Tyre abrasion test by Indoor Drum Method

PMP IWG meeting 54th session
9th January 2024
Tyre abrasion rate [mg/km] is the relevant indicator to quantify tyre wear particle

| Example |
|------------------|------------------|
| ![6 mm Tread Depth](image1) | ![9 mm Tread Depth](image2) |

<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>

To develop test methods for abrasion rate are necessary
Factors affecting tyre abrasion

There are four factors affecting tyre abrasion, other than tyre design.

Factors affecting tyre abrasion

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

- These 4 factors affect tyre abrasion greater than tyre design.
- Test methods need to control these 4 factors.

✔ Indoor Drum method can control these variances.

Degree of Impact

Data Source: JATMA
Test conditions for Indoor Drum Method

◆ Test machine
◆ Running condition
  Force condition
  Others
◆ Drum Surface
  Texture & Material
◆ Environment
◆ Test program
◆ Validation
◆ Measurement
◆ Evaluation
Test Conditions for Indoor Abrasion Drum

**Test machine:**
- Test Drum: External Drum
- Drum diameter, width: [1.7]m or above, more than tyre width

**Running condition**
- Tyre Load: 80% of the tyre LI
- Tyre inflation pressure:
  - Standard Load: 210kPa
  - Reinforced, Extra load: 250kPa
- Force condition: Condition proposed based on WLTC ➞ Next page
  - 1 test cycle is 250km. Repeat 20 times.
- Running distance: 5000km
- Running velocity: Constant speed (100km/h for flat road, 60km/h for curve/slope)
**Force for indoor drum test**

**Force mode Concept**

- Drum running mode based on **WLTC**
- **“Curve and Slope”** running mode is added as lateral force is a necessary element for tyre abrasion

**Measurement Vehicle data**

- *selecting representative public road*

**Conversion to tyre input acceleration**

- *using the vehicle models*

**Conversion to drum testing conditions**

- Drum running mode developed by contract research to JARI, a core member of developing WLTP / GTR-15
- Converting the vehicle driving conditions representing the world into the test conditions of indoor drums

*JARI: Japan Automobile Research Institute*
Drum Surface

- Texture: The range of surface shape MPD
  - Measure MPD before and after the test

- Material: Sand or stone or substitute materials shall be the constituent elements of a drum surface

Mapping world road surface by wavelength and MPD to define drum surface shape as tyre wear depends on road surface characteristics.

Drum surface is defined by road surface shape MPD.
Environment

- Preparation: 3-hour conditioning
- Ambient Temperature: 25°C +/- 5°C
- Adhesion prevention system
  - Tread wear test equipment shall be equipped with the powder distribution system to spray a controlled volume of such material (e.g., talc) on the test surface near the test tyre contact patch so that abrasion fragments does not adhere to the tyre surface or the test drum surface.

Test program

- 2 position drum: Test both SRTT and candidate at the same time
  - Tyre position shall be exchanged at 2500km
- 1 position drum: Test SRTT and Candidate tyres alternately
  - SRTT 1000km → Cand. 2000km → SRTT 2000km → Cand. 2000km → SRTT 2000km → Cand. 1000km
Validation
- Abrasion rate of reference tyre
  - SRTT17S : 50 mg/km/t to 190 mg/km/t
  - SRTT17W : 35 mg/km/t to 165 mg/km/t
- Record actual force level
  - Root Mean Square RMS of Gx & Gy : +/- 5%

Measurement
- Mass loss : Measure mass of the before and after test

Evaluation
- Abrasion rate : Mass loss per kilometer normalized by tyre load (mg/km/t)
- Abrasion index : Abrasion rate of candidate compared to abrasion rate of SRTT
Verification
✓ Test campaign results

Correlation
✓ Test result of vehicle test & indoor drum test
Specifications of evaluation for indoor test method

<table>
<thead>
<tr>
<th>Tire Size</th>
<th>L1/SS</th>
<th>Category</th>
<th>Abrasion rate</th>
<th>Rim</th>
<th>Test period (week)</th>
<th>1st time</th>
<th>2nd time</th>
<th>3rd time</th>
<th>4th time</th>
</tr>
</thead>
<tbody>
<tr>
<td>155/65R14</td>
<td>75H</td>
<td>Normal</td>
<td>low abrasion</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>155/65R14</td>
<td>75T</td>
<td>3PMSF</td>
<td>low abrasion</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>205/55R16</td>
<td>94W</td>
<td>Normal</td>
<td>high abrasion</td>
<td>6.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>205/55R16</td>
<td>91V</td>
<td>Normal</td>
<td>high abrasion</td>
<td>6.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>205/55R16</td>
<td>91V</td>
<td>M+S</td>
<td>low abrasion</td>
<td>6.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<td>6.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>235/55R19</td>
<td>105Y</td>
<td>Normal</td>
<td>low abrasion</td>
<td>7.5</td>
<td>2</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>235/55R19</td>
<td>105V</td>
<td>M+S</td>
<td>low abrasion</td>
<td>7.5</td>
<td>2</td>
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<td>235/55R19</td>
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<td>3PMSF</td>
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<td>7.5</td>
<td>2</td>
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<td></td>
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<tr>
<td>235/65R17</td>
<td>108T</td>
<td>Special Use</td>
<td>high abrasion</td>
<td>7.5</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>225/45R17</td>
<td>94V</td>
<td>Reference(Normal)</td>
<td>–</td>
<td>7.5</td>
<td>2</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>225/45R17</td>
<td>94H</td>
<td>Reference(3PMSF)</td>
<td>–</td>
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<td>2</td>
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✔️ 11 candidate tyres has been tested with 4 repetitions by JASIC.
✓ Indoor drum test results (4 repetitions & 2 additional data: total 46 data) has been summarized.

✓ These test results show sufficient test accuracy.
✓ Indoor drum test method is verified based on test campaign results.
Test result of vehicle test & indoor drum test: correlation

Correlation between vehicle test & indoor drum test.

- Slope: 1.47
- R: 0.86
- R²: 0.73

R: correlation coefficient
R²: coefficient of determination

✔ Correlation factor R is more than 0.8

Further correlation will be studied based on market assessment data (ca. 200 tyres)