Pavement underlayers with a high percentage of re-used materials

BUECHE Nicolas
EPFL-LAVOC

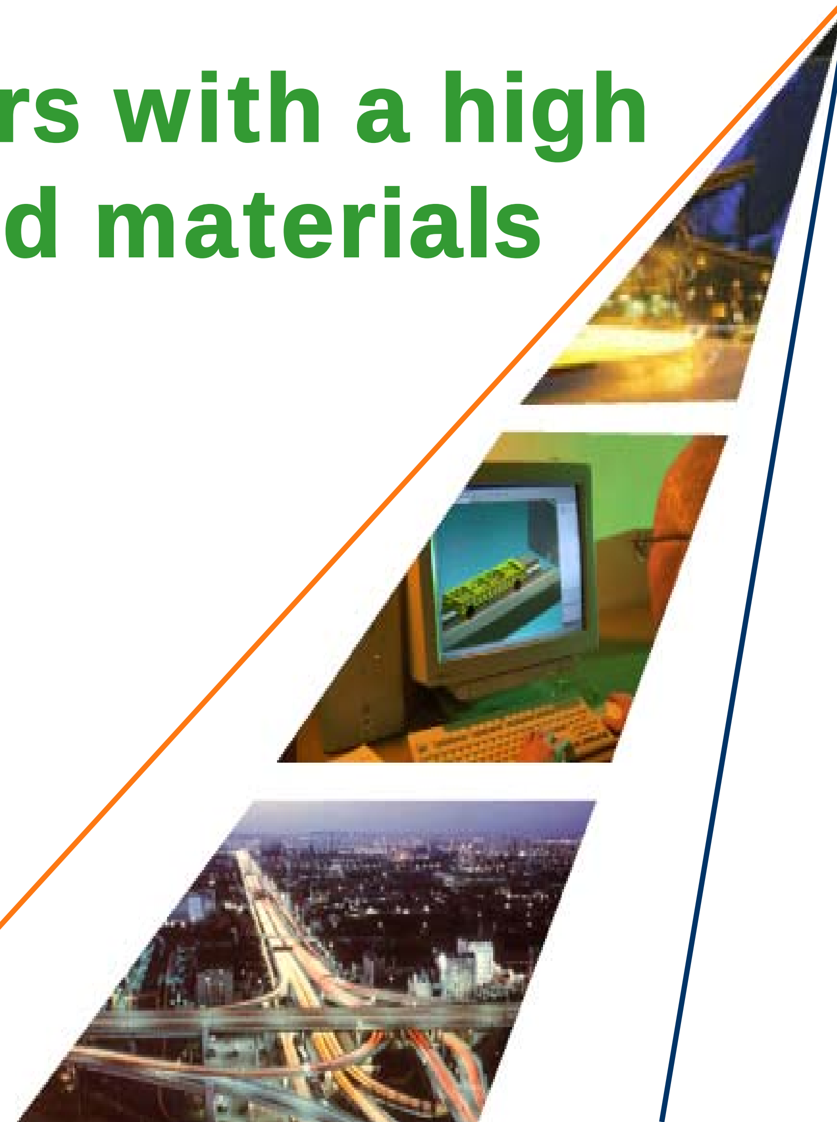


Table of content

General scope and aims

New road construction concept: Vision 2040

WP2: Interurban infrastructure

Innovation 1: Low cost pavement construction and maintenance techniques

General scope and aims

- Aim of the research:

Development of high performance underlayers with low cost materials and high percentage of re-use

- Partners:

EPFL-LAVOC	Switzerland
BRRC	Belgium
VTI	Sweden
DRI	Denmark
KTI	Hungary

Test procedure

Coring

Coring

Coring

ALT-Fatigue

ALT-Low temperature

Controlled parameters: load, temperature, speed

Continuous measurements: strain, deflection, profile

01/2006

01/2007

10/2007

Mix design

Binder analysis

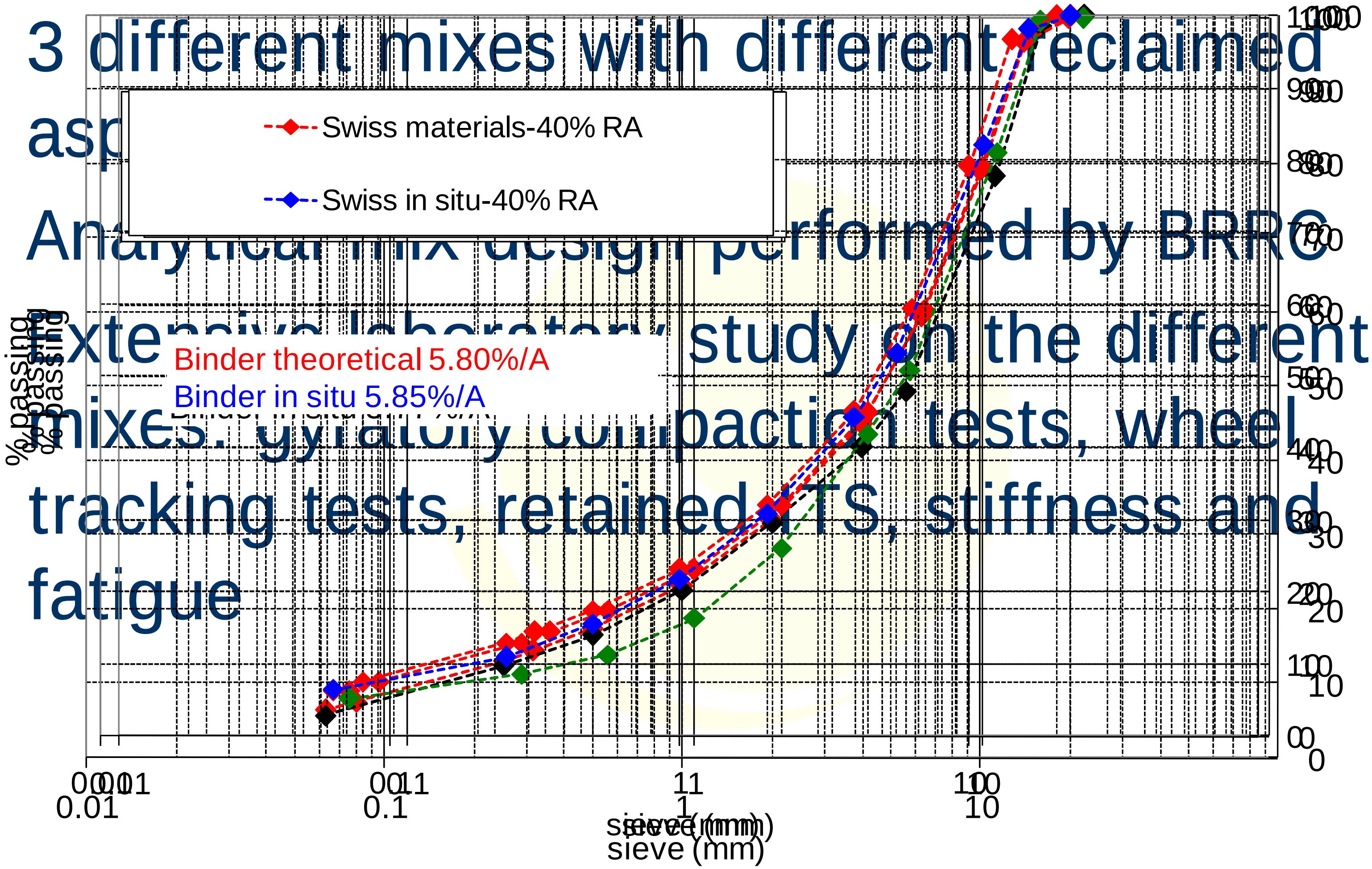
Test on big slabs

Wheel tracking tests

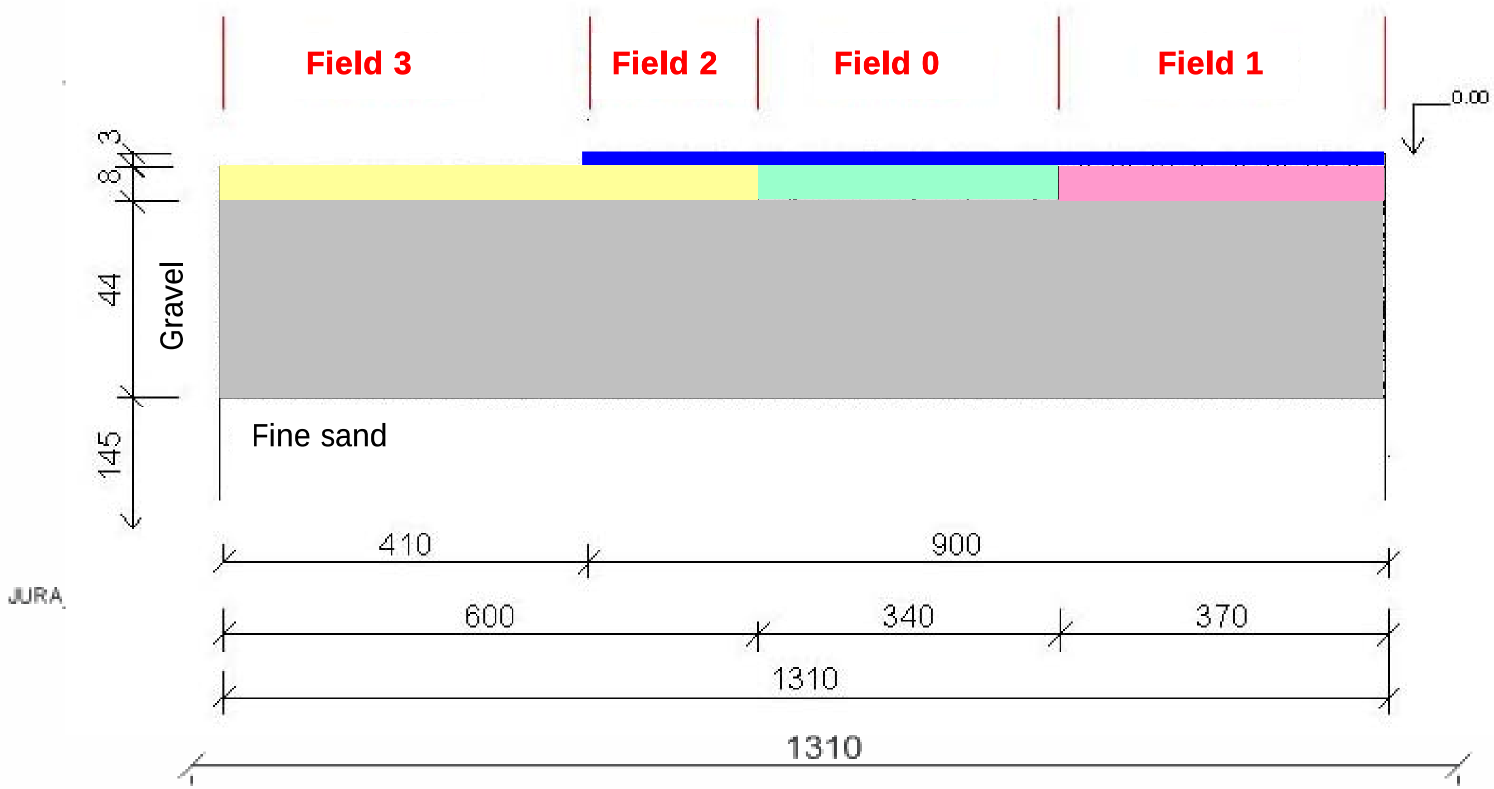
Fatigue tests

ALT setup – Mix design

- 3 different mixes with different reclaimed asp
- Analytical mix design performed by BRRC
- Extensive laboratory study on the different mixes: gyratory compaction tests, wheel tracking tests, retained ITS, stiffness and fatigue



ALT setup – Base layer tested



Fields 3-2: 8 cm HMA 40 % -RA

Field 0: 8 cm HMA 0 % -RA

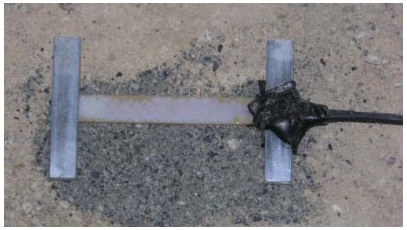
Field 1: 8 cm HMA 25 % -RA

ALT setup – Sensors and gauges

Different measurements

- Temperature sensors at each interface

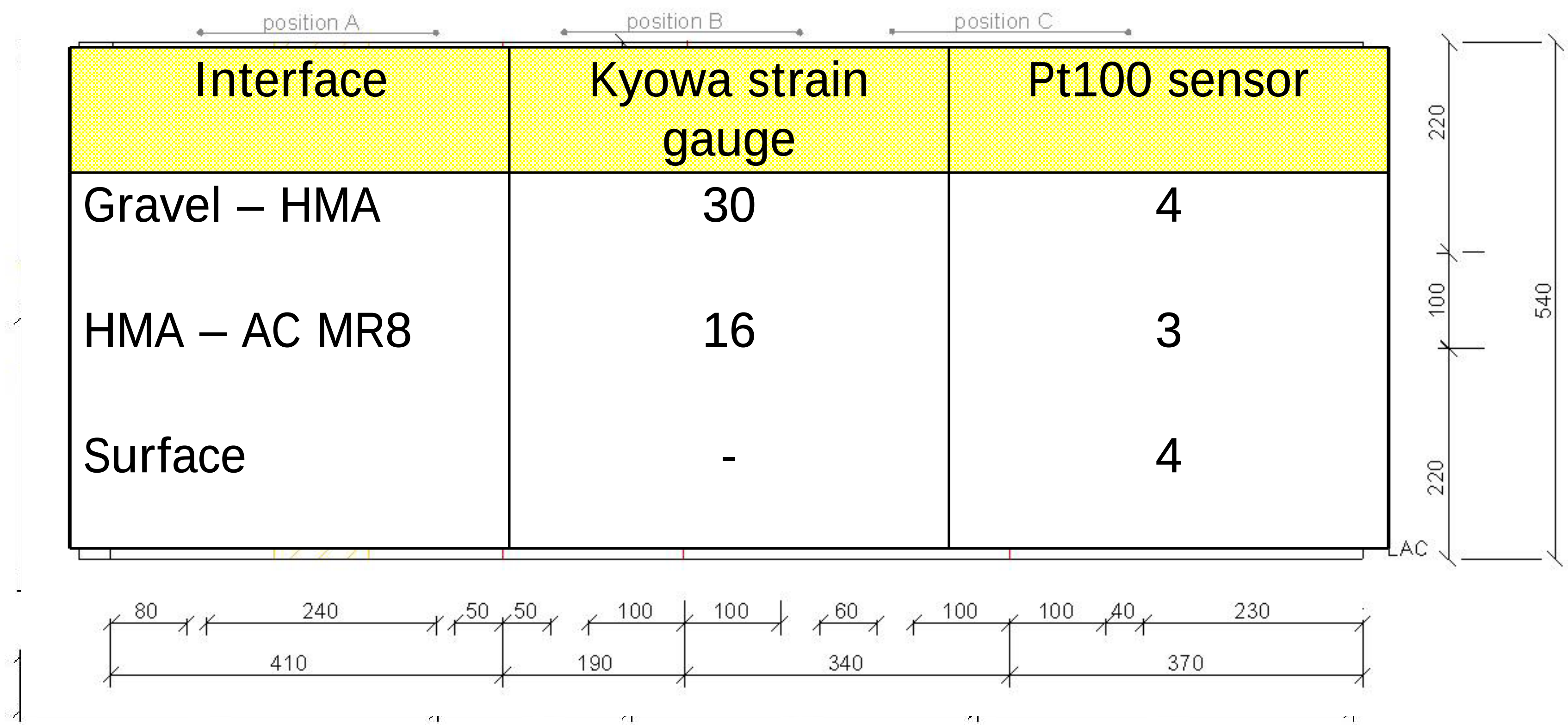
- Kyowa strain gauges at each interface



- 3 LVDT sensors for the measurement of surface deflection

ALT setup – Sensors positioning

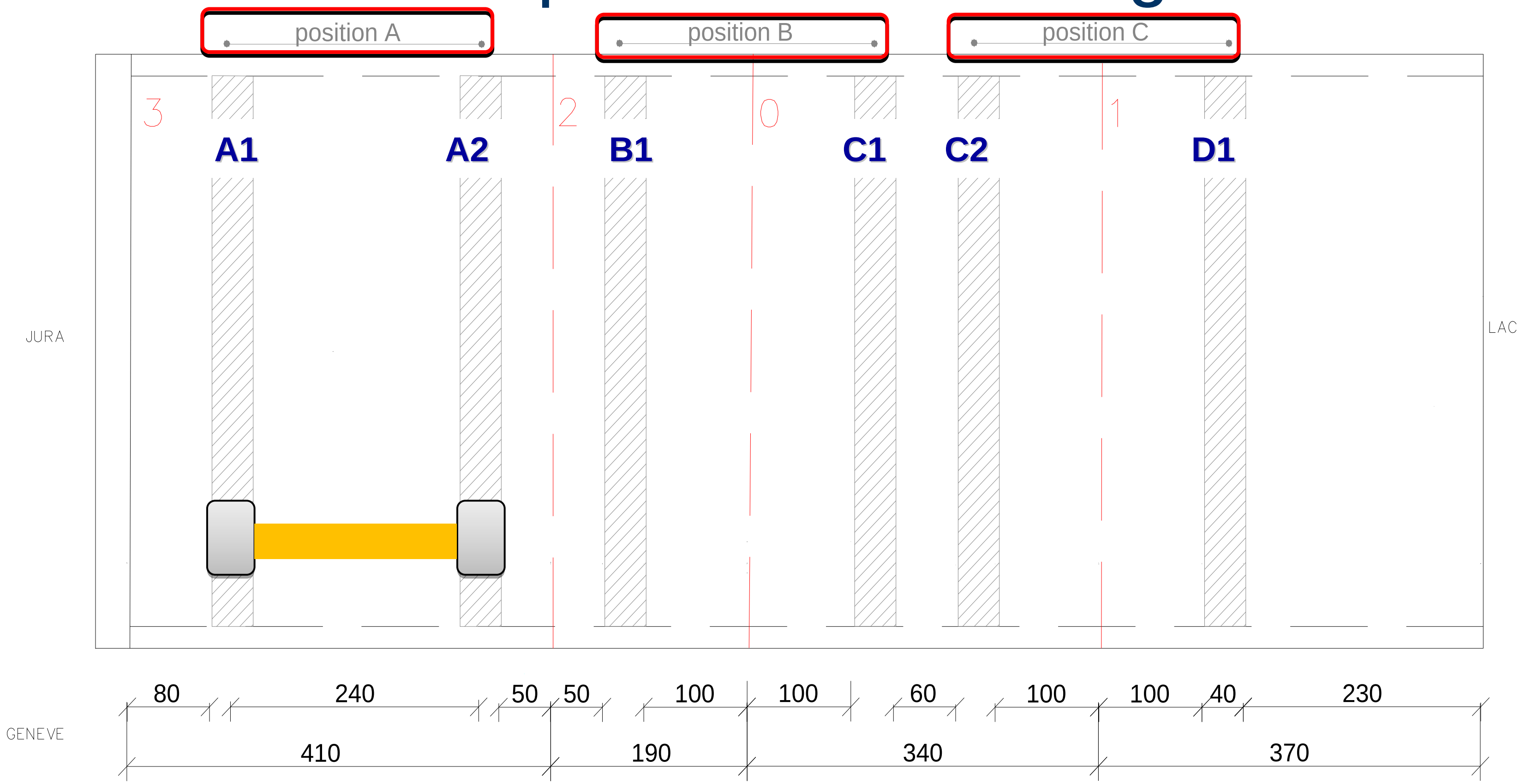
- Sensors at the top of the HMA layer
- Sensors at the bottom of the asphalt layers



Interface	Kyowa strain gauge	Pt100 sensor
Gravel – HMA	30	4
HMA – AC MR8	16	3
Surface	-	4

ALT setup – Loading

- Three different positions of loading



ALT setup – Loading

- Load: 12 tonnes
- Supersingle tyre
- Tyre pressure: 0.8 Mpa
- Speed: 12 km/h (constant area)
- 1800 passages/hour

ALT setup – Test planning

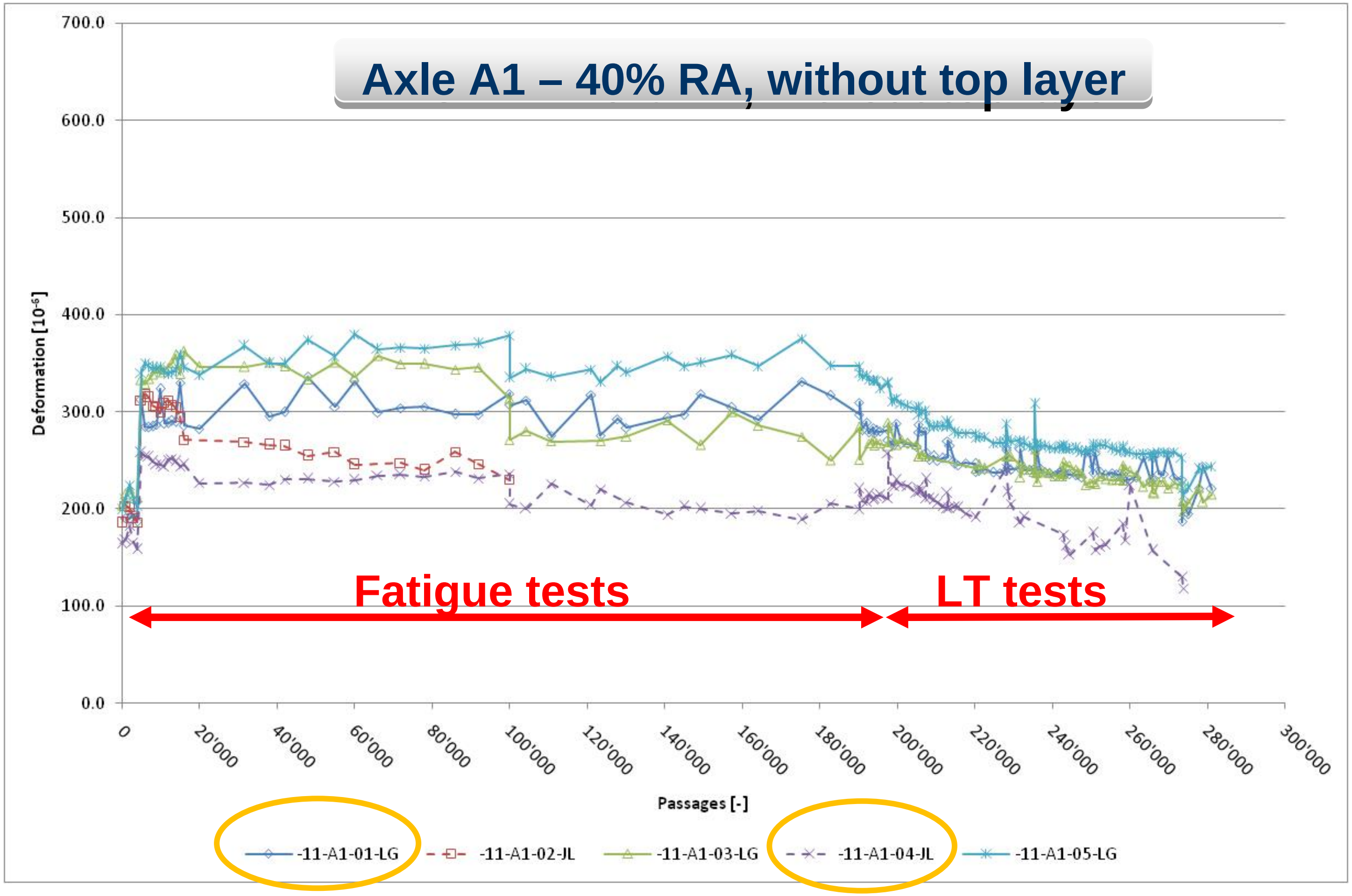
- 2 main phases:
  - **Fatigue tests**: Assessment of the fatigue resistance with a constant air temperature of 15°C
  - **Low temperature tests (LT)**: Assessment of the resistance to more severe conditions with 12 days temperature cycles between 2 °C and -7 °C

Planning for each LT test performed			
Day	T_{AIR} [°C]	Duration[h]	Passages[-]
1	10	2	3624
10	7	4	7248
11	2	4	7248
12	-7	4	7248

Loading position		A		B		C	
Wheel position	[axle]	A1	A2	B1	C1	C2	D1
Top layer	3 cm	-	-	AC MR8	AC MR8	AC MR8	AC MR8
Underlayer HMA	8 cm	40% RA	40% RA	40% RA	0% RA	0% RA	25% RA
Field	[-]	3	3	2	0	0	1
Passages fatigue	[-]	182'900	182'900	100'000	100'000	100'000	100'000
Passages LT	[-]	99'000	99'000	87'700	87'700	111'600	111'600

ALT results

- Deformation at the bottom of the HMA



ALT results

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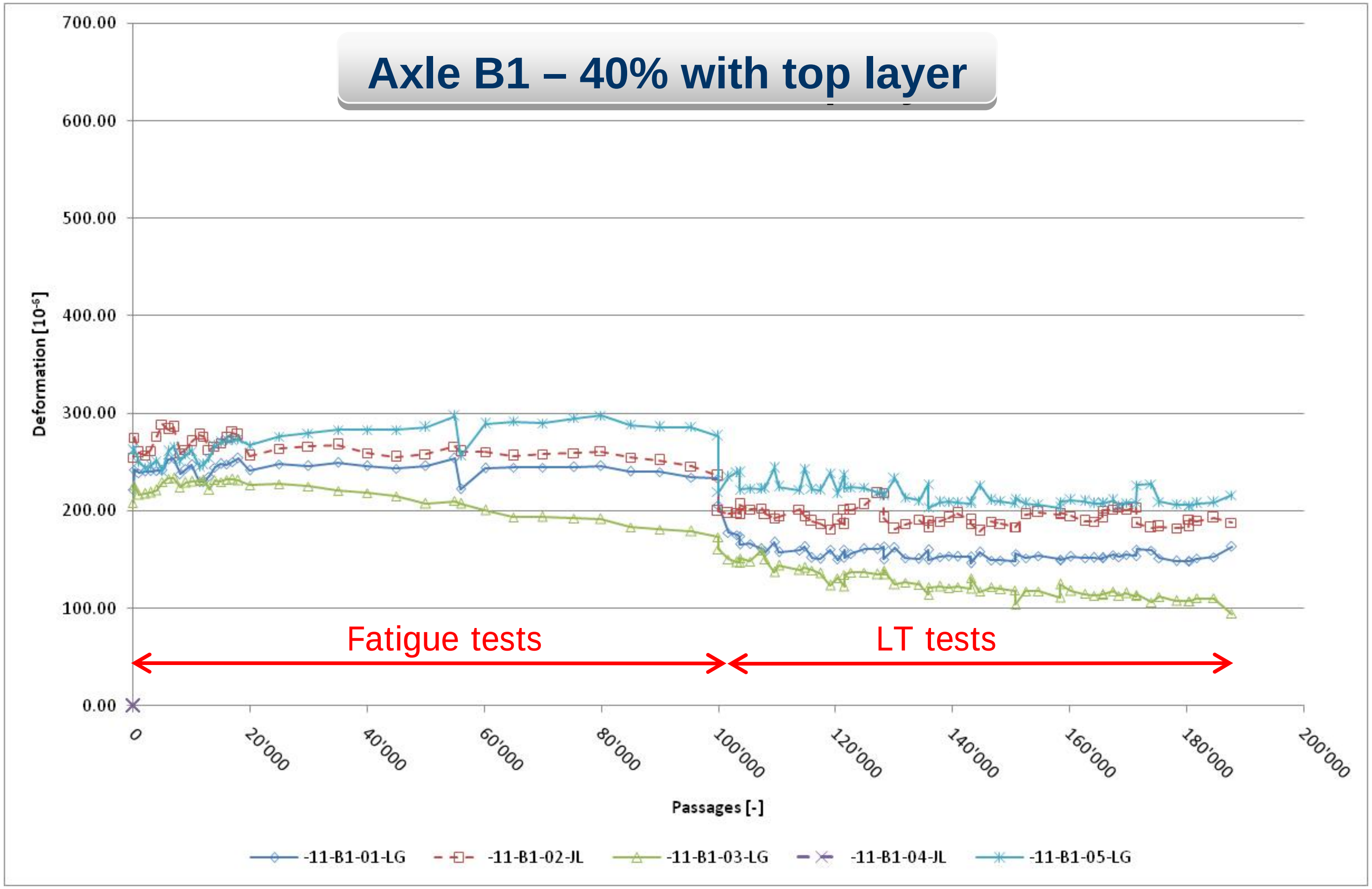
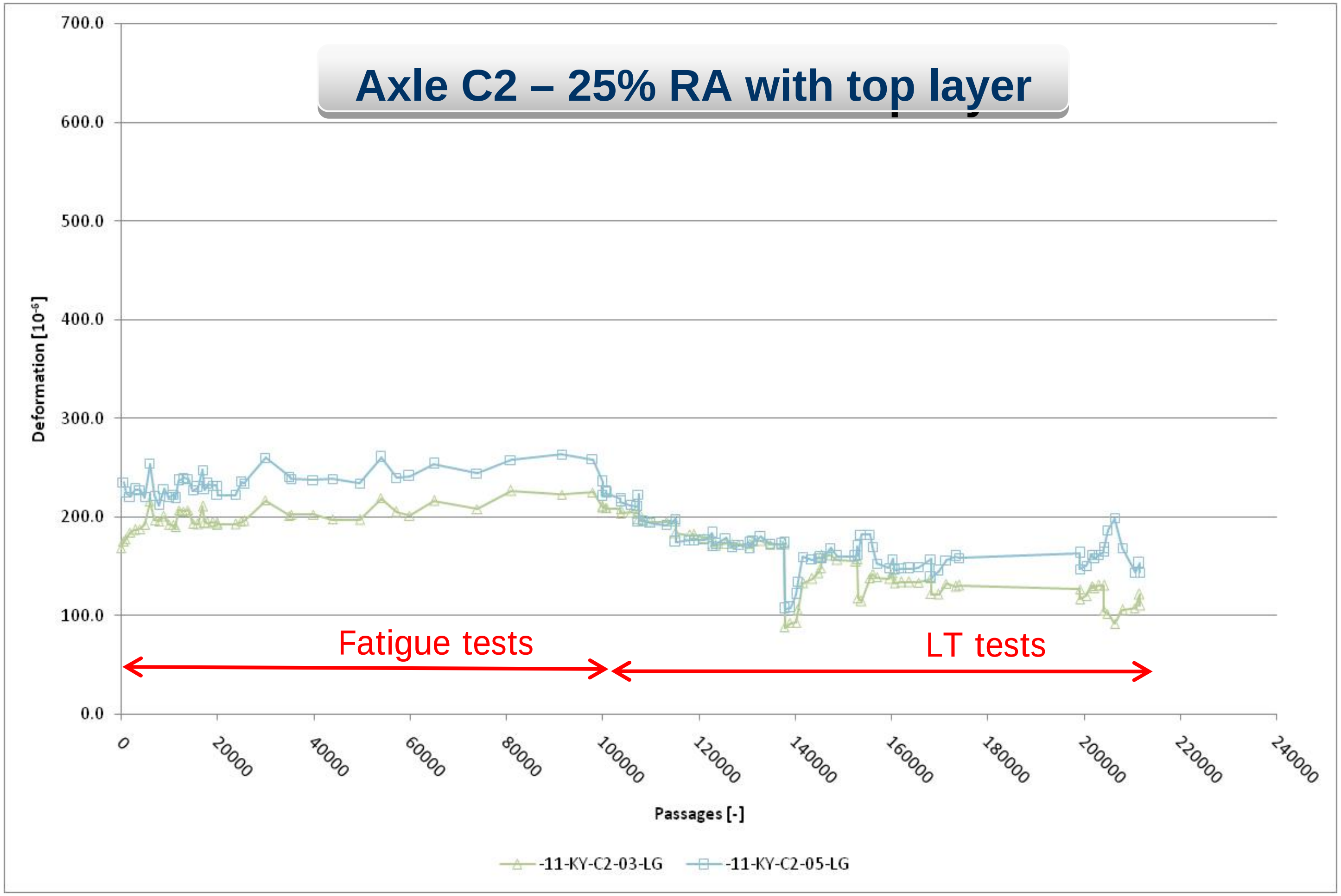


CERTAIN

FEHRL

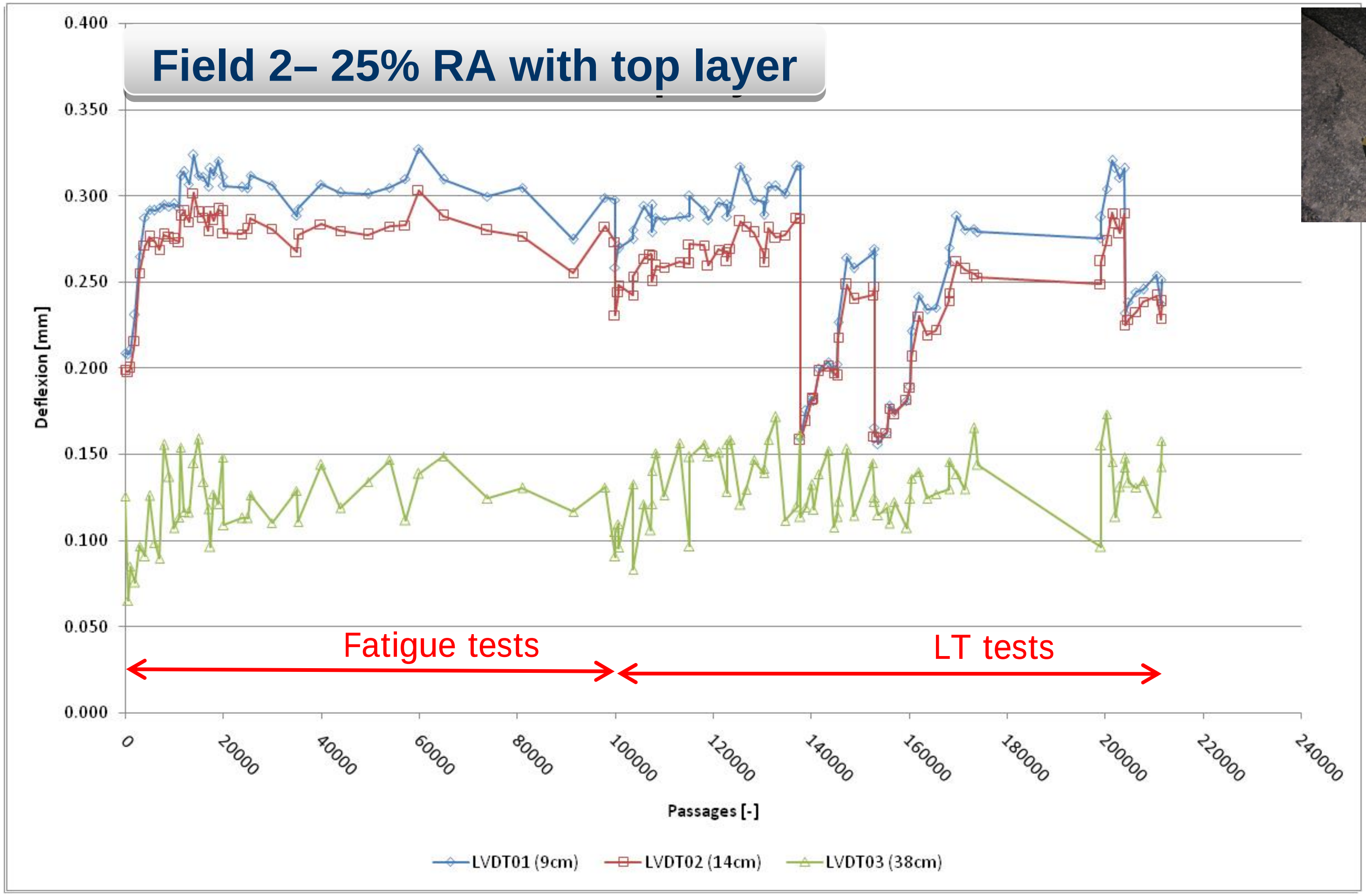
ALT results

- Deformation at the bottom of the HMA



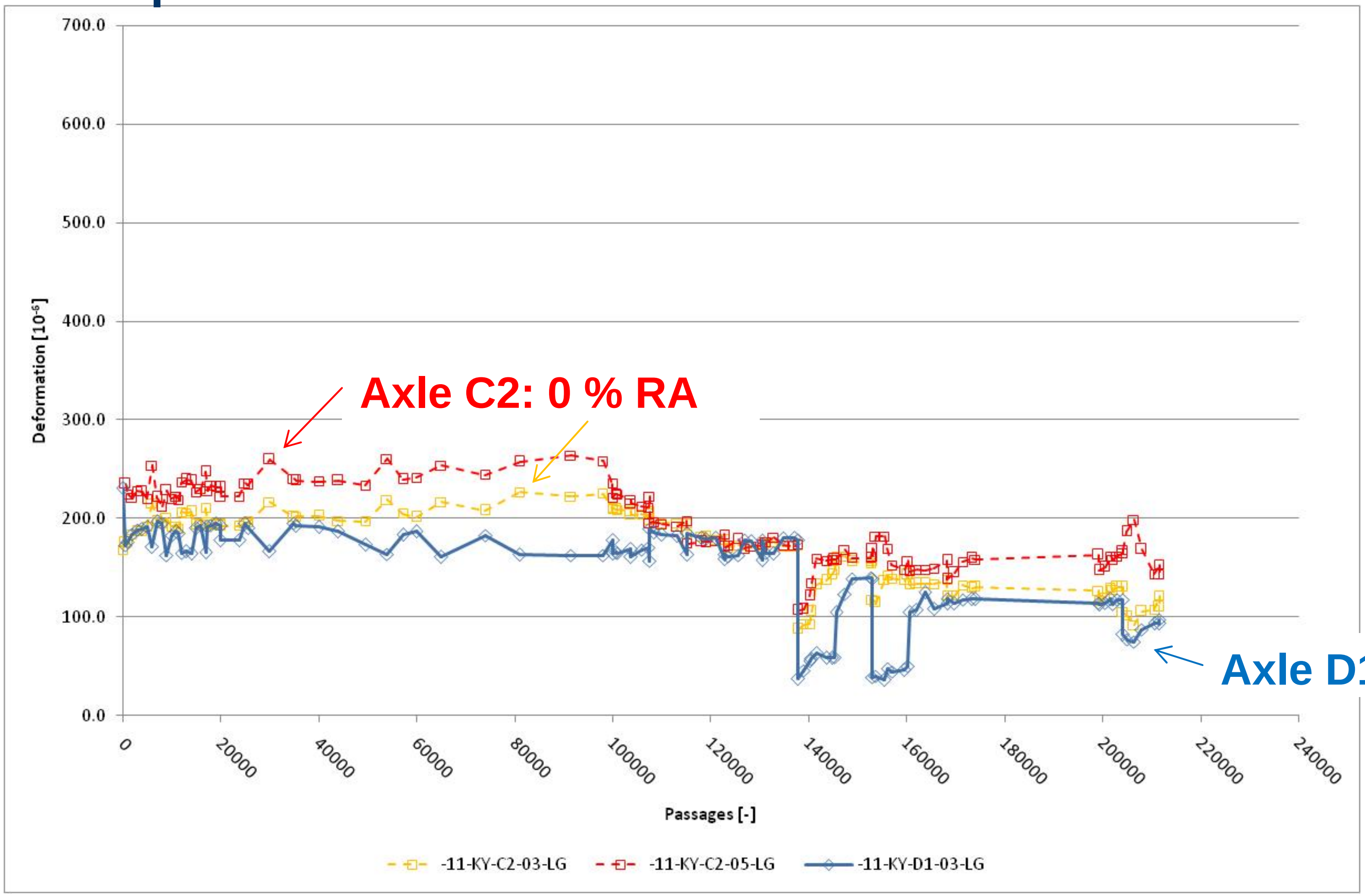
ALT results

- Evolution of the surface deflection



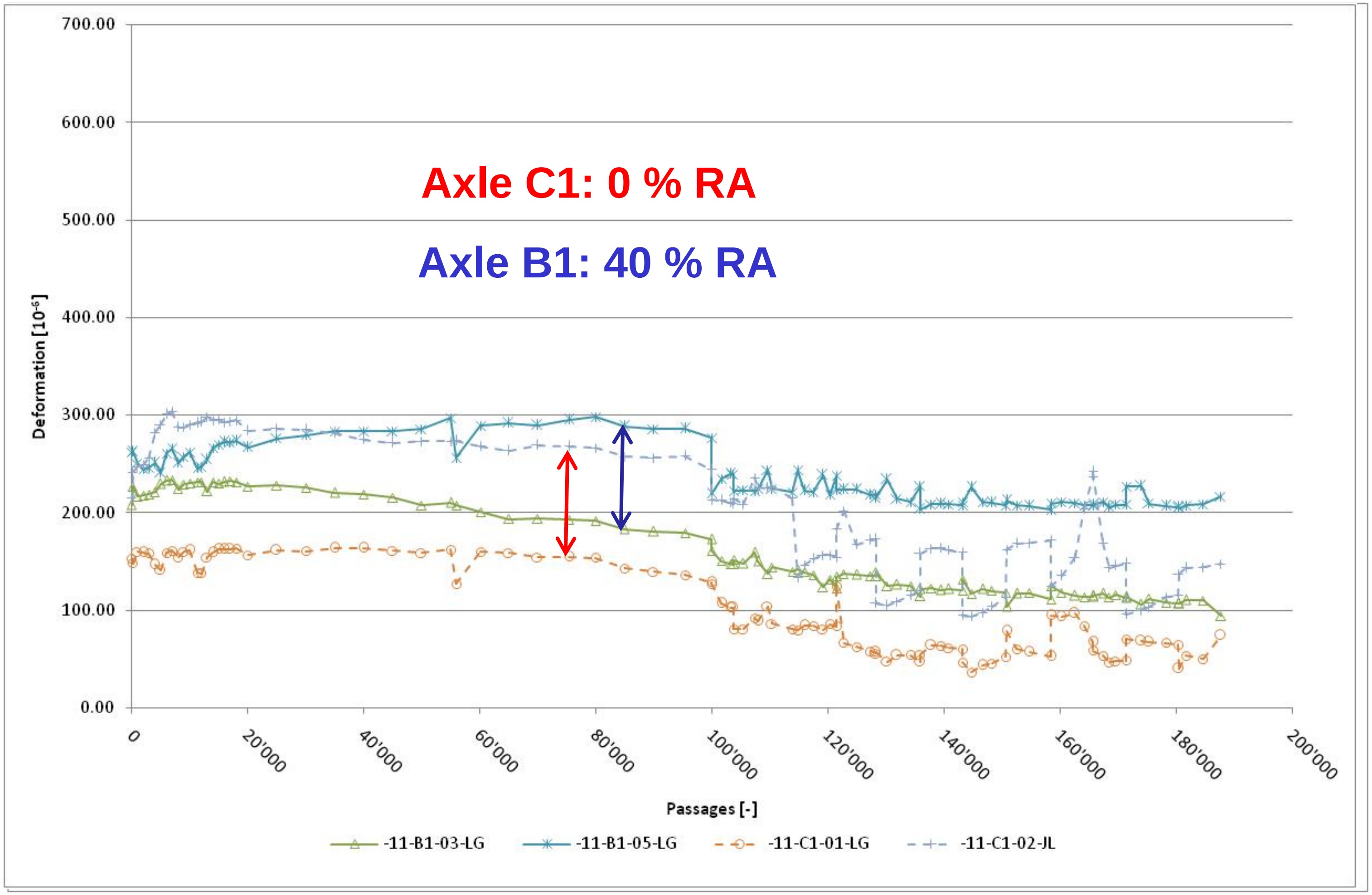
ALT results

- Comparison between HMA 0% RA and 25% RA



ALT results

- Comparison between HMA 0%RA (C1) and 40% RA (B1)



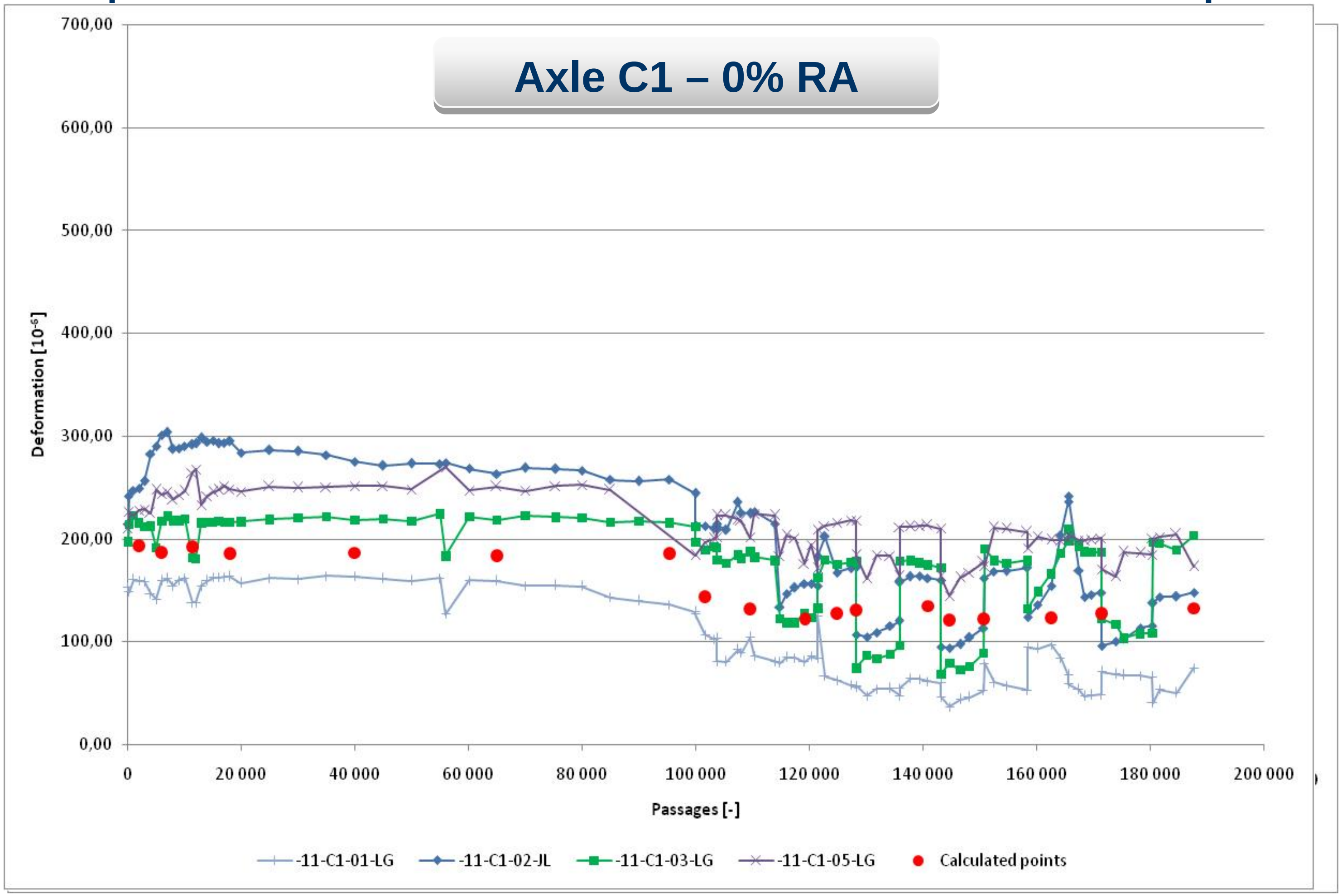
ALT results

Additional calculation performed using NOAH software

- Better understanding of the measurements results
- Assess the quality of the measurements
- Sensitivity analysis on selected parameters
- Calculation performed for selected points with updated material properties from laboratory tests
- Consideration of the temperature gradient measured

ALT results

- Comparison between calculated and measured points



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ALT results - Synthesis

- No negative effect of mixtures with a high percentage of recycling material
- Behaviour of mixes with Ra at least as good (resistant) as mixes without reclaimed asphalt
- Cracking predicted after pavement design, but not observed during ALT-testing
- Calculation performed are consistent with the ALT testing, considering the various parameters that have an influence on the results
- Effect of different parameters highlighted: bonding conditions, top layer

Results correlated to ALT

Different tests performed in order to provide some additional information concerning the behaviour of mixes containing a high percentage of RA

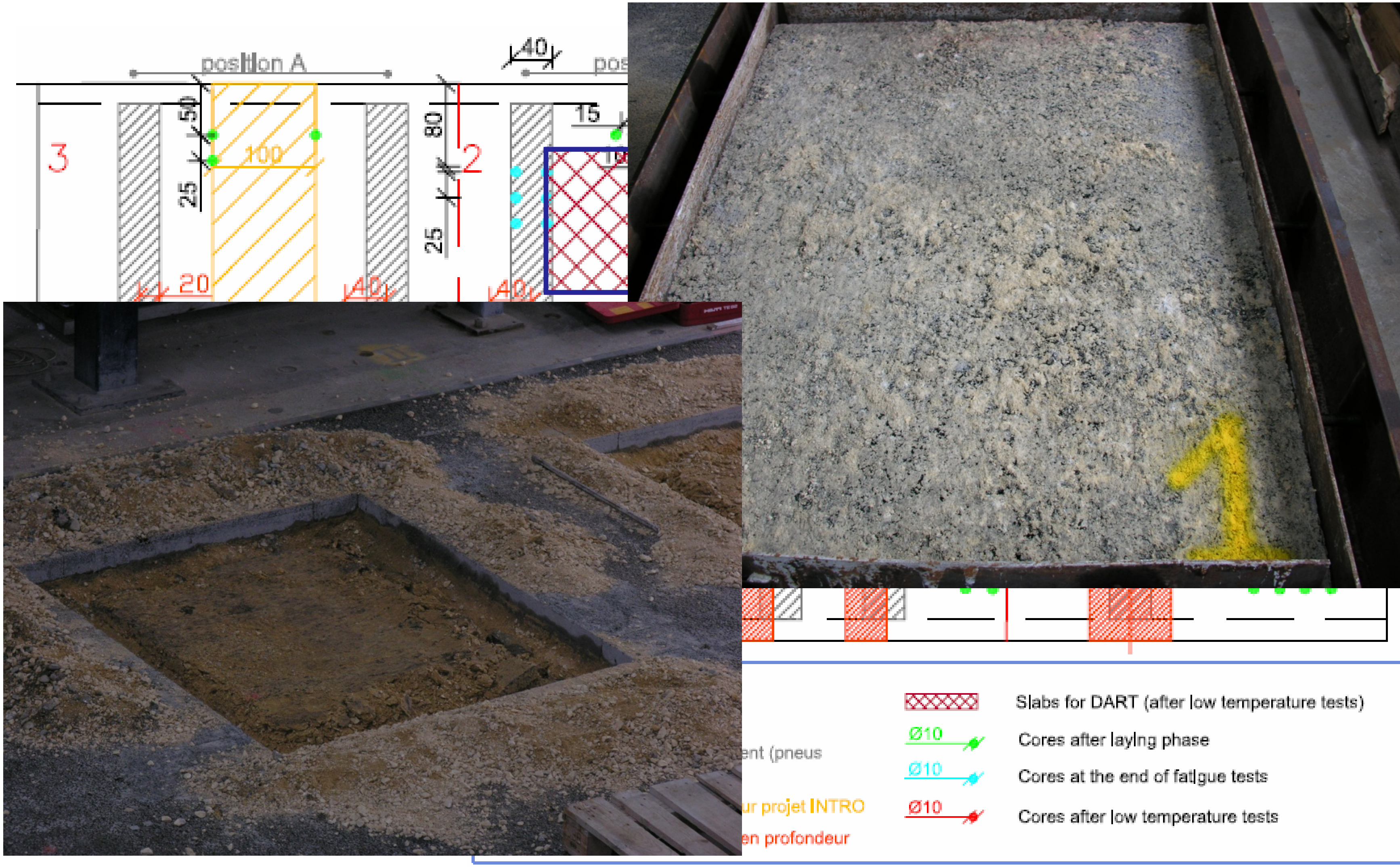
- Analysis of the binder in different conditions (KTI, BRRC, LAVOC)
- Tests on cores (VTI)
- Wheel tracking tests (LAVOC)
- Tests on big slabs (DRI)
- Fatigue tests (BRRC)

Results correlated to ALT - DART

DART: **D**anish **A**sphalt **R**utting **T**ester

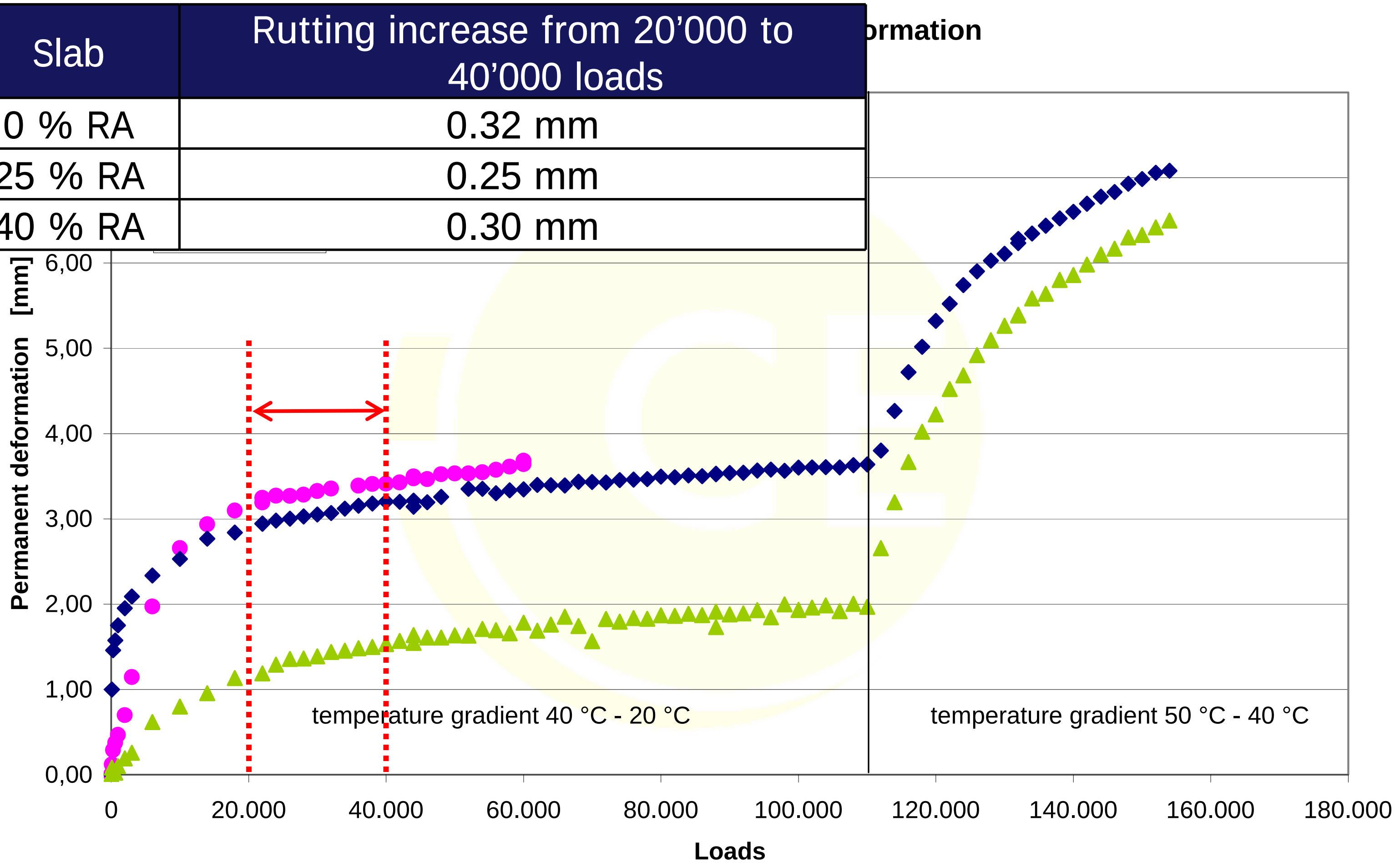
- Stationary heavy vehicle simulator with linear travel 0-5 km/h
- 24.000 loads per day (bi-directional) or 12.000 (uni-directional)
  → 100’000 for these tests (standard precedure)
- Wheel load up to 65 kN (50 kN)
- Random normally distributed wander (± 200 mm from centre travel)
  → ± 100 mm for standard procedure
- Standard lorry tyre, single or dual wheel configurations (supersingle)
- Automatic tyre pressure control (0.9MPa)
- Test sample 1200 mm by 1500 mm, thickness 100-250 mm
- Air temperature control cabinet, 25-60 °C (40°C top, 20°C bottom)
- Temperature control radiator underneath the slab, 20-60 °C
- Automatic rutting and macro texture measurements with precision laser profilometer

Results correlated to ALT - DART



Results correlated to ALT - DART

Slab	Rutting increase from 20'000 to 40'000 loads
0 % RA	0.32 mm
25 % RA	0.25 mm
40 % RA	0.30 mm



Conclusions and recommendations

- Innovation aimed to optimize the design of high stiffness underlayers and provide long term performances.
- Different domains investigated using a sophisticated methodology, based on a mix design software, lab. tests and ALT-testing.
- Use of high percentage of RA in underlayers has no negative effect on laboratory mix performance. The same conclusion obtained with ALT, tests on cores, DART, ...
- Importance of parameters: grading curve, RA batch, binder type, mix viscosity,...
- This conclusion cannot been extended to all the HMA mixes with 25% or 40% RA.
- Question still open: Where is the efficient limit of the RA content?
- In situ tests sections under real traffic and with various climatic situations needed.

Thank you for your attention

Many thanks to all the partners involved in this task and in WP2 as well, for their active contribution.

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