History and Overview of NJDOT HRAP Specification

NJAPA Paving Conference
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Background

- In 2008, NJDOT began evaluating higher RAP mixtures under request from industry
  - Under the classification of "research pilot studies"
- Some immediate concerns came out during evaluation
  - Proper AC determination of RAP
  - Ignition oven correction factors
  - Need of softer binder to maintain -22°C low temp?
    - Were blending charts right way? Extraction/recovery?
  - Mixture tests indicated higher RAP %'s had fatigue issues – especially Overlay Tester (crack propagation)

Average Results for Overlay Tester (2008 to 2010)

- 0% RAP = 138 cycles
- 15% RAP = 40 cycles
- 20% RAP = 38 cycles
- 25% RAP = 40 cycles
- 30% RAP = 24 cycles (only 1 mix – 19mm)

Back to the Drawing Board!

- Five pilot projects were produced and placed – 4 of 5 with immediate issues
  - Plant volumetrics, field compaction
  - 5th project showed issues in field 2 years later
- In 2011, NJDOT held NJ asphalt industry to current specifications
  - 15% RAP in surface; 25% RAP in intermediate/base
- In winter 2012, Rutgers and NJDOT worked to develop a Performance-Based High RAP (HRAP) specification
  - Utilized database of performance testing results to establish performance requirements for both rutting (Asphalt Pavement Analyzer) and cracking (Overlay Tester)

NJDOT HRAP Specification

NJDOT HRAP – Basic Principle

- The supplier is not held to PG grade or max. RAP content
- Have to meet basic Superpave requirements
  - NJDOT increased VMA 1% over current specs
    - Higher effective asphalt content compensates for potential lack of RAP blending
  - Could use softer binder, rejuvenators, WMA
- However, acceptance based on final mixture performance, based on database of typical "virgin" HMA

NJDOT HRAP - Volumetrics

Table 902.11.03-1 HMA HIGH RAP Requirements for Design

Compaction Levels	Required Density (% of Theoretical Max. Specific Gravity)		Voids in Mineral Aggregate (VMA)[2], % (minimum) Nominal Max. Aggregate Size, mm					Voids Filled With Asphalt (VFA) %	Dust-to-Binder Ratio
	@N_{des}[1]	@N_{max}	**25.0**	**19.0**	**12.5**	**9.5**	**4.75**		
L	96.0	≤ 98.0	13.0	14.0	15.0	16.0	17.0	70 - 85	0.6 - 1.2
M	96.0	≤ 98.0	13.0	14.0	15.0	16.0	17.0	65 - 85	0.6 - 1.2

1. As determined from the values for the maximum specific gravity of the mix and the bulk specific gravity of the compacted mixture. Maximum specific gravity of the mix is determined according to AASHTO T 209. Bulk specific gravity of the compacted mixture is determined according to AASHTO T 166. For verification, specimens must be between 95.0 and 97.0 percent of maximum specific gravity at N_{des}.
2. For calculation of VMA, use bulk specific gravity of the combined aggregate including aggregate extracted from the RAP.

Table 902.11.04-1 HMA HIGH RAP Requirements for Control

Compaction Levels	Required Density (% of Theoretical Max. Specific Gravity)	Voids in Mineral Aggregate (VMA), % (minimum) Nominal Max. Aggregate Size, mm					Dust-to Binder Ra
	@Ndes[1]	**25.0**	**19.0**	**12.5**	**9.5**	**4.75**	
L, M	95.0 – 98.5	13.0	14.0	15.0	16.0	17.0	0.6 - 1.:

1. As determined from the values for the maximum specific gravity of the mix and the bulk specific gravity of the compa mixture. Maximum specific gravity of the mix is determined according to AASHTO T 209. Bulk specific gravity of compacted mixture is determined according to AASHTO T 166.

NJDOT HRAP - Performance

- Minimum of 20% RAP in Surface Course
- Minimum of 30% RAP in Intermediate/Base
- Lab design and plant produced material must meet rutting (APA) and cracking (Overlay Tester) requirements

Table 902.11.03-2 Performance Testing Requirements for HMA HIGH RAP Design

Test	Requirement			
	Surface Course		Intermediate Course	
	PG 64-22	PG 76-22	PG 64-22	PG 76-22
APA @ 8,000 loading cycles (AASHTO T 340)	< 7 mm	< 4 mm	< 7 mm	< 4 mm
Overlay Tester (NJDOT B-10)	> 150 cycles	> 175 cycles	> 100 cycles	> 125 cycles

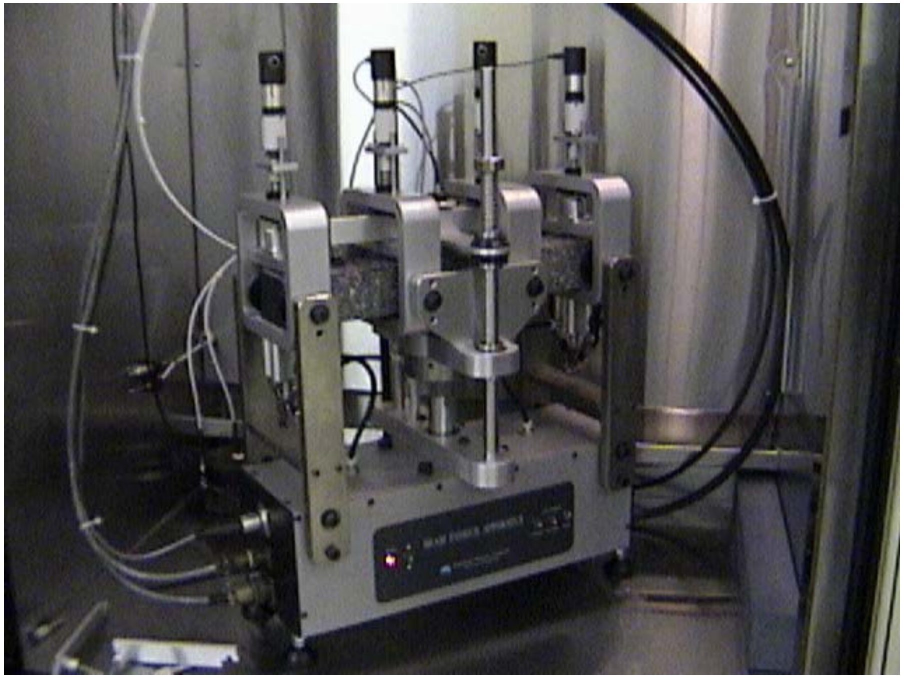
Why Overlay Tester for Fatigue?

Conflicting Information (?)

- Tons of literature illustrating conflicting information pertaining to the fatigue cracking performance of recycled asphalt mixtures
- Question is why?
  - Differences in regional materials
  - Differences in regional climate
  - Differences in production practices
  - **Differences in what we define as fatigue cracking performance (lab vs field)**

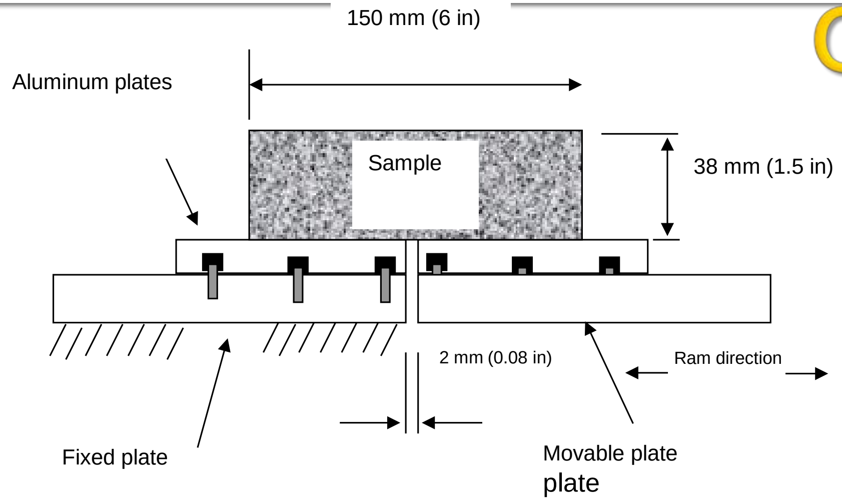
Crack Initiation Test

- Flexural Beam Device, AASHTO T321
- Test mixes ability to withstand repeated bending
- Run at strain levels higher than expected field strains to accelerate testing



Crack Propagation

Overlay Tester

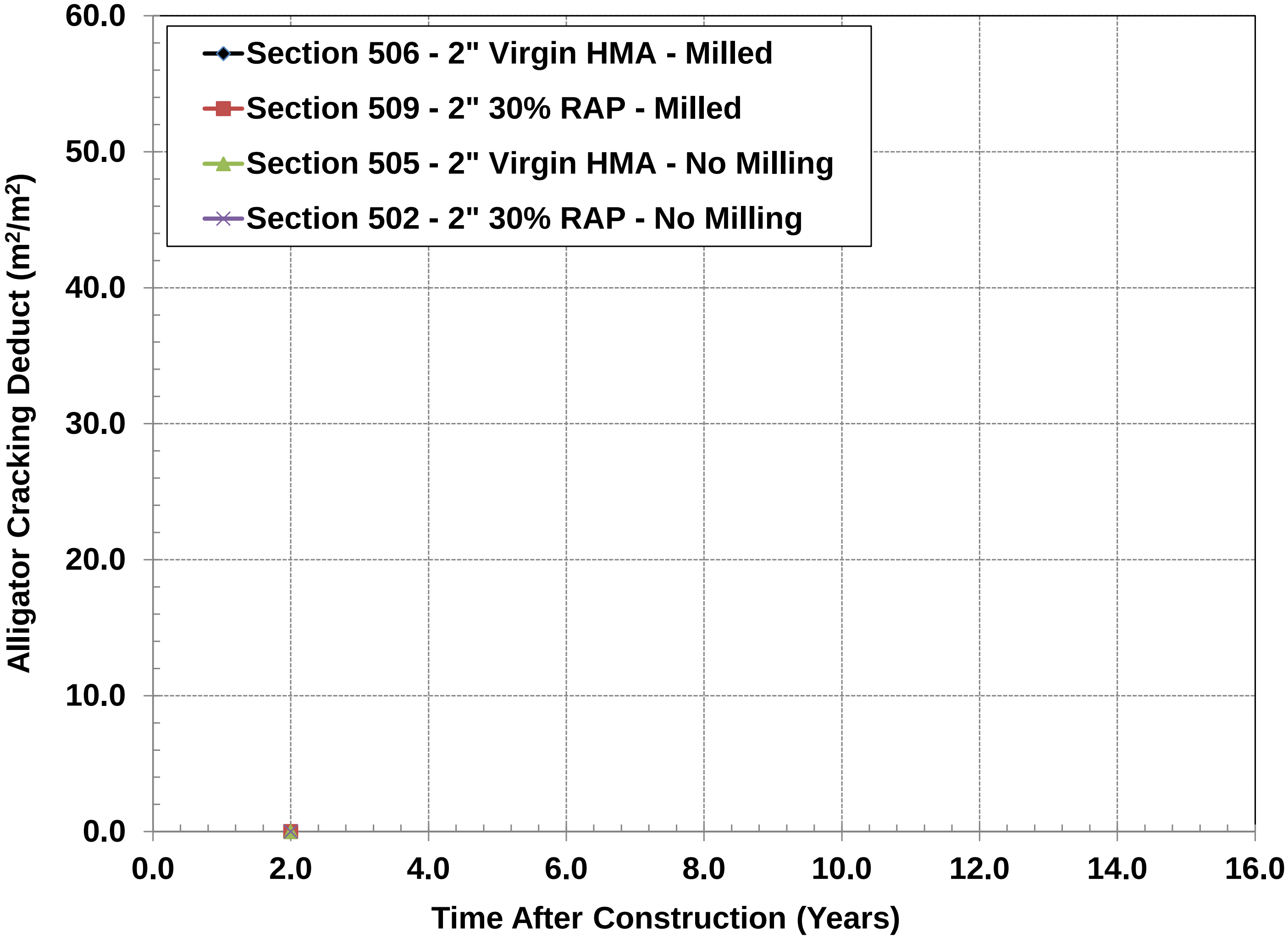


- Sample size: 6″ long by 3″ wide by 1.5″ high
- Loading: Continuously triangular displacement 5 sec loading and 5 sec unloading
- Definition of failure
  - Discontinuity in Load vs Displacement curve

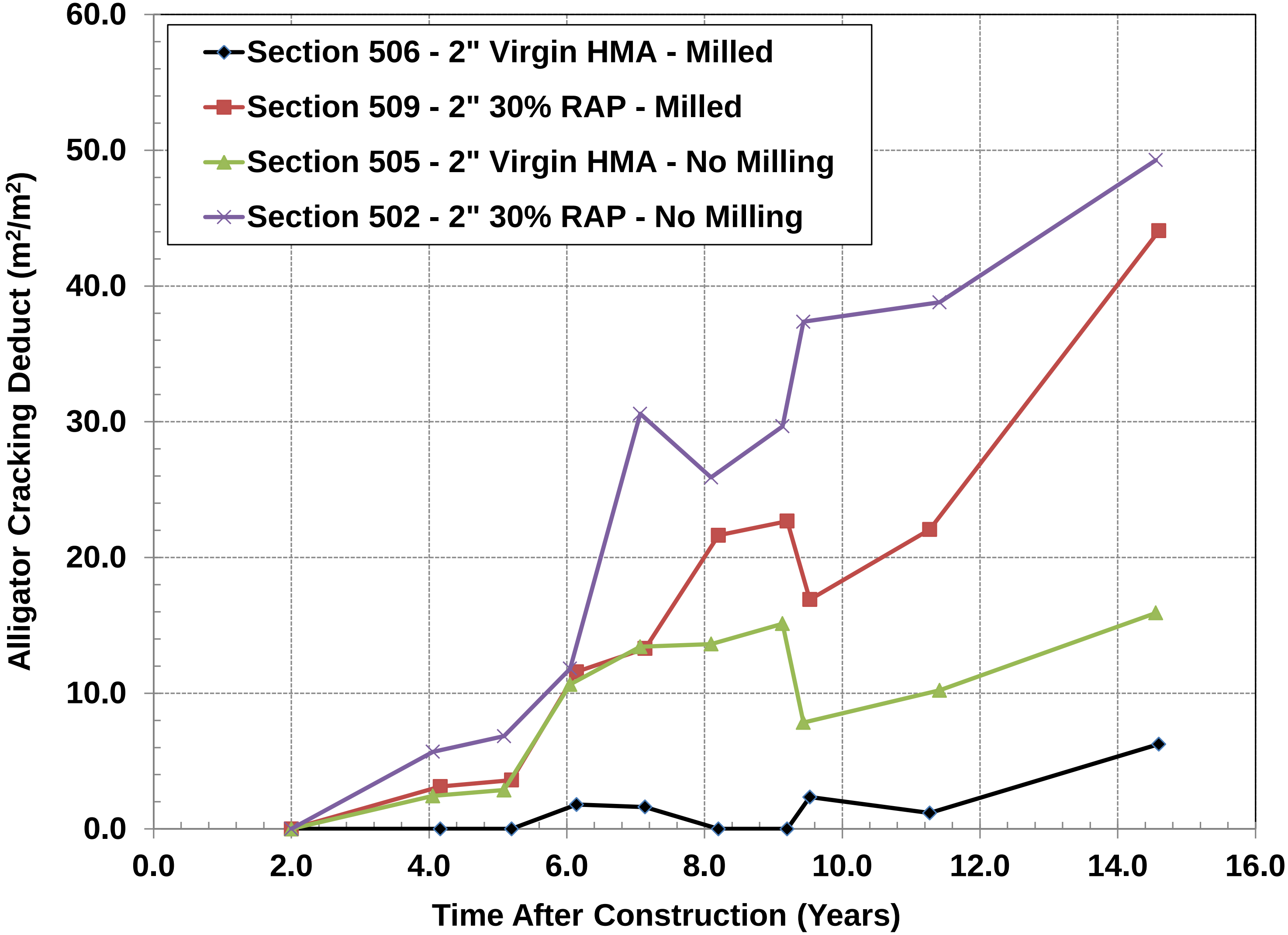
Example of Importance on How We Measure Cracking

- SPS-5 (LTPP's Special Pavement Sections) used for the "Study of Rehabilitation of Asphalt Concrete Mixtures"
  - 2-inch vs 5-inch thick overlays
  - Milled vs Unmilled surfaces
  - <u>Virgin vs 30% RAP Mixtures</u>
- NJ Constructed in 1994 – Out of Service in 2009
- Yearly distress survey
- Cores taken and tested prior to rehab, as well as retained loose mix from 1994 construction

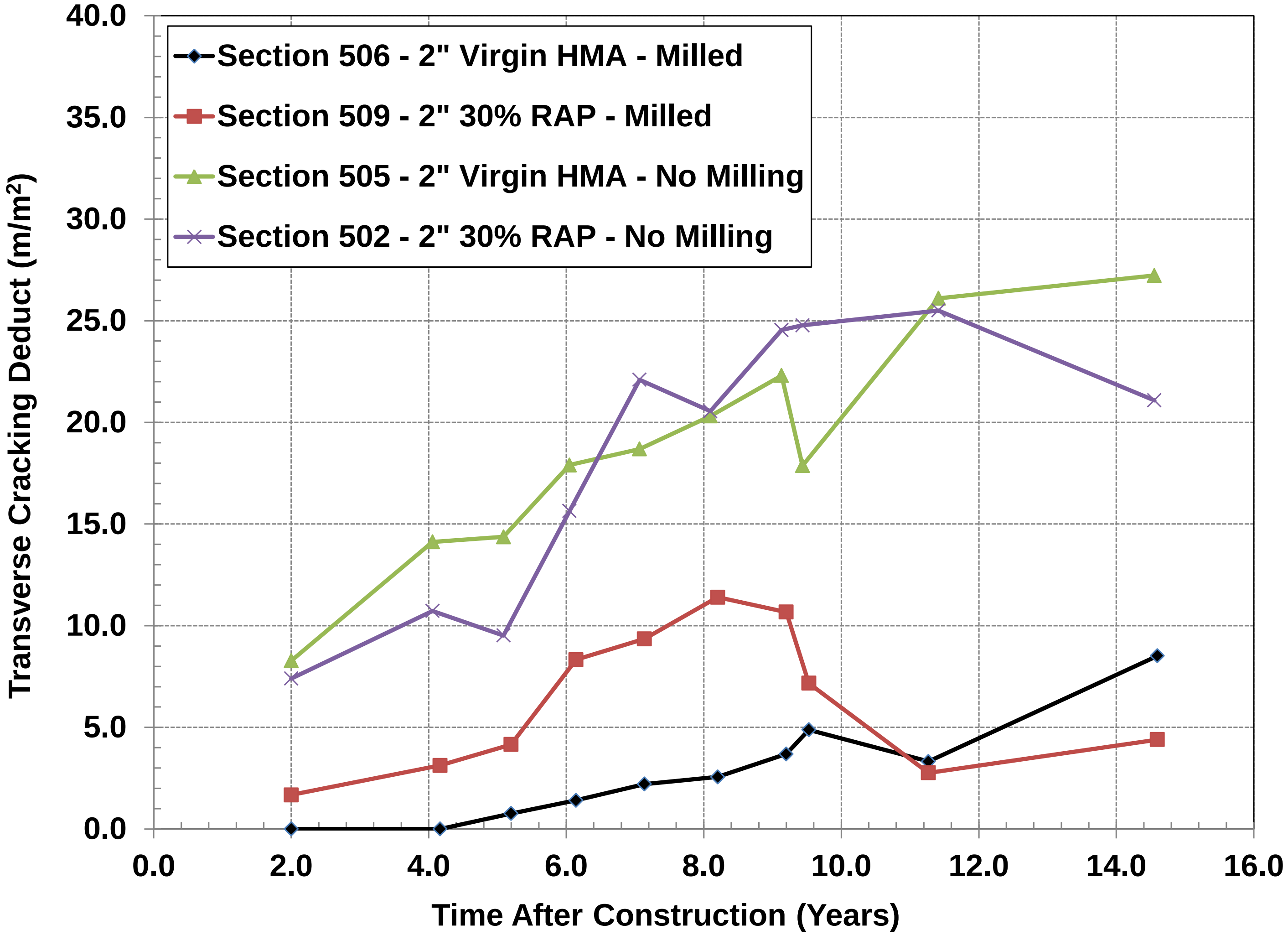
NJ SPS-5 Alligator Cracking - Initiation



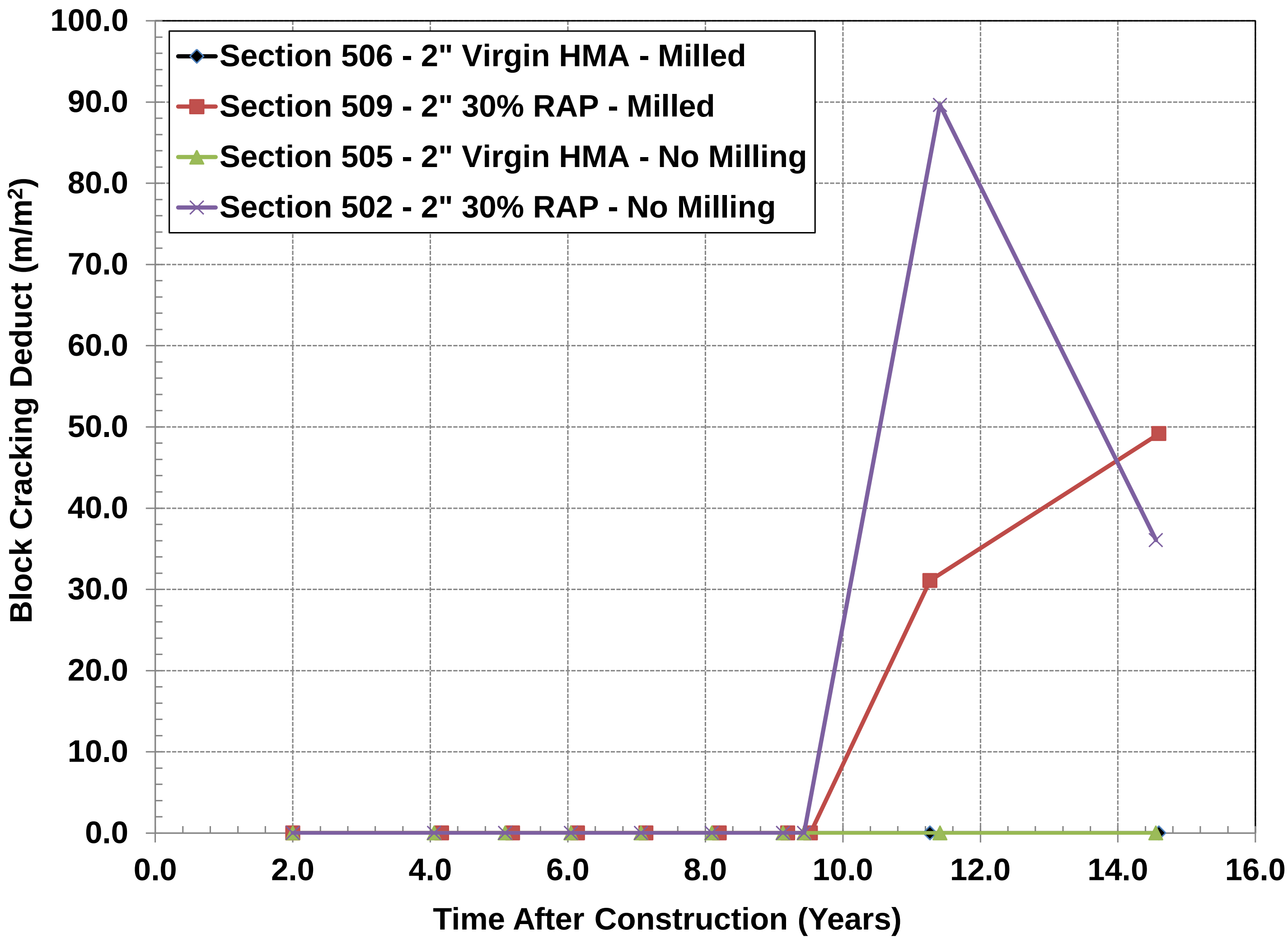
NJ SPS-5 Alligator Cracking – Final (Propagation)



NJ SPS-5 Transverse Cracking – Final



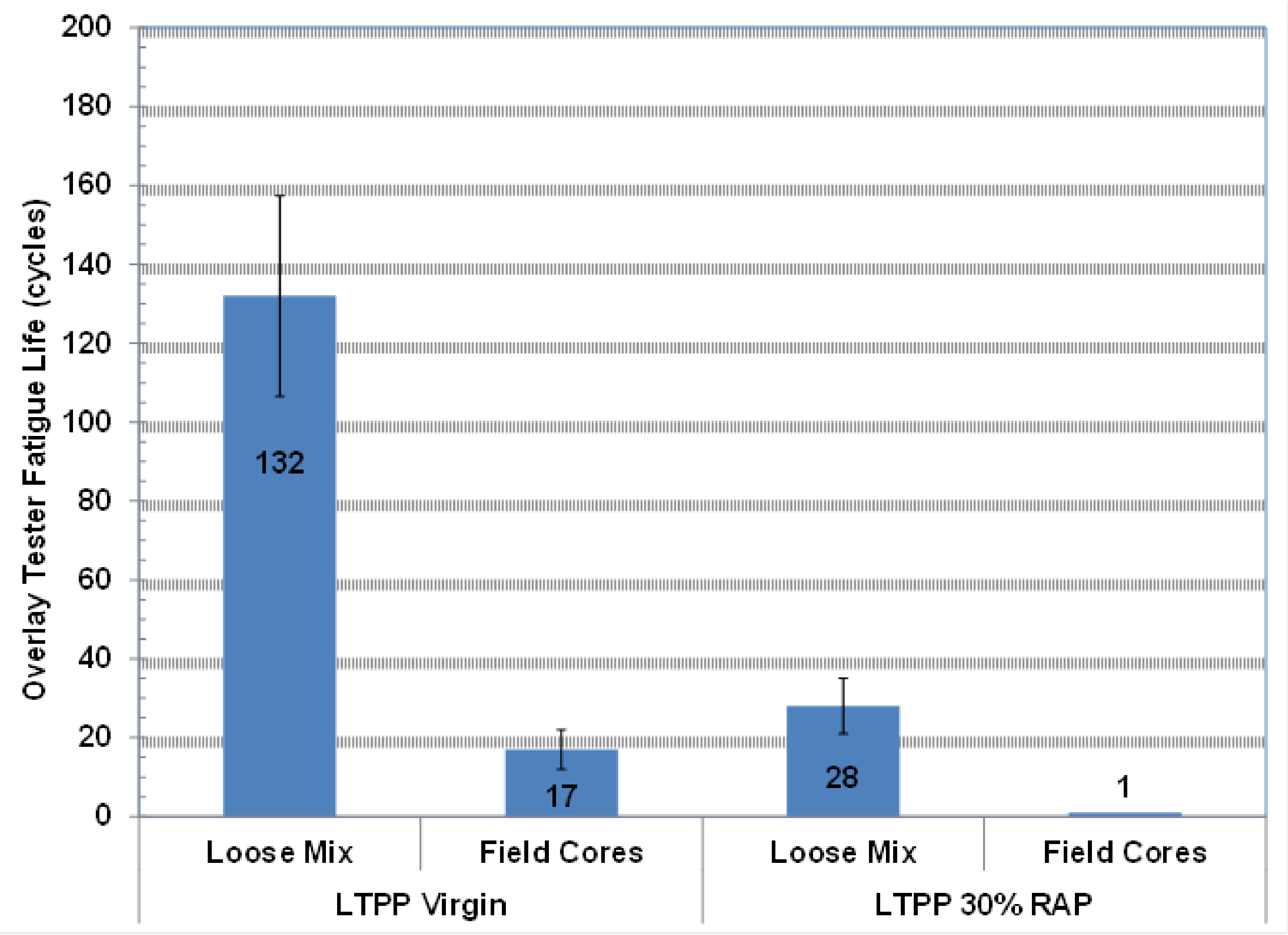
NJ SPS-5 Block Cracking – Final



NJ SPS-5 Field Initiation vs Propagation

- Sections began to have visual "cracking" around the same time period
- However, once cracking had initiated, the cracking propagated through the RAP sections at a greater rate
- Therefore, crack initiation rankings appear to differ from crack propagation rankings
  - Crack propagation better represents the <u>mixture's</u> ability to resist cracking

Initiation vs Propagation – Overlay Tester for NJ SPS-5



Additional Rutgers Testing Confirms Overlay Tester

- PANYNJ Newark & JFK Airfield Cracking
- FHWA ALF Fatigue Study
- NYSDOT RAP-RAS Studies
- NYSDOT WMA Studies

Conclusions

- HRAP specification provides a means for industry to use more RAP
  - Can use up to 100%!
  - Most plants can not use more than 40% - 50% anyway
- Gives flexibility to supplier to use different design and production alternatives – think outside the box a little
- Performance tiered for needed performance
- Field performance used to select and verify performance testing and criteria


Thank you for your time!
Questions?
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