Civil and Environmental Engineering

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▣ Introduction

Civil and Environmental Engineering,
a field pursuing a harmony of human welfare with the Mother Nature

The educational goal of our department is to bring up talented young engineers with academic and research capability commensurate to the world's top 10 universities in the field of Civil and Environmental Engineering.

Our department was founded in 1982 and the professors and the students altogether have strived to accomplish glorious achievements. Joongangilbo has ranked our department 1st in Korea for 15 consecutive years and we recently topped the department evaluation at KAIST. Our department will continue to move forward to achieve what lies beyond.

The field of civil and environmental engineering was borne at the dawn of human civilization to fulfill basic necessities of life. Over thousands of years, the field has contributed to technological advances in construction and maintenance of infrastructures including water and wastewater treatment and transportation systems. The field has also contributed to the search for sustainable energy sources and disaster control. Recently, civil and environment engineering has expanded to include diverse areas involving management of public sectors for enhancement of the public welfare.

▣ Academics and Research Areas

Structural Engineering and Materials, Geotechnical Engineering and Geosystems, Environmental Engineering and Sustainability, Urban and Architectural Planning and Design, and IT for Construction Engineering are the main research areas of the Department of Civil and Environmental Engineering at KAIST.

❒ Structural Engineering and Materials

-Structural Design Laboratory

Primary research efforts in the structural design laboratory focus on the analysis, design and construction of structure including bridge. Also, propose effective and economical construction scheme based on analysis of the structural system.

- Structural Analysis & Materials Research Laboratory

Structural Analysis & Materials (SAM) Research Lab focuses on development of modeling and simulation, analysis of composite materials. In particular, SAM Research Lab has studied repair systems using CFRP (Carbon Fiber Reinforced Polymer) strips or sheets and SFRP (Sprayed Fiber Reinforced Polymer) for increasing flexure, load carrying capacities and ductility of damaged concrete structures. The latest researches in SAM Research Lab include an experimental study on mechanical properties of lightweight aggregate, electromagnetic shielding and radiation shielding concrete, etc.

- Smart Structures and Systems (SSS) Laboratory

SSS laboratory develops sensing, signal processing, and machine learning techniques relevant to the fields of Structural health monitoring (SHM) and Non-Destructive testing to assess and ensure the safety and integrity of civil infrastructure, mechanical systems, aircraft and micro devices.

-Structure Control and Intelligent Systems Laboratory (SCaIS Lab)

SCaIS Lab seeks to develop innovative structural control systems based on smart materials such as MR fluid/elastomer and energy harvesting techniques such as electromagnetic/piezoelectric transduction mechanism. We also conduct research on applying advanced measurement/actuation technologies including wireless sensor network and piezoelectric sensors/actuators to civil infrastructure such as bridges and buildings.

- Advanced Applied Mechanics Laboratory (AAML)

Physical behavior of structures and materials is being investigated by applying various numerical analysis techniques. A Lamb wave phased array system is developed using finite element method, and the simulation of the Lamb wave propagation is being studied. The mechanical reliability of electric circuits under shock and thermal cycling conditions is evaluated. Also, program parallelization is implemented for more efficient calculation. Additionally, numerical studies on thin-film blisterings in nano-scale, failure characteristics of building structures under impact and blast loadings, Peridynamicsandothersarebeingconducted.

- Research group for concrete structures, materials and construction

Concrete is the most consumed engineering material in the world. The research group investigates the mechanical properties of concrete, and pursues (1) the development of performance-based design and specifications, (2) quantitative analysis on construction performance, and (3) the consideration of economical and environmental aspect.

❒ **Geotechnical Engineering and Geosystems**

- Geotechnical Engineering Laboratory

Our laboratory conducts researches on analysis, design, construction, and maintenance of geo-structures constructed on soft-clay and unsaturated weathered soils. The main target structures are embankments on soft-clay, earth dams, and slopes. Especially, we aim to develop an optimum system for the complex geo-structures. We not only perform fundamental researches related to the stress-strain behavior characteristics of soil materials, but also develop numerical analysis techniques and softwares for the analysis and design of related geo-structures. Recently, we have developed a CFD-based finite element modeling for analyzing thermal behaviors of Ground Coupled Heat Pump (GCHP) system as well as thermal energy storage (TES) system.

- Soil Dynamics Laboratory

Main research areas include evaluation of dynamic soil property using field/laboratory tests, offshore foundation and anchor design, and seismic design for geotechnical structures. A world-class 5m-diameter Geo-Centrifuge Testing facility is equipped with a shaking table and various physical model tests are performed to reproduce natural and manmade disasters like earthquake and flood and to evaluate the safety and performance of geotechnical structures such as rocking foundation, disconnected piled raft, dam, foundations of offshore wind turbine, port and harbor structures, and consequence of liquefaction.

- Geosystems laboratory

Geosystems laboratory founded in June 2002, is dedicated to overcoming the limits of nature and civilization through focused research on creation of new space and development of alternative energy. Using world-class elastic wave and electrical resistivity techniques, we understand the behavioral properties ranging from minuscule soil particles to large-scale underground spaces and also conduct numerous research in various fields, such as the design and construction of underground space, development of alternative construction methods for large-scale construction in urban areas, properties of gas hydrate-bearing sediments and geological CO2 storage within sub-seabed sediments.

- GeoEnergy Laboratory

GeoEnergy Laboratory focuses on how we can use our scientific understanding of earth materials to bring solutions to the energy and sustainability related problems that humanity has faced. This is a question that intrigues our interest. We study the physics and mechanics of particulate materials and porous media. We apply our theoretical, computational, and experimental research to bring solutions to geo-related energy and sustainability problems, such as methane hydrate, geologic carbon storage, energy resource recovery, and microbial activities in geo-materials.

❒ **Environmental Engineering and Sustainability**

-Environment Management Research Laboratory

EMRL is studying and conducting researches for technology and policy development focusing on Integrated water management, smart and green infrastructure management, and urban disaster management and sustainability.

-Environmental Biotechnology and BioEnergy Laboratory

EBTEL focuses on making environmental-friendly bioenergy production through biodiesel, and capturing & utilizing toxic materials in exhaust gas using electro-chemical approach.

-Sustainable Water Environment and Energy Technology Laboratory

SWEET laboratory has focused on production of the safe water for drinking and industrial purposes by state-of-art membrane and adsorption technologies. We also interest in the recovery of energy and resources from wastes. Current projects include (1) environmental applications and implications of nanomaterials, (2) colloidal and microbial interactions with solid surfaces for biofouling control of membrane processes during water production, (3) development of novel CNT hybrid-filter systems for water and wastewater treatment.

-Environmental Microbiology Laboratory

The Environmental Microbiology Laboratory at KAIST is carrying out world-class research on microbial ecology and ecophyisology. Our research group focuses on understanding and harnessing microbial reactions to find solutions to various impending environmental problems including global warming and chemical contamination. Our research group seeks solutions to reduce the greenhouse gas (CH4 and N2O) emission from natural and engineered environments by understanding and manipulating the microbial C- and N-cycles. Our research group will also carry out research on bioremediation of various organic and inorganic contaminants.

❒ **IT, Planning and Transportation**

IT-based civil engineering research fields focus on the fusion technologies between IT and civil engineering including civil robotics, intelligent construction automation, and U-City management that are aimed at constructing smart and sustainable environment. We also focus on a variety of domains ranging from urban and architectural theories, design methodology, representation and visualization techniques, structural and ecological sustainability. Our department also considers transportation engineering as a study of providing accessibility rather than the flow of people and goods as traditionally defined.

- Smart Transportation System

Smart Transportation System Lab aims to deliver effective and sustainable transport systems and community by modeling of transport phenomena, prediction and safety using information and communication technology combined with intelligent transportation systems

- Transportation Research and Urban Engineering Laboratory

Transportation Research and Urban Engineering (TRUE) Lab's research objective is to offer solutions to problems in complexly connected transportation and social infrastructure systems by data-driven analysis including statistical methods and simulation techniques. The solutions encompassing economical and operational engineering aspects aim to build a foundation for a sustainable and intelligent urban environment in future.

- Urban Robotics Laboratory

Urban Robotics Lab (URL) focuses on the development of fusion technologies between IT/robotics and civil engineering for smart cities. The research fields include structural health monitoring and inspection robots, localization and autonomous robot navigation in smart cities, 3D modeling and perception of civil structures, urban and environmental management robot for smart city, object recognition using artificial intelligence, etc.

- Intelligent Robotic Autonomy and perception Laboratory

Intelligent Robotic Autonomy and Perception (IRAP) Lab focuses on robotics problems in civil and environmental engineering applications. Targeting many hardly accessible or dangerous sites in the environment, IRAP Lab solves for robot autonomy dealing with perceptual sensor data. Main research interest and detailed robotics topics include perception based environment mapping, intelligent sensor fusion, decision making and control of the robotic agents, robotic operation and navigation in GPS-denied enthronements (e.g., underwater, indoor).

- Urban Design Laboratory

Urban Design Lab's design and research both explore roles of built environments in human being's daily challenges to continuously sustain their urban life. Design and research interests include, but are not limited to urban design and theory, urban redevelopment and revitalization, spatial analysis, cross-cultural comparison, and neighborhood design and development in Asia.

- Maturepolis Lab

Mapping the hidden flows and activities in cities, so we can make them more sustainable and accessible, especially for the elderly. Urban sensing, spatial data analysis, pedestrian studies, computer vision, data visualization, waste tracking.