Precast Contributes to Net Zero Goals on the National Renewable Energy Laboratory Campus – Past, Present, and Future Innovator of Sustainability

— Stephanie Corrigan

The Energy System Integration Facility in Golden, Colorado used high performance precast concrete to help meet their Net Zero goals. Photo: Dennis Schroeder, NREL.

Sustainability has been a hot topic issue for years. In the United States and around the world consumers are demanding sustainable products and "green" production processes. The US government has dedicated resources to developing improved processes and systems to create innovative solutions to today's sustainability needs and goals. Much of this work is done at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) campus.

The NREL is a 327,000-acre campus located in Golden, Colorado. According to their website, the NREL is dedicated to developing "clean energy and energy efficiency technologies and practices, advancing related science and engineering, and providing knowledge and innovations to integrate energy systems at all scales." The mission of the organization goes beyond the research performed in the laboratories. It actually begins with the design build process for the buildings that make up the campus.

– Stephanie Corrigan, MBA is Manager, Communications at the Precast/Prestressed Concrete Institute.

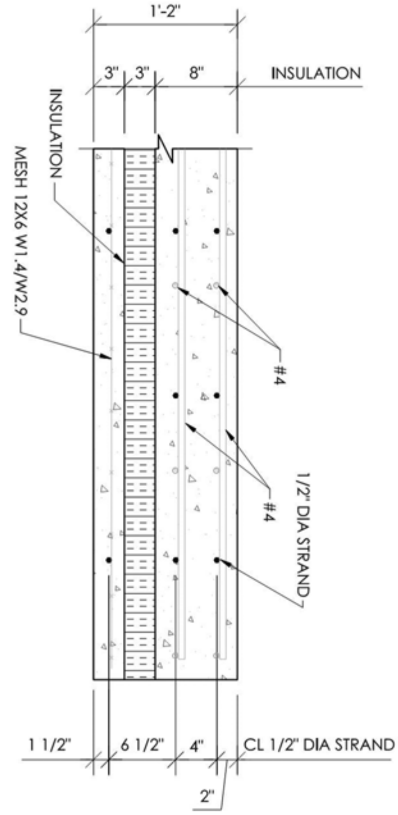
The NREL has experienced rapid growth in recent years resulting in the need to commit $400 million in new construction over the last five years. The building requirements for their expansion projects start with the Advanced Energy Design Guide from ASHRAE, and focus heavily on creating the most energy efficient buildings possible. As an organization dedicated to advancing clean energy and energy efficiency, it is important that their own buildings represent best-in-class examples. One building on the campus, the Research Support Facility (RSF), did achieve net-zero for the 2013 – 2014 year.

Energy efficient buildings require attention to many areas, one of the most important being a building's enclosure system. Thermally efficient enclosures require continuous insulation, along with the minimization of thermal bridging and management of air and moisture. Another key property that can be used to greatly improve energy efficiency is thermal mass. This is primarily available when using cementitious-based systems such as precast concrete. Concrete has a high heat capacity, which means it can store heat energy and then slowly release it as needed. This offsets large temperature fluctuations, and helps reduce the energy needed to maintain the interior temperature at a desired level, thereby also reducing the overall energy consumption of a building. According to Shanti Pless, Senior Energy Efficiency Research Engineer with NREL, the design-build team chose precast concrete as part of their high performance enclosure system for the recent RSF and Energy Systems Integration Facility (ESIF) projects, to meet energy efficiency goals.

Energy Systems Integration Facility

When a new structure is in the design phase, the team at NREL builds off experiences learned from past projects. The most recent facility built on the campus is the ESIF, in which precast concrete was used throughout.

The goal of the ESIF is to provide transformative capabilities to advance our nation's energy system into a cleaner, more intelligent infrastructure. It is the first facility in the nation to help public and private sector researchers with clean energy



Prestressed, insulated walls were provided on the perimeter of the structure to accommodate the high thermal performance requirements of the laboratory building. Material is 14" (8+3+3) and 16" (10+3+3) structural gray concrete, sandwiching 3" of insulation, providing an effective R-value of 28.4 for the building envelope.

technologies[1], and is the only national laboratory dedicated solely to energy efficiency and renewable energy[2].

The ESIF is used by commercial, governmental, and academic researchers to develop new technologies and to integrate these into the nation's energy system[5]. The facility supports more than $13 million in Department of Energy research performed in six departments: EERE Fuel Cell Technologies Office; EERE Solar Energy Technologies Office; Buildings Technologies Office; EERE Vehicle Technologies Office; EERE Wind and Water Power Office; and Office of Electricity[5].

Green Design Build Process

When developing specifications and designing the ESIF, it was important for the team to consider energy efficiency throughout the design build process and the resulting structure. Building a high performance building is important to the overall ESIF brand. According to

The high performance precast concrete enclosure had an effective R-value of R-28.4. Photo: Dennis Schroeder, NREL.

Brian Larsen, Principal Project Leader with the Alliance for Sustainable Energy, LLC, the campus needs to be a "living model of sustainable energy." With that in mind the project was designed to be a net-zero building.

The design build team, which consisted of Martin/Martin, Inc., JE Dunn Construction, and Smith Group JJR , incorporated sustainable design practices throughout the build process including recycled materials, skylights, windows for cooling and ventilation, and solar powered fans[1]. They also utilized Building Information Modeling (BIM) throughout the design build process.

The 182,500 square feet structure was completed in 2013 and consists of 34-feet tall high-bay laboratories; 204 office spaces; 1,190 teraflops of high performance computational capability; and cost a total of $134.96 million.

The structure is certified LEED Platinum and achieved all of the 56 LEED points that it applied for. The building is rated at 46.2% more energy efficient than the baseline and projects an estimated $1 million in annual operating cost savings, including $200,000 in thermal energy savings from reusing the waste heat from the high performance computer data center to heat the ESIF building.

High Performance Precast Concrete

According to Larsen, precast concrete best met the performance specifications. The aesthetic versatility of precast helped create a look that integrated well with the campus style and the environment. It also met cost, schedule, and performance needs, especially from an energy reduction perspective.

Larsen went on to say that precast was a great option because it results in fewer issues compared to other building material options. He described precast as "highly reliable." Due to its reliability, it was used for a number of elements on the structure including insulated wall panels, floors, and ceilings. In total, 876 pieces of precast were used throughout the structure.

A portion of the enclosure system consisted of high performance precast concrete wall panels that contained three-inches of integral, edge-to-edge insulation. This provided a material R-value of 20.5 and an even higher effective R-value 28.4 which helped ESIF achieves an energy performance 40 percent greater than the ASHRAE 90.1 building standards baseline building. Stresscon, the precast manufacturer, won an Award of Excellence for Precast Concrete from the American Concrete Institute for this project[1].

The continued growing relevance of sustainability for consumers, professionals, and policy makers enforces how critical it is for the design community to consider all aspects of green building when developing projects. The achievements of the ESIF design build process and the research it continues to develop, is paramount in continued progress for energy efficiency in our nation and the world.

Sources:

1. Stresscon press release: http://www.enconunited.com/pdf/Stresscon%20Project%20Wins%20ACI%20Award.pdf
2. Brian Larsen's Power Point
3. http://www.nrel.gov/news/press/2014/10330.html
4. http://www.nrel.gov/
5. ESIF Annual Report

For more information on these or other projects, visit www.pci.org/ascent.