May new roads be less safe for a while?

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Innovative (e.g. noise reducing) asphaltic surface layers can have lesser skid resistance, both wet and dry, in first hours, days, weeks, months after laying, if no action is taken, like gritting or change of mix composition.
Summary

Why should we care?

Traffic safety risk is about ¼ of end-of-service low friction risk, non-negligible.

What is the cause?

Exposed bitumen/mortar/mastic with low microtexture (wet) prone to bituplaning (dry)
Summary

Can we solve the problem?
In principle yes: make exposed (but well-embedded) aggregate stand out
- by removing the bituminous coating
- by changing mix composition
- by gritting, but logistics are difficult on porous/thin surfacings

Can we understand the solutions?
Maybe, but not yet quantitatively
Contents

Historical development of the challenge
Assessment of the safety risk
Possible solutions?
Modeling film thickness
Conclusions
Surfaces from then till now

- 1960’s DAC 0/16
  - always gritted (chip-treated), no initial friction problems
- 1970’s SMA 0/11 (and 0/8)
  - sometimes gritted, sometimes not, problems yet unknown
- 1980’s PA 0/16
  - initially low dry friction (bitu-planing), initial wet friction OK
- 1990’s 2-layer PA 4/8 or 2/6 + 11/16
  - initially low dry & wet friction
- 2000’s texture optimised thin surface layers
  - initially low (dry? &) wet friction
- 2000’s PA 0/16 + 1%(mass) extra bitumen
  - initially low dry & wet friction
Contents

Historical development of the challenge
Assessment of the safety risk
Possible solutions?
Modeling film thickness
Conclusions
Estimate of accident risk increase 1/3

Road type
- Motorways
- Sec. roads

Risk Ratio

Friction class

Portorož, Slovenia
### Estimate of accident risk increase 2/3

<table>
<thead>
<tr>
<th>Network</th>
<th>Motorway initial</th>
<th>Sec. roads initial</th>
<th>Motorway overdue</th>
<th>Sec. roads overdue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>PA</td>
<td>SMA</td>
<td>PA</td>
<td>SMA</td>
</tr>
<tr>
<td>Service life (yrs)</td>
<td>12-14</td>
<td>15-20</td>
<td>12-14</td>
<td>15-20</td>
</tr>
<tr>
<td>Part of network with less friction</td>
<td>8%</td>
<td>6%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Fraction of year with less friction</td>
<td>6% (3 weeks)</td>
<td>6% (3 weeks)</td>
<td>100% (1 year)</td>
<td>100% (1 year)</td>
</tr>
<tr>
<td>Risk increase</td>
<td>25%</td>
<td>53%</td>
<td>25%</td>
<td>53%</td>
</tr>
<tr>
<td>Total higher yearly risk</td>
<td>0.12%</td>
<td>0.19</td>
<td>0.38</td>
<td>0.80</td>
</tr>
</tbody>
</table>
Traffic safety risk increase is about 0.1-0.2% (1-2 extra accidents/injured/fatalities per 1000), if these kind of pavements were applied untreated to 100% of the road network.

This is about ¼ of end-of-service low friction risk.

This is non-negligible.

But, it is more manageable (known moment, limited period) if you don’t hide for the facts.
Contents

Historical development of the challenge
Assessment of the safety risk
Possible solutions
Modeling film thickness
Conclusions
Solutions?

Make exposed (but well-embedded) aggregate stand out

• by removing the bituminous coating
• by changing mix composition
• by gritting
Removing the bitumen

Pneumatic tyre roller after Infrared reheating the surface

Did not work well, damaged the mix
Thoughts behind mix changes

- Wet friction
  - increasing micro texture of “binder” film
- Dry friction
  - increasing viscosity of “binder” film
Changes in mix composition

2005: four test sections 2-layer PA with different additives

Only two additives seemed to work, but did not work consistently in later trials

Additives seem to have negative effect on durability (ravelling)
Mastic with higher viscosity and more texture might be less ‘sticky’ ???
2-layer PA 4/8 (between wheelpaths)

Wet friction, 50 km/h, 86% slip, 0.5 mm water

Weeks in traffic
Improvement of wet skid resistance

![Graph showing wet skid resistance DVI over weeks of traffic NS wp]

- A15
- Zebra A28
- Zebra A30

Portorož, Slovenia
Improvement of wet skid resistance

- **A15**
- **Zebra A28**
- **Zebra A30**

**Wet skid resistance DVI**

- **weeks of traffic IB wp**

- **Portorož, Slovenia**
Challenges in gritting

- No gritting devices allowed between asphalt finisher and first roller, otherwise they’ll damage the asphalt.

- Mix temperature is critical at application of chips:
  - too cold: chips won’t be embedded in mastic
  - too hot: chips may be fully ‘submerged’ in mix

- Porous and/or thin layers cool very fast!
Challenges in gritting

- Chipping size critical relative to mastic film thickness and nominal aggregate size in mix
  - too big won’t be embedded in mastic
  - too small will be fully ‘submerged’ in mastic
  - possibly 0.5 – 1 mm is best ???
- Homogeneous amount of chippings needed, to avoid ‘bald’ patches, or ‘ridges’ damaging the mix
- Fear for detrimental effects on noise and drainage (turned out to be unjustified, if chippings applied carefully)
Chip size relative to binder thickness
Chippings 1/3 on PA 4/8
Brake test on PA 4/8 + chippings 1/3
Crushed slag 0/1 on PA 4/8

Portorož, Slovenia
Challenges in gritting; solutions?

- Chip spreaders between 1st and 2nd roller passes (need own motor, but speed dependent, ‘hop in, hop out’ logistic nightmare)
- Chip spreader on roller? (problems on turning points, stops needed for refilling)
- Chip spreader on asphalt finisher? (seems to work quite well, still stops needed for refilling)
Spreading device on finisher

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Contents

Historical development of the challenge
Assessment of the safety risk
Possible solutions
Modeling film thickness
Conclusions
Modeling film thickness / coverage

- Bitumen film thickness = volume of bitumen / surface area of all aggregates
- Mortar film thickness = volume of (bitumen + filler) / surface area of (sand + coarse aggregates)
- Mastic film thickness = volume of (bitumen + filler + sand) / surface area of coarse aggregates
- “Binder film” thickness: bitumen + aggregates in increasing size until they protrude from film
- “Coverage”: area of protruding fines / area of coarse aggregates
- Seek correlations with skid resistance
“binder” thickness & “coverage”
Modeling film thickness / coverage

2PA-pilots
wet skid resistance at various days versus coverage

\[ y = -0.0776x + 0.606 \]
\[ R^2 = 0.0081 \]

\[ y = 0.1671x + 0.534 \]
\[ R^2 = 0.098 \]

\[ y = -0.0222x + 0.5012 \]
\[ R^2 = 0.0005 \]

\[ y = -0.6499x + 0.5358 \]
\[ R^2 = 0.2618 \]

\[ y = 2.5887x + 0.096 \]
\[ R^2 = 0.7278 \]

\[ y = 4.4255x - 0.0161 \]
\[ R^2 = 0.6476 \]

\[ y = 0.4592x + 0.3246 \]
\[ R^2 = 0.1453 \]
Modeling film thickness / coverage

- Looks promising when mix composition is known accurately from “as-built” determination
- Does not seem to make sense when mix composition is taken from asphalt plant “recipe”
- Seems more research is desirable
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Historical development of the challenge
Assessment of the safety risk
Challenges associated with gritting
Modeling film thickness

Conclusions
Conclusions 1/3

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Conclusions 2/3

Why should we care?

Traffic safety risk increase is about 0.1-0.2% (1-2 extra accidents per 1000),

i.e. ¼ of end-of-service low friction risk, non-negligible, (but manageable??)

What is the cause?

Exposed bitumen/mortar/mastic,
with low microtexture (wet skid resistance),
prone to bituplaning (dry skid resistance)
Conclusions 3/3

Can we solve the problem?

In principle yes: make exposed (but well-embedded) aggregate stand out

- by removing the bituminous coating
- by changing mix composition
- by gritting, but logistics are difficult on porous/thin surfacings

Can we understand the solutions?

Maybe, but not yet quantitatively
May new roads be less safe for a while?

Preferably not, especially if we can prevent it

Thank You!