Remote sensors tests on Lithuanian roads

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Overview

• Introduction – RWIS in Lithuania
• Remote sensors test background
• Remote sensors DST111 & DSC111
• DST111 measurements & case studies
• DSC111 measurements & case studies
Introduction – RWIS in Lithuania (1)

• The Lithuanian Road Administration under the Ministry of Transport and Communications of the Republic of Lithuania;
• Lithuania National Significance road network length – 21,320 km;
• RWIS in Lithuanian since 1998;
• RWIS includes: 45 Road Weather Stations (RWS), 18 road video cameras (RVC), 4 weather information signs;
• RWS information on the official internet site; http://www.lra.lt/en.php/traffic_conditions/weather_information/105
• Also in Baltic States and Finish National Road Administration’s supported internet site. http://www.balticroads.net/en/
Introduction – RWIS in Lithuania (2)
Introduction – RWIS in Lithuania (3)
Remote sensors test background (1)

- The main objective of Vaisala Oyj’s pilot project was to compare data from the remote sensors with RWS, RVC and the periodic field measurements and to evaluate operative potential of these sensors on Lithuanian roads. To achieve this objective the following tasks had been defined:
  - Verify applicability and creativity of RWS data;
  - Analyse sensors and equipment specification;
  - Form database and computing programs for further analysis;
  - Perform data comparative study during different weather conditions.

- Pilot project was run from the 6th of December, 2006 to the 17th of April, 2007 (the end of the cold season).
Remote sensors test background (2)

RWS “Bubiai” & DSC111/DST111 sensors on motorway E77 (A12) Riga – Siauliai – Taurage – Kaliningrad in Northern part of Lithuania
Remote sensors test background (3)

- The right side of the 4 lane road (A12)
- Near the bridge across river Dubysa.
Remote sensors test background (4)

- Precipitation sensor OpticEye
- Air temperature & relative humidity sensor
- RVC with IR lamp
- Vaisala DST111
- Vaisala DSC111
Remote sensors test background (5)

- The spot of DSC111 remote sensor is on the first lane between the ruts close to right side

- Visual range of RVC is oriented towards bridge side

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Vaisala Remote Road Surface Temperature Sensor DST111:

- Remote temperature measurement (measuring distance 2 ... 15 m, operating temperature -40 ... +60°C, operating humidity 0 ... 100% RH);
- Unique correction of the error caused by the emission of the road surface, negating the need for emission adjustment;
- Easy installation and service;
- Low maintenance costs;
- No internal moving parts;
- Stable measurement results even with intense traffic (resolution 0.1 °C, surface temperature -40 ... +60 °C, time constant 1 min, data refresh time 30 s);
- Weather-proof, durable design;
- Reports air temperature and humidity;
- Easy integration with Vaisala ROSA Road Weather Station;
- Capability to act as stand-alone device in remote locations with solar/gsm option.
Remote sensors DST111 & DSC111 (2)

Vaisala Remote Road Surface State Sensor DSC111:

- Remote surface state sensing (measuring distance 2 ... 15 m, operating temperature -40 ... +60°C, operating humidity 0 ... 100% RH);
- Spectroscopic measuring principle (surface states: dry, moist, wet, snow/frost, ice, slush);
- Unique measurement of grip (level of grip 0.01 ... 1.00);
- Accurate and stable measurement results even with intense traffic (layer thickness: water 0.00 ... 2 mm, ice 0.00 ... 2 mm, snow 0.00 .. 10 mm);
- Eye-safe laser technology (eye-safe, laser class 1);
- Easy installation and service;
- Low maintenance costs;
- Weather-proof, durable design;
- Easy integration with Vaisala ROSA Road Weather Station, or can operate as a standalone solution with solar/GSM options.
Remote sensors DST111 & DSC111 (3)

- Remote sensor’s DSC111/DST111 complementing, installing, mounting, calibrating, software updating, maintaining tests ran mostly well for Lithuanian conditions.

- Since winter season of 2006-2007 was very short and atypically warm, there is a need for further testing. We need extra testing to decide whether the extensive usage of these sensors in Lithuania is necessary.
DST111 measurements & case studies (1)

- Air, dew point, road surface temperature differences between RWS “Bubiai” and DST111

<table>
<thead>
<tr>
<th></th>
<th>Air, °C</th>
<th>Dew point, °C</th>
<th>Road surface, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean difference</td>
<td>-0,14</td>
<td>-0,86</td>
<td>0,05</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0,32</td>
<td>0,98</td>
<td>0,60</td>
</tr>
<tr>
<td>Mean difference (dangerous conditions)</td>
<td>-0,05</td>
<td>-1,25</td>
<td>0,17</td>
</tr>
<tr>
<td>Standard deviation (dangerous conditions)</td>
<td>0,32</td>
<td>0,61</td>
<td>0,54</td>
</tr>
</tbody>
</table>
DST111 measurements & case studies (2)

- Relation between RWS “Bubiai” and DST111 measured road surface temperatures

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DST111 measurements & case studies (3)

- Measuring difference under different road surface temperature means

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Daily mean road surface temperature flow chart:
- Underestimation: from 7AM to 11AM, max – 0.3°C;
- Overestimation: from 12AM to 5PM, max – 0.3°C.
DST111 measurements & case studies (5)

RWS "Bublal" January 18-19, 2007

- Underestimation
- Overestimation

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DST111 measurements & case studies (6)

RWS "Bublal" January 21-22, 2007

Small fluctuations
DST111 measurements & case studies (7)

RWS "Bubiai" April 12, 2007

Underestimation

Overestimation
DST111 measurements & case studies (8)

- Road surface temperature values **were very similar** (diff. 0.05°C) if temperatures were below 5°C limit when comparing DST111 and RWS sensor’s data.

- Temperature range level was **permissible** (standard dev. 0.6°C) and the data **were possible** to use for road temperature real situation, analysis and forecasting purposes.

- However, when the road surface temperature exceeded 10°C the difference between the two sensors **increased** (even to 4-7°C). DST111 **had not enough accuracy** in warm period in Lithuania, but this period wasn’t important for winter road maintenances specialists.
Mismatch cases for RVC and DSC111 data under different road surface conditions

<table>
<thead>
<tr>
<th>Road surface conditions</th>
<th>RVC Mismatch / Overall</th>
<th>DSC111 Mismatch / Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>4 / 245 2%</td>
<td>34 / 275 12%</td>
</tr>
<tr>
<td>Damp / Wet</td>
<td>13 / 183 7%</td>
<td>144 / 314 46%</td>
</tr>
<tr>
<td>Slush / Snow / Ice</td>
<td>138 / 474 29%</td>
<td>7 / 343 2%</td>
</tr>
</tbody>
</table>
Grip level and road surface conditions measured by DSC111 (2006-12-20)
Grip level and road surface conditions measured by DSC111 (2007-03-08)

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Grip level and road surface conditions measured by DSC111 (2007-03-18)

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Remote sensor DSC111 variables of road **surface state**: 
• 1- dry, 2 – damp, 3 - wet, 6 – snow, 7 – ice, 9 – slush.

**Precipitation type** from RWS “Bubiai” data: 
• 1 - no precipitation, 2 – rain, 3 – freezing rain, 4 - snow, 6 – sleet, 7 – snowstorm.

Road surface conditions from **RVC (CCTV)**: 
• 1 - dry, 2 – damp, 3 – wet, 4 – snow, 5 – slush.

6 variables were derived: 
• **Water** - water film thickness, mm; 
• **Ice** - ice thickness, mm;  
• **Snow** - snow thickness, mm;  
• **PrecType** – precipitation type from RWS “Bubiai” varying from 1 to 7;  
• **SurfState** – road surface state from DSC111 varying from 1 to 9;  
• **CCTV** - RVC data varying from 1 to 5.
DSC111 measurements & case studies (6)
DSC111 measurements & case studies (7)

2.5h

Snow

2007-01-20 - 2007-01-21

Slush
DSC111 measurements & case studies (8)
DSC111 measurements & case studies (9)

• Remote sensor DSC111 data were mostly correct and representative when compared with RVC measurements. Especially when road surface conditions were dry.

• The most inadequate results were under heavy driving conditions (wet / damp / ice / rammed snow on road surface). First reason was that the remote sensor was able to recognize 0.01 mm thick water film on the road’s surface which other devices could not spot. And the other reason was that the remote sensor has a narrow-gauge field of view which was decreasing under snow conditions compared to the road surface size.

• Also measurements may differ because of an inadequacy of thermal road conditions and diverse spread of salt on the road surface.
Acknowledgments to:

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Thank you for your attention!