Discrepancies between longitudinal high slip and lateral low slip friction measurements on prepared ice surfaces

Niclas Engström¹, Henrik Andrén², Roland Larsson¹, Lennart Fransson²

1 Department of Applied Physics and Mechanical Engineering
2 Department of Civil, Mining and Environmental Engineering
Luleå University of Technology
S-971 87 Luleå, Sweden

1 Introduction

Road surface conditions impact the safety of transportation on the Scandinavian road systems, especially during the winter months. One of the main challenges is to monitor and predict the dangerous conditions. High road grip, i.e. the total friction between road and tires is of great importance in avoiding hazards. The ability to decelerate and change direction quickly is affected mainly by the friction between tires and surface, the normal force is twice as large as on the measurement wheel.

The RT3, pictured in Figure 1 below, measures lateral low slip friction via a wheel, turned a few degrees in comparison to the line of driving. No braking or accelerated force is used for friction measurements, so only side forces are measured.

![Figure 1: RT3 tow hitch model mounted on Mitsubishi L200, in upper left corner tire pattern and in upper right corner display unit.](image1)

The tests were conducted in the following fashion:

- Line up in the left or right lane, according to what type of tires the towing vehicle had.
- Distribute target speed to drivers. Used the speedometer in the vehicle to maintain the speed required. Speeds used were 30 km/h, 50 km/h and 70 km/h.
- Accelerate each vehicle to target speed and maintain it throughout the test.
- RT3 drivers started logging data manually at the “Start” position, marked with a marker. The TWO units started the logging around 100 meters before the “Start” position, see Figure 5.
- Logging of data was stopped at the “End”, also marked with a marker.

2 Equipment

This presentation centers mostly on how the two longitudinal measurement devices Traction Watcher One (TWO) and RT3 differ and correlate in the measurements. The RT3 gives measurements in Halliday Friction Numbers (HFN) and the TWO calculates a friction coefficient $\mu_{\text{TWO}}$. March 18th, 2008.

3 Track

The test track was professionally prepared on Lake Kakel, Arjeplog, by IceMakers. For these tests we used a track divided into three parts, as seen in Figure 4, each part consisting of a man made well defined surface according to Figure 3.

![Figure 3: System 2000 tool, Old System 2000 ice, Brushed old polished ice](image2)

4 Tests

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<table>
<thead>
<tr>
<th>Time</th>
<th>Run Number</th>
<th>Speed</th>
<th>Units on right side</th>
<th>Units on left side</th>
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<td>30</td>
<td>G055, G055</td>
<td>G055, G055</td>
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<tr>
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<td>G055, G055</td>
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<tr>
<td>10:15-10:24</td>
<td>3</td>
<td>30</td>
<td>G055, G055</td>
<td>G055, G055</td>
</tr>
</tbody>
</table>

![Table 1: All the tests relevant for the data gathered. As can be seen, the TWOs changed sides by the end of the day, for comparison.](image3)

Weather conditions were recorded and stable during the day. Ice temperatures were between -4°C (24.8°F) and -3°C (26.6°F).

5 Results

There are two main results presented from this report. The most important one is shown on Figure 5, where the difference of the RT3 and TWO is obvious. Both observations and measurements show that the grip on both kinds of System2000 ice is adequate. But careful measurements show that the RT3 reports a better grip on Old System 2000 ice compared to the New System 2000 ice, whereas the TWO claims the opposite.

![Figure 5: Normalized weighted road grip comparison, all speeds included, with RT3s G053, G056 and TWOs TWOV and TWOT. March 16th, 2008.](image4)

Figure 6: All road grip values from VBOX at 50 km/h together with average and standard deviation.

The other observation from the data is that velocity did not affect the measurements in any discernable way. The measurements from one RT3 represents this in Figure 7, but no measurements from any RT3 or TWO in the test could display any speed dependencies whatsoever.

![Figure 6: Normalized weighted road grip comparison, all speeds included, with RT3s G053, G056 and TWOs TWOV and TWOT. March 16th, 2008.](image5)

![Figure 7: Normalized weighted road grip comparison, all speeds included, with RT3s G053, G056 and TWOs TWOV and TWOT. March 16th, 2008.](image6)

6 Conclusions

The main conclusion from these tests is that there are discrepancies between longitudinal high slip and lateral low slip friction measurements on prepared ice surfaces with fursows. Longitudinal high slip devices measure the absolute grip to be higher on new System 2000 ice compared to old System 2000 ice. Lateral low slip devices measure the road grip to be lower on new System 2000 ice compared to old System 2000 ice. Lateral low slip devices report larger relative difference between surface contacts with high road grip and surface contacts with low road grip compared to Longitudinal high slip devices.

Speed did not affect road grip in a significant way during these tests.

7 Acknowledgements

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