

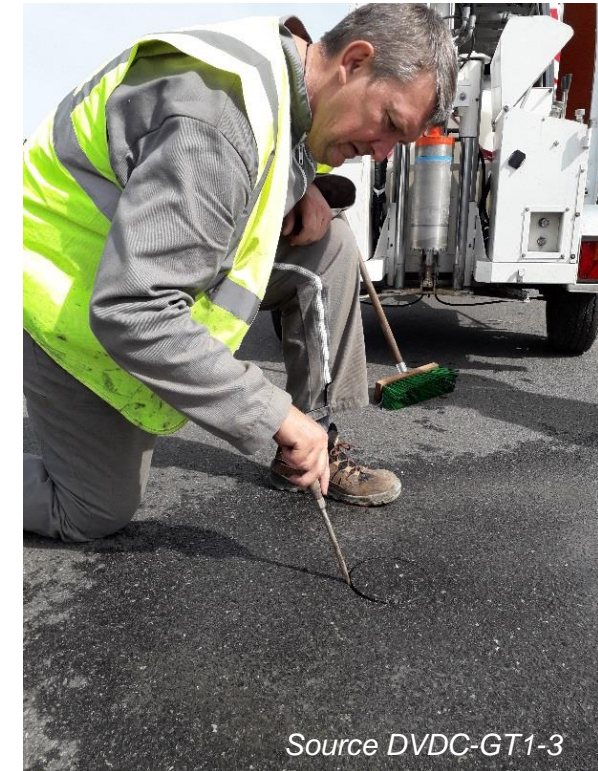
# BONDING OF COURSES

*In situ performance characterisation of surface course  
interfaces*

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- ▶ Context and objectives
- ▶ Analysis of the current situation
- ▶ Development of an in situ measurement device
  - Study phase and laboratory tests
  - Field measurement campaign
  - Teaching and interest of the profession
  - Industrialisation
- ▶ Conclusion and outlook



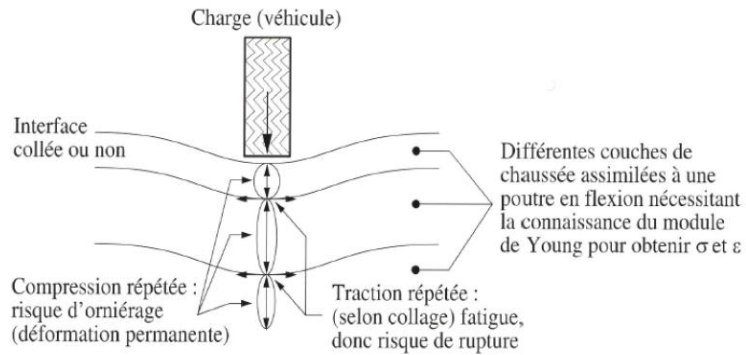


- ▶ **Course delamination: one of the causes of deterioration in road pavement structures...**
- ▶ **Need to characterise bonding quality**



- ▶ **DVDC Consortium:** Pérennise Chaussées/Road Pavement Durability, University of Limoges, ESTP/ENSAM, RDF (via COLAS), EUROVIA, EIFFAGE
- ▶ **Specifications:**
  - In-situ test producing a torsional shear effect
  - Rapid, inexpensive, semi-destructive, common and accessible to the entire profession
  - Reliable and functional method with acceptable metrology (Standard - approval)





v. Domec : *Fatigue damage to bituminous mixes under simulated traffic and temperature conditions*; Bordeaux; 2005

## Stress on the road pavement:

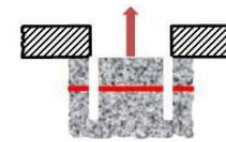
- Multiple stresses (shear, tension, compression) depending on the bonded, semi-bonded interface, etc.
- Normal vehicle load stress
- Cyclic combined load
- Variant (braking, acceleration, cornering, etc.)

Complex stress zone....

➔ European standard  
(NF EN 12697-48 November 2021)  
6 test methods proposed!

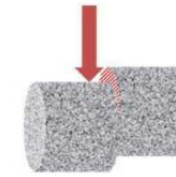
Several approaches...:

- 3 normative monotonic tests



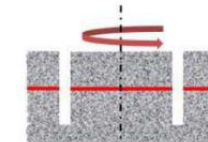
**Tensile (TAT) :**  
0 +1 °C ou 10 ±0,5 °C  
200 N/s  
Ø = 100 mm

Lab and  
jobsite



**Shearing (SBT) :**  
20 ±1 °C  
50 ±2 mm/min  
Ø = 100 mm

Lab



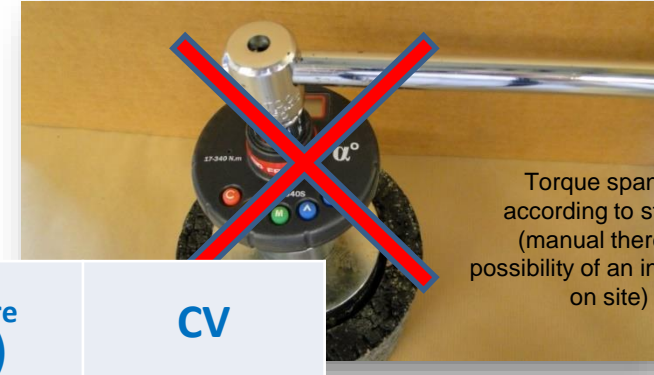
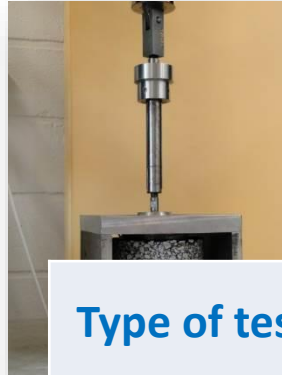
**Torque (TBT) :**  
20 ±2 °C  
30 ±15 s/90°  
Ø = 100 mm

Lab and jobsite





Via testing machine



Torque spanner according to standard (manual therefore possibility of an in situ test on site)

Type of test	T test (°C)	Speed	$\sigma_{\text{rupture}}$ (MPa)	CV
Tensile strength	10°C	200N/s	1.64	12%
Shear	20°C	50 mm/min.	1.73	15%
Torsion (via device)	20°C	90° in 30 sec i.e. 196 mm/min	3.38	5%

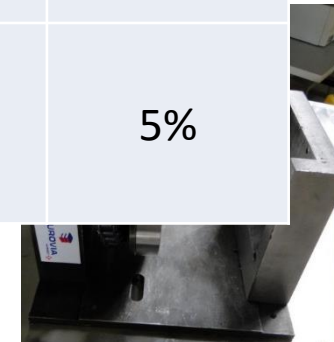
...the mechanical torsion tests, we saw that the ... up to 900N.m, which translates into the mass ... of a one-metre bar (around 90Kg). This ... of manual testing." G. Marmer

Via testing machine



Via testing machine

(Eurovia mechanical device)

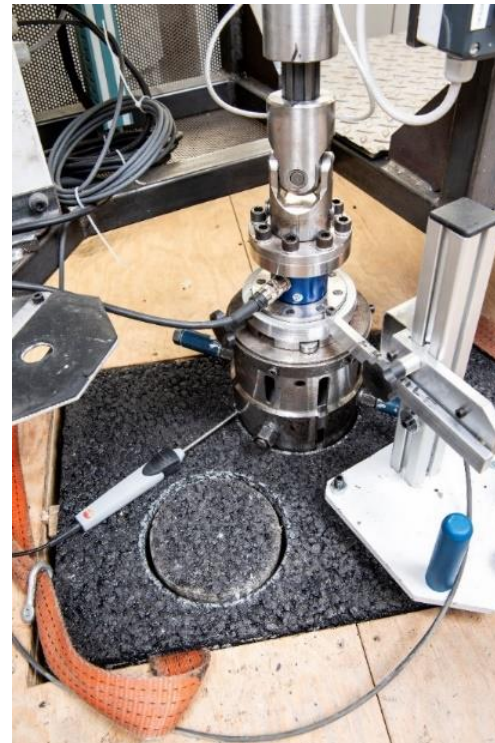


Difficulties in comparing results... different conditions and strong influence of test conditions



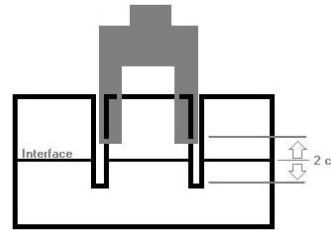
Ref: Dony, A., Koutiri, I., Yvinec, B., Godard, E. (2016). Analysis of the Draft European Standard on Interlayer Bonding and Understanding of the Influencing Factors. In: Chabot, A., Buttlar, W., Dave, E., Petit, C., Tebaldi, G. (eds) 8th RILEM International Conference on Mechanisms of Cracking and Debonding in Pavements. RILEM Bookseries, vol 13. Springer, Dordrecht. [https://doi.org/10.1007/978-94-024-0867-6\\_71](https://doi.org/10.1007/978-94-024-0867-6_71)

## ► Step 1: Laboratory study and testing phase (2018)

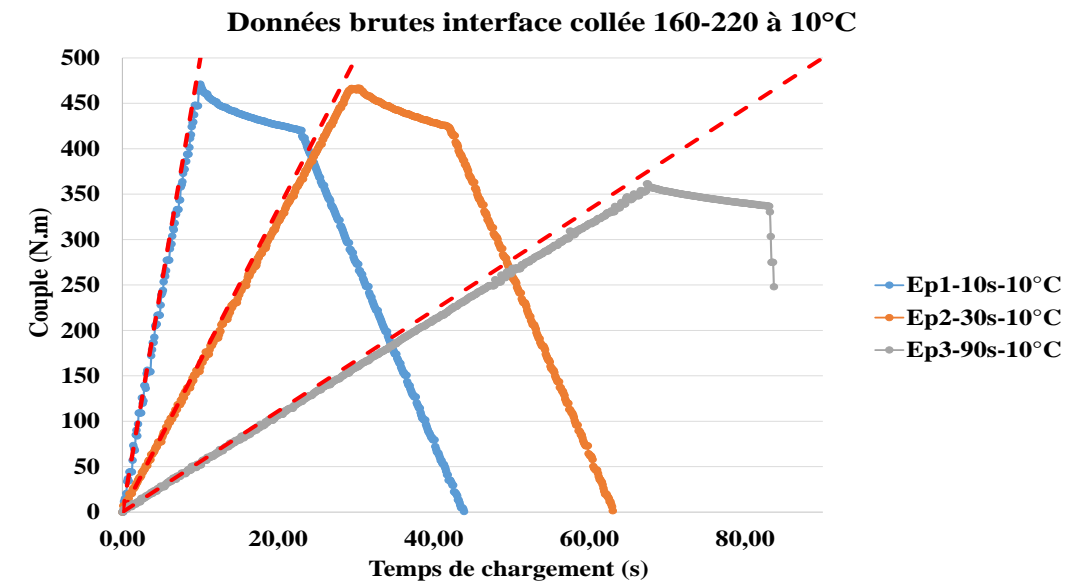


## ► Evaluation and parameterisation of the prototype

- Experimental design:
  - ECR 69 to 35/50, 160/220 and 35/50 amended
  - 10°C, 20°C and 30°C
  - 3 repeatabilities



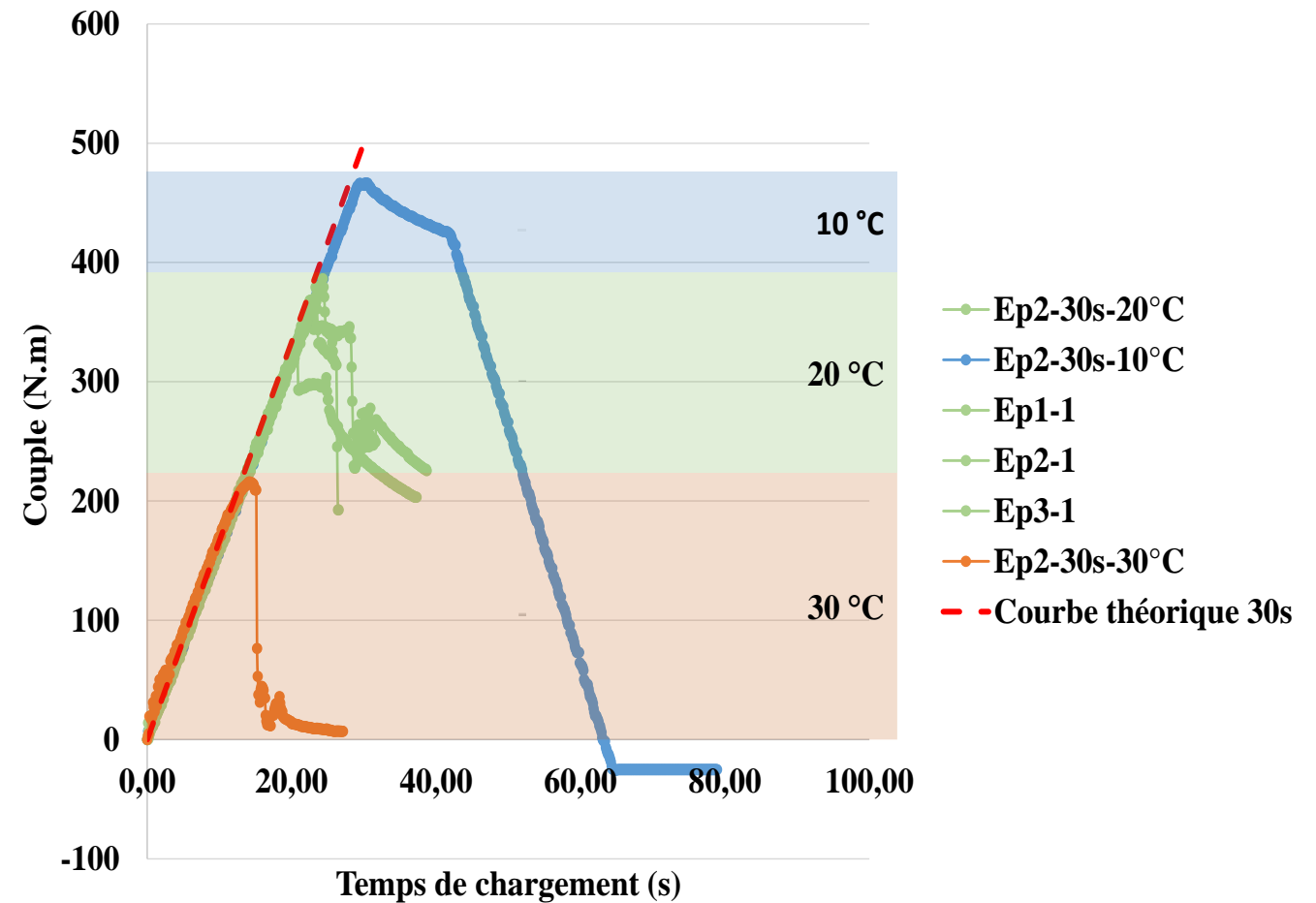
- Prototype parameterisation
  - Loading ramp
  - Rotational fracture
  - Influence of temperature





## ► Lab test results

- Influence of T° on stress
- Fracture beyond 500Nm at 10°C
- No effect of the emulsion type



## ► Stage 2: field measurement campaigns (2019)

### 4 fields of play

- USSEL (19) - Former RN 89 (April)
- UGE fatigue carousel (Nantes 44) (May)
- RD909 PN MURE (Moriat, 63) ) (July)
- N102 New bituminous mix (Brioude 43) (September)

### Objectives and test programme

- Field logistics
- Temperature control?
- Influence of media or interface types



15 minutes  
Handling time



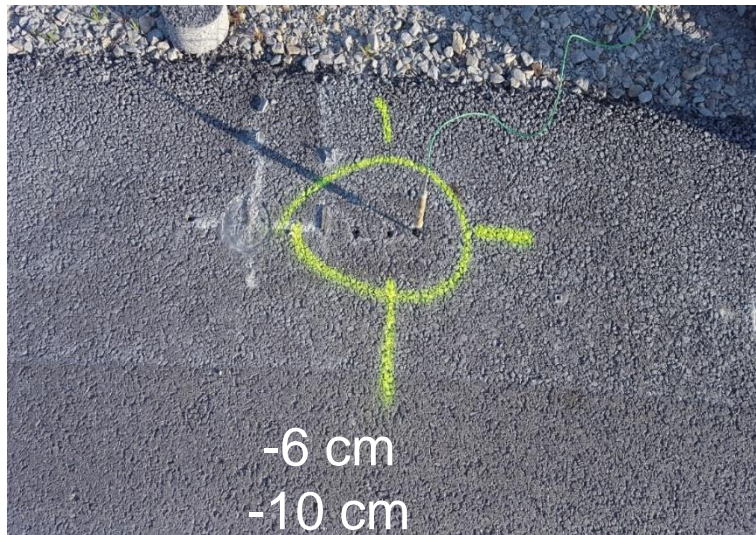
- ▶ **15 minutes in the field** (set-up, measurement and dismantling)
- ▶ Immediate, quantified results (test curve)
- ▶ A prototype that does not prefigure the commercial version





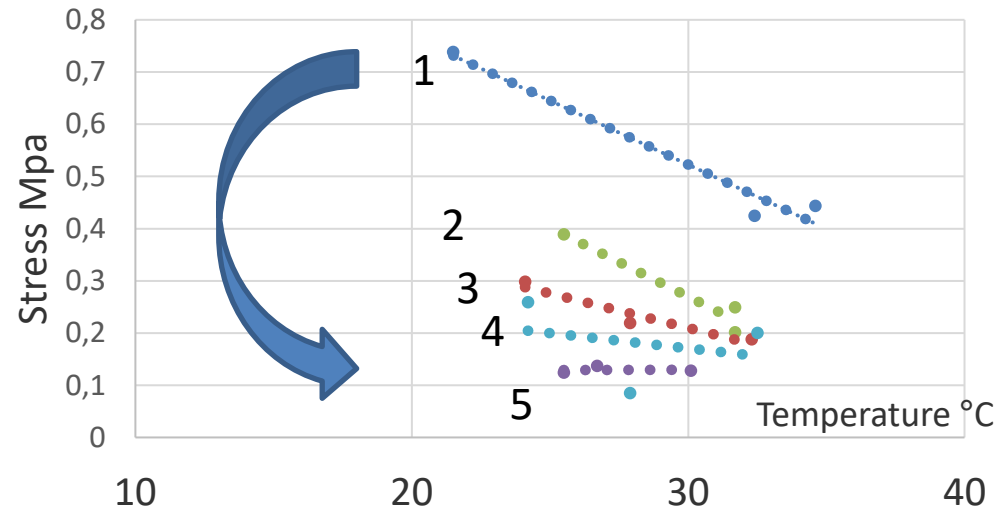
Simple temperature measurement procedure (at a point close to the area being assessed)

Rapid non-destructive pothole patching solutions



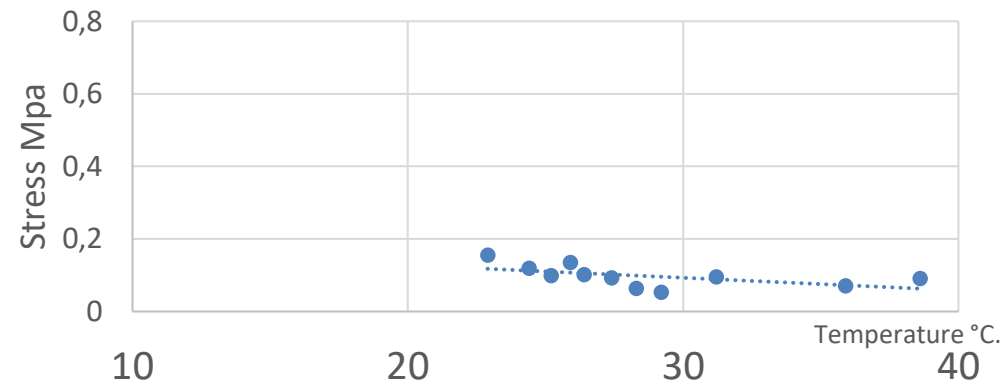


Nantes in-situ torsion test (Université G. Eiffel)



1. Standard bonded to the emulsion
2. Bonded interface
3. Bonded interface
4. Normally bonded interface
5. Poorly bonded interface

MORIAT in-situ torsion test (D909)



Unbonded screwdriver test → < 0,15 MPa  
Minimum test parameters  
No influence of temperature



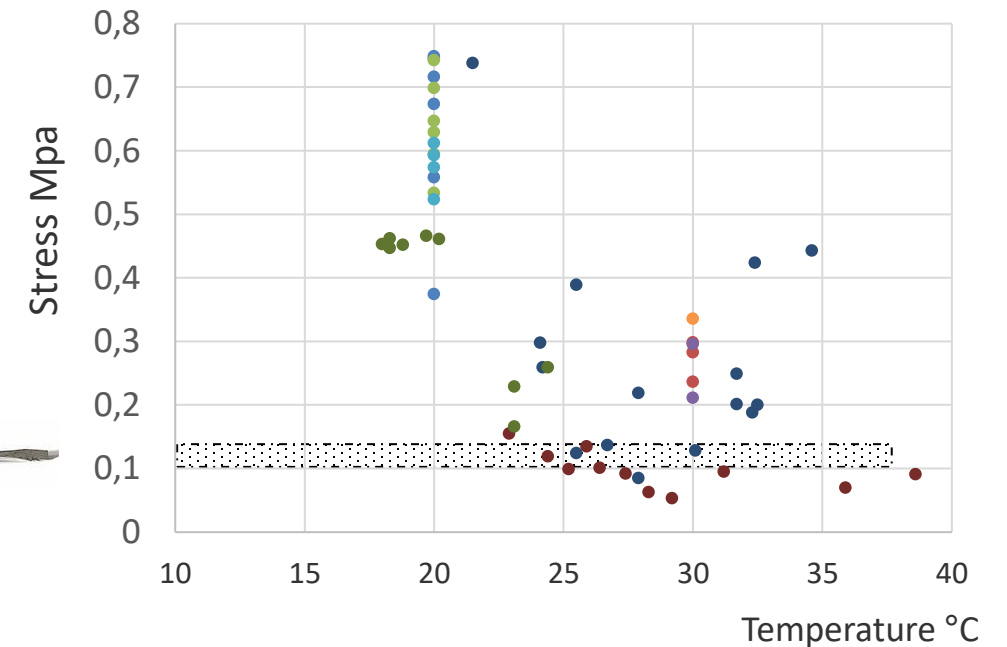
## ► Initial lessons from the results...

- Influenced by many parameters
  - **Type of Support**
  - **Interface quality**
  - **Interface temperature**

...



Essai de torsion laboratoire et in-situ



## ► Exchange seminar (14/10/20) + Laboroute laboratoires survey

### ► A rich discussion:

Desire for a very simple and rapid technique for site inspections or expert appraisals BUT phenomena are complex

Unsatisfactory EU standard and interest in the developed device BUT need further work

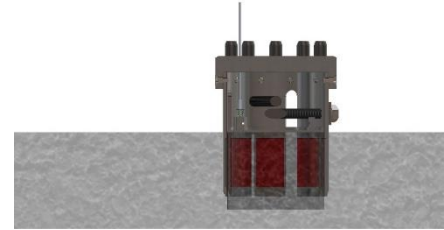
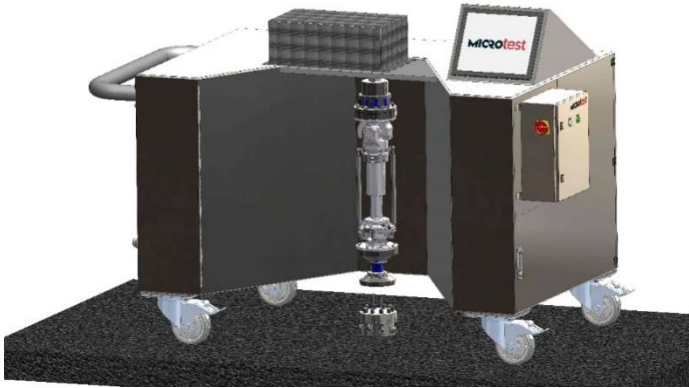
Various complementary technical and research resources developed

### ► Real interest in field testing subject to cost, ergonomics and speed



## ► Industrialisation of the prototype

New "field" tool developed by DVDC

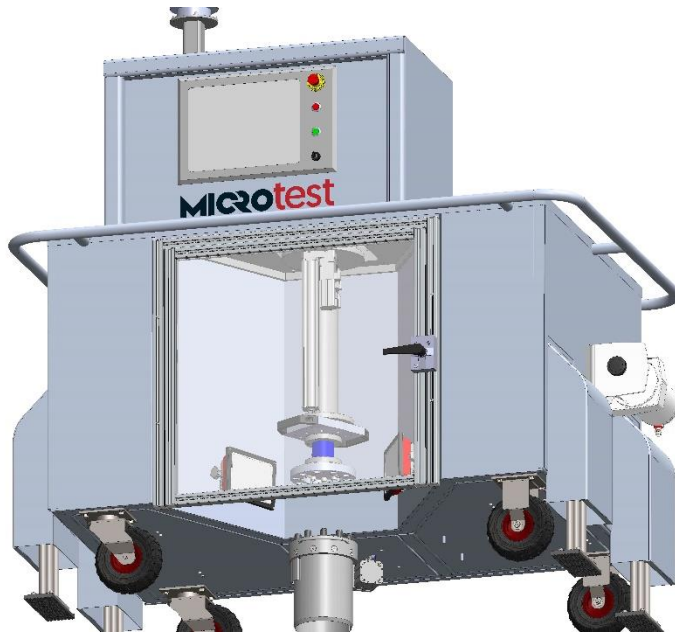


## ► According to precise specifications





## ► New "field" tool developed by DVDC



Consultation and identification of design service provider

→ First PROVITEQ proposal combined with MICROTEST...  
Discussions, exchanges and compromises!

Proposal for a costed device with identified supplier



- ▶ Promising experiments with a prototype → design of a tool in line with specifications
- ▶ **Complex theoretical approach** between interface fatigue and monotonic testing
- ▶ Development program **to be continued...** in DVDC ... beyond DVDC?...
- ▶ Need to **collect jobsite data** (feedback)
- ▶ Positioning in relation to **the European standard** : asserting the French position...
- ▶ Definition of **threshold specifications** qualifying the bonding of courses is **too premature**



## Summary of Productions and Achievements

### ► Reports

- Report DVDCR014-Th1 - Towards in-situ performance characterisation of surface courses (phase 1)
- Report DVDCR017-Th1- In situ road pavement bonding system (phase 2)
- Report DVDCR030-Th1- Towards in situ performance characterisation of surface course interfaces (phase 3)

### ► Articles

- RGRA No.963 – May 2019
- RGRA No.977 – Nov/Dec 2020

### ► Seminars

- FNTP 20 Oct 2020 + media distribution
- DVDC 23 JANUARY 2020 "Information day on monitoring techniques and road pavement service life" : In situ performance-based characterisation of road pavement interfaces using a new measurement device - A Dony/P Barrière/L Brissaud

### ► Communication

- Eurobitume Madrid 2020 + Poster
- JTR 2022 (DVDC workshop)



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