INTERNATIONAL ROAD CONGRESS
Innovation in Road Infrastructure

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FÉDÉRATION ROUTIÈRE INTERNATIONALE

Long Term Evolution of SBS Crosslinked PmB in Comparison with Conventionnal Bitumen: Field Study

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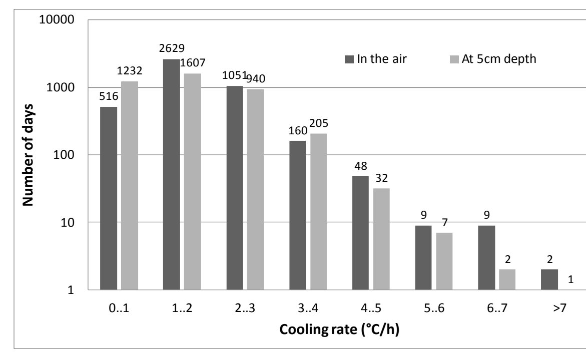
TOTAL

Valais (CH) Test Sections – 1988-2002

- 16 binders tested in the lab and on the road
- 16 test sections of 300 m length each
  - Same structure and mixes - 4.5% air void
- 4 plain bitumens / 3 plant mixes / 12 PmB
  - Same binder content: 5%
- Test sections laid on N9 motorway in 1988
- On site inspection of the surface layer durability
  - Binder extraction (classical and rheological testing)
  - Observations made after 4, 7 and 10 years of traffic, in 1992,1995 and 1998
  - Follow up until 2002 (14 years)



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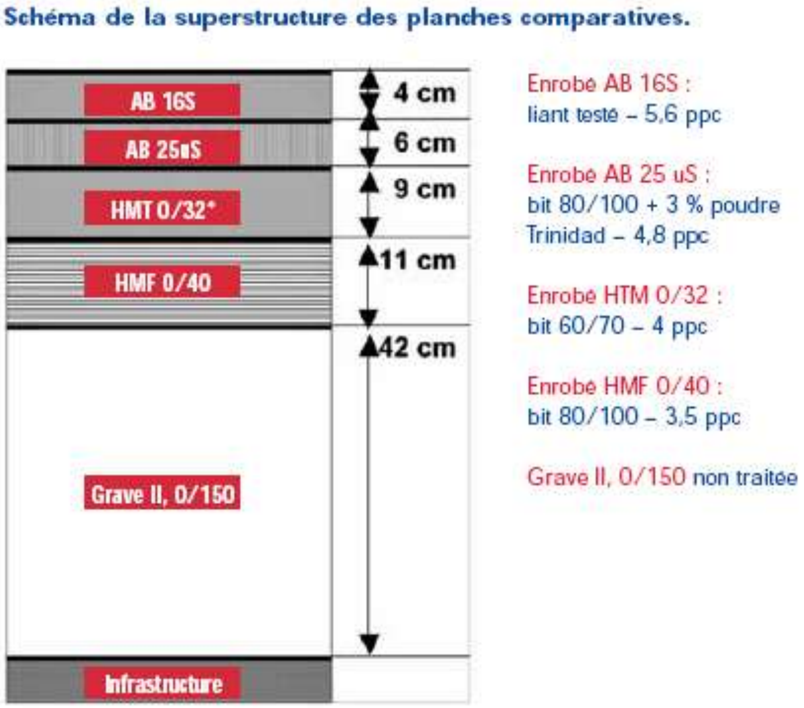
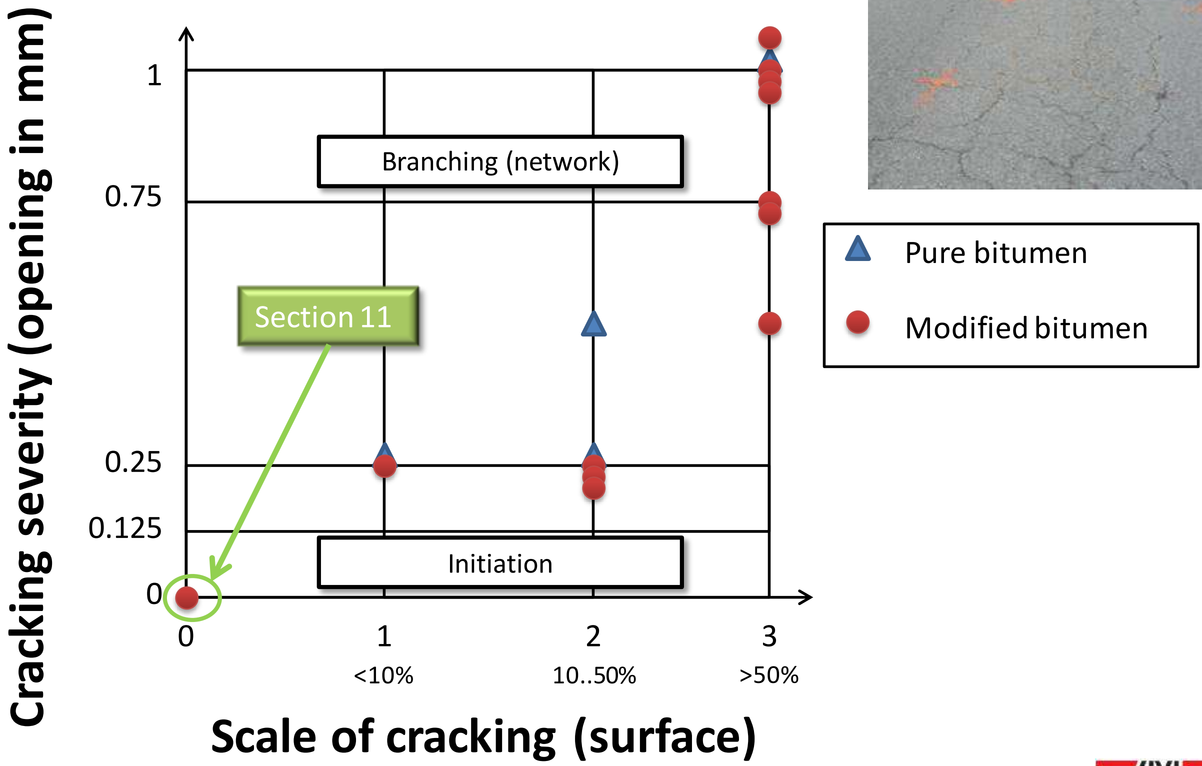
Valais Test Sections – Pavement Design



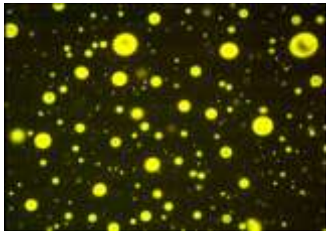
- 4 cm wearing course
  - 5.6 ppc
- 6 cm Binder course
  - 80/100 pen + TLA – 4.8 ppc
- Base courses
  - Bound layer
  - Unbound layer

Valais Test Sections – Results



Valais Test Sections – Conclusions

- **PmB's low temperature properties depends on**
  - Their base bitumen
  - Their polymer modification process including polymer nature
  - Aging state
- **Homogeneous Elastomer PmB's (at µm scale level) tend to be more stable upon aging and feature better cold behavior**
- **BBR m-value seem to discriminate PmB's**



100 µm

- **Test sections in good health → On-going monitoring until 2007**
  - Total 80/100 : end of life 2002 (14 years)
  - Styrelf 13/80 : end of life 2009 (21 years)

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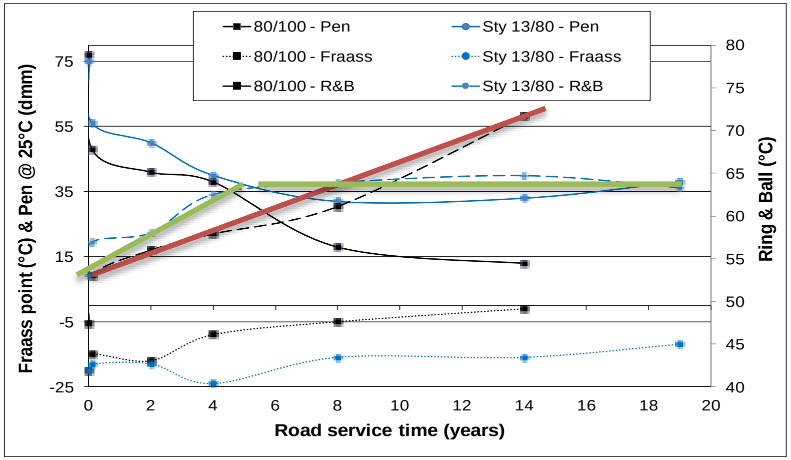
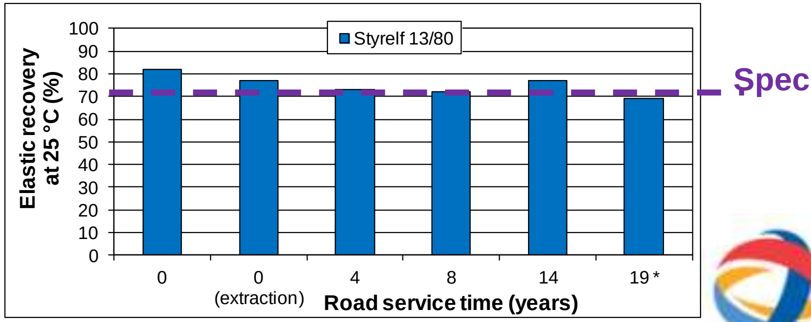
Pure vs Styrelf – Further Investigation (2002-2007)

- Mechanical and chemical analysis of mixes and binders (Styrelf 13/80 and pure bitumen 80/100)
  - Emergency Lane and Right Lane
  - Initial, RTFOT, PAV, can aged, 2, 4, 8, 14, 19 years (mixes and extracted binder)
  - Pen, R&B, Fraass, ER, Traction, BBR, GPC, IRTF + Modulus, Fatigue, TSRST, Uniaxial Traction.
- References
  - *Durability Study : Field Aging of Conventionnal and Polymer Modified Bitumen*, TRB2010, Dreessen & al
  - *Ageing Gradient in a 19-Year-old Wearing Course in Switzerland*, ISAP2010, Gallet & al

Pure vs Styrelf – Classical performances

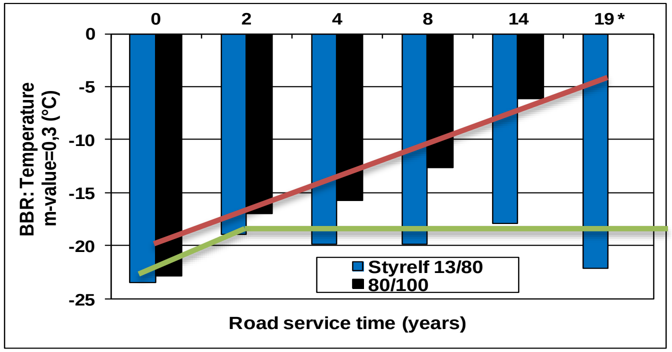
- Strong hardening during plant mixing
- Pure binder 80/100
  - Continuous evolution
  - Hard binder at 14 years
- Styrelf 13/80
  - Stabilization after 4-8 years
  - Elastic performances: OK after 19 years

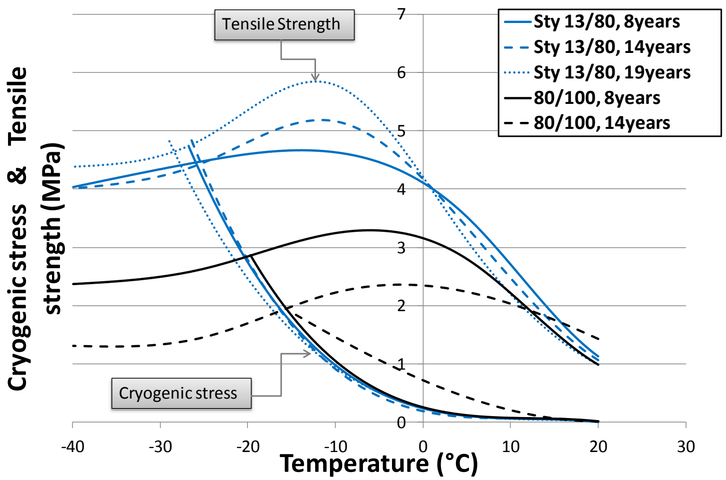


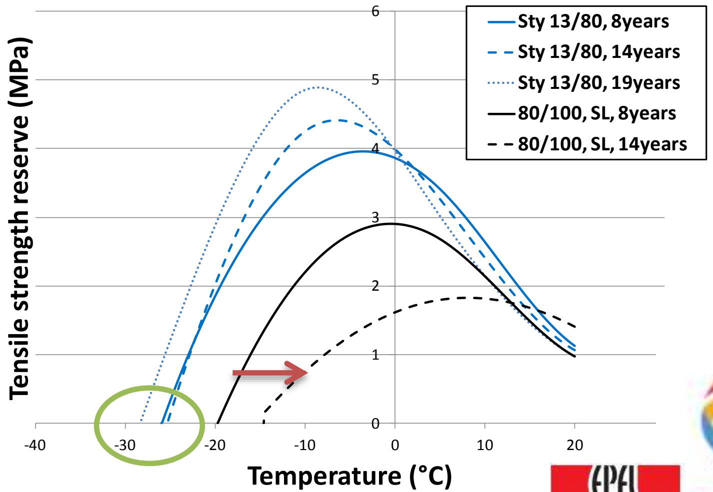


Pure vs Styrelf – Low Temperature Performances

- Conventionnal 80/100
  - Continuous hardening up to 14 years
- Styrelf 13/80:
  - No degradation after 8 years







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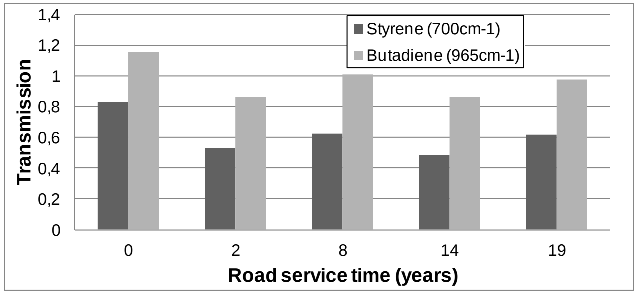
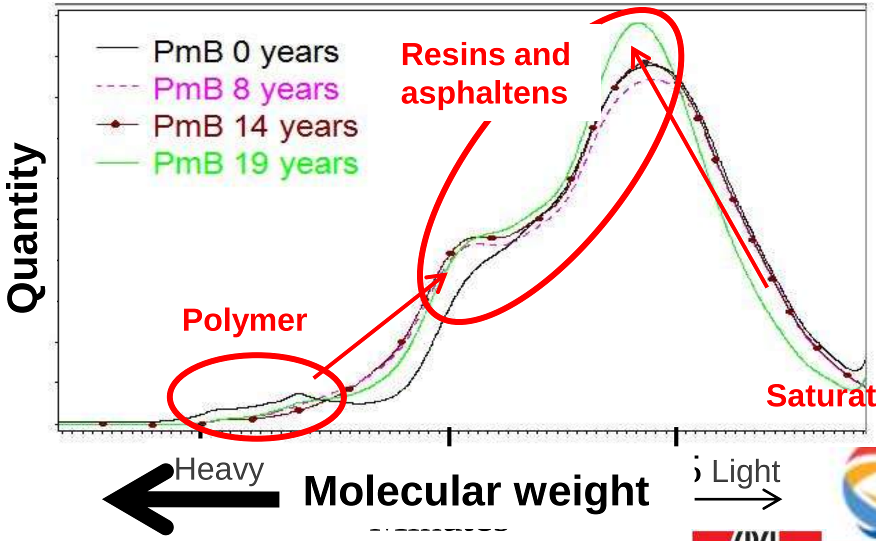
Pure vs Styrelf – Polymer evolution in Styrelf 13/80

- Monomere content is stable
- Bitumen oxydation
  - Aromatics → Resins & Asphaltenes
- Polymer evolution
  - Polymer size diminution
  - Hyp: Partial polymer chain scission





Conclusions

- Better resistance of Crosslinked PmB Styrelf 13/80
  - Lifetime: up to 21 years with no cracks
  - Less sensitive to aging than conventional 80/100
  - No further evolution after 8 years: binder (BBR) and mix (TSRST)
  - Homogeneous dispersion (@ µm scale)
- Polymer evolution
  - Possible chain scission
  - Still present and efficient after 19 years

Questions

From Western Europe

to

Russia **soon** …

Ageing Gradient

- Top 15 mm
  - Performances lost
  - Polymer degraded
- Below
  - Binder intact

Characterization		0 year (initial)	0 year (extracted)	RTFOT	PAV 40h	19 years (can aged)	Slow Lane			Emergency Lane		
							Who.	Top.	Bot.	Who.	Top.	Bot.
Penetration at 25°C	1/10mm	75	56	52	27	68	38	24	44	46	26	62
Softening point (R&B)	[°C]	53	56,9	57,9	71	56,4	63,3	68,1	61,2	61,2	67,3	57,8
PI Pfeiffer	[-]	0,6	0,7	0,7	1.5	1,1	1	0,8	0,9	1	0,9	1,1
Fraass breaking point	[°C]	-20	-18	/	/	-15	-12	-10	-16	-18	-12	-17
Plasticity range	[°C]	73	75	/	/	71	75	78	77	79	79	74
Elastic recovery @25°C	[%]	82	77,3	78	X	80	69,0	X	73,8	76,0	X	82,5

- Top 15mm = Protection
- Few diffusion of oxydation