



Use of rejuvenators in asphalt mixtures

10-11 September 2019
Padova (Italy)



Use of rejuvenators : a pragmatic approach from Belgium

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Introduction

- Belgium: front-runner worldwide for use of RA (reclaimed asphalt)
 - success story petroleum crisis in 70-ties
 - important experience with hot recycling
 - application % very high in base and binder layers (up to 60 %)
- However, reuse forbidden in surface courses ↔ allowed in the past (90ties till 2009; *forbidden > 2010 with new version of standard*) ; since 2019 reintroduced to max 20% for low volume roads (AC-surf)
- Increasing issues in case of multiple reuse : ‘multi-recycling’ due to ageing of the binder (‘black rock’)



Need the use of rejuvenators to reactivate the aged binder
⇒ Maintain or improve the performance characteristics

Use of rejuvenators

- Needs and questions coming up with their use
- More practical experiences needed => 2 projects ongoing : Re-RACE and Rejuvebit

Topics	Re-RACE	REJUVEBIT
Functioning of rejuvenator		
Impact on performance : binder evaluation		
Impact on performance : asphalt level		
Procedure for screening efficiency of rejuvenator		
Standard Methodology for lab evaluation (e.g. ITT - gap in EN standards)		
Validation study : link lab (ITT) – practice		
Global evaluation on sustainability : Important for Green Public Procurement		
Gain experience in production with the use of rejuvenators and construction on the road (% RA + rejuvenators)		
Start and duration project	1/6/17 – 2 y	1/11/18 – 2 y

Re-RACE: set up study

- Research project : Re-RACE ‘Rejuvenation of Reclaimed Asphalt in a Circular Economy’
- Collaboration BRRC – Stadsbader Inc and Kraton Chemical (supplier Sylvaroad™ RP1000)
- Study aiming mainly for:
 - Detailed binder and asphalt evaluation
 - Standard procedure ITT with rejuvenator
 - Validation lab with practice - link
- E&E 2020 : 2 papers submitted
 - S.Vansteenkiste et al: on test sections
 - T.Tanghe et al: on labstudy – ITT



Re-RACE: test sections

- Test sections 7 to 11 September 2017 on the production site of the contractor
- Six variants:
 - Base layers AC- base 14 (APO-B) – 4.2 % binder:
 - Mix AC –base 14 with 50 % RA
 - Mix AC –base 14 with 70 % RA
 - Mix AC –base 14 with 70 % RA + rejuvenator
 - Toplayers AC- Surf 14 (APT-B) – 5.5 % binder :
 - Mix AC – surf 14 with 30 % RA
 - Mix AC – surf 14 with 50 % RA
 - Mix AC – surf 14 with 50 % RA + rejuvenator

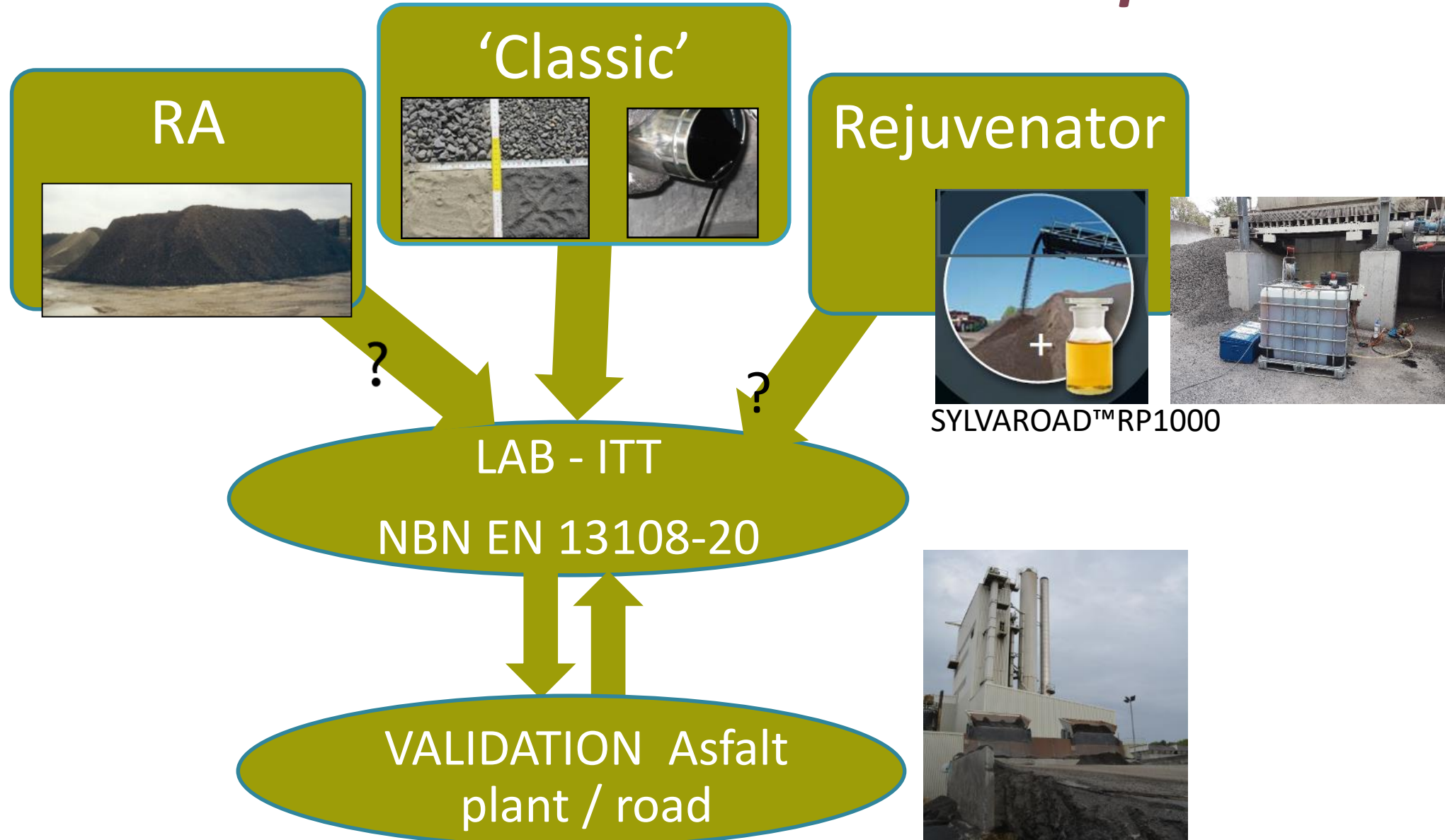


Re-RACE: test program

- Test program $\neq$ phases :
 - During asphalt production: dosage rejuvenator, T-measurements, time interval ...
 - During compaction: T-measurements in situ, follow up compaction, homogeneity of compaction,...
 - Taking of bulk material: determination compactibility , water sensitivity, stiffness, ...
- A posteriori:
 - On cores: water sensitivity and rutting
 - Recovery binder : empirical and rheological tests on binder
 - Follow up durability in time
- Link ITT : on raw materials taken at moment of test sections: compactibility , water sensitivity, stiffness, fatigue, rutting on same mix compositions as sections



Re-RACE : Lab - asphalt- ITT



Re-RACE: Link plant – lab

Procedures adding rejuvenator in practise

On RA on conveyor belt to parallel drum (upstream)



Directly in mixer

In binder

<https://youtu.be/346eHEa7zTE>

A – Upstream of RAH drier drum:

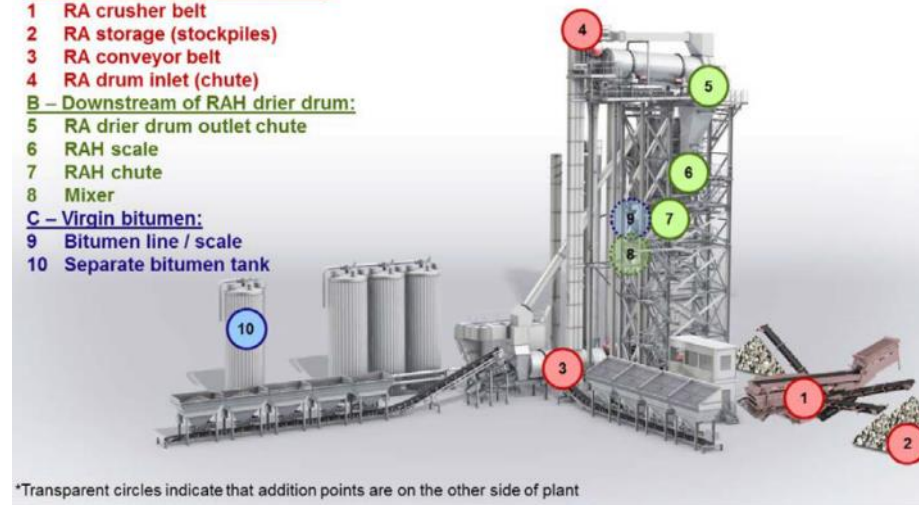
- 1 RA crusher belt
- 2 RA storage (stockpiles)
- 3 RA conveyor belt
- 4 RA drum inlet (chute)

B – Downstream of RAH drier drum:

- 5 RA drier drum outlet chute
- 6 RAH scale
- 7 RAH chute
- 8 Mixer

C – Virgin bitumen:

- 9 Bitumen line / scale
- 10 Separate bitumen tank



Source: Boesiger et al., EATA June 2017

EAPA Workshop on the use of rejuvenators in asphalt mixtures. 10-11 Sep 2019. Padova (Italy)

Re-RACE: Link plant – lab

Way of adding rejuvenator : practice => lab

On RA on conveyor belt to parallel drum

‘ COLD ’



- Rejuvenator equally dropped over cold and spread RA
- RA + rejuvenator:
Oven 2.5 ± 0.5 h at 130°C
- Mix sequence : NBN EN 12697-35
- Aggregates – RA – binder – filler

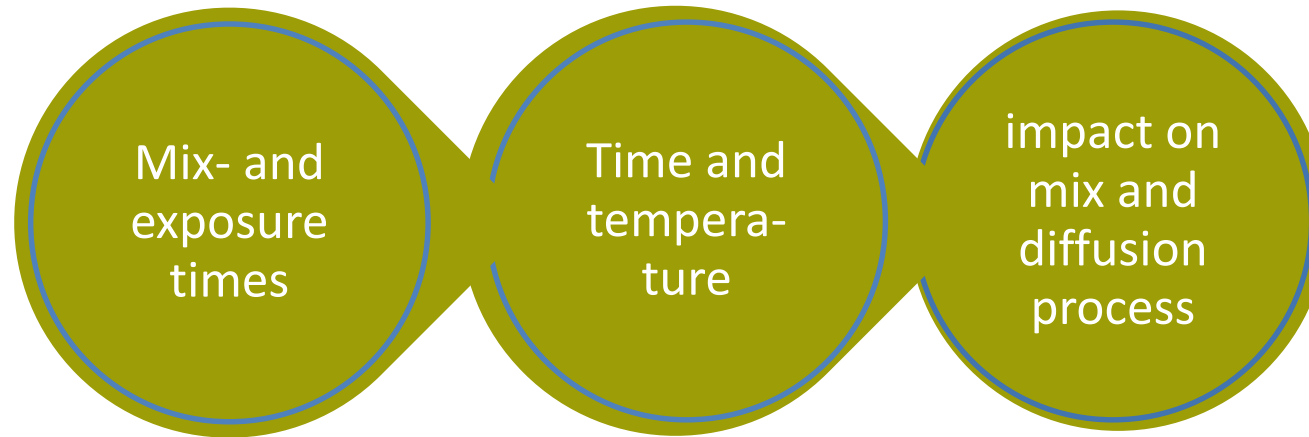
Directly in mixer

‘ WARM ’



- Rejuvenator equally dropped on warm RA in mixing bowl at start
- RA :
Oven 2.5 ± 0.5 h at 130°C
- Mixing sequence: $\neq$ NBN EN 12697-35
 - RA - Aggregates – binder – filler

Re-RACE: Exposure time

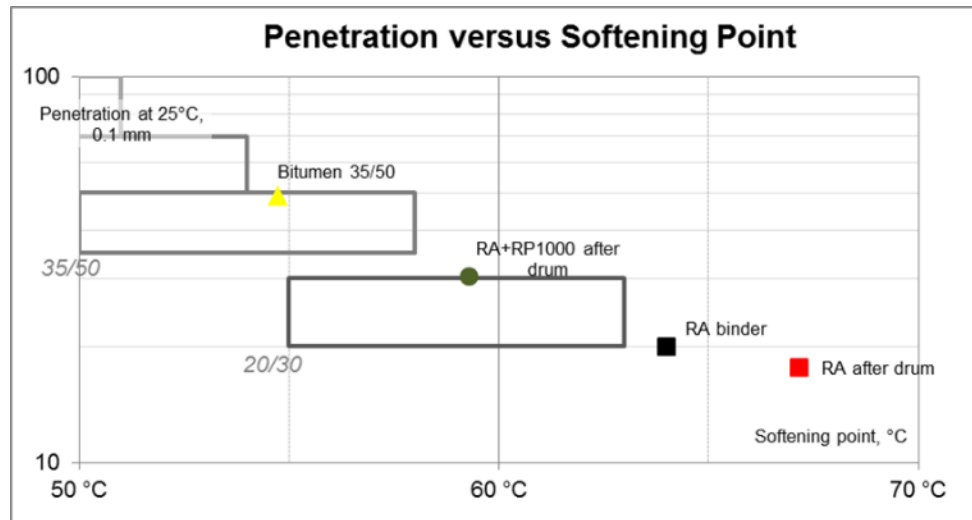


- Variation 'exposure times': COMPACTION
 - 15 min after mixing ('immediately')
 - 1 hour after mixing (simulating storage + transport to jobsite)
 - Storage in oven at compaction temperature

Base layer

Impact rejuvenator on RA - different points of sampling

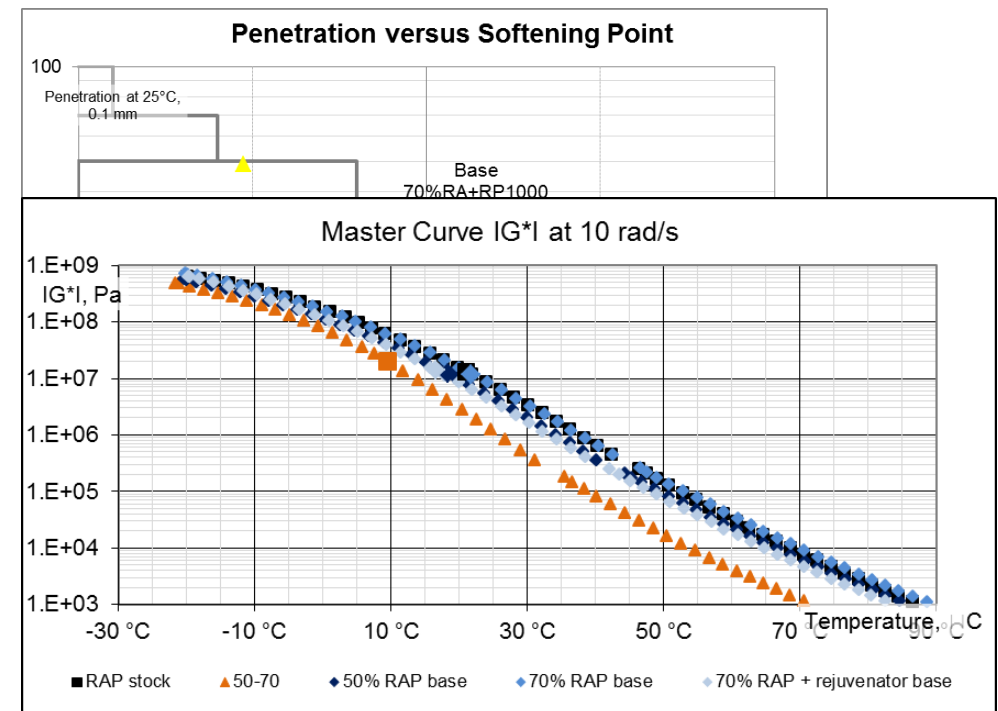
- RA on stockpile: pen 20x0.1mm and R&B 64°C
- After “black drum”, loss of 1 grade
- With rejuvenator, gain of 1 grade *
- * : dose calculated to obtain 35/50 in final mix



Re-RACE: binder results

Impact rejuvenator in final mix

- Mix 70% RA no rej very hard
- Mix 70% RA + rej even better reference mix 50% RA



Re-RACE: Asphalt results

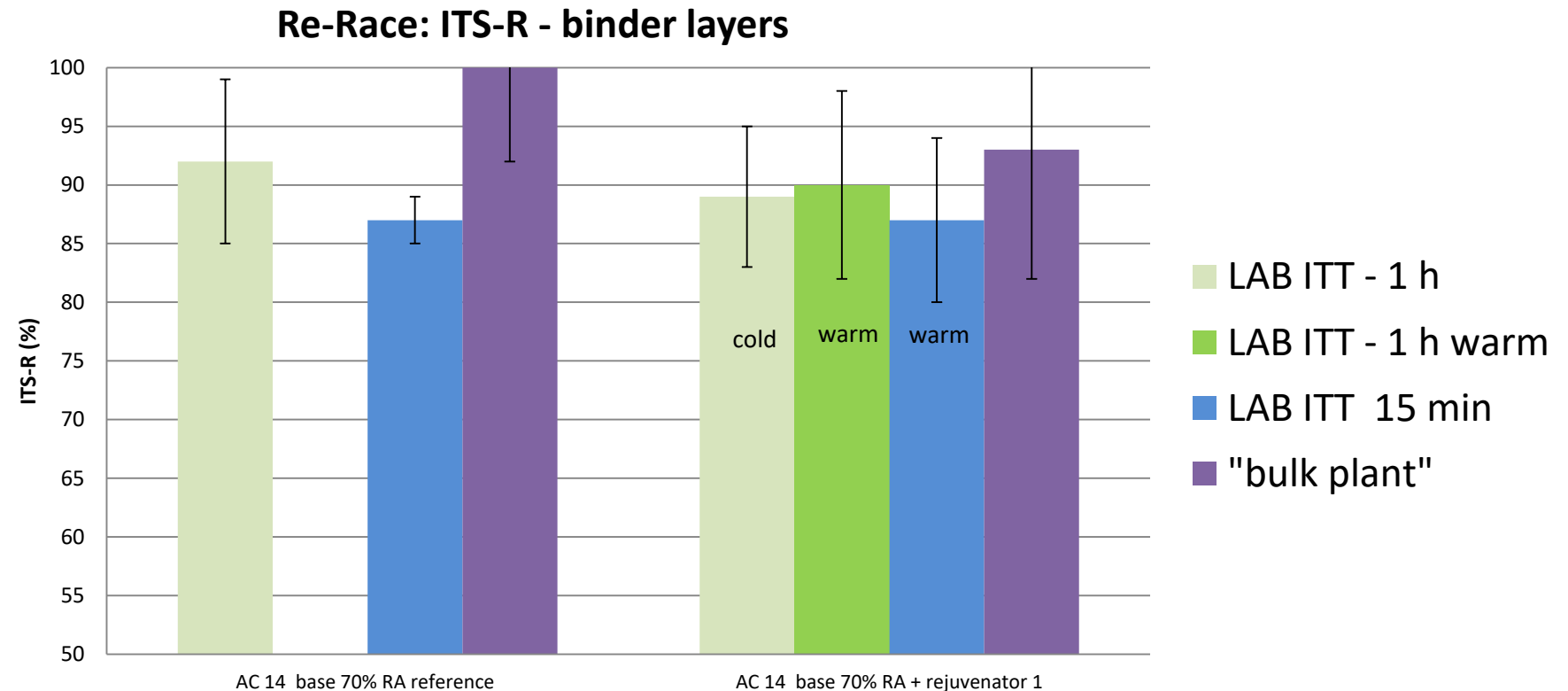
Gyratory compaction

AC-14 base	LAB ITT			bulk material	
Gyrator (60G)	reference	+ Rejuvenator	+ Rejuvenator	reference	+ Rejuvenator
		method 1 cold	method 2 warm		n.a.
	15 min waiting before compaction				
% voids	5.1 % ± 0.7%	4.9% ± 0.3%	5.0% ± 0.2%	5.0% ± 0.4%	5.1% ± 0.5%
	1 hour waiting in gyratory mould				
% voids	6.0% ± 0.2%	5.8% ± 0.3%	4.8 % ± 0.2%		
	1 hour in tin before compaction				
% voids	5.5% ± 0.4%	n.a.	6.1% ± 0.1%		

- Warm/cold: no difference
- 15 min (short time) before compaction : best comparison with bulk material
- 1 hour waiting : large effect on void content

Re-RACE: Asphalt results

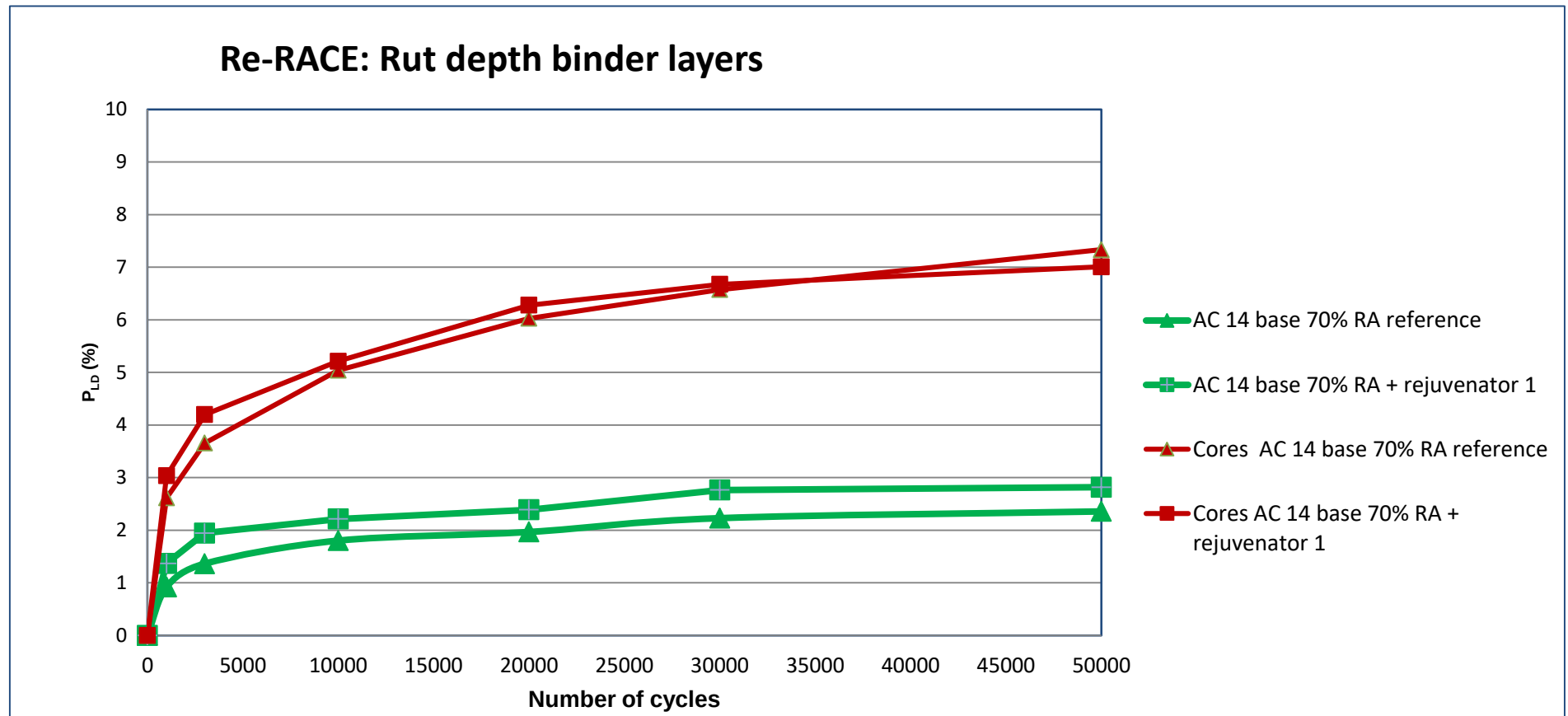
Water sensitivity



- With and without rejuvenator: very good results, no significant difference , complying national specifications
- Warm/cold: no difference

Re-RACE: Asphalt results

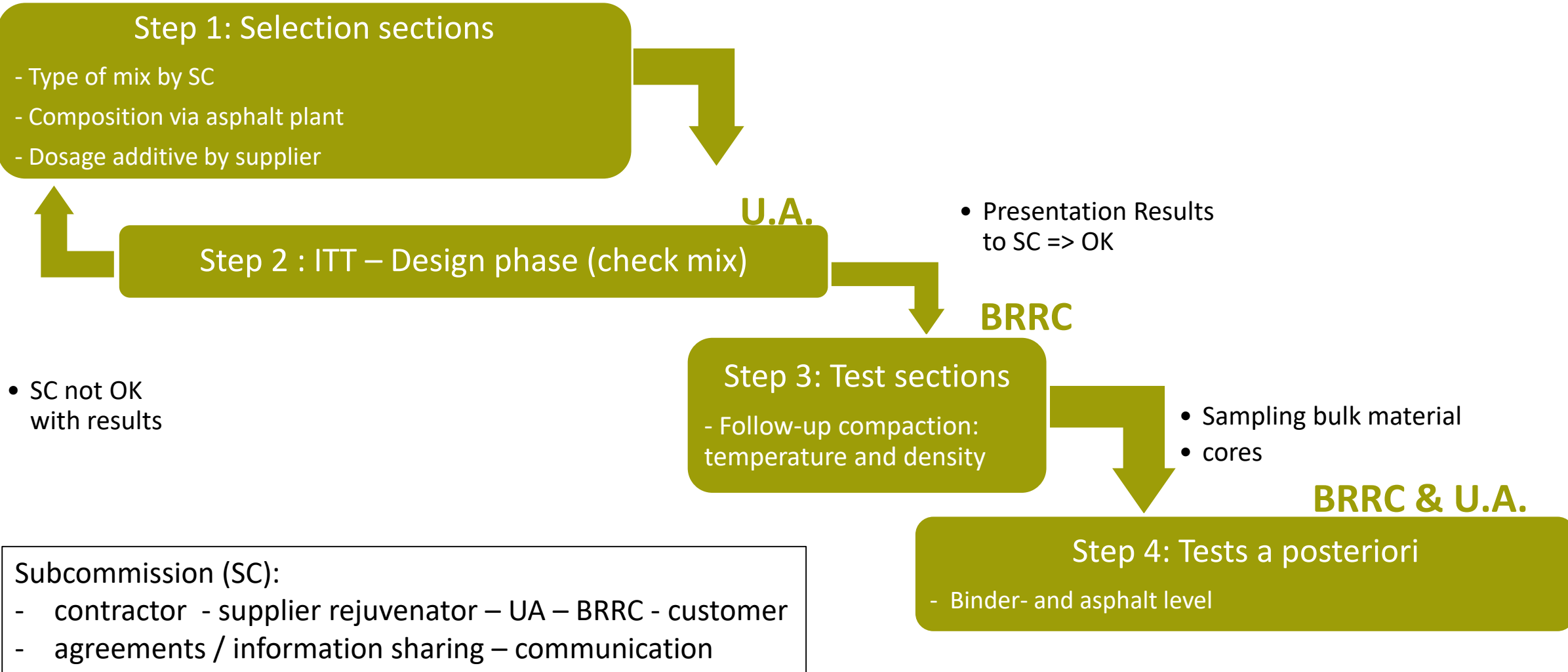
Rutting



- With and without rejuvenator: results considered equal
- Cores vs Lab : different results due to unfavourable conditions during compaction

- Joined project UAntwerpen (EMIB – coordinator) and BRRC (partner) : REjuveBIT : ‘Sustainable asphalt by use of rejuvenators’
- Demonstration project on the use of rejuvenators from 5 test sections in 2019 – 2020
- Aim : With 5 different (types) rejuvenators and asphalt plants (contractors)
 - Gain practical experience
- Field study in 2019 aims to use rejuvenators in wearing courses with high % RA : 3 sections
- Field study in 2020 aims to use rejuvenators in base courses with high % RA: 2 sections

Rejuvebit: Set-up project



Rejuvebit: test sections

	Test section 1 : Retie	Test section 2 : Kallo, Port of Antwerp
Location		
Collaboration	BRRC, UAntwerpen, AWW (province Antwerp), Besix Infra and Nynas	between BRRC, UAntwerpen, Port of Antwerp, Willemen Infra Inc and Cargill
Rejuvenator	Nygen 910 (aromatic petroleum oil), added to binder weighing scale	Anova™ 1817 (bio-based oil) – added to RA on conveyor belt
Type of mix	surface layer AC- surf 10	surface layer AC- surf 10
Variants	- without RA (fresh binder 50/70) = reference - with 20 % RA (fresh binder 70/100) - with 40 % RA + rejuvenator (fresh binder 70/100)	- without RA = reference - with 40 % RA - with 40 % RA + rejuvenator - Fresh binder all variants: 50/70
Objective	obtain same emperical properties of the binder (= pen)	to demonstrate effect of RA in combination with rejuvenator

Rejuvebit: test sections

Test sections coordinated by BRRC



Perspectives

Continuation project Re-RACE II: 'Rejuvenation of Reclaimed Asphalt in a Circular Economy':

- Impact of rejuvenators on aged binders
 -  {
 - Rheological indicators
 - Thermal analysis (DSC)
 - Screening methodology for rejuvenator efficiency
- Durable re-use of RA in surface layers – impact rejuvenators
 - Control of variability of RA properties
 - Adequate test for workability of asphalt mixtures
- Objective assessment of sustainability (use of RA in combination with rejuvenators)



Thank you

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