THINLAY

SAFE. SMOOTH. DURABLE.

John Hickey, P.E., Esq.
Executive Director
Asphalt Pavement Association of Oregon

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PAVEMENT MAINTENANCE

PAVEMENT MAINTENANCE

How to Work with Thinlays

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THINLAY
NAPA: Thinlay Asphalt Overlays Preserve Road Assets

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Why Thin Is In

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Affordable Striping & Sealing is in the "Yes" Business

PAVEMENT MAINTENANCE

How to Pave a Circle

EQUIPMENT

Perfect Asphalt Roller Operation

PAVEMENT MAINTENANCE

How to Work with Thinlays

BY JESSICA STOINES ON AUG 14, 2015

Thinlays are a popular approach to pavement preservation because of their ability to provide improved ride quality, reduce pavement distresses, maintain surface geometrics, reduce noise levels, reduce life cycle costs, and provide long-lasting service.

As owners are continually trying to do more with less money, contractors are faced with the challenge to move away from new construction and shift towards cost-effective pavement preservation.

U.S. Department of Transportation
Federal Highway Administration

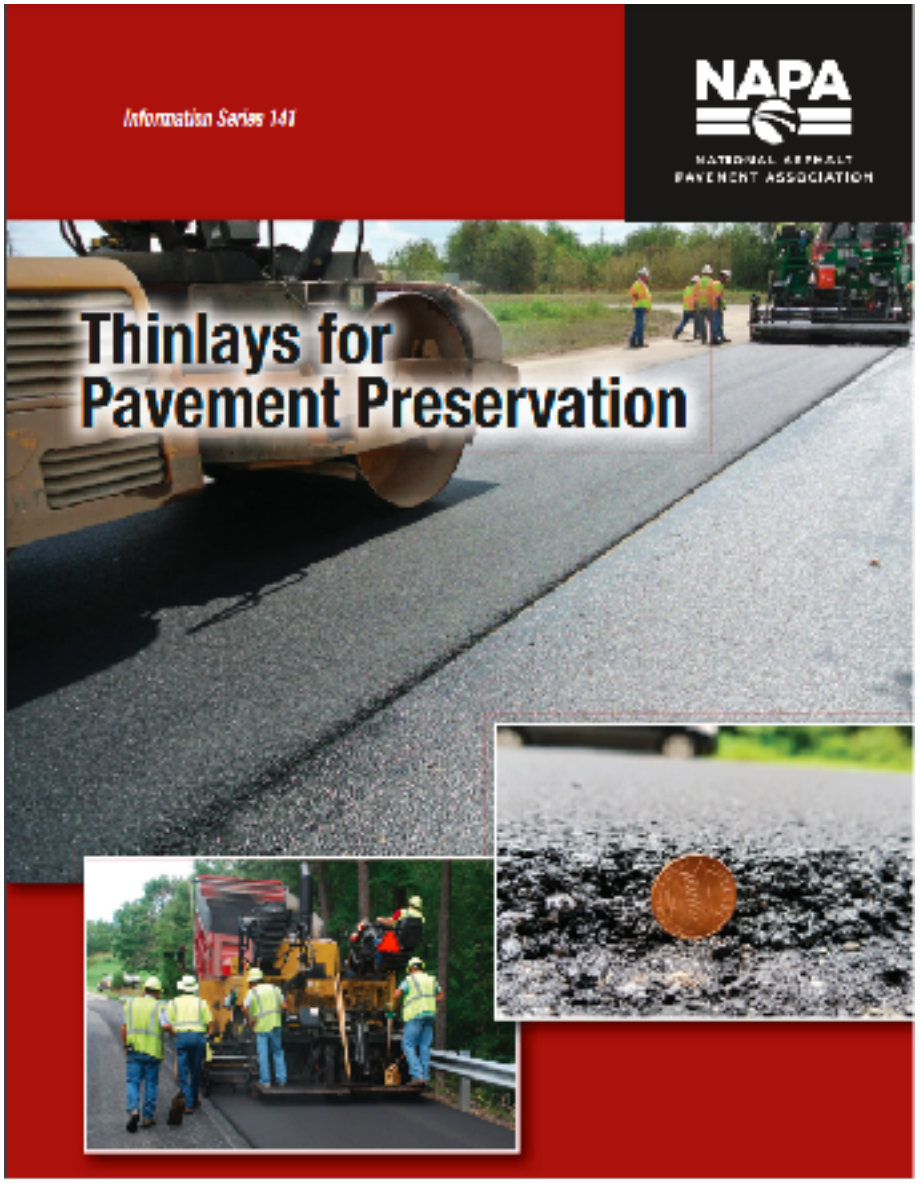
The Use of Thin Asphalt Overlays for Pavement Preservation

Thinlays Becoming a Pavement Preservation Option

Asphalt lifts thinner than 1-1/2 in. becoming more common preservation option

May 5, 2020 | By Roger Smith

PAVEMENT MAINTENANCE & RECONSTRUCTION



The Opportunity

- Focus nationwide has shifted from construction to preservation
- The value of our highway and road system estimated at $1.75 trillion
- Preservation of the existing system is the primary challenge for pavement managers

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Goals

- Develop and Place high Quality ***THINLAYS***
- Improve our cost competitiveness w/o sacrificing quality and performance
- Market ***THINLAYS*** as an effective preservation method

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- Superpave Mix Design
- Smaller aggregates (3/8 or 1/4 inch NMAS)
- Softer binders
- Polymer modified binders if needed
- Max gyrations typically 80
- Lift thickness 3/4 inch to 1.5 inches
- Compaction

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Should correct surface distresses

- Cracking
- Rutting
- Raveling

Preservation Treatments

- Should seal the existing pavement to prevent intrusion of water and air

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Preservation Treatments

should also improve serviceability

- Smoothness
- Surface friction
- Drainage issues

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Preservation Treatments

should last as long as possible

- Long life = low life cycle cost
- Long life = minimal user impacts
- Long life allows the pavement manager to optimize the performance of the entire network

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Are designed to

- ✓ Correct Surface distress
- ✓ Seal the existing surface
- ✓ Improve Serviceability
- ✓ Provide long life
- ✓ Extend structural life

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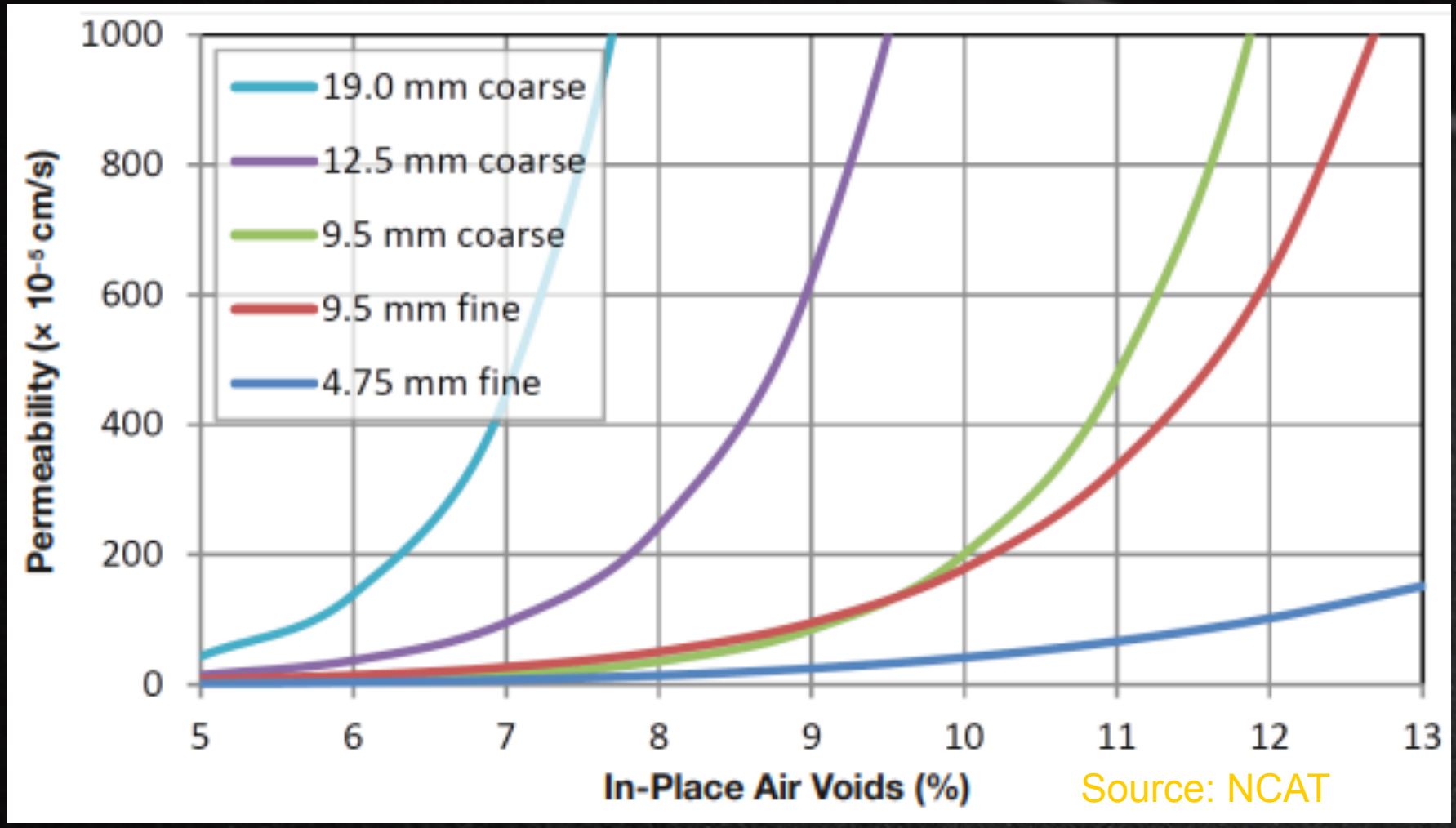
Thinlay Benefits



Source: NCAT

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Thinlay Benefits

- No need to seal a Thinlay
- If reflective cracks form, seal the cracks only

Asphalt.

Thinlay Benefits

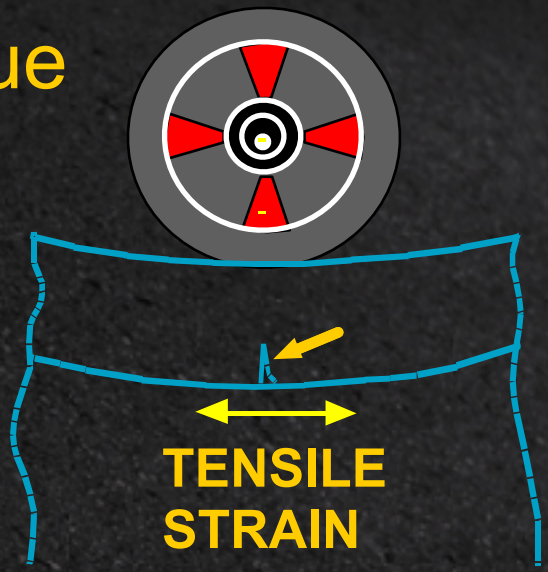
- Fast and immediately open to traffic
- Public views the road as “like new”
- No cure time, sweeping, or broken windshields
- Limited performance risk
- Preferred by cyclists, pedestrians and windshields
- Reduced traffic noise

Structural Benefits

- Preventive Maintenance treatments should be applied to structurally sound pavements
- Slurry seals, chips seals, micro surfacing add no structure
- A 1-inch Thinlay provides structural benefits

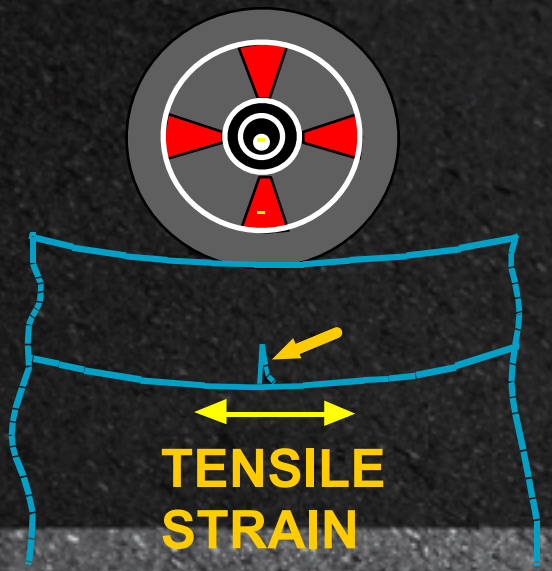
Structural Benefits

- Most in-service pavements were designed for 20 years with AASHTO design
- They have finite bottom-up fatigue life, meaning if thickness is not increased the pavement will eventually fail from bottom-up cracking



Structural Benefits

- A seal type treatment applied on those pavements will have no impact on the tensile strain and therefore no impact on the structural life



Structural Benefits

- Preventive seals on these pavements will only mask the impending structural distresses and eventually lead to full depth failures

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Timely Thinlays can extend structural life

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What's in an inch?
Asphalt Thickness & Fatigue Life

Thickness	Micro strain	Reps to failure
2	-652	30,234
3	-495	71,537
4	-383	160,693
5	-302	340,507
6	-242	682,133

Structural contribution of 1”

- A 1-inch overlay of an existing 4-inch pavement will double the fatigue life
- A second 1-inch overlay can extend the structural life beyond 50 years
- Once you achieve a perpetual thickness you can focus on the surface

Thinlay Mix Design

- Design specifically for pavement preservation
- Aggregate gradations allowing placement as thin as ¾-inch
- Binders and gradations selected to optimize flexibility, durability, and rut resistance

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Sustainability Attributes

- High recycled materials content is achievable
- Great application for warm mix technology
- Improving smoothness reduces user emissions

RAP

Why?

- Economic savings
- Environmental benefit

- Reduced demand for virgin materials

How do RAP mixes perform?

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RAP

Evaluation of LTPP Data (20-year study)

30% RAP v. All Virgin

Distress Parameter	Virgin Performed Significantly Better than RAP (percentage)	RAP Performed Significantly Better than Virgin (percentage)	Insignificant Difference Between Virgin and RAP (percentage)	RAP Performed Better Than or Equal to Virgin (percentage)
IRI	42	39	19	58
Rutting	33	29	38	67
Fatigue Cracking	29	10	61	71
Longitudinal Cracking	15	10	75	85
Transverse Cracking	32	15	53	68
Block Cracking	3	1	96	97
Raveling	7	15	78	93

Table 1. Comparison of distress measurements for companion virgin and RAP sections

FHWA Publication No.: FHWA-HRT-11-051

RAP

FHWA LTPP:

"In summary, the performance data from LTPP SPS-5 shows that RAP and virgin HMA mixes used in overlays of flexible pavements showed approximately the same performance across a range of climates, traffic, and existing pavement conditions over a period of up to 17 years."

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Information Series 139

NATIONAL ASPHALT PAVEMENT ASSOCIATION

High RAP Asphalt Pavements

Japan Practice — Lessons Learned

アスファルト舗装廃材

New York City

Why is recycling asphalt pavement more energy-efficient than producing new material?

- ✔ No excavation required from quarries or refineries for new rock
- ✔ No trucking needed to transport materials from outside the city
- ✔ Old asphalt from city streets isn't traveling to landfills at the end of its lifecycle
- ✔ No petroleum is used to make recycled asphalt
- ✔ Less heat is needed to mix recycled asphalt

Right now, the City uses a minimum of 30% recycled asphalt pavement (RAP) to create new asphalt according to Local Law 71. DDC, together with Green Asphalt, wants to make that 100%. **Green Asphalt**, based in Long Island City, is one of the only hot mix asphalt plants in the country that produces 100% RAP, and is the only asphalt plant that does so in New York City.

Warm Mix

Foaming

Chemical - benefit depends on dose

- Compaction aid
- Temperature reduction (20-50° F)
- Improved aggregate/binder adhesion

Uses

- Late season paving – compaction aid
- Long hauls
- Reduced fuel use

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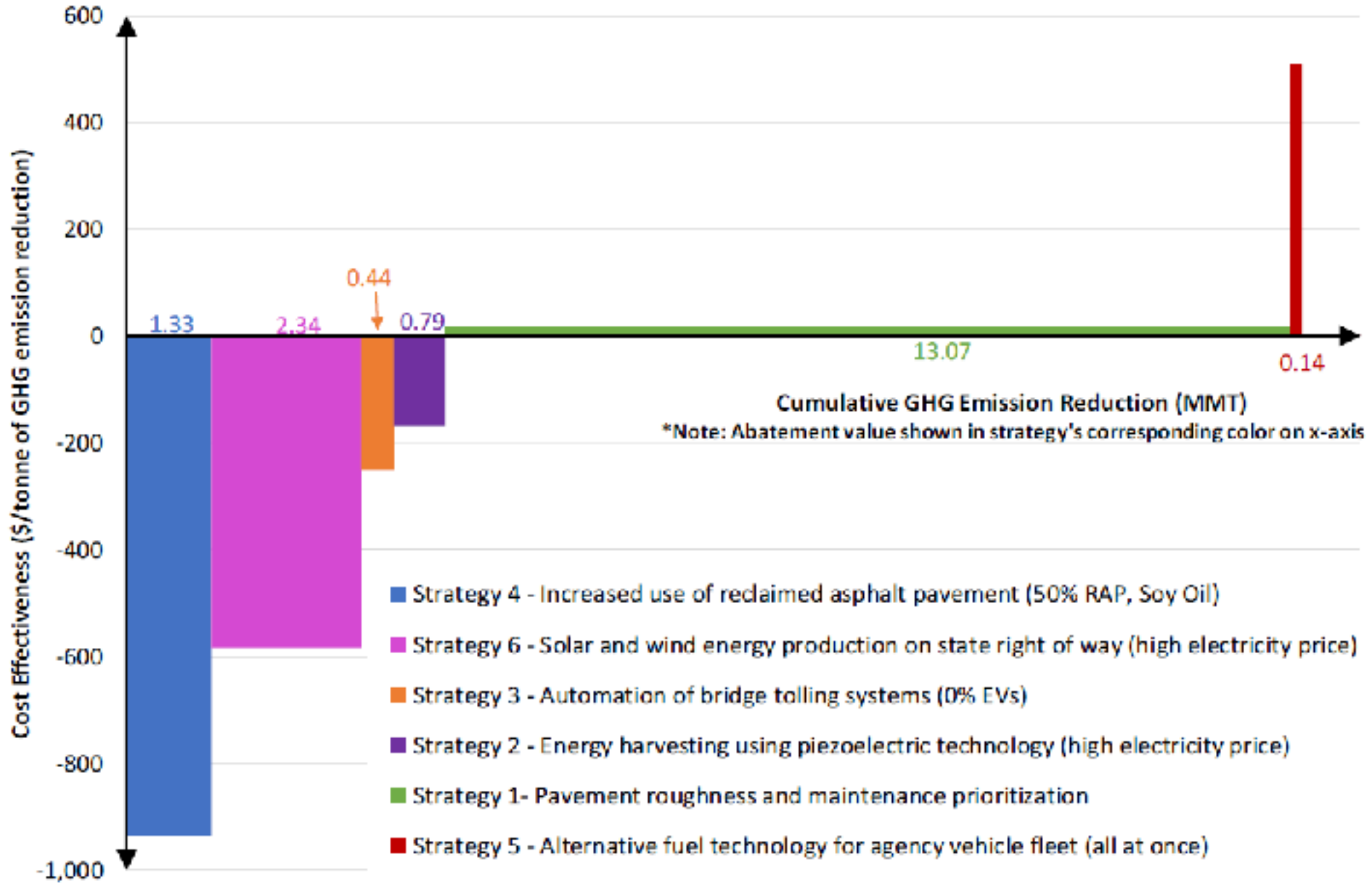
Caltrans Research



Thinlay Mix Design

- Mix Design Criteria for Preservation
  - ✓ Nominal Max =/< 1/3 lift thickness (for ¾” lift use 6.3 mm or smaller mix)
  - ✓ binder selected to optimize crack resistance (softest binder that passes rut test), polymers for highest demand areas
  - ✓ RAP and RAS combined with softer base binders to provide optimum value

Thinlay Mix Design

- Mix design Criteria for Preservation
  - ✓ Gyration = 80 all levels
  - ✓ Va (4 +/- 1%); VMA (15-17); VFA (70-80); avoid low VMA high dust mixes
  - ✓ Minimum binder contents normally 6%, typically higher due to fine grading

Research & Cost

- APAO in conjunction with NCAT and NAPA conducted research to develop high performance and high recycle content Thinlay mixes
- Mixes designed to:
  - be placed as thin as ¾”
  - provide excellent crack resistance
  - maximize recycle content

Research & Cost

- Softer binders were used to improve crack resistance and to offset the stiffening effects of the RAP/RAS
- Softer binders in conjunction with higher RAP/RAS ensures high temperature rut resistance and durability

Control Mixes

- Control mix: ½” Level 3 with 30% RAP and 64-22, 64-28 binders (most common Oregon mix)
- Control mix: Thinlay ¼” mix Level 3 with 30% RAP and 64-22, 64-28 binders

Mixes Used

	L3 ½" 30% RAP	L3 ¼" 30% RAP	L3 ¼" 40% RAP	L3 ¼" 50% RAP	L3 ¼" 20% RAP 3% RAS	L3 ¼" 20% RAP 5% RAS
Pb	6.2	7.2	7.0	7.0	7.7	7.5
Pbr	5.9	7.75	7.75	7.75	14.44	11.8
Binder Grade	64-22 64-28	64-22 64-28	58-28 58-34	58-28 58-34	58-28 58-34	58-28 58-34
Binder Replaced	28.5%	32.3%	44.3%	55.4%	33%	39.3%

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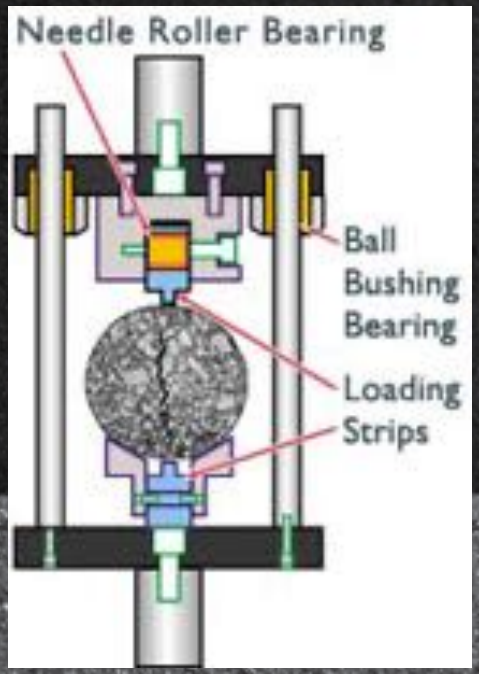
Testing

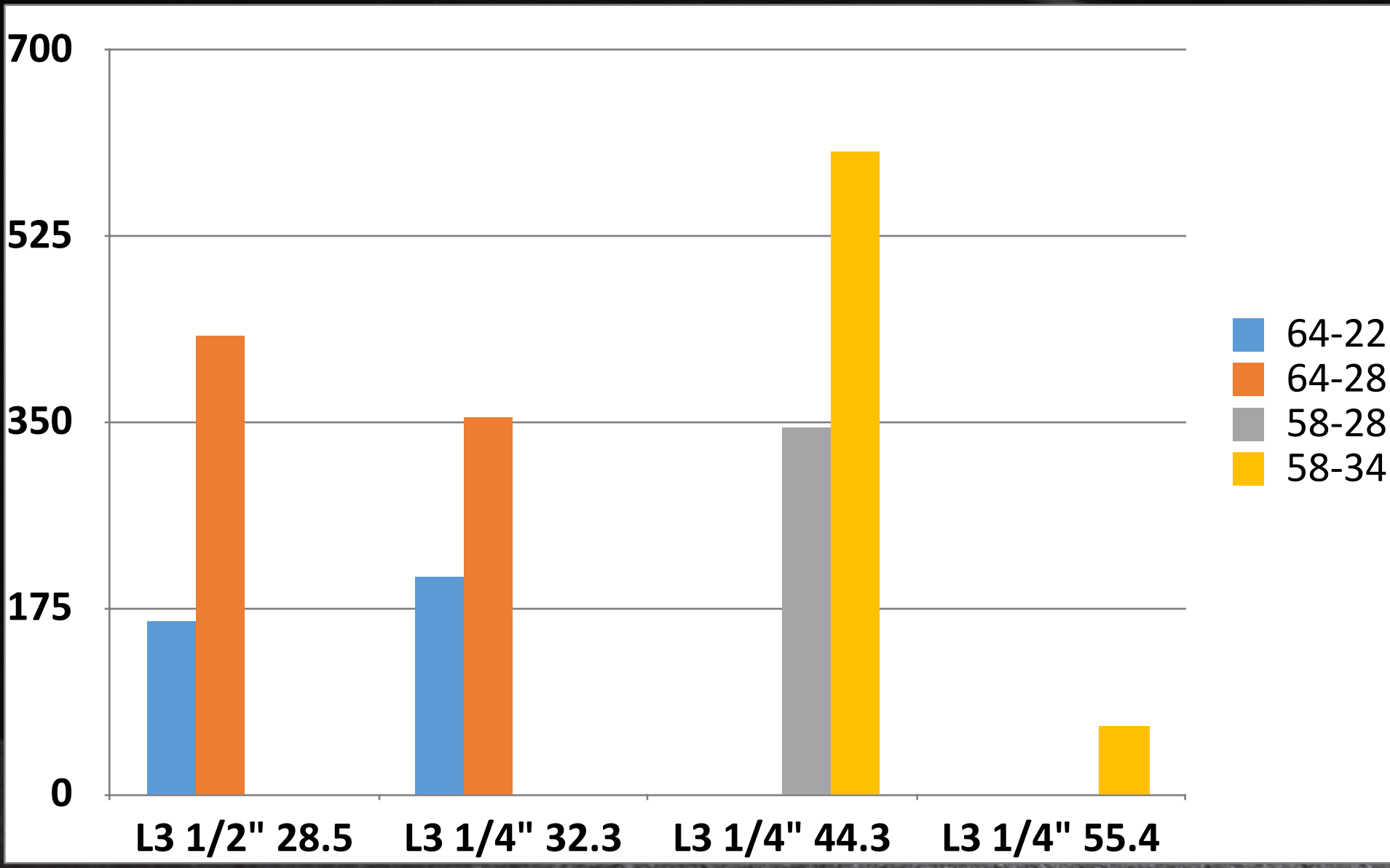
- The overlay crack test results were used to “screen” the mixes for further testing
- Further testing included IDT for fatigue and cold temperature properties



Overlay crack test results

	L3 ½" 30% RAP	L3 ¼" 30% RAP	L3 ¼" 40% RAP	L3 ¼" 50% RAP	L3 ¼" 20% RAP 3% RAS	L3 ¼" 20% RAP 5% RAS
Pb	6.2	7.2	7.0	7.0	7.7	7.5
Pbr	5.9	7.75	7.75	7.75	14.44	11.8
Binder Grade	64-22 64-28	64-22 64-28	58-28 58-34	58-28 58-34	58-28 58-34	58-28 58-34
Binder Replaced	28.5%	32.3%	44.3%	55.4%	33%	39.3%
Overlay test results	160/430	205/365	350/605	-/65	N/A	N/A

Overlay Crack Test Results



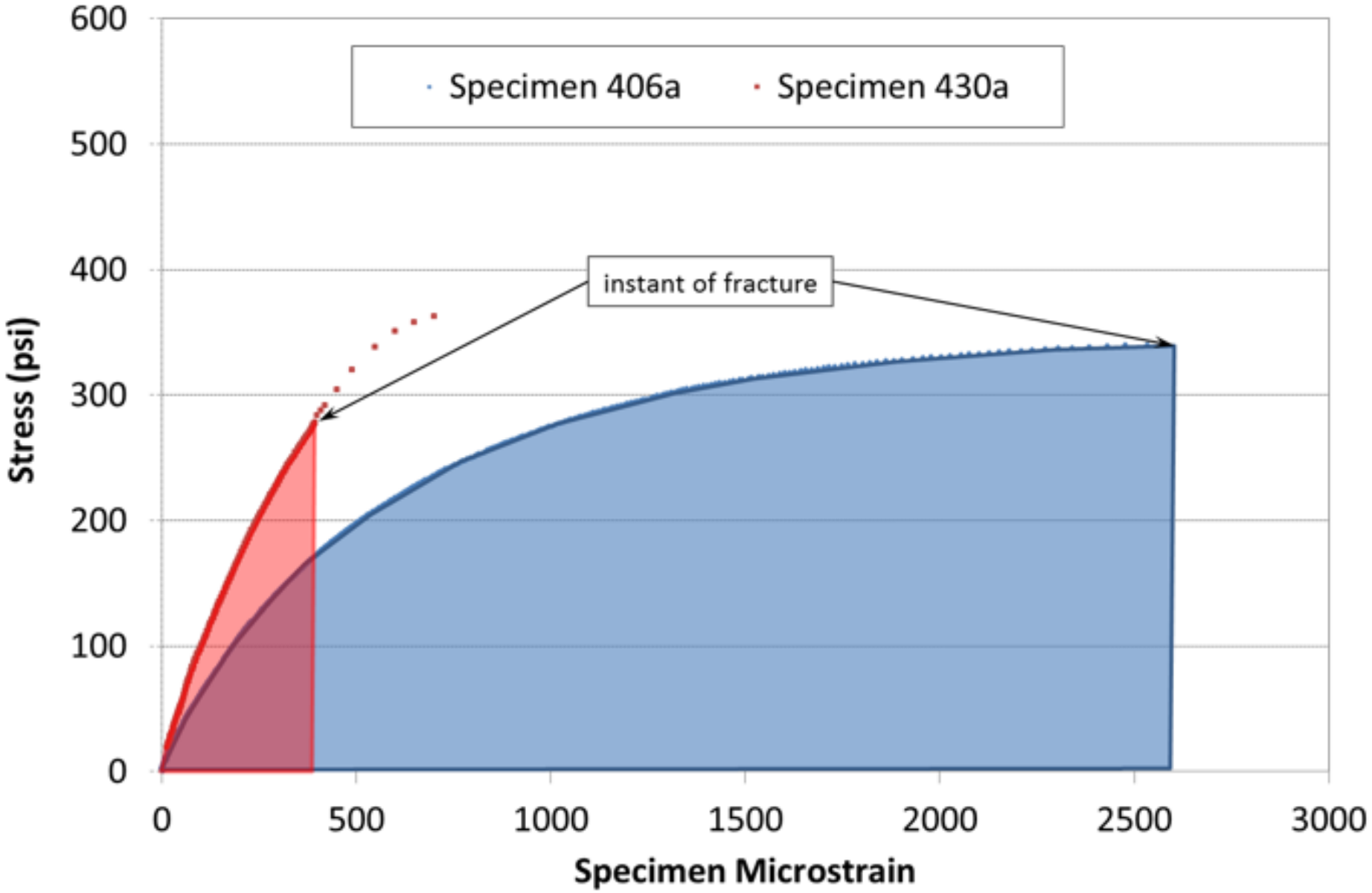
Overlay Testing Findings

- Low temperature grade has greatest influence on the overlay crack test results
- High temp grade has some influence
- Using softer binders can more than offset the stiffening effects of increased RAP binder up to a point

Overlay Testing Findings

- Results appear to be independent of NMAS
- These results relate to reflective type cracking (strain control) and not necessarily to fatigue

IDT Fracture Energy



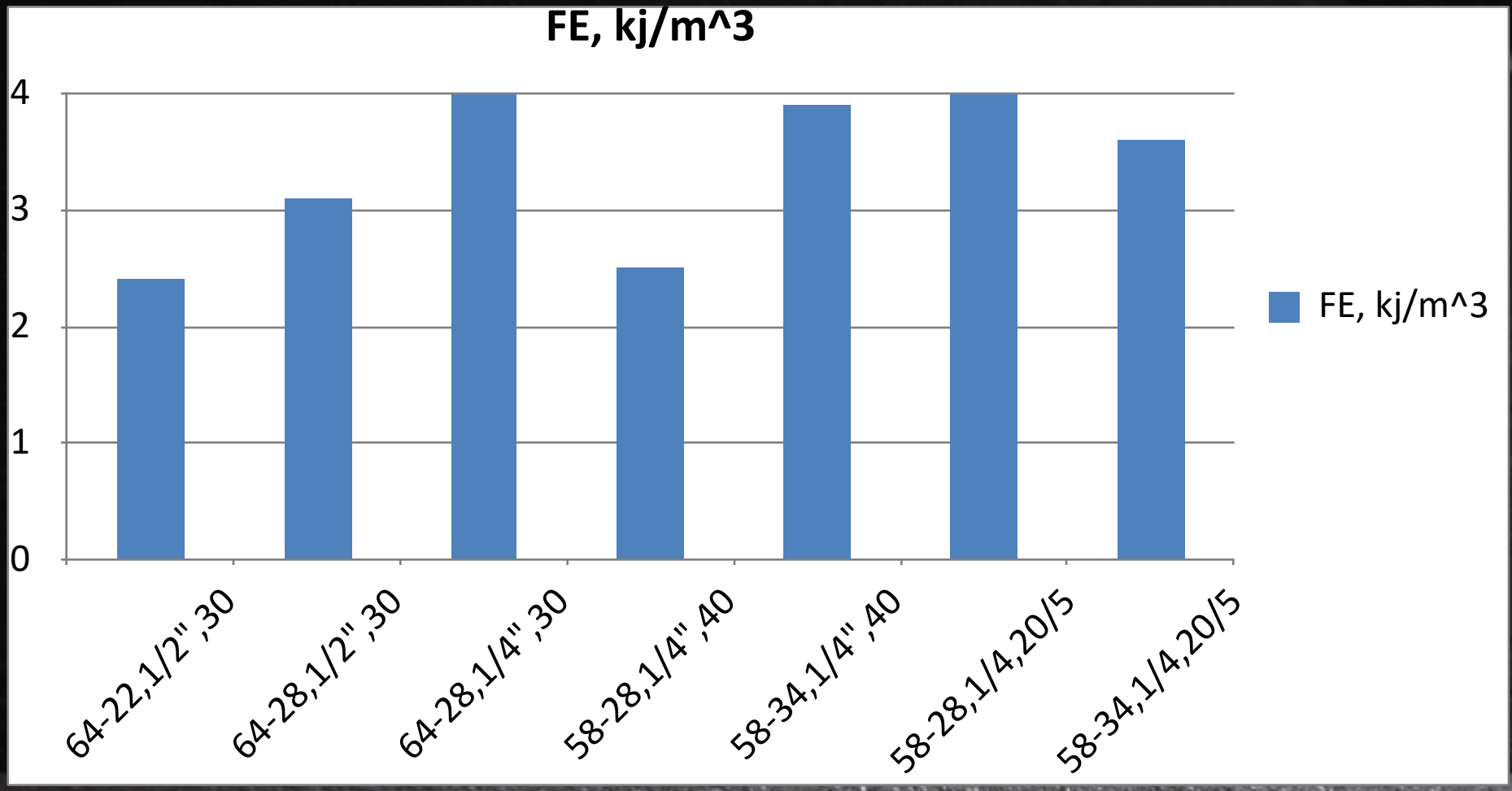
Fracture Energy

- What we know – those mix parameters that improve fatigue also improve FE
  - More binder content = higher FE
  - Lower voids = higher FE and better fatigue
  - Softer binders = higher FE and better fatigue
  - Finer mixes = higher FE and better fatigue

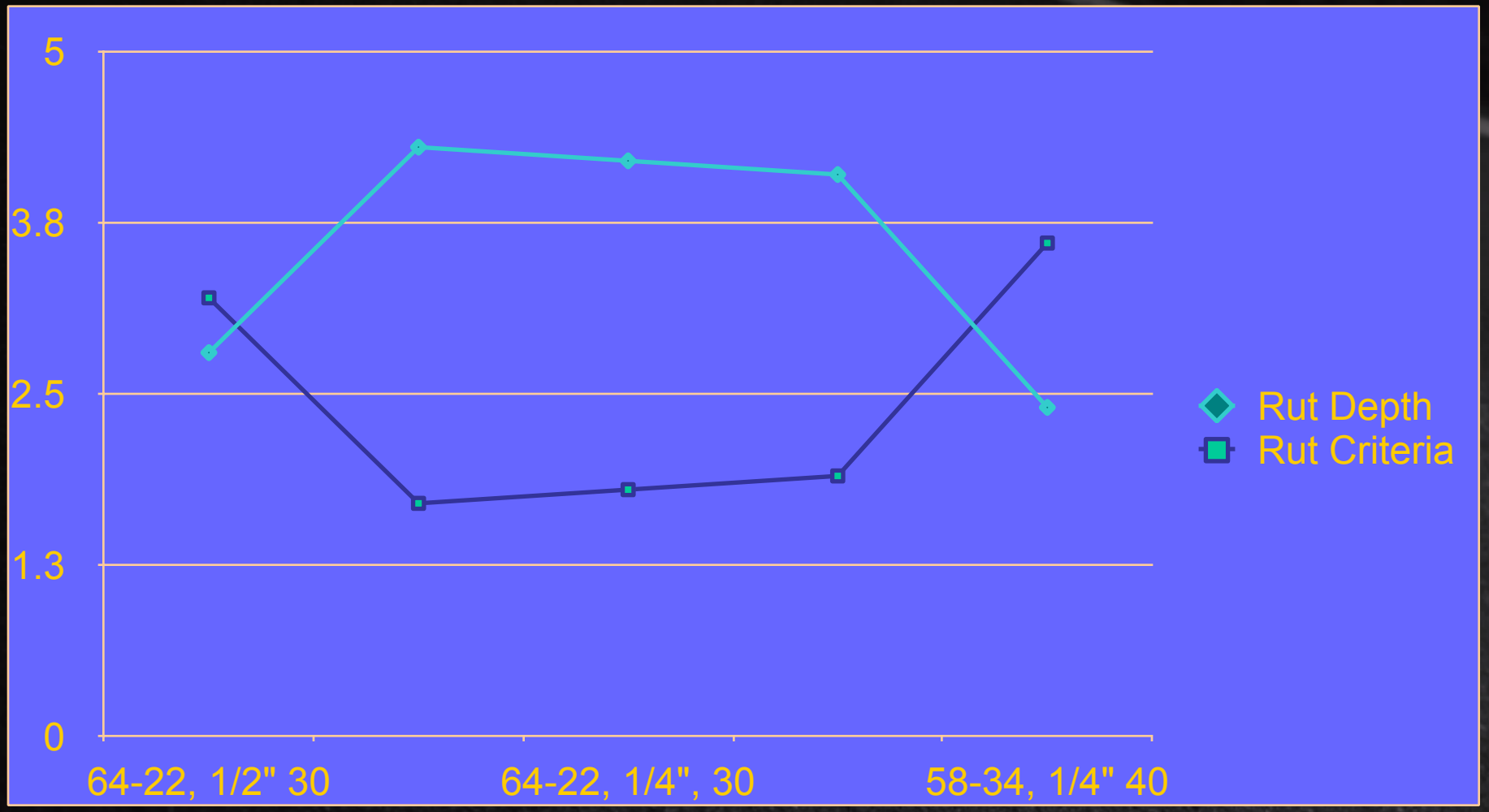
Fracture Energy from IDT Correlates well with Fatigue

- Indirect tensile fracture energy has proven to be a good indicator of the resistance of asphalt to fatigue cracking at West Track
- A study in Florida also found a strong correlation between FE and fatigue

Fracture Energy Test Results



Rut Test Results



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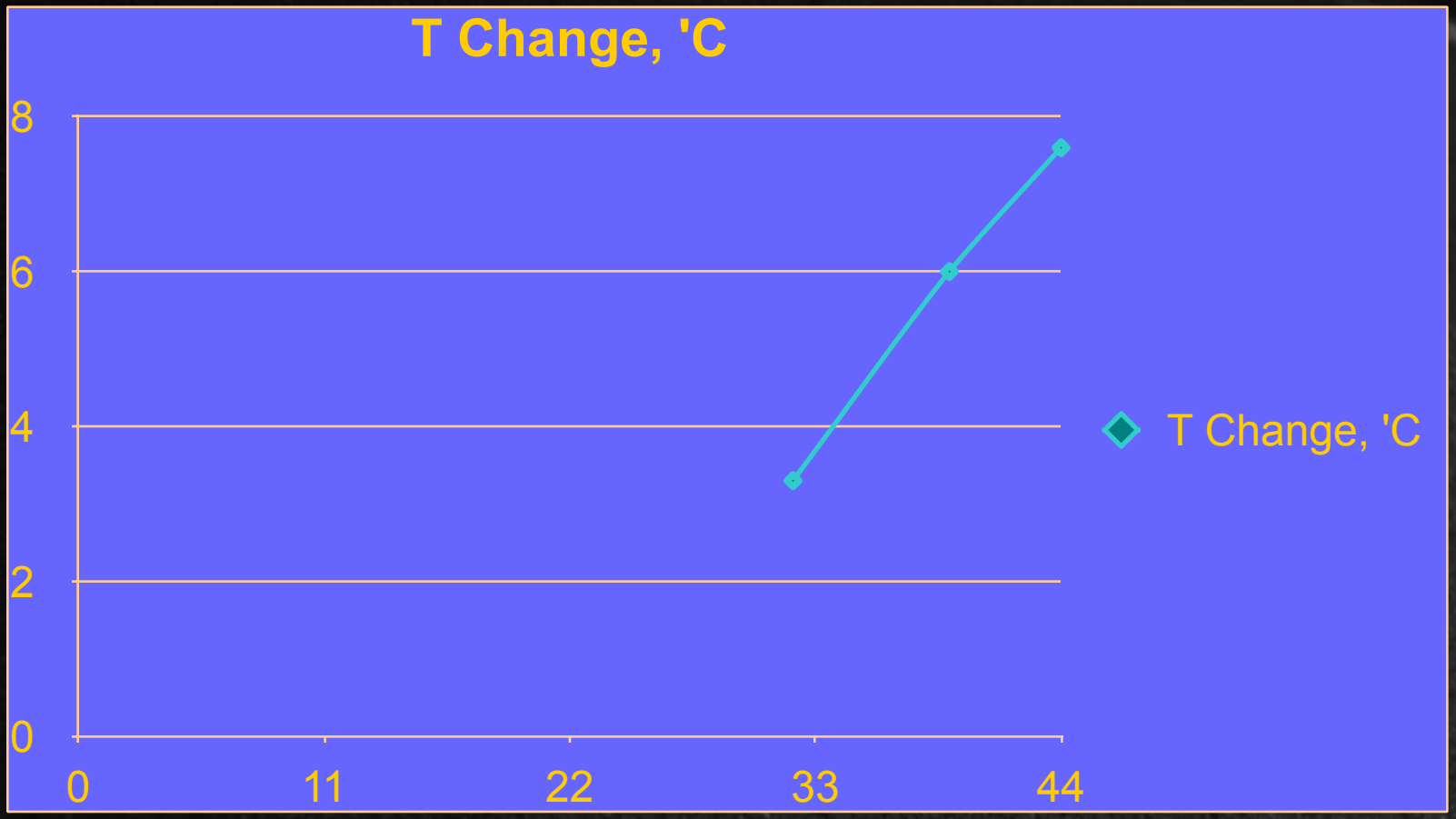
Finding

Softer binders in *THINLAYS* do not increase rut potential when used with higher RAP contents

Cold Temp Crack testing

Mix Type	Failure Temperature (C)
64-28, ¼” 30% RAP 32% binder replacement	- 24.7
58-34, ¼” 40% RAP, 44% binder replacement	- 26.4
58-34, ¼” 20% RAP, 5% RAS 39% binder replacement	- 28.1

Temperature Change Versus Binder Replacement



% Binder Replacement

Finding

No increase in cold temperature cracking risk with up to 40% binder replacement if the virgin binder's low temperature grade is dropped 1 level

Virgin binder grade: PG 64-22

Dropping low temp grade 1 level: PG 64-28

Outcomes

- Guide specification for material selection and mix design
- Includes both 1/4” and 3/8” NMAS mixes
- Target 35% binder replacement with -28 and -34 low temperature grade binders

At 35% binder replacement

- Going 1 cold temp grade softer will more than offset cold temperature cracking risk caused by increased binder replacement
- Going one cold temp grade softer will increase cracking resistance 33-50% over current 1/2” mix with 30% RAP

Oregon Thinlays

TABLE 1 Gradation Bands for Type I and Type II Thinlay Mixes 80 gyrations

Sieve Size	Type I	Type II
1/2"	100.01	100.01
3/8"	100.0	90.0–100.0
#4	70.0-80.0	90.0
#8	40.0-65.0	32.0-65.0
#200	2.0-10.0	2.0-10.0
Property		
Mix Design Voids %	3.5-4.0	3.5-4.0
Design VMA, %	15-18.0	15-17
Binder Replacement	35% max,	35% max,
P200/Pbe	0.8-1.6	0.8-1.6

Where to and not to use Thinlay for Preservation

- Thinlay treatments are meant to preserve pavements in fair to good condition
- Timely application is the key to optimal success

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Where not to use Thinlay

- Widespread deep rutting > 0.5 inches deep
- Surface cracks wider than 3/8 inch
- Areas of extensive, deep (> 4 inches) patching (at > 20% the pavement is probably structurally inadequate)
- More than 20% by area of the section has moderate to severe alligator cracking

Where not to use Thinlay

- Areas where layer debonding or subsurface stripping is suspected
- Areas of severe bleeding/flushing (these need to be milled first)

Poor candidate: excessive patching and failures

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Poor candidates: structurally deficient

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Poor candidates: excessive cracking and rutting

Asphalt.

Where to use Thinlay

- Shallow rutting ≤ 0.5 inch
- Top-down cracking
- Block cracking – must seal
- Less than 20% moderate fatigue cracking (spot repair prior to Thinlay)
- Limited vertical clearance or curb reveal

Where to use Thinlay

- Longitudinal cracking in the wheel path,
- Overlaying widened sections
- Transverse cracking (not thermal)
- Raveling
- Highly oxidized
- Polished surface (loss of skid)

Good candidate: raveling chip or slurry seal

Asphalt.

Good candidate: block cracking

Asphalt.

Good candidate: minor longitudinal and transverse cracking

Asphalt.

Existing Distress	Use Thinlays	Do Not Use Thinlays
Rutting	Where rutting is ½ inch or less	Where rutting is greater than ½ inch (unless milling or pre-leveling before placing Thinlay)
Age Hardening Cracking (Block Cracking)	Where crack widths do not exceed ¼ inch	Where block cracking has progressed to alligator cracking or cracks wider than ¼ inch
Loading Cracking (Fatigue Cracking)	After patching isolated areas of full depth fatigue cracking, in areas of top-down fatigue cracking if cracking is low severity, or where milling is used to eliminate or reduce top-down cracking	Where there is medium- or high-severity full-depth fatigue cracking (close interconnected cracking covering more than 20% of surface and/or where cracks are wider than ¼ inch)
Cold Temperature Cracking (Thermal Cracking)	Where full-depth repairs are made in areas of thermal cracking (if full-depth repairs are not made, Thinlays will preserve pavement between thermal cracks and may be effective when thermal cracks are far apart)	Without first making full-depth repairs in areas of thermal cracking
Cracks in Underlying Materials (Reflective Cracking in Existing Pavement)	Where full-depth repairs are made in areas of reflective cracking (if full-depth repairs are not made, Thinlays will preserve pavement between reflective cracks and may be effective when reflective cracks are far apart)	Without first making full depth repairs are made in areas of reflective cracking
Cracking Caused by Improper Mixing or Construction	Except where cracking has progressed to alligator cracking or full-depth cracks in or adjacent to wheel paths	Where cracking has progressed to alligator cracking or full-depth cracks in or adjacent to wheel paths
Roughness	In almost every case	Where there is extremely high severity roughness
Friction Loss	All cases of friction loss or textural problems	N/A
Raveling	In almost every case	Where raveling caused by stripping throughout the pavement structure may indicate the existing pavement lacks sufficient structural strength and must be reconstructed
Delamination	After milling or patching areas of delamination	Without first milling or patching areas of delamination
Bleeding	In all cases, provided existing pavement is sufficiently stable for construction loads and milling is performed in areas of high-severity bleeding	Without first milling areas of high-severity bleeding (milling will ensure an adequate surface for bonding the Thinlay to the existing surface)
Permeability	In all areas of excessive porosity	Where permeability has caused stripping throughout the pavement structure

Case Studies

- We have over 21 years of good performance history with thin lift paving
- Oregon DOT has added ***THINLAYS*** to their preservation tool chest
- Several local agencies with success

THINLAYS

NCAT Test Track

- 1.7 mile oval
- Loaded tractor trailers
- 10 million ESALs every 3 years

THINLAYS

NCAT Test Track, Mississippi test sections 2003

- 4.75 mm NMAS
- 3/4-inch thickness
- 50 gyrations
- 6.1% asphalt binder content
- PG 76-22 & 67-22
- 48 million ESALs

THINLAYS

NCAT Test Track, Mississippi test sections 2003

Photo October 2017

THINLAYS

Murray Boulevard, Washington County, OR

2001 Paving – Baker Rock Resources

2,700 feet of 1-inch lift

THINLAYS

- L3, 3/8-inch NMAS mix, PG 64-22, no RAP/RAS
- $40/ton, $15,488 per lane mile = $2.20/SY
- Replaced 2019, $0.12 per SY per year – unbeatable!

THINLAYS

Murray Boulevard 2007 Paving

- Baker Rock Resources
- Over 2 miles, 1-inch lift, 4,797 tons
- L3, 3/8-inch NMAS mix, PG 64-22, RAP

THINLAYS

Murray Boulevard 2007

- Mix Design Asphalt Binder Content = 6.1%
- Production Asphalt Binder Content = 6.6 – 7.0%
- $46.70/ton, $2.55/SY
- Replaced 2019, $0.21 per SY per year

THINLAYS

Polk County, OR

2010/2011 Paving – 10-12 Thinlays

1/4-inch & 3/8-inch NMAS (over 7% binder)

75 gyrations, PG 64-22, No RAP

THINLAYS

Polk County, Wigrich Road & Wells Landing (2010)

1/4-inch NMAS mix placed 3/4 inch thick

Photos October 2017

THINLAYS

Polk County, Wigrich Road & Wells Landing (2010)

Photos April 2022

THINLAYS

Polk County, Bethel Heights Road (2010)

1/4-inch NMAS mix placed at 3/4-inch thickness

Photo October 2017

THINLAYS

Polk County, Bethel Heights Road (2010)

Photo April 2022

THINLAYS

Halls Ferry Rd

THINLAYS

Halls Ferry Rd

THINLAYS

Polk County, Hoffman Road (2010)

1/4-inch NMAS, placed 3/4 inch in thickness

THINLAYS

Polk County 2010 *THIN**LAYS***

- **11+ years – minimal distress**
- **Estimated life 12-15 years**
- **2010: $80/ton, $5.00/SY**
- **Assume 14 year life: $0.36 per SY per year**

THINLAYS

Dripping Springs Texas – RM12 (2012)

This TxDOT vehicle equipped with an OBSI data collection system measured the pavement noise of RM12, before and after the addition of Thinlay over a deteriorating chip seal road surface.

THINLAYS

Dripping Springs Texas – RM12

Chip seal: aggregate loss & noise complaints

Chip Seal Loudness: 109.3 dBA

Thin Overlay Loudness: 96.3 dBA

10 dBA: doubling of perceived loudness

THINLAY

SAFE. SMOOTH. DURABLE.

- ✓ Increased Service Life
- ✓ Waterproof
- ✓ Improved Ride
- ✓ Quiet
- ✓ No Curing
- ✓ Sustainable
- ✓ Preferred by Cyclists, Pedestrians and Windshields
- ✓ Improve Strength
- ✓ Local Experience

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Asphalt Materials for Managers Workshop

February 16 or 17

Oregon Asphalt Pavement Conference

February 28

Oregon Safety Symposium

March 1

Thinlay at ODOT

- Highway 6 project micro mill and pave 1 inch

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Micro Mill

- Micro milling removed surface distress and provides a very smooth and uniform surface to place a 1 inch lift

Normal tack shot rates and materials

halt.


CATERPILLAR


CATERPILLAR
BOMAG

THINLAY

SAFE. SMOOTH. DURABLE.

- Long life
- Low life cycle cost
- Superior smoothness
- Preferred by road users
- Preferred by residents
- Improves structure
- Sustainable

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