Thinlay Asphalt for Pavement Preservation

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ASPHALT PAVEMENT ASSOCIATION OF OREGON

Preservation Treatments

need to correct minor surface distresses

- Cracking
- Rutting
- Raveling

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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

Thinlay Asphalt Treatments

- Are designed to address all of these important Preservation needs
  - ✓ Correct Surface distress
  - ✓ Seal the existing surface
  - ✓ Improve Serviceability
  - ✓ Provide long life
  - ✓ Extend structural life

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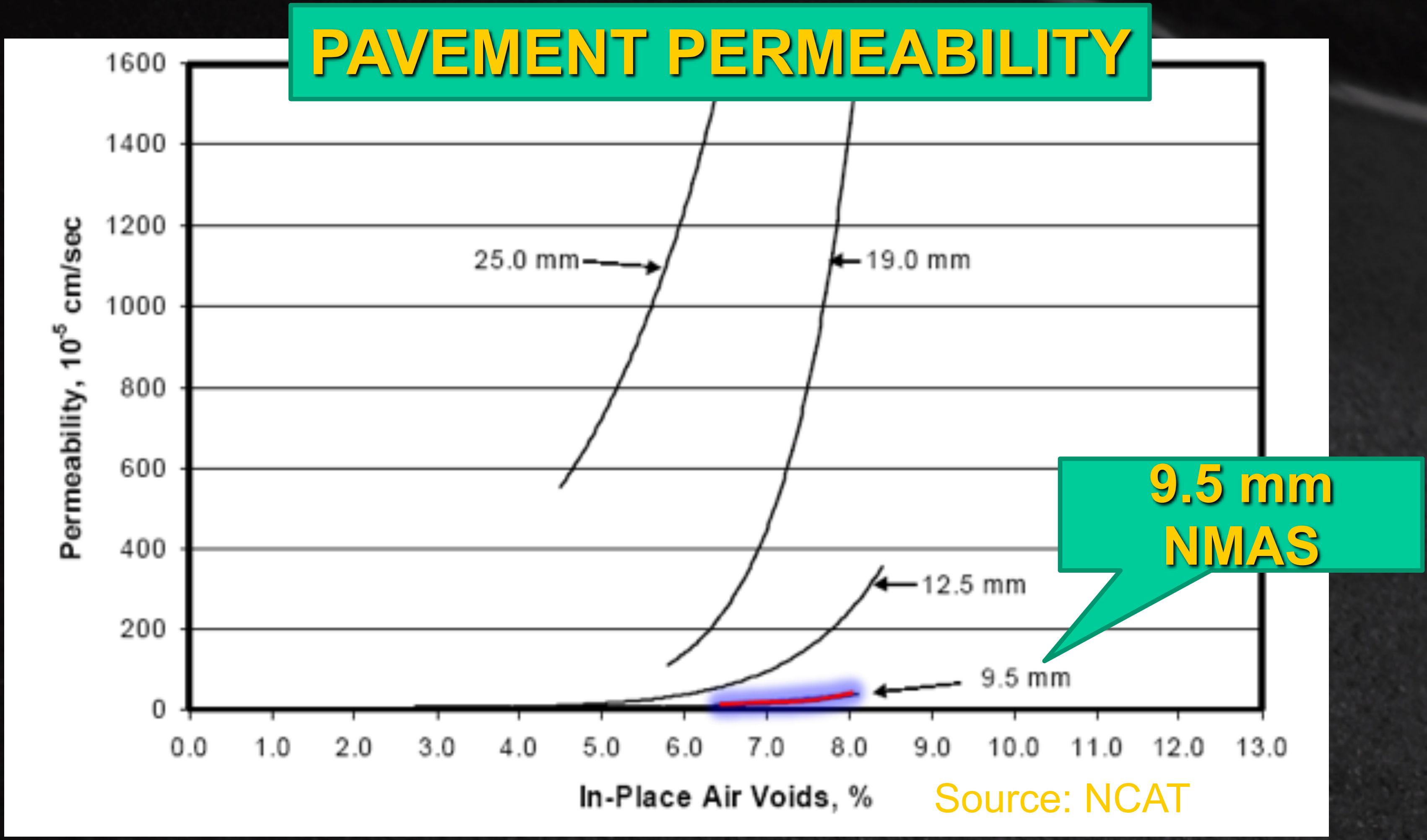
Thinlay Asphalt Benefits



Reduced permeability improves pavement longevity by protecting the pavement from the damaging effects of air and moisture intrusion… SIMILAR TO A SHINGLE !

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Thinlay Asphalt Benefits

- No need to program seals on a thinlay, they are impermeable
- If reflective cracks form seal the cracks, that is it.

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Thinlay Asphalt Benefits

- Rapid construction and immediately open to traffic
- Public views the road as “like new” following thinlay paving
- No cure time or sweeping, or broken windshields
- Limited performance risk
- Preferred by cyclists and other non auto traffic

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Thinlay Asphalt Treatments

- Asphalt mixes engineered specifically for pavement preservation
- Designed with aggregate gradations allowing placement as thin as ¾”
- Binders and gradations selected to optimize flexibility, durability and rut resistance

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Thinlay Asphalt Treatments

- Can include recycled materials RAP, RAS, GTR to enhance performance, reduce costs, reduce demand for new raw materials (improve sustainability)
- Can be produced with warm mix technology to further enhance sustainable qualities

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Thinlay Mix Design

- Mix design Criteria to optimize Preservation needs
  - ✓ 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 to optimize Preservation needs
  - ✓ 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

Structural Benefits

- Preventive Maintenance treatments are typically non-structural
- Preventive Maintenance treatments should be applied to structurally sound pavements
- Slurry seals, Chips Seals, micro surfacing add no structure
- A 1 inch thinlay asphalt treatment does provide structural benefits

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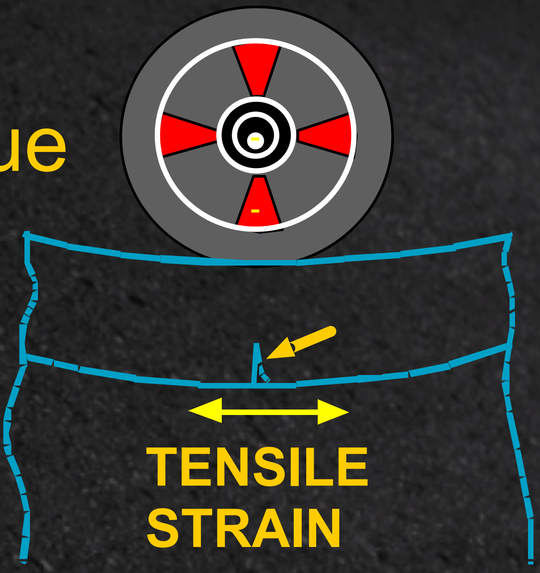
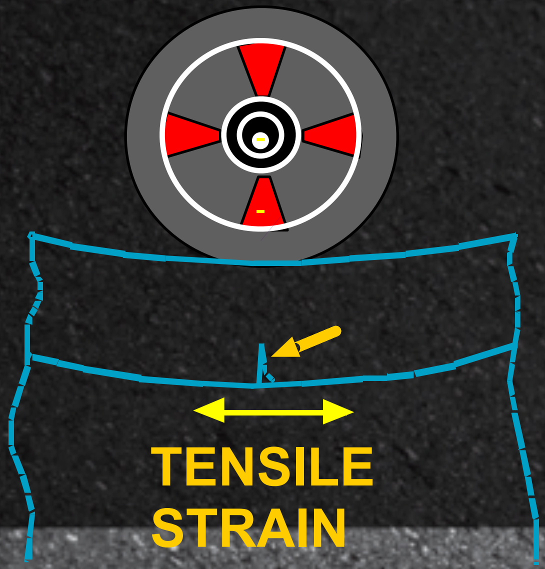
Structural Benefits

- 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 Thinlay treatments can save your structure

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What's in an inch?
Asphalt Thickness VS. 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

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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 managing at the surface for functional attributes as your structural worries are over

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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 (> 20%; this assumes the pavement is 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 (needs further investigation to verify)
- 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

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Where to use Thinlay

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

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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)

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Good Candidate, raveling chip or slurry seal

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Good Candidate, block cracking

Good Candidate, minor longitudinal and transverse cracking

Thinlay Experience in Oregon

- We have over 16 years of good performance history with thin lift paving
- Oregon DOT recently has added thinlay to their preservation tool chest
- Several local agencies with on going success

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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.


CB-534D
CATERPILLAR


CATERPILLAR
BOMAG

Many other Oregon success stories

Walnut micro mill and thinlay

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Happy Valley

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Polk County

Washington County

A Case Study Rehabilitation Using Thinlay Overlays

Washington County
Summer, 2001

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Murray Blvd.

- ADT = 30,000 vehicles per day

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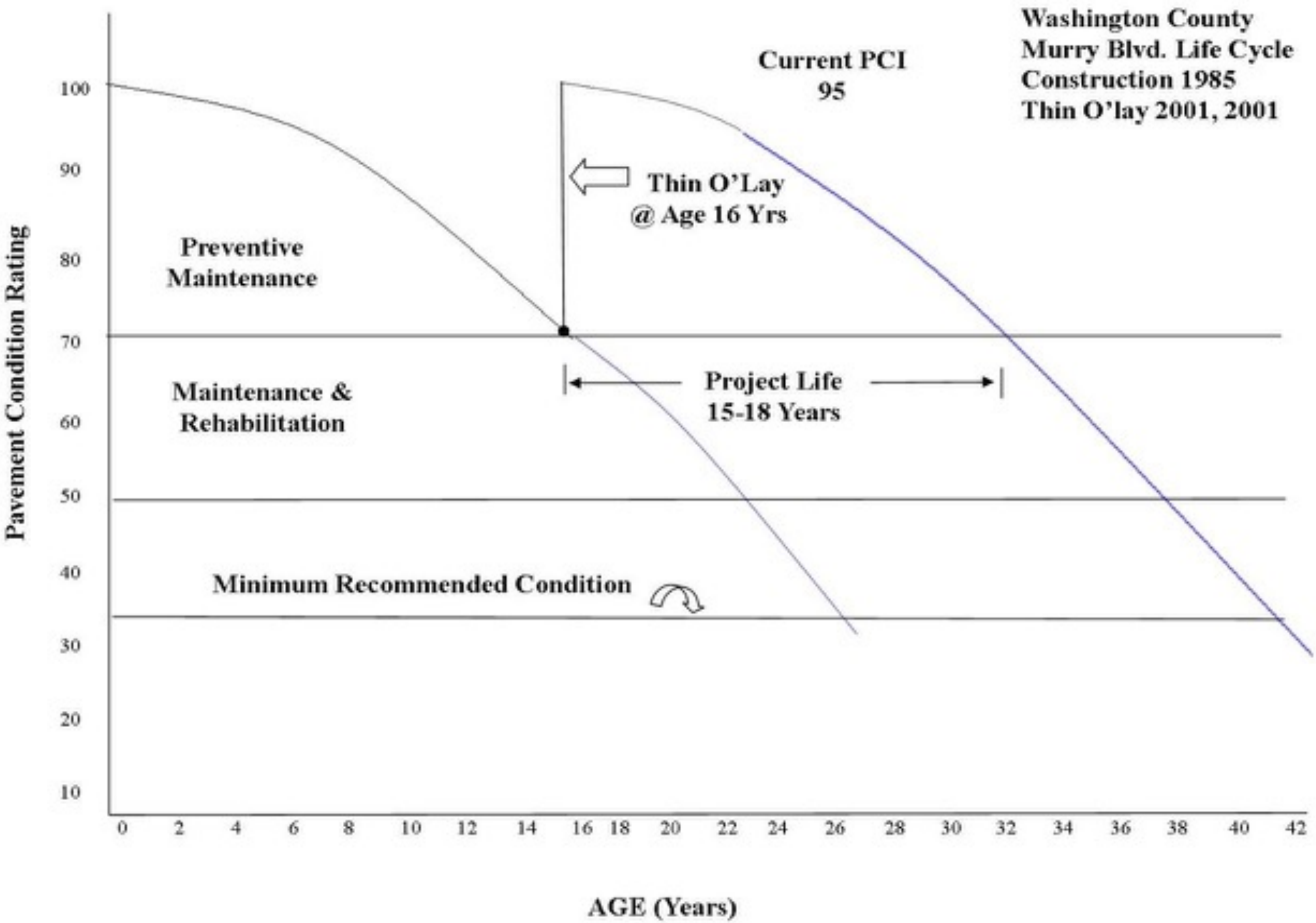
Cost

- Thinlay Treatment = $2.53 per square yard
- Micro-Surfacing = $1.92 per square yard
- 32% cost increase



Washington County
Murry Blvd. Life Cycle
Construction 1985
Thin O'lay 2001, 2001
Current PCI
95
Thin O'Lay
@ Age 16 Yrs
Preventive
Maintenance
Project Life
15-18 Years
Maintenance &
Rehabilitation
Minimum Recommended Condition
Pavement Condition Rating
100
90
80
70
60
50
40
30
20
10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
AGE (Years)

Actual Life Cycle Costs

- 15 Years, I=4%, Thinlay life = 15 year life
- Average micro surfacing life = 5 years
- Thinlay = $2.53
- Micro Surface = $4.79

Thinlay Saves $2.26/yd^2 in 15 Years, adds structure, and provides high serviceability, far less user impact

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Cost Comparison on Murray Blvd. (no discount)

- Thin Lift Overlay = $2.53 per square yard
  - $0.18 per square yard per year of service
- Micro-Surfacing = $1.92 per square yard
  - $0.38 per square yard per year of service

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High binder replacement thinlay

- APAO in conjunction with NCAT and NAPA conducted research to develop high performance high recycle content thinlay mixes for preservation
- Mixes designed to be placed as thin as ¾”
- Mixes designed to be flexible and provide excellent crack resistance
- Mixes that maximize recycle content to provide value

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Approach

- Softer base 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

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Testing

- Mix tests for cracking were used rather than blended binder properties because they better predict mix performance and model actual binder blending
- Mixes meet all current mix design criteria and rut test parameters

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Control Mixes

- Basic control mix is the most common mix used in Oregon currently – ½" Level 3 with 30% RAP and 64-22, 64-28 binders
- Second control is Thinlay ¼" mix level 3 with 30% RAP and 64-22, 64-28 binders

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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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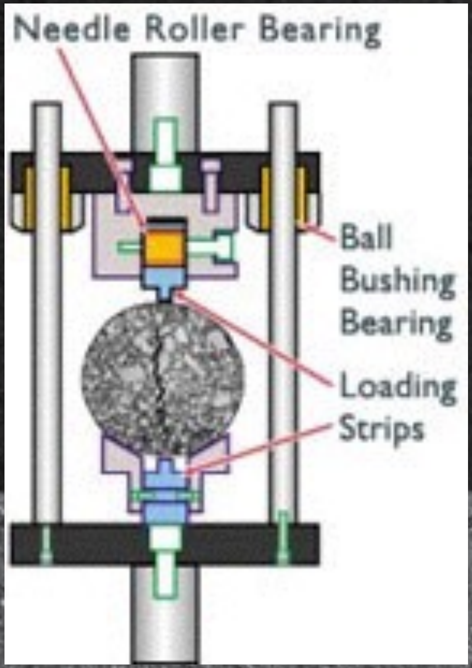
Testing

- All mixes meet Superpave criteria and ODOT criteria for rutting, TSR and voids
- All mixes were tested first in the Overlay Crack Tester

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



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O’lay 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

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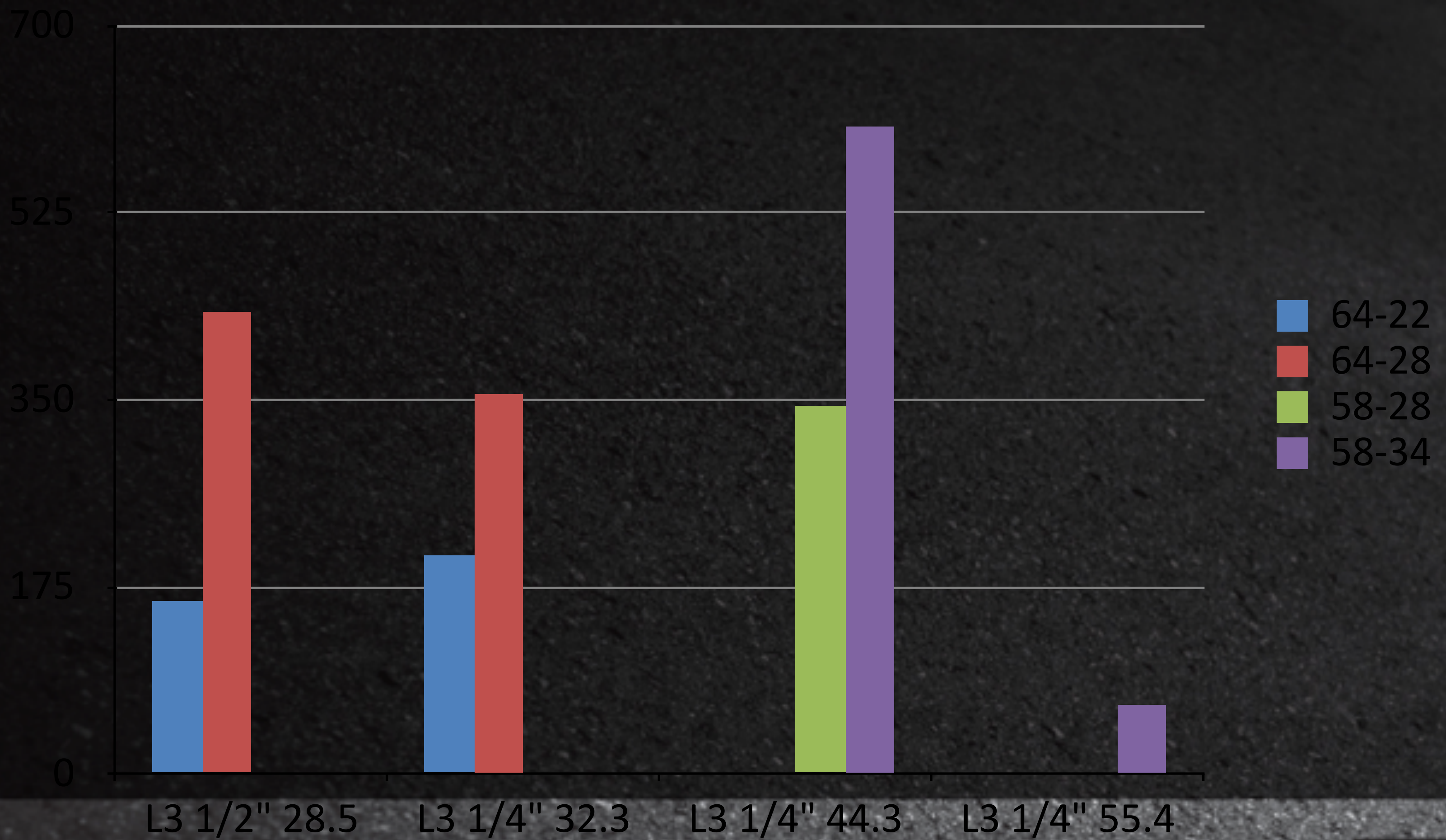
Preliminary Overlay Crack Test Results



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Findings from O'lay testing

- 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

Findings from O'lay testing

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

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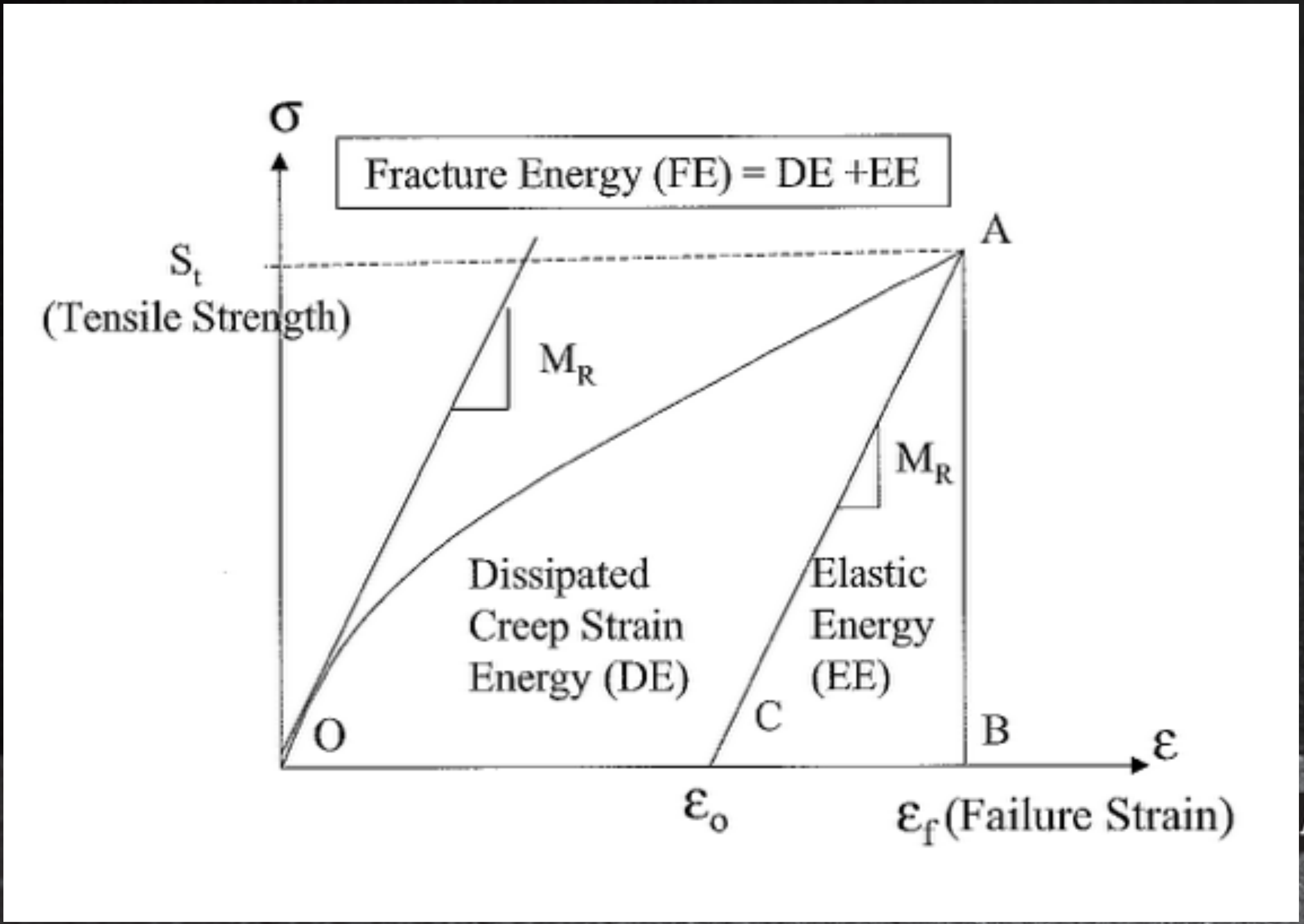
IDT test to determine Fracture Energy



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Fracture Energy

- What we know – those mix parameters that improve fatigue also improve FE
- So, ^ binder content = ^ FE
- Lower voids = ^ FE and ^ fatigue
- Softer binders = ^ FE and ^ fatigue
- Finer mixes = ^ FE and ^ fatigue

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Fracture Energy from IDT reported to correlate well with fatigue

- Indirect tensile fracture energy, has proven to be an excellent 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

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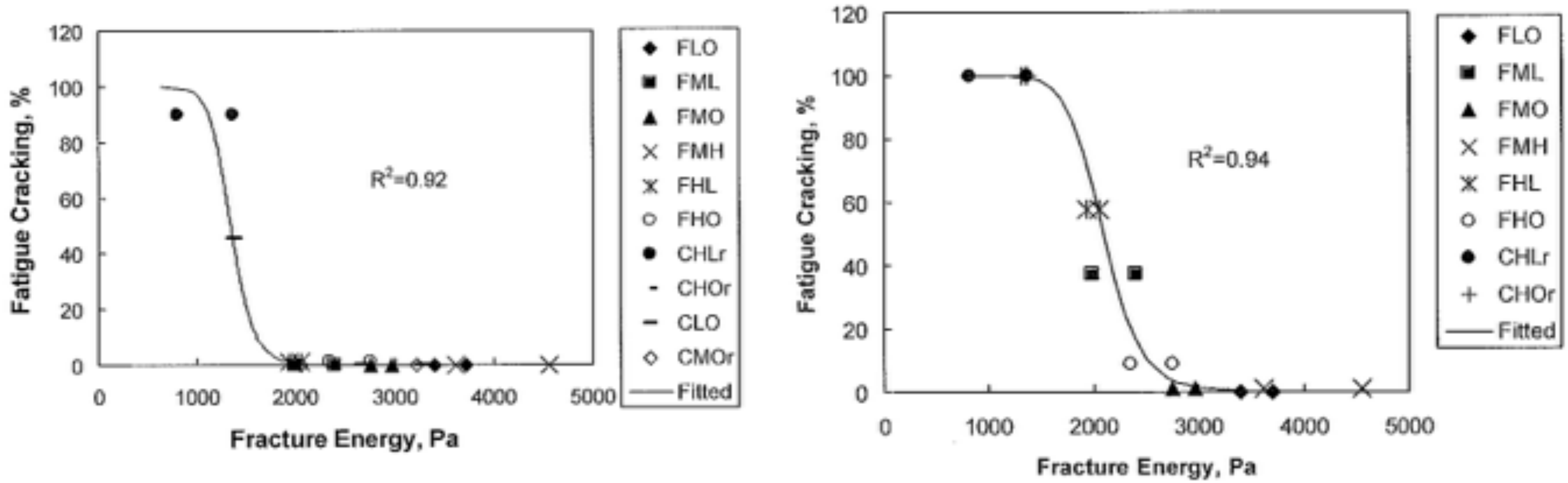
FE vs fatigue at West Track



(a) At 2.2 million ESALs

(b) At 5 million ESALs

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Florida study FE vs field performance

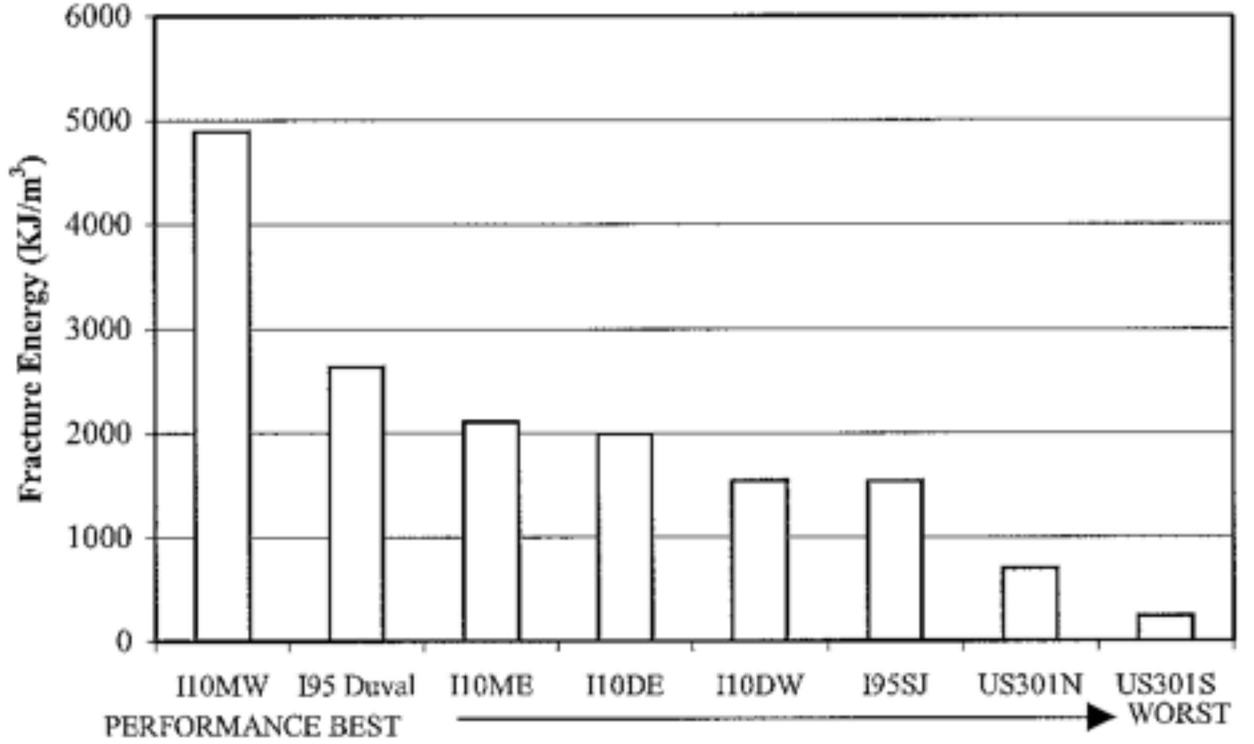
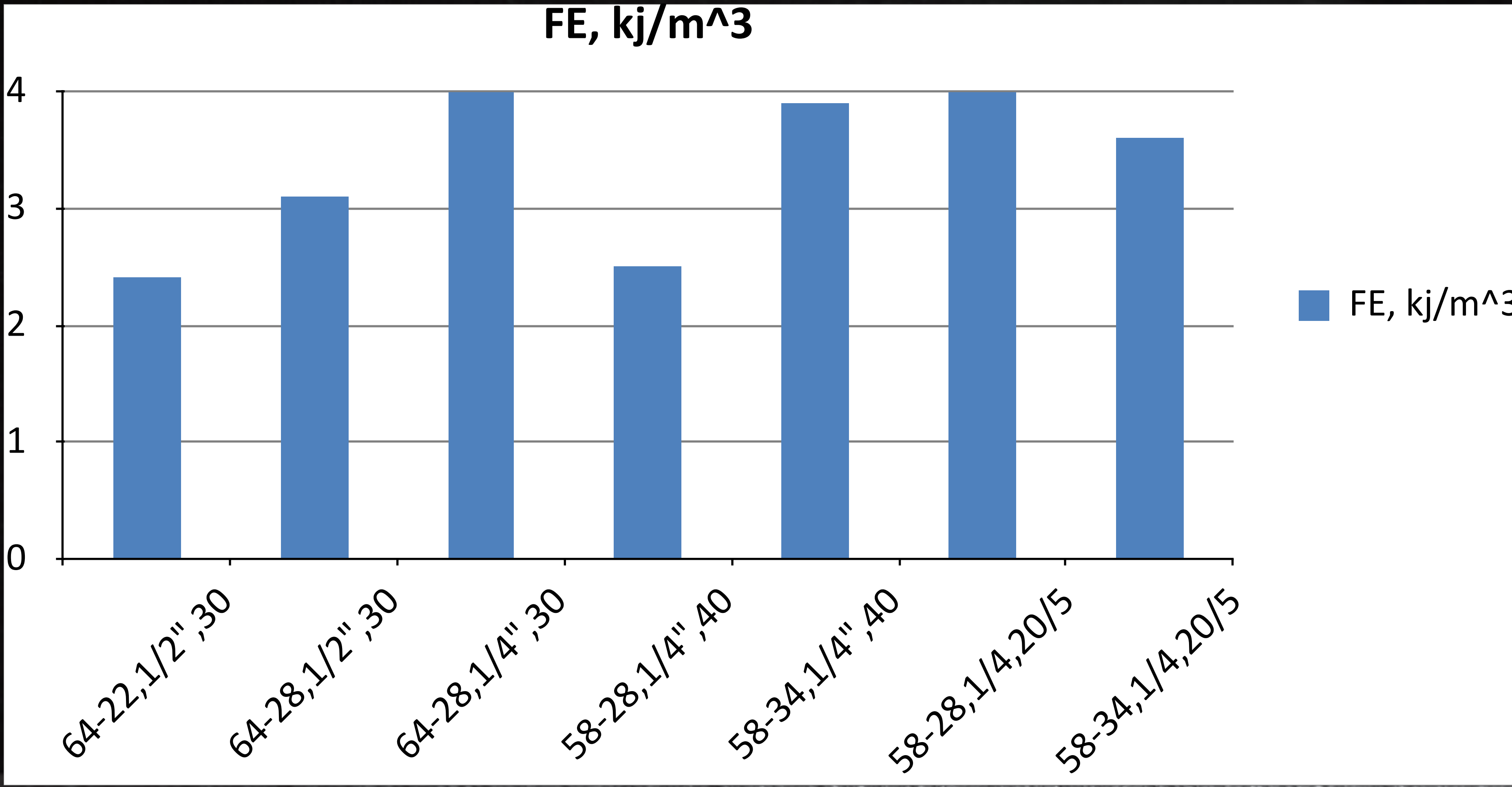


Figure 5.31 Fracture Energy Density of Eight Field Sections @ 10C

Fracture Energy Test Results from Oregon (10'C)



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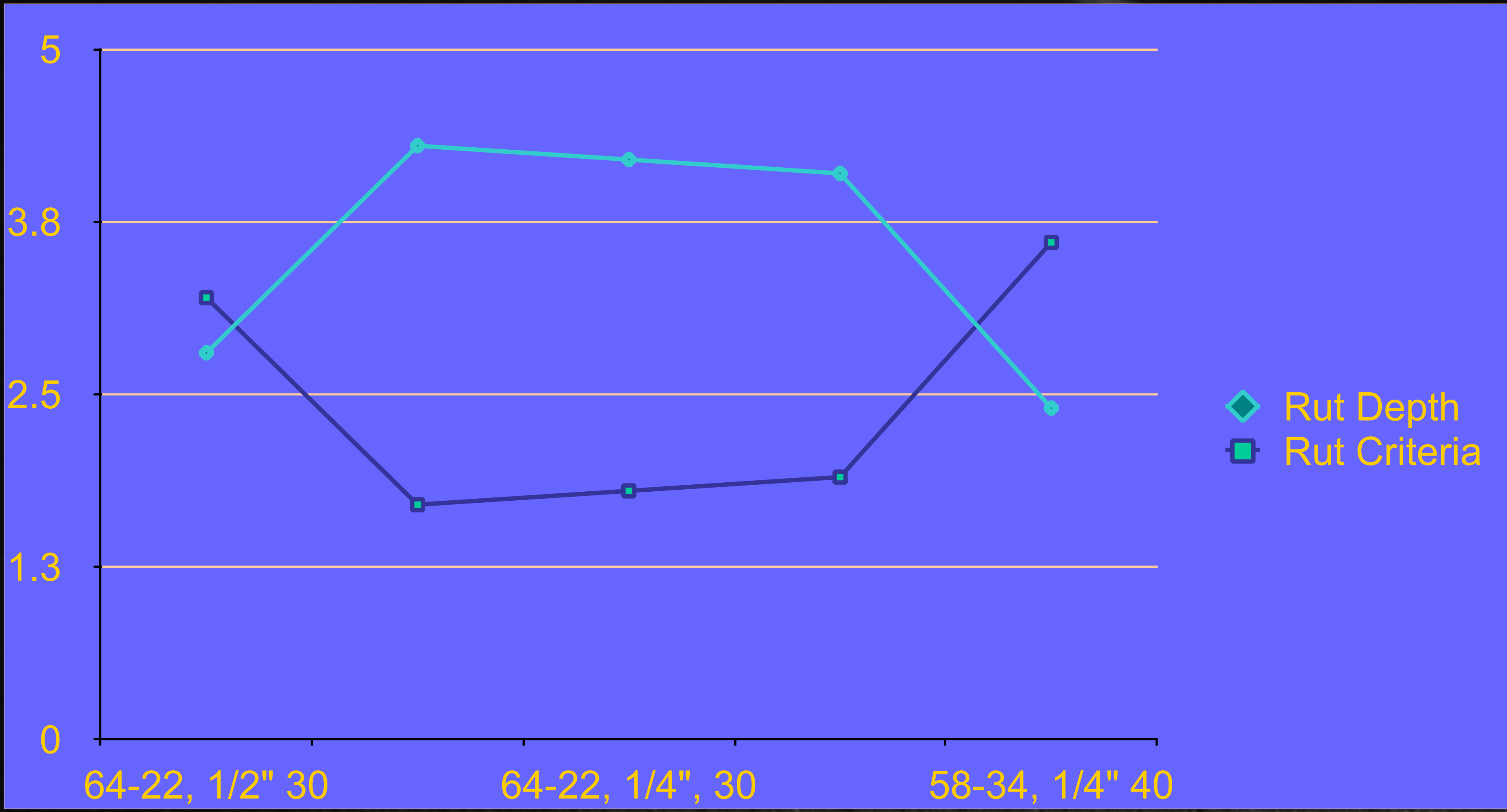
Findings

- These test results demonstrate clearly that we can increase RAP content and improve cracking resistance at the same time by using softer base binders
- The overlay crack testing and the Indirect Tensile testing gave similar results lending strong support to findings

Rut Test Results



Findings

- The use of softer binders in Thinlay mixes do not result in increased rut potential when used in combination with higher RAP and RAS contents

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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

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Cold Temperature Cracking Example

- Bend at 98% reliability has a design cold temperature of -25 C and requires a -28 grade binder
- The 44% binder replacement mix with the -34 grade binder has a true cracking temperature of -26 C
- The recovered binder would grade -22 but still not crack in Bend,

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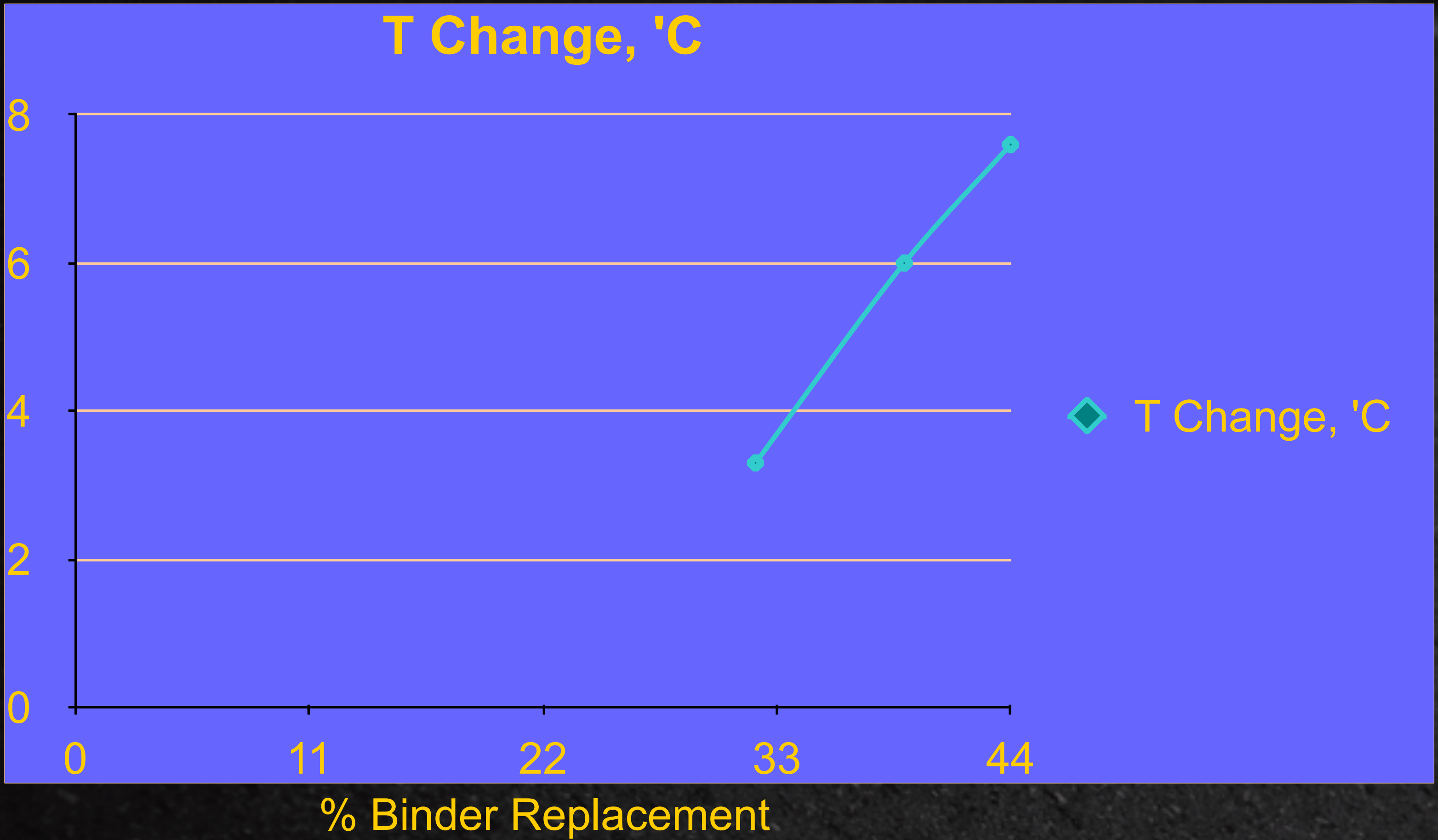
Temperature Change Versus Binder Replacement



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Findings

- There is a strong relationship with cold temperature cracking temperature and binder replacement
- Dropping the cold temperature grade 1 level will more than compensate for the impact up to about 40% binder replacement

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Outcomes

- Our research is 98% complete
- Guide specification for material selection and mix design (we can do this now)
- Includes both ¼" and 3/8" nmas mixes
- Our spec will target 35% binder replacement with -28 and -34 low temperature grade binders

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At 35% binder replacement

- Going one cold temp grade softer will more than offset cold temperature cracking impact
- Going one cold temp grade softer will increase cracking resistance 33-50% over current ½" mix with 30% RAP

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Proposed Mix Spec

TABLE 1 Gradation Bands for Type I and Type II Thinlay Mixes 80 gyrations		
Sieve Size	**Type I**	**Type II**
1/2"	100.0[1]	100.0[1]
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		
Va, %	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

Proposed Binders

- For western Oregon applications use 58-28 grade binder
- For Eastern Oregon or other areas “normally” requiring a -28 grade binder use 58-34 grade binder
- For extreme cases (very heavy traffic and very high design temperatures) consider 64 high temp grade

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Thinlay Asphalt

Smooth, Strong, Durable

- Longest Life of all treatments
- Lowest life cycle cost
- Superior Smoothness
- Preferred by road users
- Maintains Structural integrity
- Sustainable

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