Concrete Parking in Practice

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CPIP No. 1

Concrete Parking Lot Lighting

Lighting up concrete Saves Money and Improves Safety

Paved surfaces (such as highways, roads, parking lots, and driveways) typically constitute about 30 to 40% of developed urban areas. The color of these surfaces can help to reflect light back into an area, reducing the number of lighting fixtures needed and making the area a safer place.

Lighting fixtures are an important element of every project. Concrete pavements reflect from 33% to 50% more light than asphalt so cities can achieve the same street lighting standard, satisfying American National Standards Institute criteria, with a lower initial investment in lighting fixtures and equipment, and, as well, can sustain considerably lower long-term energy costs. A report comparing the environmental impacts of concrete pavements to asphalt pavements indicates that asphalt pavements require more lights per unit length to achieve the same illumination as concrete pavements. The results suggest cost savings of as much as 31% in initial energy and maintenance costs for lighting concrete pavements versus lighting asphalt pavements. Similar results are shown in the figure below, where energy costs required to illuminate an asphalt roadway are estimated to exceed the costs of illuminating a concrete roadway by 33%. The cost savings for switching from asphalt pavements to concrete pavements can save an owner (such as a city, municipality, or state) millions of dollars a year.

Which pavement do you want your family walking to their car on?

Lighter colored pavements, like parking areas and streets, produce a brighter environment with higher visibility and improved safety. Pavement designers often take pavement color into account when planning lighting needs. Better illumination from lighter pavements is valuable in public and private projects, security or customer appeal. Some sources cite nighttime illumination enhancements of 10 to 30 percent with more reflective pavements.


What is the next step?

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CPIP No. 2  Freeze and Thaw Protection

Exterior concrete surfaces exposed to cycles of freezing and thawing, and deicing chemicals, are susceptible to progressive deterioration. Following proper ACI guidelines for quality concrete and concrete placement can help make it more durable.

Concrete is a porous material. Absorbed water in concrete capillaries can expand up to 9% after freezing. As the water freezes, the ice forces water through the concrete resulting in very high hydraulic pressures. Cumulative freeze-thaw cycles lead to concrete deterioration.

The use of air entrainment provides tiny air bubbles in the paste where the displaced water can enter during ice formation. An adequate air void system reduces hydraulic pressures and keeps the concrete from deterioration.

Following ACI 201 “Guide to Durable Concrete” and the use of durable aggregates and proper placing, finishing, curing and sealing of the concrete are other ways to increase hardened concrete’s resistance to cycles of freezing and thawing.

These tips will help prevent future problems.
- Always use air entrained concrete for exterior projects.
- For added protection, you can seal your exterior concrete with a penetrating concrete sealer once a year.
- Never use deicing chemicals to combat icy surfaces, such as chloride base, ammonium nitrate or ammonium sulfate. These deicers attack and disintegrate portland cement concrete. Instead use clean sand for traction.
- When fertilizing your lawn, limit overspray and sweep any fertilizer from your concrete surface.

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CPIP No. 3 LEED - Recycled Content

Slag Cement and Fly Ash

Slag cement and fly ash are the two most common SCM’s (Supplementary Cementitious Materials) used in concrete. Most concrete produced today includes one or both of these materials. For this reason, their properties are frequently compared to each other by mix designers seeking to optimize concrete mixtures.

LEED Credits

Leadership in Energy and Environmental Design (LEED) is a system developed by the United States Green Building Council to rate a building’s environmental performance. This system has become the principal method by which buildings can achieve green building certification. The system is based on credits earned in five major categories. Slag cement and fly ash can positively impact several credit categories including:

- Site credit for reduction of heat islands: Use of high-albedo materials like concrete produced with slag cement.
- Materials credit for building reuse: Slag cement makes concrete structures more durable.
- Materials credit for recycled content: Slag cement and fly ash is a recycled material used in concrete.
- Materials credit for use of local/regional materials: Slag cement and fly ash can be considered a local material in many areas.

Substituting fly ash for Portland cement is another way to make concrete greener. Fly Ash is a pozzolan and a byproduct of coal combustion for electric power facilities. Fly Ash is normally used in quantities between 15 and 25 percent as compared with substantially higher substitution levels for slag cement (which is hydraulic cement).

References

1. ECCO EV27. LEED Green Building Rating System and Concrete, Environmental Council of Concrete Organizations, Skokie, IL, 2002.

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LEED Regional Materials (MR Credit 5)

The intent of this credit is to increase demand for building products that are extracted and manufactured locally, thereby reducing the environmental impacts resulting from their transportation and supporting the local economy. To meet the intent of this requirement, 10% (based on cost) of the total materials must be harvested, extracted or recovered within 500 miles of the project site. An additional point is awarded for 20% regional materials. Projects with large amounts of concrete can meet the required 10% or 20% regional materials to meet this credit.

Concrete is made up of raw materials such as sand, stone, cement, and water. These materials are typically extracted, harvested, or recovered within the 500-mile LEED requirement of a concrete plant. There are several sand & gravel facilities, stone quarries, and cement manufacturing plants in the state of Maryland. This allows every ready mix plant to transport the raw materials needed to produce a yard of concrete a short distance. This in turn cuts down on the number of trucks needed on the roads in Maryland. Concrete is batched wet and needs to be placed on the job soon after the raw materials are put into the concrete mixer truck. This means that the concrete mixer truck can only travel short distances to deliver the product.

Innovation in design 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.

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CPIP No. 5  LEED Heat Island (SS Credit 7.1)

Portland cement concrete pavements contribute to a sustainable environment by reducing heat islands. A heat island is a local area of elevated temperature in a region of cooler temperatures. Heat islands are found where there is an abundance of dark surfaces and a lack of vegetation. Higher ambient temperatures within a heat island increase the demands on building air conditioning systems.

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System recognizes the benefit of heat reflectance. The LEED-NC Sustainable Sites (SS) Credit 7.1 Heat Island Effect grants points for reducing heat island effect. One point can be obtained for using a paving material with a SRI of at least 29 for a minimum of 50% of the hardscape. This includes roads, sidewalks, courtyards and parking lots. Unless actually measured, LEED allows an SRI of 35 for ordinary Portland cement concrete pavement.

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Four types of concrete pavement are typically constructed; plain jointed, plain with dowels at the joints, steel reinforced with dowels at the joints, and continuously reinforced. Plain jointed pavement is recommended for parking lots subjected to limited truck traffic. Three types of joints are constructed in plain jointed concrete pavements; construction, isolation, and contraction (control) joints.

Construction joints exist between areas of pavement constructed at different times. Load transfer devices are used for heavier traffic loads. Butt-type joints are recommended for parking lots carrying light traffic loads. A thickened edge butt joint is recommended where pavements of different thicknesses come together.

Contraction joints provide a plain for normal volume change cracking. Properly spaced, contraction joints limit stresses caused by warping and curling. The depth of the joint should be ¼ of the slab thickness, or 1 inch using early-entry saws. For plane jointed pavement, the maximum spacing is 30 times the thickness of the slab up to a maximum of 15 ft. The length of a panel should not be more than 25% greater than its width.

Isolation joints are provided to separate the pavement from other structures. In addition to normal volume changes in the pavement, adjoining structures can be expected to move. They are provided for the full thickness of the pavement.

Sawing contraction joints as soon as possible will minimize random cracking. Excessive random cracks occur when contraction joints are cut the day after placement of the concrete. Early-entry dry cut sawed joints should be cut immediately after initial set of the concrete at the joint. Joints formed with conventional dry or wet saws should be cut immediately after the concrete has hardened sufficiently to prevent raveling of the surface.

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CPIP No. 7 Elimination of Sub-base

Parking lot pavements are typically used for light traffic and less than 10 heavy trucks per day. Portland cement concrete pavements, unlike asphalt pavements, have the capacity to distribute applied loads over a wide area of the supporting materials. This allows most concrete parking lot pavements to be constructed directly on the subgrade.

The design professional determines the adequacy of the subgrade to directly support the pavement. In addition to supporting the pavement and applied loads, the subgrade provides a stable platform for construction operations. The subgrade must be dense, firm and uniformly smooth during the paving operation. When prepared to satisfy the following, most concrete parking lot pavements can be constructed directly on the subgrade.

1. The subgrade should be prepared in coordination with the installation of utilities and other excavations. Areas where excavations are performed for utilities should be filled and compacted with suitable materials to produce the required subgrade elevation. If subsidence of compacted trench backfill is evident, the backfill material should be excavated and recompacted, or use flowable fill.

2. The subgrade should provide an adequate degree of drainage beneath the pavement. A stable subgrade should not be sacrificed for the sake of drainage. A subgrade with a permeability of 200-300 ft/day provides adequate drainage that will support paving equipment, construction vehicles and the pavement. Prior to the start of work, moisture-density relationship for the subgrade material is determined. The moisture content of the subgrade material is adjusted and compacted to the required density.

3. The subgrade should be constructed to the proper and uniform elevation. Pavement performance is dependent on its thickness. Construction to the design depth is important to assure long term performance. A subgrade of uniform elevation allows contraction joints in the pavement to act as designed. Final grading should be checked to ensure proper elevation. The typical tolerance is not more than ¼ in. above or ½ in. below.

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CPIP No. 8 Use of Welded Wire Reinforcement

Welded wire reinforcement, often called welded wire fabric, consists of wires arranged in square or rectangular configuration. The wire is welded at their intersections. WWR is used in slabs-on-ground as primary and secondary reinforcement. As primary reinforcement, WWR increases the structural capacity. As secondary reinforcement, also known as distributed steel, WWR contributes to the crack-width control and will not add load-carrying capacity.

Newly placed concrete pavements undergo volume changes due to drying shrinkage, and temperature and moisture changes. Contraction joints are constructed to control the location and widths of cracks that may occur due to these volume changes. In plain jointed pavements, strength to resist the load of a wheel rolling across a contraction joint or random crack is provided by the larger size aggregates that are interlocked across the crack. Aggregates are not able to provide the needed strength if the cracks become too wide.

The efficiency of aggregate interlock is typically maintained by limiting the spacing of joints to no more than 24 to 30 times the pavement thickness. For joint spacing that exceeds this recommendation, WWR can be used for crack-width control. ACI 332R-08 states “shorter unreinforced panels are generally more economical and provide better performance.”

ACI 332-10 specifies crack-width control for slabs on ground with loads resulting from pedestrians and vehicles with passenger capacity of nine or less. These loads are typical for parking lots subjected to light traffic loads. ACI 332 requires WWR when joints are not provided and when the spacing of joints exceeds 24 times the pavement thickness. The minimum area of WWR is 0.1% at a spacing of 24 times the pavement thickness. The minimum area of WWR is 0.5% when joint spacing exceeds 100 times the pavement thickness. For intermediate joints spacing, the area of reinforcement shall be determined by linear interpretation.

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