WASHINGTON STATE UNIVERSITY
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Pervious Concrete

By

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What is Pervious Concrete?

Mixture of :

- Coarse aggregate,
- Cementitious material,
- Admixtures, and
- Water.
- Carefully controlled amounts of water & cementitious materials are used to create a paste that forms a thick coating around aggregate particles without flowing off during mixing & placing.

How is pervious concrete placed?

Concrete	Con	PC
Cement	1	1
Aggregate	3	4
Water	1/2	1/4
Fines	2	0

Mixed

Compacted & Covered

Cured 7 days

Porosity of Pervious Concrete

- Total Porosity Ranges: ~13%-40%
- Tortuosity

Reduces Runoff

- Reduces need for stormwater facilities
- Models the pre-existing hydrology through Infiltration
  - Vegetation Irrigation
  - Groundwater Levels
  - Baseflows

Removes Pollution

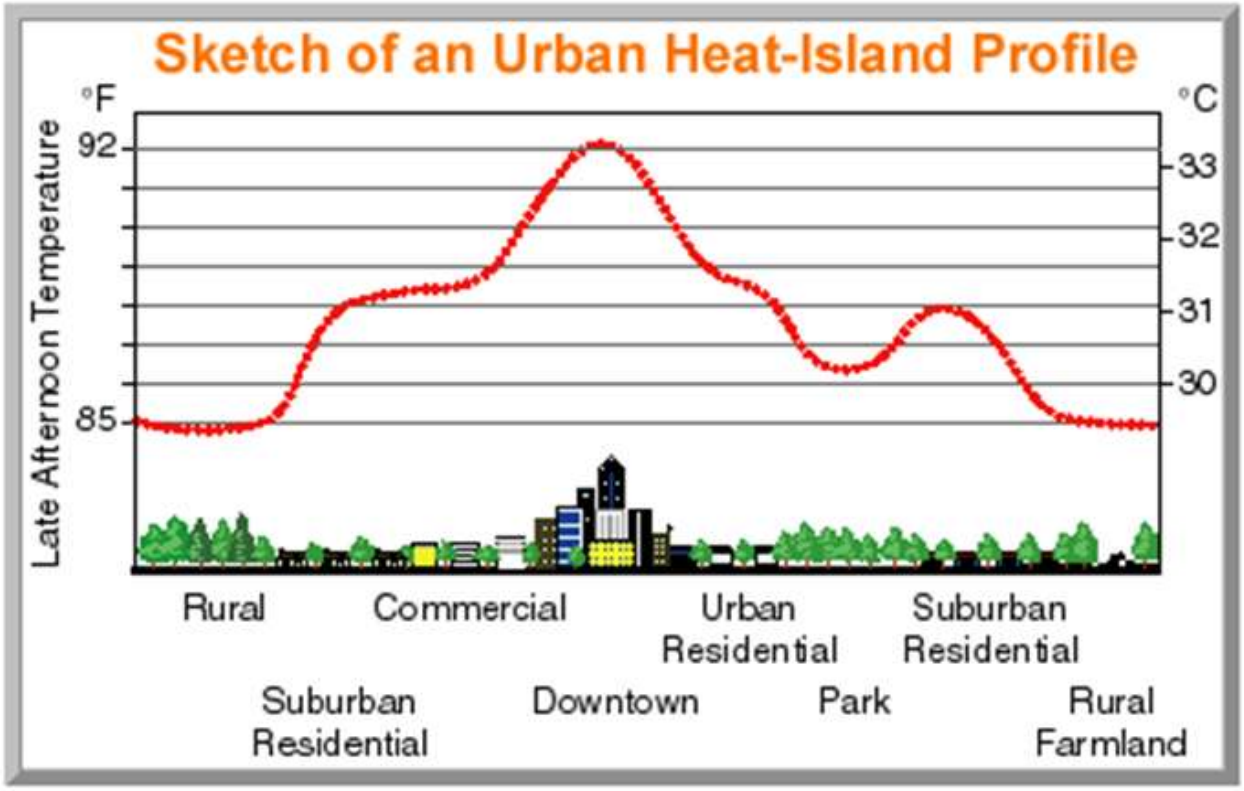
- Oil is filtered out in concrete and removed from runoff.
- Hydrocarbons such as gasoline may pass through the concrete and base material, but will degrade in soil.
- Studies show that most heavy metals are retained in concrete and base material.

Safety

- No hydroplaning
- Reduces slickness of roadways
- Eliminates ponding/ice in parking lots

PerviousPavement.org

Mitigates Heat Island Effect

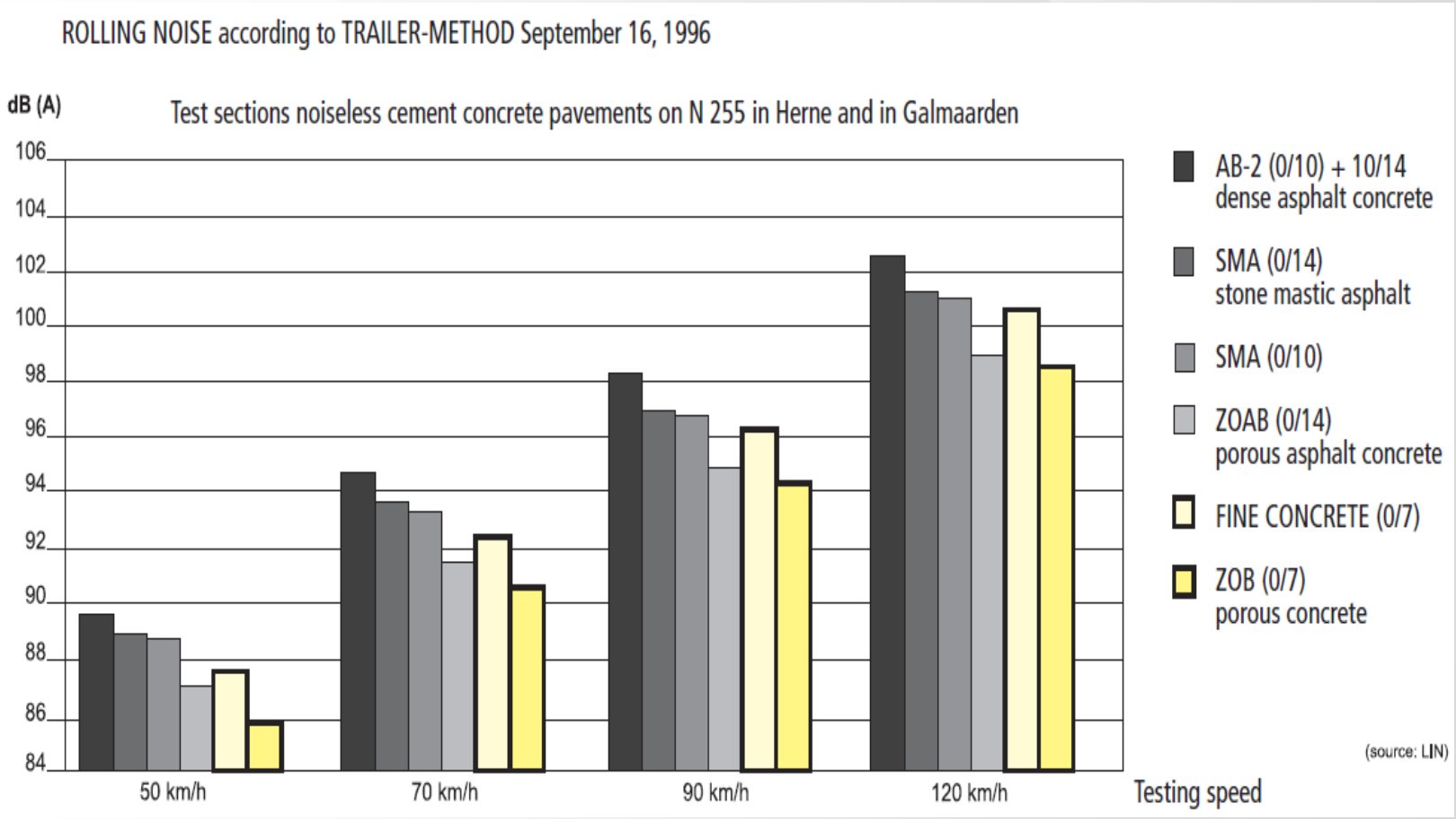


Source (EPA, 1992)

Decreases Erosion

- Pervious Concrete spreads water
- No Channeling on road Shoulders

Reduces Road Noise



Source (Caestecker, 1997)

Smaller Carbon Footprint

- Absorbs CO_2 from atmosphere
- Carbonation Process
  - $CO_2(g) + H_2O(l) = H_2CO_3(aq)$
  - $H_2CO_3(aq) = H^+(aq) + HCO_3^-$
  - $HCO_3^-(aq) = H^+(aq) + CO_3^{2-}(aq)$
  - $Ca(OH)_2(s) = Ca^{2+}(aq) + 2OH^-(aq)$
  - $H^+(aq) + OH^-(aq) = H_2O(l)$
  - $Ca^{2+}(aq) + CO_3^{2-}(aq) = CaCO_3(s)$
- Simplified Equilibrium Equation
  - $CO_2(g) + Ca(OH)_2(s) = H_2O(l) + CaCO_3(s)$

Pervious Concrete Cost

- Installation Costs
  - Pervious Concrete: $2-$6 per square foot[1]
  - Regular Concrete: $2-$6 per square foot
- Cost Benefits
  - Eliminates need for
    - Traditional curb and gutter systems
    - Underground piping
    - Grading site
    - Retention basins
  - Does not add water to existing sewer systems
  - Increases land utilization

1. http://www.epa.gov/heatisld/images/extra/level3_pavingproducts.html Wang et al, 2007

Pervious Concrete Uses

- Applications with relatively light and low frequency loading
  - Sidewalks
  - Bike Paths
  - Parking Lots
- Applications are limited by its relatively unknown strength properties and durability

Strength Properties

- Typical Compressive Strength
  - 500 to 4000psi for pervious concrete[1]
    - My testing: 1300-5100psi
  - 3500 to 5000psi for traditional concrete[2]

1. Tennis et al, 2004
2. Wang et al, 2007

Strength Properties

- Typical Tensile Strength
  - 150 to 550psi for pervious concrete[1]
    - My testing: 110-260psi
  - 350 to 600psi for traditional concrete[2]

1. Tennis et al, 2004
2. Wang et al, 2007

Strength Properties

- Modulus of Elasticity
  - 1300-2700ksi for pervious concrete[1]
    - My testing: 1500-2200ksi
  - Typically 3000-4000ksi for regular concrete[2]
- Poisson's Ratio
  - Similar to regular concrete: 0.15-0.20[1]
    - My testing: 0.15-0.25

1. Ghafoori and Dutta, 1995
2. Wang et al, 2007

Strength Properties

- Dependent on:
  - Porosity
    - Porosity definition: ratio of volume of voids to total volume
    - Higher porosity yields lower strength
    - Typical porosities for pervious concrete: 15-25%[1]
      - My testing: 12-32%
    - Porosity depends on water to cement ratio and compaction effort

1. Tennis et al, 2004

Strength Properties

- Dependent on:
  - Aggregate Effects
    - Size
    - Shape
    - Gradation
  - Admixtures can be used to:
    - Increase workability
    - Increase strength
    - Delay setting time

Durability

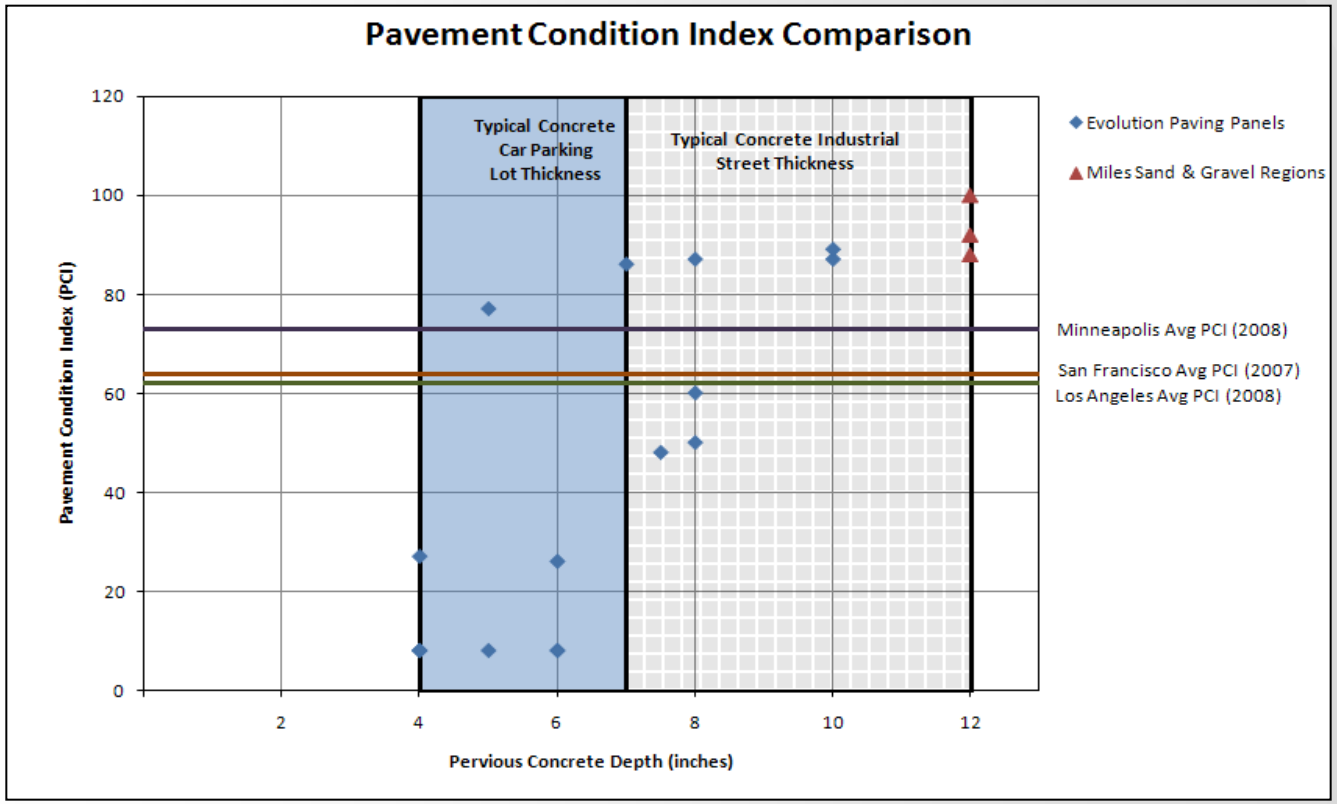
- Pavements often have a design life of 20 to 30 years, so long-term durability is very important
- Few field investigations of the long-term durability of pervious concrete have been performed
- Quantifying durability:
  - Distress Identification
  - Pavement Condition Index (PCI)

Durability

- Distress Identification
  - 2 site visits were made
    - Evolution Paving
    - Miles Sand & Gravel
  - Distress was classified according to type and severity

Durability

- Pavement Condition Index (PCI)
  - Numerical value that represents the surface condition of a pavement



Summary

- Benefits of pervious concrete:
  - Reduces runoff
  - Removes water pollutants
  - Increases driver safety
  - Lessens urban heat island effect
  - Decreases erosion
  - Reduces road noise
  - Has a smaller carbon footprint
- Pervious concrete strengths are lower than regular concrete strengths and depend on the porosity
- My research shows that the durability of pervious concrete is comparable to that of regular concrete