GEOTECHNICAL EARTHQUAKE ENGINEERING

A BERKELEY VIRTUAL SHORT COURSE SERIES

https://www.geoengfdn.org/geotechnical-earthquake-engineering

Module 1: *Earthquake Ground Motions & Seismic Site Response* | February 19 - 22, 2024
Module 2: *Liquefaction Engineering* | March 25 - 28, 2024
Module 3: *Seismic Performance of Slopes and Earth Structures* | April 29 - May 2, 2024

All days live (synchronous) from 12:30 to 16:00 Pacific Standard Time

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University of California at Berkeley (Instructor)

Register for the series

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WHY THIS COURSE SERIES

Berkeley pioneered many of the advances in geotechnical earthquake engineering over the last six decades in large part under the leadership of the late Professor H. Bolton Seed. The Berkeley Faculty continue to be leaders in developing concepts and procedures instrumental to advancing the field of geotechnical earthquake engineering. Key elements of Berkeley's highly rated Geotechnical Earthquake Engineering graduate course are being made available through this short course series. Similar short courses have been offered previously around the world, and they have been well received by practicing engineers, government regulators, and researchers.

This series of three short courses focuses on key concepts and recent advances in geotechnical earthquake engineering. In the first short course module, engineering seismicity is reviewed with a focus on characterizing and selecting design ground motions. Seismic site response procedures, including evaluating dynamic soil properties, are discussed. In the second short course module, soil liquefaction is explored. Field and laboratory observations of the cyclic response of soils are discussed. Simplified liquefaction triggering procedures are presented. Focus is placed on the effects of liquefaction through evaluation of the residual shear strength of liquefied material and liquefaction-induced ground displacements and their effects on structures. Mitigation techniques are presented. In the third short course module, seismic considerations related to seismic slope stability, dams, levees, embankments and retaining systems are presented. Some example problems are solved to illustrate the primary issues involved in evaluating geotechnical earthquake hazards. Question and answer sessions provide opportunities to discuss selected concepts in greater detail. Each attendee will be given course notes that support the lectures.

COURSE SERIES OBJECTIVES

Module 1 Course Objectives:

The objective of Module 1 is to present the State of the Art and Practice on seismic site response. Specific course objectives:

1. Considerations in conducting a DSHA and a PSHA
2. Considerations in ground motion selection and modification
3. Selection of dynamic soil properties and seismic site response analyses

Module 2 Course Objectives:

The objective of Module 2 is to present the State of the Art and Practice on soil liquefaction engineering. Specific course objectives:

1. Understand the state concept of soil response in drained and undrained shear under monotonic and cyclic loading
2. Perform liquefaction triggering assessments using state-of-the-practice tools and procedures and interpret the results
3. Evaluate the effects of soil liquefaction on the ground and structures

Module 3 Course Objectives:

The objective of Module 3 is to present the State of the Art and Practice on the seismic performance of Slopes and Earth Structures. Specific course objectives:

1. The seismic stability considerations for natural hillslopes and engineered earth slopes
2. The seismic stability considerations for the seismic analyses of dams, tailings dams, levees and landfills
3. The seismic performance of retaining structures, the calculation of seismic earth pressures calculation and seismic displacement of walls

Module 1: Earthquake Ground Motions & Seismic Site Response

BERKELEY VIRTUAL SHORT COURSE SCHEDULE

All Dates & Times are Pacific Time Zone (California Time)

DAY 1 (19 FEB 2024):

12:30 – 13:30 **1. Engineering Seismicity** (A. Athanasopoulos-Zekkos)
- intro; plate tectonics; elastic rebound; earthquake magnitude; MMI; recurrence interval
- source, path and site effects; wave propagation; source characterization

13:45 – 14:45 **2. Earthquake Engineering** (A. Athanasopoulos-Zekkos)
- fundamentals of vibration; response spectra; Fourier spectra
- ground motion intensity measures (IMs; amplitude; frequency content; duration)
- ground motion models (GMMs); median and standard error of estimations

15:00 – 16:00 **3. Deterministic Earthquake Ground Motions** (J. Bray)
- deterministic seismic hazard assessment - DSHA
- fault rupture, near-fault forward-directivity pulse motions; long duration ground motion
- deterministic estimation of design rock motions – amplitude scaling of motions

DAY 2 (20 FEB 2024):

12:30 – 13:30 **4. Probabilistic Seismic Hazard Assessment** (N. Abrahamson)
- probabilistic seismic hazard assessment - PSHA; epistemic and aleatory uncertainty
- hazard curves and de-aggregation; uniform hazard and conditional mean spectra

13:45 – 14:45 **5. Design Ground Motions** (N. Abrahamson)
- 'seed' ground motion selection
- ground motion modification – spectrum compatible scaling of motions
- review of design suite of ground motions

15:00 – 16:00 **6. Q&A and Panel Discussion of Earthquake Ground Motions** (A. Athanasopoulos-Zekkos)

DAY 3 (21 FEB 2024):

12:30 – 13:30 **7. Dynamic Soil Properties** (D. Zekkos)
- field and laboratory tests; factors affecting material behavior
- cyclic loading and strain-dependent shear modulus and material damping curves

13:45 – 14:45 **8. Soil Response under Shear** (J. Bray)
- volume change (contractive or dilative response to shear)
- pore water pressure change during undrained loading
- dynamic shear strength

15:00 – 16:00 **9. Q&A and Panel Discussion of Dynamic Properties** (D. Zekkos)

DAY 4 (22 FEB 2024):

12:30-13:30 **10. Seismic Site Effects** (J. Bray)
- historical evidence, sources of ground motion amplification: site, basin, topographic effects
- simplified methods and analytical approaches (transfer function)
- layered systems; application of input motions (outcropping and within profile)
- seismic response of soft clay sites

13:45-15:00 **11. Seismic Site Response Analysis** (A. Athanasopoulos-Zekkos)
- equivalent-linear analysis
- nonlinear analysis: total and effective stress
- equivalent-linear & nonlinear analyses comparison

15:15 – 16:00 **12. Q&A and Panel Discussion of Site Response & Site Effects** (J. Bray)

Live (synchronous) from 12:30 to 16:00 Pacific Standard Time on February 19 - 22, 2024

Register for the first module

Module 2: Liquefaction Engineering

BERKELEY VIRTUAL SHORT COURSE SCHEDULE

All Dates & Times are Pacific Time Zone (California Time)

DAY 1 (25 MARCH 2024):

12:30 – 13:30 **1. State Concept** (J. Bray)
- intro; state concept interpretation of sand behavior under monotonic shearing

13:45 – 14:45 **2. Cyclic Response of Sand** (A. Athanasopoulos-Zekkos)
- cyclic response of sand, pore water generation, and soil liquefaction

15:00 – 16:00 **3. Key Factors Affecting Liquefaction Triggering** (J. Bray)
- susceptibility; key factors of liquefaction; laboratory tests; fines content; plasticity

DAY 2 (26 MARCH 2024):

12:30 – 13:30 **4. Liquefaction Investigation Tools** (D. Zekkos)
- in situ site investigation tools
- soil sampling and sampling disturbance

13:45 – 14:45 **5. CPT-Based Liquefaction Procedures** (J. Bray)
- simplified liquefaction triggering procedure: CSR, CRR, MSF, K_σ, K_α, & FS_L
- CPT-based simplified procedures for evaluating liquefaction triggering

15:00 – 16:00 **6. Q&A and Panel Discussion of Soil Liquefaction & Triggering** (A. Athanasopoulos-Zekkos)

DAY 3 (27 MARCH 2024):

12:30 – 13:30 **7. Other Liquefaction Triggering Procedures** (R. Kayen)
- other approaches to evaluating liquefaction triggering, SPT and V_S procedures
- effects of geologic deposition

13:45 – 14:45 **8. Liquefaction Evaluation of Silt and Gravel** (A. Athanasopoulos-Zekkos)
- silty sand, silts, clayey soil
- gravelly soil liquefaction

15:00 – 16:00 **9. Liquefaction Ground Settlement, Lateral Spreading & Ejecta** (J. Bray)
- liquefaction-induced ground deformation: settlement, lateral spreading, ground failure indices (Ishihara 1985, LPI, LSN, L_D-C_R), and ejecta

DAY 4 (28 MARCH 2024):

12:30 – 13:15 **10. Residual Shear Strength of Liquefied Soil** (A. Athanasopoulos-Zekkos)
- flow slides & post-liquefaction stability check
- contractive, brittle soil response
- residual strength of liquefied soils

13:30 – 14:45 **11. Liquefaction Effects on Structures** (J. Bray)
- dynamic analyses
- simplified methods
- countermeasures against liquefaction and evaluation of mitigation

15:00 – 16:00 **12. Q&A and Panel Discussion of Evaluating Liquefaction Effects** (J. Bray)

Live (synchronous) from 12:30 to 16:00 Pacific Standard Time on March 25 – 28, 2024

Register for the second module

Module 3: Seismic Performance of Slopes and Earth Structures

BERKELEY VIRTUAL SHORT COURSE SCHEDULE

All Dates & Times are Pacific Time Zone (California Time)

DAY 1 (29 APRIL 2024): SEISMIC SLOPE STABILITY

12:30 - 13:30 **1. Observations of Seismic Slope Stability of Slopes and Cliffs** (N. Sitar)
- intro; rock slopes; cliffs; soil slopes

13:45 - 15:00 **2. Seismic Slope Stability** (J. Bray)
- pseudostatic stability analyses, seismic coefficient
- calculated seismic slope displacement
- simplified seismic slope stability analyses

15:15 - 16:00 **3.System-Level Frameworks for Seismic Stability Assessments** (D. Zekkos)
- importance of system-level analysis of hillslopes & methodology
- model integration & back-analyses of failed slopes
- landslide runout and impact on infrastructure

DAY 2 (30 APRIL 2024): SEISMIC PERFORMANCE OF DAMS

12:30 - 13:30 **4. Observations and Dynamic Analyses of dams** (A. Athanasopoulos-Zekkos)
- observations of performance; preliminary assessment
- dynamic analyses of earth dams

13:45 - 14:45 **5. Seismic Performance of Tailings Dams** (J. Bray)
- observations of tailings storage facilities in earthquakes
- tailings material characterization
- evaluation of tailings dams

15:00 - 16:00 **6. Q&A and Panel Discussion on Seismic Performance of Slopes and Dams** (J. Bray)

DAY 3 (1 MAY 2024): SEISMIC PERFORMANCE OF LEVEES & LANDFILLS

12:30 - 13:30 **7. Observations and Dynamic Analyses of Levees** (A. Athanasopoulos-Zekkos)
- observations of performance; preliminary assessment
- dynamic analyses and seismic performance of levee systems

13:45 - 14:45 **8. Seismic Performance of Waste Landfills** (D. Zekkos)
- observations of seismic performance of landfills
- waste characterization; seismic evaluation of landfills

15:00 - 16:00 **9. Q&A and Panel Discussion on Levees and Waste Landfills** (D. Zekkos)

DAY 4 (2 MAY 2024): RETAINING SYSTEMS

12:30 - 13:45 **10. Seismic Performance & Assessment of Retaining Structures & Basement Walls** (N. Sitar)
- observations of seismic performance
- retaining & basement walls
- mechanically stabilized walls and embankments
- experimental studies
- limit equilibrium design methods and their limitations
- dynamic analysis methods

13:45 – 15:00 **11. Seismic Performance of Port Structures & Mitigation Strategies** (A. Athanasopoulos-Zekkos)
- observations of seismic performance of port piers and waterfronts
- deformation-based seismic design of retaining structures
- case study: Performance, characterization and modeling of port piers and waterfronts in the 2014 M_W 6.1 Cephalonia earthquake
- seismic isolation strategies

15:15 – 16:00 **12. Q&A and Panel Discussion on Retaining Systems** (A. Athanasopoulos-Zekkos)

Live (synchronous) from 12:30 to 16:00 Pacific Standard Time on April 29 – May 2, 2024

Register for the third module

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COURSE CONTENT DELIVERY METHOD

By registering to any of the courses you can get the course content in two ways:

1. Live (synchronous) from 12:30 to 16:00 Pacific Standard Time on February 19 - 22, 2024 (Module 1), March 25 - 28, 2024 (Module 2), and April 29 - May 2, 2024 (Module 3).
2. Recorded lectures that will remain available for one month after the Live version of each course. This has been shown to facilitate particularly participants in different time zones.

In addition, the courses include significant time for discussion and consultations in joint rooms and break-out rooms with the instructors.

DELIVERABLES

- 14 hrs of online lectures for each module – Available for real-time during the course delivery as well as non-real-time (i.e., asynchronous). Registered participants will be able to view the presentations for an entire month following the completion of the course through a password-protected website.
- All course slides
- Recommended Technical literature for each specific technology/theme
- Certificate of attendance by the Short Course Organizer
- Certificate for 8 PDH hours (separate for each module)

COURSE COST

The cost of each four half-day course is $985. A limited number of spots are available for students (with a 35% price reduction) after coordination with the short course leader.

A 10% reduction in cost is provided for 3-4 registrations and a 20% off for 5+ registrations (if paid at the same time during course registration).

A 50% reduction in cost for the third module is provided to users that will register in all three modules (if paid at the same time during course registration).

Refund Policy: Course registration can be fully refunded based on requests made until two weeks before each short course. Specifically, until February 5, 2024 for the first module and the whole series, until March 11, 2024 for the second module, and until April 15, 2024 for the third module.

Register for the series

Register for the first module

Register for the second module

Register for the third module

COURSE REGISTRATION

Registration deadline is **February 12, 2024** for the first module and the whole series, **March 18, 2024** for the second module, and **April 22, 2024** for the third module, unless the course becomes fully-booked earlier.

CONTACT

For questions related to this short course, please contact the short course leader Prof. Dimitrios Zekkos (zekkos@berkeley.edu)