GUIDE SPECIFICATIONS FOR CONSTRUCTION OF AQUAPAVE® PERMEABLE STORMWATER MANAGEMENT SYSTEM

SECTION 32 14 13.19
AQUAPAVE® PERMEABLE INTERLOCKING CONCRETE PAVEMENT

Note: This guide specification is for the construction of an AquaPave® permeable interlocking concrete paver system which is designed to allow for the infiltration, detention and release of stormwater from a permeable, open-graded base. Components covered under this specification include AP-SC Woven Geotextile, permeable clear crushed open-graded sub-base, Inbitex® Geotextile, Bedding Layer, AquaPave® Pavers and Joint Stabilizer, which are generic to all AquaPave® Systems. Additional specifications are required where drain pipes, geogrid and/or an impermeable liner are used. The text below must be edited to suit specific project requirements. It will require review by a qualified civil or geotechnical engineer, or landscape architect familiar with the site conditions and local materials. Edit this specification as necessary to identify the design professional in the General Conditions of the Contract. This guide specification is intended for use in the U.S. or Canada and should be edited to fit terms and standards appropriate to each region.

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes
   1. AquaPave® Permeable concrete pavers.
   2. Joint Stabilizer.
   3. Clear crushed aggregate Bedding Course.
   4. Inbitex® Geotextile.
   5. Clear crush open-graded sub-base materials.
   6. AP-SC Woven Geotextiles.
   7. [Impermeable liner].

Note: Curbs will typically be precast or cast-in-place concrete. Plastic edging with steel spikes can be used if the spikes are driven into substantial soils and are not driven into any of the open-graded drain rock or pierce any portion of the water containment system. Plastic edging should not be used where wheel loads are within 2.5 feet of the restrained edge. In areas of severe freeze-thaw cycles plastic edge restraints are not recommended.

1.02 RELATED SECTIONS

A. Section [-]: Curbs.
B. Section [-]: Stabilized aggregate base.
C. Section [-]: [PVC] Drainage pipes.
D. Section [-]: Impermeable liner.
E. Section [-]: Edge restraints.
F. Section [-]: Drainage pipes and appurtenances.
G. Section [-]: Earthworks/excavation/soil compaction.

1.03 REFERENCES

A. American Society of Testing Materials (ASTM)
   1. C 33, Specification for Concrete Aggregates.
   2. C 131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C 136, Method for Sieve Analysis for Fine and Coarse Aggregate.
   4. C 936, Standard Specification for Solid Interlocking Concrete Pavers.
   5. C 979, Specification for Pigments for Integrally Colored Concrete.
   6. D 698, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5-lb (2.49 kg) Rammer and 12 in. (305 mm) drop.
   7. D 1557, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (4.54 kg) Rammer and 18 in. (457 mm) drop.
   8. D 1883, Test Method for California Bearing Ratio of Laboratory- Compacted Soils.
   9. D 2488, Description and Identification of Soils (Visual/Manual Procedure)
   10. D 4873, Guide for Identification, Storage and Handling of Geotextiles
   11. D 6928, Standard Test Method for Resistance of Course Aggregates to Degradation by Abrasion in the Micro-Deval Apparatus.

B. Canadian Standards Association (CSA)
   1. A231.2-06, Precast Concrete Pavers.
   2. A231.1-06, Precast Concrete Paving Slabs.
   3. A23.2A, Sieve Analysis of Fine and Coarse Aggregates.

1.04 SUBMITTALS

A. In accordance with Conditions of the Contract and Submittal Procedures Section.
B. Site Plan - indicate the following: area of AquaPave® Paver installation; perimeter conditions; stormwater run-on area; and, layout, patterns and color arrangements.
C. Installation details – provide details for each of the following: junction with other materials; expansion and control joints; layout, pattern, and relationship of paving joints to fixtures; geotextile panel installation drawing; and, project formed details.
D. Joint Stabilizer, Bedding Course and Sub-base (upper and lower):
   1. Sieve analysis of aggregates per [ASTM C 136] [CSA A23.2A].
   2. Durability of aggregates using Micro-Deval Degradation per [ASTM D 6928] [CSA A23.2A].
   3. Percentage of angular and sub-angular particles per [ASTM D 2488].
E. Site soils report including: in-situ density test reports; soil classification(s); infiltration rate(s) measured on-site under compacted conditions; and recommendations on suitability of native soils for the intended project.
F. Erosion and sediment control plan.
G. Stormwater management (quality and quantity) calculations.
H. Permeable concrete pavers:
   1. Manufacturer’s product catalog sheets with specifications.
   2. [Four] representative full-size samples of each paver type, thickness, color, and finish. Submit samples indicating the extremes of color expected in the finished installation. Note that accepted samples become the standard of acceptance for the work of this Section.
   3. Laboratory test reports certifying compliance of the concrete pavers [slabs] with [ASTM C 936] [CSA A231.1-06] [CSA A231.2-06].
   4. Manufacturer's material safety data sheets for the safe handling of the specified materials and products.

I. Geotextiles:
   1. Manufacturer's product catalog sheet with specifications.
   2. One 0.5 x 0.5 m (18 x 18 in.) panel of each geotextile for inspection and testing. The sample panels shall be uniformly rolled and shall be wrapped in plastic to protect the material from moisture and damage during shipment. Samples shall be externally tagged for easy identification. External identification shall include: name of manufacturer; product type; product grade; lot number; and, physical dimensions.

J. Paver Installation Subcontractor:
   1. Statement of Installer Qualifications: Submit list of comparable projects completed by installer. Include list of completed projects with project names, addresses, names of Architect/Engineer and Owners with contact information, and dates of construction.
   2. Copy of current 'ICPI Concrete Paver Installer Certification School' Certificate for the site supervision personnel.
   3. A letter of assurance stating that the site supervising personnel is an Approved AquaPave® Installer.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has successfully completed permeable pavement installations similar in design, material, and extent indicated for this project.

B. Field-constructed Mock-up:
   1. Install 3 x 3 m (10 x 10 ft) area with Geotextiles, Sub-base, Bedding Course, Joint Stabilizer and Pavers.
   2. Use area to determine surcharge of the bedding layer, joint sizes, lines, laying pattern(s), color(s), and texture of the job.
   3. Use the area as the standard to judge the remaining work.
   4. Subject to acceptance by the owner, mock-up may be retained as part of the finished work.
   5. If mock-up is not retained, remove and dispose of mock-up.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Concrete Pavers:
   1. Coordinate delivery of paving stones to minimize interference with onsite works, and normal use of buildings, roads and structures adjacent to works.
   2. Deliver concrete pavers to the site palletized for transfer by forklift or clamp lift. Maintain manufacturer's original, unopened, undamaged packaging with identification labels intact.
   3. Unload pavers at job site in the location designated by the Installer Subcontractor and in such a manner that no damage occurs to the product or existing construction.

B. Imported Soils:
   1. Handle and transport material to avoid segregation, contamination and degradation.
   2. Keep different materials sufficiently separated as to prevent mixing. Do not dump or store one material on top of another unless it is part of the installation process.
   3. Cover material with waterproof covering if needed to prevent exposure to rainfall or removal by wind. Secure the covering in place.

C. Geotextiles:
   1. Geotextiles shall be delivered, stored and handled in accordance with [ASTM D-4873].
   2. Maintain manufacturer's original, unopened, undamaged packaging with identification labels intact.
   3. The geotextiles shall be kept dry and wrapped in waterproof wrapping such that it is protected from UV light and the elements during delivery and storage.

D. The Installer shall check all materials delivered to the site to ensure that the correct materials have been received and are in good condition prior to signing off on the manufacturer's packing slip.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not install in heavy rain, or snow.
B. Do not install frozen Bedding Course, Joint Stabilizer or Sub-base materials.
C. Do not install on frozen soil subgrade.

1.08 MAINTENANCE

A. Extra materials: Provide [Specify area] [Specify percentage] additional material for use by owner for maintenance and repair.

PART 2 PRODUCTS

2.01 PAVING UNITS

A. Manufactured by Brown's Concrete Products Limited
Phone: 1-800-461-4888 Fax: 1-705-522-8220

AquaPave® Nordic: [Color]
200 mm x 100 mm x [60, 80] mm thick

Note: ASTM C 936 or CSA A231.2-06 applies to AquaPave® pavers. CSA A231.1-06 applies to AquaSlab® HydraPressed slabs.

B. Meet [ASTM C 936] [CSA A231.2-06] [CSA A231.1-06]. Freeze-thaw requirements may be waived in applications with no freeze-thaw conditions.
   1. When testing 3-1/8 in. (80 mm) thick units for conformance to [ASTM C 936], compressive strength tests shall be corrected by multiplying the results by 1.18.
C. Manufactured in a plant where paving products are certified by ICPI as having passed manufacturer designated [ASTM] [CSA] requirements.
D. Color(s): [Specify from selection in Brown's Concrete Products' product literature].

2.02 CLEAR CRUSHED AGGREGATE BEDDING COURSE AND SUB-BASE MATERIALS

Note: The bedding and sub-base materials are an integral part of the AquaPave® system design. When designing an AquaPave® system, compliance with the following points must be strictly observed.

A. Aggregates to be clean, non-plastic, and free from deleterious or foreign matter.
B. Micro-Deval Degradation of less than 8%. Soft Aggregates such as Limestone cannot be used as they will lead to total system failure.
C. Percentage of angular and sub-angular particles greater than 90%. Do not use rounded river gravel. Base and bedding materials must be crushed aggregates.
D. Gradation criteria

Note: Dx is the particle diameter size at which x percent of the particles are finer. For example, D15 is the particle size of the aggregate for which 15% of the particles are smaller and 85% are larger.

   1. D15 upper and lower sub-base stone /D50 bedding stone < 5.
   2. D50 upper and lower sub-base stone/D50 bedding stone > 2.

E. LA Abrasion <40, minimum CBR of 80%.

Note: The following gradations in Tables 1, 2 and 3 can be used for the clear crushed open-graded bedding course and sub-bases. Check gradations against the above criteria.

Table 1

Grading Requirements for Clear Crushed Bedding Course (ASTM No. 8)	
Sieve Size	Percent Passing
12.5 mm (1/2 in.)	100
9.5 mm (3/8 in.)	85 to 100
4.75 mm (No. 4)	10 to 30
2.36 mm (No. 8)	0 to 10
1.16 mm (No. 16)	0 to 5

Table 2

Grading Requirements for Clear Crushed Upper Sub-Base (ASTM No. 56)	
Sieve Size	Percent Passing
37.5 mm (1-1/2 in.)	100
25 mm (1 in.)	90 to 100
19 mm (3/4)	40 to 85
12.5 mm (1/2 in.)	10 to 40
9.5mm (3/8 in.)	0 to 15
4.75mm (No. 4)	0 to 5

Table 3

Grading Requirements for Clear Crushed Lower Sub-Base (ASTM No. 2)	
Sieve Size	Percent Passing
75 mm (3 in.)	100
63 mm (2-1/2 in.)	90 to 100
50 mm (2 in.)	35 to 70
37.5 mm (1-1/2 in)	0 to 15
19 mm (3/4 in.)	0 to 5

2.03 GEOTEXTILES

A. AP-SC 1000 or 2000, and Inbitex®, as supplied by:
Brown's Concrete Products PH: 1-800-461-4888

2.04 JOINT STABILIZER

A. Pre-bagged Joint Stabilizer as supplied by:
Brown's Concrete Products PH: 1-800-461-4888

PART 3 EXECUTION

3.01 EXAMINATION

Note: Compaction of the soil subgrade may be necessary to achieve stability under vehicle loads. Compaction, however, will reduce the permeability of soils. In such cases, laboratory and on-site testing for density and soil permeability should be conducted. These can help establish a relationship between compacted density and anticipated design permeability after compaction. An experienced civil or geotechnical engineer familiar with local soil conditions should be consulted for determining project standards for the percentage of soil Proctor density and test methods for permeability. When soil compaction is required, standard Proctor density per ASTM D 698 for pedestrian and driveway areas is recommended. Modified Proctor density per ASTM D 1557 is recommended for vehicular areas. Density and moisture should be checked in the field with a nuclear density gauge or other test methods for compliance to specifications. Stabilization of the soil and/or base material may be necessary with weak or continually saturated soils, or when subject to high wheel loads. These conditions may require the use of drain pipes within open-graded bases. Compaction on the "open aggregate base" for pedestrian and residential driveway areas, a minimum 97% standard Proctor density per ASTM D 698 is recommended. For vehicle and high traffic areas, a minimum 97% modified Proctor density per ASTM D 1557 is recommended.

A. Subgrade:
   1. Verify that subgrade surface is free from standing water, uniform, even, free of any organic material or sediment, debris, ready for installation of AP-SC 1000 or 2000 geotextile.
   2. Verify correct gradients and elevations of subgrade surface, particularly where backup drains are to be located.
   3. Verify compaction density and soil permeability.
B. Edge Restraints:
   1. Verify location, type, installation and elevations of edge restraints around the perimeter to be paved. Ensure the side of the edge restraint adjacent to the paver is perpendicular to the bedding course. This will ensure a tight fit, eliminating a future trip hazard.
C. Beginning of installation means acceptance of subgrade and edge restraints.

3.02 INSTALLATION

Note: Geotextile is placed on the compacted soil subgrade under the clear crushed open-graded lower sub-base. The geotextile is applied to the bottom and sides of the excavation with overlapped joints a minimum of 30cm (12 in.) Overlap is a function of CBR, 30 to 45cm (12 to 18in.) for CBR 3.0 and above, 60 to 90cm (24 to 36 in.) for CBR 1.0 to 3.0, for CBR values below 1.0 they should be sewn. Please consult manufacturers' specifications and your Geotechnical Engineer. Overlaps should follow down slope with drainage. All drainpipes, observation wells, overflow pipes, and impermeable liner (if applicable) should be in place per the drawings either prior to or during placement of the base, depending on their location. The open-graded base is typically compacted in 10 to 15 cm (4 to 6 in.) thick lifts with a minimum 10 T (10 ton) static roller. Care must be taken not to damage drainpipes during compaction and paving. There should be at least 4 passes with no visible movement in the base material when compaction is complete. Absolutely no mud or sediment can be left on the base or bedding aggregates. If they are contaminated, they must be removed and replaced with clean materials.

A. Keep area where pavement is to be constructed free from sediment during entire job. Geotextiles, sub-bases and bedding materials contaminated with sediment shall be removed and replaced with clean materials.
B. Place geotextile on the bottom and sides of the excavated area with a minimum down slope overlap of 30cm (12 in.). Allow for enough geotextile to exceed the final elevation of the AquaPave® surface. After final compaction the excess geotextiles should be cut flush with the finished surface.
C. Place and spread the clear crushed open-graded lower sub-base without wrinkling or folding the geotextile. To prevent damage to the geotextile, track vehicles must not be used to spread the initial base course.

D. Do not damage drainpipes, overflow pipes, observation wells, or any inlets and other drainage appurtenances during installation.
E. Spread, moisten and compact clear crushed open-graded lower and upper sub-bases in 10 to 15 cm (4 to 6 in.) lifts with a minimum 10 T (10 ton) vibratory roller.
F. For each lift, make at least two passes in the vibratory mode then at least two in the static mode until there is no visible movement of the material.
G. The elevation of the final surface of the clear crushed upper sub-base should not deviate more than ±13 mm (± 1/2 in.) over a 3 m (10 ft.) straightedge.
H. Place the Inbitex geotextile over the clear crushed upper sub-base following the panel installation drawings. Ensure a minimum down slope overlap of 30cm (12 in.).
I. Spread, moisten and lightly compact the bedding material course. Use a Plate Compactor on this course. No visible movement should occur in base material when compaction is complete.
J. Loose screed the Bedding Course.
K. Lay the AquaPave® in the pattern(s) shown on the drawings. Maintain straight pattern lines.
L. Fill gaps at the edges of the paved area with cut units, ensuring no cut unit is less than one third its original size.
M. The use of Guillotine or Paver Splitters is not acceptable. Cut pavers with a masonry saw only. Do not allow slurry from the cuts to adhere to the surface of the pavers.
N. Compact and seat the pavers into the bedding material using a low amplitude, 75-90 Hz plate compactor capable of at least 5,200 lbs. (23 kN) centrifugal compaction force. After the first pass with the vibrating plate compactor remove and replace any damaged pavers.
O. Apply a dressing of Brown's Concrete Products' Joint Stabilizer to the surface and sweep into the joints. Approximately 3kg/m2 (6.6lbs/10 ft2) will be required. Fill joints and sweep off excess material before continuing compaction. Two or three more passes with the compactor will be required.
P. Do not compact within 1 m (3 ft) of the unrestrained edges of paving units.
Q. Remove excess aggregate by sweeping pavers clean.
R. All pavers within 1 m (3 ft) of the laying face must be left fully compacted at the completion of each day.
S. The final surface elevations shall not deviate more than ±10 mm (±3/8 in.) under a 3 m (10 ft) long straightedge.
T. The surface elevation of pavers shall be 3 to 6 mm (1/8 to 1/4 in.) above adjacent drainage inlets, concrete collars, or channels to allow for future settlement.

3.03 FIELD QUALITY CONTROL

A. After sweeping the surface clean, check final elevations for conformance to the drawings.
B. The top surface of the pavers shall extend 3 to 6 mm (1/8 to 1/4 in.) above the final elevations after compaction to compensate for possible minor settling. (see 3.02 T)
C. Lippage: No greater than 3 mm (1/8 in.) difference in height between adjacent pavers.

3.04 PROTECTION

A. After work in this Section is complete, the Contractor shall be responsible for protecting the work from damage and sediment due to subsequent construction activity on the site.
B. Design consideration should be taken to ensure that soft landscaping is retained to prevent migration of softscape materials on to the AquaPave® surface. This will significantly help to maintain the integrity of the system.

End of section