



NJDOT High RAP Specification and Testing

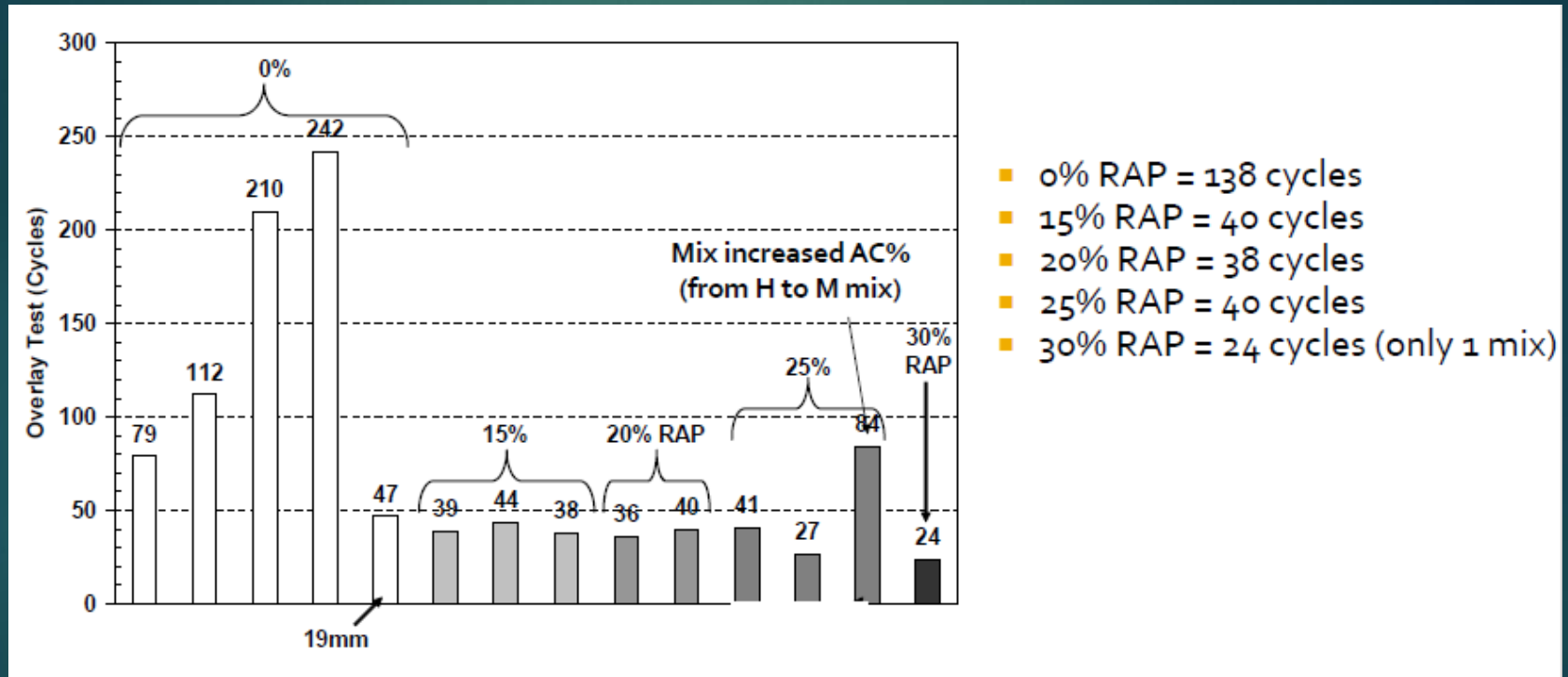
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NJDOT History of High RAP Projects

- ▶ Prior to implementation of High RAP Specifications, NJDOT Standard Specifications allowed up to 15 percent RAP in the Surface Course and 25 percent in the Base and Intermediate Courses
- ▶ HMA suppliers had excess RAP stockpiles and requested the ability to use more RAP
- ▶ NJDOT conducted 5 High RAP Pilot Projects in 2009 and 2010 using RAP percentages 25 percent or higher in surface course
 - ▶ Sections with 0 percent RAP used for comparison purposes



Overlay Testing Results for 2009/2010 Pilot Projects



(Bennert, AAPT Webinar)

Development of High RAP Specification

- ▶ NJDOT encouraged use of more RAP in a responsible way
- ▶ In 2012, NJDOT and Rutgers used database of performance testing results to develop High RAP Specifications using APA and Overlay Tester
 - ▶ APA (Asphalt Pavement Analyzer) measures rutting susceptibility, Overlay measures susceptibility to crack propagation
 - ▶ APA and Overlay criteria based on performance results from 0 percent RAP mix



High RAP Standard Specification Requirements

- ▶ Minimum of 20 percent RAP in Surface Course, 30 percent RAP in Base and Intermediate Courses
 - ▶ Contractors and suppliers can use as much RAP as can meet performance requirements
- ▶ Performance testing (APA and Overlay) required for Mix Design, Test Strip, and Production
- ▶ VMA increased 1 percent over Standard HMA mixes
- ▶ Rejuvenators are allowed

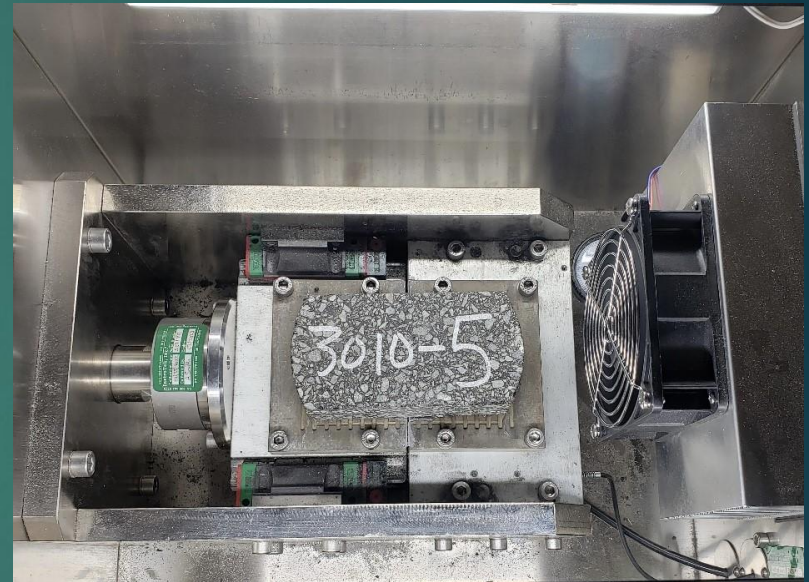
APA Test Procedure (AASHTO T340)

- ▶ 6 Gyrotory Samples (77 mm height)
- ▶ Target Air Void Content 6.5 ± 0.5 percent (To be verified at NJDOT Headquarters Lab)
- ▶ Samples Tested at 64°C , 100 psi Hose Pressure, 100 lb. Wheel Load, run to 8,000 cycles
- ▶ APA rut depth is measured as average rut depth from three test positions



Overlay Test Procedure (NJDOT B-10)

- ▶ 5 Gyratory Samples (115 mm height)
- ▶ Samples are cut from the middle to 38 mm height
- ▶ Target Air Void Content of 6.5 ± 0.5 percent for Cut Samples (To be verified at NJDOT Headquarters Lab)
- ▶ Test temperature run at 25°C , sliding blocks apply tension to sample at maximum displacement of 0.06 cm and returns to its initial position in 10 second cycles
- ▶ Test is run until failure (number of cycles to achieve load reduction of 93 percent of initial load)



APA/Overlay Requirements in Standard Specifications (Mix Design)

Table 902.13.03-2 Performance Testing Requirements for HMA HIGH RAP Design

Test	Requirement			
	Surface Course		Intermediate and Base Course	
	PG 64S-22	PG 64E-22	PG 64S-22	PG 64E-22
APA @ 8,000 loading cycles (AASHTO T 340)	≤ 7 mm	≤ 4 mm	≤ 7 mm	≤ 4 mm
Overlay Tester (NJDOT B-10)	≥ 200 cycles	≥ 275 cycles	≥ 100 cycles	≥ 150 cycles

- ▶ Samples fabricated at HMA plant and tested at NJDOT Headquarters Lab

APA/Overlay Requirements in Standard Specifications (Test Strip and Production)

	Surface Course		PPA
	PG 64S-22	PG 64E-22	
APA @ 8,000 loading cycles, mm (AASHTO T 340)	$t \geq 7$	$t \leq 4$	0
	$7 < t \leq 10$	$4 < t \leq 7$	PG 64S-22: $-50(t-7)/3$ PG 64E-22: $-50(t-4)/3$
	$t > 10$	$t > 7$	-100 or Remove & Replace
Overlay Tester, cycles (NJDOT B-10)	$t \geq 200$	$t \geq 275$	0
	$200 > t \geq 150$	$275 > t \geq 200$	Surface PG 64S-22: $-(200-t)$ Surface PG 64E-22: $-(275-t)/1.5$
	$t < 150$	$t < 200$	-100 or Remove & Replace

	Intermediate and Base Course		PPA
	PG 64S-22	PG 64E-22	
APA @ 8,000 loading cycles, mm (AASHTO T 340)	$t \leq 7$	$t \leq 4$	0
	$7 < t \leq 10$	$4 < t \leq 7$	PG 64S-22: $-50(t-7)/3$ PG 64E-22: $-50(t-4)/3$
	$t > 10$	$t > 7$	-100 or Remove & Replace
Overlay Tester, cycles (NJDOT B-10)	$t \geq 100$	$t \geq 150$	0
	$100 > t \geq 75$	$150 > t \geq 110$	Intermediate PG 64S-22: $-(2t-200)$ Intermediate PG 64E-22: $-1.25(150-t)$
	$t < 75$	$t < 110$	-100 or Remove & Replace

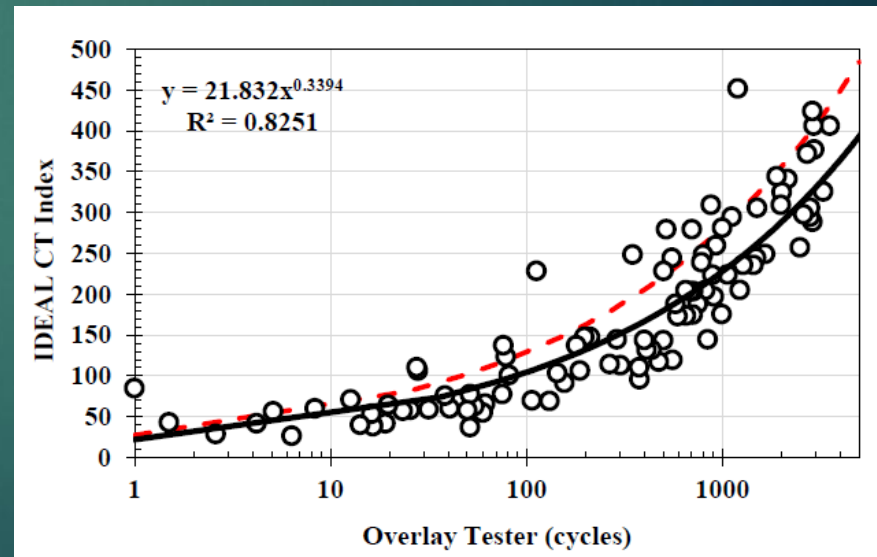
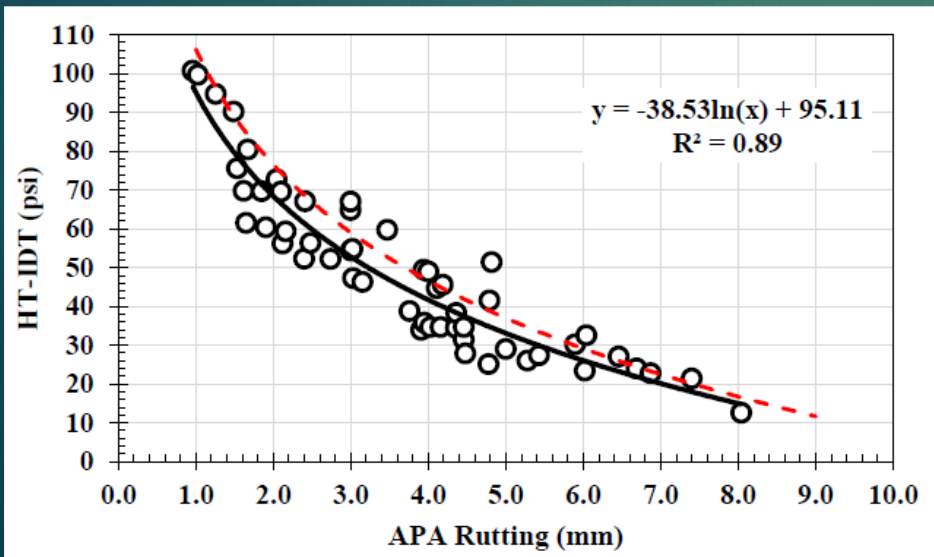
- ▶ Production samples taken every 3,500 tons
- ▶ Location in pavement and binder grade will affect specification limits

Limitations of High RAP Specifications

- ▶ Contractors have used High RAP mixes sparingly since implementation
 - ▶ APA and Overlay has limitations as QC tool due to testing time and equipment costs
- ▶ IDT and IDEAL-CT correlate well with APA and Overlay
 - ▶ NJDOT proposed the use of IDT as surrogate rutting test, IDEAL-CT as surrogate cracking test
- ▶ IDT and IDEAL-CT are a good QC tool for HMA suppliers
- ▶ In 2024, NJDOT implemented High RAP Pilot Projects while specifying the use of IDT and IDEAL-CT testing

Correlation between APA/Overlay and IDT/IDEAL-CT

- ▶ Rutgers conducted extensive comparison testing over a two-year period to establish correlation between APA/IDT and Overlay/IDEAL-CT
- ▶ Plant and laboratory produced mixes both included (Different types of mixes)
- ▶ Figures below show good agreement between tests



IDT/IDEAL-CT Testing Requirements

- ▶ IDT Test Method: ASTM D6931, IDEAL-CT Test Method: ASTM D8225
- ▶ 3 Gyratory Samples for each test (Compacted to 62 mm height)
- ▶ Test Samples for Bulk Specific Gravity (AASHTO T166), then allow 12-24 hours for sample to rest prior to conditioning
- ▶ Samples must be conditioned for 2 hrs. \pm 10 minutes in an environmental chamber or water bath (Conditioning temperature 44°C for IDT, 25°C for IDEAL-CT)
- ▶ Peak load at failure is used to measure High Temperature Indirect Tensile Strength (HT-IDT)
- ▶ Load and displacement curve is used to calculate Cracking Tolerance (CT Index)



Details of 2024/2025 Pilot Projects

- ▶ 2024 Pilot Projects: 2 North, 1 Central, 2 South
- ▶ 2025 Pilot Projects: 1 North, 2 Central, 1 South
- ▶ Requirements for RAP percentages and volumetrics are the same as High RAP Standard Specifications
- ▶ APA and Overlay testing still used for Mix Design Approval
- ▶ IDT and IDEAL-CT testing used for Test Strip and Production
- ▶ 6 total IDT and IDEAL-CT samples taken for every 1,400 tons of High RAP production
- ▶ 2 buckets of loose mix used to make APA and Overlay samples if IDT or IDEAL-CT samples fail
 - ▶ Penalty based on failing APA or Overlay test results

IDT/IDEAL-CT Requirements in Special Provisions (Test Strip and Production)

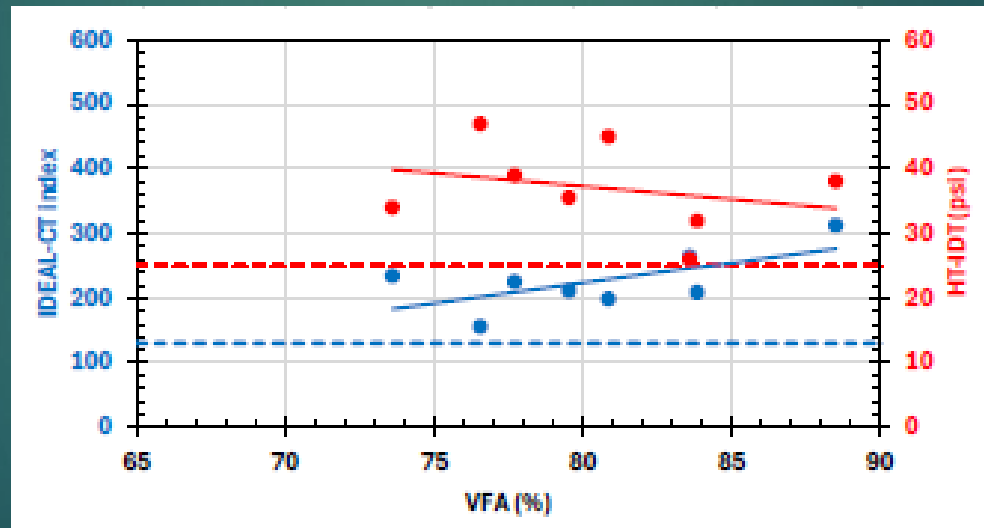
	Surface Course		PPA
	PG 64S-22	PG 64E-22	
High Temperature IDT (psi) (ASTM D6931)	$t \geq 25$	$t \geq 34$	0
	$21 < t \leq 25$	$25 < t \leq 34$	PG 64S-22: $-(t-25)/0.08$ PG 64E-22: $-(t-34)/0.18$
	$t < 21$	$t < 25$	-100 or Remove & Replace
IDEAL-CT Index (ASTM D8225)	$t \geq 130$	$t \geq 150$	0
	$130 > t \geq 120$	$150 > t \geq 130$	Surface PG 64S-22: $-(t-130)/0.2$ Surface PG 64E-22: $-(t-150)/0.4$
	$t < 120$	$t < 130$	-100 or Remove & Replace

	Intermediate and Base Course		PPA
	PG 64S-22	PG 64E-22	
High Temperature IDT (psi) (ASTM D6931)	$t \geq 25$	$t \geq 34$	0
	$21 < t \leq 25$	$25 < t \leq 34$	PG 64S-22: $-(t-25)/0.08$ PG 64E-22: $-(t-34)/0.18$
	$t < 21$	$t < 25$	-100 or Remove & Replace
IDEAL-CT Index (ASTM D8225)	$t \geq 100$	$t \geq 120$	0
	$100 > t \geq 91$	$120 > t \geq 104$	Intermediate PG 64S-22: $-(t-100)/0.18$ Intermediate PG 64E-22: $-(t-120)/0.32$
	$t < 91$	$t < 104$	-100 or Remove & Replace

- Specification limits based on APA/IDT and Overlay/IDEAL-CT correlation from Rutgers database

Early Takeaways from 2024/2025 Pilot Projects

- ▶ Volumetrics are still an important performance indicator
 - ▶ As Voids Filled with Asphalt (VFA) increases, IDEAL-CT Index increases and HT-IDT decreases
- ▶ QC Volumetric and Performance testing at plant is critical
 - ▶ Allows for adjustments to be made in real time to get more consistent mix



(2025 Rutgers PSP Report)

Future High RAP Projects

- ▶ NJDOT will continue with 6 High RAP Pilot Projects for 2026 paving season using current Special Provisions
- ▶ NJDOT will monitor Pilot Projects
 - ▶ Performance Testing Results
 - ▶ Pavement condition
 - ▶ Rutgers Research
- ▶ Stakeholder meetings between NJDOT, Industry, and Academia will continue to be held to discuss progress of Pilot Projects
- ▶ Determine if adjustments are needed to Standard Specifications
 - ▶ IDT and IDEAL-CT specification limits
 - ▶ Number of samples

Questions?

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