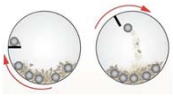
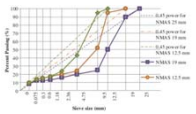
Stone Matrix Asphalt Current Status in SC

Mix Design





Binder - M320 / M332 with MSCR – Use PG 76-22 – SBS mods.

9.5mm and 12.5mm options

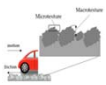
Local aggregate typically are good granite materials that meet LA : < 45.0. Issues exists in the upstate where materials range from 40-58%.

Major concern

SC aggregate is typically blended and not singe sized, and not too many fractionated quarry options in SC.

9.5mm is the overwhelming solution to most of the gradation issues. Keep in mind that a 9.5mm is actually12.5mm NMA size!

SCDOT wants to try more 12.5mm in the future hoping that the coarser blend will provide additional macro texture and friction..TBD



SCDOT Specification

- 1998 – First 12.5mm SMA was placed on I-85 Business in Spartanburg and most of it still in service!

  50 blow Marshall design.
- 2020 – Started looking back into SMA.
- Main issue SC was facing was lack of long-term performance of surface courses (OGFC) on Interstates.
- Easy button was to remove OGFC*. Eliminate the ~ 8-year expensive cycle of removing and replacing it.

*SC made significant strives to improve the long-term durability of OGFC prior to pulling the plug.

Mix Design Requirements:

- Gyrations: 35 – N Design (get the binder in the mix)
- AV range of 3.0 – 4.0%
- VMA: Min 16.5
- RAP: 15% maximum aged binder replacement.

Design Requirements				
Volumetrics	See SC-M-400 Surface Courses	Range for % AC	5.80 – 7.00	5.80 – 7.00
		Range for Air Voids (%)	3.0 – 4.0	3.0 – 4.0
		VMA, %	16.5 min	16.5 min
		VFA, %	65.0 – 85.0	65.0 – 85.0
		Drain-down, % Retention (SC-T-90)	99.7 min	99.7 min
		Tensile Strength Ratio (SC-T-70)	85% min	85% min
		Rutting Susceptibility (AASHTO T 340)	3.0 mm max	3.0 mm max
	AASHTO T 19 / R46	Voids in Coarse Aggregate Tests	VCAdrc > VCAmix Volume of CA (Dry-Rodded Condition) vs. Volume of CA (Mixture)	
Dust to Asphalt Ratio			N/A	
Gyration Level			35	

SMA Expectations

- **Improved rutting resistance**
- **Greater fatigue life**
- **Longer service life (when compared to OGFC)**
- **Lower annualized cost**
- **Potentially less prone to stripping due to hydrophobic properties of fly ash**

Mix Design

Recent adjustments made by SCDOT to allow for current blended aggregates to be used...Thank You!

Mixture Control Tolerances		Asphalt Mixture	9.5 mm SMA	12.5 mm SMA
		Grading Requirements	Percent Passing	
Gradation	See 401.2.3.3 for tolerance for Surface Courses	19.0mm (3/4") Sieve	100.0	95-100
		12.5mm (1/2") Sieve	90.0 –100.0	83.0 – 93.0
		9.5mm (3/8") Sieve	75.0 – 90.0	60.0 – 80.0
		4.75mm (No. 4) Sieve	32.0 – 54.0	22.0 – 36.0
		2.36mm (No. 8) Sieve	17.0 – 30.0	14.0 – 26.0
		0.60 mm (No. 30) Sieve	12.0 – 20.0	10.0 – 22.0
		300µm (No. 100) Sieve	9.0 – 15.0	9.0 – 15.0
		75µm (No. 200) Sieve	8.00 – 13.00	8.00 – 12.00

Mix Design – More changes allowed by SCDOT for Mineral Filler on July 1, 2024.

Mineral Filler. Use mineral filler that consist of crushed aggregate fines, marble dust, or fly ash. Ensure the filler is sufficiently dry to flow freely and be free from lumps.

Table 2 - Mineral Filler Properties - Mineral Filler will be graded within the following limits

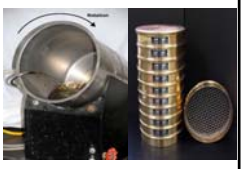
Sieve Size	Percent Passing (AASHTO T 27)
600µm (No. 30)	100.0
300µm (No. 50)	95.0 – 100.0
75µm (No. 200)	55.0 – 100.0

Ensure the Mineral Filler is free from organic impurities using AASHTO T 21 and has a plasticity index not greater than 4 using AASHTO T 90. Provide a certificate of analysis ensuring that the material filler meets these requirements.

Fineness: AASHTO M–17

Old requirement of 20% maximum passing the No. 635 sieve was originally used SCDOT. However, we found that most fly ash is closer to 50-70% passing on local sources. This may be due to coal being processed more (crushed) prior to using – burning and ultimately dependent on localized sources.

Performing Washed Gradations vs. Dry Gradations to check for actual dust content…time consuming but necessary..



- Need to verify actual total dust in the extracted QC/QA test – Wash vs. Dry gradation often done to capture the true P-200.

Washed gradations on this material is very subjective…when in doubt …just keep washing!

Early lessons learned - production

- No SC asphalt plants were initially set up to run mineral filler until SMA contracts were put out to bid…contractors usually bid accordingly to pay for upfits (+ $).

- Attempted to run WMA - 230-260° F

Issues noted:

Stiff mix unloading trucks

Locked up MTV / Transfer Machines

Poor Density

- **Running hotter now…**

300-350°F

Using Lime and WMA Additives (workability)

No cellulose needed on 9.5mm, no draindown issues witnessed.

Likely going to need cellulose with 12.5mm mixtures (more gap graded structure-skeleton) – draindown concerns, and lack of enough 1/2" aggregate fraction.

More lessons learned…

- Mineral filler cannot be run through a cold feed bin
- Must be kept dry and avoid any wind exposure
- Usually added just prior to the injection of the asphalt binder in most drum plants
- Sources: Fly ash and Marble Dust (not always locally sourced)
- Fly ash* – Not all fly ash sources are equal! .

*Chemical composition and gradation are different with each supply source and often the raw coal used at the power plant is sourced from various sources.

Plant Issues

More lessons learned..

- Feeding 5-8% fly ash out of a silo designed to feed lime at 1% does not work without modifications!
- Additional storage trailer/ pigs are often used to be able to supply enough filler to aid in production requirements
- Must make changes to size of weigh pod to compensate for additional material.
- Must increase size of auger to feed the higher percentage of fines.
- Must add more air capacity to aide in material flow.
- Run the plant slower at 200ton/hr. or less to ensure asphalt mixture is uniformly coated-mixed.
- Don't store that mix for long periods of time to prevent in any chance of draindown.

Plant Issues – We worked on these and figured out by doing test sections at the plant and milling up some mix from the road.

Continued - Plant Issues – We worked on these and figured out by doing test sections at the plant yard and milling up some mix from the road.



EPDs
Lower carbon = savings $$?
*What about **Quality Mixtures?????***


On average we have seen 30-40% increase of EPD over conventional asphalt mixtures!

Can we find ways to lower the EPD on a SMA?

- Use less virgin binder – cannot go below 6.0% with most SMA mixtures!
- Push to use more RAP and RAS - difficult to meet criteria on gradation and pass VCA –
- (savings of both virgin binder and aggregate).
- Use more fuel or gas to produce SMA – SMA requires higher temps due to PG 76-22 and GTR.
- Increased haul distances to obtain stringent aggregate properties - aggregates.
- Unsuccessful with WMA thus far in SC – we need to keep trying and innovate!

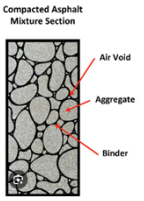
Ultimate Question!
Will SC get more service life out of SMA compared to other high volume mix options?
OGFC? Yes – when compared to a1" OGFC surface layer vs. 2" SMA"

What about using a dense graded mix with more PMA – highly modified?? Use a PG 82-22…
Success in other states has been noticed and should be investigated!

2024 Changes to the Special Provision

Changes made by SCDOT – Changes in gradation, especially in upper tolerance to aid in allowing blended aggregate sources.

New **option** to use **10** ~~7~~% dry process GTR – 2024 in lieu of PG 76-22.
Adding durability additives – single dose of Aramid Fibers when GTR is not used. Time will tell whether this adds more life to the pavement for the added initial cost.

Finding our balance…TBD
We must remain flexible and find means to innovate and help our industry rise to the challenge!

Future Concerns – Lack of sources of mineral filler to continue using SMA?

Fly ash

- Sourced from coal fired power plants
- Are we going to have continued access of this material with increased pressure to get away from coal? – Envirnomental push to reduce carbon, etc.
- Not all fly ash makes good mineral filler, it often contains cementitious material properties, it will clog the silo up and create no flow situations.

Marble dust

- Very effective filler base on a couple projects in SC. Successful for years on GDOT projects, included part of the FHWA TOPS study in 2022.
- Higher specific gravity, likely need more air to aid in material feeding – flowing correctly.
- Very few sources of this material available in our region, future concerns with distance to obtain the material, and perhaps impact on EPDs.
- Other Products? Tailings from other manufacturers, etc. Be sure and read the SDS prior to introducing a potentially harmful chemical into our mixtures! We must ensure that our mixtures are sustainable and not harmful when being recycled 15-20 years from now!

Thank for your attention and enjoy the conference!

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