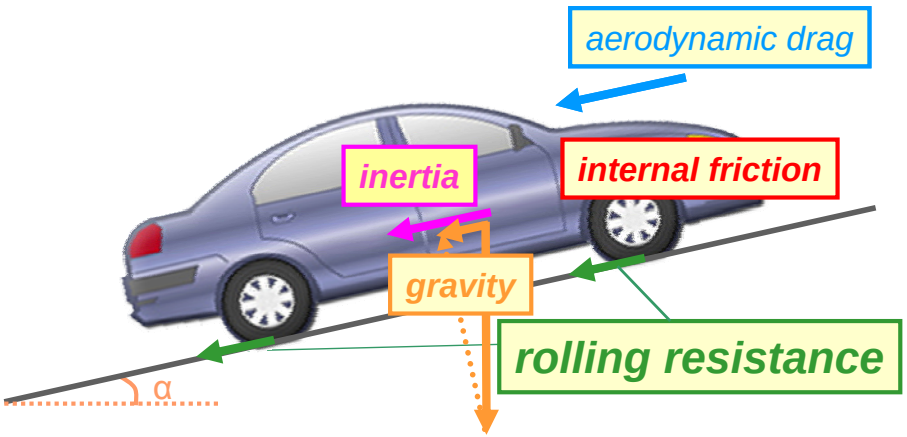
Informal Document No. **GRRF-66-28**
66th GRRF 15-17 September 2009
Agenda Item 9(f)

Amendment of Rolling Resistance in R117

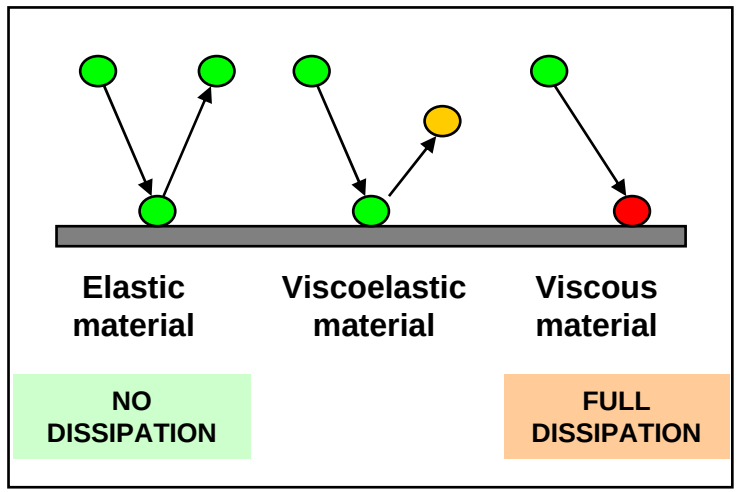
- Tyre Rolling Resistance
- Rolling Resistance measuring methods
- Calibration of RR Machines

Tyre Rolling Resistance

Rolling Resistance is one of the forces acting on a vehicle:



Rubber compounds are visco-elastic materials. Each time they are deformed they dissipate energy:



RR is a force acting opposite to the travel direction if a tyre is rolling. Due to the vehicle load, the tyre is deformed in the contact area with the road surface.

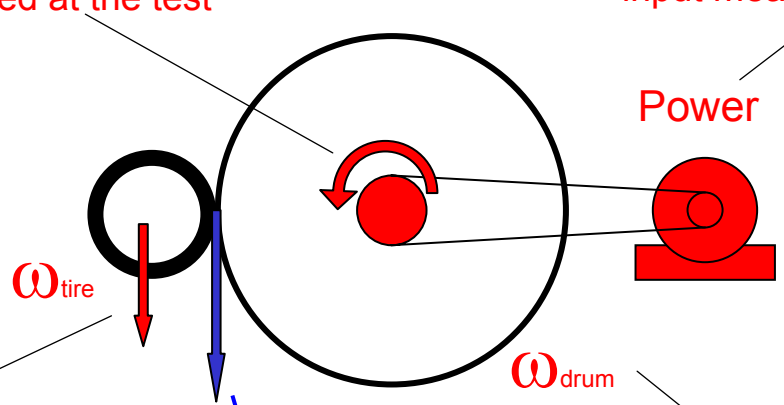
Pneumatic tyres as we know them today need the rubber materials and deformation to generate the required grip between vehicle and road surface, to give vehicle comfort and generate low rolling noise.

Rolling Resistance measuring method

The following alternative measurement techniques for data acquisition are given in International Standards. The choice of an individual technique is left to the tester.
The same phenomenon is measured, at different points of the testing machine.

Torque technique: the torque input measured at the test drum.

Power technique: the power input measurement to the test drum.



Force technique: the reaction force measured at the tire spindle.

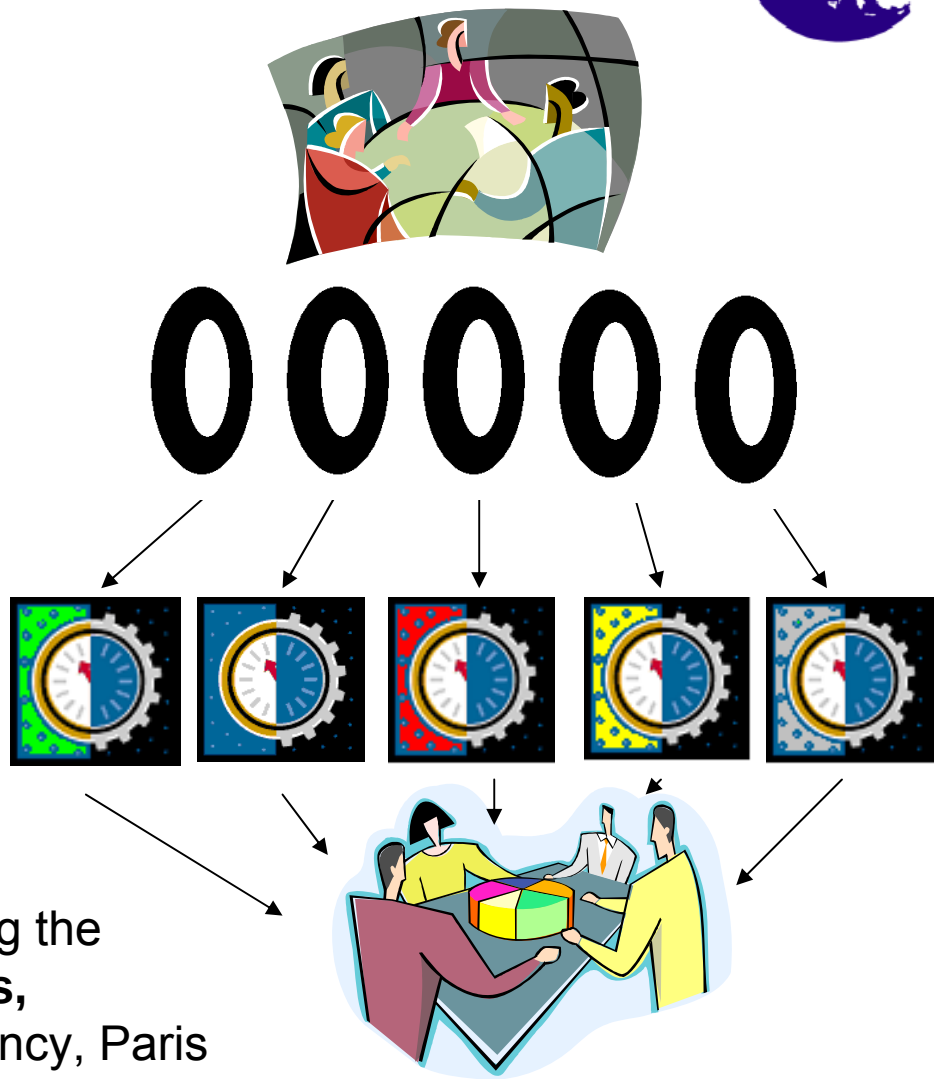
Deceleration technique: the measurement of deceleration of the test drum and tire assembly.

For each technique, the test measurements are converted to a force acting at the tire/drum interface, which is the blue arrow, always EQUIVALENT.

NB : The expression "measuring method" in the standard may be misleading. ISO 28580 describes a single measurement method, with 4 variants for measurement technique for data acquisition.

Calibration of RR machines

Round Robin Test procedure done by ETRTO members:

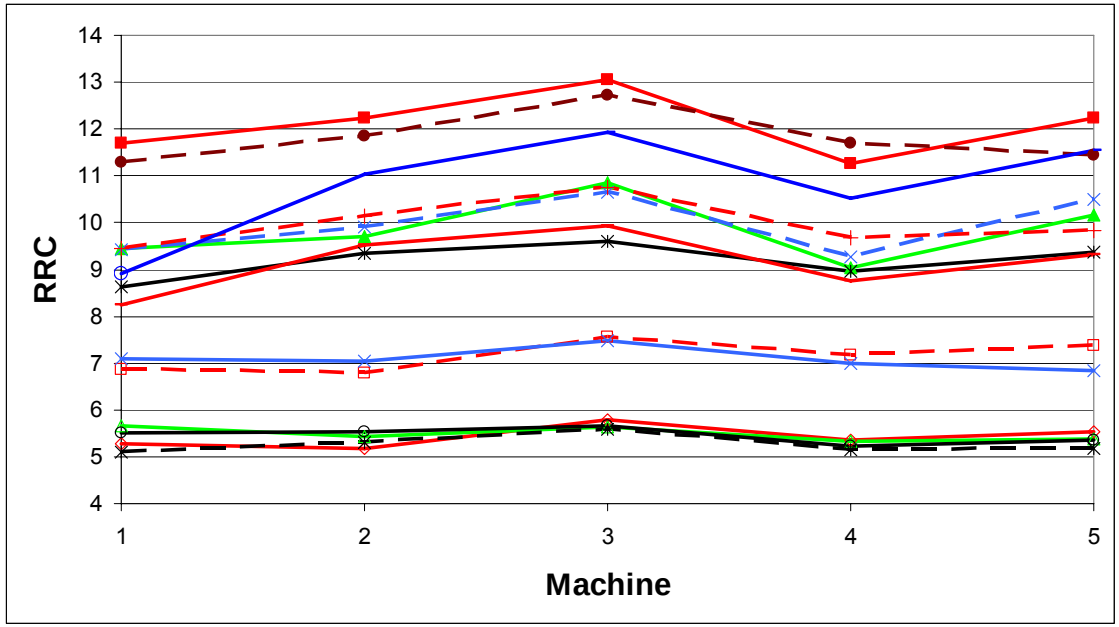


- Choice of 14 selected tyre types.
- For each tyre type, selection of tyres of the same batch with very close RR values.
- Dispatch of one tyre to each of the 5 participating lab.
- Measurement by each lab according to the method.
- Statistical analysis.

Results of this study were presented during the **IEA workshop on Energy Efficient Tyres,** 15-16 Nov, 2005 International Energy Agency, Paris

Calibration of RR machines

Results of an ETRTO round robin study:



Average values of the results of the 14 identical tyres measured by each Lab:

8.01 **8.50** **9.09** **8.19** **8.58**

Machine 3 gives higher values than the others and machines 1 and 4 give lower values. Differences among machines exceed 1 N/kN.

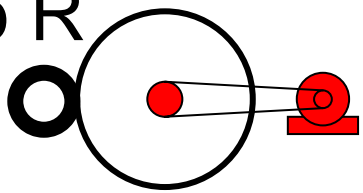
A calibration is necessary to get comparable values.

NB: Within its recent NPRM on "Tire Fuel Efficiency Consumer Information Program", the NHTSA recommended the use of ISO 28580 as "the ISO 28580 test method is unique in that it specifies a procedure to correlate results between laboratories and test equipment, which our Research shows is a significant source of variation." (Federal Register / Vol. 74, No. 118 / Monday, June 22, 2009 / Proposed Rules).

Calibration of RR machines

Concept of ISO 28580

Lab R



STEP1

Measure **2 ARRRT** in LabR

Tire1 RRC=7.2

Tire2 RRC=10.5

Tire1' RRC7.3 Tire2' RRC10.4

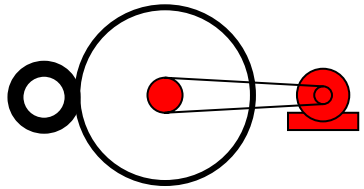
→ Lab B

LabR needs the highest level of accuracy. (repeatability)

STEP2

Ship the 2 tires

Lab A



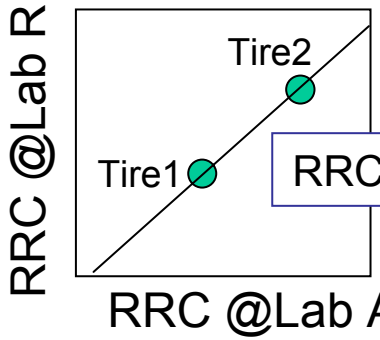
STEP3

Measure **the same 2 ARRRT** in LabA

Tire1 RRC=7.3

Tire2 RRC=10.8

STEP4 Set up the calibration formula for Lab A



Calculate a and b

RRC@LabR = a x RRC@LabA + b

STEP5 **LabA can measure any tires for TA purpose**.
Measured RRC is converted to LabR scale with calibration formula.

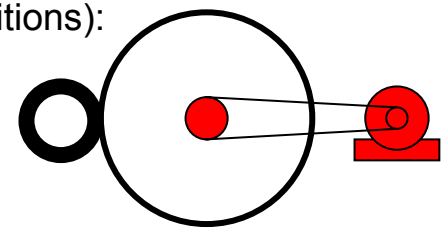
(ARRRT = Alignment Reference Rolling Resistance Tire. Tire1 & Tire2 must have 3N/kN difference.)

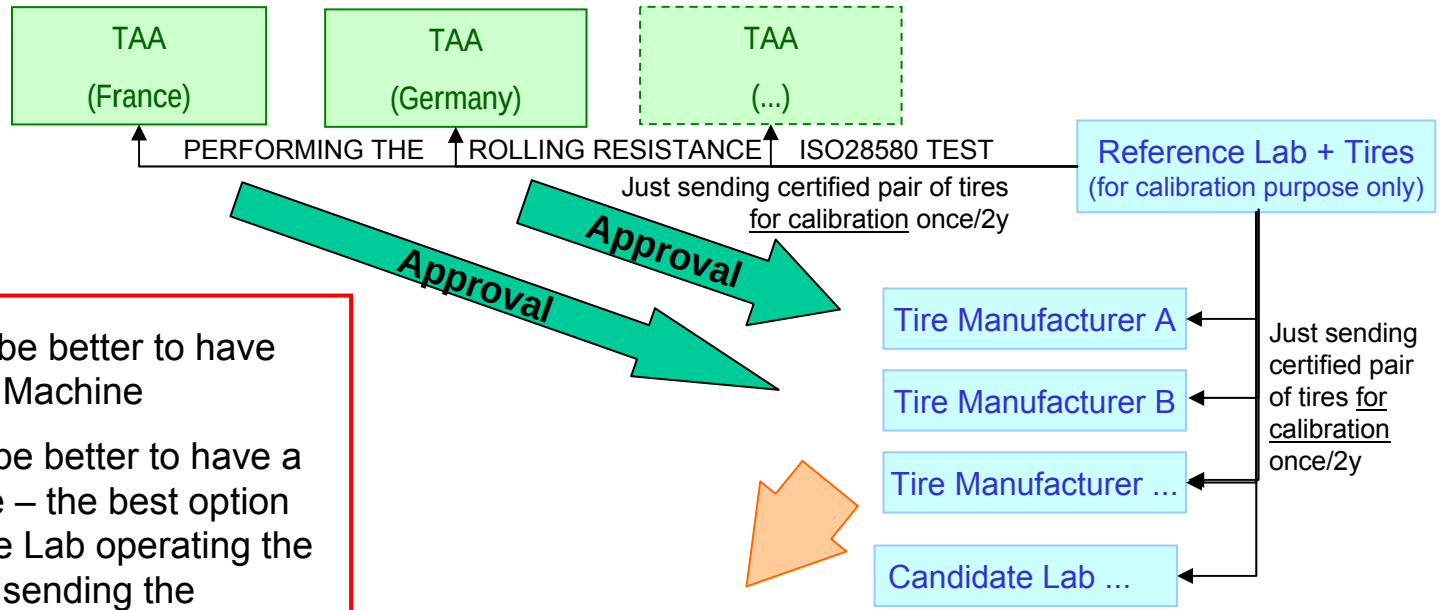
Calibration of RR machines

To have reliable results, all Candidate Machines must measure almost the same value for any given tyre, with a good repeatability.

Repeatability is assured by ISO 28580 (Clause 10 - Conditions):

- Reference Lab Machine $\sigma_m \leq 0{,}050$ N/kN
- Candidate Machine (LI ≤121) $\sigma_m \leq 0{,}075$ N/kN
- Candidate Machine (LI >121) $\sigma_m \leq 0{,}060$ N/kN





Accuracy: it would be better to have only one Reference Machine

Logistics: it would be better to have a "one way" exchange – the best option would be to have the Lab operating the Reference Machine sending the couples of tyres already measured, with "certified" values.

Homologated tyres with fully harmonised values on all CP countries market

Calibration of RR machines in ISO 28580

- ISO 28580 will be the RR test method in UNECE R117 (also in other European regulations like R692_2008, motor vehicle emissions Euro5/6).
- ISO 28580 will probably be used on a global basis (EU, JP, US) and may support different regulatory applications.
- The ISO 28580 Reference Laboratory could be any organization operating a Rolling Resistance Test Machine and complying with all requirements of ISO 28580.
- The choice of an appropriate Reference Laboratory is very important.
- The Reference Laboratory concept is under discussion in the ISO TC31 WG6.