Eco-House Foundation Project

Plymouth State University's Eco-House Mission Statement:
To demonstrate environmentally sustainable technology in a residential setting, to provide hands-on experiential learning opportunities to Plymouth State University students and the surrounding region, to collect and disseminate information about sustainability and to help others live in more sustainable ways.

As part of the Fall of 2009 Sustainability in Residences class, students identified projects that would contribute to the sustainability of the Eco-House. Among the proposals were solar hot water, rain catchment, organization and operations, building layout and floor plan, lighting and weatherizing plans. This project is the culmination of a Fall 2008 project entitled "Eco-House Basement Opportunity" that identified the need of PSU and Eco-House staff to address the structural integrity of foundation walls, as well as, related moisture and air quality issues. It was determined in the Spring of 2009 that the foundation walls of the Eco-House need to be replaced and construction was to be completed during the Summer of 2009. Upon partnering with ABODE Green Home Builders of Plymouth, NH, material choices and site design were selected.

The intent of construction done during the Summer of 2009 was to ensure the structural integrity of PSU's Eco-House for generations to come. This entailed repairing and replacing three main foundation walls, replacing the sill plate above foundation walls, replacing two main structural beams, repairing roof rafters and bracing in the attic. Subsequent issues resolved during construction entailed on site water management, insulation of foundation walls, and removal of over half of impervious surfaces that abutted the building and covered the lot. These issues were remediated through the installation of a perimeter drain and engineered drainage plane, the use of Insulated Concrete Forms (ICFs) for foundation walls and the application of a capillary break on the exterior of new foundation walls. Critical components of water management and building longevity were completed during this construction phase at the Eco-House in order to ensure its integrity.

Why the FOUNDATION?

Pre-existing conditions in the basement of the Eco-House demonstrated water and moisture in the air caused building materials to deteriorate from the inside. This is supported by the evidence of dry rot on original support beams, floor joists, and other wooden boards in the basement. Additionally, moisture in basement air caused metal pipes and tanks to rust. The source of the problem water originated from surface and ground water entering through cracks and holes in foundation walls. Water would run off of the uphill slope and pass through foundation walls, where it would remain until surrounding moisture conditions would change. The source of problem water also entered the enclosed space of the basement by means of air movement and infiltration through gaps and cracks in building materials. This created humidity issues and lead to the development of mold and fungus, both of which cause building materials to decay and health issues for people.

Original foundation walls were constructed from large and small rocks, bricks and granite slabs. These materials were pieced together with a mixture of mortar that deteriorated over the years due to its original quality, amount used, and the presence of water. Its deterioration allowed for the further entrance of water and air, the settling of the building upon a structurally compromised foundation, and further decay of building materials. These conditions required immediate attention and were the focus of work done during the Summer of 2009.

The NEW Foundation Wall:

Existing conditions reveal that a more recent concrete slab poured on the interior basement floor and up foundation walls held in place many large, oddly shaped boulders. Removal of the boulders and concrete would have compromised the basement floor and added to time, labor, waste, and removal costs. Insulated Concrete Forms (ICFs), therefore, were assembled along the perimeter of the remaining portion of the original foundation.

Instead of using and removing wooden forms as in traditional concrete foundations, ICFs remain in place. This reduces onsite soil contamination, waste production, and costs associated with labor and installation times.

ICFs are a series of interlocking hollow foam blocks that snap together to create a formwork that doubles as insulation.

The rigid foam formwork insulate the foundation walls on the inside and outside, dramatically reducing energy loss through uninsulated walls. Additionally, ICFs are easy to assemble and allow the concrete to cure under optimal temperature and moisture conditions.

After building the ICF wall, concrete was poured in the gap between the ICFs and the protruding boulders. This resulted in the base of the foundation wall to have dimensions of 3ft by 4ft and 3ft by 5ft, due to the difference in grade of slope. ICFs were then constructed from this base to meet the sill plate.

Water Management

The original basement was most likely used as a root cellar to store food before refrigerators. Moisture and air migration were not a major issue when this space was intended for food storage. The ad-

dition of concrete came some years after the foundations initial construction and is thought to be an attempt to prevent moisture and water from entering through walls.

To limit water infiltration through foundation walls, it is critical to divert surface and subsurface water away from the building. This was achieved through a combination of methods:

Small stones were placed on the perimeter of building to encourage drainage down and away from the building, as well as, to prevent the accumulation of surface water nearby the top of the foundation walls.

A waterproof layer was applied to the exterior of the ICF in order to form a barrier that water should not enter.

A perimeter drain was installed around the bottom of foundation walls to encourage soil drainage and reduce the amount of water next to subsurface walls. This consisted of interconnected perforated piping installed below the level of the footings of the foundation and directs water to a lower point away from the building.

The perforated piping was covered with filter fabric to prevent clogging of holes and was surrounded by clean gravel and crushed stone to encourage drainage. The discharge of a perimeter drain may be connected into a storm water system in a town or may simply empty to a down slope location. At the Eco-House, the pipes of the perimeter drain were connected to an engineered drainage system that functions to divert, collect, and slow down surface and ground water. A elevated drain was installed in the center of the catchment area that connects to the public storm water system in the event of a large amount of water.

Keeping water away from the foundation is the key to water management. The presence of water in the winter months contributes to frost and foundation movement due to the expansion of frozen water. A water managed foundation is designed to move water away from and prevent the accumulation of water next to foundation walls. This was achieved at the Eco-House during work completed during the Summer of 2009.

SUSTAINABLE CONSIDERATIONS

•Indoor Air Quality
•Moisture and Water Management
•Material Choices
•Adaptability
•Durability and Building Life
•Housing Envelope and Systems Approach
•Energy Conservation