ASCE | CONTINUING EDUCATION

Earthquake-Induced Ground Motions

Purpose and Background

This two-day seminar presents a step-by-step evaluation of seismic ground motions for design and assessment of geotechnical and structural systems. The evaluation of site-specific ground motions requires an interaction between geology, seismology, geotechnical engineering and structural engineering. Professionals in any of these fields possess some knowledge of the related fields, but, invariably gaps are left in this knowledge. This seminar is aimed at closing those gaps through an intuitive approach.

The seminar is divided into five parts - each aimed at answering a few key questions:

- **Basic geology and seismology**: Why earthquakes happen. Where future earthquakes are likely to happen. How big are future earthquakes expected to be?
- **Ground motions from past earthquakes**: How ground motions are measured. Which characteristics of ground motions are most significant for engineering analyses? What are the key parameters to capture those characteristics? Where are the sources of ground motion data?
- **Ground motions for future earthquakes**: How ground motion prediction equations are derived from pre-recorded seismic data. How these relations are used to estimate ground motions for future earthquakes. How ground motion maps in NEHRP, IBC and ASCE 7 are generated.
- **Effect of local geology on ground motions**: How local site conditions affect the ground motions. How these effects are considered.
- **Soil-structure interaction**: How the presence of a structure influences the ground motions at a site.

Seminar Instructor

Praveen K. Malhotra, Ph.D., P.E., M.ASCE, is a Principal at StrongMotions, Inc. in Massachusetts. He publishes extensively and provides consulting services related to seismic hazard and risk assessment around the world. He has actively participated in updating seismic design standards in USA, Europe and India. Dr. Malhotra received his Ph.D. in structural/geotechnical earthquake engineering from Rice University. Prior to starting his own consulting practice, he worked with the California Geological Survey and a major worldwide property insurance company. He is a member of the American Society of Civil Engineers (ASCE), Earthquake Engineering Research Institute (EERI), Seismological Society of America (SSA), and the Indian Society of Earthquake Technology (ISET). He is a registered Civil Engineer in California.

- **For group training, contact John Wyrick (JWyrick@asce.org or Stephanie Tomlinson (STomlinson@asce.org)**

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Summary Outline

DAY ONE

Basic geology and seismology

- Plate tectonics
- Seismic sources
- Seismic waves
- Earthquake magnitude
- Earthquake potential of a source
- Frequency of earthquakes on a source

Ground motion histories

- Amplitude, frequency and cyclic-demand parameters of ground motion
- Sources of strong-motion data

Seismic response spectrum

- Dynamic response characteristics of structures
- Calculation of response spectrum from ground motion histories
- Calculation of response spectrum from ground motion parameters
- Pseudo-acceleration, pseudo-velocity, and deformation response spectra
- Tripartite response spectrum
- Smooth response spectrum
- Acceleration-deformation spectrum for pushover analysis

Ground motion prediction equations

- Prediction equations for spectral accelerations
- Effects of geology on ground motion attenuation
- Uncertainty in ground motion prediction

DAY TWO

Site-specific response spectrum

- Deterministic seismic hazard analysis
- Probabilistic seismic hazard analysis
- Treatment of uncertainty in hazard analysis
- Uniform hazard response spectrum
- Deaggregation of hazard
- Intent of building codes
- `Risk-targeted' design ground motions in building codes

Site-specific ground motion histories

- Amplitude, frequency and duration requirements for ground motion histories
- Selection and modification of recorded histories

Effects of local site conditions on ground motions

- Dynamic characteristics of soil deposits
- SHAKE analysis
- Effects of: (1) soil stiffness and damping, (2) bedrock stiffness, and (3) intensity of shaking, on free-surface ground motions
- General code-type procedure for considering soil effects

Soil-structure interaction

- Effect of foundation flexibility on period and damping of soil-structure system

Seminar Benefits

- What are the uncertainties in time, location and size of future earthquakes and how they are included in a seismic source model
- The main characteristics of ground motions produced by earthquakes
- The strengths and limitations of the response spectrum of seismic ground motion
- About the uncertainties in ground motions due to an earthquake of known magnitude
- How deterministic and probabilistic seismic hazard analyses are performed
- How design ground motions are derived from the results of deterministic and probabilistic seismic hazard analyses
- Why design ground motions do not have the same probability of exceedance throughout the country
- How 3-dimensional site-specific ground motion histories are derived
- How local soils affect the ground motions
- How to perform a practical soil-structure interaction analysis

Who Should Attend?

- Structural engineers
- Geotechnical engineers
- Geologists
- Seismologists
- Architects
- Educators and students
- Risk managers
- Building officials
- Professionals in related fields who are interested in consolidating and widening their knowledge of earthquake ground motions and their effects on structural and geotechnical systems.

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