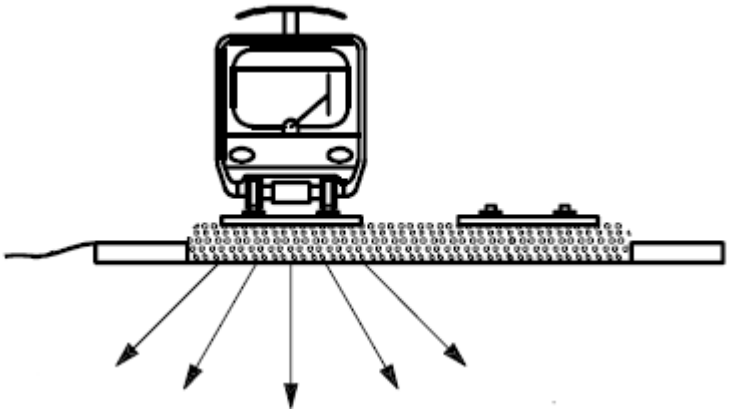
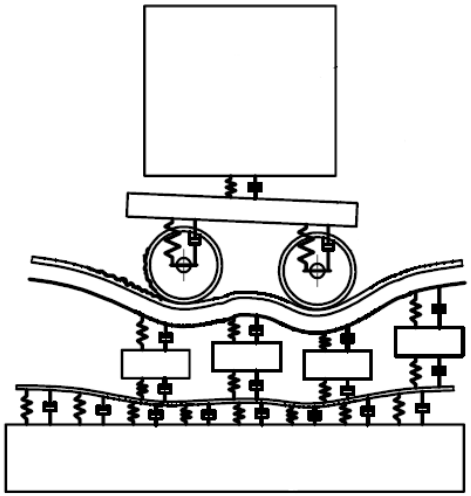
RIVAS
Towards targeted maintenance to reduce vibrations
WP2: Mitigation measures at source

October 26th, 2012

Vibration sources





Train-induced vibrations:

- Quasi-static component
  - Axle load and distance
  - Vehicle speed

- Dynamic excitation
  - Dominates
  - Wheel/rail irregularities
  - Irregularities in support stiffness

RIVAS WP2

Objectives

1. Define

Influence of track/wheel condition on GBV levels
- *Simulations (+ validation)*

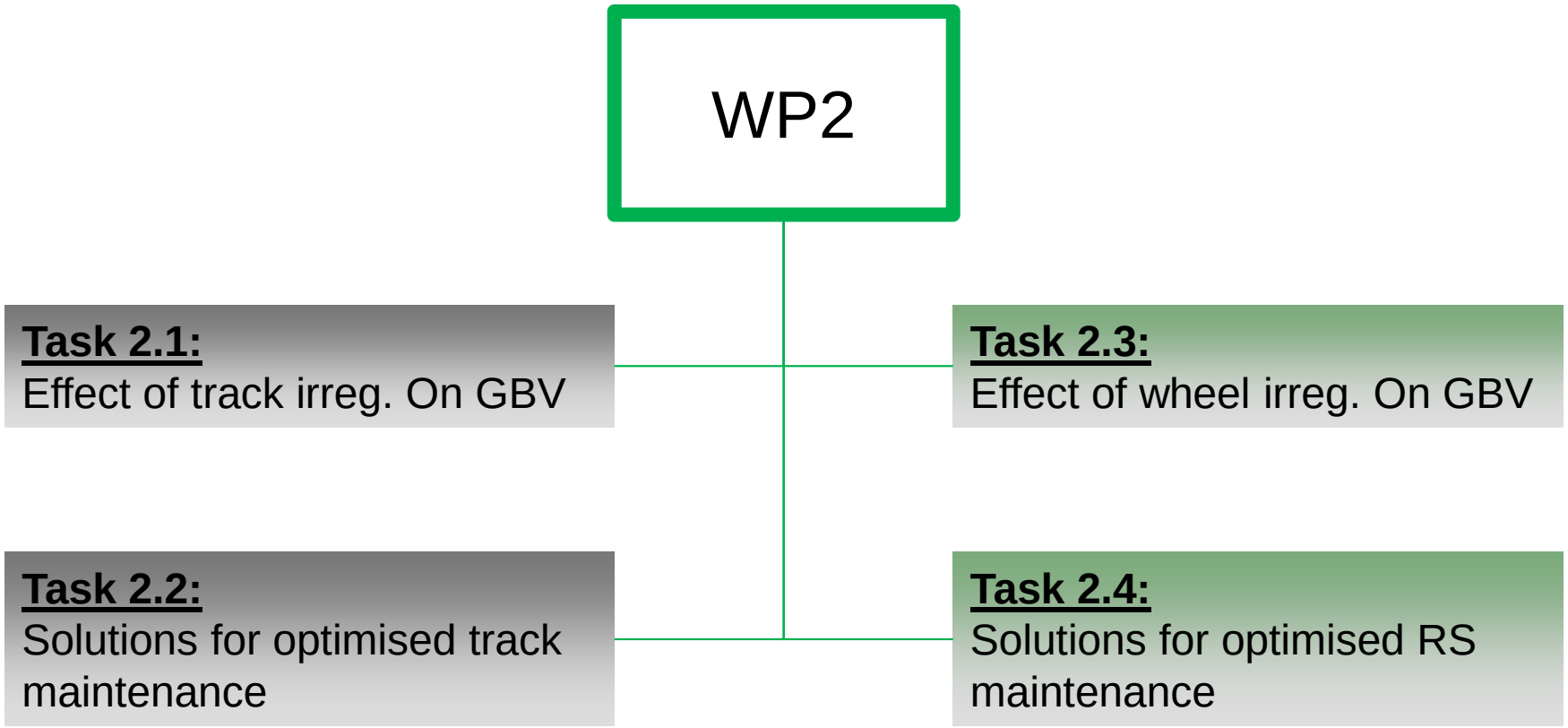
2. Optimise

Depending on results from 1:
- Identify related mitigation measures
- Life Cycle Cost Estimation

3. Demonstrate

The effect of a mitigation measures on vibration levels
- *Measurements Campaign*

Breakdown structure



Alstom, Chalmers, D2S, DB, SBB, SNCF, Trafikverket

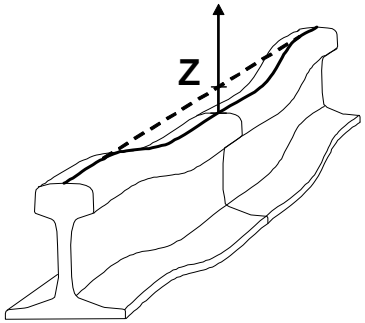
Influencing irregularities

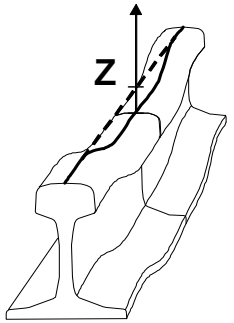
	40km/h	80km/h	160km/h	320km/h
Feelable vibrations — 4 Hz	2.8	5.6	11	21
8 Hz	1.4	2.8	5.6	10
16 Hz	0.69	1.4	2.8	5.2
31.5 Hz	0.35	0.70	1.4	2.6
63 Hz	0.18	0.35	0.71	1.3
Groundborne noise — 125 Hz	0.089	0.18	0.36	0.67
250 Hz	0.044	0.089	0.18	0.33

Relation between irregularity wavelength [m] and excitation frequency [Hz] at a given vehicle speed [km/h]

Unevenness

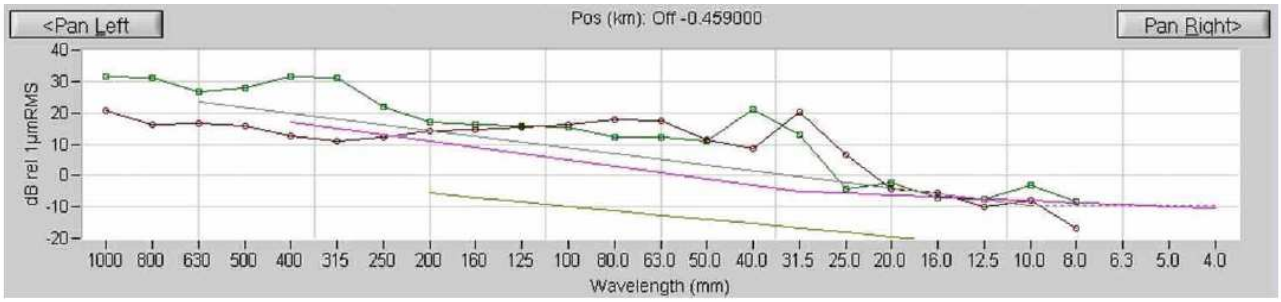
- Longitudinal Level
  - Standard deviation
  - Wavelength spectrum
  - Isolated defect
  - Wavelength >1m





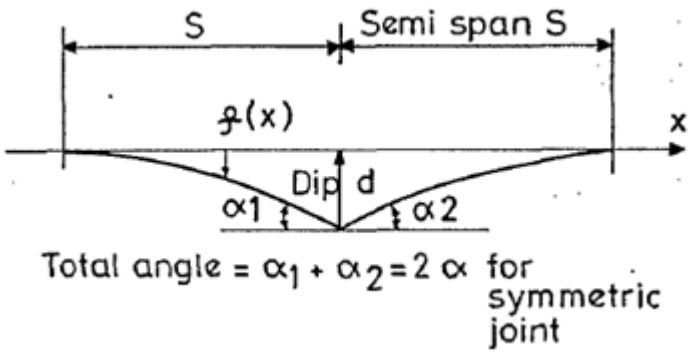
Track recording cars

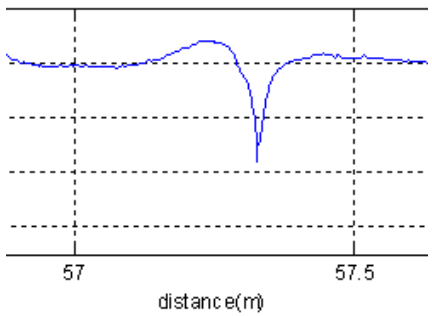
- Corrugation
  - Wavelength 25-1500mm

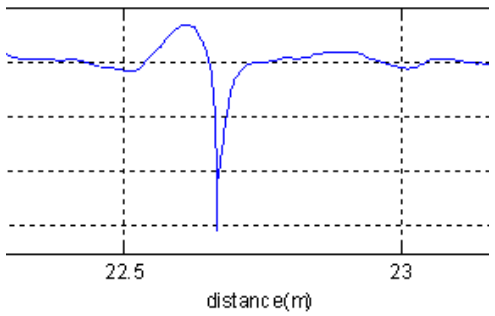


Unevenness

- Rail joints
- Dipped rail or welds

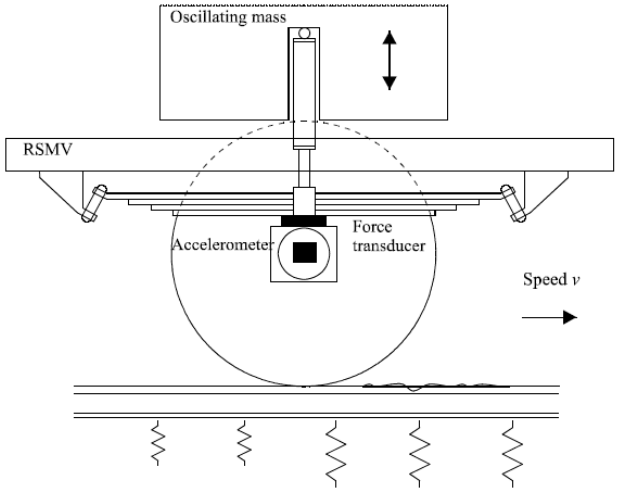






Irregularities in track stiffness

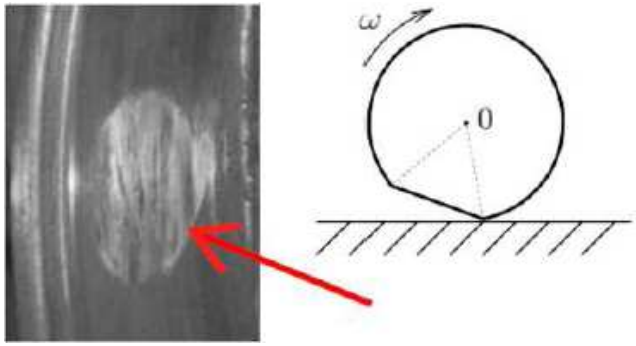
- Parametric excitation
- Track Stiffness
- Hanging sleeper



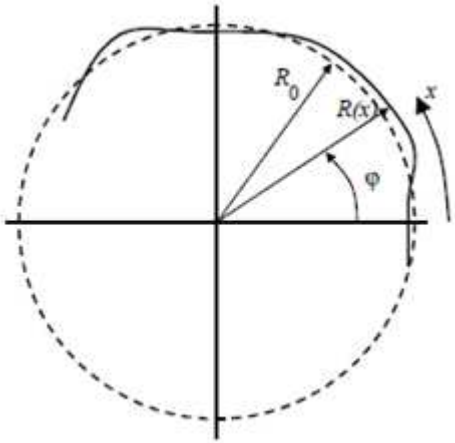
RSMV car

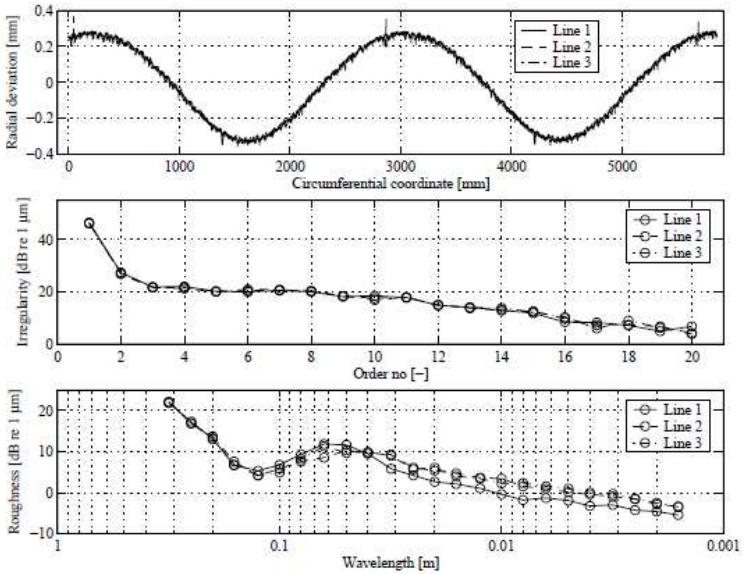
Wheel irregularities

- Flat



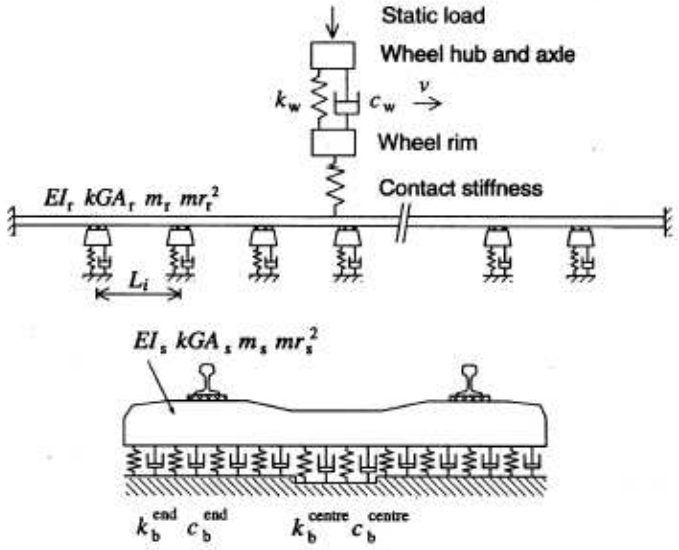
- Polygonal wheels





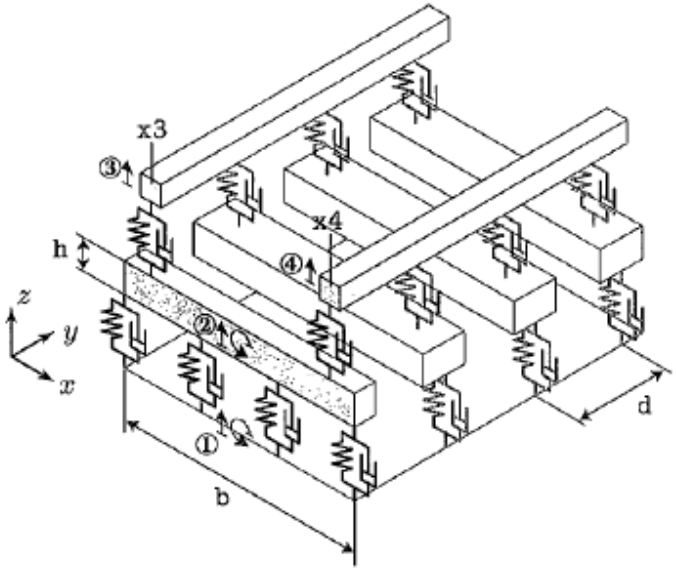
Modelling influence of irregularities

- DIFF
  - Time domain calculations
  - Vertical wheel/rail contact forces



  - Chalmers

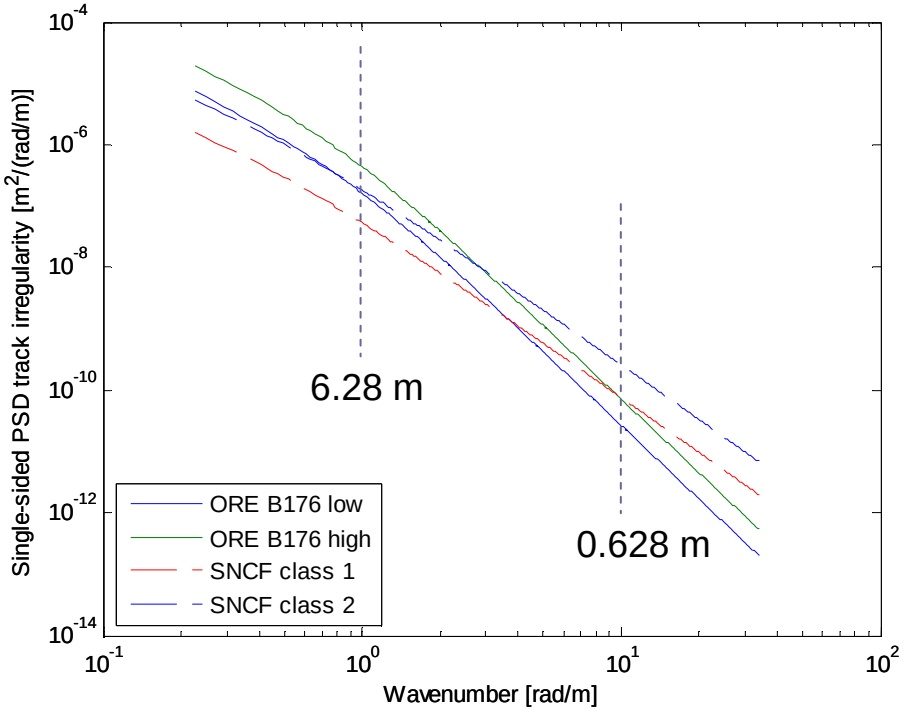
- TRAFFIC
  - Frequency-wavenumber domain
  - Prediction of groundborne vibrations

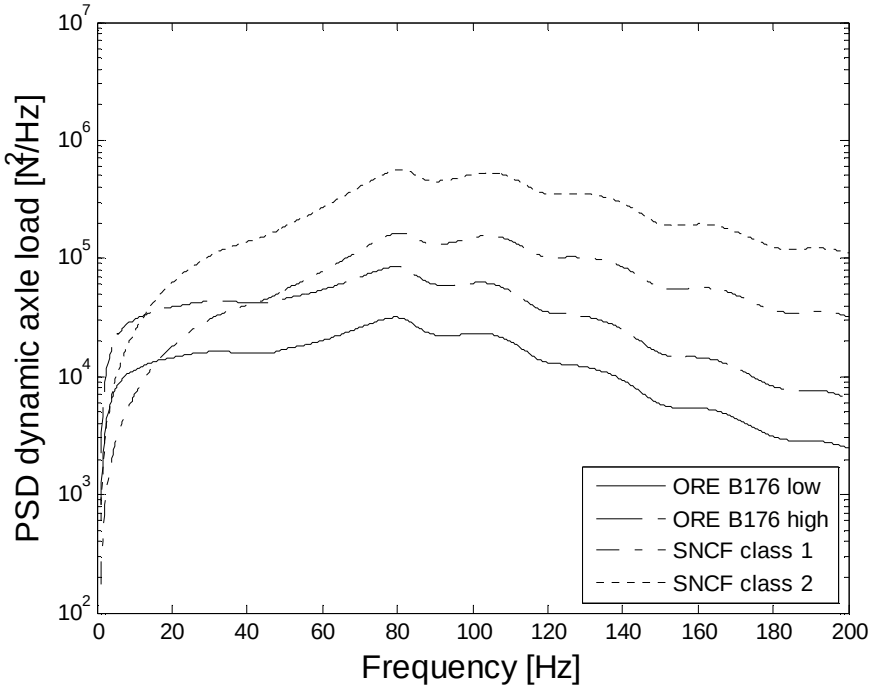


  - KUL

Track geometry

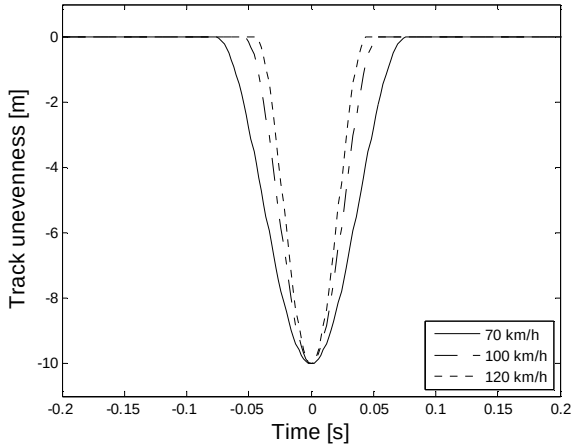
- The wavelength of track defects is very important
  - higher defects for wavelengths <2m generate more vibrations

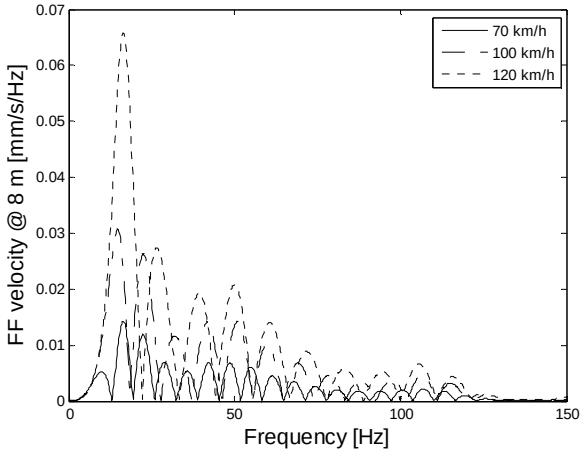


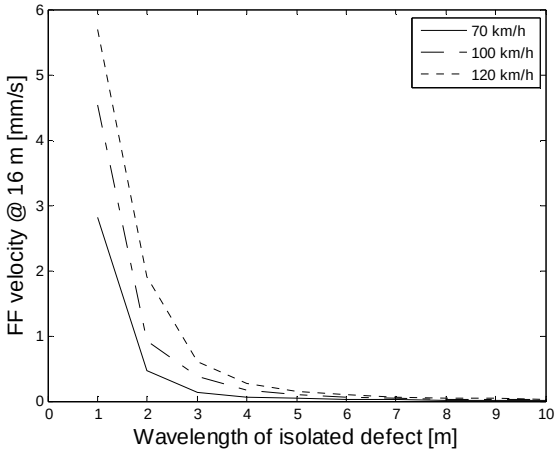


Track geometry: isolated defect

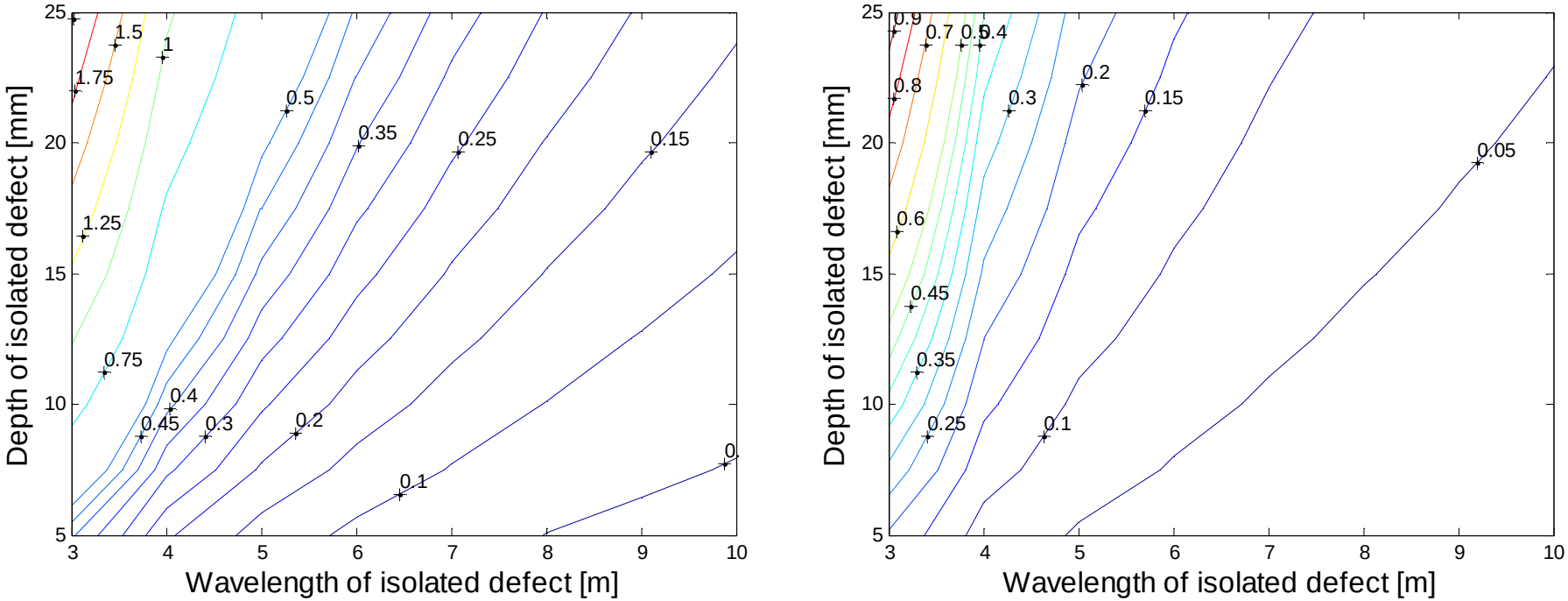
- One wavelength of a sinusoid
- High levels of free field vibration are generated by defects with short wavelengths





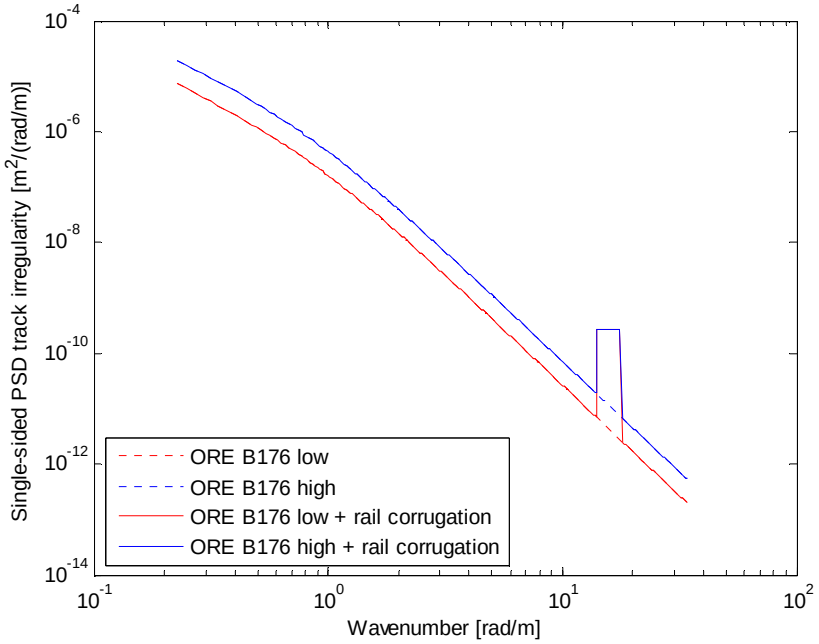


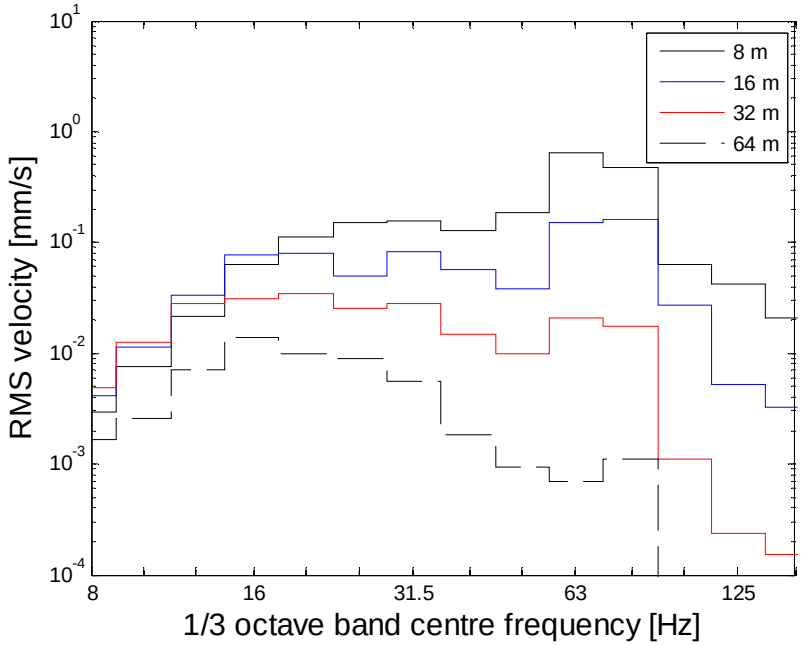
Track geometry: isolated defect



Influence of defect wavelength and depth on maximum free field velocity [mm/s] at (left) 8 m, (right) 16 m. Y25 bogie, train speed 100 km/h, Lincent

Corrugation

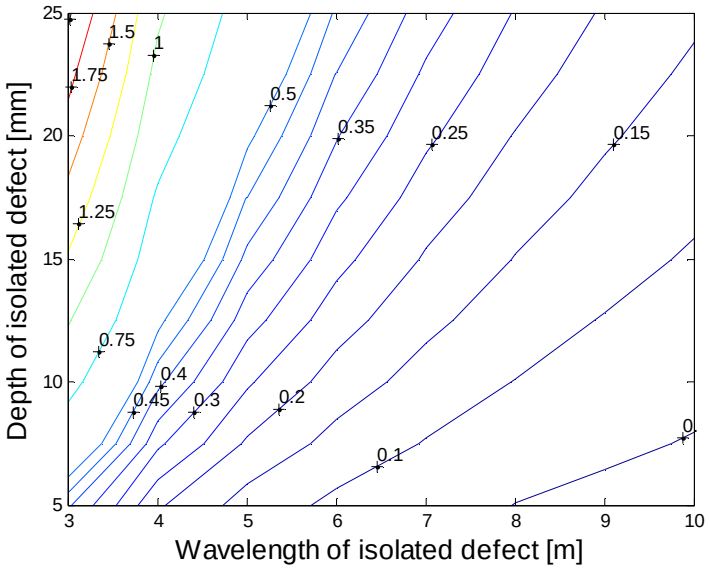


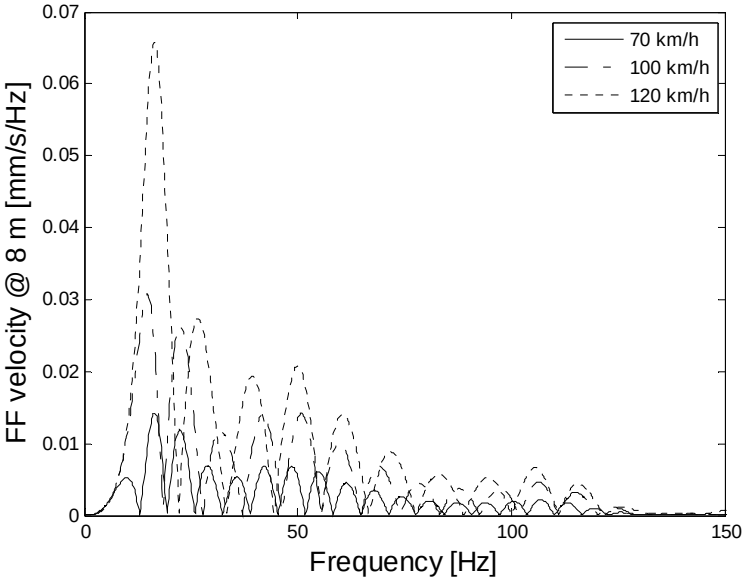


- Increased vibration level

Local defect

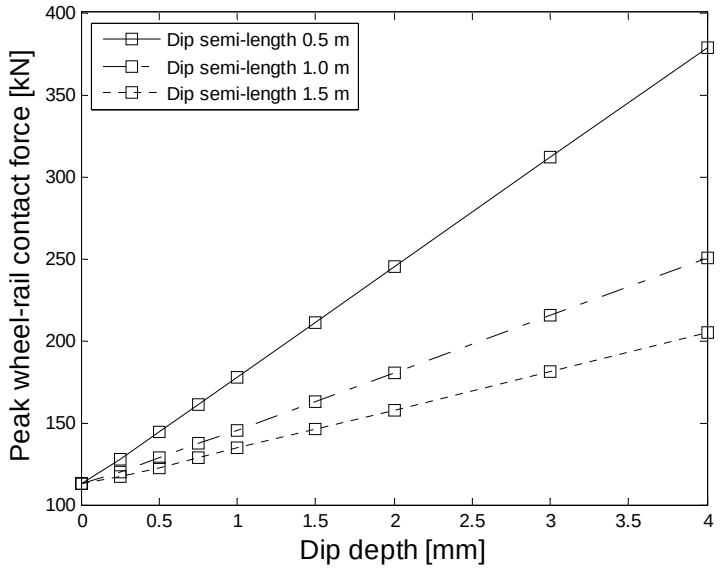
- Dipped rail or joint
  - Dominated by low frequencies
  - Increases with speed
  - Depth, build-up and gap width

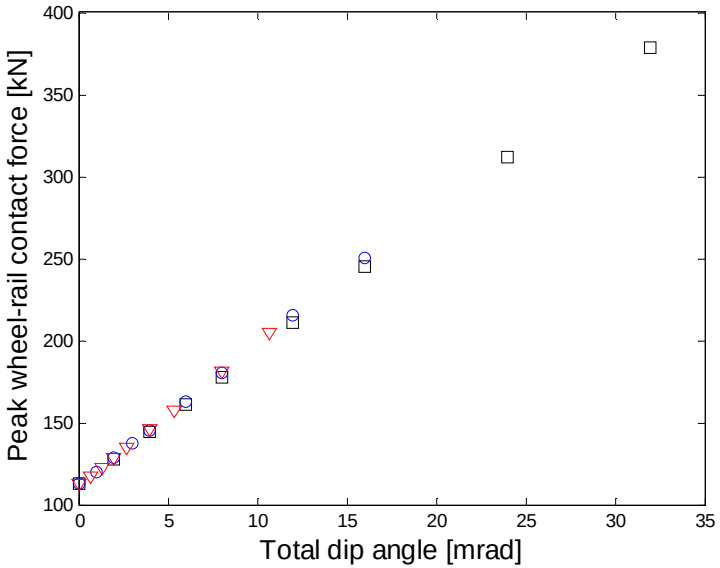




Local defect

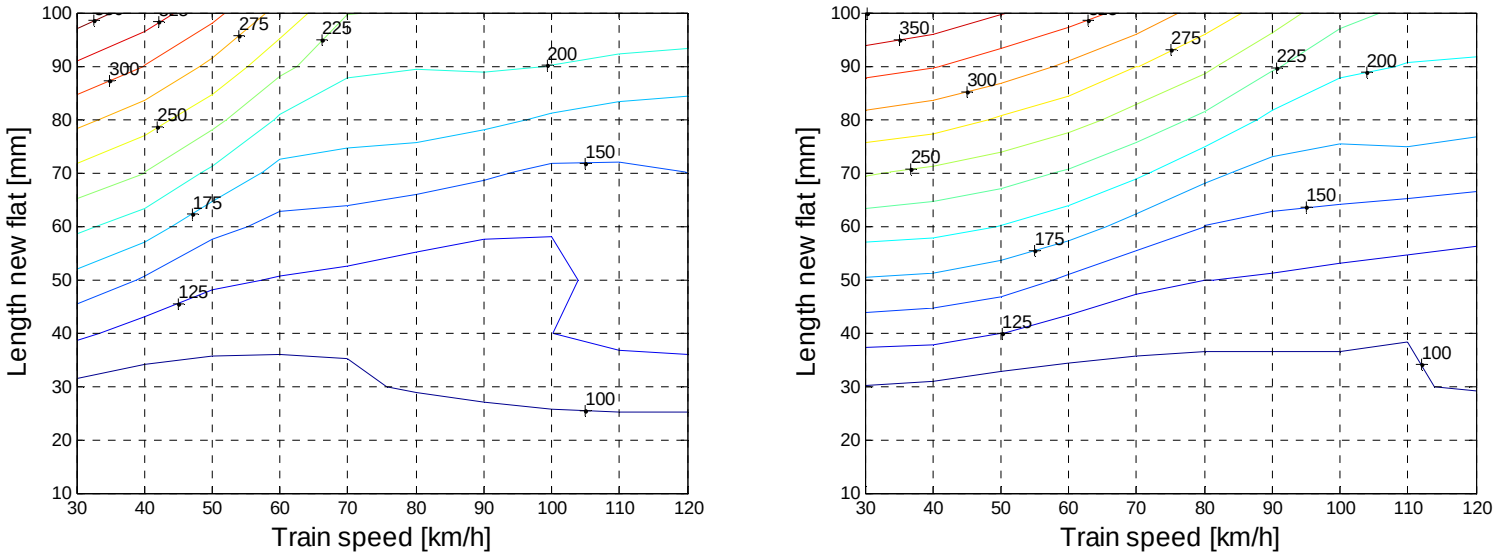
- Dipped rail or joint
  - Short defects with high depth introduce very high contact forces





Wheel flat

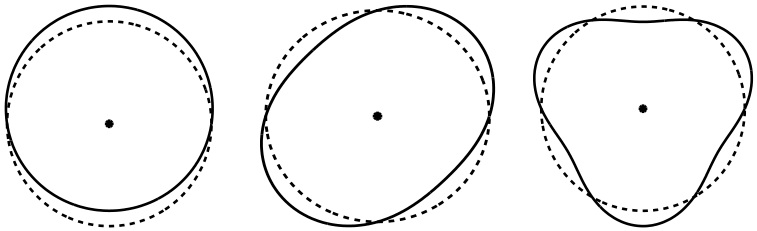
- long and deep wheel flats generate the most vibration
- influence of speed is not clear

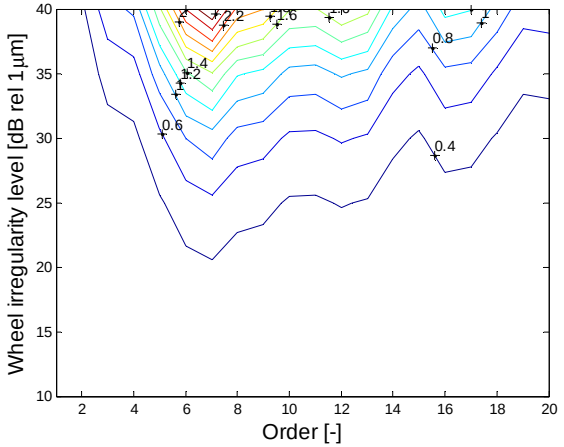


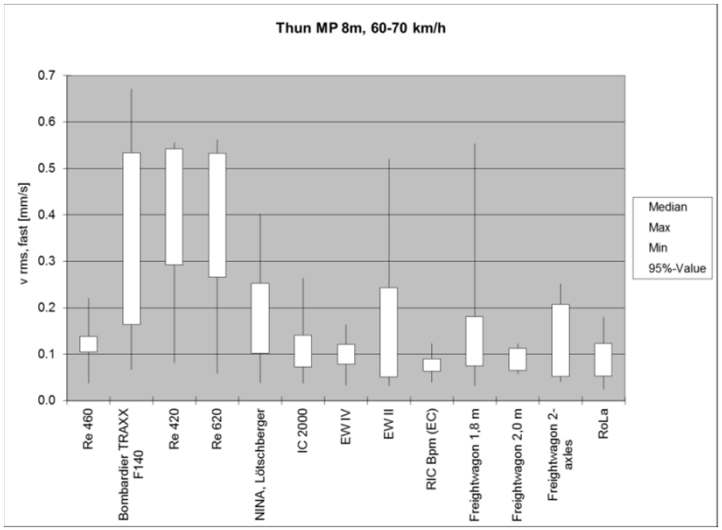
Influence of train speed and length of wheel flat on max *wheel–rail impact load* [kN] (a) new wheel flat with length l_0 and (b) rounded wheel flat with length $1.5l_0$

Polygonalisation

- Simulations show that common track irregularities induce more vibrations than OOR
- Field measurements show that wheel OOR can have a major effect on impact load and vibration emission

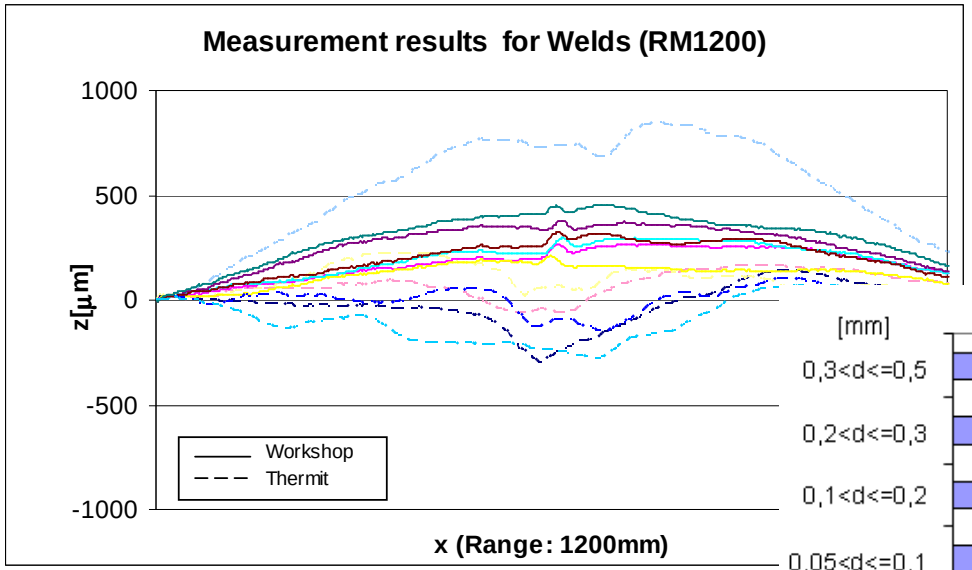


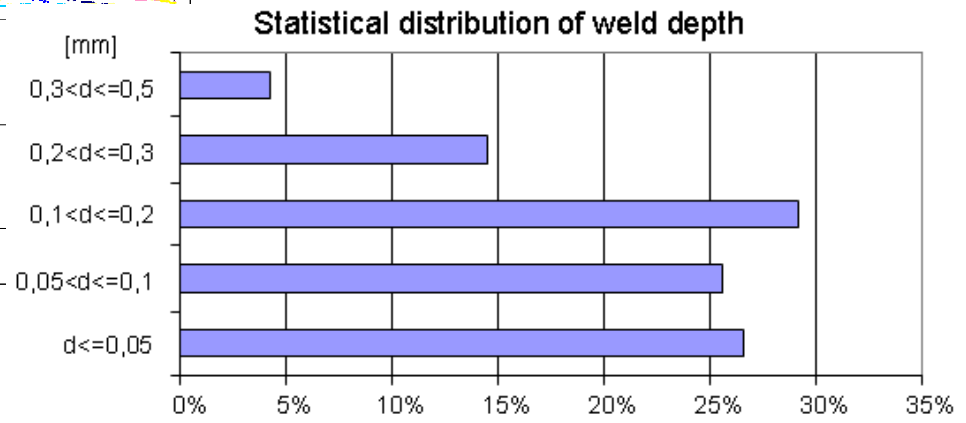




Towards optimised maintenance

- Existing data for defects is classified
- Insertion Gain from maintenance operation is evaluated





Maintenance operations

Irregularity	Possible mitigation measures
1. Misalignment (longitudinal level)	1. Tamping Enhanced track geometry irregularity detection Enhancement of existing regulations
2. Insulation joints	2. Design guidelines
3. Welds	3. Weld repairs Enhanced Welds defect detection
4. Crossings/Switches	4. WP3
5. Track Stiffness	5. Design guidelines Enhanced detection
6. Transition zones	6. Design guidelines?
7. Hung sleepers	7. Stabilisation Enhanced hung sleepers detection
8. Corrugation	8. Grinding
1. Wheel	1. Reprofiling

Towards optimised maintenance

- Guidelines for enhanced defects detection
  - Analysis of frequency content of track geometry
  - Roughness measurements for dips and welds analysis
  - Track stiffness evaluation
  - OOR detection
- Understanding of combined effect of wheel and rail defects

Thanks for your attention

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