

Rutting Evaluation of VDOT SMA Mixtures

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SMA

Improved durability

- Higher asphalt content
- Lower in-place air voids

Improved resistance to rutting

- Stone on stone contact
- Polymer modified asphalt binder
- Improved aggregate quality



SMA in Virginia

- SMA is the most common gap graded mix used in Virginia
- Used extensively throughout Virginia since 2003
- The field performance of SMA in Virginia has been generally excellent
- Reported service lives of 15-18 years
- Few SMA pavements have experienced premature failures



SMA Rutting Issue

Few SMA 12.5 mix field projects showed higher rutting after few years in service



I -95 SB in Spotsylvania



I-95 SB in Richmond district



SMA Rutting Issue

VDOT Materials Division conducted field investigation for few projects in Fredericksburg district.

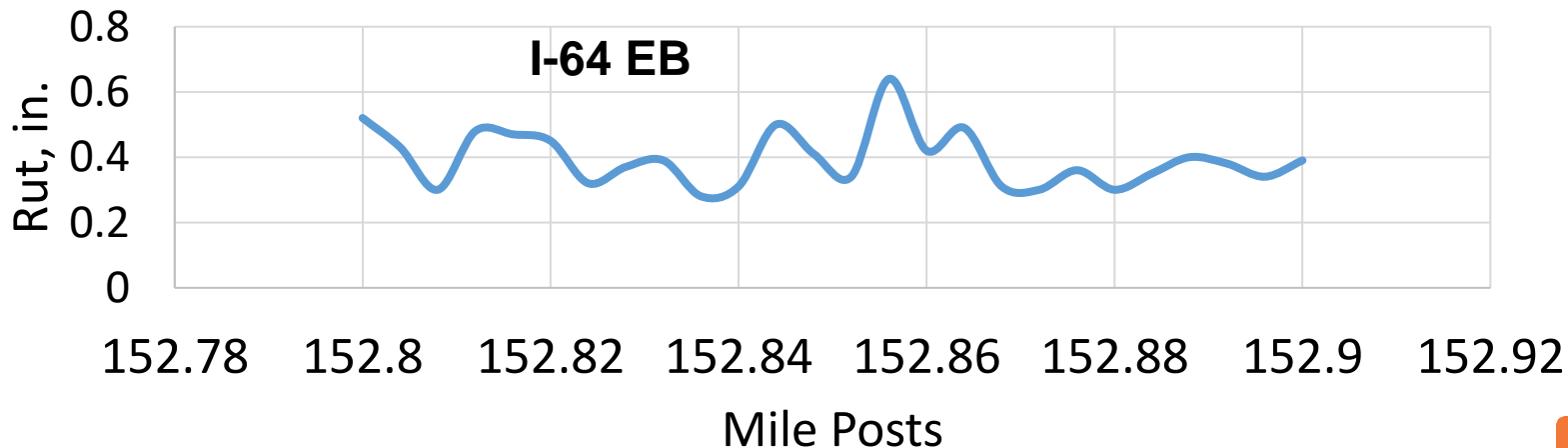
Rutting due to:

- Substandard binder
- Weak underlying layer
- Substandard compaction during construction.



SMA Rutting Issue

VDOT Maintenance division conducted a preliminary network level rutting data analysis for SMA and confirmed rutting concerns for SMA-12.5 mixes (predominantly in Fredericksburg and Richmond District).



Impact on VDOT Pavement Condition Rating

- Rutting
 - Source of major deduct values in the rating system
 - 0.2 in. : 10
 - 0.4 in. : 45
 - Max deduction: 75
 - Design criteria (MEPDG): 0.26 in. as a failure



SMA Rutting Issue

VDOT Materials Division formed a subcommittee to address SMA rutting concern

- Members from VDOT and VAA

VTRC tasked with identifying potential methods to prevent the SMA rutting in the future.



Initial Research Tasks

- Compare the specification with other state DOT's SMA specification.
- Evaluation of mixture volumetrics from past projects.
- Evaluation of past binder data
- Evaluation of past compaction data
- Evaluation of historic field performance data.



SMA Specification Comparison

- SMA design gradation range comparable to other state DOT specification.
- None of the other states are experiencing any rutting issue and overall observed good field performance.
- Like Virginia, some states allow (up to 15%) RAP in SMA mixtures (e.g. Maryland, Georgia, Wisconsin etc..)
- In several states, the minimum binder content is based on aggregate specific gravity.



SMA Volumetric Data Analysis

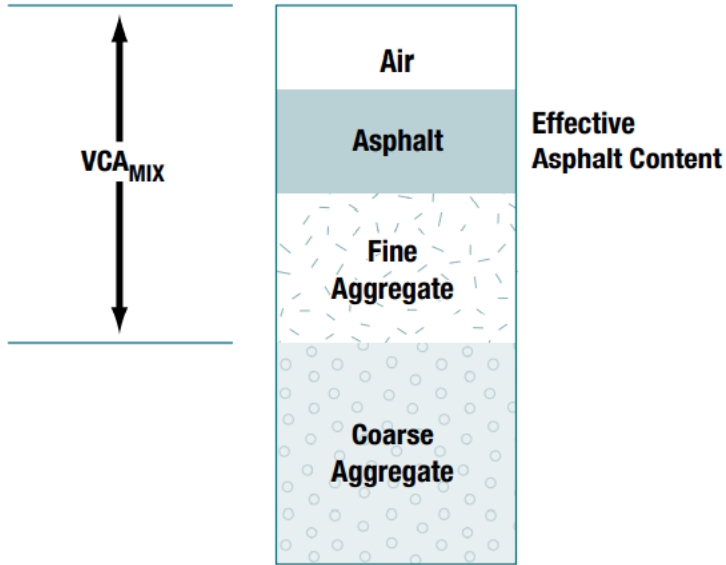
Stone on Stone Contact

Stone on stone contact is expected to exist when the voids in coarse aggregate in mix (VCA_{mix}) is less than VCA in the dry rodded condition (VCA_{drc})

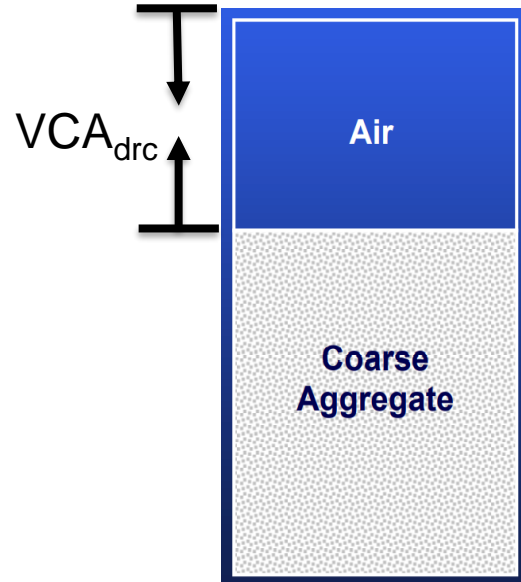


Stone –on- Stone Contact

Voids in Coarse Aggregate (Mix)



Source: NAPA

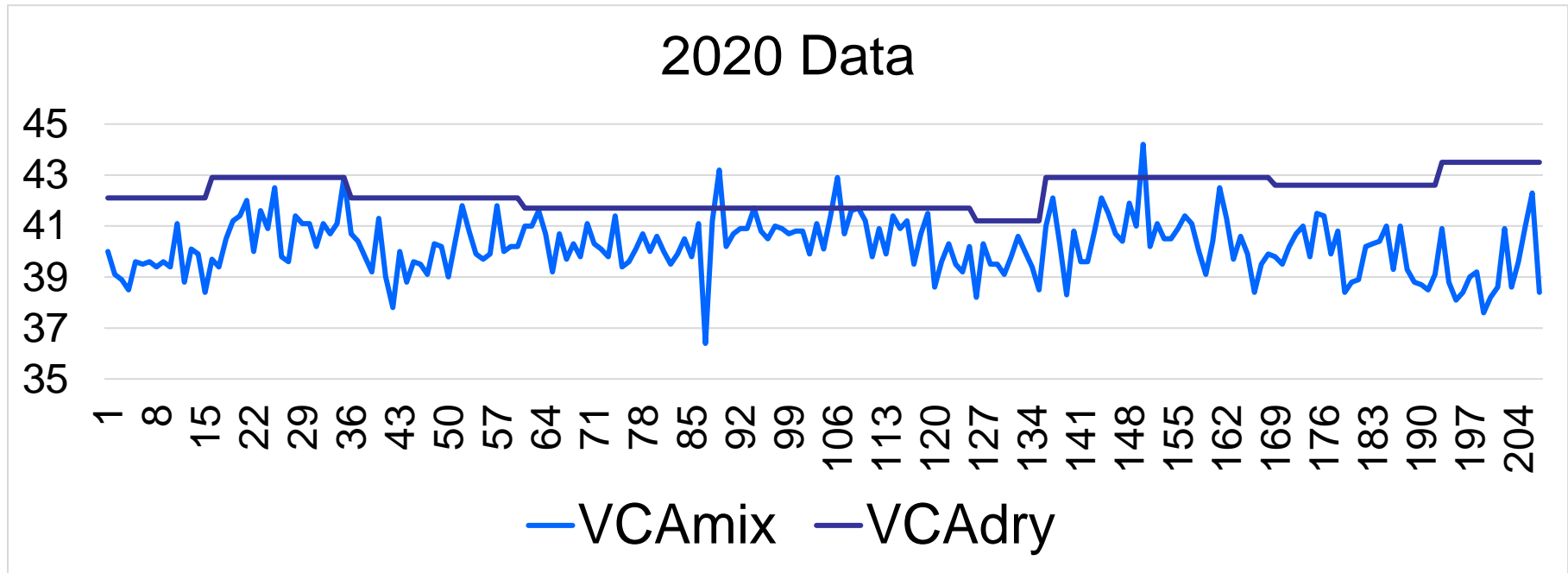


Source: VAA



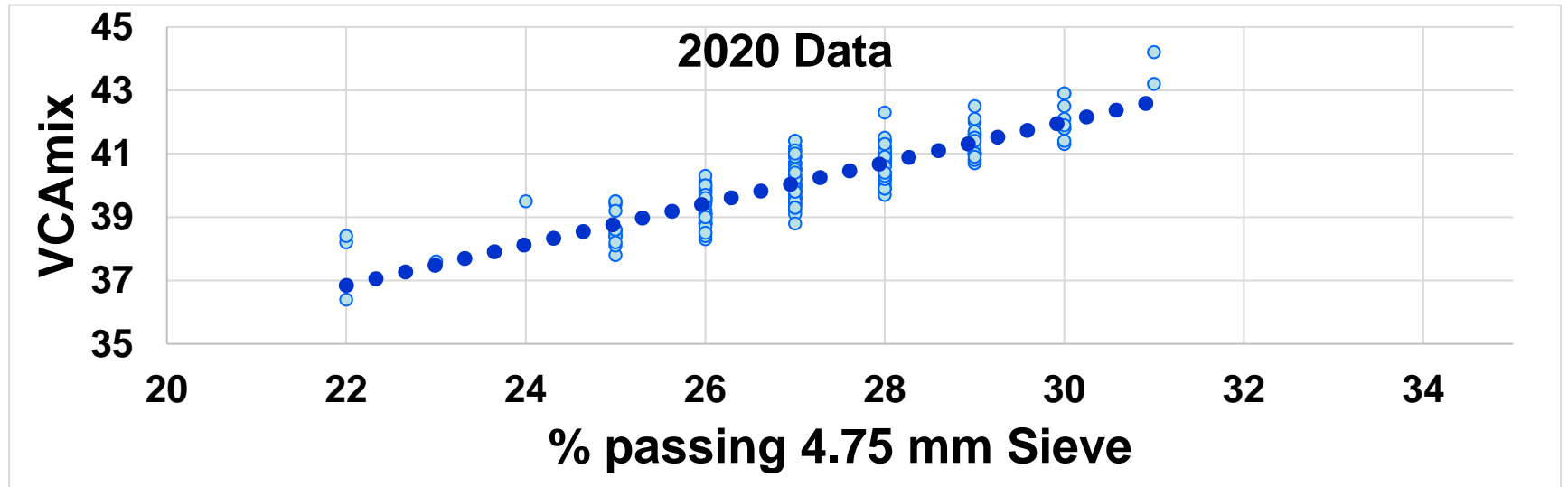
SMA Volumetric Data Analysis from Past projects

VCA_{mix} vs VCA_{drc}



% Passing 4.75 mm sieve - Breakpoint sieve

	2020	2019	2018	VDOT spec range
Average	27	27	27	
Min	22	23	22	22
Max	32	32	33	28

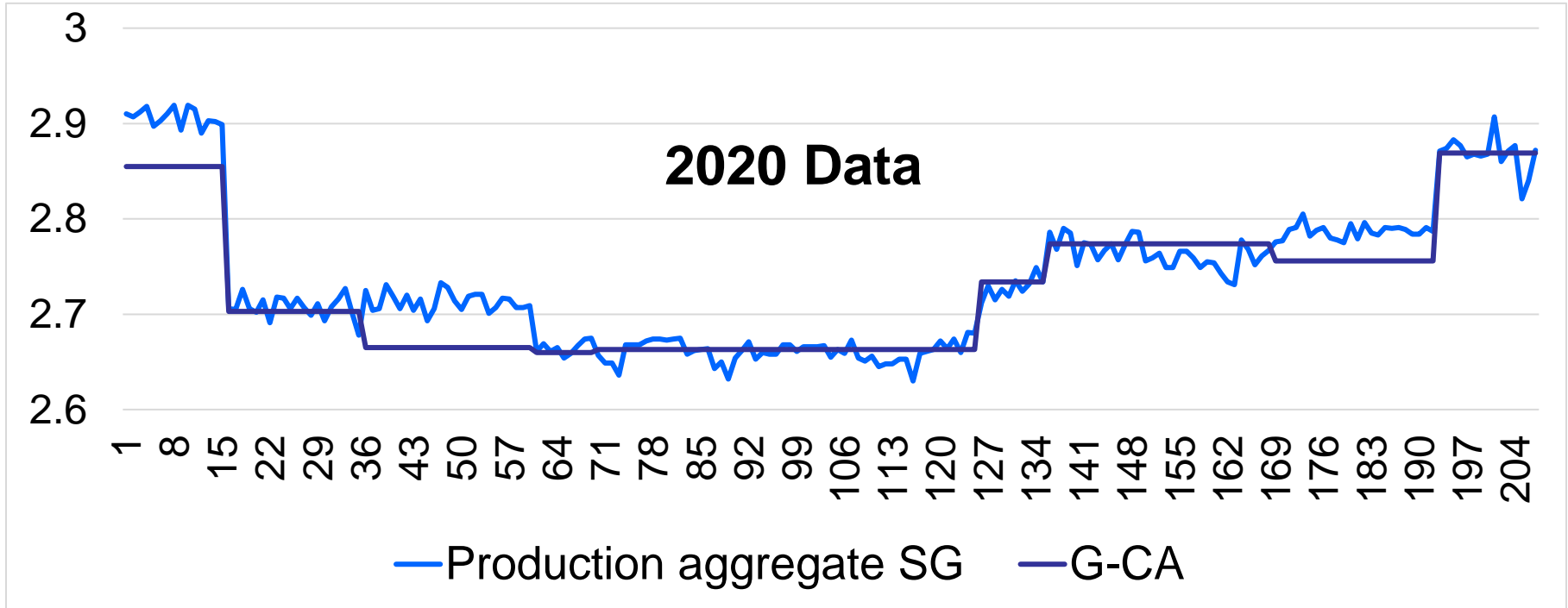


#200 Sieve passing

	2020	2019	2018	VDOT spec range
Average	9	9	9	
Min	6	5	7	9
Max	13	12	13	11



Aggregate Specific Gravity Comparison



G-CA: Specific gravity of coarse aggregate



Asphalt Binder

Polymer modified binder test – central database did not indicate any systematic failure

SMA Field Compaction

2018 Data

Mix Type	Avg. In place Air voids	Standard Deviation	Range
SMA	4.2%	1.0%	1.7%-6.8%



Asphalt Binder Testing

Mix ID	PG Grade	Non Recoverable Jnr	
		0.1KPa	3.2KPa
13-1070	70-22	0.82	0.90
14-1047	76-22	0.17	0.17
15-1012	76-22	0.35	0.49
15-1068	82-28	0.02	0.03

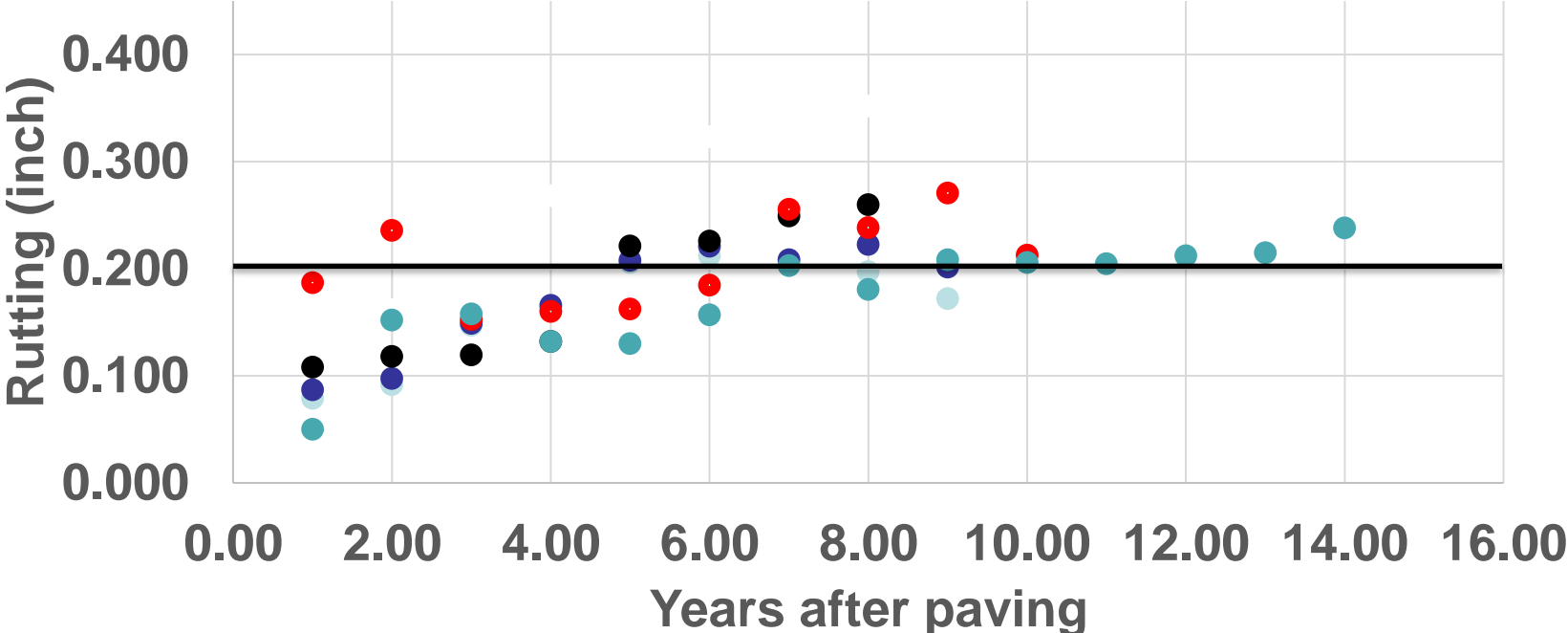
AASHTO M 332 Specification

Very Heavy Traffic: Jnr3.2, max **1.0 Kpa⁻¹**

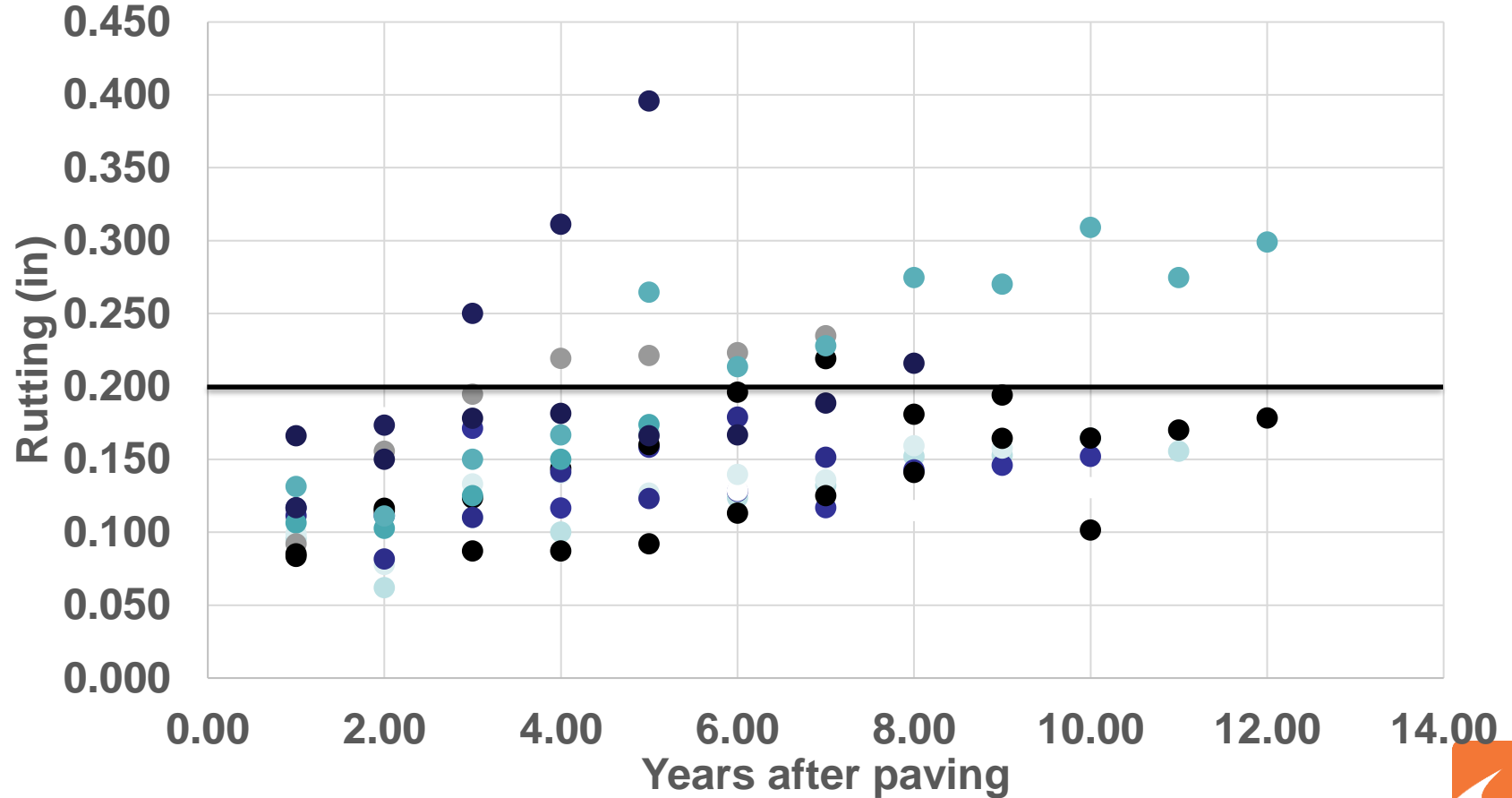
Extremely Heavy Traffic: Jnr3.2, max 0.5 Kpa⁻¹



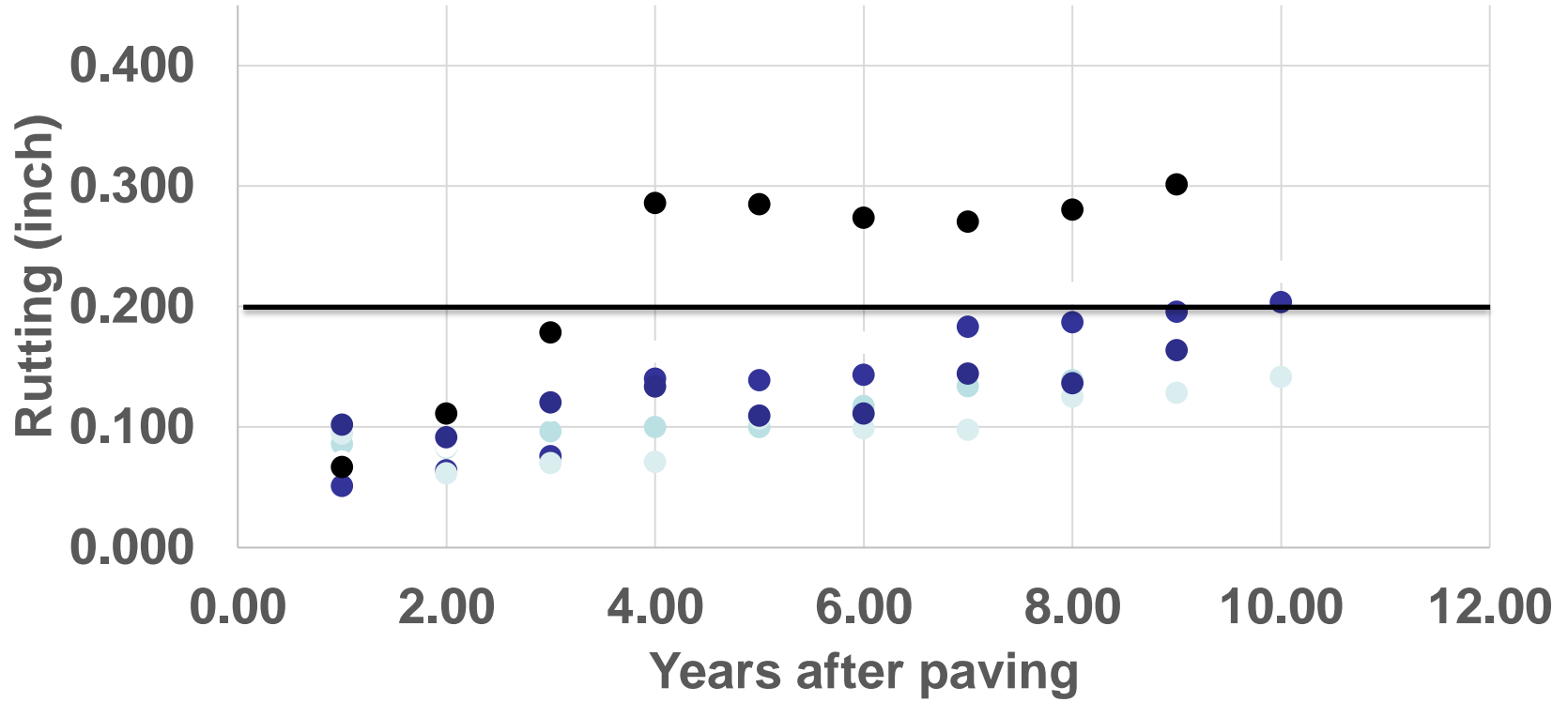
Field Performance Data : SMA over CRCP



Field Performance Data : SMA over JCP



Field Performance Data : SMA over Existing AC



Summary

Renewed Emphasis on SMA Basics needed:

- Gradation, Gradation, Gradation
- VCA as an Important Calculation
- Specific gravity of aggregate
- Mineral filler is crucial
- Use of polymer modified binder

- Further research planned to explore good and bad performing SMA from field projects.





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Thank you!