Sustainable and economical pavements with a novel class of SBS polymers

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Erik J. Scholten
Contents of the presentation

- Key elements of the concept of superior modified asphalt mixes
- Demonstrating the concept
  - Asphalt mix fatigue
  - Comparing structures using Finite Element Modelling
  - Full scale trial at NCAT
- Design examples
- Concluding remarks
Preparing for tomorrow’s requirements

Superior modified asphalt mixes are now possible
  ▪ High modulus, fatigue resistant bitumen bound base courses
  ▪ Up front Cost Savings and reduced ecological impact through thickness reduction
  ▪ Perpetual pavement at standard thickness

Kraton Polymers’ new SBS grades
  ▪ make it possible with current equipment
The logical next step

<table>
<thead>
<tr>
<th>Original macadam</th>
<th>Separation of function</th>
<th>Increased Loading</th>
<th>Design continuity</th>
<th>Practicality of construction</th>
<th>Modification</th>
<th>Rut Resistance</th>
<th>Heavy Modification</th>
<th>Thin overlays</th>
<th>Crack Resistance</th>
<th>Enhanced Binder Course</th>
<th>Crack resilience</th>
<th>SAMI</th>
<th>Very High Modif</th>
<th>Base Course</th>
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Fatigue Resistant Base Course Through Highly Modif Hard bitumens

Enhanced Binder Course

Crack resilience

SAMI Very High Modif

Base Course

Through Highly Modif Hard bitumens

Fatigue Resistant Base Course Through Highly Modif Hard bitumens

Enhanced Binder Course

Crack resilience

SAMI Very High Modif

Base Course

Through Highly Modif Hard bitumens
The importance of fatigue resistance

<table>
<thead>
<tr>
<th>Traffic Level</th>
<th>Fatigue Resistance</th>
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<tr>
<td>Low traffic</td>
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<tr>
<td>Medium traffic</td>
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<td>High traffic</td>
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<td>Very high traffic</td>
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<td>Total asphalt mix thickness</td>
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Testing & Modelling

Polymer

Asphalt fatigue tests

Fundamental asphalt tests

Modelling asphalt for 1 element

Modelling elements into a structure

Calculate ‘damage’ from repeated load
Making it possible with current equipment

**Challenges:**

- Hard base bitumens (40-70 pen)
- High SBS content
- Storage stability

> Issues solved by adapting design of the polymer

**Kraton D 243**

- Provides a low viscosity, even in hard bitumens at elevated SBS content
- Provides compatibility
- Provides storage stable PMBs with most base bitumens
Fatigue lines

Max aggregate Ø 22 mm
Void content 5%
Bitumen content 4.6%

Measured with full sine loading in 4 point bending (20° C, 8 Hz)
Modelling, comparing options

1
7.5% D 243
150mm
Limited damage

2
6% standard SBS
150mm
More damage
6% not enough

3
Unmodified
250mm
Lots more damage
Despite 66% thicker
Equivalent to 5x higher rutting depth than (1)
National Center for Asphalt Technology, Auburn, Alabama

- Test track with dedicated trucks
  10 year heavy traffic simulated in 2 years
- Began June 2009
- Interim feedback set for Summer 2010

Kraton Polymers sponsors:

- Reduced base course thickness test section
- Using Kraton HiMA base course binder
- Comparison to be made with standard thickness, unmodified base course section
Design examples

- Design calculations with Shell Pavement Design Manual
- Inland climate
- Taking into account sub grades with CBR = 2-30%
- Gravel sub base: 100-300 MPa

Standard asphalt mix:
Stiffness at 20° C – 8 Hz: 8900 MPa
Fatigue equation:

\[ N = 6.10^{11} x^{-3.36} \]

Polymer modified mix:
Stiffness at 20° C – 8 Hz: 9900 MPa
Fatigue equation:

\[ N = 3.10^{21} x^{-7.30} \]
Thickness reduction capability with weak sub grades

(1) Thickness determined by asphalt strain criterion
(2) Thickness determined by sub grade strain criterion

HiMA = Highly Modified Asphalt
Thickness reduction capability with good quality sub base

(1) Thickness determined by asphalt strain criterion
(2) Thickness determined by sub grade strain criterion

HiMA = Highly Modified Asphalt
Concluding remarks

- Thickness reduction of 20-60% depending on base layers
  - Reduce eco impact by reduced resource use
  - Up front cost reduction

- Enhance performance for sustainability
  - Perpetual pavements without excessive base courses

- Enabled by Kraton polymer innovations
  - Efficient interaction between polymer and bitumen
  - Compatibility and workability
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