



HRVATSKO ASFALTERSKO DRUŠTVO



CROATIAN ASPHALT ASSOCIATION

EVALUATION OF THE DURABILITY OF EMULSION BASED AC MIXTURES FOR WEARING COURSES

PROCJENA TRAJNOSTI AC MJEŠAVINA NA BAZI EMULZIJA UGRAĐENIH U ZAVRŠNE SLOJEVE

9. MEĐUNARODNA KONFERENCIJA ASFALNI KOLNICI 2025

9. INTERNATIONAL CONFERENCE ASPHALT PAVEMENTS 2025

OPATIJA 08. – 09. 05. 2025.

XAVIER CARBONNEAU, COLAS





CURRENT SITUATION



Well adapted for low traffic road

Low knowledge on in situ behavior

Low carbon footprint solution –
Important for our Roadmap

Need data to support
development

PROJECT



IDENTIFICATION OF CONSTRUCTION SITES

- Select different jobsites with increasing ages
- Agreement from clients for survey & take cores



PAVEMENT MONITORING

- Damage quantification
- Significant network



SAMPLING

- Cores : Void content / Binder aging



PERSPECTIVES

- Argue on CO2 footprint based on durability !
- Communicate on new data

ACTION PLAN

- Select
- 1 Production plant of Easycold ECOUFLANT



Formula

- As constant as possible
- Composition
- Emulsion (knowledge)
- Quality control
- In situ QC
 - MTD, thickness, void content

Jobsites

- Localisation
- Traffic
- Date on paving
- Damage evaluation
- coring

SELECTION OF JOBSITES

RD 154



RD 111

RD 751



RD 84

SELECTION OF JOBSITES

RD 125



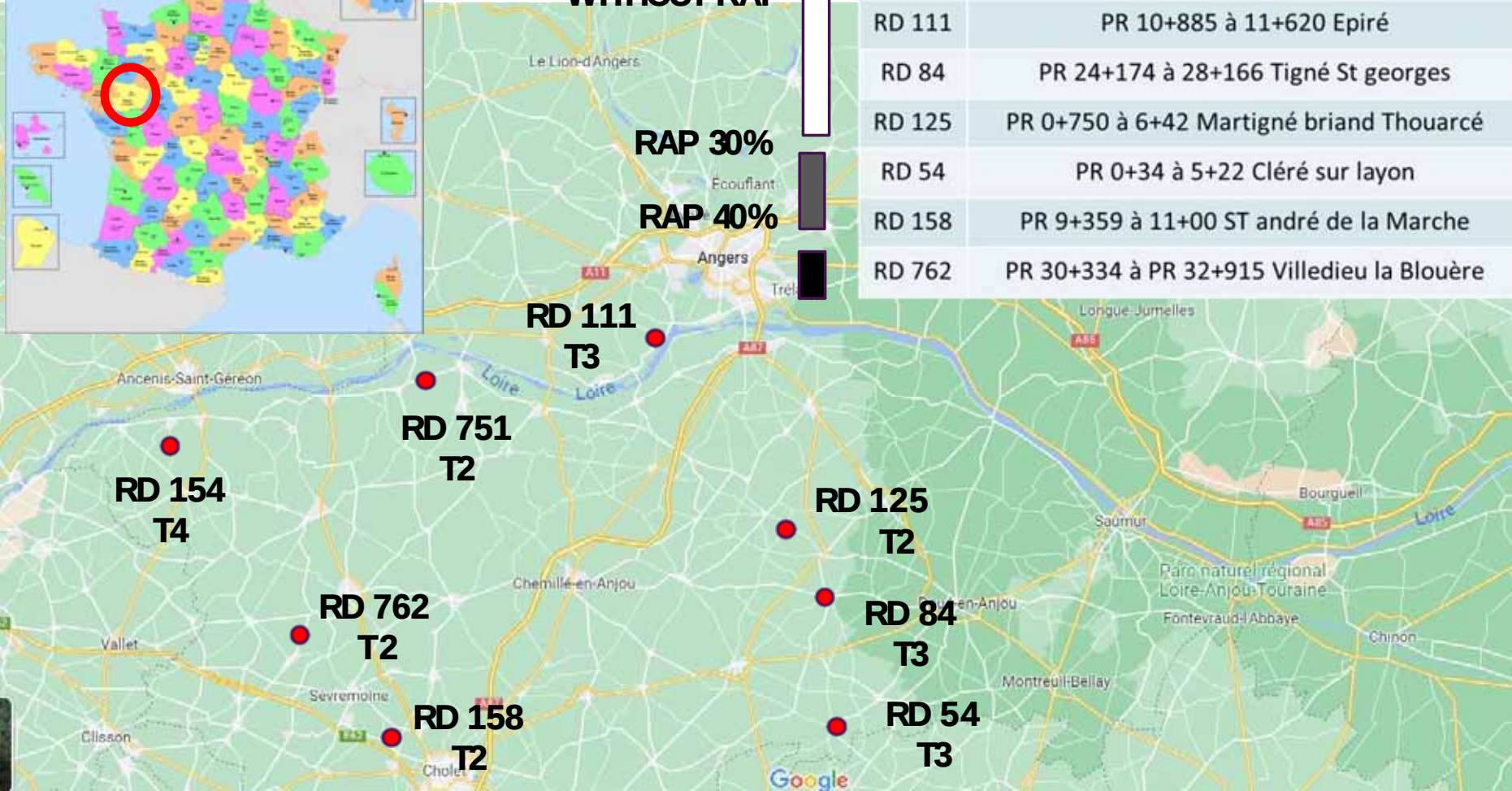
RD 54



RD 158

RD 762

SELECTED JOBSITES MAINE AND LOIRE (49)



REF	listing chantier	Age
RD 154	PR 9+530 à 10+270 (2010)	14
RD 751	PR 77+65 PR 79+28 (2011) (ESU 2024) ?	13
RD 111	PR 10+885 à 11+620 Epiré	13
RD 84	PR 24+174 à 28+166 Tigné St georges	10
RD 125	PR 0+750 à 6+42 Martigné briand Thouarcé	10
RD 54	PR 0+34 à 5+22 Cléré sur layon	5
RD 158	PR 9+359 à 11+00 ST andré de la Marche	5
RD 762	PR 30+334 à PR 32+915 Villedieu la Blouère	3

CORE SAMPLING – ON SITE MEASUREMENTS



Coring - FWD -PMT : 25,26 & 30 April + 13&14 May
Survey (Evalis 3D TN) : 13&14 May

	RD 54 (2019)	RD 84 (2014)	RD 111 (2011)	RD 125 (2014)	RD 154 (2010)	RD 158 (2019)	RD 751 (2011)	RD 762 (2021)
Photos								
Structure	Easycold 5cm, 2019	Easycold 4 cm, 2014	Easycold, 4 cm, 2011	Easycold, 3 cm, 2014	Easycold 4 cm, 2010	Easycold, 4 cm, 2019	Easycold, 3 cm, 2011	Easycold, 4 cm, 2021
	SD 1 cm, 2005	SD, 1 cm, 2002		SD, 1 cm, 2003		SD, 1 cm, 2008	SD, 1 cm, 1998	ECF*, 1.5 cm, 2011
	SD, 1 cm, 1995	SD, 1 cm, 1992	SD, 1 cm, 1999	SD, 1 cm, 1992	SD, 1 cm, 2000	SD, 1 cm, 1996	SD, 1 cm, 1988	SD, 1 cm, 1991
	SD, 1 cm, 1987	Road Base asphalt, 6.5 cm, 1970	SD, 1 cm, 1989	GRH*, 45 cm, 1989		SD, 1 cm, 1986	SD, 1 cm, 1987	SD, 1 cm, 1988
	Old pavement, 10 cm, 1965	SD, 1 cm, 1962	SD, 1 cm, 1983	As dug gravel, 30 cm, 1989	SD, 1 cm, 1990	Sand asphalt, 1.5 cm, 1963	GRH*, ?, 1987	Graded aggregates, 20 cm, 1988
		SD, 1 cm, 1958				Cement treated gravel, 9 cm, 1963	SD, 1 cm, 1978	SD, 1 cm, 1987
Traffic	744 veh/d	1377 veh/d	2371 veh/d	2226 veh/d	1634 veh/d (4,3 % trucks)	2083 veh/d (8,4 % trucks)	3516 veh/d (8,2% trucks)	6900 veh/d (8,4 % trucks)

* Easycold Cold AC mix
 * SD : Surface dressing
 * GRH : Graded aggregate

Source: Data from Department for pavement structure and 10 past maintenance operations on Easycold.

WORK DONE

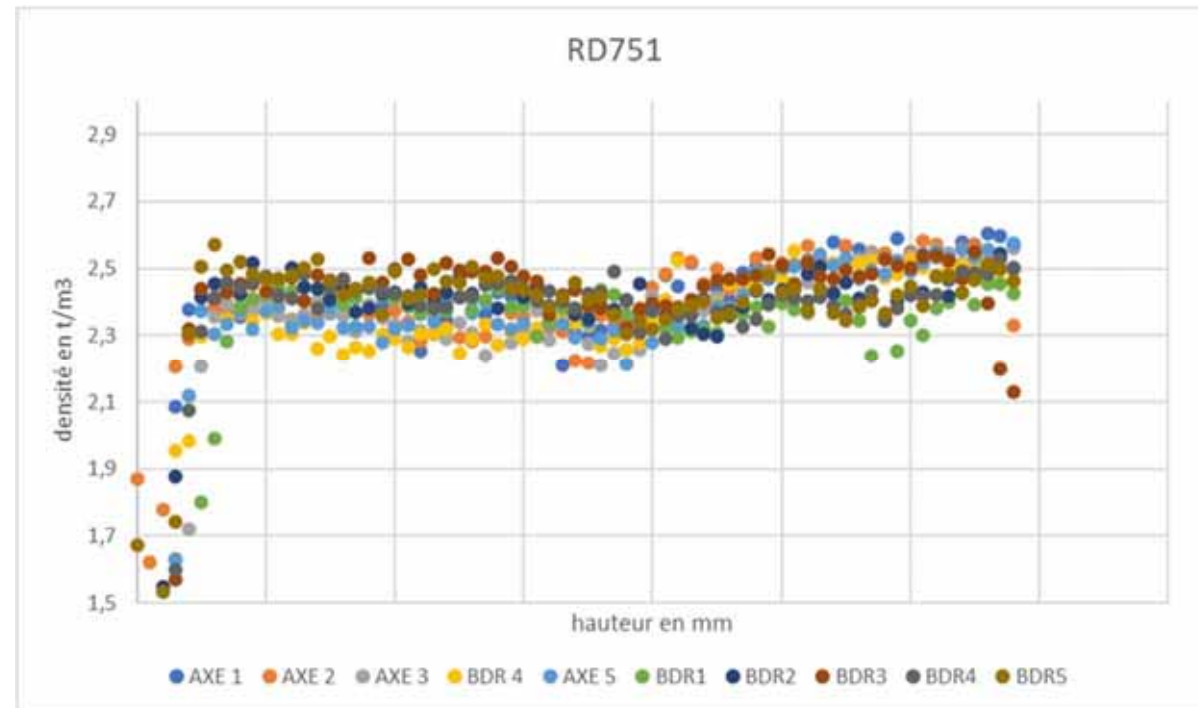
	RD 154	RD 751	RD 111	RD 84	RD 125	RD 54	RD 158	RD 762
JOBSITES SELECTION	●	●	●	●	●	●	●	●
Paving date	Juin 2010	2011	Juin 2011	Juin 2014	Juin 2014	Sept 2019	Avril 2019	Avril 2021
Pavement structure (Dpt)	●	●	●	●	●	●	●	●
Trafic (Dpt)	●	●	●	●	●	●	●	●
Maintenance (Dpt)	●	●	●	●	●	●	●	●
Production Quality control	Juin (92/8)	?	●	●	●	●	●	●
Pavement structure (Cores)	●	●	●	●	●	●	●	●
Survey TN	●	●	●	●	●	●	●	●
MTD measurements(TO)	●	●	●	●	●		●	●
Cores (TO)	●	●	●	●	●	●	●	●
FWD (TO)	●	●	●	●	●	●	●	●

WORK DONE

	RD 154	RD 751	RD 111	RD 84	RD 125	RD 54	RD 158	RD 762
Photo	●	●	●	●	●	●	●	●
Thickness Easycold	●	●	●	●	●	●	●	●
Banc gamma	●	●	●	●	●	●	●	●
<i>Sawing</i>	●	●	●	●	●	●	●	●
ITSM (modulus)	●	●	●	●	●	●	●	●
Sawing	●	●	●	●	●	●	●	●
Binder recovery	●	●	●	●	●	●	●	●
Rheological test (DSR)	●	●	●	●	●	●	●	●

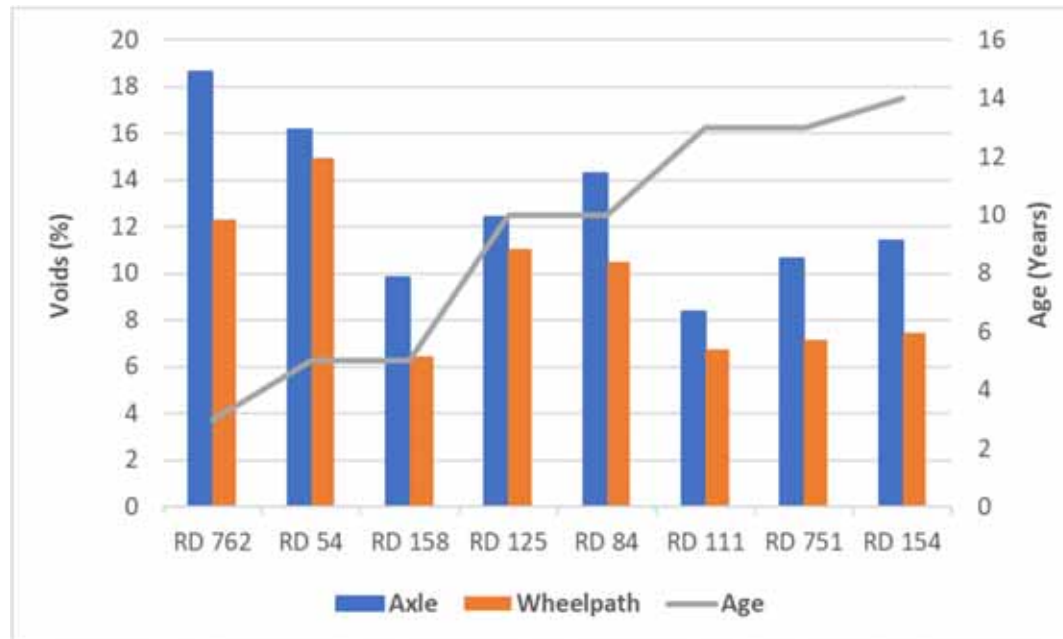


RESULTS ON CORES

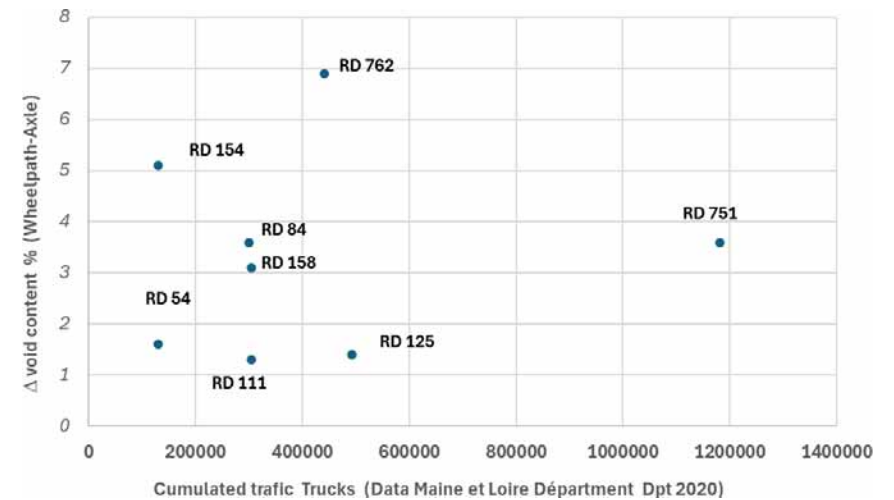
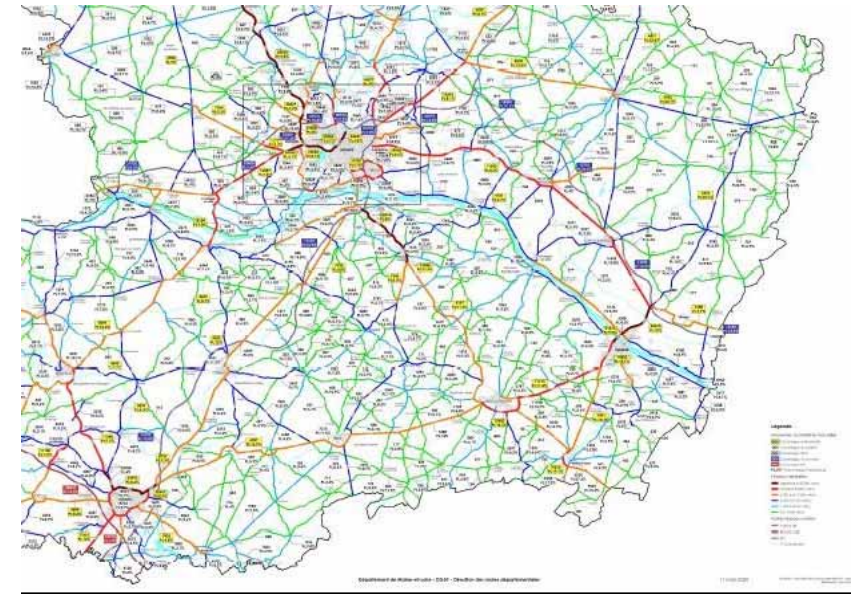


Homogeneity of cores
Difference WheelPath /Axle

RESULTS ON CORES



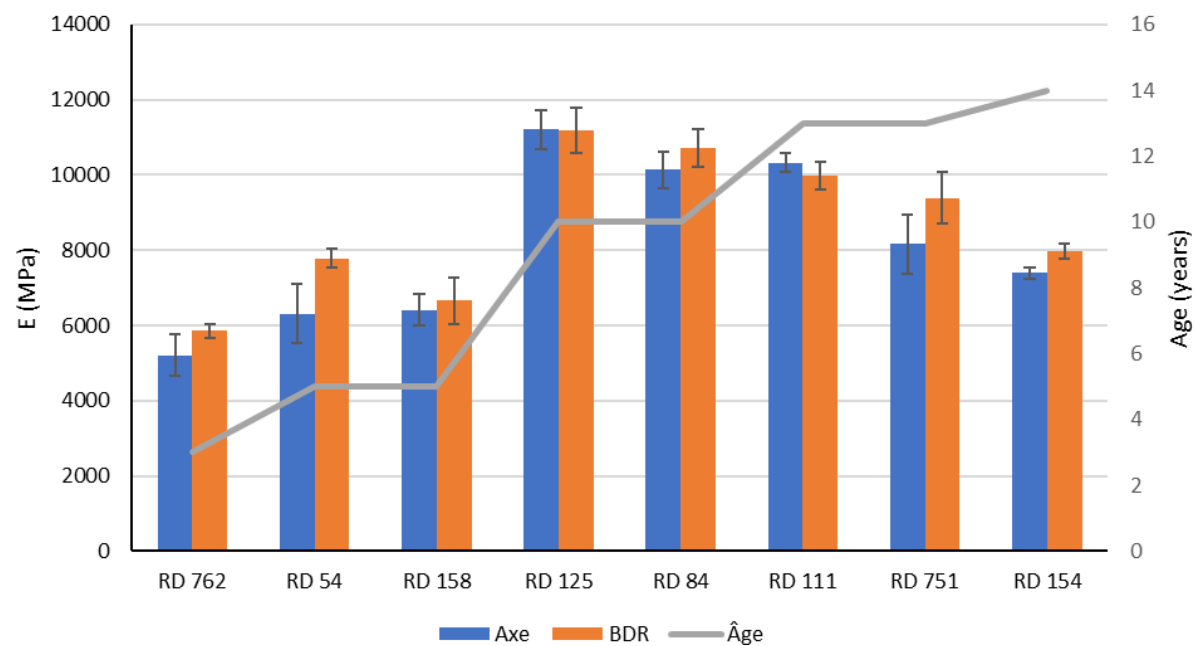
Possible effect of the trafic ?



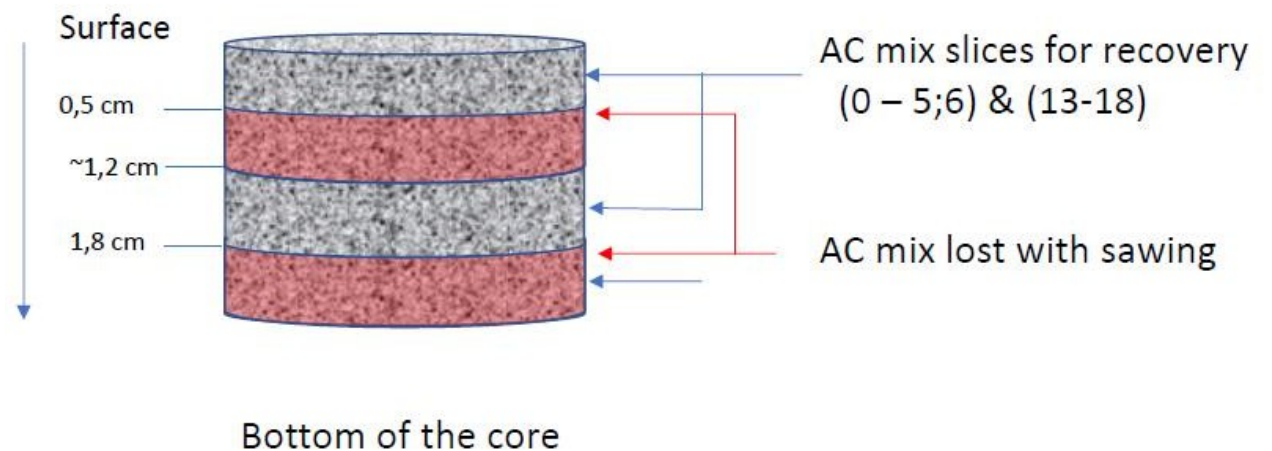
RESULTS ON CORES



Indirect tensile stiffness modulus @ (10°C, 124ms)



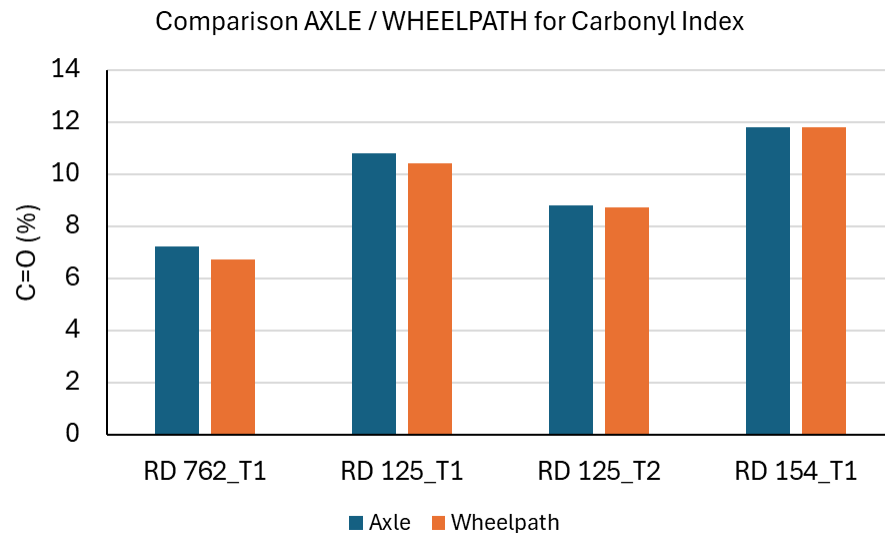
RESULTS ON CORES



2 recovered binders / sections
(surface and «bottom »)

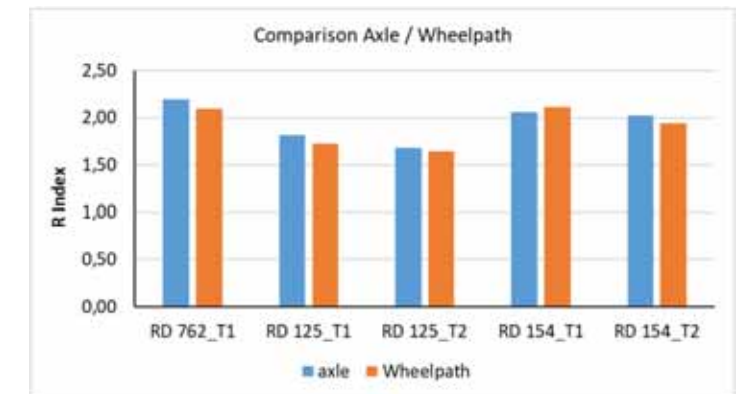
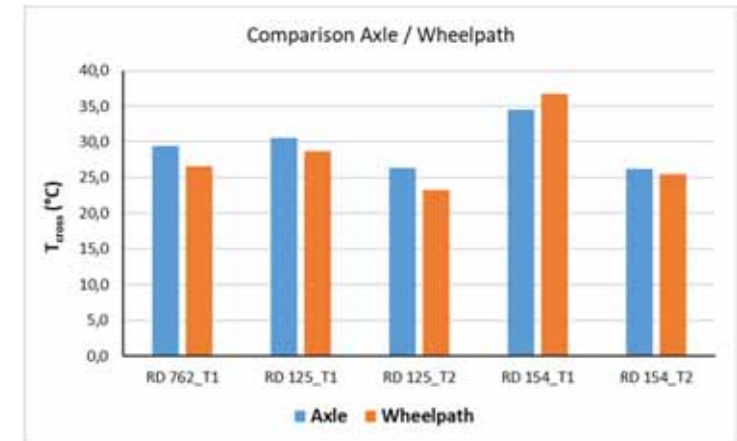
RESULTS ON RECOVERED BINDERS – DSR TESTS

COMPARISON Wheelpath – AXLE



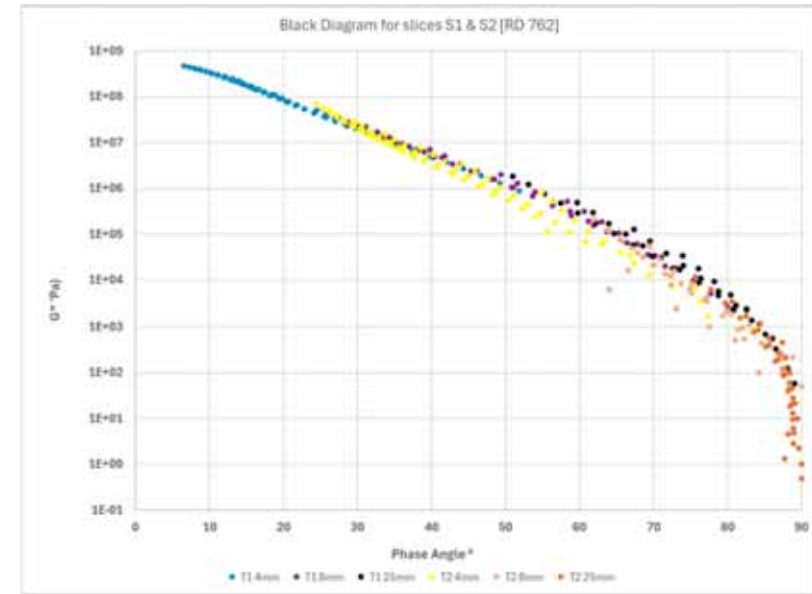
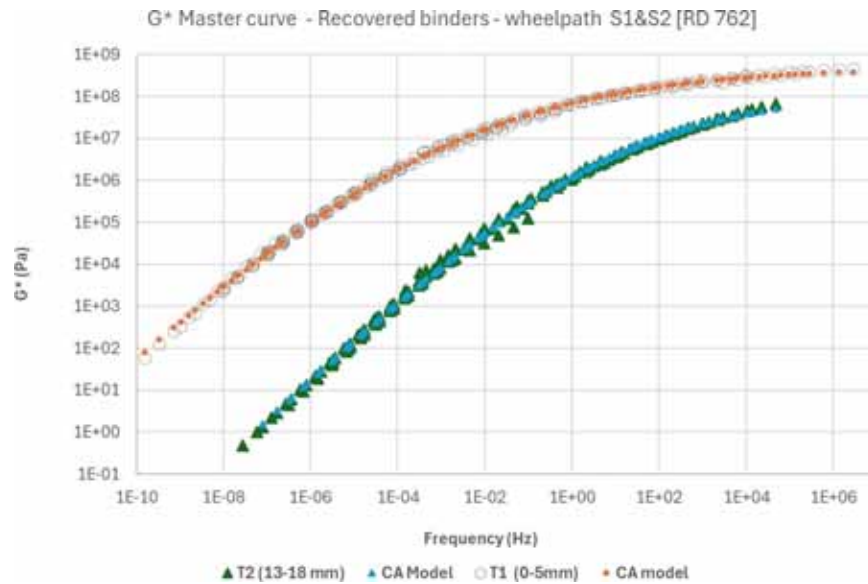
Limited difference
Wheelpath – AXLE
(for surface & bottom)

Difference in modulus
= Difference in voids content



Next step : only recovered
Binder from WP

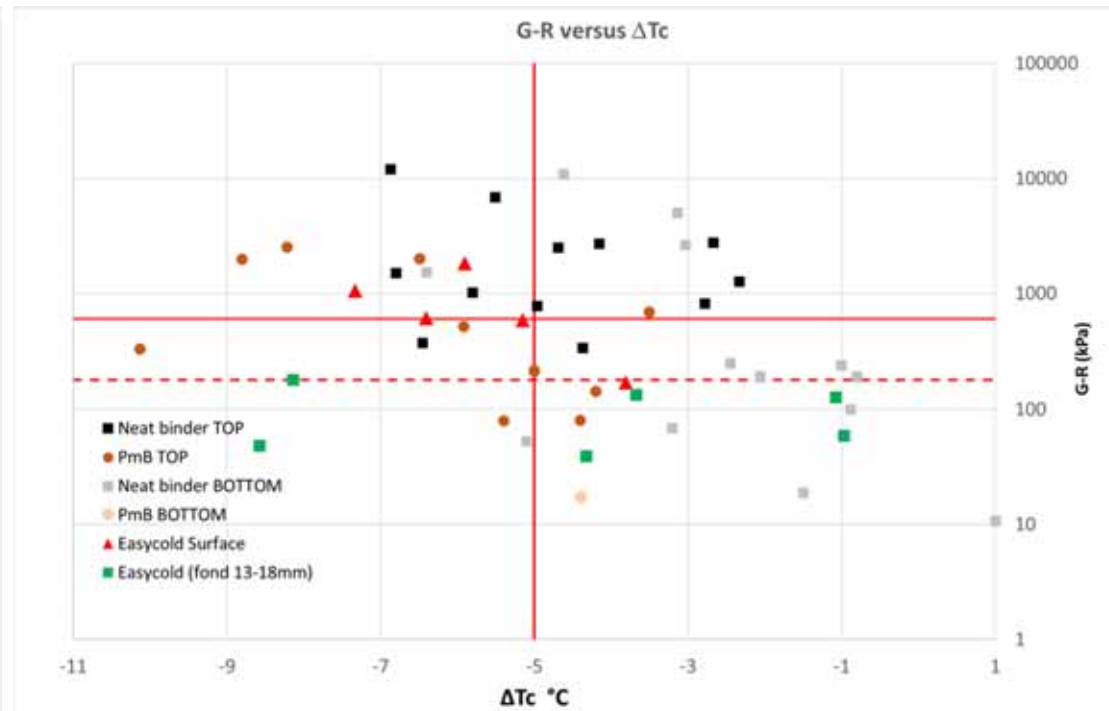
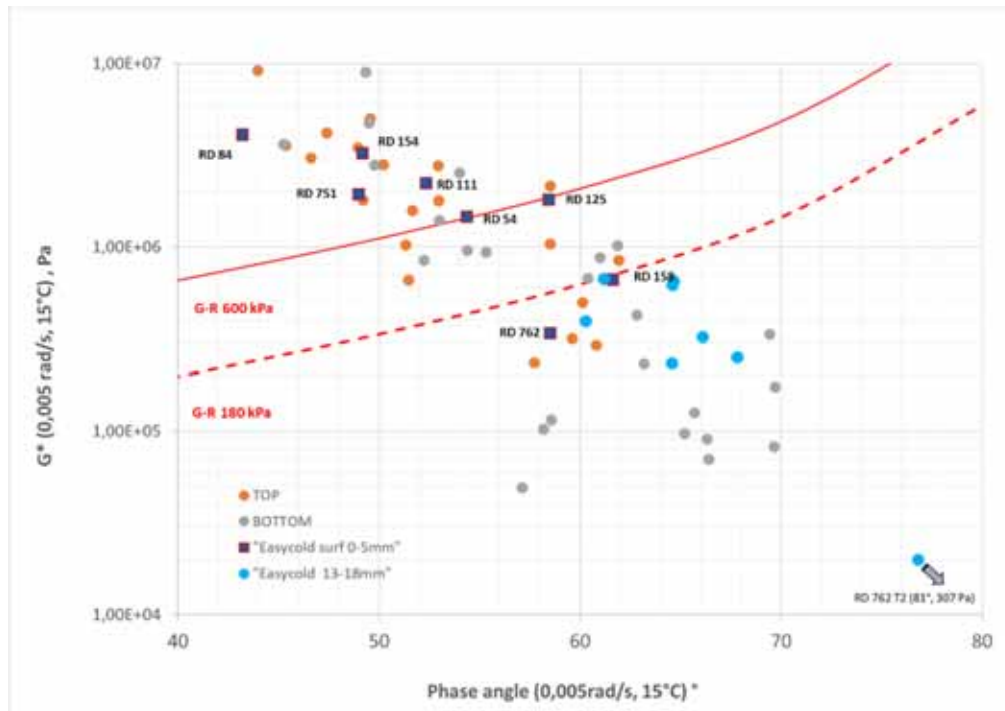
RESULTS ON RECOVERED BINDERS – DSR TESTS



Binder	R-value	Crossover Modulus (Pa)	Crossover T @10 Hz (°C)	ω_c 15°C (Hz)	G* 10 Hz 15°C (MPa)	G-R (kPa)	ΔT_c (°C)
RD 54 bdr t1	2,03	7,0E+06	31,3	1,4E-02	8,8E+01	611	-6,4
RD 54 bdr t2	1,72	1,6E+07	22,5	1,7E-01	8,8E+01	126	-1,1
RD 84 bdr t1	2,16	3,1E+06	45,6	4,5E-04	9,2E+01	3190	-19,9
RD 84 bdr t2	1,81	9,7E+06	25,6	7,3E-02	7,0E+01	178	-8,1
RD 111 bdr t1	2,04	7,4E+06	33,8	7,3E-03	1,1E+02	1056	-7,3
RD 111 bdr t2	1,83	7,5E+06	21,5	2,3E-01	3,7E+01	48	-8,6
RD 125 bdr t1	1,72	1,4E+07	28,7	2,7E-02	1,3E+02	585	-5,2
RD 125 BDR t2	1,64	1,5E+07	23,3	1,3E-01	8,6E+01	133	-3,7
RD 154 bdr t1	2,11	6,4E+06	36,8	2,9E-03	1,2E+02	1835	-5,9
RD 154 BDR t2	1,95	5,7E+06	25,5	7,6E-02	4,2E+01	112	-11,4
RD 158 bdr t1	1,86	1,2E+07	24,6	9,7E-02	7,7E+01	171	-3,8
RD 158 bdr t2	1,80	1,4E+07	20,0	3,5E-01	6,1E+01	58	-1,0
RD 751 bdr t1	2,16	3,8E+06	37,6	2,8E-03	7,4E+01	1109	-17,2
RD 751 bdr t2	1,69	1,3E+07	19,6	4,2E-01	5,2E+01	39	-4,3
RD 762 bdr t1	2,10	4,1E+06	26,6	6,0E-02	3,3E+01	109	-14,4
RD 762 BDR t2	1,64	3,0E+06	-4,8	2,0E+02	5,5E-01	0	#VALEUR!

RESULTS ON RECOVERED BINDERS – DSR TESTS

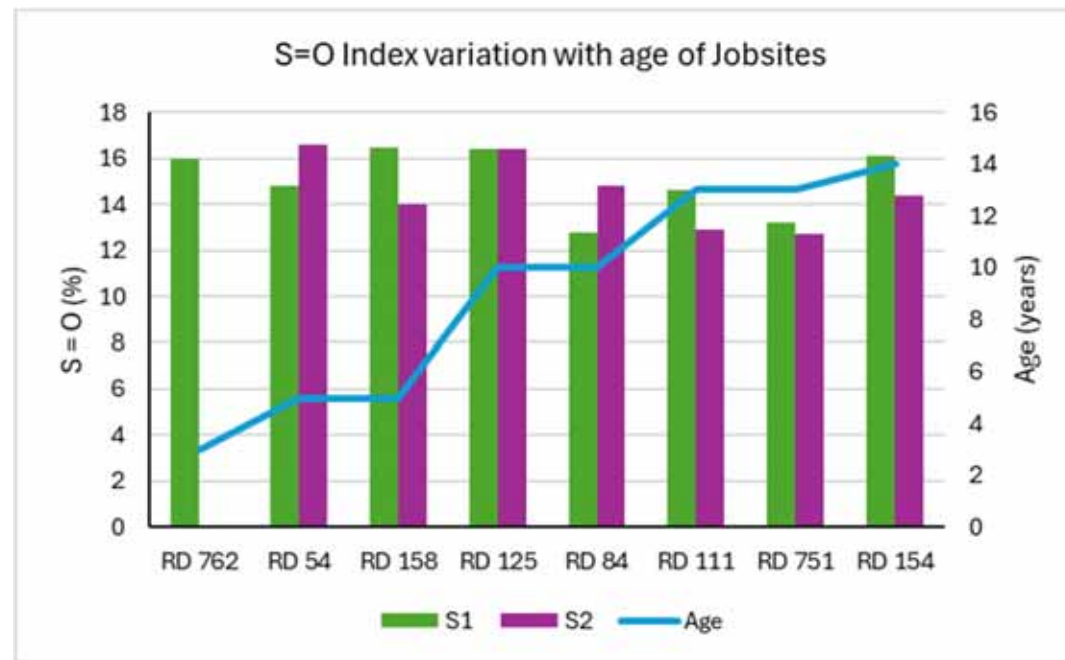
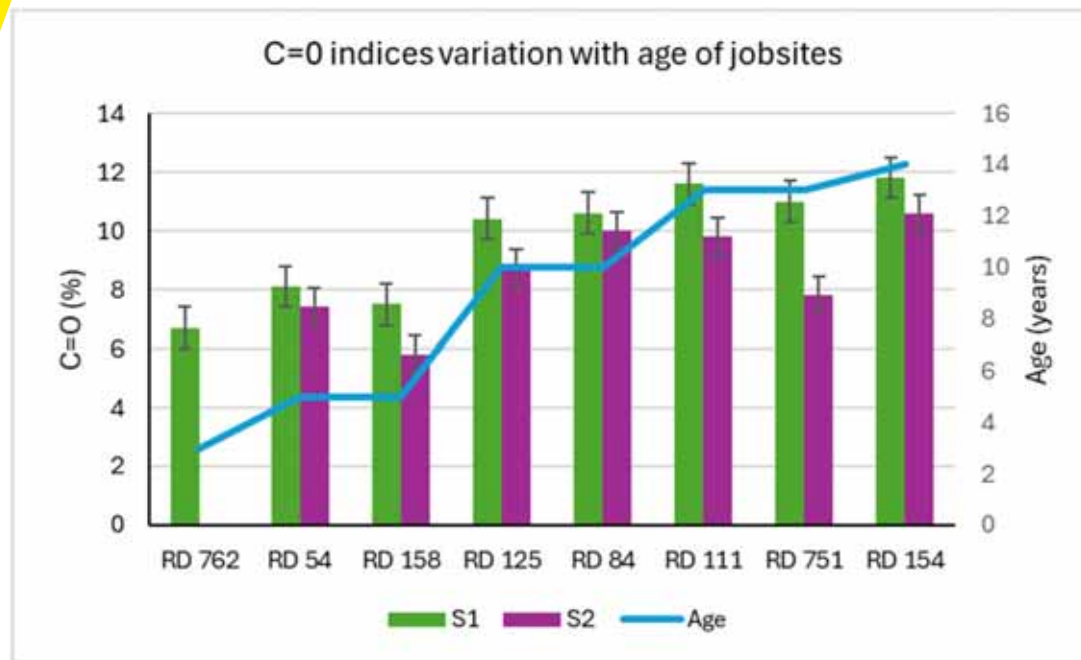
COMPARISON WITH AVAILABLE DATA ON HOT AC (*)



(*) «Rheological and Chemical properties of field aged binders and their variation within the wearing course », Soenen, Carbonneau, Lu, Robertus, Tapin, ROAD MATERIALS AND PAVEMENT DESIGN .
<https://doi.org/10.1080/14680629.2021.1994450>

RESULTS ON RECOVERED BINDERS

CHEMICAL ANALYSIS



40% RAP 30% RAP No RAP

40% RAP 30% RAP No RAP

IN SITU MEASUREMENTS

MTD
Ex RD 158

COLAS

COLAS FRANCE - TERRITOIRE OUEST
Laboratoire de Saint-Herblain

PROFONDEUR DE MACROTEXTURE
(Technique volumétrique à la tache)
NF EN 13036-1

PMT_Fev.2021

CHANTIER	DVDC Easycold RD 158 - La Séguière		
Matériau	Easycold		
Provenance	-		
Référence prestation	D49 24 ANJOU 028	Date de mise en oeuvre	-
Destinataire	CORE CENTER - CARBONNEAU X	Date du contrôle	13/05/2024
Nature de la couche	Roulelement Ep. -	volume de matériau par essai ponctuel (mm³)	N° : 25000
Compacteurs	-		

Plan de situation



COLAS

COLAS FRANCE - TERRITOIRE OUEST
Laboratoire de Saint-Herblain

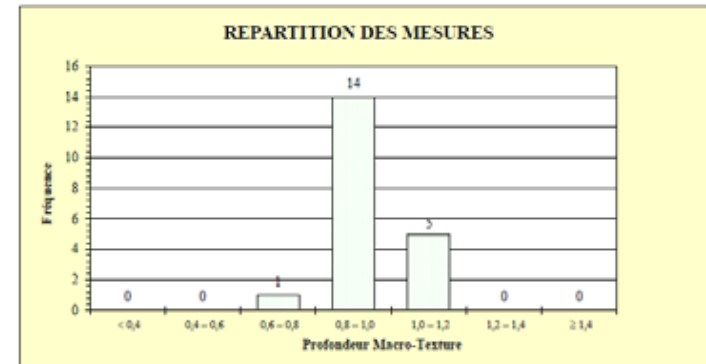
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Compacteurs	-		

N° Mesures	Min	Max	Moyenne	Ecart-type
Profondeurs de Macrotexture	0,60	1,10	0,93	0,14

Répartition des mesures	≥ 0,4 mm	100,0	≥ 0,9 mm	60,0
	≥ 0,5 mm	100,0	≥ 1,0 mm	25,0
	≥ 0,6 mm	100,0	≥ 1,1 mm	20,0
	≥ 0,7 mm	95,0	≥ 1,2 mm	0,0
Reproductibilité 1 %	≥ 0,8 mm	75,0	≥ 1,3 mm	0,0
Reproductibilité 2 %				



Observation: Métho : Beau temps

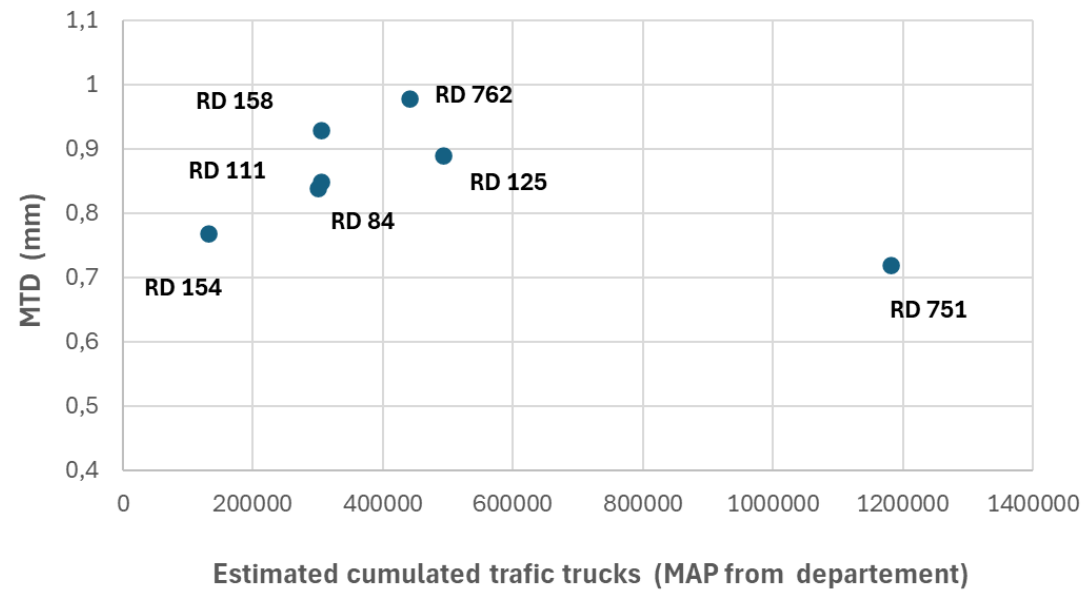
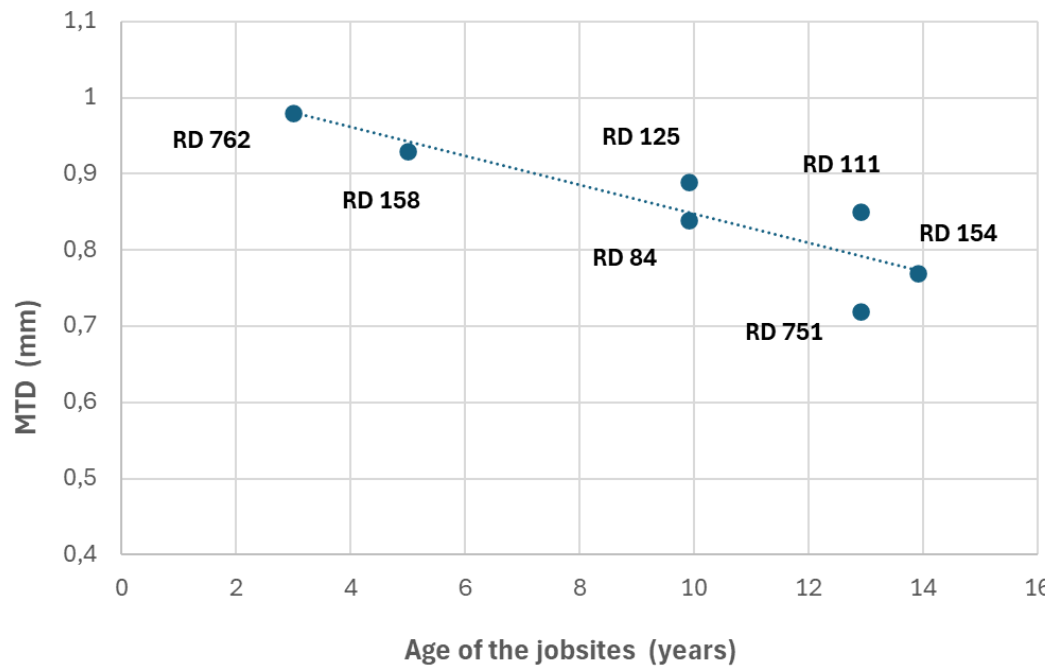
Visa:

Toussaint G.

Nombre de passe P1
Nombre de passe VT1(vib) (lisse)

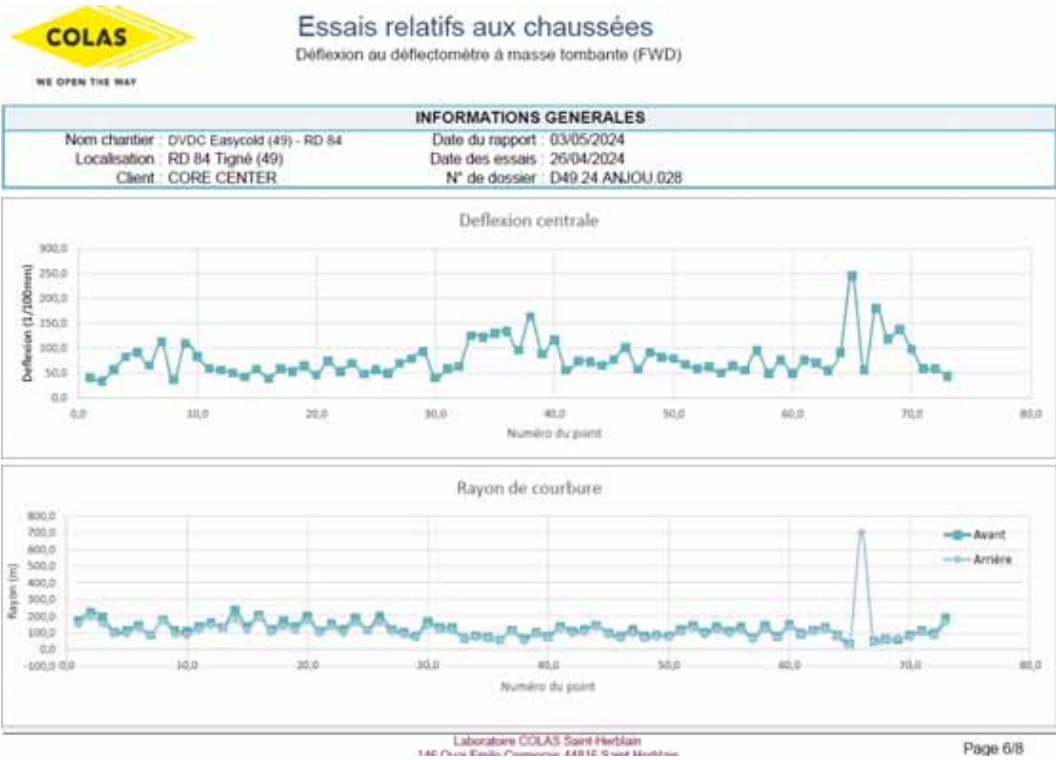
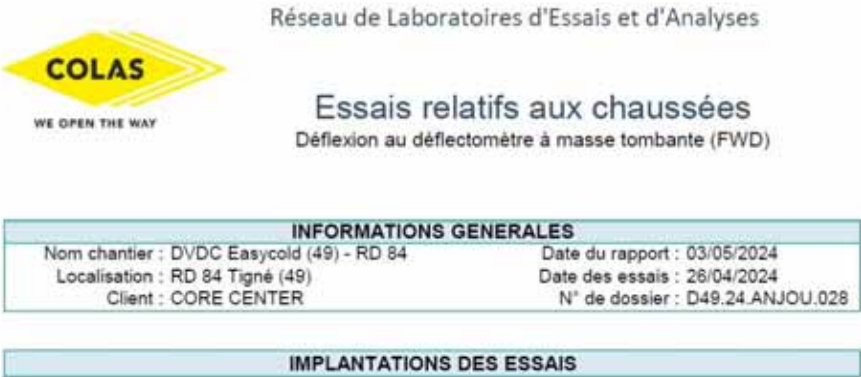
IN SITU MEASUREMENTS

MTD



IN SITU MEASUREMENTS

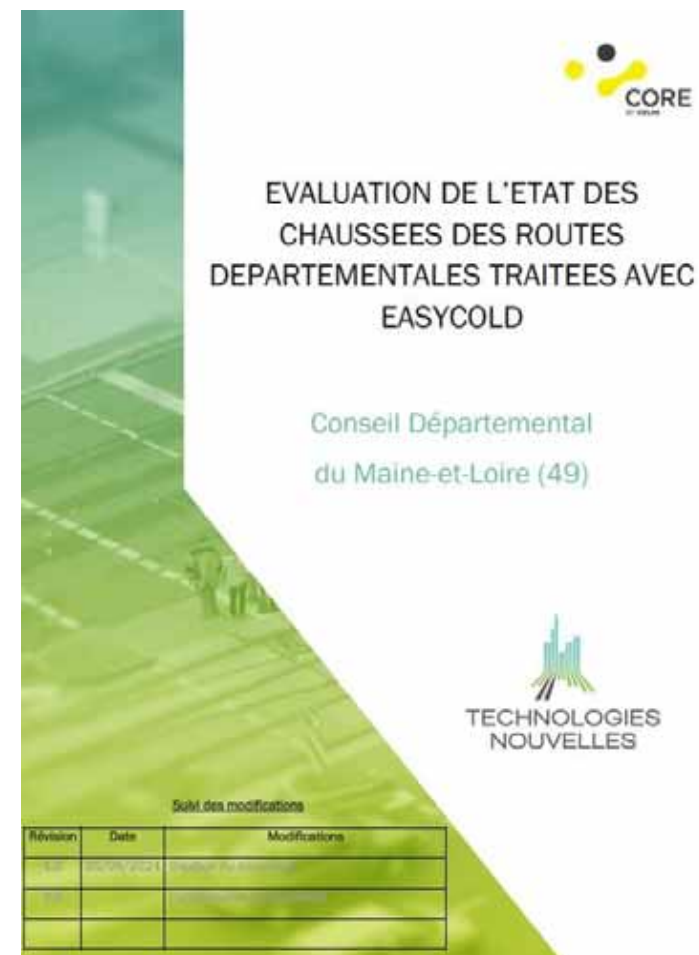
FWD results



SURVEY PAVEMENT MONITORING



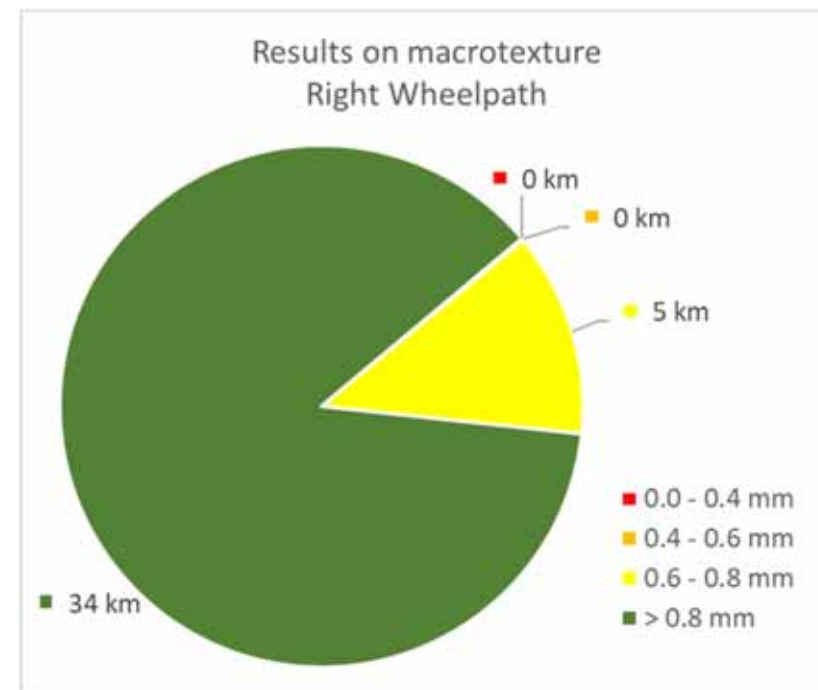
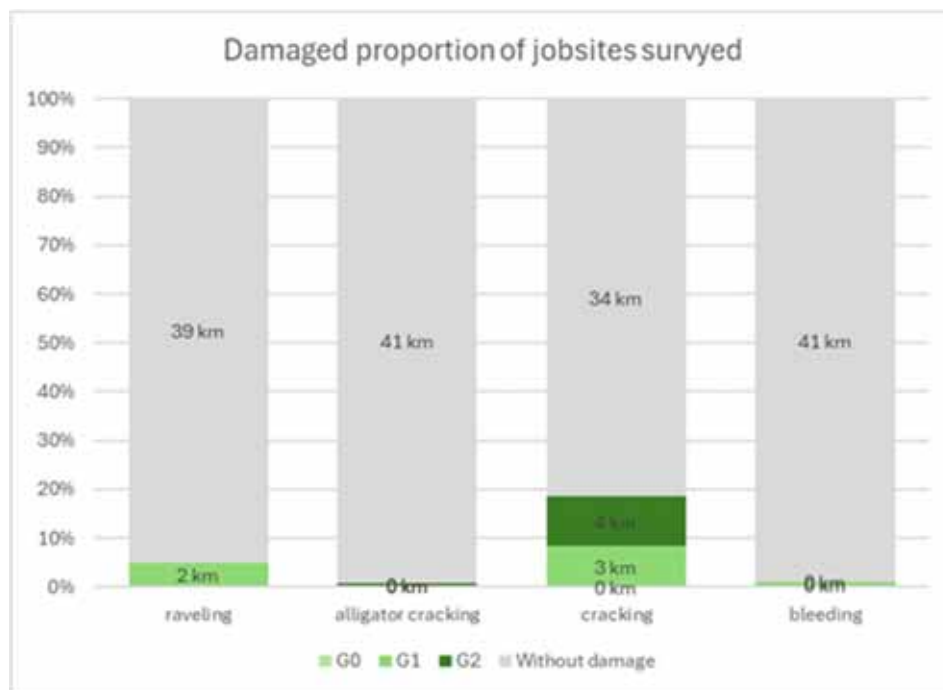
EVALIS 3D
LCMS Sensors





SURVEY

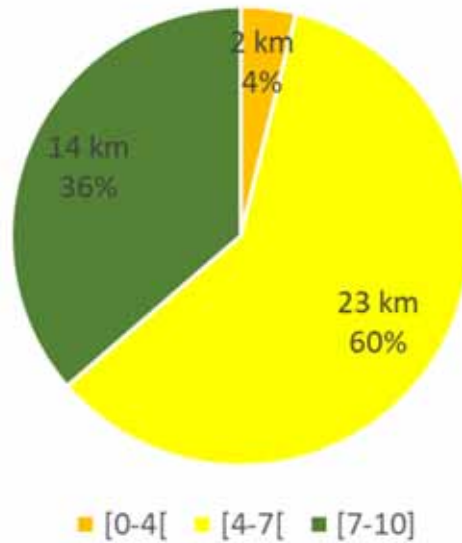
Results for 42 km of network



SURVEY

EVENNESS

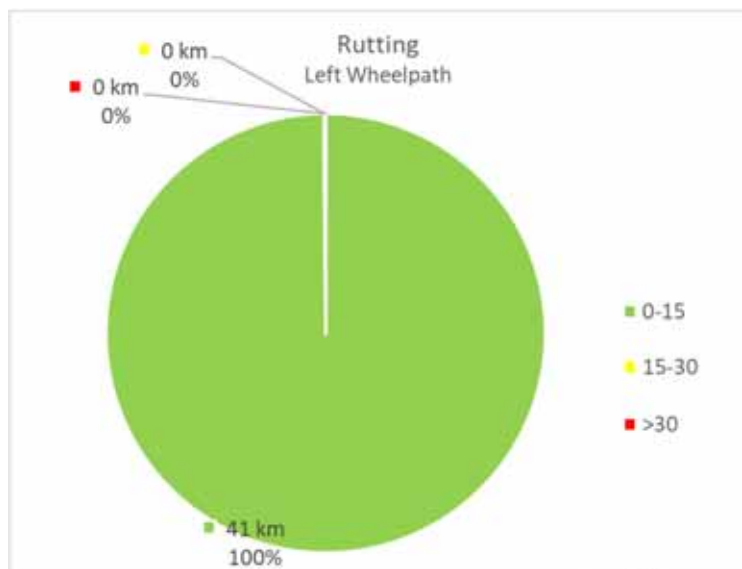
Evenness Results for small wavelength
(0,7 - 2,8 m)



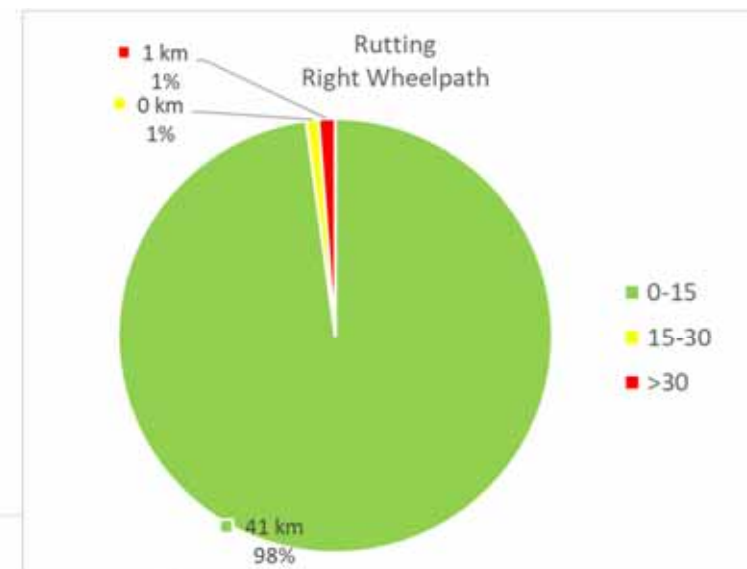
EVENNESS Results for middle wavelength
(2,8-11,3)



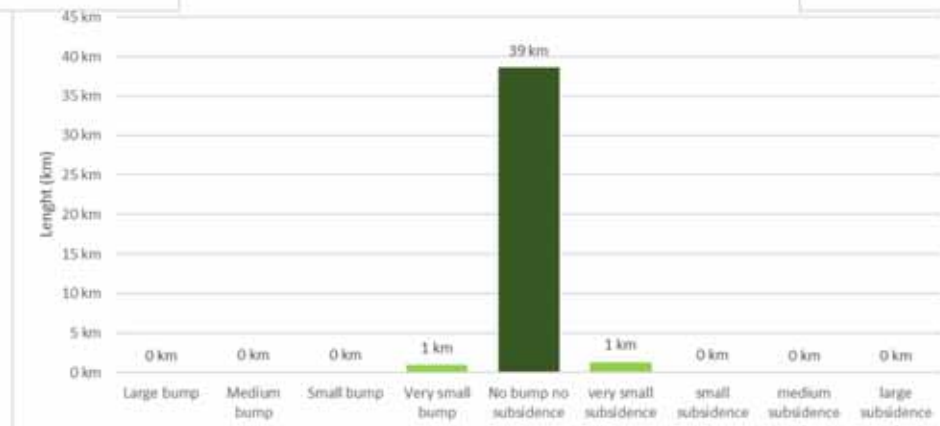
SURVEY



RUTTING



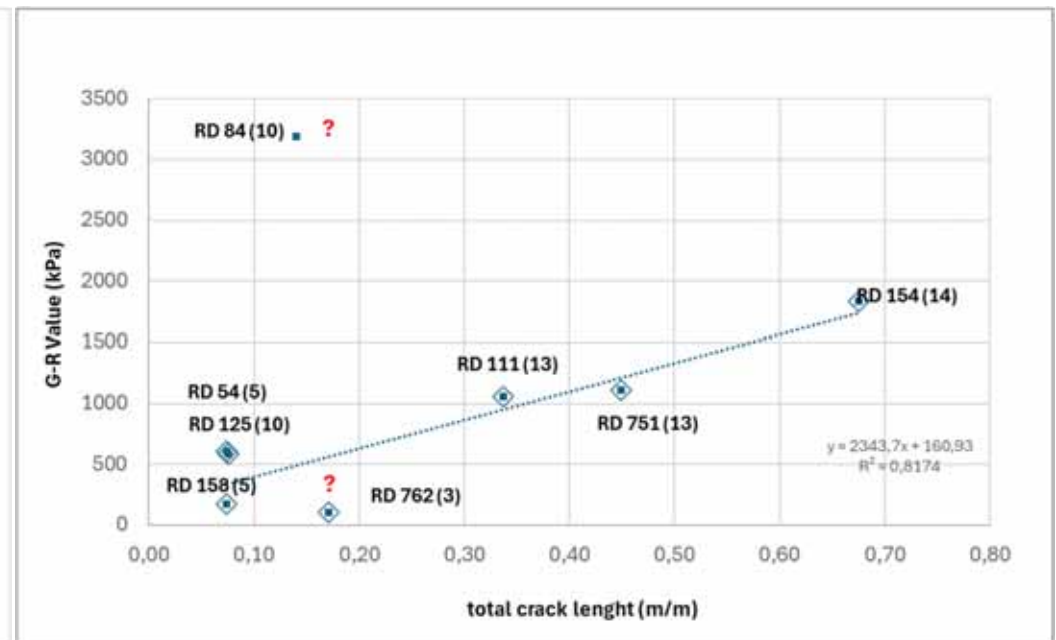
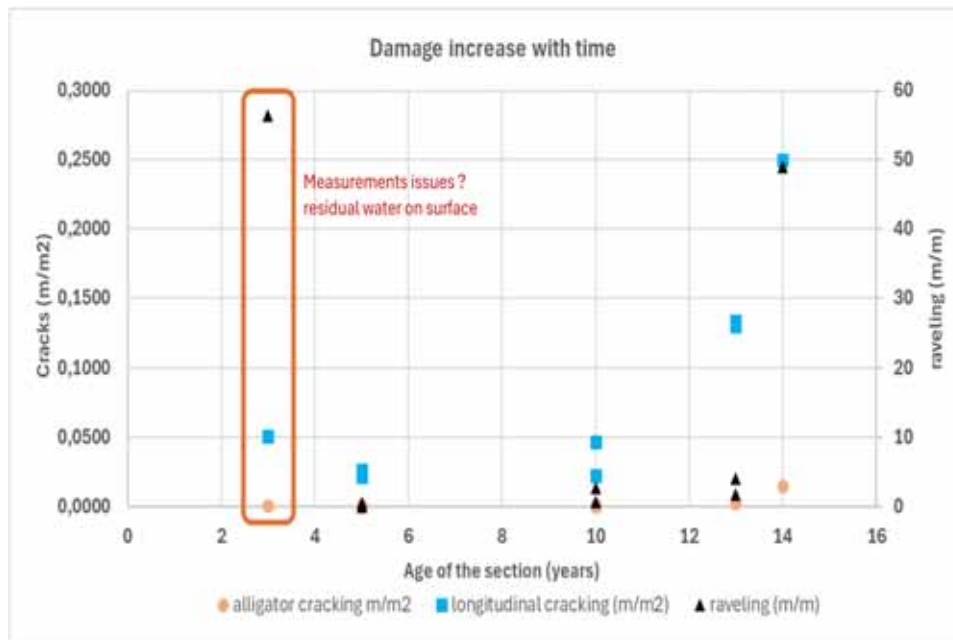
Distribution of bank deformation measurements



SURVEY

DATA ANALYSIS BY SECTION

Opportunity to approach
damage curves ?



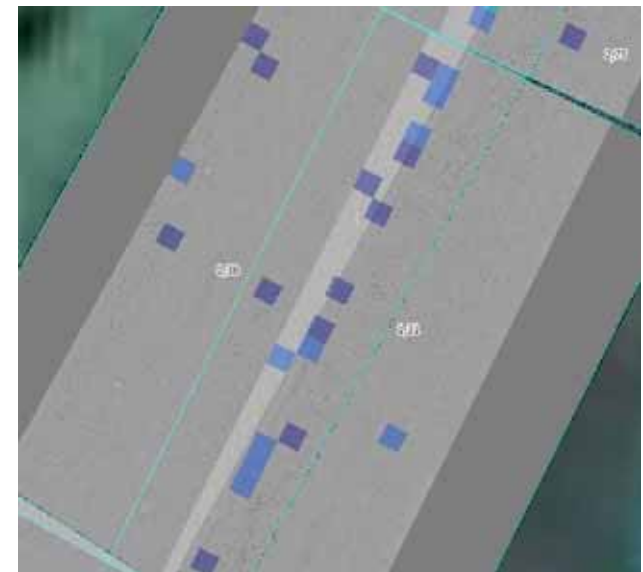
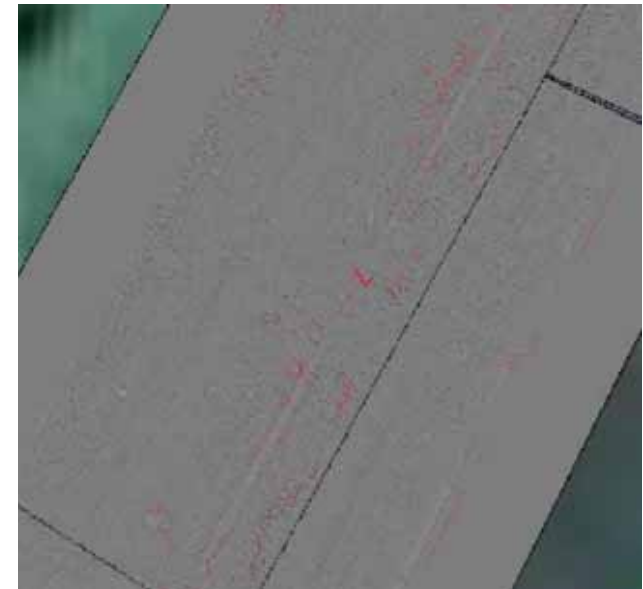
Search for correlation with
binder characteristics

SURVEY

Detection limits

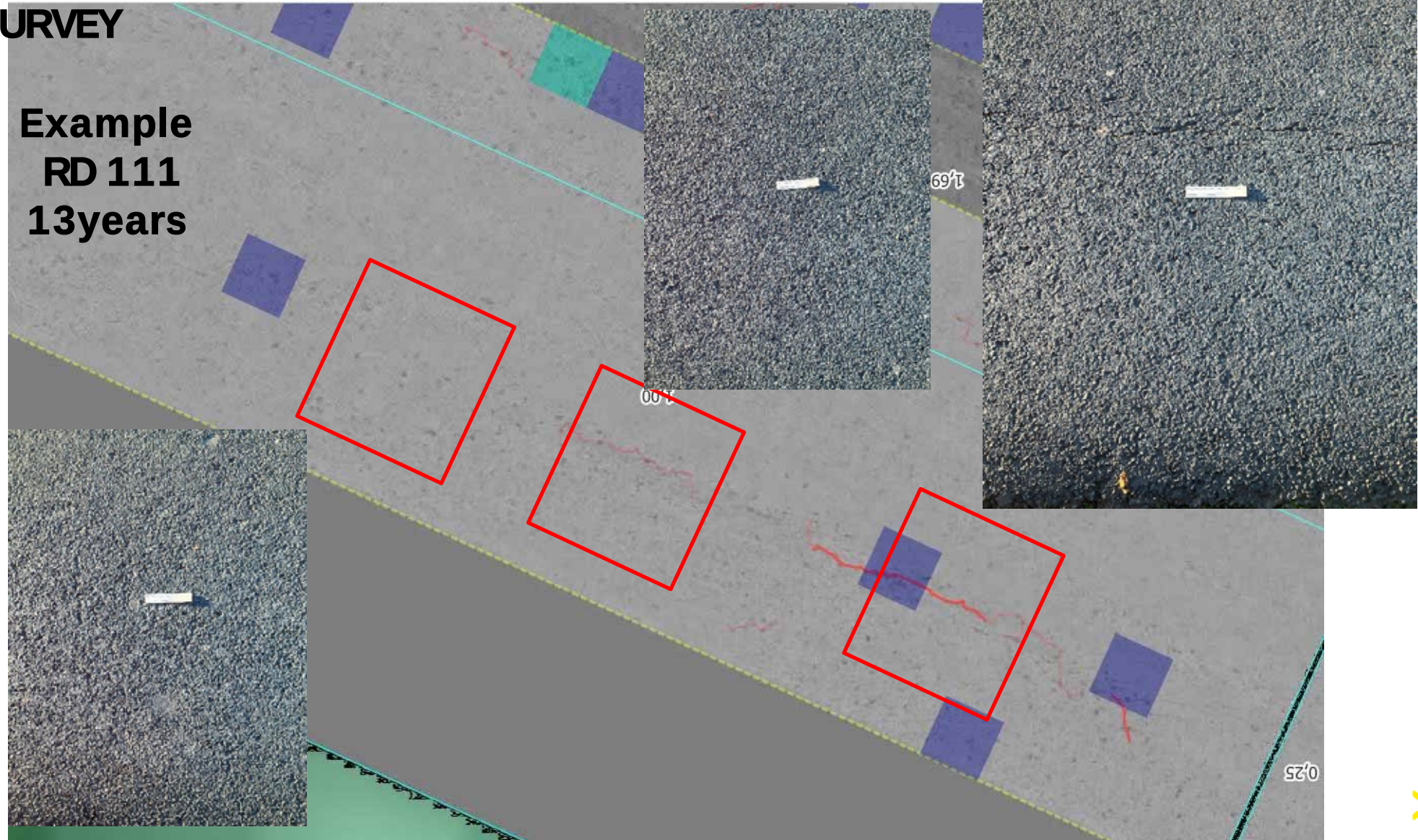
Possible confusions small ravelling/crack ?

Adaptation on algorithms – Ongoing
localised damage



SURVEY

Example
RD 111
13years



CONCLUSION - OUTLOOK



FIRST ASSESSMENT

- Sustainability figures on EASYCOLD
- Lifetime > 12-14 Years !
- Possible way to define damage curves of wearing courses



ADDITIONNAL RESEARCH - NEEDS

- Improve relevancy on rheological parameters on binders (Effect of Aging)
- Adaptation of algorithms : quatify very small damages



NEXT STEP ?

- Way to quantify lifetime in situ ?
- Shall we think about maintenance differently ?



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