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

by

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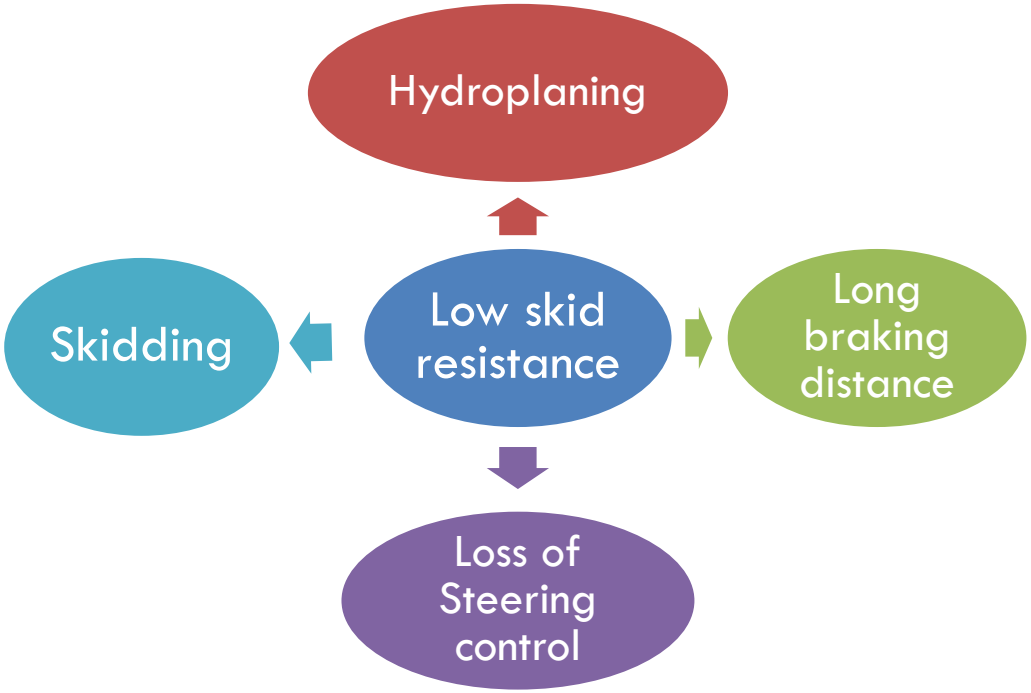
Introduction

The importance of runway low-speed skid resistance



Accidents

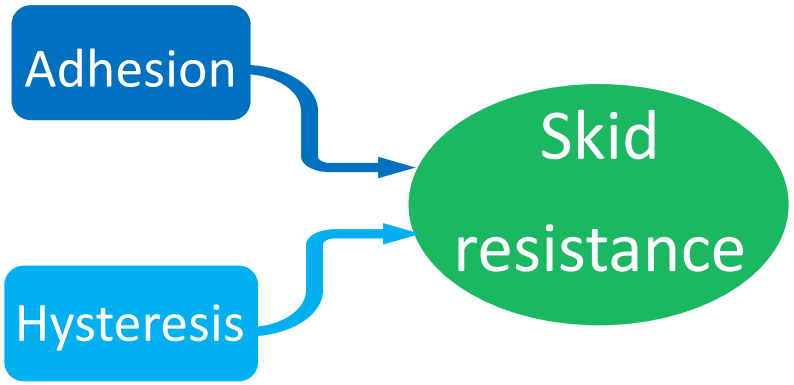
- Skid resistance of pavement is closely related to traffic safety.
- key pavement characteristics that affect the magnitudes of skid resistance are the microtexture and macrotexture of pavement surface materials.

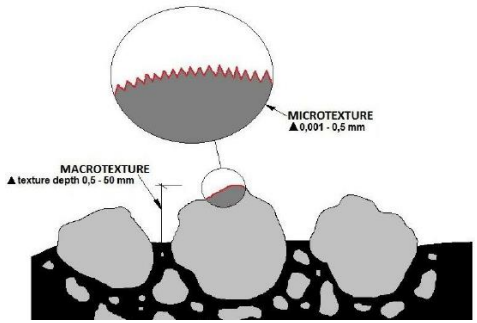
Introduction

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

Skid Resistance Measurements

Devices of skid resistance testing

1 Measure transverse friction with a tyre that is angled to the direction of travel.

Side-force friction testers

Small sliders testers

Slip-speed testers

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

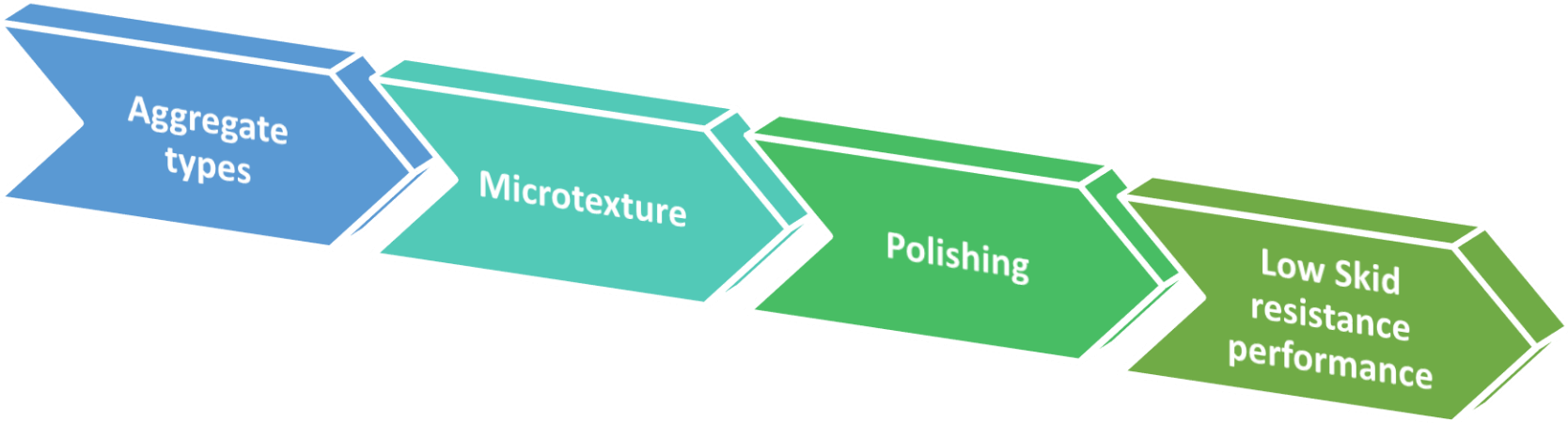
2 Measure longitudinal friction, according the percentage of slip, they are divided into Locked wheel, Fixed slip and Variable slip.

Skid Resistance Measurements

- **Limitation of BPT used for low-speed skid resistance**

- A pendulum impact-type tester . The contact mode and mechanism are different from those between moving vehicle tires and pavement surface
- Unreliable or misleading results on coarse-textured pavement surfaces
- Practical difficulties in levelling the equipment and obtaining consistent test results on sloping or uneven pavement surfaces
- 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.

Description of Walking Friction Tester

First version of WFT

Walking Friction Tester (WFT)

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.

Description of Walking Friction Tester

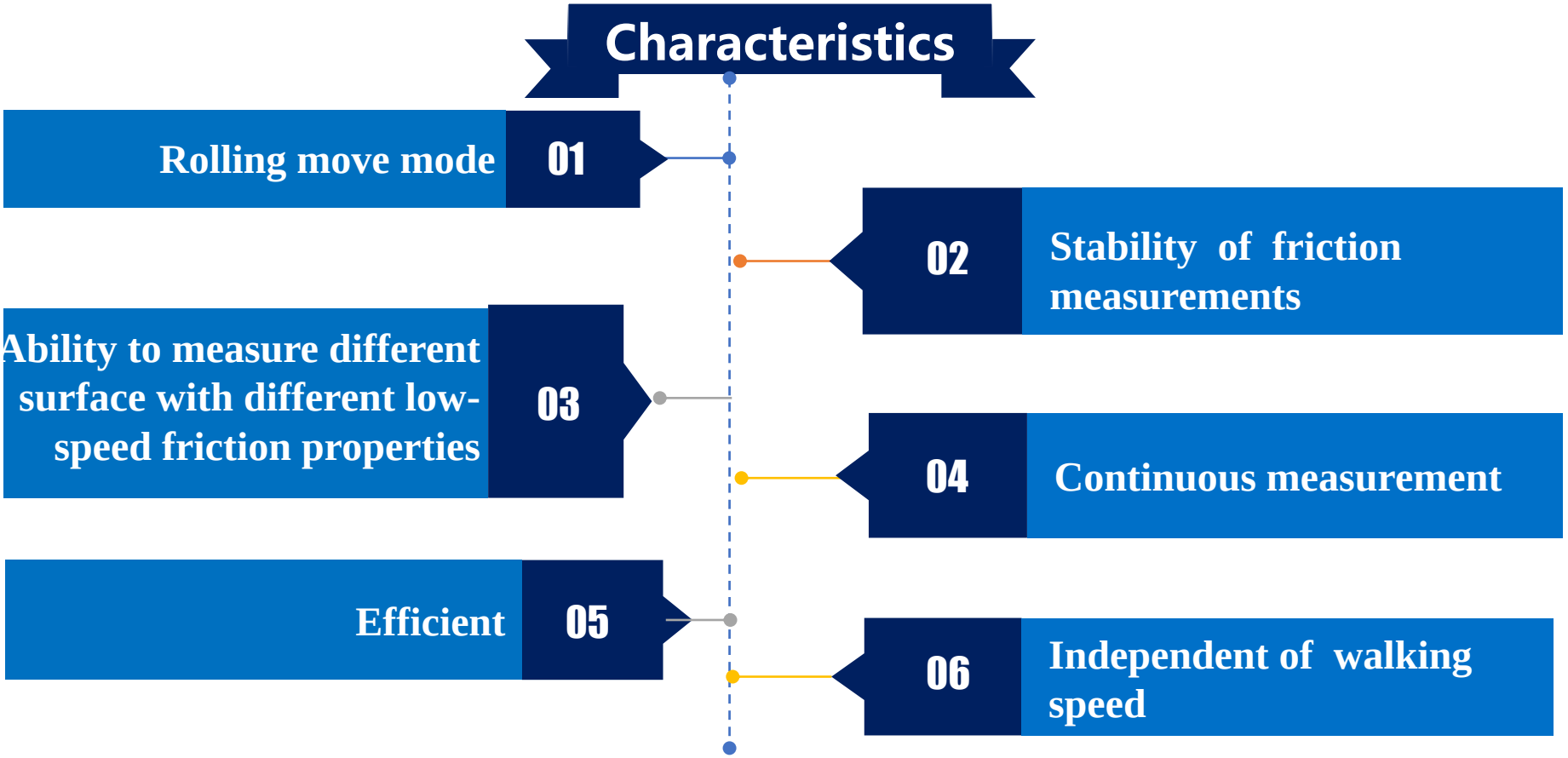
Technical Specification of WFT

Size(without handle, mm)	
Length	980
Width	640
Height	700
Length with handle	2050
Weight(kg)	60
Testing wheel	
Texture	Smooth
Radius(mm)	200
Width(mm)	60
Vertical load(N)	196
Tire pressure(MPa)	0.1
Slip ratio	0%, 10%, 20%, 30%, 100%

Speed	
In the laboratory (m/min)	15
In the field (m/min)	45±5
Counting frequency	
Friction coefficient(s)	0.2
Speed(s)	1
Water spray Capacity (ml/s)	45
Display	R4100
Driving wheel	
Texture	pattern
Radius(mm)	200
Distance to test wheel(mm)	540
Voltage(V)	12

Description of Walking Friction Tester

Characteristics of WFT



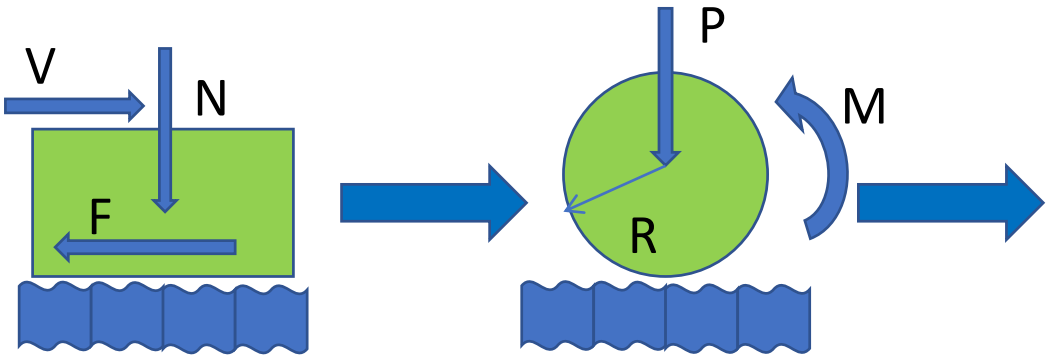
Description of Walking Friction Tester

Theory of WFT

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

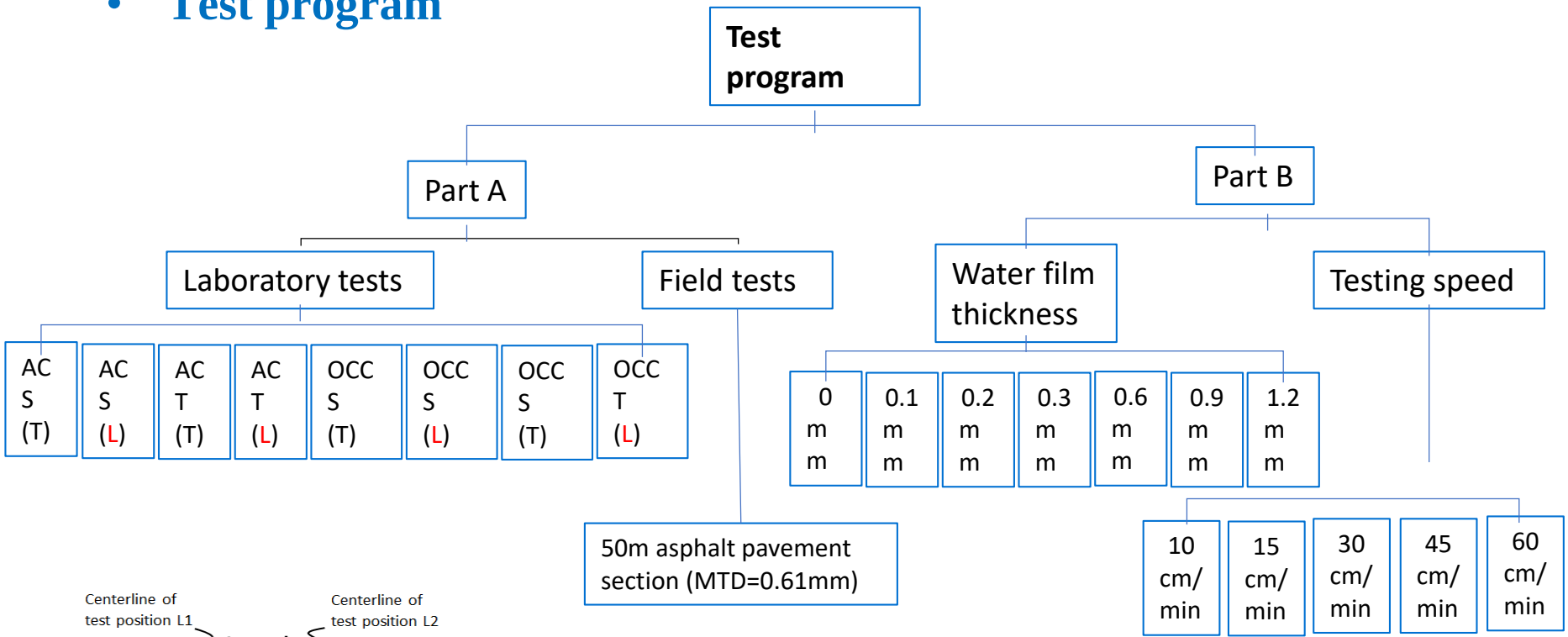
$$WFC = \frac{M}{R \times P}$$

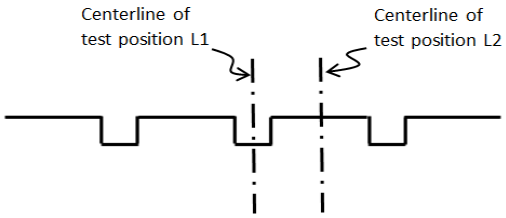
where M is the measured torque, R is the radius test wheel, and P is the vertical load on the test wheel. The data recorder of WFT computes the friction coefficient at an interval of 0.2 s.



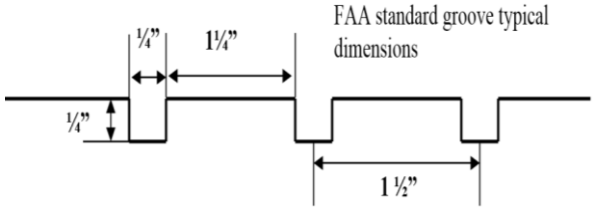
BPT vs WFT

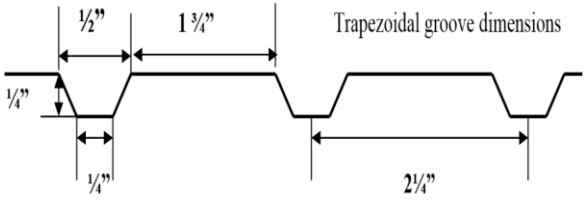
- **Test program**





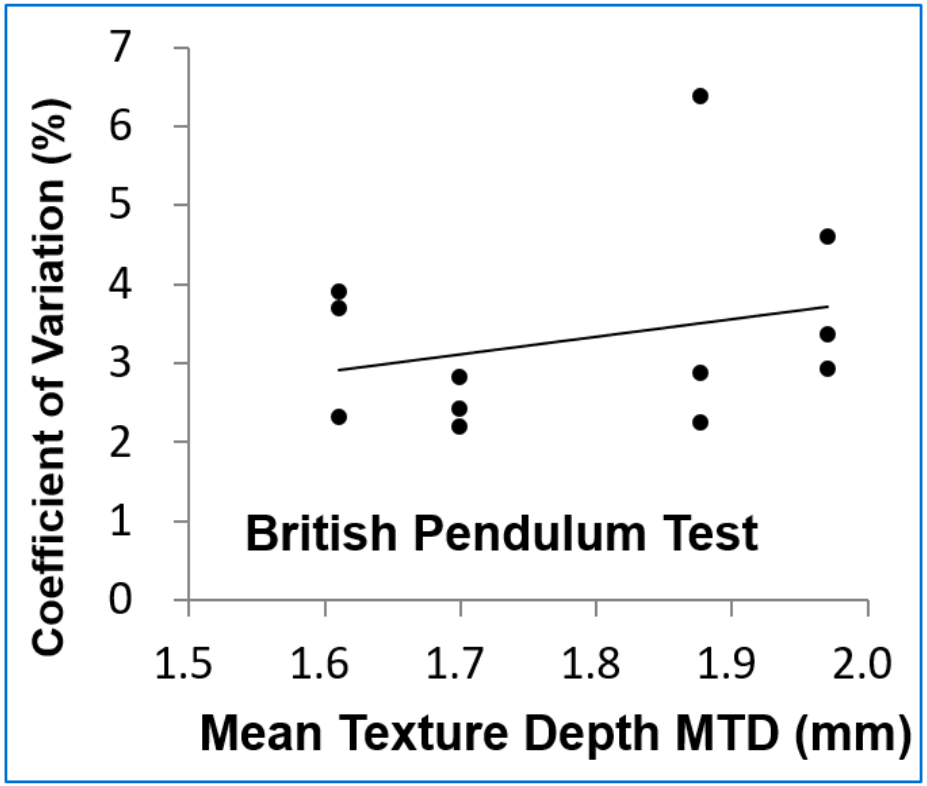
Note: Centerline of test position refers to the center of contact width of the BPT slider or the center of the plane of WFT test tire.



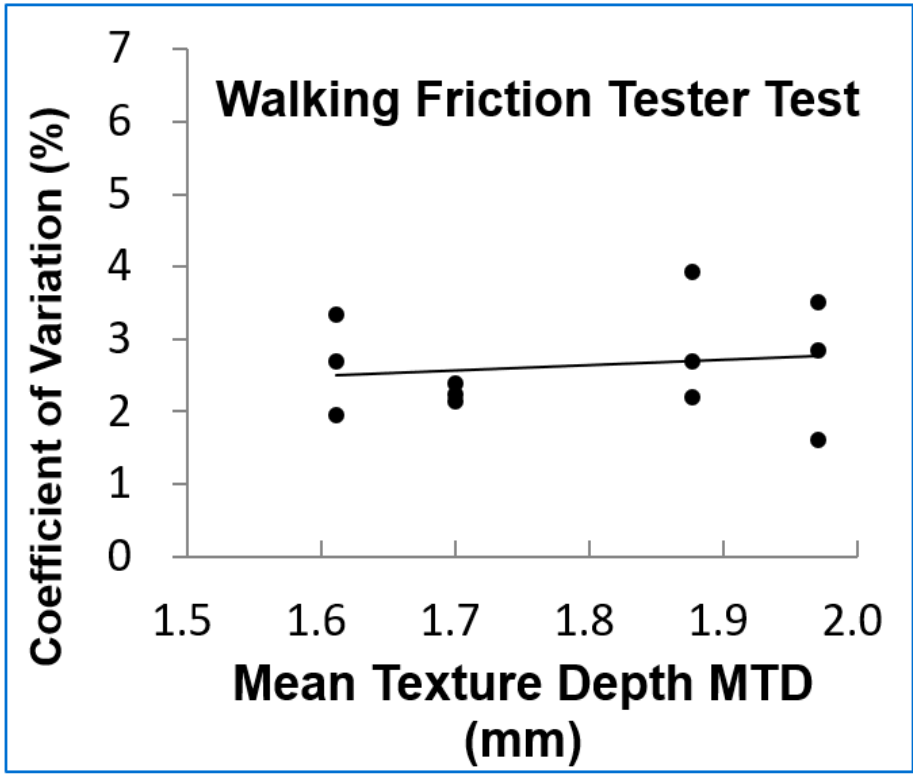


BPT vs WFT

Variability of friction measurements



(a) Effects of MTD on measured BPN values

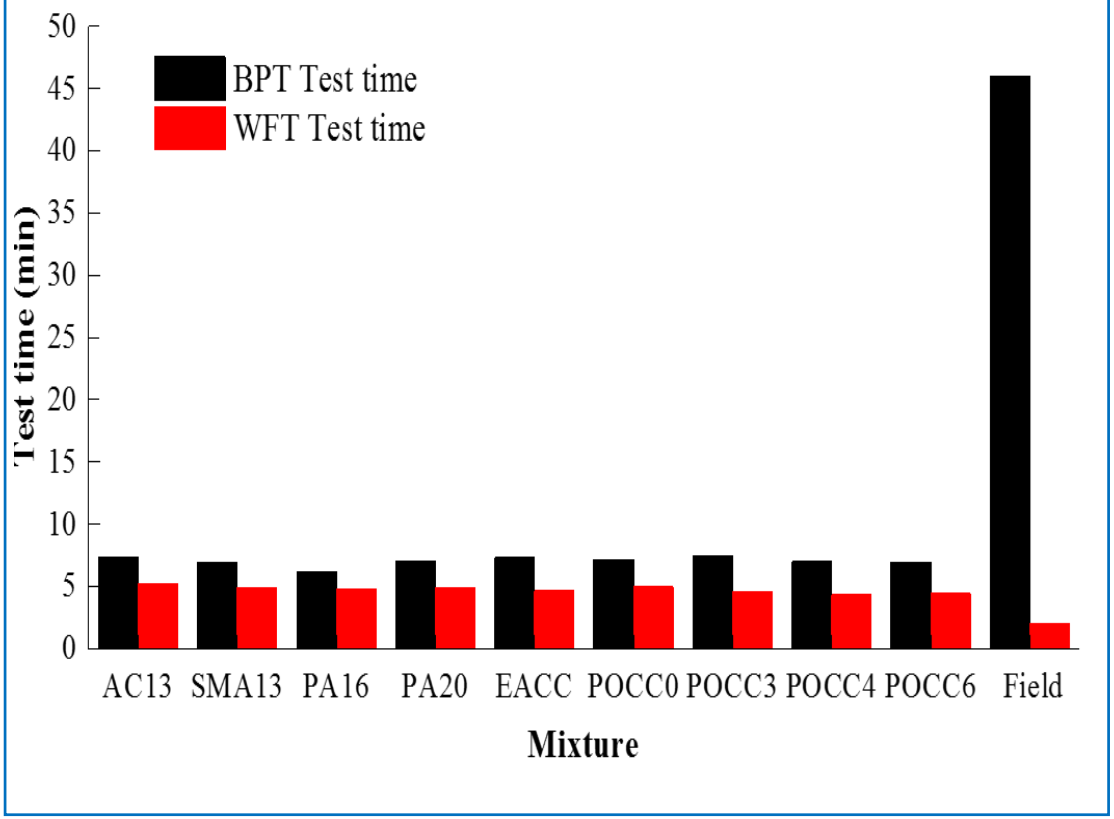


(b) Effects of MTD on measured WFC values

- 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%.**

BPT vs WFT

Efficiency of WFT



The test time of WFT and BPT in the same case

- 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.

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1st PFDM Symposium 2019

First iSMARTi International Symposium on Pavement Service Functional Design and Management

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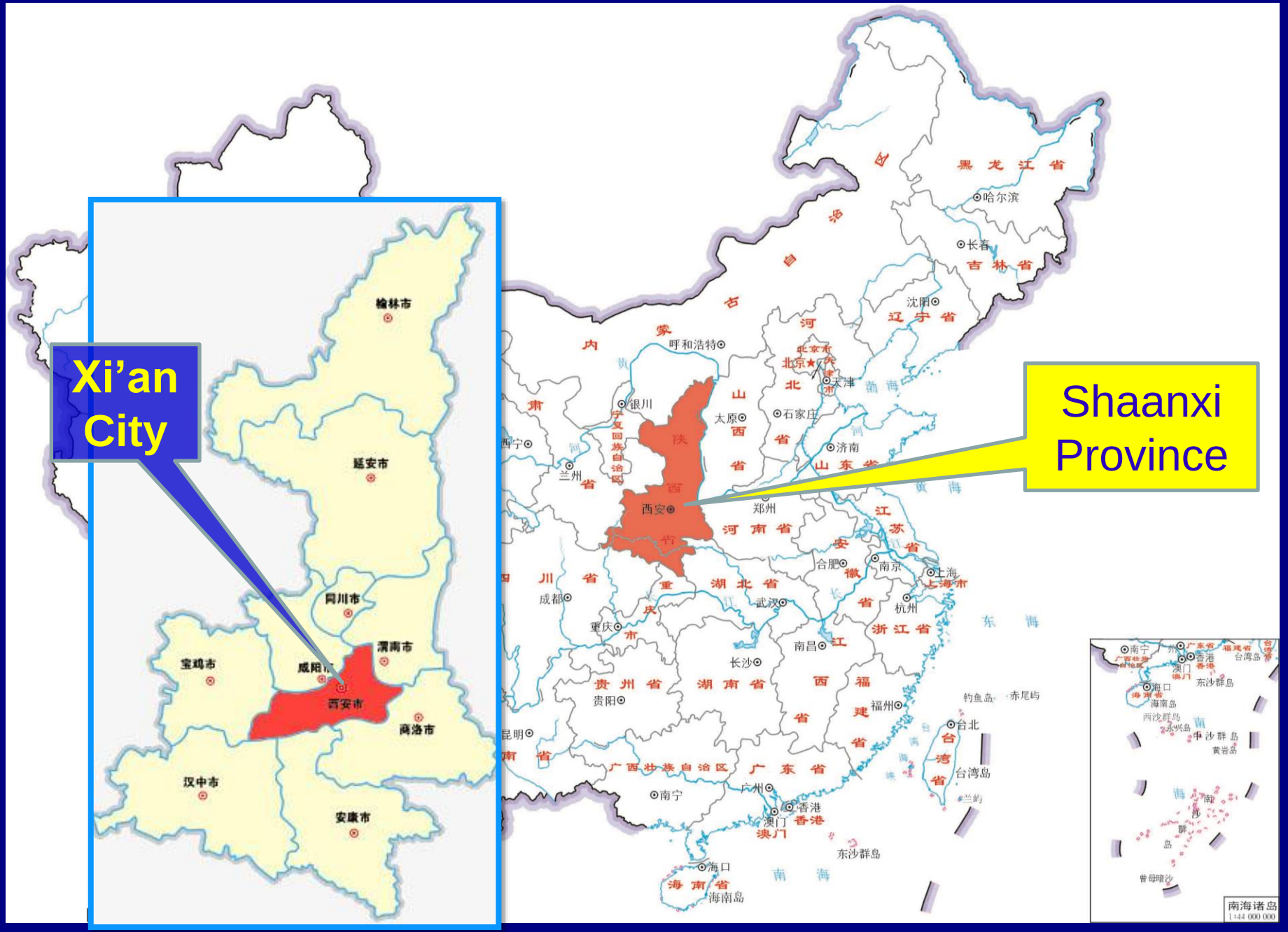
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TOPICS COVERED.

- 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