OBJECTIVE SHEET — PERVIOUS CONCRETE — 17

INTRODUCTION

Pervious concrete has actually been in use for more than 100 years, but since the 1970's this reputation of this paving process has gained rapidly in popularity. Because of its ability to treat, filter, control and partially contain stormwater runoff, pervious concrete is proving an ecologically friendly alternative to asphalt, impervious concrete and other paving materials. It will, more than likely, continue to grow in use as a "green" building product. The Environmental Protection Agency has, in fact, named the use of pervious concrete paving as a "Best Management Practice" in addressing stormwater management and groundwater purification practices.

FOCUS ASSIGNMENT

FOCUS ASSIGNMENTS

1. Explain the difference between pervious concrete and conventional concrete.
2. List at least three types of concrete applications that are best served by pervious concrete materials.
3. Describe the process for managing stormwater and rainfall runoff in a pervious concrete project.
4. List and explain at least three economic advantages of using pervious concrete in paving projects.
5. List and explain at least three environmental advantages of using pervious concrete in paving projects.
6. Identify and explain the three levels of certification for pervious concrete technology workers.

UNIT OBJECTIVE

After completing this unit you will show the following competencies by scoring at least 85% on the written test.

SPECIFIC OBJECTIVES

1. Define pervious concrete.
2. List materials that comprise a pervious concrete mix.
3. List typical pervious concrete applications.

4. Describe subgrade preparations for pervious concrete mixes.

5. Describe placement methods for pervious concrete.

6. Describe proper methods of finishing pervious concrete.

7. Explain the importance of proper curing of pervious concrete.

8. Describe the compressive strength of pervious concrete.

9. Describe the structural benefits of pervious concrete.

10. Describe the economic benefits of pervious concrete.

11. Describe the environmental benefits of pervious concrete.

12. Define LEED and explain its importance in pervious concrete construction.

13. Explain the certification program and process for pervious concrete contractors.

PERVIOUS CONCRETE

OBJECTIVE 1

Define pervious concrete.

Pervious concrete is a structural concrete mix which contains little to no sand. This lack of sand in the mixture creates a material with a porous open-cell structure (typically 15% to 25% interconnected voids) that allows water to pass through readily. This highly permeable concrete mixture permits rain and storm water to percolate through it rather than flood surrounding areas or storm drains. With carefully controlled amounts of water and cementitious materials, the mixture becomes a paste that forms a thick coating around aggregate particles.

Pervious concrete, because of this porosity, can be invaluable in outdoor projects that deal with stormwater runoff and groundwater contamination. Thus, it is becoming a friendly alternative to impervious concretes and asphalts. It has become known as a unique and effective means to address important environmental issues and support green, sustainable growth.

Pervious concrete should not be confused with Roller Compacted Concrete (RCC), which is still an impervious concrete. It is, however, also commonly known as “no fines” concrete and has also been called permeable concrete, gap-graded concrete, and enhanced-porosity concrete.

OBJECTIVE 2

List materials that comprise a pervious concrete mix.

Pervious concrete is composed of many traditional concrete elements, including: cement, coarse aggregates, admixtures, and water, with little to no sand being used in the mixture.

Cement — Typically a Portland cement (Types I, II, IS or IP are most commonly used) serves as the base with supplementary cementitious materials (SCMs) such as fly ash, silica fume, or blast furnace slag added to mixture. These SCMs help to increase the concrete’s setting time, rate of strength development, porosity and permeability.

Coarse Aggregates — To minimize surface roughness, it is recommended that a narrow gradation of coarse aggregate, such as a Number 89 (ASTM D-448) or a Number 8 (ASTM C-33) be used. Aggregates can be either rounded or angular, although higher strengths are achieved with rounded. Vulcan rock or limestone has been found to be a particularly effective coarse aggregate for use in pervious concrete mixtures.

To maximize the mixture's percolation capability, it is recommended that aggregates are triple-washed to remove fines prior to mixing. Because the amount of water used in this mixture is so critical, these aggregates must be close to a saturated, surface-dry condition when mixing.

Again, fine aggregates such as sand are used in very small amounts because they have a tendency to fill in the air voids. 15% to 25% is the standard void space within pervious concrete.

Admixtures — Admixtures are those chemicals which enhance special properties of the pervious concrete mixture. Following ASTM C-494 guidelines, these admixtures include retarders or hydration-stabilizing chemicals which lengthen cement's rapid setting time as well as air-entraining admixtures which reduce freeze-thaw damage.

Admixtures will vary by project scope and purpose and by local environmental conditions and are specified by the project engineers to best reflect and address these differences.

Water — Water is an extremely critical component of the pervious concrete mix. Quantity should be such that the cement paste displays a wet metallic sheen. Too little water will cause inconsistency in the mix and reduce bond strength and will lead to aggregates that are dry and do not place well, ultimately causing aggregate to separate from the pavement over time. On the other hand, too much water will make the paste form membranes which seal off the void system, primarily at the bottom of the slab, will make the mixture soupy and can ultimately create a poor surface bond.

As a general rule, water that is drinkable is suitable for use in pervious concrete mixes.

OBJECTIVE 3

List typical pervious concrete applications.

Pervious concrete, while new to some parts of the country, has been used extensively in Florida and other areas of the southeast United States since the 1970's. Its use is enjoying a growing popularity in the Western Coastal states, particularly for its environmental benefits.

The most common use of pervious concrete is in pavement projects including parking lots, driveways, sidewalks, pool decks, patios, and golf cart paths (Figures 1 and 2). It is being used, particularly in California, for subdivision streets, as well. Because its porosity creates a surface that is rough-textured, almost honeycombed, moderate amounts of raveling are common, which can be problematic on more heavily trafficked streets or roadways.

FIGURE 1

FIGURE 2

Pervious pavement technology has proven ideal for management of stormwater runoff and supports efficient land use by eliminating the need for retention ponds, swales, and other stormwater management devices. Because it helps to recharge groundwater and reduce stormwater runoff, it handily meets EPA (U.S. Environmental Protection Agency) stormwater regulations; in fact, it has been recommended by the EPA as a Best Management Practices use.

OBJECTIVE 4

Describe subgrade preparations for pervious concrete mixes.

Pervious concrete's success in absorbing stormwater runoff and providing a much-desired environment-friendly impact depends heavily on expert subgrade preparation and form work. Pervious concrete applications cannot perform accurately if subgrade does not meet strict specifications. Proper engineering of the substrate is essential, since it must be able to temporarily store water while it percolates into the soil (Figure 3).

FIGURE 3

Prior to specifying the concrete mixture for the application, an initial soils site survey and site-specific stormwater calculations should be performed by a stormwater management engineer. The existing soil must be evaluated for stability, drainage and identification of buried organic material or hazardous waste. Any problems identified at this point should be addressed and remedied by the general contractor or other appropriate source. Absolutely no organic material (roots, wood, stumps, sod, etc) can be allowed, nor can clay or organic sludge be tolerated.

SUBGRADE MATERIAL: Subgrade base should be installed with a minimum 6” of granular soil or gravel (with a limited amount of silt or clay in the mixture) or up to 10” of crushed stone (or a recycled, crushed concrete material). With type of sub-base specified by the project engineer, this material should be compacted by a vibratory compactor to a minimum density of 92% of a maximum dry density (as established by ASTM D-1157 or AASHTO T-180).

SUBGRADE MOISTURE: The subgrade should be in a moist condition with no free-standing water, within 3% (+ or -) of the optimum moisture content determined by the modified compaction test ASTM D-1157 or AASHTO T-180.

SUBGRADE PERMEABILITY: Prior to pervious concrete application, the general contractor or other representative of the owner should test the subgrade for its rate of permeability with a double ring infiltrometer to determine soil conditions and water table level. Test borings that locate a layer of clay less than 5 feet below the base may restrict the permeability. It is only if soil shows good permeability and stability and has not been disturbed for at least three years, that this testing and certification may not be required.

SUBGRADE SUPPORT: Subgrade materials should be placed and compacted by a mechanical vibratory roller to a minimum density of 94% (+ or – 2%, by ASTM D-1557 or AASHTO T-180 standards), according to engineering specifications. Again, this work should be the responsibility of the general contractor or the owner prior to pervious application.

If fill material is needed to bring subgrade to final elevation, it should be compacted in maximum layers of 8” by a mechanical vibratory roller or compactor to a minimum 92% maximum dry density.

FORMS: Forms should be set to specifications and elevations should be checked by a laser or other suitable device.

OBJECTIVE 5

Describe placement methods for pervious concrete.

The pervious concrete mixture is available from any number of concrete manufacturers and is usually delivered to the worksite in Ready-Mix trucks, mixed at a specified speed of 75 to 100 rotations of the drum before being discharged. (NOTE: Pervious concrete does not lend itself to being pumped.) Because the water quantity and timing as well as the mixture's consistency are so critical to pervious paving, it is important that the batch is discharged and applied within 60 minutes of mixing. The batch must be placed, rolled and covered as quickly as possible and, therefore, requires a team of workers, each with specific duties coordinated throughout this installation process.

The mechanical compactive equipment, must provide a minimum of 10 psi vertical force. The pervious concrete pavement will be placed to the required cross section and should not deviate +/- 3/8" in 10 feet from the profile grade.

Workers will rake concrete close to grade (Figure 4). Then, one of many different types of screeds will be used to level the material (Figure 5). Some screeds will also be used to compact, while other screeds will need to have a compactor follow them (Figure 6).

FIGURE 4

FIGURE 5

FIGURE 6

Control joints should be placed if prevention of random cracking of pavement is desired, although joint spacing is usually larger than for conventional concrete. Because setting time and shrinkage are accelerated in pervious concrete construction, joint installation should be soon after compacting. Use of a rolling joint tool is typically preferred as the slurry from a saw-cut operation could block some of the voids in the pavement surface (Figure 7). Some pervious concrete pavements are not jointed, as random cracking has no significant affect on the structural integrity of the pavement.

FIGURE 7

✔ **NOTE:** Use form oil on joint roller or cover with thin mil plastic.

OBJECTIVE 6

Describe proper methods of finishing pervious concrete.

Normal floating and troweling operations tend to close up the top surface of voids, which defeats the purpose of pervious concrete in most applications. For the majority of pervious pavements, the "finishing" step is the compaction. However, additional straightening and detail may need to be performed on the edgework.

During placement, care should be taken to avoid workers stepping into the mix during placement as footprints can compress and force cement paste into the voids at the bottom of the slab, which may interfere with moisture percolation in the finished project.

OBJECTIVE 7

Explain the importance of proper curing of pervious concrete.

Within 20 minutes of final placement operations, the pavement surface should be covered with a 6 mil (minimum) polyethylene sheet. If ambient conditions (temperature, wind or humidity) require it, a light mist may be sprayed above the surface prior to covering. The cover should overlap all exposed edges by at least 12 inches and should be secured sufficiently to avoid bubbles which will cause uneven curing and/or discoloration (Figure 8).

FIGURE 8

Typically, Portland cement types I, II, or IS require a minimum 7 days curing time while Portland type IP requires a minimum 10 days of curing. It is important that no passenger cars or light trucks be allowed on the surface for at least 7 days and no heavy truck traffic should be allowed for 10 days following placement. A full 28 days should pass before pervious concrete reaches its maximum strength.

OBJECTIVE 8

Describe the compressive strength of pervious concrete.

The compressive strength of pervious concrete is limited since the void content is so high. However its compressive strengths are typically sufficient for a number of applications. Pervious concrete mixtures typically develop compressive strength of about 2500 psi (17 MPa), although they can range up to 4000 psi (28 MPa), depending on application. The properties and combinations of materials, as well as placement techniques and environmental conditions, will ultimately determine the compressive strength of a project.

To determine the compressive strength, it is recommended that drilled cores be implemented to accurately measure in-place strength. However, applications constructed with pervious concrete do not typically require measurement of flexural strength for design.

OBJECTIVE 9

Describe the structural benefits of pervious concrete.

The most obvious structural benefit of pervious concrete pavement is its porosity, which allows it to conduct runoff water back into the soil beneath. Yet there are other significant advantages, including:

- Less shrinkage than conventional concrete
- Less crack or separation than conventional concrete
- Less need for control joints, or increased distance between control joints
- Less distortion under traffic, such as ruts and ripples from the sun and from friction of braking vehicle tires
- Less heat absorption from the sun (often 50% to 75% less)
- Reduced reflection of heat into the atmosphere

- The open cell structure enables volatiles from oil or grease drips to evaporate while remaining solids pass into the soil below, where microbial activity may consume or convert them (Figure 9).

FIGURE 9

- Less maintenance than conventional concrete because it is far less apt to settle

OBJECTIVE 10

Describe the economic benefits of pervious concrete.

At first glance, initial costs for pervious concrete pavements are higher than those for conventional concrete or asphalt pavements, however when overall installation and life-cycle costs are compared, pervious concrete become quite cost-efficient. The materials itself is only a little more expensive than other products, but we tend to install pervious concrete thicker than conventional concrete. In addition, there are other economic benefits, including:

- Ability to adapt mixture to meet environmental conditions in different regions

- Less need for storm sewer tie-ins

- Less need for rebuilding existing sewer systems when new developments go up

- Less need for installing underground piping and storm drains
- Less grading of pavement areas when there is no need to slop to storm drains
- Less need for retention ponds and other water-retention and filtering systems for stormwater management
- Irrigations systems can be downsized or eliminated
- Increased land utilization and more efficient land usage
- Life expectancy of 20 to 40 years per project
- Pervious concrete can be recycled once it has reached the end of its life-cycle

OBJECTIVE 11

Describe the environmental benefits of pervious concrete.

Stormwater runoff is a leading source of the pollutants entering our waterways, with about 90% being carried in the first 1 ½ inches of a typical rainfall. Stormwater drains don't typically channel this polluted runoff to treatment facilities, but instead moves it directly into local bodies of water, increasing algae and harming aquatic life.

The Environmental Protection Agency (EPA), through the EPA Storm Water Phase II Final Rule, has tightened its environmental regulations and provides programs and practices to help control the contaminants in our waterways. Pervious concrete pavement systems have become a valuable stormwater management tool and are considered an EPA "Best Practices Management" model. Pervious concrete pavement has a number of environmental benefits, including:

- Reduced amount of untreated runoff discharging into storm sewers
- Directly recharges groundwater to maintain aquifer levels
- More water is channeled to tree roots and landscaping, which means less need for irrigation
- Permits "treatment" of pollution with long-term pollutant removal that contaminates watershed and ecosystems
- Eliminates hydrocarbon pollution from asphalt pavements and sealers

- Reduces the urban “heat-island effect”; with its light color and open-cell structure, it does not absorb or store heat and radiate it back into the environment

- Open void structure allows cooler earth temperatures from below to actually cool the pavement

- Lighter color makes the pervious concrete more reflective, lessening the need for night lighting on traffic ways and parking lots

- Absorption of rainfall increases driver and pedestrian safety by reducing puddling, ponding, hydroplaning, tire spray, and rain-induced glare

OBJECTIVE 12

Define LEED and explain its importance in pervious concrete construction.

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is a nationally accepted benchmark for the design, construction, and operation of high performance "green buildings." Developed by the U.S. Green Building Council, LEED's rating system gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings’ performance.

LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. By these standards of performance, pervious concrete is definitely considered a “green” building product and is considered by the EPA to be “an integral part of green infrastructure”.

OBJECTIVE 13

Explain the certification program and process for pervious concrete contractors.

Certification programs have been created for contractors who are involved with placement of pervious concrete product. These programs have been developed to ensure that the workforce involved with this product is trained and knowledgeable of all aspects of pervious concrete. These certification programs are typically developed and administered locally with planned training sessions and/or demonstrations. NRMCA (National Ready Mixed Concrete Association) provides certification exams and performance evaluations to approved local sponsoring groups for administering the certification.

Certification typically covers the following topics:

- Basic concrete technology
- Pervious concrete materials and mix proportioning
- Proper use of tools and equipment
- General design principles of pervious concrete pavements
- Pervious concrete construction
- Maintenance and troubleshooting

There are three levels of NRMCA certifications, with increasingly more stringent requirements for each. Requirements include not only being able to show proficiency on a written exam, but also performance exam as well as work and/or project experience. These three levels are:

- A Pervious Concrete Technician is a person who demonstrated knowledge about proper procedures to place, compact, finish, edge, joint, cure and protect pervious concrete pavements, but who lacks the requisite field experience to qualify as a pervious concrete Installer or Craftsman.

- A Pervious Concrete Installer is a person who has demonstrated the ability to place, compact, finish, edge, joint, cure and protect pervious concrete pavements and has documented a limited project-based field experience in placing pervious concrete.

- A Pervious Concrete Craftsman is a person who has demonstrated the ability to place, compact, finish, edge, joint, cure and protect pervious concrete pavements and has documented a higher level of field time-based experience in placing pervious concrete.

Recertification is required every 5 years and includes proficiency on a written exam.