

AV '17 KONFERENCE ASFALTOVÉ VOZOVKY 2017

Using a rejuvenating binder to help regenerate reclaimed asphalt

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28. – 29. listopadu 2017, České Budějovice

Motto: Asfaltové vozovky – bezpečná cesta k prosperitě

Agenda

Recycling

- ➔ Recycling scheme
- ➔ Different regeneration mechanisms
- ➔ Recycling in France (some figures)

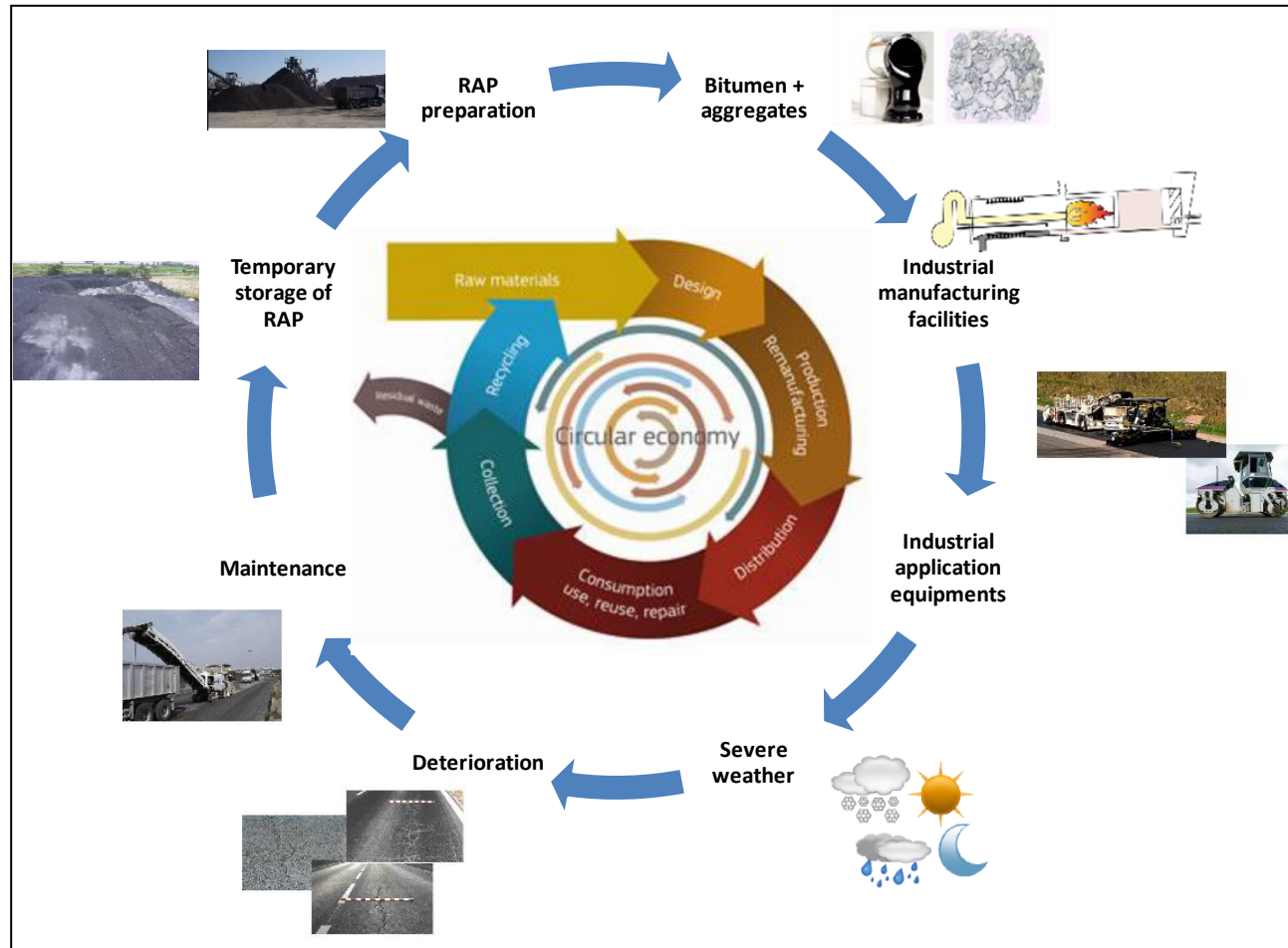
Study

- ➔ Site construction
- ➔ Characterization of asphalt mixes
- ➔ Determination of the rate of regeneration

Conclusions and prospects

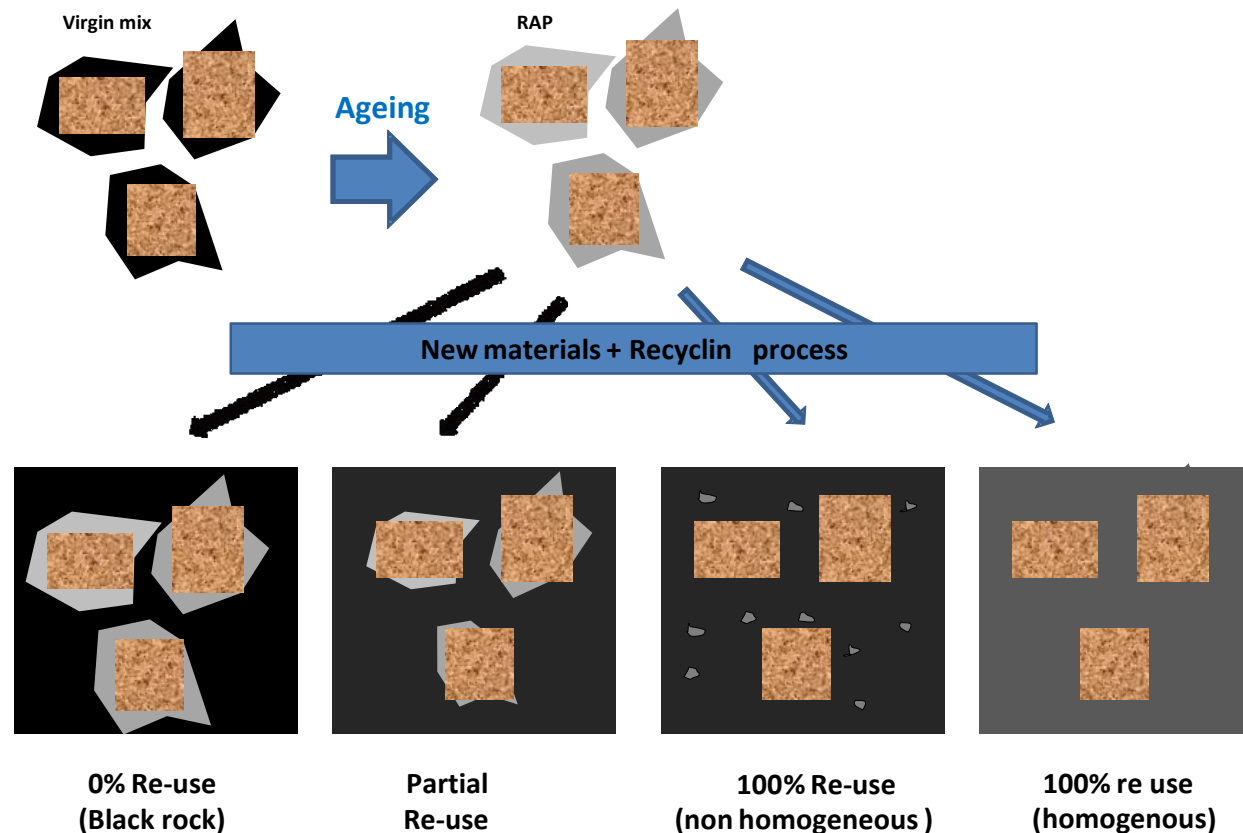


Recycling Scheme

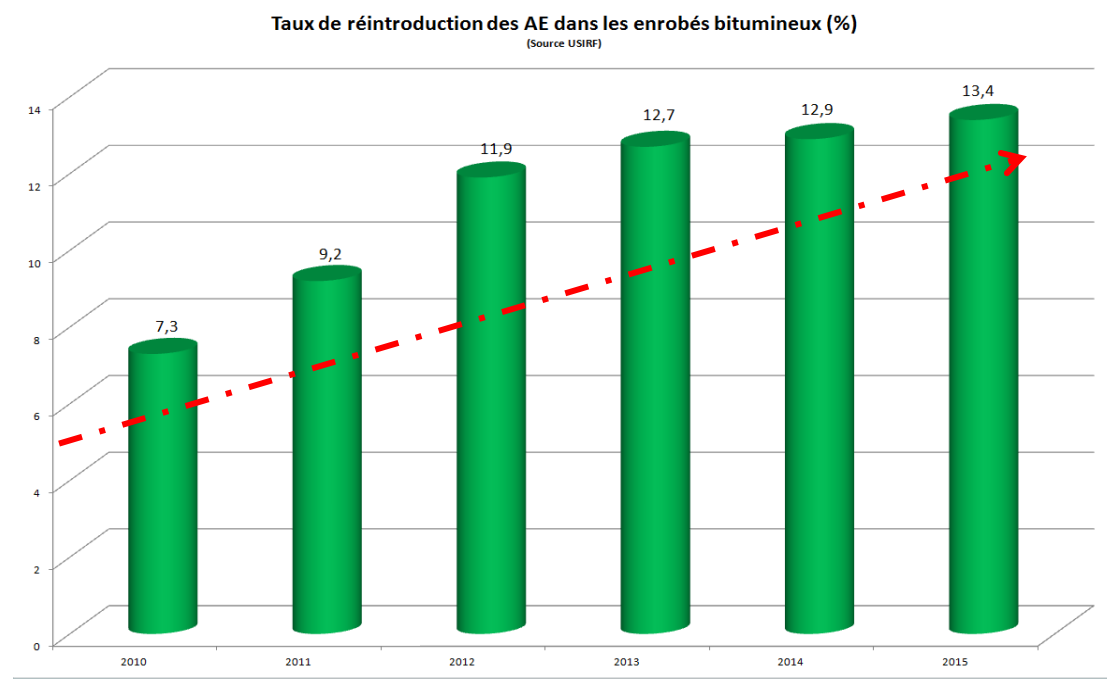


Regeneration Mechanisms

The various regeneration mechanisms possible during a recycling process



Recycling in France



Recycling raised up from 7.3 to 13.4% between 2010 and 2015 in France

Challenges:

- ➔ Most appropriate binder
- ➔ Recombination of both binders
- ➔ Lab characterization

Site trial and lab study

Organisation of site

Site trial on A29 (North-West of France)

- ➔ High modulus asphaltic concrete
- ➔ RAP content = 50%
 - Pen = 18 $1/10$ mm
 - R&B = 71°C
 - Total binder content = 6%_w

Date of trial : 04/05 September 2012

Two sections:

- ➔ Section with Rejuvenator (grade 50/70) on 2.4 km
- ➔ Section of reference with Multigrade 35/50 on 2.9 km



Asphalt mixes characterizations

	Test Standard	Rejuvenator		Multigrade		bitumen 50/70
		Site	Lab	Site	Lab	Lab
Gyratory compaction (% voids)	NF EN 13108-1	6.5	7.4	8.4	5.8	6
Water resistance (r/R)	EN 12697-12-B	0.98	0.97	0.98	0.89	0.96
Resistance to rutting (%)	EN 12697-22	f : 4.4 F : 4.2	f : 4.2 F : 3.9	f : 3.5 F : 3.2	f : 3.2 F : 2.8	f : 2.7 F : 2.8
Stiffness (Mpa)	EN 12697-26	12109	12349	9345	8597	9571
Fatigue (Eps6)	EN 12697-24	105 ± 3	100 ± 6	158 ± 5	144 ± 9	103 ± 4

- ➔ **Good correlation between lab and site**
- ➔ **All mixes show similar rutting resistance and water resistance.**
- ➔ **However, the blend with rejuvenating binder has a higher stiffness, but a lower fatigue resistance compared to the Multigrade bitumen**

Lab study – Aging

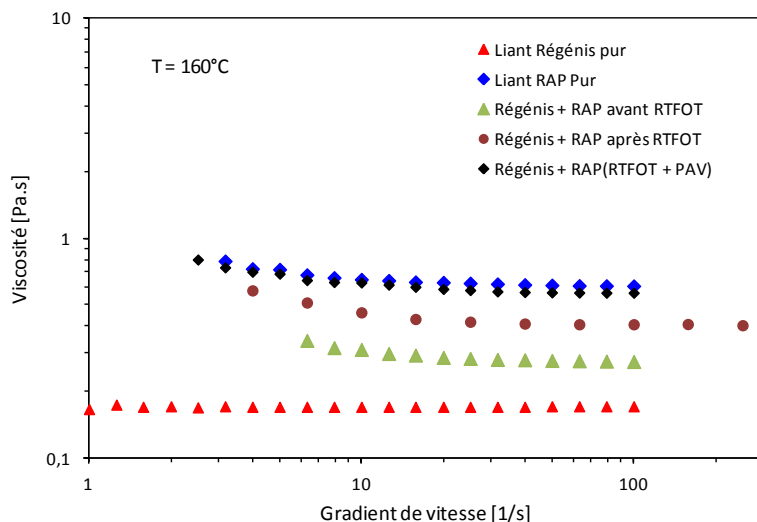
3 mixtures at lab scale were performed by mixing : 40% of RAP binder + 60% of new binder (hypothesis : 80% of remobilization on site)

	Virgin mixture			After RTFOT			After RTFOT + PAV		
Binder	Pen	R&B	Fraass	Pen	Retained pen	R&B	Pen	R&B	Fraass
	1/10mm	°C	°C	1/10mm	%	°C	1/10mm	°C	°C
Multigrade + RAP binder	21	66.7	-12	17	78	73.2	13	80.6	-5
Rejuvenator + RAP Binder	25.5	56.2	-9	20	79	60.1	14	65.8	-4
Bitumen 50/70 + RAP binder	28	57.9	-14	22	77	63.6	15	69.6	-5

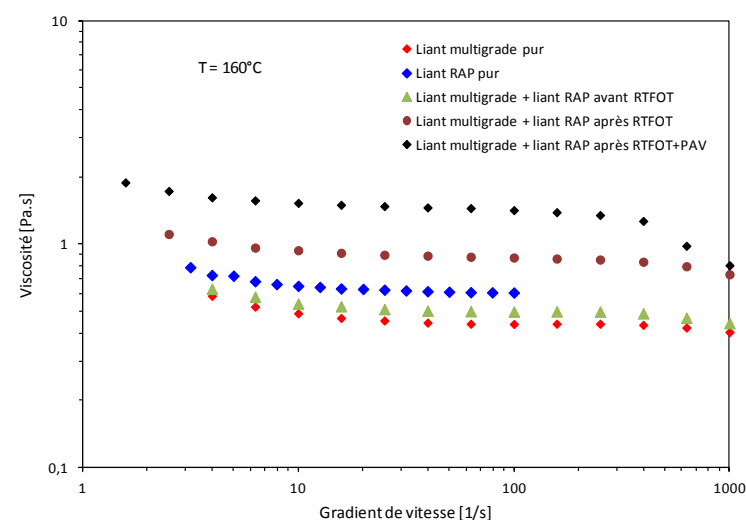
- ➔ Aging tendency higher with Multigrade
- ➔ Rejuvenator is the least sensitive binder to aging
- ➔ Low trends

Lab study – Aging vs. viscosity

Mixture with rejuvenator



Mixture with Multigrade



After PAV : η (Mixture rejuvenator+ RAP binder) $\approx \eta$ (Pure RAP binder): due to the low viscosity of rejuvenator the aging phenomenon is slowed: a twice-aged binder has the same viscosity as a once-aged binder

After PAV : η (Multigrade + RAP binder) $\approx 2.5 \eta$ (Pure RAP binder). Harder binder \rightarrow cracking

Cold properties after aging (Rejuvenator) are more efficient than those with Multigrade: less cracking.

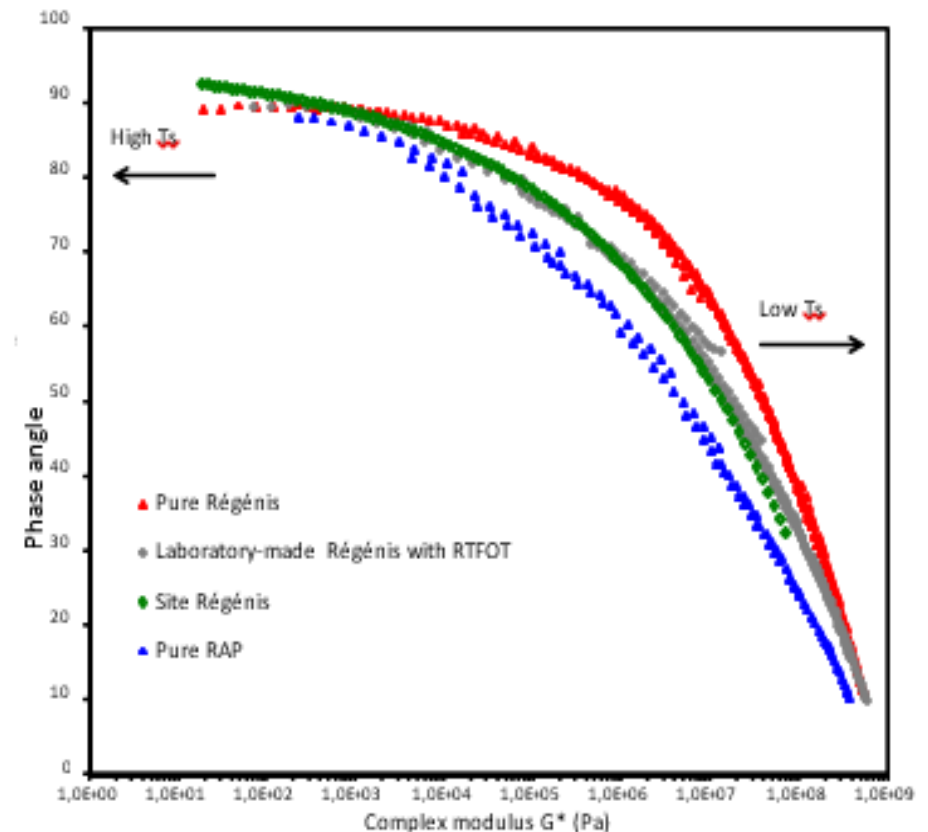
Lab study – Estimation of the rate of regeneration (1/3) Case of rejuvenator

Used method:

- 1) Frequency sweep (G' vs. ω) at different temperatures from -10 to 100°C in the linearity domain
- 2) Plot of data (Phase angle δ vs. complex modulus G^*) according to black diagram

As reminder:

- Rejuvenator site = 50% RAP binder + 50% Rejuvenator
- Rejuvenator Lab = 40% RAP binder + 60% Rejuvenator



- ➔ Very good superposition between lab and site
- ➔ RTFOT is very well correlated with mixing in plant
- ➔ Rate of regeneration?

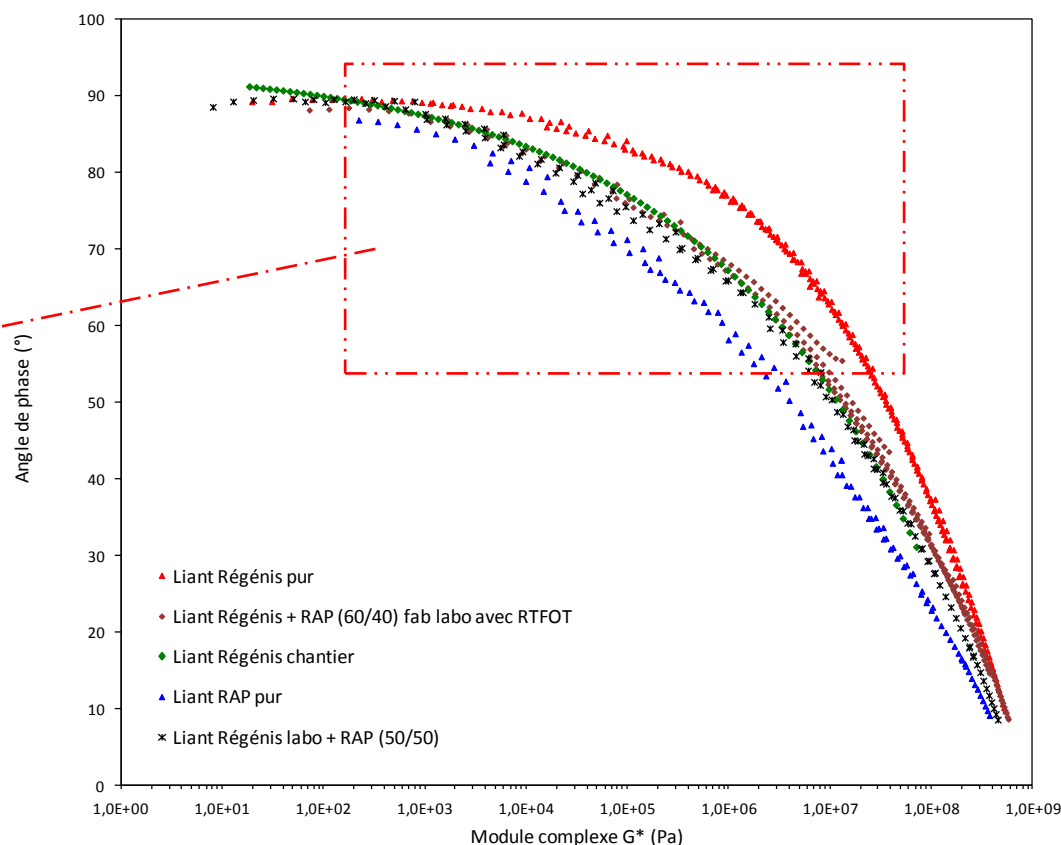
Lab study – Estimation of the rate of regeneration (2/3)

Case of rejuvenator

As reminder:

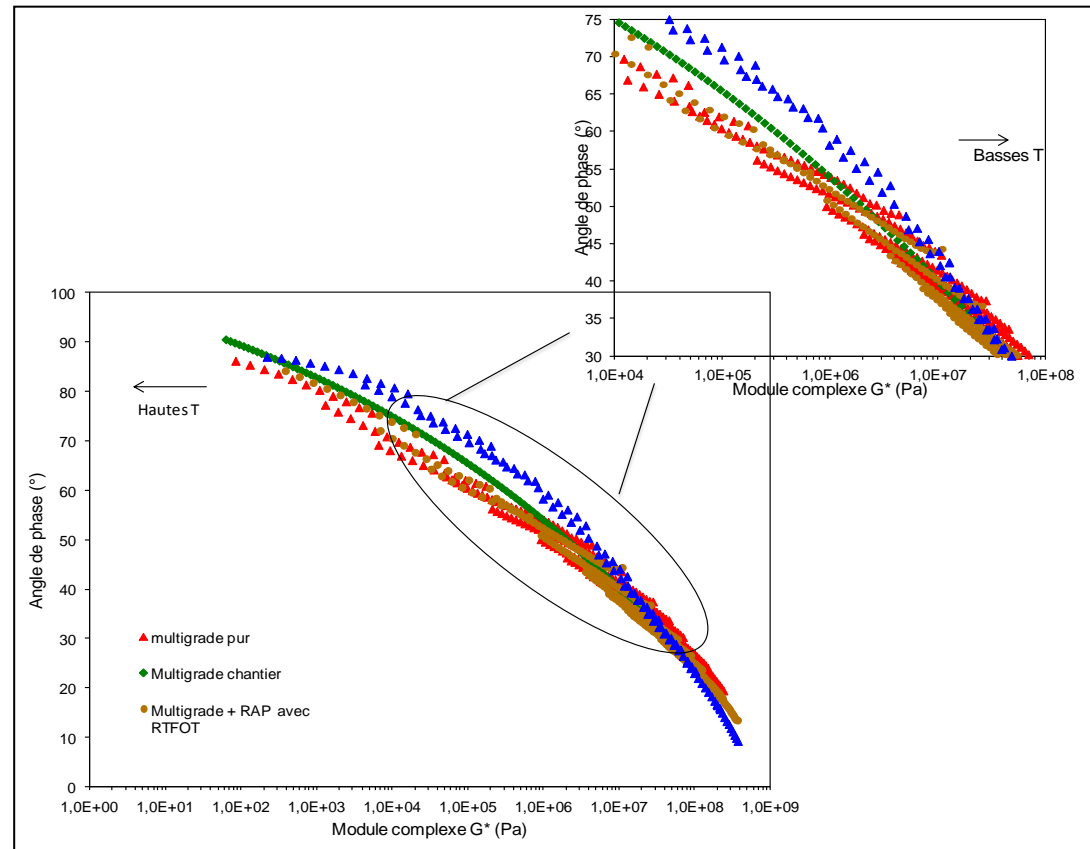
- **Site = 50% RAP binder + 50% rejuvenator**
- **Lab = 40% RAP binder + 60% rejuvenator after RTFOT**
- **Lab = 50% RAP binder + 50% Rejuvenator after RTFOT**

The rate of regeneration is between 80 and 100% but close to 80%.



Lab study – Estimation of the rate of regeneration (3/3) Case of Multigrade

- ➔ Bad superposition with Multigrade and black diagram is not applicable
- ➔ Mixture « Multigrade/ RAP binder» behaves more viscous than the case of RAP binder due to the high viscosity of Multigrade binder
- ➔ The percentage of regeneration is too difficult to determine in this case and the rate is probably very low.



Conclusions

Very good superposition between lab and site

All mixes present similar rutting and water resistance.

The mixture with the rejuvenating binder has a better stiffness but a lower fatigue resistance compared to the Multigrade bitumen.

Thanks to the use of a rejuvenating binder, the evolution of the aging of the reconstituted binder is reduced.

A remobilization percentage between 80 and 100% for the TOTAL rejuvenating binder mixture.

This percentage is lower for the other binders studied and in some cases is difficult to determine (case of Multigrade).

Prospects

In the continuity of this project and to verify the results obtained at lab scale, series of coring on the track will be carried out in the beginning of 2018 (5 years after use).

A second core drill is scheduled for 2020 to confirm the results obtained and assess long-term aging.

In addition, other tests will soon be launched at the laboratory scale to confirm the regeneration rates of the binder aged in the final product.