

# Civil Engineering

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*Master of Science in Engineering  
Doctor of Philosophy*

## For More Information

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## Objectives

The objectives of the graduate program in civil engineering are excellence in engineering education, research, and professional service. The program seeks to educate students to assume leadership positions in engineering practice, research, and education. The program also seeks to advance the state of the art and of the practice of civil engineering at both fundamental and applied levels through extensive research programs, and to disseminate the research outcomes through professional and scholarly activities. The program's thematic areas include architectural engineering, construction engineering and project management, construction materials, environmental and water resources engineering, geotechnical engineering, ocean engineering, structural engineering, and transportation engineering, as well as interdisciplinary areas of study.

## Facilities for Graduate Work

The Department of Civil, Architectural, and Environmental Engineering occupies eight floors in Ernest Cockrell Jr. Hall, which also houses computer facilities for use by civil engineering students. In addition, the facilities of Information Technology Services are available to students working on problems in any of the areas listed below. Laboratories are equipped and staffed to provide for both instruction and research.

**Building energy and environments.** The Building Energy and Environments program investigates a wide range of issues related to building environments and environmental systems. The program research focuses on energy flows and conservation methods; building energy efficiency; environmental control systems; moisture transport and control; indoor microbial growth and fate; sources of VOCs, SVOCs, and particles; homogeneous and heterogeneous reactions; transport of indoor pollutants; and human exposure. Beside taking coursework in other areas of civil engineering and in other departments, students have a chance to specialize in building environmental systems and various aspect of indoor environmental quality. The diverse faculty, with expertise ranging from environmental, architectural, and mechanical engineering, offers a large variety of graduate courses that address different aspects of indoor air quality and energy efficiency of building environmental systems. This provides students with a unique opportunity to receive both the depth and breadth of knowledge necessary to design and maintain truly sustainable buildings. Students, faculty, and staff within the Building Energy and Environments Group conduct their research in academic laboratories equipped with cutting-edge instrumentation and simulation systems. The research activities take place in laboratories at the Center for Energy and Environmental Resources at the University of Texas' J. J. Pickle Research Campus. Five separate laboratories totaling 6,000 square feet are devoted to building

energy and environments research on the J. J. Pickle Research Campus. These laboratories are used for experiments using physical simulation systems, preparation for field studies, instrumentation calibration and maintenance, and analysis of samples collected in the field or in laboratory. The laboratories contain a wide range of instruments and facilities and among the physical simulation systems are a 1,200-square-foot test house, three full scale test rooms with state-of-the-art environment control systems, a variety of small chambers for testing emissions from building materials, human simulators such as a thermal manikin with breathing systems, and a family of wind tunnels for testing various components of heating, ventilation, and air conditioning systems (HVAC).

**Construction engineering and project management.** The construction laboratories include a well-equipped computer cluster on the main campus and a high-bay laboratory for construction automation research at the J. J. Pickle Research Campus. Software includes three-dimensional computer-assisted drafting and modeling packages, statistical packages, construction project management software, discrete modeling and simulation packages, advanced communication hardware, and software developed through research. The program also has access to the Texas Advanced Computing Center Visualization Laboratory, which makes available various world-leading research and teaching infrastructure such as a 307 Mpixel display and a large-scale, tiled display supporting 32-point multi-touch for collaborative manipulation. Students also benefit from the many facilities under construction on campus and in the surrounding community as living laboratories for class visits and research studies.

**Infrastructure materials engineering.** The graduate program in infrastructure materials engineering emphasizes the characterization and testing of materials such as asphalt, cement, aggregates, concrete, steel, masonry, wood, polymers, and composites. Research and coursework focus on the materials science, property development, field performance, durability, forensics, and repair of infrastructure materials. The Laboratory for Infrastructure Materials Engineering (LIME) is located at the J. J. Pickle Research Campus. Excellent facilities are available for proportioning and batching concrete, mechanical testing, and durability testing, including both accelerated tests and outdoor exposure sites. The laboratory has the capability to perform a wide range of materials tests, including freezing and thawing, alkali-silica reaction, shrinkage, creep, aggregate characterization, rapid chloride, and corrosion evaluation. Microscopes, x-ray diffraction, thermal analysis instrumentation, and rheometers are also available. The Infrastructure Materials Performance and Characterization (IMPACT) laboratory is located in Ernest Cockrell Jr. Hall and is dedicated to the characterization and testing of asphalt binders and mixtures. The lab includes facilities to synthesize different asphalt binders, fabricate test specimens and evaluate them under a variety of different temperature and loading rate conditions. In addition to the above labs, students also take advantage of central facilities such as UTCT for X-ray CT and Texas Materials Institute for materials investigation using tools such as gel permeation chromatograph, atomic force microscope, scanning electron microscope etc.

**Environmental and water resources engineering.**  
*Program.* This program is designed to educate engineers who will solve environmental and water resources problems by applying concepts of sustainability and fundamental principles from the natural sciences, mathematics, mechanics, economics, and other underlying disciplines. To achieve this objective, the program offers a breadth of possible research and study areas. The faculty is one of the largest and most diverse in the nation, with expertise ranging from environmental fluid mechanics to water resources planning and from pollutant transport to treatment processes. The major areas of emphasis are treatment process engineering, air resources engineering, environmental remediation, water quality, water resources engineering,

and ocean engineering. Because the program requires no specific courses, each student's education can be designed to meet their goals. The faculty offers a wide variety of courses, and students may choose courses in other related fields, such as chemical engineering, chemistry, geology, mathematics, microbiology, petroleum engineering, physics, and public policy. Once students choose a particular study area, they work closely with the faculty member or members conducting research in that area. Each student's program of study includes a balanced combination of coursework, seminars, and research. Well-equipped research laboratories, state-of-the-art instrumentation, and superb computation facilities support the graduate program, as do cooperation and coordination with research faculties and laboratories in physical, chemical, biological, and social sciences and other engineering disciplines.

*Facilities.* Environmental and water resources engineering laboratories are well-equipped for both basic and applied state-of-the-art research in virtually all environmental and water resources areas. On campus, the program has twenty thousand square feet of space on three floors of Ernest Cockrell Jr. Hall for physical, chemical, and biological analyses and for research on water, wastewater, and hazardous waste treatment processes. Facilities include a clean room for metal or particulate analysis, four laboratories with temperature and humidity control, numerous hoods for the safe handling of hazardous chemicals and biological samples, and an instrumentation laboratory for characterization of analysis of environmental samples in air, water, and soil matrices. Additional analytical equipment is available in other departments on the main campus.

The Computational Hydrodynamics Laboratory in Ernest Cockrell Jr. Hall has a high-performance computer cluster (16 nodes of eight cores each, Intel Xeon E5420 processors). This cluster provides the necessary platform for solving nonlinear flow problems about complex hull and/or propulsor geometries (involving cavities or free surfaces), and for developing algorithms for the design of efficient propeller or tidal turbine blades using nonlinear optimization techniques.

The Program in Air Resources Engineering maintains 5,000-square-foot of laboratory space in five laboratories at the Center for Energy and Environmental Resources. These laboratories also include facilities for studying outdoor sources of volatile organic compounds and indoor sources and sinks of volatile chemicals. A wide range of instrumentation is available for field monitoring in both indoor and outdoor environments. The Center for Energy and Environmental Resources also maintains extensive computational resources for air quality modeling and energy and climate change research.

The Center for Research in Water Resources is located at the J. J. Pickle Research Campus. Computational research focuses on applications of geographic information systems using ArcInfo and ArcView, simulation of pollutants in soil and groundwater, and assembly and synthesis of historical water quantity and quality information. The experimental research uses scaled physical models, models of innovative wastewater treatment facilities, and field monitoring of water quality. The 24,000-square-foot laboratory includes general- and special-purpose fixed and tilting channels and instrumentation and data acquisition systems for laboratory and field studies.

**Geotechnical engineering.** This program is designed to offer students a broad range of activities with a solid basis in the core areas of geotechnical engineering. Graduates receive a strong background in the basics through courses in geotechnical engineering, which offer the foundation for a successful professional career. In addition, the program exposes students to research activities that are at the forefront of developments in the field.

The geotechnical engineering laboratories are located in the Ernest Cockrell Jr. Hall and at the Pickle Research Campus. The laboratories include modern workstations for conducting standard geotechnical tests, including index tests, flexible wall permeameter tests, one-dimensional and triaxial consolidation, direct shear tests, and triaxial shear tests.

The soil dynamics laboratory has extensive facilities for combined resonant column and torsional shear testing. Large-scale multimode equipment is available for dynamic laboratory testing with specimens up to 0.3 meters in diameter. The geosynthetics laboratory includes tensile testing devices, a large-scale pullout testing device, large-scale time-temperature testing equipment, as well as specialized interface shear tensile devices. The unsaturated soils laboratory includes pressure plate testing devices, hanging columns, infiltration column systems, and multiple calibration chambers.

The ground improvement/pore fluid engineering research laboratories include one cyclic direct simple shear and one cyclic triaxial device; both devices can be run under static/cyclic loading with stress/strain complete servo control. Special setups for testing grouted soils, including static triaxial setups, are available as well. The laboratories have an advanced rheometer than can measure the engineering properties of fluids, suspensions, and gels. The facilities also include a multi-use dynamic/static (MUDS) testing setup that consists of a shaking table with a laminar box mounted on top of it. The MUDS testing setup allows for running 1-D 1-g free top shaking table tests on large specimens (1 m x 0.5 m x 0.5 m with shaking along the 1 m direction). The setup allows for running large scale static and cyclic simple shear tests as well as direct shear tests at confining stresses up to 200 kPa.

The rock mechanics laboratory is equipped to carry out uniaxial and triaxial tests with confinement of up to 70 MPa and with the possibility of controlling the pore pressure up to 70 MPa; and direct shear tests both in stiffness control and in load control; all of the above equipment is completely servocontrolled, and any sensor may be used to program the tests. Additional rock testing capabilities include: slake durability, point load, Brazilian (indirect tensile), Cerchar, brittleness, Sievers' J, abrasion value (on rock and soil), rebound hardness (Schmidt Hammer), pulse velocity and dynamic elastic constants, swelling, unit weight, porosity, and water content.

The centrifuge laboratory includes a high G-level centrifuge permeameter that was developed with the specific objective of expediting the measurement of the hydraulic characteristics of soils. It includes a water flow control system and an in-flight data acquisition system capable of collecting data under accelerations in excess of 500 Gs. In-flight instrumentation includes systems suitable to measure the infiltration rate (flow pump and outflow transducer), volumetric water content (time domain reflectometry), matric suction (tensiometers), and volumetric changes (displacement transducers). A small prototype centrifuge is also available in the laboratory for hydraulic testing of soil samples.

For model studies of foundation systems, two large test tanks are available together with loading and tracking systems to install, monitor, and load a variety of foundation types. Equipment available for field measurement programs includes fiber optical strain gauges, inclinometers, and time domain reflectometry moisture probes.

A large-scale calibration chamber is available for testing 2.1-meter cubical samples under three-dimensional states of stress for dynamic, cyclic, and static conditions. A second calibration chamber is available for testing in situ tools and model foundations. For dynamic field testing, the program has a broad array of equipment for measuring in situ stress wave velocities using borehole and surface wave methods, as well as vane, cone, and dilatometer devices. A vibroseis truck, which is capable of applying static, cyclic, and dynamic loads up to fifty thousand

pounds, is available for field measurements at geotechnical, foundation, and pavement sites. Three hydraulic shakers, field instrumentation, and teleparticipation equipment are available to the department as a participant in the Network for Earthquake Engineering Simulation (NEES).

**Mechanics, uncertainty, and simulation in engineering (MUSE).** The graduate program in MUSE aims at preparing students to address the increasingly complex engineering problems modern societies face, through multi-disciplinary training rooted in applied mechanics, applied mathematics, and computational modeling. Students are expected to take courses reflective of the interdisciplinary character of the program.

Graduate students pursuing a thesis-option Master of Science degree or doctoral studies are exposed to the program's research activities. Current research endeavors focus on model-based simulation of challenging multi-physics and multi-disciplinary engineering problems. Examples include the modeling of the dynamic response of structures; performance of structures in the offshore environment; structural response under extreme loads (wind, earthquake, hurricane, blast, etc.); soil-structure interaction problems under seismic loads; inverse problems and the non-destructive condition assessment of engineered and natural systems; structural reliability and uncertainty quantification problems; the performance of subsea systems, pipelines, and energy-generating systems such as wind turbines and hydrokinetic devices; the modeling of deterioration and aging processes afflicting the infrastructure; the modeling of material behavior; the propagation of waves and their interactions; and problems in computational engineering. Though the program's focus derives chiefly from problems affecting the infrastructure and the built environment, our reach goes well beyond as we seek to address bigger societal questions related to energy, natural and man-made disasters, and physical/natural processes at various temporal and spatial scales. Research projects integrate theoretical results and computational modeling with experimental studies, where appropriate.

MUSE graduate students and faculty conduct research using various computational facilities within the department and the University of Texas. These include two computational laboratories within the Ernest Cockrell Junior Building (ECJ): the MUSE laboratory (ECJ 4.602), and the MUSE *too* laboratory (ECJ 3.301), occupying approximately 1,200 square feet. The two laboratories are equipped with several high-end workstations, including multi-processor and multi-core computers. For research projects demanding supercomputing resources, students and their faculty advisors have access to the Texas Advanced Computing Center's (TACC) massively parallel systems and visualization resources.

**Ocean engineering.** Students interested in ocean engineering and in offshore structures may develop an appropriate course of study in consultation with the faculty. These programs are typically interdisciplinary, including work in hydrodynamics, structural analysis and dynamics, steel design, soils and foundations, and computational methods. Students may also participate in the work of the Offshore Technology Research Center.

**Structural engineering.** The graduate program in structural engineering addresses the analysis and design of reinforced and prestressed concrete, timber, steel, masonry, and composite structural systems. Extensive experimental research facilities are available for the observation and study of the behavior of structures under a variety of loadings.

Most of the experimental studies in structural engineering are conducted in the Phil M. Ferguson Structural Engineering Laboratory, located at the J. J. Pickle Research Campus. Ferguson Laboratory is one of the largest, best-equipped structural research facilities in the world. Multistory structures and full-size multigirder bridge structures have been tested.

The laboratory contains three test slabs, 40' × 80', 40' × 60', and 30' × 60'. One of the test floors surrounds a 600-kip universal test machine that permits testing full-size plate girders. In addition, a unique three-dimensional test facility consisting of a 44' × 32' test floor, combined with two perpendicular vertical walls, each nineteen feet high, permits three-dimensional loading. Fatigue testing capabilities permit study of full-size components under random amplitude and frequency to simulate actual service conditions. A number of closed-loop servo-controlled loading systems are available. Cables, such as those used in cable-stayed bridges, can be tested in fatigue up to loads of three million pounds in the cable testing facility. A materials-testing facility is also located in the Ferguson Laboratory. For structural fire engineering research, test frames and furnaces are available for elevated temperature tests of structural materials, components, and connections. Data acquisition systems are available that are suitable for static, dynamic, and fatigue loading programs. The systems are controlled by the laboratory's own computer systems. Direct access to the main University computer facility is also available.

Excellent computational facilities are available to all students in structural engineering in support of both instructional and research activities. These include: (1) the Civil Engineering Learning Resource Center (LRC), a general-use, 24-hour access facility equipped with more than 150 workstation-class computers ranging from single-core/single-processor to multicore/multiprocessor machines and several dedicated color laser printers, plotters, and flatbed scanners; (2) the Virtual Design Lab, a smaller computational facility equipped with several workstations that provide students with access to the latest suite of high-end CAD and graphics software; (3) a student lounge equipped with computational centers that can be used for team projects; (4) a graduate student computational laboratory equipped with high-end workstations dedicated to research activities; and (5) a similarly equipped graduate computational laboratory housed at the Ferguson Structural Engineering Laboratory. In addition, for research demanding supercomputing resources, students and their faculty advisors have access to the Texas Advanced Computing Center's (TACC) supercomputers, which include Ranger, currently the largest open-science computing system in the world, featuring 62,976 computing nodes, 123 TB of aggregate memory, and peak performance of about 0.5 petaFLOPS. The TACC also provides access to other massively parallel systems and visualization clusters. Access to computational resources is facilitated through the network infrastructure that comprises both wired and wireless segments; the wireless network covers most of the University's main campus.

**Sustainable systems.** The graduate program in Sustainable Systems is intended to provide students with an education and research experience that is cross-disciplinary. The program permits considerable flexibility in the selection of courses and participation in research experiences, thereby allowing students to tailor the graduate program according to their background and educational objectives. This program aligns with CAEE's Strategic Plan, which focuses on the Cities, Water, and Energy nexus, challenging civil, architectural, and environmental engineers to address complex problems through innovative and cross-disciplinary solutions. To foster this, research of each Sustainable Systems student can be co-supervised by two faculty members in different areas. Hence, students are affiliated to laboratories in their respective supervisor(s) area(s). Students also benefit from the many facilities and infrastructure systems on campus and in the surrounding community as living laboratories for class visits and research studies.

**Transportation engineering.** The University's proximity to the headquarters of governmental transportation agencies provides ready access to the facilities and records of these organizations by graduate students, in planning, behavioral modeling and demand prediction, geometric and structural design, large-scale infrastructure systems analysis and optimal resource allocations, policy making, and operation

of streets, highways, and transit and non-motorized transportation systems. The Center for Transportation Research administers an extensive cooperative research program with the Texas Department of Transportation, the United States Department of Transportation, as well as a spectrum of sponsored projects with other agencies, including the Transportation Research Board, and the National Science Foundation.

Equipment for specialized and routine testing of materials used for constructing and maintaining transportation facilities is available. The bituminous materials laboratory includes state-of-the-art asphalt binder and asphalt concrete testing equipment, an environmental control chamber, and mix preparation and aggregate handling facilities.

Facilities are provided for studying traffic operations, including traffic volume counters, speed meters, motor-driven movie cameras, video cameras and recorders, projectors, portable delay recorders, and other special measuring and recording equipment.

The Transportation Infrastructure and Information Systems Laboratory provides the capability to conduct research in analysis and simulation of large-scale infrastructure systems. The Transportation Equilibrium, Simulation, and Optimized Networks Laboratory allows research on large-scale complex networks with a focus on transportation systems. In addition, the University's high-performance computers and hardware and software in the department's Learning Resources Center are available to support research in transportation networks, infrastructure systems, land uses, and traffic operations.

**Libraries.** In addition to the Perry-Castañeda Library and libraries in physics and mathematics, geological sciences, life sciences, and chemistry, a complete library of books, periodicals, and society proceedings in civil engineering is housed in the McKinney Engineering Library.

## Areas of Study

Civil engineering majors may specialize in building energy and environments; construction engineering and project management; infrastructure materials engineering; environmental and water resources engineering; geotechnical engineering; mechanics, uncertainty, and simulation in engineering; ocean engineering; structural engineering; sustainable systems; or transportation engineering. In addition, the Department of Civil, Architectural, and Environmental Engineering offers the Master of Science in Engineering with a major in environmental and water resources engineering.

## Graduate Studies Committee

The following faculty members served on the Graduate Studies Committee (GSC) in the spring 2023 semester.

David T Allen  
Matthew David Bartos  
Oguzhan Bayrak  
Amit Bhasin  
Chandra R Bhat  
Stephen Boyles  
Carlos H Caldas  
Sergio Castellanos  
Alexandra Clara Saracho  
Christian Claudel  
Patricia Clayton  
C Tyler Dick  
Berkin Dortdivanlioglu  
Chadi Said El Mohtar  
Michael D Engelhardt  
Ofodike A Ezekoye  
Kasey M Faust  
Anca-Cristina Ferche  
Raissa Patricia Ferron  
Kevin J Folliard  
Benny D Freeman  
Robert B Gilbert  
Matt Hebdon  
Todd A Helwig  
Ben R Hodges  
Blair Johnson  
Maria Juenger  
Loukas F Kallivokas  
Lynn E Katz  
Spyridon A Kinnas  
Kerry A Kinney  
Mary Jo Kirisits  
Kara Kockelman

Krishna Kumar  
Manish Kumar  
Desmond F Lawler  
Fernanda Lustosa Leite  
Howard M Liljestrand  
Randy B Machemehl  
Lance Manuel  
Pawel Misztal  
Javad Mohammadi  
Gyorgy Zoltan Nagy  
Dev Niyogi  
Atila Novoselac  
William J O'Brien  
James T O'Connor  
Jon E Olson  
Paola Passalacqua  
Gary A Pope  
Jorge A Prozzi  
Ellen M Rathje  
Salvatore Salamone  
Navid Saleh  
Polina Sela  
Kamy Sepehrnoori  
Gerald E Speitel Jr  
Kenneth H Stokoe II  
Eric van Oort  
C Michael Walton  
Michael Webber  
Charles J Werth  
Eric B Williamson  
Sharon L Wood  
Jorge G Zornberg

## Admission Requirements

A Bachelor of Science degree from a program in engineering accredited by ABET is the general prerequisite for admission to a graduate program in civil engineering. An applicant whose training does not meet this prerequisite may be accepted but will be required to pass a sequence of courses stipulated by the Graduate Studies Committee that will make up the deficiencies in undergraduate preparation. A list of the required courses is available from the graduate advisor.