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TOTAL

New developments in predicting rutting of asphalt mixtures from binder rheological characteristics

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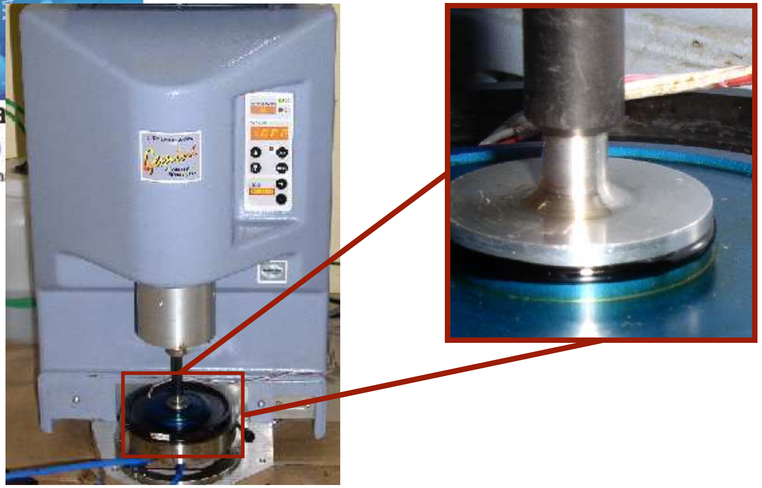
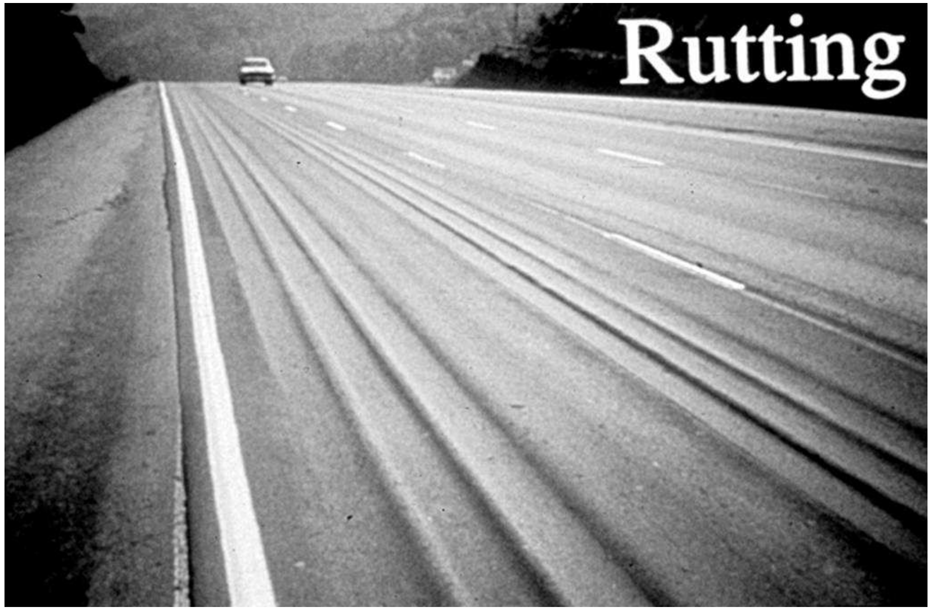
The purpose of the presentation



DSR - MSCRT

French LCPC Rut Tester



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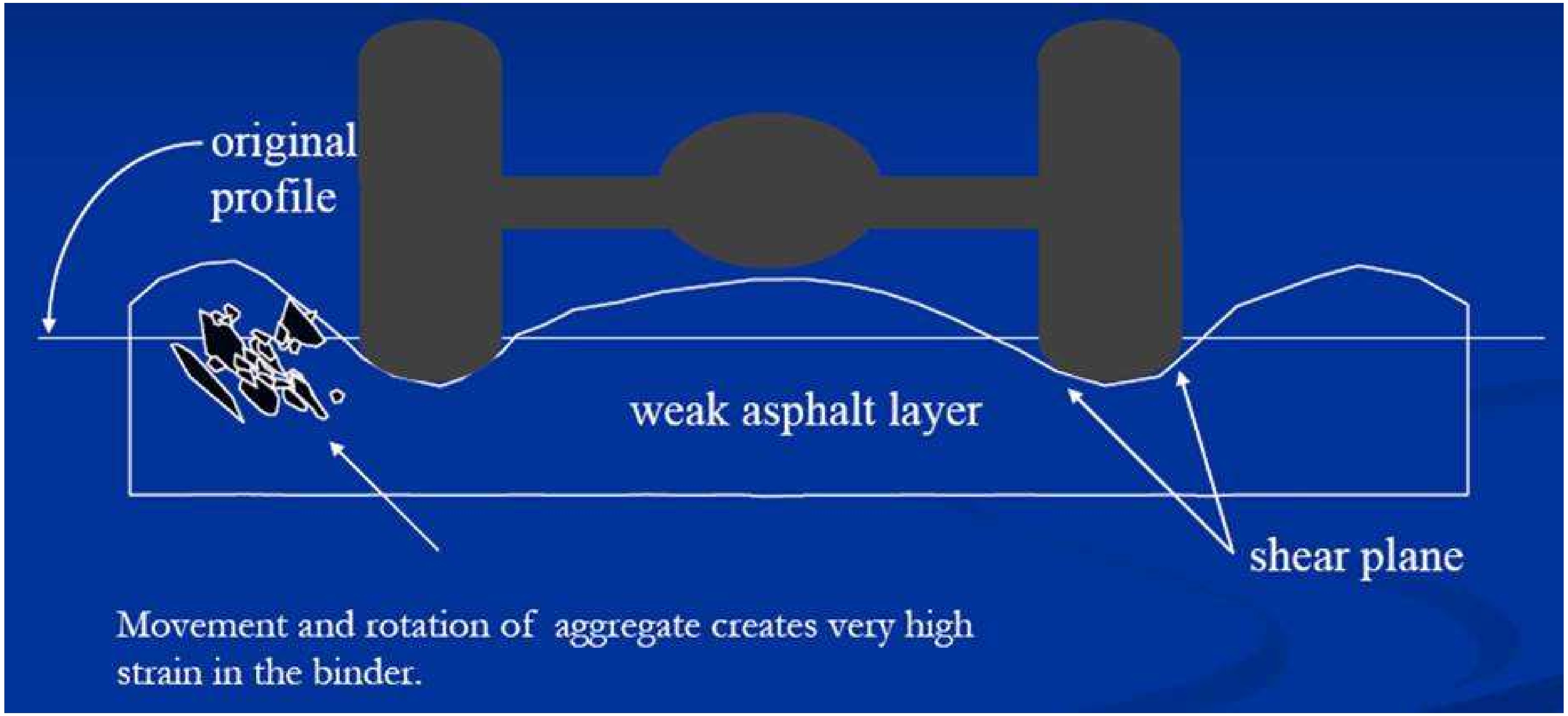
Background: What is Rutting?

- One of the main pavement damages
- Plastic deformation of a asphalt mix caused by heavy traffic loads
- High strain failure in the pavement
- Non-linear response

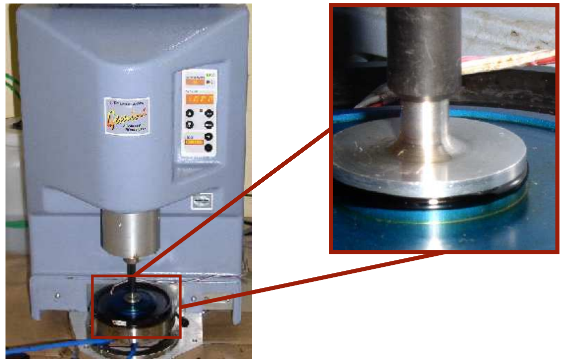


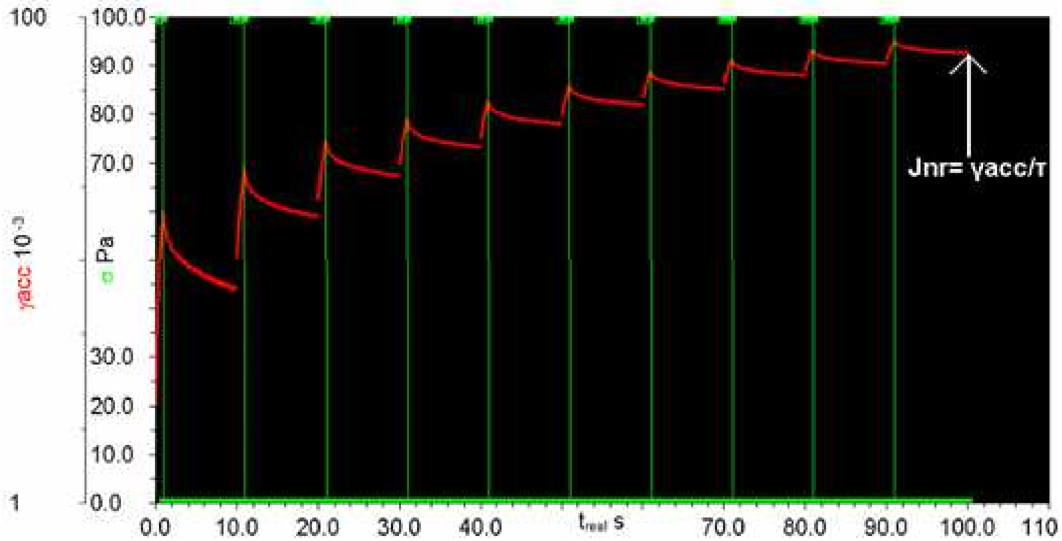
What is MSCRT? (1/3)

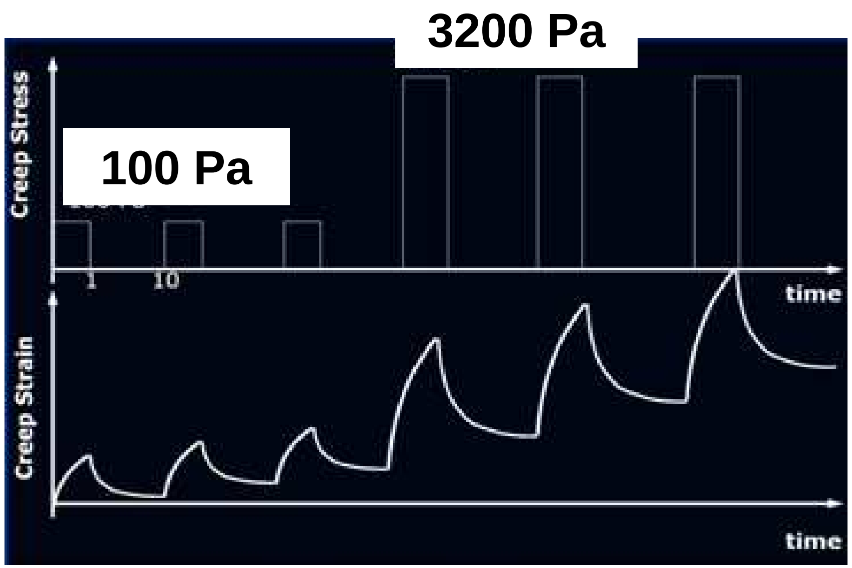
- Multiple Stress Creep and Recovery Test
- Method developed in the USA for high temperature performance based binder specification
  - Standard AASHTO TP 70
  - Standard ASTM D7405-08A
- Post-SHRP development to better predict the impact of modified binders on asphalt mix rutting performances
  - Rheological criteria G*/sin δ not showing good correlation between binder performances and rutting

What is MSCRT ? (2/3)

- Using the Dynamic Shear Rheometer
- RTFOT aged binder
- Creep and recovery test
  - 1s creep and 9 s recovery
  - 10 cycles per stress level, no rest periods
  - 2 stress levels: 100 and 3200 Pa
  - PG grade temperature



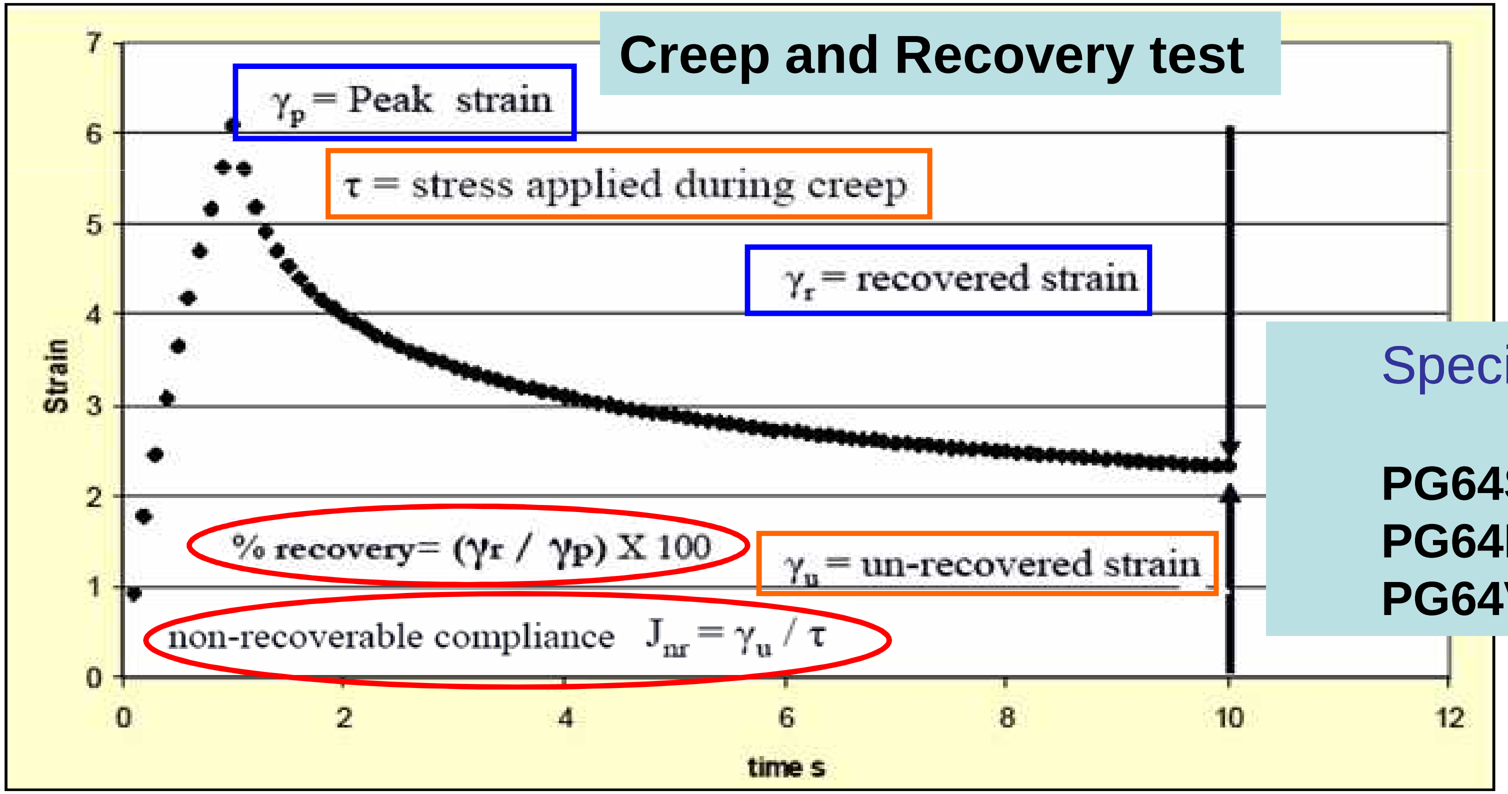




What is MSCRT? (3/3)

As a function of cycle numbers and stress levels

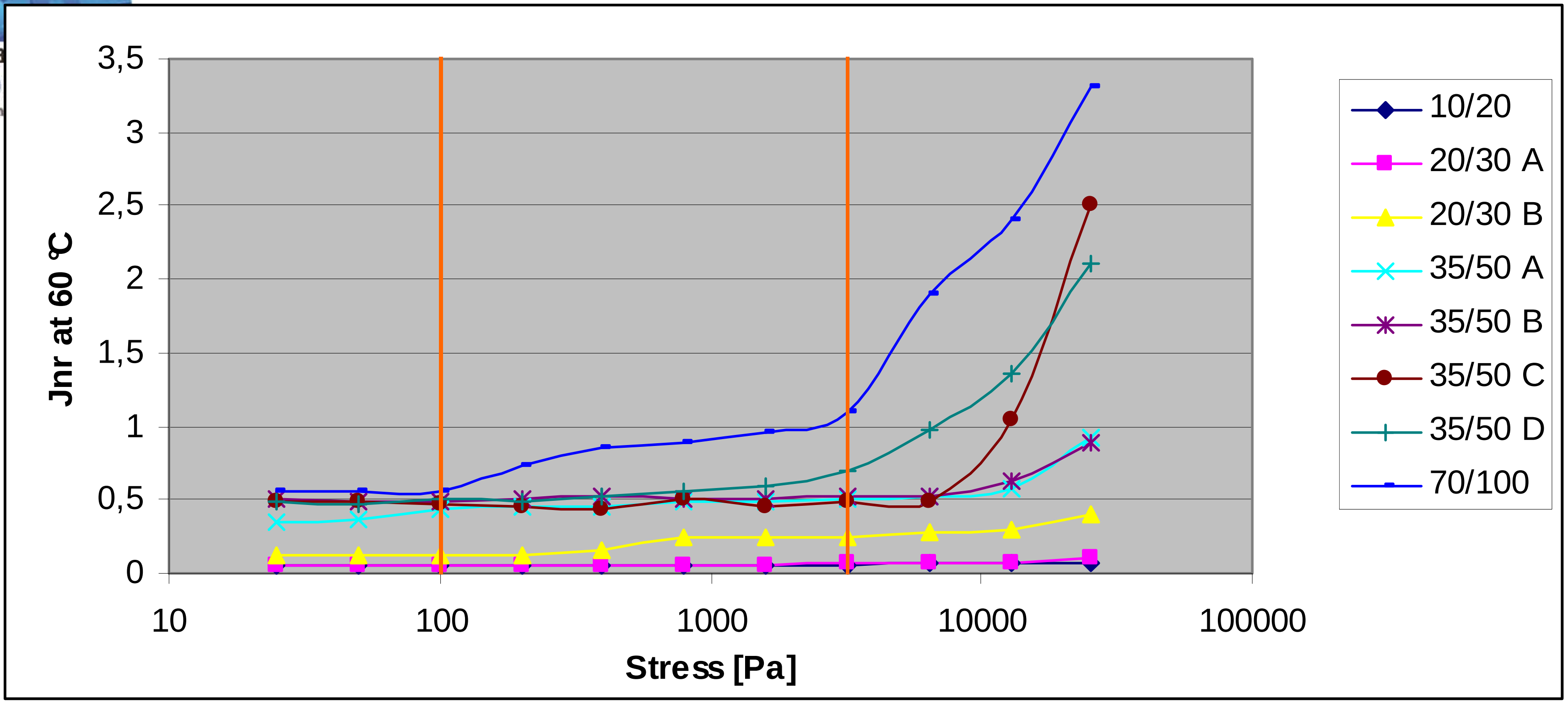
- Determining the criteria Jnr = non-recoverable creep compliance
  - The lower the Jnr, the better the resistance to deformation
- Determining the % recovery
  - Characterization of polymer modification



Specifications:

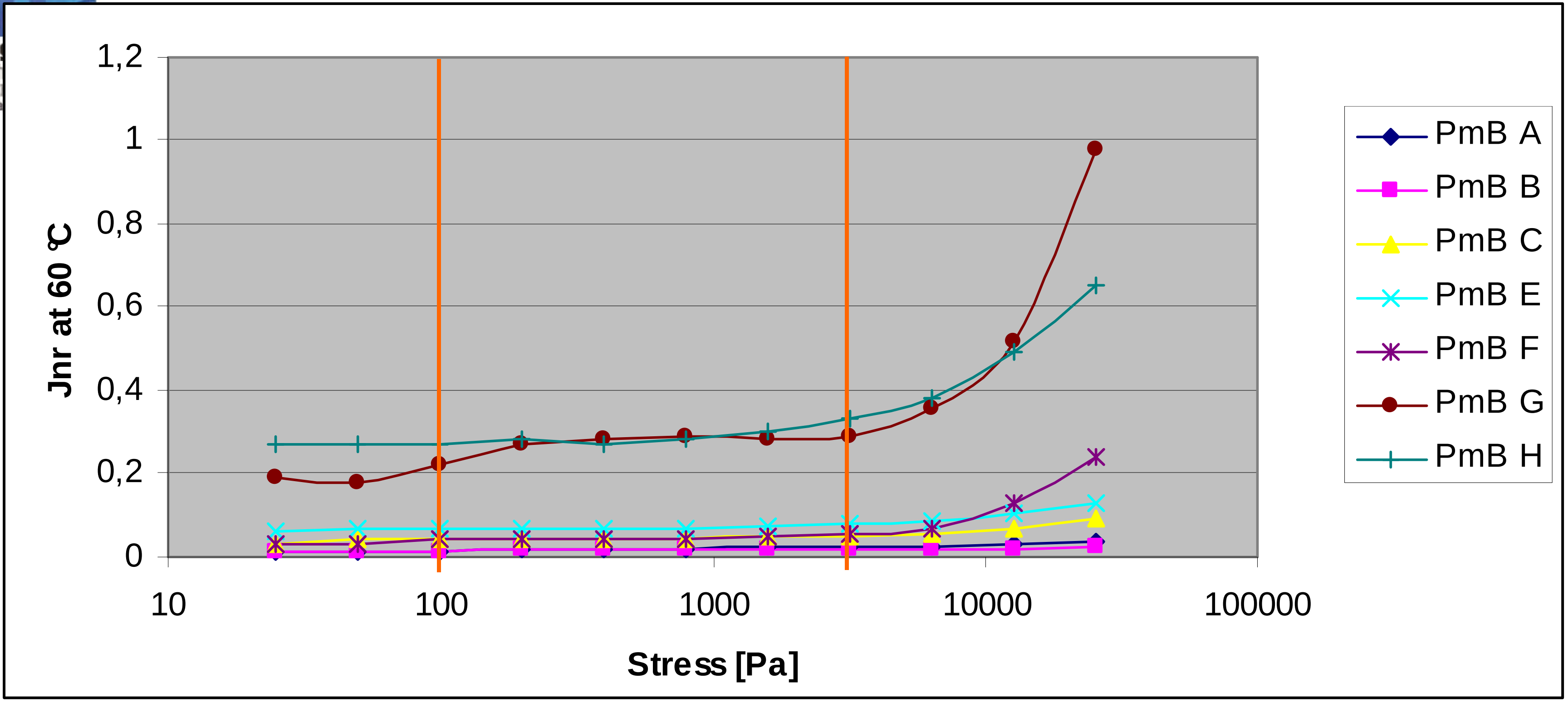
PG64S-XX Jnr ≤ 4
PG64H-XX Jnr ≤ 2
PG64V-XX Jnr ≤ 1

Binder MSCRT Results: Pure bitumen



- ➢**Jnr is bitumen dependant**
- ➢**Tendency: The harder the grade, the lower the Jnr = the higher the resistance to deformation under high shear stress**
- ➢**Clear stress dependency - loss of linearity**

Binder MSCRT Results: (Crosslinked) PmB's

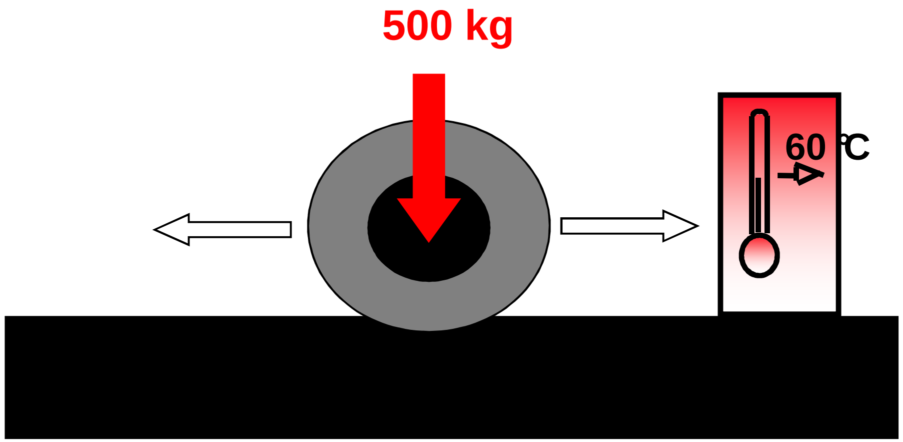


- **High resistance of Styrelf® to stress = low Jnr level**
- **Highly modified and harder crosslinked PmB's are more resistant to repeated stress deformation**

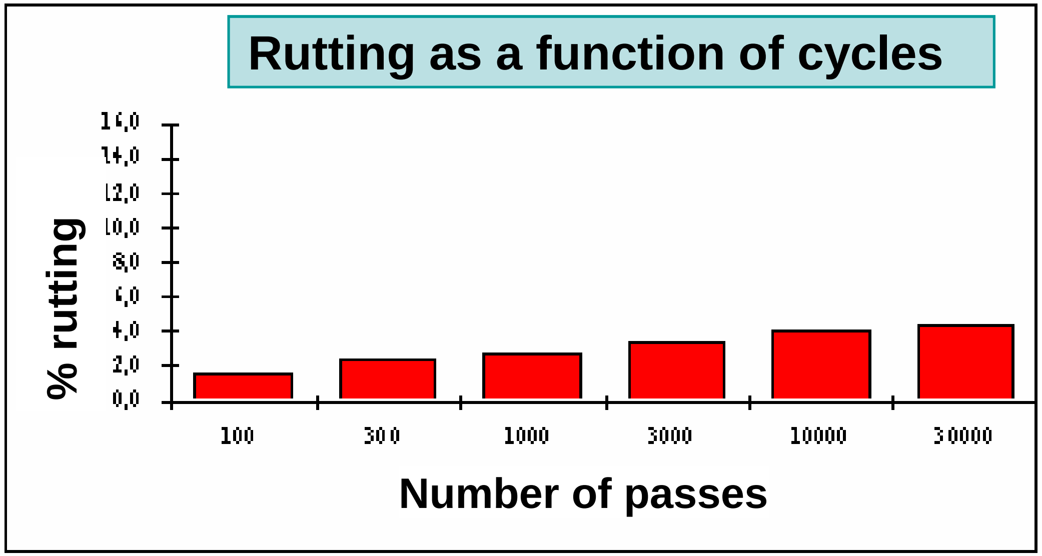
Asphalt testing: French rut tester

Principle:

30000 cycles



Result:



Simulation of heavy truck load

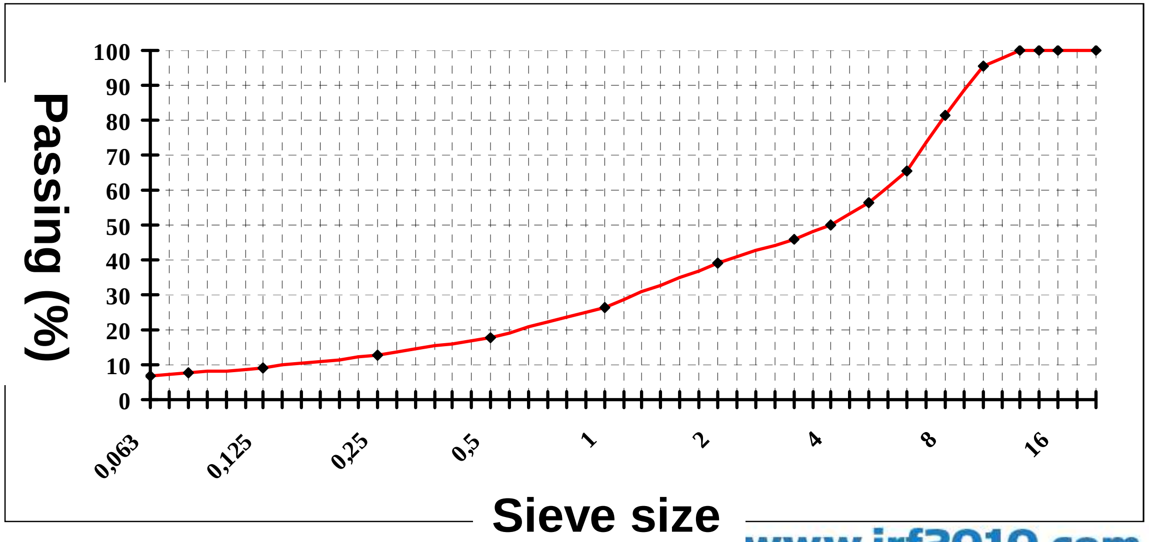
Formulation of AC (EB) 10

Asphalt testing Experimental protocol

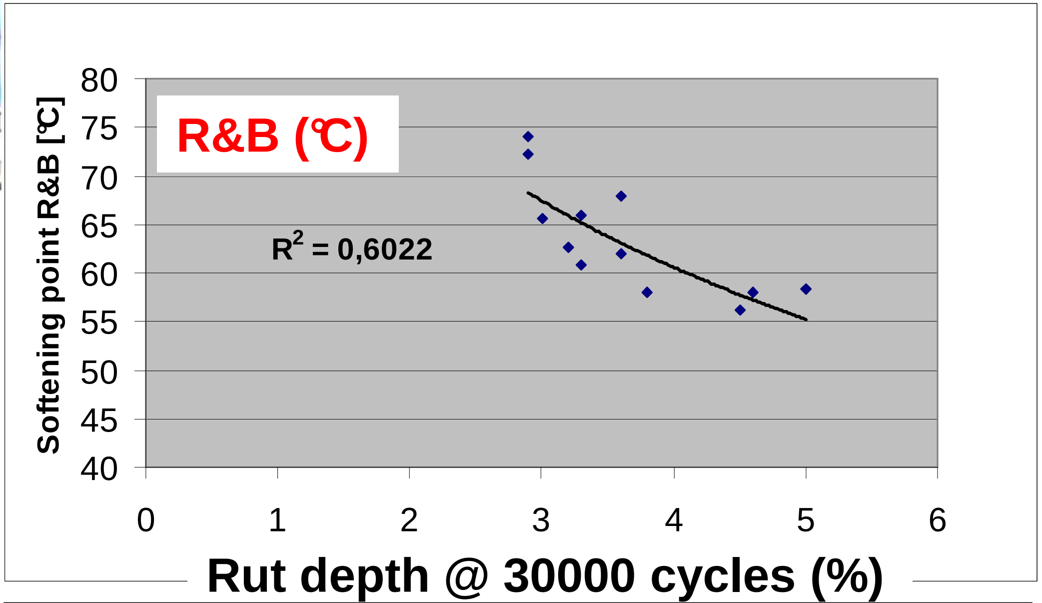
- **Asphalt mixture**
  - **Rut resistant asphalt concrete wearing course**
  - **AC 10 according to EN 13108-1 – 3rd class (rut depth < 5%)**

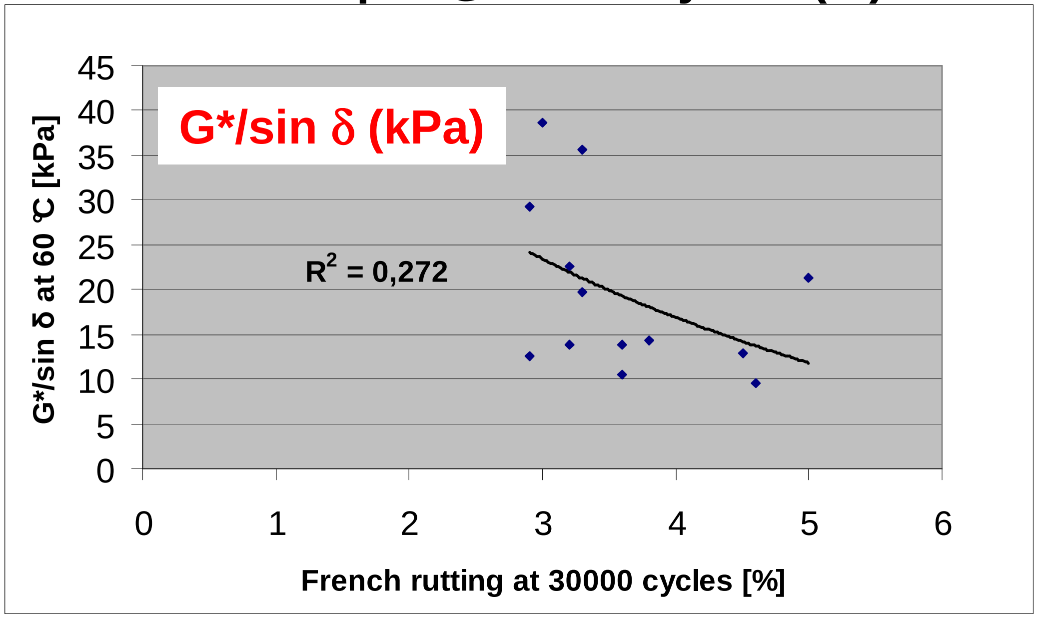
Sand 0/2 [%]	**37,0**
2/4 [%]	**10,0**
4/6 [%]	**12,0**
6/10 [%]	**39,0**
Filler [%]	**2,0**

- **Aggregate: Diorite**
- **Binder: 5.7 ppc**
- **Air Void: 7.2% (6.8-7.3)**



Asphalt concrete - binder Correlation?





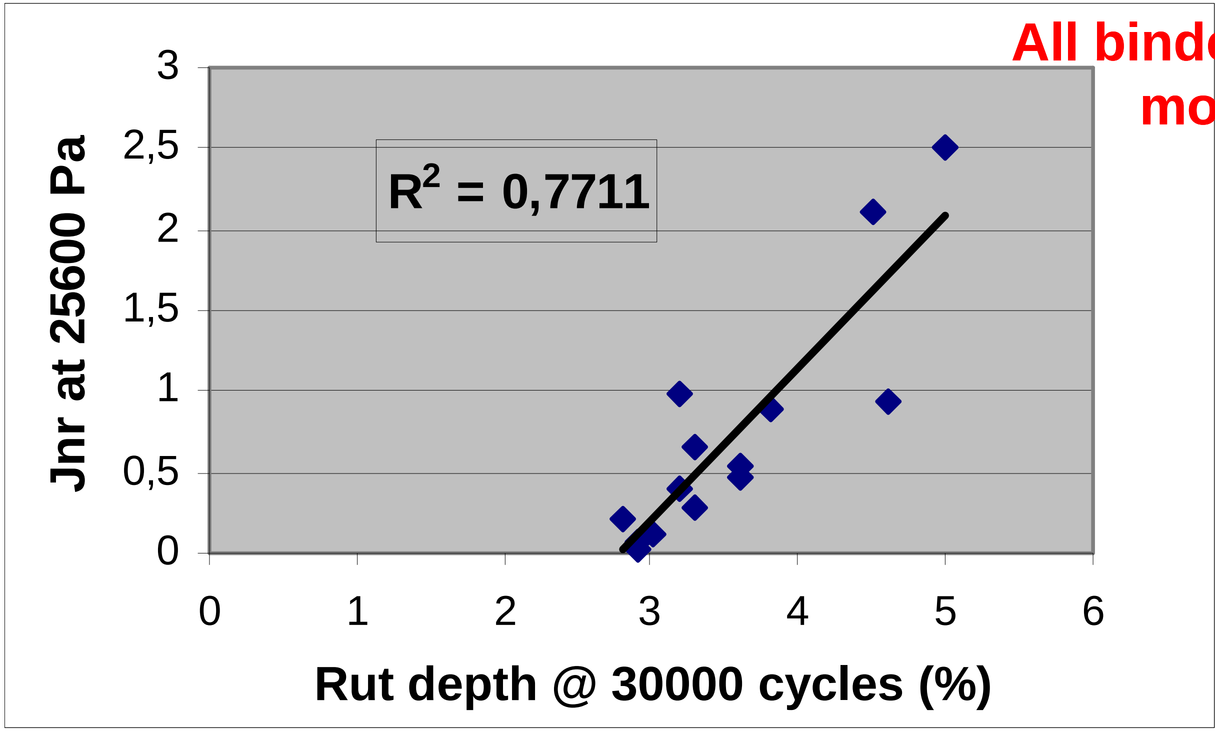
All binders – pure / modified

- **A trend for softening point**

- **G*/sin δ not a good predictor for rutting**

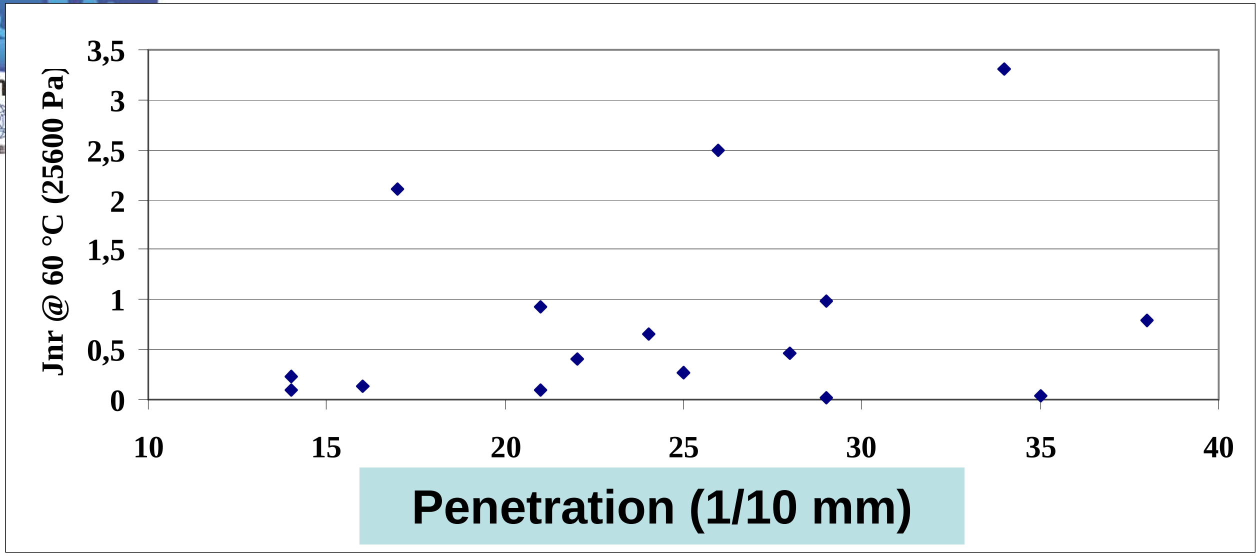
- **Does not capture modified binders resistance to deformation**

MSCRT: asphalt concrete - binder correlation

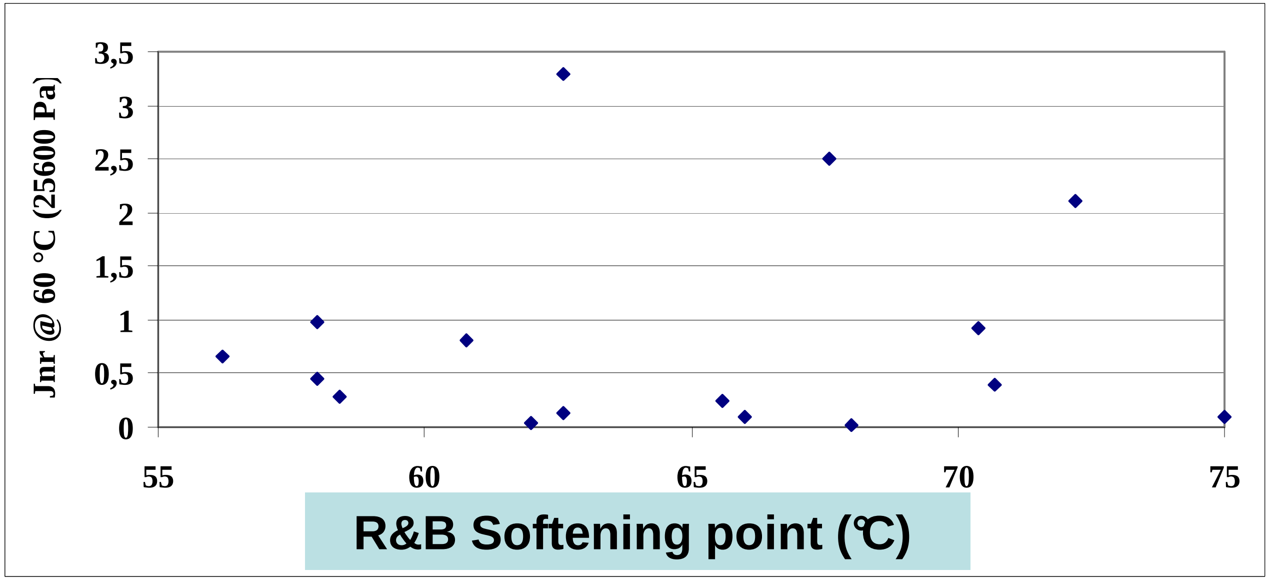


- ➢Fair correlation between Jnr and rut depth @ 30000 cycles
- ➢Better correlation at higher stress levels at 60 °C
  - ➢At 100 Pa ⇒ R^2=0,36 – At 3200 Pa ⇒ 0,44, - At 25600 Pa ⇒ 0,77
- ➢Validation of links between rutting and non linearity

Comparison Jnr - Classical characteristics



- **<u>No</u> correlation between Jnr and Penetration and R&B**



- **Binders with similar R&B or PEN can display very different Jnr**

Conclusions (1/2)

- **Possible ranking of binders by the non-recoverable creep compliance Jnr**
  - Jnr normalizes the binder strain response to stress
  - Better differentiation at high stress level at 60°C
    - Or lower stress level at higher temperature
  - No correlation between the Jnr values and softening point, penetration and G*/sin δ

Conclusions (2/2)

- **Jnr, a relevant alternative to replace R&B soft. point and G*/sin δ for rutting prediction**
  - Jnr allows characterizing both modified and unmodified binders
  - Jnr better correlates to French WT rutting test at 60 °C than G*/sin δ, softening point and Pen
  - Stress related correlation confirming binder non linearity impact in rutting

⇨ **Interest for EN standardization ?**

Thank you ! Any questions?