Accuracy & data quality of WIM systems
NaTMEC 2018
Christoph Klauser & Jeff Rice
Agenda

Weigh in Motion for Enforcement - Improving accuracy

• WIM sensor layouts
• Calibration methods
• Kistler Services

Weigh in Motion for Traffic Data Collection - Improving data quality

• Sensor reliability
• Sensor life time
Kistler WIM portfolio
For DoTs and System Integrators

Scope of WIM site

Lineas quartz WIM sensors
> 20 years

WIM Data Logger
> 3 years

WIM Systems:
KiTraffic Plus
KiTraffic Statistics

WIM Services:
Calibration Service
Road Analysis

2018

NEW

NEW

NEW

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WIM for (Direct) Enforcement

The challenge

How do you get Weigh In Motion data

• With best accuracy on a given road?
• Ensure accuracy for all vehicle types?
  • For all driving maneuvers?
• Under all environmental conditions?
  • With reasonable effort?
Improving accuracy

Sensor layout

- 2 WIM sensors are enough to get weight and speed data
- Additional WIM sensors to better compensate vehicle dynamic effects
- Tilted sensors enable
  - Detection of single / dual tires
  - Improved vehicle classification
  - Lateral position calibration
- Additional loop increase classification accuracy
Improving accuracy

Calibration methods

• **Standard calibration***
  • 2 different Class09 trucks
  • 18 runs in total (3 runs per truck each at min. / intermediate / max. speed)
  • 4 runs after adjustment (1 run per truck at close to min. & max. speed)
  • All runs in the center of the lane
  • All runs with 90 % of max. weight

• **Improved calibration with different**
  • Types of trucks
  • Loading situations
  • Driving positions on the lane
  • Speeds

* In accordance with ASTM E 1318 / 7.5.: Calibration Procedure for Type I, II and III WIM Systems
Improving accuracy - calibration

Impact of verification methods

Verification method:
- Number of different trucks: 1
- Weight: fully loaded
- Driving position: center
- Speed: 50km/h

GVW accuracy: +/-1.5%

Verification method:
- Number of different trucks: 3
- Weight: fully and empty loaded
- Driving position: left & center & right
- Speed: various

GVW accuracy: -10% / +6%
Improving accuracy - calibration
System optimization and lateral position calibration

1. Additional calibration runs to record all dependencies to be compensated
   • Different truck types
   • Weight range: empty and full
   • Driving position: left / center / right

2. Tilted sensors enable compensation of lateral driving position

3. Improved calibration algorithm to optimize system accuracy

Example at uncalibrated test site
Improving accuracy

GVW accuracy performance, verified with
- 3 different truck types
- Full and empty loaded
- Driving position variation
- Speed variation

**GVW accuracy**:

- **Basic calibration**: GVW accuracy: -10%/+6%
- **Improved calibration** (Incl. position calibration): GVW accuracy: +/-2.5%
To achieve best possible weight accuracy, the road of a WIM site must meet following requirements*:

- Homogenous, stiff underground
- Even road surface
- Minimum longitudinal and transversal slope
- Minimum curvature

* For details check ASTM E 1318-09 / 6.1: Site Conditions
Improving accuracy
Kistler’s Road Analysis Service

Kistler’s Road Analysis Service* comprises

**Input data from:**
- Falling Weight Deflectometry
- Road Surface Profilometer

**Benefits of the Road Analysis Service:**
- Recommendation if a road is suitable for a WIM installation
- Optimize WIM system accuracy on a given road
  - Selection of best suitable WIM sensor layout
- Estimate achievable WIM accuracy prior to installation
- Reduced maintenance cost

* Largely used for Direct Enforcement sites.
Conclusion

Advanced calibration and comprehensive road analysis enabled other countries - Czech Republic, Hungary, Russia - to implement Direct Enforcement

Direct Enforcement site in Czech Republic
WIM for Traffic Data Collection

The challenge

How do you get Weigh In Motion data

• with good accuracy in a given road?
  • within your budget?
  • without maintenance?
  • with a long life time?
• under all environmental conditions?
Improving data quality
For Traffic Data Collection applications

Reliability of the measurement chain is key for data quality
- Sensor life time in the road
- Electronics uptime in the cabinet
- Stability over time, environment & loadings

New KiTraffic Statistics WIM system
- Provides reliable WIM data
- Designed for
  - Traffic Data Collection
  - Count & Classify

KiTraffic Statistics components:
- New Lineas Compact subsurface quartz WIM sensor
- Kistler’s WIM data logger
- Prewired system components with loop card
Improving data quality
For Traffic Data Collection applications

Key Characteristics
- Lineas Compact is installed 20 mm below road surface
- Sensor lifetime = road-surface life time
- Installation possible in roads with rutting
- Meet ASTM Type I & II accuracy requirements
- Easy installation due to prewired components
- Web based Graphical UI & Machine readable REST API

Subsurface installation of Lineas Compact
Web based GUI
Improve data quality
Lineas Compact Sensor reliability

Extensive testing verifies durability of Lineas Compact sensors

Millions of load cycles
at extreme temperatures
exposed to corrosive substances
Improving data quality
KiTraffic Statistics

First installations

Switzerland

USA

Runs with only one vehicle
Advantages of Lineas Compact Sensors compared to existing solutions

- Proven technology - based on Lineas 9195
- Long sensor lifetime - no ageing (change over time)
- Stability of measurements - quartz is temperature independent

The right sensor for each application:

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Count &amp; Classify</th>
<th>Data Collection (ASTM Type II – 15%)</th>
<th>Data Collection (ASTEM Type I -10%)</th>
<th>Enforcement (ASTEM Type III - 6%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lineas Compact</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Lineas 9195</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

Achievable GVW accuracy*

- Medium
- Medium
- High
- High

Lifetime

- High
- High
- High
- High

Total Lifecycle Cost

- Low
- Low
- Medium
- Medium

* Increase number of sensor per lane for better accuracy
KiTraffic Statistics WIM system enables

- Count & classify vehicles
- Cost efficient traffic data collection
- Better maintenance planning

KiTraffic Statistics is the key to sustainably managed road infrastructure
Open questions?

Thank you for your attention!