Pervious Concrete
When it Rains, it Drains
Darrell F Elliot, FACI
Buzzi Unicem USA
What is Pervious Concrete?

- Open cell structure allows water to pass through

- AKA
  - Porous Concrete
  - Permeable Concrete
  - Gap-Graded Concrete
  - No-Fines Concrete
  - Enhanced-Porosity Concrete
Applications

- First used in 1852 in residential walls in Europe when sand & other fine aggregates were not readily available

- Primary use as a pavement
  - Parking areas
  - Sidewalks & pathways
  - Residential roads, alleys and driveways
  - Shoulders & Medians
  - Under Overpasses & Bridges
Parking Areas
Streets and Roadways
Driveways
Concept

When rain falls, much of it will flow off impermeable surfaces into storm drains, creeks, rivers, and low areas.

- Volume
- Contaminants
Concept

With pervious concrete, this water is captured and contained.
- Used to recharge the ground water
- Provides natural filtration
Typical Section

- Pervious Pavement
- Additional Pervious Material
- Impermeable Subgrade
Pervious Pavement System

STORMWATER IN

PERVIOUS CONCRETE PAVEMENT

AGGREGATE BASE

STORMWATER OUT

SUBGRADE
Pervious Pavement Cross Section (Warmer Climates)

- Curb
- Filter Fabric
- Stormwater
- Pervious Concrete
- Aggregate Base
- Subgrade
Deeper Reservoir
Perforated Pipes
Trenches and Perforated Pipes
340” of Rain per Hour
Concept

Can be designed as “Passive” to capture the rainwater that falls on the pavement area.

Can be designed as “Active” to capture additional rainwater.
Mitigates surface pollutants

- Not an oil-based pavement material
- Reduce first flush pollutants
  - Oil
  - Anti-freeze
  - Other automotive fluids
  - Various Chemicals
- Treats pollutants naturally
  - Contaminated water percolates into the ground
  - Soil chemistry & biology “treat” water naturally
Cost Advantages

- Zoning ordinances on impervious surfaces
- Stormwater utility fees
- Eliminates need for detention ponds, retention ponds & other costly stormwater management practices
- Provides for more efficient use of land
Traditional Parking Lot
Pervious Parking Stalls

Fewer Light Poles

Smaller Retention Pond
Pervious Parking Lot

Fewer Lights
2X Parking Space

Retention Pond Eliminated
Mix Design

- If you want concrete to drain water, you need to have voids.
- To create voids we take out most, if not all, of the sand.
Conventional vs. Pervious

Conventional Concrete

Pervious Concrete
Mix Design

- If we take out all the sand, we need more coarse aggregate.
- To determine how much, take the “dry rodded weight” of the stone and multiply it by 27.
- DRW = 99.5 \times 27 = 2686
Mix Design

- Aggregate size can range from:
  - #67 (3/4 in. to No.4)
  - #89 (3/8 in. to No. 50)

- Too coarse = texture too open
- Too fine = not enough voids
- Narrow gradation = maximum voids
Mix Design

- Most pervious mixes have between 450 to 700 pounds of cementitious materials in a cubic yard.
- The shape and size of the CA and the end usage of the pervious will determine the amount.
- May use portland or a combination/blend of portland with slag and/or fly ash.
Mix Design

- Water is next...How much?
- Typical w/cm ratios are 0.27 to 0.34 (up to 0.40)
- If we are using 600# of cementitious at a 0.30 w/cm then we have 180# of water.
Mix Design

Correct Water Content

- The mixture should have a sheen without water flowing off of the aggregate
- A handful of pervious concrete formed into a ball should not crumble
- Pervious concrete should have a stiff consistency
Mix Design

Since there is cementitious material in the mix, we can use chemical admixtures.

Admixtures have become a very important part of pervious concrete.

- Retarder or Hydration Controlling Admixture
- Water-Reducing Admixture or Mid-Range
- Viscosity Modifying Admixture
- Air-entraining admixture
Mix Design

- Cement: (450-) 600-700 pounds
- Fly Ash or Slag substitution possible
- Water/Cement Ratio: 0.27 to 0.34 (to 0.40)
- Single Size Coarse Aggregate: #67, #89
- Aggregate-cement ratio: 4 to 4.5:1
- 2000-2700 lbs.
- Optional:
  - Admixtures, color, fibers
- Work with local RM supplier to achieve required performance
Fresh Properties

- Low slump about ½” to 2”
- For QC, density is the preferred measurement (100 to 125 pcf)
- Placement and haul times reduced, as increased surface area leads to increased evaporation rates (usually 1 hr. between mixing & placing)
- Mandatory mixing requirements for optimum consistency
- Admixtures can help
Hardened Properties

- Typical compressive strength of 2500+ psi
- 15% to 25% void structure facilitates permeability
- 3-8 Gallons of water transfer per square foot per minute = 340” of rain per hour
- 5” section with 20% voids holds 1” of rain water
- Base design important to storage as well
- Roughly ½ the shrinkage of normal concrete
Compliance Testing
ACI 522R-06

Voids, Thickness, & Compressive Strength In-place From Cores

Unit Wt. Tests
Pervious vs. Conventional Concrete

- **Aggregate** – Smaller Aggregates, Typically
- **W/C Ratio** – LOWER
- **Set Time** – FASTER (most cases, but modifiable)
- **Strengths** – LESS (due to lower density & 15-30% voids)
- **Durability** – SIMILAR (except abrasion)
- **Shrinkage & Cracking** – LESS
- **Curing Sensitivity** – MUCH HIGHER
- **Appearance** – OPEN GRADED
- **Costs** – In-Place is more
Durability

- Freeze-thaw resistance
  - Appropriate test method
  - Importance of drainable base
  - Air entrainment for paste

- Sulfate resistance
  - Similar precautions as in ACI-201

- Abrasion resistance
Typical Placing Procedures
(can vary by market)
Layers
Finishing
JOINTS

- Joints can be grooved or sawcut
- Can be placed with no joints.
- No joint sealant needed
Jointing

“Pizza Cutter”
No Joints
Surface Texture
Colors
Stamped
Curing pervious concrete is **critical** due to the porosity and low water-cement ratio.
Opening to Traffic

- After 7 days
- Depending on weather conditions
Maintenance

- Majority of pervious concrete needs little or no maintenance
  - Handled in original design and site plan
  - Prevent flow of debris onto pavement surface
- Clogged pervious concrete
  - Vacuuming surface
  - Pressure washing
- Maintenance practices still under development
Regular Maintenance

Vacuum Sweep Periodically
Maintenance if Clogged

Power Wash First

Then Vacuum Sweep
Pervious Concrete –
NRMCA Certification Program
For Contractors

Modeled after ACI’s Flatwork Finisher Certification Program is administered by local sponsoring groups. Goal is to ensure that knowledgeable contractors are selected to place pervious concrete.

Two Certification Levels Are Possible:

**Pervious Concrete Technician**
Must pass a written exam

**Pervious Concrete Craftsman**
Must pass a written exam
Work experience and/or pass a performance exam
Additional Information

www.nrmca.org
www.cement.org
www.aci-int.org

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PCA/NRMCA Hydrologic Design Software

Pervious Concrete: Hydrological Design and Resources

Concrete Thinking for a sustainable world
PCA Portland Cement Association
NRMCA
Specifications for Pervious

Specifications:

- Fresh properties
- Hardened properties
- Contractor qualifications

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Thank You!!