The Engineer's View

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Achieving LEED® Credits with Segmental Concrete Pavements

According the to the Canadian Green Building Council, green building design strives to balance environmental responsibility, resource efficiency, occupant comfort and well-being, community development and the economics of building construction and operation. An increasing number of facility and site designs recognize these sustainable building values.

Over the past eight years, the North American design community has embraced sustainable design through the adoption of LEED® (Leadership in Energy and Environmental Design). Developed by the U.S. Green Building Council (USGBC) in 1998, LEED® is a voluntary system of design for buildings and sites that provides a rating system which encourages the use of technologies that reduce energy and conserve non renewable resources. The Canadian Green Building Council (CaGBC) was formed in 2003 and adapted the USGBC LEED® green building rating system. Differences in the CaGBC point system relate to Canadian climates, construction practices and regulations. The latest version, LEED® NC Version 2.2 was recently released in the U.S. and this article reflects those changes. CaGBC is expected to follow with version changes similar to 2.2 in 2006.

LEED® Credits

LEED® establishes a consensus-based means for measuring building and site performance by promoting designs that integrate energy and resource conservation. One of the primary objectives of LEED® is to help facility owners reduce maintenance and life-cycle costs. For new commercial construction (or LEED® – NC), the U.S. and Canadian Green

Figures 1 and 2. No matter the climate—wintry Toronto or sunny Southern California---permeable interlocking concrete pavement supports vehicles, reduces runoff and earns LEED® points. The Toronto Harbourfront Fire Station pavement has been in service since 1998.

Building Councils grant certification based on the same number of points (credits) earned from each rating system. A project must earn a minimum of 26 points to achieve US or CaGBC certification. Higher ratings are also possible; silver for a project that attains 33 to 38 points, gold for a project that attains 39 to 51 points and platinum for a project earning 52 to 69 points.

Points are earned by fulfilling the requirements and prerequisites as specified in each credit. Prerequisites and credits are organized under five principal LEED® categories; Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Material and Resources (MR), Indoor Environmental Quality (IQ). An additional category, Innovation and Design Process (ID) recognizes expertise in green design and construction and accounts for measures not covered under the five aforementioned categories.

Segmental concrete paving can contribute up to 14 points under the SS, MR, and ID credits. They can contribute to Sustainable Site (SS) credits under stormwater design by incorporating permeable interlocking concrete pavement systems (PICP's) that reduce the rate and quantity of surface runoff and that also reduce pollutants such as total suspended solids (TSS) and total phosphorous (TP). Under sustainable site credits, segmental concrete paving can also reduce the heat island effect in both roof and non-roof applications. They can also be applied to Material and Resources (MR) credits by providing solutions to construction waste management, resource reuse, recycled content and regional manufacture and extraction.

Figure 3. Concrete grid pavements reduce runoff, introduce a cooler microclimate and earn LEED® points.

Sustainable Site (SS) Credits

The SS performance credits encourage site selection, planning, landscaping and design strategies that use land more effectively and minimize construction and operational impacts. There are 14 points available in the SS category through eight credits. Segmental concrete pavements can contribute to four points in two of these credits by fulfilling the requirements and prerequisites under Stormwater Design and Heat Island Effect.

Stormwater Design (SS Credit 6)

Stormwater design credits are concerned with the rate, quantity and quality management of stormwater runoff. The rate and quantity of storm water runoff is dependent on the amount of pervious and impervious surface on a building site. In their pre-development condition many sites may allow infiltration of most precipitation. However, the amount of post-development runoff can be significantly increased in urban areas with pervious pavements. Permeable Interlocking Concrete Pavements (PICP's) are a type of pervious pavement that mitigate these impacts and achieve the credits (See Figures 1 and 2). A typical design consists of solid concrete pavers with openings or wide joints. The openings are filled with small sized, open-graded crushed stone and built on an open graded aggregate base and subbase. The ICPI publication, *Permeable Interlocking Concrete Pavements – Selection, Design, Construction and Maintenance* provides design guidelines for design professionals and contractors. This publication can be ordered on www.icpi.org by clicking the link to the Publications Catalog.

Stormwater Design: Quantity Control (SS Credit 6.1)

The US and CaGBC LEED® credit SS 6.1 gives one credit for sites with less than 50% net imperviousness where the designer implemented a stormwater management plan that prevents the post-development and one- and two-year 24-hour peak discharge rate from exceeding the pre-development discharge rate from the same storms. For audit pur-

poses the designer must show, through pre-construction and post-construction site drawings, no increase in net imperviousness of the site. Alternatively, the design must "implement a stormwater management plan that protects stream channels from excessive erosion by implementing a stream channel protection strategy and quantity control strategy." This provides the designer with some latitude in demonstrating protection for stream channels.

For sites where the net imperviousness is greater than 50%, the designer must show a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff from a 2-year 24-hour design storm. For audit purposes, the designer must provide a copy of the stormwater management plan and include calculations that show a net decrease in imperviousness by 25% over existing conditions.

PICP's can be used to meet the prerequisites for both of the conditions described above. The ICPI manual on permeable pavement notes that the long-term conservative pavement surface infiltration rate is approximately 3 in. /hour (210 l/sec/ha). This rate will easily accommodate 2-year, 24-hour rainfall intensities given sufficient base storage and soil infiltration.

For calculating site perviousness, PICP's are given a runoff coefficient (C) of 0.25 to 0.4 depending on the soil conditions. Low C values should be used in high infiltration sandy soils and higher values for lower infiltration silt and clay soils. These runoff coefficients are similar to grass turf areas recommended by the CaGBC in their document *LEED® Green Building Rating System for New Construction and Major Renovations* published in 2004.

Curve Numbers (CN) developed by the U.S. National Resource Conservation Service (NRCS) approximate runoff volumes from pre- and post-development conditions based on land cover. Some localities use the CN approach which is a central concept to the NRCS TR-55 design method. CNs for permeable interlocking concrete pavements will vary depending on the storage volume of the base and the soil infiltration rate. These can be calculated for each project and will likely range between 45 and 65.

Stormwater Design: Quality Control (SS Credit 6.2)

Impervious cover such as roofs, sidewalks, driveways and streets contribute additional runoff and pollution by denying infiltration of stormwater. USGBC requirements include capturing and treating rainfall from at least 90% of all rainstorms. This translates to 0.5 to 1 in. (13 to 25 mm) of rainfall depending on the region. Given their much higher storage capacity, PICPs should have no problems managing these everyday storms.

The US and CaGBC LEED® credit SS 6.2 each give one credit to sites where the stormwater treatment systems are designed to remove 80% of the average annual post-development total suspended solids (TSS). Designers are encouraged to use best management practices (BMPs) complying with state or local standards or provide in-service monitoring data that supports compliance with this level of TSS reduction.

Since PICP reduces runoff through infiltration, it has the ability to reduce TSS and TP. Several studies have demonstrated 80% reduction of TSS and at least 40% TP reduction. These studies compared reductions in pollutants from PICP to that from impervious pavements and are available from ICPI upon request. Along similar lines, CaGBC states that treatment of first flush is critical to successful treatment strategies, and that if a project can demonstrate that 100% of the first 1 in. (25 mm) of rainfall infiltrates on site and/or is collected in rainfall cisterns, the intent of this credit would also be met

Additional points can be earned through reducing the urban heat island on parking lots and roofs, by reducing construction waste, reusing pavers and by using recycled materials in them. Using materials made from within the region also earns points as well as proposing innovative design and using durable materials. How to earn these credits will be covered as Part 2 in the next issue. ❖