HRVATSKO ASFALTERSKO DRUŠTVO

CROATIAN ASPHALT ASSOCIATION

THE ASSESSMENT OF THE LIFETIME AND THE RESIDUAL DURATION OF THE ROADS

PROCJENA ŽIVOTNOG VIJEKA I PREOSTALOG TRAJANJA CESTE

XAVIER CARBONNEAU, COLAS

WE OPEN THE WAY

MEĐUNARODNI SEMINAR ASFALTNI KOLNICI 2021

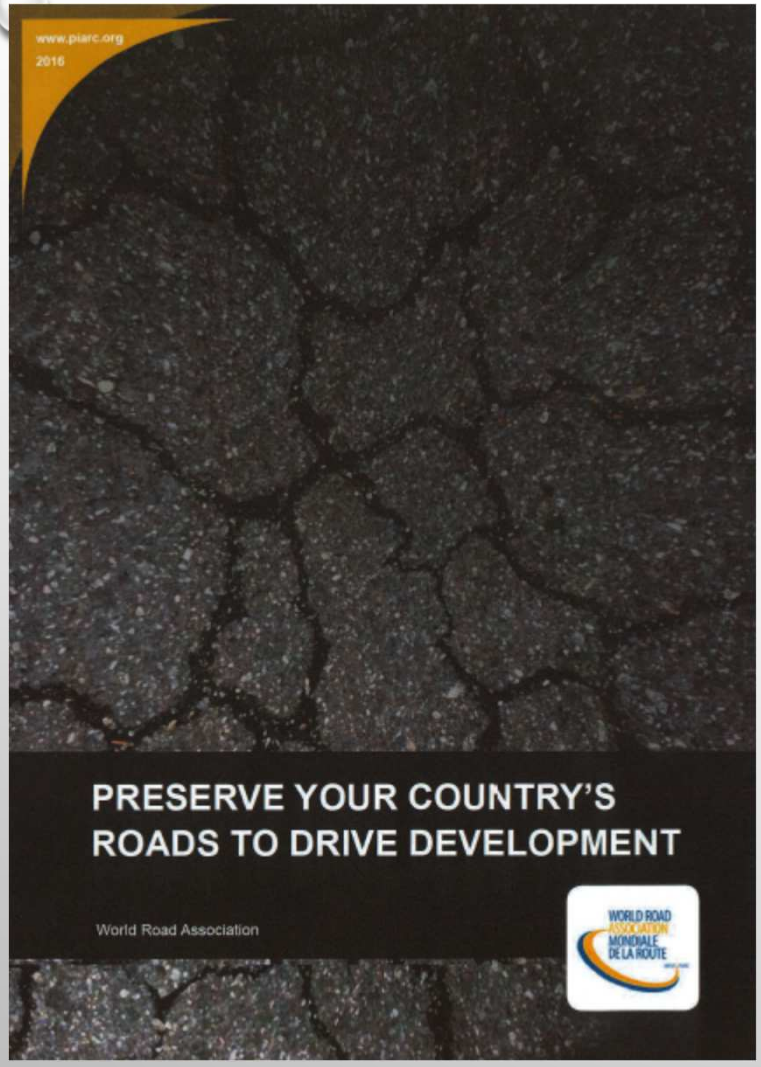
INTERNATIONAL SEMINAR ASPHALT PAVEMENTS 2021

OPATIJA, 30.09. – 01.10. 2021.

CONTENT

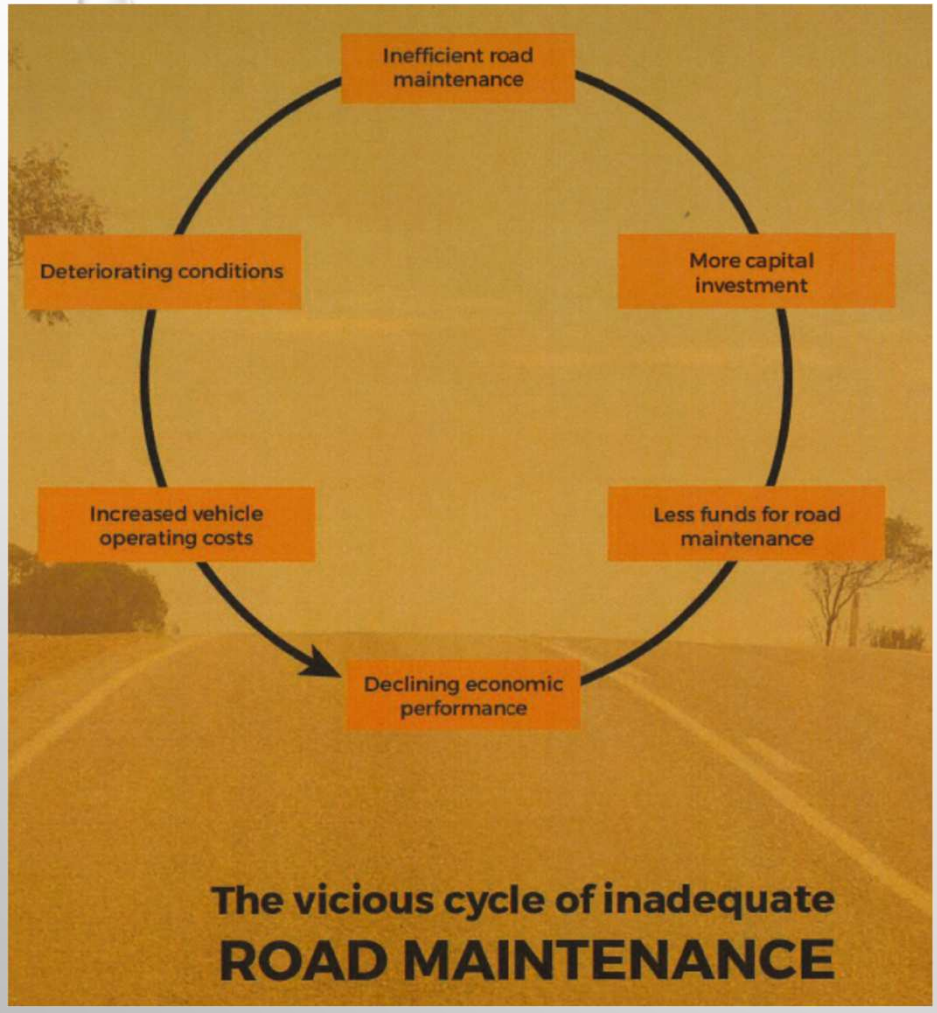
- Lifetime of Roads
- Pavement Design
- Survey
- Residual lifetime (DVDC)
- What’s an Old binder ?
- Expectations
- Conclusion

LIFETIME OF THE ROAD



VUE pendant la période récente le transport a assuré son rôle malgré lockdown !

LIFETIME OF THE ROAD



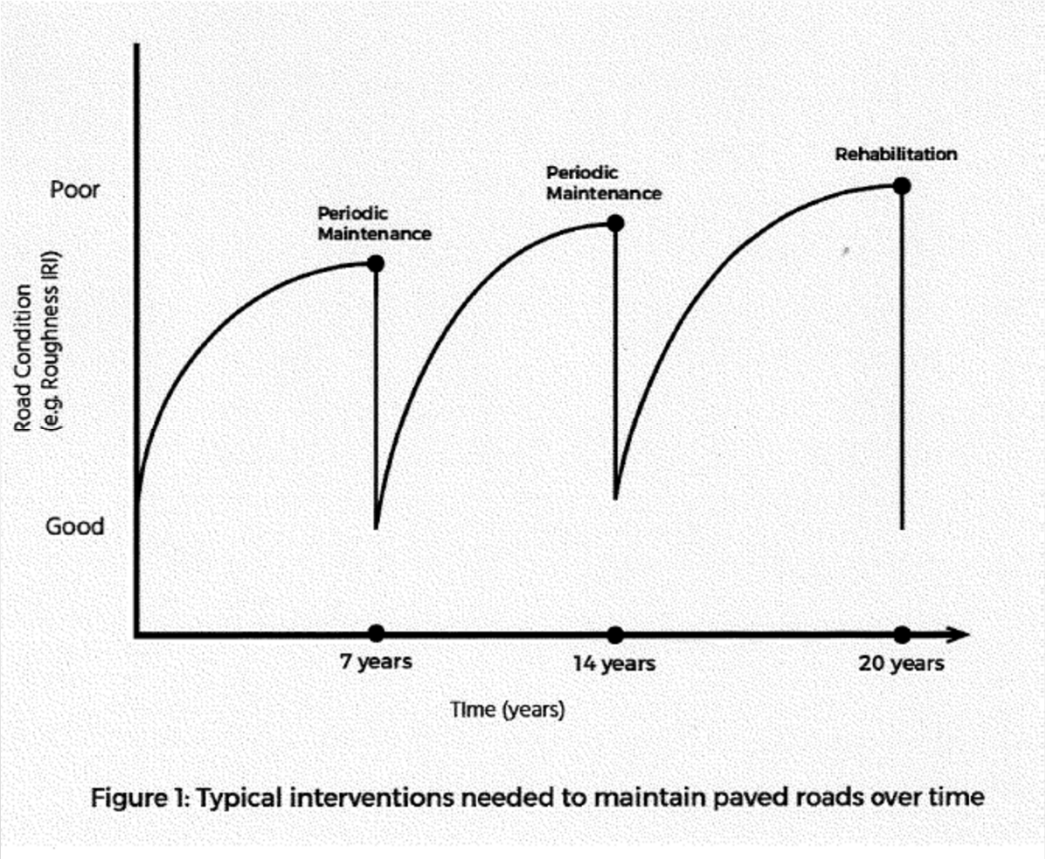
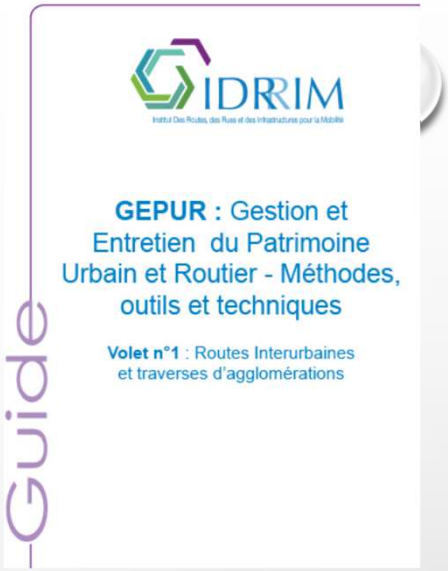


Figure 1: Typical interventions needed to maintain paved roads over time

LIFETIME OF THE ROAD

	Catégorie 1	Catégorie 2	Catégorie 3
BBTM	8 à 10	8 à 12	-
BBM	8 à 12	10 à 14	12 à 18
BBSG ou BBME	8 à 12	10 à 14	12 à 18
BBS	-	-	10 à 20
ESU	6 à 10	8 à 14	10 à 20
MBCF	6	7	8



Mix	Service life (years)	Layer thicknesses
1. SMA 16 – reference	16*	0.030 m
2. SMA 11 - 40% RAP + PMB + LTA	10 - 14**	0.030 m
3. SMA 8 - 60% RAP + PMB	10 - 14**	0.030 m
4. SMA 11 - Long service life	20**	0.035 m
5. PA 8 - top layer 2L PA + PMB	10*	0.025 m
6. SMA 8 - 60% RAP + regular bitumen	14**	0.030 m

* Based on (Keijzer, et al., 2020).

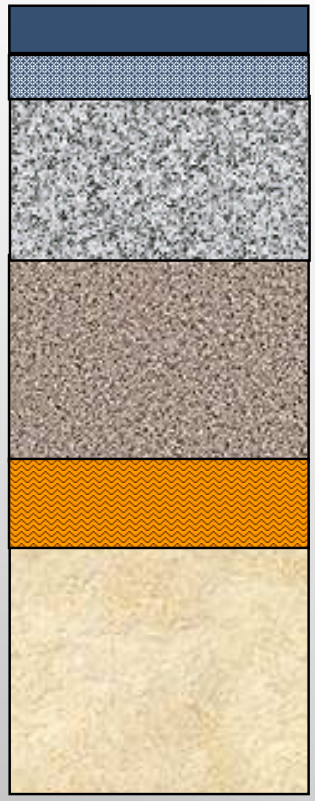
** Expert guess based on the average service life of SMA 16

*** All back 2 pave D5.2 and (Keijzer, et al., 2020).

From T Parry EAPA Workshop on Pavement LCM

PAVEMENT DESIGN

Define the structure (layers nature & thickness) able to support the trafic (estimated) under define climatic conditions, with a limited budget.



Wearing course
Binder course

= top layers

Security, comfort as evenness, skid resistance, low rolling noise

Base layer

Structural stiffness ➔ Mechanical and thermal protection of the subgrade

Sub-base layer (if necessary)

Capping layer (if necessary)

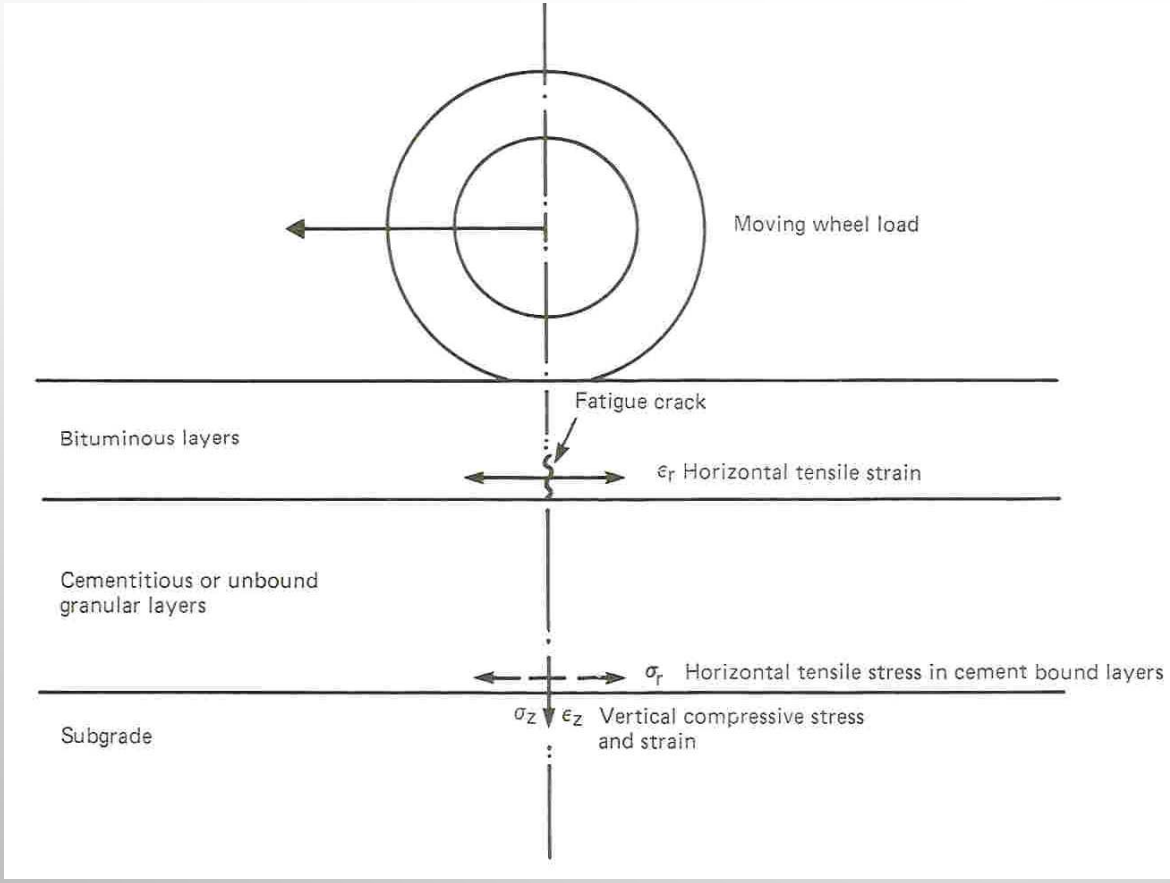
Soil

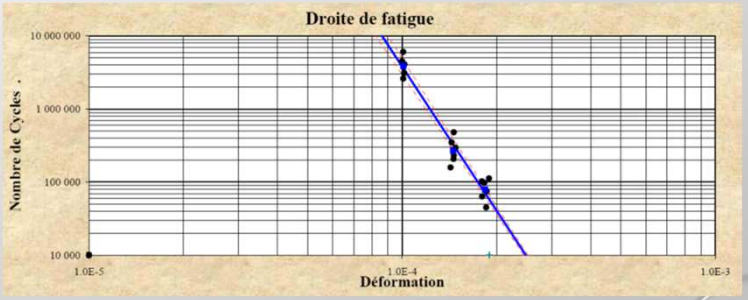
Subgrade : drainage + lime / cement treatment (if necessary) to improve soil characteristics as freeze resistance or bearing capacity

With new constraints :

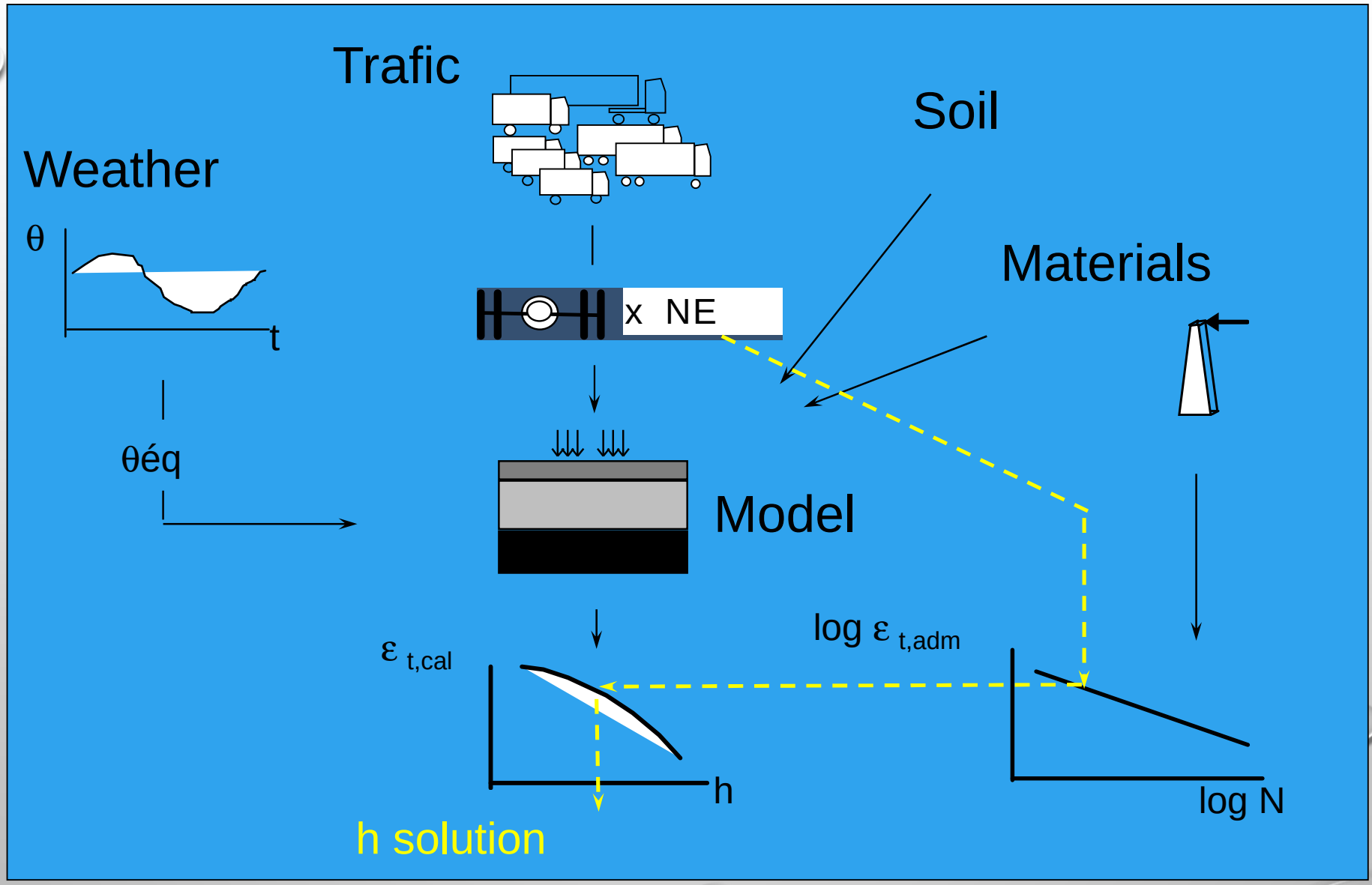
- **Less money**
- **New parameters (CO2 emissions) – New products –**
- **Durability**
- **Climatic change - Resilient**

PAVEMENT DESIGN



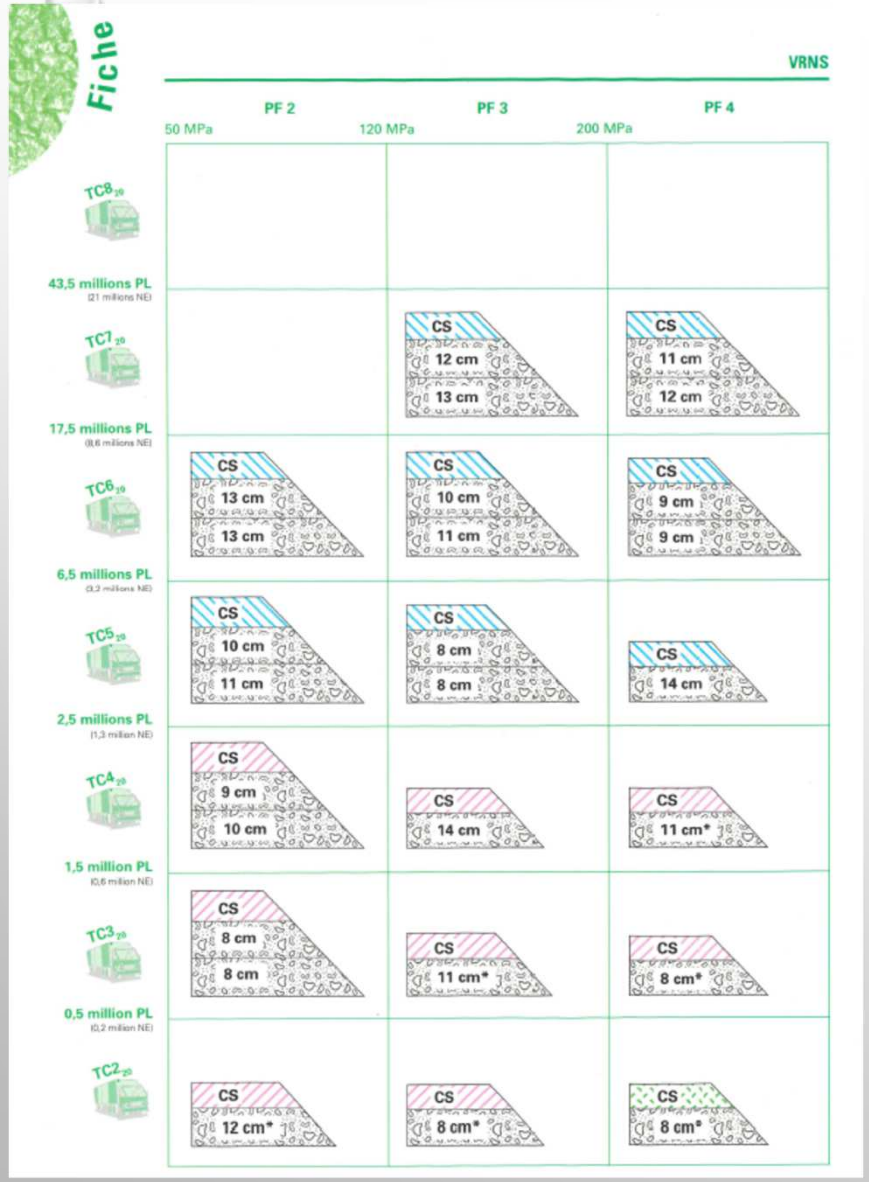


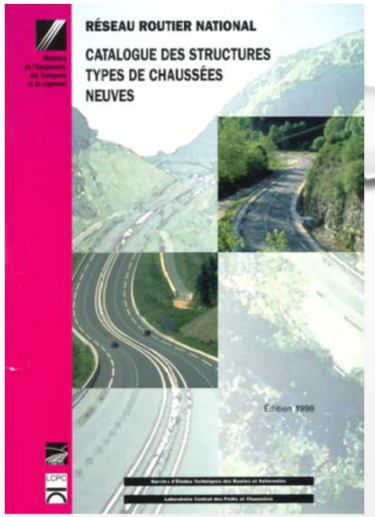
PAVEMENT DESIGN

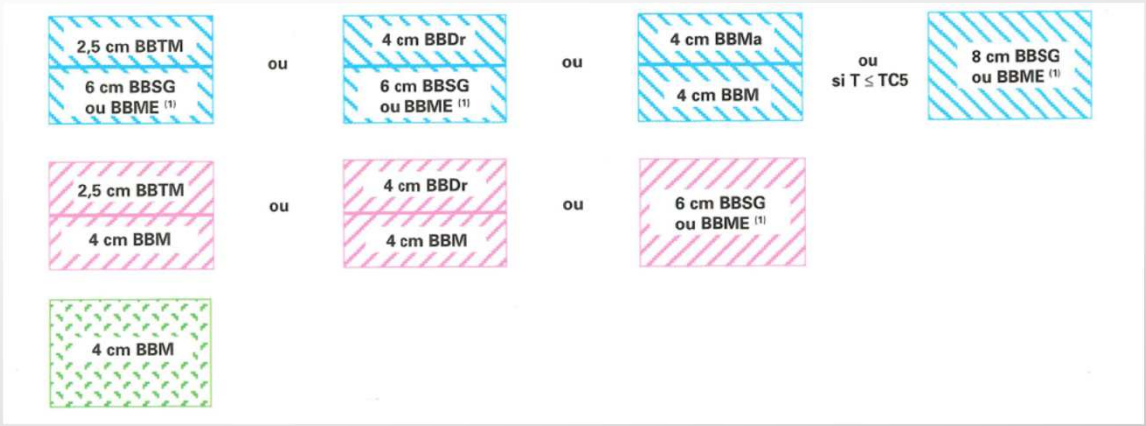


PAVEMENT DESIGN

Thicknesses for Base course for Lifetime 20y







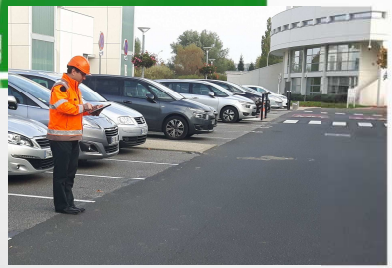
LIFETIME FOR NEW ROADS
FOCUS ON STRUCTURAL BEHAVIOR

SURVEY

- Knowledge of network
- Balance between needs & available budget
- Adapted to raod category (largest part of the network less documented ?)
- Only a picture one day ..

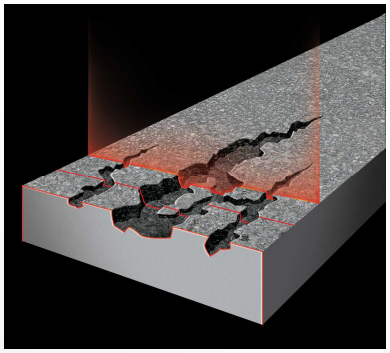
SURVEY

SURFACE

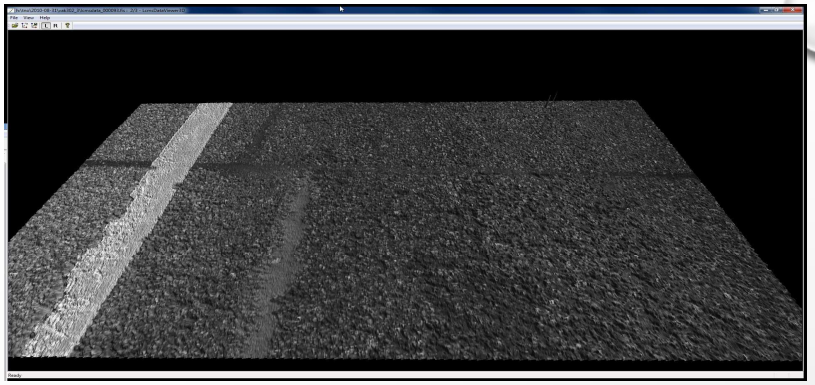


STRUCTURE

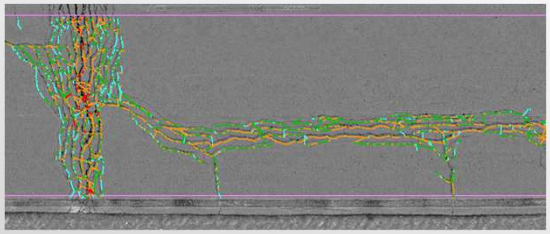
SURVEY



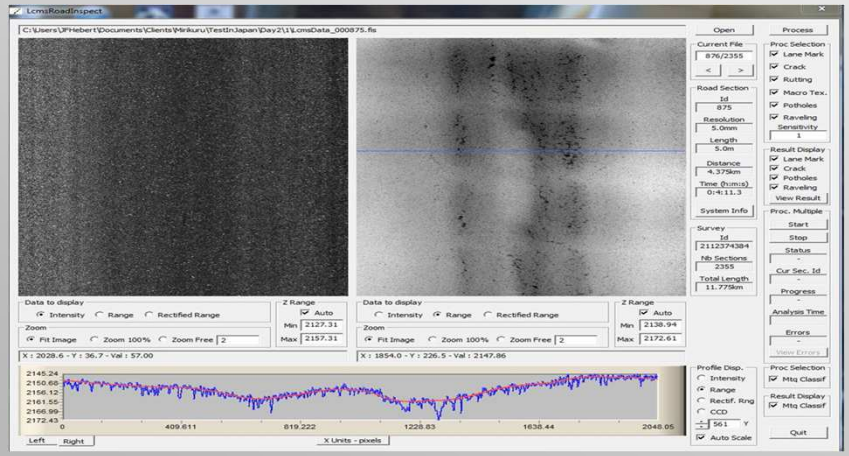
Cracking



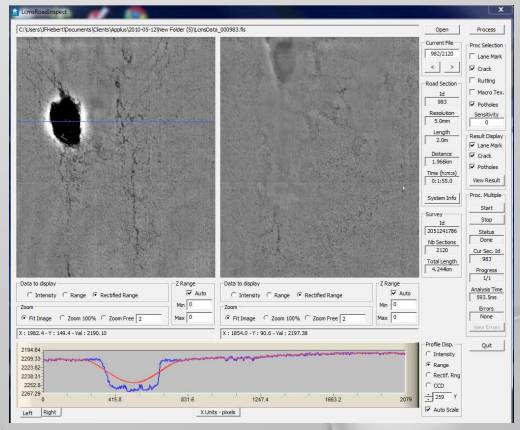
Ravelling



Rutting



Potholes



SURVEY

NEED OF A CONVERSION SYSTEM

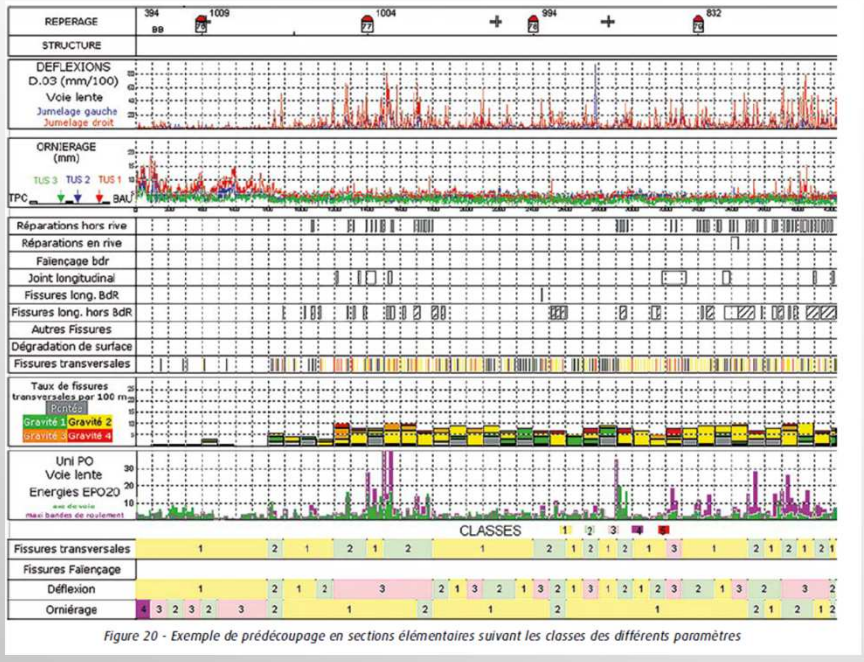
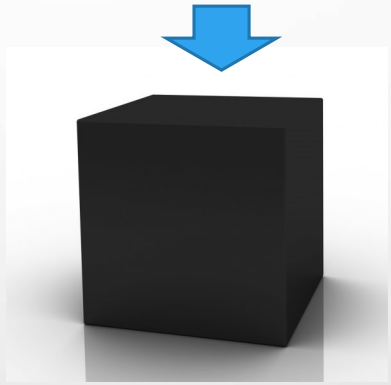


Figure 20 - Exemple de prédécoupage en sections élémentaires suivant les classes des différents paramètres

Required threholds for each section



- Very good
- Good
- Fair
- Poor
- Bad
- Failed

€ → Network Maintenance Policy

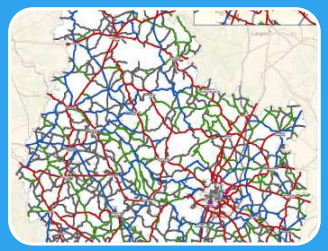
PN - ANR MOVE
DVDC
DURÉE DE VIE DES CHAUSSÉES

RESIDUAL LIFETIME ?

COLLABORATIVE RESEARCH PROGRAM
5 years – 3,6 M€ - 41 partners

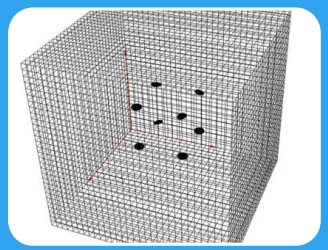
1 Pavement degradations mechanism

- Structural behaviour and evolution
- Rutting unbound materials / Interfaces /Aging / winter damage



2 knowledge of network

- Surveys - comparison between methods
- Lack to improve maintenance stragety

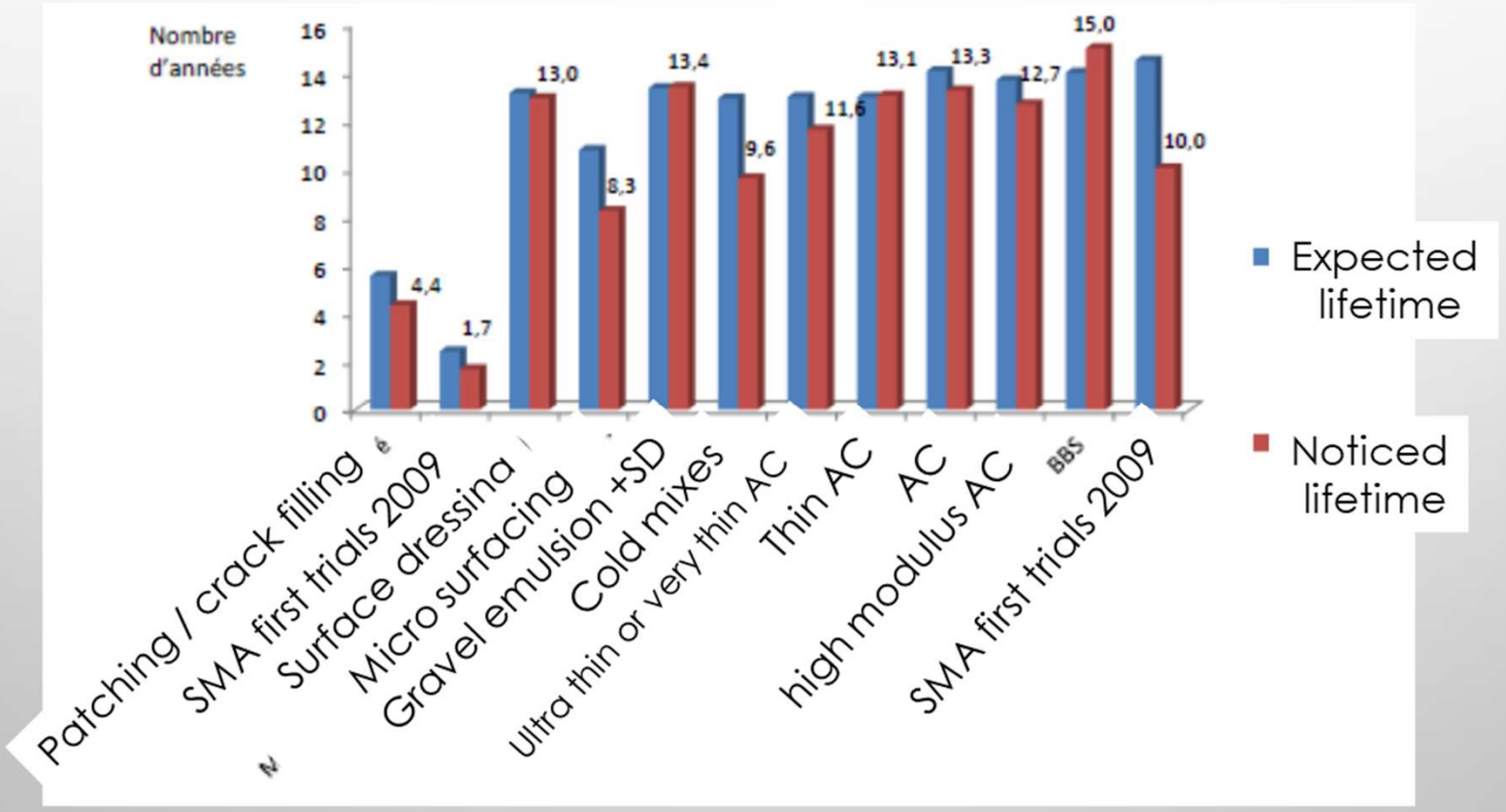


3 Residual lifetime

- Modelling pavement structure damage
- Probabilistic approach for structural index evolution
- Focus on wearing courses

PN - ANR MOVE
DVDC
DURÉE DE VIE DES CHAUSSÉES

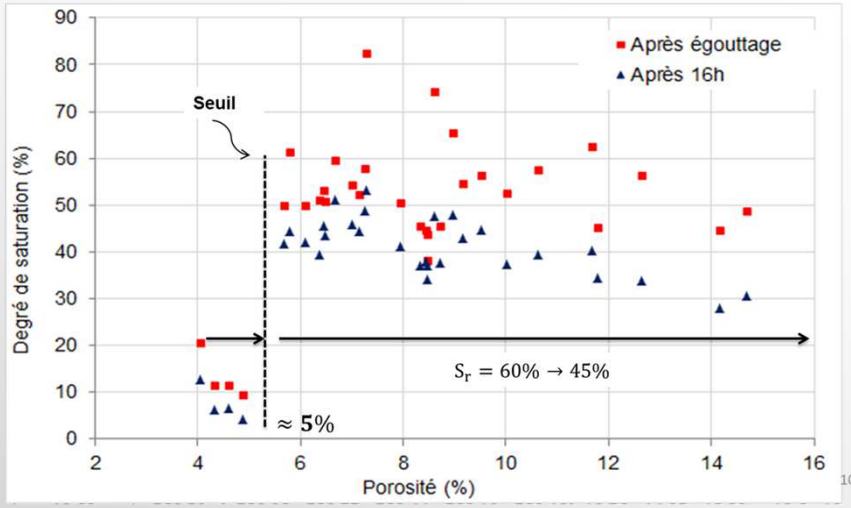
RESIDUAL LIFETIME ?

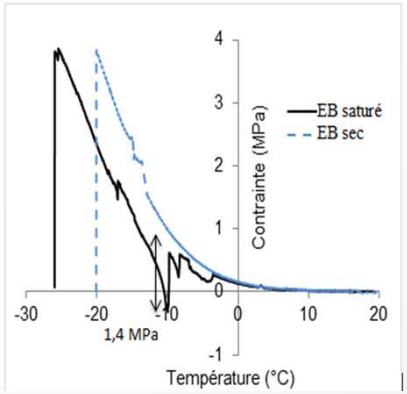


PN - ANR MOVE
DVDC
DURÉE DE VIE DES CHAUSSÉES

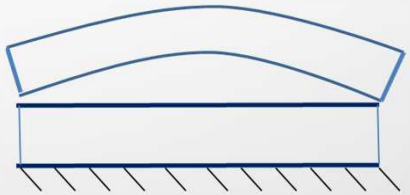
RESIDUAL LIFETIME ?

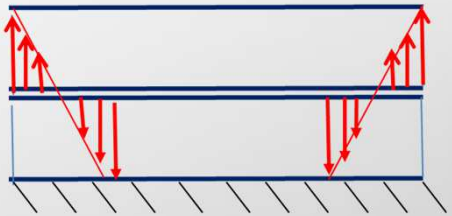
WINTER DAMAGE- EFFECT OF FREEZE





Effect of small amount of water





IN SITU INTERLAYER BONDING MEASUREMENT

PN - ANR MOVE
DVDC
DURÉE DE VIE DES CHAUSSÉES

RESIDUAL LIFETIME ?

Necessary Evolution
of methodologies

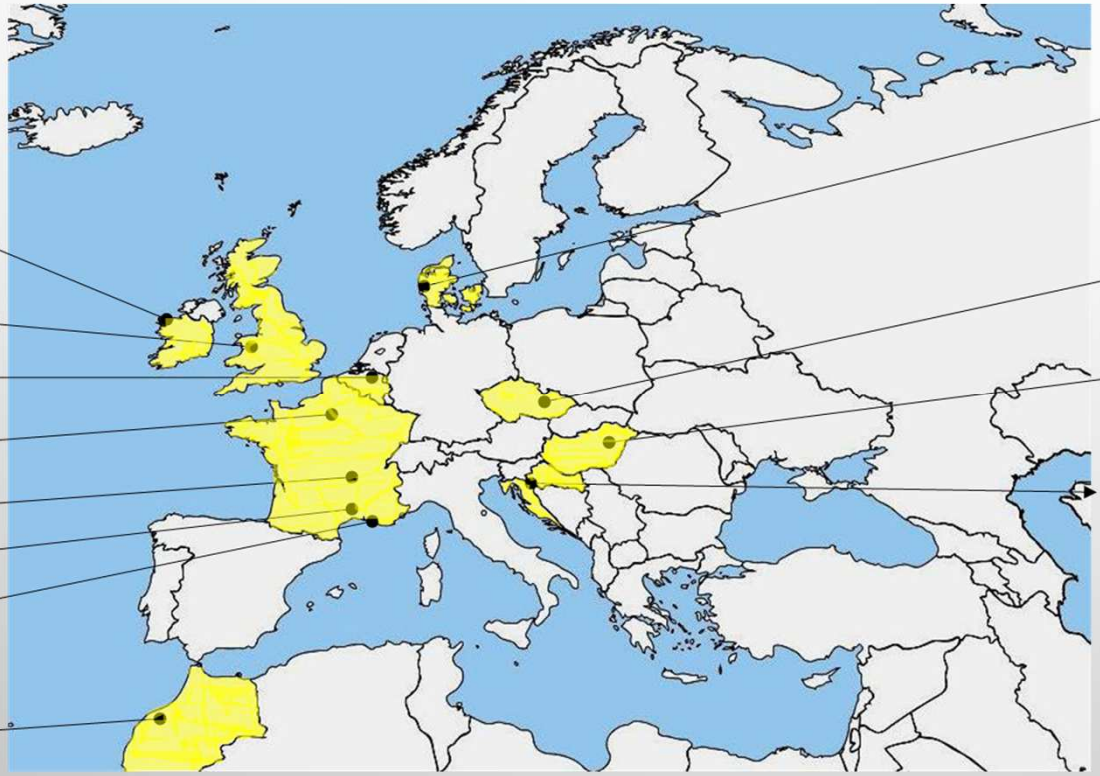
Quality of the results

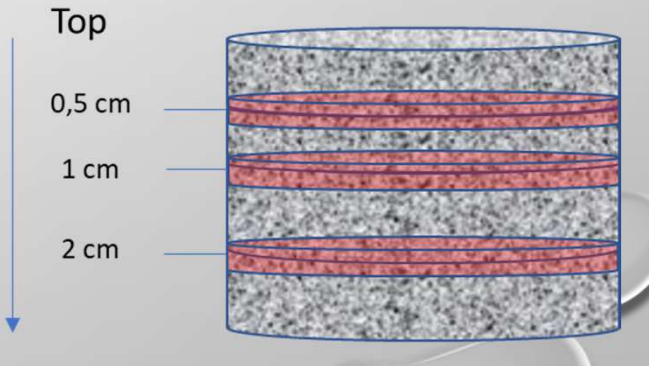
Road surface indicators
(relevant – useful for qualification of road)

New indicators

WHAT'S AN OLD ROAD ?

STUDY OF WEARING COURSES

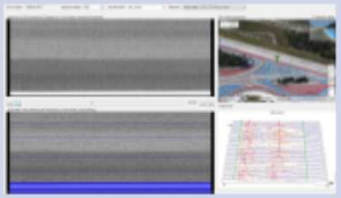




WHAT'S AN OLD ROAD ?

Chanos RD 67 (FR)
BBMc 0/10
8 years
~ 80 T/d
No crack. Few spots with raveling
Wearing course still in place

Jihlava By Pass (CZ) BAU
SMA 11 S
10 years
Trafic : cores from emergency lane
No crack local raveling
Wearing course still in place



Circuit du Castellet (FR)
BBMc 0/10
15 years
Racetrack
Few cracks
Coring before resurfacing

A4 Zagreb Goričan (HR)
AC 11
21 years
3500 v/d
Cracking fatigue + cement treated materials
Coring before resurfacing

A13 Road (DK 1,2,3)
SMA11 Colflex
8 years
Trafic : 10000 v/d with ~ 20% truck
Very few cracks. Some spots of mastic removed
Wearing course still in place

Rétie N118 (BEL)
SMA D2 0/6,3
10 ans
3000 T/d
Few cracks (fatigue)
Wearing course still in place

Manchester Airport (UK)
BBA 0/14
8 years
CT5/NS4 (guide STAC)
No damage -Still in place

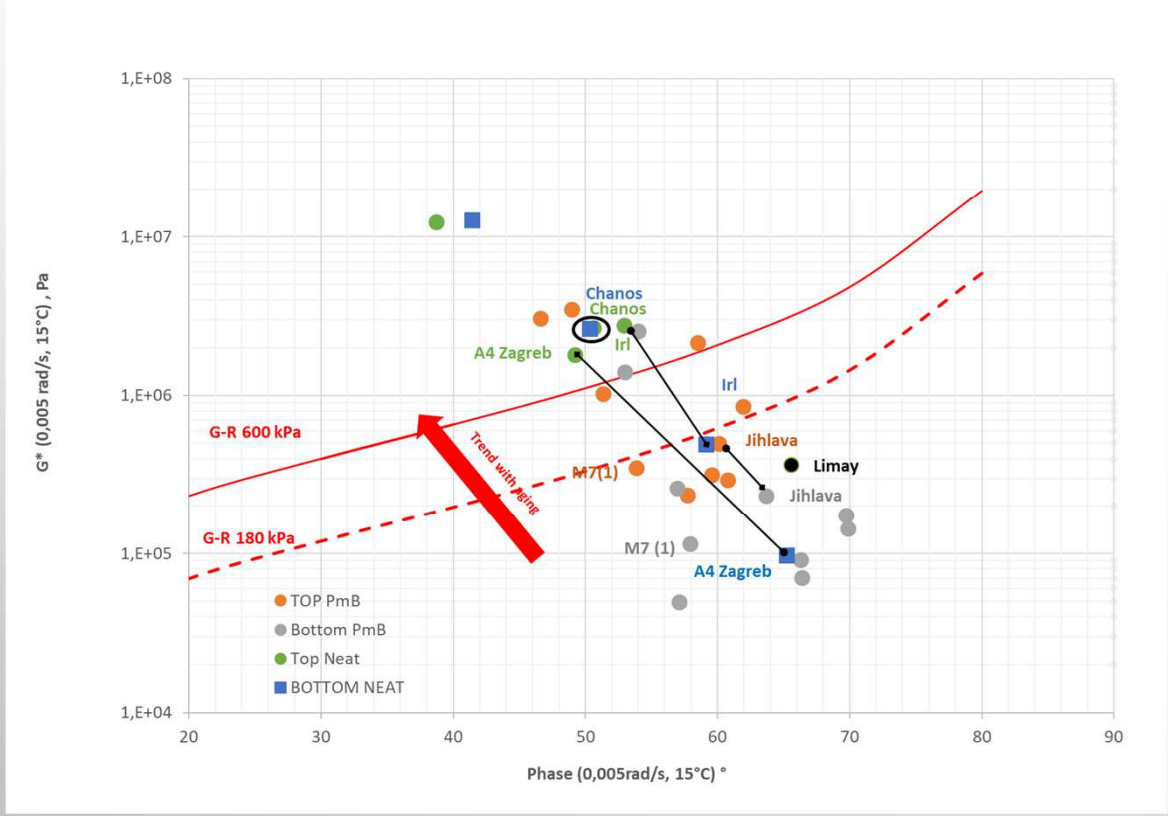
M7 PK 102 Slow lane (HU)
SMA 12
18 years
Buses 229/d - - T 364/d - PL trailer 458/d - Semi trailer 2778/d
Coring before resurfacing

Limay D190 (FR)
BBSG 010
21 years
10000/d (~ 800 T) 2011
Cracks fatigue and rutting
RAP samples during milling

M1 Drogheda By pass
Hot Rolled Asphalt (IRL)
16 years
40000 v/d 9% Trucks
Ravelling
Coring before maintenance

A5 Morocco
AC 14 with hard binder
9 years
Fatigue cracking
Still in place

WHAT'S AN OLD ROAD ?



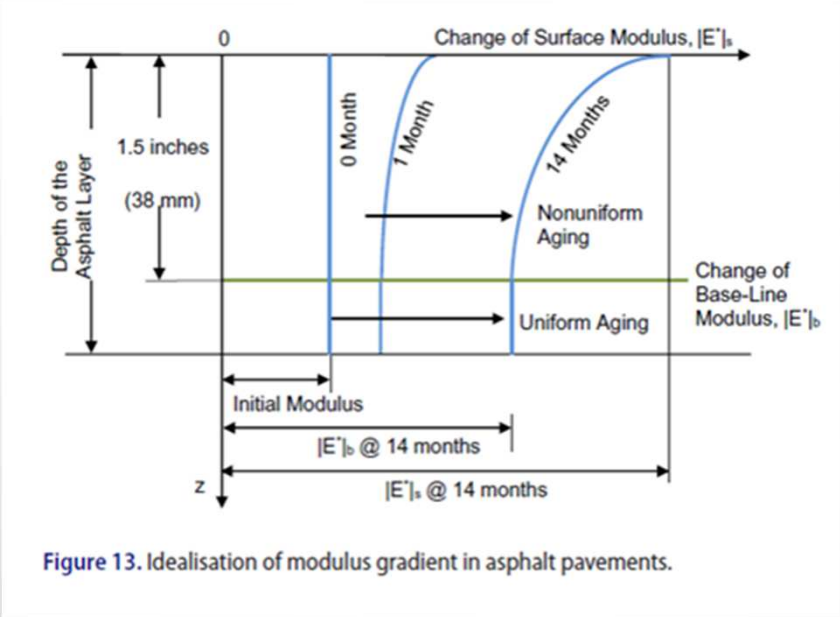
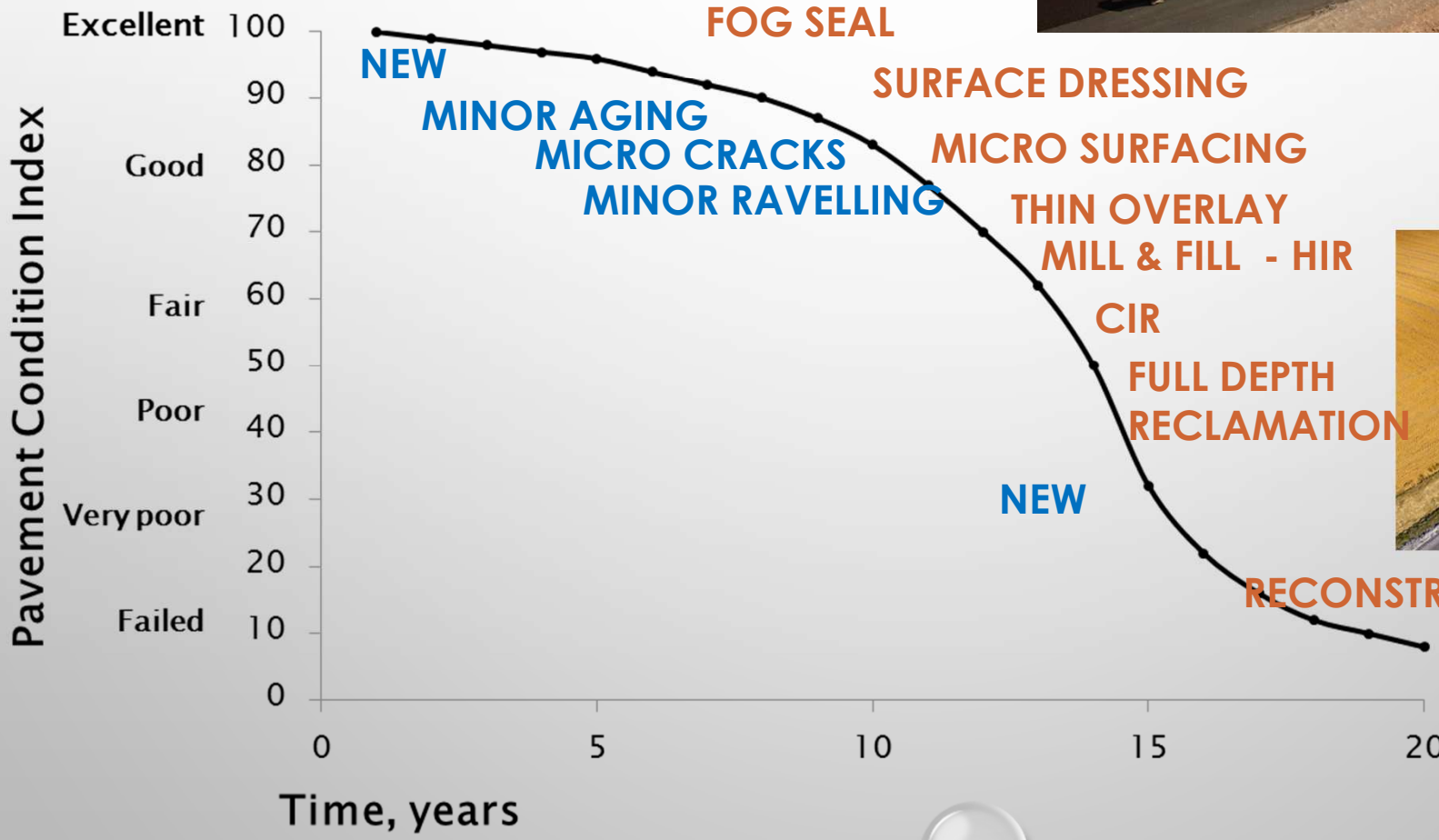


Figure 13. Idealisation of modulus gradient in asphalt pavements.

« Characteristics of undamaged asphalt mixtures in tension compression »
R. L Lytton, F Gu, Y Zhang, X Lue ,
IJPE vol 19 N°3 p192-204

Meaning of recovered binders ?

EXPECTATIONS



EXPECTATIONS

- DURABILITY IS PART OF THE SOLUTION
- BETTER KNOWLEDGE OF USE STAGE

	CONSTRUCTION WORKS ASSESMENT INFORMATION																
	CONSTRUCTION WORKS LIFE CYCLE INFORMATION																
	A1 - A3			A4 - A5		B1 - B7											
	PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							EN				
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1				
	Raw material supply	Transport	Manufacturing	Transport	Construction - Installation process	Use	Maintenance	Repair	Replacement[1]	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	
				scenario	scenario	scenario	scenario	scenario	scenario	scenario	scenario	scenario	scenario	scenario	scenario	scenario	scenario
Cradle to gate with modules C1-C4 and module D	Mand.	Mand.	Mand.										Mand.	Mand.	Mand.	Mand.	Mandatory
Cradle to gate with options, modules C1-C4 and module D	Mand.	Mand.	Mand.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Mand.	Mand.	Mand.	Mand.	Mandatory
Cradle to grave and module D	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mandatory

Vroom! Vroom! Anti-ageing technologies go head-to-head

BITUMEN TECHNOLOGY

Both Shell Bitumen and TotalEnergies are concentrating on the message that longer lasting roads are the secret to lower carbon roads - ***Kristina Smith*** reports

Silverstone in the UK is best known as the home of British motor racing. But on the A43, a dual carriageway which runs past the racing circuit, a different sort of competition is underway: two new technologies aimed to slow down the ageing process in bitumen are both under trial on the Highways England operated road.

One is Shell Bitumen's Cariphalte AgeSafe, the other is Styrelf Long Life from TotalEnergies. Both products claim to go beyond the performance of polymer modified bitumen (PMB), extending the time between resurfacing interventions, saving money and carbon and reducing disruption to motorists.

A 10% improvement in ageing durability would remove one intervention in the life of a road such as the A43, which might have a 50 year design life with resurfacing planned for every 10 or 12 years. However, both Shell and TotalEnergies hope that their technologies can do even better than that.

"We have got a lot of data from the lab so we are feeling confident," said Richard Taylor, global product technology manager at Shell. "But now we need to see how it performs in the field."

Shell Bitumen started work on its anti-ageing technology three years ago, using the Western Research Institute (WRI) in Laramie, Wyoming which is renowned in its work on longer-lasting roads, to verify its lab research and results. Shell researchers looked at several additive combinations which were then assessed and the best one taken forward.

The plan, said Taylor, was to find a combination which tackled all the different forms of ageing, looking at changes in chemistry, performance and what happens to the asphaltenes in bitumen, which Taylor explained attract most of the ageing process.

The result is something totally new, said Taylor: "We are dealing with new chemicals and a new supply chain." Shell Bitumen applied for a patent in August last year.

For the Shell Bitumen product, the Silverstone trial, carried out with CRH, was its first trial worldwide, although another section was laid on a road in Thailand soon afterwards with a further test section laid in Cumbria in the North of England in June and two more to follow. "We want to test it out in different geographies," said Taylor.

TotalEnergies' Styrelf Long Life Bitumen has already been laid on roads in the Netherlands and in Germany. The stretch on the A43 is its first trial in the UK, and the first time it will be subjected to such high traffic levels.

On the A43, Long Life will be compared against stretches laid using standard grade bitumen and Styrelf eXtreme 100 which is a PMB bitumen. "This trial paves the way for enhanced highways asset management and predictive deterioration modelling for Highways England," said Rick Ashton, market development manager for Total UK, part of TotalEnergies.

TotalEnergies' Bitumen UK technical manager Gary Schofield explained how Styrelf Long Life works: "We are effectively blocking the pathways for oxidation to occur within the molecular structure of the bitumen where we have lots of double bonds. Oxygen is attracted to those areas and forms oxidised groups that makes the bitumen stiffer and stops it from relaxing when strain or movement is applied to it."

In performance terms, this means that the ability of the asphalt mix to resist fatigue, fretting and cracking should be retained for longer.

In the laboratory, researchers assess the performance of different asphalt mixes over time by artificially ageing specimens using a pressure ageing vessel (PAV), typically at temperatures between 80°C and 100°C. As well as doing multiple PAV cycles, TotalEnergies performed other tests too, said Schofield.

"We developed a test to look at how well the bitumen could keep up with strain or movement, with multiple cycles, since the ability to relax any movement is the real benefit that bitumen brings."

»

ABOVE: Shell Bitumen has applied for patents for its technology BELOW: Shell Bitumen has been working on its anti-ageing system for three years

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CONCLUSION NECESSARY SIGNIFICANT EVOLUTION OF ROAD CONSTRUCTION