Amazing Georgia Tech Structures Lab

By Marlo Sedki

*Concrete **can** be pretty…and it can also be "pretty amazing". A tour of the Structural Engineering and Materials Research Laboratory at the Georgia Institute of Technology confirms the "amazing" part. The 18,000 square foot lab houses a unique concrete strong-wall and strong-floor system, as well as a broad range of testing equipment and instrumentation for research in all aspects of modern structural engineering, mechanics, and materials research.*

Construction of the steel frame.

Students and professors use the facility to perform a variety of structural-related tests. The unique 8,000 square foot strong-floor system is used to test structural behavior of full scale bridge and building components. In combination with the strong-floor, the strong-wall is used to test behavior of full-scale structures in response to seismic and other lateral loads. Specimens tested by the lab include structures made of concrete, steel, masonry, and composite materials.

When the lab was completed in 1999, there were only four other facilities in universities across the country similar to this one. However, according to the Engineer of Record, Nebil B. Sedki of Sedki & Russ Structural Engineers, Inc, this facility is different from the others. The structural system was more economical to build, easier to use, and requires less maintenance.

Sedki described the unique structural design requirements of this laboratory as follows:

1) The concrete strong-floor slab must be capable of withstanding concentrated forces imposed by the testing equipment. The slab was designed for tensile forces of 200,000 pounds and compression forces of 400,000 pounds at 4 feet on center, over the entire area of the strong-floor.
2) Anchor points spaced at 4 feet on center over the strong-floor must allow repeated anchoring and removal of the constantly changing test setups, and must transfer the loads from the equipment to the slab. The anchoring system must be easy to use and maintain.
3) The concrete strong walls must be capable of resisting lateral loads imposed by the testing equipment, such as horizontal forces from a hydraulic ram simulating seismic forces on a test specimen. The 34-foot and 26-foot high walls must be capable of resisting a lateral load of 350,000 pounds applied 2 feet below the top of each wall. They must also resist three 250,000 pound loads, applied at 12 feet, 24 feet, and 32 feet from the floor for the 34-foot high wall, and at 8 feet, 16 feet, and 24 feet from the ground for the 26-foot high wall.
4) The laboratory's structural system must provide vertical and lateral support for two 30-ton bridge cranes to operate simultaneously, serving the 38-foot clear height testing bay.

After evaluating studies and research, Sedki, a Georgia Tech graduate himself, designed the following structural systems that were constructed and are now performing very well:

1) The slab in front of the strong walls is 6-foot deep, and reinforced with 3 #11 bars at 12 inches on center and three 0.6-inch post tensioning strands at 2 feet on center each way top and bottom.
2) A 4-foot 6-inches thick concrete slab was used for the areas outside the strong walls. The slab was reinforced with 2 #11 bars at 12 inches on center each way, and two 0.6-inch post tensioning strands at 2 feet on center at top and bottom.
3) To anchor testing equipment to the slab and to allow the 200,000-pound upward concentrated forces, a new and unique system was invented. Four 1¼-inch round Dywidag threaded bars are connected to a steel plate at the bottom of the slab. The threaded bars are sheathed in spiral duct, and the tops area attached to heat treated couplers accessible at the top of the slab. To anchor to the slab, users thread Dywidag bars into the top of these couplers. A steel cover plate with four ¾-inch round studs protects the couplers when not in use. This system is easier to use and maintain than the systems used at other similar test facilities.
4) The strong walls were constructed to be 2 feet thick with 3-foot wide by 12-foot deep buttresses at 12 feet on center. The buttresses were reinforced with #6 bars each way each face. At each end, 1⅜-inch round Dywidag and #11 bars were added. The walls between the buttresses were reinforced each way, each face with the addition of post-tensioning rods vertically and 0.6-inch strands horizontally.
5) At each anchor point on the strong-wall, four 2-inch round steel pipes were cast into the wall, creating horizontal sleeves through the wall. To anchor to the wall, the user slides threaded Dywidag bars through these sleeves and attaches nuts at the front and behind the wall. These anchor points are spaced at 4 feet on center vertically and horizontally over the area of the strong-wall.

Strong-floor reinforcement layout with anchor point cover plates visible.

Other systems in the state-of-the-art laboratory include a high pressure, high capacity MTS hydraulic system. This system is distributed throughout the testing bay with modular ports to facilitate quick and flexible setup of hydraulic rams used in structural testing. These digitally-controlled servo-hydraulic rams have up to 30-inch stroke length and 328-kip capacities. Several smaller pumps and rams are also used for stand-alone testing. Various data acquisition systems are used, including systems made by OPTIM, Omega, and National Instruments.

Students and professors perform a variety of materials-related testing including investigations into strength, durability, creep, and shrinkage of construction materials such as concrete. The lab houses a concrete mixing and preparation area with concrete mixers made by Lancaster and Eirich, and extensive ASTM test apparatus. Testing machines include a Baldwin 600-kip capacity screw-type universal testing machine, a state-of-the-art 55-kip MTS 810 system with hydraulic grips and an environmental testing chamber, and a SATEC 800-kip capacity compression machine.

The laboratory also has a 400 square-foot room having the ability to maintain constant temperature and humidity level for long-term material evaluation such as concrete creep testing, plus a 100% humidity fog room for specimen curing.

Another key element in this laboratory is the large environmental chamber for studying full size structural components under various combinations of loading and environmental conditions. This chamber is 19 feet long, 13 feet wide and 12 feet high. Students and professors can cycle temperatures from minus 40 degrees to 180 degrees Fahrenheit, relative humidity from 20% to 95%, and can expose test specimens to fresh and salt water spray and UV exposure.

At the dedication ceremony, Georgia Tech President G. Wayne Clough described the lab as "the newest contribution to engineering the new South".

The lab offers construction companies the opportunity to test new construction materials and techniques. It offers interested public and private parties the opportunity to test new ideas and designs for highways, bridges and railroads. It offers architects opportunities to test building plans against forces like earthquakes or high winds, and it offers manufacturers of construction materials the opportunity to test new composites from concrete, wood or metal.

President Clough joked that since General Sherman handed us our first experience at Urban Renewal, we have been building and rebuilding. He added, "We look forward to working in partnership with the construction industry to put Atlanta and Georgia on the forefront, not only in the amount of construction we do, but also in the quality and the technology of that construction."▪

Project Team

Sedki & Russ Structural Engineers, Inc.
Richard + Wittchiebe Architects
Skanska USA, Contractors
Geoffrey Crabbe, Construction Manager

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Construction of the strong-wall & strong-floor.

Buttresses on the rear of the strong-wall during construction.

The Georgia Tech Structures Lab today, with 30-ton crane visible.