High Performance Underlayers with High Percentages of Re-use as developed in the NR2C-project

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Context

- Part of ongoing NR2C-project “New Road Construction Concepts”

- Partners and collaborators:
  - BRRC: J.De Visscher; S.Vansteenkiste; J.Maeck; A.Vanelstraete
  - LAVOC: A.G.Dumont; L.Arnaud; N.Bueche

Aim

- To design and to study high stiffness underlayers with high percentages of re-use material
- To optimize the designs so as to reach the same performance as mixtures without re-use, e.g. bearing capacity, resistance to permanent deformation, resistance to fatigue cracking, water sensitivity,...
- To define a design and optimization methodology

Steps

- **Laboratory study:** BRRC
  - Material characterization
  - Mix design
  - Laboratory performance study
  - Selection of variants for ALT-testing
  - Structural design
- **Accelerated loading testing:** LAVOC
  - Laying of the sections
  - Instrumentation
  - Measurements on test sections prior to ALT-testing
  - ALT-testing with data-acquisition
  - Coring after testing
- **Further laboratory testing on samples of ALT-sections:** VTI, other FEHRL-laboratories

Mix design

- To limit transport of materials, the bituminous mixes were prepared with:
  - Belgian materials: for extensive laboratory study
  - Swiss materials: in a second phase based on knowledge from study with the Belgian mixes and intended for ALT-testing

- Designs:
  - without Reclaimed Asphalt (reference)
  - with 25 % RA
  - with 40 % RA

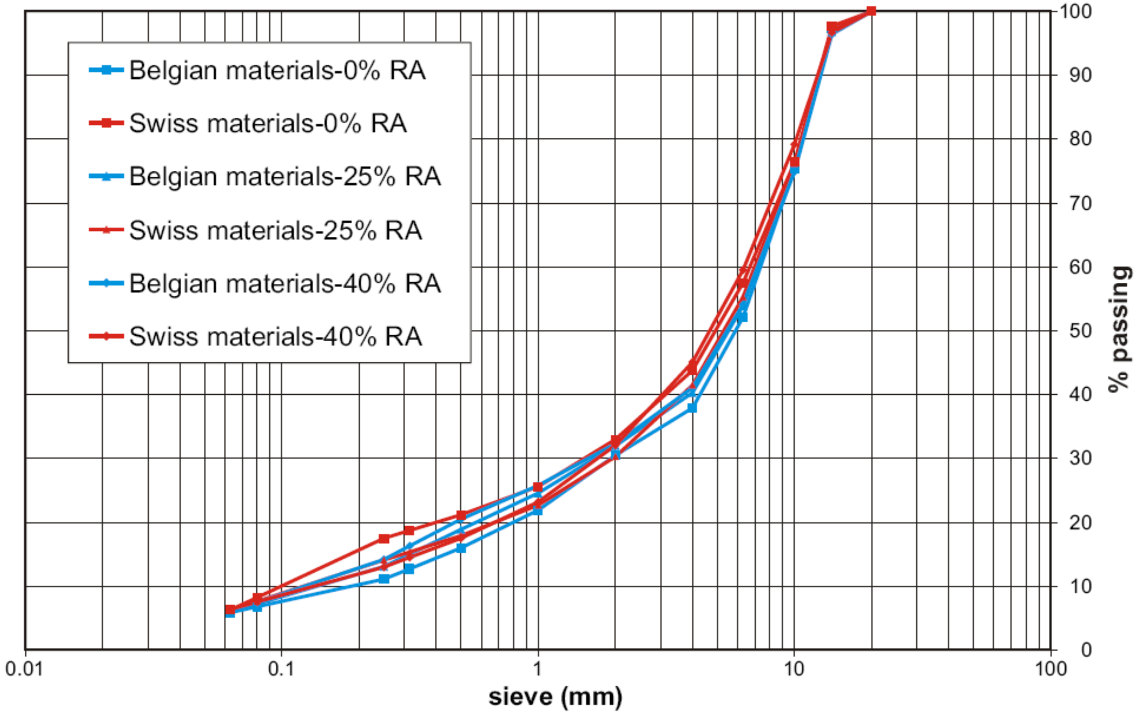
- Analytical mix design based on:
  - BRRC-Software Prado-Win
  - Check of workability and compactibility

Mix design

- Design with Prado-Win software: set up similar grading curves for all mixes and use same total binder content with and without RA

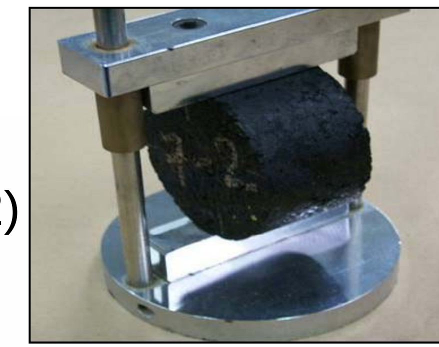
- Check of compactibility with gyratory compactor

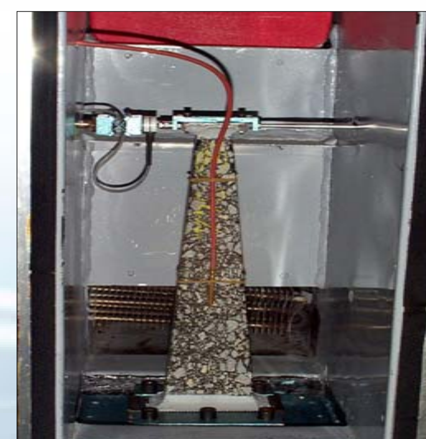
- If necessary, further optimization based on laboratory performance



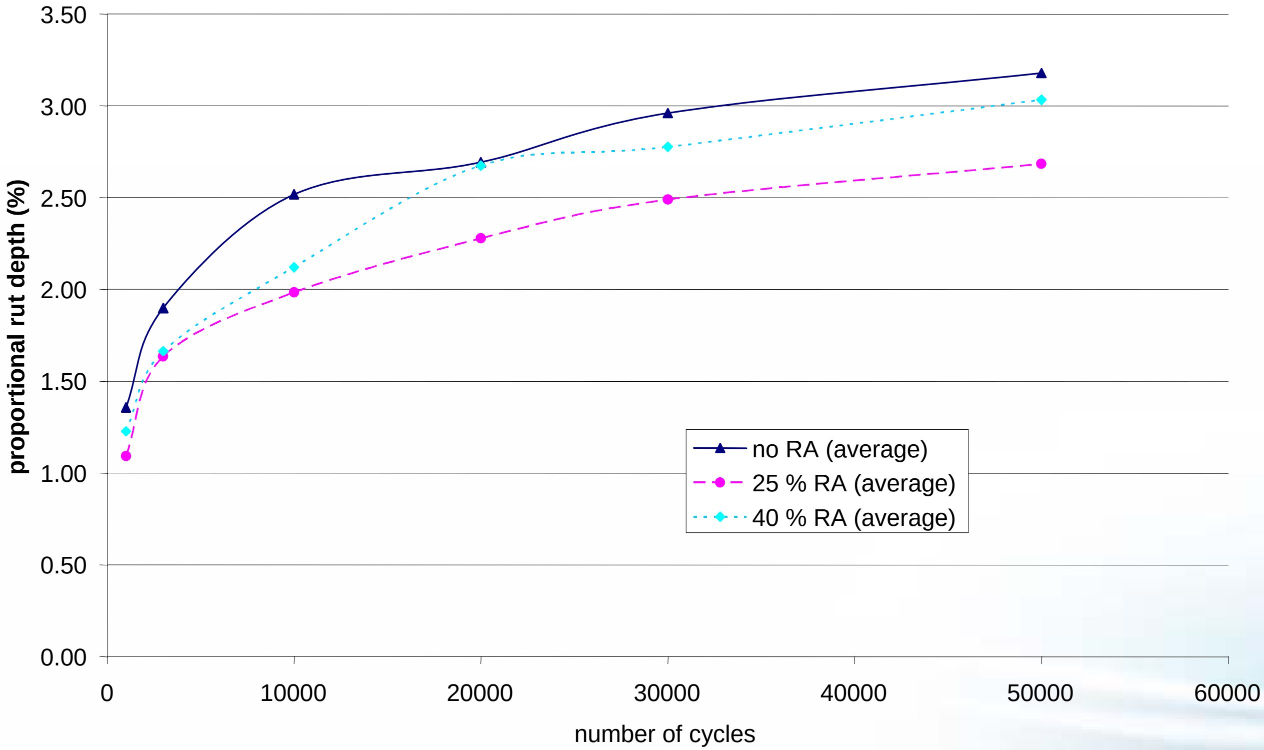
Laboratory testing

- Resistance to permanent deformation
  - wheel tracking EN12697-22 (large device in air)
  - at 50 °C and 30000 cycles
- Water sensitivity
  - indirect tensile test EN12697-23
  - before and after conditioning in water (EN12697-12)
- Stiffness modulus
  - two point bending test EN12697-26
  - between -20 and 30 °C
- Resistance to fatigue cracking
  - two point bending test
  - 15 °C, 10 Hz, stress controlled





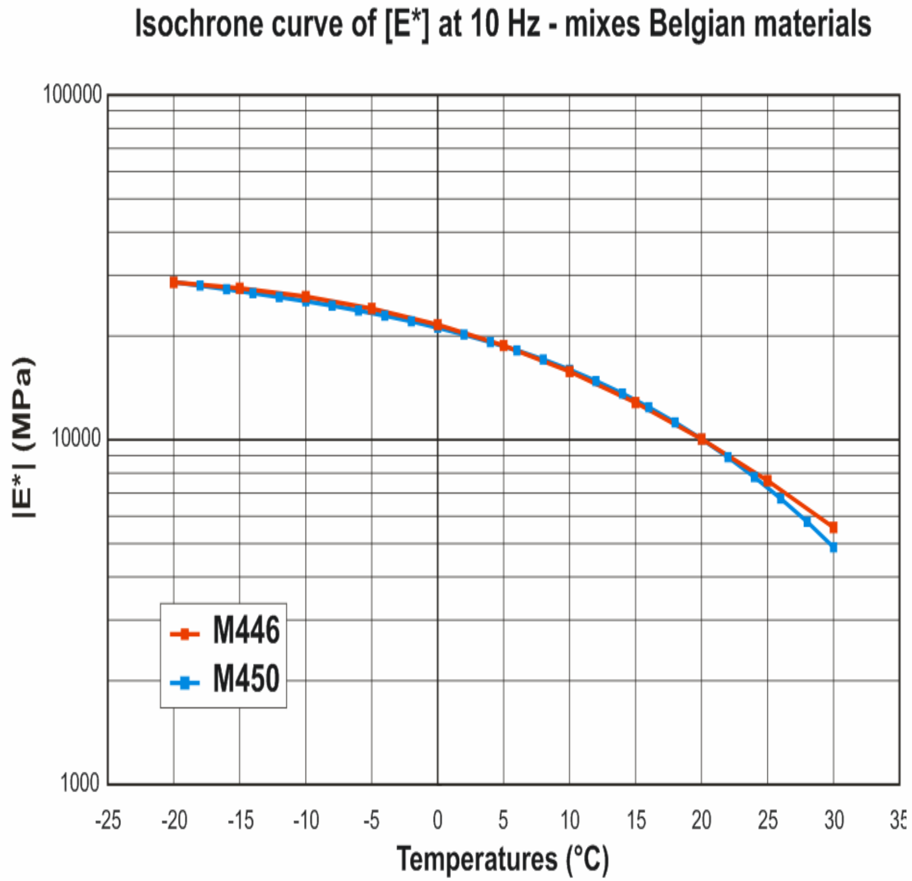
Resistance to permanent deformation: wheel tracking at 50 °C for mixes with Swiss materials

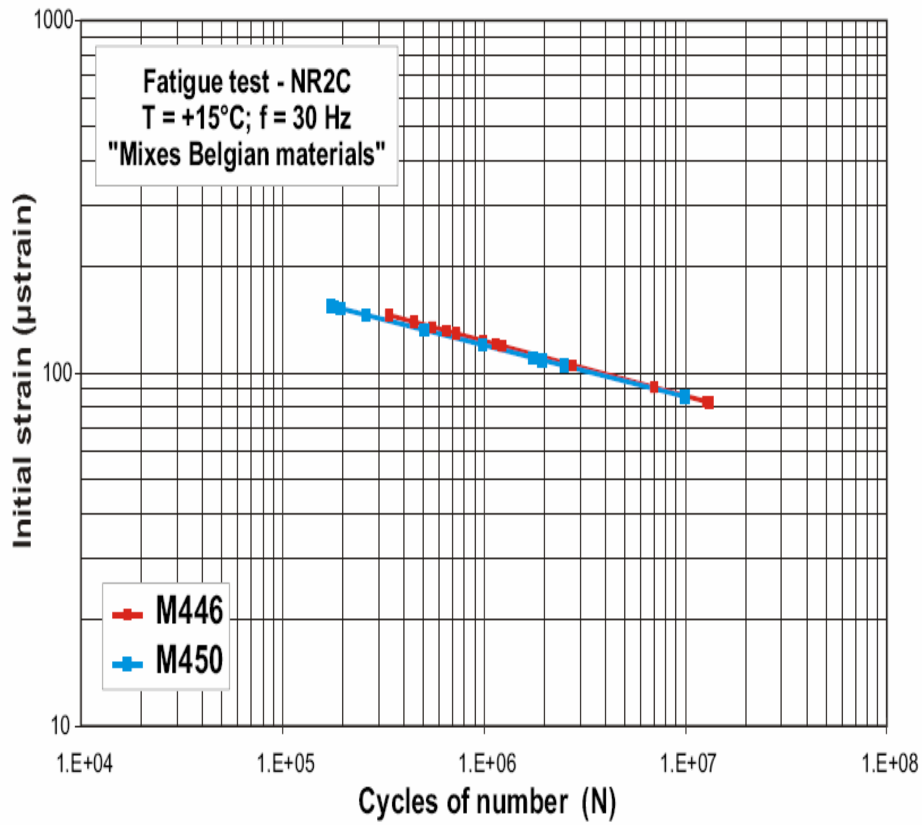


Water sensitivity by indirect tensile test before and after conditioning in water

Mix type	% RA	Indirect tensile strength ratio (%)
Belgian materials	0	92
	25	104
	40	94
Swiss materials	0	96
	25	95
	40	101

Stiffness modulus and resistance to fatigue cracking for mixes with 0% and 40% RA





ALT-testing

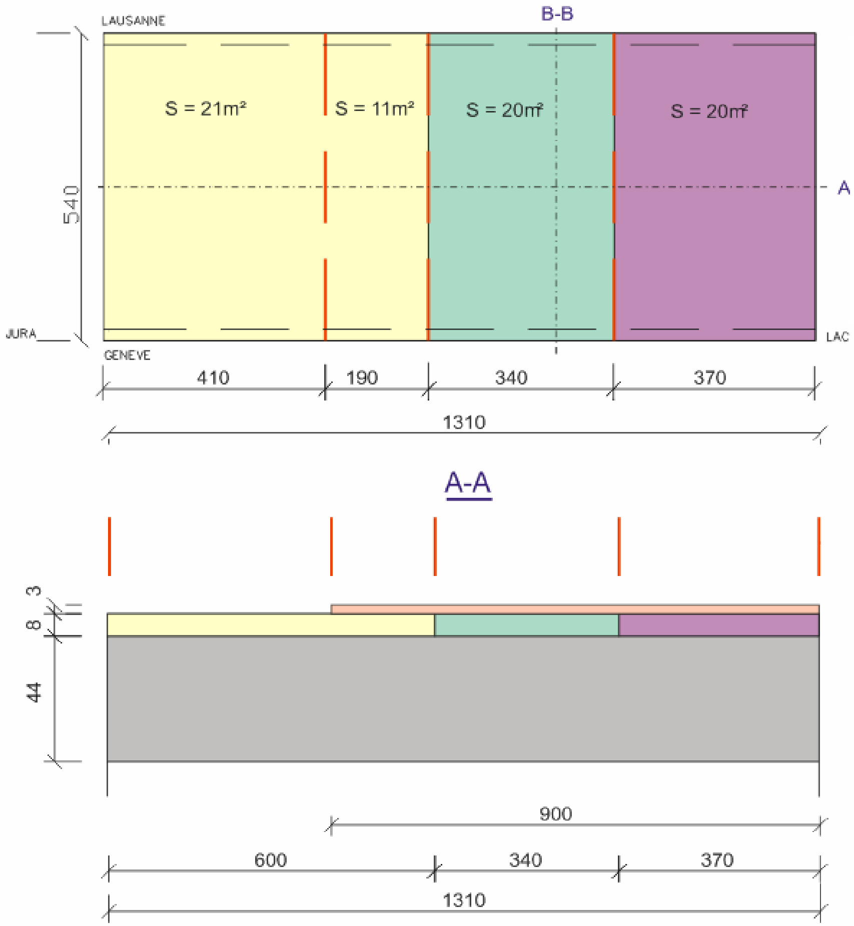
13,10 m x 5,40 m

►4 test sections:

- 8 cm HMA 0% RA + 3 cm AC
- 8 cm HMA with 25% RA + 3 cm AC
- 8 cm HMA 40 % RA + 3 cm AC
- 8 cm HMA 40 % RA

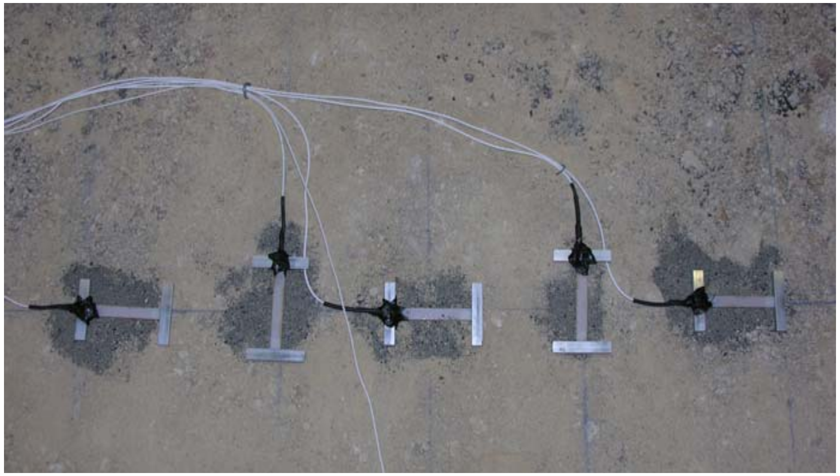
Layer thickness was deduced from structural design software so as to have failure during testing

Laying of ALT-sections



Instrumentation of ALT-sections

- In wheel paths: deformation (strain gages) and deflection (LVDT) sensors
- Between wheel paths: temperature sensors (PT100)



Location in each section	Strain gages	LVDT	Temperature sensor
Bottom high stiffness mix	30	4	4
Interface toplayer - high stiffness mix	16	-	3
At surface	-	-	2

ALT-testing

-Load: 10 tons (first days) and then 12 tons, all at 15 °C and for about 600 000 wheel passages on each section

-Ending with ALT-testing at more severe temperature of -5 °C

- Data acquisition during testing: strain, temperature, deflection

- Specific measurements:
  - o FWD before and after testing
  - o Cores before and after ALT-testing for control, for comparison with laboratory study and for further investigation

Conclusions so far

- In the laboratory it is possible to make high stiffness mixes with a high percentage of RA without loss of performance
- What about real production and laying ?
  → to follow in ALT-testing
- Importance of :
  - Homogeneous RA
  - Known characteristics
- In progress: Design methodology