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FACILITIES ENGINEERING APPLICATIONS PROGRAM

USER'S GUIDE

USER'S GUIDE: CONCRETE BLOCK PAVEMENT

by

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U.S. Army Engineering and Housing Support Center
Fort Belvoir, VA 22060-5516

Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities

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A concrete paving block is an accurately dimensioned combination of well-graded aggregates and hydrated portland cement which fits closely together with other paving blocks to form a low-maintenance, high-strength pavement surface. The concrete block pavement resists heavy, concentrated, or abrasive loads and chemical spills involving fuel, hydraulic fluid, and other materials.

This report includes discussions of the description, applications, benefits, limitations, costs, and recommended uses for concrete block pavements. Information on a concrete block pavement demonstration site is also provided.

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USER'S GUIDE: CONCRETE BLOCK PAVEMENT

PART I: EXECUTIVE SUMMARY

Description

A concrete block pavement is, for the most part, designed and constructed using typical flexible pavement methods. The main difference is that the concrete block pavement is surfaced with a tight pattern of brick-sized concrete blocks placed over a thin sand bedding layer. The resulting surface is flexible and yet durable in that it is constructed with rigid materials.

Application

Concrete block pavements are used to provide a low-maintenance, high-strength pavement surface that resists heavy, concentrated, or abrasive loads and chemical spills involving fuel, hydraulic fluid, and other materials. Concrete paving blocks are uniquely applicable whenever a flexible pavement structure and a durable, high-strength surfacing are both required.

Benefits

Concrete block pavements can support large, concentrated loads and heavy, abrasive traffic, even over relatively weak subgrades. The concrete block surface is resistant to damage from the environment and from fuel and oil spillage. Block pavements allow for easy access to the subsurface for utilities or subgrade repair and the paving blocks are reusable for resurfacing the repair area.

Limitations

Concrete block pavements are generally limited to low speed (less than 40 mph) applications due to rideability or smoothness considerations. The construction of the paving block surface is usually labor intensive with the surfacing rate directly related to the number of block layers available.

Concrete block pavements allow water to infiltrate the underlying layers; therefore, no moisture sensitive base materials may be used.

Costs

Surfacing costs for concrete block pavements have varied from approximately $1.00 to $5.50 per sq ft. Project size is a significant factor in determining the unit price with the larger projects usually priced in the lower ranges. Local differences in labor, material, and transportation costs also contribute to the wide range of unit prices for this technology. In certain circumstances, the unit cost of a concrete block pavement may be near that of an asphalt concrete (AC) surfacing, but in most circumstances, the cost of the block pavement ranges from 1.5 to 2 times greater. The unit cost of a concrete block surfacing has also ranged from 50 percent less than to 50 percent greater than the unit cost of a portland cement concrete (PCC) surfacing. The usual higher initial cost of a concrete block pavement is offset in the life-cycle analysis due to its low maintenance costs.

Recommendations for Use

Concrete block pavements are recommended for use whenever heavy, concentrated, or abrasive traffic conditions exist and when fuel, oil, and chemical spills are likely. Concrete blocks should be considered whenever a flexible pavement structure is required, but a durable, rigid surfacing material is also needed.

Points of Contact

Points of contact regarding this technology are:

Technical:

Director
US Army Engineer Waterways Experiment Station
ATTN: CEWES-GP-Q (Mr. Gary L. Anderton)
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
Telephone: 601-634-2955
Facsimile: 601-634-3020

US Army Engineering and Housing Support Center:

Commander
US Army Engineering and Housing Support Center
ATTN: CEHSC-FB-P (Mr. Joe Sicuranza)
Fort Belvoir, VA 22060-5516
Telephone: 703-704-1574
Facsimile: 703-704-1610

Demonstration Site:

Commander
US Army Corps of Engineers, Baltimore District
Aberdeen Area Office
ATTN: CENAB-COF-AA (Mr. Robert Roll)
Aberdeen Proving Ground, MD 21005-5201
Telephone: 410-278-4095

PART II: PREACQUISITION

Description of Concrete Block Pavements

A concrete paving block is an accurately dimensioned combination of well-graded aggregates and hydrated portland cement which fits closely together with other paving blocks to form a pavement surface. The blocks are manufactured in a wide variety of shapes, some of which are shown in Figure 1. Generally, the blocks are about the size of a common brick with a thickness of 2-3/8 to 4 in., and they weigh about 9 to 12 lb each.

A thin, 1- to 2-in.-thick leveling course of sand is used under the blocks. The blocks are generally laid by hand on the sand layer. The blocks are then compacted with a manually operated vibratory plate compactor which seats the blocks in the sand layer, compacts the sand layer, and forces some sand into the joints between the blocks. A fine-graded masonry sand is spread over the compacted block layer and swept into the small joint spaces between the blocks. More passes are made with the vibratory plate compactor to compact and wedge the sand into the joints. The densified sand joints provide vertical and horizontal stability in the block layer. A base and subbase course under the leveling course provides structural support similar to that of a conventional flexible pavement. Figure 2 shows a typical cross section of a block pavement. Many different patterns for laying blocks are possible, and several patterns are illustrated in Figure 3. The herringbone pattern laid at a 45-deg angle to the normal direction of traffic (Figure 4) is recommended for pavements designed to carry vehicular traffic.

Previous research at the US Army Engineer Waterways Experiment Station (WES) using heavy truck and tank traffic (WES TR GL-83-3) has resulted in interim design guidelines for the Corps of Engineers. The guidelines for design are similar to those for flexible pavements, except that the block and sand bedding layer is assumed to be equivalent to 6.5 in. of asphalt concrete surfacing. This equivalency factor is based upon the standard 60- or 80-mm-thick paving blocks.

Applications

Concrete block pavements provide a low-maintenance, high-strength pavement surface that resists heavy, concentrated, or abrasive loads and chemical spills involving fuel, hydraulic fluid, and other materials. With proper design for shear strength and densification in the underlying layers, concrete block pavements are able to withstand concentrated and heavy loads, even when constructed over soils which are prone to settlement or frost heaving. Concrete block pavements should be considered when any of these traffic or soil conditions exist, especially whenever a durable, flexible surfacing is required.

A block pavement's unique combination of characteristics, such as strength, abrasion resistance, flexible structure, and esthetics, makes it applicable to many pavement uses. Block pavements are visually appealing alternatives for any pedestrian trafficked areas such as sidewalks, plazas, and courtyards. From a structural standpoint, concrete block pavements are well suited for effectively carrying tracked vehicle traffic on tank trails, hardstands, and motorpool areas. Heavily trafficked roads and streets are also areas where paving blocks should be considered. Other pavement areas well-suited for paving blocks include port facilities, loading terminals, and any low-speed (<40 mph) traffic areas of an airfield.

Limitations/Disadvantages

The use of concrete block pavements for vehicular traffic should be limited to those areas where traffic speeds will be less than 40 mph. Rideability or smoothness problems may occur at speeds greater than 40 mph if the pavement has incurred uneven settlements or displacements. High speed traffic has also been known to pull loose jointing sand from a new concrete block pavement.

The construction of the concrete block and sand bedding layers is usually labor intensive, requiring more man-hours when compared to typical pavement surfacings. With the typical hand-placement of these layers, the surfacing rate is directly related to the number of block layers available. Mechanical placement of the sand and block layers is an evolving technology and will likely help to alleviate this disadvantage for larger projects in the future.

The numerous sand-filled joints between individual concrete blocks in the pavement can allow surface water to soak into the underlying base and subbase layers. A new concrete block pavement can have up to 20 percent initial permeability to surface water which decreases over time. To prevent undo settlement or frost-heave problems, no moisture sensitive materials should be used in the underlying pavement layers.

FEAP Demonstration/Implementation Site

Site conditions

In FY89 a concrete block pavement demonstration project was conducted at Aberdeen Proving Ground, Maryland. The demonstration site at Aberdeen Proving Ground was identified as an unsurfaced tank road intersection located on the outer rim of the Tank Retrieval Range Area. The intersection brought four range roads together near a tracked vehicle motor pool area. The traffic count for this intersection was estimated at 10 M-88 (56 ton) tank retrievers and 10 M-578 (30 ton) tracked vehicles per day. Approximately 12,000 sq ft of the existing gravel surfaced intersection was scheduled for reconstruction using the concrete paving blocks as the new pavement surfacing.

The existing subgrade was relatively weak and when combined with heavy seasonal rains, the intersection required constant maintenance and regrading in order to remain functional. An economical surfacing of the intersection required a flexible pavement in order to withstand the settling conditions caused by the weak subgrade. A traditional flexible pavement surfacing, such as asphalt concrete, would not have withstood the abrasive action of the turning tracked vehicles, however. The combination of a soft subgrade and tracked vehicle traffic made the Aberdeen Proving Ground site a good candidate for the concrete paving block demonstration.

Construction techniques

The first step in the construction process was to erect silt fence barriers around the intersection to prevent excessive silt runoff during the earthwork stage. Next, a total of 27 in. of the existing soil was removed, and the existing subgrade was compacted to at least 90 percent of the CE-55 maximum density. A geotextile was placed on top of the compacted subgrade, and a select-fill subbase material was spread and compacted over the geotextile in several lifts for a total subbase thickness of 19 in. To complete the

base and subbase construction, a 4-in.-thick crushed stone base course was placed and compacted over the subbase.

After the final compaction and grade requirements for the base course were achieved, a cast-in-place concrete curb was built around the intersection area. A commercial slipform type curb machine was used to place the 6-in. wide by 10-in. high curb. The concrete curb was constructed at a 3-1/2-in. height differential from the surface of the base course to match the final thickness of the paving block and sand bedding layers. The curb would act as the required edge restraint to prevent the paving blocks from shoving under traffic.

Once the concrete curbs had sufficiently cured, construction of the paving block system began. A sand bedding layer was placed over an area of the compacted base estimated to equal to 1 day's coverage of paving blocks. The bedding sand was dumped and spread over this area (Figure 5) with the use of screeding pipes. The pipes were 1-1/4 in. outside diameter and were used along with a wooden screeding board to achieve the specified 1-1/4 in. initial depth. After screeding the 1-1/4 in. sand bedding layer on both sides of the screeding pipe, the pipe was carefully pulled and the resulting void in the sand layer was filled and screeded with a small piece of wood mounted on a broom handle.

The paving blocks were hand laid in a herringbone pattern beginning at the center edge of one of the road entrances (Figure 6). The paving blocks were placed directly on the 1-1/4 in. sand bedding layer. The resulting height differential at the curb was 3/4 in. (Figure 7) to allow for 1/2-in. settlement of the sand bedding layer during compaction and an additional 1/4-in. estimated settlement of the underlying layers under traffic.

Near the end of each day's production, the newly laid paving blocks were compacted with several passes of a manually operated vibratory plate compactor (Figure 8). Once the paving blocks had been compacted, a fine-graded masonry sand was spread over the paving blocks (Figure 9) and broomed into the joints. Several passes of the vibratory plate compactor consolidated this jointing sand (Figure 10). The spreading and vibrating of the jointing sand was repeated several times until the joint was filled.

By the end of each working day, all areas of screeded bedding sand were covered by paving blocks to prevent disturbance of the sand bedding layer before block placement and compaction. The paving block installation for the

entire 12,000 sq ft intersection was completed in approximately 16 working days. The paving block installation crew generally consisted of one person screeding sand and trimming in the edges, two people laying the paving blocks and two people carrying the paving blocks from nearby pallet stacks to the block layers.

Performance monitoring

WES personnel visited the demonstration site twice during the first year of use to observe the concrete block pavement's performance. No apparent damage to the block surfacing had occurred during this initial traffic period. Also, straightedge measurements taken throughout the intersection indicated that no significant rutting or settlement had occurred. Local personnel were very pleased with the initial performance of the concrete block pavement intersection.

Personnel representing the US Army Engineer District, Baltimore, visited the demonstration site in August 1992. At this time the concrete block pavement had been in service for 3 years. Visual observations and straightedge measurements again indicated that the pavement had maintained its structural integrity. Local personnel reported that no maintenance activities had been performed on the block pavement and that the pavement users continued to be pleased with its performance.

Life-Cycle Costs and Benefits

The total cost of the paving block project at Aberdeen Proving Ground was $126,743. This cost included all subbase and base course work, the geotextile placed beneath the subbase, and all related incidentals and miscellaneous expenses. The cost of obtaining and placing the paving blocks including all block and sand materials, labor, and equipment charges was $51,431. This translates into a cost of about $4.29 per sq ft for the paving blocks on this job. The elimination of continual maintenance on this intersection (including regrading, resurfacing, drainage reconstruction, and other work) will result in long-term savings for the installation.

It was estimated that it would have cost approximately the same amount to build an asphalt concrete surfaced pavement structure capable of carrying the same traffic loads at this site. Building such an asphalt concrete pavement would not have been advisable however, as the abrasive action of the turning

tracked vehicles would have significantly shortened the service life of an asphalt concrete surface. Because of the relatively small surface area of the intersection, it was estimated that a portland cement concrete (PCC) pavement designed for the demonstration site would have cost between 10 and 30 percent more than the paving blocks for initial construction. Maintenance costs would likely have been high for a PCC pavement, resulting from costly crack repair, slab failures, and moisture damage. The concrete block pavement is expected to require virtually no maintenance throughout its 20-year design life.

Advantages/Benefits

There are many advantages in using concrete paving blocks under certain conditions. Weighing these advantages against the disadvantages of using concrete paving blocks is a much easier task when specific site conditions such as subgrade quality, material availability and cost, and traffic conditions are known. Although certain site conditions may create special benefits for using paving blocks, the following list comprises the major reasons for using paving blocks as a pavement surfacing. Concrete paving blocks:

a. Provide a flexible pavement surface which is composed of durable, rigid materials.

b. Provide a low-maintenance or zero-maintenance pavement surface.

c. Can support large concentrated loads and heavy, abrasive traffic.

d. Can support heavy loads over relatively weak subgrades.

e. Are high-quality pavement materials as the blocks are centrally manufactured and tested before going to the jobsite.

f. Are resistant to environmental damage (e.g. freeze-thaw).

g. Are resistant to damage from fuel and oil spillage.

h. Allow for easy access to subsurface for utilities or subgrade repair.

i. Are re-usable (90 - 95 percent) after removing from an existing pavement surface.

j. Are constructable at any ambient temperature.

k. Negate traffic delays because of curing (in relation to PCC).

l. Offer good skid resistance, wet or dry.

m. Are aesthetically pleasing.

PART III: ACQUISITION/PROCUREMENT

Potential Funding Sources

Typically, installations fund the implementation of Pavements and Railroads technologies from their annual budgets. However, the annual budget is always underfunded and normally the Pavements and Railroads projects do not compete well with other high visibility/high interest type projects. As a result, it is in one's best interest to seek all of the funds possible from other sources when the project merits the action. Listed below are some sources commonly pursued to fund projects.

a. Productivity program. See AR 5-4, Department of the Army Productivity Improvement Program for guidance to determine if the project qualifies for this type of funding.

b. Facilities Engineering Applications Program (FEAP). In the past, a number of Pavement and Railroad maintenance projects located at various installations were funded with FEAP demonstrations funds. At that time, emphasis was placed on demonstrating new technologies to the Directorate of Engineering and Housing (DEH) community. Now that these technologies have been demonstrated, the installations will be responsible for funding their projects through other sources. However, emphasis concerning the direction of FEAP may change in the future; therefore, one should not rule out FEAP as a source of funding.

c. Special programs. Examples of these are as follows:

   (1) FORSCOM mobilization plan which may include rehabilitation or enlargement of parking areas and the reinforcement of bridges.

   (2) Safety program which may include the repair of unsafe/deteriorated railroads at crossings and in ammunition storage areas.

   (3) Security upgrade which may include the repair or enlargement of fencing.

d. Reimbursable customer. Examples of this source are roads to special function areas such as family housing or schools and airfield pavements required to support logistical operations.

e. Special requests from MACOMS.

f. Year end funds. This type of funding should be coordinated with the MACOMS to ensure that the funds will not be lost after a contract is advertised.

g. Operations and Maintenance Army. These are the normal funds used for funding pavement and railroad projects.

Technology Components and Sources

Components of this technology which must be procured to construct a concrete block pavement are project design (may be accomplished in-house or contracted out), construction of pavement sublayers and edge restraint, and placement of the concrete block surfacing. A paving contractor is required to construct the pavement sublayers and edge restraint. A contractor with experience in the construction of concrete block pavements is required to place or at least supervise the placement of the concrete block and sand bedding layers.

All of the items used in the construction of concrete block pavement sublayers and edge restraints are conventional paving materials, equipment, and procedures; therefore, no special materials or procedures are required. The items used in the construction of the concrete block surfacing are particular to the concrete block paving industry, but are relatively easy to procure. These items include masonry sand, concrete paving blocks, pipes and boards for screeding the bedding sand, a manually operated vibratory plate compactor, and a masonry saw or splitter for trimming in the pavement edge.

Concrete block manufacturers and paving contractors experienced with concrete blocks are found throughout the United States and in many other parts of the world. A listing of concrete block manufacturers and paving contractors in the United States and Canada may be obtained by contacting:

National Concrete Masonry Association
Concrete Paver Institute
3202 Horse Pen Road
Herndon, VA 22071
Telephone: 703-713-1900
Facsimile: 703-713-1910

Procurement Documents

A specification on concrete block pavements is available to provide assistance in completing project specifications. Design and construction guidance is also available in several WES technical reports. The available guidance includes:

a. CEGS-02518, "Concrete Block Pavement"

b. Technical Report GL-83-3, "Concrete Block Pavements," US Army Engineer Waterways Experiment Station, Vicksburg, MS.

c. Technical Report GL-91-1, "Concrete Paving Blocks: Facilities Engineering Applications Program (FEAP) Demonstration, FY89, " US Army Engineer Waterways Experiment Station, Vicksburg, MS.

d. Technical Report GL-91-12, "Concrete Block Pavement for Airfields," US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Procurement Scheduling

There are virtually no special scheduling considerations required to implement the concrete block paving technology. Normal construction contract schedules should be established that would allow adequate design and plan preparation time, design review and approval, contract preparation, advertising and award, and construction time. Placement of the concrete block surfacing will typically require more time than that required by other pavement surfacing techniques, and will be directly related to the size of the project and the block paving crew.

PART IV: POST ACQUISITION

Initial Implementation

Equipment

The equipment required to construct the typical concrete block pavement surfacing includes pipes and wooden boards for screeding the bedding sand, a manually operated vibratory plate compactor, and a masonry saw or splitter for trimming in the pavement edge with cut blocks. On some larger block pavement projects, additional equipment has included an asphalt paver for laying the bedding sand, a mechanical block layer, and a large steel wheel or rubber-tired roller for proof rolling.

Material

The materials required to construct the typical concrete block pavement surfacing include the bedding sand, the jointing sand, and the concrete paving blocks. The physical properties required for each of these materials are described by respective ASTM Standards, which are referenced in CEGS-02518, "Concrete Block Pavements." There will be a site-specific choice of block color, block shape (rectangular is recommended for most applications), and block thickness (60-mm for pedestrian traffic, 80-mm for vehicular traffic, and 100-mm for some heavy industrial applications).

Personnel

Personnel experienced in concrete block paving should be used to construct the concrete block surfacing. At the demonstration site, the block paving work was contracted out to a local contractor who specialized in block pavements. Installation personnel provided project design, inspection, and contract administration.

Procedure

The general procedure used to construct a concrete block pavement includes the following steps:

a. Construct subgrade, subbase, and base course layers in a fashion similar to that used for other flexible pavements.

b. Construct a concrete (curb-type) edge restraint around the perimeter of the block pavement area wherever existing pavement surfacing (asphalt concrete or portland cement concrete) does not exist to act as the required edge restraint.

c. Screed a 1- to 2-in.-thick layer of bedding sand on top of the compacted base course, covering an area which can be covered with paving blocks during the same day.

d. Lay the paving blocks on the bedding sand in the designated pattern, beginning at any convenient pavement edge.

e. Compact the paving blocks into the bedding sand with the manually operated vibratory plate compactor.

f. Sweep the jointing sand into the joints between the paving blocks and around the inside edge of the edge restraint.

g. Vibrate the jointing sand into the block joints with the manually operated vibratory plate compactor.

h. Repeat steps f. and g. until all joints are completely filled with jointing sand.

i. Repeat steps c. through h. until the concrete block surfacing is completed.

Operation and Maintenance

Operation and maintenance of a concrete block pavement are very similar to that of any conventional pavement system. If properly designed and constructed, a concrete block pavement should require virtually no maintenance during its entire design life, which is usually about 20 years. It is recommended that a small number of extra blocks be stockpiled for future use for random replacement and repairs.

Since the blocks themselves are very durable, the typical concrete block pavement failures are caused by failures in the sublayers. When this occurs, the block surfacing is readily removed by breaking the first block and prying the rest loose with a screwdriver. After repairing and replacing the sublayers, the same concrete blocks may be used to resurface the pavement.

Service and Support Requirements

No special services or support are required to implement or maintain this technology.

Performance Monitoring

Installation personnel can monitor and measure the performance of the concrete block pavement by making periodic inspections of the surface for signs of distress. Typical concrete block pavement distresses include block cracks or raveling, creeping of the block pattern, wheelpath rutting, or raveling of the edge restraint. Typical concrete block pavement distresses can be attributed to one of three failure areas: (1) the pavement sublayers, (2) the edge restraint, and (3) the blocks themselves. A failure in the pavement sublayers is evidenced by some form of surface displacement. A failure of the edge restraint may cause lateral creeping or dislodging of the blocks. Concrete block failures are evidenced by cracking or raveling of the block surface. Immediate repair of the responsible failure area can help to prevent further damage to the pavement and/or users.

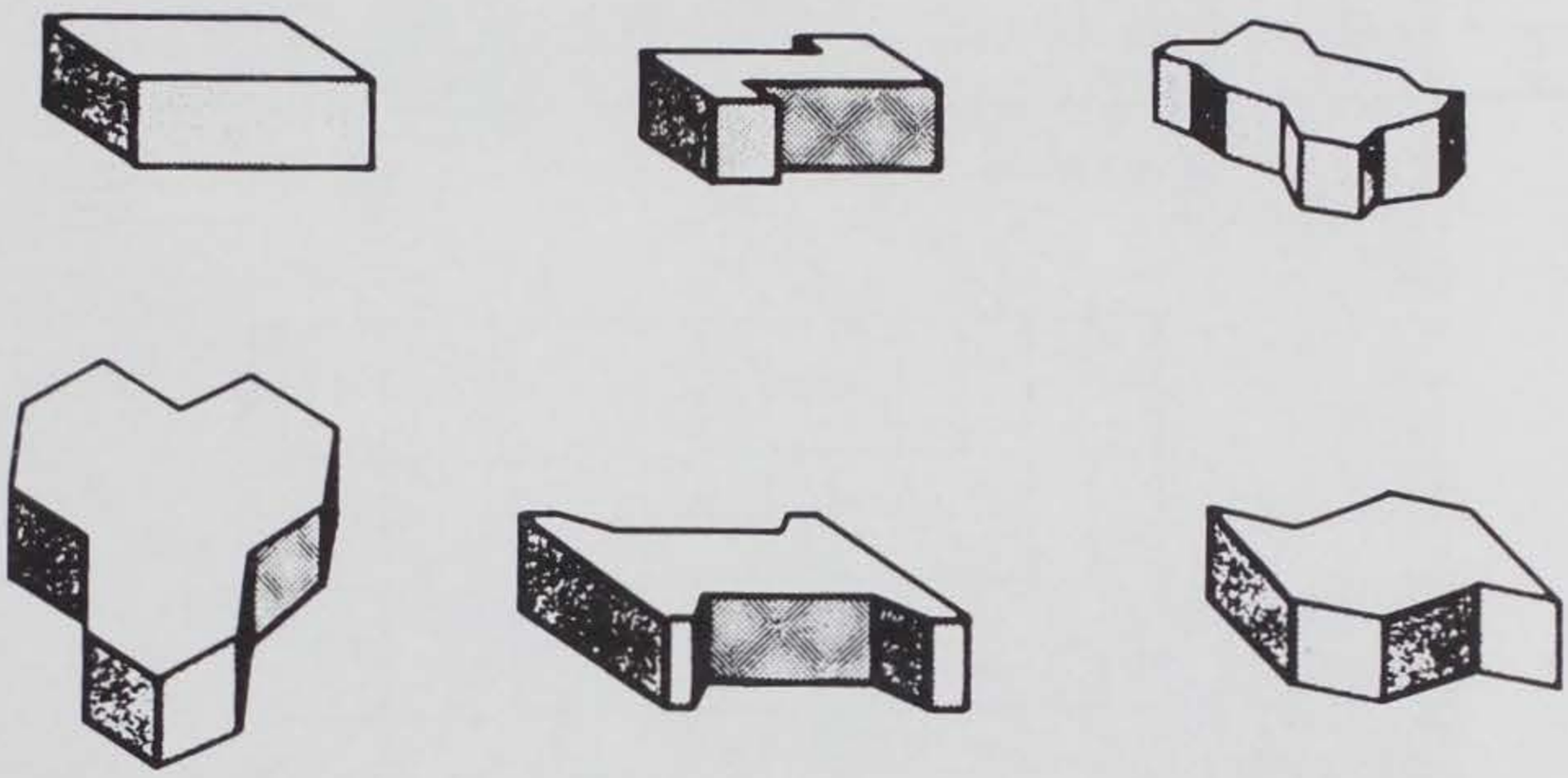


Figure 1. Concrete paving block shapes

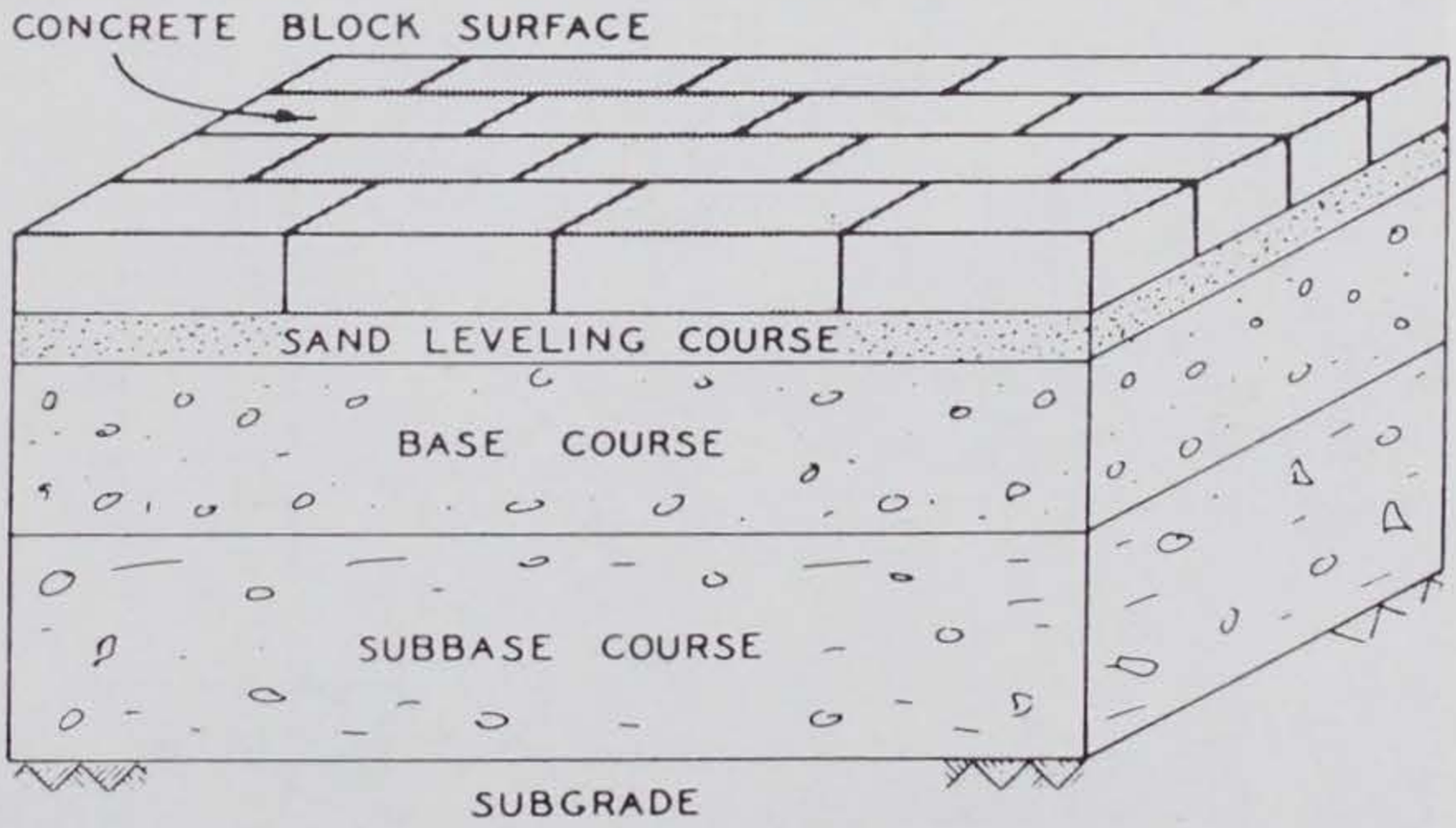
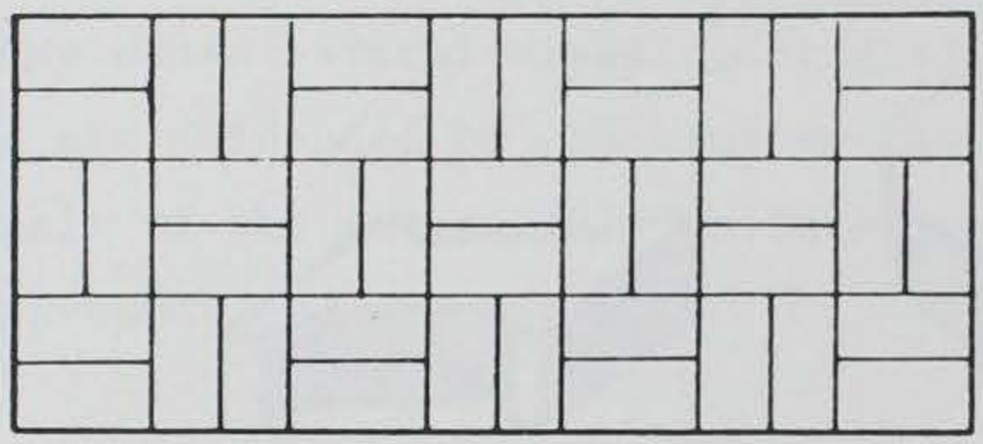


Figure 2. Typical cross section of block pavement

a. Stretcher bond

b. Herringbone



c. Parquet

Figure 3. Examples of common laying patterns

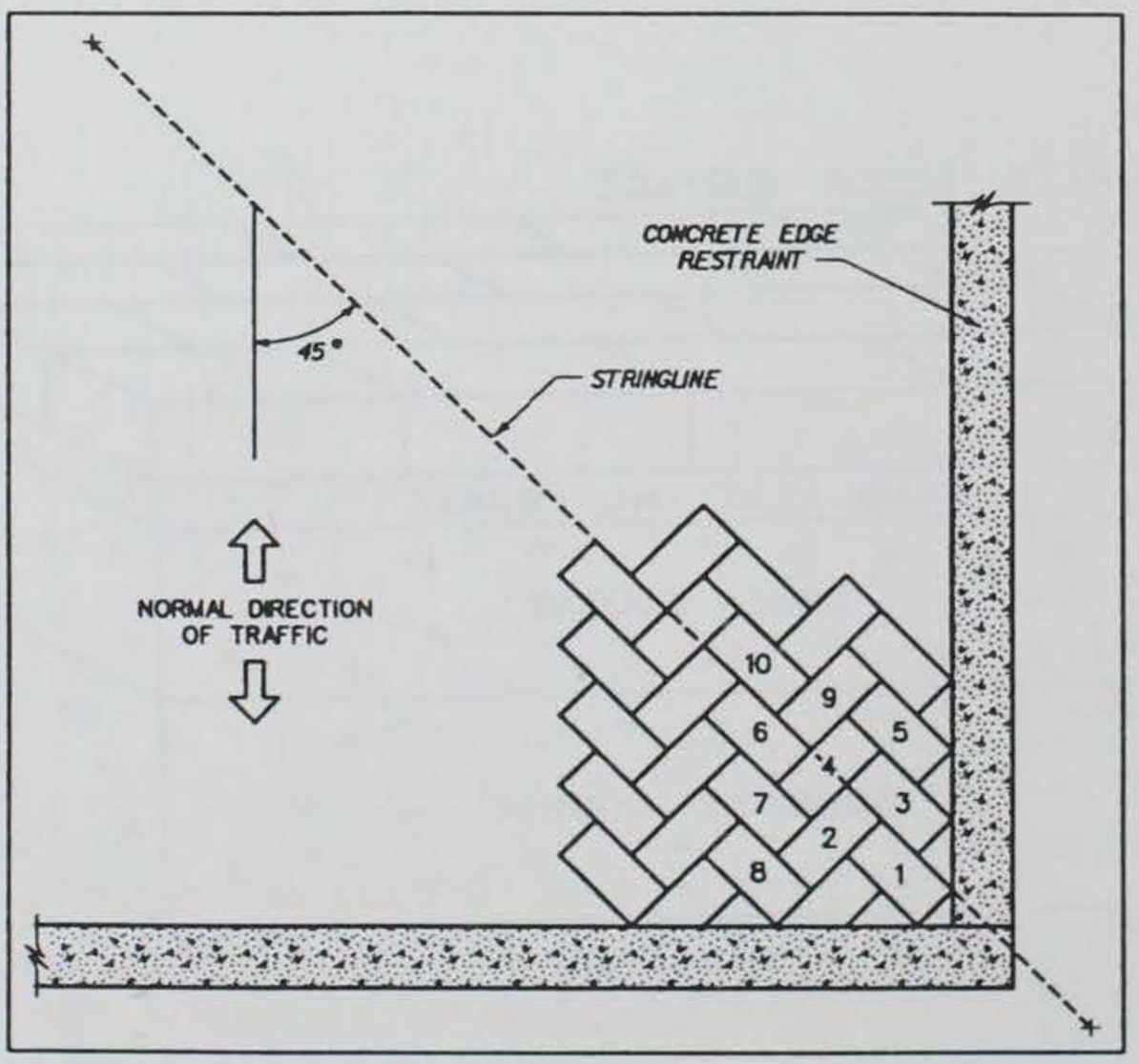


Figure 4. Establishing the 45-degree herringbone pattern

Figure 5. Screeding bedding sand

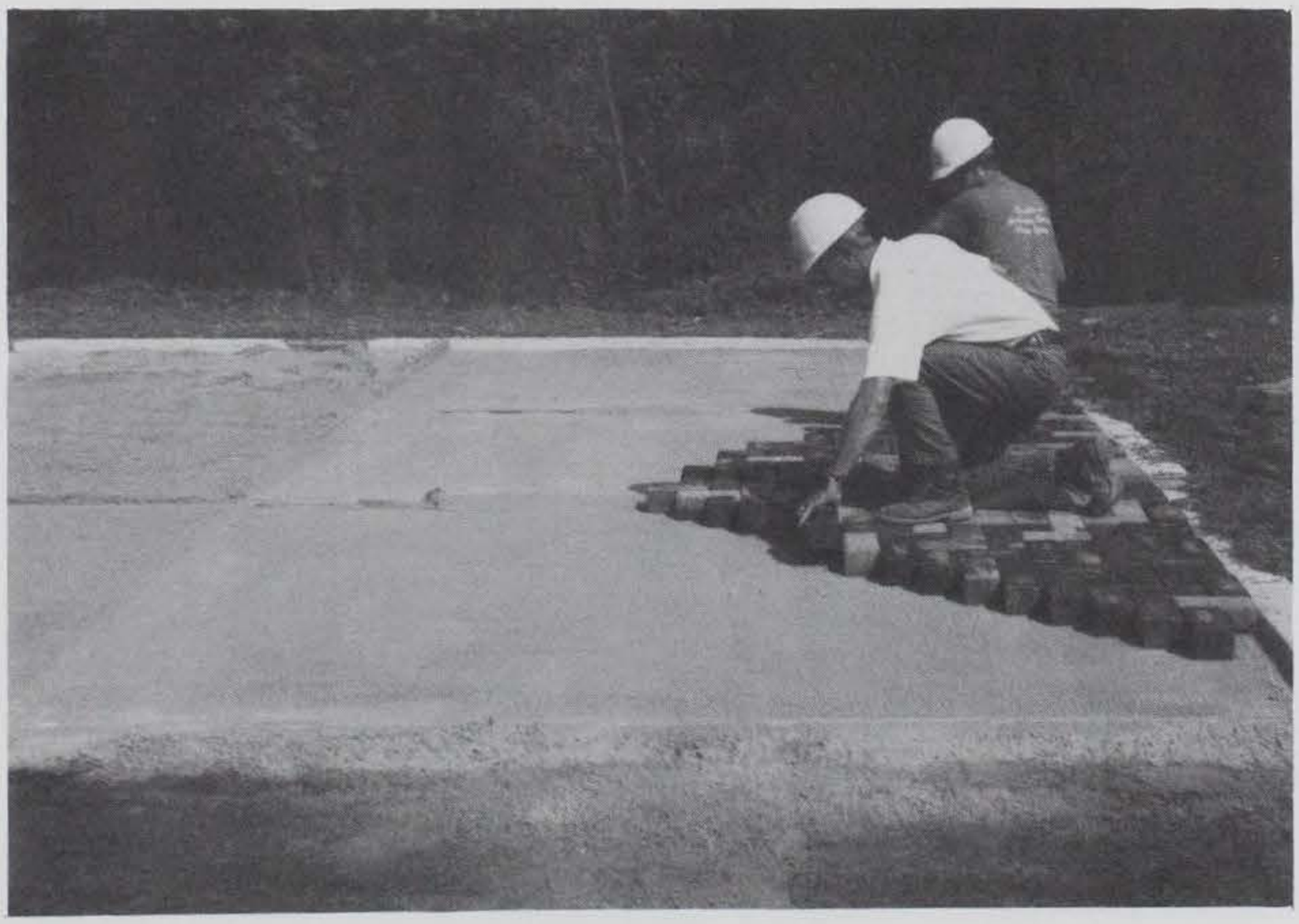


Figure 6. Hand placing concrete paving blocks

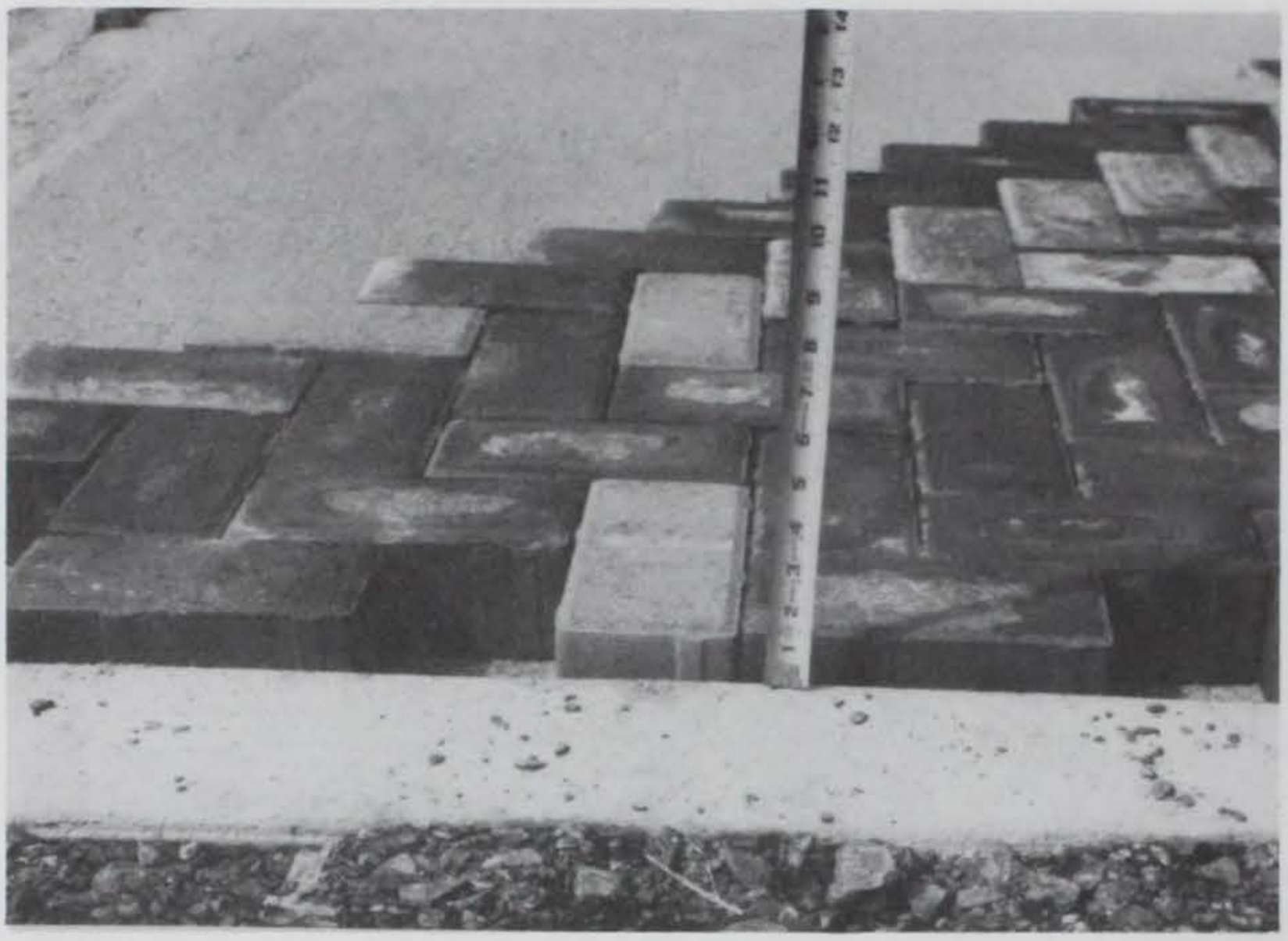


Figure 7. A 3/4-in.-height differential at edge restraint

Figure 8. Initial compacting of paving blocks

Figure 9. Spreading jointing sand over compacted paving blocks

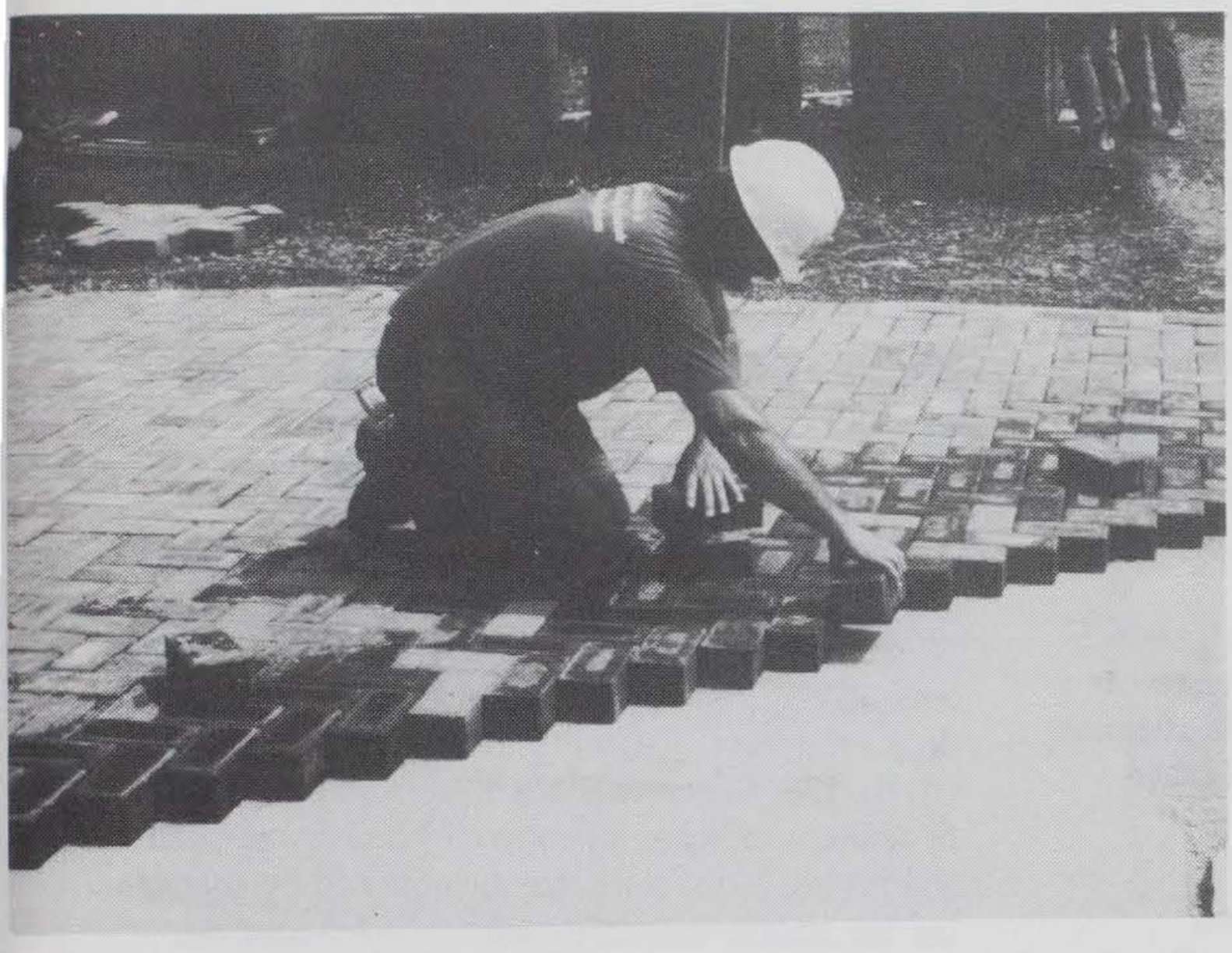
Figure 10. Vibrating jointing sand into paving block joints

APPENDIX A: AD FLIER

FACILITIES ENGINEERING APPLICATIONS PROGRAM

Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities

Concrete Block Pavement



Left: *Hand placement of concrete blocks on sand bedding layer.*

Above: *M-88 tank retriever on one-year-old concrete block pavement.*

Durable Surface Material at Reduced Cost

PROBLEM: Some pavement areas have relatively weak or unstable subgrades which require a flexible pavement structure, but the design traffic requires a durable, rigid surfacing material.

TECHNOLOGY: Concrete block pavements can support large, concentrated loads and heavy, abrasive traffic, even over relatively weak and unstable subgrades.

DEMO SITES: Aberdeen Proving Ground, MD - FY88

BENEFITS:

- Provided the required durable and flexible surfacing at Aberdeen where traditional pavement surfacing would likely have failed.
- Eliminated routine maintenance costs from previous gravel surfacing at demo site.

PR-12/Dec 92

Concrete Block Pavement: Quality Structural Support That Endures

Rigid, Low-Maintenance Pavement Surface

A concrete paving block is an accurately dimensioned combination of well-graded aggregates and hydrated portland cement that fits closely together with other paving blocks to form a pavement surface. Generally, the blocks are about the size of common bricks. They are manufactured in a wide variety of shapes and colors.

A thin, 1- to 2-inch-thick leveling course of sand is used under the blocks. The blocks are generally laid by hand on the sand layer in a herringbone pattern. The blocks are then compacted with a manually operated vibratory plate compactor which seats the blocks in the sand layer, compacts the sand layer, and forces some sand into the joints between the blocks. A fine-graded masonry sand is spread over the compacted block layer and swept into the joint spaces between the blocks. More passes are made with the vibratory plate compactor to compact and wedge the sand into the joints. A base and subbase course under the sand leveling course provide structural support similar to that of a conventional flexible pavement.

Concrete block pavements provide a low-maintenance, high-strength pavement surface that resists heavy, concentrated, or abrasive loads and chemical spills involving fuel, hydraulic fluid, and other materials.

Paving Blocks Demonstrated

An unsurfaced tank road intersection at Aberdeen Proving Ground, MD, was reconstructed and surfaced with concrete paving blocks in FY89. In years past, the gravel intersection had required continual regrading and resurfacing as a result of carrying daily tracked vehicle traffic. Although the tracked vehicle traffic required the new pavement surfacing to be made of rigid materials, the existing weak subgrade suggested that a flexible pavement structure would be more cost-effective.

The concrete block pavement alternative was selected to meet the unique requirements at Aberdeen. As of August 1992, the concrete block pavement intersection had continued to carry almost daily tracked vehicle traffic, while requiring no maintenance.

Benefits

At Aberdeen, the concrete block pavement provided the only cost-effective solution for the given soil and traffic conditions. No other existing pavement technology could have provided the durable, traffic- and fuel-resistant surfacing in a flexible pavement structure. The concrete block pavement is expected to require virtually no maintenance throughout its 20-year design life.

Costs

Surfacing costs for concrete block pavements have varied from approximately $1.00 to $5.50 per square foot. Project size is a significant factor in determining the unit price, with larger projects usually priced in the lower ranges. Local differences in labor, material, and transportation costs also contribute to the wide range of unit prices for this technology.

Procurement Information

Available guidance to provide assistance in completing project specifications includes: CEGS-02518, "Concrete Block Pavement"; TR GL-83-3, "Concrete Block Pavements," TR GL-91-1, "Concrete Paving Blocks: Facilities Engineering Applications Program (FEAP) Demonstration, FY89, TR GL-91-12, "Concrete Block Pavement for Airfields." In addition, a listing of concrete block manufacturers and paving contractors may be obtained by contacting the National Concrete Masonry Association, Concrete Paver Institute, 2303 Horse Pen Road, Herndon, VA 22071, COMM 703-713-1900.

Points of Contact

Gary Anderton, Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, ATTN: CEWES-GP-Q, Vicksburg, MS 39180-6199; COMM 601-634-2955. Joe Sicuranza, U.S. Army Engineering and Housing Support Center (USAEHSC), Building 358, Fort Belvoir, VA 22060-5516, COMM 703-704-1612.

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APPENDIX B: FACT SHEET

FACILITIES ENGINEERING APPLICATIONS PROGRAM

Fact sheet

PRR-3

March 1990

Paving Blocks

Description of Technology

Paving blocks are used primarily in the United States for their esthetic value, but overseas their unique characteristics have many heavy load applications, such as port or industrial pavements and urban streets. Concrete block pavements provide a low-maintenance, high-strength paved surface that resists heavy, concentrated, or abrasive loads and chemical spills involving fuel, hydraulic fluid, and other materials. Their modular nature and potential for reuse allow easy removal and replacement for access to buried utilities or to correct settlement. Block pavement's unique characteristics--strength, flexible structure, and esthetics--have led to its widespread use in Europe, Australia, and South Africa. Its use in North America is expanding.

Previous research performed at the U.S. Army Engineer Waterways Experiment Station (WES) using heavy truck and tank traffic (Technical Report GL-83-3) has resulted in interim design guidelines for the Corps of Engineers. The guidance is similar to that for flexible pavement except that the block and sand bedding layer is assumed to be equal to 6.5 inches of asphalt concrete surfacing.

Status of Demonstration

In August 1989, the construction of a concrete paving block pavement was demonstrated at Aberdeen Proving Ground, MD. The paving block system was used to upgrade the existing gravel surface on a military tank road intersection covering approximately 12,000 square feet. The subgrade was a very soft clay (design CBR 3) with a high moisture content. Traffic from heavy tracked vehicles during daily training exercises had created high maintenance costs on this pavement intersection.

The subgrade and base course were first reconstructed using a fabric interlayer. This interlayer was placed above the 2 feet of recompacted subgrade and below the 2-inch-thick crushed stone base course. After the base course was compacted, a cast-in-place concrete curb was constructed to provide an edge restraint for the paving blocks. A 1-inch sand bedding layer was placed on top of the crushed stone base. The rectangular concrete paving blocks were then hand-laid on top of the sand in a herringbone pattern. After the paving blocks were embedded in the sand bedding

For information on FEAP projects, contact the FEAP Information Center, P.O. Box 4005, Champaign, IL 61824-4005 or 217-352-6511, ext. 386. Toll-free 1-800-USA-CERL, ext. 386 (outside Illinois) and toll-free 1-800-252-7122, ext. 386 (within Illinois).

layer with a small plate vibrator, the joints between the blocks were filled with masonry sand and the surface was swept clean.

Immediately after the pavement construction was completed, the concrete block pavement was tested successfully by having an M88 tank retriever (56 tons) perform high-speed braking and acceleration maneuvers as well as several 360 degree locked-wheel turns. To date, the concrete block pavement is performing exceptionally well under heavy daily traffic.

Personnel from WES will visit the demonstration site at least twice in FY90 to monitor the block pavement's performance under traffic. During FY91, a technical report and videotape describing the demonstration and proper construction techniques will be produced.

Benefits of Technology

The esthetic value of block pavements is widely recognized, but the value of these high-quality, low-maintenance pavements for heavy industrial use is not well known in the United States. Block pavements offer a surface that resists high point loads, fuel and other fluid spills, and abrasive loads. The modular nature of paving blocks is ideally suited for special problems concerning settlement, utility access, or for a replaceable sacrificial pavement surface.

Block cost varies, depending on job size and the specific site. In the United States, the initial cost of block pavements tends to be somewhat higher than conventional paving surfaces, but maintenance costs are generally lower. Surfacing costs for concrete block pavements have varied from $1.14 to $5.50 per square foot and are a function of many factors, such as project size, distance to manufacturer, and familiarity of local contractors with paving blocks.

The total cost of the paving block project at Aberdeen Proving Ground was $126,743. This cost includes all subbase and base course work, the geotextile placed between these layers, and all related incidentals and miscellaneous expenses. The cost of the paving blocks, including all materials, labor, and equipment charges, was $51,431. This translates into a cost of about $4.29 per square foot for the paving blocks on this job. The elimination of continual maintenance on this intersection (including regrading, drainage reconstruction, and other work) will result in long-term savings for the installation.

Points of Contact

Gary L. Anderton or Richard H. Grau, WES, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, COMM 601-634-2955 or toll-free 800-522-6937 ext 2955. Bill Riles, Aberdeen Area Office, Corps of Engineers Baltimore District, COMM 301-278-4095. Ken Gregg, U.S. Army Engineering and Housing Support Center, COMM 703-355-3582.