

Advanced Technology For Large Structural Systems (ATLSS) Research Center

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The ATLSS Engineering Research Center is a leading national hub for research and education focused on the structures and materials that support infrastructure. Established in May 1986 with a grant from the National Science Foundation (NSF), the Center aligns its research efforts with the goals of the NSF, the U.S. Department of Energy, the U.S. Department of Transportation, the Commonwealth of Pennsylvania, the U.S. Department of Defense, and various national, state, and local industry and government agencies.

The Center has conducted significant research to gather data on fatigue resistance, fracture resistance, strength evaluation of various components and configurations, proof testing, design verification, high-performance materials, and product evaluation for a wide range of transportation structures. Additionally, the Center has studied the response of civil, coastal, offshore, and energy harvesting infrastructure under normal and extreme loading conditions, including earthquakes, tsunamis, strong wind storms, coastal flooding, storm surges, blasts, and fires.

The research at ATLSS focuses on large-scale systems, covering the following key areas:

- Advanced Structural Systems and Materials
- Advanced Measurements, Simulation, and Evaluation of Structural Systems
- Infrastructure Reliability, Maintenance, and Life-Cycle Performance
- Infrastructure Hazard Mitigation
- Intelligent Infrastructure Systems

This work is conducted in close collaboration with engineers and scientists from various Lehigh departments, as well as industry, government, professional and design groups, and other universities.

ATLSS is equipped with world-class research facilities, including two premier structural testing laboratories: the Fritz Engineering Laboratory and the ATLSS Multi-Directional Testing Laboratory. These facilities enable researchers to study large-scale structural subassemblies under static, dynamic, and/or cyclic multidirectional loading through fully computer-controlled experimentation.

The Center also houses the NSF-sponsored large-scale real-time multi-directional (RTMD) cyber-physical systems experimental facility, part of the NSF's Natural Hazards Engineering Research Infrastructure (NHERI) program. This facility is designed to evaluate

the performance of engineering designs and materials under extreme conditions such as earthquakes, hurricanes, tsunamis, landslides, and other natural disasters.

Additionally, ATLSS offers exceptional resources for computing, the integration of artificial intelligence into structural testing and simulation, as well as for mechanical testing, welding, metallography, and non-destructive evaluation.

RESEARCH ACTIVITIES

Advanced Structural Systems and Materials

Research focuses on developing new structural forms and systems to enhance efficiency through innovation. The aim is to promote the competitive use of high-performance materials, including steel, concrete, fiber-composites, and mixed systems, for applications in bridges, buildings, offshore structures, and ship hulls.

ADVANCED Measurements, Simulation, and Evaluation of Structural Systems

Techniques are available for measuring and simulating the behavior of structural systems under realistic loading conditions, both in the laboratory and in the field. Assessments are performed on bridge, highway, railway, soil-foundation systems, coastal infrastructure, and ship structures to evaluate their behavior under load, as well as the effects of corrosion, fatigue, and other forms of damage.

Infrastructure Reliability, Maintenance, and Life-Cycle Performance

Research is conducted on the optimal design, maintenance, monitoring, and management of infrastructure systems. It also focuses on structural health monitoring, damage modeling and assessment, and predicting the remaining life of structures, while accounting for uncertainties.

Infrastructure Hazard Mitigation

Research focuses on engineering processes, structural systems, soil-foundation systems, and materials technology to predict and reduce economic losses and injuries from hazard events, including earthquakes, blasts, fires, tsunamis, hurricanes, and vehicular impacts. This research incorporates real-time, large-scale cyber-physical experimentation to study the behavior of structural systems under multi-directional natural hazards and cascading events. The objective is to deepen the understanding of infrastructure interactions with complex environmental loading conditions and enhance the resilience, sustainability, and adaptive capacity of civil, energy harvesting, coastal, and offshore infrastructure, as well as their soil-foundation systems, through innovative response modification devices and advanced performance-based structural designs.

Intelligent Infrastructure Systems

Research focuses on materials, components, and systems for sensing, processing, and utilizing sensor data, as well as adaptively controlling the behavior of large-scale infrastructure structures.

Educational Opportunities

The ATLSS Engineering Research Center offers extensive programs of study and research in the fields of structures and materials. Graduate students in the Center's programs can earn Master of Science, Master of Engineering, or Doctor of Philosophy degrees in structural engineering, materials science and engineering, or mechanical engineering. Financial support for graduate students is available through fellowships and research assistantships associated with sponsored research programs.

Undergraduate students have the opportunity to participate in the Center's research through summer internships and academic-year special projects.

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