FINDINGS FROM THE ACCURACY EXPERIMENT OF DEVICES MEASURING FRICTION COEFFICIENT (FC) OF ROAD SURFACES IN THE CZECH REPUBLIC

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Content:

- Introduction – measurement of FC in the Czech Republic
- TP 207 (2017): Round robin tests (accuracy experiments)
- Skid resistance – round robin test in 2018
- Upgraded version of TRT device
- Conclusions
Situation in the Czech Republic

skid resistance:
Czech standard ČSN 73 6177 - classification levels: 1 – 5
- requirements were added to this standard in 2009 – 4 types: for new pavement surfaces, at the end of warranty period, to start prepare a measure, to carry out the measure or lower traffic speed
- in 2015 the measurement speed for motorways was increased to 80 km/h
- detailed analyses – 5 different measurement speeds

macro-texture (MPD, MTD), micro-texture (PTV): 5 class. levels, but skid resistance measurement is preferred/required

Table 3: LFC classification levels for 20 m long road sections according ČSN 73 6177

<table>
<thead>
<tr>
<th>LFC - TRT speed km/h</th>
<th>Classification level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>40</td>
<td>≥ 0.68</td>
</tr>
<tr>
<td>60</td>
<td>≥ 0.60</td>
</tr>
<tr>
<td>80</td>
<td>≥ 0.53</td>
</tr>
<tr>
<td>100</td>
<td>≥ 0.47</td>
</tr>
<tr>
<td>120</td>
<td>≥ 0.42</td>
</tr>
</tbody>
</table>
Situation in the Czech Republic

**Requirements** for 4 parameters LFC, PTV, MPD or MTD according to classification levels:

<table>
<thead>
<tr>
<th>Classification level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>all roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>speed &gt; 50 km/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>speed ≤ 50 km/h</td>
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Acceptance testing of **new pavement surfaces**

Requirements **before the end of warranty period**

Start to **plan a measure**

Carry out the measure
LFC: measuring on new pavement surfaces – before and after putting the road to the operation

- requirement of road administrators
- problematic to clean sufficiently
- preliminary result
- valid result of the measurement to be compared with requirements
Czech national reference device - TRT

for measuring skid resistance - ČSN 73 6177
measuring **longitudinal FC and IRI** (profilometer with a dual-mass response system) allowing different slip ratio from 0 % to 100 %

**routine measurements: slip ratio = 25 % = low slip device**
vertical wheel force is hydraulically controlled: 500-1400 N  \( F = 1000 \text{ N} \)
measuring speeds: 40 to 120 km/h \( v = 60 \text{ and } 80 \text{ km/h} \)

CEN TS 15901-4
Technical regulation TP 207: Round robin tests

5 parameters: \textbf{FC}, MPD, IRI, deflection (FWD), thickness (GPR)

\textbf{FC} - friction coefficient:

- repeatability calculation
- correctness evaluation
- conversion equations of devices to the level of national reference device (regression analysis)

- min. 5 test surfaces - length > 100 m:
  - 40, 60 and 80 km/h 5 runs

- min. 1 used road section (control) - length > 1000 m (IRI ≤ 3):
  - 60 or 80 km/h

- control: wheel position (0.5 m), driven distance (metal plates), speed,…

- requirements for authorization from the Ministry of Transport
Technical regulation TP 207: Round robin tests

**FC - friction coefficient:**

Diagram of a pavement test section with one type of surface
Technical regulation TP 207: Round robin tests

**FC - friction coefficient:**

template for authorization from the Ministry of Transport

**it includes:**

- conversion equations for different speeds

based on results of:

- round robin test
- direct comparison with device
Skid resistance - round robin test 2018

3 devices:
- TRT (national reference device) – measuring in left wheel path
- Skiddometer BV 11 VI – measuring in the middle of wheel paths
- GripTester MK2 – more positions of measurement are possible

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>TRT</td>
<td>with longitudinal controlled slip (LFCT)</td>
<td>1000</td>
<td>25</td>
</tr>
<tr>
<td>-7</td>
<td>Griptester</td>
<td>with longitudinal fixed slip ratio (LFCG)</td>
<td>250</td>
<td>15</td>
</tr>
<tr>
<td>-12</td>
<td>BV 11 and Saab f.t.</td>
<td>with longitudinal controlled slip (SFT)</td>
<td>1000</td>
<td>17</td>
</tr>
</tbody>
</table>
Skid resistance - round robin test 2018

Test sections:
- airport – 6 surfaces (1F - 6F)
  40, 60 and 80 km/h  5 runs
- operated pavement – 1 section (7F)
  60 km/h  2 runs (control)

Line LF1: surface 1F
Line LF2: surfaces 2F, 3F, 4F, 5F a 6F
Skid resistance - round robin test 2018

Test surfaces:

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1F asphalt concrete</td>
</tr>
<tr>
<td>2F concrete surface</td>
</tr>
<tr>
<td>3F asphalt concrete</td>
</tr>
<tr>
<td>4F road marking</td>
</tr>
<tr>
<td>5F road marking with rough surface</td>
</tr>
<tr>
<td>6F surface treatment to increase safety - bauxite</td>
</tr>
<tr>
<td>7F asphalt concrete – road</td>
</tr>
</tbody>
</table>

1F – 320 m
2F – 160 m
3F – 160 m
4F – 160 m
5F – 160 m
6F – 160 m
7F – 1042 m
Skid resistance - round robin test 2018

- basic work with LFC values for 1 m
- checking and correction of driven distance + referencing most important = correct data for evaluation !!!
- the LFC values, depending on the measurement speed, can be adversely affected by inhomogeneity on the road surface, especially in the form of longitudinal unevenness - outliers must be filtered
- after sudden changes in skid resistance, it takes some time to adjust the sensors of the individual devices, at a speed of 80 km/h it may be up to 40 m - such places are not subject to evaluation
- standard deviation - used for repeatability and accuracy
- regression linear model - separately for 40, 60 and 80 km/h
Skid resistance - round robin test 2018

LFC values for 3 devices - each 1 m - surfaces: 4F, 5F and 6F, speed: 60 km/h
Skid resistance - round robin test 2018

Example: comparison of results for TRT and 1 device, LFC for 20 m, speed 60 km/h

LFC before conversion:

LFC after conversion:
Skid resistance - round robin test **2018**

**Example:** LFC conversion for speed *60 km/h*, *20 m* long sections

**Requirements of TP 207:**

- standard deviation $\sigma < 0.03$
- for individual test surfaces / road sections *20 m* long
- correlation coefficient $r > 0.85$
- linear regression model
Skid resistance - round robin test 2018

Next steps:
- authorizations from the Ministry of Transport have been issued
- TP 207 will be adjusted, in the sections on the measurement and evaluation of the round robin test
- test surfaces prepared at the airport for round robin test are maintained and a control measurement is planned before the start of each measurement season
Upgraded version of the TRT device

- 2 new devices
- preservation of wheel load $1000 \pm 300$ N
- preservation of slip ratio from 0 to 100 %, 25 %
- preservation of measuring tyre ASTM E 1551-08 - 20,3 cm (8"")
- hinged suspension of the measuring wheel (UM)
Upgraded version of the TRT device

- measuring wheel braking system with retarder (UM)
- pneumatic system controlling the load of the measuring wheel during measurements (UM)
- 3 utility models
Conclusions

- friction coefficient is measured and evaluated according to Czech standard ČSN 736177
- SRI is not used
- round robin test is carried out according to TP 207 (Ministry of transp.)
- Czech national reference device is TRT
- conversion equations to the level of the national reference device have been established for 2 devices
- reference surfaces from 2018 experiment are available
- 2 new TRT devices will start measuring
Thank you for your attention.

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