JOURNEES TECHNIQUES ROUTE 2024

EIFFAGE ROUTE · UNIVERSITÉ DE LYON · ENTPE · CIRCOPAV · Marie Skłodowska-Curie Actions

DESIGN OF NEW SUSTAINABLE BIO-BINDERS FOR COLD-IN-PLACE RECYCLING

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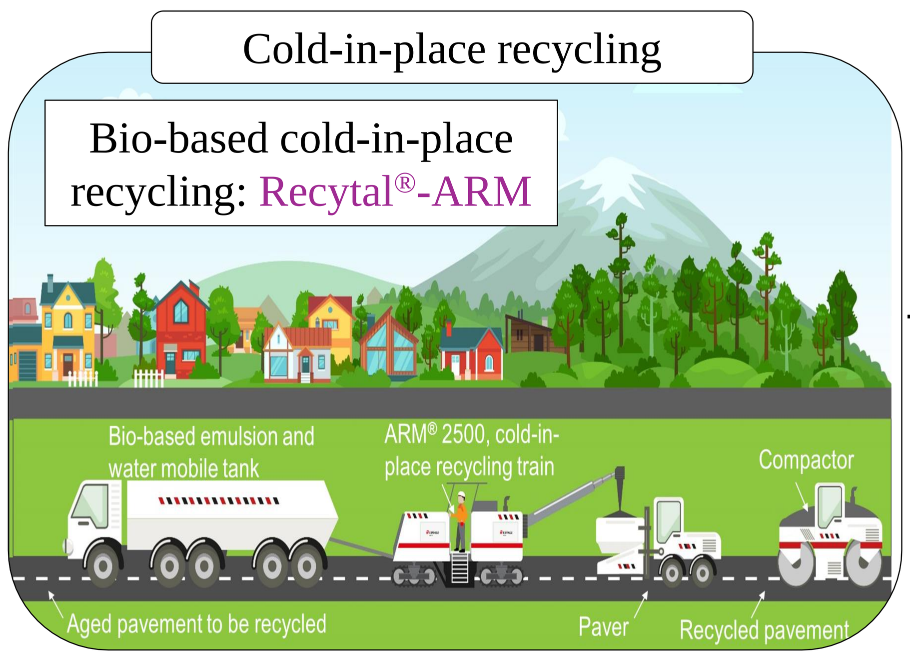
Introduction

Deteriorated pavement

New pavement

Bio-based emulsion and foam



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- Economy of non-renewable natural resources
- Less greenhouse gas emissions
- More efficient and lower cost

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- Curing period and cover layer required
- Traffic limitation
- Uncertainties - blending of binders.

Objectives

This work aims to prove that alternative bio-based emulsion and bio-based foam can be used for cold-in-place recycling with the same level of performance as conventional petroleum product solutions. To achieve this, will be necessary:

- Design bio-based emulsions & foams
- Carry out advanced experimental characterization & modelling to assess the specific behaviour of the bio-based cold products in a pavement design calculation
- Implement results on test section
- Validate results via life-cycle assessment.

Materials and Methods

Materials

- Bitumen 160/220 → **Bitumen Emulsion**
- Bio Binder → **Biobinder Emulsion**
- RAP 0/10mm

→ **Production of 2 types of mixtures**

MIXTURES Compositions	E. Bitumen*	E. Biobinder*
RAP	100%	100%
Emulsions Bitumen / Biobinder	3,1%	3,2%
Added binder content (from RAP)	1,9%	1,6%
Total water content (addition water+ emulsion + RAP)	7,0%	7,0%

*The percentages that correspond by weight to the total sample.

54 samples/mix

Methods

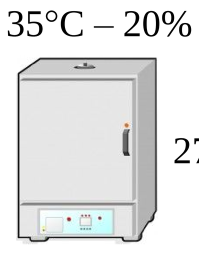
1st analysis – Influence of curing on mix properties

➢ **2 curing conditions**

- 18°C – 50% RH

27 samples

- 35°C – 20% RH



27 samples

Compressive strength determined by simple compression tests on 3 specimens at 1mm/s (± 0.1 mm/s)

Beginning of curing time

Compressive strength test on **3 specimens / curing period**

T0 → T7 → T14 → T28 → T42 → T56 → T90

Separation - 5 samples put in water (18°C and 35°C)

Compressive strength (5 air/5 water)

Duriez test NF P98-251-4

Results

- Water content;
- Apparent density by geometric measurements;
- Void percentage;
- Compressive strength R(air);
- Compressive strength r(water);
- Ratio r/ R.

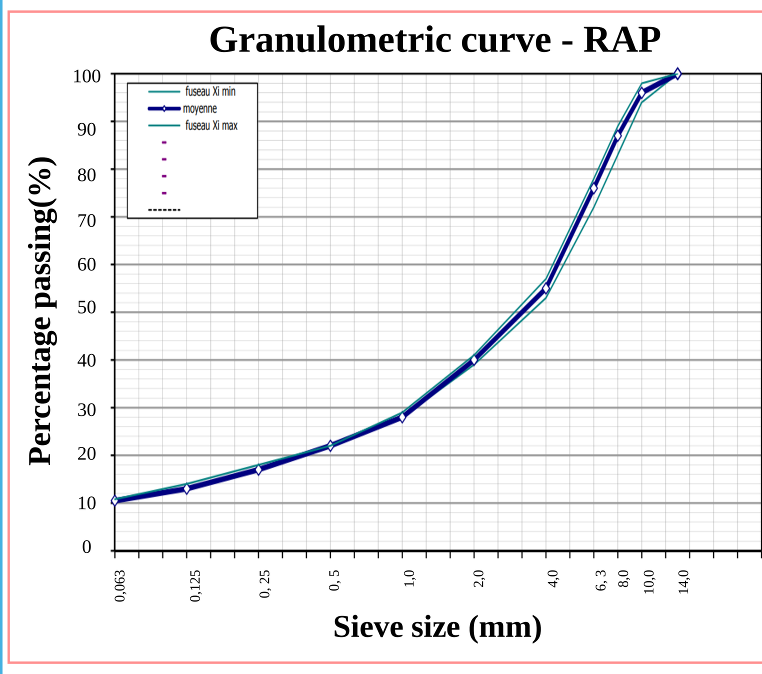
Preliminary results

Materials characterization

Binder characteristics		Bitumen	Biobinder
Penetration	1/10 mm	185	> 300
Softening point	°C	40,4	33,1
Acid Index	mg KOH / g	0,333	43,9

Emulsion characteristics		Bitumen	Biobinder
Water content	%	34,8	48,12
pH	-	2,7	2,3
Residues at 7d	%	0,0024	0,0204
Rupture index	-	122,13	121,13

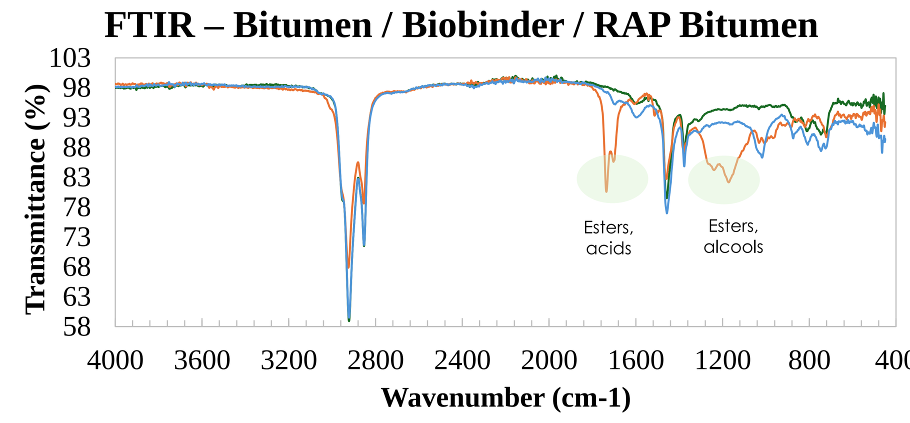
Granulometric curve - RAP



Particle size RAP 0/10mm

- Binder content : 5,44%
- Penetration : 16 mm/10
- Softening point : 66,2 °C

FTIR – Bitumen / Biobinder / RAP Bitumen



Mechanical results

Classification of mixtures according to the Technical Guide: **“Retraitement en place à froid des anciennes chaussées"**

→ **Classe III**

Duriez test

Voids (%) ≤ 14%

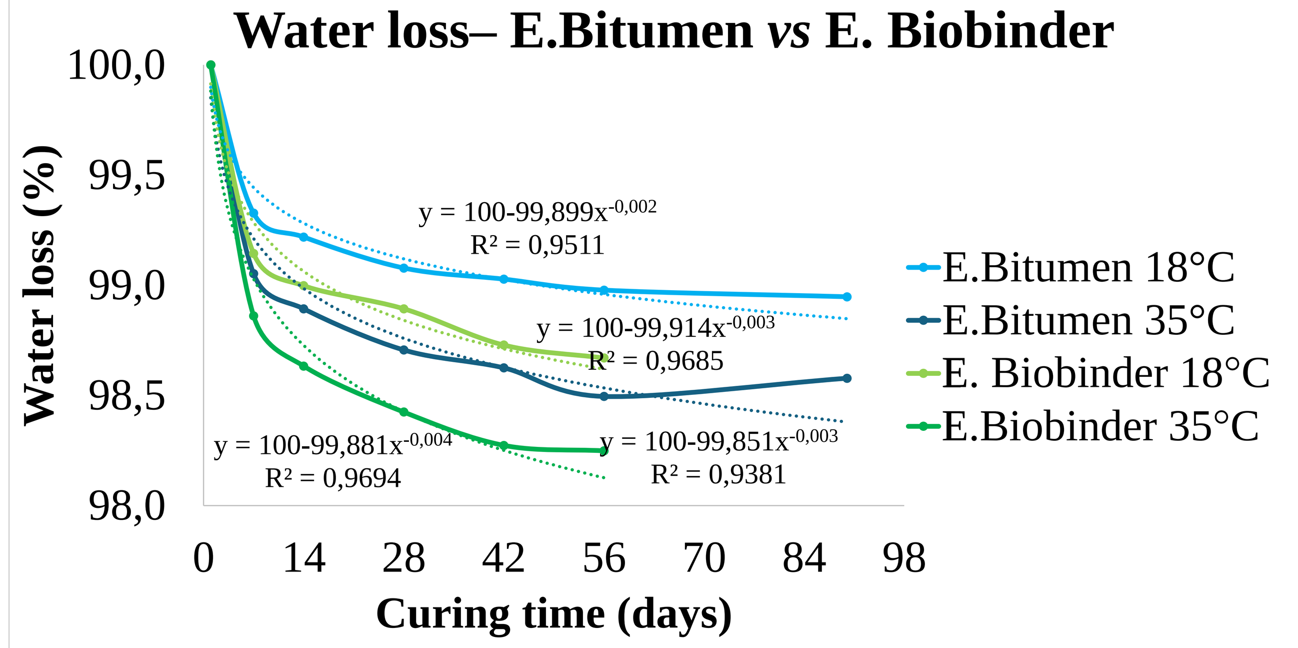
r/R ≥ 0,70

Rc (14 days) ≥ 5 MPa

Classification

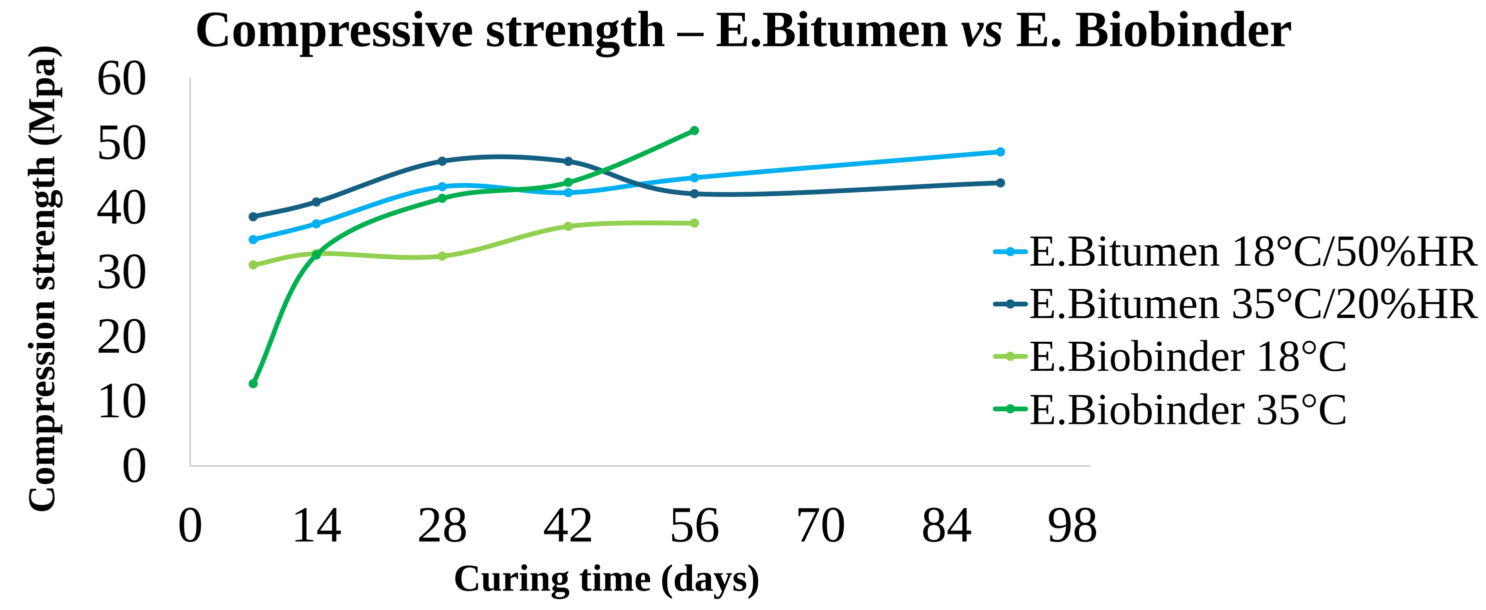
Parameters	E.Bitumen		E. Biobinder	
	Air	Water	Air	Water
Void (%)	5,92	5,94	6,18	6,32
r/R	0,80		0,79	
Rc (MPa)	7,5	6,0	6,5	5,2

Water loss– E.Bitumen *vs* E. Biobinder



Considering the total amount of initial water present in the mixture at 100%.

Compressive strength – E.Bitumen *vs* E. Biobinder



Similar trends and no significant difference between bitumen and bio-based emulsion mixtures, highlighting the potential of these alternative materials.

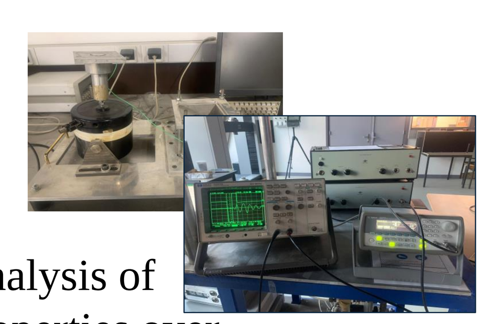
Perspectives

Foamed Asphalt

- Analysis of bitumen and bio-based foam mixtures

Stellenbosch University, South Africa

Wave propagation

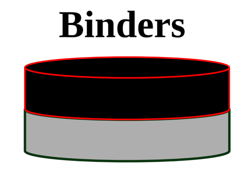


- Analysis of properties over curing time in a single sample

Binder tests

- Analysis of recovered binders
- Rheological study - blending of binders

Binders



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