The Economics of Pavements that Last

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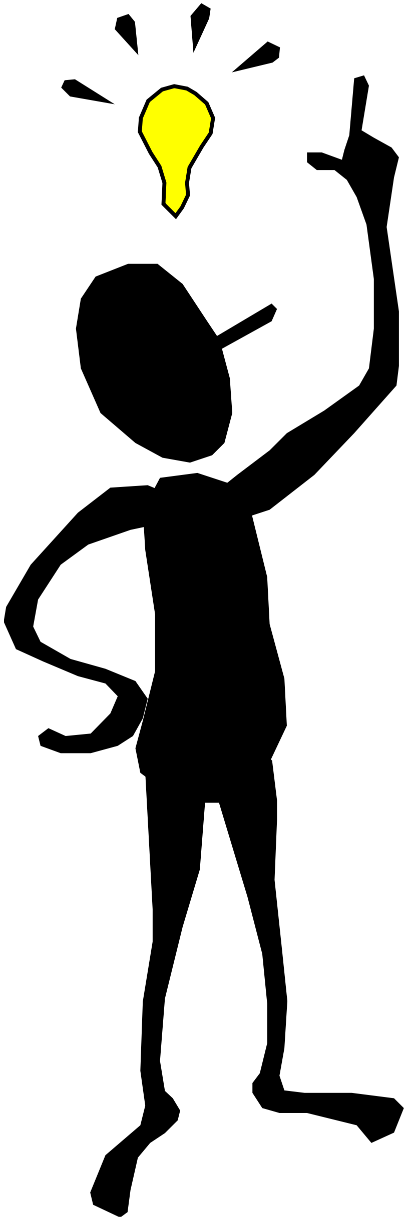
Asphalt Pavements and Sustainability

- Virtually 100% recyclable
  - Most recycled material in the US
  - Over 80% of old asphalt pavement reused
  - Reduces demand for new aggregates and binder
- *Beneficial* reuse of waste materials and by-products
  - Slags
  - Asphalt Shingles
  - Crumb rubber
  - Glass
  - Waste oils
  - Foundry sands



Perpetual Pavements

Recycling is great, but what is more sustainable than leaving the pavement in place?

Perpetual = continuing or enduring forever

Perpetual Pavement

- Asphalt pavement designed to last over 50 years without requiring major structural rehabilitation and needing only periodic surface renewal.
  - *Full-depth pavement* – constructed on subgrade
  - *Deep-strength pavement* – constructed on thin granular base course
  - AKA *extended-life pavement* or *long-life pavement*

Concept

- Asphalt pavements with high enough strength will not exhibit structural failures even under heavy traffic.
- Distresses will initiate at the surface, typically in the form of rutting or cracking.
- Surface distresses can be removed/ repaired relatively easily,
  - Before causing structural damage,
  - Leaving most of pavement in place, performing well.

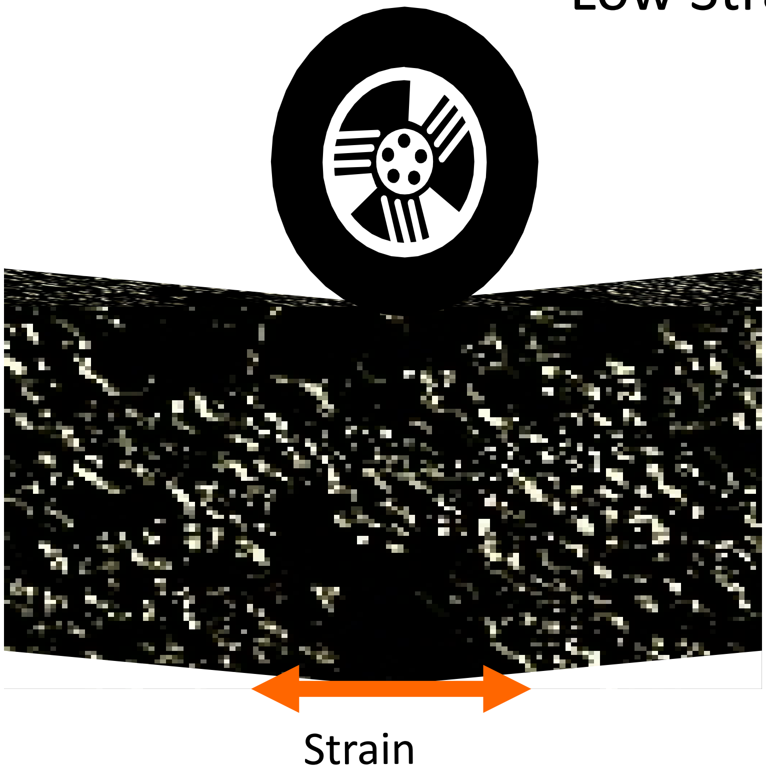
Perpetual Pavement Features

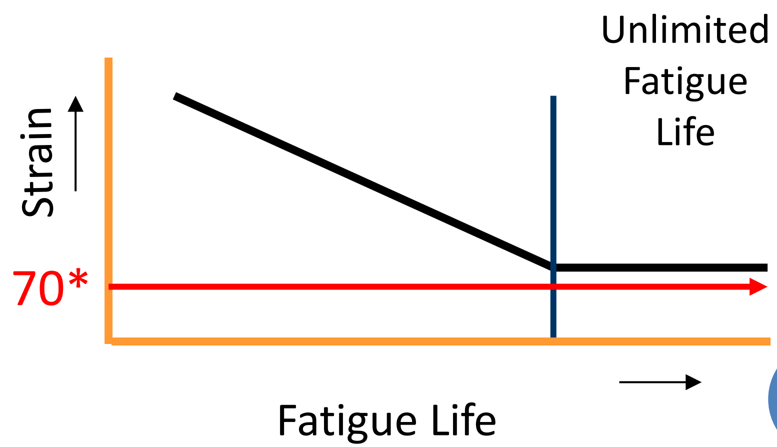
- Three layer system
- Each layer designed to resist specific distresses
- Base – designed to resist fatigue and moisture damage, to be durable
- Intermediate/binder – designed for durability and stability (rut resistance)
- Surface – designed to resist surface initiated distresses (top-down cracking, rutting, other)

Perpetual Pavements

High Strain = Short Life

Low Strain = Unlimited Life

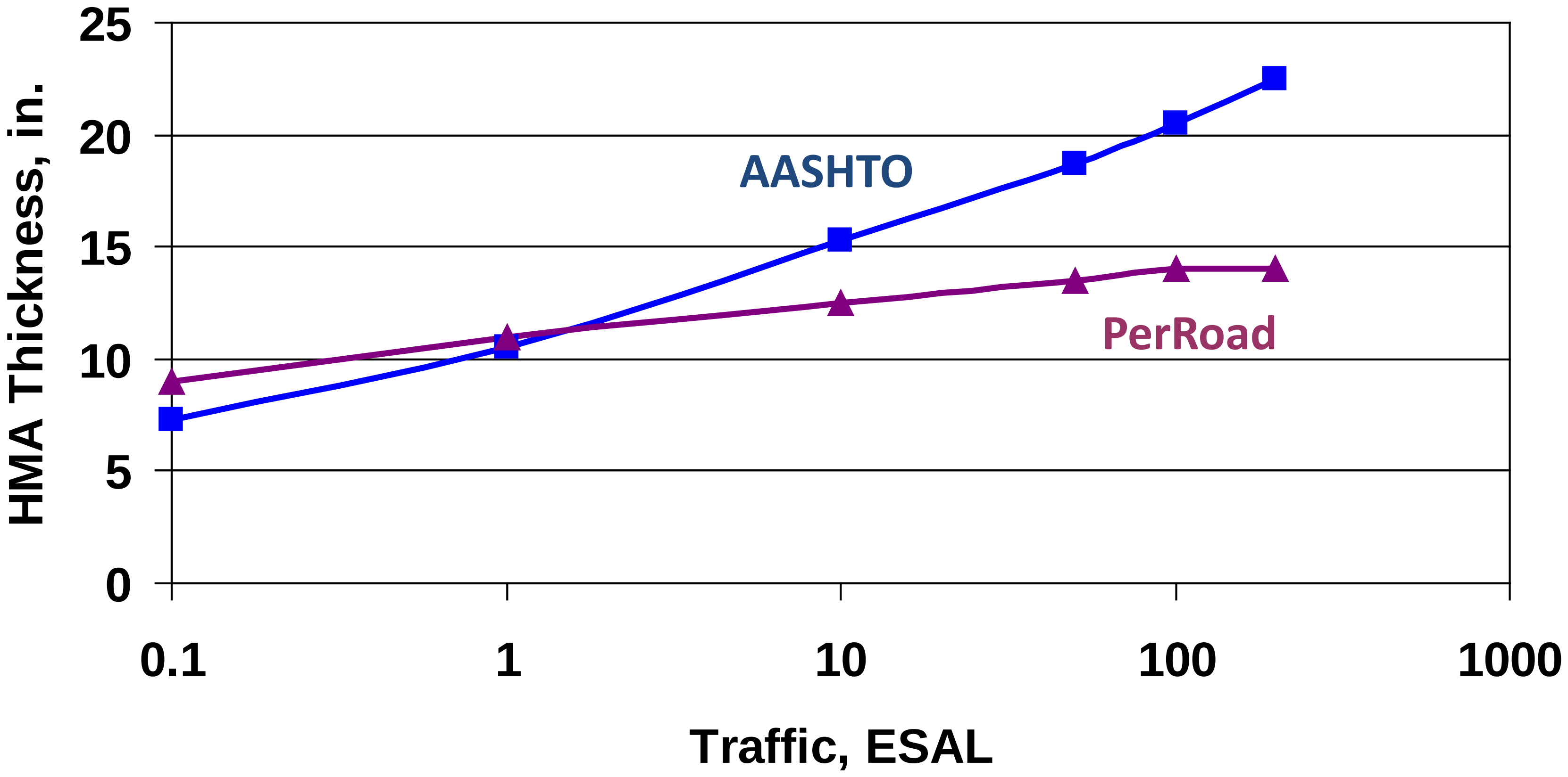




That Sounds Expensive

- Not necessarily
- Pavement thickness may be comparable to or even less than conventional
- Existing pavements may be or could become perpetual
- Costs for later rehabilitation are lower
- User delay costs are lower
- Safety is improved

Perpetual Pavement vs. Conventional Design



Design Options

- Stage construction
  - Plan for added thickness
- Make existing pavements perpetual with overlays
  - Where structure is adequate or nearly so
- Low to medium volume roadways
  - Not necessarily thicker and more expensive than conventional
- Rubblized concrete pavement foundation

Surface Renewal

- Repair surface distresses before they become structural
  - Mill and fill
  - Thin overlay
- Quick
- Cost effective

Performance and Case Studies

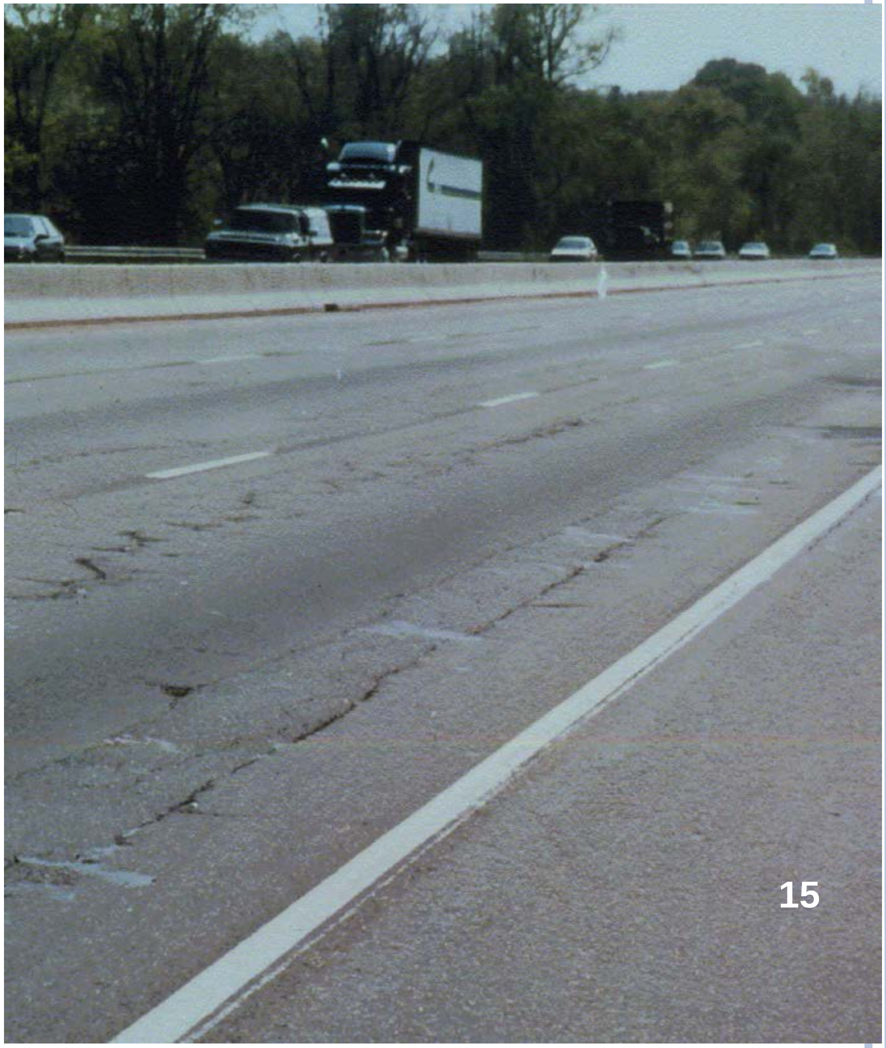
- APA Perpetual Pavement Awards
  - Pavements more than 35 years old
    - Some *50-70* years old
  - No more than 4 inches added thickness
  - Overlays at least 13 years apart
  - More than 70 awarded since 2000

New Jersey I–287

- Original construction in 1968
  - No rehab for over 26 years
  - Surface repairs to existing pavement
- 10" of HMA on 8" crushed stone base on 10" of sand subbase
- Heavy traffic
  - 110,000 ADT in 1993 with 22% trucks
  - 20-year ESALs = 50 million
  - Slow, congested traffic
- Cores and FWD showed base was OK.

Fee; Rowe

I-287 Rehabilitation

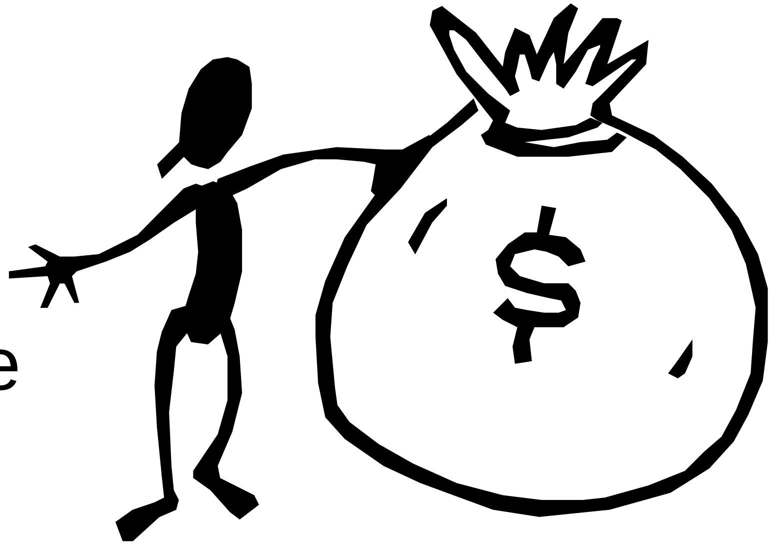


Mill 3” and Overlay with 4”

After rehab: structural capacity = 69 million ESALs

“Indeterminate pavement life” with surface renewal.

I-287 Economics



- Total rehab cost estimate
  - $429,000 per lane mile
  - No user costs included

- Perpetual pavement cost estimate (mill and fill)
  - $139,000 per lane mile
  - Faster construction → less delay, lower user costs

Case Studies: Ohio Study of Flexible Pavements

- Examined performance on 4 Interstate routes
  - HMA pavements - Up to 34 Years without rehabilitation or reconstruction
  - "No significant quantity of work . . . for structural repair or to maintain drainage of the flexible pavements."

Case Study – Red Hill Valley Parkway

- 1997, Hamilton, Ontario
- Expected traffic up to 90,000 vehicles per day
- Environmentally sensitive area

Red Hill Valley Parkway

- 20 year Deep Strength design
  - 30 million ESALs
  - Total thickness 760 mm
  - 140 mm HMA, 150 granular base, 450 subbase
- 50 year Perpetual Pavement design
  - 90 million ESALs
  - Total thickness 760 mm
  - 120 mm HMA, 80mm Rich Bottom mix, 150 mm granular base, 370 mm subbase
- Life cycle costs favored Perpetual Design

Red Hill Valley Parkway

- Perpetual Pavement vs. conventional
  - Reduced total CO_2 emissions
  - Reduced life cycle energy consumption
  - Somewhat higher emissions and energy for materials processing for initial construction
  - Much lower for later maintenance

Other Case Studies

- Washington State – I-90 (Mahoney)
  - No section required structural repair
  - Ages ranged from 23 to 35 years
  - Time to first resurfacing from 12 to 18.5 years
- Kansas Interstates (Romanoschi; Cross and Parsons)
  - Low strains in flexible pavements on US 75
  - Asphalt pavements more economical than PCC over 40 year life

Projects to Watch

- I-710 in California – perpetual pavement design constructed in 2003 with very heavy traffic (200 million ESALs!)
- Marquette Interchange in Wisconsin – instrumented pavement under heavy traffic
- I-695 around Baltimore – 175,000 vehicles per day

Costs of Congestion

- TRIP report: Congestion
  - Weakens our global competiveness
  - Reduces productivity
  - Leads to higher prices for consumers
- TAMU study: In 2011, congestion
  - Wasted 2.9 billion gallons of fuel
  - Caused 5.5 billion hours of lost productivity
  - Cost $121 billion dollars
  - Caused 56 billion pounds of CO_2 emissions

Asphalt Pavements Reduce Congestion

- Opened to traffic sooner
- Are built faster
- Are maintained more easily
- Can be placed at night, reducing congestion

- Also reduce air pollution and are safer

Benefits of Perpetual Pavements

Sustainability/Environmental Benefits

- Better use of resources
- The ultimate in recycling
- Reduced CO_2 emissions
- Reduced energy consumption

Benefits of Perpetual Pavements

Economics

- Lower life cycle costs
- Reduced user delays and costs
- No structural repairs means lower cost rehab
- Little to no added thickness preserves curb and gutter elevations, overhead clearance

Perpetual Asphalt Pavements

- Sustainable pavement lasting more than 50 years with periodic surface renewal
- Environmental and societal benefits
- Design tools available
- Experience on different traffic roads in different climates and condition
- Conventional construction
- Economical
- *History of successful use*

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