


2004 SEAUPG Conference - Baton Rouge

Perpetual Pavements 

Perpetual Pavements

Quality Issues

Southeast Asphalt
User-Producer Group
November 16, 2004


www.AsphaltAlliance.com

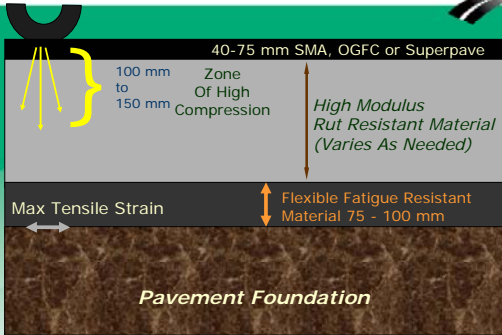
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Perpetual Pavements 

If you have quality, then you won't have issues!

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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

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Value

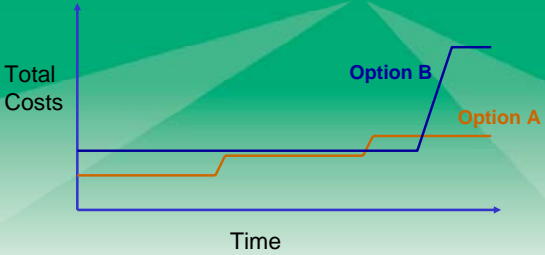
Quality in a product or service is not what the supplier puts in. It is what the customer gets out and is willing to pay for. A product is not quality because it is hard to make and costs a lot of money, as manufacturers typically believe. This is incompetence. Customers pay only for what is of use to them and gives them value. Nothing else constitutes quality.

Peter Drucker

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Economics




Total Costs

Option B

Option A

Time

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Why are Perpetual Pavements Important?

- Lower Life Cycle Cost
 - Better Use of Resources
 - Low Incremental Costs for Surface Renewal
- Lower User Delay Cost
 - Shorter Work Zone Periods
 - Off-Peak Period Construction


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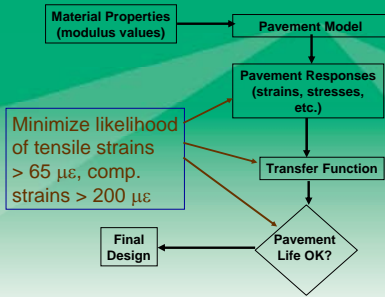
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Quality in Design

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Mechanistic-Based Design



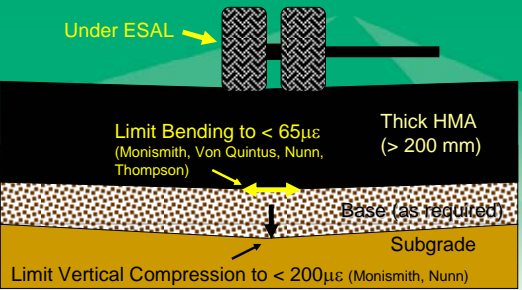
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    graph TD
      A[Material Properties (modulus values)] --> B[Pavement Model]
      B --> C[Pavement Responses (strains, stresses, etc.)]
      C --> D[Transfer Function]
      D --> E{Pavement Life OK?}
      E --> F[Final Design]
      E --> C
      G[Minimize likelihood of tensile strains > 65 με, comp. strains > 200 με] --> C
      G --> D
  
```

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Mechanistic Performance Criteria



Under ESAL

Limit Bending to $< 65\mu\epsilon$ (Monismith, Von Quintus, Nunn, Thompson)


Thick HMA ($> 200\text{ mm}$)

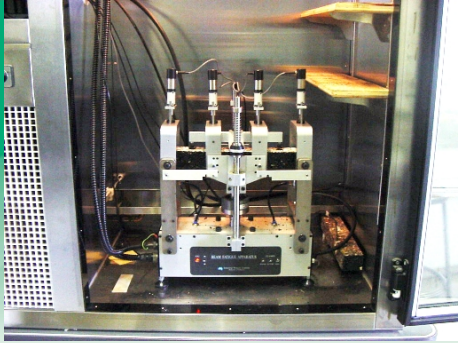
Base (as required)

Subgrade


Limit Vertical Compression to $< 200\mu\epsilon$ (Monismith, Nunn)

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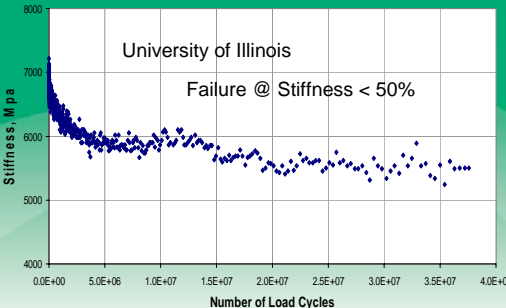
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70 Micro Strain Test




University of Illinois

Failure @ Stiffness $< 50\%$

Stiffness, Mpa

Number of Load Cycles

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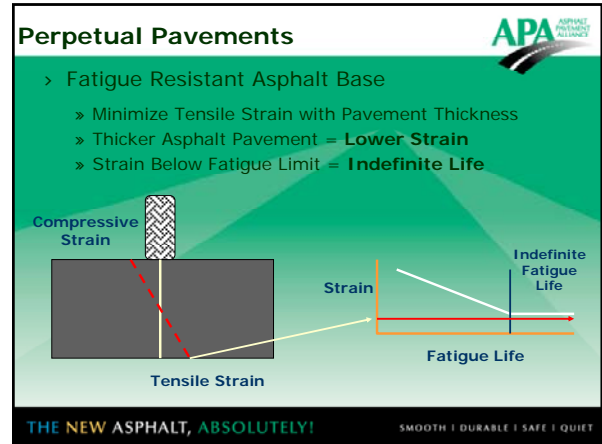
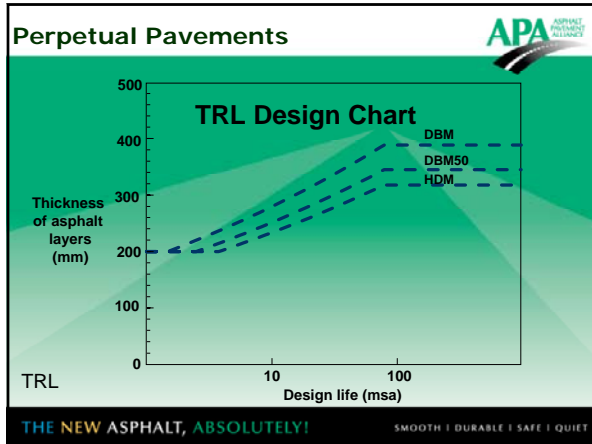
Significance of Fatigue Endurance Limit

“...such a limit would provide a thickness limit for the pavement..Increasing the thickness beyond the limiting thickness... would provide no increased structural resistance to fatigue damage and represent an unneeded expense.”

Prof. Carpenter

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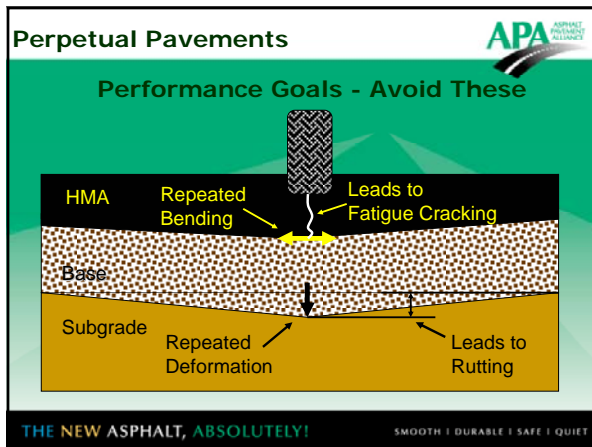
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PerRoad

Logos for the Asphalt Pavement Alliance (APA), the National Center for Asphalt Technology (NCAT), and Auburn University (AU).


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- Perpetual Pavements
- Key Components**
- Based on fully functional M-E design software
 - Layered elastic analysis
 - Incorporates
 - Seasonal effects
 - Thickness variability
 - Material property variability
 - Load Spectra
 - Deterministic and Probabilistic analyses
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- Perpetual Pavements
- Quality in Design**
- Design it to last.
 - Thick HMA
 - Threshold strains
 - Right materials in the right places
 - Stable Foundation
 - Construction
 - Performance
 - Finnish Philosophy
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Quality in Materials

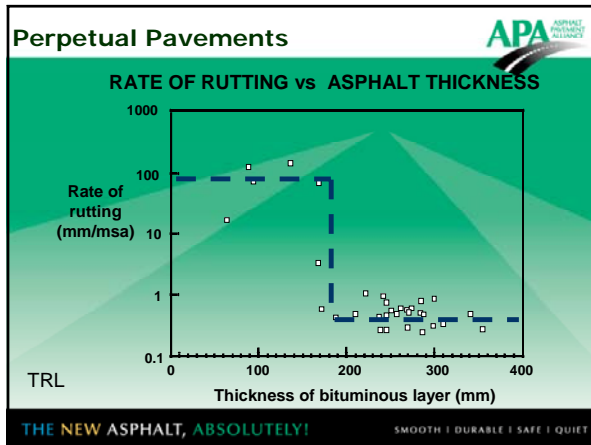
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Perpetual Pavements 

- > Rut Resistant Upper Layers
 - Aggregate Interlock
 - > Crushed Particles
 - > Stone-on-Stone Contact
 - Binder
 - > High Temperature PG
 - > Polymers
 - > Fibers
 - Air Voids
 - > Avg. 4% to 6% In-Place
 - Surface
 - > Renewable
 - > Tailored for Specific Use



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Moisture Sensitivity

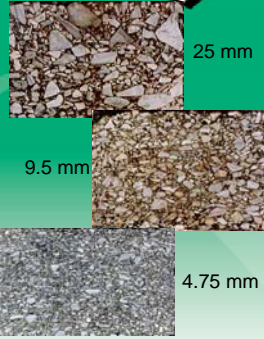
- Design
 - Avoid large stone/thin lifts
 - Mix Design
 - Film thickness
 - Testing
 - Additives
- Materials
 - Aggregates
 - Performance history
 - Type of mineralogy
 - Construction
 - Rain
 - Aggregate Drying
 - Compaction, Compaction

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Lift Thickness

- NCHRP Report 531:
 - Coarse - 4X NMAS
 - Fine - 3X NMAS
 - These are *minimums*
- Thin lifts cool faster
 - less time available for compaction




25 mm

9.5 mm

4.75 mm

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Quality in Materials

- Can you specify quality?
 - Only to the degree that you don't prevent it.
 - Mix type selection
 - Lift thickness
 - Performance testing is important.
 - Rutting in surface mixes
 - Moisture sensitivity when it is called for


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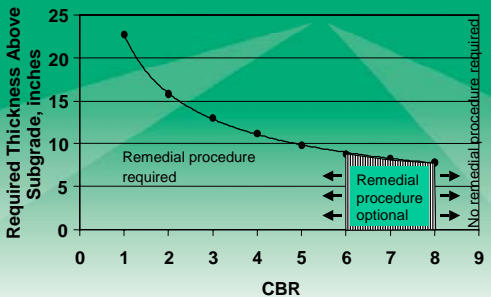
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Quality in Construction

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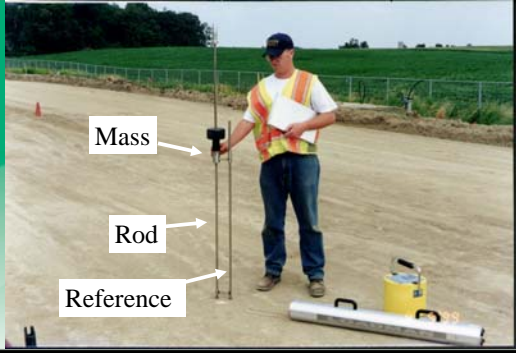
Foundation - Illinois



CBR	Required Thickness Above Subgrade (inches)	Remedial Procedure Status
1	~23	Required
2	~16	Required
3	~13	Required
4	~11	Required
5	~10	Required
6	~9	Optional
7	~8	Optional
8	~7	Not Required
9	~6	Not Required

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Compaction Support

Weak Support Leads to Poor Compaction!



Weak!!!

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Compaction Support

Strong Support Helps Compaction!



Strong!!!

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If you don't need a joint don't use one.

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If you need one, make it better than this.

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Consistency is the key, segregation isn't!



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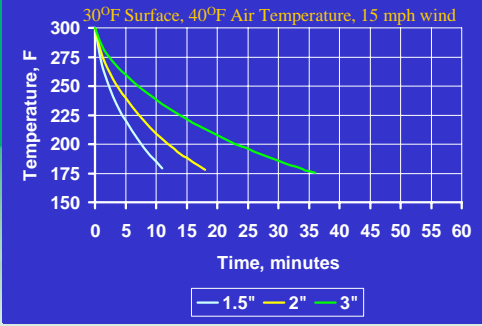
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30°F Surface, 40°F Air Temperature, 15 mph wind

Time (minutes)	1.5" Thickness (F)	2" Thickness (F)	3" Thickness (F)
0	300	300	300
5	250	270	280
10	200	230	250
15	180	210	230
20	170	200	220
30	165	190	210
40	160	185	205
50	155	180	200
60	150	175	195


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Quality in Performance

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Performance of Washington Interstate Flexible Pavements (based on 284 km)

Statistic	Time Since Original Construction (years)	Thickness of Original AC (mm (in.))	Time from Original Construction to First Resurfacing (years)
Average	31.6	230 (9.2)	12.4
Range	23 to 39	100 to 345	2 to 25


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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.”
 - Only small incremental increases in Present Cost for HMA pavements.

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FHWA - Data from Long-Term Pavement Performance Study

- Data from GPS-6 (FHWA-RD-00-165)
- Conclusions
 - Most AC Overlays ≥ 15 years before Rehab
 - Many AC Overlays > 20 years before Significant Distress
 - Thicker overlays mean less:
 - Fatigue Cracking
 - Transverse Cracking
 - Longitudinal Cracking

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Rehabilitation 

Possible Distresses

- Top-Down Fatigue
- Thermal Cracking
- Raveling

Solutions

- Mill & Fill
- Thin Overlay

50 - 100 mm


Structure Remains Intact



High Quality SMA, OGFC or Superpave

20+ Years Later

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Perpetual Pavement

- Structure Lasts 50+ years.
 - Bottom-Up Design and Construction
 - Indefinite Fatigue Life
- Renewable Pavement Surface.
 - High Rutting Resistance
 - Tailored for Specific Application
- Consistent, Smooth and Safe Driving Surface.
- Environmentally Friendly
- Avoids Costly Reconstruction.

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Quality - The Last Word.

A pavement cannot perform any better than it is built.

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PAVING
ALLIANCE

**If you don't
have quality,
you have an
issue!**

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