Pervious concrete – An overview

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Pervious concrete is a special high porosity concrete used for flatwork applications that allows water from precipitation and other sources to pass through, thereby reducing the runoff from a site and recharging ground water levels. Its void content ranges from 18 to 35% with compressive strengths of 400 to 4000 psi (28 to 281 kg/cm^2). The infiltration rate of pervious concrete will fall into the range of 2 to 18 gallons per minute per square foot (80 to 720 litres per minute per square meter). Typically, pervious concrete has little or no fine aggregate and has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids. Pervious concrete is traditionally used in parking areas, areas with light traffic, pedestrian walkways, and greenhouses and contributes to sustainable construction.

Keywords: *Pervious concrete, no fines, permeable, sustainable, storm water, drought, water table, flooding.*

Background and applications

Although not a new technology (it was first used in 1852 (Ghafoori and Dutta 1995)), pervious concrete is receiving renewed interest in the USA, partly because of Federal Clean Water Legislation. The US Environmental Protection Agency's (EPA) Phase II Final Rule requires the operators of all municipalities in urban areas to develop, implement, and enforce a program to reduce pollutants in post-construction runoff from new development and redevelopment projects that result in land disturbance of greater than or equal to 1 acre. The above is a requirement to attain a National Pollutant Discharge Elimination System (NPDES) permit. Among other stipulations the municipalities are required to develop and implement strategies which include a combination of structural and/or non-structural best management practices (BMPs). Pervious concrete pavement is recognised as a Structural Infiltration BMP by the EPA for providing first flush pollution control and storm water management. In addition to federal regulations, there has been a strong move in the USA towards sustainable development. Sustainable development is development that meets the needs of the present generation without compromising the needs of future generations. The US Green Building Council (USGBC) through its Leadership in Energy and Environmental Design (LEED) Green Building Rating System fosters sustainable construction of buildings. Projects are awarded Silver, Gold, or Platinum certification depending on the number of credits they achieve. Pervious concrete pavement qualifies for LEED credits and is therefore sought by owners desiring a high LEED certification (Ashley, 2008).

Figure 1. Pervious concrete cylinder showing water passing through

Figure 2. Pervious concrete residential street showing water infiltration

Figure 3a. Pervious concrete application - Naturepaths

Figure 3b. Pervious concrete application - Driveways

Figure 3c. Pervious concrete application - Sidewalks

As regulations further limit storm water runoff, it is becoming more expensive for property owners to develop real estate, due to the size and expense of the necessary drainage systems. Pervious concrete paving reduces the runoff from paved areas, which reduces the need for separate storm water retention ponds and allows the use of smaller capacity storm sewers. This allows property owners to develop a larger area of available property at a lower cost. Pervious concrete also naturally filters storm water and can reduce pollutant loads entering into streams, ponds and rivers. It captures the first flush of rainfall (the first 30 to minutes of rainfall which will lead to a runoff with most pollutants) and allows that to percolate into the ground, so that soil chemistry and biology can treat the polluted water. Pervious concrete functions like a storm water retention basin and allows the storm water to infiltrate the soil over a large area, thus facilitating recharge of precious groundwater supplies locally (Figures 1 and 2). All of these benefits lead to more effective land use. Pervious concrete can also reduce the impact of development on trees. A pervious concrete pavement allows the transfer of both water and air to root systems allowing trees to flourish even in highly developed areas.

Common applications for pervious concrete are parking lots, sidewalks, pathways, tennis courts, patios, slope stabilisation, swimming pool decks, green house floors, zoo areas, shoulders, drains, noise barriers, friction course for highway pavements, permeable based under a normal concrete pavement, and low volume roads. Pictures of some of the applications are shown in Figure 3. Pervious concrete is generally not used solely for concrete pavements for high traffic and heavy wheel loads.

Materials

Pervious concrete, also known as porous, gap-graded, permeable, or enhanced porosity concrete, mainly consists of normal portland cement, coarse aggregate, and water. In normal concrete the fine aggregates typically fills in the voids between the coarse aggregates. In pervious concrete fine aggregate is non-existent or present in very small amounts (<10% by weight of the total aggregate). Also, there is insufficient paste to fill the remaining voids, so pervious concrete has a porosity anywhere from 15 to 35% but most frequently about 20%. Aggregate gradings used in pervious concrete are typically either single-sized coarse aggregate or grading 3/4 and 3/8 in (between 19 and 9.5 mm). A wide aggregate grading is to be avoided as that will reduce the void content of the pervious concrete. All types of cementitious materials such as fly ash, slag cement, natural pozzolans conforming to their ASTM specifications have been used. Pervious concrete can be made without chemical admixtures but it is not uncommon to find several types of chemical admixtures added to influence the performance favourably. Since pervious concrete has a low workability, it is important to maintain it to provide sufficient working time at the jobsite. Therefore, retarding admixtures or hydration stabilising admixtures are useful. Viscosity enhancing agents are also beneficial as they can help add more water without causing paste drain down and hence can improve workability.

Properties

The plastic pervious concrete mixture is stiff compared to traditional concrete. Slumps, when measured, are generally less than 3⁄4 in. (20 mm), although slumps as high as 2 in. (50 mm) have been used. However, slump of pervious concrete has no correlation with its workability and hence should not be specified as an acceptance criterion. The density and void content of freshly mixed pervious concrete is measured according to ASTM C1688. Typical densities and void contents are on the order of 100 lb/ft^3 to 125 lb/ft^3 (1600 kg/m^3 to 2000 kg/m^3) and 20 to 25% respectively.

When placed and compacted, the aggregates are tightly adhered to one another and exhibit the characteristic open matrix that looks like popcorn (Figure 4). Pervious concrete mixtures can develop compressive strengths in the range of 500 psi to 4000 psi (3.5 MPa to 28 MPa), which is suitable for a wide range of applications. Typical values are about 2500 psi (17 MPa). Flexural strength in pervious concretes generally ranges between 150 psi (1 MPa) and 550 psi (3.8 MPa).

Figure 4. Typical top surface of hardened pervious concrete

The infiltration rate (permeability) of pervious concrete will vary with aggregate size and density of the mixture, but will fall into the range of 2 to 18 gallons per minute per square foot (80 to 720 liters per minute per square meter). A moderate porosity pervious concrete pavement system will typically have an infiltration rate of 3.5 gallons per minute per square foot (143 liters per minute per square meter). Converting these units to in./hr (mm/hr) yields 336 in./hr (8534 mm/hr). Perhaps nowhere in the world would one see such a heavy rainfall. In contrast, the steady state infiltration rate of soil ranges from 1 in./hr (25 mm/hr) to 0.01 in./hr (0.25 mm/hr). This clearly suggests that unless the pervious concrete is severely clogged up possibly due to poor maintenance, it is unlikely that the infiltration rate of pervious concrete is the controlling factor in estimating

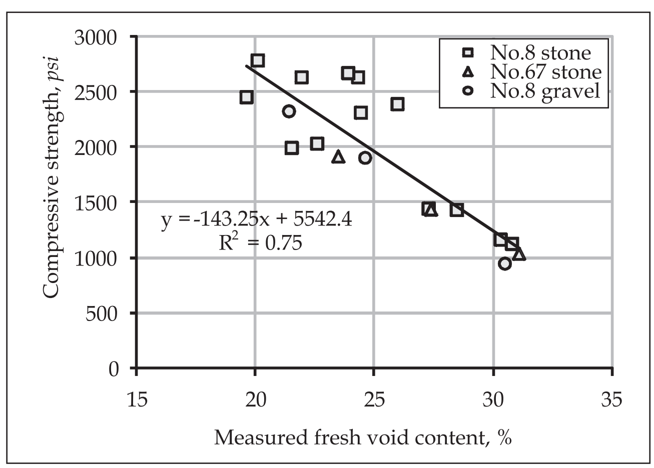

Figure 5. Compressive strength vs. Measured fresh void content and density[16]

runoff (if any) from a pervious concrete pavement. For a given rainfall intensity the amount of runoff from a pervious concrete pavement system is controlled by the soil infiltration rate and the water storage capacity available in the pervious concrete and aggregate subbase (if any) under the pervious concrete.

Generally for a given set of materials, strength and infiltration rate of pervious concrete are a function of the concrete density. Greater the density higher the strength, and lower the infiltration rate. This is shown in Figures 5, 6, and 7 where the infiltration rate was measured in the laboratory by a falling head device. Incorporation of up to 10% by weight of fine aggregate reduces the void content thereby leading to increased density, compressive strengths and reduced infiltration rate. For given mixture proportions density can be controlled by consolidation. Excessive consolidation should be avoided as it can lower infiltration rate.

Limited testing in freezing-and-thawing conditions indicates poor durability if the entire void structure is filled with water (NRMCA 2004). Many paving projects have been successfully executed and have lasted several winters in harsh Northern climates in USA. This is because pervious concrete is unlikely to remain saturated in the field. The freeze thaw resistance of pervious concrete can be enhanced by the following measures – (1) Use of fine aggregates to increase strength and slightly reduce voids content to about 20%; (2) Use of air-entrainment of the paste; (3) Use of a 6 to 18 in (152 to 457 mm) aggregate base particularly in areas of deep frost depths; (4) Use of a perforated PVC pipe in the aggregate base to capture the water and let it drain elsewhere.

Mixture proportioning

At a void content lower than 15%, there is no significant percolation through the concrete due to insufficient interconnectivity between the voids to allow for rapid percolation. So, concrete mixtures are typically designed for 20% void content in order to attain sufficient strength and infiltration rate.

The water-cementitious material ratio (*w/cm*) is an important consideration for obtaining desired strength and void structure in pervious concrete. A high *w/cm* reduces the adhesion of the paste to the aggregate and causes the paste to flow and fill the voids even when lightly compacted. A low *w/cm* will prevent good mixing and tend to cause balling in the mixer, prevent an even distribution of cement paste, and therefore reduce the ultimate strength and durability of the concrete. Experience has shown that *w/cm* in the range of 0.26 to 0.40 will provide the best aggregate coating and paste stability. The conventional *w/cm*-versus-compressive strength relationship for normal concrete does not apply to pervious concrete. Careful control of aggregate moisture and *w/cm* is important to produce consistent pervious concrete.

The total cementitious material content of a pervious concrete mixture is important for the development of compressive strength and void structure. An insufficient cementitious content can result in reduced paste coating of the aggregate and reduced compressive strength. The optimum cementitious material content is strongly dependent on aggregate size and gradation but is typically between 450 and 700 lb/yd^3 (267 and 415 kg/m^3). The above guidelines can be used to develop trial batches. ASTM C1688 test can be

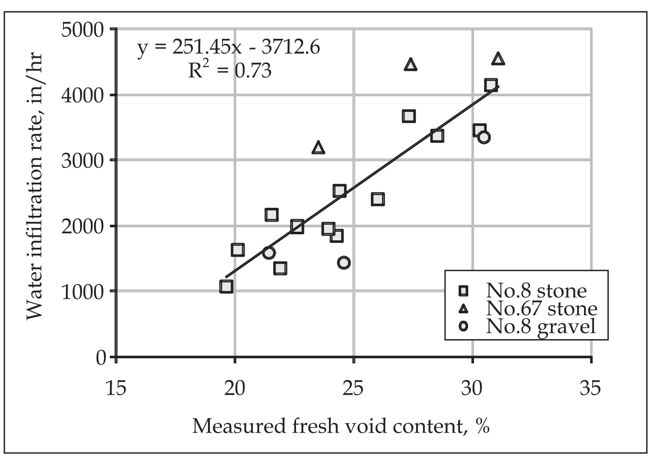

Figure 6. Water infiltration rate vs. measured fresh void content[16]

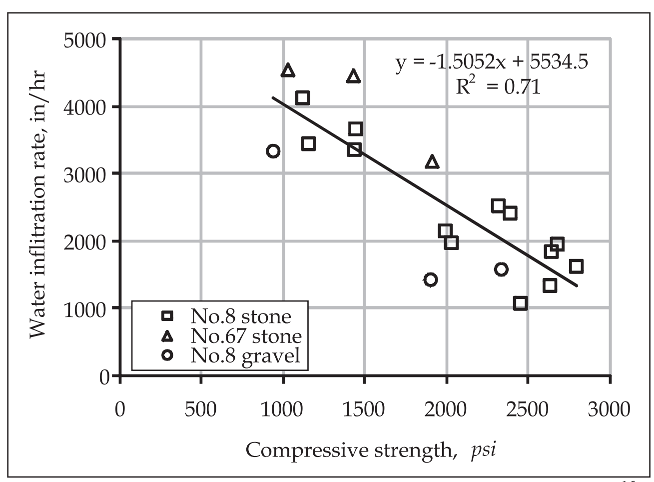

Figure 7. Water infiltration rate vs. compressive strength[16]

conducted in the laboratory to observe if the target void contents are attained. Since this was not always attained in 2009 NRMCA developed a pervious concrete mixture proportioning methodology and a computer program. The basic concept for that is given below:

The first step is to measure the void content of the dry-rodded coarse aggregate by ASTM C29. If fine aggregate is used the void content of the dry-rodded combined aggregates must be measured. The paste volume (PV) is then calculated as follows:

Required *PV* (%) = Aggregate Void Content (%) + *CI* (%) - Design Void Content (%)

CI = compaction index. The value of compaction index can be varied based on the anticipated consolidation to be used in the field. For greater consolidation effort, a compaction index value of 1 to 2% may be more reasonable. For lighter level of consolidation a value of 7 to 8% can be used. Tests at NRMCA have established that choosing a value of 5% will result in an experimentally measured fresh pervious concrete void content (ASTM C1688) that is close to the design void content.

Once the paste volume is determined the water and cement amounts can be calculated since the w/cm is known by a paste testing procedure as discussed in the report or simply by assuming a value between 0.28 and 0.35.

Design

There are two factors that determine the design thickness of pervious pavements: the hydraulic properties, such as infiltration rate and volume of voids, and the mechanical properties, such as strength and stiffness. Pervious concrete pavements must be designed to support the intended traffic load and contribute positively to the site specific storm water management strategy. The designer selects the appropriate material properties, the appropriate pavement thickness, and other characteristics needed to meet the hydrological requirements and anticipated traffic loads simultaneously. Separate analyses are required for both the hydraulic and the structural requirements, and the larger of the two values for pavement thickness will determine the final design thickness.

Many applications have used a 5 to 6 in (125 to 150 mm) thick pervious concrete over an aggregate base generally of the same dimension. Field performance of these projects have shown that they are adequate to handle the traffic loads expected in parking lot applications (passenger cars) where the heaviest loads are generally from garbage trucks (equivalent of Indian lorries up to 5 times/day). If heavier loads and higher traffic are expected then a thicker pavement 8 to 12 in. (203 to 304 mm) has been used. Another approach would be to try and use the structural design techniques outlined in the ACI 330R which could help optimise the pavement thickness.

Traditional pavement design attempts to exclude water from entering the subgrade (soil) below the pavement. In most cases, porous paving is designed to encourage water to saturate the subgrade below paving. This condition should be taken into account when determining the properties for the subgrade. The more a soil is compacted, the less porous it becomes. For this reason, pervious paving subgrades are usually compacted to a lower density than subgrades for traditional concrete paving. The level of compaction is typically 90% of Standard Proctor Maximum Dry Density (SPMDD). The modulus of subgrade reaction used in design should account for this lower level of compaction.

Initial recommendations had been that pervious concrete should be used only in sandy soils with infiltration rate greater than 0.5 in./hr (12.5 mm/hr). However, a detailed hydrologic analysis (Leming et al. 2007) for a specific example with soils with infiltration rate of 1, 0.5, 0.1, and 0.01 in./hr (25, 12.5, 2.5, 0.25 mm/hr) has shown that the post construction run-off was lower in all 4 soils when compared to the pre-construction runoff. The draw down time (time taken for all of the accumulated water in the pervious pavement to be discharged into the sub grade) in all cases was acceptable except for the soil with the lowest infiltration rate and that too only when an aggregate base was used. The authors concluded that pervious concrete can be used in silty soils with a soil infiltration of only 0.1 in./hr (2.5 mm/hr) and that there is no need to arbitrarily limit its use only to sands. In soils with infiltration rates considerably less than 0.1 in./hr (2.5 mm/hr) one way to reduce the draw down time could be to use buried perforated pipes that can transfer the collected water elsewhere. If that is not feasible the pervious concrete system could be placed without an aggregate base and the resulting excess run off (over preconstruction but still lower than if an impervious system had been used) could be handled using additional detention devices. It is important to note that soils with infiltration rates much below 0.1 in./hr (2.5 mm/hr) are likely to have runoff even on undisturbed land. Over the last 10 years there have been several successful pervious concrete pavement installations on soils with permeability of 0.1 in/hr (2.5 mm/hr) or lower.

Construction

An experienced installer is vital to the success of pervious concrete pavements. The subgrade is the bed on which the pavement structure is constructed and can be either native materials or imported fill. As with any pavement, proper subgrade preparation is important. The subgrade should be properly compacted to provide a uniform and stable surface. It is important, to examine carefully the soils present on each project for both structural and drainage capacities before specifying a compaction range since soils differ in the way compaction affects infiltration rate. The level of compaction is typically 90% of Standard Proctor Maximum Dry Density (SPMDD). In some cases, pavement will be placed on a subbase of clean gravel or crushed stone, which may be used as a stormwater storage basin. If the compacted site soils or imported fill have sufficient percolation rates and the project is not in an area where freezing and thawing is a concern, then a subbase may not be required and the pervious concrete can be placed directly on the subgrade. The project engineer should make this determination based on local regulations, soil permeability, stormwater volume, anticipated traffic loads, and pavement purpose. If a subbase is used engineering fabrics are used to separate fine grained soils from the stone layer. The subgrade and subbase should be moistened prior to concrete placement to prevent the pervious concrete from setting and drying too quickly. Also wheel ruts from construction traffic should be raked and re-compacted.

Pervious concrete is sensitive to changes in water content, so field adjustment of the fresh mixture is usually necessary. The correct quantity of water in the concrete is critical. Too much water will cause segregation, and too little water will lead to balling in the mixer and very slow mixer unloading. Too low a water content can also hinder adequate curing of the concrete and lead to a premature raveling surface failure. A properly proportioned mixture gives the mixture a wet-metallic appearance or sheen. Pervious concrete has little excess water in the mixture. Any time the fresh material is allowed to sit exposed to the elements is time that it is losing water needed for curing. Drying of the cement paste can lead to a raveling failure of the pavement surface. All placement operations and equipment should be designed and selected with this in mind and scheduled for rapid placement and immediate curing of the pavement. A pervious concrete pavement may be placed with either fixed forms or slip-form paver. The most common approach to placing pervious concrete is in forms on grade that have a riser strip on the top of each form such that the strike off device is actually 3/8-1/2 in. (9 to 12 mm) above final pavement elevation. Strike off may be by vibratory (Figure 8) or manual screeds. After striking off the concrete, the riser strips are removed and the concrete compacted by a manually operated roller that bridges the forms (Figure 9). Rolling consolidates the fresh concrete to provide strong bond between the paste and aggregate, and creates a smoother riding surface. Excessive pressure when rolling should be avoided as it may cause the voids to collapse. Rolling should be performed immediately after strike off. Since floating and trowelling tend to close up the top surface of the voids they are not carried out.

Figure 8. Pervious concrete struck off by vibratory screed

Figure 9. Example of compaction of pervious concrete by rolling

Jointing pervious concrete pavement follows the same rules as for concrete slabs on grade, with a few exceptions. With significantly less water in the fresh concrete, shrinkage of the hardened material is reduced significantly, thus, joint spacings may be wider. The rules of jointing geometry, however, remain the same. Joints in pervious concrete are tooled with a rolling jointing tool. This allows joints to be cut in a short time, and allows curing to continue uninterrupted. Saw cutting joints also is possible, but is not preferred because slurry from sawing operations may block some of the voids, and excessive raveling of the joints often results. Removing covers to allow sawing also slows curing, and it is recommended that the surfaces be re-wet before the covering is replaced. Some pervious concrete pavements are not jointed, as random cracking is not viewed as a significant deficit in the aesthetic of the pavement (considering its texture), and has no significant affect on the structural integrity of the pavement.

Proper curing is essential to the structural integrity of a pervious concrete pavement. The open structure and relatively rough surface of pervious concrete exposes more surface area of the cement paste to evaporation, making curing even more essential than in conventional concreting. Curing ensures sufficient hydration of the cement paste to provide the necessary strength in the pavement section to prevent raveling. Curing should begin within 20 minutes after final consolidation and continue through 7 days. Plastic sheeting is typically used to cure pervious concrete pavements.

Testing

As with regular pavements subgrade testing such as particle size analysis, soil testing and classification, and standard or modified proctor test should be conducted. In addition, a double ring infiltrometer (ASTM D3385) or other suitable test should be performed to adequately test the soil permeability.

Since it is not possible to duplicate the in-place consolidation levels in a pervious concrete pavement one has to be cautious in interpreting the properties of small pervious concrete specimens prepared in the laboratory or in the field. Such specimens may be adequate for quality assurance namely to ensure that the supplied concrete meets specifications.

ACI Committee 522.1 is a pervious concrete specification that requires the following test methods. Job site acceptance must be based on the density (unit weight) of fresh concrete measured according to ASTM C1688. An acceptable tolerance is ±5 lb/ft^3 (80 kg/m^3) of the design density. This ensures that the concrete that is supplied to the job site is the same as the concrete that was ordered for the project. Once the pavement has been constructed cores are taken and tested for the following: 1. Thickness; 2. Unit weight. Unit weight can be determined according to ASTM C 140. Slump and air content tests are not applicable to pervious concrete.

ASTM C1701 is a standard test method to calculate the Infiltration Rate of In-Place Pervious Concrete (Figure 10). An infiltration ring is temporarily sealed to the surface of a pervious pavement. After prewetting the test location, a given mass of water is introduced into the

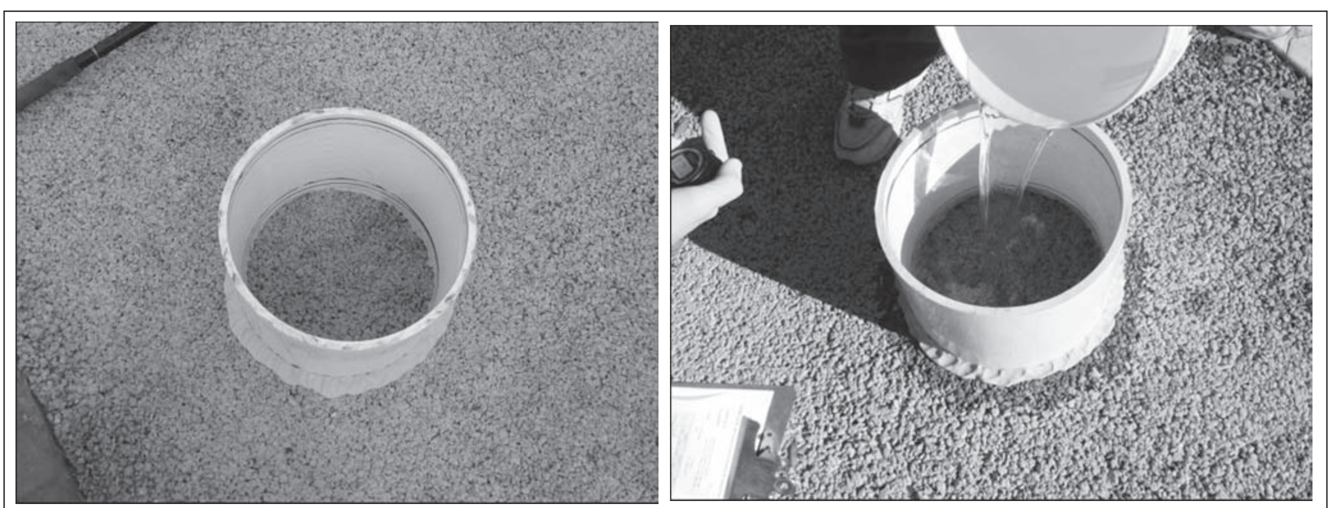

Figure 10. Infiltration rate testing of in-place pervious concrete (ASTM C1701-09)

ring and the time for the water to infiltrate the pavement is recorded. The infiltration rate is calculated using the equations provided in the standard. Tests performed at the same location across a span of years may be used to detect a reduction of infiltration rate of the pervious concrete, possibly by clogging, thereby identifying the need for remediation. A low infiltration rate reading on a new pervious concrete pavement suggests paste sealing during construction due to either improper mixture proportions or construction practices. This test should be conducted at several locations and the average infiltration rate calculated.

Concrete acceptance should not be based on compressive strength of the pervious concrete. Compressive strength varies widely with the amount of compaction used and there is no ASTM standard test method yet. Coring pervious concrete pavements can disturb the cement paste matrix and lead to artifically low strength test results.

Performance and maintenance

Two common preventable problems with pervious concrete are surface raveling and clogging.

Surface raveling is removal of loose aggregate material from the pervious concrete surface and is caused by inadequate *w/cm*, inadequate compaction, or improper curing procedures. Good curing practices, appropriate w/cm (not too low), and adequate compaction is important to reduce raveling. Where as severe raveling is unacceptable some loose stones on a finished pavement is always expected. Once the top layer of loose stones is removed raveling usually stops. Use of snowploughs could increase raveling. A plastic or rubber shield at the base of the plow blade may help to prevent damage to the pavement.

Clogging is the deposition of fines and vegetative matter on the pervious concrete surface or in its voids thus reducing its infiltration rates. Vegetative matter such as leaves can be deposited and may have to be removed periodically. Fines can be water-borne, wind-borne, or tracked onto the pervious concrete pavement by traffic. In preparing the site prior to construction, drainage of surrounding landscaping should be designed to prevent flow of materials onto pavement surfaces.

Due to the very high levels of initial infiltration rate, most pervious concrete pavements can work well with some amount of clogging. A recent investigation of several field sites in Southern USA (Wanielista et al. 2007) indicated that pervious concrete pavements that were installed 10 to 15 years ago, with no maintenance requirements, are operating in a satisfactory manner with insignificant amounts of clogging. The two commonly accepted maintenance methods are pressure washing and power vacuuming. Pressure washing forces the contaminants down through the pavement surface. This is effective, but care should be taken not to use too much pressure, as this will damage the pervious concrete. Power vacuuming removes contaminants by extracting them from the pavement voids. The most effective scheme, however, is to combine the two techniques and power vacuum after pressure washing.

For a pervious pavement system to perform well, it may need to be maintained at some regular interval. On a monthly basis, the paving area should be ensured to be clean of debris or sediments by broom sweeping. Power vacuuming is suggested on an annual basis. For critical projects ASTM C1701 testing could be conducted to evaluate if there is significant clogging and if there is more advanced measures could be considered. If a pavement is in a harsh environment, such as a coastal area, or anywhere that would cause heavy accumulations of fines, it may be necessary to perform this preventative maintenance more frequently.

Pervious concrete projects

Over the last 10 years thousands of pervious concrete projects have been completed in USA. A listing of some of the projects as well as a lot of information about this material is available at http://www.concretepromotion.org/Application_Resources/Pervious.htm. Figures 11 to 14 show some of these projects.

Figure 11. Glendale stadium parking and ride facility in arizona (4 acres)

Figure 12. Parking for prime outlets mall in Williamsburg, Virginia (7.6 acres)

Figure 11 shows the 4 acre Glendale Stadium Parking and Ride Facility in Arizona. Arizona is a desert type environment. Construction was conducted in summer of 2007 in the middle of the night. Peak day time temperatures in Arizona can reach 45°C. The project was a success and was used for the 2008 superbowl. Figure 12 shows the 7.6 acre parking Area for Prime Outlets Mall in Williamsburg, Virginia. The owner wanted to expand the existing mall space by 40%. The only way this was possible was by converting the existing detention pond into an underground water storage tank. A pervious concrete parking lot was placed above it. Perforated plastic pipes were placed in the aggregate subbase layer under the pervious concrete. These pipes routed the infiltrated water to the storage tank from which the water was reused for landscaping (to water trees). Figure 13 shows 2.7 million square feet of pervious concrete used in dock frontage for the rowing and sailing venue for the 2008 Olympics in Beijing, China. A multi-layer approach was used. The bottom layer consisted of larger aggregates. The top layer contained a finer aggregate and was colourised to create an attractive effect. Figure 14 shows a green alley in the city of Chicago. Chicago has 1900 miles of alleyways paved with about 3500 acres of concrete or asphalt that leads to localised flooding and overwhelms the city's storm water collection system. Some of the alleys are fully being replaced with pervious concrete while in others the alleyway is pitched to direct storm water towards the centre section that is built with pervious concrete.

Pervious concrete in India

Pervious concrete can be successfully used in India in applications such as parking lots, driveways, gullies/ sidewalks, road platforms, etc. Over the next 20 years there is expected to be a significant amount of housing construction India. The roads around the apartments/

Figure 13. Walkway in Beijing, China built for 2008 Olympics

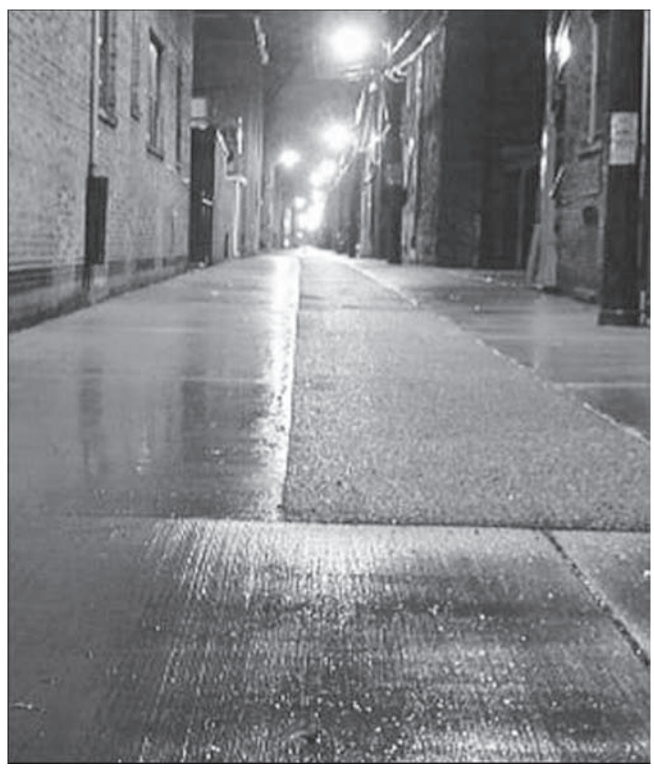

Figure 14. Green alleys in Chicago

homes and the surfacing inside the compound can be made with pervious concrete.

Massive urban migration in Indian cities is causing the ground water to go much deeper and is causing water shortages. For example, in states like Tamil Nadu residents commonly pay for water delivered and it is not uncommon to receive water only for a few days of a week in many parts of the country. Flooding and extended water logging in urban areas is common since all the barren land which could hold the rain water are being systematically converted into valuable real estate with a result that impervious surfaces such as roads, parking lots, roof tops are covering the natural vegetation. It is indeed ironical that even the world's wettest place Cherrapunji suffers drought while the monsoons brings flooding. Further, the rain water that falls on the concrete and asphalt surfaces tend to carry a high level of pollution and this pollution ends up in our waterways ultimately. The use of pervious concrete can help alleviate the damage of all of these ills.

Another significant advantage in India as compared to Western countries is the significantly lower cost of labor. Much of the pervious concrete construction is manual and can be done without heavy equipment and therefore pervious concrete can be placed at a lower cost even in rural areas.

A caution though is the higher prevalence of airborne dust in India that could lead to clogging of the pervious concrete. Pervious concrete can function with no maintenance and some level of clogging. Nevertheless, frequent preventative maintenance is recommended. In apartment communities, resident associations could perhaps take this over and those applications could be the first ones to be attempted.

In future with increased urbanisation, diminishing ground water levels and focus on sustainability, technologies such as pervious concrete are likely to become even more popular in India as well as other countries.

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