A Mechanized Low-Speed Friction Tester for Detection of Pavement Polishing

by

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Introduction

The importance of runway low-speed skid resistance

- Skid resistance of pavement is closely related to traffic safety.
- Key pavement characteristics that affect the magnitudes of skid resistance are the microtexture and macrotexture of pavement surface materials.
Importance of low-speed skid resistance

- Adhesion develops from molecular forces at the contact interface between a tire and pavement surface materials.

- Hysteresis component is due to the energy storage and dissipation associated with deformation of tires as a vehicle travels on the pavement.

- Both Macrotexture and Microtexture of pavement have influence on these two components at different degree.

- Microtexture governs low-speed skid resistance.
- Macrotexture influences high-speed skid resistance.
1 Measure transverse friction with a tyre that is angled to the direction of travel.

2 Measure longitudinal friction, according to the percentage of slip, they are divided into Locked wheel, Fixed slip and Variable slip.

3 Use rubber pads or sliders attached to a falling pendulum or rotating disc.
Skid Resistance Measurements

• Limitation of BPT used for low-speed skid resistance

1. A pendulum impact-type tester. The contact mode and mechanism are different from those between moving vehicle tires and pavement surface

2. Unreliable or misleading results on coarse-textured pavement surfaces

3. Practical difficulties in levelling the equipment and obtaining consistent test results on sloping or uneven pavement surfaces

4. Spot measurements: interval and too time consuming
Unsatisfactory Pavement frictional performance

- Polishing of pavement surface aggregates is responsible for the loss of microtexture due to smoothening and rounding of aggregates in pavement surface caused by traffic.
- Polishing leads to low skid resistance performance of a pavement at both low- and high-speed vehicle movements.
- Low-speed skid resistance tester is suitable for detecting polishing effect of pavements.
The Walking Friction Tester (WFT) developed by Chang’an University is applied to measure the low-speed skid resistance in laboratory or field.

The new generation of WFT has been improved into a portable, accurate, economical friction coefficient measuring equipment gradually.
Mechanized Walking Friction Tester

Advantages:
1. Improved control on test speed.
2. Improved test stability, eliminating jerking caused by improper operator handling of walking mode.
3. Better control of line of testing.
4. Increase productivity, reduced operator rest time compared with walking mode.
5. More suitable for pavement network level testing, including airport runways.
## Technical Specification of WFT

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size (without handle, mm)</strong></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>980</td>
</tr>
<tr>
<td>Width</td>
<td>640</td>
</tr>
<tr>
<td>Height</td>
<td>700</td>
</tr>
<tr>
<td>Length with handle</td>
<td>2050</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>60</td>
</tr>
<tr>
<td><strong>Testing wheel</strong></td>
<td></td>
</tr>
<tr>
<td>Texture</td>
<td>Smooth</td>
</tr>
<tr>
<td>Radius (mm)</td>
<td>200</td>
</tr>
<tr>
<td>Width (mm)</td>
<td>60</td>
</tr>
<tr>
<td>Vertical load (N)</td>
<td>196</td>
</tr>
<tr>
<td>Tire pressure (MPa)</td>
<td>0.1</td>
</tr>
<tr>
<td>Slip ratio</td>
<td>0%, 10%, 20%, 30%, 100%</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td></td>
</tr>
<tr>
<td>In the laboratory (m/min)</td>
<td>15</td>
</tr>
<tr>
<td>In the field (m/min)</td>
<td>45±5</td>
</tr>
<tr>
<td>Counting frequency</td>
<td></td>
</tr>
<tr>
<td>Friction coefficient (s)</td>
<td>0.2</td>
</tr>
<tr>
<td>Speed (s)</td>
<td>1</td>
</tr>
<tr>
<td>Water spray Capacity (ml/s)</td>
<td>45</td>
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<tr>
<td>Display</td>
<td>R4100</td>
</tr>
<tr>
<td><strong>Driving wheel</strong></td>
<td></td>
</tr>
<tr>
<td>Texture</td>
<td>pattern</td>
</tr>
<tr>
<td>Radius (mm)</td>
<td>200</td>
</tr>
<tr>
<td>Distance to test wheel (mm)</td>
<td>540</td>
</tr>
<tr>
<td>Voltage (V)</td>
<td>12</td>
</tr>
</tbody>
</table>
Description of Walking Friction Tester

Characteristics of WFT

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolling move mode</td>
<td>01</td>
</tr>
<tr>
<td>Ability to measure different surface with different low-speed friction properties</td>
<td>03</td>
</tr>
<tr>
<td>Efficient</td>
<td>05</td>
</tr>
<tr>
<td>Stability of friction measurements</td>
<td>02</td>
</tr>
<tr>
<td>Continuous measurement</td>
<td>04</td>
</tr>
<tr>
<td>Independent of walking speed</td>
<td>06</td>
</tr>
</tbody>
</table>
Theory of WFT

**Theory**: The WFT friction coefficient WFC is the longitudinal friction coefficient calculated by the following equation:

\[ WFC = \frac{M}{R \times P} \]

where \( M \) is the measured torque, \( R \) is the radius test wheel, and \( P \) is the vertical load on the test wheel. The data recorder of WFT computes the friction coefficient at an interval of 0.2 s.
BPT vs WFT

- Test program

Test program

Part A

Laboratory tests

Part B

Field tests

Water film thickness

Testing speed

AC S (T) AC S (L) AC T (T) AC T (L) OCC S (T) OCC S (L) OCC T (T) OCC T (L)

50m asphalt pavement section (MTD=0.61mm)

Centerline of test position L1

Centerline of test position L2

Note: Centerline of test position refers to the center of contact width of the BPT slider or the center of the plane of WFT test tire.
Variability of friction measurements

(a) Effects of MTD on measured BPN values
(b) Effects of MTD on measured WFC values

This figure shows that the CV of BPT measurements increased by about 2.22% for each mm increase in MTD, while the corresponding increase of WFT measurements was only 0.75%.

RPUG-PDRG 1st Joint Meeting
The test time of WFT is less than that of BPN

Especially for assessing the skid resistance of 50 m section, WFT test spent only 2 min but test time of BPT was 46 min. Mechanized WFT took less than 1 min.

In the laboratory test, a test for each plate saved about 2 min by WFT.
Conclusion

1. This report highlights the need and signification of low-speed skid resistance testing for pavements, and has presented the new method for mechanized measurement of low-speed microtexture-related pavement skid resistance.

2. BPT test results had higher variations than WFC in all test cases.

3. The variations of BPT test results on grooved pavements in the direction perpendicular to the grooves was significantly greater than the variations of WFT test results.

4. WFT could save much test time compared to BPT and provide a continuous reading that can describe the changes in friction during the testing trip, especially in the field test.

5. Mechanized WFT is suitable network level low-speed skid resistance testing for identifying polishing problem of pavements.
Welcome to
1st PFDM Symposium 2019
First iSMARTi International Symposium on Pavement Service Functional Design and Management
24-26 October 2019, Xian, China
Hosted by Chang’nan University
TOPICS COVERED.

- Pavement skid resistance
- Tire-pavement noise
- Pavement riding quality
- Pavement surface characteristics

The Symposium will include a day for technical visits (Pavement Surface Function Lab, HVS, Vehicle Test Track etc.).

There will be lectern presentation or forum discussion sessions in one track of sessions.
SUBMISSION DEADLINES:

Abstract deadline: 31 May 2019
Presentation slides deadline: 31 August 2019
Symposium website: www.htp2-pfdm.cn

Symposium Chairs:
Dr. T. F. Fwa, Distinguished Professor, Chang’an University,
Adjunct Professor, National University of Singapore
Dr. Paulo Pereira, Professor, Minho University

Organization Committee Chair:
Dr. Sen Han, Dr. Ouming Xu, Professors, Chang’an University

Symposium Secretary:
Dr. Longjia Chu, Lecturer, Chang’an Uni.
Dr. Yaming Liu, Associate Professor, Chang’an Uni.
Thank you