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

Preparing for Paver Installation—Installing the Bedding Layer

The previous three issues of *Contractor Focus* discussed proper subgrade and base and installation of edge restraints. After preparing the base and before installing the pavers, bedding sand is selected and installed. This article covers selecting the right bedding material and installation according to industry recommendations. Although they appear to be a small part of job, getting the bedding sand right is just as important as achieving the same for other pavement components. All contribute to the project's success.

Is the site ready for bedding sand?

A proper bedding layer ensures that final pavement surface will have a uniform slope without undulations or waviness. The first step toward preventing this is checking the compacted base surface for deviations exceeding 3/8 inch (10 mm) over a 10 ft (3 m) straightedge in any direction. Figure 1 illustrates checking the base surface with a straightedge. If the base surface area or contour prohibits using a long straight edge, carefully check the contoured base surface for unevenness with a rod and level. If there are depressions, low areas need to be filled with base material and compacted. High areas can be raked off and re-compacted. A base that meets these surface tolerances will save labor costs. Screed rails placed are ready for sand without rocking on high spots or spanning low spots on the base surface.

ICPI guidelines note that bedding sand can be installed between 3/4 in. (20mm) and 1 1/2 in. (40 mm). The sand layer should be a consistent thickness. For residential jobs, 1 in. (25 mm) outside diameter rails are typically used for screeding which produce a compacted sand layer less than 1 in. Some contractors use square screed rails because they are convenient to stack and transport, but round screed rails are recommended since they always lay true on the base. This is not always the case with square screed rails. Most contractors will use round aluminum electrical conduit or cast iron gas pipe. PVC pipe is not recommended because it doesn't always lay flat on the base and isn't as durable as conduit or iron pipe.

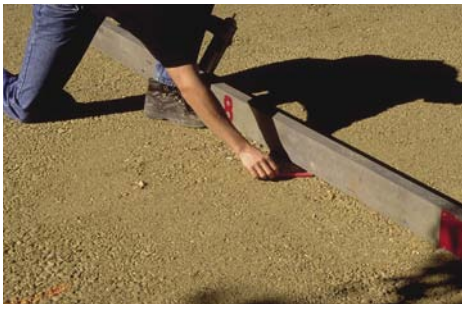


Figure 1. All effort placed into making a smooth base surface will result in a smooth paver surface. The base surface is checked with a straightedge after compaction.

Bedding sand should not compensate for depressions in the base. Depressed areas filled with sand will reflect to the surface early in the pavement service life, sometimes within a few months. Base depressions reflected to the surface are from lack of consistent density in a varying sand layer thickness. The sand eventually settles in low base surface areas and the pavers with it. Such depressions can collect water, often saturating the sand in that area. The water will eventually pump out of joint sand and bedding sand when trafficked by tires. Interlock will be lost and the pavement surface weakens.

More efficient bedding sand distribution, screeding tools and methods can reduce crew members from four shown here to one or two persons. The result is increased productivity through saved labor hours.

What is the right material for the bedding layer?

ICPI recommends using sand that meets the same gradation requirements for concrete sand. This sand is used by the ready-mix concrete industry to manufacture concrete. In the United States this means ASTM C33 sand, and in Canada this is CSA A23.1 (FA1) sand. ICPI also states that the amount of fines (the amount passing the No. 200 or 0.075 mm sieve) should be limited to 1% maximum (See Table 1). Contractors should request a sieve analysis for bedding sand from their local material supplier. There is usually no charge for this service.

Table 1

Bedding Sand Gradations

ASTM C 33

Sieve Size	Percent Passing
3/8 in.(9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	5 to 30
No. 100 (0.150 mm)	0 to 10
No. 200 (0.075 mm)	0 to 1

CSA A23.1-FA1

Sieve Size	Percent Passing
10 mm	100
5 mm	95 to 100
2.5 mm	80 to 100
1.25 mm	50 to 90
0.630 mm	25 to 65
0.315 mm	10 to 35
0.160 mm	2 to 10
0.075 mm	0 to 1

Figure 2. A mechanical screed is useful for doing straight driveways and other large areas. Most designs can adjust to various lengths.

Figure 3: One of the most cost-effective tools is this one-person screed pull. They come in different lengths and are well suited for walkways, patios and driveways.

Bedding sand should not be screeded too wet or too dry. If saturated, it will immediately pump water during initial paver compaction, resulting in uneven settling over time. On the other hand, if the sand is too dry it won't compact to its maximum density. Again, it can settle unevenly over time. Typically, settlement will be greater in trafficked areas that receive constant loads from tires.

The right sand helps ensure proper paver seating during their initial compaction with a plate compactor. This result after compaction should be a smooth even paver surface without "lipping" between units. Concrete sand meeting the above gradation requirements will help achieve this.

Do not use limestone screenings. Limestone screenings tend to break down during the initial compaction and can continue degrading over time with moisture, freeze-thaw and repeated wheel loads. If soft bedding sand particles break down immediately or over time, depressions will eventually occur in the pavement surface. In addition, limestone screenings seldom meet the gradation requirements in Table 1. Screenings often have 10% or greater fines passing the No. 200 (0.075 mm) sieve.

Hardness contributes to bedding sand performance. One simple test for hardness is scratching larger sand particles with a pocket knife. Scratch most limestone screening particles with a pocket knife they will easily mark or break. Most screenings consist of flat, elongated particles (length-to-thickness and length-to-width greater than 3:1) and some pieces can actually be broken with bare hands. Take a pocket knife to hard, durable concrete sand and the larger particles won't scratch or break.

Layer Thickness and Moisture Content

Like the soil subgrade and base materials, achieving maximum density of the bedding sand layer assists in pavement performance. Achieving this depends on uniform layer thickness and proper moisture content.

Staging materials

Like any job site material, locating and staging the bedding sand will expedite screeding. For example, if the job requires laying pavers up from the street, stockpile some sand at the street and the rest at the top of the driveway. It is preferable to have small piles for ease of spreading and screeding. At the end of the day these piles should be tarped, especially if rain is forecasted.

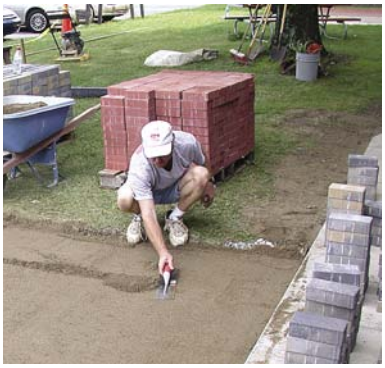
Screeding

Screed rails are typically spaced 8 to 10 ft (2.5 to 3 m) and should allow for the screed board to overlap by at least 6 in. (150 mm) on both sides. Spacing depends on screed board length and elevation changes in the base such as crowns or swales. For tight contours or compound curves (slopes in two directions) the rails will need to be set much closer.

The sand piles should be carefully moved with a shovel or a "come-along" to cover the base between the screed rails, taking care not to disturb the rails and not to move sand *under* the rails. Accidentally moving sand under the rails will affect the final bedding layer thickness and the final elevation of the pavers. In addition, the base should be compacted at the correct height and not adjusted by pressing sand under the screed rails to raise them. This can lead to excessively thick sand layer which can become unstable, especially under vehicular traffic.

The pavement geometry and overall site plan govern where screeding begins. It will typically start at the lowest elevation and work

Figure 4. A notched screed board easily rides along plastic or metal edge restraints or curbs.



Figures 5 and 6. After removing screed rails, the voids are filled with sand and smoothed with a trowel or a flat rake sometimes called a "come-along."

uphill. The foreman establishes the starting point(s) and the location(s) of dumped sand. These and all other foreman decisions should aim for maximum productivity with minimal movement of sand piles.

Labor Saving Devices

On smaller jobs screeding can be done by hand using an aluminum screed. This typically requires two people, one to screed another to supply sand. Depending on the job size, specialized tools can save a contractor 50% to 100% in labor costs for screeding. Figure 2 shows a mechanical screed that can be pulled manually or with a loader. These are effective on large jobs with little or no grade changes. They can be set on curbs and adjusted to establish a consistent bedding layer thickness. Mechanical screeds can range from 4 feet to 24 feet (1.2 m to 7.3 m) wide and vary in price. The labor savings realized over several jobs will often justify the expense of purchasing this equipment.

For smaller areas, single operator sand screeds quickly level the bedding sand. Some designs operate with screed rails and others run along the top of curbs with no screed rails in the sand (see Figure 3). These modestly priced tools reduce the number of persons and quickly return their investment from increased productivity and reduced labor hours. In addition, safety and fatigue are better managed because of the ergonomic advantages to the crew. These tools can reduce back injuries, the number one cause for workers compensation insurance claims.

Notched aluminum screed boards can also be used with rigid plastic or metal edging installed in the base as a guide (see Figure 4). Notched equipment can ensure a quick, uniform bedding layer installation. Although these types of boards could be made on-site by notching a piece of lumber, consider the advantages of an aluminum screed board that won't warp or rot over time.

For hard to reach areas, hand trowels or (concrete) floats can be used. These are the same tools used by concrete flatwork finishers. The urge to press down and compact the sand must be resisted when using hand trowels or floats since all sand should be loosely screeded. Hand trowels or "come-alongs" are used to fill and smooth bedding sand placed in the voids left by the removed screed rails (see Figures 5 and 6).

At the end of the day any screeded sand beyond the paver laying face (i.e., not covered with pavers) should be protected from rain or from drying out in the sun. Replacing saturated sand after a rain storm provides incentive to tarp screeded sand before leaving the job site. It also provides incentive to screed only as much sand covered by the crew in a day. Tarps over screeded areas will also keep out tree leaves and discourage foot and paw prints from wandering animals.

Documenting Productivity

Contractors who document job functions will divide them logically by construction steps. These typically include site excavation and preparation, geotextile and base installation, bedding sand and paver installation including compacting and filling the joints, edge restraint installation, saw cutting and clean up. Capturing labor hours for job functions through daily time sheets reported by the foreman enables accurate estimating and pricing of future projects, accurate comparisons to job estimates, as well as accurate company scheduling. Labor hours for sand screeding are typically included in the documentation and recording the man hours for paver installation for each job, especially since both tasks often occur at the same time.

This article provided a brief overview of the right materials, installation procedures and some labor saving equipment ideas for screeding bedding sand. If the base has a smooth surface, all of these considerations result in an efficiently installed, long-lasting bed for the concrete pavers.

The next edition of Contractor Focus will review paver installation. Topics will include establishing the starting point a laying a paver field, establishing perpendicular reference lines and bond lines, proper methods for hand laying the pavers, establishing patterns, paving around openings, saw cutting and answering an important question on whether the bedding sand layer should be compacted before installation of the pavers.

Contractor Focus CE Questions – November 2005

Editorial Note: Although ICPI has changed the ICPI Certified Installer Certification Renewal program to an annual fee program, an ICPI Construction Committee task group is developing higher levels of certification. These will include hourly requirements for continuing education credits and this column will continue to offer 1 hour credits to those who successfully complete the questions. These credits can be applied to hourly requirements for higher certification levels when the new programs are announced.

Please also note the submission requirements have changed. Log onto www.icpi.org and follow these links: *Contractors, Certification then Online Construction Training*. Magazine CE's will continue to be offered free of charge. This one is labeled Exam 5. By entering answers online you will receive your certificate immediately upon successful completion and ICPI will maintain an automatic record of your continuing education credit. We do not accept faxed answers. If you are looking for more hourly credits, you will see others offered for the ICPI member price of only $20.00. Good luck on your exam! ❖

Helpful Job Site Tip

Check the moisture content by drawing a handful of sand from inside the sand pile and squeeze it in the palm of a hand. If the sand holds together after opening the hand without shedding excess water, it has the proper moisture content. Contractors should exercise caution on hot days since screeded sand will dry out quickly. A careful contractor will screed sufficient sand with some moisture in it and pave over it while being careful to not screed so much sand that it is bone dry by the time it receives pavers.

Contractor Focus CE Questions – November 2005

1. ***Bedding sand should be dry when screeded?***
   a. True
   b. False
2. ***Square screed rails are more apt to sit true on a compacted aggregate base then round screed rails:***
   a. True
   b. False
3. ***If the top of the base is not within tolerance this can easily be adjusted by either digging the sand screed rails into the base or adding sand under the rails:***
   a. True
   b. False
4. ***ICPI recommends the following limit on the No. 200 (0.075 mm) sieve for bedding sands:***
   a. 0% passing
   b. 1% passing
   c. 2% passing
   d. No limit
5. ***When the screed rails are placed 10 feet (3 m) apart, how long should the screed board be?***
   a. 10 feet (3 m)
   b. 12 feet (4 m)
   c. 11 feet (3.3 m)
   d. It doesn't really matter
6. ***The main factor in bedding sand selection and installation is:***
   a. Particle size distribution (gradation) and moisture content of sand
   b. Base surface tolerance
   c. Thickness of the bedding layer
   d. Selection of the proper tools
   e . All of the above
7. ***Limestone screenings are an economical and effective choice for a bedding material in an interlocking concrete pavement.***
   a. True
   b. False
8. ***Since bedding sand installation is a small part of the job, it is not necessary to include it as part of the calculation or recordkeeping for labor hours.***
   a. True
   b. False
9. ***If it rains after bedding sand has been screeded and the sand becomes saturated, a contractor should simply wait a few hours after the rain stops before installing the pavers.***
   a. True
   b. False
10. ***It is permissible for the thickness of the bedding sand layer to be 2 inches (50 mm).***
    a. True
    b. False