Influence of crumb rubber added by dry process on thermomechanical properties of bituminous mixtures

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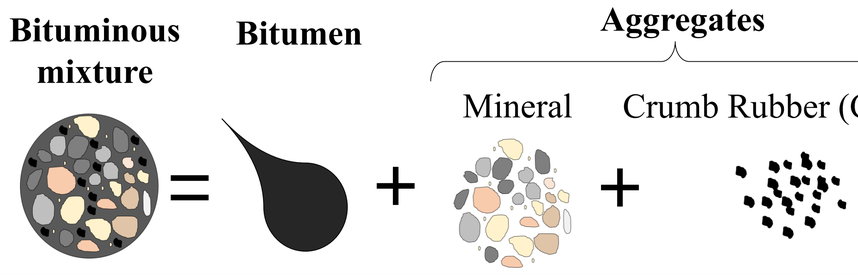
JOURNEES TECHNIQUES ROUTE 2020

CONTEXT AND OBJECTIVES

- 50 millions tires produced each years in France → To be recycled
- One solution → Incorporate rubber in bituminous mixtures

Dry process → replacement of a part of aggregates



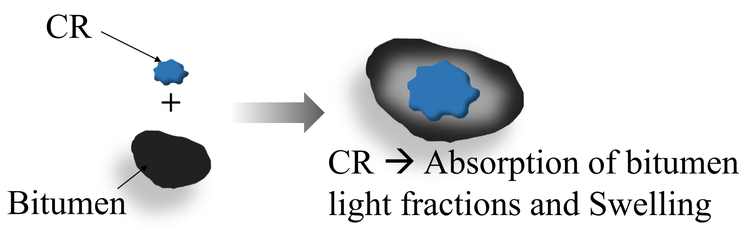
Objectives:

- Bituminous mixtures design with dry process
- Characterisation of thermomechanical behaviour

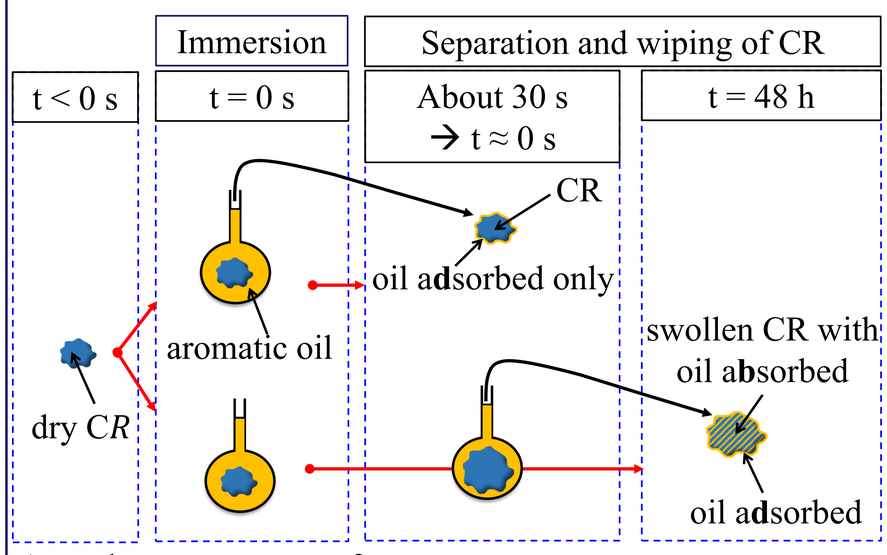
EXPERIMENTAL STUDIES FOR MIXTURES DESIGN

CR/bitumen interactions

Phenomenological explanation:

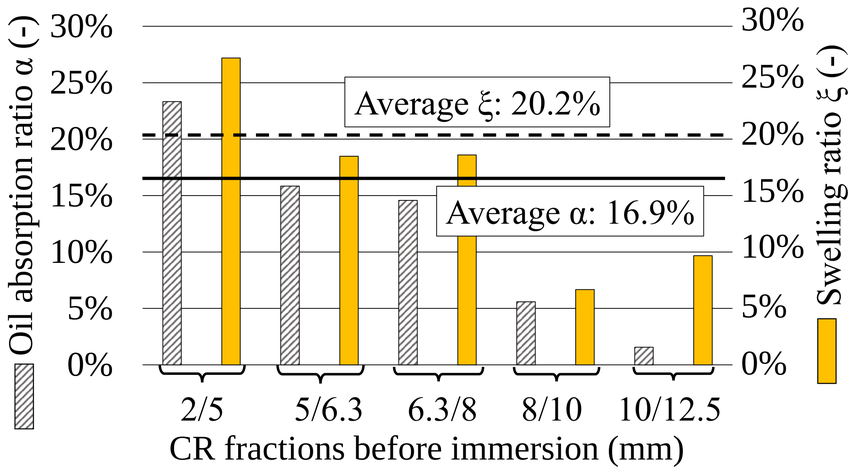


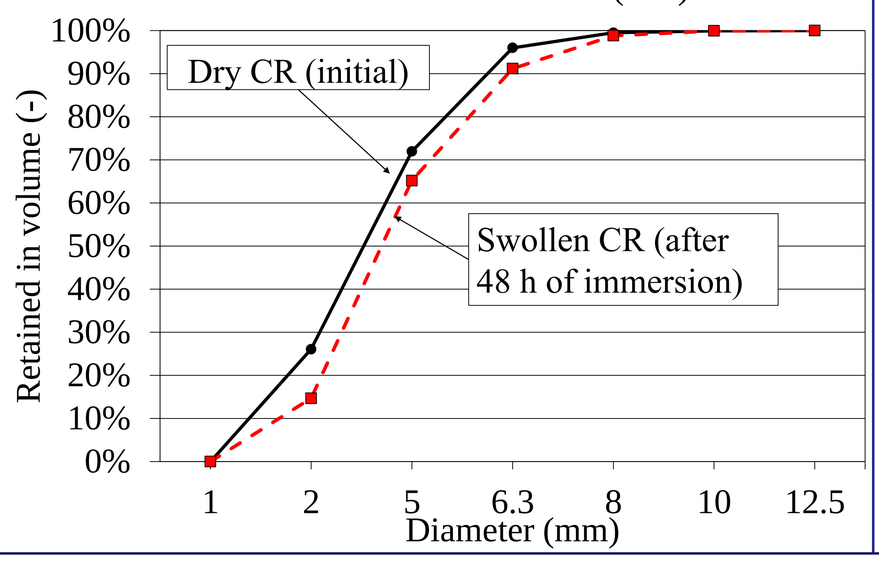
Experimental evaluation for each five CR fractions:



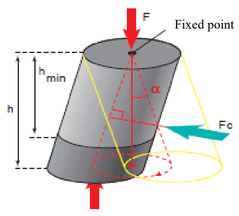
At each step, measure of:
- Volume (pycnometer) and weight

Results in volume of dry CR:





Gyratory shear compactor



→ High deformability of CR particles

→ Failure of samples

Not adapted

→ Do not reproduce correctly in-situ compaction

→ Samples obtained from wheel compactor

Advanced test samples | Slabs for rutting test

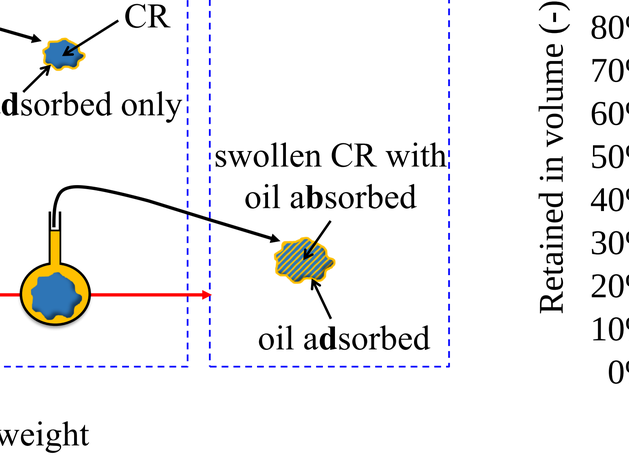
MATERIALS AND ADVANCED LABORATORY TESTING

Production of specimens

Slabs compacted using an LPC wheel compactor:

- Investigations of the swelling of mixtures slabs with CR aggregates

Coring plan for each mixture:



Types of materials

Different materials:
- GB5 0/14 with 25% of RAP and 4/8 mm CR aggregates
- BB5 0/10 with 25% of RAP and 3/6mm CR aggregates

Bitumen:
- Pure 35/50
- Biprène 43
- Biprène 63

Amounts of rubber:
- 0%
- 2%
- 4%

Compatibilizers:
- Oléoflux
- Poix tall oil

+ Pure rubber specimens

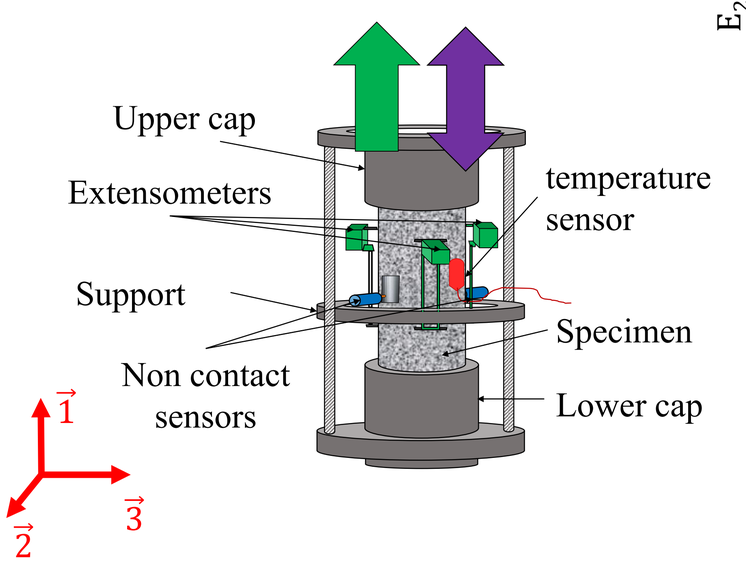
Advanced Laboratory testing and modeling

TSRST in 3 dimensions:

Failure in tensile by thermal stress restrained:
- Initial temperature T_i = 5ºC
- $\varepsilon_{axial} = 0$
- Temperature decrease of -10ºC/h until failure

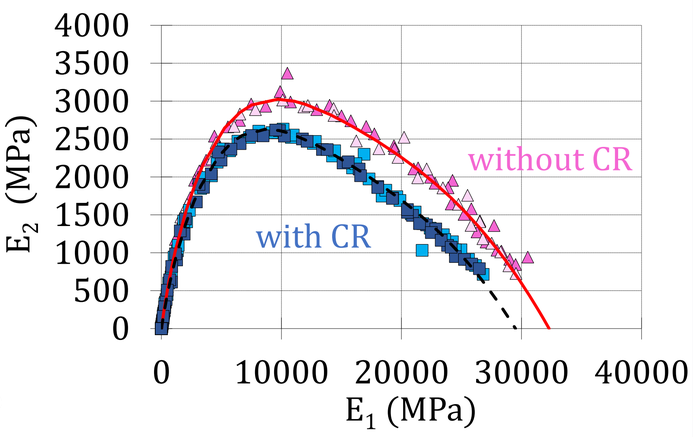
Direct tensile strengh tests:

Axial lengthening of a specimen at:
- T = -5ºC, 5ºC, and 10ºC
- 3.2%/min until failure



Complex modulus tests

- Axial sinusoidal cyclic loading in tension/compression
- 50 µm/m imposed axial strain amplitude
- 9 temperatures from -25ºC to 50ºC
- 8 frequencies from 0.003 Hz to 10 Hz



- 2S2P1D model: