Statistical Properties of Road Traffic Noise Emission Measurements

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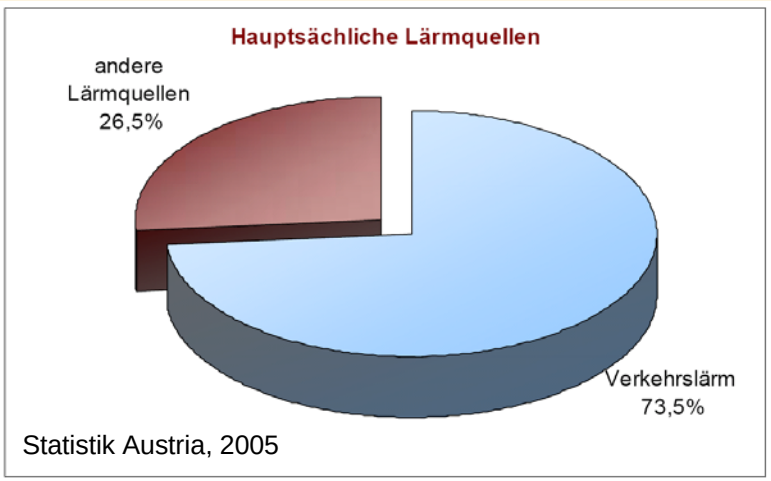
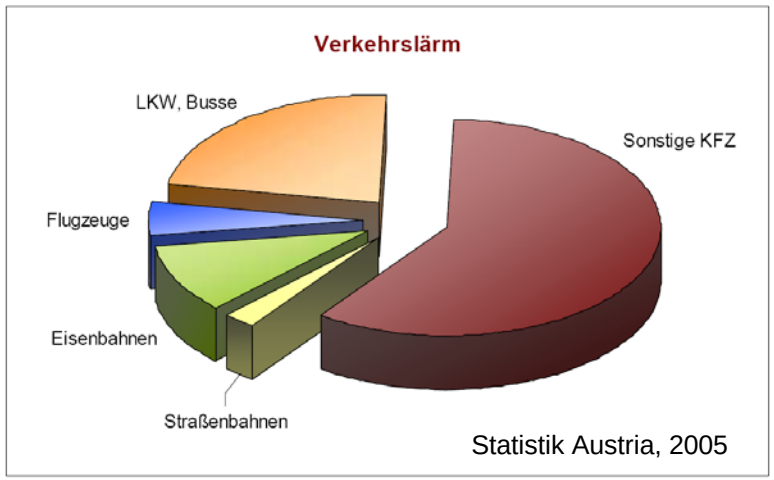
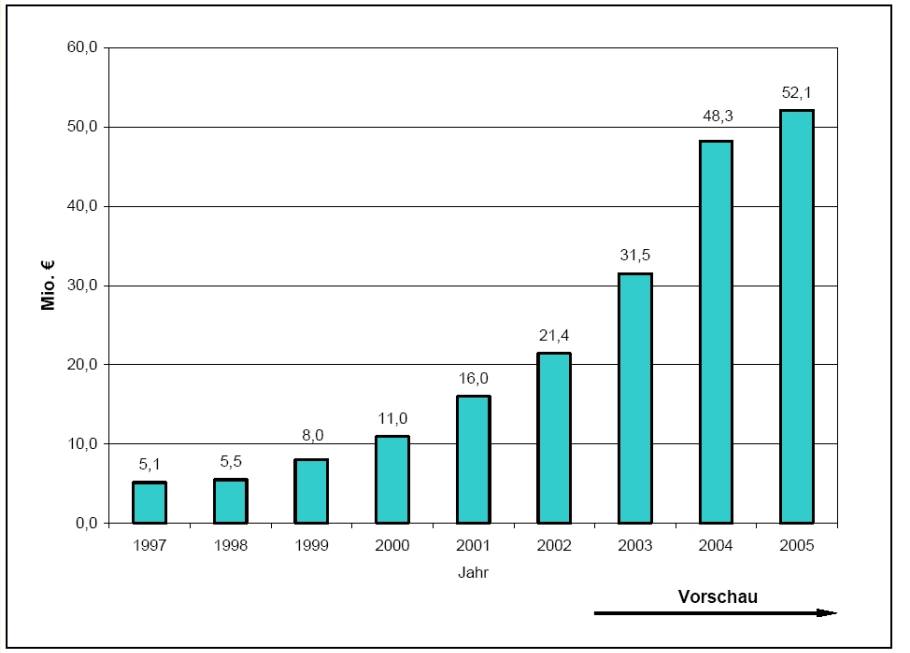
The Problem: Road Traffic Noise





- **Traffic noise is a big environmental problem within the EU**
- **28 % of the Austrian inhabitants are disturbed by noise**
- **73,5 % are disturbed by traffic noise**
- **80 % of the traffic noise is caused by road traffic noise!**

Costs for Road Traffic Noise



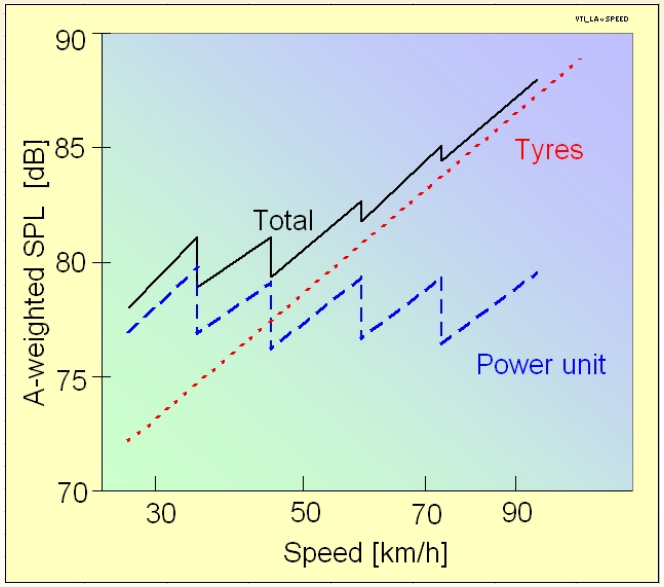
Quelle: ASFiNAG

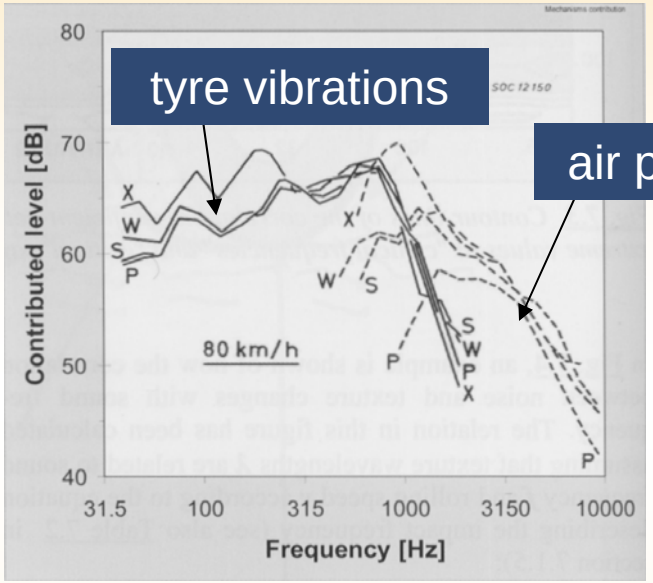
Abb. 2: Aufwendungen für Lärmschutz im bestehenden Autobahn- und Schnellstraßennetz. In der Vorschau auf die Jahre 2004 und 2005 sind jeweils 17,5 Mio. € für die Umweltentlastung der A10 berücksichtigt.

UBA Austria 2004

Costs for traffic road noise are increasing: only in Austria more than 52 Mio. Euro in 2005!

Generation of Road Traffic Noise



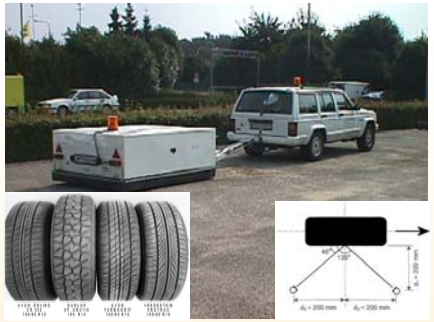


Sandberg/Ejsmont, Tyre/Road Noise Reference Book

- Major part of noise emitted by vehicles on roads in the mid- to high-speed range (v > 30 km/h) is due to tyre/road noise
- Tyre/road noise: the tyre tread pattern interacts with the texture of the road surface, which generates complex tyre **vibrations** as well as **aerodynamic effects and resonances** (are called **air pumping**)
- Tyre/road surface combination must be optimized → noise reductions.

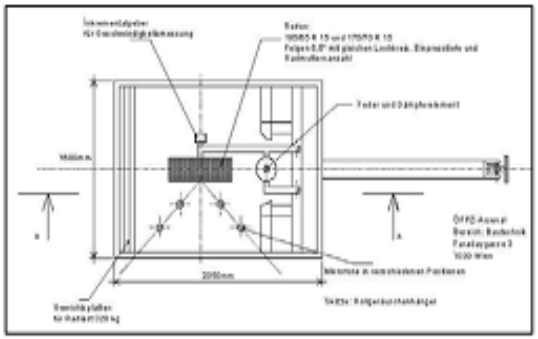
The Measurement Campaign

- Measurements have been carried out during the years 2002 to 2003 for the Austrian Ministry of Transport (BMVIT)
- 3 measurements methods: CPX, RVS and SPB
- 11 road sections with different pavements currently in use on the Austrian high-speed road network (real life sections):
  - exposed aggregate cement concrete (EACC),
  - stone mastic asphalt (SMA),
  - porous asphalt (PA),
  - asphalt concrete (AC),
  - thin asphalt layer (DDH).



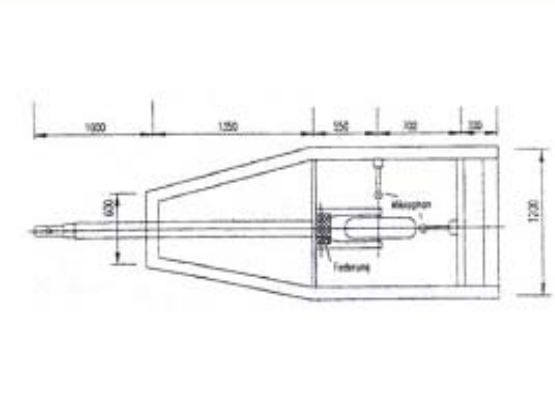
- Building year of the pavement: 1975 to 2001
- Chipping size: 8 mm to 18 mm

Measurement Methods of Road Traffic Noise: 1) CPX Method (ISO/CD 11819-2)



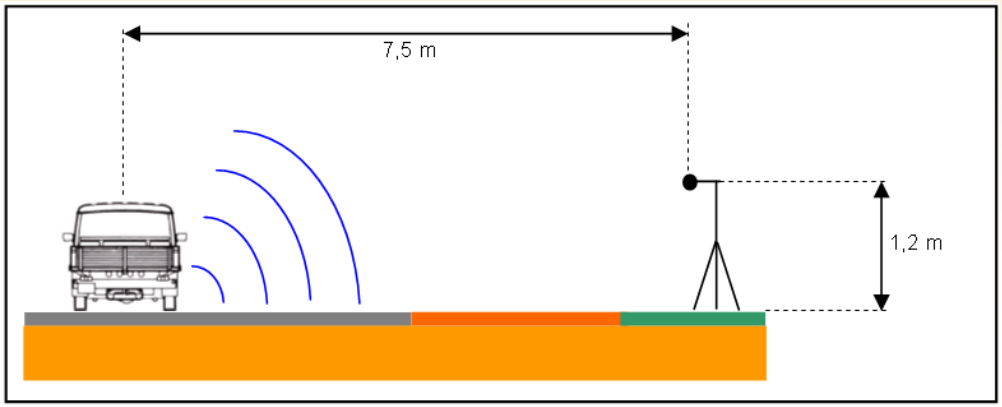
- The International method CPX (Close-Proximity-method) uses four test tyres (one emulates truck tyre characteristics)

2) Austrian Method: RVS 11066 IV



- The Austrian RVS method measures noise emission using a 4-groove PIARC test tyre with microphones mounted in the trailer (standardized before CPX and used for approval testing)

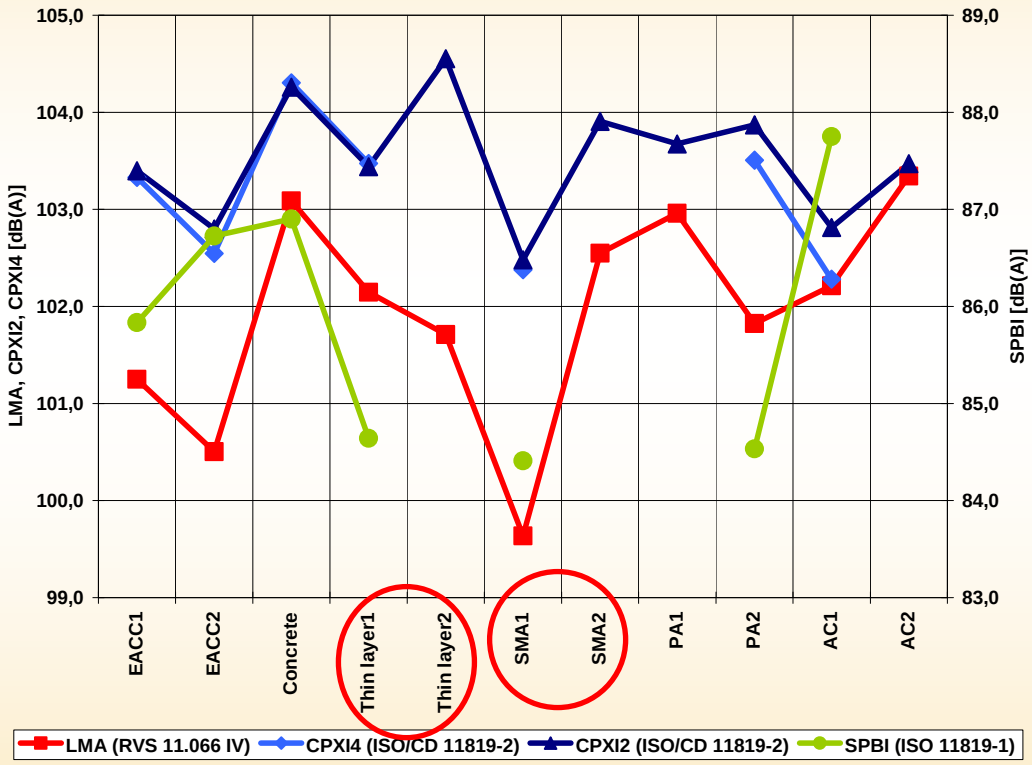
3) Statistical-Pass-By Method (ISO 11819-1)



- Based on the measurement with a microphone at the roadside (7,5 m from the measured vehicles and 1,2 m high)
- At least 180 vehicles (divided into three categories: passenger cars, heavy and light trucks)
- Reference speed: 110 km/h for cars, 85 km/h for trucks
- Variant of this method is used in Germany for classification of road surface noise emission

Results of the Measurement

Experimental results using RVS, CPX and SPB methods



Within the same pavement type, there can be substantial differences in noise emission!

Relationship between different pavement types using different methods:

- RVS: LMA index between 99.5 and 103.5 dB(A), the noisier pavements are AC2, Concrete, PA1 and SMA2, the quieter pavements are SMA1, EACC2 and EACC1
- CPX: CPXI index between 102 and 105 dB(A), noisier pavements are Thin layer1, concrete and SMA2, quieter are SMA1, EACC2 and AC1
- SPB: SPBI index between 84 and 88 dB(A), the noisier pavements are Concrete and AC1, the quieter are SMA1, PA2 and Thin layer1

Correlation between Measurement Methods (1)

	RVS	CPXI4	CPXI2	L_E	L_B	L_C	L_D	SPBI	L_{PKW}	L_{LKW1}	L_{LKW2}
RVS	1,00	0,97	0,95	0,91	0,89	0,98	0,16	-0,02	0,00	0,02	-0,05
CPXI4	0,97	1,00	0,97	0,87	0,93	0,94	0,30	-0,01	0,07	0,03	-0,09
CPXI2	0,95	0,97	1,00	0,93	0,85	0,96	0,19	-0,03	0,17	-0,03	-0,19
L_E	0,91	0,87	0,93	1,00	0,74	0,96	-0,17	-0,14	0,08	-0,21	-0,28
L_B	0,89	0,93	0,85	0,74	1,00	0,81	0,30	-0,16	-0,18	-0,11	-0,12
L_C	0,98	0,94	0,96	0,96	0,81	1,00	0,02	0,03	0,12	0,01	-0,07
L_D	0,16	0,30	0,19	-0,17	0,30	0,02	1,00	0,31	0,26	0,55	0,28
SPBI	-0,02	-0,01	-0,03	-0,14	-0,16	0,03	0,31	1,00	0,78	0,94	0,90
L_{PKW}	0,00	0,07	0,17	0,08	-0,18	0,12	0,26	0,78	1,00	0,67	0,43
L_{LKW1}	0,02	0,03	-0,03	-0,21	-0,11	0,01	0,55	0,94	0,67	1,00	0,90
L_{LKW2}	-0,05	-0,09	-0,19	-0,28	-0,12	-0,07	0,28	0,90	0,43	0,90	1,00

- Correlation between the different indices of the methods has been carried out in order to correlate each tyres of the CPX-method with the RVS- method and with all indices of the SPB methods.
- Correlation of the overall indices has been carried out → see next page...

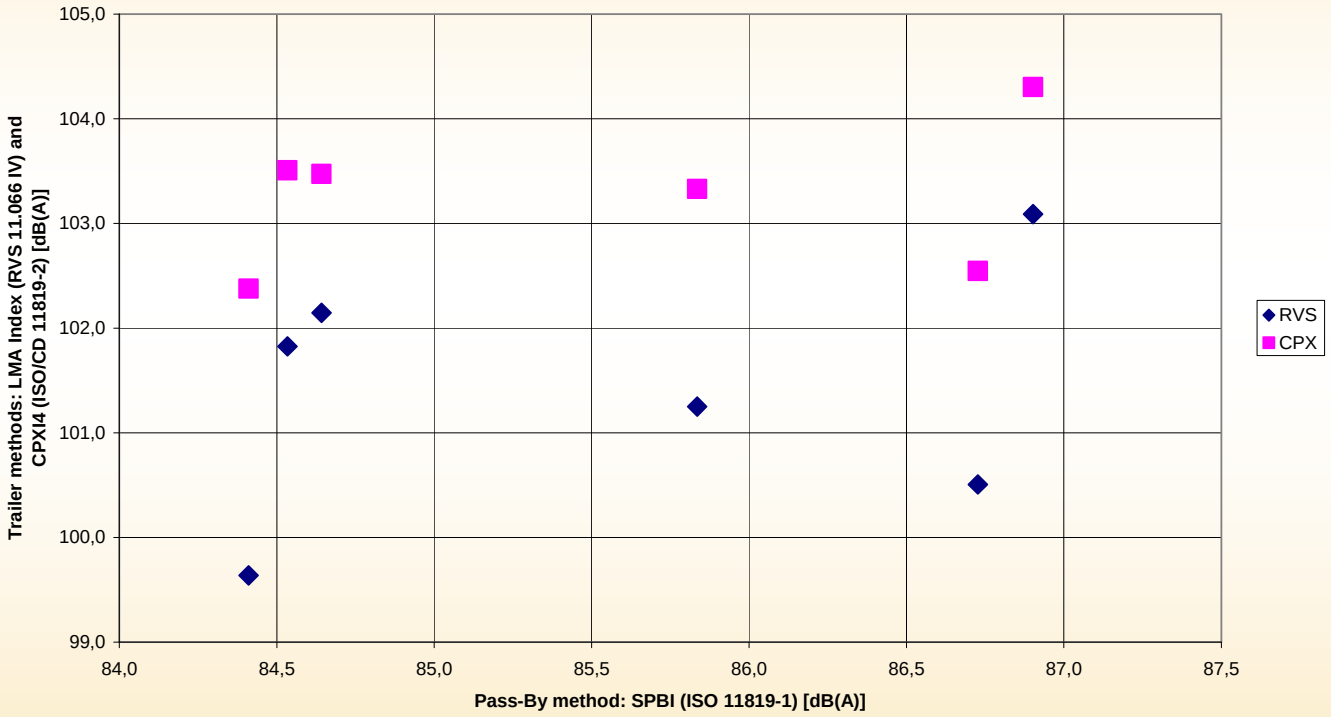
Correlation between Measurement Methods (2)

	RVS	CPXI4	CPXI2	SPBI
RVS	1,00	0,97	0,95	-0,02
CPXI4	0,97	1,00	0,97	-0,01
CPXI2	0,95	0,97	1,00	-0,03
SPBI	-0,02	-0,01	-0,03	1,00

- Correlation between the two trailer methods (RVS and CPX) is very high (0.95 for the overall index and about 0.90 for the detailed indices).
- Correlation between RVS and the tyres A, B and C of the CPX method is very good, only with the tyre D (for truck tyre emulation) the RVS method cannot show a correlation (only 0.16).
- RVS yields larger differences in sound pressure level for different road surfaces than found with CPX → tread pattern reduces the effects of road surfaces.
- The differences between using the investigatory (4 tyres) and survey (2 tyres) CPX method are very small.

Correlation between Measurement Methods (3)

Correlation between trailer methods (CPX and RVS) and Pass-By method



Considering all types of pavements there is no correlation between SPB and trailer methods (RVS, CPX) (correlation coefficient less than 0.30)

Summary and Conclusions (1)

- Methods based on near-field measurements in trailers (CPX, RVS) show good agreement.
- Correlation with SPB was very low considering all surface types.
- Correlation could be better within one surface category (e.g. SMA, EACC,...).
- Truck-emulating capability of tyre D of the CPX method has been confirmed (comparison with SPB measurements of light trucks).
- For heavy trucks this correlation was very low → CPX method cannot represent heavy trucks.

Summary and Conclusions (2)

- The differences between the investigatory (4 tyres) and survey (2 tyres) CPX method were small → for cheaper and easier measurements the survey method is enough (new tyres SRTT, Avon).
- **RVS** represents **only** the traffic of passenger cars.
- **CPX** represents also the **light truck** traffic.
- **SPB** is the only method that currently accounts for passenger cars, light trucks and heavy trucks.
- Even within pavement subtypes there can be substantial differences in noise emission → **more investigation are needed.**

Thank you very much for your attention!