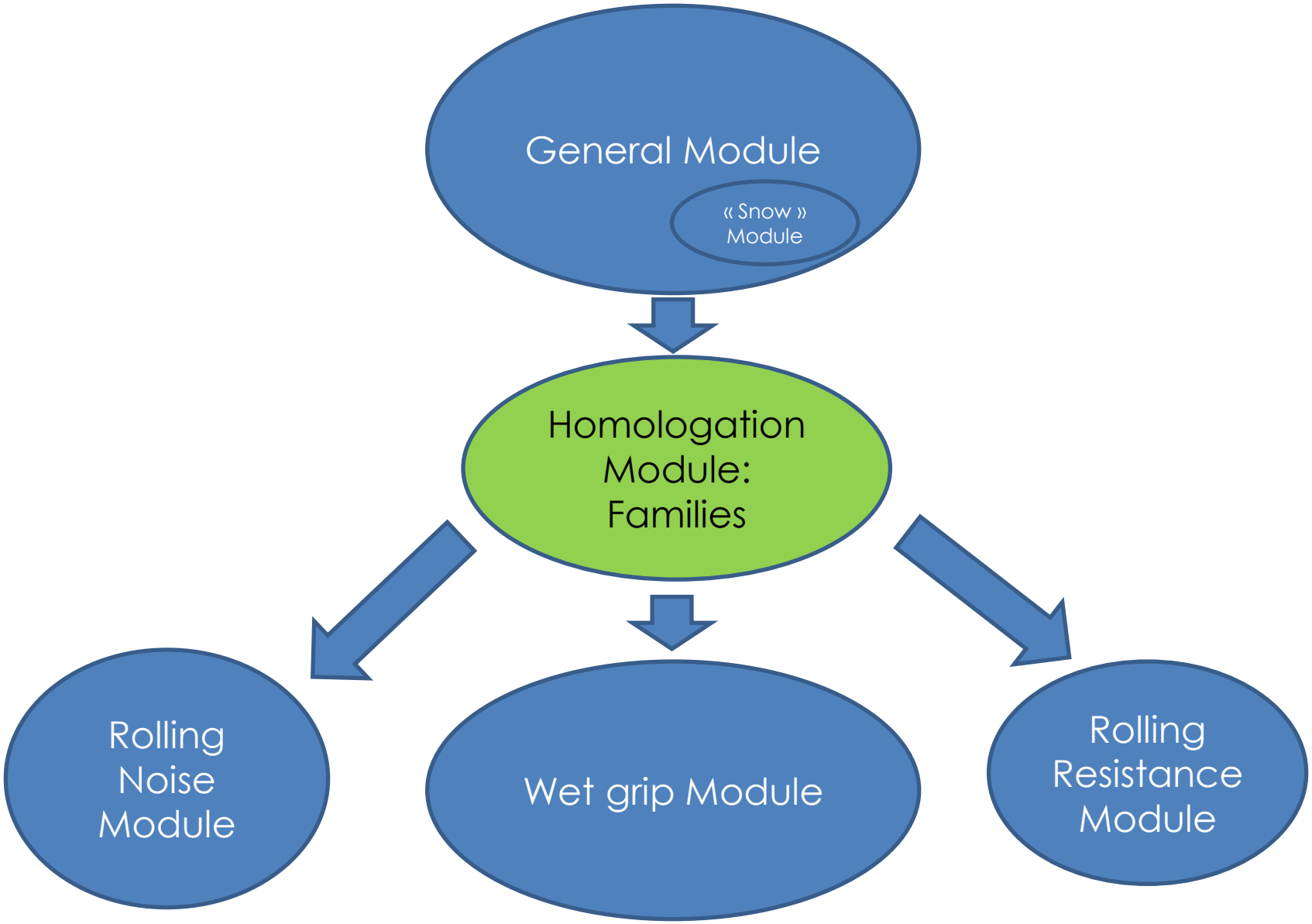
WET GRIP MODULE (WG)

APPROVAL AND LABELLING FOR EUROPEAN TIRES


General Module
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Families
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Rolling
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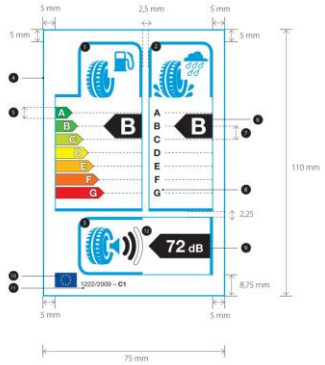
Module

HOW TO MEASURE ADHERENCE ON WET SURFACE? HOW?

- On special track
- With vehicles or trailers.
- Classes of tyres: C1, C2 et C3



Chipping size : 8 à 13 mm

The texture depth as measured by a sand patch : 0.4 à 1 mm

Gradient < 2% (A 3 m straight edge , deviation 6mm max.

Height of water: C1:(0.5 à 1.5 mm) C2 et C3 : (0,5 à 2 mm)

Adhesion level with SRTT 14'': 0;6 à 0.8 at 65km/h

Adhesion with pendulum BPN : 42 à 60 for C1 et 40 à 60 for C2 and C3
To be measured 5 times every 10m (maxi 10% of variation)

SRTT: Standard Reference Test Tyre
BPN: British Pendulum Number

HOW TO MEASURE ADHERENCE ON WET SURFACE?

- With vehicles or trailers.
- Classes of tyres: C1, C2 et C3

With a trailer or a vehicle fitted with an ABS(C1) or a truck fitted with an ABS (C2-C3)

FOOT-NOTE: On trailer the system of watering can be integrated into the trailer.

HOW TO MEASURE ADHERENCE ON WET SURFACE?

- **General principle:**

  To compare the performances obtained with pneumatic tyres known as of reference tyres (SRTT) and those obtained with the pneumatic candidates (ratio > value limits):

  - SRTT / Candidate tyre1 / SRTT or,
  - SRTT / Candidate Tyre1 / Candidate tyre2 / SRTT or,
  - SRTT / Candidate tyre1 / Candidate tyre2 / Candidate tyre3 / SRTT.

- **The track:**
  - Preliminary watering during at least ½ h before use.
  - Preparation of the surface: 10 tests at 90km/h (case of the vehicle) or at 65km/h (case of the trailer) with pneumatic tyres not included in the program of tests.

HOW TO MEASURE ADHERENCE ON WET SURFACE?

- **Environmental conditions:**
  - Temperature of track and ambient temperature: between 2°C and 20°C (snow tyres C1) and between 5°C and 35°C (C1 normal tyre), between 5°C and 35°C (C2 and C3)
  - Difference between T° track and T° ambiant: ≤ 10°C for C1,C2 and C3
  - Variation temperature of track during the test: < 10°C (C1, C2 and C3)
- **Loadings:**
  - Vehicle method for C1: between 60% and 90% of the load capacity indicated by the load index (LI) of the tyre and variation on 1 axle ≤ 10%.
  - Vehicle method for C2 and C3 (Standard configuration): between 60% and 100% of the load capacity indicated by the index of load (LI) of the tyre but ≤ 100% of the LI of the SRTT and variation on 1 axle ≤ 10%.
  - Trailer method for C1, C2 and C3: 75% ± 5%

HOW TO MEASURE ADHERENCE ON WET SURFACE?

Inflation Pressures :

- Case of the vehicle for C1: 220kPa; case of the trailer for C1: 180 kPa (normal tires) and 220 kPa (reinforced tires).

- Case of the trailer for C2 and C3:

  P =Préf× (Q/Qréf) $^{1.25}$ with Préf= pressure of inflation marked on the sidewall of the tyre,

  if the mark is not present, refer to the handbooks of the standards and Qréf. = maximum mass corresponding to the LI.

- Case of the vehicle for C2 and C3: P =Préf× (Q/Qréf) $^{1.25}$

  if vertical load ≥ 75% of the load capacity of LI

  or P = 0,7x Préf if vertical load < 75%

HOW TO MEASURE ADHERENCE ON WET SURFACE?

Reference tyres SRTT:

- For measuring the adhesion characteristic of the track: SRTT P195/75 14 (ASTME1136-93 re-approved in 2003);
  - For C1: SRTT P225/60R16 (ASTM F2493-08);
  - For C2: SRTT 225/75 R 16 C LI=116/114 (ASTM F2872);
  - For C3 ≥ 285 mmm : SRTT 315/70R22.5 LI=154/150 (ASTM F2870);
  - For C3 < 285 mmm : SRTT 245/70R19.5 LI=136/134 (ASTM F2871);

HOW TO MEASURE ADHERENCE ON WET SURFACE?

The method (case of the vehicle):

- Drive the vehicle at a speed of 85 km/h ± 2 for C1 or 65 km/h ± 2 for C2 and C3
- Apply the brake (automatically or manually with an effort of 60daN for C1) in a given point of the track.
- Repeat the tests with a maximum variation on the given point of the track of 5m into longitudinal and 0.5 m into transverse.:
  - 3 valid tests with the SRTT,
  - 6 valid tests with the candidate tyre 1 to be controlled
  - [6 valid tests with the candidate tyre 2 to be controlled],…
  - 3 valid tests with the SRTT.

HOW TO MEASURE ADHERENCE ON WET SURFACE?

The method (case of the vehicle):

- Calculate for each test the average deceleration between

  - Between 80km/h and 20 km/h for C1 or between 60 km/h and 20 km/h for C2 and C3:

    $$AD = (\text{final Speed}^2 - \text{initial Speed}^2)/2 \times \text{distance}$$

  - The coefficient of variation per pneumatic tyre is calculated:
    (CV = Standard deviation / average): CV must be 3%

HOW TO MEASURE ADHERENCE ON WET SURFACE?

The method (case of the vehicle):

- **Calculation of the performance (index of adherence on wet surface G):**

If cycle of tests =SRTT, Candidate tyre, SRTT
AD of SRTT = ½ [Result (SRTT)i+ Result (SRTT)f]

For C1: G (candidate tyre) = 0,01x [125 X AD (candidate tyre) /AD (SRTT) +a × (T - t0) + b × (0.1499 X AD (SRTT) - 1.0)]

with a= -0.4232 and b = -8.297 for the normal pneumatic tyres; a = 0.7721 and b = 31.18 for the tyres "snow "[a is expressed by (1/°C)].

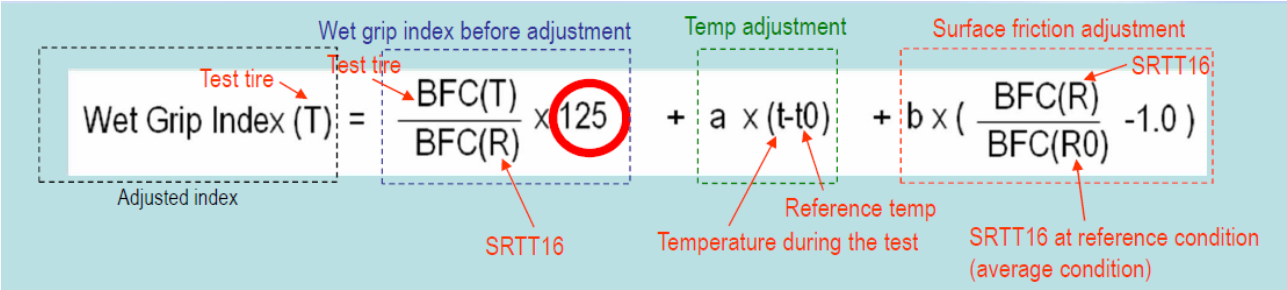
For C2 and C3: G (candidate tyre) = AD (candidate tyre) /AD (SRTT)

HOW TO MEASURE ADHERENCE ON WET SURFACE?

The method (case of the trailer):

Calculation of the performance (index of adherence on wet surface G):

If cycle of tests =SRTT, candidate tyre, SRTT
μ peak of SRTT = ½ [Result (SRTT)i + Result (SRTT)f]



with a= -0.4232 and b = -8.297 for the normal tyres; a = 0.7721 and b = 31.18 for the tyres "snows"[a is expressed by (1/°C)].

For C2 and C3: G (candidate tyre) =μ peak average (tire candidate)/μ peak average (SRTT)

HOW TO MEASURE ADHERENCE ON WET SURFACE?

- **The method (case of the trailer and vehicle):**

G (candidate tyre) =μ peak average (tire candidate)/μ peak average (SRTT)

HOW TO MEASURE ADHERENCE ON WET SURFACE?

Some additional issues:

- Tyres have to be assemblied on dimensions rims specified by an organization of standardization.
- Pneumatic tyres without burs on the tread.
- Storage of the tyres on track 2 hours before the tests at ambiant conditions avoiding the exposure to the sun.
- Systematic realization of 2 blank tests for each sequence.
- In the event of impossibility of testing the candidates and the SRTT on the same vehicle, possible recourse with an intermediate tyre called " witness tyre".

  The cycle becomes:
  - Vehicle 1: SRTT, Witness tyre, SRTT
  - Vehicle 2: Witness tyre, Candidate tyre, Witness tyre

  In this case the final result of the index of adherence on wet surface G is the multiplication of the indexes obtained in each phase: G= G1 X G2

HOW TO MEASURE ADHERENCE ON WET SURFACE?

Some additional issues (continuation):

- For the pneumatic tyres C2 and C3 tested on vehicles, several configurations of mounting are possible:
  - Configuration 1 : Candidates tyres on front and rear axles =Standard Configuration
  - Configuration 2 : Candidates tyres on the only front axle . The load on the front axle must be > the load on the rear axle.
  - Configuration 3 : Candidates tyres on the only rear axle. The load on the rear axle must be > 1,8 x the load on the front axle.

  Foot-note : In configuration 2 or 3, the index of adherence on wet surface is calculated using specific formulas.

- Difference on the results retained for the index on wet ground in approval and labelling:
  - G approval = computed values by the formulas
  - G labelling = computed values by the formulas – 0.03

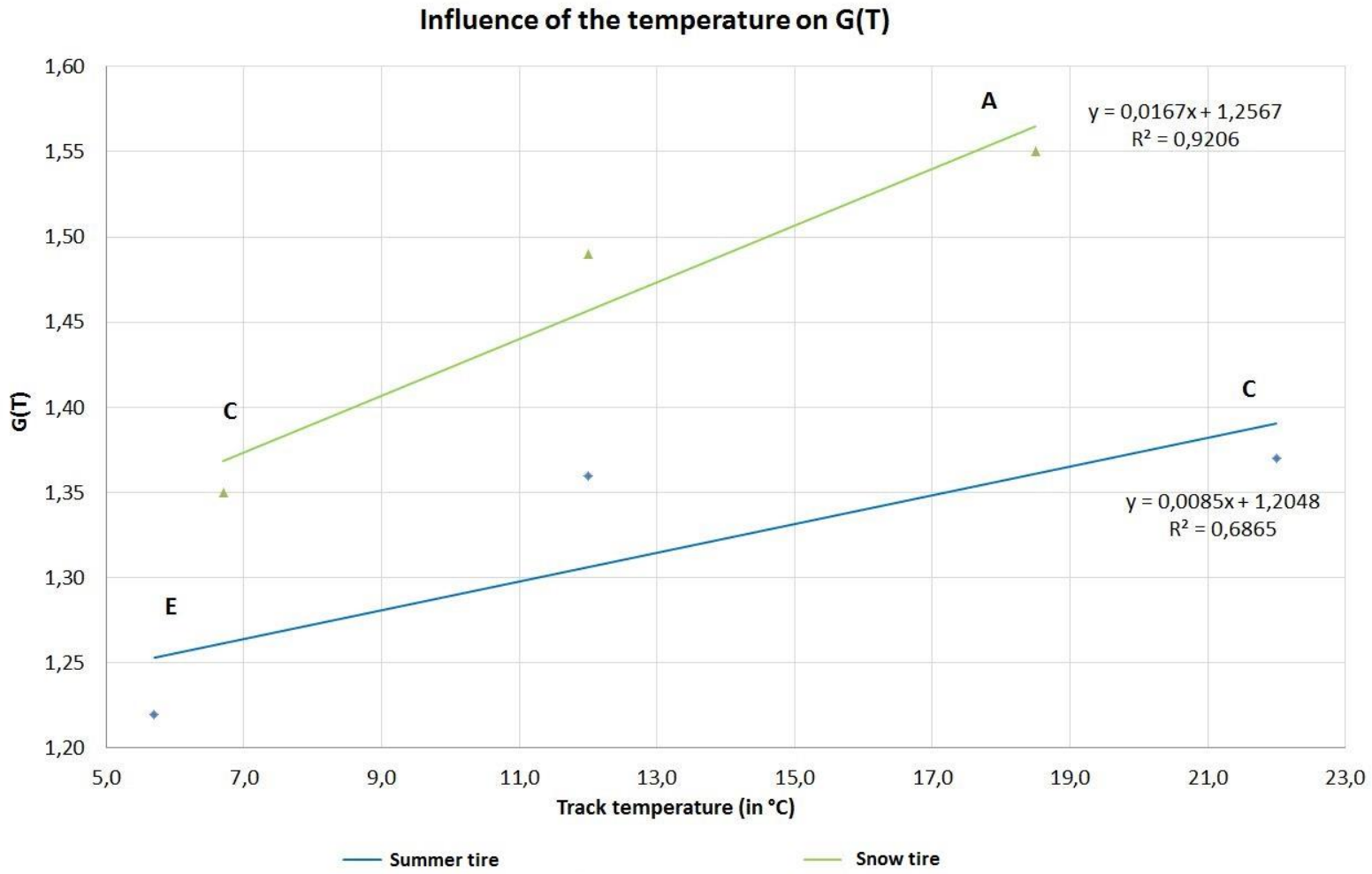
FEED-BACK OF EXPERIENCE

- Based on inter laboratories studies and internal studies.

- These studies made it possible to evaluate the most influence of the following parameters:

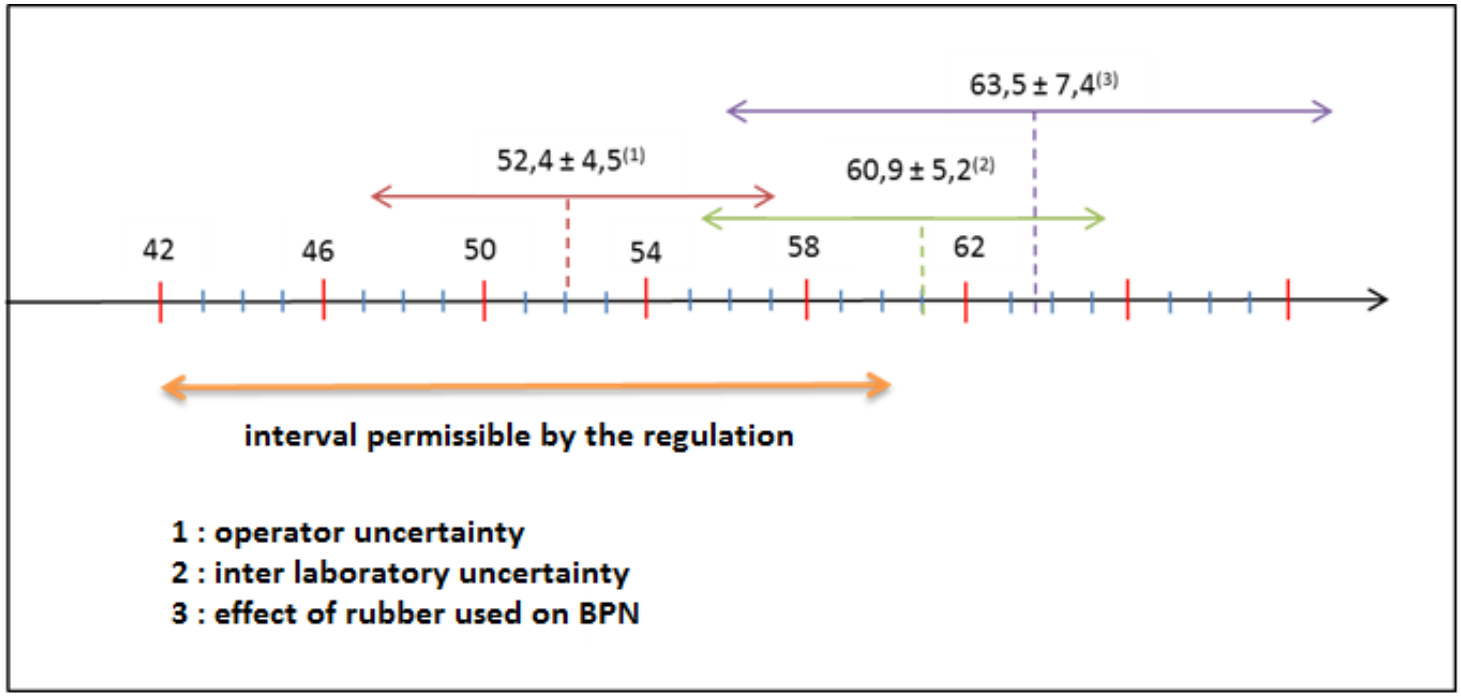
  - Temperature of the track.
  - Coefficient of friction (BPN)
  - Wear of the reference tyre (SRTT)
  - Choice of the method (vehicle or trailer).
  - Selection of data for calculation

- Temperature of the track.



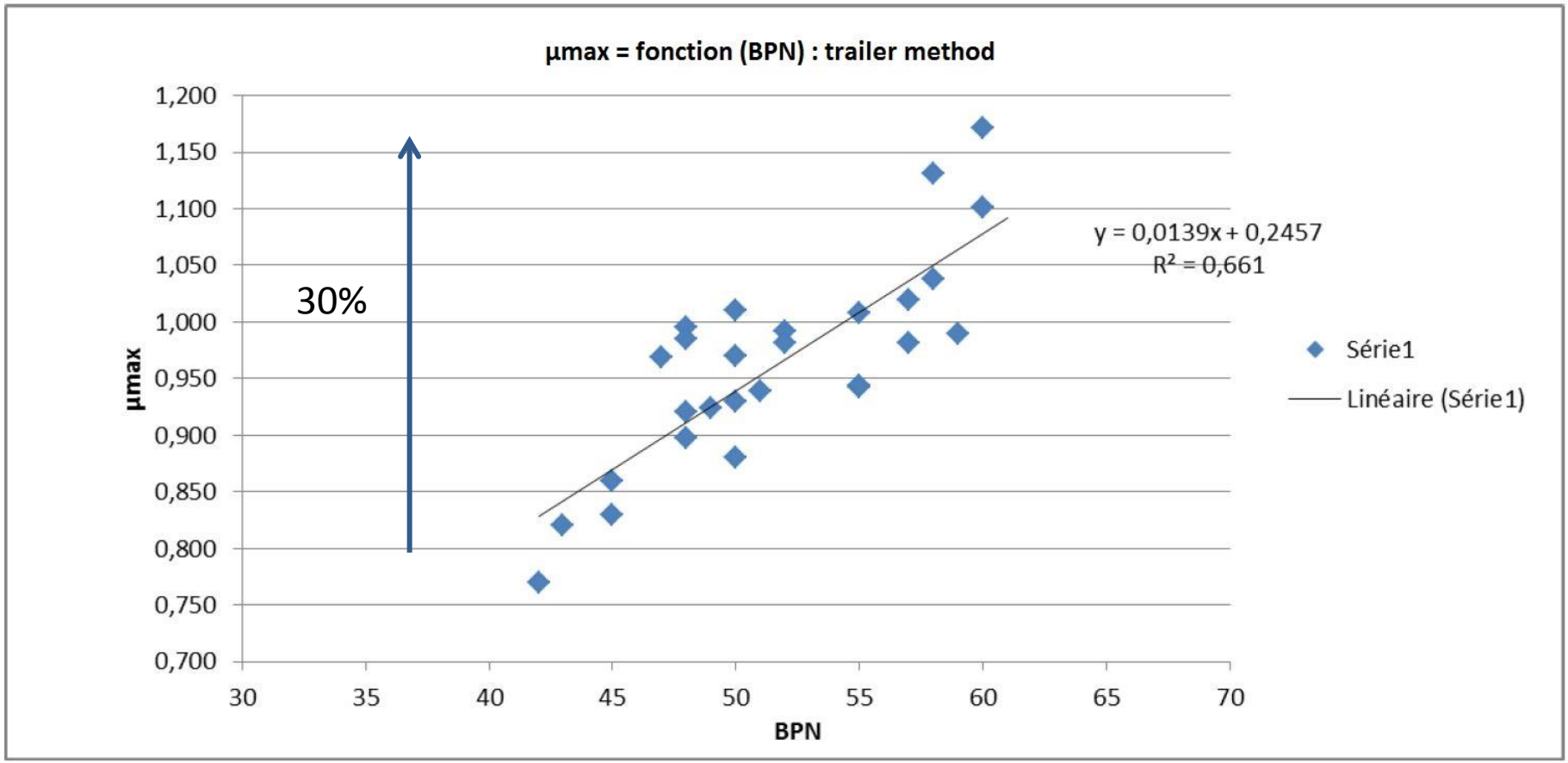
• Coefficient of friction (BPN)

- Uncertainty of the measurement method with the BPN



• Coefficient of friction (BPN)

- Effect of the BPN on the maximum adhesion coefficient µmax



⇨ Uncertainty of the correction in the formula of wet grip

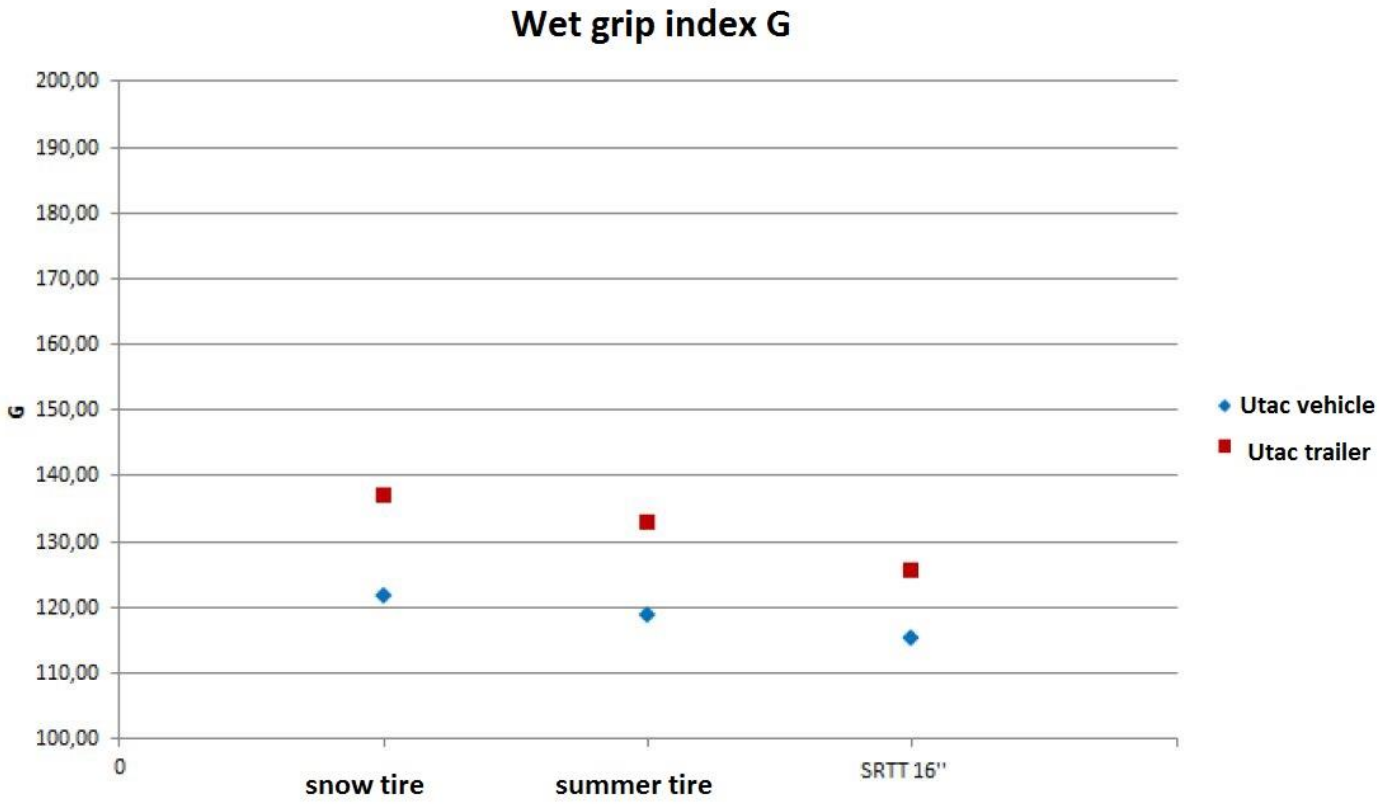
- Wear of the reference tyre (SRTT)

	BPN=48; T°Piste = 17°C; T° = 19°C					
	SRTT 16'' UTAC REMORQUE 1		SRTT 16'' UTAC REMORQUE 2		SRTT 16'' UTAC REMORQUE 2	
	old tire (335 brakings 167 km)		new tire (R1)		new tire (R2)	
	0,991	1	0,720	1	0,920	1
	1,057	2	0,847	2	0,849	2
	0,987	3	0,868	3	0,905	3
	1,048	4	0,862	4	0,974	4
	1,076	5	0,990	5	0,901	5
	1,094	6	0,859	6	0,899	6
	1,041	7	0,869	7	0,920	7
	0,996	8	0,863	8		
	1,034	10	0,891	9		
			0,886	10		
			0,929	11		
			0,940	12		
average	1,036		0,891		0,910	

Difference = 14 %

- Effect of the storage conditions of the SRTT tire (temperature)

- Choice of the method (vehicle or trailer).



Difference trailer/vehicle between 10% and 12%

• Selection of data for calculation

	SRTT 16" R1		Tire candidate T1		SRTT 16" R2	
Air temperature (°C)	19,7		21,3		22,3	
Track temperature (°C)	23,2		24,3		22,3	
Wind speed (m/s)	1,2		1,5		1,5	
Category of use	M+S		Normal		M+S	
Pressure tire (kPa) / and rim size	180	6,5"	180	8"	180	6,5"
Load (kg)	548		420		548	
	N° Data	µmax	N° Data	µmax	N° Data	µmax
1	3	0,91	1	0,96	1	0,89
2	4	0,86	5	0,97	2	0,87
3	5	0,85	6	1,01	3	0,90
4	6	0,88	8	0,93	4	0,87
5	7	0,88	9	0,95	5	0,87
6	8	0,90	7	1,00	8	0,84
	1	0,82	2	0,90	6	0,81
	2	0,85	3	0,93	7	0,81
	9	0,92	4	1,05		
Average $\mu_{max\ peak}$		0,88		0,97		0,87
Standard deviation $\mu_{max\ peak}$		0,03		0,03		0,02
Coeff variation % (max 5%)		2,85		3,19		2,31
Corrected average AD (ref. (μ_{max}))			0,88			
G(T)			1,36			
G labelling			**1,33**			
G labelling			**C**			

Successive SRTT standard deviation (m/s²)	0,02
Successive SRTT average (m/s²)	0,88
Successive SRTT Coeff variation % (max 5%)	2,53