Development of tyre abrasion test methods by Indoor Drum Method

Task Force on Tyre Abrasion
28 April 2022

JAPAN AUTOMOBILE STANDARDS INTERNATIONALIZATION CENTER
Vision: Development of abrasion test method

Background

- Microplastic - Tyre and Road Wear Particles (TRWP) is considered one of major source.
- Regulatory actions on TRWP mitigation becoming global.
  - Tyre Abrasion had been raised on priority items of GRBP and Task Force on Tyre Abrasion was created.
  - EU’s tyre labeling regulation, Regulation 2020/740, stipulate that abrasion performance shall be introduced once the reliable test method will be available.
  - USEPA/CARB intends to work on tyre abrasion issues.

Vision

- To develop a global abrasion test method, which is reliable, universal regardless of regions, and fair.
Evaluation on abrasion test methods

• Vehicle Method vs Indoor Drum Method
  - Vehicle Method has many variance factors, which are not possible or difficult to control.
  - Indoor Drum Method can control those variances. Thus, it has smaller variance.

• Japan Conclusions
  - As an abrasion test method, Indoor Drum is superior in repeatability.
  - In view of future standardization as ISO, Indoor Drum is more fair and transparent vs Vehicle Method that needs to designate the specific test course at specific location.

• Moving Forward
  - Japan is working on development of Indoor Drum (external drum) tyre abrasion test method, which is:
    ✓ Fair, reliable and affordable.
    ✓ Reflecting real world’s condition of each region.
Requirement:
• Represents the driving conditions of the world

How to represent the driving conditions of the world?
• Drum running mode based on WLTC
  ✓ Because “representativeness” of real-world endorsed by many countries
  ✓ However, WLTC does not give enough lateral force on the tyre
• “Curve and Slope” running mode will be added
  ✓ As lateral force is a necessary element for tyre wear
Development of Indoor Drum Method

Converting the vehicle driving conditions representing Japan / the world into the test conditions of indoor drums.

Based on vehicle running conditions (traction/brake, lateral force...)“Representative” measurement data (vehicle)

Reproduce the real-world driving conditions

Convert to tyre input using the vehicle models

Acceleration, speed, lateral force...

Convert to drum testing conditions

Drum running mode developed by JATMA based on the contract research to JARI, a core member of developing WLTP (GTR-15/UN R154)

JARI: Japan Automobile Research Institute
Japan believes that good Indoor Drum Method will benefit all stakeholders

- Contracting Parties, tyre industries, end users and society
- All regions, not only Japan

Thus, Japan proposes Indoor Method which represents driving conditions of the world

- Japan is developing Indoor Method based on WLTC plus Curve and Slope test cycle

Once tentative testing condition will be fixed, validation tests will be conducted

Japan requests that the indoor drum test method be an item for consideration in this Task Force.
Thank you for your attention
Factors affecting tyre wear

Vehicle, Circumstance (weather, climate...), Road and Driving conditions and Driver are known as factors affecting tyre wear.

**Degree of Impact**

Data Source: JATMA

- These 4 factors affect tyre wear greater than tyre design.
- Test methods need to control these 4 factors.
Typical abrasion testers – Indoor external drum

Japan develops an abrasion test method by indoor external drums
Japan does not develop a tester itself

https://www.youtube.com/watch?v=Ve8Kwv6UB9s
## Test Methods Assessment

<table>
<thead>
<tr>
<th>Factor</th>
<th>Vehicle Method</th>
<th>Indoor Drum Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Vehicle</strong></td>
<td>1) Alignment, especially dynamic alignment cannot be adjusted.</td>
<td>1) Alignment controlled</td>
</tr>
<tr>
<td></td>
<td>2) A wide variety of test vehicles needed to cover all tyre sizes, resulting in variance by vehicles.</td>
<td>2) One test machine covers all tyre sizes</td>
</tr>
<tr>
<td><strong>Circumstance</strong></td>
<td>1) Climate out of control - rain, wind and temp.</td>
<td>1) Climate controlled</td>
</tr>
<tr>
<td></td>
<td>2) Inflation pressure changes during operation by temperature changes and direct sunlight.</td>
<td>2) Internal pressure controlled</td>
</tr>
<tr>
<td><strong>Road</strong></td>
<td>1) Difficulty in setting up multiple courses (cannot match road surface, curve and slope).</td>
<td>1) Can simulate real road conditions, by defining standards</td>
</tr>
<tr>
<td></td>
<td>2) Surface management of public roads is not possible (Aging degradation and repair frequency).</td>
<td>2) Surface controlled (once procedures established)</td>
</tr>
<tr>
<td><strong>Driving Condition/Driver</strong></td>
<td>1) Different drivers have different driving styles.</td>
<td>1) Driving controlled</td>
</tr>
<tr>
<td></td>
<td>2) Driving mode varies due to traffic conditions (Traffic jams, construction works, etc.).</td>
<td>2) Driving controlled</td>
</tr>
<tr>
<td></td>
<td>3) Large test load tolerance required.</td>
<td>3) Test load controlled</td>
</tr>
</tbody>
</table>

Vehicle Method does not control tyre abrasion factors, while Indoor Drum method does
• WLTP is a global harmonized standard for emissions and fuel consumption
• Adopted by UNECE as GTR-15/UN R154
• WLTC is based on real-driving data submitted by:
  ✓ EU, India, Japan, South Korea and USA
• WLTC is used as an emission or a fuel consumption standard by:
  ✓ China, EU, India (plan), Japan and South Korea (plan)
• Brake-dusts test method which is under development, is also based on WLTC

WLTC is endorsed by various countries
• Supplementary materials
Endorsement of WLTC: Example

**WHAT ARE THE BENEFITS OF WLTP?**

WLTP WILL INTRODUCE MUCH MORE REALISTIC TESTING CONDITIONS. THESE INCLUDE:

- More realistic driving behaviour
- Representative accelerations and decelerations
- Shorter stops

Because of all these improvements, WLTP will provide a much more accurate basis for calculating a car’s fuel consumption and emissions. This will ensure that lab measurements better reflect the on-road performance of a car.

Source: https://www.wltpfacts.eu/wltp-benefits/

Representativeness of real-driving conditions endorsed by EU Industry
tyre abrasion rate [mg/km], NOT tyre mileage, is the relevant indicator to quantify tyre wear particles.

Example

<table>
<thead>
<tr>
<th></th>
<th>6 mm Tread Depth</th>
<th>9 mm Tread Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tread depth (at new)</td>
<td>6 mm</td>
<td>9 mm</td>
</tr>
<tr>
<td>Tread weight (at new)</td>
<td>(a) 1.0 kg</td>
<td>1.8 kg</td>
</tr>
<tr>
<td>tyre life (mileage)</td>
<td>(b) 50,000 km</td>
<td>60,000 km</td>
</tr>
<tr>
<td>Abrasion rate / km</td>
<td>(a)/(b) 20 mg/km</td>
<td>30 mg/km</td>
</tr>
</tbody>
</table>

Test methods for abrasion rate are necessary to measure tyre emitted particles.
Other than tyre itself, there are four (4) factors affecting tyre wear:
- Vehicle
- Road
- Driving condition/ Driver
- Circumstances