

Paving Systems Using Clay Pavers on a Sand Setting Bed

Abstract: This *Technical Note* describes the proper design and construction of pavements made with clay pavers on a sand setting bed in pedestrian and vehicular, residential and nonresidential projects.

Key Words: flexible, mortarless paving, paving, rigid, sand setting bed.

SUMMARY OF RECOMMENDATIONS:

General

- Determine if application is pedestrian, light duty vehicular or heavy duty vehicular
- Implement regular maintenance program to maintain pavers in a safe and serviceable condition

Patterns

- Use herringbone pattern for pavements subject to vehicular traffic
- Design flexibility into layout to accommodate field conditions

Drainage

- Provide a minimum slope of $\frac{1}{4}$ in. per foot (2 percent grade)
- For concrete and impermeable bases, provide weeps through base

Edge Restraints

- For pavements subject to vehicular traffic, use concrete or stone curbs or steel angles anchored to a concrete base or foundation or a proprietary system rated for traffic
- For all other pavements, use any of the above or clay pavers in a concrete foundation, proprietary plastic or metal edge restraint systems spiked into aggregate
- Use edge restraint with vertical face at paver interface

Clay Pavers

- For most residential, pedestrian and light duty vehicular applications, such as driveways, entranceways and passenger drop-offs, use clay pavers complying with ASTM C902
- For heavy duty vehicular applications, such as streets, commercial driveways and industrial applications, use clay pavers complying with ASTM C1272
- Refer to *Technical Note 14* for additional recommendations

Setting Bed

- Use concrete sand complying with ASTM C33
- Min. $\frac{3}{4}$ in. (19 mm) to max. 1 in. (25 mm) thickness after compaction

Joints

- Use concrete sand complying with ASTM C33
- Min. $\frac{1}{16}$ in. (1.6 mm) to max. $\frac{3}{16}$ in. (4.8 mm) wide
- Optimum joint width for vehicular traffic is between $\frac{1}{16}$ and $\frac{1}{8}$ in. (1.6 and 3.2 mm), but some wider joints may be required with Application PS pavers

Stabilized Joint Sand

- Use where potential sand loss or high water permeability is anticipated and not desired
- Follow paver manufacturer's recommendation regarding the use of stabilized joint sand or joint sand stabilizer
- Use performance history as a basis for selection

Concrete Base

- Provide control joints spaced at a maximum of 12 ft (3.66 m) o.c. through concrete base only
- Provide minimum 12 in. (305 mm) wide woven geotextile strips centered over control joints to prevent loss of sand
- Provide 2 in. (50 mm) weeps cast or cored at lowest elevations; fill with washed pea gravel and cover with geotextile

Base, Subbase and Subgrade

- Refer to *Technical Note 14*

INTRODUCTION

This *Technical Note* covers the design, detailing and specification of clay pavers when laid on a sand setting bed (see **Figure 1**). Refer to *Technical Note 14* for clay paver design considerations, including traffic, site conditions, drainage and appearance.

Sand-set pavers are the most cost-effective method of constructing a pavement made with clay pavers. The system relies upon developing interlock in the paving course, which is generated by friction between the pavers and the jointing sand. This enables the pavers to function as part of the structural pavement system.

Applications

Clay pavers set on a sand setting bed are appropriate for virtually any paver application, ranging from pedestrian to heavy duty vehicular traffic. At a minimum, the system requires clay brick pavers and a sand setting bed, compacted after paver placement. Depending on subgrade conditions, additional layers and subbase may be required.

Residential Patios and Walkways. These applications are the most common and handle the lightest loads. The sand setting bed should be spread and screeded to an uncompacted nominal thickness of 1 in. (25 mm). Once compacted, the thickness of the sand setting bed should be between a minimum of $\frac{3}{4}$ in. (19 mm) to a maximum of 1 in. (25 mm). The sand setting bed should be separated from the subgrade by a compacted aggregate base (see **Figure 2**). This base typically consists of coarse aggregate (gravel) of varying gradation, compacted to a minimum thickness of 4 in. (102 mm) using mechanical tamping or vibration.

Residential Driveways. The heavier and more localized loads of vehicles on driveways serving one- or two-family houses result in a thicker paving system requiring a minimum 4 in. (102 mm) compacted aggregate subbase. The base should consist of a minimum 4 in. (102 mm) layer of coarse aggregate, cast-in-place concrete or asphalt (see **Figure 3**).

The sand setting bed thickness should be spread and screeded to an uncompacted nominal 1 in. (25 mm). Once compacted, the thickness of the sand setting bed should be between a minimum of $\frac{3}{4}$ in. (19 mm) to a maximum of 1 in. (25 mm). The base typically consists of coarse aggregate (gravel) of varying gradation, compacted to a minimum thickness of 4 in. (102 mm) using mechanical tamping or vibration.

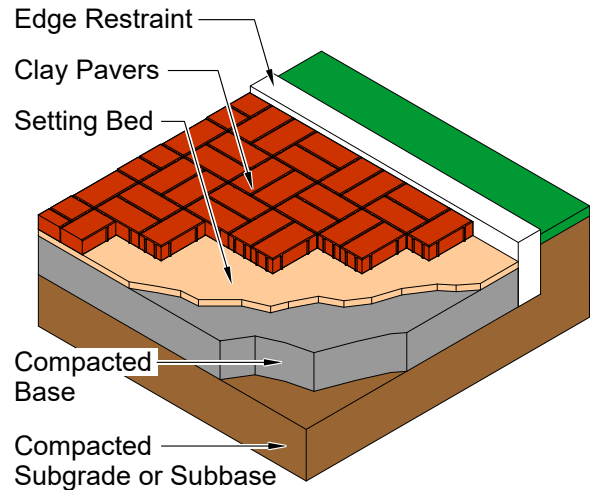


Figure 1
Typical Brick Pavement

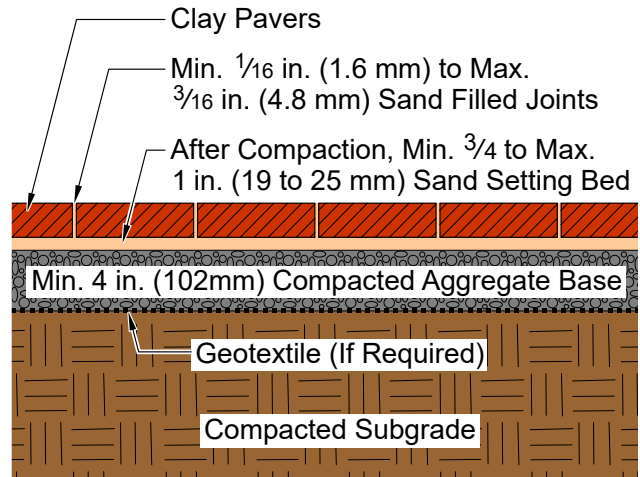


Figure 2
Typical Residential Patio or Walkway

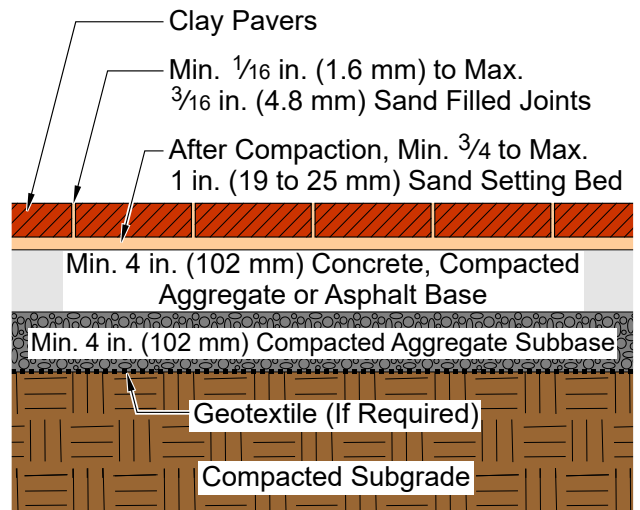


Figure 3
Typical Residential Driveway

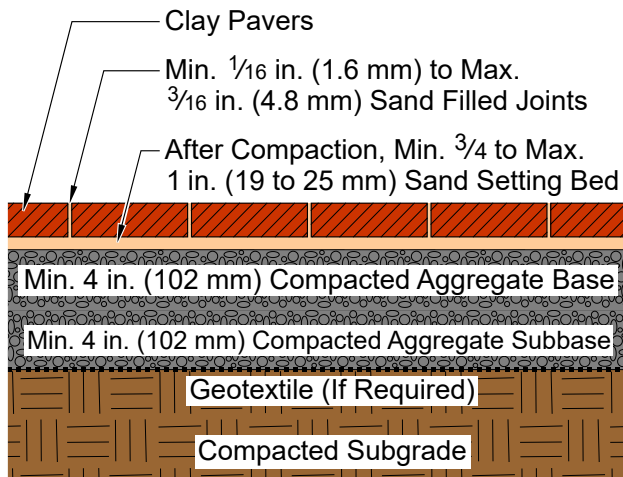


Figure 4
Typical Commercial/Pedestrian
Public Plaza/Sidewalk

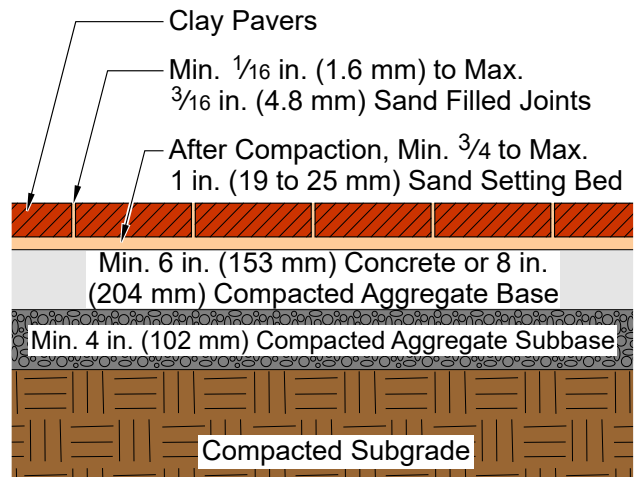


Figure 5
Typical Light Duty Vehicular

Commercial/Public Plazas and Walkways. With increased pedestrian traffic and increased risk of injury from any localized differential displacements, these types of applications require a firm pavement, similar to that of residential driveways. For plazas, however, a minimum 4 in. (102 mm) compacted aggregate base and subbase typically are used (see [Figure 4](#)). Note that for these applications on sites consisting of silty or clayey soils, geotextile should be placed on the compacted subgrade below the subbase.

The sand setting bed thickness should be spread and screeded to an uncompacted nominal thickness of 1 in. (25 mm). Once compacted, the setting bed thickness should be between a minimum of $\frac{3}{4}$ in. (19 mm) to a maximum of 1 in. (25 mm). The base typically consists of coarse aggregate (gravel) of varying gradation, compacted to a minimum thickness of 4 in. (102 mm) using mechanical tamping or vibration.

Light Duty Vehicular. For parking areas and neighborhood streets serving light duty vehicles, the brick pavement section should be similar to that of a residential driveway, but with a more substantial base. A pavement with a concrete base as depicted in [Figure 5](#) or a thicker aggregate or asphalt base is required.

Heavy Duty Vehicular. Paving systems exposed to more than 251 daily equivalent single axle loads (ESAL) from trucks or combination vehicles having three or more loaded axles are considered heavy duty vehicular applications. Such paving systems are beyond the scope of this *Technical Note* series. For further information about heavy vehicular applications, refer to *Flexible Vehicular Brick Paving—A Heavy Duty Applications Guide* [Ref. 6].

GENERAL DESIGN AND DETAILING CONSIDERATIONS

Interlock

Sand-set pavers interlock with one another by generating friction across the joints. This is the result of tightly packing sand into the joints during the vibration process. The interlock improves as the pavement is subjected to traffic. There are three types of interlock present in a sand-set paver pavement when properly constructed: vertical, horizontal and rotational interlock. Interlocked pavers cannot be readily extracted from the pavement.

Vertical interlock allows load transfer across joints between pavers. When a load is applied to one paver, a portion is transferred through sand in the joints to adjacent pavers, as shown in [Figure 6](#), distributing the load to a greater area and reducing the stress on

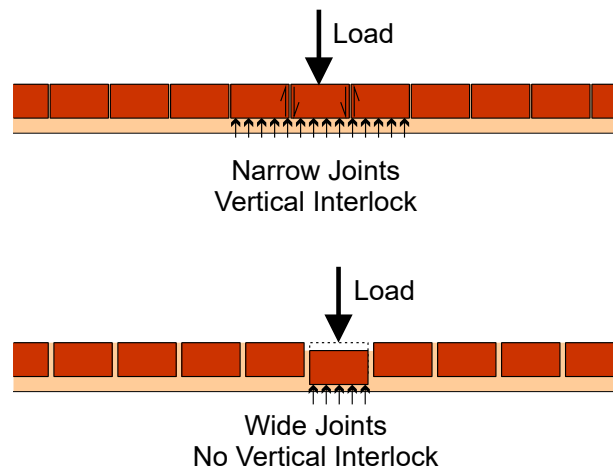


Figure 6
Vertical Interlock of Pavers

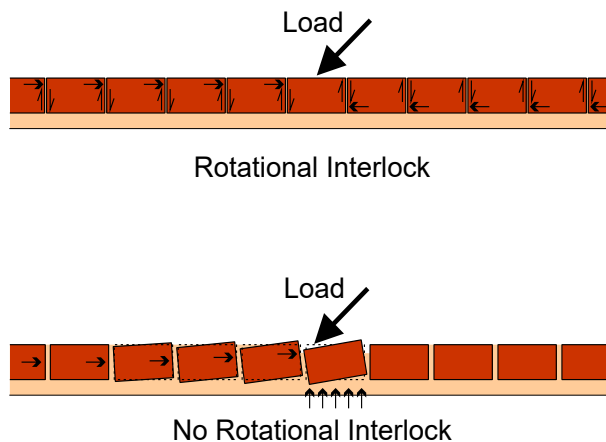
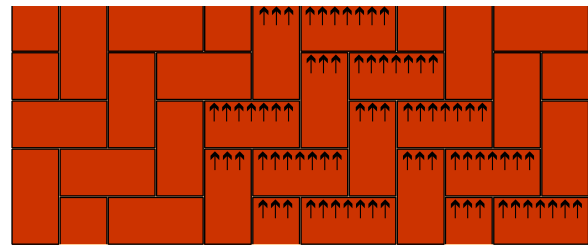
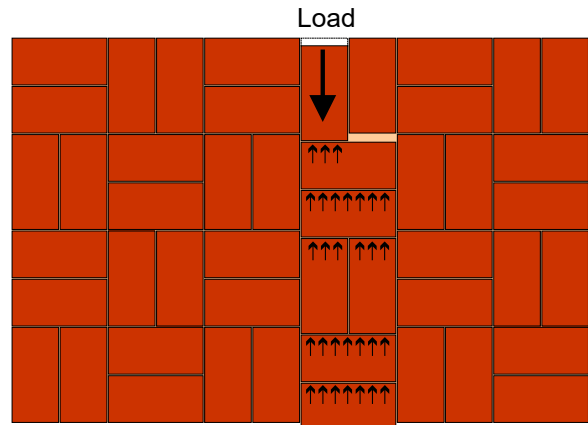


Figure 7
Rotational Interlock of Pavers



Horizontal Interlock



No Horizontal Interlock

Figure 8
Horizontal Interlock of Pavers

the sand bed and the underlying layers. Vertical interlock allows a paving layer to act as a structural layer. Without vertical interlock, the pavers do not act as a structural layer, and localized stress on the setting bed directly under a loaded paver is increased. Pavers installed on a sand setting bed should not be laid with $\frac{1}{4}$ in. (6.4 mm) joints, because this is too wide to achieve interlock, making the pavers unable to transfer load to adjacent pavers. The proper joint width is $\frac{1}{16}$ to $\frac{3}{16}$ in. (1.6 to 4.8 mm).

Rotational interlock is the result of lateral resistance from adjacent pavers and adequate edge restraints, as shown in [Figure 7](#). It is improved with full joints that support the top of the paver. Without adequate restraint, the pavers can roll in the direction of lateral loading, which may result in an irregular surface profile.

The extent of horizontal interlock depends upon the laying (bond) pattern of the pavers and the edge restraint. Patterns that have staggered joint lines allow the load to be distributed to a larger number of pavers, as shown in [Figure 8](#). This reduces joint compressive stress and the potential for horizontal creep of pavers. Continuous joints result in minimal load distribution and increased joint compressive stress, which may produce horizontal movement.

Pavement Section

Clay pavers over a sand setting bed can be installed over a flexible or rigid base, including aggregate, asphalt, cement-treated aggregate or concrete bases. For further information on bases, refer to *Technical Note 14*.

The design of the base is beyond the scope of this *Technical Note*, and the advice of a qualified and experienced pavement designer should be sought. For preliminary design, it is reasonable to assume that a minimum of 4 in. (102 mm) of concrete, cement-treated aggregate, asphalt or aggregate base will be needed for sand and gravel subgrades. For residential driveway, commercial/pedestrian and light duty vehicular applications with clay or silt subgrades, an additional 4 in. (102 mm) of aggregate subbase or base should be added to each option. Additional thickness may be required when the subgrade is susceptible to frost heave or when the pavement must support heavy axle loads from trucks.

Concrete bases should be reinforced with welded wire fabric or reinforcement bars and should have control joints spaced at 12 ft (3.66 m) intervals to control expansion and contraction. To minimize movement of slabs, detail

movement joints as shown in **Figure 9**. Control joints should have dowels or a keyway to limit vertical separation across the joint.

Vehicular Traffic

For light duty vehicular paving systems, a maximum traffic speed of 30 mph (50 kph) is considered appropriate for pavers in a sand setting bed. When frequent vehicular traffic is anticipated, attention is required to ensure that joints between pavers remain filled with sand. Higher speed applications require more vigilance, as the interlock between pavers is reduced with sand loss. Paving systems for vehicular traffic applications usually will include a compacted subbase to distribute loads (see **Figure 5**).

The designer should consider the bond pattern for vehicular traffic applications. Any pattern may be used under foot traffic. When vehicles operate on a pavement, patterns that distribute horizontal loads (i.e., loads from turning, accelerating or braking vehicles) across multiple pavers, such as herringbone, are recommended. Patterns with continuous joints, such as stack bond or running bond, are more susceptible to creep from horizontal loading. Where such patterns are used in vehicular pavements, continuous joint lines should be oriented perpendicular to the direction of vehicle travel.

Bond Patterns/Layout

The size of pavers may influence the selection of a suitable bond pattern. Pavers for use on a sand setting bed typically are manufactured in sizes that accommodate a joint width of approximately $\frac{1}{8}$ in. (3.2 mm) to encourage optimal interlock. Bond patterns such as herringbone, basket weave and others make use of the 1:2 or 1:3 ratios between the pavers' length and width to maintain the pattern and joint alignment. Pavers sized to accommodate joint widths of approximately $\frac{3}{8}$ in. (9.5 mm) do not achieve these ratios. Such pavers typically are used in pavements with mortar joints. When they are laid on a sand setting bed, only a running bond, stack bond or chevron pattern should be used, since these patterns do not depend on these ratios.

An individual clay paver's dimensions may be slightly different from the dimensions of another clay paver from the same run. The inherent variability of their dimensions is a result of the manufacturing process. Pavers may be larger or smaller within allowable tolerances of their specified size. This variability may not be consistent, because actual dimensions may be greater or smaller than the specified dimensions. As such, the pavers may not be

able to be placed in a standard modular pattern. Blending of pavers from multiple cubes during installation can overcome this issue. The installer should constantly monitor paver size during installation to ensure that the bond pattern and joint size are maintained.

When designing an installation pattern with changes in bond and color, incorporating some tolerance in the placement of certain paver features is recommended. This can be achieved by using saw cut pavers at junctions of colored areas or by allowing approximate dimensions and realistic tolerances when placing certain paver features. Two examples are depicted in **Figure 10**.

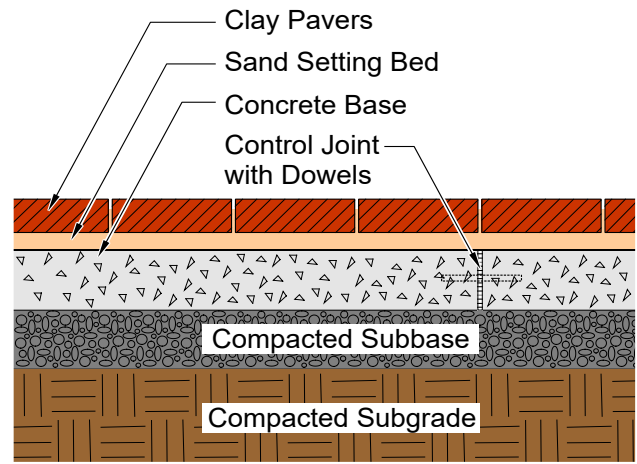


Figure 9
Control Joints

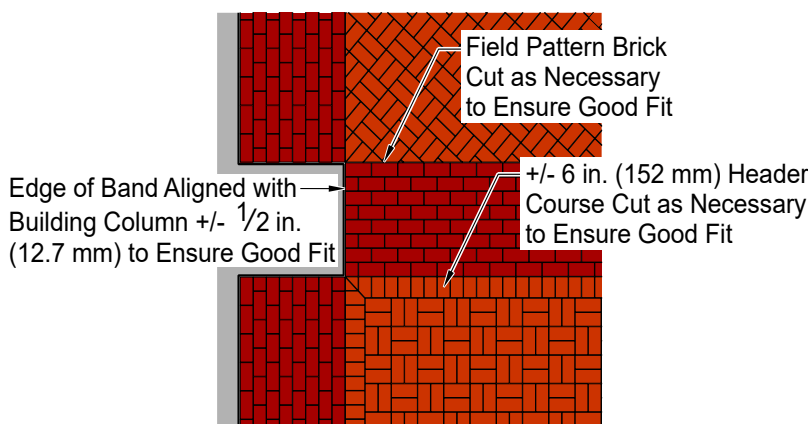
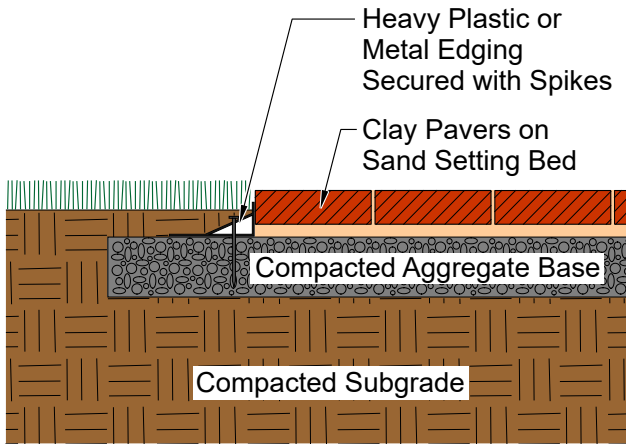
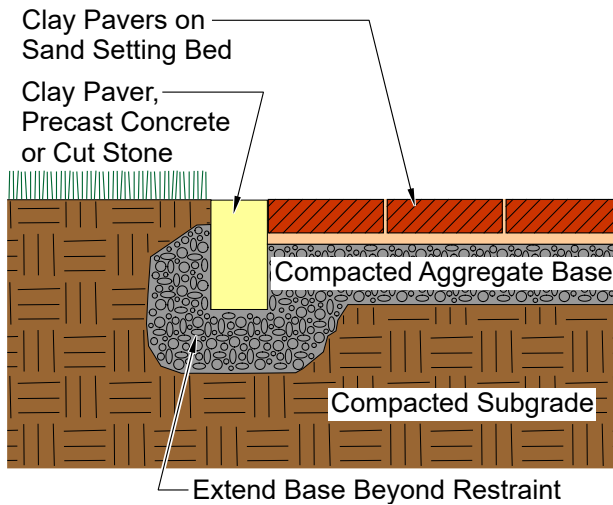


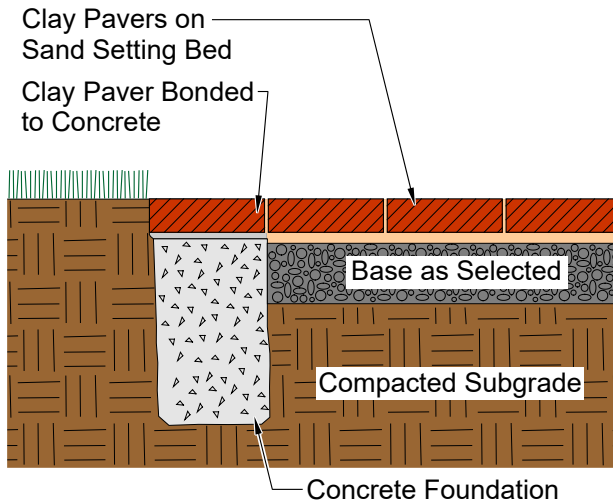
Figure 10
Pattern Options to Maintain Specified Joint Widths



(a) Proprietary Edge Restraint System



(b) Clay Paver, Precast Concrete or Cut Stone Edge Restraint

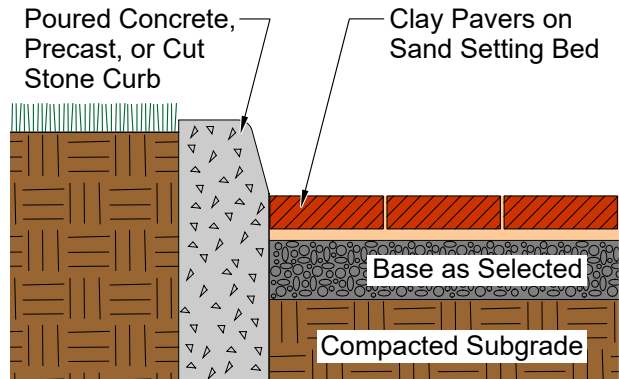


(c) Bonded Clay Paver Edge Restraint

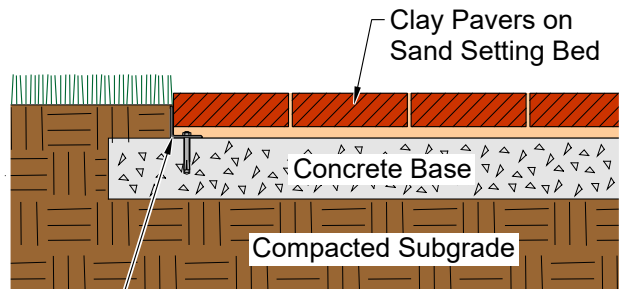
Edge Restraints

Edge restraints are critical in a pavement with a sand setting bed to enable consistent interlock and to resist horizontal loads transferred from pavers.

Selection of edge restraint will depend on pavement section and use. **Figure 11** (pages 6 and 7) presents various options, in increasing order of load capacity. Concrete curbs or steel angles attached to a concrete foundation or concrete base layer are the most robust edge restraints. They are recommended for all pavements subject to regular vehicular traffic. Edge restraints for other applications may include pavers bonded to a concrete foundation, and a range of proprietary plastic and metal edge restraint systems that are typically spiked into aggregate bases. Timber edging and concrete backing poured to restrain edge pavers may not be effective over the long term. It is important that all edge restraints have a vertical rather than inclined face for the pavers to butt against.

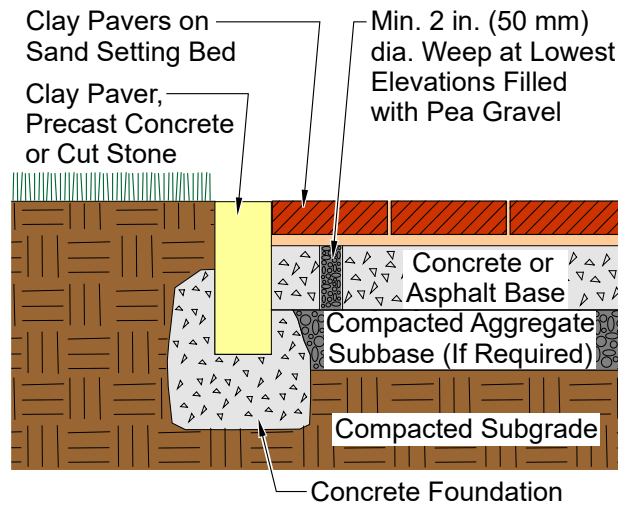


(d) Curb Edge

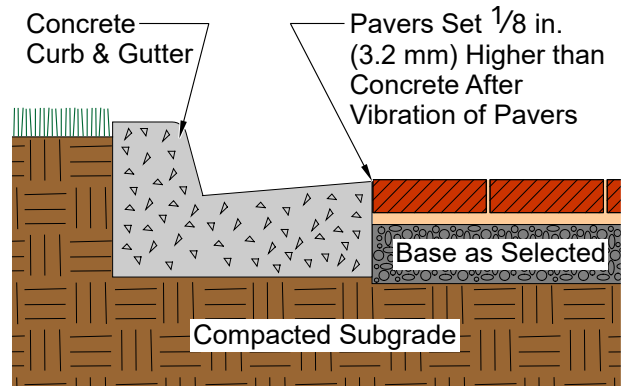


(e) Steel Angle Edge Restraint

Figure 11
Edge Restraints



(f) Clay Paver, Precast Concrete or Cut Stone Edge Restraint



(g) Poured Concrete Curb and Gutter Edge Restraint

Figure 11 (continued)
Edge Restraints

Drainage

Adequate drainage is important to the performance and durability of any clay paving system. Water should be drained from the paving system as quickly as possible. A minimum slope of $\frac{1}{4}$ in. per foot (2 percent grade) is recommended. Adequate drainage should be provided to ensure the integrity of all layers in a paving system.

A sand setting bed will continue to consolidate slightly after construction is complete. Pavers should be finished slightly higher than drainage inlets and other low edges of a pavement. This will minimize water puddling at these locations. Typically, $\frac{1}{8}$ in. (3.2 mm) will be adequate and will not present a short-term tripping hazard.

Over time, small amounts of water will migrate through sand joints. Consequently, a sand-set paving system with an impermeable base will require weep openings at low points in the pavement. Weep openings permit moisture to seep out of the pavement rather than saturating the setting bed. Even a well-compacted aggregate base may benefit from the installation of weep openings. Sand is less durable in a saturated state than when it is dry or slightly damp.

Several weep opening options are available. A small-diameter (min. 2 in. [50 mm]) pipe with ends wrapped in geotextile may be placed through the side wall of drain inlets or through edge restraints. Such weeps should be installed at spacings of 2 to 6 ft (0.60 to 1.83 m) depending on pavement geometry and profiles, environmental conditions and pavement use. As an alternative, a drainage mat may be placed vertically through the base. This may be used in conjunction with small pipes at drain inlets. For a concrete base, 2 in. diameter weeps may be cast or cored through the slab at its lowest elevations to weep water to the subbase. Fill weeps with washed pea gravel and cover with geotextile. Locating weeps away from the impact of wheel loads is necessary, since the subbase materials may be moisture sensitive.

Penetrations

Large and small features that penetrate through the paver layer should be properly detailed. These features include utility covers, tree pits, light pole bases, signposts and street furniture. Features may either penetrate the entire pavement section to an independent structure or foundation, or be anchored to a concrete subslab. Such features can present some issues in cutting the pavers to form a uniform joint around them.

Some utility covers and other frames are relatively shallow, or have buttresses, inclined faces, anchor bolts or other features that may interfere with the bottom of a paver. Where possible, features should be specified, designed and installed deeper than the setting bed. Where this is not possible, casting a concrete collar around

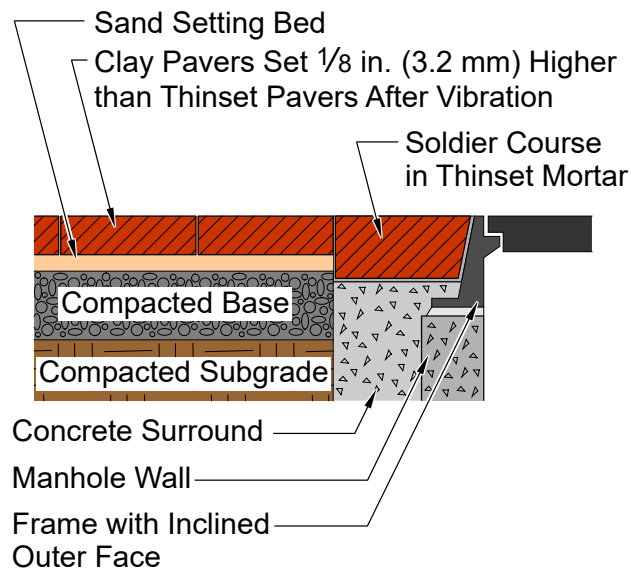


Figure 12
Large Penetration

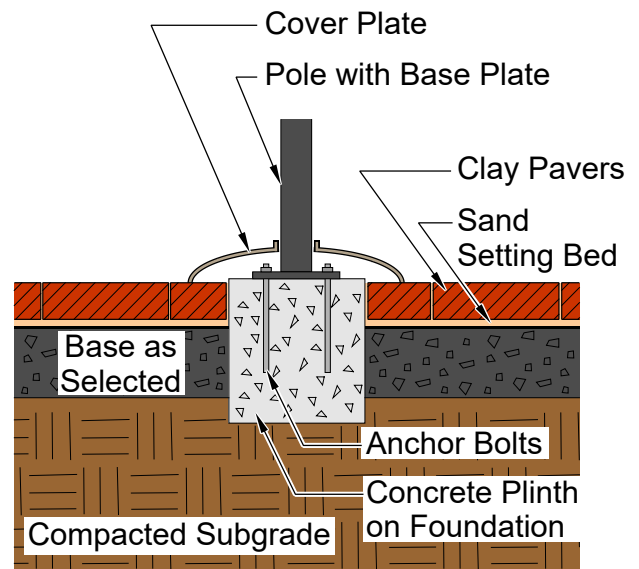


Figure 13
Small Penetration

the frame and thin-setting a header course of pavers on the concrete may clear obstructions to the sand setting bed interface, as shown in [Figure 12](#).

Accurately cutting and placing pavers against small features may prove difficult. An alternative is to construct a concrete plinth up to the pavement surface and to install a cover plate to conceal the anchorage of the feature, as shown in [Figure 13](#). This also allows easy access for repairs, without removing pavers.

MATERIALS

Subgrade

For design purposes, the subgrade is considered to be either sand/gravel or clay/silt. The latter are more sensitive to moisture and frost and may require the use of subbase layers and proper drainage to protect against shrinkage, swelling and frost heave. The advice of a properly qualified and experienced pavement designer should be sought in regard to the preparation of the subgrade.

Base and Subbase

Base materials for pavers laid in a sand setting bed may be of aggregate, cement-treated aggregate, asphalt or concrete. When a subbase is required, aggregate generally is used. Concrete should have a minimum compressive strength of 4000 psi (27.6 MPa) and should have control joints spaced a maximum of every 12 ft (3.66 m). For a more detailed discussion of base and subbase materials, refer to *Technical Note 14*.

Geotextiles

Geotextiles are used to help stabilize subgrades and prevent loss of sand under sand setting beds. Woven geotextiles that conform to ASTM D4751, *Test Method for Determining Apparent Opening Size of a Geotextile* [Ref. 5], are preferred for use directly under the bedding sand, as they maintain their integrity under loads exerting abrasion on the pavers. Nonwoven geotextiles can be used for light-traffic applications. Geotextiles should be lapped at the sides and ends of rolls a minimum of 12 in. (305 mm). Care should be taken to not locate laps directly under anticipated wheel paths. Geotextiles should extend 6 in. (152 mm) beyond potential areas of sand loss. These may be adhered in place, but they generally will stay in position once covered by the sand setting bed. Geotextiles should not be allowed to span over unfilled holes or pits in the surface of the base that are greater than 1 in. (25.4 mm).

Setting Bed Sand

A sand setting bed provides a strong support layer under pavers and accommodates variations in paver thickness to produce a smooth surface profile. A portion of setting bed sand penetrates the joints during vibration and initializes the development of interlock among the pavers. Sand for the setting bed should be clean, naturally occurring material with angular and subangular shaped particles, with a maximum size of about $\frac{3}{16}$ in. (4.8 mm). Concrete sand conforming to the requirements of ASTM C33, *Specification for Concrete Aggregate* [Ref. 1], or local department of transportation standards is recommended for use as setting bed material. This provides a more stable and durable setting bed than mason sand or screenings, which have a more rounded shape and should not be used. Sand rich in silica-based minerals is desirable, because carbonate-based minerals are softer and can break down when saturated. Manufactured limestone sand usually causes efflorescence and should be avoided unless it has a proven track record on similar projects.

Clay Pavers

A wide selection of colors and textures is available in clay pavers. Further information on clay pavers can be found in *Technical Note 14*.

Pavers generally are manufactured with their length equal to a module of their width. Two commonly specified clay paver sizes are 4 in. wide by 8 in. long (102 by 203 mm) and $3\frac{3}{4}$ in. wide by $7\frac{1}{2}$ in. long (95 by 190 mm). Other similar sizes are available, such as $3\frac{5}{8}$ in. wide by $7\frac{5}{8}$ in. long (92 by 194 mm), and several manufacturers are able to provide custom sizes. Common specified thicknesses are $1\frac{1}{2}$ in. (38 mm), $2\frac{1}{4}$ in. (57 mm), $2\frac{5}{8}$ in. (67 mm) and $2\frac{3}{4}$ in. (70 mm) [$2\frac{5}{8}$ in. (67 mm) excluding chamfered edge].

All clay pavers covered by ASTM C902, *Specification for Pedestrian and Light Traffic Paving Brick* [Ref. 2] and ASTM C1272, *Specification for Heavy Vehicular Paving Brick* [Ref. 3] can be installed on a sand setting bed. The designer should select the appropriate Application, Type and Class of the paver for the project based on aesthetics, use, abrasion resistance and the required resistance to damage from weather exposure. For more detailed information on specifying clay pavers, refer to *Technical Note 14*.

When square-edged pavers or pavers without lugs are laid with sand joints, care should be taken to ensure that they do not make direct contact with or lip under adjacent pavers. A minimum $\frac{1}{8}$ in. (1.6 mm) wide sand-filled joint should separate each clay paver to minimize potential chipping. However, the maximum joint width should be no more than $\frac{3}{16}$ in. (4.8 mm) to minimize the potential for horizontal movement under vehicular traffic. If pavers with spacers and/or a rounded or chamfered edge are installed, there is less potential for direct paver contact. When lugs are used, the potential for creep is reduced.

Jointing Sand

Sand within pavement joints creates interlock between pavers by generating friction across the joint. Larger particles present in joints reduce the potential for lateral movement. Finer particles reduce contact stresses around the larger particles, reducing the potential of the particles breaking down. The sand also accommodates the variations in paver size and reduces the potential for contact between pavers that can lead to chipping. ASTM C33 concrete sand should be placed in joints before vibration to maximize interlock at the bottom portion of joints. However, coarse particles that do not fall into joints should be brushed off the pavement surface rather than worked in. After vibration, finer jointing sand may be placed so that it penetrates to the bottom of the joints and achieves better filling. When the typical joint dimension exceeds $\frac{3}{16}$ in. (4.8 mm), stabilized sand or joint sand stabilizer should be used.

Joint Sand Stabilizers

In conditions where potential sand loss or high joint permeability may not be desirable, a joint sand stabilizer is recommended. These conditions include intensive cleaning practices, high surface water flows and flat areas with moisture-sensitive subgrades. There are several types of joint sand stabilizers. These include breathable polymeric liquids that can be sprayed onto the pavement surface and squeezed into the joints with a squeegee, as well as dry products that can be mixed with the joint sand before installation. Pretreated sands also are available for joint filling. Strict adherence to the stabilizer manufacturer's recommendations is required to achieve successful installations. When selecting a stabilizer, it is important to choose one with a proven history that does not discolor

the surface or peel over time. The paver manufacturer's recommendation regarding joint sand stabilizers should be followed. Joint sand stabilizers should be applied to the completed paver surface. Stabilizers should be applied to the pavement surface before the application of other coatings to enhance the appearance of the pavers or to protect against staining. For further guidance on selecting coatings for use on brick pavements, refer to *Technical Note 6A*.

INSTALLATION AND WORKMANSHIP

Subgrade

The subgrade should be brought to the proper level and cleared of organic material. Compaction should comply with ASTM D698, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))* [Ref. 4] to 98 percent of standard Proctor density clay and 100 percent maximum dry density for sand/gravel. For a more detailed discussion of subgrade preparation, refer to *Technical Note 14*.

Base and Subbase

Base and subbase materials should be placed per the design. Aggregate should be compacted in accordance with ASTM D698 to 98 percent of standard Proctor density. The maximum variation under the setting bed should be $\pm\frac{3}{16}$ in. (4.8 mm) when a 10 ft (3.05 m) straightedge is laid on the surface. The minimum slope of the concrete base surface should be 1 in. (25.4 mm) in 4 ft (1.22 m) to allow for drainage. For a more detailed discussion on the installation of base and subbase materials, refer to *Technical Note 14*.

Setting Bed

Whenever possible, the direction of installation should be planned to protect the paving against premature use or damage by rain or other construction activities. The surface of the underlying base material should be thoroughly clean and dry before installation of the bedding sand. Elevations should be verified to ensure that the sand setting bed will be a consistent thickness after compaction. The setting bed should not be used to bring the pavement to the correct grade. Isolated high and low spots should be corrected before sand placement to avoid an uneven pavement surface resulting from variable sand setting bed thicknesses. Lines should be established for setting out the pattern. The contractor should become aware of size variations in the pavers to maintain the pattern without localized opening or closing of joints to meet a fixed edge. All areas of potential sand loss should be covered with geotextile.

Screed rails should be set on the surface of the base to proper line and level. They are typically placed 8 to 12 ft (2.44 to 3.66 m) apart, or closer when working on a grade. An allowance should be made in the thickness of the setting bed for compaction of bedding sand as pavers are installed, as well as additional consolidation in service. An experienced contractor will be aware of the proper thickness for different conditions to achieve the correct long-term surface profiles. The bed thickness should be established so that when the pavers are compacted, their top surface will be $\frac{1}{8}$ in. (3.2 mm) above the required grades to allow for limited settling in service. After compaction, the thickness of the sand setting bed should be between a minimum of $\frac{3}{4}$ in. (19 mm) to a maximum of 1 in. (25 mm).

To prevent disturbance, setting bed sand should not be spread too far ahead of the paver laying face. Voids left after removing the screed rails should be filled. The screeded bedding sand may be affected by wind or rain, as well as by wayward construction operations. If sand is disturbed, it should be loosened and rescreeded. Extensive areas of screeded sand should not be left overnight unless they are properly protected from disturbance and moisture. The moisture content of setting bed sand should be kept as uniform as possible to minimize undulations in the pavement surface. The sand should be kept in a damp condition conducive to packing. Water should not be applied except by very light misting. Stockpiled sand should be covered to protect it from wind and rain.

Paver Installation

The pavers are laid on the setting bed working away from an edge restraint or the existing laying face while following the pattern lines that have been established. Full pavers should be laid to the required pattern with $\frac{1}{16}$ to $\frac{3}{16}$ in. (1.6 to 4.8 mm) wide joints. The optimum joint width for vehicular traffic is between $\frac{1}{16}$ and $\frac{1}{8}$ in. (1.6 and 3.2 mm), but some wider joints may be required with Application PS pavers, and particularly with Application PA pavers. Lugs enable the correct joint width to be achieved when the pavers are placed in contact with one another.

Pavers should not be forced together, resulting in excessive contact, because this may cause them to chip during installation or compaction. At least two cubes of each color of pavers should be drawn from at one time, and the manufacturer's recommendations on color blending should be followed. The pavers should be adjusted to form straight pattern lines while maintaining the correct joint widths.

Several feet of pavers should be installed before beginning to add cut pavers as infill against edge conditions. Bench-mounted masonry saws are the best means of cutting the pavers to achieve a neat edge and a vertical cut face. Use of a wet saw or dust collection system is recommended to control dust. Guillotine cutters also may be used, but their cuts typically are not as straight and neat. Convex curves can be formed using multiple cuts, but this requires skill to meet allowable joint tolerances. Concave curves are very difficult to form and should be avoided when possible.

Pavers should be compacted at the end of each day to prevent any damage while left unattended. The pavement surface should be compacted using a plate compactor. These typically have a plate area of 2½ to 3 sq ft (0.23 to 0.28 sq m) and operate at a frequency of 80 to 100 Hz. To prevent pavers from chipping during vibration, a little bedding sand material can be swept into the joints, or the underside of the plate compactor can be fitted with a rubber mat. Pavers also can be covered with a sheet of geotextile or sheets of plywood during vibration. For molded pavers, vibration is especially important, since irregularities and dimensional variations on the underside could lead to air gaps or improper support if not properly compacted into the sand setting bed. Compaction should not be carried out within 4 ft (1.2 m) of unfinished edges.

The vibrated surface should be slightly above adjacent pavement surfaces, drainage inlets and channels to allow for secondary compaction of the bedding layer under traffic. The maximum variation in surface profile should be less than ⅜ in. (4.8 mm) in 10 ft (3.05 m). Water should drain freely from the surface and not form puddles. Lipping between adjacent pavers should not be greater than ⅛ in. (3.2 mm) if the pavers have chamfers, or ¼ in. (1.59 mm) if they have square edges.

After vibration of the pavers to finished elevations, dry fine-grained jointing sand is brushed over the surface of the pavement and additional vibration is undertaken until all the joints are completely filled with sand. Surplus jointing sand should be maintained on the surface to enhance the process of joint filling. Typically, the sand should be level with the bottom of the chamfer or approximately ⅛ in. (3.2 mm) below the top of square edge pavers.

Joint Sand Stabilizers

The paver manufacturer's recommendation regarding joint sand stabilizers should be followed. Jointing sand that is pretreated with a stabilizer product should be brushed or blown off the pavement surface as soon as possible and not be allowed to become stuck in the surface texture of the pavers. If pretreated sand or a joint sand additive is used, then the stabilizer should be activated by lightly misting the surface with water. If a liquid joint sand stabilizer is used, it should be sprayed onto the pavement surface and forced into the joints with a squeegee. It may be necessary to fill the tops of the joints with the liquid several times before it sets to achieve adequate penetration. The stabilizer manufacturer's instructions should be followed closely, because each stabilizer is slightly different. Probing several joints to verify that the sand is stabilized to an adequate depth of approximately two times the joint width — rather than just forming a crust — is recommended.

MAINTENANCE

Cleaning

Sand-set pavers can be kept clean in most environments by regular sweeping. In situations that lead to a greater degree of buildup of grease, tire marks or other stains, the pavers can be cleaned by pressure-washing. The sand-filled joints generally are resistant to this treatment if the nozzle surface is clear and the water jet is not directed along the joints. Aggressive pressure-washing can cause localized removal of the joint filling material and can even undermine the pavers. More stubborn stains, including paint and gum, can be cleaned by scraping off the hard residue and then scrubbing with a stiff-bristled brush and a proprietary cleaner or scouring powder. In damp or shady areas where moss and lichen have grown in the joints, these can be killed with a bleach-water mixture or with proprietary treatments.

Snow Removal

Snow prevention and removal can be carried out by hand, by machine or by chemicals. Hand methods include shovels and brooms. Mechanical methods include snow blowers, snowplows, and buckets or brushes attached to tractors. Shovel and machine removal methods can chip the edges of the pavers, particularly if excessive lipping is present. This equipment should be properly adjusted so that it does not damage the pavement surface.

Skid-steer snow removal equipment also may move pavers, causing distortion of pattern lines and some chipping of the pavers if the equipment is driven aggressively. When tractor and particularly skid-steer mounted equipment is used, the pavement must be able to support the wheel loads without damage.

A range of anti-icing and deicing chemicals are used for pavements. Deicing chemicals can cause thermal shock in a pavement by “supercooling” the pavement surface. This can lead to spalling or surface damage on pavers of Class NX or MX pavers. Deicing agents should be used with care, as chemical residue left on the surface can penetrate the joints and result in staining and efflorescence. Class NX pavers should not be used where subject to freezing.

Resanding

Over time, due to wind, rain and other means, the sand within the top portions of joints can be eroded. Therefore, the joints should be periodically resanded using the same methods described for applying jointing sand after vibration of the pavers.

Repairs

Underground utilities commonly pass beneath paved areas on congested sites. Access to these utilities frequently is required for repair or to install new lines. Sand set pavers readily accommodate such work, as they can be removed and reinstated with little evidence of the work having been carried out. Repairs to the paving also can be made if they are overloaded or otherwise damaged.

Removal can be undertaken by prying or breaking out the initial paver so that it can be removed without damaging adjacent units. It is then possible to work the adjacent pavers loose using a hammer and chisel or pry bars in the joints and under the paver. Some chipping of the pavers should be expected, and a few spare pavers will be required for reinstatement. The bedding sand can be removed as necessary. Traffic should be kept at least 4 ft (1.2 m) from the unrestrained edge. If a trench is open for a significant amount of time, then the adjacent pavers should be temporarily restrained to stop them from moving laterally. Trenches should be filled with proper care paid to compaction of the backfill. The base should be replaced to match the original section.

To reinstall the pavers, the bedding sand should be replaced with an adequate pressure to allow for compaction. The pavers should be replaced in the appropriate pattern and fresh sand spread into the joints. The repair area should be leveled by hammering on a wooden pack if the area is small or with a plate vibrator if it is large enough. The joints should be refilled with sand and new stabilizer applied if necessary.

SUMMARY

Pedestrian and light duty vehicular pavements of clay pavers laid on a sand setting bed provide the most cost-effective system for pedestrian and light duty vehicular pavement. When properly constructed, the interlock of the pavers provides the necessary stability for the desired service life of the pavement. This *Technical Note* provides the basic information required to properly select materials, design, detail and construct brick pavements over sand setting beds. Further information about the properties of other brick pavements and concepts not unique to sand setting beds is discussed in the *Technical Note* 14 series.

The information and suggestions contained in this Technical Note are based on the available data and the combined experience of engineering staff and members of the Brick Industry Association. The information contained herein must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information contained in this Technical Note are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.

REFERENCES

1. ASTM C33, Standard Specification for Concrete Aggregate, *Annual Book of Standards*, Vol. 04.02, ASTM International, West Conshohocken, PA, 2016.
2. ASTM C902, Standard Specification for Pedestrian and Light Traffic Paving Brick, *Annual Book of Standards*, Vol. 04.05, ASTM International, West Conshohocken, PA, 2016.
3. ASTM C1272, Standard Specification for Heavy Vehicular Paving Brick, *Annual Book of Standards*, Vol. 04.05, ASTM International, West Conshohocken, PA, 2016.
4. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)), *Annual Book of Standards*, Vol. 04.08, ASTM International, West Conshohocken, PA, 2016.
5. ASTM D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile, *Annual Book of Standards*, Vol. 04.13, ASTM International, West Conshohocken, PA, 2016.
6. *Flexible Vehicular Brick Paving – A Heavy Duty Applications Guide*, Brick Industry Association, Reston, VA, 2004.