

AquaPave Permeable Concrete Specification

1. GENERAL

1.1. Summary

Work shall generally be in accordance with the requirements of ACI 522.1 “Specification for Pervious Concrete Pavement” published by the American Concrete Institute. This work includes specifications for Permeable Concrete at the location and to the dimensions shown on the plans, in accordance with the project manual.

1.2. Qualification

The work shall employ no less than one National Ready Mixed Concrete Association (NRMCA) certified Pervious Concrete Contractor, who shall oversee concrete placement. Installer shall submit proof of certification.

2. TESTING

2.1. ASTM C1688 Fresh Density Test

Perform a minimum of one density test in accordance with ASTM C1688 during each day’s placement or when visual inspection indicates a change in the concrete. Fresh density shall be between +/-80 Kg/m³ of the specified fresh density.

2.2. ASTM C1701 Infiltration Test

Surface infiltration shall be tested using ASTM C 1701. One test for every 900m³, minimum 3 tests, and results should be averaged. Test locations should be at least 4.5 meters from each other.

2.2.1. Must be tested on clean, level permeable pavement upon completion of the curing period but before acceptance and opening the pavement to traffic.

2.2.2. Permeability shall be at least 8,900 millimetres per hour, with no test below 2,500 millimetres per hour, on average as tested after the curing period has ended.

3. FIELD CONDITIONS

3.1. Protection of Existing Improvements

2.2.3. General contractor is responsible for preparing the site for work – clearing area, protecting adjacent finished surfaces, materials and previously installed objects or furniture. General contractor shall provide suitable protection where required before work commences and maintain protection throughout the course of the work.

2.2.4. To whatever extent possible, do not damage or disturb existing adjacent vegetation. Installer shall not be responsible for damaged vegetation within the work area. Remove all concrete stains from adjacent exposed surfaces of paving, structures, and grounds. Remove all waste and spillage.

3.2. Safety and Traffic Control:

3.2.1. General contractor shall notify and cooperate with local authorities and other organizations having jurisdiction when construction work will interfere with existing roads and traffic.

3.2.2. General contractor shall provide temporary barriers, signs, warning lights, flagmen, and other protections as required to assure the safety of persons and vehicles around the construction area and to organize the smooth flow of traffic.

3.3. Weather Limitations:

3.3.1. Do not place permeable concrete pavement when the ambient temperature is below 7°C, is expected to fall below 0°C within 48 hours of placement, or is above 32°C, unless otherwise permitted in writing by the design professional of record. In the case of cold

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weather installation, surface efflorescence, as well as streaking, or tiger striping, which is a result of the curing membrane, may be significant.

- 3.3.2.** Do not place permeable concrete pavement when the wind, heat or humidity does not allow enough time to place, properly joint, compact, edge, finish and cure before the surface dries to the point where it will result in ravelling, i.e. loss of wet metallic sheen.
- 3.3.2.** Do not place permeable concrete pavement to receive runoff of asphalt pavement areas. Sticky tar fines will destroy the permeability of permeable concrete.

4. ACCEPTANCE

Acceptance of permeable concrete pavement will be based on the following criteria:

4.1. Appearance

Each lot of finished permeable concrete will be inspected for appearance by the Engineer. The permeable concrete shall have a consistent surface texture, shall have no more than three (3) percent of the surface area within each panel (joint to joint) clogged/sealed with cement paste or ravelled, shall be free of ridges or other surface imperfections, shall have joints that are in the specified location and are constructed per specification, and shall be free of cracks. Ravelling is defined as: the contiguous dislodging of the surface layer(s) of aggregate.

4.2. Smoothness

Permeable concrete pavement smoothness shall be checked with a 3-metre straight edge. Vertical measurement should be taken between the pavement's determined plane and straight edge discounting surface void and roughness irregularities. The surface of the finished pavement shall be uniform to a degree such that no variations greater than 19mm over 3 metres are present when tested with a 3-metre straight edge and checked in a direction perpendicular or parallel to the centreline and the pavement's planed surface.

4.3. Grade

Permeable concrete shall be true to designed grades plus or minus 19mm. Where abutting existing facilities such as sidewalks, walkways, curbs, driveways or other pavements, the permeable concrete shall be within 6mm of that surface.

4.4. Line

Permeable concrete margins shall be true to designed lines plus or minus 19mm at any point.

4.5. Infiltration Rate

The average of all three (3) infiltration tests shall be greater than 8,900mm per hour with no single test less than 2,500mm per hour.

4.6. Pressure wash testing

Before final acceptance the Engineer may require a pressure wash test of the permeable concrete. Pressure washing shall be provided and completed by using portable washer equipment working at a minimum of 3000 psi at 2.4 gpm. The nozzle shall be a zero degree nozzle and be held 75mm off the concrete surface and moved at a slow but steady rate. The Contractor shall pressure test a min three (3) locations per lot or as determined by the Engineer. Any sections of permeable concrete that breaks up, ravel, or does not infiltrate shall be removed and replaced with acceptable permeable concrete to the nearest joints. The Engineer may reject the concrete if the pressure washing dislodges more than a few individual aggregate particles in each panel. The Contractor shall decide, after placing the permeable concrete, when to perform the quality assurance pressure wash testing for the acceptance.

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5. PRODUCTS

5.1. Fabric

Non-woven geotech fabric, if required for separation, shall be Mirafi 140n or approved equal. If the designer determines geotech fabric is required for strength use, Mirafi FW402 or approved equal with similar flow rate and strength ratings. Permeable Concrete shall not be placed directly on filter fabric.

5.2. Base

Base shall be composed of an open graded washed clean crushed rock maintaining a minimum of 35% void space.

5.2.1 Recycled concrete aggregate shall not be used if using a geotechnical fabric.

5.2.2 For installations of more than 150mm thick the section below the upper 75mm may be a larger size to provide more stability so long as it meets 5.2.

5.3. Forms

Form materials must be durable enough to resist deformation during edge compaction and maintain grade.

Forms shall be clean and free of debris of any kind, rust, and hardened concrete.

5.4. Permeable Concrete

The concrete shall be **AquaPave Ready Mixed Permeable Concrete™**, which complies with ASTM C94/C94M and the following requirements:

5.4.1. Aggregates

Aggregate shall have a minimum specific gravity of 2.60, a minimum rodded void content of 35% per ASTM C29, and a maximum absorption rate of 3%. Crushed aggregate or gravel shall be permitted.

6.4.1.1. Size of aggregate to be determined by engineer or owner based on locally available materials but in no case shall be larger than 8mm nominal except when otherwise specified.

5.4.2. Supplementary Cementitious Materials (SCMs)

SCMs such as fly ash, slag and silica fume are approved for use in permeable concrete. SCM mix proportions shall be included in the mix design.

SCM shall be as specified herein:

- Fly Ash: Fly ash shall conform to the requirements of ASTM C618, Class F or C.
- Slag Cement: Slag cement shall meet the requirements of ASTM C989, Grade 100 or Grade 120.
- Silica Fume: Silica fume shall meet the requirements of ASTM C1240.

5.4.3. Reinforcing Materials

The use of Macro-fibres in permeable concrete mixtures increases durability and is permitted when required. Micro-fibres have minimal effect.

No reinforcing bars, tie bars or dowels will be used in the installation of permeable concrete.

5.4.4. Pigments

Use pigments or colour complying with ASTM C979 if specified in Contract Documents.

5.4.5. Water

Clean potable water shall be used per ASTM C 1692.

5.4.6. Mix Design

5.4.6.1 Mix Design Voids: Mix design voids shall be in the range of 18-21%.

5.4.6.2 Water Cement Ratio: Mix design water-cement ratio minimum shall be 35%.

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5.4.7. Cure Materials

- **Moisture-Retaining Cover:**

A damp-proof membrane curing sheet of at least 150 mu shall be placed over the concrete, and all exterior edges are to be secured. Cure pavement for a minimum of 7 uninterrupted days, unless otherwise specified. Cold weather or the use of SCM's will require a minimum of 10 uninterrupted days curing. Where there is the risk of frost the curing sheet is to be overlaid with a layer of Bidim cloth.

- **Evaporation Control**

Surface stabilizers and ASTM C309 compliant curing agents are allowed prior to polyethylene cover as long as they are applied in mist form and do not dilute the surface paste.

6. EXECUTION

6.4. Pre-Installation Meeting

If required, a pre-paving meeting shall be scheduled at prior to the installation. The following individuals are required to attend:

- General contractor representative
- Permeable concrete installation representative
- Site work contractor representative
- Engineer

6.5. Subgrade Preparation

The Ideal compaction rate for permeable pavements is 88-92%. Compaction rates over 92% significantly decreases soil permeability. Subgrade compaction rate shall not exceed 92%. The surface of the subgrade must be compacted using any equipment, such as plate compactors, to no more than 92%. The subgrade should be level to the maximum extent possible. General contractor shall ensure that the required pavement thickness is obtained in all locations by verifying subgrade elevation.

General contractor shall ensure that subgrade is not over-compacted before installing the base rock material.

General contractor shall keep all traffic off the subgrade during construction to the maximum extent practical. Re-grade and re-compact subgrade disturbed or over-compacted by construction traffic, as needed. Compact the material added to obtain final subgrade elevation.

6.6. Base Installation

Placement of all other elements of the design (i.e. conduits, drainage pipe(s), utilities, irrigation sleeves, etc.) are to be reviewed by the General contractor and site contractor prior to placing base.

Geotech fabric (if required) must extend outside of base area, or per the design documents, whichever is greater unless otherwise specified by the design professional.

General contractor shall inspect the in-place open graded base aggregate to ensure compliance to the plans and specifications.

Verify the base rock is free-draining. If not, do not proceed.

General contractor shall ensure that the required pavement thickness is obtained in all locations by verifying base elevation.

Base must extend at least 75mm beyond edge of slab.

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6.7. Setting Formwork

Install forms to allow continuous progress of work and so that forms can remain in place at least 72 hours after concrete placement. Assemble formwork to permit easy stripping and dismantling without damage to concrete.

The vertical face of previously placed concrete may be used as a form ensuring that the pavement is protected from damage. Forms may be wood or metal.

6.8. Batching & Mixing

Total cementitious material should be sufficient to result in a design void content of 18-21%.

Water cement ratio shall be designed and batched at a minimum of 0.35%.

Batch and mix in compliance with ASTM C94/C94M.

Discharge shall be completed as long as the mix is workable.

Water addition to maintain wet metallic sheen on the paste is permitted at the point of discharge. Water addition at site does not extend working time.

6.9. Delivery

Delivery of materials must be carefully scheduled to avoid trucks waiting for excessive periods of time on job. Permeable concrete that has been in the truck for excessive periods of time and is no longer workable should be rejected.

6.10. Permeable Concrete Placement

6.10.3. Prior to Placement

In hot and or dry conditions, prior to placement of permeable concrete, moisten sub-base aggregate to provide a uniform dampened condition at the time concrete is placed.

If initial application of water is quickly absorbed apply a second application of water just before installing permeable concrete.

6.10.4. Placement

Deposit concrete either directly from the transporting equipment onto the subgrade or sub-base, unless otherwise specified.

Do not place concrete on frozen subgrade or sub-base.

Finish the pavement to the elevations and thickness specified in Contract Documents and meet the requirements of 4.2 & 4.3.

6.10.5. Edging

Edge top surface to a radius of not less than 1.5x the nominal size of the aggregate.

6.10.6. Finishing

Compact fresh concrete to stay within the requirement tolerances. Compact permeable concrete to a dense, permeable surface.

6.10.7. Finishing Tools

Spinning "Roller" screed: A spinning/motorized roller screed is the preferable method of strike off and initial compaction.

Hand Operated Straight Edge: A hand operated straight edge may be used to place the permeable concrete where the spinning roller screed is not feasible.

Cross roller or motorized float pan should be used to provide secondary compaction and improve surface flatness and texture.

Hand floats/trowels and other tools typical to concrete finishing may be used but only if they do not seal the surface.

Asphalt rollers, truss screeds or plate compactors – shall not be used.

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6.10.8. Jointing

Joint placement in permeable concrete is more restrictive than traditional concrete. Joint placement is at the discretion of the installer unless noted in the design documents, in which case the designer or engineer shall consult with installer on joint location. When joint placement is not indicated on the Project Drawings, the installer shall submit drawings describing proposed jointing. Do not proceed with Work until the joint placement is accepted by the Architect/ Engineer.

Spacing between contraction joints shall not exceed 5.5 meters. The larger horizontal dimension of the slab panel, shall not exceed 150% of the smaller dimension. Tool contraction joints to the specified depth and width in fresh concrete immediately after the concrete is compacted.

Contraction joint depth shall be a minimum of one fifth the pavement thickness. Saw cut concrete joints may be placed after concrete has hardened sufficiently to prevent aggregate from being dislodged. If saw cuts are performed before the curing period has ended, the slabs must be kept sufficiently wet when it is uncovered and immediately recovered.

6.10.9. Concrete Curing

Proper moisture level is indicated by cement paste with a wet metallic sheen. Loss of surface moisture, as indicated by a loss of wet metallic sheen, results in insufficient curing and ravelling. Begin the curing as soon as possible after discharge of material and before excessive loss of surface moisture occurs. Moisture-Retaining Cover:

- Completely cover the pavement surface with a minimum 6 mil thick damp-proof sheet. Cut sheeting to a minimum of a full placement width plus 30cm on both sides.
- Cover all exposed edges of pavement with sheet. Overlap sheet edges by a minimum of 30cm.
- Secure curing cover material in such a manner as to ensure curing sheet will remain securely in place throughout the duration of the curing period.
- Evaporation Control: Water, surface stabilizers and ASTM C309 compliant curing agents are allowed as long as they are applied in mist form and do not excessively dilute the surface paste.
- Permeable concrete shall not be exposed to rain before it is covered with curing sheet.

Cure pavement for a minimum of 7 uninterrupted days, unless otherwise specified. Mixes with 20% or more SCMs shall be cured a minimum of 10 days.

All curing times are based on temperatures at or above 13°C during the curing time. Each day temperatures are lower than 13°C does not count as a curing day. The added time required is to be determined by the design professional of record.

6.10.10. Concrete Protection During Construction

General contractor shall not use permeable concrete pavements for staging areas of construction materials or equipment, must inform all trades not to dump materials such as dirt, debris, or bark on the permeable concrete.

General contractor shall protect the pavement surface from abrasion, discoloration, or sediments until completion of any construction or landscaping activity that may expose the pavement to hazards.

General contractor shall be responsible to clean, repair and touch-up, or replace when directed, pavement which has been soiled, discoloured, or damaged by other trades outside the installer's control prior to substantial completion.

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6.10.11. Cleaning

Pressure washing or vacuuming or a combination of both may be used as required. Pressure washers are approved for use after 14 days.

6.10.12. Maintenance

After completion of installation General Contractor is responsible for protecting and cleaning.

Owner is responsible for all maintenance after project work acceptance.

The contractor must supply the owner with a copy of a Permeable Concrete Maintenance Manual.

6.10.13. Opening to Traffic

The pavement must have cured for at minimum 7 uninterrupted days before light vehicle traffic is permitted, 28 days cure for heavy vehicles. The Architect/Engineer must accept the pavement before being opened up to traffic.