

L'exploitation  
et la maintenance  
des infrastructures



# CHARACTERISATION OF THE STATE OF THE NETWORK

*STRUCTURAL INDICATOR*

## ► Definition

- A structural index, or structural rating, is a real numerical variable, taking its value over a certain range  $[V_d; V_f]$  and varying continuously over this range as a function of the condition of the road pavement structure. This index reflects the ability of a road pavement to support the traffic applied to it without deteriorating visibly and rapidly

## ► Structure of the work carried out

- Phase 1: Current situation
  - In France
  - Internationally
- Phase 2:
  - List the pathologies affected by structural fatigue
- Phase 3 and 4
  - Translate a structural condition indicator using new high-performance measurement technologies.



## ► Current situation

- In France: Structural indicators:
  - MNQTR (trunk roads) structural rating
    - Calculation of the Asset rating expressed in centimetres of asphalt surfacing (AS) in tables cross-referencing the transverse deformations and cracks recorded during inspection
  - The Motorway Network Quality Image (MNQI) structural indicator
    - The calculation principle used to develop the structural MNQI is similar to that for the MNQTR
  - For the departments
    - Approaches based on the MNQTR
    - Methodologies developed in-house
  - Metropolises
    - MNQTR unsuitable
  - Communities of communes
    - No indicator defined



## ► Current situation

### ■ In Germany: Structural indicators:

- Objective: "Maintain a road condition that provides users with the best possible road behaviour and maximum safety, while ensuring low macroeconomic costs and maximum environmental compatibility." This objective is assessed based on 2 ratings:
  - The structure rating: A Usage indicator for users, characterising the quality of the infrastructure of major roads in terms of road pavement behaviour (serviceability) and road safety,
  - An Asset indicator for the operator in charge of the road pavement, describing the quality of the existing assets of the trunk road infrastructure with a view to timely and economically optimal intervention
  - An overall indicator is the worst of the two partial indicators
- Action Cost 354 "Road pavement performance indices"
  - For the structural index, the project recommends the following technical indicators:
    - » 1) bearing capacity
    - » 2) cracking
    - » 3) rutting
    - » 4) longitudinal deformations



## ► Current situation

### ■ U.S. Indicators

#### • Pavement Condition Index PCI

- The index has been standardised by ASTM for road and airport pavements
- The PCI of each section is calculated using a penalty method. The index is initialized to 100. Penalties are calculated based on the deterioration extension or density values and subtracted from 100 to give the PCI value.
- The catalogue of road pavement deteriorations used to calculate the index is extremely comprehensive.

### ■ PSI (Present Serviceability Index)

- The PSI index expresses the quality of the road pavement at a given point in its life. It combines the structural quality of the road pavement (presence of deterioration, cracking and rutting) and the quality of use (driving comfort, related to the evenness value). The dominant value is evenness.
- It varies according to the overall quality of the road pavement between 0 (impossible level) and 5 (excellent level).

		5 niveau excellent		
excellent	4		→	p 0
bon	3			} Δ PSI
moyen	2		→	
mauvais	1			
très mauvais	0	chaussée à renforcer		



## ▶ Objective of DVDC

- Need to define a structural indicator

## ▶ DVDC:

- Presentation of two approaches
  - Cerema MNQTR 3D approach
  - DVDC approach





Public presentation of results  
7 November 2023, ENTPE, Vaulx-en-Velin



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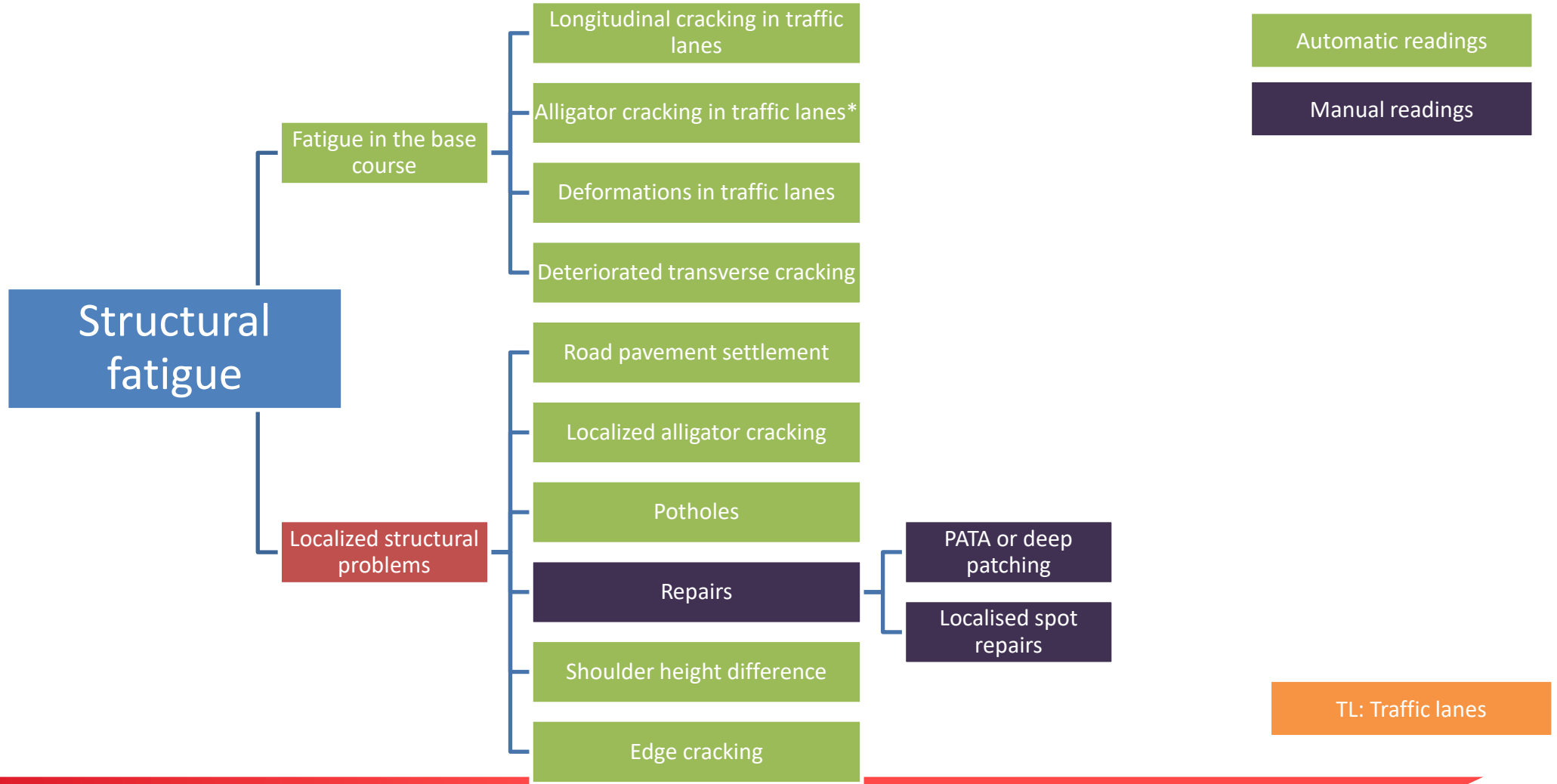


► List of pathologies impacting the structural indicator:

Pathology	Sub-pathology	Deteriorations	Possible maintenance techniques	
Structural fatigue	Fatigue in the base course	Longitudinal cracking in traffic lanes	Reinforcement, with or without milling or excavation, with or without central recycling.	
		Deformation in traffic lanes		In-situ reprocessing with emulsion or hydraulic binder
		Transverse cracks	Purging of deteriorated transverse cracks	
	Localized structural problems		Settling on the road pavement	Deep patching
			Localized alligator cracking	Surface patching
			Potholes	Pothole patching
			Spot surface repair	If not very dense: nothing If dense: structural inspection
			One-time deep repair	If not very dense: nothing If dense: structural inspection
	Shoulder defects		Edge settlement	Deep patching
			Edge cracking	Edge beam
			Edge spalling	Reprofiling



## ► Contribution of new technologies



## ► Principles

- Make the most of the wealth of information available from automatic readings
- Analyse the total lane surface
- Use the concept of available surfaces with automated readings

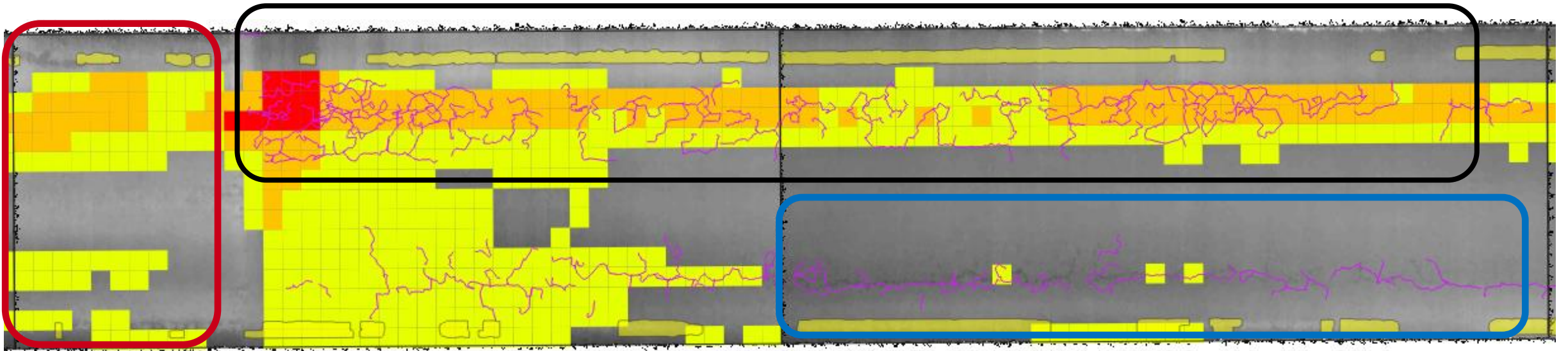
## ► Methodology

- Use geo-referenced deformation and cracking data, looking at whether or not these deteriorations occur simultaneously
- Assess the road pavement surfaces impacted based on a basic mesh
- Calculate a structural condition indicator based on the severity and surface area of deterioration and cracking



## ► Example of treatment

- Locate and assess the surface areas:
  - Deformed and cracked (black rectangle)
  - Deformed only (red rectangle)
  - Cracked only (blue rectangle)



*Yellow, orange and red: deformed areas according to their severity  
 Cracking in purple*

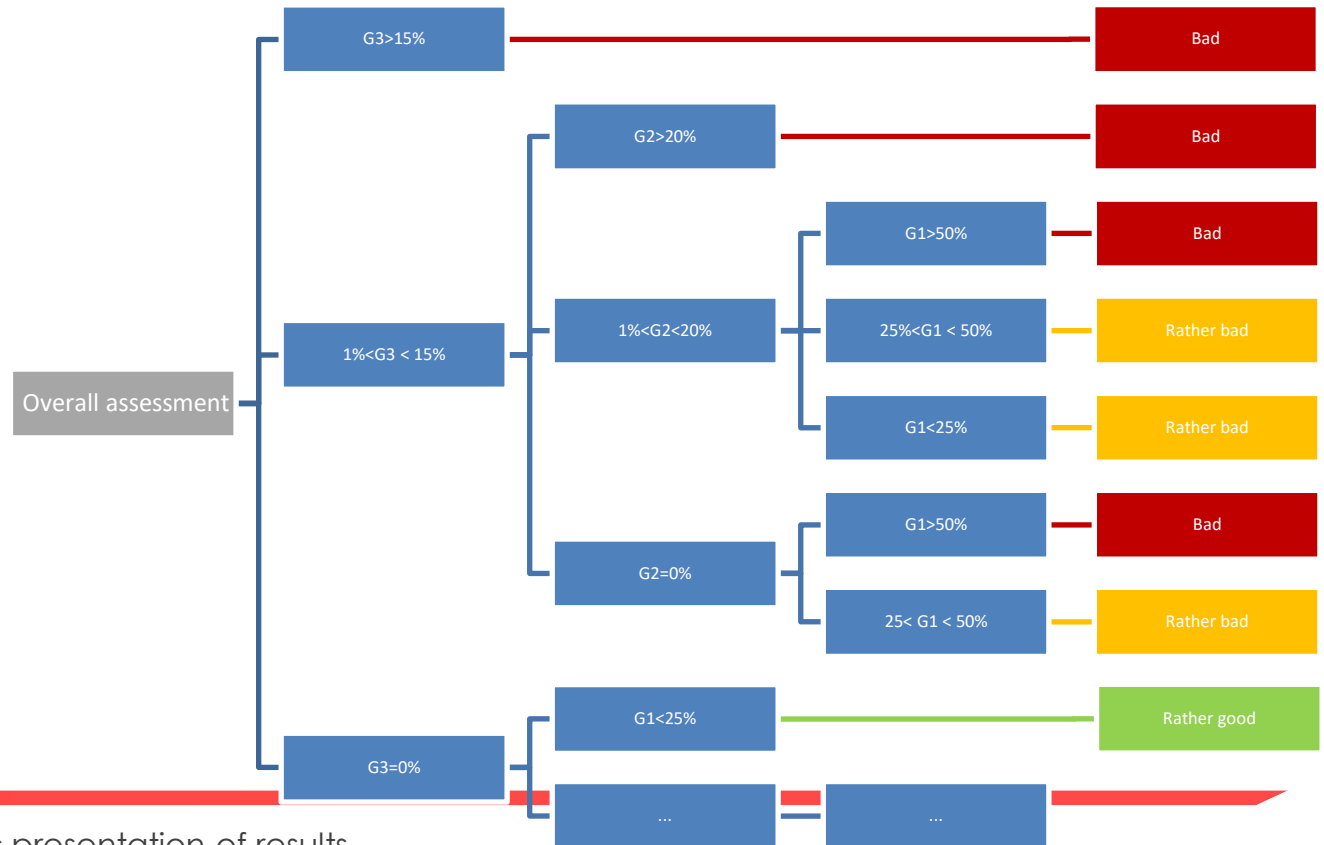


## ► Structural condition

- "GOOD" / "RATHER GOOD" / "RATHER BAD" / "BAD" assessment based on:
  - Quantities of surfaces impacted
  - Thresholds calibrated according to the networks analysed

Structural Indicator		Cracking severity				
		0	1	2	3	4
Deformation severity	0	0	0	1	1	1
	1	1	1	2	2	2
	2	2	2	2	3	3
	3	3	3	3	3	3

Rating	Structural Indicator
0	Good
1	Rather good
2	Rather bad
3	Bad



## ► Contributions of new indicators

- Use of new LCMS-type monitoring technologies
  - More information to be exploited, especially in terms of locating deterioration
- Based on the use of deteriorated road pavement surfaces
- Enables changes in road pavement conditions to be monitored

## ► Action to be taken

- Implement one or more shared indicators (depending on the type of network)

## ► Documentation

- Deliverables can be consulted on the dedicated IREX website

