AVAILABLE RESEARCH FACILITIES

The following is a detailed listing of available research facilities and equipment at the University of Virginia for conducting research in the areas of bridge engineering, structural health monitoring, high performance material characterization, condition assessment, and preservation. The descriptions include physical laboratory, computing, and library and support facilities. The research facilities described herein are limited to those at the University of Virginia (UVA), but it should be noted that the Virginia Center for Transportation Innovation and Research (*see VCTIR letter of collaboration*) is also housed on the grounds at UVA and the two entities have a long-standing resource sharing agreement. The physical equipment listed below is predominantly situated in two laboratory spaces in Thornton Hall, the Mobile Laboratory for Rapid Evaluation of Transportation Infrastructure (MOB Lab) and Resilient and the Advanced Infrastructure Laboratory (RAIL). These spaces are complementary and allow for bidirectional sharing of resources.

PHYSICAL LABORATORY FACILITIES

MOBILE LABORATORY FOR RAPID EVALUATION OF TRANSPORTATION INFRASTRUCTURE

The Mobile Laboratory for Rapid Evaluation of Transportation Infrastructure, supports research related to in-service condition and behavior of infrastructure systems. The laboratory is equipped with a variety of testing equipment suited for rapid load testing and monitoring as well as equipment dedicated to non-destructive evaluation of civil infrastructure.

Available Equipment:

- Smart Travel Van - A vehicle designed to collect on-site, real-time data traffic data has been integrated in the Mobile Laboratory for Rapid Evaluation of Transportation Infrastructure for field-testing purposes. The van allows for the collection of field data at any location accessible by a vehicle including heavily traveled freeways, busy signalized intersections, work zones, or remote rural locations. In addition, the Smart Travel Van is a non-intrusive data collection device - it does not require placing or installing any equipment in travel lanes. The van's data collection capabilities complements the Mobile Laboratory for Rapid Evaluation of Transportation Infrastructure and provides a platform for integration of new sensor technologies for condition assessment.
- Bridge Diagnostics – Wireless Bridge Evaluation System: Portable high-speed data acquisition system with wireless base station and wireless 4-channel nodes (6). Capable of measuring suite of available sensors including strain, displacement, rotation, acceleration, and other voltage transducers. System is ideally suited for rapid load testing and monitoring applications.
- Campbell Scientific Data Acquisition Systems: 1) CR9000X – High-speed and rugged acquisition system for high-speed measurement and long term monitoring. Modular input cards capable of measuring suite of available sensors including strain, displacement, rotation, acceleration, and other voltage transducers. System is ideally suited for rapid load testing and monitoring applications. 2) CR 3000 - self-contained, rugged datalogger that includes battery-backed, real-time clock and nonvolatile data storage. The CR 3000 along with two available CDM 305 units is capable of measuring vibrating wire gages at frequencies up to 100Hz. Designed for stand-alone operation in harsh, remote environments. 3) CR 1000 – Rugged general use datalogger with a broad range of measurement and control functions.
- Correlated Solutions digital image correlation systems (3D and 2D) – Non-contact, optical, full-field deformation measurement system. The system is able to measure arbitrary displacements and strains from 50 microstrain to 2000% strain and above, for specimen sizes ranging from <1mm to >10m. This system includes 6 CCD cameras with suite of lenses (8mm, 12mm, 35mm,

and 75-300mm) and is equipped to integrate the FLIR A615 IR camera. System was designed specifically for civil engineering application and has capabilities for both laboratory and field use.

- GSSI StructureScan Mini HR (2600 MHz) Ground Penetrating Radar: This is an all-in-one handheld high-resolution GPR system for concrete inspection. The system is suited for locating rebar, conduits and post-tension cables in depths of up to 16 inches (40 cm) and can be used to provide a measure of subsurface deterioration in concrete structures.
- FLIR research grade infrared thermal cameras
    - Model T440 - High performance infrared camera with on-board visual camera and thermal fusion capabilities. Temperature range -4°F to 2192°F (-20°C to 1200°C); spectral range 7.5 to 13µm; IR resolution 320 x 240 pixels; Thermal sensitivity (N.E.T.D) <0.045°C at 30°C.
    - Model A615 - High speed fixed-mount infrared camera for permanent monitoring. Temperature ranges -40°C to +150°C (-40°F to +302°F), 100 to +650°C (+212 to +1202°F) and 300 to +2000°C (+572 to +3632°F); spectral range 7.5 to 14µm; IR resolution 640 × 480 pixels; Thermal sensitivity/NETD < 0.05°C at +30°C (+86°F) / 50 mK. Includes both 41.3mm (15°) and 13.1mm (45°) lenses.
- German Instruments MIRA ultra-sonic tomographer: Multi-array dry point contact (DPC) transducer shear wave ultrasonic tomographer for 3D concrete evaluation.
- Additional peripheral equipment includes:
    - 2 - Rugged laptops for field deployment.
    - Suite of STS compatible BDI sensors: 18 rugged strain transducers, 4 LVDTs, 6 Potentiometer, 4 tiltmeters, 10 accelerometers, auto-clicker wireless load position indicator.
    - Model testing equipment: PCB Piezotronic - Instrumented impact hammer and APS Electro-Seis electrodynamic force generator shaker.

RESILIENT AND ADVANCED INFRASTRUCTURE LABORATORY (RAIL)

The Resilient and Advanced Infrastructure Laboratory (RAIL), focuses on applying smart technologies and interdisciplinary expertise to the development of resilient and sustainable civil infrastructure systems. The laboratory equipped for component level testing and allows for multiple loading configurations under static and dynamic conditions. The laboratory is equipped for performing real-time hybrid simulation experiments, in which scale experiments and numerical simulations are coupled, allowing for a real-time system level interaction while only testing a substructure component.

Available Equipment:

Real-Time Hybrid Simulation

- (2) 22k capacity MTS Series 244 dynamic-rated hydraulic actuators each w/ 15-gpm servovalve
- (2) 110k capacity MTS Series 243 static hydraulic actuators
- Two-channel servo-control system with MTS FlexTest 60 digital controller
- 100-gpm hydraulic service manifolds
- 30gpm hydraulic power supply
- MTS quasi-static hybrid simulation software
- MTS real-time hybrid simulation hardware and software
- 24-channel data acquisition system from National Instruments

Other Equipment

- 22k capacity MTS 810 Universal Test Frame with MTS Test Star II 493.01 Controller
- MTS 851 – Environmental Chamber

- Suite of accelerometers, LVDTs, and load cells

COMPUTING LABORATORY FACILITIES

The Department of Civil and Environmental Engineering maintains an open access high performance computer lab equipped with a variety of engineering software including: ANSYS Teaching, Simulia (formerly Abaqus), SAP 2000, Visual Analysis, Bentley Suite, AUTODESK, and MatLab. The PI maintains a research license for ANSYS Research, which will be used for the numerical simulations described within the technical approach.

In addition, the University of Virginia maintains the *UVa Hive*, a virtual desktop service, for accessing specialized software hosted on a central server. This resource allows for computations to be performed remotely using shared computational resources.

LIBRARY AND SUPPORT FACILITIES

Charles L. Brown Science & Engineering Library

The Charles L. Brown Science & Engineering Library, in Clark Hall, has extensive research collections (physical and online) that support students and faculty in the Engineering and Environmental Sciences programs. In addition, the Brown Library is also home to the UVA Scholar's Lab, which supports research activities related to digital resources such as visualization and GIS based utilities.

Bridge Information Systems Laboratory for Virginia (BISLVA)

A research laboratory focused on data mining and exploratory data analysis of bridge data for Virginia. This laboratory provides the Virginia Department of Transportation with a resource to conduct problem focused research in informatics, data mining and exploratory data analysis of bridge data. The laboratory collects and warehouses all available legacy data on the bridges in Virginia including the historic NBI data, all available Pontis data and complementary data that will be used to expand the scope of data analysis and modeling, such as climatic data, geologic data, geophysical data, transportation network data, socio-economic data, and natural hazard data. This complementary data can be combined with and related to the bridge data and analyzed within a geospatial analysis framework.

University of Virginia Alliance for Computational Science and Engineering (UVACSE)

UVACSE supports activities related to the transformation computational research across Grounds. As the need for computational techniques in all disciplines increases, UVACSE serves researchers through education, consultation, and the management of shared compute resources. UVACSE is funded by the Office of the VP/CIO and UVa's Board of Visitors through the Commission on the Future of the University.