Contractor Focus **Rob Burak, P. Eng.—ICPI Director of Engineering**

Edge Restraint FAQs

Previous editions of *Contractor Focus* emphasized the "flexible" nature of compacted aggregate bases. Flexible refers to the slight movement and rebound in reaction to loads. The articles emphasized the need for base compaction and density such that the base remains flexible under loads while adjusting to changes in moisture and temperature. As aggregate bases supporting concrete pavers experience these movements, edge restraints fastened to the base should adjust with minor base movement while holding the pavers tightly together. This enables consistent interlock across the entire pavement, the key to long term performance and integrity of the pavement surface. Restraints should also be selected, designed and installed to remain stationary under occasional impacts from tires.

Are edge restraints required for all interlocking concrete pavements?

Yes, edge restraints are a critical component of all interlocking concrete pavements. There are three types of interlock that must be achieved in any segmental pavement–vertical, horizontal and rotational. Properly selected and installed restraints prevent lateral (horizontal) and rotational movement of the paving units. Movement can come from tire traffic, minor settlement of the base or soil or frost heave. These reasons justify edge restraints for residential walkways, patios and driveways, as well as for commercial and municipal applications.

Can all edge restraints be used for all applications?

No. Some have limited use and are selected in consideration of the application and environment. Figure 1 shows typical applications ranging from sidewalks and plazas to truck terminals. The type of anticipated load determines the restraint selection for a particular project. For example, some plastic edge restraints can be used for sidewalks, plazas and residential driveways and are available in industrial grades for commercial driveways and parking lots. Consult manufacturers for specific application recommendations. A full-depth concrete curb can be used for any application while troweled-in-place concrete (a.k.a. concrete toe) is only recommended for pedestrian applications and residential driveways. Table 1 provides some application guidance.

	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				•

Figure 1. Application guide for edge restraints

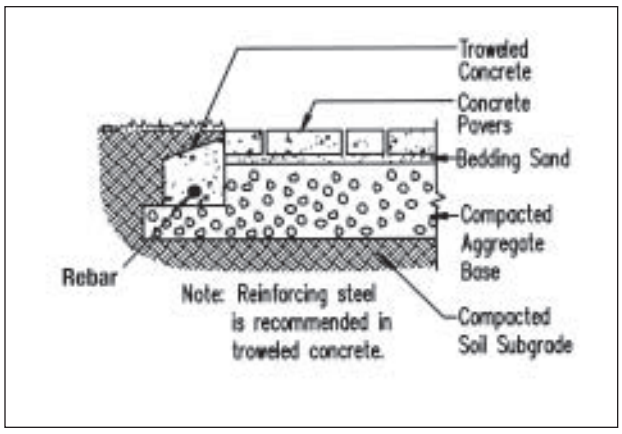

Figure 2. Troweled concrete detail and installation. This edge restraint is intended for mild climates and residential uses only.

How does climate factor into selecting an edge restraint?

Edge restraints need to meet the durability requirements for the particular area. In colder climates edge restraints need to resist freeze/thaw cycles and de-icing chemicals. Plastic edge restraints meet these requirements in addition to properly designed air-entrained concrete mixes, either precast or delivered on site from a ready-mix truck. Troweled edge restraints (also called a concrete toe) are an exception (See Figure 2). These are typically mixed on site in a portable concrete mixer.

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They have questionable durability in harsher climates especially since they are not as flexible as metal or plastic restraints. Steel restraints need rust resistant coatings for long term performance and aluminum edge restraints should have electrolytic coatings. Timber edging is not recommended in any application.

Plastic edge restraints should be kept from direct exposure to the sun prior to installation to eliminate potential damage from ultraviolet rays. When using full-depth, poured-in-place concrete edging over weak or expansive soils, consideration should be given to strengthening the soil with cement stabilization techniques to avoid potential movement and cracking.

Can landscape edging be used as an edge restraint?

No. Plastic edging for planting beds and flower gardens is not acceptable for restraining interlocking concrete pavements. This type of edging can come in varying thicknesses, material composition and grades depending on the manufacturer. Plastic and metal restraints should be specifically designed for pavers. Some flexible plastic edge restraints

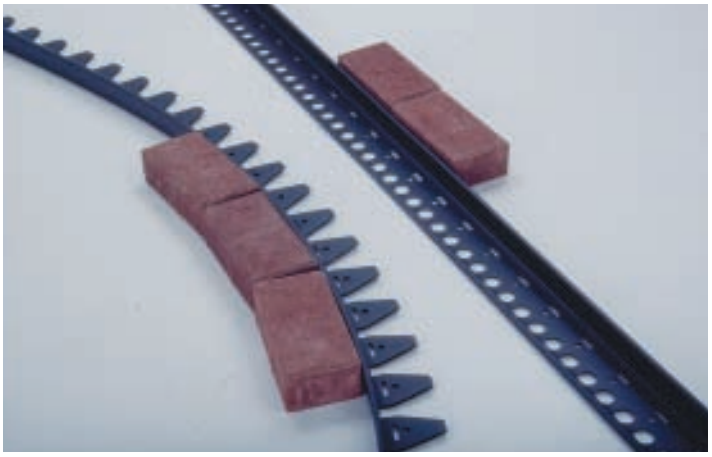
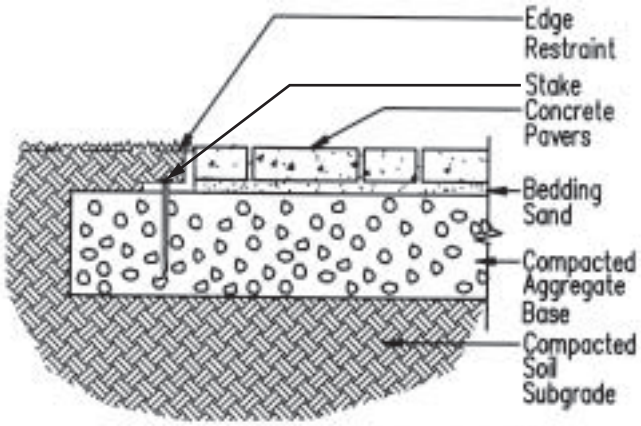
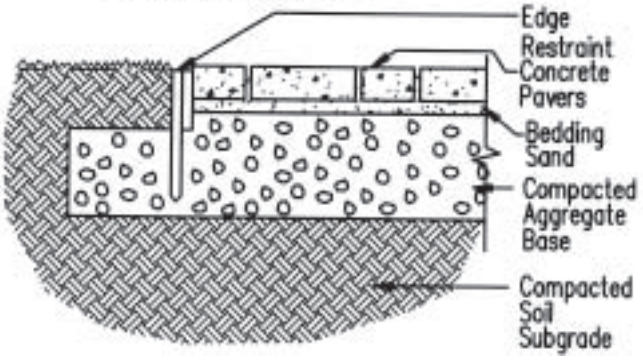


Figure 3. Various types of plastic edging all of which are spiked to a compacted aggregate base.





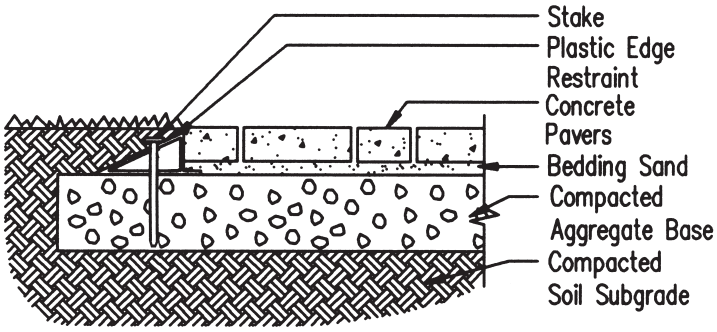


Figure 4. Additional soil is excavated and the base si installed beyond the back of the edge restraint at a minimum of 6 in. (150 mm) past the outside paver edge. This is sometimes called "over excavation" of the base. Metal and plastic edging shown here are fastened into the base extension.

are usually made of a lighter gauge material (when measured by weight/unit length) that allows a contractor to create curves while still restraining the pavers.

Rigid edge restraints have heavier gauge plastic or metal and are used for straight sections in a pavement. Some edge restraints offer a combination of flexibility and rigidity in one material for use in curved and straight sections. See Figure 3. The most important factor in selecting a plastic edge restraint is proven performance. Contractors should ask their suppliers for project references to verify performance including grass survival and resistance to occasional tire impact. A sturdy edge restraint will resist impact without deformation and provide long term performance.

What are an edge restraints most important performance features?

Although some materials have advantages over others, the most important feature for performance is proper installation. Some general tips follow:

- All edge restraints designed to rest on an aggregate base require a minimum excavation past the edge of the pavers at a distance equal to the thickness of the base (but never less than 6 in. or 150 mm). This allows proper support for the restraint from the base and the dispersion of loads at the pavement edge. Figure 4 illustrates how the base extends past the back of the edge restraint for stability
- Contractors should be careful that the "faces" of the edge of the excavation are cleanly cut and perpendicular. It may be necessary to create them with a hand shovel. See Figure 5. Soil at the edge may slide into the place where base will be placed reducing thickness at its edge. As a result the edging spikes will not be secured entirely by the dense aggregate base as intended by the manufacturer. Spikes may be set partly in the soil, weakening the edge of the pavement and being subject to movement from errant tires.
- Edge restraints should not be installed on top of the bedding sand. Plastic and metal edging secured by spikes should rest on the base. Edge restraints restrain the pavers and bedding sand. If the sand is not restrained, it will migrate from under the edge and cause the pavers to sink at the edge.
- Most plastic and metal restraints *should* be installed before placing the bedding sand and pavers. This will ensure that the edging sits on an adequate area of base. For example, if the pavers are installed first and the paver field accidentally extends outside the planned paving area (even slightly), the edging and spikes will have less base support behind it. Another advantage to installing the edging first is the contractor can control the final outline of the paving from the beginning and throughout the entire job. When installed first, the edging also offers a guide for marking cuts.
- Use the right number of spikes per lineal foot or meter with plastic or metal restraints. Consult the restraint manufacturer for the amount of spikes required for a 10 ft (3 m) length of edging. The number will depend on strength and rigidity of the restraint material. Spikes for edging can come in 8 or 10 in. (200 to 250 mm) lengths. 8 in. long spikes are adequate for most residential applications. It's easy to determine where spikes *should* have been after a job is completed. These edges eventually show bulging and shifted pavers.
- Pay attention to any areas where bedding sand will migrate, such as joined areas in pre-fabricated edgings or joints in poured-in-place concrete. In these areas, apply geotextile or caulking to contain the bedding sand.
- Troweled concrete batched onsite can be applied against edge pavers and on the compacted base without forms. When concrete is mixed on-site the aggregate (sand and crushed stone) to cement ratio should be at least 5 to 1. Most bagged concrete mixes will not have this amount of cement so it will be better to mix the concrete on the job site.

  If the top of the concrete edge is recessed and slopes away from the pavers, grass can grow next to them. There should be sufficient distance between the top of the pavers and the top of the concrete edge where it meets the side of the paver. This distance should be at about one-third of the paver thickness. The concrete edge sloping away from the pavers will prevent the concrete from becoming a heat sink that dries the topsoil and kills the grass along the edge.

  Troweled edges should be at least 6 in. (150 mm) wide and of sufficient depth to cover at least two-thirds of the sides of the edge pavers, plus the bedding sand layer, and a minimum of 2 in. (50 mm) into the base. Therefore, 2 3/8 in. (60 mm) thick pavers and 1 in. (25 mm) of bedding sand will require an outer concrete edge slightly over 4 in. (100 mm) thick. That means the concrete will be thicker next to the edge pavers, over 5 in. (125 mm).

  Steel reinforcing bars should 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.
- A submerged concrete edge may support pavers mortared to it. Acrylic fortified mortar is recommended for such applications. If the pavers will be exposed to freeze-thaw and deicing salts, the units should be fastened to the concrete with high-strength epoxy mortar. The minimum cross section 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. Figure 7 shows a submerged concrete curb detail with pavers fastened to the surface.

  The submerged concrete curb may require a layer of compacted aggregate base as a foundation. The width of concrete

Figure 5. A clean excavation cut in the soil may need some touching up with a shovel to create perpendicular sides.

will need to be equal to the width of the 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. When using submerged curbs the field of pavers should be compacted in place after the mortar on the curbs has set.

Maintenance is another key to long term performance. Any edge restraint could suffer damage over time by unintended abuse or alterations to the pavement. Clients need to be informed about making periodic visual inspections.

Should edge restraints be used with mortared or bitumen-set pavers?

Yes. These are rigid applications that require a concrete base. Edge restraints are advisable in all applications, and especially under vehicular traffic.

How is edge restraint installation estimated?

By linear foot (m) per person per hour plus materials with applicable labor and materials overhead costs applied to each. As a starting point, plastic and metal restraints can be estimated to be installed with spikes on a compacted aggregate base at a rate of at least 30 to 35 ft (9 to 10.6 m) per person per hour. Productivity will depend on the amount of cutting to create corners and assumes that the surface tolerance of the compacted aggregate base is at least $\pm 3/8$ in. (10 mm) over a 10 ft (3 m) straightedge.

Which edge systems are the most cost-effective?

Those that require the least amount of labor, enable the pavers to remain stationary and withstand occasional overruns from vehicles without movement and long term maintenance. Plastic and metal restraints can meet this requirement for residential applications. Although these restraints may have higher material costs than troweled concrete the labor required to place them will always be lower.

Troweled concrete requires bringing bagged cement, extra aggregate and sand to the site, water and an electric or gasoline powered concrete mixer, as well as reinforcing bars. After taking time to mix, place the steel and concrete and trowel the concrete edges, the mixer and tools will also need to be rinsed, adding labor time to the job.

Plastic or metal edge restraints fastened to an aggregate base with metal spikes don't require this type of labor and additional materials. Contractors are encouraged to estimate the labor and material components of troweled concrete edges for comparison with purchase and placement costs for plastic or metal systems. Labor and material for the base for each system should be the same since both require an extended base past the edge of the paver field.

Can metal or plastic edge restraints be fastened to concrete or asphalt bases?

Yes. Spikes may be hammered directly into asphalt. For concrete, holes will need to be drilled or ramset and the edge restraint bolted with expansion fittings in the concrete.

Where can I find more information on edge restraints?

ICPI Tech Spec 3 Edge Restraints for Interlocking Concrete Pavements provides a useful guide for contractors. Visit the ICPI web site at www.icpi.org, select Contractors and then Publications and Specifications.❖

Figure 6. A strip of geotextile contains bedding sand against a curb.

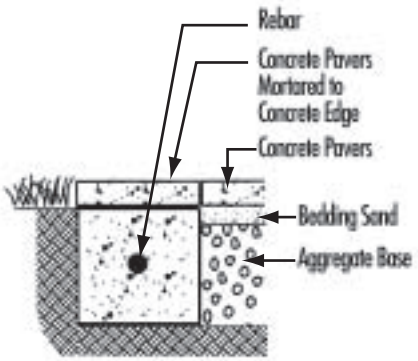


Figure 7. Submerged concrete curb with pavers fastened to the top with high-strength mortar or bitumen adhesive.

Continuing Education Credits

ICPI recently changed renewal of ICPI Certified Installer Certification from earning continuing education credits to an annual fee. Therefore, continuing education credits are taking a new direction. An ICPI Construction Committee task group is developing higher levels of certification through new on-line education programs with credit hour requirements for earning continuing education. These credits can help fulfill continuing education requirements when the new education programs are announced.

ICPI continues to offer one hour credits to readers who correctly answer the questions below. To earn continuing education credits after reading the Contractor Focus article log on to www.icpi.org and follow these links: *Contractors, Publications and Specifications, Publications Catalogue,* and *Online Construction Training Programs* and take **Exam 4**. You will receive a certificate immediately upon successful completion. ICPI automatically records your continuing education credit in our database system.

The questions for Exam 4 on the ICPI web site are given below. We will no longer accept faxed exams. If you would like to earn additional credits, they are offered on the ICPI web site for the member price of only $20.00 per credit hour. Good luck on your exam!

1. ***Troweled concrete edge restraint systems can be used in North America climates.***
   a. True b. False
2. ***Some landscape edging is rigid enough to be used as an edge restraint for segmental pavements.***
   a. True b. False
3. ***Steel and aluminum edging can be used for parking lot applications.***
   a. True b. False
4. ***Although most steel, aluminum and plastic edging systems are designed to be installed on the aggregate base, it is acceptable in some applications to install them directly on the bedding sand.***
   a. True b. False
5. ***A driveway with a 10 in. (250 mm) thick aggregate base and a plastic edge restraint in Coboconk, Ontario, Canada would require a minimum over-cut with base extension of:***
   a. 4 in. (100 mm)
   b. 6 in. (150 mm)
   c. 8 in. (200 mm)
   d. 10 in. (250 mm)
6. ***A patio with a 4 in. (100 mm) aggregate base and a troweled concrete edge restraint in Chokoloskee, Florida would require a minimum over-cut with base extension of:***
   a. 4 in. (100 mm)
   b. 6 in. (150 mm)
   c. 8 in. (200 mm)
   d. No over-cut is required. The troweled edging can be set directly on the soil.
7. ***Edge restraints are an important factor in maintaining vertical interlock in any segmental pavement.***
   a. True b. False
8. ***Interlocking concrete pavements for pedestrian applications in non-freeze thaw environments can have optional edge restraints.***
   a. True b. False
9. ***Bedding sand loss is only a concern with cast-in-place and pre-cast concrete curb systems.***
   a. True b. False
10. ***When excavating a job and considering an edge restraint system, contractors need only be concerned about the over-excavated perimeter of the pavement.***
    a. True b. False