Kent R. Hansen, P.E.
Director of Engineering
National Asphalt Pavement Association

Outline

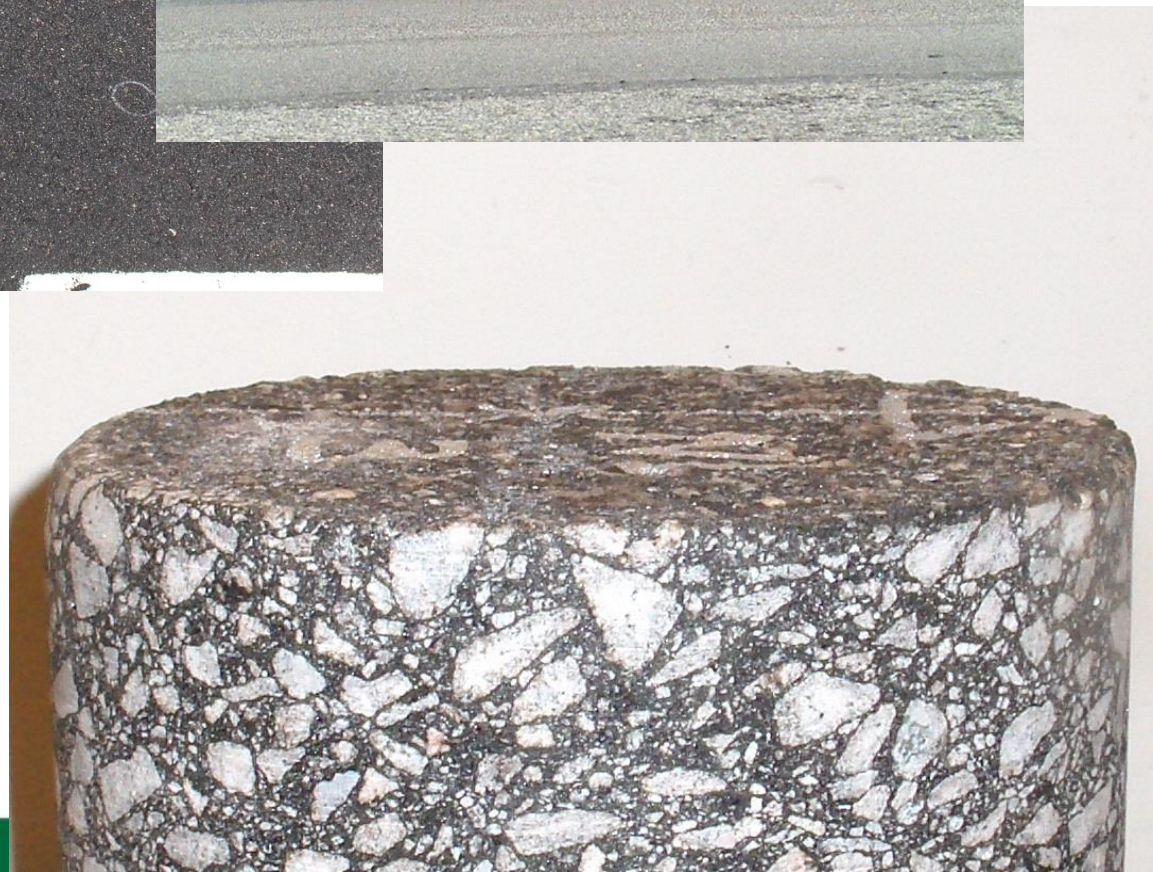
- **Overview**
- **Advantages**
- **Sustainability**
- **Top 10**

What is a Perpetual Pavement?

- **No deep structural distress**

Dave Timm 2012


S11-Trench 1 - 2/17/2009
Keep Deformation in Surface
Dave Timm 2012



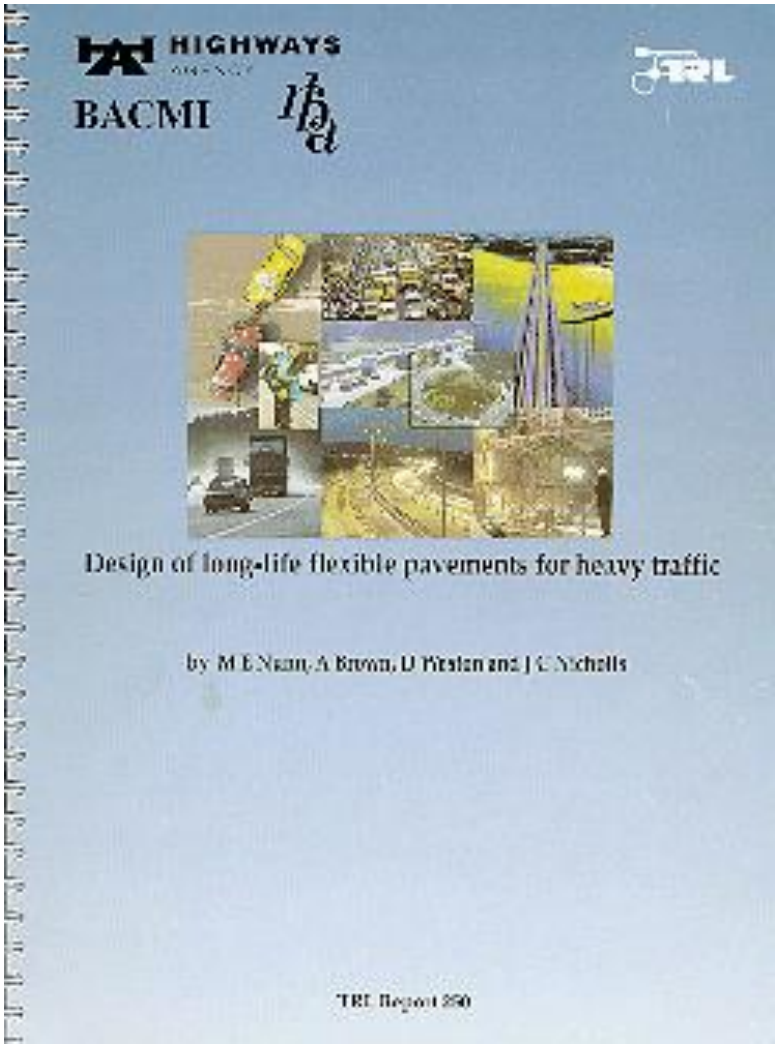
Limit Cracking to top-down

Dave Timm 2012

New Jersey I-287 Surface Cracking

Goal of Perpetual Pavement Design

- Design so there are no deep structural distresses
  - –Bottom up fatigue cracking
  - –Structural rutting
- All distresses can be quickly remedied from surface
- Result in a structure with ‘Perpetual’ or ‘Long Life’

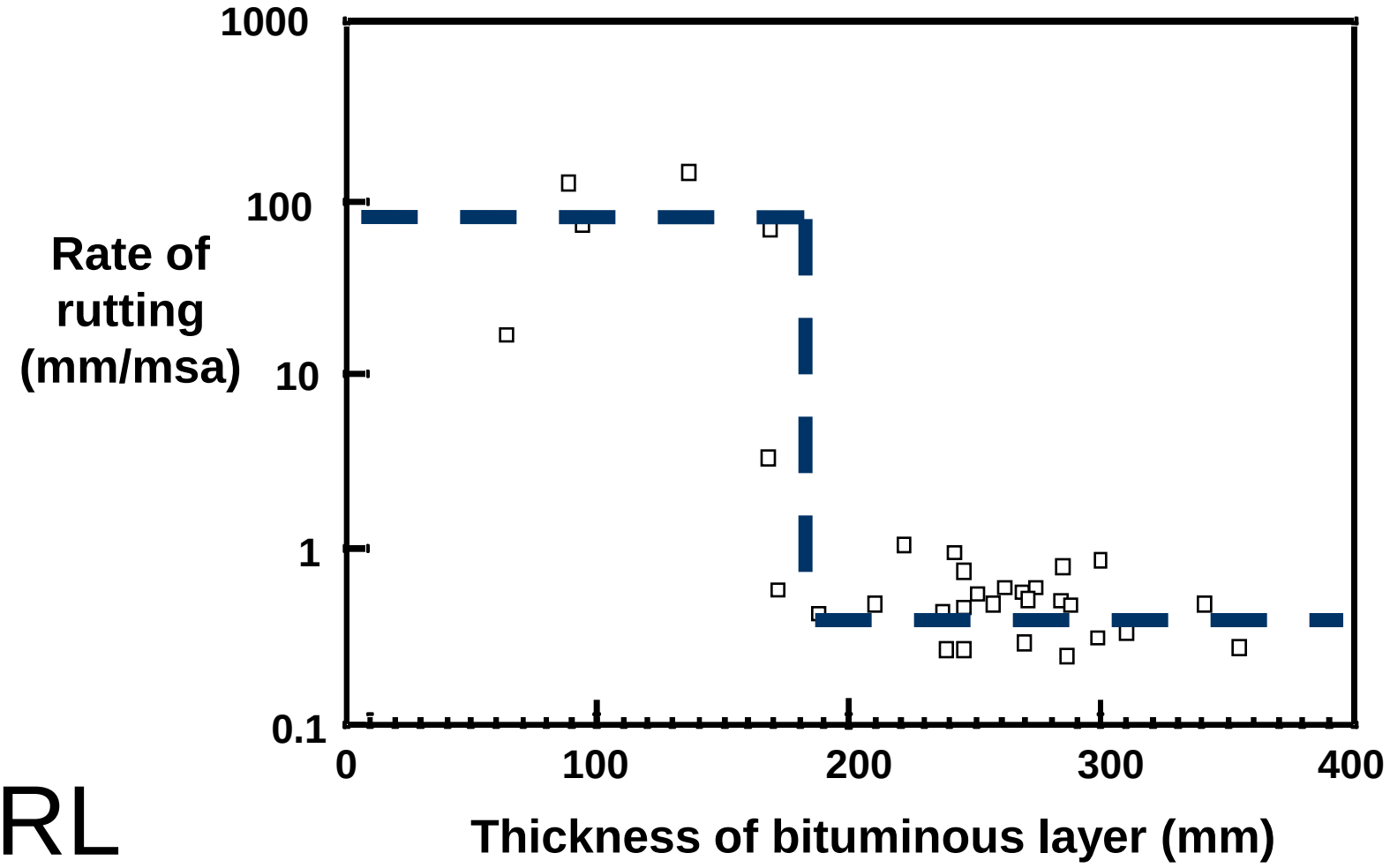


TRL Report 250
Nunn, Brown, Weston
& Nicholls

Design of Long-Life Flexible Pavements for Heavy Traffic

http:\\www.trl.co.uk

RATE OF RUTTING vs ASPHALT THICKNESS

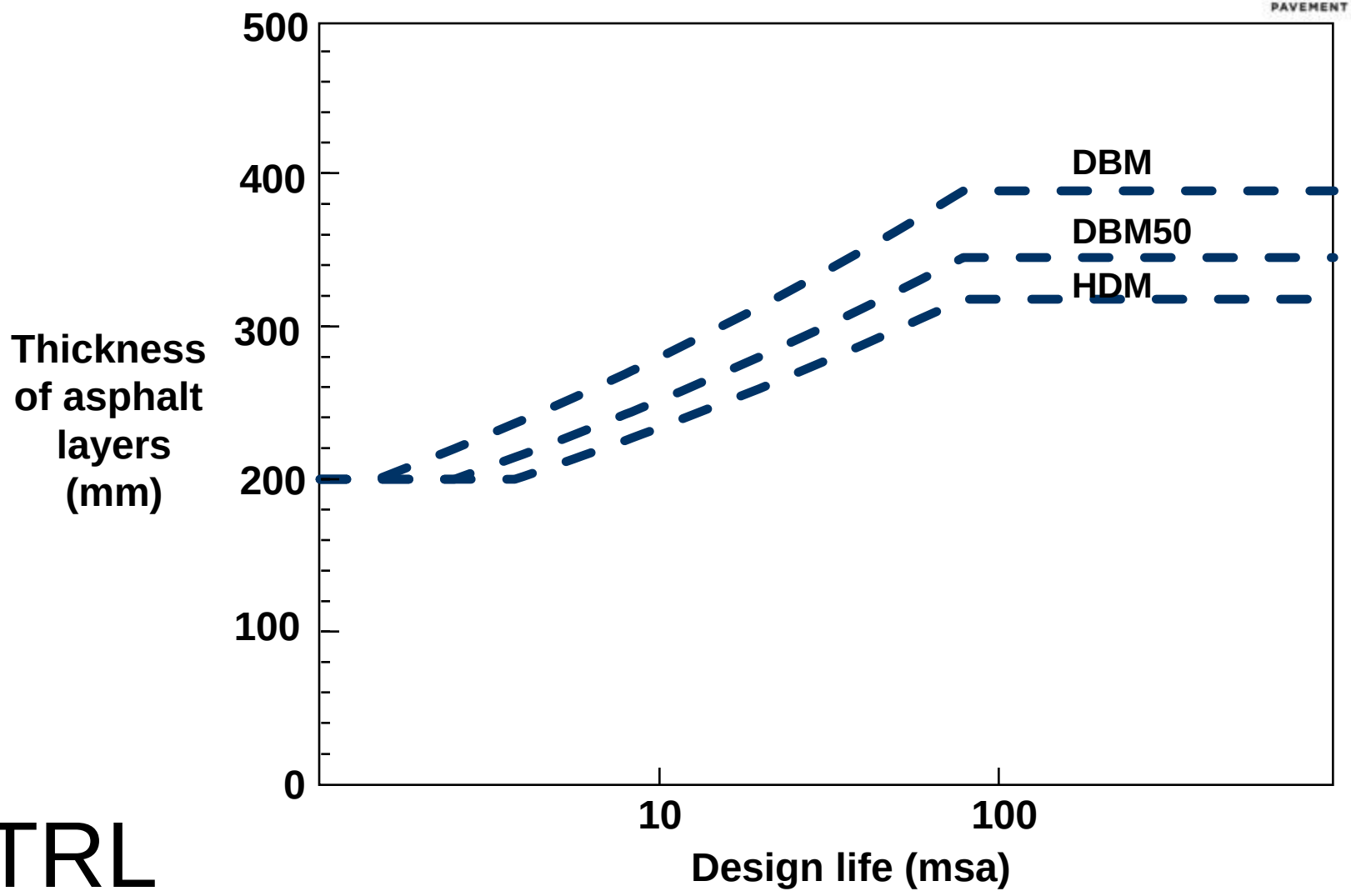


TRL

TRL

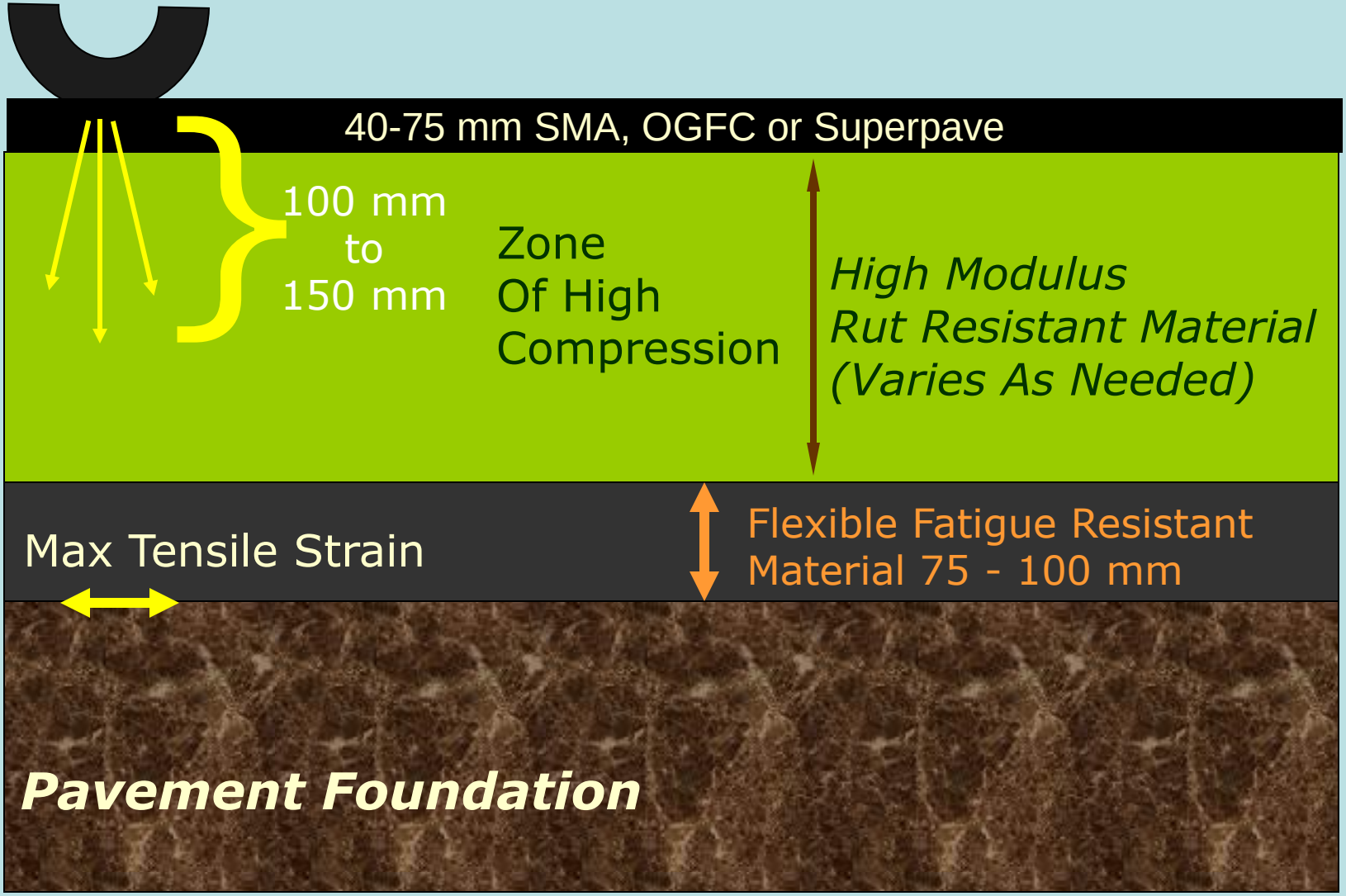

TRL

TRL Design Chart

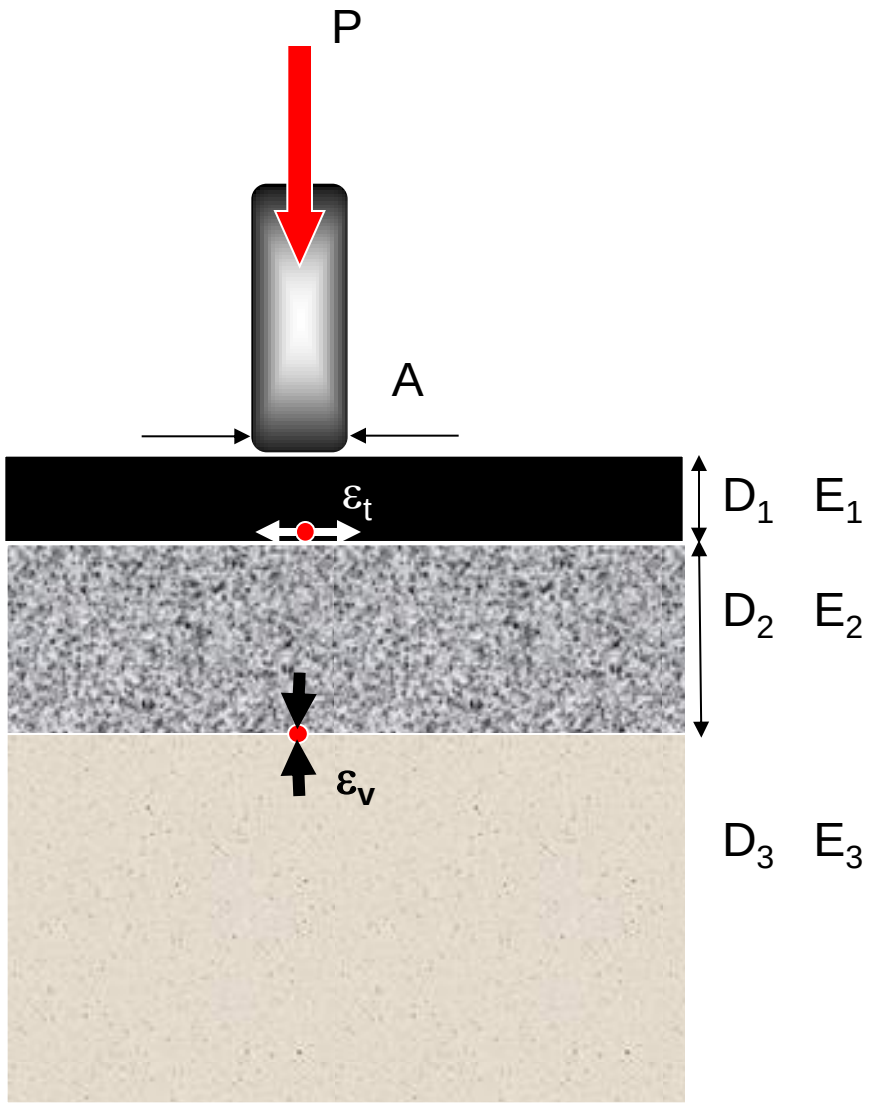


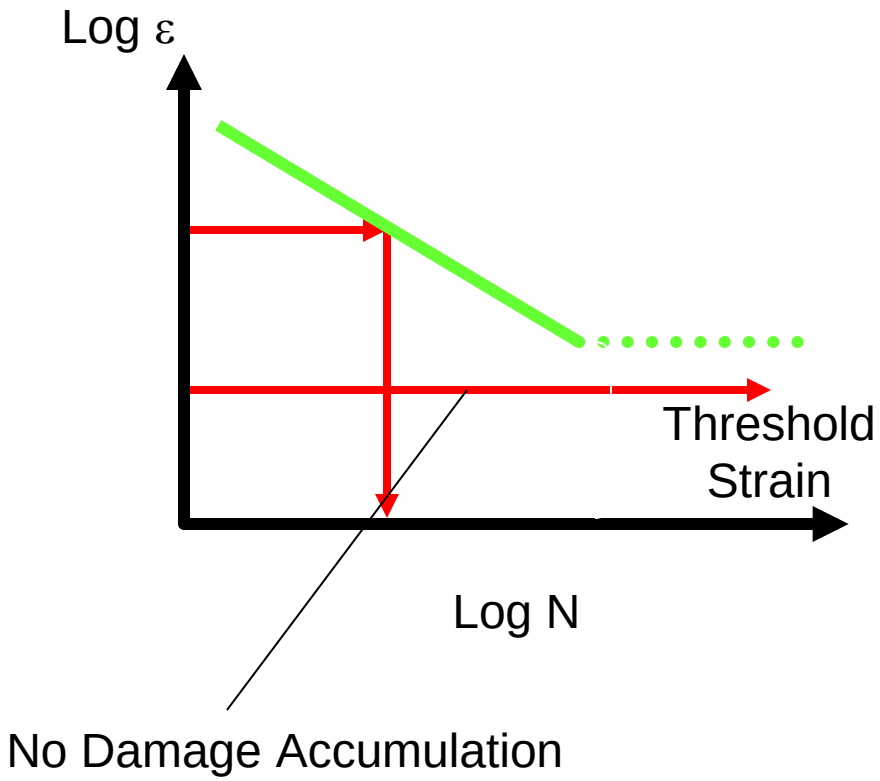
TRL

Concept

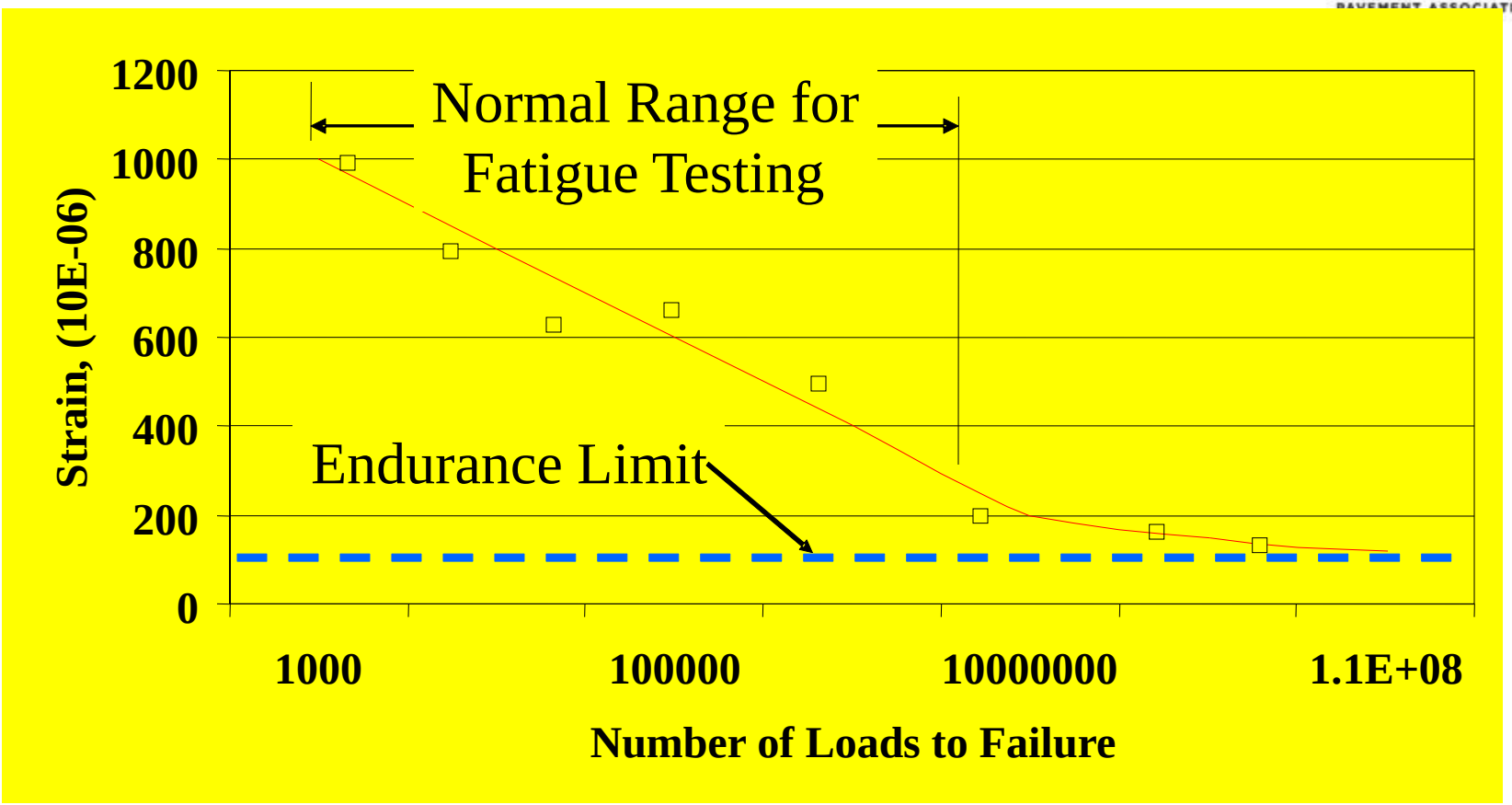

40-75 mm SMA, OGFC or Superpave
100 mm
to
150 mm
Zone
Of High
Compression
High Modulus
Rut Resistant Material
(Varies As Needed)
Max Tensile Strain
Flexible Fatigue Resistant
Material 75 - 100 mm
Pavement Foundation

M-E Perpetual Pavement Design





Endurance Limit



Normal Fatigue Testing Results Versus Endurance Limit Testing

What is the Endurance Limit for HMA?

- 1972 – Monismith estimates about 70 με
- 2001 – I-710 designed at 70 με
- 2002 – 70 με used by APA
- 2007 – NCHRP 9-38 Lab Study
  - –100 με for unmod binders
  - –250 με for mod binders
  - –More severe than field
- 2007 – MEPDG uses 100 to 250 με
- 2008 – Field measurements show higher strains

Perpetual Pavement Advantage

- Efficient Design – No Overdesign
- Avoid Reconstruction
- Reduce Rehabilitation
- Reduce Life Cycle Cost
- Reduce Energy Consumption
- Reduce Materials Use

Design Applications

- High Volume Pavements
  - MEPDG (DarWIN-ME)(Pavement ME Design)
  - PerRoad
- Low and Medium Volume Pavements
  - PerRoadXpress

Sustainability

- Economic
  - –Lowest Life Cycle Cost
  - –Lowest Initial Cost
  - –Don’t spend money our children don’t have
- Social
  - –Reduce Dependency on Outside
  - –Save Resources
  - –Make sure you leave something behind
- Environmental
  - –Reduce Impact on Environment
  - –Don’t leave your garbage behind

Perpetual Pavements

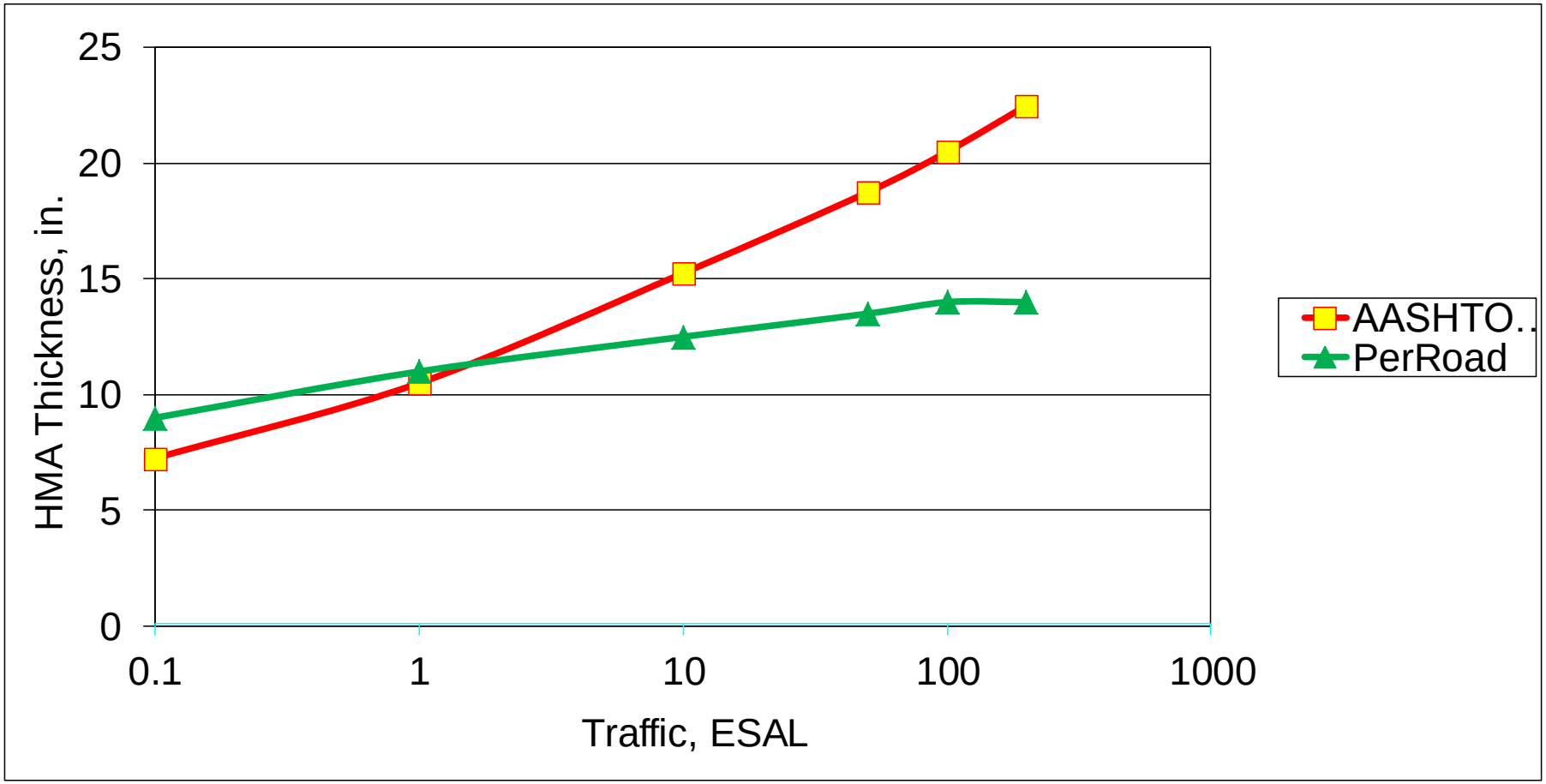
NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

- Save Money
- Save Asphalt
- Save Aggregate
- Reduce Construction Pollution
- Reduce GHG
- Reduce Vehicle Pollution

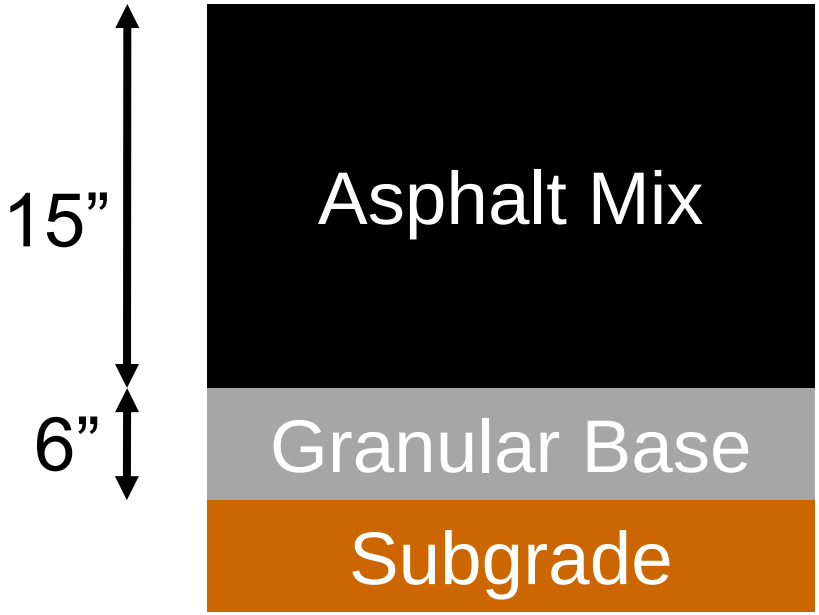
Two Cases

- Conventional Design (AASHTO 1972) vs. Perpetual Pavement
- Concrete Rehab with PCC Remove and Replace vs. Perpetual Pavement

Perpetual Pavement versus Conventional Design



Conventional vs. Perpetual



- One Lane-Mile
- Compare Materials Usage
- Compare Costs

Assumed Economic Inputs

- Materials
  - –Conventional -
    - •25% RAP All Layers
    - •8” Base - $60/ton
    - •4” Intermediate - $65/ton
    - •3” Surface - $70/ton (Mill & Replace Every 15 yrs)
  - –Perpetual –
    - •25% RAP (Base & Intermediate) 10% in SMA
    - •8” Base - $60/ton
    - •2” Intermediate - $65/ton
    - •2” SMA Surface - $80/ton (Mill & Replace Every 20 yrs)
- Discount Rate = 4%

Comparison of Structures

Conventional

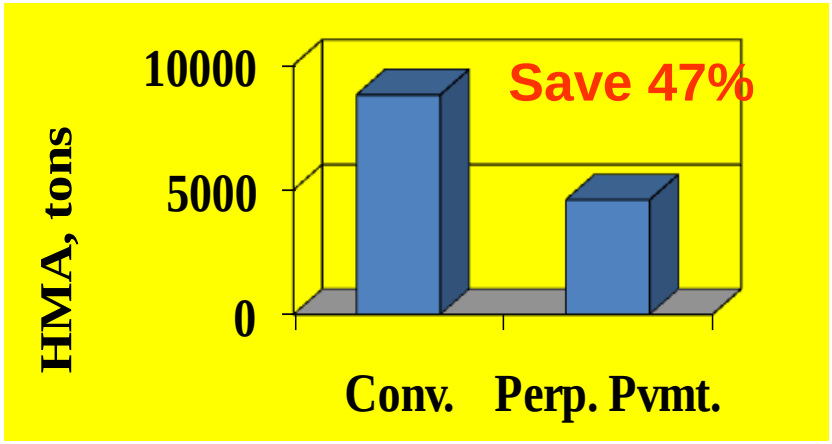
Year	Activity
0	15” HMA/6” Base
15	Mill 3”/Overlay 3”
30	Mill 3”/Overlay 3”
45	Mill 3”/Overlay 3”
50	------

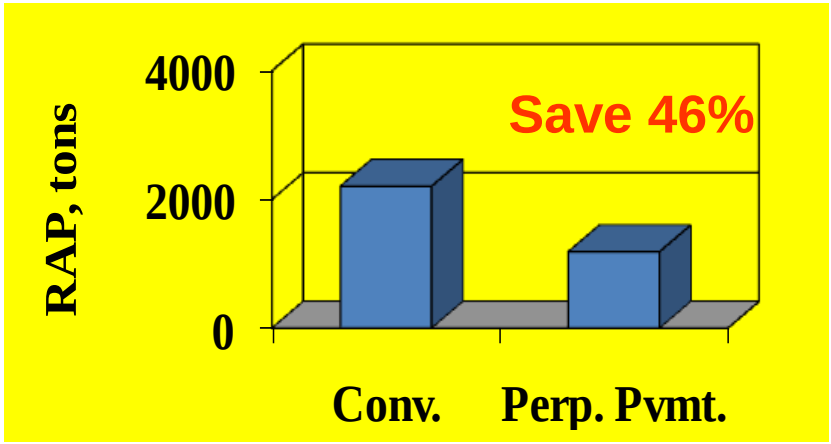
Perpetual

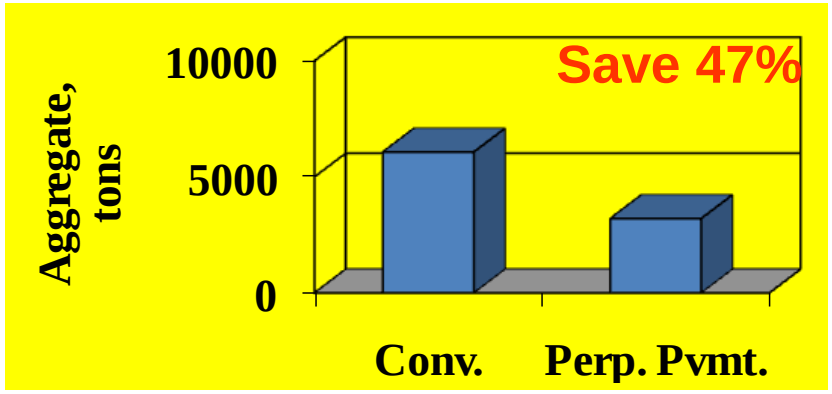
Year	Activity
0	11” HMA/6” Base
20	Mill 2”/Overlay 2”
40	Mill 2”/Overlay 2”
50	------

	Conventional (tons/lane-mile)	Perpetual Pavement (tons/lane-mile)
Year	HMA*	HMA*
0	5,358	4,594
15	1,148	
20		766
30	1,148	
40		766
45	1,148	
50	----	
Total	**8,802**	**4,594**
RAP	**2,205**	**1,187**
Aggregate	**6,069**	**3,203**
Asphalt Binder**	**396**	**204**

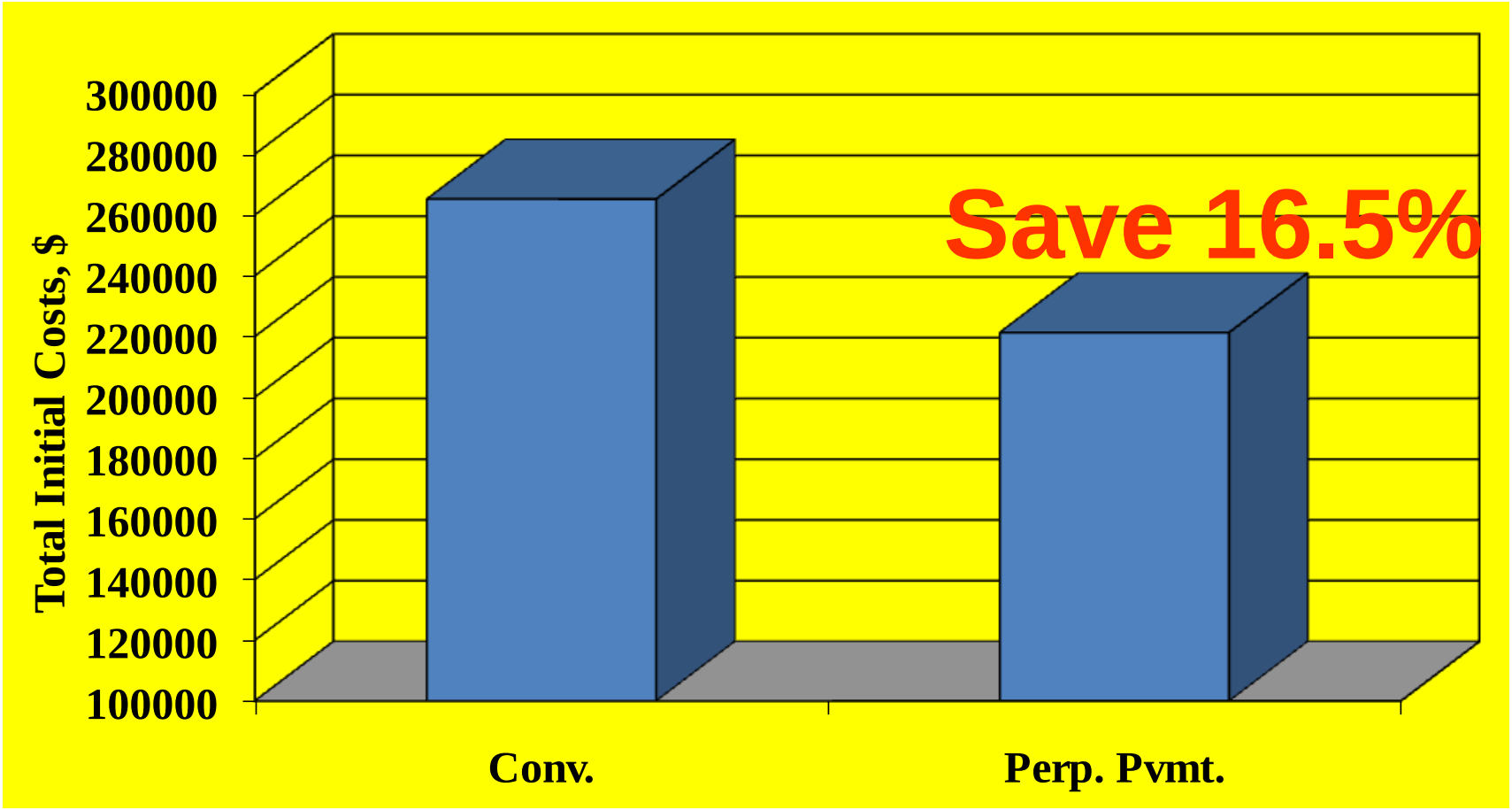
Material Usage



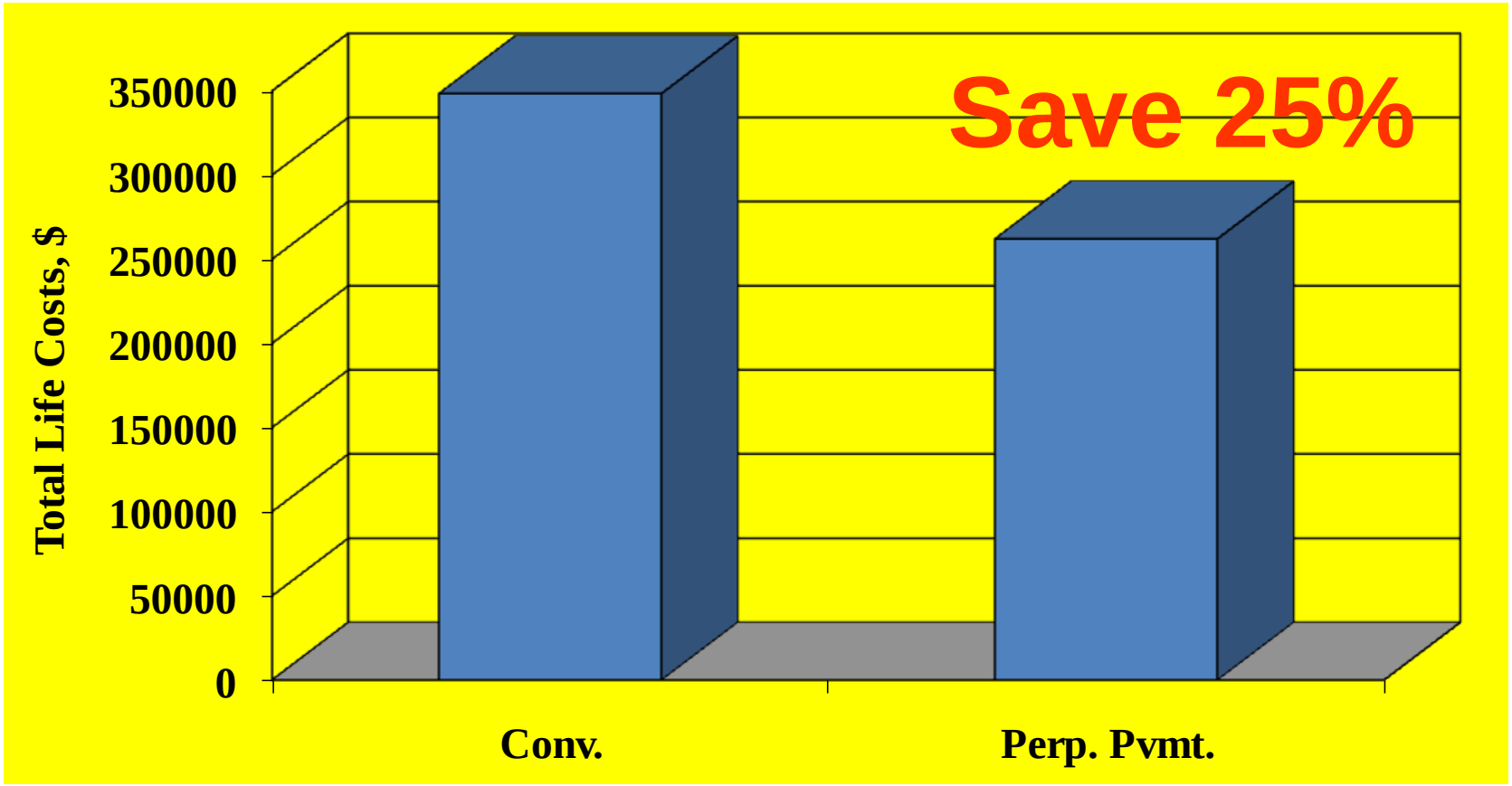




Initial Costs



Costs


Save 25%
Total Life Costs, $
350000
300000
250000
200000
150000
100000
50000
0
Conv.
Perp. Pvmt.

Rubblization with Perpetual Pavement Overlay versus Remove/Replace PCC

First Cost Comparisons

- One Mile, Four Lanes (7040 SY)
- Case 1: Rubblization with Perpetual Pavement
- Case 2: Remove PCC and Replace with PCC

Case 1

- Perpetual Pavement with Rubblization
  - –Rubblize 11” PCC
  - –Overlay with 8” HMA
- Initial Cost:

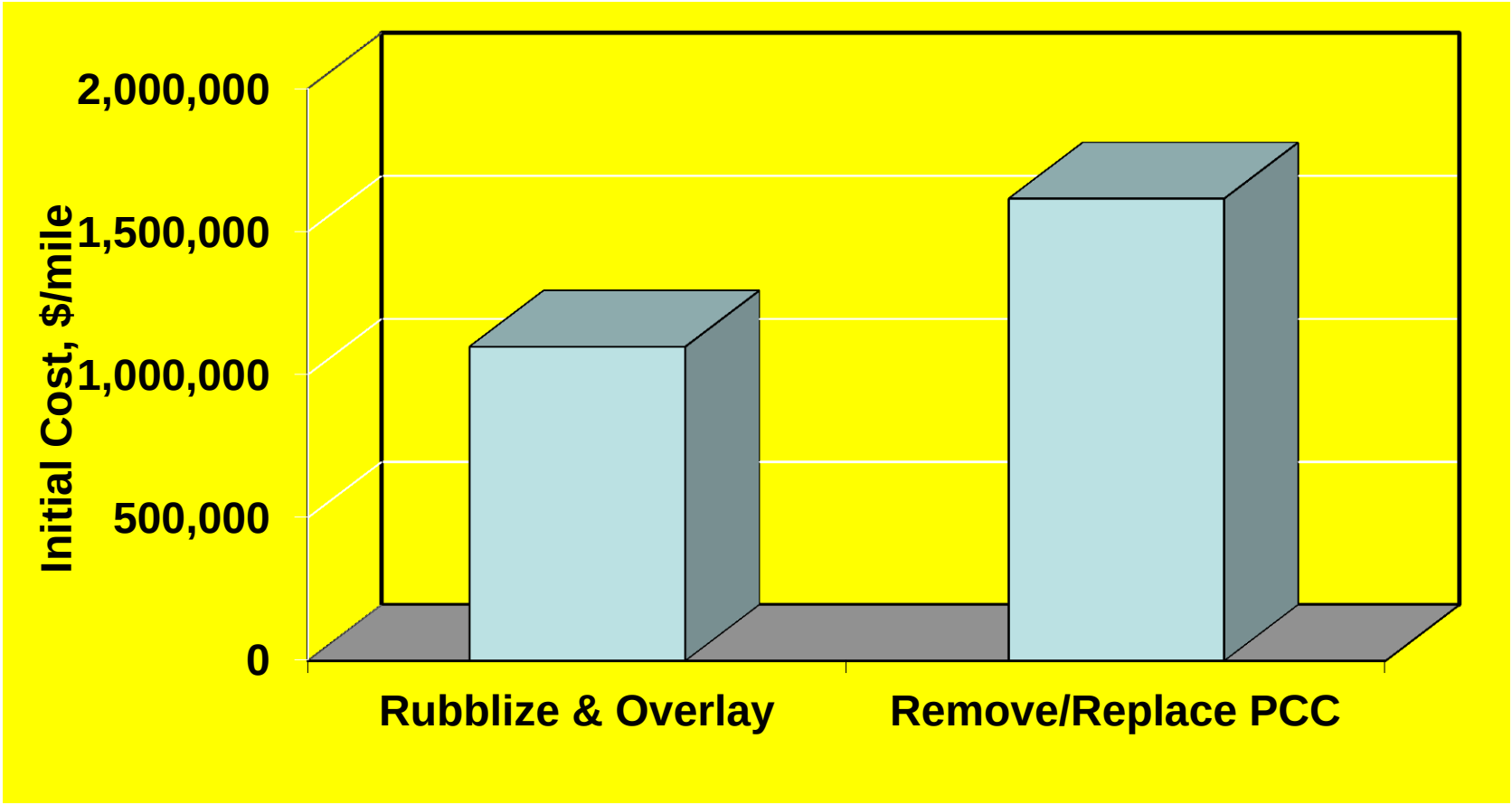
Item	Unit Cost
Edge Drains	5.00
Rubblize	1.50
HMA Overlay	60.00

Case 2

- Remove/Replace PCC
  - –Remove PCC
  - –Replace with 11” PCC
- Initial Cost:

Item	Unit Cost
Remove PCC	30.00
PCC Placement	43.00

Initial Cost Comparison



General Experience

- First Cost: Rubblization ~ 32% less than remove/replace
- Speed of Construction: days vs. weeks
- Impact of User Costs?

Work Zone Assumptions

- 1 mile long
- 4 lanes
- One lane open each direction during work
- 40,000 ADT

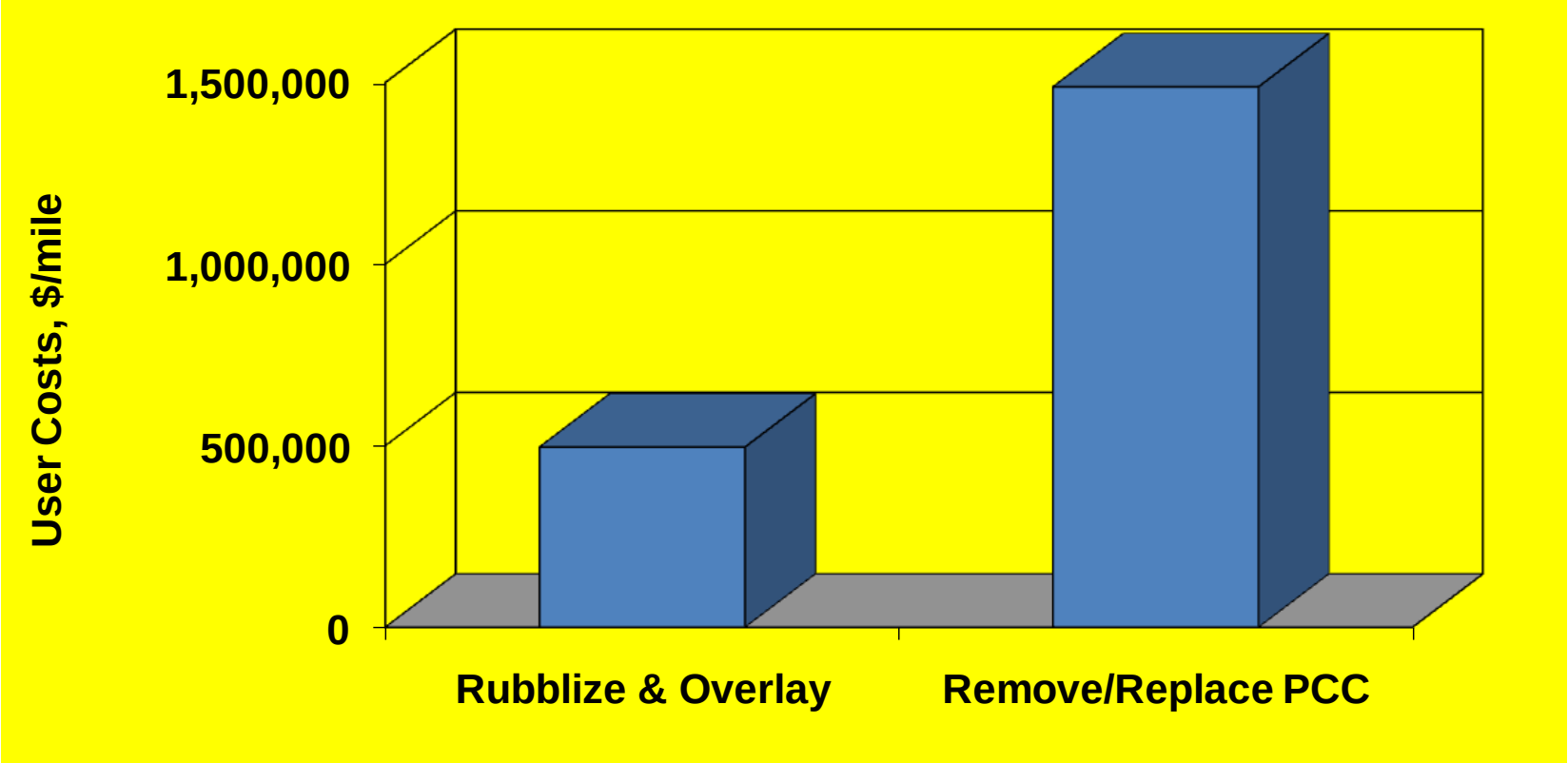
Case 1

- Rubblization: One lane-mile/day production
- Paving: 2 lane-miles/day
  - –Sequence
    - •3” bottom lift
    - •3” 2nd lift
    - •2” 3rd lift
  - –24 hour closure until 2nd asphalt lift
  - –12 hour closure for 3rd

Case 2

- Remove/Replace PCC
  - –Removal: 2000 SY/day ~ 3.5 days/lane – 24 hr/day
  - –Trim Base and Set Dowels – 12 hr
  - –Paving: 0.75 mile/day – 11 hr
  - –Curing: 7 days – 24 hr/day

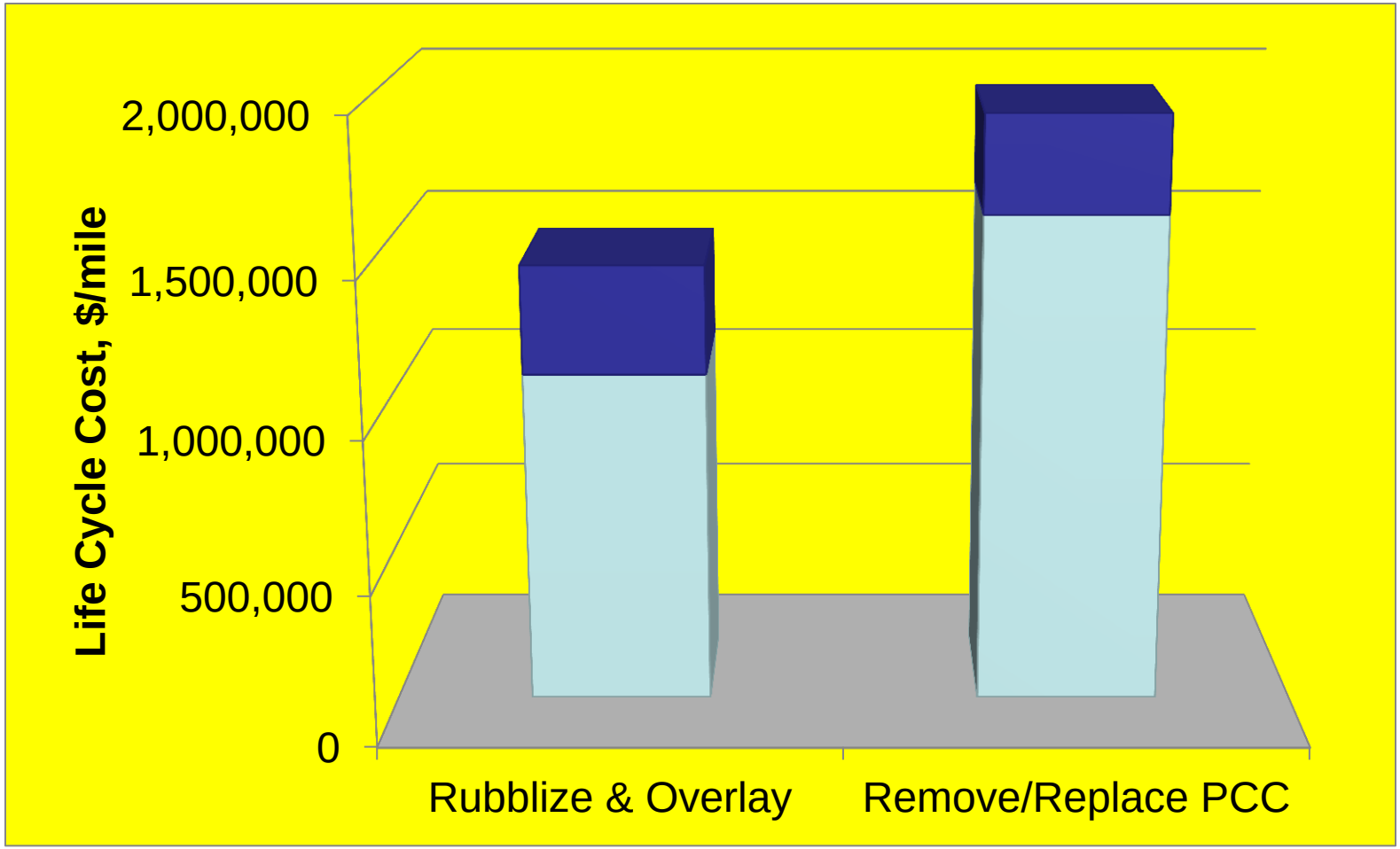
User Costs


User Costs, $/mile
1,500,000
1,000,000
500,000
0
Rubblize & Overlay
Remove/Replace PCC

Life Cycle Costs

- Asphalt
  - –Initial Construction
  - –Overlay Every 15 years
- Concrete
  - –Initial Construction
  - –Grind at Year 15
  - –Overlay at 25 years
  - –Overlay at 35 years

Life Cycle Costs



Rubblization Summary

- Economic Sustainability
  - –Lower Initial Cost
  - –Lower Life Cycle Cost
  - –Lower User Cost
- Social Sustainability
  - –Less User Inconvenience
  - –Recycled both Concrete (as base) and Asphalt
- Environmental Sustainability
  - –Lower GHG
  - –Lower Pollution from Traffic Delays

Economic Sustainability

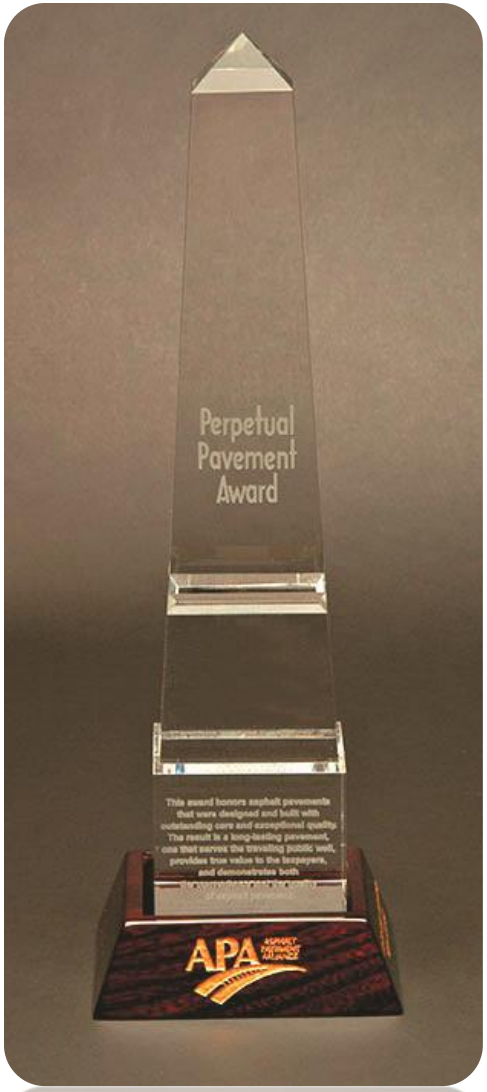
- Perpetual Pavement design is improving
  - More efficient pavements
  - More cost-effective
- Perpetual Pavement is Less Expensive
  - Initial Cost – 1/3 less
  - User Cost – 2/3 less
  - Life Cycle Cost -1/4 less

Social Sustainability

- Lower User Delay Costs
  - –Lower Crash
  - –Lower VOC
  - –Lower Fuel Consumption
- Save Resources for Other Uses and Future Generations
- Maintain Smoothness/Quietness

Environmental Sustainability

- Completely Recycle Concrete In-Place
- Use Recycled Asphalt in Surface
- Lower GHG Emissions



This award honors asphalt pavements that were designed and built with outstanding care and exceptional quality. The result is a long-lasting pavement, one that serves the traveling public well, provides true value to the taxpayers and demonstrates both the convenience and the quality of asphalt pavement.

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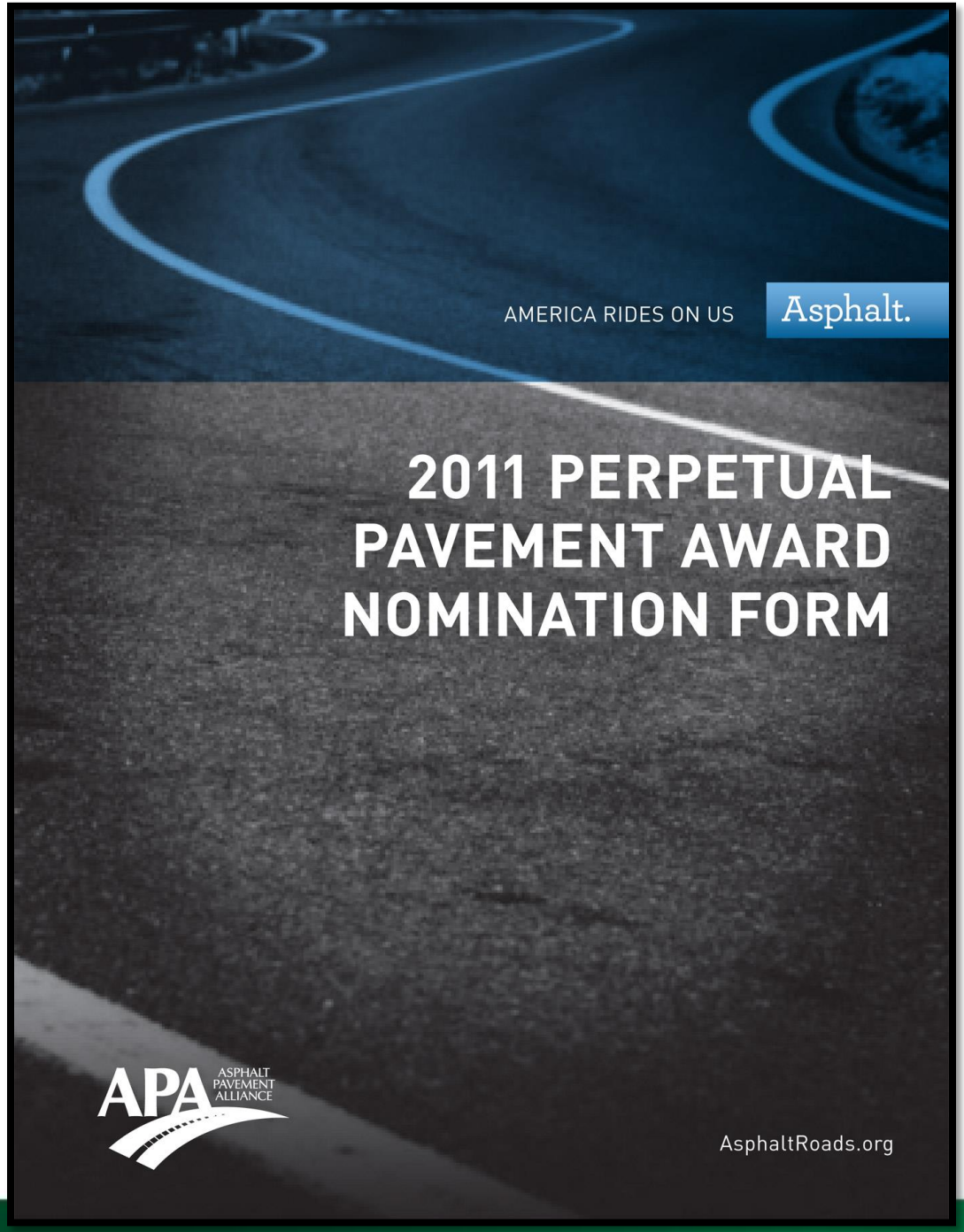

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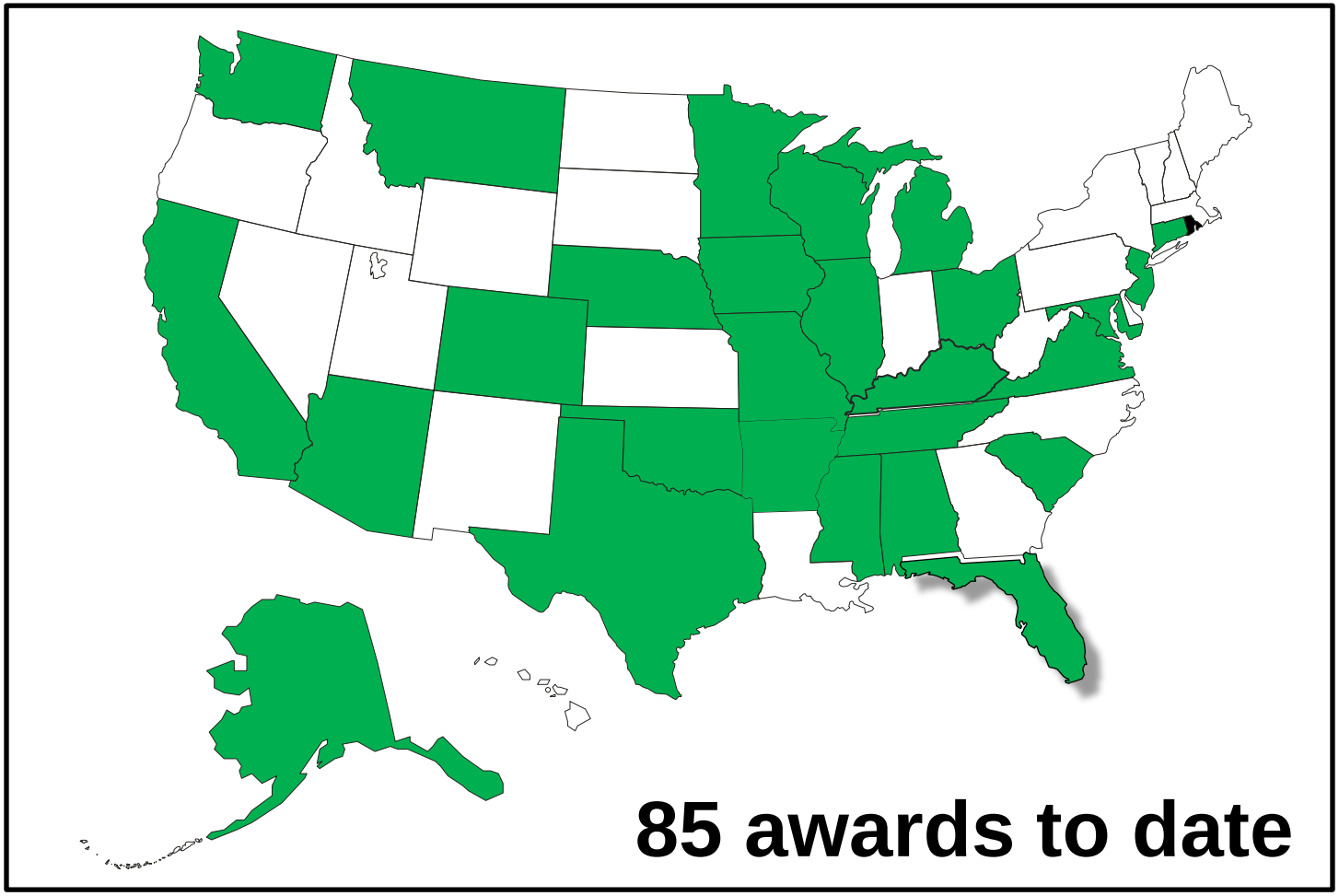
- 35+ years old
- 13+ years between overlays
- No increase >4”

Perpetual Pavement Awards from 2001 to 2012

NATIONAL ASPHALT PAVEMENT ASSOCIATION

Alabama - 4
Alaska - 1
Arizona – 1
Arkansas - 3
California - 2
Colorado - 1
Connecticut – 2
Florida - 3
Illinois - 1
Iowa - 2
Kentucky - 4
Maryland - 4
Michigan - 2
Minnesota - 11
Mississippi - 4
Missouri - 4
Montana - 3
Nebraska - 3
New Jersey - 2
Ohio - 3
Oklahoma – 3
Pennsylvania - 2
Rhode Island - 1
South Carolina - 4
Tennessee - 8
Texas - 2
Virginia - 1
Washington - 2
Wisconsin - 1
Toronto, Canada - 1



Top 10

NATIONAL ASPHALT PAVEMENT ASSOCIATION

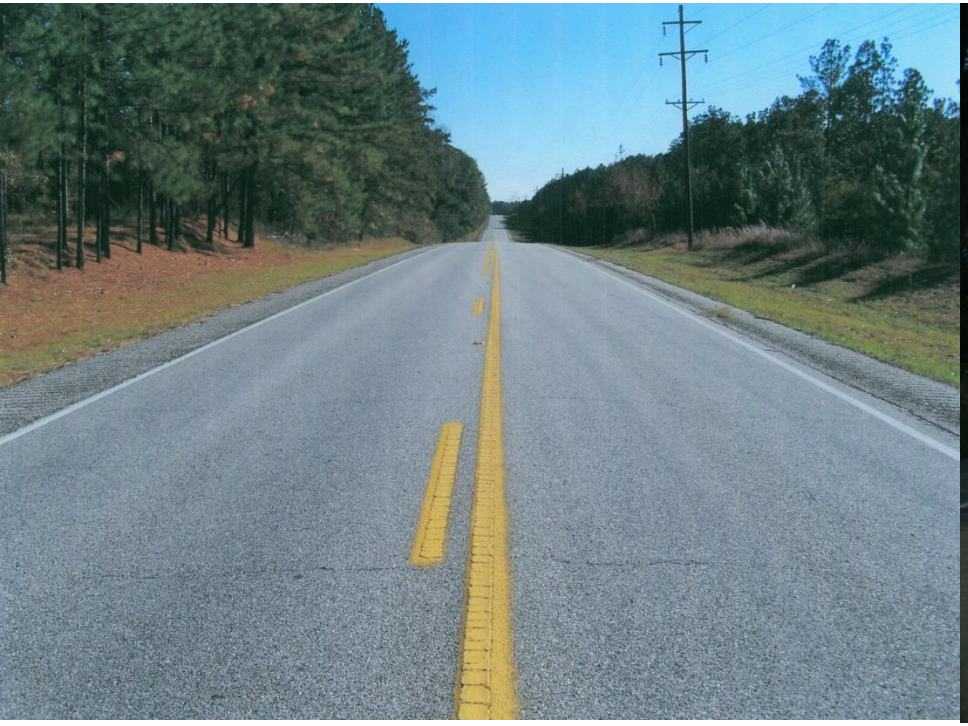
Nebraska 1934

Ohio 1937-40

Top 10

NATIONAL ASPHALT PAVEMENT ASSOCIATION

Alabama 1940



Tennessee 1948

Top 10

NATIONAL ASPHALT PAVEMENT ASSOCIATION

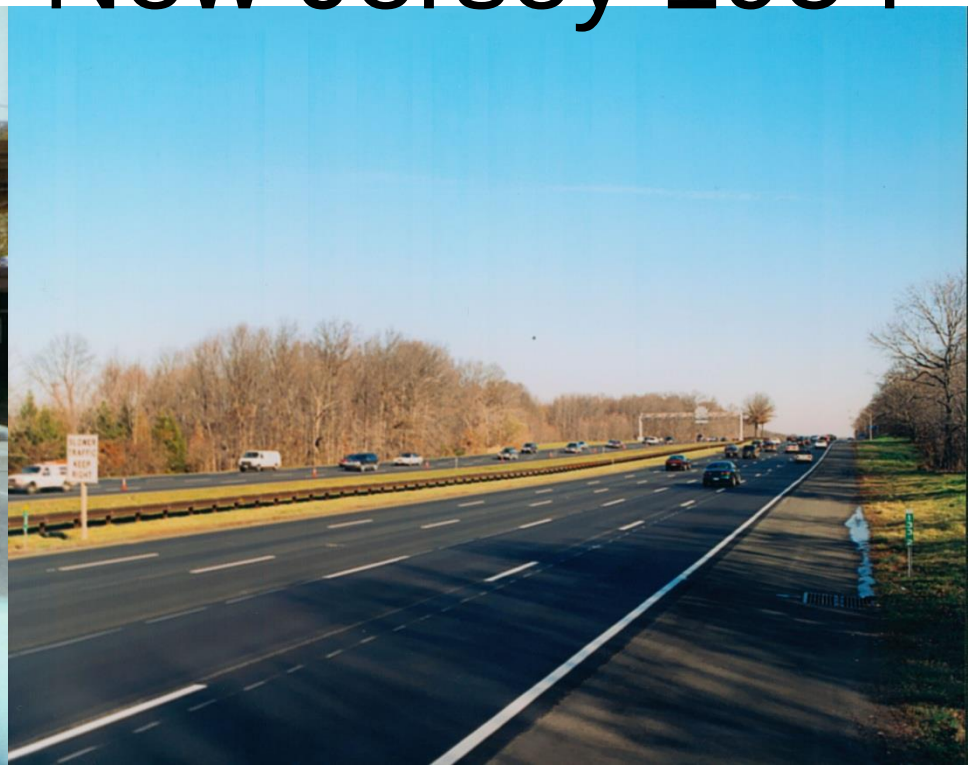
Toronto 1948

Maryland 1951

Top 10

New Jersey 1952

New Jersey 1954



Top 10

Michigan M-24, 1956

Summary

- Perpetual Pavement Design is Improving
- Perpetual Pavement is Less Expensive
- Perpetual Pavement is Sustainable