WET GRIP TEST METHOD IMPROVEMENT for Passenger Car Tyres (C1)

Overview of Tyre Industry / ISO activities

Ottawa

June 11th, 2017

- **CURRENT REGULATORY FRAMEWORK**
- **CURRENT WET GRIP PROCEDURE - TECHNICAL PRINCIPLES**
- **ISO ACTIVITIES - TECHNICAL DIRECTIONS**
- **TIMELINE**

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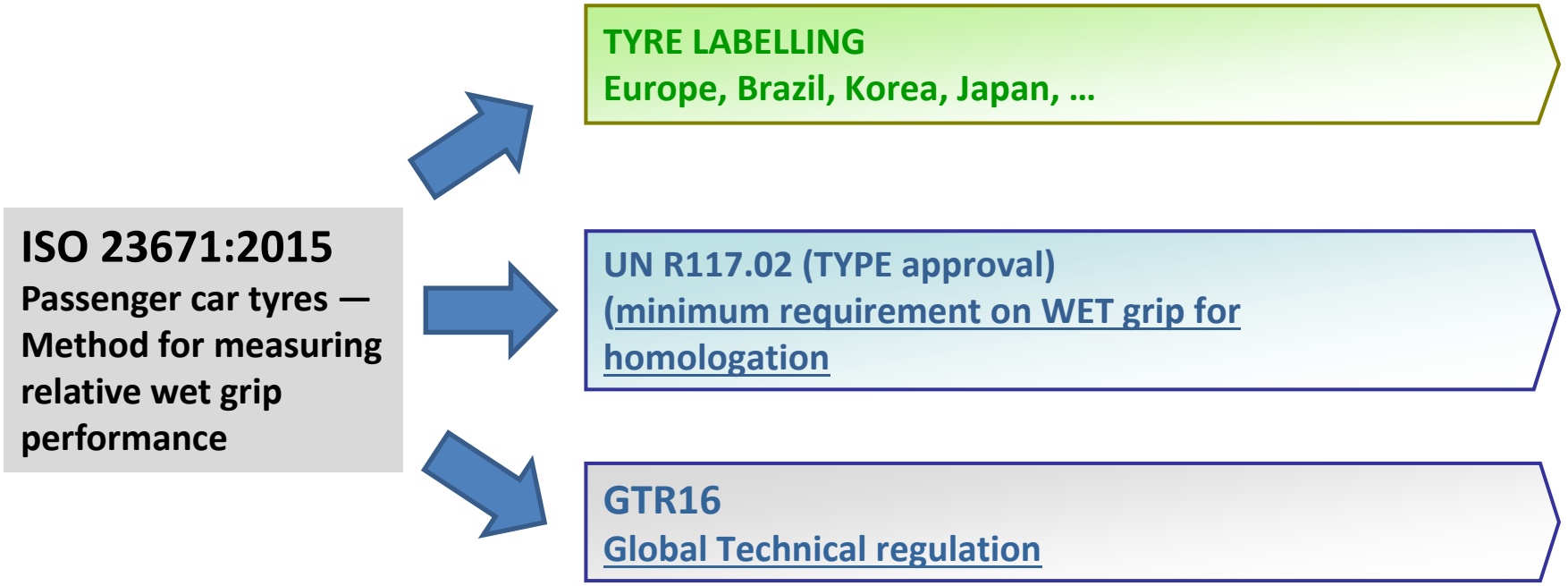
CURRENT REGULATORY FRAMEWORK



- **ISO test method for PSR wet grip is currently a key reference for several regulations worldwide**

- CURRENT REGULATORY FRAMEWORK

- **CURRENT WET GRIP PROCEDURE - TECHNICAL PRINCIPLES**

- ISO ACTIVITIES - TECHNICAL DIRECTIONS

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CURRENT WET GRIP TEST - TECHNICAL PRINCIPLES

For the calculation of the wet grip index of a candidate tyre, the wet grip performance of the **candidate tyre is compared to the reference tyre ASTM SRTT 16''** (Standard Reference Tyre Test).

→ Thus it is a **COMPARISON TEST**.

The wet grip index can be measured with one of the 2 following methodologies (considered as equivalent):

TRAILER

using a trailer towed by a vehicle

VEHICLE

consisting of testing a set of tyres mounted on an instrumented passenger car

CURRENT WET GRIP TEST - APPLICABLE REFERENCE TYRES (ASTM)

SRTT 16”

ASTM F2493 P225/60R16

*Must be used as **reference tyre** to determine the relative wet grip performance of the candidate tyre*

SRTT 14”

ASTM E1136 P195/75R14

*It **can be** used to verify / certify **track friction properties** (one of the 2 possible methods)*

CURRENT WET GRIP TEST - TECHNICAL PRINCIPLES

Mathematical corrections are applied to align the results when the tests are performed in different conditions: i.e. different test locations (tracks) or different weather conditions (temperatures).

$$G(T) = \frac{\mu_{candidate\ tyre}}{\mu_{SRTT16}} 1{,}25 + A \cdot (Temp - T_0) + B \cdot (\mu_{SRTT16} - \mu_0)$$

This ratio is a **raw index** of the measured friction of the candidate tyre vs the SRTT16'' at the tests conditions (Temp, μ_{SRTT16})

Linear correction in temperature to estimate the value of the index at the reference temperature T_0

Linear correction in friction to estimate the value of the index at the reference friction (track) μ_0

The mathematical corrections (coefficient A and B) depend on category of use of the candidate tyre:

- **Normal Tyres**

- **Snow Tyres (all tyres marked M+S**, including the tyres marked also 3PMSF)

REPRODUCIBILITY OF THE CURRENT WET GRIP TEST

The current wet grip test method **allows the necessary flexibility** in terms of testing conditions: *possibility to test using different tools (vehicle/trailer), on different tracks (wide friction range for tracks), and in different periods of the year (wide temperature range).*

When the test was firstly developed, it appeared to grant both **a good repeatability** (same test conditions = same test results) and a good reproducibility (different test conditions = same grade).

Anyhow the **reproducibility of the test is not in line with the initial evaluations**.

In other words, when different set of testing conditions (within the allowed ranges) are adopted to test the same tyre, the same grade might not be always granted.

- CURRENT REGULATORY FRAMEWORK
- CURRENT WET GRIP PROCEDURE - TECHNICAL PRINCIPLES
- **ISO ACTIVITIES - TECHNICAL DIRECTIONS**
- TIMELINE

Following preliminary collaboration among EUROPE, USA and JAPAN, the revision of the existing ISO 23671:2015 for PSR was launched last Sept 14th, 2017;

An ISO (global) "technical table" is currently in place:
The WET GRIP Working Group (**TC31/WG12**) was established with the aim to

By priority

1. Improve the reproducibility of the current ISO,

2. Try to keep on average similar wet grip indexes values and ratings as current test procedure (minimize gaps with the current worldwide regulations)

3. Drive the **global standardization & promote harmonization worldwide**

ISO TECHNICAL ACTIVITIES

Step 1 – Identification of the parameters affecting the dispersion of the test

✓ ✓ *completed*

Step 2 - three Round Robin Tests using TRAILER methodology

✓ **tests activities completed**
… analysis almost finalized
(ref. ETRTO / ISO)

Step 3 – 1 Round Robin Tests Using VEHICLE methodology

… tests activities completed
Analysis ongoing

Step 1 – Identification of the parameters affecting the dispersion

The **parameters having an influence on the variability of test method** were listed exhaustively
The ones to be analyzed to be better controlled in the future test method were identified:

	CURRENT ISO TEST METHOD	
Tyre typologies	**Normal tyres**	**Snow tyres (M+S)** Including severe snow (M+S & 3PMSF)
Methodologies	**Vehicle method** **Trailer method**	
Conditioning of test tyres	break-in = 2 braking runs	
Wet Track Grip	MTD = 0,7 ± 0,3 mm **BPN = 42-60 or µSRTT14 = 0,7 ± 0,1**	
Wet Track Temperature	5-35 °C	2-20 °C
Correction equation & coefficients	TRAILER: $G(T) = \frac{\mu_{test}}{\mu_{SRTT16}} 1.25 + a \cdot \Delta T + b \cdot \Delta\mu$ VEHICLE: $G(T) = \frac{BFC_{test}}{BFC_{SRTT16}} 1.25 + a \cdot \Delta T + b \cdot \Delta\mu$	$\mu_{0-SRTT16} = 0{,}85$ $BFC_{0-SRTT16} = 0{,}68$
	a= – 0,4232 b= – 8,297	a = 0,7721 b = 31,18

Step 2 - Two Round Robin Tests using TRAILER methodology

Three huge tire testing plans were carried out for a total of 37 tires - **1163 results!**

Tyres were tested on different tracks, using the trailer of each participant, in different periods of the years, for a total of
16 different test sites/trailer in EU (ETRTO), Japan (JATMA) and USA (USTMA).

Agreed direction

- **Stabilization of the tyre** performance prior testing
- **Better definition of the track surface (one method)**
- **Consider the specificity of tyre typologies for the temperature conditions and the corrections formulas**

- With the new proposed approach, **the dispersion of the test is significantly reduced for each tyre typology**
- **On average, similar WGI values as current procedure**

TRACK GRIP

- In the current method, the grip of the track can be controlled with one of two criteria

  BPN **[42-60]** or μ SRTT14" **[0,6-0,8]**

  Anyhow there is **no correlation between the 2 criteria** → this point is an important source of variability between different test centers.

  Also the reference tyre **SRTT14'' will be discontinued**

- **SRTT 16'' will be used NOT ONLY AS REFERENCE TYRE, BUT ALSO FOR TRACK VALIDATION IN PLACE OF [SRTT 14 or BPN]**
  - ✓ **Replacement of SRTT14 and discontinuation of BPN measurement**
  - ✓ **A source of variability eliminated**

TYRE TYPOLOGIES

3 different typologies of tyres should be treated differently within the wet grip test procedure

Normal

SUMMER

Normal tires are designed to perform best in warm weather and are **not typically used at low temperature**

M+S - not 3PMSF

USA ALL SEASON

ALL SEASON

intended to perform across most temperature ranges. They are designed also for use in lower temperatures but not at the level of a Severe Snow (Winter) tire. They **can operate at higher temperatures**, without the typical limitations of Severe Snow (Winter) tires

M+S and 3PMSF

EU ALL SEASON

ALL WEATHER

guarantee the min snow traction of a Severe Snow (Winter) tire. They are **also designed to operate at higher temperatures**, without the typical traction limitations of Severe Snow (Winter) tires

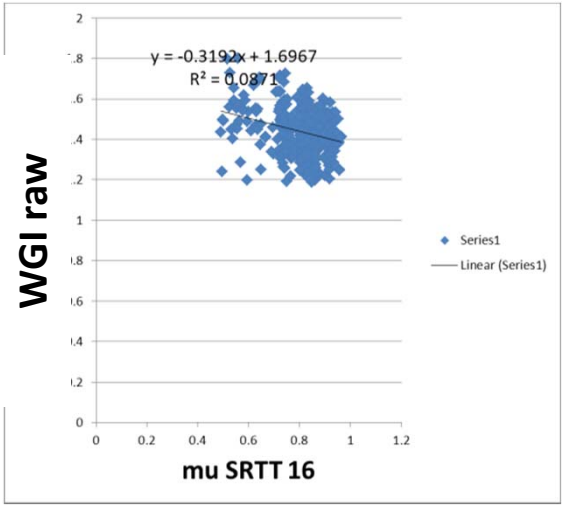
WINTER

Severe Snow tires are designed to perform best in severe cold weather conditions and are **not typically used during extended warm weather conditions**

each tyre typology has its own behavior vs friction & temperature
→specific /different correction formulas and coefficients shall be applied

CORRECTION FORMULAS – BASIC IDEA

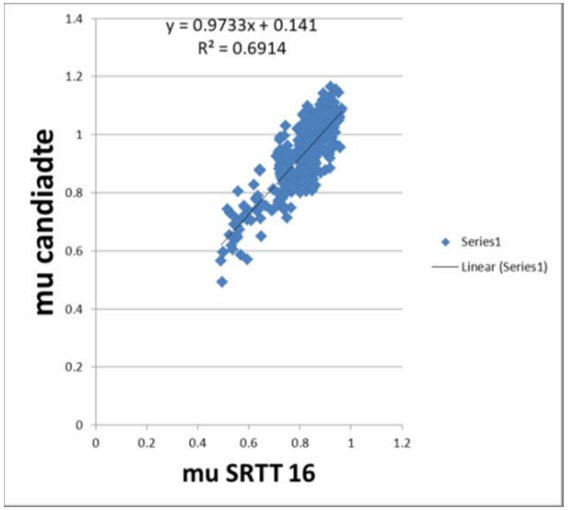
$$\text{WGI raw} = \frac{\mu_{candidate\ tyre}}{\mu_{SRTT16}}$$



No relation between Ratio WGI raw and µ-SRTT16

Correction should NOT be applied to WGI raw (as done today)

$$\mu_{candidate\ tyre}$$



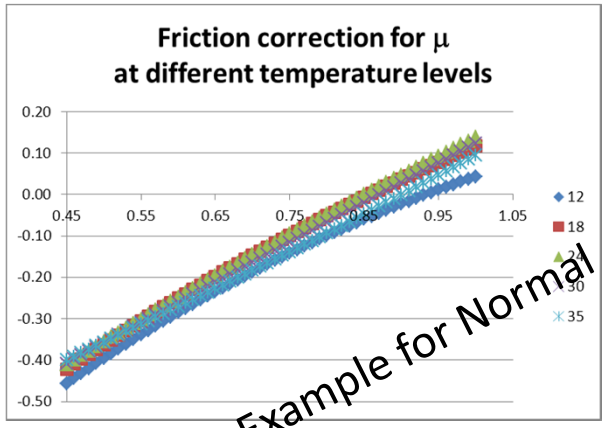
Evident linear relation between µ-cand and µ-SRTT16 (track friction)

Correction should be applied directly to µ-cand tyre

CORRECTION FORMULAS – BASIC IDEA

The grip of the track has a strong influence on the results.

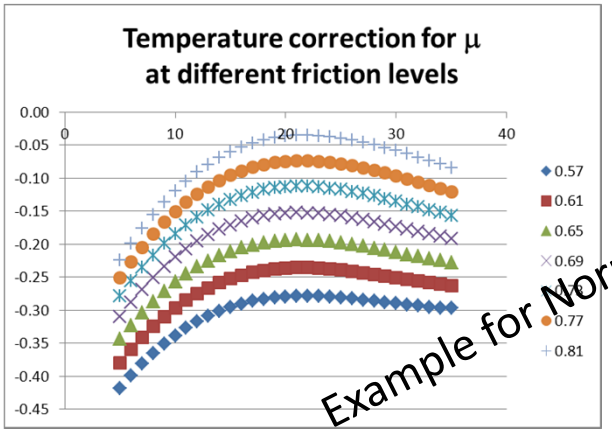
The MTD (Mean Texture Depth) has also a minor influence (linear)



Example for Normal

μ(test) vs track grip μ(SRTT16) approximately linear

The temperature (especially the low temperature for normal tyres) has also an influence (even if lower than the grip)



Example for Normal

μ(test) vs Track temperature T approximately quadratic

$$correction = f(\Delta T, \Delta\mu, \Delta MTD) = a\Delta\mu + b\Delta T + c\Delta T^2 + (d\Delta\mu^2\Delta T) + e\Delta MTD$$

a, b, c, e
different depending on tyres typologies

CORRECTION FORMULAS

G(T) must NOT be based on: raw μ candidate / raw μ SRTT16" (as done today),
but be based on: μ candidate at reference conditions / μ SRTT16" at reference conditions

FROM

$$\boldsymbol{CURRENT} \quad \boldsymbol{G(T)} = \frac{\mu_{test}}{\mu_{SRTT16}} \mathbf{1.25} + \boldsymbol{a}\cdot\Delta\mathbf{T} + \boldsymbol{b}\cdot\Delta\boldsymbol{\mu}$$

TO

$$\boldsymbol{NEW} \quad \boldsymbol{G(T)} = \boldsymbol{K} * \left[\mu_{test} - \left(\boldsymbol{a}\,\Delta\boldsymbol{\mu} + \mathbf{b}\,\Delta\mathbf{T} + \mathbf{c}\,\Delta\mathbf{T}^2 + \mathbf{e}\Delta\mathbf{MTD}\right)\right]$$

K *is a factor to*

- *grant consistency between future revised standard and current standard*
- *ensure convergence between vehicle and trailer method*

a, b, c, e
different depending
on tyres typologies

Step 3 – Round Robin Tests Using VEHICLE methodology

Some of - **but not all** - the technical findings on trailer can be automatically transposed to vehicle methodology.

ETRTO (EU only) is carrying-out dedicated test campaign on vehicle; main purposes are:

1. to **compare the variability of both TRAILER and VEHICLE methodologies**
2. to check the **correlation between the two modified** methods (both methods should give same Index)

Based on today information, the **directions for the VEHICLE method could be similar to the trailer**:

- **Better definition of the track surface**
- **Restricting the testing conditions ranges**
- **Revised mathematical corrections formulas (different from the trailer ones)**
- **Stabilizing of the tyre prior the Wet Grip test**
- **Tyres Inflation Pressure adjusted depending on actual load of the vehicle**
- **Technical specification for vehicle to be used**

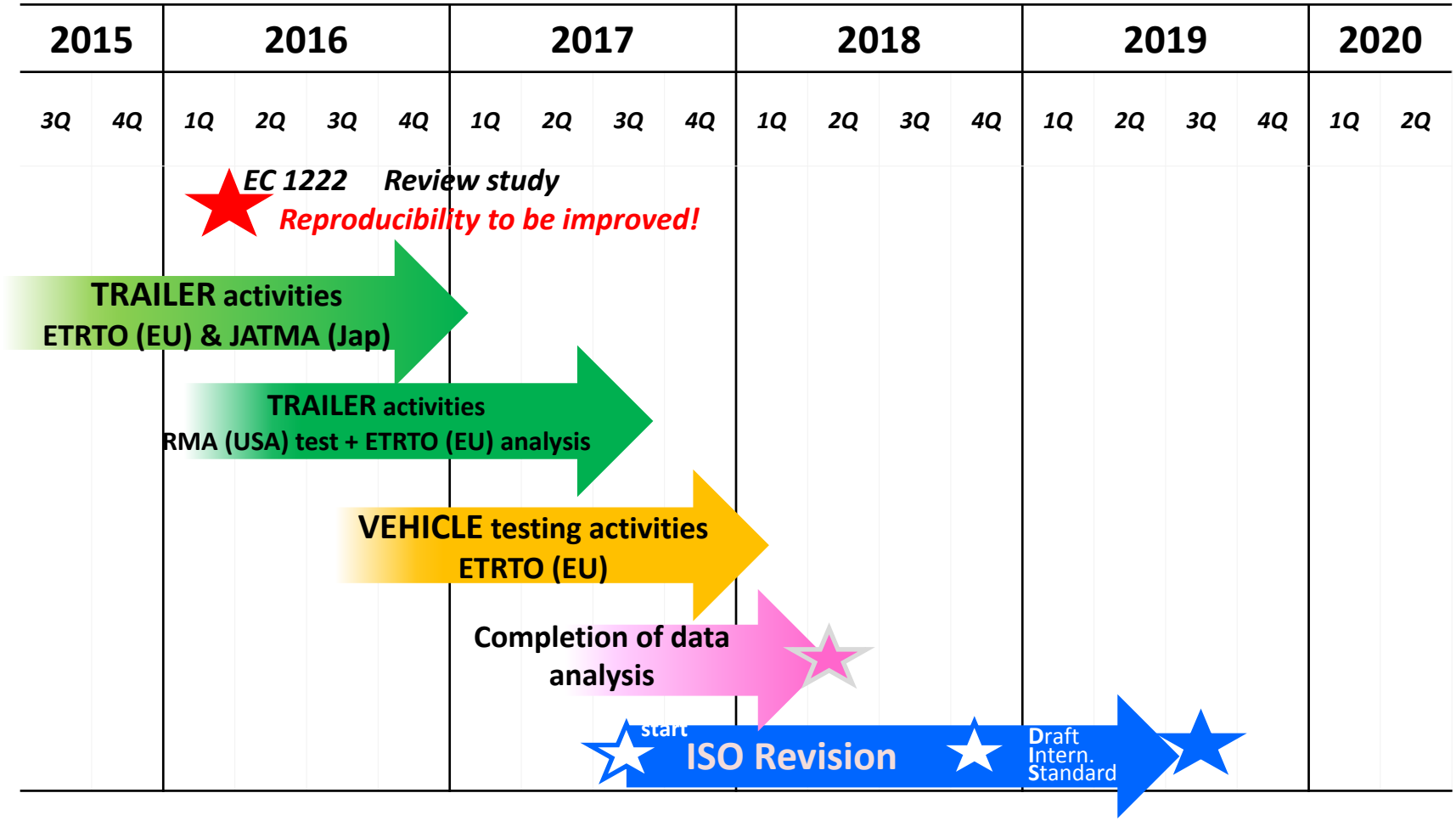
ACTIVITY ONGOING

- CURRENT REGULATORY FRAMEWORK
- CURRENT WET GRIP PROCEDURE - TECHNICAL PRINCIPLES
- ISO ACTIVITIES - TECHNICAL DIRECTIONS
- **TIMELINE**

TIMELINE & ISO APPROACH

ACTIVITIES ENLARGED AT ISO level

- *Robust technical approach*
- *Worldwide Harmonization*



ISO/NP 23671 – TIMELINE considered by TC31/WG12

Project started (registered)	May 2017 (**SDT 36 Standards development track**)
Deadline for DIS registration	May 2019
Deadline for IS publication	May 2020

→ **DIS should be registered by Q4 2018** to respond particular market needs (especially in EU)

✓ **New Project approved (TC31 plenary meeting)**	**May 2017**
✓ Kick-off meeting, **Working Draft available**	**Sept 14th 2017**
✓ ISO WG12 WebEx's	Oct 2017 → March 2018
✓ **ISO WG12 Physical meeting (Washington)**	**April 9th,10th 2018 (Technical consensus on the revised text)**
✓ **CD submittal for ballot**	**Q2 2018 → if no negative technical comments**
✓ CD closed and **DIS submittal for ballot**	**Q3 2018**
✓ **DIS registration (text publicly available)**	Q4 2018
✓ **IS publication**	Q2-Q3 2019

Activities at UN will be launched soon to grant alignment with the revised ISO procedure and promote Worldwide harmonization

APPENDIX

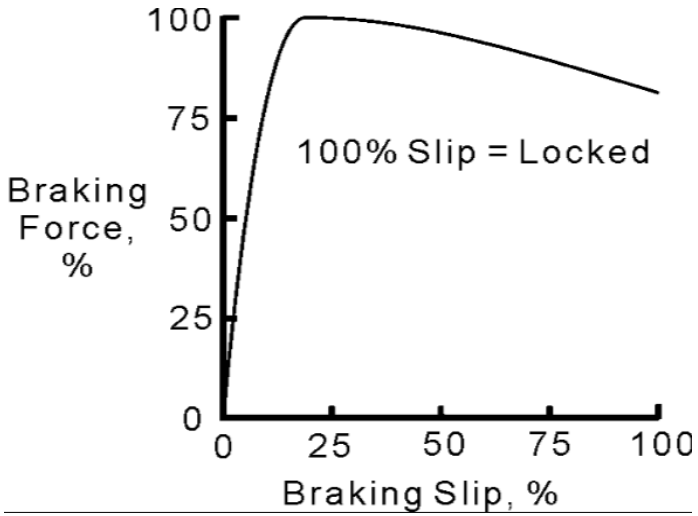
WET GRIP TEST METHOD - CURRENT REGULATORY FRAMEWORK

TRAILER METHODOLOGY

The tyre to be tested is fitted on a specific position for measurements (test position)

The brake in the test position is applied maintaining the specified speed (65 km/h) and the specified Load (depending on the Load Index of the tyre) until test-tyre lock-up

The ratio braking force / vertical load is acquired in real time: the highest value of this ratio provide the wet grip performance of the tyre.
It is called **tyre peak braking force coefficient (μ peak)**



WET GRIP TEST METHOD - CURRENT REGULATORY FRAMEWORK

VEHICLE METHODOLOGY

An instrumented passenger car, equipped with an Antilock Braking System (ABS).

Starting with a defined initial speed, the brakes are applied on four wheels at the same time to activate the ABS

The **average deceleration** is calculated between two pre-defined speeds (80→20km/h).

VEHICLE METHODOLOGY USING CONTROL TYRE SET

Where the candidate tyre size is significantly different from that of the reference tyre (SRTT), a direct comparison on the same instrumented passenger car may not be possible.

In that case the comparison between a candidate tyre and a reference tyre is obtained through the use of a control tyre set (so called “bridge”) and two different instrumented passenger cars.

CAR 1
Control
Vs
SRTT

+

CAR 2
Candidate Tyre
Vs
Control

Candidate Tyre
Vs
SRTT