

# DEVELOPMENT OF A LABORATORY BITUMINOUS MIXTURES AGEING PROTOCOL

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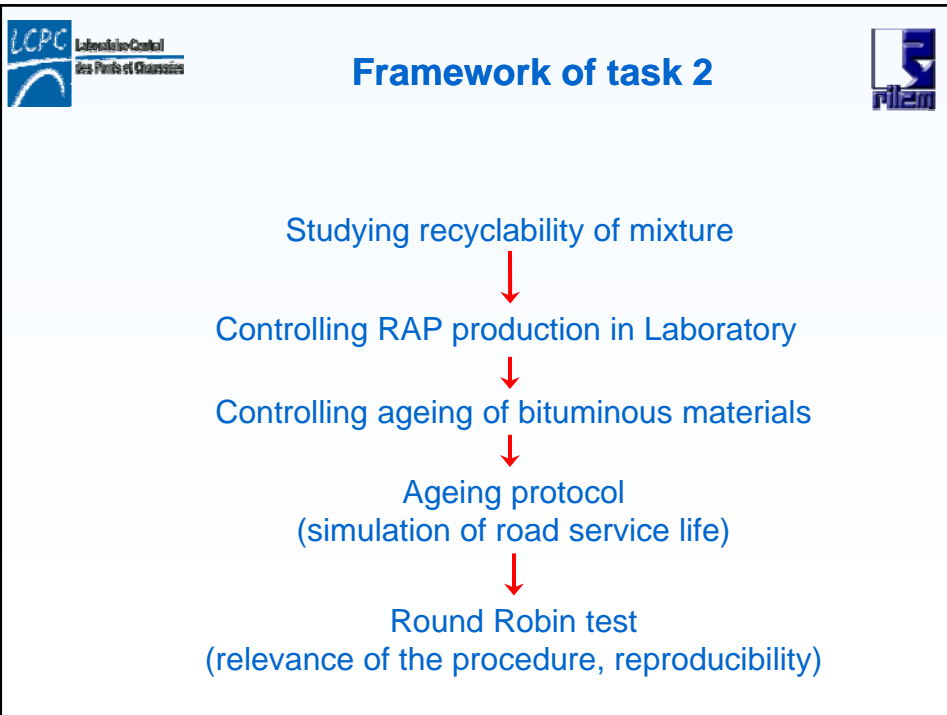
TC ATB – TG5 - Recycling of Bituminous Materials

## Context

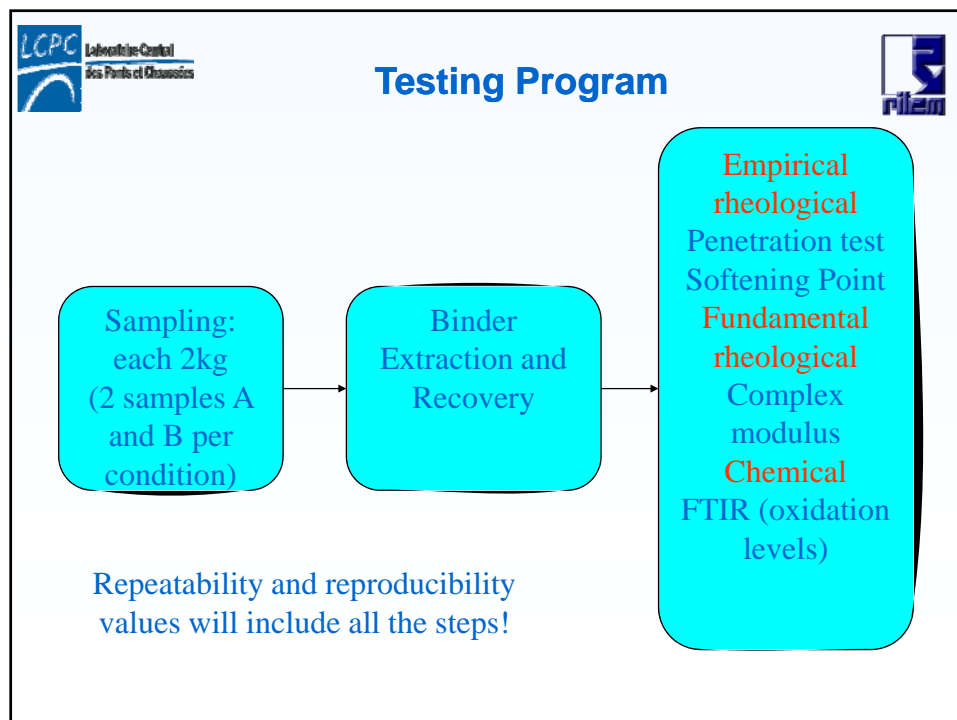
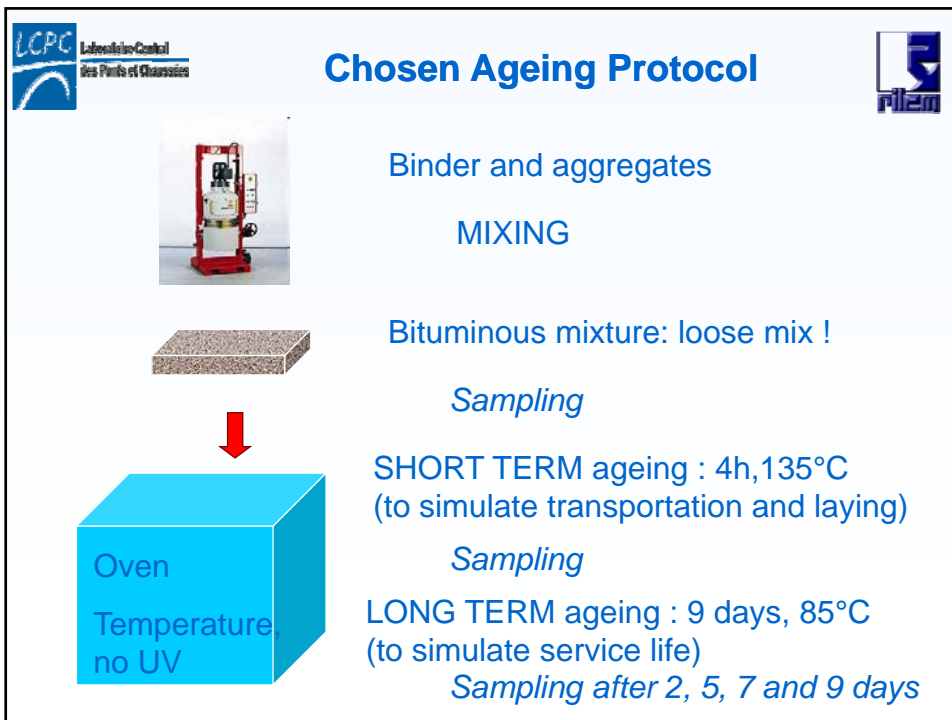
- ❖ RILEM TC ATB – Advanced Testing of Bituminous Materials
- ❖ TG5 “Recycling of Bituminous materials”

3 tasks

- 1 - Bibliography and state of the art on RAP use
- 2 - **Recyclability of mixes**
- 3 - Mix design methodology of mixes containing RAP



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- ## Analysis of existing aging protocols (Porot et al, 2008)
- ◆ Objectives of mix ageing protocols
    - Mostly to simulate long term ageing of asphalt mix
  - ◆ Type of material
    - Mostly compacted samples (6 protocols)
    - Only few on loose materials (3 protocols)
  - ◆ Short-term ageing
    - Not systematic, if so mostly at 135°C between 2 and 4 hours
  - ◆ Long-term ageing
    - Mostly in oven some times with air or oxygen flow
    - Couple of days (5-7) at temperature in range of 60°C to 85°C
    - Couple of hours (16-24) at high temperature (100°C to 120°C)





## Proposal for an inter laboratory test



### ◆ Participating laboratories

Acronym	Country
Aggregate industries	UK
AHA/Delft University	Belgium/Netherlands
Danish Road Institute	Denmark
EMPA	Switzerland
ISBS	Germany
LCPC	France
LRPC-Aix	France
NTEC	United Kingdom
University of Parma	Italy
Repsol	Spain
SINTEF	Norway
TOTAL	France

- ◆ Organizing and analyzing core group : Van de Ven, Van den Bergh, Dubois, Gabet, de la Roche, Grenfell



## Material tested



60 mm thick layer of a french "0-10 mm" BBSG (AC 10)  
(dense asphalt concrete for surface course)



Experiment on the LCPC fatigue  
Carrousel...

Sampling in the paver



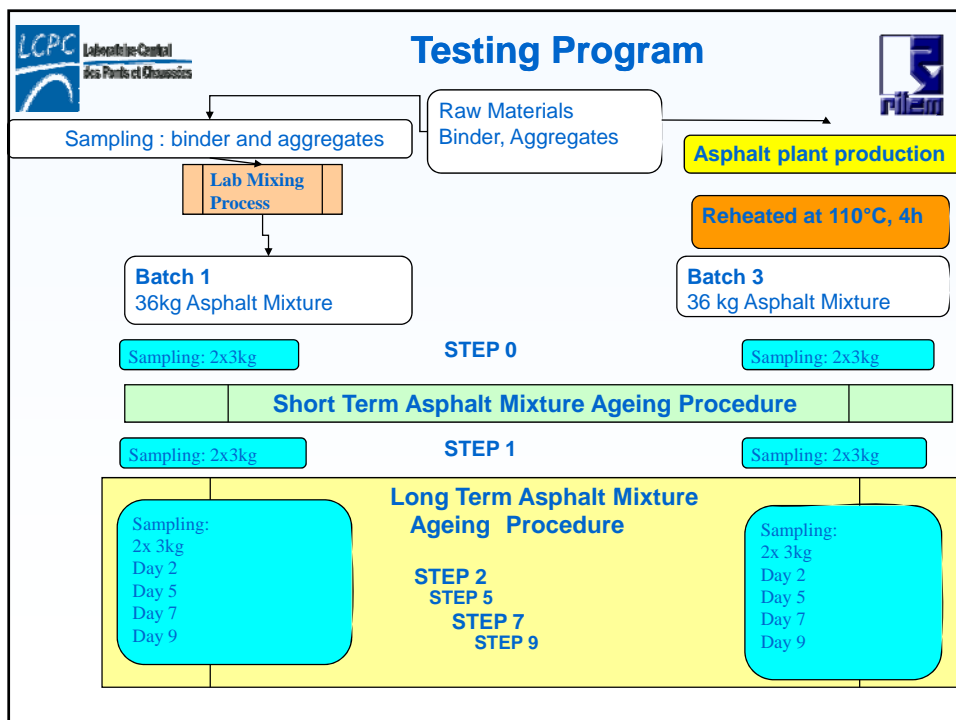
Loose mix (750 kg) + aggregates & binder (2950 kg)

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## Material composition

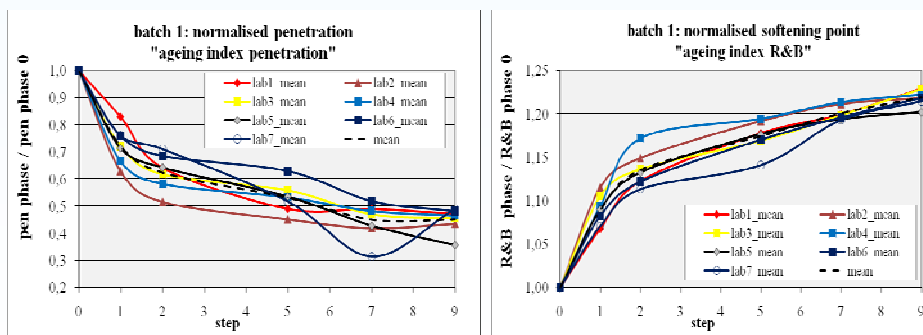
RTE

Component	Proportions	Quantity for 36 kg of lab mix (1)	Quantity for each lab (1)
0-2 mm Quarry <i>Brefauchet</i>	34 %	11,65 kg	24 kg
2-6.3 mm Quarry <i>Brefauchet</i>	16 %	5,4 kg	11 kg
5.6-11.2 mm Quarry <i>Brefauchet</i>	49 %	16,68 kg	34 kg
Fillers	1 %	0.36 kg	1 kg
Pure binder 35/50 (pen 35 1/10mm, R&B 54,1°C)	5.7 % (ext. perc.)	1,92kg	4 kg
Loose mix			36 kg (2)



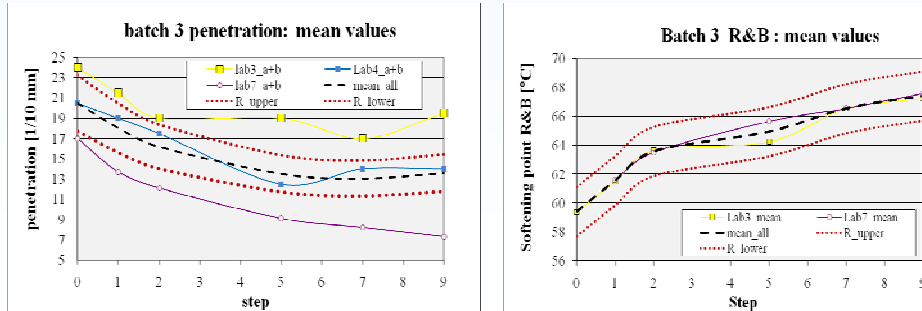
- ◆ Up to now, only partial results available
- ◆ First trends

## Penetration and Softening point Batch 1 (laboratory manufacturing) ratios to phase 0 (7 labs)



Still scattered results but same trend  
 Stability of penetration after 7 days but still R&B evolution  
 More available tests (RCAT, RTFOT and PAV) for further analysis

## Penetration and Softening point tests : Batch 3 (plant manufacturing) Absolute values (3 labs)

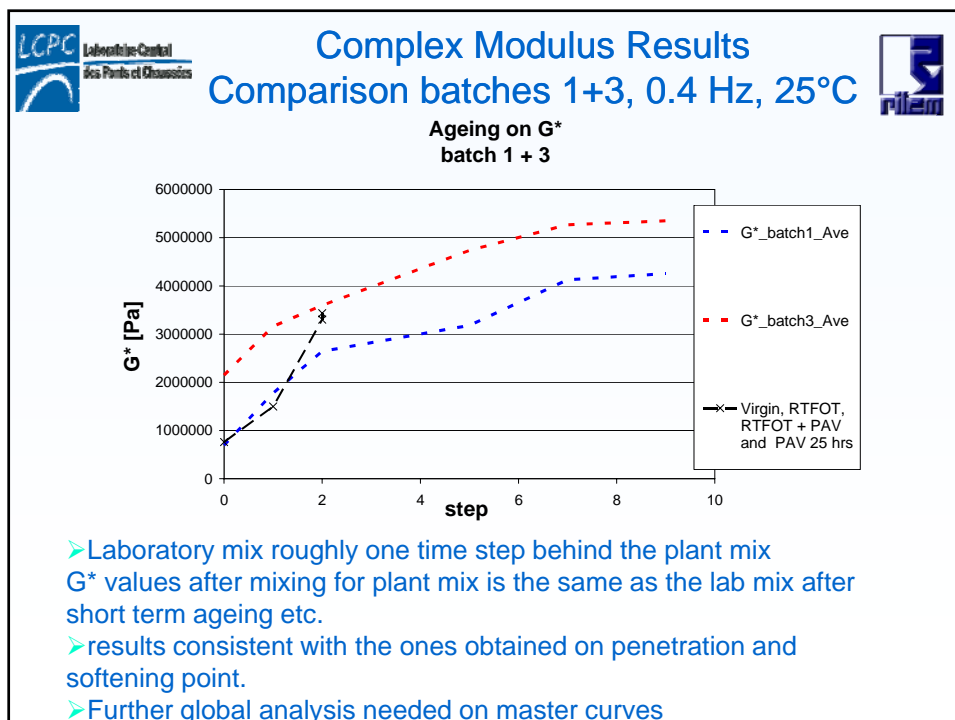
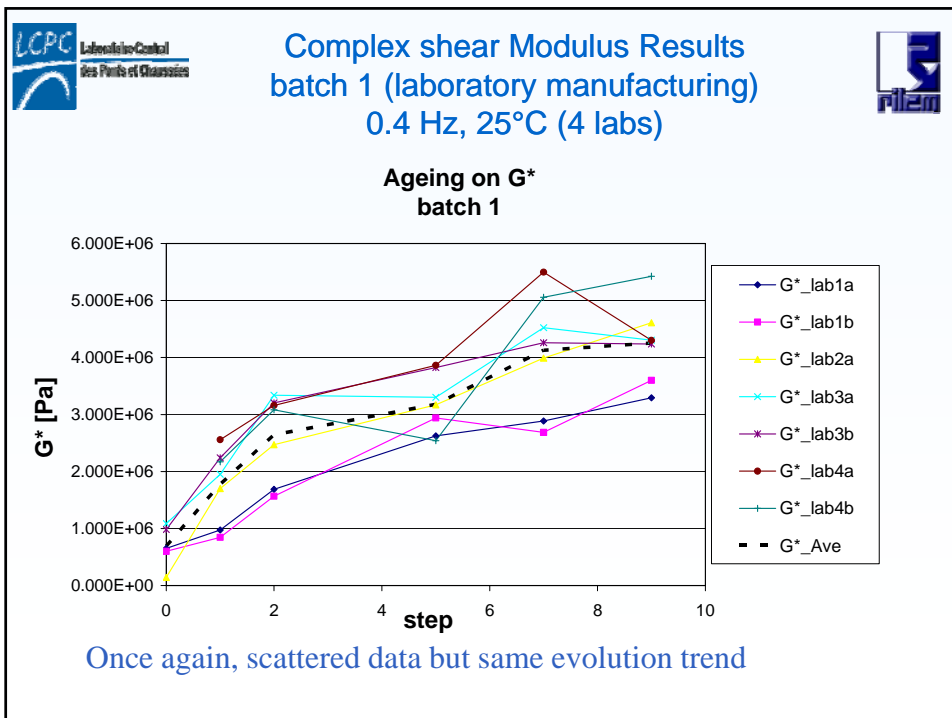


More scattered results in penetration than R&B  
 R&B results included in the test reproducibility range  
 Stability of penetration after 7 days but still R&B evolution  
 More available tests (RCAT, RTFOT and PAV) for further analysis

## Complex modulus measurement on recovered binder EN 14770

Testing program :

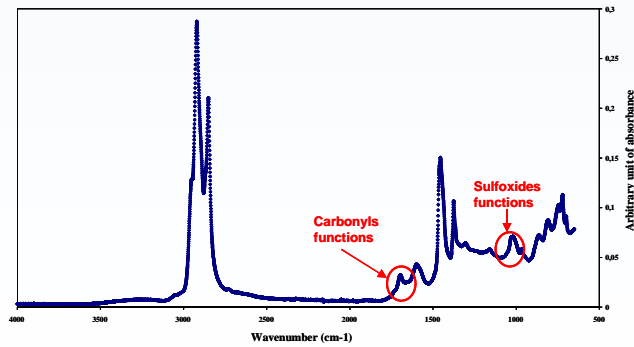
- ◆ Frequency sweeps ( $G^*$  and  $\delta$ ) from 0,1 to 10 Hz
- ◆ -5, 5, 15 and +25°C ;
- ◆ Master curve construction
- ◆ Common measurement point :  $G^*$  and  $\delta$  at 0,4Hz and 25°C





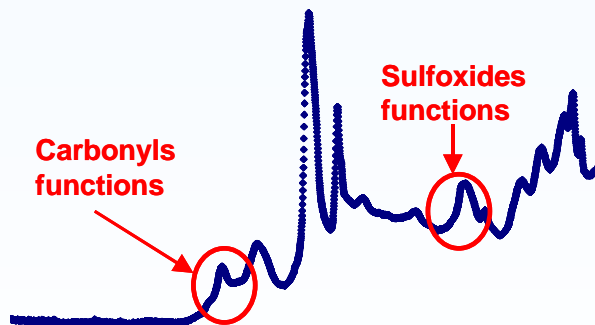
## FTIR measurements (Fourier Transform InfraRed Spectroscopy)

- ◆ Identification and quantification of bituminous binder's oxygenated species (using LCPC method n° 9)

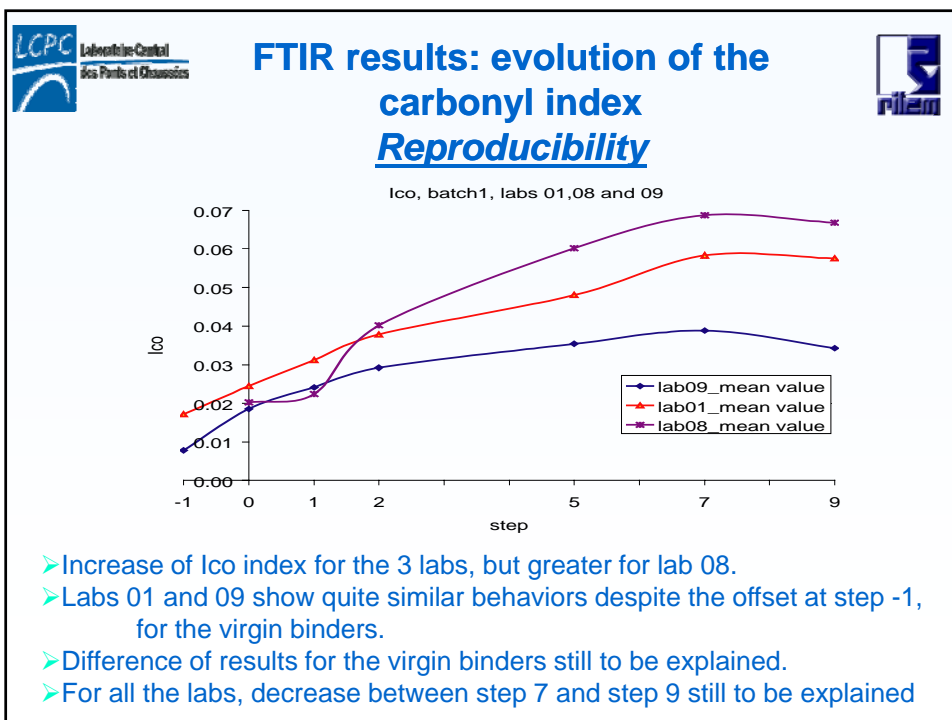
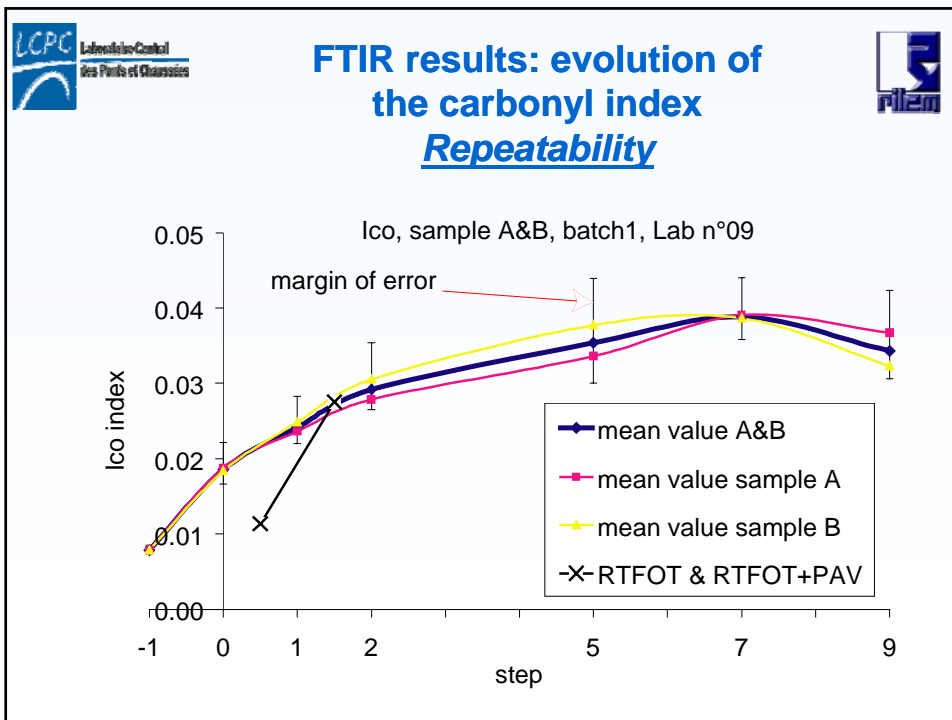




- ◆ **Carbonyl Index :  $I_{CO}$**  = 
$$\frac{\text{Area around } 1700 \text{ cm}^{-1}}{\text{Area around } 1460 \text{ cm}^{-1} + \text{Area around } 1375 \text{ cm}^{-1}}$$
- ◆ **Sulfoxide Index :  $I_{SO}$**  = 
$$\frac{\text{Area around } 1030 \text{ cm}^{-1}}{\text{Area around } 1460 \text{ cm}^{-1} + \text{Area around } 1375 \text{ cm}^{-1}}$$

## Comments on FTIR analysis





- Difficulties :
- defining the area around a peak from a valley to another valley, especially when wavenumbers of 2 components are very close to carbonyl and sulfoxide indexes
  - If all the area are defined with the same wavenumbers, these wavenumbers will not correspond to valleys for all the tests ...






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## FIRST CONCLUSIONS ON AGEING INTERLABORATORY TEST

Good Results ...  
but only preliminary results

- Protocol ready even if it could be optimized
- Good trends for every kind of tests
- Good reproducibility
  
- Number of results not representative enough yet, difficult to analyze
- How to deal with the dispersion (results could give an ageing level ?)
- Still analysis to perform
- Need to compare with real pavement data


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## What's next?

- ◆ Final results of batches 1 and 3 expected for mid September
- ◆ After evaluation and analysis :
  - Mechanical tests on mixtures
  - Tests on RAP taken from the test track (after 1,5 year)
- ◆ Towards a RILEM recommendation

We will keep you informed !

## Special Thanks

- ◆ Core group of RILEM TG5 for the organization and the analysis
- ◆ Rilem TG5 members for their participation to tests and analysis
- ◆ Additional participants to the RRT for performing tests



Thank you for your attention!