White Paper WP003
Precast Sustainability and LEED®

Reducing the amount of material and energy used and emitted by buildings has an impact that goes far beyond the structures themselves. LEED provides guidelines and techniques that are helping to shape the global movement towards sustainable building, industries, and lifestyles. The EnCon Companies share this commitment to sustainability and LEED. In response to rising energy costs and growing concerns about destruction to the environment, the U.S. government has adopted green or "sustainable" building programs. In addition, an increasing number of states are offering tax benefits for green public buildings, and large corporations are applying sustainable design practices to decrease management and maintenance expenses.

Sustainability, Green Building Design, and LEED

In their 1987 report, the Brundtland Commission of the United Nations defined sustainable development as "that which meets the needs of the present without compromising the ability of future generations to meet their own needs." Green building design refers to design and construction practices that lessen or eliminate the negative impact buildings have on the environment and their occupants. This integrated approach encompasses not only the construction process, but the life cycles and long-term operations of buildings as well. In addition to the ecological impact, green building design considers sociological and economic factors that are beneficial to the project's stakeholders. Studies show that green buildings offer improved air and water quality, more access to daylight, and lower energy demand. In 1998, the U.S. Green Building Council (USGBC) established the Leadership in Energy and Environmental Design (LEED) standard rating system in an effort to define and measure sustainable building design practices. The USGBC estimates that a green building generates an 8% to 9% reduction in operational costs while adding 7.5% to the building's value.

THE LEED system addresses these key areas:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere
4. Materials and Resources
5. Indoor Environmental Quality
6. Innovation and Design Process
7. Regional Priority

LEED certifies buildings to four levels, each with an increasing degree of sustainable performance:

- Certified (40-49 points)
- Silver (50-59 points)
- Gold (60-79 points)
- Platinum (80-110 points)

Precast Contributions to Sustainable Practices

Precast/prestressed concrete contributes to the categories **Sustainable Sites, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation and Design Process**. Precast concrete is extremely durable due to the low water-cement ratios, 0.36 to 0.40. The thermal mass of precast allows for the shifting of heating and cooling loads, moderating the demand on mechanical systems. Precast concrete incorporates

Brigade and Battalion Headquarters, Fort Carson, CO
LEED Gold Certified

recycled materials like course and fine aggregates, and rebar used for reinforcement is recyclable as well. Nearly all manufacturing facilities reuse and recycle excess material, so less waste is produced. Optimized cross sections and design capabilities create long spans eliminating redundant members, while integrated insulation enhances R-values in conjunction with decreasing wall thickness. Precast components have long life cycles, which augment the sustainability of the building.

The inherent benefits of precast may yield LEED credits[1]:

- Warmer surface temperatures
- High albedo (solar reflectance)
- Low emittance (low surface temperature reflection)
- Resistance to noise
- Design innovation
- Mitigation of the urban heat island effect
- Low radiation and toxicity
- Thermal mass and nocturnal effects
- Ease of demolition and reuse
- Indoor environmental quality

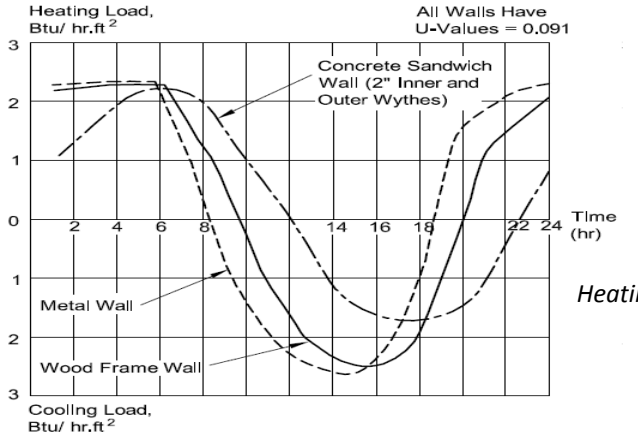
Sustainable Sites (SS)

- Precast concrete building components are cast off-site at a production plant, which minimizes disruption to the job site and beyond the building footprint, preserving natural areas and helping to achieve SS credit 5.1.
- Precast easily accommodates design features such as underground or tuck-under parking to reduce site disturbance, hardscape, building footprint, and heat island effect, aiding in the protection of natural permeable areas and applicable to SS credits 5.2, 6.1, and 7.1.
- The light color of concrete enhances reflectivity and limits the absorption of heat, reducing the heat island effect and contributing to SS credit 7.1.
- Green roofs can significantly improve the performance of a building by mitigating the heat island effect, decreasing the amount of stormwater runoff, and cleaning the air. These factors, as well as landscaping with plants native to the locale, can help protect and restore habitat and lead to the procurement of SS credits 6.1 and 7.2. Prestressed concrete has a high load-carrying capacity and is an ideal structural system to support a green roof. In many cases the additional loads from a green roof can be supported with very little additional material or structural depth.

5.1	Site Development - Protect or Restore Habitat	✓
5.2	Site Development - Maximize Open Space	✓
6.1	Stormwater Design - Quantity Control	✓
7.1	Heat Island Effect - Non-roof	✓
7.2	Heat Island Effect - Roof	✓

Energy and Atmosphere (EA)

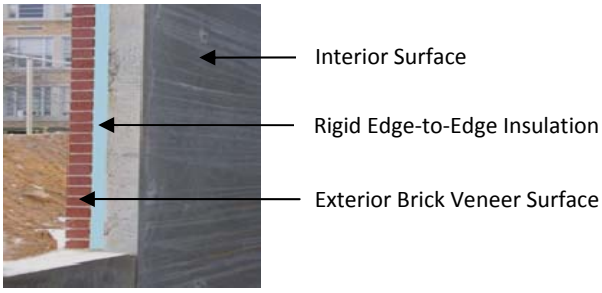
- Precast wall panels with continuous insulation and thermal mass enhance the energy performance of the entire building and may lower heating and cooling demands. As energy use decreases, so does the impact it has on the environment and the economy. Improved energy performance is the basis for acquiring EA prerequisite 2 and points in EA credit 1.
- In nearly all cities, buildings with thermally efficient precast concrete walls will most likely qualify for 1 point. In the cold climate category (Denver and Chicago), these buildings will most likely qualify for 2 points. [2]



Heating & Cooling Load Comparison

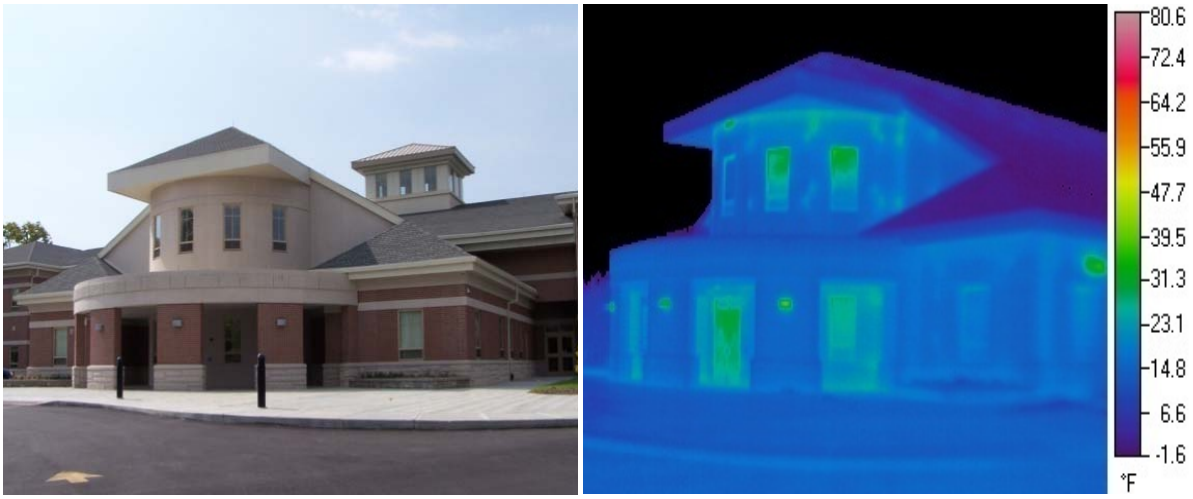
Prerequisite 2	Minimum Energy Performance	✓
1	Optimize Energy Performance	✓

Edge-to-Edge Insulated Precast Wall Panel with Thin Brick Veneer



Edge-to-Edge Insulation

In a wall system, a thermal bridge provides a path for heat to flow from hot to cold through the thickness of the wall. On a near 16° F day, there are no thermal bridges (shown by regions of warm or hot temperatures) from the interior of the structure to the exterior within the insulated brick-veneered precast panel.



Woodlawn Elementary School, Woodlawn, OH. Architect: DNK Architects

Materials and Resources (MR)

- Some excess concrete in the plant is reclaimed for construction fill, while the scrap plate steel and reinforcement is separated and recycled. Minimal job site waste is created, and all debris from field cutting openings can easily be recycled. This reduces the demand on landfills, supporting points for MR credits 2.1 and 2.2.
- Production facilities are capable of using cement alternatives or pozzolans. Fly ash and silica fume, post-consumer recycled products, may decrease the demand for cement by up to 50%. Using recycled material to lessen the demand for virgin resources necessary to make concrete will contribute to the achievement of MR credits 4.1 and 4.2.
- Steel used in precast concrete is high in recycled content, which can help accrue points towards MR credits 4.1 and 4.2.

Prerequisite 1	Storage and Collection of Recyclables	✓
2.1	Construction Waste Management - Divert 50% from Disposal	✓
2.2	Construction Waste Management - Divert 75% from Disposal	✓
4.1	Recycled Content - Use 10% (Post-Consumer + Half Pre-Consumer)	✓
4.2	Recycled Content - Use 20% (Post-Consumer + Half Pre-Consumer)	✓
5.1	Regional Materials - 10% Extracted, Processed and Manufactured Regionally	✓
5.2	Regional Materials - 20% Extracted, Processed and Manufactured Regionally	✓

- Most materials needed for cement production can be extracted, processed, and manufactured within a 500-mile radius of the project site. Precast fabricators purchase 50% to 100% of raw materials, e.g. coarse aggregates and sand, from local suppliers and deliver products to job sites often less than 200 miles. Limiting the environmental impact of transportation can contribute to the acquisition of MR credits 5.1 and 5.2.

Indoor Environmental Quality (IEQ)

- The use of precast concrete can ease indoor air quality concerns that arise during construction, the focus of IEQ credit 3.1.

3.1	Construction Indoor Air Quality Management Plan - During Construction	✓

- Precast is plant-fabricated, which reduces onsite dust and airborne particles. Cast-in openings for windows allow the building envelope to be closed early to keep out construction debris.
- Applying architectural or textured interior finishes and pigments for color limits the use of materials that produce VOCs, volatile organic compounds, such as paint, varnish, and wallboard.

Precast also improves indoor environmental quality for occupants of the completed building.

- The structural nature of precast allows for more openings to improve lighting as well as outdoor views.
- Precast is water resistant, undamaged by moisture, and eliminates contaminants such as mold and pest infestation.
- Inherently non-combustible, precast does not require additional fireproofing, which can emit VOCs.
- Precast walls and floors diminish noise transmission for a more soundproof structure.

Innovation and Design Process

- Precast projects can exceed the 10 percent recycled content threshold by another 5 percent, helping to attain Innovation credit 1.1.
- Thin brick usage lessens the amount of quarried materials and energy required for production and transportation, which can support points towards credits 1.1 through 1.5

1.1	Innovation in Design - Use of High Volume Supplementary Cementitious Materials	✓
1.2 - 1.5	Apply for other credits demonstrating exceptional performance	✓
2	LEED Accredited Professional	✓

- A precast wall system that is structural and load bearing requires fewer resources and less energy to manufacture and maintain, potentially increasing the number of 1.2 through 1.5 credits received.
- Innovation credits can also be obtained if the sustainable design methods applied are not part of the LEED system. A novel approach to increasing energy efficiency or resource conservation may earn an additional point.
- Credit 2 is earned if at least one member of the project team is LEED accredited.

Government Services Administration Office Building
Lakewood, CO
LEED Silver Certified

Principles of Design

Sustainable design goals are most successfully achieved when the project design team as a whole establishes these objectives and identifies ways in which to meet them.

Design considerations include:

• Reuse of existing buildings or components	• Ability to use less material
• Use of local materials	• High R-values
• Thermal mass	• Recyclable raw materials
• Light color choices	• Minimal disruption to the environment
• Less waste generation	• Energy efficiency and cost savings
• Quality of life enhancements	• Creation of safer, cleaner job site

Acknowledging the significance of sustainability and LEED certification, the Precast/Prestressed Concrete Institute has tasked its Sustainability Committee with the investigation and dissemination of information related to these topics. Additional information and further discussion pertaining to the involvement of precast concrete in sustainable design can be found at http://www.pci.org/resources/sustainability/index.cfm/resources. EnCon plays an active role in the advocacy of green building practices, and our design teams work collaboratively to achieve the desired results in sustainability and innovative design.

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Includes other members of EnCon Companies:
EnCon Utah, EnCon Washington, EnCon Colorado, Stresscon Corporation, Atlanta Structural Concrete Company

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1. Designer's Notebook on Sustainability, PCI's Ascent Magazine, Precast/Prestressed Concrete Institute, Chicago, IL, 2006

2. Modeling Energy Performance of Concrete Buildings for LEED-NC v2.1 EA Credit 1, Medgar L. Marceau and Martha G. VanGeem, Portland Cement Association, 2005