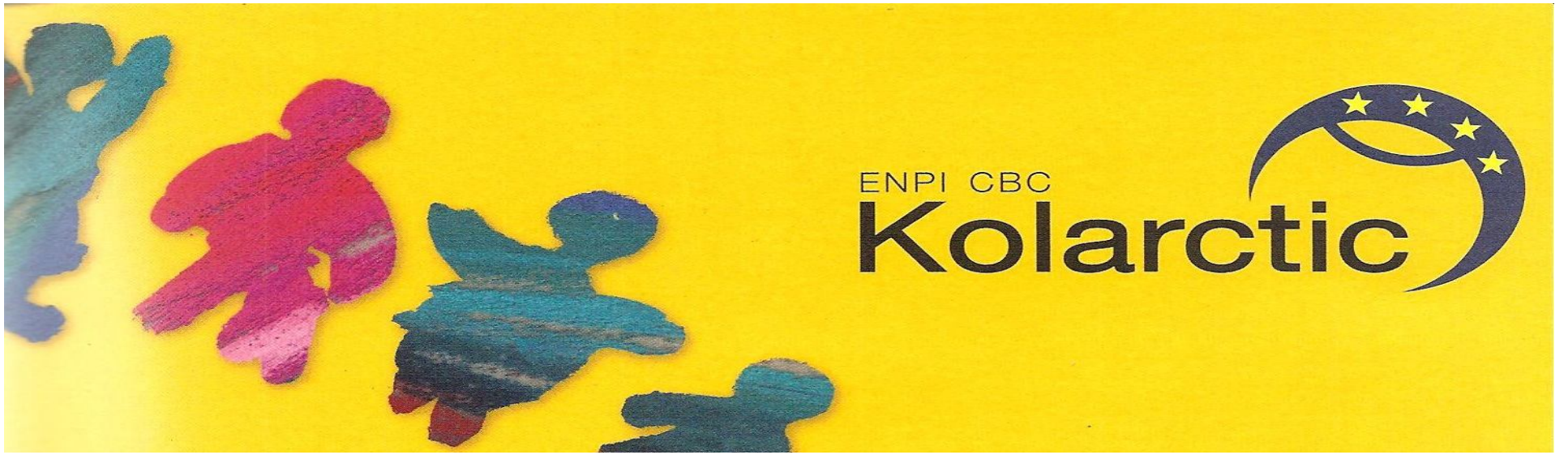

Poor road condition as a health risk

Johan Granlund, Chief Technology Officer
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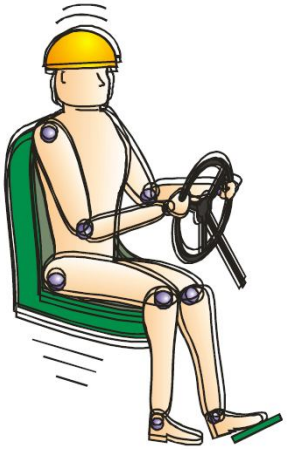
Poor road condition as a health risk

Photo: Max Risberg, Vectura



Pic from ”EU Guide to Good Practise on Whole-Body Vibration”

1. High vibration dosis at any work => Disease risk
2. Intense vibration in a vehicle => *Also* safety risk

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Outline

Health and safety aspects on ride vibration.

Disproportionate risk on rural low volume roads.

EU legislation on vibration at work.

Roadex demonstration projects in Finland, Scotland, Norway and Sweden.

Identifying road features decisive for risk factors:

•ride vibration,

•lateral force (both quasi-static and transient),

•poor road surface drainage, and

•low friction; often in combo with split friction,

using data from high speed road profilometers.

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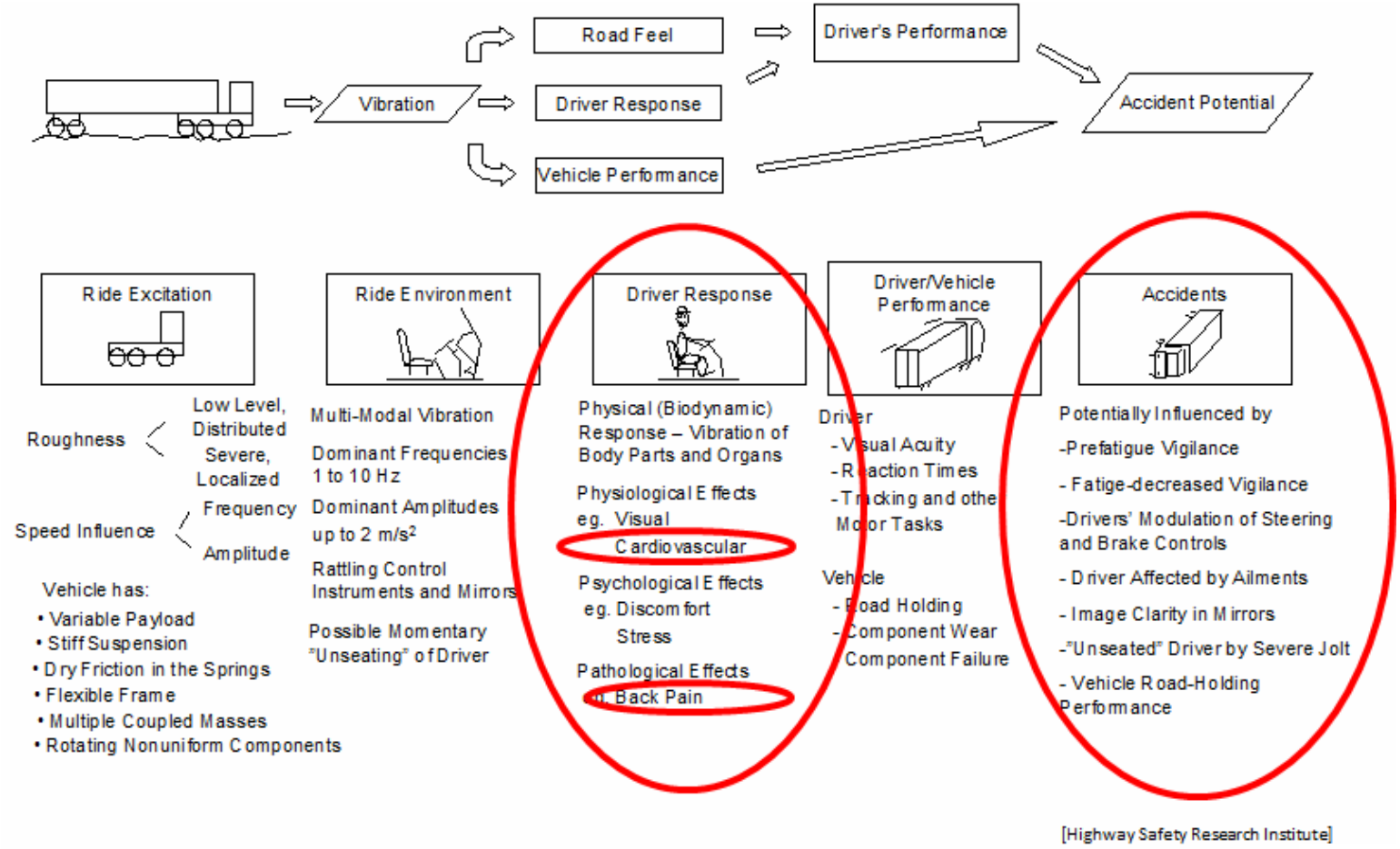
Health and safety issues raised by ride vibration



[Highway Safety Research Institute]

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Health effects from ride vibration/shock

- 0.5 – 80 Hz ride vibration; Bounce, Pitch and Roll
- Human is most sensitive for Whole-Body Vibration (WBV) at these frequencies
- Resonance in eye globes, head, spine, stomach…
- Bumps – stressing effect (long term: fatigue)
- Undulations – create drowsiness
- Truck seat vibrations are often in the ”Health caution zone” set in standard ISO 2631-1.

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Current medical knowledge on health effects from WBV

- Low Back Pain: Confirmed!
- Sciatica / Herniated discs: Confirmed!
- Arthrosis: More research needed.
- Miscarriage: More research needed, Regulation.
- Male fertility: Clearly indicated, more research…
- Viscus/Guts: No scientific support.
- Heart: Several findings, more research needed.
- Prostate cancer: Handful studies, more research...
- Motion sickness: Confirmed!
- Performance: Several findings, more research...
- Mortality: Complex findings, more research...

Sources: Swedish Work Environment Authority Report 2011:8 and Work & Health (Arbete & Hälsa) Report 2012:46

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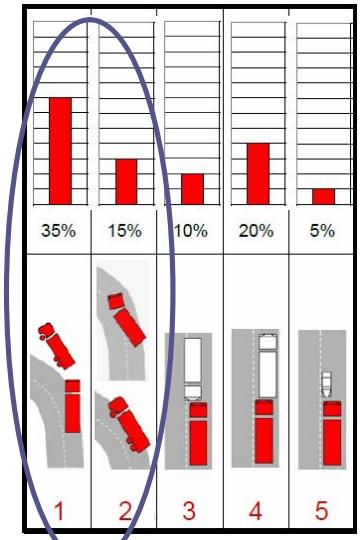
Heavy vehicles are extra susceptible to lateral forces

The crash type were most truck drivers are injured is the *rollover*. A high C.O.G. makes the heavy vehicle prone to improperly banked outercurves.

Crashes with severely injured truck drivers / passengers



Source: Volvo Trucks crash investigation

Typical number of truck rollovers:

- **Norway: 200 per year**
- **Finland: 200 per year**
- **Sweden: 650 per year**

Source: Insurance-companies IF & LF

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Disproportionate risks in the rural EU Northern Periphery

153 % higher risk to die in a vehicle crash in rural NP areas, than in Stockholm, Gothenburg & Malmoe.

NP road crashes take 39 % more lives than the worst therapeutically treatable “big killer” Diabetes Mellitus.

Truckies 3 times higher prevalence of heart disease.

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EU health & safety legislation 2002/44/EC on vibration at work

For truck drivers with exposures exceeding the Action Value A(8)= 0.5 m/s² (or intensive shocks):

- **Driver must be sent to special health survey.**
- **Driver must be informed on all risks.**
- **Haulier must take technical and organizational actions to MINIMIZE vibration.**

Not proper risk assessment, no action taken?
- Standard fine 100 000 Euro (Sweden).
Supervision of foreign truck companies?

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Roadex demonstration projects in Finland, Scotland, Norway and Sweden

Demonstrating the ROADEX method for recording vibration in drivers and reconciling the data collected with road condition measured by profilometer.

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Roadex demonstration projects in Finland, Scotland, Norway and Sweden

Scopes:

1.Measuring truck drivers daily vibration exposure, A(8), comparing to the Action Value 0.5 m/s^2 in 2002/44/EC.

2.Measuring spine compression, S_{ed}, comparing to 0.5 MPa stress limit in ISO 2631-5.

3.Relating measured truck roll & lateral buffeting to the new road condition parameter RBCSV (indicating non-uniform road edge deformation), which is measured with laser profiler.

4.Relating truck ride quality to (winter) road condition.

5.Vibration isolation by Tyre Pressure Control?

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3700 km demo. measurement



Partner	Location	Vehicle
Lapland	Hw 21 Pello – Kilpisjarvi. Raattamaa road. 763 km	Grocery/Beer
Highland	Local roads at Fort William A82 to Inverness. 512 km	Timber haulage
NPRA	E6 Fauske - Trondheim. 636 km	Chilled fish
STA	E4, roads 87, 323, 331, 335, 1035 and local roads in Ramsele forest area. 1417 km during spring thaw (very rough). 450 km reproduced in autumn.	Timber haulage

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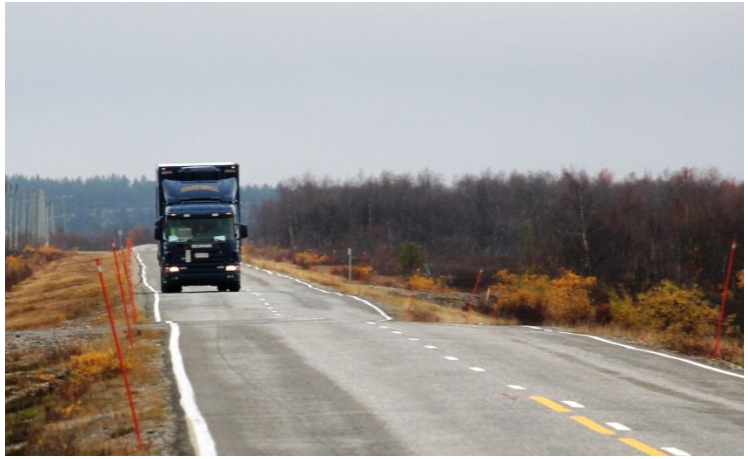
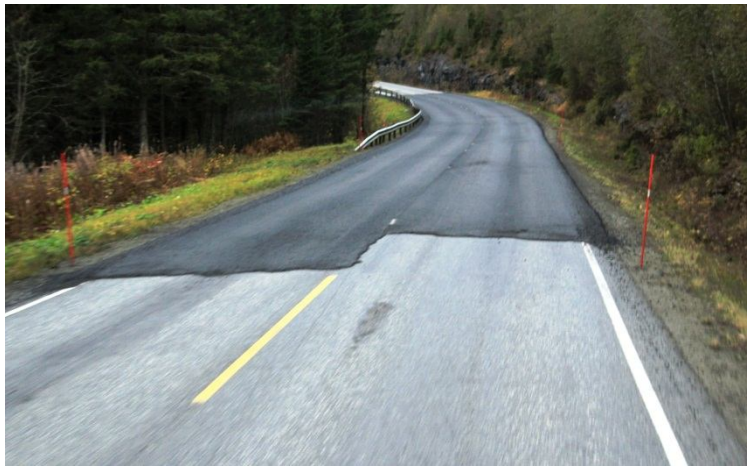
Demo route photos





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Some results from the demo projects

In most of the typical truck operations in the Northern Periphery, the driver´s daily exposure to vibration exceed EU Action Value A(8) = 0.50 m/s^2.

Frost-related roughness makes the ride much worse.

In many cases the spinal compression stress exceeded the health caution limit of S_{ed} = 0.50 MPa.

Hazardous lateral buffeting is a common problem on all demo routes. Road sections causing roll vibration and lateral buffeting are detected with the RBCSV road condition parameter, derived with high speed road profilometer.

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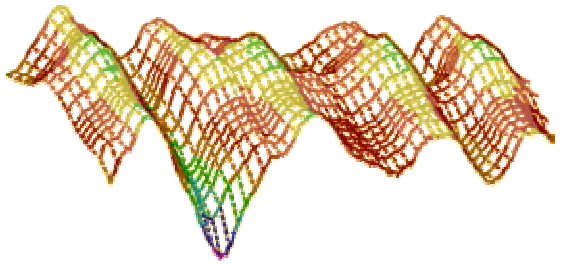
Use high-speed profilometer to identify risk factors



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Identifying risks: Ride vibration

International Roughness Index **detects 0.5 – 30 m waves.**
Note: IRI does NOT measure waves < 0.5 m, ie potholes.
Use *MegaTexture* parameter to detect surface damage such as ravelling and potholes with waves < 0.5 m.

Dirt roads may be extremely rough and have high variance in stiffness; “soft spots” cause heavy vehicles to bounce.

Corrugation in ice-capped winter roads? Use *truck-mounted accelerometers* to monitor winter roads and dirt roads.

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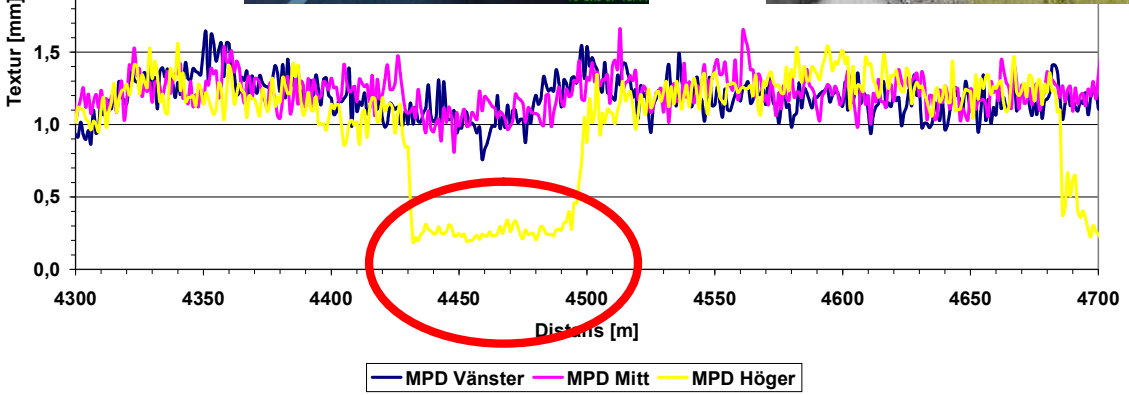
Identifying risks: Low friction



5 crashes in 2 weeks, after patch work.
Patch texture far below intervention level ”Minimum 0.6 mm”.
This equals having slick worn tires on one side of the vehicle.

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High texture and high surface friction number are not enough… ;)

Photo: Johan Granlund, Vectura

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Hydroplaning at banked outer curve

Oncoming Heavy Goods Vehicle brakes at entrance of curve. The waterfilm is very thick just there, due to improperly designed Drainage Gradient (DG).

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Insufficient drainage gradient (DG)

-Hot spots located at entrance/exit of outercurves.

$$DG = \sqrt{(i^2 + E^2)}$$

Right hand traffic

Left hand traffic

DG lower than 0.5 % is a key cause to the fact that outer curves show <u>5 times higher rate in fatal crashes</u>!

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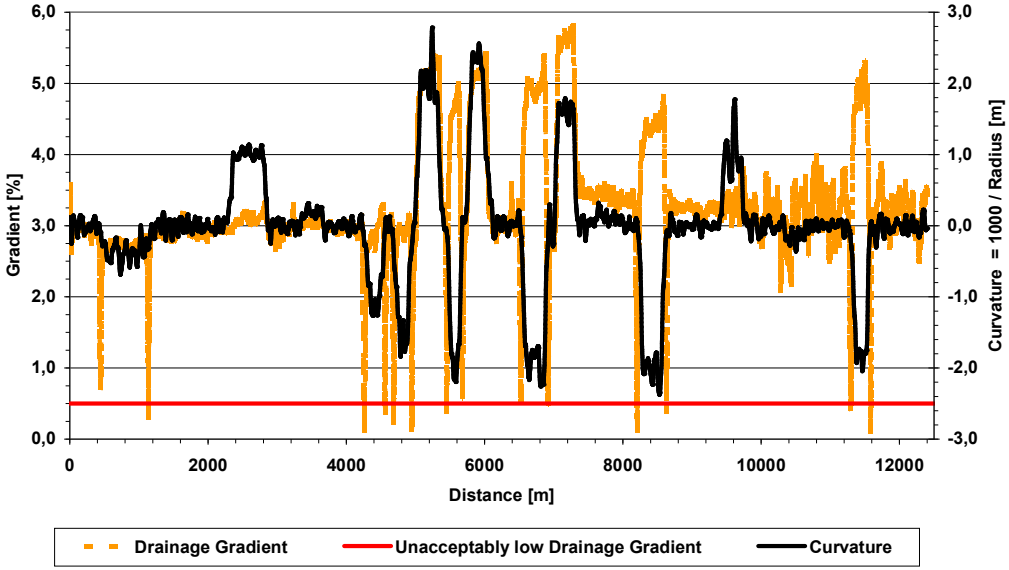
Identifying risks: Hydroplaning



Use road profiler data on crossfall and grade to calculate Drainage Gradient.

Example: 12 risk sections with DG lower than 0.5 % in a 12 km long new road.

All risk sections located at entrance/exit of banked outercurve.

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Lateral buffeting

As a truck rolls, it experience lateral buffeting.
This may trigger a skid crash.
If worser than 5 m/s^2, cargo latches may break.
A root cause is deformed weak road shoulder.

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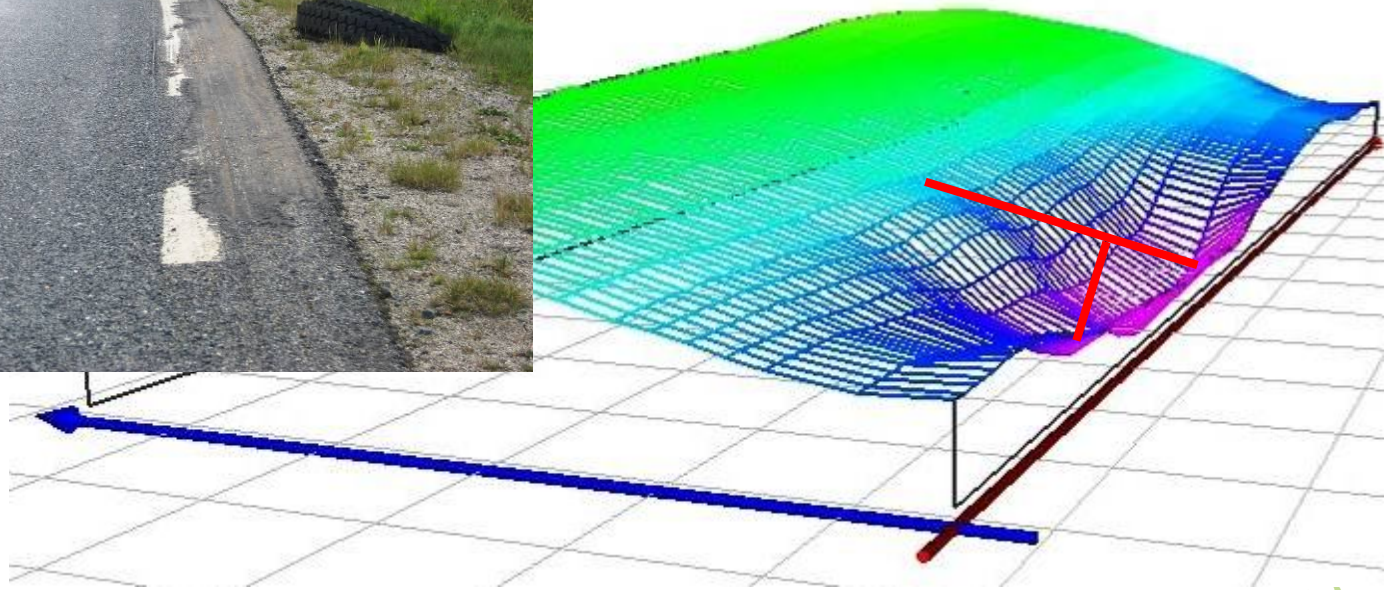
Identifying risks: Lateral buffeting

Note: Exploded truck tyre

A 69 mm deep deformation



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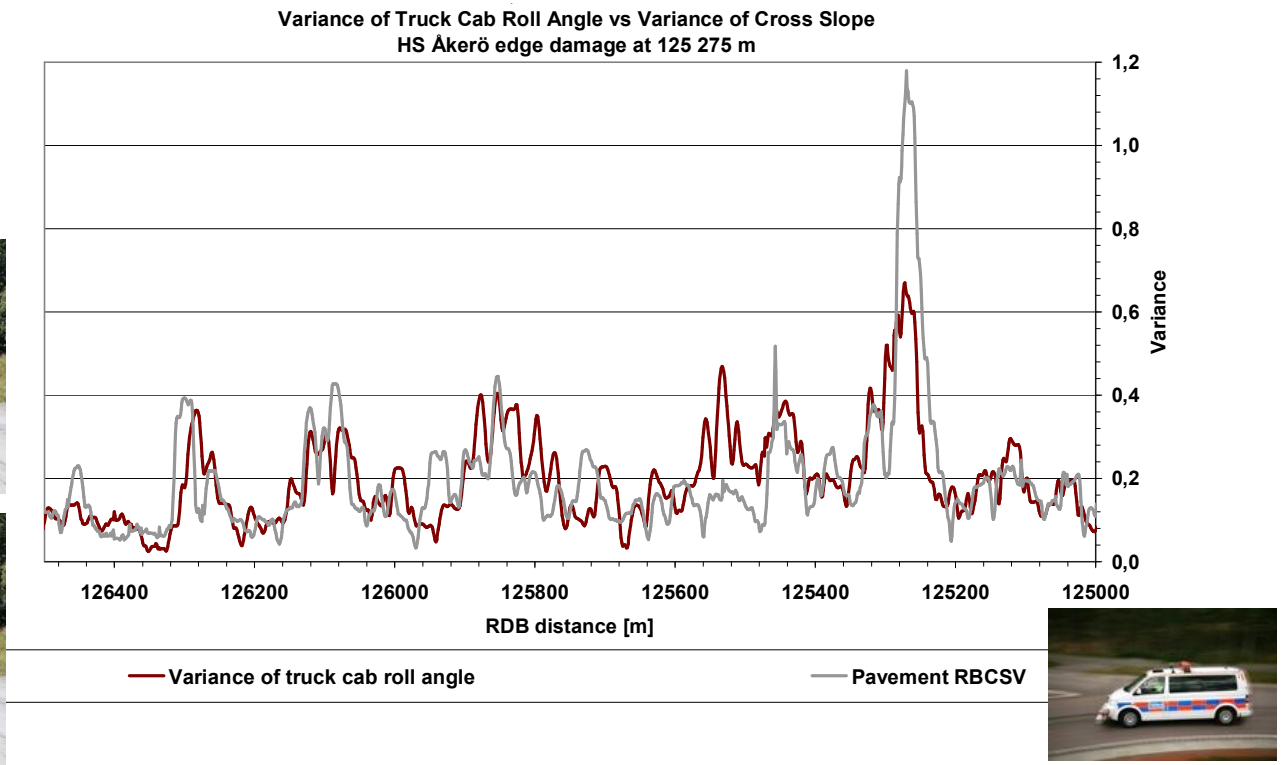
Identifying risks: Lateral buffeting



Road "warpiness" is detected by the new RBCSV parameter. Limit value 0.30 %.

Read report & paper for details.

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Summary

Health and safety aspects on ride vibration.

Disproportionate risk on rural low volume roads.

EU legislation on vibration at work.

Roadex demonstration projects in Finland, Scotland, Norway and Sweden.

Read the Roadex report to learn details on how to identify road features decisive for risk factors, using data from high speed road profilometers.

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Health Issues Raised by Poorly Maintained Road Networks

Content:

- **ROADEX III Report, 2008**
- **PIARC Video Lecture, 2008**
- **HVTT11 Symposium Highlight Paper, 2010**

Available at www roadex.org, www.videolectures.net and www.hvttconference.com

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