Transmitted by the co-chairs
of TF for Tyre Abrasion

Informal document **GRPE-90-29-Rev.2**
(90th GRPE, January 9-12, 2024,
agenda item 7.(c)

Status report to 90th GRPE
(January 2024)

Task Force on Tyre Abrasion

On behalf of GRBP and GRPE

Task Force on Tyre Abrasion

Targets	• Develop a robust procedure for measuring the abrasion of tyres: Test conditions and methods; • Define the acceptable uncertainty for the tyre abrasion test method(s) and assess the uncertainty of the tyre abrasion test method; • Based on the abrasion test method, define a characterisation of relative mileage potential index; • Evaluate the abrasion performance and tread depth reduction of a wide range of tyres available in the market; • Define abrasion limits for tyres in order to limit the emission of microplastics to the environment; • Develop a proposal of amendment to UN Regulation No 117 for the type approval of tyres in respect to their abrasion.
Roles	• Co-chairs: France (Elodie.COLLOT@utac.com) and European Commission (Theodoros.GRIGORATOS@ec.europa.eu) • Secretariat: ETRTO (European Tyre and Rim Technical Organisation)
Reporting	To both working parties: GRPE and GRBP Adoption: GRBP
Web page	Task Force on Tyre Abrasion (TF TA) - Transport - Vehicle Regulations - UNECE Wiki ToRs (under revision): TF TA Terms of Reference

Task Force on Tyre Abrasion: facts and figures

- Meetings
  - 13th web-meeting: 11th May 2023
  - 14th web-meeting: 5th June 2023
  - 15th hybrid-meeting: 20th July 2023
  - 16th web-meeting: 26th Sept 2023
  - 17th web-meeting: 26th Oct 2023
  - 18th web-meeting: 13th Nov 2023
  - 19th web-meeting: 13th Dec 2023

- Attendees ~80
  - CPs:
    European Commission, France, China, Germany, India, Japan, Norway, Netherlands, South Korea, Spain, Switzerland, UK, USA, Canada
  - NGOs:
    ADAC, AVL, ETRMA, ETRTO, HORIBA, IDIADA, ITMA, JAMA, JATMA, LINK, OICA, SMMT, TRAC, TÜV Nord, UniBW., USTMA, UTAC, VTI

Testing methods developed by TFTA

©UTAC

LABORATORY
(Indoor drum method)

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IN-VEHICLE REAL LIFE
(On-road method)

Task Force on Tyre Abrasion: work progress

Work on the 2023 test campaign	• Validation and correlation test campaign for 2023: ongoing **for C1**
	  • Tyres selections (candidate and "reference" tyres) for correlation: done ☑
	  • Tyres selections for alignment: done ☑
	  • Validation test campaign on 3 on-road test centres and 4 drum test centres: done ☑
	  • Alignment test campaign on 7 on-road test centres and 4 drum test centres: ongoing ☐
	  • Post processing: done ☑ (for the correlation)
	  • Market assessment

Working document	• Test conditions and methods*: submitted ☑ **for C1** tyres
	  • GRBP/2024/10 new supplement to UNR117.04
	  → to complete by informal document
	• Revision of the ToRs (ongoing)

Market assessment for 2024	• **For C1**: preparation and first discussions on the number of tyres (~200 TBC), sizes and characteristics to be tested for 2024

*detailed description of the methods: GRBP-78-26

Task Force on Tyre Abrasion: next

Next steps	• Final proposal of methods
	  • Feedback expected of the GRPE (January 24)
	  → comments expected by end of January 2024
	  • Adoption expected at GRBP (February 24)

C1 tyres	• Perform the market review (2024 and 1H 2025 (multi circuit assessment) • Define and introduce reference tyre(s) for abrasion test in ASTM standard • Set the limits for abrasion [2025] • Work on the feasibility of rating and definition of the mileage of tyres [2025]
C2 tyres	• Propose abrasion method(s) [2026] • Set the limits for abrasion [2027] Anticipation of 1 year will be evaluated depending on the C1 method(s)' suitability for C2 tyres C2 clustering (and timeline) TBC
C3 tyres	• Propose abrasion method(s) [2028] • Set the limits for abrasion [2029]

Under revision in the ToRs

Back up

Scope

- Applicable to C1 tyres as defined in R117, excluded:
  - Ice grip tyres and tyres having a nominal rim diameter code ≤ 13.

Reference tyres

- Reference tyres shall be stored in condition recommended by ASTM.

Normal: 225/45R17 94 XL

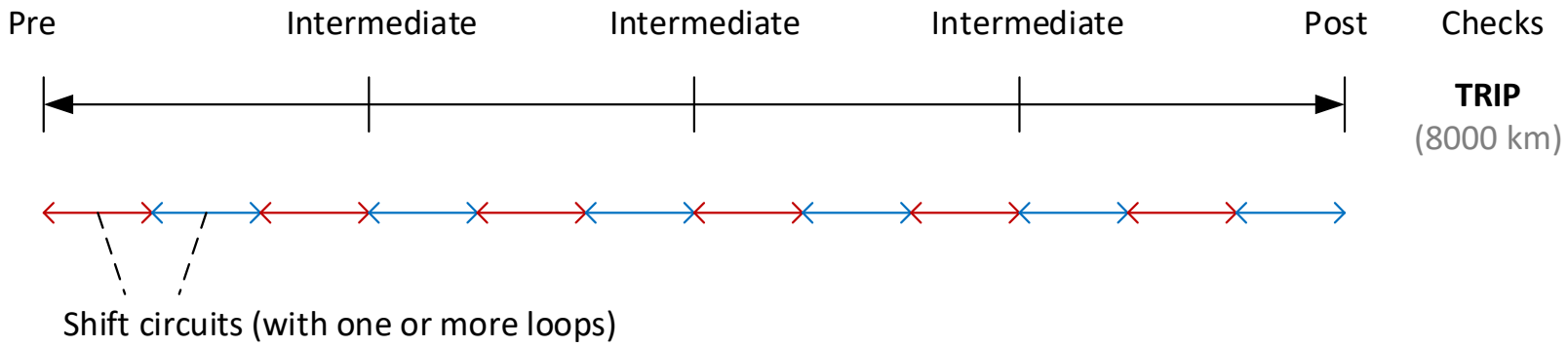
3PMSF: 225/45R17 94 XL

		Reference tyre	
Candidate tyre		SRTT17S	SRTT17W
Normal tyre		X	
Snow tyre			X
	Snow tyre that is classified as tyre for use in severe snow conditions		X
Special use tyre		[X]	
	"M+S" or "M.S" or "M&S"		X
	Special use tyre that is classified as tyre for use in severe snow conditions		X

Red: under discussion

On-Road method - Circuit

- Test distance: 8 000 km (±300 km) driven by repeating circuits on open public roads
- Circuit consists of one or more loops, with cars returning to the departure point without being transported.
- Circuit min distance 300 km of different roads.
- Loop: section of circuit having the same start and end point. Loop driven opposite way is considered different loop. The loops of a circuit can be run in any order.



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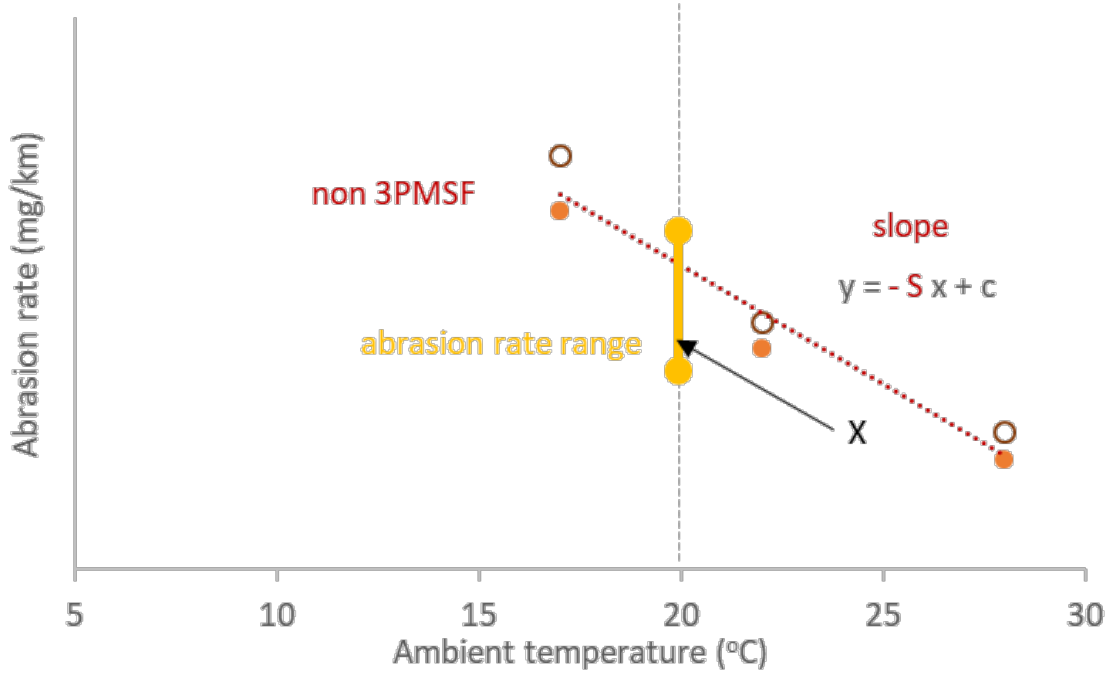
On-Road method - Circuit

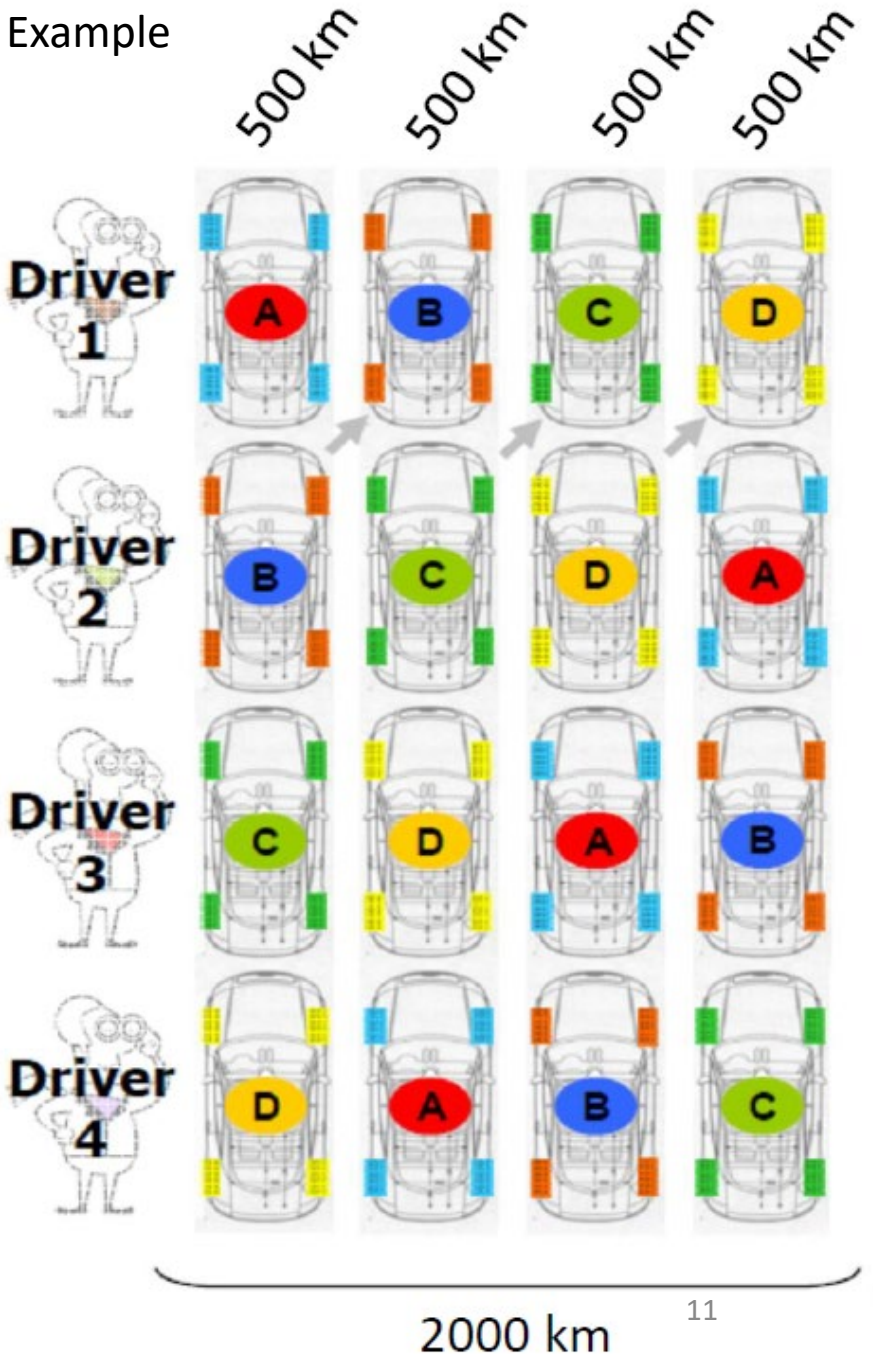


- The circuit abrasion rate shall be determined:
  - Convoy of at least 2 vehicles having the reference tyres (Normal or 3PMSF)
  - At three ambient temperatures: one at least 15-25°C (Normal) or 5-15°C (3PMSF)
- The circuit abrasion rate shall be (one needs to be checked)
  - @20°C (Normal reference tyres) needs to be in the range [range] mg/km/ton
  - @10°C (3PMSF reference tyres) needs to be in the range [range] mg/km/ton
- If the circuit is modified by ≤10 km, or 10-30 km for ≤8 shifts or <100 km (or 20% of circuit, whichever is smaller), it is still valid

Red: under discussion

On-Road method - Preparation

- Convoy
  - Up to 4 vehicles. One is fitted with reference tyres
  - Convoy composition. Homogeneous for:
    - Number and position of driven wheels
    - FWD or RWD or AWD only in the convoy
    - Propulsion energy converters (e.g. ICE, or NOVC-HEV etc.)
    - F2 vehicle ref. tyres ≤1.2*F2 vehicle candidate tyres (if available)
  - Vehicles and drivers' rotation
    - Each tyre shall be exposed to the same distance (±10%) to all drivers and positions in convoy



Red: under discussion

On-Road method - Preparation

- Tyres preparation
  - Tyre mass measurement (without rim)
  - Tyre fitment on rim (*and vehicle*)
  - Tyre and wheel assembly mass measurement (optional)
  - Tyre inflation pressure: Ref. tyres: 290 kPa, candidate tyres: 250 kPa for standard load tyres or 290 kPa for reinforced load and high load capacity tyres (XL, HL)
- Vehicles preparation
  - Vehicle balasting]
    - Tyre load 67% (±7%) of tyre load capacity (and not exceeding 85% vehicle max payload)
    - Load distribution: FWD: 56% (±7%) to 44% (±7%); RWD/AWD: 50% (±7%) to 50% (±7%);
  - Vehicle tuning (alignment)
  - Vehicle mass measurement and load at each wheel

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On-Road method – Acceleration and Speed

- Instrumentation
- Circuit
  - Total distance 8000 km (±300 km) along selected circuit
  - Circuit of at least 300 km consisting of one or more loops
  - Driving style distribution (see table)
  - Abrasion level for reference tyres at 20°C (normal) and/or 10°C (severe snow) [range] mg/km/t

To be checked at the end of the test (*monitored* continuously):

- Global (test) acceleration levels
- Speed requirements (<140 km/h)

	Urban	Regional	Highway	Global
	Circuit approval			End of test
Share (% distance)	>25	>25	>35	-
Long. acc. stdev (m/s^2)	0.40-0.90	0.20-0.75	0.15-0.55	0.35-0.55
Lat. acc. stdev (m/s^2)	0.40-1.20	0.70-1.80	0.15-0.80	0.83-1.03

Red: under discussion

On-Road method - Measurements

Before and after test

- Tyre mass
- Load on each tyre
- Vehicle alignments
  - (unloaded and loaded vehicle)
- Tyre pressure
  - Before test and after tyre fitment
  - After test and before dismounting

Red: under discussion

On-Road method - Measurements

During test

- Long. and lat. acc. of each vehicle with frequency ≥10 Hz (e.g. constant monitoring)
- Speed of each vehicle (constant monitoring)
- Tyre pressure each day (cold condition)
- Average of five temperatures of at least start, end, at lower and higher altitude points
- Wet distance measurement, ice on road measurement

At intermediate stops

- Vehicle alignment of reference vehicle every 2 000 km
- Tyre and wheel assembly mass (optional but compulsory during the test campaign)
- Vehicle alignment of test vehicles (optional at half distance but compulsory during the test campaign)

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On-Road method - Troubleshooting

- Vehicle:
  - Repair is possible: The repaired vehicle shall run the distance lost (without other vehicles of the convoy)
  - Major failure or accident: The replacement vehicle equipped with the same (new) tyres shall run the distance lost (without other vehicles of the convoy)
  - If failure happens to a test vehicle and not reference vehicle, the failed vehicle (and tyres) can be withdrawn.
- Tyres:
  - Tyre is destroyed: Spare part with same size and pattern is used. The mass loss of the other tyre is multiplied by two for the calculations
  - Tyre is reparable: The added repair mass is taken into account in the calculations. Spare tyre can be used for max one loop. Distance will be considered in the calculations

Red: under discussion

On-Road method - Validation

	Normal	3PMSF
Average T (°C)	7 to 35	-3 to 20
Min/max for 90% of dist. (°C)	2 / 40	-7 / 25
Wet mileage	<20%	<20%
Ice or snow mileage	0%	<5%

- Weather and Climate
- Accelerations
  - see table beside
  - Long. and lat. acc. stdev within 5% of ref. vehicle values
- Vehicle alignments
  - End-Start: ±0.15° toe, ±0.3° camber
- Visual inspection
  - Sidewall marking readable
  - Tyre loss <1cm^2 of tread chunking area (for Ref tyre: all results invalid)
- Ref. tyres abrasion rate value @20°C or @10°C within abrasion rate range

	Global
Max speed (km/h)	140
Long. acc. stdev (m/s^2)	0.35-0.55
Max long. acc. (m/s^2)	±5 (for ≥99.8% distance)
Lat. acc. stdev (m/s^2)	0.83-1.03
Max lat. acc. (m/s^2)	±5 (for ≥99.6% distance)

Red: under discussion

On-Road method - Test report

Calibration

Instrument	Interval	Criterion
Scale for tyres	Yearly and at major maintenance	±2 g
Instrument for toe and camber	Yearly	+/- 0.033°
Acceleration/Speed sensor	Yearly	
Scale for vehicle	Yearly and at major maintenance	+/- 0.1%
Temperature sensor	Yearly	±1°C
Tyre pressure sensor	Yearly	±3 kPa
Scale for tyre and wheel assembly	Yearly and at major maintenance	±2 g

Red: under discussion

Indoor drum method - Drum specification

- Tyre Wear Test Equipment

  A drum, a tyre mounting device, a loading device and an adhesion prevention system

- Drum diameter

  The test dynamometer shall have a cylindrical flywheel (drum) with a diameter of at least [1,7] m.

  The roller diameter shall be defined and reported considering the thickness of test surface, to compute test speed and running distance correctly.

- Width

  The width of the test surface shall always exceed the width of the test tyre contact patch throughout entire test duration.

Red: under discussion

Indoor drum method - Drum specification

- Surface
  The test surface shall be applied to external surface of the cylindrical drum.
  The test surface of drum shall:

(a) have MPD measured at the start and the end of the drum test, according to ISO 13473-1 except for low pass filter, applied from 0,22 mm to 2,10 mm.
(b) low pass filter cut-off shall be 0,1mm for MPD data processing procedure.
(c) be textured with sands, stone or an alternative material, e.g., aluminium oxide resin
(d) The drum surface shall be built with rigid and not deformable material.

- Check surface by reference tyre abrasion rate.
  - The abrasion rate of the reference tyre for all surface shall be in the range
    - 50 mg/km/t to 190 mg/km/t for SRTT17S
    - 35 mg/km/t to 165 mg/km/t for SRTT17W

Red: under discussion

Indoor drum method - Tyre carriage and drive system

- The tyre carriage and drive system shall be able to provide dynamic control of:
  - (a) tyre lateral force developed by the drag force produced by tyre slip angle during running
  - (b) Longitudinal tyre force or torque developed by tractive force by the tyre during braking and accelerating

- Adhesion prevention system
  - Tread wear test equipment shall be equipped with the powder delivery system to spray a controlled volume of such material (e.g., talc) on the test surface near the test tyre contact patch so that a test tyre does not adhere to and change the test surface.

Red: under discussion

Indoor drum method - Test Conditions

- Test load
  - Test load Fz is 80% of maximum load capacity
- Tyre inflation pressure
  - Standard load : 210 kPa
  - Extra load : 250 kPa
- Testing condition
  - Longitudinal force, lateral force and speed
  - Running distance is 5 000km.
  - Running velocity , constant speed
    - 100km/h for flat road ,
    - 60km/h for curve/slope

Red: under discussion

Test equipment tolerances

Table B.1 - Instrumentation accuracy

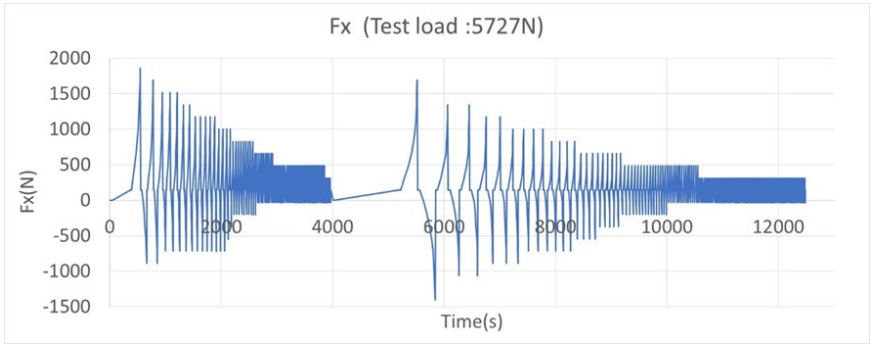
Parameter	Control accuracy	Instrumentation accuracy
Tyre forces and torque	Fz: ±150N or 3% whichever is greater, for semi-static input. Fy: ±100N or 5% whichever is greater, for the difference between input peaks and actually generated peaks. Fx: ±100N or 5% whichever is greater, for the difference between input peaks and actually generated peaks. My: ±40Nm or 5% whichever is greater, for the difference between input peaks and actually generated peaks.	Fz: ±1% Fy: ±1% Fx: ±1% My: ±1%
Inflation pressure	±3 kPa	±3 kPa
Mass scale	±2 g	±2 g
Test duration	For the test time durations, the total time of an actual test shall not differ more than ±5% from the total input time, 68.83h (247,800s). The interval of measurement shall be minimum 1Hz.	±0.02s for the time increments
Speed	±2 km/h	±0.1%

Indoor drum method - Input of test cycle

- Fx (or My) and Fy calculation
  - Longitudinal force : Fx = Test load Fz × Longitudinal acceleration G(x)

    or Tyre torque : My = Fz × G(x) × Loaded Radius RL
  - Lateral force : Fy = Fz × Lateral acceleration G(y)

    At a point of test duration T, the values of G(x) and G(y) shall be equal to those listed in Table A1;
    G(x) and G(y) shall change linearly between two adjacent points.
    Therefore, the values of Fx and Fy will also change linearly from one point to another.
    The following graphs show samples of linear change for Fx or Fy with respect to T.



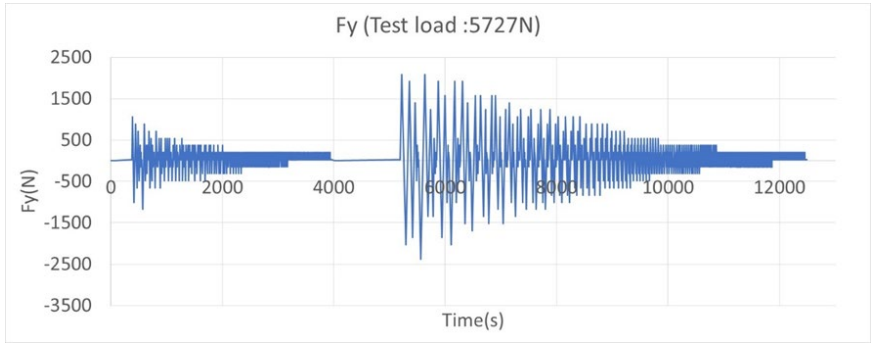


Table A1. – Input of test cycle

1 cycle : 250 km

T [s]	v [kph]	G(x)	G(y)
0	100	0.000	0
50	100	0.000	0.000
373.2	100	0.025	0.005
388.4	100	0.025	0.185
418.7	100	0.055	-0.175
446.5	100	0.085	0.155
471.7	100	0.115	-0.115
491.9	100	0.145	0.125
509.6	100	0.175	-0.085
522.3	100	0.205	0.065
532.4	100	0.235	-0.025
540.0	100	0.265	0.035
545.0	100	0.295	0.005
547.5	100	0.325	0.005
556.8	100	0.025	0.005
574.5	100	0.025	-0.205
602.3	100	-0.005	0.155
620.0	100	-0.035	-0.085
632.6	100	-0.065	0.065
645.2	100	-0.095	-0.055
657.9	100	-0.125	0.065
662.9	100	-0.155	0.005
668.8	100	0.025	0.005
678.9	100	0.025	0.125
699.1	100	0.055	-0.115
719.3	100	0.085	0.095
737.0	100	0.115	-0.085
	100		0.065

T represents the total test duration from the beginning of the test
G(x) and G(y) represent the index compared to the standard acceleration due to earth gravity

Red: under discussion

Indoor drum method - Test procedure

- Thermal conditioning
  Place the inflated tyre in the thermal environment of the test location for a minimum of 3 h.

- Pressure adjustment
  After thermal conditioning, the inflation pressure shall be adjusted to the test pressure.

- Thermal environment
  During the test, the ambient temperature, at a distance of not less than 0,15m and not more than 1 m from the tyre, shall be 25 °C ± 5 °C
  Average temperature for reference and candidate tyre during test within 2 degrees

- Mass measurement
  The mass of tyre shall be measured before and after 5 000km of run set out in paragraph 5.6 for both reference and candidate tyres.

Red: under discussion

Indoor drum method - Test cycle

- Input condition
  - Both reference tyre and candidate tyre shall be tested according to input condition of Appendix 1.
  - The Appendix 1 test condition of 250 km is set as one set, and the test cycle shall be repeated 20 times until 5 000 km is reached.

Red: under discussion

Indoor drum method - Test cycle

- Basic test cycle (2 positions)
  - Both reference tyre and candidate tyre shall be mounted different position of one drum. Test of both reference tyre and candidate tyre shall be conducted at the same time.
  - Tyre positions shall be exchanged once after the completion of 2 500km.
  - Direction of rotation shall remain constant throughout the test.
- Alternative test cycle (1 position)
  - In case test of reference tyre and candidate tyre is not possible at the same time, the alternative test cycle is available. As Reference tyre (R) and Candidate tyre (T), test order is following:

    R(1000km) - T(2000km) - R(2000km) - T(2000km) - R(2000km) - T(1000km)

    Repeat a set of Appendix 1 input conditions 4 times for 1 000 km and 8 times for 2 000 km.

Red: under discussion

Indoor drum method - Measurement and recording

The following shall be measured and recorded:

(a) Test speed;

(b) Load on the tyre normal to the drum surface, Fz;

(c) Test inflation pressure: initial and middle of the test;

(d) Ambient temperature measured in degree °C;

(e) Force or torque applied to the test tyre and testing duration, with a maximum time interval of 1s;

(f) Test rim size;

(g) Mass of tyre; at the beginning and the end of the test

(h) MPD of the test surface; at the beginning and the end of the test

(i) Photograph of tyre after test run;

Red: under discussion

Indoor drum method - Validation

- Test operate undergo with NO…
  Permanent deformation
  Loss of air

- Visual inspection to check there are NO…
  Visual evidence of tread, sidewall, ply, cord, inner liner, belt
  Bead separation
  Chunking
  Open splices
  Cracking
  Broken cords
  Rubber adhesion

Red: under discussion

Thank you