The ROADEX IV Project

Ron Munro, Munroconsult Ltd

Timber Transport Forum Conference 2010
Perth, Thursday 11th March 2010
ROADEX Update

Outline:

- Background
- Demonstration projects
- Example: vehicle-human vibration
- FCE/ROADEX seminar Stirling 23 June 2010
EU Northern Periphery Programme
# The ROADEX Partners:

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<td>🇸🇪</td>
<td>Lead Partner, The Swedish Road Administration Northern Region, The Swedish Forest Agency</td>
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<td>🇫🇮</td>
<td>The Finnish Road Administration, Lapland District</td>
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<td>The Government of Greenland</td>
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<td>The Icelandic Road Administration</td>
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<td>The Northern Region, Norwegian Public Roads Administration</td>
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<td>The Highland Council, The Forestry Commission, Comhairle Nan Eilean Siar</td>
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<td>National Roads Authority, Department of Transport, Ireland</td>
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<td>🇨🇦</td>
<td>Associate Partner: The Forest Engineering Research Institute of Canada, (FERIC)</td>
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Project Consultant: Roadscanners Oy, Finland
Project structure

**Project Manager**

- **Dissemination**
  - Website
  - Knowledge Centre
  - Consultancy
  - eLearning

- **Demonstrations**
  - 7 countries
  - 11 Partners
  - 25 projects

- **Research**
  - Climate change
  - Vehicle vibration
  - Road widening
Demonstration categories

- **Drainage maintenance**
  - Timo Saarenketo

- **Low Impact Vehicles & TPC**
  - Pauli Kolisoja

- **Forest road policies**
  - Svante Johansson

- **Design against rutting**
  - Pauli Kolisoja

- **Rocks on Peat**
  - Haraldur Sigursteinsson

- **Vehicle-human vibration**
  - Johan Granlund
Locations of the demonstrations

Location of a demonstration project
Demonstration D6: Vehicle-human vibration
Lateral vibration due to road condition
Health effects due to ride vibration & shock

• Ride vibration (bounce, pitch and roll) 0.5 – 80 Hz:
• Resonance in eye globes, head, spine, stomach,
• Pain in neck, shoulders and back
• Lower back pain elated to annual mileage
• Bumps cause spinal stress
• Undulations create drowsiness

Whole-Body Vibration

Whole-Body Vibration
EU 2002/44/EC
Physical Agents Directive (Vibration)

- Covers workers only – not passengers
- Refers to ISO 2631-1*
- Based on a "daily exposure" of 8 hours $A(8)$
- Truck drivers exposure often exceeds the Action Value of $0.5 \text{m/s}^2$ which requires Employers to "take technical and/or organisational measures to minimize vibration exposure"
- All work that exceeds the $A(8)$ exposure limit of $1.15 \text{m/s}^2$ is prohibited

* ISO 2631-1:1997 “Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration”
Typical ride vibration levels

From ISO 2631-1*:  
- < 0.3 m/s\(^2\) is ”not uncomfortable”
- > 0.5 m/s\(^2\) is ”fairly uncomfortable”
- > 2 m/s\(^2\) is ”extremely uncomfortable”

EU Action Value  
A(8) = 0.5 m/s\(^2\), average over 8 hours

Heavy trucks  
- 0.2 to 1.6 m/s\(^2\) average for route
- > 2 m/s\(^2\) at bumps

Passenger cars  
- 0.1 to 1 m/s\(^2\) average for route
- up to 2 m/s\(^2\) at bumps

* ISO 2631-1:1997 “Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration”
Vibration tests on Road 331 “The Beaver Road”, northern Sweden

- 170 km 2 lane regional route
- Daily traffic of 350 to 2,000 vehicles per day.
- Speed limits of 70 and 90 km/h, 50 km/h through villages.
Haulage company: Brorssons Åkeri AB

- 2 mobile cranes
- 14 timber logging trucks with trailers
- Each truck runs 18 hrs/day (8 hrs on Fridays)
- Annual mileage 200,000 km/truck
- All trucks and trailers are changed every 3 - 4 years
- ROADEX test: 4 days of 2 x 140 km
The truck ride sensors:

- Z-axis 1 kHz at L and R frame.
- Z-axis at L and R front wheel axles.
- GPS + 6-axis 100 Hz inertial unit in the cab.
- X, Y, Z-axis 1 kHz seat pad.
- Videocamera for visual reference.
- Microphone for interior noise < 5 kHz.
Road surface measurement

A laser/inertial Profilograph scanned the test road’s surface condition 20,000 times per metre.

Photo: Mats Landerberg
“Rock n’ Roll” at Backe:

Note the warping between the truck and the trailer.

In-truck data:
3.5°/s change in cab roll angle
“Rock n’ Roll” on the Åkerö straight:

Truck cab roll angle:
- Very high rate; 5°/s (at high freq).

High lateral acc in cab: 2 m/s².

Very high lateral acc at the driver seat: 3.5 m/s² (+ 75 %)
Typical 3D lasercan of edge deformation at Åkerö:

Note: Exploded truck tire

The 1.18 % RBCS variance was caused by a 69 mm deep deformation

RBCS = Rut bottom cross slope
Bumps at culverts:

3D laserscan of settlement at a culvert repair

79 mm deep hollow
Transient vibration can cause high compression stresses in the spine; a special health risk.

The worst bumps gave $S_{ed} > 0.5$ MPa. Exceeding this stress level corresponds to health risk, as per ISO 2631-5 (2004).

$S_{ed} = “Equivalent daily static compression dose”$
Average daily vibration exposure $A(8)$ (EU Directive 2002/44/EC)

Results for normal driving shifts, taking roundtrips from the forests to the coast:

$A(8) = 0.76 \text{ m/s}^2$, over EU Action Value $0.5 \text{ m/s}^2$. 
Tests in Finland, Norway & Scotland

Reproducing the case study from the Beaver Road

1. Measuring truck drivers daily vibration exposure, $A(8)$.  
2. Measuring spine compression, $S_{ed}$, caused by jolts at severe bumps.  
3. Relating truck roll & lateral buffeting to road edge deformation.
!!Advance notice – Free seminar!!

FCE/ROADEX seminar on ”Low Impact Vehicles and TPC”
Stirling, Wednesday 23 June 2010

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<td>Case Study</td>
<td>David Leslie, James Jones &amp; Sons Ltd</td>
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