected to Periodic Base Motion
- 10.3 Wave Propagation in Two Dimensions

11. DYNAMIC SOIL PROPERTIES

- 11.1 Introduction
- 11.2 Determination of Dynamic Soil Properties
 - 11.2.1 Laboratory Tests
 - 11.2.2 Field Methods
 - 11.2.3 Empirically Based Estimation of G and ζ
- 11.3 Estimation of G and ζ versus γ (Approaches Followed in Practice)
- 11.4 Example

12. SHEAR STRENGTH DURING REPEATED LOADING (LIQUEFACTION)

13. EARTHQUAKE-INDUCED PERMANENT DEFORMATIONS / DISPLACEMENTS

14. EARTHQUAKE-INDUCED DEFORMATIONS OF SLOPES AND EARTH DAMS

15. SEISMIC DESIGN OF EARTH RETAINING STRUCTURES

GRADING

Final grades will be based on six (6) Projects (for a total of 100%).

Project 1	??%
Project 2	??%
Project 3	??%
Project 4	??%
Project 5	??%
Project 6	??%
	<hr/>
Total	100%

Northeastern University
Department of Civil and Environmental Engineering
SOIL & FOUNDATION DYNAMICS (CIVG311)

CLASS NOTES

References

- Bachman, H., “*Vibration Problems in Structures*,” Birkhauser, 1995
- Beer, F.P., and Johnston, E.R.Jr., “*Mechanics for Engineers – Statics*”, McGraw-Hill
- Bowles, J.E. “*Foundation Analysis and Design*” McGraw-Hill Book Company
- Das, B.M., “*Fundamentals of Soil Dynamics*” Elsevier.
- Dowding, C.H., “*Blast Vibration Monitoring and Control*,” Prentice-Hall, Inc.
- Dowding, C.H., “*Construction Vibrations*”, Prentice-Hall, Inc.
- Gazetas, G. (1991) “*Foundation Vibrations*” *Foundation Engineering Handbook*, 2nd Edition, Van Nostrand
- Kramer, S.L., “*Geotechnical Earthquake Engineering*”, Prentice-Hall, Inc.
- Liu, T., Kinner, E., and Yegian, M., “*Ground Vibrations*” *Sound and Vibration*, Oct.1974.
- Makdisi, F., and Seed, H.B. ASCE, *Geotechnical Journal* No. GT7, 1978
- Prakash, S., “*Soil Dynamics*” McGraw-Hill, Inc.
- Prakash, S., and Puri, V. “*Foundations for Machines: Analysis and Design*”, John Wiley & Sons.
- Richart, F.E., Hall, J.R., and Woods, R.D., “*Vibrations of Soils and Foundations*”, Prentice-Hall, Inc.
- Sykora and Koester, (1988), ASCE Specialty Conference on Earthquake Engineering and Soil Dynamics.
- Vucetic and Dobry, (1991), “*Effect of Soil Plasticity on Cyclic Response*” ASCE, *Geotechnical Journal*, Vol. 117.
- Wiss, J., “*Construction Vibrations: State-of-the-Art*”, ASCE, *GT-Journal*, Feb. 1981.