Program Overview

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Civil & Environmental Engineering

Within our department, we have six areas of study:

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108 Incoming Graduate Students
Structural Engineering and Mechanics Faculty

Jeff Berman
Steel Structures
Structural Control

Paolo Calvi
Concrete Structures
Forensic Analysis

Marc Eberhard
Concrete Structures
Earthquake Engineering

Dawn Lehman
Concrete Structures
Performance-Based
Seismic Design

Laura Lowes
Constitutive Theory
Numerical Modeling

Peter Mackenzie
Structural Stability
Numerical Modeling

Greg Miller
Solid Mechanics
Computational Methods

Mike Motley
Fluid-Structure
Interaction Probabilistic
Design

Charles Roeder
Steel and Composite
Structures
Seismic Design

John Stanton
Concrete Structures
Seismic Isolation

Richard Wiebe
Nonlinear Dynamics
Experimental Mechanics
Close Collaborators

Geotechnical Engineering

Pedro Arduino
Computational Geomechanics

Mike Gomez
Bio-mediated Soil Improvement

Steven Kramer
Gootechnical Eq. Engineering

Brett Maurer
Soil Liquefaction Paleoseismology

Joseph Warthman
Engineering Geology Landslides

Construction and Systems Engineering

Jessica Kaminsky
Developing Communities

Amy Kim
Engineering and Energy

Joe Mahoney
Transportation and Construction

Stephen Muench
Transportation Infrastructure and Sustainability

Dorothy Reed
Wind Engineering Resilient Infrastructure
Research

- Research projects expected to hire students in the near future are listed in the following slides.
- It is expected that additional projects may be added in the future.
Impacts of Cascadia Subduction Zone M9 Earthquake

**Faculty:** Eberhard, Berman, Maurer (geo), Kramer (geo)

**Funding:** NSF, WSDOT, USGS

**Objectives:** What will CSZ M9 do to Infrastructure?
- Bridges, soil types, location

**Approach:**
- Analyses of systems to get demands on components
- Tests to determine component capacities

**Students:** Currently 1 graduate student and 1 post-doc. Will need 1-3 more
New Structural System for VES

**Title:** Vertical Evacuation Structures Subjected to Sequential Earthquake and Tsunami Loadings. Lehman, Roeder & Motley. NSF

**Research Objectives & Research Approach:** Develop new system for earthquake and tsunami resistant structures. Testing of new slab-CFT column systems in UW structures lab. Testing of wall and new CFTs in OSU lab. Simulation of structures including structure-fluid interaction using OpenSees & OpenFoam

**Students:** Currently 3 graduate students. Hiring another 2 students in AY 2019-2020.
3D Printing of Fiber-Reinforced Concrete

Faculty: Lehman and Ganter (ME)
Funding: Pactrans (NSF pending)

Objectives & Approach:
Investigate the fresh-state and hardened engineering properties of fiber reinforced cementitious material (FRCM) components using extrusion-based 3D printing.

- Design and fabricate material extrusion-based 3D printer for construction of FRCM components.
- Develop a quality control protocol to investigate voids and fiber alignment of 3D printed FRCM components using x-ray tomography
- Investigate fresh-state & properties of 3DP FRCMs

Students: Currently 1 ME graduate student. Possibly hiring 1 student in AY 2019-2020.
Chevron Concentrically Braced Frames with Yielding Beams

Faculty: Lehman, Berman & Roeder    Funding: AISC

Research Objectives & Approach: Permit yielding in chevron braced frames.
• Experimentally investigate the seismic response of allowing yielding of beams to optimize size. One-story and three-story frames tested with different beam sizes
• Use finite element analyses to investigate untested parameters
• Investigate dynamic response of 3, 6 and 9 story provisions

Investigation of Hollow PSC Pile-columns

**Faculty:** Stanton and Calvi.

**Funding Agency:** WSDOT.

**Problem:** Hollow prestressed concrete columns, built in the 1960s are vulnerable to earthquakes by spalling internally.

**Goal:** Investigate behavior and design a retrofit concept, using experimental and computational methods.

**Methods:** Create a ductile fuse in the column directly below the cross-beam. Use it to reduce the forces elsewhere to a tolerable level. Test the fuse. Use computer models to investigate forces in other parts of the structure.

**Students:** Currently 2 CEE graduate students. Possibly hiring 1 student in AY 2019-2020.
High Speed Rail in Seismic Regions

**Faculty:** Stanton and Eberhard.

**Funding Agency:** FIU ABC Center, PEER.

**Problem:** High Speed Rail imposes stringent demands, seismic and otherwise.

**Goal:** Investigate existing HSR raised structures, develop high-performance structural systems for seismic regions.

**Methods:** Discussions with HSR authorities, designers, contractors, literature review to establish current methods. Design and computational modeling to investigate performance of new structural systems.

**Students:** Currently 1 CEE graduate student. Possibly hiring 1 student in AY 2019-2020.
Ultra-High-Performance Concrete – Shear Strength

Faculty: Calvi and Stanton.

Funding Agency: FIU ABC Center.

Problem: Shear behavior of UHPC is unknown.

Goal: Investigate behavior of UHPC in shear and other combined stress states. Develop preliminary constitutive model.

Methods: Use UW “Panel tester”, developed by Calvi, to impose biaxial load states. Use measured responses to characterize material constitutive behavior.

Local Effects & Global Structural Dynamics in Extreme Environments

**Faculty:** Wiebe

**Funding Agency:** AFOSR.

**Problem:** We need better predictive capability to design high-speed aircraft. High-speed flight tests are expensive, and simulation is slow.

**Goal:** Develop fast + efficient reduced order models for structural dynamics and damage progression.

**Methods:** High-fidelity FEM coupled with efficient simplified models. Experimental validation.

**Students:** One postdoc, 2 graduate students. Hiring 1 next year.
Facilities

> Large-Scale Structural Research Lab
> CT Scanning facility
> NHERI RAPID Post-Disaster Rapid Response Research Facility
> Structural Vibrations Laboratory
> More Details at:
  - https://www.ce.washington.edu/research/facilities
Program Overview
Master’s Degree Program

Both programs offer the flexibility to tailor a program in structural engineering to fit specific needs through both introductory and advanced electives.

General Program Requirements

- 3 required fundamental courses
- 4-5 500-level structural engineering electives
- 0-3 credits of structures seminar

Non-thesis Program

- 15 remaining course credits – 5 courses
  - Any 500-level SEM course, approved 400-level SEM courses, approved electives outside of SEM

Research/Thesis Program

- 9 credits of CEE 700 (thesis)
- 6 remaining coursework credits – 2 courses
  - Any 500-level SEM course, approved 400-level SEM courses, approved electives outside of SEM

Students can transfer up to 6 credits of comparable coursework toward their degrees.
Ph.D. Degree Program

Ph.D. Requirements

MSCE
Ph.D. Qualifying Exam
Additional Coursework
General Examination
Dissertation
Final Examination

Usually takes 4-5 years (including MSCE)

Unofficial requirement:
Find a research project
Courses
SEM Courses

Structural Analysis
- CESG 501: Structural Mechanics, 6 credits, (Autumn)
- CESG 502: Structural Dynamics, 3 credits, (Winter)
- CESG 504: Finite Element Methods in Structural Mechanics, 3 credits, (Spring)
- CESG 505: Engineering Computing (Autumn)
- CESG 506: Nonlinear Analysis of Structural Systems (Spring)
- CESG 507-1: Structural Stability (Winter – Every other year)
- CESG 507-2: Elasticity (Winter – Every other year)
- CESG 508: Materials Modeling, (Winter)
- CESG 509: Reliability and Design (Autumn)

Structural Design
- CESG 521: Advanced Reinforced Concrete (Autumn)
- CESG 522: Prestressed Concrete Design (Winter)
- CESG 523: Advanced Structural Systems (Spring)
- CESG 524: Advanced Steel (Winter)
- CESG 526: Earthquake Engineering I (Spring)
- CESG 527: Earthquake Engineering II (Autumn)
- CESG 528: Wind Engineering Design (Spring)
- CESG 529: Bridge Engineering (Winter)
- CESG 599: Advanced Steel II (Summer)
SEM Courses

Structural Analysis

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  REQUIRED CORE
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**SEM Courses**

**CESG 501: Structural Mechanics (Wiebe)**

- Direct and variational formulations of stiffness method.
- Beams, trusses, frames
- Buckling of systems
- Driver’s license on integral and variational methods for mechanics.
- Background for later coursework

- 4-credits
SEM Courses

CESG 502: Structural Dynamics (*Calvi*)

- Study of the dynamic vibration of deformable bodies and structures, including free and forced vibrations of linear, single, and multiple degree of freedom systems and the effects of damping.
- Analysis in the time and frequency domains by time history and by response spectrum methods.
- Numerical methods for solutions of linear dynamic systems.
- Free and forced vibrations of continuous systems and wave propagation in rods and beams.
- **4-credits**
SEM Courses

CESG 504: Finite Element Methods in Structural Mechanics (Motley)

- Extension of the matrix methods of structural analysis to the solution of multi-dimensional structural mechanics problems by use of finite element approximations.
- Discussion of convergence and bounding and extension to investigation of stability and finite deformations.
- 4-credits
SEM Courses

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SEM Courses

**CESG 505: Engineering Computing (Mackenzie)**

- Applied computing in civil and environmental engineering contexts.
- Programming in python (procedures, OOP, scripting and more)
- SQL database systems for collecting, managing, and analyzing large data sets (experimental, sensor, and synthetic data).
- Distributed computing.
- Image processing and Visualization concepts
SEM Courses

CESG 506: Nonlinear Analysis of Structural Systems (Motley)

- Formulation, solution, and interpretation of nonlinear numerical models of structural systems.
- Solutions procedures for nonlinear system; truss, frame and continuum element formulations including material and geometric nonlinearities.
- Matlab programming of solution algorithms and element formulations. Use of commercial software.
SEM Courses

CESG 507-1: Structural Stability (Wiebe)

- Concepts of stability of equilibrium states.
- Stability of columns with various boundary conditions and loads.
- Determination of critical loads for structural systems with analytical and approximate methods.
- Inelastic buckling of columns and lateral buckling of beams.
Fundamentals of 3D structural mechanics – Equilibrium, Compatibility/Kinematics, Constitutive/Material Laws

Focus on linear, elastic regime, which allows for some closed form analysis.

Classical solutions of torsion, beams, and subsurface loads.

Dovetails into FEM.
SEM Courses

CESG 508: Materials Modeling
(Mackenzie/Arduino)

- Inelastic behavior of materials
- Creep, stress relaxation, elastic-plastic behavior.
- Effect of cyclic and other non-proportional loading.
- Damping and friction (Dissipation).
- Numeric algorithms and implementation for 2D and 3D models.
- Intro to anisotropic and composite materials.
SEM Courses

**CESG 509: Reliability and Design (Reed)**

- Introduction to theory of structural reliability and its application to design procedures in civil engineering, including probability theory
- Assessment of uncertainties
- Code specification and the related concept of risk and the influence of socioeconomic factors
- Loads, load combinations, and probabilities of damage.
SEM Courses

**Structural Analysis**
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**DESIGN ELECTIVES**
SEM Courses

CESG 521: Advanced Reinforced Concrete (Eberhard)

- Reinforced concrete behavior, analysis and design.
- Fundamental material behavior including confined concrete and cyclic response of reinforcing steel.
- Development of full nonlinear behavior of flexural components, including moment-curvature response and plastic hinge analysis tools.
- Shear design including strut and tie modeling and bi-directional loading of columns.
- Introductory topics in seismic design including moment frames and columns.
SEM Courses

CESG 522: Prestressed Concrete Design

(Stanton)

- Analysis, design, and construction of prestressed concrete structures.
SEM Courses

CESG 523: Advanced Structural Systems (Stanton)

- Examines structural design of floor systems for buildings, including one-way and two-way slabs, strip method, yield line theory, prestressed concrete slabs.
- Lateral load resisting systems for buildings.
SEM Courses

CESG 524: Advanced Steel Design (Berman)

- Factors influencing strength and serviceability of steel structures.
- LRFD limit state design procedures.
- Use of theories of plasticity and stability in development of design methods and specifications.
- Bolted and welded connections, temperature effects, and affect of different fabrication methods on behavior of structure.
SEM Courses

CESG 526: Earthquake Engineering I (Calvi)

- Earthquake mechanism and ground shaking, response spectra, linear elastic methods for prediction of behavior.
- Displacement prediction methods for inelastically behaving structures, modeling and solution schemes, earthquake design philosophy, capacity design.
- Reinforced concrete, steel, and base-isolated structures.

(Kramer 1996)
SEM Courses

CESG 526: Earthquake Engineering II (Berman)

- Performance-based design, development of fragility curves.
- Characteristics and effects of ground-shaking records.
- Passive and active control.
- Dynamic inelastic time history analysis.
- Design of parts, system detailing.
- Soil-structure interaction.
- Repair and retrofit of structures.
SEM Courses

CESG 528: Wind Engineering Design (Reed)

- Wind effects on structures, including atmospheric boundary layer flow.
- Bluff body aerodynamics
- Structural dynamics and aeroelasticity
- Development and use of the ASCE Standards
- Estimation of along-wind, across-wind, and torsional response of tall buildings
- Design strategies for avoiding wind-induced discomfort.
SEM Courses

CESG 529: Bridge Engineering

- Design of decks, joints, girders, columns and foundations.
- Gravity loads and seismic loading.
CEE 500: Seminars

There are several seminars options available. Up to three credits may be used toward degree.

**Department-Wide Seminars**
- Great presentations
- Broad civil engineering topics
- Wenk/Evans/Burgess

**Structural Engineering Practice**
- Local structural engineering firms
- MKA, KPFF, CPL, DCI, etc.
- Buildings and Bridges

**Research and Presentation**
- Enrolled students research and present a “hot topic” in structural engineering
- Additional presentation on active UW research
SEM Courses

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DESIGN ELECTIVES
## SEM Courses

Course offerings for the 2017-2018 academic year

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Sample CEE Electives Outside of Structures

We encourage you to take electives from other disciplines within the department.

- Infrastructure Construction
- Reinforced Concrete Construction
- Energy and the Environment
- Geotechnical Earthquake Engineering
- Hydrodynamics
- Introduction to Wind Turbine Design
- Advanced Foundations Engineering
- Geohazards
Sample Courses Outside of CEE

Outside of the department, there are many recommended options, including College of Engineering

**Aerospace Engineering**
- AA 532: Mechanics of Composite Materials
- AA 538: Introduction to Structural Optimization
- AA 543: Computational Fluid Dynamics

**Materials Science and Engineering**
- MSE 431: Failure Analysis and Durability of Materials
- MSE 462: Mechanical Behavior of Materials
- MSE 475: Introduction to Composite Materials

**Mechanical Engineering**
- ME 415: Sustainability and Design for the Environment
- ME 515: Life Cycle Assessment
- ME 541: Fatigue of Materials
- ME 551, 552: Elasticity I/II
- ME 556, 557: Experimental Stress Analysis I/II
- ME 559: Introduction to Fracture Mechanics
- ME 564, 565: Mechanical Engineering Analysis I/II
Sample Courses Outside of CEE

Outside of the department, there are many recommended options, including

College of the Built Environment

**Architecture**
- ARCH 521: Structural Planning and Design
- ARCH 537: Traditional Building Methods: New Adaptations
- ARCH 538: Building Reuse Seminar
- ARCH 578: Case Studies in Contemporary Architecture

**Construction Management**
- CM 404: Integrated Design/Build Studio
- CM 450: Construction Project Management
- CM 500: Design and Construction Law
- CM 505: Advanced Integrated Computer Applications
- CM 510: Advanced Construction Technique
- CM 515: Innovative Project Management Concepts
- CM 530: Project Economics and Risk Analysis
- CM 540: Sustainable Construction
- CM 560: Design-Building Project Management
- CM 580: Temporary Structures
Sample Courses Outside of CEE

Outside of the department, there are many recommended options, including

College of Arts and Sciences

- AMATH 503: Methods for Partial Differential Equations
- AMATH 506: Applied Probability and Statistics
- AMATH 515: Fundamentals of Optimization
- AMATH 516: Numerical Optimization
- AMATH 572: Introduction to Applied Stochastic Systems
- AMATH 581, 582, 583: Scientific Computing
- AMATH 584, 585, 586: Numerical Analysis
TA Opportunities for Incoming Graduate Students

- CEE 220: Mechanics of Materials
- CEE 377: Introduction to Structural Analysis
- CEE 451: Steel Design
- CEE 452: Reinforced Concrete Design
- CEE 456: Structural Analysis I
Why UW?

- Active and diverse research program
  - Local (WSDOT, Sound Transit, M9)
  - National (FHWA, NCHRP, NSF, NHERI, PEER, USAF)
  - International (NCREE)
- Excellent teaching and coursework program
  - Two UW distinguished teaching award winners
- Well-connected with local industry
  - Career fairs, CEE 500 seminars, and more opportunities
- Growth in Seattle provides professional advantages with increasing employment opportunities and of large number of local firm
  - Puget Sound region number 2 in the country in terms of CEEs per thousand employed people across all professions
- Outcomes
  - Our students get competitive positions, and work on exciting projects immediately after graduation.
WA State Employment Projections

Selected Economics Sectors, 2020

Why UW?

Seattle is also a great place to forget about work for a while...
Thank You