TECH NOTE
PAV-TEC-003-22

CONCRETE MASONRY &
HARDSCAPES ASSOCIATION

Provided By:

EDGE RESTRAINTS FOR INTERLOCKING CONCRETE PAVEMENTS

INTRODUCTION

Edge restraints are an essential component of interlocking concrete pavements. Restraints hold the pavers tightly together, enabling consistent interlock of the units across the entire pavement. They prevent spreading of the pavers from horizontal forces from traffic. Edge restraints are designed to remain stationary while receiving impacts during installation, from vehicles and from freeze-thaw cycles.

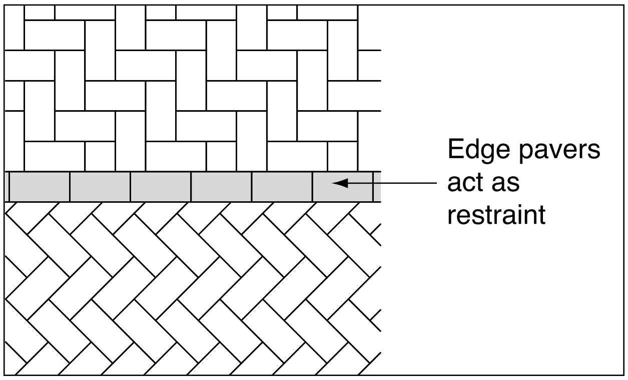

Figure 1. Change in laying pattern direction.

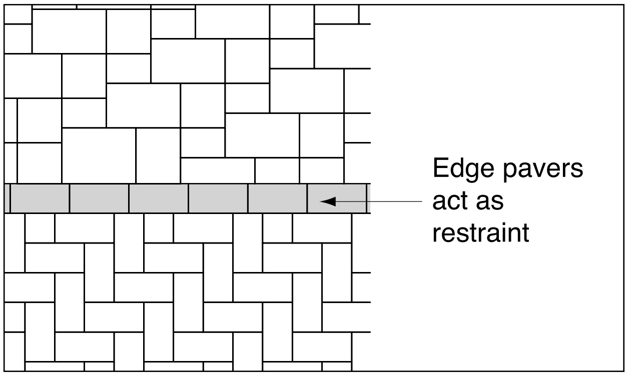

Figure 2. Change in paver shape.

The following is a discussion of methods of restraining concrete pavers placed on bedding sand and installed on a flexible or rigid base. Edge restraint options for permeable interlocking concrete pavements (PICP) are discussed in *Tech Note PAV-TEC-018-22–Construction of Permeable Interlocking Concrete Pavement*.

DESIGN CONSIDERATIONS

Restraints are required along the perimeter of interlocking concrete pavements or where there is a change in the pavement material. For example, when a laying pattern changes direction, there may be a need for an edge paver to act as a restraint (Figure 1). When a paver shape changes within an area of paver, the edge paver at the end of each pattern can serve as a restraint (Figure 2). Vertical walls of buildings can also provide a suitable restraint.

Some edge restraints require spiking to a flexible aggregate base. The rule of thumb is the base should extend beyond the restraint at least the same dimension as the thickness of the base material. For example, a 6 in. (150 mm) thick base should extend at least 6 in. (150 mm) beyond the spikes in the restraints. This contributes stability to the restraint especially in soils subject to heaving. Soil backfill is never a suitable edge restraint and edge restraints should never be installed on top of the bedding sand.

When installing an edge restraint on an existing rigid concrete base there are two methods typically used: direct fastened, or drilled and anchored. In a direct fastened system an explosive charge is used to drive the fastener into the solid concrete base. When using the drill and anchor method, holes must be drilled through the edge restraint (unless pre-drilled) and into the concrete to a sufficient depth. There are several "anchor" manufacturers and types available:

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	Poured Concrete and Walls	Precast Concrete and Cut Stone	Plastic, Aluminum or Steel	Submerged Concrete
Sidewalks—no vehicular traffic	✓	✓	✓	✓[1]
Plazas—no vehicular traffic	✓	✓	✓	✓[1]
Residential driveways	✓	✓	✓	✓[1]
Commercial/Industrial driveways	✓	✓	✓[2]	
Parking lots	✓	✓	✓[2]	
Crosswalks in asphalt or concrete streets	✓	✓		
Streets—all types	✓	✓		
Utility covers	✓	✓		
Gas stations	✓	✓		
Industrial flooring	✓			
Trucking terminals	✓			

[1]not appropriate for areas with freeze thaw cycles
[2]only products designed for heavy duty applications

Table 1. Application guide for edge restraints

1. Wedge Anchors,
2. Strike Anchors,
3. Drop-in Anchors,
4. Expansion Anchors.

When using direct fastened or drill and anchor system, it is important to consider several factors. When selecting materials consider the potential for galvanic corrosion created by using different metals. It may also be necessary to use a washer to prevent the fastener or anchor from pulling through the preformed hole in the edge restraint. Consult the fastener/anchor product information to ensure that you are utilizing the right charge and fastener/anchor for the application. Also consider the loads on the edge restraint when determining the spacing between each fastener/anchor. Also ensure that the proper Personal Protective equipment is utilized.

If there is a possibility of sand loss from beneath the pavers or between or under the joints of the edge restraints, geotextile is recommended to prevent its migration. A 12 in. (0.3 m) wide strip can be applied along the base and turned up along the sides of the restraints. Geotextile generally is not required across the entire surface of an aggregate base, nor should it be placed on top of the bedding sand.

TYPES OF EDGE RESTRAINTS

Table 1 shows the types of edge restraints and their application. There are two general types of edge restraints. Those made elsewhere and installed at the site include precast concrete, plastic, cut stone, aluminum and steel. Restraints formed onsite are made of poured in place concrete. Regardless of the material the edge restraint is made of, it should have a smooth vertical surface that will allow the side of the pavers to be in full contact with it.

MANUFACTURED EDGE RESTRAINTS

Full depth precast concrete or cut stone edging generally extends the depth of the base material. They can be set on compacted aggregate or concrete backfill (Figure 3).

Partial depth precast concrete edge restraints may be used for residential and light duty commercial applications. (Figure 4). These precast units are anchored on a compacted aggregate base with steel spikes. The spikes are typically 3/8 in. (10 mm) diameter. Depending on the design, the top of the concrete edge can be hidden or exposed.

Plastic edging installs quickly and will not rust or rot. Plastic edging should be specifically designed for use with pavers. It can be used with light duty residential and commercial applications, depending on the design. It should be firmly anchored into the compacted aggregate base course with spikes (See Figure 6). The spikes should penetrate well into the aggregate base. Spikes do not need to penetrate the bottom of the base. Consult the manufacturer's literature for the recommended size and spacing of the spikes.

Aluminum and steel edging should be selected to provide a smooth vertical surface against the pavers. L-shaped edging provides additional stability. Stakes or spikes fastened to the edging should be below the pavers or on the outside of the restraints. Steel should be painted or galvanized so that rust does not stain the pavers. Consult manufacturer's literature for recommended spacing of the spikes. Spikes to secure aluminum edging should extend well into the base course

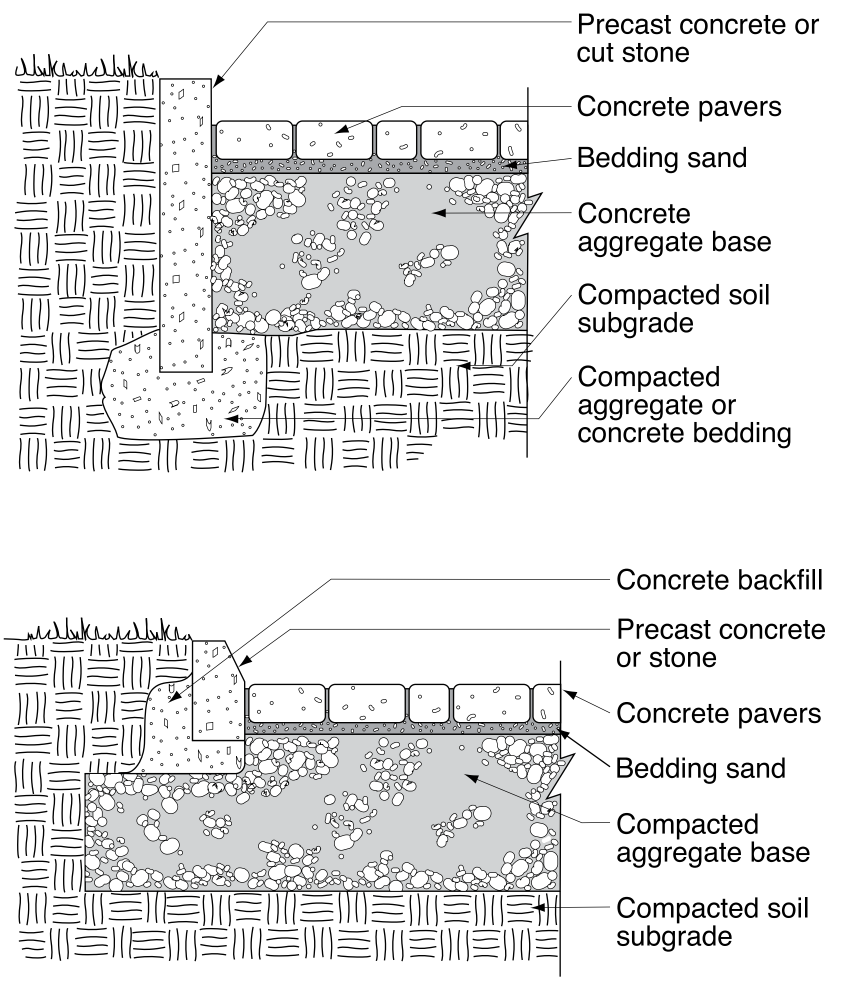

Figure 3. Precast concrete/cut stone.

(Figure 5) or secured to the rigid base. Like plastic edging, spikes used for aluminum edging should never be placed into the soil. Aluminum and steel edgings are manufactured in different thicknesses. The thickest edging is recommended when pavers are subjected to vehicular traffic.

Plastic or aluminum edge restraints can be used for flexible or rigid bases. Steel edge restraints should only be used on rigid bases. Do not use steel on flexible bases. Flat metal or plastic landscape edging used around plantings and flower beds is not an acceptable restraint for interlocking concrete pavements.. They do not provide enough lateral support to hold the pavers tightly together and maintain interlock.

Timber is not recommended for an edge restraint because it warps and eventually rots.

Elevations should be set accurately for restraints that rest on the base. For example, $2^3/_8$ in. (60 mm) thick pavers with 1 in. (25 mm) of bedding sand would have a base elevation set 3 in. (75 mm) below that of the finish elevation of the pavers. This allows $^1/_4$ in. (6 mm) settlement from compaction and $^1/_8$ in. (3 mm) for minor settling over time. A minimum of 1 in. (25 mm) vertical restraining surface should be in contact with the side of the paver to adequately restrain it. For heavy duty application a greater restraining surface may be warranted.

RESTRAINTS FORMED ONSITE

Poured in place concrete curbs or combination curb and gutters required by municipalities make suitable restraints for pavers. Exposed concrete edges should have a $^1/_4$ in. to $^3/_8$ (3 to 10 mm) radius edge to reduce the likelihood of chipping. As with precast, the side of the curbs should extend well below the sand bedding course (Figure 7). Complete compaction of the soil subgrade and base next to these curbs is essential to preventing settlement of the pavers.

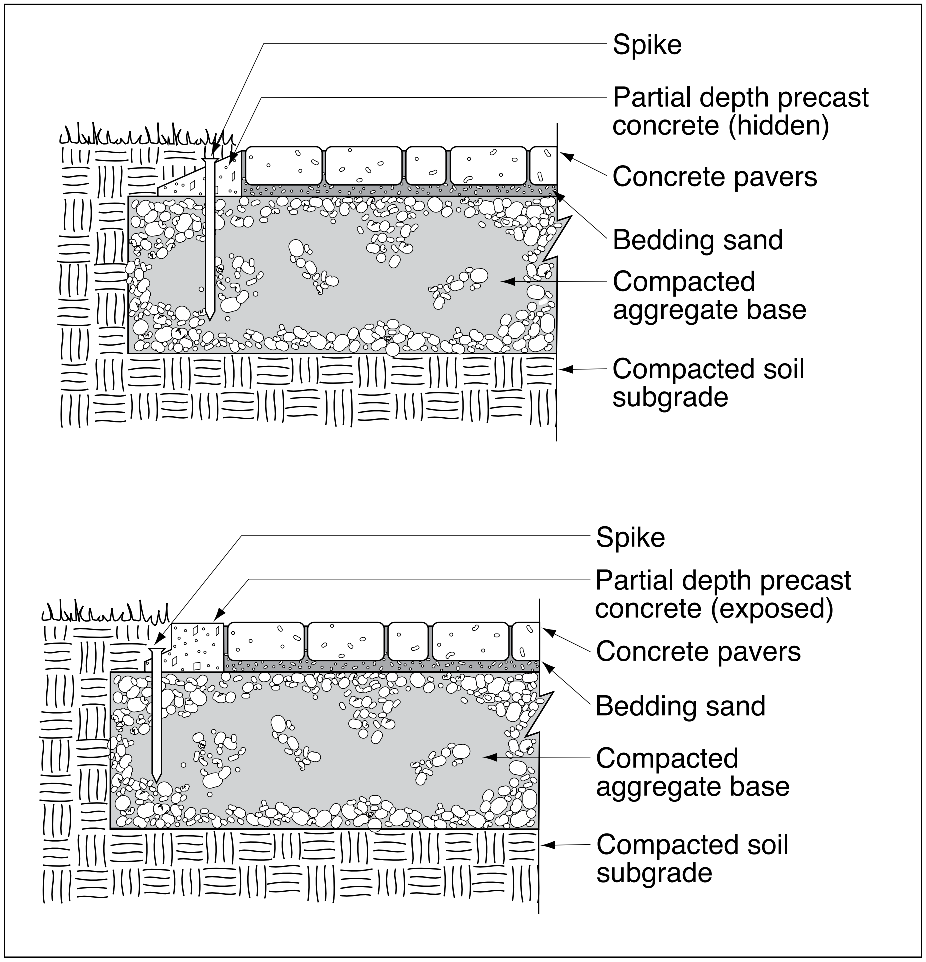

Figure 4. Partial depth precast concrete edge.

A concrete curb or edge that is "submerged" or hidden can be used to restrain concrete pavers. See Figure 8. The top surface of the concrete edge has pavers mortared to it. Acrylic fortified mortar is recommended and pavers exposed to freeze-thaw and deicing salts should be applied with high-strength epoxy mortar materials. The minimum cross section dimensions of the curb should be 8 in. x 8 in. (200 mm x 200 mm). These dimensions apply to residential driveways and low volume streets. Larger sized curbs will be required in higher traffic areas or for support over weak soil. The concrete edge may require a layer of compacted aggregate base as a foundation. The width of concrete will need to be equal to the width of whole pavers mortared to it. This detail should not be used in heavy traffic areas such as major urban streets with regular truck or bus traffic.

In areas where the ground does not freeze, it may be possible to use a troweled reinforced concrete edge restraint. This type of edge restraint may be used for applications where loading is limited to pedestrian and light residential driveways. Accelerating, braking and turning vehicles may exceed the capacity of this type of edge restraint. Troweled reinforced concrete edge restraints should be constructed directly on the compacted base aggregate at least 4 in. (100 mm) wide and of sufficient thickness to cover at least two-thirds of the side of the edge pavers and bedding sand. Steel reinforcing must be placed in the concrete to increase service life.

OTHER DESIGN CONSIDERATIONS

Paver sidewalks against curbs—Joints throughout poured in place or precast concrete curbs should allow excess water to drain through joints in them without loss of bedding sand. If there are no joints, weep holes placed at regular intervals will prevent the sand from migrating. A 1 in. (25 mm) diameter hole every 15 ft. (5m) is a recommended spacing. The bottom of the holes should be at the same elevation as the top of the base. They should be covered with filter cloth to prevent loss of bedding sand.

Joints in curbs often have expansion material in them. This material tends to shrink and decompose. Filter cloth placed over these joints will prevent the sand from migrating. Expansion joint materials are not required between the pavers and the curb.

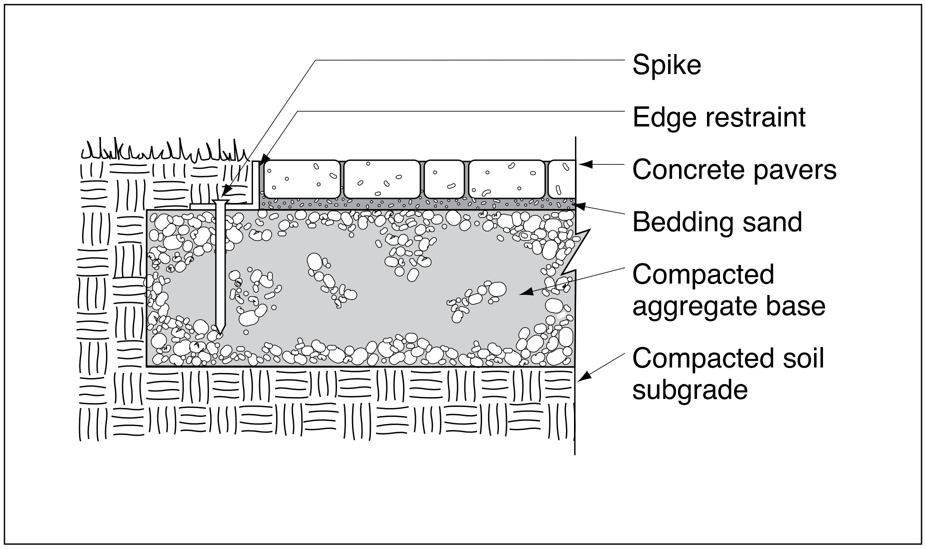

Figure 5. Aluminum edging.

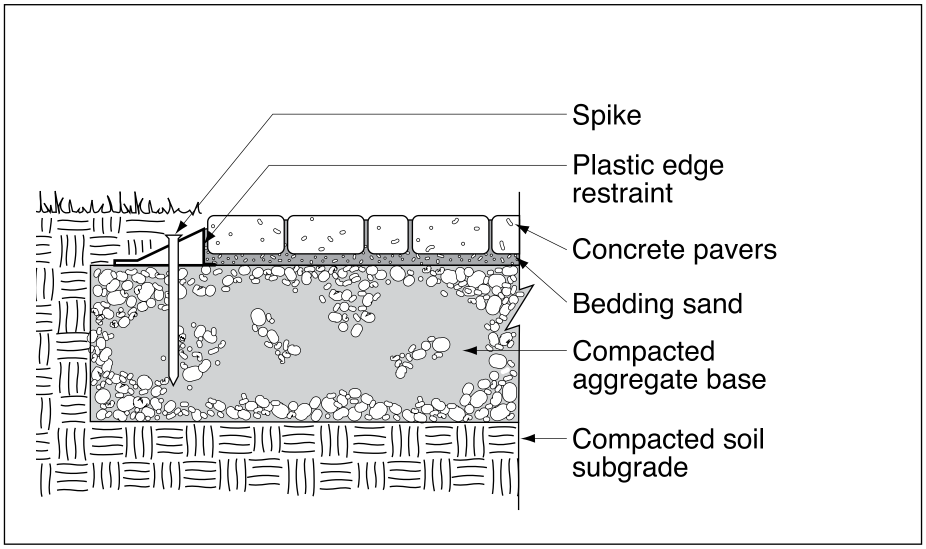

Figure 6. Plastic edge restraint.

Utility covers in streets and walks (e.g., sewers, water and gas valves, telephone, electrical,) should have concrete collars around them. Consistent compaction of aggregate base against cast iron collars is difficult, so a concrete collar placed around them after base compaction reduces the potential for settlement. Concrete collars should be $^{1}/_{4}$ in. (6 mm) below the pavers to prevent catching snowplow blades (Figure 10). Drain and catch basin inlets should have a concrete collar around them if they are not encased in concrete.

When overlaying existing asphalt or concrete streets with pavers and bedding sand, utility covers are raised and new concrete collars poured around them. When raised, the covers and frames should be inspected for cracks that might allow migration of sand. Cracks should be repaired. Filter cloth should be applied on the base around the concrete collar, turned up against the collar to prevent sand loss.

Catch basins—During the early life of interlocking concrete pavement, there may be a need to drain excess water from the bedding sand. Drain holes may be drilled or cast into the sides of catch basins to facilitate this. The bottom of the holes are at the same elevation as the bottom of the base. Space holes at least 12 in. (0.3 m) apart, and make 1 in. (25 mm) in diameter. The holes should be covered with filter cloth to prevent loss of bedding sand. This drainage detail can prevent pumping and loss of bedding sand around the catch basin.

Crosswalks—Pavers in a crosswalk or abutting another pavement can be placed against a concrete beam (Figure 10),

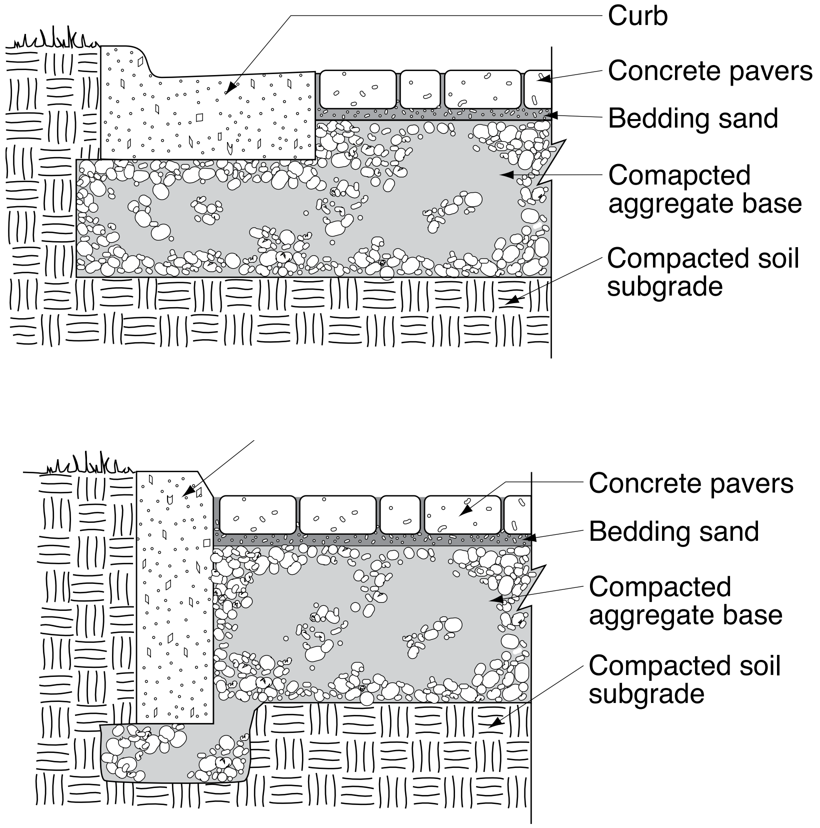

Figure 7. Poured in place concrete curbs.

or a beam and slab base combination for pavements subject to heavy vehicular traffic (Figure 11). The beam prevents horizontal creep of the pavers due to braking and turning tires. Figure 12 shows a light duty crosswalk appropriate for residential streets with minimal truck traffic. Refer to *Tech Note PAV-TEC-019–Crosswalk Construction Using Interlocking Concrete Pavers* for further details.

Gutters and drainage channels made with pavers should be embedded in fortified mortar, a bitumen-neoprene bed, or polymer adhesive. The mortar mix should resist degradation from freeze-thaw and salt. Care must be taken in applying the mortar as it can stain the pavers.

Sand is not recommended in joints subject to channelized water flow. The sand will eventually wash out of the paver joints and weaken the pavement. Cement can be dry mixed with joint sand (3% to 4% by weight) to reduce washout in areas subject to channelized drainage or from water draining from roof eaves without gutters. Care must be taken to not let the cement stain the pavers when placing the sand and cement into the joints. A more effective method is use of joint sand stabilization materials. Stabilizers are recommended to reduce risk of wash out on steep slopes. See *CMHA Tech Note PAV-TEC-005—Cleaning, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement* for more information.

Elevations—When edge restraints are installed before placing the bedding sand and pavers, the restraints are sometimes used to control thickness when screeding the bedding sand. Elevations for screeding should be set from the restraints after their elevations have been verified.

Attention should be given to the elevation of the pavers next to the restraints. Sand-set pavers may require a finish elevation of 1/4 in. (6 mm) above the top of the restraint. This allows for minor settlement of the pavers and surface drainage. Bitumen-set, mortared or adhesive-set pavers should be at least 1/8 in. (3 mm) above adjacent curbs or other edge restraints.

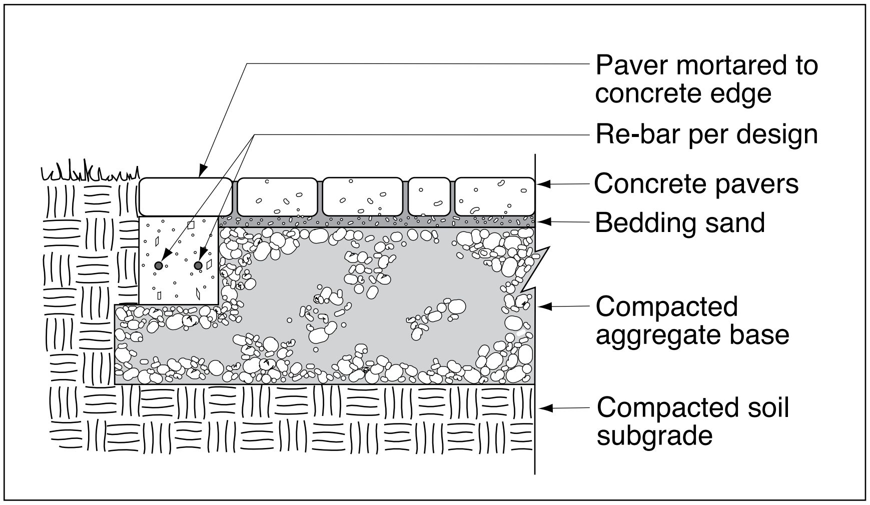

Figure 8. Submerged concrete edge.

Construction tips—Some restraints allow the pavers and bedding sand to be installed prior to placing the edge materials. The field of pavers is extended past the planned edge location. The pavers are marked with a chalk line, or by using the edge material itself as large ruler for marking (Figure 14). The marked pavers are then cut with a powered saw or mechanical splitter. The unused ends and excess bedding sand are removed up to the cut pavers, and the edge restraints installed. This technique is particularly useful for creating curved edges.

When the gap between the pavers and the restraint exceeds $^3/8$ in. (10 mm), the space should be filled with cut pavers. Gaps up to $^3/8$ inch (10mm) should be filled with the coarsest sand or aggregate available that will fit. Cut pavers exposed to vehicular traffic should be no smaller than one-third of the whole paver. The paving pattern may require shifting to accommodate cut pavers. Stability of cut edge pavers exposed to tire traffic is increased when a running course (string or sailor) of whole pavers is placed between the edge restraint or concrete collar and the cut edge pavers. Pavers are cut to fit against this edge course (see Figures 9 and 10). Other shapes include edge pavers that make a straight, flush edge. This detail can reduce incidental chipping of the cut pavers.

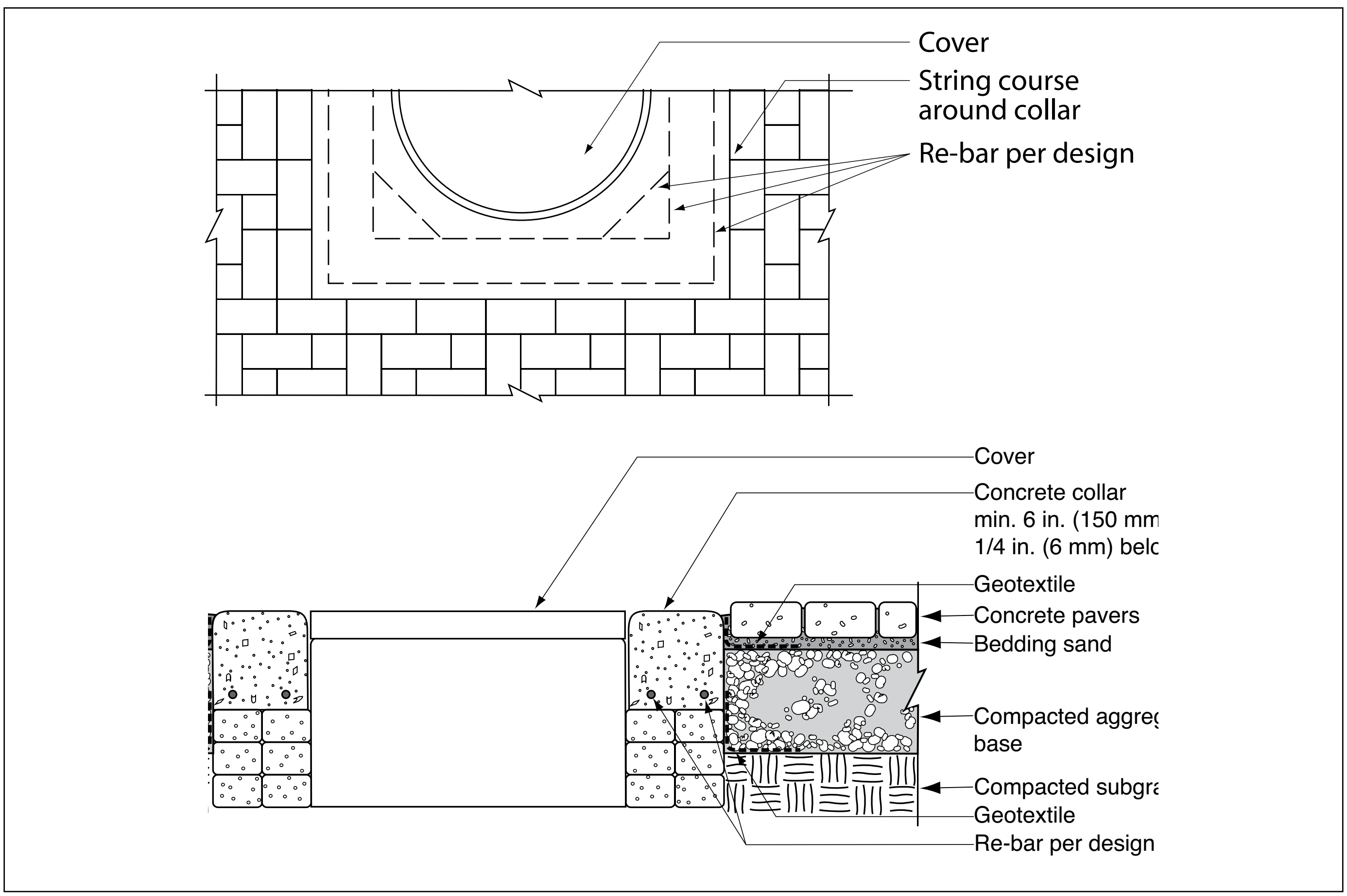

Figure 9. Utility cover.

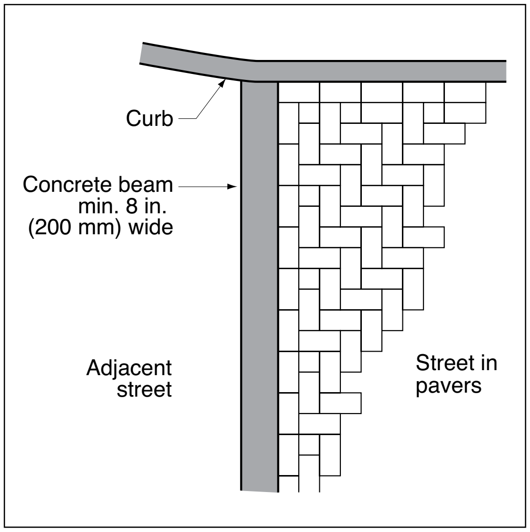

Figure 10. Concrete beam.

In some situations, site fixtures can be installed after the pavers are placed and vibrated and the joints filled with sand. Openings can be saw cut, the edge restraints placed, and the tree grates, bollards, or other fixtures installed.

MAINTENANCE OF INTERLOCKING CONCRETE PAVEMENT

Occasionally interlocking concrete pavements will require maintenance for them to deliver peak performance. Refer to *Tech Note PAV-TEC-006–Operation and Maintenance Guide for Interlocking Concrete Pavement* for information on preventative maintenance, identifying and remedying aesthetic and structural distresses and best practices for the disassembly and reinstatement of interlocking concrete pavement.

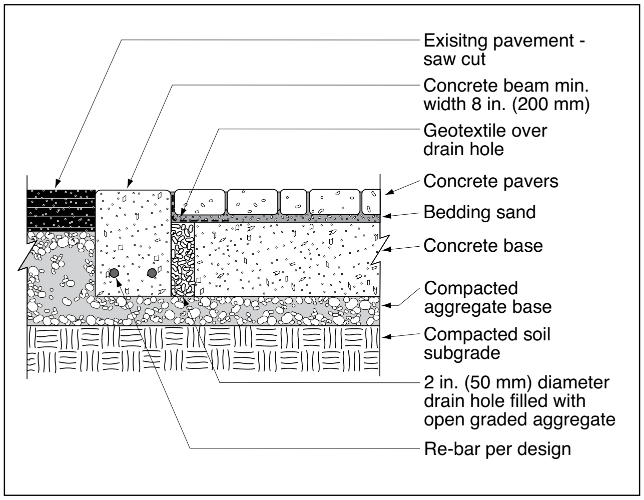

Figure 11. Crosswalk with concrete base.

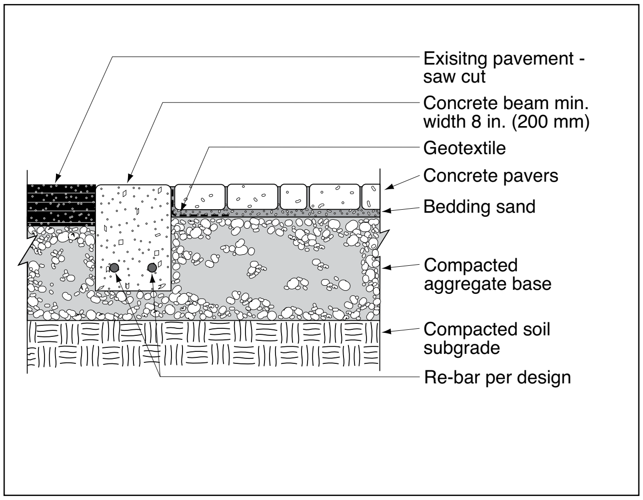

Figure 12. Crosswalk in existing asphalt pavement.

Figure 13. Marking pavers for saw cutting. The cut pavers are carefully removed and edging is placed against the pavers.

REFERENCES

1. Refer to the latest published ASTM and CSA standards and CMHA Tech Notes.
2. ASTM–American Society for Testing and Materials International, Conshocken, PA. www.astm.org
3. CSA–Canadian Standards Association, Rexdale, ON. www.csagroup.org
4. CMHA– Concrete Masonry and Hardscapes Association, Herndon VA. www.MasonryandHardscapes.org
5. ASCE 2016– American Society of Civil Engineers, *Structural Design of Interlocking Concrete Pavements for Municipal Streets and Roadways*. Reston, VA. www.ASCE.org
6. CSA–CAASHTO 2015–American Association of State Highway and Transportation Officials, *Standard Specification for Geotextile Specification for Highway Applications M288-15*, Washington, D.C., 2006

Figures 1, 6a, 7, 10, 12, 13 are courtesy of the Waterways Experiment Station, U.S. Army Corps of Engineers. Figure 5 is courtesy of the Portland Cement Association.

ABOUT CMHA

The Concrete Masonry & Hardscapes Association (CMHA) represents a unification of the Interlocking Concrete Pavement Institute (ICPI) and National Concrete Masonry Association (NCMA). CMHA is a trade association representing US and Canadian producers and suppliers in the concrete masonry and hardscape industry, as well as contractors of interlocking concrete pavement and segmental retaining walls. CMHA is the authority for segmental concrete products and systems, which are the best value and preferred choice for resilient pavement, structures, and living spaces. CMHA is dedicated to the advancement of these building systems through research, promotion, education, and the development of manufacturing guides, design codes and resources, testing standards, and construction practices.