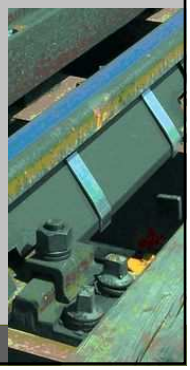
Why track related noise mitigation measures often have no effect



Manfred KALIVODA,
psiA-Consult GmbH, Wien
kalivoda@psia.at

General introduction

Manfred T. Kalivoda

- from 1994: self-employed consultant for acoustics & noise control
- from 2000: Technical Director & shareholder of psiA-Consult ltd.

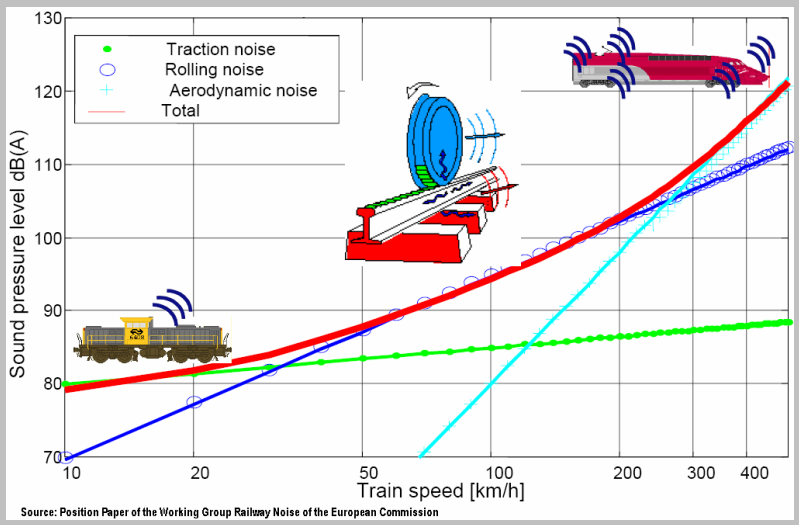
psiA-Consult Umweltforschung & Engineering GmbH

- Consulting in the field of acoustics, noise control & vibrations
- Partner of EU R&D-projects *STAIRRS, EURailNoise, Metarail, MEET, ARTEMIS*
- Focus on assessment of railway noise & development of mitigation measures
- From 2006: development of ***acramos***, an automatic railway noise and vibration monitoring system
- "Feminova" award in 2008 and "Vienna Future Award" in 2009 for ***acramos***

Content

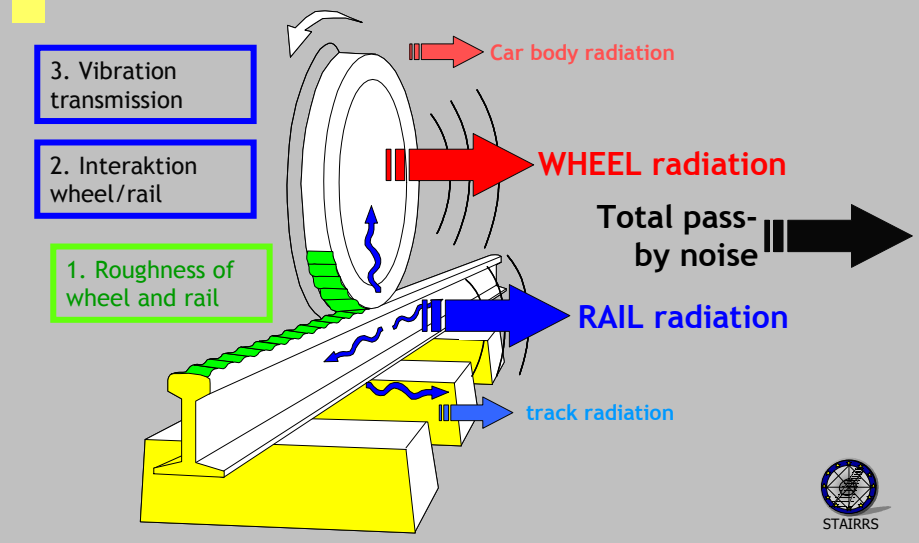
1. Understanding rolling noise generation
2. Noise from track and wheels
3. Some examples
4. Conclusions

Sound pressure level as a function of train speed

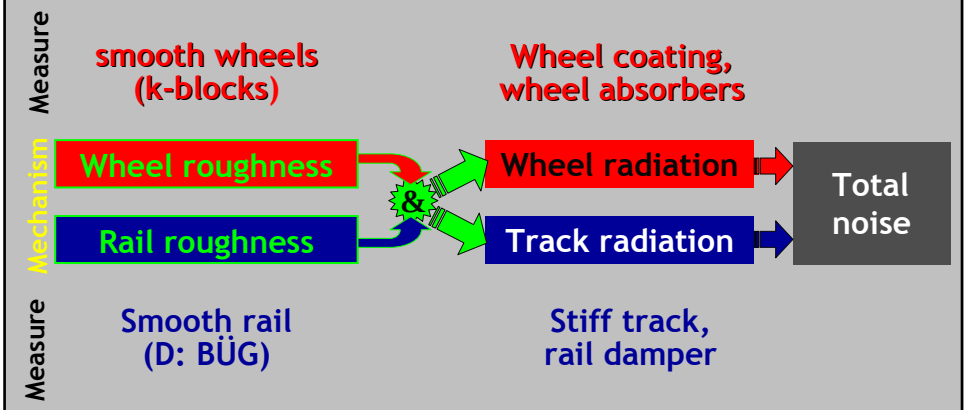


Source: Position Paper of the Working Group Railway Noise of the European Commission

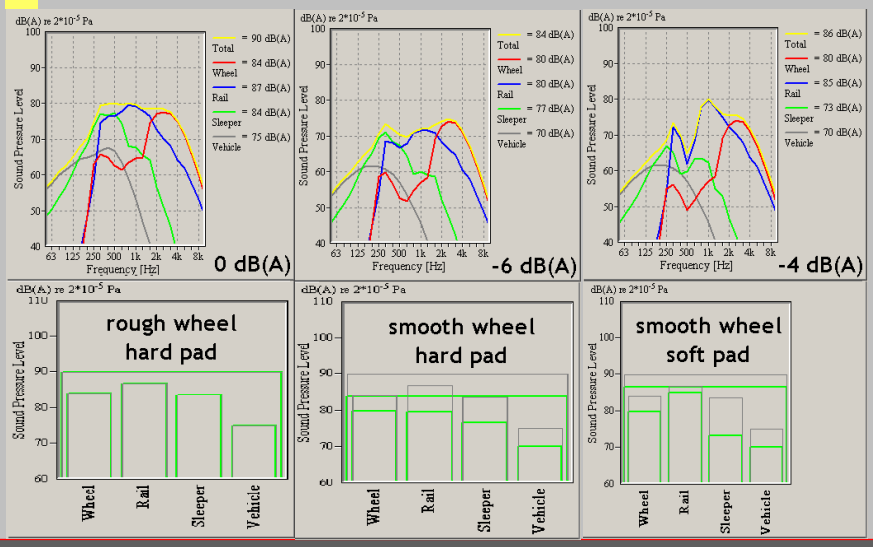
Principles of rolling noise generation



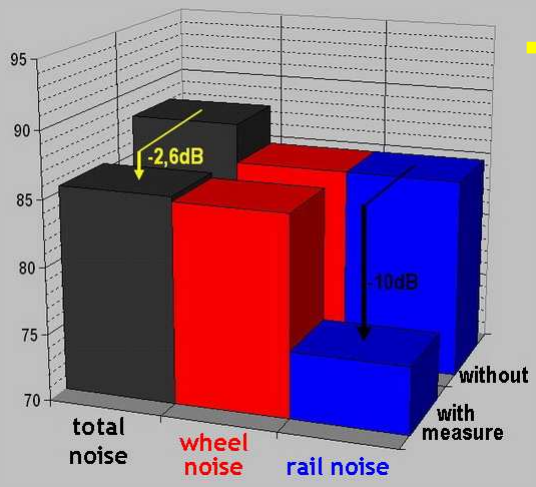
Rolling noise generation scheme



Noise separation tools

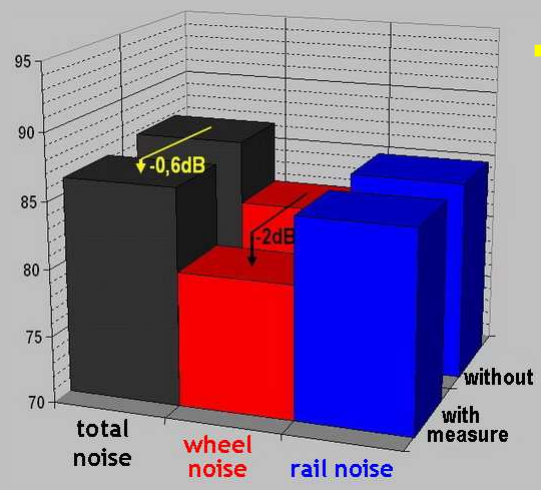


Contribution of wheel & rail noise (1)



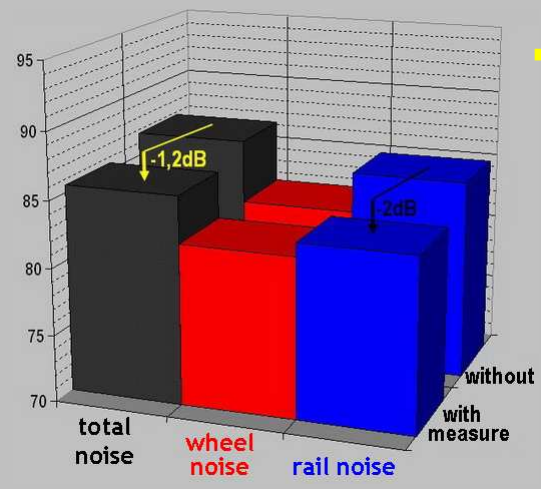
- If wheel and rail noise originally was about the same, a reduction of rail radiated noise by 10 dB will lower total rolling noise by 2,6 dB only

Contribution of wheel & rail noise (2)



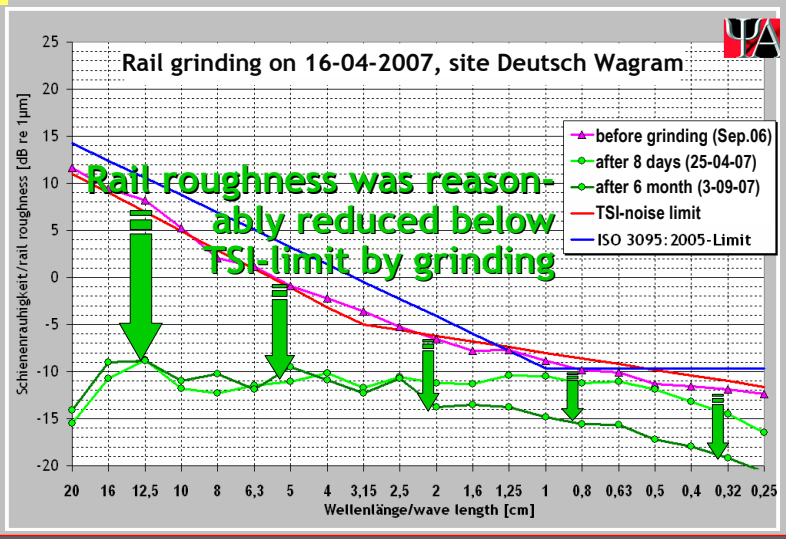
- If wheel noise originally has been lower than rail noise, a further reduction of wheel radiated noise by 2 dB will lower total rolling noise by 0,6 dB only

Contribution of wheel & rail noise (3)

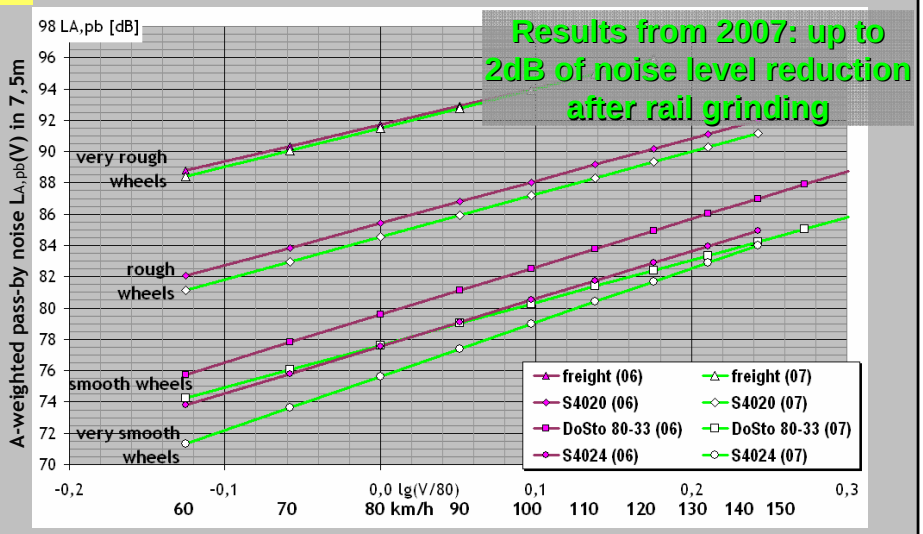


- If wheel noise originally has been lower than rail noise, a reduction of rail radiated noise by 2 dB only will lower total rolling noise by 1,2 dB

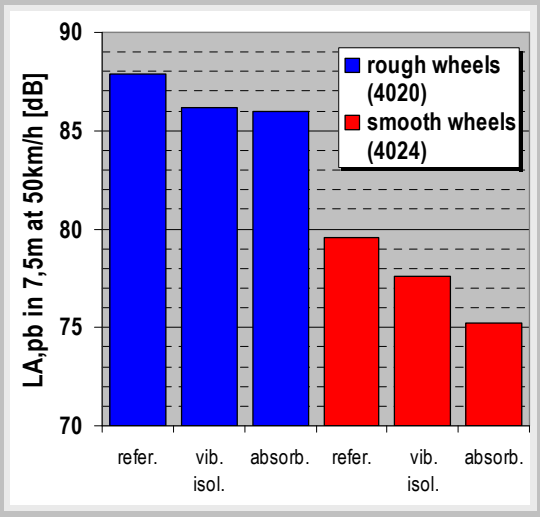
Influence of rail roughness on rolling noise generation



Influence of rail roughness on rolling noise generation



Effect of track measure depending on vehicle type

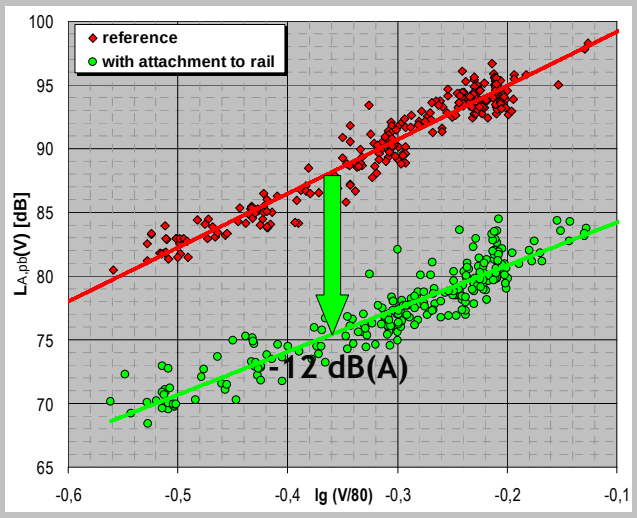


Pass-by noise
- on untreated track (refer.)
- vibration isolated sleeper
- track with rail absorber

for vehicles with
- big rough wheels (4020) and
- small smooth wheels (4024)

Rail absorber has no effect with class 4020 vehicles → wheel dominates

3 results on effects of rail damper in a narrow curve



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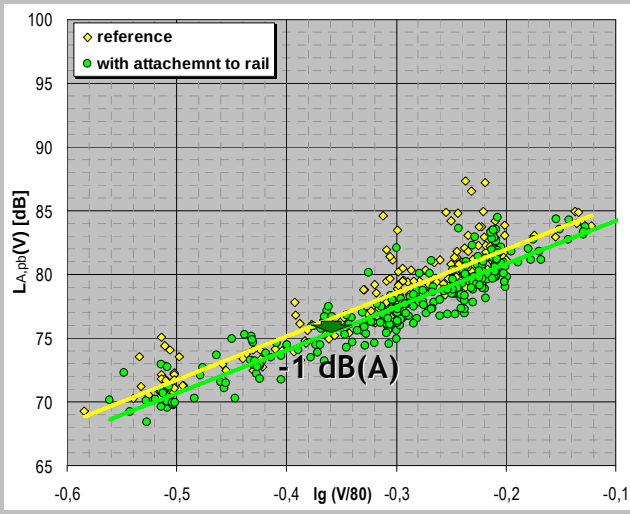

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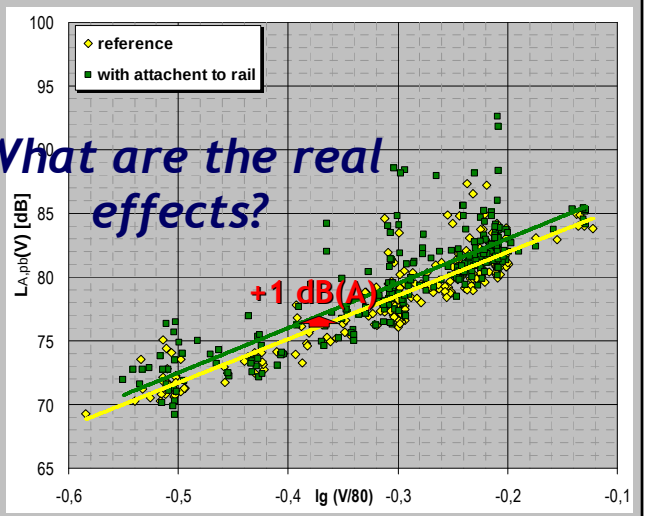
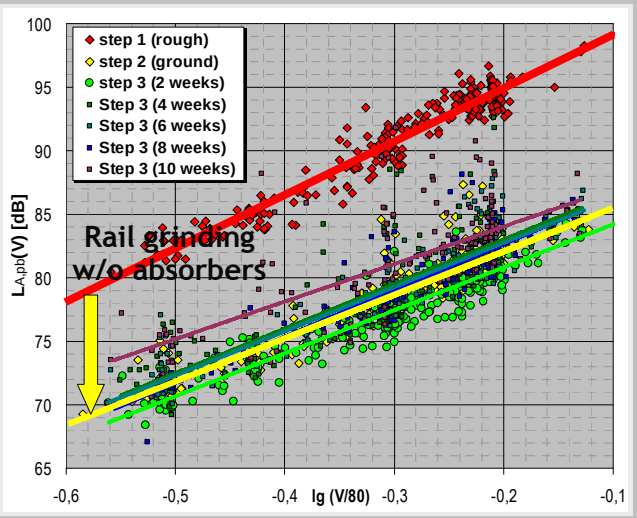


Vanishing effect of a rail damper in a narrow curve



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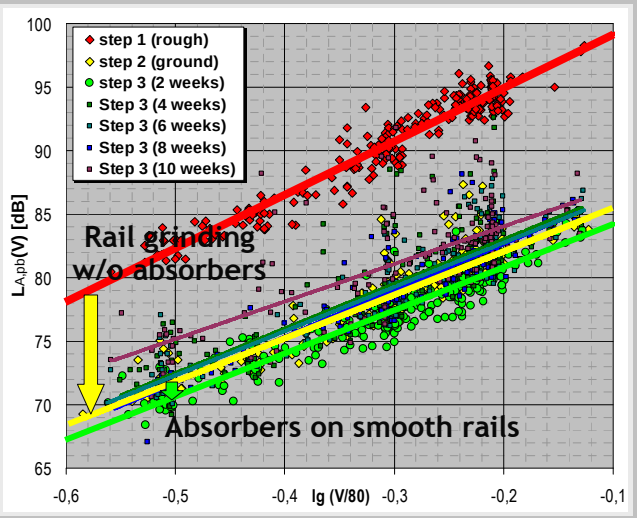

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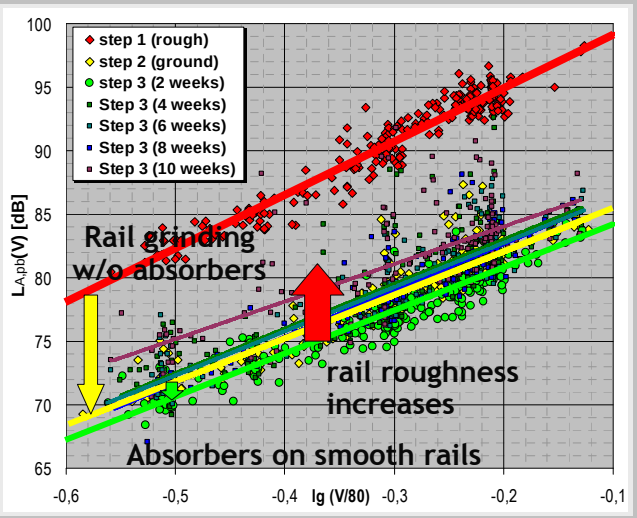

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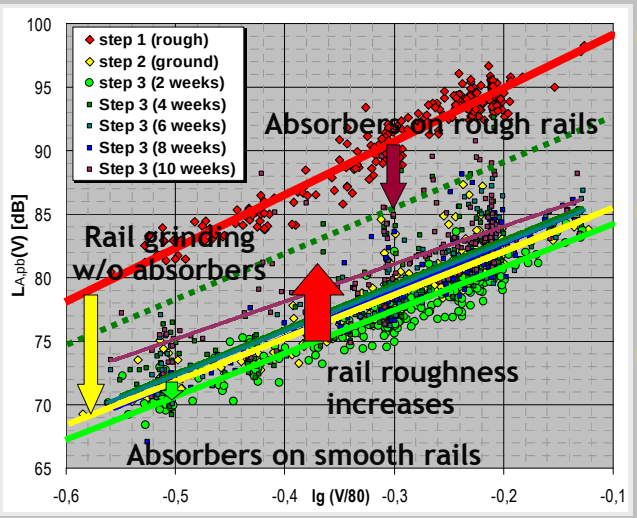


- Absorbers have a limited effect on rolling noise on the smooth rail: ~1dB(A)
- With rising rail roughness effect of absorber increases: ~5dB(A)
- However, keeping the rails smooth earns 10 – 12dB(A)

Basic methodologies for measurements

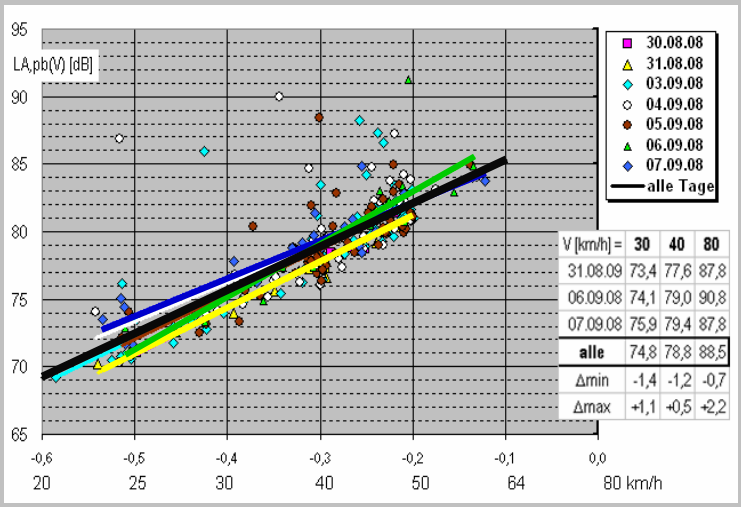
Controlled Pass-by

- same vehicles at all sites („golden test train“)
- defined operation condition (speed)
- few pass-bys necessary → measurement is cheap
- (high) cost for test train
- obstruction of daily operation

Statistical Pass-by

- different vehicles with high variation in noise generation
- operation conditions (speed) cannot be influenced
- many data sets necessary → measurement is expensive
- no cost for a test train
- no influence on daily operation

Sample size and reproducibility



V [km/h] =	30	40	80
31.08.09	73,4	77,6	87,8
06.09.08	74,1	79,0	90,8
07.09.08	75,9	79,4	87,8
alle	74,8	78,8	88,5
Δmin	-1,4	-1,2	-0,7
Δmax	+1,1	+0,5	+2,2

Getting data from railway noise monitoring

acramos: acoustic railway monitoring system
developed by psiA-Consult

acramos

- Automatic measurement and data processing
  - Automatic train categorisation
  - Pass-by level of whole train per train category
  - Pass-by level of single axle of each single train
  - Rail vibrations for indirect roughness detection
  - Ground borne vibration levels
  - Detection of “irregularities” in the train’s noise footprint
- since 2006 used by ÖBB Infrastructure at the Nordbahn north of Vienna
- 2 mobile system used for assessment studies since 2008

Application of monitoring

Conclusions

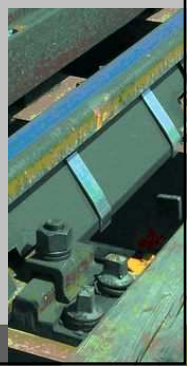
1. Rolling noise is generated by vehicle/wheel AND track/rail
2. Superposition of both noise components follows acoustics:
   - removing one of 2 equal sources will reduce level 3 dB only
3. There are 4 main factors determining rolling noise level:
   - wheel roughness – rail roughness
   - wheel radiation – rail radiation
4. Very smooth rails (specially maintained track) can reduce rolling noise from vehicles with smooth wheels, only
5. Rolling noise reduction of a track related mitigation measure (such as rail absorbers) will be different for train categories due to different wheel radiation

Conclusions

6. no standard for assessment of track components, yet
7. It's very important to use well prepared measurement concept for the assessment of track related noise mitigation measures
   - Check rail roughness before and after installation since roughness effects can be reasonably higher than the effects studied
   - Collect enough train pass-bys to get statistically significant data
8. Investment in a reliable assessment of products does pay
   - Little money will be saved by an inadequate assessment

   but
   - a large amount of money will be lost by investment in the wrong solution

Thank you for your attention



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