



POROUS PAVEMENT DESIGN AND PRODUCTION



An association for the development,
improvement and advancement of
quality asphalt pavement construction.

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THE
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Oldcastle
Materials

What is Porous Asphalt Compared to Regular HMA?

- Porous is Open graded.
 - Open graded indicates a mix has coarse material only. Porous has no Sand.
 - HMA Surface typically contains around 45% Sand and 55% Coarse Aggregate. This is called Dense Graded Mix.
 - Like HMA Surface, Porous contains ~ 6.0% PG
 - Since both HMA Surface and Porous have similar PG contents, but their aggregate structure is different... Drain Down is a concern.

Drain Down

- What is Drain Down?
- When a mix is saturated, or over PG'ed, the liquid can tend to drain off of the aggregate and pool in the plant silo, truck, or job site.
- Why is this bad? Because the mix design requires a certain percentage of liquid, or film thickness and if you have excessive Drain Down, you are not getting this “Effective” asphalt in the finished mix.
- Controlling it... Mix temperature, gradation, aggregate selection and a good mix design.
- This is critical to Porous Success!!!!

Porous VS HMA

- Porous is designed to allow water to flow through it.
- HMA is designed to resist water flowing through it.
- Porous, in place should have around **15% - 20%** Air Voids.
- HMA, in place should have around **3% - 8%** Air Voids.
- Samples up front without AC, and samples with AC.

Type 1 HMA

Porous Surface



Porous Surface Gyro Cut



Design Background

- 2007 Sand Run Metro Park
 - Porous Surface, One lift, 3"
 - Confusing (for me) specifications. FHWA and FPI specs were provided.
 - Called around the industry to see if anyone had done these designs before and found no one.
 - Winged it with all of the available specifications.
 - Design components were the same then as today.
 - I made a lot of assumptions based on what I understood the specifications to imply.

Sand Run Park being Paved



Design Background

- Fast forward to 2009
 - Received calls that the Sand Run job was failing.
 - We all began to analyze all of the test data, design, and paving.
 - Coordinated with Paul Wilkerson to personally go out and core the job.
 - When I arrived on the job, I was surprised as to how good it actually looked and worked.
 - Cut the cores and analyzed the results.

Sand Run Park 2009



2009 Core from Sand Run Park



Core Bottom, no significant binder Drain Down



Core Top



Design Background

- The surface did show raveling and loss of 'fines'. Tire turning and twisting areas were much worse.
- The core, under the exposed surface was perfect. It looks like the remainder of the mix was unaffected.
- Upon further review with Cliff leading the way, and consulting with those in other states who have done a lot of this mix... it was determined that the mix design for Sand Run, probably had too little binder.
- Yes, shoot the mix designer!
- However, it was agreed that in the future, designs would have minimum total binder that was higher than this particular design.
- Sand run had a total binder content of 5.8% 76-22 SBR

Design Background

- 2010 the return of Porous
- Nordonia High school
- This project required Porous Surface and Base
- I believe I began work on this in the early Spring.
- The Porous Base is pretty straightforward, #57 and 3.5% 76-22 SBR.
- That did not stop me from trying to compact samples in the gyro. A mess ensued numerous times.
- Porous Base will not compact in the Gyro.
- Cliff consulted experts again and that was confirmed.

Design Background

- Porous Surface... a whole different story.
- I did the mix design exactly as was done for Sand Run. However I adjusted the mixing and compaction temperatures to meet the new minimum of 6.0% 76-22 SBR... in doing this drain down was better controlled.
- However. I was determining the Bulk Specific gravities of the lab compacted specimens in a new way. By measuring the 'pills' and calculating the Air Void content. No longer weighing them in water.
- When comparing the measuring method versus weighing method... the air void difference can be around 5%. Weighing being 5% lower.

Background

- This change, allowed for more binder to be used. Hopefully to help in reducing the wear and tear of tire turning, and oxidation.
- After going through a number of new techniques to determine drain down, the design was finally ready, looked over and approved.
- Cliff and I developed a spreadsheet for the cumbersome calculations required to meet certain parameters.
- Of these new parameters was the addition of a VIR calculation. VIR is Volume Increase Ratio. According to experts, this value must exceed 11.5. Interesting to note, that the Sand Run design did not meet this minimum.

Calculation Spreadsheet

Pba	1.511
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Pbe	4.579
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Enter data into Green cells only!

Gse	2.786
Gsb	2.677
Gb	1.034

Pba	1.511
Ps	94.0
Pb	6.0

VIR	12.613
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← **11.5%
Minimum!**

Pba	1.511185
Pbe	4.579486

VCA _{drc}	52.928
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Gca	2.653
Ys	1246.334
Yw	998.000

VCA _{mix}	27.330
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Gca	2.653
Gmb	2.051
Pca	94.0

Design porous pavement mixes such that stone-on-stone contact is achieved. VCA_{mix} must be less than VCA_{drc} ($VCA_{mix} < VCA_{drc}$). This ensures stone-on-stone contact.

Nordonia High School Porous Base



Nordonia High School Porous Surface



Porous Base Close Up



Porous Surface Close Up



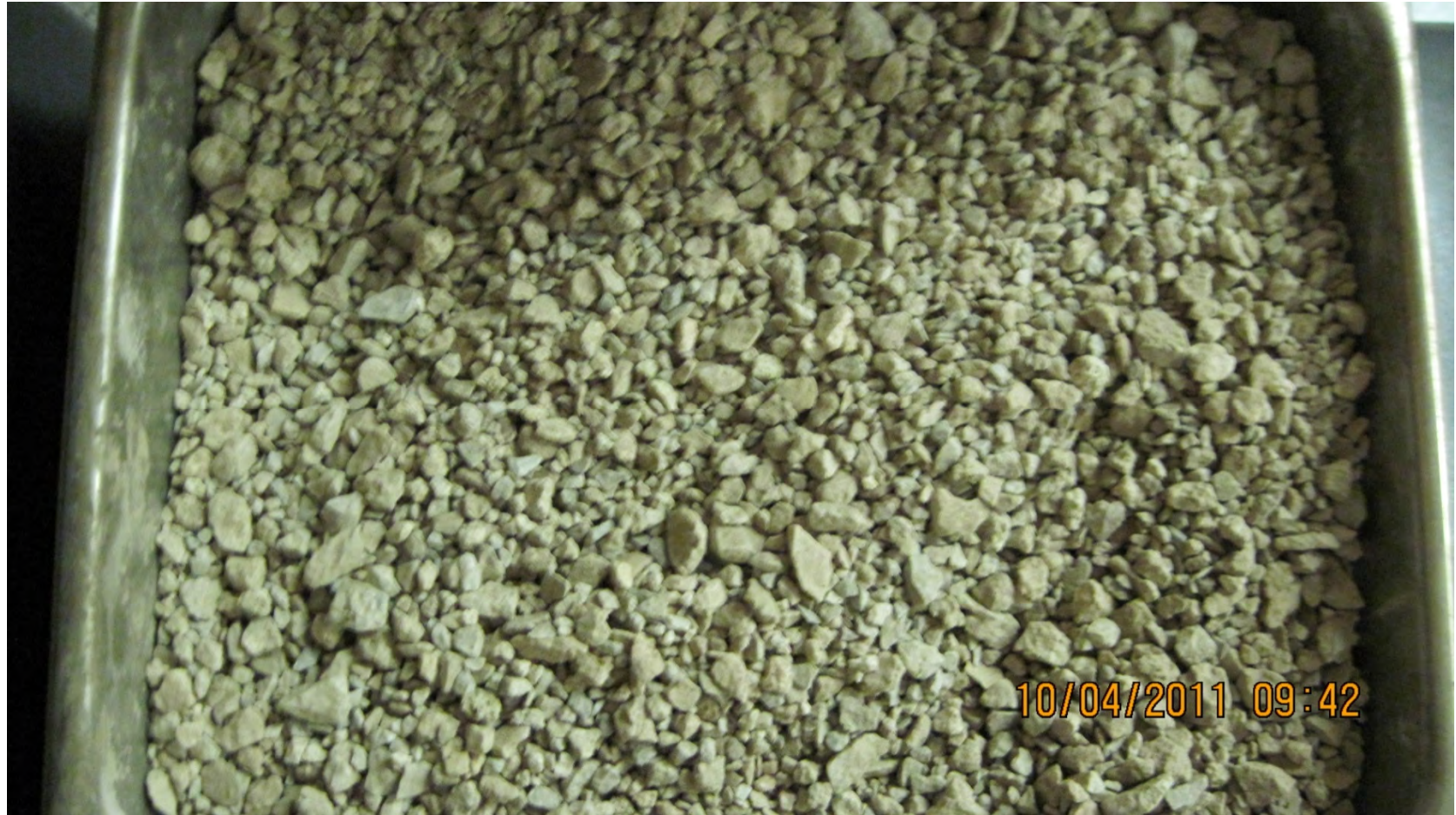
Design and Production Notes

- Any Questions so far?

Aggregate Selection

- Hard, durable Limestone Aggregate that is not prone to stripping in Dense Graded Mixes.
- It is Normal to use #8 and #9 sized aggregate to achieve the PAPS gradation (Surface). May also need a mineral filler. (Dust)
- Insure that current plant stockpiles of the aggregate is tested for Gradation, Bulk Gravity, and Dry Rod prior to use.

Aggregate



Liquid Requirement

- PG 64-22
- SBR Latex (902.14) dosed at 5%.
- This yields 76-22SBR
- Some talk of allowing 76-22SBS? Cliff?

SBR = Styrene Butadiene Rubber



PG 64-22



Plant Requirements

- Mixes have been produced from both a Drum plant and a Batch plant.
- Static SBR mixer. (Drum plant only)
- A good plant operator who can control the delicate mix production temperatures required.
- We have found that a 280F production temperature, and 250F compaction temperature work well.

Mix Design Notes

- Designing PAPS will take a lot of time. Plan for that.
- Prepare at least 6 trials. Two gyros at 5.0%, 5.5% and 6.0% or above. And three rice's.
- Be very precise in your mix batching process. 4400 grams works well. Mix by hand... much more accurate.
- When compacting your samples in the Gyro... it is a good idea to put a fan on the extruded specimen to help it cool off. You have a sample that has 15-20 percent Air Voids.

Mix Design Notes

- Also with the Gyro sample be careful removing the base from the sample.
- Remember in this design you measure your pills and not weigh in water.
- High School math... $V = \pi * r^2 * h$
- Rice... (Maximum Theoretic Density)... run it as you normally do except for no SSD dry back is needed.
- TSR... don't bother.

Mix Design Notes

- Drain down... Can run typical Drain down tests as used in SMA. However, also run ODOT Test Method 318-09.
- Need two Pyrex 8 inch round bowls.
- Refer to a good copy of TM 318-09 for the drain down charts.
- Just as with SMA, VCA_{drc} and VCA_{mix} will need calculated.
- VIR... must be calculated and be above 11.5.

Plant and Field Guidelines

- Make sure the plant is set up properly with a current plant calibration, and proper dosing of the SBR.
- Monitor the mix temperature closely. The design mixing temperature must be followed. Too high and Drain down will result.
- Do not try to produce at regular HMA speed. May have to drop well under 200 TPH to produce.
- Sample and test from a sample obtained from a truck load. Report all calculations including VCA_{drc} , VCA_{mix} and VIR.

Plant and Field Guidelines

- Nuke and Burn your sample to determine gradation and binder content.
- Extracting mix containing SBR is not accurate.
- At the project site... make sure the base material is not disturbed during the paving operation.
- Be diligent on the rolling. Stick to your compaction temperature. You are seating the material, not looking for density.

Plant and Field Guidelines

- Have a well trained or experienced technician on site to monitor the rolling.
- Porous sounds difficult. It really is not. As long as attention is focused on the design phase, the production phase, and lay down phase, it should go very smoothly.

Summit Metropark Monroe Falls

Thank You!

