Porous Asphalt Pavement Overview

- Site Design Considerations
- Materials and Specifications
- Construction Sequencing
- Performance of Permeable Asphalt
- Emerging Green Technologies for Asphalt
- City of Puyallup Upcoming Projects
- Questions

Porous Asphalt Defined

- Porous Asphalt: Full depth porous asphalt.
- All materials in the roadway section are permeable, allowing free flow of water to subgrade for infiltration or other routing.
- Contrasts to common use of porous asphalt for a Porous Friction Course (PFC) or Open Graded Friction Course (OGFC) over dense graded hot mix asphalt (HMA) substrates. (Examples locally: I-5 52nd Ave West to SR-526; SR-520 MP 4.24 to MP 5.82; I-405 112th Ave SE to SE 8th St.)
Site Design Considerations

1. Poor soils do not necessarily restrict use of porous asphalt.
2. Sloping sites do create significant design issues—porous asphalt should not exceed 6% slopes.
3. Porous pavements can be subdrained in areas of high water tables or extremely poor draining soils.
4. Porous asphalt is a good product for local roads, parking lots and trails. It has also been used in limited freeway applications such as Arizona SR-87. This road is still in use after 20 years of service.

Site Design Considerations

- Conclusions of Final Report for SR-87 project:
  - “The porous pavement test section has performed satisfactorily for five years. Although a slight decrease in the infiltration rate has occurred, both the infiltration rate and the storage capacity are above the design values.”

Site Design Considerations

“Visual observation during rain storm has shown that the surface of the porous pavement section does not include sheet flow. This provides a marked improvement in stripe delineation and pavement glare during nighttime inclement weather driving compared to conventional pavement.”
Site Design Considerations

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2. Sloping sites do create significant design issues—porous asphalt should not exceed 6% slopes.
3. Porous pavements can be subdrained in areas of high water tables or extremely poor draining soils.
4. Porous asphalt is a good product for local roads, parking lots and trails. It has also been used in limited freeway applications such as Arizona SR-87. This high volume road was still in use after 20 years of service.
5. Try to keep the bottom of the road section in native material—don’t install road section in compacted, impervious fill.
6. If you must transition from porous asphalt pavement to dense graded asphalt pavement, consider installing a concrete divider (costly) or extending the reservoir course under the dense graded asphalt (preferred).

Site Design Considerations Continued

7. Always provide an alternative method for water to enter or leave the subgrade.
   - Stone edge allows stormwater to enter reservoir course if pavement is overlaid or sealed.
   - Stone edge intercepts upstream flows to reservoir course.

8. Roadways do not need to be crowned, particularly if there is a longitudinal slope or free draining soils.
9. Use barrier curb (no gutter), or flush curb if allowed. If using curb and gutter, reverse the slopes on curbs—direct flow to the pavement.
10. Stormwater flows from roofs and driveways can be accommodated in the porous asphalt section too (account for in hydrology calculations).

Perforated pipes dispersing roof drainage in reservoir course.
Finished grade at or slightly above surrounding elevations BUT with road section still in native material.

For areas deeper than road section, use ballast, reservoir course or other open graded materials for fill.
Vertical Road Alignment

Note: Cul-de-sac is flat

Consider overflow relief at low points.

Site Design Considerations Continued

Overflow catch basins installed at low point and connection to positive outlet

Interceptor shoulder ballast used in this case to intercept uphill flows and pass under the pavement and through the road reservoir section.

Typical Porous Asphalt Road Section

A" LINE ROADWAY SECTION

- Place 2" TYPICAL AND HOE-DREDGED ALL SHOULDER AREAS
- KEY LOCATIONS INDICATED. AREA HONORED FOR ASPHALT
- KEY LOCATIONS SPECIFIED. HOE WASHED BALLAST FOR
- KEY LOCATION PRODUCTION. HOE WASHED BALLAST FOR
Typical Porous Asphalt Road Section

Materials and Specifications - Geotextile Fabric

Reference: Section 9-33.2(1) of WSDOT 2008 Standard Specifications

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM/ISO Method</th>
<th>Tensile Strength</th>
<th>Elongation</th>
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<tbody>
<tr>
<td>geotextile</td>
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WSDOT Geotextile for Separation

Reference: Section 9-03.9(2) of WSDOT 2010 Standard Specifications

Material should be clean, less than 2% passing the No. 100 is good.

75% Fracture provides some interlocking—suggest modifying to 100% if possible.

Uniform size, 60-100% of material is between № 4 and 2", allows for a large percentage of voids.

The grading and quality requirements are:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
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<tbody>
<tr>
<td>2½&quot;</td>
<td>100</td>
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<tr>
<td>2&quot;</td>
<td>65 - 100</td>
</tr>
<tr>
<td>¾&quot;</td>
<td>40 - 80</td>
</tr>
<tr>
<td>No. 4</td>
<td>5 max.</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 - 2</td>
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</table>

All percentages are by weight. The sand equivalent value and dust ratio requirements do not apply. The fracture requirement shall be at least one fractured face and will apply the combined aggregate retained on the No. 4 sieve in accordance with FOP for AASHTO TP 61.

Uniform size, 60 - 100% of material is between № 4 and 2", allows for a large percentage of voids.
Materials and Specifications - Reservoir Course

- Material shown meets 75% fractured face was moderately difficult to work with.

WSU Puyallup LID Retrofit Submitted Reservoir & Choker Course

Uniform size, 74% of material is between ¾" and 1-3/4", allows for a large percentage of voids. AESI gradation showed voids at 46.5%.

Material should be clean, less than 2% passing the #100 is good.

Materials and Specifications – Choker Course & Asphalt Aggregate

WSDOT 2000 specification for Class D Aggregate & ½" Open Graded

<table>
<thead>
<tr>
<th>Sieve Size</th>
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<tbody>
<tr>
<td>¾&quot;</td>
<td>100</td>
</tr>
<tr>
<td>½&quot;</td>
<td>65-100</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>50-75</td>
</tr>
<tr>
<td>No. 4</td>
<td>10-25</td>
</tr>
<tr>
<td>No. 8</td>
<td>5-10</td>
</tr>
<tr>
<td>No. 200 (wet sieve)</td>
<td>0-3</td>
</tr>
</tbody>
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NAPA IS-115 gradation for Asphalt and choker course

<table>
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<tr>
<th>Sieve Size</th>
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<tr>
<td>¾&quot;</td>
<td>100</td>
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<td>10-25</td>
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<tr>
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<td>5-10</td>
</tr>
<tr>
<td>No. 200 (wet sieve)</td>
<td>0-4</td>
</tr>
</tbody>
</table>
Aggregate slightly smaller than specification, but voids ratio was easily met.

Example of Choker Course predominant single size

Poorly graded choker course-unstable
Materials and Specifications – Choker Course & Asphalt Aggregate

Choker Course must be well graded above #100 (uniform distribution of sieve sizes) in order to perform as stable platform for placing asphalt.

Well graded choker course-stable

Materials and Specifications – Porous Asphalt

Asphalt materials will comply with WSDOT specifications for Class ½ HMA PG 70-22 (Polymer modified) with the following modifications:

- Asphalt cement shall be between 6.0% and 9.0% by total weight. Test for drain down and void content at 75 gyrations at 6, 7, 8, and 9%, use highest percentage that passes both tests.

- NAPA IS-115 or other aggregates meeting requirements as noted in previous slide to be used.

- Anti-stripping agent, not to exceed 1% by weight of the aggregates, provides a conservative design (Mix design will determine).

- Stiffer asphalts (70-22), polymer modifications, and anti-stripping agents all work to reduce drain down.

- If drain down is still a problem, consider adding fibers or slightly increasing fines vs. reducing asphalt content.
Pavement Section Design:
- Three factors: reservoir capacity, frost depth, structural loading.
- Reservoir capacity as determined by modeling, soil infiltration rate and contributing areas.
- Frost Depth only for poor draining soils, but generally 1 foot in Puget Sound lowlands.
- Structural section, use appropriate WSDOT Flexible Pavement Layer Thicknesses Design Table, assume poor soils to simulate saturated conditions.
- Thickest of three parameters determines pavement section, usually structural will govern.

Materials and Specifications – Porous Asphalt

Construction Sequencing
1. Install normal erosion control measures.
2. Strip and Clear site as needed.
3. Grade to subgrade elevations for road. Minimize compaction of the subgrade by installing alternate haul route outside road section, or other methods of keeping traffic off subgrade.
Construction Sequencing

1. Install normal erosion control measures.
2. Strip and Clear site as needed.
3. Grade to subgrade elevations for road. Minimize compaction of the subgrade by installing alternate haul route outside road section, or other methods of keeping traffic off subgrade.
4. Alternately, leave 6-12" of material above subgrade while other work continues, removing material to subgrade just prior to paving.
5. Install wet utilities, sanitary sewer and storm and utility crossings.
6. Place geotextile on uncompacted subgrade, scarify if needed.
7. Place reservoir course per plan depth by pushing on to geotextile fabric—don’t drive directly on subgrade.
8. Roll reservoir course with vibratory rollers.
9. Place and roll Choker Course over reservoir course.
10. Construct concrete curbing.
11. Place Porous Asphalt
Construction Observation Keys

Shoulder ballast - clean, fractured loose in place

Construction Observation Keys

Shoulder ballast - clean, fractured rolled

Construction Observation Keys

Choker Course is smooth, no voids showing. Note this was specified with standard Crushed Surfacing Base Course per the WSDOT Specifications.

Choker Course is interlocked tightly but still has plenty of voids showing.
Construction Observation Keys

Which one of these two choker courses is unacceptable? Why?

Construction Observation Keys

On close observation there should be plenty of voids, very similar to previous slide's choker course.

From a distance, pavement will look no different than standard HMA.
Construction Testing for Porous Asphalt

1. Minimum air voids 16% with 75 gyrations.
2. Drain Down - ASTM D6390-05, 0.3% max. @ 15° above mix temperature
3. ODOT TM 318-Oregon Drain Down test.
4. Require mix design, calculations and testing results for mix at 6.0%, 7.0%, 8.0% and 9.0% asphalt content.
5. Select mix design with highest asphalt content that meets all requirements.
6. Require submittals of aggregate, asphalt, anti-stripping.
7. Sieve analysis of aggregates-verify specification met particularly on fines. Look for distribution of sizes for choker course.
8. Observe materials in field during installation to assure material continually meets specifications.

Construction Testing for Porous Asphalt

ASTM D6390-05 Process in pictures

Top Myths

Myth #1 - Porous asphalt (and other types of porous pavements) will clog over time and is not durable.

Truth – While some caution is needed to prevent careless transport of sediments and fines on to pavements, many pavements have been operating for decades with little maintenance and others that have become clogged have been successfully rehabilitated.

Clogging has occurred from asphalt draining down from the surface and resetting lower in the asphalt pavement. Use of polymer modified asphalt, stiffer asphalt mix and sometimes the use of fibers mitigates this effect.

Porous Asphalt Performance
Porous Asphalt Performance

Top Myths

Myth #1 - Porous asphalt (and other types of porous pavements) will clog over time and is not durable.

Truth –
  - Initial installation of porous asphalt at Walden Pond completed in 1977 still functioning.
  - Arizona SR-67 still in use after 20 years.
  - “Several dozen large, successful porous pavement installations, including some that are now 20 years old, have been developed by Cahill Associates of West Chester, PA, mainly in Mid-Atlantic states”
  - Use of regenerative vacuums periodically can restore pavements to installation infiltration rates or higher.

Porous Asphalt Performance

Top Myths

Myth #2 - Porous asphalt will rut under traffic loads.

Truth –
  - The structural strength of flexible pavements comes primarily from the supporting roadway section, not the asphalt.
  - Cahill Associates experience confirms that the deeper pavement sections generally result in a more durable pavement.
  - Further, A Caltrans study performed in 1989 on the structural value of open graded asphalt-treated base and open graded asphalt concrete pavement concluded that these materials would be assigned the same structural strength value as their dense graded counter parts.
  - ODOT has also concluded in their design guidelines that open graded asphalt will be given the same structural value as dense graded asphalt.

Regenerative Sweepers

Elgin Crosswind
Regenerative Sweeper also available with Alternative Fuel option

Tymco Model 600
Regenerative Sweeper also available with Alternative Fuel option
Porous Asphalt Performance

Myth #2 - Porous asphalt will rut under traffic loads.

Truth – Using WSDOT Flexible Pavement Layer Thickness Design Tables for low volume roads and assuming Poor Soil conditions would result in a 1.1' thick section – Annalese heights was 1.33' thick over good soils.

Porous Asphalt Performance

Myth #3 - Porous asphalt will lead to pollution of the ground water.

Truth –
- Intuitively, porous asphalt decreases pollution risk by keeping stormwater dispersed. Not a pollution generating surface.
- Several studies have looked at the water quality treatment that occurs at the geotextile soil interface and concluded that removal of most pollutants is very good.
- Other studies have shown that the porous pavement itself traps many of the heavy metals with fine sediments, and adsorption occurs to neutralize them. More study is needed in this area, but so far the results are positive.

EcoStorm Plus Treats Stormwater With Porous Concrete
Top Myths

Myth #4 – Porous asphalt is prohibitively expensive.

Truth –

• Porous asphalt costs about 20% more than HMA.
• On a 20,000 square foot parking lot, 3” porous asphalt over 2” choker course at 2010 prices would be $43,000 ($2.15/sq ft) vs. $36,000 ($1.85/sq ft) for 3” Class 1/2” HMA over 2” CSTC.
• The cost differential above represents about 1 ea. 2-cartridge StormFilter®.
• There is more depth of ballast and geotextiles for porous asphalt vs. HMA.
• Porous asphalt may replace and eliminate catch basins, pipes, water quality treatment devices and storm ponds which may actually SAVE money.

Other Benefits of Porous Asphalt Pavement

• Infiltration helps recharge groundwater, helps base stream flows.
• Reduction of spray on higher speed roads.
• Reduction of hydroplaning.
• Reduction of glare.
• Less area required for stormwater control features.
• Reduced tire noise.
• May be less costly than standard road system, site dependant.
• Reduction in salt application.
• Above all, pollution prevention by eliminating surface runoff.
Ways to make Porous Asphalt even Greener

Consider specifying Warm Mix technology.

- What is Warm Mix Asphalt?
- Warm-mix asphalt is the generic term for a variety of technologies that allow the producers of hot-mix asphalt pavement material to lower the temperatures at which the material is mixed and placed on the road.
- Reductions of 50 to 100 degrees Fahrenheit have been documented. Such drastic reductions have the obvious benefits of cutting fuel consumption and decreasing the production of greenhouse gases.
- In addition, potential engineering benefits include better compaction on the road, the ability to haul paving mix for longer distances, the ability to pave at lower temperatures, better asphalt coverage of aggregate, and safer conditions for workers.

Warm Mix Asphalt Pavement - Lower Emissions

HMA - 315°F  
Aspha-Min WMA - 265°F

Warm Mix Asphalt Pavement - Wider Range of Compaction Temperatures

- [Graph showing viscosity vs. temperature for PG 64-22 (Approx.)]
Concerns/Issues

- Protection of pavement during building construction.
- Homeowner/End User care of pavement.
- Education of maintenance personnel.
- Utility installations and roadway repairs.
Recent/Future Projects

- Neighborhood Rain Garden Installations at 6th Ave SW and 13th St SW May 18th.
- Project will include up to 3 porous driveway installations, at least one of which will be pervious concrete.

Recent/Future Projects

- 8th Ave NW LID Retrofit-30% plans in to Ecology for review, construction pending this summer.
Recent/Future Projects

- 8th Ave NW LID Retrofit
- Porous Alley Initiative-converting gravel driveways to porous asphalt
- Clarks Creek Riparian Restoration and Porous Maintenance Road
Porous Pavements and LID in Puyallup

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