ICPI INTERLOCKING CONCRETE PAVEMENT INSTITUTE®
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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 and from minor settlement. Edge restraints are designed to remain stationary while receiving occasional impacts from tires.

Restraints are required along the perimeter of interlocking concrete pavements, or where there is a change in the pavement material.

The following is a discussion of methods of restraining concrete pavers placed on bedding sand and installed on a base. This is the prevailing method of construction. Edge restraints are often needed for concrete pavers joined to a rigid base with mortar, bitumen/neoprene, or polymer adhesive.

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). If there is a change in slope, a straight edge should be formed at the top, with the pavers and the pattern resumed down the slope (Figure 3). Vertical walls of buildings can also provide a suitable restraint.

Some edge restraints require spiking to an aggregate base. The rule of thumb is that the base extend beyond the restraint at least the same dimension as the thickness of the base material. For example, if the base is 6 in. (150 mm) thick, then it should extend at

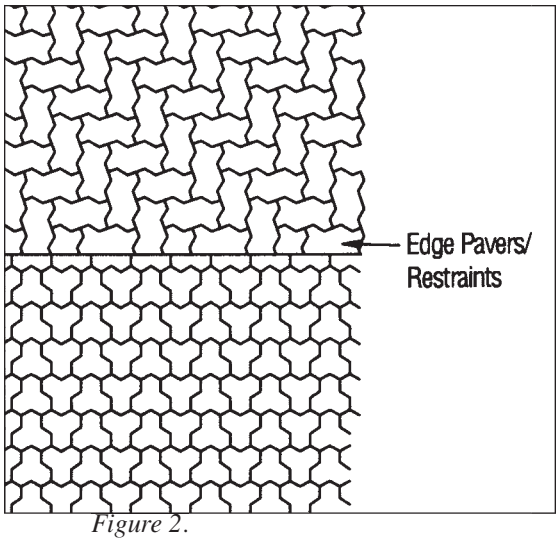


Figure 2.

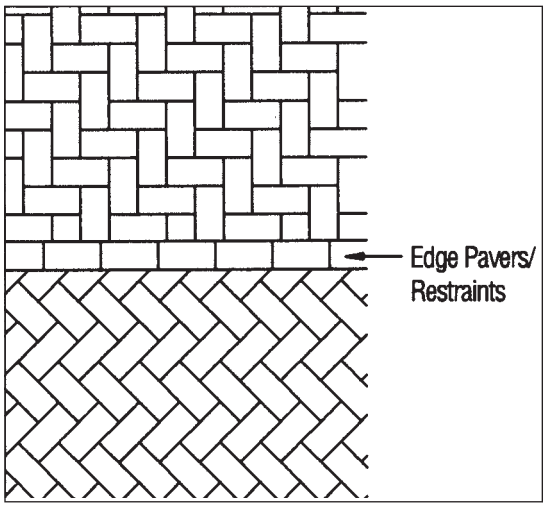


Figure 1. Change in laying pattern direction.

Figure 3. Ramp pavers changing angle.

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.

If there is a possibility of sand loss from beneath the pavers or between the joints of the edge restraints, geotextile (filter cloth) 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. Filter cloth generally is not required across the entire surface of an aggregate base, nor should it be placed on top of the bedding sand.

	Precast Concrete Cut Stone	Steel Aluminum Troweled Concrete	Plastic	Poured Concrete and Walls
Sidewalks-no vehicular traffic	•	•	•	•
Plazas—no vehicular traffic	•	•	•	•
Residential driveways	•	•	•	•
Crosswalks in asphalt or concrete streets	•	•	•	•
Commercial/Industrial driveways	•			•
Parking lots	•		•	•
Streets—all types	•			•
Utility covers	•			•
Gas stations	•			•
Industrial flooring				•
Trucking terminals				•

Table 1. Application guide for edge restraints

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 on-site are made of poured-in-place concrete.

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 4).

Partial depth precast concrete edge restraints may be used for residential and light duty commercial applications. (Figure 5). 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, commercial or on some heavy duty, industrial applications, depending on the design. It should be firmly anchored into the compacted aggregate base course with spikes (See Figure 7). The spikes should penetrate well into the aggregate base, but not through the bottom of the base. Consult the manufacturer's literature for the recommended spacing of the spikes. *Edging for planting beds and flower gardens is not an acceptable restraint for interlocking concrete pavements.*

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 steel and aluminum edging should extend well into the base course (Figure 6). Like plastic edging, spikes used for aluminum or steel 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.

Timber is not recommended for an edger 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. (7 mm) settlement from compaction and $^{1}/_{8}$ in. (3 mm) for minor settling over time.

Restraints Formed On-site

Poured-in-place concrete curbs or combination curb and gutters required by municipalities make suitable restraints for pavers. Exposed concrete edges should have a $^{1}/_{8}$ in. (3 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 8). Complete compaction of the soil subgrade and base next to these curbs is essential to preventing settlement of the pavers.

Troweled concrete from a bag mix or batched on-site can be applied without forms against edge pavers and on the compacted base. When mixed on-site the aggregate (sand and crushed stone)-cement

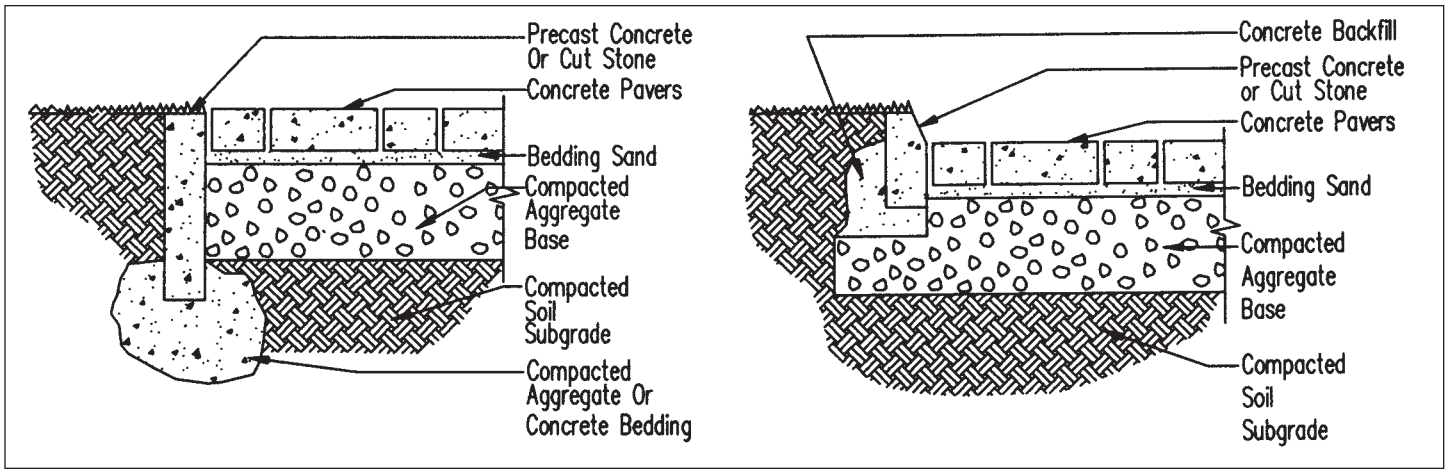


Figure 4. Precast concrete/cut stone.

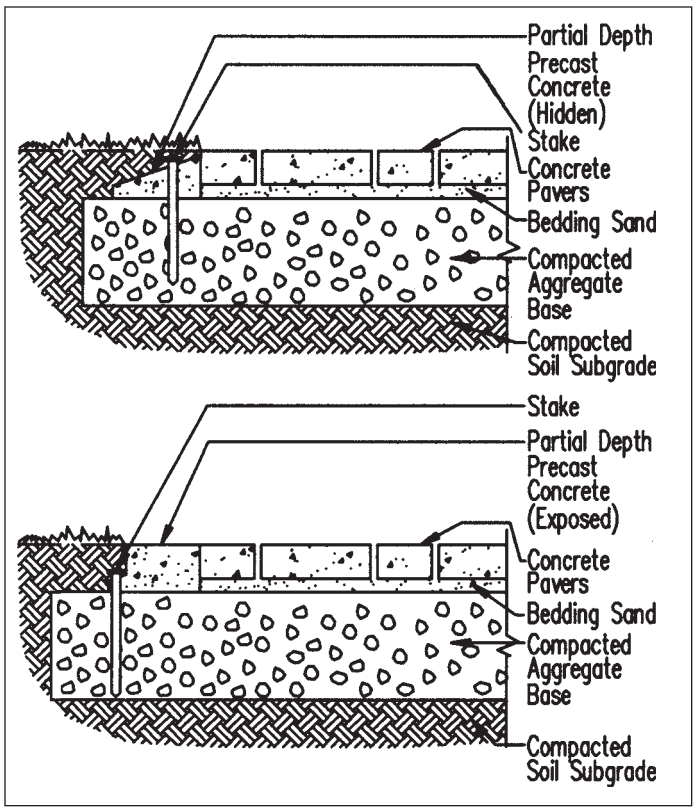


Figure 5. Partial depth precast concrete edge.

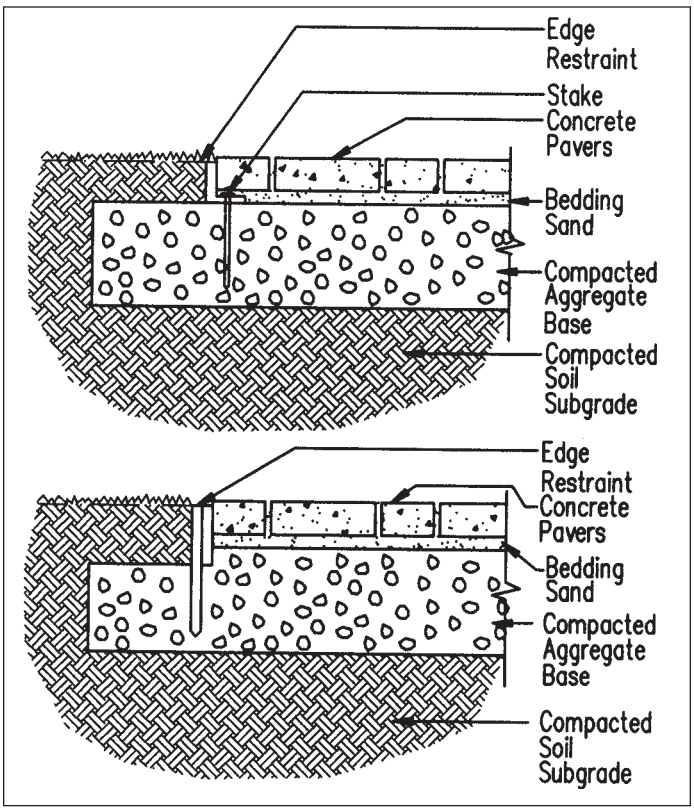


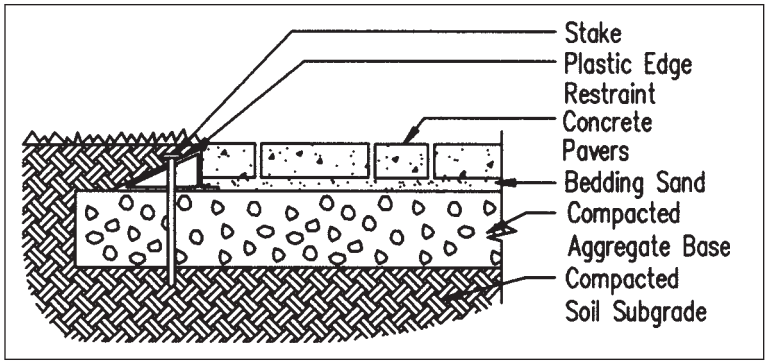
Figure 6. Aluminum and steel edging.

ratio should be at least 5 to 1. If the top of the concrete edge is recessed and slopes away from the pavers, grass can grow next to them (Figure 9). The depth below the surface of the pavers must be sufficient to prevent the concrete from becoming a heat sink that dries the grass and topsoil. This edge restraint is suitable for pavers subjected to pedestrian traffic and for residential driveways. Troweled edges should be at least 6 in. (150 mm) wide and of sufficient thickness to cover at least two-thirds of the side of the edge pavers, bedding sand layer, and a minimum of 2 in. (50 mm) into the base. Steel reinforcing can be placed in the concrete to increase service life.

Compacting units against troweled concrete should be done after the concrete has set. Care should be taken to ensure that the plate compactor does not crack the concrete edge or loosen pavers imbedded in it. If the concrete is left to cure for a few days prior to compacting the pavers, the edges should be covered with plastic sheeting to prevent water from settling the uncompacted bedding sand. If water is allowed to enter bedding sand of any installation, it will be difficult to compact the pavers into it. The pavers will need to be removed, the saturated bedding sand removed, unsaturated sand installed, and the pavers replaced and compacted.

Troweled concrete edges are not recommended in freezing climates as they may crack and be an ongoing maintenance problem.

A concrete curb or edge that is "submerged" or



hidden can be used to restrain concrete pavers. See Figure 10. 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 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.

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.

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 11). 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

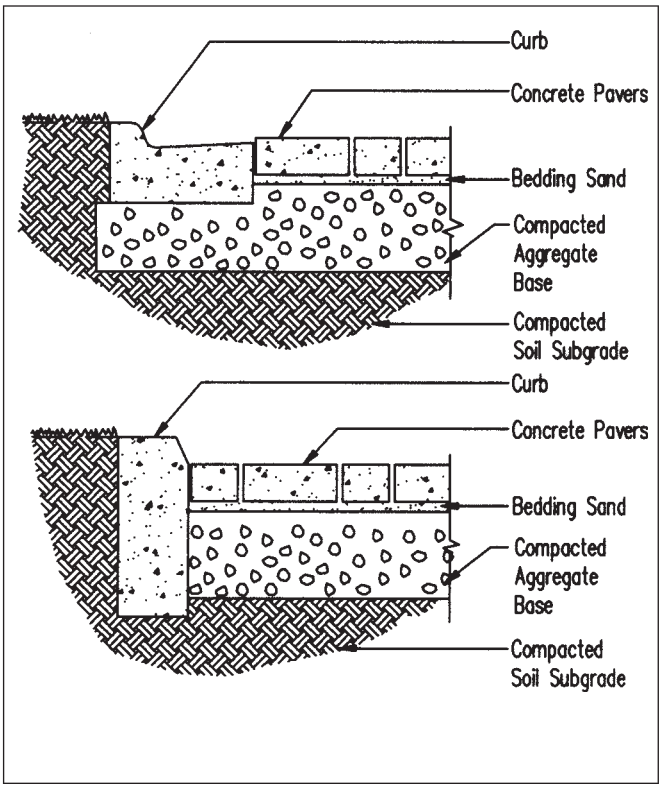


Figure 8. Poured-in-place concrete curbs.

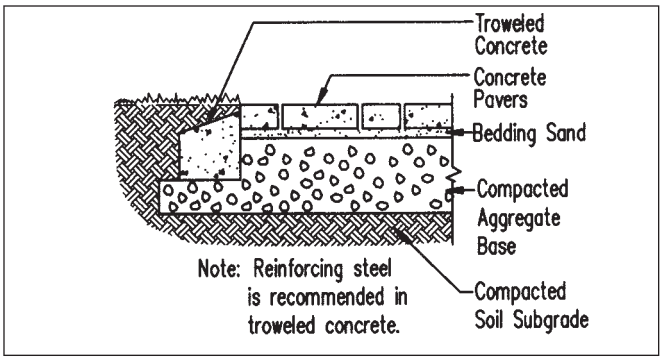


Figure 9. Troweled concrete edges.

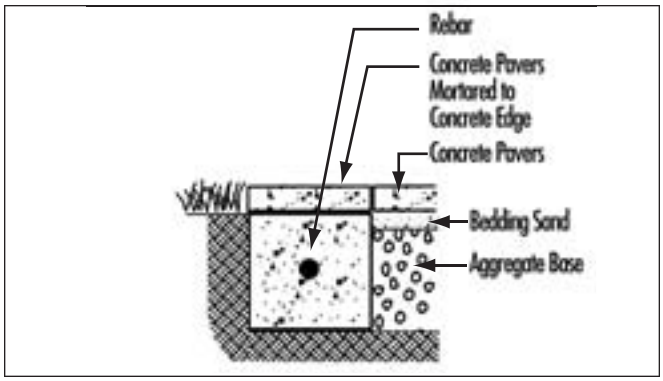


Figure 10. Submerged concrete edge.

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 12), or a beam and slab base combination for pavements subject to heavy vehicular traffic. The beam prevents horizontal creep of the pavers due to braking and turning tires.

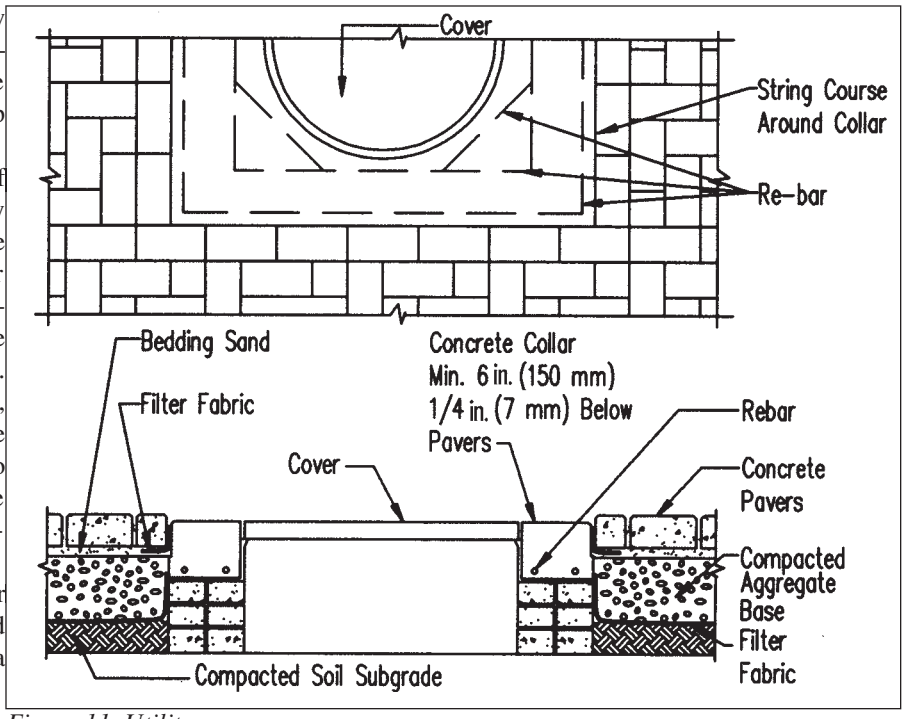


Figure 11. Utility cover.

When a concrete base is used under a crosswalk or plaza, drain holes should be drilled or cast at the lowest elevation(s) (Figure 13). These should be a minimum diameter of 2 in. (50 mm), filled with open-graded aggregate, and covered with filter cloth. This drain detail can be applied in areas where the water table is over 3 ft (0.9 m) deep. Otherwise, the drain should be enclosed in a pipe and directed to a sewer or other appropriate outlet.

Figure 14 shows a crosswalk section through an existing saw-cut asphalt pavement. The existing asphalt should be in good condition with no cracks, raveling, or delamination. The thickness of the cut asphalt should extend below the bottom of the bedding sand in order to prevent loss of bedding sand. The typical asphalt thickness would be 4 in. (100 mm). A small strip of filter fabric placed along the base and the cut asphalt can help prevent bedding sand from migrating.

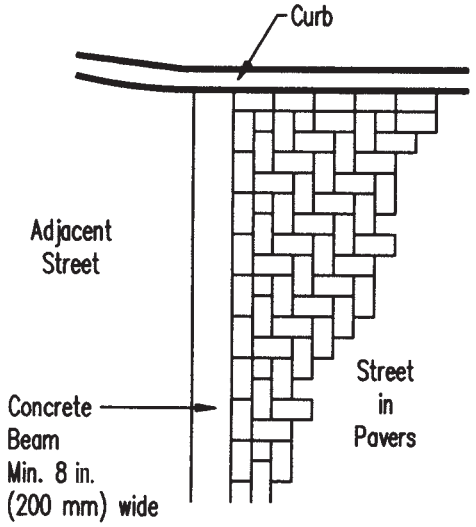


Figure 12. Concrete beam.

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 sweeping the sand and cement into the joints. A more effective method is use of liquid joint sand stabilization materials or polymeric sand. They are recommended to reduce risk of wash out on steep slopes.

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. Some pavers may require a finish elevation $^1/_4$ in. (6 mm) above the top of the restraint. This allows for minor settlement of the pavers and surface drainage. It further minimizes potential tripping due to excessive wear on the restraining material. Other restraint designs help prevent minor

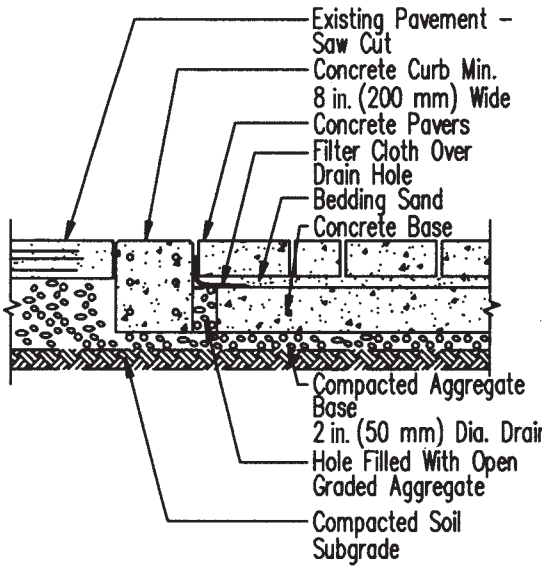


Figure 13. Crosswalk with concrete base.

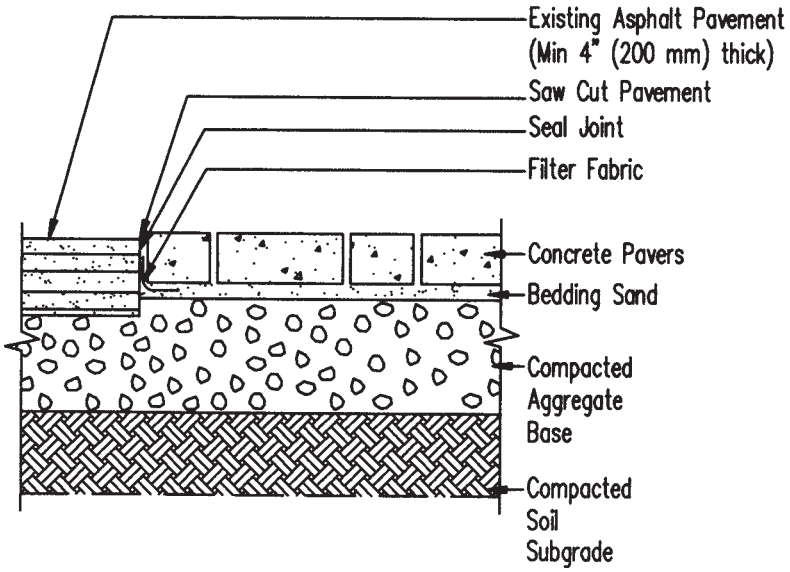


Figure 14. Crosswalk in existing asphalt pavement.

settlement of edge pavers by extending slightly under them. These restraints do not generally require any adjustment of the final elevation of the edge pavers to compensate for minor settlement.

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 15). 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. Cut pavers exposed to tires should be no smaller than one-third of the whole paver. Stability of cut edge pavers exposed to tire traffic is increased when a running course of whole pavers is placed between the edge restraint or concrete collar and the cut edge pavers. Pavers are cut to fit against the course (Figures 11 and 12). Other shapes include edge pavers that make a straight, flush edge. This detail can reduce incidental chipping of the cut pavers.

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.

Figure 15. Saw cutting marked pavers on bedding sand. The cut pavers are carefully removed and edging is placed against the pavers and spiked in place.

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