Back to Basics
Asphalt Pavement
for
Preservation

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Goal:

Discuss the basics for asphalt pavements that are essential for preservation quality and longevity

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Asphalt Pavement Basics

Materials & Mix

- Materials Selection
- Mix Design

Structural Design

- Thickness design

Construction

- Best Practices
- QC & QA

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Asphalt Pavement Basics

Materials & Mix Design

3 stage process

1. Aggregate gradation & materials selection
2. Volumetric testing of selected gradation
3. Performance testing

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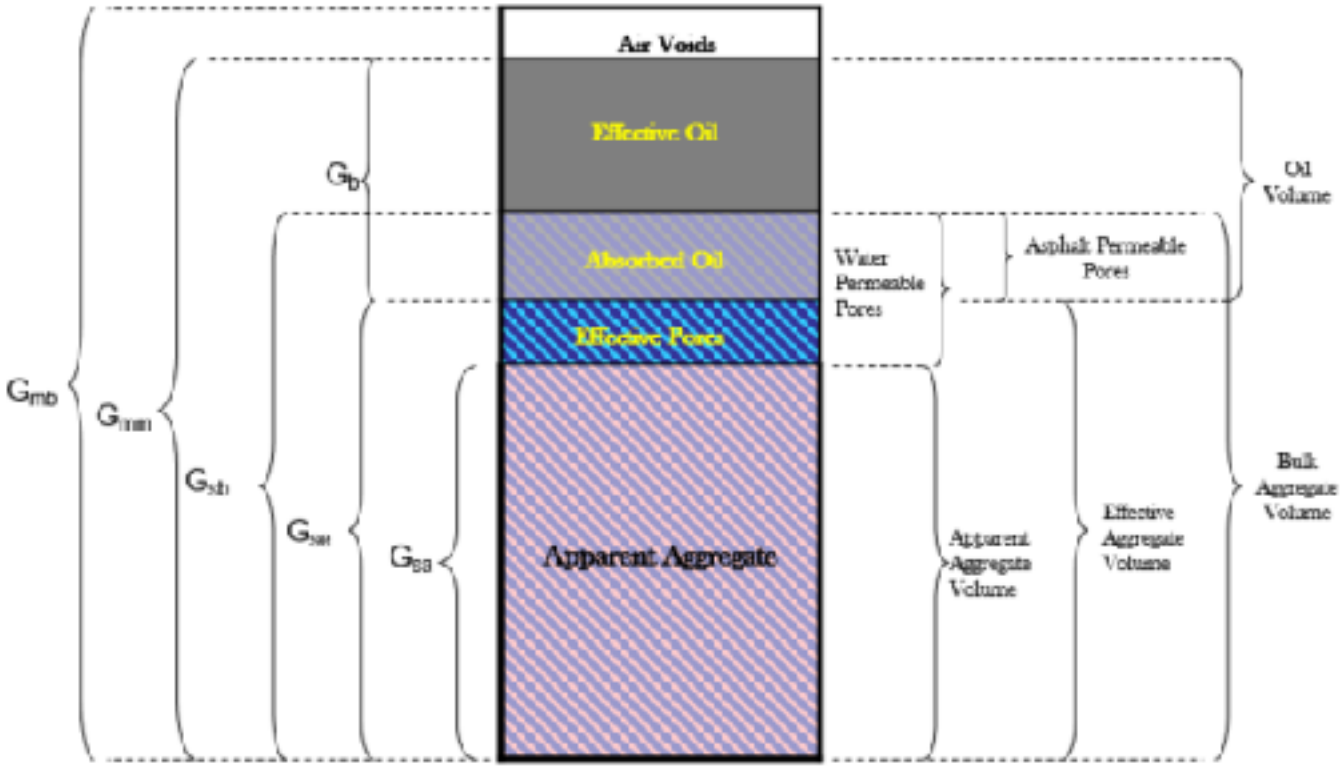
Materials & Mix Design

Density

- **Solids v. air voids**
- **What is the optimum density?**



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Materials & Mix Design

Primary Compaction

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Materials & Mix Design

Secondary Compaction

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Overestimating secondary compaction?

- Less density over pavement life
- Less density = less life

Underestimating secondary compaction?

- Rutting
- Bleeding

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Materials & Mix Design

Superpave gyratory compactor models compaction in lab

Materials & Mix Design

Superpave gyratory compactor models compaction in lab

- **Light traffic/no trucks = 50 gyrations**
- **Med. traffic & trucks = 75 gyrations**
- **High traffic & trucks = 100 gyrations**
- **Very high traffic (highways) = 125 gyrations**

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Materials & Mix Design

Aggregates

- NMAS
- Gradation

RAP & RAS

- Cost savings
- Sustainability
- Added stiffness

Asphalt Binder

Additives

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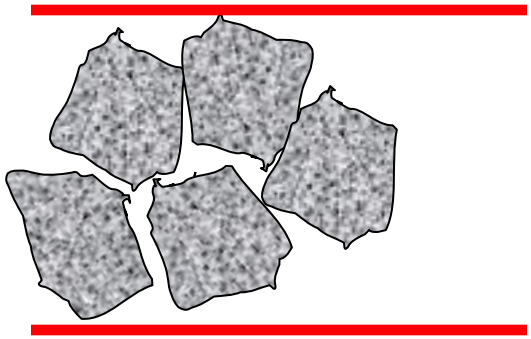
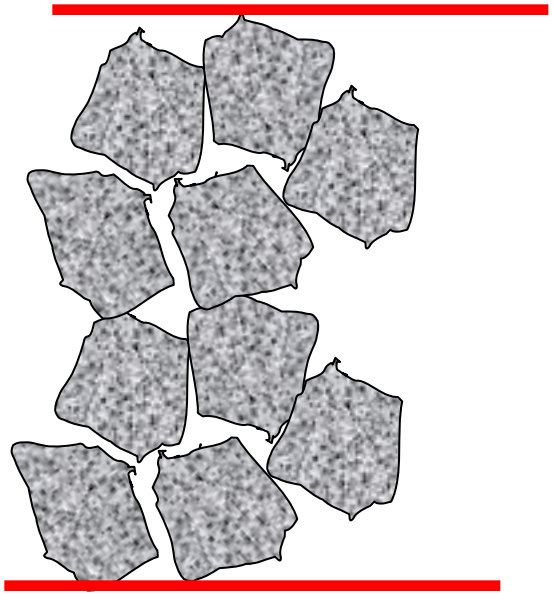
Materials & Mix Design

Aggregates: critical factor for thinner preservation pavement lifts is NMAS



Lift Thickness/NMAS = 2



Lift Thickness/NMAS = 4

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Materials & Mix Design

RAP & RAS

Why?

- **Economic savings**
- **Environmental benefit**
- **Reduced demand for virgin materials**

How do RAP mixes perform?

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Materials & Mix Design

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

Materials & Mix Design

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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Materials & Mix Design

Asphalt Binder

- Climate – High & Low Pavement Temp
- Volume of Traffic
- Speed of Traffic
- Recycled Materials Content
- Polymer Modified Binder?

PG 64-22

PG 64-28

PG 70-22

PG 70-22 ER

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Materials & Mix Design

When should you use polymer modified binders?

- **What are they?**
- **What do polymers do?**
- **Are they needed?**
- **How much do they cost?**
- **Is the cost worth it?**

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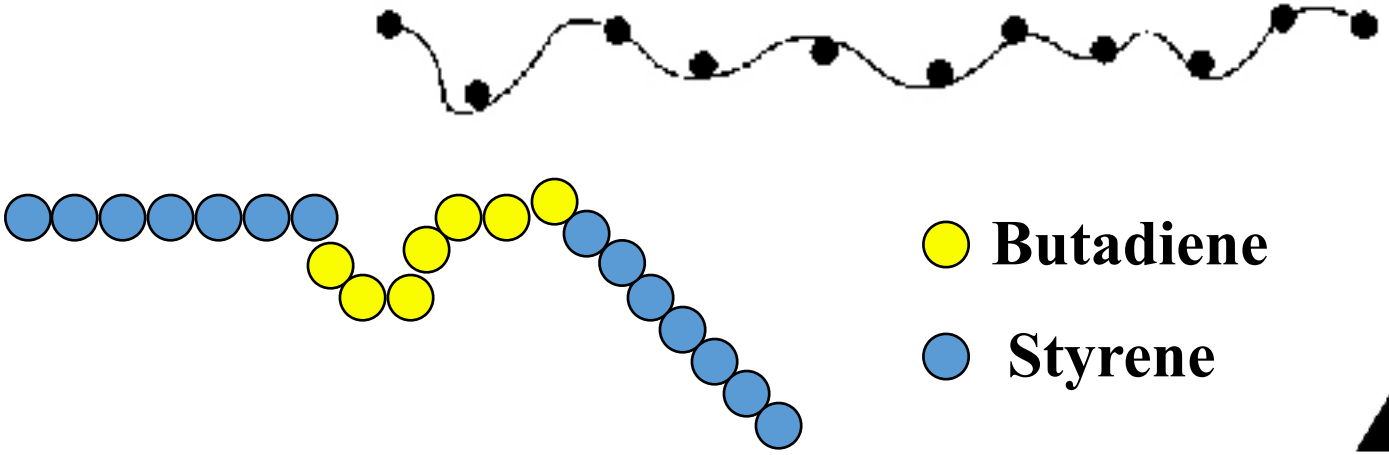
Materials & Mix Design

What are polymers?

- Many small connected molecules
- Usually “SBS”: Styrene-Butadiene-Styrene
- Elastomer/hard rubber
- High elasticity over repeated heating and cooling cycles



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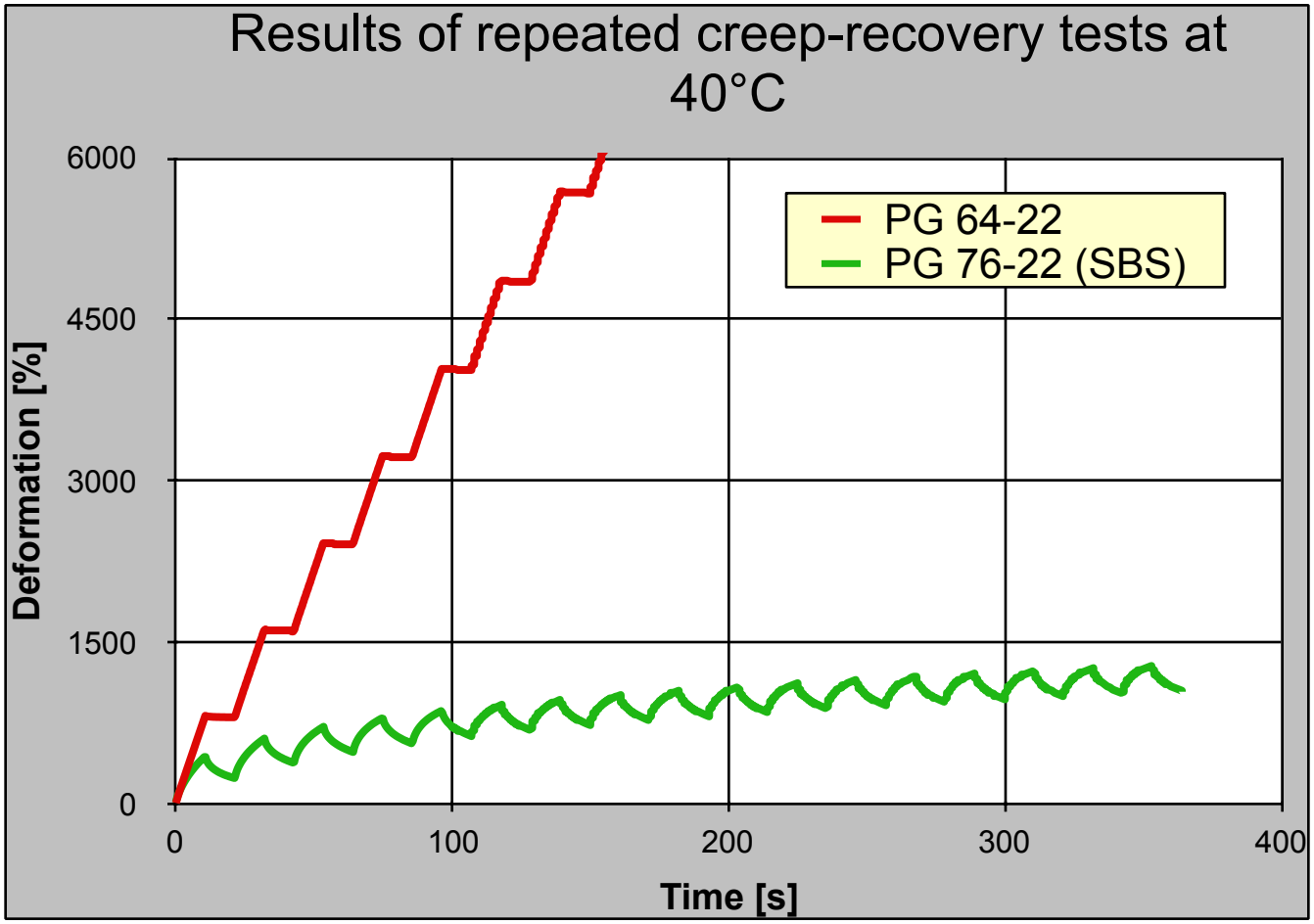
Materials & Mix Design

Polymer cost/benefit

- **Benefit: recovery after loading**



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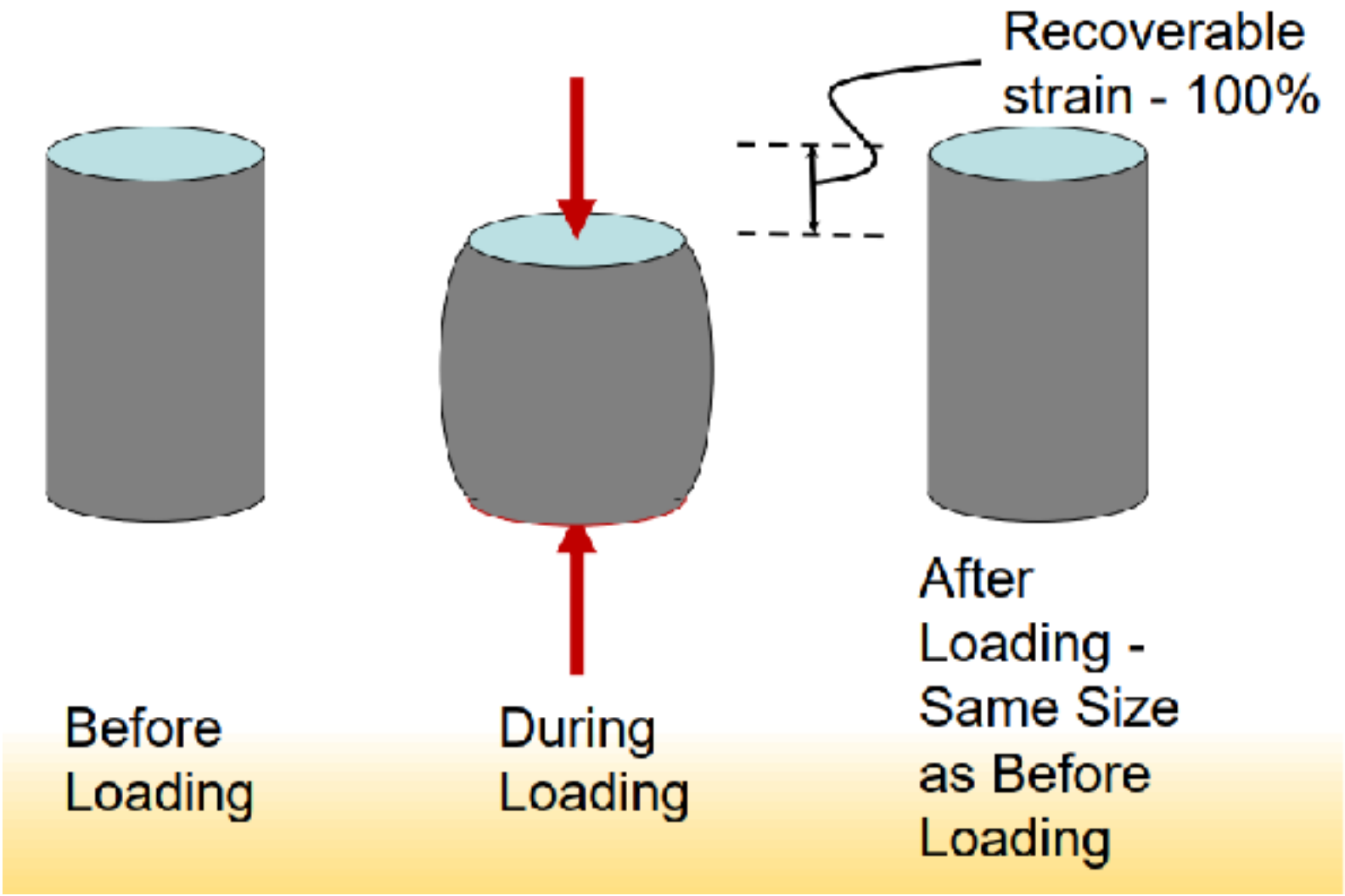
Materials & Mix Design



Materials & Mix Design

Polymer cost/benefit

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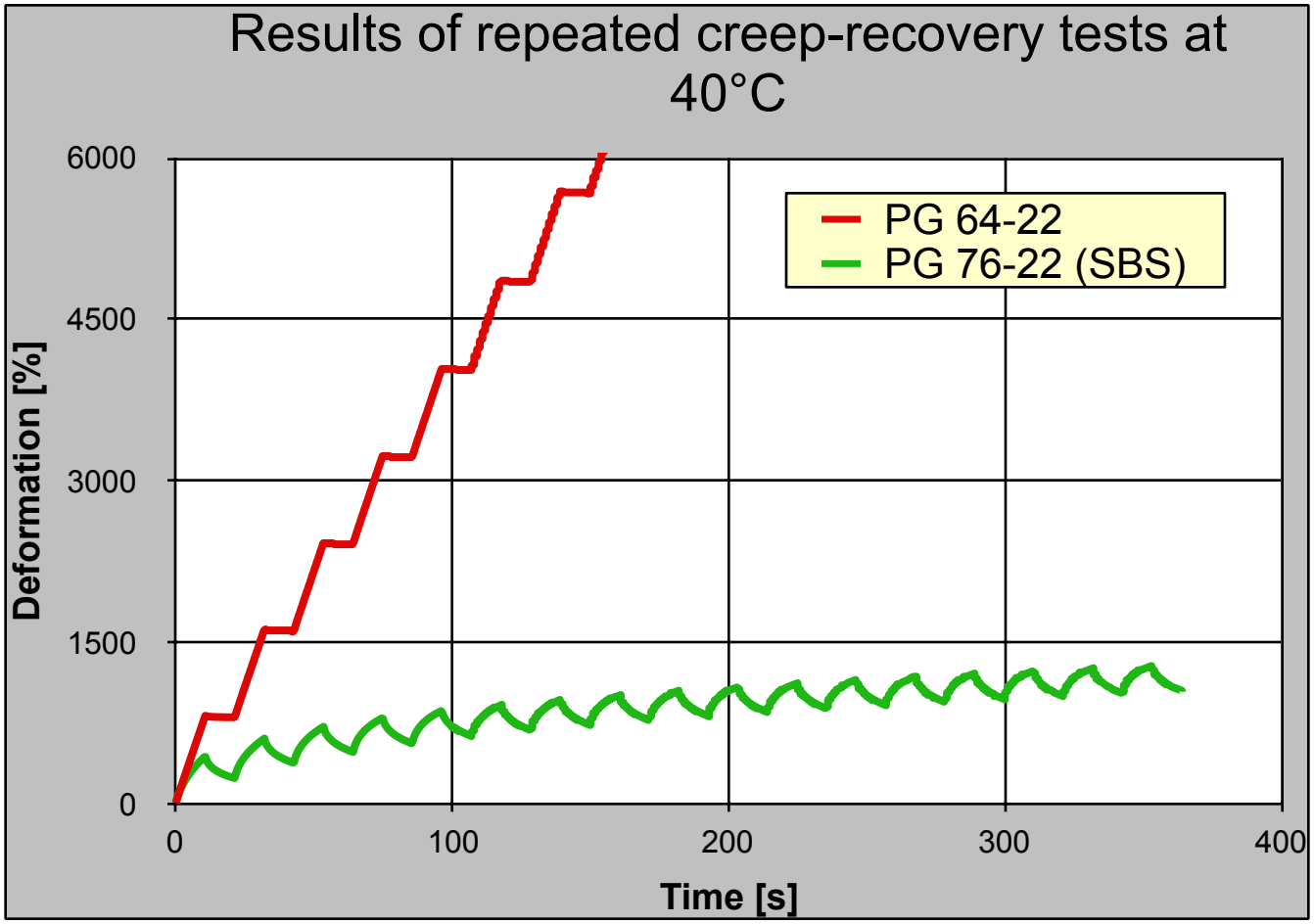

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Materials & Mix Design

Polymer cost/benefit

- **Benefits:**
  - **Reduced susceptibility to moisture damage**
  - **Improved rutting resistance**
  - **Reduced fatigue cracking**
  - **Mitigate thermal cracking**
  - **Resist top-down cracking**

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Materials & Mix Design

Polymer cost/benefit

- **Benefits**
  - **OSU (Coleri, 2017): “significantly higher crack resistance”**
  - **NCAT (Timm, 2012/2013): “over an order of magnitude increase in fatigue life”**
  - **ARA (Von Quintus, 2004): For overlays**
    - **“25 to 100% increase in service life”**
    - **“3 to 10 years increase in service life”**

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Materials & Mix Design

Polymer cost/benefit

- **Cost**
  - **Current Oregon Cost: $100 more/liquid ton**
  - **Liquid Binder $10/ton = Mix $0.50/ton**
  - **Polymers = $5 more per mix ton**

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Materials & Mix Design

Additives

- **Hydrated Lime**
- **Liquid anti-strip**
- **Warm mix**
- **Warm mix & anti-strip**
- **Rejuvenators**

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Materials & Mix Design

Warm mix & anti-strip example

Evotherm P25 - 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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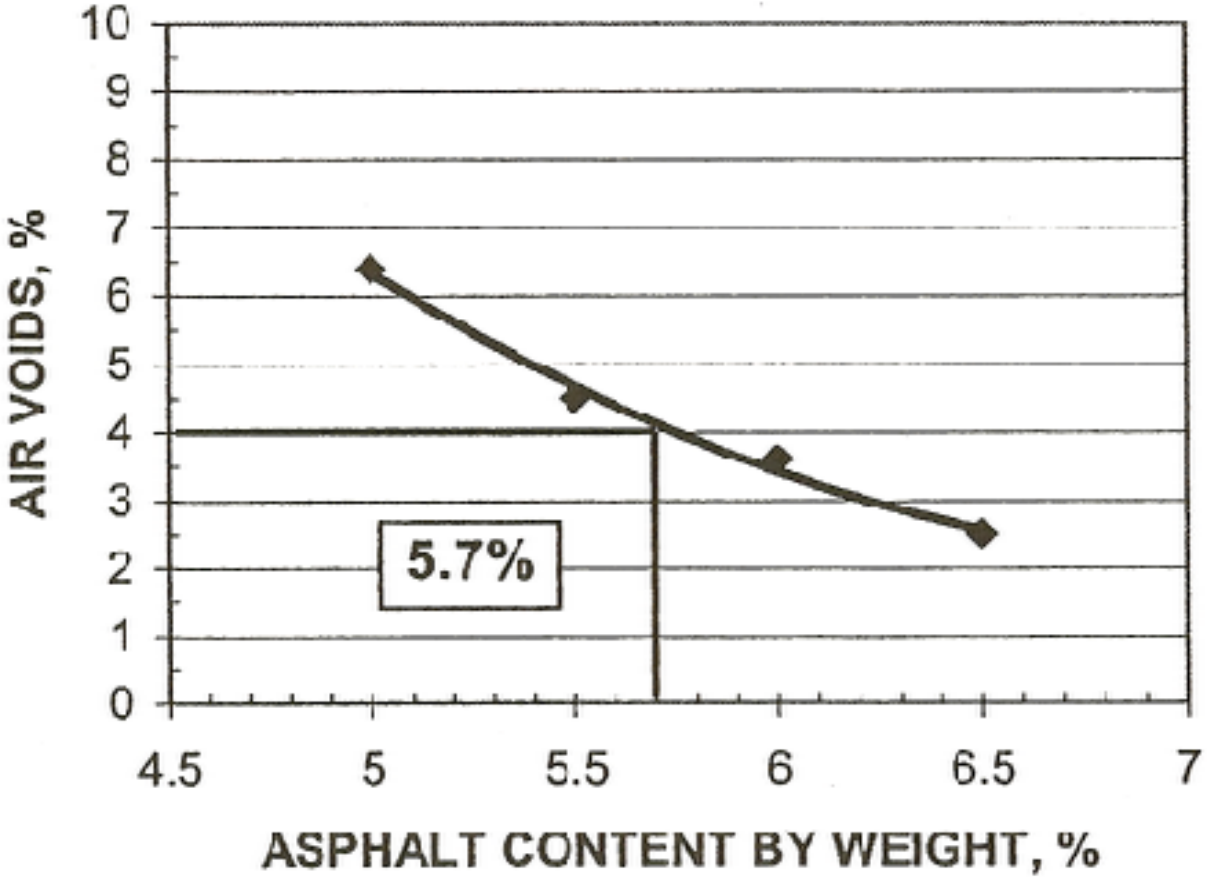
Materials & Mix Design

Stage 2 – Design Asphalt Binder Content

- Test selected materials with different asphalt binder contents
- Select asphalt binder content that gives 4% air voids after compacted in gyratory compactor
- Minimum 4 asphalt contents

Materials & Mix Design

Stage 2 – Design Asphalt Binder Content



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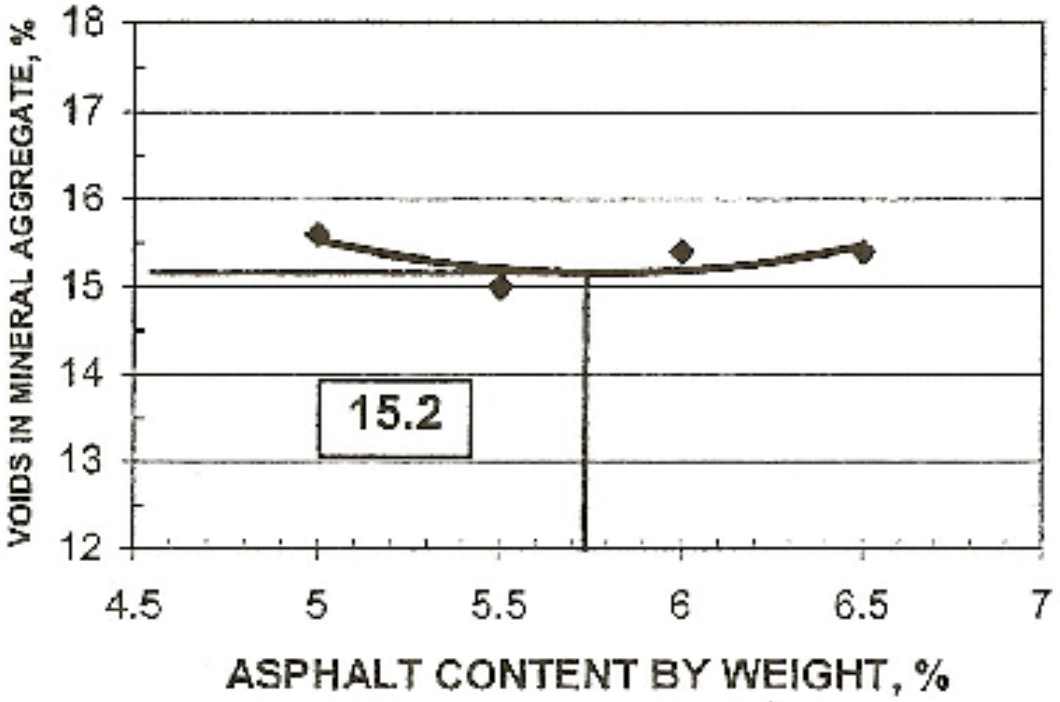
Materials & Mix Design

Stage 2 – Design Asphalt Binder Content

- **Must evaluate other volumetric properties (e.g., VMA & dust to effective)**



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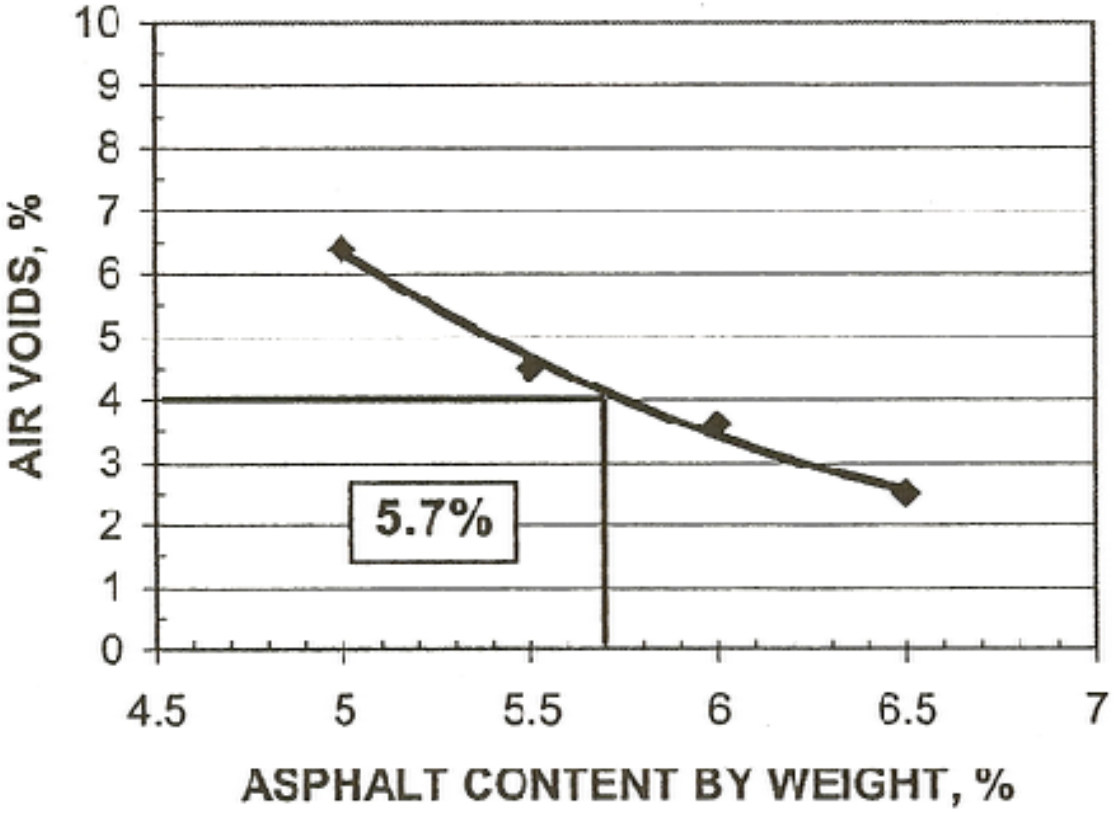
Materials & Mix Design

Past APAO Presentations - improve durability:

- **"Specify selecting binder content at 3.5% air voids"**
- **"Require additional compaction"**



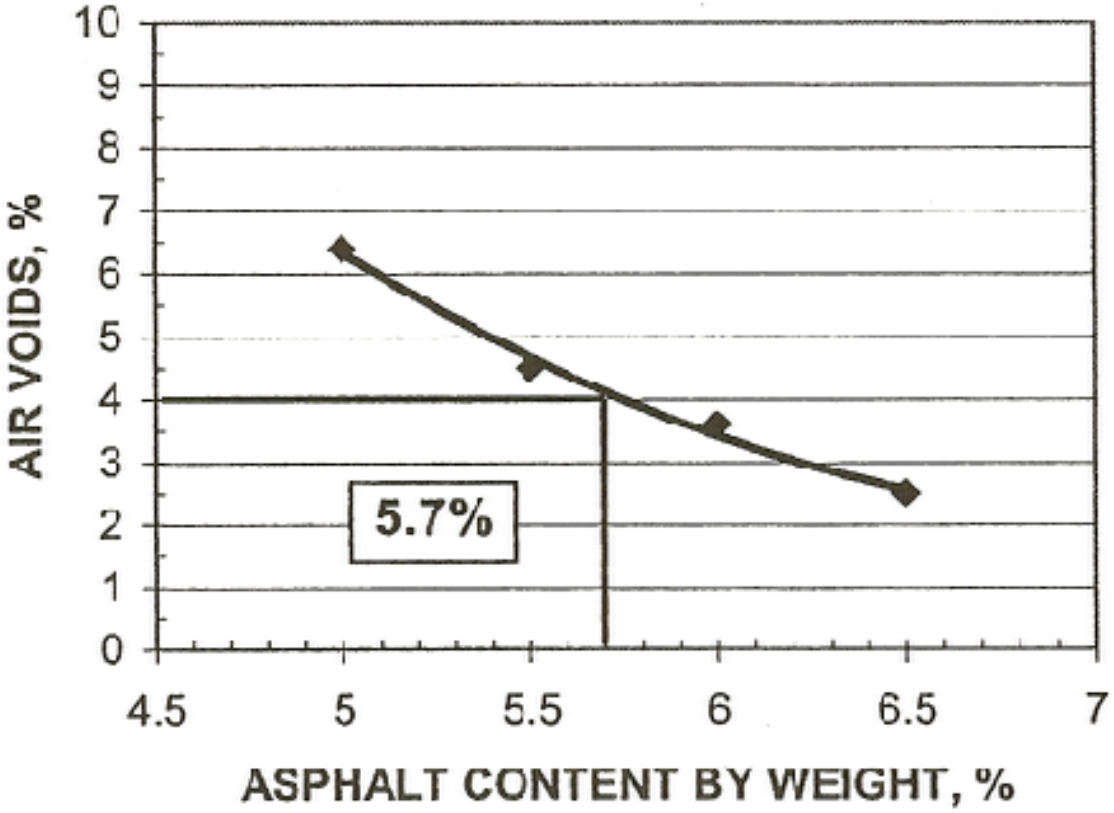
Improve fatigue response

- To enhance fatigue response use higher binder content in bottom lifts
- Select binder content at 3.5% air voids instead of the surface course standard 4.0%
- To improve density/compaction construct thick base lifts (3” minimum)

Materials & Mix Design

Past APAO Presentations - Improve durability:

- **"Specify selecting binder content at 3.5% air voids"**
- **"Require additional compaction"**



Materials & Mix Design

Recent ODOT Research:

- **SPR734 (Williams, 2015): "reduce design air voids from 4% to 3.5% which would effectively increase the design binder content of mixes by about 0.25%"**
- **SPR785 (Coleri, 2017):**
  - **Increased binder "can create significant savings and improve pavement longevity"**
  - **Increased density "can potentially create a significant improvement in the cracking resistance of asphalt mixtures"**

Improve performance of preservation pavements by:

_____

_____

_____

_____

_____

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Improve performance of preservation pavements by:

Design for correct traffic level

_____

_____

_____

_____

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Improve performance of preservation pavements by:

Design for correct traffic level

Binder grade

_____

_____

_____

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Improve performance of preservation pavements by:

Design for correct traffic level

Binder grade

Polymers

_____

_____

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Improve performance of preservation pavements by:

Design for correct traffic level

Binder grade

Polymers

Binder Content

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Improve performance of preservation pavements by:

Design for correct traffic level

Binder grade

Polymers

Binder Content

Compaction

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Pavement Structural Design

- Proper NMAS for lift thickness
- Increase thickness whenever possible
- Lower air voids (more density)
- Increase binder content
- Polymers in top lift for high loading areas

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Construction Best Practices

- Surface preparation
- Asphalt placement
- Quality control

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Surface Preparation

Surface preparation is how we ensure bonded layers.

- **Proper milling, if needed**
- **Clean existing surface**
- **Proper tack coat**

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Bonding Demonstration

(courtesy of FHWA/AI Tack Workshop)

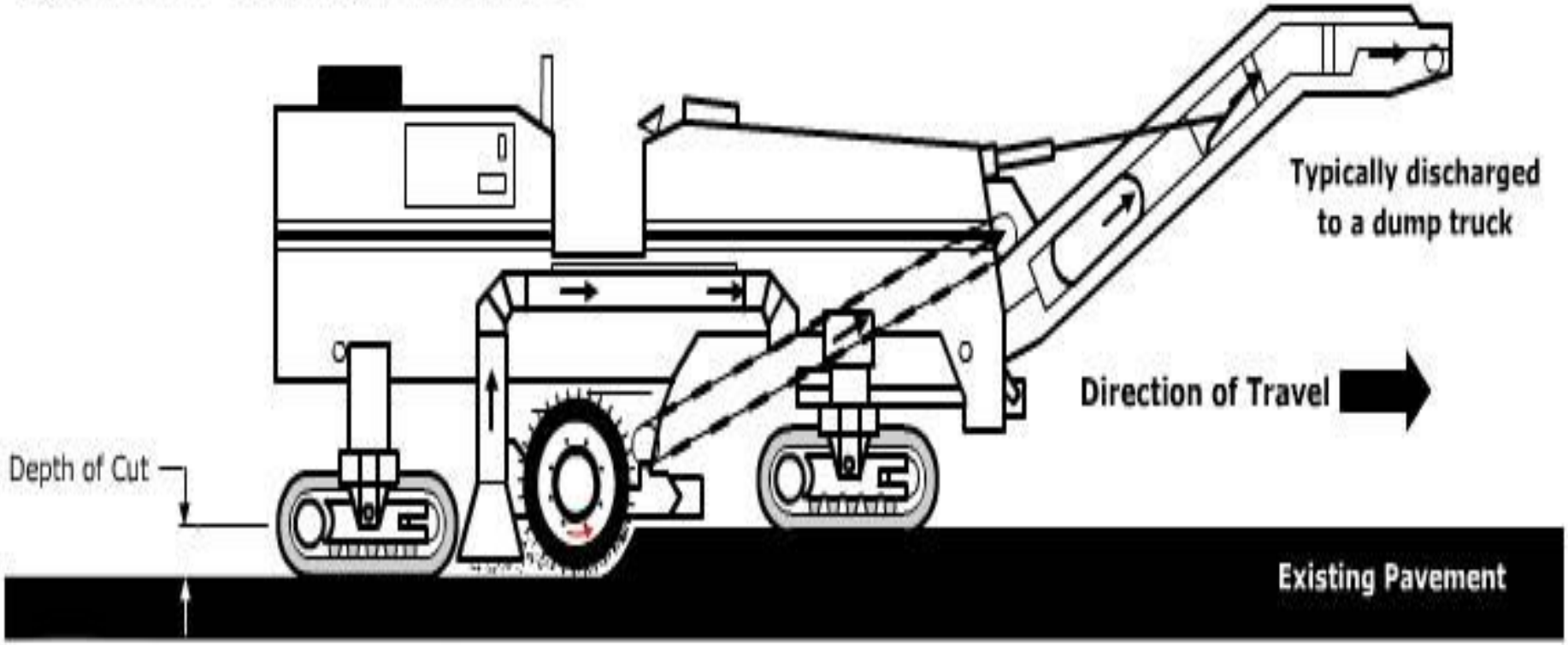
½" Deflection,
60lb Load

Unbonded

¼" Deflection,
160lb Load

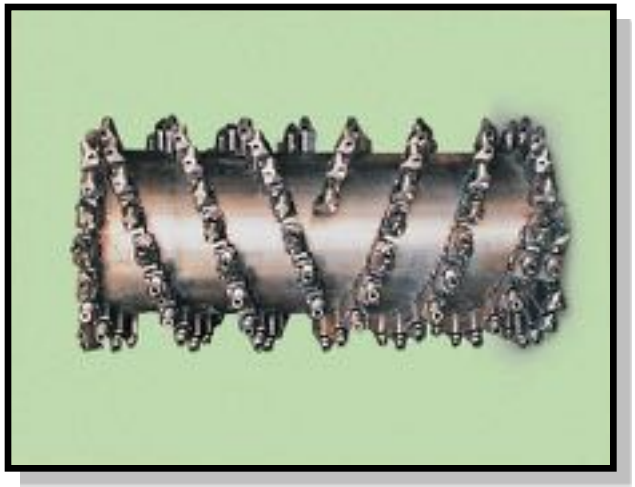
Fully Bonded

Typical Milling Machine

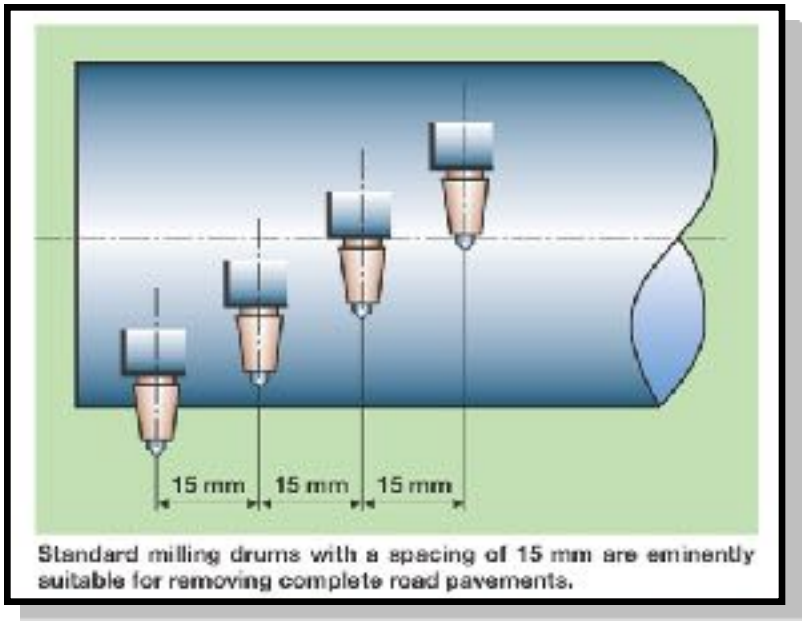


- Tracks
- Vacuum
- Cutter Drum
- Conveyor Belts

Triple Wrap

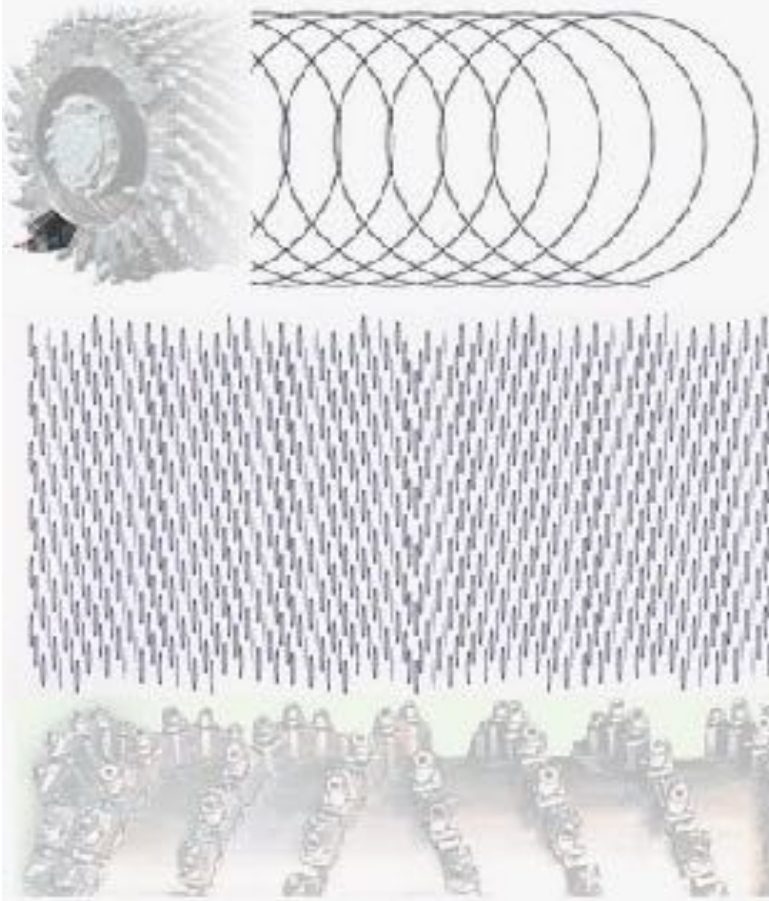


5/8” Spacing

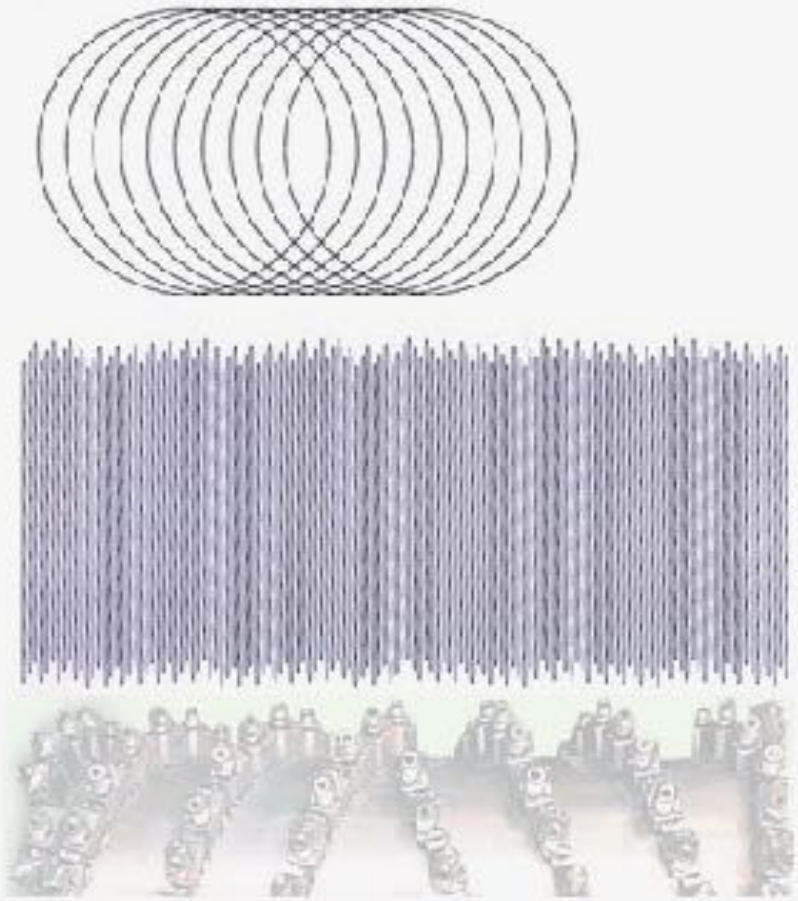


Standard milling drums with a spacing of 15 mm are eminently suitable for removing complete road pavements.

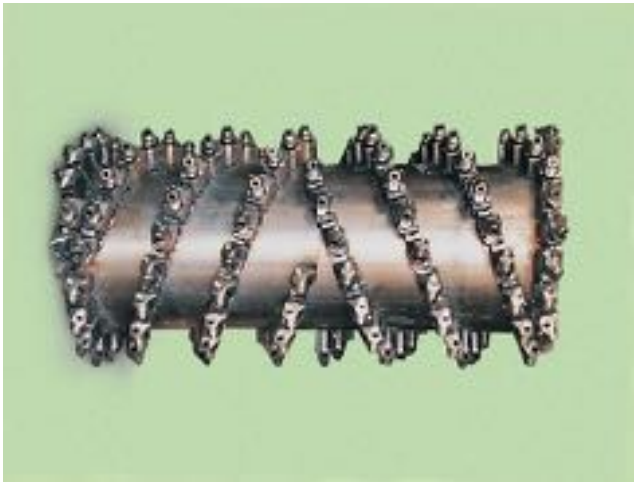
Standard milling drum FB 2000_LA 16
Advance speed: 16 m/min

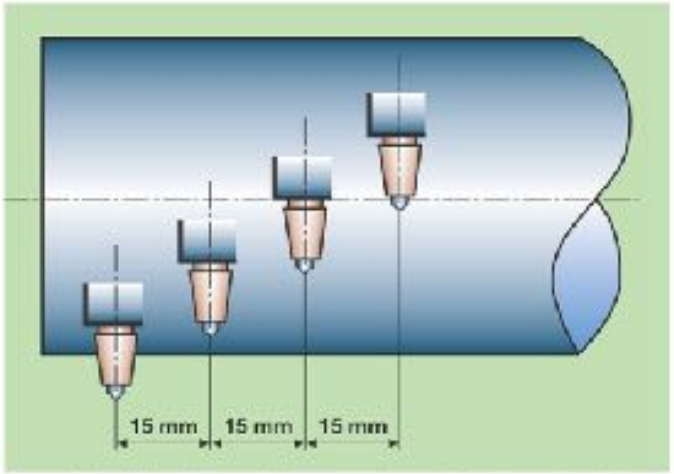


Standard milling drum FB 2000_LA 16
Advance speed: 8 m/min

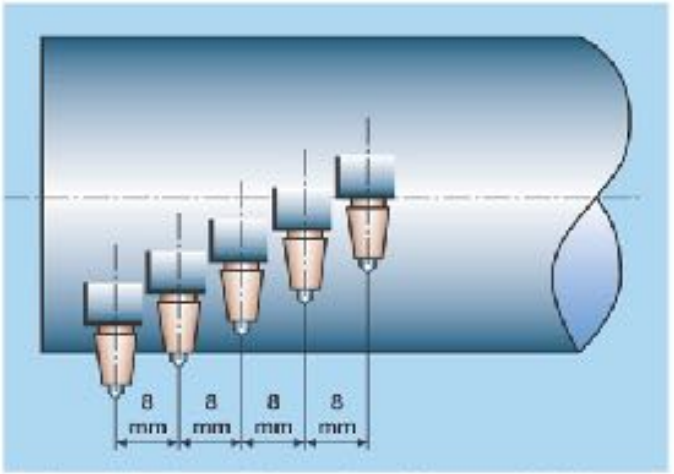


FINE MILLING



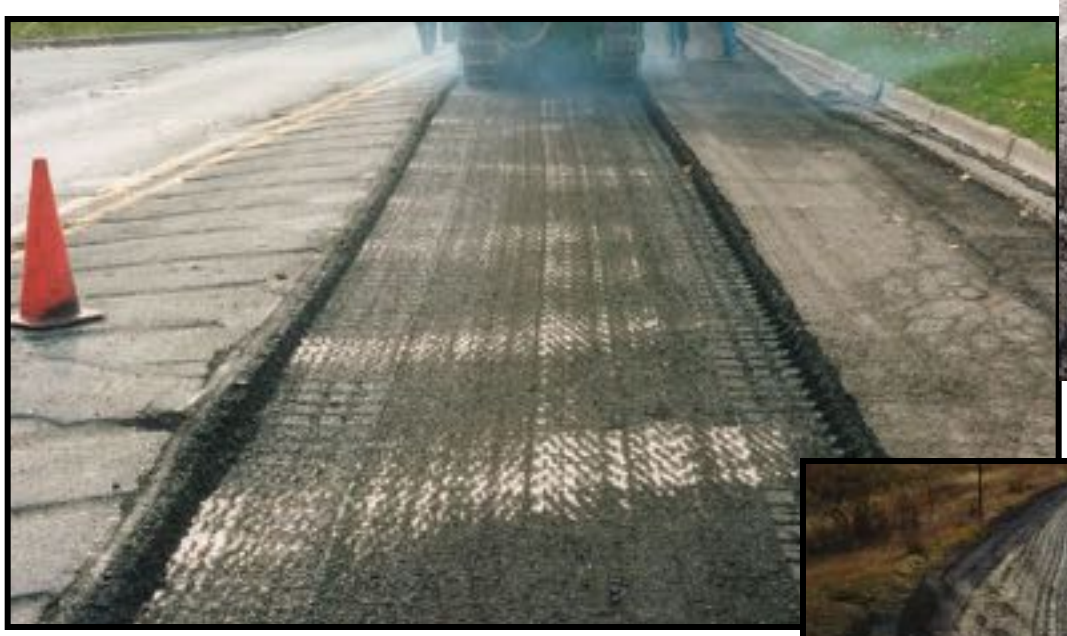


Standard milling drums with a spacing of 15 mm are eminently suitable for removing complete road pavements.



The fine milling drums with a spacing of 8 mm are ideal for treating the surface of pavement courses.

MILLING PROBLEMS



BAD TEETH AND HOLDERS

MILLING PROBLEMS

TOO FAST

MILLING PROBLEMS

JUST RIGHT

Milling Considerations

- Existing distresses
- Existing layer thicknesses
- NMAS of existing pavement
- Standard or fine or micro?
- Condition of milling equipment
- Speed of machine & cutter drum
- Resulting pattern
- Thinlays

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Surface Preparation

Whether milled or not, what is an essential step before tack?

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Tack Coat

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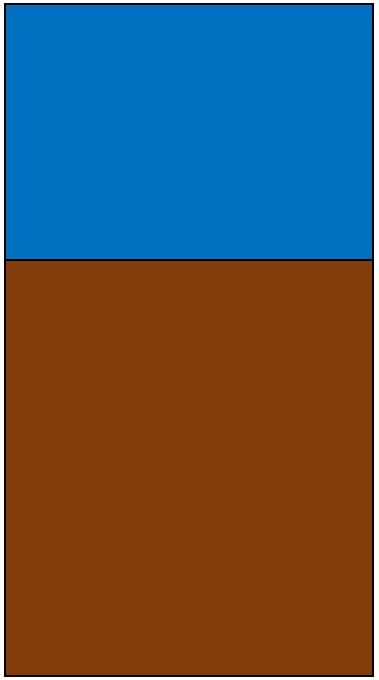
What is it?

Produced

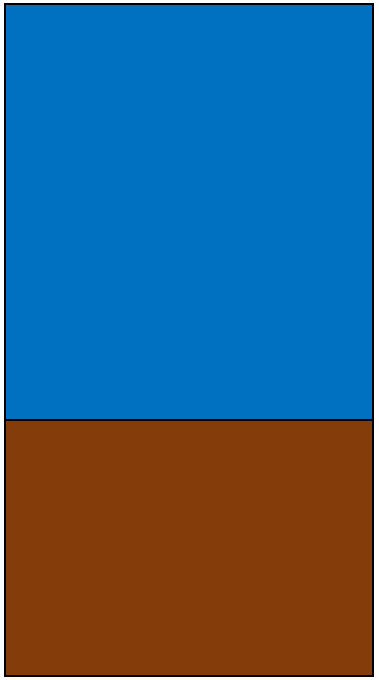


1/3

2/3

Diluted

2/3



1/3

Diluting Tack

Advantages

- More uniform application
- Fewer plugged nozzles

Disadvantages

- Need to accurately calculate application rate
- Longer time to break

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Tack

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Bonding Demonstration

(courtesy of FHWA/AI Tack Workshop)

½" Deflection,
60lb Load

Unbonded

¼" Deflection,
160lb Load

Fully Bonded

Tack

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Tack

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Tack

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Pavement Preservation Case Studies

THINLAY

SAFE. SMOOTH. DURABLE.

Dense-graded asphalt designed to:

- **Last**
- **Resist Cracking**
- **Be Thin (minimize materials)**

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THINLAY

SAFE. SMOOTH. DURABLE.

- 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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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

Murray Boulevard 2001 Paving

- L3, 3/8-inch NMAS mix, PG 64-22, no RAP/RAS
- $40/ton, $15,488 per lane mile = $2.20/SY
- $0.14 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
- $0.26 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, Bethel Heights Road (2010)

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

Photo October 2017

THINLAYS

Halls Ferry Rd

THINLAYS

Polk County, Hoffman Road (2010)

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

THINLAYS

Polk County 2010 Thinlays

- **7 years – almost no 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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Jim Ryan | The Oregonian/OregonLive

Oregon Department of Transportation contract workers hit, June 6, 2017

Safety Culture

- Increased separation
- Requests for police presence
- Improved message boards
- Responsibility not delegated
- Speed reductions
- Day paving
- New technology
- Solicit contractor suggestions

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