

## LCPC Database set-up for the Rilem TC-CAP TG1

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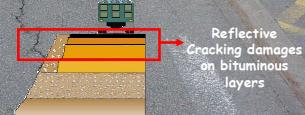
Division Matériaux et Structures de Chaussées, LCPC-Nantes

### Context: rehabilitation



Road Network in France (2004)

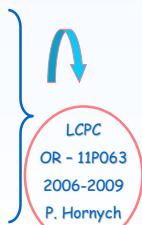
Highways	10 383 km
National roads	26 625 km
Departmental roads	359 644 km
Urban roads	604 308 km



Reflective  
Cracking damages  
on bituminous  
layers

### LCPC first State of art Data

- Bank of data from real pavement specimens:
  - Since 1993 French IQRN data bank (SETRA, 2000) (Lepert et al., 2004) (Brillet et al., ICAP2006)
    - statistic data of several pathologies (visual method)
  - 22 French Test sections « SHRP » (Kobisch, 2000)
    - coarses, FWD, rutting and visual informations
- Data from ALT facilities
  - LCPC Carrousel of fatigue
    - For cracking 6 experiences
      - extend of cracking curves, sensors information, Material characterization
  - LCPC « FABAC » machine
    - Recent results from PhD thesis (Pouteau et al., RGRA2006) (Pérez et al., ICEFAII-2006)



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### Pavement building, partnership of LCPC ALT programme

- ◆ pavement construction : by Pavement compagnies



- ◆ main partnership :

- Road Administration
- Motorways societies
- Pavement compagnies
- Petroleum compagnies

- ◆ due to financial reason : external association is always requested (at this date)

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### 20 years of extensive ALT

- ◆ 14 tests with Motorways companies on structural design
- ◆ 34 tests with Road contractors for evaluation of new products for base and surface layers
- ◆ 12 tests with Contractors and Producers unions to adjust design of pavements
- ◆ 60 tests with Motorways companies and Oil producers on rutting
- ◆ 12 tests with Tire manufacturer
- ◆ 28 tests with Urban transportation consortium

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### LCPC-Nantes carroussel



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**Main characteristics of the facility**

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- ◆ Circular outdoor facility, commissioned in 1984
- ◆ Central 1000 HP (746 kW) electrical plant
- ◆ Radii of rotation : adjustable from 15 m to 20 m
- ◆ Maximum speed 13.5 rot/mn (100 km/h at radius 19.5 m)
- ◆ Transverse wandering of real traffic can be reproduced
- ◆ Various types of loads from 8-ton single-axle to 30-ton multiple-axe (only a half-axe per arm)
- ◆ 3 test sites, the 3rd one including water table control system (pumping station)
- ◆ Track width up to 6 m - length 122 m (radius 19.5m)

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**Load configurations**

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**Traffic transversal wandering simulation**

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Up to up four wheel-paths

Position of the load	Percentage
1	2.00%
2	3.00%
3	5.00%
4	11.00%
5	22.00%
6	16.00%
7	11.00%
8	6.00%
9	3.00%
10	1.00%
11	1.00%

Distance from pavement centerline (m)

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**Example of test on flexible pavement**

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Sector 5 : Bituminous reference structure

Track 1, mean radius 19.5m : trafficked during the stage 1

Track 2, mean radius 16.5m : trafficked during the stage 2

Sectors 1 to 4 : Flexible pavement, thickness of UGM from 20 cm to 50 cm

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**Up to 4 or 5 pavement structures per test**

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Example of test track arrangement for fatigue experiment on flexible pavement

Sector1	Sector2	Sector3	Sector4	Sector5
22.50m	22.50m	22.50m	22.50m	30m (reference)

Theoretical live duration (millions loading)

Sector	Theoretical live duration (millions loading)
Sector 1	0.18
Sector 2	0.30
Sector 3	0.75
Sector 4	1.25
Sector 5	1.50

Legend: Asphaltic concrete (light grey), Asphaltic base course (dark grey), UGA untreated graded aggregates Soil (80 to 110 Mpa according water level) (yellow).

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**Pavement instrumentation**

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Pressure cell

Horizontal strain gauge

Vertical strain gauge

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**Example of test on flexible pavement**

**Load configuration :**

- wandering +/- 0.55m
- twined standard wheels (32.5 kN/wheel)
- speed 10 rot/mn (70 km/h)
- 1.7 millions loading for each stage

**Stage 1 :**

- low water table level
- subgrade bearing capacity 110 Mpa
- rotations at radius 19.5 m

**Stage 2 :**

- high water table level
- subgrade bearing capacity 85 Mpa
- rotations at radius 16.5 m

Radius 19.5m  
Radius 16.5m

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**Examples of tests**

**For cracking**

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**3 fatigue cracking experiments**

**I**

C1	8 BB <sub>1</sub>	8 BB <sub>2</sub>	8 BB <sub>3</sub>	12 GB	USAP SHELL	06/07/91
6,5 t	40 GRH	40 GRH	40 GRH	40GRH	au	15/07/91
Nb passages	2 731 000	2 731 000	2 731 000	2 731 000		

**II**

C2	BB <sub>1</sub>	BB <sub>2</sub>	40 GB	BB <sub>3</sub>	USAP SHELL	10/10/91
6,5 t	42 GRH	42 GRH	40 GRH	46GRH	au	31/10/91
Nb passages	1 390 000	1 390 000	1 390 000	1 390 000		

**III**

B2	BB <sub>1</sub>	BB <sub>2</sub>	BB <sub>3</sub>	BB <sub>4</sub>	USAP ELF	24/11/93
6,5 t	40 GRH	40 GRH	40 GRH	40 GRH	au	18/04/94
Nb passages	3 160 000	3 160 000	3 160 000	3 160 000		

(Achimastos, 1998), Courage project (Hornych and Salaska, 1999)

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**For instance**

**S1**

B2	BB <sub>1</sub>	BB <sub>2</sub>	BB <sub>3</sub>	BB <sub>4</sub>	USAP ELF	24/11/93
6,5 t	40 GRH	40 GRH	40 GRH	40 GRH	au	18/04/94
Nb passages	3 160 000	3 160 000	3 160 000	3 160 000		

**S2**

B2	BB <sub>1</sub>	BB <sub>2</sub>	BB <sub>3</sub>	BB <sub>4</sub>	USAP ELF	24/11/93
6,5 t	40 GRH	40 GRH	40 GRH	40 GRH	au	18/04/94
Nb passages	3 160 000	3 160 000	3 160 000	3 160 000		

**S3**

B2	BB <sub>1</sub>	BB <sub>2</sub>	BB <sub>3</sub>	BB <sub>4</sub>	USAP ELF	24/11/93
6,5 t	40 GRH	40 GRH	40 GRH	40 GRH	au	18/04/94
Nb passages	3 160 000	3 160 000	3 160 000	3 160 000		

**S4**

B2	BB <sub>1</sub>	BB <sub>2</sub>	BB <sub>3</sub>	BB <sub>4</sub>	USAP ELF	24/11/93
6,5 t	40 GRH	40 GRH	40 GRH	40 GRH	au	18/04/94
Nb passages	3 160 000	3 160 000	3 160 000	3 160 000		

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**Available Data**

(Achimastos, 1998)

+ material characteristics

Fig. III.4 : Evolution de l'étendue de fissuration des planches soumises à un essai de 13 t

Courage project (Hornych and Salaska, 1999)

$\varepsilon_{xx}$  (strain) vs Number of cycles (13)

Figure 4.3 : Example of recorded signal of a longitudinal strain gage placed at the bottom of the asphalt layer

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**3 examples of Rehabilitation data for cracking**

**I**

B0	5 BB	5 BB	24 GC	LCPC Seuil	19/04/85
6,5 t	45 GRH			au	21/10/86
Nb passages	768 000	3 653 000			

B0	4 BB	4 BB	8 BB	1 A	02/11/87
6,5 t	45 GRH	45 GRH	45 GRH	au	12/10/88
Nb passages suppl.	+ 630 000	+ 2 456 000	+ 3 086 000		

**II**

B1	6 BB	12 BB	6 BB	O.C.D.E au	20/12/88
5,75 t	30 GRH	30 GRH	18 GC	TO.RCE	06/11/89
Nb passages	260 000	3 972 000	1 780 000		

B1	6 BB	6 BB	18 GC	1 A	05/06/89
5,75 t	30 GRH	30 GRH		au	06/11/89
Nb passages suppl.	+ 3 712 000		+ 2 192 000		

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**Format Project WP3 – experiment with Lcpc's ALT Innovative maintenance treatment VTAC + Geogrid**

**III**

Application of Geogrid over the bituminous tack-coat, before the bituminous overlay placing

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**Format Project WP3 – experiment with Lcpc's ALT Structure survey**

**1- Before the maintenance roadwork :**

- Cartography of crackings (pictures)
- Evaluation of severity of cracking (cores)
- Evaluation of structural capacity of pavement (benkelman and fwd)

**2- During the maintenance roadwork : Laboratory tests on formulation, Pictures ...**

**3- After the overlays application:**

- Evaluation of structural capacity of pavement with overlays (benkelman and FWD)

**4- During the test : evolution of :**

- Cartography of cracking (pictures)
- Rutting
- Roughness, Sand patch, Pendulem (skid resistance)
- Drainability
- Temperatures and raining
- Ravelling, noise (?)

**5- After the test: Cores on cracks, trenches**

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**LCPC FORMAT Results**  
(Deliverable Report D9, 2004)

- Hot summer 2003 → rutting (19mm)  
- fine transversal cracking (28% extent of surface cracking after 1.5M)  
- interface debonding before and after rehabilitation....

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**First Conclusions on LCPC carrousel data**

- ✓ No relation between deflection and extent of surface cracking
- ✓ Orientation of cracks depends on the thickness layers  
→ loading?!
- ✓ Specially for thin layers top down cracking exists
- ✓ Don't forget to take into account debonding!
- ✓ New modelling tools need to analyze and diagnostic the data set-up (OR Fondepny 2006\_2009):
  - Bitumen Cracking modelling (Nguyen, 2006) (Chailleux, ICAP2006)
  - Damage modelling (Bodin, 2002) (Bodin et al., ASCE2004), ...
  - Visco-élastique structural model (Duhemel et al., BLPC2005) (Chabot et al., ICAP2006), ...
  - Cracking structural model (Tran, 2004) (Chabot et al., BLPC2005), ...
  - Visco-plastique modelling (Nguyen, 2006) (Nguyen et al., ICAP2006), ...
  - Non linearity modelling for GNT and soil material (El Abd, 2006)(Hornych et al., RMPD2006 or 2007) ...

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**Cracking in Pavement**

2 Fabac Machines -> Asphalt and/or concrete pavements

Loading conditions : standard twinned wheels 32.5 kN/wheel or single wheel 42 kN/wheel, speed : 3.6 km/h no lateral wandering length of road trafficked = 2 meters

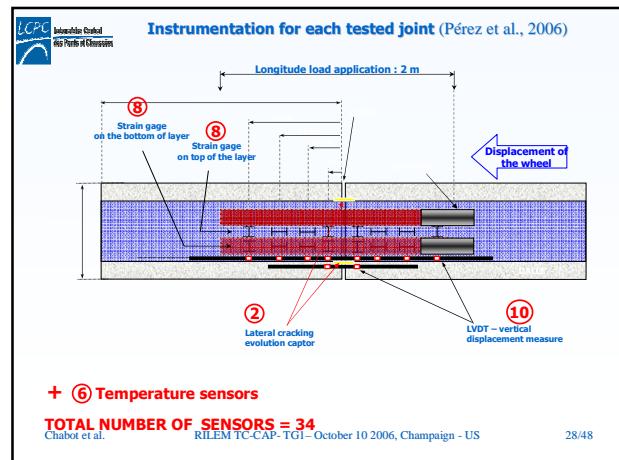
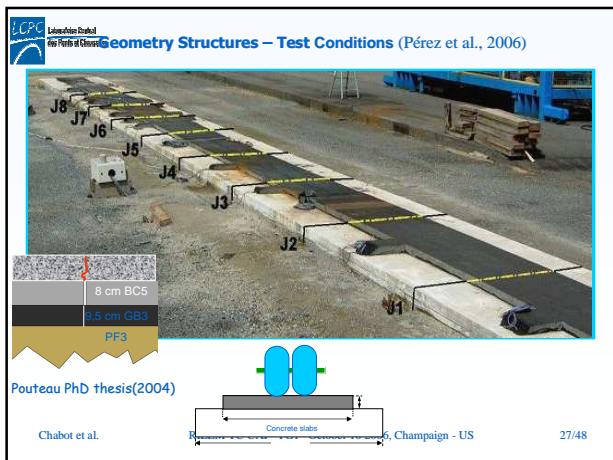
Dimension length: 9.80 m width: 2.50m height: 3.30m Weight: 15 Tons Power : 45 kw

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Area for Score fest -maximum length 20 meter, width 3 meters

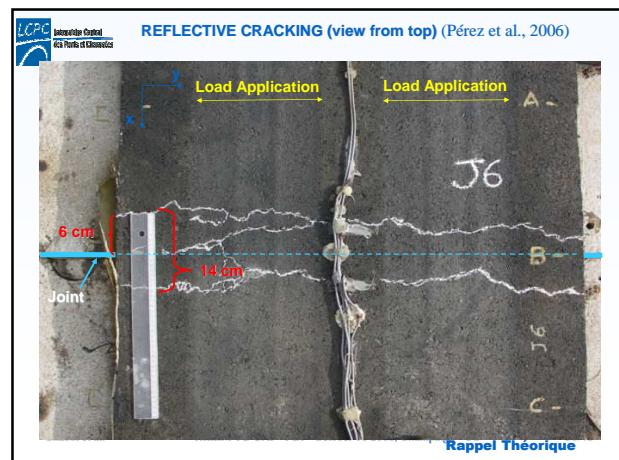
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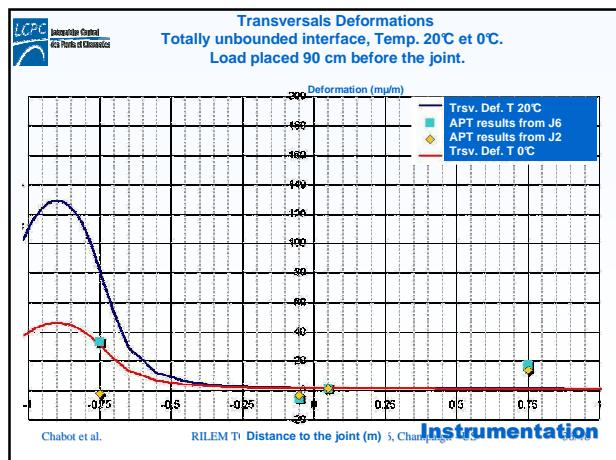
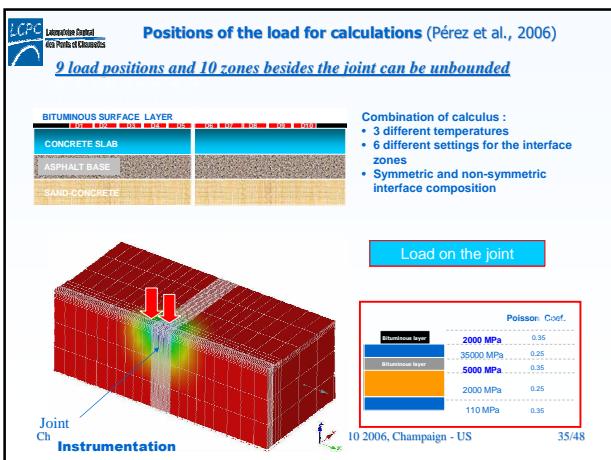
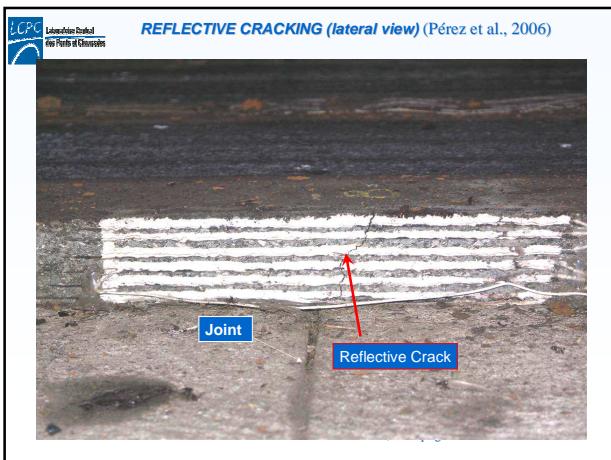
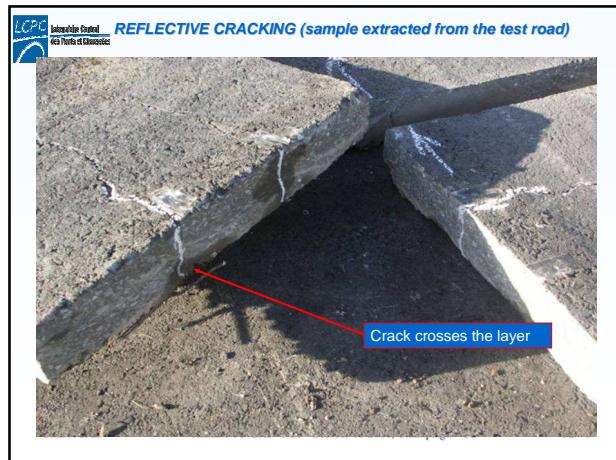
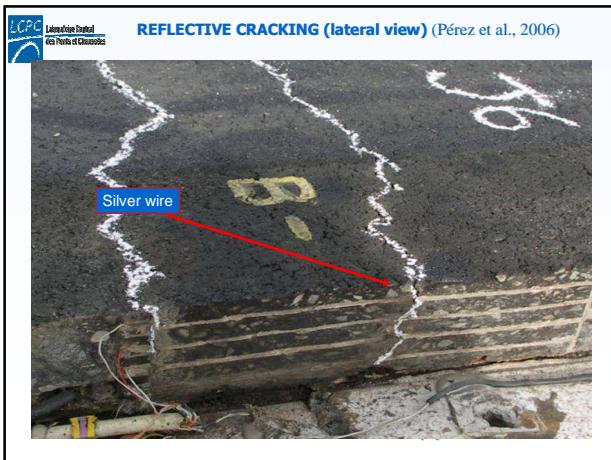


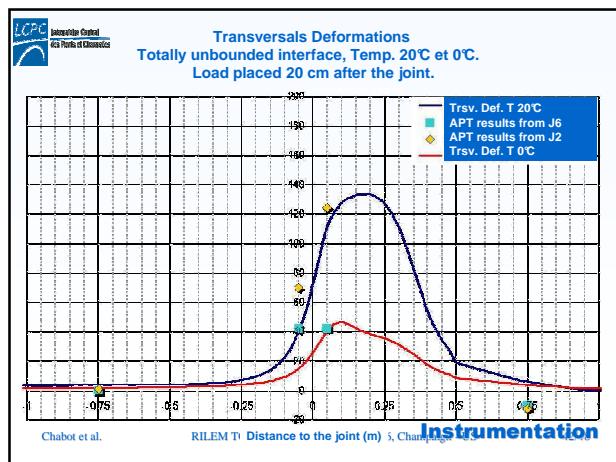
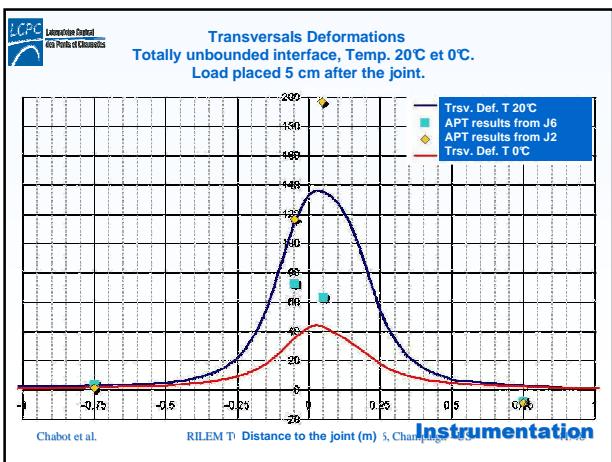
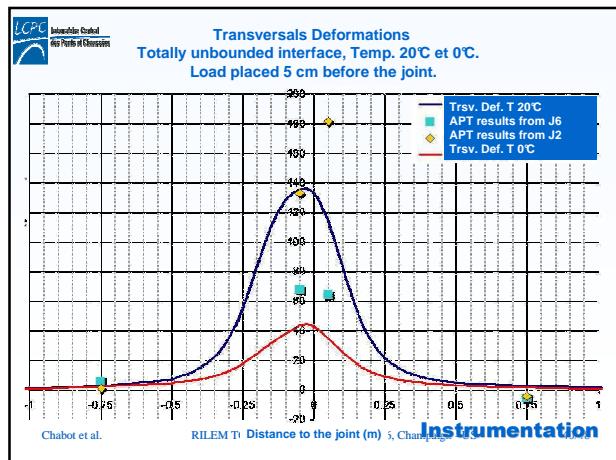
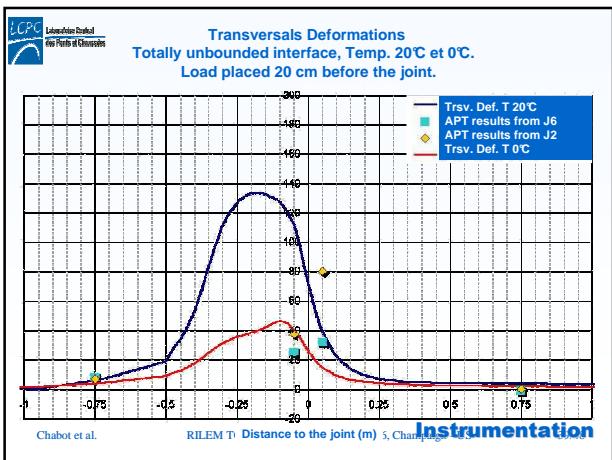
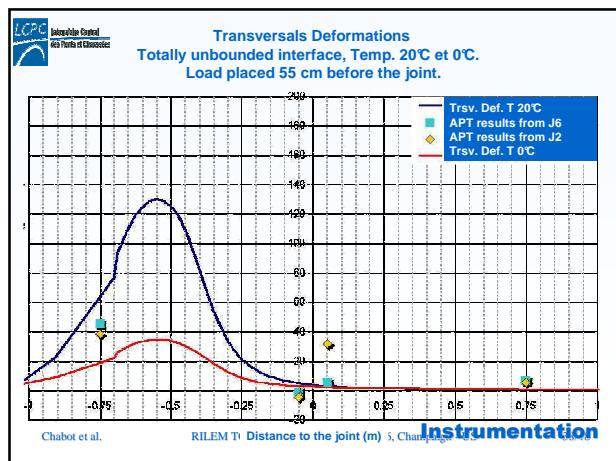
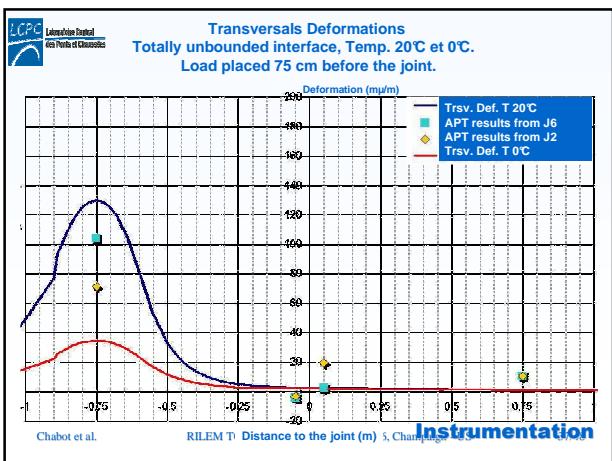
**APT Time Schedule (Pérez et al., 2006)**

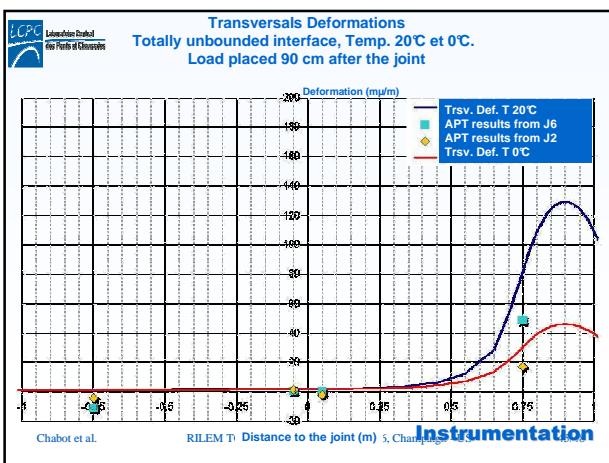
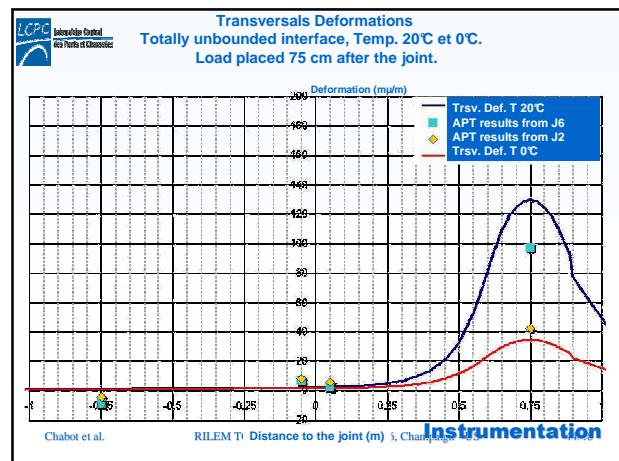
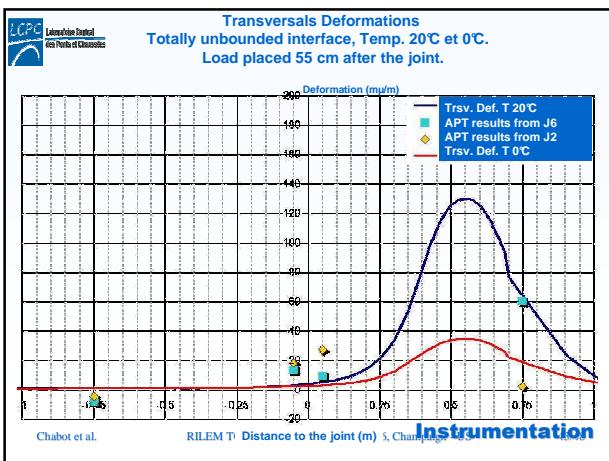
TEST	2005					2006										
	March	April	M.	J.	A.	September	October	November	D.	January	February	M.	A.	May	June	
N°1	500 000															
N°2					1 000 000											
N°3							1 000 000	cycles								

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## Main conclusions

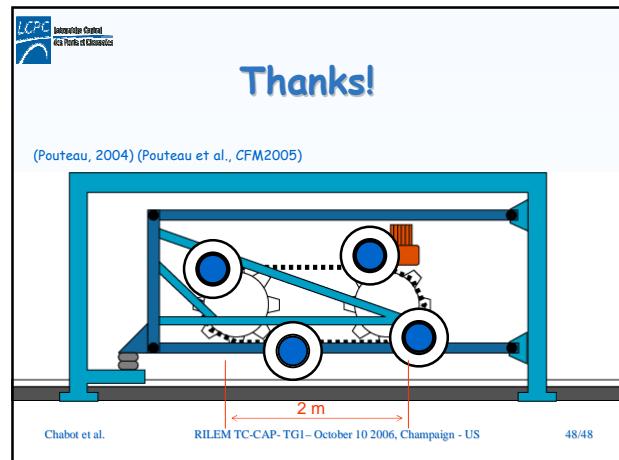
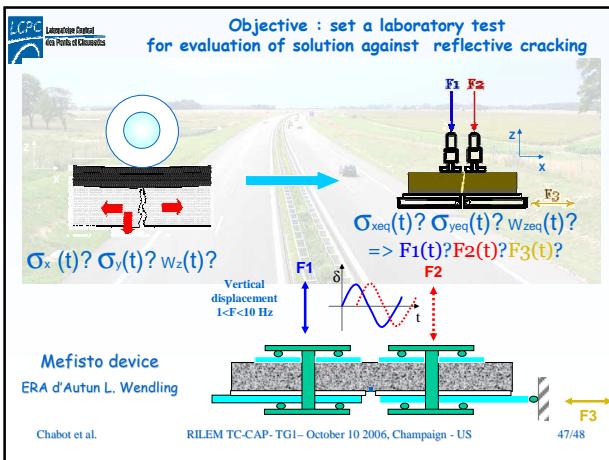
For the Rilem TC-CAP, it can be used:  
Fabac data (Pérez et al., 2006)

**Limitations of ALT**

- Missing the alea and traffic & climatic histograms of the real life
- Missing the aging of materials
- Continuity in working programs regarding the pursuit of "research objectives" is often difficult to reach with ALT, considering :
  - ✓ Cost aspects
  - ✓ Compatibility with the necessary and useful "External demand"

**Needs**

- work on a comparative basis (reference materials, reference structures and reference load configuration)
- complement ALT with RLT (Real Load Testing) on real road network.
- complement with lab structural test



## Essai accéléré de durabilité

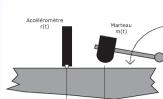
Mise au point d'un outil d'auscultation de l'interface



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- ◆ Dispositif COLIBRI
- Principe [Bats Villard, 1991],



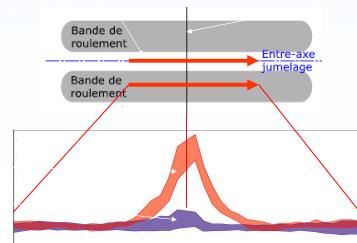
- Étude du collage de l'interface entre deux couches :
- Analyse des fonctions de transfert Réponse / Excitation
- Phénomène physique mesuré

[Pouteau,2004]

## Essai accéléré de durabilité

Mise au point d'un outil d'auscultation de l'interface

- ◆ Calibration initiale sur la structure à tester :
- mesures sur joints témoins collés et décollés

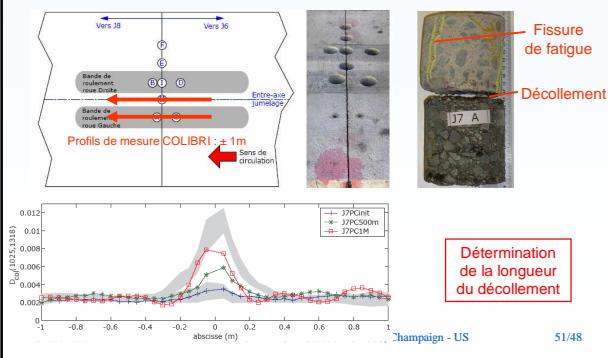


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## Essai accéléré de durabilité

Exemple de résultat / J7 – Carottage – Auscultation



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