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

Base Construction for Interlocking Concrete Pavements

The previous two editions of Contractor Focus reviewed layout, excavation and preparation of the subgrade for interlocking concrete pavements. This edition of Contractor Focus will discuss the steps involved in geotextile and base installation. Site preparation, excavation, subgrade preparation and base installation are the most important construction components of a project. The performance of an interlocking concrete pavement relies greatly on proper execution. Although unseen when the job is completed, these components represent the foundation for success.

Installing Geotextiles
Geotextiles are an important part of many pavements. Geotextiles are recommended over cohesive soils, i.e. clays or silts. They are also a good choice over soils saturated for a large portion of the year. The fabric separates fines in soils from the base and prevents them from migrating upward (carried by water through capillary action) into the base. The fabric prevents slow movement fines from weakening the support from the base.

Geotextiles do not typically increase the load bearing capacity of a pavement. Rather, they retain the intended load bearing capacity. They can be considered inexpensive insurance for extending the life of a compacted base. They do not enable decreasing the aggregate base thickness.

Geotextiles are manufactured as woven or non-woven. Woven geotextiles are recommended where the base needs to be separated from the subgrade. Woven geotextiles have a higher bursting or “tear” strength than non-woven, and tend not to stretch or elongate as much. ICPI recommends following manufacturer’s recommendations for selecting woven geotextile as a separation fabric.

When installing geotextiles it is important to overlap and cover the sides of the excavation. Create an overlap in the direction of the grade, much like shingles on a house. Begin by placing the fabric at the lowest elevation and working upslope. To prevent contamination of the base by soil at the sides of the excavation, cover the sides of the excavation with fabric and fasten it to the ground with metal staples while removing all wrinkles. Excess fabric and exposed staples can be removed once the job is completed.

When a new section of fabric is placed it should overlap a minimum of 12 in. (300 mm). In weaker soils, it may be necessary to increase overlap to a minimum of 24 in. (600 mm). Geotextile manufacturers can provide guidance on overlap requirements.

Selecting Base Aggregates
Base materials for interlocking concrete pavements can be crushed stone, cement-treated base, asphalt-treated base, asphalt or concrete. The most common base is compacted crushed aggregate. Aggregate base materials under flexible interlocking concrete pavements should follow state DOT or provincial specifications for base used under asphalt. Materials from state or provincial certified quarries provide some additional assurance of consistent aggregates and gradations that conform to agency specifications. The largest aggregates for bases are typically 3/4 in. (19 mm). For pedestrian applications in residential settings, 1/2 in. (13 mm) top size aggregate is acceptable.

There are four important properties of an aggregate base material: strength, resistance to frost heaving, density and drainage. They are all influenced by the amount of material passing the No. 200 (0.075 mm) sieve. The key is balancing these properties to optimize performance. Experience shows that 5% to 10% passing the No. 200 sieve gives optimum performance of these properties. The foreman should monitor the amount of fines by inspecting each truck load of base and by requesting a sieve analysis from the

Figure 1. Geotextile should cover the sides of the excavation and be secured into the ground with metal staples. Excess fabric can be trimmed after paver installation. Note that the loader operator is driving into the excavation over base material and not driving over exposed fabric. This prevents wrinkled or damaged fabric.

Figure 2. The depth to the top of a base lift is checked at the edge of pavement. This provides a good visual check to guide the loader operator.

Continued on p. 2
rounded particles. Flat and elongated particles and almost no
A visual check should confirm very few
lar sides from crushing with cubical shapes.
Another approach is to use the following for
the base and the weight of the aggregate.
will depend on the compacted density of
compacted thickness. The exact area yield
include geotextile installation with base pro-
accept bedding sand. Some contractors
until the base surface is smooth and ready
crushing in lifts, raking each lift smooth,
time includes transferring the base into the
installation in tons per person per hour. This
best to measure crew productivity for base
spread and moisten by spraying before com-
aggregate and visually check the number
ing the No. 200 sieve.
The foreman should sample a handful of
of crushed or “fractured” faces on the aggre-
gate. The best base materials have all angu-
A visual check should confirm very few
flat and elongated particles and almost no
rounded particles.

**Estimating and Job Costing**

One ton of loose base generally yields about
80 to 100 sf (8 to 10 m²) at 2 in. (50 mm)
compacted thickness. The exact area yield
will depend on the compacted density of
the base and the weight of the aggregate.
Another approach is to use the following for-
ula for estimating the tons of base:

\[
\text{Square feet covered by the base} \times \frac{\text{compacted thickness of base in inches}}{175} \times 1.1
\]

Since base is purchased by the ton, it is
best to measure crew productivity for base
installation in tons per person per hour. This
time includes transferring the base into the
evacuation in lifts, raking each lift smooth,
compacting it, and repeating this process
until the base surface is smooth and ready
to accept bedding sand. Some contractors
include geotextile installation with base pro-
duction estimates.

**Base Construction for Interlocking Concrete Pavements**

Continued from p. 1

Since each job site is different, productiv-
ity varies. Tracking the labor hours for each
size and type of job will provide a useful way
to view labor hours over time for base place-
ment and other job functions in the project.
This database will lead to more accurate esti-
mates and aid in scheduling projects.

**Best Practices for Base Installation**

Like soils, the right amount of moisture in the
base material ensures reaching maximum
density during compaction. Most crushed
aggregate bases require about 5% to 6%
optimum moisture content to reach 100%
Proctor density. If the aggregate is dry,
spread and moisten by spraying before com-
acting, letting the water penetrate the full
deepth of base lift thickness.

If the aggregate is not at its optimum
moisture throughout the lift thickness, there
is a risk of compacting only the top crust of
the base lift. As a result, the base lift will not
compact to maximum density and pavement
settlement may occur in the future. Do not
add excessive water as this can create pump-
ing of the aggregate under compaction. This
leads to lower than desired densities. Check
the moisture content of the aggregate by
grabbing a handful and squeezing it tightly
for a few seconds. After opening your hand,
a good sign of the right amount of moisture
is the aggregate sticking together with no
water draining.

When installing the first lift of aggregate
it is important to not compromise the integrity
of the geotextile with wrinkles. Place the first
aggregate lift ahead of the loader wheels as
shown in Figure 1, ensuring that the equip-
ment does not drive directly over the geotex-
tile. This also reduces the risk of tearing or
puncturing the fabric.

**Compacting the Base**

ICPI recommends that the base is installed
typically in 4 to 6 in. (100 to 150 mm) lifts.
The thickness depends on the size of compac-
tor. For example, a 5,000 lbf (22 kN) plate
compactor will compact up to 4 in. (100 mm)
thick lifts. A 7,000 lbf (31 kN) machine can
compact up to 6 in. (150 mm). ICPI recom-
mends using a minimum 7,000 lbf machine
to compact aggregate base. Larger compac-
tion equipment will adequately compact lifts
thicker than 6 in.

Using the larger compactor for a 10 in.
(250 mm) thick base may require only two
lifts of aggregate versus three when using a
smaller compactor. Compacting two versus
three lifts saves labor hours and the savings
can be multiplied by total area of base com-
pacted over the course of year. When choos-
ing a compactor size for rent or purchase,
consider the labor and price savings realized
from using a larger compactor. The amount
of labor hours to excavate, prepare the sub-
grade, and install the aggregate base will be
at least 70% of the labor expended on jobs
throughout the year. Any reduction in time
without compromising workmanship contrib-
utes to company profitability.

Moving the aggregate into corners
and other difficult or inaccessible places

Figure 3. When compacting soils or base, over-
ap by at least one-third the width of the plate
compactor. A best practice is to always start
compaction at the perimeter, work inwards, and
work uphill from the low end of the grade.

Figure 4. Choose the right equipment for the job. In difficult areas such as corners, unreach-
able by larger plate compactors, use a jumping jack or hand tamper. Remember, these
neglected areas can lead to soil or base settling and callbacks.
will depend on the crew. Rake and grade the base to string lines so that the base will compact to a uniform thickness and to the planned slope. This can be done with the backside of a lute (asphalt rake). The rake helps prevent aggregate segregation of larger particles from smaller ones which reduces the compacted density. A garden rake shouldn’t be used to spread base aggregate.

Individual base lifts should be installed in uniform thicknesses to prevent waste and help ensure uniform density. ICPI recommends a thickness tolerance of +3/4 in. (19 mm) to –1/2 in. (14 mm) for the final base thickness. Too much aggregate wastes time and money. Too little aggregate can create a base with reduced support.

When compacting soils or base, compact in one direction, then compact the entire area with passes perpendicular to previous ones. Overlap should be about one-third the width of the plate compactor base (see Figure 3). The total number of passes to accomplish full compaction to the required Proctor density depends upon the weight and travel speed of the compactor.

Some indicators that indicate nearly complete compaction:

1. When the compactor starts “crabbing” (moving in a sideways motion)
2. The “spike test” – where it takes at least a three pound (1.5 kg) hammer to drive an 8 or 10 in. (200 mm to 250 mm) long spike into the base.

Some experienced contractors know that a certain number of passes of a plate or roller compactor yields adequate density in base materials. However, they may be over compacting in some jobs and wasting time. This approach to compacting base is useful if the number of passes is correlated initially to base density measurements with a nuclear density gauge.

The best way to ensure proper density is having a soils testing laboratory technician check the base with a nuclear density gauge. They typically charge a minimum fee for a set amount of time for “nuking” compacted soil or base. For base, the Proctor density (in lbs/ft³ or kg/m³) and optimum moisture content can be obtained from the quarry rather than paying for laboratory testing to determine these. While density measurements aren’t needed for bases in residential pedestrian applications, they are a good idea for residential driveways. The cost of testing is substantially less than the cost of a crew callback for settlement repairs. Density measurements should be specified and followed in commercial and municipal projects.

ICPI recommends minimum base thickness for different applications. For pedestrian areas, including patios and walkways, a minimum 4 in. (100 mm) thickness is recommended. For residential driveways over well-drained soils a minimum of 6 in. (150 mm) thickness is recommended. These thicknesses will be increased in colder climates or over continually wet or weak soils. Most driveways in freezing climates are at least 10 in. (250 mm) thick. Northern U.S. and most Canadian regions with cold winters will require driveway bases well over 1 ft (0.3 m) thick.

Vehicular applications such as streets and parking lots will typically have greater base thicknesses or in stiffer bases. ICPI Tech Spec 4 Structural Design of Interlocking Concrete Pavement for Roads and Parking Lots provides base thickness guidance for these applications. These should be designed by an engineer familiar with local soils, local base materials and construction practices. The ICPI thickness design procedure is based upon one developed by the American Association of State and Highway Transportation Officials (AASHTO) in 1993. Most state and provincial DOT’s have adopted this pavement design method.

ICPI recommends a base surface tolerance of ±3/8 in. (10 mm) over a 10 ft (3 m) straight edge. Drainage is achieved through a minimum longitudinal slope of 1% and a minimum cross slope of 2%. Set and check slopes with string lines, a level or a transit.

Figure 5 shows a string line pulled to the finished elevation and slope. A simple way to check the final elevation of the compacted base is to run a lute under the string with a blade as thick as the compacted pavers and bedding sand (usually about 3 in. or 75 mm). This enables a quick visual check on the base height and slope as the lute (asphalt rake) is moved under the string.

**Conclusion**

Proper base construction is the “foundation” for success. The interlocking pavement industry continues to experience the dynamic growth it’s seen over the past 10 years. In order to continue the dynamic growth of the interlocking concrete pavement industry it is critical for contractors to follow industry best practices. The unseen components of a segmental concrete pavement determine the success of the installation. The next edition of Contractor Focus will review bedding sand installation and proper construction of edge restraints – two areas that demand attention to detail.

---

**Figure 5.** Checking base surface tolerance: the surface should be ±3/8 in. (10 mm) over a 10 ft (3 m) straight edge.

**Figure 6.** Some lutes are as tall as the thickness of compacted pavers and bedding sand. Therefore, a lute can be a convenient gauge for comparing the elevation and slope of the finished surface set by the string line, and the elevation and slope of the compacted base surface.