Low temperature characterization of bituminous binders

“How relevant are binder test methods for prediction?”

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How to easily identify durable materials for long-lasting pavement?

Field experiment...

- Time and labour cost-effective
- Reliable test methods to predict binder performances in road pavement

... Laboratory experiment

Asphalt mixture & binder test method

- Effective binder performances” ranking
- Realistic ageing impact on binder
- Distinguish long lifespan binder VS insidious ones
- Huge investigation and large period of time
- Materials quantities
- Available experiments field
Description of test methods

Thermal Stress Restrained Specimen Test (as control test method)
Cooling rate: 10°C/h

Fraass breaking point
Cooling rate: 1°C/min

Asphalt Binder Cracking Device
Cooling rate: 10°C/h

Bending Beam Rheometer
**Objectives:** Assess several binder test methods (Fraass, ABCD, BBR) on their ability to predict low temperature failure behavior as measured through TSRST (control test method).

**Investigation program:**

<table>
<thead>
<tr>
<th>Bitumen</th>
<th>Crosslinked PmB</th>
<th>Physical Blend PmB</th>
<th>TSRST</th>
<th>Fraass-O</th>
<th>ABCD-O</th>
<th>BBR-O</th>
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<th>AC 10 surf</th>
<th>Content (%)</th>
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<td>Binder</td>
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<td>Voids</td>
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**TRSRT test results**

- Generally enhancement due to polymer modification
  - Optimum performance at 3.5% modification
  - Investigated physical blends no better than the unmodified bitumen
- Impact of bitumen sources variability decreased by polymer modification
Unmodified bitumen: prediction trends from binder tests

Fraass is more severe and poor predictive tool; ABCD is more optimistic.

BBR appears to be relevant

- rheologically « simple behavior »
- relationship between stiffness and failure
Polymer modified Bitumen: prediction trends from Fraass binder test

There is no universal correlation between Fraass and TSRST failure temperatures.

Fraass is still more severe…
Polymer modified Bitumen: prediction trends from ABCD binder test

ABCD is still slightly optimistic…

ABCD predicts optimistically polymer modification on TSRST performance…

… Correlations could possibly be established on the basis of « product families »

ABCD is over-sensitive in case of physical blend
Polymer modified Bitumen: prediction trends from BBR binder test

Impact of polymer content

Monotonous decrease of $T_{S=300\,\text{MPa}}$ with increasing polymer content

No significant changes for $T_{m=0.3}$

But existence of an optimum performance at 3.5% polymer content for TSRST
Polymer modified Bitumen: prediction trends from BBR binder test

Polymer modification at 3.5% enhances more dramatically TSRST than BBR

Polymer modification at 5% is similar to unmodified bitumen trends

BBR stiffness may be correlated to TSRST performance…

… but only on a « case per case » basis (families of products)
Conclusion and prospect

In comparison to TSRST . . .

- Fraass test appears as non relevant, very likely due to operating conditions (cooling rate, fatigue cracking contribution, etc...) which are too severe.

- ABCD, which mimics TSRST, is however more optimistic and is not related to TSRST in a unique way (e.g.: it is over-sensitive in the case of physical blends).

- BBR, not being a failure test, may only predict TSRST performance through correlations. Those are however not universal and have to be established per « families or products » (e.g. pure bitumen, PmB at a given polymer content, ....)

- Wider investigation on sensitivity to ageing of test methods in additional paper (#413)
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