STRUCTURAL ENGINEERING AND EARTHQUAKE SIMULATION LABORATORY (SEESL)
EXPANDING THE BOUNDARIES OF ENGINEERING DISCOVERY

- For decades, earthquake engineering researchers at the University at Buffalo (UB) have been at the forefront of their field, leading the nation in earthquake engineering discoveries.

- With the opening of the new $21.2 million George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) Facility, within UB’s Department of Civil, Structural and Environmental Engineering (CSEE), faculty researchers and students are set to broaden their vision and sharpen their focus as they continue to transform earthquake engineering research and optimize discovery in other related fields as well, including homeland security.

- The largest investment of 15 laboratories in the National Science Foundation’s $81.9 million nationwide network of advanced engineering facilities, the expanded UB laboratory ranks as the world’s most versatile testing facility of its type.

- This state-of-the-art facility represents the best that America offers in advanced computational and experimental equipment—and with the intellectual capital of faculty and students at UB and from across the country, it will enable researchers to push back the boundaries of engineering investigation and discovery.
UB-NEES MISSION AND VISION

- Develop a versatile large-scale dynamic hybrid testing facility, as a node of NEES, which combines state-of-the-art equipment capable of carrying out simultaneous physical and computational simulations of full size or large sub-scale structures and components under simulated seismic conditions. This mission and vision is intended to foster:

  - The development of new experimental techniques and approaches to earthquake engineering
  - The development of new analytical and computational methods to support simulation efforts
  - The development of network-based collaborative research and data sharing
  - As a node of the NEES Consortium, operate and manage this state of the art dynamic hybrid testing facility to attract and stimulate the best research from members of the broad earthquake engineering community performed in a safe, responsible, effective and collegial manner
The expansion of the University at Buffalo's Structural Engineering and Earthquake Engineering Laboratory (SEESL) more than doubles the capacity of the original laboratory from 12,000 to 25,000 square feet. The new facility stands four-high and houses twin reconfigurable six-degree-of-freedom shake tables co-located in a 120 foot long trench, a 3,400 square foot strong floor, a 30 x 60 foot reaction wall, 3-large-scale servo controlled 100-ton dynamic and 2 200-ton static actuators and digital controllers, and a high performance hydraulic supply and distribution and control system.

In addition, a new very large Geotechnical Laminar Box has been developed for soil-structure interaction studies. Networked tele-experimentation capabilities, using modular and expandable tele-observation and tele-operation equipment, tied to discrete and global sensors including high-resolution digital video and imaging capabilities, enable off-site researchers to collaborate with UB researchers and view experiments in real time.
The SEESL facility features two high performance six-degree-of-freedom shake tables, each having a 50-metric ton capacity. The shake tables are co-located in a 125 foot long trench allowing them to be easily repositioned accommodating models of various lengths up to 120 feet. The tables can be operated fully in-phase, or in any other way to provide correlated or fully independent multiple support excitations. They are capable of operating at frequencies up to 100Hz, making it possible to investigate unresolved issues relating to the seismic performance of large, stiff, non-structural types of equipment.

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<th>Performance and Specifications of the Twin Shake Tables</th>
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HYDRAULIC SUPPLY AND DISTRIBUTION SYSTEM

- The shake tables and high performance actuators are supported by a high-capacity high-performance hydraulic supply and distribution system capable of supplying 1,600 gpm of hydraulic fluid. Accumulator banks and manifolds are strategically located to efficiently supply and distribute the hydraulic fluid. The system is driven by 4-900 horse-power pumps operating at 3,000psi. The pumps are located in the ground floor (basement) of the new laboratory in an acoustically insulated room to minimize noise on the main laboratory floor during operation. The main distribution piping system and horizontally deployed accumulators are also co-located in the basement.
A key component of the new SEESL facility is the modular 2-D geotechnical laminar box for 1-g soil and soil-structure interaction testing. In its largest configuration, the box measures 2.75x5.0x6.2m. The box is made of 24 laminates, separated by ball bearings, facilitating 2-D motions, including the ability to simulate sloping ground subjected to large deformations. The laminar box can simulate boundary stresses closely to that of free ground and can be re-configured into two smaller modules. The modular design of the laminar box enables full scale tests to be performed on the strong floor as illustrated or it may be divided into two modules, each deployed on the twin shake tables.
REAL TIME DYNAMIC HYBRID TESTING (RTDHT)

The new UB-NEES expansion facilitates the use of modern testing techniques, such as Real-Time-Dynamic-Hybrid-Testing (RTDHT) along with conventional static, quasi-static and dynamic force techniques. This novel form of dynamic sub-structure testing, RTDHT, was developed at the University at Buffalo and involves the combined use of shake table and actuator force experiments of substructures with real time simulations of the remainder of the structure. This technique provides a more complete picture of how earthquakes affect large structures, including bridges and buildings without the need to physically test the entire structure.
The networked tele-experimentation system developed for the SEESL laboratory uses modular and expandable tele-observation and tele-operation equipment. The UB-node of the NEES network is structured around an integrated system for data collection, and computational models that serve as the center and gateway for tele-observation, -processing, -control and interfacing with advanced experimental equipment for RTDHT. This equipment is tied to the testing systems using discrete and global sensors, including high-resolution digital video and imaging hardware making it possible for collaborators to use the UB-NEES facility and to observe tests remotely. The lab is equipped with a gigabit local area network (LAN) connected to the campus backbone network with a fiber gigabit link. This high speed network facilitates all of the tele-presence capabilities of the lab and provides the pipeline for the very large data files sent to participants, whether local or remote. This network can be accessed at gigabit speeds throughout the laboratory via wired connections or via a wireless network.
Tele-presence and collaboration rooms equipped with NEESgrid enabled equipment were developed to support collaborative research and testing activities among the NEES sites. The laboratory is equipped with 8-high resolution digital video cameras strategically located to obtain detailed video coverage of experiments in progress. The tele-presence room, enables real time tele-observation of experiments via audio and video streaming, data streaming and visualization, and video conferencing.

The newly developed collaboration room is equipped with 9-workstations providing visiting researchers with workspace and access to the tele-experimentation and tele-presence systems.
THE UB-NEES TEAM

The following members of the UB team are acknowledged for their contributions leading to the development of the new SEESL facility as a node of NEES

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ACCESS TO SEESL—THE UB NEES NODE

To aid in the development and performance of research programs, prospective researchers can access the SEESL-UB NEES Website at:

http://nees.buffalo.edu

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