The Energy Research Laboratory at Hampden-Sydney College

by Paul F. Hemler

The Mathematics and Computer Science Department and the Physics and Astronomy Department have been collaborating on a project that has resulted in the construction of a new academic building on the campus. The building is called the Energy Research Laboratory (ERL) and its current focus is to provide a basis for student/faculty research in the area of sustainable and small carbon footprint buildings. The building is constructed primarily with concrete but has a conventional truss supported roofing system. Another fundamental difference between ERL and other structures is that it is sealed and insulated to minimize any outside air from entering the building. The concrete used in the footers, frost walls, slab floor and walls also uses a special micro rebar fiber made of high tensile steel called helix™. The figure at left shows a picture of the helix mixed in with conventional concrete used in pouring the footers of the building. Similar helix mixtures were used in all the concrete of the building. The helix eliminates the need for much of the rebar and labor found in conventional concrete construction and it is hypothesized helix concrete will be stronger but more flexible. The result of these properties is that buildings constructed with this material are expected to withstand a direct hit from an F5 tornado, a nearby explosive blast, and a massive earthquake. Large public buildings such as schools, hospitals, government buildings, and high-rise commercial centers constructed with helix concrete should remain in service for many centuries.

The micro rebar called helix™ mixed in with conventional concrete

Our research at Hampden-Sydney will focus more on the energy efficiency a building with this enormous thermal mass may provide. We are devising experiments to heat and cool the building with the green technologies of solar hot water and geothermal. When constructing ERL, PEX tubing was placed in the slab floor and concrete walls. At left is an image showing the ¾ inch diameter PEX tubing in the floor as the concrete is being poured. The main thesis of our work is that pumping cool ground water through the tubes in the summer and warm solar heated water in the winter will result in a comfortable, annual indoor temperature. If we find this theory to be correct, the energy costs will be that of some pumps to circulate water, which use significantly less electrical power than conventional compressors found in heat pumps. Perhaps the required amount of electricity could be generated using a photovoltaic system, further reducing heating and cooling expenses.

The PEX tubing in the floor slab

In addition to the mechanical work of adding the appropriate plumbing for solar and geothermal, our work will closely monitor the indoor temperature and humidity levels to see how the building responds to changes in the external ambient temperatures. We are using both commercial and an internally developed system to monitor the temperatures while storing the measured data on a web site and online database. We have also developed a dynamic web page (http://cslabfs.hsc.edu/erg/homepage.html) so users can interact and visualize the data and an Android application for access to the data with only a phone connection. Through this extensive monitoring and data collection coupled with a careful analysis we will determine the cost effectiveness of maintaining a comfortable indoor temperature.

The Energy Research Laboratory on the Hampden-Sydney campus. The exterior is four inches of foam insulation covering one-foot thick concrete walls.

ERL has an inside dimensions of 45 feet by 26 feet with 12 feet tall concrete walls, which could be a single floor in a reasonably sized home. At left is a picture of ERL as it stands at this point in time.

The building is fully functional and we have been monitoring the inside temperatures without adding any external heat over the past few weeks of cold weather so we can empirically observe its thermal loses in cold weather. The students and faculty involved in the project so far include Computer Science and Physics double major **David Foulke '16**, Computer Science major **Jim Woodward '15**, Physics major **Zach Carter '17**, Physics major **Caleb Bowyer '16**, Computer Science major **Travis Newcome '18**, Professor of Mathematics and Computer Science **Paul Hemler**, and Professors of Physics and Astronomy **Stan Cheyne** and **Mike McDermott**. We are most interested in developing collaborations with faculty from other departments to maximize the utility of this most wonderful asset now gracing the campus.

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