



OPERATION & MAINTENANCE GUIDE

for Belgard Interlocking Concrete Pavement Systems



BELGARD INTERLOCKING CONCRETE PAVERS AND SLABS are produced by Oldcastle plants throughout North America and are manufactured in accordance with ASTM C-936 *Standard Specification for Solid Concrete Interlocking Paving Units*, and ASTM C1782 *Standard Specification for Segmental Concrete Paving Slabs* in the United States. In Canada pavers and slabs are manufactured in accordance with CSA A231.1/A231.2 *Precast Concrete Paving Slabs/Precast Concrete Pavers*.

Interlocking Concrete Pavement (ICP) requires periodic inspection and maintenance to ensure long-term performance throughout the pavement life. The type of maintenance method varies based on site-specific conditions.

This document addresses the key inspection and maintenance requirements for Belgard ICP systems and does not address pedestal-set rooftop applications, porcelain pavers, permeable pavers, or other hardscaping materials. This Operation & Maintenance (O&M) document is intended to provide guidance for pavement systems in both freezing and non-freezing climates. Belgard recommends that a Project-Specific O&M manual be developed, based on guidelines presented in this document, for large commercial and municipal projects.

Visit <http://www.BelgardCommercial.com> for a full collection of resources related to Belgard pavers and slabs including typical details, guide specifications, laying patterns, and other reference material.

Oldcastle, a part of CRH International, is committed to delivering sustainable products that provide environmental benefits including concrete products. Belgard pavers and slabs include a variety of light colors for urban heat island mitigation and can offer other sustainability and environmental benefits. Oldcastle's commitment to a cleaner environment extends beyond the products we manufacture and now includes a variety of post-construction maintenance programs for owners, municipalities and facility managers. For more information about Oldcastle's commitment to the environment, go to <http://www.crh.com/sustainability>.

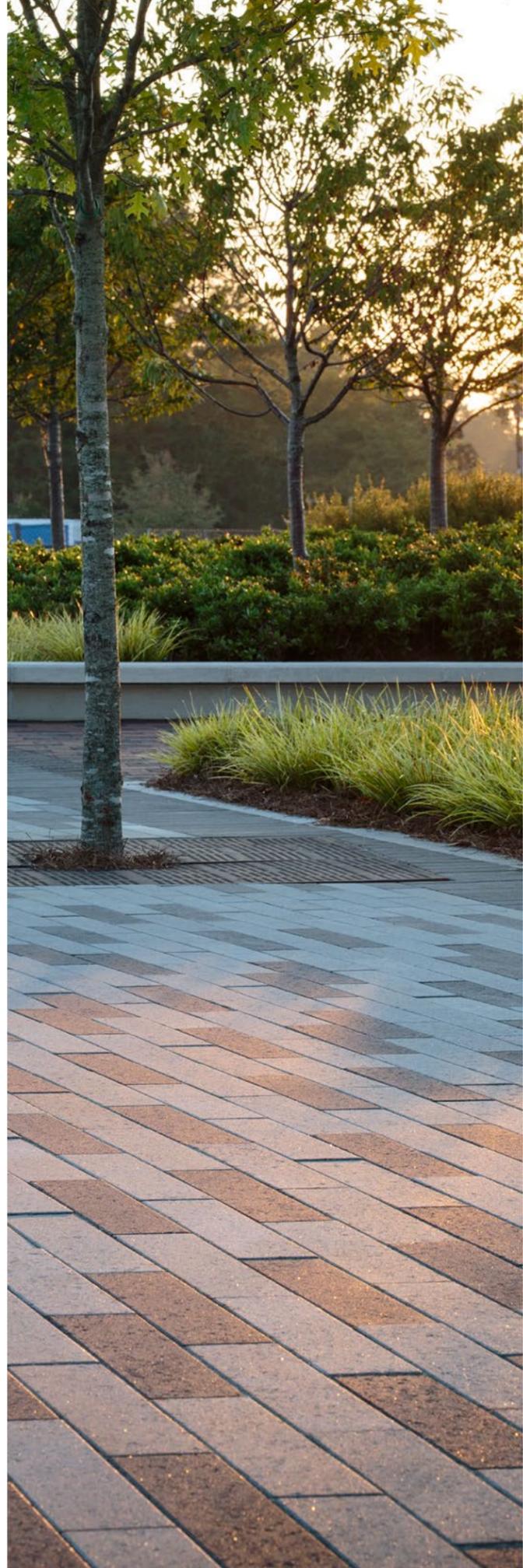


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TYPICAL PAVER DETAILS

Interlocking concrete pavers and slabs may be installed in a variety of assemblies based on application. The most common typical details are illustrated below.

Figure 1. Sand Set on Aggregate

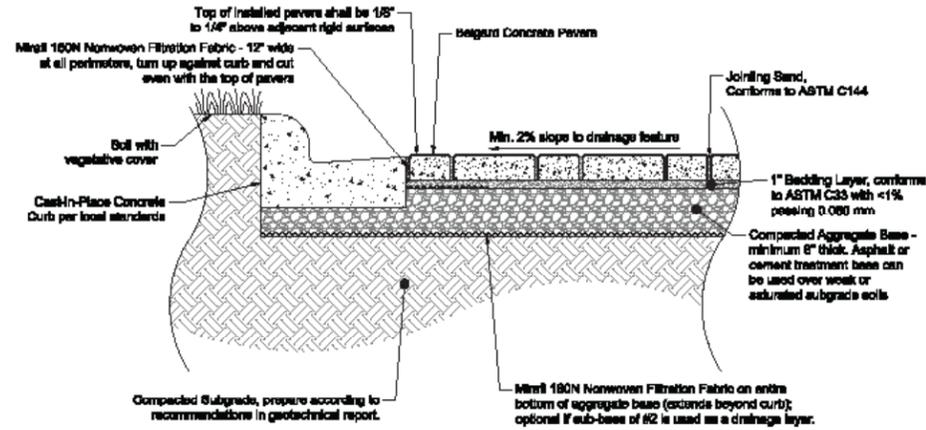


Figure 2. Sand Set on Concrete F

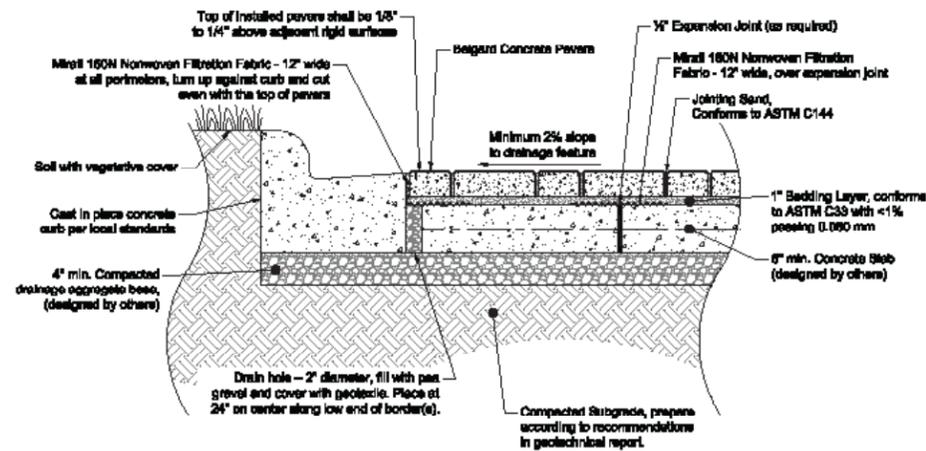
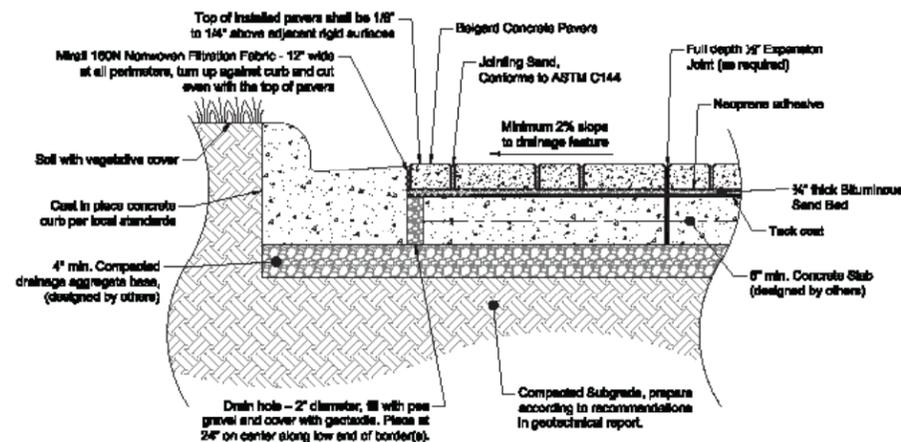


Figure 3. Bituminous Set on Concrete



ICP ACCEPTANCE & CONSTRUCTION TOLERANCES

ICP systems should be inspected upon completion of construction and should, at a minimum, meet the criteria in the chart below prior to owner acceptance of the system. Any aspects of the pavement that do not meet the criteria should be corrected to be within the given tolerances.

SETTING BED MATERIALS	ATTRIBUTE	CONSTRUCTION TOLERANCES
Sand setting beds for concrete pavers and paving slabs	Joint width between adjacent units	1/8 in. (2 mm) to 3/16 in. (5 mm)
Bituminous setting beds for concrete pavers and paving slabs	Joint width between adjacent units	1/8 in. (2 mm) to 3/16 in. (5 mm)
Mortar setting beds for concrete pavers and paving slabs	Joint width between paving units with no chamfers	Maximum 3/8 in. (10 mm) – Joints between individual paver units shall be mortared flush with adjacent pavers.
Mortar setting beds for concrete pavers and paving slabs	Joint width between paving units with chamfers	Maximum 3/8 in. (10 mm) – The surface of the mortared joint meets the bottom of the chamfers between adjacent pavers.

ALL SETTING BED MATERIALS	
ATTRIBUTE	CONSTRUCTION PLACEMENT & SURFACE TOLERANCES
Joint fill depth	Maximum depth of 1/4 in. (7.5 mm) measured from the bottom of the chamfer or the top surface of paver if there is no chamfer
Joint or bond lines	Maximum ±1/2 in. (15 mm) horizontal deviation from either side of a 50 ft (15 m) string line pulled over a joint or bond line
Slope for drainage	Minimum 2%
Surface smoothness	Maximum 1/8 in. (3 mm) lippage Variation in height between adjacent units
Surface flatness	±3/8 in. (10 mm) over 10 feet (3 m), noncumulative
Cut Pavers	No less than 1/2 for vehicular application No less than 3/8 in. (10 mm) for all other applications

Figure 4. Joint width measurement: inside edge to inside edge of adjacent paver

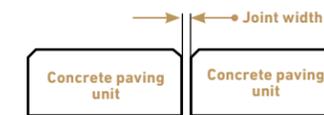


Figure 5. Lippage measured from top of paver to top of adjacent paver

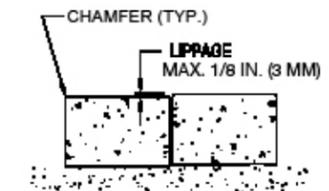
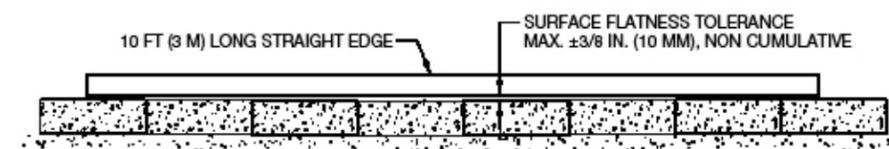


Figure 6. Paver surface flatness measured with a straight edge



ANNUAL MAINTENANCE GUIDELINES

Annual maintenance shall include the following activities:

- ✓ Inspect vegetation and sediment and erosion control measures around the ICP perimeter. Repair sediment and erosion control measures and re-plant vegetation as needed.
- ✓ Inspect and replenish paver joints with additional jointing sand if level is more than ¼ in. below chamfer bottoms.
- ✓ Inspect and repair all paver surface deformations (depressions/ settlement) exceeding 1/2 in.
- ✓ Repair paver heights offset by more than 1/4 in. above or below adjacent structures or edge restraints or offset by more than 1/8 in. lippage from paver-to-paver.
- ✓ Replace cracked paver units impairing surface structural integrity. *
- ✓ Check edge restraints and all perimeter paver abutments for settled or low pavers, remove pavers and add sand to bring pavers to proper elevation. Repair/replace edge restraint as required.
- ✓ Clean surface annually (typically spring) to remove debris, encrusted sediment, leaves, grass clippings, etc. Leaf blowers or other standard onsite manual methods that are used for standard pavement maintenance may be employed to remove this surface debris.
- ✓ For difficult stain removal, utilize a professional contractor experienced with cleaning compounds and applicators including high pressure sprayers (between 1,000 and 4,000 psi). Efflorescence removal can be accomplished with low pressure pump sprays (30 to 100 psi).

* For commercial applications including roadways and parking lots it is recommended that a careful assessment of conditions be made BEFORE replacement of cracked or damaged pavers. Review ASTM E2840 Standard Practice for Pavement Condition Index Surveys for Interlocking Concrete Roads and Parking Lots for guidelines for assessing pavement repair needs.

STRUCTURAL REPAIRS

Interlocking concrete pavements may require structural repairs during the life of the pavement to correct pavement distresses and to maintain an acceptable level of service. The most common distresses that affect the structural performance of ICP include damaged pavers and depressions and rutting. A more comprehensive list of distresses can be found in ASTM E2840 Standard Practice for Pavement Condition Index Surveys for Interlocking Concrete Roads and Parking Lots. For large commercial projects (> 100,000sf), Belgard recommends calculating a Pavement Condition Index (PCI) in accordance with ASTM E2840 once every five years to identify areas of distress and to establish a maintenance schedule to assist the Owner in prioritizing maintenance needs and to establish a more accurate long-term maintenance budget.

Damaged Pavers

Damaged pavers include distresses such as cracking, chipping, or spalling. The severity of the distress can vary and will determine what remedial action, if any, is required.

DAMAGED PAVER SEVERITY LEVELS	
Low	One or two cracks with no separation, chips, or spalls in the pavers.
Medium	Advanced cracking with no separation, spalling, or chipping in the pavers but pavers are not disintegrated
High	Pavers are cracked into multiple pieces or are disintegrated from cracks, chips, and/or spalls.

Damaged pavers that are determined to be Low Severity should remain in place unless the frequency of breakage is greater than 1.0% of the surface area of the pavement. If this occurs, additional material testing and site investigation is recommended to determine the cause of the breakage. Damaged pavers determined to be in the Medium and High Severity Levels shall be removed and replaced as described below.

Place the new replacement pavers to match the existing laying pattern. Compact the paver as described above. If the newly reinstalled paver is not flush to plus ⅛-inch with the surrounding pavers following compaction, it should be removed, and the thickness of the bedding layer should be modified to result in a flush to plus ⅛-inch surface following paver replacement and compaction. Once the desired grades are accomplished, sweep jointing sand or polymeric sand into the joints and compact into place; repeat until the joints are full.

Depressions & Ruts

Depressions are areas of the pavement that have settled within the base or subgrade and are typically not load related. Depressions can occur near the edge restraints, utility structures and penetrations, and at utility crossings. Ruts are depressions in the wheel paths of the pavement generally caused by repeated traffic loading and can occur in the base and/or subgrade.

DEPRESSIONS & RUTTING SEVERITY LEVELS	
Low	¼ to ½ in. depth using a straight edge
Medium	½ to 1 in. depth using a straight edge
High	> 1 in. depth using a straight edge

For both depressions and ruts, the maximum depth determines the severity. Depressions and ruts of low severity shall typically remain in place but should be monitored during annual inspections for increased severity. Depressions and ruts with medium severity shall be evaluated by the engineer of record to determine if repair is necessary, and those with high severity shall be corrected.

Corrective action for depressions and ruts shall be discussed with the engineer of record and the installing contractor to determine the extent of repairs that are needed. The pavement shall be reinstated using the same procedure outlined in the 'Utility Repairs' section of this document.

Structural repairs or replacement of concrete pavers or slabs installed with a bituminous setting bed or a mortar setting bed should be performed only by an experienced professional Contractor.



UTILITY REPAIRS

An advantage of unit concrete pavers is that they can be removed and reinstated for access to underground utilities. This important advantage allows the pavement surface to be utilized immediately after repairs are made.

Should utility repairs be required below the ICP surface, the pavers can be removed by hand, or with the use of specialty equipment like a paver extractor, without the use of saw cutting equipment or pneumatic jack hammers. Once the first paver is removed, it is relatively easy to remove the remaining pavers beyond the extent of excavation and set the pavers aside for future reinstatement. Undisturbed pavers can be secured with a wood or metal frame as shown in Figure 7.

The bedding material (typically a course sand) should be removed and disposed of, then replaced with new washed coarse sand. The aggregate base and any subbase (if used) can be removed and stored separately for reinstatement.

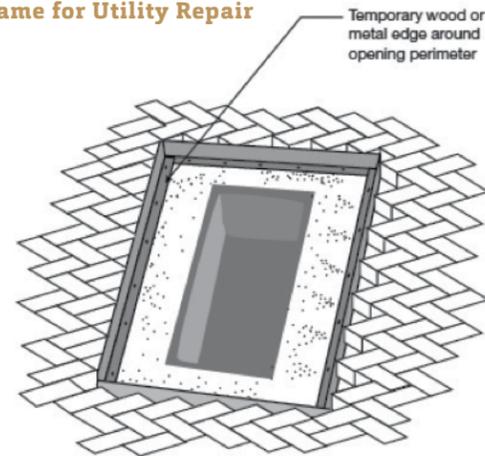
Where repairs require excavation into the underlying subgrade soil, Belgard recommends using flowable concrete fill (200 to 500 psi) to support the repaired utility. Dense graded base cannot adequately flow under pipes or boxes, nor can it be compacted in these places. A minimum 4 in. layer of flowable concrete fill should be used to cover a pipe or box structure.

When reinstating the aggregates, place and compact the base aggregate in 4 in. lifts; the thinner lift thickness is to accommodate the smaller sized compactor that will likely be used due to access limitations in the excavation.

When reinstating the pavers, install the pavers slightly higher than the adjacent pavers to account for settlement of the underlying materials (based on depth of excavation). In either scenario, the bedding layer should be 1/8 in. higher so that once the pavers are reinstalled and compacted, they should be the same elevation as the adjacent units. Once the desired grades are accomplished, sweep jointing material into the joints and vibrate into place; repeat until the joints are full.

Additional information regarding ICP repair is available from the Interlocking Concrete Pavement Institute (ICPI) Tech Spec 6, Reinstatement of Interlocking Concrete Pavements.

Figure 7.
Paver Frame for Utility Repair



CLEANING PAVERS AND SLABS

Concrete pavers and slabs are produced with pigments integrally mixed within the concrete at the time of production. Over time, dirt, wear, food and oil stains will affect the appearance of the paver surface. Pavers that are installed properly with a 2% pitch will drain quickly and carry most surface sediment to the edge of pavement or to storm drain inlets. Stains should be addressed quickly by using a cleaner & brush appropriate for the type of stain and hosed to the nearest drain inlet. This process will serve most paver surfaces and will not require additional attention beyond the use of leaf blowers to remove grass clippings, leaves and other surface clutter. Stains that cannot be removed with common cleaning agents, may require use of paver cleaners as provided by Techniseal using brushes and low flow water to rinse the cleaning material from the paver surface. High pressure sprayers are typically used by professional contractors experienced with paver cleaning and joint sand replacement.

Paver surfaces may be enhanced or protected from food and oil stains by applying a paver sealer after use of a cleaner. Sealers should be applied after one year of service to allow for any potential efflorescence to dissipate from your pavement system.

Efflorescence (calcium carbonate) is a white powder-like deposit which can appear on any concrete product. Efflorescence does not affect the structural performance or durability of concrete pavers and can appear within months of installation and may wear away. If there is a need to remove these deposits, best results can be obtained by using Techniseal efflorescence cleaner. More guidance is available from www.techniseal.com or your local Belgard representative.

Additional information regarding surface cleaning is available from ICPI Tech Spec 5 Cleaning, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement.



Techniseal® Products

The leading manufacturer of paver care products in the landscape industry, Techniseal is proud to offer the most reliable cleaners, stain removers and protective sealers in the business.

www.techniseal.com

WINTER MAINTENANCE

Standard snow removal equipment used for impervious pavements may be used on Belgard ICP systems without damaging the surface. It is not necessary to utilize rubber tips or shoes on snowplow blades because the chamfered edges on the pavers prevent chipping. However, steel blades may scratch or abrade the paver surface, particularly if the paver is textured, leaving behind steel particles that may rust and stain the paver surface.

When using a snowplow or snowplow box, the utilization of rubber or plastic snow blades with properly adjusted skis/guides will prevent unwanted rust or scrape marks on the paver surface. When using a snowblower, ensure the guides are properly adjusted to keep the rotating impeller from scraping and damaging the paver surface. Note: These same practices will prevent unwanted rust, scrape marks and winter sediment on the surface of asphalt and concrete pavements.

Deicing Chemicals

When needed, use sodium chloride (rock salt). If air temperatures fall below 14 degrees Fahrenheit, calcium chloride may be used in moderation. Excess deicing chemicals should be removed immediately. Any deicing chemical should be used sparingly and in accordance with the manufacturer's application instructions. Never use magnesium chloride or materials containing ammonium nitrate and ammonium sulfate.

Snow & Ice Melt Systems

There are electric and liquid glycol melting systems that can be installed beneath a Belgard pavement system that will reduce or eliminate the need for snow and ice removal. When considering the use of these systems, it is imperative that you review the melting system manufacturer's installation and operating recommendations, as well as consulting with your local Belgard representative or a professional engineer to verify compatibility and proper design. It is important to follow the maintenance requirements provided by the snow melt equipment supplier to ensure the long-term functionality of the system.

Additional information regarding snow and ice melt systems is available from ICPI Tech Spec 12, Snow Melting Systems for Interlocking Concrete Pavements.



RESOURCES

The following resources address ICP design and maintenance and may provide additional guidance:

- ICPI Tech Spec 2 Construction of Interlocking Concrete Pavements
- ICPI Tech Spec 4 Structural Design of Interlocking Concrete Pavement for Roads and Parking Lots
- ICPI Tech Spec 5 Cleaning, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement
- Interlocking Concrete Pavement Institute (ICPI) Tech Spec 6, Reinstatement of Interlocking Concrete Pavements
- ICPI Tech Spec 12 Snow Melting Systems for Interlocking Concrete Pavements.
- ASCE 58-16 Structural Design of Interlocking Concrete Pavements for Municipal Streets and Roadways
- ASTM E2840 Standard Practice for Pavement Condition Index Surveys for Interlocking Concrete Roads and Parking Lots

Go to [BelgardCommercial.com](https://www.belgardcommercial.com) to download ICP resources including:

- Guide specifications
- Typical details
- Case Studies
- Product Description Sheets (cut sheets)
- Color options
- Installation guidelines
- Inspection & Maintenance checklists

Belgard Commercial offers design support services for commercial paver projects. Design professionals that need assistance or technical input regarding ICP can obtain the following at no cost:

- Project-specific details
- Project-specific specifications
- Concept plan review for alternative paver designs
- Cost analysis comparing paver systems to conventional impervious pavement systems
- Life-cycle cost analysis comparisons

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