Sustainable Opportunities for Parking Structures

Green building techniques can greatly enhance projects' sustainable strategies and contribute to achieving LEED points

— By Kathy Buck, LEED-AP BD+C, Neumann/Smith Architecture

Precast concrete construction, including parking structures, can contribute in a variety of ways toward good sustainable design and LEED certification. A key way for parking structures to raise their contributions to sustainable design and LEED certification can come from an area often overlooked, creating a significant missed opportunity: creating a green roof and otherwise taking advantage of the upper deck or roof of the structure to provide added renewable-energy resources.

Incorporating a green roof onto a parking structure contributes significantly to the project's ability to meet its sustainable goals. Providing a roof over lower parking levels extends the deck's serviceable life by eliminating the need to remove snow with mechanical means or the use of chemicals and salts, minimizing the deleterious and corrosive nature of those materials on the deck structure.

Providing a green roof over parking can create useable space for occupants, such as contemplative spaces, eating/picnic areas and other activity uses.

Vegetated roofs can provide an urban habitat for birds and insects that are essential to a bio-diverse environment as well as provide a more attractive vista when viewed from taller buildings.

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The Blue Cross Blue Shield of Michigan parking structure features a 1/10th mile walking track, the use of which has been incorporated into a corporate-sponsored health and fitness program offered to its employees.

Certified Parking Project

An example of what can be accomplished is the Blue Cross Blue Shield of Michigan (BCBSM) parking structure in Detroit. On October 23, 2007, that total-precast concrete structure was awarded LEED certification under LEED's v2.1 Rating System. It achieved 27 points out of 69 possible required under that version of the rating system, which qualified it as Certified. (See the accompanying LEED scorecard and sidebar on current LEED requirements.)

BCBSM officials were aggressive in incorporating sustainable-design ideas into the structure. The company is committed to making "green" and sustainable design an integral part of how they do business every day. BCBSM elected to incorporate a 1/10th mile walking track, the use of which has been incorporated into corporate-sponsored health and fitness programs offered to employees.

Showers and locker/changing rooms are provided at the ground level of the deck. The selection of other materials on the roof, such as the track materials, include the use of recycled rubber products, which can further decrease the use of virgin materials.

Planting Choices

Green roof systems are classified as being either "extensive" (those with relatively shallow soil profiles of less than 6 inches) or "intensive" (those with soil profiles of 6 inches and above). Each system is capable of hosting a vast assortment of plant materials although intensive systems offer an opportunity for a much broader use of

The BCBSM parking structure features eight varieties of low-growing sedum in 2 to 3 inches of growing medium over drainage layers. The saturated weight of the system is approximately 15 psf.

grasses, flowers and even shrubs and trees. However, extensive systems also afford a wide selection of lower growing grasses and sedum, which are more drought-tolerant selections.

The 52,307-square-foot green roof on the nine-story BCBSM parking structure was the second largest green roof in Michigan (following the Ford Motor Co. Rouge Plant roof). It features an extensive system of eight varieties of low-growing sedum in 2 to 3 inches of growing medium over drainage layers. The saturated weight of the system is approximately 15 psf, although this can vary widely between projects depending on the overall composition of the system and materials selected.

At BCBSM, the large sections of vegetated sedum matts were installed much like conventional sod over a drainage fabric. It allows for the collection of water above an Ethylene Propylene Diene Monomer (EPDM) membrane that was fully adhered to the precast concrete roof's double-tee structure.

When planning for green roofs, consideration must be given to the use of the space below. Factors include conditioning requirements (if it's an occupied space in a multi-use project), accessibility issues (for access to repairs from below the roof structure, if required) and longevity

Sustainable Suggestions

Additional ways that designers can incorporate sustainable strategies into precast concrete or cast-in-place concrete parking structures include:

- Give strong preference to regional materials.
- Consider concrete mix designs that incorporate materials such as fly ash, slag cement and recycled aggregates that in total will reduce the use of raw/new materials and also reduce the amount of materials disposed of in landfills.
- Work with the contractor to encourage construction-waste programs that will emphasize recycling and reduce the use of materials being sent to landfills.
- Include carbon-dioxide monitoring for regularly occupied spaces of the deck/ building.
- Include battery-charging stations within the deck for electric cars.
- Designate preferred parking spaces for carpools, vanpools, fleet cars and for low-emission vehicles (LEVs).
- Design the parking structure to be a code-defined Open Deck structure that does not require mechanical ventilation for the parking areas, reducing overall energy consumption.
- Incorporate smart lighting systems including sensors, controls and ties to building automation systems and security to maximize use of natural daylight.
- Consider finish materials, paints, adhesives and sealants that are low in volatile organic compounds (VOCs) that can be detrimental to workers and building occupants.
- Encourage the creation of dense and sustainable parking structures to minimize the amount of inefficient surface parking.

Sustainable opportunities are not limited to how they interact with the concrete structures. Thoughtful location of projects in urban environments where there is previously developed land with existing infrastructure vastly reduces the use of new resources and the demand put onto utility systems.

The use of remediated Brownfield sites allows redevelopment of underutilized land. Locating projects near public transportation and community services lessens the emphasis on automobiles while strengthening the local economy. Offering employees opportunities to ride bikes and safely store their bicycle equipment securely on site also reduces the impact of autos while promoting health and fitness.

These concepts can make a contribution toward LEED credits and subsequently encourage the reduction of energy use.

BCBS of Michigan
Project # 10002520
Certification Level: Certified
10/23/2007

LEED for New Construction v2.0/2.1

27 Points Achieved — Possible Points: **69**

Certified 26 to 32 points **Silver** 33 to 38 points **Gold** 39 to 51 points **Platinum** 52 or more points

10 Sustainable Sites — Possible Points: **14**

Y			
Y	Prereq 1	**Erosion & Sedimentation Control**	
1	Credit 1	**Site Selection**	1
1	Credit 2	**Development Density**	1
1	Credit 3	**Brownfield Redevelopment**	1
1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
	Credit 4.4	**Alternative Transportation**, Parking Capacity & Carpooling	1
	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1	Credit 6.1	**Stormwater Management**, Rate & Quantity	1
1	Credit 6.2	**Stormwater Management**, Treatment	1
1	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
1	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
	Credit 8	**Light Pollution Reduction**	1

2 Water Efficiency — Possible Points: **5**

Y			
1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
	Credit 2	**Innovative Wastewater Technologies**	1
	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere — Possible Points: **17**

Y			
Y	Prereq 1	**Fundamental Building Systems Commissioning**	
Y	Prereq 2	**Minimum Energy Performance**	
Y	Prereq 3	**CFC Reduction in HVAC&R Equipment**	
	Credit 1.1	**Optimize Energy Performance**, 15% New / 5% Existing	1
	Credit 1.2	**Optimize Energy Performance**, 20% New / 10% Existing	1
	Credit 1.3	**Optimize Energy Performance**, 25% New / 15% Existing	1
	Credit 1.4	**Optimize Energy Performance**, 30% New / 20% Existing	1
	Credit 1.5	**Optimize Energy Performance**, 35% New / 25% Existing	1
	Credit 1.6	**Optimize Energy Performance**, 40% New / 30% Existing	1
	Credit 1.7	**Optimize Energy Performance**, 45% New / 35% Existing	1
	Credit 1.8	**Optimize Energy Performance**, 50% New / 40% Existing	1
	Credit 1.9	**Optimize Energy Performance**, 55% New / 45% Existing	1
	Credit 1.10	**Optimize Energy Performance**, 60% New / 50% Existing	1
	Credit 2.1	**Renewable Energy**, 5%	1
	Credit 2.2	**Renewable Energy**, 10%	1
	Credit 2.3	**Renewable Energy**, 15%	1
	Credit 3	**Additional Commissioning**	1
	Credit 4	**Ozone Depletion**	1
	Credit 5	**Measurement & Verification**	1
	Credit 6	**Green Power**	1

6 Materials & Resources — Possible Points: **13**

Y			
Y	Prereq 1	**Storage & Collection of Recyclables**	
	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1	Credit 2.1	**Construction Waste Management**, Divert 50%	1
1	Credit 2.2	**Construction Waste Management**, Divert 75%	1
	Credit 3.1	**Resource Reuse**, Specify 5%	1
	Credit 3.2	**Resource Reuse**, Specify 10%	1
1	Credit 4.1	**Recycled Content**, Specify 5%	1
1	Credit 4.2	**Recycled Content**, Specify 10%	1
1	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
	Credit 6	**Rapidly Renewable Materials**	1
	Credit 7	**Certified Wood**	1

5 Indoor Environmental Quality — Possible Points: **15**

Y			
Y	Prereq 1	**Minimum IAQ Performance**	
Y	Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	
1	Credit 1	**Carbon Dioxide Monitoring**	1
	Credit 2	**Ventilation Effectiveness**	1
	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1	Credit 4.2	**Low-Emitting Materials**, Paints	1
1	Credit 4.3	**Low-Emitting Materials**, Carpet	1
1	Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	Credit 6.1	**Controllability of Systems**, Perimeter	1
	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

4 Innovation & Design Process — Possible Points: **5**

Y			
1	Credit 1.1	**Innovation in Design**: Exemplary Performance for SSc7.1	1
1	Credit 1.2	**Innovation in Design**: Exemplary Performance for MRc2	1
1	Credit 1.3	**Innovation in Design**: Green Housekeeping	1
	Credit 1.4	**Innovation in Design**	1
1	Credit 2	**LEED® Accredited Professional**	1

This LEED scoring chart shows how the Blue Cross Blue Shield of Michigan parking structure in Detroit achieved its Certified rating. LEED's scoring has changed since that time, with certification now requiring 40 out of a possible 110 points.

expectations by the owner. The green roof extends the life of the underlying roofing membrane by shielding it from sunlight and degradation from ultraviolet rays and direct contact with weather.

Loading and Other Code Considerations

It is imperative to consider the loading requirements: 100 psf live load is required if the roof level will function as a roof garden/assembly space. This must be considered by the structural engineer in the design of the overall roof system. Code-wise, making the roof level a more accessible space can result in increased need for roof egress, wider egress and elevator access. These must be coordinated with local building codes and building authorities.

At BCBSM, the roof became a popular location for special functions, such as viewing Independence Day celebrations in downtown Detroit over the Detroit River. It is also important to be aware that additional fall-protection measures need to be considered, based on the extent of use of the green roof by occupants. At BCBSM, the use of black vinyl-coated fencing woven over stainless-steel cable strands provided code-required guard protection while minimizing any visual barrier to the vast views of the city and river.

Providing a roof over the structured parking levels may result in 100% covered parking, which for those projects seeking LEED certification can qualify for exemplary performance associated with Heat Island Effect, non-roof (SSc7.1) as an Innovation & Design credit. Heat-island effect refers to the absorption of heat by hardscapes, such as dark, nonreflective pavement and buildings, and its radiation to surrounding areas.

Providing light-colored roofs or including vegetated green roofs

minimizes this impact on the environment. Green roofs reduce the heat-island effect of structures (SSc 7.2). The decision to place parking under cover (including in parking structures) minimizes the non-roof heat island effect by decreasing the amount of site parking-lot area (SSc 7.1).

Green roofs also offer the opportunity for increased stormwater control on site by delaying the flow rate of water into stormwater-catchment systems and the utility infrastructure. They also offer the opportunity to collect and store water in precast concrete cisterns, which can then be used for landscape irrigation and other gray water use (if allowed by the local municipality).

At BCBSM, the water from the green roof was combined with water collected from elsewhere on site and collected in an underground concrete stormwater catchment system 164 feet long and 10 feet in diameter. This water is used for site irrigation, including to establish the green roof vegetation, which vastly reduces demand for domestic water use.

Other Energy Options

A parking structure's top level or roof can provide a great opportunity for the inclusion of other site-located renewable energy resources. Onsite renewable energy can be used as captured energy for use in the structure or to sell back to the utility.

An example is a solar-array project to be installed on the roof of a recently renovated cast-in-place concrete

Showers and locker rooms/changing rooms were provided at the ground level of the parking structure, enhancing its use by employees. The structure's roof has become a popular location for corporate activities, such as watching fireworks on July 4th.

New LEED Considerations

The current rating system for new construction under LEED standards is the 2009 LEED BD+C (Building Design and Construction) as part of the overall LEED v3 (version 3). It requires a minimum of 40 out of a possible 110 points for certification of a project.

Formalized with LEED 2009 are Minimum Program Requirements (MPRs) that determine if a project is eligible for certification. Of particular relevance to parking structures is MPR #5: Must Comply with Minimum Occupancy Rates.

It is important to note that for those structures seeking LEED certification under the new LEED v3 rating system for new construction, the project must serve one or more Full Time Equivalent (FTE) occupant(s), calculated as an annual average, to use LEED in its entirety. If the project serves less than one annualized FTE, optional credits from the Indoor Environmental Quality category may not be earned. All prerequisites must still be earned in order to qualify for LEED certification.

Often, parking structures don't include spaces considered to be regularly occupied that can satisfy this condition. Security, parking-attendant or maintenance areas, if designed to qualify for consideration as a conditioned/habitable space, may satisfy this requirement.

This was how the requirement was addressed on the BCBSM parking structure project, which also incorporated other conditioned spaces including meeting rooms, a fitness facility and shower/locker rooms. Other parking structure projects may have to include non-deck related mixed-uses in order to comply with this requirement.

Of course, structured parking can be used to help primary occupied spaces achieve LEED certification as part of a larger project, as well.

Neumann/Smith Architecture created a plan to remove several levels of a parking structure in Detroit. A 200-kW pv array will be installed on the roof and will generate power equivalent to the annual needs of 40 homes.

parking deck originally constructed in 1970 in downtown Detroit for BCBSM. This structure's upper levels had surpassed their serviceable life due to harsh exposure to the elements for more than 30 years.

Neumann/Smith Architecture developed a plan to remove the south half of the deck and two of the upper levels on the north half. The design team elected to leave an elevated level to function as protection for the lower deck levels and to eliminate the need for snow removal from the upper deck level. The exterior of the deck was then clad with a skin of masonry to visually relate to the remainder of the downtown Bricktown District.

The vacant roof space was considered and planned for a potential future green roof, but most recently it presented the perfect opportunity for the installation of a solar array that will cover 31,000 square feet of the 42,000-square-foot roof. Detroit Edison (DTE) and BCBSM have signed a 20-year agreement for a 200-kW photovoltaic system that will be installed on the roof and began operation this spring.

This $1-million solar array will provide BCBSM and the customers of DTE with renewable energy generated from the sun. The PV system is expected to generate an equivalent amount of power that would be consumed by approximately 40 homes in a year. BCBSM expects the array will produce about 20 percent of the base power for its downtown Lafayette campus in Detroit.

Onsite renewable energy can also be used to make use of captured energy for use in the deck, for other project use or to sell back to the utility. The installation is part of Detroit Edison's pilot SolarCurrents program that calls for photovoltaic systems to be installed on customer rooftops or property over the next five years to generate 15 megawatts (MW) of electricity through southeast Michigan.

Thoughtful methods of dealing with and addressing parking in the urban environment can lessen the impact of the automobile on the environment while creating enhanced opportunities for the creation of open space, landscape features and other sustainable benefits, including onsite renewable energy. Design professionals should advise clients of available sustainable strategies to minimize the impact of autos and the built environment and reduce the use of fossil fuels. ■

For More Information

LEED certified projects can be viewed at http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx.

For LEED minimum program requirements, visit: www.usgbc.org/ShowFile.aspx?DocumentID=6715

For more on the BCBSM parking structure project see the Winter 2008 issue of *Ascent* in the Publications/Ascent/Archives menu at www.pci.org