CONCRETE SUSTAINABILITY REPORT
NATIONAL READY MIXED CONCRETE ASSOCIATION CSR01—MARCH 2010

Concrete's Contribution to LEED® 2009 NC

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Using concrete in new buildings and major renovation projects can facilitate the process of obtaining LEED® 2009 for New Construction (NC) and Major Renovations certification. Leadership in Energy and Environmental Design (LEED) is a point rating system devised by the United States Green Building Council (USGBC) to evaluate the environmental performance of buildings. The system is credit-based, allowing projects to earn points for environmentally friendly strategies employed during the design and construction process.

LEED was launched in an effort by the USGBC to develop a "consensus-based, market-driven rating system to accelerate the development and implementation of green building practices." The program is not rigidly structured, i.e., not every project must meet identical requirements to qualify. LEED for New Construction (NC) rating system is currently in its third major iteration with LEED 2009 NC being introduced in April 2009. Both new buildings and major renovation projects can be certified using LEED 2009 NC. This paper details credits associated with the LEED 2009 NC where the use of ready mixed concrete can contribute to achieving LEED points.

LEED 2009 NC rating system has five main credit categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality. Each credit category is divided into credits and outlines the intent, requirements, technologies and strategies for meeting each credit. Credits are broken down into individual points. Additional points can be earned for Innovation & Design Process credits and meeting specific Regional Priority Credits.

Credit Category	Points Available
Sustainable Sites (SS)	26
Water Efficiency (WE)	10
Energy & Atmosphere (EA)	35
Materials & Resources (MR)	14
Indoor Environmental Quality (EQ)	15
Innovation in Design (ID)	6
Regional Priority (RP)	4
Total Points Available	**110**

Table 1. LEED credit categories and points available in each credit category.

LEED Certification Levels	Points Required
Certified	40-49
Silver	50-59
Gold	60-79
Platinum	80+

Table 2. LEED certification levels and points required for each level.

Points for Certification

A building requires at least 40 points for the basic certification level. Silver level requires 50 points, gold level requires 60 points and platinum level requires 80 points. There are a total of 110 points available.

Concrete and LEED

The following are suggestions for earning LEED points through the use of ready mixed concrete products. The paragraph headings below correspond to the credit categories and the credit numbers in the LEED 2009 NC rating system.

SS Credit 2: Development Density and Community Connectivity

The intent of this credit is to channel development to urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources. One strategy to achieve this credit is to construct or renovate a building on a previously developed site and in a community with a minimum density of 60,000 square feet per acre or meet certain community connectivity criteria such as proximity to basic services and pedestrian access. This often necessitates construction of multistory buildings. Concrete has long been the material of choice for multi-story construction. Its strength, economy and versatility make it ideal for residential and commercial construction in urban settings. Features such as long spans, low floor-to-floor heights and energy efficiency also contribute to environmental performance that can contribute to LEED points in other credit categories. This credit is worth 5 points.

SS Credit 3: Brownfield Redevelopment

Cementitious materials can be used to solidify and stabilize contaminated soils and reduce leaching concentrations to below regulatory levels. Although not typical, ready mixed concrete trucks and plants have been used to mix and deliver cementitious slurries for solidification and stabilization projects. To achieve this credit, documentation is required indicating the site was contaminated or a site defined as a brownfield and the remediation performed. This credit is worth 1 point.

SS Credit 5.1: Site Development—Protect or Restore Habitat

The intent of this credit is to conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity. Strategies include stacking the building program and using tuck-under parking. Concrete parking garages within buildings can be used to limit site disturbance. A parking garage located within a building helps maintain existing natural areas that would otherwise be consumed by surface parking. Using a pervious concrete parking area to store and treat rainwater, thereby eliminating or minimizing land required for detention ponds, helps protect and restore habitat. This credit is worth 1 point.

SS Credit 5.2: Site Development—Maximize Open Space

The intent of this credit is to provide a high ratio of open space to development footprint to promote biodiversity by meeting specific ratios of open space to developed space. Parking garages on the lower floors of a building can be used to help reduce the footprint of a site development. Pervious concrete parking areas can eliminate or reduce land required for detention ponds and can help maximize open space. This is worth 1 point.

Figure 1. Concrete has long been the material of choice for multi-story construction, a requirement for meeting Sustainable Sites Credit 2 in LEED 2009 NC.

SS Credit 6.1: Stormwater Design—Quantity Control

The intent of this credit is to limit disruption of natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants. Using pervious concrete pavements will reduce the rate and quantity of stormwater runoff because it increases infiltration of stormwater. Pervious concrete contains coarse aggregate, little or no fine aggregate, and sufficient cementitious paste to bind the aggregate while providing a network of interconnected voids between the

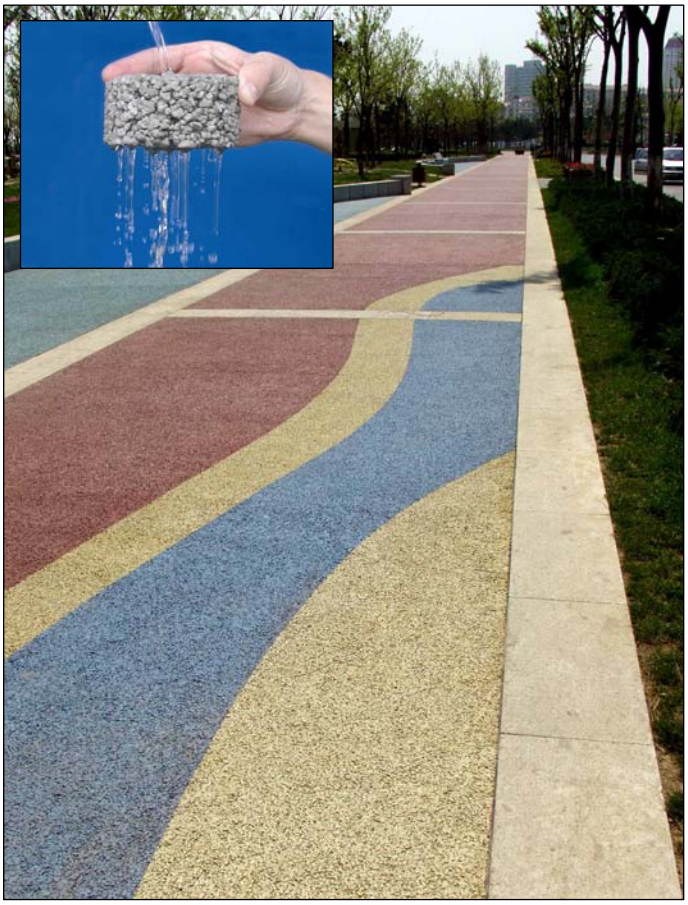

Figure 2. Pervious concrete pavements help control quantity and quality of stormwater (Sustainable sites Credit 6.1 and 6.2) and help conserve water resources (Water Efficiency Credit 1, 2, and 3)

coarse aggregates. The result is concrete with a high volume of voids (15% to 25%) and high permeability that allows water to flow through easily. Vegetated roofs (green roofs) are also identified as a strategy to achieve this credit. Reinforced concrete is often used as the structural system to support the heavy loads of vegetated roofs. This credit is worth 1 point.

SS Credit 6.2: Stormwater Design—Quality Control

The intent of this credit is to limit the disruption of natural water flows by managing stormwater runoff. To achieve this credit, a best management practice that removes 80% or more of the total suspended solids in stormwater must be used. Pervious concrete systems generally remove over 80% of total suspended solids and are considered a best management practice for treating stormwater. Vegitated roofs (green roofs) can also be used to meet the intent of this credit which are often supported by concrete structural systems. This credit is worth 1 point.

SS Credit 7.1: Heat Island Effect—Non-Roof

The intent of this credit is to reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat. Strategies include providing shade for at least 50% of hardscaped surfaces or providing hardscaped surfaces with solar reflectance index (SRI) of at least 29. The requirement for SRI can be met by using concrete rather than asphalt for 50% of all sidewalks, parking lots, drives and other impervious surfaces.

Solar reflectance is the ratio of the amount of solar radiation reflected from a material to the amount that shines on the material. Generally, light-colored surfaces have a high SRI. Where paved surfaces are required, using materials with higher SRI will reduce the heat island effect—consequently saving energy by reducing the demand for air conditioning—and improve air quality.

Concrete generally has an SRI of greater than 29. Concretes made with white cements or slag can have SRI greater than 78. As a comparison, new asphalt generally has an SRI of approximately 0, and asphalt five or more years old has an SRI of approximately 6. This credit is typically achieved when parking areas, walks and plazas are paved with concrete.

Another strategy to achieve this credit is to place a minimum of 50% of parking spaces under cover, including underground,

Figure 3. Concrete pavement can be used to reduce urban heat islands (Sustainable Sites Credit 7.1)

under deck, under roof or under building. Concrete is typically the material of choice for parking structures. This credit is worth 1 point.

SS Credit 7.2: Heat Island Effect—Roof

The intent of this credit is to reduce heat islands (thermal gradient between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat. The requirement is to use highly reflective/high emissivity roofing for a minimum of 75% of the roof surface; or install a vegetated roof for at least 50% of the roof surface; or a combination of both for the entire roof area. Concrete with high SRI can be used for roofing and concrete structural systems are ideal for supporting the heavy loads of vegetated roofs. This credit is worth 1 point.

WE Credit 1: Water Efficient Landscaping

The intent of this credit is to reduce or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation. Strategies include using only captured rainwater, recycled wastewater or recycled greywater for irrigation. Cisterns for capturing rain water are often built using concrete. Pervious concrete systems and other stormwater management systems can be used to capture stormwater for collection into cisterns for later use for irrigation. This credit is worth 2 points for 50% reduction from the midsummer baseline case and an additional 2 points for no potable water used for irrigation.

WE Credit 2: Innovative Wastewater Technologies

The intent of this credit is to reduce the generation of wastewater and potable water demand, while increasing the local aquifer recharge. Strategies include the use of non-potable water, recycled greywater and on-site treated wastewater for sewage conveyance. Concrete cisterns and treatment tanks can be used to fulfill the requirements of this credit. This credit is worth 2 points.

WE Credit 3: Water Use Reduction

The intent of this credit is to further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems. Employ strategies that in aggregate use less water than a typical building. Strategies include using alternate on-site sources of water, such as rainwater and stormwater. Pervious concrete systems in combination with concrete cisterns can be used to fulfill the requirements for this credit. This credit is worth 2, 3 or 4 points for 30%, 35% and 40% reduction of water use from the baseline.

Figure 4. High performance concrete building systems such as insulating concrete forms, tilt-up concrete and concrete frame construction help a building meet the requirements of LEED 2009 NC energy performance requirements.

EA Prerequisite 2: Minimum Energy Performance

To achieve any level of LEED certification buildings must demonstrate a 10% improvement for new buildings or a 5% improvement for existing building renovations in the proposed building performance rating compared to the baseline building performance rating per ASHRAE Standard 90.1-2007. The requirements of the ASHRAE standard are cost-effective and support the use of thermal mass for building components. Insulating to exceed the requirements of the standard is generally a wise business choice.

Building components constructed of concrete generally exhibit a property known as thermal mass. This means the compo-

nents have enough heat-storage capacity to moderate daily temperature swings. Buildings constructed of cast-in-place frame, tilt-up or insulating concrete forms (ICF) possess thermal mass which helps moderate indoor temperature extremes and reduces peak heating and cooling loads. In many climates, these buildings have lower energy consumption than non-massive buildings with walls of similar insulation. In addition, heating, ventilating and air-conditioning needs can be met with smaller capacity equipment. This credit is a prerequisite for certification and is not worth any points.

EA Credit 1: Optimize Energy Performance

This credit is awarded if energy cost savings beyond a baseline can be demonstrated compared to a baseline building that meets the requirements of ASHRAE 90.1-2007. Performance must be measured by a whole building simulation using the Building Performance Rating Method in Appendix G of the ASHRAE Standard. Many engineering consulting firms have the capability to model a building to determine energy savings using a computer-based program such as DOE2. When concrete is considered, it is important to use a program like DOE2 that calculates yearly energy use on an hourly basis. Such programs are needed to capture the beneficial thermal mass effects of concrete.

Insulated concrete building systems, used in conjunction with other energy savings measures, will most likely be eligible for points under this credit. The number of points awarded will depend on the building, climate, fuel costs and minimum requirements of the standard. From 1 to 19 points are awarded for energy cost savings of 12% to 48% for new buildings and 8% to 44% for existing buildings.

MR Credit 1.1 Building Reuse—Maintain Existing Walls, Floors and Roof

The purpose of this credit is to leave the existing building structure and shell in place when renovating. The building shell includes the exterior skin and structural system but excludes window assemblies, interior walls, floor coverings and ceiling systems. This credit should be obtainable when renovating buildings with a concrete frame and/or skin since concrete generally has a long service life. This credit is worth 1 point if 55% of the existing building structure and shell is left in place, 2 points if 75% is left in place and 3 points for 95% is left in place.

MR Credit 2: Construction Waste Management

This credit is provided for diverting construction, demolition and land clearing waste from landfill and incinerator disposal. Since concrete is a relatively heavy construction material and is frequently crushed and recycled into aggregate for road bases or construction fill, this credit should be obtainable when concrete buildings are demolished. In addition, returned concrete that is diverted from landfills by making landscaping blocks or recycling into new concrete can be considered for this credit. This credit is worth 1 point if 50% of the construction, demolition and land clearing waste are recycled or salvaged and is worth 1 additional point if 75% is diverted.

MR Credit 4: Recycled Content

The intent of this credit is to increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials. The requirements are to use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer recycled content constitutes at least 10% of the total value of the materials in the project to receive 1 point and 20% to receive 1 additional point. Supplementary cementitious materials, such as fly ash, slag cement and silica fume, are considered pre-consumer recycled content. Furthermore, using recycled concrete as aggregate instead of virgin aggregates would qualify as post-consumer recycled content. Although not considered part of concrete, most reinforcing bars are manufactured from recycled steel and considered post-consumer recycled content.

MR Credit 5: Regional Materials

The intent of this credit is to increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation. The requirement of this credit is to use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% (based on cost) of the total materials value for 1 point and 20% for 2 points. If only a fraction of a product or material is extracted, harvested or recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value. Ready mixed concrete will almost always qualify since ready mixed concrete plants are generally within 500 miles of a job site and most of the ingredient materials are harvested within 500 miles. The percentage of materials is calculated on a cost basis.

IEQ Credit 8.1: Daylight & Views—Daylight
IEQ Credit 8.2: Daylight & Views—Views

The intent of these credits is to provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building. The strategy is to design the building to maximize interior daylighting and views to the outdoors through building orientation, shallow floor plates and increased building perimeter. Concrete floor systems can span large distances with shallow floor plates and column free spaces to help achieve these credits. You can also use exposed concrete ceilings to reflect light deep into interior spaces. Credit 8.1 is worth 1 point if 75% of the space has daylight and Credit 8.2 is worth 1 point if 90% of the space has views to the outdoors.

Figure 5. Concrete floor systems can span large distances with shallow floor plates helping improve daylights and views (Indoor Environmental Quality Credit 8.1 and 8.2)

ID Credit 1: Innovation in Design

These points can be applied for if an innovative green design strategy is used that does not fit into the point structure of the five LEED categories or if it goes significantly beyond a credit requirement in one of the existing credit categories. For example, if the project team used materials on the project such that 30% of the materials were extracted, processed and manufactured regionally then the project could receive an extra point in going significantly beyond the requirements of Materials and Resources Credit 5. Concrete contributes significantly to this credit category and therefore could be used to achieve an Innovation in Design credit.

Another example would be if the design team used materials on the project such that they have over 30% recycled content thereby exceeding Materials and Resources Credit 4 by 10 percentage points. Concrete made with some percentage of recycled aggregate in combination with supplementary materials can contribute significantly to this credit.

One strategy that has been used to obtain a LEED point in the Innovation in Design credit category is to reduce CO_2 embodied in concrete by 40%. One way to accomplish this is by using high volumes of fly ash, slag or silica fume in concrete such that the result is a decrease in embodied CO_2 by 40% over typical mixes in the area.

Another potential innovation is to use exposed concrete for walls, floors and ceilings. This strategy would eliminate a significant quantity of wall and floor coverings along with ceiling materials, all of which are common sources of volatile organic compounds (VOCs) that can degrade indoor air. This strategy could significantly improve indoor air quality. 1-5 points are available under the Innovation in Design credit.

ID Credit 2: LEED Accredited Professional

The intention of this credit is to encourage the design integration required by a LEED 2009 project and to streamline the application and certification process. To achieve this credit, at least one principal participant of the project team shall be a LEED Accredited Professional (AP). Most LEED projects will have a LEED AP as a member of the design team. In addition, the concrete industry has many LEED Accredited Professionals available to help maximize points for concrete. This credit is worth 1 point.

RP Credit 1: Regional Priority

These regional bonus credits are identified by USGBC Chapters and Regional Councils for each "environmental zone" and a maximum of four points are available for project teams to pursue in this credit category. Each USGBC region has the authority to create six potential bonus credits, of which one may pursue a maximum of four. This is a new category of credits available under LEED 2009. This allows for the "regional authority" to designate targeted credits that are of particular importance for a region and potentially give additional credits for projects that meet criteria in existing credit categories.

For example, in a region where urban heat island reduction is identified as an important goal, the USGBC Chapter could increase the points available for Sustainable Sites Credit 7.1 and 7.2 to 2 points each instead of 1 point thus creating greater incentive for design teams to employ heat island reduction strategies of these credits. Since concrete contributes to most credit categories it will play a significant role in achieving Regional Priority credits. 1-4 points are available for this credit.

Summary

Using concrete can potentially contribute to 20 LEED credits totaling between 37-62 points. Table 3 provide a list of LEED credits for which concrete can contribute. Concrete's environmental attributes can help project designers achieve LEED certification.

Obtaining a LEED certification demonstrates a positive environmental image to the community. Additionally, implementing green building practices can result in energy and cost savings over the life of the structure. Other advantages include better indoor air quality and plenty of daylight. Studies have shown that workers in these environments have increased labor productivity, job retention and days worked. These benefits contribute directly to a company's profits because salaries—which are about 10 times higher than rent, utilities and maintenance combined—are the largest expense for most companies occupying building space. Students in these environments often have higher test scores and lower absenteeism.

Detailed information on the LEED program and project certification process is available on the USGBC Web site, www.usgbc.org. More information about the environmental benefits of concrete can be found at www.nrmca.org/greenconcrete and www.nrmca.org/sustainability.

References

U.S. Green Building Council, November 2008, LEED 2009 New Construction and Major Renovations, Washington, DC.

U.S. Green Building Council, 2009, LEED Reference Guide for Green Building Design and Construction, Washington, DC.

RMC Research & Education Foundation, 2010, Ready Mixed Concrete Industry LEED Reference Guide, Silver Spring, MD.

LEED Credit Categories in Which Concrete Can Contribute	Points Concrete Can Influence
Sustainable Sites (26 Points Available)	
SS Credit 2: Development Density & Community Connectivity	5
SS Credit 3: Brownfield Redevelopment	1
SS Credit 5.1: Site Development—Protect or Restore Habitat	1
SS Credit 5.2: Site Development—Maximize Open Space	1
SS Credit 6.1: Stormwater Management—Quantity Control	1
SS Credit 6.2: Stormwater Management—Quality Control	1
SS Credit 7.1: Heat Island Effect—Non-Roof	1
SS Credit 7.2: Heat Island Effect—Roof	1
Water Efficiency (10 Points Available)	
WE Credit 1.1: Water Efficient Landscaping	
Reduce potable water use for irrigation by 50%	2
No potable water use or no Irrigation	2 additional
WE Credit 2: Innovative Wastewater Technologies	2
WE Credit 3: Water Use Reduction	
30% reduction	2
35% reduction	1 additional
40% reduction	1 additional
Energy & Atmosphere (35 Points Available)	
EA Prerequisite 2: Minimum Energy Performance	Required
EA Credit 1: Optimize Energy Performance	
12-48% new buildings or 8-44% existing buildings	1-19
Materials & Resources (14 Points Available)	
MR Credit 1.1: Building Reuse—Maintain Existing Walls, Floors and Roof	
55% building reuse	1
75% building reuse	1 additional
95% building reuse	1 additional
MR Credit 2: Construction Waste Management	
Divert 50% from disposal	1
Divert 75% from disposal	1 additional
MR Credit 4: Recycled Content	
10% (post-consumer + ½ pre-consumer)	1
20% (post-consumer + ½ pre-consumer)	1 additional
MR Credit 5: Regional Materials	
10% extracted, processed and manufactured regionally	1
20% extracted, processed and manufactured regionally	1 additional
Indoor Environmental Quality (15 Points Available)	
EQ Credit 8.1: Daylight & Views—Daylight	1
EQ Credit 8.2: Daylight & Views—Views	1
Innovation in Design (6 Points Available)	
ID Credit 1: Innovation in Design	1-5
ID Credit 2: LEED Accredited Professional	1
Regional Priority (4 Points Available)	
RP Credit 1: Regional Priority 1-4	1-4
TOTAL	**37-62**

Table 3. Concrete's Potential Contribution to LEED 2009 Certification

National Ready Mixed Concrete Association
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